The Medium and High Frequency Telescopes of LiteBIRD

Team
The European collaboration consists of 9 partners: France, Italy, United Kingdom, Germany, Spain, Sweden, Norway, Ireland, the Netherlands, with a total of about 200 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.

MHFT Instruments
The European collaboration is responsible of the sub-K stage of the cryo-chain, and of the Mid- and High-Frequency Telescopes (MHFT), covering a large frequency range from 89 to 224 Hz and 166 to 448 GHz, respectively. Both refractive telescopes are cooled down at 4.8 K, with two half-wave plates rotating continuously. The two focal planes, cooled down at 100 mK, consist, respectively, in 2074 and 1324 detectors delivered by the US.

Mechanical Structure
Cooled down to 5 K a thermoelastic study is performed to estimate the thermal contractions and reach the constraints on the optical alignments. Made of Aluminum, the mechanical structure of the telescopes ensures the thermal link between the MHFT’s subsystems and the cryo-chain.

HWP rotator
The rotation is performed thanks to 32 coupled coils on the stator, paired with 8 small SmCo magnets on the rotor. Eddy currents produced on the rotor will heat up the HWP. For its thermal model we assumed:
- motor composed by 32 coupled copper coils (RRR > 100)
- ~10 mA current needed in the motor
- ~0.1 mW dissipated during operation on the rotor
- Emissivities: HWP = 0.03 and Al = 0.4.
After a drift of a few hours, the expected temperatures are both below 20 K (figure below)

A similar concept is being used for the LSPE-SWIPE mission.

Quasi-optical components
Filters
- Embedded Mesh-Filter
- Polypropylene embedded mesh-filter technology
- Thermal shielding and spectral bands definition
- Space qualified technology employed in many other ground-based, balloon-borne and satellite instruments
- Filter diameters up to 500 mm

Mesh-HWPs
- Embedded Mesh-HWP
- Large diameter embedded mesh-HWP (30 cm)
- Basic Frequency Selective Surfaces (FSSs)

Lenses
- Millimetre-wave Anti-Reflection Coated dielectric lenses
- Coating made with ¼ wave Porous PTFE
- Process developed and refined under ESA contract
- Deployed on several ground & balloon-based experiments
- MFT and HFT telescopes based on two A/R coated polypropylene lenses

- Solution based on polypropylene embedded mesh-filter technology
- Anisotropic grids providing phase-shifts in opposite directions
- Employed in ground-based and balloon-borne instruments
- Further performance developments funded by ESA contract