The E and B Experiment (EBEX): Overview and status

Michael Milligan and the EBEX Collaboration

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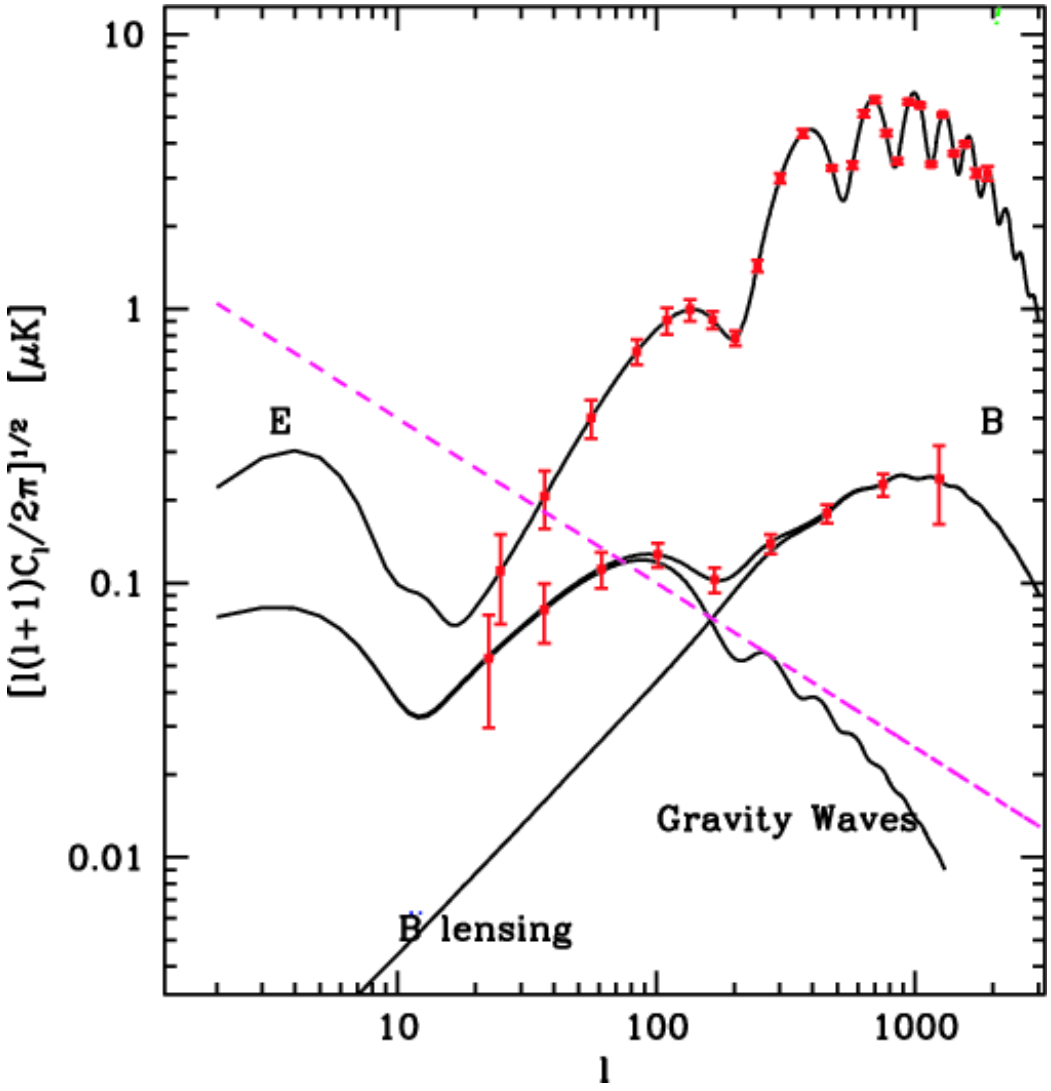
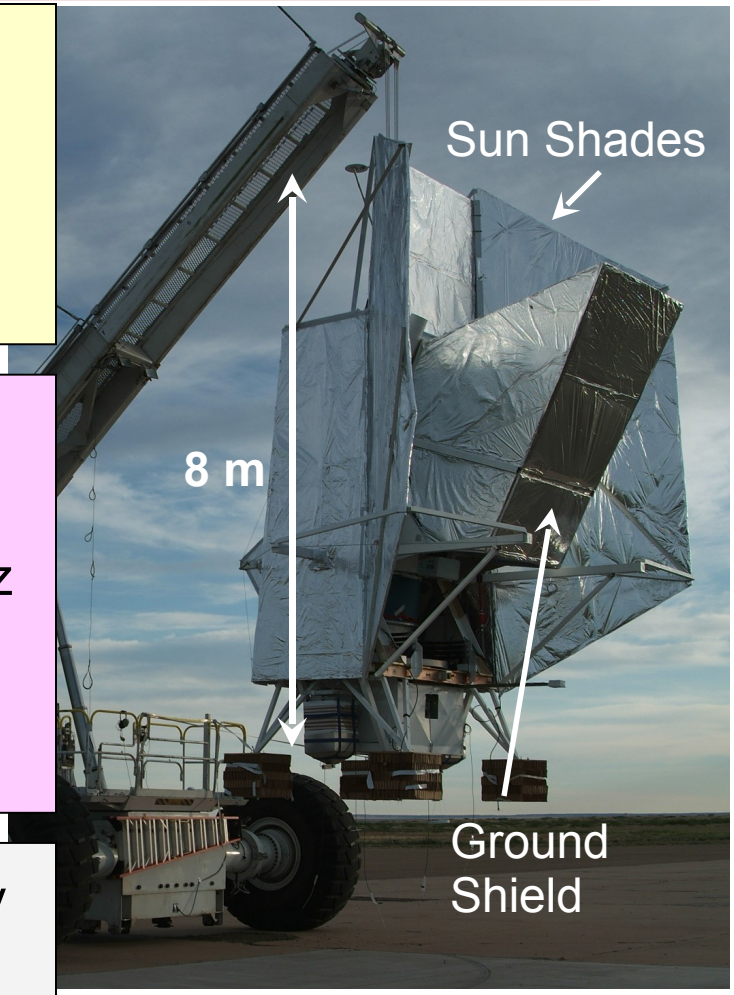
Science Goals

