# LAT Baffle Surface Finishes

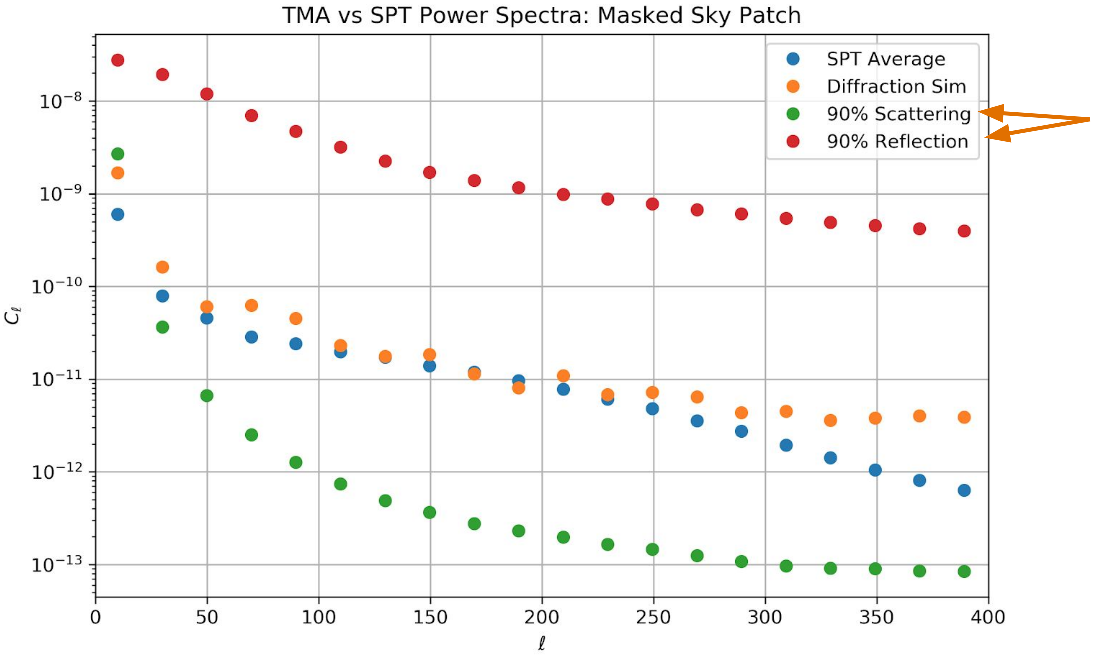
## Fabricating and Testing Scattering Materials

**CWRU+WUSTL**

(Gullett, King, May, Nagy, and Ruhl)

# Motivation for Scattering Baffles

Comparison of sidelobe power spectra from Zemax simulations and SPT sidelobe map (assume 1% Lambertian window scattering)




Cabin wall treatment in Zemax sims of TMA Single Pixel

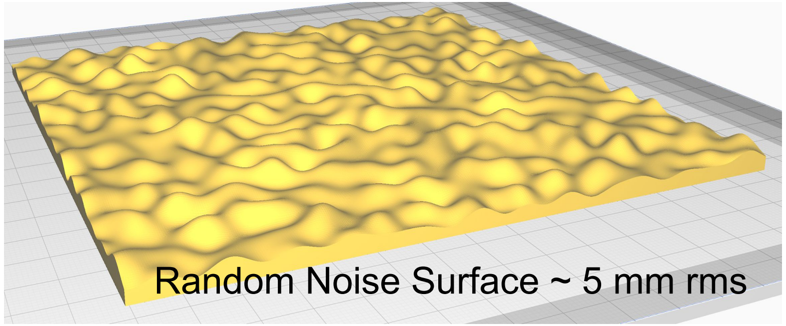
**TMA "reflective walls" is ~100x worse than SPT**

