



SARAL Project Status



Thierry Guinle, CNES

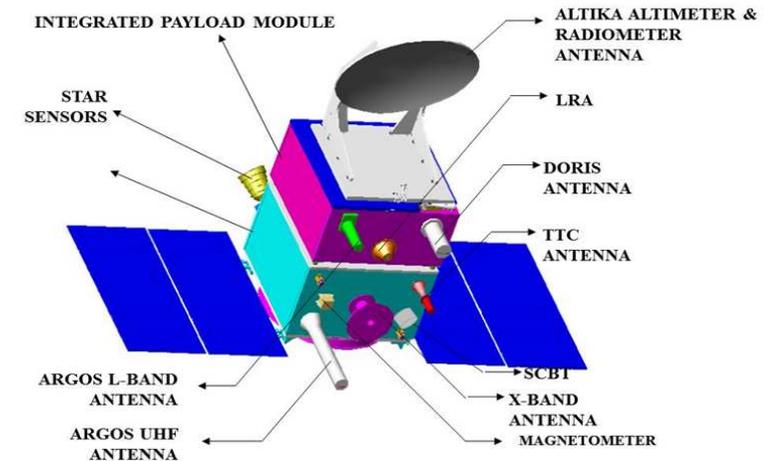
Major events since last OSTST (October, 2014)

- Project Milestones
 - Second SARAL REVEX : October 14, 2015 → successful
- Satellite major events
 - Safe hold mode (6-9 October 2014)
 - Reaction wheel #1 failure and concerns about RW stiction/friction
 - +/- 1km GTS loss from 31/03/2015 to 05/08/2015
- Payload major events
 - None
- Ground major events
 - Better X-Band antenna availability
 - Orbits in GDR-E standard available - routine early July

Current SARAL mission Status is OK

Platform Status

The SARAL satellite bus is **OK**



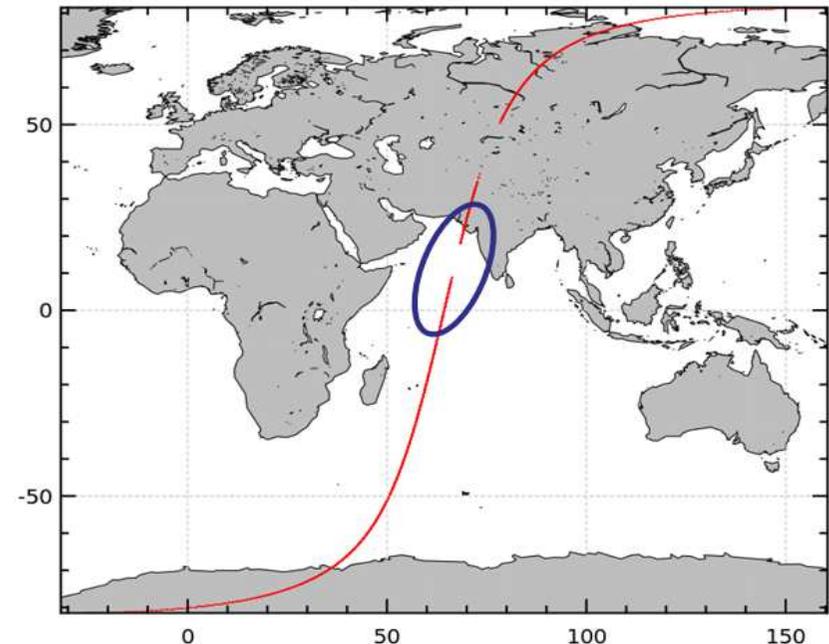
- Command / control , RF : **OK**
- Thermal aspects : **OK**
- Electrical aspects : **OK**
- AOCS (attitude and orbit control system) : **OK**
with some concerns on reaction wheels

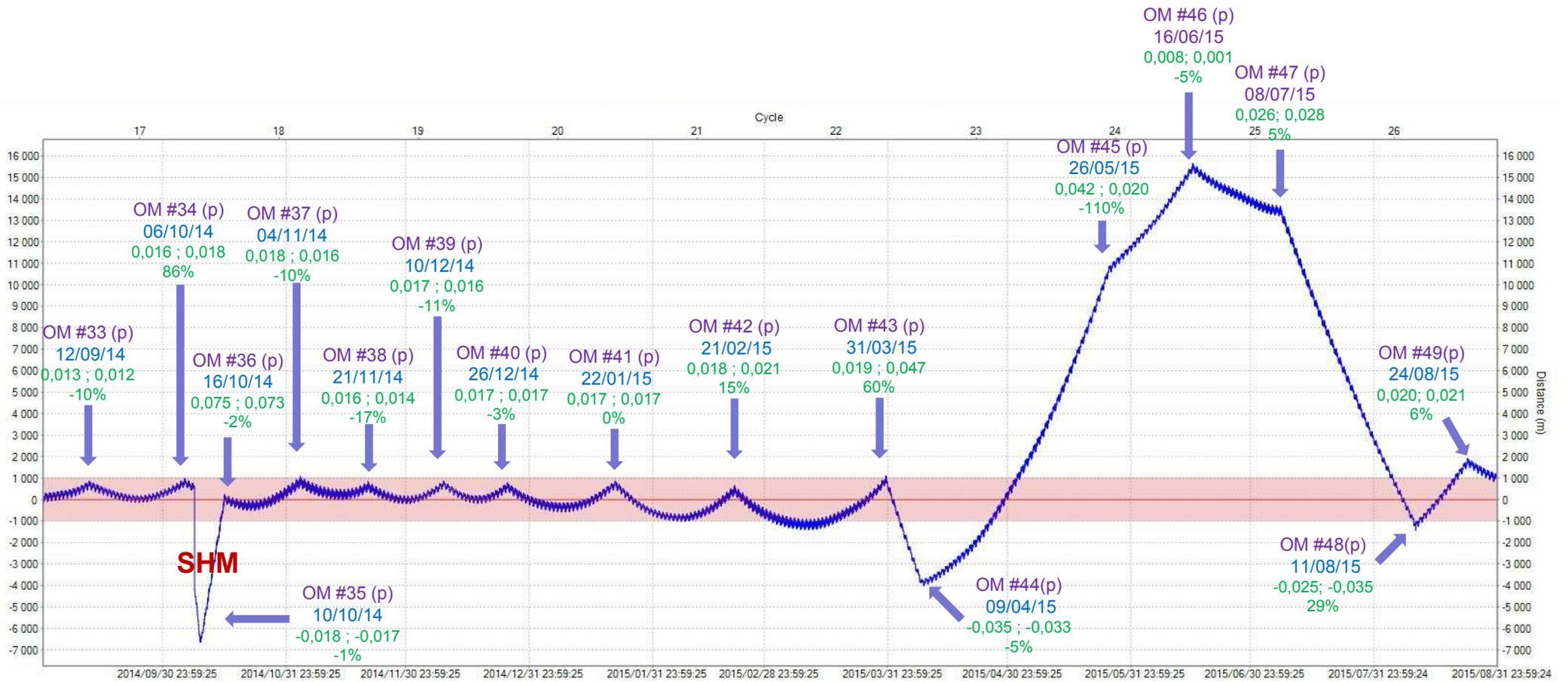
SARAL bus is operational after 2,5 years in orbit

Navigation and guidance

- no collision avoidance maneuver
- station keeping maneuvers
 - ground tracks are maintained within $\pm 1\text{km}$ from the reference grid at Equator; **back to nominal since August**
 - station keeping maneuvers are made with only one thrust above land on any orbit; **3 thrusts since July**

