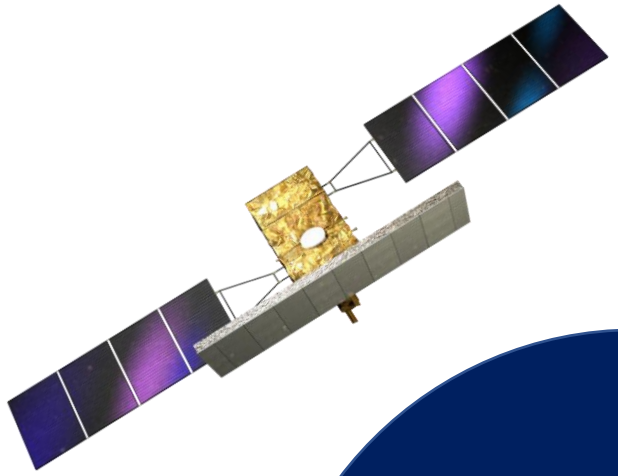

EARTH TECHNOLOGY EXPO

COSMO-SkyMed prima e Seconda Generazione: osservare la Terra tramite un radar ad altissima risoluzione

Maria Virelli
Mission Manager COSMO-SkyMed

Agenzia Spaziale Italiana

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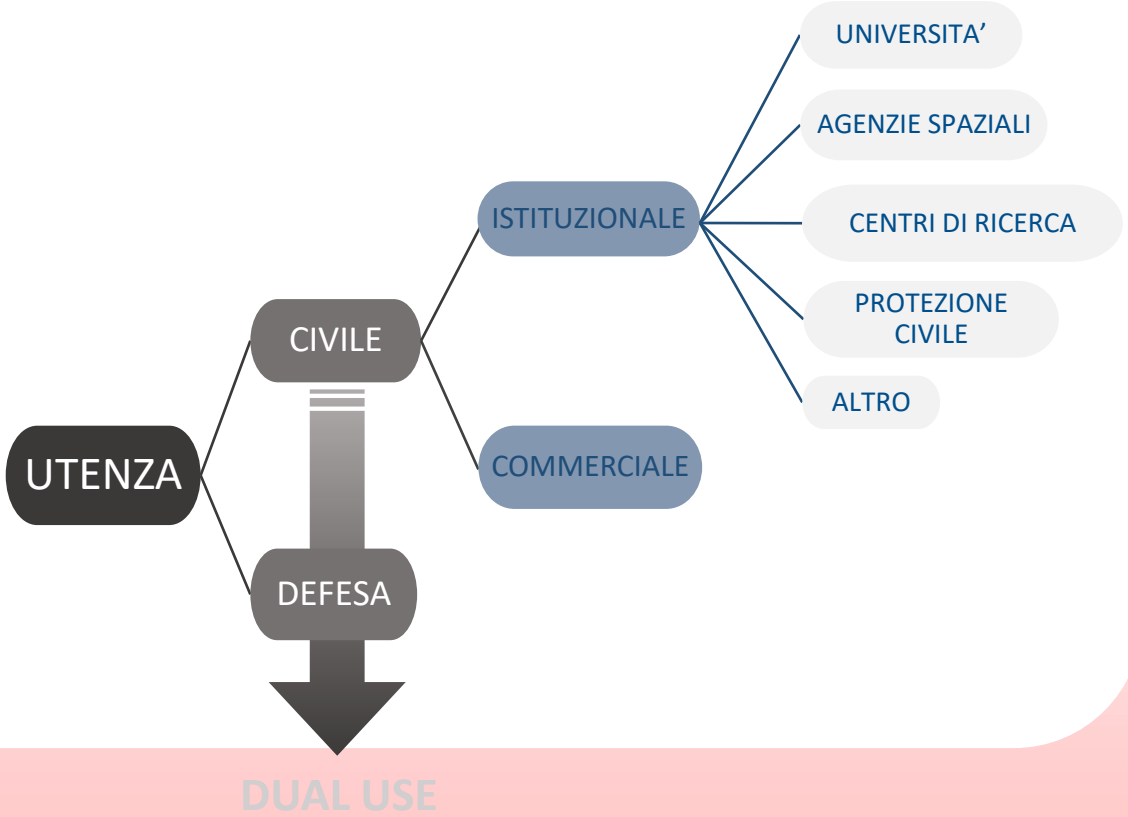
COSMO-SkyMed Mission

COSMO-SkyMed è la Missione Italiana di Osservazione della Terra *end-to-end* commissionata e concepita da:

Agenzia Spaziale Italiana **Ministero della Difesa**

E con l'obiettivo primario di soddisfare contemporaneamente le esigenze applicative di diverse tipologie di utenti

- Emergenze
- Oceani e Ghiacci
- Linee di Costa e acque interne
- Foreste e Agricoltura
- Pianificazione Urbana e Topografia
- Applicazioni di Sicurezza



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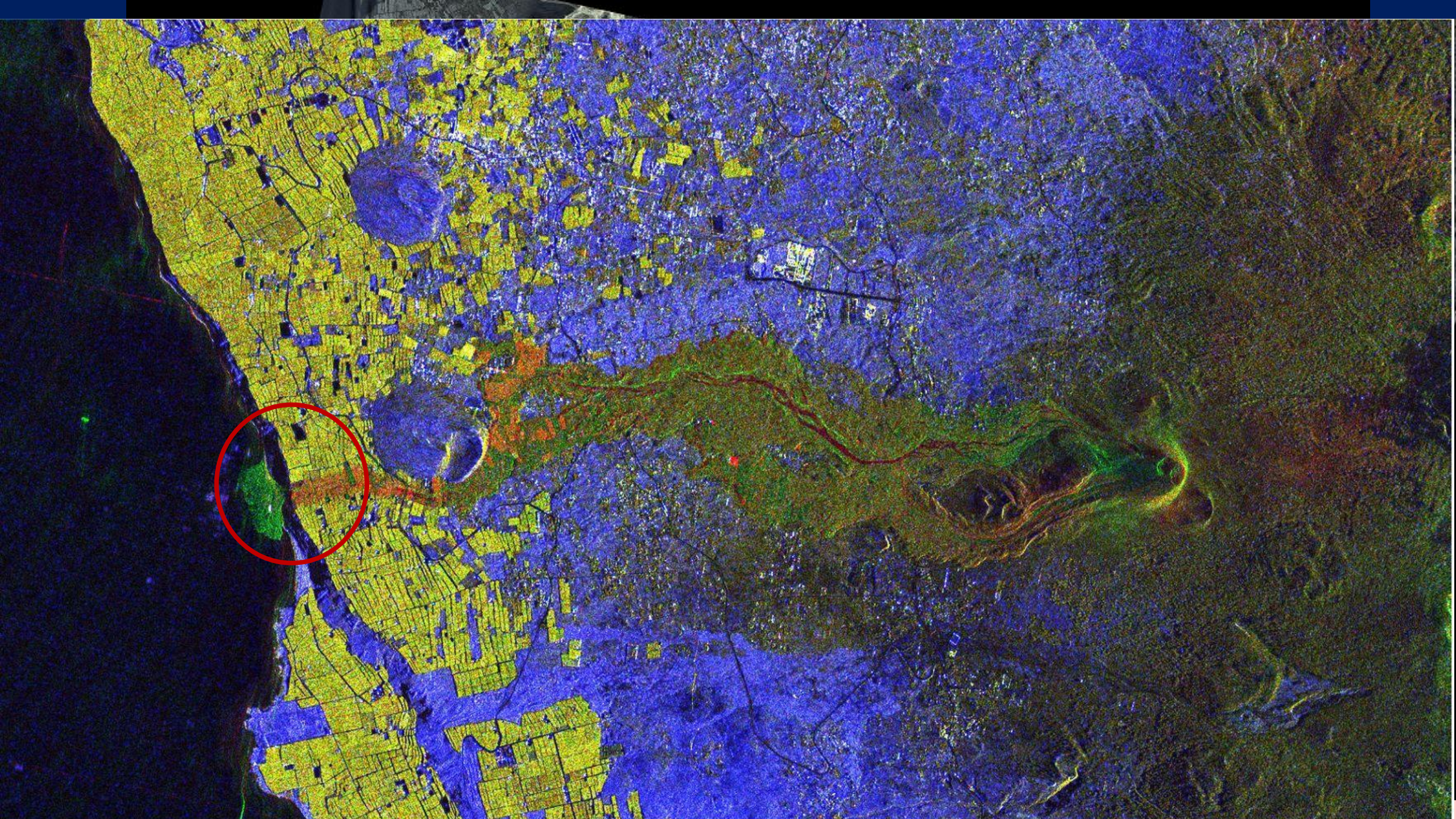
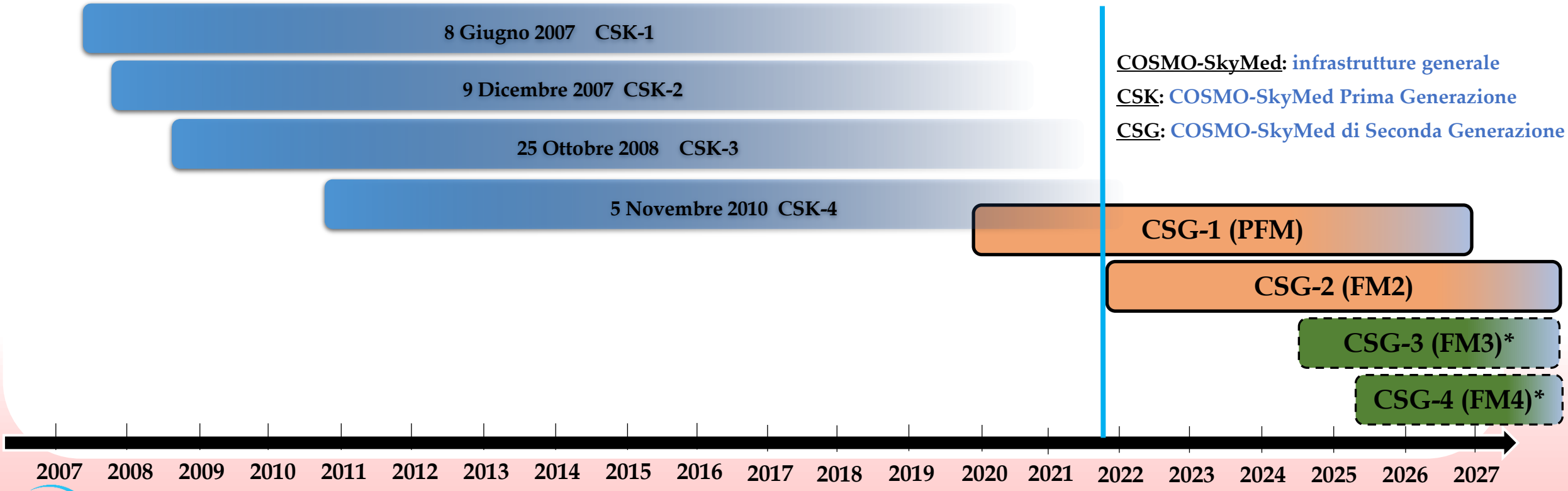


COSMO-SkyMed Evolution

COSMO-SkyMed Seconda Generazione (CSG):

- Garantisce la continuità operativa dei satelliti della Prima Generazione
- E' un passo avanti in termini di funzionalità, prestazioni e servizi di sistema per gli utenti dell'Osservazione della Terra

La durata operativa nominale dei satelliti di Seconda Generazione è di 7 anni.



* FM3 and FM4 launch dates not in scale

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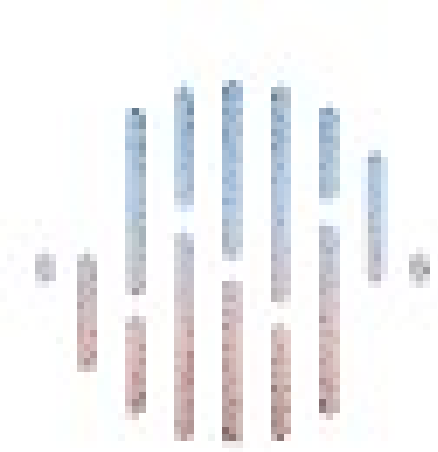
COSMO-SkyMed System

Il sistema COSMO-SkyMed è composto da:

- **Un segmento spaziale 4 satelliti CSK + 4 satelliti CSG dotati di radar ad apertura sintetica (SAR) in banda X**
- **Un Segmento di Terra geograficamente distribuito su un vasto territorio**



Tutti i satelliti COSMO-SkyMed sono posizioneti sullo stesso piano orbitale

COSMO-SkyMed constellation – Orbital Parameters	
Orbit Type	SSO
Inclination	97.86°
Revolutions/day	14.8125
Orbit Cycle	16 days
Eccentricity	0.00118
Argument of Perigee	90°
Semi Major Axis	7003.52 km
Nominal Height	619.6 km
Nominal LTAN	6:00 A.M.
Deployment	Progressive

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Infrastruttura COSMO-SkyMed

Satelliti CSK

Satelliti CSG

UGS: User Ground Segment

Oltre ai principali Centri di terra, COSMO-SkyMed dispone di una Rete Fiduciaria GPS di 20 stazioni in tutto il mondo e diversi Terminali Utente Portatili

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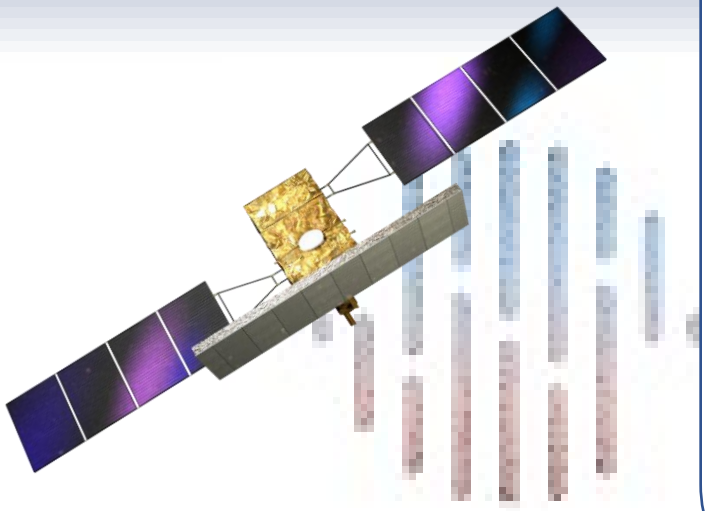
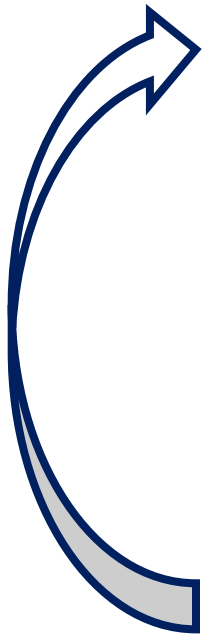
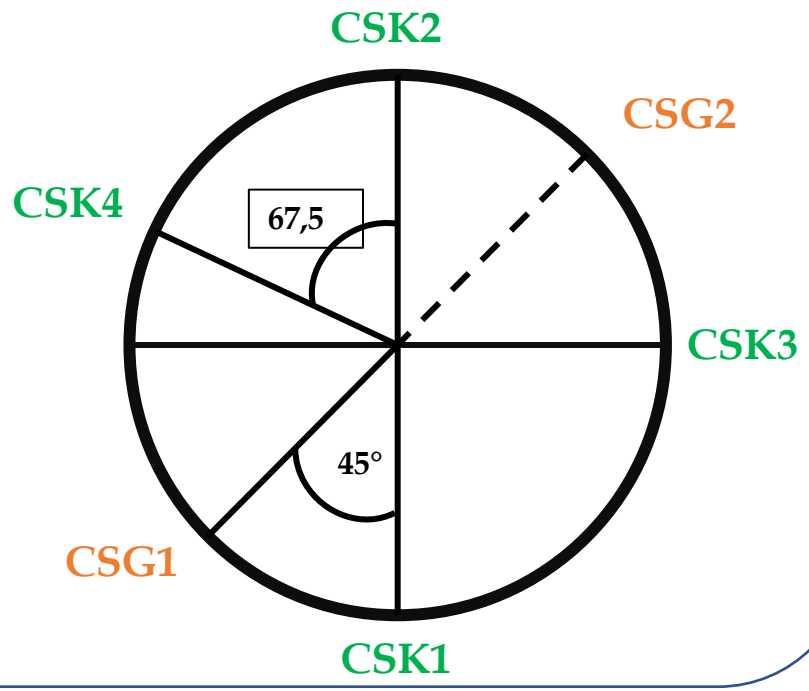
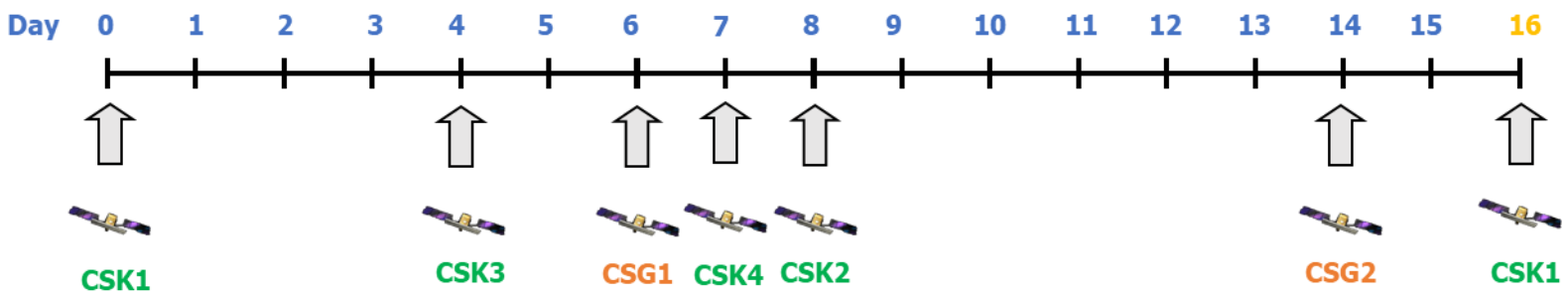
COSMO-SkyMed Configurazione Orbitale









