PAZ CALIBRATION STATUS UPDATE

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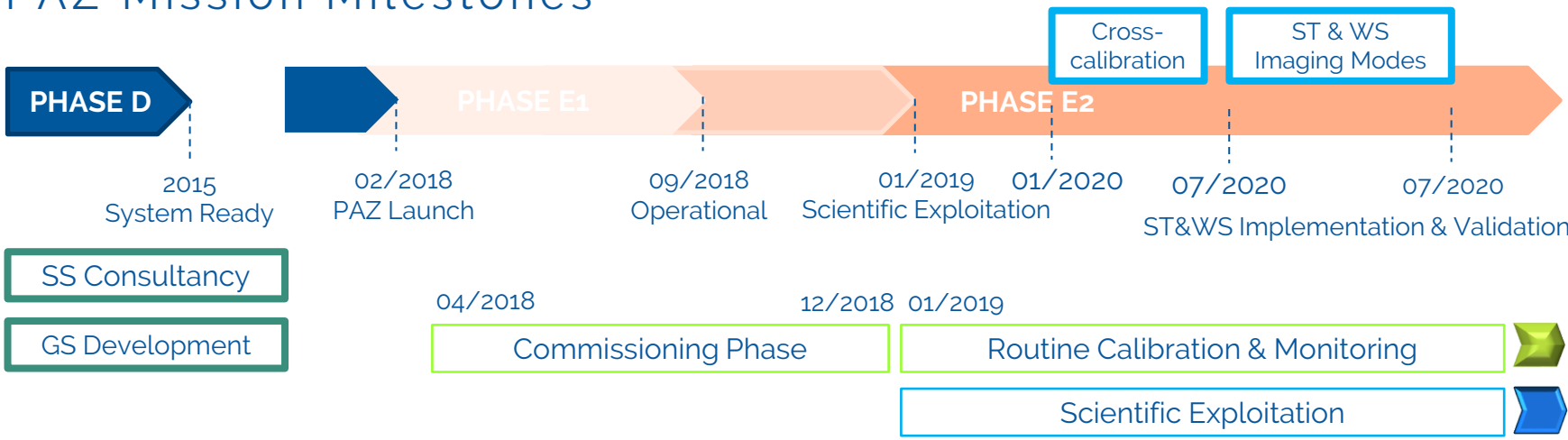
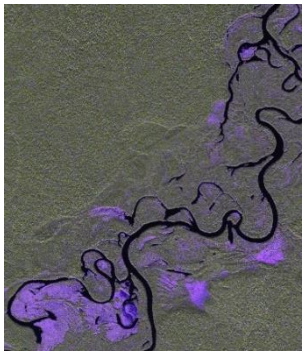
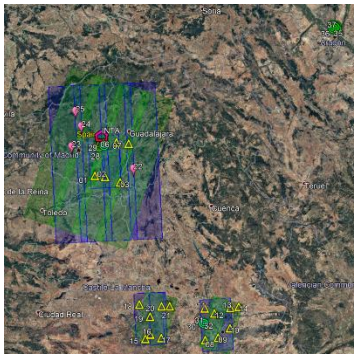
PAZ Mission Milestones







System Monitoring

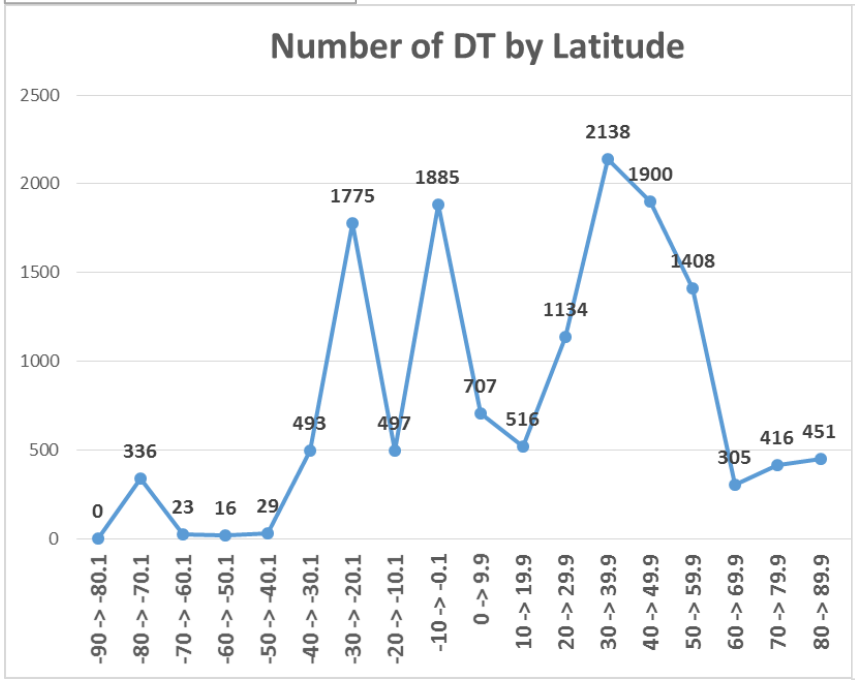
Verification of **Nominal Performances** & Instrument **Stability**

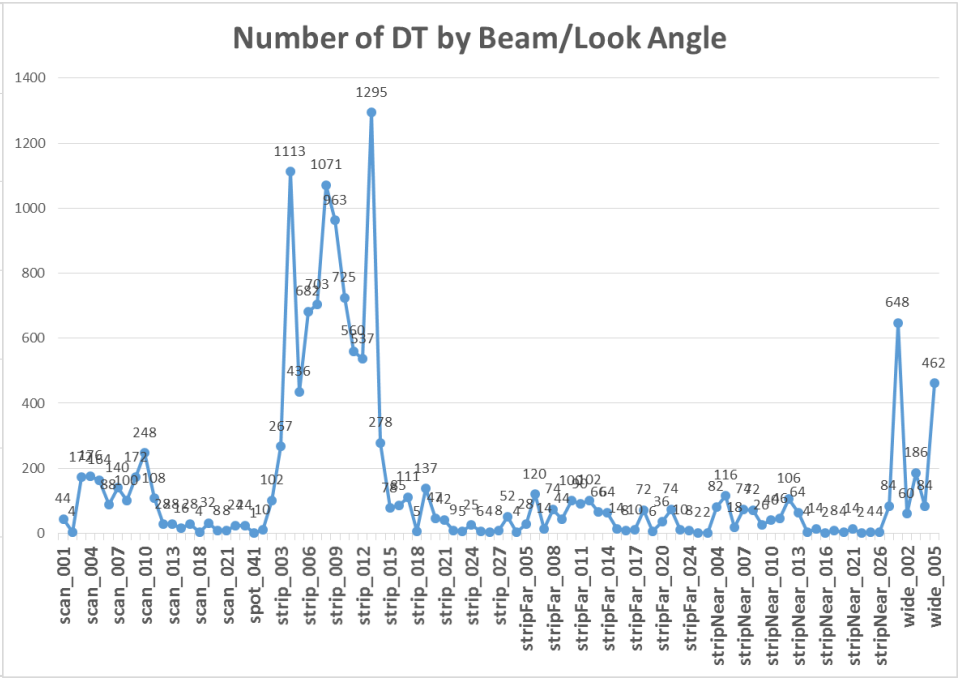
More than **27750** data takes monitored

Doppler Analysis

- Monitoring Strategy
  - All commercial and calibration data takes
  - Specific acquisitions to cover less used beams / latitudes

Period: 2019-2020

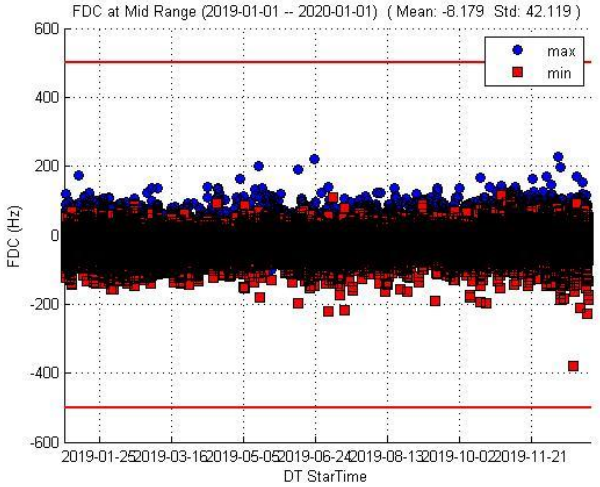




Doppler Analysis

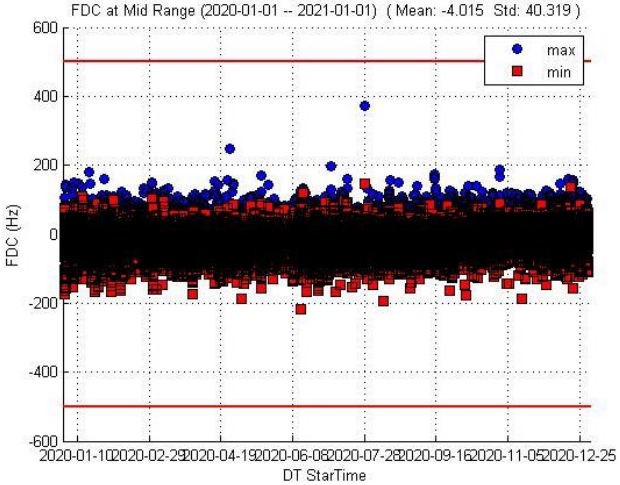
2019

Statistics					
	Min	Mean	Max	Std	Uncertainty
Geometrical Doppler	-150.7612554	-5.16431241	135.2738065	20.81706712	0.291126438
BaseBand Doppler	-1292.195771	-10.7214046	1174.191264	42.7897116	0.598413611



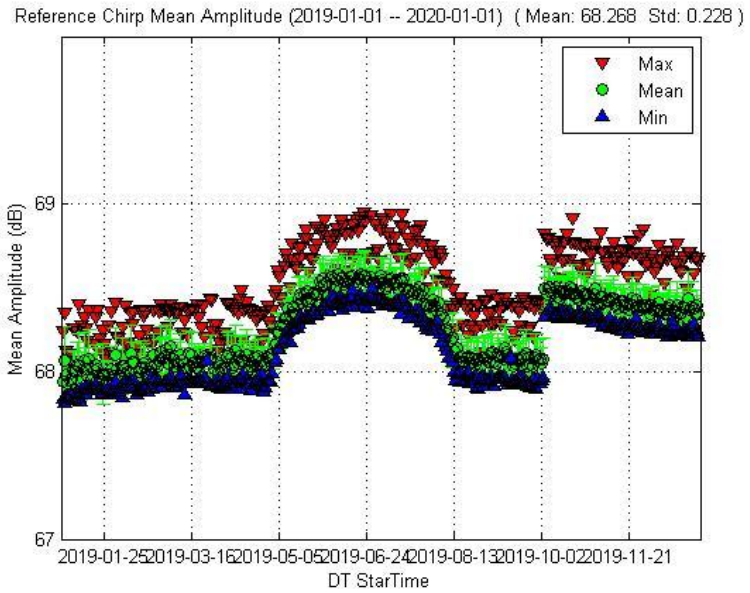
2020

Statistics					
	Min	Mean	Max	Std	Uncertainty
Geometrical Doppler	-193.653033	-3.66696154	146.1815643	20.35540318	0.214184355
BaseBand Doppler	-3394.154532	-3.645754559	1857.6983	44.58131546	0.46909512

