Nuova Sigla CSN II @ Roma II

LiteBIRD

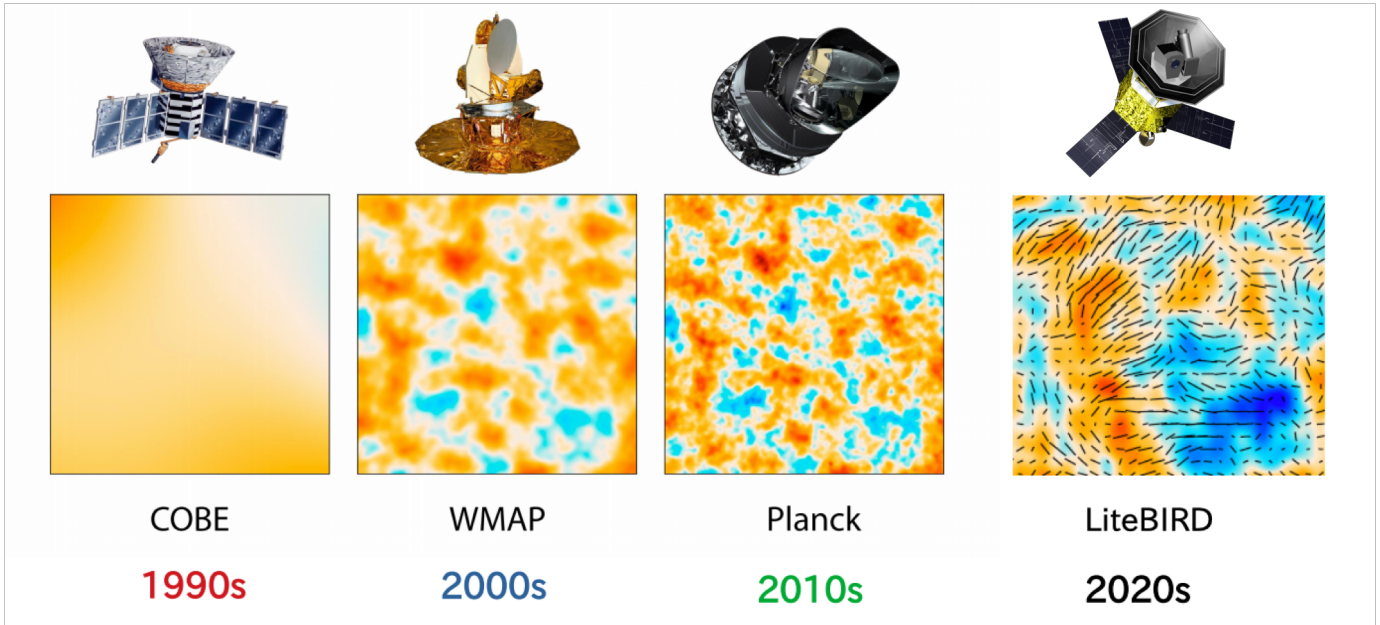
Lite (light) satellite for the studies of **B**-mode polarization and **I**nflation from cosmic background **R**adiation **D**etection

