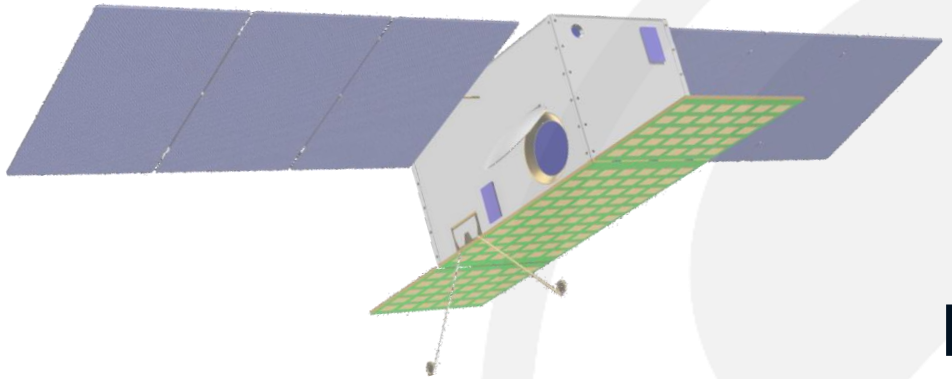
ASI CubeSat Workshop



RaCERS

Radar **C**luster for **E**arth **R**emote **S**ensing

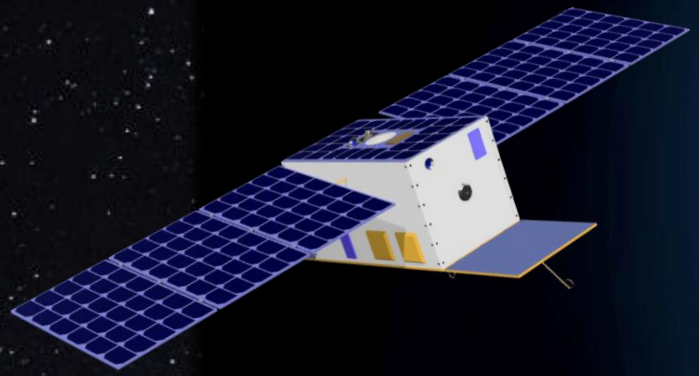
July 2024

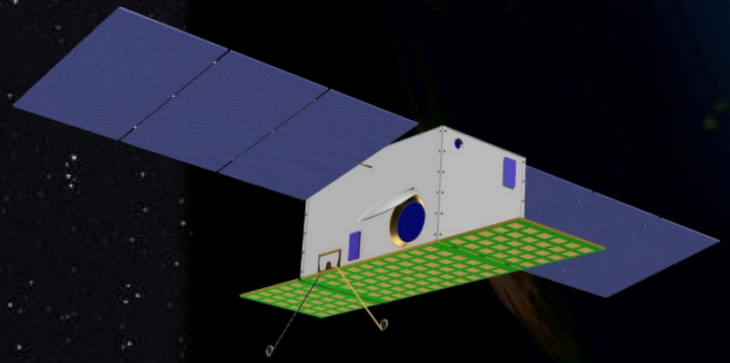
Tyvak**: Andrea Bergamasco**, Alessandro Colombo, Giorgio Taiano

Introduction

RaCERS

Radar **C**luster for **E**arth **R**emote **S**ensing





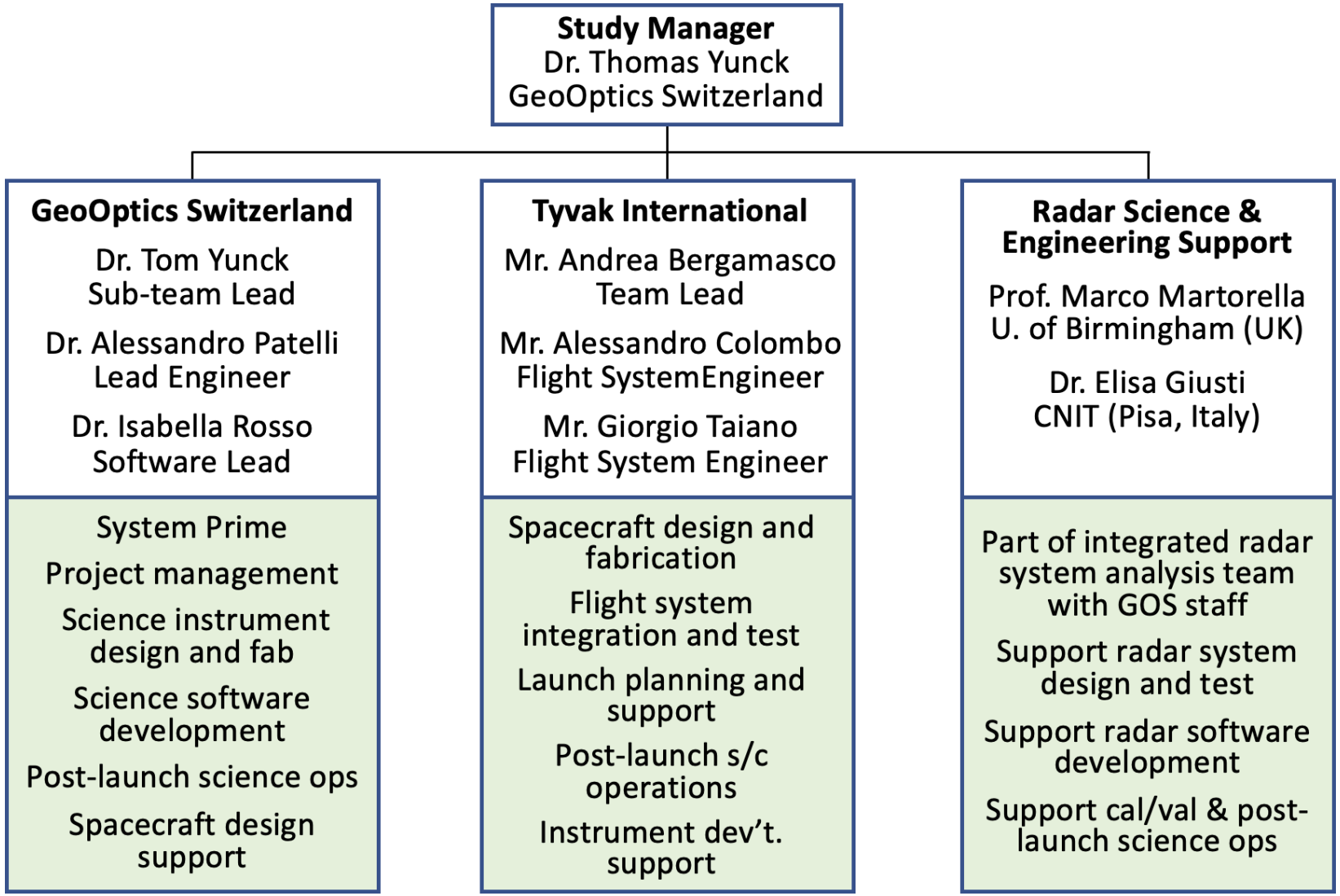
GeoOptics Switzerland SA

Tyvak International S.r.l., Torino

The University of Birmingham, UK

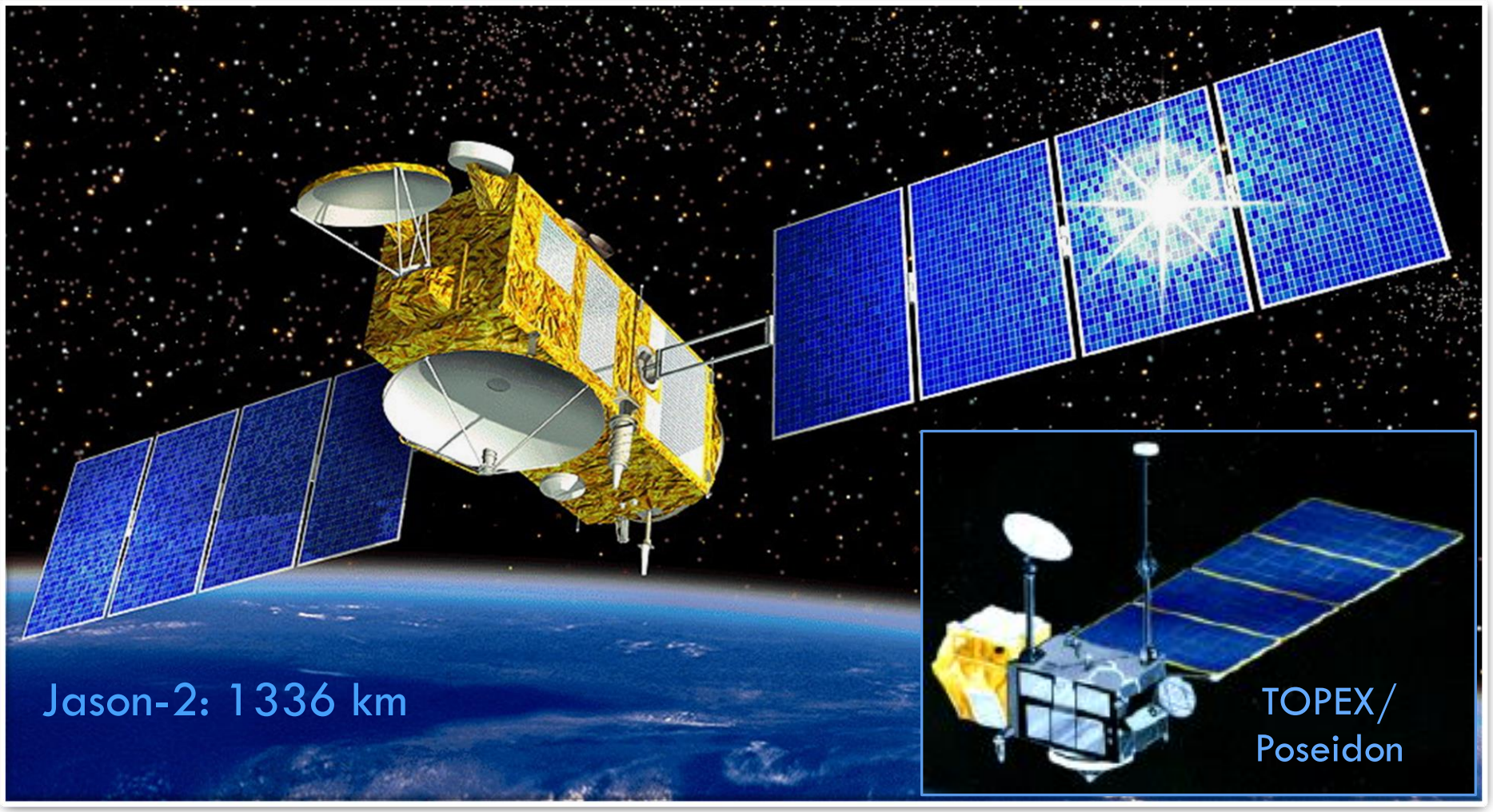
National Interuniversity Consortium for Telecommunications, Pisa