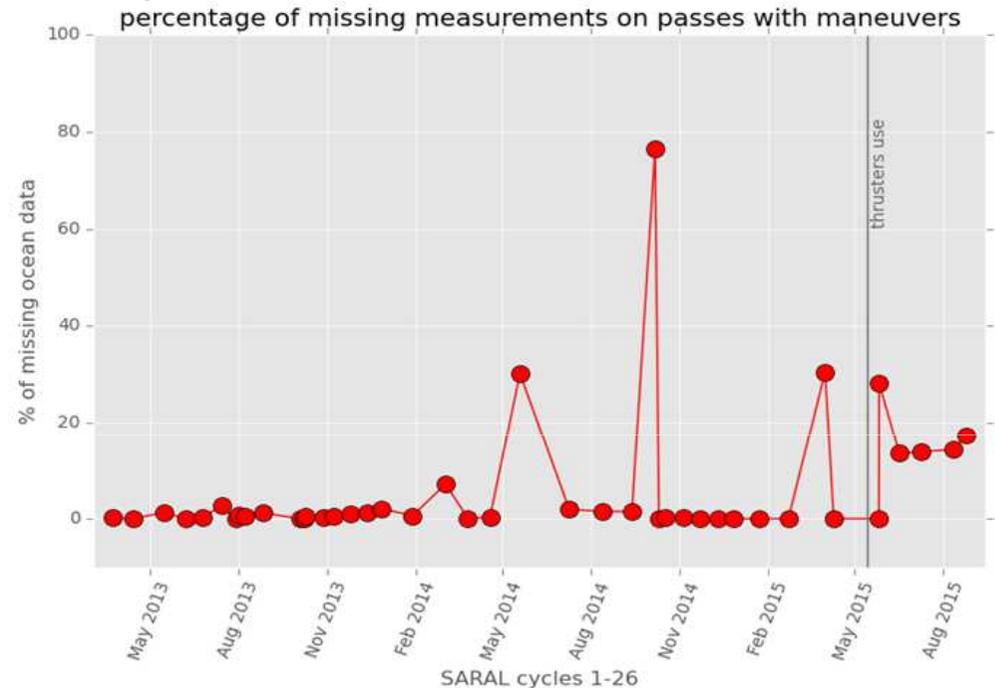
- propellant : ~15 kg (150 g/year)





Issue on RW & consequences (1/2)

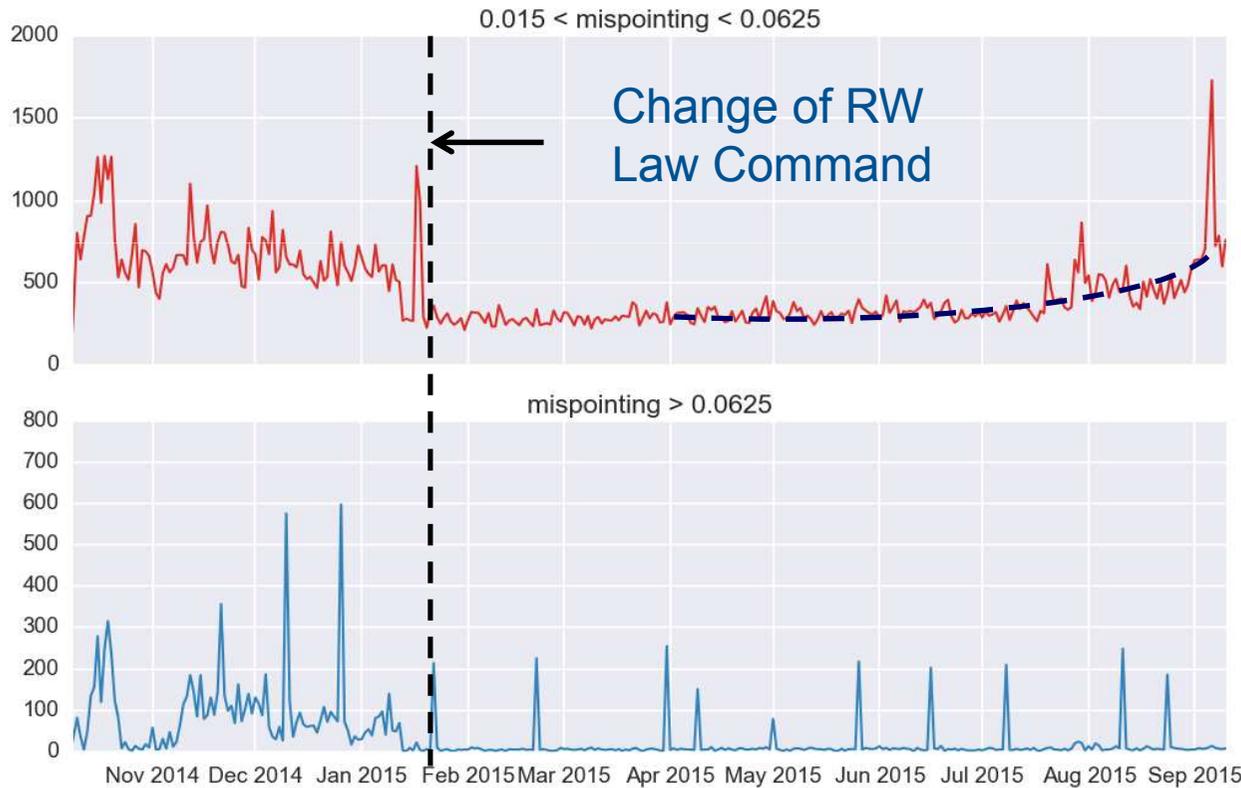
- Maneuver with thrusters
 - Increase of data unavailability during maneuvers



- errors on the real time orbit estimation
 - Highest effect in SLA corruption for OGDR (Diode data) after maneuver
- limited to the maneuver period for IGDR & GDR

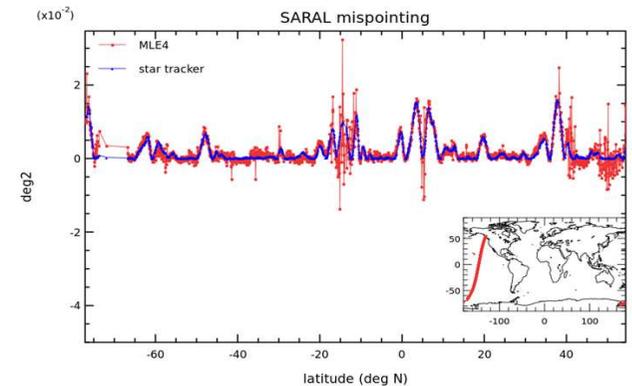
Issue on RW & consequences (2/2)

- RW friction produces mispointing



slight increase of mispointing events

assessed with ISRO through PF attitude vs WF



Payload Status since last OSTST (October, 2014)

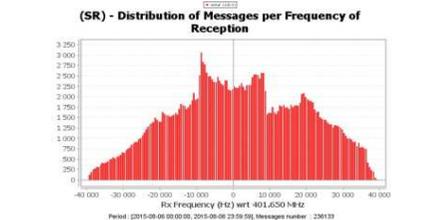
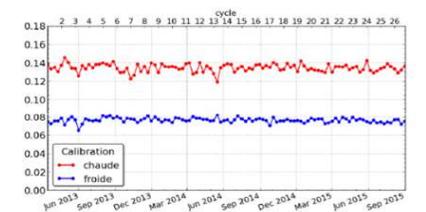
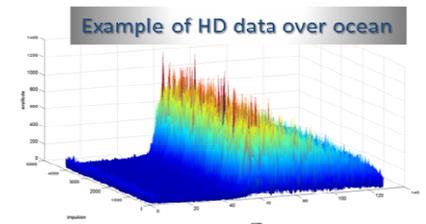
- 100% available except SHM
 - **AltiKa**
 - routine calibrations PTR, LPF
 - Specific calibrations over sea & ice (HD mode)
 - **Radiometer**
 - Very good stability & sensitivity
 - 5 March & 9 April 2015: temporary radiometer K band saturation over Japan due to external signal
 - **DORIS**
 - Nominal
 - **ARGOS**
 - Nominal; performance similar to other satellites