May 2019: Selected by JAXA as strategic L-class mission

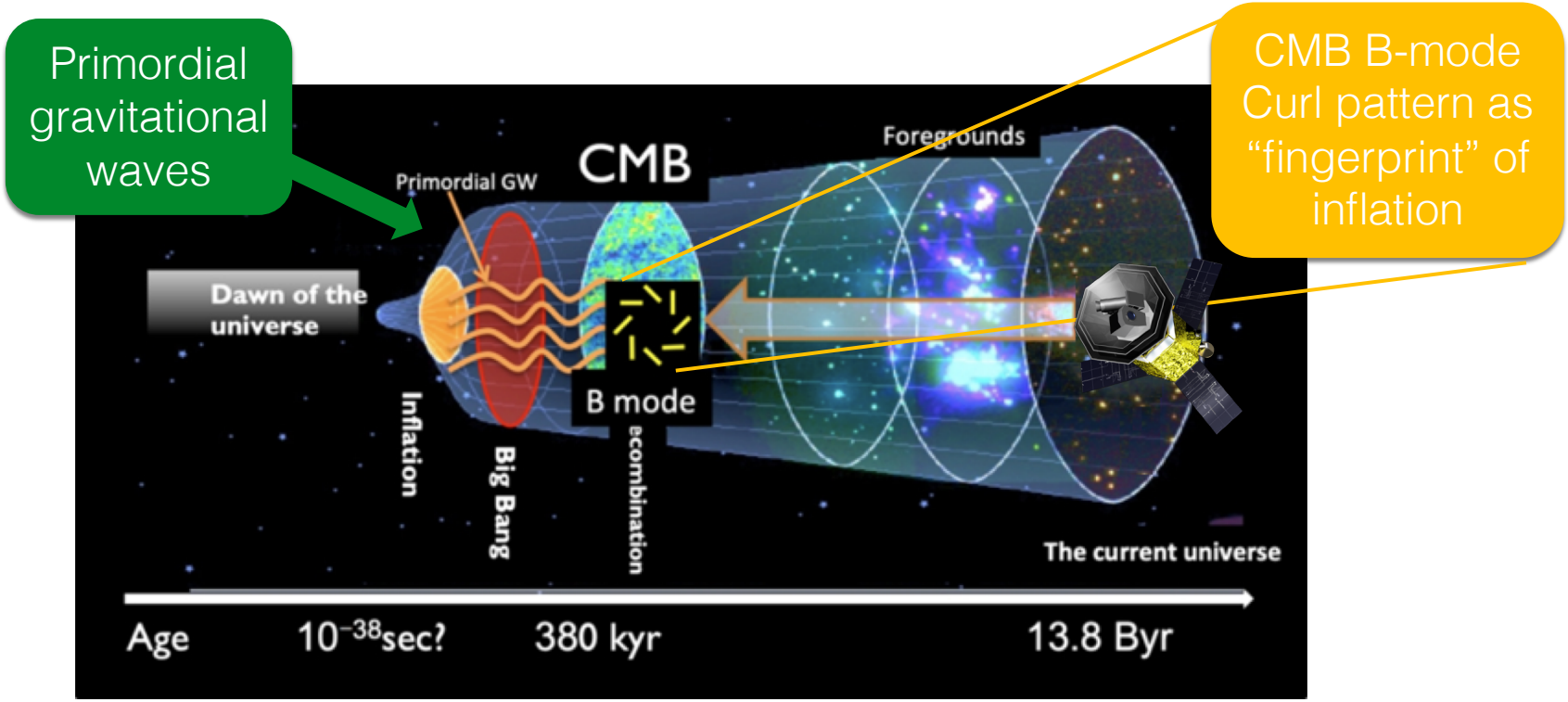
Official announcement

http://www.isas.jaxa.jp/home/rikou/godo/2019/0602/gbi7uzhxfxmz/misison_selection_announcement_may2019.pdf

