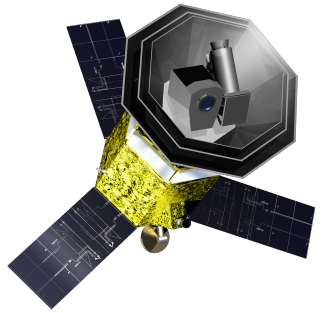
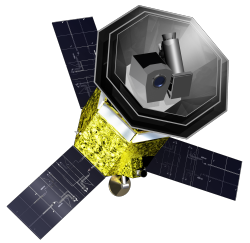


LiteBIRD – CMB B-mode satellite mission

(a quick overview with a European slant)

R.Stompor (APC) on behalf of the
LiteBIRD Joint Study Group

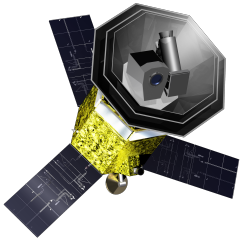
What is LiteBIRD ?

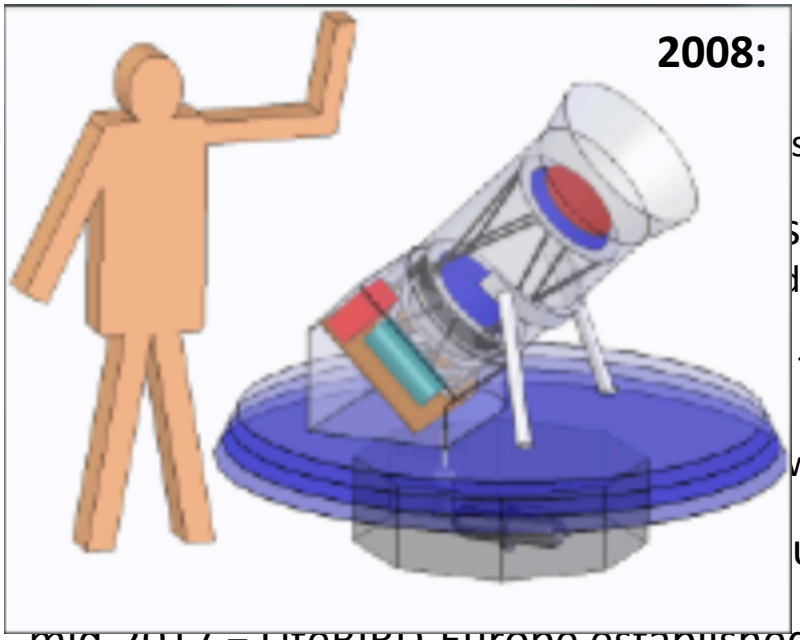


- A focused satellite mission aiming at high precision, reliable detection of the primordial B-mode polarization with a precision δr (total uncertainty) < 0.001 (for r=0)

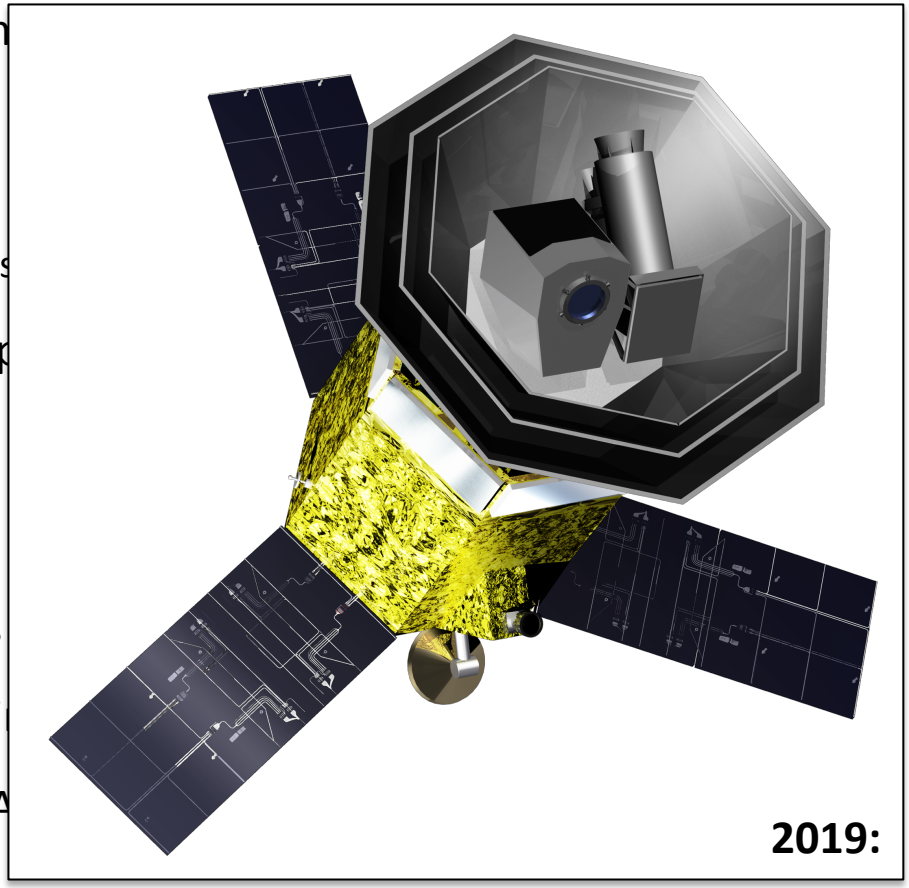
- An international, Japan-led (PI: Masashi Hazumi, KEK/IPMU) collaboration of ~200 researchers from 12 countries (3 continents) working to making this happen.

(Selective) history/status

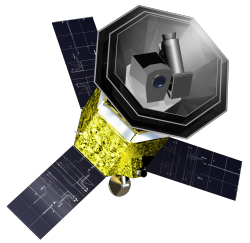




- shed;
- subn
  d;
- the
- wn as
- urop
- mid-2017 − LiteBIRD-Europe established;
  - first meeting in Cardiff, UK, Aug 2-4;
- mid-2018 − ESA-JAXA CDF study;
  - LiteBIRD-Europe collaboration representatives
- mid/fall - 2018 − selection for the phase A i
- May 2019 − LiteBIRD downselected by JAXA
  2027.

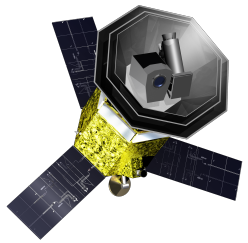


LiteBIRD globally



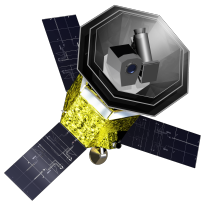
- ~200 members;
- 12 countries;
- 3 continents;
- Governed by Interim Governance Board (IGB) coordinated by 4 PIs (M. Hazumi, A. Lee, L. Montier, M. Dobbs);
- Organized in 5 Joint Study Groups.
- BTW. lots of info about LiteBIRD in the proceedings of the LTD conference in Milano this year …