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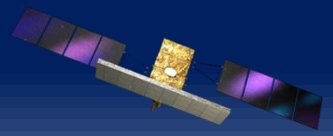
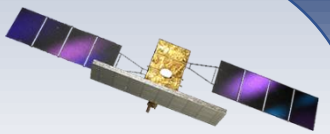
Miglioramenti introdotti in CSG rispetto CSK





- **Continuità** con i satelliti CSK (Affidabilità già consolidata)
- **Qualità** dell'immagine e **polarimetria** migliorate, nuove funzionalità dei prodotti
- **Nuove modalità di acquisizione**
- Migliorato **l'accesso** degli **utenti** al sistema
- Gestione dinamica delle **risorse di bordo**
- Miglioramento delle **prestazioni della piattaforma** (es. agilità, gestione e trasmissione dei dati)
- Un portafoglio più ampio di opzioni di **espandibilità** e funzionalità avanzate **multi-missione/multi-sensore**

EARTH TECHNOLOGY EXPO

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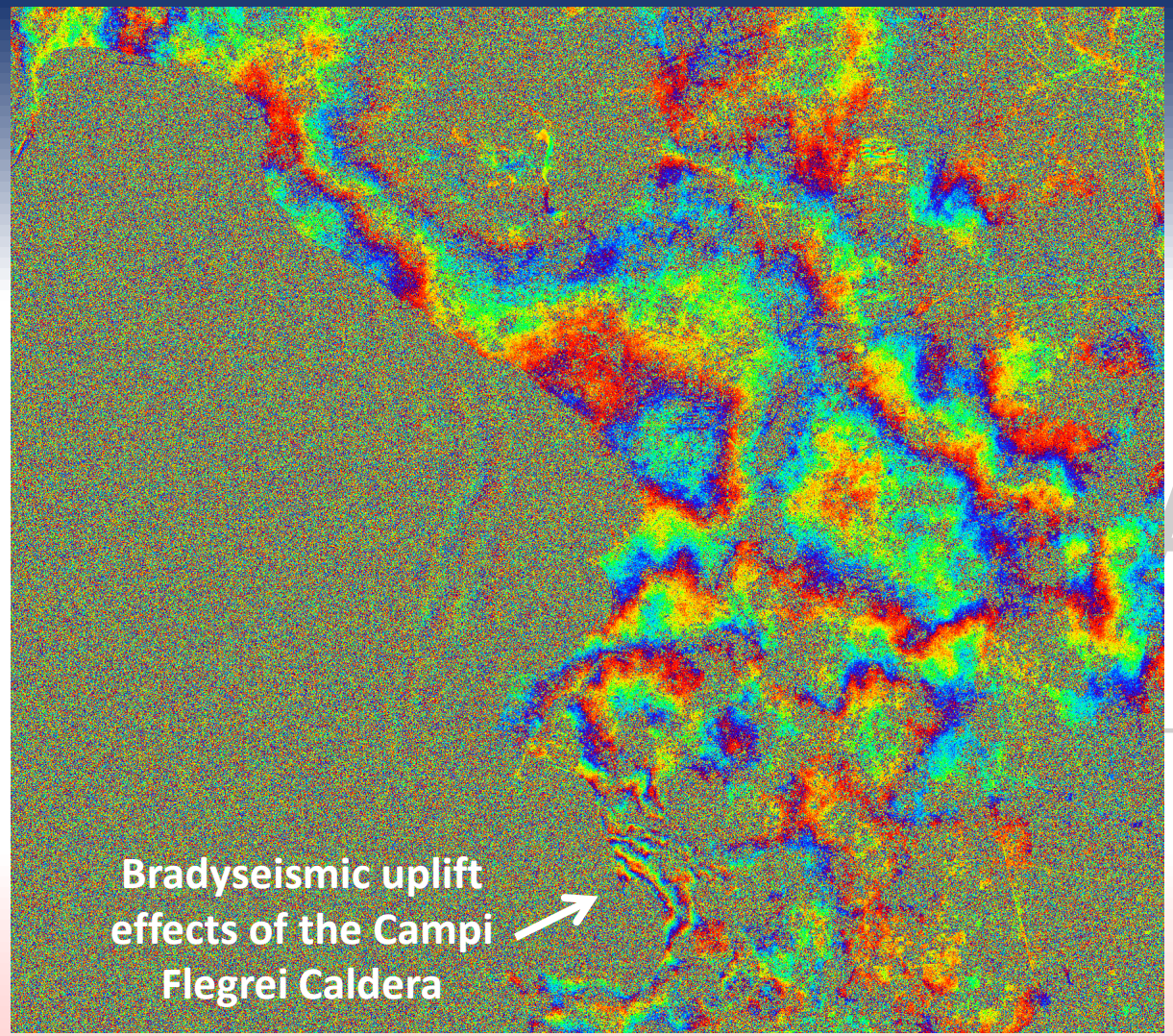
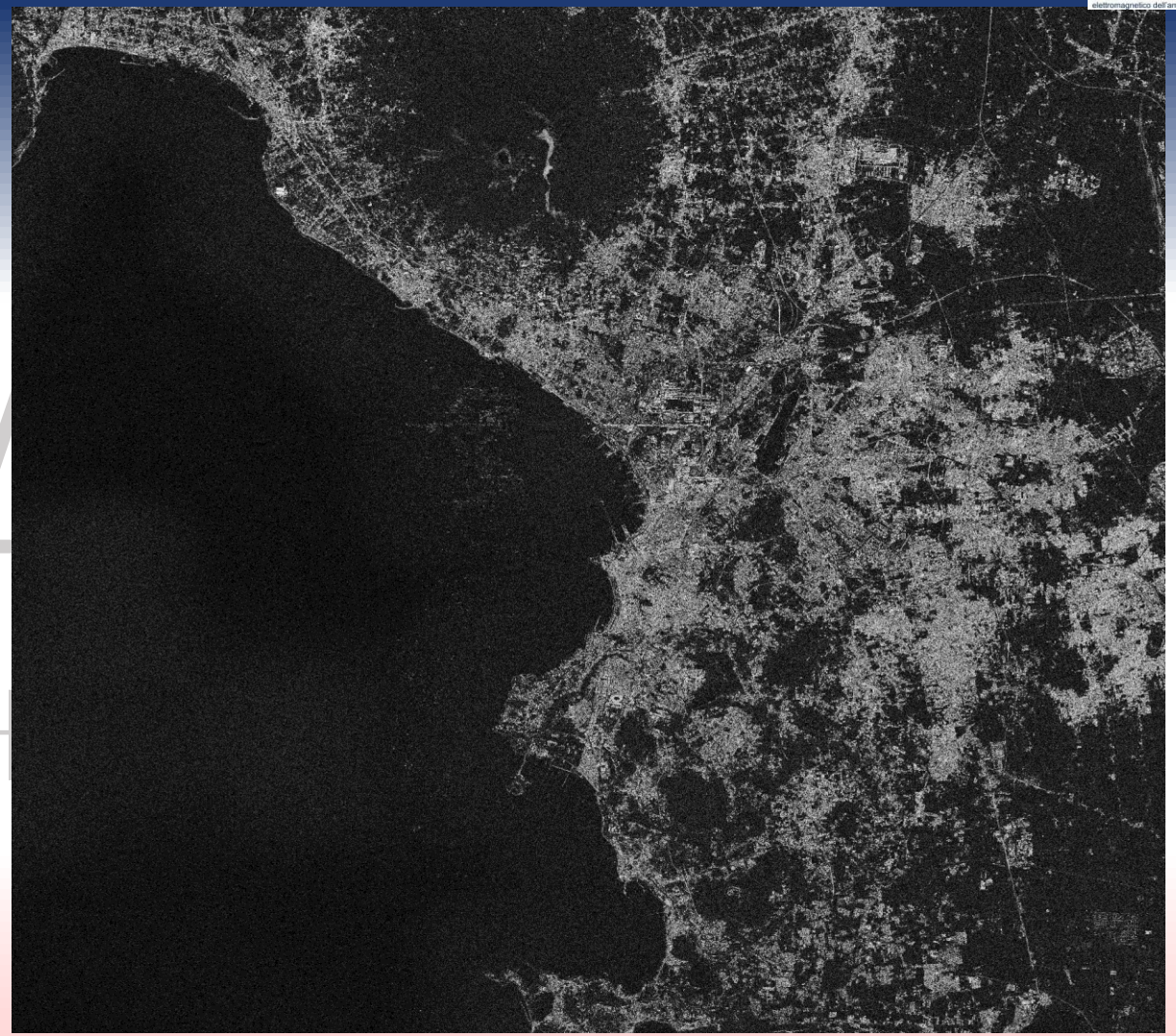
CSK-CSG interferogramma Napoli





23052020CSK_31122020CSG

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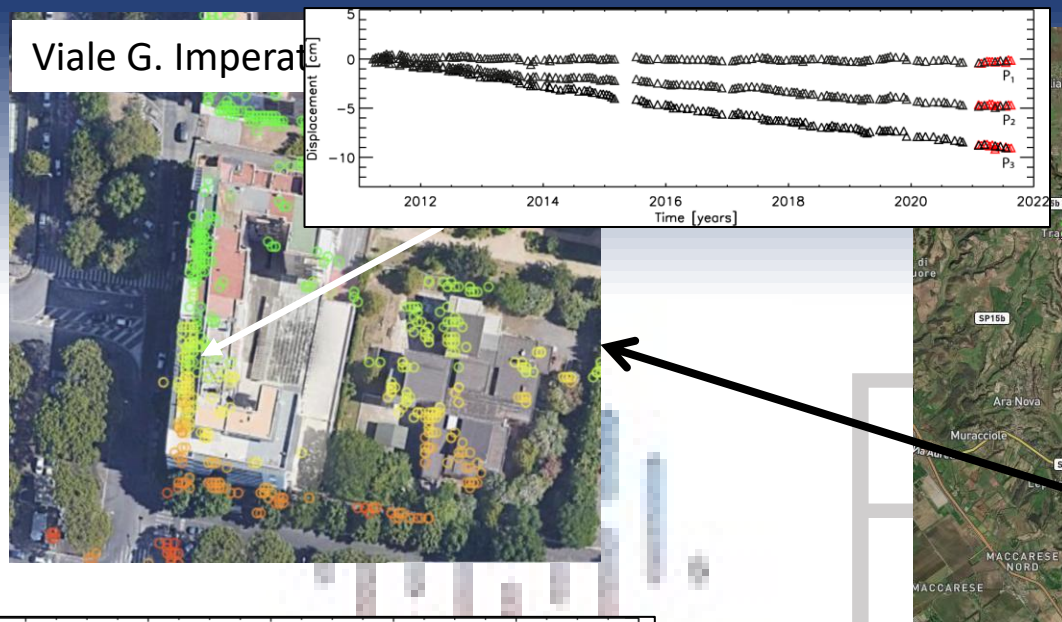
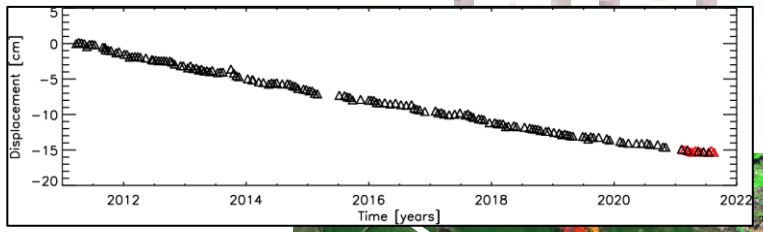
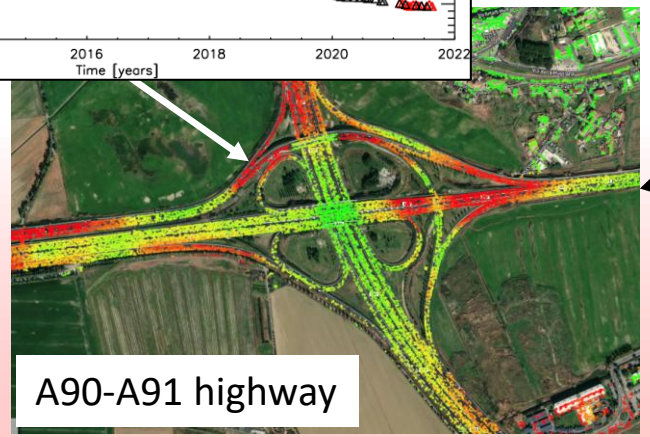
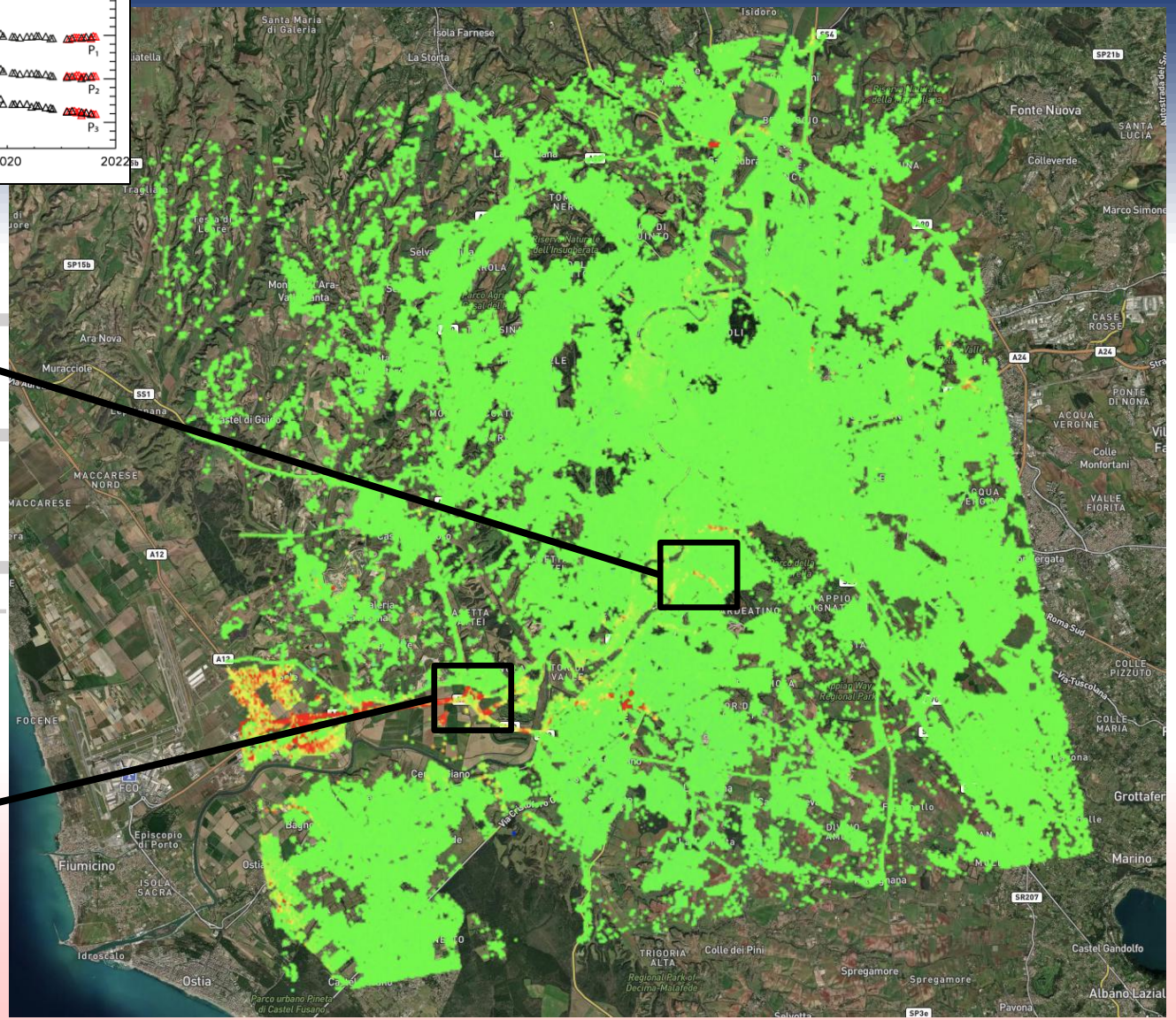
CSK-CSG analisi SBAS-DInSAR: Roma









