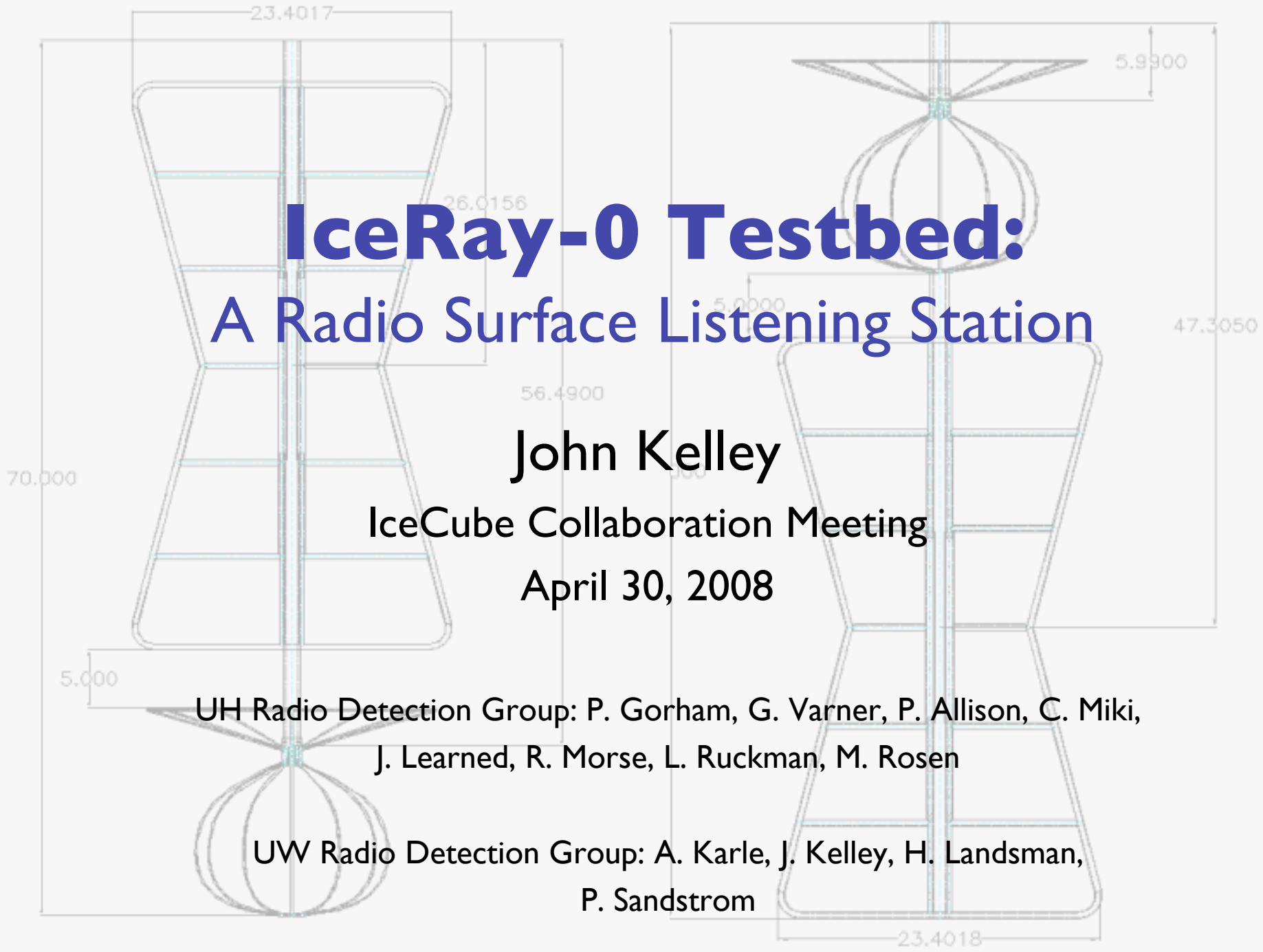


IceRay-0 Testbed:

A Radio Surface Listening Station

John Kelley

IceCube Collaboration Meeting

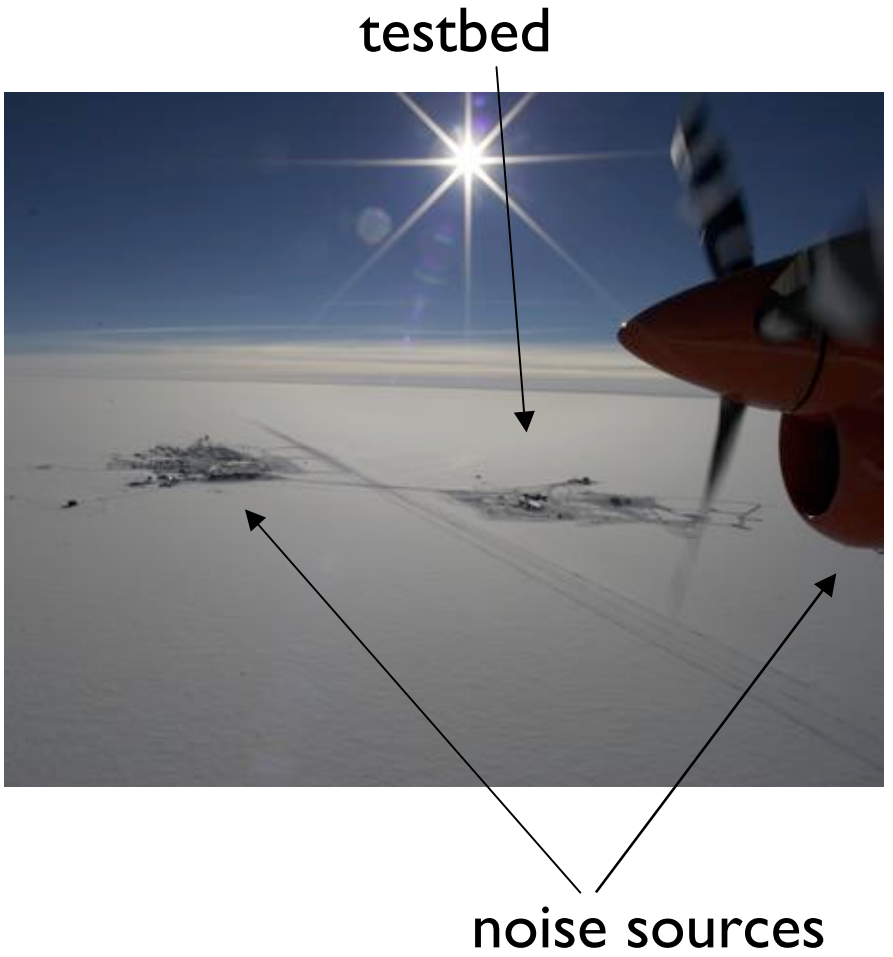
April 30, 2008

UH Radio Detection Group: P. Gorham, G. Varner, P. Allison, C. Miki, J. Learned, R. Morse, L. Ruckman, M. Rosen

