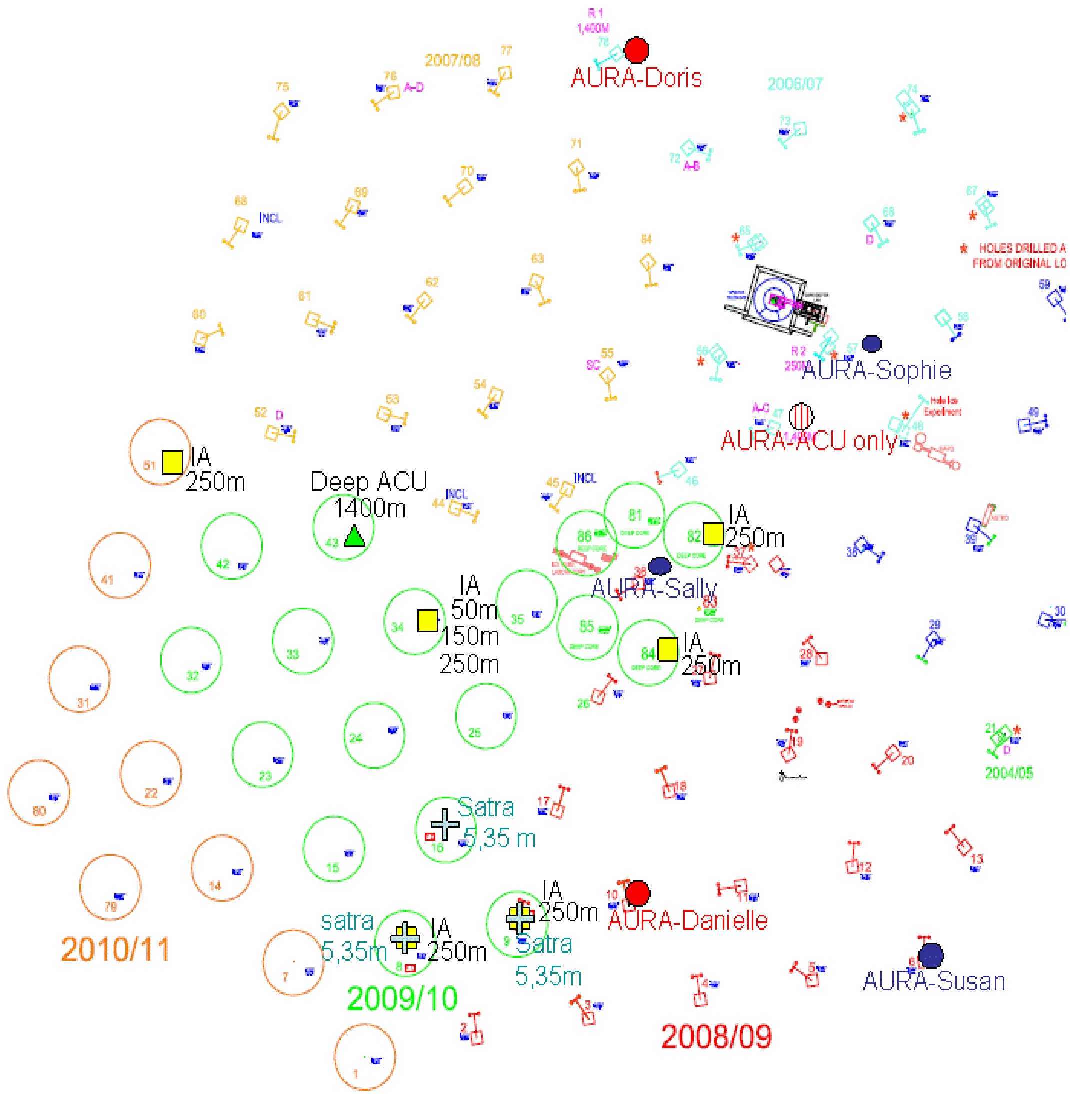
Lesson Learned

What we can learn from AURA and in ice NARC

AURA? NARC? SATRA? ahh?



