The future of COSMO (the COSmic Monopole Observer)

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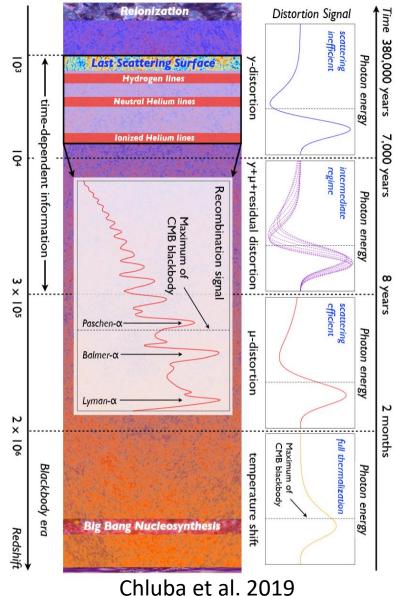






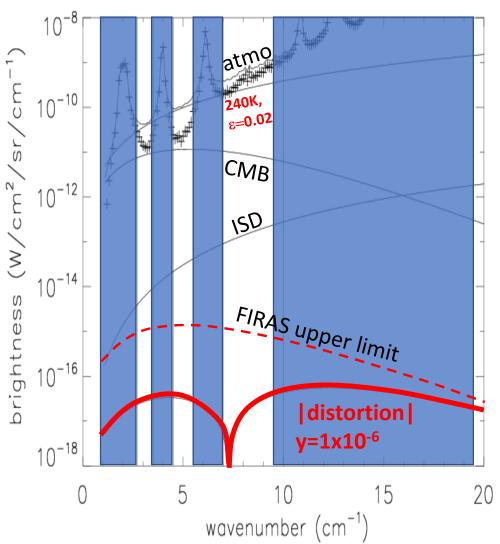
Spectral Distortions of the CMB

- CMB Spectral Distortions represent a research path orthogonal and synergic to CMB polarization studies.
- Promising to shed light on:
 - Cosmic Reionization
 - Physicws of recombination
 - Dark matter & Energy releases in the primeval fireball
 - Very Early Universe and Cosmic Inflation
 - ... much more
- Current upper limits for spectral distortions are at a level of 0.01% of the peak brightness of the CMB [COBE – FIRAS:, Mather et al. (1990) Ap.J.L. **354** 37, Fixsen et al. (1996) Ap.J. **473** 576)] >20 years ago !
- The final measurement must be carried out from space. PIXIE, CORE proposals being reiterated.
- Meanwhile, ground and near-space efforts are useful to test and refine methods, and possibly to detect the largest distortions.



The observable is small, compared to ... everything.

- Distortion signals are guaranteed to exist, but are very small compared to:
 - detector noise,
 - instrument emission,
 - atmospheric emission and its fluctuations,
 - foregrounds,
 - the CMB itself.
- Intelligent measurement methods required: Experimentalists way behind theorists.
- **COSMO** is a pathfinder experiment, ground-based in the first implementation, and balloon-borne in its second step
- It does not target at the smallest distortions, but tries to exploit at best existing, relatively cheap opportunities.