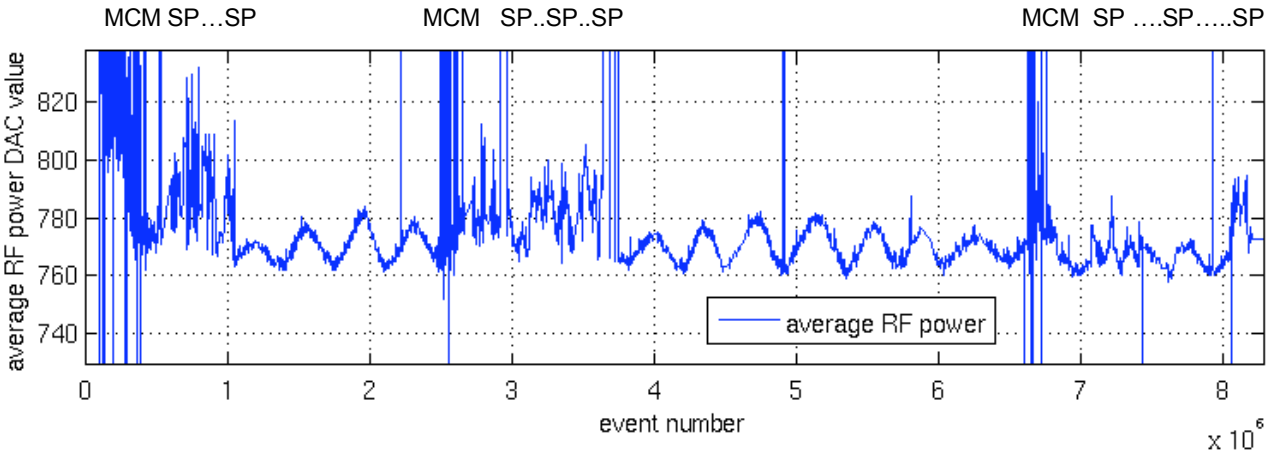
UW Radio Detection Group: A. Karle, J. Kelley, H. Landsman, P. Sandstrom

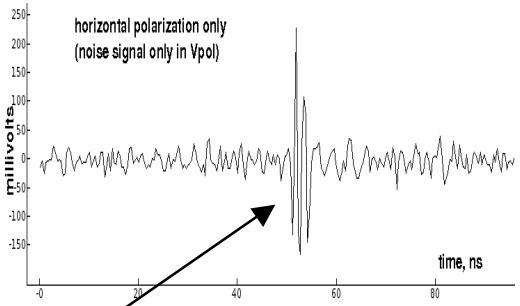
The Plan

- Testbed radio detector ~2km distant
  - extension from IceCube SJB
- Measure ambient power density spectrum in the 60-1000 MHz range
- Above surface:
  - environmental noise
  - CR air showers
- Below surface:
  - 12 antennas below ground screen
  - Reach thermal noise floor