AURA: Fully digitized WFs. Combination of ANITA/IceCube/RICE technologies:

- 2 clusters in 2006-2007
- 3 clusters in 2008-2009 (last year)

Depth of 1450 m or 300 m

SATRA: Envelope detection.

6 units deployed at -30 and -5 meters (2009-2010)

6 units in various depth/location (On top of ICL, terminated, -250m)

IA: Instrumental Antennas: Symmetrical designed antenna. Deployed at -250m, -50m, -150m

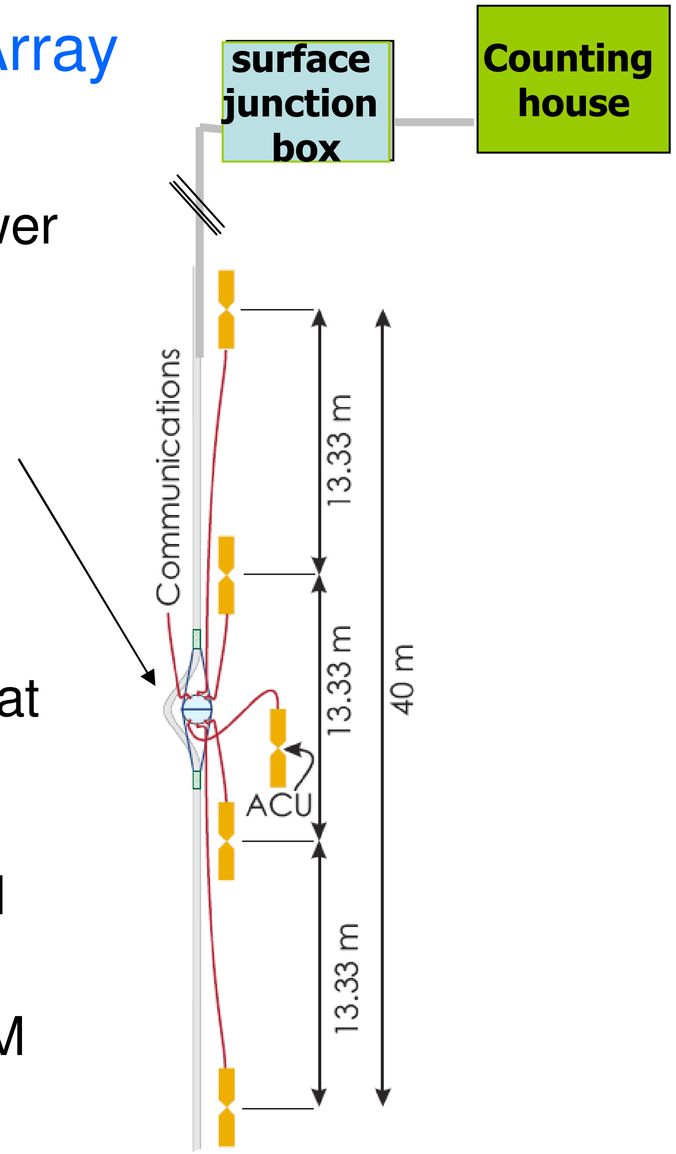
New ACU – To be used in future seasons.

AURA Radio Cluster

Askaryan Unde-rice Radio Array

Use IceCube's resources: holes, comm. and power

- Each Cluster contains:
  - Digital Radio Module (DRM) – Electronics
  - 4 Antennas
  - 1 Antenna Calibration Unit (ACU)
- Signal conditioning and amplification happen at the front end
- Signal is digitized and triggers formed in DRM
- A cluster uses standard IceCube sphere, DOM main board and surface cable lines.