OK

OK

OK

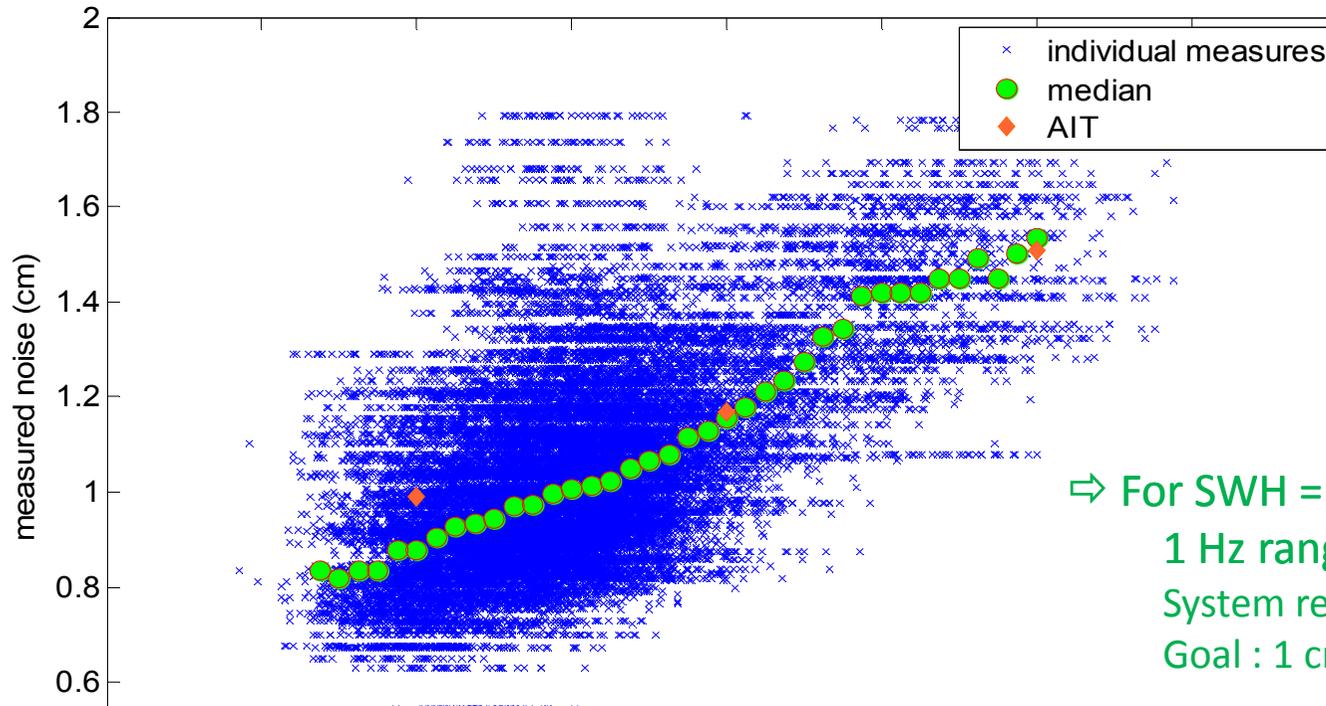
OK



➔ fully OPERATIONAL

Altimeter performances – range noise

RANGE NOISE @ 1Hz

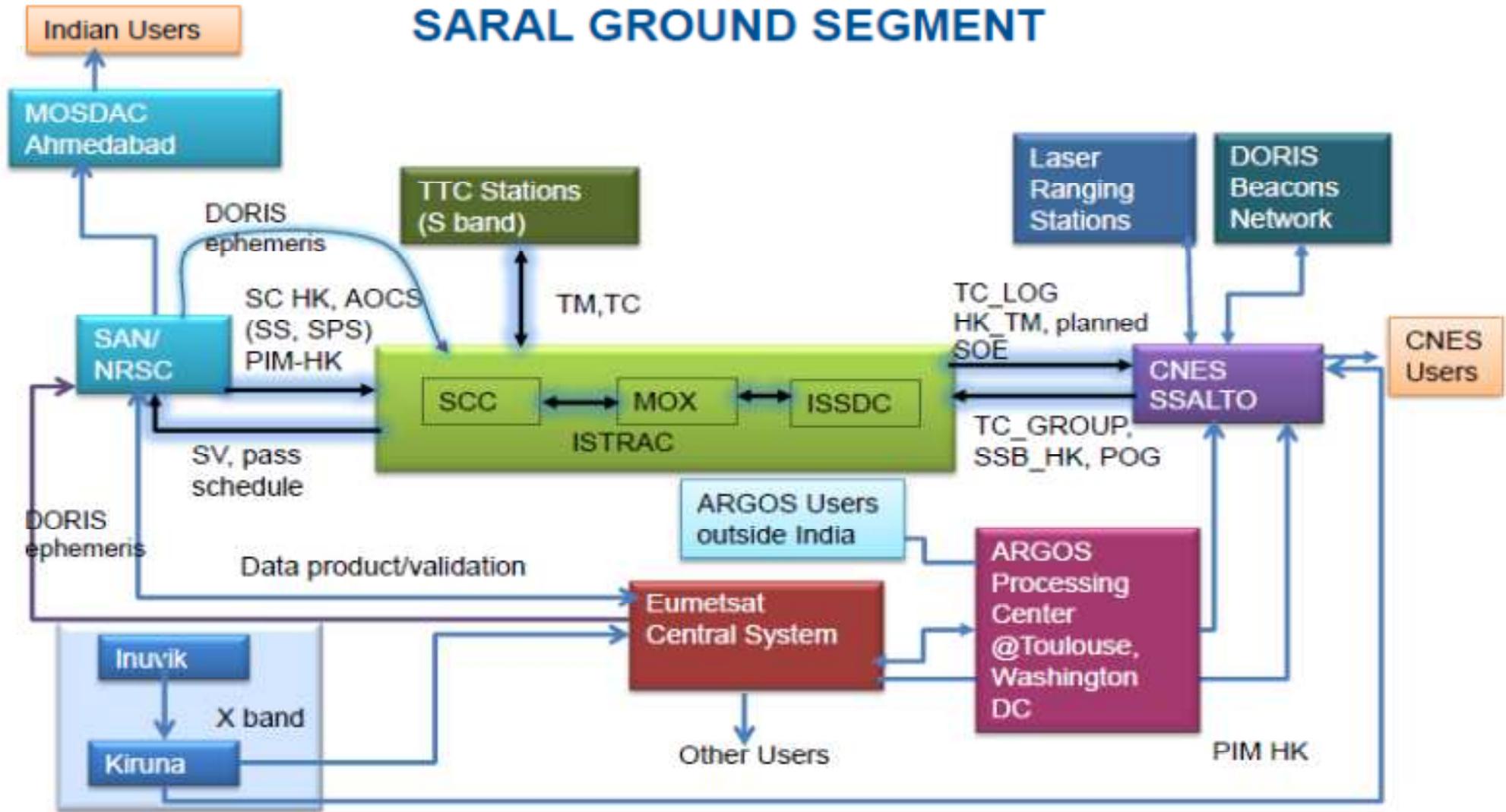


⇒ For SWH = 2 m
 1 Hz range : 0,9 cm
 System requirement : 1,5 cm
 Goal : 1 cm

Altimeter parameter	Specifications	Measured on ground	In flight data
1 Hz range	1.5 cm	0.9 cm	0.9 cm
1Hz SWH	6.3 cm	5.7 cm	5 cm
1 Hz Sigma0	0.2 dB*	N/A	0.012 dB

from 2nd SARAL exploit. review

SARAL GROUND SEGMENT



Ground & Operations - Status and performances

- Earth terminals :
 - ISRO band-S (Bangalore, Lucknow) **OK**
 - ISRO band-X (Shadnagar) **OK**
 - CNES band-X (Kiruna and Inuvik) **OK**

- Control Centers :
 - ISRO/ISTRAC Control center **OK**

- Instrument Commanding and Monitoring Centers :
 - SSALTO for Altimetry **OK**
 - ARGOS PC for ARGOS **OK**

