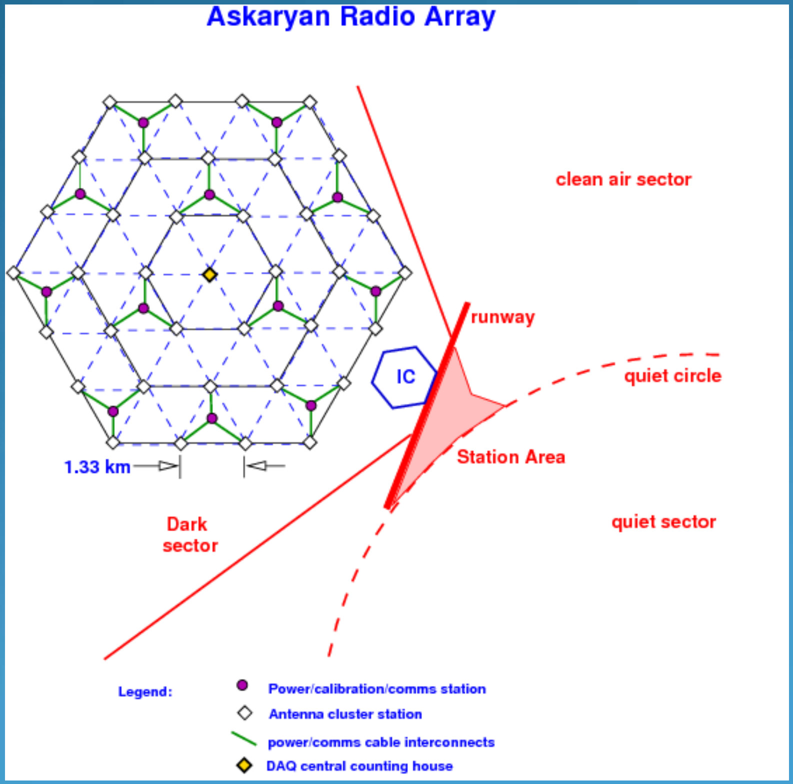
ARA testbed plans



P. Gorham

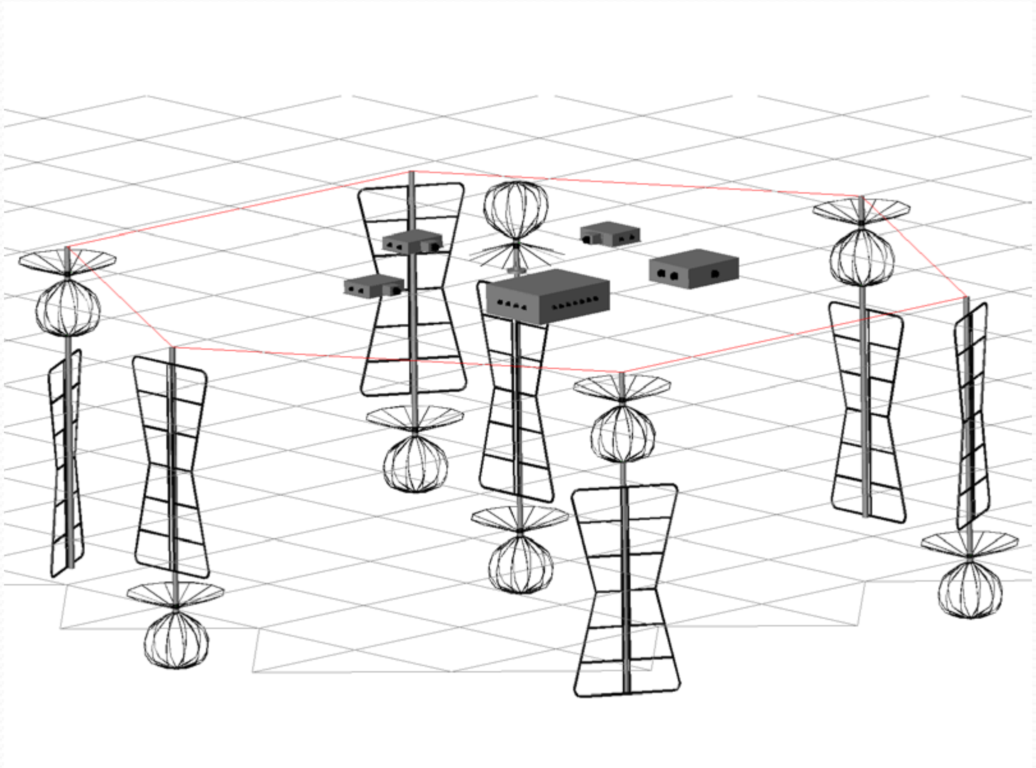
history

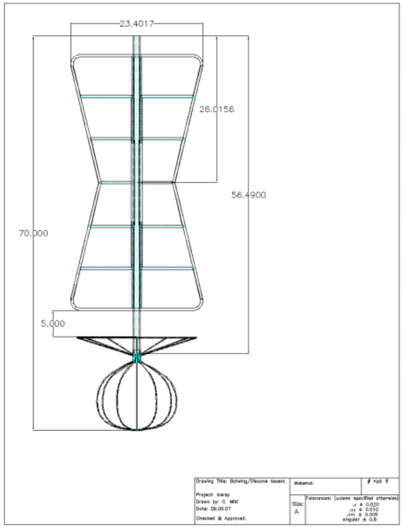
- Current testbed built in 2007 with UH in-house funds, plans to deploy in 2007-2008 season if possible
  - Uses AURA-esque architecture, 16 RF channels, plugs into IceCube data stream
- Original Goal: to get continuous RF data sets at a location relatively distant from SP station, both under-ice and up-ward-looking antennas
  - Investigate long-term thermal noise environment, prove that RFI environment was good enough for large-scale detector commitment
  - Intended distance: up to 2km out from edge of IceCube

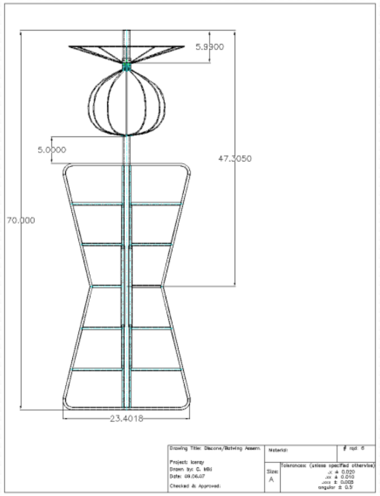
- Design driven by costs and drilling logistics: near-surface antennas (boreholes better but not practical for that season) in 24" holes drilled by bobcat → allowed for much larger antennas than a borehole

