LITEBIRD-LNF

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1 General Introduction

1.1 Scientific Rationale

The LiteBIRD [1] (Lite spacecraft for the study of B-mode polarization and Inflation from cosmic background Radiation Detection) mission aims to measure the primordial gravitational waves produced during inflation by taking extremely precise measurements of the B-mode polarization pattern of the Cosmic Microwave Background (CMB). According to inflationary theory, the universe underwent a very rapid expansion immediately after its beginning, and primordial gravitational waves were produced during the inflationary era, approximately 10^{-38} seconds after the beginning of the Universe. These waves would then have been imprinted in the B-mode polarisation pattern of the CMB, making measuring the polarisation of the CMB the best way to detect primordial gravitational waves.

1.2 Italian Contribution to LiteBIRD

The Italian contribution to LiteBIRD [2] was planned about ten years ago thanks to various activities and workshops sponsored by the Italian Space Agency (ASI). In short: while Planck has set important milestones in the measurement of the CMB, the frontiers of fundamental physics and cosmology remain far from being reached, so it is crucial that the Italian community maintains its leading role. Alongside theoretical, simulation and data analysis activities, the Italian contribution to LiteBIRD involves designing, constructing and testing the two MHFTs (Mid Frequency and High Frequency Telescopes) [1].

2 INFN-LNF Contribution to LiteBIRD

2.1 Locally

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

- Thermal balance test (and correlation with models) of the electronics of interest, thanks to the ‘pocket’ cryostat at our disposal, instrumented in a dedicated space.
- (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 what was done in 2025 (Figures 1, 2, 3, and 4):

- The 'pocket' cryostat [5] was finally instrumented in a dedicated space and fitted with complete remote-operated electronics.
- Several thermo vacuum and thermal balance tests were performed to commission the facility.
- Several actual thermo vacuum and thermal balance tests were performed on the electronics of interest.

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:

- "Requirements on the gain calibration for LiteBIRD polarisation data with blind component separation" [6].
- "LiteBIRD science goals and forecasts: constraining isotropic cosmic birefringence" [7].
- "A simulation framework for the LiteBIRD instruments" [8].
- "On the computational feasibility of Bayesian end-to-end analysis of LiteBIRD simulations within Cosmoglobe" [9].
- "First release of LiteBIRD simulations from an end-to-end pipeline" [10].

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.

3 Comments

2025 marked the third year of LiteBIRD-LNF's involvement in the collaboration. Next year, 2026, will see the completion of Phase A of the overall LiteBIRD programme. It is anticipated that the collaboration will be restructured in view of Phase B (from 2027 until launch).

References

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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^{th} 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`.

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7. E. de la Hoz et al JCAP07(2025)083, 10.1088/1475-7516/2025/07/083.

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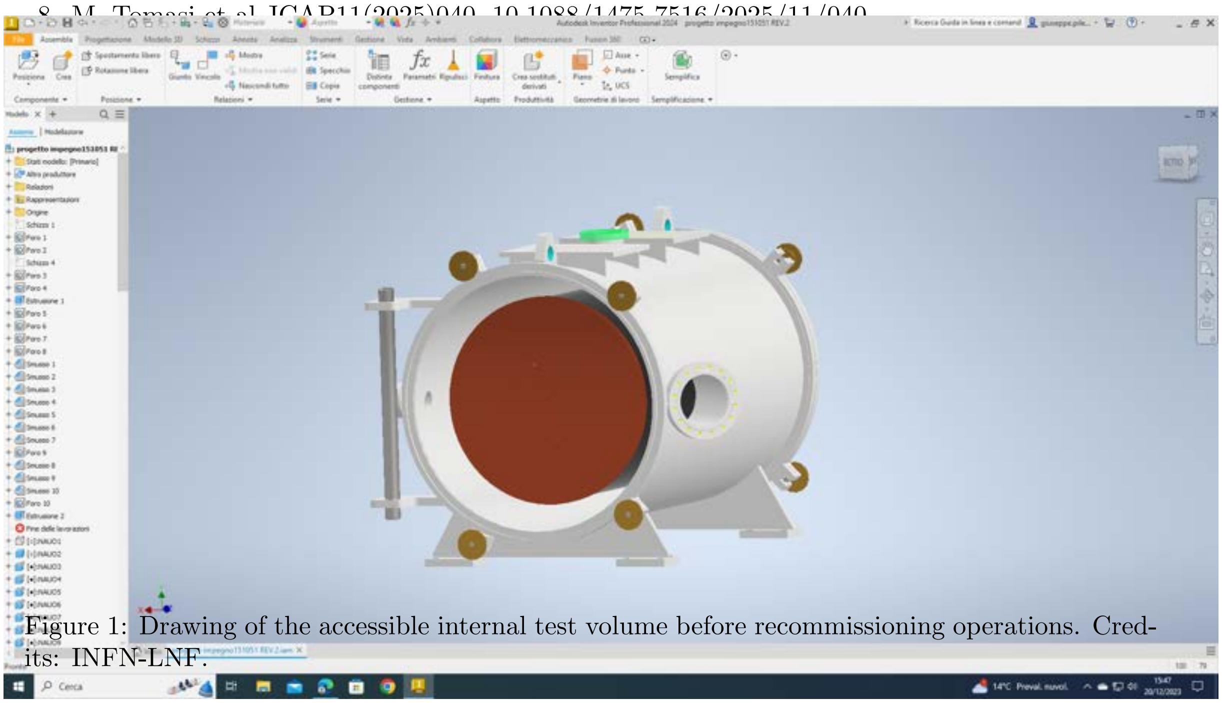

