COSMO-SkyMed Seconda Generazione: System and Products Description

INDEX

1. SCOPE

Scope of the Document is to provide a COSMO-SkyMed Seconda Generazione overview, describing the overall mission and its performances, pointing out the main differences and improvements with respect to the COSMO-SkyMed First Generation and describing the Products that are generated from it.

2. ACRONYMS

ACRONYM	
AR	Acquisition Requests
ASI	Agenzia Spaziale Italiana
AIV	Assembly, Integration and Verification (Assemblaggio, Integrazione e Verifica)
ANS	Agenzia Nazionale per la Sicurezza
AVS	Avionic Subsystem
CAL	CALibrazione
CDM	Client Deposit Manager
CGS	Core Ground Segment
CPCM	Mission Planning Center
CSG	COSMO-SkyMed di Seconda Generazione
CSK	COSMO-SkyMed (1ªGenerazione)
DEE	Digital Electronics Equipment
DEM	Digital Elevation Model
DI2S	Discrete Stepped Strip
EO	Earth Observation
EPS	Electrical Power Subsystem
FM	Flight Model
GCP	Ground Control Point
GEM	Geocoded Elevation Matrix
GFN	Global Futures Network
GIM	Geocoded Incidence Mask
GPS	Global Positioning System
G/S	Ground Station
HP	High Priority
IEM	Interoperability, Expandibility, Multimission/Multisensor
IRF	Impulse Response Function
LMP	Last Minute Planning
MoD	Italian Ministry of Defence

ACRONYM	
MS	Multi-Swath (modality)
NRT	Near Real Time
OBC	On-Board Computer
OR	Optimized Resolution
OS	Optimized Swath
PDHT	Payload and Data Handling Transmission S/S
PLM	PayLoad Module
PP	Privileged Priority
PPM	ProPulsion Module
PRF	Pulse Repetition Frequency
PRI	Pulse Repetition Interval
PRP	Propulsion Subsystem
QLK	Quick Look Product
RF	Radio Frequency
RFE	the Radio Frequency Equipment
RTN	Routine
SAR	Synthetic Aperture Radar
SAS	SAR Antenna Subsystem
SES	SAR Electronic Subsystem
SSE	Service Support Element
SVM	SerVice Module
SRT	Structure S/S
SSO	Sun Synchronous Orbit
S/S	Subsystem
TCS	Thermal Control S/S
TPS	Telecommand Protection System
TT&C	Telemetry, Tracking & Control Subsystem
UGS	User Ground Segment
UM	User Manage
UTM	Universo Traverso Mercatore
VU	Very Urgent

3. COSMO-SKYMED MISSION OVERVIEW

COSMO-SkyMed (COnstellation of small Satellites for Mediterranean basin Observation) Mission is the largest Italian investment in Space Systems for Earth Observation, commissioned and funded by the Italian Space Agency (ASI) and the Italian Ministry of Defence (MoD). COSMO-SkyMed is "natively" conceived as a Dual-Use (Civilian and Defence) end-to-end Earth Observation System. It aims to establish a global service supplying provision of data, products and services compliant with well-established international standards to the Scientific Community, especially working in the Earth Science field, as well as to the Technical Community of developers of value added products and services, particularly in the fields of risk management, environmental monitoring, natural resources management and defence / intelligence.

COSMO-SkyMed mission will then offer an efficient response to actual needs of Earth Observation Market providing an asset characterized by full global coverage, all weather, day/night acquisition capability, higher resolution, higher accuracy (geo-location, radiometry, etc.), superior image quality, fast revisit/response time, interferometric/polarimetric capabilities and quicker-and-easier ordering and delivery of data, products and services.

COSMO-SkyMed First Generation consists of a constellation of four Low Earth Orbit mid-sized satellites, each equipped with a multi-mode high-resolution Synthetic Aperture Radar (SAR) operating at X-band and fitted with particularly flexible and innovative data acquisition and transmission equipment. The system is completed by dedicated full-featured Ground infrastructures for managing the constellation and granting ad-hoc services for collection, archiving and distribution of acquired remote sensing data. First generation deployment started in 2007 and the system is fully operative since 2010.

COSMO-SkyMed Seconda Generazione is based on 2 enhanced SAR Satellites, placed on the same orbit of the First Generation, and on an improved Ground Segment.

As already done for the First Generation, also for the Seconda Generazione particular emphasis has been put on Dual-Use Mission Planning functionality in order to optimize system utilization and fulfilling at the same time different user classes needs.

Additionally, COSMO-SkyMed Mission allow the access at different Earth Observation Systems from Civilian Partners (Institutional, Scientific and Commercial) and Defence Partners though an integrated User Ground Segment. To this purpose, the system has been conceived in order to pursue a multi-mission approach thanks to its intrinsic Inter-operability with other EO missions and Expandability towards other possible partners, also with different sensors typologies, to implement an integrated space-based system providing Earth Observation integrated services to large User Communities and Partner Countries (IEM capability). These features designate COSMO-SkyMed as a system capable to provide "Institutional Awareness" information in support to decisions in preventing and managing world-wide crisis.

3.1. Mission

In the frame of COSMO-SkyMed infrastructure, COSMO-SkyMed Seconda Generazione aims to provide service continuity to the first generation constellation, while improving performances, functionalities and system services for the Earth Observation users' community.

The mission objectives of COSMO-SkyMed Seconda Generazione are related to a space mission having a dual nature (i.e. capable to satisfy civilian and defence customers) able to provide information and services in several applicative field, such as risk management applications, cartography and planning applications, agriculture, forest, hydrology, geology, marine domain, archaeology etc.

The high level requirements lead to the development of a system with the following main capabilities:

- Large amount of daily acquired images;
- Satellites worldwide accessibility;

- All weather and Day/Night acquisition capabilities;
- Very fast interval between the finalization of the user request for the acquisition of a certain geographic area and the release of the remote sensing product (System Response Time);
- Very fine image quality (e.g. spatial and radiometric resolution);
- Flexible image spatial resolution vs. size acquisition, starting from sub-meter resolution;
- Capability to be cooperating, interoperable, expandable towards other EO missions, acting as multi-mission system able to provide EO integrated services to large User Communities on a worldwide scale.

3.2. Infrastructure

COSMO-SkyMed is the main component of the Italian infrastructure for Earth Observation (EO), which is a System of Systems, expandable, which can incorporate or interface with any kind of EO Mission. It provides services both to Civilian and Defense Users (dual-use).

The first generation constellation − 4 Satellites carrying an X-band Synthetic Aperture Radar (SAR) − has been fully operative since 2010. The evolution of the Second Generation is based on 2 enhanced SAR Satellites and an improved Ground Segment.

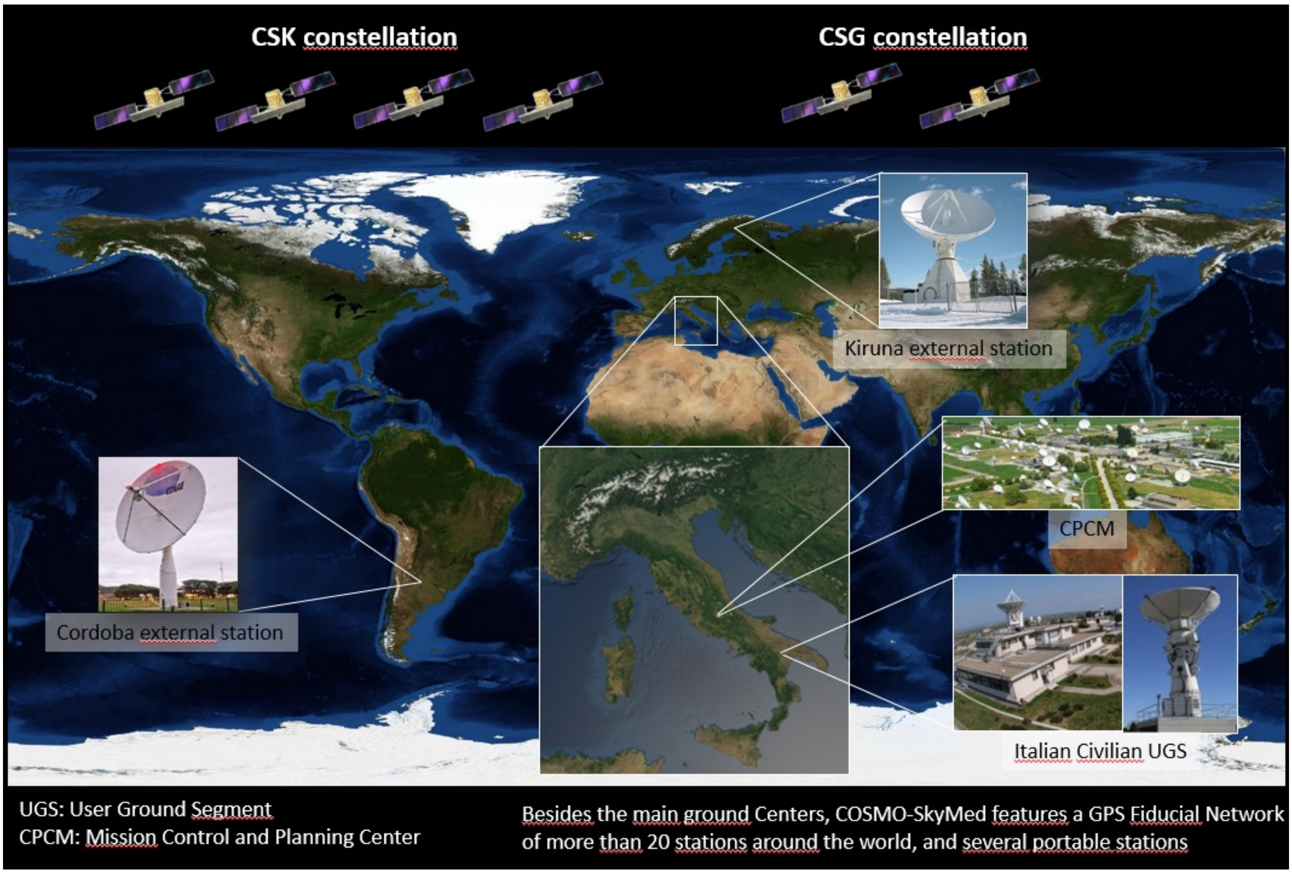


Figure 1 - COSMO-SkyMed Infrastructure

3.2.1. Space Segment

COSMO Seconda Generazione Space Segment is based on 3-axis stabilized satellites orbiting in Sun Synchronous Orbit (SSO). Its state of art technology main features are:

- A side looking **X-band SAR payload** capable to access both right and left with respect to the flight direction with a 20°- 60° incidence access area capability corresponding to an on ground access area of about 2 x 650 Km wide;
- A **Payload Data Handling and Transmission** (PDHT) comprising all the functions necessary for the real-time acquisition, storage and handling of SAR data generated by the Payload, and for their transmission to the ground station;
- A 3 axis stabilization **Platform**, with steering capabilities on each axis, high pointing accuracy and knowledge and real time orbit determination;
- 2 solar array wings that provide power generation for the platform and the SAR payload;
- A propulsion system for orbit control.

The satellite pictorial representation is given in the following Figure 2; its physical architecture consists of the subsystems and payloads listed below:

- **Payload,** composed by:
  - SAR Instrument
  - Payload and Data Handling Transmission S/S (PDHT)
- **Platform**, composed by the following Subsystems:
  - Thermal Control S/S (TCS)
  - Structure S/S (STR)
  - Propulsion Subsystem (PRP)
  - Avionic Subsystem (AVS)
  - Telemetry, Tracking & Control Subsystem (TT&C)
  - Electrical Power Subsystem (EPS)
  - Harness S/S (DC & Pyro)
  - Telecommand Protection System (TPS)

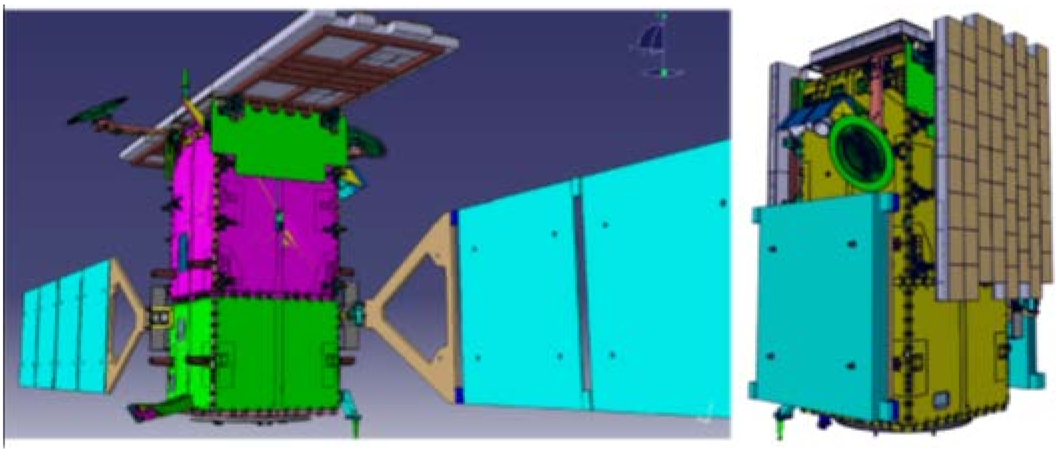


Figure 2 - COSMO-SkyMed Satellite (deployed and stowed configuration)

Platform

The **Platform** general architecture is based on the PRIMA concept which foresees three main modules structurally and functionally decoupled to allow the parallel modules integration and testing activities up to the satellite final integration. The modules are:

- the SerVice Module (SVM) carrying only bus units apart from the propulsion ones;

- the ProPulsion Module (PPM) carrying all the propulsion items connected by the pipelines;
- the PayLoad Module (PLM) carrying al the payload equipment including the pertinent appendages

PRIMA platform family has an extensive heritage in already flown programs, with 5 Satellites already fully operational (Radarsat-2, COSMO-SkyMed FM-1, FM-2, FM-3 and FM-4 with a total of more than 110,000 flight hours), in which it has successfully demonstrated the flexibility of use, low management costs and the ability to adapt to changing operational conditions.

To fulfil its functions, the Platform is organized in Subsystems, as briefly recalled hereafter:

On board Subsystem	Main Functions / Equipment
Avionic S/S	- Attitude Control, including sensor and actuators driving functions - On board Software processing, including Operating System, Data Handling, Software Applications, Failure Detection Isolation and Recovery. - Navigation Tasks, orbit prediction - Autonomy functions - Processor Module Reconfiguration Logic - TC and housekeeping TM data handling
Electrical Power S/S	- Sunlight photo-voltaic conversion in electrical power by means of Solar Arrays - Unregulated Power Bus clamped to Battery voltage - Energy Storage to support SAR and Eclipse operations - Power conditioning, distribution and switching; - Eclipse and Battery management (under SMU control) - Power Supply for SAR P/L antenna and its survival heaters - Pyrotechnic devices operations
Propulsion S/S	- Orbit Control by means of Six 1N hydrazine Reaction Control Thrusters, Hydrazine Tank, pipes, valves and Pressure transducer.
TT&C S/S	- S/B Transponders to support TT&C operations
Thermal S/S	- Thermal control of on board equipment. Active and passive elements are included such as Heat Pipes, Heaters, Reflectors and Insulators. - Bus thermal controller implemented by software - Payload Thermal state monitoring
Structure	- Structural support and interface with launch vehicle - Stiffness and resistance - Thermo-elastic stability - EMC radiated electrical fields protection for internal units - SAR Antenna support - Appendage hold-down points and release mechanisms;

Table 1 - Platform S/S's Main Functions

The enhancement of the Platform at architectural level is the result of an optimization process performed at each subsystem level, on the basis of the CSK lesson learned and on the technological improvements already adopted in the frame of previous heritage programs.

Payload

CSG Payload is composed by:

- SAR Instrument
- Payload and Data Handling Transmission S/S (PDHT)

The **SAR instrument** is based on a deployable planar phased array antenna (SAS) and a central electronics (SES) for signal generation, reception and instrument command and control.

The approach to the instrument design takes into account the heritage and know-how acquired within the SAR2000 and COSMO-SkyMed First Generation programs, and capitalise the lesson learned during of the in-flight operations.

The SAR instrument, operating in the X-band with horizontal and vertical polarization and with the capability to electronically steer the beam in both the azimuth and the elevation planes, is capable to operate in different modes satisfying different user needs, in particular:

- Stripmap (with single, dual and quad-pole capability)
- PingPong (with four polarization capability in burst mode)
- Spotlight (with single and dual polarization capability)
- ScanSAR (with single and dual polarization capability)

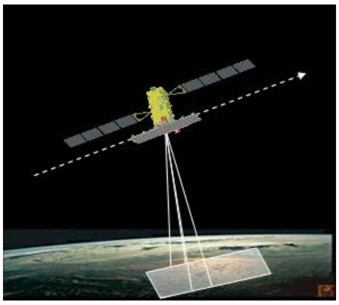
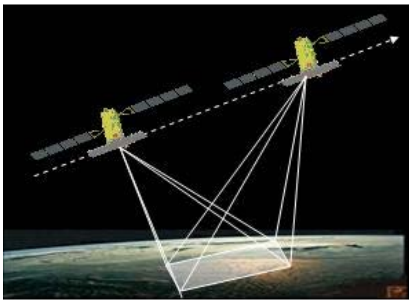
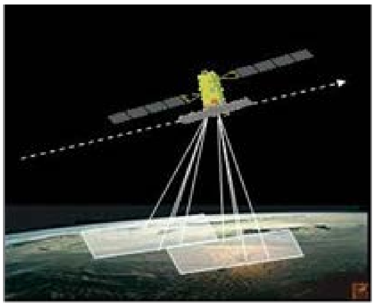
		
STRIPMAP-PINGPONG MODES	**SPOTLIGHTS MODES**	**SCANSAR MODES**

Figure 3 - CSG SAR Operative Modes

The SAR instrument is composed of two major subsystems:

- the SAR Electronic Subsystem (SES) which in turn is composed by
  - the Radio Frequency Equipment (RFE)
  - the Digital Electronics Equipment (DEE)
  - RF and DC harness
- The SAR Antenna Subsystem (SAS)

The **Payload Data Handling and Transmission (PDHT)** subsystem manages the handling and transmission of data generated by the SAR on-board satellite payload; it is designed also to provide the capability to acquire, store and downlink data from additional sources (i.e. GPS raw data).

SAR data are supplied by the payload in the form of CCSDS Source Packets. Auxiliary data are supplied by the On-Board Computer (OBC) through the specific packets format.

The main improvements respect COSMO First Generation are summarized below:

SAR: the observation sensor, that is the Synthetic Aperture Radar (SAR), capable to improve the spatial resolution of the (narrow field) images by a factor 2, providing also multi-polarization, and great versatility of narrow and wide field images at extremely high operational profiles. The technology innovations necessary to sustain such a performance are deeply interesting all SAR elements, realizing completely renewed design of SAR central electronics and active phased array antenna with respect to CSK First Generation.

PDHT: the basic PDHT S/S design will take benefit from the development currently on-going in the frame of Sentinel 1 program. The on board Payload Data Handling and Transmission (PDHT) will be capable to double the performances of the PDHT of the CSK first generation both in terms of data volume handled on-board and transmission throughput to ground. This technology innovation also interests all composing elements of PDHT, such as memory technologies for on-board data storage, on-board C&C software, data encryption, modulation scheme and communication assets.

3.2.2. Ground Segment

The COSMO-SkyMed Ground Segment is geographically distributed over a wide territory (see Figure 1), including Fucino, Matera, Pratica di Mare and some external stations.

In addition, the GS uses a world-wide network of GPS receivers to improve performance requirements on the product Geolocation accuracy and the CSK GS includes *mobile terminals* (C-MAPS, TUPs and D-MAPS) for civilian and defense utilization.

The COSMO SkyMed top-level decomposition is made by the following Elements:

- the Mission Planning Center (CPCM), which is located in Fucino plain in Italy, is in charge of coordinating the on-board and ground activities, performing overall mission planning, allocating resources and solving conflicts;
- the Core Ground Segment (CGS), encompassing all those facilities devoted to manage the satellite constellation;
- the User Ground Segment, further composed by a Civilian and a Military center (C-UGS and D-UGS) which manages the user requests to acquire, archive, process and deliver the products data. Only within the CSK UGS, some Mobile Stations extend the UGS usage;
- the G/S Global network to provide communication services;
- a set of complementary elements grouped as Service Support Element (SSE) in CSK, and that in CSG have been pointed explicitly and managed individually (e.g.: External Station, GFN).

The improvements introduced by the CSG Ground Segment (that is a multi-mission system thanks to its enhanced features and therefore able to interact with the CSK Ground Segment) will allow to consider and interact with CSG and CSK as a single unique system, having the following main characteristics:

- an integrated operative environment,
- a set of products defined as equivalent and the capability to handle them in order to fulfil specified generalized services,
- an integrated management of the available resources.

The improvement of the Ground Segment with respect to the CSK system consists in the ability to handle and treat a massive amount of data in order to obtain more performing products in shorter response time and into a specific timing. This is somehow correlated with the improvement of the Space Segment, that in turn responds to the demand of new products and services defined by Defense, Civilian and Commercial Users.

At the same level of importance of the innovations, there are the constraints related to the 'relation' with CSK, all together referred as "**CSK continuity**". It can be summarize in the following requirements:

- The CSK capability shall not be modified, for aspects related to the service implementation, qualification and certification;
- The compatibility vs CSK data shall be guaranteed: data and products generated by CSK and currently archived at UGS have to be accessible and interpretable, at format level by CSG;
- To provide an integrated COSMO-SkyMed (CSK & CSG) service: even if the two systems and the related performances are independent, the user request shall be processed in an integrated way, addressing it to the mission defined explicitly by the user/operator or to both systems.

Main drivers for this architectural solution are:

- keeping the operative continuity not critical: indeed both the planner and the control centre functionalities manage separately the 2 constellations
- keeping the AIV and qualification regression tests limited to the S/S interfacing the common layers
- minimizing the needs of re-certification, as the modifications are focalized on interfaces to the layer

3.3. Deployment Plan

The CSG User Interface entered into operations in 2017, in order to manage the access to the first generation constellation and be ready as soon as the first CSG launched was going to be launched.

The first CSG satellite was launched on December 18, 2019 at 08:54 UTC from the Kourou Space Center using a Soyuz launcher (flight VS23).

The launch of the second satellite (CSG2) is expected by the end of 2021.

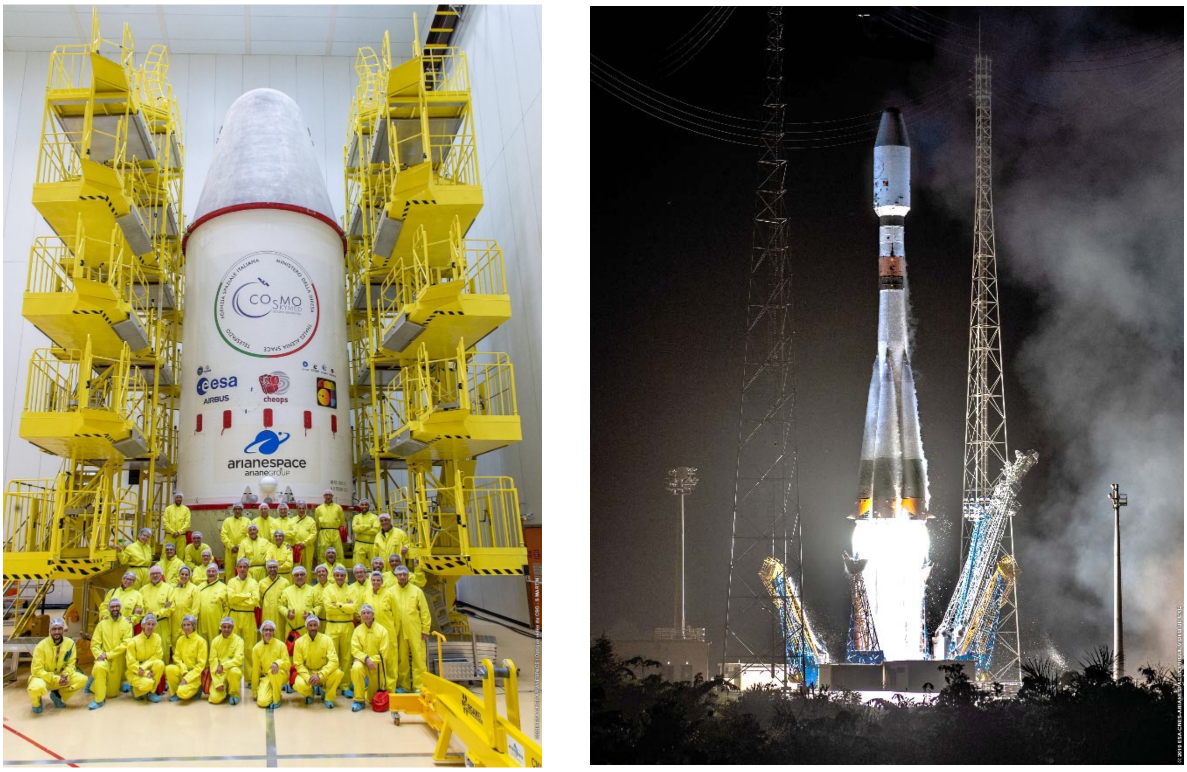


Figure 4 – CSG first satellite launch

4. SYSTEM PERFORMANCES

4.1. Acquisition Performances

Each CSG satellite is able to acquire every day up to:

- 46 Spotlight-2 scenes +
- 36.19 min of Stripmap Dual Pol images (equivalent to about 330 scenes)

4.2. Time Performances

4.2.1. Input and Assumptions

The time performances reported in this document consider two CSG satellites only. The actual time performances will depend on the final phasing of CSG satellites in the orbital plane. A phasing of 180° is assumed here.

The Revisit Time depends on the payload access angle to the ground targets, so it is separately provided for:

- Stripmap Quad-Pol and DI2S modes: incidence angles in the range [20°-45°]
- other acquisition modes: incidence angles in the range [20°-60°]

The Information Age depends on the processing time which is different for any acquisition mode. In this document we refer to the worst cases (Spotlight 2B and DI2S Spotlight Multi-Swath).

4.2.2. CSG Satellites Revisit Time

Revisit Time (i.e. the time between two consecutive satellite passages) for the 2 CSG satellites is defined according to the following Table 2.

Acquisition modes	Average	Max
Quad-Pol and DI2S	9.6 h	85 h
Other acquisition modes	4.5 h	37 h

Table 2 – CSG Revisit Time

It should be anyway specified that since the CSG satellites' orbit is dusk-dawn, the imaging is always happening at 6 AM (Ascending) and 6 PM (Descending) local time. This means that even if there are more imaging opportunities per day (the higher the latitude, the more the imaging opportunities), they are anyway temporally grouped in 2 slots, which are about 12 hours from each other.

At the latitude of Rome (42° N) we have about 48 CSG acquisitions in a 16 days cycle, which means an average revisit of 8 hours. In reality all acquisitions are at 12 hours distance from each other, apart 3 days when the acquisitions are at 24 hours from each other.

The max revisit of 37/85 hours reported in the above table is to be intended as the biggest gap between 2 consecutive acquisitions, in the worst possible scenario (i.e. at the equator).

4.2.3. CSG Satellites Information Age

Information Age (i.e. the time needed to have a product after sensing) is defined according to the following Table 3

Requested geolocation	Average	Max
Fast	2.5 h	5.8 h
Standard	4.1 h	7.5 h
Scientific (1)	16 d	16 d

(1) The scientific geolocation can be requested from the catalogue, provided that the acquisitions have an information age older than 16 days.

Table 3 - Information Age

4.3. Orbital Parameters

The orbit of CSG satellites is sun-synchronous, with repeating ground track and frozen perigee on the North Pole, with the same orbital parameters of CSK spacecraft.

Semi-major axis	6997.76 Km
Mean altitude	619.6 Km
Orbital period	97.2 min
Mean motion	(14 + 13/16) orbits/day
Ground track repeat cycle (1)	16 days (237 orbits)
Eccentricity	0.001185
Argument of perigee	90°
Nominal inclination (2)	97.87°
Nominal Local Time at Ascending Node (3)	05:46 AM

(1) The orbit provides a near-repeat cycle of 5 days
(2) The actual values vary during the mission lifespan

Table 4 – CSG Mean Orbital Parameters

The current position of the first CSG satellite on the same orbital plane of the 4 CSK satellites is shown in the following Figure. In the same Figure there is also evidence of the expected position for the CSG-2 satellite.

Position of the CSG satellites may be changed according to the status of the CSK satellites.

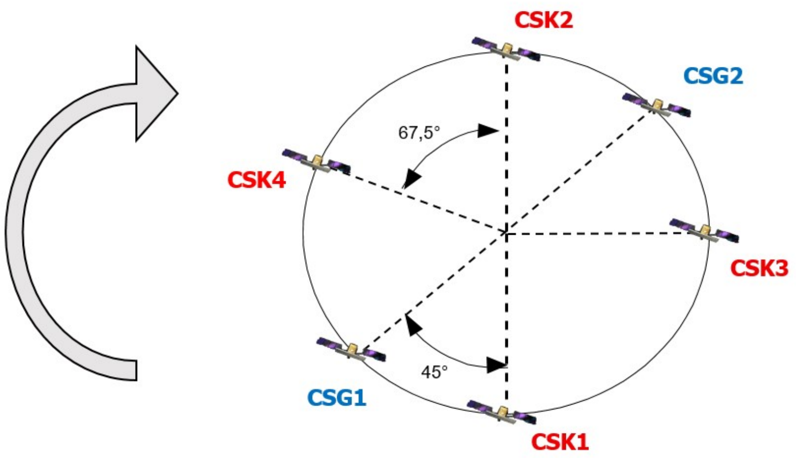


Figure 5 – COSMO-SkyMed satellites orbital position

4.3.1. Interferometric revisit

The interferometric revisit of each satellite is 16 days, exactly like the repeat cycle.

CSG1 and CSG2 satellites, being positioned at 180° from each other on the same orbit, can make interferometric acquisitions every 8 days.

In consideration of the fact that it is possible to make interferometric acquisitions also between different CSK and CSG satellites (for the Stripmap mode only), this is the temporal distance between the satellites having the same exact acquisition geometry:

- Day 1: CSK1
- Day 5: CSK3
- Day 7: CSG1
- Day 8: CSK4
- Day 9: CSK2
- Day 15: CSG2
- Day 17: CSK1
- …

5. ACQUISITION MODES

In the following Figure 7 an overview of CSG Acquisition Modes is given. In particular:

- **Standard Acquisition Modes** include Spotlight, Stripmap, PingPong, QuadPol and Scansar
- **Non-Standard Acquisition Mode** are divided into:
  - Operational Modes: the system is programmed to meet the required performances;
  - Experimental Modes (for authorized Users only): the performances unknown on-ground and characterized in-flight in the frame of Commissionig phase. The performances have not to be guaranteed.

The CSG SAR instrument operates with multimode (Spotlight, Stripmap, and ScanSAR) and multi-polarization capabilities.

In **Stripmap** mode the instrument provides uninterrupted coverage with medium geometric resolution and medium image size. When operating in Stripmap mode, the SAR instrument operates with a fixed and constant set of parameters in a continuous manner. The antenna is configured to generate a beam with fixed azimuth and elevation pointing. Coverage in along track is inherently achieved by the spacecraft orbital movement. According to the desired swath position within the access range, appropriate beam forming is applied for range ambiguity suppression.

ScanSAR wide-swath modes provide huge image size (i.e. about 5 times the Stripmap) at the expense of resolution.

When operating in ScanSAR mode, the SAR antenna beam is scanned in the elevation plane to cover a wider swath in the cross-track direction; since the scanning cycle shall be completed within the maximum integration time allowed by the synthetic aperture, the swath width is achieved at the expense of the azimuth resolution.

In **Spotlight** standard mode, the SAR instrument steers the beam in the azimuth plane to increase the integration time over a single target to get the required azimuth resolution. The steering scheme is such that the illuminated spot on ground slides in the azimuth direction in order to achieve, at the same time, both the azimuth resolution and the along-track spot extension.

In addition, CSG system, the DI2S Spotlight Multi-Swath (MS) mode allows the acquisition of two different Spotlight images simultaneously, overcoming the nominal space/time-gap constraint between two standard Spotlight acquisitions. The pair of images can be acquired cross-track or along track.

The Spotlight acquisitions on a Theatre Scenario allows the acquisition of adjacent and scattered Spotlight images on a Theatre scenario exploiting both platform and SAR instrument agility, with both fixed or variable pitch rates.

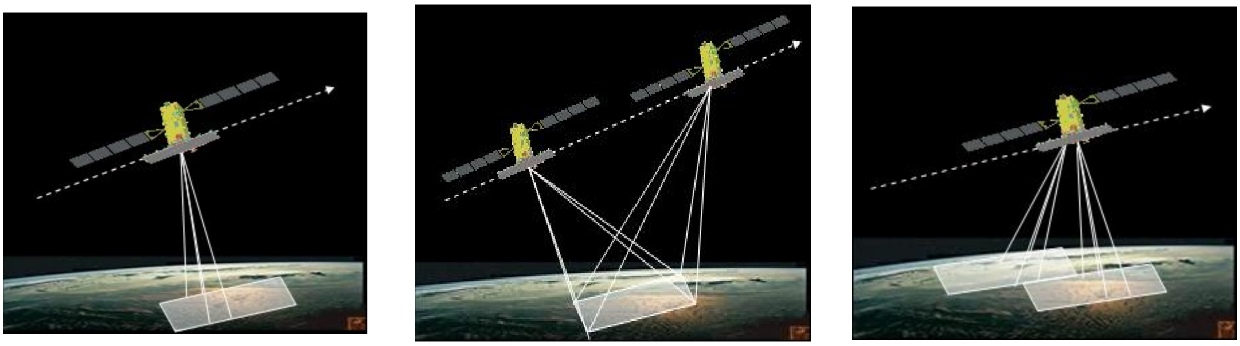
The CSG-C SAR instrument can be operated in the following operative modes (see Fig. 6):

- **Spotlight-2**
  - S2-A (single or dual pol) (for authorized Users Only)
  - S2-B **(**single or dual pol) (for authorized Users Only)
  - S2-C **(**single or dual pol)
  - DI2S Spotlight 2 Multi-Swath Optimized Swath (Spotlight 2 MS OS) – online* (single or dual pol) (for authorized Users Only)
  - DI2S Spotlight 2 Multi-Swath Optimized Swath (Spotlight 2 MS OS) – offline** (single or dual pol) (for authorized Users Only)
  - Scattered Spotlight on a Theatre Scenario (Spotlight SC) – offline** (single or dual pol)
  - Adjacent Spotlight on a Theatre Scenario (Spotlight AJ) – offline** (single or dual pol) (for authorized Users only)
- **Stripmap (**single or dual pol)
- **Ping-Pong** (dual or quad pol)
- **Quadpol**
- **Scansar**

- ScanSAR-1 **(**single or dual pol)
- ScanSAR-2 **(**single or dual pol)

* online means that the user, by checking the “subscription” flag into the Mission Functions Tab empowers the system to convert two Spotlight requests into only one DI2S-MS request in case of scheduling conflicts between them.

** Offline mode is a particular acquisition mode not available on the user interface, but managed with an offline tool at the User Ground Segments.



Stripmap (single, dual and quadpol polarization) and Ping Pong (four polarization capability in burst mode) — Spotlight (single and dual polarization) — ScanSAR (single and dual polarization)

Figure 6 – CSG-C SAR Operative Modes

In addition, CSG system is able to acquire adjacent and scattered Spotlight acquisitions on a Theatre scenario exploiting both platform and SAR instrument agility, with both fixed and variable pitch rates.

SAR Non-Standard Operational on-line Modes:

- DI2S Spotlight 1 Multi-Swath Optimized Resolution (Spotlight 1 MS OR) – (single or dual pol);
- DI2S Spotlight 2 Multi-Swath Optimized Swath (Spotlight 2 MS OS) - (single or dual pol);

SAR Non-Standard Operational off-line Modes:

- DI2S Spotlight 1 Multi-Swath Optimized Resolution (Spotlight 1 MS OR) – (single or dual pol);
- DI2S Spotlight 2 Multi-Swath Optimized Swath (Spotlight 2 MS OS) - (single or dual pol);
- Scattered Spotlight on a Theatre Scenario (Spotlight SC) - (single or dual pol);
- Adjacent Spotlight on a Theatre Scenario (Spotlight AJ) - (single or dual pol).

Offline mode is a particular acquisition mode not available on the user interface, but managed with an offline tool at the User Ground Segments. Access to these imaging mode is subject to ad hoc authorization.

The Online DI2S Multi Swath allows the CSG system to solve a conflict between two different requests in Spotlight mode by taking advantage of the capability of DI2S-S2-MS-OS mode to combine two requests in only one. This feature shall be enabled only on Spotlight acquisitions and increases the probability that a Spotlight request is scheduled.

Whilst the term "offline" means that the user prompts the submission of a request in DI2S-MS modes, the term "online" means that the user empowers the system to convert two Spotlight requests into only one DI2S-MS request in case of scheduling conflicts between them.

