



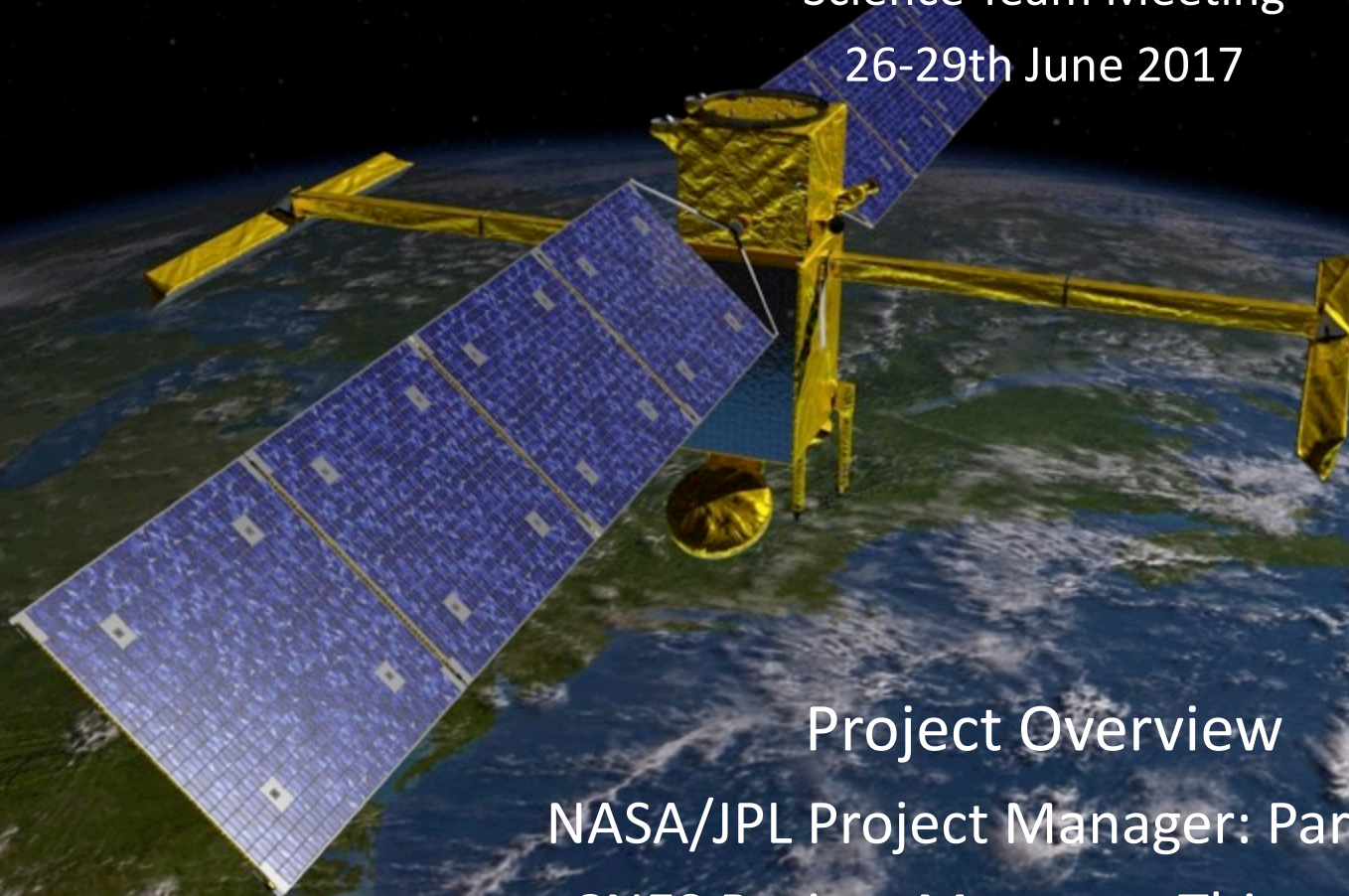
National Aeronautics and
Space Administration



Surface Water and Ocean Topography (SWOT) Mission

Science Team Meeting

26-29th June 2017



Project Overview

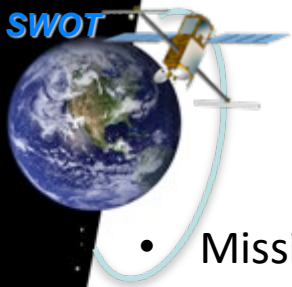
NASA/JPL Project Manager: Parag Vaze

CNES Project Manager: Thierry Lafon



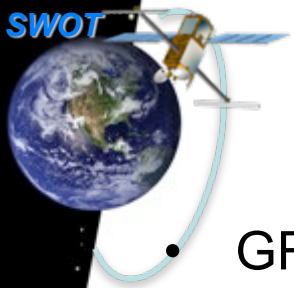
Project Summary Status (1/2)

- Progressing all mission elements (Flight, Ground, System) towards project Critical Design Review (CDR) - Feb 2018
- Flight System:
 - Nadir Payload: Advancing heritage elements (AMR, X-band Telecom, GPSP, Nadir Altimeter and DORIS)
 - Flight Models in build and test; All will be completed by early 2018
 - KaRIn development steadily progressing towards KaRIn CDR and Payload CDR (Summer, Fall 2017)
 - Engineering Models being tested
 - Conducting progressive reviews towards KaRIn CDR (Summer 2017)
 - Payload Mechanical: Completed CDR, Flight Model hardware build will start soon.
 - S/C: All procurements are in-place; Detailed design analysis being conducted in preparation for CDR (Nov 2017)
 - Launch vehicle: Selected SpaceX Falcon-9.