Figure 1: Drawing of the accessible internal test volume before recommissioning operations. Credits: INFN-LNF.

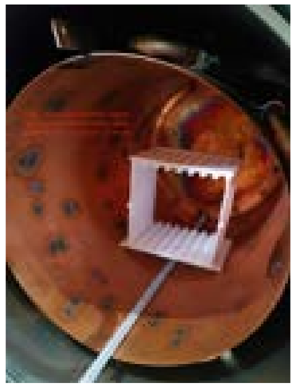

Figure 2: Accessible internal test volume, before recommissioning operations and showing a sample 3D-printed rack for clearance assessment. Credits: INFN-LNF.

Figure 3: The assembled sample setup: a solid aluminun parallelepiped ($8\times8\times20$ cm^3) on its control and support baseplate. With respect to the year 2024 (Figure 2), the wiring is complete and the copper inner shroud has been painted with Aeroglaze Z306 flat black. Credits: INFN-LNF.

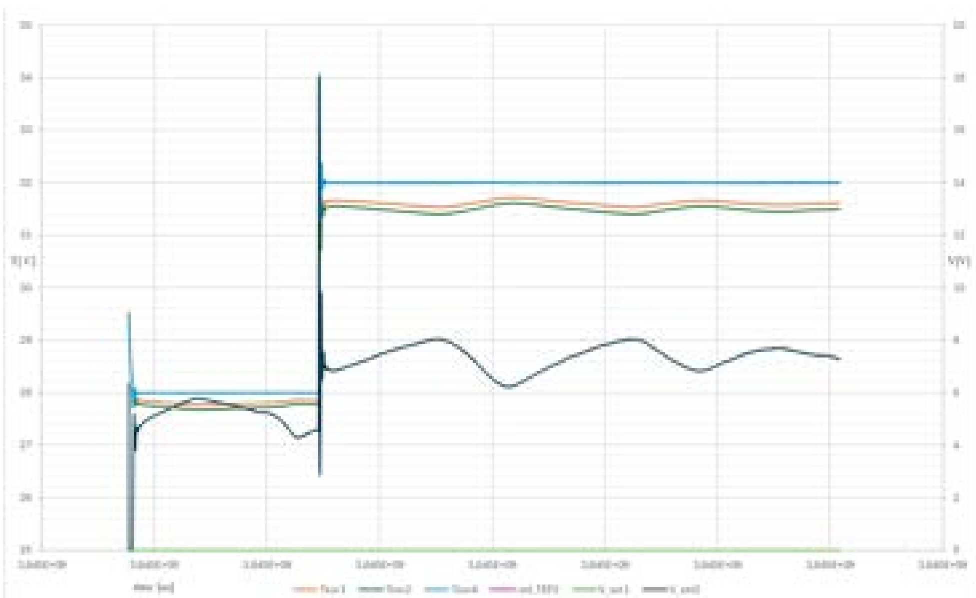

Figure 4: Example of a control plot of the sample controlled to preset temperatures via resistor heaters: left vertical axis: temperature; right vertical axis: voltage; horizontal axis: time (about 6 hours). Credits: INFN-LNF.