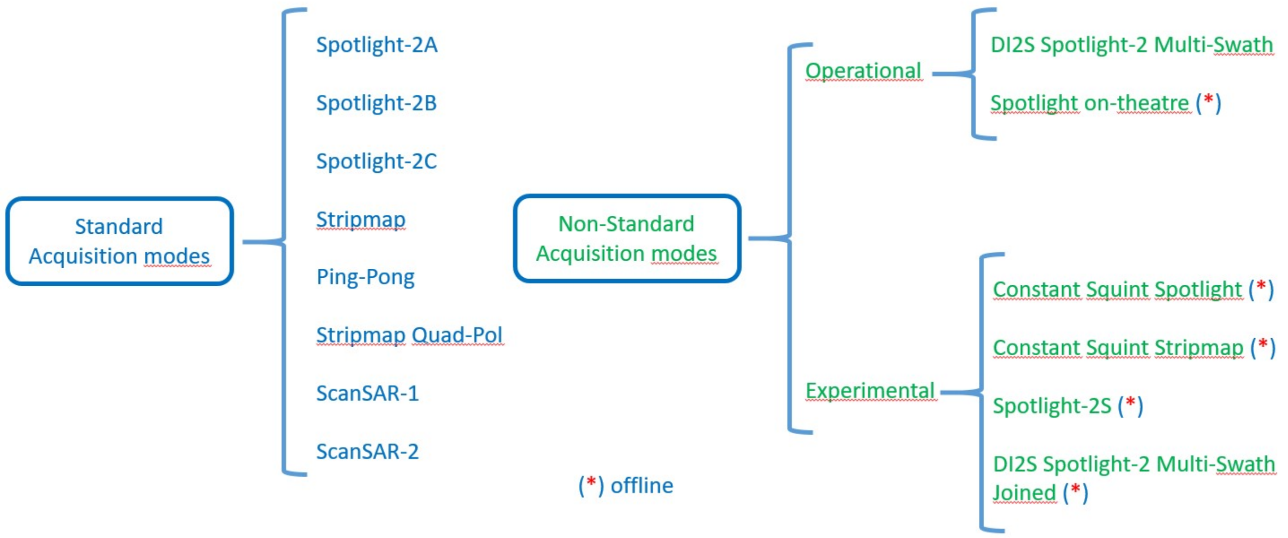


Figure 7 - Overview of CSG civilian Acquisition Modes

5.1. Standard Acquisition Modes

CSG Standard Acquisition Modes benefit of significant improvements w.r.t. CSK, especially in terms of geometric resolution and polarimetry.

5.1.1. Standard Spotlight Modes

CSG has 3 submetric Spotlight modes for the civilian users. Each mode is already an improvement compared to the CSK modes, and each one has its own specific characteristics.

Very high image quality mode (Access to these imaging mode is subject to ad hoc authorization):

- Spotlight-2A: mode with constant SAR bandwidth to optimize the resolution (resolution not constant in range and non-squared)
- Spotlight-2B: maximum scene size (10 x 10 Km)

Low energy consumption mode:

- Spotlight-2C: minimum resources consumption lead to a greater number of images per day and a higher probability of acquisition

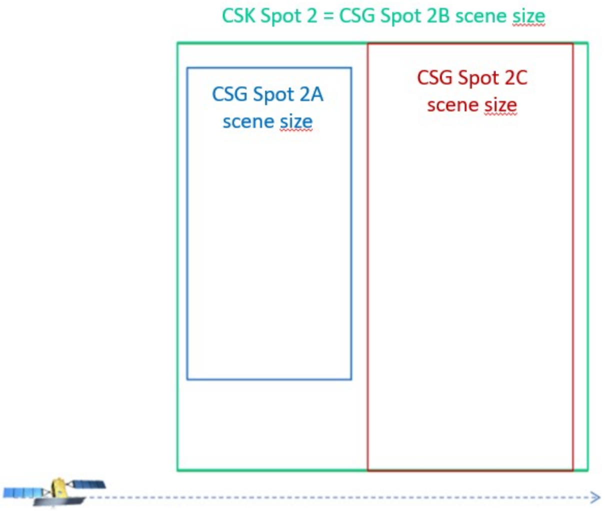


Figure 8 - Diversification of Standard Spotlight 2 modes image size

Imaging mode	Polarization	Access region	Swath [Az. X Rg]	Resolution [Az. X Rg]
Spotlight-2A	Single/Dual	20-25° 25-50° 50-60°	3.1 x 7.3 Km 3.2 x 7.3 Km 4.4 x 7.3 Km	0.3 x 0.6 m 0.3 x 0.5 m 0.3 x 0.5 m
Spotlight-2B	Single/Dual	20-60°	10 x 10 Km	0.6 x 0.6 m
Spotlight-2C	Single/Dual	20-60°	5 x 10 Km	0.8 x 0.8 m

Table 5 - Standard Spotlight 2 imaging modes

5.1.2. Standard Wide Field Modes

CSG Standard wide field modes feature enhancements particularly in resolution and polarization if compared to the CSK first generation. In the following Table the main characteristics. Note that the swath in azimuth refers to the "Standard frame", the actual maximum length in the azimuth direction is above 2000 km.

Imaging mode	Polarization	Access region	Swath [Az. X Rg]	Resolution [Az. X Rg]
Stripmap	Single/Dual	20-50° 50-60°	40 x 40 Km 40 x 30 Km	3 x 3 m
Ping-Pong	Dual/Quad	20-60°	30 x 30 Km	12 x 5 m
QuadPol	Quad	20-45°	40 x 15 Km	3 x 3 m
ScanSAR-1	Single/Dual	20-60°	100 x 100 Km	20 x 4 m
ScanSAR-2	Single/Dual	20-50° 50-60°	200 x 200 Km 200 x 190 Km	40 x 6 m

Table 6 - CSG Standard Wide Field Modes

5.1.3. Polarization Characteristics

All standard modes will provide dual-pol products, thanks to the SAR antenna design which allows to simultaneously receive the horizontal (H) and vertical (V) polarizations scattered by the target.

The Ping-Pong heritage mode has become a quad-pol (burst) mode (in CSK it was a dual-pol mode).

CSG features a Quad-polarization Stripmap mode, achieved with the “interleaved” technique

- The “interleaved” technique consists in halving the Pulse Repetition Interval (PRI) and alternatively transmitting in H and V polarization
- The SAR collects from the same target the echoes of the two polarizations signals
- The epochs of the echoes will differ of half a standard PRI; the position of the satellite at the time of the 2 transmissions will differ of the path travelled during the same interval
- Both echoes received in H and V pol due to the antenna capability to simultaneously receive both pol, thus achieving the quad-pol components of the scattered echoes

Imaging Mode	Polarization
Spotlight-2A	Single (HH, VV) or Dual (HH+HV, VV+VH)
Spotlight-2B	Single (HH, VV) or Dual (HH+HV, VV+VH)
Spotlight-2C	Single (HH, VV) or Dual (HH+HV, VV+VH)
Stripmap	Single (HH, VV, HV, VH) or Dual (HH+HV, VV+VH)
Ping-Pong	Alternate (HH/VV, HH/VH-HV/VV)
QuadPol	Quad (HH+HV+VV+VH)
ScanSAR-1	Single (HH, VV, HV, VH) or Dual (HH+HV, VV+VH)
ScanSAR-2	Single (HH, VV, HV, VH) or Dual (HH+HV, VV+VH)

Table 7 - CSG polarizations for each standard imaging mode

Dual Pol and Quad Pol products are delivered as separate products, one for each polarization. Similarly, they are catalogued with different Record Numbers, one for each polarization.

Different polarizations of the same acquisitions are not co-registered with each other.

5.1.4. Standard Acquisition Modes Image Quality Summary

In the following Tables the Standard Acquisition Modes Image Quality values are summarized. In particular NESZ and Geolocation accuracy.

Imaging mode	Polarization	Access region	NESZ
Spotlight-2A	Single/Dual	20-25° 25-50° 50-60°	-23.5 dB -22.5 dB -20 dB
Spotlight-2B	Single/Dual	20-60°	-20 dB
Spotlight-2C	Single/Dual	20-25° 25-50° 50-60°	-22 dB -20 dB -19 dB
Stripmap	Single/Dual	20-60°	-22 dB
Ping-Pong	Dual / Quad	20-60°	-22 dB
QuadPol	Quad	20-45°	-22 dB
ScanSAR-1	Single/Dual	20-60°	-22 dB
ScanSAR-2	Single/Dual	20-60°	-22 dB

Table 8 - Standard Acquisition Modes Image Quality Summary

Geolocation accuracy is depending on the quality of the orbital parameters used to generate the products:

- "Fast delivery" products use the orbital data included in the image raw data stream. Useful for "near real time" requests;
- Products with "Standard" geolocation use the filtered orbits provided, a few times per day, by Flight Dynamics S/S;
- Products with "Scientific" geolocation use orbits "reconstructed" by the reconstructed orbit and COSMO-SkyMed GPS Fiducial Network and are available from the catalogue 1 orbital cycle (16 days) after the acquisition.

Imaging mode	Fast Delivery Geolocation Accuracy	Standard Geolocation Accuracy	Scientific Geolocation Accuracy
Spotlight-2A	25 m (3 σ)	3.75 m (CE 90%)	1.25 m (CE 90%)
Spotlight-2B	25 m (3 σ)	3.75 m (CE 90%)	1.25 m (CE 90%)
Spotlight-2C	25 m (3 σ)	3.75 m (CE 90%)	1.25 m (CE 90%)
Stripmap	25 m (3 σ)	3.75 m (CE 90%)	2 m (CE 90%)
Ping-Pong	25 m (3 σ)	12 m (3 σ)	10 m (3 σ)
QuadPol	25 m (3 σ)	3.75 m (CE 90%)	2 m (CE 90%)
ScanSAR-1	25 m (3 σ)	12 m (3 σ)	10 m (3 σ)
ScanSAR-2	25 m (3 σ)	12 m (3 σ)	10 m (3 σ)

Table 9 - Standard Acquisition Modes Geolocation Accuracy

5.1.1. Beams and Incidence Angles

In the following tables the details of all the beams for the different Standard Imaging Modes of CSG, which are valid for both the Right and the Left looking modes. Angles represented are off-nadir angles.

Spotlight-2A/2B/2C Imaging Modes			
Beam #	**Near off-nadir angle**	**Center off-nadir angle**	**Far off-nadir angle**
S2(x*)-001	18.16	18.84	19.51
S2(x*)-002	19.33	20.01	20.68
S2(x*)-003	20.41	21.09	21.76
S2(x*)-004	21.58	22.21	22.84
S2(x*)-005	22.66	23.28	23.91
S2(x*)-006	23.73	24.35	24.98
S2(x*)-007	24.8	25.42	26.05
S2(x*)-008	25.78	26.36	26.93
S2(x*)-009	26.76	27.33	27.91
S2(x*)-010	27.73	28.31	28.88
S2(x*)-011	28.7	29.26	29.81
S2(x*)-012	29.59	30.11	30.64
S2(x*)-013	30.47	30.99	31.52
S2(x*)-014	31.34	31.87	32.39
S2(x*)-015	32.22	32.74	33.27
S2(x*)-016	33.14	33.64	34.14
S2(x*)-017	33.96	34.44	34.92
S2(x*)-018	34.79	35.29	35.8
S2(x*)-019	35.65	36.11	36.57
S2(x*)-020	36.42	36.87	37.32
S2(x*)-021	37.15	37.6	38.05
S2(x*)-022	37.92	38.35	38.77
S2(x*)-023	38.69	39.11	39.54
S2(x*)-024	39.41	39.81	40.21
S2(x*)-025	40.09	40.49	40.88
S2(x*)-026	40.76	41.14	41.51
S2(x*)-027	41.39	41.76	42.14
S2(x*)-028	42.01	42.39	42.76
S2(x*)-029	42.64	42.99	43.34
S2(x*)-030	43.22	43.57	43.92
S2(x*)-031	43.79	44.12	44.45

S2(x*)-032	44.33	44.65	44.98
S2(x*)-033	44.86	45.18	45.51
S2(x*)-034	45.38	45.69	45.99
S2(x*)-035	45.87	46.17	46.47
S2(x*)-036	46.35	46.65	46.95
S2(x*)-037	46.83	47.13	47.43
S2(x*)-038	47.35	47.63	47.9
S2(x*)-039	47.83	48.1	48.38
S2(x*)-040	48.3	48.57	48.85
S2(x*)-041	48.77	49.02	49.27
S2(x*)-042	49.2	49.45	49.7
S2(x*)-043	49.62	49.87	50.12
S2(x*)-044	50.05	50.3	50.54
S2(x*)-045	50.47	50.7	50.92
S2(x*)-046	50.85	51.08	51.3
S2(x*)-047	51.23	51.45	51.68
S2(x*)-048	51.6	51.83	52.05
S2(x*)-049	51.75	51.98	52.2

* x can be A,B,C

Table 10 - Spotlight modes beams

Stripmap Imaging Mode			
Beam #	**Near off-nadir angle**	**Center off-nadir angle**	**Far off-nadir angle**
STR-001	16.36	18.25	20.14
STR-002	19.96	21.73	23.5
STR-003	22.6	24.13	25.65
STR-004	23.13	24.67	26.21
STR-005	25.09	26.55	28
STR-006	27.71	29.09	30.47
STR-007	29.27	30.61	31.96
STR-008	30.6	31.99	33.38
STR-009	32.3	33.52	34.75
STR-010	33.6	34.8	35.99
STR-011	34.59	35.9	37.2
STR-012	35.9	37.02	38.14
STR-013	37.41	38.47	39.54
STR-014	38.55	39.61	40.67

STR-015	39.37	40.38	41.39
STR-016	40.06	41	41.95
STR-017	41.34	42.27	43.2
STR-018	43.03	43.86	44.7
STR-019	44.49	45.2	45.92
STR-020	45.68	46.27	46.85
STR-021	46.79	47.39	47.98
STR-022	47.68	48.19	48.69
STR-023	48.61	49.18	49.75
STR-024	49.65	50.13	50.61
STR-025	50.51	50.94	51.36
STR-026	51.14	51.56	51.98
STR-027	16.36	52.42	20.14

Table 11 - Stripmap beams

Ping-Pong Imaging Mode			
Beam #	**Near off-nadir angle**	**Center off-nadir angle**	**Far off-nadir angle**
PPS-001	16.36	18.25	20.14
PPS-002	19.96	21.73	23.5
PPS-003	22.6	24.13	25.65
PPS-004	23.13	24.67	26.21
PPS-005	25.09	26.55	28
PPS-006	27.71	29.09	30.47
PPS-007	29.27	30.61	31.96
PPS-008	30.6	31.99	33.38
PPS-009	32.35	33.52	34.66
PPS-010	33.6	34.8	35.99
PPS-011	34.59	35.9	37.2
PPS-012	36.03	37.02	38.02
PPS-013	37.41	38.47	39.54
PPS-014	38.55	39.61	40.55
PPS-015	39.33	40.38	41.09
PPS-016	40.21	41	41.78
PPS-017	41.37	42.27	43.17
PPS-018	43.08	43.86	44.65
PPS-019	44.49	45.2	45.92

PPS-020	45.68	46.27	46.85
PPS-021	46.79	47.39	47.98
PPS-022	47.68	48.19	48.69
PPS-023	48.61	49.18	49.75
PPS-024	49.65	50.13	50.61
PPS-025	50.51	50.94	51.36
PPS-026	51.24	51.56	52.05
PPS-027	51.98	52.42	52.75

Table 12 - Ping-Pong beams

Quad-Pol Imaging Mode			
Beam #	**Near off-nadir angle**	**Center off-nadir angle**	**Far off-nadir angle**
QPS-001	18.15	18.83	19.51
QPS-002	19.47	20.14	20.82
QPS-003	20.77	21.43	22.08
QPS-004	22.05	22.69	23.33
QPS-005	23.3	23.93	24.56
QPS-006	24.52	25.13	25.74
QPS-007	25.71	26.31	26.92
QPS-008	26.89	27.48	28.07
QPS-009	28.04	28.62	29.19
QPS-010	29.16	29.71	30.26
QPS-011	30.24	30.79	31.34
QPS-012	31.3	31.83	32.35
QPS-013	32.32	32.83	33.34
QPS-014	33.31	33.81	34.31
QPS-015	34.27	34.75	35.23
QPS-016	35.21	35.69	36.17
QPS-017	36.14	36.6	37.05
QPS-018	37.02	37.45	37.89
QPS-019	37.87	38.31	38.75
QPS-020	38.73	39.16	39.58
QPS-021	39.56	39.96	40.36

Table 13 - Stripmap Quad-Pol beams

ScanSAR-1 Imaging Mode				
Beam #	**Sub-Beam #**	**Near off-nadir angle**	**Center off-nadir angle**	**Far off-nadir angle**
SC1-001	SS-001	16.72	18.57	20.41
	SS-002	20.34	22.04	23.73
	SS-003	22.66	24.35	26.05
	SS-004	25.6	27.11	28.63
SC1-002	SS-005	28.44	29.98	31.52
	SS-006	31.17	32.57	33.97
	SS-011	32.71	33.89	35.07
	SS-012	34.83	35.95	37.07
SC1-003	SS-013	36.79	37.73	38.66
	SS-014	38.55	39.6	40.65
	SS-015	40.4	41.13	41.87
	S4-016	41.75	42.62	43.5
SC1-004	SS-017	43.4	44.08	44.77
	SS-018	44.5	45.21	45.92
	SS-019	45.75	46.4	47.06
	SS-020	46.93	47.53	48.14
SC1-005	SS-021	48.06	48.59	49.12
	SS-022	49.08	49.59	50.09
	SS-023	49.96	50.31	50.65
	SS-024	50.52	50.94	51.36
SC1-006	SS-022	49.08	49.59	50.09
	SS-023	49.96	50.31	50.65
	SS-024	50.52	50.94	51.36
	SS-025	51.2	51.66	52.12

Table 14 - ScanSAR-1 beams

ScanSAR-2 Imaging Mode				
Beam Combination	**Beam #**	**Near off-nadir angle**	**Center off-nadir angle**	**Far off-nadir angle**
SC2-001	SS-001	16.72	18.57	20.41
	SS-002	20.34	22.04	23.73
	SS-003	22.66	24.35	26.05
	SS-004	25.6	27.11	28.63
	SS-005	28.44	29.98	31.52
	SS-006	31.17	32.57	33.97

SC2-002	SS-007	21.85	23.55	25.25
	SS-008	24.8	26.4	28
	SS-009	27.64	29.1	30.55
	SS-010	30.12	31.56	33
	SS-011	32.71	33.89	35.07
	SS-012	34.83	35.95	37.07
SC2-003	SS-010	30.12	31.56	33
	SS-011	32.71	33.89	35.07
	SS-012	34.83	35.95	37.07
	SS-013	36.79	37.73	38.66
	SS-014	38.55	39.6	40.65
	SS-015	40.4	41.13	41.87
SC2-004	SS-013	36.79	37.73	38.66
	SS-014	38.55	39.6	40.65
	SS-015	40.4	41.13	41.87
	SS-016	41.75	42.62	43.5
	SS-017	43.4	44.08	44.77
	SS-018	44.5	45.21	45.92
SC2-005	SS-017	43.4	44.08	44.77
	SS-018	44.5	45.21	45.92
	SS-019	45.75	46.4	47.06
	SS-020	46.93	47.53	48.14
	SS-021	48.06	48.59	49.12
	SS-022	49.08	49.59	50.09
SC2-006	SS-020	46.93	47.53	48.14
	SS-021	48.06	48.59	49.12
	SS-022	49.08	49.59	50.09
	SS-023	49.96	50.31	50.65
	SS-024	50.52	50.94	51.36
	SS-025	51.2	51.66	52.12

Table 15 - ScanSAR-2 beams

5.2. Non-Standard Acquisition Modes

The CGS System is able to provide *Non-Standard Acquisition Mode*s that are those which use SAR agility to acquire two scenes at the same time or perform non-zero doppler acquisitions with a squinted attitude of the platform (even exploiting the CSG improved platform agility).

The Non-Standard Acquisition Modes are defined either Operational or Experimental.

A Non-Standard Acquisition Mode can be either completely integrated inside the system or an “Offline” mode. In particular, the Offline mode is not available on the user interface, but managed with an offline tool at the User Ground

Segments. The tool produces an output which can be ingested and managed by the system. Access to these imaging mode is subject to ad hoc authorization.

The Non-Standard Operational Acquisition Modes foreseen:

1. Discrete Stepped Strip (DI2S) Spotlight Multi-Swath (1 and 2), based on the SAR agility;
2. Spotlight on theatre, based on the platform agility and designed for the offline mode only.

5.2.1. Non Standard Operational modes

5.2.1.1. DI2S Spotlight-2 Multi-Swath

The DI2S is a novel technique which can be used to simultaneously acquire two separate targets. It is based on the interleaved transmission with a Pulse Repetition Interval (PRI) halved with respect to a standard acquisition. Access to these imaging mode is subject to ad hoc authorization.

DI2S Multi-Swath (MS) modes allow to double the number of acquisitions over an area of interest also in the case a target is partially overlapped in azimuth with the other target, differently from nominal zero-doppler acquisitions. Thanks to the DI2S technique, it will be possible to go beyond the time gap violation of standard Spotlight and to have coupled acquisitions with same azimuth position or with same range and shifted in azimuth, but also to acquire two images overlapped in azimuth.

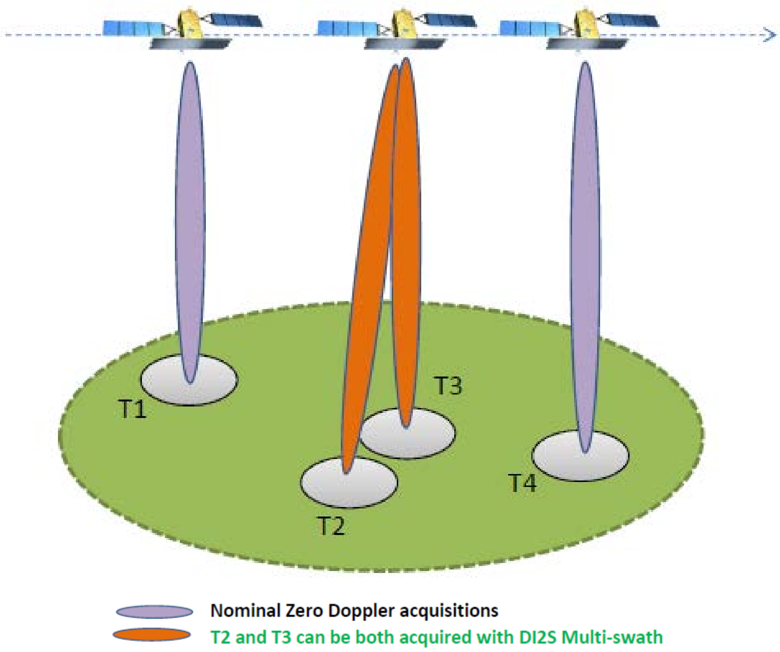


Figure 9 - Performances of DI2S Multi-Swath in doubling the number of acquisitions

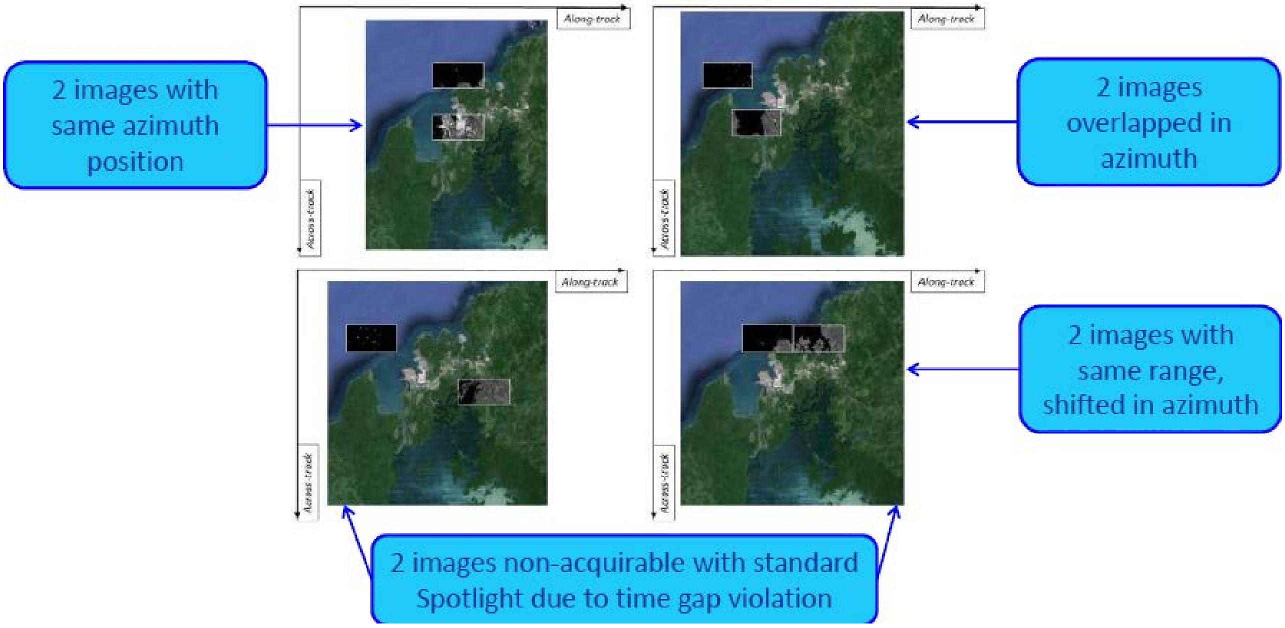


Figure 10 - Possible DI2S coupled acquisitions

As the PRI is halved, the "swath time" available for each acquisition is reduced as well, resulting in a reduced swath in range.

The DI2S performances are summarized in the following table:

Imaging mode	Polarisation	Access region	Swath [Az x Rg]	Resolution [Az x Rg]	NESZ
DI2S Spotlight 2 MS Optimised Swath	Single /Dual	20-45°	10 x 4 Km (2 images)	0.6 x 0.6	-20 dB

Table 16 – DI2S Spotlight-2 Optimised Swath imaging mode

The DI2S acquisitions which can be paired are constrained in the Pulse Repetition Frequency (PRF) versus incidence angle plane. Indeed as the two acquisitions have the same PRF, the rank parity has to be the same for the two acquisitions (both even or both odd), otherwise the echoes from the two scenes would be simultaneously received by the radar.

5.2.1.1. Spotlight on theatre

In case of the Spotlight on theatre mode, the Spotlight acquisitions are performed while the satellite platform performs a pitch manoeuvre aimed to bypass the geometrical constraints (azimuth overlap) or time gap constraints (due to the SAR reconfiguration time). The required angular speed of the pitch manoeuvre depends on the azimuth distance of the acquisitions: the manoeuvre can be performed with the the Control Moment Gyro Assembly able to increase the agility of CSG satellites . The expected effect of this kind of acquisition is the degraded image quality with respect to Standard Spotlight ones. Access to these imaging mode is subject to ad hoc authorization.

The usefulness of the squinted technique is to acquire a series of images on the area of interest, in this case called "theatre".

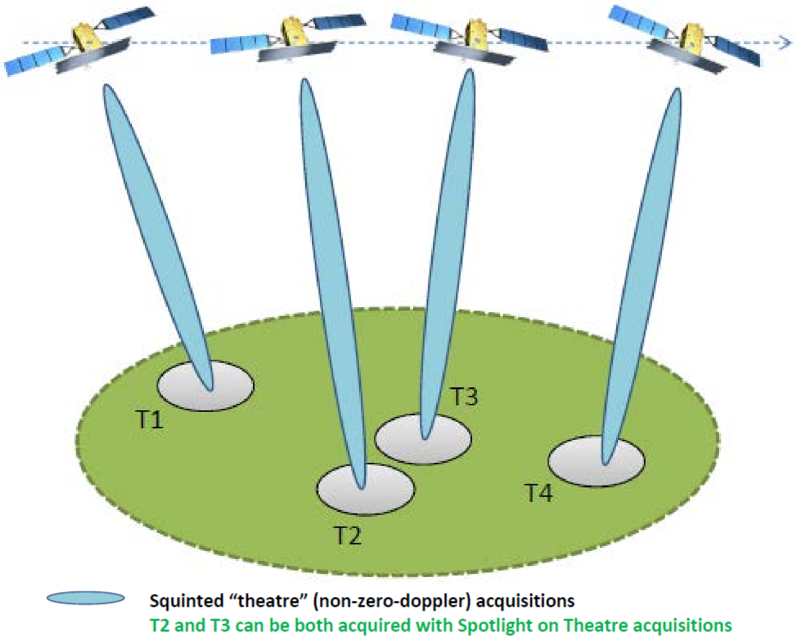


Figure 11 - How to exploit the Spotlight on Theatre

The following possible theatre scenarios are foreseen: adjacent Spotlight acquisitions (both along-track and across-track); scattered Spotlight acquisitions (both along two consecutive shifted tracks and in sequence of single target along-track in diagonal line).

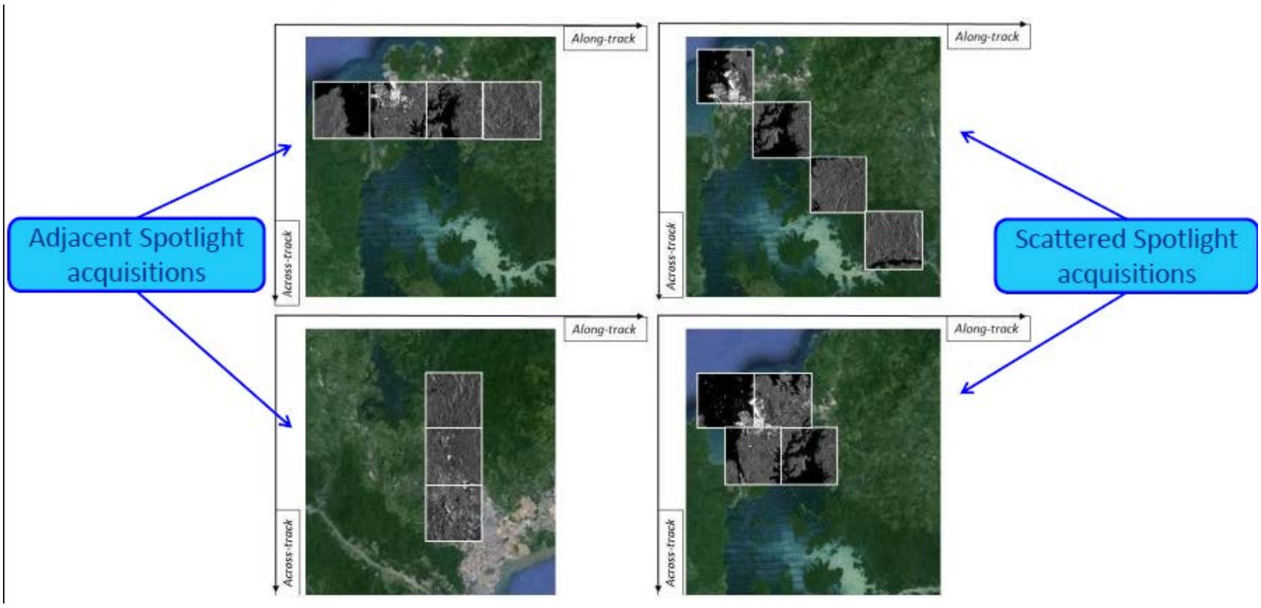


Figure 12 - Possible theatre scenarios

6. PRODUCTS DESCRIPTION

This section gives an overview of the services provided at CSG User through the CSG Interface Manager. Where applicable, reference to the related CSK products are given.

CSG Interface Manager services can be summarized into the following categories:

- Services for CSG Standard Products generation
- Services for CSG Non-Standard Products generation
- Calibration Services

The following table provides an overview of the products relevant to the foreseen CSG services:

Product Type Identifier	Description	Applicable only to CSG
RAW_B	SAR Products at processing level 0. Unpacked echo data in complex in-phase and quadrature signal (I and Q) format. (*Access to this CSG product is subject to ad hoc authorization*)	
SCS_B	SAR Products at processing level 1A. Focused, hamming weighted and radiometrically equalized data in complex format, in slant range and zero doppler projection.	
SCS_U	SAR Products at processing level 1A. Focused, unweighted and not radiometrically equalized data in complex format, in slant range and zero doppler projection.	
SCS_F	SAR Products at processing level 1A. Focused, apodized and radiometrically equalized data in complex format, in slant range and zero doppler projection (Applicable to Spotlight modes only).	Yes
DGM_B	SAR Products at processing level 1B. Focused, amplitude detected, optionally de-speckled by multi-looking approach, radiometrically equalized data represented in ground /azimuth projection.	
DGM_F	SAR Products at processing level 1B. Focused, apodized, amplitude detected, optionally despeckled by multi-looking approach, radiometrically equalized data represented in ground /azimuth projection (Applicable to Spotlight modes only).	Yes

GEC_B	SAR Products at processing level 1C. Focused data, amplitude detected, optionally despeckled by multi-looking approach, geolocated on the reference ellipsoid and represented in a uniform preselected cartographic presentation.	
GEC_F	SAR Products at processing level 1C. Focused, apodized, amplitude detected, optionally despeckled by multi-looking approach, geolocated on the reference ellipsoid data represented in a uniform preselected cartographic presentation (Applicable to Spotlight modes only).	Yes
GTC_B	SAR Products at processing level 1D. Focused data, fully calibrated with the usage of terrain model, amplitude detected, optionally despeckled by multi-looking approach, geolocated on a DEM and represented in a uniform preselected cartographic presentation.	
GTC_F	SAR Products at processing level 1D. Focused data, apodized, fully calibrated with the usage of terrain model, amplitude detected, optionally despeckled by multi-looking approach, geolocated on a DEM and represented in a uniform preselected cartographic presentation (Applicable to Spotlight modes only).	Yes
QLK_B	Low resolution synoptic of the entire L0F datum, represented at 1B processing level.	Yes
SPF_B	Product generated starting from Level 1B products. Focused, detected, radiometrically equalized, ground /azimuth projected, speckle filtered data.	
CRG_A	Co-registered products generated starting from a pair of CSG Level 1A (complex) images acquired on the same area and represented on the same reference grid.	
CRG_B	Co-registered products generated starting from a pair of CSG Level 1B (real) images acquired on the same area and represented on the same reference grid.	
IPH_B	Interferometric phase products.	Yes
COH_B	Interferometric coherence products.	Yes
DTM_H	Digital Terrain height Model products.	
MOS_D	Mosaicked Image of a set of Level 1D products.	
MOS_H	Mosaicked Image of a set of DTM products.	

Table 17 - CSG Products description

COSMO SAR Products are generated starting from input data acquired by the instrument modes mentioned in section 5 above and summarized in the following list:

- Standard Operational Modes (not-squinted)
  - Spotlight 1A (operating in Single Pol and Dual Pol)
  - Spotlight 1B (operating in Single Pol and Dual Pol)
  - Spotlight 2A (operating in Single Pol and Dual Pol)
  - Spotlight 2B (operating in Single Pol and Dual Pol)
  - Spotlight 2C (operating in Single Pol and Dual Pol)
  - Stripmap (operating in Single Pol and Dual Pol)
  - Ping-Pong (operating in Dual-Pol and Quad4-Pol)
  - QuadPol
  - ScanSAR 1 (operating in Single Pol and Dual Pol)
  - ScanSAR 2 (operating in Single Pol and Dual Pol)
- Non-Standard Operational Modes (not-squinted)
  - DI2S - Multi-swath - Spotlight 2 – Optimized Swath (operating in Single Pol and Dual Pol)
- Non-Standard Experimental Modes (not-squinted)
  - DI2S - Multi-swath - Spotlight 2 – Joined (operating in Single Pol and Dual Pol)
- Non-Standard Operational modes (squinted):
  - Spotlight 2A (operating in Single Pol and Dual Pol)
  - Spotlight 2B (operating in Single Pol and Dual Pol)
  - Spotlight 2C (operating in Single Pol and Dual Pol)

Data acquired in multiple polarization modes are distributed in form of separated image products.

SAR Standard product consists of SAR signal data or SAR image (originated by standard processing of the signal data) distributed on optical or electronic media.

If some alternative approach has been in some case adopted for the product specification, it has been oriented to add value to the output data, preserving in any case the possibility for the final user to remove the effects of the additional non-standard processing applied to the data. Implementation of such policy will be better detailed in the following sections (e.g. when talking about the products radiometric equalisation).