LiteBIRD in Europe



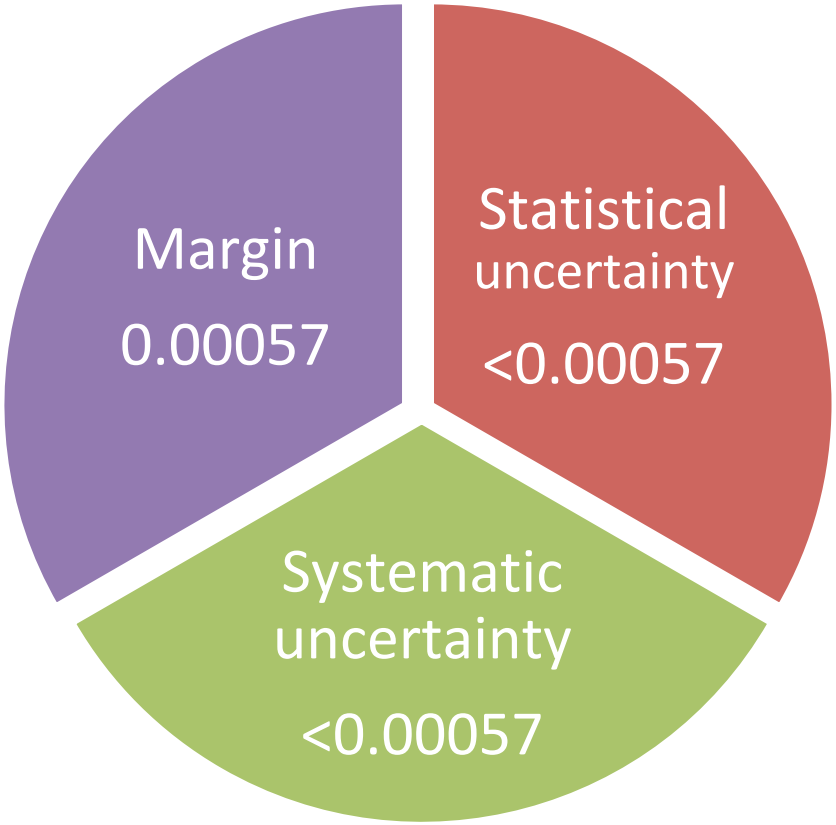
- ~100 people;
- 9 countries (France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, UK);
- Coordinated by 11-person Steering Committee made of national representatives;
  - Spokespeople: L. Montier, E. Calabrese;
  - Chair: P. Natoli.

Science goal



Full Success :
- $\delta r < 1 \times 10^{-3}$ (for r=0)
- $>5\sigma$ observation for each bump (for $r \geq 0.01$)

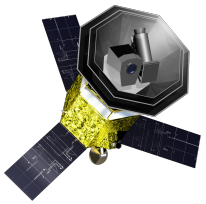
δr : Total uncertainty



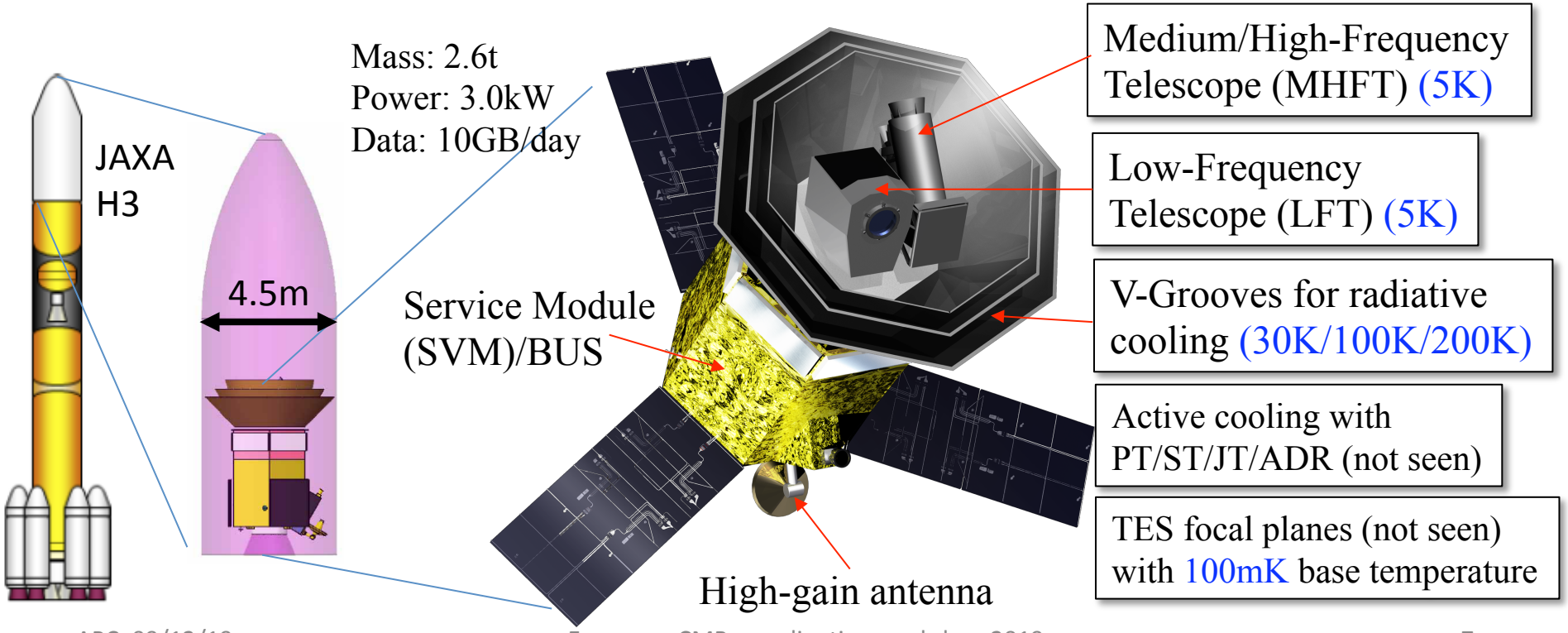
Statistical uncertainty includes
- foreground cleaning residuals
- lensing B-mode power
- 1/f noise

Systematic uncertainty includes
- Bias from 1/f noise
- Polarization efficiency & knowledge
- Disturbance to instrument
- Off-boresight pick up
- Calibration accuracy

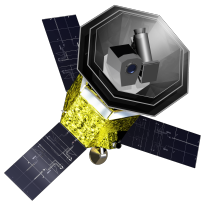
LiteBIRD - the basics



- JAXA's L-class mission (selected in May 2019)
- Expected launch in 2027 with JAXA's H3 rocket.
- Observations for 3 years (baseline) around Sun-Earth Lagrangian point L2.
- Millimeter-wave all sky surveys (34–448 GHz, 15 bands) at 70–20 arcmin.