4th generation space mission for CMB studies



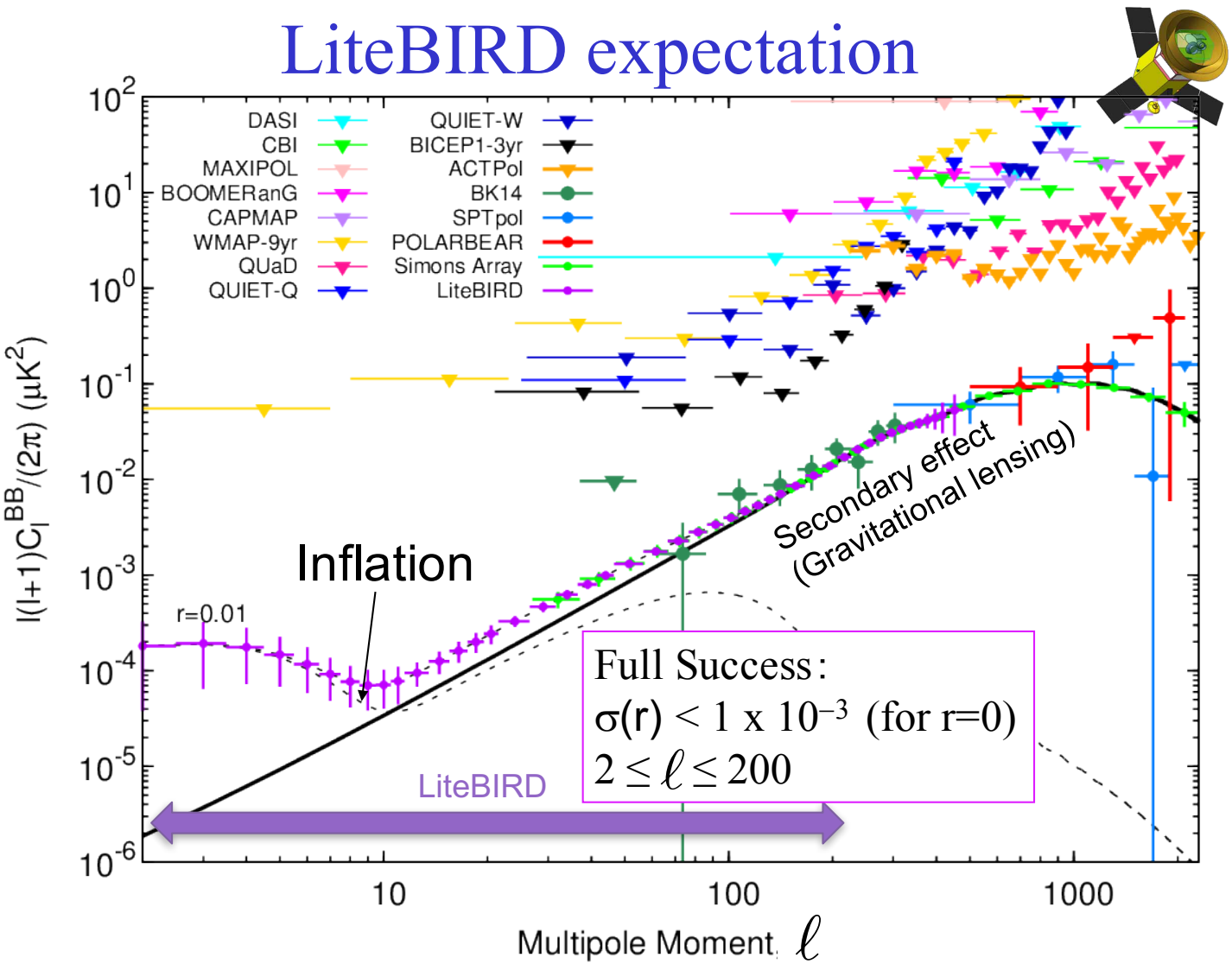
Main scientific objective



Detection of CMB B-mode from primordial gravitational waves

- Direct evidence for inflation, and knowledge on when it happened
- Knowledge on the inflation energy scale
- First evidence for quantum fluctuation of space-time