Project Summary Status (2/2)

- Mission System: Maturing all elements and conducting engineering peer reviews in preparation of project CDR:
 - Ground Data System & Mission Operations:
 - Builds on heritage from Jason series
 - Detailed specifications, interfaces, network design, prototyping
 - Detailed mission ops planning, team formulation; interface docs
 - Planning for test and training utilizing simulators and testbeds
 - Science Data processing System:
 - Established joint (JPL & CNES) architecture and implementation plans
 - Detailed specifications and interface documents
 - Conducted detailed sizing and limited prototyping
 - System (Performance, Algorithm, Cal/Val): Preparing for Measurement Review (Dec 2017) in advance of project CDR
 - Released revised error budget document
 - Established joint (JPL & CNES) algorithm development plan
 - Focus on long-lead, low-maturity algorithm development
 - Cal/Val development progressing towards preparations for establishing baseline methodologies and instrumentation



CNES Ground System Status

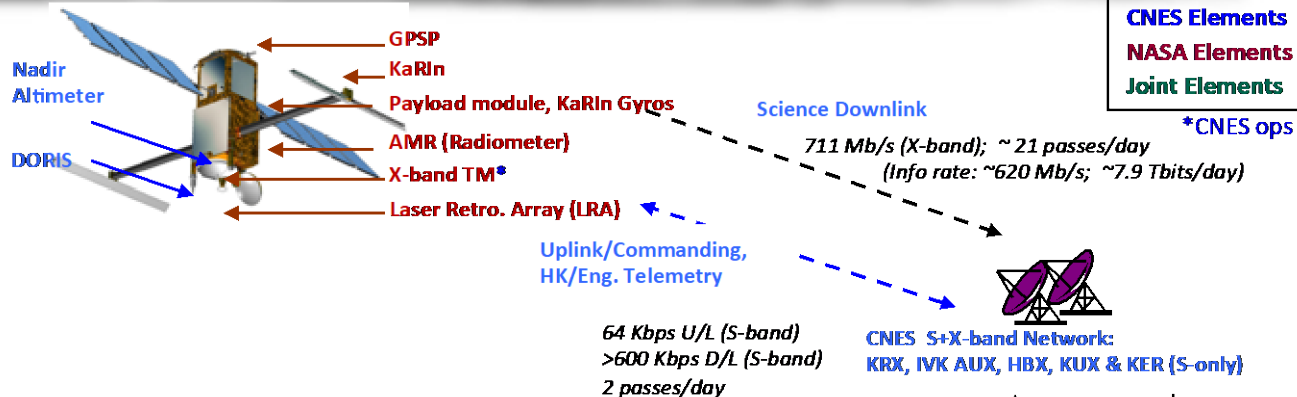
- GROUND CONTROL SYSTEM:
 - SWOT SCC design and V&V based on new CNES product line,
 - Implementing new authentication scheme for TC security.
 - SCC PDR scheduled in November 17,
 - SCC implementation to start in 2018.
- SCIENCE DATA SYSTEM:
 - JPL/ CNES SDS K.P held in April 17. Verified maturity, Interfaces, verification plan, security plan , Algorithm deliverables status.
 - CNES SDS PDR scheduled in October 2017
 - CNES SDS Implementation starting in 2018
- SYSTEM Interfaces KP scheduled in December 2017:
 - Verify system design, interfaces, verification plan, and development plan. Check coherence, phasing and REC/ DEL schedule



Mission System Architecture

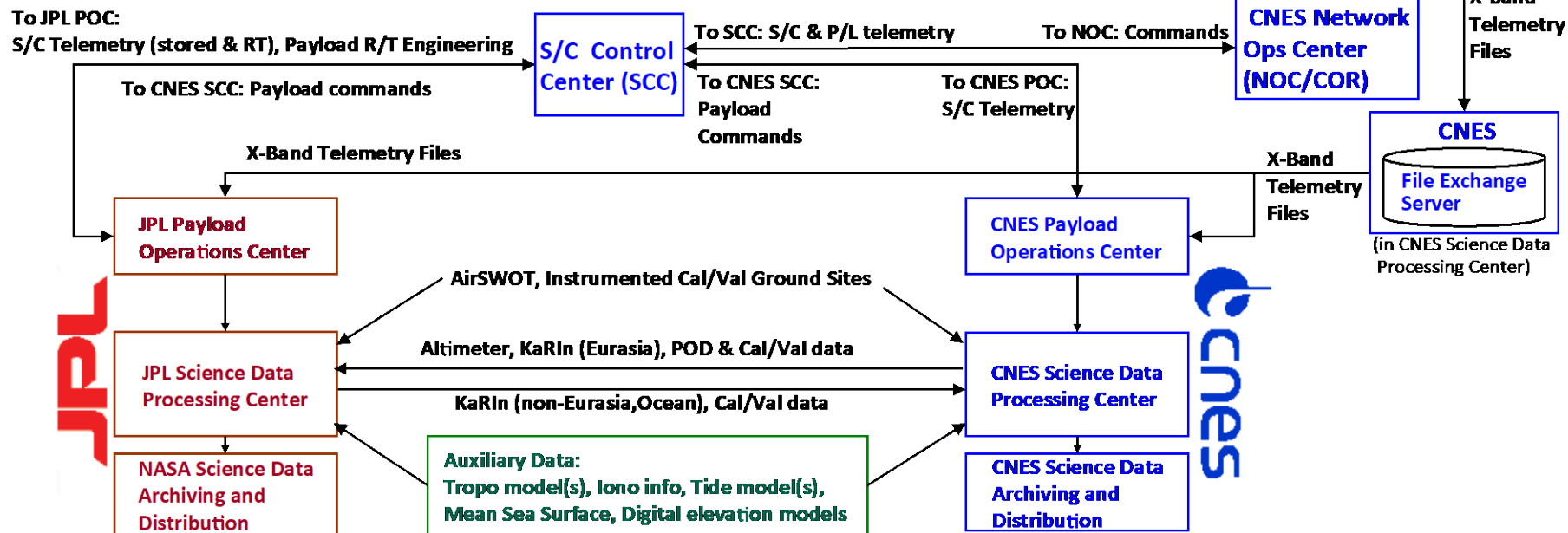


SpaceX – Falcon 9



CNES Elements
NASA Elements
Joint Elements

*CNES ops



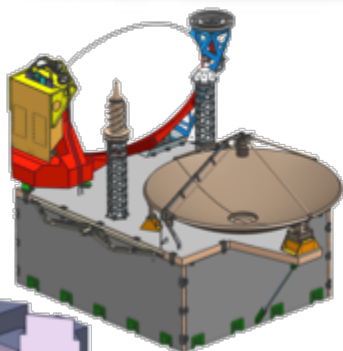
NASA – CNES Partnership across all major elements of the mission



