Calibration Overview & Update & Plans

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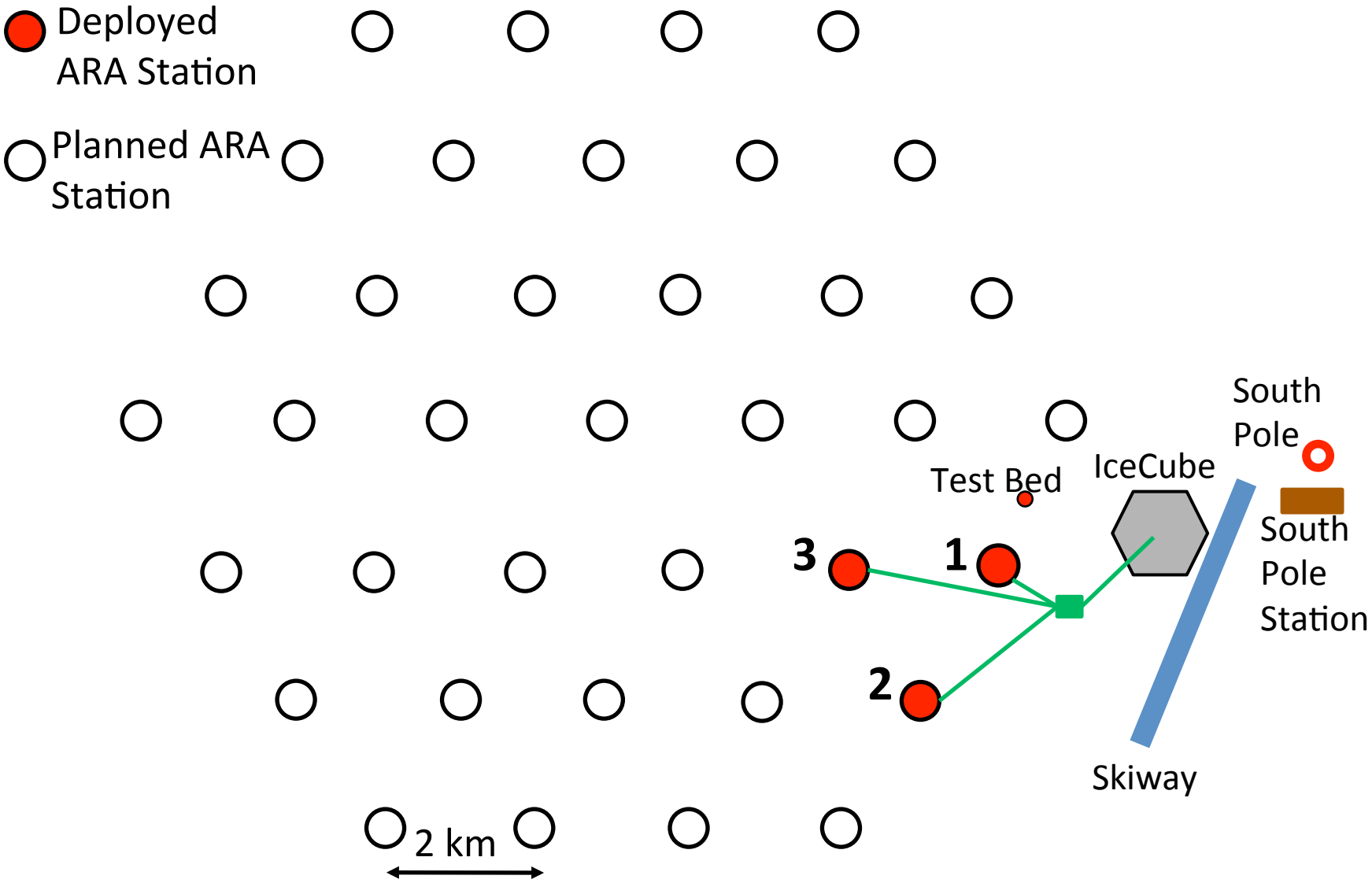
