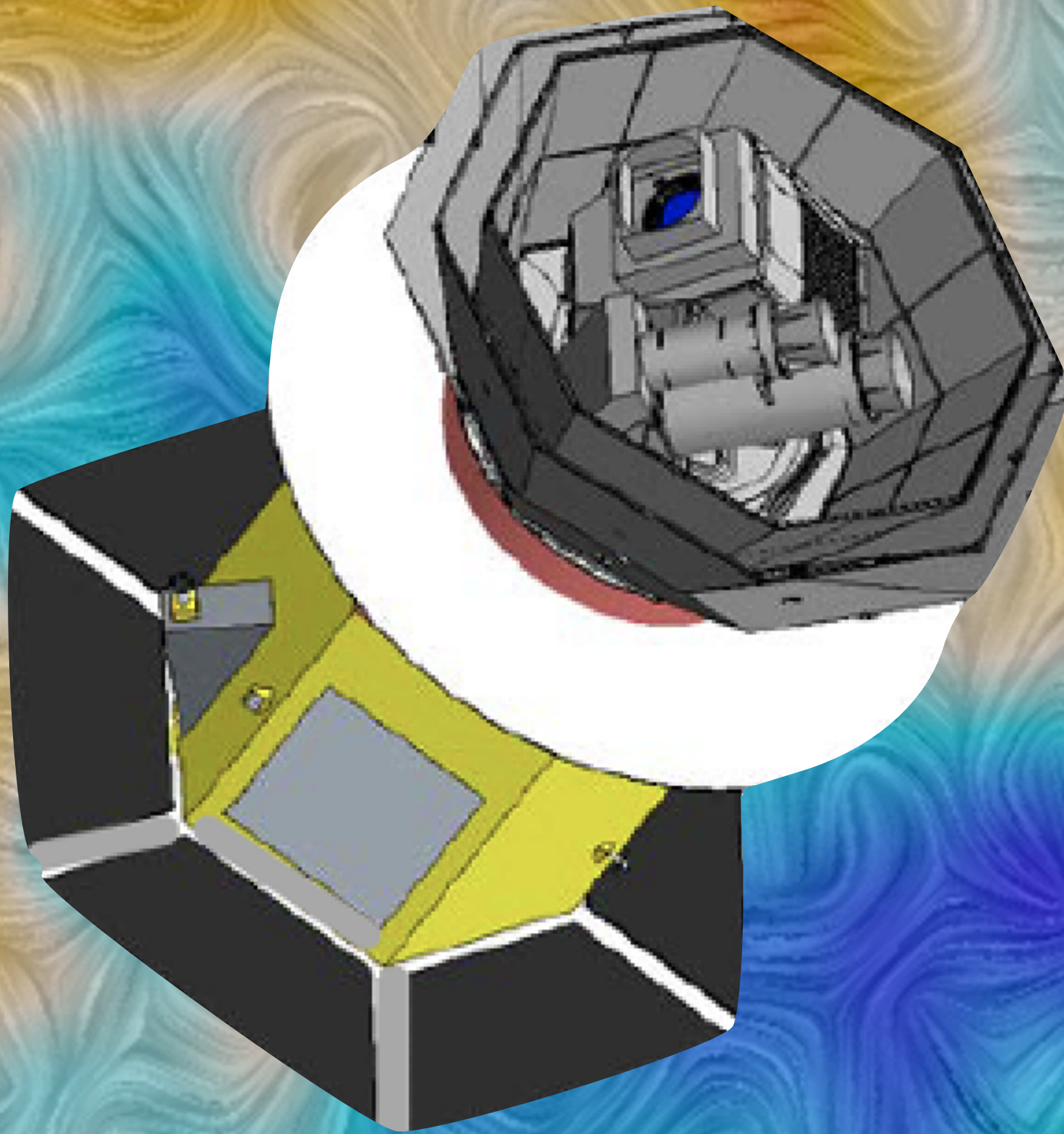


LiteBIRD Status


L. Montier

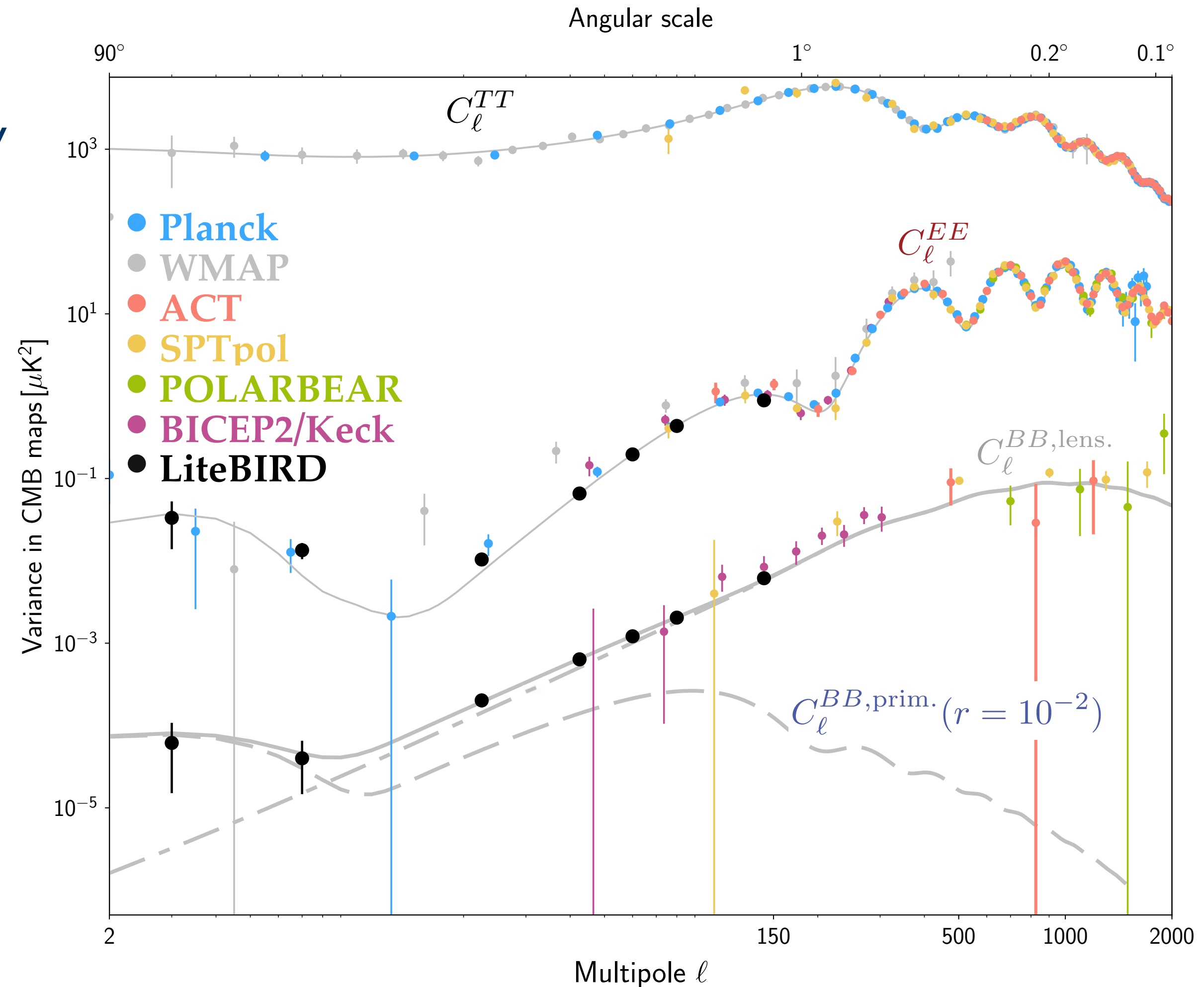
on behalf of LiteBIRD Collaboration



CMB-France #6

Main Scientific Objectives

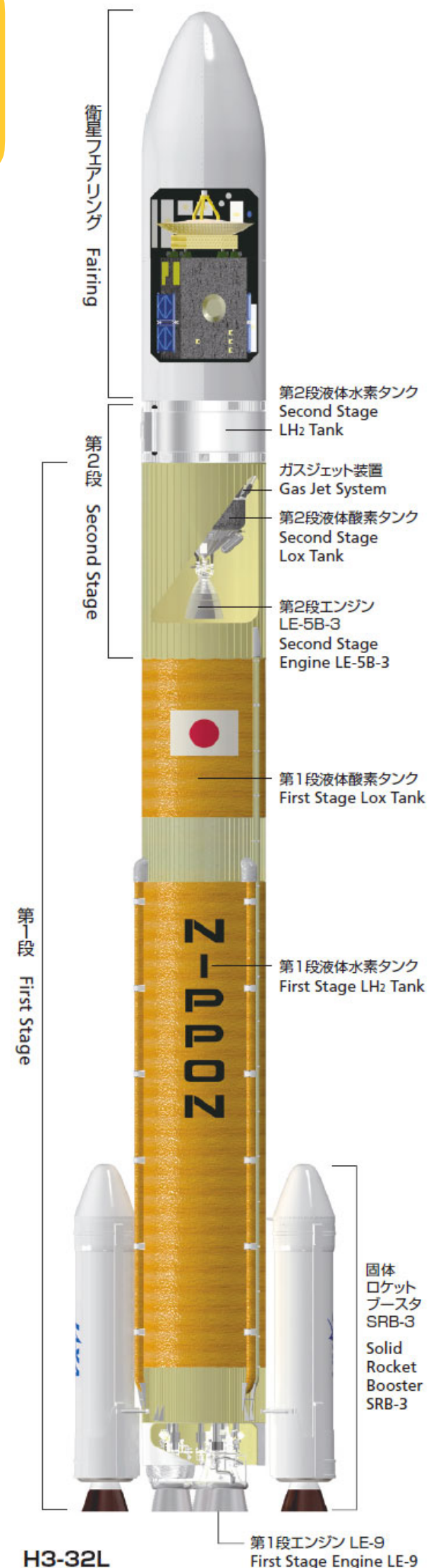
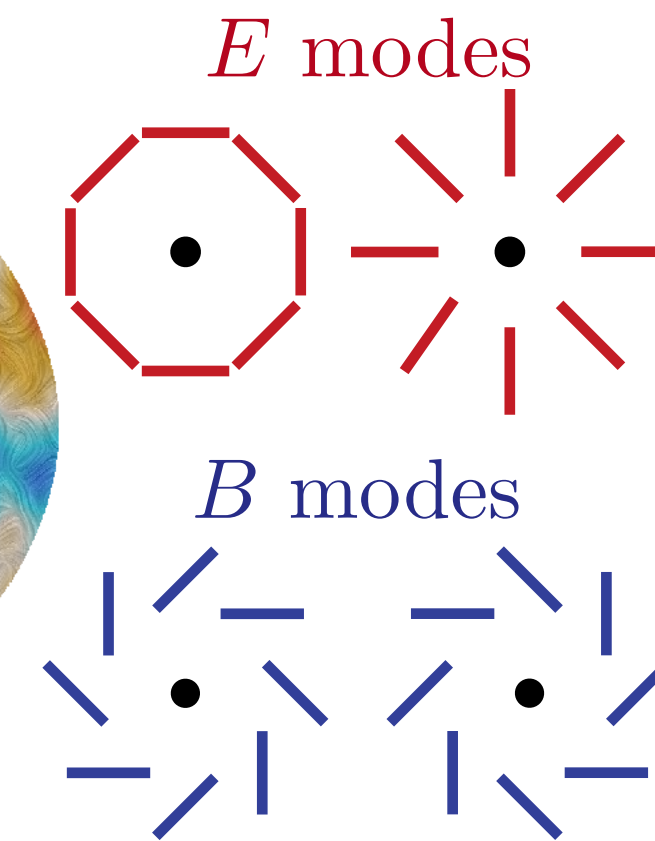
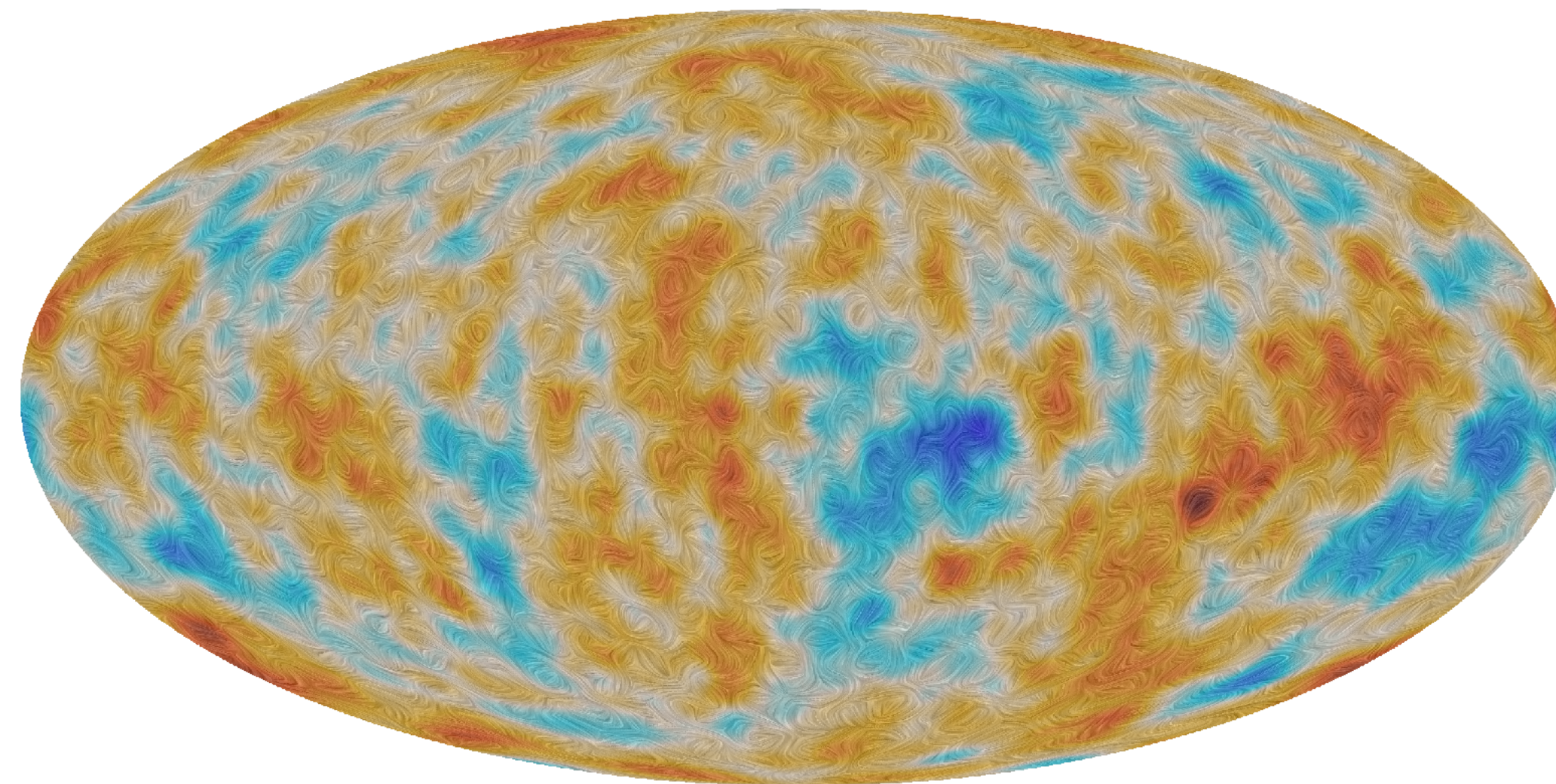
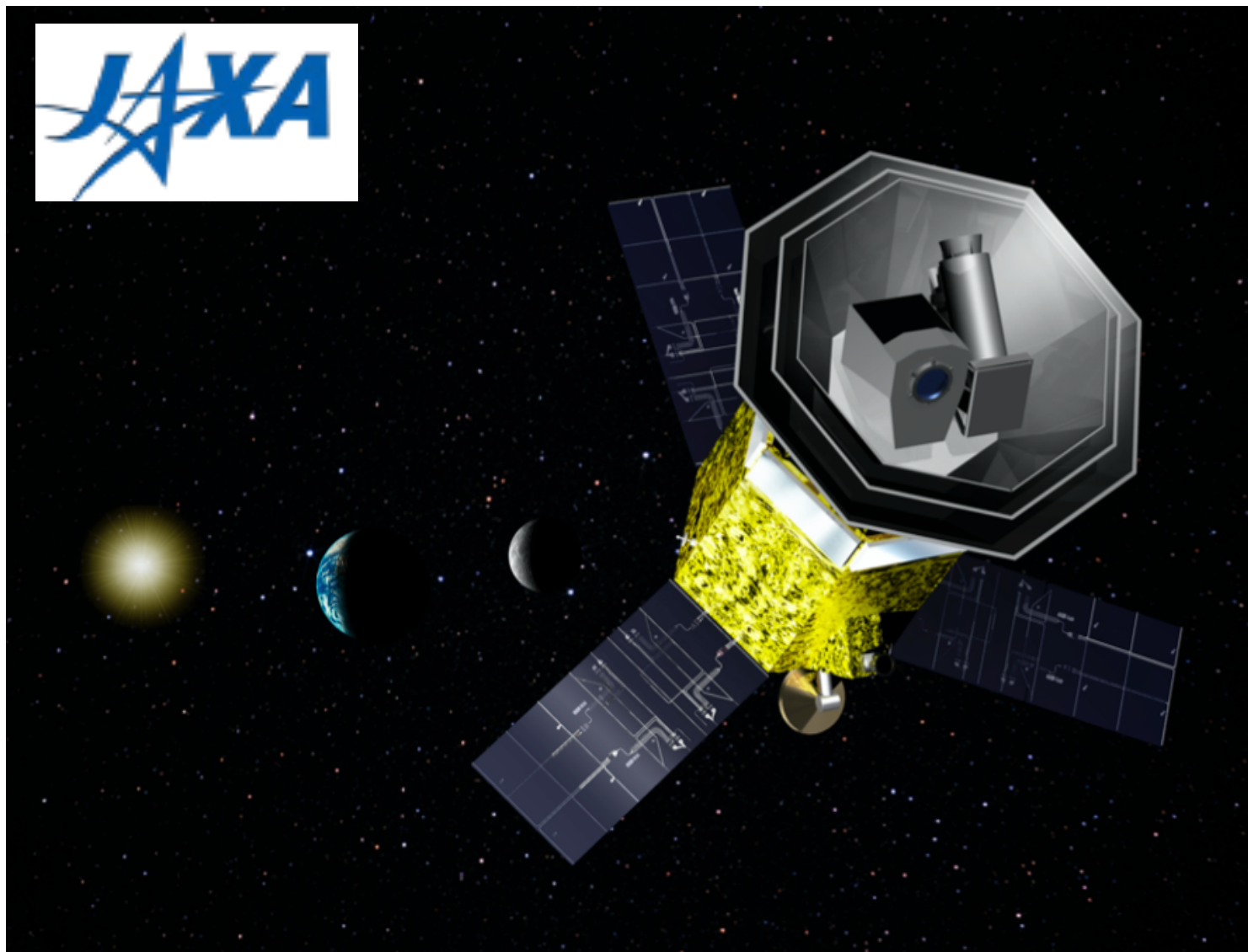
- Definitive search for the **B-mode signal** from **cosmic inflation** in the CMB polarization
 - Making a discovery or ruling out well-motivated inflationary models
 - Insight into the quantum nature of gravity
- The inflationary (i.e. primordial) B-mode power is proportional to the **tensor-to-scalar ratio, r**
- Current best constraint: $r < 0.032$ (95% C.L.)
( Tristram et al. 2021, combining BK18 + Planck PR4 data)
- LiteBIRD will improve current sensitivity on r by a factor ~ 50
- Science requirements (no external data):
 - For $r = 0$, **total uncertainty of $\delta r < 0.001$**
 - For $r = 0.01$, 5- σ detection of the reionization ($2 < \ell < 10$) and recombination ($11 < \ell < 200$) peaks independently
- Huge discovery impact (evidence for inflation, knowledge of its energy scale, ...)