LOS mean deformation velocity [cm/year]

> 1

<- 1

Δ CSK

Δ CSG

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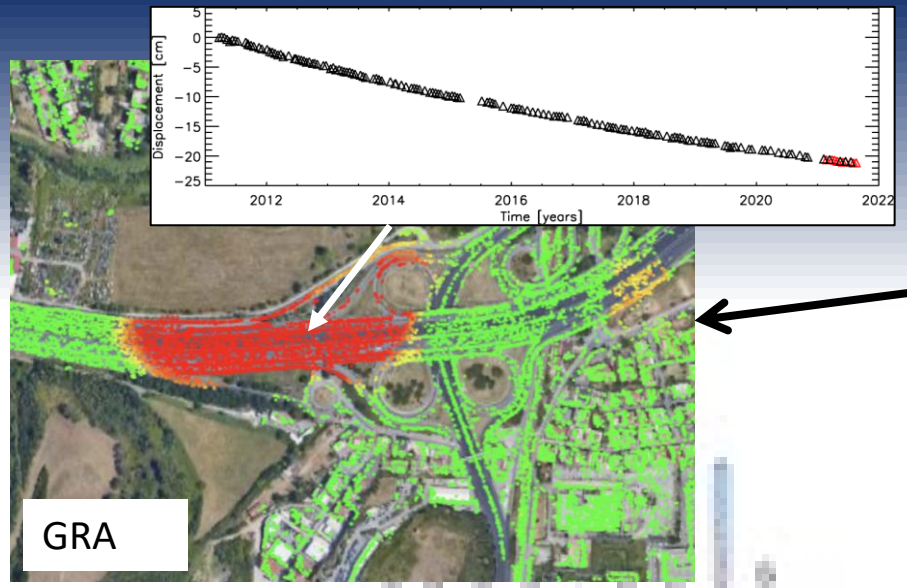
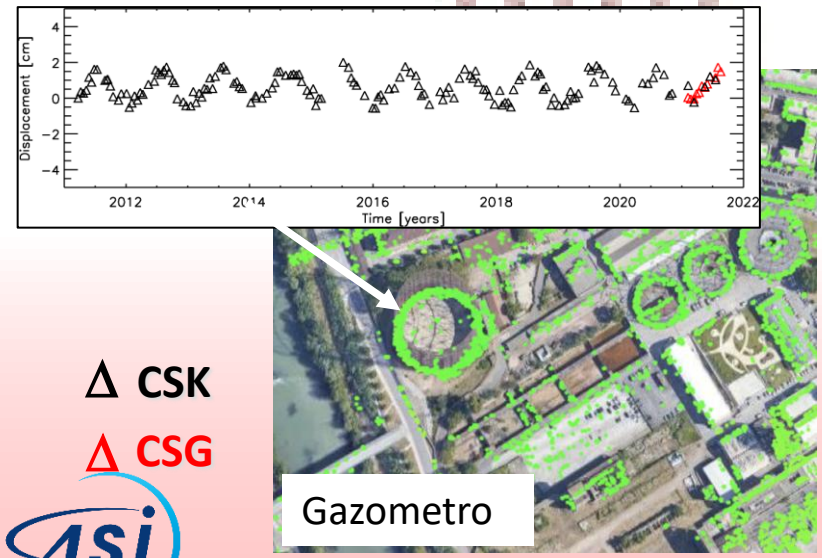
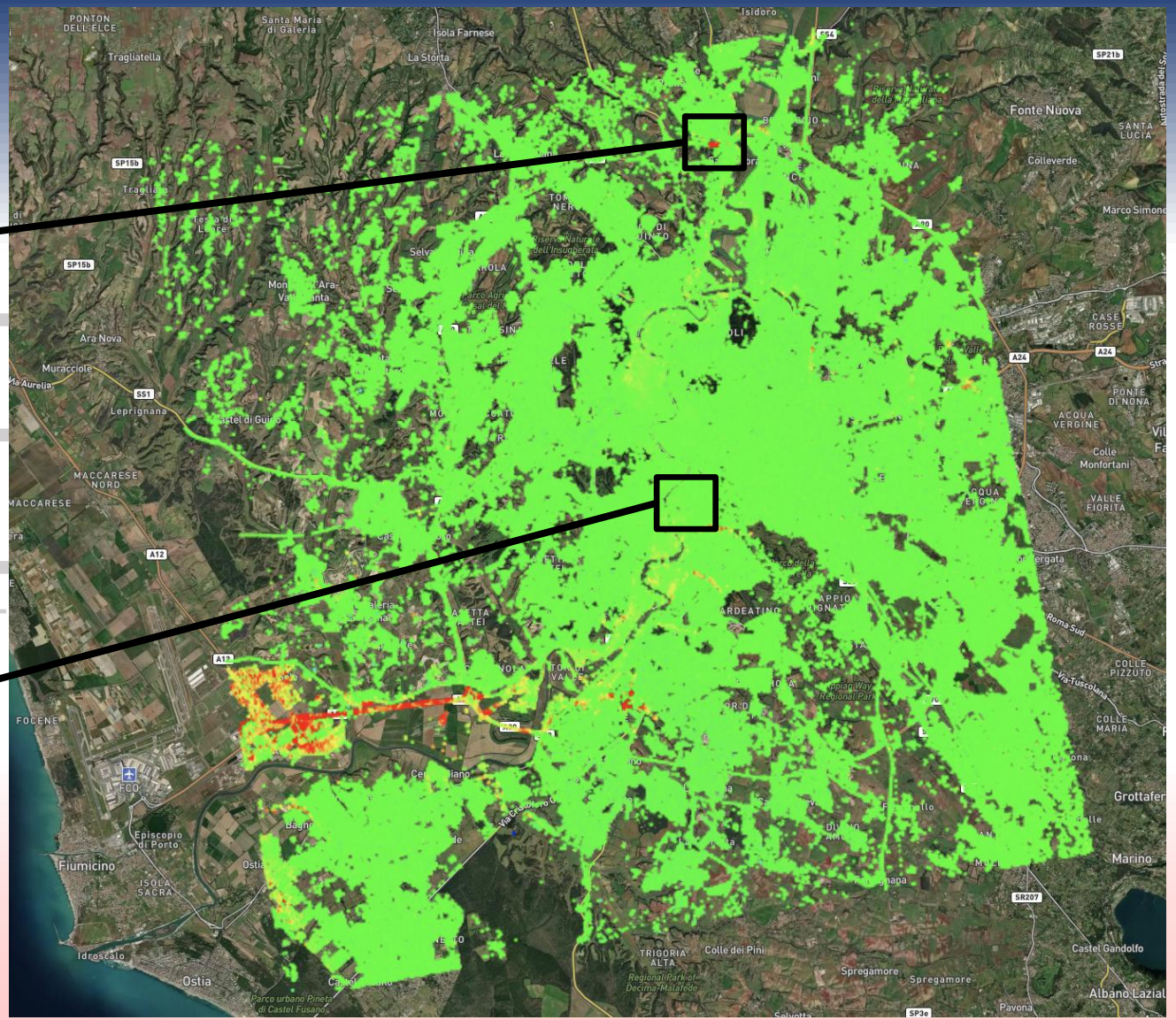
CSK-CSG analisi SBAS-DInSAR: Roma







Δ CSK

Δ CSG

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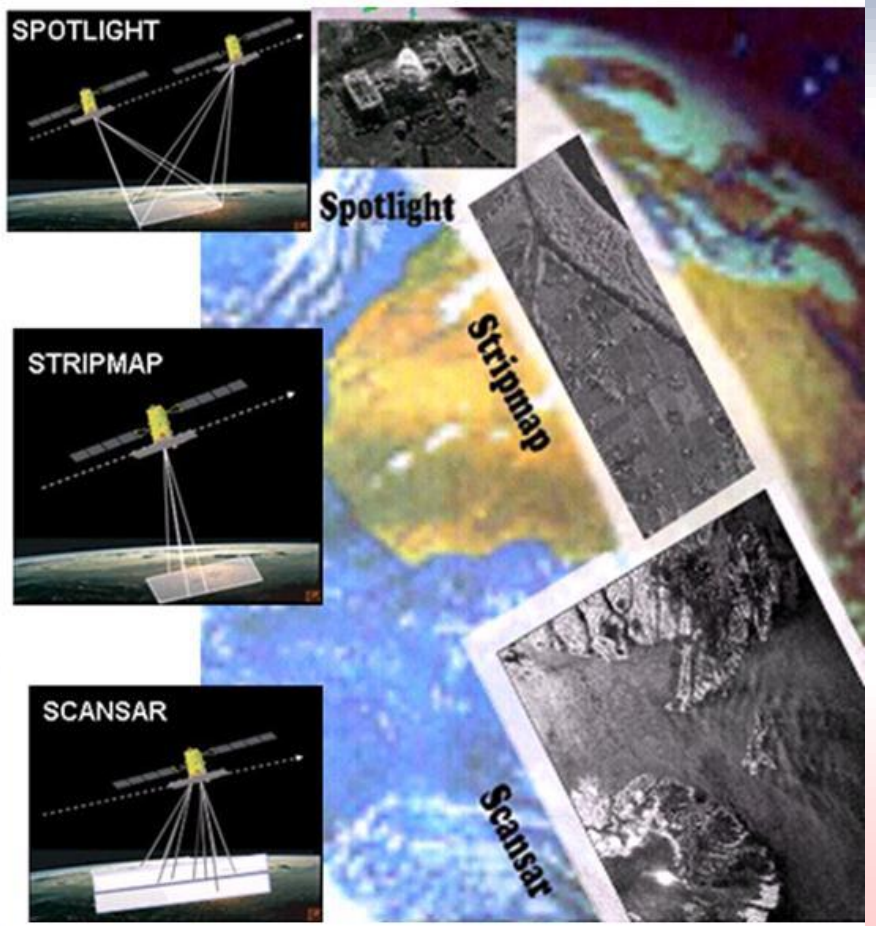
Miglioramenti introdotti in CSG a livello Acquisition Mode rispetto CSK

	CSK	CSG
Narrow field images	**Very High Resolution** **VHR** *(sub-metric)* Governmental Use	**Ultra-High Resolution (UHR)** Governmental Use
Narrow field images	Resolution: 1 m Single Polarization Size 10 km x 10 km Civilian and Defence use	**Spot-2** *VHR and Dual Pol.* (**) Sp-2A res. ≤ 0.35 x 0.55 m Swath ≥ 3.1 x 7.3 Km Sp-2B res. ≤ 0.63 x 0.63 m Swath ≥ 10 x 10 Km Sp-2C res. ≤ 0.80 x 0.80 m Swath ≥ 5 x 10 Km Civilian and Defence Use
Wide field images	Resolution: 3 m Single Polarization Swath Size 40 km Civilian and Defence use	Resolution : 3m x 3m Swath Size Dual Pol 40 km Swath Size QUADPOL 15 km Civilian and Defence use
Wide field images	Resolution: 30 m Single Polarization Swath Size: 100 km or Resolution : 100 m Single Polarization Swath Size: 200 Km Civilian and Defence use	Resolution : 4 x 20 m Double Polarization Swath Size : 100 km or Resolution : 6 x 40 m Double Polarization Swath Size: 200 Km Civilian and Defence use

(**) in azimut and range



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STRIP	CSK			CSG		
	Max resolution (Az. x Ra.)	Polarization	Scene size (Az. x Ra.)	Max resolution (Az. x Ra.)	Polarization	Scene size (Az. x Ra.)
HIMAGE	3 x 3 m	Single	40 x 40 Km	3 x 3 m	Single / Dual	40 x 40 Km
Ping Pong	15 x 15 m	Alternating	30 x 30 Km	12 x 5 m	Alternating	40 x 40 Km
Quad Pol				3 x 3 m	Quad	40 x 15 Km

SCAN	CSK			CSG		
	Max resolution (Az. x Ra.)	Polarization	Scene size (Az. x Ra.)	Max resolution (Az. x Ra.)	Polarization	Scene size (Az. x Ra.)
Wide	23 x 13,5	Single	100 x 100			
Huge	38 x 13,5	Single	200 x 200			
ScanSAR-1				20 x 4	Single / Dual	100 x 100
ScanSAR-2				40 x 6	Single / Dual	200 x 200

SPOT	CSK			CSG		
	Max resolution (Az. x Ra.)	Polarization	Scene size (Az. x Ra.)	Max resolution (Az. x Ra.)	Polarization	Scene size (Az. x Ra.)
Spotlight-2	1 x 1 m	Single	10 x 10 Km			
Spotlight-2A				0,3 x 0,5 m	Single / Dual	3,5 x 7 Km
Spotlight-2B				0,6 x 0,6 m	Single / Dual	10 x 10 Km
Spotlight-2C				0,8 x 0,8 m	Single / Dual	5 x 10 Km

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CSG Migioramenti in Acquisition Modes

NOT STA MODES

CSG HIMAGE mode:

❖A Quad-Pol

CSG Spotlight standard mode:

❖Risoluzione Migliorata
❖Possibilità di acquisire in Spotlite ~100 km

CSG Theatre mode:

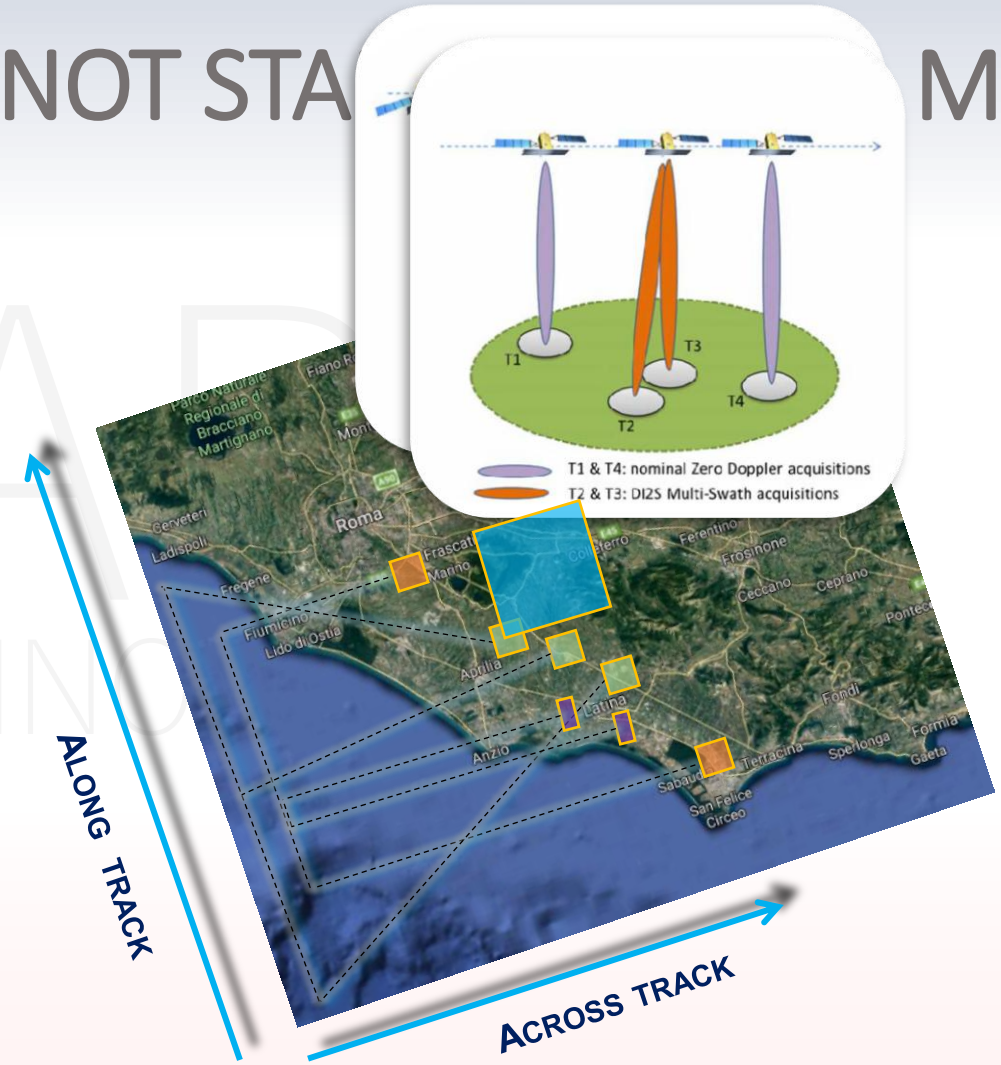
❖**L'agilità della piattaforma** consente di eseguire manovre di pitch

❖**Acquisire nell'area del theatre molte immagini a pochi km**

CSG DI2S:

❖ Possibilità di acquisire 2 targets differenti **contemporaneamente**

❖ Lo swath è ridotto in range



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CSG Acquisition modes - overview

Standard Acquisition Modes

- Spotlight-2A
- Spotlight-2B
- Spotlight-2C
- Stripmap
- Ping-Pong
- Stripmap Quad-Pol
- ScanSAR-1
- ScanSAR-2

Non-Standard Acquisition Modes

- Operational
  - DI2S Spotlight OR Multi-Swath
  - DI2S Spotlight OS Multi-Swath
  - Spotlight on theatre (offline)
  - Spotlight Quad-Pol — Working Progress
- Experimental (offline)
  - Constant Squint Spotlight
  - Constant Squint Stripmap
  - Spotlight 2S
  - DI2S Spotlight 2 Multi-Swath Joined

Total daily imaging profile per satellite (wideband mode)	
SAR Mode	Daily
Spotlight-1 [num]	31
Spotlight-2 [num]	46
Stripmap Dual Pol [min]	36.19

- Non-Standard **Operational** Modes: per esercitarli è necessario l'intervento degli operatori
- **Offline**: modalità di acquisizione non disponibile sull'interfaccia utente, ma gestita con uno strumento **offline** presso gli User Ground Segment di COSMO-SkyMed
- Non-St. **Experimental** Modes: Modi Spoerimentali per cui le performance non sono garantite

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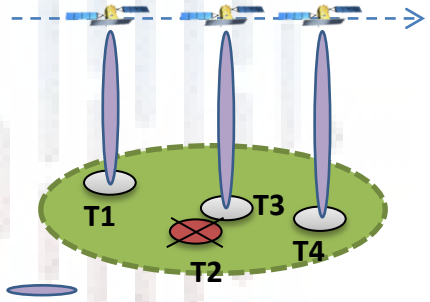
CSG Acquisition modes – Non-standard modes

Standard Spotlight

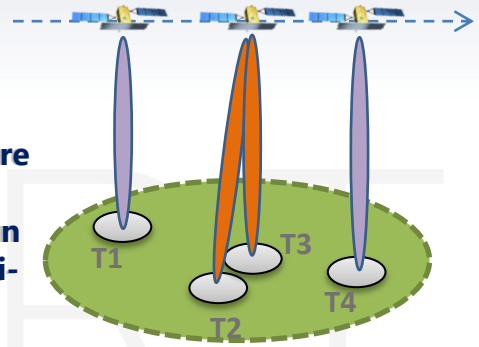
T2 NON può essere acquisita perchè in overlap con T3 in azimuth



Nominal zero-doppler acquisitions

Discrete Stepped Strip (DI2S) Spotlight Multi-Swath

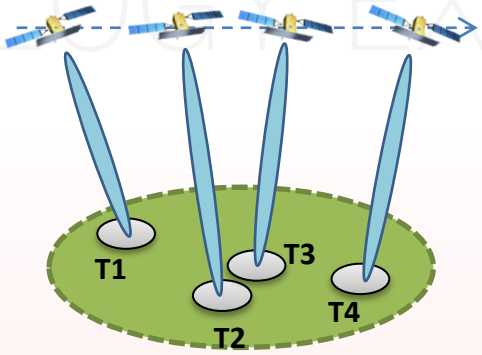
T2 e T3 possono essere acquisite entrambe con la DI2S Multi-swath



Nominal Zero Doppler acquisitions
DI2S Multi-Swath acquisition

Spotlight on Theatre

T2 e T3 possono essere acquisite con acquisizioni Spotlight mediante Theatre



Squinted "theatre" (non-zero-doppler) acquisitions

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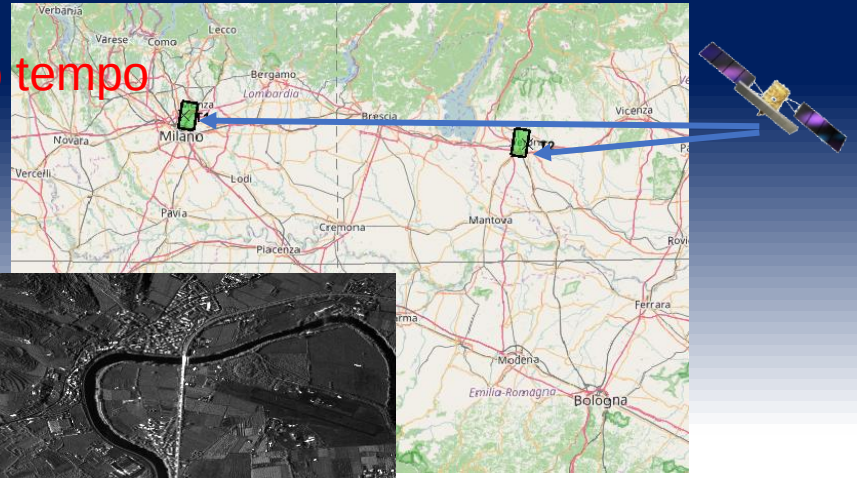
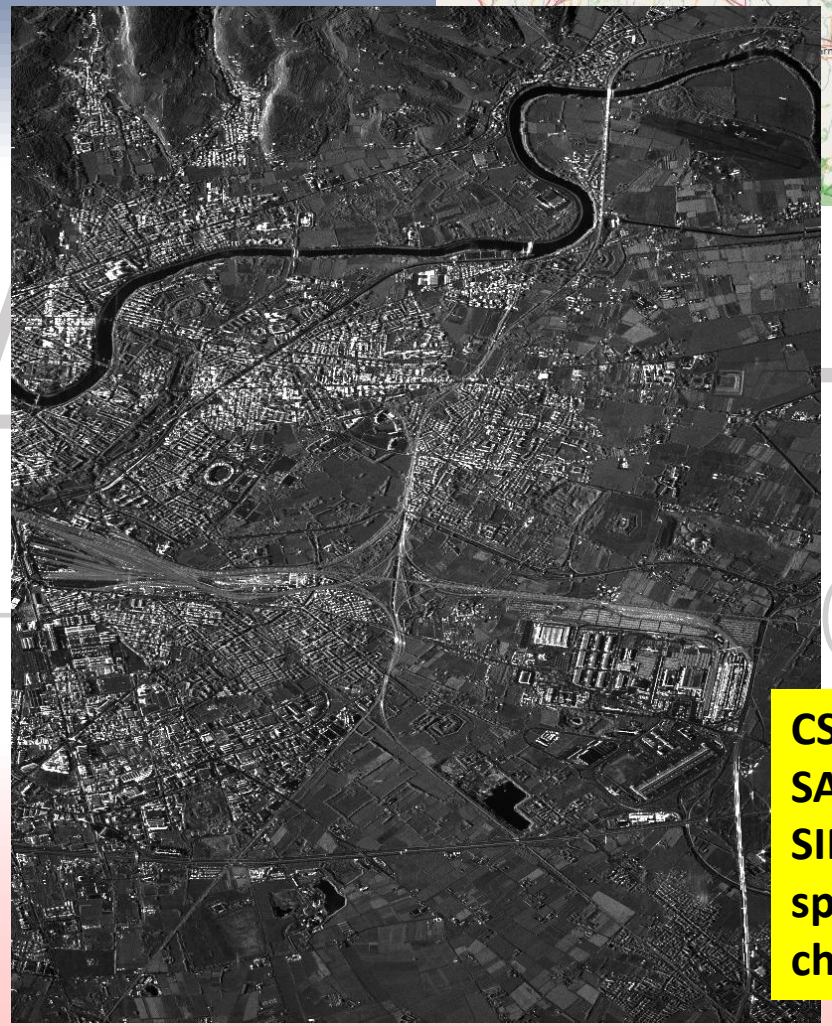
CSG PFM

2 Spotlight Dual Pol (HH+HV) acquisite allo stesso tempo



- **DI2S Milano e Bresso - HH**

CSG_SSAR1_SCS_B_0101_D2S_031_HH_RD_F_20200816170810_20200816170822_1_F_46N_Z32_F00.h5



CSG_SSAR1_SCS_B_0101_D2S_021_HH_RD_F_20200816170810_20200816170822_2_F_45N_Z32_B00.h5

CSG è il primo sistema SAR capace di acquisire SIMULTANEAMENTE 2 spotlight images a diversi chilometri di distanza

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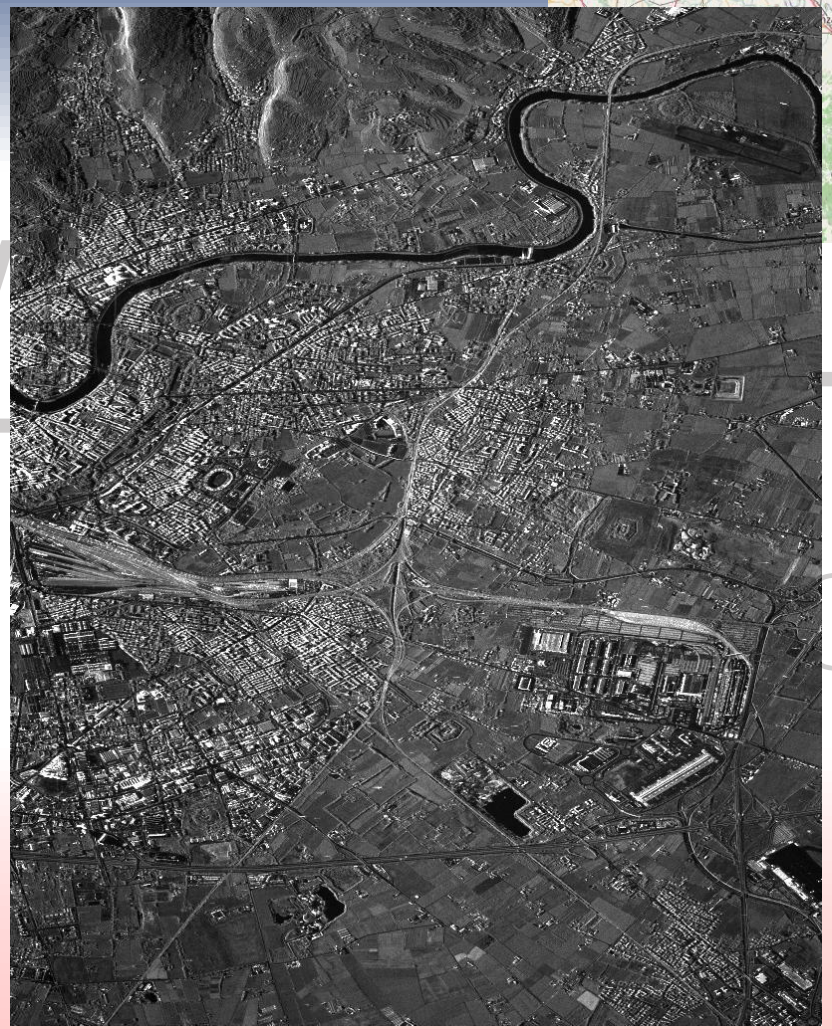
CSG PFM

- DI2S Milano e Bresso - HV

CSG_SSAR1_SCS_B_0101_D2S_031_HV_RD_F_20200816170810_20200816170822_1_F_46N_Z32_F00.h5



CSG_SSAR1_SCS_B_0101_D2S_021_HV_RD_F_20200816170810_20200816170822_2_F_45N_Z32_B00.h5

Processed by Thales Alenia Space S.p.A.

