Airbus-Hisdesat Radar Constellation
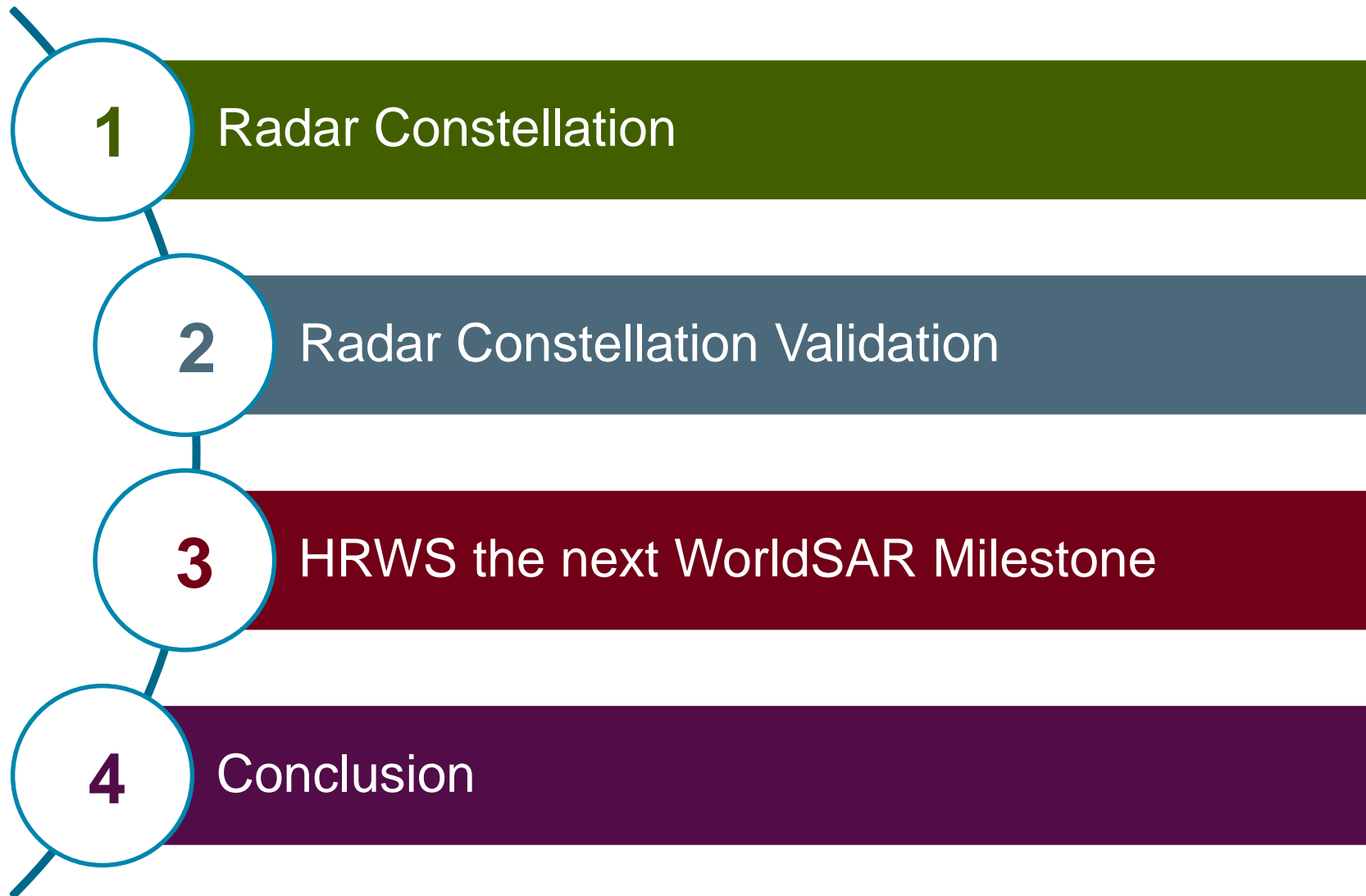
VH-RODA & CEOS SAR Calibration & Validation Workshop
November 18th - 22nd, 2019
ESA ESRIN, Frascati

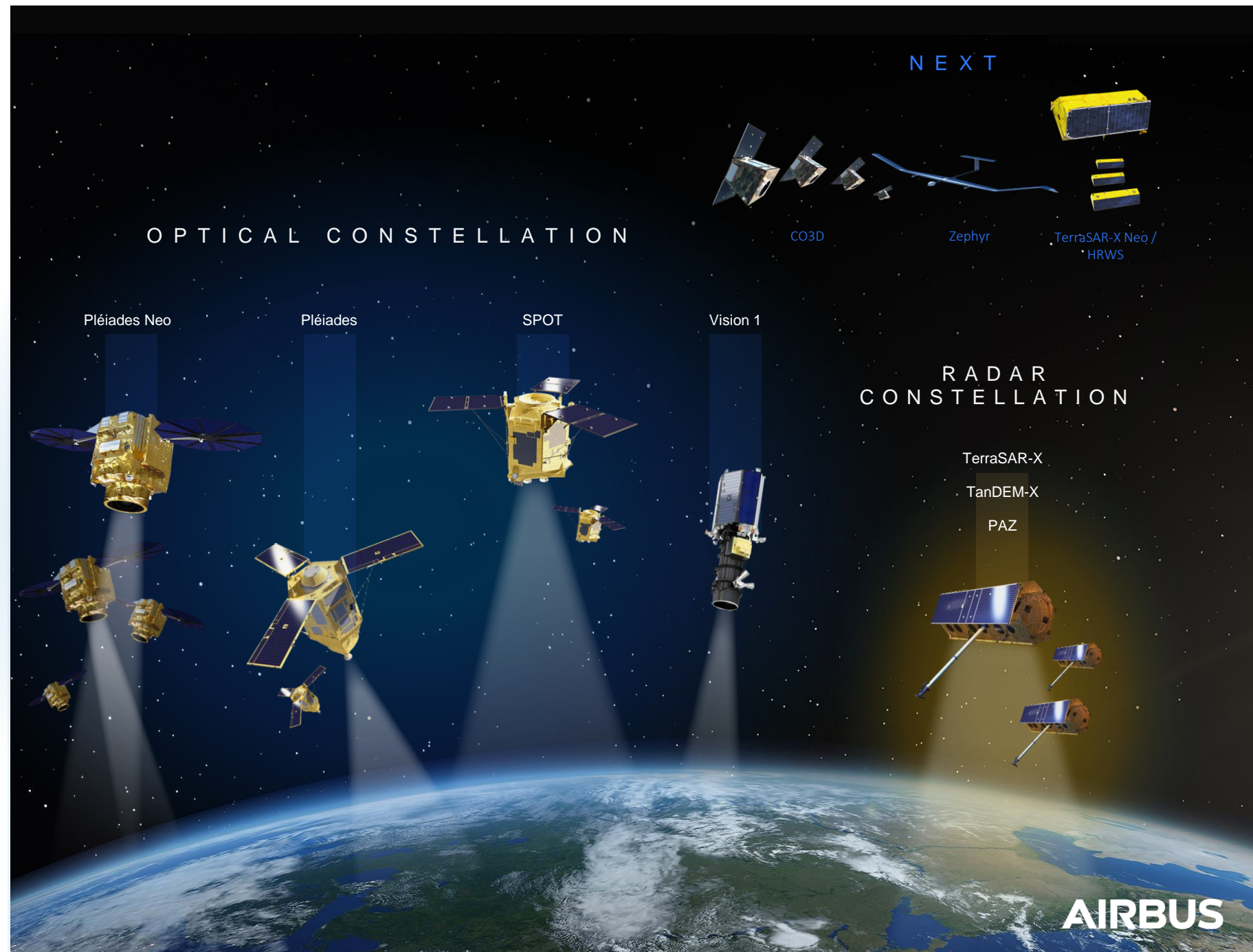J. Janoth[1], W. Koppe[1], H. Kahabka[1], V. d. E. Fernandez[2], J. I. C. Peréz[2]
[1] Airbus Defence and Space GmbH, Intelligence; Hisdesat Servicios Estratégicos S.A.