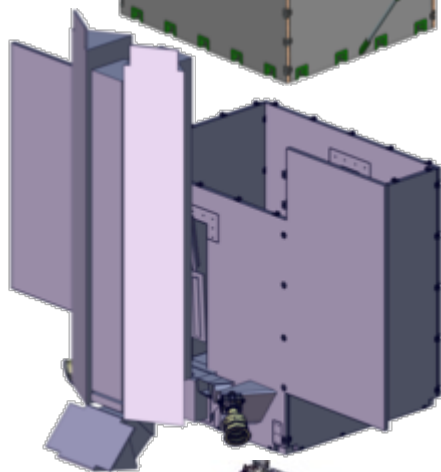
Flight System Workshare

Payload Module
NASA/ JPL

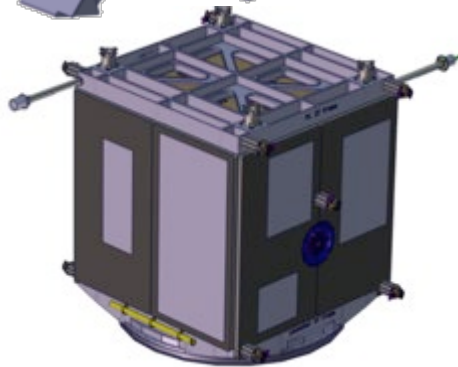
Spacecraft
Bus
CNES



Nadir
Module
NASA/ JPL



KaRIn
Module
NASA/ JPL



Payload Module

JPL

Radiometer

JPL

Doris

cnnes

LRA

JPL

Ku/ Altimeter

cnnes

X Band TM

JPL

KaRIn RFU

cnnes

KaRIn Gyro

JPL

KaRIn Digital

JPL

KaRIn HPA

JPL

KaRIn Nadir
channel

JPL

KaRIn Antenna/
structure

JPL

Star trackers

cnnes

S/C Bus

cnnes

Platform

cnnes

Science Data
recorder

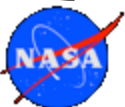
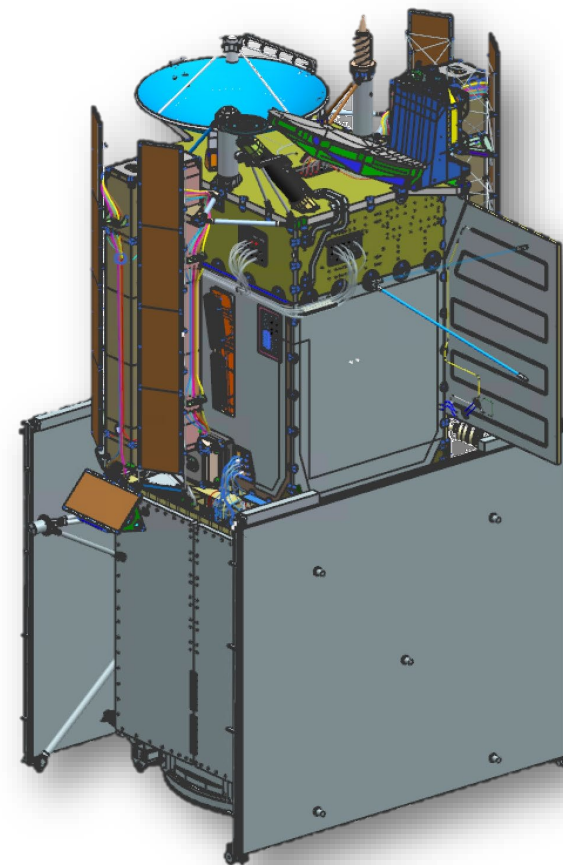
cnnes

