

SARAL MISSION STATUS

Jocelyne NOUBEL
& SARAL team

- **SYSTEM OVERALL PRESENTATION – RECALL**
- **SSB SUB-SYSTEMS STATUS**
- **PIM PAYLOAD STATUS**
 - ◆ PIM Payload operations and status
 - ◆ Station Acquisition and Station Keeping Maneuvers
 - ◆ X_Calibration Maneuvers
- **MISSION PRODUCTS GENERATION**
 - ◆ Data availability
 - ◆ Data latency

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SARAL MISSION

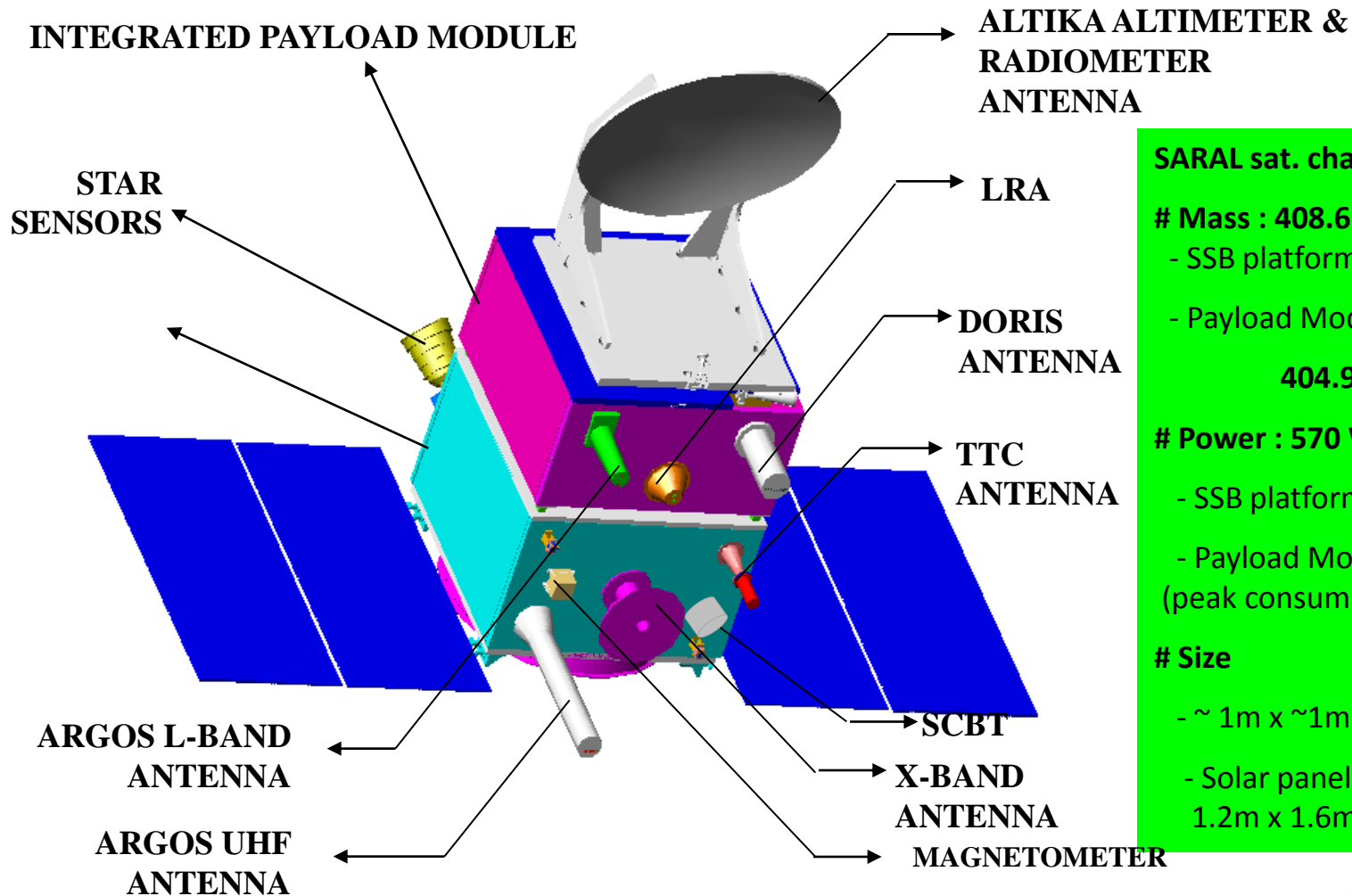
2 independent missions on-board the ISRO SSB platform

