LiteBIRD – testing cosmic inflation and quantum gravity
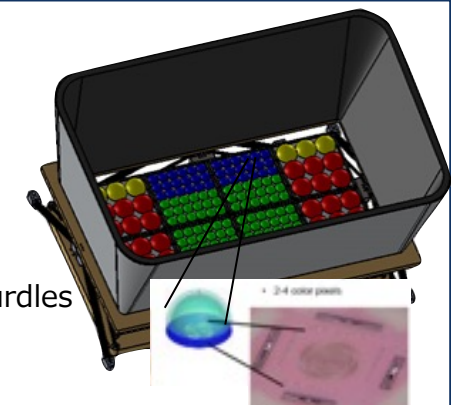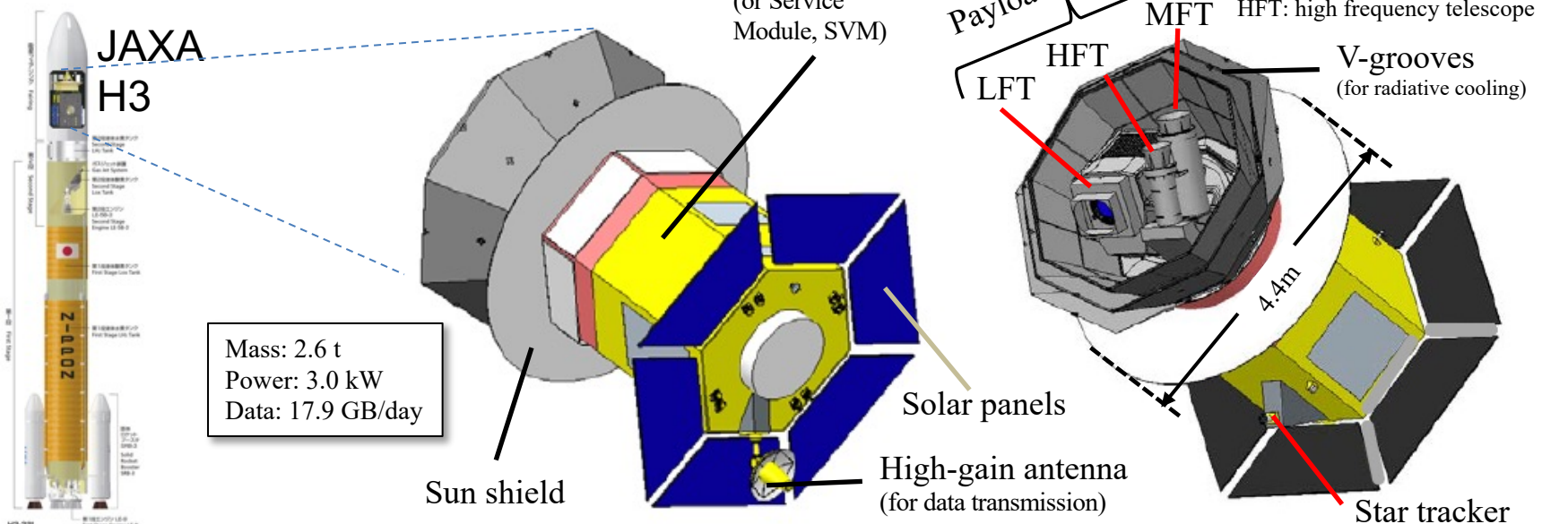
Mission

- Primordial Cosmology
  - A definitive search for signal from cosmic inflation in CMB polarization map
  - Either making a discovery or ruling out well-motivated inflationary models
- Fundamental Physics
  - Giving insight into the quantum nature of gravity and other new physics

Project

- Originally proposed by the KEK CMB group
- JAXA's L-class mission selected in May 2019
- On May 20, 2022, Space Development Strategy Headquarters of Japan (led by the prime minister Fumio Kishida) accepted a proposal to start development of LiteBIRD for a launch in JFY2028.
- JAXA submitted a budget request to MEXT in 2022 and passed all hurdles
- CNES-led Phase A studies in progress in Europe.
- MoU with CMB-S4 for joint studies in preparation.
- QUP at KEK with US team in charge of detector development and tests.