- Detect or set upper bound on B-mode
- Detect the lensing B-mode
- Determine properties of polarized dust



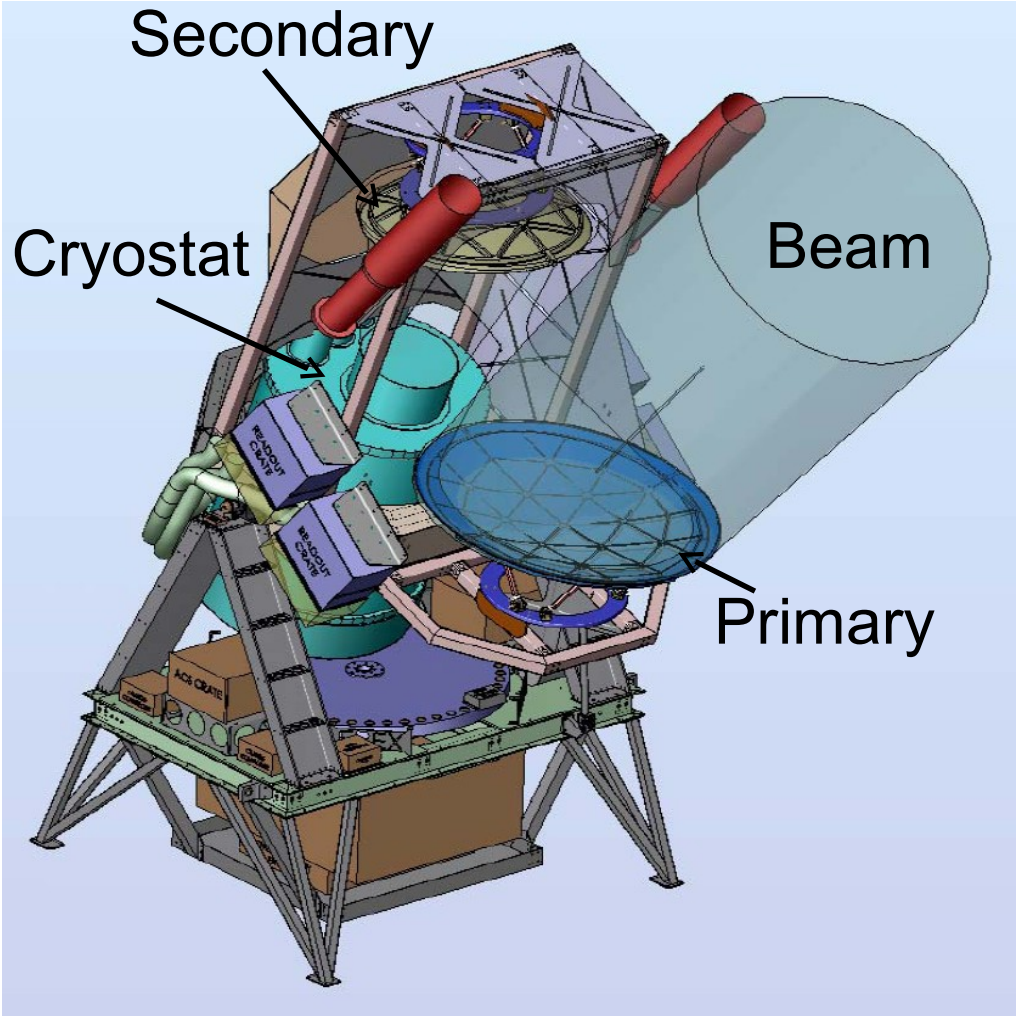
EBEX Instrument Summary

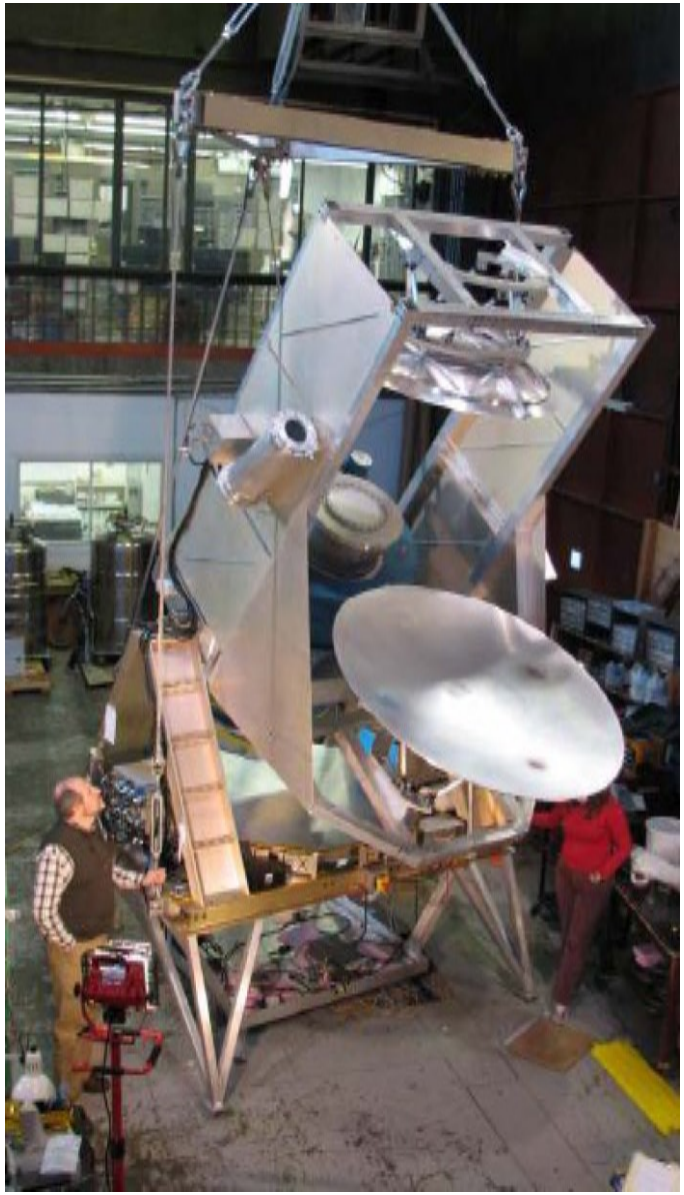
1. High Sensitivity	• 1432 TES bolometers • 1st balloon implementation of these bolometers • 14-day flight, Antarctica
2. Foreground Discrimination	• Deal with only dust foreground • 3 bands:150, 250, 410 GHz • Broadest range of any suborbital CMB experiment
3. Systematic Error Mitigation	• Half-wave plate polarimetry • Continuous rotation • Strong heritage in astrophysical polarimetry