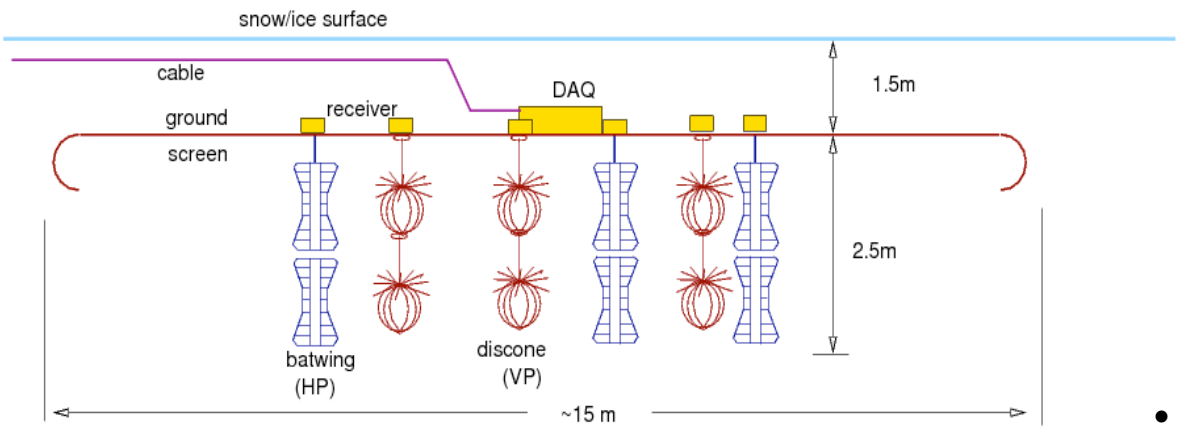
ANITA Experience

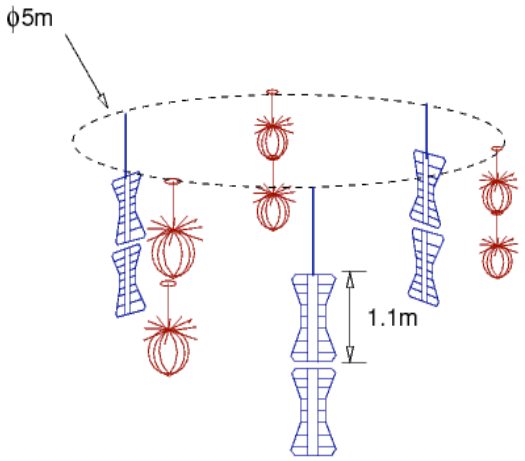




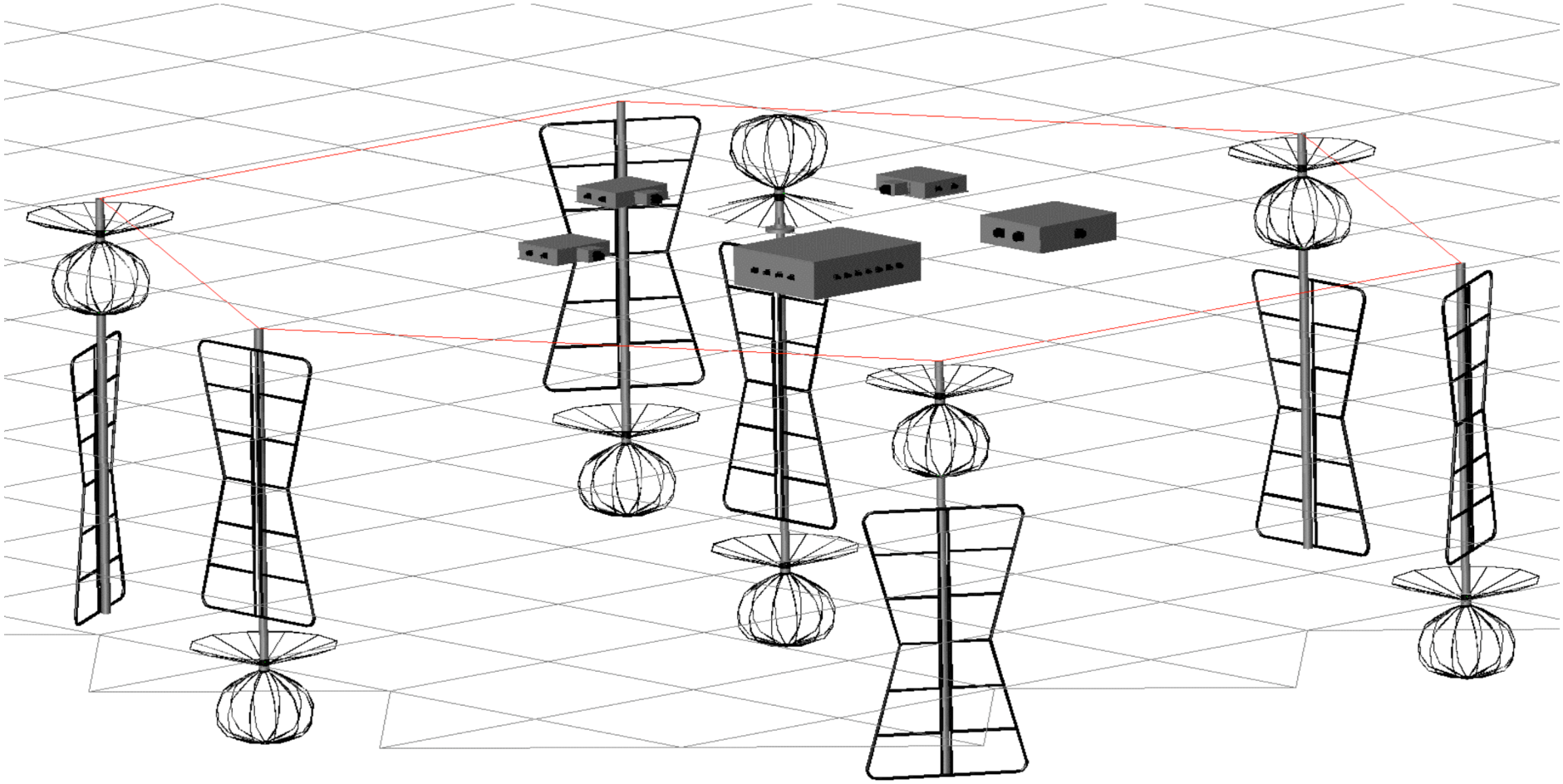
- South Pole isn't so radio-quiet
  - strong impulsive sources (ν-like)
  - 400-500 MHz range noisy (where you want to be for ice)
  - understanding / eliminating b.g. is key for large-scale radio array