6.1. Standard products

The COSMO-SkyMed SAR processors implement five levels of standard processing (from level 0 up to level 1D), which a specific output product corresponds to. More than one product can correspond to each processing level:

- a product obtained by a basic processing will be in the following referred with the suffix <B>;
- additionally, one or more products obtained by special processing can be considered, applying “non-standard” (from the point of view of the literature definition) operators for the product generation; such special processing will be indicated with a their own suffix. Examples of not standard products generated by standard processors are the ones referred with the suffix <F>;

The following table summarizes the feature of the COSMO-SkyMed SAR Standard Products Extended Set, which can be considered applicable independently on the instrument mode:

Proc. Lev.	Code	Sample Information	Projection
0	RAW_B	In-Phase and Quadrature of the echoed data with annexed Noise and Periodic Calibration measurements	N/A Time ordering organization within pulse and between pulses

1A	SCS_B	In-Phase and Quadrature of the focused data, Hamming weighted and radiometrically equalized	Slant Range / Azimuth (Zero-Doppler)
	SCS_U	In-Phase and Quadrature of the focused data, unweighted and not radiometrically equalized	
	SCS_F	In-Phase and Quadrature of the focused data, apodized and radiometrically equalized (only available in the Spotlight case)	
1B	DGM_B	Amplitude of the focused data, multilooked, Hamming weighted	Ground (WGS84 Ellipsoid) / Azimuth (Zero-Doppler)
	DGM_F	Amplitude of the focused data, ground projected, apodized (only available in the single-look Spotlight case)	
	QLK_B	Equal to DGM_B represented on a sub-sampled grid	
1C	GEC_B	Amplitude of the focused data, multilooked	Option 1: UTM (-80 ≤ center latitude < 84°), UPS (otherwise) Option 2: Geodetic LAT LON
	GEC_F	Amplitude of the focused data, apodized (only available in the single-look Spotlight case)	
1D	GTC_B	Backscattering coefficient of the observed scene, multilooked, with annexed the Incidence Angles Mask	Option 1: UTM (-80 ≤ center latitude < 84°), UPS (otherwise) Option 2: Geodetic LAT LON
	GTC_F	Amplitude of the focused data, apodized (only available in the single-look Spotlight case)	

Table 18 - List of products in the SAR Standard Products Extended Set

Concerning with the global accuracy, CSG SAR products can be distinguished on the basis of the class of support data used in the image formation step.

Support data for processing are mostly static products archived at the processing centre. The orbital product is the only datum needing to be dynamically provided (hence requesting higher latency time for its generation).

Standard processors can work with one of the following orbital data:

- Satellite orbital data representing the navigation solution of the on-board GPS receiver, extracted from SAR level 0 input file (L0F); such data are used in the Level 0 processing step and propagated to higher processing levels in the case any external precise orbital product isn't available; products generated with this orbital information are of poorer geolocation accuracy and are classified as Fast-Delivery products
- Orbital product generated by on-ground precision processor; if available, such orbit is used in the core of the Level 0 processor and propagated to higher processing levels; products generated with this orbital information have better geolocation accuracy and are classified as Standard-Delivery products

	Unit of measure	SPOTLIGHT (S2A / S2B / S2C) (as function of the access area)	STRIPMAP	SCANSAR / PING PONG	QUAD POL
Tneσ0(dB)	dB	−19/−17/−19 inc. angle [20°−25°] −19/−17/−17 inc. angle [25°−50°] −16.5/−17/−16 inc. angle [50°−60°]	≤−19.0	≤−19.0	
Neσ0(dB)	dB	−22/−20/−22 inc. angle [20°−50°] −19.5/−20/−19 inc. angle [50°−60°]	≤−22.0	≤−22.0	
Ambiguity over a point target	dB	≤−40.0	≤−36.0	≤−22.0	
ASR	dB	≤−20.0			
Geolocation accuracy – Nominal Delivery	m	≤3.75		≤12.0	≤3.75
Geolocation accuracy – Fast Delivery	m	≤25.0			
Geometric Conformity		≤.001			
Instantaneous Dynamic	dB/res. Cell	≥ 3.0			
Global Dynamic	dB	≥ 60.0 (*)			
PSLR	dB	≤−22.0			
SSLR	dB	≤−22.0			
ISLR	dB	≤−12.0			
IRF Shape: -6 dB / -3 dB	adim	≤1.39			
IRF Shape: -10 dB / -3 dB	adim	≤1.75			
Radiometric Accuracy	dB	≤1.0			
Radiometric Stability	dB	≤1.0			
Radiometric Linearity	dB	≤1.5			
Local RadiometricStability	dB	-	-	≤0.5	-

(*) 35dB Local dynamic + 25 dB Gain control

Table 19 - Standard Products Quality Specification

6.1.1. Level 0 Product

The RAW product contains for each sensor acquisition mode the unpacked echo data in complex in-phase and quadrature signal (I and Q) format. It is originated starting from the following input data:

- SAR Level 0 data file
- Orbital, attitude and pointing Data (only for generation of attributes)

The only processing performed to the downlinked X-band raw signal data is:

- the frame synchronization, removal of the data overstructure It consists of:
  - data deciphering;
  - extraction of the Packet Data Field;
  - data decompression;
- packet data filed re-assembly;Data decompression
- statistics estimation
- packets' reconstruction
- data formatting into the output format.

A RAW product will not ever combine data from more than one Instrument Mode, which are always packaged as two separate products.

A RAW product must be SAR processed before it can be displayed as imagery.

The Level 0 product will include a set of annotations, which detail its features in terms of:

- Time Correlation Data
- Sensor Parameters
- Orbital and attitude data
- Calibration data
- Localization info
- Raw data quality statistical parameters
- Doppler parameter of the scene evaluated on the basis of nominal mechanical and electronic antenna pointing knowledge

It's worth stating that parameters for the internal calibration of the RAW data (that is the channels' bias, imbalance and non-orthogonality) are evaluated but not applied, in order to leave the data unchanged as much as possible.

Access to this product is subject to ad hoc authorization.

6.1.2. Level 1A Product

All SAR Products at processing level 1A (SCS), can be requested starting from CSG Level 0 Data Files (L0F).

The SCS product contains for each sensor acquisition mode the focused data in complex format, in slant range and zero doppler projection.

All product at processing level 1 (with the exception of ones from Spotlight data) shall have a coverage corresponding to the full resolution area illuminated by the SAR instrument.

The following product classes can be requested

- SCS_B
- SCS_U
- SCS_F (applicable to Spotlight modes only)

SCS products include a set of attributes, which detail its features in terms of:

- Time Correlation Data
- Sensor Parameters
- Orbital and attitude data
- Calibration data
- Localisation info
- Processing parameters
- Raw data quality statistical parameters
- Product Confidence Data

Doppler Parameters (Doppler Centroid, Doppler Rate) models, are estimated separately in the range and azimuth directions from echo data.

Additional considerations depending on the instrument mode need to be done.

6.1.2.1. SCS_B Product

The basic processing features characterizing the SCS_B product are:

- Missing lines management done with a sensor mode dependant criteria; for Stripmap, QuadPol and Spotlight modes by extrapolation if lower than two, in ScanSAR and Pingpong mode by energy recovery approach
- compensation of the transmitter gain and receiver attenuation
- internal calibration on the RAW data in terms of:
  - unbiasing
  - compensation of gain imbalance
  - compensation of non-orthogonality of I and Q channels
- the data focusing according to algorithm depending on the specific instrument mode
- estimation and removal of the noise level
- compensation of the azimuth antenna pattern
- weighted processing is optionally performed with application of cosine-like windowing, so obtaining the maximum performances of the IRF features in terms of PSLR, ISLR, SSLR to the detriment of spatial resolution;
- radiometric equalization of the complex image is optionally performed in terms of:
  - compensation of the range spreading loss
  - compensation of the range antenna pattern, with off-nadir angles estimated in acquisition geometry on WGS84 ellipsoidal surface, inflated with the mean height of the scene, if available
  - compensation of the incidence angle estimated in acquisition geometry on WGS84 ellipsoidal surface, inflated with the mean height of the scene, if available
  - application of the calibration constant

Data are processed at full range and azimuth resolution; hence any multilook processing isn't applied.

6.1.2.2. SCS_U Product

SCS_U product differs from SCS_B for the following features

- a unweighted processing is performed, that is any windowing isn't applied on the processed bandwidth both in range and azimuth directions;
- the following radiometric equalization operators are suppressed
  - range spreading loss compensation
  - range antenna pattern compensation
  - incidence angle compensation

- calibration constant application

Unweighted processing performed on raw data, allows achievement of the maximum performances in terms of spatial resolution.

6.1.2.3. SCS_F Apodized Product (non-standard)

SCS_F product is available for all the Spotlight modes. The level 1A Spotlight product will be processed in a special variant where the hamming filtering is substituted by a Space Variant Apodization (NON_LINEAR) filter, which preserves the image resolution allowing at the same time to Adaptively Reduce Side Lobes.

L1A product from Spotlight data, shall not apply any shift of the azimuth spectrum of the focused signal.

6.1.2.4. ScanSAR Mode

In the case of data acquired in ScanSAR mode (both ScanSAR 1 and ScanSAR 2), the SCS product is formed by the mosaicking in the azimuth direction of the focused bursts belonging to the same subswath after the compensation in each burst of the azimuth antenna pattern in order to avoid scalloping effects.

Imaging mode	Access area (inc.angle) [degree]	Ground range coverage [km]	Azimuth coverage [km]	Range resolution (ground) [m]	Azimuth resolution [m]	Column spacing [m]	Line spacing [m]
SPOTLIGHT-2A (standard and apodized)	[20, 25]	7.3	3.1	≤ 0.6	≤ 0.4	Natural	≈ 0.25
	[25, 50]	7.3	3.2	≤ 0.5	≤ 0.4		≈ 0.25
	[50, 60]	7.3	4.4	≤ 0.5	≤ 0.4	Natural	≈ 0.25
SPOTLIGHT-2B (standard and apodized)	[20, 60]	10.0	10.0	≤ 0.7	≤ 0.7	Natural	≈ 0.45
SPOTLIGHT-2C (standard and apodized)	[20, 60]	10.0	5.0	≤ 0.8	≤ 0.8	Natural	≈ 0.56
STRIPMAP	[20, 50]	≈ 40.0	≈ 40.0	≤ 3.0	≤ 3.0	Natural	Natural
PING PONG	[20, 60]	≈ 30.0	≈ 30.0	≤ 5.0	≤ 12.0	Natural	8.00
QUADPOL	[20, 45]	≈ 15.0	≈ 40.0	≤ 3.0	≤ 3.0	Natural	Natural
SCANSAR 1	[20, 50]	≈ 100.0	≈ 100.0	≤ 4.0	≤ 20.0	Natural	14.00
SCANSAR 2	[20, 50]	≈ 200.0	≈ 200.0	≤ 6.0	≤ 40.0	Natural	27.00

DI2S (standard and apodized)	[20, 45]	4.0	10.0	≤ 0.7	≤ 0.7	Natural	≈ 0.45

Table 20 - L1A Product Features

6.1.3. Level 1B Product

All SAR Products at processing level 1B (DGM), can be requested starting from CSG Level 0 Data Files (L0F).

The DGM product contains for each sensor acquisition mode focused data, amplitude detected, optionally despeckled by multi-looking approach, radiometrically equalized and represented in ground /azimuth projection.

6.1.3.1. DGM_B Product

The basic processing features characterizing the DGM_B product are:

- the same ones previously detailed for the generation of the SCS_B product, but suppressing the weighting of the processed bandwidth
- multi-looking processing with weighted processing on each look, oriented to reduce the speckle on the image; if necessary, oversampling interpolation is performed to prevent problems deriving from band enlargement due to detection operation
- the ground projection on the WGS84 ellipsoid
- the image detection that starting from the complex data originates the signal amplitude

The projection to ground is done by a one-dimensional interpolation. Due to non-linear nature of the Slant range to Ground projection, the ground range resolution in the DGM product slightly varies over range.

As far as the multi-look design approach, CSG provides the opportunity to select the multi-look level within a predefined set of values defined adopting the following basic criteria:

- Availability of a single-look product for the maximum exploitation of the spatial resolution
- Achievement of squared resolution cell for all multi-looking levels
- Availability of a multi-looking entry level using the minimum number of looks for achievement of a squared resolution cell
- Availability of a multi-looking level generating a product having resolution features inherited from CSK
- Maximum exploitation of the radar pulse bandwidth

The product will include a set of annotations, which detail its features in terms of:

- Time Correlation Data
- Sensor Parameters
- Orbital and attitude data
- Calibration data
- Localisation info
- Ground projection parameters
- Processing parameters (including those specific to multilooking and ground projection)
- Raw data quality statistical parameters
- Product Confidence Data

6.1.3.2. QLK_B Product

The Quick Look Product (in the following referred as QLK) is a low resolution synoptic of the entire datum allowing having a look to the image content in a faster way than by inspecting the full resolution product.

It is originated from the Level 0 product starting from the entire Image Segment File making use of the standard Level 1B processor. The Quick Look Product is mainly used for cataloguing purposes.

6.1.3.3. Special DSM_W Product

The DSM_W product contains for each sensor acquisition mode the focused data, detected, optionally multi-looked, radiometrically equalized according to the same rules used for the generation of the DGM_B product. Such product, which is represented in zero-Doppler geometry by the slant-range/azimuth projection, will be used as input for generation of Level 1D standard product.

6.1.3.4. DGM_F and DSM_F Apodized Product (non-standard)

Level 1B products DGM_F and DSM_F (inheriting their projection features from DGM_B and DSM_W products), compliant with a limited set of requirements, can be also originated from SCS_F product only if the requested multilooking factor in range/azimuth direction is equal to 1 x 1.

6.1.3.5. ScanSAR Mode

In the case of data acquired in ScanSAR mode (both ScanSAR 1 and ScanSAR 2), the DGM product is obtained by the mosaicking both in range and azimuth direction of the processed bursts. For this reason, in order to minimize the beam boundary effects, for this class of products the calibration constant is applied to all subswaths composing the SAR image.

6.1.4. Level 1C Product

All SAR Products at processing level 1C (GEC), can be requested starting from CSG Level 0 Data Files (L0F).

The GEC product contains for each sensor acquisition mode the focused data, amplitude detected, optionally despeckled by multi-looking approach, geolocated on the reference ellipsoid and represented in a uniform preselected cartographic presentation. Any geometric correction derived by usage of terrain model isn’t applied to this product as default.

6.1.4.1. GEC_B Product

The basic processing features characterizing the GEC_B are fully inherited from DGM_B product, with the only difference of the cartographic representation.

The data shall be aligned with the north direction. The area of the product, outside the SAR sensed image data, shall be filled with invalid value because of the rotation to align with North.

The product will include a set of annotations, which detail its features in terms of:

- Time Correlation Data
- Sensor Parameters
- Orbital and attitude data
- Calibration data
- Localization info
- Processing parameters (including those specific to multilooking)
- Raw data quality statistical parameters
- Product Confidence Data
- Doppler Parameters (Doppler Centroid, Doppler Rate)
- Geolocation Parameters

The same processing features peculiar to various instrument modes, detailed for Level 1B product, are applicable to Level 1C, too.

6.1.4.2. GEC_F Apodized Product (non-standard)

Level 1C products, compliant with a limited set of requirements, can be also originated from DGM_F product only if the requested multilooking factor in range/azimuth direction is equal to 1 x 1.

6.1.5. Level 1D Product.

All SAR Products at processing level 1D (GTC), can be requested starting from CSG Level 0 Data Files (L0F).

The GTC product contains for each sensor acquisition mode the focused data, fully calibrated with the usage of terrain model, amplitude detected, optionally despeckled by multi-looking approach, geolocated on a DEM and represented in a uniform preselected cartographic presentation. The planimetric accuracy of the product will depend on DEM accuracy.

6.1.5.1. GTC_B Product

The processing features characterizing the GTC_B product are similar to that ones listed for the processing Level 1C with the following differences:

- usage of DEM for the ground projection
- usage of DEM for the estimation/compensation of the range antenna pattern and incidence angle
- application of the calibration constant to derive the backscattering coefficient

Image is represented in linear scale.

The product will include a set of annotations, which detail its features in terms of:

- Time Correlation Data
- Sensor Parameters
- Orbital and attitude data
- Calibration data
- Localization info
- Processing parameters (including those specific to multilooking)
- Raw data quality statistical parameters
- Product Confidence Data
- Doppler Parameters (Doppler Centroid, Doppler Rate)
- Geolocation Parameters

The same processing features peculiar to various instrument modes, detailed for Level 1B product, are applicable to Level 1D, too

The GTC product includes an additional layer representing the mask (coregistered with the GTC product, therefore in the same cartographic projection) of the incidence angles at which each pixel included into the GTC SAR data had been acquired. Such angle is measured between the target to sensor direction and local normal to the terrain (not projected on the acquisition plane).

In the case of data acquired in Spotlight mode, the incidence angles included in the GIM layer are defined supposing a zero-doppler geometry for the scene observation; hence, implication on the incidence angle evaluation deriving from the antenna azimuth steering scheme are not considered.

This layer also gives information about conditions of layover and shadowing occurred at the sensing time due to particular acquisition geometry and terrain topography.

The following table, summarizes the coding key of the GIM layer annexed to Level 1D products:

Sample Information	Pixel Value
Incidence Angle	The radar wave incidence angle in hundredths of a degree (as detailed above), if the corresponding GTC pixel wasn't observed under layover or shadowing conditions (the allowed dynamic for such pixels is [–9000, 9000] corresponding to incidence angles ranging in the interval [-90°, 90°])
Layover Code	9999
Shadowing Code	-9999

Table 21 - GIM layer coding key

The GTC product also includes an additional layer representing the matrix (coregistered with a sub-sampled representation of the SAR image, therefore in the same cartographic projection) of the elevation angles at which SAR data had been acquired. Such angle is measured between the target to sensor direction and local normal to the terrain (not projected on the acquisition plane).

The following table, summarizes the coding key of the GEM layer annexed to Level 1D products:

Sample Information	Pixel Value
Elevation Angle	The target unsigned elevation angle in hundredths of a degree measured with respect to the geodetic nadir

Table 22 - GEM layer coding key

6.1.5.2. GTC_F Apodized Product (non-standard)

Level 1D products, compliant with a limited set of requirements, can be also originated from DGM_F product, only if the requested multilooking factor in range/azimuth direction is equal to 1 x 1.

	Multilook ID	Number of Range Looks	Number of Azimuth Looks	Ground Range Resolution (as function of incidence angle) [m]	Azimuth resolution [m]	Column Spacing [m]	Line Spacing [m]	Justification
SPOTLIGHT-2A	#1	1	1	[0.3, as L1A]	as L1A	0.15 0.12 (apo)	0.15 0.12 (apo)	Single-look CSK legacy
	#2	2	2	(0.6, 0.8)	≤ 0.7	0.30	0.30	Multi-looking entry level
	#3	3	3	[1.00, 1.1)	≤ 1.0	0.45	0.45	
SPOTLIGHT-2B and DI2S	#1	1	1	[0.5, as L1A]	as L1A	0.25 0.20 (apo)	0.25 0.20 (apo)	Single-look CSK legacy

	#2	2	2	[1.0, 1.2]	≤ 1.2	0.50	0.50	Multi-looking entry level
	#3	4	4	(2.1, 2.4)	≤ 2.3	1.00	1.00	
SPOTLIGHT-2C	#1	1	1	as L1A	as L1A	0.30 0.24 (apo)	0.30 0.24 (apo)	Single-look CSK legacy
	#2	2	2	≤ (1.3, 1.5)	≤ 1.4	0.60	0.60	Multi-looking entry level
	#3	3	3	≤ (1.9, 2.2)	≤ 2.1	0.90	0.90	

Table 23 - L1B/L1C/L1D standard and apodized Spotlight products features

	Multilook ID	**Number of Range Looks**	**Number of Azimuth Looks**	**Ground Range Resolution (as function of incidence angle)**	**Azimuth Resolution [m]**	**Column Spacing [m]**	**Line Spacing [m]**	**Justification**
STRIPMAP and QUADPOL	#1	1	1	[2.7, as L1A]	as L1A	1.25	1.25	Single-look
	#2	2	2	[5.4, 6.7]	≤ 5,6	2.50	2.50	CSK legacy
	#3	4	4	[10.8, 13.5]	≤ 11.2	5	5	
SCANSAR1	#1	3	1	[10.8, 13.5]	as L1A	5	5	Single-look (in azimuth), square pixel
	#2	5	1	[21.5, 27.0]	≤ 23.0	10	10	Square resolution entry level
	#3	8	2	[32.0, 40.0]	≤ 35.0	15	15	CSK legacy
SCANSAR2	#1	4	1	[21.0, 27.0]	as L1A	10	10	Single-look (in azimuth), square pixel
	#2	7	1	[42.0 54.0]	≤ 47.0	20	20	Square resolution entry level
	#3	16	3	[106.0, 135.0]	≤ 115.0	50	50	CSK legacy
PING PONG	#1	1	1	[4.2, 5.9]	as L1A	2	2	Single-look
	#2	2	1	[8.5, 10.0]	as L1A	4	4	Multi-looking entry level
	#3	5	2	[21.5, 25.5]	≤ 22.5	10	10	CSK legacy

Table 24 - L1B/L1C/L1D standard non-Spotlight products features

6.2. Non Standard Products Higher Level Products

This is the list of the available non standard products:

Non-standard prod.	Description
Quicklook	L1B product using an appropriate configuration of multilooking parameters allowing generation of an image of small size
Speckle Filtered	L1B speckle filtered using a filter among: Mean, Median, Frost, Lee, Kuan, Enhanced Lee, Enhanced Frost, Gamma MAP
Coregistered	A pair of L1A (complex) or L1B (real) images acquired on the same area and represented on the same reference grid. The slave image must be re-sampled into the master geometry in order to be super-imposed in a pixel by pixel base
Interferometric	Generated starting from a pairs of L1A (complex) co-registered image. An external DEM can be used. It consists of two layers: • the interferometric phase: the wrapped phase difference between the two input images without the contribution due to a reference surface (DEM or ellipsoid) • the interferometric phase model: the phase contribution due to this reference surface
Coherence	The interferometric coherence processing consists of the following main steps: (I) interferometric processing, (II) filtering, and (III) cross-correlation estimation
DEM	Generated by using SAR Interferometry technique applied to pairs SAR images
Mosaicked	Aggregation of homogeneous Level 1D images (MOS_D) or DEMs (MOS_H) into a common grid (no apparent discontinuities at the border of the overlapping areas)
Cropped	Sub-frame of a standard size product

Table 25 - CSK Non Standard Products and Services

In the following table the list of the CSG services for the generation of high level products, named Non-Standard Products, for civilian application is reported.

Service Name	Description
MOS_B	Mosaicked Level-1B product (MOS_B) - from catalogue
MOS_C	Mosaicked Level-1C product (MOS_C) - from catalogue
MOS_D	Mosaicked Level-1D product (MOS_D) - from catalogue
CRG_A_from_SCS_B	Co-registered Level-1A product (CRG_A through SCS_B) - from catalogue. Please, before submitting a request, read carefully HELP on www.cosmo-skymed.it to get constraints.

CRG_A_from_SCS_U	Co-registered unweighted Level-1A product (CRG_A through SCS_U) - from catalogue. Please, before submitting a request, read carefully HELP on www.cosmo-skymed.it to get constraints.
CRG_B	Co-registered Level-1B product (CRG_B) - from catalogue
SPF_B	Level-1B speckle filtered product (SPF_B) - from catalogue
GEC_B speckle filtered	Level-1C speckle filtered product (GEC_B SF) - from catalogue
GTC_B speckle filtered	Level-1D speckle filtered product (GTC_B SF) - from catalogue
MOS_H	Mosaicked Digital Terrain Model product (MOS_H) - from catalogue
MOS_B from CRG	Co-registered and mosaicked Level-1B product (MOS_B through CRG) - from catalogue
IPH/COH	Interferometric and Coherence map - from Catalogue
DEM_H	Digital Elevation Model - from Catalogue

Table 26 - CSK Non Standard Products and Services

6.2.1. Quick Look Product

In CSG, the Quick Look product (QLK_B) is generated starting from the Level 0 data (the entire Image Segment File) making use of the Level 1B standard processor.

For this reason, it can be seen as a special L1B product using an appropriate configuration of multilooking parameters allowing generation of an image of small size, allowing a fast synoptic displaying of the entire scene by common software tool, generated having a full control on a limited significant set of product performance (geometric resolution and geolocation accuracy). It is mainly used for cataloguing purposes. It includes a raster image layer represented in floating point mode using ground/azimuth projection; any part of the image dynamic isn't destroyed; for this reason, this layer could be used for measurement of the IRF performance on point targets. The same set of annotations characterizing the Level 1B product is included into the QLK product.

The following table shows the QLK products features for all CSG sensing modes.

	Ground Range Resolution [m]	**Azimuth Resolution [m]**	**Column Spacing [m]**	**Line Spacing [m]**
S2A	≈ 10	≈ 10	5	5
S2B DI2S	≈ 25	≈ 25	10	1
S2C	≈ 20	≈ 20	6	6
STRIPMAP QUADPOL	≈100	≈100	40	40

SCANSAR1	≈ 250	≈ 250	100	100
SCANSAR2	≈ 500	≈ 500	200	200
PING PONG	≈100	≈100	30	30

Table 27 - QLK_B product specifications

6.2.2. Speckle Filtered Product

The Speckle Filtered product contains, for each sensor acquisition mode, focused, detected, radiometrically equalized, ground /azimuth projected, multilooked and speckle filtered data, to suppress the speckle noise and increase the Equivalent Number of Looks aiming at improving the radiometric resolution of the SAR Standard images. The Speckle Filtered product is generated starting from Level 1B products. It will preserve the characteristics of the input products, in terms of spatial coverage, image dimensions, pixel spacing, number of bands (more than one in case of multi-polarimetric acquisition modes), image projection (azimuth - ground) and will be equivalent to a standard L1B product in order to guarantee further processing as if it was an L1B product. This product will be generated using a user-selectable speckle filter and processing parameters. The foreseen filters and the associated configurable parameters are detailed in the table 8, together with the family each filter belongs to. As a default, the Speckle Filtered Product will be generated using the "Gamma MAP" filter.

Speckle Filter	Family	Parameters
Mean	Non-Adaptive	moving window size
Median		
Frost	Adaptive MMSE	moving window size, equivalent number of look (can be estimated)
Lee		
Kuan		
Enhanced Lee		
Enhanced Frost		
Gamma MAP	Adaptive MAP	
Crimmins	Morphological	number of iterations

Table 28 - Implemented speckle filters

6.2.3. Coregistered Product

A CSG co-registered product consists of a pair of CSG Level 1A (complex) or Level 1B (real) images acquired on the same area and represented on the same reference grid. The reference image is named master and the other, named slave, must be re-sampled into the master geometry in order to be super-imposed in a pixel by pixel base. As a result of that the re-interpolated slave image can include a bounding box filled by invalid pixel corresponding to the missing overlap area with the master image. The co-registered product inherits the same characteristics of the input master product in term of data type, number of bands, number of rows/columns, projection and spacing. The following table summarizes the basic features of Coregistered products originated in CSG.

Code	Sample Information	Projection

CRG_A	In-Phase and Quadrature of the focused data, inheriting features from the input product (SCS_U or SCS_B), co-registered with a master reference image. The master image is left unchanged	Slant range /Azimuth grid of the master reference image
CRG_B	Amplitude of the focused data, multilooked, Hamming weighted The master image is left unchanged	Ground / Azimuth grid of the master reference image

Table 29 - Coregistered product basic features

In CSG two main categories of images are considered in input to the co-registration processor: images acquired in interferometric and non-interferometric modes. The policies on the input data for the two co-registration methods are reported in the following table 10. If all the policies are not contemporary satisfied the co-registration process will be aborted.

	Coregistration of interferometric acquisitions	**Coregistration of non interferometric acquisitions**	**Notes**
Sensor mode	Only the same. The following sensor modes are allowed for L1A coregistration: Spotlight not-squinted modes; Stripmap; QuadPol. All sensor modes (but Spotlight squinted ones) are allowed for L1B coregistration:	Only the same	It is not possible to co-register data acquired in different sensor modes
Polarization	Only the same	Only the same	Coregistration on distinct single polarization files
Interferometric orthogonal baseline	Less than 2 km	N/A	
Spectral overlap	Greater than 50%	Any	The difference in the Doppler frequency causes phase de-correlation and, the matching algorithm based on phase information could be not able to identify correspondences between the input images.

Spatial Overlap	Range overlap depending on the interferometric baseline. Azimuth overlap must be greater than 50%.	Greater than 50% on the observed area	Allowed a significant shift between images only in azimuth direction for Stripmap, QuadPol, ScanSAR and Pingpong acquisition modes. In Spotlight mode the shift is allowed only in range direction and only for images acquired with the same beam.
Satellite track	Only the same	No functional constraints	The geometric deformations on the amplitude SAR image change significantly on orbits too far away and it is not possible to find overall matching between the two input images.
Look angle	Only the same	No constraints	The phase information is not preserved on images acquired with different look angle or opposite look sides and/or orbit directions. The geometric deformations on the amplitude SAR image change significantly with the incidence angle and it is not possible to find matching between the two input images.
Look side (left / right)	Only the same	No functional constraints	
Orbit direction (ascending / descending)	Only the same	No functional constraints	
Time delay between the acquisitions	Any	Any	The co-registration based on phase information requires an high coherence of the observed scene in order to allows a correct matching. Usually, this is possible only considering short revisit time or on arid terrain.
Processing level	Level 1A or Level 1B	Level 1B	
Maximum number of products	Up to 5 slave images coregistered w.r.t. a master image		

Table 30 - Coregistration input data policies

6.2.4. Interferometric Product

The interferometric product is generated starting from a pairs of CSG Level 1A (complex) co-registered images. An external DEM can be used to remove topographic signatures from the interferometric phase and reduce geometric decorrelation effects. The images forming the interferometric pair can come from acquisitions taken at different times using the same or different sensors. In CSG only images acquired with the same sensor mode, the same look angle, the same wavelength and the same polarization are considered as input for interferometric product generation. The interferometric processing consists of the following main steps: interferometric phase model estimation, image filtering, full resolution interferogram generation, interferogram filtering. The interferogram product consists of two layers: the interferometric phase and the interferometric phase model. The first layer represents the wrapped phase difference between the two input images without the contribution due to a reference surface (DEM or ellipsoid); the second represents the phase contribution due to this reference surface. They are presented in radar coordinate system (azimuth – slant range) and the spatial resolution depends on the acquisition mode and the adopted filters. The policies on the input data are reported in the following table. If all the policies are not contemporary satisfied the coherence product generation process will be aborted.

	Interferometric phase	**Notes**
Sensor mode	Only the same The following sensor modes are allowed: Spotlight not-squinted modes; Stripmap; QuadPol.	It is not possible to compute the coherence of data acquired in different sensor modes
Polarization	Only the same	Distinct single polarization files
Interferometric baseline	Less than 2 km	
Spectral overlap	Greater than 50%	The range and Doppler band overlap has to be greater than 50% in order to allow an estimation of the cross-correlation coefficient. A reduction of the spatial resolution up to 50% could be necessary to reduce spectral decorrelation effects. In particular, for images acquired in Spotlight, it is necessary to synchronize the acquisitions otherwise the interferometric coherence will decrease and the product will result poor or completely unfeasible.
Satellite track	Only the same	
Look angle	Only the same	The phase information is not preserved on images acquired with different look angles or opposite look side and/or orbit direction..
Look side (left / right)	Only the same	
Orbit direction (ascending / descending)	Only the same	
Time delay between the acquisitions	Any	It is allowed any time difference between the acquisitions. However, regardless the observed scene, the probability to observe coherent objects decrease with the time difference between the two acquisitions.
Input Product level	Only Level 1A	

Table 31 - Interferometric Product input data policies

6.2.5. Coherence Product

The interferometric coherence processing consists of the following main steps: (I) interferometric processing, (II) filtering, and (III) cross-correlation estimation. It is generated starting from the same pairs of CSG image as the interferometric product. The policies on the input data are the same defined for interferometric product listed in the Table above. If all the policies are not contemporary satisfied the coherence product generation process will be aborted. The coherence product consists of one layer; it represents the correlation coefficient of the SAR images forming the interferometric pair.

6.2.6. DEM Product

The CSG DEM product is generated by using Synthetic Aperture Radar (SAR) Interferometry technique applied to pairs SAR images acquired with the same sensor mode, the same look angle, the same look direction, the same wavelength and the same polarization, and a suitable spatial baseline. It is foreseen the processing only of standard frames and not long stripes. The product to be provided requires as input a few interferometric pairs with different acquisition geometries (e.g. ascending/descending, left/right) and different baselines, relative to the area of interest. Regardless the number of input interferometric pairs, the product consists of two layers: DEM (georeferenced digital elevation model of the observed scene) and HEM (estimated height error values associated to each pixel of the DEM). The elevation and the associated error estimation are expressed in meter with respect to the reference ellipsoid WGS84. The policies on the input data are reported in the table 12. If all the policies are not contemporary satisfied the DEM product generation process will be aborted.

The following table shows the input data policies to generate DEM product using up to height interferometric pairs, also combining different baseline, orbit directions and look side in order to recover layover and shadow effects. In CSG considering pairs of non-tandem interferometric acquisitions (more than about 20 s between the acquisitions), the interferometric processing allows improving only the spatial resolution and the local relative accuracy of a mandatory input low resolution DEM, but does not allow recovering the systematic errors that impact on the absolute accuracy. This improvement is possible only in correspondence of areas with sufficient coherence, elsewhere the input low resolution DEM is left unchanged.

	Interferometric DEM	**Notes**
Sensor mode	Only the same. DEM generation allowed only from Spotlight, Stripmap, QuadPol modes	It is not possible to compute the coherence of data acquired in different sensor modes.
Polarization	Only the same into the entire set of interferometric pairs	Multi-polarization acquisitions are managed by separated instances of co-registration processor working on distinct single polarization files
Look angle	Only the same into a single observation geometry	The phase information is not preserved on images acquired with different look angles.
Interferometric baseline	Sensor mode dependant	

Spectral overlap	Greater than 80%	The range and Doppler band overlap of each interferometric pair has to be greater than 80% to reduce spectral decorrelation effects. In Spotlight mode it is necessary to synchronize the acquisitions otherwise the interferometric coherence will decrease and the product will result poor or completely unfeasible.
Spatial Overlap	Range overlap depending on the interferometric baseline. The intersection area among all the products concurring to the interferometric DEM shall be greater than 70% of the extension of the master product of the 1st geometry	In case of Spotlight mode the shift is expected only in range direction; azimuth spatial shift represents a condition for violation of the spectral overlap constraints.
Look side (left / right)	Any. Only the same into a single observation geometry	The phase information is not preserved on images acquired with opposite look sides or orbit direction. Each interferometric pair has to be acquires with the same look side and the same orbit direction, but pairs with opposite look sides and/or orbit direction can be combined in order to recover layover/shadow effects.
Orbit direction (ascending / descending)	Any	
Time delay between the acquisitions	Any	It is allowed any time difference between the acquisitions. However, the time decorrelation effects can limit the feasibility of the product.

Table 32 - Interferometric DEM Product input data policies

	Interferometric DEM	Notes
Number of interferometric pairs	At least 1 and up to 8 interferometric pairs	The following scenarios are allowed: • 1 pair • 2 pairs, same geometry, different baseline (MultiBaseline mode) • 2 pairs, different geometry AscDesc or LeftRight (Fusion-2 mode) • 4 pairs, including two quartets, each of them exploiting MultiBaseline capacity in a peculiar geometry (MultiBaseline & Fusion-2 mode) • 4 pairs, each of them in a peculiar geometry (Fusion-4 mode) • 6 pairs, including three quartets, each of them exploiting MultiBaseline capacity in a peculiar geometry (MultiBaseline & Fusion-2 mode) • 8 pairs, including four quartets, each of them in a peculiar geometry (MultiBaseline & Fusion-4 mode)

Table 33 - MultiBaseline and Fusion mode input data policies

6.2.7. Mosaicked product

The mosaicked product consists in an aggregation of homogeneous Level 1D images (MOS_D) or DEMs (MOS_H) into a common grid, in order to generate a unique composite image without apparent discontinuities at the border of the overlapping areas. The main steps of the mosaicking processing are: (I) estimation and correction of systematic horizontal errors; (II) estimation and correction of radiometric/vertical systematic errors; (III) data fusion. In the case of L1D images only the layer of SAR data shall be mosaicked, hence excluding the incidence angle mask. In the case of DEMs, the mosaicked HEM is also included into the output product. The mosaicked product is in the same projection of the input data, with spacing selectable between a set of values ranging between the finest and a multiple of the coarsest input data resolution. The size of the mosaicked products is variable, depending on the output coverage and spacing. The maximum allowed size for a Mosaicked product is 32 Gb. The policies on the input data for MOS_D and MOS_H products are reported in the following tables. If all the policies are not contemporary satisfied the mosaicked product generation process would be aborted.

	Mosaic of L1D images	Notes
Sensor mode, Polarization, Satellite track, Look side (left / right), Orbit direction (ascending / descending)	Any	The mosaicked product may exhibit negligible discontinuities at the stitching edges only if homogeneous tiles (in terms of look side, orbit direction, polarization, sensor mode, satellite track) are mosaicked. Any other sensing scenarios may go to the detriment of the product final result. Mosaicking of not-homogeneous data is provided only for experimental purposes.
Projection	Only the same	The input L1D Products must be in the same projection, zone and grid. Please, note that if the images to be mosaicked are not pertaining to the same UTM zone, mosaic cannot be performed.
Processing level	Only Level 1D	

Table 34 - MOS_D product input data policies

	Mosaic of DEM products	Notes
Sensor mode, Look side (left / right), Orbit direction (ascending / descending)	Any	The mosaicked product may exhibit negligible discontinuities at the stitching edges only if homogeneous tiles (in terms of look side, orbit direction, polarization, sensor mode, satellite track) are mosaicked. Any other sensing scenarios may go to the detriment of the product final result. Mosaicking of not-homogeneous data is provided only for experimental purposes.
Projection	Only the same	The input DEMs must be in the same projection and zone. Please, note that if the DEMs to be mosaicked are not pertaining to the same UTM zone, mosaic cannot be performed.
Processing level	DEM	

Table 35 - MOS_H product input data policies

6.2.8. Cropped Product

Cropped product represents a sub-frame of a standard size product. A storage structure identical to that one used for the representation of the corresponding full size product, will be exploited for the cropped product formatting. The obtained product will include a set of annotations, extracted from the native full-size product and updated in function of the selected sub-frame. The cropped products can be given in input to further processing levels according to the same policy applicable to the original products they have been cropped from. The following table lists the products for which the “cropped product" shall be requested.