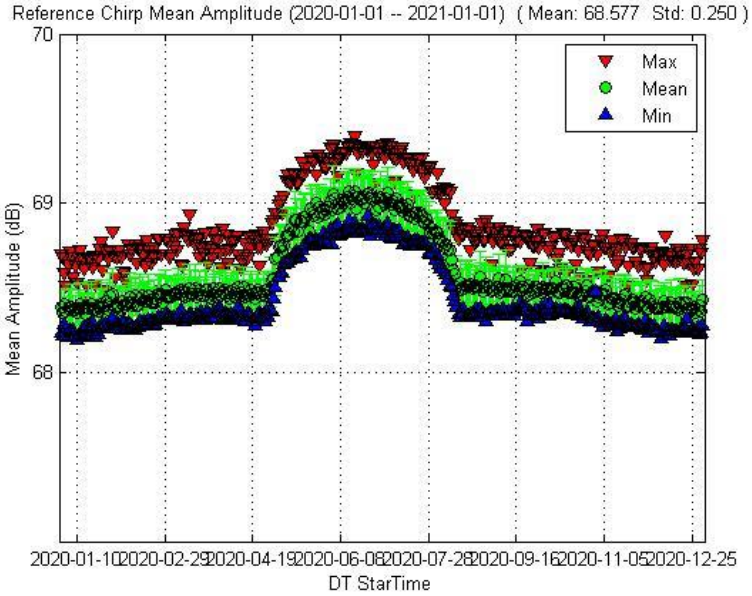


Replica amplitude

2019

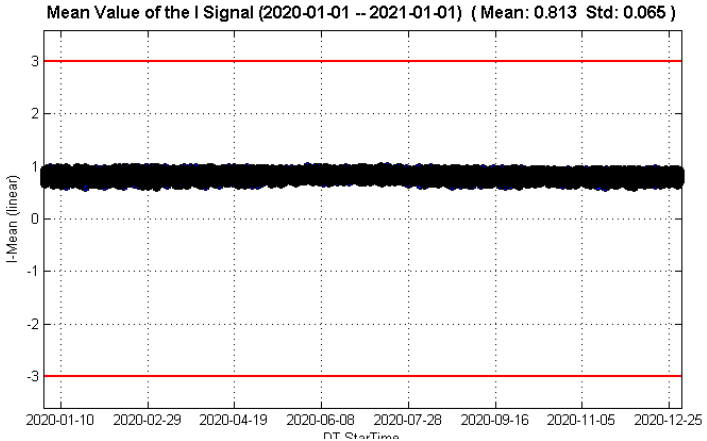


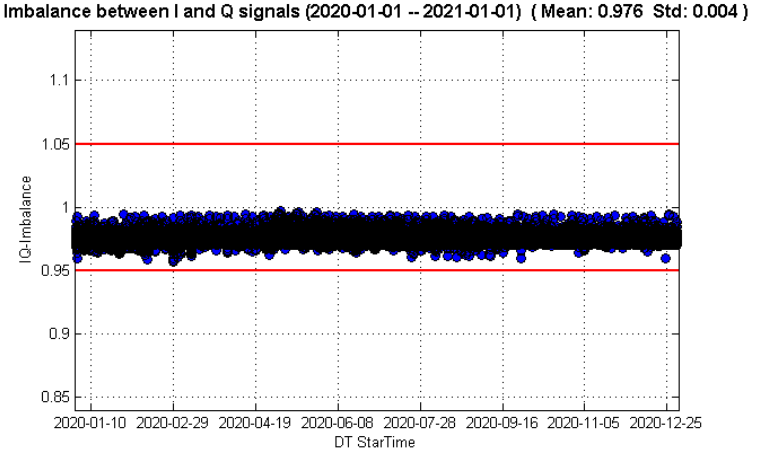
2020

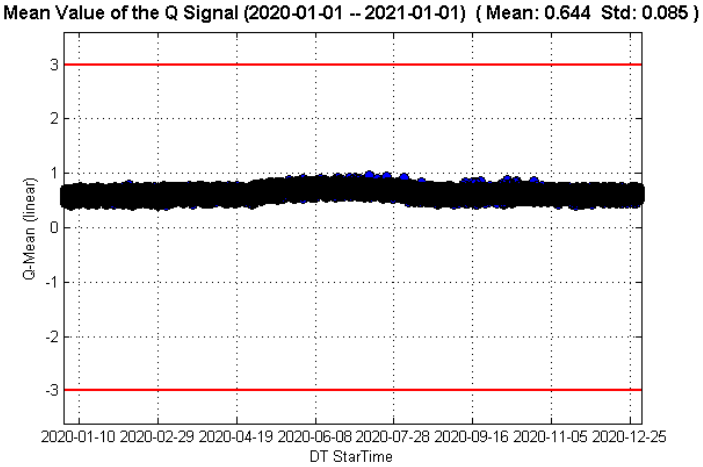


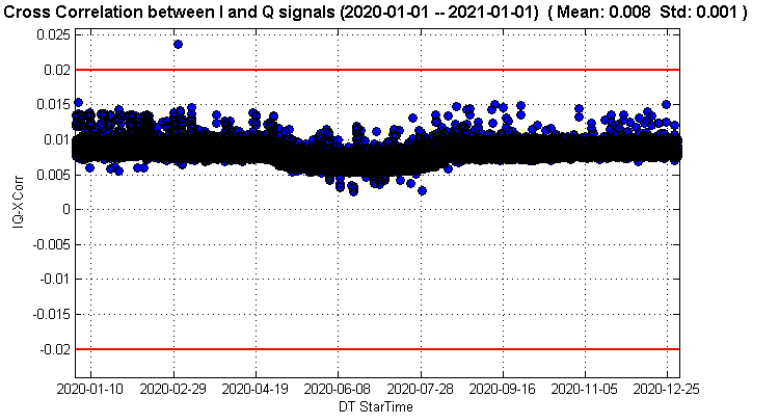
Raw Data

2020







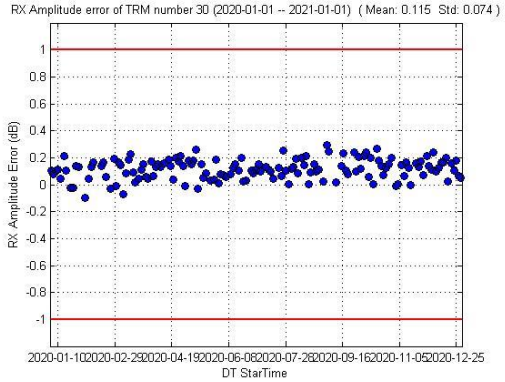


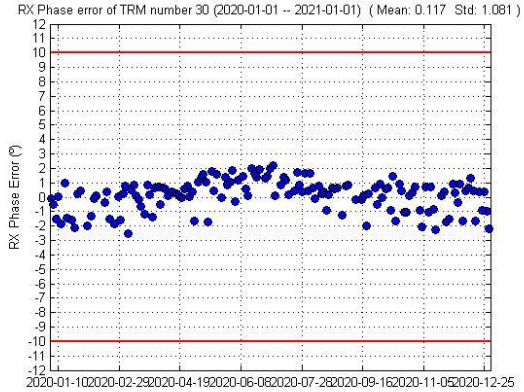
TRM Analysis

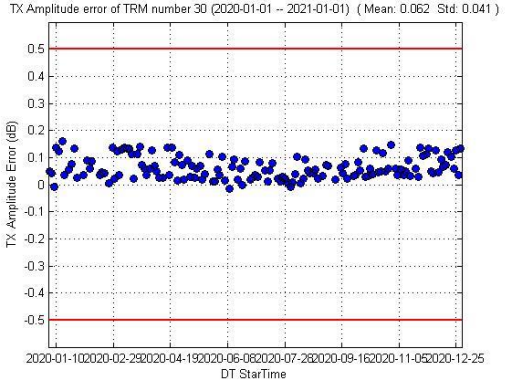
Specific DTs for PN-Gating analysis

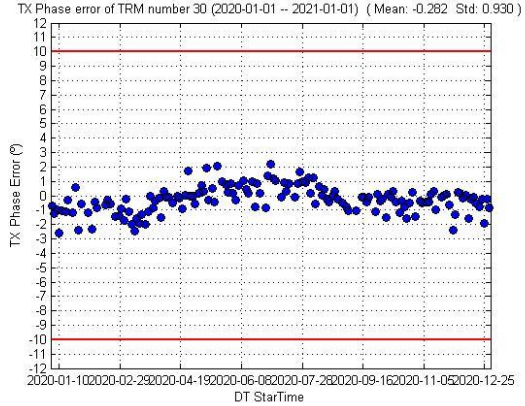
Number of PN-Gating commmanded lowered to 1 module acquisition every two days

2020









Radiometric Stability

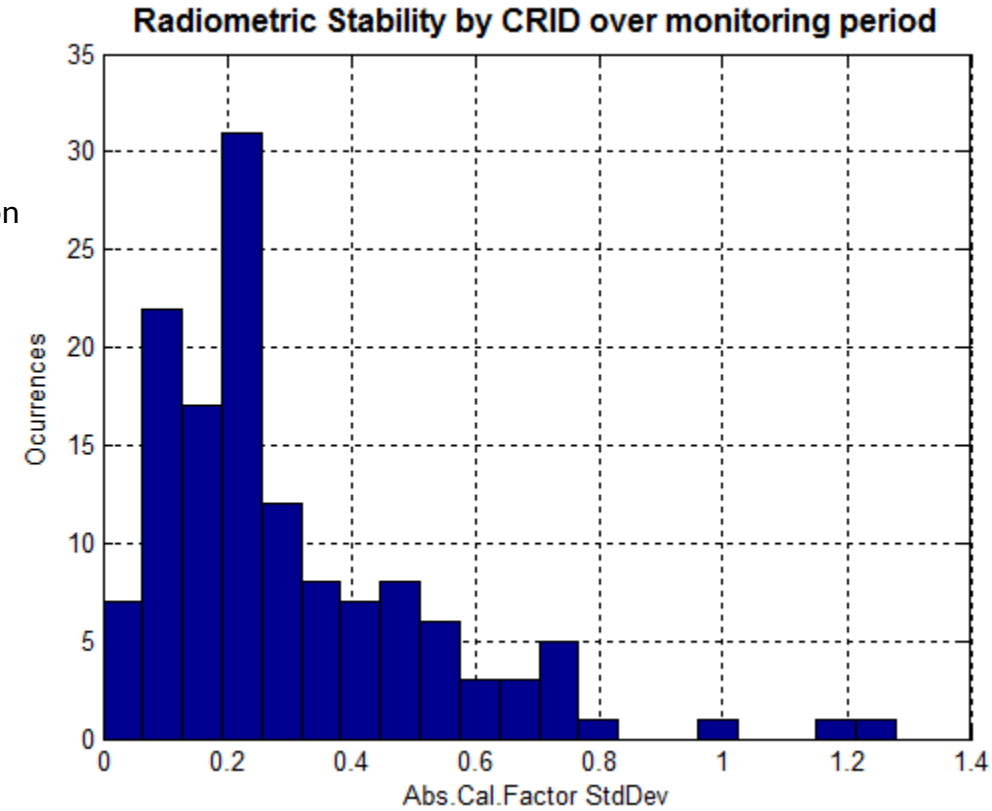
Radiometric Stability

Absolute Calibration Factor of INTA Corner Reflectors measured over time

Radiometric Stability estimated by standard deviation of identical data takes (CR, imaging mode and observation geometry)

Major instability contributions addressed to local conditions (meteo, spurious elements in CR neighbourhood, reflector misalignments and degradation)

Monitoring Period:
Januany 2019 - March 2021



Wide Scansar & Staring Spotlight Imaging Modes Upgrade

Declared operational on December, 2020

Staring Spotlight

Mode configuration designed by Microwaves and Radar Institute (DLR) for TerraSAR-X Mission [1]

Considerations:

- Same elevation beams than SL, HS modes
- Extended azimuth beam span
- PRF optimization to minimize azimuth ambiguities

PAZ Verification domain:

- PAZ back-end identical to TDX back-end
- PAZ front-end equivalent to TSX-TDX front-ends

- Expected equivalent performances to ST mode from TSX Mission
- Radiometric performances of azimuth beams may differs for extended beams

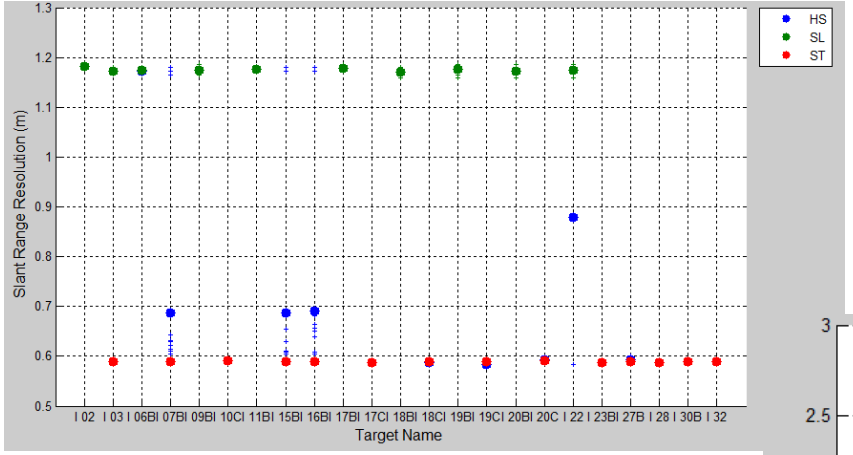
➡ Verification focused on radiometric and IRF performances

[1] TerraSAR-X Staring Spotlight Mode Optimization and Global Performance Predictions, Kraus et all.)