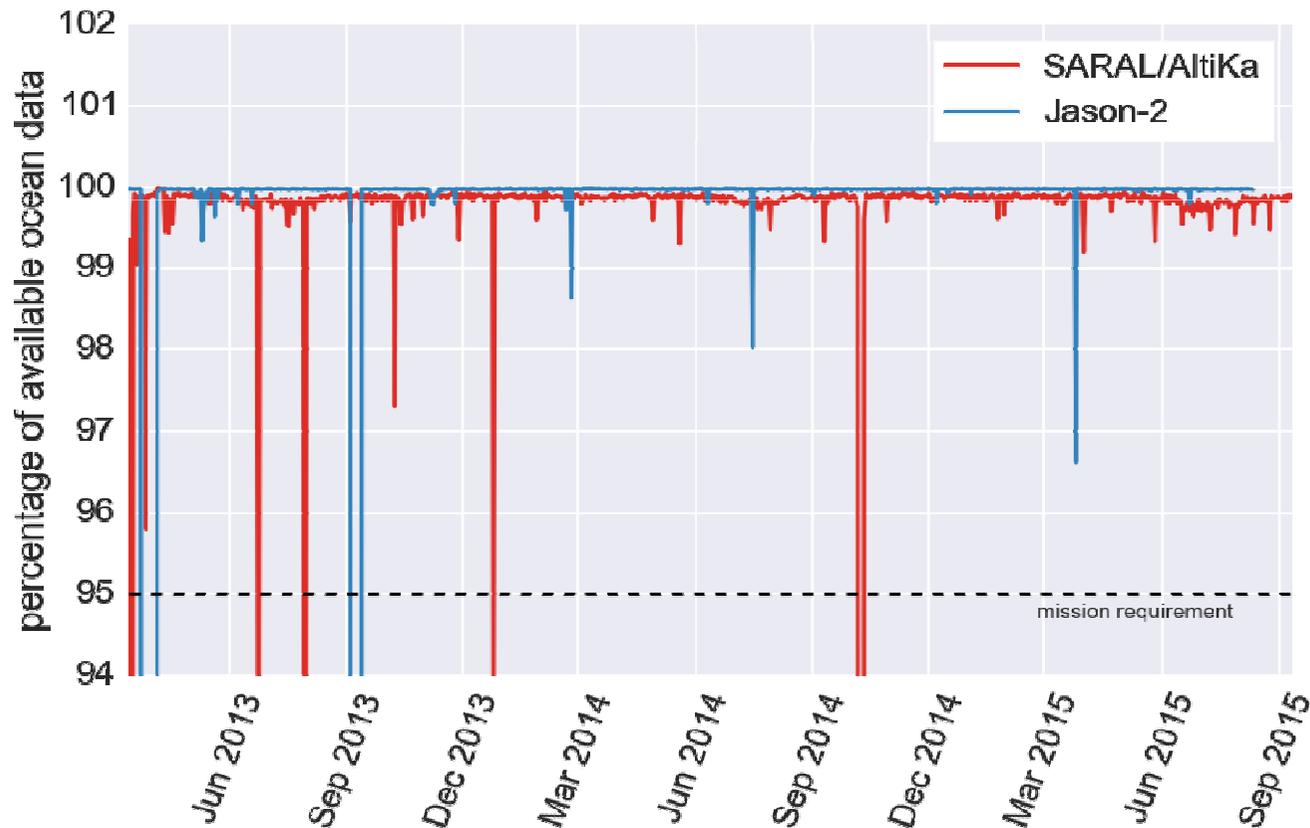
Data products latency

Product	Requirement	Effective performance for REVEX period	
		Revex#1	Revex#2
OGDR	75% ≤ 3 hours 95% ≤ 5 hours	97% < 3 hours ¹ 97% < 5 hours	97.6% < 3 hours 98% < 5 hours
IGDR	< 3 days (objective : 1 or 1,5 days max)	95,65% < 1,5d 99,7% < 3d	97,18% < 1,5d 99,61% < 3d
GDR	~40 days	compliant for 9 cycles over 12	compliant (average: 35 days)

from 2nd SARAL
exploit. review

Data availability – ocean only

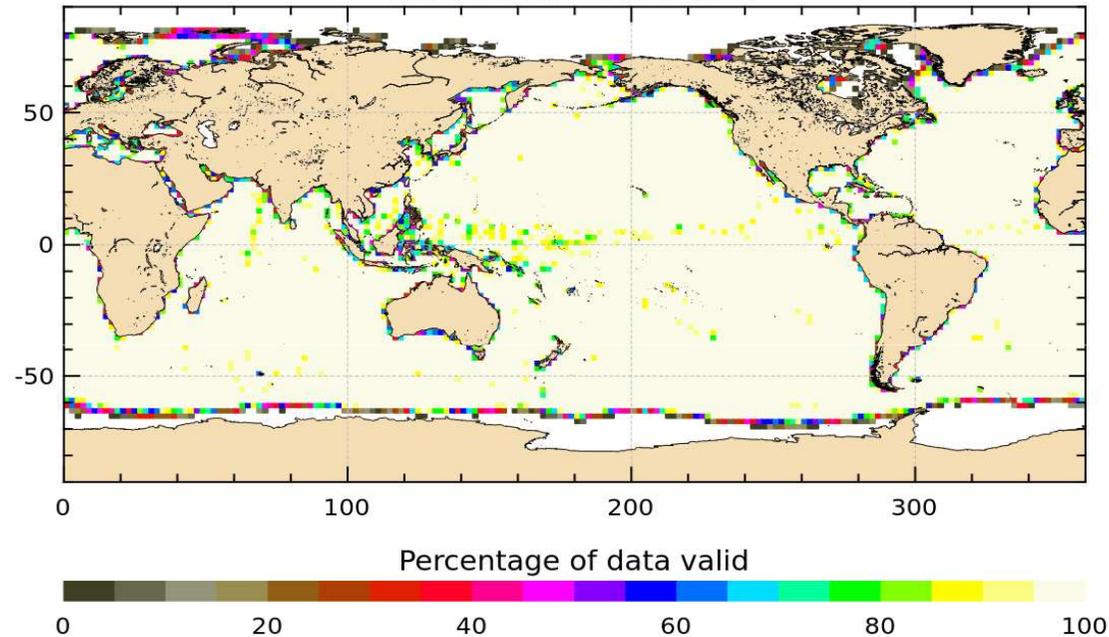
- Exceeds mission requirements
- 99.8 % (SHM excluded), 99.3% (SHM included)



Edited Data

AltiKa GDR-T P2 Cycle 024

28/05/2015 - 02/07/2015



Nominal editing - inline with other altimetry missions metrics

High latitudes editing mainly due to ice

mean ratio : 2,53% (excluding ice), even better than Jason-2

ALTIKA Mission Performance requirements

	OGDR 3 Hours	IGDR 1.5 days	GDR 40 days	GOALS
Altimeter noise(1) (2)	1.5	1.5	1.5	1
Ionosphere	0.6	0.3	0.3	0.3
Sea state bias (3)	2	2	2	2
Dry troposphere	1.5	0.7	0.7	0.7
Wet Troposphere	1.2	1.2	1.2	1
Altimeter range after corrections (RSS)	3.2	2.9	2.9	2.6
Orbit (4) (Radial component) (RMS)	Req : 30 Goal : 10	Req : 4 Goal : 1.5	Req : 3 Goal : 2	2
Total RSS Sea Surface Height	Req : 30.2	Req : 4.9	Req : 4.2	3.2
Significant Wave Height (H1/3) (6)	10% or 6.3cm	10% or 6.3cm	10% or 6.3cm	5% or 3.9cm
Sigma naught Relative Value (7)	0.2 dB	0.2 dB	0.2 dB	0.1 dB
Wind speed	2 m/s	1.7 m/s	1.7 m/s	1 m/s
Sigma naught Absolute Value after in-flight calibration	0.7 dB	0.7 dB	0.7 dB	0.5 dB

Available in the annual CALVAL report

X-overs statistics (with radiometer)

