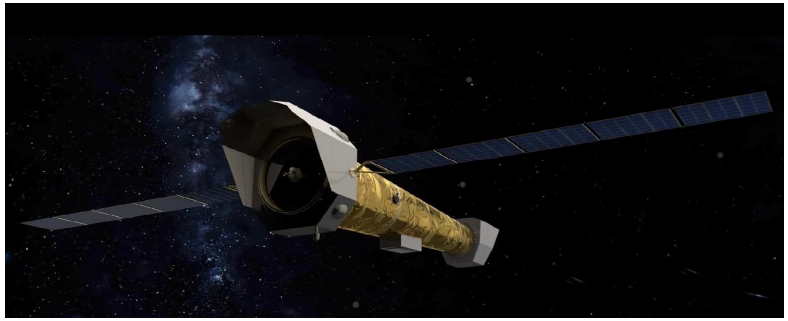
ATHENA X-ray Integral Field Unit

ATHENA SCHOOL

Project Management

Vincent Albouys, CNES - ATHENA X-IFU Project Manager – 06/21/2022

Agenda



ATHENA X-ray Integral Field Unit

- Space project management – Key principles
- X-IFU project management and planning
- X-IFU CNES project team

Space Project management
Key principles

Space project management - Context

What's project management ?

- Project planning and implementation = all of the processes to plan and execute a space project
  - from initiation to completion at all levels in the customer-supplier chain
  - in a coordinated, efficient and structured manner
  - It is a project wide activity receiving inputs from all project disciplines and involving close co-operation across the project domains.

What does usually cover a space project ?

- A space project typically comprises a space segment and a ground segment which are implemented in parallel.
- They rely on, and have interfaces with the launch service segment.
- These three segments comprise a space system.

Athena X-IFU is an instrument, part of the space segment. Athena project covers all 3 segments

Who runs space project (most common) ?

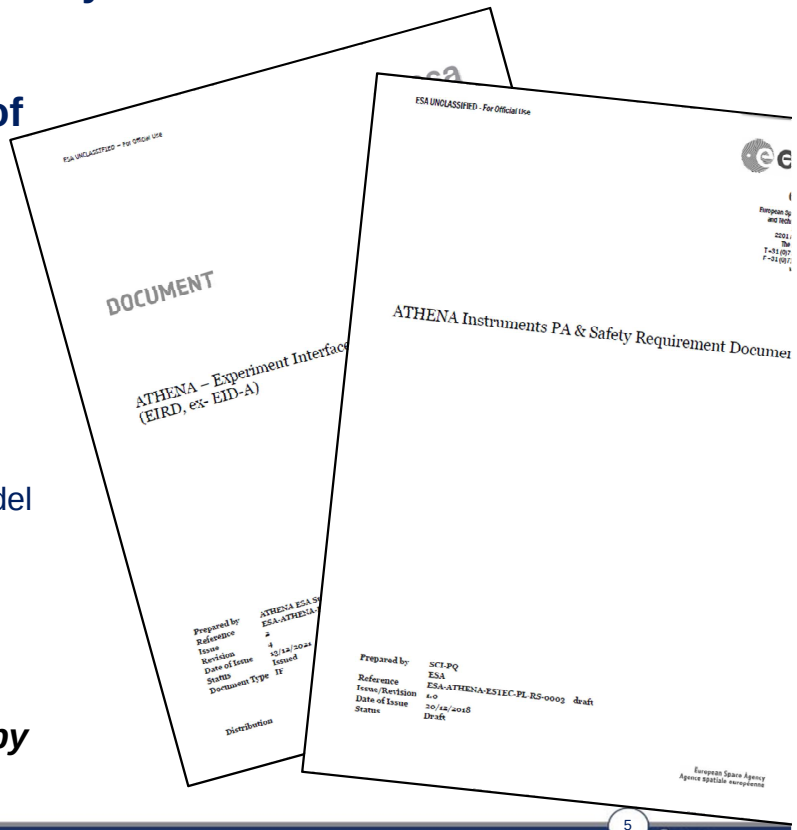
- individual governments, or co-operation between a number of governments;
- national, or international space agencies, either singly or collectively;
- national or international scientific communities;
- operators of commercial space systems.

See Athena project organization slide

Space project management – Input from customer

- **Whatever the overall organization of the project, the customer has to define input documents to be ingested and management by the supplier**
- **Usually named Project Requirement Document, this set of document usually comprise:**
  - Statement of work
  - Technical requirements documented in Technical Specification
  - Management requirements
  - Engineering requirements
  - Product assurance requirements
  - Programmatic requirements
  - Other, project specific requirements (e.g. geographical distribution, model philosophy to be applied)
  - Documents requirements list (DRL)
  - Tender requirements

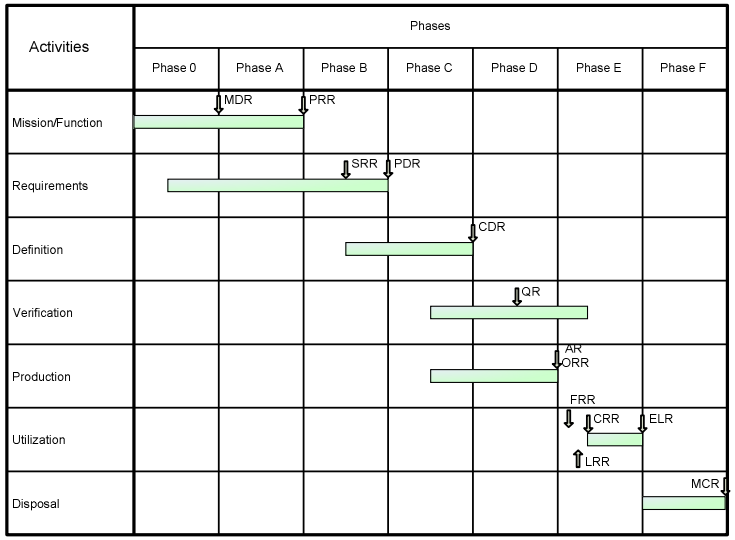
In the case of Athena X-IFU this documentation is provided by ESA to the X-IFU consortium



Space project management - Development approach

- **The development approach for a project is jointly defined by the customer and supplier to comply with the project initiator's mission objectives, statement, requirements and constraints**

- **The life cycle of space projects is typically divided into phases, as follows:**
  - Phase 0 - Mission analysis/needs identification
  - Phase A - Feasibility
  - Phase B - Preliminary Definition
  - Phase C - Detailed Definition
  - Phase D - Qualification and Production
  - Phase E –Utilization
  - Phase F – Disposal