EBEX instrument in Ft Sumner, NM

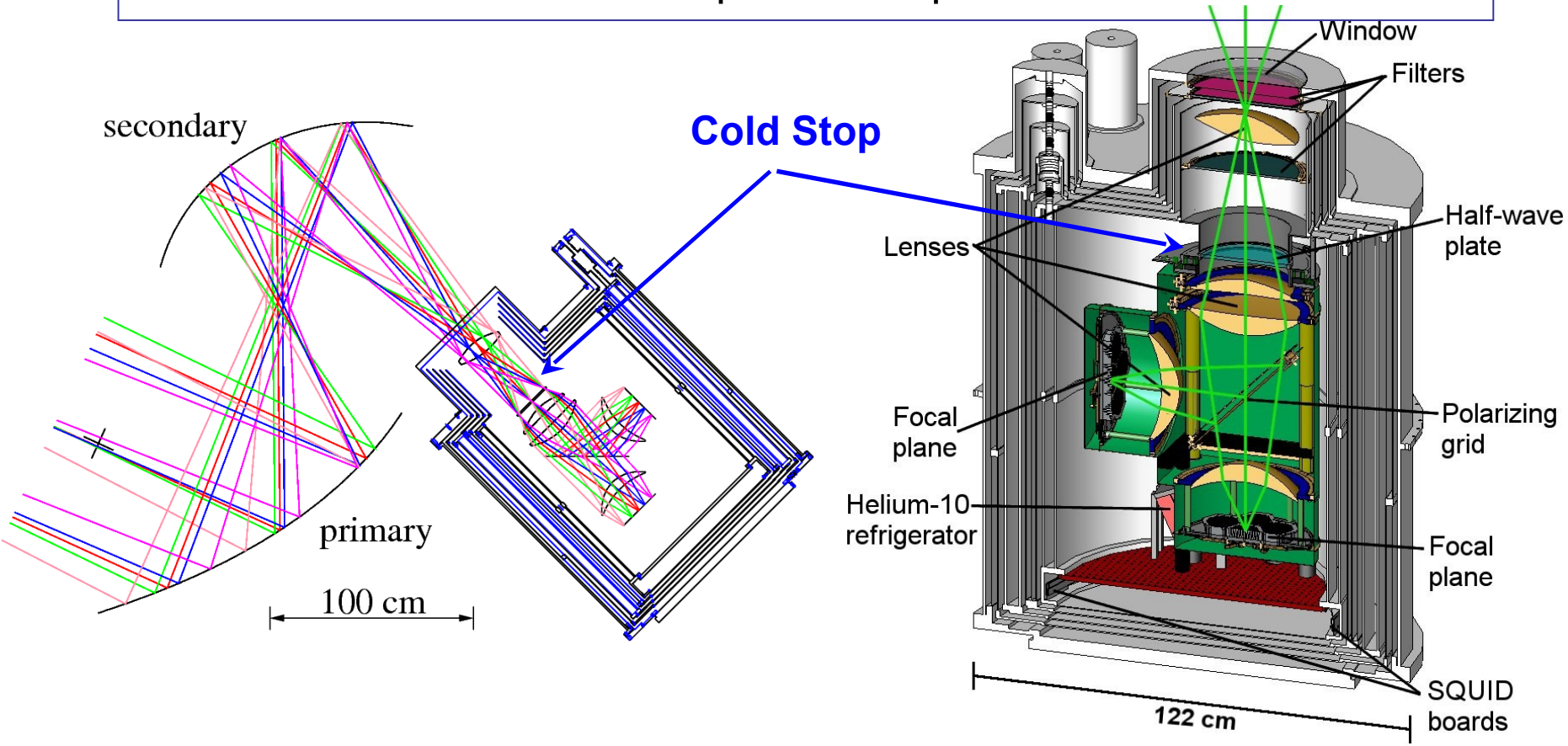
Instrument





Optics

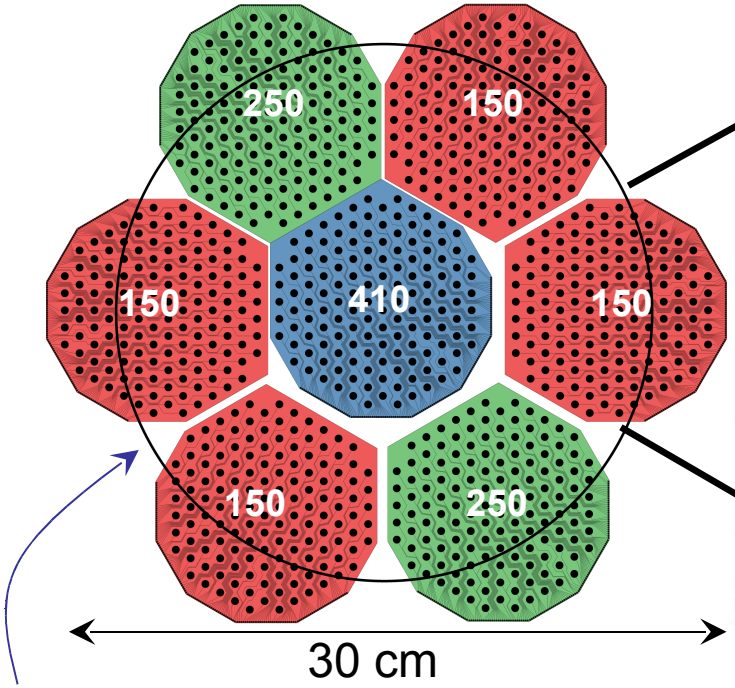
- Lensing B-mode: 1.5 m aperture Gregorian Dragone telescope