Outline

1 Radar Constellation

2 Radar Constellation Validation

3 HRWS the next WorldSAR Milestone

4 Conclusion

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

AIRBUS

30 years of development

and experience alongside our customers and partners

Airbus Constellation

NEXT

OPTICAL CONSTELLATION

CO3D   Zephyr   TerraSAR-X Neo / HRWS

Pléiades Neo   Pléiades   SPOT   Vision 1

RADAR CONSTELLATION

TerraSAR-X

TanDEM-X

PAZ

AIRBUS

Our Data
Makes the
Difference

TerraSAR-X /
TanDEM-X
Formation

(Est. 2007/2010)

Reliability

Precision

Flexibility

AIRBUS

Our Data
Makes the
Difference

PAZ Satellite

(Est. 2018)

Build by Airbus

Owned & managed by

Hisdesat

AIS Receiver

Launch

2018

© SpaceX 2019

© Hisdesat Servicios Estratégicos S.A. 2019

hisdeSAT

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

AIRBUS

Our Data
Makes the
Difference

Radar Constellation

Improvements:

Acquisition Capacity

Overall Revisit Rate

InSAR Repeat Cycle

hisdeSAT

AIRBUS

Radar Constellation

Orbit Position

→ Same Orbit Plane

→ ~98° anticlockwise phasing

TSX / TDX Formation

Radar Constellation

AIRBUS

Radar Constellation

Experience …

… **Coordinated Tasking**

… **Joint Pricelist**

… same **Acquisition Modes**

… same **Processing Levels**

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

AIRBUS
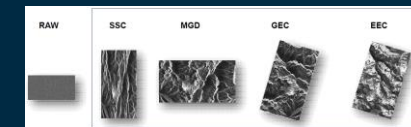
Radar Constellation

Experience …

… same **Product Specification**

… same **Product Structure**

… same **Data Quality**

… same **Way of Delivery**

… same **Delivery Formats**   TSX1_SAR__AAA_BBBB_CC_D_EEE_xxxxxxxxTxxxxxx_yyyyyyyyTyyyyyy

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

AIRBUS

hisdeSAT

Radar Constellation

Improvements

→ **Acquisition Capacity**

doubled

→ **Benefitting Monitoring and Mapping applications**

AIRBUS

Radar Constellation

Improvements

→ **Revisit Capacity strongly**

increased

(daily mean revisit < 24 hours)

TSX/TDX only
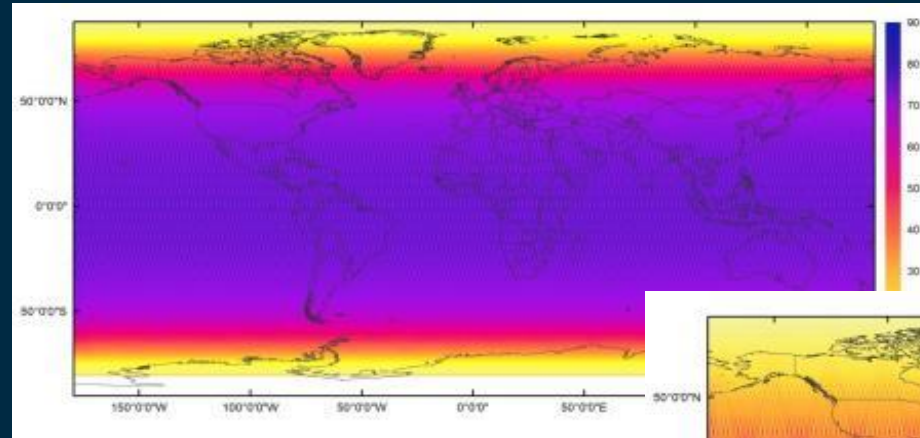
Radar Constellation
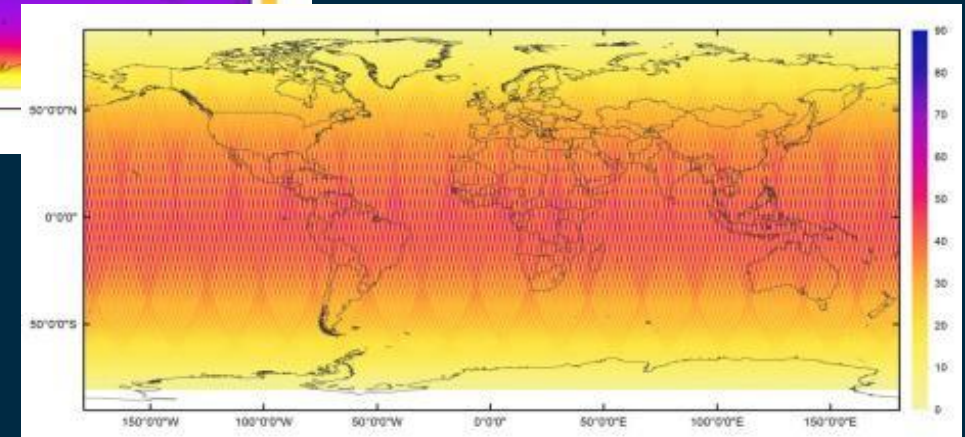
Mean Revisit Example: StripMap, left
+ right looking, Sat Phasing optimized
for max. revisit time

→ **Benefitting Monitoring and Mapping applications**

hisdeSAT

AIRBUS

Radar Constellation

Improvements

→ **Enhanced** InSAR-Repeat-Cycle

4-Day-Cycle

7-Day-Cycle

11-Day-Cycle
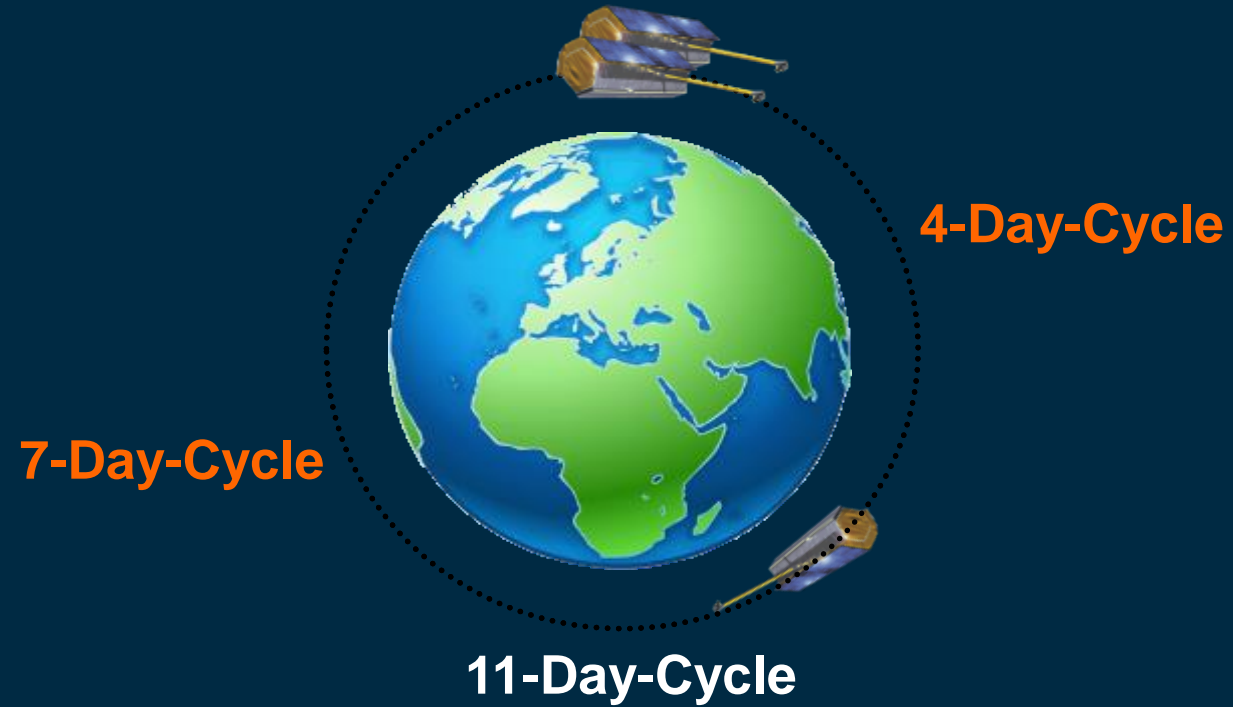
→ **Benefitting Monitoring applications**
- → Interferometric Data Stacks
- → Coherent Change Detection

AIRBUS

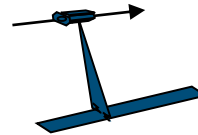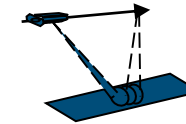# Imagery – Acquisition Modes

Wide ScanSAR
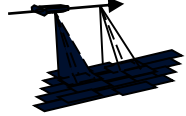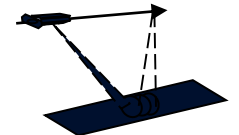
ScanSAR
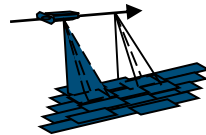
StripMap

High Res. SpotLight & SpotLight

Staring SpotLight

Multi-resolution – Multi-scale – Multi-polarized:

Acquisition Modes for various Applications

40m Resolution

200 - 270 x 200km

Large area maritime monitoring of traffic, oil, ice

18m Resolution

100 x 150km

Detailed maritime monitoring & detection

3m Resolution

30 x 50km

Detection & classification of vessels, infrastructure, etc.