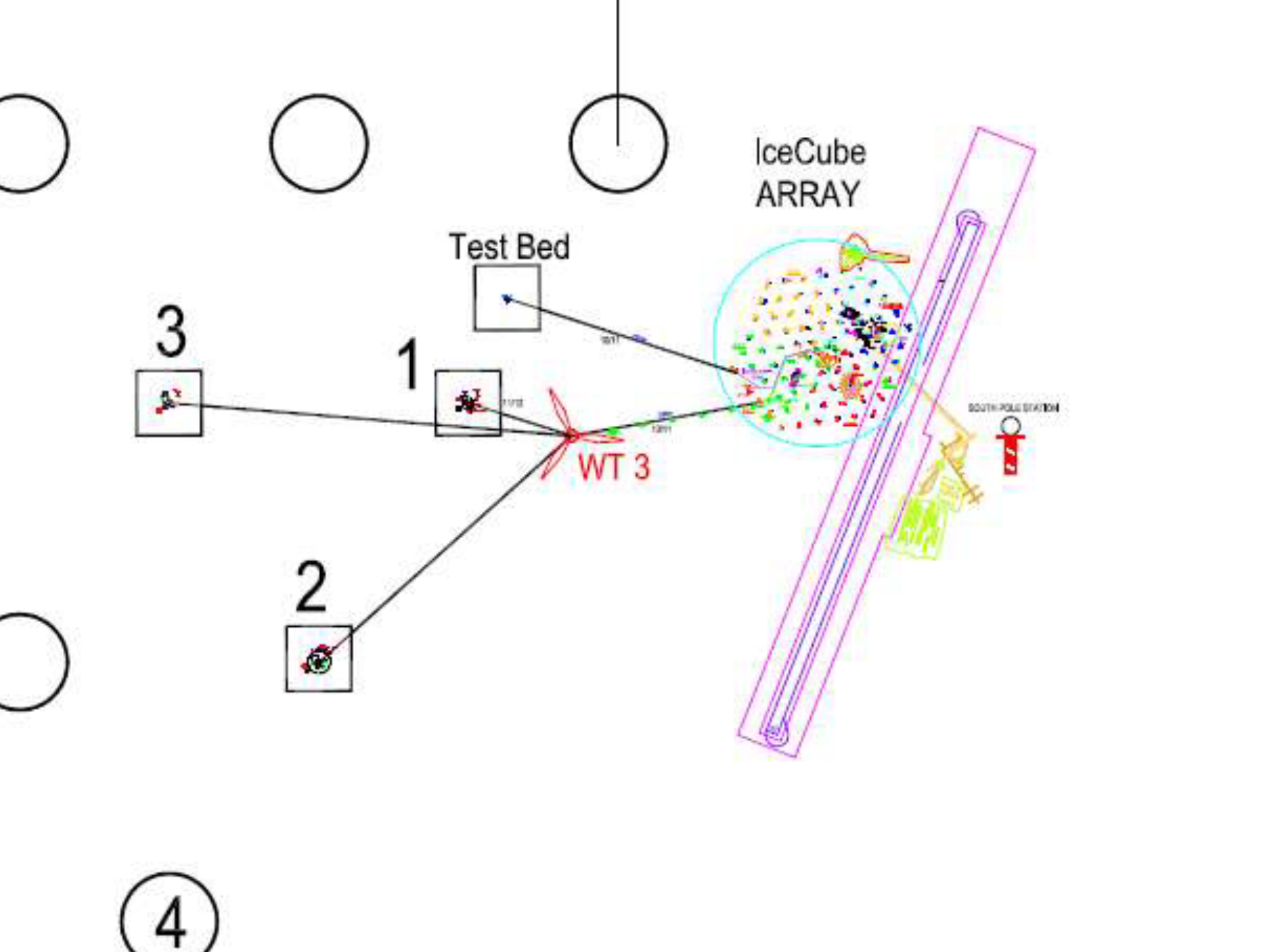
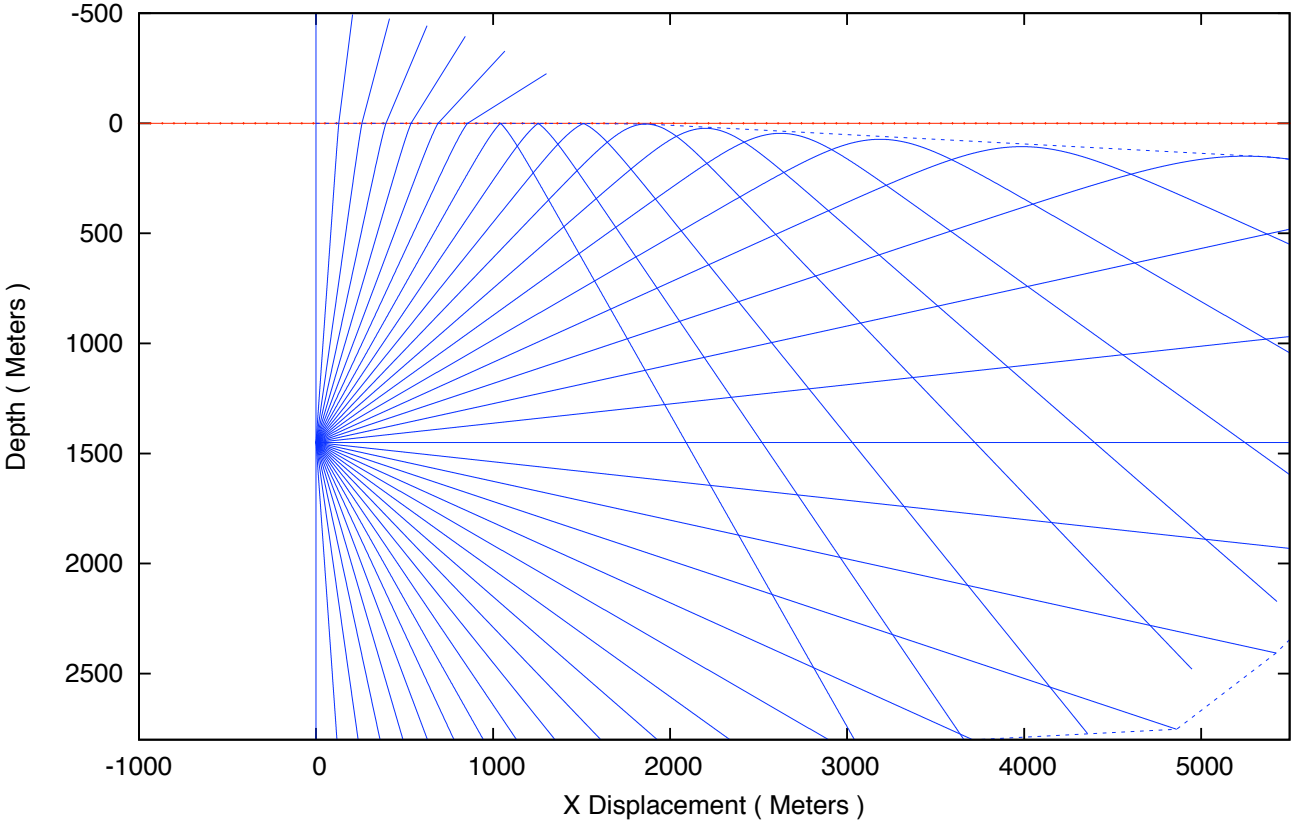
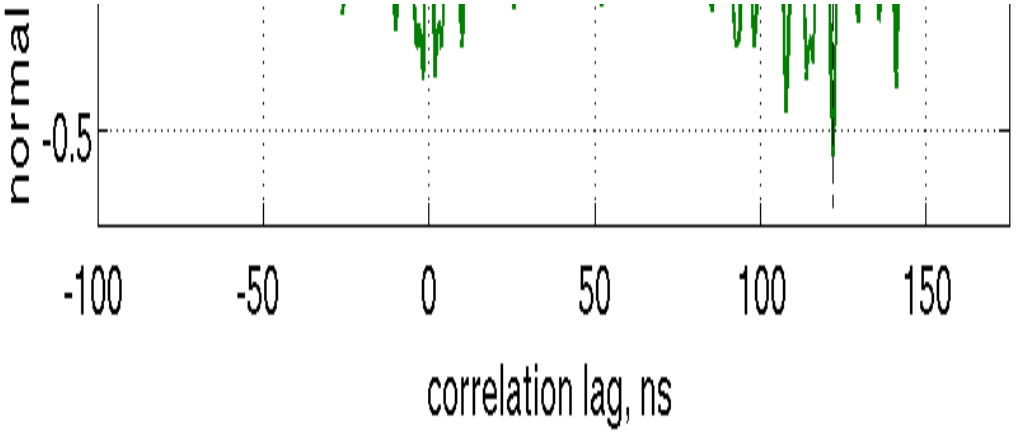