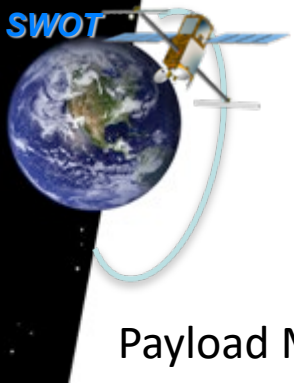
Launcher and
P/L I/Fs

cnnes

P/L GPS

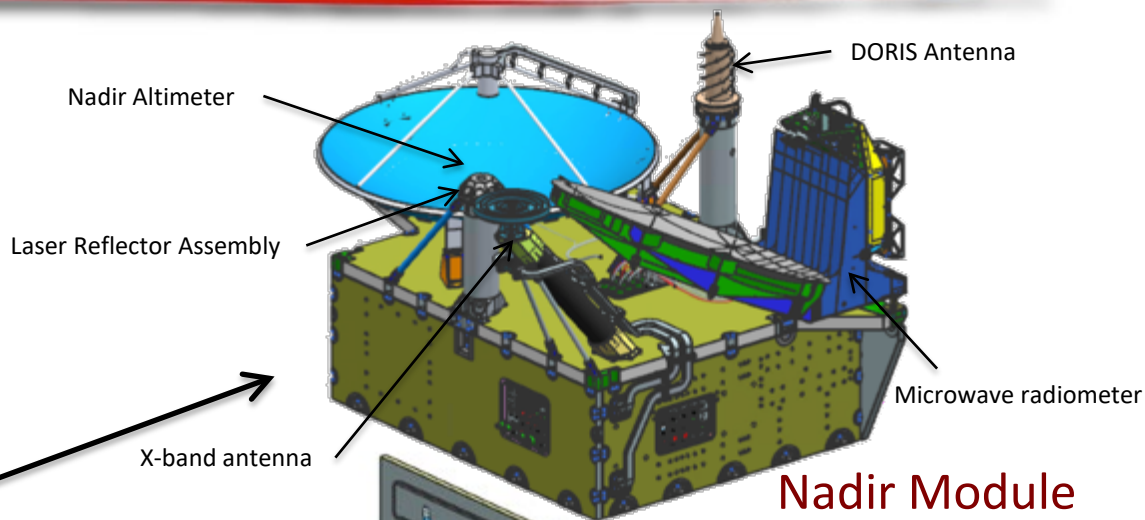
JPL





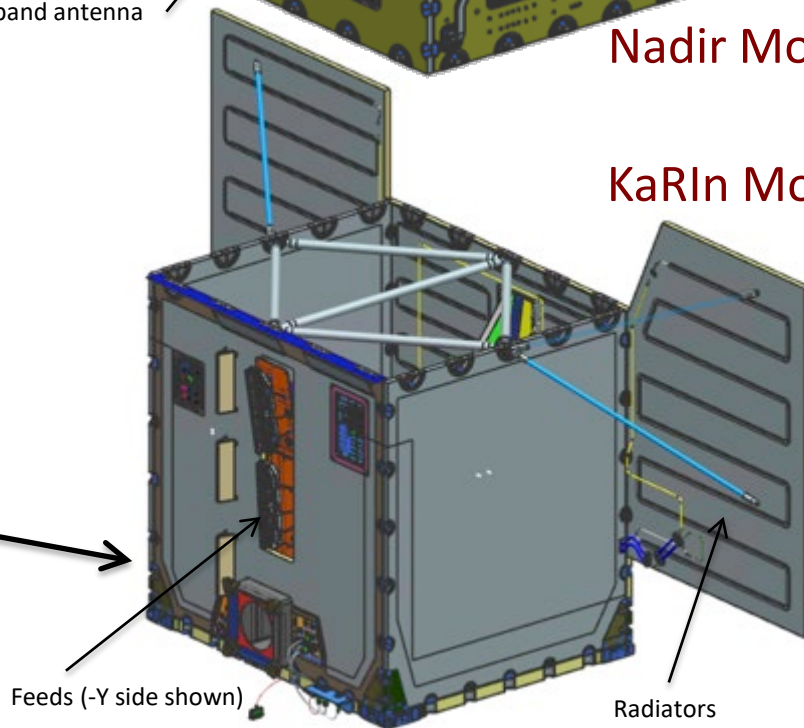
Payload Configuration

Payload Module



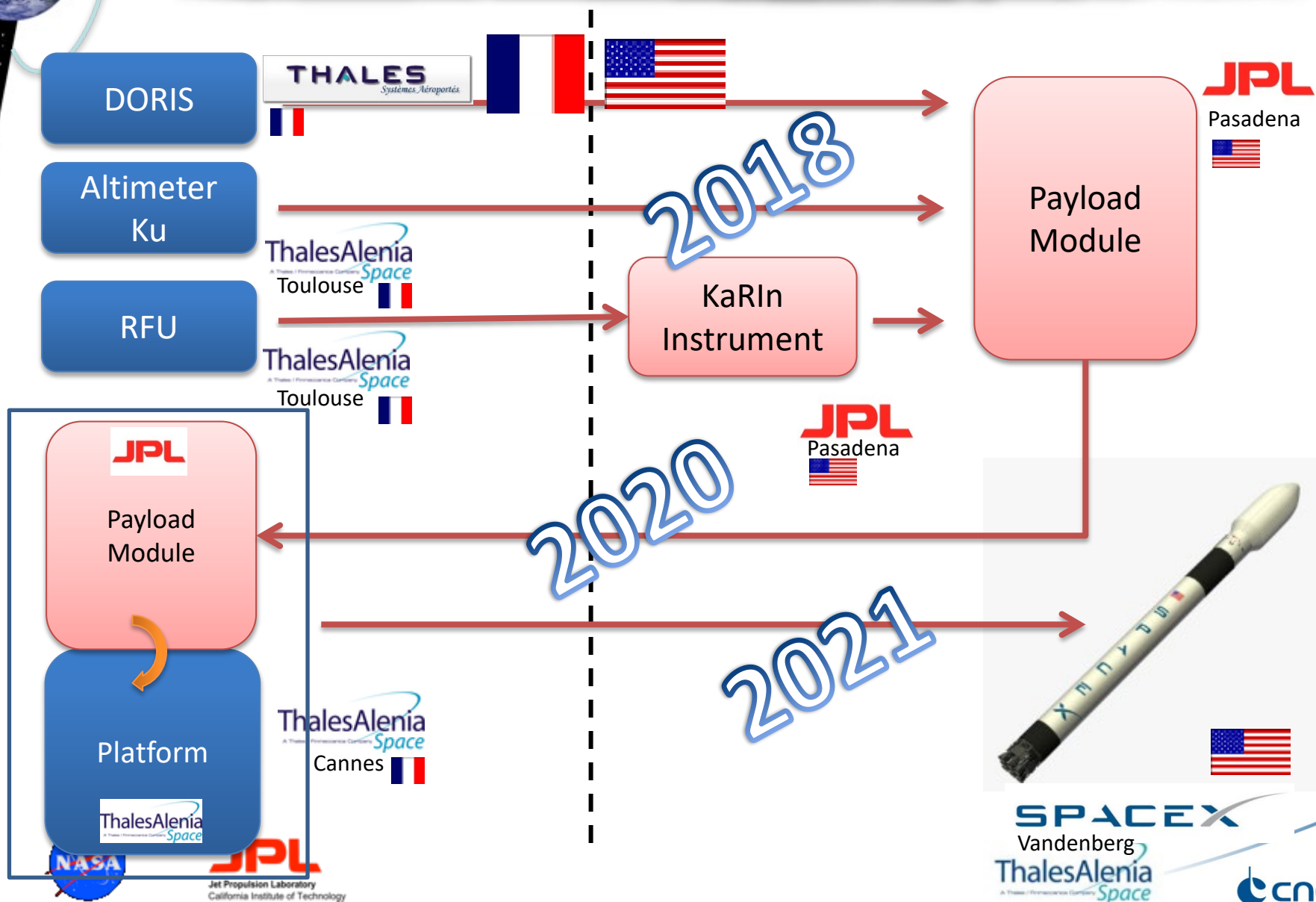
Nadir Module

KaRIn Module





Operational flow CNES/NASA





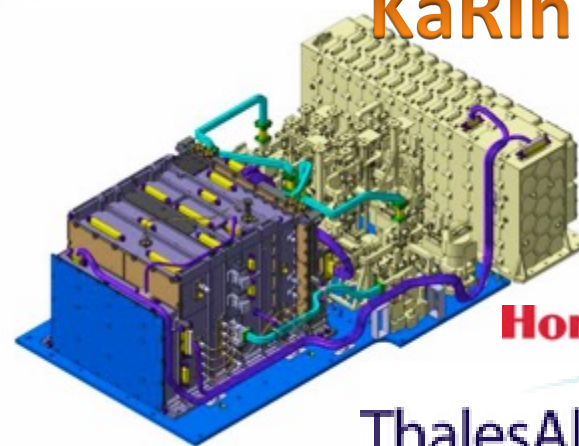
CNES FLIGHT SYSTEM ELEMENTS

ThalesAlenia
Space



P/F and Satellite

KaRIn RFU



Honeywell

ThalesAlenia
Space

DORIS

THALES
Systèmes Aérospatiaux



Nadir
Altimeter



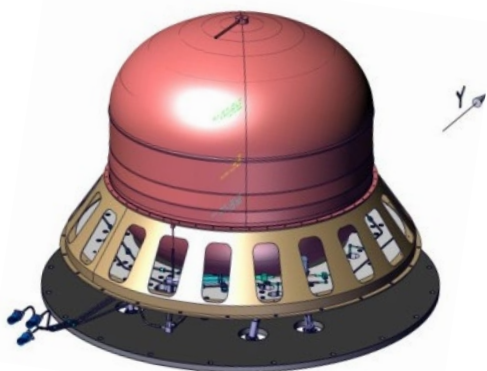
