SAT Calibration Plan

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SAT Calibration Plan

Based on experience from previous generations of SATs, design specialized hardware to

- Validate SAT performance during commissioning
  - Do responsivity, beam shapes, etc. look reasonable?
- Measure instrument parameters to well-defined precision, in lab and *in situ*
  - Bandpasses, beam shapes, polarization angles…
- Probe potential instrumental systematics relevant to the *r* measurement
  - T->P, E->B, sidelobe pickup…

Calibration should be built into the SAT design and schedule!

- Mounting points (in lab and *in situ*), cranes...
- Should understand measurement SNR to plan calibration campaigns

SAT Calibration Plan

To develop our calibration plan, we need to:

- Survey heritage calibration strategies
  - What does/doesn’t work? Why?
- Define calibration hardware to be built
  - Validation of hardware
- Set calibration requirements for SAT verification
  - In-lab: determining whether something is field-worthy
- Set calibration requirements for science
  - Flowdown from science requirements
  - Simulations informed by heritage calibration data
  - Feeds into on-site calibration strategy, timing, etc.

Defining Calibration Requirements

For each measurement, write down

- A well-defined metric
  - What apparatus is needed? How to derive the metric from data?
- Acceptable measurement uncertainty on that metric
- Range of acceptable values
  - To be deployed
  - To be used in science analysis
  - Impact of not meeting requirements (sensitivity, systematics)

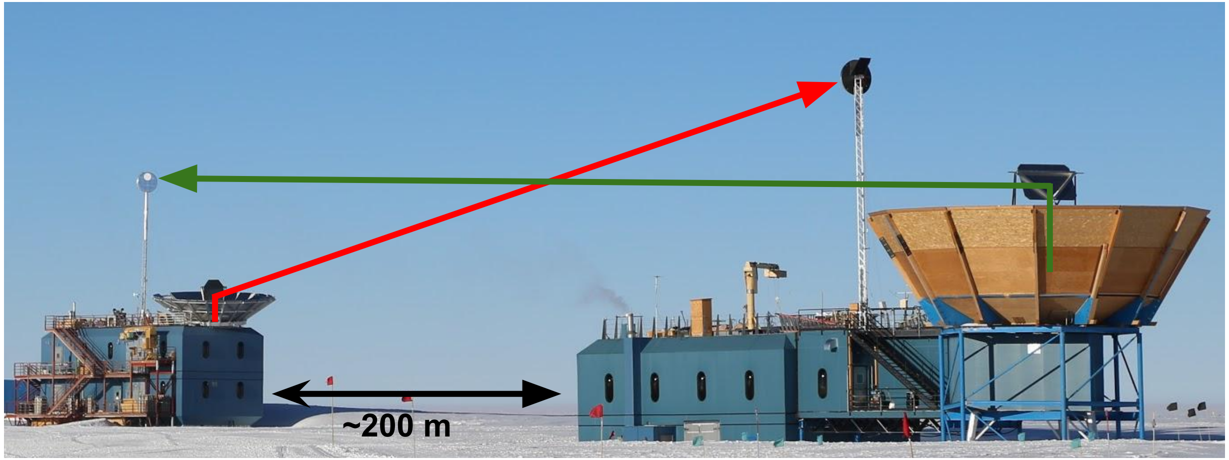
How to figure out the above...

- Heritage analyses good starting point (in some cases can be scaled easily)
- Full sims likely too unwieldy for quick iteration, designing apparatus, etc.
- What quick-turnaround tools exist?

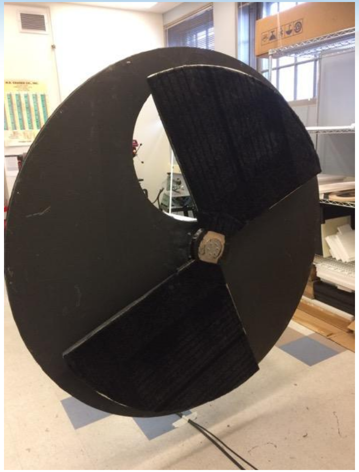
Measurement -> Hardware

Things to measure	**Hardware**
Main beams	Near-field beam mapper
	Large thermal chopper
	Far-field flat mirror
	Mast

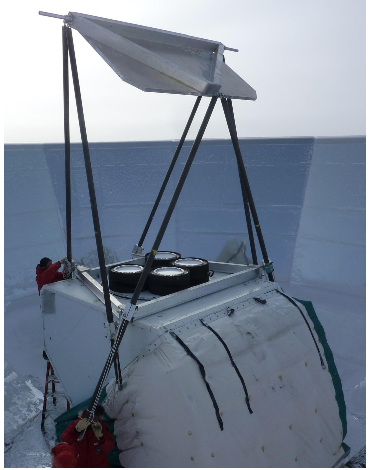
Main Beams



Far-field measurements using a redirecting flat mirror and source on mast



Thermal chopper 24” aperture



Far-field flat mirror

Measurement -> Hardware

Things to measure

Main beams

Sidelobes

TQU beams/pol angles

Bandpasses

Time constants

Hardware

Near-field beam mapper

Large thermal chopper

Far-field flat mirror

Mast

Amplified microwave source (+ rotating polarized stage)