Deployed
ARA Station
Planned ARA
Station
South
Pole
Test Bed
IceCube
South
Pole
Station
3
1
2
Skiway
2 km


IceCube
ARRAY
Test Bed
3
1
2
WT 3
4

Additional deep pulsers on IceCube strings

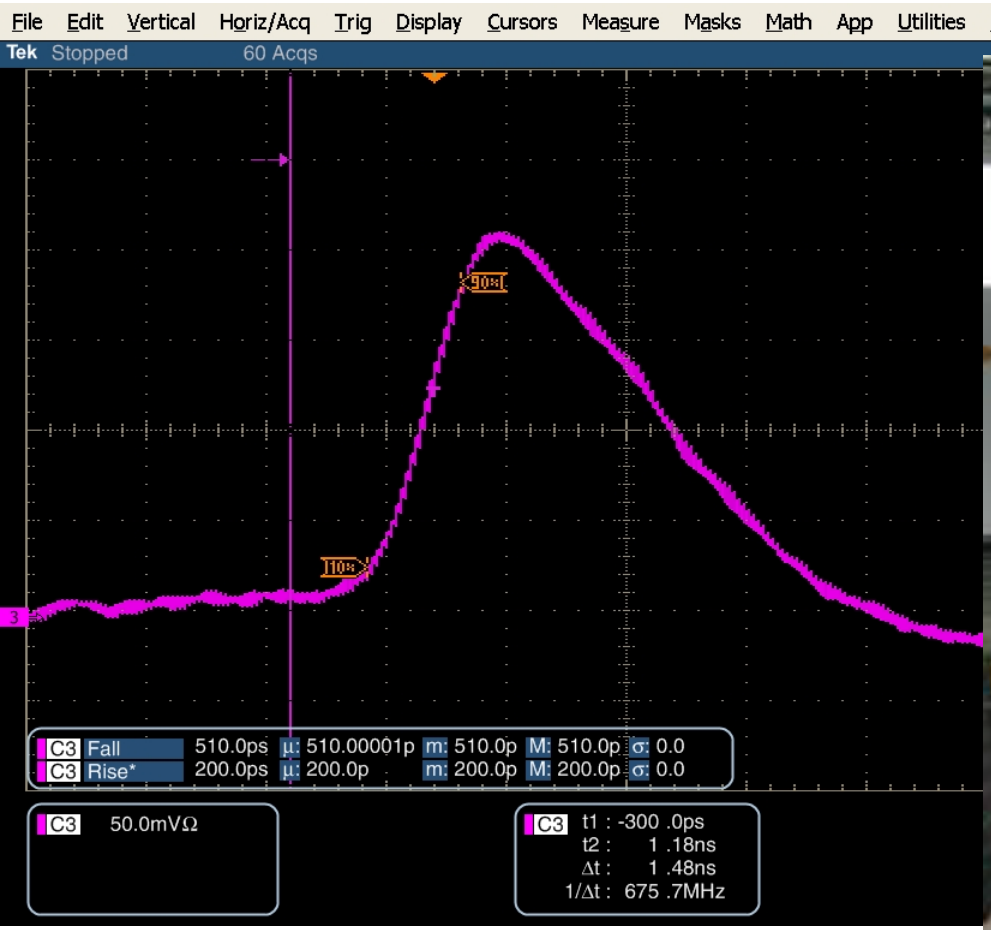


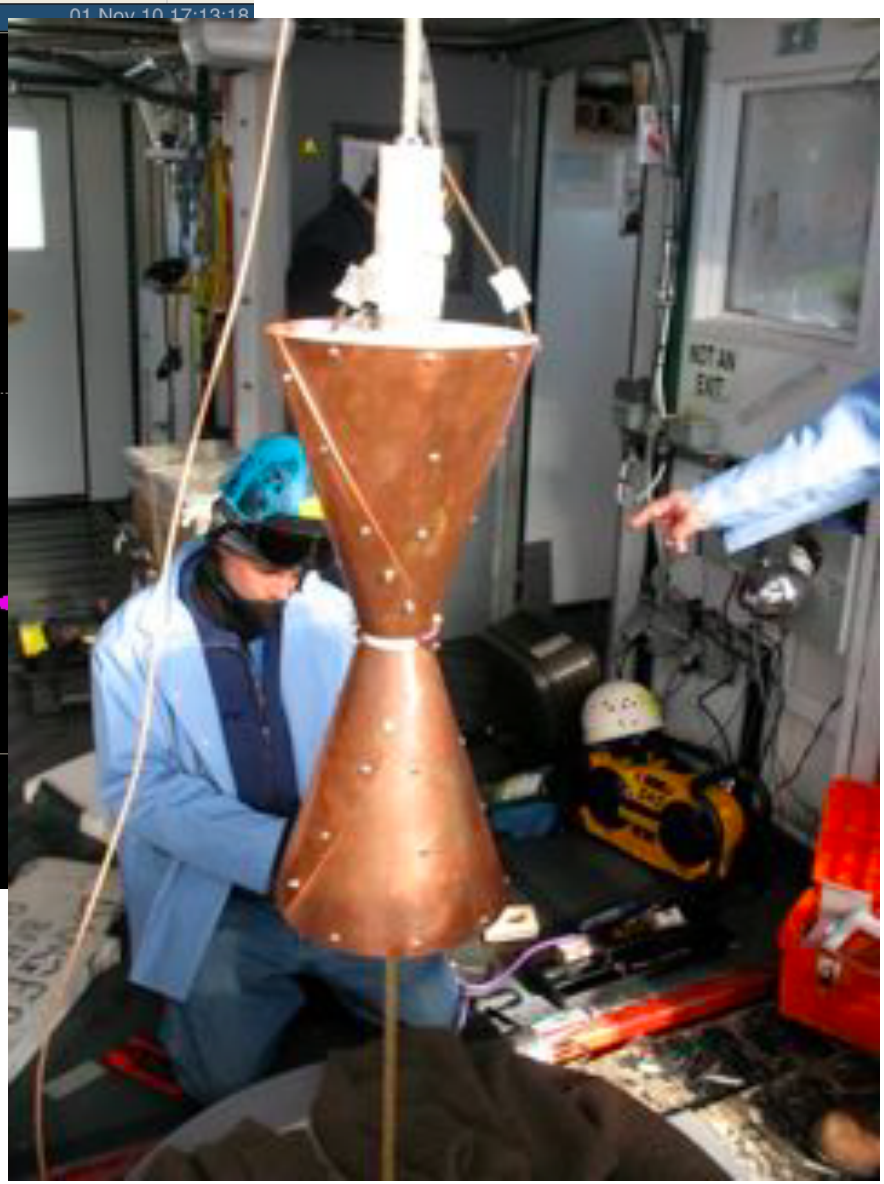
Reflected ray from mirroring!