Main scientific objective



70 x improvement w.r.t. present limits

Can measure both bumps in the power spectrum → Rule out and discriminate among many inflation models

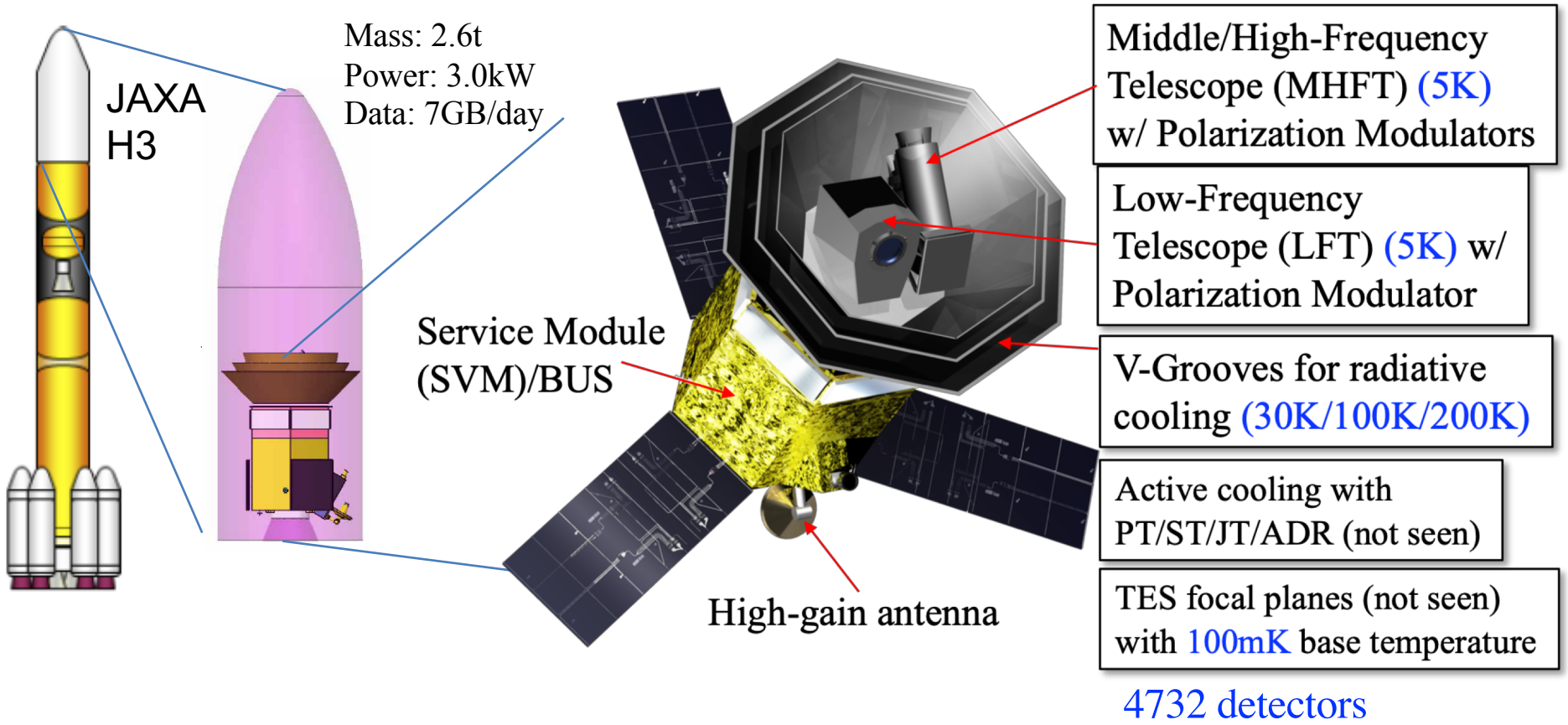
Prove validity of large-field single-field slow-roll models, which is a milestone in cosmology.