System   PTEP Invited Paper

JAXA H3

Bus system (or Service Module, SVM)

Mass: 2.6 t
Power: 3.0 kW
Data: 17.9 GB/day

Sun shield

Solar panels

High-gain antenna (for data transmission)

Payload module

LFT: low frequency telescope
MFT: middle frequency telescope
HFT: high frequency telescope

LFT

HFT

MFT

V-grooves (for radiative cooling)
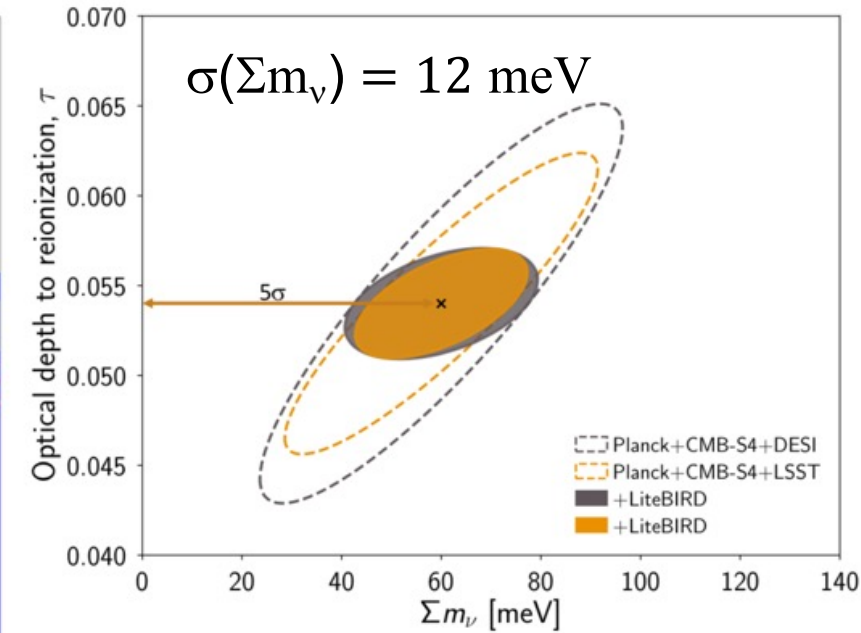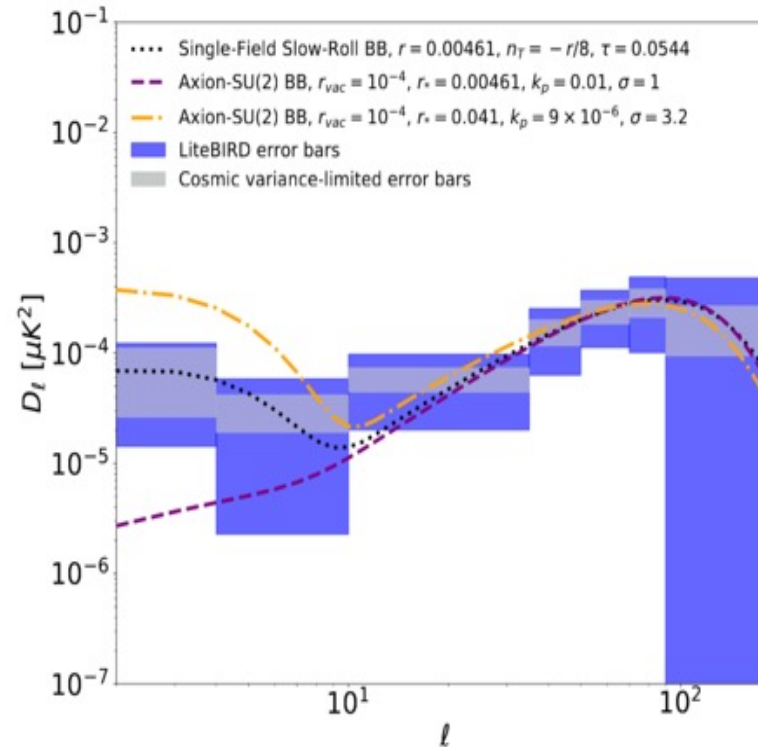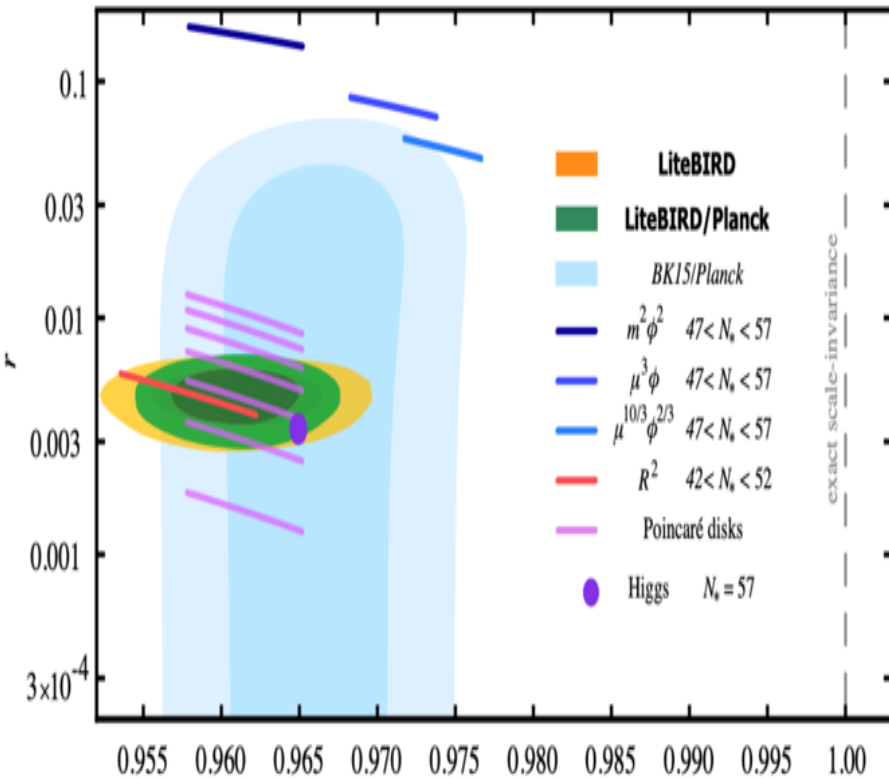
4.4m