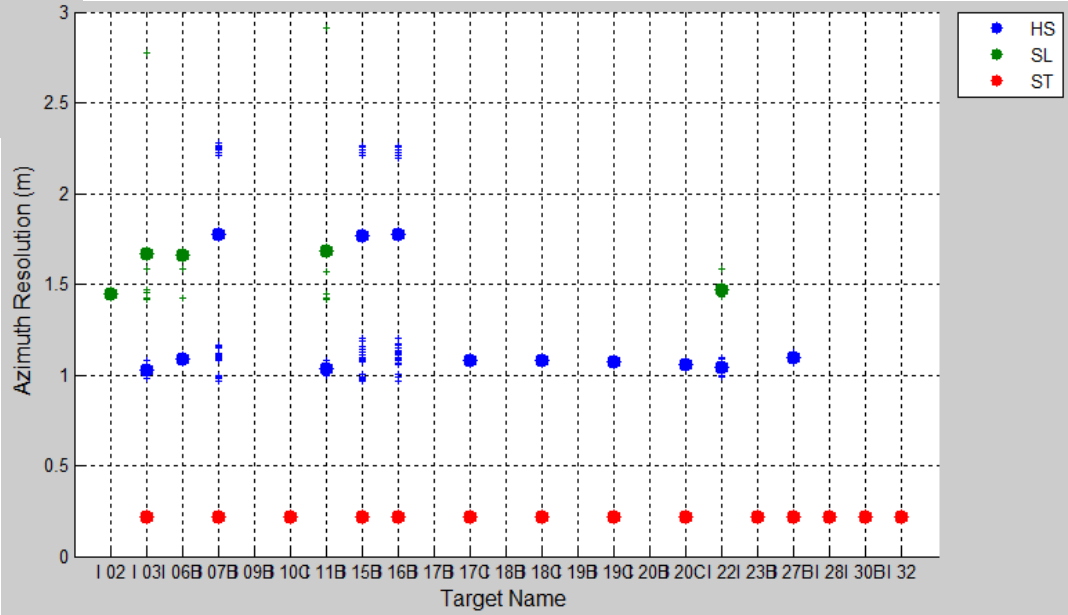
Staring Spotlight

Imaging Mode	ST				
Product Type	Detected				Complex
Geometric Projection	(MGD, GEC, EEC)				SSC
Polarization Mode	S				
Resolution Mode	SE		RE		
Polarization Mode	HH, VV				
Characterization Range	20°-55°				
Rg Scene Size (Km)	9… 4.6				
Az Scene Size (Km)	2.7… 3.6				
NESZ (dB)	<-19				
PSLR (dB)	-25				
Ra/Az ISLR (dB)	-18.5 / -18.7				
Incidence Angle (deg)	20	45	20	45	
Slant Range Res. (m)	-	-	-	-	0.59
Ground Range Res. (m)	1.78	0.96	1.78	0.97	-
Az Resolution (m)	0.7	0.38	1.42	0.97	0.22
Rg Pixel Spacing (m)	0.38	0.20	0.74	0.54	0.45
Az Pixel Spacing (m)	0.38	0.20	0.74	0.54	0.17
ENL	3.3	2	6.6	5	
Pixel Localization (m)					0.20

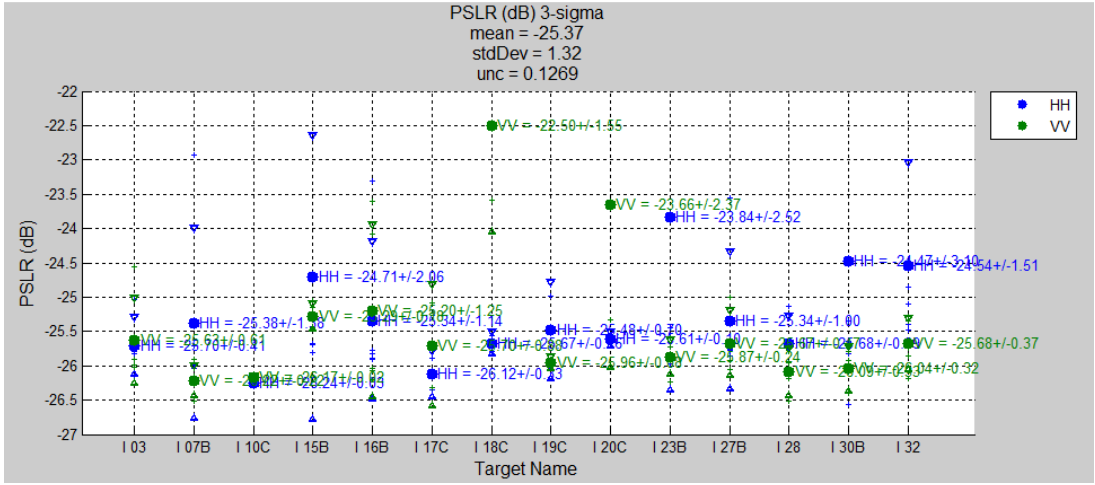
Staring Spotlight. Resolution Verification

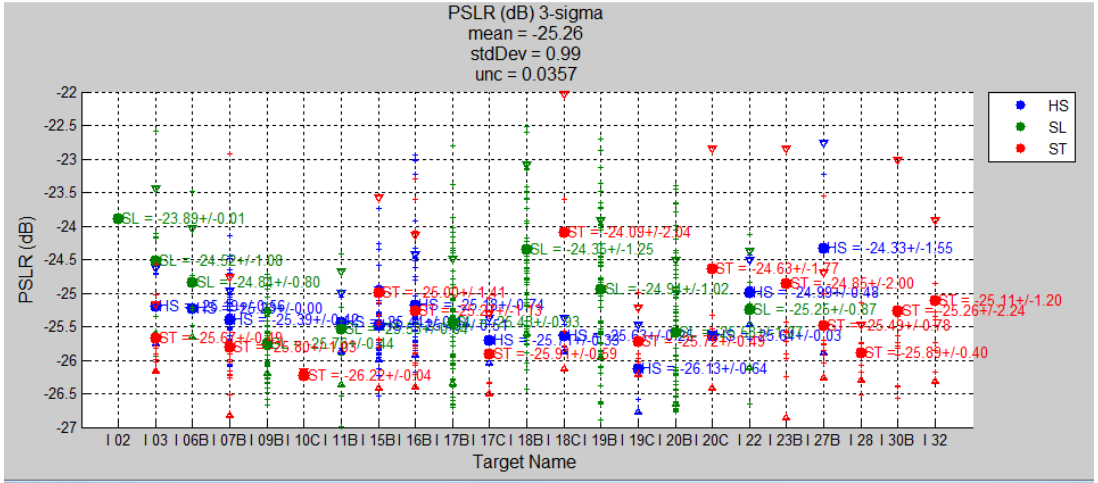


*(some test HS 150MHz included)