Science Outcome

- Tests of Cosmic Inflation
- B-mode power spectrum
- Beyond the B-mode power spectrum
- Cosmic variance limited measurement of EE on large angular scales will be guaranteed
- Optical Depth, Reionization of the Universe and Neutrino Masses
- Cosmic Birefringence
- Mapping the Hot Gas in the Universe
- Anisotropic CMB Spectral Distortions
- Elucidating Anomalies with Polarization
- Galactic Science
- Magnetic fields
- Interstellar dust
- Discovery power

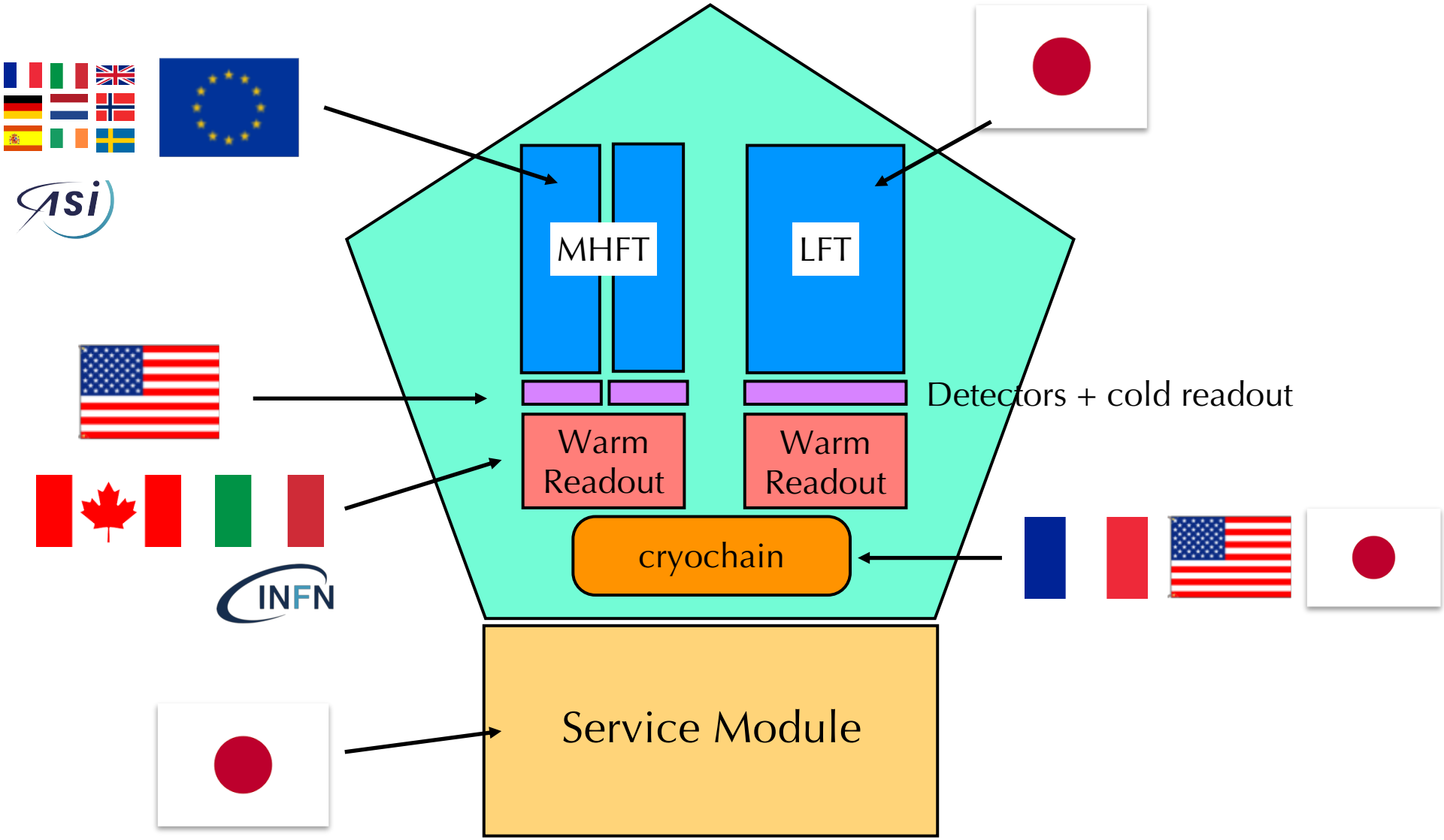
LiteBIRD mission instrument

- Expected launch in 2028 with JAXA H3 rocket
  - LiteBIRD is the only CMB space mission that can be realized in 2020s
- 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



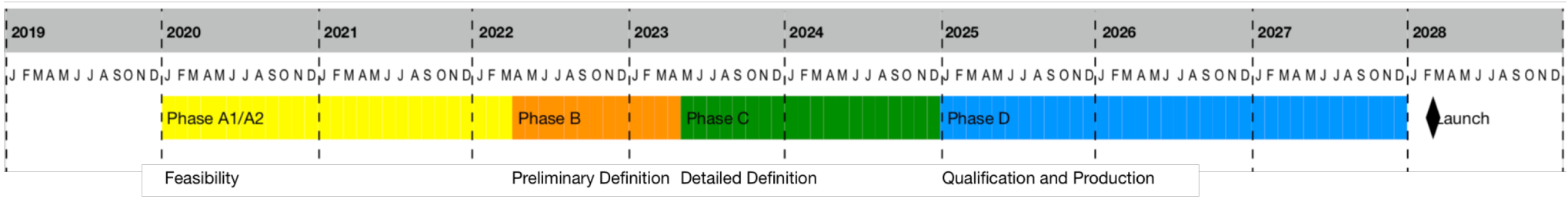
Task division

- JAXA led with strong U.S. (NASA), Canadian (CSA) and EU participation
- About 200 researchers, still growing, with CMB, X-ray, HEP background
  - PI M.Hazumi (KEK), US PI A.Lee, Can PI M.Dobbs, EU SP L. Montier



LiteBIRD/INFN why now?

- This is the right moment
  - ✓ LiteBIRD has been approved by JAXA (Maggio 2019) as the only Large-mission expected to be launched in 2028
  - ✓ Phase-A (design and feasibility) started, responsibilities and competences have been re-distributed inside the collaboration
- Since 2020 INFN participates with several groups on the hardware (readout electronics - SQUID control unit - radiation hardness tests) in synergy with LSPE
  - Pisa (G. Signorelli, Resp. Naz.) → coordination, mechanics, radiation hardness, test
  - MiB (M. Zannoni) → electronics, test
  - RM1 (L. Lamagna) → cryogenic test
  - FE (P. Natoli) → rad hardness, simulation
- In 2021 strengthening analysis and simulation activities
  - RM2 (M. Migliaccio) → analysis methods to study the impact of instrumental effects on the mission
  - TS (N. Krachmalnicoff) → foreground studies, coupling of astrophysical signals with instrumental effects
  - MI (M. Tomasi) → implementation of a simulation pipeline including systematic effects
- Synergy with ASI contribution