SAR Product Level	Sensor Modes
1A	Spotlight, Stripmap, QuadPol, Pingpong
1B	All
1C	All
1D	All
SPF	All
IPH	Spotlight, Stripmap, QuadPol
COH	Spotlight, Stripmap, QuadPol
DEM	Spotlight, Stripmap, QuadPol
MOS_D	All
MOS_H	Spotlight, Stripmap, QuadPol

Table 36 - Cropped product input data policies

7. ON-DEMAND SERVICES

A key point to satisfy the Users of an on-demand EO system is the timely provision of data while assuring confidentiality and integrity of data and a high availability of the system. To this aim, the following services and features have been introduced or improved w.r.t. CSK:

- New concept of Crisis Requests and a new management of absolute priority
- Very Urgent Service, improving the response time w.r.t. CSK
- Last Minute Planning
- Near Real Time data delivery
- Separate Acquisition and Processing/Delivery priorities
- On-demand area coverage

7.1. Acquisition Requests with diversified priorities

Depending on their rights, users can submit Acquisition Requests (AR) with different levels of priority. The following levels of priority are CSK heritage:

- High Priority (HP, for Italian Governmental Users)
- Privileged Priority (PP, for Privileged Civilian Users)
- Routine (RTN, class 1-4)

CSG will add a further (higher) level of priority – named Crisis (CRS) – which can be used by Governmental and Privileged Civilian users when requesting acquisitions over a Crisis Area.

All Users requests (including the routine ones) are ranked by means of innovative adaptive planning algorithms implemented in the mission planning service (S-PLA).

It is worth noting that in order to optimize the overall plan, CSG will be able to fill the schedule of the already allocated ranked requests with the set of unranked Routine requests (RTN, class 5), namely background mission.

7.2. Very Urgent Service

In CSG the acquisition of Very Urgent (VU) requests is a service (for authorized users only) that can be deposited via web. This implies no need to modify the timeline of the nominal Routine Mode and no need for a mission mode reconfiguration (the so called “mode change” of CSK).

As VU AR is asynchronous, the authorized user is allowed to deposit the AR and to define the acquisition parameters (e.g. target coordinates) just before the command uplink windows, without need of a “recovery point” in the Mission Plan. This allows to reduce the actual response time by several hours w.r.t. CSK.

The VU will modify the current nominal Mission Plan by inserting the VU ARs and removing (if needed) just a few ARs which either are in conflict with the VU ones or deplete the system resources needed by the VU ARs.

It is worth noting that it will be possible to submit more than one VU request, conversely in CSK the VU was a mission mode reconfiguration aimed at serving one single AR.

7.3. Last Minute Planning

The Last Minute Planning (LMP) is conceptually similar to VU, but it is synchronous and not impacting the nominal mission plan (of other users). Hence, in principle, the LMP service might be permitted to any User.

It consists on an orbital segment “pre-booking” performed by a User. This “booking” will undergo the nominal planning process like any AR, as it “uses” system resources and it is ranked on the base of the priority rights of the User. If the orbital segment “booking” is planned, its owner will be able to deposit an actual AR on it at the latest possible time (prior to the last command uplink window), without affecting in any way the other ARs in the mission plan.

The orbital segment "booking" is characterized by specified look angle (right or left looking), specified length and by a resources consumption which envelopes all possible acquisition modes.

In terms of planning constraints to other ARs, the cost of the "booking" depends on the "booking" only (not on the actual acquisitions on it). Hence, the User's programming rights shall be consumed on the basis of the "booking" (worst case consumption of all the resources), regardless for the actual resources consumption of the real AR.

The LMP also allows to substitute an AR with another of the same User, provided that the new AR has a resources consumption less than or equal to the old one.

It is important to highlight that the LMP is not associated to a dedicated priority level but it has the priority of any other request (CRS, HP, PP or Routine).

7.4. Near Real Time data delivery

For Users interested in Near Real Time (NRT) acquisitions, CSG implements the following innovations or improvements w.r.t CSK:

- Processing and Delivery Priority: a request flagged as NRT benefits of a high level of priority both in routing of the satellite raw data from the external stations and in processing and delivery at the User Ground Segment. It is important to highlight that this priority is completely independent w.r.t. the acquisition priority, indeed a NRT request, if acquired, is routed, processed and delivered before a request having higher acquisition priority, but not having a NRT relevance;
- Significantly improved processing time w.r.t. CSK, despite CSG products have a much increased volume;
- Pass-through requests: the acquisitions performed in visibility of an X-band ground station can be requested as "pass-through". It is worth noting that as the planner tries to download an acquisition ASAP, it would always try to download in pass-through any AR taken in visibility of a ground station. Hence the pass-through flag means that the User is NOT interested in the image unless it is immediately downloaded. If this is not possible, the acquisition is rejected by the mission planner, avoiding wasting the User's programming rights (for an acquisition that is no longer desired) and leaving room for other ARs;
- Fast Delivery Geolocation: any NRT request is processed without waiting for accurate orbital estimate, using just the orbital information provided by the satellite inside the science raw data stream. The geolocation accuracy for the fast delivery is of 25 minutes in any acquisition mode.

7.5. On-demand area coverage

CSG will provide Users with the possibility to request the coverage of an area with new acquisitions only or using also past acquisitions, in this case the area of interest can be served with a mix of new acquisitions and archived data (or just archived data if available).

7.6. Service Requests from the Catalogue

The CSG improvements w.r.t CSK include also the Service Requests from the Catalogue. Regarding it a new web-interface should improve the User experience in searching and ordering from the catalogue, moreover the response time of Products Requests from the archive will benefit from the introduction of the already cited Processing and Delivery Priority parameter.

8. PRE-PROGRAMMED MONITORING

CSG has been defined as a system with two different mission operational modes: primary on demand and secondary background. Based on lesson learnt from CSK exploitation, Mission Requirements have been defined in order to allow for a continuous interferometric monitoring of the Italian territory (the so called Map Italy project), without any interference with government priority requests. In fact, pre-programmed monitoring can have a fundamental value for some Civilian Users, thus deserving a high priority of acquisition. Moreover, even when acquisitions do not have a major priority in the short period, having a considerable archive can turn out to be a significant advantage in the long period exploitation. Moving from these considerations, the following services and features have been introduced or improved w.r.t. CSK:

- Reserved Orbital Segments for Italian territory monitoring
- Automatic background mission

8.1. Italian territory monitoring (Map Italy)

The continuous Italian territory monitoring is aimed to establish an archive of acquisitions which can be used, for instance, for Civil Protection reasons.

With the aim of creating a regularly updated interferometric archive, according to the specific needs of the Civil Protection Department, in 2009 the ASI activated the Map Italy project, a full interferometric mapping service of the whole National territory based on Stripmap HIMAGE acquisitions, both in Ascending and in Descending orbit direction, using the COSMO-SkyMed Mission.

Thanks to this project, called Map Italy, historical series of images are acquired on the Italian territory in order to use them for interferometric analysis of instability phenomenon and endogenous risk of the same territory (seismic and volcanic phenomenon, landslides, subsidence, etc.). Due to the strategic importance of Map Italy project, it was agreed to increase the priority level of this interferometry mission, which started as a “background mission”.

The Map Italy data archive has proven invaluable for tracking ground deformation and surface change. The same availability of long time series acquired regularly on the same site, up to hundreds of images over a decade of observation, is a fundamental requisite for being able to set up ordinary high frequency, frequency monitoring activities. In this way, it is possible to verify the state of conservation and, on the contrary, identify events of damage, accidental or intentional, natural or anthropic, which could intervene over time, in certain cases even without any warning or possibility of intervening, if not at happened event.

CSG guarantees the acquisitions over the Italian territory by means of Reserved Orbital Segments (agreed upon by the System Owners). In principle, these orbital segments are reserved to Privileged Civilian use for the monitoring of Italian territory. Anyhow, any User can request a routine acquisition over a reserved segment, but, obviously, it would be rejected if conflicting with a Privileged Priority acquisition request. At the same time, even though Reserved Segments are conceived for continuous monitoring, they are overridden by Crisis or Very Urgent requests.

8.2. Automatic background mission

A COSMO-SkyMed Background Mission has been implemented starting in 2011 to build up consistent and strategic data sets considering the overall mission objectives and maximizing the system exploitation during the operational lifetime of the constellation, without affecting in any way the Users requests plan. The background mission applies a systematic low priority acquisition strategy, to obtain regular, repetitive and comparable acquisitions. Focus of this background mission is to make available to institutional and commercial user a data archive characterized by systematic acquisition over large areas. Such data archive has proven to be very useful in the past both for institutional that commercial users. In fact, the availability of such data to archive has made possible the development and implementation of new applications and value-added products without the limitation of waiting the time required for data acquisition. Access to an archive of reference data is crucial for applications of Emergency response.

9. CIVILIAN USERS ACCESS TO THE SYSTEM

COSMO-SkyMed Civilian users are divided into 2 macro classes of users:

- Institutional Civilian User
- Commercial User

Institutional users can request new acquisitions and standard products via ASI web site (www.asi.it):

- CSK Service: the products already provided by the CSK mission
- CSG Service: the products provided by the CSG mission
- Generalized Service: equivalent (CSK and CSG mission) or combined products (multi-mission)

The Commercial Users are redirected to the commercial provider's web site (www.e-geos.it).

Three options are possible for Institutional Users:

1. **Users' Registration**, for a new registration to COSMO-SkyMed services, by clicking on Users' registration link, two options are possible:

    - **Fast registration**, with only the possibility of browsing of catalogue, without request of products.

    - **Standard Registration**, for *complete* access to CSK services for requesting a product in terms of:

        - ✓ Catalogue Service request

        - ✓ New Acquisition Request

    All registrations must be authorized by ASI.

    Note that the user can to proceed with standard registration, without accessing to fast. After the fast registration anyway, the user can to complete with standard registration, but in order to proceed with orders, after the standard registration, it will be necessary to create and receive the activation of a project card, that shall be approved first by ASI.

2. **UM Users,** to:

    - access your personal account information

    - create and manage a project card It is important to note that with the new MSI-UGS system, each account will be related to a person and not to a project: there will not be an account for each project, but there will be an account of a person to which several projects will be related.

3. **CDM Homepage**, to access the Client Deposit Manager online application **(only after the approval of registration)** for Service Request Management:

    - Catalogue capable of querying all data collections. No ordering functionality is provided.

    - RawData Processing: It allows performing the catalogue browsing for archived Raw Data. From this service, it is possible to query the raw data catalogue collections, selecting items to be used for the production and then choosing the standard service level.

    - Services: It allows performing orders in assisted mode for standard product services from new acquisitions and archived data.

    - Orders Monitoring: It allows monitoring the status of the submitted orders.

10. STANDARD PRODUCTS FORMAT DESCRIPTION

The data packaging organization adopted as distribution format for the civilian products is HDF5. The support format detailed below will be used to store image layers and the relevant ancillary information, forming the output product to be distributed to the final user.

10.1. HDF5 format

The HDF5 (Hierarchical Data Format) format and software, was developed and supported by NCSA (National Centre for Supercomputing Applications University of Illinois) since 1988 and is freely available.

It is used worldwide in many fields, including environmental science, the study of neutron scattering, non-destructive testing, and aerospace research. Scientific projects that use HDF include NASA's Earth Observing System (EOS), and the Department of Energy's Accelerated Strategic Computing Initiative (ASCI).

For more information or software the following link is available http://hdf.ncsa.uiuc.edu.

HDF5 files are organized in a hierarchical structure, with two primary structures:

- groups
- datasets

A grouping structure contains instances of zero or more groups or datasets, together with supporting metadata.

Any HDF5 group or dataset may have an associated attribute list. An HDF5 attribute is a user-defined HDF5 structure that provides extra information about an HDF5 object. Attributes are described in more detail below.

The hierarchical organization of the HDF5 format is graphically represented in Figure 14.

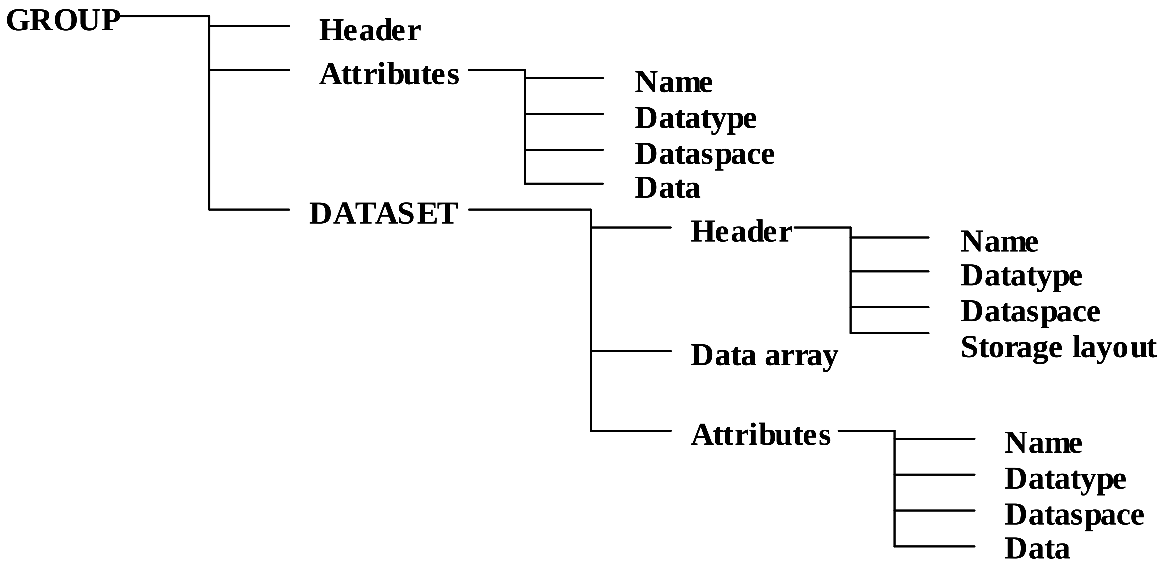


Figure 13 – HDF5 organization

10.1.1. Groups

An HDF5 group is a structure containing zero or more HDF5 objects. A group has two parts:

- A group header, which contains a group name and a list of group attributes.

- A group symbol table, which is a list of the HDF5 objects that belong to the group.

Working with groups and group members is similar in many ways to working with directories and files in UNIX. As with UNIX directories and files, objects in an HDF5 file are often described by giving their full (or absolute) path names.

/ signifies the root group.

/foo signifies a member of the root group called foo.

/foo/zoo signifies a member of the group foo, which in turn is a member of the root group.

10.1.2. Datasets

A dataset is a multidimensional array of data elements, together with supporting metadata.

A dataset is stored in a file in two parts

- A header
- A data array.

10.1.2.1. Dataset header

The header contains information that is needed to interpret the array portion of the dataset, as well as metadata (or pointers to metadata) that describes or annotates the dataset. Header information includes the name of the object, its dimensionality, its number-type, information about how the data itself is stored on disk, and other information used by the library to speed up access to the dataset or maintain the file's integrity.

There are four essential classes of information in any header:

- Name
- Datatype
- Dataspace
- Storage layout:

10.1.2.2. Name

A dataset name is a sequence of alphanumeric ASCII characters.

10.1.2.3. Datatype

HDF5 allows one to define many different kinds of datatypes. There are two categories of datatypes:

- atomic datatypes (which differentiates in system-specific, NATIVE or named)
- compound datatypes (which can only be named).

Atomic datatypes are those that are not decomposed at the datatype interface level, such as integers and floats.

NATIVE datatypes are system-specific instances of atomic datatypes.

Compound datatypes are made up of atomic datatypes.

Named datatypes are either atomic or compound datatypes that have been specifically designated to be shared across datasets.

Atomic datatypes include integers and floating-point numbers. Each atomic type belongs to a particular class and has several properties: size, order, precision, and offset. In this introduction, we consider only a few of these properties.

Atomic classes include integer, float, date and time, string, bit field, and opaque. (Note: Only integer, float and string classes are available in the current implementation.)

Properties of integer types include size, order (endian-ness), and signed-ness (signed/unsigned).

Properties of float types include the size and location of the exponent and mantissa, and the location of the sign bit.

The datatypes that are supported in the current implementation are:

- Integer datatypes: 8-bit, 16-bit, 32-bit, and 64-bit integers in both little and big-endian format.
- Floating-point numbers: IEEE 32-bit and 64-bit floating-point numbers in both little and big-endian format.
- References.
- Strings.
- NATIVE datatypes. Although it is possible to describe nearly any kind of atomic data type, most applications will use predefined datatypes that are supported by their compiler. In HDF5 these are called native datatypes. NATIVE datatypes are C-like datatypes that are generally supported by the hardware of the machine on which the library was compiled. In order to be portable, applications should almost always use the NATIVE designation to describe data values in memory.

The NATIVE architecture has base names that do not follow the same rules as the others. Instead, native type names are similar to the C type names.

A compound datatype is one in which a collection of simple datatypes are represented as a single unit, similar to a struct in C. The parts of a compound datatype are called members. The members of a compound datatype may be of any datatype, including another compound datatype. It is possible to read members from a compound type without reading the whole type.

Named datatypes. Normally each dataset has its own datatype, but sometimes we may want to share a datatype among several datasets. This can be done using a named datatype. A named data type is stored in the file independently of any dataset, and referenced by all datasets that have that datatype. Named datatypes may have an associated attributes list. See Datatypes in the HDF User's Guide for further information.

The following predefined HDF5 data types are used for the purpose of formatting of dataset and attributes of the COSMO-SkyMed products

Type name	Sign	Bits' number	Endianness
H5T_STD_I8LE	Signed Integer	8	Little Endian
H5T_STD_I16LE	Signed Integer	16	Little Endian
H5T_STD_I32LE	Signed Integer	32	Little Endian
H5T_STD_I64LE	Signed Integer	64	Little Endian
H5T_STD_U8LE	Unsigned Integer	8	Little Endian
H5T_STD_U16LE	Unsigned Integer	16	Little Endian
H5T_STD_U32LE	Unsigned Integer	32	Little Endian
H5T_STD_U64LE	Unsigned Integer	64	Little Endian
H5T_IEEE_F32LE	Floating Point	32	Little Endian
H5T_IEEE_F64LE	Floating Point	32	Little Endian

Table 37 – Predefined HDF 5 data types

10.1.2.3.1. Dataspace

A dataset dataspace describes the dimensionality of the dataset. The dimensions of a dataset can be fixed (unchanging), or they may be unlimited, which means that they are extendible (i.e. they can grow larger).

Properties of a dataspace consist of the rank (number of dimensions) of the data array, the actual sizes of the dimensions of the array, and the maximum sizes of the dimensions of the array. For a fixed-dimension dataset, the actual size is the same as the maximum size of a dimension.

A dataspace can also describe portions of a dataset, making it possible to do partial I/O operations on selections.

Given an n-dimensional dataset, there are currently four ways to do partial selection:

- Select a logically contiguous n-dimensional hyperslab.
- Select a non-contiguous hyperslab consisting of elements or blocks of elements (hyperslabs) that are equally spaced.
- Select a union of hyperslabs.
- Select a list of independent points.

Since I/O operations have two end-points, the raw data transfer functions require two dataspace arguments: one describes the application memory dataspace or subset thereof, and the other describes the file dataspace or subset thereof.

10.1.2.3.2. Storage layout

The HDF5 format makes it possible to store data in a variety of ways. The default storage layout format is contiguous, meaning that data is stored in the same linear way that it is organized in memory. Two other storage layout formats are currently defined for HDF5: compact, and chunked. In the future, other storage layouts may be added.

Compact storage is used when the amount of data is small and can be stored directly in the object header.

Chunked storage involves dividing the dataset into equal-sized "chunks" that are stored separately. Chunking has three important benefits. It makes it possible to achieve good performance when accessing subsets of the datasets, even when the subset to be chosen is orthogonal to the normal storage order of the dataset. It makes it possible to compress large datasets and still achieve good performance when accessing subsets of the dataset. It makes it possible efficiently to extend the dimensions of a dataset in any direction.

10.1.3. HDF5 Attributes

Attributes are small named datasets that can be attached to one of the following structures:

- primary datasets
- groups
- named datatypes

Attributes can be used to describe the nature and/or the intended usage of a dataset or group.

An attribute has two parts:

- name
- value

The value part contains one or more data entries of the same data type.

When accessing attributes, they can be identified by name or by an index value. The use of an index value makes it possible to iterate through all of the attributes associated with a given object.

10.1.4. Products Organization

Specific data organization will be detailed to meet the storage needs of data acquired with all the instrument modes allowed by the COSMO-SkyMed constellation.

10.1.5. Naming Convention

The following naming convention will be used for the identification of the COSMO-SkyMed SAR Products files.

CSG_SSAR<i>_<YYY_Z>_<RR><AA>_<MMM>_<SSS>_<PP>_<s><o>_<Q>_...

…<YYYYMMDDhhmmss>_<YYYYMMDDhhmmss>_<j>_...
…<S>_<ll><H>_Z<LL>_<AAA>.h5

The semantic of the variable sub-strings is reported in the following table:

Sub-string code	**Meaning**	**Allowed values**
<i>	Identifier of the satellite within the SAR constellation that acquired the scene	1 2
<YYY_Z>	Product Type	Standard Products Extended Set:: RAW_B SCS_B SCS_U SCS_F DGM_B DGM_F GEC_B GEC_F GTC_B GTC_FQLK_B
<RR>	Number of range looks	[01, 20] 01 is used in the case of L0 product
<AA>	Number of azimuth looks	[01, 20] 01 is used in the case of L0 product
<MMM>	Instrument Mode used during the acquisition	S2A (Spotlight 2A) S2B (Spotlight 2B) S2C (Spotlight 2C) D2R (Spotlight 1 Optimized Resolution) D2S(Spotlight 2 Optimized Swath) D2J(Spotlight 2 Joined) OQR (Spotlight 1 Operational QuadPol Optimized Resolution) OQS (Spotlight 2 Operational QuadPol Optimized Swath) STR (Stripmap) SC1 (ScanSAR 1) SC2 (ScanSAR 2) PPS (Pingpong) QPS (QuadPol)

<SSS>	Identifier of the swath (or subswath combination in the case of ScanSAR mode) used for the data acquisition	[001-049] for Spotlight 2A [001-049] for Spotlight 2B [001-049] for Spotlight 2C [001-024] for Spotlight 2MS-OS [001-024] for Spotlight 2 Joined [001-024] for Spotlight 2 QP-OS [001-027] for Stripmap [001-007] for ScanSAR 1 [001-006] for ScanSAR 2 [001-027] for Pingpong [001-021] for QuadPol
<PP>	Polarizations code	HH = Horizontal Tx/Horizontal Rx VV = Vertical Tx/ Vertical Rx HV = Horizontal Tx/ Vertical Rx VH = Vertical Tx/ Horizontal Rx
<s>	Identifier of the Look Side	L = LEFT R = RIGHT
<o>	Identifier of the Orbit Direction	A = Ascending D = Descending
<Q>	Orbital data quality indicator	D = Downlinked P = Predicted F = Filtered R = Restituted
<YYYYMMDDhhmmss>	Sensing Start Time rounded to the closest integer second	YYYY = year MM = month DD = day of the month hh = hour mm = minute ss = second
<YYYYMMDDhhmmss>	Sensing Stop Time rounded to the closest integer second	As for sensing start time
<j>	File Sequence identifier of the image into the downlinked data stream. Useful to distinguish data, if interleaved with a second image during the downlink (DI2S, QuadPol, PP4P)	1 2
<S>	Code indicating if the product coverage corresponds to the standard size of the mode or it represents a chop of a standard size product	F = Full standard size C = Cropped product

<ll>	Latitude of the scene centre in positive deg rounded to the closest integer	[00, 90]
<H>	Hemisphere identifier	N = North S = South
<LL>	Two-chars code providing information about scene position in the east direction	• [01, 60] equal to the UTM zone of the scene center, if latitude is in the range [-80, 80]: • 00 = South Pole area • 61 = North Pole area
<AAA>	Three character code indicating the squint angle at the scene centre. It allows identification of squinted Spotlight acquisition	The first char represents the type and sign of the squint N = flag indicating not squinted data (NULL or near-zero squint); in this case the next three characters are set equal to *<00>* F = forward squint (corresponding to negative squint angle) B = backward squint (corresponding to positive squint angle) In the last two cases, the last three chars represents the squint angle in degrees (e.g. B04 means 4° of backward squint) rounded to the closest integer

Table 38 - File naming convention

10.1.6. Hierarchies organization

The HDF5 allows the hierarchical organization of the information to be stored.

In order to standardize the data organization and the access to the image layers stored by the HDF5 support format, each level of the HDF5 hierarchy has been univocally assigned to the storage of a specific level of information of the SAR products according to the following scheme.

/ - Root group

For each Instrument Mode and processing level it includes:

- the attributes to be considered applicable to the whole acquisition/product, hence that are subswaths-independent
- one or more group named S<mm> detailed below
- zero or one dataset named IMG detailed below
- zero or one dataset named QLK (Quick Look) detailed below
- zero or one dataset named GIM (Geocoded Incidence Mask) detailed below
- zero or one dataset named GEM (Geocoded Elevation Matrix) detailed below
- zero or one group named MAS detailed below
- zero or one group named SLA detailed below

S<mm> groups

It includes:

- the attributes dependent on the specific elementary beam. The term “beam” is used to identify an unambiguous (from the electrical point of view) Tx/Rx configuration of the antenna.
- one or more dataset named B<nnnn> detailed below
- zero or one dataset (or group) named IMG, in the case of ScanSAR modes, detailed below
- zero or one dataset named QLK (Quick Look) detailed below
- zero or one dataset CAL including all the ShortCal pulses acquired during the acquisition’s sequence of the scene echoes.
- zero or one dataset REPLICA including all the reconstructed replica chirp.
- zero or one dataset NOISE including all the Noise measures performed during the acquisition’s sequence of the scene echoes.

In the case of Stripmap, Spotlight, Pingpong and QuadPol products <mm> = 01

In the case of ScanSAR products <mm> ∈ {01, 02, 03, 04, 05, 06} used in increasing order from the nearest subswath to the farthest one. Moreover, S01 group will always include the earliest acquired burst.

B<nnnn> dataset

It includes:

- the attributes dependent on the time sequential data block (the acquisition cycle, collapsing with the burst conceipt in the case of Spotlight, ScanSAR and Pingpong data) to be considered applicable for the acquired raw data
- the array with the raster layer of the RAW data.

In the case of Stripmap, QuadPol and Spotlight products <nnnn> = 001

In the case of ScanSAR products <nnnn> ∈ [0001, 9999] used in increasing order from the earliest acquired burst to the latest one.

The same number of bursts will be always included in each S<mm> group of the distributed product in the case of ScanSAR data.

B<nnnn> group

For each Instrument Mode and processing levels 1A/1B/1C/1D it includes the attributes dependent on the time sequential data block (the burst) to be considered applicable for the acquired raw data (for example the Sensing Start Time)

IMG dataset

It includes:

- the attributes dependent on the subswath used within the access area to be considered applicable for the distributed product (for example the Line Time Interval)
- one raster data array representing the full resolution image layer

IMG group

Used into CRG (resp. IPH/COH) products under MAS and SLA groups

It includes

- the attributes inherited from the input SCS/DGM (resp. CRG) products

QLK Dataset

It includes the quick look of the distributed product. See 10.1.8 for further details.

GIM Dataset

It includes the raster layer representing the mask (coregistered with the GTC product) of the incidence angles at which each pixel included into the level 1D product had been acquired.

GEM Dataset

It includes the raster layer representing the matrix (represented in the same projection of the full resolution image layer) of the elevation angles at which pixels belonging to a sub-sampled grid of the image layer had been acquired.

DPH Dataset

It includes the raster layer representing the phase used to demodulate the interferogram layer provided into the IMG datased of the IPH non-standard product..

HEM Dataset

It includes the raster layer representing the Height Error Map annexed to the DTM product, co-registered with it.

START group

It includes the dataset of Calibration (CAL) and Noise (NOISE) measurements performed during the acquisition initialization sequence extracted from the downlinked RAW data

STOP group

It includes the dataset of Calibration (CAL) and Noise (NOISE) measurements performed during the acquisition termination sequence extracted from the downlinked RAW data

NOISE dataset

It includes the Noise data from the downlinked RAW data.

- The dataset /S<mm>/START/NOISE (respectively STOP/NOISE), includes the Noise measurements performed during the acquisition Initialization (respectively Termination) sequence;
- The dataset /S<mm>/NOISE, includes all the Noise measures performed during the acquisition's sequence of the scene echoes

Missing or invalid packets are compensated by zero-filled lines

CAL dataset

It includes the Calibration data from the downlinked RAW data. Three cases can be identified:

- the datasets /S<mm>/START/CAL and /S<mm>/STOP/CAL, include all the Calibration measurements listed below performed during the acquisition's Initialization/Termination sequences;
    - RXCAL POC2
    - RXCAL POC128
    - ShortCal
    - ShortCal Isolation
    - RFCal AttOff
    - RFCal AttOn
    - TXCAL POC2
    - TXCAL POC128

- the dataset /S<mm>/CAL, includes all the calibration pulses acquired during the periodic acquisition cycles
  - ShortCal

Missing or invalid packets are compensated by zero-filled lines

NOTCH dataset

It includes the beam notch packets included into the downlinked RAW data.

Such dataset is omitted in the case of polarizations not including NOTCH packets into the acquisition timeline.

REPLICA dataset

It includes the replica chirp reconstructed from the periodic calibration data included into the downlinked RAW data. It includes a number of lines equal to the number of measured ShortCal pulses acquired during the periodic acquisition cycles. Missing or invalid packets are compensated by zero-filled lines

LRHM dataset

It includes one raster data array representing the Low Resolution Height Model and the relevant attributes for layer exploitaition

MAS group

Into each master/slave product of a coregistered stack, it includes a sub-structure inherited by the input standard products (SCS/DGM) providing the quick look and the relevant attributes of the master product.

Into the interferometric products (IPH/COH), it includes a sub-structure inherited by the input co-registered products (CRG_A/CRG_B) providing the quick look and the relevant attributes of the master image contributing to interferometric product.

SLA group

Into each slave product of a coregistered stack, it includes a sub-structure inherited by the input standard products SCS/DGM) providing the quick look and the relevant attributes of the slave product used as input.

Into the interferometric products (IPH/COH), it includes a sub-structure inherited by the input co-registered products (CRG_A/CRG_B) providing the quick look and the relevant attributes of the slave image contributing to interferometric product.

GCP dataset

Into each slave product of a coregistered stack, it includes statistical parameters relevanto to the valid GCPs used in the warp matrix evaluation step.

Each row of the dataset is associated to a valid GCP and includes the following fields

Col. #	Content	Description
1	CRG GCPs Position, X coordinate	Column index of the GCP
2	CRG GCPs Position, Y coordinate	Row index of the GCP

3	CRG GCPs Residuals X	Differences between the column index of GCP as estimated during the patch correlation step and the ones obtained by applying the warping function.
4	CRG GCPs Residuals Y	Differences between the row index of GCP as estimated during the patch correlation step and the ones obtained by applying the warping function.
5	CRG GCP Cross-correlation	The cross-correlation coefficient of the GCP as estimated during the patch correlation step. For the method used for evaluation of the cross-correlation for the current image, refer to the attribute "CRG GCP Cross-correlation Method".
6	CRG GCP Cross-correlation SNR	The ration between the intensity of the peak of the cross-correlation matrix and the mean value of the intensity of the matrix itself as estimated during the patch correlation step

Table 39 - Fields included in the data set lines associated with the GCP

T<jjj> Group

It includes the attributes relative to the different images contributing to a mosaicked products.

The following table summarizes the policy for missing lines management into the L0 Product; in the case of uncompensated lines (allowed only in the case of calibration and noise datasets), the time array

Dataset	Line compensation	Compensated lines indexes annotated	Time (QNaN) driven missing lines identification	Note
Init/Final CAL	Yes	No	Yes	
Periodic CAL	Yes (ScanSAR/Pingpong) No (Stripmap/QuadPol)	No	Yes	
Init/Final NOISE	Yes	No	Yes	
Periodic NOISE	Yes (ScanSAR/Pingpong) No (Stripmap/QuadPol)	No	Yes	
NOTCH	Yes	No	No	Line compensation by zero-filling
ECHO	Yes	Yes	No	
REPLICA	Yes	No	Yes	

Table 40 - Missing lines management into L0 Product

10.1.7. Graphical representation of the hierarchical organization for each Instrument Mode and Processing Level

The hierarchical organization for each Instrument Mode and Processing Level is graphically represented in the following diagrams

A not colour filled structure

Group

represents a HDF5 structure group.

A colour filled structure

Dataset

represents a generic HDF5 dataset including data array and the relevant attributes.

Suffixes <mm>/<nnnn> between angular brackets indicates that the cardinality of the group/dataset is greater than one.

