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# PAZ Status After First Year of Operation

Juan Manuel Cuerda Muñoz  
[cuerdamjm@inta.es](mailto:cuerdamjm@inta.es)

Nuria Casal, Patricia Cifuentes, Marcos García, Nuria Gimeno, María José González

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- PAZ Mission
- Instrument Monitoring
- Calibration
- Next Steps

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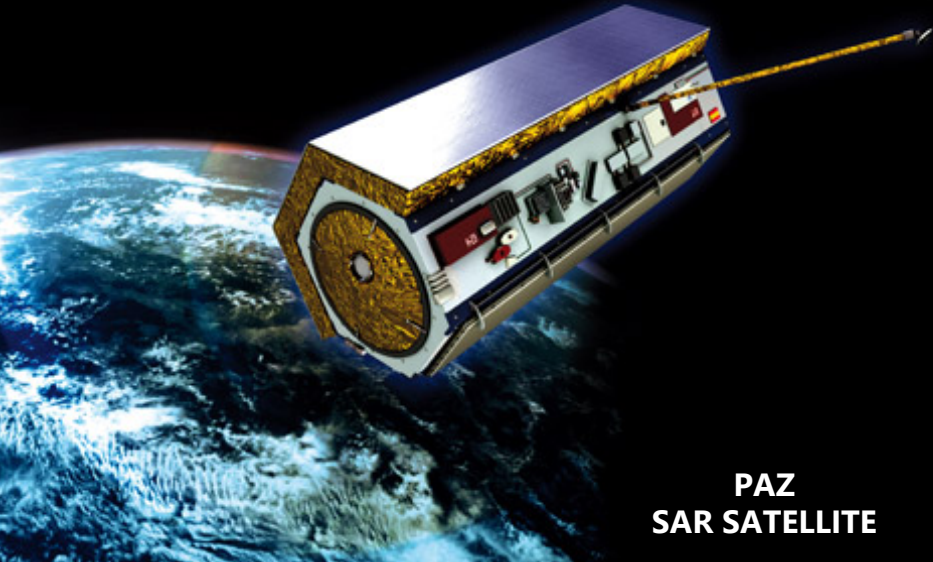
PAZ Mission

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# PNOTS

## National Plan for Earth Observation

Launch date: 22 February,  
2018



**PAZ**  
**SAR SATELLITE**

Launch date: mid  
2020



**INGENIO-SEOSAT**  
**OPTICAL SATELLITE**

# PAZ Mission Structure

DEFENCE MINISTRY

DEVELOPMENT

SPACE SEGMENT

AIRBUS



Crisa Indra

GROUND SEGMENT



indra

gmv

deimos

isdefe

OPERATION

FLIGHT  
OPERATIONS  
SEGMENT



CIVIL PAYLOAD  
GROUND SEGMENT



DEFENCE PAYLOAD  
GROUND SEGMENT



CALVAL CENTER  
SCIENCE



SECURITY, ADMIN,  
MAINTENANCE



EXPLOITATION

COMMERCIAL  
SERVICES



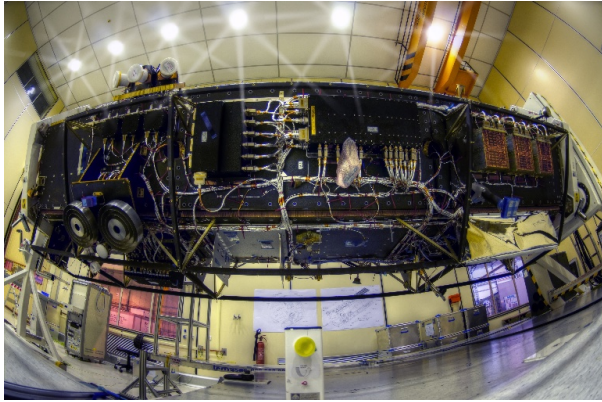
DEFENCE SERVICES



SCIENCE SERVICE  
SEGMENT



# PAZ satellite



©Hisdesat Servicios Estratégicos S.A. 2018



©Hisdesat Servicios Estratégicos S.A. 2018

## Orbital Characteristics

Nominal height over equator	514 km
Orbits / day	$15^{2/11}$
Revisit cycle	11 days
Inclination	97.42
Equatorial crossing of the ascending node (local)	18:00

## System parameters

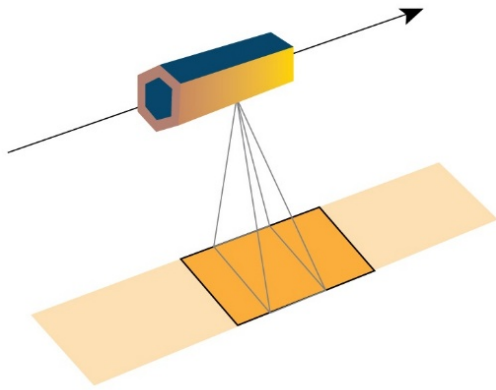
Central frequency	9,65 GHz
Incidence angles	20-45 (SM-SC) 20-55 (SL-HS)
Polarizations	HH, VH, HV, VV
Antenna length	4,8 m
Nominal antenna look direction	Right
Antenna width	0,7 m
Elevation beams (SM-SC)	27 / 12° <i>*Full Performance</i>
Elevation beams (SL-HS)	122 / 91° <i>*Full Performance</i>
Azimuth beams	115
PRF	2000-6500 Hz
Bandwidth (MHz)	100/150/300

PAZ orbits ahead of TSX \ TDX

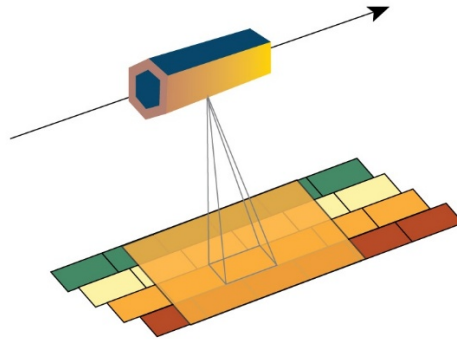
Same orbital plane, offset  
98.18° in true anomaly

Revisit time for interferometry  
4-7 days

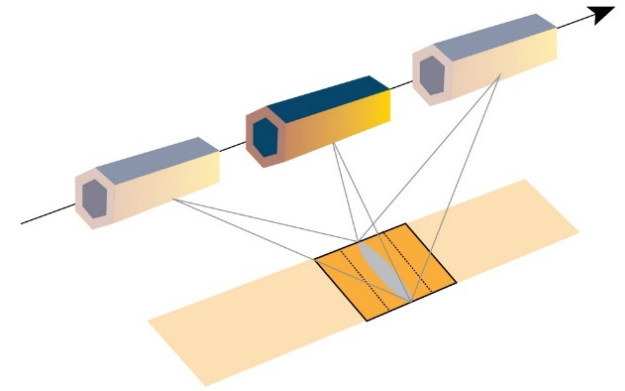
# PAZ Imaging Modes



Stripmap



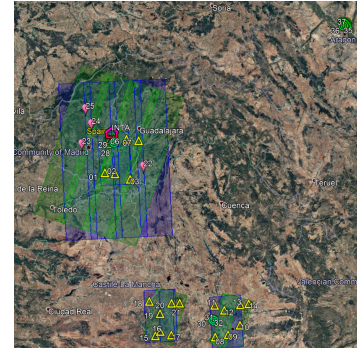
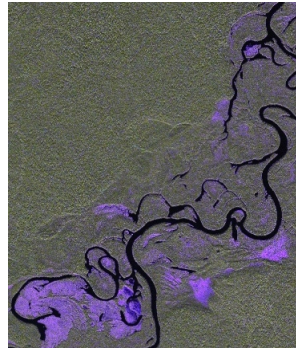
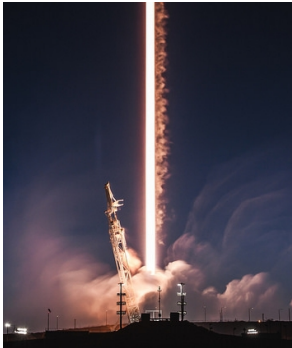
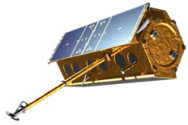
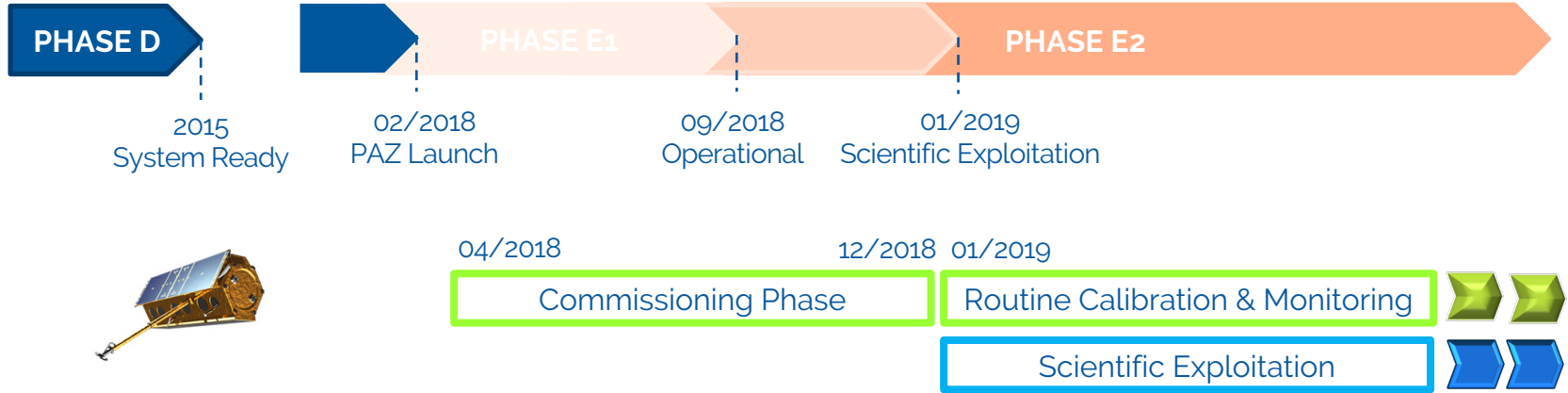
ScanSAR



Spotlight / High Resolution SL

PGS Upgrade for Wide ScanSAR and Staring Spotlight expected next year

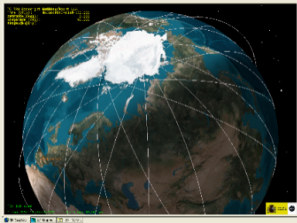
# PAZ Mission Milestones



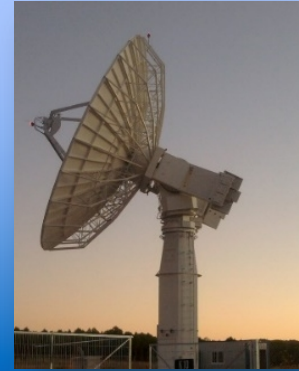


# Facts

+ 9200 orbits  
+ 396 MKm



+ 2420 contacts TRN-1  
+ 580.000 commands



October 2019  
>600 days in orbit

53.528 Commanded DT

Nominal Center:  
12.980 acquisition requests  
9.538 processing requests  
1.733 dissemination requests