- Currently: testbed allows for quick response in ARA, to have a prototype station in place this coming season
  - Still some flexibility on how we deploy and use it

Testbed layout

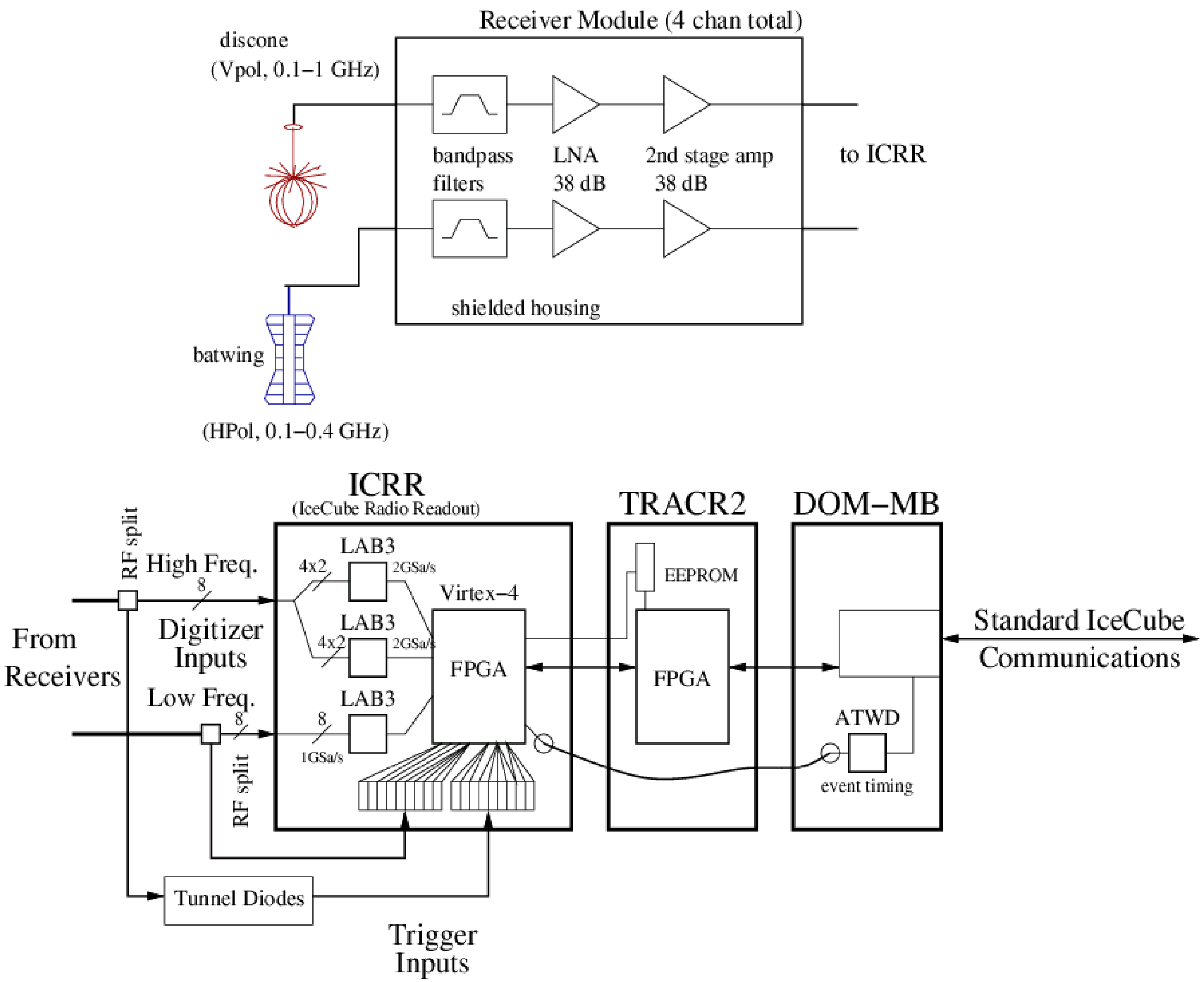






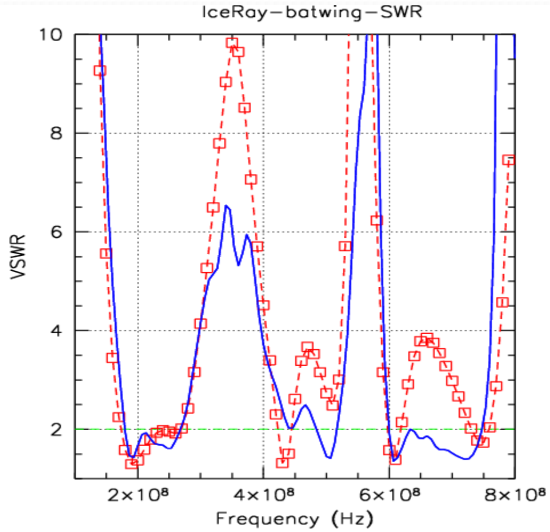
- ~2m depth: electronics level
- ~2m (or more?) deeper: subsurface antennas
- Surface antennas above ground screen (not shown)

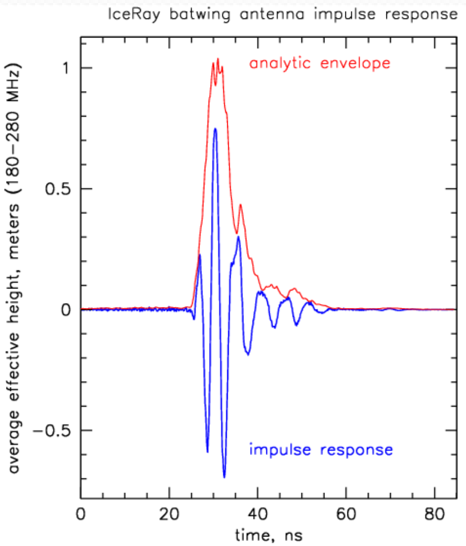
Testbed schematic



Antenna response

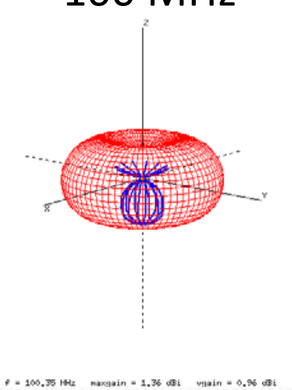
Batwing:



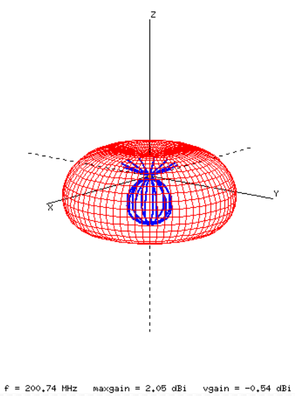


Discone:

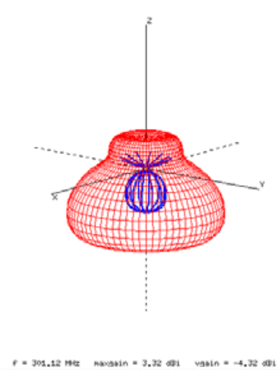
100 MHz



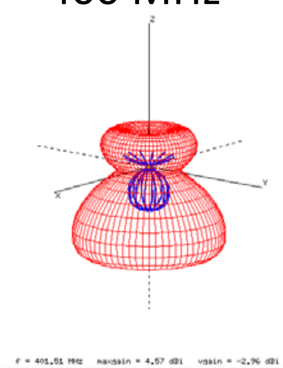
200 MHz



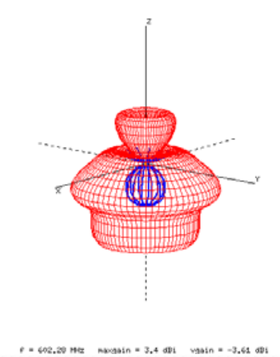
300 MHz



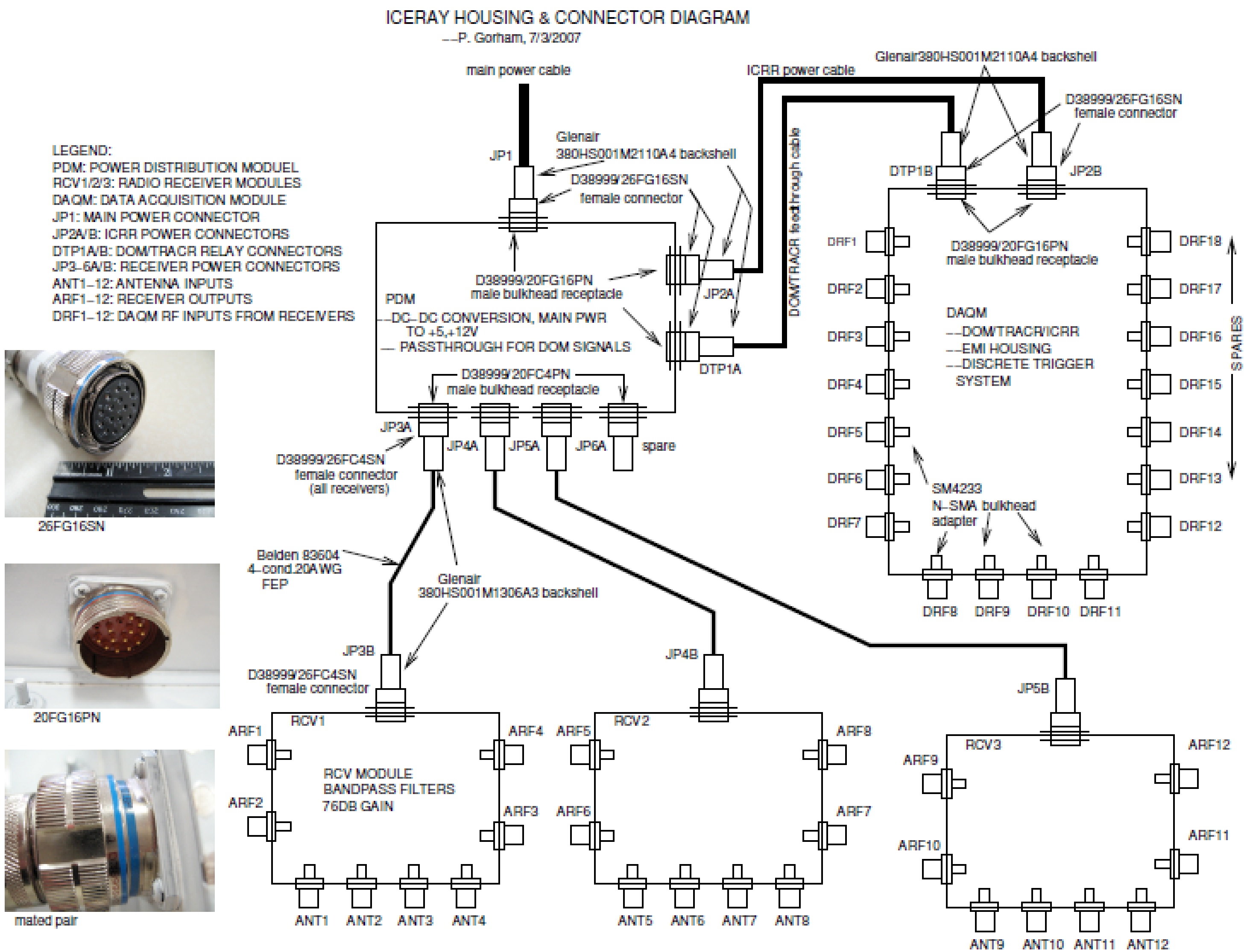
400 MHz



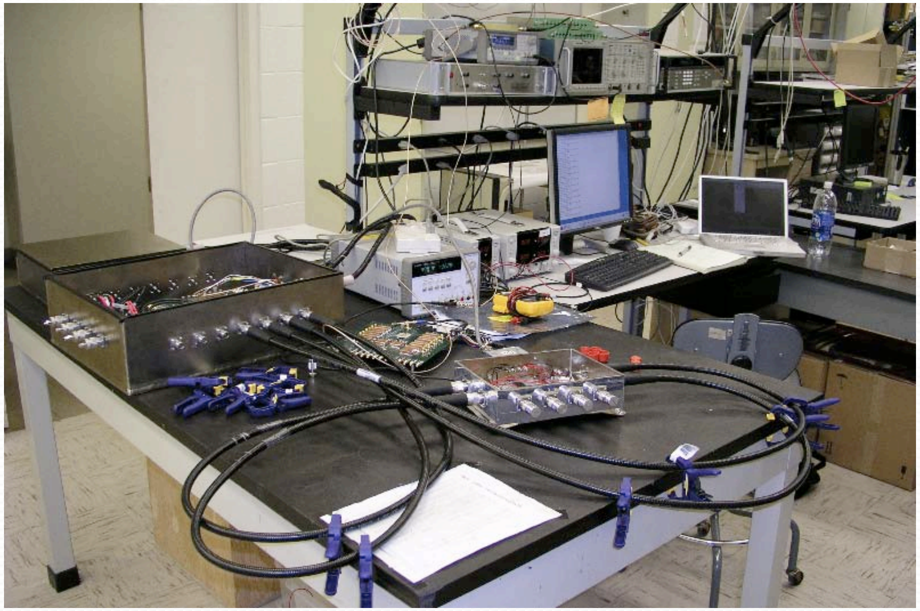
600 MHz

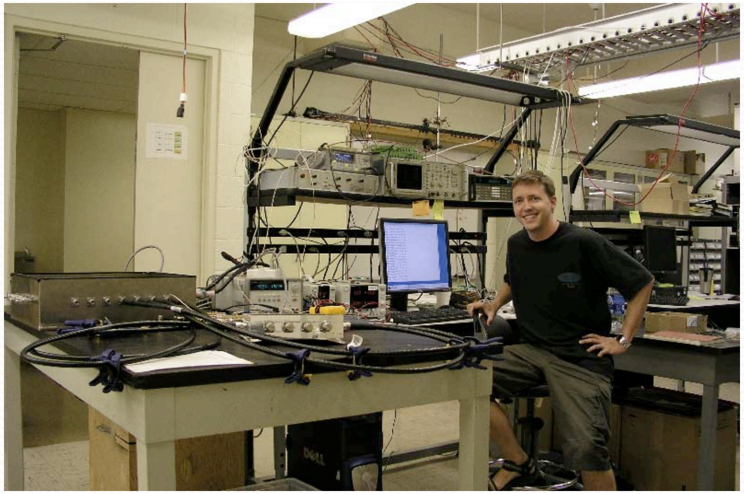


