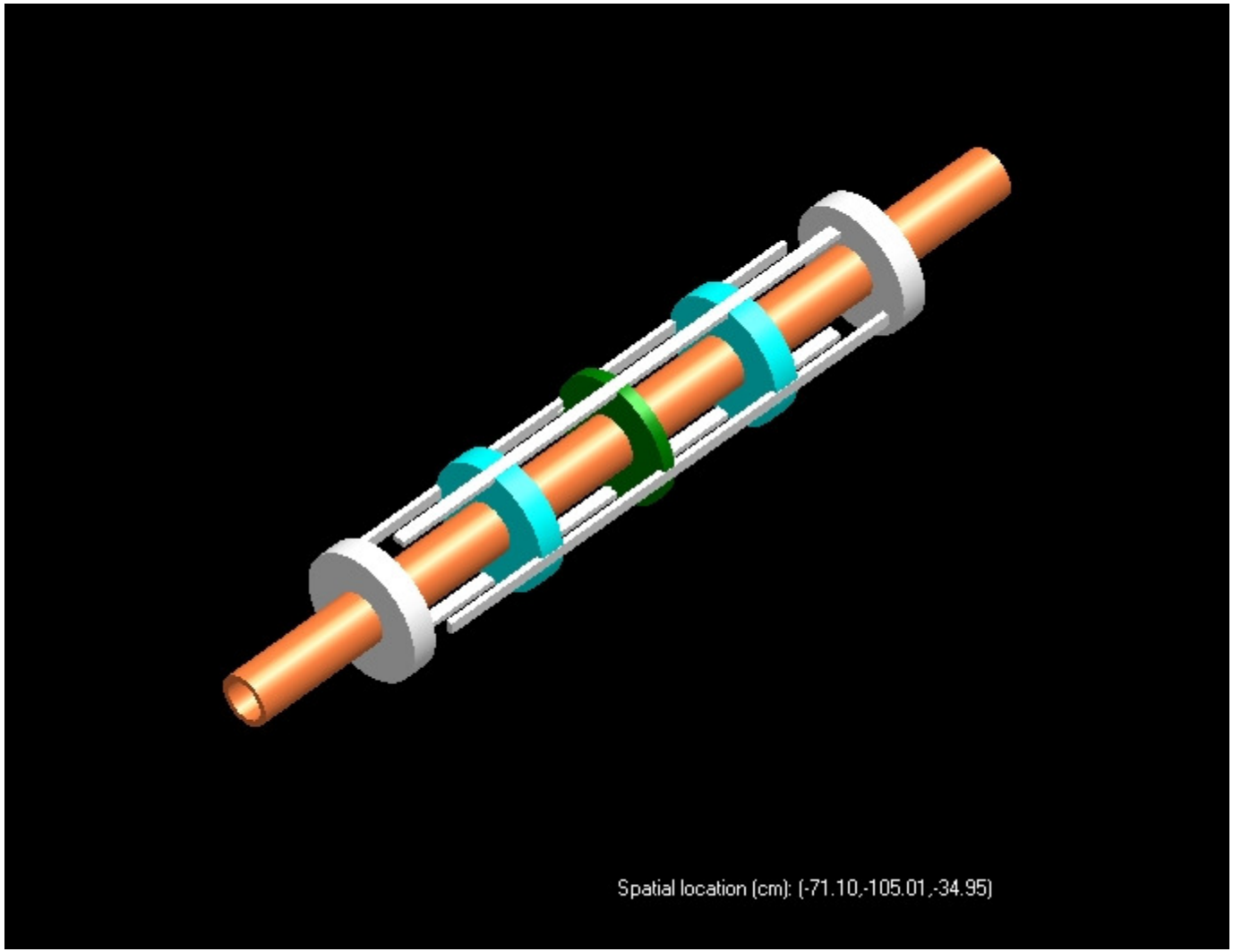
ARA Antenna Development

Andrew Laundrie
UW Madison

March 15, 2010

Quad dipole concept

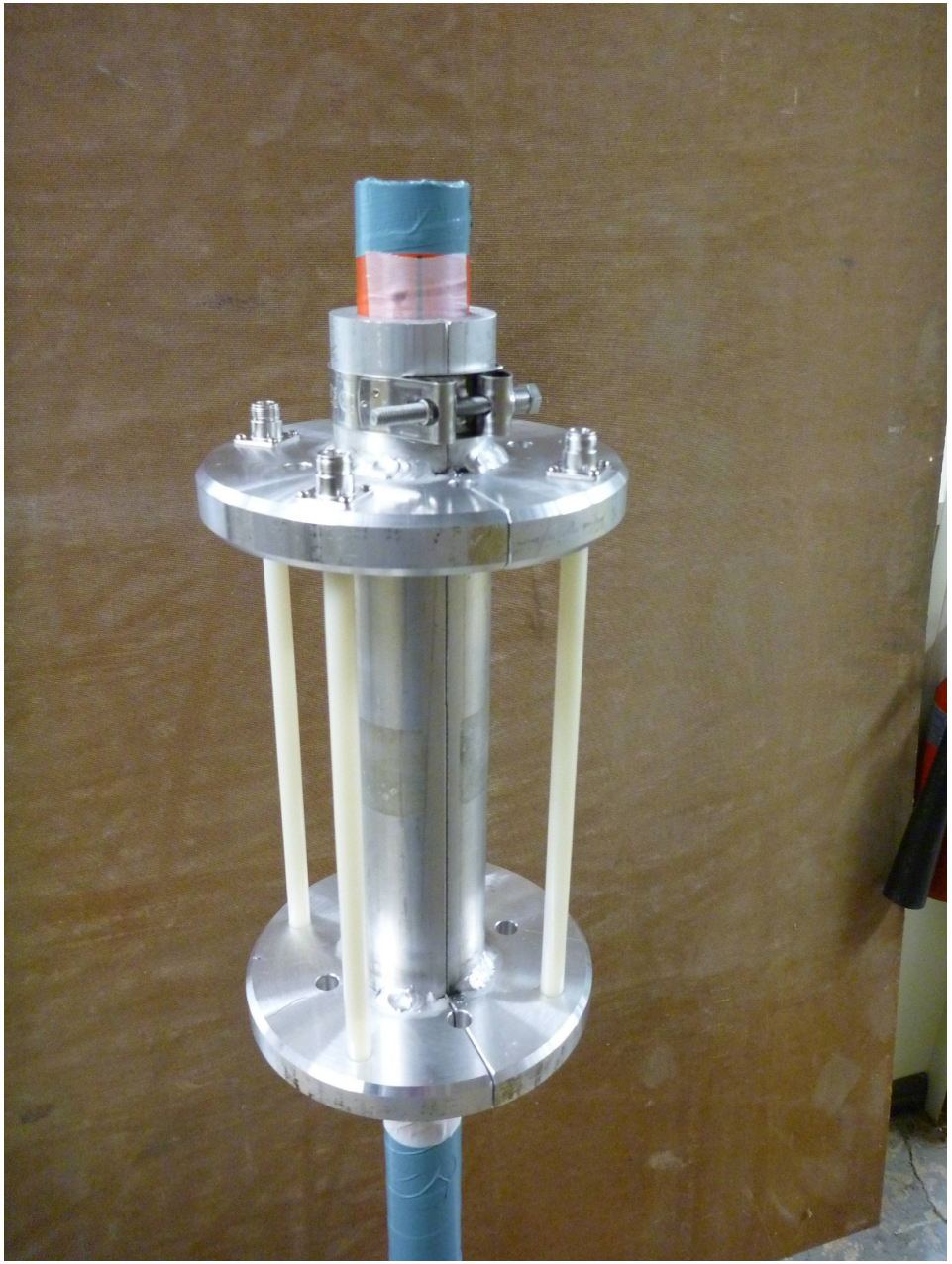


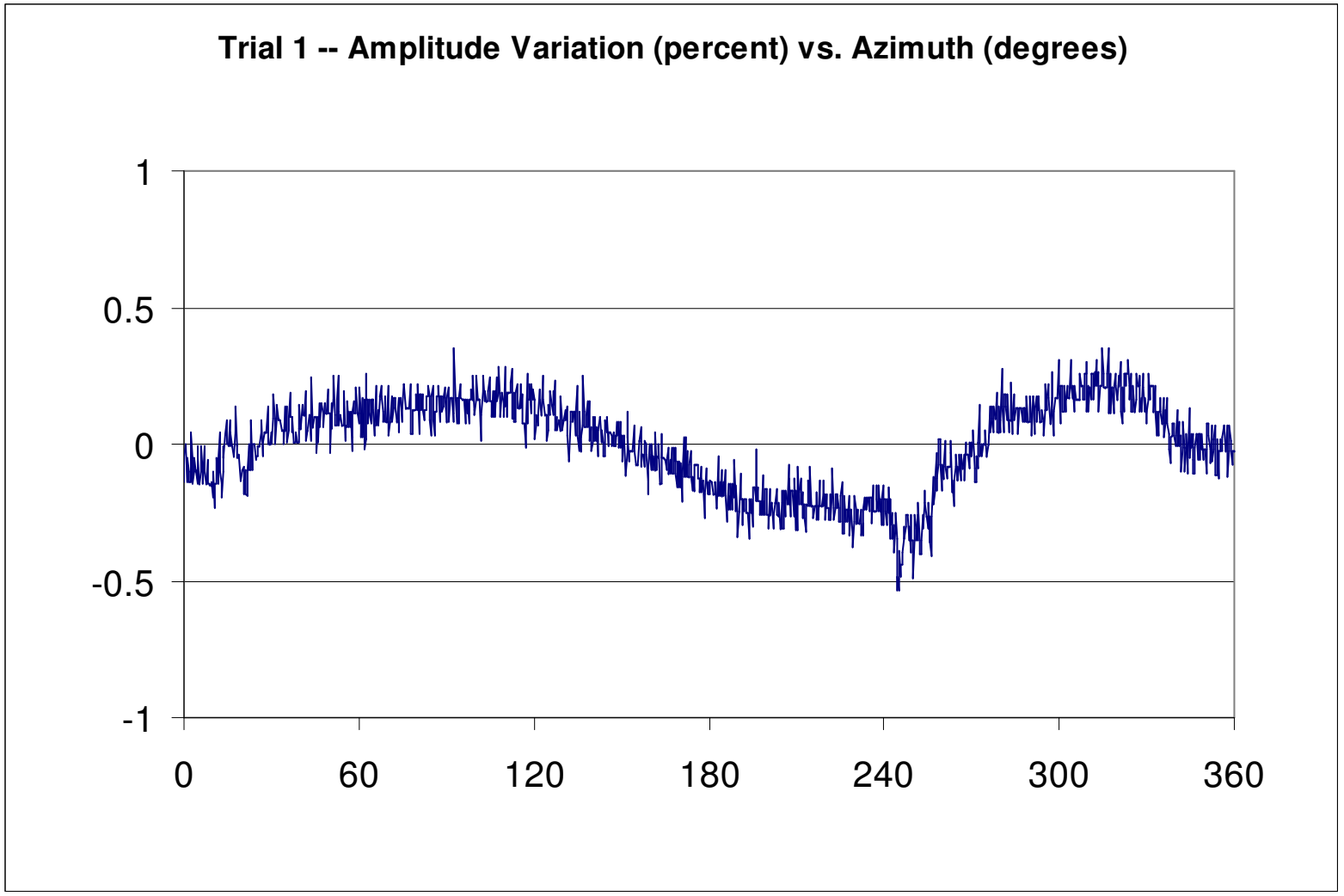