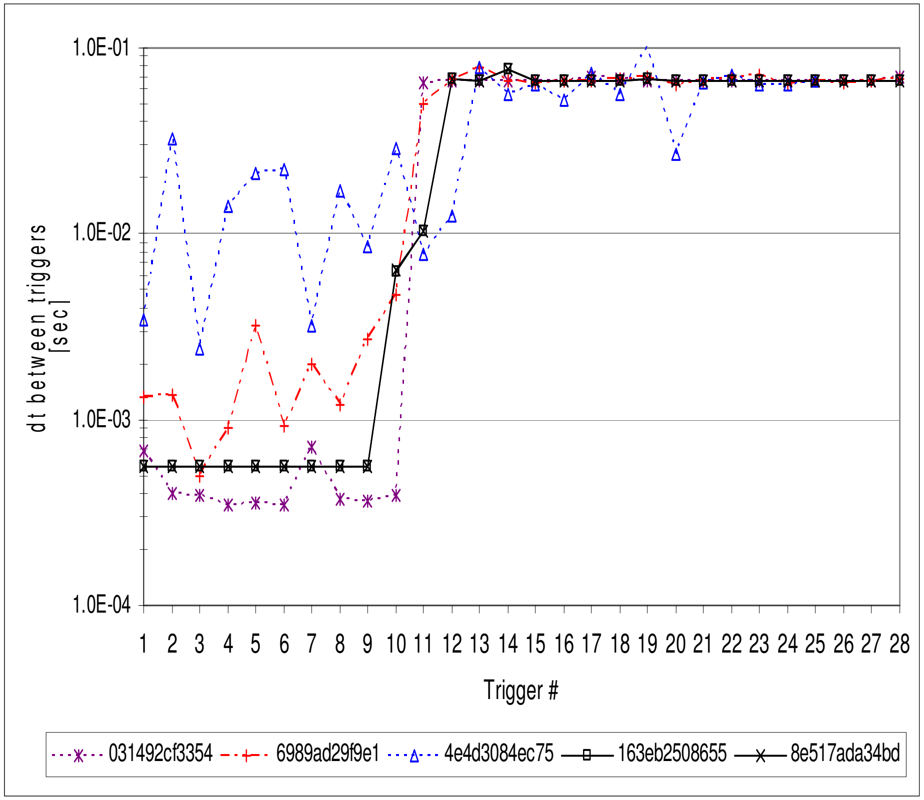


Data acquisition and control

* Allow “higher” trigger rate – we are currently limited by the cable band width

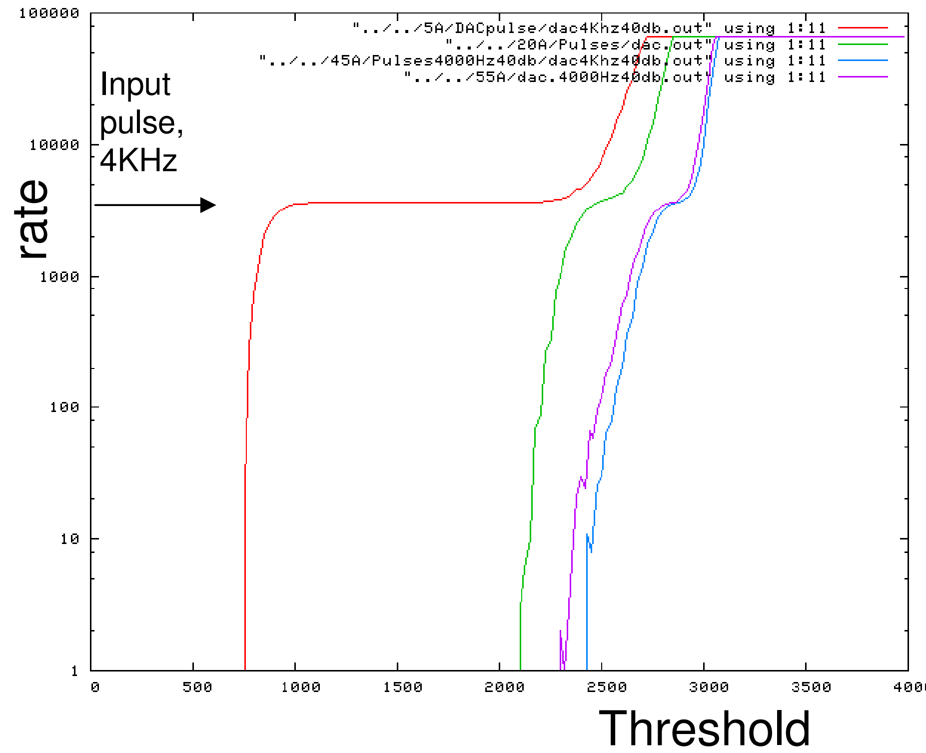
  penalty is longer dead times or decreases sensitivity