- At crossovers, SARAL/AltiKa performs as well as Jason-2,

5.3 cm vs **5.4** cm

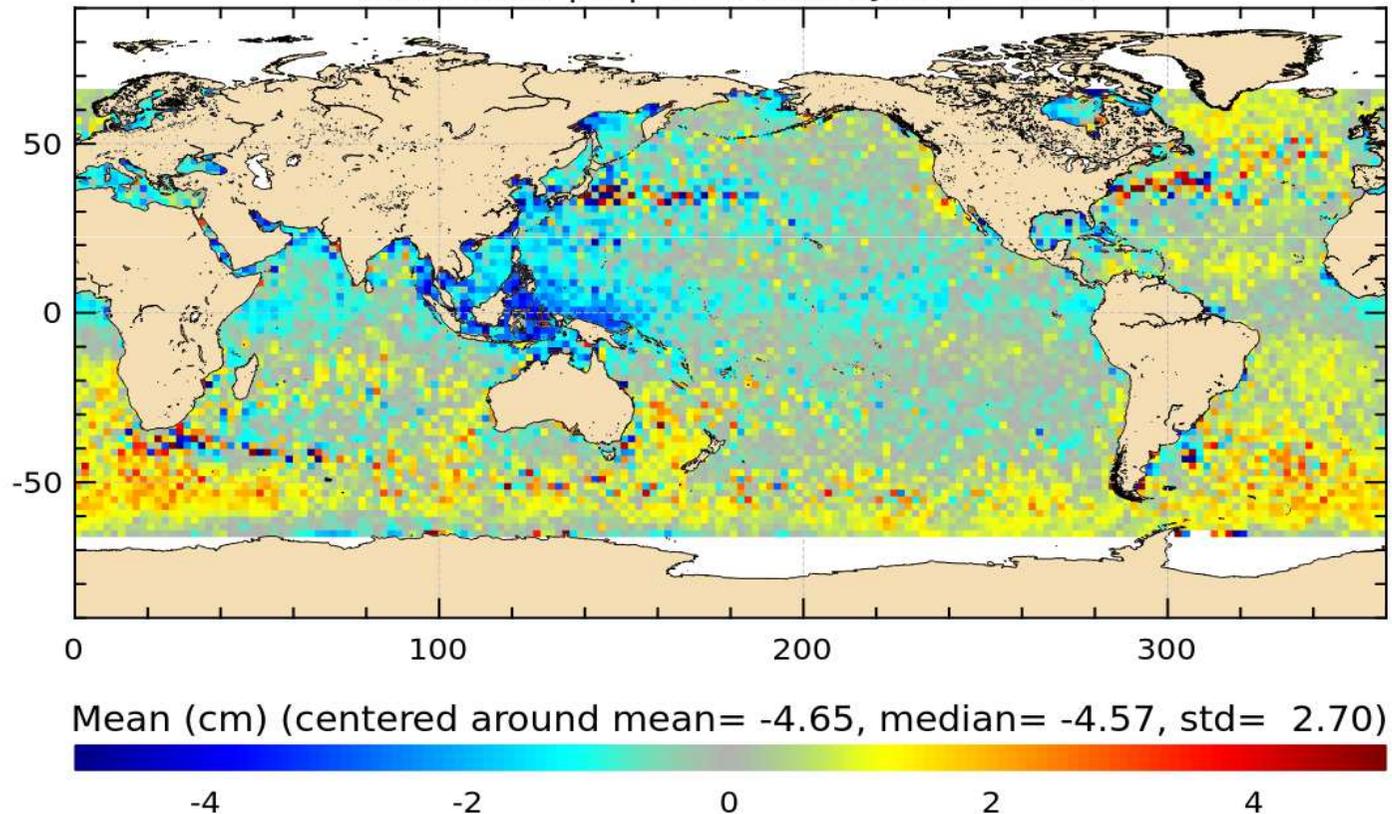


Sea-level performances (Altika – Jason-2)

Very limited differences; Good agreement

AL-J2 SLA differences (using radiometer wet tropo)

valid data, $|\text{lat}| < 66$ (SRL cycle 1 - 024)



System Requirements and Performances

from October 2014 until October 2015

⇒ **satellite unavailability**

~3 % < **4% req**

– bus : 3% altimeter : 01%

Doris : 0%

radiometer : 0%

⇒ **ground unavailability**

~0 % < **1% req**

➔ **Global SARAL system availability : 99.7 %**

NB : GDR data availability vs theory (from 2014 annual CALVAL report)

All surfaces : 96.5 %

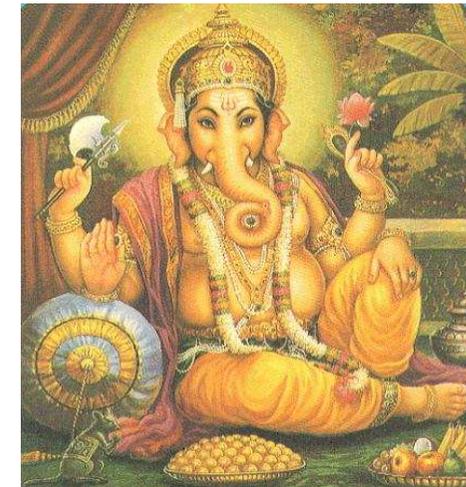
Over Ocean : 99.2 %

Conclusion

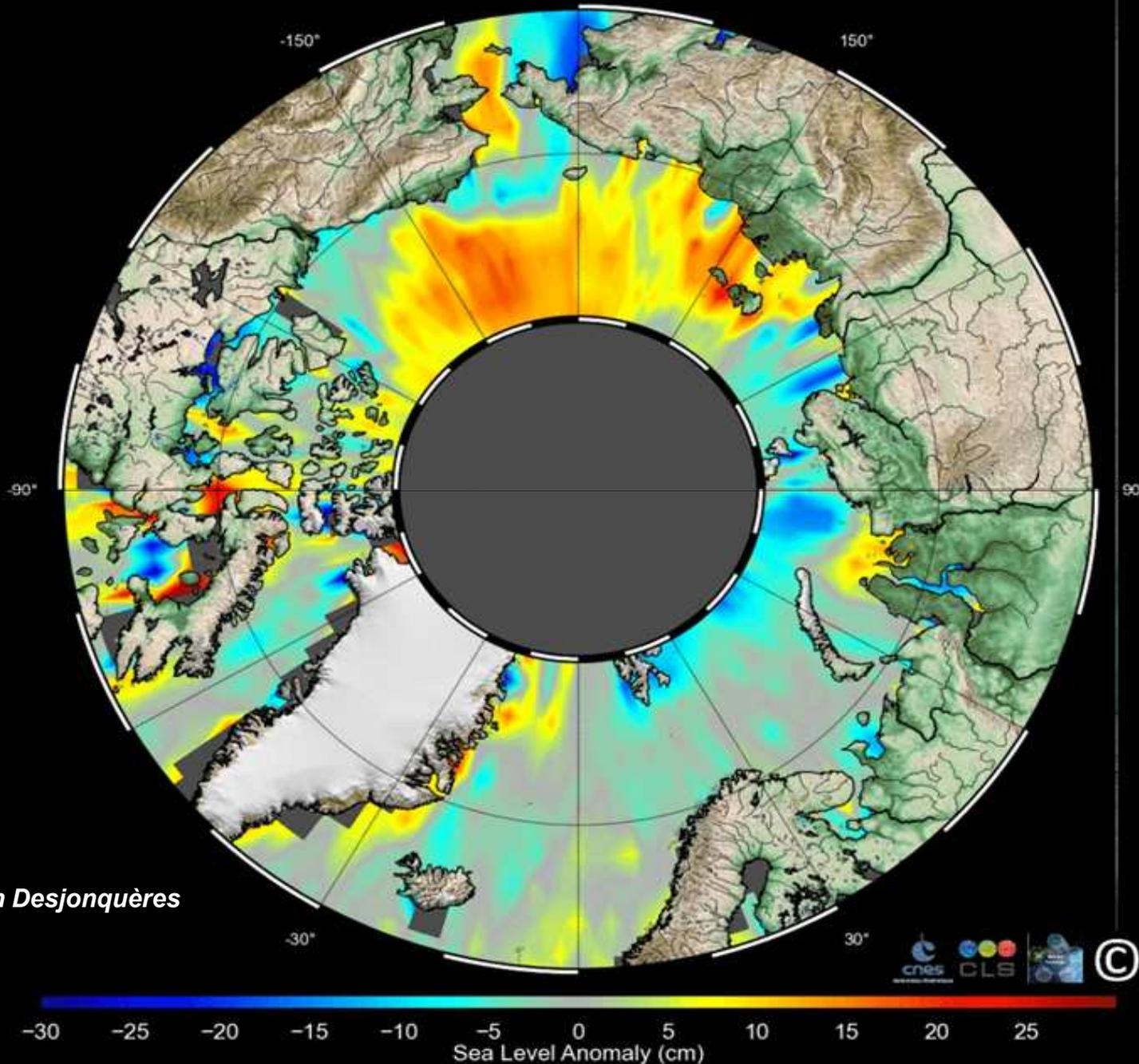
- SARAL satellite has still a good behavior
- AltiKa and ARGOS performances are excellent
- AltiKa is a “world premiere” and pave the way for SWOT
- ISRO and CNES OPS teams are working closely to preserve the lifetime
- Nominal mission continues up to 3rd birthday (Feb 2016)
- Then formal JSC to decide the way forward

One question to OSTST :

“do you prefer relaxed ground track or drifting orbit ?