LiteBIRD Mission

- Lite (Light) spacecraft for the study of *B*-mode polarization and Inflation from cosmic background Radiation Detection
- JAXA's L-class mission was selected in May 2019 to be launched by JAXA's H3 rocket.
- **All-sky 3-year survey**, from Sun-Earth Lagrangian point L2
- Large frequency coverage (**40–402 GHz**, 15 bands) at **70–18 arcmin** angular resolution for precision measurements of the **CMB *B*-modes**
- Final combined sensitivity: **2.2 $\mu\text{K}\cdot\text{arcmin}$**

LiteBIRD collaboration
PTEP 2023

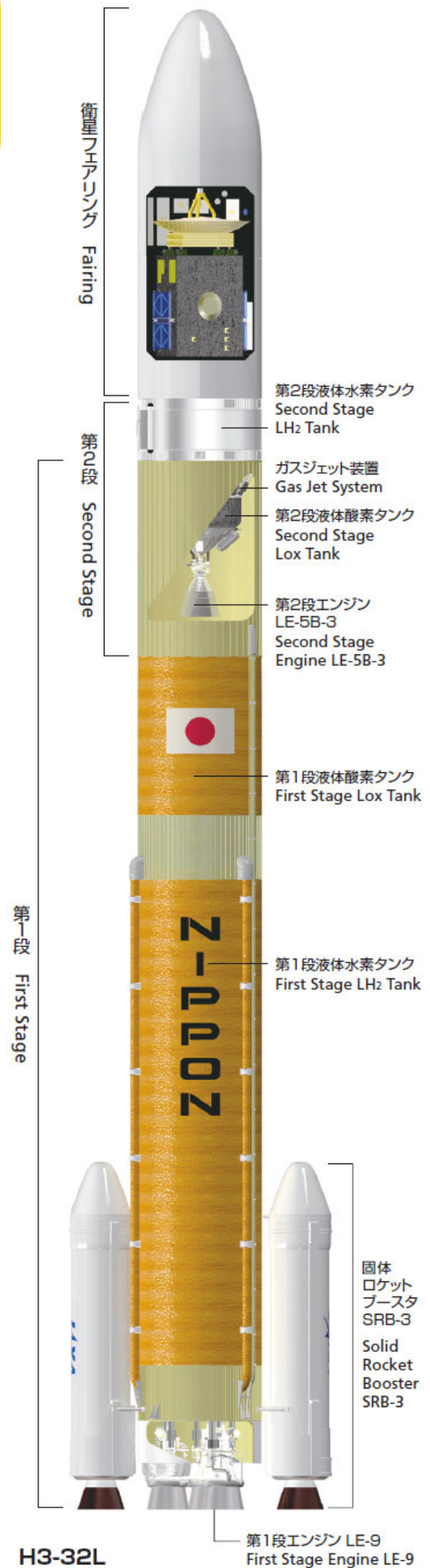
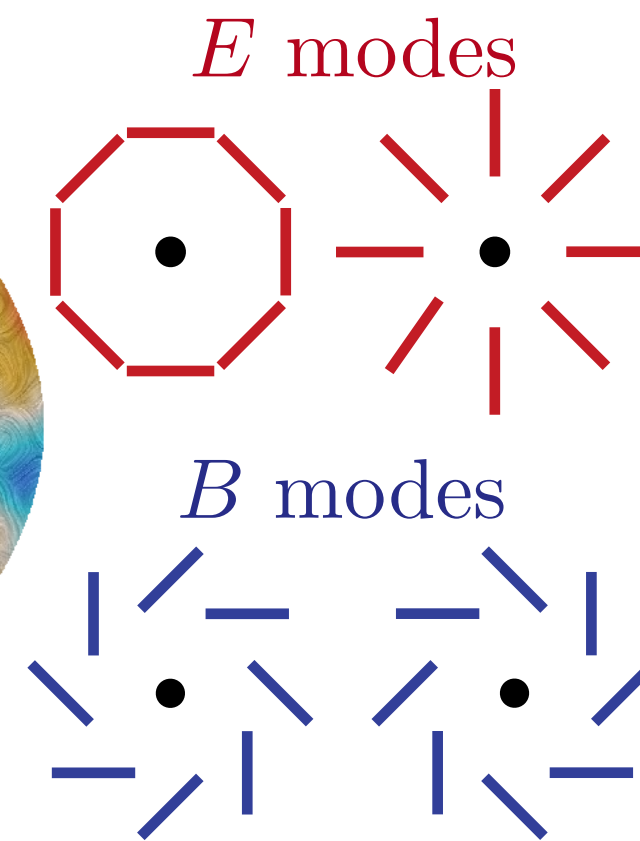
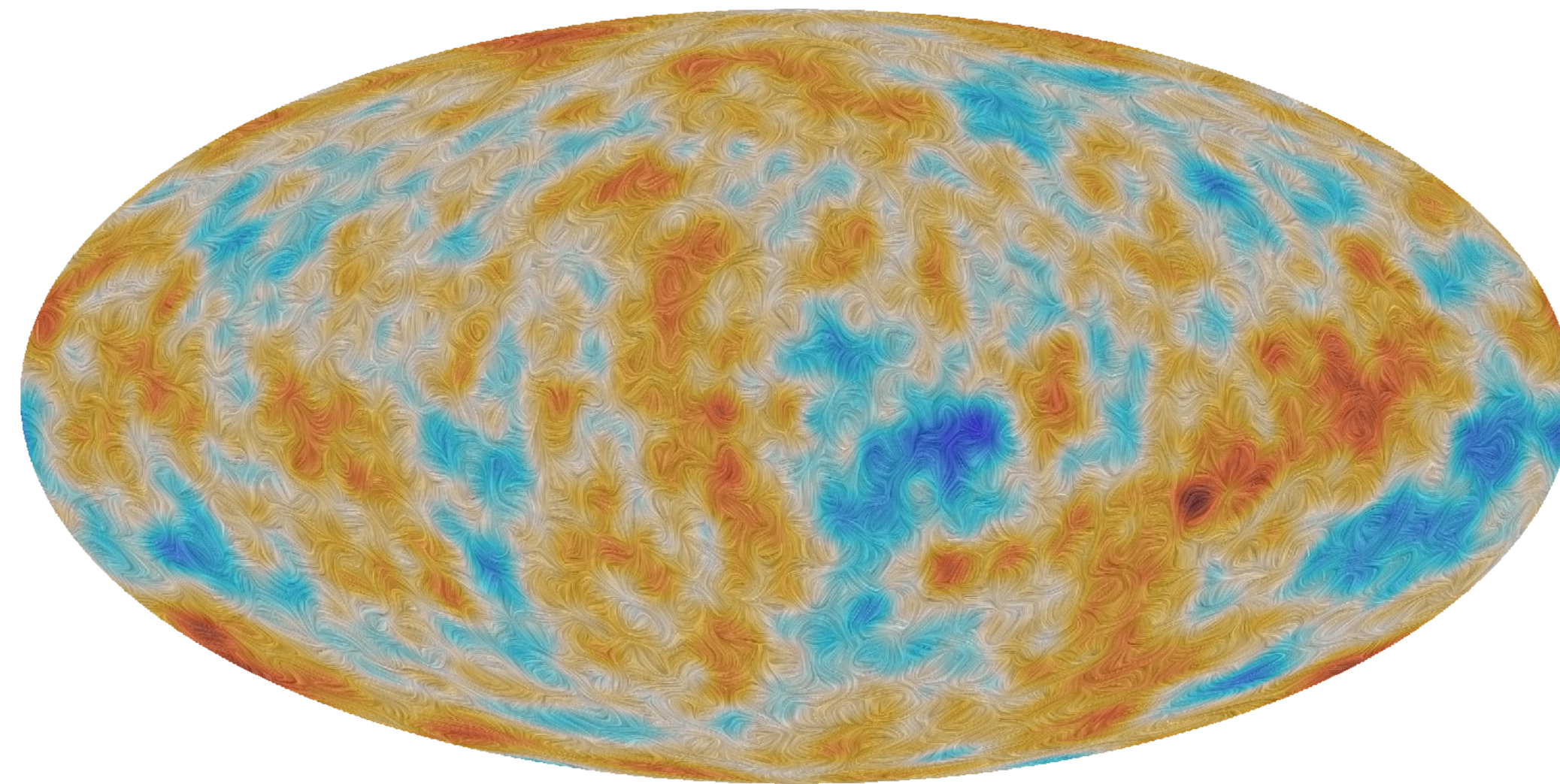
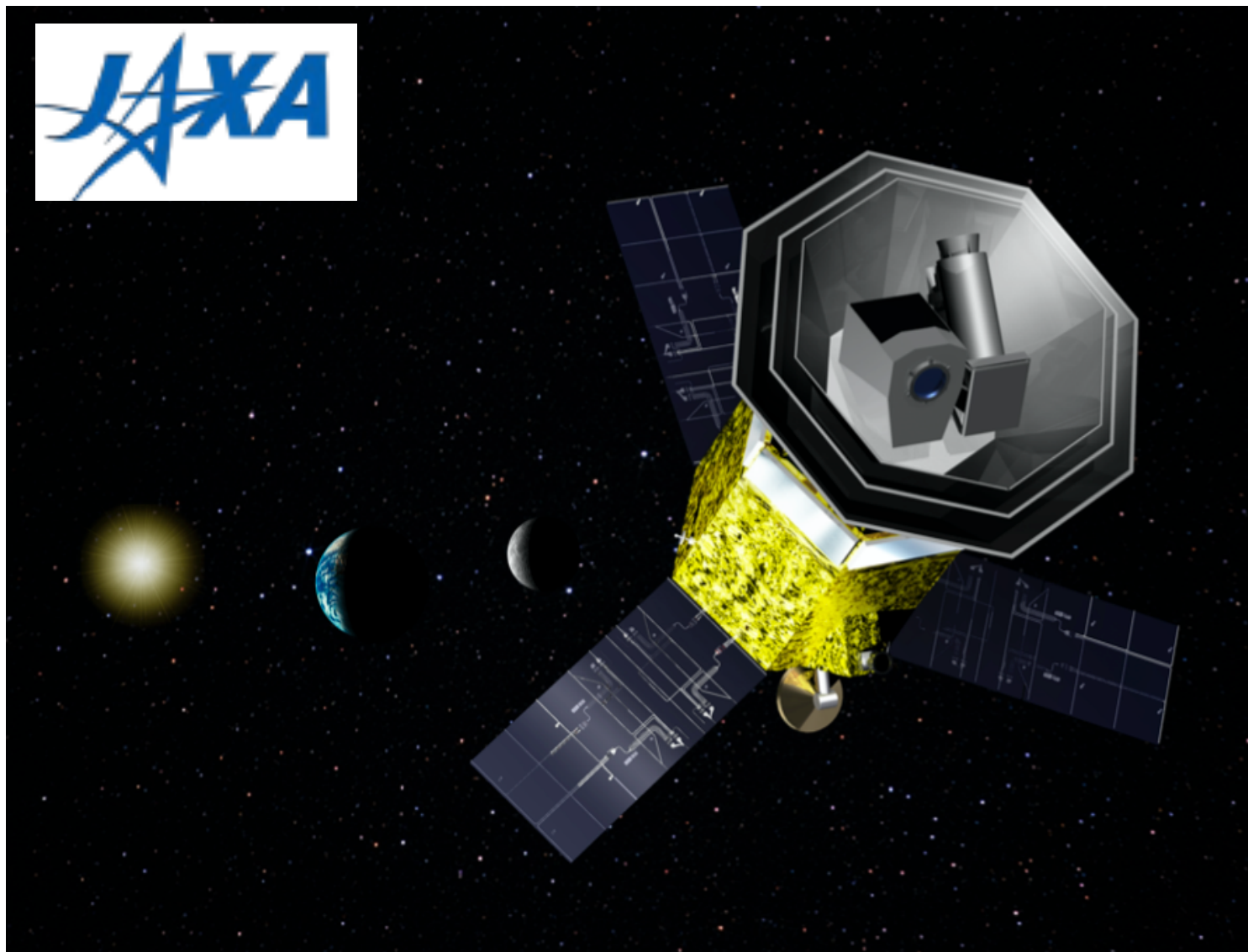