Geometry

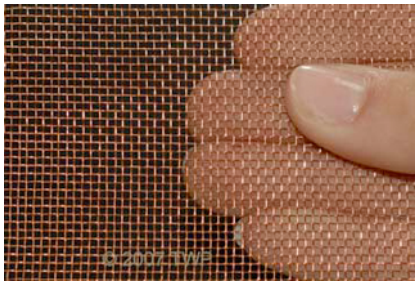


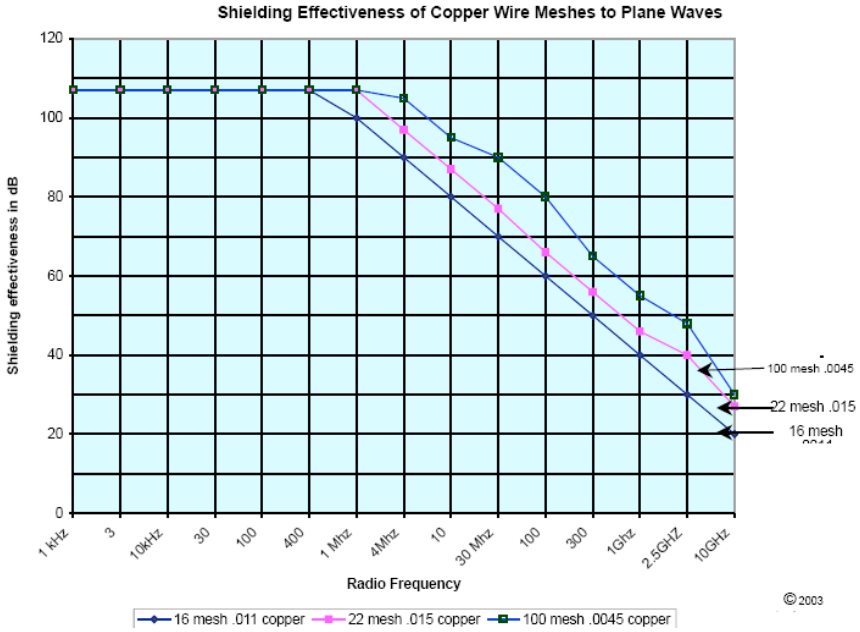


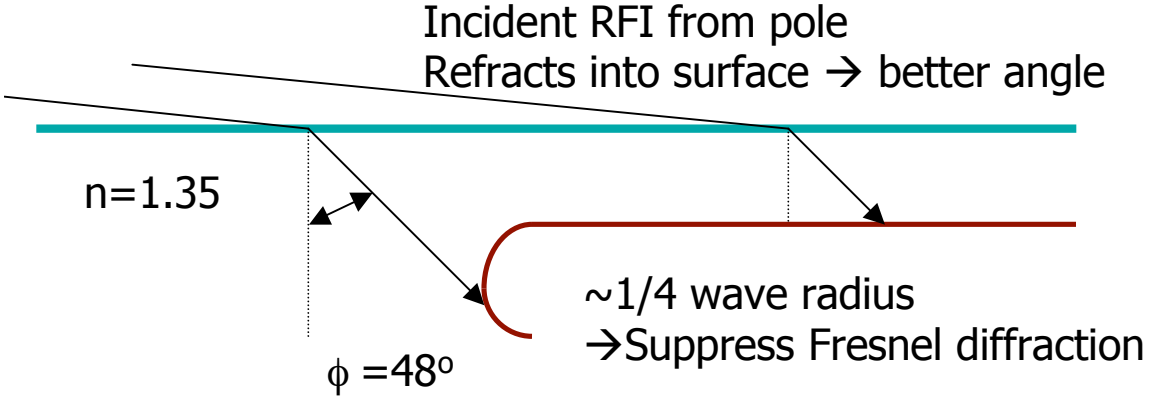
- 12+2 antennas
  - 6 V_{pol} 6 H_{pol}
  - Discones for V_{pol}
  - Batwings for H_{pol}
  - 5m circle
  - 2.5m depth below screen
  - Stacked in pairs for vertical resolution
- 15m Cu mesh ground screen
- DAQ & receivers in shielded boxes ~1.5m depth just above screen
- Also:
  - 1 monitor antenna above screen, but ~1m deep
  - Pulser bicone ~15m away, in 24" augered hole, 2.5-3m deep