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# Instrument Monitoring

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# Verification of **Nominal** **Performances &** Instrument **Stability**

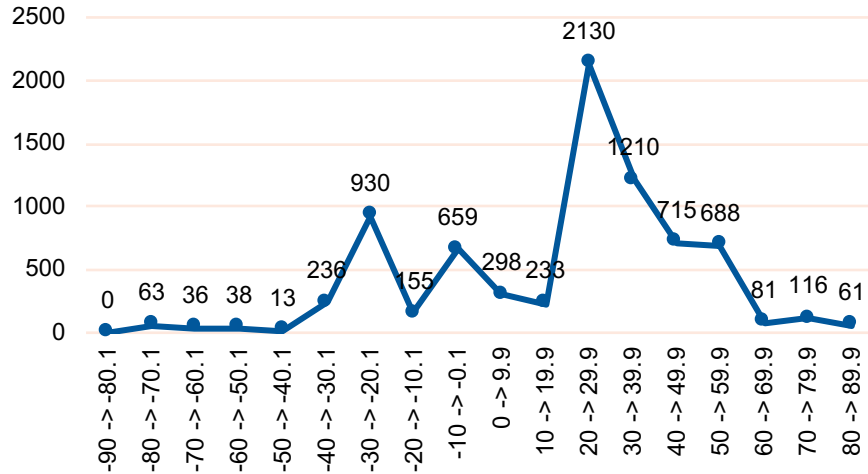
More than **7500**  
acquisitions analyzed



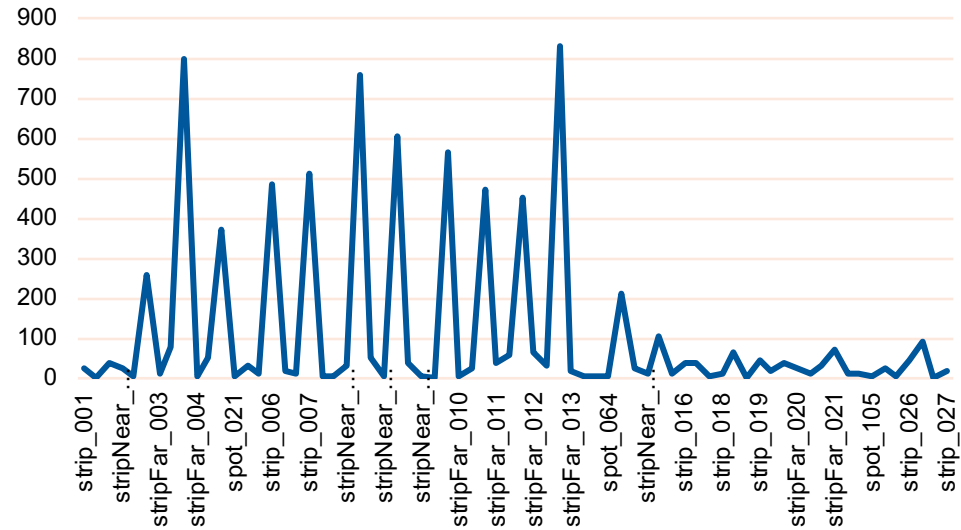
# Doppler Analysis

- All DTs available
  - Commercial and calibration DTs
  - Specific acquisitions to cover less used beams / latitudes
- 7797 DTs since 09/2018

## Number of DTs by latitude

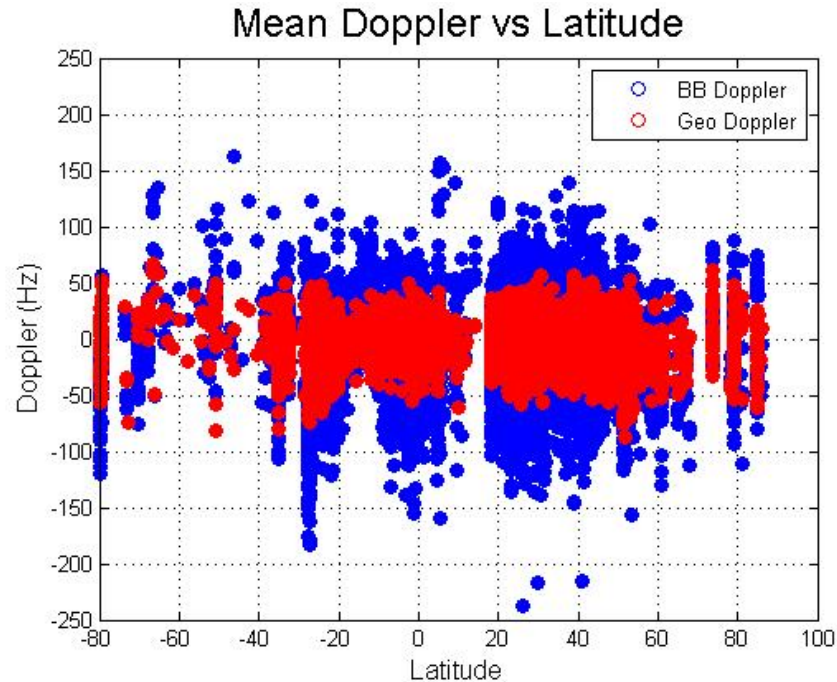


## Number of DTs by beam/look angle

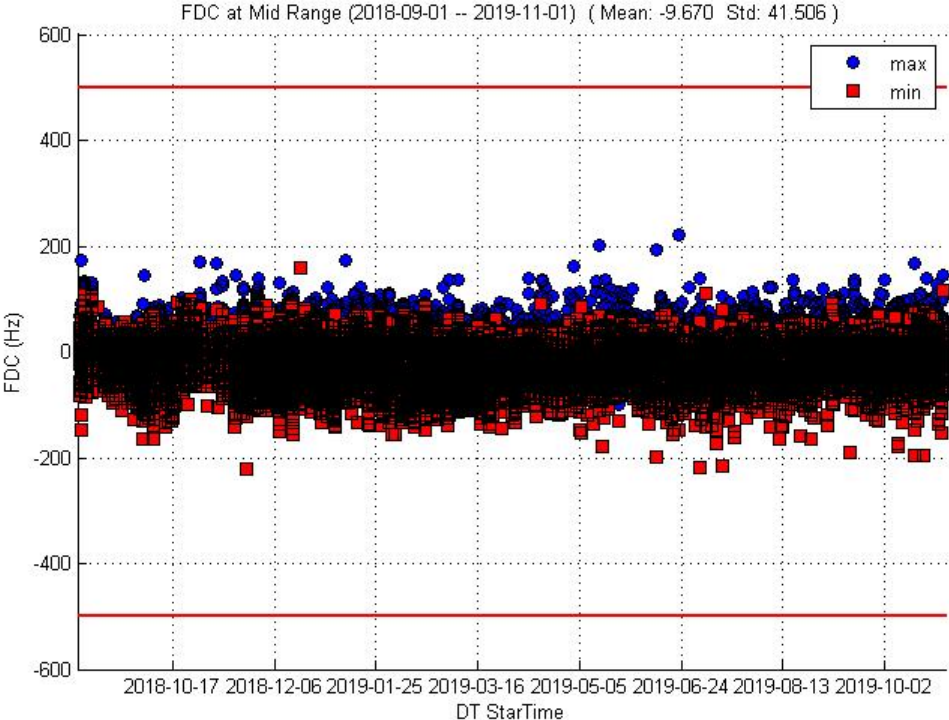


# Doppler Analysis By Latitude

	Min	Mean	Max	Std	Uncertainty
Geometric Doppler	-150.7612554	-2.139024077	134.9053015	20.49595307	0.232115611
BaseBand Doppler	-2816.736727	-14.50588825	1174.191264	46.00443377	0.52099784

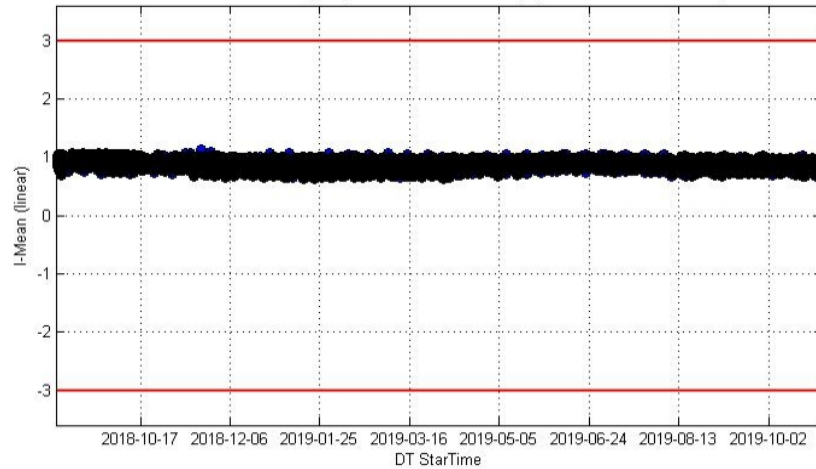


# Doppler Analysis over Time

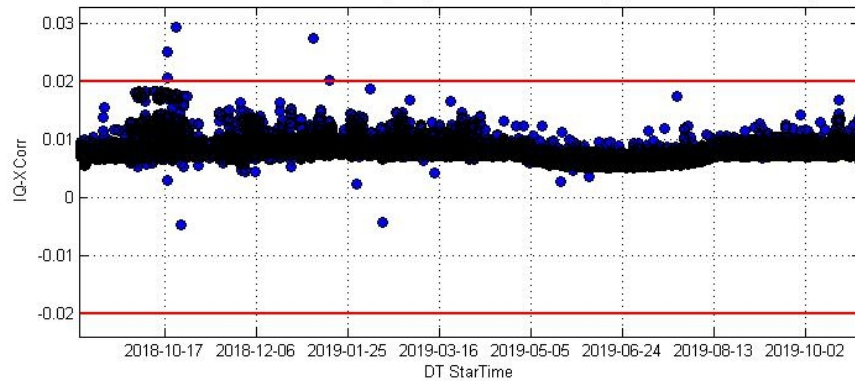


# RawData Analysis

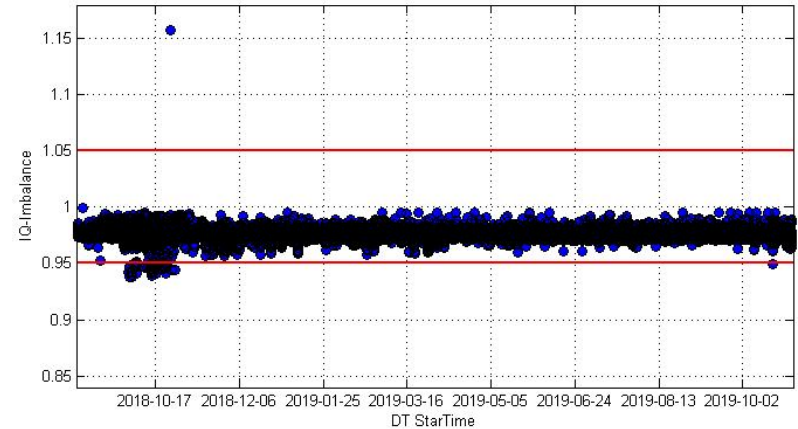
Mean Value of the I Signal (2018-09-01 -- 2019-11-01) ( Mean: 0.853 Std: 0.082 )