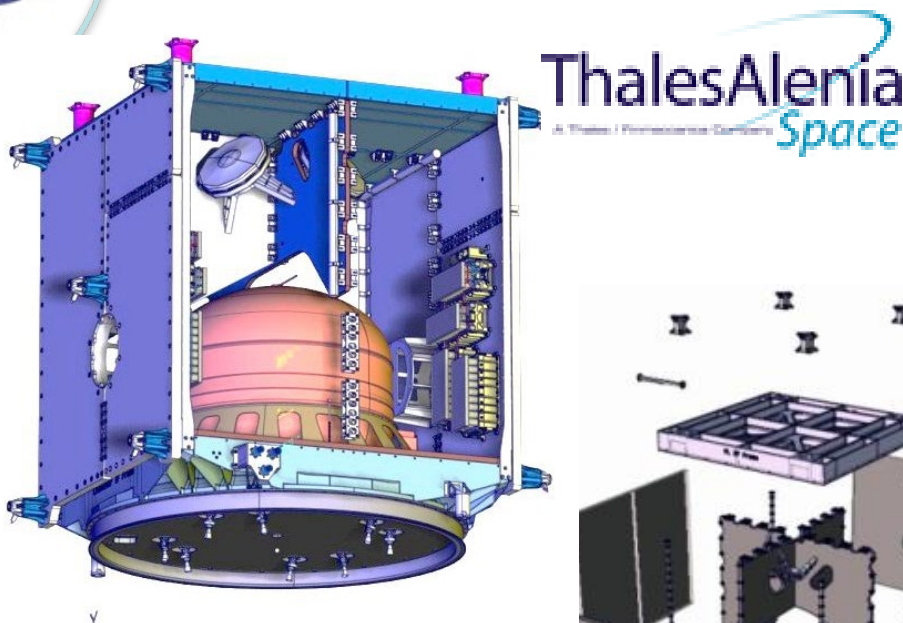
ThalesAlenia
Space



Spacecraft development

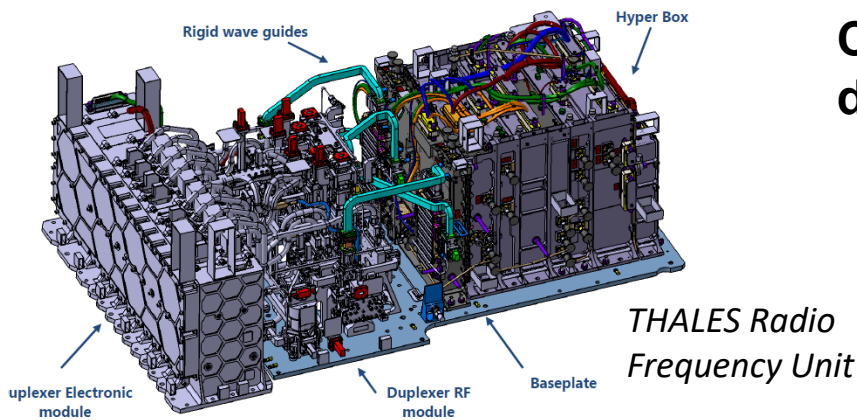
S/C development progressing towards CDR (Nov. 2017):

- P/F Design consolidated and detailed definition finalized,
- Flight equipment procurement on going,
- KaRIN deployment phase robustness confirmed,
- Ready to start functional validation with S/C hardware and instrument simulators early 2018,
- Platform integration due to start early 2019.



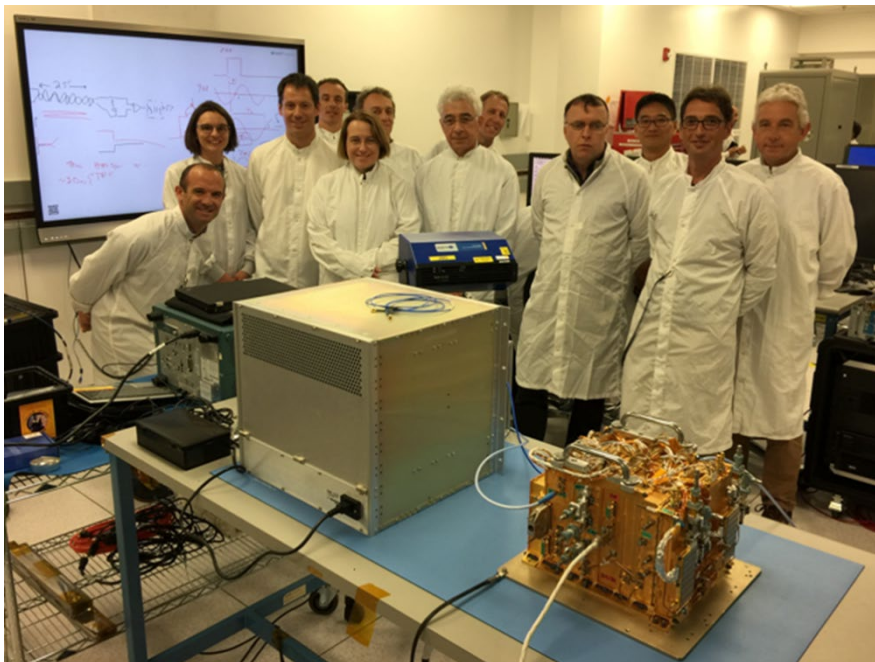


KaRIn RFU/ HYPERBOX Status



CNES/ TAS RFU hyperbox delivered on April 22d:

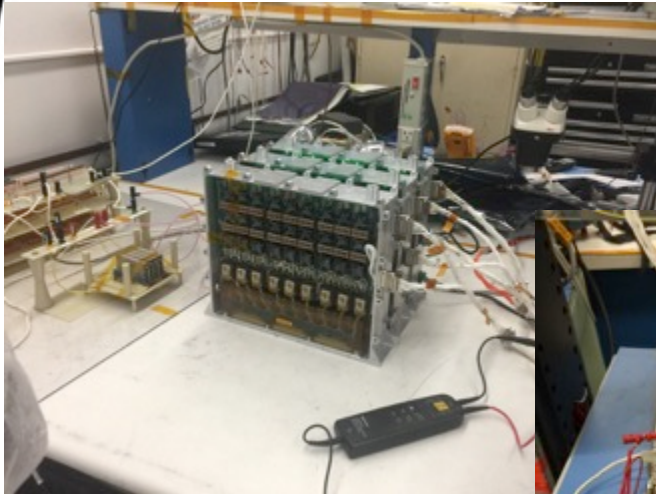
- Delivered on time for KaRIn EM pre-integration sequence
- Flight like model
- Very good Phase stability performance
- Mating to JPL KDES successful
- intensive testing on going at JPL before coupling of the Duplexer EM and the Hyperbox for RFU integrated EM testing @ TAS



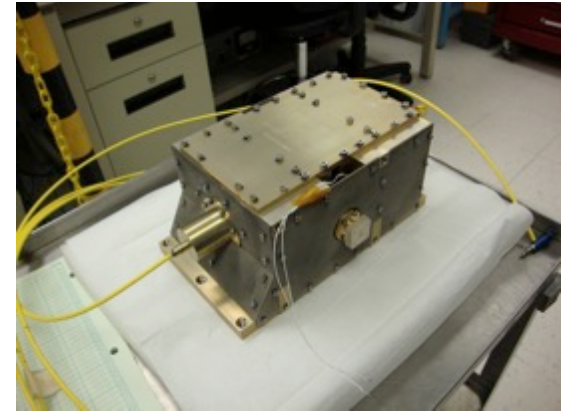
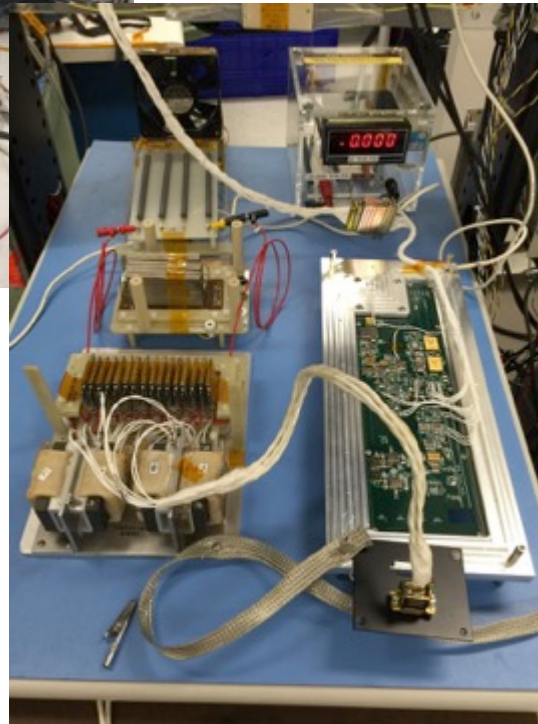
THALES
Hyperbox



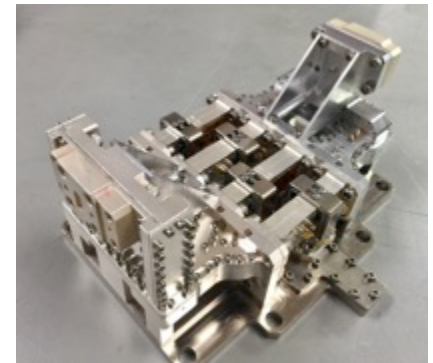
KaRIn – High Power Assembly



*HVPS Collector (top) and
Cathode (right) supplies*

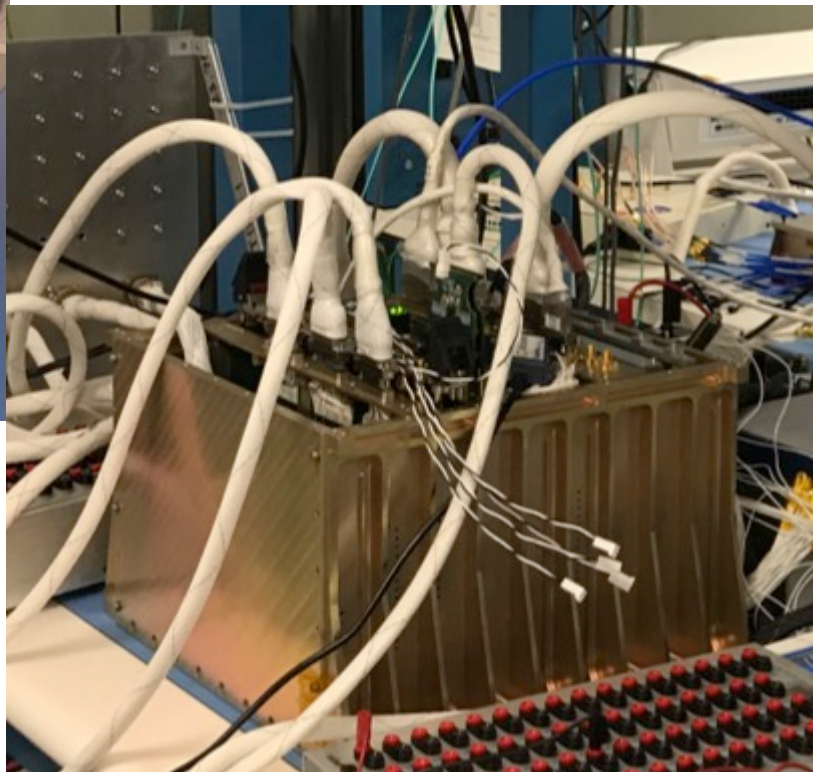
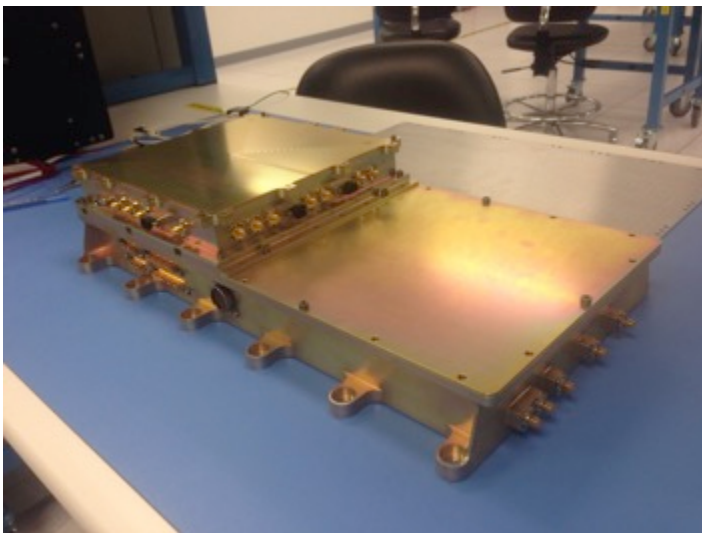