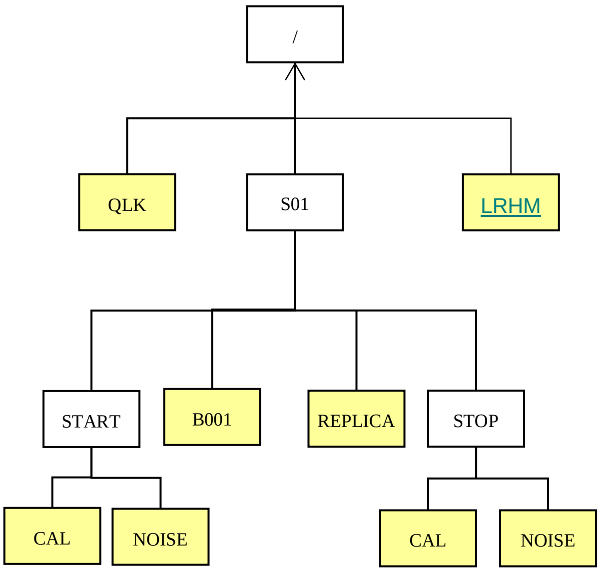


Figure 14 – Level 0 product (Stripmap)

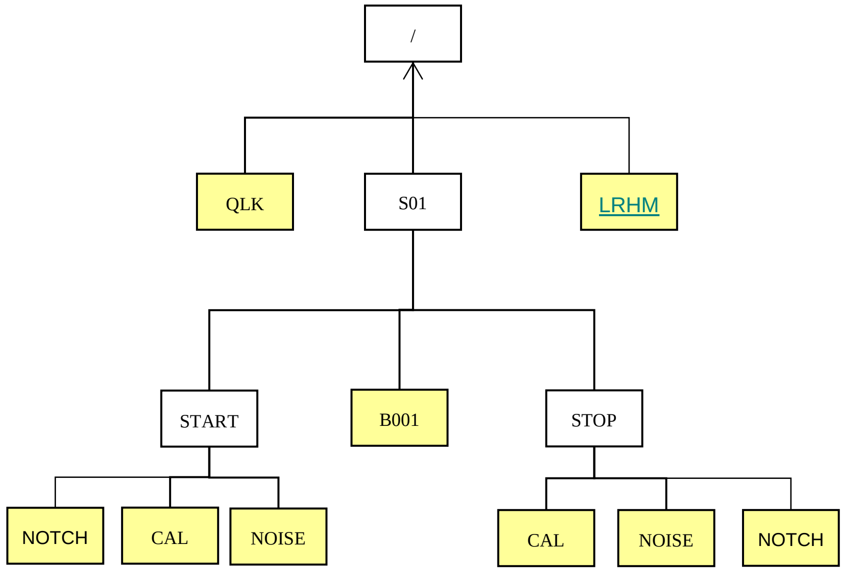


Figure 15 – Level 0 product (Spotlight)

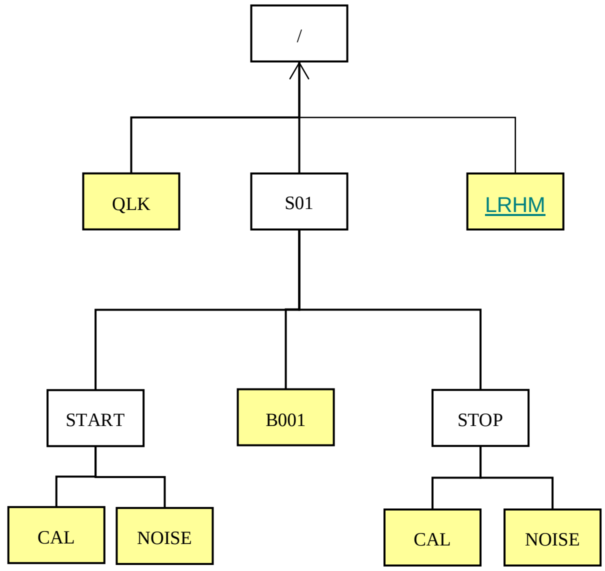


Figure 16 – Level 0 product (DI2S)

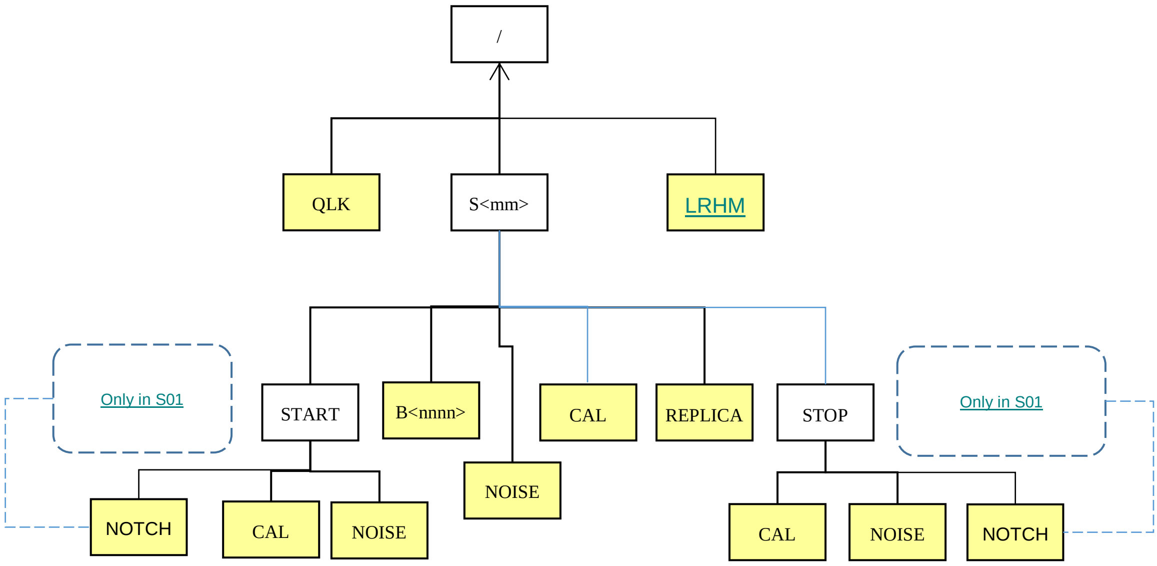


Figure 17 – Level 0 product (ScanSAR)

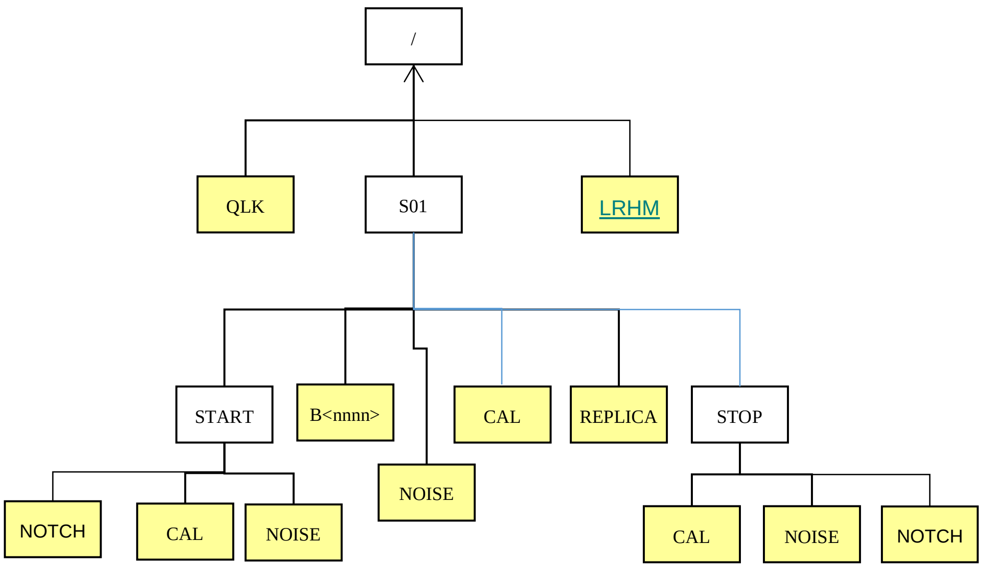


Figure 18 – Level 0 product (Pingpong)

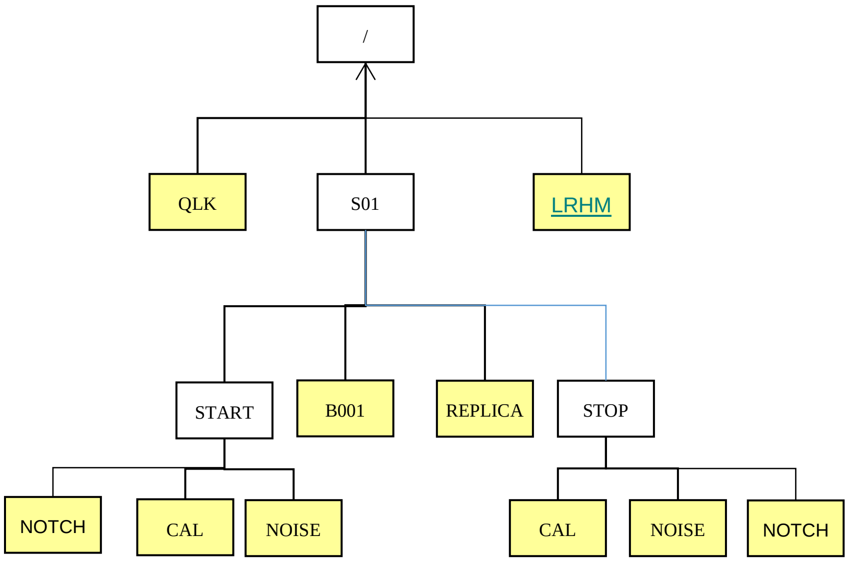


Figure 19 – Level 0 product (QuadPol)

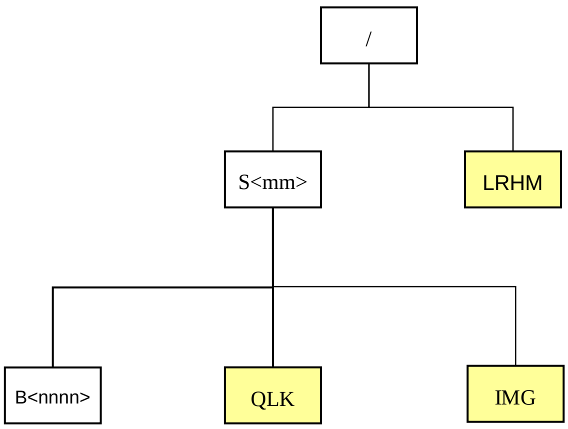


Figure 20 – Level 1A product

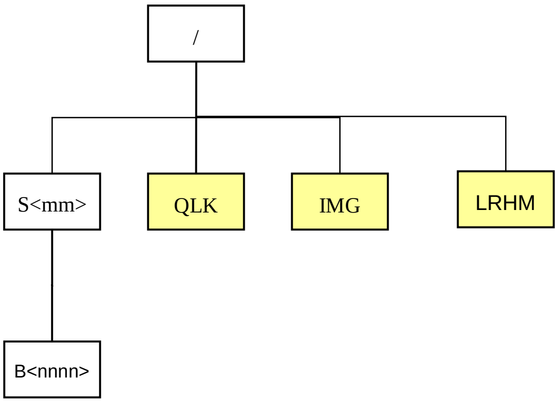


Figure 21 – Level 1B/1C product

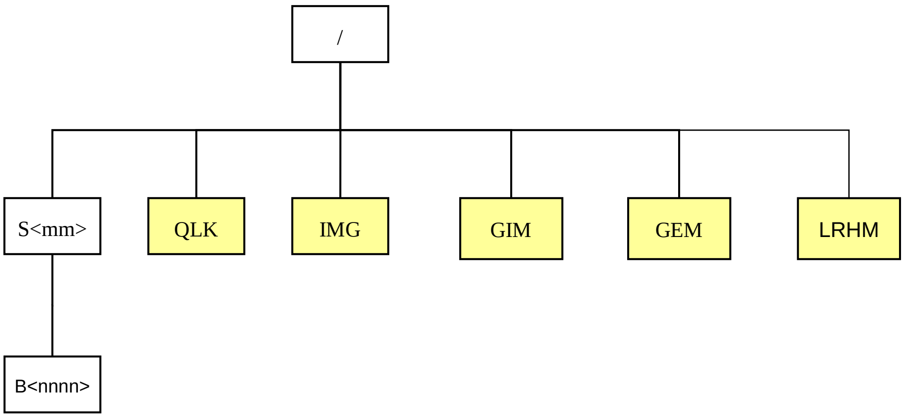


Figure 22 – Level 1D products

10.1.8. Quick Look layer

A synoptic of the entire datum allowing having a look to the image content is annexed to all SAR standard and non-standard product.

For product at processing level 1, the quick look is originated by undersampling of the full resolution raster layer, obtained by a filter (realized by a kernel of configurable size) moving in the raw and columns directions at steps derived by the ratios of the output and input spacing. Following tables details features of the quick look layer.

It is rescaled for 8 bits representation by a linear transformation applied to the most significant part of the dynamic around the mean value of the full resolution image

Products	Sample Information	Projection
Lev. 0	Focused image, detected, extracted from the Quick Look generated at the ISF screening time.	Ground /Azimuth
Lev. 1A	The same sample information of the distributed product the quick look is annexed to, detected, undersampled both in range and azimuth direction with factors depending on the sensor mode: One image per subswath is included in ScanSAR Mode	Slant Range/Azimuth
Lev. 1B	The same sample information of the distributed product the quick look is annexed to, undersampled both in range and azimuth direction by a reduction factor (depending on the multilooking level of the full resolution array) originating a raster layer including about one thousand columns	Ground /Azimuth
Lev. 1C/1D	As for level 1B	Option 1 • UTM (-80° ≤ center latitude ≤ 84°) • UPS (otherwise) Option 2 • Geodetic LATLON

Table 41 - Features of the Quick Look layers

Dataset	Sample Format	Bits per Sample	Samples per Pixel	Type Represent.	Invalid Value
Quick Look annexed to the Full resolution product	Unsigned Integer	8	1	Little Endian	0

Table 42 - Data type for Quick look layer

10.1.9. Ancillary information organization

The attributes to be appended (in terms of HDF5 Attributes) to the COSMO-SkyMed SAR products, depending on the processing Level are listed in Appendix section, at the end of this document. For each attribute the corresponding HDF5 storage structure is reported.

10.1.10. Date Format

A specific format will be used for date’s specification into the HDF5 products that will be referred to as “Epoch” format. If not differently specified, all Epochs strings contain UTC Time represented in the following format

YYYY-MM-DD hh:mm:ss.nnnnnnnnn (Length of 29 ASCII char)

Where:

Field Name	Description	Validity Range
DD	Day of month	[01, 31]
MM	Month number	[01, 12]
YYYY	Year	[0000, 9999]
hh	Hour of day	[00, 23]
mm	Minute of hour	[00, 59]
ss	Second of minute	[00,59]
nnnnnnnnn	Nanoseconds	[000000000, 999999999]

Table 43 - UTC time values

10.1.11. Data storage policy

The arrangement used for storage of raster data layers of the SAR Products into HDF5 datasets is listed in the following table:

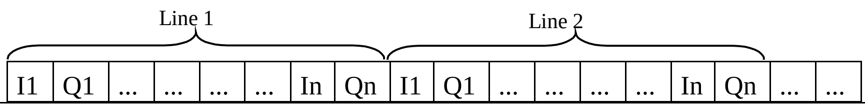
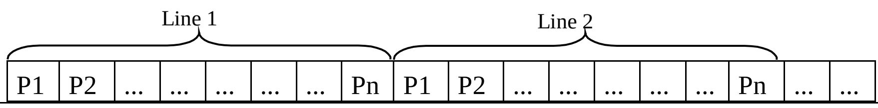
Samples per pixel	HDF5 data type
Two (Complex data)	Tri-dimensional array having: the first dimension (the slowest varying) corresponding to the number of lines of the data array the second dimension corresponding to the number of columns of the data array the third dimension (the most fast varying) corresponding to the pixel depth, hence used for representation of Real and Imaginary part of each pixel Such representation, will be used for complex types independently on the sample format (byte, short, integer, long, long long, float, double) and sign (signed, unsigned). Data organization in file is showed in the following schema 
One (Real data)	Bi-dimensional array having: the first dimension (the slowest varying) corresponding to the number of lines of the data array the second dimension corresponding to the number of columns of the data array Such representation will be used for images on single-sample pixel, independently on the sample format (byte, short, integer, long, long long, float, double) and sign (signed, unsigned) 

Table 44 - The arrangement used for storage of raster data layers of the SAR Products into HDF5 datasets

The following chunking policy for data storage is recommended.

Dimension	Chunk Size
Image Length (Lines)	128
Image Width (Columns)	128
Image Depth (Samples)	2

Table 45 – Chunking policy for data storage

10.2. Tiff Format

The TIFF file format was designed jointly by Aldus and Microsoft with leading scanner vendors to faciliate incorporating scanned images into publishing.

The described TIFF specification is TIFF 5.0. A TIFF file consists of several different blocks which define the palette data or the LZW-compressed body among other things. TIFF files can be in Motorola _or_ Intel byte order, depending on the first word. If it is 'II', the byte order is in Intel order, if it is 'MM', then you have Motorola byte ordering.

Each TIFF file begins with a image file header which points to one or more image file directories, which contain the image data and image information.

The format of the image header :

OFFSET Count TYPE Description

- 0000h 2 char ID='II', ID='MM'

  This is the identification, 'II' stands for Intel byte order, 'MM' for Motorola byte order. The following data must be interpreted accordingly!

- 0002h 1 word TIFF "version number".

  This version number never changed and the value (42) was choosen for its deep philosophical value. In fact, if the version number ever changes, this means that radical changes to the TIFF format have been made, and a TIFF reader should give up immediately. You can consider this word to be a part of the header ID.

- 0004h 1 dword Offset of first image directory in file form start of file.

  The first image directory must begin on an even byte boundary. The image directory may follow the image data it describes. The image directory is described below.

An organization may wish to store information that is meaningful to only that organization in a TIFF file. Tags numbered 32768 or higher are reserved for that purpose. Upon request, the administrator will allocate and register a block of private tags for an organization. Private enumerated values can be accommodated in a similar fashion.

The format of the image file directory (IFD):

All entries are sorted in ascending order by the tag field.

OFFSET Count TYPE Description

0000h 1 word Number of entries

="NUM"

0002h "NUM" rec Field descriptor

1 word Field tag, see below

1 word Field type

1 - byte

2 - ASCII string, counted in length.

Most often an ASCIIZ string, the

trailing zero is counted with the

data length.

3 - word

4 - dword / uword

5 - rational (2 dwords, numerator and denominator)

1 dword Length of the field in units of the data type.

A single 16-bit word has the length 1.

1 dword Data offset of the field. The data starts

on a word boundary, thus the dword should

be even. The data for the field may be

anywhere in the file, even after the image

data. If the data size is less or equal to

4 bytes (determined by the field type and

length), then this offset is not a offset

but instead the data itself, to save space.

If the data size is less than 4 bytes, the

data is stored left-justified within the 4

bytes of the offset field.

0002h+

"NUM"*12 1 dword Offset of next IFD in file, 0 if none follow

If a certain field in the IFD does not exist, you have to presume the default values. The different fields are :

--- BitsPerSample

Tag = 258 (102)

Type = word

N = SamplesPerPixel

Default = 1

Number of bits per sample. Note that this tag allows a different number of bits per sample for each sample corresponding to a pixel. For example, RGB color data could use a different number of bits per sample for each of the three color planes.

--- ColorMap

Tag = 320 (140)

Type = word

N = 3 * (2**BitsPerSample)

No default.ColorMap must be included in all palette color images.

This tag defines a Red-Green-Blue color map for palette color images. The palette color pixel value is used to index into all 3 subcurves. The subcurves are stored sequentially. The Red entries come first, followed by the Green entries, followed by the Blue entries. The width of each entry is 16 bits, as implied by the type of word. 0 represents the minimum intensity, and 65535 represents the maximum intensity.

--- ColorResponseCurves

Tag = 301 (12D)

Type = word

N = 3 * (2**BitsPerSample)

Default: curves based on the NTSC recommended gamma of 2.2.

This tag defines three color response curves, one each for Red, Green and Blue color information. The Red entries come first, followed by the Green entries, followed by the Blue entries. The length of each subcurve is 2**BitsPerSample, using the BitsPerSample value corresponding to the respective primary. The width of each entry is 16 bits, as implied by the type of word. The purpose of the color response curves is to refine the content of RGB color images.

--- Compression

Tag = 259 (103)

Type = word

N = 1

Default = 1.

1 = No compression, but pack data into bytes as tightly as possible, with no unused bits except at the end of a row. The bytes are stored as an array of bytes, for BitsPerSample <= 8, word if BitsPerSample > 8 and <= 16, and dword if BitsPerSample > 16 and <= 32. The byte ordering of data >8 bits must be consistent with that specified in the TIFF file header (bytes 0 and 1). Rows are required to begin on byte boundaries.

2 = CCITT Group 3 1-Dimensional Modified Huffman run length encoding. See ALGRTHMS.txt BitsPerSample must be 1, since this type of compression is defined only for bilevel images (like FAX images...)

3 = Facsimile-compatible CCITT Group 3, exactly as specified in "Standardization of Group 3 facsimile apparatus for document transmission," Recommendation T.4, Volume VII, Fascicle VII.3, Terminal Equipment and Protocols for Telematic Services, The International Telegraph and Telephone Consultative Committee (CCITT), Geneva, 1985, pages 16 through 31. Each strip must begin on a byte boundary. (But recall that an image can be a single strip.) Rows that are not the first row of a strip are not required to begin on a byte boundary. The data is stored as bytes, not words - byte-reversal is not allowed. See the Group3Options field for Group 3 options such as 1D vs 2D coding.

4 = Facsimile-compatible CCITT Group 4, exactly as specified in "Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus," Recommendation T.6, Volume VII, Fascicle VII.3, Terminal Equipment and Protocols for Telematic Services, The International Telegraph and Telephone Consultative Committee (CCITT), Geneva, 1985, pages 40 through 48. Each strip must begin on a byte boundary. Rows that are not the first row of a strip are not required to begin on a byte boundary. The data is stored as bytes, not words. See the Group4Options field for Group 4 options.

5 = LZW Compression, for grayscale, mapped color, and full color images.

32773 = PackBits compression, a simple byte oriented run length scheme for

1-bit images. See Appendix C.

Data compression only applies to raster image data, as pointed to

by StripOffsets.

--- GrayResponseCurve

Tag = 291 (123)

Type = word

N = 2**BitsPerSample

The purpose of the gray response curve and the gray units is to provide more exact photometric interpretation information for gray scale image data, in terms of optical density.

--- GrayResponseUnit

Tag = 290 (122)

Type = word

N = 1

For historical reasons, the default is 2. However, for greater accuracy, 3 is recommended.

1 = Number represents tenths of a unit.

2 = Number represents hundredths of a unit.

3 = Number represents thousandths of a unit.

4 = Number represents ten-thousandths of a unit.

5 = Number represents hundred-thousandths of a unit.

--- ImageLength

Tag = 257 (101)

Type = word or dword

N = 1

No default.

The image's length (height) in pixels (Y:vertical). The number of rows (sometimes described as "scan lines") in the image.

--- ImageWidth

Tag = 256 (100)

Type = word or dword

N = 1

No default.

The image's width, in pixels (X:horizontal). The number of columns in the image.

--- NewSubfileType

Tag = 254 (FE)

Type = dword

N = 1

Default is 0.

A general indication of the kind of data that is contained in this subfile. This field is made up of a set of 32 flag bits. Unused bits are expected to be 0. Bit 0 is the low-order bit.

Currently defined values for the bitmap are:

0 - Image is reduced of another TIFF image in this file

1 - Image is a single page of a multi-page

2 - Image is a transparency mask for another image in this file

--- PhotometricInterpretation

Tag = 262 (106)

Type = word

N = 1

No default.

0 = For bilevel and grayscale images: 0 is imaged as white.

2**BitsPerSample-1 is imaged as black. If GrayResponseCurve exists, it overrides the PhotometricInterpretation value.

1 = For bilevel and grayscale images: 0 is imaged as black.

2**BitsPerSample-1 is imaged as white. If GrayResponseCurve exists, it overrides the PhotometricInterpretation value.

2 = RGB. In the RGB model, a color is described as a combination of the three primary colors of light (red, green, and blue) in particular concentrations. For each of the three samples, 0 represents minimum intensity, and 2**BitsPerSample - 1 represents maximum intensity. For PlanarConfiguration = 1, the samples are stored in the indicated order: first Red, then Green, then Blue. For PlanarConfiguration = 2, the StripOffsets for the sample planes are stored in the indicated order: first the Red sample plane StripOffsets, then the Green plane StripOffsets, then the Blue plane StripOffsets.

3 = "Palette color." In this mode, a color is described with a single sample. The sample is used as an index into ColorMap. The sample is used to index into each of the red, green and blue curve tables to retrieve an RGB triplet defining an actual color.When this PhotometricInterpretation value is used, the color response curves must also be supplied. SamplesPerPixel must be 1.

4 = Transparency Mask. This means that the image is used to define an irregularly shaped region of another image in the same TIFF file. SamplesPerPixel and BitsPerSample must be 1. PackBits compression is recommended. The 1-bits define the interior of the region; the 0-bits define the exterior of the region. The Transparency Mask must have the same ImageLength and ImageWidth as the main image.

PlanarConfiguration

Tag = 284 (11C)

Type = word

N = 1

Default is 1.

1 = The sample values for each pixel are stored contiguously, so that there is a single image plane. See PhotometricInterpretation to determine the order of the samples within the pixel data. So, for RGB data, the data is stored RGBRGBRGB...and so on.

2 = The samples are stored in separate "sample planes." The values in StripOffsets and StripByteCounts are then arranged as a 2-dimensional array, with SamplesPerPixel rows and StripsPerImage columns. (All of the columns for row 0 are stored first, followed by the columns of row 1, and so on.) PhotometricInterpretation describes the type of data that is stored in each sample plane. For example, RGB data is stored with the Red samples in one sample plane, the Green in another, and the Blue in another. If SamplesPerPixel is 1, PlanarConfiguration is irrelevant, and should not be included.

Predictor

Tag = 317 (13D)

Type = word

N = 1

Default is 1.

To be used when Compression=5 (LZW).

1 = No prediction scheme used before coding.

2 = Horizontal differencing. See Appendix I.

ResolutionUnit

Tag = 296 (128)

Type = word

N = 1

Default is 2.

To be used with XResolution and YResolution.

1 = No absolute unit of measurement. Used for images that may have a non-square aspect ratio, but no meaningful absolute dimensions. The drawback of ResolutionUnit=1 is that different applications will import the image at different sizes. Even if the decision is quite arbitrary, it might be better to use dots per inch or dots per centimeter, and pick XResolution and YResolution such that the aspect ratio is correct and the maximum dimension of the image is about four inches (the "four" is quite arbitrary.)

2 = Inch.

3 = Centimeter.

RowsPerStrip

Tag = 278 (116)

Type = word or dword

N = 1

Default is 2**32 - 1, which is effectively infinity. That is,the entire image is one strip. Recomended is a strip size of 8K.

The number of rows per strip. The image data is organized into strips for fast access to individual rows when the data is compressed - though this field is valid even if the data is not compressed.

--- SamplesPerPixel

Tag = 277 (115)

Type = word

N = 1

Default = 1.

The number of samples per pixel. SamplesPerPixel is 1 for bilevel, grayscale, and palette color images. SamplesPerPixel is 3 for RGB images.

--- StripByteCounts

Tag = 279 (117)

Type = word or dword

N = StripsPerImage for PlanarConfiguration equal to 1.

= SamplesPerPixel * StripsPerImage for PlanarConfiguration equal to 2

No default.

For each strip, the number of bytes in that strip. The existence of this field greatly simplifies the chore of buffering compressed data, if the strip size is reasonable.

--- StripOffsets

Tag = 273 (111)

Type = word or dword

N = StripsPerImage for PlanarConfiguration equal to 1.

= SamplesPerPixel * StripsPerImage for PlanarConfiguration equal to 2

No default.

For each strip, the byte offset of that strip. The offset is specified with respect to the beginning of the TIFF file. Note that this implies that each strip has a location independent of the locations of other strips. This feature may be useful for editing applications. This field is the only way for a reader to find the image data, and hence must exist.

--- XResolution

Tag = 282 (11A)

Type = RATIONAL

N = 1

No default.

The number of pixels per ResolutionUnit in the X direction, i.e, in the ImageWidth direction.

--- YResolution

Tag = 283 (11B)

Type = RATIONAL

N = 1

No default.

The number of pixels per ResolutionUnit in the Y direction, i.e, in the ImageLength direction.

--- Artist

Tag = 315 (13B)

Type = ASCII

Person who created the image. Copyright notice.

--- DateTime

Tag = 306 (132)

Type = ASCII

N = 20

Date and time of image creation. Uses the format "YYYY:MM:DD HH:MM:SS", with hours on a 24-hour clock, and one space character between the date and the time. The length of the string, including the null, is 20 bytes.

--- HostComputer

Tag = 316 (13C)

Type = ASCII

"ENIAC", or whatever.

--- ImageDescription

Tag = 270 (10E)

Type = ASCII

For example, a user may wish to attach a comment such as "1988 company picnic" to an image.

--- Make

Tag = 271 (10F)

Type = ASCII

Manufacturer of the scanner, video digitizer, or whatever.

--- Model

Tag = 272 (110)

Type = ASCII

The model name/number of the scanner, video digitizer, or whatever. This tag is intended for user information only so format is arbitrary.

--- Software

Tag = 305 (131)

Type = ASCII

Name and release number of the software package that created the image. User information only.

--- Group3Options

Tag = 292 (124)

Type = dword

N = 1

Those options are for fax-images stored in TIFF format. This field is made up of a set of 32 flag bits. Unused bits are expected to be 0. It is probably not safe to try to read the file if any bit of this field is set that you don't know the meaning of.

Bit map :

0 - 2-dimensional coding used.

1 - Image is uncompressed

2 - Fill bits have been added before EOL codes, so that EOL always ends on a byte boundary.

--- Group4Options

Tag = 293 (125)

Type = dword

N = 1

This field is made up of a set of 32 flag bits and is used for the images with fax group 4 compression. Unused bits are expected to be 0. It is probably not safe to try to read the file if any bit of this field is set that you don't know the meaning of. Gray scale and color coding schemes are under study, and will be added when finalized.

For 2-D coding, each strip is encoded as if it were a separate image. In particular, each strip begins on a byte boundary; and the coding for the first row of a strip is encoded independently of the previous row, using horizontal codes, as if the previous row is entirely white. Each strip ends with the 24-bit end-of-facsimile block (EOFB).

Bit map :

0 - reserved (unused)

1 - uncompressed mode is used

2-31 - reserved

--- DocumentName

Tag = 269 (10D)

Type = ASCII

The name of the document from which this image was scanned.

--- PageName

Tag = 285 (11D)

Type = ASCII

The name of the page from which this image was scanned.

--- PageNumber

Tag = 297 (129)

Type = word

N = 2

This tag is used to specify page numbers of a multiple page (e.g. facsimile) document. Two word values are specified. The first value is the page number; the second value is the total number of pages in the document. Note that pages need not appear in numerical order. The first page is 0 (zero).

--- XPosition

Tag = 286 (11E)

Type = RATIONAL

The X offset of the left side of the image, with respect to the left side of the page, in ResolutionUnits.

--- YPosition

Tag = 287 (11F)

Type = RATIONAL

The Y offset of the top of the image, with respect to the top of the page, in ResolutionUnits. In the TIFF coordinate scheme, the positive Y direction is down, so that YPosition is always positive.

--- White Point

Tag = 318 (13E)

Type = RATIONAL

N = 2

Default is the SMPTE white point, D65: x = 0.313, y = 0.329.

The white point of the image. Note that this value is described using the 1931 CIE xyY chromaticity diagram and only the chromaticity is specified. The luminance component is arbitrary and not specified. This can correspond to the white point of a monitor that the image was painted on, the filter set/light source combination of a scanner, or to the white point of the illumination model of a rendering package. The ordering is x, y.

--- PrimaryChromaticities

Tag = 319 (13F)

Type = RATIONAL

N = 6

Default is the SMPTE primary color chromaticities:

Red: x = 0.635 y = 0.340

Green: x = 0.305 y = 0.595

Blue: x = 0.155 y = 0.070

The primary color chromaticities. Note that these values are described using the 1931 CIE xyY chromaticity diagram and only the chromaticities are specified.For paint images, these represent the chromaticities of the monitor and for scanned images they are derived from the filter set/light source combination of a scanner. The ordering is red x, red y, green x, green y, blue x, blue y.

--- SubfileType

Tag = 255 (FF)

Type = word

N = 1

A general indication of the kind of data that is contained in this subfile.

Currently defined values are:

1 = full resolution image data - ImageWidth, ImageLength, and StripOffsets are required fields

2 = reduced resolution image data - ImageWidth, ImageLength, and StripOffsets are required fields. It is further assumed that a reduced resolution image is a reduced version of the entire extent of the corresponding full resolution data.

3 = single page of a multi-page image (see the PageNumber tag description).

Continued use of this field is not recommended. Writers should instead use the new and more general NewSubfileType field.

--- Orientation

Tag = 274 (112)

Type = word

N = 1

Default is 1.

1 = The 0th row represents the visual top of the image, and the 0th column represents the visual left hand side.

2 = The 0th row represents the visual top of the image, and the 0th column represents the visual right hand side.

3 = The 0th row represents the visual bottom of the image, and the 0th column represents the visual right hand side.

4 = The 0th row represents the visual bottom of the image, and the 0th column represents the visual left hand side.

5 = The 0th row represents the visual left hand side of the image, and the 0th column represents the visual top.

6 = The 0th row represents the visual right hand side of the image, and the 0th column represents the visual top.

7 = The 0th row represents the visual right hand side of the image, and the 0th column represents the visual bottom.

8 = The 0th row represents the visual left hand side of the image, and the 0th column represents the visual bottom.

It is extremely costly for most readers to perform image rotation "on the fly", i.e., when importing and printing; and users of most desktop publishing applications do not expect a file imported by the application to be altered permanently in any way.

Threshholding

Tag = 263 (107)

Type = word

N = 1

1 = a bilevel "line art" scan. BitsPerSample must be 1.

2 = a "dithered" scan, usually of continuous tone data such as photographs. BitsPerSample must be 1.

3 = Error Diffused.

ColorImageType

Tag = 318 (13E)

Type = word

N = 1

Default is 1.

Gives TIFF color image readers a better idea of what kind of color image it is. There will be borderline cases.

1 = Continuous tone, natural image.

2 = Synthetic image, using a greatly restricted range of colors. Such images are produced by most color paint programs. See ColorList for a list of colors used in this image.

ColorList

Tag = 319 (13F)

Type = BYTE or word

N = the number of colors that are used in this image, times SamplesPerPixel

A list of colors that are used in this image. Use of this field is only practical for images containing a greatly restricted (usually less than or equal to 256) range of colors. ColorImageType should be 2. See ColorImageType.

The list is organized as an array of RGB triplets, with no pad. The RGB triplets are not guaranteed to be in any particular order. Note that the red, green, and blue components can either be a BYTE or a word in length. BYTE should be sufficient for most applications.

10.3. JPEG Format Specifications

A JPEG is a type of image format that is saved using the method of lossy compression. The output image, as result of compression, is a trade-off between storage size and image quality. Users can adjust the compression level to achieve the desired quality level while at the same time reduce the storage size. Image quality is negligibly affected if 10:1 compression is applied to the image. The higher the compression value, the higher the degradation in image quality. JPEG image file format was standardized by the Joint Photographic Experts Group and, hence, the name JPEG. The format has been the choice of storing and transmitting photographic images on the web. Almost all Operating systems now have viewers that support visualization of JPEG images, which are often stored with JPG extension as well. Even the web browsers support visualization of JPEG images.

10.3.1. File Format Specifications

Before going into the JPEG file format specifications, the overall process of steps involved in JPEG creation need to be mentioned.

10.3.1.1. JPEG Compression Steps

Transformation: Color images are transformed from RGB into a luminance/chrominance image (Eye is sensitive to luminance, not chrominance, so that chrominance part can lose much data and thus can be highly compressed.

Down Sampling: The down sampling is done for colored component and not for luminance component .Down sampling is done either at a ratio 2:1 horizontally and 1:1 vertically (2h 1 V). Thus the image reduces in size since the 'y' component is not touched, there is no noticeable loss of image quality.

Organizing in Groups: The pixels of each color component are organized in groups of 8×2 pixels called " data units" if number of rows or column is not a multiple of 8, the bottom row and rightmost columns are duplicated.

Discrete Cosine Transformation: Discrete Cosine Transform (DCT) is then applied to each data unit to create 8×8 map of transformed components.DCT involves some loss of information due to the limited precision of computer arithmetic. This means that even without the map there will be some loss of image quality but it is normally small.

Quantization: Each of the 64 transformed components in the data unit is divided by a separate number called its 'Quantization Coefficient (QC)' and then rounded to an integer. This is where information is lost irretrievably, Large QC cause more loss. In general, the most JPEG implements allow use QC tables recommended by the JPEG standard.

Encoding: The 64 quantized transformed coefficients (Which are now integers) of each data unit are encoded using a combination of RLE and Huffman coding.

Adding Header: The last step adds header and all the JPEG parameters used and output the result.

The JPEG decoder uses the steps in reverse to generate the original image from the compressed one.

10.3.1.2. File Structure

A JPEG image is represented as a sequence of segments where each segment begins with a marker. Each marker starts with 0xFF byte followed by marker flag to represent the type of marker. The payload followed by marker is different as per marker type. Common JPEG marker types are as listed below:

Short Name	Bytes	Payload	Name	Comments
SOI	0xFF, 0xD8	none	Start of Image	
S0F0	0xFF, 0xC0	variable size	Start of Frame	
S0F2	0xFF, 0xC2	variable size	Start fo Frame	
DHT	0xFF, 0xC4	variable size	Define Huffman	
DQT	0xFF, 0xDB	variable size	Define Quantization	
DRI	0xFF, 0xDD	4 bytes	Define Restart	
SOS	0xFF, 0xDA	variable size	Start Of Scan	
RSTn	0xFF,	none	Restart	
APPn	0xFF, 0xE*n*	variable size	Application specific	
COM	0xFF, 0xFE	variable size	Comment	
EOI	0xFF, 0xD9	none	End Of Image	

Table 46 - Common JPEG marker types

Within the entropy-coded data, after any 0xFF byte, a 0x00 byte is inserted by the encoder before the next byte, so that there does not appear to be a marker where none is intended, preventing framing errors. Decoders must skip this 0x00 byte. This technique, called byte stuffing (see JPEG specification section F.1.2.3), is only applied to the entropy-coded data, not to marker payload data. Note however that entropy-coded data has a few markers of its own; specifically the Reset markers (0xD0 through 0xD7), which are used to isolate independent chunks of entropy-coded data to allow parallel decoding, and encoders are free to insert these Reset markers at regular intervals (although not all encoders do this).

Appendix A PRODUCT ATTRIBUTES

The Excel file annexed to this section, defines and specifies all attributes included in the SAR Standard and Non-Standard Product.

The choice to aggregate the list of metadata of Standard and Non-Standard products, derives from the need to offer to the final user a synoptic of this class of information for all SAR products.

As far as the column "HDF5 struct" included into attribute list table, it gives the dataset/group where the attribute is annexed. In the case more than one location is indicated, in most cases only one of them is available into the product (therefore ambiguities are absent); for exceptions, see the description of the attribute.