Star tracker

LiteBIRD Collaboration

About 400 researchers from Japan, North America and Europe

Team experience in CMB experiments, X-ray satellites and other large projects (ALMA, HEP experiments, …)

Expected Outcomes

We expect many more results.
See the LiteBIRD overview paper (PTEP 2022)

Single-Field Slow-Roll BB, $r = 0.00461$, $n_T = -r/8$, $\tau = 0.0544$
Axion-SU(2) BB, $r_{vac} = 10^{-4}$, $r_* = 0.00461$, $k_p = 0.01$, $\sigma = 1$
Axion-SU(2) BB, $r_{vac} = 10^{-4}$, $r_* = 0.041$, $k_p = 9 \times 10^{-6}$, $\sigma = 3.2$
LiteBIRD error bars
Cosmic variance-limited error bars

$\sigma(\Sigma m_\nu) = 12$ meV

LiteBIRD
LiteBIRD/Planck
BK15/Planck
$m^2\phi^2$ $47 < N_* < 57$
$\mu^3\phi$ $47 < N_* < 57$
$\mu^{10/3}\phi^{2/3}$ $47 < N_* < 57$
R^2 $42 < N_* < 52$
Poincaré disks
Higgs $N_* = 57$

◆ Detailed foreground cleaning studies yield $\sigma(r=0) = 0.6 \times 10^{-3}$
◆ Thorough systematic error studies yield total uncertainty $\delta r < 1.0 \times 10^{-3}$
◆ Achieved without delensing

The example above shows that the spectrum can change due to a new gauge field (Axion-SU(2) model.) Large-angle correlations with multipoles smaller than 10 are where LiteBIRD's all-sky surveys are most powerful.

There is a degeneracy between the fluctuations at recombination and the optical depth (τ), limiting the precision on $\sigma(\Sigma m_\nu)$.
LiteBIRD can determine τ precisely from the E-mode, and as a result can improve the precision of the sum of the neutrino masses.