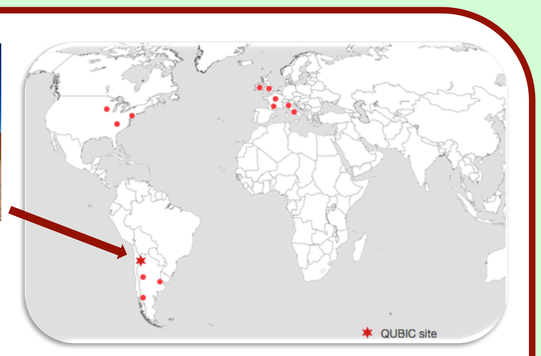
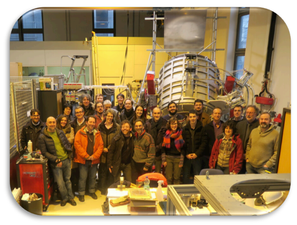
QUBIC

a Q & U Bolometric Interferometer for Cosmology



E.S. Battistelli for the QUBIC collaboration

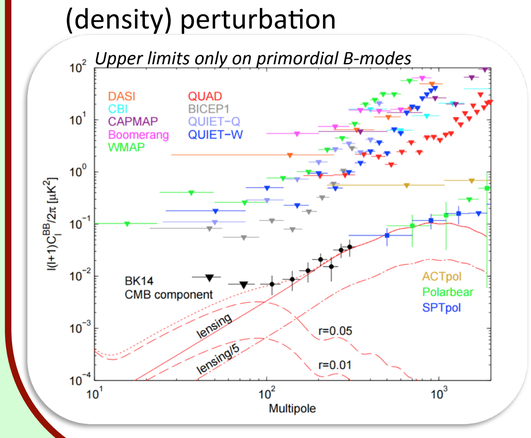


Abstract

The Q & U Bolometric Interferometer for Cosmology, QUBIC, is an innovative experiment designed to measure the polarization of the Cosmic Microwave Background and in particular the signature left therein by the inflationary expansion of the Universe. The expected signal is extremely faint, thus extreme sensitivity and systematic control are necessary in order to attempt this measurement. QUBIC addresses these requirements using an innovative approach combining the sensitivity of Transition Edge Sensor cryogenic bolometers, with the deep control of systematics characteristic of interferometers. In this contribution we report a description of the QUBIC instrument including recent achievements and the demonstration of the bolometric interferometry performed in lab. QUBIC will be deployed at the observation site in Alto Chorrillos, in Argentina at the end of 2019.

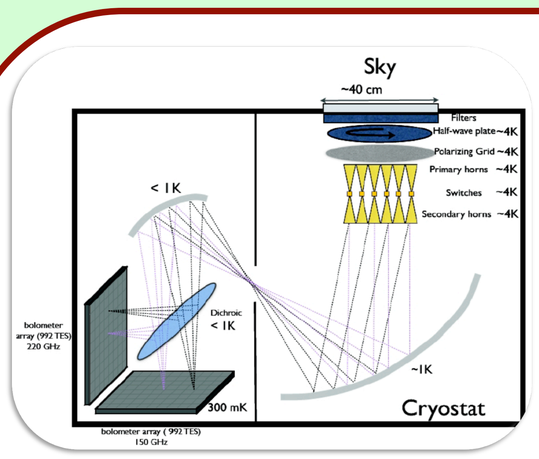
INFLATION FOOTPRINT

- Cosmic Inflation: an exponential acceleration of the Universe at 10^{-35}s is invoked in the Cosmological Standard Model to solve its main *paradoxes*
- A stochastic background of gravitational waves (GW) is predicted within the Inflationary paradigm
- The CMB can be used as a giant antenna to detect this background of GW through a curl component of CMB polarization: B-modes
- The energy scale of the Inflationary field is directly connected to the ratio r between the tensor (GWs) and the scalar (density) perturbation