- Small data packets For faster triggering and better data transfer .
- Real time coincidence triggering
- Reduce complexity of the boards (merge TRACR and mb into a single board)



RF system

- Increase sensitivity range or have several gain channels – a'la' icecube three gain channels
- Flatter gain. The DRM has a high bias toward lower gain
- Optimize the system to work at cold: the DRMs are doing worse at cold
- Longer time capturing window (right now 256ns) – makes it hard to catch and reconstruct full WF. Limits separation between antennas.
- Less cross talk on the boards - especially between channels 1/2
- Calibration data.



Antennas

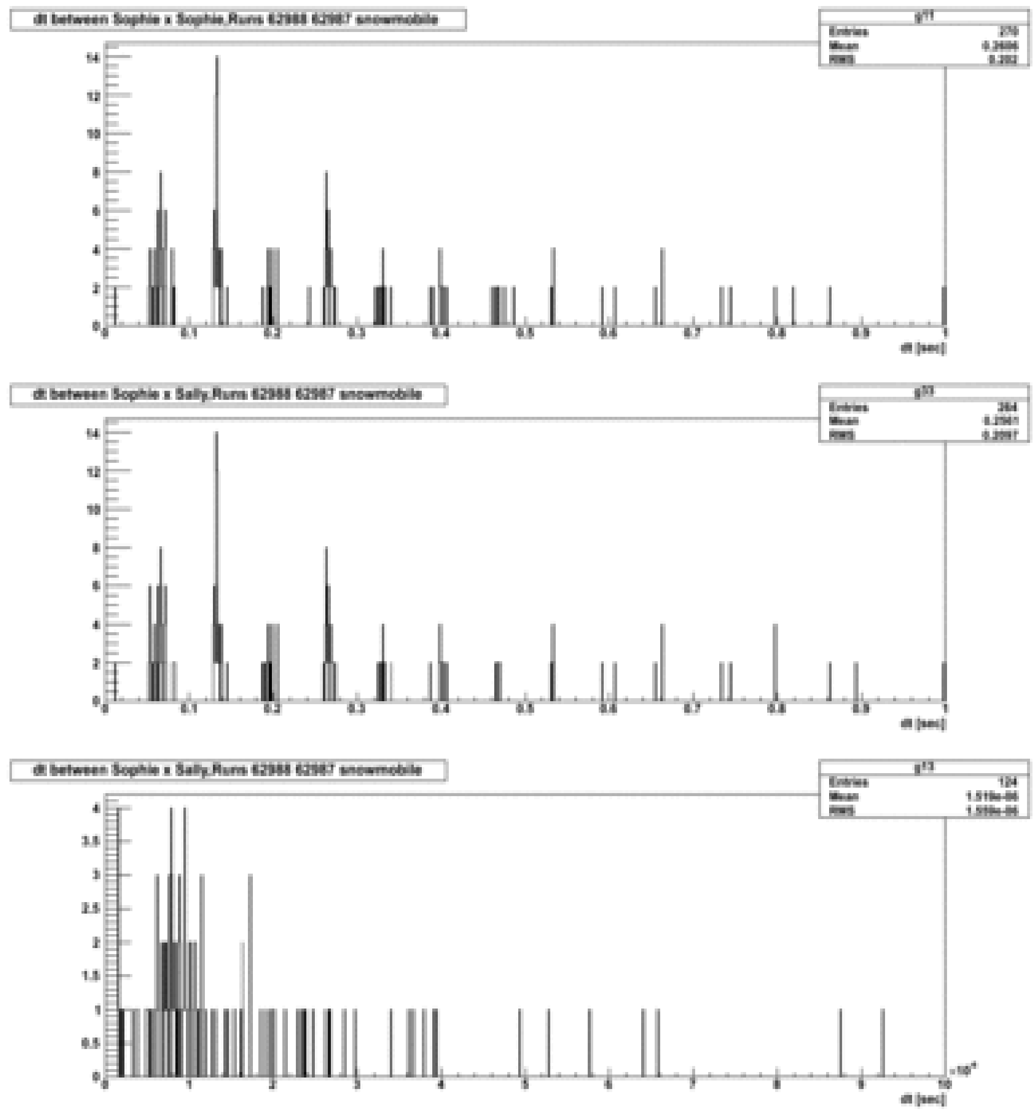
- Minimize cable shadowing – cable centered antennas or several antennas
- Have different polarizations.