LiteBIRD @ ROMA II

People

Alessandro Carones (Dottorando)	100%
Javier Carron Duque (Dottorando)	20%
Marina Migliaccio (RTDB - coord. Locale)	50%
Nicola Vittorio (PO - Coord. Nazionale dell'accordo con ASI)	50%
TOTAL FTE	**2.2**

2021 Main Activities

- Development of a data analysis pipeline to study the impact of instrumental choices and systematics on the mission scientific targets
- Design and implementation of component separation methods to characterize and mitigate astrophysical foregrounds

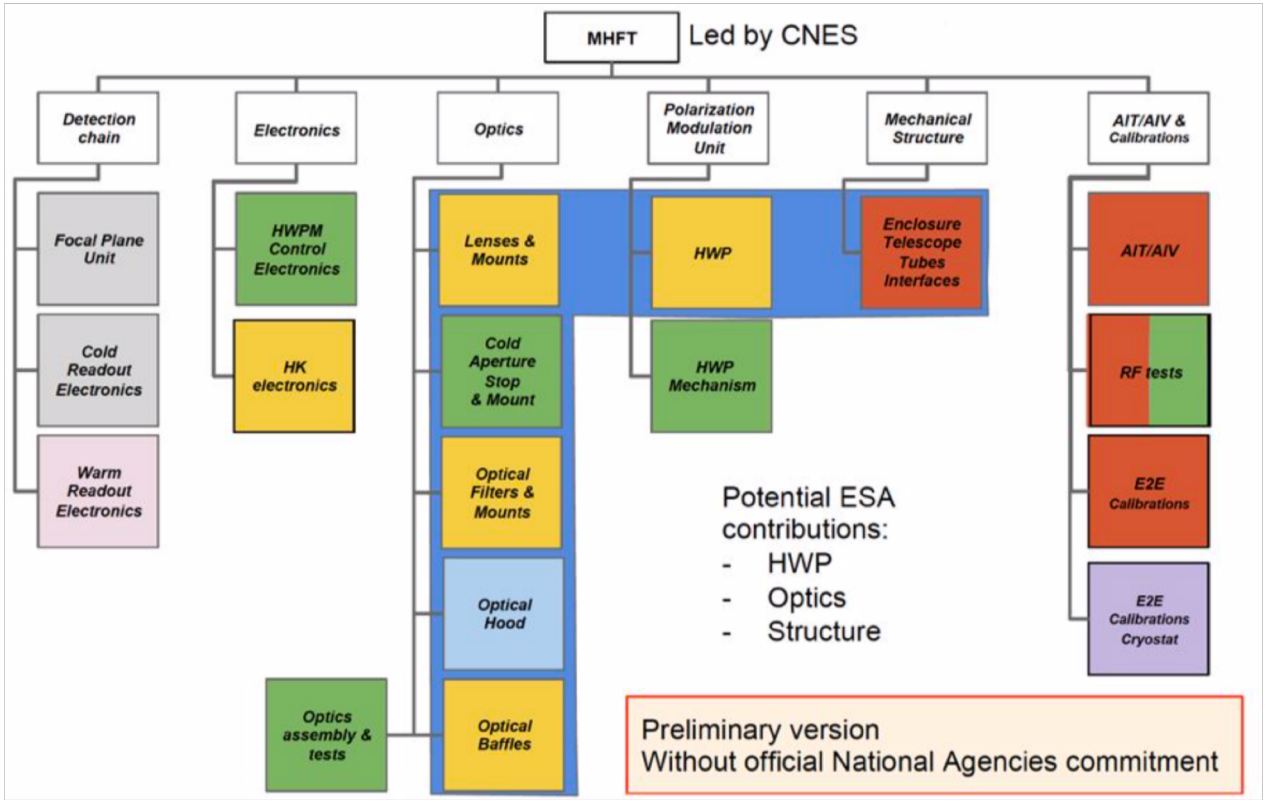
2021 Request

TOTAL 11KE : 2KE Consumo, 9KE Missioni

Backup Slides

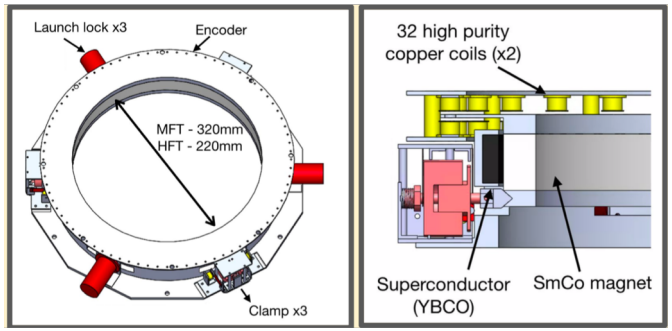
European Consortium

- The European collaboration consists of 9 partners:
  - France, Italy, United Kingdom, Germany, Spain, Sweden, Norway, Ireland, the Netherlands, with a total of more than100 members.
- Since 2018, we have settled a European Steering Committee composed of the representatives of all partners, and reinforced by a system engineer and an engineering team.
  - European SP: Ludovic Montier (FR)
  - Italy has two members: Paolo Natoli (FE, chair of the SC) e Francesco Piacentini (RM1)