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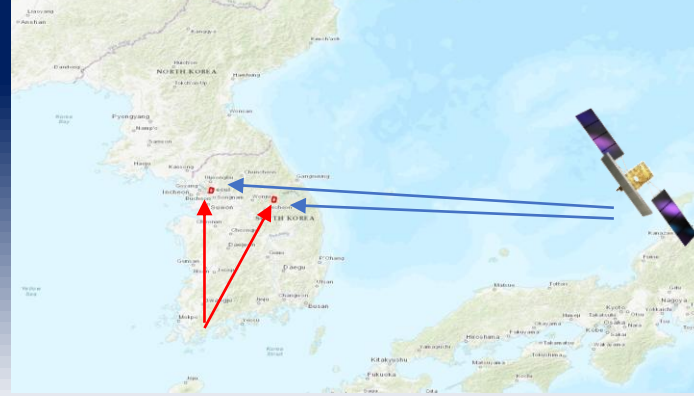
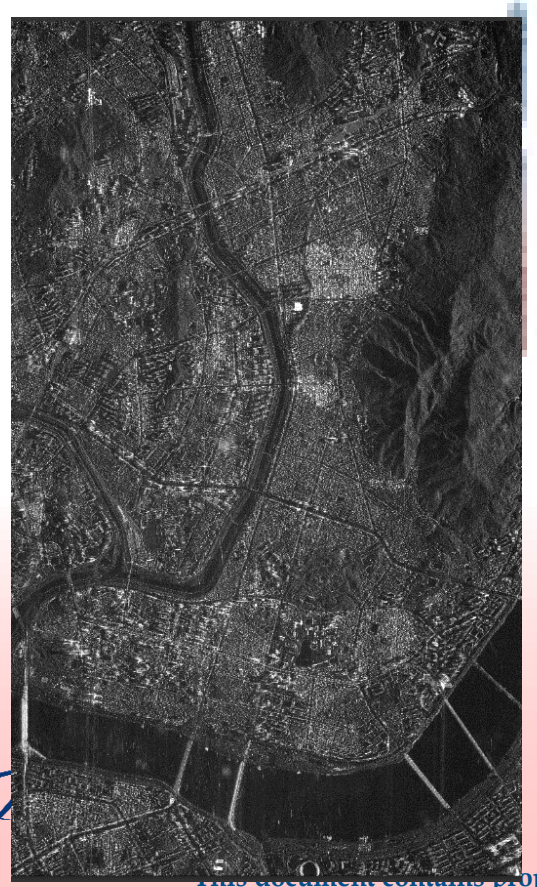
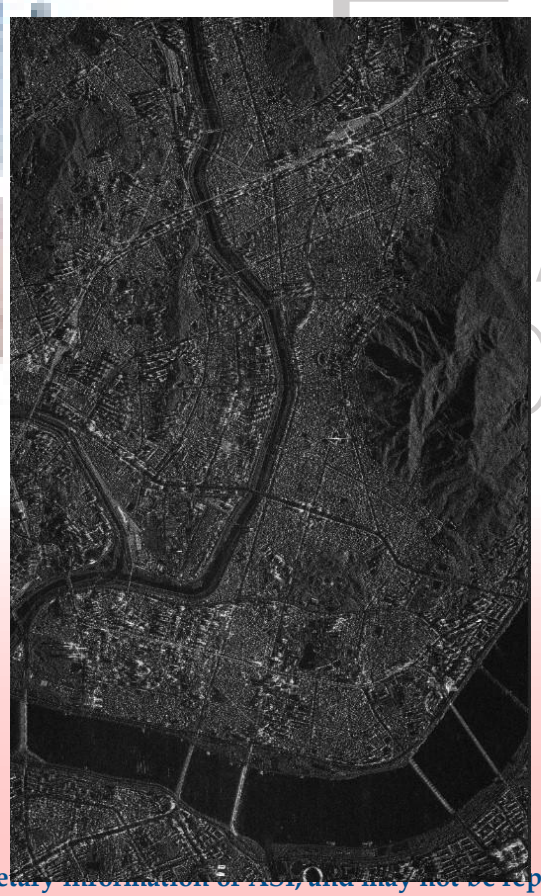
DI2S, South Korea, 23/05/2020

2 Spotlight Dual Pol (HH+HV) acquisite allo stesso tempo



Seoul





Pyeongchang

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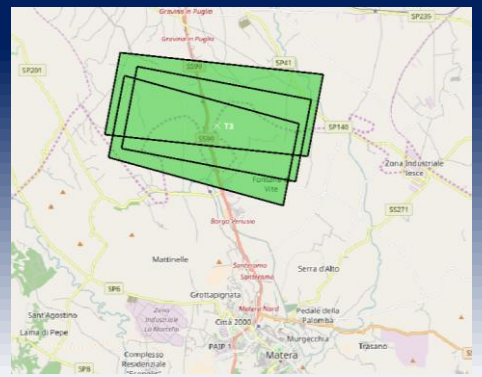
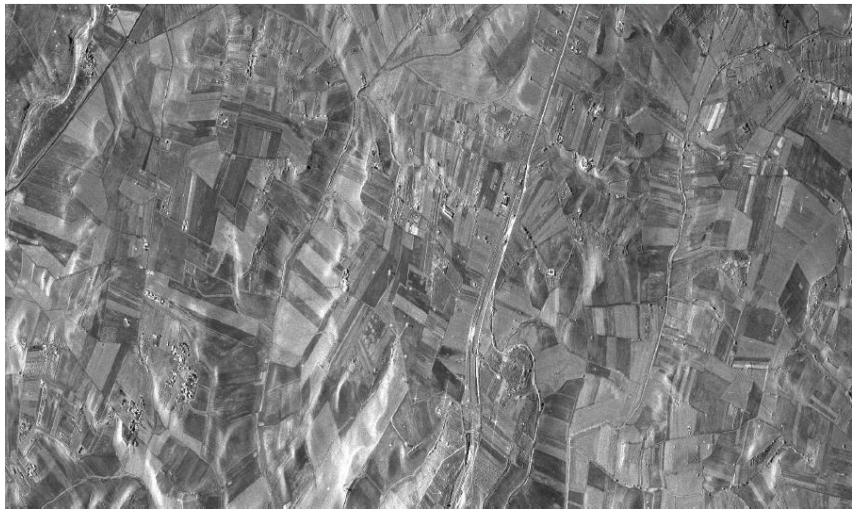
CSG PFM



- **MATERA Theatre (tri-stereo)- VV**



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Pitch +5.5°

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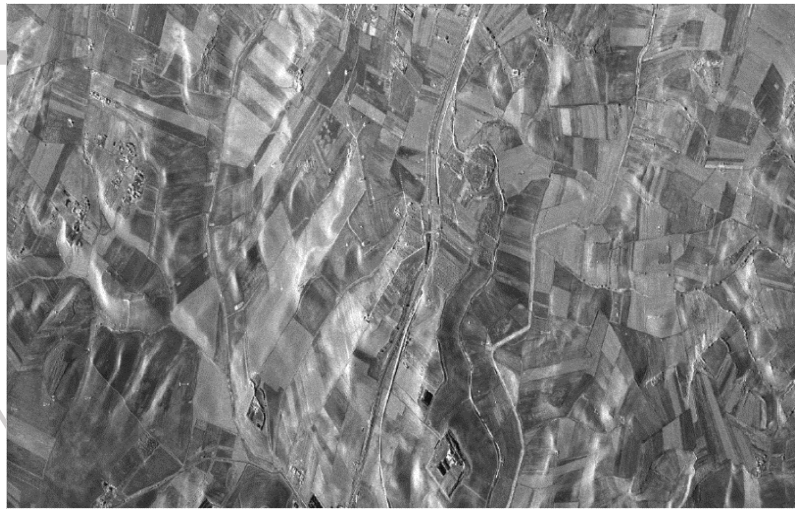
Pitch 0°



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Pitch -5.5°

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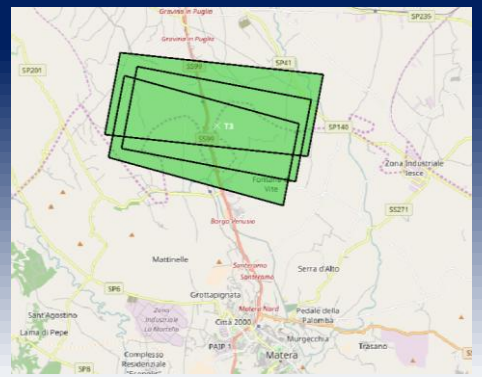
CSG PFM

- MATERA Theatre (tri-stereo) - VH



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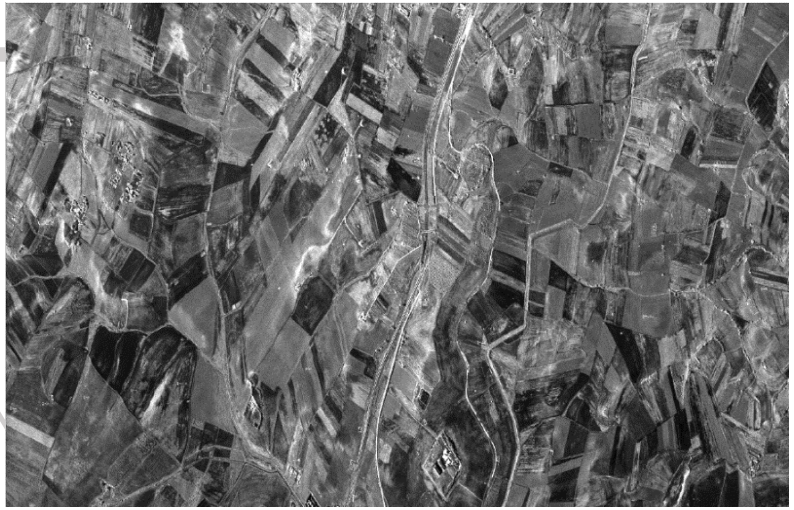
Pitch +5.5°

CSG_SSAR1_SCS_B_0101_S2A_009_VH_RD_F_20200815165109_20200815165119_1_F_41N_Z33_N00.h5

Pitch 0°



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Pitch -5.5°

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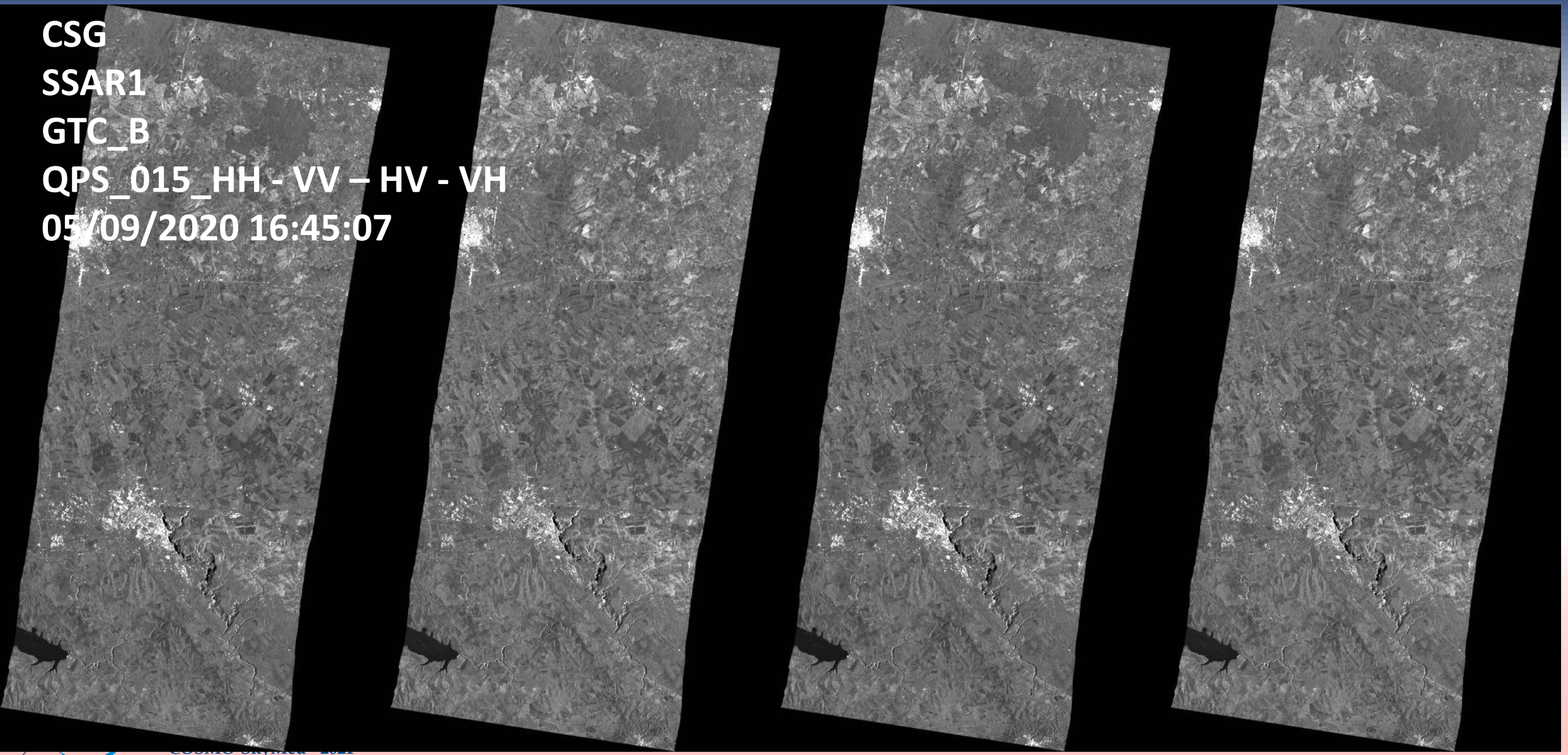
CSG PFM

QUADPOL - Matera



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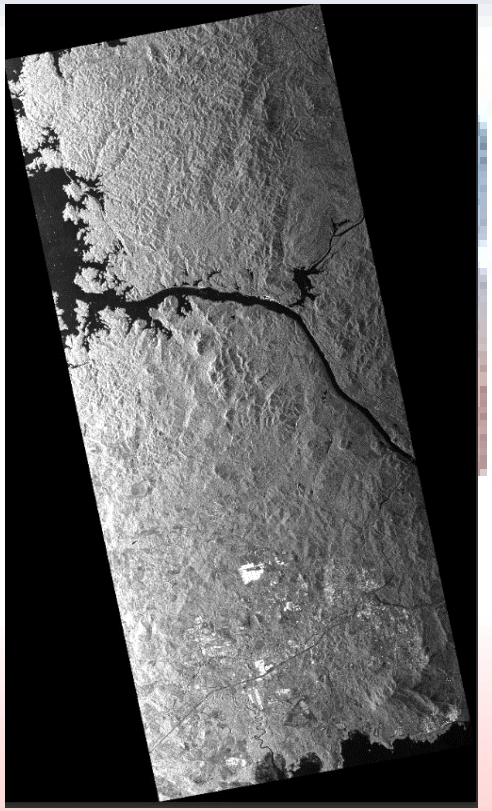
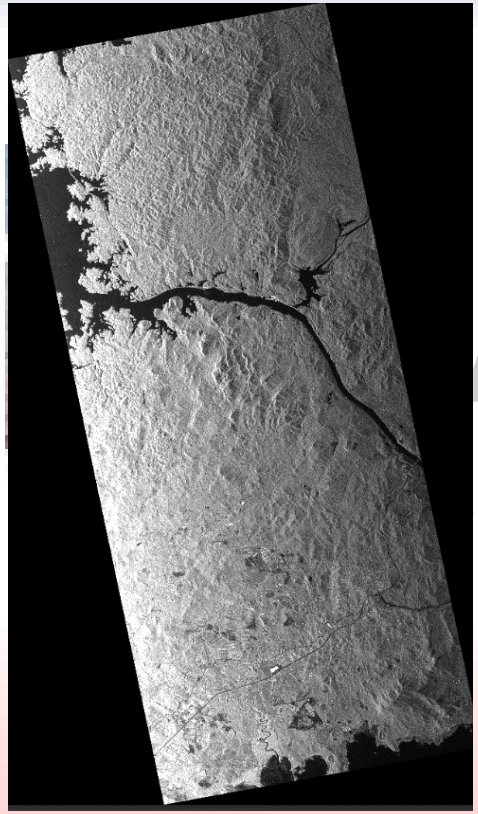
CSG PFM