Absolute measurement approach

COSMO

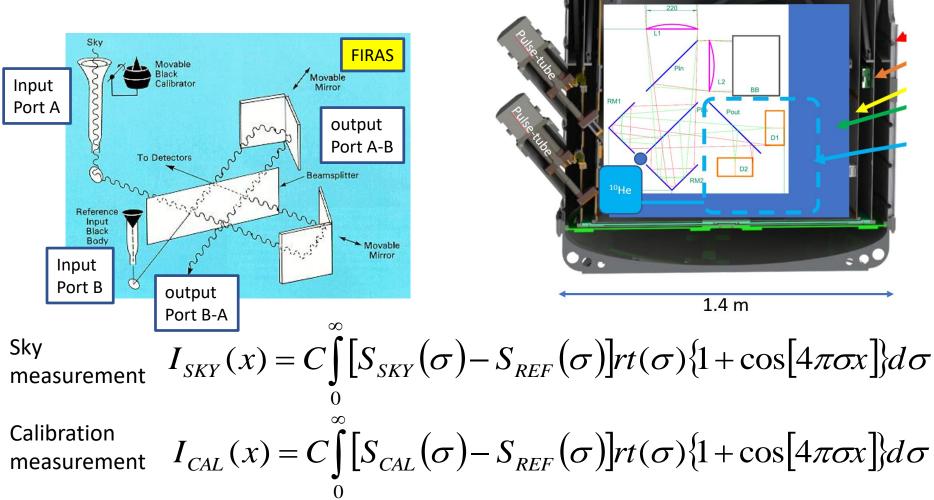
window

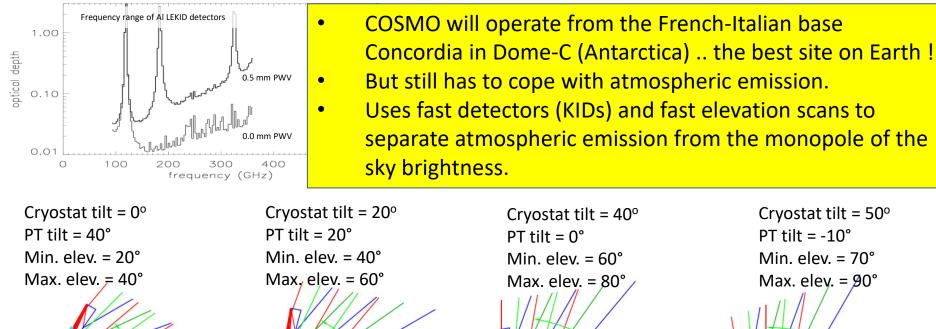
Thermal filters

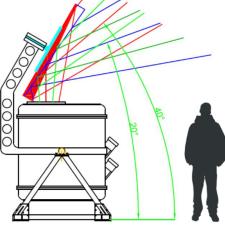
Mechanism for

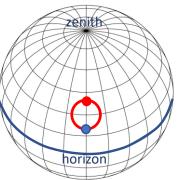
external calibrator

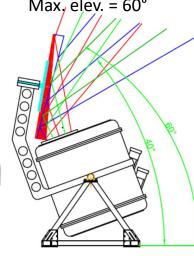
- The Martin-Pupplett Fourier Transform Spectrometer used un FIRAS and PIXIE has two input ports.
- The instrument is intrinsically differential, measuring the spectrum of the difference in brightness at the two input ports. Normally one port looks at the sky, the other one at an internal reference blackbody.
- For calibration, a movable blacbody fills the sky port.

