LAT/LATR Absolute Polarization

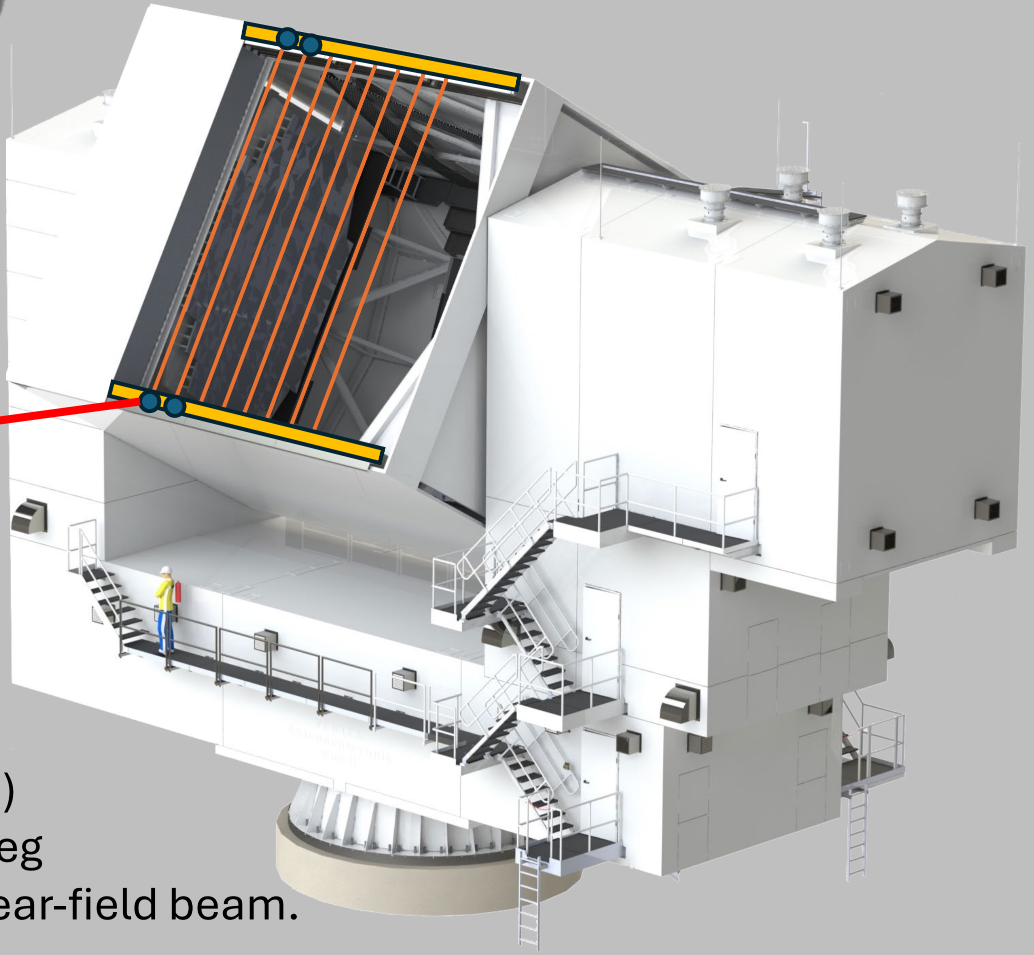
There are several important science cases that will be limited by the knowledge of the absolute polarization. The LAT/LATR have several key design features which may enable a dramatic improvement of the absolute polarization angle accuracy.

- We have access to the exit aperture of the LAT. This enables us to place a sparce polarization grid in front of the entire telescope and measure its absolute angle with respect to gravity with high precision.
- We are able to rotate the receiver with high precision with respect to the sparce grid to find the phase of the polarization of the receiver with respect to sparce grid.
- We can flip the elevation frame and change the azimuth to check for systematic effects.

Grid Installation and Alignment

~10 x 0.127 mm diameter wires.

- ~0.5% polarization.
- 50 mK => S/N ~100 (from the atmosphere)
- Simulate to see if more are needed.