LiteBIRD Mission

LiteBIRD reformation phase

- After the ISAS/JAXA mission definition review, LiteBIRD is under rescope studies to consolidate the mission's feasibility with the same scientific objectives.
- The LiteBIRD collaboration will spend approximately one year (~ late 2025) on the studies of the reformation plan.

LiteBIRD collaboration
PTEP 2023



H3-32L



LiteBIRD reformation phase (in a nutshell)

Why

- Jul 2024: New financial constraints
- Sep 2024: Key Decision Point #1 by JAXA
 - one year Reformation Study

What

- Rescope with same scientific goals
- Broaden the scientific case
- Simplification & consolidation of the design
- Increase feasibility, lower risk
- Within original budget at JAXA
- Need a new procurement for Detection Chain

Reformulation of top-level requirements

1 single telescope (w/ or w/o HWP)

Consolidation detectors procurement

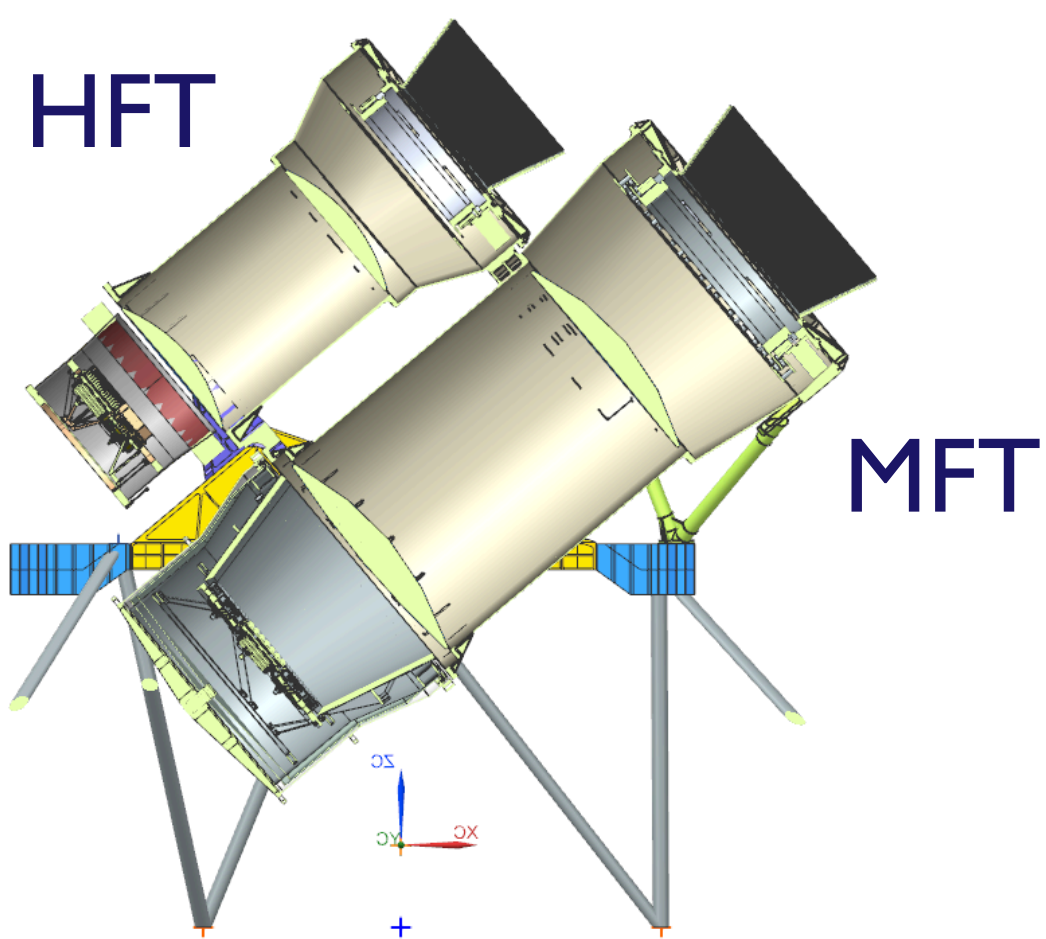
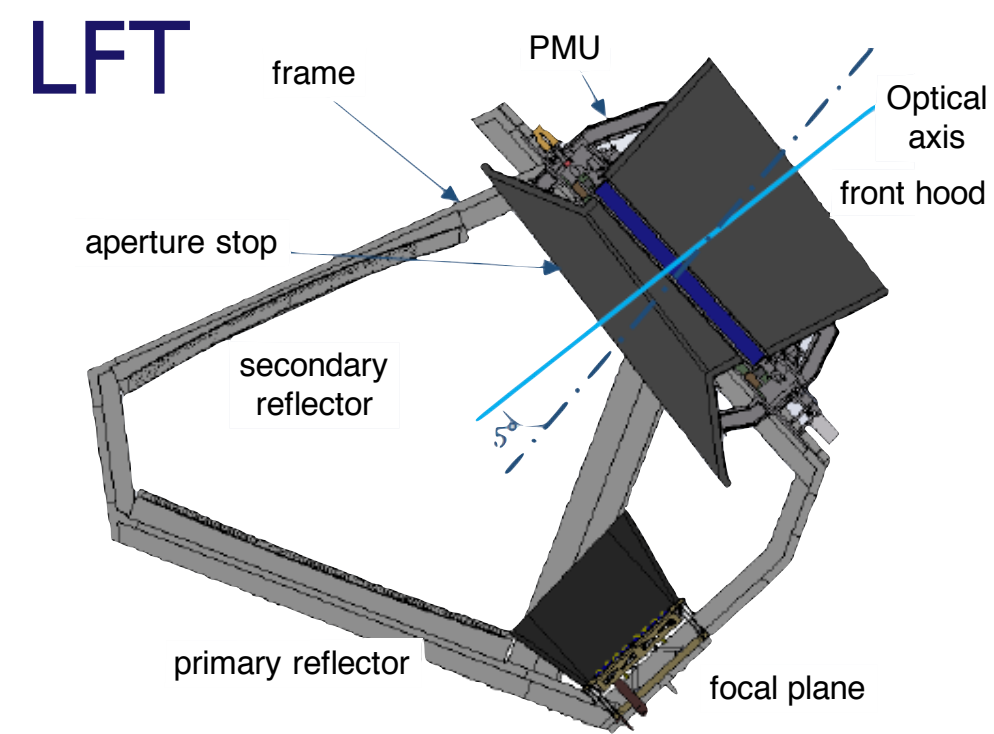
When

- Sep 2025: Key Decision Point #2 by JAXA
- Mid 2026: Mission Definition Review #2 by JAXA

Design Simplification

Optical design

PTEP Baseline



Thanks to
a new HWP design with a very broad frequency range
in Transmission or in Reflexion