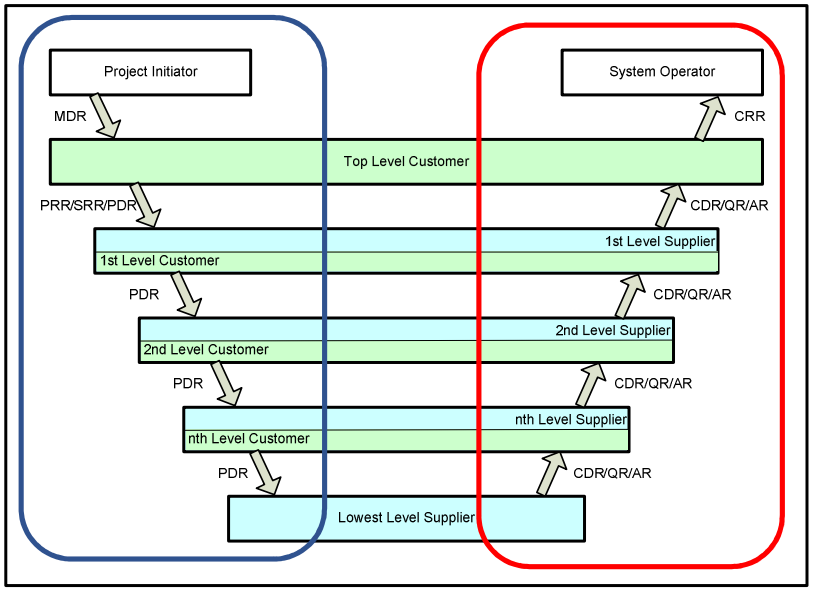
- **At the conclusion of the major activities and the related project reviews configuration baselines are established**

Athena X-IFU globally follows this approach

Space project management - Classical V-Model

- **From the PRR to the PDR, the sequence of the reviews is “top down”,**
  - starting with the top level customer and his top level supplier,
  - continuing down the customer-supplier chain to the lowest level supplier.

- **From the CDR to the AR, the sequence of reviews is reversed to “bottom up”,**
  - starting with the lowest level supplier and its customer
  - continuing up through the customer-supplier chain to the 1st level supplier and the top level customer.



- **This model can not be applied in the case of space programs driven by instrument or Payload complexity which impose to anticipate subsystem level development sometime well in advance**

This is the case for XIFU instrument itself and for some of XIFU subsystem as well

Space project management – Requirements & Breakdown structures

- **Project requirements are applicable to all actors of a project from the top level customer down to the lowest level supplier.**
- **Each supplier develops a product tree for his products down to the deliverable end items and elaborate specification for each of them**
  - The product tree is the breakdown of the project into successive levels of HW/SW products or elements,
  - The product tree includes the development models, the GSE, the integration tools and test equipment,
  - It includes items submitted to customer configuration control
  - All items from the product tree is the subject of a technical specification.
- **Each supplier develops also a Work Breakdown Structure (WBS)**
  - The WBS is the principal structure used in managing a project and provides a framework for managing cost, schedule and technical content.
  - The WBS is derived from the product tree, includes support functions and associated services.

See X-IFU PT and WBS in next slides

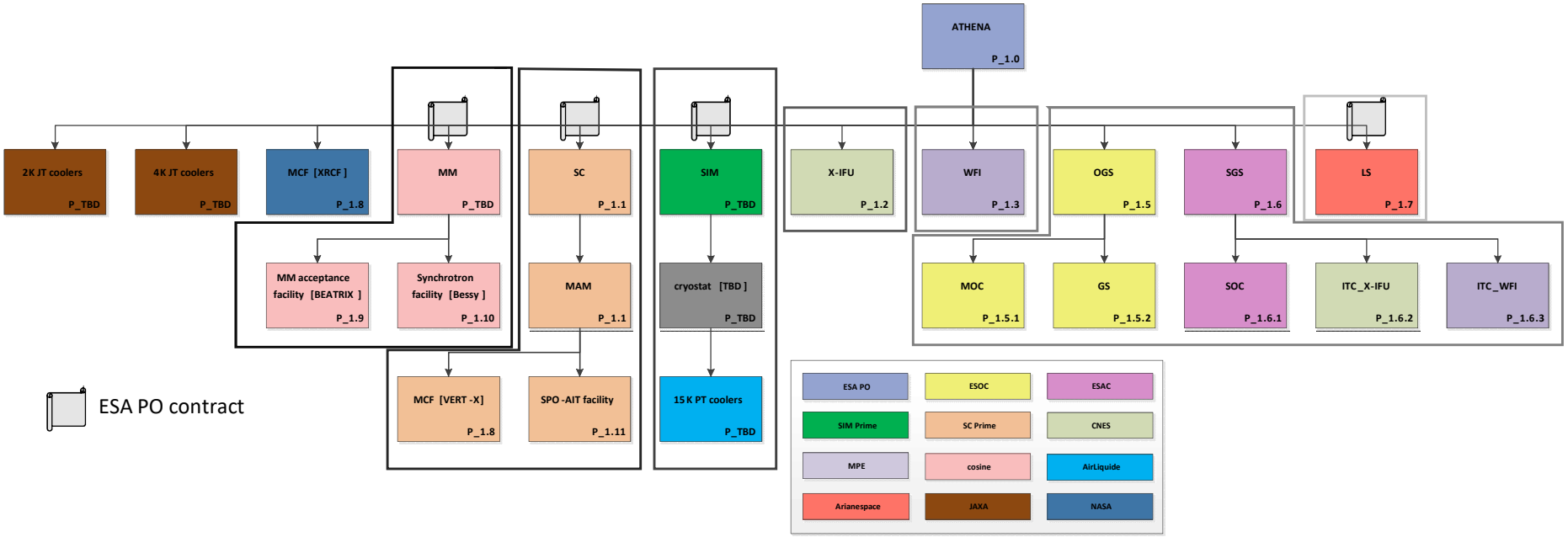
Space project management – Cost & Schedule

- **The main objectives of Cost and Schedule management are to:**
  - plan accurately the phasing of procurements, expenses and resources for the project;
  - highlight any deviations and propose remedial actions, with the aim of completing the project within the given time and financial constraints.
- **Schedule management includes the activities to accomplish timely completion of the project**
  - Schedule definition, including activity definition and sequencing, activity duration estimating and schedule baseline establishment;
  - Schedule control, including the comparison between the current working schedule and the baseline schedule;
  - Schedule reporting
- **Cost management includes the activities to complete the project within the approved budget**
  - Cost estimating and planning;
  - Cost control;
  - Cost reporting