**SPT Calculated and measured agree fairly well**

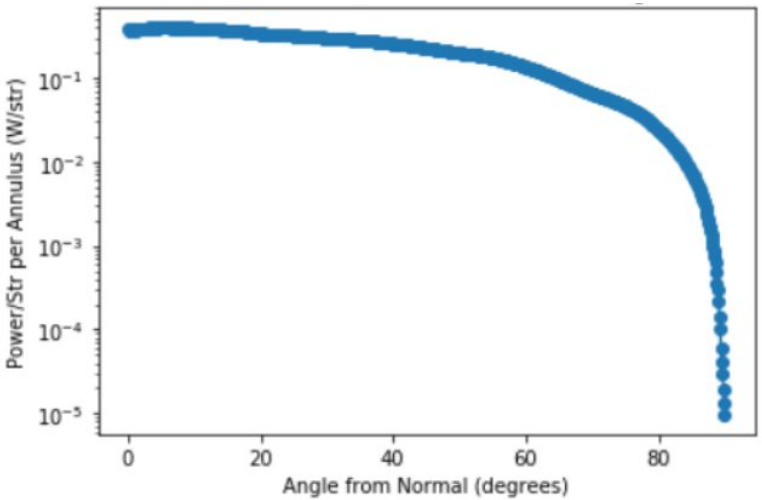
**TMA "scattering walls" is ~10x better than SPT**

# Simulating a scattering surface

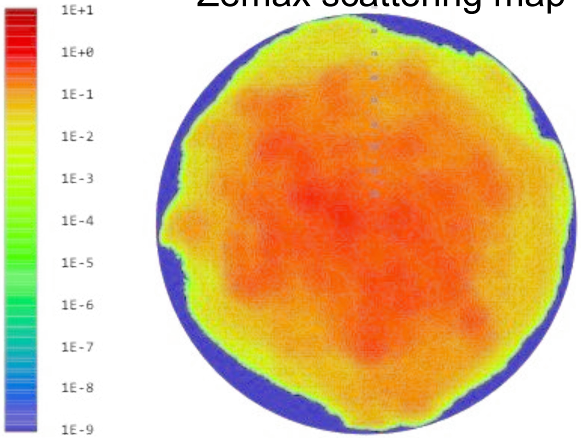
Significant scattering to wide angles from random noise surface




Radial Scattering Profile




Zemax scattering map



# Prototyping Random Noise Surfaces

- Rapid prototyping to make small samples for measurements

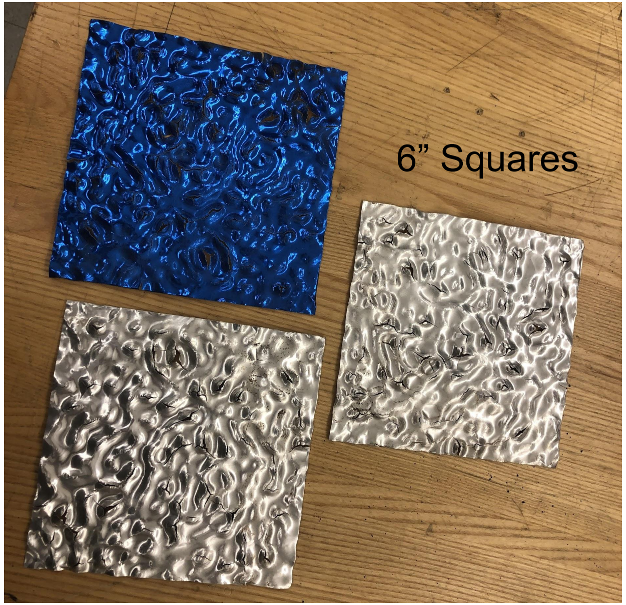
3D-Printed Mold

+

Hydraulic Press

=

Aluminum Samples




- Exploring different methods for mass production

# LAT Calibration Hardware

## Overview and Discussion

# LAT-CH Scope (WBS 1.06.05)

- LAT-CH scope:
  - Optics tube testing (North America)
  - North American test build
  - On-site validation (commissioning)
  - On-site calibration (observing)
- Does NOT include
  - Calibration hardware for testing individual modules (MAT WBS)
  - Calibration measurements that do not require specialized hardware (e.g. noise, Psat, etc)