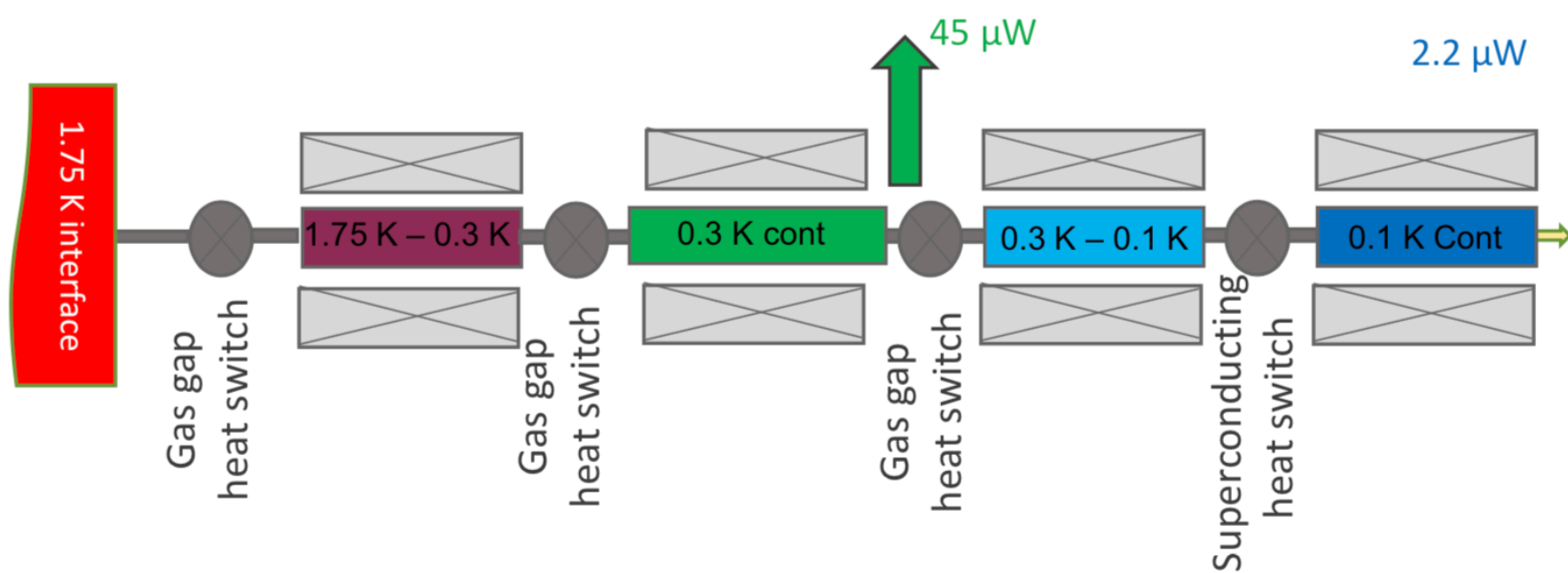
Design Simplification



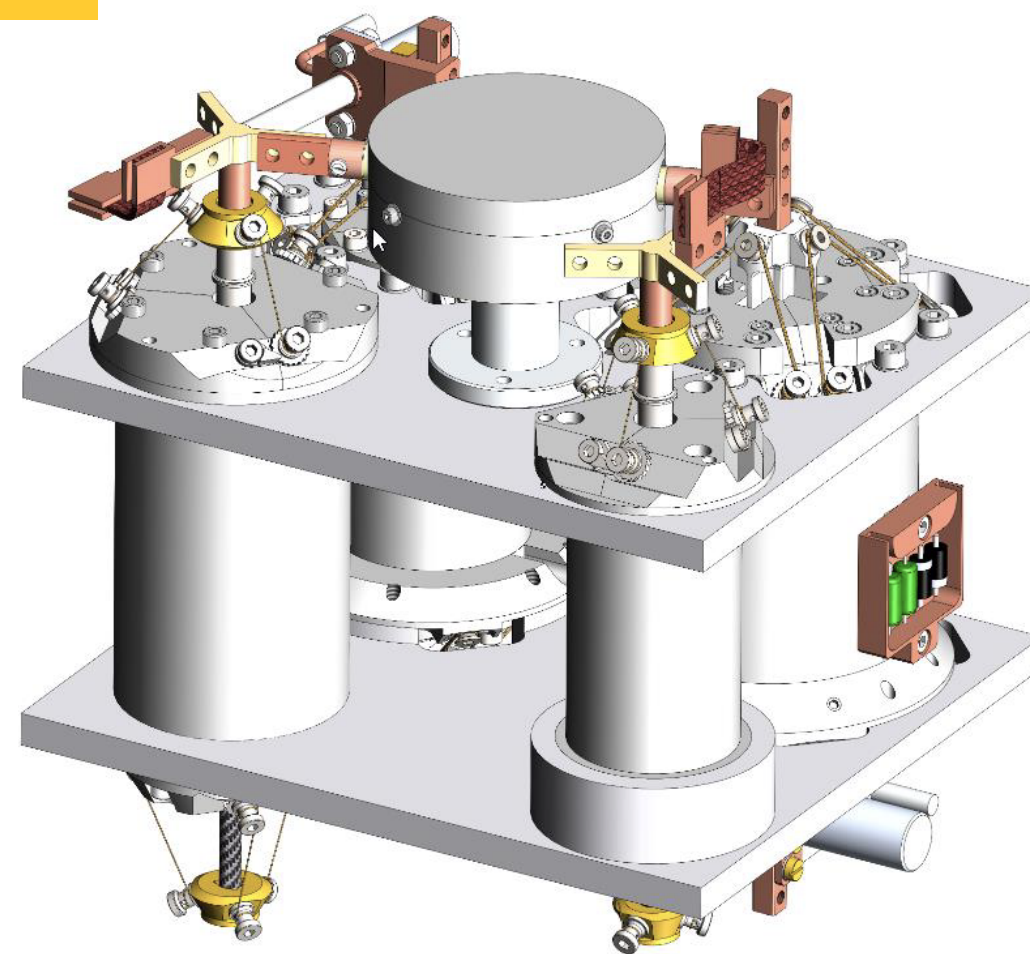
Cryo-chain & Sub-K Cooler

Sub-K Cooler

- Continuous cooling at 100mK
- 4 ADRs in series
- **Single chain for a single FP**

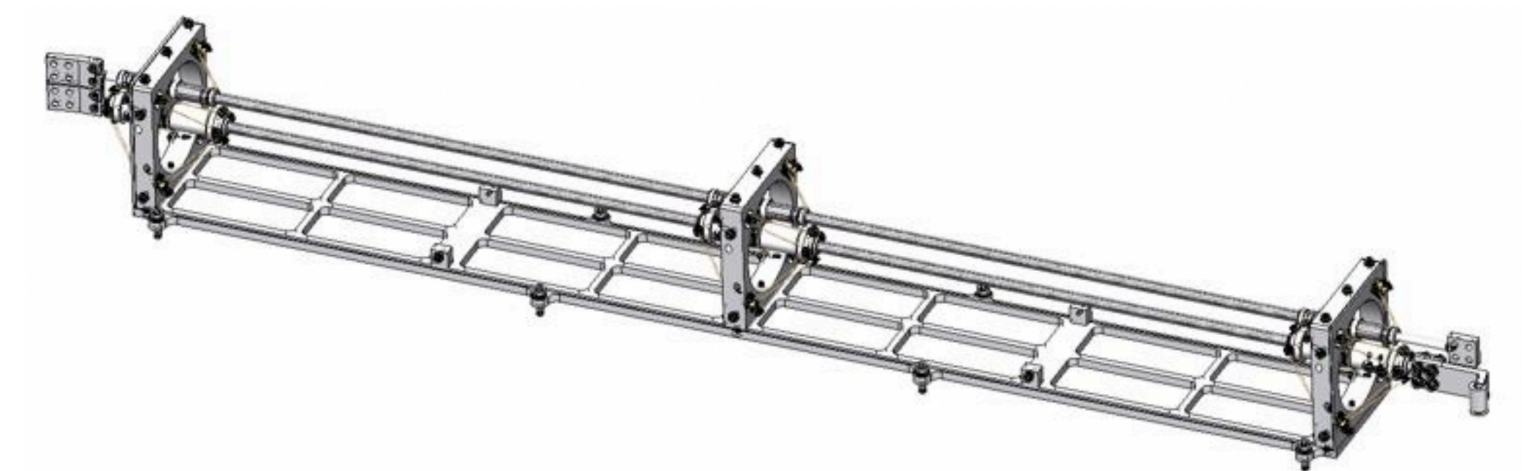
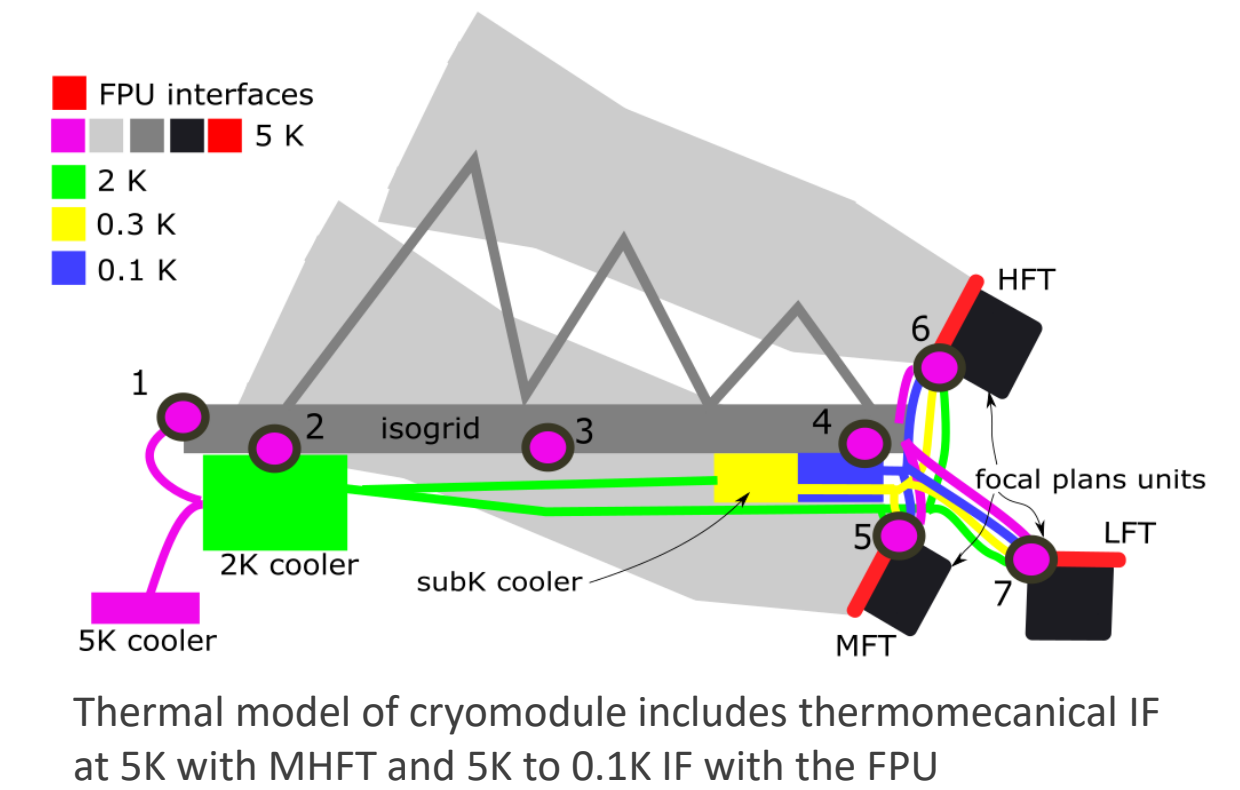


- High maturity
- Concept Demonstration @ 350mK with 2.7K interface



4 hours cycles
2.7 K interface

Thermal links



- Kevlar sustained
- High maturity

A tight action plan !



