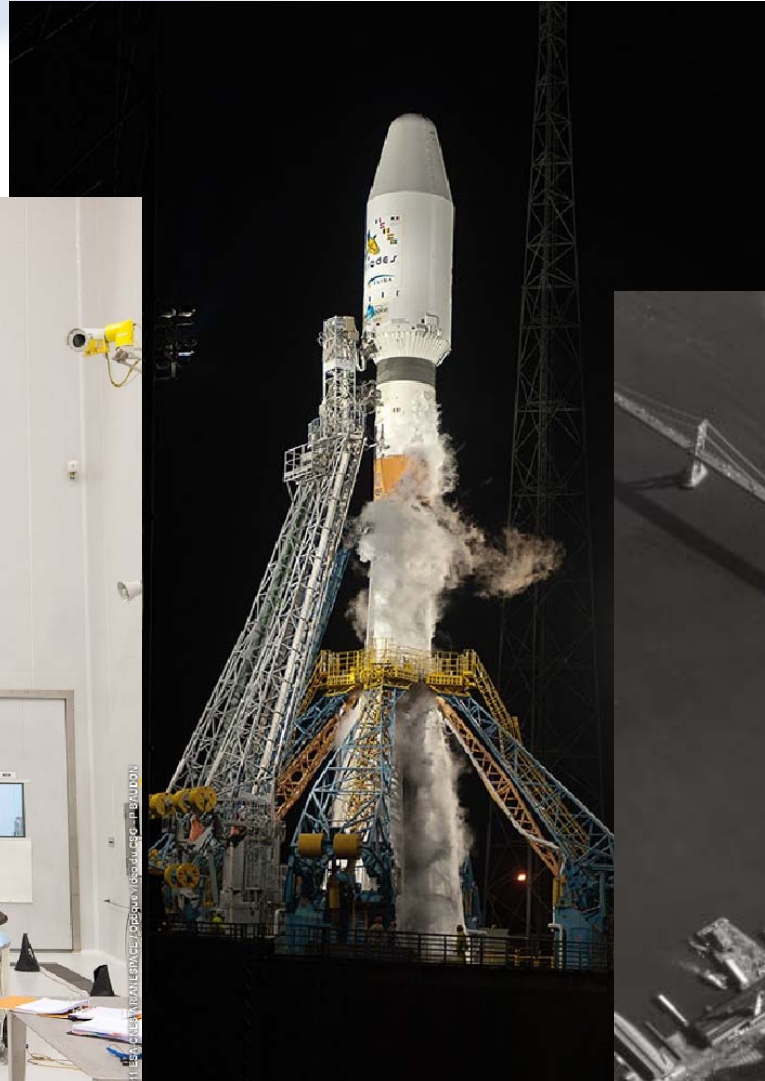




The Pléiades System



Pléiades

Main Mission Features

■ Image characteristics (at nadir)

- ◆ 0.7 m Pan resolution
- ◆ 2.8 m XS bands (blue, green, red, near IR)
- ◆ 20 km swath

■ Orbit

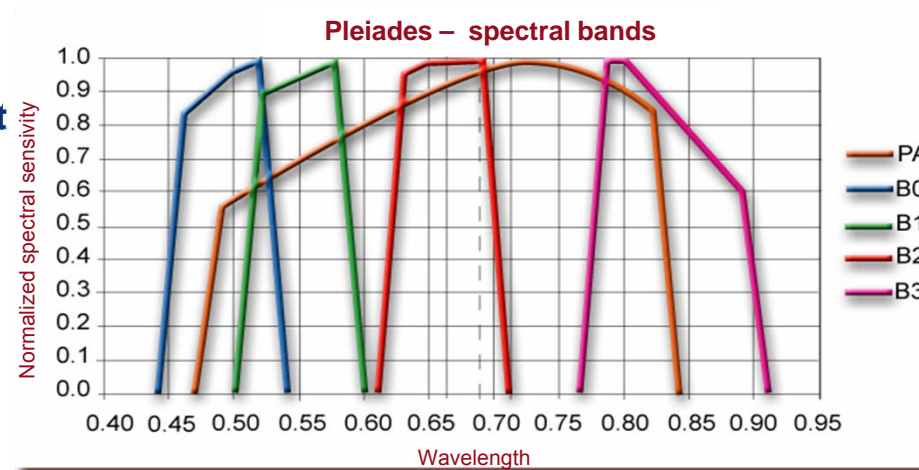
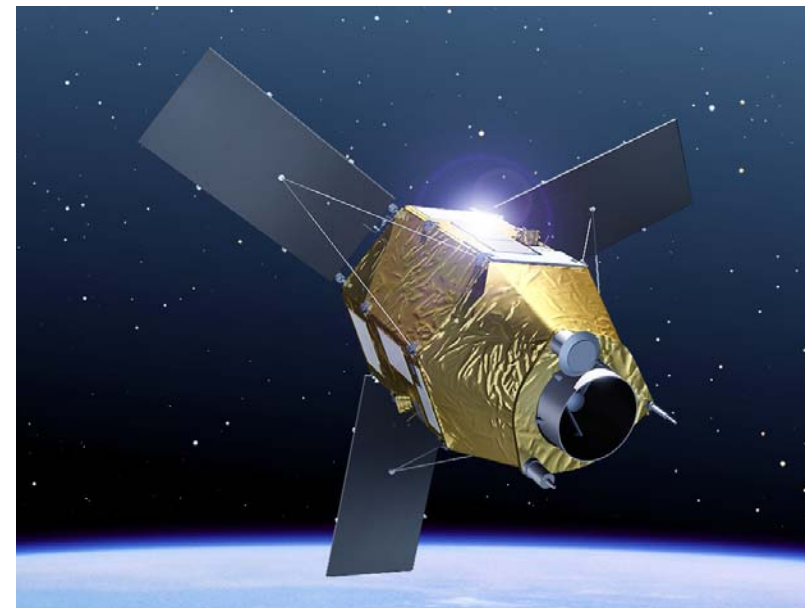
- ◆ sun-synchronous, 695 km
- ◆ 26-days cycle, descending ECT at 10:30
- ◆ 2 satellites : 180° offset between the two satellites
 - 1st launched : 17th Dec. 2011, 2nd launch : Nov./Dec. 2012

■ Accessibility

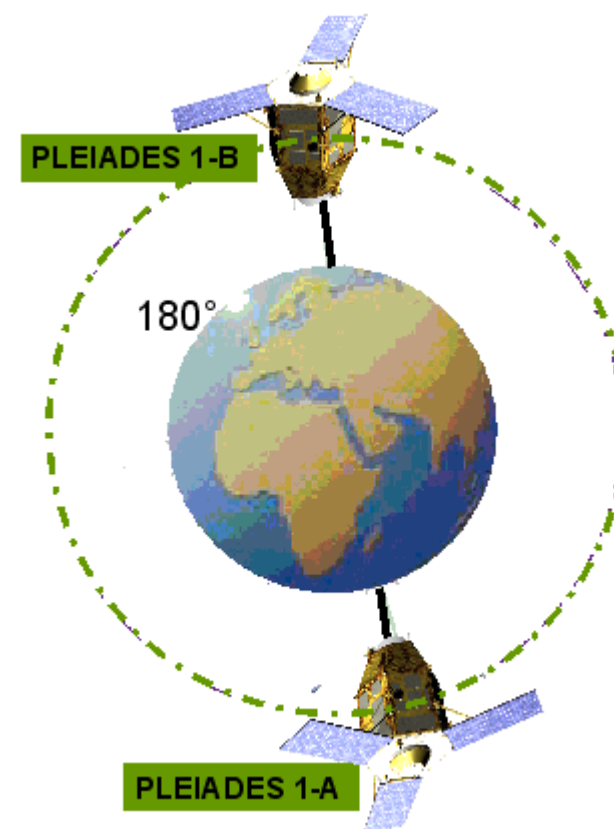
- ◆ Daily accessibility to any point on the globe (using tilt)
- ◆ Access image delay : < 24 hours between image request and image delivery in nominal mode

■ CNES takes the opportunity of the commissioning phase to acquire many images over calibration sites

- ◆ Improve the knowledge of the sites characteristics



- **Two satellites on a sun-synchronous, phased and quasi-circular at 695 km 14+15/26 orbit**
 - ◆ 26-days cycle, crossing the descending node at 10:30 local time
 - ◆ 180° offset between the two satellites
 - First satellite launch : 17th Dec. 2011
 - Second satellite launch : Nov./Dec. 2012
- **Revisit :**
 - ◆ Daily revisit with a resolution of 2.25 m (with 2 satellites and a viewing angle of 43°)
 - ◆ Daily revisit with a metric resolution at latitude greater than 50° (with 2 satellites and a viewing angle of 30°)



| Viewing angle | 1 satellite | 2 satellites | resolution |
|---------------|-------------------------------------|-------------------------------------|------------|
| 5° | 26 days | 13 days | 0.7 m |
| 30° | 5 days | 3 days (1 day over 50° latitude) | 1 m |
| 45° | 2 days (1 day over 50° latitude) | 1 day | 2.25 m |