- Control of sidelobes: Cold aperture stop



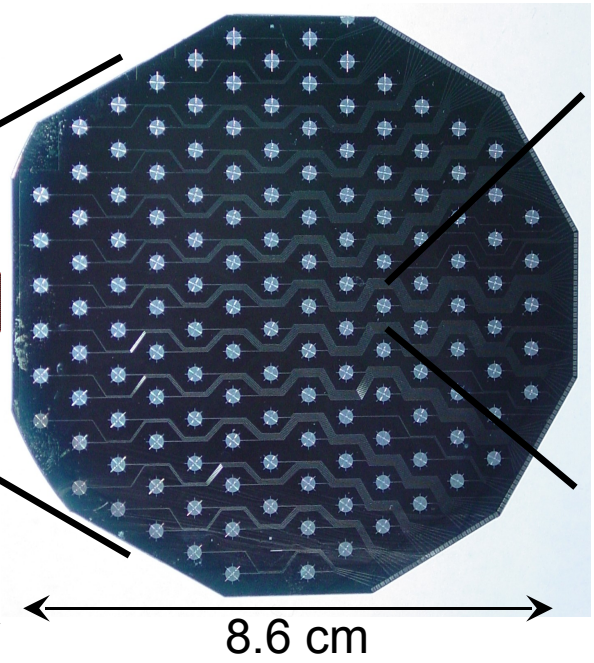
- Polarimetric systematics: Half Wave Plate
- Efficiency: Detection of two orthogonal states