LMHFT
Project
Office

- Optimisation of new design with a single telescope
- New procurement tree assessment
- Calibration PBS re-discussion
- Consolidation between agencies

TF
Sensitivity
Forecasts

- Comparative analyses of various designs (w/ & w/o HWP)
- Optimisation of FP layout
- Optimisation of number of bands

TF
Requirements

- New recipe for top-level requirements (map-depth based)
- New consolidated Requirements Flow-down

JSG
Systematics

- Revisit the systematics budget allocation
- Simulation effort on key systematics

TF
Detectors
Procurement

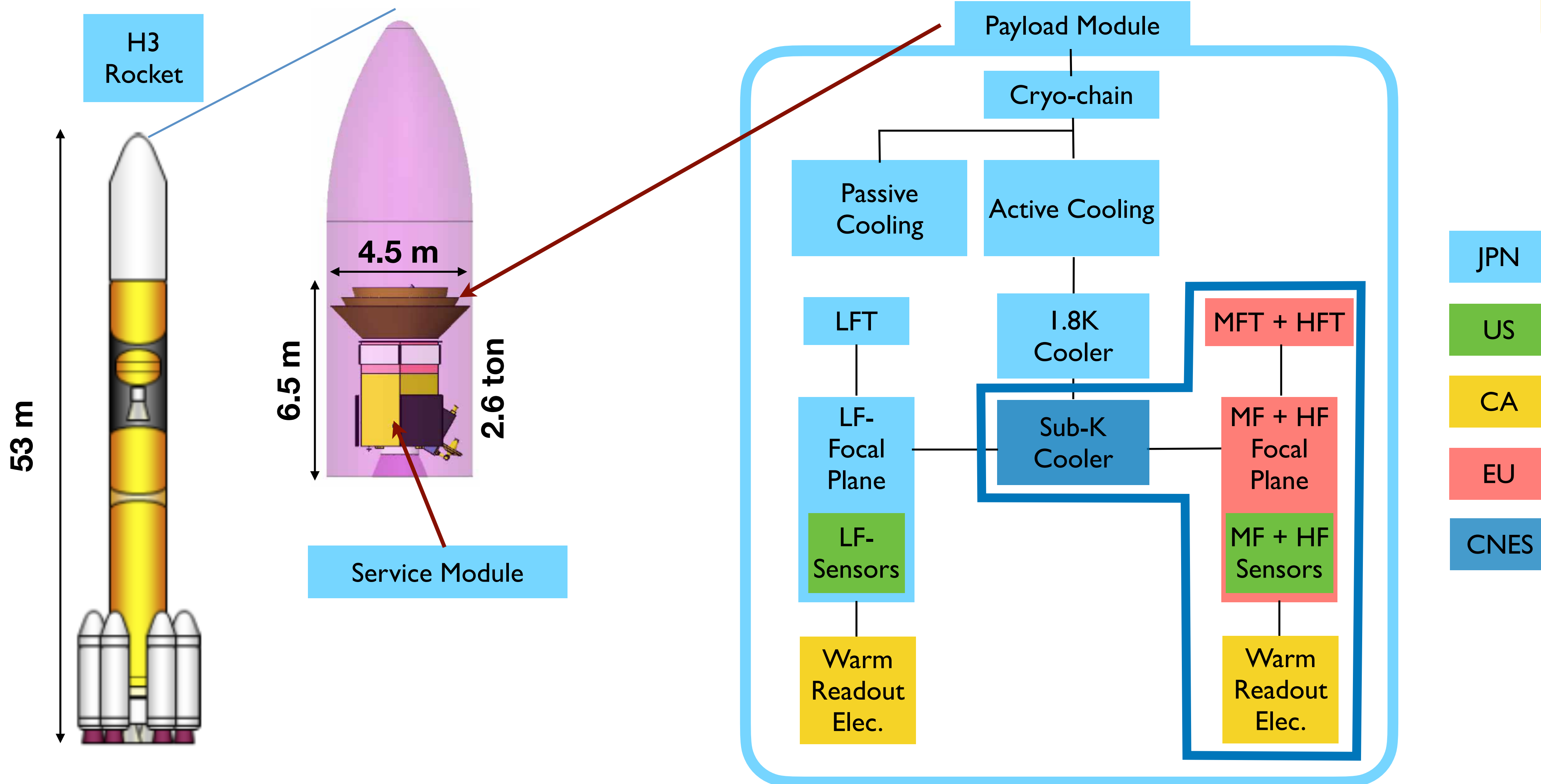
- Detectors Technical trade-off
- Detectors Procurement trade-off
- Costing estimates

Procurement Update: (previous)



Dec 2023

International Task Sharing

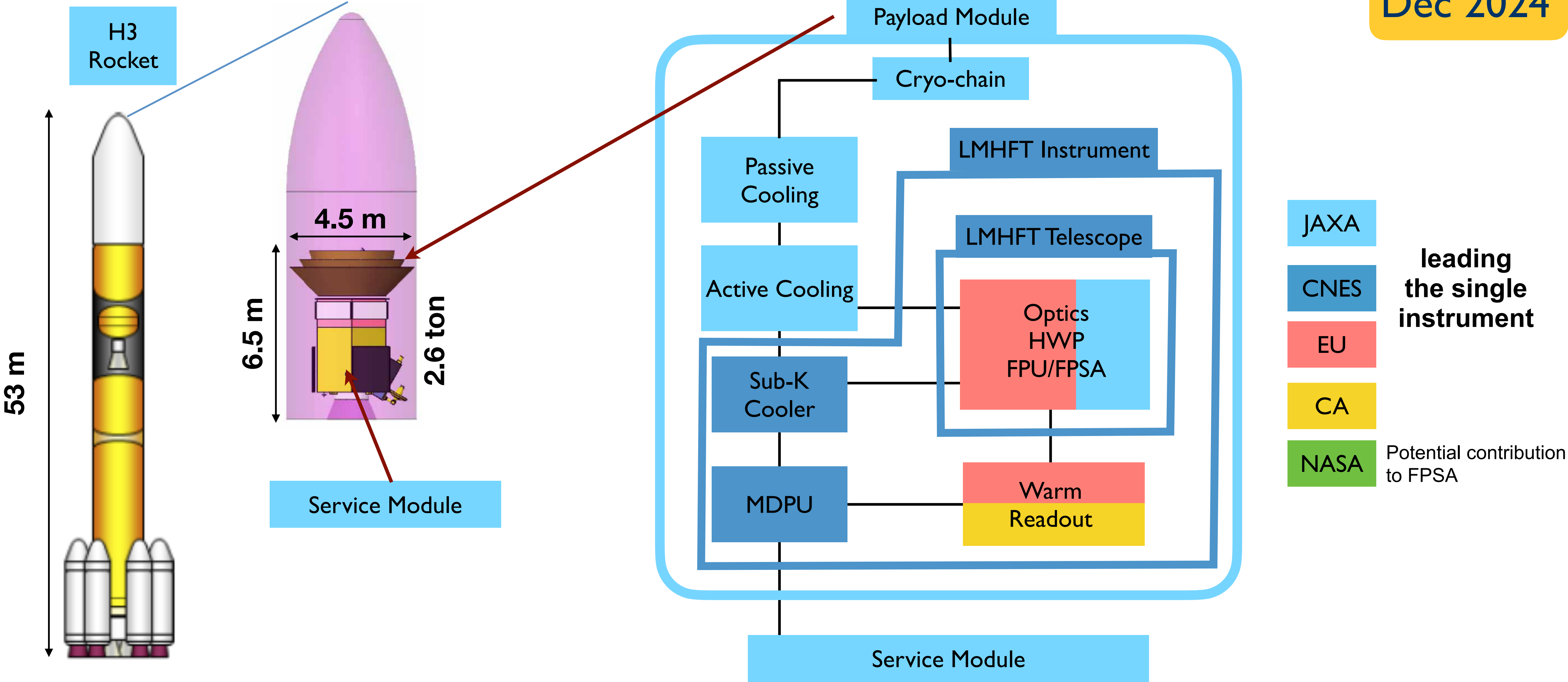


Procurement Update: (under discussion)