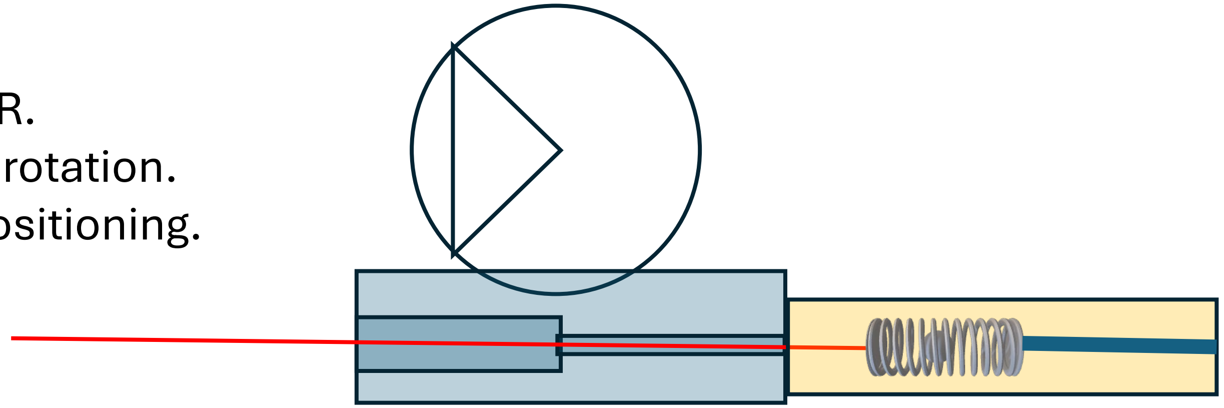


FARO Alignment of the sparse grid.

- Need <1.5 mm from top to bottom (0.01deg spec.)
- FARO Level Accuracy +/- 2 arcsec = +/- 0.00055 deg
- Provides absolute position of grid w/ respect to near-field beam.
  - Precise modeling of grid.
- Repeat at different elevations.
- Align directly with optics.

Custom SMR mount:

- Centers the wire below the SMR.
- Eliminates effects from mount rotation.
- Mates with 80/20-like rail for positioning.
- TBD Spring-loaded tensioner.



LATR Rotation:

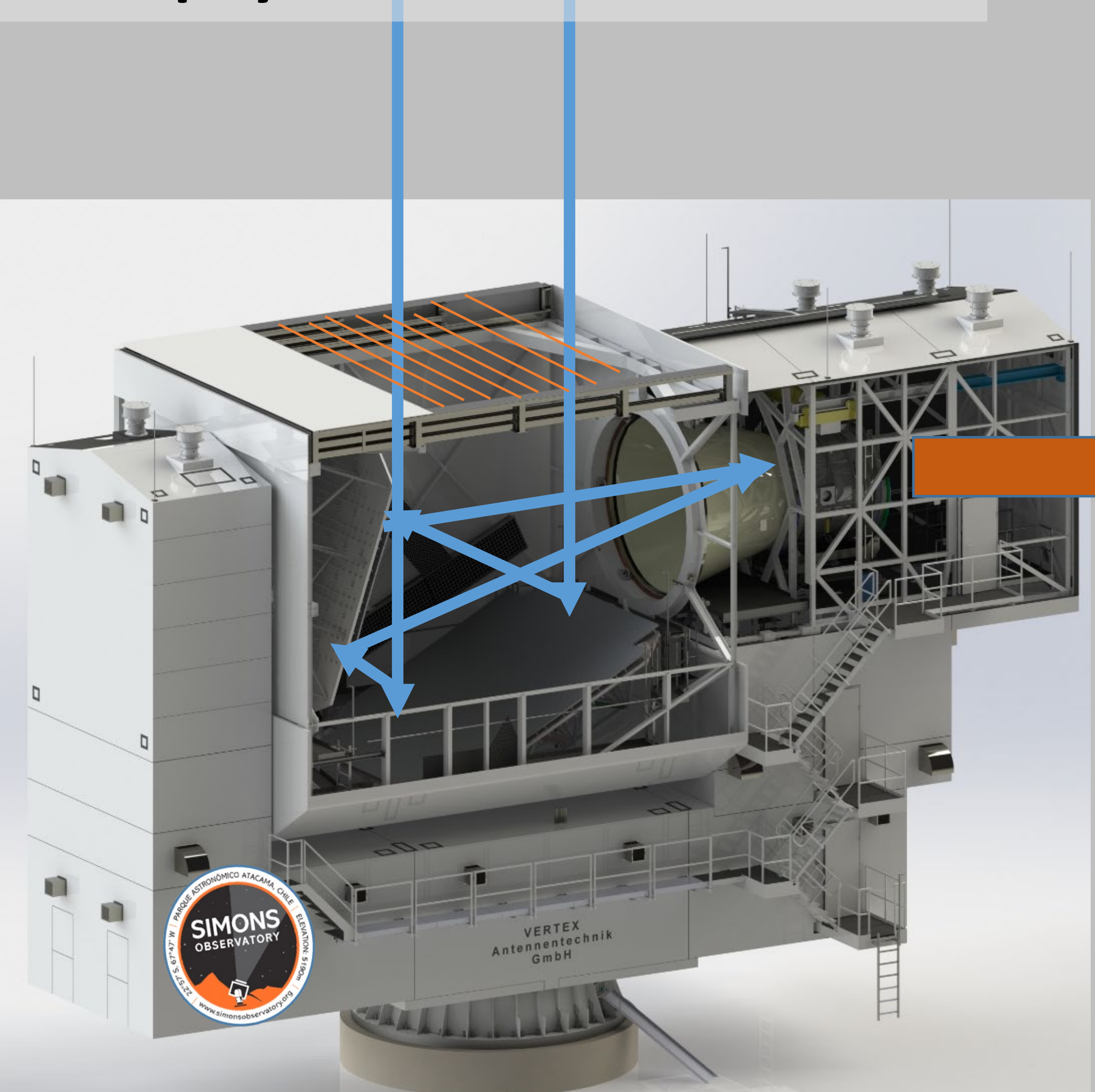
- Relative angle known to very high precision.
- Can rotate +/- 45 degrees
- Speed can be varied to optimize the measurement and check for systematic effects.