Cross Correlation between I and Q signals (2018-09-01 -- 2019-11-01) ( Mean: 0.008 Std: 0.002 )



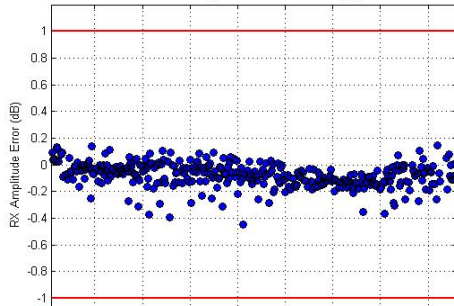
Imbalance between I and Q signals (2018-09-01 -- 2019-11-01) ( Mean: 0.975 Std: 0.005 )



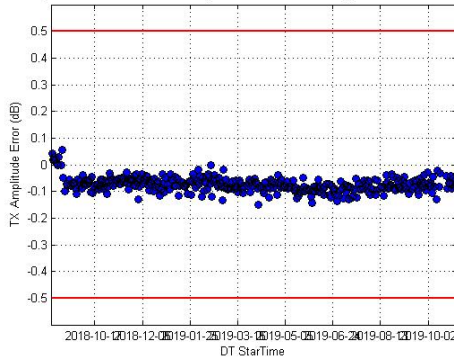
# TRM Analysis

Specific DTs for PN-Gating analysis  
3 acquisitions every day (Row, Panel and Module)  
413 analysis performed

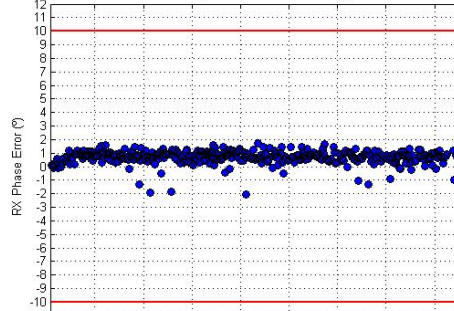
RX Amplitude error of TRM number 40 (2018-09-01 -- 2019-11-01) ( Mean: -0.078 Std: 0.090 )



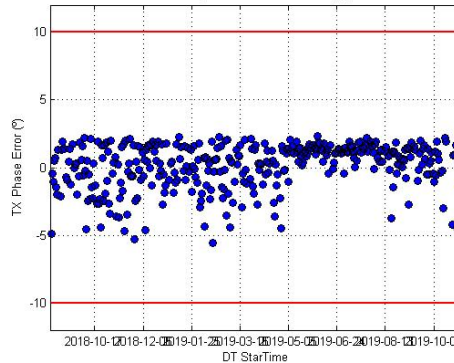
TX Amplitude error of TRM number 40 (2018-09-01 -- 2019-11-01) ( Mean: -0.074 Std: 0.028 )



RX Phase error of TRM number 40 (2018-09-01 -- 2019-11-01) ( Mean: 0.692 Std: 0.496 )



TX Phase error of TRM number 40 (2018-09-01 -- 2019-11-01) ( Mean: 0.139 Std: 1.657 )





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An aerial grayscale photograph of a rural landscape. The image shows a patchwork of agricultural fields, a central lake, and some buildings. The word "Calibration" is overlaid in large white text in the center. Two horizontal white lines are present: one near the top and one near the bottom of the image.

# Calibration

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# Channel Imbalance

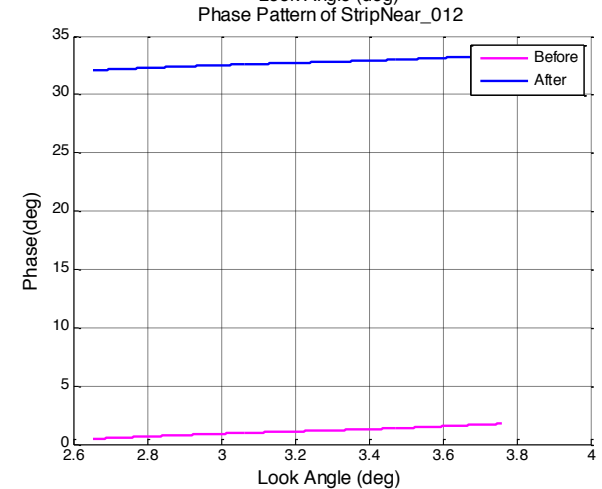
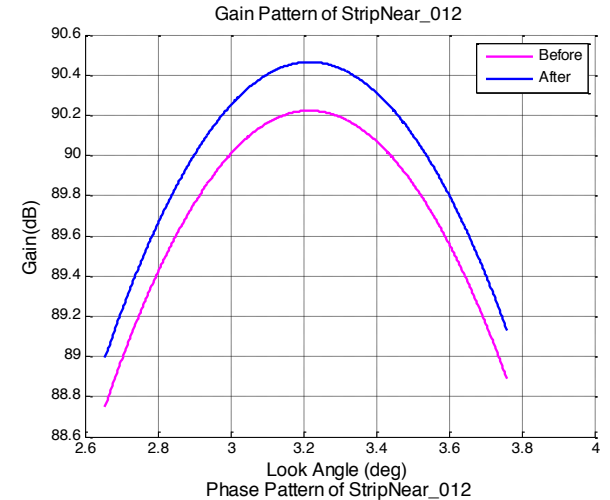


# Statement

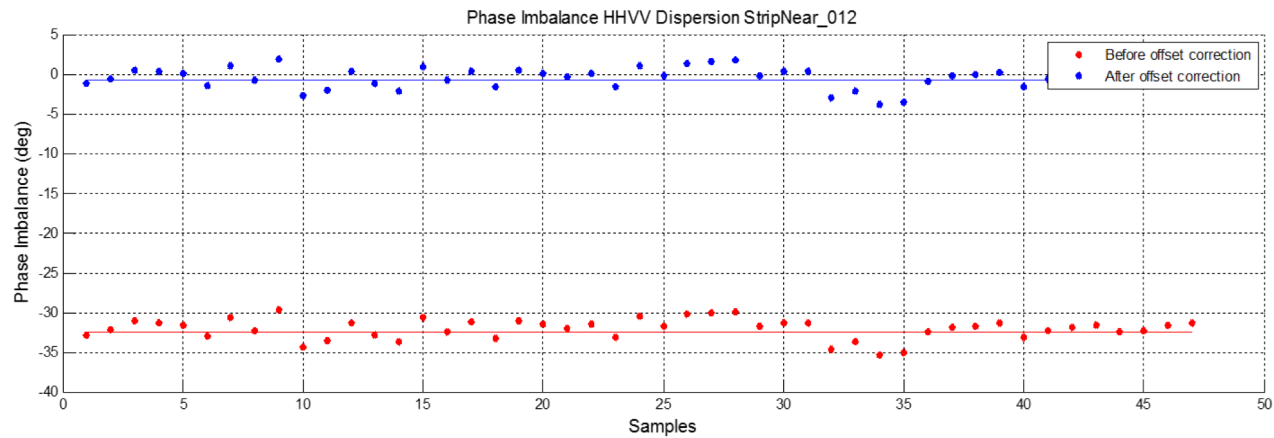
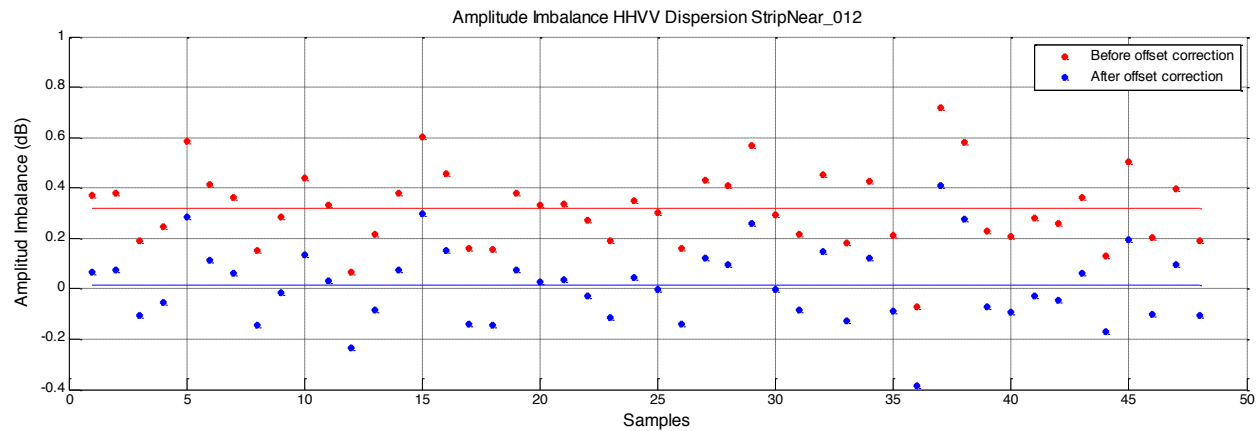
Commissioning Phase StripNear_012				
Co-Polar (HH-VV)	Target	Measurements	Mean	StdDev
Amplitude (dB)	CR	53	0,3252	0,1522
Phase (deg)	CR	53	-32,0408	1,2741



Channel Imbalance: Jan-19 Configuration Update StripNear_012				
Co-Polar (HH-VV)	Target	Measurements	Mean	StdDev
Amplitude (dB)	CR	53	0,0154	0,1520
Phase (deg)	CR	53	-0,4604	1,3023

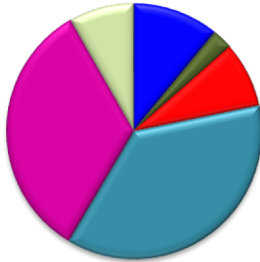


# StripNear\_012 Correction

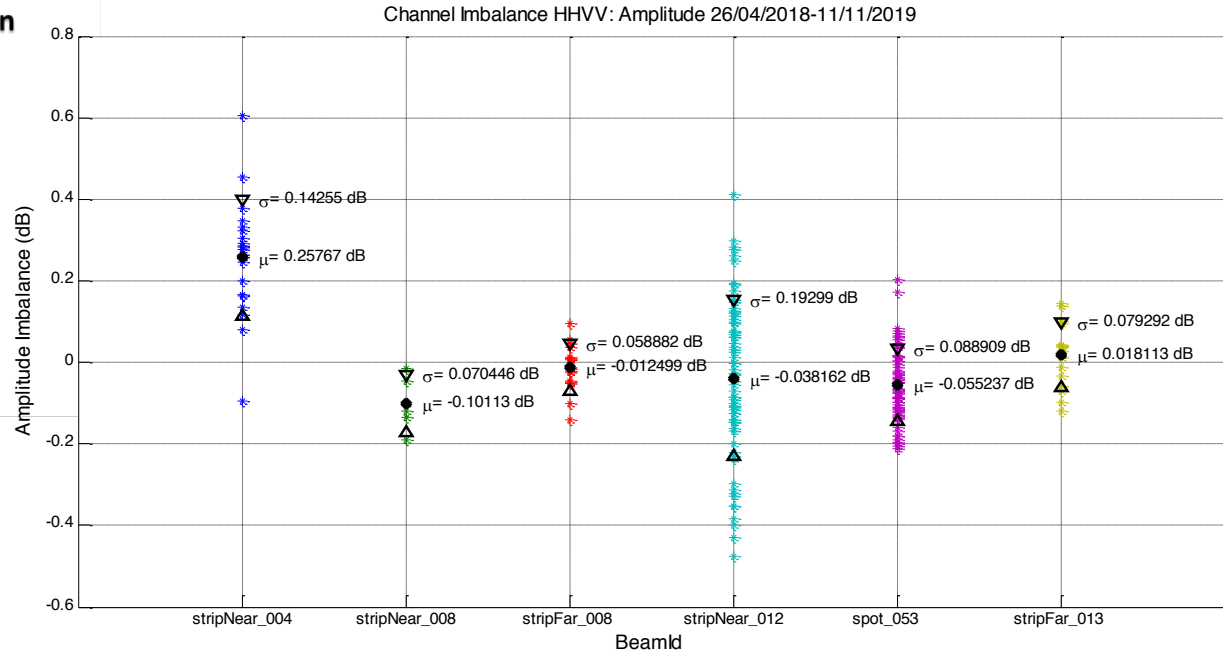


# Configuration Update: Amplitude Analysis

Channel Imbalance data distribution



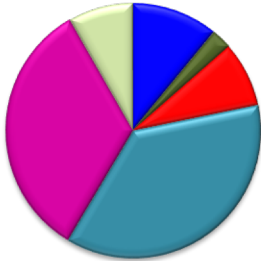
- stripNear\_004
- stripNear\_008
- stripFar\_008
- stripNear\_012
- spot\_053
- stripFar\_013