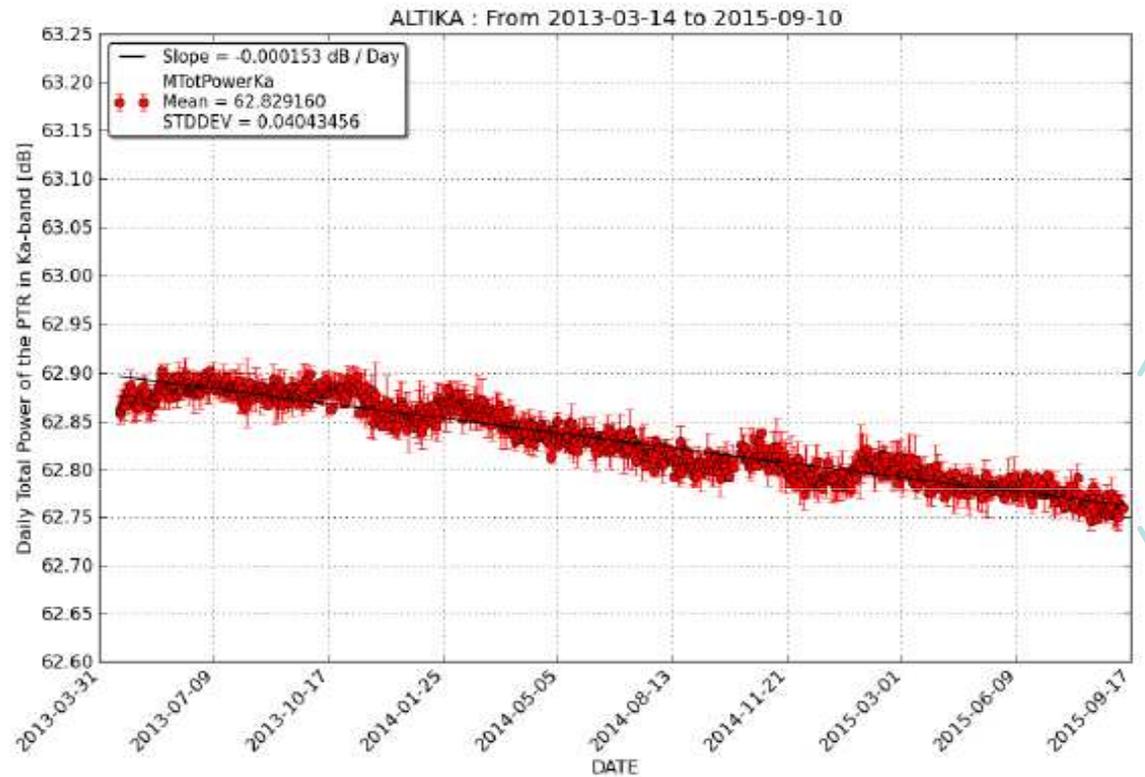
Thanks for your attention and many thanks to the contributors !!



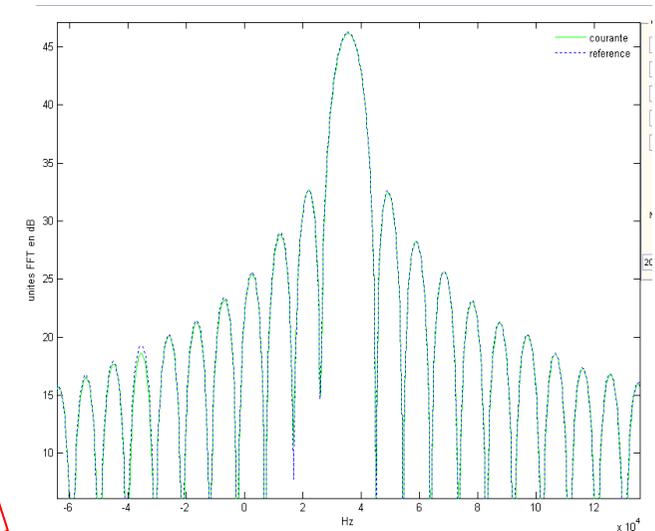
- *ISRO team*
- *EUMETSAT team*
 - *S. Dieterle*
- *CNES Team*
 - *S. Mazeau*
 - *D. Delacroix*
 - *N. Steunou*
 - *I. Denis*
 - *N. Picot*
 - *Jean-Damien Desjonquères*
 - *F. Didelot*
- *CLS team*

Backup slides

Altimeter performances : PTR analysis



< 0,2 dB since beg. Of life



Routine PTR : **observed evolutions are as expected**

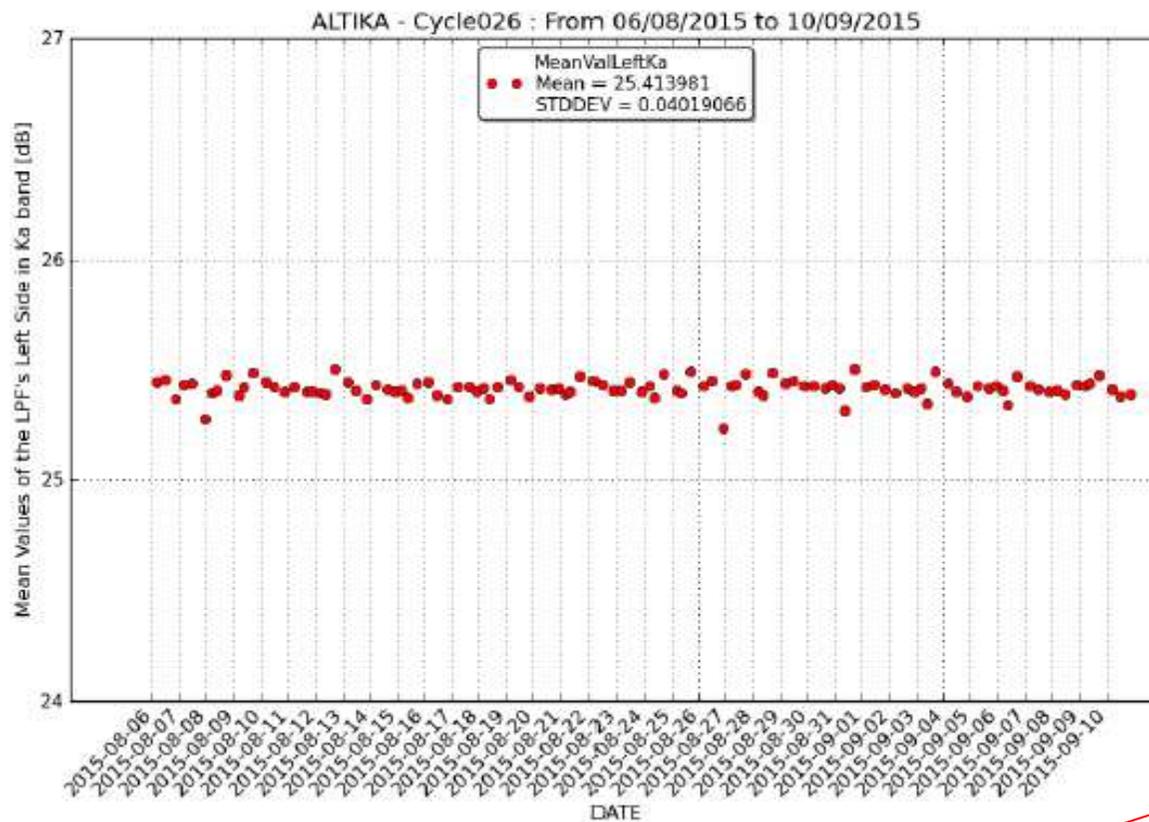
In the ground processing PTR parameters are averaged on 3 days basis to reduce the noise

from 2nd SARAL
exploit. review

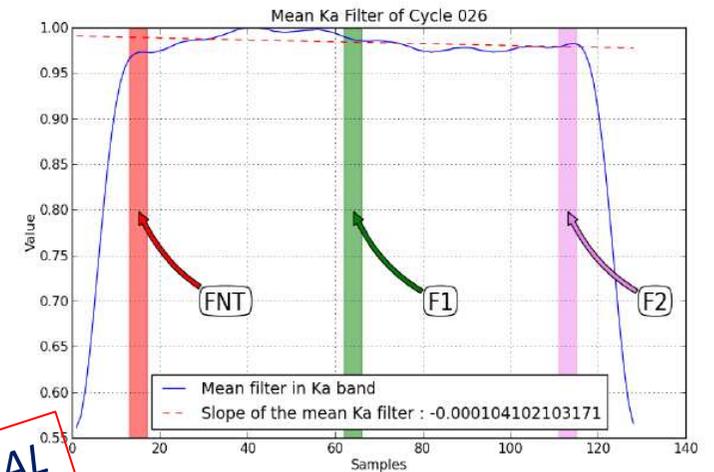
Altimeter performances : Low Pass filter analysis

Routine LPF : **Very good stability since launch**

In the ground processing LPF parameters are averaged on 7 days basis to reduce the noise