Cu mesh Ground screen

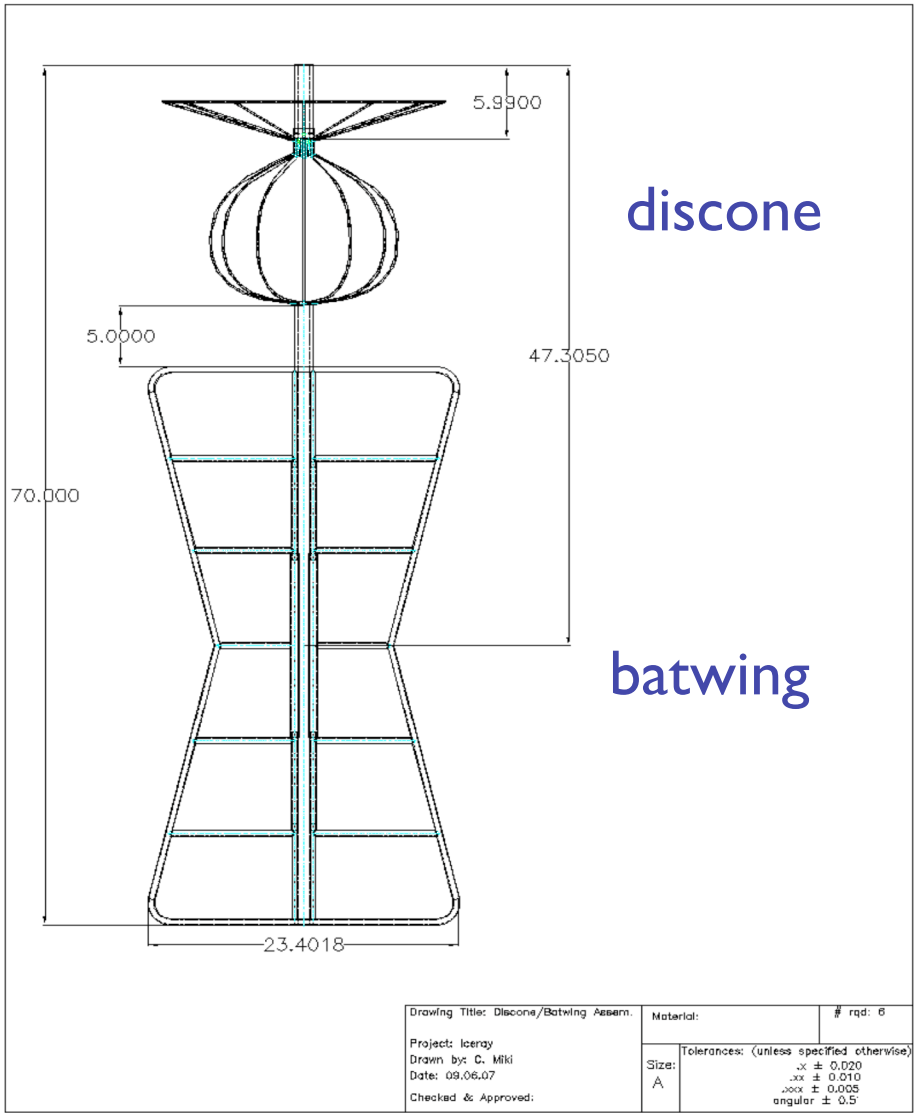




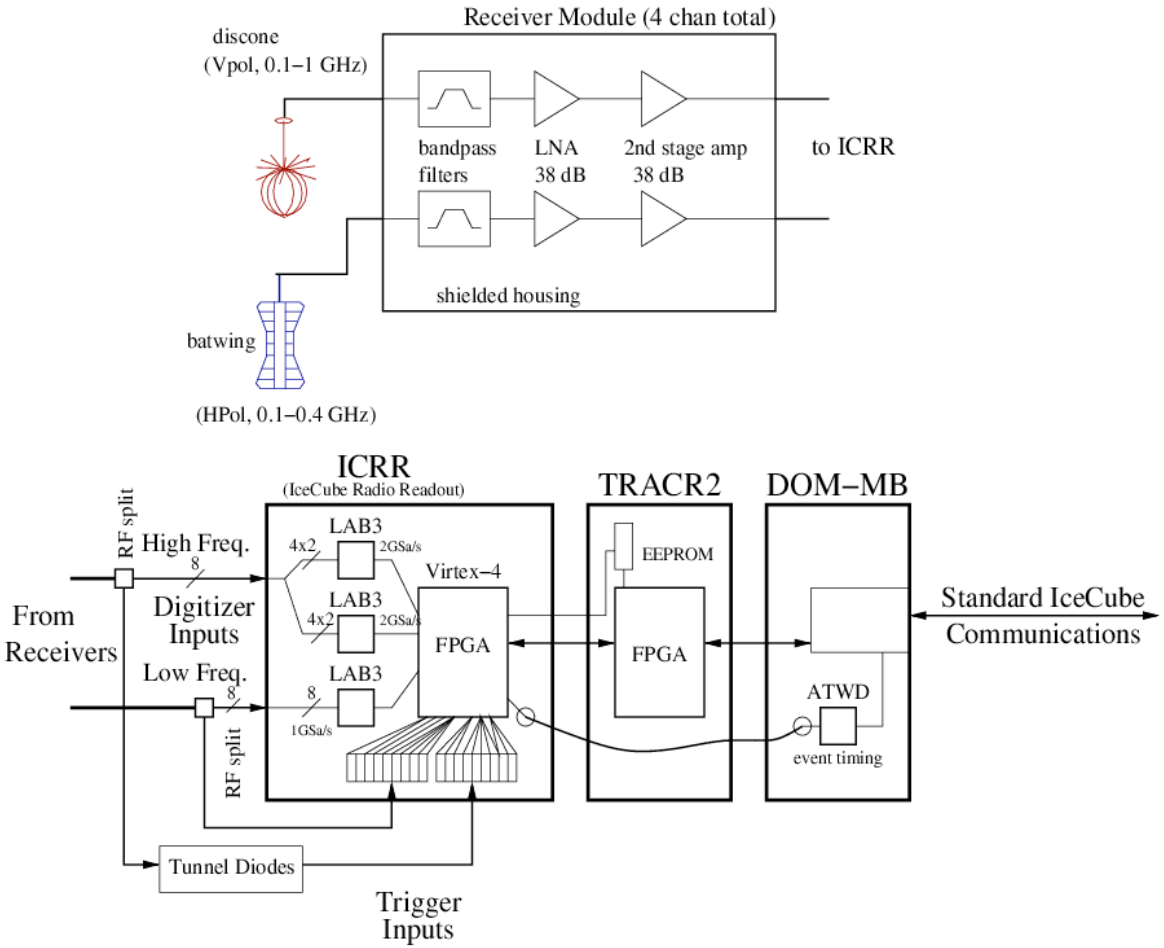


- Ground screen goals:
  - suppress surface noise from Pole
  - block aircraft RFI
  - block galactic & solar RF emission (strong at 100MHz)
- Size: ~ 3 times antenna array diam, → ~15m
- High-quality EMI mesh is really needed for best performance