Amplitude Imbalance < 0,25dB

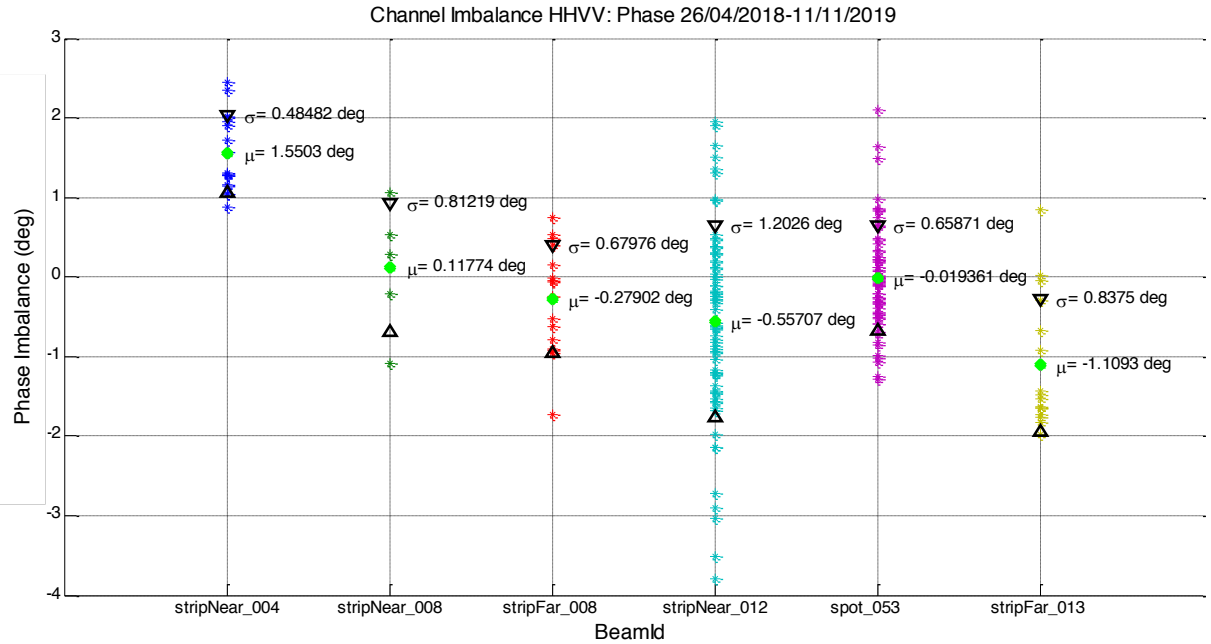
# Configuration Update: Phase Analysis

## Channel Imbalance data distribution



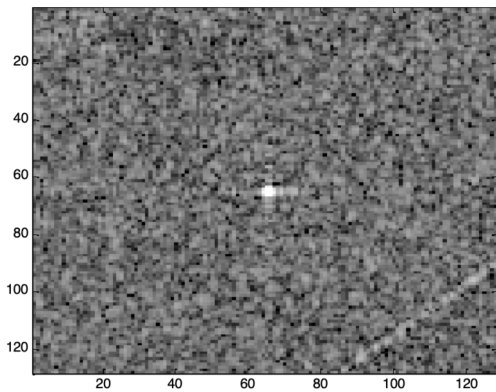
stripNear\_004 stripNear\_008 stripFar\_008  
stripNear\_012 spot\_053 stripFar\_013

Phase Imbalance < 1.55 deg

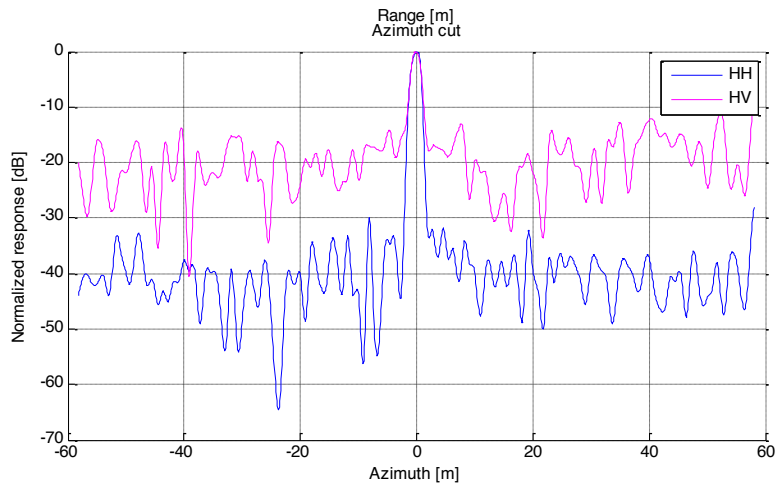
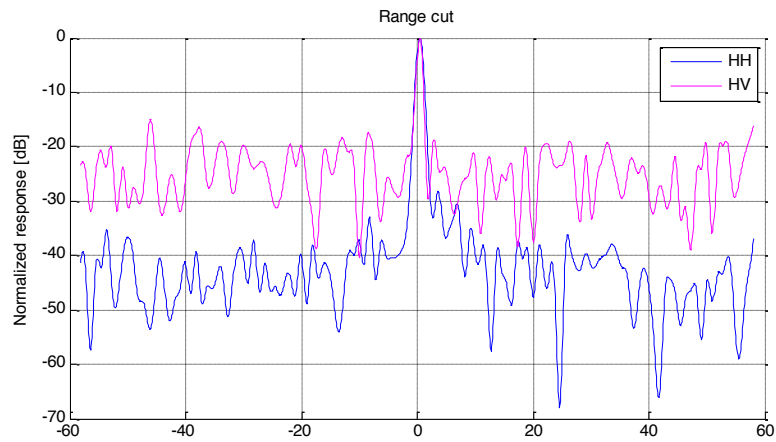
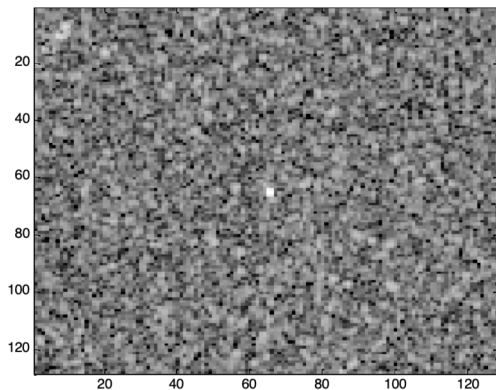


# Cross Polar Isolation

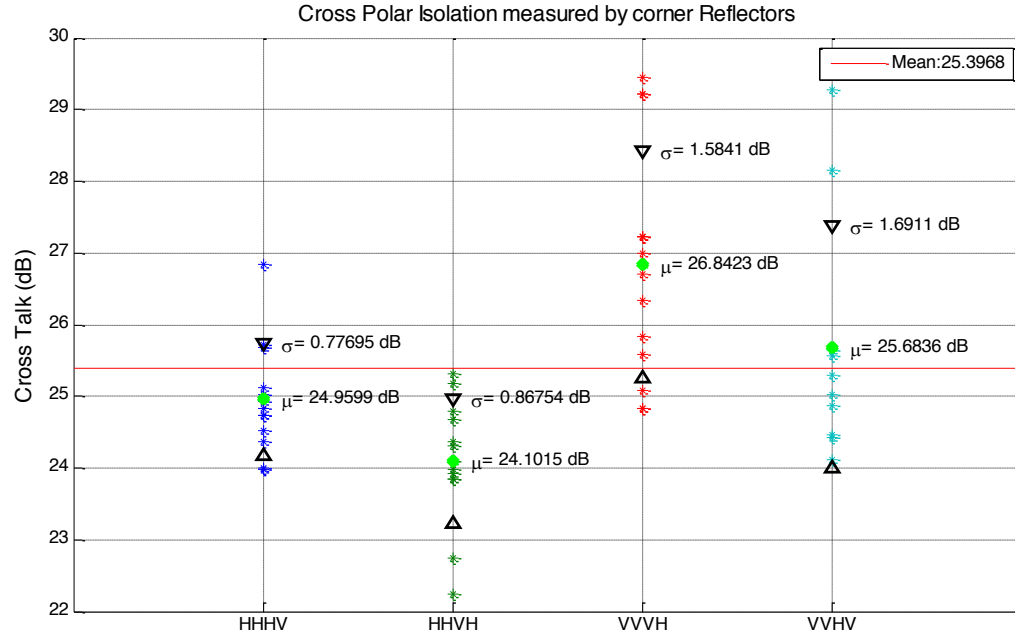
HH



HV



# Cross Polar Isolation



Cross Polar Isolation > 24.10 dB

Cross Polar Isolation: Measurements by Reference Targets					
Reference Channel	Cross Channel	Target	n° measurements	mean (dB)	std (dB)
HH	HV	CR	13	24,9599	0,7769
HH	VH	CR	13	24,1015	0,8675
VV	VH	CR	14	26,8423	1,5841
VV	HV	CR	10	25,6836	1,6911



# Geometric Analysis



# Geometric Accuracy Analysis

## TEST DATA SET

DTs over P.T.  
INTA CRs + CEOS PTs:  
Right Looking acquisitions  
Variability:  
Inc.Angle  
Asc/Des  
Imaging Mode  
Polarization  
C.P + Monitoring Cycles



## ACTIVITIES

Pixel Location Accuracy Determination Update

- SSC product based -

Pixel Geolocation Accuracy Characterization.