Quad-element antennas

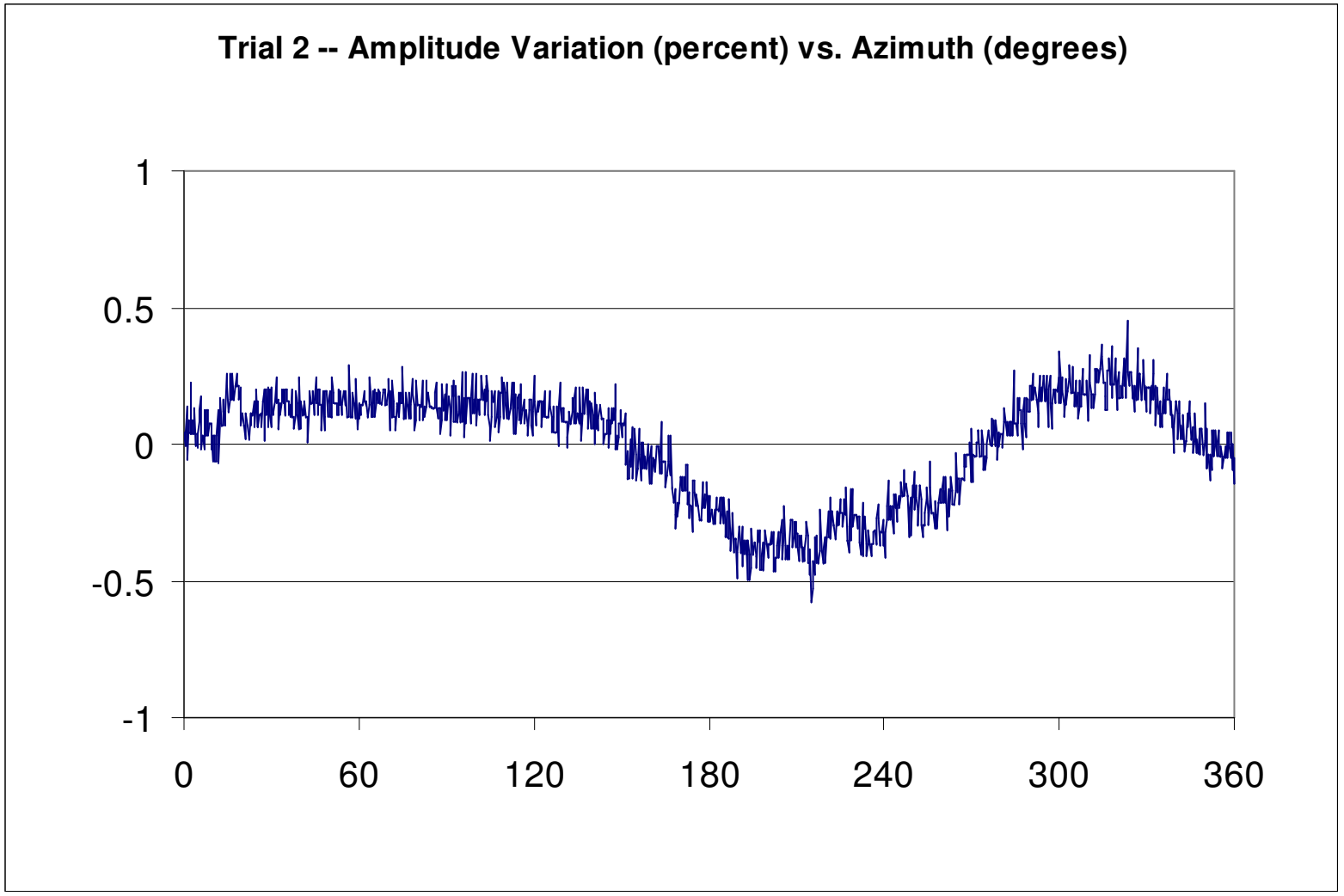
- This approach accommodates a central pipe to allow cable feed-through
- Antenna gain variation vs azimuth is small if all elements are driven in-phase and mechanical symmetry is maintained
- Preliminary testing of a prototype antenna was completed in last fall
- Amplitude varies less than +/- 0.5 percent versus azimuth for elevation = 0 deg.