See X-IFU Schedule in next slides

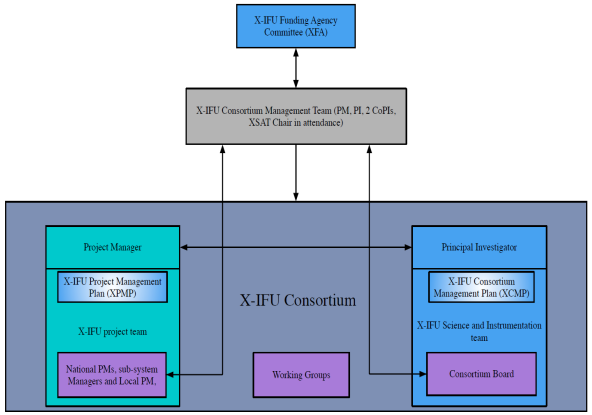
X-IFU Project organization and planning

Athena Project general organization



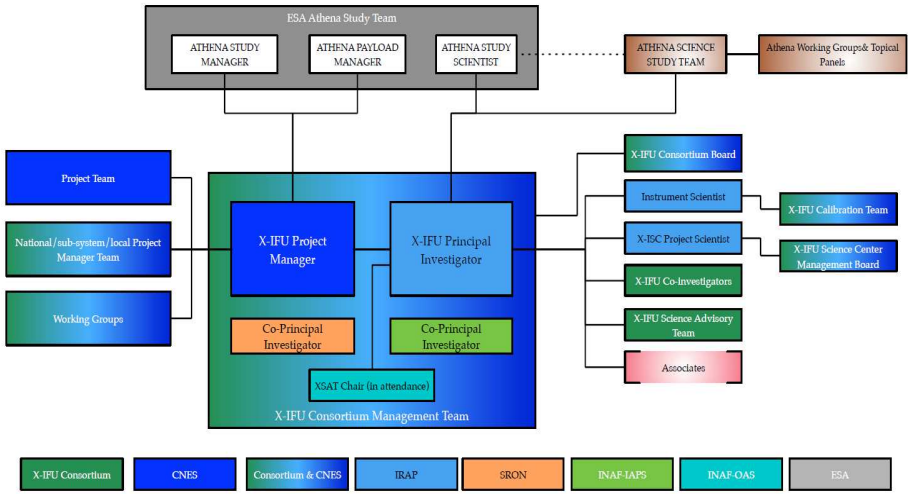
➢ Mirror Module	ESA contract with COSINE (Netherlands)
➢ SC (Platforme)	ESA contract with TAS-Fr and ADS- Germany
➢ SIM (Payload + Cryostat)	ESA contract avec TAS-Fr and ADS- Fr
➢ X-IFU	Consortium PI-ship France (IRAP) – Project management CNES
➢ WFI	Consortium PI-ship and Project management Max Planck Institute
➢ Ground Segment	Lead ESA
➢ Launch	ESA contract with Arianespace (A6)

Consortium X-IFU



- X-IFU Consortium Management Team (XCMT) acts as the governing body of the X-IFU consortium
- Decisions by the XCMT are taken by consensus, If no consensus can be reached the issue must be brought up for arbitration to the X-IFU Funding Agency (XFA) committee

- The X-IFU consortium is a multi-national entity, containing ~280 members from ESA Member States, Japan and the United States.
  - IRAP : Pi-ship / leads all science-related and management aspects of the consortium
  - Equipe scientifique – Lead PI (IRAP)



PI / PM relationship

X-IFU PI and X-IFU PM both work in extremely close loop

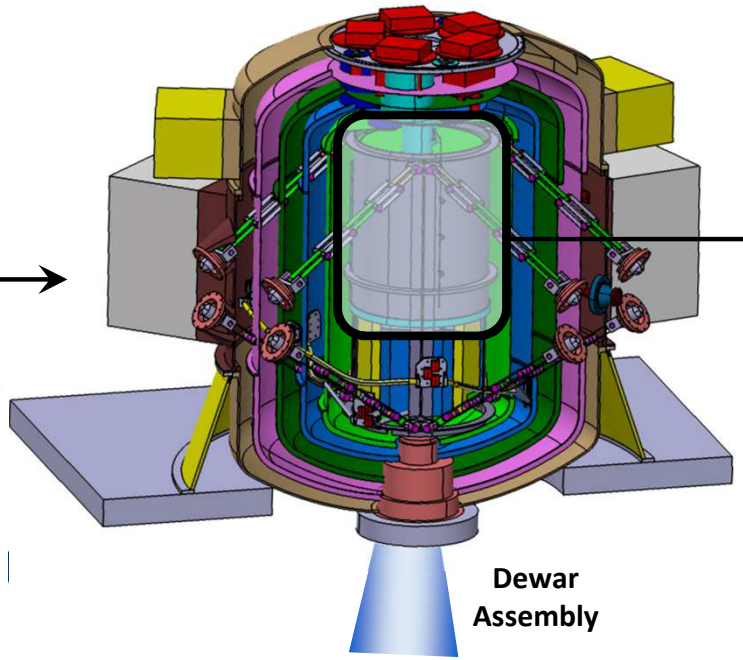
- Mandatory for the Project team to understand what are the science requirements, requested performances, potential area for optimization
- Exchange between PI and PM happen on a day-by-day basis
- PM is associated with the PI in all decisions about performance, schedule, cost, tradeoffs

PI/PM pre- eminence

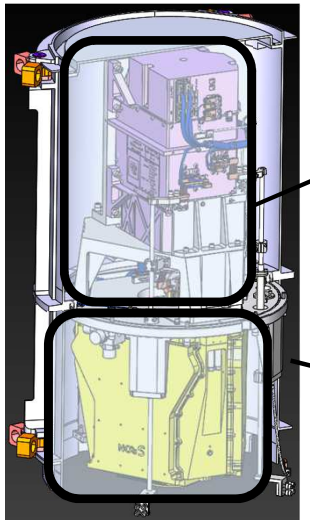
	Principal investigator	Project manager
Performance requirements	✓	
Engineering and design		✓
Compromise Performance / schedule / costs	✓	✓
International cooperation	✓	✓
Interface project / consortium	✓	
Interface with national project managers		✓
Satellite / payload interface with ESA and Primes		✓
Interface with Athena organisation	✓	