- last access to deep IceCube holes in 2010-2011
- 3 high voltage calibration transmitters installed on IceCube strings- 2 at 1450 m and 1 at 2450 meters
- Nominal 5 kV pulsers
- For calibration and radioglaciological studies

Deep pulser installation





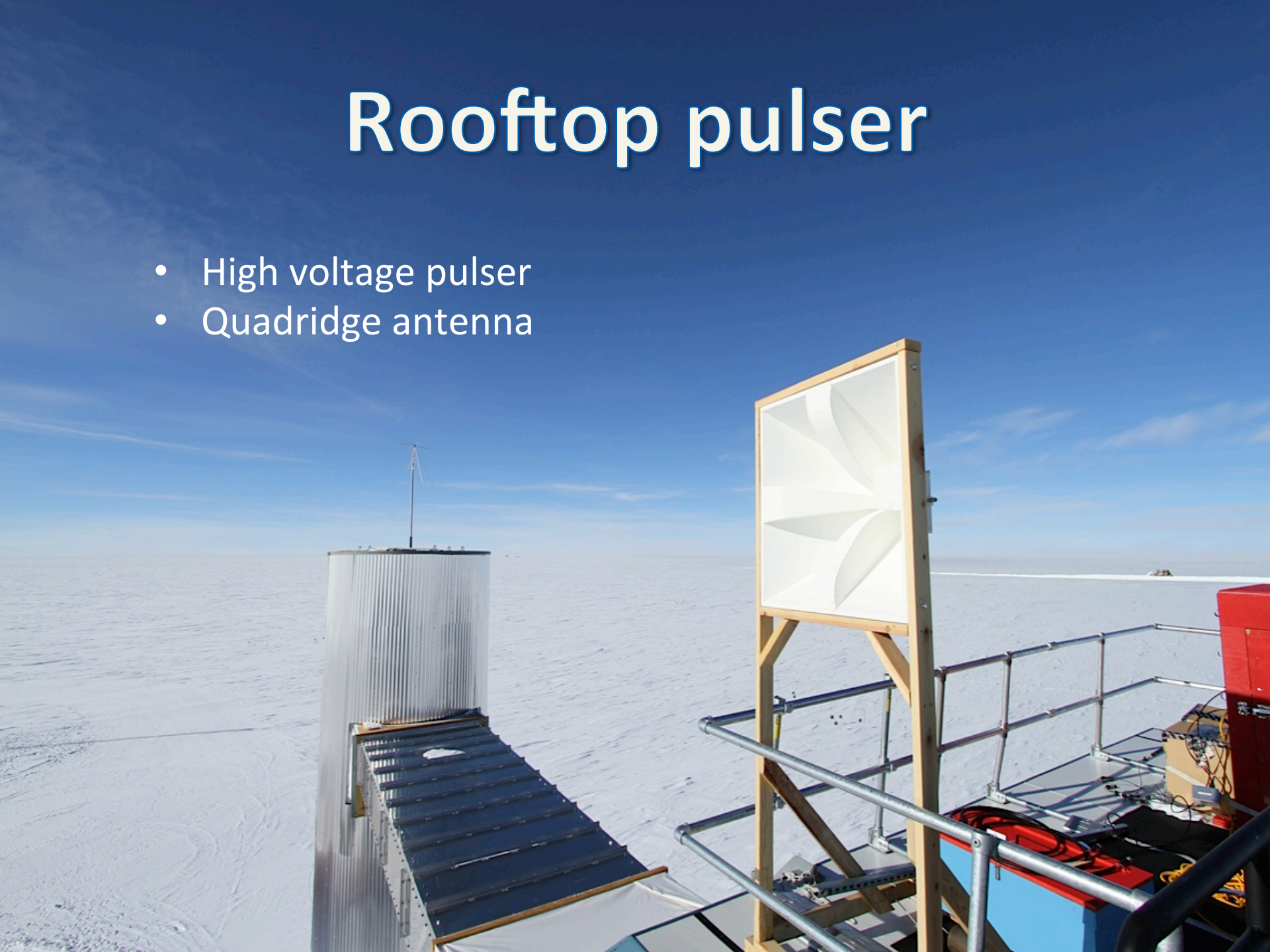
- 3 deployed on last IceCube strings in Dec 2011
- 2 at 1450m
- 1 at 2450m

Deep Pulser Data & Status

- All three pulsers were run successfully the season they were installed.
- The pulser at 2450m, was seem at the testbed 3.2 km away at a 40 degree angle. This yielded the longest point to point measurement of ice attenuation to date, but the 2450 m pulser appeared to fail shortly after.
- Mike DuVernois took new pulser runs with all pulsers in the last Pole season. The 1450m pulsers were seen in the ARA stations.
- Despite "going rogue" and running for a long time unintentionally, the 2450m pulser has not been seen in ARA data. This is despite the fact that the data on the IceCube host string was unusable due to the interference. This is a bit of a mystery.
- We are looking for an opportunity piggyback on deep drilling operations (Espresso? IceCube Gen2?) to install an additional deep pulser.