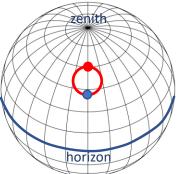


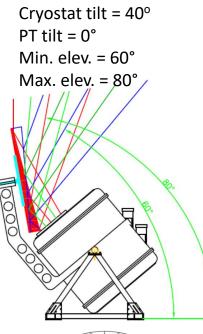


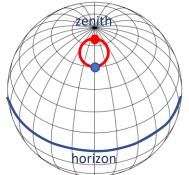


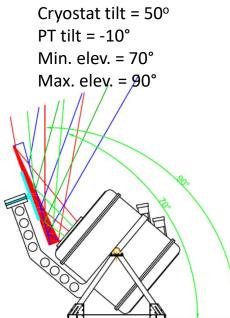


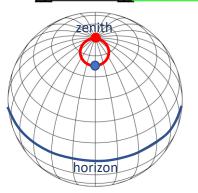




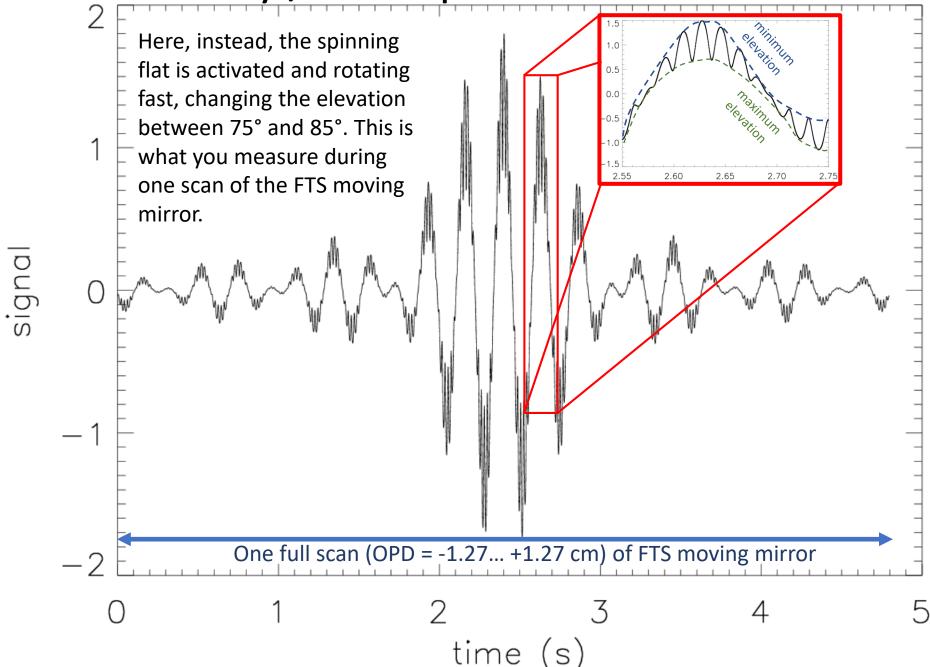




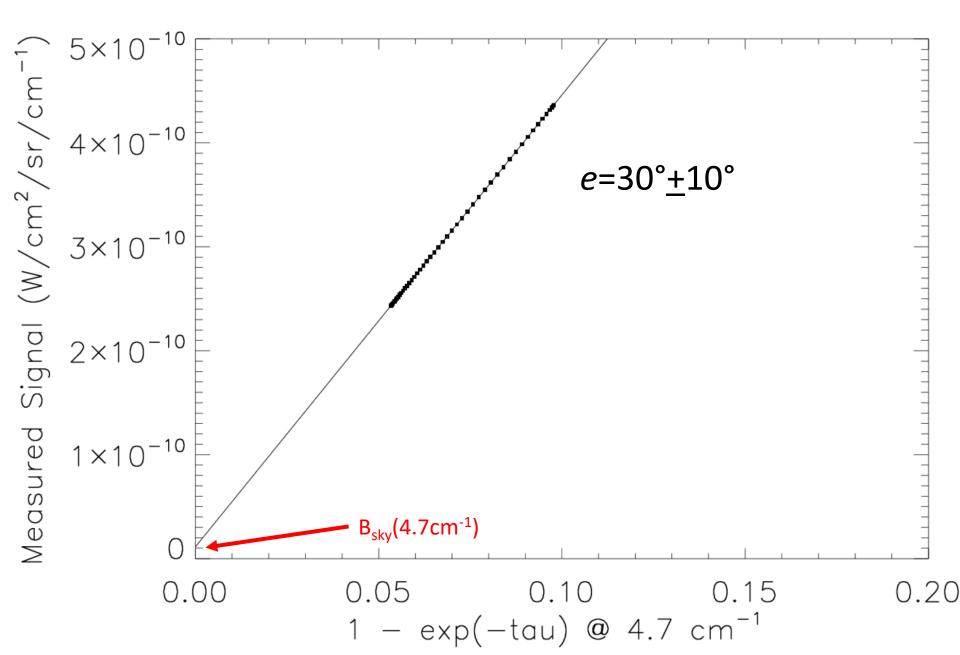




COSMO sky / atmosphere scan simulations

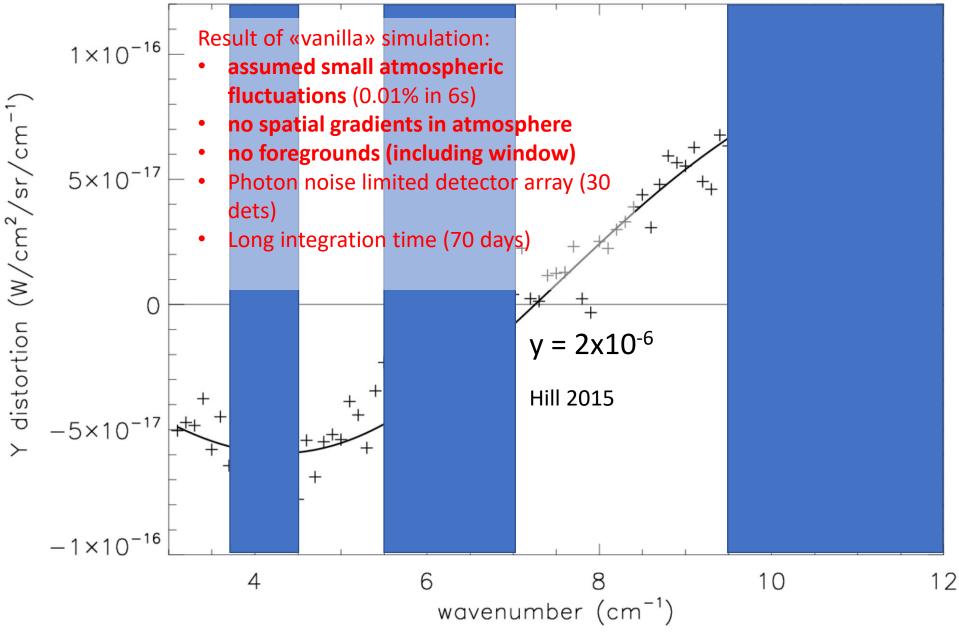


COSMO sky / atmosphere scan simulations



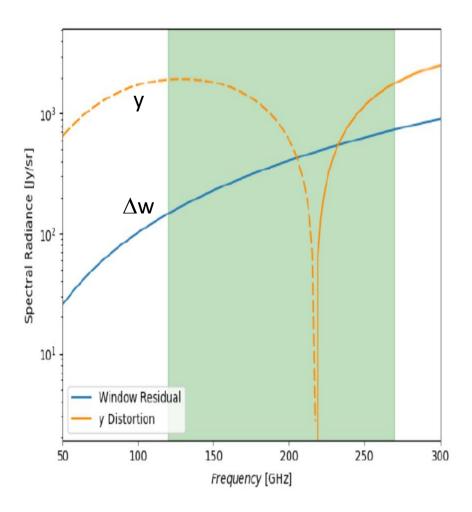
COSMO sky / atmosphere scan simulations





COSMO window emission

- Window (& mirror) common mode emissions must be measured and removed with high accuracy.
- Special calibration procedure based on the comparison of the emission from 1 or 2 windows stacked.
- PhD thesis, Lorenzo Mele
- Preliminary results:



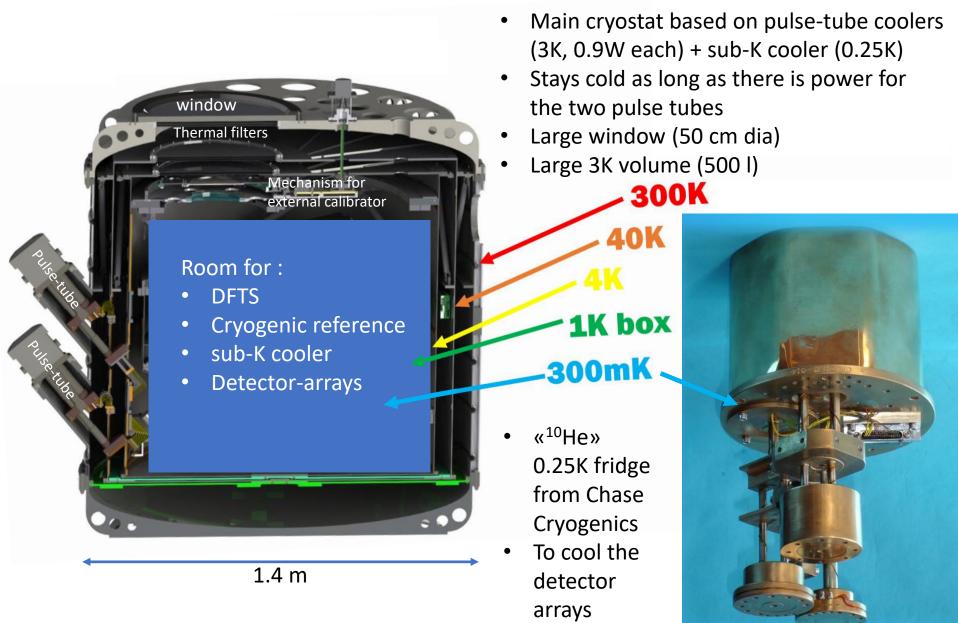
COSMO continuous cryogenics



COSMO continuous cryogenics

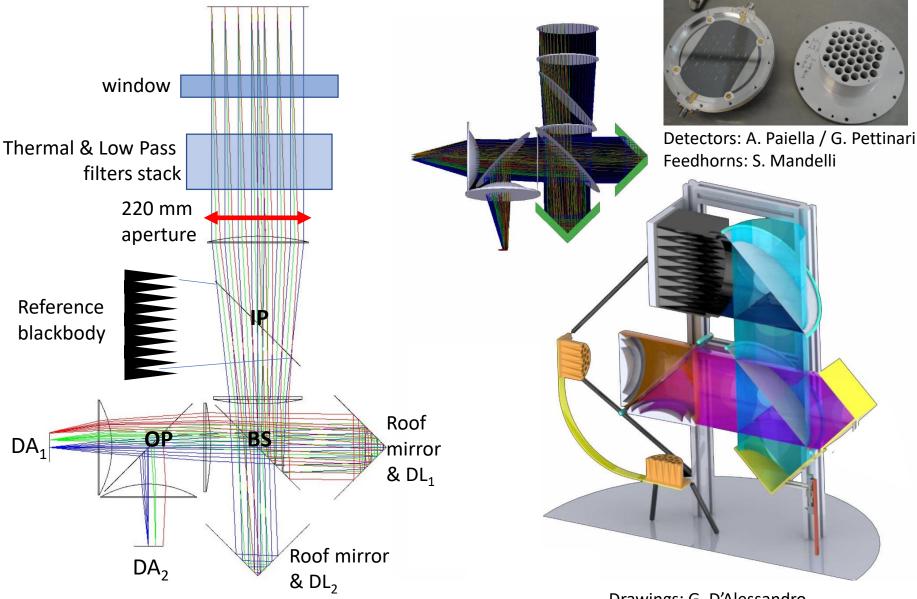


COSMO continuous cryogenics



COSMO Martin-Puplett interferometer:



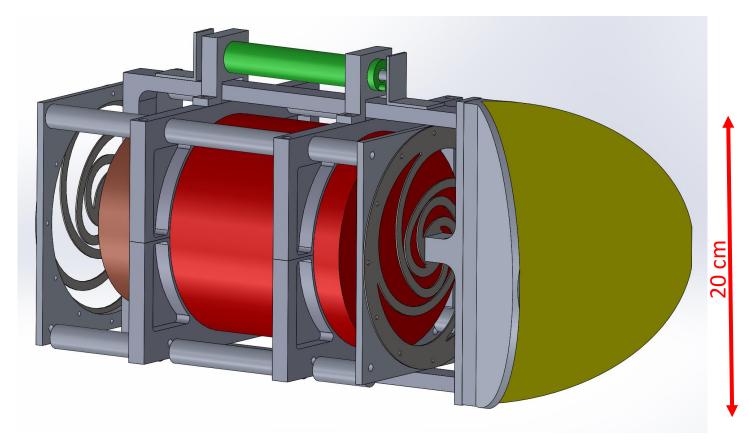


Drawings: G. D'Alessandro

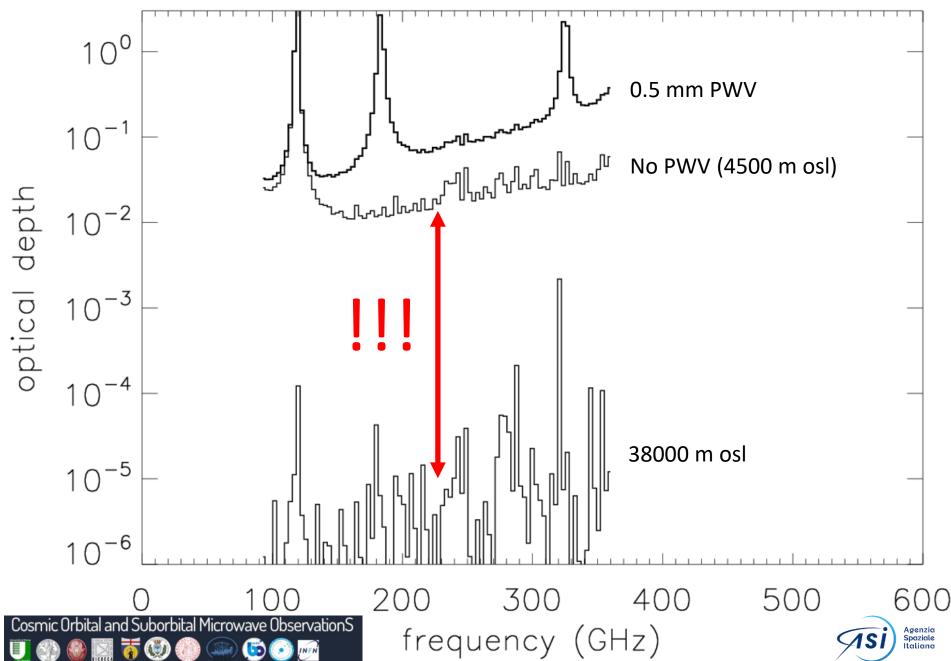
COSMO Martin-Puplett interferometer: implementation ideas