Instrument X-IFU

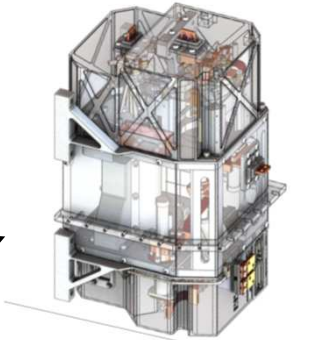
X-IFU dans le PL module



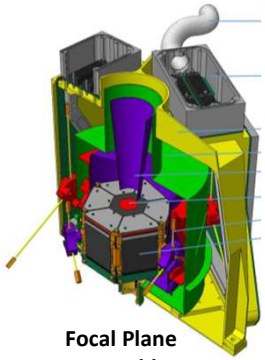
Dewar Assembly



2K Core

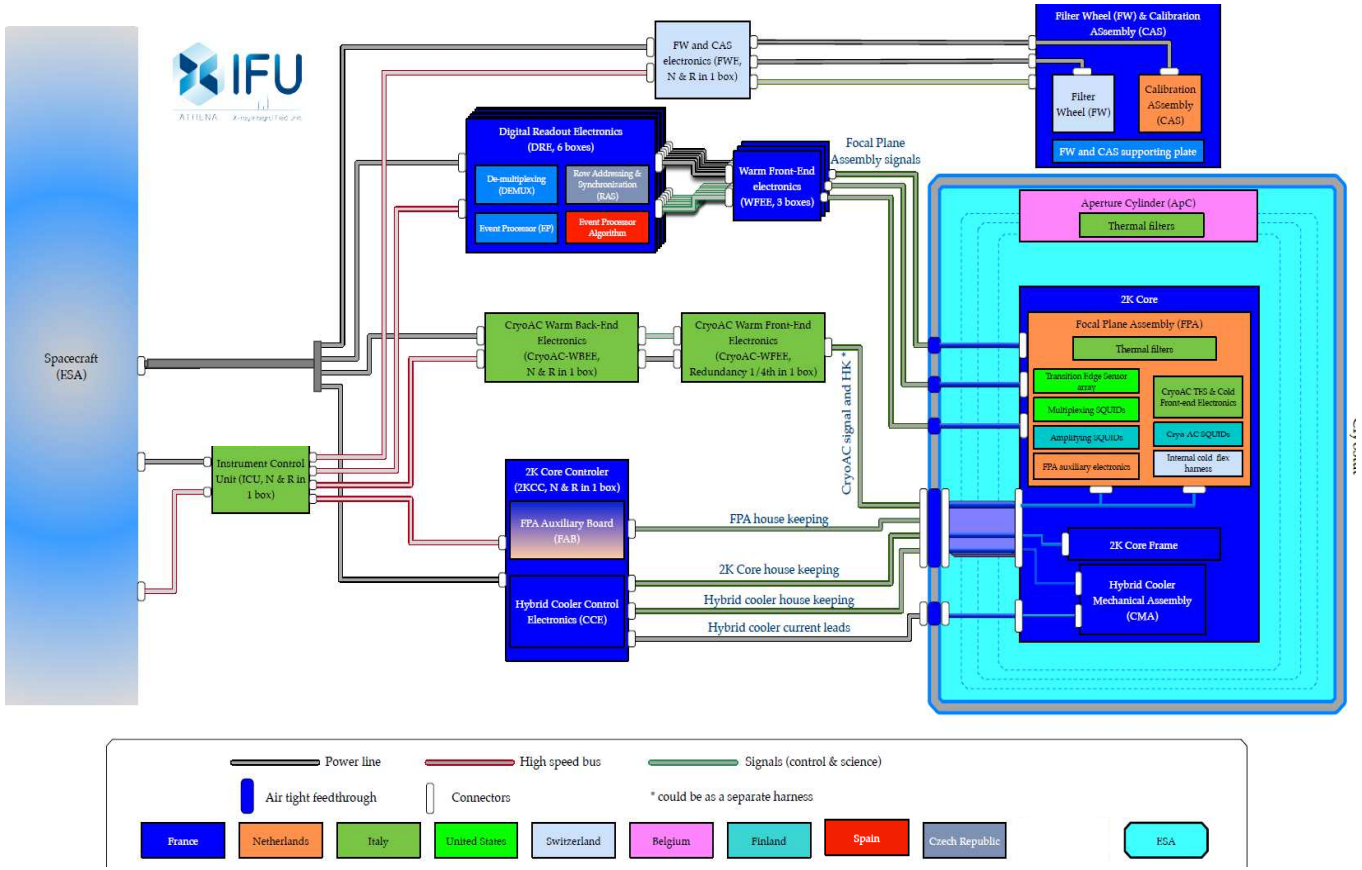


SubK cooler



Focal Plane Assembly

X-IFU partners and responsibilities

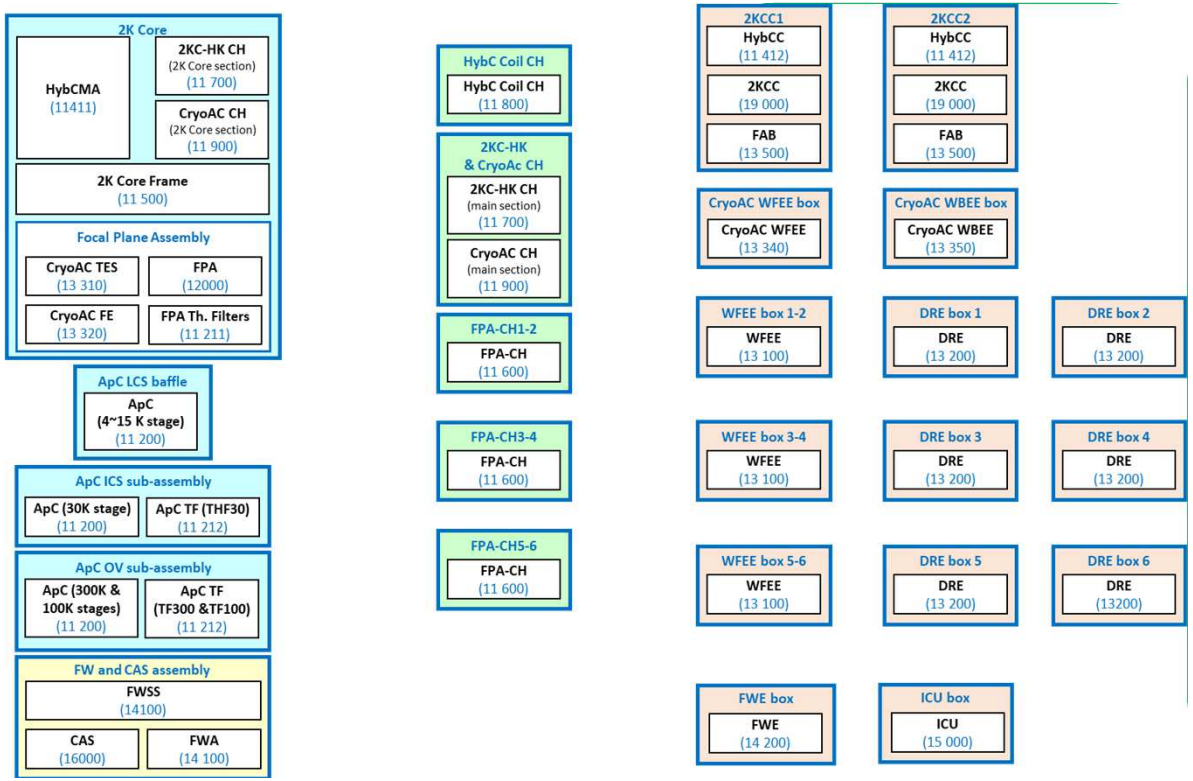


- Partners are in charge of developing and delivering a product (subsystem or equipment).
- No contractual link between CNES and partners (except French ones)
- CNES responsible for managing technical development of subsystem and elaborating all subsystem requirements

X-IFU physical entities

- **The Physical breakdown of X-IFU instrument is complex with many pieces of equipement to be developed**
  - 4 cold mechanical assemblies on the optical path interfacing with the SIM Dewar:
    - The 2K Core
    - 3 sub-assemblies of the Aperture Cylinder including Thermal Filters (*ApC LCS, ICS and OV s/a*)
  - 1 warm mechanical assembly on the optical path interfacing with the warm SIM:
    - The Filter Wheel and Calibration Assembly
  - 5 Cold Harnesses interfacing with the SIM Dewar (and warm SIM for some of them)
  - 15 electronic boxes interfacing with the warm SIM