■ A new concept compared to Spot

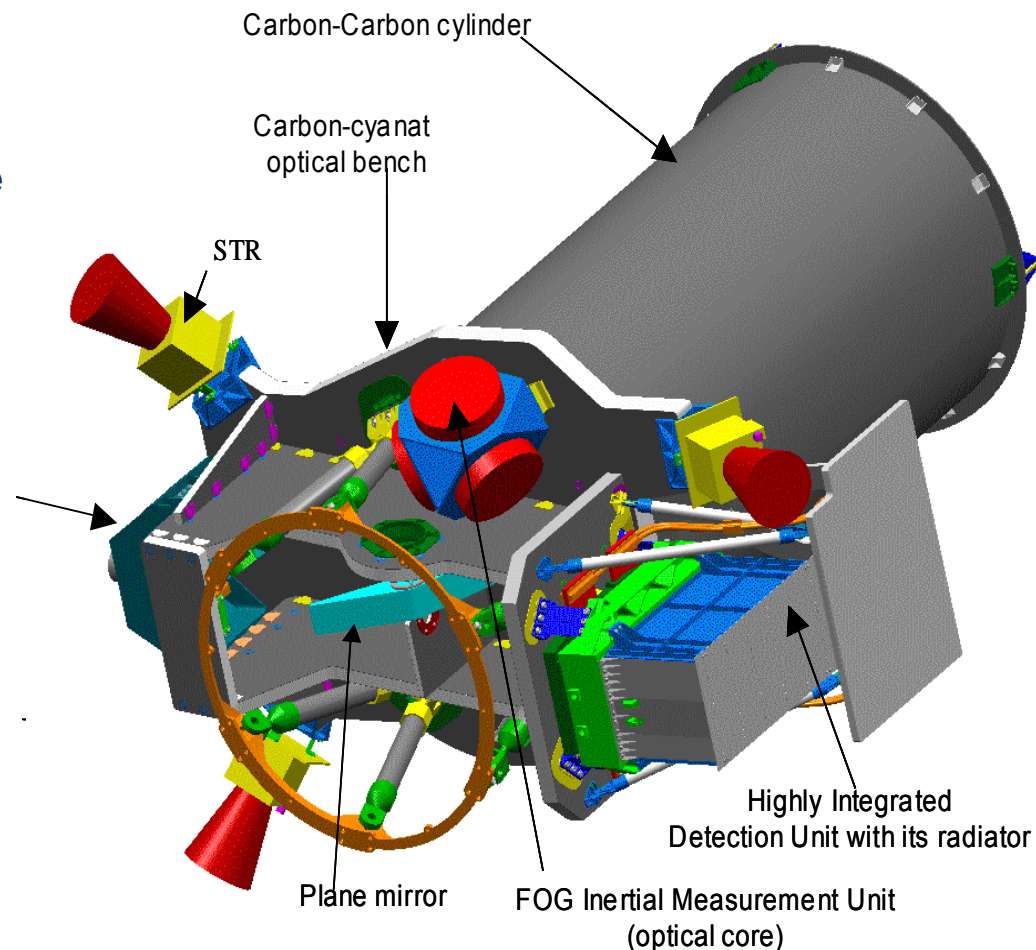
- ◆ A small and very agile satellite to improve operational capability and minimize the conflicts between users

■ Designed for an high agility

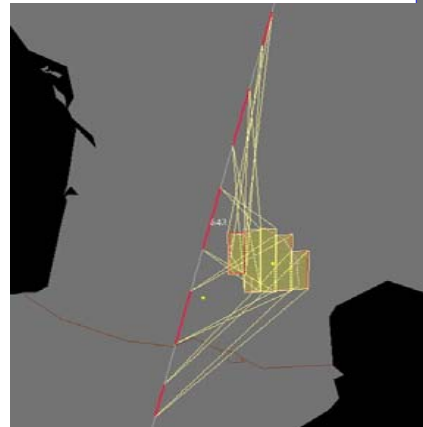
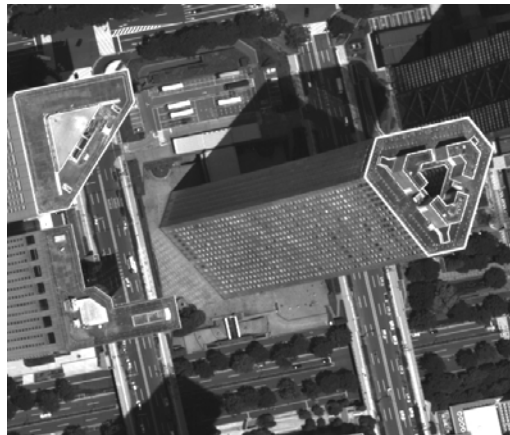
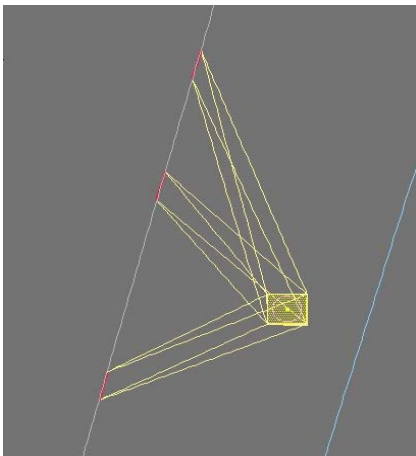
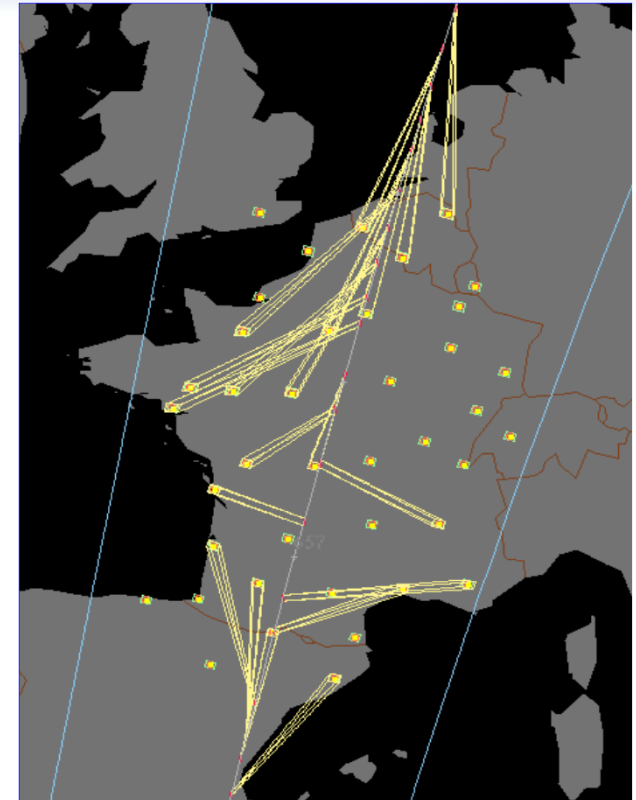
- ◆ Compact 1 ton satellite with low inertia
- ◆ Rigid satellite with fixed solar array
- ◆ Attitude control system
 - Powerful actuators

■ Designed for an high image quality

- ◆ High stability instrument with high precision sensor heads mounted on the optical bench
 - for maximum geometrical quality accuracy

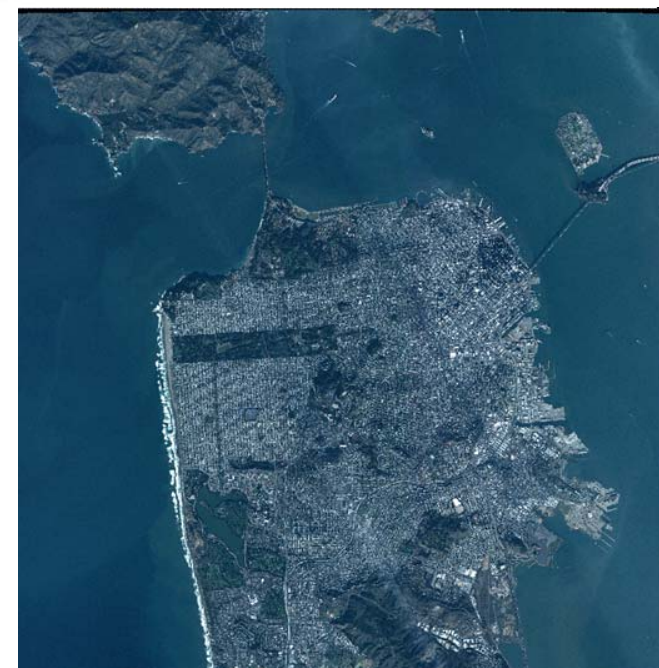


- Remarkable high agility
 - ◆ full agility reached on Day4
- Up to 350 images per day (and per satellite)
 - ◆ In a 50° cone around vertical (30° with all performances)
 - ◆ High agility permits to minimize conflicts between users
- Simultaneous stereo capacity with 1 satellite on 1 pass
- Swath enlargement with 1 satellite on 1 pass
- Possibility to follow a coast line or a river
- Can be used to help calibration site characterization



■ Perfect Sensor

- ◆ Equivalent to a regularly sampled Image delivered by a “perfect” linear sensor
 - Distorsion, focal plane tilt, attitude, orbit and datation correction
 - MTF enhancement : deconvolution and denoising
 - XS/Pan fusion, true or false colour
- ◆ System level MTF for PA of 0.2
- ◆ Signal to noise ratio better than 90
- ◆ Product Sampling : 0.5 m



■ Orthoimage

- ◆ Corrected with Digital Terrain Model

■ Mosaics

- ◆ Lateral multi-band mode acquisition :
 - ortho images stitched together to generate a single product
- ◆ Look as a single image :
 - no geometric discrepancy
 - no visual discrepancy



Pléiades system

Access to the Resources

- **Pléiades is a dual system**

- **Two ways to access the system**
 - ◆ Defence channel
 - **High priority requests for cooperating defence**
 - tasking, data reception, processing, archiving and distribution by a Defence Operator
 - 50 requests maximum per day for 2 satellites (among 700)
 - **Specific defence Users Centres in Spain and France**
 - ◆ Civil Channel operated by a Civilian Operator
 - **For the other requests**
 - responsibility of tasking, data reception, processing, archiving and distribution is given to a Civilian Operator
 - **Civil User Centre in Toulouse**
 - Main Receiving station in Toulouse and Kiruna

- **Final scheduling performed in a dual center**
 - ◆ By optimizing the civil plan around the defence one

■ Delegated to a Civil Operator

◆ Mission of the Civil Operator

- To develop and fund the Civil Centre and to fund system improvements
- To operate the Civil Channel and to fund these operations

◆ Astrium GEO-Information Services (ex Spot Image) chosen after an European Call for Tender in July 2004

- Delegation signed in December 2007
- Exclusive licence for the exploitation of the Civil Channel

■ Public Service Delegation

◆ Stress is put on Public Service for

- Authorized Institutional Users of the cooperating countries (France, Austria, Belgium, Spain, Sweden and Italy)
- GMES services