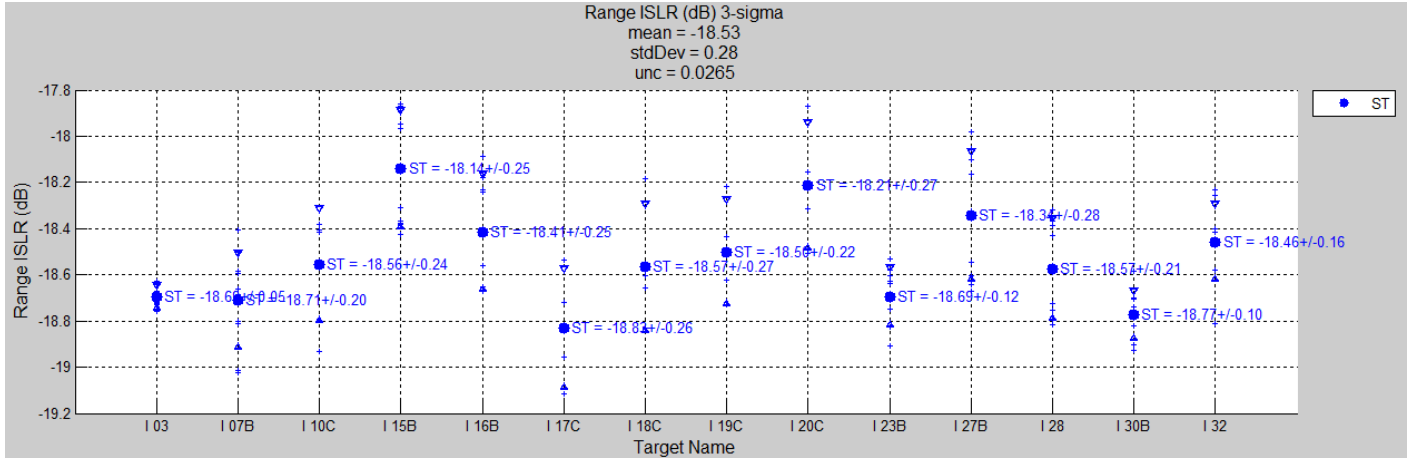


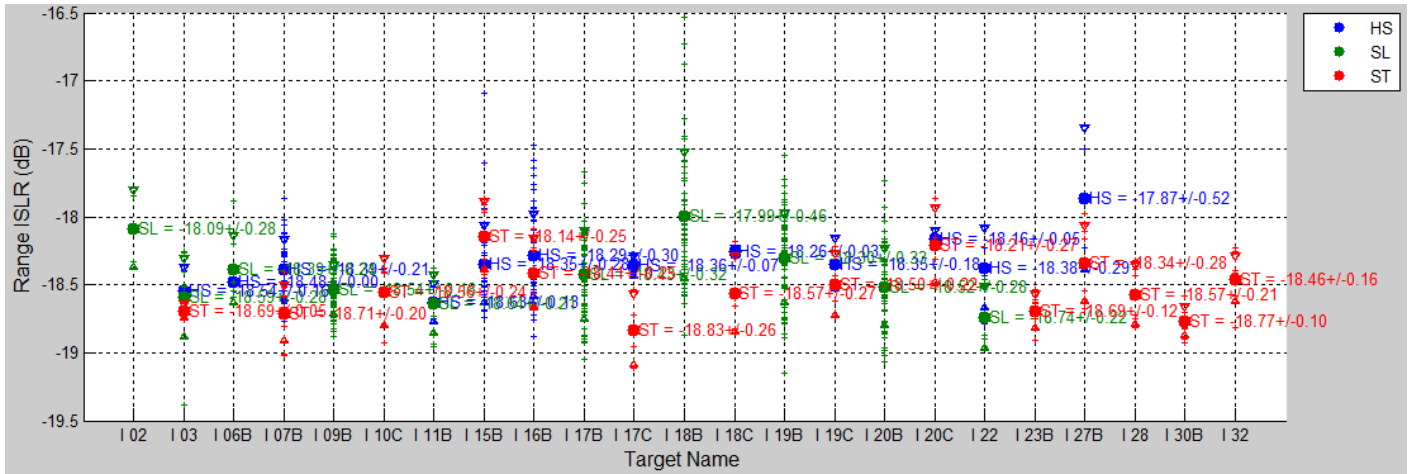
Staring Spotlight. PSLR Verification



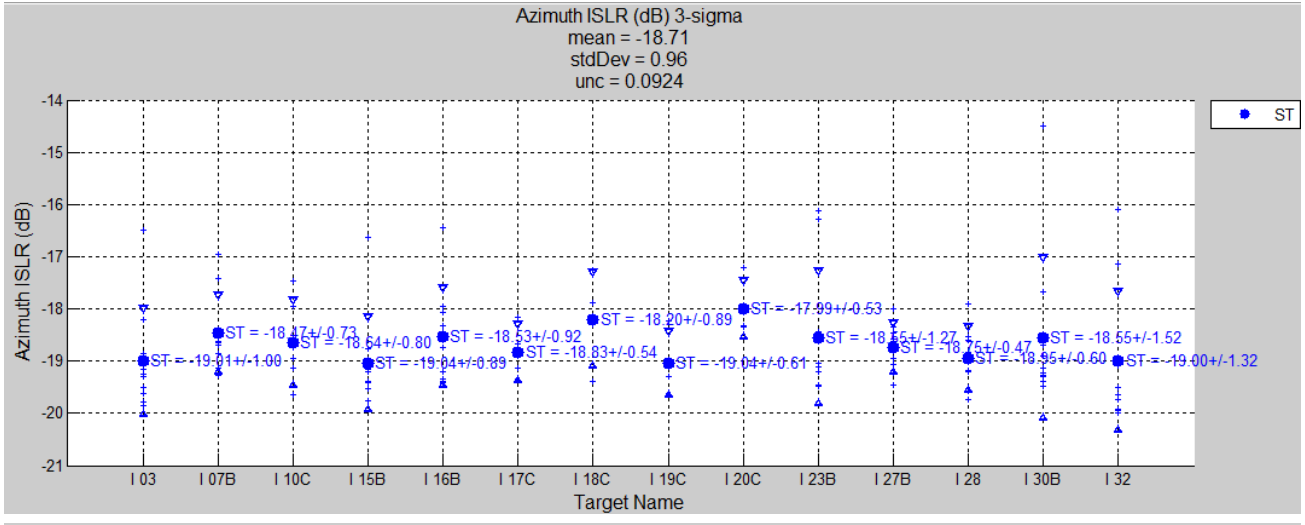


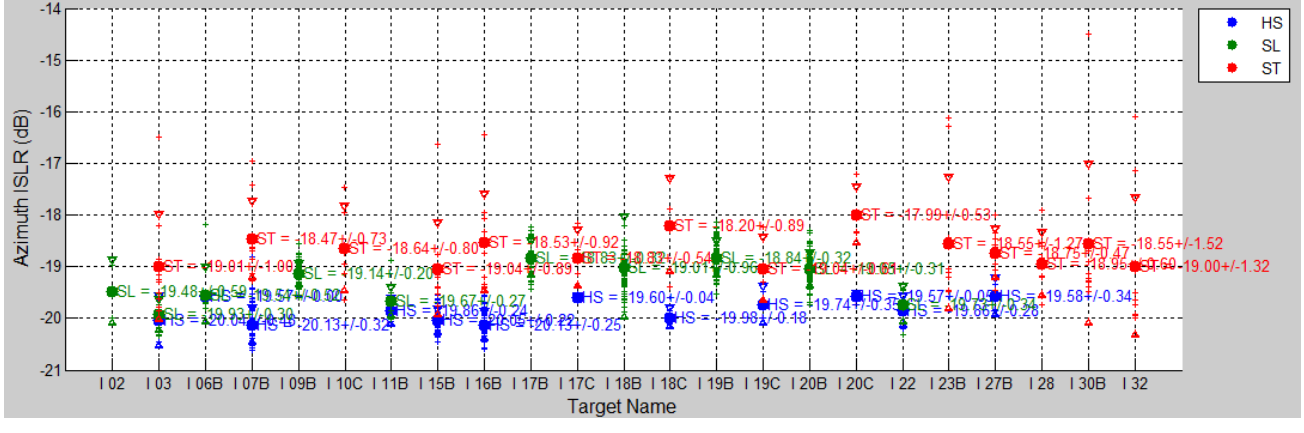
Staring Spotlight. IRF Verification



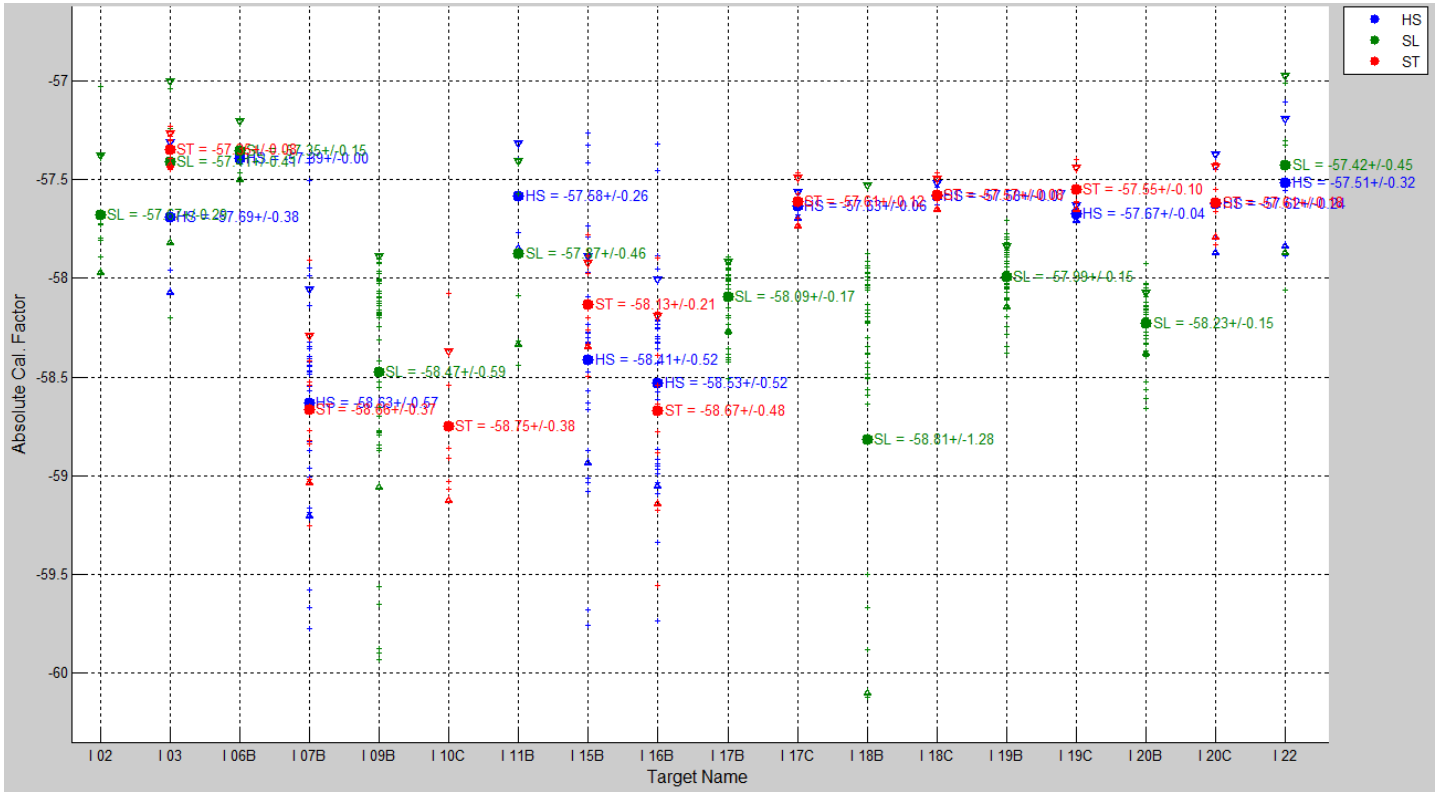


Staring Spotlight. IRF Analysis





Staring Spotlight. Radiometric Calibration Verification



Radiometric losses observed are mainly caused by maintenance status of individual CR

-> Radiometric Calibration Equivalent for all modes

Wide Scansar Mode

6 beam-Scansar Mode configuration designed by Microwaves and Radar Institute (DLR) for TerraSAR-X Mission [2]

Considerations:

- New elevation beams definition and antenna patterns.
- PRF and range bandwidth optimization for noise reduction

PAZ Verification domain:

- PAZ back-end identical to TDX back-end
- PAZ front-end equivalent to TSX-TDX front-ends

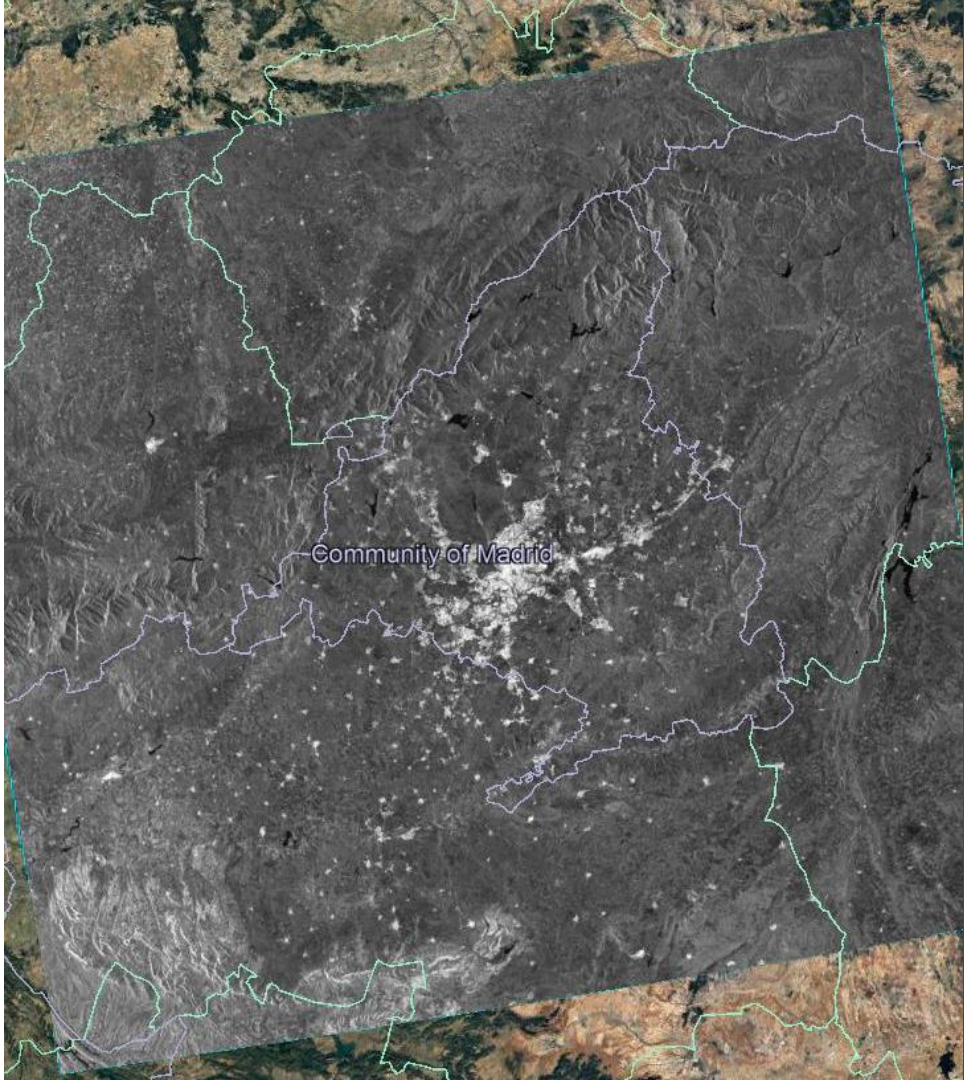
- PRF and range configuration assumed valid for PAZ and equivalent to TSX Mission
- Main uncertainty -> reference antenna pattern generation

