

## LITEBIRD-LNF

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### 1 General Introduction

#### 1.1 Scientific Rationale

The LiteBIRD <sup>1)</sup> (Lite satellite for the studies of B-mode polarization and Inflation from cosmic background radiation Detection) mission aims to measure the primordial gravitational waves produced during inflation by making ‘extremely’ precise measurements of the B-mode polarisation pattern of the CMB (Cosmic Microwave Background). Cosmological inflation describes the first moments of the Universe and claims that the Universe underwent a ‘very’ rapid expansion ‘immediately’ after its own beginning; according to inflationary theory, primordial gravitational waves were produced during the inflationary era, about  $t \approx 10^{-38}$  s after the beginning of the Universe. Primordial gravitational waves would then have been imprinted in the B-mode polarisation pattern of the CMB; thus, measuring the polarisation of the CMB is the ‘best’ probe to detect the primordial gravitational waves.

#### 1.2 Italian Contribution to LiteBIRD

The Italian contribution to LiteBIRD <sup>2)</sup> was planned almost 10 years ago, thanks to the activities of the workshop ‘ASI CMB Day’ (30<sup>th</sup> March 2016) and the ‘ASI/COSMOS Project’: while the Planck Surveyor has been the driving force for setting milestones in the history of the CMB, the frontiers of fundamental physics and cosmology are still far from being reached; it is crucial for the Italian community to maintain its leading role, without dispersing the Planck legacy, in the theoretical, experimental and data analysis fields. In addition to the theoretical, simulation and data analysis activities, the Italian contribution to the instrument focuses on the design, construction and testing of the two MHFTs, the Mid Frequency Telescope (MFT) and the High Frequency Telescope (HFT) <sup>1)</sup>.

### 2 INFN-LNF Contribution to LiteBIRD

#### 2.1 Locally

The INFN-LNF LiteBIRD Group <sup>3)</sup>, hereafter LiteBIRD-LNF, whose activity started in January 2023, contributes to the design, manufacture and testing of the two MHFTs, thanks to <sup>4)</sup>:

- Thermal balance test (and correlation with models) of the electronics of interest, thanks to the ‘pocket’ cryostat at our disposal, instrumented in a dedicated room.
- (Non)destructive irradiation testing of the electronics of interest in XlabF, with extrapolation to other wavelengths, and X-ray circuit diagnostics on a specially designed and instrumented optical bench.

- Participation in simulation and data analysis activities, both at the cosmological and instrumental levels (see also Section 2.2).

Concerning the ‘pocket’ cryostat <sup>5)</sup>:

- It has been instrumented in a dedicated space.
- It was specifically designed for thermo vacuum tests and thermal balance tests.
- Operational pressure,  $p < 10^{-6}$  mbar, and operational temperature, ( $80 < T < 380$ ) K.
- It has got a new, stronger, custom-made stand with wheels, and it is getting control remotely-operated electronics.

## 2.2 Globally

The LiteBIRD-LNF Group also participates in some of the activities carried out by the international collaboration; namely, joining in in the Joint Study Groups and coauthoring of several papers:

- “Searching for Primordial Magnetism in the Cosmic Microwave Background with LiteBIRD” <sup>6)</sup>.
- “The LiteBIRD mission to explore cosmic inflation” <sup>7)</sup>.
- “The LiteBIRD space mission” <sup>8)</sup>.
- “LiteBIRD Science Goals and Forecasts - Mapping the Hot Gas in the Universe” <sup>9)</sup>.
- “Multi-dimensional optimisation of the scanning strategy for the LiteBIRD space mission” <sup>10)</sup>.
- “Requirements on the gain calibration for LiteBIRD polarisation data with blind component separation” <sup>11)</sup>.

As part of the mission, the Joint Study Groups are specialised working groups formed to address different scientific, technical and engineering aspects of the LiteBIRD mission. These groups are responsible for carrying out in-depth studies, providing expertise and contributing to the overall development and execution of the mission. The Joint Study Groups for LiteBIRD involve collaboration between researchers, scientists and engineers: they contribute to the design, analysis and implementation of the mission by focusing on different aspects of the project; namely, as of now, the CMB Science, Instrument Science, Data Analysis, and Mission Operations Groups.

## 3 List of Conference Talks by LNF Authors in Year 2024

- L. Porcelli, et al., “Novel Hardware Setup for Astrophysics and Cosmology at INFN-LNF”, Proceedings of the 10<sup>th</sup> International Conference “Charged & Neutral Particles Channeling Phenomena” (Channeling 2024), Riccione, Italy, September 8-13, 2024 <sup>4)</sup>.

## References

1. M. Hazumi, et al., “LiteBIRD: A Satellite for the Studies of B-Mode Polarization and Inflation from Cosmic Background Radiation Detection”, Journal of Low Temperature Physics (2019) 194:443-452, <https://doi.org/10.1007/s10909-019-02150-5>.

2. N. Vittorio, “The Italian Contribution to LiteBIRD”, Workshop ‘LiteBIRD-Italia 2023 @ INFN-LNF (LB-ITA23@INFN-LNF)’, Frascati, Italy, May 22-24, 2023, <https://agenda.infn.it/event/35371/>.
3. L. Porcelli, et al., “LNF Thermo-Vacuum Facility and Contribution to LiteBIRD”, Workshop ‘LiteBIRD-Italia 2023 @ INFN-LNF (LB-ITA23@INFN-LNF)’, Frascati, Italy, May 22-24, 2023, <https://agenda.infn.it/event/35371/>.
4. L. Porcelli, et al., “Novel Hardware Setup for Astrophysics and Cosmology at INFN-LNF”, Proceedings of the 10<sup>th</sup> International Conference “Charged & Neutral Particles Channeling Phenomena” (Channeling 2024), Riccione, Italy, September 8-13, 2024, <https://agenda.infn.it/event/39892/>.
5. L. Porcelli, et al., “The INFN-LNF Astrophysics and Cosmology Integrated Test Facility Startup”, NDT 2024, 2, 249-254, <https://doi.org/10.3390/ndt2030015>.
6. D., Paoletti, et al., “Searching for Primordial Magnetism in the Cosmic Microwave Background with LiteBIRD”, Proceedings of the Bernoulli Workshop 2024, Lausanne, Switzerland, April 29-June 7, 2024.
7. T., Ghigna, et al., “The LiteBIRD mission to explore cosmic inflation”, Proceedings of SPIE Conference 13092 - Space Telescopes and Instrumentation 2024, Yokohama, Japan, June 16-21, 2024, <https://doi.org/10.1117/12.3021377>.
8. A., Rizzieri, et al., “The LiteBIRD space mission”, Proceedings of SPIE Conference 13092 - Space Telescopes and Instrumentation 2024, Yokohama, Japan, June 16-21, 2024.
9. M., Remazeilles, et al., “LiteBIRD Science Goals and Forecasts - Mapping the Hot Gas in the Universe”, arXiv:2407.17555.
10. Y., Takase, et al., “Multi-dimensional optimisation of the scanning strategy for the LiteBIRD space mission”, arXiv:2408.03040.
11. F., Carralot, et al., “Requirements on the gain calibration for LiteBIRD polarisation data with blind component separation”, arXiv: 2411.02080.