1m/2m Resolution

10 x 5 km / 10 x 10 km

Recognition of objects (aircrafts, hangars, vessels,..)
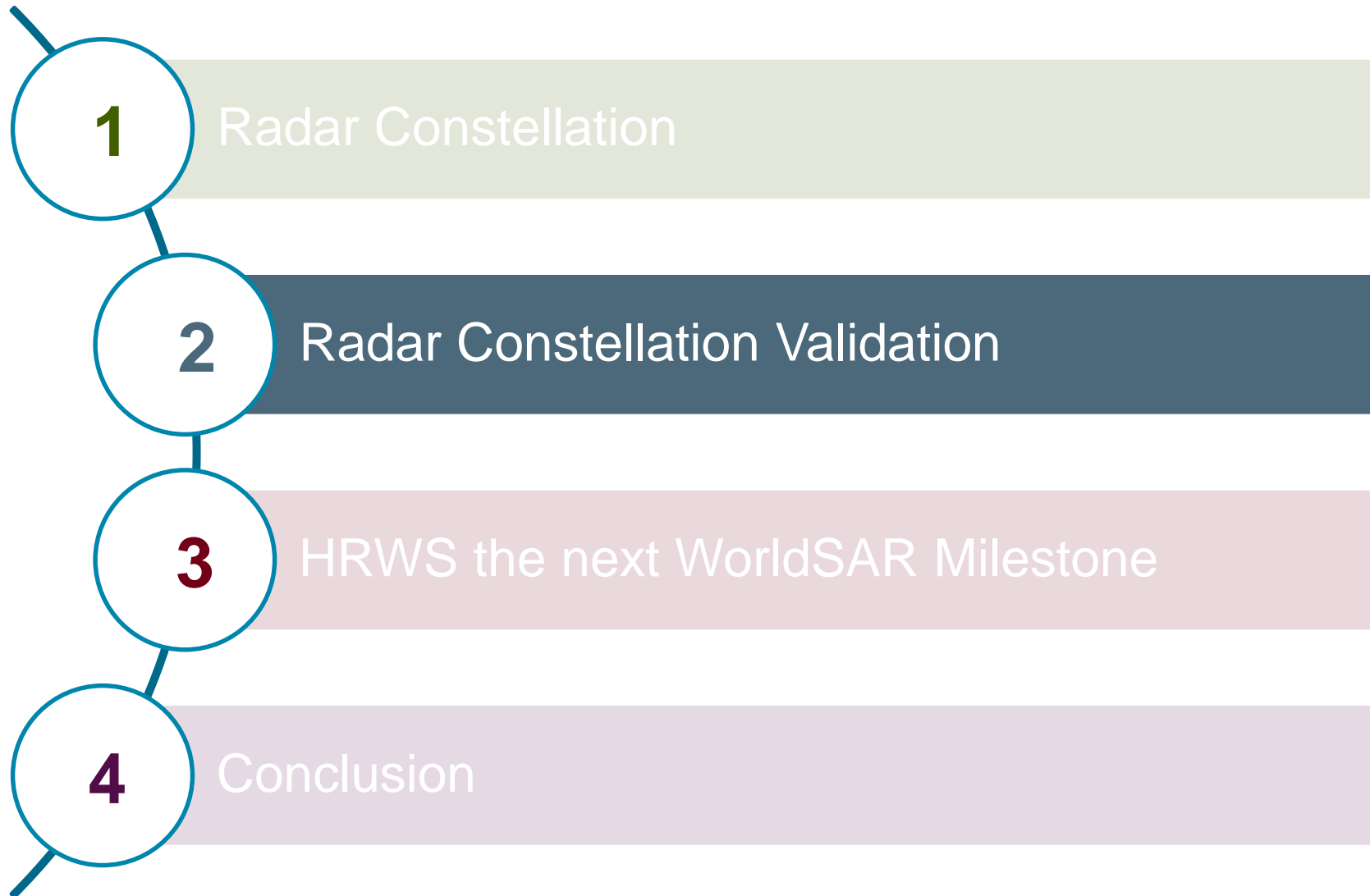
0.25m Resolution

4 x 3.7km or 2.5 x 7.5km

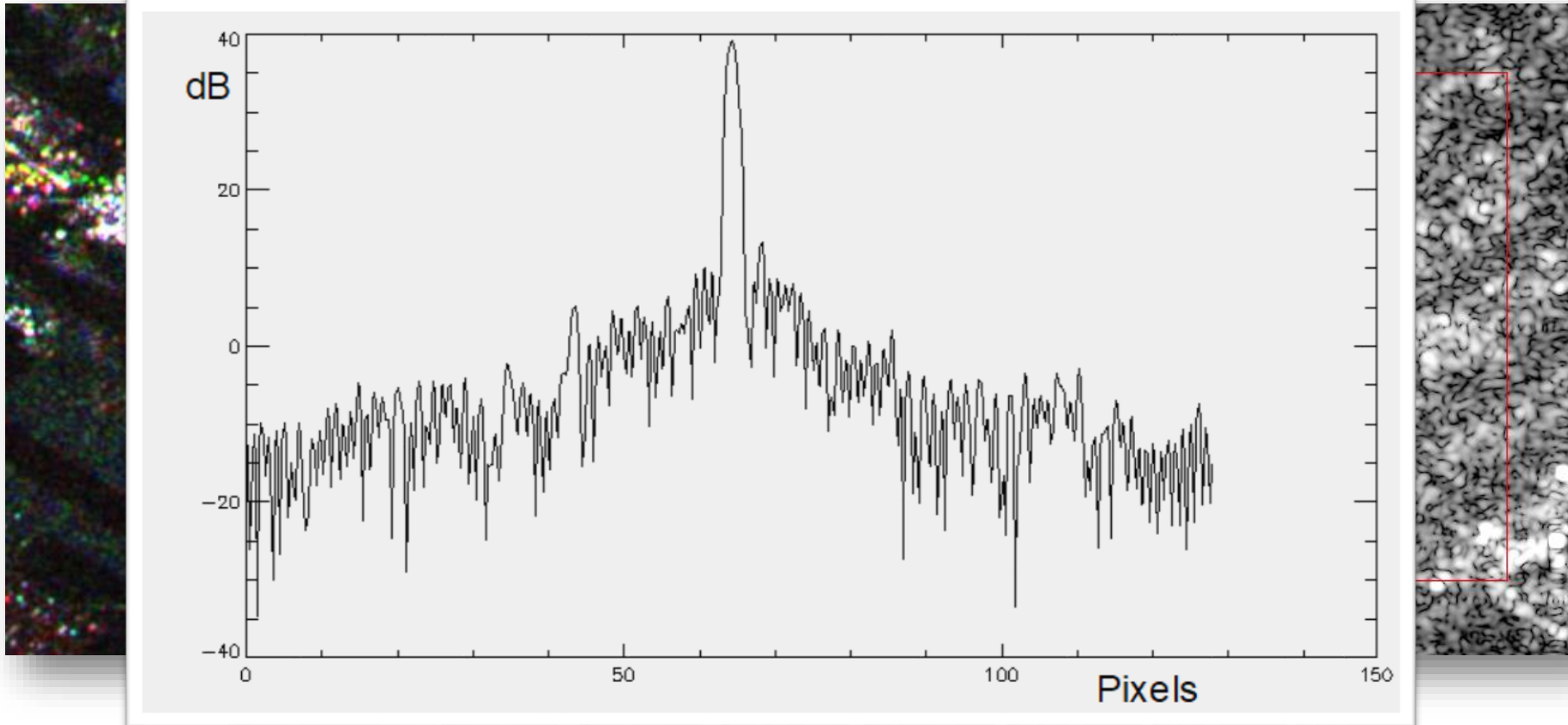Identification of objects

Monitoring & Detection **Recognition & Classification** **Identification**

AIRBUS

Agenda

1 Radar Constellation

2 Radar Constellation Validation

3 HRWS the next WorldSAR Milestone

4 Conclusion

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

AIRBUS
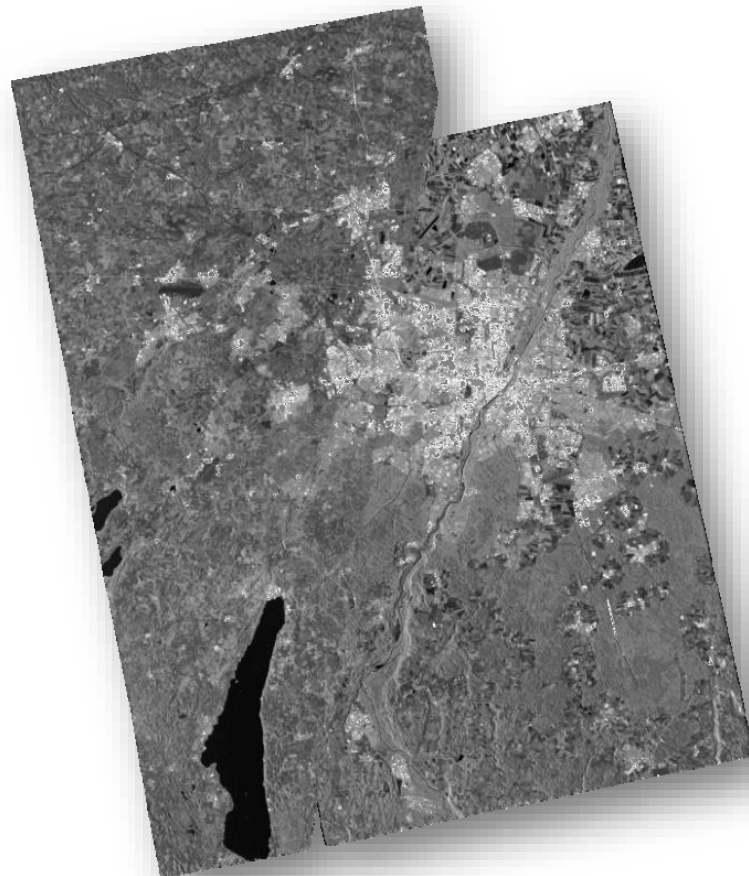
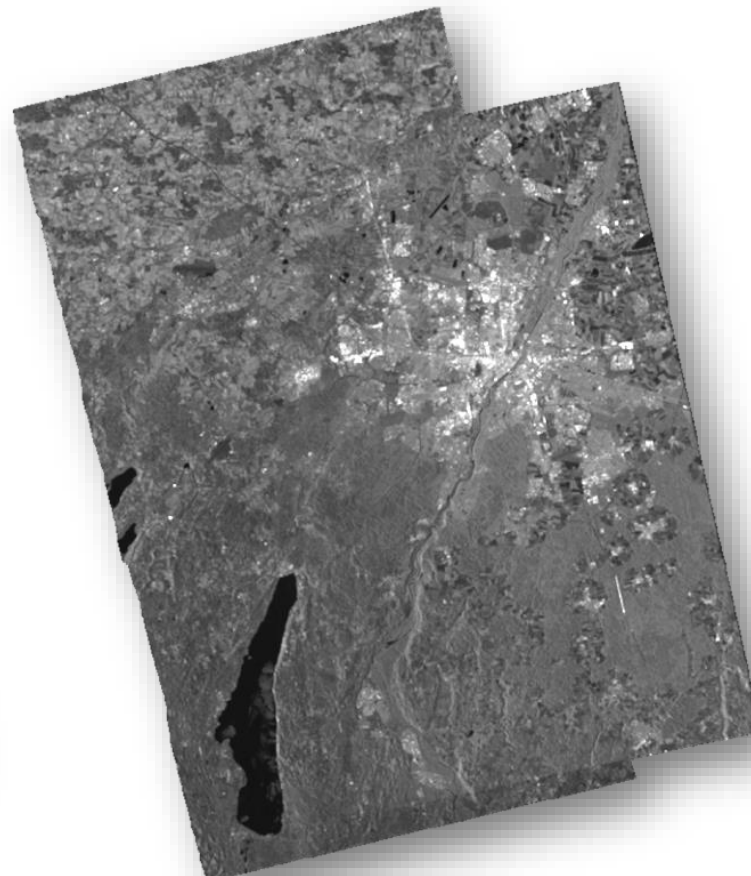# Radar Constellation Validation