◆ Resources are allocated

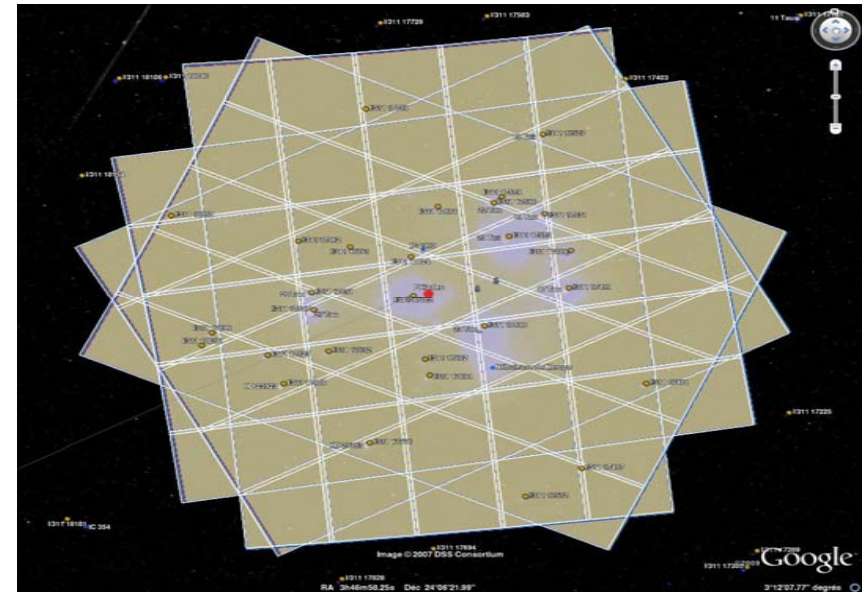
- 40% for Public Service
 - At the operational cost
- 60% for commercial use

■ Refocusing using “Stars method”

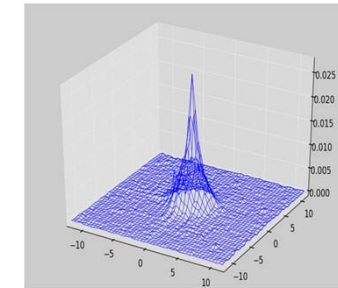
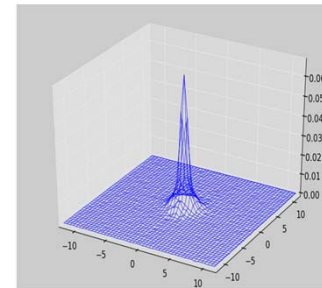
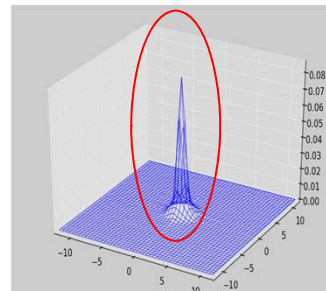
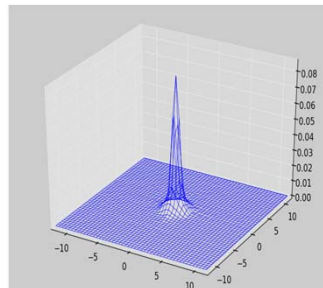
- ◆ 24 stars acquisitions on PLEIADES constellation ...
- ◆ 6 focus states
- ◆ 4 stars acquired each time

■ MTF is also estimated using stars

PAN 0.15
 B0,1,2,3 > 0.3



| T° C | 22 | 24 | 26 | 28 | 30 | 32 |
|----------|------|------|-----|-----|-----|-----|
| Foc (µm) | 1476 | 1203 | 930 | 656 | 383 | 109 |



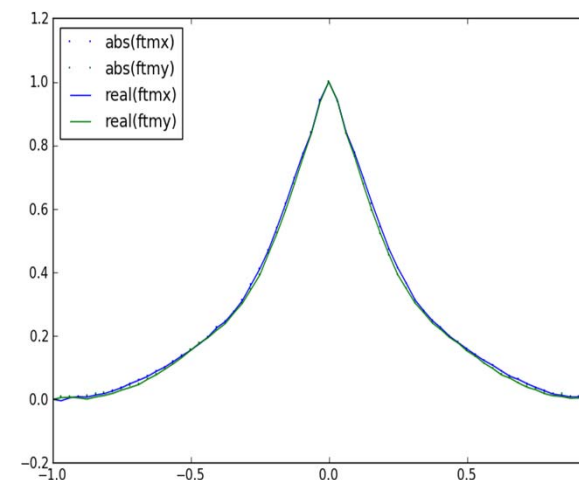
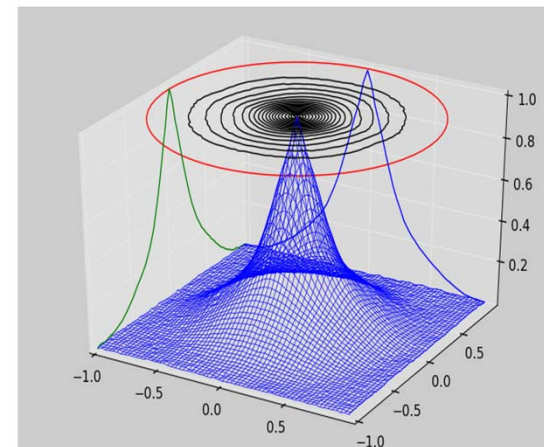
■ Stars method

- ◆ 2 campaigns, before and after Dec. 26 refocusing
- ◆ Before: PAN MTF: (0.125 / 0.135)

◆ After:

| | | |
|-----|------|------|
| PAN | 0.15 | 0.15 |
| B0 | 0.33 | 0.27 |
| B1 | 0.36 | 0.29 |
| B2 | 0.33 | 0.27 |
| B3 | 0.34 | 0.26 |

- ◆ Light but visible improvement after/before refoc.
- ◆ Interbands differences

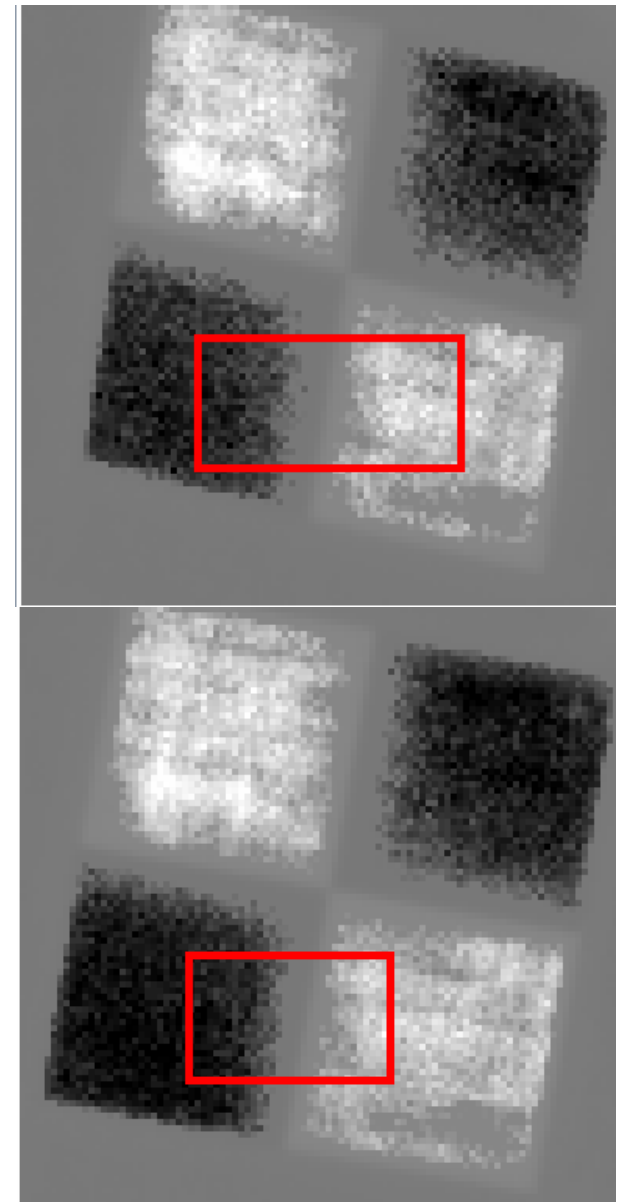


■ MTF target located near Salon (south of France)

- ◆ Two acquisitions :
 - Before refocusing 23/12/2011
 - After refocusing 29/12/2011

◆ Accuracy +/- 0.01

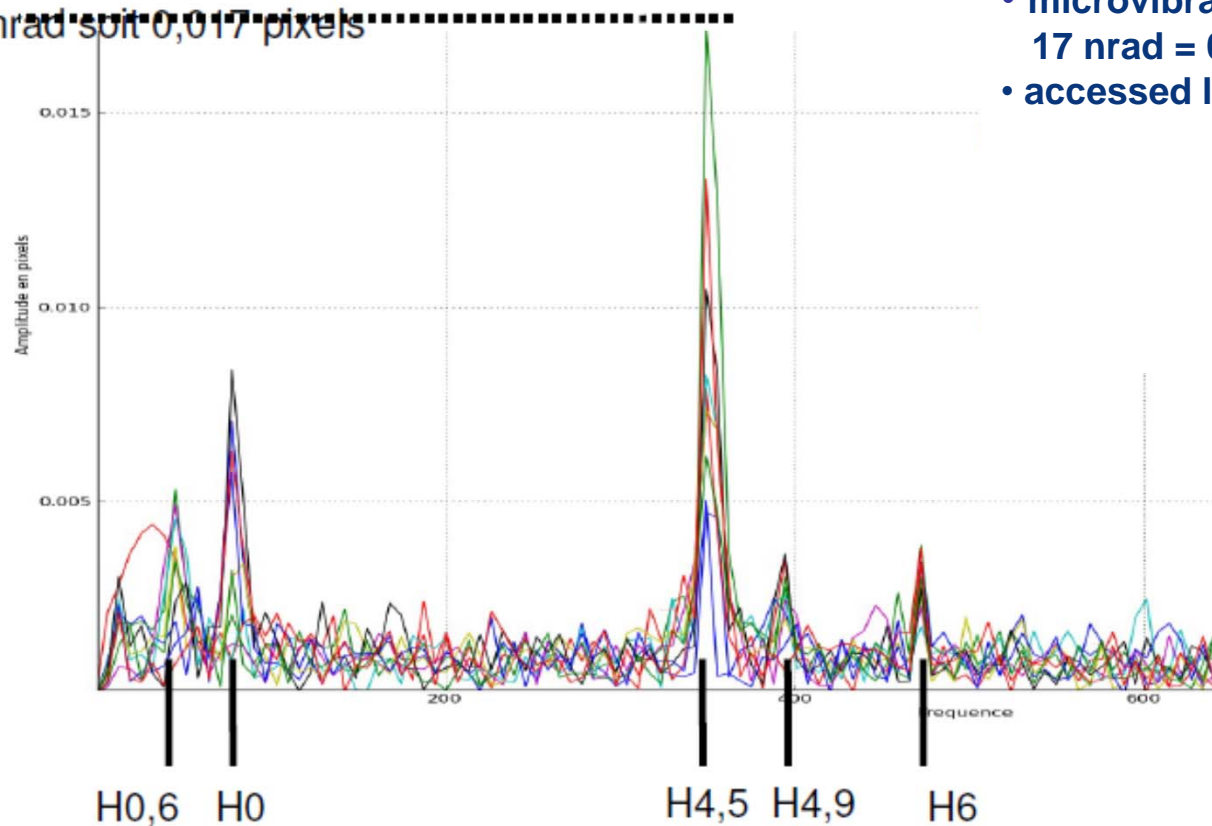
| | 23/12 | 29/12 |
|-------|-------|-------|
| PAN X | 0.11 | 0.14 |
| PAN Y | 0.12 | 0.14 |