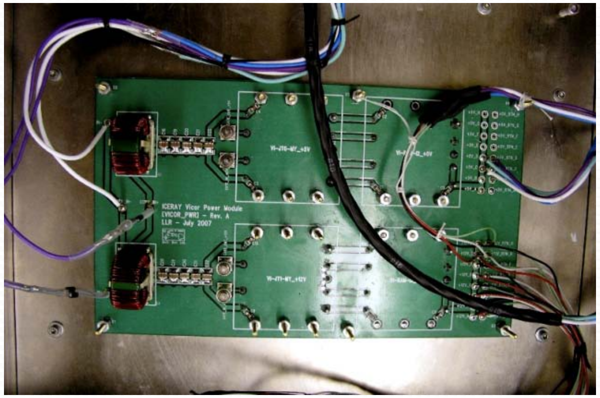
Testbed housing schematic

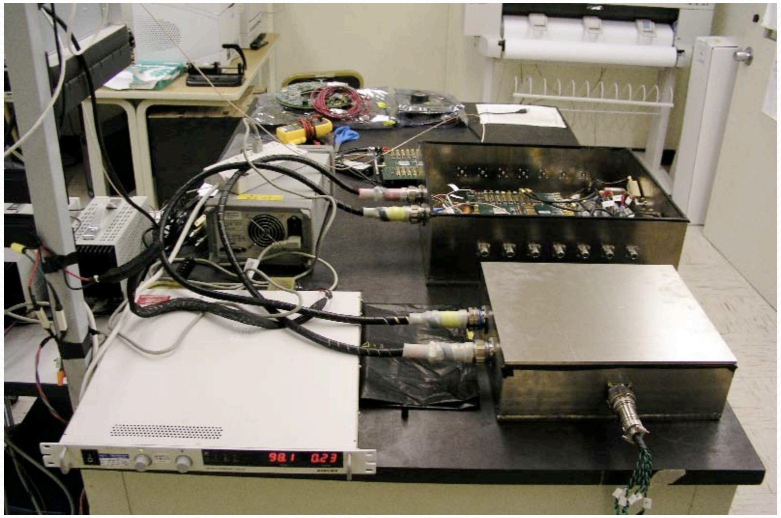


Summer 2007 integration

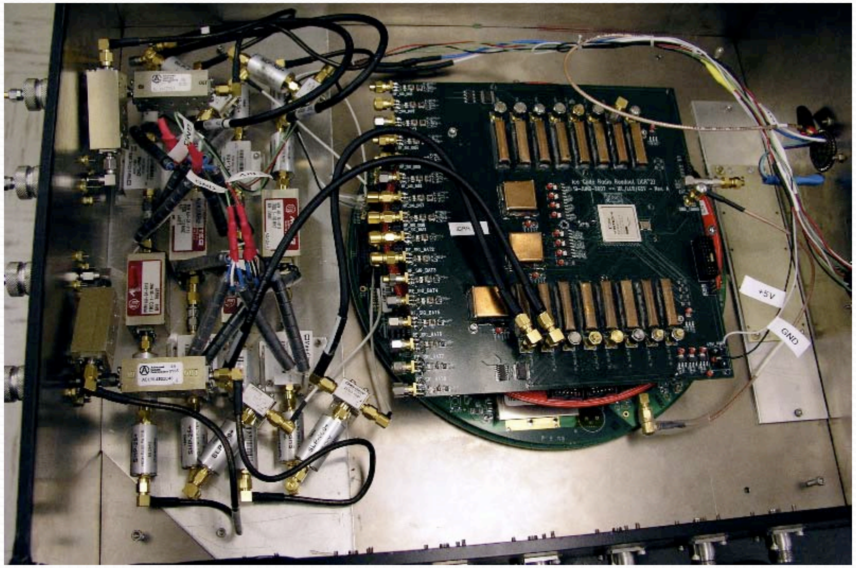


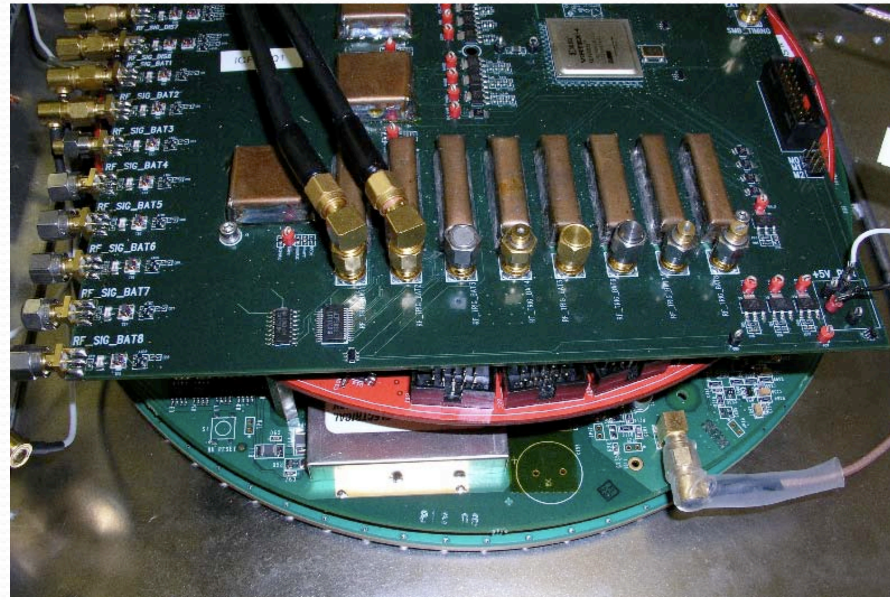


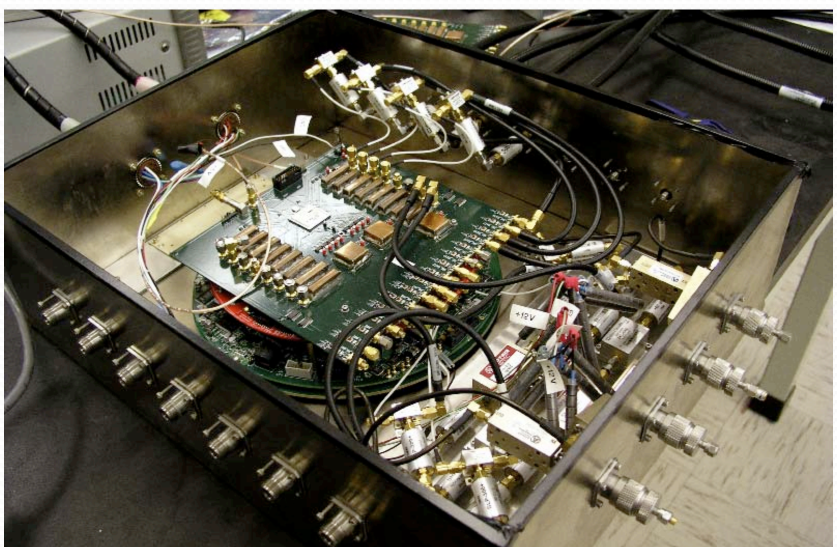