Radiometric Analysis

Objective:
Comparative radiometric analysis

Approach:
Analysis of responses of Point & Distributed Targets

Results:
Values well within the specifications

AIRBUS

Radar Constellation Validation

Mosaic of PAZ at 37° dated 31.05.2019, and
TerraSAR-X image at 47° of 20.01.2019

Mosaic of PAZ at 37° dated 31.05.2019, and
TerraSAR-X image at 21° of 01.12.2018

Radiometric Analysis

Objective:
Comparative radiometric analysis

Approach:
Analysis of responses of Point & Distributed Targets

Results:
Values well within the specifications

AIRBUS

Radar Constellation Validation

TerraSAR / PAZ Time Position Plot
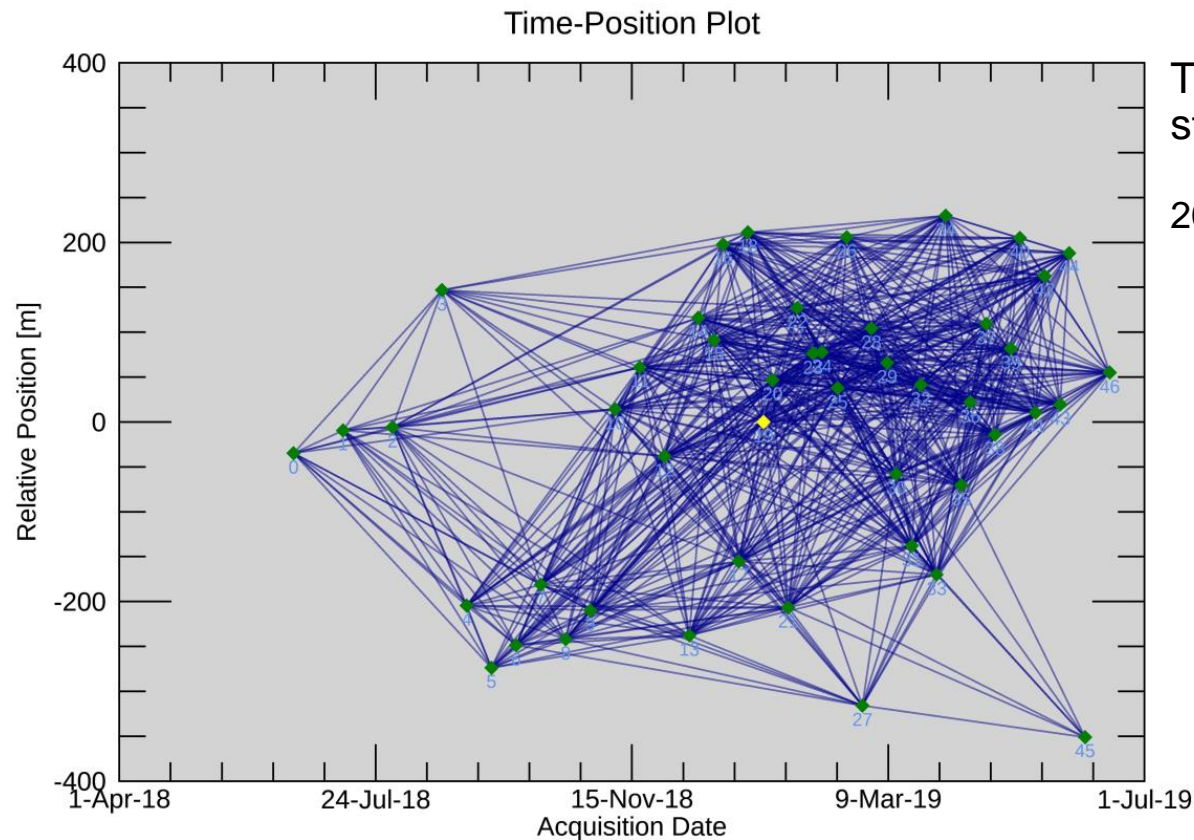
TSX/PAZ mixed data stack

2018/06/17 – 2019/06/15

Interferometric Validation

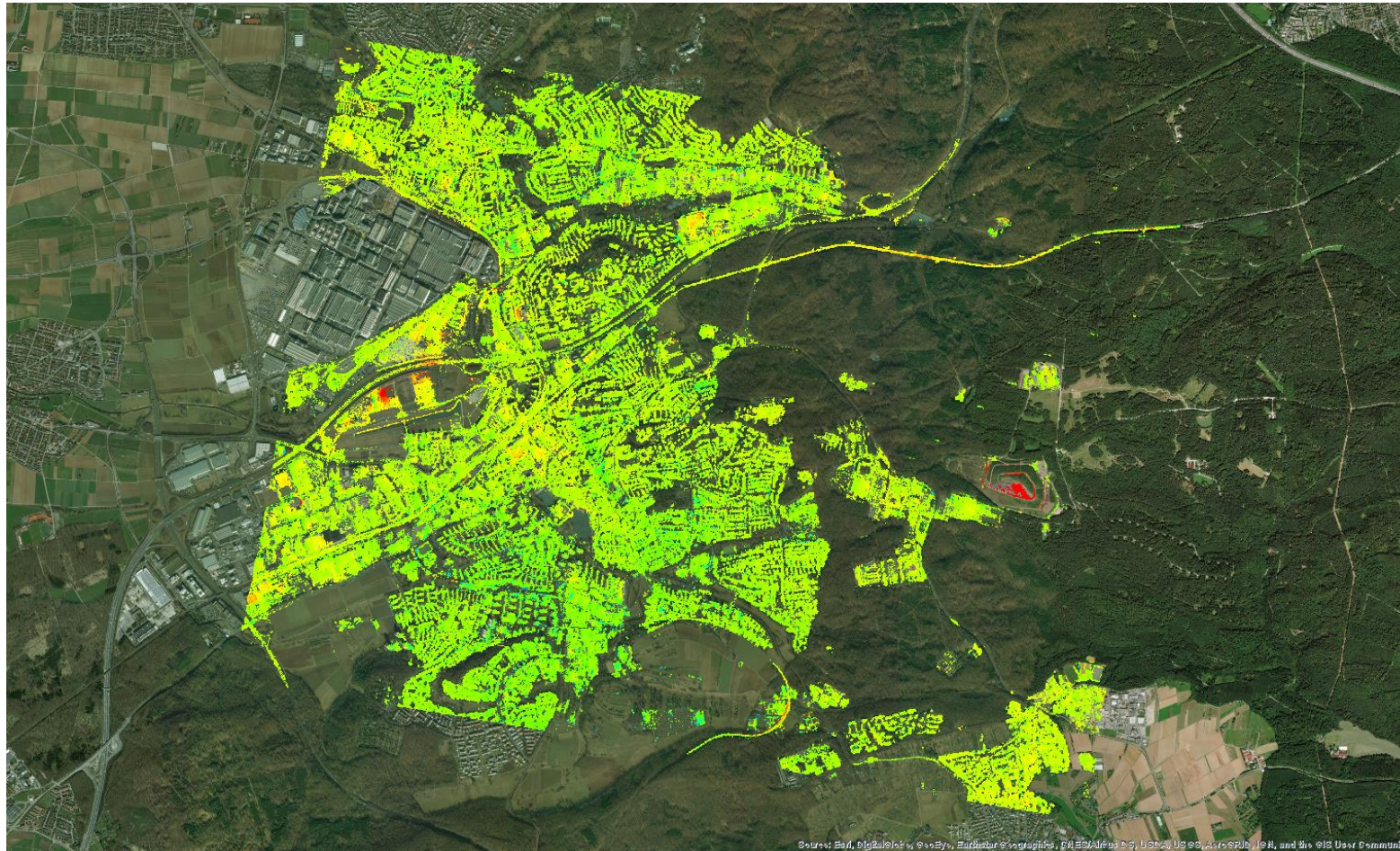**Objective:** Combined use of TSX and PAZ for Interferometry