➡ Verification focused on NESZ and reference antenna pattern verification

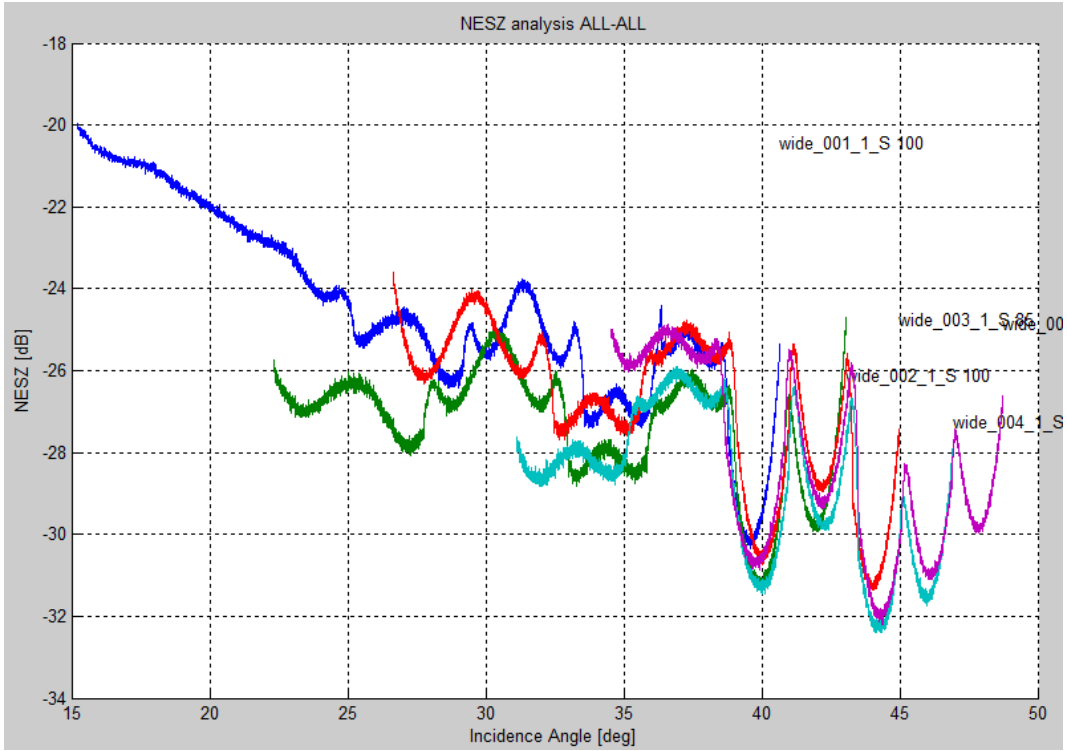
[2] TerraSAR-X Design of the new operational Wide Scansar mode, U. Steinbrecher et all.)

Wide Scansar Mode

Imaging Mode	SC		
Product Type	Detected		Complex
Geometric Projection	(MGD, GEC, EEC)		SSC
Polarization Mode	S		
Resolution Mode	RE		
Polarization Mode	HH, VV, HV, VH		
Characterization Range	20-45		
Rg Scene Size (Km)	273-196		
Az Scene Size (Km)	208		
NESZ (dB)	<-24		
PSLR (dB)	-18		
Ra/Az ISLR (dB)	-15		
Incidence Angle (deg)	20	45	
Slant Range Res. (m)	-	-	1.75-3.18
Ground Range Res. (m)	35	35	-
Az Resolution (m)	39	39	38.27
Rg Pixel Spacing (m)	15	15	1.36
Az Pixel Spacing (m)	15	15	14.21
ENL	7.27	8.46	
Pixel Localization (m)			0.97

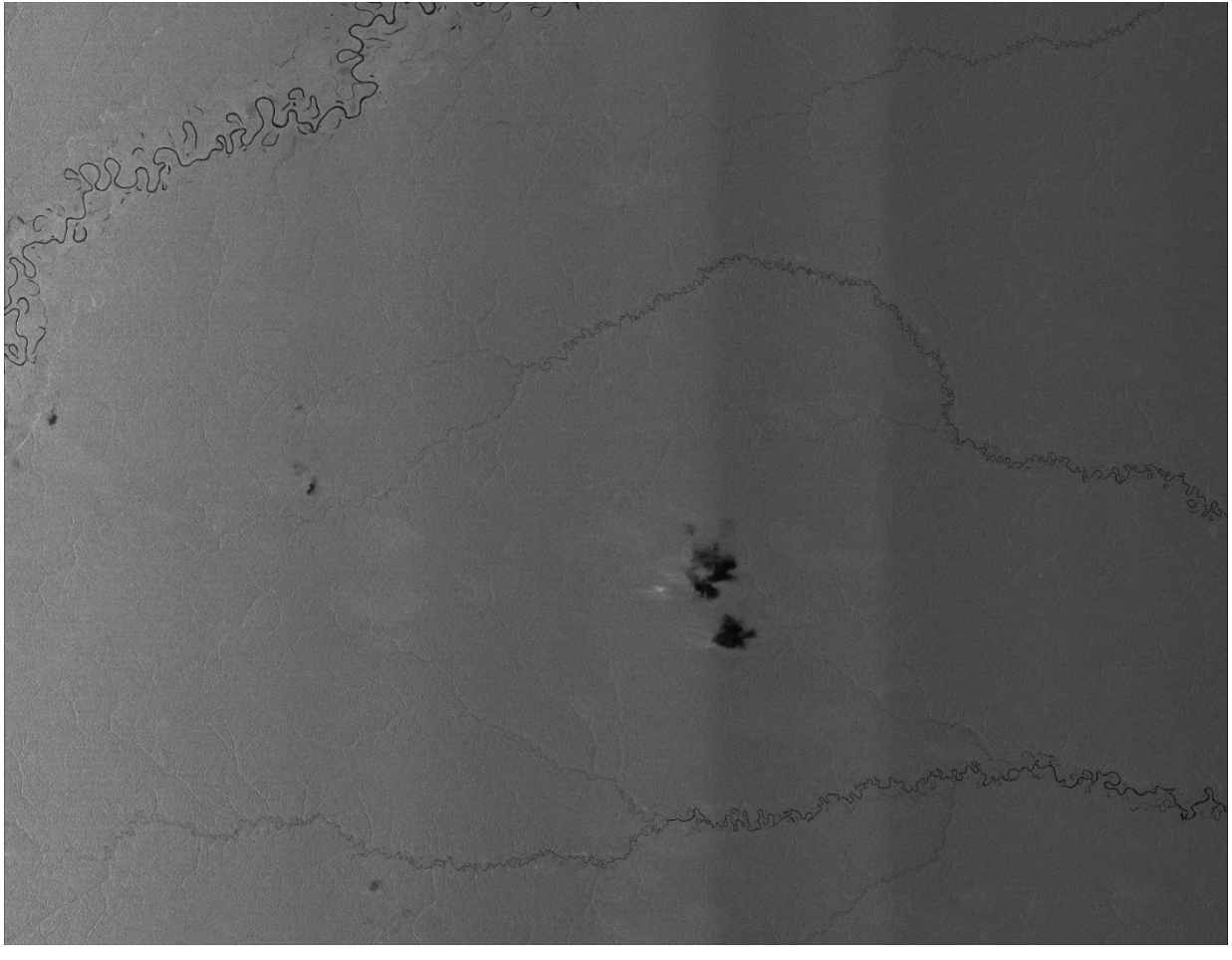


Wide Scansar. NESZ Verification



NESZ derived from HV MGD –RE images acquired over Pacific Doldrums

Wide Scansar. Reference Antenna Pattern Verification



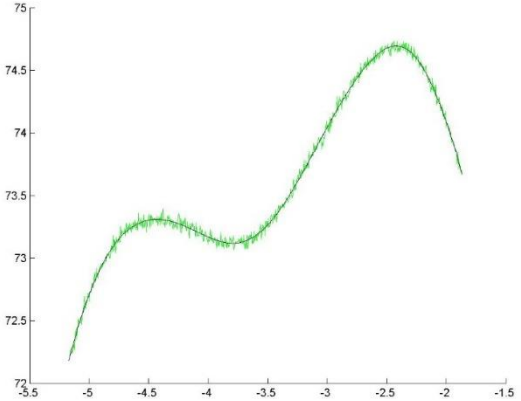
Visible swath transitions due to inaccurate shape and gain reference antenna pattern generation

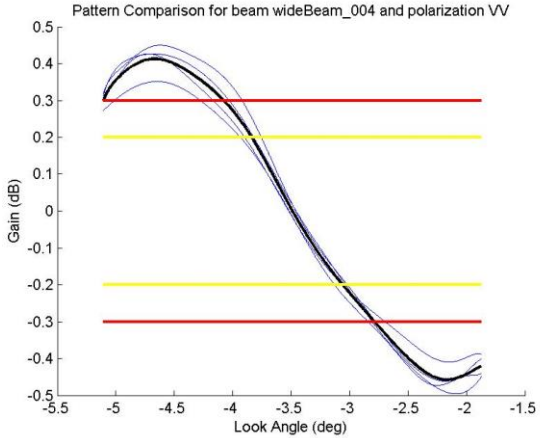
Estimation

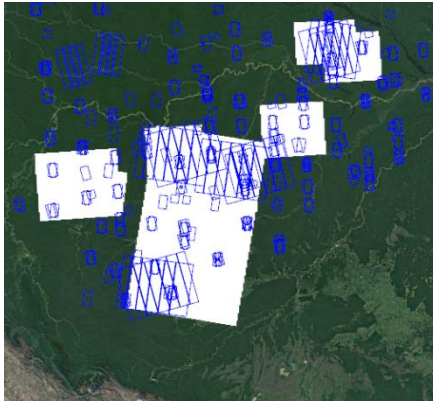
Regeneration

Validation

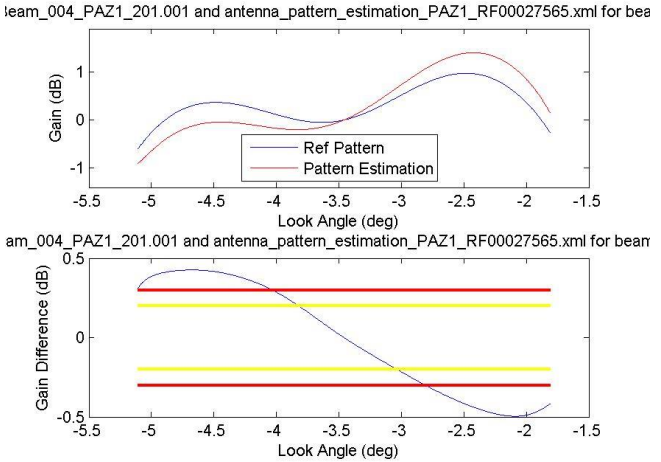
Wide Scansar. Reference Antenna Pattern Verification



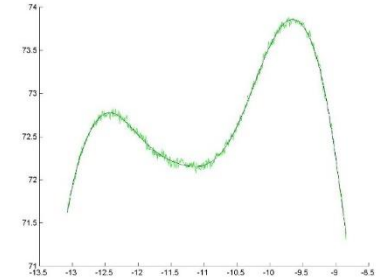


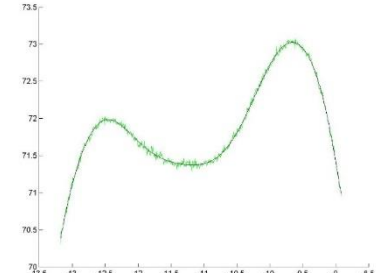


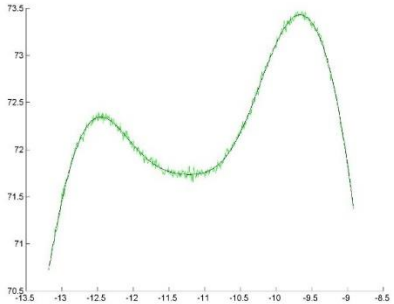
Pattern estimation over Rainforest Area 01 and Average Error Estimation