RaCERS Study Team



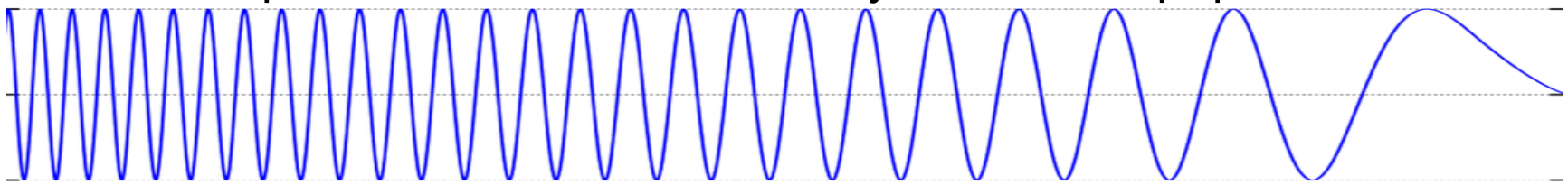
The Challenge

Jason-class altimetry in 16U



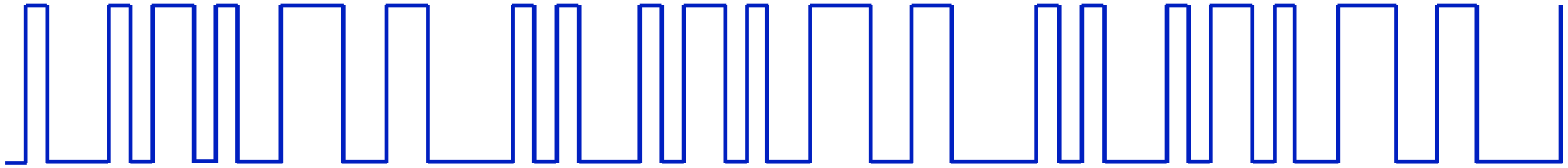
RaCERS Signal Structure

Space radars have traditionally used a “chirp” pulse:



Linear frequency sweep over the pulse width

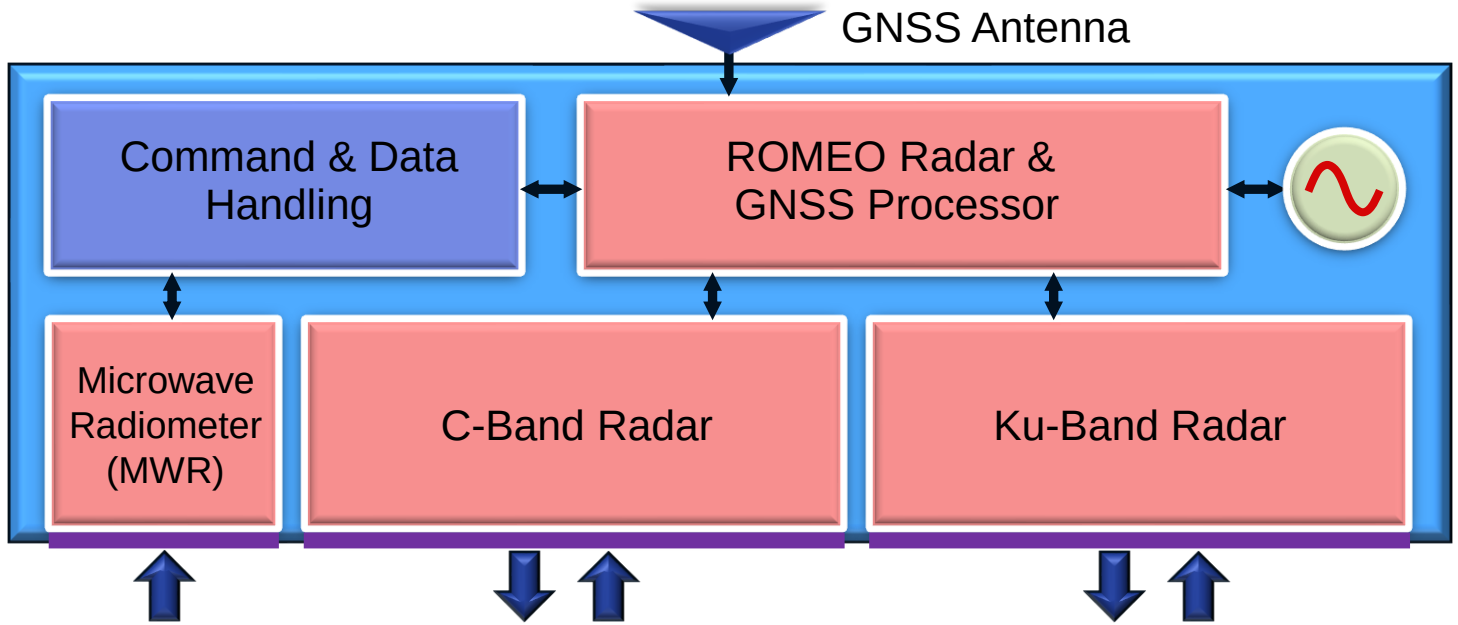
RaCERS will use a pseudo-noise coded pulse:

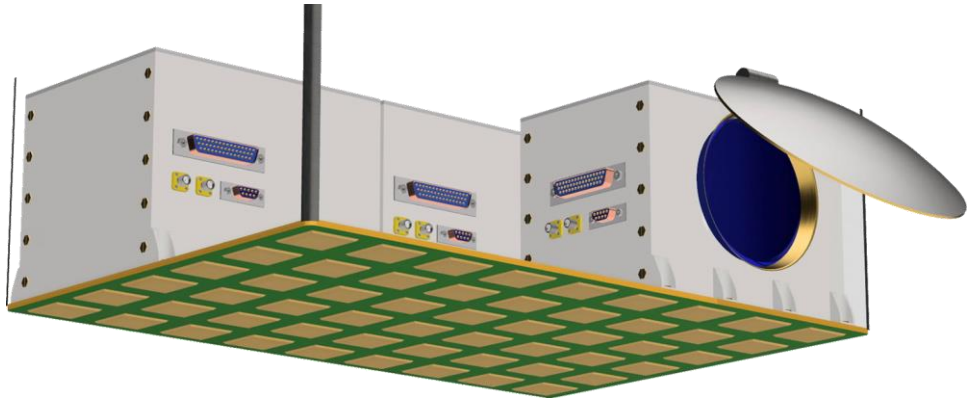


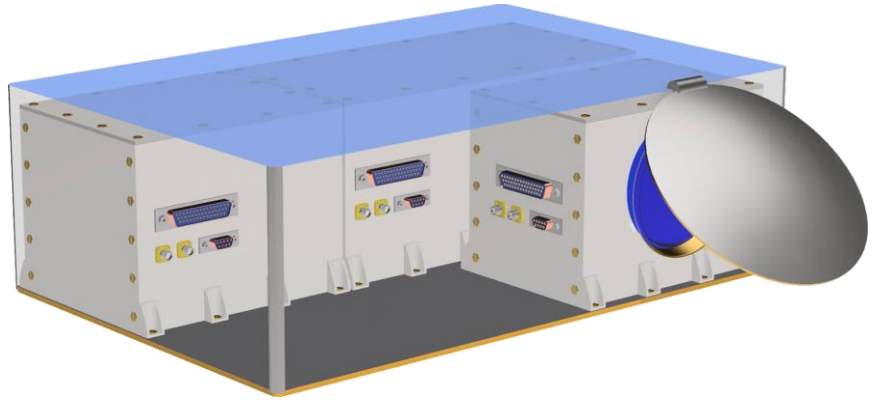
Square-wave modulation up to 300 Mbps

- Ability to distinguish multiple signals
- Eliminate off-nadir range ambiguity
- Flexible pulsing schemes & processing
- Compatible with current processors