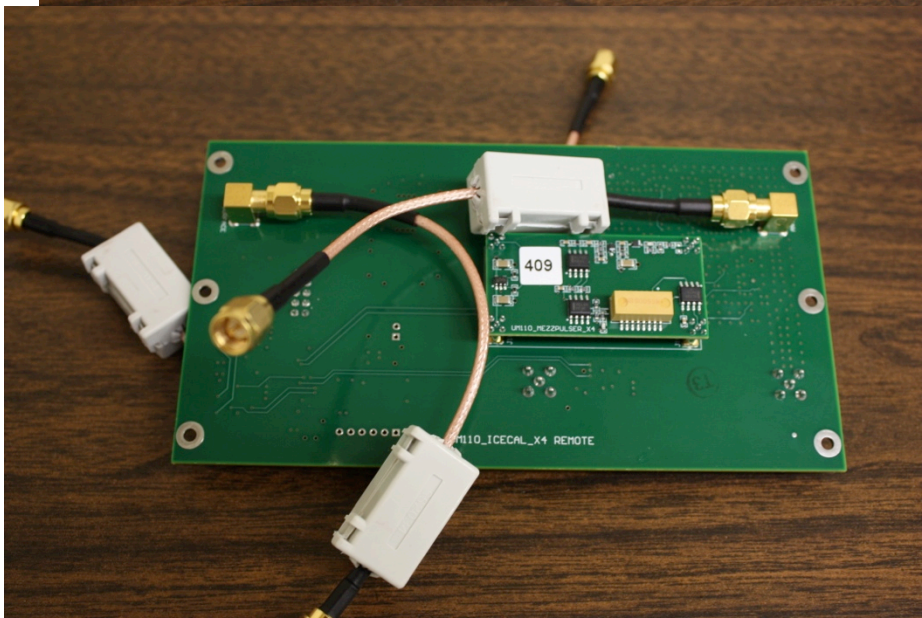
Rooftop pulser

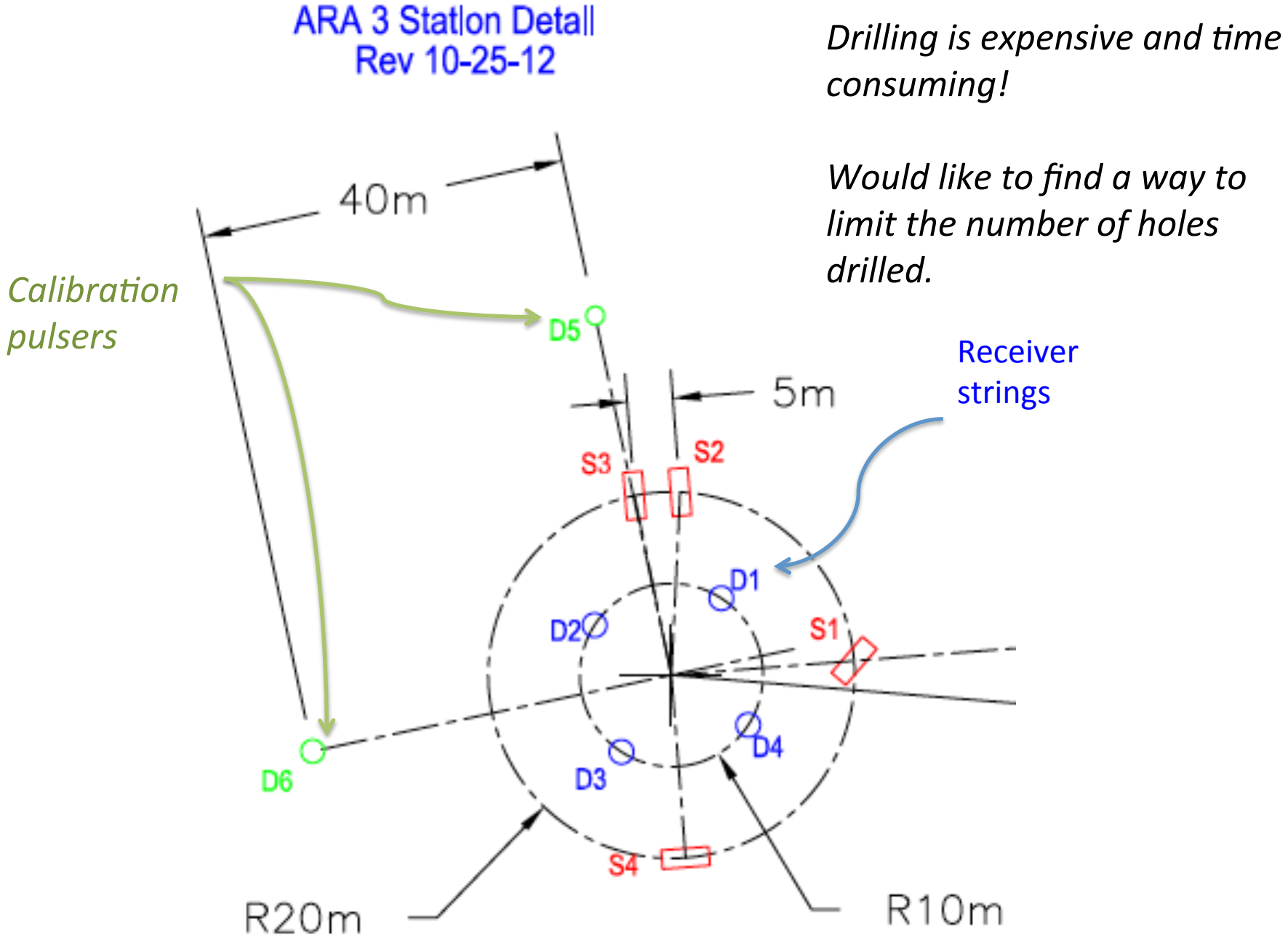
- High voltage pulser
- Quadridge antenna



ARA local pulsers

- Includes high frequency pulse generator and noise diode
- Can pulse automatically at 1 Hz, or can accept triggers from the station clock
- Remotely set attenuator can provide 31 dB of attenuation in 1 dB steps
- Can select either horizontal or vertical antenna
- System (including topside control board) draws ~2W of power
- Power and CANBUS communication go over a single cable
- TTL boosted clock is transmitted to the downhole pulser on a second clock





Drilling is expensive and time consuming!

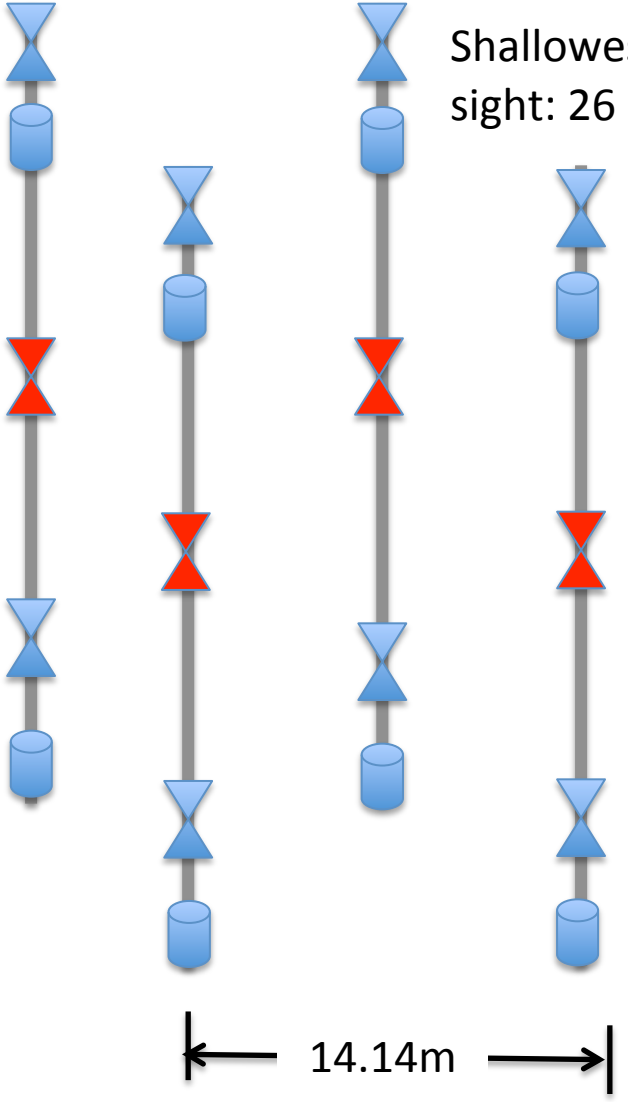
Would like to find a way to limit the number of holes drilled.