■ Microvibrations estimate

Amplitude max :

17 nrad soit 0,017 pixels



- microvibrations amplitudes are very weak :
17 nrad = 0.017 pixel = 1.2 cm
- accessed level as low as 3 nrad

H4.5: max. amplitude 17 nrad

H1: max. amplitude 8 nrad

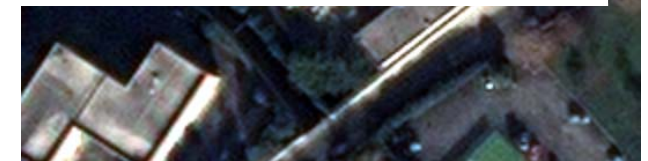
H0.6: max. amplitude 5 nrad

H6: max. amplitude 3.2 nrad

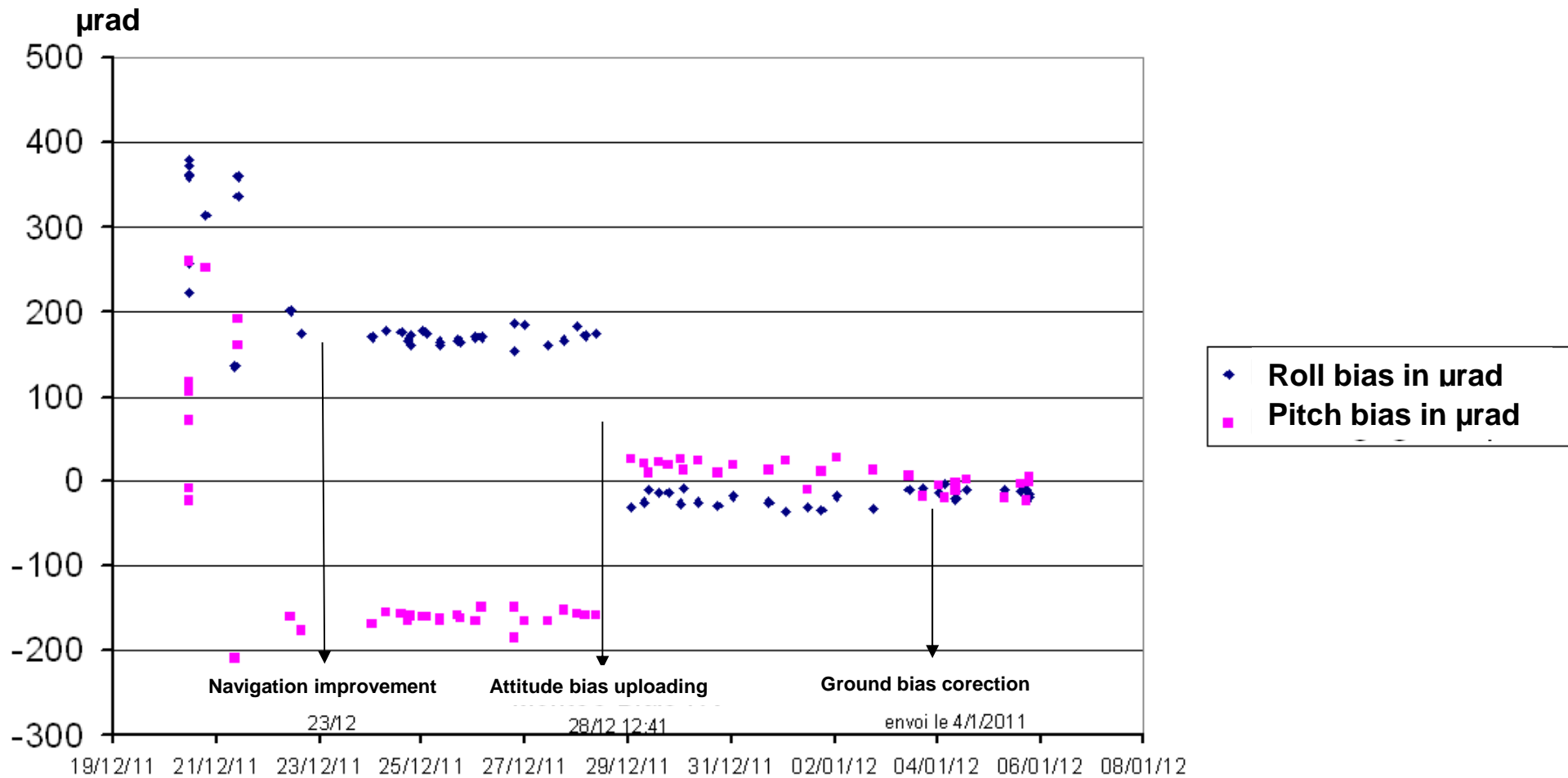
H4.9: max. amplitude 3.1 nrad

■ Absolute location accuracy : in progress :

- ◆ today's performance : around 25 m
- ◆ goal : 5 m ...



Attitude bias as measured using calibration test sites



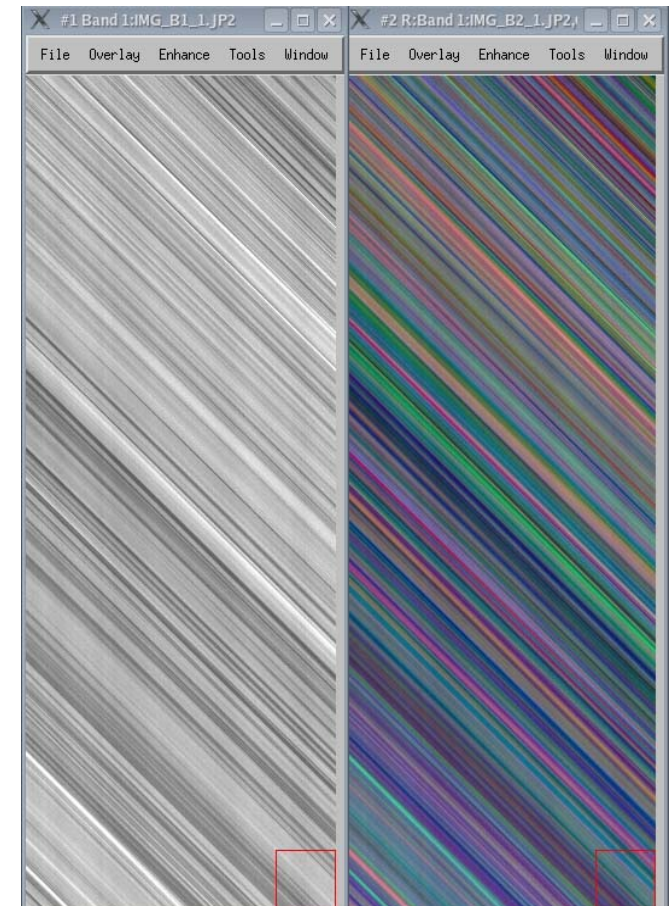
■ AMETHIST acquisition profile

- ◆ line of sight is tilted 90° in yaw so that every detector sees the same landscape



■ Relative calibration parameters uploaded to the satellite

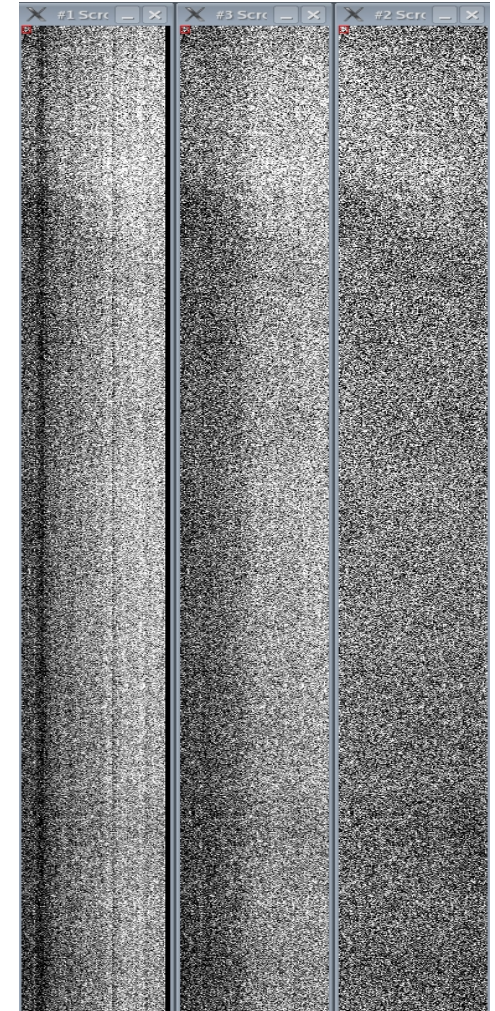
An AMETHIST image



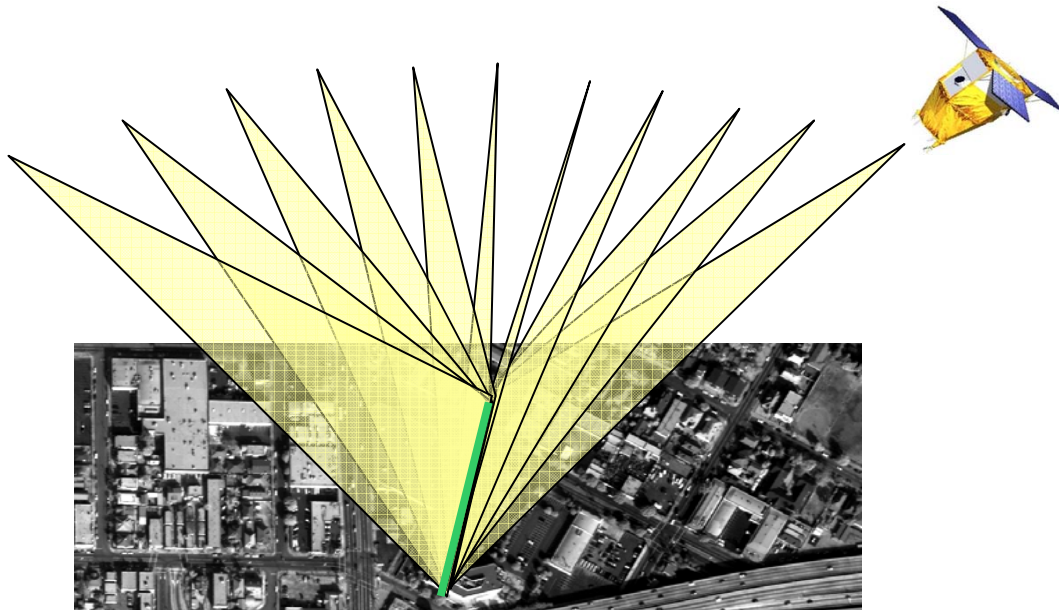
- Ground relative calibration coefficients not suitable in orbit
- New coefficients computed in orbit thanks to the AMETHIST method