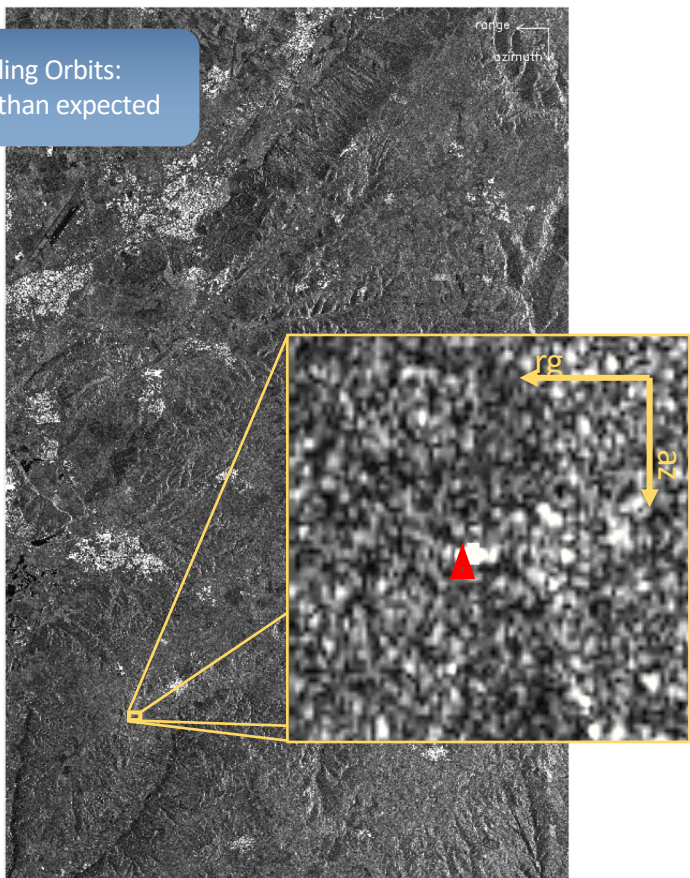
- Geocoded products based -

# Pixel Location Accuracy Determination Update

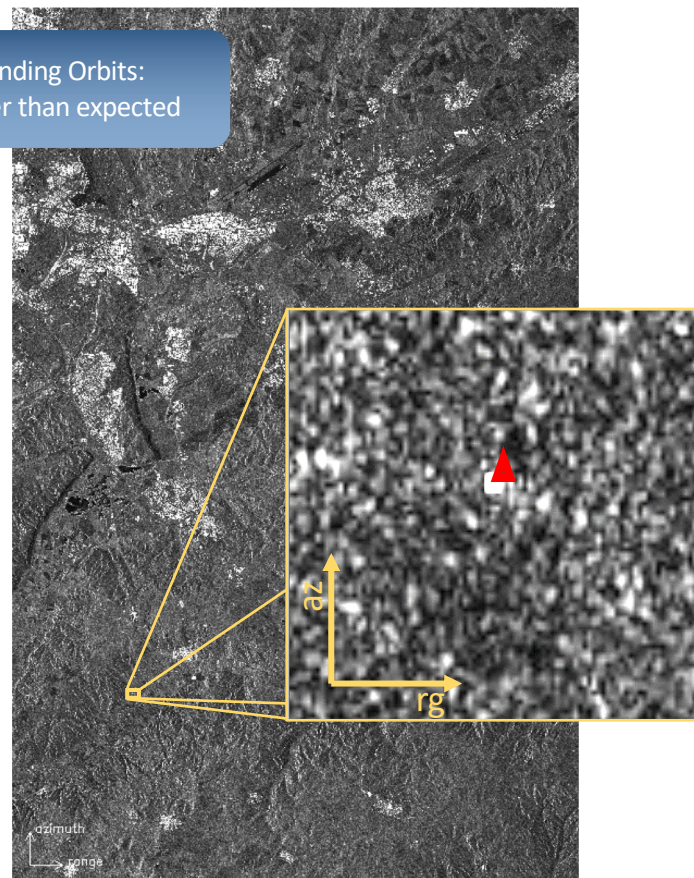
Orbit vs. GPS Locations Reference  
Frame Harmonization

# Radar Coordinates Offsets identified

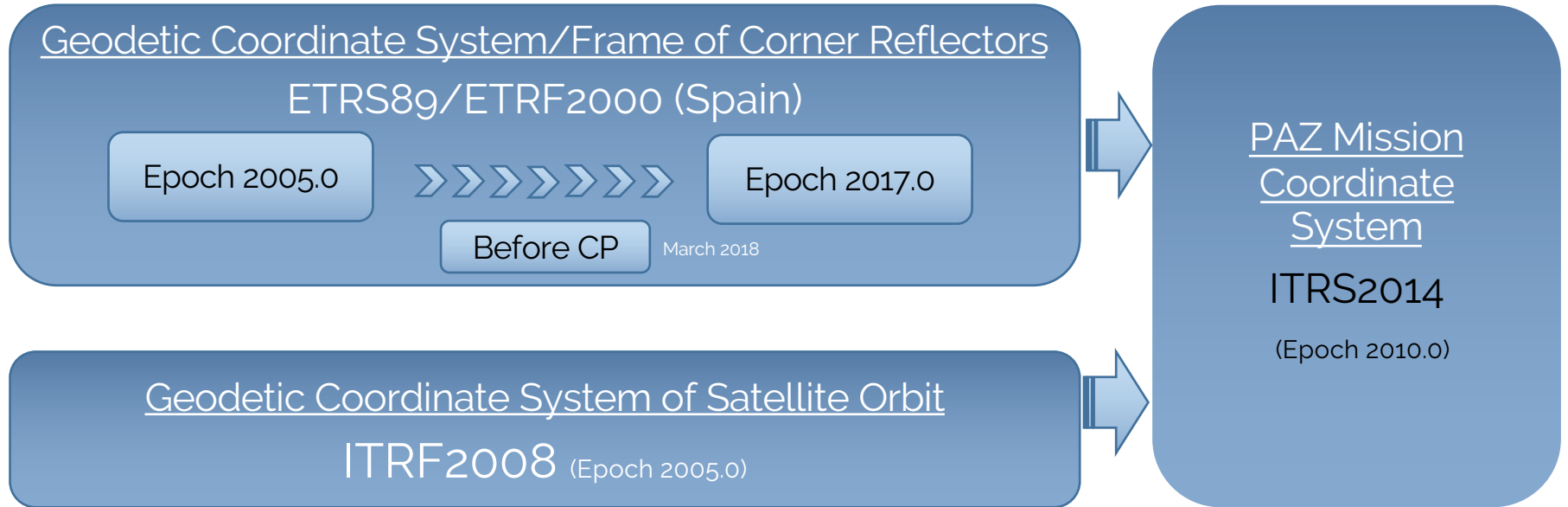
Descending Orbits:  
CRs before than expected



Ascending Orbits:  
CRs after than expected



# Coordinate Systems Misinterpretation\*

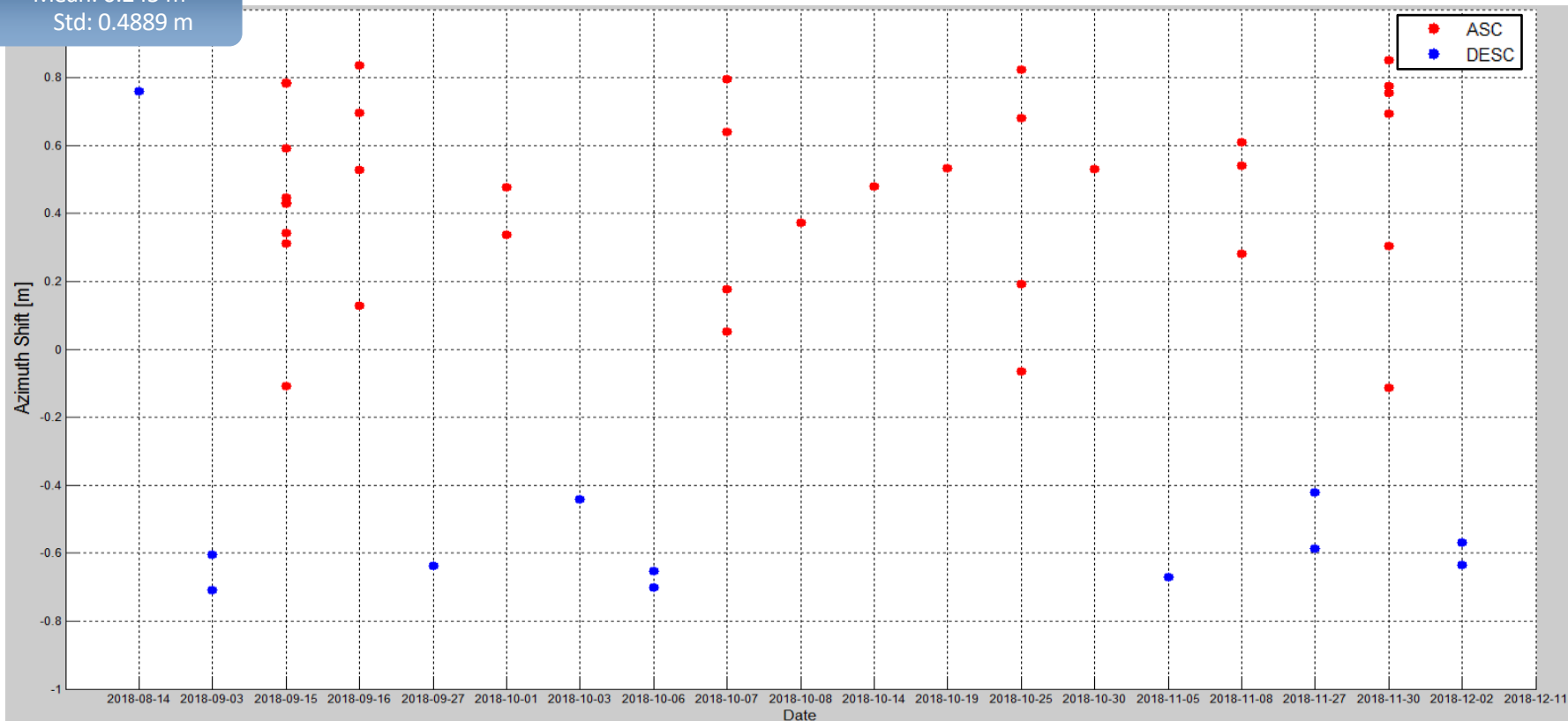


\* Balss, Cong, Eineder, Breit, Fritz, Schättler. *Recent Advances in Pixel Localization Accuracy*. CEOS SAR Workshop 2011.