Antenna Assembly

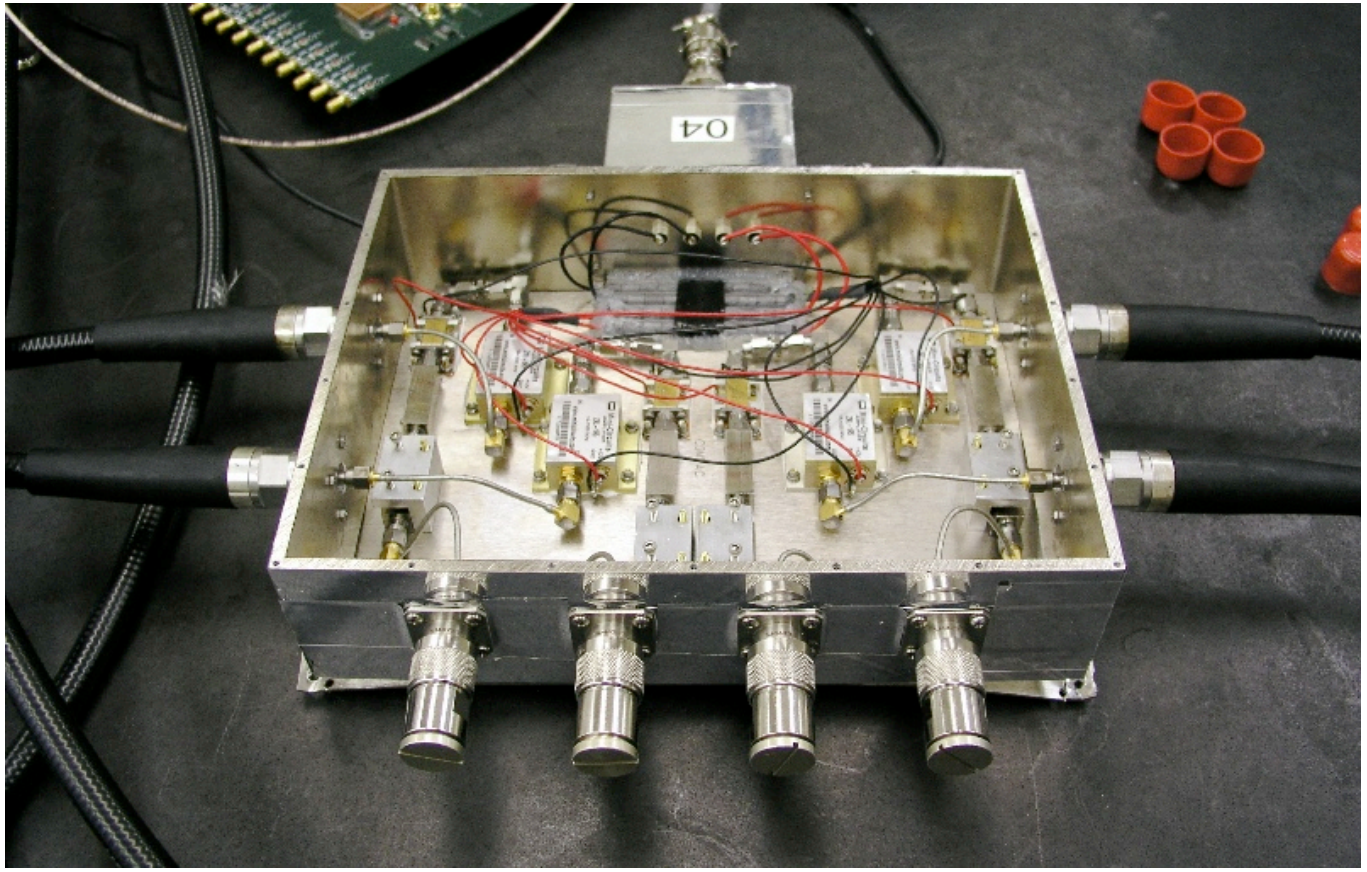


Receivers & DAQ system

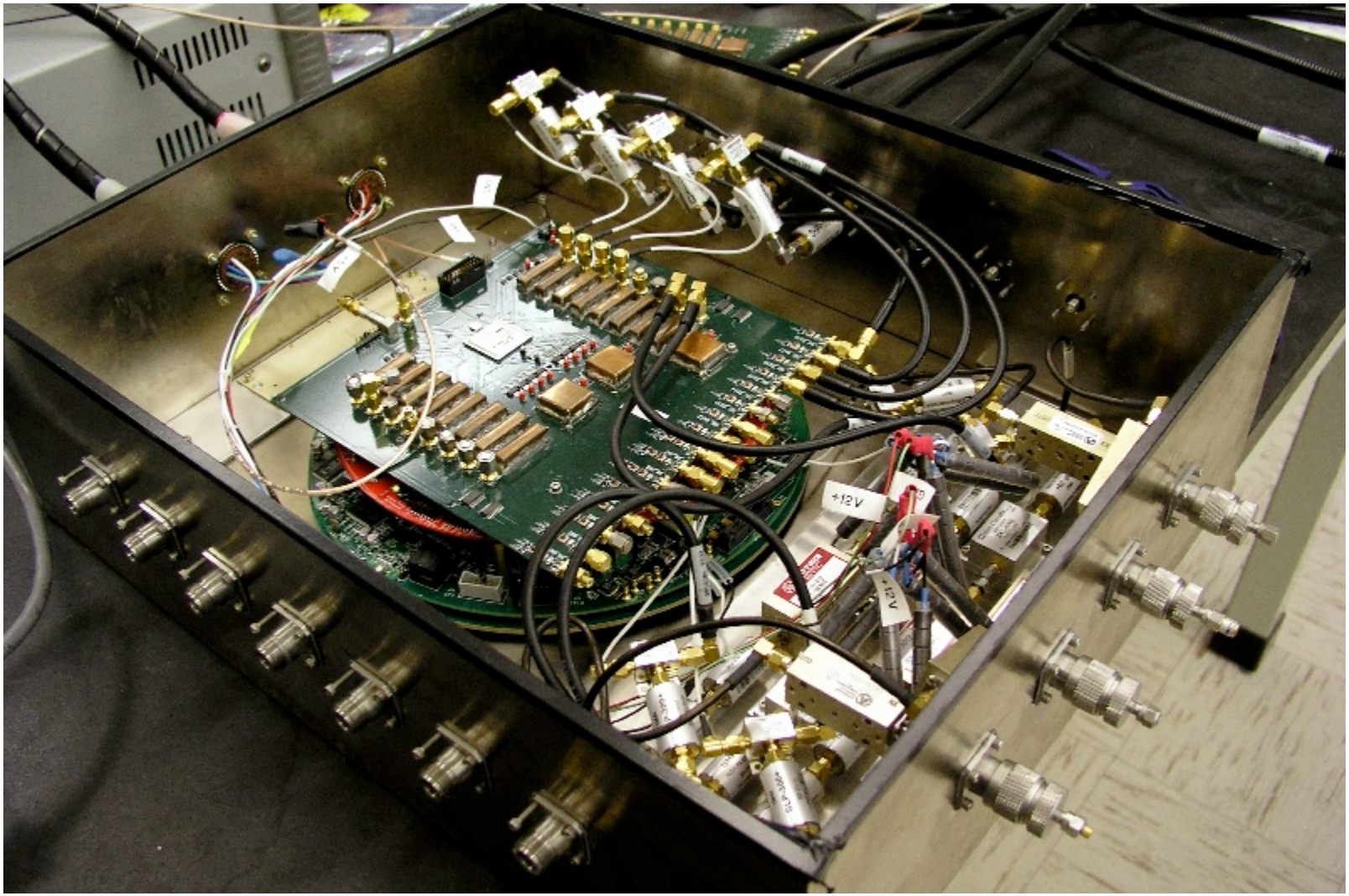


- RF receivers:
  - ANITA design, ~76 dB gain, 140K noise temperature
  - Bandpass 115-1200 MHz
- IceCube radio readout (ICRR):
  - Based on LABRADOR digitizer + Virtex-4 FPGA combination
  - Similar to ANITA design, 16 chan, 8@1Gs/s, 8@2Gs/s
  - Interfaces to std. IceCube DOM readout