$$V^{1/4} \approx \left(\frac{r}{0.01}\right)^{1/4} (10^{16} GeV)$$

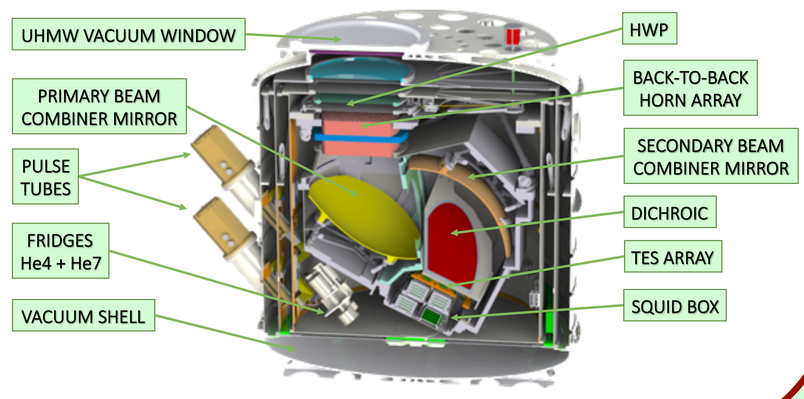
r≅0.01 would imply an energy scale close to that of grand unified theories



QUBIC

The signal from the sky is detected after having gone through several optical components, all located within the QUBIC cryostat. Before being detected by two arrays of TES', radiation goes through:

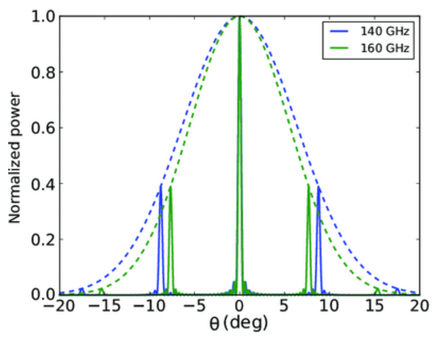
- a 50cm diameter, 20mm thick UHMW Polyetilene window;
- a rotating HWP + a polarizing wire grid to form a Sotkes polarimeter;
- an array of 400 back-to-back corrugated horns;
- a dual mirror beam-combiner;
- a dichroic filter able to separate the two QUBIC observational bands;
- thermal and band-pass quasi-optical filters on each of the thermal stages of the cryostat.



BOLOMETRIC INTERFEROMETRY

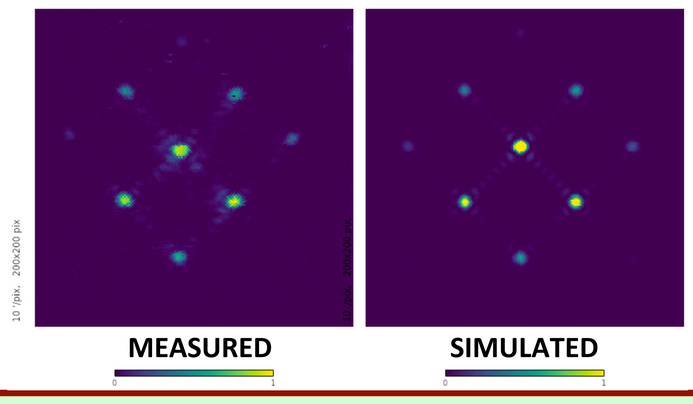
SPECTRAL CAPABILITY

- The effective synthesized beam depends on the frequency



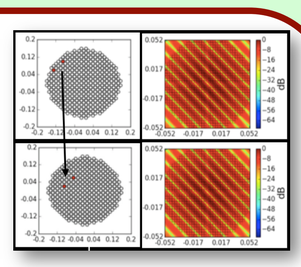
SYNTHESIZED BEAM

- Each horns pair defines a *baseline*, i.e. a Fourier mode of the Sky, and forms interference fringes on the focal planes
- The sum of all baselines defines the synthesized beam

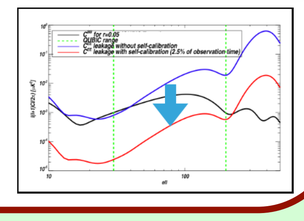


SELF-CALIBRATION

- Equivalent baselines should produce the same fringe patterns in absence of systematics.



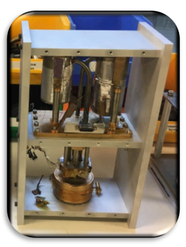
- In this way systematic effects from the beam, optics, misalignments can be identified and corrected.