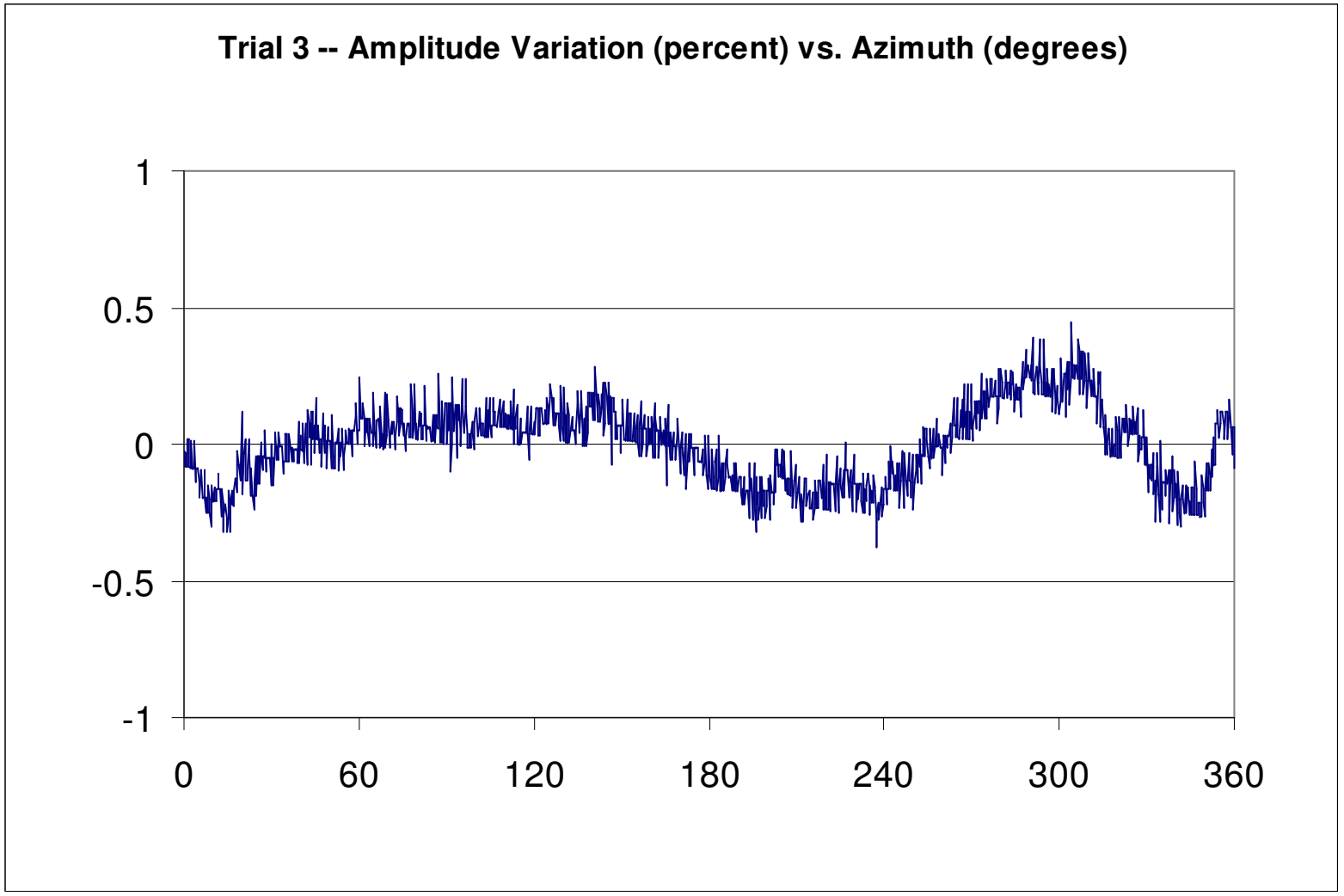
Quad-Pole Model A

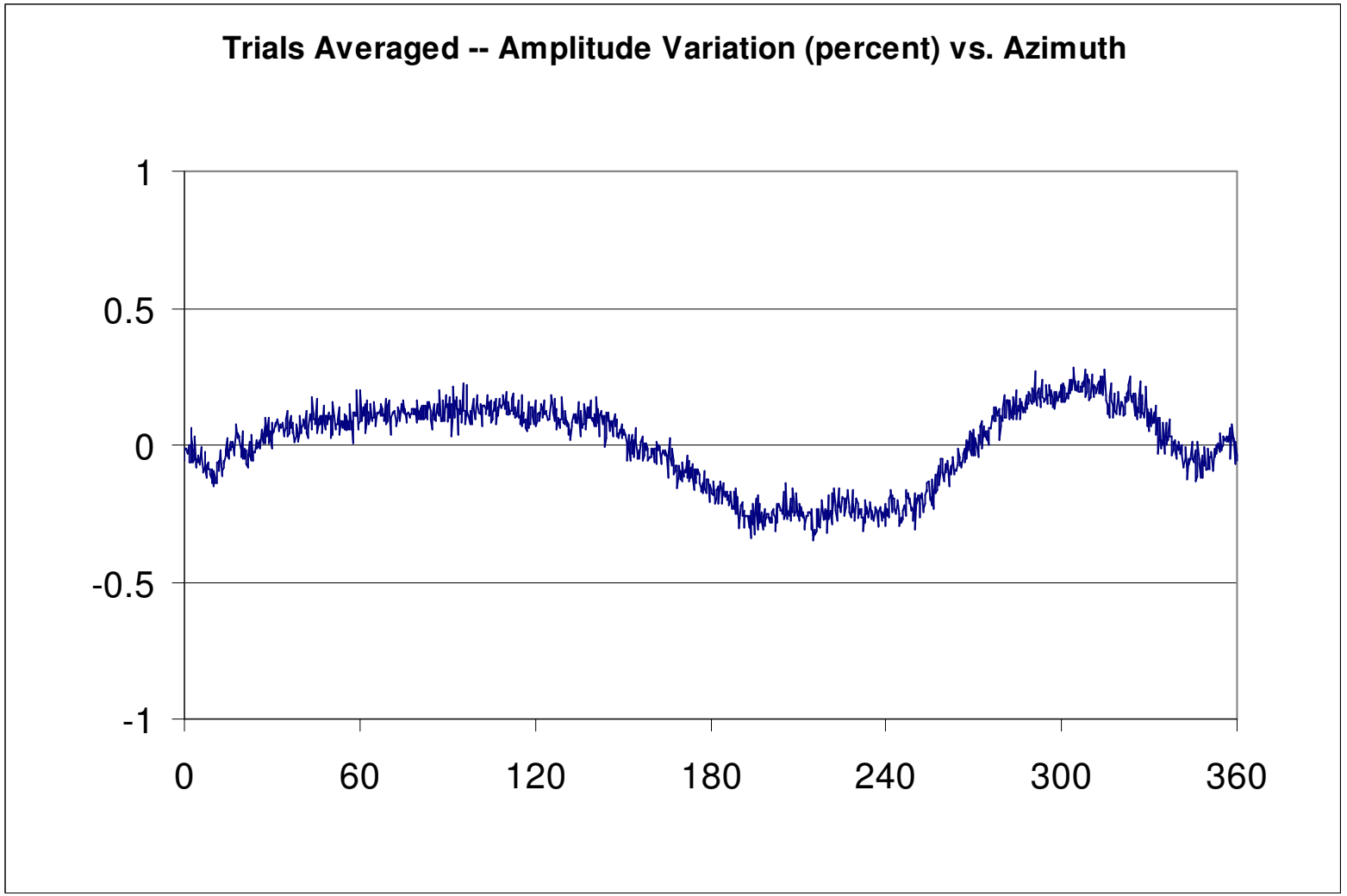
(several installed at Pole)