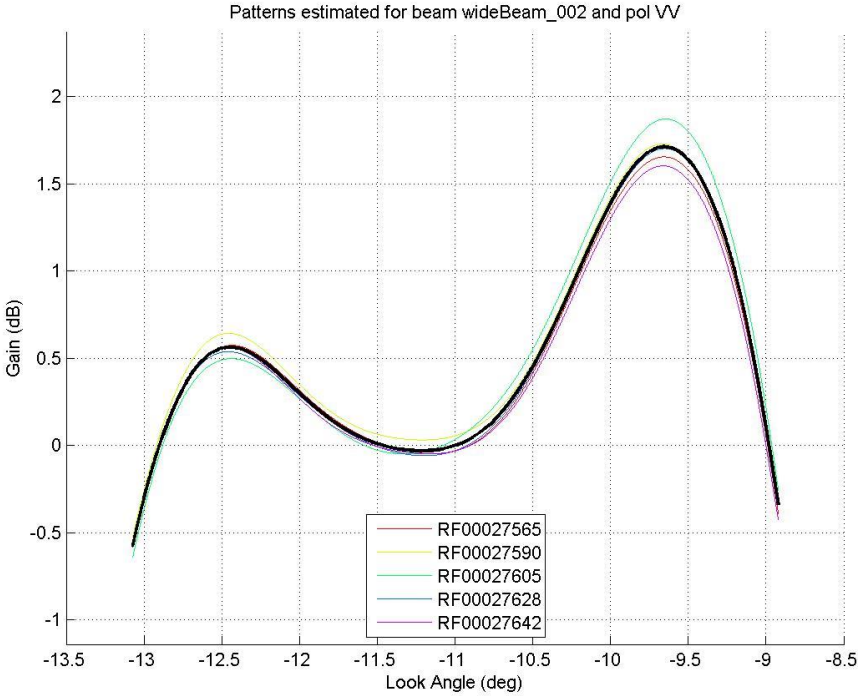
Wide Scansar. Reference Antenna Pattern Verification



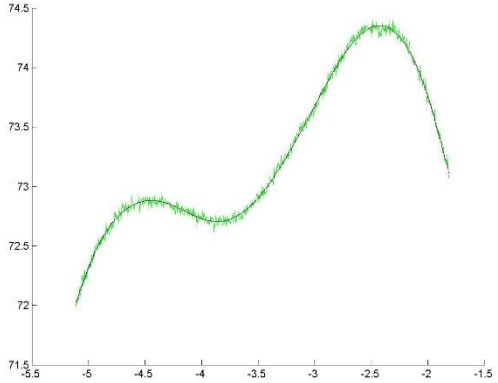


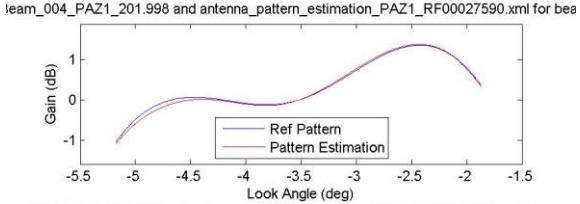


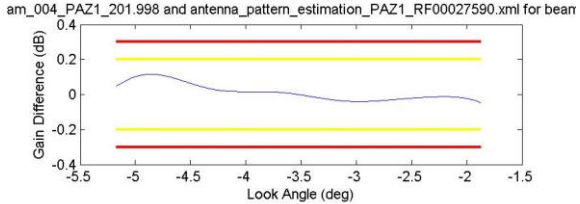
Reference Antenna
Pattern Set regeneration

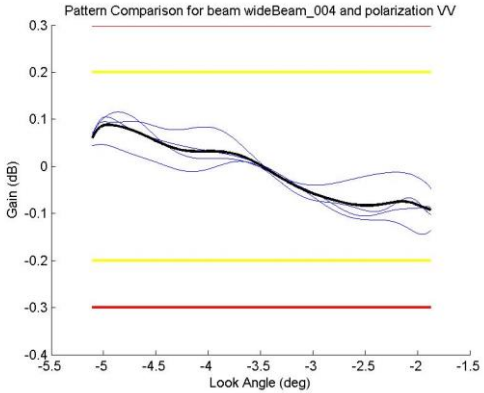


Wide Scansar. Reference Antenna Pattern Verification









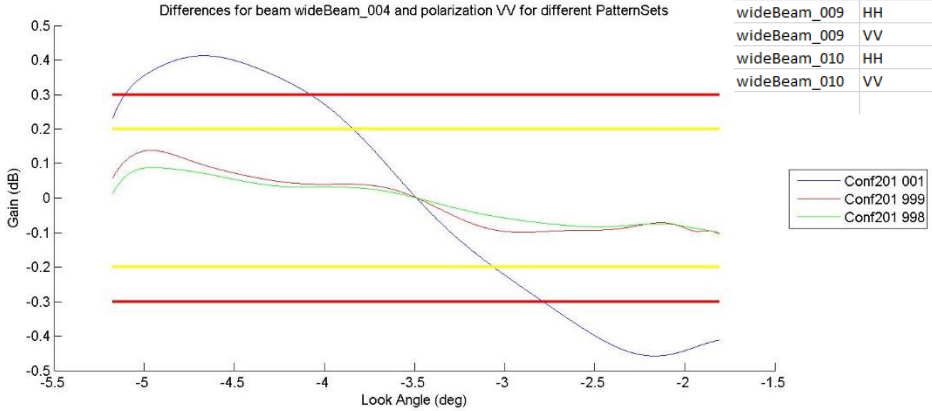
Verification over
Rainforest Area 02

Wide Scansar. Reference Antenna Pattern Verification

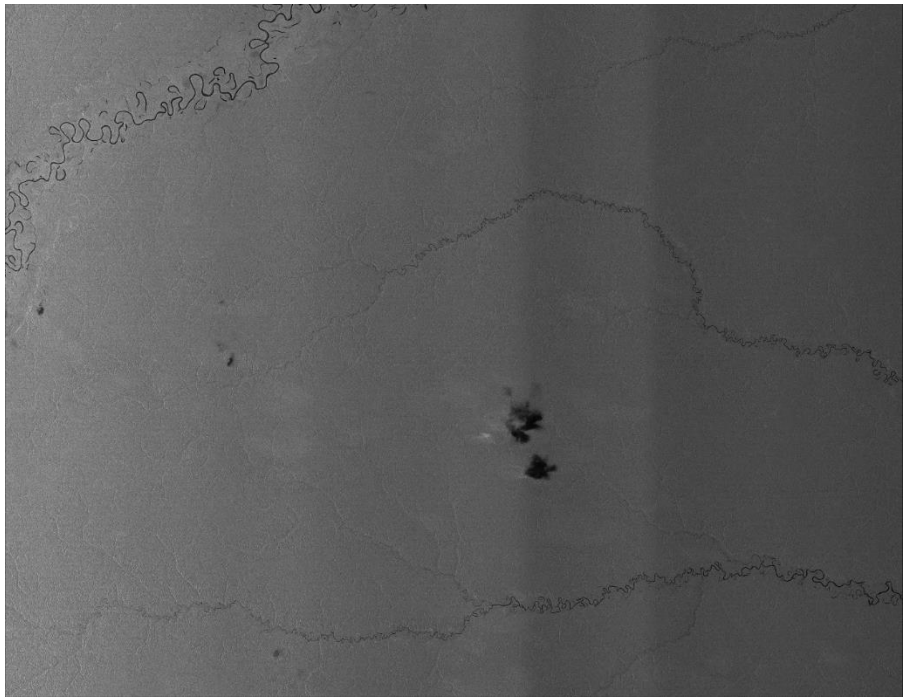
All wideBeams 001-010
estimated and regenerated

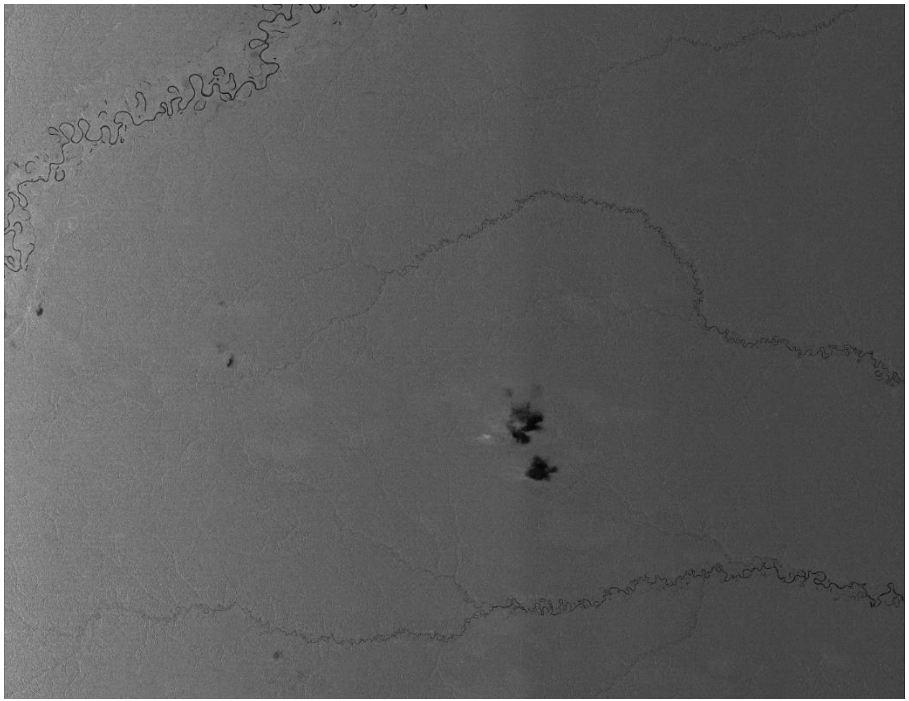
Verification

		CONFIGURATION Conf201_001		CONFIGURATION Conf201_999		CONFIGURATION Conf201_998	
		SHAPE DIFF		SHAPE DIFF		SHAPE DIFF	
Beam	Pol	Mean	Max	Mean	Max	Mean	Max
wideBeam_001	HH	0.05254144	0.15548474	0.01364181	0.07350289	0.03108906	0.06612662
wideBeam_001	VV	0.09054883	0.3646907	0.07327391	0.17001111	0.05263625	0.10850009
wideBeam_002	HH	0.31401263	0.66731371	0.01764471	0.19902478	0.03421906	0.16159317
wideBeam_002	VV	0.24525041	0.4633858	0.03837446	0.08007814	0.02865241	0.11632712
wideBeam_003	HH	0.12287993	0.38287799	0.00857418	0.04933473	0.01069184	0.04555592
wideBeam_003	VV	0.1193917	0.30313177	0.05165696	0.19415146	0.04857389	0.11880609
wideBeam_004	HH	0.06335453	0.49149905	0.0018907	0.08775292	0.00043265	0.10546107
wideBeam_004	VV	-0.00282235	0.4575613	-0.00584299	0.13835181	-0.00793862	0.09366869
wideBeam_005	HH	0.03560666	0.2417063	0.02217154	0.05374586	0.00252364	0.04322983
wideBeam_005	VV	-0.00921758	0.29493562	0.01914059	0.05411285	0.0284251	0.07326484
wideBeam_006	HH	0.01165466	0.10331874	-0.0139619	0.04045742	-0.01041	0.0356269
wideBeam_006	VV	0.03853099	0.14413911	-0.0054666	0.04884175	-0.00406987	0.047778
wideBeam_007	HH	-0.01034936	0.09106409	0.01081597	0.16179457	0.00425244	0.1254455
wideBeam_007	VV	0.03428164	0.13901757	-0.00953169	0.16863043	0.00105278	0.14698743
wideBeam_008	HH	-0.10452805	0.1919151	-0.08851739	0.23794303	-0.10068442	0.23108507
wideBeam_008	VV	-0.05196907	0.22278752	-0.05476685	0.12541298	-0.05300566	0.13904404
wideBeam_009	HH	0.00985863	0.09768802	0.07213544	0.22794487	0.03068152	0.15481406
wideBeam_009	VV	0.03199556	0.21003413	0.00363962	0.08167267	0.02064146	0.12513891
wideBeam_010	HH	-0.00181077	0.04619891	0.01368241	0.1537455	-0.00438159	0.13846563
wideBeam_010	VV	0.02000739	0.08103681	-0.01573284	0.05834967	0.00585043	0.10367891