Image Antarctique

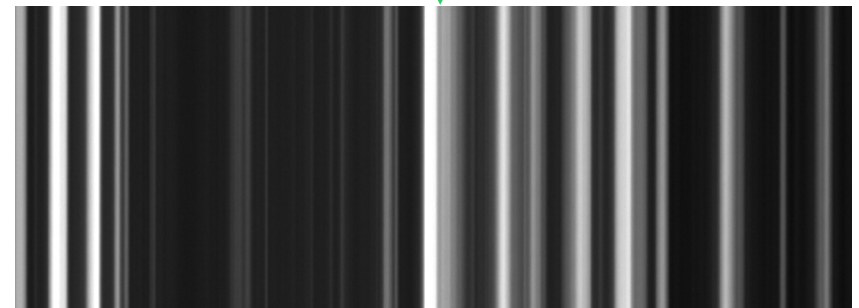
Sans égalisation Avec égalisation Avec égalisation
coef sol coef vol



■ “one line” acquisition

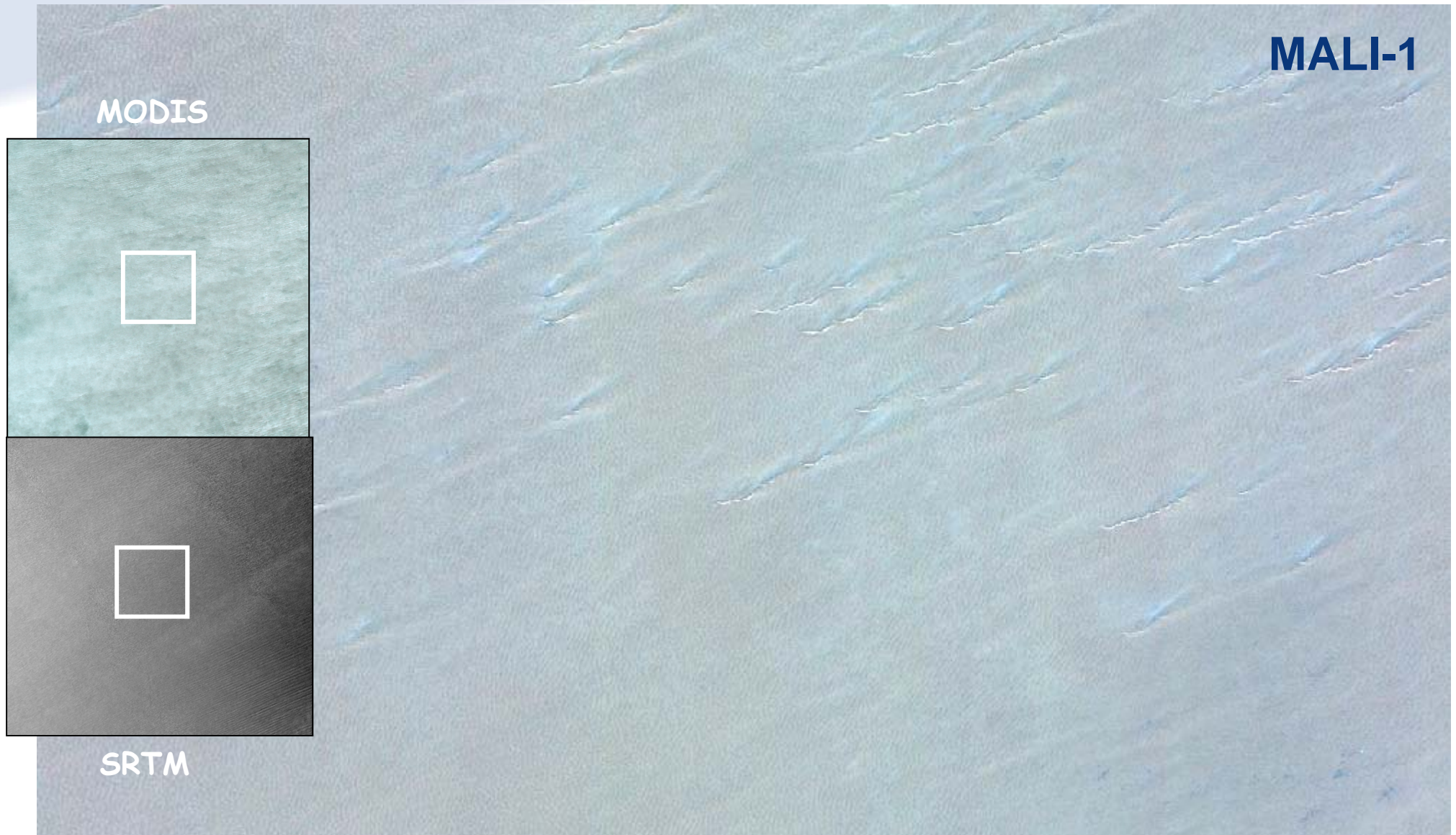


captured image

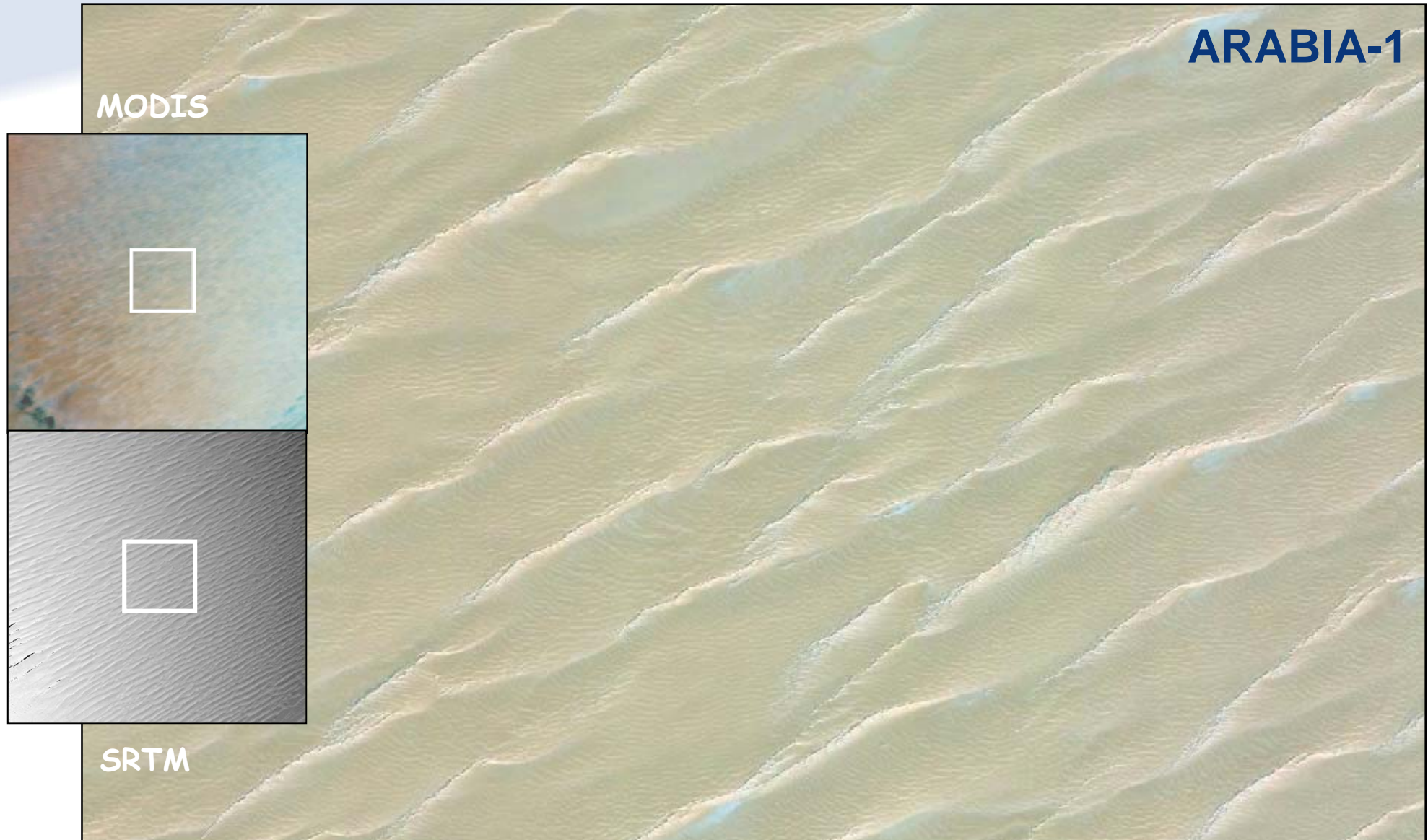


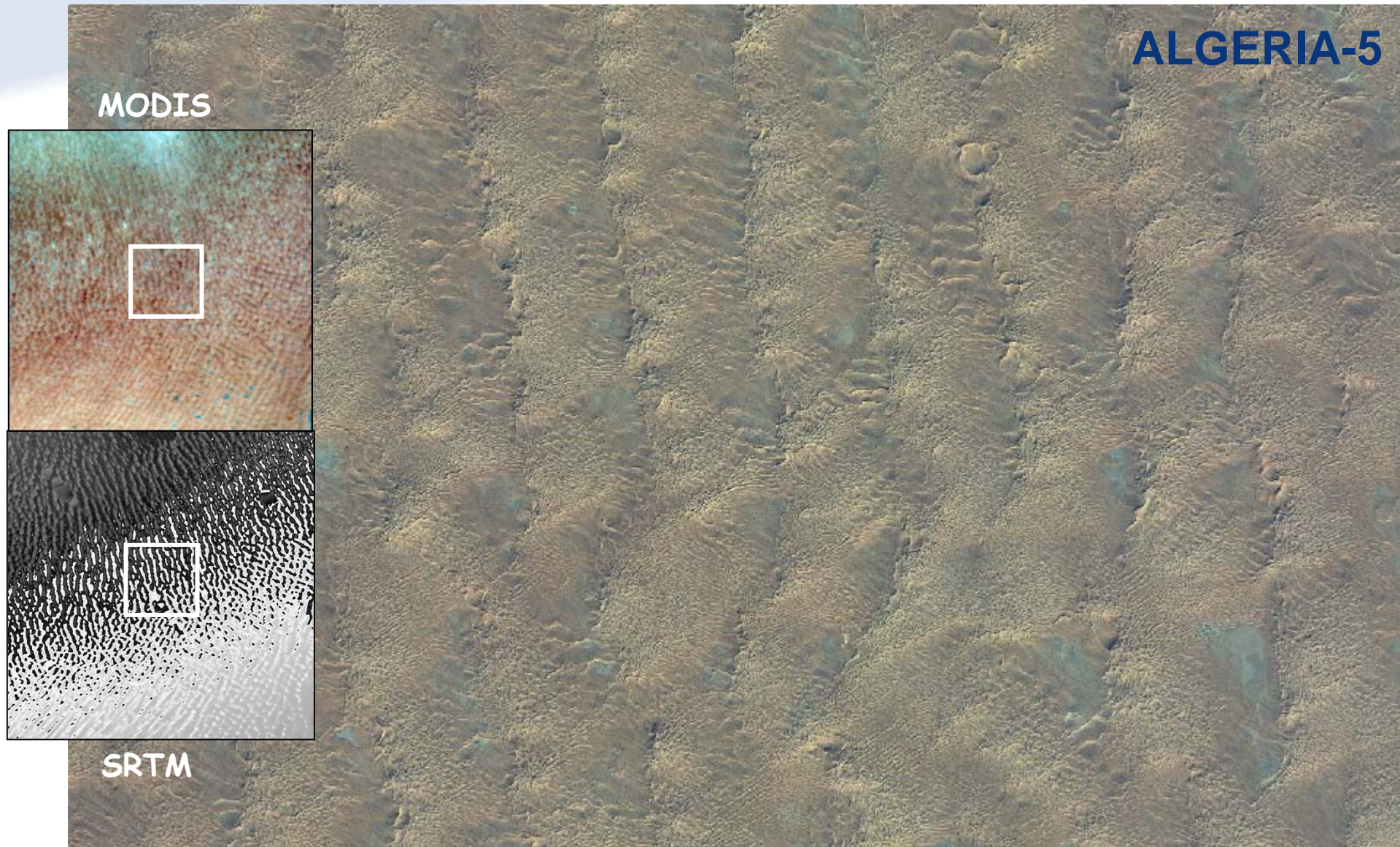