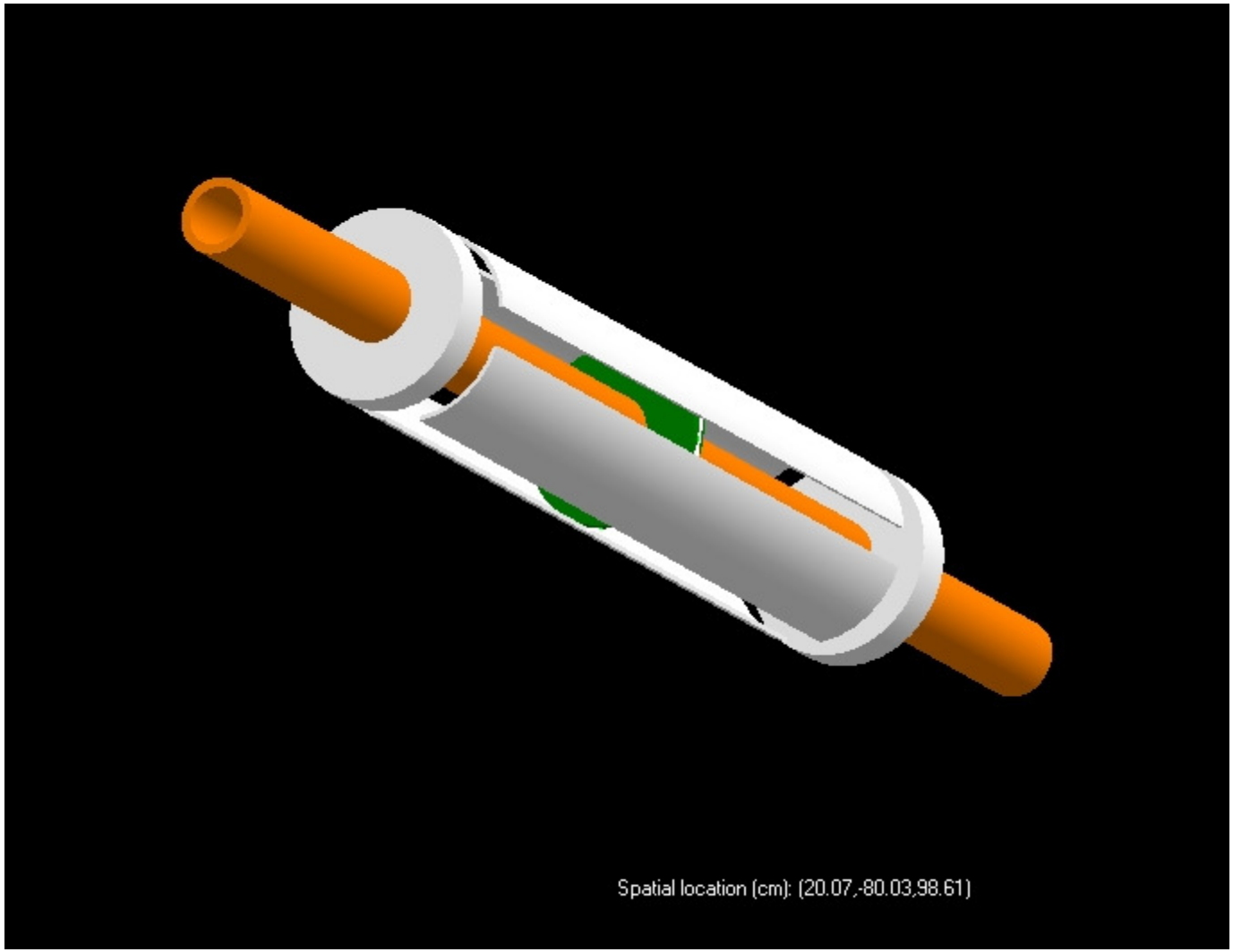

Trial 1 -- Amplitude Variation (percent) vs. Azimuth (degrees)
1
0.5
0
-0.5
-1
0
60
120
180
240
300
360


Trial 2 -- Amplitude Variation (percent) vs. Azimuth (degrees)
1
0.5
0
-0.5
-1
0
60
120
180
240
300
360


Trial 3 -- Amplitude Variation (percent) vs. Azimuth (degrees)
1
0.5
0
-0.5
-1
0
60
120
180
240
300
360


Trials Averaged -- Amplitude Variation (percent) vs. Azimuth
1
0.5
0
-0.5
-1
0
60
120
180
240
300
360