AltiKa mission

ARGOS-3 mission

with high level of operability

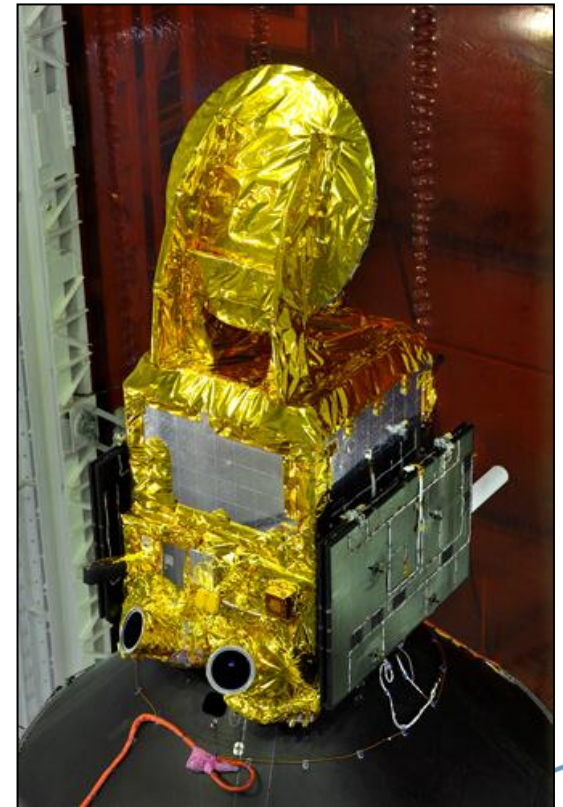
SARAL SATELLITE : PIM & SSB



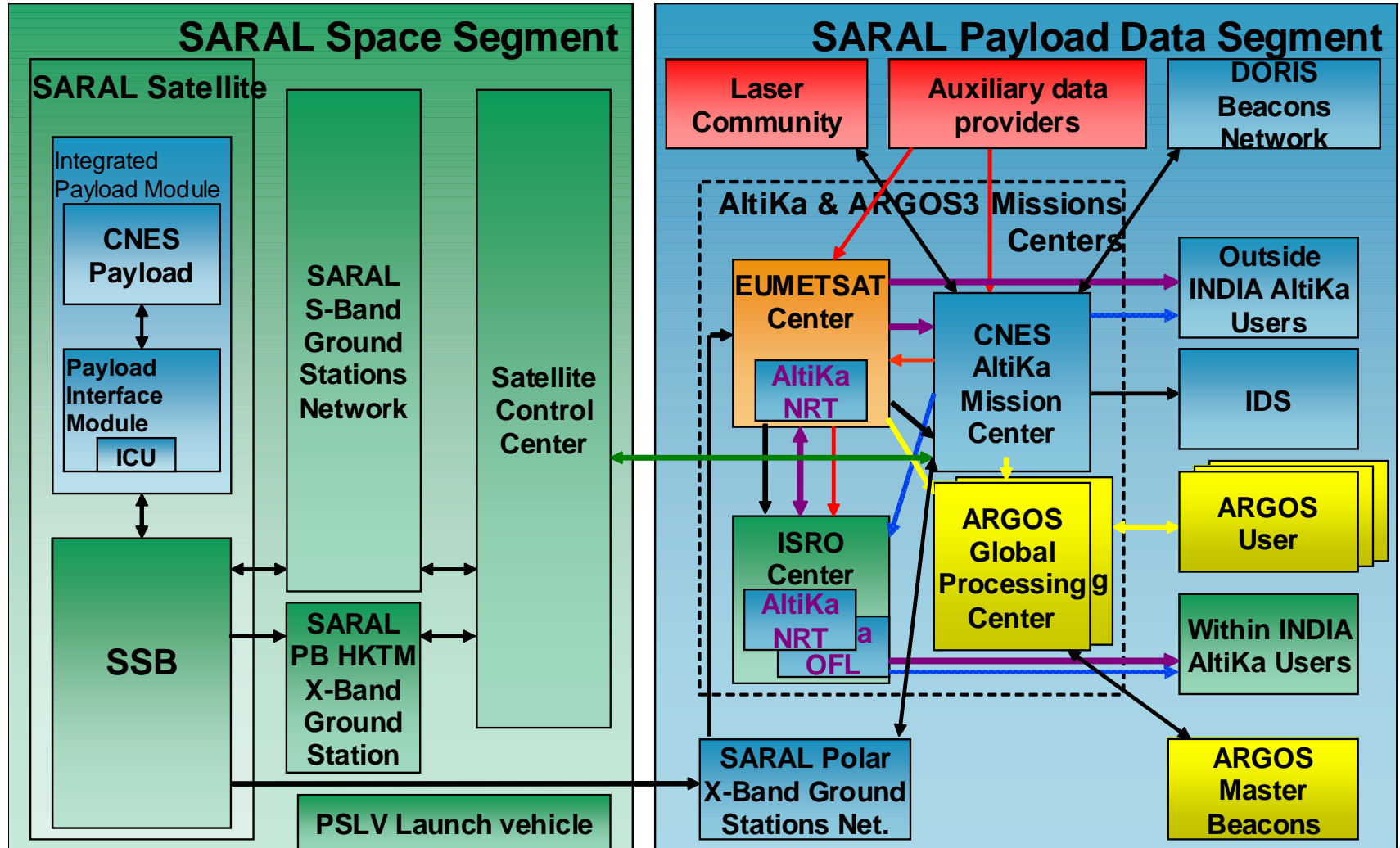
SARAL sat. characteristics

- # Mass : 408.6 kg – Dec '12
 - SSB platform : 244.8kg
 - Payload Module : 163.8 kg
- 404.916 kg – April '13**
- # Power : 570 W (end of life)
 - SSB platform : ~ 205 W
 - Payload Module: 250 w (peak consumption < 300 W)
- # Size
 - ~ 1m x ~1m x 2.7 m
 - Solar panels : 1.2m x 1.6m (x2)