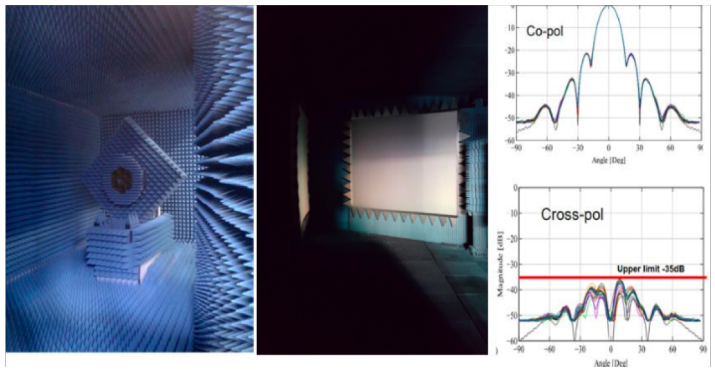


Il contributo (HW) italiano

- L'Italia è membro del consorzio europeo che è in carico di fornire il telescopio di media e alta frequenza MHFT
- Finanziamento addendum ASI/COSMOS (terminato 2019) per lo studio di fattibilità ha chiaramente identificato i seguenti items di hardware, in linea con la tradizione della cosmologia sperimentale/osservativa in italia, sull'eredità di Planck
- Ulteriore finanziamento ASI (2020-2022) per la fase-A
  - Rotatore di Polarizzazione per MHFT
    - HWP rotante a levitazione proposto da Roma1
    - Componenti dell'ottica di MHFT



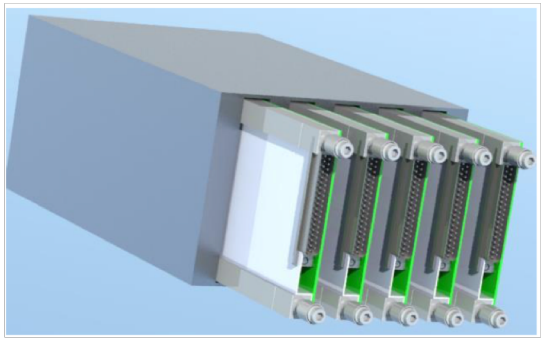
  - Calibrazioni
    - Basata sull'esperienza della sezione di Milano nella calibrazione di Planck per la Telescope Subsystem Calibration