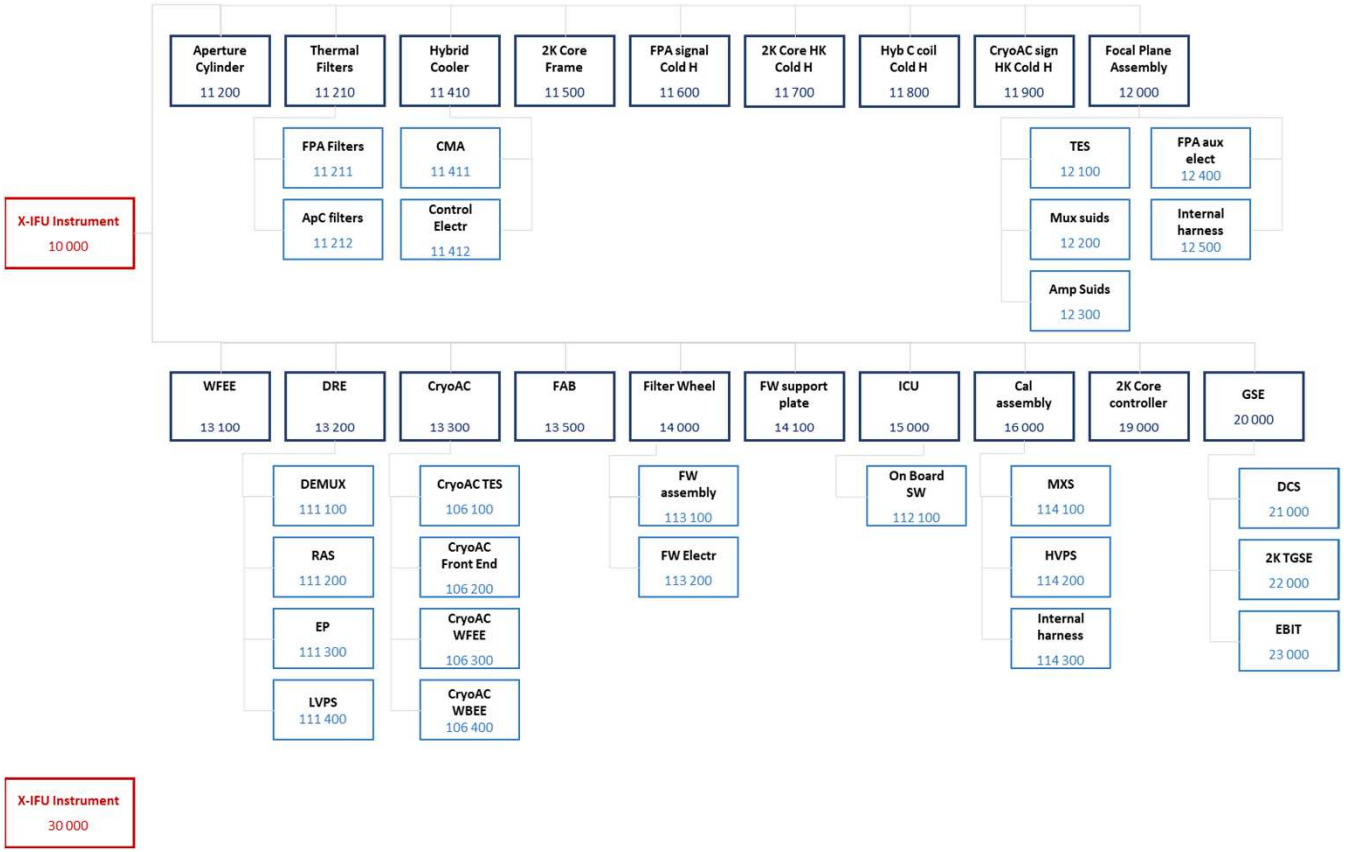
for a total of 25 physical entities.



X-IFU hardware breakdown

Legend S/S name (product N°) | Mechanical assembly | Cold assembly | Warm assembly | Cold harness | Electronic box

X-IFU Product Tree



As explained in p8

- XIFU product tree is the breakdown of the project into all level of HW/SW products
- All these items are the subject of a technical specification.

X-IFU WBS

	WBS Code	Product Tree Code	WB item	SAP code
PROJECT OFFICE	1000		Management	
	1010	10 000	X-IFU Project Management	B-ATH2/10
	2000		Product Assurance	
	2010	10000	X-IFU Product Assurance	B-ATH2/10
	3000		Engineering	
	3010	10 000	X-IFU System Engineering	B-ATH2/22-01
	3020	10 000	X-IFU Mechanical Engineering	B-ATH2/22-01
	3030	10 000	X-IFU Thermal Engineering	B-ATH2/22-01
	3040	10 000	X-IFU Structure Engineering	B-ATH2/22-01
	3050	10 000	X-IFU Avionics	B-ATH2/22-01
	3060	10 000	X-IFU Command and control	B-ATH2/22-01
	3070	10 000	X-IFU Detection Chain	B-ATH2/22-01
	3080	10 000	X-IFU EMC	B-ATH2/22-01
	3090	10 000	X-IFU Software	B-ATH2/22-01
	4000		Performance	
	4010	10 000	X-IFU System Performance	B-ATH2/22-01
	5000		ESA/Prime Interface management	
	5010	10000	X-IFU Interface management	B-ATH2/22-01
	6000		Validation	
	6010	10000	X-IFU V&V Engineering	B-ATH2/22-01

	WBS Code	Product Tree Code	WB item	SAP code
AIT & GSE	8000		AIT	
	8010	10 000	X-IFU AIT preparation	B-ATH2/23-03
	8020	10 000	X-IFU DM AIT (early verif)	B-ATH2/23-03
	8030	10 000	X-IFU EM AIT	B-ATH2/23-03
	9000		GSE	
	9010	10 000	MGSE	B-ATH2/23-02
	9020	10 000	TGSE	B-ATH2/23-02
	9030	10 000	EGSE	B-ATH2/23-02
	9040	10 000	Container	B-ATH2/23-02

	WBS Code	Product Tree Code	WB item	SAP code
GROUND	10000		Ground Segment	
	10010	30 000	System Engineering	B-ATH2/24-01

	WBS Code	Product Tree Code	WB item	SAP code
PROCUREMENT	7000		Partner Subsystem procurement	
	7010	10 000	X-IFU Procurement Engineering	B-ATH2/23-01
	7020	12 000	FPA	B-ATH2/23-01
	7030	11 211	FPA filters	B-ATH2/23-01
	7040	11 500	2K Core Frame	B-ATH2/23-01
	7050	11 410	Hybrid cooler	B-ATH2/23-01
	7060	11 600	FPA signal cold harness	B-ATH2/23-01
	7070	11 900	CryoAC signal and HK cold harness	B-ATH2/23-01
	7080	11 700	2K Core HK cold harness	B-ATH2/23-01
	7090	11 800	Hybrid Cooler cold harness	B-ATH2/23-01
	7100	19 000	2K Core Controller	B-ATH2/23-01
	7110	13 500	FAB (FPA aux Board	B-ATH2/23-01
	7120	11 412	Hybrid cooler Control Electronic	B-ATH2/23-01
	7130	13 300	CryoAC	B-ATH2/23-01
	7140	13 100	WFEE	B-ATH2/23-01
	7150	13 200	DRE	B-ATH2/23-01
	7160	13 210	DRE DEMUX	B-ATH2/23-01
	7170	13 230	DRE EP	B-ATH2/23-01
	7180	13 240	Low Voltage Power Supply	B-ATH2/23-01
	7190	15 000	ICU	B-ATH2/23-01
	7200	14 200	FW & CAS Electronics	B-ATH2/23-01
	7210	11 200	Aperrture Cylinder	B-ATH2/23-01
	7220	14 000	Filter Wheel	B-ATH2/23-01
	7230	16 000	Calibration assembly	B-ATH2/23-01
	7240	14 100	FW and CAS supporting Plate	B-ATH2/23-01

- **WBS is complementary to the product tree, includes all includes support functions**
- **This is the basis for cost monitoring of the project**