Approach: Analysis of a mixed TSX/PAZ data stack

Analysis of TSX/PAZ baselines

Results: Baselines well within nominal tube

AIRBUS

Radar Constellation Validation

TerraSAR / PAZ SBAS Result Böblingen

TSX/PAZ mixed data stack: 2018/06/17 – 2019/06/15

Interferometric Validation

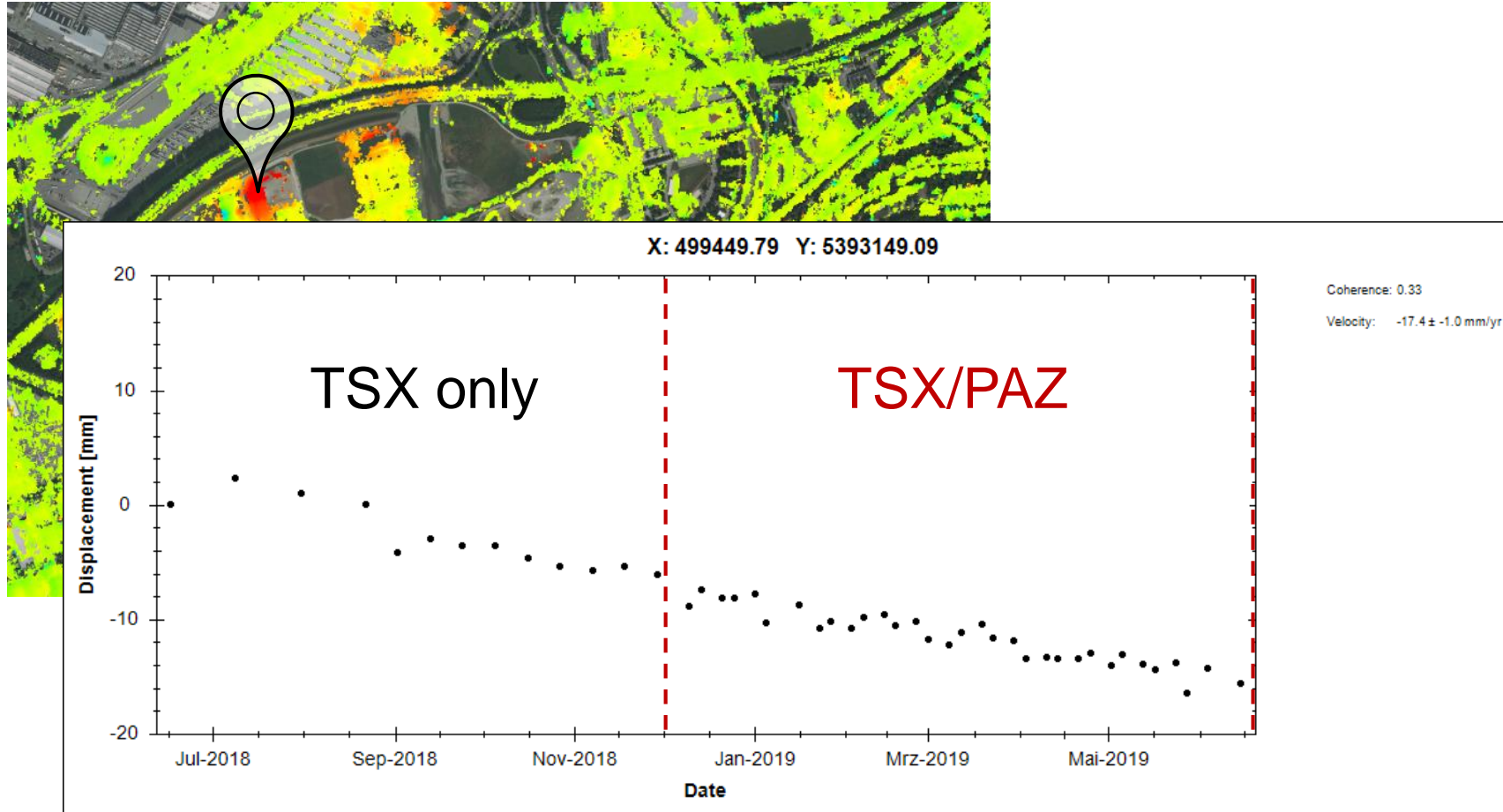**Objective:** Combined use of TSX and PAZ for Interferometry

Approach: Analysis of a mixed TSX/PAZ data stack

SBAS Analysis

Results: No abnormalities while interferometric processing

AIRBUS

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

Radar Constellation Validation

TerraSAR / PAZ SBAS Result Böblingen

TSX/PAZ mixed data stack: 2018/06/17 – 2019/06/15
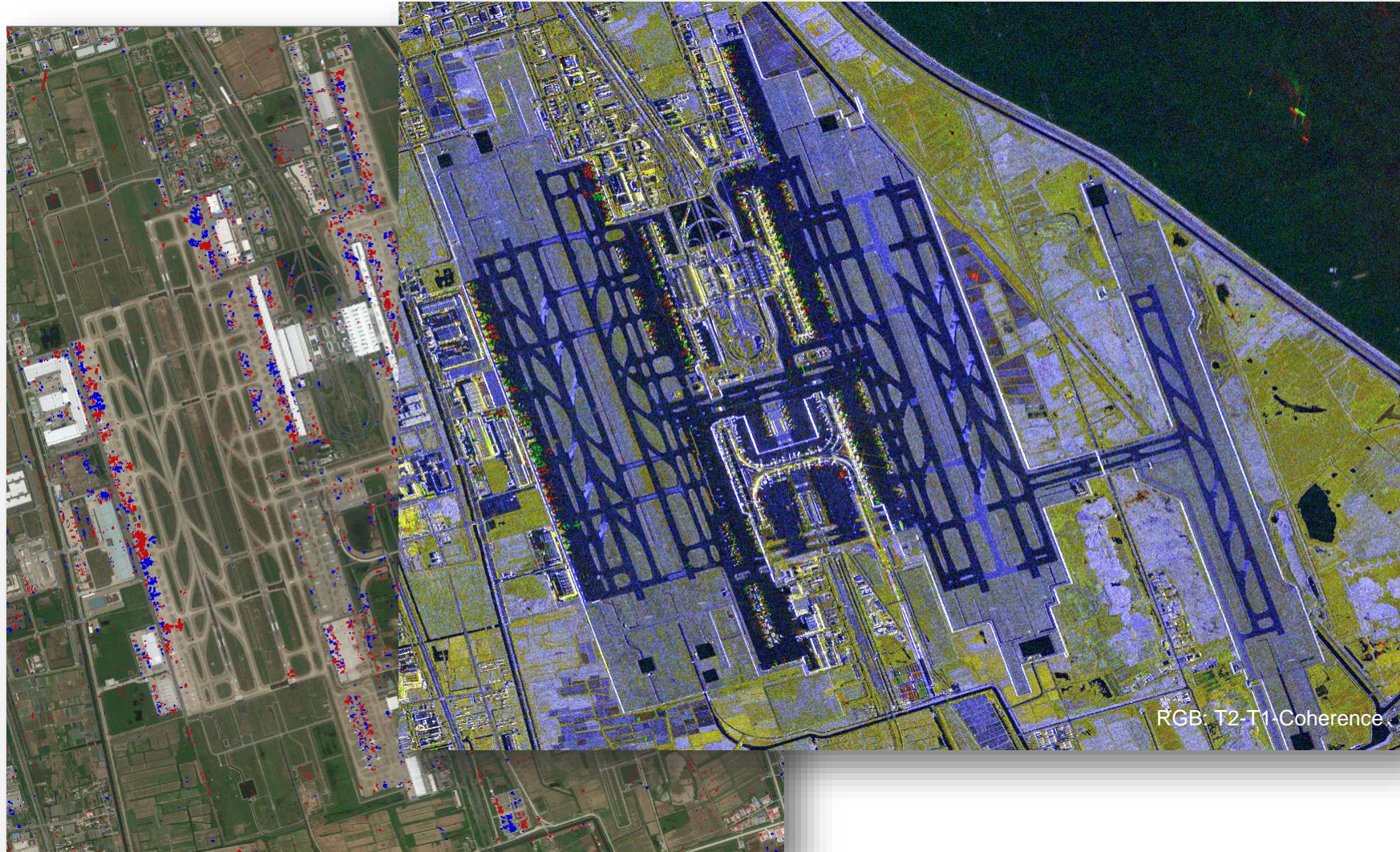
Interferometric Validation