Focal Plane

716 element array

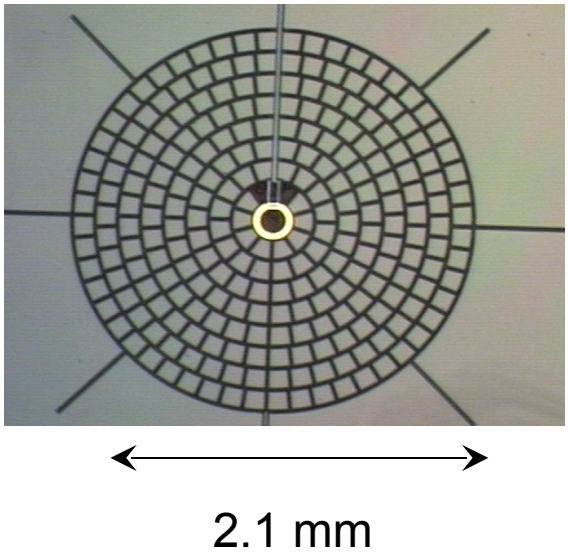


140 element decagon



Single TES

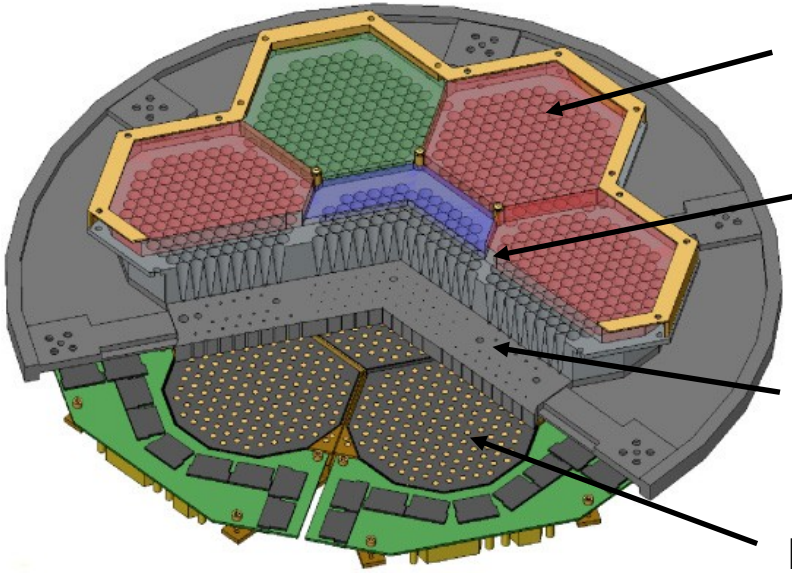
Meng, Lee, UCB



Strehl>0.85 at 250 GHz

- Total of 1432 detectors
- Maintained at 0.27 K
- 3 frequency bands/focal plane

Focal Plane Assembly

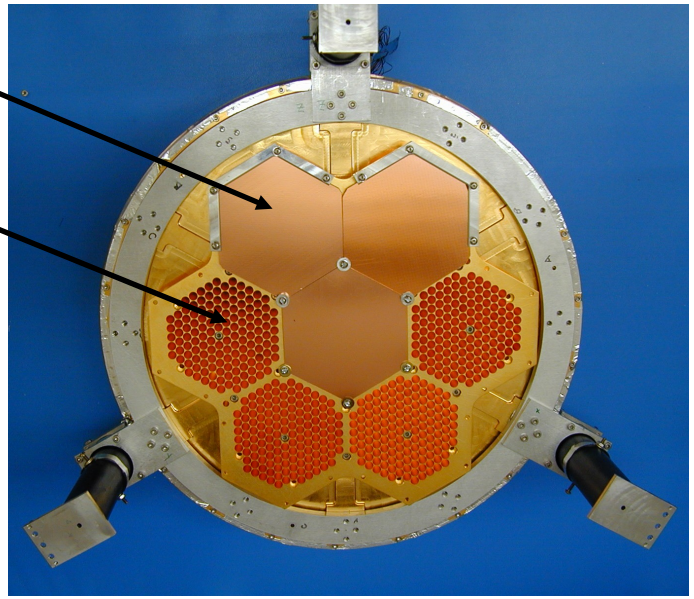