Main under-ice RF DAQ sections

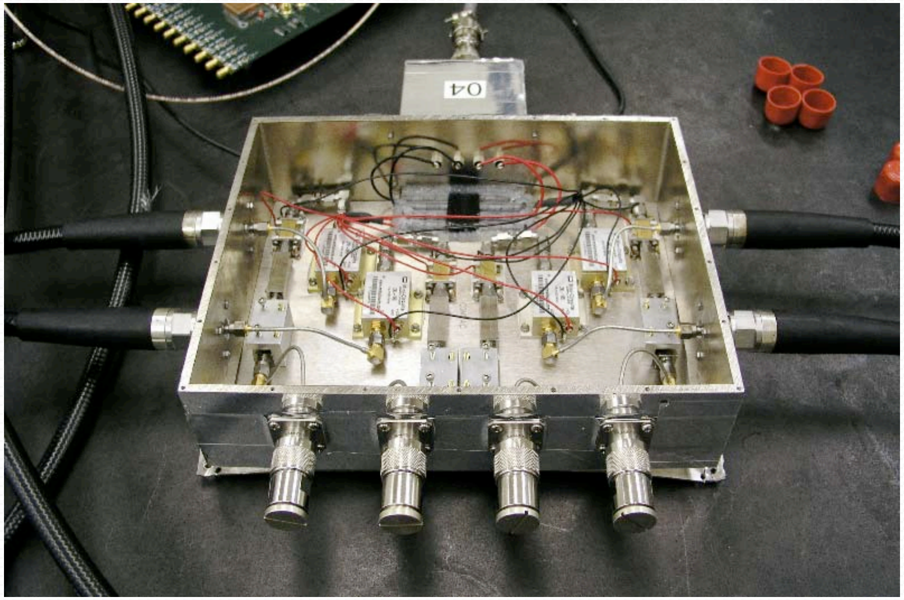


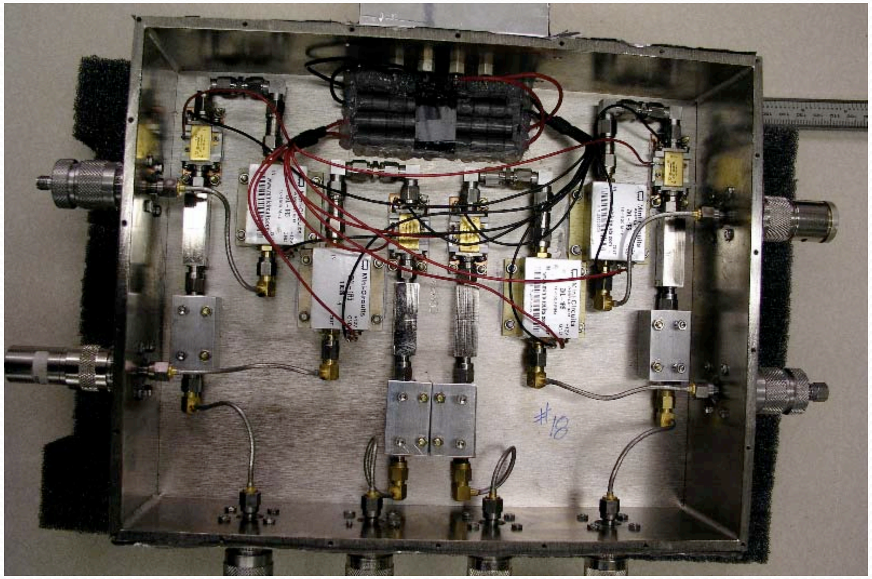




- 6 VHF + 6 UHF channels
- Discrim. uses tunnel-diodes for UHF, Xilinx LVDS discriminators for VHF
- Nickel-plated EMI housing, MIL-std EMI connectors