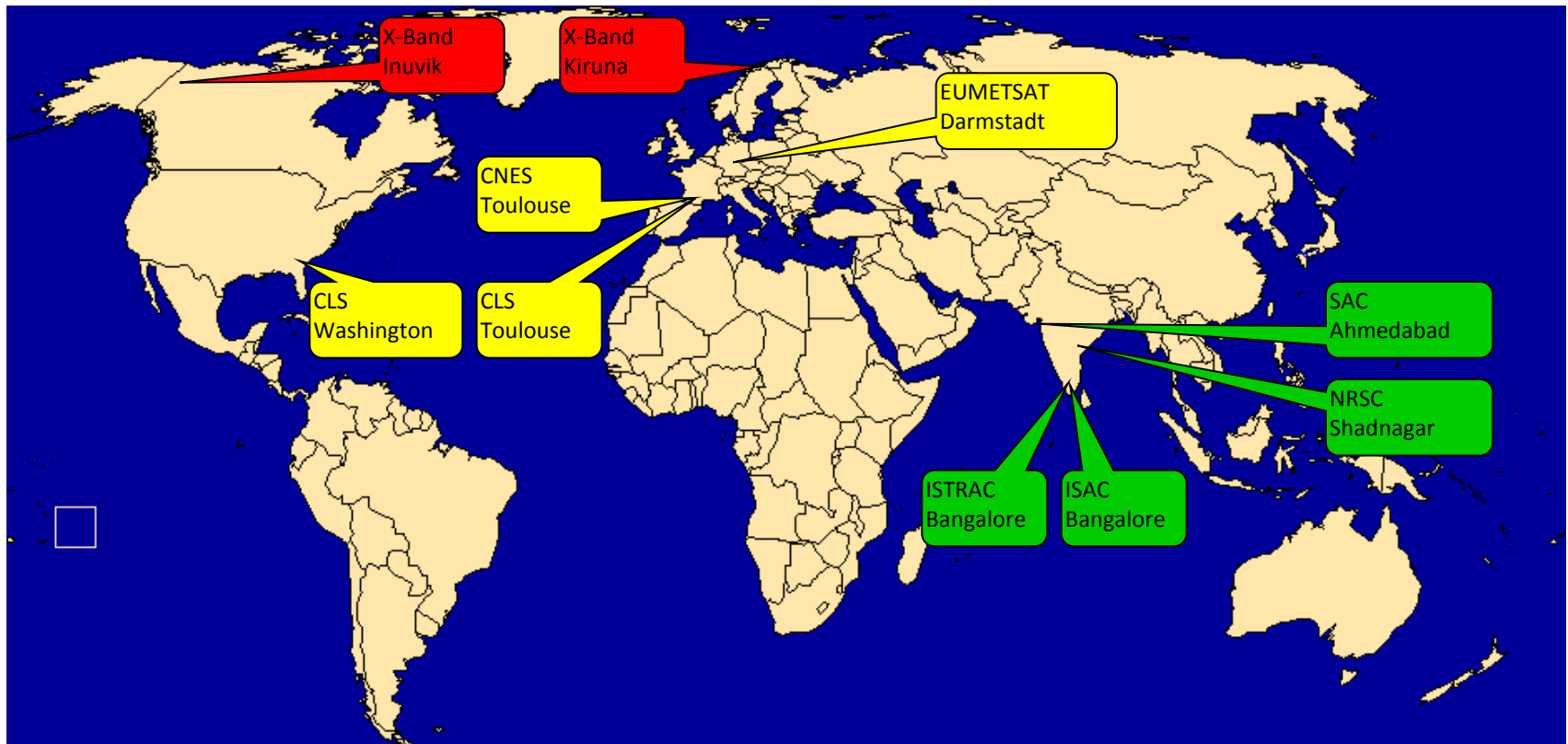
VIEWS OF THE SARAL SATELLITE



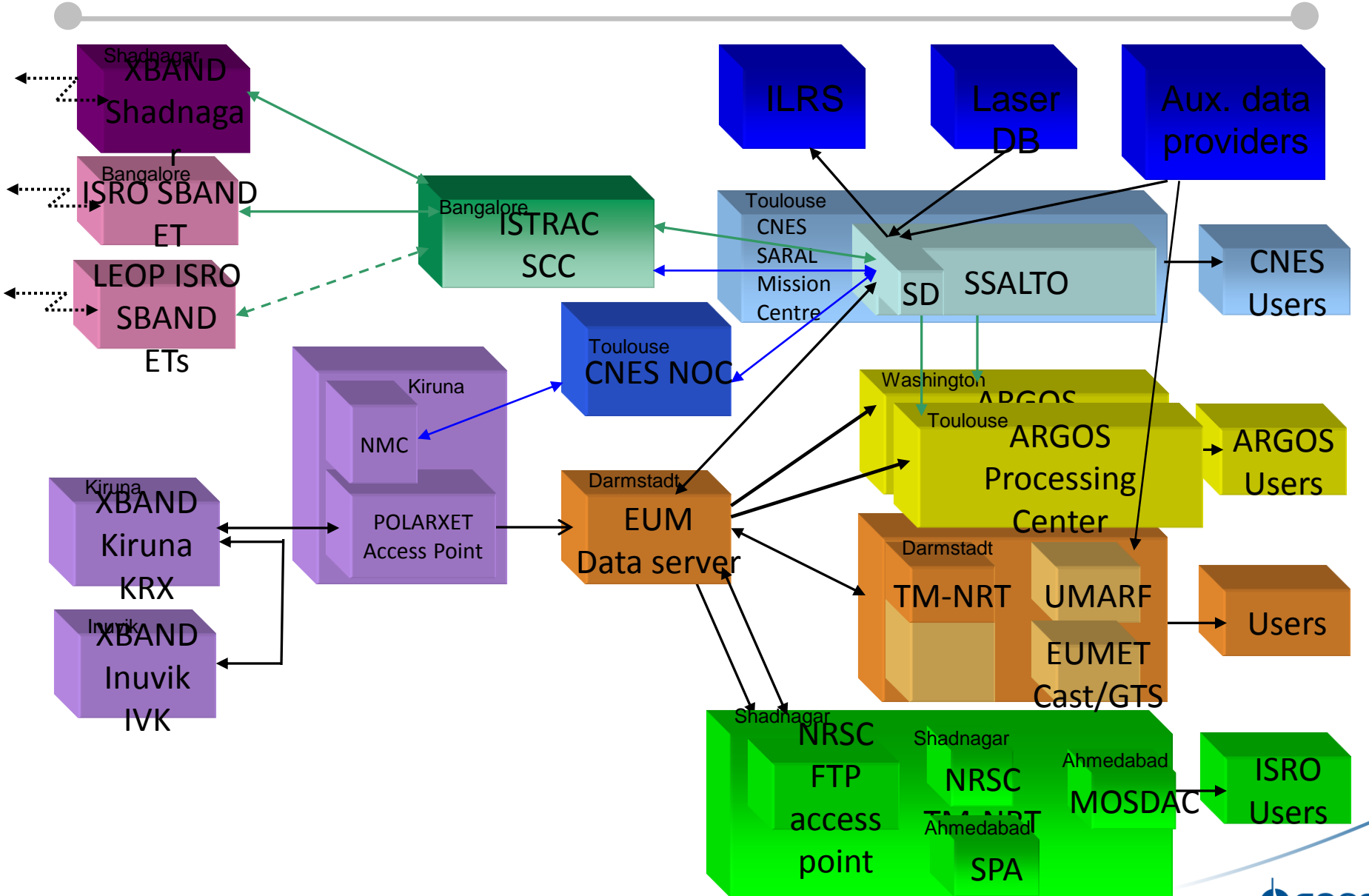
SARAL SYSTEM OVERVIEW



SITES / SARAL



SARAL DATA CIRCULATION



LEOP & IN-FLIGHT ASSESSMENT MAJOR MILESTONES

- ❑ **SARAL Launch on February 25th, 2013 @ 12:31:00**
- ❑ **All PIM payload instruments ON within 12 hours from launch**
- ❑ TM received during the 1st X-Band Polar Station data dump, routine operations at Day2
- ❑ 1st PIM payload In-Flight Assessment operations (DORIS Jamming then ALK calibration) 24 hours from launch
- ❑ Station Acquisition Maneuvers - Day3
- ❑ **ALK data processing within 1 day from launch (OGDR, PIM Monitoring)**
- ❑ **OGDR AUX data circulation and 1st OGDR processing by EUM and ISRO at the beginning of the cycle0 – Day17 – March 13th 2013**
- ❑ **IGDR processing at CNES from cycle0**
- ❑ **Ephemeris provided by CNES SSALTO POD team for Laser Tracking - week7**
- ❑ **X-MAN performed with ISRO - week8**
- ❑ **PIM In-Flight Operations completed on June 3rd – In-Flight Assessment Meeting for the European part of SARAL held on June 6th**
- ❑ **GDR_T arc1-cycle1 processing at CNES from June 6th, at ISRO from June 12th**

All the system operations have been conducted smoothly as soon as needed

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SSB SUB-SYSTEMS STATUS

- POWER SYSTEM
 - TTC RF SYSTEMS
 - X-BAND SYSTEM
 - SPS (SSB GPS RECEIVER)
 - AOCS
 - BMU (HK TM management)
 - BDH & SSR (PLTM management)
 - REACTION WHEEL ASSEMBLY
 - IRU
 - RCS (Propulsion)
 - THERMAL CONTROL
- ✓ ALL SSB SUB-SYSTEMS PERFORMANCES ARE NORMAL

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LEOP & IN-FLIGHT ASSESSMENT PIM OPERATIONS

- ❑ PIM payloads Switch-ON
 - Orbit 3 : PIM (ICU) power supply ON
 - Orbit 8 : DORIS ON
 - Orbit 8 : ARGOS ON
 - Orbit 9 : ALTIKA ON
 - Orbit 71: ICU FDIR enabled
 - Orbit 72: PIM temp FDIR enabled