Can we integrate the antennas into the string?

Configuration 1

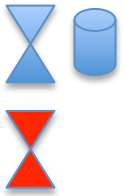
Steepest angle of sight: 35 degrees

Shallowest angle of sight: 26 degrees



Could be a technical challenge to cram more stuff down the hole.

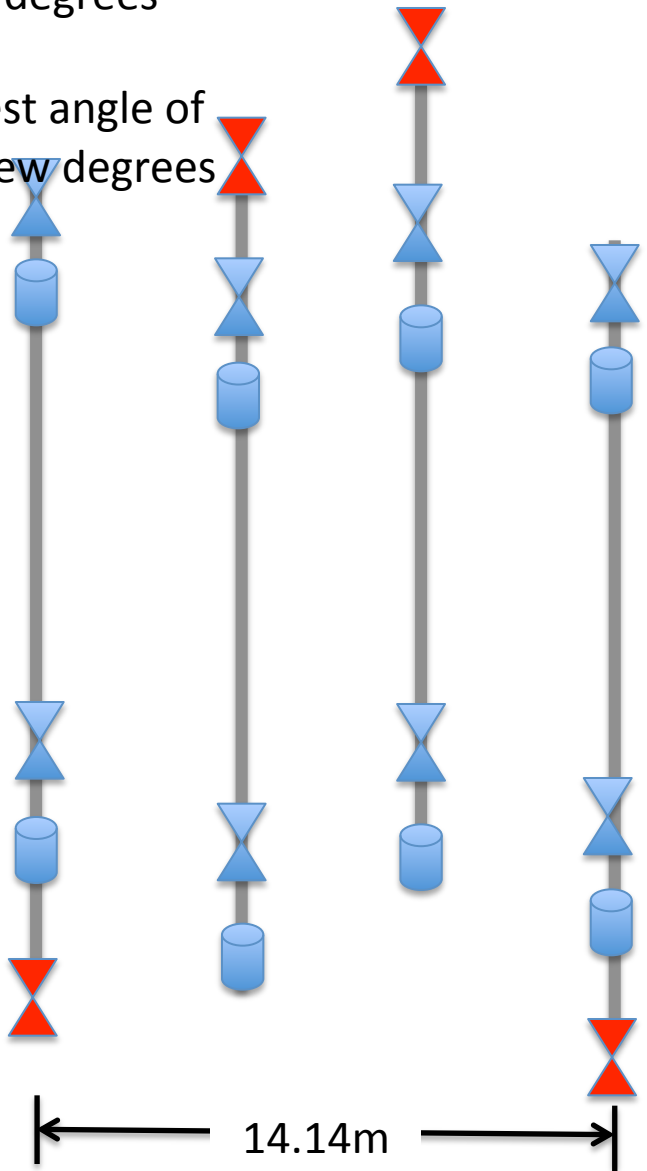
Ryan Maunu (UMD) played with simulations on this