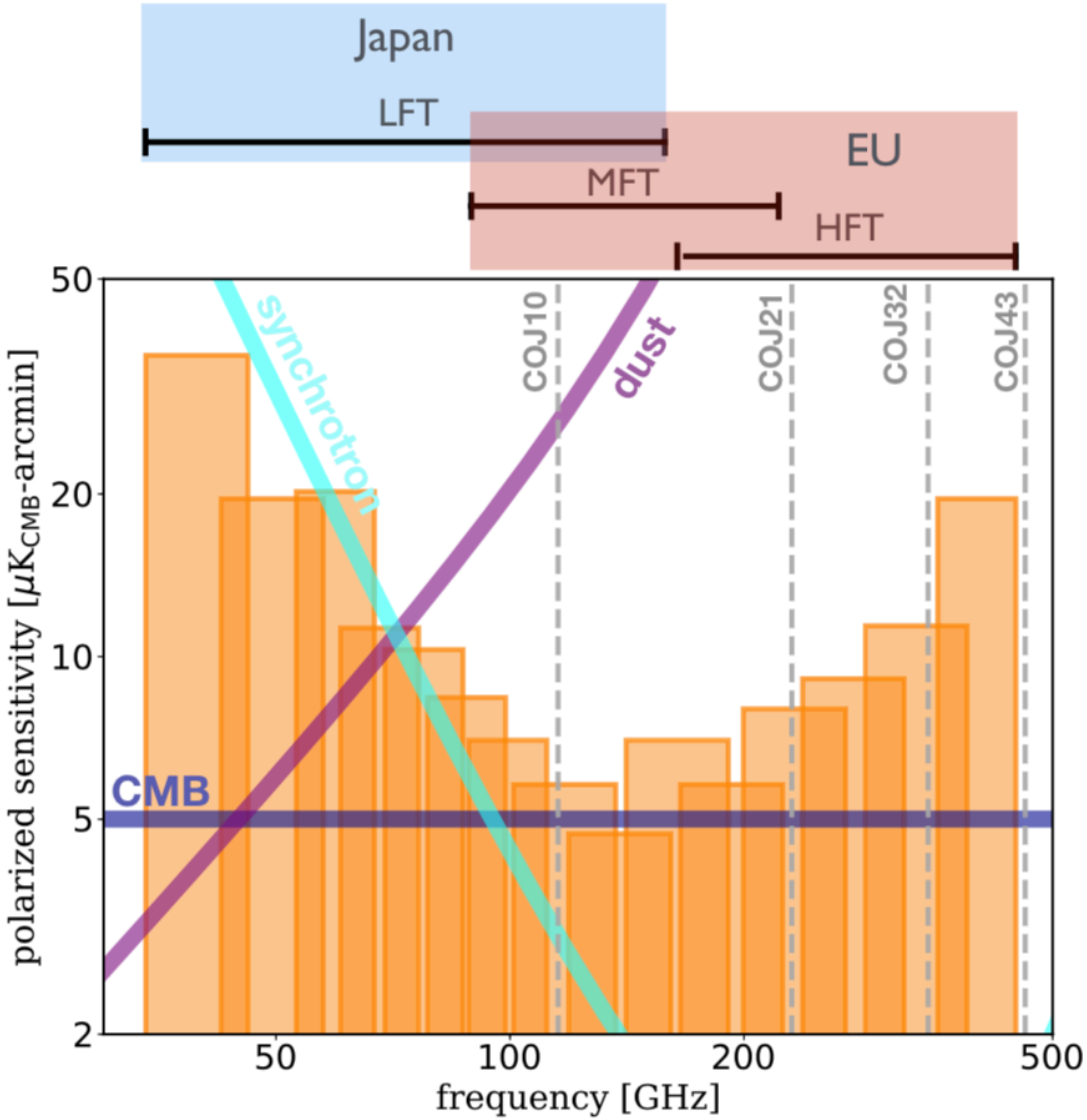


Frequency coverage and sensitivity



15 bands
from 34GHz
to 448GHz

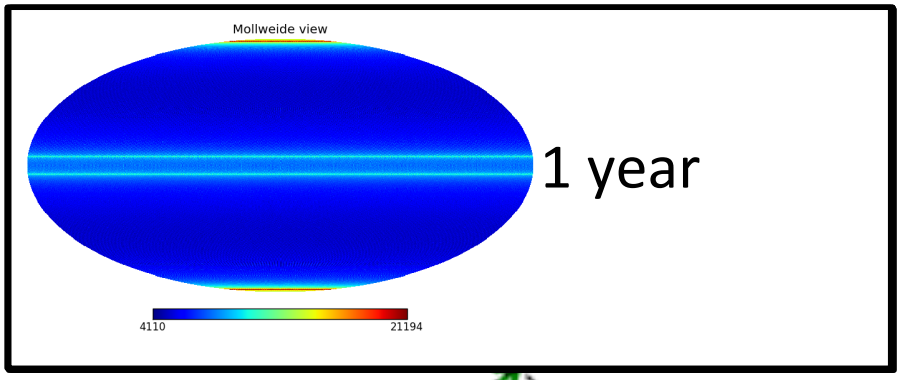
+4600
detectors



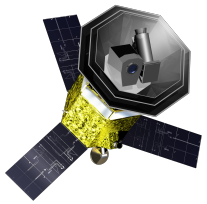
9 bands LFT
5 bands x 2 MHFT
+
4 bands
overlapping