- ❑ No ICU operations

- ❑ AltiKa
 - Tracking modes
 - ✓ sub cycles in different tracking configurations
 - Diode Acq – Median tracker
 - Diode Acq – EDP tracker
 - Diode+DEM
 - ✓ HD : burst data
 - Routine calibrations
 - CNG calibration / CAL1 I&Q / CAL2 long
 - Radar Data Base update (DIODE_MNT_TPG_ALTI)

- ❑ DORIS
 - Jamming analysis
 - ZQS update (Com-center of phase update)

- ❑ No ARGOS operations

➔ All LEOP & IFA planned operations for PIM payload have been realized

PIM – ICU STATUS

❑ ICU turned ON on February 25th , 2013 at 15:36 UT. Since this date,

- No ICU switch OFF, no reset
- No anomaly detected in ICU operation
 - ◆ TC management and routing: OK
 - ◆ Payload TM acquisition and management :OK
 - ◆ ICU PPS distribution and time-tagging : OK
- ICU Currents, voltages and temperatures are nominal
- ICU FDIR (by SSB) and PIM ATC FDIR (by ICU) enabled on March 2nd
=> no FDIR triggering

➔ **PIM – ICU status is nominal**

❑ PIM ACTIVE THERMAL CONTROL (performed by ICU) :OK

- Automatically enabled at ICU turned ON
- During payloads switch ON : 4 lines (Main) cycled as expected
- When all payloads ON : only 1 line (AMBIANT/Main) cycles as expected
- PIM equipments and aerals temperatures are nominal
- PIM ATC power consumption is nominal

DORIS STATUS

❑ **Doris (chain 1) turned ON on February 25th , 2013 at 23:40 UT. Since this date,**

- No DORIS switch OFF, no restart
 - No anomaly detected in DORIS operation
 - ◆ TC reception and processing: OK
 - ◆ TM generation: OK
 - Doris currents and temperatures are nominal
 - Jamming : no on-board jammer detected
 - DIODE (Doris embedded real-time navigator) : OK
 - ◆ Auto-initialization : nominally achieved on February 26th
 - ◆ See C. Jayles DORIS-DIODE presentation
 - Accuracy of DORIS Off-line (ground processing) SARAL orbit restitution (MOE,POE): OK
 - ◆ See L. Cerri POD presentation
- DORIS status is nominal**