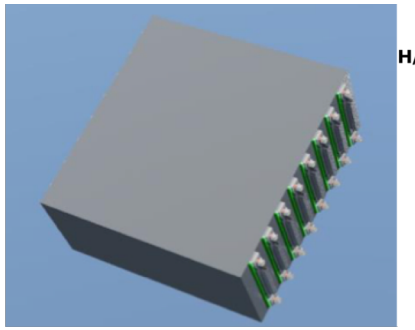


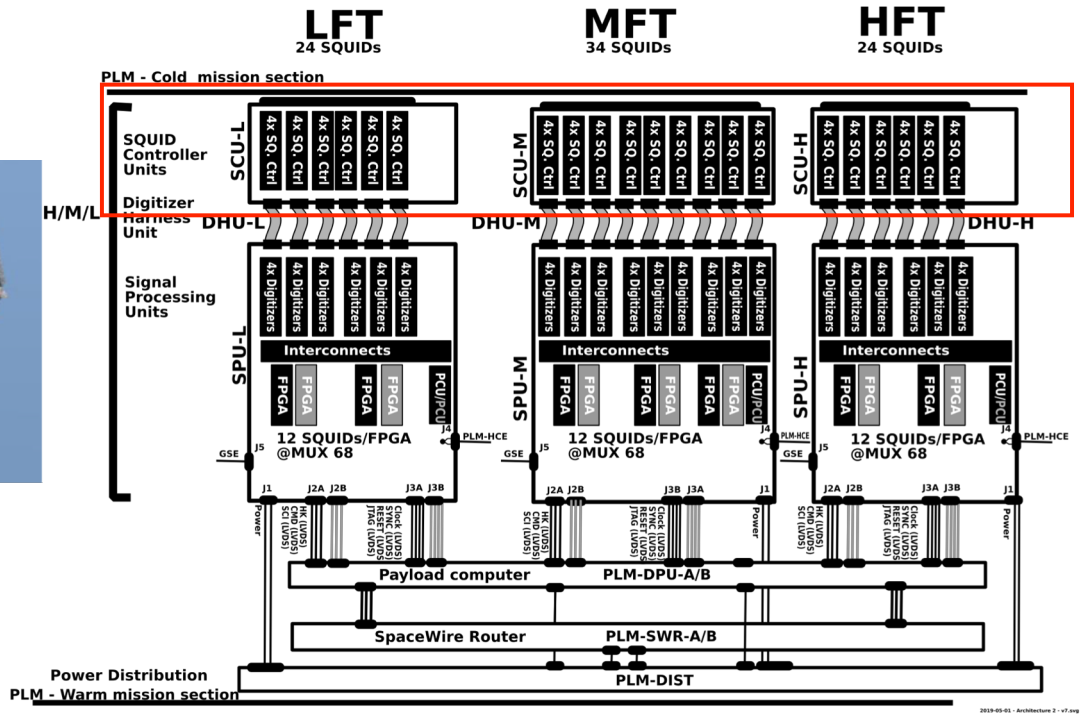
  - Elettronica di controllo e readout.
    - Detector readout: SQUID Control Unit

Il contributo hardware INFN

- Il contributo INFN si inquadra nel contesto dell'elettronica di readout (Warm Readout electronics) :
  - Fornire le SQUID control units (per i tre telescopi LFT + MHFT)
    - schede elettroniche, meccanica di supporto, interfacce termiche
  - Flight qualification di componenti selezionati
    - qualificare per lo spazio il DAC LT1668

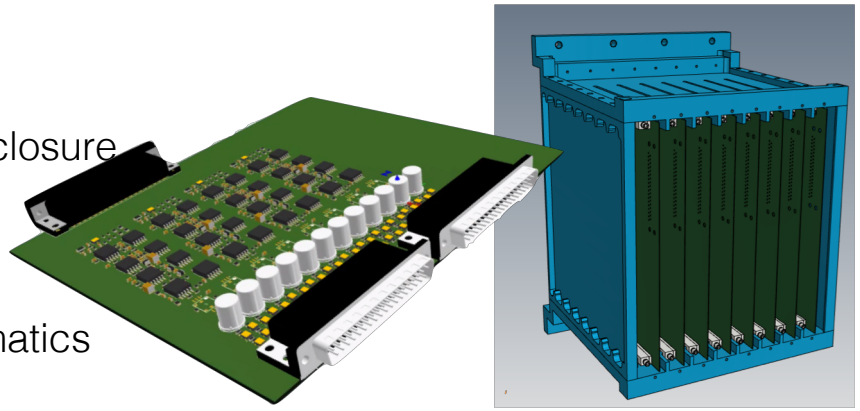






- In previsione dell'analisi dati
  - simulation
  - map making
  - CMB parameters extraction

- Attività nel 2021: Fase-A finisce alla fine del 2021.
  - Consegna del Demonstration Model di elettronica + enclosure
    - test dell'elettronica e della meccanica
  - Review del CNES per il passaggio alla fase-B
  - WG analisi e simulazione → electronics induced systematics



LiteBIRD-INFN status as of 30/06/2020

1. We are implementing, in close synergy with McGill, the handling of the newly introduced DA (Digital Assembly) redundancy on the SQUID control units ensuring the maximum possible internal redundancy.
    1. start with Canadian TRL5 design → Implement redundancy circuit and latch-up prevention circuit
    2. Finalize design by mid-July then send for production of prototype0 (P0)
    3. Test P0 during summer-autumn then redesign and implement DM version (P1) due March 2021
    4. In parallel working on mechanical structure (crate) with same timeline
    5. Ready for phase-A exit review in November 2021
2. COVID-19 impact → limited on design, may have on bid/production
3. Radiation hardness testing for the DAC LTC1668
    1. Originally requested two beam-time slots at LNL Alpi/Tandem: May and Jul 2020
    2. Delay due to COVID-19 → possible beamtime in Sep 2020.