*EM1 EIK - top
EQM Iso-filter - bottom*





KaRIn – Digital (KDES)

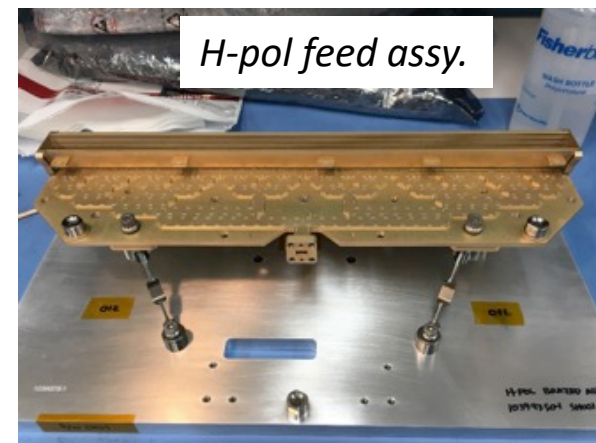




KaRIn - Antenna (panels / feeds)



*full EM antenna subsystem
at the antenna range (top)*



V-pol feed assy.

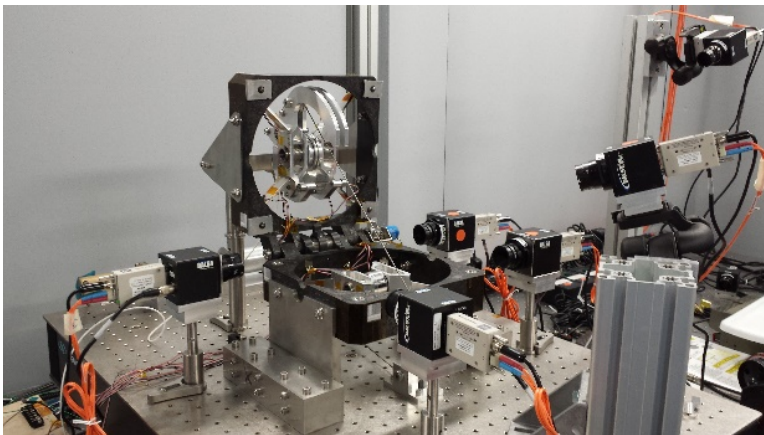
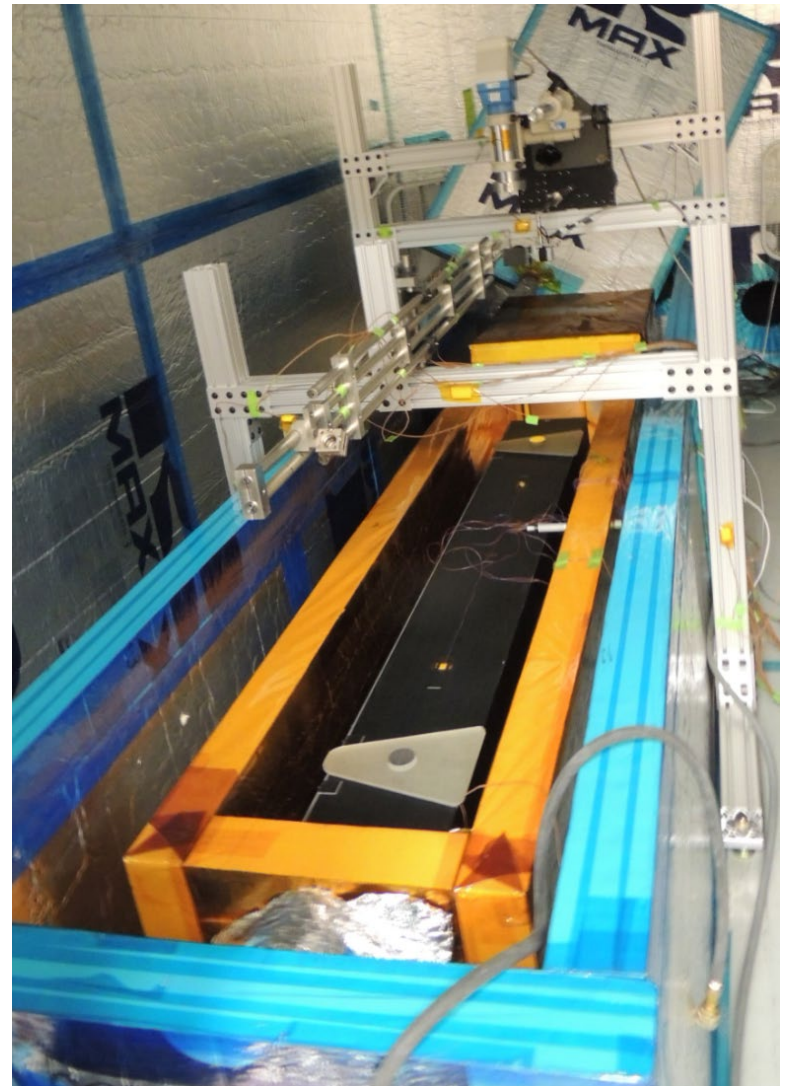




