

# 1<sup>ST</sup> year Ph.D. report - Beatrice Siri

Ph.D. supervisor: prof. Flavio Gatti.

Detecting B-mode polarization of the Cosmic Microwave Background is one of the main challenges of modern observational Cosmology. It can be proved that polarization B-modes can only be generated when there is a tensor perturbation component present. Inflationary models, proposed along the standard cosmological model, imply the existence of a background of primordial gravitational waves which would generate a curl component (B-modes) in the Cosmic Microwave Background at large angular scales. The amplitude of this signal is expected to be linked to the energy scale of inflation. Thus, a direct measure of large scale B-modes polarization would strongly confirm inflationary theories.

LSPE (Large Scale Polarization Explorer) is an experiment aimed at measuring the polarization of the Cosmic Microwave Background at large angular scales. Its primary target is to improve the limit on the tensor to scalar perturbations amplitude ratio down to  $r=0.03$ , at 99.7% confidence. A second target is to produce wide maps of the foreground polarization. The mission is optimised for large angular scales, with coarse angular resolution (around 1.5 degrees FWHM) and wide sky coverage (25% of the sky). The mission is composed of two instruments: SWIPE and STRIP. STRIP is a ground-based telescope that will be installed at El Teide Observatory (Tenerife, Canary Islands). It will use an array of coherent polarimeters with cryogenic HEMT amplifiers to survey the sky at 45 and 90 GHz. SWIPE is a balloon-borne experiment that will fly in a circumpolar long duration balloon mission during the polar night. It will use an array of bolometric polarimeters, with large throughput multi-mode bolometers and rotating Half Wave Plates (HWP), to survey the sky in three bands at 140, 220 and 240 GHz.

My work revolved around fabrication and test of bolometer for the SWIPE instrument. The detectors are TES (Transition Edge Sensor) spider-web bolometers with a micromesh absorber. The bolometer is fabricated using thin film techniques on a silicon nitride membrane over a silicon substrate. The detector is then suspended by removing the silicon layer.

During this year I worked on defining the final characteristics of the detectors, getting ready for the final production. The focus was on the absorber: one of the drawbacks of such a large absorber is the achievement of an optimal trade-off among the different requirements on thermal properties and EM characteristics. In order to improve the response time of the detector I tested an alternative to the standard gold absorber using bismuth gold film: this allows us to reduce the heat capacity even if with an increase of resistivity. We are currently undergoing characterization and beam response measurements of detectors with this new design.

During this year I also refined and improved some steps of the production of the detectors focusing on the etching processes used to shape and suspend the silicon nitride membrane.

### Conferences:

I attended the following conferences:

- XVIII International Workshop on Neutrino Telescopes (<https://indico.cern.ch/event/768000/overview>)
- Incontri di Fisica delle Alte Energie (IFAE 2019) (<https://agenda.infn.it/event/17945/overview>)
- 18th International Workshop on Low Temperature Detectors (LTD-18) (<https://www.ltd18.unimib.it/home>)

and I participated to the following contributions:

- B. Siri et al. "Large Area Superconducting TES Spiderweb Bolometer for CMB Polarisation Measurements for the LSPE balloon borne telescope." - poster at XVIII International Workshop on Neutrino Telescopes, presented by me.
- B. Siri et al. "The TES bolometric instrument of LSPE." - poster at IFAE 2019, presented by me.
- B. Siri et al. "Bismuth-Gold absorber for large area TES spiderweb bolometers" - poster at LTD18, presented by me.
- M. Biasotti et al. "The phonon mediated TES cosmic ray detector for focal plane of ATHENA x-ray Telescope" - poster at LTD18, presented by Michele Biasotti.
- F. Columbro et al. "SWIPE multi-mode pixel assembly design and beam pattern measurements at cryogenic temperature" - oral presentation at LTD18, presented by Fabio Columbro.

### Courses and School:

- Gravitational Waves
- Spectroscopic and Microscopic Analysis of surfaces and interfaces
- Introduction to high energy astrophysics
- Cosmology

I have already taken the exams for the courses of Introduction to high energy astrophysics and Cosmology and I plan on taking the exam of Gravitational Waves by the end of October.

I also attended the school "XXVIII Giornate di Studio sui Rivelatori" (<http://gsr.to.infn.it>)