Dec 2024

International Task Sharing



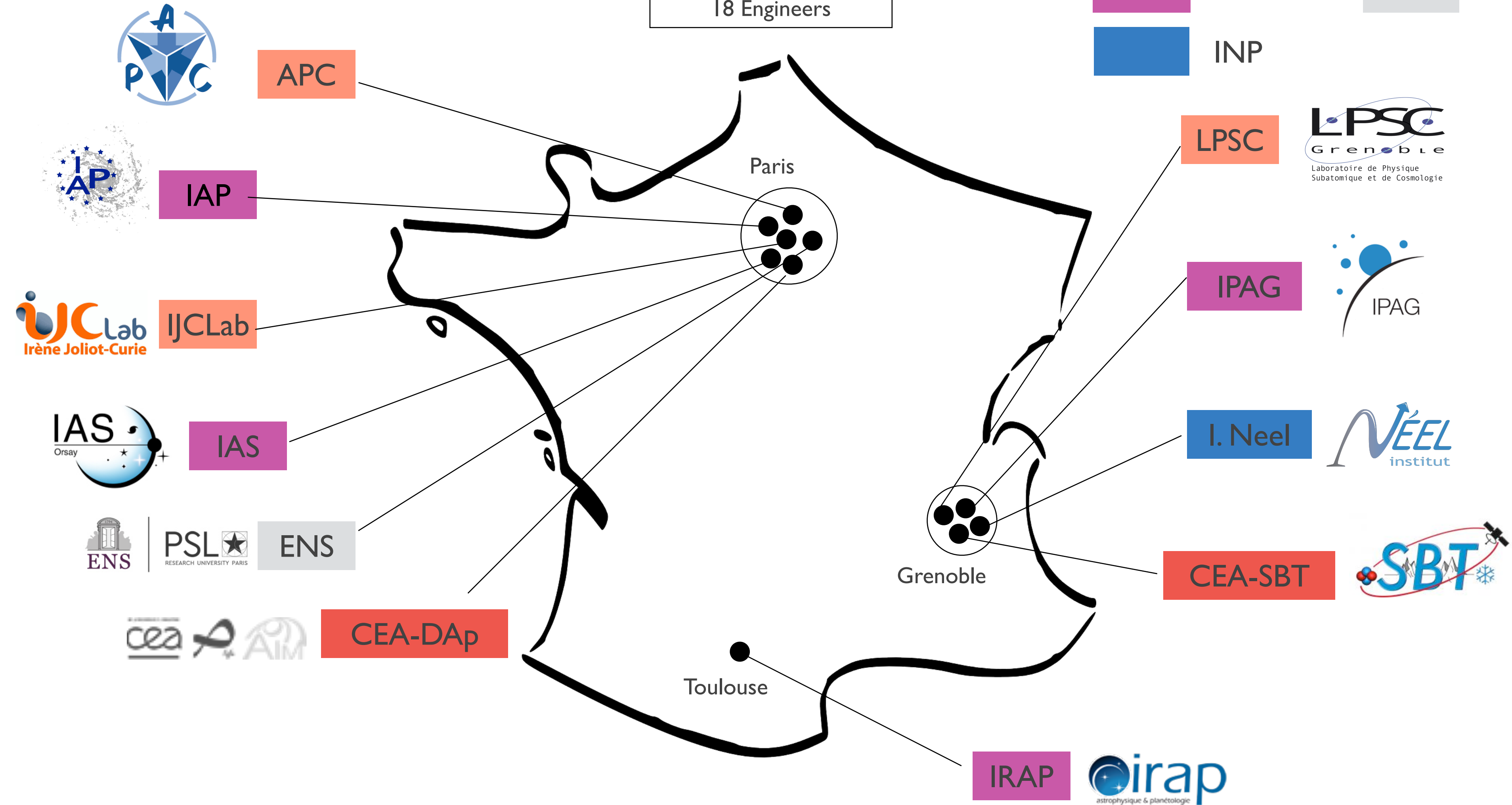
The LiteBIRD Collaboration



LiteBIRD France

37 Scientists
18 Engineers

- IN2P3
- INSU
- INP
- CEA
- ENS



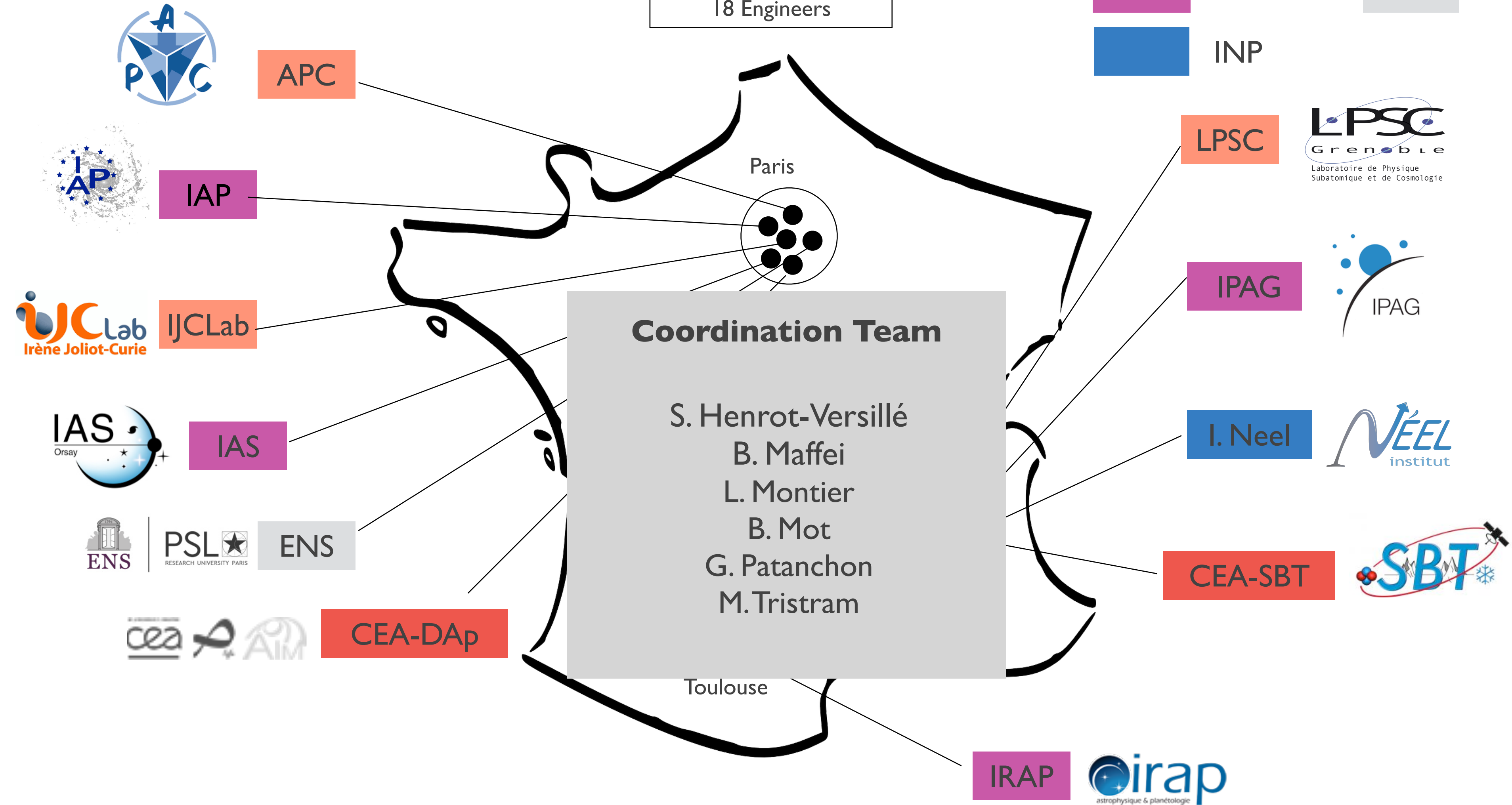
The LiteBIRD Collaboration



LiteBIRD France

37 Scientists
18 Engineers

- IN2P3
- INSU
- INP
- CEA
- ENS





LiteBIRD Collaboration

until Oct 2024

PI: Masashi Hazumi (JPN)
 PI-US: Adrian Lee (LBNL)
 PI-CA: Matt Dobbs (Mc Gill)
PI-EU: Ludovic Montier (IRAP)



Interim Governance Board

40 members
(7 French)

Joint Study Groups

systematics	G. Patanchon (APC) H. Ishino (IPMU) J. Borrill (LBNL)
foregrounds	N. Katayama (Japan) R. Flauger (US) C. Baccigalupi (Europe)
calibration	T. Matsumura (Japan) K. Arnold (US) S. Henrot-Versille (IJClab)
Payload Module	Y. Sekimoto (Japan) K. Thompson (US) B. Mot (IRAP)

Data Management Group

Instrument Model Team	Paolo Natoli (Italy) M. Tristram (IJClab)
Simulation Team	S. Henrot-Versillé
Production Team	M. Tomasi
Map-making, Power-Spectrum, Likelihood algorithms	G. Puglisi

Publication Board

A. Banday (IRAP)
T. Matsumura (Japan)

Liaison:
J. Aumont (IRAP)

Speaker Selection

B. Barreiro (Spain)

Membership Board

M. Hazumi (Japan)
 A. Lee (US)
 E. Calabrese (UK)

Deep involvement of the French community in the LB collaboration and in the management levels

Organisation



LiteBIRD Collaboration

Dec 2024

PI: Tomotake Matsumura (JPN)
 deputy-PI: Hirokazu Ishino (JPN)
EU-SP: Ludovic Montier (IRAP)

 **Interim Governance Board**

40 members
(7 French)

Coordination Team

T. Matsumura (JPN)
 H. Ishino (JPN)
L. Montier (IRAP)
 F. Piacentini (IT)

G. Patanchon (APC)
S. Henrot-Versillé (IJCLab)
A. Bandy (IRAP)
 L. Pagano (IT)
 Y. Chinone (JPN)

Joint Study Groups

Calib + Systematics
G. Patanchon (APC)
 H. Ishino (IPMU)
S. Henrot-Versillé (IJCLab)

Foregrounds
 N. Katayama (Japan)
 R. Flauger (US)
 C. Baccigalupi (Europe)

Data Management Group

Paolo Natoli (Italy)
M. Tristram (IJCLab)

Instrument Model Team

S. Henrot-Versillé

Simulation Team

M. Tomasi

Production Team

G. Puglisi

Map-making, Power-Spectrum, Likelihood algorithms

Y. Chinone

Publication Board

A. Bandy (IRAP)
 T. Matsumura (Japan)

Speaker Selection

Liaison:
J. Aumont (IRAP)

B. Barreiro (Spain)

Membership Board

H. Ishino (JPN)
 A. Lee (US)
 F. Piacentini (IT)

Deep involvement of the French community in the LB collaboration and in the management levels

Programmatic in Europe



Dec 2023

European Collaboration



Committed in Phase-A2 leading the MHFT since 2020

France ✓

APC (Paris)
CEA-DAp (Saclay)
CEA-SBT (Grenoble)
ENS-LERMA (Paris)
IAP (Paris)
IAS (Orsay)
Institut Néel (Grenoble)
IPAG (Grenoble)
IRAP (Toulouse)
IJCLab (Orsay)
LAM (Marseille)
LESIA (Paris)
LPSC (Grenoble)

Italy ✓

Università di Roma "Tor Vergata"
Università di Milano
Sapienza Università di Roma
INAF/IASF, Bologna
INAF/OATS, Trieste
Università di Milano-Bicocca
Università di Genova
INFN-Sezione di Pisa
Università di Ferrara
Università di Padova
SISSA – Trieste

UK ✓

Cardiff University
University of Cambridge
Imperial College London
University of Manchester
University College London
University of Oxford
University of Portsmouth
University of Sussex

Germany ✓

Max Planck Society (MPA, MPE, MPIfR)
Ludwig-Maximilians-Universität München
Universität Bonn
RWTH Aachen Universität

Phase-A commitment:

- France:
 - Phase A I 2018
 - Phase A2 (MHFT leadership) 2020
- Italy: 2018
- Spain: 2021
- Germany: 2022
- Belgium: 2022
- UK 2023
- Poland 2023

Spain ✓

IFCA, IDR/UPM, DICOM/UC
ICCUB, IAC
Universidad de Oviedo
Universidad de Salamanca
Universidad de Granada
CEFCA

Holland

SRON
RuG

Norway

University of Oslo

Sweden

Stockholm University

Ireland

Maynooth

Belgium ✓

CSL
University Louvain

Polland ✓

Copernicus Center

All European Partners
working with CNES toward
Phase-B commitment

~240 scientists, including experts on instrument and data analysis

Programmatic in Europe



Dec 2024

European Collaboration



Committed in Phase-A2 leading the **Single Instrument since Mid-2024**

France ✓

APC (Paris)
CEA-DAP (Saclay)
CEA-SBT (Grenoble)
ENS-LERMA (Paris)
IAP (Paris)
IAS (Orsay)
Institut Néel (Grenoble)
IPAG (Grenoble)
IRAP (Toulouse)
IJCLab (Orsay)
LAM (Marseille)
LESIA (Paris)
LPSC (Grenoble)