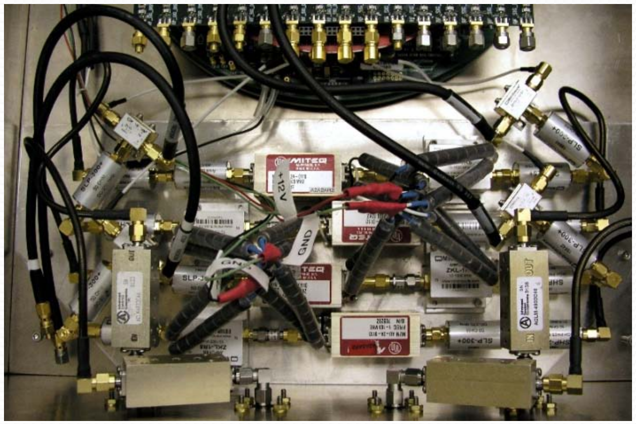
Receivers

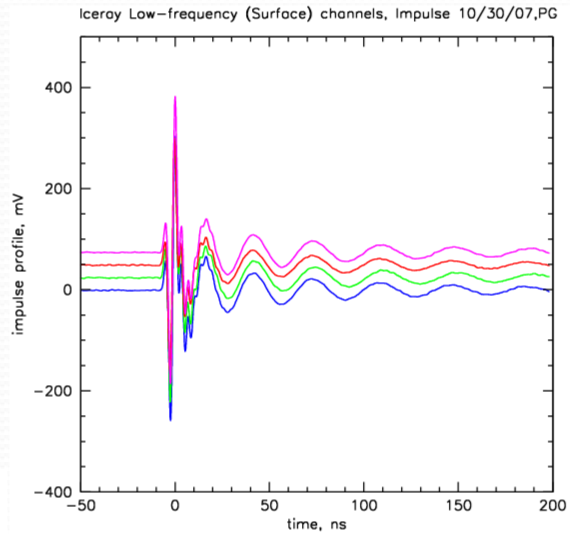


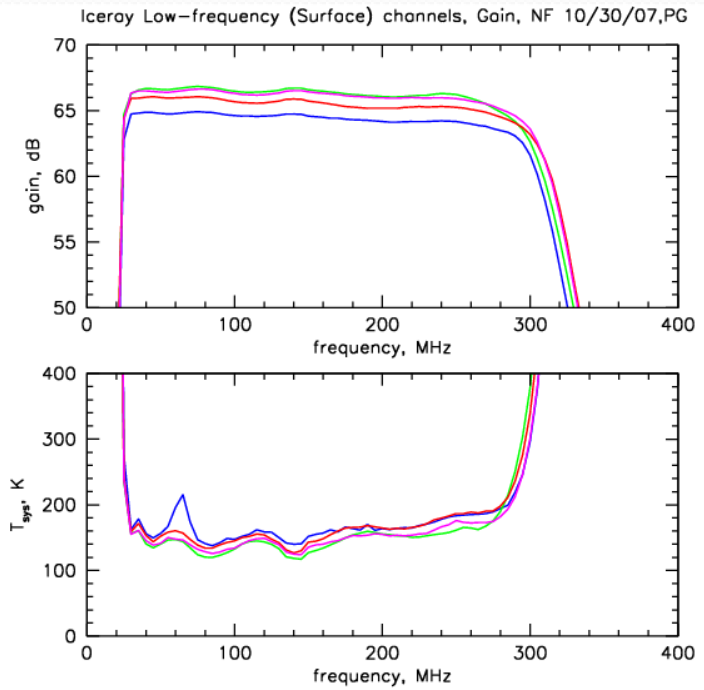


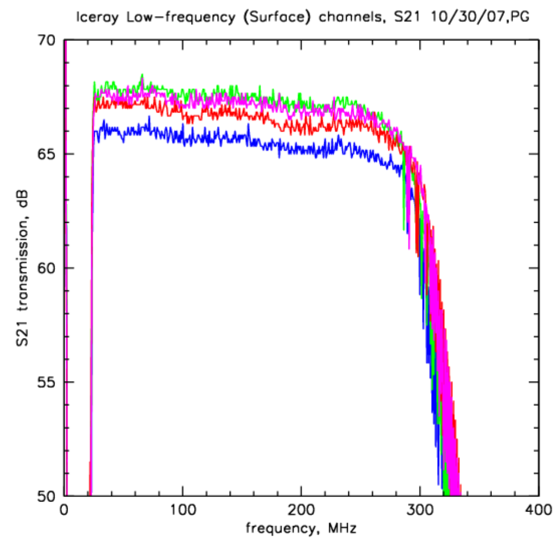
- 4 ch, ~76 dB gain, ~140K NF, based on ANITA-1 design
  - Currently 200-1200MHz, can be modified to 130 – xxx Mhz
- ANITA-2: used a bias tee to power a remote pre-amp, reduce NF to 90K
- Double shielded + filter-pins on power inputs, 110 dB MILstd backshells
- Probably good to >100 dB overall (hard to test beyond ~90 dB)
- Need to build 4 more! (originals were taken for ANITA when OPP turned down testbed deployment)

Surface (low-freq) channels



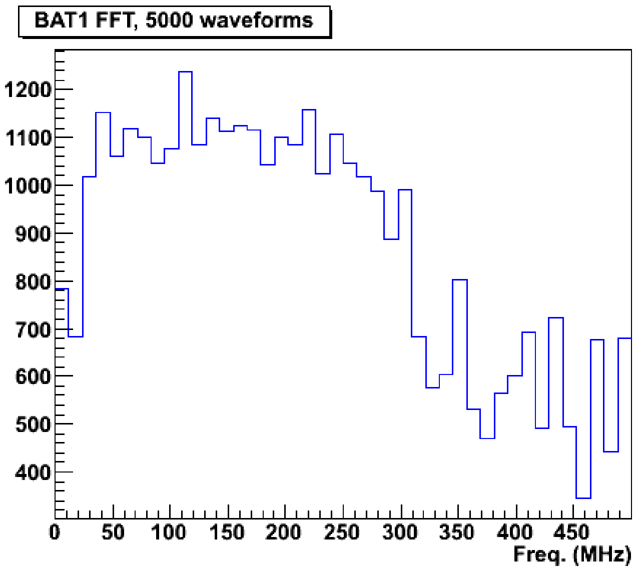


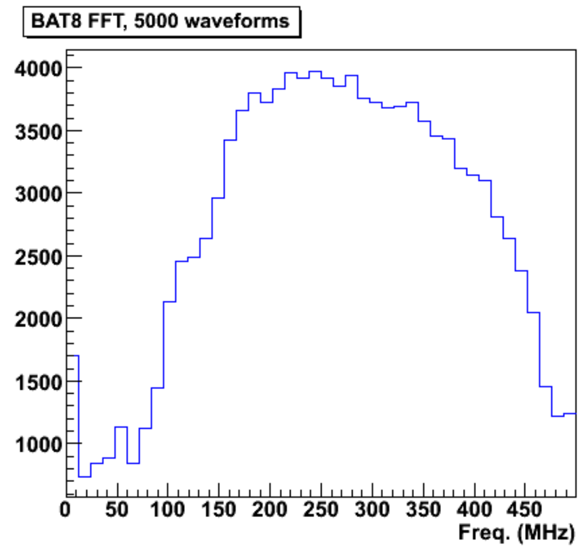


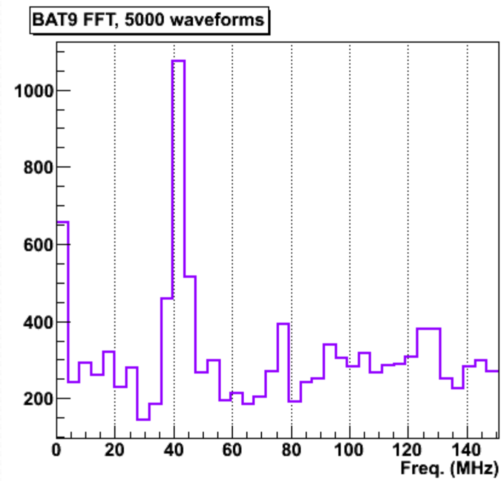


- 4 channels with 25-300 MHz passband ~150K NF (at 290K)
- Limiters for all 4 channels (13 dBm saturation)
  - Will protect front end from almost any strong interference
- Designed for surface antennas
  - Triggering will be by direct Xilinx LVDS discriminators