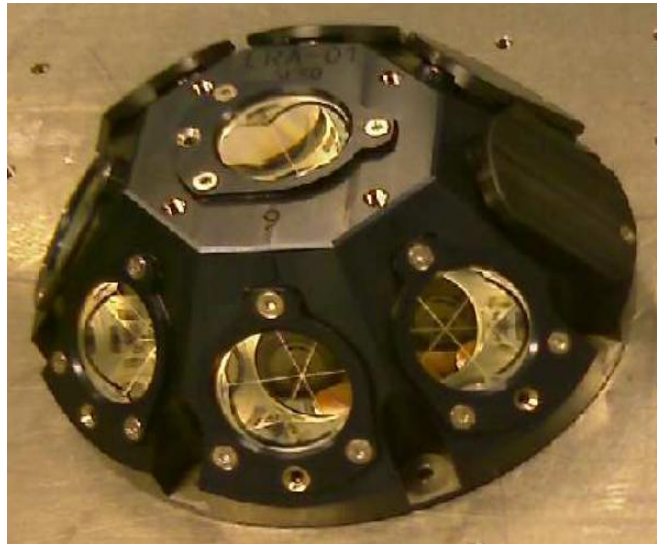
AltiKa STATUS

- ❑ **AltiKa turned ON on February 26th , 2013 at 01:42 UT. Since this date,**
 - No ALTIKA switch OFF, no restart
 - No anomaly detected in ALTIKA (altimeter & radiometers) operation
 - ◆ TC reception and processing: OK → **AltiKa altimeter and radiometer status is nominal**
 - ◆ TM generation: OK
 - ALTIKA (altimeter & radiometers) currents and temperatures are nominal
 - All acquisition/tracking modes (autonomous, Diode aided and DIODE+MNT) and both trackers (median and EDP) have been successfully tested and evaluated
 - Altimeter calibrations (routine calibrations : CAL1, CAL2, expertise calibrations) have been performed : see N. Steunou presentation
 - Altimeter RF beam nadir pointing estimation (with X-cross calibration maneuvers)
 - Radiometer : always ON

LRA

- ❑ **LRA description, optical center position**
 - Given in document SRL-SYS-NT-066-CNES updated (V2.2)
 - Value applicable from 14/03/2013 (CoG position at the beginning of cycle1)

- ❑ **LRA range correction map/law**
 - Correction table given by designer team (DCT/SI/OP)



LASER TRACKING EVOLUTION AND CURRENT STATUS

Reminder : Laser stations determine their tracking thanks to ephemeris delivered to ILRS (CPF_EPHEMERIS files)

- First phase

- ◆ Ephemeris provided by ISRO SCC

- » Difficulties for stations to track SARAL

- » accuracy of SCC ephemeris was not sufficient w.r.t. to Laser tracking 'requirement' (100m)

- Since April 9th:

- ◆ Ephemeris provided by CNES POD

- » Based on MOE

- » no more difficulties for the stations to track SARAL

- ◆ Ephemeris meet the accuracy 'requirement' (several cm w.r.t. 100m)

⇒ Tracking now satisfying (see POD presentation)

➔ Laser Tracking status is nominal

FORESEEN PIM OPERATIONS

- AltiKa
 - HD over Antarctica: see AltiKa presentation

MISSION ORBIT ACQUISITION SUMMARY

STATION ACQUISITION MANEUVERS

□ Station acquisition maneuvers

- Feb. 27th, 2013 : inclination maneuver - 2 out-of-plane maneuvers separated by ~1 revolution
- March 1st, 2nd, 3rd, 5th, 13th : 5 semi-major axis maneuvers

□ Operational orbit reached

□ Beginning of cycle 0 on 13/03/2013

□ Main characteristics of the orbit reached on 13/03/2013

- inclination = ~ 98,53 deg - local time at asc. node = ~ 06:05 AM
- Semi-major axis = ~ 7 159.350 km
- eccentricity : 1,167 E-3 - perigee: ~88,73 deg with an oscillation of +/- 3 deg.
- Beginning of the monitoring of actual ground track with respect to the +/- 1km control band at equator crossing

□ Beginning of cycle #1 / pass # 1

□ On 14/03/2013 at 05:39:28 UT

- corresponding to the orbit # 1 with a longitude of the asc. node ~0,1335 deg.