■ SNR is very good :

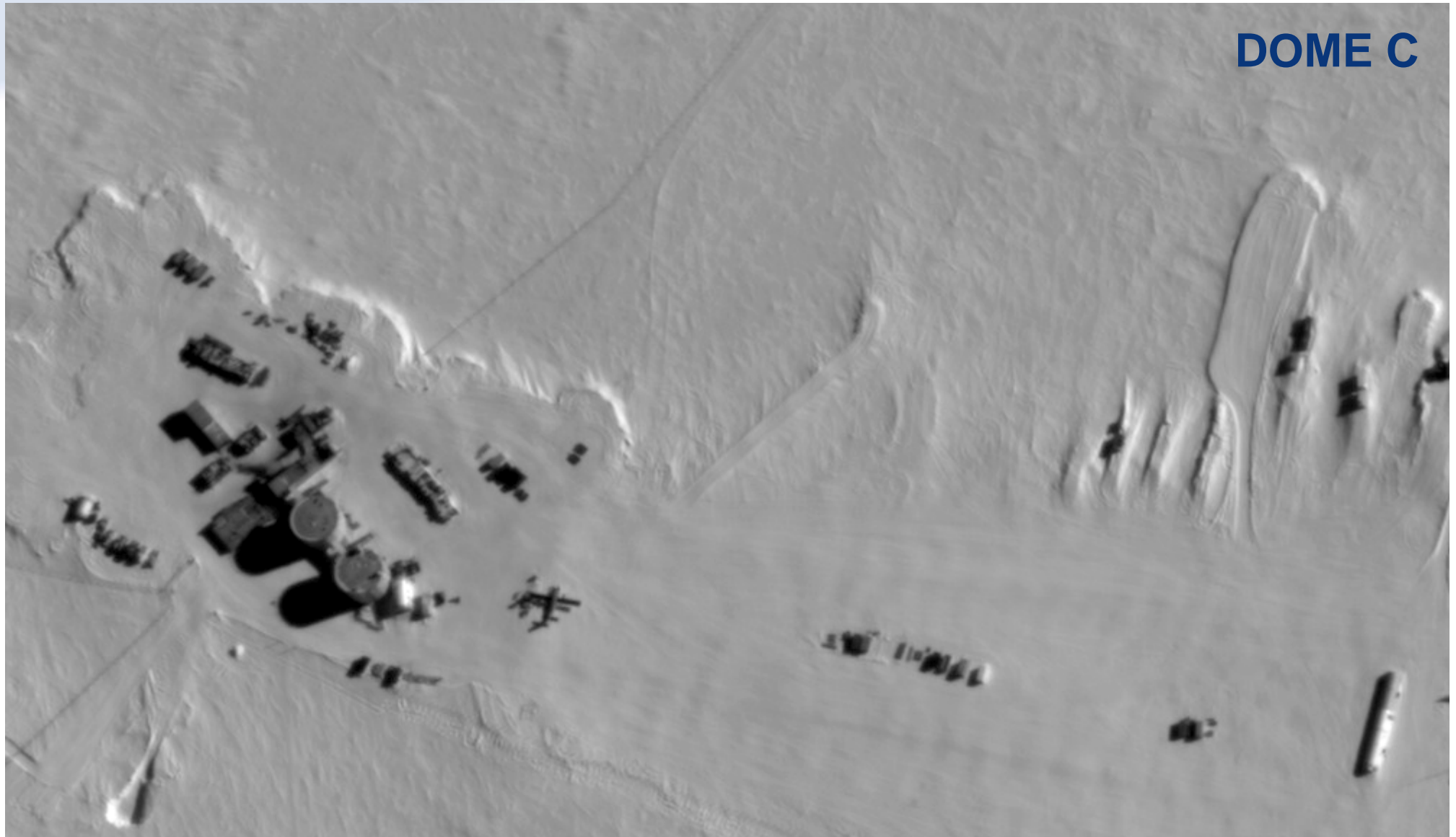
| | PAN | B0 | B1 | B2 | B3 |
|--------|--------|--------|--------|--------|--------|
| S/B L1 | 43,31 | 69,65 | 58,69 | 44,05 | 28,40 |
| S/B L2 | 155,92 | 151,98 | 153,41 | 154,40 | 195,47 |
| S/B L3 | 234,86 | 222,21 | 226,61 | 229,08 | 290,56 |

