Strategic solutions for new CMB detectors

COSMOS Feasibility Study

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WP 6-6x1 outputs

- Survey of the present detector technology for application to CMB studies

- Present and Future projection of the CMB detector technologies

- Present and Future of the detector for CMB: a strategic study for the next experiments.

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Outputs outline

1. A review of the physics detection principle

2. Qualification and Selection

3. Performance predictions

4. Possible Instrument design

A review of the physics detection principle: Thermal Sensors

- **Phonon mediated detectors.**

  Here the EM absorber and the thermal sensors are connected through a phonon link made of dielectric or other compound with low specific heat and high phonon transmission. The thermal signal is “filtered” by at least two electron-phonon barrier.

- **Electron gas mediated sensors**

  Here the EM absorber and the thermal sensors are connected through an electron gas link made of normal metal. The electron-electron transmission at the absorber-sensor interface. Diffusion process as reflection ad the interface lead the signal dynamic. TES, HEB, CEB micro or nanostructure are mainly belonging to this class.

A review of the physics detection principle: not thermal Sensors

- **Cooper pair breaking sensors**

  Superconductor cooper pairs binding energy can be tuned to be equal or lower than the EM photons in order to gives to quasi-particle creation by cooper breaking. Cooper breaking under the EM mm-wave radiation has been one of the elective method for studying superconductivity in the '60-'80. Most of the superconductivity's properties effect discovered in these years have been proposed as methods for detecting EM. This is the case of Superconducting-Insulator-Superconducting junction and the Kinetic Inductance. In the past other methods, like microwave "pumped" superconductor in a cavity in order to enhance the sensitivity, have been proposed<u>. Those methods are not always compatible with the CMB detection.</u>

- **Magnetic mediated sensor**

  There are at least two common methods for sensing the power released by EM radiation: the thermal perturbation of the spin gas under a small Zeeman splitting and the changes of the magnetic penetration depth of a superconductor. The first method is based on the fine tuning of the Shottcky anomaly of a paramagnetic material. The second method is based on the generation of small magnetic field in proximity of superconductor film. The penetration depth is changing fast with the temperature at the S/N transition. Typically the field generator works also as transducer.

- **Mesoscopic system as sensor**

  These are quantum dots and similar systems that can be seen as "simulated atoms" that are excited by the EM radiation. Microwave photons can excite the coherent electronic state form lower to higher energy Landau levels of quantum dots. The decay through electron emission and consequent charge change of the Q dot gives rise to a sizable electrostatic potential energy. Among many configurations the change of potential energy can be amplified with Single Electron Transistor. There are several configuration proposed for detecting from few photons to high EM flux. The field of mesoscopic devices rapidly changing and commercial application are mainly devoted to photonics.

- **Coherent detection**

Qualification and selection: monitored parameters

- Responsivity
- NEP
- Polarization sensitivity
- EM coupling
- Operating Temperature
- Readout Scheme and electronics
- Dynamics

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