Objective: Combined use of TSX and PAZ for Interferometry

Results:
TSX/PAZ baseline within nominal tube

No abnormalities while interferometric processing

SMM procedures with TSX/PAZ well done

AIRBUS

Radar Constellation Validation

RGB: T2-T1-Coherence

Change Detection Validation

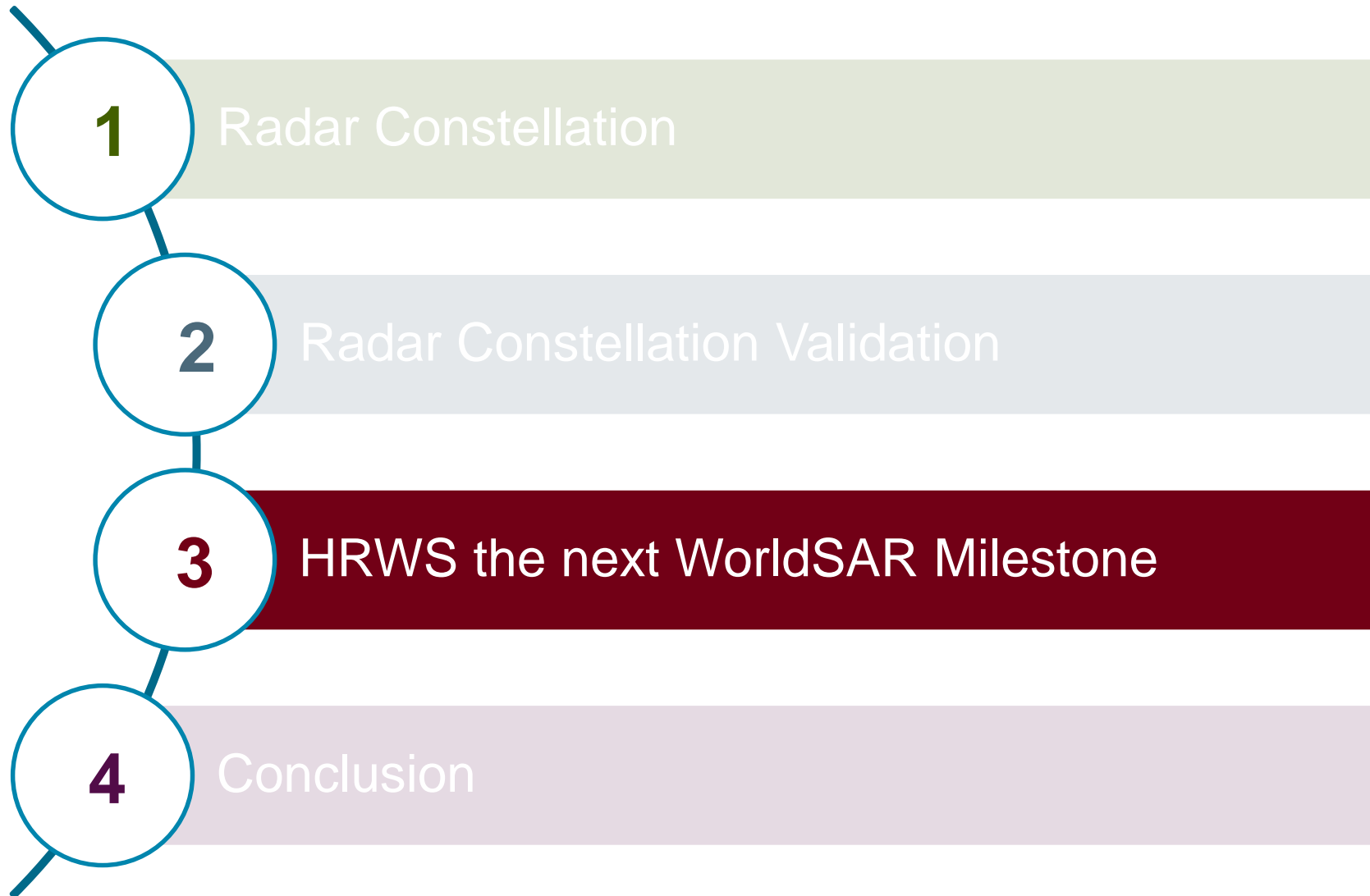**Objective:** Exploit increased revisit rate for Change Detection

Approach: Combined Amplitude & Coherence Change Detection
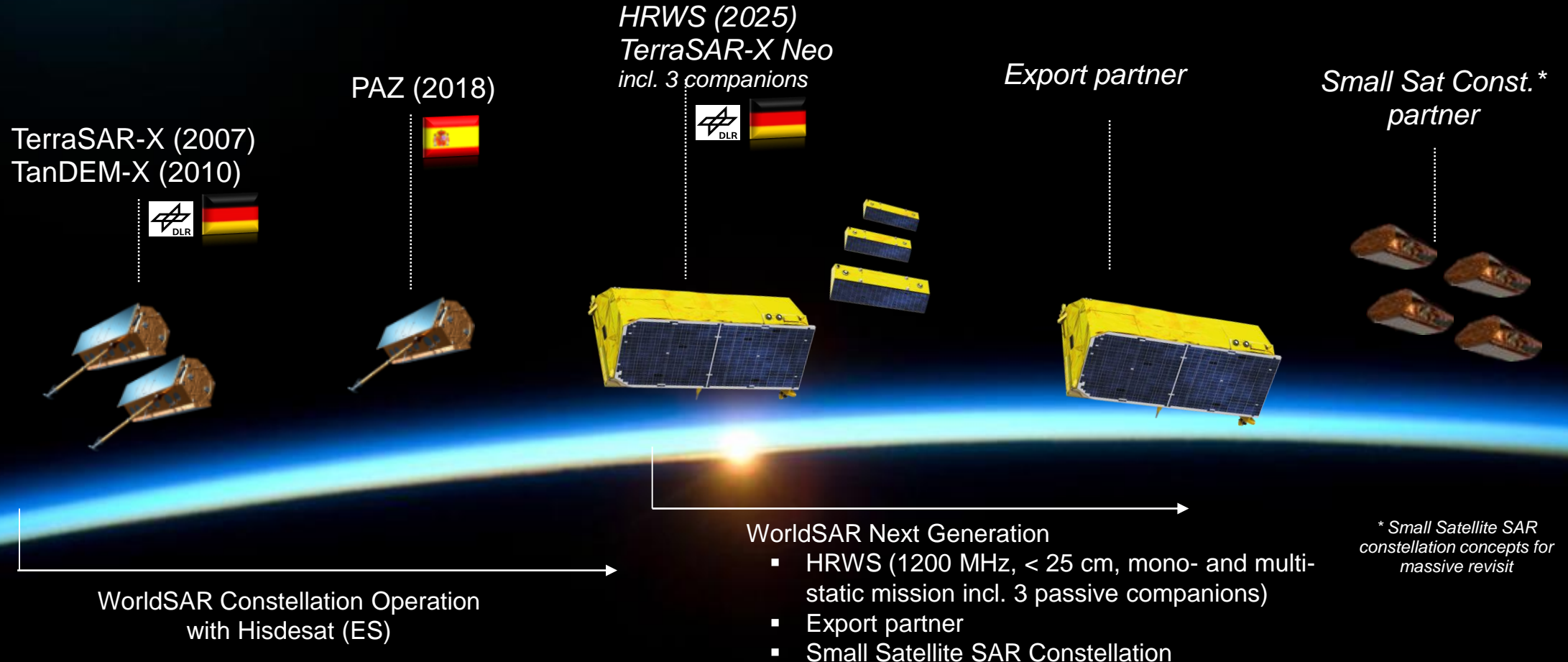
Results: Image co-registration is precise

Amplitude & phase coherence exploitable for CD

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

AIRBUS

Agenda

1 Radar Constellation

2 Radar Constellation Validation

3 HRWS the next WorldSAR Milestone

4 Conclusion

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

AIRBUS

WorldSAR – Current and Future Missions

HRWS (2025)
TerraSAR-X Neo
incl. 3 companions

PAZ (2018)

Export partner

*Small Sat Const.**
partner*

TerraSAR-X (2007)
TanDEM-X (2010)

WorldSAR Constellation Operation
with Hisdesat (ES)

WorldSAR Next Generation
- HRWS (1200 MHz, < 25 cm, mono- and multi-static mission incl. 3 passive companions)
- Export partner
- Small Satellite SAR Constellation

** Small Satellite SAR
constellation concepts for
massive revisit*

AIRBUS

HRWS Mission Background

Mission Context and Status

- Next National Civilian X-Band SAR Mission to continue the successful TerraSAR-X and TanDEM-X Missions

- Partnership approach between DLR Space Administration, Industry and international Partners

- Opportunity for joint mission development, manufacturing and utilization

- Phase 0/A Study contracted by DLR to Airbus

- Preliminary Requirements Review successfully passed

- Launch envisaged for 2025

Main User Groups

Institutional Users including MOD

Science Users

Commercial Users

AIRBUS

HRWS Capability Overview

Best in class X-Band data and innovative multi-static 3D measurements

☑ Better resolutions and wider swaths at excellent image quality

☑ Best commercially available resolution (25 cm)

☑ High agility and flexibility

☑ On-demand high resolution digital elevation models

☑ Largely improved access revisit

☑ Low global latency through Space Data Highway (Option)