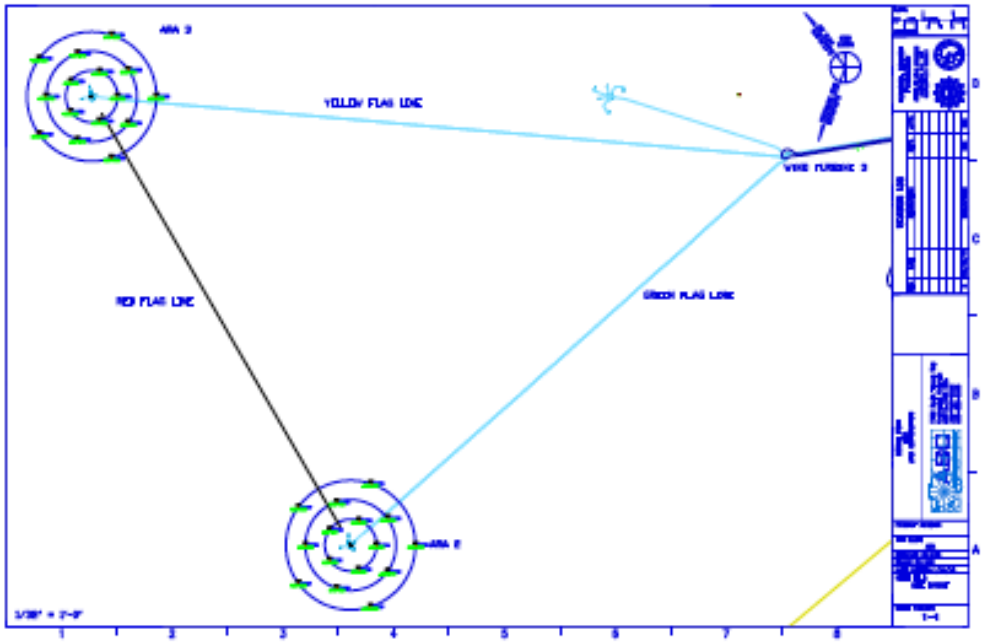
Configuration 2

Steepest angle of sight: 55 degrees

Shallowest angle of sight: a few degrees

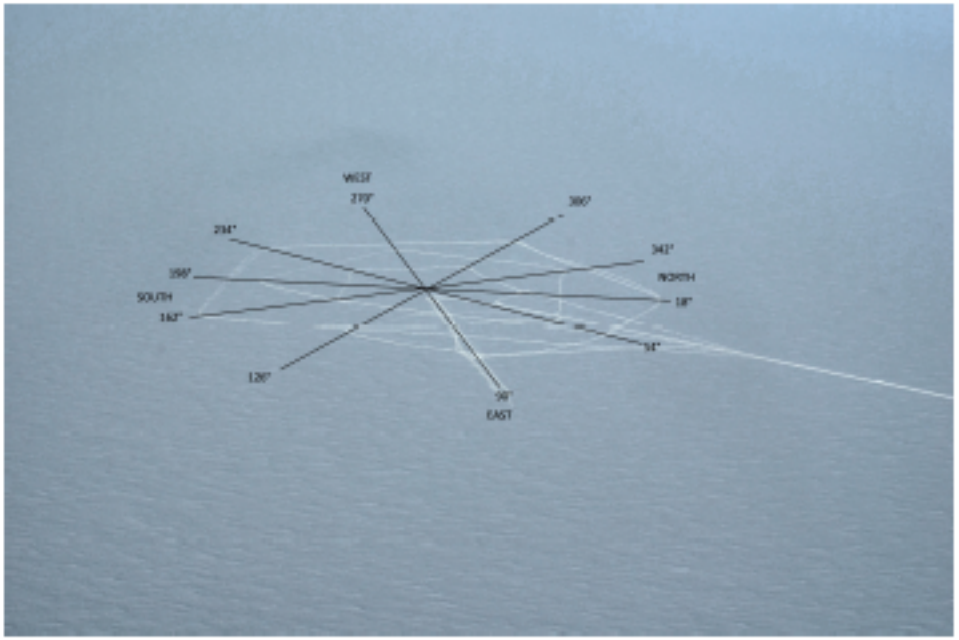


Surface pulser



In 2013-2014 ARA 2 and 3 were surveyed:

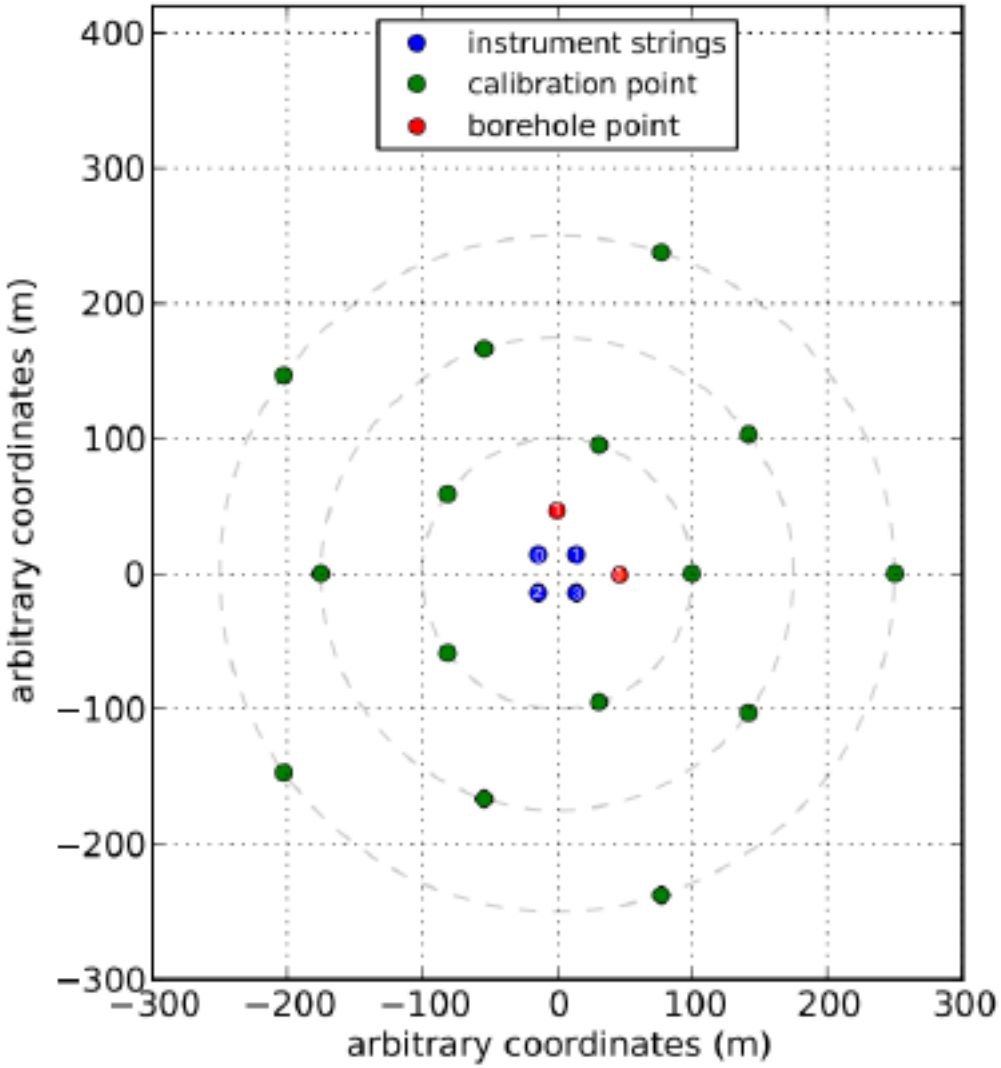
- Precision GPS survey by Matt Shaylor
- 3 min per point to average statistical error
- Base at benchmark location to subtract out systematic error
- Post-processed pulsing locations known within mm