# North American Optics Tube Validation

All of these will be done on the high-Tc transition, with detectors highly loaded by the room.
Some may require special coupling optics;  prime focus is near tube window.

| **Test** | **Equipment needed** | **Notes** |
|---|---|---|
| Band properties | FTS | Width and placement.  Pass/fail, not calib. |
| Pol. angle and effic. | Chopped polarized source | Pass/fail, not calib. |
| Optical efficiency | Beam-filling thermal loads | Pass/fail |
| Beam maps at window | Thermal beam mapper | Verify reasonable illumination patterns, look for vignetting. |
| Scattering maps | Non-thermal beam mapper? | Estimate total power that will miss mirrors. |

# North American Telescope (Test-build) Validation

*(Cryo-free tests)*

| Test | Equipment needed | Notes |
|---|---|---|
| Individual mirror surface | Laser tracker | Mostly off the shelf, could customize reflector movement and thermal gradient sensors |
| Multi-mirror alignment | Holography setup (tower, source, receiver) | |
| Pointing | Star camera | |
| Sidelobes | Sidelobe source, warm receiver (freq = ?) | |

# On-site Telescope Validation

*(Cryo-free tests)*

| Test | Equipment needed | Notes |
|---|---|---|
| Individual mirror surface | Laser tracker | Mostly off the shelf, could customize reflector movement and thermal gradient sensors |
| Multi-mirror alignment | Holography setup (tower, source, receiver) | |
| Pointing | Star camera | |

# On Site Full-system Validation and Calibration

| Test | Equipment needed | Notes |
|---|---|---|
| Far Sidelobes | Coherent sources | Pass/Fail or calibration? |
| Band properties | FTS (easily mounted/moved) | Need calibration requirement. |
| Pol Angle | Options: tower, drone, or celestial | Need calibration requirement. |
| Pol Efficiency | Options: tower, drone, or celestial | Need calibration requirement. |
| Time Constants | Chopped source(s).<br>[Do we need a hole in a mirror?] | Need calibration requirements on precision, acceptable range, and measurement cadence. |

*(Main beams and gain calibration will come from celestial sources.)*

# Future Work and Open Questions

- Other groups working to define calibration requirements based on instrument-specific studies and flowdown from science targets
  - May be different at each site, but will have separate sets of calibration hardware
- Use these requirements to design calibration hardware, building on experience from current generation experiments as much as possible
- Coordinate within LATs and with other groups (especially MAT and Sites) on the calibration hardware plan
- Looking for feedback on…
  - Is anything missing from the measurement list or PBDR chapter?
  - What's the most important calibration hardware to design early?
  - Are there any other thoughts or concerns about LAT calibration hardware? (or baffle finishes)