CRYOGENIC SYSTEM

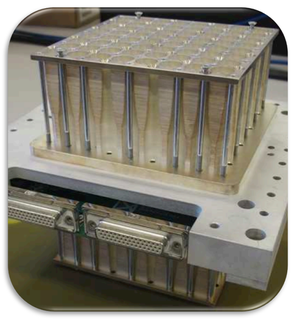
A large (1.4m×1.55m[h]) aluminum vacuum shell cryostat:

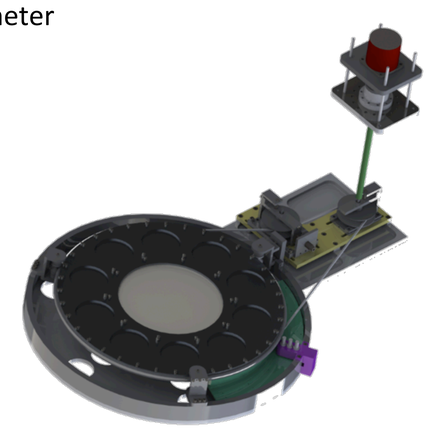
- two pulse tube to cool a large volume (~ 1m^3) at 4K with 0.9W cooling power each (first thermal stage of ~40K);
- radiation shields coated with MLI;
- a ^{4}He closed cycle evaporation refrigerator to cool to the 1K-optics-box (with the beam-combiner and the dichroic filter);
- a mechanical heat switch and two convective heat switches to pre-cool the optics box;
- a ^{3}He+^{4}He (^{7}He) closed cycle evaporation refrigerators to cool down at 0.3K the detector arrays.

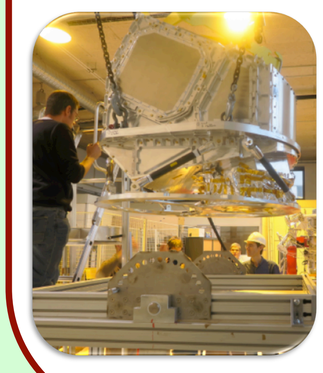


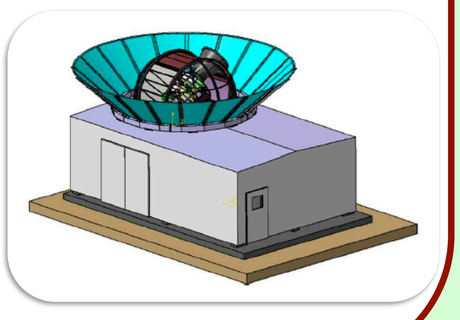
OPTICS

- 400 co-aligned back-to-back horns fabricated using the platelets technique with a RF switch between the two
- a double mirror beam-combiner after which a dichroic filter to split between the 220GHz and the 150GHz array of detectors
- a rotating HWP (stepped) and a polarizing wire-grid to form a Stokes polarimeter



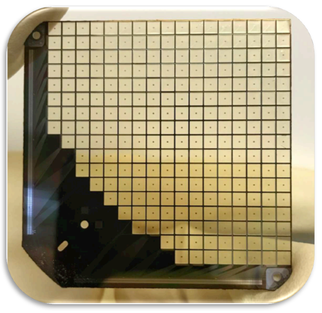


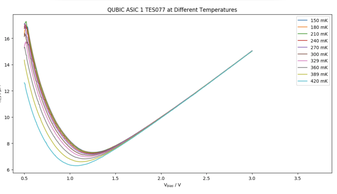


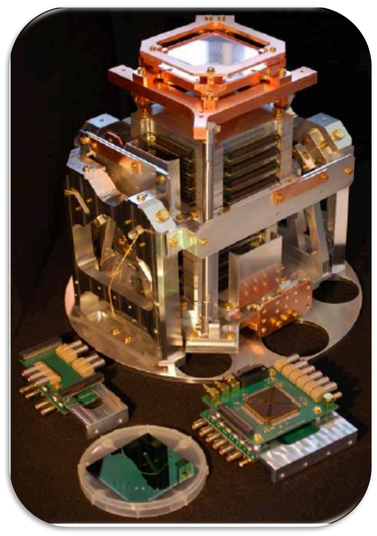


DETECTION CHAIN

- Four 256-pixels arrays of Nb_xSi_{1-x} TESs with T_c~500mK;
- P_{opt}~5-50pW; G~ 50/500pW/K. NEP~$5\times10^{-17} W/Hz^{0.5}$, t~10/100ms;
- Readout based on SQ600S1 SQUIDs width 128:1 TDM using cryogenic ASIC







Check Piat et al; Marnieros et al. in these proceedings.

QUBIC is supported by:

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