Concerning with the "Data Type" field the following semantics have to be considered (the column "Default Invalid Value", represents the value to be given to the attribute – if not differently specified - in the case it is present into the product format but it is not used by processor, or not applicable to the product)

"Data Type"	Number of bits	Sign feature	Type Representation	Default Invalid Value	HDF5 type
UByte	8	Unsigned		0	H5T_STD_U8LE
UShort	16	Unsigned	Little Endian	0	H5T_STD_U16LE
Short	16	Signed	Little Endian	$-(2^{15})$	H5T_STD_I16LE
UInt	32	Unsigned	Little Endian	0	H5T_STD_U32LE
Int	32	Signed	Little Endian	$-(2^{31})$	H5T_STD_I32LE
ULong	64	Unsigned	Little Endian	0	H5T_STD_U64LE
Long	64	Signed	Little Endian	$-(2^{63})$	H5T_STD_I64LE
Float	32	Signed	Little Endian IEEE	QNaN	H5T_IEEE_F32LE
Double	64	Signed	Little Endian IEEE	QNaN	H5T_IEEE_F64LE
String	-	-	-	"N/A"	H5T_C_S1

Table 47 - HDF5 struct

Into the following table, refer to:

- L0 column for description of RAW_B product
- L1A column for description of SCS_B, SCS_U, SCS_F products
- L1B column for description of DGM_B, DGM_F, DGM_B Speckle Filtered and DSM_W products
- QLK column for description of QLK_B product
- L1C column for description of GEC_B and GEC_F products
- L1D column for description of GTC_B and GTC_F products
- CRG_A column for CRG_A product
- CRG_B column for CRG_B product
- INT column for IPH and COH products
- DEM column for DEM_H product
- MOS column for MOS_D and MOS_H products

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Acquisition	Orbit Number	Orbit Number relevant to the Scene Centre Time. Set to zero if not available.	Root	UInt			x	x	x	x	x	x	x					

Acquisition	Scene Sensing Start UTC	Initial sensing time in UTC of the processed portion of Level 0 data. It is not updated (but simply copied) by processors using SAR products as input Standard and SPF products: Information stored at root level ------------------ CRG: Master product: Master information are stored both at Root and MAS levels Slave products: Slave information are stored at root and SLA levels Master information are stored at MAS level ------------------ IPH/COH At root level the earliest time inherited from the input data set is stored At MAS/SLA level the initial sensing time of the single Master/Slave input product is stored ------------------ DEM At root level the earliest time inherited from the input data set is stored ------------------ MOS At root level the earliest time inherited from the input data set is stored At T<jjj> level, the Scene Sensing Start of the jjj-th tile, inherited from the root level of the input tile	Root MAS SLA T<jjj>	String		Epoch	x	x	x	x	x	x	x	x	x	x	x	x

Acquisition	Scene Sensing Stop UTC	Final sensing time in UTC of the processed portion of Level 0 data. It is not updated (but simply copied) by processors using SAR products as input Standard and SPF products: Information stored at root level ----------------- CRG: Master product: Master information are stored both at Root and MAS levels Slave products: Slave information are stored at root and SLA levels Master information are stored at MAS level ----------------- IPH/COH At root level the latest time inherited from the input data set is stored At MAS/SLA level the final sensing time of the single Master/Slave input product is stored ----------------- DEM At root level the latest time inherited from the input data set is stored ----------------- MOS At root level the latest time inherited from the input data set is stored At T<jjj> level, the Scene Sensing Stop of the jjj-th tile, inherited from the root level of the input tile	Root MAS SLA T<jjj>	String		Epoch	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Acquisition	Track Number	Track Number relevant to the Scene Centre Time. It is the unique identifier of the satellite track within the 16-days orbital cycle. Both CSG satellites use the same numerical identification policy. ------------------ Standard and SPF products: stored at root level ------------------ CRG : Master product: Master information are stored both at Root and MAS levels Slave products: Slave information is stored at root and SLA levels Master information is stored at MAS level ------------------ IPH/COH At MAS/SLA level, the relevant information inherited from the input product is stored Tag not used at the root level	Root MAS SLA	UInt	[1, 237]		x	x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Calibration	Antenna Pattern Compensation Reference Surface	Designator of the surface used for the compensation of the range antenna pattern. It is modified into the output product if the following conditions are simultaneously verified: - processor capability to perform the specific calibration - calibration is explicitly requested by Processing Request File (or, if card is not allowed, if calibration is implicit into specification of output product) - calibration status retrieved from the input product ELLIPSOID+ value, indicates the usage of ellipsoid inflated by the height value indicated into Terrain Reference Height metadata	Root	String	NONE ELLIPSOID TERRAIN ELLIPSOID+			x	x	x	x	x	x	x	x			
Calibration	Azimuth Antenna Pattern Compensation Geometry	Geometry used for the compensation of the azimuth antenna pattern. It is modified into the output product if the following conditions are simultaneously verified: - processor capability to perform the specific calibration - calibration is explicitly requested by Processing Request File (or, if card is not allowed, if calibration is implicit into specification of output product) - calibration status retrieved from the input product	Root	String	NONE ACQUISITION ZERO DOPPLER			x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Calibration	Azimuth Antenna Pattern Gains	Antenna two-way power azimuth pattern gain values, corresponding to the Antenna Pattern angles obtainable by other specific tags	S<mm>	Double(N01)		dB	x	x	x	x	x	x	x	x	x			
Calibration	Azimuth Antenna Pattern Origin	Angular offset in signed degrees from beam centre measured into the azimuth plane (i.e. the Z-X plane of the Antenna Electrical System), the first value of the azimuth antenna pattern gains is referred to. It is given in the Antenna Electrical System. Negative value indicates an angle positioned on the back w.r.t. the basic pointing direction.	S<mm>	Double		deg	x	x	x	x	x	x	x	x	x			
Calibration	Azimuth Antenna Pattern Resolution	The angular step in degrees the values of the azimuth antenna pattern gains are referred to. It is given in the Antenna Electrical System. Positive value indicates that the antenna pattern is represented from backward to forward angular positions.	S<mm>	Double		deg	x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Calibration	Calibration Constant	It is the Calibration Constant value (K) of the subswath. It includes all constant proportionality terms between the target energy in the input product and the actual backscattering of the scene. It excludes terms related to Range Spreading Loss, Incidence angle and Antenna Pattern compensation operators. The multiplier term (1/sqrt(K)) have to be applied to calibrate the signal amplitude. It is applied to the output SAR image if the following conditions are simultaneously verified: - processor capability to perform the specific calibration - calibration is explicitly requested by Processing Request File (or, if card is not allowed, if calibration is implicit into specification of output product) - calibration status retrieved from the input product is set to "Not Calibrated". The attribute, in any case, must be left unchanged.	S<mm>	Double			x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Calibration	Calibration Constant Compensation Flag	Flag showing the application of the calibration constant. It is modified into the output product if the following conditions are simultaneously verified: - processor capability to perform the specific calibration - calibration is explicitly requested by Processing Request File (or, if card is not allowed, if calibration is implicit into specification of output product) - calibration status retrieved from the input product Set to invalid value in the case of mosaicked DEM	Root	UByte	0 = Not Applied 1 = Applied			x	x	x	x	x	x	x	x			
Calibration	Calibration Constant Estimation UTC	Calibration constant estimation date	S<mm>	String		Epoch	x	x	x	x	x	x	x	x	x			
Calibration	Incidence Angle Compensation Geometry	Geometry used for the compensation of the incidence angle. It is modified into the output product if the following conditions are simultaneously verified: - processor capability to perform the specific calibration - calibration is explicitly requested by Processing Request File (or, if card is not allowed, if calibration is implicit into specification of output product) - calibration status retrieved from the input product	Root	String	NONE ACQUISITION ZERO DOPPLER			x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Calibration	Incidence Angle Compensation Reference Surface	Designator of the surface used for the compensation of the incidence angle. It is modified into the output product if the following conditions are simultaneously verified: - processor capability to perform the specific calibration - calibration is explicitly requested by Processing Request File (or, if card is not allowed, if calibration is implicit into specification of output product) - calibration status retrieved from the input product Set to invalid value in the case of mosaicked DEM ELLIPSOID+ value, indicates the usage of ellipsoid inflated by the height value indicated into Terrain Reference Height metadata	Root	String	NONE ELLIPSOID TERRAIN ELLIPSOID+			x	x	x	x	x	x	x	x			
Calibration	Noise Level	Absolute Noise level in mV estimated on the noise packets after unbias	S<mm>	Double		mV		x	x	x	x	x	x	x	x			
Calibration	Noise Removal Flag	Flag showing the application of the noise removal step For mosaicked products it is annexed only to tiles.	Root	UByte	0 = Not Applied 1 = Applied			x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Calibration	Notch Angle	Angular offset in degrees from range beam centre, where the radiometric notch is expected into the notch beam packets.	S<mm>	Double	[-6, 6]	deg	x	x	x	x	x	x	x	x	x			
Calibration	Range Antenna Pattern Compensation Geometry	Geometry used for the compensation of the range antenna pattern. It is modified into the output product if the following conditions are simultaneously verified: - processor capability to perform the specific calibration - calibration is explicitly requested by Processing Request File (or, if card is not allowed, if calibration is implicit into specification of output product) - calibration status retrieved from the input product	Root	String	NONE ACQUISITION ZERO DOPPLER			x	x	x	x	x	x	x	x			
Calibration	Range Antenna Pattern Gains	Antenna two-way power range pattern gain values, corresponding to the Antenna Pattern angles obtainable by other specific tags	S<mm>	Double(N02)		dB	x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Calibration	Range Antenna Pattern Origin	Angular offset in signed degrees from range beam centre measured into the elevation plane (i.e. the Y-Z plane of the Antenna Electrical System), the first value of the range antenna pattern gains is referred to. It is given in the Antenna Electrical System. Negative value indicates an angle positioned into the elevation plane Y-Z on the left w.r.t. the basic pointing direction (supposing the observer aligned with the flight direction).	S<mm>	Double		deg	x	x	x	x	x	x	x	x	x			
Calibration	Range Antenna Pattern Refinement Model	Model used for range antenna pattern refinement in the case of ScanSAR data	Root	UByte	0 = No refinement applied or N/A 1 = beam dependant 1st degree refinement applied	deg			x	x	x	x	x					
Calibration	Range Antenna Pattern Resolution	The angular step in degrees the values of the range antenna pattern gains are referred to. It is given in the Antenna Electrical System. Positive value indicates that the antenna pattern representation moves in the elevation plane from the left toward the right side of the basic pointing direction (supposing the observer aligned with the flight direction). As a consequence, if this metadata is positive,, in the case of Right (resp. Left) Looking data, the antenna gains are represented from the Near (resp. Far) to the Far (resp. Near) of the image	S<mm>	Double		deg	x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Calibration	Range Spreading Loss Compensation Geometry	Geometry used for the compensation of the range spreading loss. It is modified into the output product if the following conditions are simultaneously verified: - processor capability to perform the specific calibration - calibration is explicitly requested by Processing Request File (or, if card is not allowed, if calibration is implicit into specification of output product) - calibration status retrieved from the input product	Root	String	NONE ACQUISITION ZERO DOPPLER			x	x	x	x	x	x	x	x			
Calibration	Subswaths Crossing Estimated Shift Angles	The signed (positive sign used for left shift) off-nadir estimated shift (before any casting) for achievement of radiometric equalization of adjacent beams in the case of ScanSAR products Its dimension, is equal to the number of subswath minus one in the case of the L1B ScanSAR product Set equal to an array of invalid value if unused.	IMG	Double(N03)		deg			x	x	x	x	x					
Calibration	Subswaths Crossing Reference Angles	The signed (positive sign used for left looking) off-nadir angle at which refinement of antenna elevation gain axis is done in the case of ScanSAR products Its dimension, is equal to the number of subswath minus one in the case of the L1B ScanSAR product Set equal to an array of invalid value if unused.	IMG	Double(N03)	[-60, 60]	deg			x	x	x	x	x					

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Azimuth Polynomial Reference Time	Reference azimuth time (in seconds since the annotated reference UTC) used to represent: - the azimuth polynomial of Doppler estimation model (valid for the geometric model and estimation from echo data) - the azimuth polynomial of Range spectrum central frequency	S<mm>	Double		s	x	x	x	x	x	x	x					

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Azimuth Polynomial Reference Time - ZD	Reference azimuth time (in seconds since the annotated reference UTC) used to represent: - the azimuth polynomial of Doppler estimation model (valid for the geometric model and estimation from echo data) in zero-Doppler geometry - the azimuth polynomial of Range spectrum central frequency ------------------ CRG products Master product At S<mm> level the tag is inherited (updated, if necessary) from the input master product At the MAS/S<mm> level the tag is copied from the relevant input product Slave product At S<mm> level the tag is inherited (updated, if necessary) from the input slave product At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product ------------------ IPH/COH products At S<mm> level the tag is copied from the input slave product. At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product	S<mm>	Double		s		x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Doppler Ambiguity Estimation Method	Identifier of the algorithm adopted for estimation of the Doppler ambiguity.	Root	String	GEOMETRY		x	x	x	x	x	x	x					
Doppler	Doppler Centroid Estimation Method	Identifier of the algorithm adopted for estimation of the fractional part of the Doppler centroid. In the case of RAW product, it is evaluated by geometric method, making use of: - platform attitude and pointing features of the image - the terrain reference height provided into appropriate metadata	Root	String	GEOMETRY ACCC (for Himage/Spot) ACCC_GG (for Spot) ACCC_GB (for Spot) MLCC (for Scan) MLBF		x	x	x	x	x	x	x					
Doppler	Doppler Centroid vs Azimuth Time Polynomial	Coefficients of the Doppler centroid azimuth simplified polynomial model (from the lowest to the highest degree) valid for the specific subswath of the product. This model is the result of the Doppler estimation step, making use of the acquisition geometry and echo data. Time axe have to be considered in acquisition geometry. Reference time annotated into "Azimuth Polynomial Reference Time".	S<mm>	Double(5)		Hz/s^i		x	x	x	x	x	x					

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Doppler Centroid vs Azimuth Time Polynomial - RAW	Coefficients of the Doppler centroid azimuth simplified polynomial model (from the lowest to the highest degree) valid for the specific subswath of the product. This model is evaluated only by the acquisition geometry. Reference time annotated into "Azimuth Polynomial Reference Time".	S<mm>	Double(5)		Hz/s^i	x	x	x	x	x	x	x					

Doppler	Doppler Centroid vs Azimuth Time Polynomial - ZD	Coefficients of the Doppler centroid azimuth simplified polynomial model (from the lowest to the highest degree) valid for the specific subswath of the product. Into complex products, this model can include effects deriving from spectrum realignment application. Into detected products, this model gives information about the spectrum characteristics of the image grid before any spectrum realignment operation. Time axe have to be considered in zero-Doppler geometry. Reference time annotated into "Azimuth Polynomial Reference Time - ZD". ------------------ CRG products Master product At S<mm> level the tag is inherited from the input master product, updated if necessary as a consequence of algorithmic steps operating on the image spectrum (e.g. common band, ...) At the MAS/S<mm> level the tag is copied from the relevant input product Slave product At S<mm> level the tag is inherited from the input slave product, updated if necessary as a consequence of algorithmic steps operating on the image spectrum (e.g. common band, ...) At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product	S<mm>	Double(5)		Hz/s^i		x	x	x	x	x	x	x	x	x		

		------------------ IPH/COH products At S<mm> level the tag is copied from the input slave product. At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product																

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Doppler Centroid vs Range Time Polynomial	Coefficients of the Doppler centroid range simplified polynomial model (from the lowest to the highest degree) valid for the specific subswath of the product. This model is the result of the Doppler estimation step, making use of the acquisition geometry and echo data. Time axe have to be considered in acquisition geometry. Reference time annotated into "Azimuth Polynomial Reference Time".	S<mm>	Double(5)		Hz/s[i]		x	x	x	x	x	x					
Doppler	Doppler Centroid vs Range Time Polynomial - RAW	Coefficients of the Doppler centroid range simplified polynomial model (from the lowest to the highest degree) valid for the specific subswath of the product. This model is evaluated only by the acquisition geometry. Reference time annotated into "Azimuth Polynomial Reference Time".	S<mm>	Double(5)		Hz/s[i]	x	x	x	x	x	x	x					

Doppler	Doppler Centroid vs Range Time Polynomial - ZD	Coefficients of the Doppler centroid range simplified polynomial model (from the lowest to the highest degree) valid for the specific subswath of the product. Into complex products, this model can include effects deriving from spectrum realignment application. Into detected products, this model gives information about the spectrum characteristics of the image grid before any spectrum realignment operation. Time axe have to be considered in zero-Doppler geometry. Reference time annotated into "Azimuth Polynomial Reference Time - ZD". ------------------ CRG products Master product At S<mm> level the tag is inherited from the input master product, updated if necessary as a consequence of algorithmic steps operating on the image spectrum (e.g. common band, ...) At the MAS/S<mm> level the tag is copied from the relevant input product Slave product At S<mm> level the tag is inherited from the input slave product, updated if necessary as a consequence of algorithmic steps operating on the image spectrum (e.g. common band, ...) At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product	S<mm>	Double(5)		Hz/s^i		x	x	x	x	x	x	x	x	x		

		------------------ IPH/COH products At S<mm> level the tag is copied from the input slave product. At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product																

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Doppler Centroid vs Times 2D Model	Coefficients of the Doppler centroid 2D 4-th degree full polynomial model valid for the specific subswath of the product. This model is the result of the Doppler estimation step, making use of the acquisition geometry and echo data. Time axe have to be considered in acquisition geometry. Reference time annotated into "Range Polynomial Reference Time" and "Azimuth Polynomial Reference Time". A 2D array $(a_{ij})_{0<i<4\ 0<j<4}$ is provided to be used as follows: $f_{Dc}(\tau,t) = \sum_{\substack{0\le i\le 4 \\ 0\le j\le 4}} a_{i,j}(t-t_{ref})^i(\tau-\tau_{ref})^j$ Where • i is the row index • j is the column index • t is the azimuth time • τ is the range time • t_{ref} is the reference azimuth time • τ_{ref} is the reference range time In the case of slave CRG_A product, the time axe is referred to the one of the master product. Set equal to NaN, if unused				See descr.		x	x	x	x	x	x					

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Doppler Centroid vs Times 2D Model - RAW	Coefficients of the Doppler centroid 2D 4-th degree full polynomial model valid for the specific subswath of the product. This model is evaluated only by the acquisition geometry. Reference time annotated into "Azimuth Polynomial Reference Time".	S<mm>	Double(5, 5)		See descr.	x	x	x	x	x	x	x					

Doppler	Doppler Centroid vs Times 2D Model - ZD	Coefficients of the Doppler centroid 2D 4-th degree full polynomial model valid for the specific subswath of the product. Into complex products, this model can include effects deriving from spectrum realignment application. Into detected products, this model gives information about the spectrum characteristics of the image grid before any spectrum realignment operation. Time axe have to be considered in zero-Doppler geometry. Reference time annotated into "Azimuth Polynomial Reference Time - ZD". ------------------ CRG products Master product At S<mm> level the tag is inherited from the input master product, updated if necessary as a consequence of algorithmic steps operating on the image spectrum (e.g. common band, ...) At the MAS/S<mm> level the tag is copied from the relevant input product Slave product At S<mm> level the tag is inherited from the input slave product, updated if necessary as a consequence of algorithmic steps operating on the image spectrum (e.g. common band, ...) At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product	S<mm>	Double(5, 5)		See descr.		x	x	x	x	x	x	x	x	x		

		------------------ IPH/COH products At S<mm> level the tag is copied from the input slave product. At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product																

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Doppler Rate Estimation Method	Identifier of the algorithm adopted for estimation of the Doppler rate .	Root	String	GEOMETRY CENTROID		x	x	x	x	x	x	x					
Doppler	Doppler Rate vs Azimuth Time Polynomial	Coefficients of the Doppler rate azimuth polynomial coefficients (from the lowest to the highest degree) Range/azimuth times axis are considered in acquisition geometry.	S<mm>	Double(5)		$Hz/s^{(i+1)}$	x	x	x	x	x	x	x					
Doppler	Doppler Rate vs Range Time Polynomial	Coefficients of the Doppler rate range polynomial coefficients (from the lowest to the highest degree) Range/azimuth times axis are considered in acquisition geometry.	S<mm>	Double(5)		$Hz/s^{(i+1)}$	x	x	x	x	x	x	x					
Doppler	Range Polynomial Reference Time	Reference range time used to represent the range Doppler polynomial model (valid for the geometric model and estimation from echo data).	S<mm>	Double		s	x	x	x	x	x	x	x					

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Range Polynomial Reference Time - ZD	Reference range time (in second) used to represent: - the range polynomial of Doppler estimation model (valid for the geometric model and estimation from echo data) in zero-Doppler geometry ------------------ CRG products Master product At S<mm> level the tag is inherited (updated, if necessary) from the input master product At the MAS/S<mm> level the tag is copied from the relevant input product Slave product At S<mm> level the tag is inherited (updated, if necessary) from the input slave product At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product ------------------ IPH/COH products At S<mm> level the tag is copied from the input slave product. At the MAS/S<mm> and SLA/S<mm> levels the tag is copied from the relevant input product	S<mm>	Double		s		x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Doppler	Spectrum Realignment Flag	Flag indicating processing level on the azimuth spectrum.	Root	UByte	0 = Azimuth Spectrum Unchanged 1 = Azimuth Spectrum Realigned 2 = Azimuth Spectrum Realigned and Shifted to baseband			x										
Formatting	Analog Cal Reconstruction Levels	Look Up Table to be used for reconstruction of the analogue signal level from the quantized levels included into the CAL lines of the RAW product. Equal to QNaN for unused levels	Root	Double(2048)		mV	x											
Formatting	Analog Noise Reconstruction Levels	Look Up Table to be used for reconstruction of the analogue signal level from the quantized levels included into the NOISE lines of the RAW product. Equal to QNaN for unused levels	Root	Double(2048)		mV	x											
Formatting	Analog Signal Reconstruction Levels	Look Up Table to be used for reconstruction of the analogue signal level from the quantized levels included into the ECHO lines of the RAW product. Equal to QNaN for unused levels	Root	Double(2048)		mV	x											
Formatting	Equivalent Column Time Interval	Equivalent time spacing in the range direction between columns	S<mm>	Double		s	x											

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Formatting	Equivalent First Column Time	Equivalent time of the first column of the data in seconds. If set to QNaN it indicates that the compensation of SWST change has not been performed and the attribute "Range First Times" must be considered. In the case of burst mode data, it is set to the minimum of the equivalent times of the bursts included into the subswath	S<mm>	Double		s	x											
Formatting	Equivalent First Line Time	Equivalent time of the first line of the data in seconds since the annotated reference UTC. In the case of burst mode data, it is set to the equivalent time of the first burst included into the subswath	S<mm>	Double		s	x											
Formatting	Equivalent Line Time Interval	Equivalent time spacing in the azimuth direction between lines	S<mm>	Double		s	x											
Formatting	Image Scale	Scale used for image representation	Root	String	LINEAR POWER DB		x	x	x	x	x	x	x	x	x			x
Formatting	Layover Pixel Value	Value used for representation of pixels in layover geometry	GIM	Short								x						
Formatting	Shadowing Pixel Value	Value used for representation of pixels in shadowing geometry	GIM	Short								x						

Formatting	Zero Doppler Azimuth First Time	Standard products, SPF Zero-Doppler time of the first line of the output image expressed in seconds since the annotated reference UTC ------------------ CRG Product Master product At the MAS/IMG or MAS/S<mm>/IMG level, metadata are copied from the input standard master product At the IMG level, metadata is derived from the input master product, calculated taking into account possible image cut, if applied. Slave product At the MAS/IMG or MAS/S<mm>/IMG or SLA/IMG or SLA/S<mm>/IMG level, metadata are copied from the input standard master/slave products At the IMG level, metadata is derived from the input master product and represents the azimuth time of the line of the master image corresponding to the first line of the slave image. Such value, in order to be used for coordinate conversions on the slave image, must be combined with the state vectors of the master image ------------------ IPH-COH products At the MAS/S<mm>/IMG or SLA/S<mm>/IMG level, metadata are copied from the correspondant metadata into the input CRG_A products At the IMG level, metadata is derived from the input master product and	IMG	Double		s		x	x	x	x	x	x	x	x	x		

		represents the azimuth time of the line of the interferogram.																

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Formatting	Zero Doppler Azimuth Last Time	Standard products, SPF Zero-Doppler time of the last line of the output image expressed in seconds since the annotated reference UTC ------------------ CRG Product See the rules defined for Zero Doppler Azimuth First Time ------------------ IPH-COH products See the rules defined for Zero Doppler Azimuth First Time	IMG	Double		s		x	x	x	x	x	x	x	x	x		
Formatting	Zero Doppler Range First Time	Standard products, SPF Zero-Doppler time of the first column of the output image expressed in seconds. ------------------ CRG Product See the rules defined for Zero Doppler Azimuth First Time ------------------ IPH-COH products See the rules defined for Zero Doppler Azimuth First Time	IMG	Double		s		x	x	x	x	x	x	x	x	x		
Formatting	Zero Doppler Range Last Time	Standard products, SPF Zero-Doppler time of the last column of the output image expressed in seconds. ------------------ CRG Product See the rules defined for Zero Doppler Azimuth First Time ------------------ IPH-COH products	IMG	Double		s		x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		See the rules defined for Zero Doppler Azimuth First Time																
Identification	Acquisition Station ID	Acquisition Station numeric identifier.	Root	String			x	x	x	x	x	x	x					
Identification	Confidential Flag	Confidential flag	Root	String	NC C		x	x	x	x	x	x	x	x	x	x	x	x
Identification	Confidential Level	Confidential level	Root	String	unclassified restricted confidential secret topSecret		x	x	x	x	x	x	x	x	x	x	x	x
Identification	CRG Image Flag	Flag indicating if the image has been used such as Master rather than Slave in co-registration process (both in master and slave images)	Root	String	MASTER SLAVE									x	x			
Identification	Downlink Start UTC	Downlink time of the first echo line of the Level 0 file used as input to generate the product	Root	String		Epoch	x	x	x	x	x	x	x					
Identification	Downlink Stop UTC	Downlink time of the last echo line of the Level 0 file used as input to generate the product	Root	String		Epoch	x	x	x	x	x	x	x					

Identification	File Sequence ID	Image sequence identifier within the downlinked Packet Store. Useful to associate the image product to the packets organization into the downlinked telemetry in the case of the following sensor modes: - Spotlight DI2S-MS - Pingpong - QuadPol ----------------- Standard and SPF products: At root level ----------------- CRG: Master product: Master information are stored both at Root and MAS levels Slave products: Slave information is stored at root and SLA levels Master information is stored at MAS level ----------------- IPH/COH Products: At MAS/SLA levels, identifier inherithed from the master/slave image Tag not used at the root level ----------------- MOS Product MOS_D: At T<jjj> level, identifier of the input tile. Set equal to N/A for MOS_H product Tag not used at the root level	Root MAS SLA T<jjj>	UByte	1 2		x	x	x	x	x	x	x	x	x	x		x
Identification	Master Products	Array of the filenames separated by <semicolon><blank> character sequence ("; ") of the master products used as input in the frame of interferometric product generation.	Root	String												x	x	

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Identification	Mission ID	Mission identifier	Root	String	CSG		x	x	x	x	x	x	x	x	x	x	x	x
Identification	Processing Centre	Identifier of the processing centre which generated the core processing step of the current product	Root	String	<Element>/<Subsystem> Ex.: ICUGS/PM01		x	x	x	x	x	x	x	x	x	x	x	x
Identification	Product Type	Indication of the product type.	Root	String	Standard levels - L0: RAW_B - L1A: SCS_B | SCS_U - L1B: DGM_B - L1C: GEC_B - L1D: GTC_B Non-Standard levels - Speckle Filtered: SPF_B - Coregistered: CRG_A | CRG_B - Interferometric: IPH_B | COH_B | DTM_H - Mosaiked: MOS_D | MOS_H - Quick Look: QLK_B - Apodized: SCS_F DGM_F | GEC_F | GTC_F - Intermediate levels (internal use only) DSM_W | DSM_F		x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Identification	Satellite ID	Standard and SPF products: At root level, it is the Satellite Identifier of the product ------------------ CRG: Master product: Master information are stored both at Root and MAS levels Slave products: Slave information is stored at root and SLA levels Master information is stored at MAS level ------------------ IPH/COH Products: At MAS/SLA levels, satellite identifier used for the acquisition of the master/slave image Tag not used at the root level ------------------ MOS Product At T<jjj> level, satellite identifier of the input tile. Set equal to N/A for MOS_H product Tag not used at the root level	Root MAS SLA T<jjj>	String	SSAR1 SSAR2 N/A		x	x	x	x	x	x	x	x	x	x		x
Identification	Security	Security level.	Root	String	Operational NotOperational		x	x	x	x	x	x	x	x	x	x	x	x
Identification	Slave Products	Array of the filenames separated by <semicolon><blank> character sequence ("; ") of the slave products used as input in the frame of interferometric product generation.	Root	String												x	x	

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Identification	Visibility	In the Defence context it is the National Eye Only (NEO) or NotNEO flag. In the Civilian context it is the National/International flag. Inherited by the input product In the case of services using more than one product as input, the most restrictive concept is inherited among ones extracted from the input files. Note: In the Defence context, NEO is more retrictive than NOT-NEO In the Civilian context, NATIONAL is more restrictive than INTERNATIONAL	Root	String	NEO NotNEO National International		x	x	x	x	x	x	x	x	x	x	x	x
Instrument	Acquisition Mode	All product but MOS: At root level, it is the Acquisition Mode used for image sensing ------------------ MOS Product At T<jjj> level, Instrument Mode of the input tile Tag not used at the root level	Root T<jjj>	String	SPOTLIGHT-1A SPOTLIGHT-1B SPOTLIGHT-2A SPOTLIGHT-2B SPOTLIGHT-2C SPOTLIGHT-1-MSOR SPOTLIGHT-2-MSOS SPOTLIGHT-2-MSJN SPOTLIGHT-1-OQR SPOTLIGHT-2-OQS SPOTLIGHT-1-EQR SPOTLIGHT-2-EQS STRIPMAP PINGPONG SCANSAR-1 SCANSAR-2 QUADPOL N/A		x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Antenna Beam Elevation	Elevation angle associated to the antenna beam. It represent the signed (positive sign used to represent a beam moving to the left) offset of the nominal main lobe w.r.t. the mechanical perpendicular to the antenna, measured in the elevation plane. Module of this angle is extracted from the Antenna Pattern support data. Such angle, in conjunction with the additional elevation and azimuth steering polynomial coefficients available in SAR telemetry, is used to derive the antenna electrical pointing (the z-axis of the Antenna Electrical System). Around such direction, the antenna gains in the elevation plane are represented through the following metadata: - Range Antenna Pattern Origin - Range Antenna Pattern Resolution - Range Antenna Pattern Gains	S<mm>	Double	[-20, 20]	deg	x	x	x	x	x	x	x	x	x			
Instrument	Antenna Length	Antenna length in the azimuth direction	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	x
Instrument	Antenna Width	Antenna width in the range direction (used for the avaluation of offset related to the elevation steering)	Root	Double		m	x											
Instrument	Azimuth Beamwidth	One-way antenna azimuth beamwidth at -3dB	Root	Double		deg	x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Azimuth Bias Time	Bias time applied to the OBC extracted from the Source Packets. It doesn't nclude corrections due to the start/stop sensing geometry It only includes pre-configured additoinal bias. It is already applied into the annotated azimuth times expressed in seconds. It is estimated during specific calibration campaigns and externally provided to Level 0 processor by Satellite Configuration file. For multi-swath modes distinct values are provided for each swath.	S<mm>	Double		s	x											
Instrument	Azimuth First Time	Acquisition time of the first line of the processed portion of input data/product.. It is expressed in seconds since the annotated reference UTC.	B<nnnn> NOTCH	Double		s	x	x	x	x	x	x						
Instrument	Azimuth Instrument Geometric Resolution	Theoretical azimuth geometric resolution of the data as derived from the radar parameters (that is not considering weighting and multilooking effects), including squint effects.	S<mm>	Double		m		x	x	x	x	x	x	x	x			
Instrument	Azimuth Last Time	Acquisition time of the last line of the processed portion of input data/product.. It is expressed in seconds since the annotated reference UTC.	B<nnnn>	Double		s	x	x	x	x	x	x						
Instrument	Azimuth Ramp Code	Code of the azimuth scanning ramp as it is reported in the Level 0 data. The array dimension corresponds to the number of occurrences of code's changes.	B<nnnn>	UByte(N13)	[0, 255]		x	x	x	x	x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Azimuth Ramp Code Change Lines	Image Rows indexes at which the azimuth scanning ramp has been changed (within data segment) w.r.t. the corresponding values of the previous line. Line 0 is always considered as a changing line. The array dimension corresponds to the number of occur ences of code's changes.	B<nnnn>	UInt(N13)			x	x	x	x	x	x						
Instrument	Azimuth Start Stop Correction	Bias time applied to the OBC extracted from the Source Packets. It ncludes corrections due to the start/stop sensing geometry and is added to the Azimuth time. For multi-swath modes distinct values are provided for each swath.	S<mm>	Double		s	x											
Instrument	Azimuth Steering	Array of the Azimuth angles of the antenna beam set at the Azimuth Ramp Code Change Lines. While for the ScanSAR and StripMap case such value should be constant within the strip/burst, in the Spotlight case the array including the azimuth direction of the antenna beam due to the repointing implied by the instrument mode should be given. The array dimension corresponds to the number of occur ences of angle's changes.	B<nnnn>	Double(N13)	[-2, 2]	deg	x	x	x	x	x	x						
Instrument	Beam ID	Identifier of the beam which contributes to the full swath	S<mm>	String	Spotlight 1A: S1S-001 - … - S1S-[TBD] Spotlight 1B: S1S-001 - … - S1S-[TBD] Spotlight 2A: S2S-001 -		x	x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
					… - S2S-049 Spotlight 2B: S2S-001 - … - S2S-049 Spotlight 2C: S2S-001 - … - S2S-049 Spotlight 1 OR: S1S-001 - … - S1S-[TBD] Spotlight 2 OS: S2S-001 - … - S2S-049 Spotlight 2 JN: S2S-001 - … - S2S-049 Stripmap: H4S-001 - … - H4S-027 ScanSAR 1: SS2-001 - … - SS2-025 ScanSAR 2: SS2-001 - … - SS2-025 QuadPol: QPS-001 - … - QPS-021 Pingpong: PPS-001 - … - PPS-027 Spotlight 1 Exp: S1S-001 - … - S1S-[TBD] Spotlight 2 Exp: S2S-001 - … - S2S-[TBD]													
Instrument	Beam Off-Nadir Angle	Nominal off-nadir angle of the beam (as pre-coded into the GS database at the mission start time). It can be used for a coarse approach to the antenna pattern compensation.	S<mm>	Double	[15, 55]	deg	x	x	x	x	x	x	x	x	x	x		
Instrument	Bursts per Subswath	Bursts per Subswath/Polarization. Attribute updating is applicable in the case of processing of image portion starting from Level 0 data.	S<mm>	UShort			x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Calibration Pulse Azimuth Times	Array of the slow times of the Calibration Pulses in seconds since the annotated reference UTC, derived from the OBT extracted from the downlinked product. In the case of compensated invalid lines, azimuth time is set equal to QNaN.	CAL	Double(N04) Double(N15)		s	x											
Instrument	Calibration Sampling Rate	Sampling rate of the instrument during the calibration packets acquisition	S<mm>	Double		Hz	x											
Instrument	Calibration Sampling Window Length	Sampling Window Lengths of the Periodic Calibration Data (in number of range samples coherent with the Calibration Sampling Rate) during the acquisition of the subswath.	S<mm>	UShort			x											

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Correlation Signal Amplitude Polynomial	Polynomial coefficients for reconstruction of the radar transmitted chirp signal amplitude	S<mm>	Double(13)			x											
Instrument	Correlation Signal Phase Polynomial	Polynomial coefficients for reconstruction of the radar transmitted chirp signal phase	S<mm>	Double(13)			x											
Instrument	Correlation Signal Reference Time	Offset w.r.t. the range first time, of the reference time (null frequency time) of correlation signal (used only for the Spotlight case, set to QNaN otherwise).	S<mm>	Double		s	x											
Instrument	DCU Filtered Bandwidth	Filtered bandwidth at DCU level	S<mm>	Double		Hz	x											
Instrument	Deramping Window Length	Deramping window length	S<mm>	Double		s	x											
Instrument	Deramping Window Offset	Offset of the deramping window with respect to the Sampling Window Start Time	S<mm>	Double		s	x											

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Echo Sampling Window Length	Sampling Window Lengths (in number of range samples) during the acquisition of the subswath.	S<mm>	UShort			x	x	x	x	x	x	x					
Instrument	Electronic Delay Correction	Correction term applied to the fast time electronic delay. It can be: - automatically evaluated (if requested by processor configuration file) from calibration pulses on not-deramped modes according to specification of the satellite manufacturer - statically defined into satellite configuration file (for deramped mode this is a mandatory option) and applied by Level 0 processor It is annotated for documentation purposes.	S<mm>	Double		s	x											
Instrument	Electronic Delay Measure	Measure of the fast time electronic delay, evaluated from calibration pulses on not-deramped modes according to specification of the satellite manufacturer. It is annotated for statistical analysis purposes. Set equal to QNaN for deramped modes	S<mm>	Double		s	x			x								
Instrument	Elevation Ramp Code	Code of the elevation scanning ramp as it is reported in the Level 0 data. The array dimension corresponds to the number of occurrences of code's changes.	B<nnnn>	UByte(N17)	[0, 31]		x	x	x	x	x	x						
Instrument	Elevation Ramp Code Change Lines	Image Rows indexes at which the elevation scanning ramp has been changed (within data segment) w.r.t.	B<nnnn>	UInt(N17)			x	x	x	x	x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		the corresponding values of the previous line. Line 0 is always considered as a changing line. The array dimension corresponds to the number of occur ences of code's changes.																
Instrument	Elevation Steering	Array of the signed (positive sign means the main lobe moves to the left) additional Elevation angles of the antenna beam, as it is set at the Elevation Ramp Code Change Lines. Such angle, in conjunction with the nominal antenna beam elevation, gives the total elevation angle The array dimension corresponds to the number of occur ences of angle's changes.	B<nnnn>	Double(N17)	[-20, 20]	deg	x	x	x	x	x	x						
Instrument	GNSS Antenna ID	Antenna used for evaluation of the on-board navigation solution	Root	String	ANTENNA1 ANTENNA2 ANTENNAAVG (for POD downlinked orbit only)		x											
Instrument	GNSS Antenna Offset	Offset from the satellite CoG to GNSS Center of phase extracted by the orbital file. If processing is done with the downlinked orbit, the conventional value (0, 0, 0) is annotated.	Root	Double(3)		m	x											