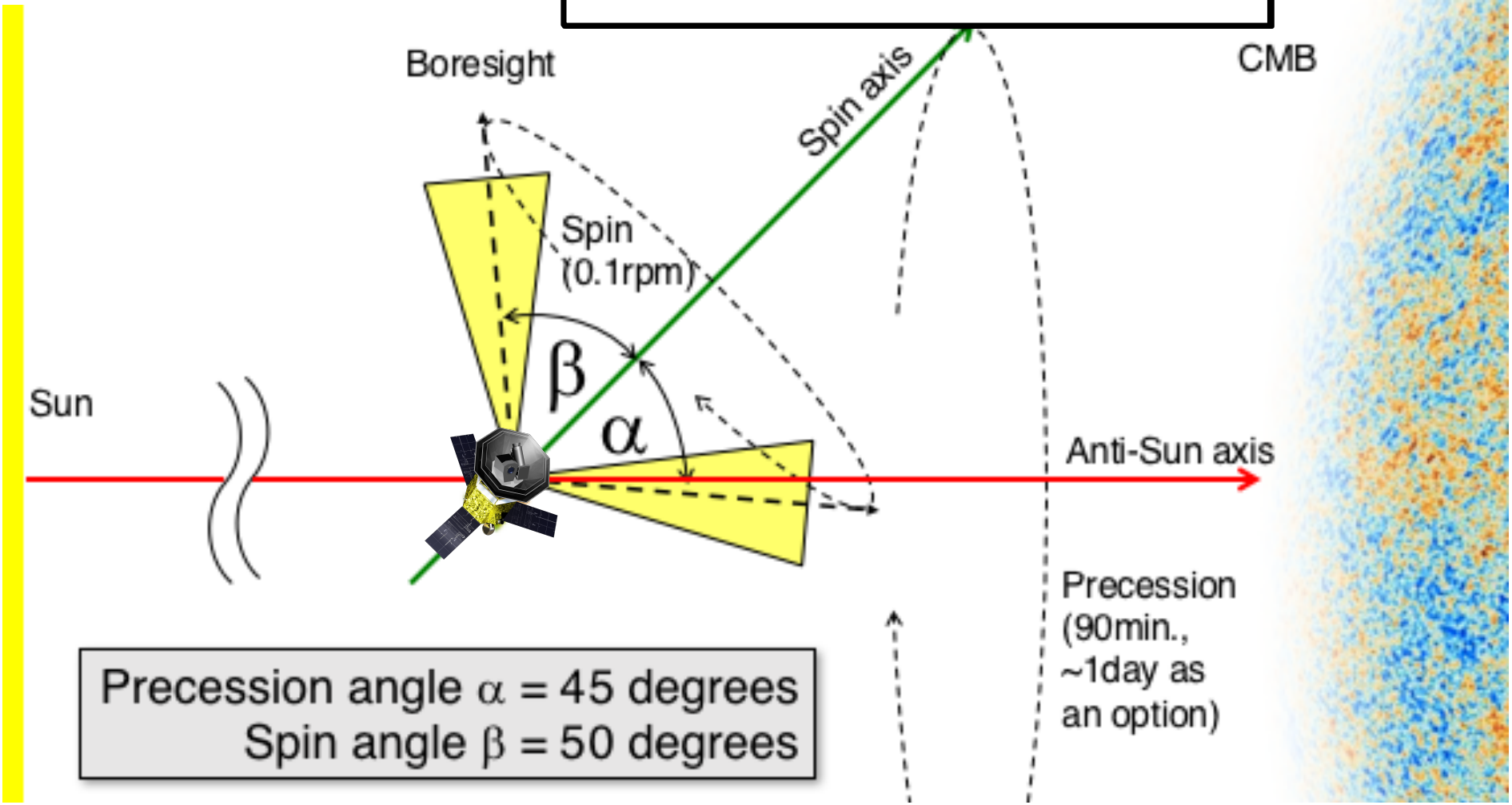
Operation

Orbit:
Sun-Earth L2 Lissajous

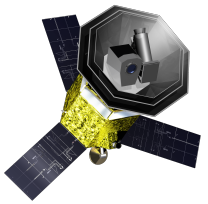


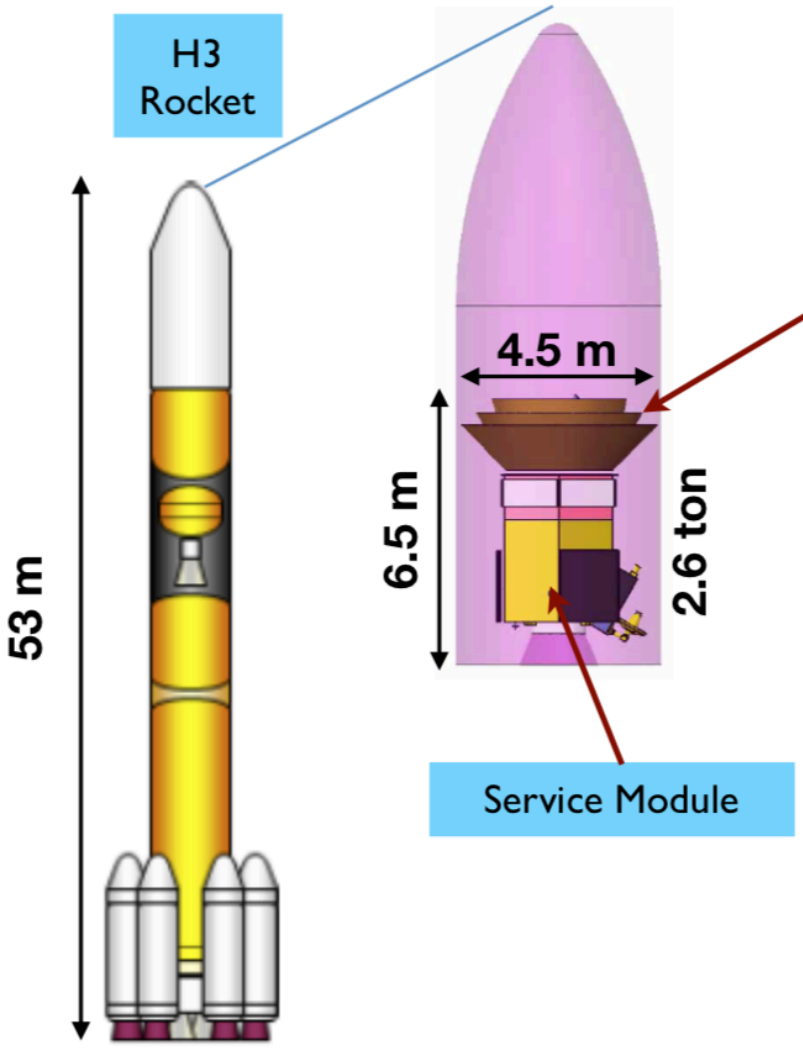
1 year

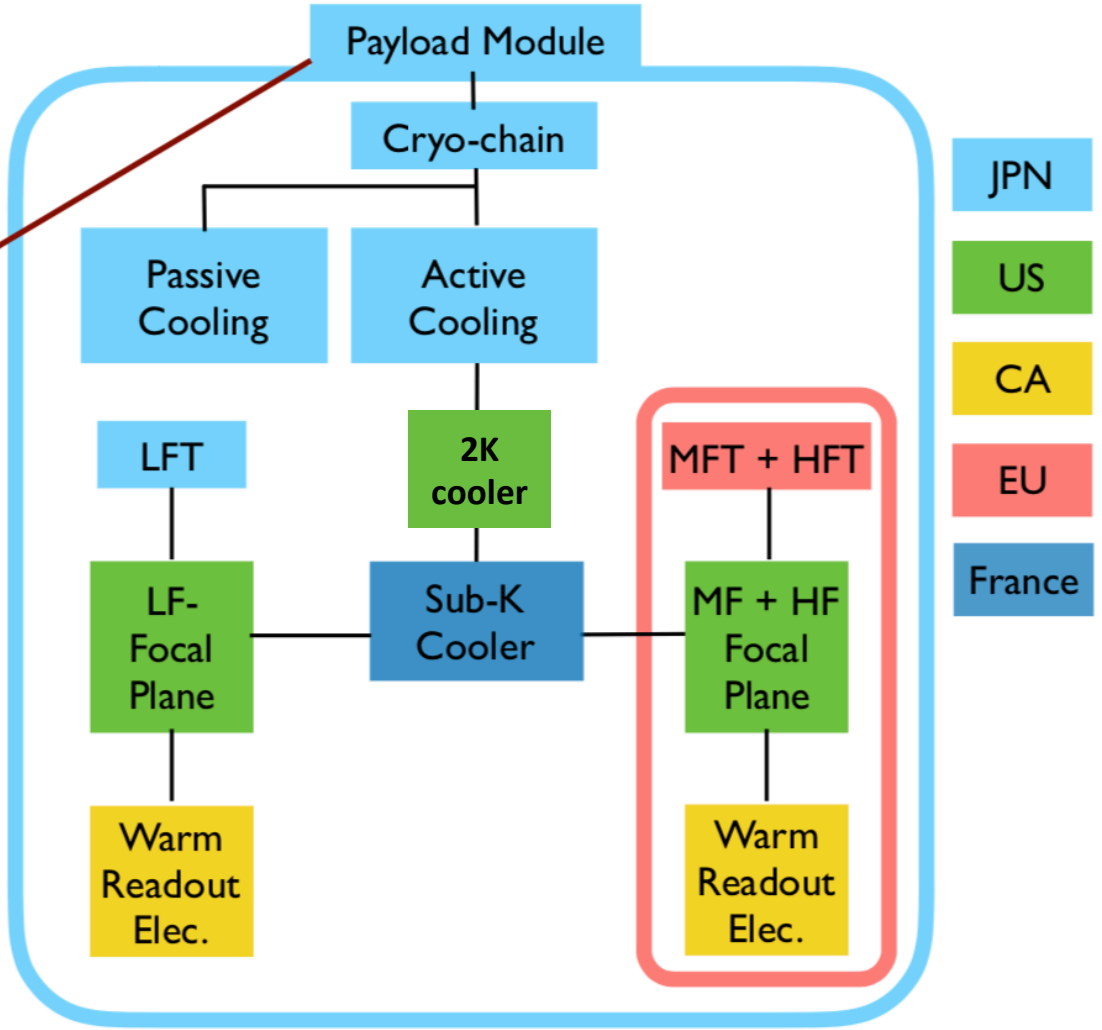




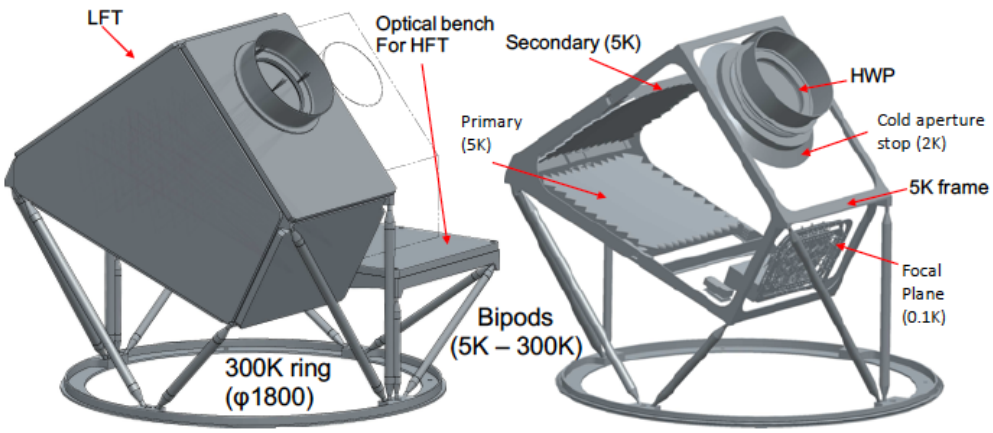
Payload




H3
Rocket
53 m
4.5 m
6.5 m
2.6 ton
Service Module

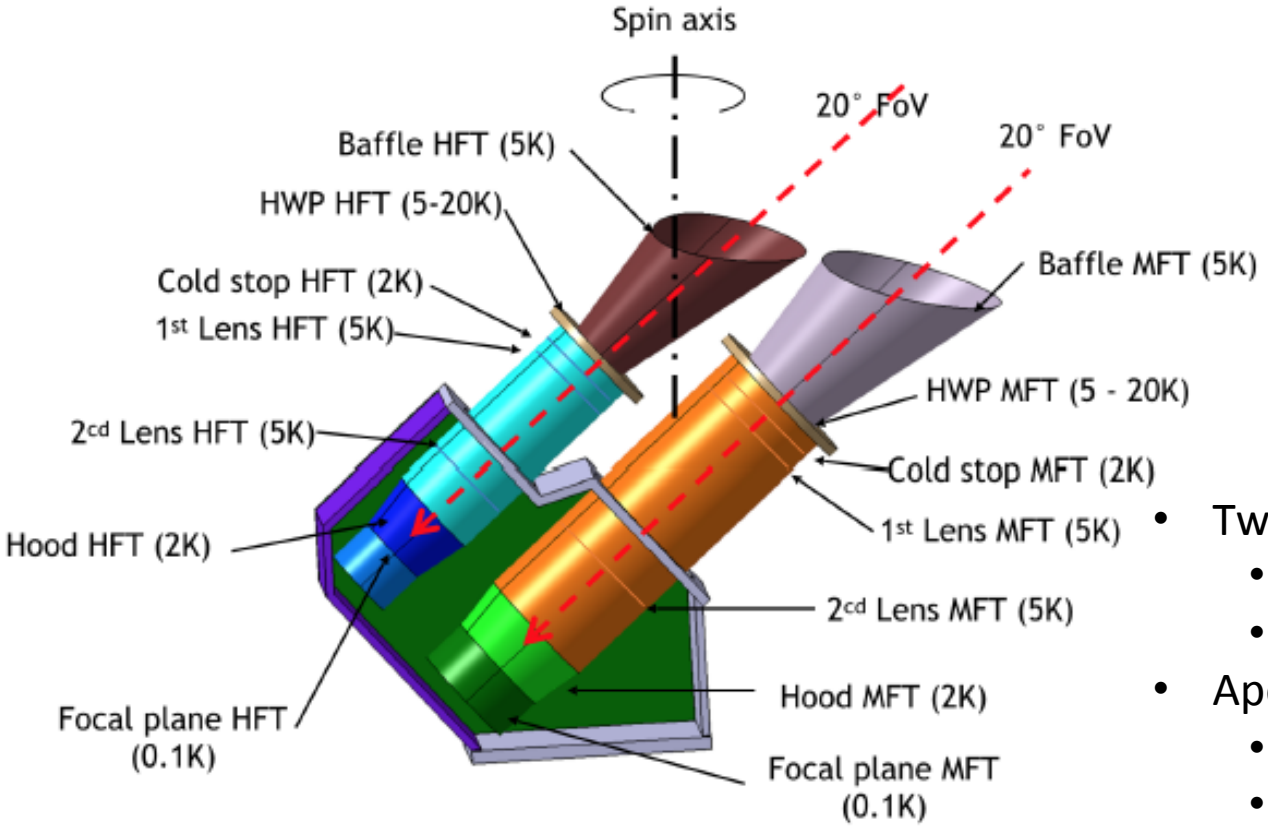

Payload Module
Cryo-chain
Passive Cooling
Active Cooling
LFT
2K cooler
MFT + HFT
LF-Focal Plane
Sub-K Cooler
MF + HF Focal Plane
Warm Readout Elec.
Warm Readout Elec.
JPN
US
CA
EU
France

Telescopes: LFT (Japan)



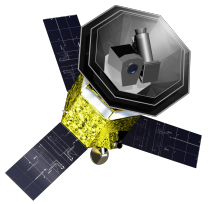
- Crossed Dragone
- Aperture diameter: 400 mm
- Angular resolution: 20 – 70 arcmin.
- Freq. coverage: 34 - 161GHz
- Field of view: 20 deg x 10 deg
- F#3.0 & crossed angle of 90 degree
- All 5K parts are made of Aluminum ➔ less than 150 kg
- New mirror design (anamorphic aspherical surfaces)

Telescopes: MHFT (Europe)