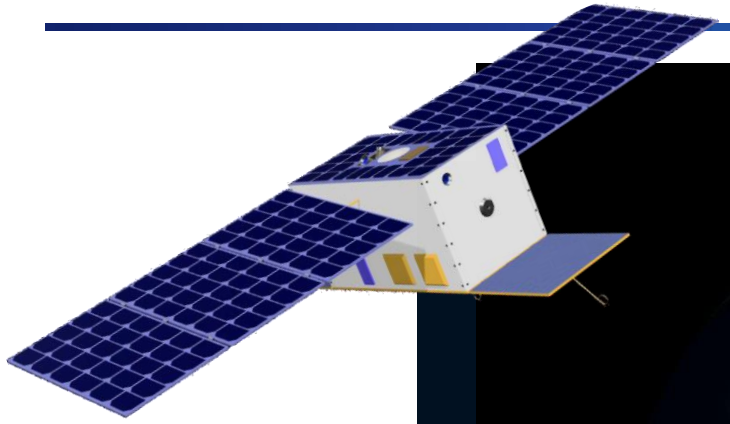
RaCERS Science Package







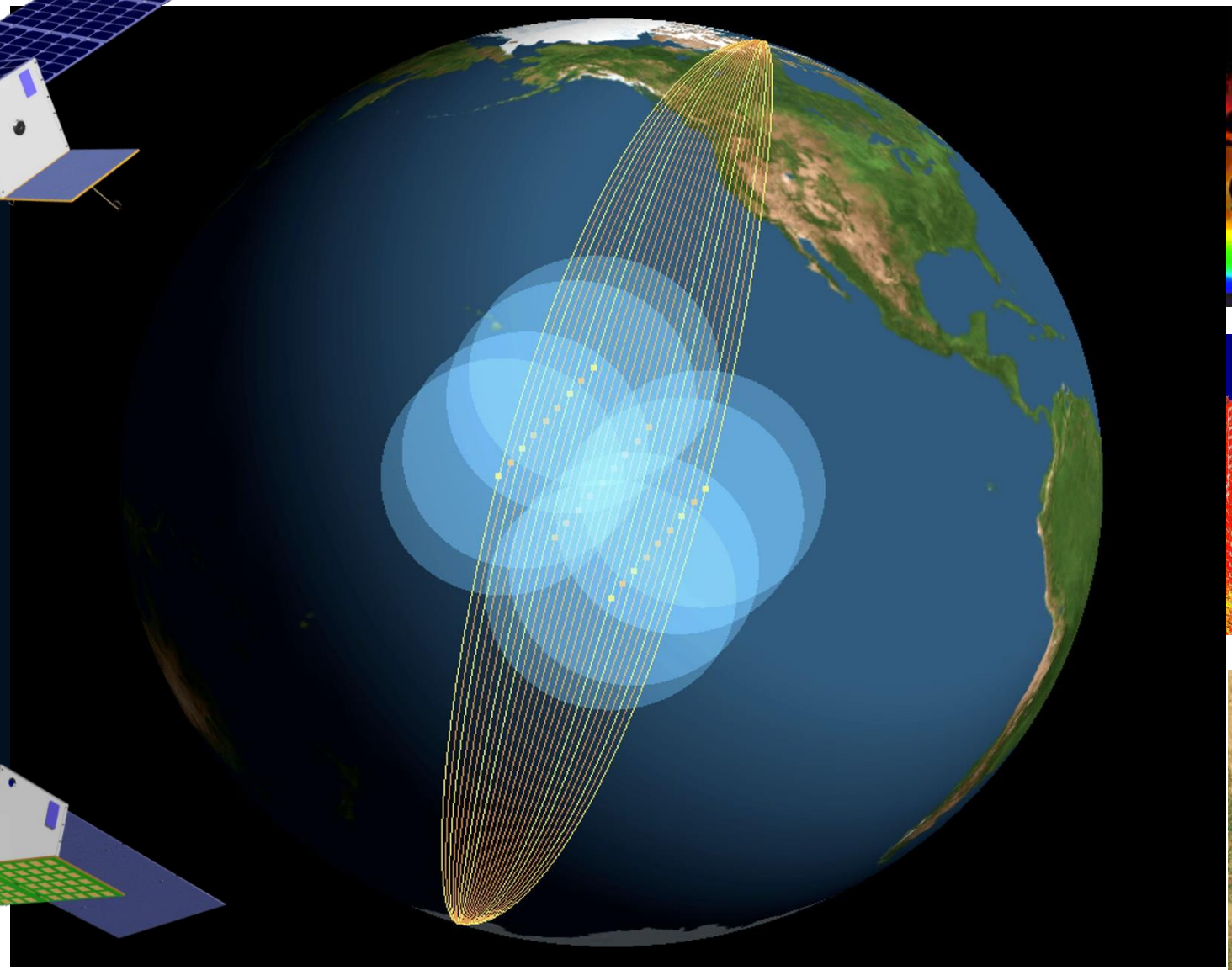
RaCERS : Swarm of 8 Radar Cubesats

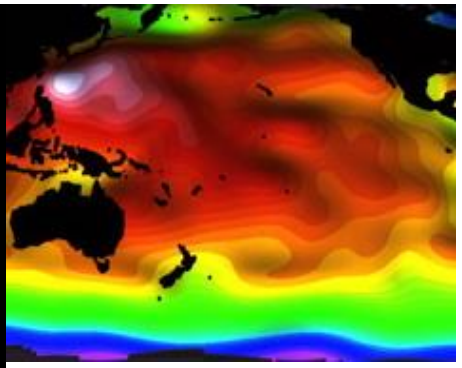


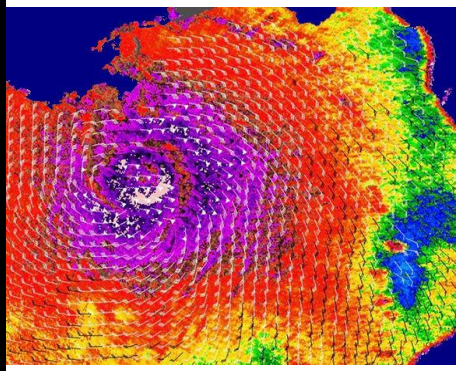
Altimetry

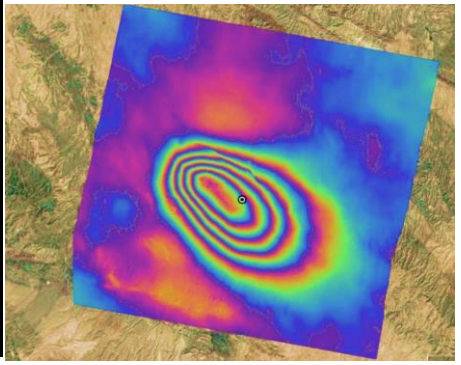
Scatterometry

SAR/InSAR



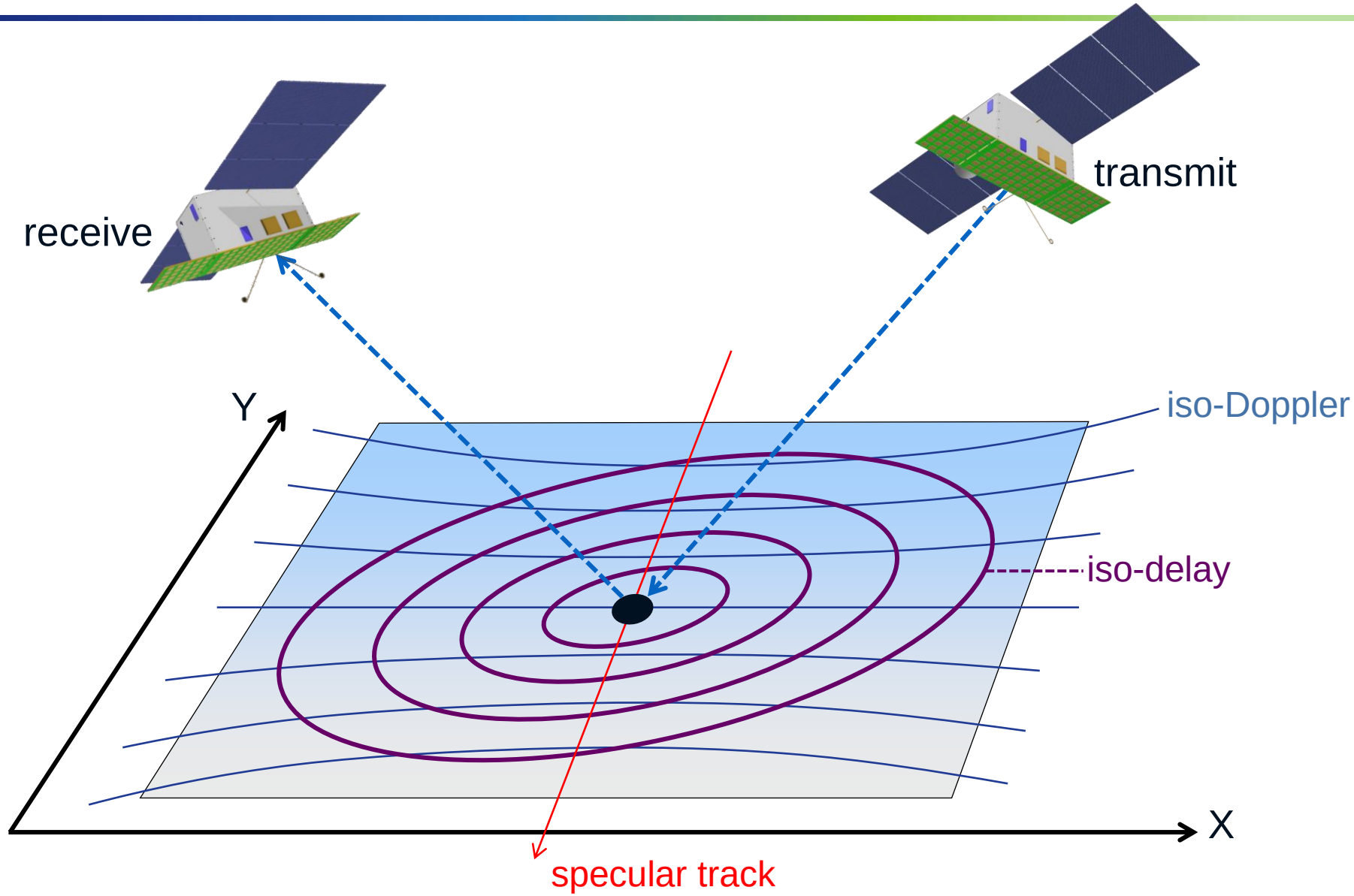




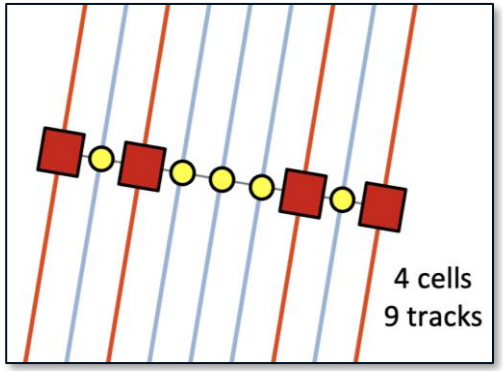


Measurements

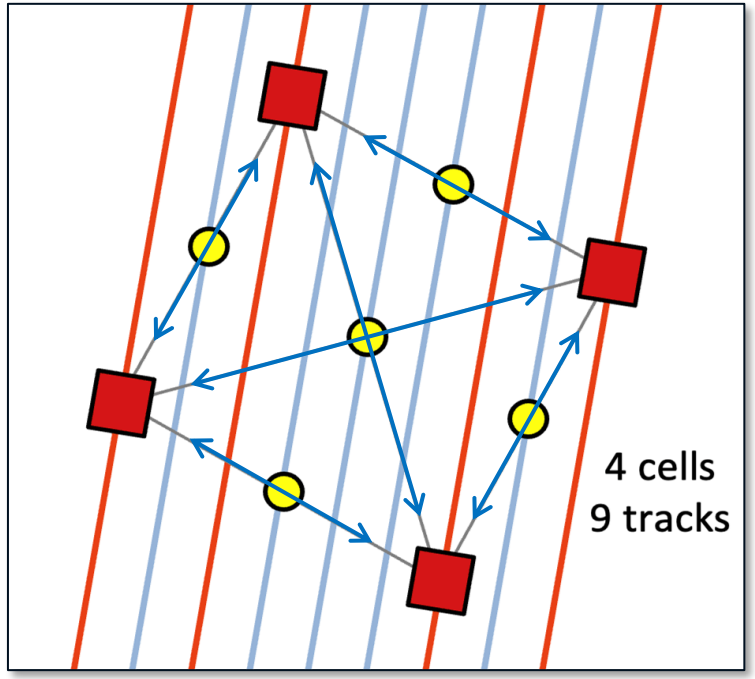