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Ground Range Instrument Geometric Resolution	Theoretical geometric resolution on ground in the range direction evaluated on the central image line in the worst case (that is at near range), as derived from the radar parameters (that is not considering weighting and multilooking effects) including squint effects.	S<mm>	Double		m		x	x	x	x	x	x	x	x			
Instrument	Lines per Burst	Lines per burst	S<mm>	UInt			x	x	x	x	x	x	x					
Instrument	Look Side	Standard and SPF products: At root level, it is the Look Side used for image sensing ----------------- CRG: Master product: Master information are stored both at Root and MAS levels Slave products: Slave information is stored at root and SLA levels Master information is stored at MAS level ----------------- IPH/COH Products: At MAS/SLA levels, Look Side used for the acquisition of the relevant master/slave image Tag not used at the root level	Root MAS SLA T<jjj>	String	RIGHT LEFT N/A		x	x	x	x	x	x	x	x	x	x		x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		------------------ MOS Product At T<jjj> level, Look Side of the input tile Set equal to the invalid value in the case of mosaicked DEM Tag not used at the root level																
Instrument	Multi-Beam ID	Standard and SPF products: At root level, it is the identifier of the beam combination used for image sensing ------------------ CRG: Master product: Master information are stored both at Root and MAS levels Slave products: Slave information is stored at root and SLA levels Master information is stored at MAS level ------------------ IPH/COH Products: At MAS/SLA levels, identifier of the beam combination used for the acquisition of the master/slave image Tag not used at the root level ------------------ MOS Product At T<jjj> level, identifier of the beam combination of the input tile Tag not used at the root level	Root MAS SLA T<jjj>	String	Spotlight 1A: S1A-001 - … - S1A-[TBD] Spotlight 1B: S1B-001 - … - S1B-[TBD] Spotlight 2A: S2A-001 - … - S2A-049 Spotlight 2B: S2B-001 - … - S2B-049 Spotlight 2C: S2C-001 - … - S2C-049 Spotlight 1 OR: D2R-001 - … - D2R-[TBD] Spotlight 2 OS: D2S-001 - … - D2S-024 Spotlight 2 JN: D2J-001 - … - D2J-024 Stripmap: STR-001 - … - STR-027 ScanSAR 1: SC1-001 - … - SC1-007 ScanSAR 2: SC2-001 - … - SC2-006 QuadPol: QPS-001 - … - QPS-021 Pingpong: PPS-001 - … - PPS-027 Spotlight 1 Exp: S1E-001 - … - S1E-[TBD]		x	x	x	x	x	x	x	x	x	x		x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
					Spotlight 2 Exp: S2E-001 - … - S2E-[TBD]													

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Noise Data Azimuth Times	Slow times of the Noise data in seconds since the annotated reference UTC, derived from the OBT extracted from the downlinked product In the case of compensated invalid lines, azimuth time is set equal to QNaN.	NOISE	Double(N11) Double(N19)		s	x											
Instrument	Noise Sampling Rate	Sampling rate of the instrument during the noise packets acquisition	S<mm>	Double		Hz	x											
Instrument	Noise Sampling Window Length	Sampling Window Lengths of the Noise Data (in number of range samples coherent with the Noise	S<mm>	UShort			x											

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		Sampling Rate) during the acquisition of the subswath.																
Instrument	Packet Type	Array including a code representing the packet type for each line of the calibration and noise datasets. Note: In the case of compensated missing lines, the corresponding element of the array is in any case set equal to the code of the expected original pulse.	CAL NOISE	UByte(N04) UByte(N11) UByte(N15) UByte(N19)	1 = RXCal POC2 (18) 2 = RXCal POC128 (18) 3 = ShortCal (21) 4 = ShortCal Isolation (22) 5 = RFCal AttOff (23) 6 = RFCal AttOn (27) 7 = TXCal POC2 (15) 8 = TXCal POC128 (15) 9 = TXCal 10 = RXCal 21 = Noise (5) 22 = SES Noise (23)		x											
Instrument	Polarization	Transmit/Receive Polarization enabled during data sensing. H = Horizontal V = Vertical Standard products: Stored at the Root level ------------------ CRG: Master product: Master information are stored both at Root and MAS levels Slave products: Slave information is stored at root and SLA levels Master information is stored at MAS level ------------------	Root MAS SLA T<jjj>	String	HH VV VH HV		x	x	x	x	x	x	x	x	x	x		x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		IPH/COH Products: At MAS/SLA levels, identifier of the polarization used for the acquisition of the master/slave image Tag not used at the root level ------------------ MOS Product In MOS_D product, at T<jjj> level, identifier of the polarization of the input tile Set equal to N/A for MOS_H product Tag not used at the root level																

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	PRF	Standard and SPF products: At S<mm> level, it is the Pulse Repetition Frequency of the instrument used for image sensing ------------------ CRG/IPH/COH Products: At /MAS/S<mm> and /SLA/S<mm> levels, PRF used for the acquisition of the specific beam of the master/slave image Tag not used at the /S<mm> level	S<mm>	Double		Hz	x	x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Radar Frequency	Radar frequency	Root	Double		Hz	x	x	x	x	x	x	x	x	x	x	x	x
Instrument	Radar Wavelength	Radar wavelength	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	x
Instrument	Range Chirp Bandwidth	Range chirp bandwidth	S<mm>	Double	[3e-6, 100e-6]	s	x	x	x	x	x	x	x	x	x			
Instrument	Range Chirp Length	Range chirp length	S<mm>	Double	[3e-6, 100e-6]	s	x	x	x	x	x	x	x	x	x			
Instrument	Range Chirp Rate	Rate of the transmitted pulse. In the case of acquisitions where an up-chirp and a down-chirp are alternated every PRI, it represents the rate of the first echo line of the L0 data segment used to generate the product and included into it.	S<mm>	Double		Hz/s	x	x	x	x	x	x	x	x	x			
Instrument	Range Chirp Rate Alternation Flag	Flag indicating if up-down chirp policy was applied during the image sensing	Root	UByte	0 = Not Applied or N/A 1 = Applied		x											
Instrument	Range Chirp Samples	Number of chirp samples, as derived from Range Chirp Length and Sampling Rate. The echo Sampling Rate is always	S<mm>	UShort			x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		considered for the evaluation of this attribute.																
Instrument	Range Chirp Sign	Array including signs of the chirp rate for each line of the calibration, replica, notch datasets. The chirp rate of the i-th line, is obtained multiplying the i-th element of this array by the module of chirp rate extracted by the Range Chirp Rate attribute. NOTE: alternated chirp shall be used for the following instrument modes: - Stripmap - ScanSAR - Pingpong Note: In the case of compensated missing lines, the corresponding element of the array is in any case set equal to the code of the expected original pulse.	CAL REPLICA NOTCH	Byte(N04) Byte(N08) Byte(N14) Byte(N15)	+1 = positive rate -1 = negative rate		x											
Instrument	Range Chirp Start Phase	Start phase at the rising edge of the range chirp pulse	S<mm>	Double	[-180, 180]	deg	x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Range First Time Change Lines	Image Rows indexes (starting from 0) at which the Sampling Window Start Time has been changed (within burst) w.r.t. the corresponding values of the previous line. Line 0 of the burst is always considered as a changing line.	B<nnnn>	UInt(N07)		s	x	x	x	x	x	x						
Instrument	Range First Times	Time between the rising edge of the transmit pulse and the rising edge of the receiving window opened to sample the echo of the same pulse, relevant to lines included in "Range First Time Change Lines". It differs from the value of the Sampling Window Start Time annotated into the downlinked data, as it take into account the time between the rising edge of the transmit pulse and the rising edge of the sampling window within the same PRI. Note:: for the notch beam, only one value is provided.	B<nnnn> NOTCH	Double(N07)		s	x	x	x	x	x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Range Gate Opening Bias Time	Systematic error affecting the measure of Sampling Window Start Time annotated into the Source Packets. This term is added to the downlinked SWST. Such value, doesn't include the following predictible error source: - tropospheric delay - range orbit reference correction time - predicted/estimated electronic delay It only represents residual bias unjustified by other known error sources.	S<mm>	Double		s	x											
Instrument	Rank	In flight pulses Note: Such value, divided by PRF is used as the anchorage point to define the range time grid of focusing step. The time of the first column of L1A standard products generated from a single Level 0 file shall be separated by an integer number of column time intervals from Rank/PRF.	S<mm>	UByte			x	x	x	x	x	x	x	x	x			
Instrument	Receiver Gain	The receiver attenuation settings used during the acquisition	S<mm>	UByte	[0, 30]	dB	x	x	x	x	x	x						
Instrument	Rechirping Signal Amplitude Polynomial	Polynomial coefficients for reconstruction of the amplitude of the rechirping signal	S<mm>	Double(13)			x											

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Rechirping Signal Phase Polynomial	Polynomial coefficients for reconstruction of the phase of the rechirping signal	S<mm>	Double(13)			x											
Instrument	Rechirping Signal Reference Time	Offset w.r.t. the range first time, of the reference time (null frequency time) of dechirping signal (used only for the Spotlight case, set to QNaN otherwise).	S<mm>	Double		s	x											
Instrument	Replica Azimuth Times	Slow times of the reconstructed replica in seconds since the annotated reference UTC, derived from the OBT extracted from the downlinked product. In the case of compensated invalid lines, azimuth time is set equal to QNaN.	REPLICA	Double(N08)		s	x											
Instrument	Sampling Rate	Standard and SPF products: At S<mm> level, it is the Range Sampling rate of the instrument used for image sensing ------------------ CRG/IPH/COH Products: At /MAS/S<mm> and /SLA/S<mm> levels, PRF used for the acquisition of the specific beam of the master/slave image Tag not used at the /S<mm> level	S<mm>	Double		Hz	x	x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Instrument	Subswaths Number	Number of subswaths included in scene	Root	UByte	1 (Stripmap/Spotlight/ QuadPol/Pingpong) 4 (ScanSAR 1) 6 (ScanSAR 2)		x	x	x	x	x	x	x	x	x	x		
Instrument	Synthetic Aperture Duration	Duration of the synthetic aperture at the central slant range	S<mm>	Double		s	x	x	x	x	x	x	x	x	x			
Instrument	Timeline Parameter N	Timeline parameter referring the number of acquisition cycles	Root	UShort			x											
Instrument	Timeline Parameter N6	Timeline parameter referring the number of acquisition PRI in the cycle	S<mm>	UShort			x											
ITF Query	IFQ Baseline	Array including orthogonal/parallel/along-track baseline components with respect to the nodes on the reference orbit where support parameters necessary for interferometric query are evaluated Included only into the QLK product	Root	Double(N20, 3)		m				x								
ITF Query	IFQ Doppler	Array including the Doppler centroid of the virtual ground target observed from the nodes on the reference orbit. Included only into the QLK product	Root	Double(N20)						x								

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
ITF Query	IFQ ECEF Satellite Acceleration	Satellite Acceleration in Earth Centred - Earth Fixed Cartesian coordinate system, evaluated on the Reference orbit corresponding to the relevant annotated times Included only into the products generated in the frame for generation of QLK product	Root	Double(N22, 3)		m/s^2	x			x								
ITF Query	IFQ ECEF Satellite Position	Satellite Position in Earth Centred - Earth Fixed Cartesian coordinate system, evaluated on the Reference orbit corresponding to the relevant annotated times Included only into the products generated in the frame for generation of QLK product	Root	Double(N22, 3)		m	x			x								
ITF Query	IFQ ECEF Satellite Velocity	Satellite Velocity in Earth Centred - Earth Fixed Cartesian coordinate system, evaluated on the Reference orbit corresponding to the relevant annotated times Included only into the products generated in the frame for generation of QLK product	Root	Double(N22, 3)		m/s	x			x								
ITF Query	IFQ Nodes	Array of times (in seconds since the annotated reference UTC) at which the satellite orbital parameters used to support the interferometric query are evaluated. Included only into the QLK product	Root	Double(N20)						x								

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
ITF Query	IFQ Reference Start Time	Start time to be associated to the single-look focused L0F, evaluated in zero-Doppler geometry on the reference orbit. Included only into the QLK product	Root	Double		s				x								
ITF Query	IFQ Reference Stop Time	Stop time to be associated to the single-look focused L0F, evaluated in zero-Doppler geometry on the reference orbit. Included only into the QLK product	Root	Double		s				x								
ITF Query	IFQ State Vectors Times	Array of times (in seconds) measured on the reference orbit at which the satellite state vectors are supplied Included only into the products generated in the frame for generation of QLK product	Root	Double(N22)		s	x			x								
PCD	Attitude Product Category	Type of Attitude product used for processing. DOWNLINKED indicates the attitude data annexed to the Level 0 data as they are downlinked from the spacecraft RESTITUTED indicates the attitude data obtained by on-ground postprocessing.	Root	String	DOWNLINKED RESTITUTED		x	x	x	x	x	x	x	x	x			
PCD	CRG Baseline	CRG products Set equal to array of invalid values into the master product. For each slave: orthogonal/parallel/along-track	Root	Double(3)		m								x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		baseline components w.r.t. the line of sight estimated at the image center IPH/COH products Inherited from the input coregistered slave product																
PCD	CRG GCP Cross-correlation Threshold	CRG products For each slave: threshold used for the cross-correlation value to accept/discard the GCP. IPH/COH products Inherited from the input coregistered slave product	GCP	Double										x	x			
PCD	CRG GCPs Residuals Mean	CRG products For each slave: Mean of geometric residuals of GCPs coregistration	GCP	Double(2)										x	x			
PCD	CRG GCPs Residuals Standard Deviation	CRG products For each slave: Standard deviation of geometric residuals of GCPs coregistration	GCP	Double(2)										x	x			
PCD	CRG Overlapping Percentage	Set equal to invalid value into the master product. For each slave: extension (as percentage of the master coverage) of the overlapping zone between the slave and the master (estimated on the	Root	Double										x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		entire scene in the case of ScanSAR mode)																
PCD	CRG Resolution Cell Size	Set equal to array of invalid values into the master product. For each slave: Size of the resolution cell along range/azimuth directions	Root	Double(2)		pixel								x	x			
PCD	CRG Track Distance	Set equal to invalid value into the master product. For each slave: - in the case of detected images, it represents the distance between tracks at the satellite nadir of master and slave images, measured at the central azimuth time	Root	Double		m								x	x			
PCD	CRG Track Flag	Set equal to invalid value into the master product. For each slave: flag indicating the interferometric features of the tracks used for acquisition of the pair.	Root	UByte	0 = Non-interferometric geometry 1 = Interferometric geometry									x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
PCD	DEM Average Slope Flag	Flag related to the average terrain slope. 1 = indicates that the average terrain slope is less than 5° in all direction	Root	UByte	[0, 1]												x	
PCD	DEM Baseline	Orthogonal/parallel/along-track baseline components inherited from the interferometric pairs, ordered coherently to the list of data provided into the attributes Master Products and Slave Products	Root	Double(N21, 3)		m											x	
PCD	DEM Baseline Flag	Flag related to the interferometric baseline behavior. 1 = indicates that the product is compliant to the constraints on the baseline for generation of multi-baseline DEM	Root	UByte	[0, 1]												x	
PCD	DEM Connected Areas Flag	Flag indicating presence of disconnected interferometric fringes' systems 1 = No disconnected areas into all interferograms	Root	UByte	[0, 1]												x	
PCD	DEM GCP Cross-correlation Threshold	Threshold used for the cross-correlation value to accept/discard the GCP during the coregistration process. Such attribute is inherited from input interferometric pairs and is ordered coherently to the list of data provided	Root	Double(N21)													x	

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		into the attributes Master Products and Slave Products																
PCD	DEM Incidence Angle	Reference incidence angle (unsigned value) associated to DEM product, to be considered for the relationship between Absolute/Relative Vertical accuracies and the Horizontal ones.	Root	Double		deg											x	
PCD	DEM Interferometric Coherence Flag	Flag indicating if the interferometric coherence is better than 0.6 on the 95% of the entire scene 0 = coherence smaller than 0.6 at least into a single interferometric pair 1 = all pairs exhibit coherence greater than 0.6 on the 95% of the entire scene	Root	UByte	[0, 1]												x	
PCD	DEM Maximum Slope Percentage Flag	Flag related to the maximum terrain slope. 1 = indicates that the maximum slope is smaller than 20° for 95% of the observed scene	Root	UByte	[0, 1]												x	
PCD	Doppler Ambiguity	Ambiguity number of Doppler centroid at the scene centre.	S<mm>	Short	[-20, 20]		x	x	x	x	x	x	x	x	x			
PCD	Doppler Centroid Confidence Measure	Normalized confidence measure of Doppler centroid. A value of zero means poor confidence. If not differently specified in the algorithm specification document, it is the ratio of the number of blocks flagged as valid in the Centroid	Root	Double	[0, 1]		x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		estimation flow and the total number of blocks used for the centroid estimation. Set to zero if estimation from the echo data is suppressed																
PCD	GNSS Receiver Configuration	Navigation signals used as input to generate the orbital product. It is inherited from the orbital product used as input, if used as support datum. Inherited from the input SAR product otherwise. N/A code is used if not available into the input data.	Root	String	N/A GPS L1-L2 GPS L1-L5 GALILEO E1-E5 GPS L1-L5 / GALILEO E1-E5		x	x	x	x	x	x	x	x	x			
PCD	Image Max	Image maximum value estimated separately on each channel of data excluding saturated pixels; second element of the array set to zero in the case of real data. Not estimated (hence set to QNaN) in the case of intermediate products. CRG products at /MAS/IMG and /MAS//S<mm>/IMG and /SLA/IMG and /SLA//S<mm>/IMG levels tag copied from input standard products At /IMG and /S<mm>/IMG levels information evaluated on the output product IPH/COH products at /MAS/IMG and /MAS//S<mm>/IMG and /SLA/IMG and /SLA//S<mm>/IMG levels tag copied from input	IMG	Double(2)				x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		coregistered products At /IMG and /S<mm>/IMG levels information evaluated on the output product																

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
PCD	Image Mean	Image mean value estimated separately on each channel of data; second element of the array set to zero in the case of real data. Not estimated (hence set to QNaN) in the case of intermediate products. For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG	Double(2)				x	x	x	x	x	x	x	x	x	x	x
PCD	Image Min	Image minimum value estimated separately on each channel of data excluding pixel with values lying on the lower (underflow) quantization bins; second element of the array set to zero in the case of real data. Not estimated (hence set to QNaN) in the case of intermediate products. For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG	Double(2)				x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
PCD	Image Null Pixel Percentage	Percentage of pixels having null module in the image.	IMG	Double	[0, 100]			x	x	x	x	x	x	x	x			
PCD	Image Saturated Pixel Percentage	Percentage of saturated pixels in the image. In the case of complex data, a pixel is saturated if real or imaginary part are represented using the maximum value allowed by the used datatype For CRG products, see the rules defined for Image Max tag.	IMG	Double	[0, 100]			x	x	x	x	x	x	x	x			
PCD	Image Standard Deviation	Image sigma value estimated separately on each channel of data; second element of the array set to zero in the case of real data. Not estimated (hence set to QNaN) in the case of intermediate products. For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG	Double(2)				x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
PCD	Input DEM Absolute Vertical Accuracy	Absolute Vertical Accuracy of the input support DEM. Set to NaN in the case of L1C product	Root	Double		m					x	x					x	
PCD	Input DEM Column Spacing	Spacing among columns of the input support DEM. It is expressed in degrees in the case of GEODETIC projection, in meters otherwise. Set to NaN in the case of L1C product	Root	Double		m deg					x	x					x	
PCD	Input DEM Contribution to Geolocation Error	Contribution to the geolocation error of the input support DEM. It depends on the Absolute Vertical Accuracy of the input support DEM and the incidence angle of the acquisition (VertAcc / TAN(IncAngle)). Incidence angle is estimated at the scene centre. Set to NaN in the case of L1C product	Root	Double		m					x	x						
PCD	Input DEM Line Spacing	Spacing among lines of the input support DEM. It is expressed in degrees in the case of GEODETIC projection, in meters otherwise. Set to NaN in the case of L1C product	Root	Double		m deg					x	x					x	

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
PCD	Input DEM Mission ID	Identifier of the source of the input support DEM. Set to N/A in the case of L1C product	Root	String							x	x					x	
PCD	Input DEM Projection ID	Projection descriptor of the input support DEM Set to N/A in the case of L1C product	Root	String		GEODETIC UPS					x	x					x	
PCD	Layover Pixel Percentage	Percentage of pixels in layover geometry with respect to the pixel of the scene (hence not considering invalid zones at the image borders deriving from image reprojection)	GIM	Double	[0, 100]							x						
PCD	POD Initial Position Accuracy	Quality index of the Precise Orbit Determination. It indicates the accuracy on the initial position of the propagation model.	Root	Double		m	x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		Further details in "POD Data Specification" document. Set to QNaN in the case POD Product Category is equal to "DOWNLINKED"																
PCD	POD Overlap Position Accuracy	Quality index of the Precise Orbit Determination. It indicates the accuracy of the platform position in the overlapping arcs. Further details in "POD Data Specification" document. Set to QNaN in the case POD Product Category is equal to "DOWNLINKED"	Root	Double		m	x	x	x	x	x	x	x	x	x			
PCD	POD Product Category	Quality index of the Precise Orbit Determination process. It indicates the level of accuracy of the orbital data annexed to the product. DOWNLINKED indicates the orbital data annexed to the Level 0 data as they are downlinked from the spacecraft PROPAGATED indicates the usage of propagated orbital data FILTERED indicates the orbital data obtained by filtering the on board navigation solution RESTITUTED indicates the orbital data based on the GPS data acquired by on board GPS and the GPS ground network (CSK fiducial network and/or IGS network). Such attribute is strictly related to the product delivery mode (Fast Delivery rather than Standard Delivery). Fast Delivery mode implies usage of	Root	String	DOWNLINKED PROPAGATED FILTERED RESTITUTED		x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		DOWNLINKED or PROPAGATED orbit Standard Delivery mode implies usage of FILTERED or RESTITUTED orbit																
PCD	POD Quality Flag	Quality index of the Precise Orbit Determination process performed on ground, extracted from the orbital product Set to "N/A" in the case of downlinked orbit are used	Root	String	PASS SUSP N/A		x	x	x	x	x	x	x	x	x			
PCD	Range Bandwidth Filtering Flag	Flag indicating if the range bandwidth of the burst has been interested by the algorithm for external interference sub-bands filtering. At the Root level, it is set equal to 1 if	Root B<nnnn>	UByte	0 = Filtering not applied 1 = Filtering applied			x	x	x	x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		at least one burst has been submitted to the spectrum filtering																
PCD	RAW Absolute Saturation Percentage - Max	Percentage of pixel belonging to BAQ blocks associated to the highest (mV) quantizer selection threshold and assuming (in I or Q channel) the maximum signal level (mV) before decoding of the bit sign. In the case of full quantized data, it is the percentage of pixel assuming (in I or Q channel) the maximum signal level (mV) before decoding of the bit sign One value per azimuth statistical block is provided.	B<nnnn>	Double(N09)	[0, 100]		x	x	x	x	x	x						
PCD	RAW Absolute Saturation Percentage - Min	Percentage of pixel belonging to BAQ blocks associated to the lowest (mV) quantizer selection threshold and assuming (in I or Q channel) the minimum signal level (mV) before decoding of the bit sign In the case of fully quantized data, it is the percentage of pixel assuming (in I or Q channel) the minimum signal level (mV) before decoding of the bit sign One value per azimuth statistical block is provided.	B<nnnn>	Double(N09)	[0, 100]		x	x	x	x	x	x						
PCD	RAW Bias	Bias of RAW data; two samples for the In-Phase and Quadrature signal (I-Q) estimated on valid lines of the block	B<nnnn>	Double(N09, N10, 2)			x	x	x	x	x	x						
PCD	RAW Gain Imbalance	Gain imbalance of the I and Q channel of the RAW data estimated on valid lines of the block	B<nnnn>	Double(N09, N10)			x	x	x	x	x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
PCD	RAW High Dyn Quantizer Percentage	Percentage of compressed BAQ blocks into the RAW data associated to the highest (mV) quantizer selection threshold In the case of full quantized data, it is set equal to QNaN. One value per azimuth statistical block is provided.	B<nnnn>	Double(N09)	[0, 100]		x	x	x	x	x	x						
PCD	RAW Low Dyn Quantizer Percentage	Percentage of compressed BAQ blocks into the RAW data associated to the lowest (mV) quantizer selection threshold In the case of full quantized data, it is set equal to QNaN. One value per azimuth statistical block is provided.	B<nnnn>	Double(N09)	[0, 100]		x	x	x	x	x	x						
PCD	RAW Missing Block Greatest Size	The maximum number of consecutive missing lines in the RAW data	Root	Ushort			x	x	x	x	x	x	x	x	x			
PCD	RAW Missing Blocks Start Lines	Image Lines' indexes at which a readjusted (e.g. by zero filling) missing block starts. If no missing blocks occur in data, a zeroed one-element array is used for this tag and for "RAW Missing Lines per Block" one.	B<nnnn>	UInt(N16)			x	x	x	x	x	x						
PCD	RAW Missing Lines per Block	Number of missing lines within each readjusted missing block If no missing blocks occur in data, a zeroed one-element array is used for this tag and for "RAW Missing Blocks Start Lines" one.	B<nnnn>	UShort(N16)			x	x	x	x	x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
PCD	RAW Missing Lines Percentage	Percentage of missing lines to total lines of the burst	B<nnnn>	Double			x	x	x	x	x	x						
PCD	RAW Normality	Measure of the Gaussian properties of I and Q channels distribution	B<nnnn>	Double(N09, N10, 2)		deg	x	x	x	x	x	x						
PCD	RAW Orthogonality	Phase difference (orthogonality) between I and Q channels of RAW data estimated on valid lines	B<nnnn>	Double(N09, N10)		deg	x	x	x	x	x	x						
PCD	RAW Phase Uniformity	Measure of the uniform properties of phase distribution of the RAW data	B<nnnn>	Double(N09, N10)		deg	x	x	x	x	x	x						
PCD	RAW Standard Deviation	Standard dev of RAW data; two samples for the In-Phase and Quadrature signal (I-Q)	B<nnnn>	Double(N09, N10, 2)			x	x	x	x	x	x						
PCD	RAW Total Absolute Saturation Percentage - Max	Total percentage of pixel belonging to BAQ blocks associated to the highest (mV) quantizer selection threshold and assuming (in I or Q channel) the maximum signal level (mV) before decoding of the bit sign	Root	Double	[0, 100]		x	x	x	x	x	x	x	x	x			
PCD	RAW Total Absolute Saturation Percentage - Min	Total percentage of pixel belonging to BAQ blocks associated to the lowest (mV) quantizer selection threshold and assuming (in I or Q channel) the minimum signal level (mV) before decoding of the bit sign	Root	Double	[0, 100]		x	x	x	x	x	x	x	x	x			
PCD	RAW Total High Dyn Quantizer Percentage	Total percentage of compressed BAQ blocks into the RAW data associated to the highest (mV) quantizer selection threshold	Root	Double	[0, 100]		x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
PCD	RAW Total Low Dyn Quantizer Percentage	Total percentage of compressed BAQ blocks into the RAW data associated to the lowest (mV) quantizer selection threshold	Root	Double	[0, 100]		x	x	x	x	x	x	x	x	x			
PCD	RAW Total Missing Lines Percentage	Percentage of total missing lines to total lines of the product	Root	Double			x	x	x	x	x	x	x	x	x			
PCD	Replica Geometric Resolution	Array including geometric resolution of each reconstructed replica	REPLICA	Double(N08)			x											
PCD	Replica ISLR	Array including ISLR of each reconstructed replica	REPLICA	Double(N08)			x											
PCD	Replica PSLR	Array including left and right PSLR of each reconstructed replica	REPLICA	Double(N08, 2)			x											
PCD	Replica Shape - 10dB -3dB	Aperture ratio of main lobe of reconstructed replica measured at -10 dB and -3dB	REPLICA	Double(N08)			x											
PCD	Replica Shape - 6dB -3dB	Aperture ratio of main lobe of reconstructed replica measured at -10 dB and -3dB	REPLICA	Double(N08)			x											
PCD	Replica SSLR	Array including left and right SSLR of each reconstructed replica	REPLICA	Double(N08, 2)			x											
PCD	Shadowing Pixel Percentage	Percentage of pixels in shadowing geometry with respect to the pixel of the scene (hence not considering invalid zones at the image borders deriving from image reprojection)	GIM	Double	[0, 100]							x						
PCD	SPF Mean Intensity Ratio	Average of the Intensity Ratio between input and speckle filtered image Set to QNaN in the case speckle filtering is not applied.	Root	Double									x					
PCD	SPF Standard Deviation Intensity Ratio	Standard Deviation of the intensity ratio between input and speckle filtered image	Root	Double									x					

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		Set to QNaN in the case speckle filtering is not applied.																
Platform	Attitude Angular Rates	Array representing the satellite attitude angular rates associated to the annotated times. They are stored in notation (roll/s, pitch/s, yaw/s).	Root	Double(N12, 3)		deg/s	x	x	x	x	x	x	x	x	x			
Platform	Attitude Euler Angles	Array of Euler angles representing the satellite attitude associated to the annotated times. They are stored in notation (roll, pitch, yaw). See attribute "Attitude Rotation Order" for the appropriate usage of such attribute	Root	Double(N12, 3)		deg	x	x	x	x	x	x	x	x	x			
Platform	Attitude Quaternions	Array of quaternions representing the satellite attitude associated to the annotated times. They are stored in notation (q1, q2, q3, q4) where q1 represents the so-called "real" part and (q2, q3, q4), is the so-called "imaginary" part of the quaternion	Root	Double(N12, 4)			x	x	x	x	x	x	x	x	x			
Platform	Attitude Rotation Order	Array representing the order to be used for interpretation of the Attitude Euler Angles (e.g. [2, 0, 1] indicates yaw, roll, pitch order).	Root	UByte(3)		deg/s	x	x	x	x	x	x	x	x	x			
Platform	Attitude Times	Array of times (in seconds since the annotated reference UTC) at which the satellite attitude is supplied	Root	Double(N12)		s	x	x	x	x	x	x	x	x	x			

$$N = \sqrt{\frac{1}{NM}\sum_{n=1}^{N}\sum_{m=1}^{M}\left(I_{n,m}^2 + Q_{n,m}^2\right)}$$

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Platform	ECEF Satellite Acceleration	Standard and SPF Products (root level) Satellite Acceleration in Earth Centred - Earth Fixed Cartesian coordinate system, corresponding to the annotated times ------------------ CRG/IPH/COH (MAS-SLA levels) Information inherited from the master/slave image Tag not used at the root level	Root MAS SLA	Double(N06, 3)		m/s^2	x	x	x	x	x	x	x	x	x	x		
Platform	ECEF Satellite Position	Standard and SPF Products (root level) Satellite Position in Earth Centred - Earth Fixed Cartesian coordinate system, corresponding to the annotated times ------------------ CRG/IPH/COH (MAS-SLA levels) Information inherited from the master/slave image Tag not used at the root level	Root MAS SLA	Double(N06, 3)		m	x	x	x	x	x	x	x	x	x	x		
Platform	ECEF Satellite Velocity	Standard and SPF Products (root level) Satellite Velocity in Earth Centred - Earth Fixed Cartesian coordinate system, corresponding to the annotated times ------------------ CRG/IPH/COH (MAS-SLA levels) Information inherited from the master/slave image Tag not used at the root level	Root MAS SLA	Double(N06, 3)		m/s	x	x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Platform	Inertial Reference Frame ID	Identifier of the inertial reference frame	Root	String	J2000		x	x	x	x	x	x	x					
Platform	Inertial Satellite Acceleration	Satellite Acceleration in Inertial Reference Frame, corresponding to the annotated times	Root	Double(N06, 3)		m/s	x	x	x	x	x	x	x					
Platform	Inertial Satellite Position	Satellite Position in Inertial Reference Frame, corresponding to the annotated times	Root	Double(N06, 3)		m	x	x	x	x	x	x	x					
Platform	Inertial Satellite Velocity	Satellite Velocity in Inertial Reference Frame, corresponding to the annotated times	Root	Double(N06, 3)		m/s	x	x	x	x	x	x	x					
Platform	Orbit Direction	Root level Ascending or descending orbit designator, derived from the third component of the ECEF satellite velocity at the scene centre time ------------------ CRG: Master product: Master information are stored both at Root and MAS levels Slave products: Slave information is stored at root and SLA levels Master information is stored at MAS level ------------------	Root MAS SLA T<jjj>	String	ASCENDING DESCENDING		x	x	x	x	x	x	x	x	x	x		x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		IPH/COH Products: At MAS/SLA levels, Orbit Direction used for the acquisition of the relevant master/slave image Tag not used at the root level ----------------- MOS Product At T<jjj> level, Orbit Direction of the input tile Set equal to the invalid value in the case of mosaicked DEM Tag not used at the root level																
Platform	Satellite Height	Satellite ellipsoidal height measured at the image central azimuth time	Root	Double		m	x	x	x	x	x	x	x	x	x			
Platform	Scene Centre Squint	Squint evaluated at the scene centre position ----------------- Standard and SPF Products (root level) ----------------- CRG/IPH/COH Products (MAS/SLA levels) Information inherited from the input master/slave image Tag not used at the root level	Root MAS SLA	Double	[-20, 20]	deg	x	x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Platform	Squint Flag	Flag indicating if the products has been acquired in squinted mode or not.	Root	UByte	0 = Not squinted 1 = Squinted		x	x	x	x	x	x	x	x	x			
Platform	State Vectors Times	Array of times (in seconds since the annotated reference UTC) at which the satellite state vectors are supplied ----------------- Standard and SPF Products (root level) Information inherited from the input image ----------------- CRG/IPH/COH (MAS-SLA levels) Information inherited from the input master/slave image Tag not used at the root level	Root MAS SLA	Double(N06)		s	x	x	x	x	x	x	x	x	x	x		
Processing	ASLR Azimuth Kernel Size	The size of the kernel used in the Adaptive Side Lobe Reduction, in the azimuth direction is given by two times the ASR Az Kernel Size plus 1 pixels	Root	UShort	[1....]			x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	ASLR Direction	Direction (range, azimuth or both) where is applied the Adaptive Side Lobe Reduction	Root	String	RANGE AZIMUTH 2D RANGE-AZIMUTH 2D AZIMUTH-RANGE			x	x	x	x	x	x	x	x			
Processing	ASLR Range Kernel Size	The size of the kernel used in the Adaptive Side Lobe Reduction, in the range direction is given by two times the ASR Rg Kernel Size plus 1 pixels	Root	UShort	[1....]			x	x	x	x	x	x	x	x			
Processing	Azimuth Bandwidth per Look	Bandwidth per look in azimuth used for the multilooked image formation	S<mm>	Double		Hz			x	x	x	x	x		x			
Processing	Azimuth Focusing Bandwidth	The Doppler bandwidth used in the single-look image generation step to represent a single target of the focused product. If Hamming windowing is turned on, it represents the filter bandwidth	S<mm>	Double		Hz		x	x	x	x	x	x	x	x			
Processing	Azimuth Focusing Transition Bandwidth	The transition bandwidth in azimuth used in the single-look image generation step. It represents the sub-band where weight in the range]0, 1[is used	S<mm>	Double		Hz		x	x	x	x	x	x	x	x			
Processing	Azimuth Focusing Weighting Coefficient	Azimuth coefficients used for the Hamming weighting function applied in the focusing step to the processed portion of the full band. Equal to NaN if weighting function is not equal to Hamming	Root	Double	[0, 1]			x	x	x	x	x	x	x	x			
Processing	Azimuth Focusing Weighting Function	Type of matched filter windowing in the azimuth direction at the focusing time	Root	String	NONE HAMMING ASLR			x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Azimuth Multilooking Transition Bandwidth	The transition bandwidth in azimuth used in the multilooked image formation step. It represents the sub-band where weight in the range]0, 1[is used	S<mm>	Double		Hz			x	x	x	x	x		x			
Processing	Azimuth Multilooking Weighting Coefficient	Azimuth coefficients used for the Hamming weighting function applied at the multilooking time to each look Equal to NaN if weighting function is not equal to Hamming	Root	Double	[0, 1]				x	x	x	x	x		x			
Processing	Azimuth Multilooking Weighting Function	Type of matched filter windowing in the azimuth direction at the multilooking time	Root	String	NONE HAMMING				x	x	x	x	x		x			
Processing	Azimuth Processing Number of Looks	Number of processing azimuth looks	Root	UByte	>0			x	x	x	x	x	x	x	x			
Processing	Azimuth Target Total Bandwidth	The Doppler total bandwidth of the target, including bandwidth enlargement due to squint effect.	S<mm>	Double		Hz		x	x	x	x	x	x	x	x			
Processing	Azimuth Unfolding Delta Time	Delta time for azimuth unfolding used in the image formation step. Used only for Spotlight modes, equal to invalid value otherwise	S<mm>	Double		s		x										
Processing	Beam Mosaicking Policy	Criteria used for merging of overlapped beams (that can be done at fixed central column, at variable column corresponding to the crossing point of antenna radiometry or at fixed	Root	String	FIXED CENTERED VARIABLE OPTIMIZED FIXED OPTIMIZED				x	x	x	x	x		x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		column equal to the mean of the variable columns) Used only for ScanSAR mode, set equal to invalid value otherwise																
Processing	Bistatic Effect Reference Range	Dual path slant range in acquisition geometry corresponding to the image column to be considered fixed in the bistatic distortion compensation step	S<mm>	Double		m	x											
Processing	Blend Region Size	Number of column around the subswath change column used as blend region between adjacent subswaths.	Root	UByte					x	x	x	x	x		x			
Processing	Central Range Frequency vs Azimuth Time Polynomial	Coefficients of the polynomial representing the variation (in the azimuth direction w.r.t. the relative azimuth times) of the central frequency of the spectrum (from the lower to the higher degree). Annotated only in complex products.	S<mm>	Double(3)		Hz/s^i		x										
Processing	Column Spacing	Spacing between adjacent columns of the specific image layer. It is expressed in degrees in the case of GEODETIC projection, in meters otherwise. In the case of slant projected images, it is expressed in slant range. For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG	Double		m deg		x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Column Spacing on Ground	Array including the basic values representing the spacing between columns of the raster image layers in the case of slant projected products: - mean spacing: ratio of the ground distance (measured on curved path on the ellipsoid inflated by the height value indicated into Terrain Reference Height metadata) between the farthest and the nearest observed points and the number of columns minus 1 - central spacing (evaluated at the central column) - minimum spacing (evaluated at the far range) - maximum spacing (evaluated at the near range) All numbers evaluated on the central image line For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG	Double(4)		m		x						x		x		
Processing	Column Time Interval	Time spacing in the slant range direction between columns Set to invalid value in the case of ground projected products For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG	Double		s		x						x		x		
Processing	CRG Coarse Window Size	Coarse Registration Window size in range and azimuth direction	Root	UShort(2)										x	x			
Processing	CRG Common Band Filter Flag	Flag indicating if the common band filter has been applied. Set equal to 0 into CRG_B product	Root	UByte	0 = Not Applied/Not Applicable 1 = Applied									x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	CRG DEM Assisted Mode Flag	Flag indicating if coregistration has been done in DEM assisted mode	Root	UByte	0 = No DEM used 1 = DEM assisted coregistration									x	x	x		
Processing	CRG Fine Window Size	Fine Registration Window size in range and azimuth direction	Root	UShort(2)										x	x			
Processing	CRG Interpolator ID	Designator of the type interpolation method performed on slave in the co-registration	Root	String	NEAREST NEIGHBOUR BILINEAR CUBIC SINC									x	x			
Processing	CRG Level ID	Designator of the type of co-registration - VERY COARSE if coregistration is done using only orbital information - COARSE label indicates method based on the maximum correlation of the image amplitude - FINE indicates method based on maximum correlation of complex patches for coherence maximization The co-registration approach can be automatically switched by the co-registration processor depending on the complexity of the input products	Root	String	VERY COARSE COARSE FINE									x	x	x		
Processing	CRG Number of GCPs	Number of GCPs used to evaluate the warp matrix	GCP	Uint										x	x			
Processing	CRG Sinc Interpolator Length	Filter length used in sinc interpolation performed on slave in the co-registration: it is the filter size in row, col	Root	UShort(2)										x	x			
Processing	CRG Software Version	Version of the co-registration software	Root	String		n.m-p								x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	CRG Warp degree	Degree of warp in Coregistration	Root	Double										x	x			
Processing	DEM Service Level ID	Type of DEM processing, depending on number of pairs, quartets, geometries used in input 1 = 1 Pair 2 = 2 Pairs = 2 Geometries 3 = 2 Pairs = 1 Quartet 4 = 4 Pairs = 4 Geometries 5 = 4 Pairs = 2 Quartets (perf. 2+2) 6 = 6 Pairs, 3 Quartets (perf. 2+2) 7 = 6 Pairs = 1 Quartet + 1 Octet (perf. 2+2) 8 = 8 Pairs = 4 Quartets (perf. 4+4) 9 = 8 Pairs = 2 Quartets + 1 Octet (perf. 4+4) 10 = 8 Pairs = 2 Octets (perf. 4+4)	Root	UByte	[1, 10]												x	
Processing	DEM Software Version	Version of the DEM generation software	Root	String		n.m-p											x	
Processing	East Spacing	Tag used only into DSM temporary product. It represents the optimal column spacing to be used for the regridding of DSM product to UTM/UPS map projection. Used as input by L1D processor to override the directive provided by the Processing Parameters support datum. Useful in the case of squinted products. Equal to NaN into DSM products when no directive override is requested Tag not present into DGM product.	Root	Double		m			x									