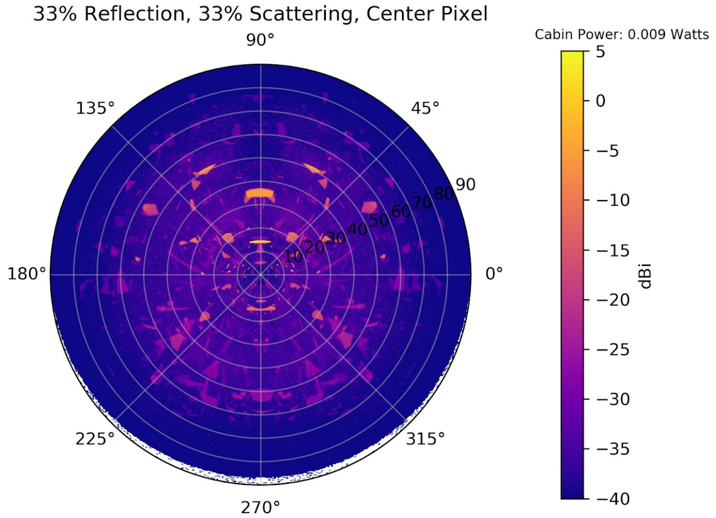
# Bonus Slides

# Measurements in progress

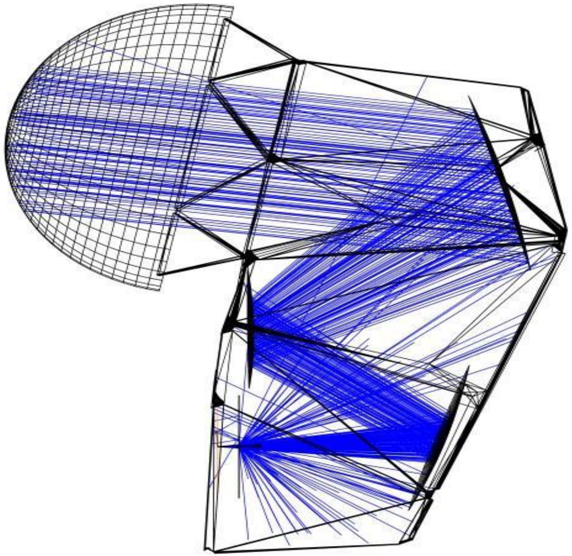
# Method: Zemax non-sequential ray-tracing

**Using** 1% scattering at ~ location of cryostat window,

- Vary cabin wall parameters: Specular reflection, Absorption, Lambertian scattering.
- Coadd sidelobes (correcting to put main beams on top of eachother) using 172 pixels. 200mm grid inside of 4m x 2.8m elliptical focal plane with up to 200mm random offset applied to each.