Wide Scansar. Reference Antenna Pattern Verification

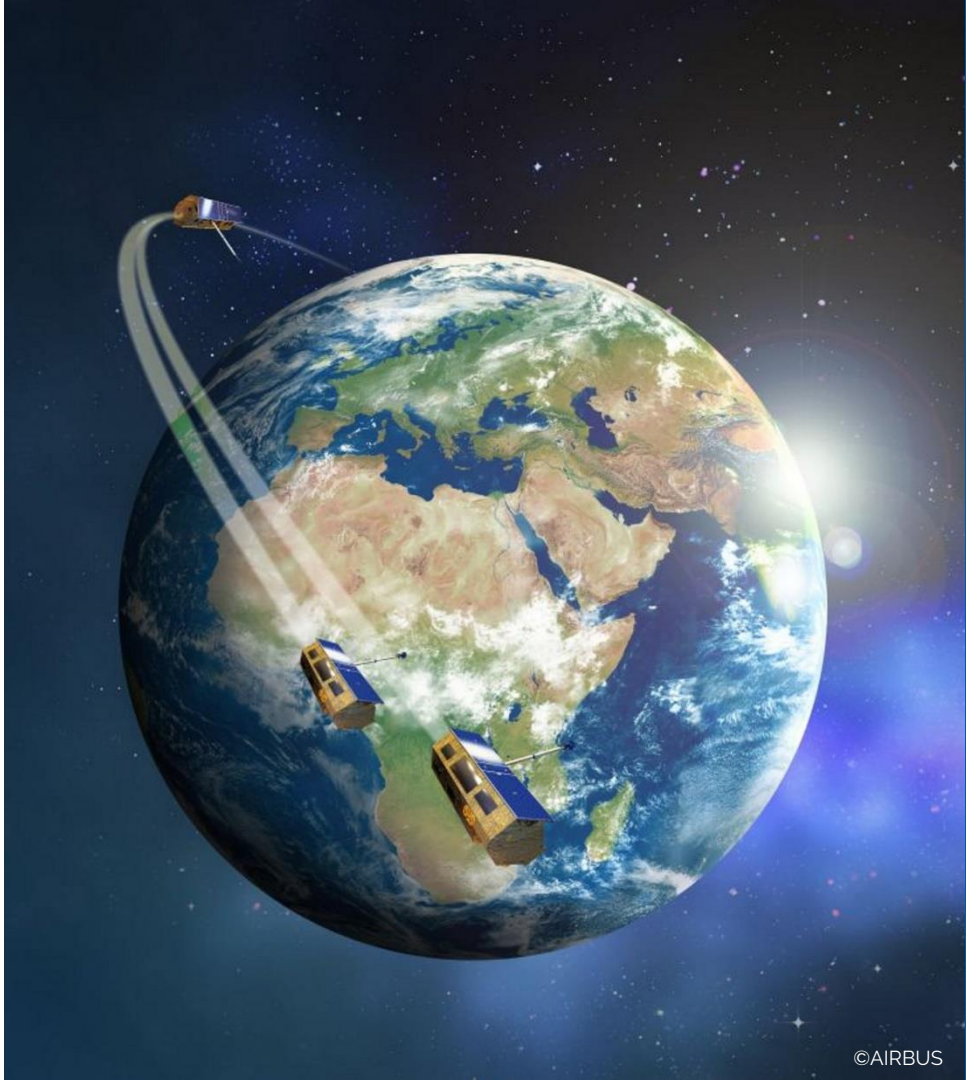




Cross Calibration campaign

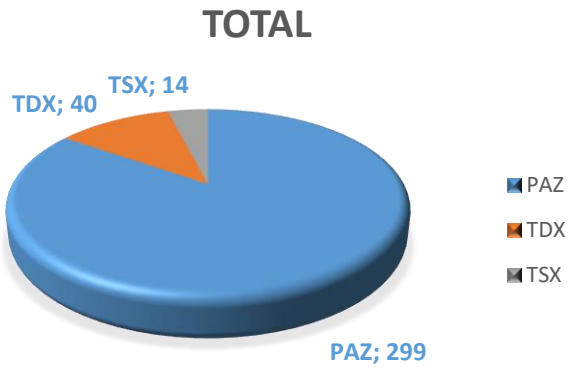
Cross Verification of PAZ Radiometric Calibration and RCS determination of INTA CR

TSX/TDX/PAZ data takes over INTA & DLR calibration fields

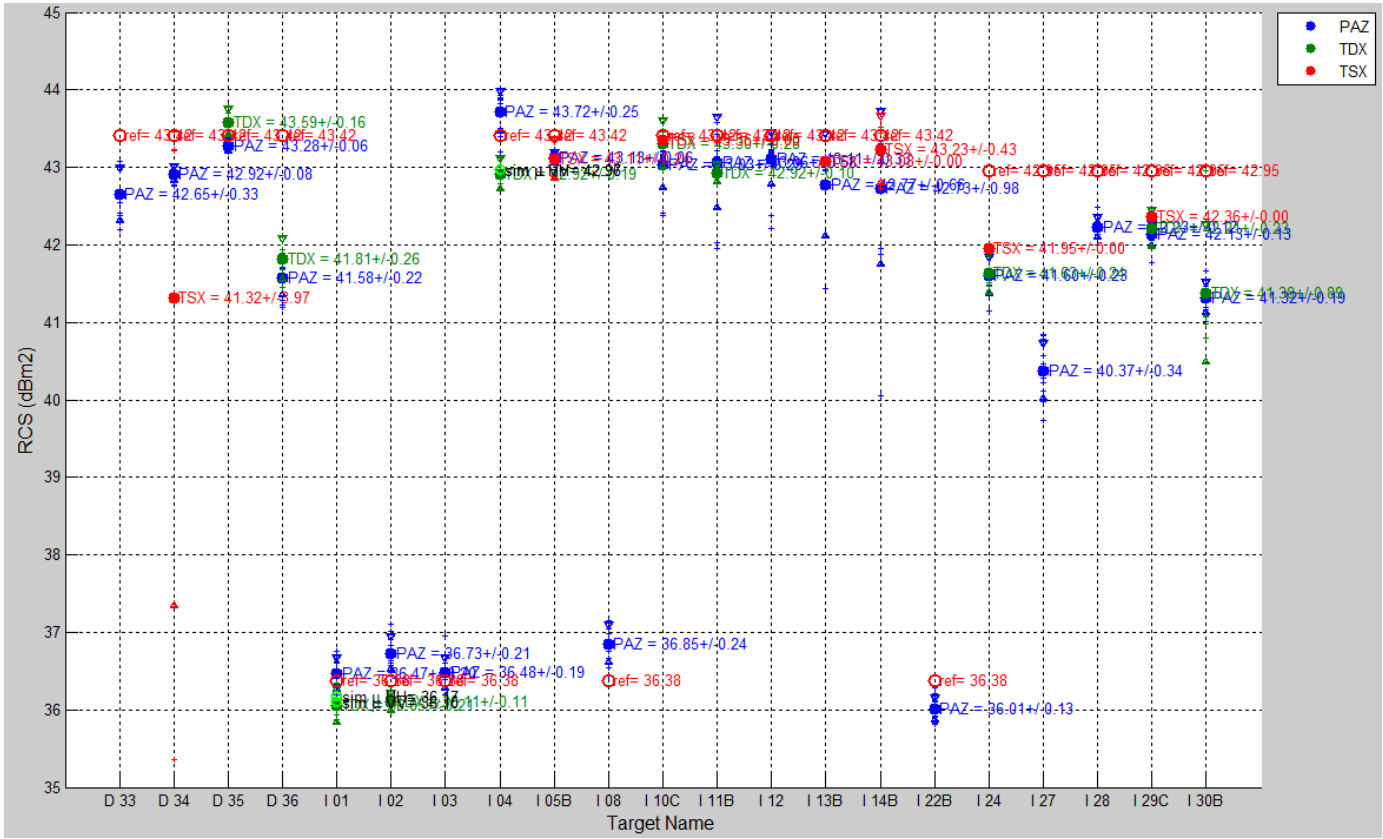


Test Data Set

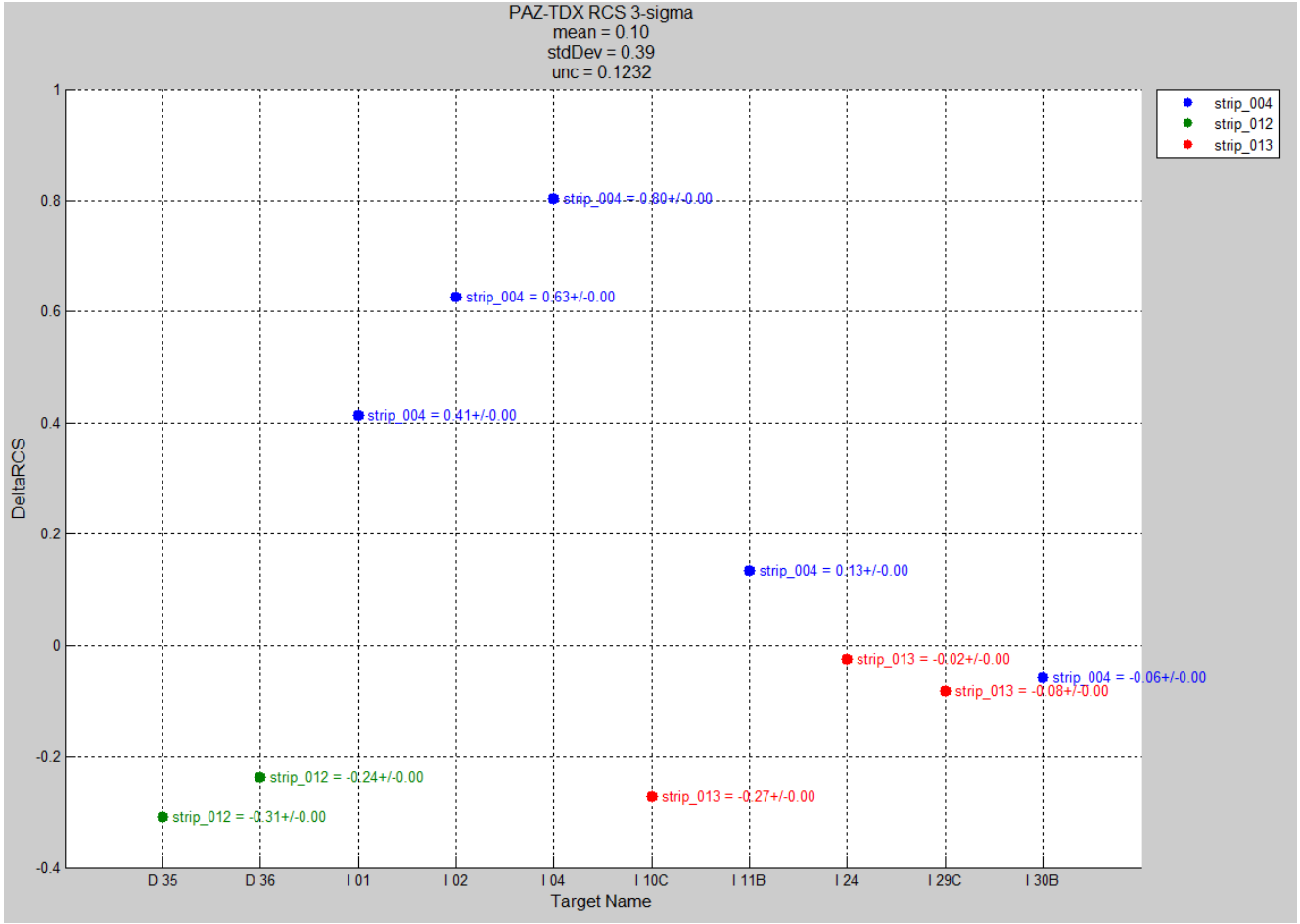
System	Samples
PAZ	299
TDX	40
TSX	14
Total general	353