2-Satellite Altimetry/Scatterometry



4-Satellite Wind Measurements



In-line

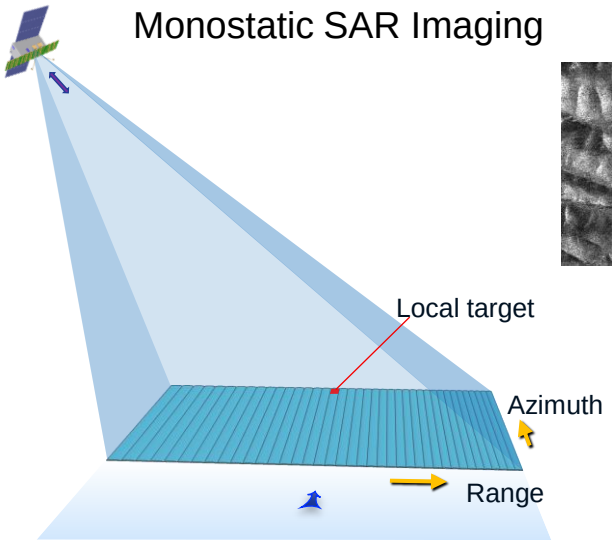


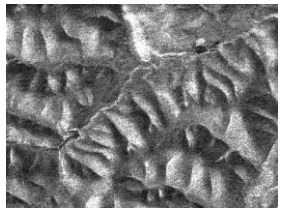
Projected Performance	
H-Resolution	1 km
Swath Width	60 km
Amplitude Accuracy	1%
Wind Speed Accuracy	<2 m/s
Wind Direction Accuracy	<20%
Geolocation Error	1 m

2D array gives precise wind direction without affecting altimetry.
4 directions, 2 orthogonal axes at center point.