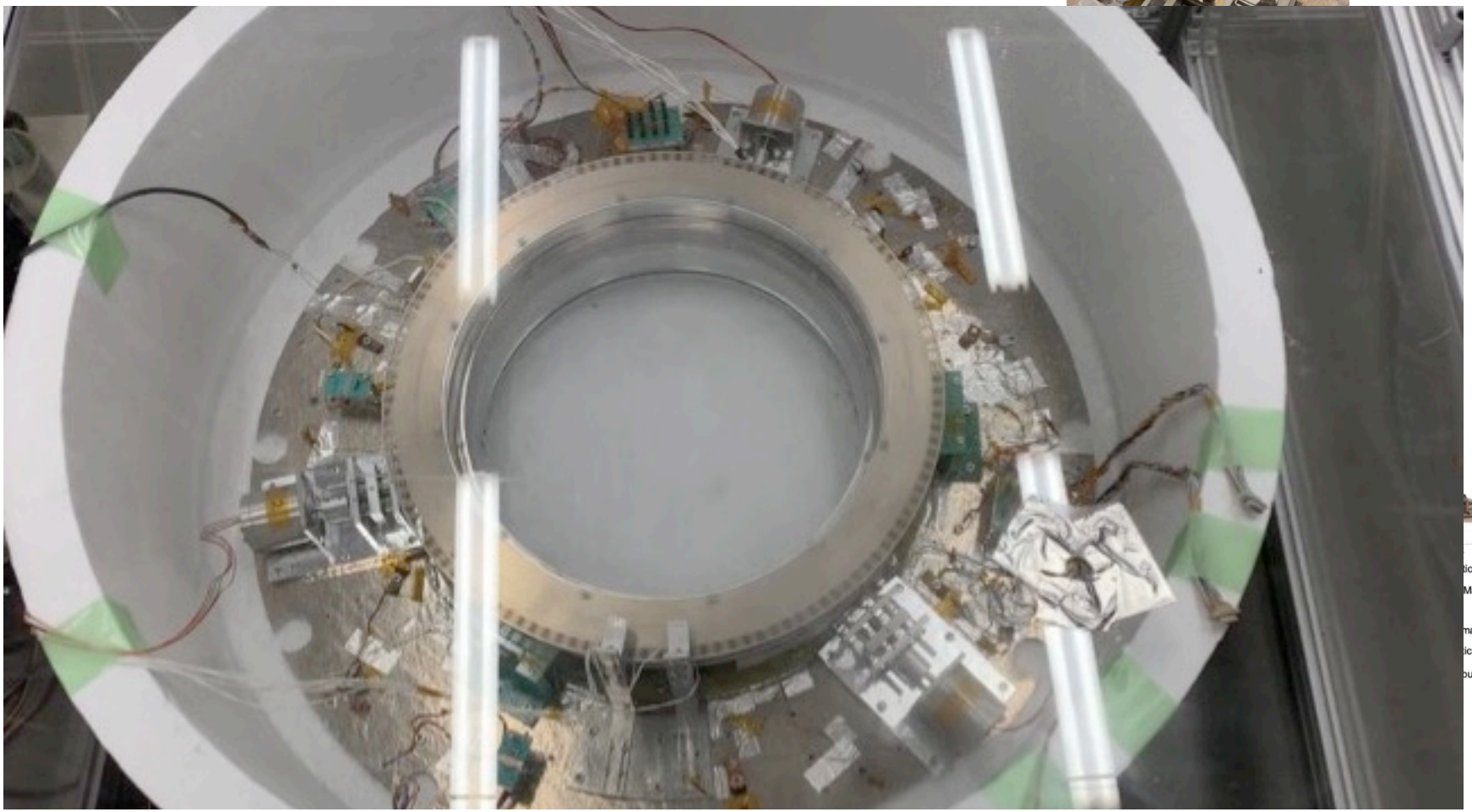


- Two F/2.3 refractive telescopes:
  - 89-270 GHz
  - 238-448 GHz
- Apertures:
  - 30mm
  - 20mm
- FoV:
  - Φ 20mm
- Transmissive metal-mesh HWP
- Silicon lenses

Continuous polarization modulator (1)



LFT: Φ 40mm , 46-83rpm

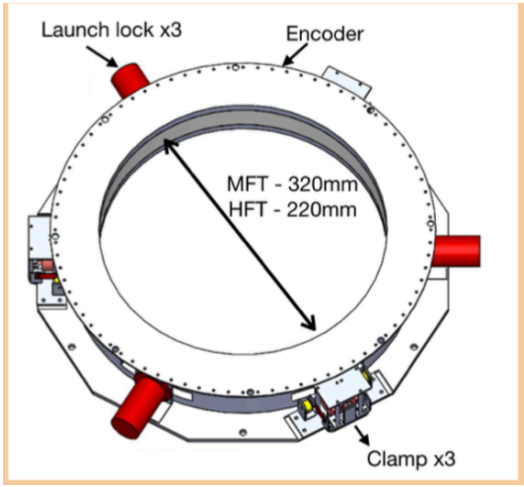


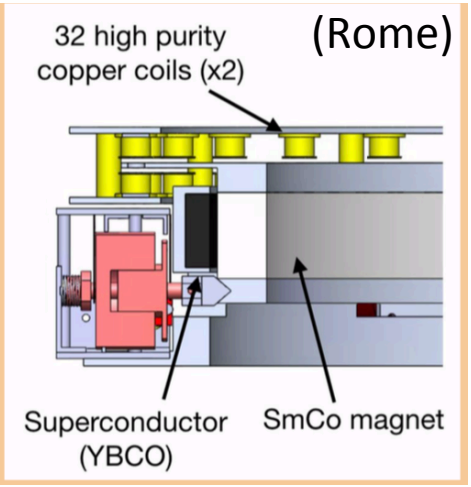
Continuous polarization modulator (2)

MHFT:

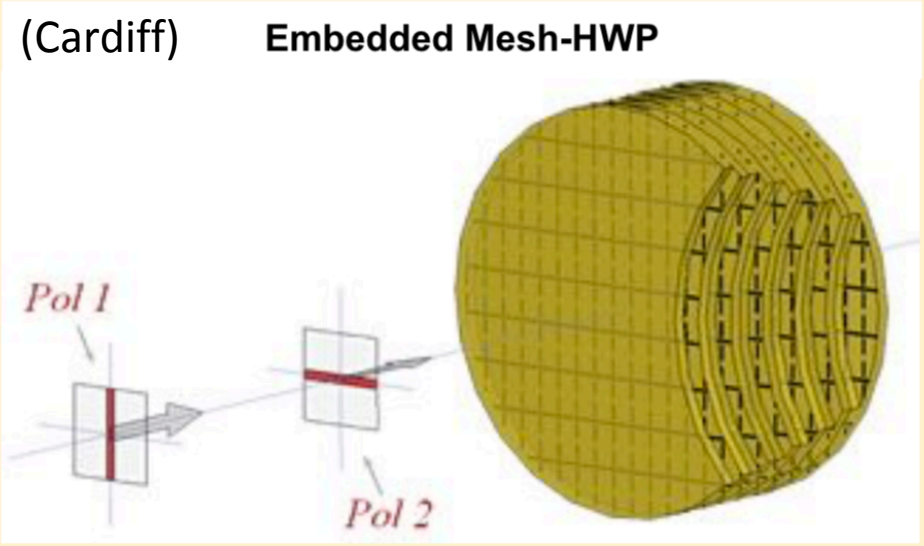
Φ 30 mm and 39-70rpm;

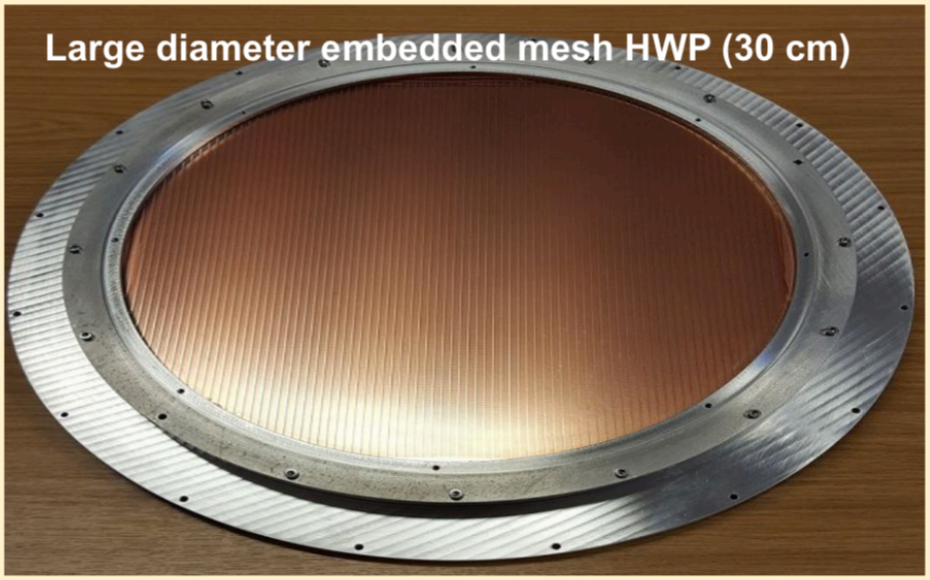
Φ 20 mm and 61-110rpm.