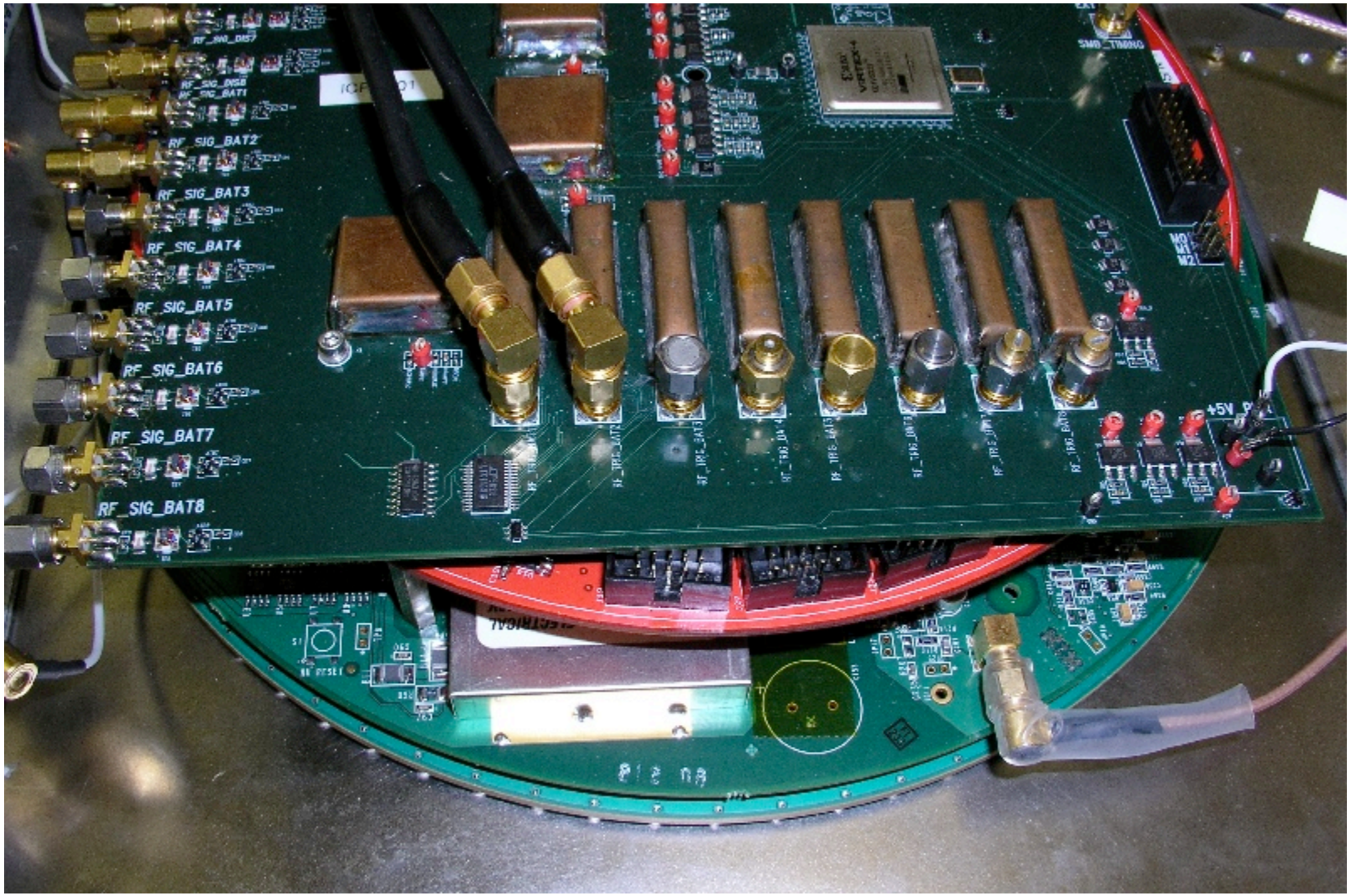
Terminated Amplifier Module



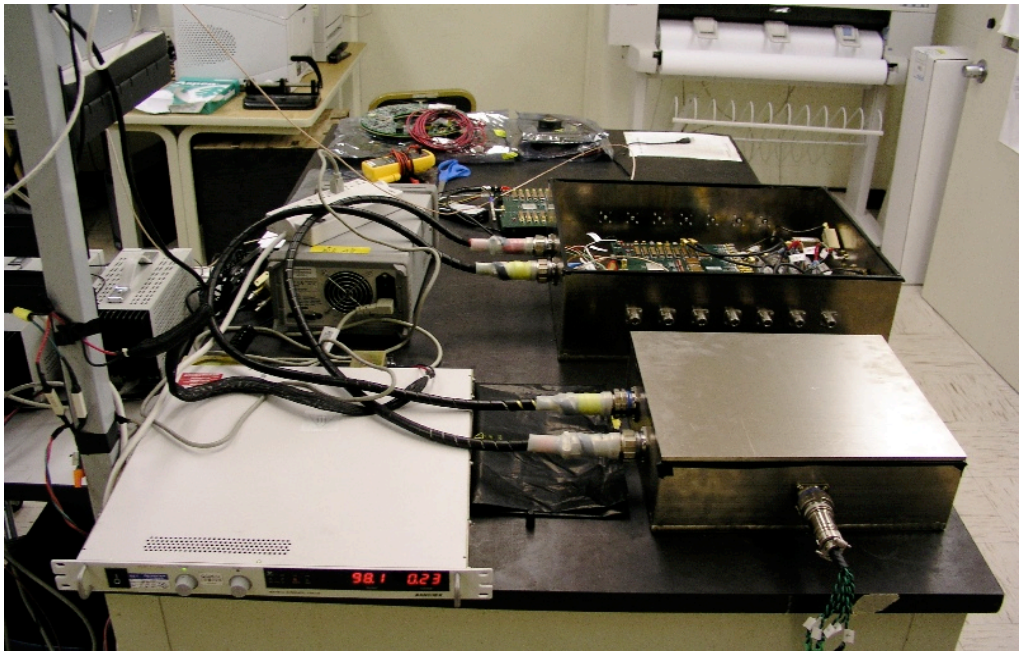
IceRay Brains

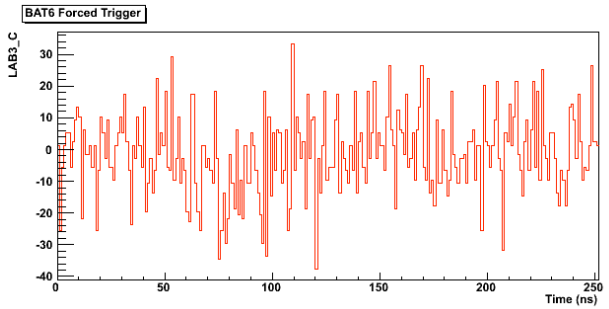


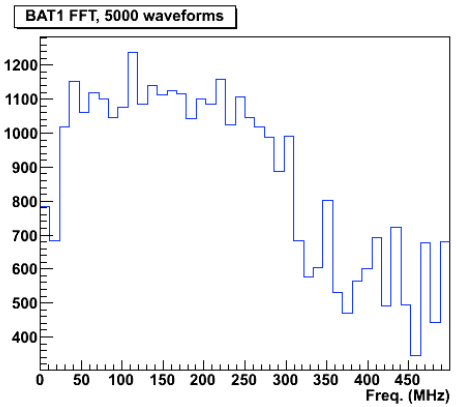
DOM MB, TRACR, and ICRR



Test Setup — UH Manoa 10/24/07







- Nearly end-to-end test
- Basic DAQ and wf analysis
- Later: cold test with dry ice also successful
- Hardware is ready!

Surface Cable

- 1700m Ericsson shielded 3-quad connects to spare quads at SJB
- Adaptor for direct DOM hookup (comms testing / debugging) also complete

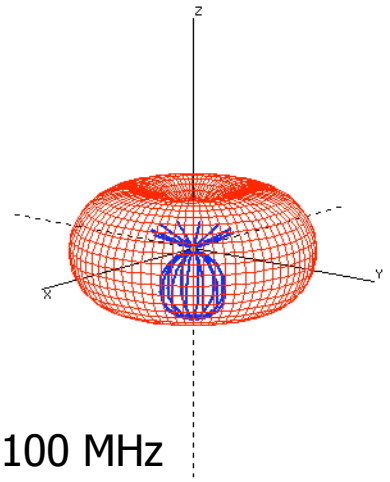
Summary

Stolen from nevillesgarden.co.uk. Want to design a logo?