Polarization Measurements Using the Atmosphere and Astrophysical Sources.

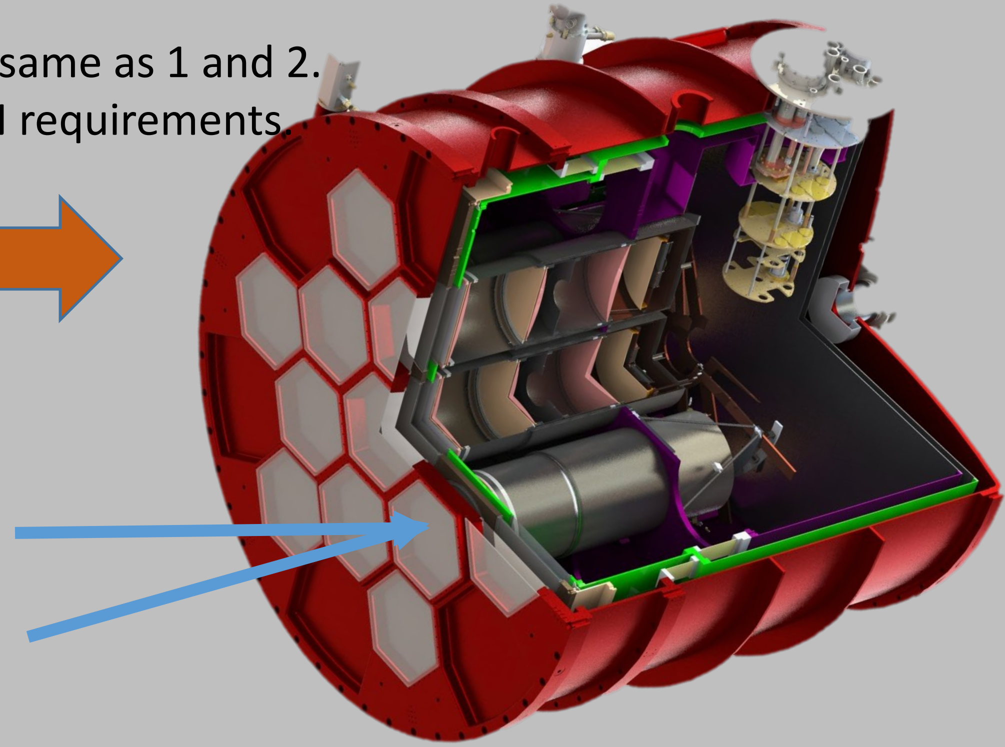
Procedure 1:
- Fix the elevation.
- Rotate the receiver by +/- 45 deg. (many cycles)
- Repeat at several elevations and with the elevation frame flipped.

Procedure 2:
- Fix the receiver angle.
- Rotate the inner frame.
- Repeat at several receiver angles.

Procedure 3:
- Map planets with same as 1 and 2.
- Need to check S/N requirements



Simons Observatory Large Aperture Telescope



Analysis:
- Essentially a phase-sensitive lock-in measurement.
- We know everything exept the amplitude and phase.
- Should be able to integrate down the noise.

Noise and Systematics:

- The atmosphere will be changing throughout.
  - We know exactly the signal we are trying to extract.
  - The detectors in the array are at known different angles. We can fit out a common-mode signal.
- What is the sag in the wire? Could be as much as a few millimeters.
  - What does this sag do to the polarization measurement in the near field?
  - Minimize the sag with high tensile strength wire (music wire).
- What is the resonant frequency and amplidude of the wire?
  - Initial tests show it could be ~5 Hz.
  - This might be more noise than systematic. Half the wire rotates the polarization in one direction and the other half in the opposite direction.
  - Check for mechanical and wind coupling. Make the measurements under low wind conditions.
- What is the polarization fraction induced by the ~10 wires? Is this enough signal.
- How much diffraction is induced by the wires?
- Does the sparce grid create some polarized signal from reflection of emission in elevation frame? Would this create an offset?
- What is the signal from spillover from M1/M2?
- Polarization effects from diffraction off LAT elevation frame opening?
- Is the LATR rotation faithfully measured by the rotator encoder? (check with FARO). Wobble too!
- Is the LAT stable on its mount vs. azimuth and elevation? Check with inclinometer and FARO.
- Does the polarization angle change with frequency/passband? Is it possible some detectors with exactly the same antenna orientation will end up with a different angle on the sky?

Need to simulate the recovery of the phase angle in the presence of noise.