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SWIPE multi-mode pixel assembly design and beam pattern measurements at cryogenic temperature

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Detecting the polarization of the cosmic microwave background (CMB) represents the best technique to study physical phenomena happening a split-second within the big bang, thus testing the standard cosmological model. In this framework the Short Wavelength Instrument for the Polarization Explorer (SWIPE) aims at the measurement of CMB polarization at the largest angular scales, where cosmic inflation left its imprint in the form of B-modes and E-modes patterns of the linear polarization field.

SWIPE is a cryogenic large aperture polarimeter which will observe 25\% of sky during a two-weeks-long circumpolar stratospheric balloon mission, thanks to 326 multi-mode bolometers cooled to 0.3 K and covering 3 frequency bands centered at 140 GHz, 220 GHz and 240 GHz.

The detectors are fed by a single large-diameter (500 mm) plano-convex lens, cooled at 1.6 K, coincident with the cold aperture stop. The lens is coupled to multi-mode feed horns (28° FWHM), collecting a total of 8800 modes on the bolometers. The bolometer thermistors are Transition Edge Sensors (TES) made of a Ti/Au bilayer with T_c tuned to operate in the 500-550 mK range. The TESs are thermally coupled to a large (10 mm diameter) spider-web absorber, made of Bi/Au coated Si_3N_4 wires, with a mesh size of 250 μm.

The pixel assembly has been tested at the bolometer base temperature of 350 mK, inside a custom cryogenic testbed, looking at a Gunn oscillator (140 GHz) in the far field.
We have developed custom cryogenic neoprene absorbers, in addition to a stack of standard metal meshes low-pass filters, so that the background on the detector is reduced at a level similar to the in-flight one, allowing to measure the full antenna beam. Once corrected for vignetting, the measured FWHM is consistent with the expected one.

Less than 5 years of experience since completion of Ph.D

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