# Coordinate System Correction: Azimuth Shift

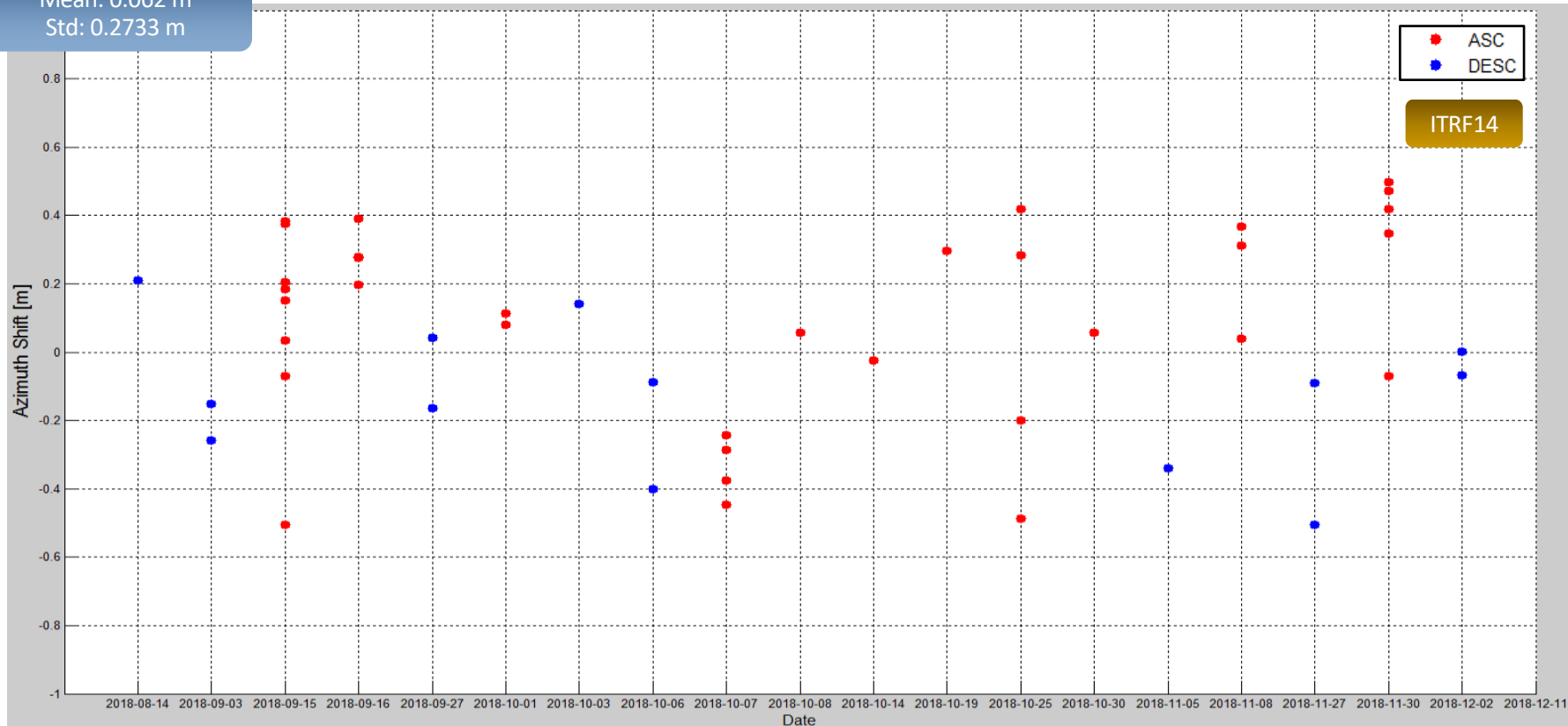
ETRF00

Mean: 0.245 m  
Std: 0.4889 m



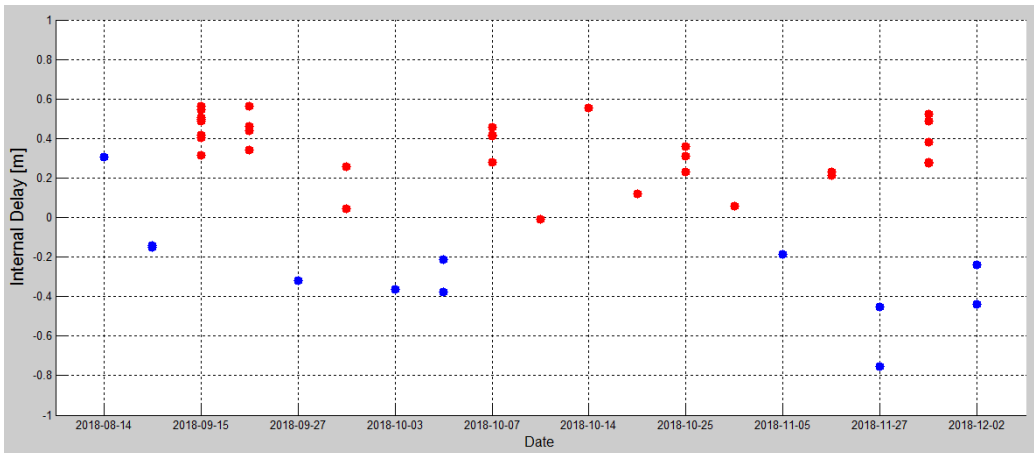
# Coordinate System Correction: Azimuth Shift

Mean: 0.062 m  
Std: 0.2733 m



# Coordinate System Correction: Internal Delay

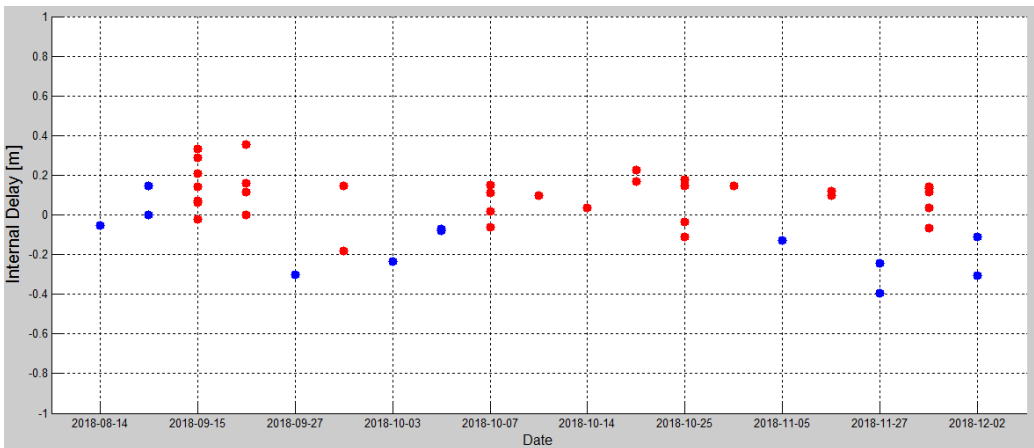
Mean: 0.193 m  
Std: 0.3144



ASC  
DESC

ETRF00

Mean: 0.027 m  
Std: 0.1686 m

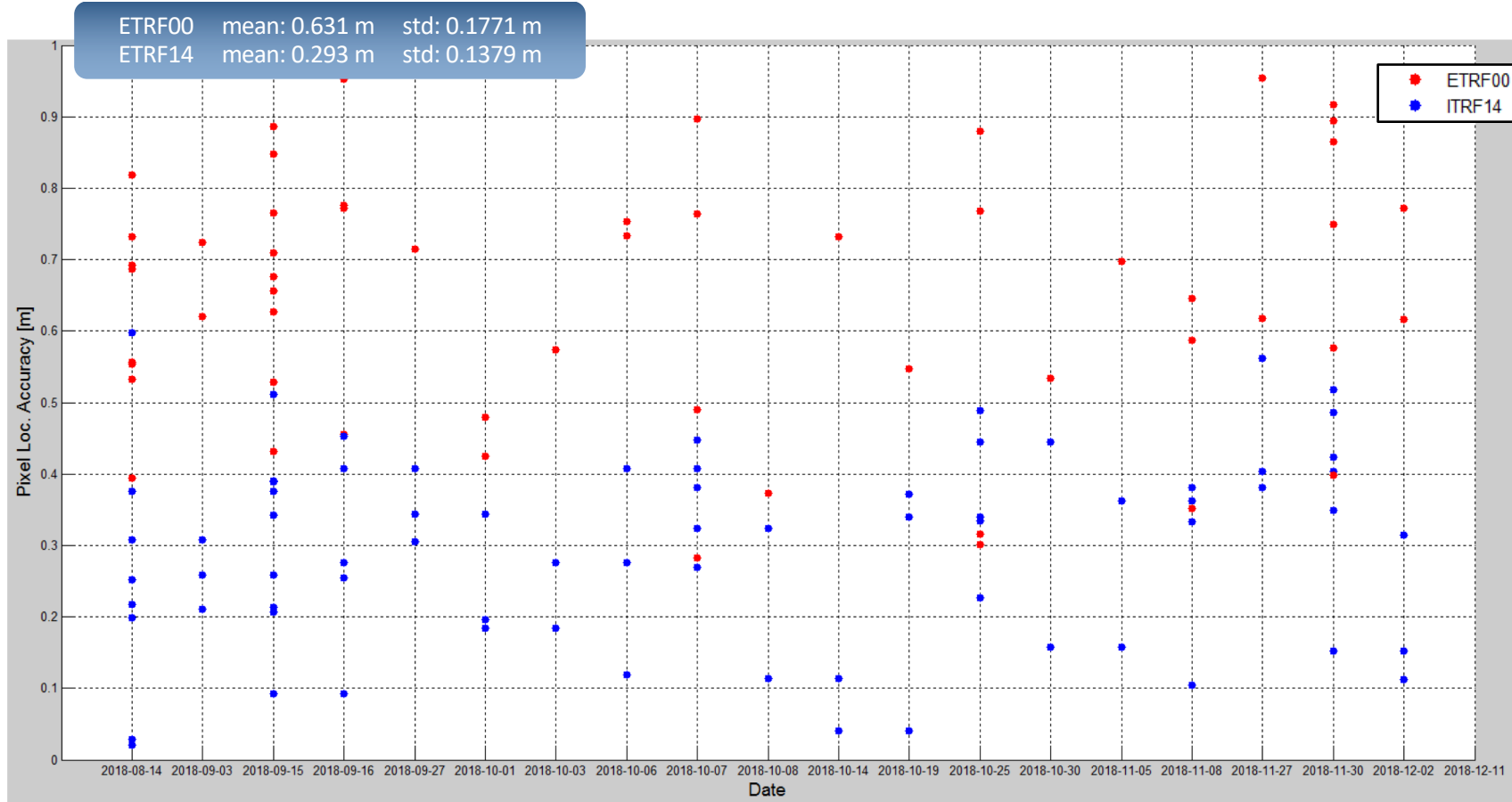


ASC  
DESC

ITRF14



# Coordinate System Correction: Pixel Location Accuracy



# Geometric Accuracy of L1B geocoded products

## CHARACTERIZATION

L1B geocoded nominal products

GEC RE/SE

EEC RE/SE

### Absolute Geolocation Error

Referred to PAZ Mission Coordinate System

Measured Vs Expected displacement due to relieve  
PAZ Processor DEM absolute accuracy \*  
Local h PAZ Processor DEM extracted

### Relative Geolocation Error

Internal geometric fidelity.

### Geolocation Stability

Multi Temporal Products Overlay.