X-IFU Schedule

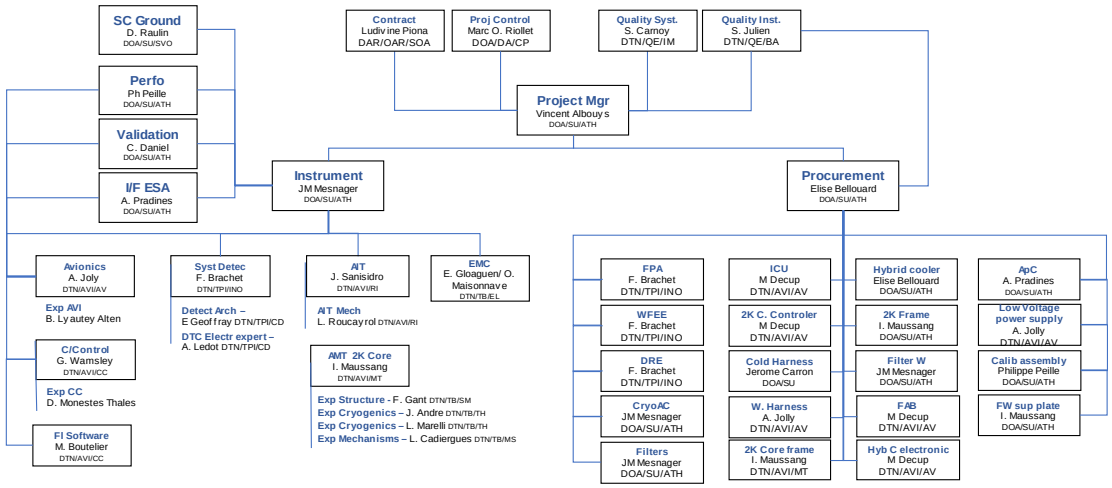
- **X-IFU PDR has been scheduled considering :**
  - The end of Early Verification test campaign (detection chain “DM” tested in 50mK bench at IRAP)
  - The end of Cryostat demonstrator (DCS) test campaign (CEA Grenoble)
  - SIM SRR complete + 6 months, in order to take into account SIM interfaces updates and perform co-engineering activities with SIM Prime.
- **X-IFU CDR has been scheduled considering :**
  - The end of EM test campaign at CNES

X-IFU CNES Project team

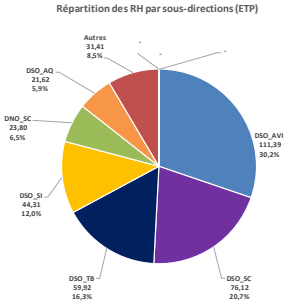
CNES project team

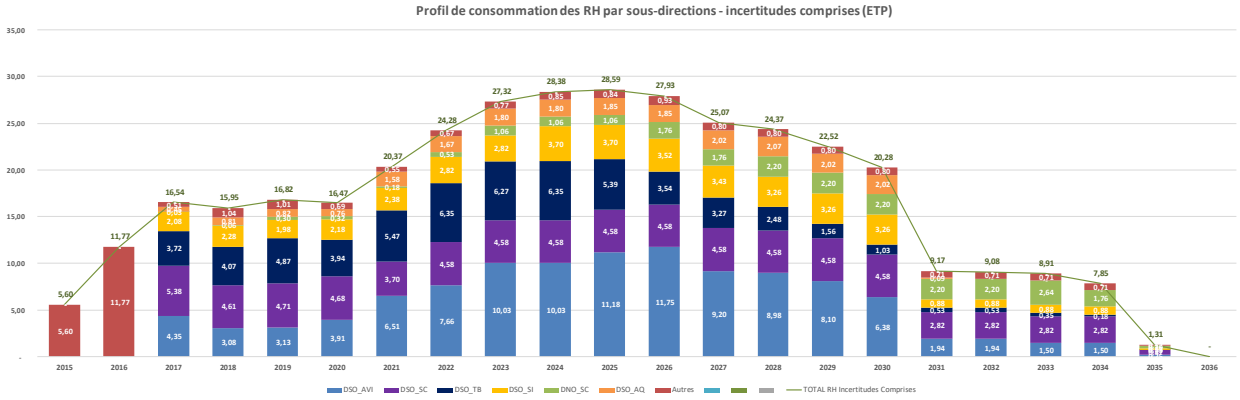
CNES Team composition

- 16 FTE during Phase A and B1
- Significant ramp-up for B2 (24 ETP en 22)
- Architecture department highly involved



Procurement Team ramping up, in charge of consortium partners follow-up



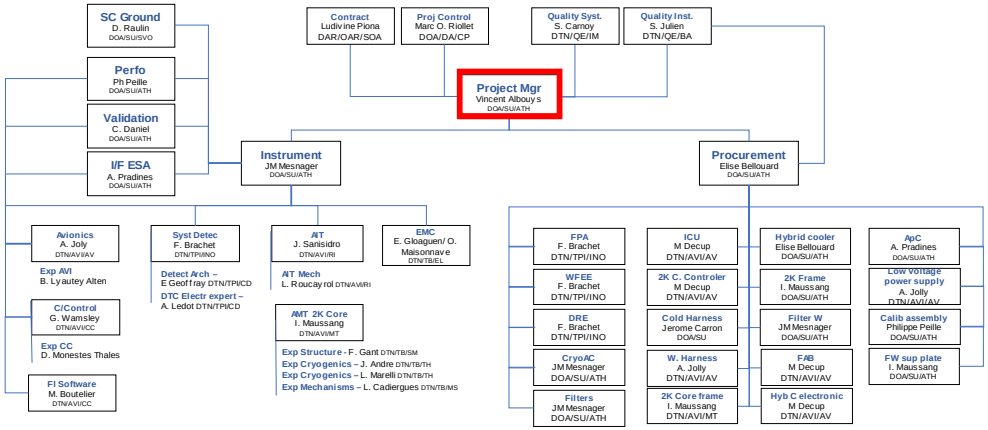


CNES organisation / project team – Key roles

Project Manager

- implementation of the X-IFU Project management plan and supervision of the related tasks within CNES team,
- identification, definition and supervision of all project activities and their allocation to members of the project team,
- management relating to contractual, cost, schedule and technical status of the project
- authorization of formal documentation and correspondence with ESA
- supervision of the preparation and release of X-IFU review documentation
- supervision of the risk management and the implementation of related actions
- supervision of project office tasks
- reporting towards CNES internal management

X-IFU project manager works full-time for the X-IFU Project



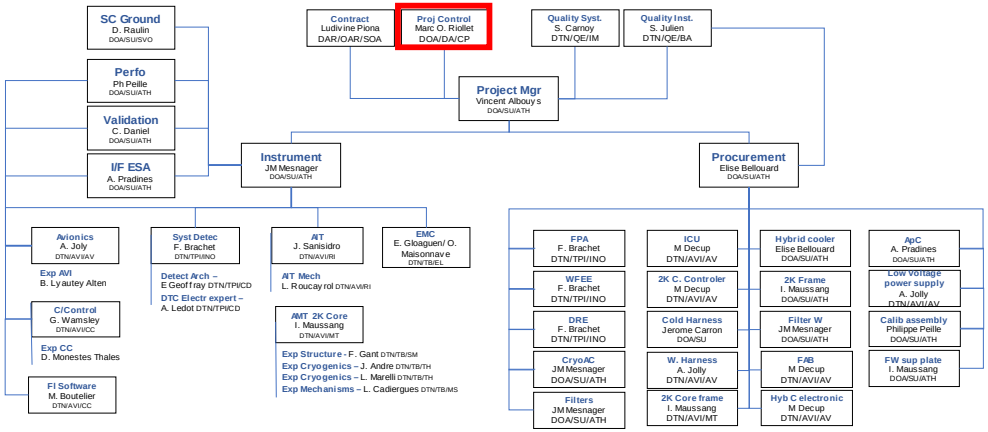
CNES organisation / project team – Key roles

Project controller

- Assists the Project manager to handle and manage all X-IFU resources of the project.
- In charge of monitoring the budget allocations and consumptions according to X-IFU plan and schedule, and the associated human resources allocations and consumptions.