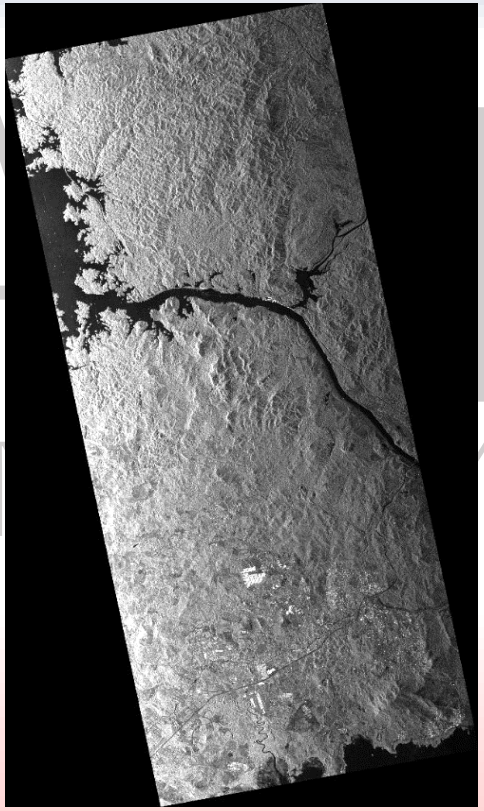
- Imaging mode: Stripmap QuadPol
- Location: Panama Canale



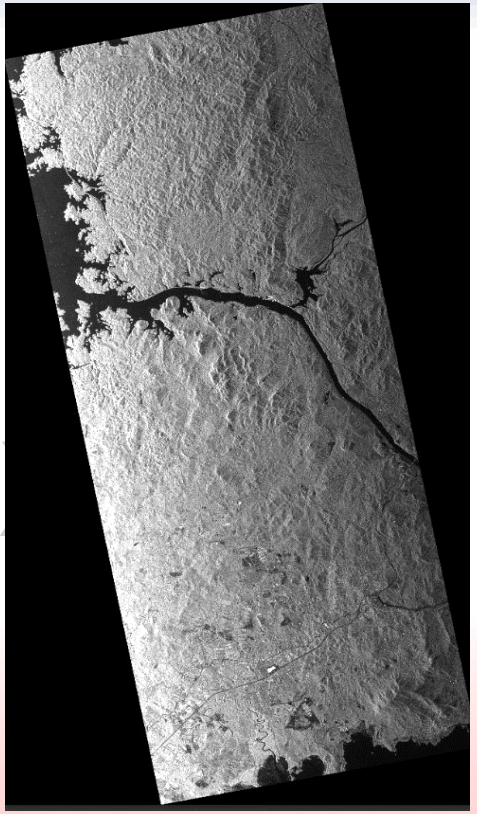
HH



HV



VV



VH

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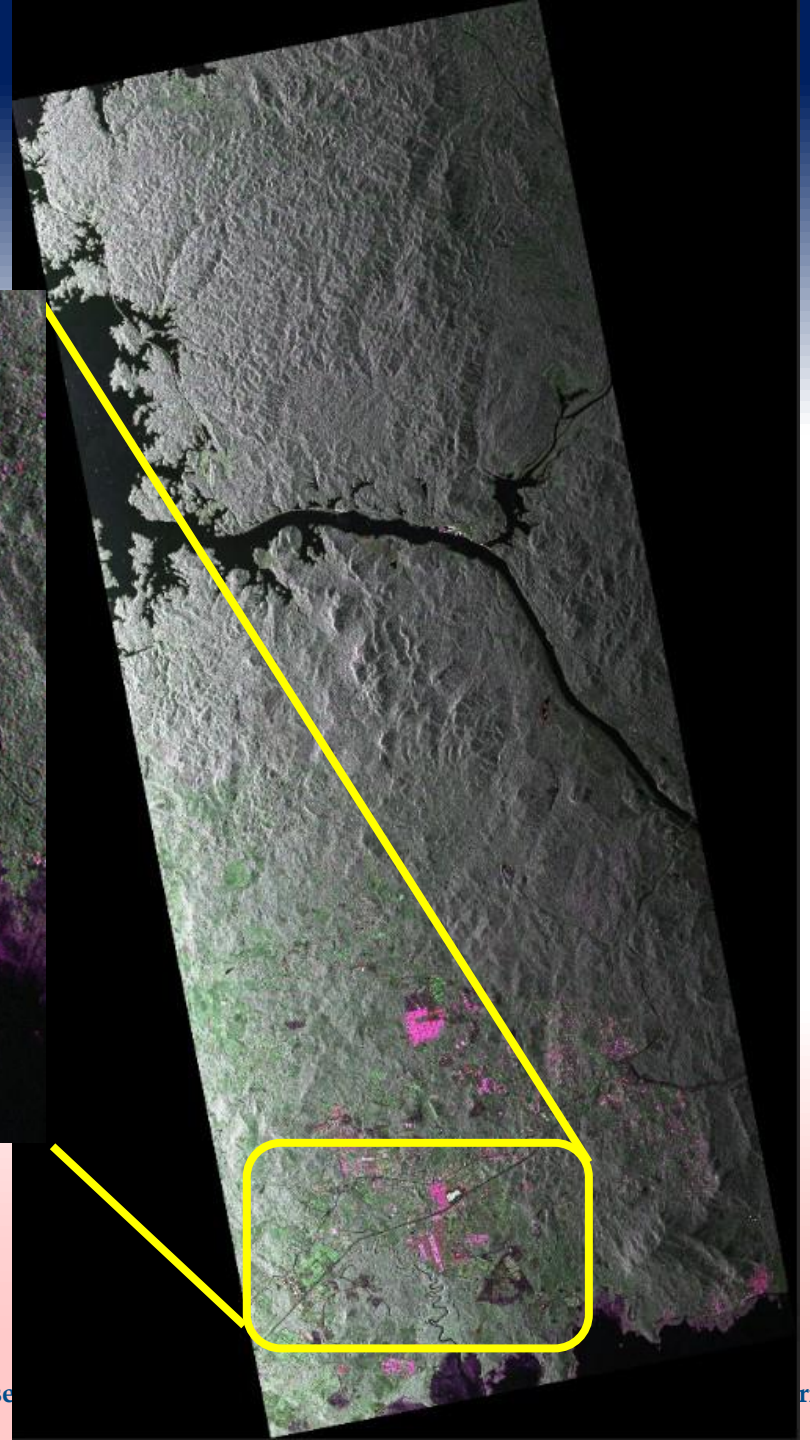
CSG PFM

- RGB = HH + HV + VV



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CSG PFM

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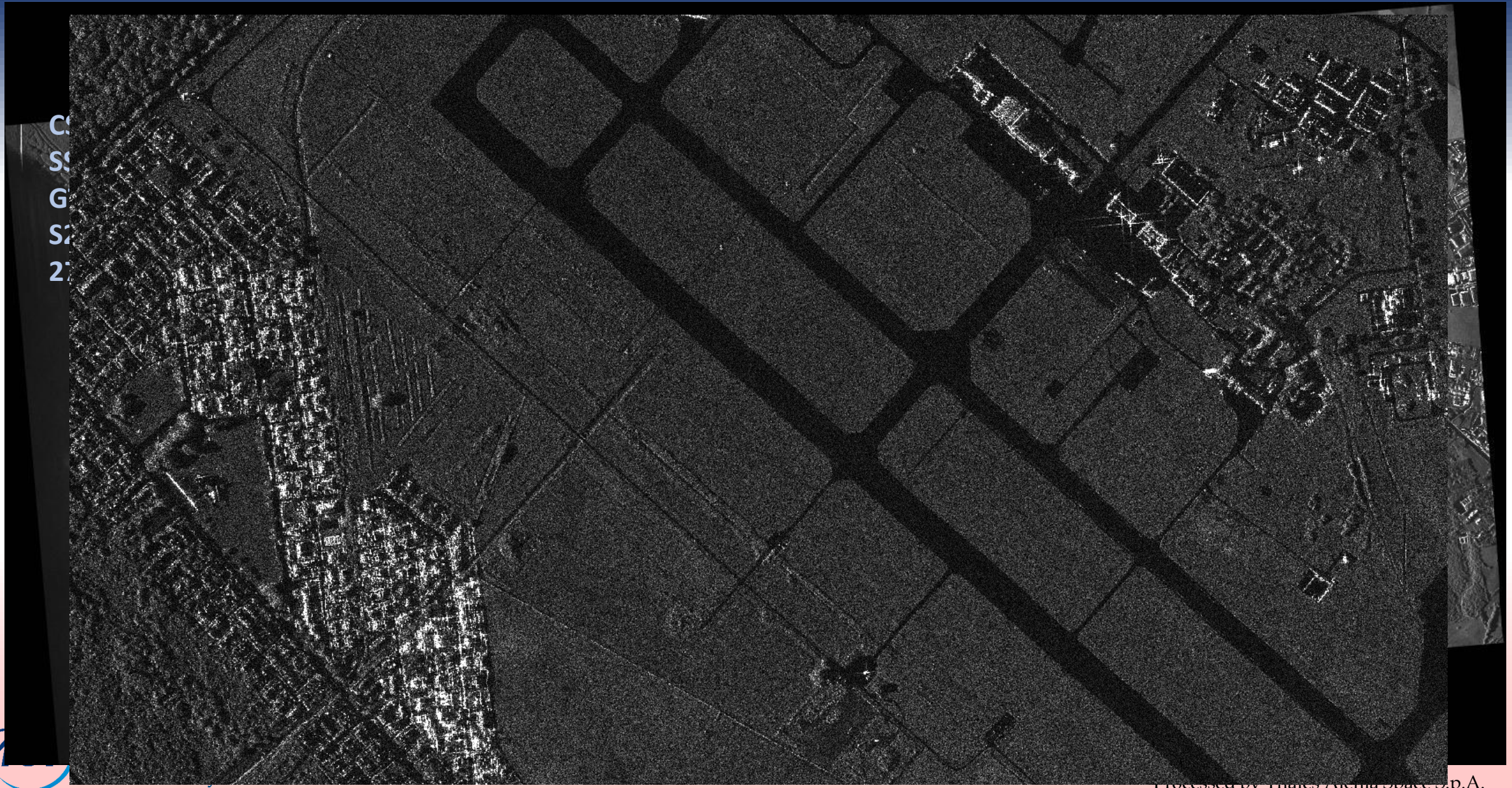
CSG PFM

CSG PFM



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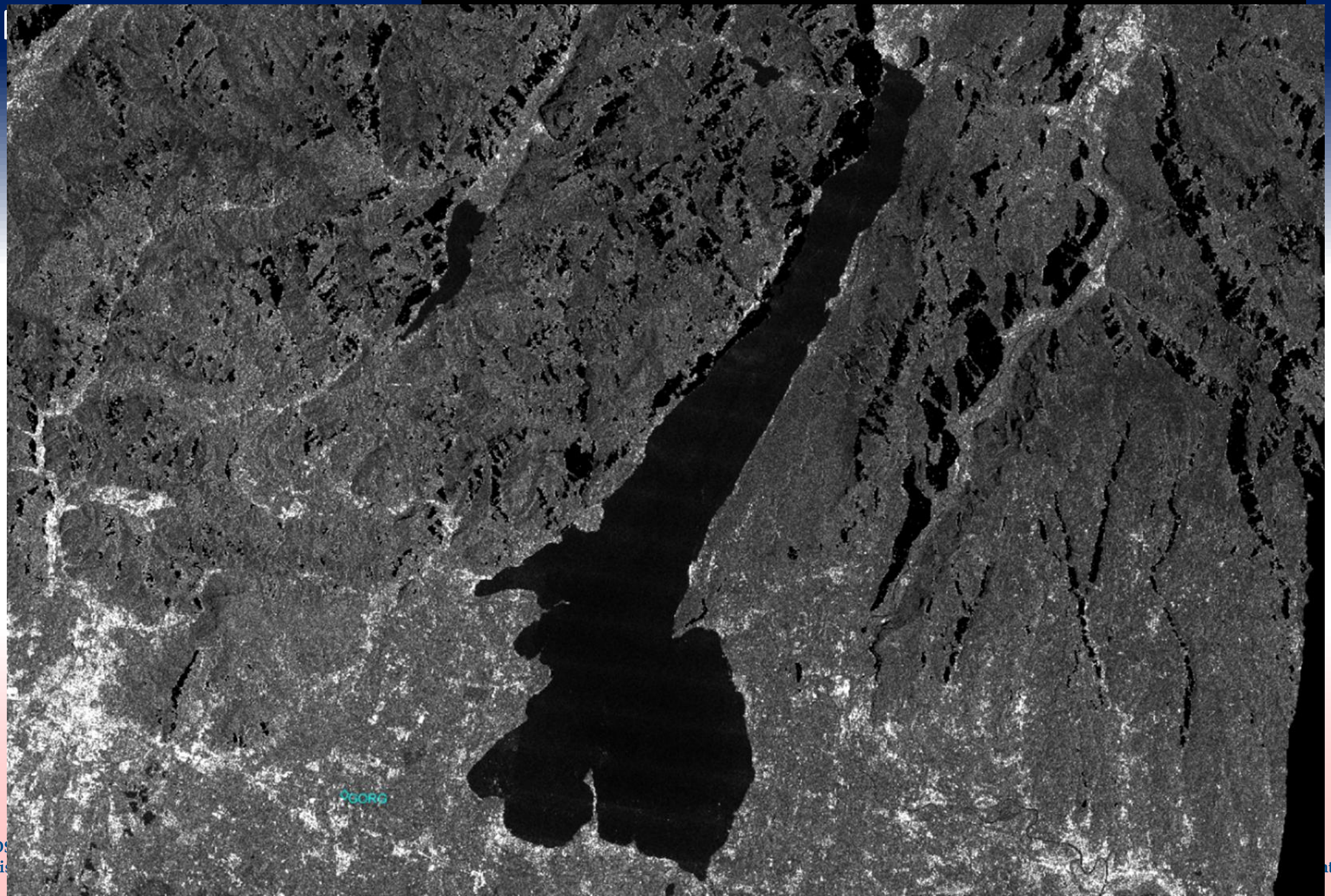
CSG PF



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COS
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CSG PFM

- Imaging mode: Spotlight-2A Dual Polarization
- Location: Istanbul, Turchia

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CSG PFM

- Imaging mode: Spotlight-2B Dual Polarization
- Location: Verrazzano Bridge, New York, USA