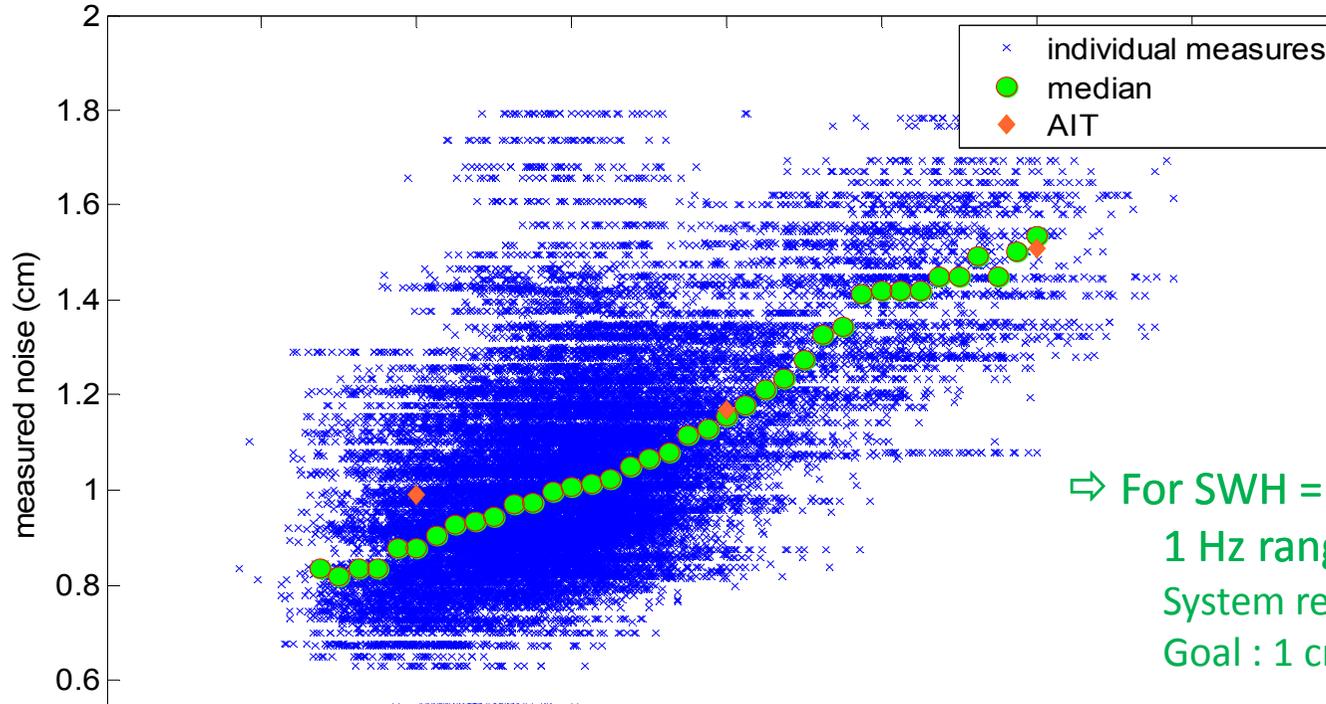
Cycle 26: mean value for left part of the filter



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 exploit. review

Altimeter performances – range noise

RANGE NOISE @ 1Hz



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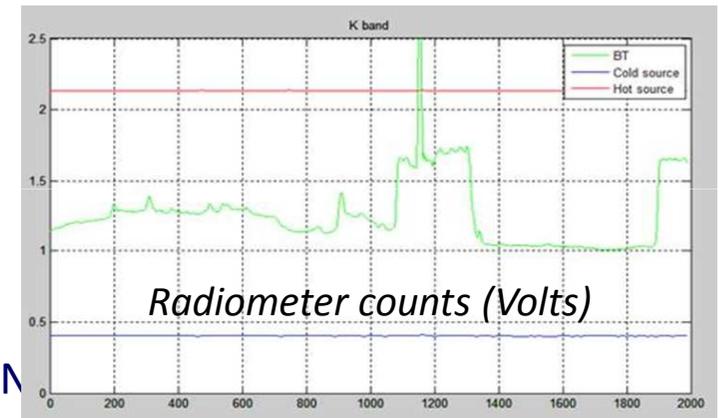
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from 2nd SARAL exploit. review

Radiometer main EVENTS

- **No anomaly, nominal behaviour**
- After SHM, slight differences were observed on estimated gain
- 5 March & 9 April 2015: temporary radiometer K band saturation over Japan
- External signal detected
- Impact on data limited to about 4 s
- No impact on further measurements

- **Routine operations**
 - None: radiometer has been working since AltiKa switch ON
 - ◆ 1 measurement every 200 ms
 - ◆ Calibrations are done continuously, every 3 sec (hot and cold targets)

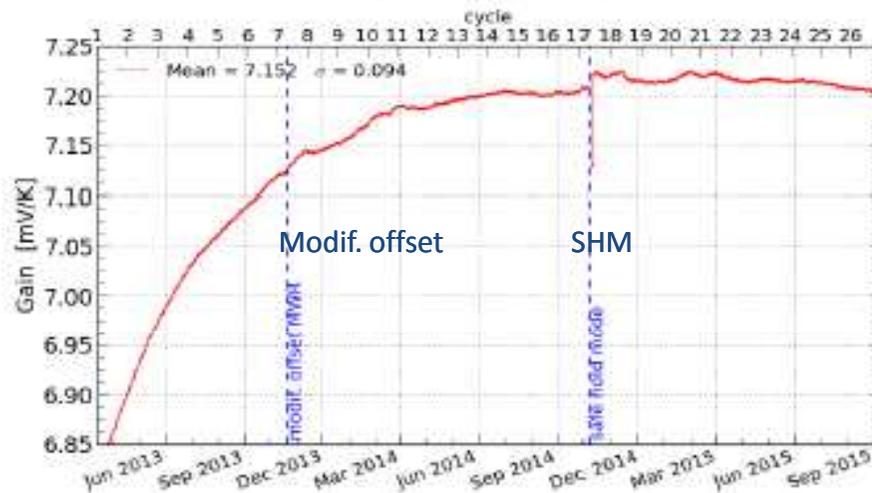


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 exp

Radiometer gain

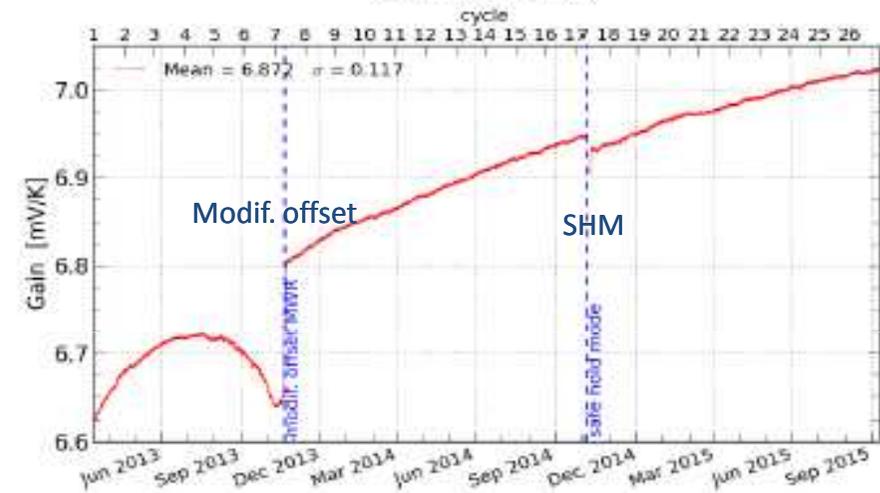
K-band

Mean / day
Gain (23.8GHz)



Ka-band

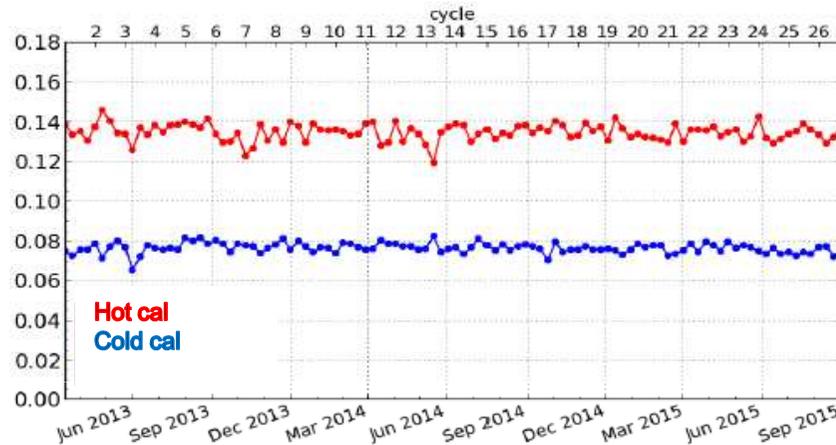
Mean / day
Gain (37GHz)