Testbed data: 2007

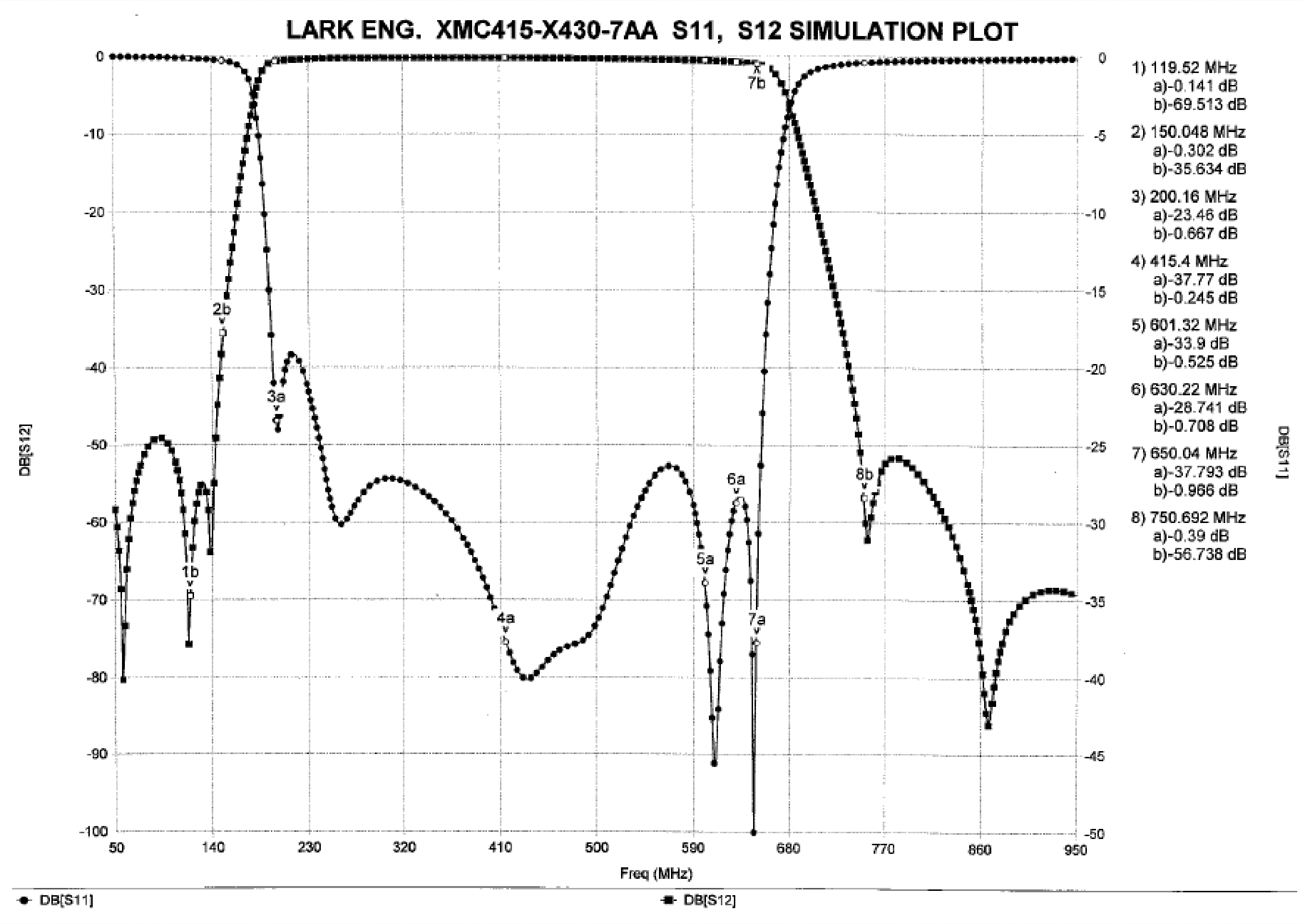






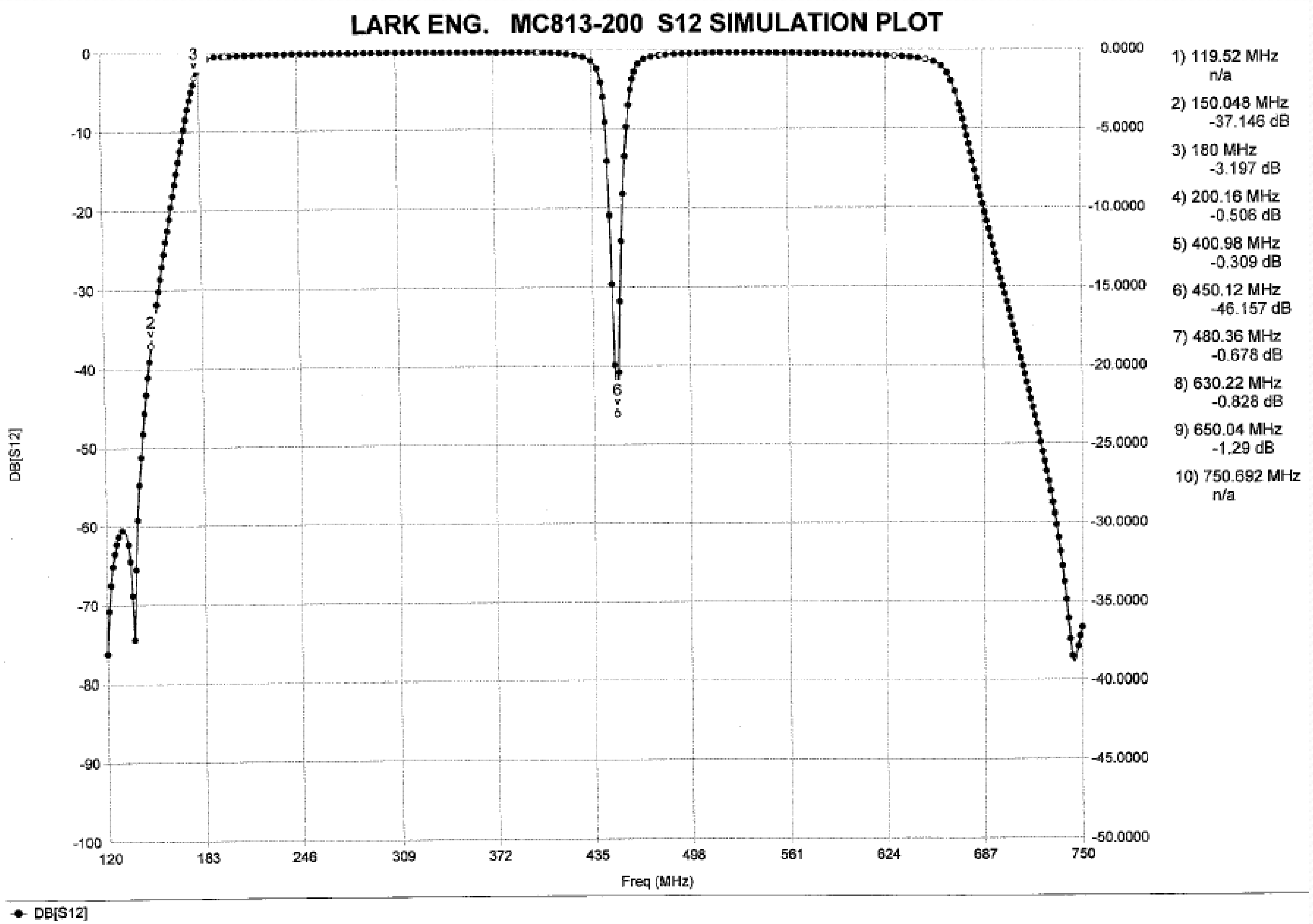
- Test data from John & Hagar:
  - Left: low frequency channel: bandpass shaping of thermal noise evident
  - Center: VHF channel, also showing shaped bandpass noise
  - Right: clock spectrum (LAB channel 9)