Quad slot concept



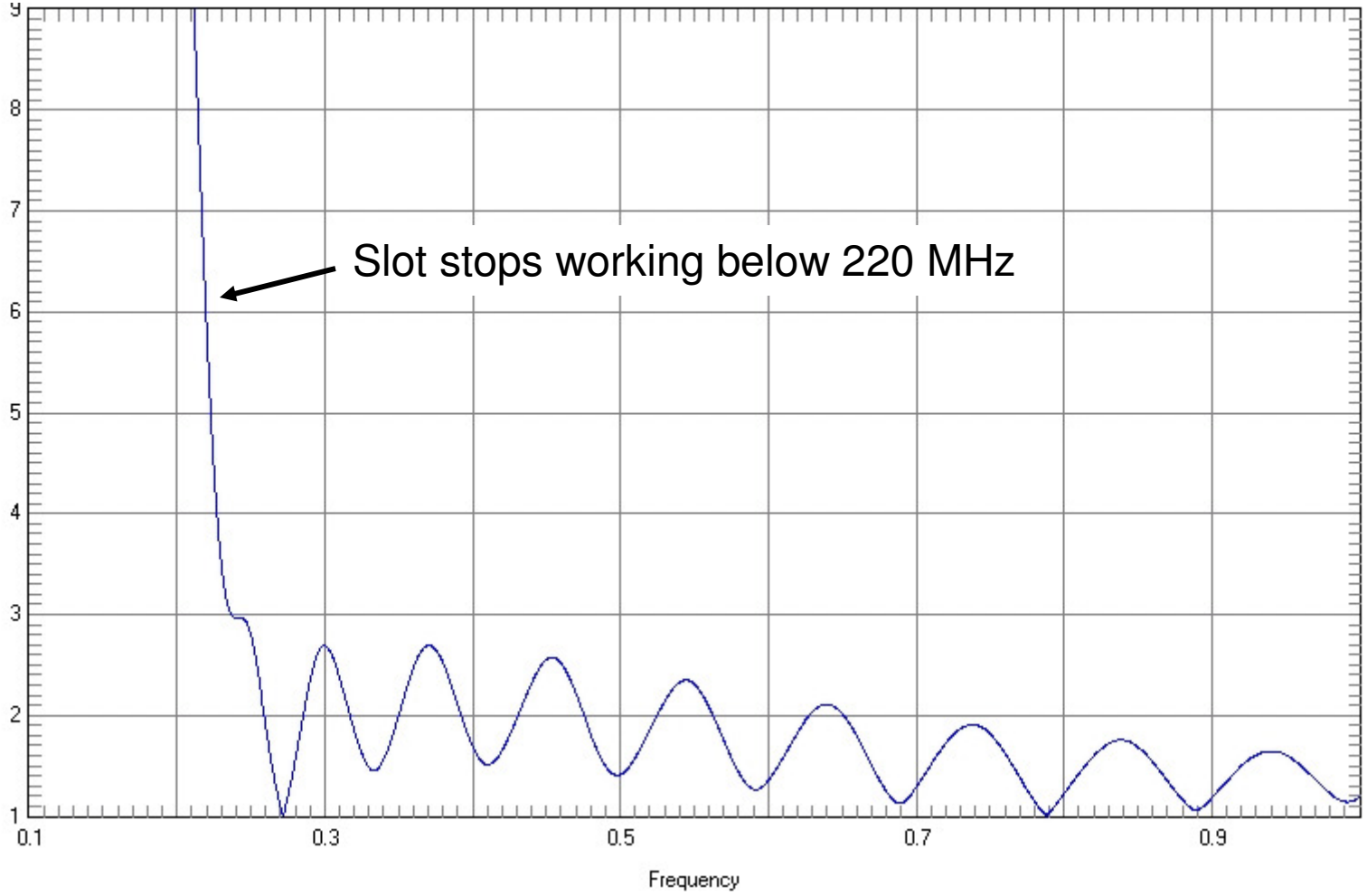
Quad-slot antennas

- Not as easy as previously thought
- Non-TEM (waveguide) propagation modes in the slot have a low-frequency cut-off
- Cylinder walls tend to shunt current away from the slot edges, where they must be concentrated to achieve effective coupling