HH

HV

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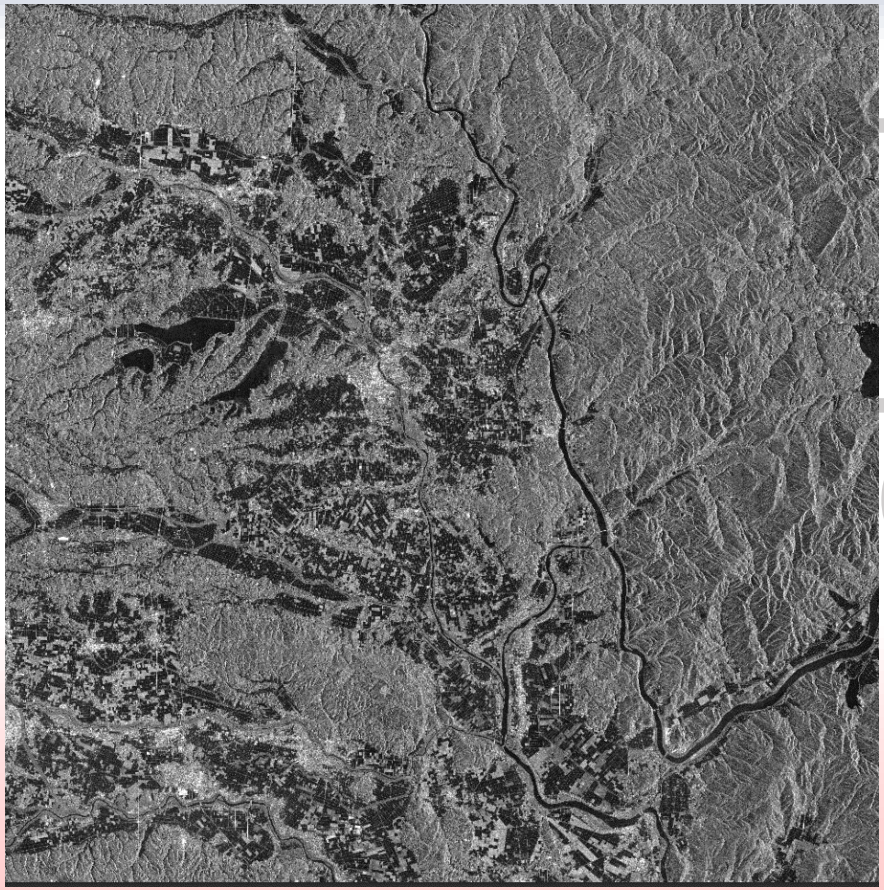
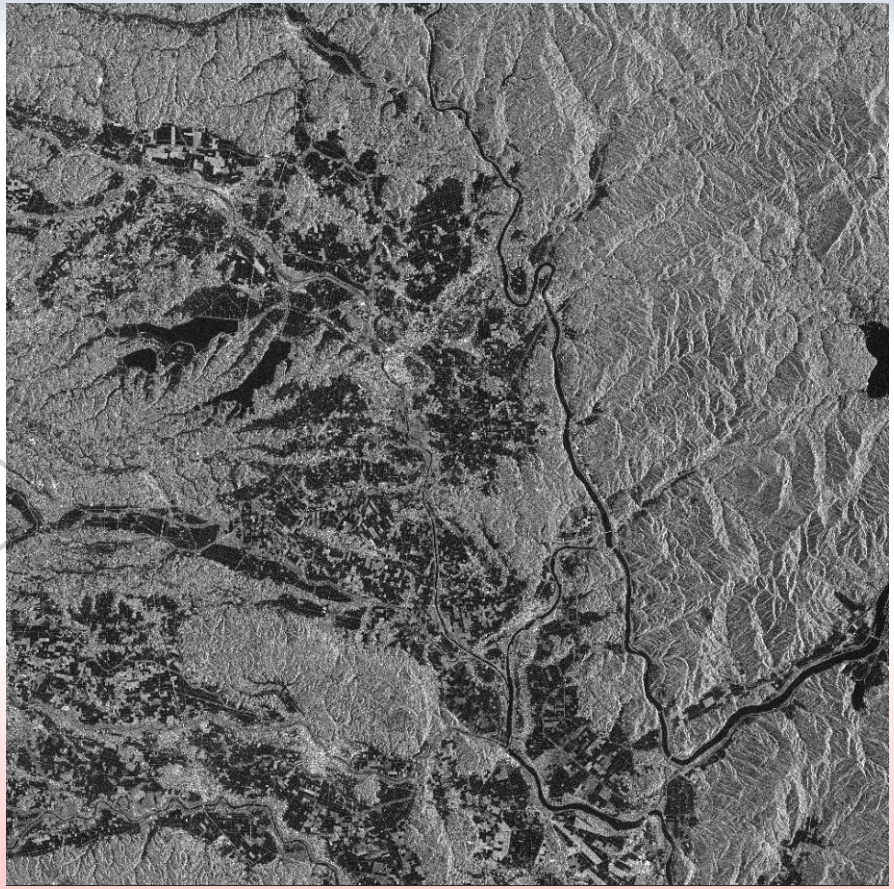
Processed by E-Geos

CSG PFM

- Imaging mode: Stripmap Dual Polarization
- Location: Miyagi, Japan



HH



HV

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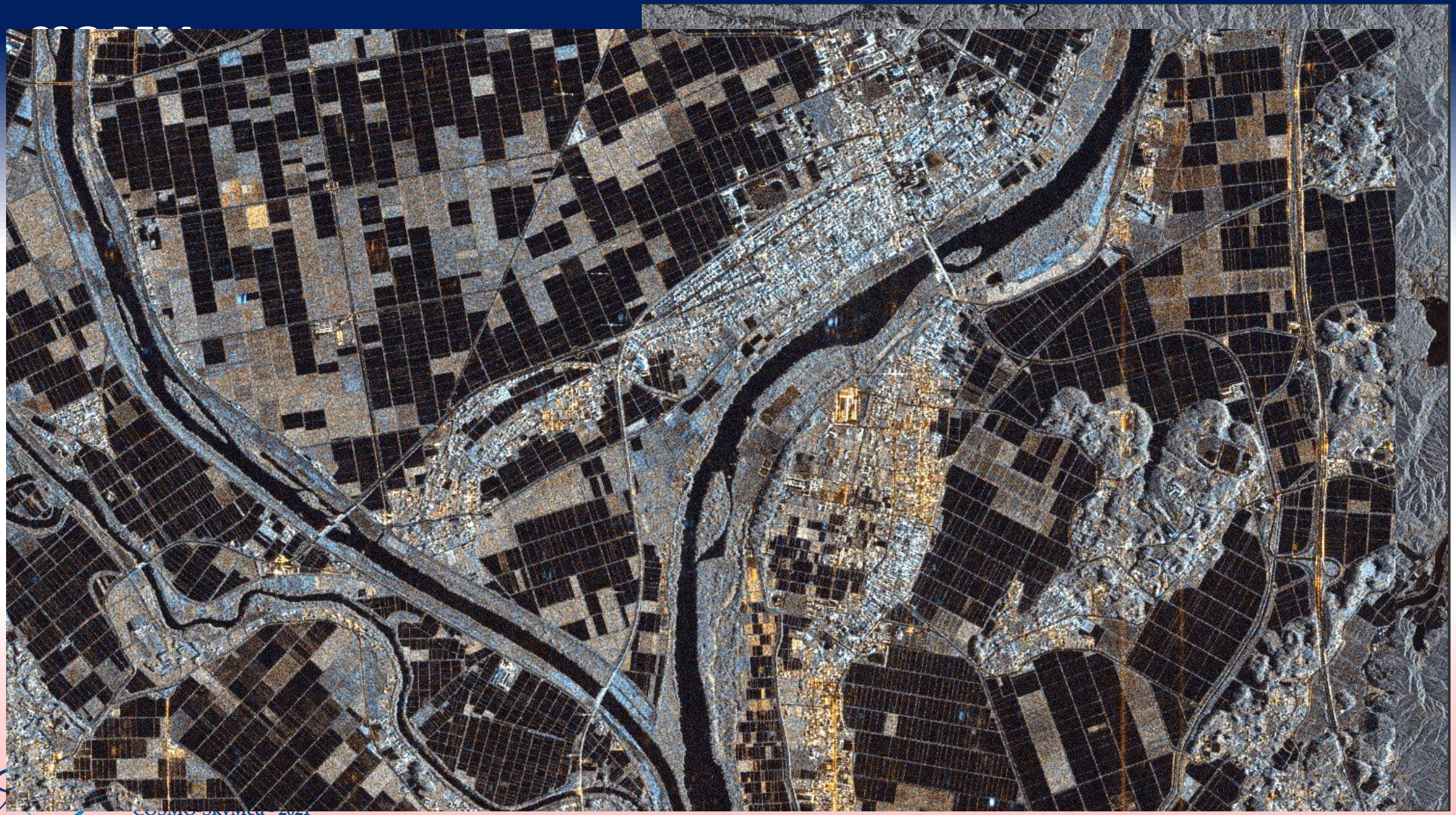

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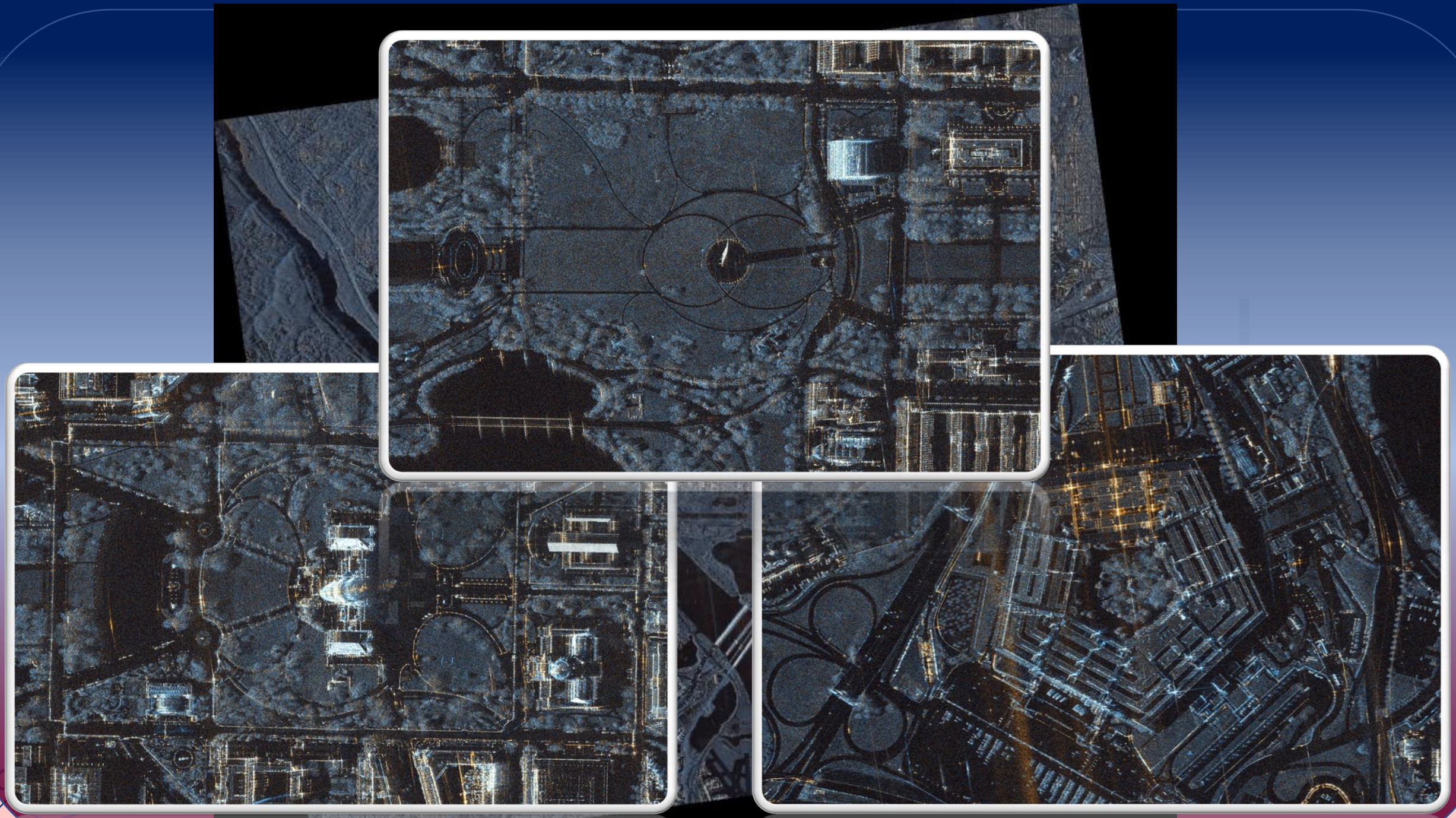

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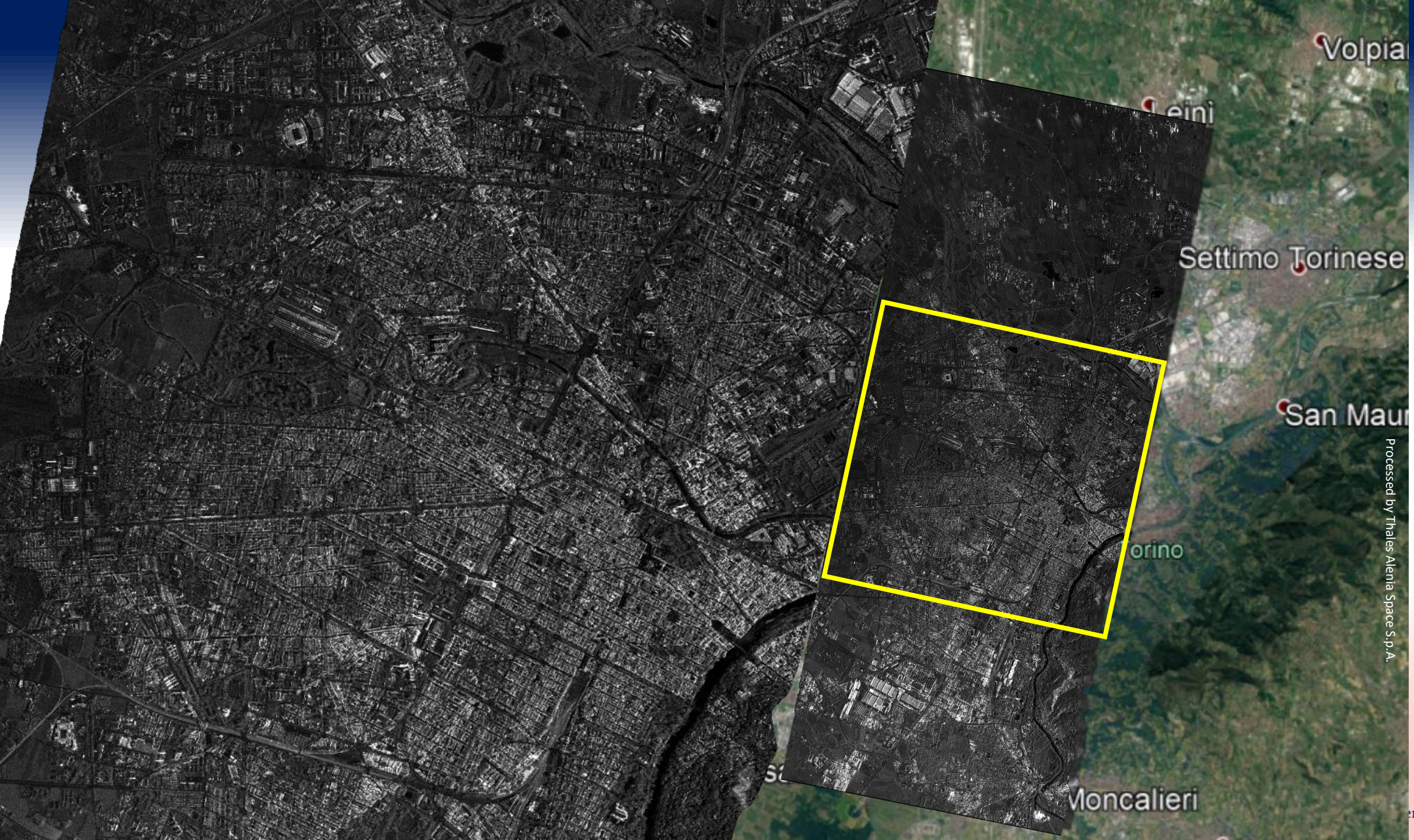

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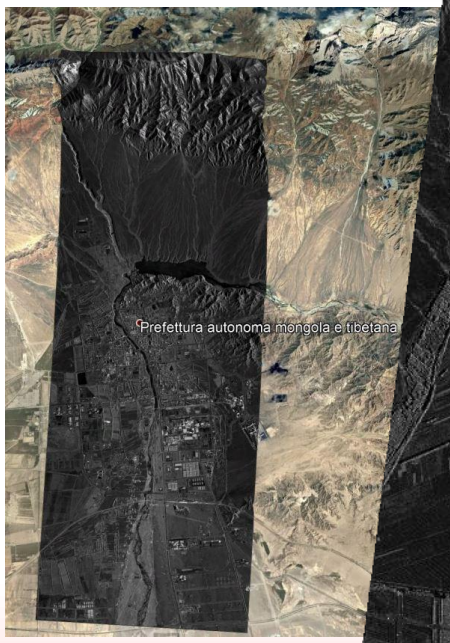
Haixi-Mongolia
Spotlight 2E
VH-VV



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COS
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of ASI