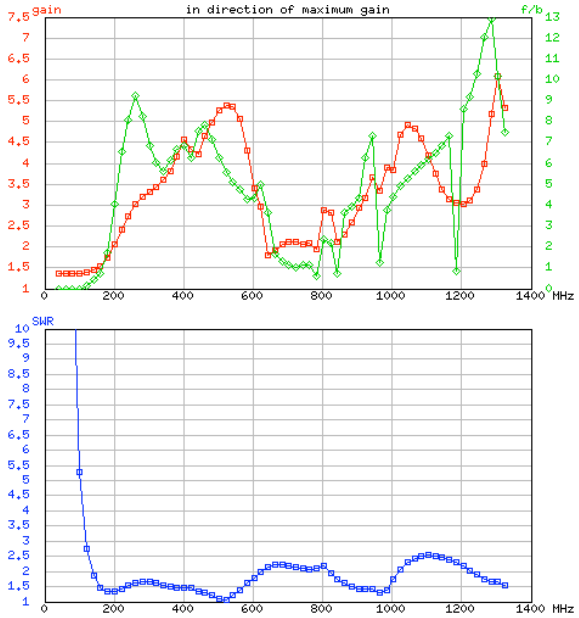
- IceRay-0 testbed is ready to go
- Will provide crucial RF background measurements, continuous monitoring
- Hope to deploy this season

Extra Slides

Discones



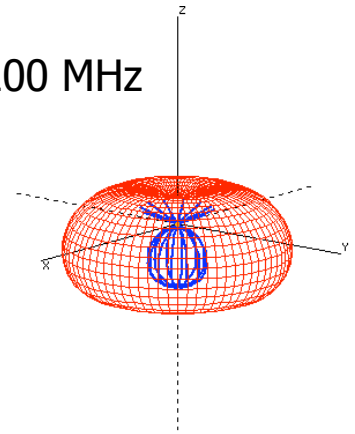
100 MHz



f = 100.35 MHz maxgain = 1.36 dBi vgain = 0.96 dBi

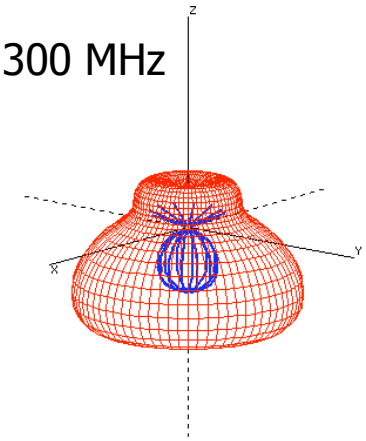
- Checked with nec2dx_firn
  - Code modified for n=1.35
- Reasonable mode structure, 100-600 MHz

200 MHz



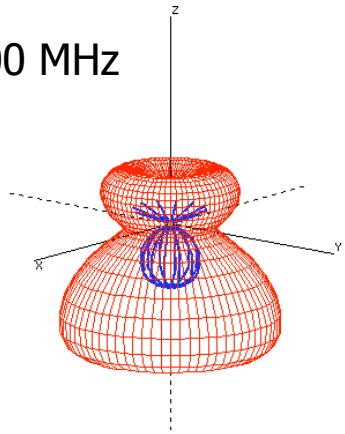
f = 200.74 MHz maxgain = 2.05 dBi vgain = -0.54 dBi

300 MHz



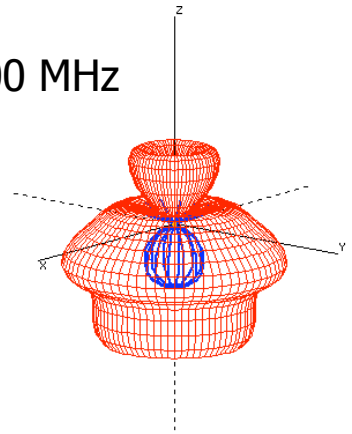
f = 301.12 MHz maxgain = 3.32 dBi vgain = -4.32 dBi

400 MHz



f = 401.51 MHz maxgain = 4.57 dBi vgain = -2.96 dBi

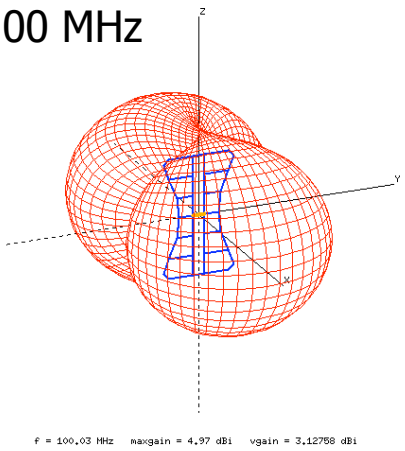
600 MHz



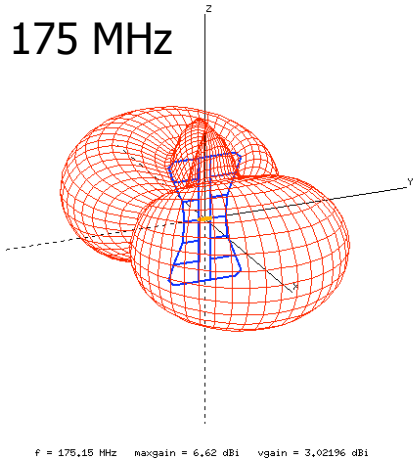
f = 602.28 MHz maxgain = 3.4 dBi vgain = -3.61 dBi

Batwing (Horizontal Pol.)

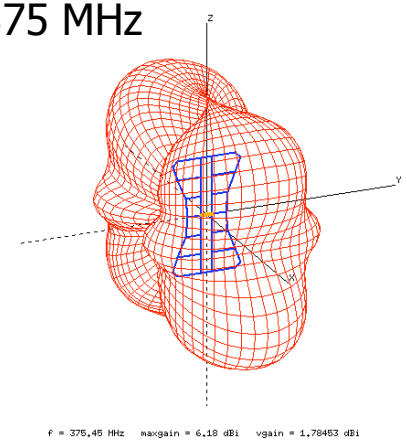
100 MHz



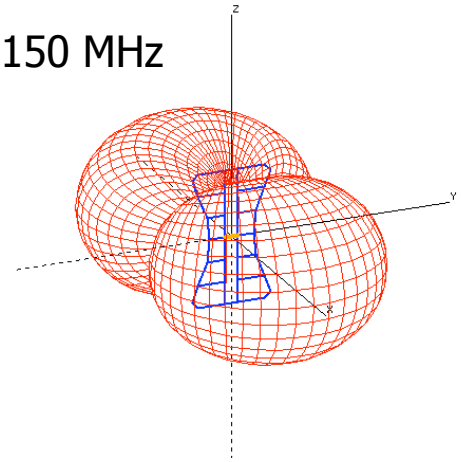
175 MHz



375 MHz



150 MHz



225 MHz