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	ECEF Beam Centre Direction for Processing	Unitary vector corresponding to the direction of the beam central plane in Earth Centred - Earth Fixed reference frame. It models the average behavior of the antenna beam central plane within each subswath acquired, hence in the case of Spotlight mode, the jumping steering scheme adopted at the scene acquisition time, is ignored.	Root	Double(N06, 3)			x	x	x	x	x	x	x	x	x			
Processing	ECEF Beam Pointing for Processing	Unitary vector corresponding to the pointing of the antenna main lobe in Earth Centred - Earth Fixed reference frame. It models the average behavior of the antenna pointing within each subswath acquired. In the case of ScanSAR mode, a different model per each subswath is used.	S<mm>	Double(N06, 3)			x	x	x	x	x	x	x	x	x			
Processing	Effective R0	Effective slant range returned by the system for the evaluation of the effective parameters used in the image formation step. Used only for Spotlight modes, equal to invalid value otherwise	S<mm>	Double		m		x										
Processing	Effective Satellite Position	Effective zero Doppler satellite position returned by the system for the evaluation of the effective parameters used in the image formation step. Used only for Spotlight modes, equal to invalid value otherwise	S<mm>	Double(3)		m		x										
Processing	Effective Satellite Time	Time corresponding to the Effective zero Doppler satellite position returned by the system for the evaluation of the effective parameters used in the image formation step.	S<mm>	Double		s		x										

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		Used only for Spotlight modes, equal to invalid value otherwise																
Processing	Effective Satellite Velocity	Module of the effective satellite velocity returned by the system for the evaluation of the effective parameters used in the image formation step. Used only for Spotlight modes, equal to invalid value otherwise	S<mm>	Double(3)		m/s		x										
Processing	Equivalent Number of Looks	Theoretical value of the equivalent number of looks For CRG products, see the rules defined for Image Max tag.	IMG	Double				x	x	x	x	x	x	x	x			
Processing	Focusing Algorithm ID	Identifier of the processing algorithm adopted	Root	String	OMEGA-KEY CHIRP SCALING RANGE DOPPLER SPECAN			x	x	x	x	x	x	x	x			
Processing	Focusing Reference Surface	Designator of the surface used during the image formation step for focusing purposes. ELLIPSOID+ value, indicates the usage of ellipsoid inflated by the height value indicated into Terrain Reference Height metadata TERRAIN indicates the usage of PTA algorithmic step in Spotlight mode.	Root	String	ELLIPSOID TERRAIN ELLIPSOID+			x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Invalid Value	Root level: value used to fill invalid pixels/lines into: - all echo, noise, calibration, replica datasets in the case of Level 0 products; - the IMG datasets in the case of Level 1 product and non-standard products. Are catalogued as invalid, the following categories of data: - compensated missing lines; - area of geocoded products outside the SAR sensed data limits. As far as portion of lines added by SWST readjustment, they are in any case filled by zero. In the case of complex dataset (hence represented by two samples per pixel), invalid pixels will be characterized by Invalid Value loaded in both of its channels For L0 product, invalid pixels are associated only to missing lines. Allowed values depend on the Product Type. GIM/GEM datasets Value associated to pixels having invalid value into the SAR image, hence originated from invalid value in the DEM used as support datum.	Root GIM GEM	Float			x	x	x	x	x	x	x	x	x	x	x	x
Processing	ITF Coherence Window Size	Coherence window estimation dimension (range, azimuth)	Root	UByte(2)												x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	ITF Demodulation Phase Reference Surface	Designator of the surface used for the evaluation of the demodulation phase	Root	String	NONE ELLIPSOID GEOID TERRAIN											x		
Processing	ITF Layover Filter Flag	Flag indicating if the layover filter has been applied	Root	UByte	0 = Not Applied 1 = Applied											x		
Processing	ITF Software Version	Version of the interferometric software	Root	String		n.m-p										x		
Processing	L0 Software Version	Version of the L0 processor used for the core processing step	Root	String		n.m-p	x	x	x	x	x	x	x	x	x			
Processing	L1A Software Version	Version of the L1A processor used for the core processing step	Root	String		n.m-p		x						x				
Processing	L1B Software Version	Version of the L1B processor used for the core processing step	Root	String		n.m-p			x	x		x	x		x			
Processing	L1C Software Version	Version of the L1C processor used for the core processing step	Root	String		n.m-p					x							
Processing	L1D Software Version	Version of the L1D processor used for the core processing step	Root	String		n.m-p						x						
Processing	Light Speed	Light Speed	Root	Double	2.99792458d+08	m/s	x	x	x	x	x	x	x	x	x	x	x	x
Processing	Line Spacing	Spacing between lines of the specific image layer. It is expressed in degrees in the case of GEODETIC projection, in meters otherwise. For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG	Double		m deg		x	x	x	x	x	x	x	x	x	x	x
Processing	Line Time Interval	Time spacing in the azimuth direction between lines For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG	Double		s		x	x	x			x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	LRHM Column Spacing	Spacing between columns of the LRHM layer. It is expressed in degrees in the case of GEODETIC projection, in meters otherwise.	LRHM	Double		m deg	x	x	x	x	x	x	x	x	x	x	x	x
Processing	LRHM Line Spacing	Spacing between lines of the LRHM layer. It is expressed in degrees in the case of GEODETIC projection, in meters otherwise.	LRHM	Double		m deg	x	x	x	x	x	x	x	x	x	x	x	x
Processing	MOS Master Tile	Identifier of the tile used as master in the mosaicking process	Root	String	T<jjj>													x
Processing	MOS Software Version	Version of the mosaicking software	Root	String		n.m-p												x
Processing	Motion Compensation Polynomial	Polynomial coefficients of the motion compensation model applied in the image formation step Used only for Spotlight modes, equal to invalid value otherwise	S<mm>	Double(7)				x										
Processing	North Spacing	Tag used only into DSM temporary product. It represents the optimal line spacing to be used for the regridding of DSM product to UTM/UPS map projection. Used by L1D processor to override the directive provided by the Processing Parameters support datum. Useful in the case of squinted products. Equal to NaN into DSM products when no directive override is requested Tag not present into DGM product.	Root	Double		m			x									
Processing	Product Generation UTC	Product generation time in UTC time format	Root	String		Epoch	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Quick Look Column Spacing	Spacing between columns of the quick look layer. It is expressed in degrees in the case of GEODETIC projection, in meters otherwise. In the case of CRG/IPH/COH products, annotation included into the MAS/QLK and SLA/QLK datasets are inherited from the input scene.	QLK	Double		m deg	x	x	x	x	x	x	x	x	x	x	x	x
Processing	Quick Look Invalid Value	Value associated to pixels having invalid value into the associated dataset In the case of CRG/IPH/COH products, annotation included into the MAS/QLK and SLA/QLK datasets are inherited from the input scene.	QLK	Short			x	x	x	x	x	x	x	x	x	x	x	x
Processing	Quick Look Line Spacing	Spacing between columns of the quick look layer. It is expressed in degrees in the case of GEODETIC projection, in meters otherwise. In the case of CRG/IPH/COH products, annotation included into the MAS/QLK and SLA/QLK datasets are inherited from the input scene.	QLK	Double		m deg	x	x	x	x	x	x	x	x	x	x	x	x
Processing	Range Bandwidth per Look	Bandwidth per look in range used for the multilooked image formation	S<mm>	Double		Hz			x	x	x	x	x		x			
Processing	Range Focusing Bandwidth	The bandwidth in range used in the single-look image generation step. If Hamming windowing is turned on, it represents the filter bandwidth	S<mm>	Double		Hz		x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Range Focusing Transition Bandwidth	The transition bandwidth in range used in the single-look image generation step. It represents the sub-band where weight in the range]0, 1[is used	S<mm>	Double		Hz		x	x	x	x	x	x	x	x			
Processing	Range Focusing Weighting Coefficient	Range coefficients used for the Hamming weighting function applied at the focusing time to the processed portion of the full band Equal to NaN if weighting function is not equal to Hamming	Root	Double	[0, 1]			x	x	x	x	x	x	x	x			
Processing	Range Focusing Weighting Function	Type of matched filter windowing in the range direction at the focusing time	Root	String	NONE HAMMING ASLR			x	x	x	x	x	x	x	x			
Processing	Range Multilooking Transition Bandwidth	The transition bandwidth in range used in the multilooked image formation step. It represents the sub-band where weight in the range]0, 1[is used	S<mm>	Double		Hz			x	x	x	x	x		x			
Processing	Range Multilooking Weighting Coefficient	Range coefficients used for the Hamming weighting function applied at the multilooking time to each look Equal to NaN if weighting function is not equal to Hamming	Root	Double	[0, 1]				x	x	x	x	x		x			
Processing	Range Multilooking Weighting Function	Type of matched filter windowing in the range direction at the multilooking time	Root	String	HAMMING NONE				x	x	x	x	x		x			
Processing	Range Processing Number of Looks	Number of nominal looks in the range direction	Root	UByte	>0			x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Orbit Reference Correction	Two-ways correction range time associated the offset between used orbit trajectory and radar centre of phase A single value is used for multi-swath modes	Root	Double		s	x											
Processing	RAW Statistics Block Size	Size (in number of rows and number of columns) of the block where statistics on the RAW data are evaluated. In the following, N9 (resp. N10) will indicate the number of azimuth (resp. range) blocks (derived from the block size for statistics evaluation) in the burst over which statistics are evaluated. It is always assumed that: - first block for statistics evaluation is anchored to the first row/col of the burst - moving steps for other block determination is equal to the block size - block size is defined so that N9 <= 300 and N10 <= 3	S<mm>	UInt(2)			x	x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Reference UTC	UTC with respect the annotated slow times are referred to. It is set to the 00:00:00.000000000 of the day at which the acquisition started. Such time is used as the anchorage point to define the azimuth time grid of focusing step. The time of the first time of L1A/L1B standard products generated from a single Level 0 file shall be separated by an integer number of line time intervals from this Reference UTC. ------------------ Standard and SPF Products (root level) Information inherited from the input slave image ------------------ CRG/IPH/COH (MAS-SLA levels) Information inherited from the input master/slave image Tag not used at the root level	Root MAS SLA	String		Epoch	x	x	x	x	x	x	x	x	x	x		
Processing	Replica Power Compensation Flag	Flag indicating if replica power has been compensated during range compression step	Root	UByte	0 = Compensation not applied 1 = Compensation applied			x	x	x	x	x	x	x	x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Replica Reconstruction Method	Designator of method for reconstruction of chirp used for image processing. Set to invalid value in the Spotlight case.	Root	String	NOMINAL REPLICA MEAN			x	x	x	x	x	x	x	x			
Processing	Rescaling Factor	IMG dataset Rescaling Factor F, used at processing time as a multiplier term applied to the signal amplitude to appropriately use the dynamic range allowed by the data type (avoiding the image saturation and minimizing quantization error in the case of integer data type representation). It is set equal to 1 in the case of calibrated products in floating point representation GIM/GEM datasets Scaling factor (equals to 100) used for representation of the GIM and GEM layers.	IMG GIM GEM	Double				x	x	x	x	x	x	x	x			x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		For CRG products, not used into the MAS/SLA branch																
Processing	SPF Filter Size	Size of the filter used for speckle filtering process in Rows/Cols	Root	Ushort(2)									x					
Processing	SPF Filter Type	Applied Speckle Filter	Root	String	NONE MEAN MEDIAN FROST LEE KUAN ENHANCED LEE ENHANCED FROST GAMMA MAP CRIMMINS								x					
Processing	SPF Iteration	Number of iterations of the applied Speckle Filter Set to 0 in the case speckle filtering is not applied.	Root	UShort	0 [1,...]								x					

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	SPF Software Version	Version of the Speckle Filtering processor. Set to "0.0" in the case speckle filtering is not applied.	Root	String		n.m-p							x					
Processing	Subswath Change Column	Column indexes (numbering starting from zero) at which the farthest between two adjacent subswath of ScanSAR data starts. Its dimension, is equal to N3 defined as: - number of subswath minus one times the number of lines of the L1B ScanSAR product - one if unused (in this case it is set equal to the invalid value). If mosaicking at variable column is activated, this attribute shall represent the mean of the array of the variable columns used on the specific subswath attachment	IMG	UInt(N03)					x	x			x					
Processing	Terrain Reference Height	Terrain reference ellipsoidal height used for algorithmic purposes	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Processing	Troposphere Reference Height	Reference ellipsoidal height of the troposphere used for delay estimation. It can be static value pre-configured in processor local configuration file or evaluated from by more complex model	Root	Double		m	x											
Processing	Troposphere ZTD	Zenith tropospheric time delay	Root	Double		s	x											
Processing	Tropospheric Delay Correction	Final tropospheric time delay along the slant range (evaluated from statically pre-configured ZTD in processor local configuration file or evaluated starting from ZTD obtained by more complex model) A single value is used for multi-swath modes	Root	Double		s	x											
Projection	Bottom Left East-North	Coordinates of the first pixel of the last image line for metric projections. It is estimated on the reference surface given into Ground Projection Reference Surface attribute. Set to QNaN otherwise. In the case of mosaicked products it is annexed both to the mosaic and to the tile In the case of the following product's levels, such metadata is present only into the LRHM dataset - L0 - L1A - L1B - SPF - CRG - IPH/COH	IMG LRHM T<jjj>	Double(2)		m	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Bottom Left Geodetic Coordinates	Geodetic coordinates (Lat-Lon-Height) of the first pixel of the last image line. It is estimated on the reference surface given into Ground Projection Reference Surface attribute Attribute updating is also applicable in the case of processing of image portion starting from Level 0 data. In the case of mosaicked products it is annexed both to the mosaic and to each tile. In the case of the following product's levels, such metadata is present only into the LRHM dataset - L0 For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG LRHM T<jjj>	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Bottom Right East-North	Coordinates of the last pixel of the last image line for metric projections. It is estimated on the reference surface given into Ground Projection Reference Surface attribute. Set to QNaN otherwise. In the case of mosaicked products it is annexed both to the mosaic and to the tile In the case of the following product's levels, such metadata is present only into the LRHM dataset - L0 - L1A - L1B - SPF - CRG - IPH/COH	IMG LRHM T<jjj>	Double(2)		m	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Bottom Right Geodetic Coordinates	Geodetic coordinates (Lat-Lon-Height) of the last pixel of the last image line. It is estimated on the reference surface given into Ground Projection Reference Surface attribute Attribute updating is also applicable in the case of processing of image portion starting from Level 0 data. In the case of mosaicked products it is annexed both to the mosaic and to each tile. In the case of the following product's levels, such metadata is present only into the LRHM dataset - L0 For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG LRHM T<jjj>	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x	x	x	x	x	x	x	x	x	x	x	x
Projection	Columns Order	Order of columns in the formatted product.	Root	String	For UTM/GEODETIC: WEST-EAST For RADAR geometry: NEAR-FAR FAR-NEAR For UPS: 90W-90E		x	x	x	x	x	x	x	x	x	x	x	x
Projection	Datum Rotation	XYZ Datum rotations with respect to WGS84 Ellipsoid to be used for Helmert transformation	Root	Double(3)		deg	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Datum Scale	XYZ Datum scale with respect to WGS84 Ellipsoid to be used for Helmert transformation	Root	Double			x	x	x	x	x	x	x	x	x	x	x	x
Projection	Datum Shift	XYZ Datum shifts with respect to WGS84 Ellipsoid to be used for Helmert transformation	Root	Double(3)		m	x	x	x	x	x	x	x	x	x	x	x	x
Projection	Ellipsoid Designator	Ellipsoid designator name	Root	String	WGS84		x	x	x	x	x	x	x	x	x	x	x	x
Projection	Ellipsoid Semimajor Axis	Semi-major axis length	Root	Double	6378137	m	x	x	x	x	x	x	x	x	x	x	x	x
Projection	Ellipsoid Semiminor Axis	Semi-minor axis length	Root	Double	6356752,314	m	x	x	x	x	x	x	x	x	x	x	x	x
Projection	Ground Projection Polynomial Reference Column	Reference pixel (column) of the ground axe used as zero to represent the ground to slant (and viceversa) polynomials. Set to invalid value in the case of products not represented in ground/azimuth projection Copied from master product In CRG_B	Root	Double		pix			x	x			x		x			
Projection	Ground Projection Polynomial Reference Range	Reference slant range used as zero to represent the ground to slant (and viceversa) polynomials. Set to invalid value in the case of products not represented in ground/azimuth projection Copied from master product In CRG_B	Root	Double		m			x	x			x		x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Ground Projection Reference Surface	Designator of the surface used for the ground projection The following approach shall be used: - TERRAIN for Orthorectified products (GTC, DEM, MOS_D, MOS_H) - ELLIPSOID otherwise.	Root	String	NONE ELLIPSOID TERRAIN				x	x	x	x	x		x		x	x
Projection	Ground to Slant Polynomial	Relative pixel index of the ground projected product to relative slant range (meters) polynomial coefficient (from lower to higher degree). Set to invalid value in the case of products not represented in ground/azimuth projection. This polynomial $(a_i)_{0 \le i \le n}$ has to be used as follow: $sr = a_0 + a_1 * (gp - gp_{ref}) + \ldots + a_n * (gp - gp_{ref})^n + sr_{ref}$ where: sr → slant range sr_{ref} → tag "Ground Projection Polynomial Reference Range" gp → pixel index in the ground projected product (zero-based notation) gp_{ref} → tag "Ground Projection Polynomial Reference Column" Copied from master product In CRG_B				m/pix^i			x	x			x		x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Lines Order	Order of lines in the formatted product.	Root	String	For UTM/GEODETIC: NORTH-SOUTH For RADAR geometry: EARLY-LATE LATE-EARLY For UPS: 180-0 0-180		x	x	x	x	x	x	x	x	x	x	x	x
Projection	LRHM Columns Order	Order of columns in the LRHM layer.	LRHM	String	For UTM/GEODETIC: WEST-EAST For UPS: 90W-90E		x	x	x	x	x	x	x	x	x	x	x	
Projection	LRHM Lines Order	Order of lines in the LRHM layer.	LRHM	String	For UTM/GEODETIC: NORTH-SOUTH For UPS: 180-0 0-180		x	x	x	x	x	x	x	x	x	x	x	

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	LRHM Map Projection False East-North	Map Projection False East/North (for UTM/UPS) used for LRHM layer In the case of UTM projection, false east equal to 500000 is used, while false north equal to 0 in the Northern hemisphere and 10000000 in the Southern one are used. In the case of UPS zone, a value of 2000000 is used both for false east and false north Set to QNaN otherwise	LRHM	Double(2)		m	x	x	x	x	x	x	x	x	x	x	x	
Projection	LRHM Map Projection Scale Factor	Map Projection Scale factor (for UTM/UPS) used for LRHM layer. In the case of UTM projection, a value of 0.9996 is used. In the case of UPS projection, a value of 0.994 is used. Set to QNaN otherwise	LRHM	Double	[0, 1[		x	x	x	x	x	x	x	x	x	x	x	
Projection	LRHM Map Projection Zone	Map Projection Zone used for LRHM layer	LRHM	UByte	[1, 60] for UTM 0 for UPS - South 61 for UPS - North 255 for GEODETIC		x	x	x	x	x	x	x	x	x	x	x	
Projection	LRHM Projection ID	Projection descriptor for LRHM Layer	LRHM	String	UTM UPS GEODETIC		x	x	x	x	x	x	x	x	x	x	x	

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Map Projection Centre	Geodetic coordinates (lat/lon) of the map projection centre (for UTM/UPS) In the case of UTM projection, latitude is set to 0 and longitude is set equal to that one of the central meridian of the UTM zone of the product. In the case of UPS projection, a projection centre equal to [90, 0] is used in the Northern emisphere, [-90, 0] is used in the Southern one Set to [0, 0] in the case of GEODETIC projection	Root	Double(2)	[[-90, 90], [-180, 179,999999]]						x	x					x	x
Projection	Map Projection False East-North	Map Projection False East/North (for UTM/UPS) In the case of UTM projection, false east equal to 500000 is used, while false north equal to 0 in the Northern hemisphere and 10000000 in the Southern one are used. In the case of UPS zone, a value of 2000000 is used both for false east and false north Set to QNaN otherwise	Root	Double(2)		m					x	x					x	x
Projection	Map Projection Scale Factor	Map Projection Scale factor (for UTM/UPS). In the case of UTM projection, a value of 0.9996 is used. In the case of UPS projection, a value of 0.994 is used. Set to QNaN otherwise	Root	Double	[0, 1[						x	x					x	x
Projection	Map Projection Zone	Map Projection Zone	Root	UByte	[1, 60] for UTM 0 for UPS - South 61 for UPS - North 255 for GEODETIC						x	x					x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Projection ID	Projection descriptor For geocoded product UPS projection is used if the scene centre latitude is greater than 84° or lower than -80°, otherwise UTM is used	Root	String	N/A SLANT RANGE/AZIMUTH GROUND RANGE/AZIMUTH UTM UPS GEODETIC		x	x	x	x	x	x	x	x	x	x	x	x
Projection	Quick Look Columns Order	Order of columns in the quick look layer. For quick look annexed to Level 0 product, it is conditioned by the consideration about geometric representation of the Quick Look product aiming to simplify the image interpretation. For other standard products, it inherits the order of the full resolution layer. In the case of CRG/IPH/COH products, annotation included into the MAS/QLK and SLA/QLK datasets are inherited from the input scene.	QLK	String	For UTM/GEODETIC: WEST-EAST For RADAR geometry: NEAR-FAR FAR-NEAR For UPS: 90W-90E		x	x	x	x	x	x	x	x	x	x	x	x
Projection	Quick Look Lines Order	Order of lines in the quick look layer. For quick look annexed to Level 0 product, it is conditioned by the consideration about geometric representation of the Quick Look product aiming to simplify the image interpretation. For other standard products, it inherits the order of the full resolution layer. In the case of CRG/IPH/COH products, annotation included into the MAS/QLK and SLA/QLK datasets are inherited from the input scene.	QLK	String	For UTM/GEODETIC: NORTH-SOUTH For RADAR geometry: EARLY-LATE LATE-EARLY For UPS: 180-0 0-180		x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Quick Look Projection ID	Projection descriptor for Quick Look Layer For geocoded product UPS projection is used if the scene centre latitude is greater than 84° or lower than -80°, otherwise UTM is used In the case of CRG/IPH/COH products, annotation included into the MAS/QLK and SLA/QLK datasets are inherited from the input scene.	QLK	String	N/A SLANT RANGE/AZIMUTH GROUND RANGE/AZIMUTH UTM UPS GEODETIC		x	x	x	x	x	x	x	x	x	x	x	x
Projection	Slant to Ground Polynomial	Relative (w.r.t. the Ground Projection Polynomial Reference Range) slant range (meters) to ground (pixels) polynomial coefficients (from the lower to the higher degree). Set to invalid value in the case of products not represented in ground/azimuth projection This polynomial $(b_i)_{0 \le i \le n}$ has to be used as follow: $gp = b_0+b_1*(sr-sr_{ref}) + \ldots +b_n*(sr-sr_{ref})^n + gp_{ref}$ where: sr → slant range sr_{ref} → tag "Ground Projection Polynomial Reference Range" gp → pixel index in the ground projected product (zero-based notation) gp_{ref} → tag "Ground Projection Polynomial Reference Column" Copied from master product In CRG_B				pix/m[i]			x	x			x		x			

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Top Left East-North	Coordinates of the first pixel of the first image line for metric projection. It is estimated on the reference surface given into Ground Projection Reference Surface attribute. Set to QNaN otherwise. In the case of mosaicked products it is annexed both to the mosaic and to the tile In the case of the following product's levels, such metadata is present only into the LRHM dataset - L0 - L1A - L1B - SPF - CRG - IPH/COH	IMG LRHM T<jjj>	Double(2)		m	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Top Left Geodetic Coordinates	Geodetic coordinates (Lat-Lon-Height) of the first pixel of the first image line. It is estimated on the reference surface given into Ground Projection Reference Surface attribute Attribute updating is also applicable in the case of processing of image portion starting from Level 0 data. In the case of mosaicked products it is annexed both to the mosaic and to each tile. In the case of the following product's levels, such metadata is present only into the LRHM dataset - L0 For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG LRHM T<jjj>	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Top Right East-North	Coordinates of the last pixel of the first image line for metric projections. It is estimated on the reference surface given into Ground Projection Reference Surface attribute. Set to QNaN otherwise. In the case of mosaicked products it is annexed both to the mosaic and to the tile In the case of the following product's levels, such metadata is present only into the LRHM dataset - L0 - L1A - L1B - SPF - CRG - IPH/COH	IMG LRHM T<jjj>	Double(2)		m	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Projection	Top Right Geodetic Coordinates	Geodetic coordinates (Lat-Lon-Height) of the last pixel of the first image line. It is estimated on the reference surface given into Ground Projection Reference Surface attribute Attribute updating is also applicable in the case of processing of image portion starting from Level 0 data. In the case of mosaicked products it is annexed both to the mosaic and to each tile. In the case of the following product's levels, such metadata is present only into the LRHM dataset - L0 For CRG/IPH/COH products, see the rules defined for Image Max tag.	IMG LRHM T<jjj>	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x	x	x	x	x	x	x	x	x	x	x	x
Scene	Azimuth Coverage	Coverage in the azimuth direction of the full scene estimated on the ellipsoid. In the case of DTM, MOS and cropped products such metadata refers to the spatial coverage along the rows direction. Attribute updating is applicable in the case of processing of image portion starting from Level 0 data.	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	
Scene	Centre Earth Radius	Earth radius at image centre Attribute updating is applicable in the case of processing of image portion starting from Level 0 data.	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Scene	Estimated Bottom Left Geodetic Coordinates	Estimated geodetic coordinates (Lat-Lon-0) of the first pixel/last line of the correspondent focused image	Root	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x											
Scene	Estimated Bottom Right Geodetic Coordinates	Estimated geodetic coordinates (Lat-Lon-0) of the last pixel/last line of the correspondent focused image	Root	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x											
Scene	Estimated Top Left Geodetic Coordinates	Estimated geodetic coordinates (Lat-Lon-0) of the first pixel/first line of the correspondent focused image	Root	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x											
Scene	Estimated Top Right Geodetic Coordinates	Estimated geodetic coordinates (Lat-Lon-0) of the last pixel/first line of the correspondent focused image	Root	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x											
Scene	Far Early Geodetic Coordinates	Geodetic coordinates of the pixel of the scene acquired at the far range at the azimuth first time, (estimated on the reference surface used for image projection, hence ellipsoid or terrain depending on the output product). It is useful for map projected products that are not represented in range azimuth projection, hence the image geometry doesn't correspond to the acquisition geometry	IMG	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)					x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Scene	Far Incidence Angle	Absolute value of the incidence angle measured at the far range on ellipsoid in zero-Doppler geometry as derived by the sampling window times represented in data. At the root level, the farthest incidence angle among all subswaths of the product is annotated. For CRG/IPH/COH products, see the rules defined for Image Max tag. Note: the mean height of the scene is used if available to the processing facility	Root IMG	Double	[0, 90[	deg		x	x	x	x	x	x	x	x	x		
Scene	Far Late Geodetic Coordinates	Geodetic coordinates of the pixel of the scene acquired at the far range at the azimuth last time, (estimated on the reference surface used for image projection, hence ellipsoid or terrain depending on the output product). It is useful for map projected products that are not represented in range azimuth projection, hence the image geometry doesn't correspond to the acquisition geometry	IMG	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)					x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Scene	Far Look Angle	Look angle measured at the far range on ellipsoid in zero-Doppler geometry as derived by the sampling window times represented in data. For CRG/IPH/COH products, see the rules defined for Image Max tag. Note: the mean height of the scene is used if available to the processing facility	IMG	Double	[15, 55]	deg		x	x	x	x	x	x	x	x	x		
Scene	Ground Range Coverage	Coverage in the cross track direction of the specific portion of data included into the output product (measured on curved path on the ellipsoid inflated by the height value indicated into Terrain Reference Height metadata). In the case of DTM, MOS and cropped products such metadata refers to the spatial coverage along the columns direction. For RAW data it is computed on the basis of the acquisition times and sensing geometry, with right transient removed (i.e. only considering scatterers which returns a complete chirp's echo to the SAR receiver).	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Scene	Near Early Geodetic Coordinates	Geodetic coordinates of the pixel of the scene acquired at the near range at the azimuth first time (estimated on the reference surface used for image projection, hence ellipsoid or terrain depending on the output product) It is useful for map projected products that are not represented in range azimuth projection, hence the image geometry doesn't correspond to the acquisition geometry	IMG	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)					x	x						
Scene	Near Incidence Angle	Absolute value of the incidence angle measured at the near range on ellipsoid in zero-Doppler geometry as derived by the sampling window times represented in data. At the root level, the nearest incidence angle among all subswaths of the product is annotated. For CRG/IPH/COH products, see the rules defined for Image Max tag. Note: the mean height of the scene is used if available to the processing facility	Root IMG	Double	[0, 90[	deg		x	x	x	x	x	x	x	x	x		
Scene	Near Late Geodetic Coordinates	Geodetic coordinates of the pixel of the scene acquired at the near range at the azimuth last time, (estimated on the reference surface used for image projection, hence ellipsoid or terrain depending on the output product). It is useful for map projected products that are not represented in range azimuth projection, hence the image	IMG	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)					x	x						

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
		geometry doesn't correspond to the acquisition geometry																
Scene	Near Look Angle	Look angle measured at the near range on ellipsoid in zero-Doppler geometry as derived by the sampling window times represented in data. Into the CRG products, the same value is annotated in master and slave products For CRG/IPH/COH products, see the rules defined for Image Max tag. Note: the mean height of the scene is used if available to the processing facility	IMG	Double	[15, 55]	deg		x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Scene	Scene Centre Geodetic Coordinates	Geodetic coordinates (lat-lon-height) of the centre of the full scene. For RAW, SCS, DSM, DGM, GEC, GTC, SPF, CRG_A, IPH, COH it is evaluated by the mean of the Lat/Lon/H annotated into the following metadata - Scene Near Edge Geodetic Coordinates - Scene Far Edge Geodetic Coordinates For DEM product (represented by orthorectified projection), the horizontal position Lat/Lon is the one corresponding to the central pixel of the grid. Height is derived from the reference low resolution DEM For MOS_D and MOS_H products (represented by orthorectified projection), the horizontal position Lat/Lon is the one corresponding to the central pixel of the grid. Height is set equal to zero	Root	Double(3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Scene	Scene Far Edge Geodetic Coordinates	Geodetic coordinates (lat-lon-height) of the far edge of the scene, estimated on DEM. It is evaluated on thirty-one equispaced azimuth positions starting from Zero-Doppler Azimuth First Time to Zero-Doppler Azimuth Last Time. In the case of CRG/IPH/COH products, this attribute is copied from the master image In the case of RAW products, it represents the best possible prediction. Note: set equal to invalid value into the RAW products generated in the frame of Quick Look generation work-flow In the case of cropped products, this tag describe the LLH profile (estimated on DEM) of the last column of the output product (even if corresponding to invalid pixel falling into the bounding box of the cropped area)	Root	Double(31, 3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x	x	x	x	x	x	x	x	x	x		

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Scene	Scene Near Edge Geodetic Coordinates	Geodetic coordinates (lat-lon-height) of the near edge of the scene, estimated on DEM. It is evaluated on thirty-one equispaced azimuth positions starting from Zero-Doppler Azimuth First Time to Zero-Doppler Azimuth Last Time. In the case of CRG/IPH/COH products, this attribute is copied from the master image In the case of RAW products, it represents the best possible prediction. Note: set equal to invalid value into the RAW products generated in the frame of Quick Look generation work-flow In the case of cropped products, this tag describe the LLH profile (estimated on DEM) of the first column of the output product (even if corresponding to invalid pixel falling into the bounding box of the cropped area)	Root	Double(31, 3)	[[-90, 90], [-180, 179,999999], -200, 9000]	(deg, deg, m)	x	x	x	x	x	x	x	x	x	x		
Scene	Scene Orientation	Clockwise measured angle between the local north at scene centre and the opposite of the azimuth oriented direction	Root	Double		deg	x	x	x	x	x	x	x	x	x	x	x	x
Scene	Terrain Maximum Height	Maximum ellipsoidal heights of the observed scene, estimated on the external reference DEM provided as support datum (if available) or alternatively on the reference DEM provided into the LRHM dataset.	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	x

Area	Attribute name	Description	HDF5 Struc.	Data Type	Allowed values/ Validity range	Unit / ASCII repr.	RAW	SCS	DGM - DSM	QLK	GEC	GTC	SPF	CRG_A	CRG_B	IPH - COH	DTM	MOS
Scene	Terrain Mean Height	Mean of the ellipsoidal heights of the observed scene, estimated on the external reference DEM provided as support datum (if available) or alternatively on the reference DEM provided into the LRHM dataset.	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	x
Scene	Terrain Minimum Height	Minimum ellipsoidal heights of the observed scene, estimated on the external reference DEM provided as support datum (if available) or alternatively on the reference DEM provided into the LRHM dataset.	Root	Double		m	x	x	x	x	x	x	x	x	x	x	x	x