10.2.4 WP 2-6X1: Future ground-based CMB experiments

PROJECT: **Studi di Cosmologia**		**WP REF.: 2-6X1**
WP TITLE: **Future ground-based CMB experiments** **SUB-CONTRACTOR**: **Dip. Fisica / Università di Milano** **START EVENT**: KO **END EVENT**: RF **WP MANAGER**: **Marco Bersanelli**		**Sheet**: 1 **of** 1 **Issue Ref**: 1 **Issue Date**:01/09/2016

1. OBJECTIVES

- Design a "medium-term ground-based" (MTGB) experiment to measure the polarization of the CMB and foreground components in the low frequency range (<100GHz), to contribute, in the next 5 years or so, to the on-going CMB international efforts (European coordination, S4).
- Study the feasibility of a "long-term ground-based" (LTGB) experiment, as an ambitious programme to measure CMB B-modes at low frequencies from the ground, to be considered a long-term contribution to CMB European coordination & S4.

2. INPUTS

- Contract and Technical Annex
- Work plan & Schedule
- Planck (and other CMB experiments) data

3. TASKS

Main collaborations: all nodes

- Survey the state-of-the-art technology for polarized detectors at low frequencies (10-100GHz), and extrapolate into the next 10 years. Analyse the current status in Italy (capabilities, institutions, industry, possible new partners) and the potential for future technology progress (detectors, antennas/OMTs, telescopes, cryogenics, electronics, mechanics). Identify international collaboration opportunities (e.g. US for next generation of HEMT LNAs). In particular, carry out a feasibility study of extension of Italian bolometer technology to low frequency (e.g. Ka and Q band) for ground operation (in close collaboration with INFN/Genova).
- Develop an atmospheric model to estimate atmospheric noise into polarization measurements. Comparative analysis of observing sites (Tenerife, White Mountain, Atacama, South Pole, Argentina, etc.).
- Develop an instrument configuration for a medium-term (~5 years) ground-based, low-frequency experiment (MTGB) aimed at precision measurements of CMB polarization and synchrotron, as a successor of LSPE/STRIP. This is conceived as a first contribution to the ongoing collaborative effort in Europe (in particular at the Tenerife site) and in the US (S4). This requires careful design, confirmed by numerical simulations, of the optical/detection/cryo systems, including laboratory tests of selected key subsystems: telescope (in particular cross polarization and sidelobes), high performance feed horn arrays, polarizers and OMTs arrays (to achieve high polarization purity), electronics, cryogenics, mechanics.
- Develop an instrument configuration for a long-term ground-based (LTGB) experiment, as an ambitious programme to measure primordial B-modes at low-frequencies (5-100GHz) from the ground. This is conceived as a long-term (~10-15 years) contribution to the ongoing

collaborative effort in Europe and in the US (S4). The study will consider simultaneously foregrounds limitations (in close collaboration with SISSA, Trieste) and technological opportunities/approaches. Identify and study main trade-offs. Identify optimal modular strategy for large arrays deployment. This requires careful design, confirmed by numerical simulations, of the optical/detection/cryo systems, including laboratory tests of selected key subsystems: telescope, optical coupling, polarization selection (OMTs). Identify feasible solutions for electronics, cryogenics, mechanics, and required test facilities. Identify institutional partnership in Italy (ASI, INFN, INAF) and International Collaborations to implement such long term ground based program.

The feasibility studies described in the last two items will directly involve all the other nodes of this project: La Sapienza and Bologna for coordination with our parallel studies on balloon and space; Milano-Bicocca, Genova, Pisa for hardware design, testing and calibration strategies; SISSA for foreground analysis; OAT/INAF for data analysis support; Roma2, Ferrara and Padua for detailed definition of science goals).

4. OUTPUTS

- Feasibility study of a medium-term ground-based experiment to measure to high precision the polarized sky (CMB and synchrotron emission) at low frequencies for implementation in a ~5yr time scale, with maximum science return for the Italian community.
- Feasibility study of a long-term ground-based programme to measure to measure CMB B-modes at low frequencies for implementation in a ~10-15yr time scale, with maximum science return for the Italian community.
- Development of an atmospheric model capable of evaluating the impact of atmosphere on low frequency measurements (including polarization) from different observing sites.
- Survey of current and future capabilities in the field, identifying strategic opportunities in Italy and through international collaboration.

5. SCHEDULE

First Year, t0+6 months

- Review of state-of-the-art in Italy on low frequency critical technologies
- Review of synchrotron and CMB polarization models and data
- Preliminary simulations of atmospheric effects and new atmospheric model.
- Preliminary design options for the MTGB

First Year, t0+12 months

- Complete review of state-of-the-art in Italy and worldwide on low frequency critical technologies
- Complete review of synchrotron and CMB polarization models and data
- Preliminary feasibility of extension to Ka and Q band of Italian bolometer technology
- Complete atmospheric model.
- Design options and trade-offs for the MTGB experiment: choice of observing site, frequencies, technology, optical system, preliminary scanning strategy.

Second year, t0+18 months

- Complete preliminary design of MTGB experiment
- Design and construction of prototypes of selected key units for the MTGB experiment polarization measurement
- Complete scientific assessment of foregrounds and CMB for the LTGB experiment (in collaboration with…)

Second year, t0+24 months:

- Complete design of MTGB experiment
- Design and construction of prototypes of selected key subsystems for the MTGB experiment polarization measurement
- Design options and trade-offs for the LTGB experiment: choice of observing site, frequencies, technology, optical system, preliminary scanning strategy.

Third year, t0+30months:

- Performance test of key units and subsystems for the MTGB experiment
- Performance test of key subsystems for the spectral measurement
- Preliminary design of the LTGB experiment.
- Preparation of data analysis for MTGB (in collaboration with…)

Third year, t0+36months:

- Final design of LTGB
- Complete scientific assessment of LTGB