KaRIn - Mast

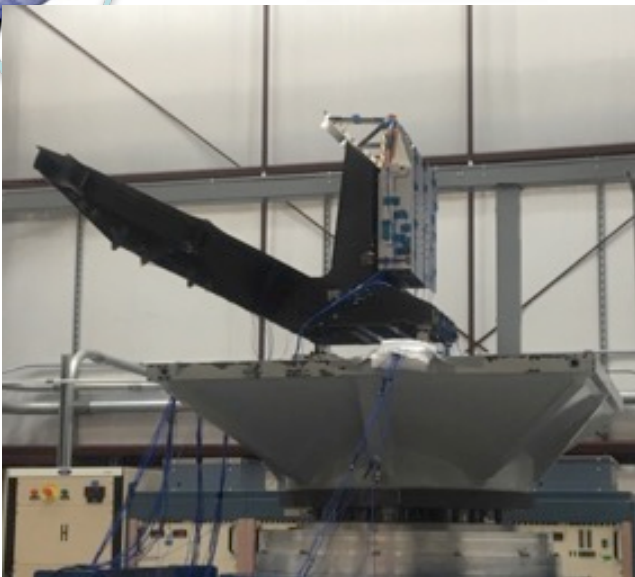
- Demonstrated sub millidegree deployment repeatability
- Ultra-stable carbon fiber tube
 - Demonstrated feasibility of very low thermal distortion boom tubes
 - Tubes are 6x more stable than SMAP
- Demonstrate shock isolation of mount to below 600g's

10" Development Tube



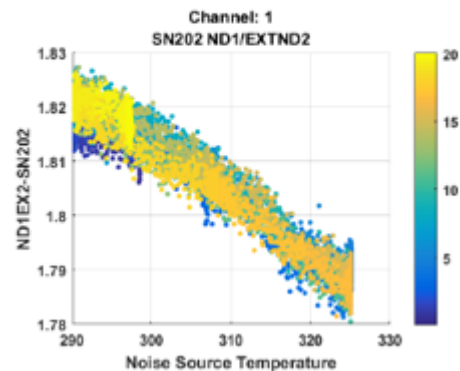


AMR Technical Highlights

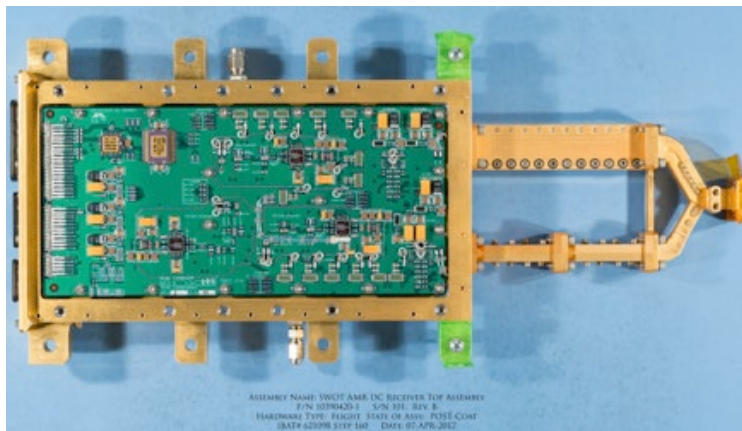


Reflector during dynamics testing

SN202 ND/ExND Ratios vs Noise Source Thermistor Temperature with Time (hours) Color Scale



Excellent noise diode repeatability over temperature

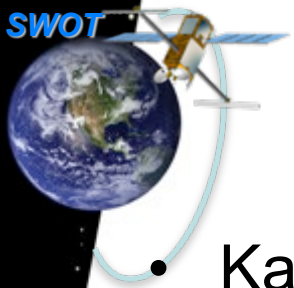


Receiver after conformal coating



Post Launch and Beyond

- Flight segment development typically matures earlier than the ground segment
 - Late 2018/ Early 2019: Most of the flight hardware will be built and start Assembly, Integration and Test (AIT)
 - Project focus will start to shift towards ground and preparations for launch
- Commissioning, Cal/Val, nominal operations:
 - Details of what will happen within the 180 days?
 - How will we be organized between all the teams?
 - What tools and training will be needed?
 - How will the seasonal data masks be created with what observation priorities?
- Science Data Products: Distribution/Access and Archive
 - How will we practically handle the large data volumes into manageable/useful data products
- Getting ready for SWOT:
 - User community engagement
 - Training
 - Applications



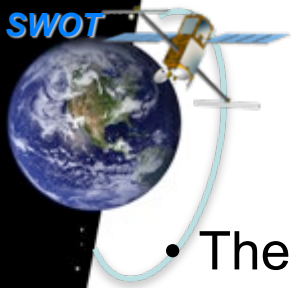
KaRIn Instrument Operation

- Ka-band interferometer operates in two modes at all times:
 - Low-Resolution (LR) mode:
 - Significant fraction of processing performed onboard.
 - Reduces data download volume.
 - Aimed towards the generation of ocean products.
 - Data downloaded regardless of surface type.
 - High-Resolution (HR) mode:
 - Aimed towards hydrology products.
 - Only downloaded for regions covered by land mask uploaded to instrument.
 - Defined by science team and subject to change.



SWOT STC/Quick-Look (QL) Products

- SWOT baseline products are aimed at science and research objectives: High quality products released within 60 days of data collection
- The importance of lower-latency $\sim <3$ days (Short-Term or Quick Look) data products for most applications is understood by the joint (CNES/JPL) projects.
- The joint projects have done a preliminary assessment and products with latencies of <3 days (with degraded performance) appear to be technically feasible but need further refinement and study for implementation
- The joint projects plan to pursue maturing the STC/QL concept and implement the production of these products on a best efforts basis:
 - Conduct a systematic **performance analysis** assessing drivers for low latency products identifying breakpoints in product latency (for example: <1 day, <3 days)
 - Conduct a analysis of the **ground and processing system implementation** drivers for low latency products identifying breakpoints in product latency
 - Review application team study result identifying **specific science benefits** for categories of lower latency products
 - Decide on an implementation baseline before project CDR
 - As a best effort initiative: The final decision for operational product processing would come in time for the Operations Readiness Review (ORR) late 2020.
 - The PoC's for each project on this effort are the respective Measurement System Engineers (Nicholas Picot, Shailen Desai)



Summary / Conclusion

- The joint project teams have made significant progress with development of all mission elements to prepare for the next major milestone (CDR) and are on-track for a spring 2021 launch
 - EM and FM hardware development well underway
 - Key performance analyses meet requirements
- Continuing to ramp-up on mission system elements:
 - Algorithm Development – Subject Matter Expert (SME) review of ATBD being prepared
 - Mission Operations
 - Ground Systems
 - Data Products including STC/QL
 - Cal/Val: Validating concepts and Developing baselines for CDR
- Greater focus now for Project, Science Team and User community to get ready for SWOT in 2021 (not so far away)