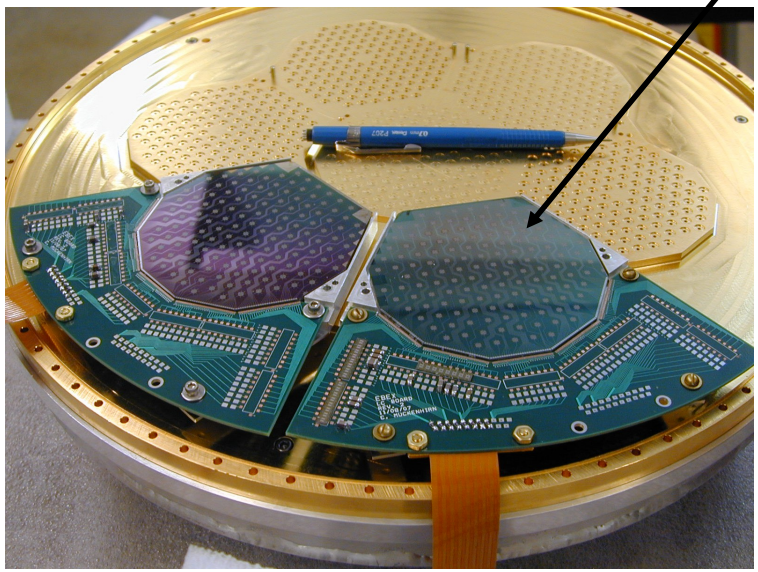
Filters

Conical Feeds

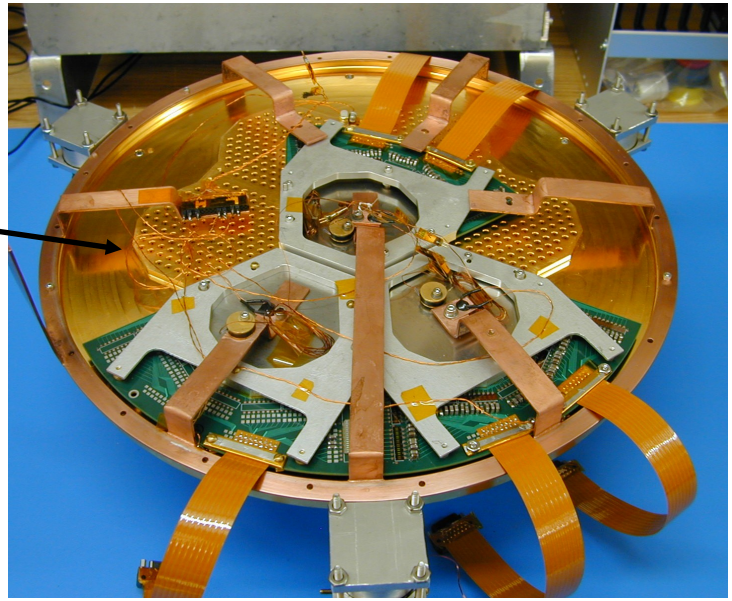
Wave Guides

Detectors + wiring



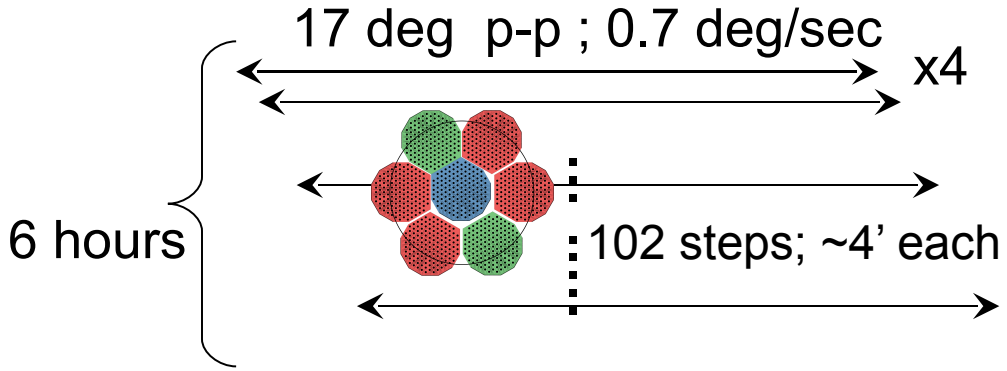


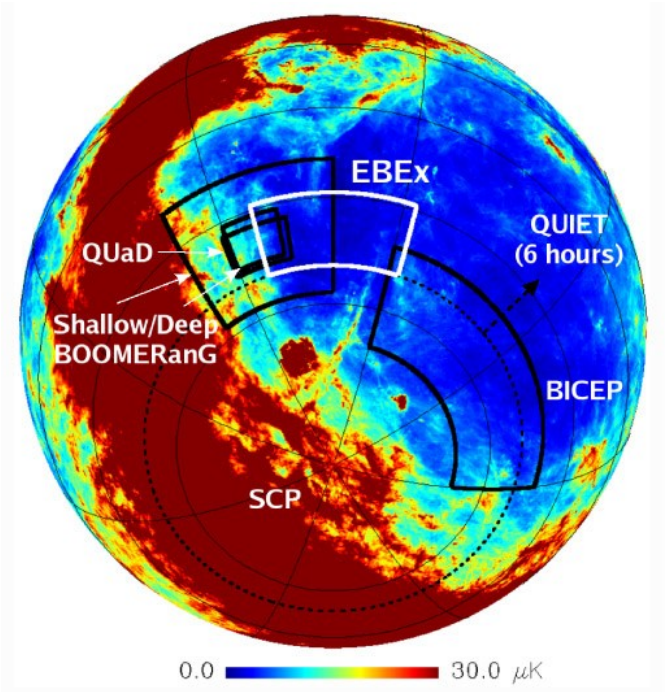
Bottom View



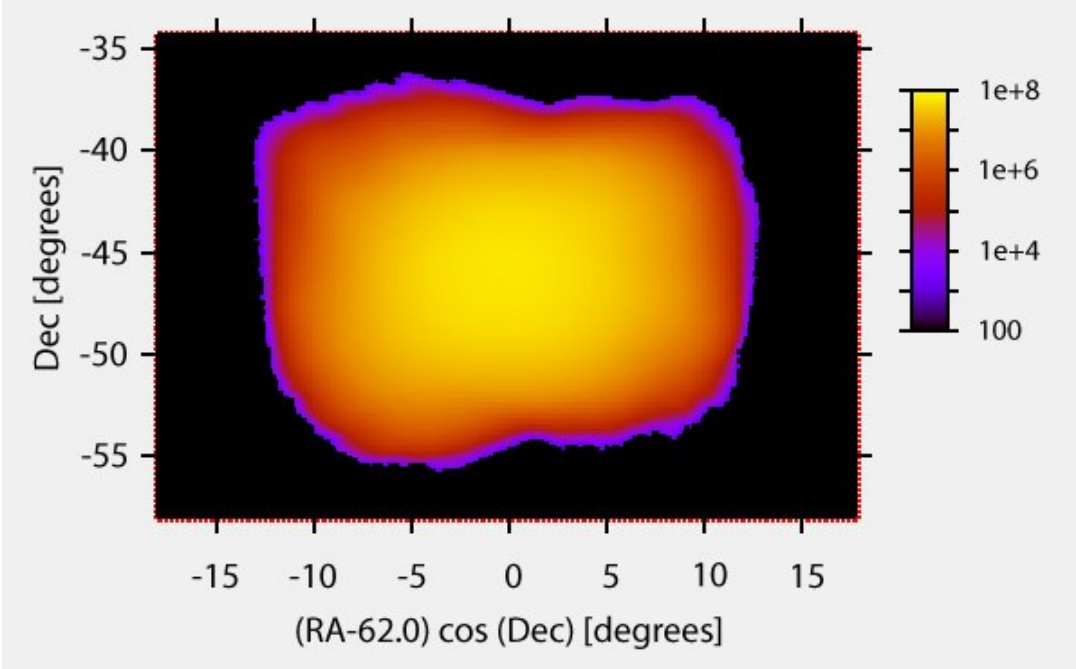
EBEX Scan

- Constant elevation
- Speed: one Q,U per ¼ beam
- Multiple visitations per pixel