Italy ✓

Università di Roma "Tor Vergata"
Università di Milano
Sapienza Università di Roma
INAF/IASF, Bologna
INAF/OATS, Trieste
Università di Milano-Bicocca
Università di Genova
INFN-Sezione di Pisa
Università di Ferrara
Università di Padova
SISSA – Trieste

UK ✓

Cardiff University
University of Cambridge
Imperial College London
University of Manchester
University College London
University of Oxford
University of Portsmouth
University of Sussex

Germany ✓

Max Planck Society (MPA, MPE, MPIfR)
Ludwig-Maximilians-Universität München
Universität Bonn
RWTH Aachen Universität

Phase-A commitment:

- France:
 - Phase A I 2018
 - Phase A2 (MHFT leadership) 2020
- Italy: 2018
- Spain: 2021
- Germany: 2022
- Belgium: 2022
- UK 2023
- Poland 2023

Spain ✓

IFCA, IDR/UPM, DICOM/UC
ICCUB, IAC
Universidad de Oviedo
Universidad de Salamanca
Universidad de Granada
CEFCA

Holland

SRON
RuG

Norway

University of Oslo

Sweden

Stockholm University

Ireland

Maynooth

Belgium ✓

CSL
University Louvain

Polland ✗

Copernicus Center

All European Partners
working with CNES inside
the Reformation Plan

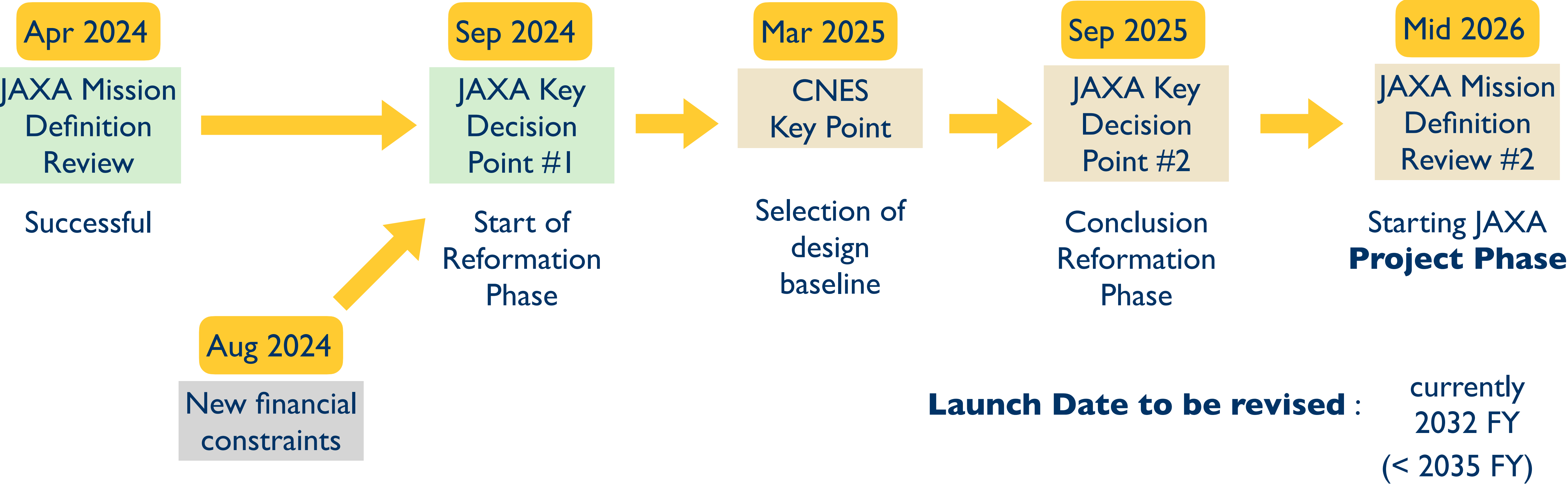
~240 scientists, including experts on instrument and data analysis

Programmatic in Japan



Toward the JAXA LiteBIRD Project Phase

Dec 2024



The Science Study Groups

A new set of Science Study Groups dedicated to science forecast with LiteBIRD.
Short term goal (1-2 years)

9 Scientific Forecasts Groups

- LiteBIRD: Isotropy and Statistics A. Banday
- LiteBIRD: Tests of Cosmic Inflation
- LiteBIRD: Optical Depth, Reionization of the Universe, and Neutrino Masses M. Tristram
- LiteBIRD: Cosmic Birefringence J. Errard
- LiteBIRD: Mapping the Hot Gas in the Universe (cf M. Remazeilles talk)
- LiteBIRD: Primordial Magnetic Fields
- LiteBIRD: Gravitational Lensing of the CMB
- LiteBIRD: Cross-correlation Science
- LiteBIRD: E-modes

Galactic Science Project Study (GSPS) J. Aumont

- 3D Galaxy
- Dust Properties / AME
- Foreground Separation techniques for Galactic Science



- 48 published papers
- 3 post-PTEP to be published
- 7 post-PTEP in prep.
- 36 other papers in prep.



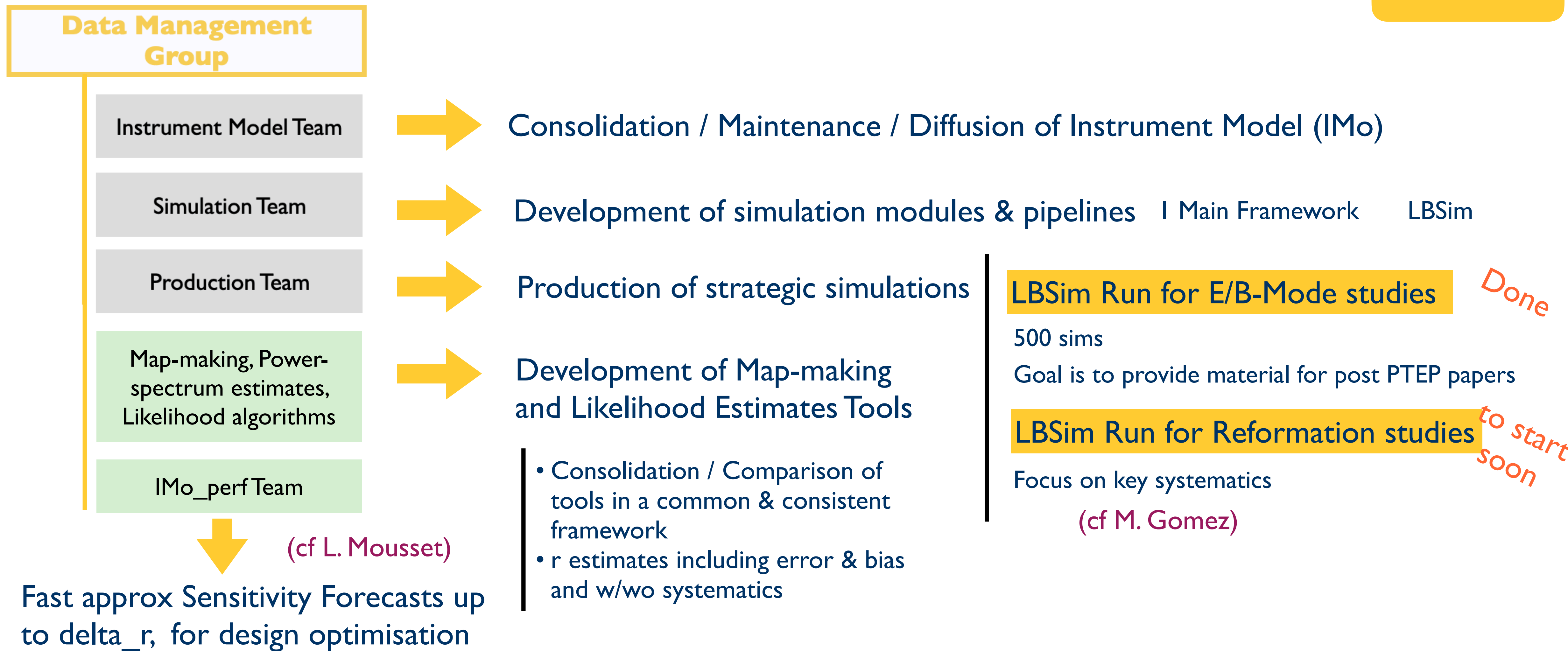
MoU between
CMB-S4 and LiteBIRD

Science Forecast Activity is increasing
We have to put more resources on this

Opportunity to include new members on
dedicated forecast activities

Simulation Pipeline Development / Production Effort

Dec 2024



The Science Ground Segment

Dec 2024

Task-Force SGS #1

Done

- Prepare a document summarizing information and discussion at past LiteBIRD IGB meetings and global meetings on science ground segments (SGSs) and related collaboration governance.
- Identify differences between projects led by Europe, Japan, and the US.
- Study possible LiteBIRD SGS configurations(1). Evaluate, compare, and score them(2).

Task-Force SGS #2

New

- Triggered by JAXA
- Members: representatives of partner agencies
- Tasks:
 - ◆ SGS role and scope
 - ◆ Build a WBS
 - ◆ Estimate of computing / human resources
 - ◆ Basic organisational structure
 - ◆ Data Management Plan

France:

- Laurence Chaoule (CNES SGS director)
- Matthieu Tristram

Report expected by Jul 2025

SGS to be included into global task-sharing

Take-away Message

Strong activity on the Reformation Plan

- ➔ Reformation Plan since Sep 2024 up to Sep 2025
- ➔ Design Simplification with increased feasibility
 - | Same scientific goals
 - | Strong commitment of CNES into single instrument lead
- ➔ Preparation of Science Exploitation still been reinforced: Science Study groups / papers / SGS / Simulations
- ➔ Strong support from Séminaire de Prospective Scientifique du CNES 2024
- ➔ Next Steps:

Mar 2025	Sep 2025	end 2025	Mid 2026	Launch date to be updated : currently 2032 FY (< 2035)
CNES KP	JAXA KDP#2	CNES Phase-A2 Review	JAXA MDR#2	