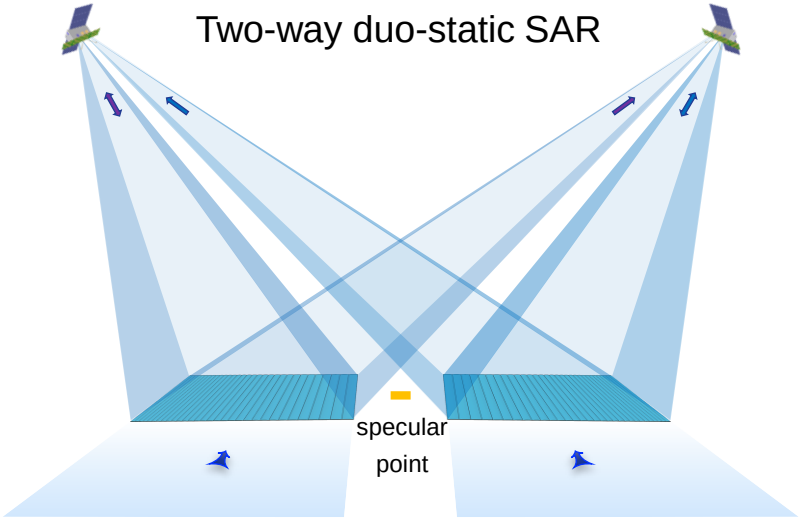
2-Satellite SAR / InSAR

Monostatic SAR Imaging

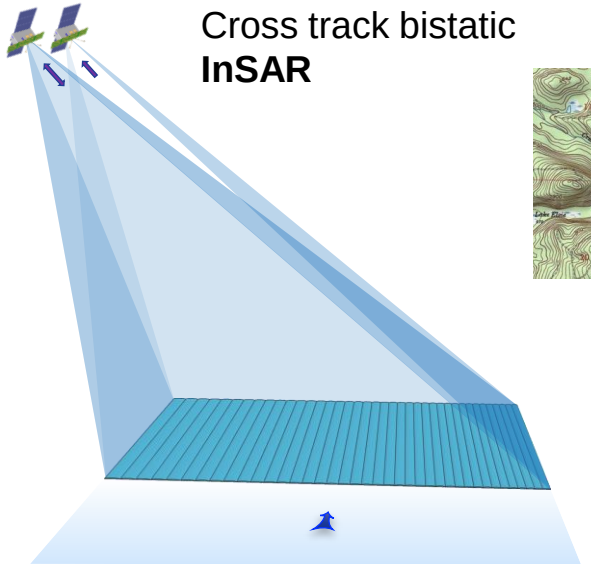


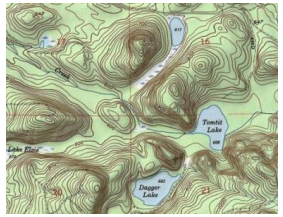


Two-way duo-static SAR



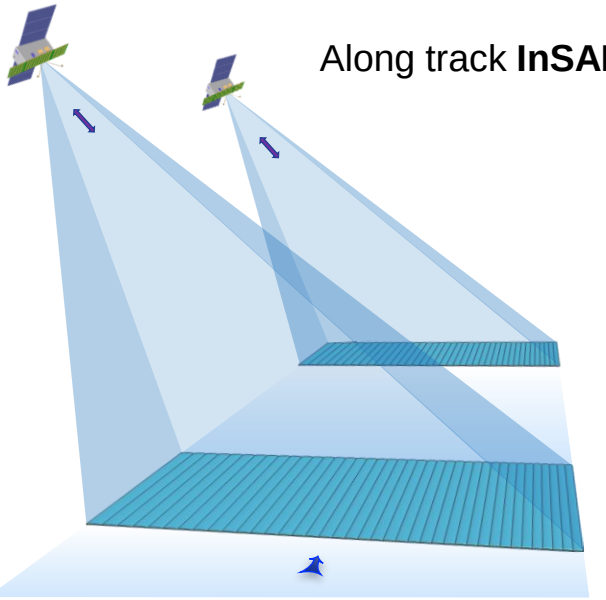
Cross track bistatic **InSAR**

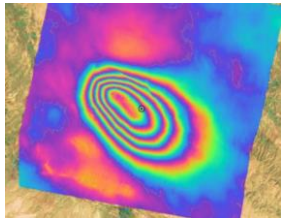




Topography

Along track **InSAR**

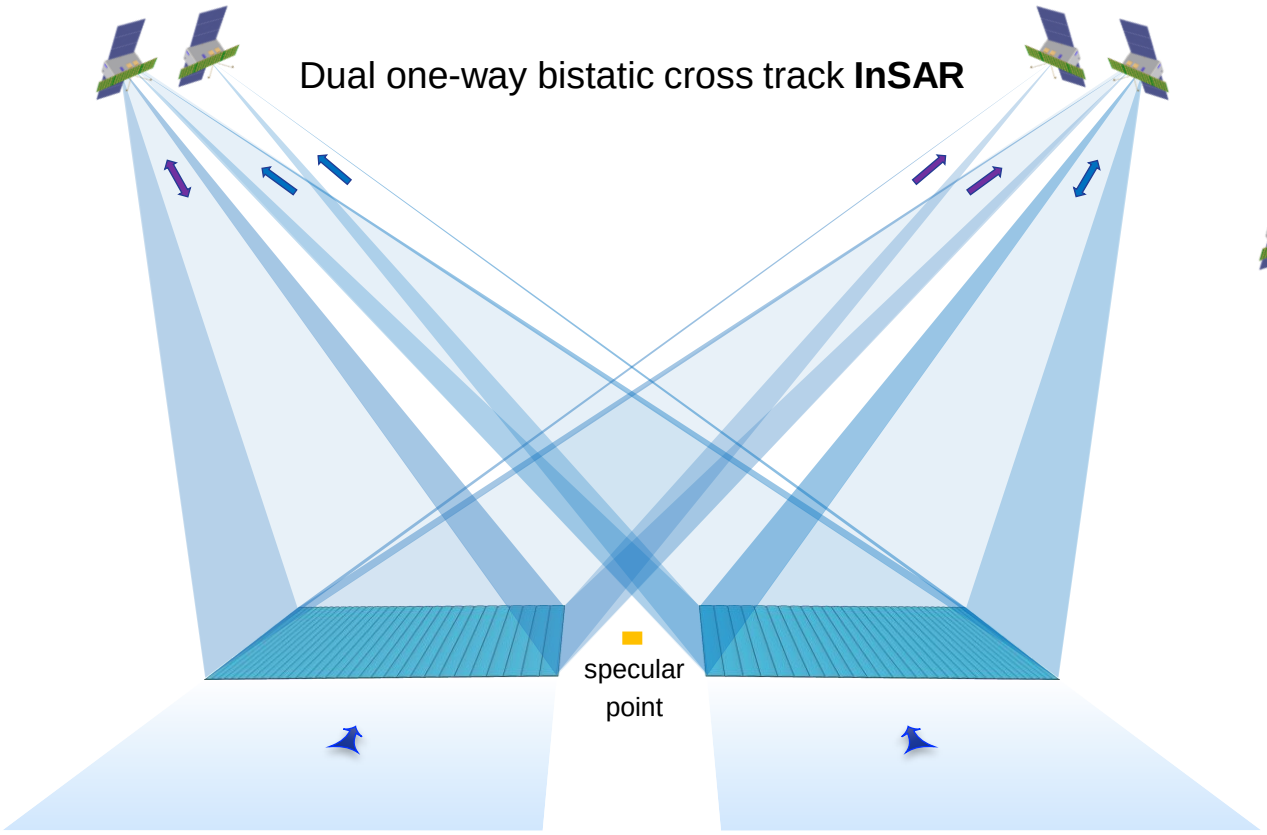


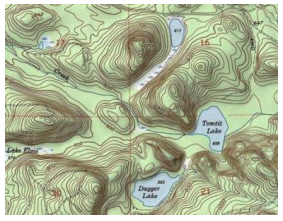


Surface change