☑ Multi-polarisation (Quad Pol) for improved feature discrimination

☑ Ground Moving Target Identification (GMTI) / ATI capability
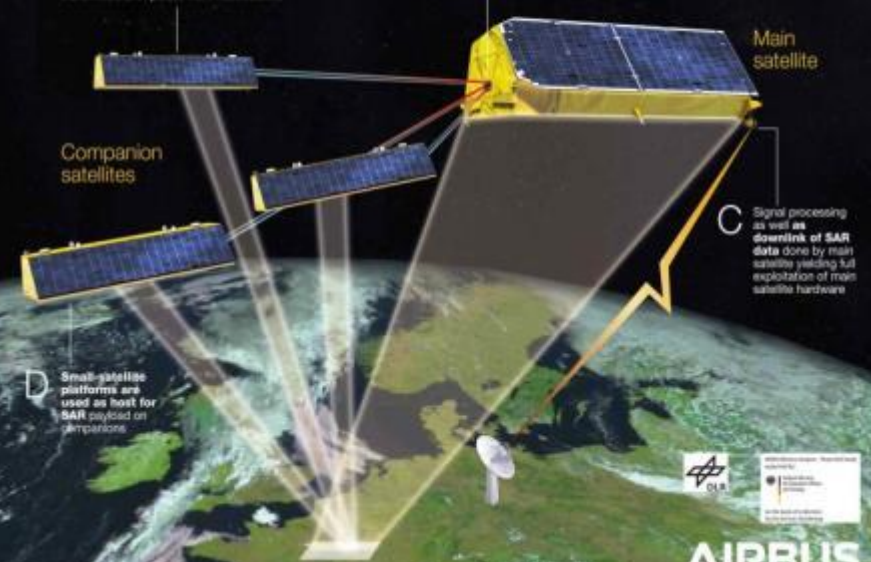
HRWS SAR Performance Examples – VHR SpotLight
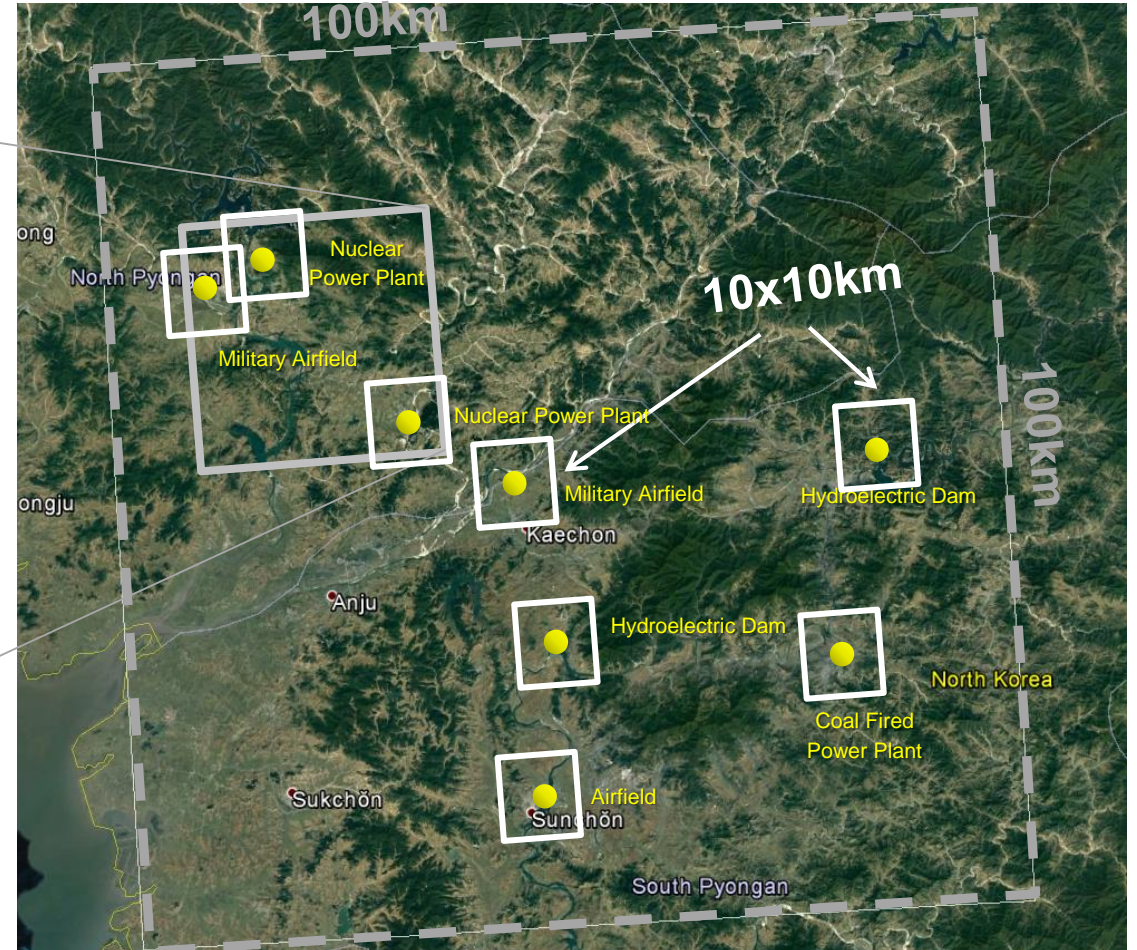

1 m | TerraSAR-X

25 cm | HRWS

Polarimetry | HRWS
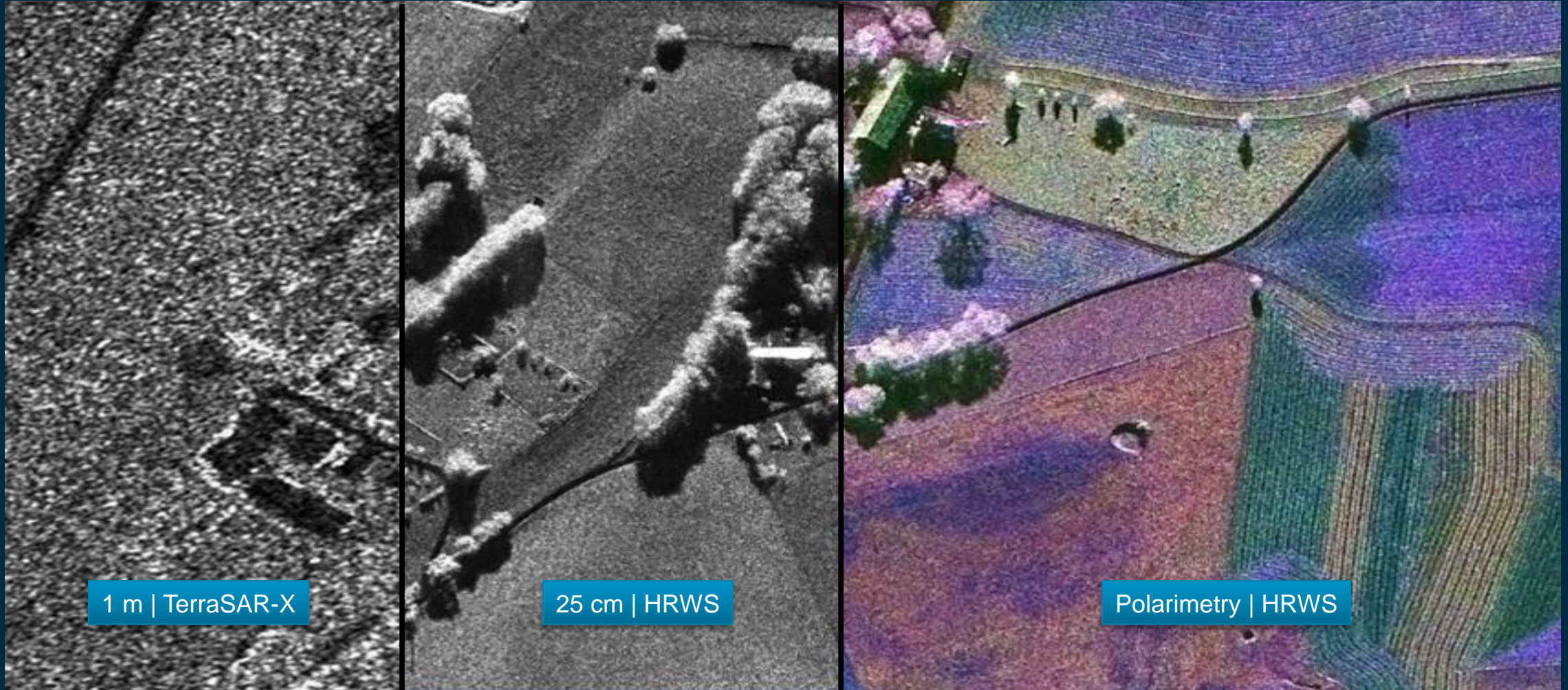
VHR Imaging Modes for Site Monitoring