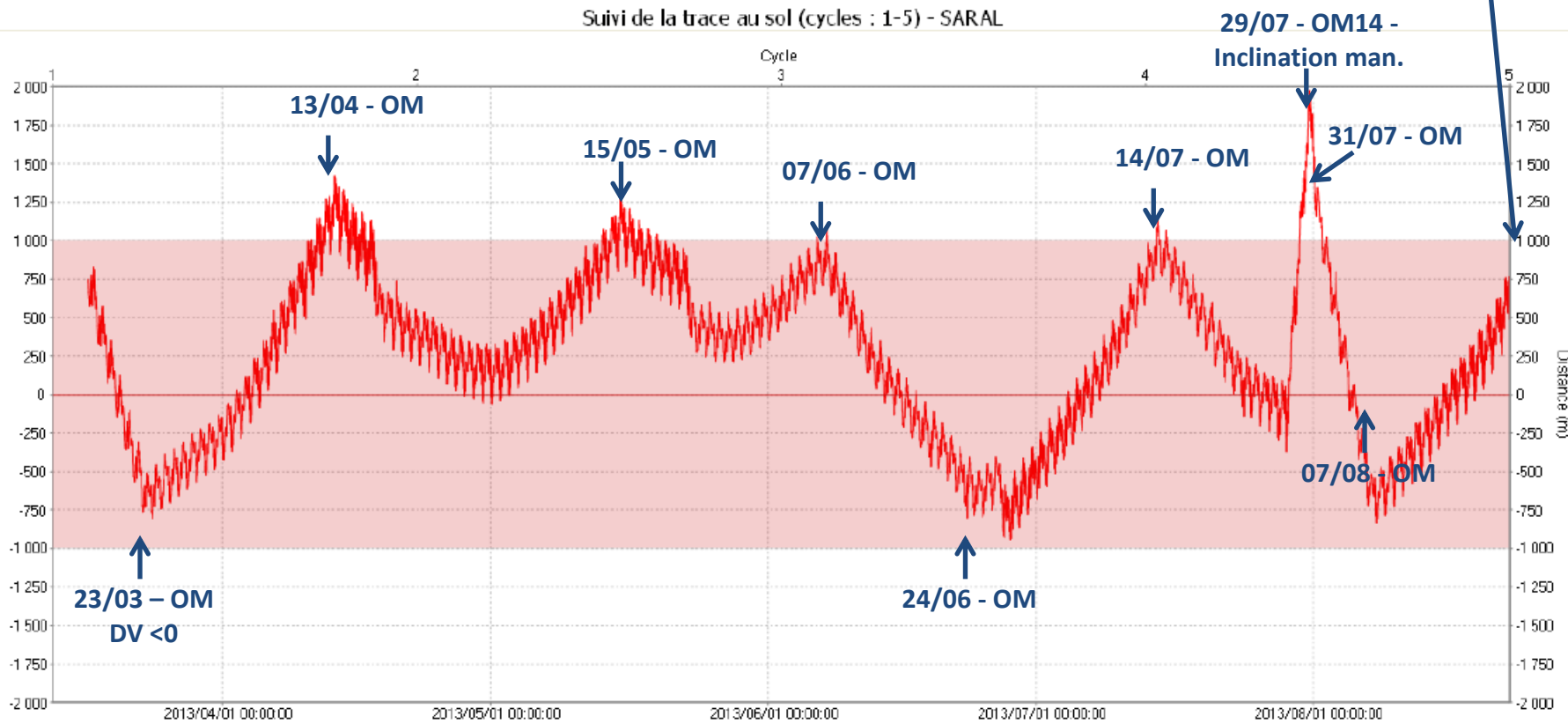
STATION KEEPING MANEUVERS

□ Station keeping maneuvers

- 23/03/2013 semi-major axis
- 13/04/2013 “
- 15/05/2013 “
- 07/06/2013 “
- 24/06/2013 “
- 14/07/2013 “
- 29/07/2013 inclination – OM14
- 31/07/2013 semi-major axis
- 07/08/2013 “
- 26/08/2013 “

STATION KEEPING – March 13, 2013 to Aug. 27, 2013

Western drift ⇔ SMA > SMAref. Eastern drift ⇔ SMA < SMAref.



STATION KEEPING IMPROVEMENTS



□ Inclination correction of $\sim +0.023$ deg. \Rightarrow agreed by ISRO

- Rationale : to have the same ground-track as Envisat at max/min latitudes : at high latitudes, SARAL ground-track was 2.2 km further north/south than Envisat ground-track.
- Impact of the continuity of the time series over ice shields (Antarctica, Greenland)
- Realized on July 29th, 2013 : the effective maneuver was larger than expected ($+0.038$ deg)

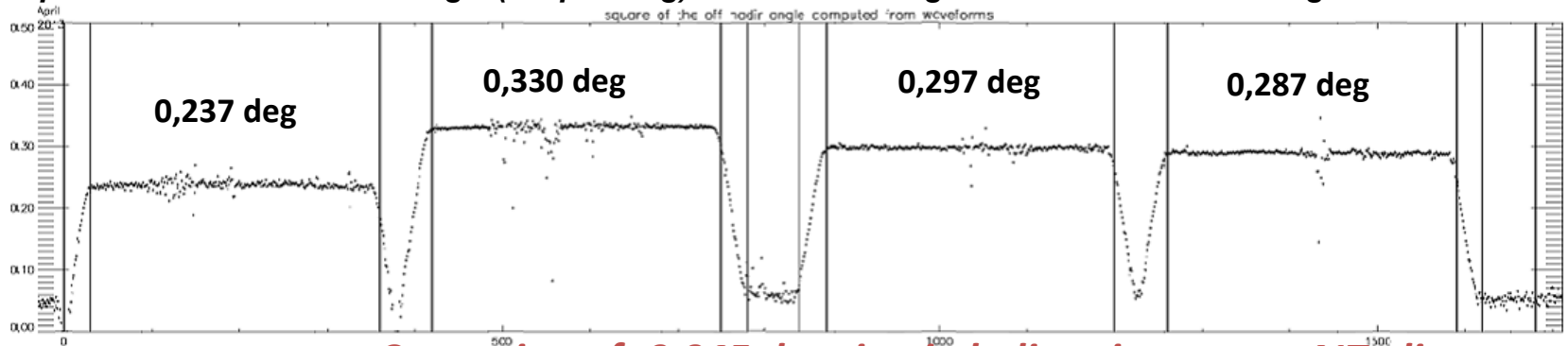
➔ new inclination correction maneuver to be discussed with ISRO