EXPERIMENTAL SPOTLIGHT

Examples of 40 seconds acquisitions with 22 km azimuth swath

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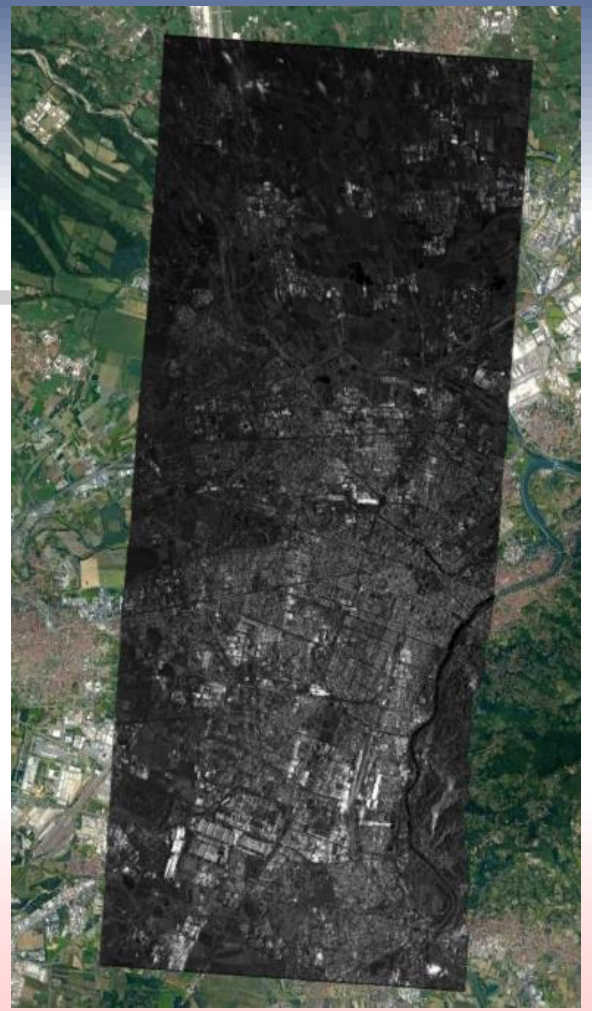
CSG_SSAR1_QLK_D_0101_S2E_008_VV_RD_FM_20200812T141941_00F0_39.61613N_054.34110E_39.40618N_054.45387E.QL



CSG_SSAR1_QLK_D_0101_S2E_005_VV_RD_FM_20200812T173234_00F0_45.19313N_007.57819E_44.98668N_007.73928E.QL

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EXPERIMENTAL SPOTLIGHT

Examples of 35 and 30 seconds acquisitions

CSG_SSAR1_QLK_D_0101_S2E_014_VV_RA_FM_20200808T090757_00F1_22.81201S_043.28321W_23.01177S_043.16262W.QL

CSG_SSAR1_QLK_D_0101_S2E_020_VH_RD_FM_20200808T065800_00B2_33.80689S_151.12508E_33.98317S_151.25673E.QL

CSG_SSAR1_QLK_D_0101_S2E_042_VV_RA_FM_20200812T135049_00B0_34.85572N_118.14790W_34.72578N_118.04038W.QL

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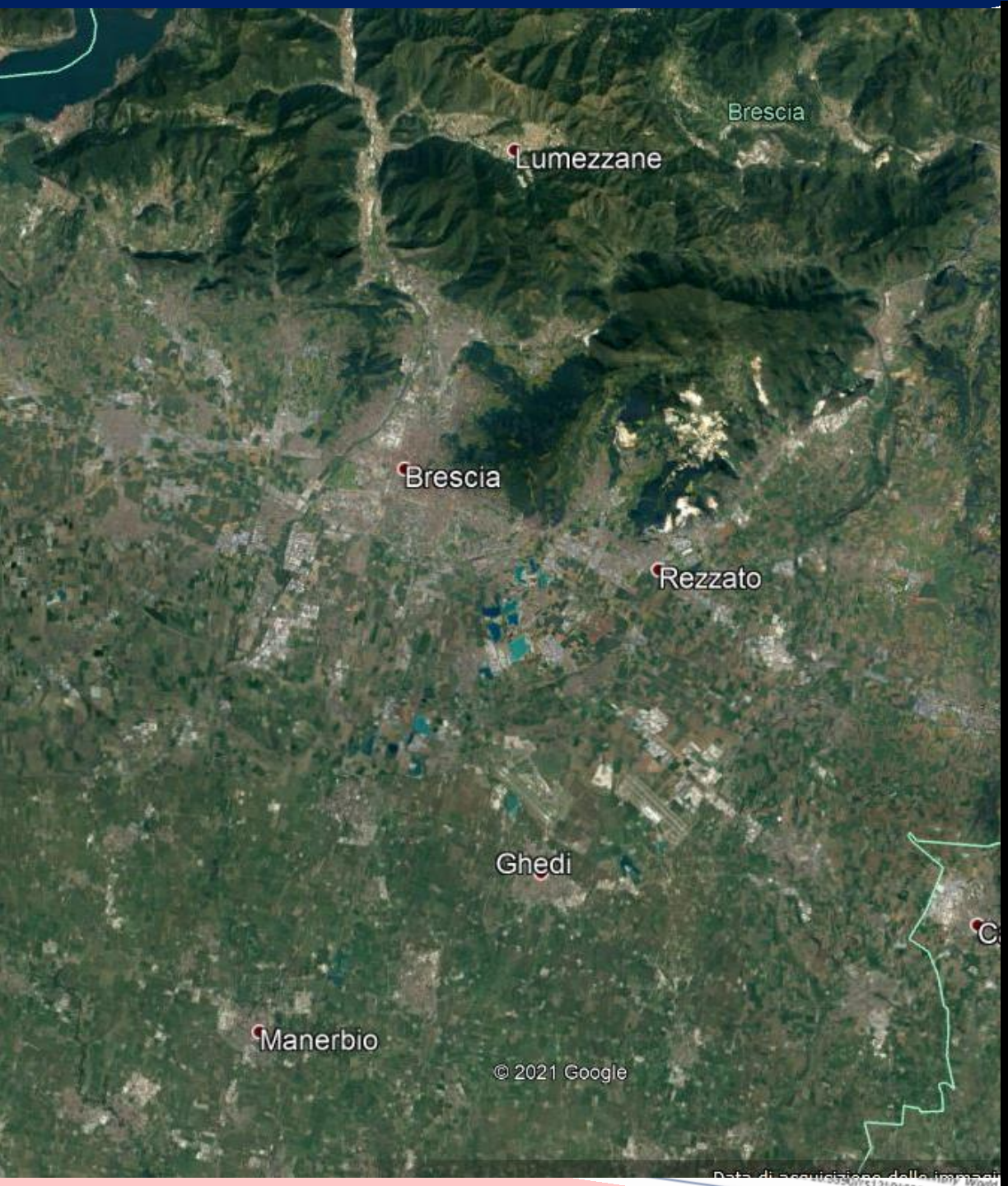
Brescia
Lumezzane
Brescia
Rezzato
Ghedi
Manerbio
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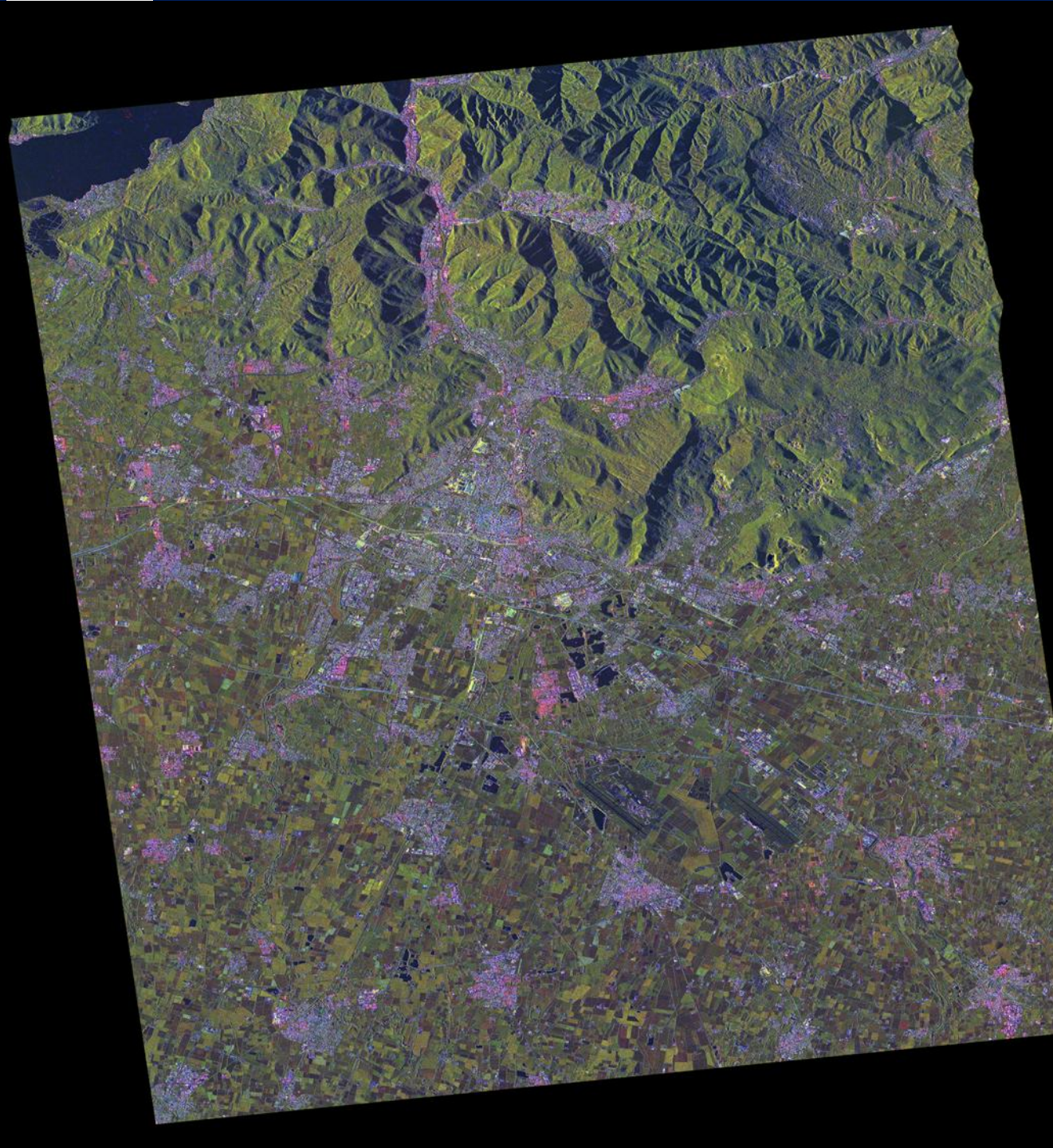
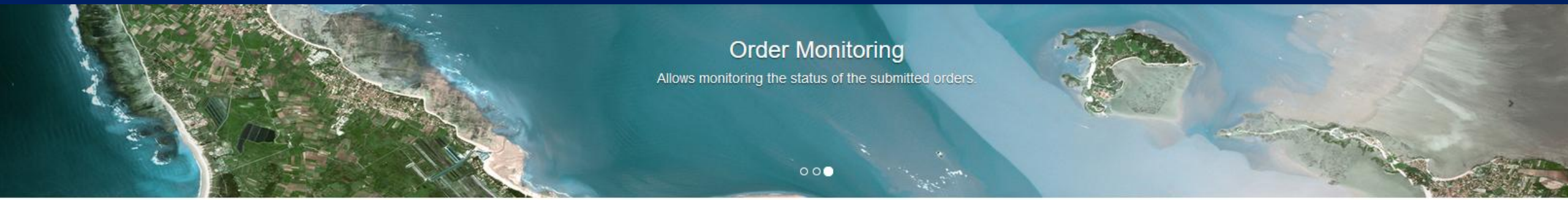
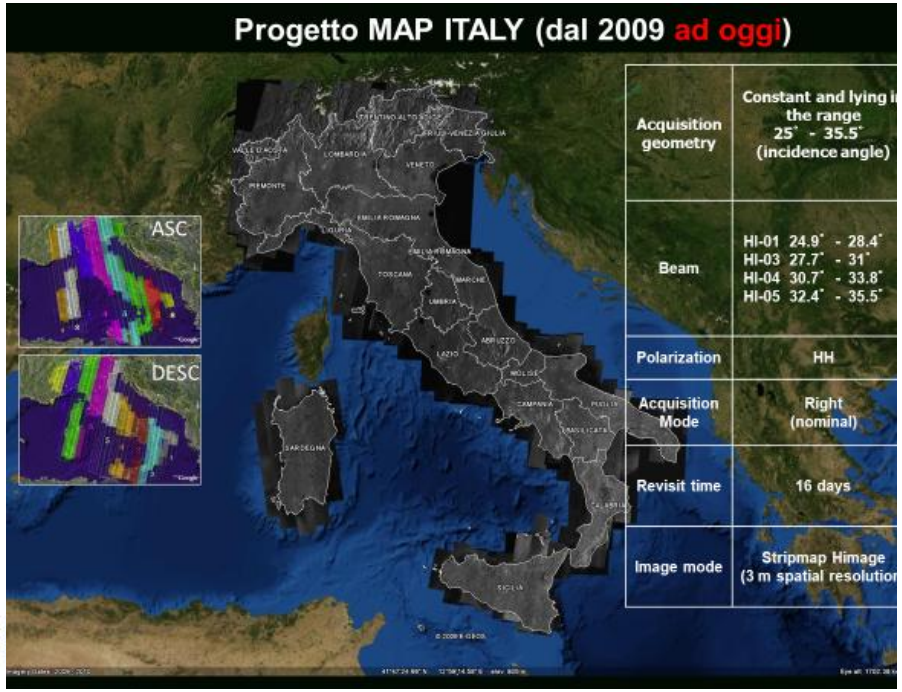




Catalogue Services Order Monitoring

https://portal.cosmo-skymed.it/CDMFE/home



Designed by Telespazio S.p.A.
Graphic optimized for Mozilla 1920x1080

OPEN CALL 'SCI' E 'PMI'

"OPEN CALL"

COSMO-SkyMed Constellation
First and Second Generation
Open Call for Science

Italian Space Agency

I progetti selezionati vengono finanziati per un Massimo di 2 anni mediante un Massimo di 100 Prodotti COSMO-SkyMed GRATIS
- 80 Prodotti di archivio
- 20 Prodotti di nuova acquisizione

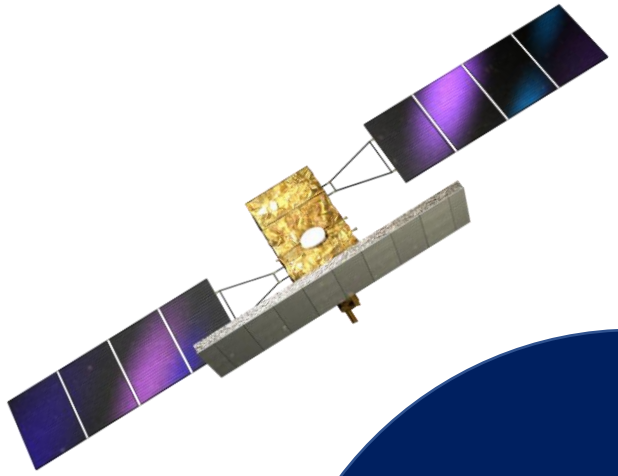
January, 2021

Open Call
per
l'industria nazionale
Utilizzo dei dati COSMO-SkyMed
prima e seconda generazione

Agenzia Spaziale Italiana

I progetti selezionati vengono finanziati per un Massimo di 2 anni mediante un Massimo di 100 free of charge COSMO-SkyMed scenes from both archive products and tasking product

Gennaio 2021



EARTH
TECHNOLOGY EXPO

Grazie per l'attenzione!

maria.virelli@asi.it

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