Cryogenic scanning roof mirror (spectral modulation, slower than sky dip)

- Max mechnical range = -10 mm ... + 40 mm corresponding to max 3.75 GHz resolution
- Max scanning Speed 7 mm/s i.e. one interferogram in 6 s (atmospheric stability)
- Voice coil actuator, low power dissipation on cryogenic system
- LVDT position sensor, 5 μ m resolution at maximum speed



The future of COSMO: a balloon-borne instrument



The future of COSM O: a balloon-borne instrument

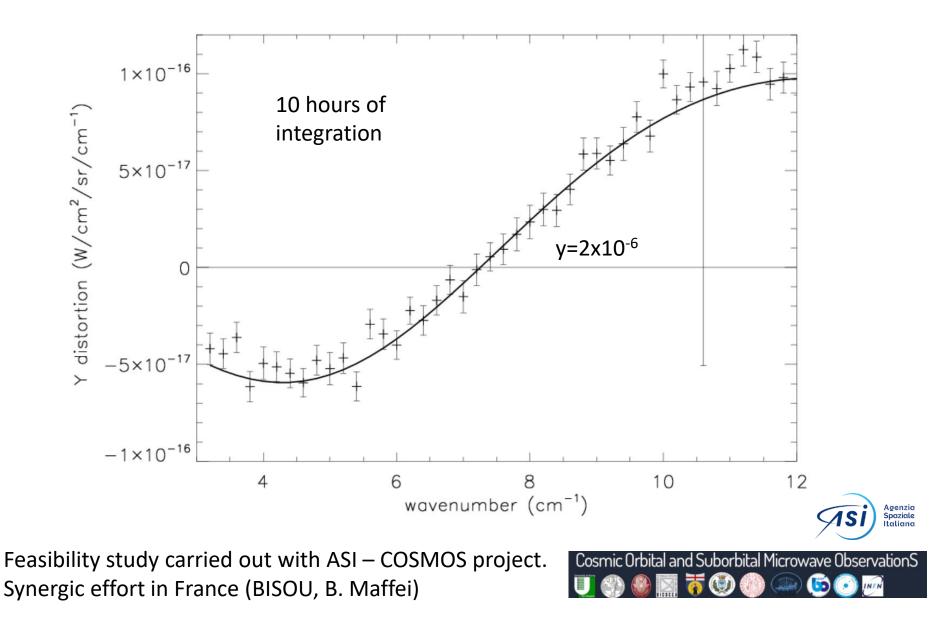
- LSPE LDB payload http://planck.roma1.infn.it/LSPE
- Works in the polar night
- Suitable cryogenic system
- Possible to add (slower ?) modulator, if needed
- Might gain a factor 10.

Cosmic Orbital and Suborbital Microwave ObservationS

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The future of COSMO: a balloon-borne instrument



Conclusions

- COSMO is a first attempt to measure the spectral distortions of the CMB monopole from the ground.
- It beats atmospheric noise and measures atmospheric emission using fast modulation and detectors.
- If this strategy is effective, the sensitivity is enough to measure the largest spectral distortion, arising from comptonization at recombination / reionization / ionized baryons in the universe.
- It paves the way to more accurate measurements with the same approach, to be carried out on a stratospheric balloon (see also the synergic proposal BISOU)
- Can (and should) be complemented with low-frequency monopole spectral distortion measurements (e.g. The Tenerife Microwave Spectrometer (TMS) or the Array of Precision Spectrometers for the Epoch of RecombinAtion (APSERa/DISTORTION).