NADIR POINTING OF ALTIKA RF BEAM : X-CROSS CALIBRATION MANEUVERS

3 X-cross calibration maneuvers have been performed

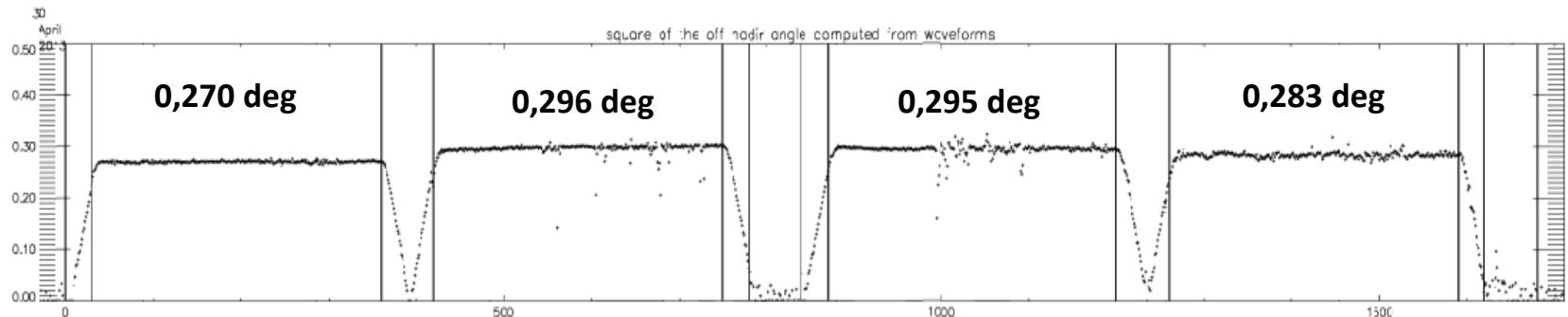
- ❑ 1st X-cross maneuver on April 19th : sequencer test over BIAK
- ❑ 2nd X-cross maneuver on April 22nd : -0,3 /+0,3 in pitch then -0,3 /+0,3 in roll

Square root of the off-nadir angle (mispointing) estimated through AltiKa echoes retracking



=> Correction of -0.045 deg. in pitch direction wrt to AIT alignments

- ❑ 3rd X-cross maneuver on April 30th :



Very good pointing accuracy achieved : estimated to be less than 0.02 deg !

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SARAL MISSION PRODUCTS GENERATION

AltiKa OGDR/IGDR/GDR

- ❑ ALK PLTM available to all AltiKa processing centers (EUM, CNES, ISRO) from the 1st PLTM data dump

- ❑ AUX Data circulation
 - Initialized before the launch - Routine since the beginning
 - Last AUX data circulation for GDR production finalized on 2013/06/04 (TBC) – with validated POE and associated AUX data

- ❑ OGDR
 - 1st OGDR processed by the SSALTO team on 2013/02/26 morning from 1st PLTM data dump over KRX
 - Automatic processing of OGDR at EUMETSAT and ISRO started the 2013/03/18
 - OGDR delivery to PI started 2013/03/21

- ❑ IGDR_CNES
 - 1st IGDR processed by CLS ops team with support of SSALTO on 2013/03/06
 - Automatic processing of IGDR at CNES started the 2013/03/19
 - IGDR delivery to PI started 2013/03/28 and to Users on June 22nd

- ❑ GDR
 - 1st GDR_T (Arc1- cycle1) processed by CLS ops team with support of SSALTO on 2013/06/06
 - GDR_T (Arc1- cycle1) ISRO processing started on June 12th
 - GDR processing by CNES-CLS and delivery to PI on July 25th

All IFs for mission products generation have been fully operational as required

SARAL DATA AVAILABILITY

Mission success and data availability

AltiKa/SARAL Mission SYS-4.3-230-R

- 95% of all possible over-ocean data during a 3-year period with no systematic gaps
- + the specific Ka-band limitation : 5% of measurements may be not achieved due to rain rate > 1.5 mm/h according to geographic areas

Since March 18th, 2013 Data Unavailability on AltiKa mission due to : (< 5% requirement)

- bus << 0.05 % (20mn per maneuver)
- altimeter 0% (IFA operations excluded)
- radiometer 0%
- Doris 0%
- ICU 0%

⇒ Total satellite << 0.05%

- ground system : < 0.1% (X-band stations pbs)

⇒ Total ground < 0.1%

Total < 0,15%

→ Compliant

SARAL DATA LATENCY

Data latency requirement

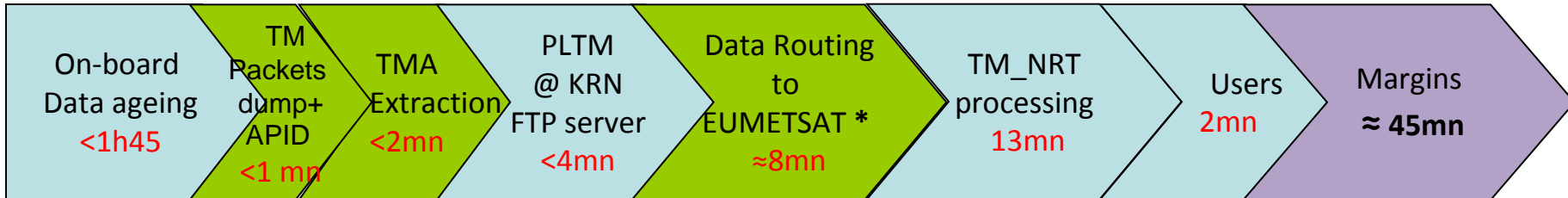
- ❑ X-Band – PLTM - Same requirement for the 2 missions :
 - 75 % of the data collected available to users within 3 hours from satellite acquisition
 - 95 % of the data within 5 hours
 - including the 5% unavailability

Data collection – CNES Polar X-band stations of Kiruna (Sweden) and Inuvik (Canada)

- ❑ All the 14/15 orbits per day are taken for data dump → no blind orbit
- ❑ On-board SSR “mode2 PlayBack” allows the download of the equivalent of 16-18 hours of recorded PLTM with PIM instruments in routine operations
- ❑ Data consolidation at station level for retrieval of the last newest data
- ❑ All the PLTM is available at Kiruna -Swedish Space Corporation focal point, for PLTM retrieval by EUMETSAT and then for routing and processing to all Mission centers