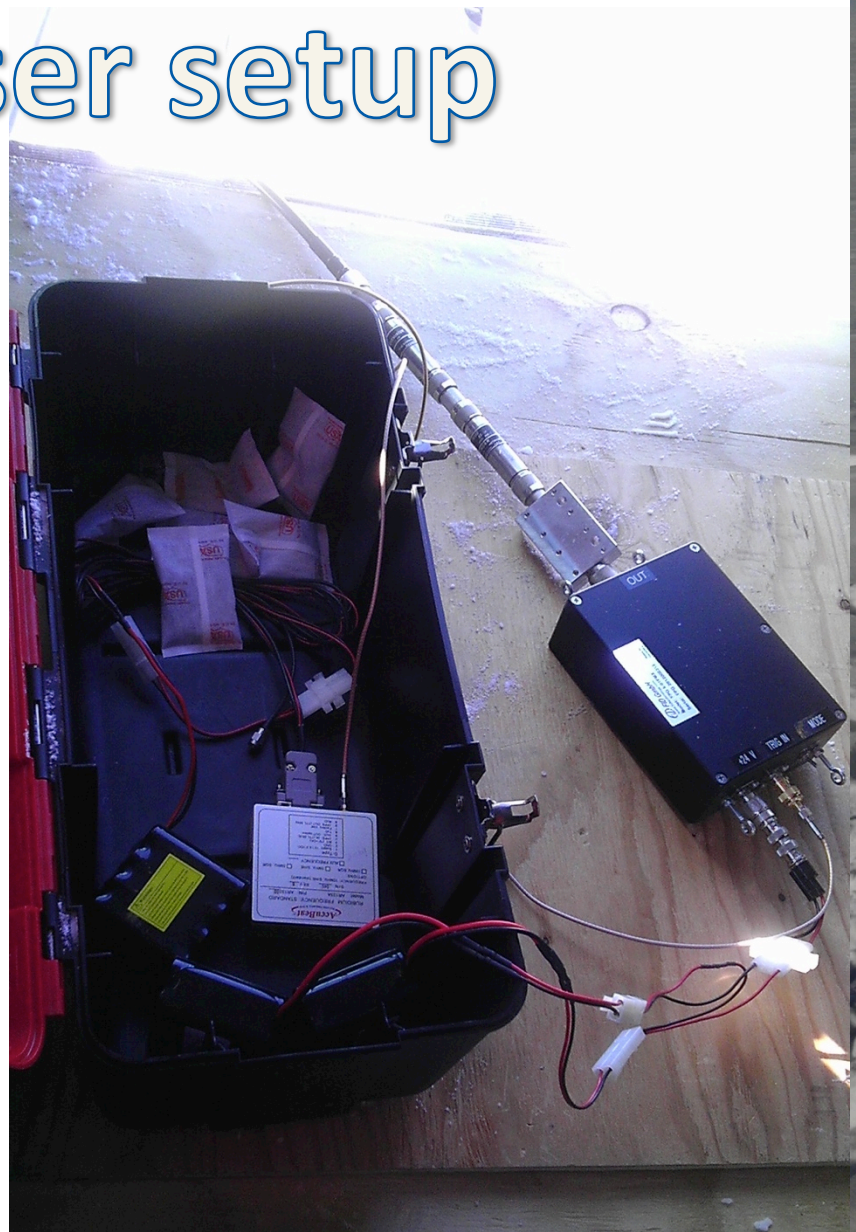
Aerial view with grid directions superimposed. (Matt Shaylor)

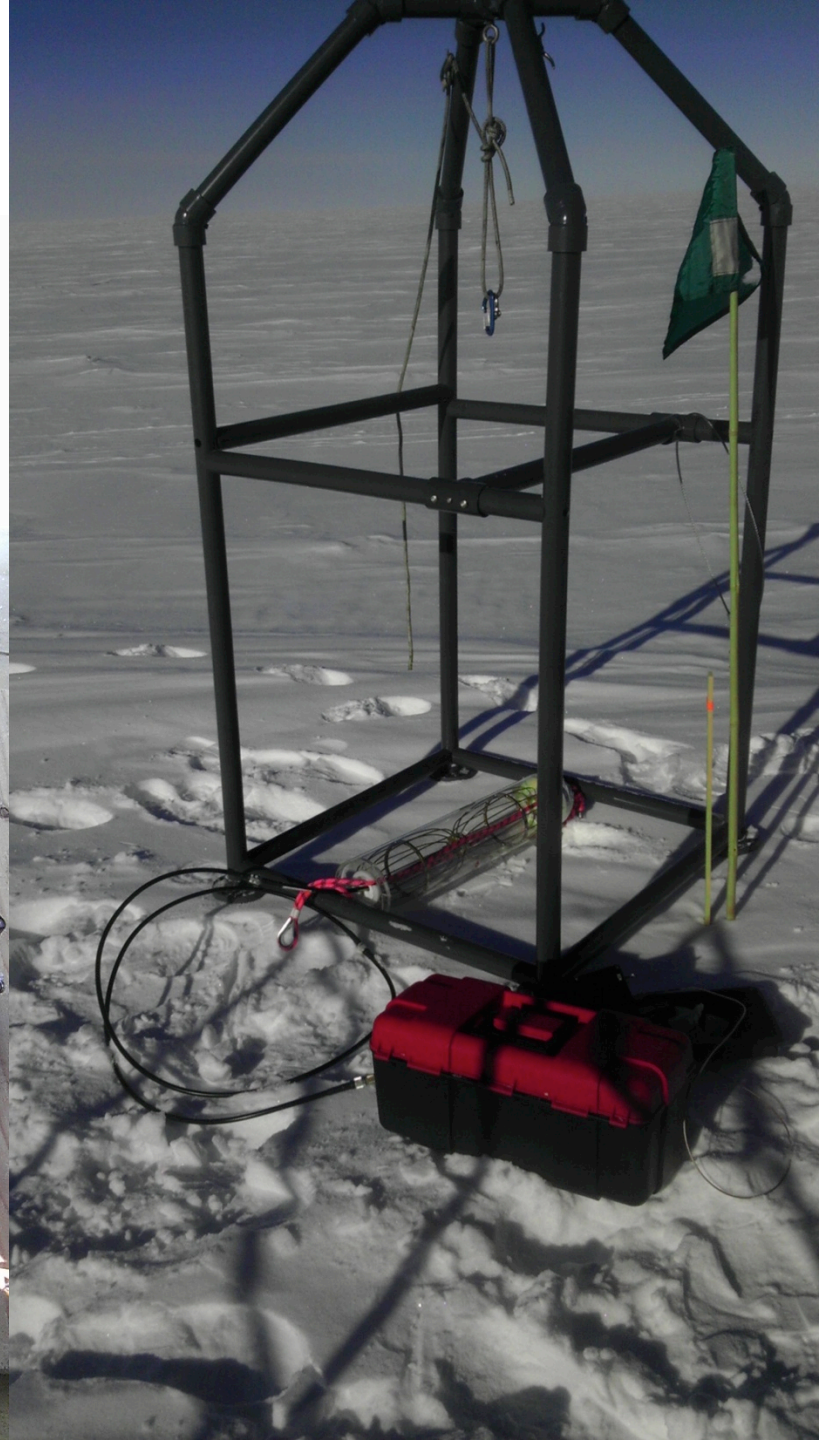
- Mike DuVernois had plans to resurvey in 2014-2015 season with improved triggering.

Local station calibration points



Retrievable pulser setup





Retrievable Pulser

- Purpose was to lower a pulser on a wench, measurements from various depths.
- Could be done using a calibration hole pre-deployment or, ideally, a dedicated hole a distance from the station.
- CW, high voltage, and low voltage pulsers available, along with attenuators.
- Fell off the schedule in the past, but should be considered for next deployment season.

To Do List

- Include recording of which antennas/pulser canisters were installed in which holes
- Make an inventory of existing calibration data (including 2014-2015 data taken by Mike D.)
- Use feedback from data analysis to improve characterization of remaining calibration apparatus
- Try to squeeze in a retrievable pulser (or dedicated extra drilled hole)
- Look for opportunities to installed additional deep pulsers
- Continue efforts to look at data we have