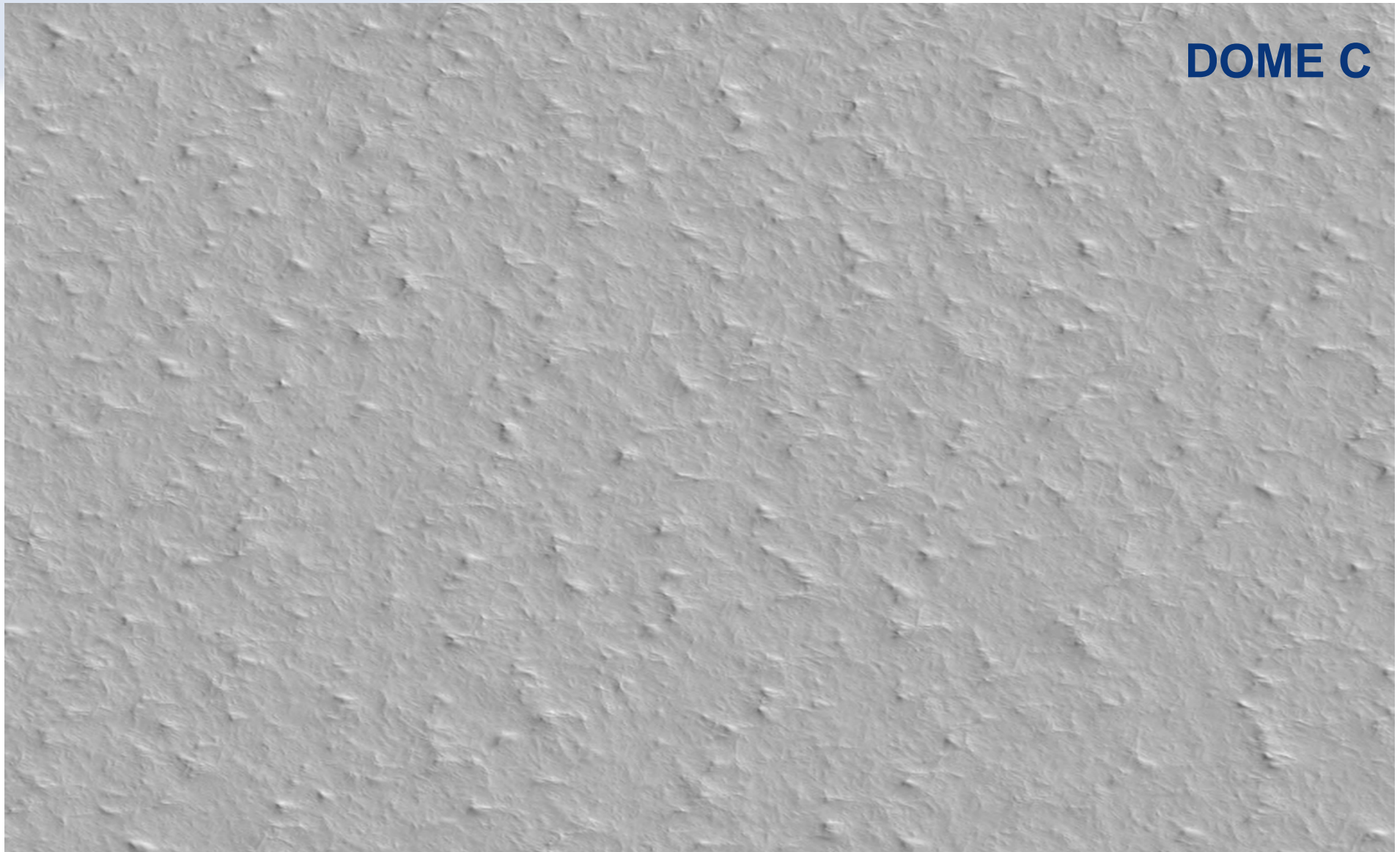








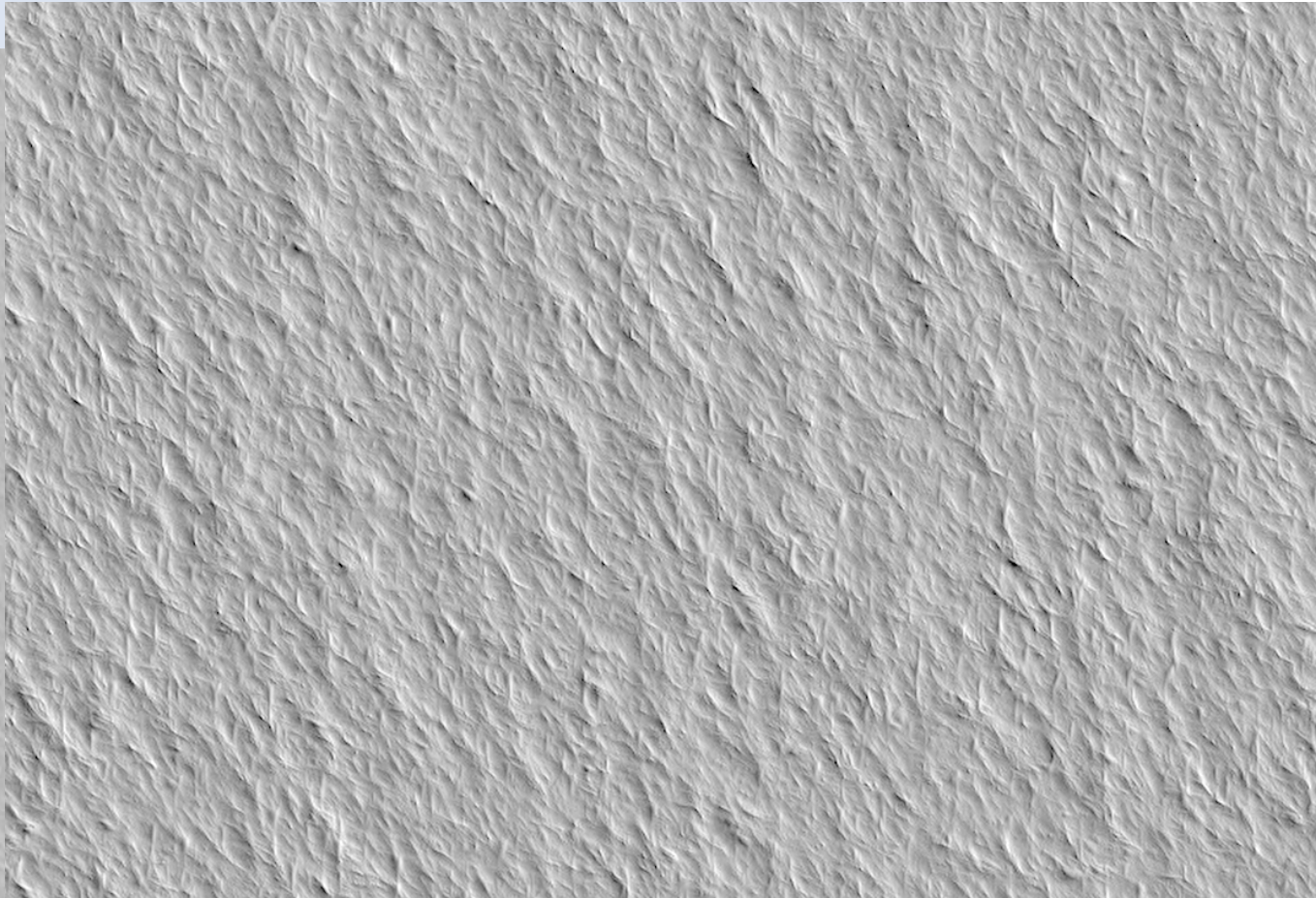




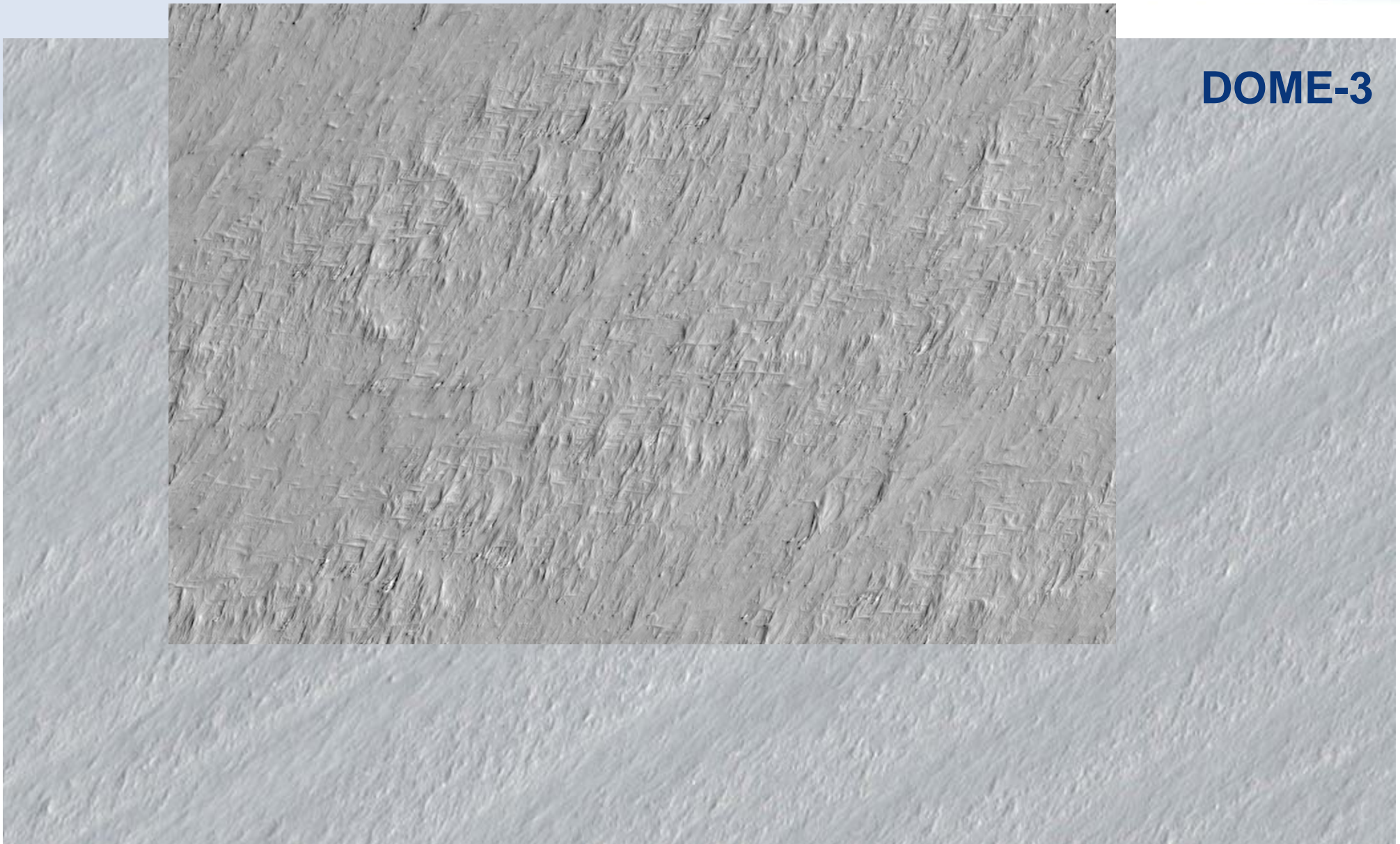
DOME 1



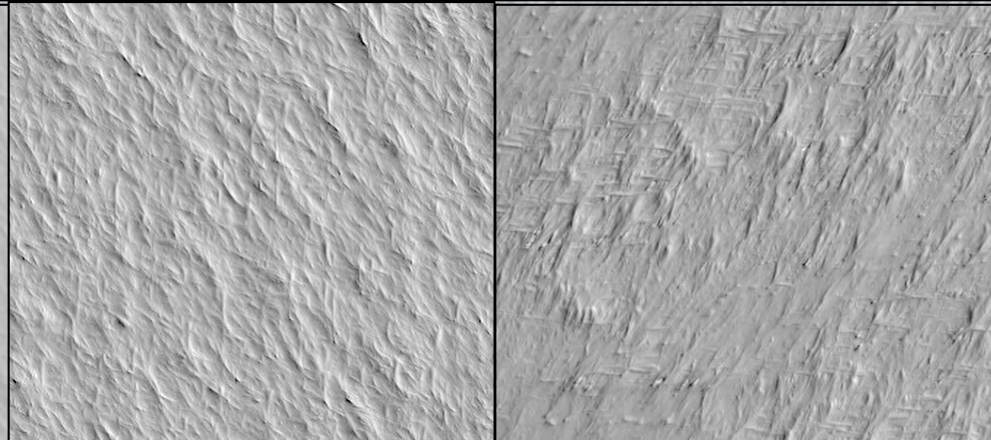
DOME-2



Calibration sites



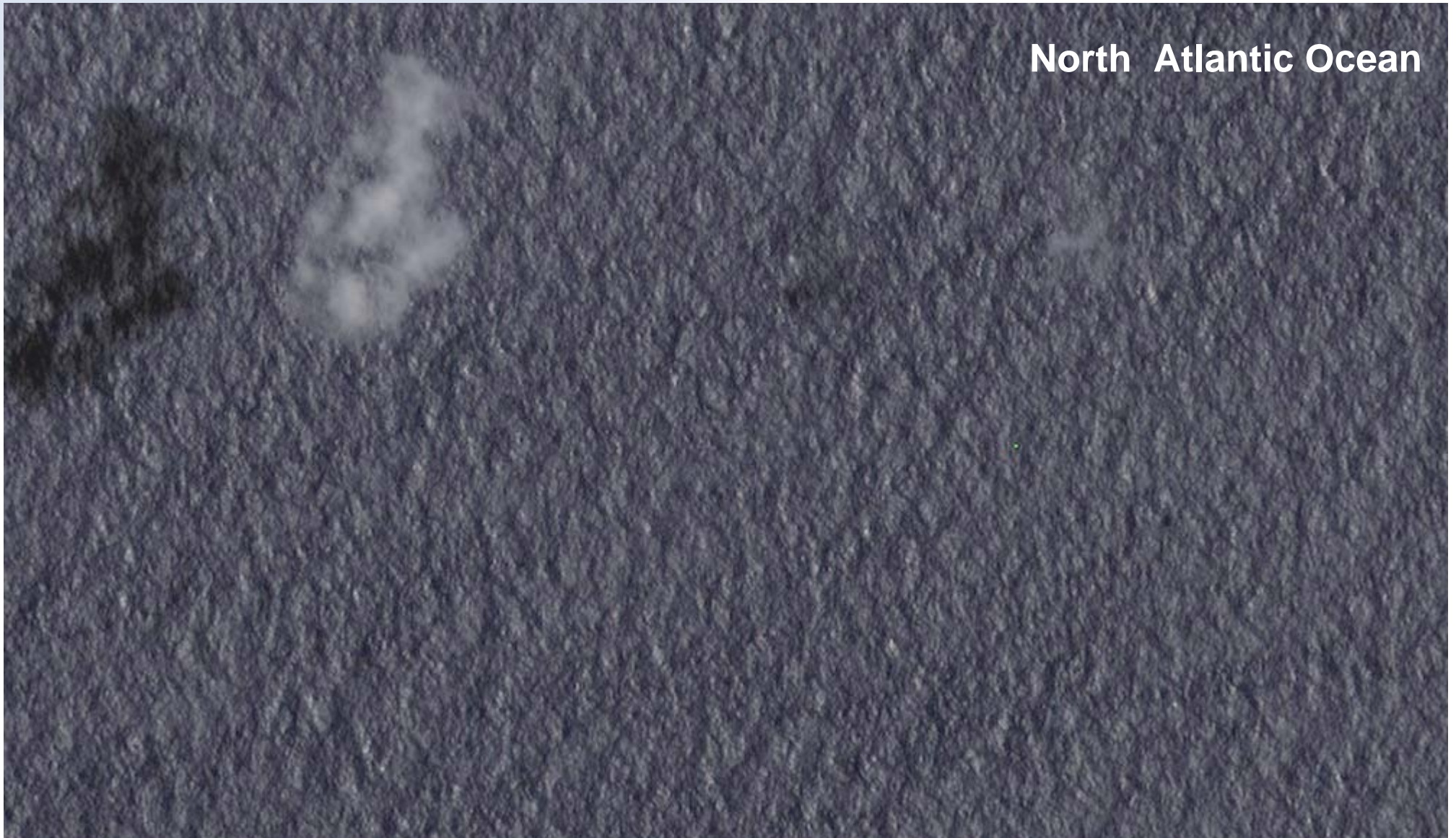
DOME-2



DOME-3

Explanation why bidirectional properties are different

**Possible stronger variation with absolute solar angle
due to very low solar elevation for Dome-3**



North Atlantic Ocean

A new site (for us...)



Moon (380 m resolution)



Full Moon

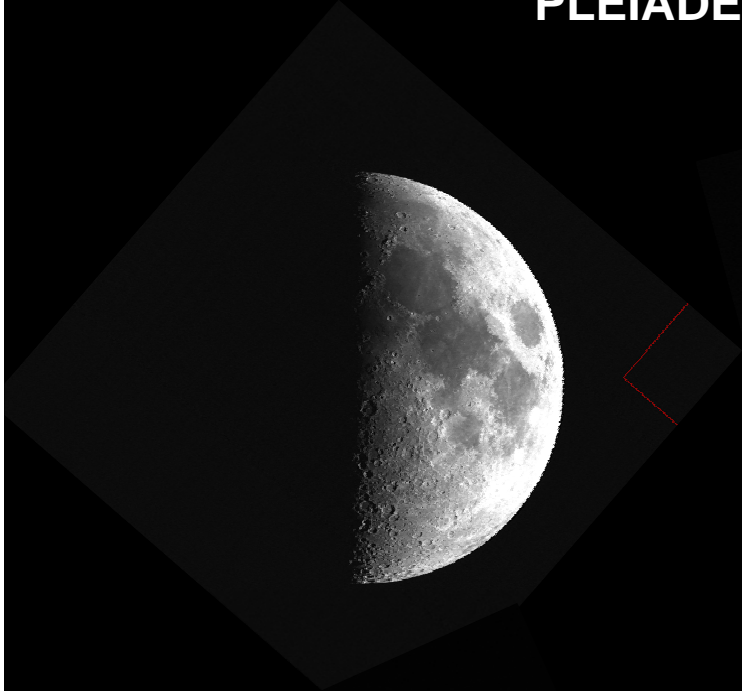
Native PAN + XS acquisitions – no need for geometrical resampling
agility + very accurate steering of LOS

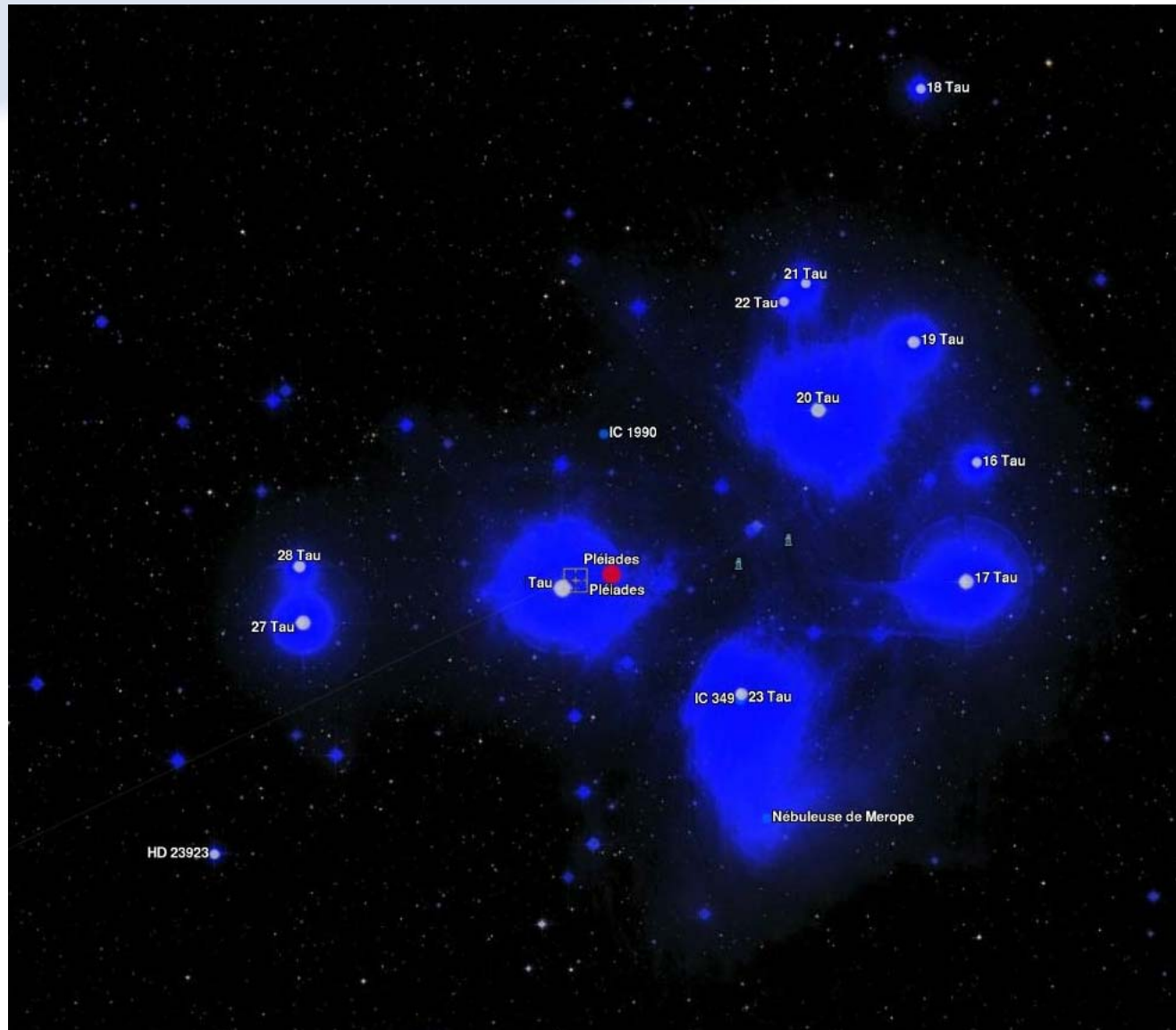
Regular acquisition of the Moon – fixed phase of -40° every month
2 views in 50 min – phase step = 0.4°

Experimental acquisitions :

- daily acquisitions over one lunar cycle : from -92° to 104°
2 views per day in 50 min – phase step = 0.4°
30 images from 31/01/12 to 15/02/12
→ document the error budget for each phase
+ investigate extrapolation slightly over 90°
Has been reproduced with the March lunar cycle
- stereoscopic acquisition allowed using the 2 views

PLEIADES Acquisitions of the MOON





The Pleiades constellation

MARS (~1 UA) & **SATURNE** (~10 UA)

JUPITER with its satellites (~4,5 UA)



Thank you for your attention

An aerial night photograph of a city. The scene is dominated by several tall, modern skyscrapers with glass facades, some of which are brightly lit from within, creating a stark contrast with the dark night sky. The buildings are arranged in a grid-like pattern. To the left, a wide river flows through the city, its surface reflecting the lights from the buildings and the streetlights along the banks. The surrounding urban landscape includes smaller buildings, parking lots filled with cars, and some green spaces. The overall atmosphere is one of a bustling, modern metropolis at night.

Thank you for your attention