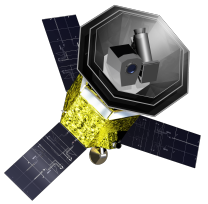


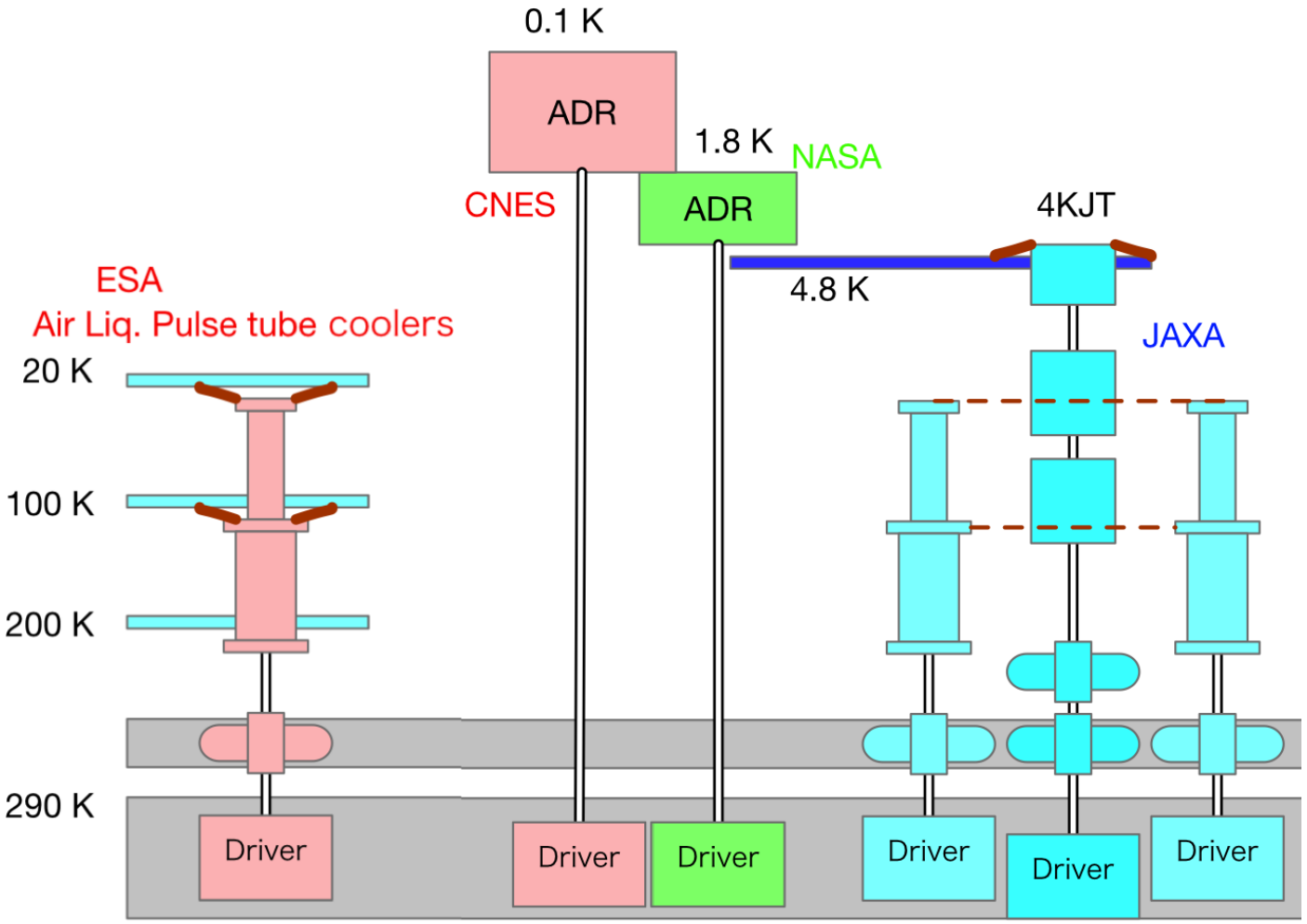
(Cardiff) **Embedded Mesh-HWP**



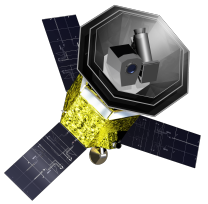


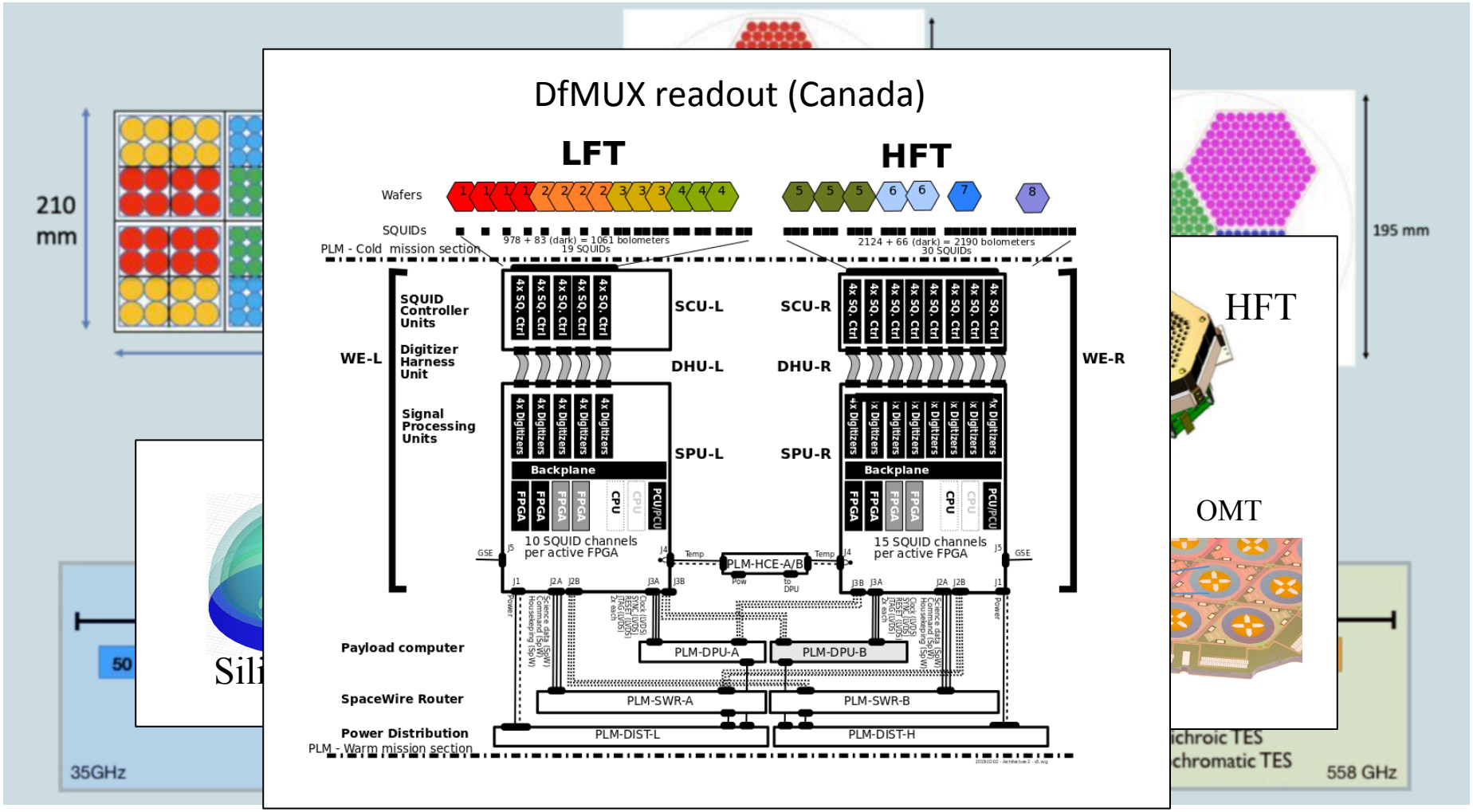
Cryogenic system (Japan, US, Europe)