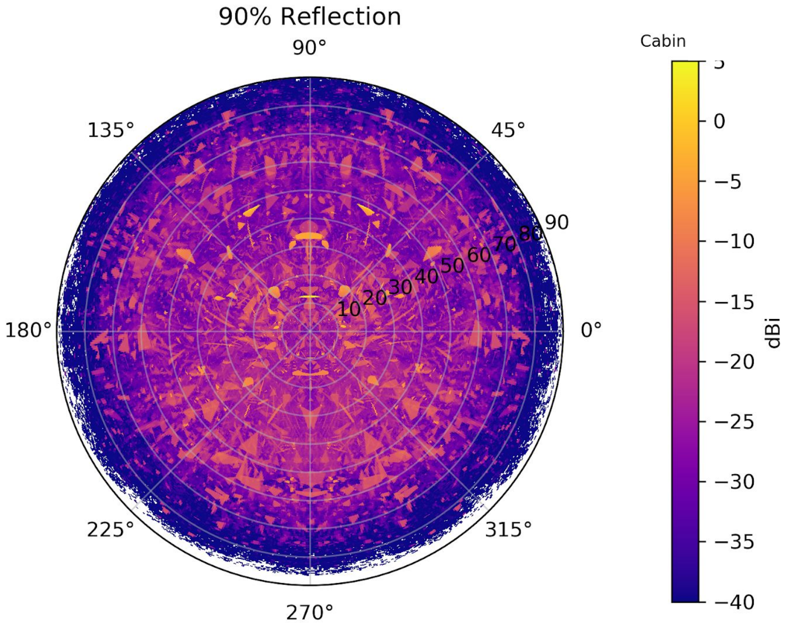


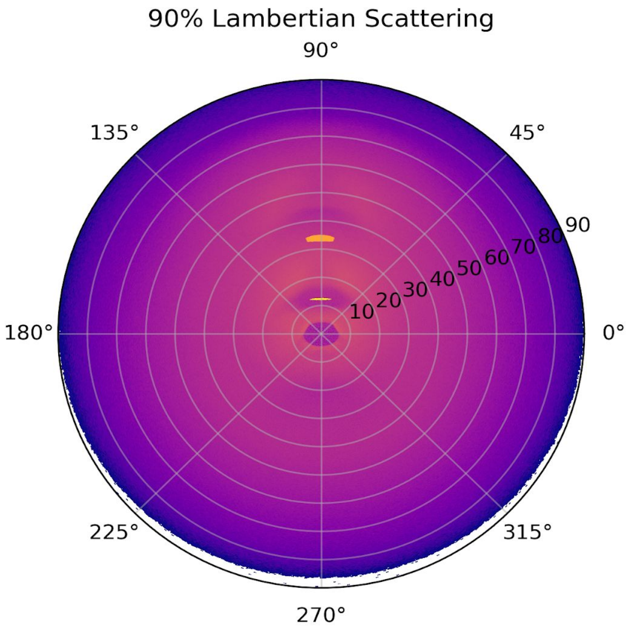

**TMA**



# TMA Sidelobe Map - specular vs lambertian cabin walls

Scattering cabin walls blur sharp sidelobe features.