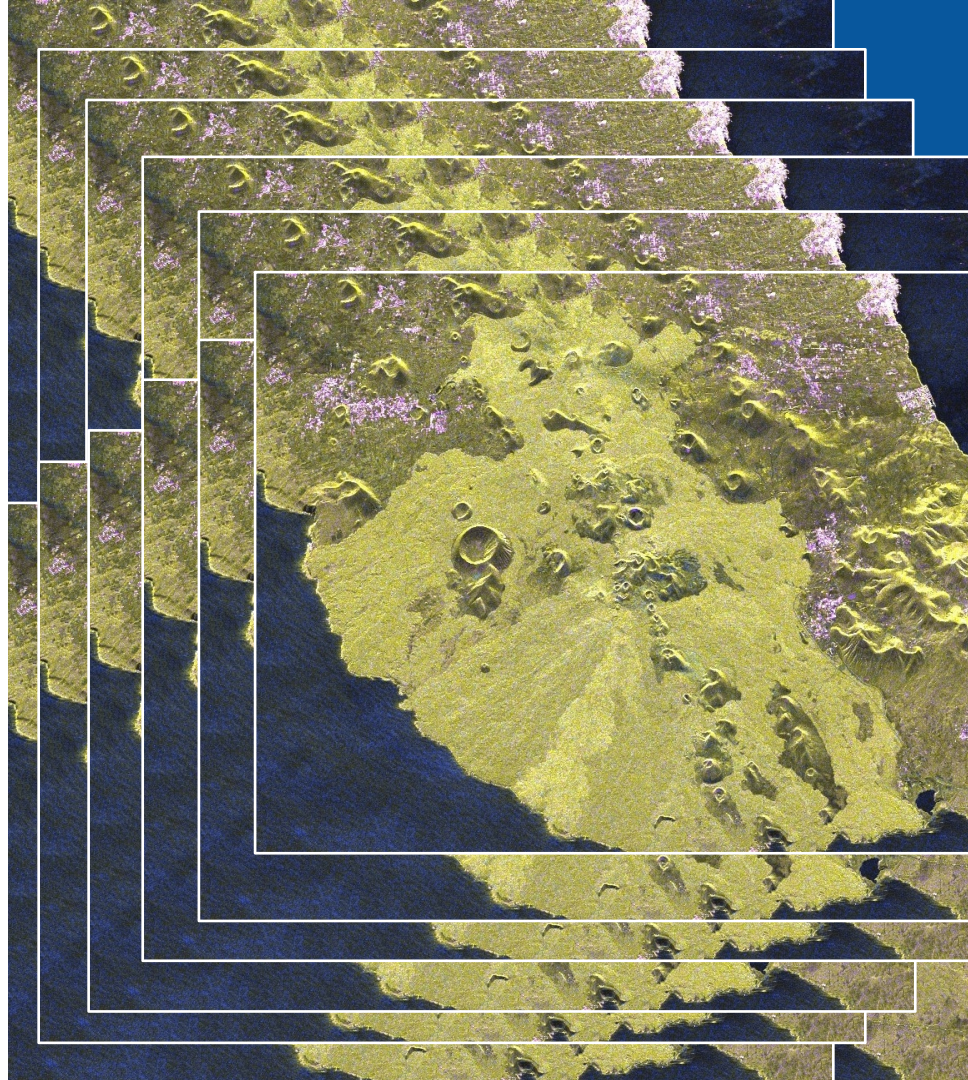
SM –Mode >100 measurements	EEC-SE	EEC-RE	GEC-SE	GEC-RE	Max. Displacement due to relieve. *
strip_004	2.83m	8.59m	5.07m	14.28m	40m
strip_013	2.02m	5.54 m	6.61 m	15.52m	19m

In progress

HS –Mode > 100 measurements	EEC-SE	EEC-RE	GEC-SE	GEC-RE	Max. Displacement due to relieve. *
spot_100	0.44 m	1.27 m	0.63 m	1.36 m	13.9 m

\* PAZ Processor Global DEM. Abs .accuracy=16m

# Radiometric Stability

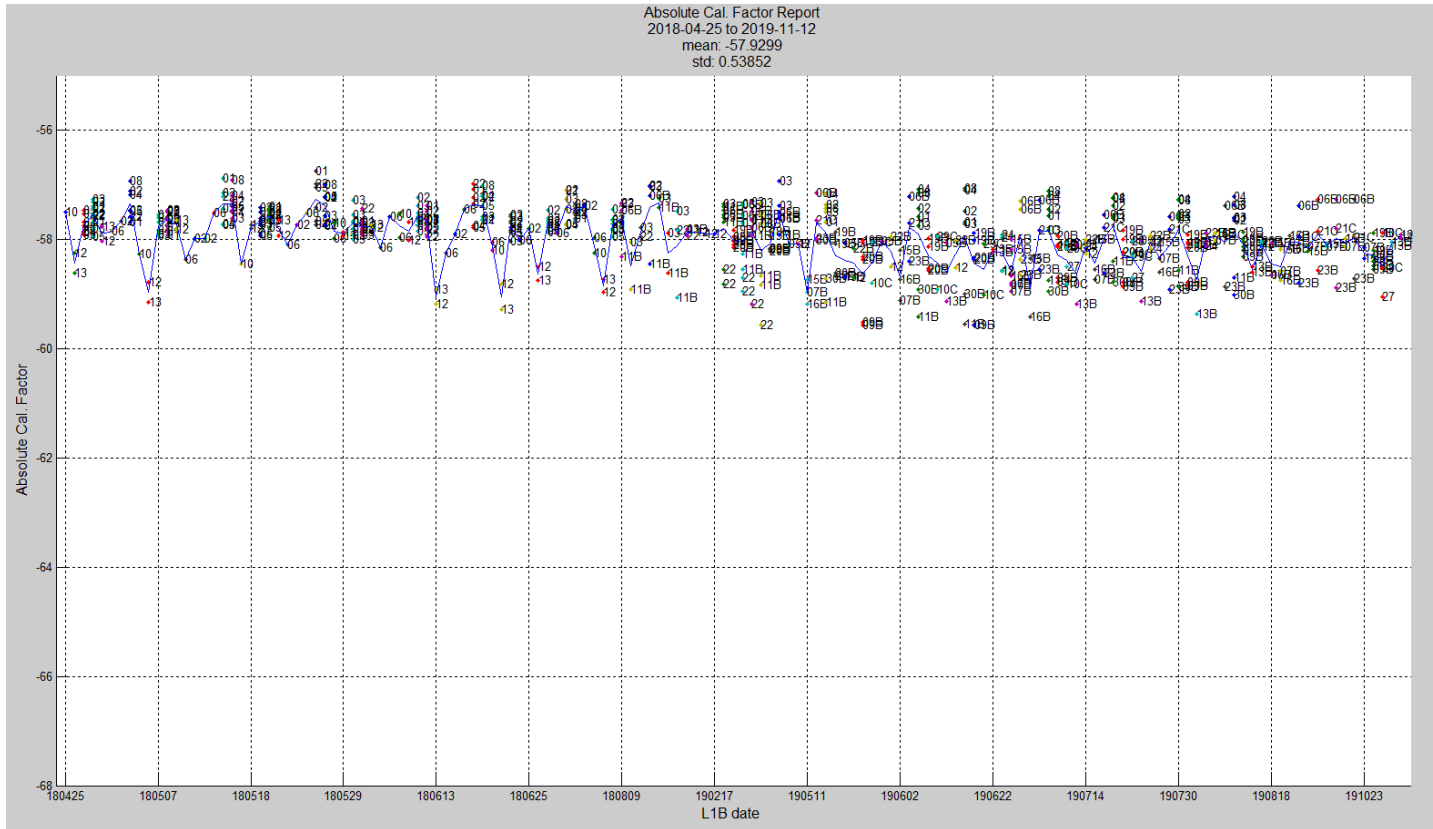


# Radiometric Stability

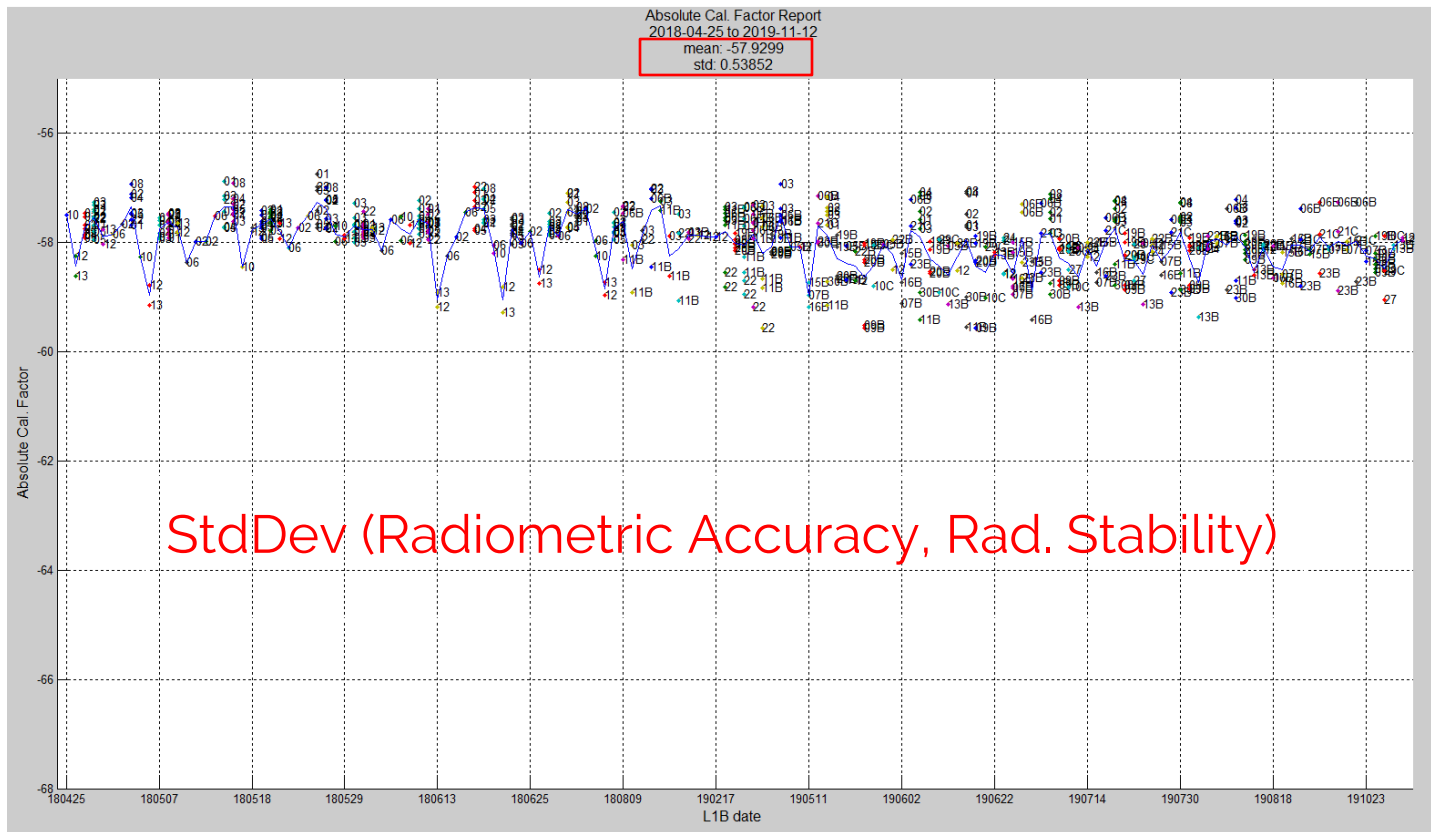
Standard deviation of a test data set that results from measuring RCS of invariant point targets at different times.