- Relatively uniform coverage
- Up to 10^8 samples/beam





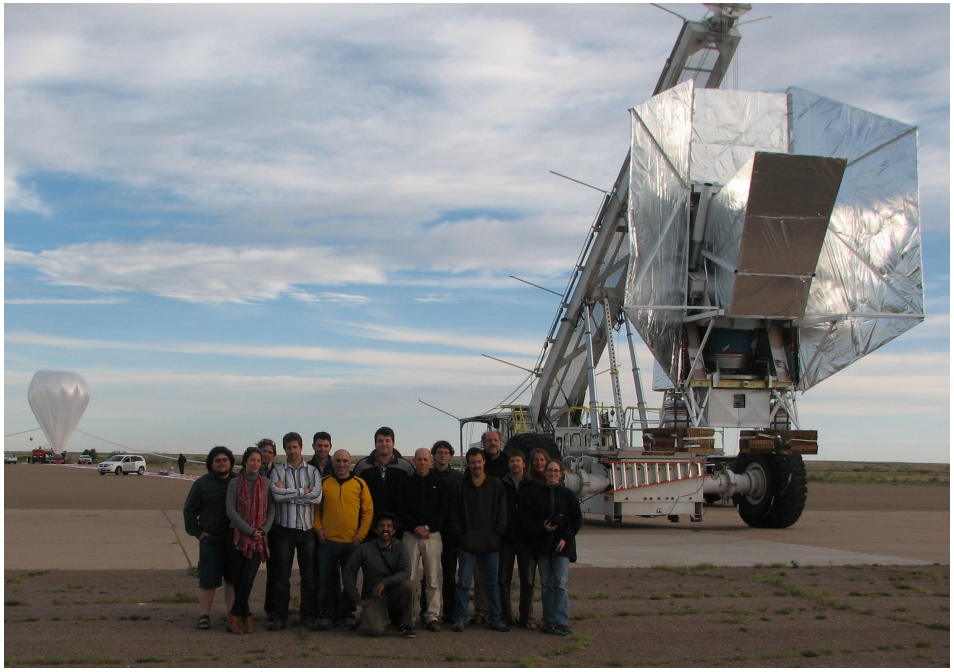
796 detectors, 14 Days



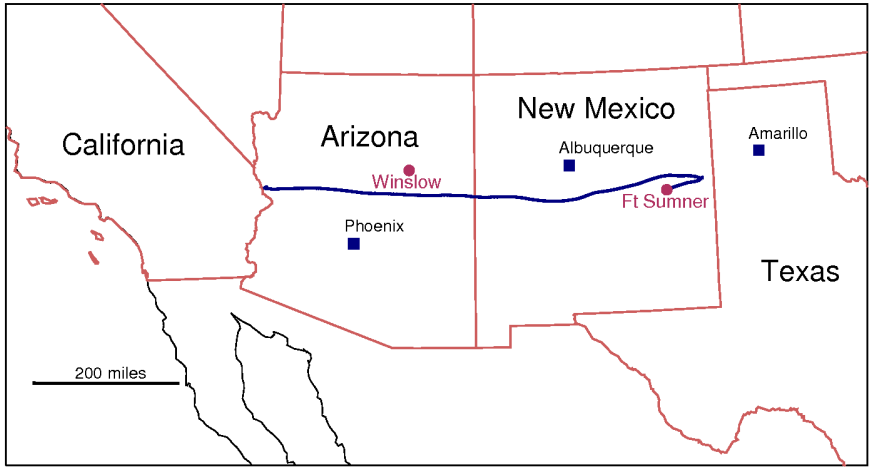
EBEX Status

- Goals for test flight:
  - Test optical system
  - Test day time operation
  - Test TES detectors at float
  - Test remote operation of TES + SQUID readout system