  Project resources are reevaluated by the project controller (with the X-IFU project manager) twice a year and reported to CNES management.

X-IFU project controller works half-time for the X-IFU Project

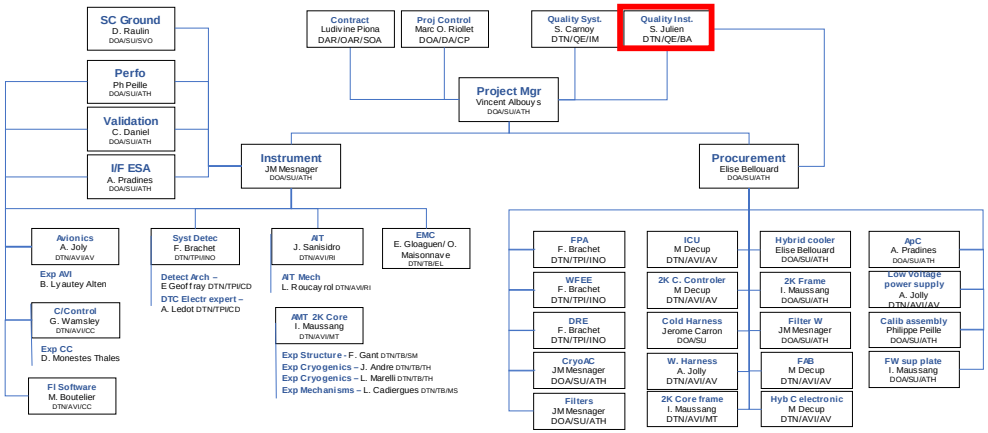


CNES organisation / project team – Key roles

Product assurance manager

- In charge to define the project PA specification, and the PA plan, which is the project PA applicable referential.
- The PA manager interfaces with ESA on PA activities (including convergence on PA Plan, and PA compliance Matrix)
- He/she coordinates CNES internal QA experts (Dependability, Safety, EEE, Radiation, M&P)
- He/she manages the project risk management activity at X-IFU instrument level, and elaborates the instrument risk portfolio + organizes Risk management review with partners
- He/she is responsible for elaborating PA and Safety requirements applicable to partners.

X-IFU Product assurance manager works 70% of his/her time for the X-IFU Project

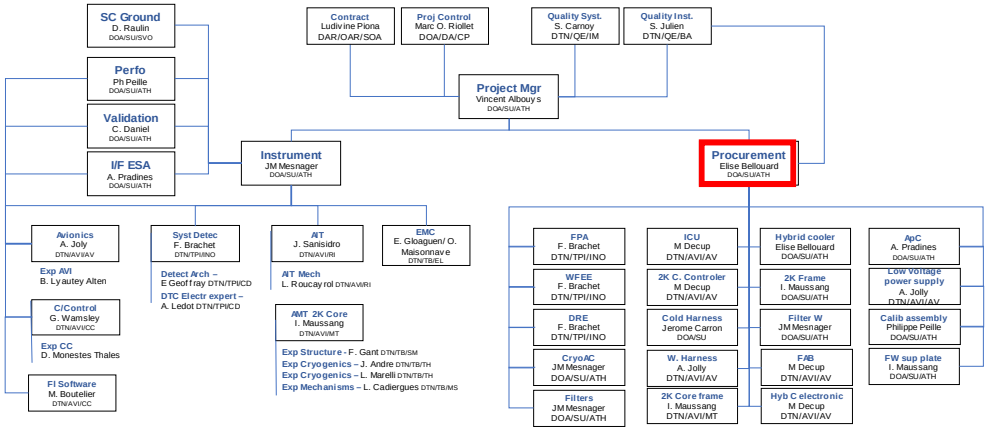


CNES organisation / project team – Key roles

Procurement manager

- coordinates of all activities related to subsystem development by X-IFU consortium partners.
- coordinates the group of subsystem procurement mangers, directly in interface with the subsystem teams. Defines and coordinates subsystem managers activity and work plan
- Responsible for defining the input and documentation to be used by CNES subsystem procurement manager and delivered to partners. He/she ensures the coherency in between all deliverables expected by CNES from the partners
- Ccoordinates subsystem schedule delivery and injects into instrument schedule.
- Elaborates instrument level schedule.
- He/she coordinates subsystem risks portfolio delivery.

X-IFU procurement manager works full time for the X-IFU Project

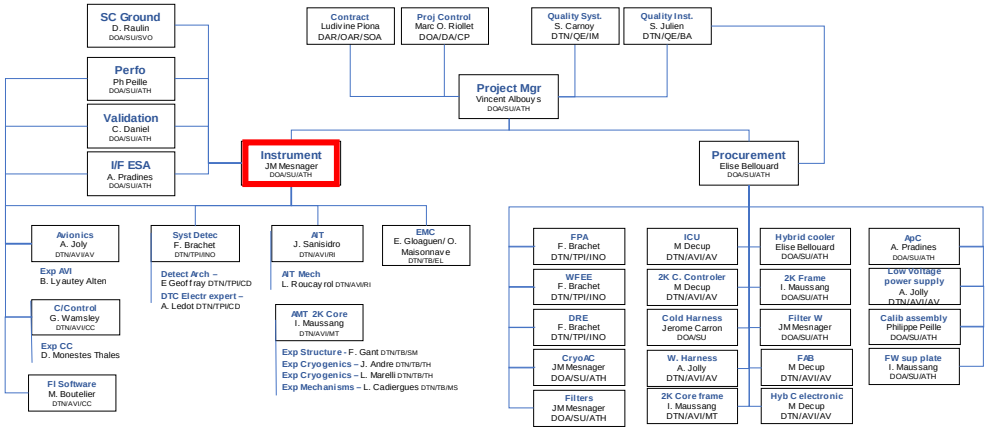


CNES organisation / project team – Key roles

Instrument technical manager

- Responsible for the design of the X-IFU instrument, defines and coordinates all X-IFU instrument engineering activities.
- Arbitrates technical trades and ensures technical coherency in the instrument design choices.
- Manages instrument technical risks with the relevant architect(s)
- Participates in ESA/Primes technical exchange meeting pending agenda and addresses instrument related questions with all partners
- He/she leads and coordinates the X-IFU technical document elaboration for instrument-level reviews.