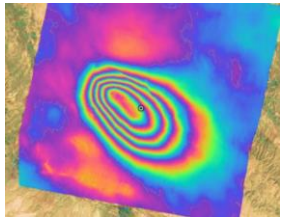
4-Satellite SAR / InSAR

Dual one-way bistatic cross track **InSAR**



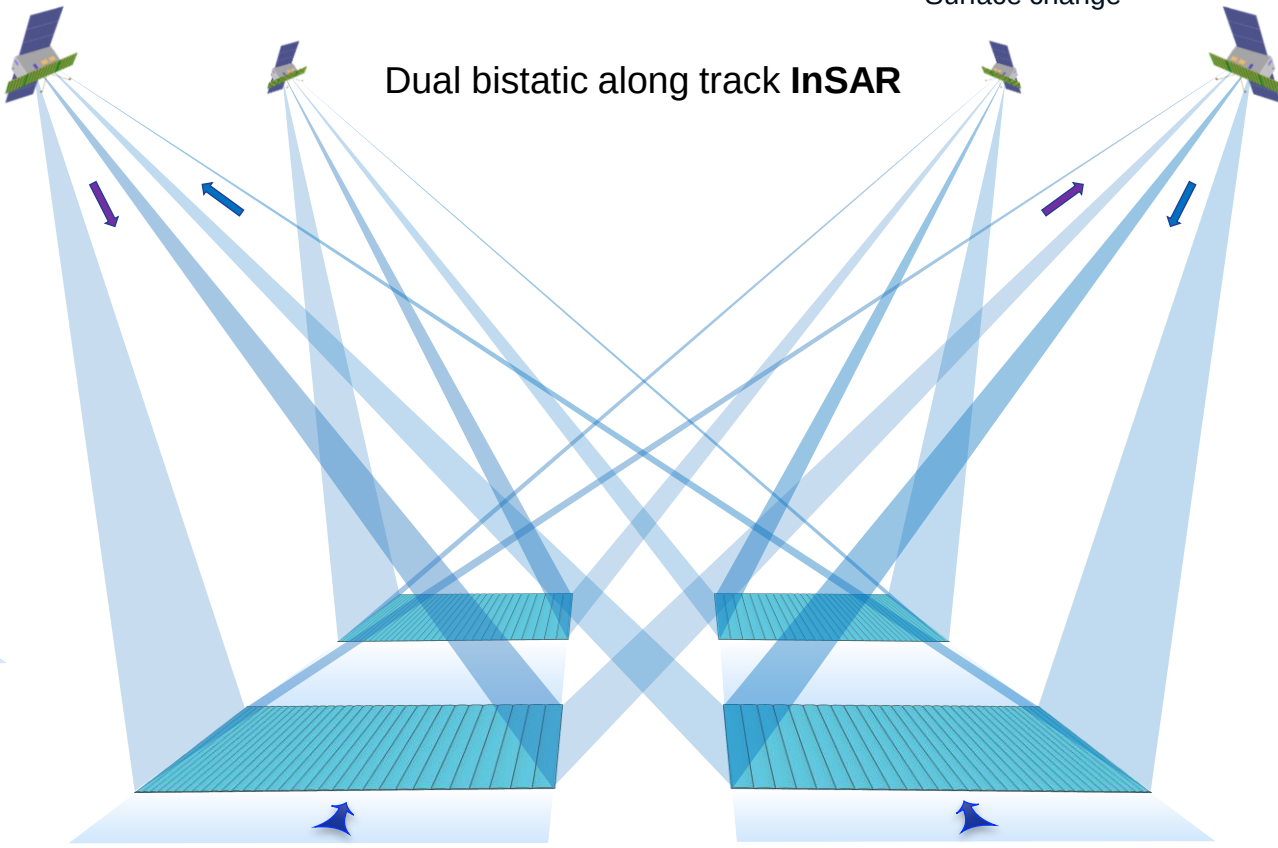


Topography



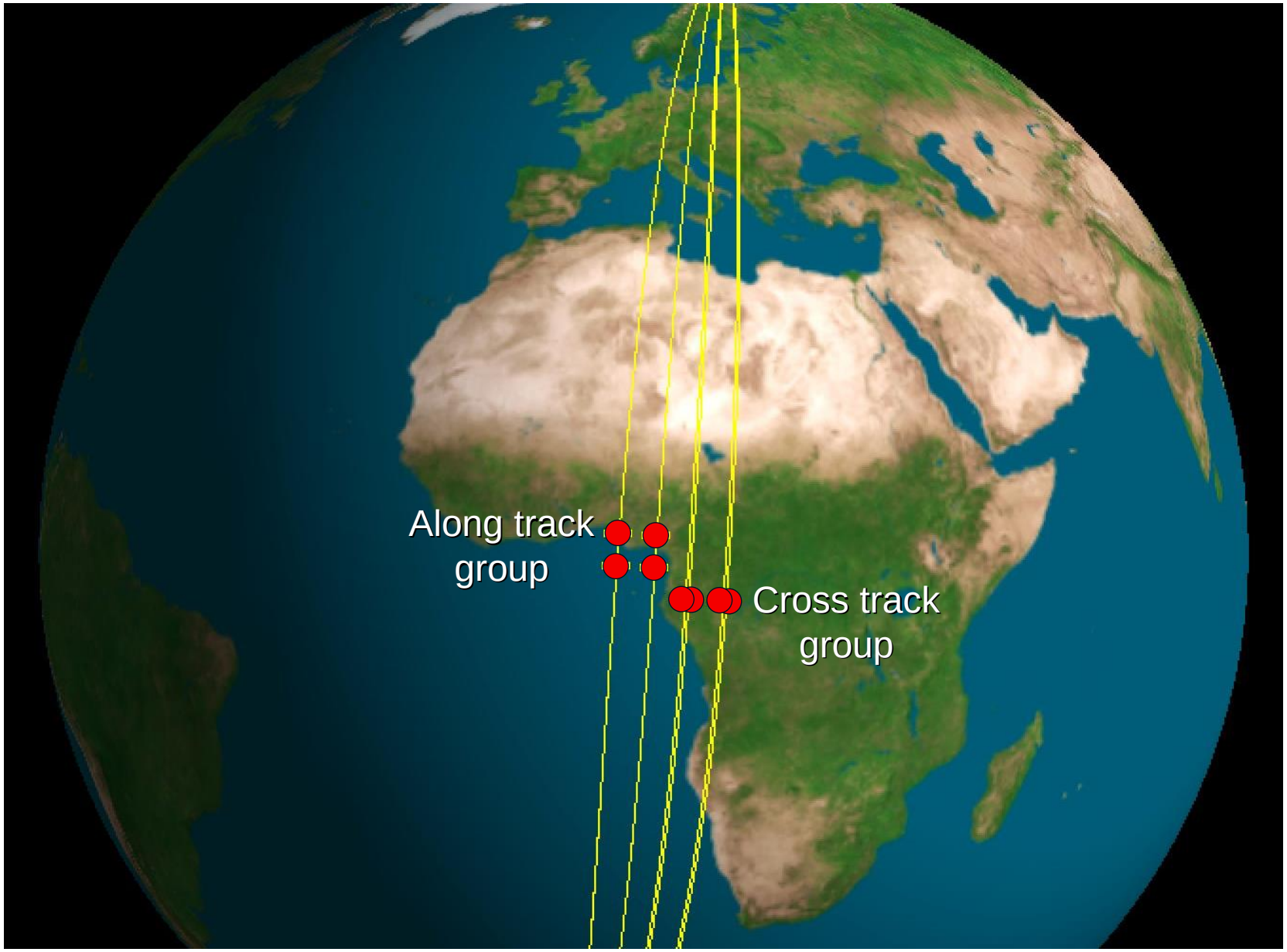
Surface change

Dual bistatic along track **InSAR**

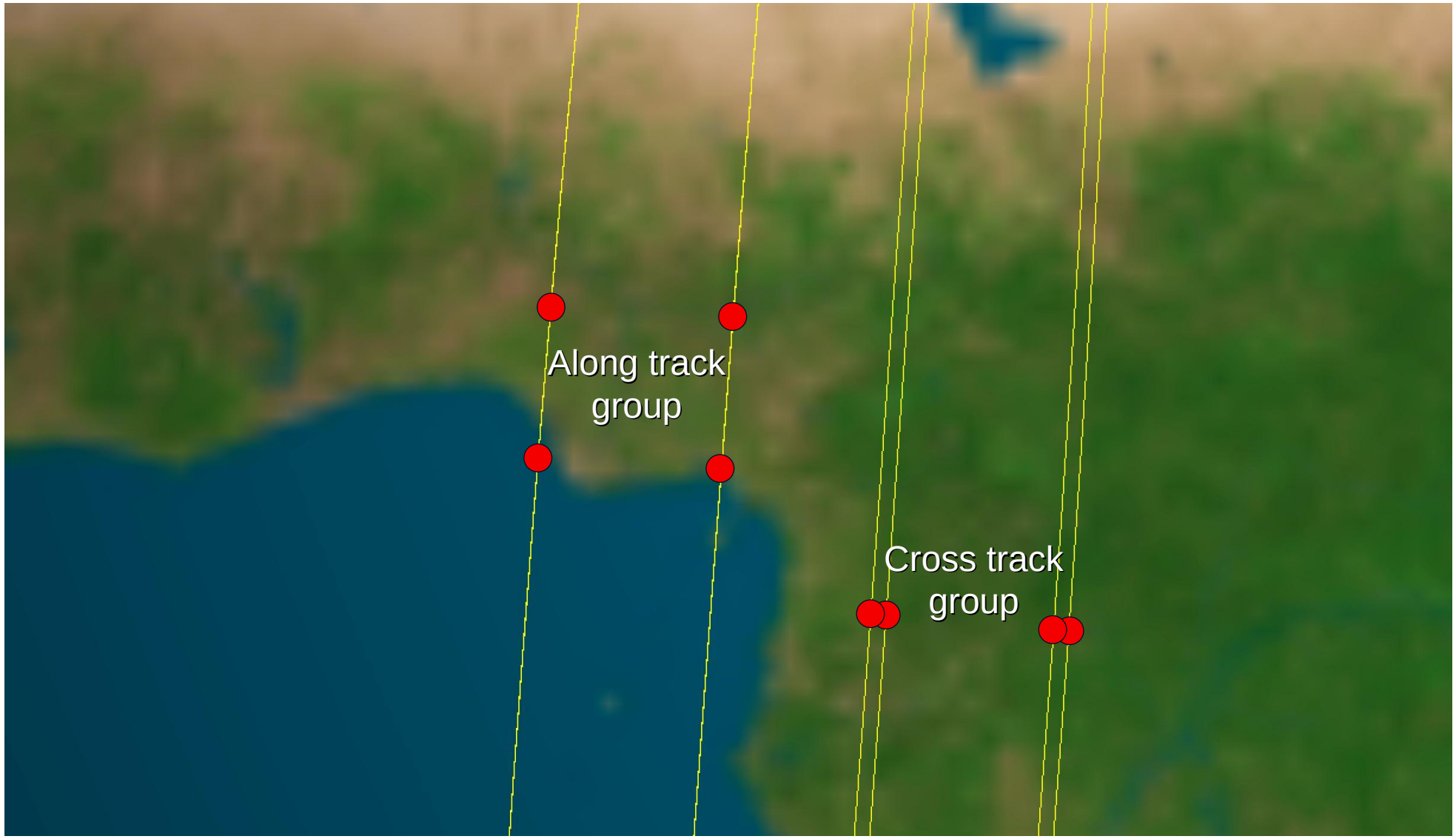


Constellation

8-Satellite Constellation

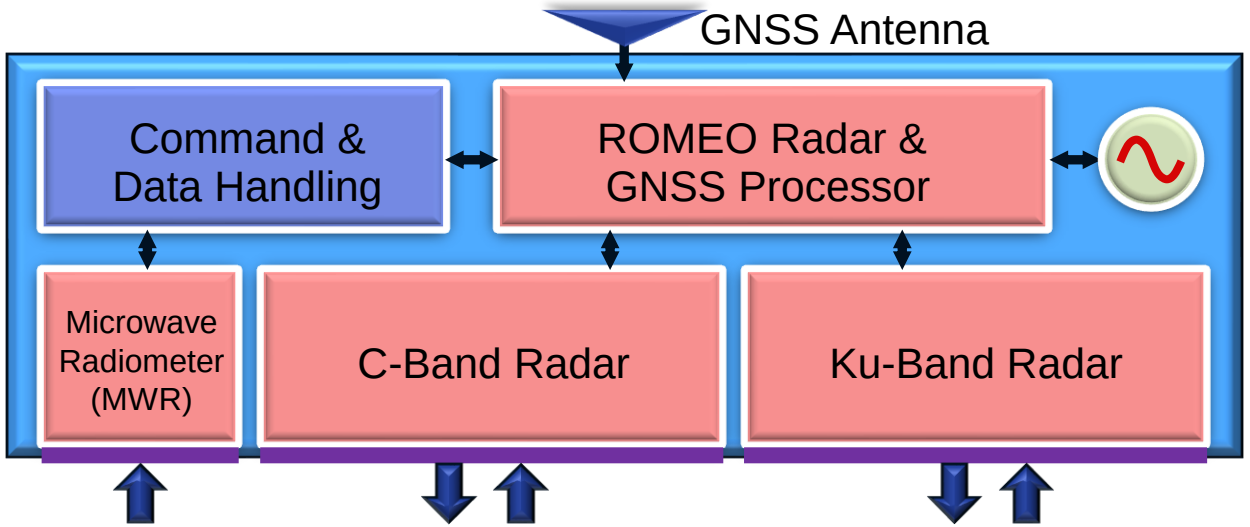


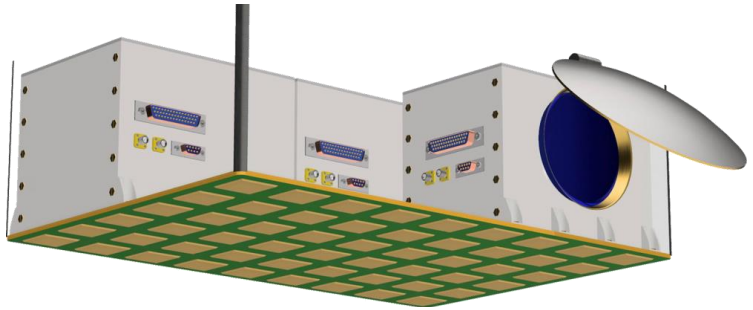
8-Satellite Constellation (Detail)