Cylindrical-slot antennas

- As the cylinder diameter is reduced, the low-frequency cut-off decreases
- A cylinder with 4-inch diameter and a single slot, embedded in ice, has a low-frequency cutoff around 220 MHz (regardless of length).

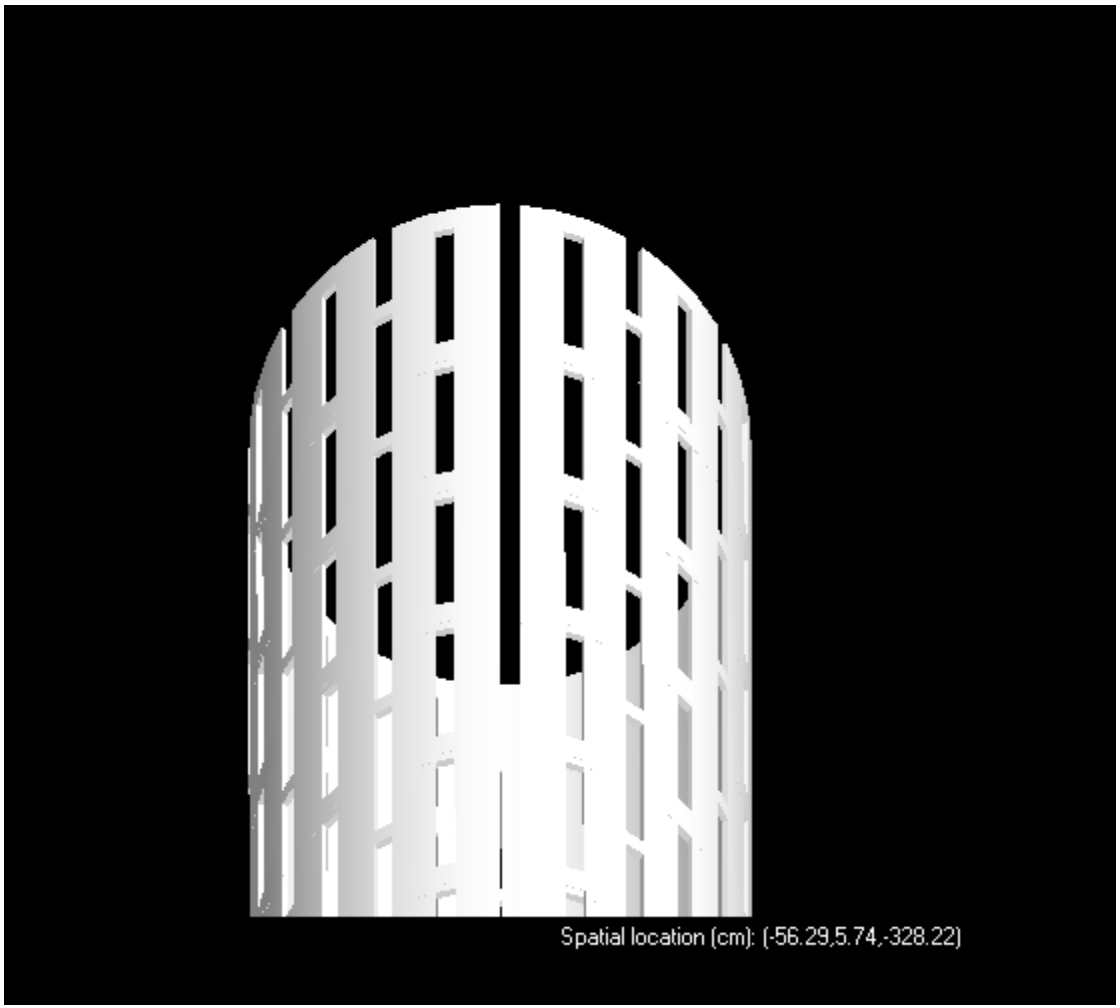
SWR for a solid 4-in. cylinder (single slot)