25 cm VHR Spot Light Mode
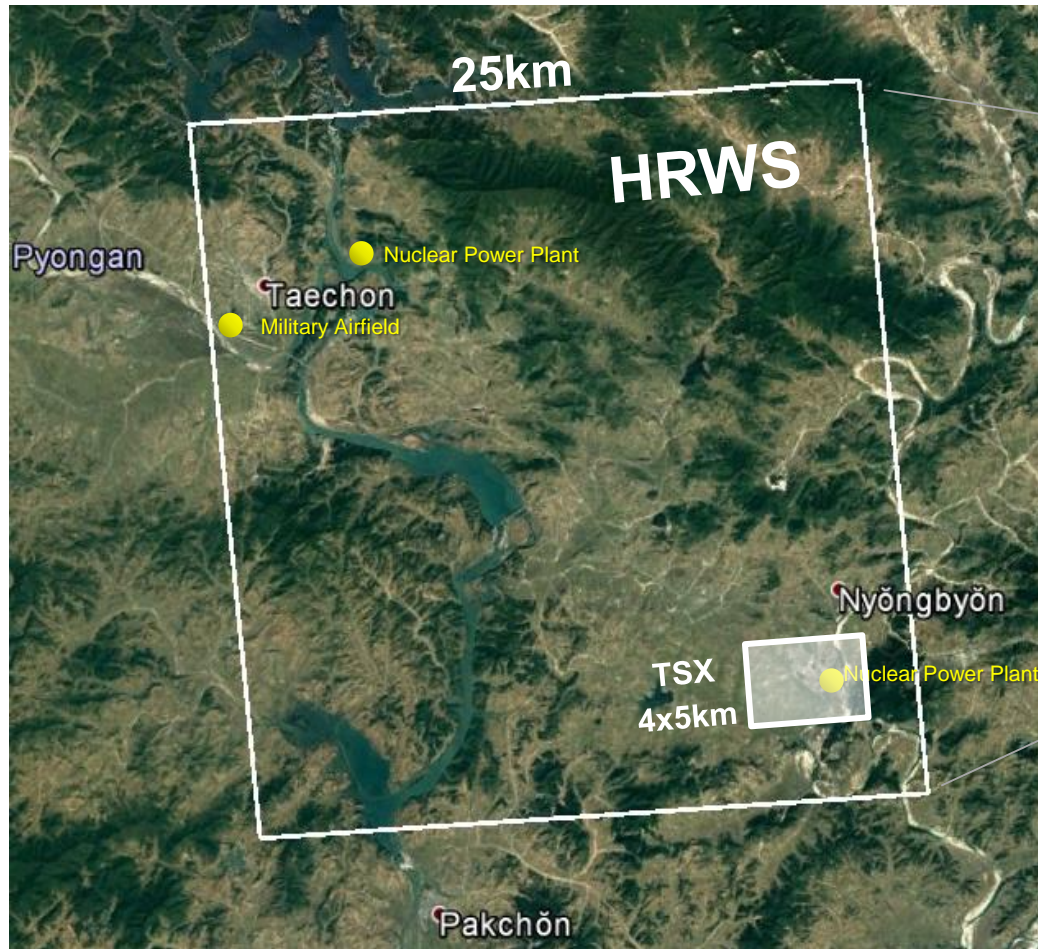
Theatre Mode in 25 cm VHR resolution

Revisit: 15 h

Revisit: 17 h

AIRBUS
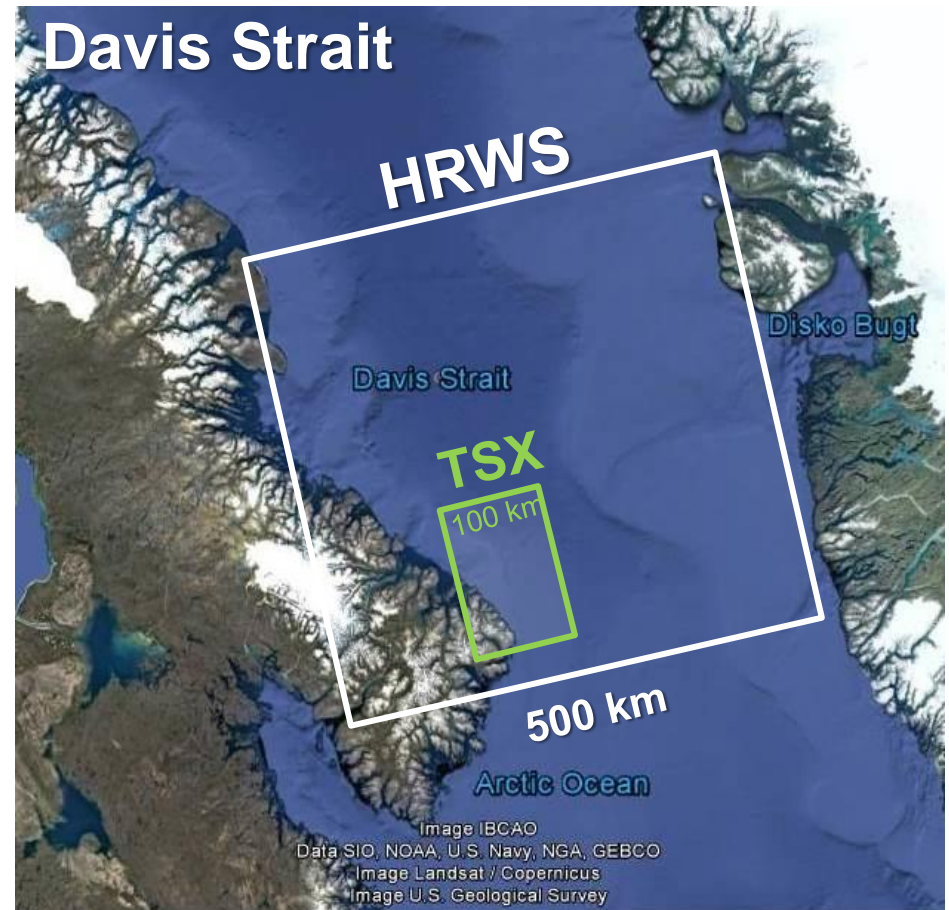
Improved Stripmap and ScanSAR Modes for Monitoring & Surveillance

Larger Coverage <u>and</u> better resolution in Stripmap

Large area maritime surveillance in ScanSAR

AIRBUS

Agenda

1 Radar Constellation

2 Radar Constellation Validation

3 HRWS the next WorldSAR Milestone

4 Conclusion

VH-RODA & CEOS SAR Calibration & Validation Workshop, 18th – 22nd November 2019. Frascati

AIRBUS
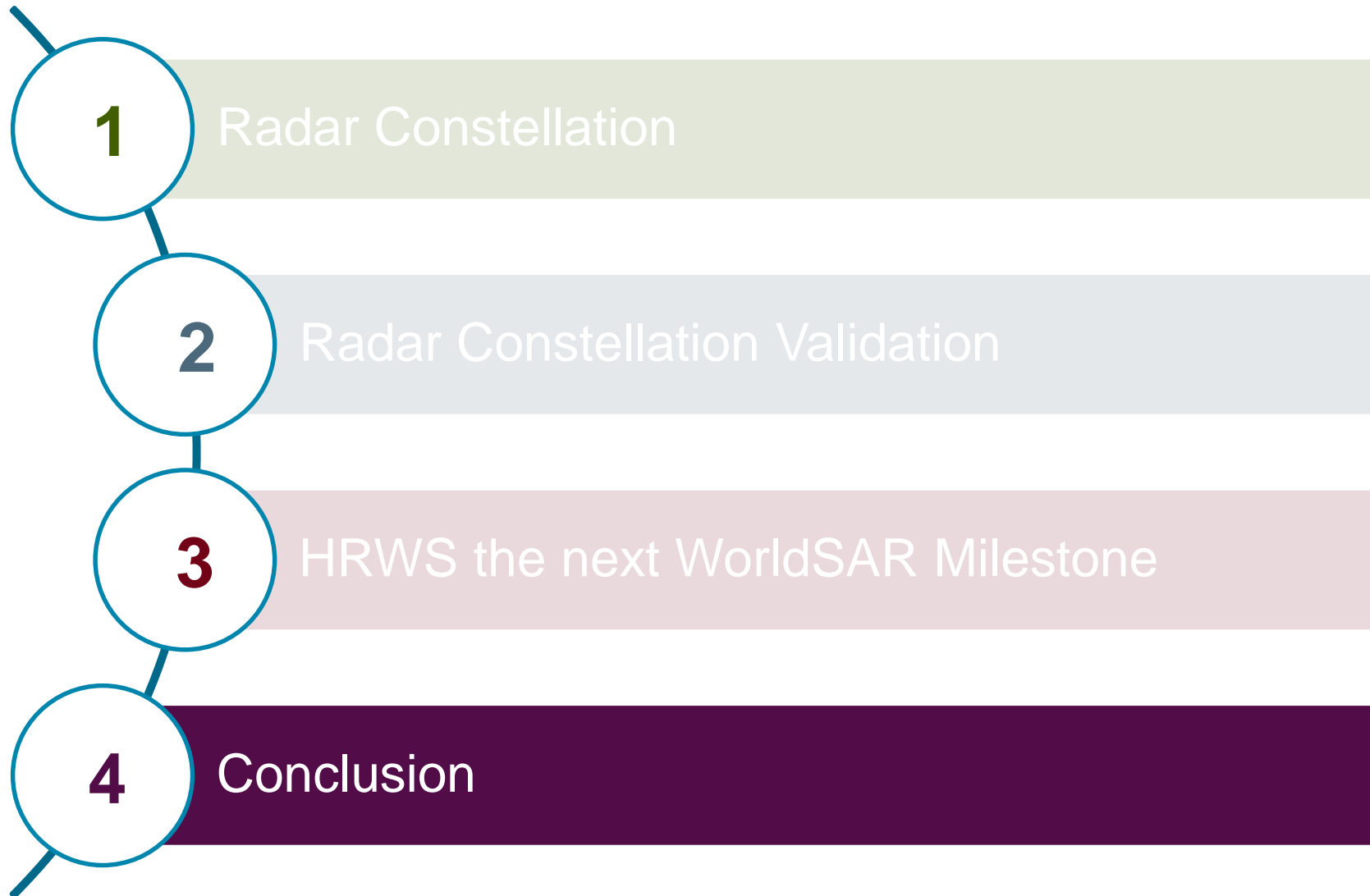
Conclusion

- The Radar Constellation is a unique programme in EO industry

- First SAR Constellation of independent Missions and first major milestone in the WorldSAR Programme

- The Radar Constellation will provide homogeneous Constellation Products and Services

- TerraSAR and PAZ Data can perfectly be used for combined applications

- HRWS / TerraSAR-X Neo is the next major breakthrough in commercial SAR Services

AIRBUS

Thank you very much!

Jürgen Janoth

Head of Innovation & Product Management |
SAR Applications

Intelligence

Juergen.janoth@airbus.com

+49 7545 84291

AIRBUS