X-IFU Instrument Technical manager works full time for the X-IFU Project

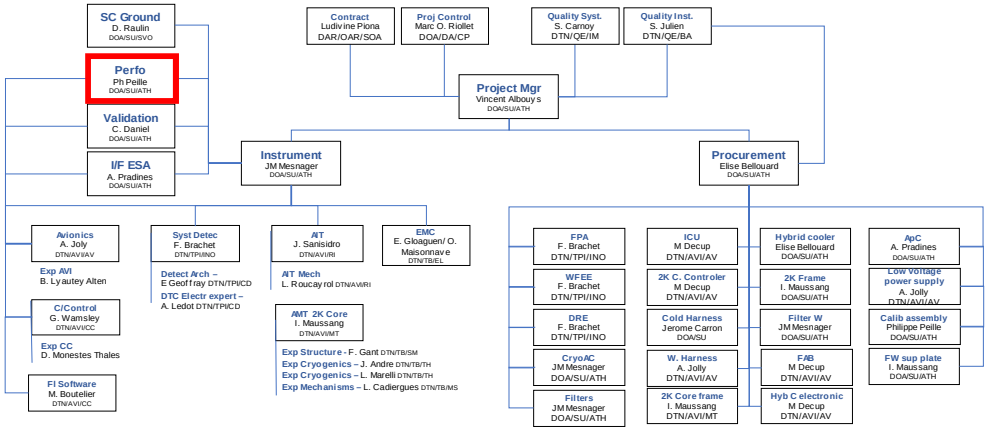


CNES organisation / project team – Key roles

Performance Manager

- Responsible for elaborating the instrument end to end performance budgets. He/she coordinates all performance related activities in interface with the project members, but also the PI supported by the science advisory team.
- Coordinates technical engineering activity in direct link with performance (EMC, microvibration)
- Participates in the definition of the instrument performance validation logic : elaborates the instrument calibration plan with partners.
- Closely interfaces with detection chain group which is the key instrument functional chain for performance.

X-IFU performance manager works full time for the X-IFU Project

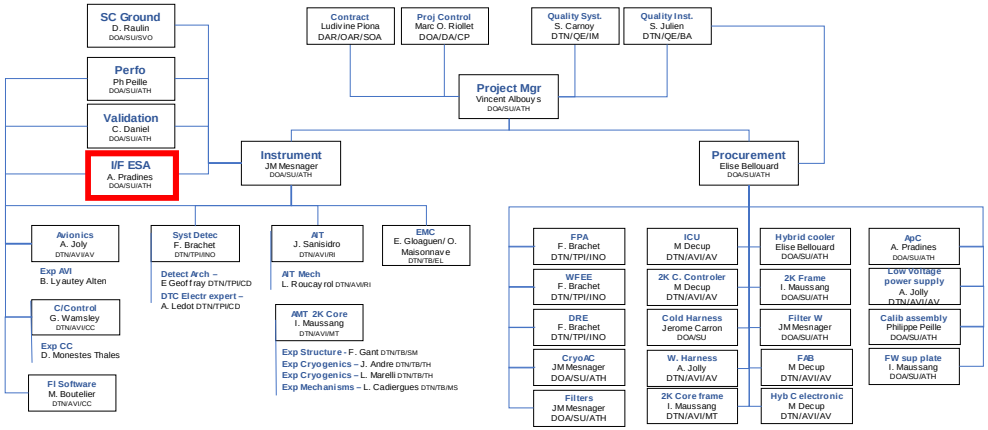


CNES organisation / project team – Key roles

ESA/Prime interface Manager

- Responsible for managing all interfaces with ESA/prime Science Instrument Module (SIM) and ESA/prime spacecraft.
- Defines instrument - to - SIM interfaces in interaction with XIFU architects and instrument technical manager
- Responsible for elaborating the instrument Interface Control Document (ICD) to be used by ESA/ Primes.
- Closely interfaces with validation manager for what concerns coupled SIM/ X-IFU V&V activity and exchange with ESA and primes about it.
- Interfaces with ESA and primes about all interface related questions or action items.

X-IFU ESA/prime interface manager works full time for the X-IFU Project

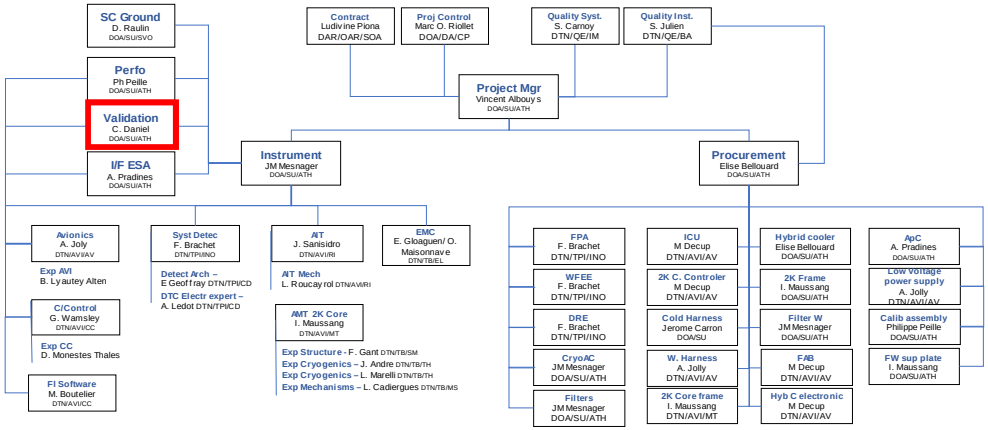


CNES organisation / project team – Key roles

Validation Manager

- Responsible for defining all demonstration / verification activities at System level. He/she defines the instrument verification logic based on architect input, and the associated model strategy and development schedule
- Coordinates the X-IFU demonstration activity for the instrument and the instrument subsystem.
- He/she interfaces with the AIT manager for AIT plan elaboration.
- He/she interfaces with ESA/primes to deal with all related V&V questions in interface with ESA IF manager.

X-IFU validation manager works full time for the X-IFU Project

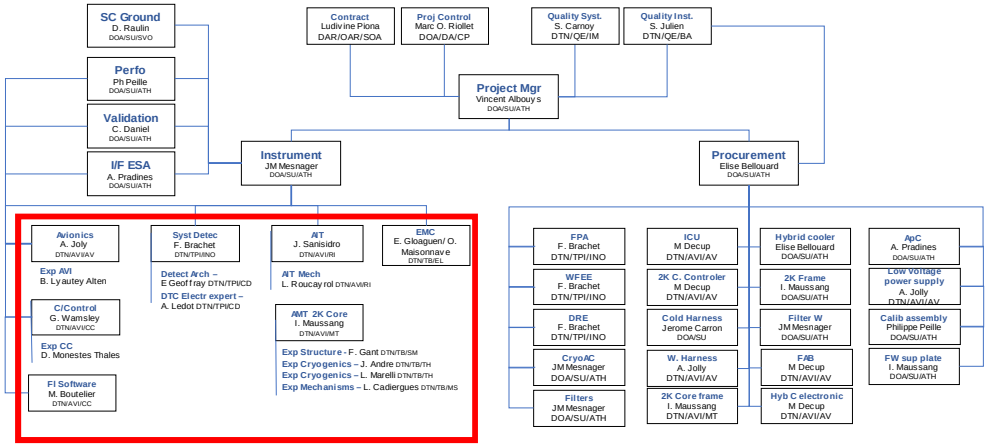


CNES organisation / project team – Key roles

Functional chain architects

- CNES Project team is based on a classical matrix organization with one architect responsible for managing each and every functional chain of the instrument.
- All instrument architects report directly to the instrument technical manager.
- X-IFU architects cover the following:
  - Mechanical and thermal (AMT)
  - Avionics
  - Detection chain
  - Command and control
  - Software
  - EMC
  - AIT

X-IFU architect most work part time for the X-IFU Project



Summary

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- **Space Project management is highly dependant on the overall organization, responsibilities, cooperation schemes etc.**
- **But some basic will always be under Project Manager responsibility**
  - Project activities planning and team management
  - Risk management
  - Cost management
  - Schedule management
- **Space Project are long and complex with possible rearrangement / descope / optimization during early phases..**

Success always come from people!