Time period > 18 months

# Radiometric Stability



# Radiometric Stability

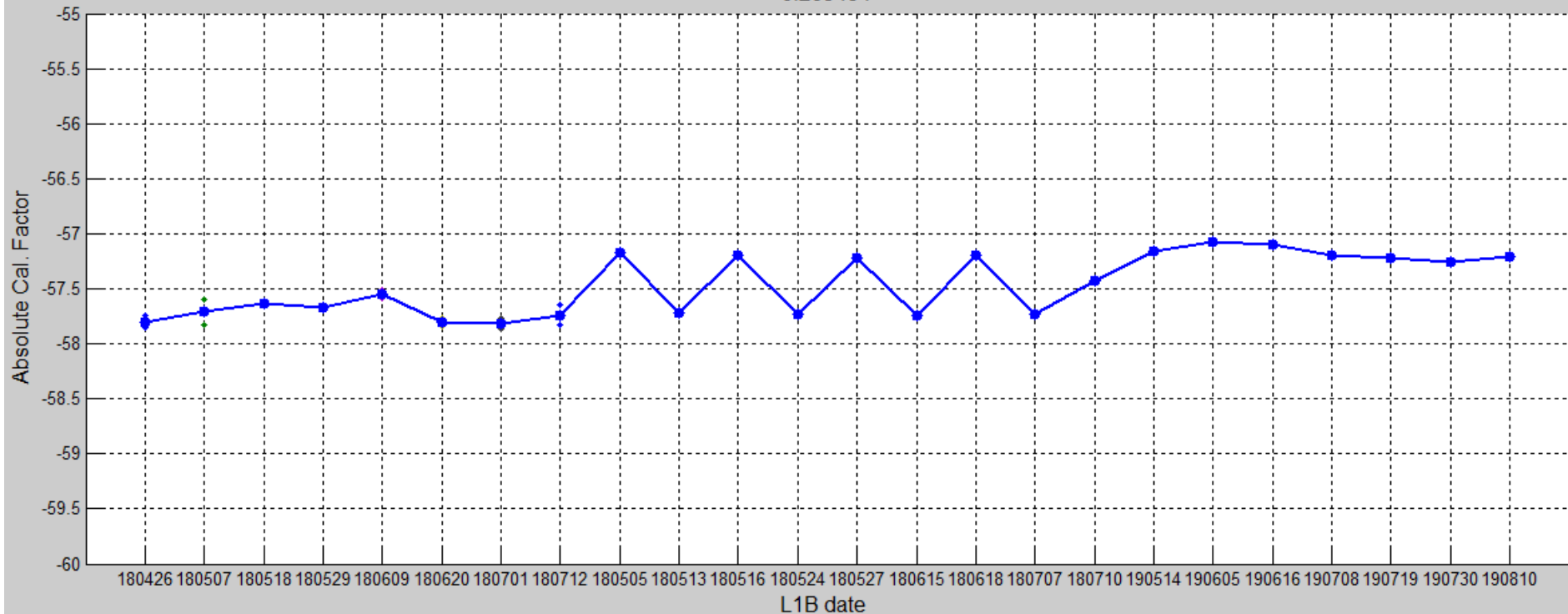


# Radiometric Stability

Analysis by target / mode / pol /  
geometry to remove Radiometric  
Accuracy contribution

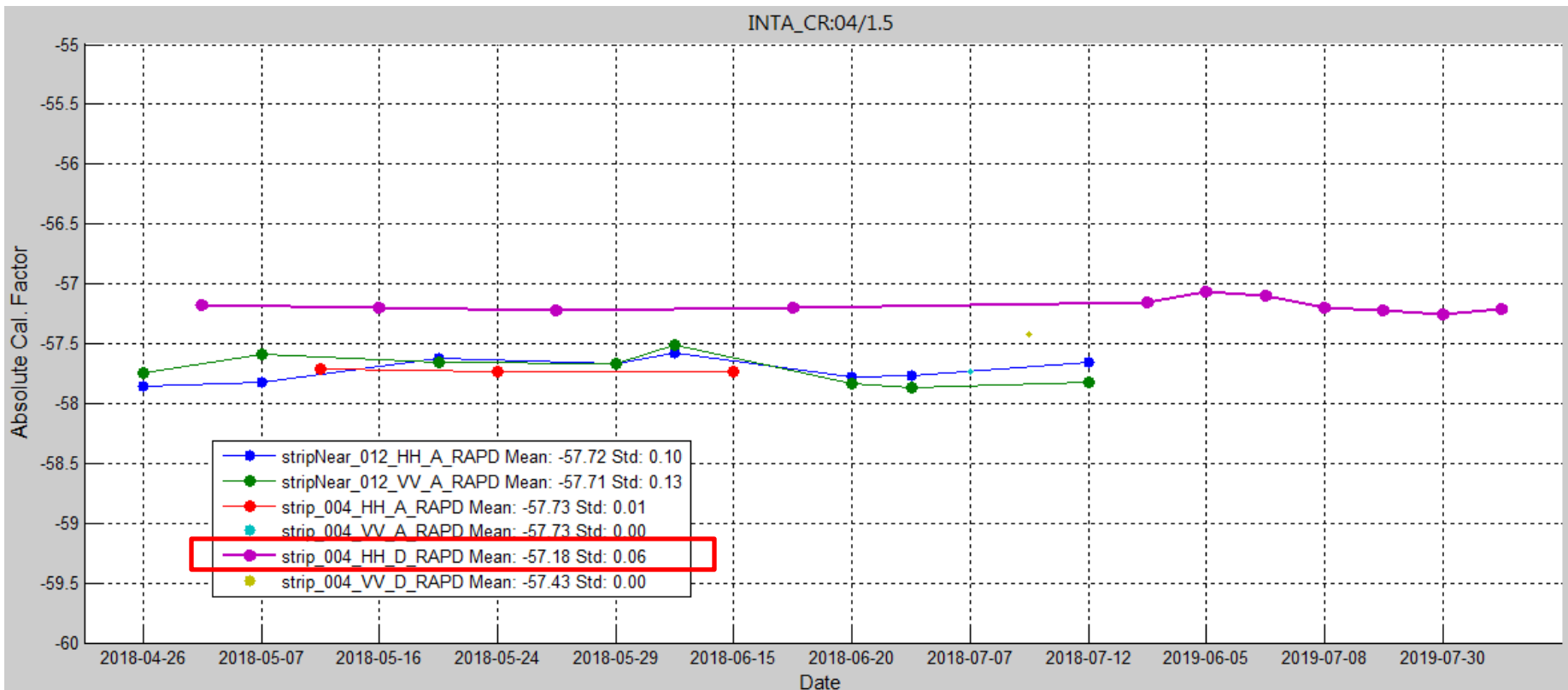
# Analysis by CR

Absolute Cal. Factor  
INTA\_CR:04/1.5  
-57.5256  
0.269434





# Analysis by CR/Beam/Pol/OrbitDir



# Analysis by CR/Beam/Pol/OrbitDir

Start Time	2018-04-25T00:00:00.000000Z
Stop Time	2019-11-15T00:00:00.000000Z
Imaging Mode	ALL
Polarization Mode	ALL

Mean StdDev 0.2069 dB

Min StdDev 0.0067 dB

'Target Name'	'Beam ID'	'Orbit Direction'	'Pol. Channel Analyzed'	'Orbit Precision'	'Mean'	'StdDev'
'INTA_CR:01/1.0'	'stripNear_012'	'D'	'HH'	'RAPD'	-57,5589014000000	0,193605930689892
'INTA_CR:01/1.0'	'stripNear_012'	'D'	'VV'	'RAPD'	-57,6867004000000	0,198169346617483
'INTA_CR:01/1.0'	'strip_004'	'A'	'HH'	'RAPD'	-56,9026520000000	0,174187217013767
'INTA_CR:01/1.0'	'strip_004'	'A'	'VV'	'RAPD'	-57,0945960000000	0
'INTA_CR:01/1.0'	'strip_004'	'D'	'HH'	'RAPD'	-57,6216622727273	0,0702978632080532
'INTA_CR:01/1.0'	'strip_004'	'D'	'VV'	'RAPD'	-57,6187090000000	0
'INTA_CR:02/1.0'	'spot_088'	'A'	'VV'	'RAPD'	-57,8388291666667	0,130428192929928
'INTA_CR:02/1.0'	'spot_088'	'D'	'HH'	'RAPD'	-57,3746330000000	0
'INTA_CR:02/1.0'	'stripNear_012'	'A'	'HH'	'RAPD'	-57,5189371250000	0,168869688887563
'INTA_CR:02/1.0'	'stripNear_012'	'A'	'VV'	'RAPD'	-57,6617306250000	0,0918936917964557
'INTA_CR:02/1.0'	'stripNear_012'	'D'	'HH'	'RAPD'	-57,5312156000000	0,162138959501720
'INTA_CR:02/1.0'	'stripNear_012'	'D'	'VV'	'RAPD'	-57,6274346000000	0,100570838438885
'INTA_CR:02/1.0'	'strip_004'	'A'	'HH'	'RAPD'	-57,3974486666667	0,0395564049975908
'INTA_CR:02/1.0'	'strip_004'	'A'	'VV'	'RAPD'	-57,4483170000000	0
'INTA_CR:02/1.0'	'strip_004'	'D'	'HH'	'RAPD'	-57,3742208181818	0,155200376576102
'INTA_CR:02/1.0'	'strip_004'	'D'	'VV'	'RAPD'	-57,4931430000000	0
'INTA_CR:03/1.0'	'spot_016'	'A'	'HH'	'RAPD'	-57,1900735000000	0,218861569592516
'INTA_CR:03/1.0'	'spot_018'	'D'	'HH'	'RAPD'	-57,2414510000000	0
'INTA_CR:03/1.0'	'spot_088'	'A'	'HH'	'RAPD'	-57,6272410000000	0,213038545249446
'INTA_CR:03/1.0'	'spot_090'	'D'	'VV'	'RAPD'	-57,9072483333333	0,123224532790080
'INTA_CR:03/1.0'	'stripNear_004'	'A'	'HH'	'RAPD'	-57,2530654000000	0,181396875694703
'INTA_CR:03/1.0'	'stripNear_004'	'A'	'VV'	'RAPD'	-57,6040164000000	0,131861915018325
'INTA_CR:03/1.0'	'stripNear_012'	'A'	'HH'	'RAPD'	-57,5903077500000	0,205229965320961
'INTA_CR:03/1.0'	'stripNear_012'	'A'	'VV'	'RAPD'	-57,6687436250000	0,146879447895144

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# Next Steps

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# Cross Calibration campaign

TSX/TDX/PAZ data takes  
over INTA & Neustrelitz

RCS Analysis  
Interferometric Analysis

Preliminary Definition  
Accomplished



# Imaging Modes Upgrade

6-beam Scansar & Staring Spotlight modes to be implemented at ground segment during 2020

Successfully upgrades integration and mode verification expected



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An aerial, grayscale photograph of a city, likely Paris, showing a dense urban grid and a winding river (the Seine) cutting through the center. The image is framed by two horizontal white lines, one near the top and one near the bottom.

**Thank you!**

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