Cross Calibration. PAZ calibration verification



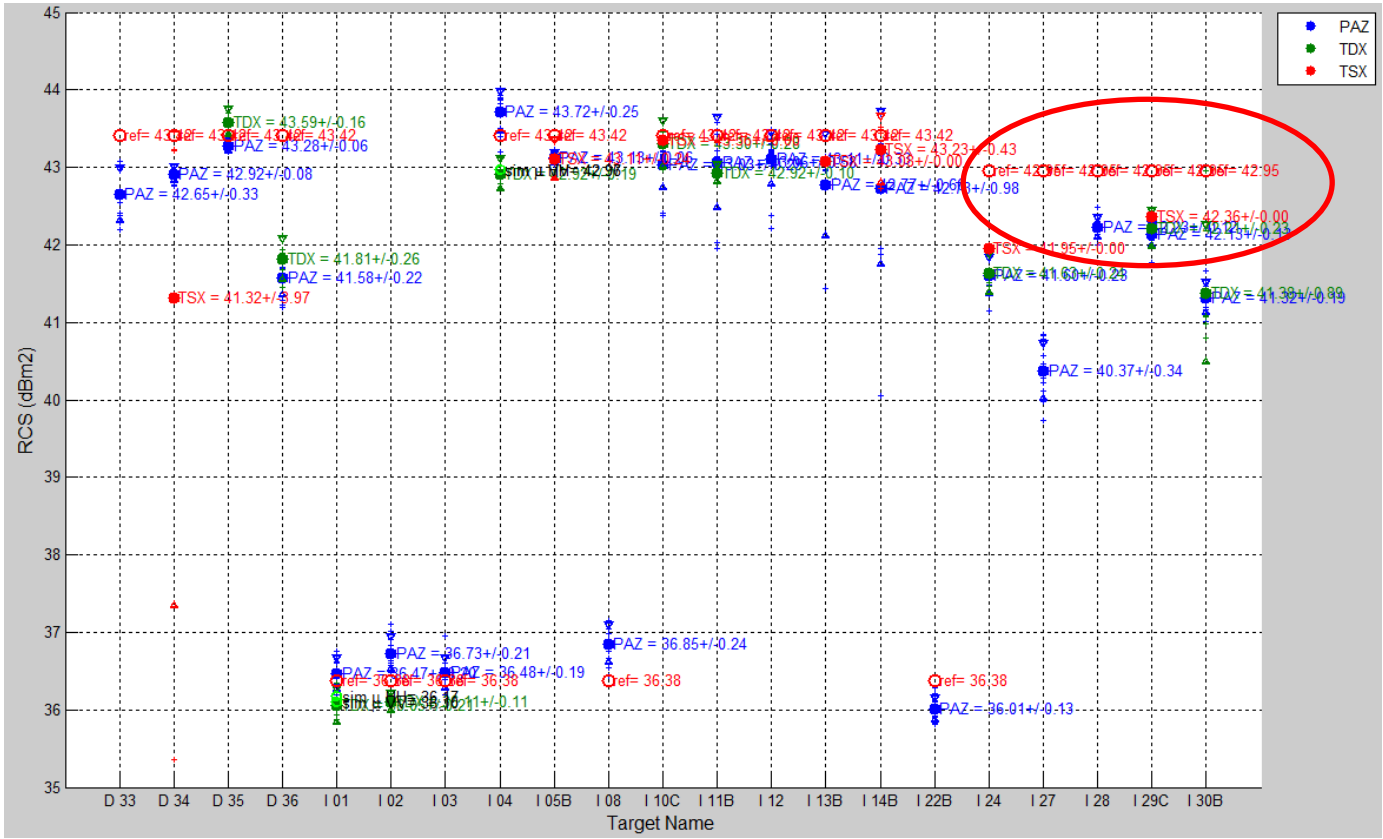
Cross Calibration. PAZ calibration verification



RMS = 0.38

~PAZ Absolute Radiometric Accuracy

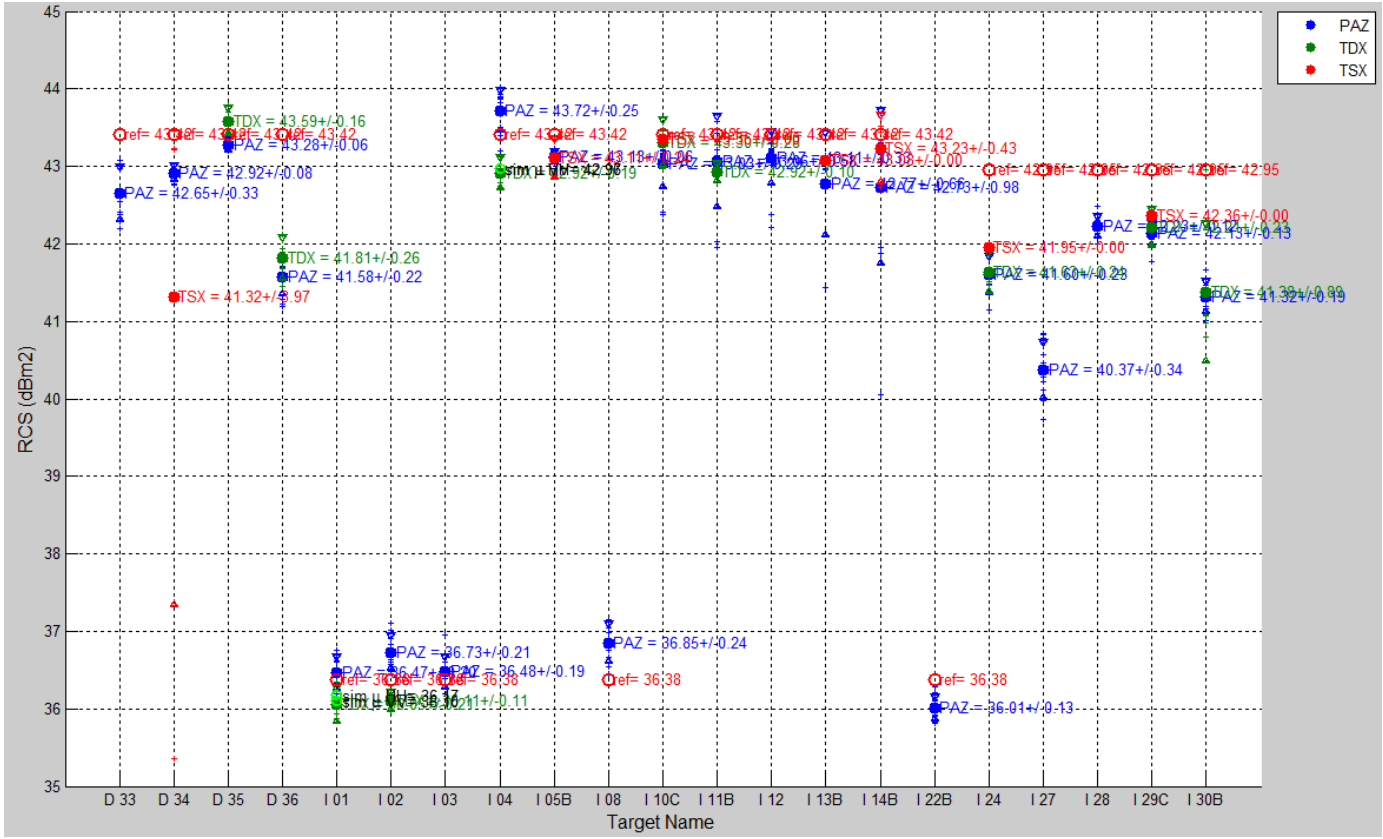
Cross Calibration. RCS determination



Newly manufactured batch CR

Dimensional distorsions

Cross Calibration. RCS determination

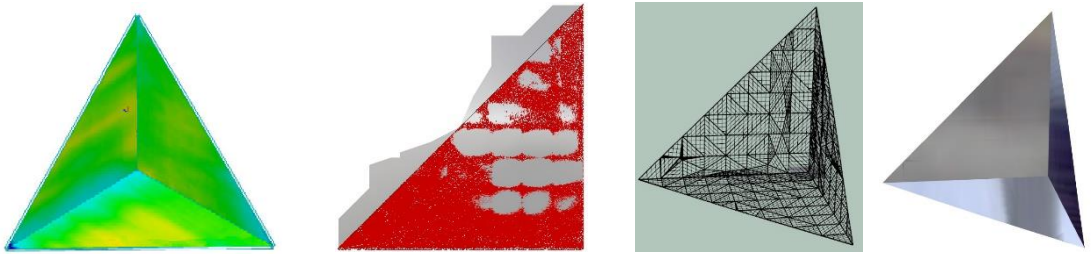


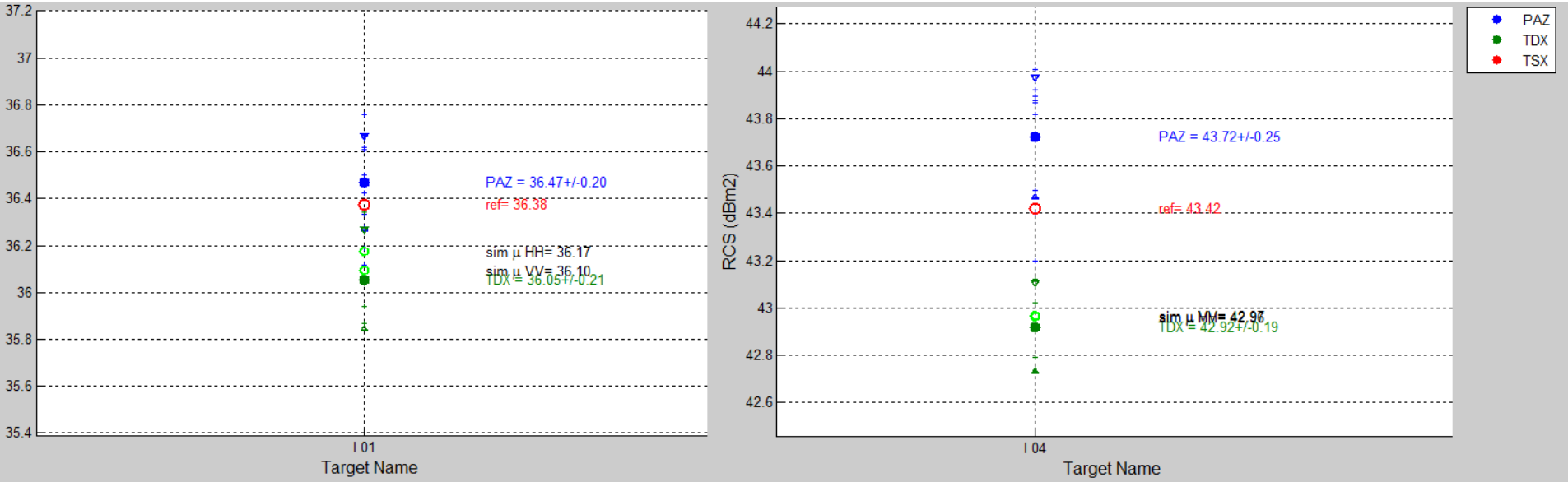
TDX measurements can be taken instead of derivation from leg size

Only 7 CRs measured

Estimation from dimensional measurements for all CR

Cross Calibration. RCS Simulation





Cross Calibration. RCS Simulation

-> Simulation process has been preliminary validated.

More simulations in progress in order to validate a representative number of CRs


Thank you