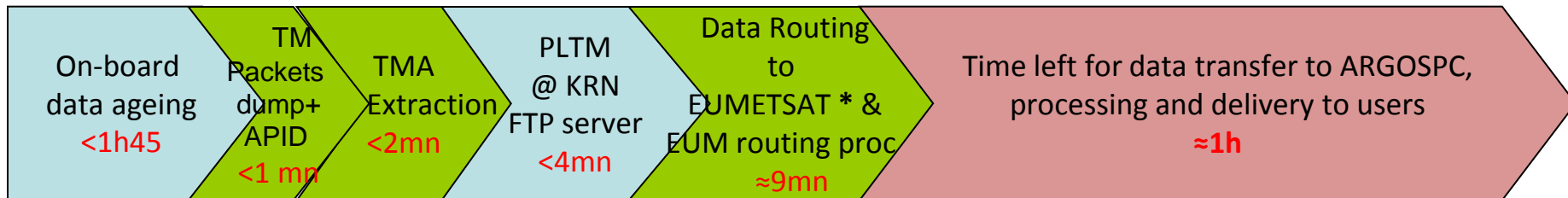
DATA LATENCY – RESULTS

Implementation ODGR processing @ EUMETSAT

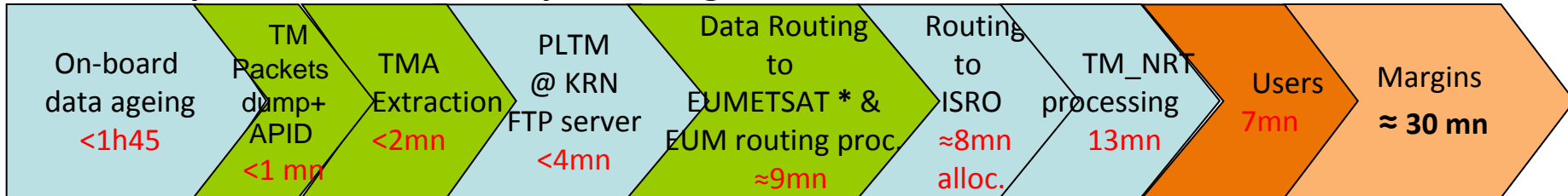


* worst case including transfer from IVK to KRX over dedicated 1Mbps link before PLTM retrieval by EUMETSAT

Implementation for ARGOS processing @ CLS



Implementation OGDR processing @ ISRO/NRSC



Mean value

SARAL DATA LATENCY – OGDR

Comfortable margins exists

AltiKa mission – OGDR

- Analysis from March 18th, 2013 until May 24th, 2013

	OGDR_EUM EXGATE to Users data latency	OGDR_EUM to Users margin
min	01:44:09	01:15:51
mean	02:09:56	00:49:36
max	02:27:26	00:32:34

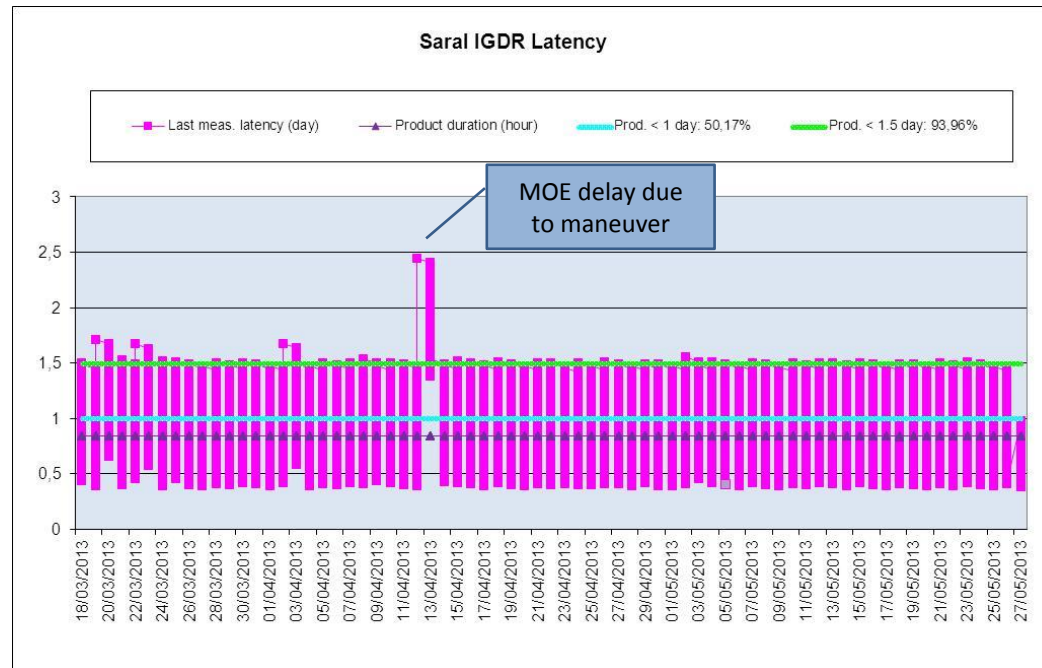
- Since March 18th, 2013
 - 40 OGDRs out of the 3hour latency among which 34 OGDRs out of the 5hour latency, corresponding to
 - ◆ 99.3% data received correctly over this time period (no gap, no loss)
OGDR processed within 3 hours
 - ◆ 99.5% within 5 hours

→ Compliant

SARAL DATA LATENCY – IGDR

Requirement (SYS-4.4-40-R) :

IGDR to be delivered in less than 3 days ; objective : within 1 or 1,5 days max



- ❑ Automatic process activated on March 19th, 2013
- ❑ **Routinely processed in less than 3 days** (28 pass over 29-daily pass within 1.5 days), even in case of maneuver (production in less than 2.5 days)
- ❑ except in case of X-band stations problems when large PLTM is downloaded because of processing limitation (<<1%)

→ **Compliant**