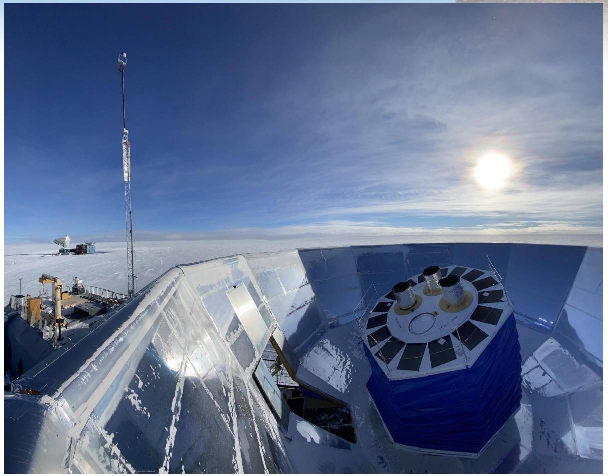
Sparse wire grid, dielectric sheet

Fourier Transform Spectrometer

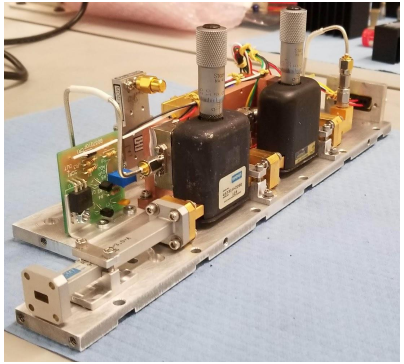
Optical filters

Narrowband source

Sidelobes, Pol, Bandpass

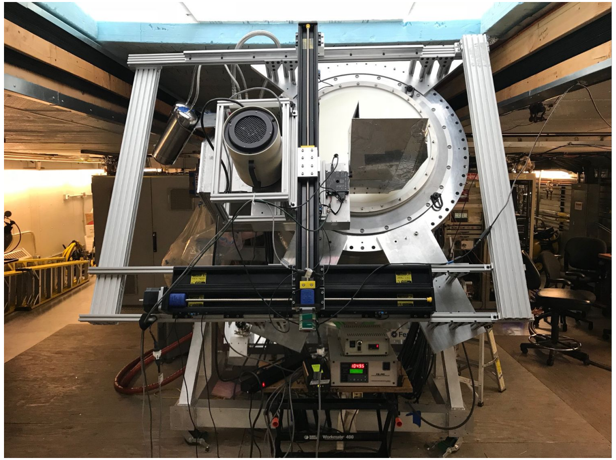


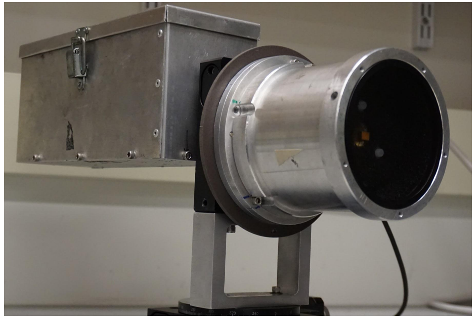
Far sidelobe measurements



Amplified broad spectrum noise source

FTS measurements (good optical coupling)





Rotating polarized source (referenced to gravity)

Measurement -> Hardware

Things to measure

- Main beams
- Sidelobes
- TQU beams/pol angles
- Bandpasses
- Time constants
- Optical efficiency
- Magnetic sensitivity
- Vibration sensitivity
- RFI sensitivity
- Pointing

- Precipitable water vapor
- RFI environment

Hardware

- Near-field beam mapper
- Large thermal chopper
- Far-field flat mirror
- Mast
- Amplified microwave source (+ rotating polarized stage)
- Sparse wire grid, dielectric sheet
- Fourier Transform Spectrometer
- Optical filters
- Narrowband source

- Aperture-filling thermal load
- Helmholtz coil
- Accelerometers
- RF sources
- Star camera

- Water Vapor Radiometer
- RF monitoring

What are we missing? Where should we coordinate with LATs?

Are these in-scope?

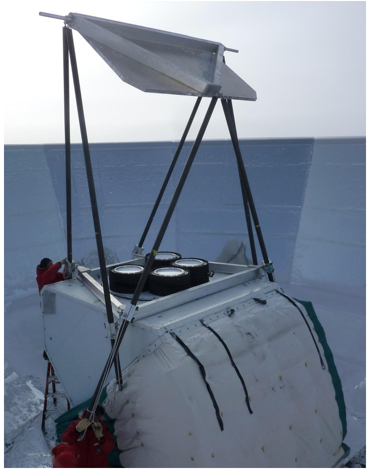
What Needs Improvement?

- Aperture-filling thermal load
  - Temperature stability, variable temperature, geometry (multiple bounces), coupling to cryostat
- FTS
  - Optical coupling, understanding systematics
- Far-field flat mirror
  - Maximizing receiver coverage, curvature measurements, ease of mounting, repeatability
  - Taking data with forebaffles on?
- Mast + source
  - Repeatability in aiming
- RF test sources
  - Absolute calibration

Interfaces to Consider

- Hardware needs to couple repeatably and securely to cryostats
  - Mounting points around window (NFBM, FTS, thermal load, wire grid...)
  - How are they lifted into place?
- Ground shield door
- Far-field flat mirror
  - Mounting points, lifting strategy, storage (see next slide)
- Communication between buildings

Far-field flat mounting



Far-field flat
mirror

Mirror
Mounting Jib
Crane
(telescoping)