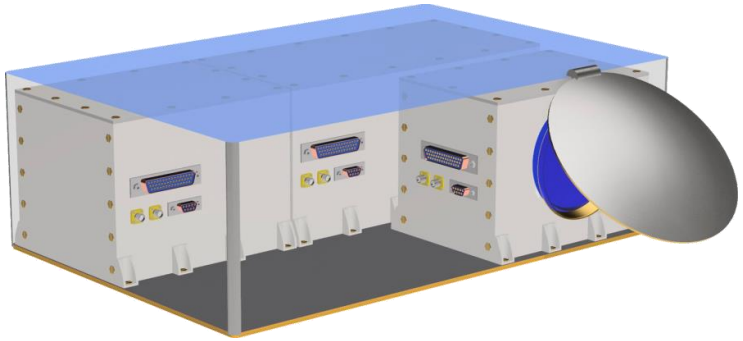


Payload

RaCERS Science Package





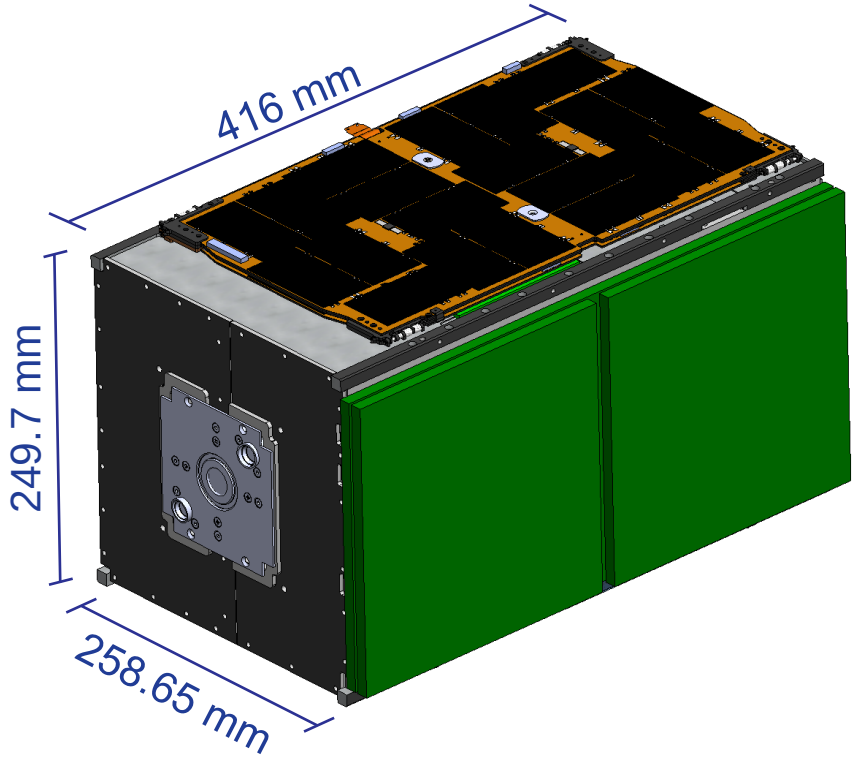


PAYLOADs:

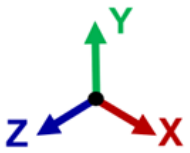
- Radiometer 9.5x9x12 cm
- COASTER 9.5x10x20 cm
- Romeo 9.5x10x12 cm
- PL Antenna 20x80x0.8 cm

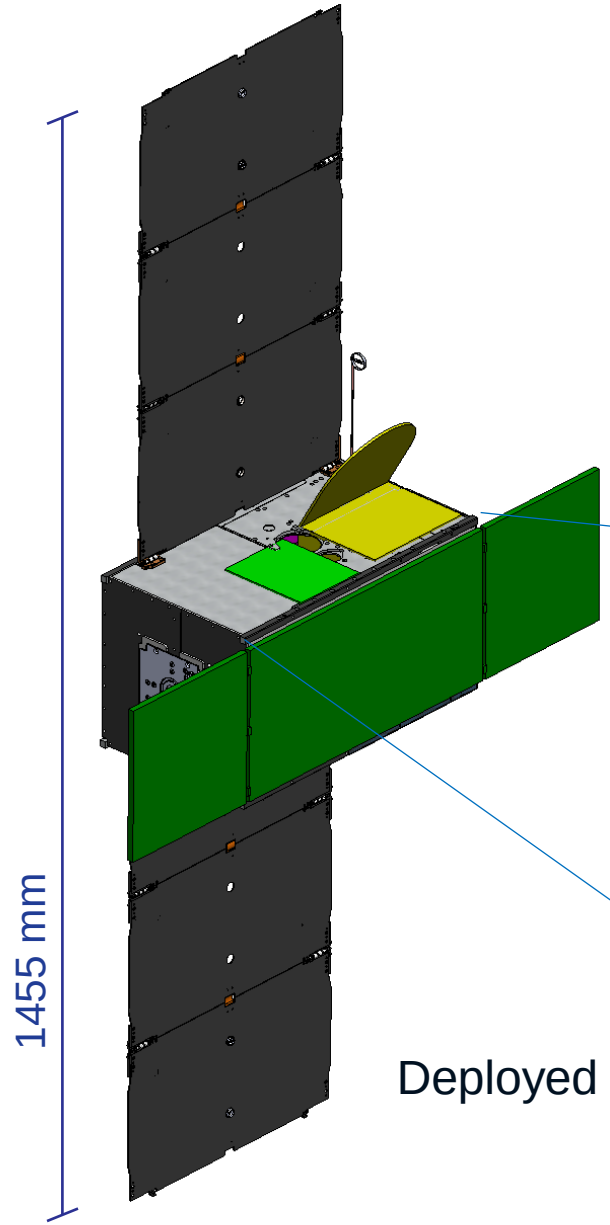
Spacecraft Design

Spacecraft Configuration



Stowed



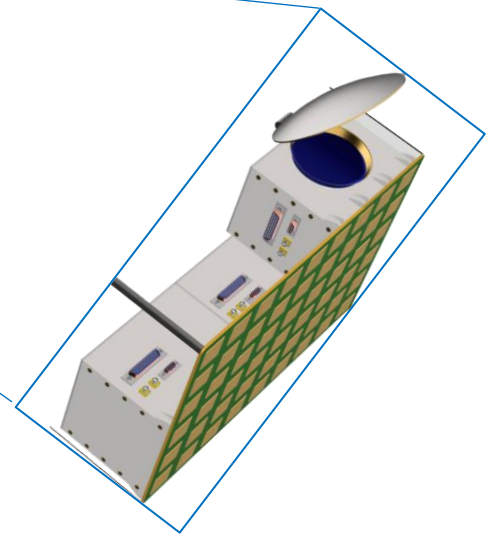


Deployed

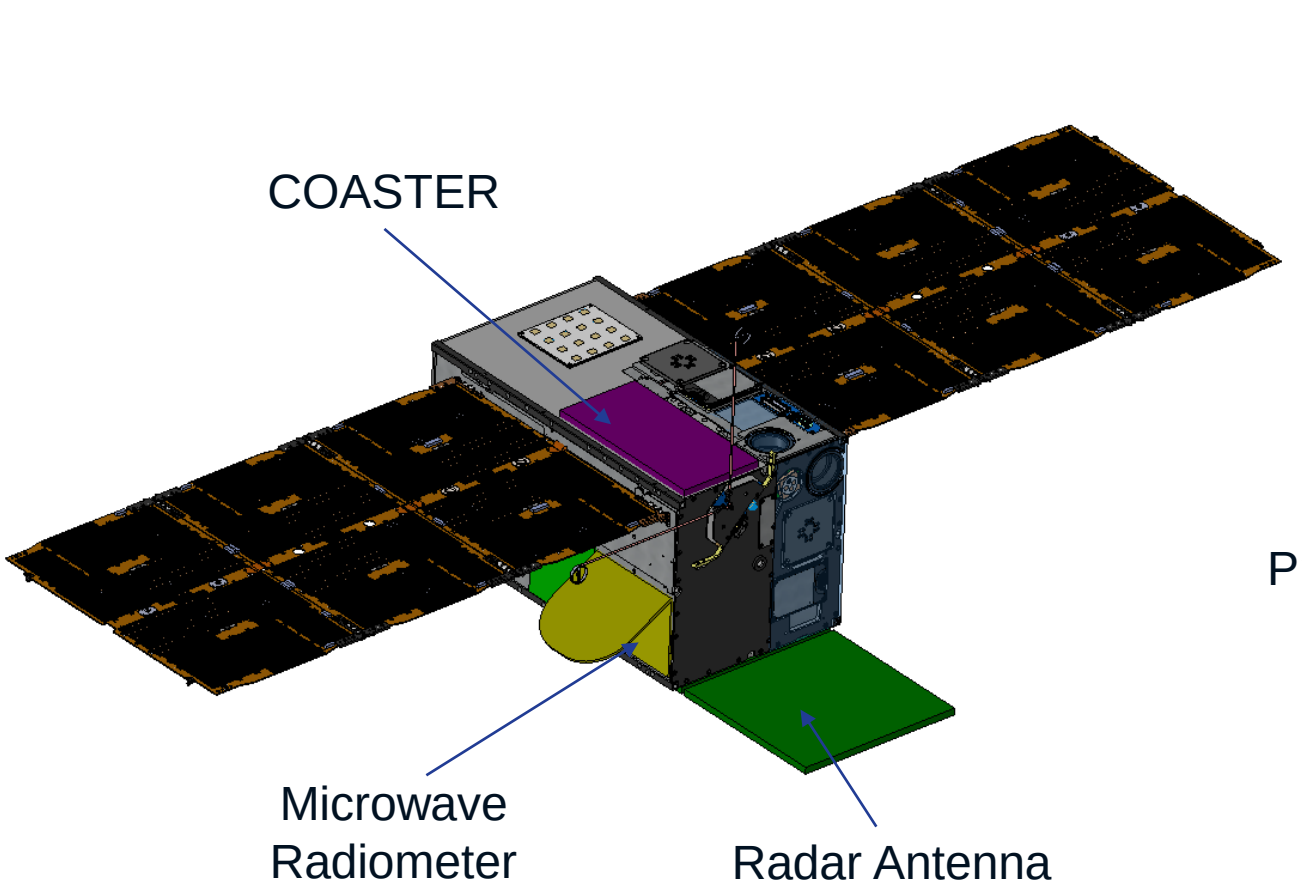
OVERAL CONFIG.:

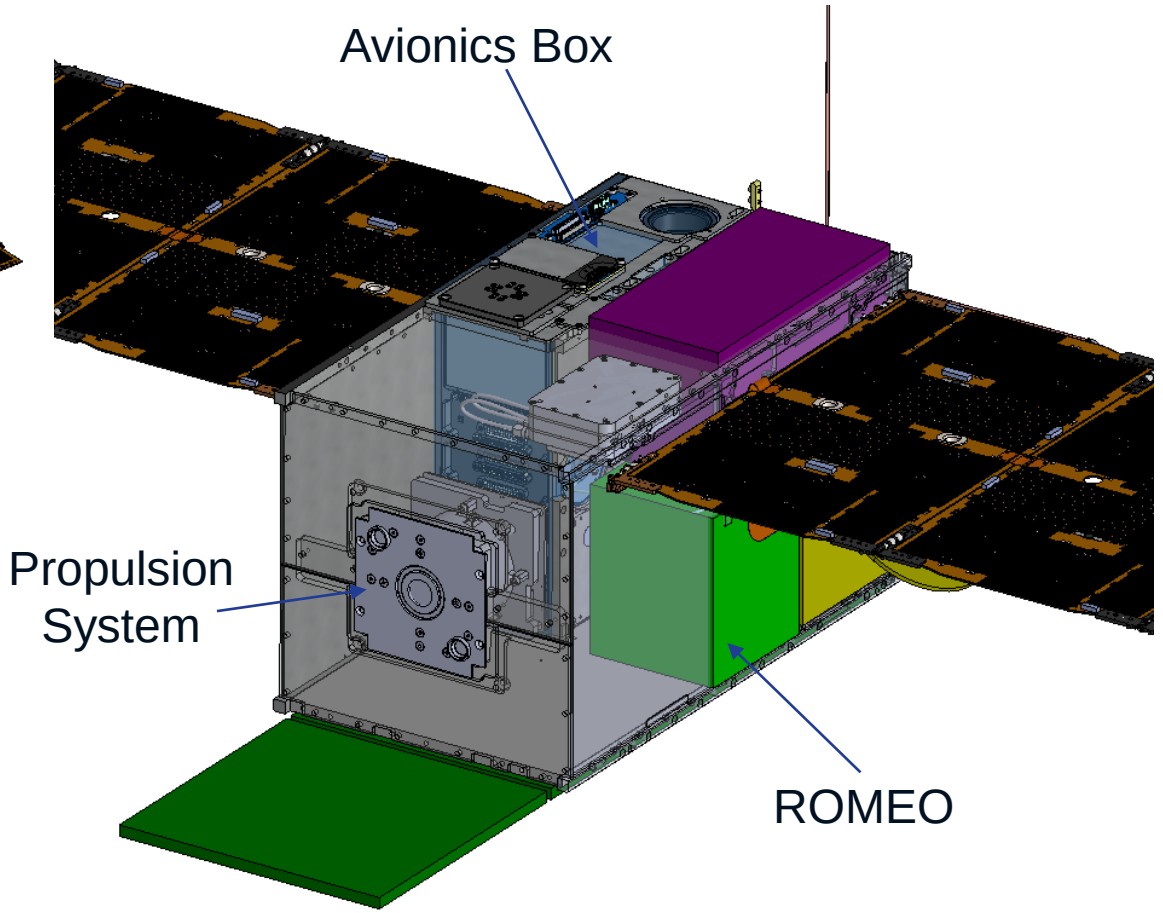
- 12UXL (16U) Satellite Platform
- 12U Deployer

Payload Layout



Spacecraft Configuration (Detail)



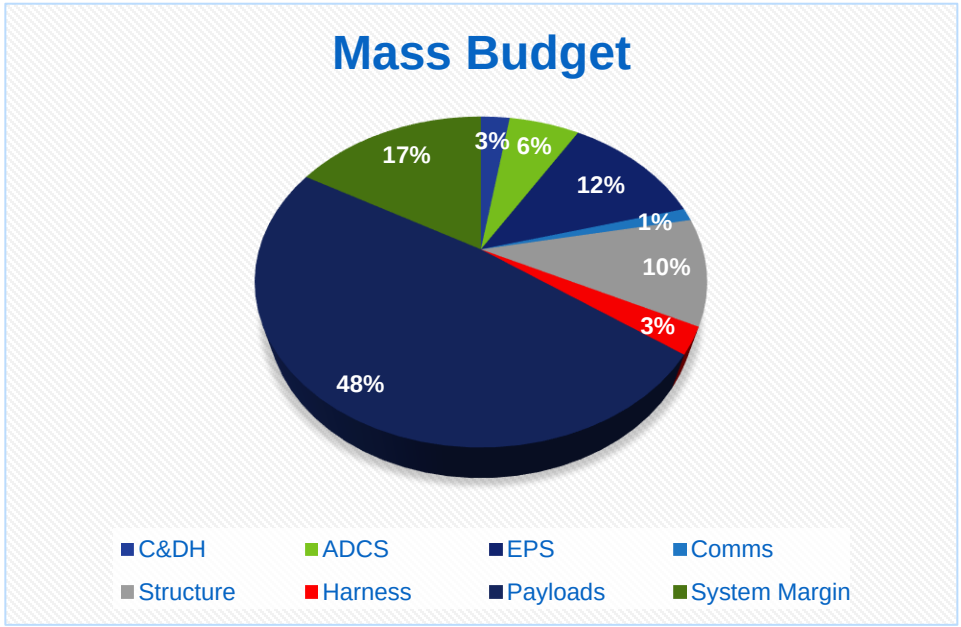


Mass Budget

Assumptions:

- All avionic modules margined at 5% at component level
- All payloads margined at 20% at component level
- Structure, internal brackets and payload interfaces estimations margined at 20% at component level

Subsystem	Mass (Kg)
C&DH	0.7
ADCS	1.8
EPS	3.6
Comms	0.4
Structure	3.1
Harness	0.8
Bus Subtotal	10.5
Payloads & Prop	14.5
Spacecraft Subtotal	25
System Margin	20%
Spacecraft Total	**30**
Mass Reserve	**6.00**
Specification Mass	36

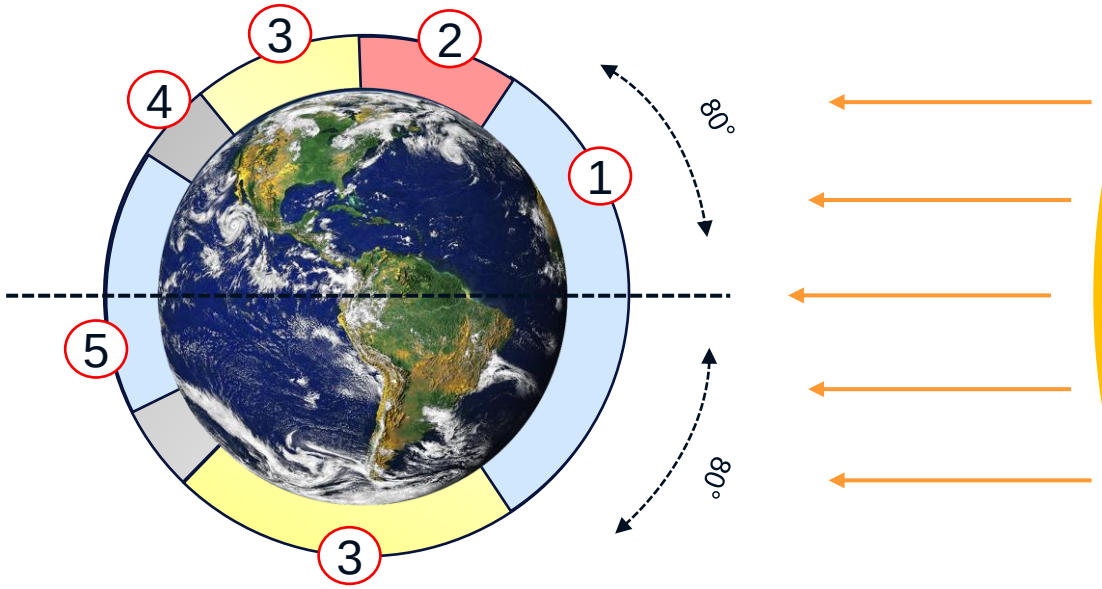


Power Budget

Assumptions:

- Payload operations are performed avoiding Poles surroundings to maximize power generation
- EPS efficiency + 20% of system margin considered in Power consumption estimations
- Beta angle of 30 deg (worst case for a 10:30 LTAN SSO)

MODE	ATTITUDE	ACTIVITY AIM
1	FIXED LVLH (Daylight)	Payload OPS
2	GROUND TARGET	Comms
3	SUN POINT (SL)	Batteries Recharge
4	SUN POINT (Eclipse)	Idle
5	FIXED LVLH (Eclipse)	Payload OPS



Power Profile:

- Payload ALT/SCAT OPS mode achievable DC **60% (~57 mins per orbit)**

OAP CONS	OAP GEN
50.9	52.6

- Payload SAR OPS mode achievable DC **23% (~22 mins per orbit)**

OAP CONS	OAP GEN
62.7	64.8

Project Status

Current status and next steps

Roadmap to full constellation deployment in orbit

- **I. Feasibility study COMPLETED**
- **II. Phase B/C design consolidation**
- **III. 2-Satellite Demo**
- **IV. 8-Satellite Constellation**

Flawless Execution Sustains Growth

Contacts: andrea.bergamasco@tyvak.eu