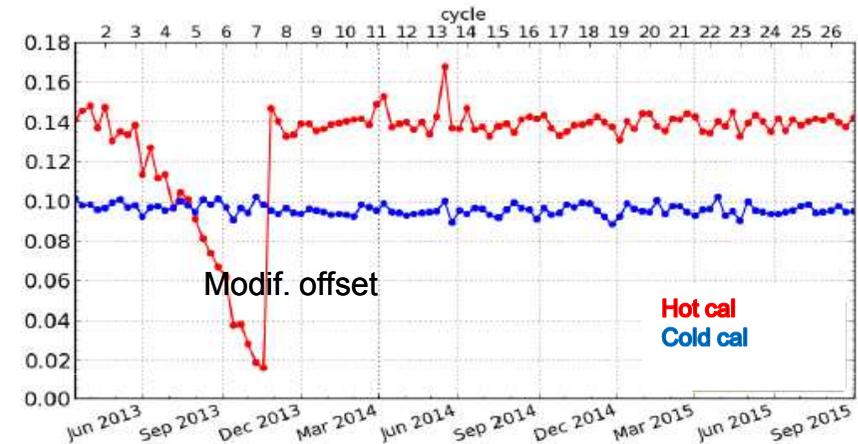
- Some analyses demonstrated that there is no anomaly related to the Ka-Band gain behavior
- After SHM a step of + 0.5K has been detected on the brightness temperatures for the 37GHz channel
- Impact on the wet tropospheric correction is small, about 1mm
- Some investigations are on-going

Stability and performance assessment

K-band: sensitivity in K



Ka-band: sensitivity in K



	Mean in-flight sensitivity	Sensitivity estimations during ground assessment tests
Cold source, K band	0,08 K	Between 0,1 and 0,14 K (for TB between 125 and 300 K)
Hot source, K band	0,13 K	
Cold source, Ka band	0,1 K	Between 0,12 and 0,16 K (for TB between 125 and 300 K)
Hot source, Ka band	0,13 K	

Instrument performance in term of sensitivity is the same as in ground test, even better as external conditions are more stable

from 2nd SARAL exploit. review

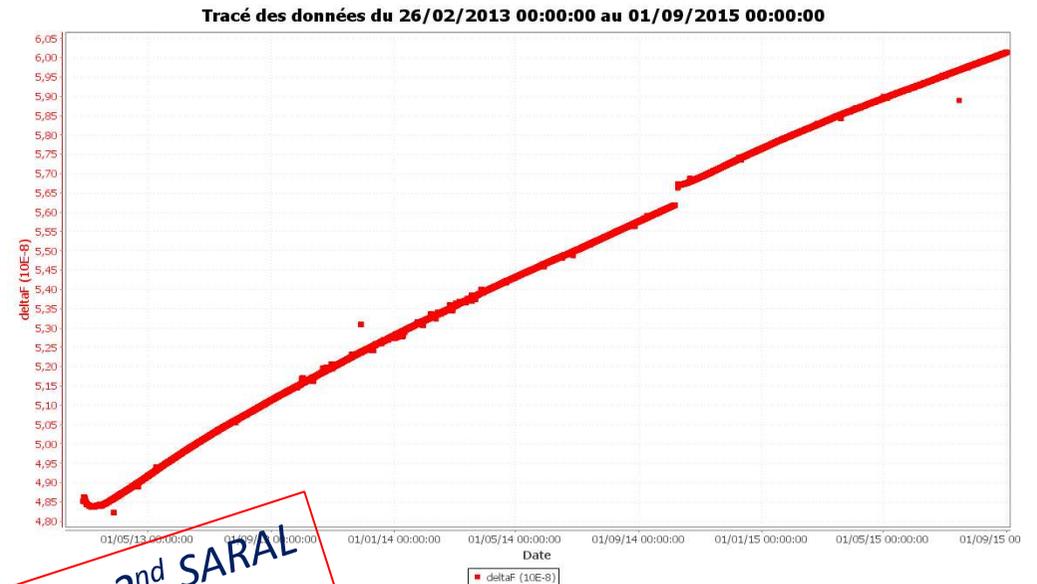
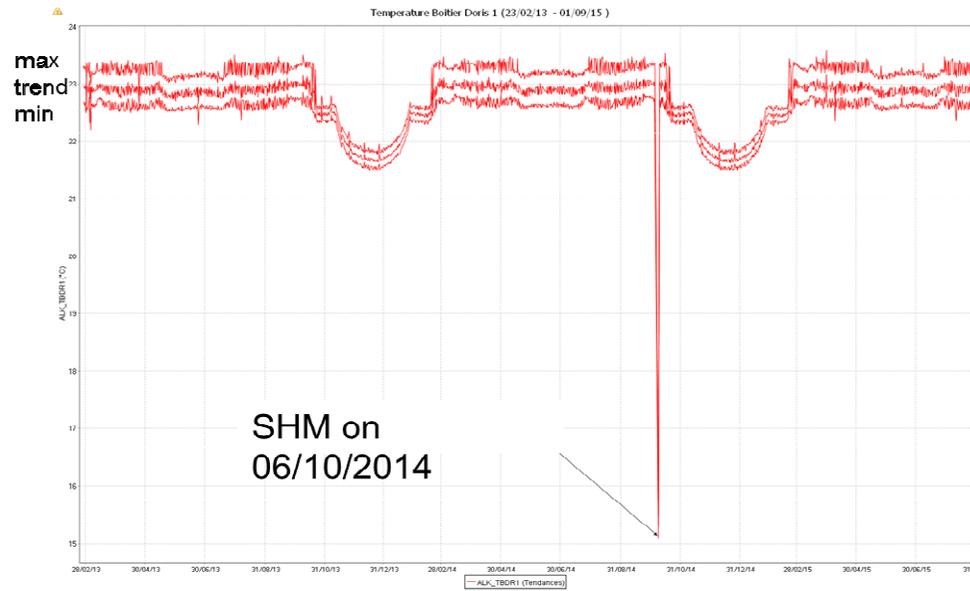
DORIS STATUS

- Availability : 100%
- Temperature : OK

USO : Good stability

» Long term drift : about $3.8 \cdot 10^{-9}$ / year

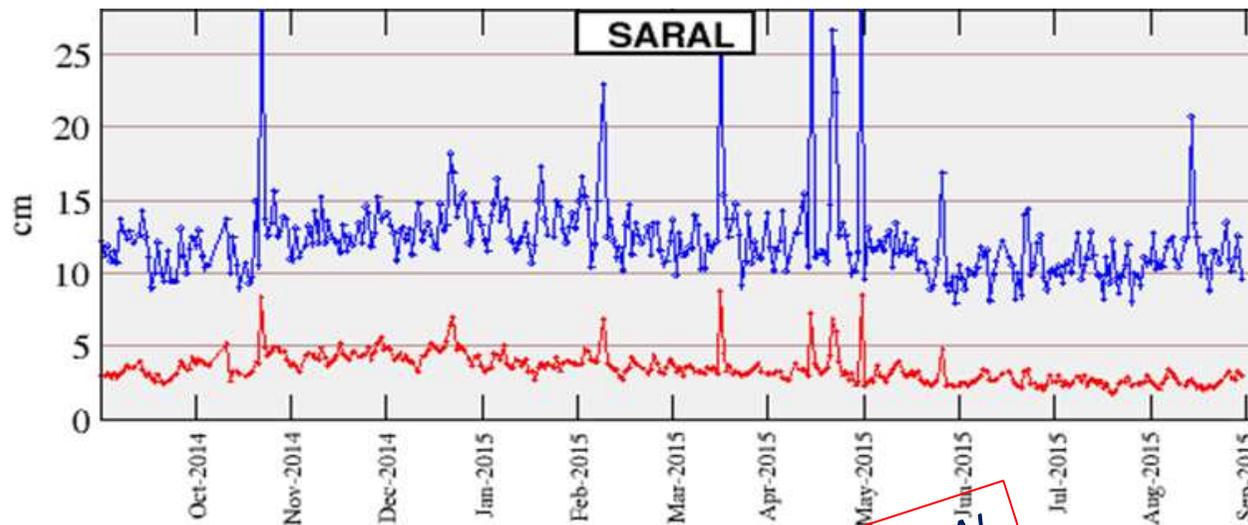
» DORIS Requirement : $2 \cdot 10^{-7}$ over 5 years



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DIODE NAVIGATOR RESULTS

- DIODE software issue : V4.05
- Accuracy : comparison with MOE
 - 3D : about 12.5cm RMS
 - Radial component : **3cm RMS** (requirement : 30 cm, goal : 10cm)
 - DIODE Navigator / MOE
 - Daily RMS , maneuver excluded



from 2nd SARAL
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ARGOS

- The overall Argos payload works nominally on board SARAL
 - All HKTМ parameters are nominal, no outage over the period from 01/09/2014 to 01/09/2015 except during the safe hold mode
 - All performances (including the L band component) are compliant with the system specification and quite similar to the performances seen on the other satellites

from 2nd SARAL
exploit. review