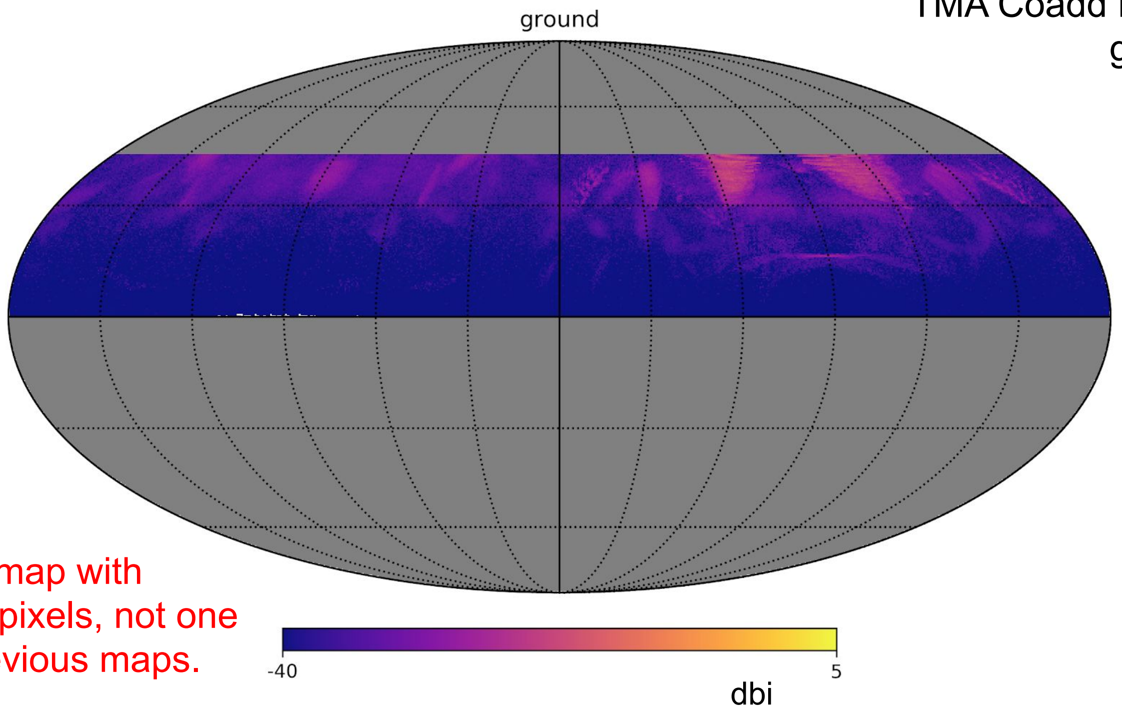

Cabin Power: 5mW

Cabin Power: 7mW

These are single-pixel maps

# Angles that could hit the ground (all boresight rotations)

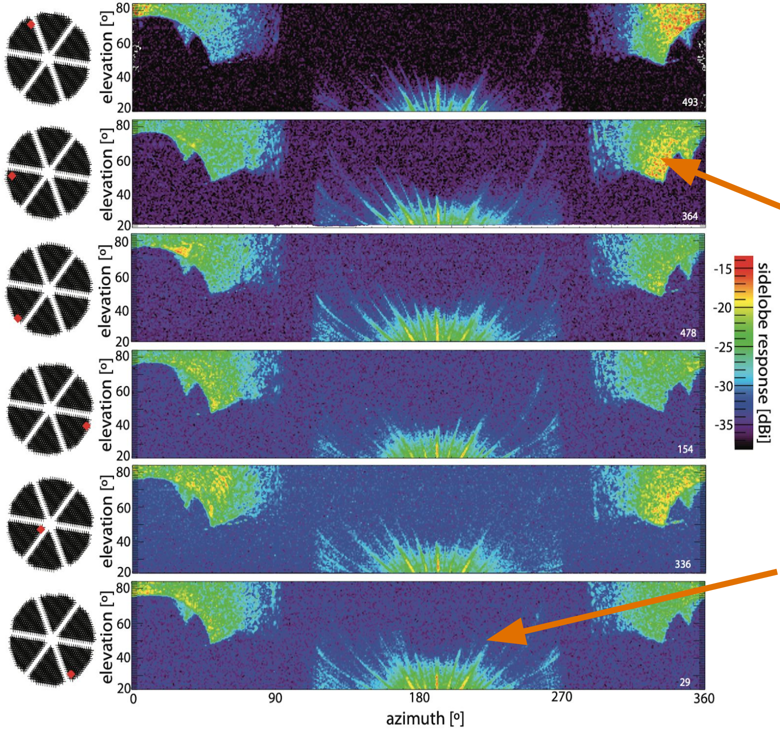
TMA Coadd Map: 90% reflection with ground mask




Define ground patch (at all boresight angles) to find power spectra of sidelobes which hit the ground at 45° elevation.

This is a map with coadded pixels, not one of the previous maps.

# SPT-SZ sidelobe maps (J. Mehl + J. McMahon, ~2009)




Pixels “A” through “F” sampled to produce healpy maps and generate power spectra

Window scattering spillover past shields, ignored here (fixed w/ later shields).

**Panel gap lobes**

# Simulated SPT panel gap maps

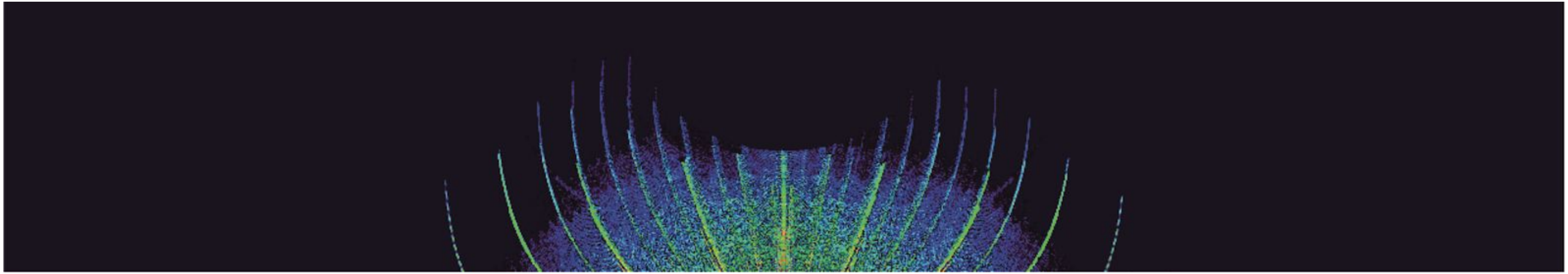


Image: McMahon, Mehl

Calculated in flat-sky approximatiuon