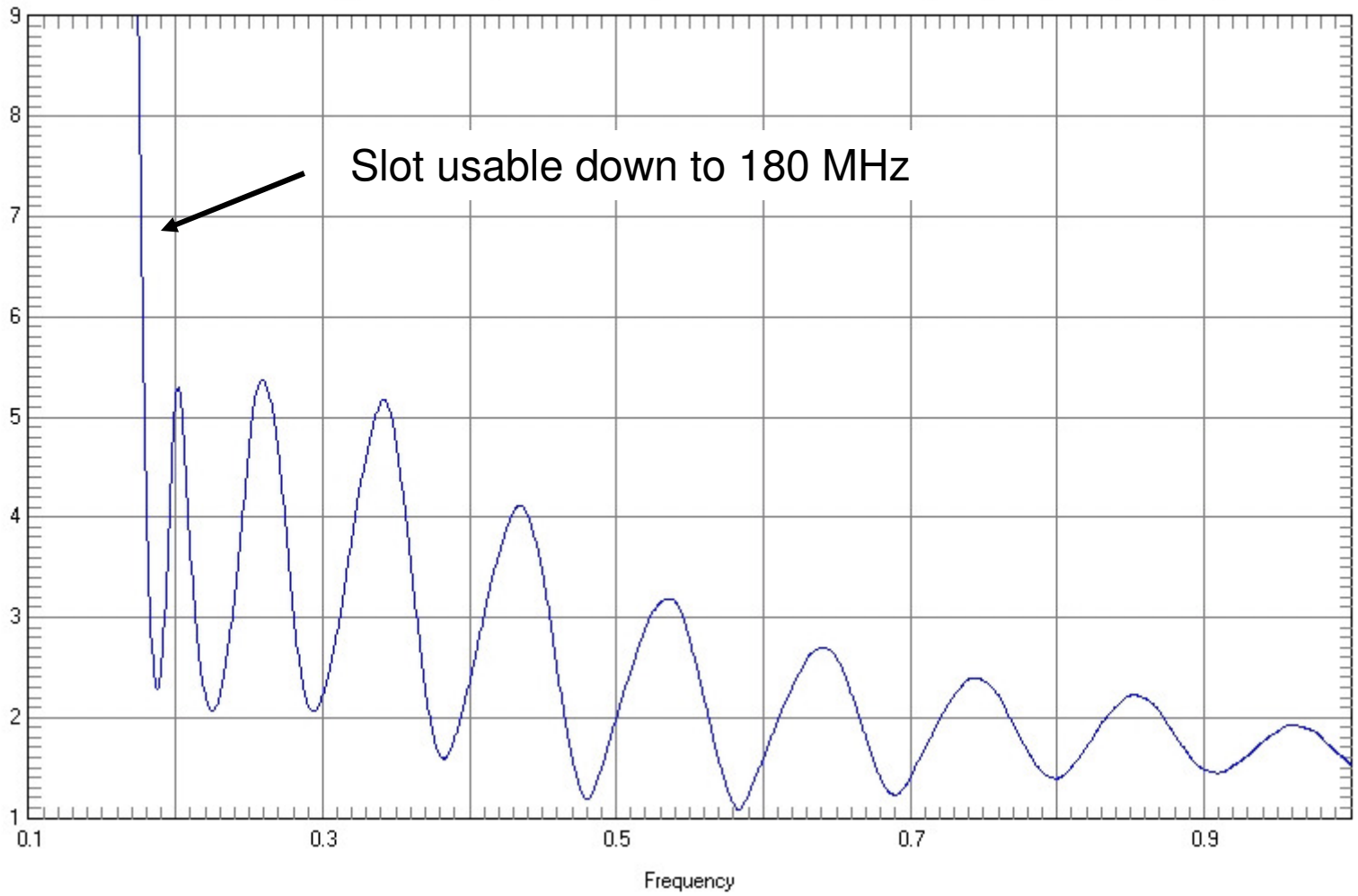
Cylindrical-slot antennas

- Simulations show that by perforating the cylinder wall, its shunting effect can be reduced significantly
- Simulations suggest doing so can drop the low-frequency cut-off to 180 MHz

Perforated Cylinder



SWR for a perforated 4-in. cylinder (single slot)



Cylindrical slot antennas

- Increasing the antenna diameter to 5 in. would reduce the low-frequency cutoff to about 145 MHz for a perforated cylinder or 175 MHz for a solid cylinder
- Loading the cylinder with a magnetic material could help, if suitable low-loss materials can be identified

Ongoing Antenna Work

- Transitioning to version 7 of XFDTD
- Developing more tools for analyzing simulation output (waveforms)
- Refining designs for narrow holes
  (H and V polarizations)
- Designing a horizontally polarized antenna for next season's ACU deployments

Other developments

- Antenna measurement facility near UMD
- Materials for an anechoic chamber at UW

Example waveforms