Lark bandpass filters (no notch)



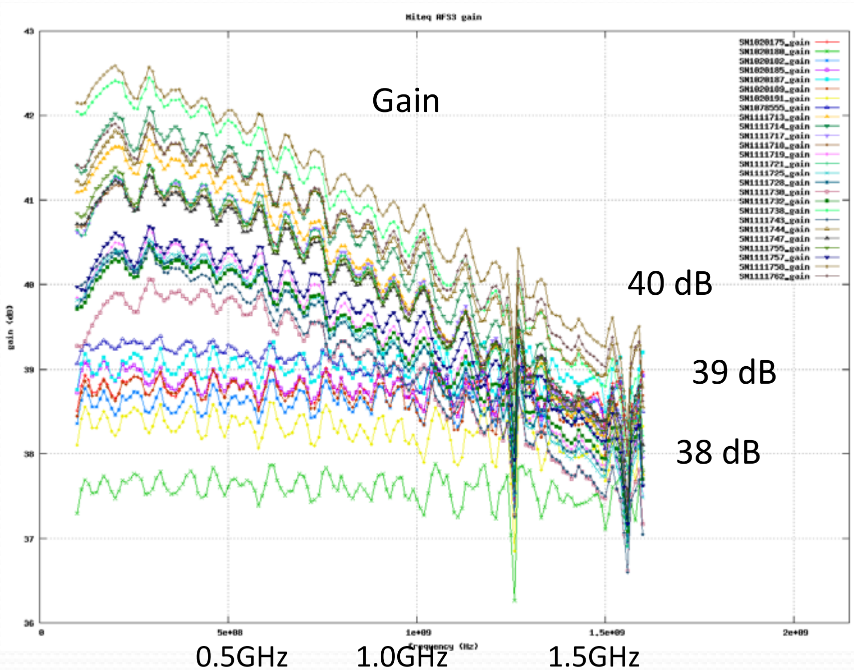
- This version started at about 180 MHz, but 150MHz is prob. OK

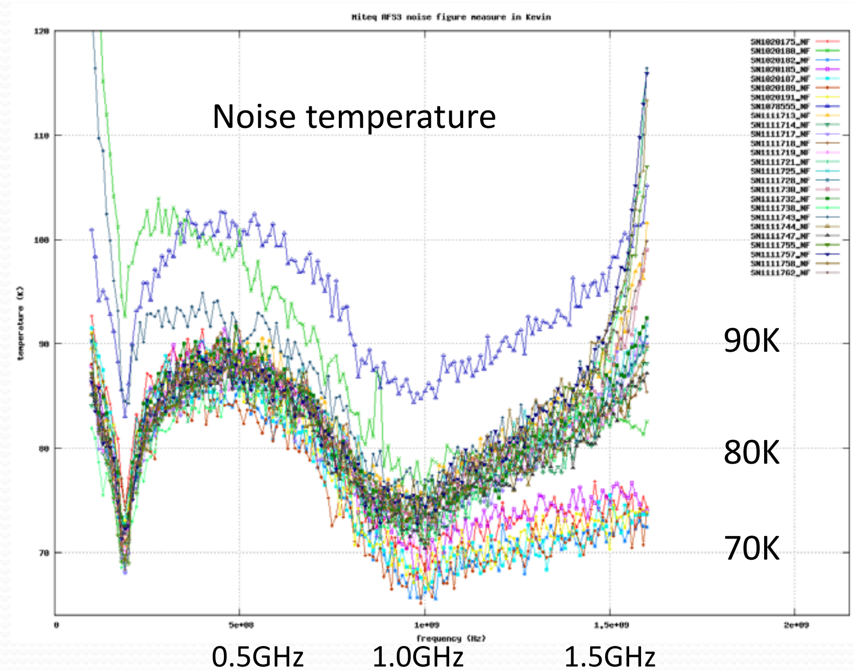
Notch+bandpass



- This one may be a good choice if we want to drop the ground screen
- 0.3-0.5 dB in-band
- 46 dB notch at 450 MHz

Miteq LNAs planned





- Miteq LNAs with 13 dBm limiters, available for testbed (24)
- Have been tested to -80C, get ~20K better noise figure, higher gain

What do we learn from testbed?

- Confirm thermal noise levels in quieter environment than current RICE & AURA locations
  - But also: learn about residual EMI away from the SP environs
- Maybe some air shower radio pulses – good for under-ice calibration? (if we use notch and no ground screen)
- Can we get cosmic sources?
  - Sun should be straightforward, maybe GC?
  - Will independently monitor absolute thermal scale
- Probably most important:
  - Exercise and determine waveform timing and triggering requirements using nearby subsurface or near surface pulsers (or farther away if deep enough)