North American Test Flight, June 11, 2009



EBEX Test Flight, 11th June 2009



~10 hours at float

~35 km

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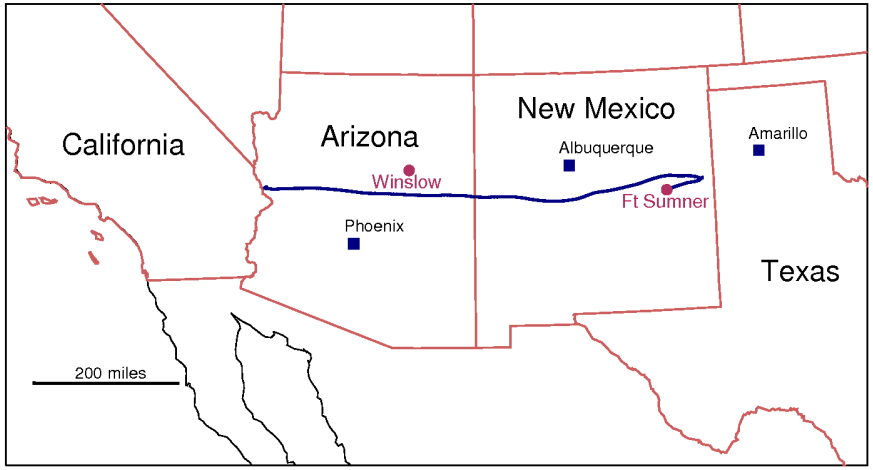
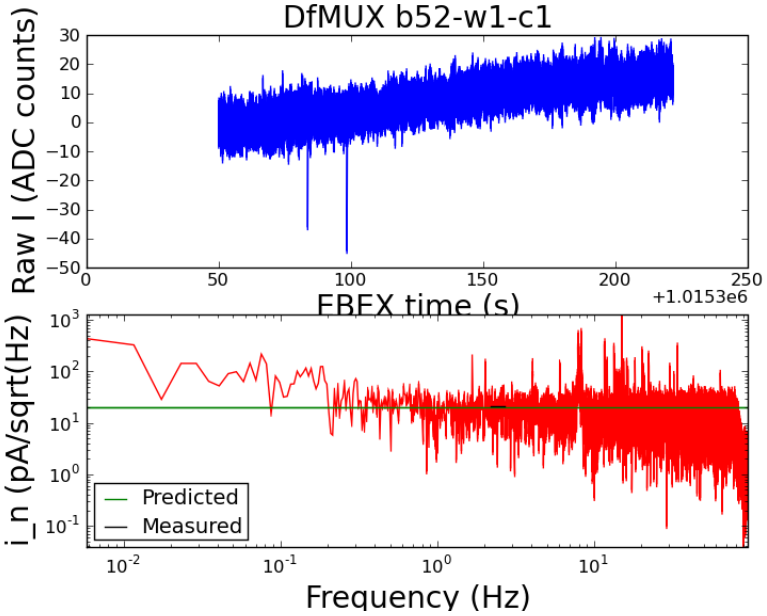
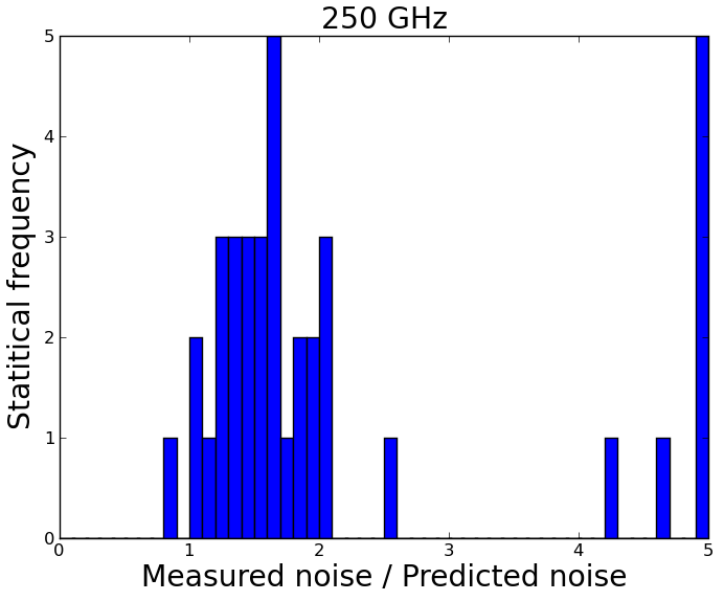


~10 hours at float

~35 km

TES Bolometers at Float





- Operated 82, 49 and 82 detectors at 150, 250 and 410GHz.
- Bolometers dropped in transition at float.
- First TES bolometers operated in space-like conditions.

- Nominal performance achieved for best detectors.
- Average detector noise 60% too high (under investigation).
- Planet, dipole and CMB scans performed.

Summary

- EBEX = Long duration balloon borne experiment

- Science: Inflation B-mode; lensing B mode, Galactic dust

- 1432 bolometric TES; 150, 250, 410 GHz; 8’ at all frequencies

- ~24,000 pixels over 1% of the sky, ~1 μK/8’ pixel – Q/U

- Polarimetry with half wave plate

- Completed a successful test flight

- Preparing for Antarctica