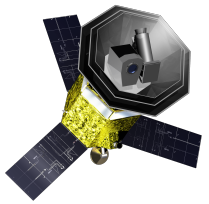


Focal Planes (US)





LiteBIRD science

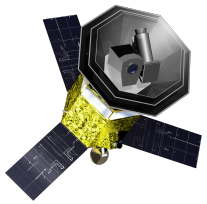


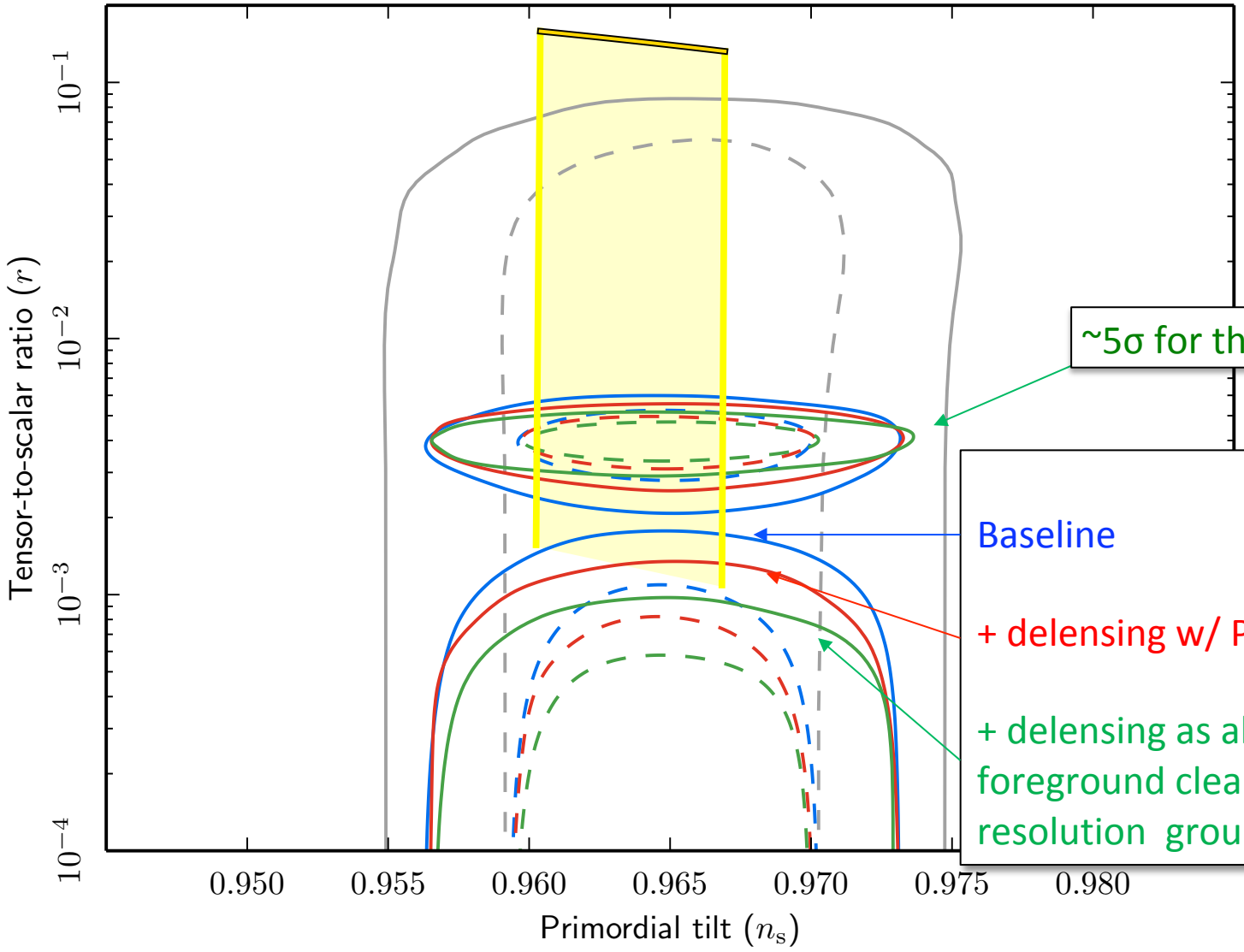
1. Full success ➔ design/requirements driver …

2. Characterization of B-mode and search for sources fields (e.g scale-invariance, non-Gaussianity, parity violation)
3. Power spectrum features in polarization
4. Large-scale E mode and its implications for reionization history and the neutrino mass
5. Cosmic birefringence
6. SZ effect (thermal and relativistic correction)
7. Anomalies
8. Galactic science

+ a unique legacy data set.

LiteBIRD extra success





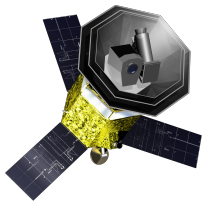
~5σ for the Starobinsky model

Baseline

+ delensing w/ Planck CIB & WISE

+ delensing as above and extra foreground cleaning w/ high-resolution ground CMB data

Summary



- LiteBIRD is here and (likely) to stay as a key feature of the European CMB landscape on the horizon of the next decade and beyond.

- LiteBIRD is a focused mission designed to exploit all the advantages provided by space to do what is difficult, or impossible to do from elsewhere (large angular scales, broad frequency coverage).

- LiteBIRD is complementary to the ground efforts even when the science goals overlap.

- Numerous exciting (and natural) synergies between LiteBIRD and the planned ground efforts. LiteBIRD will help to extend the science of the ground efforts and potentially benefit from them, bringing unique inputs to the table.