Deployment and operation

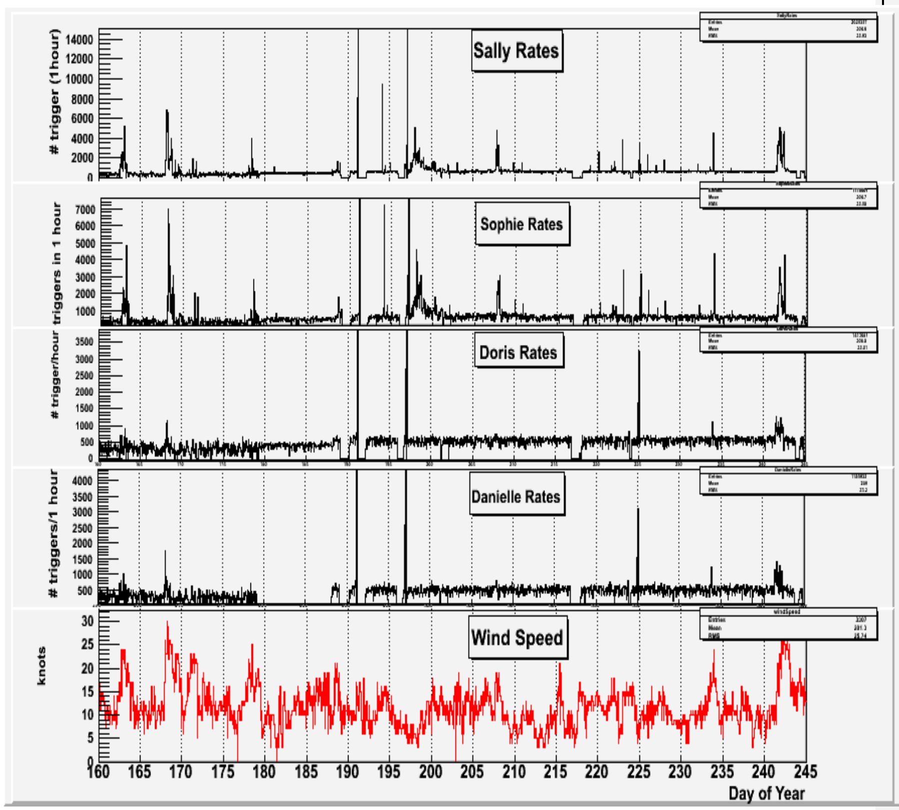
- Keep track of antennas location w.r.t cable
- Simple Installation procedures
- Running things over the satellite can be painful: Have lite and batch versions of as many tests and procedures as possible. And also:
- Train WO with basic operational procedures
- Control and monitor all parts of the system from the North (including calibration sources and power supplies).
- Good communication with NSF.

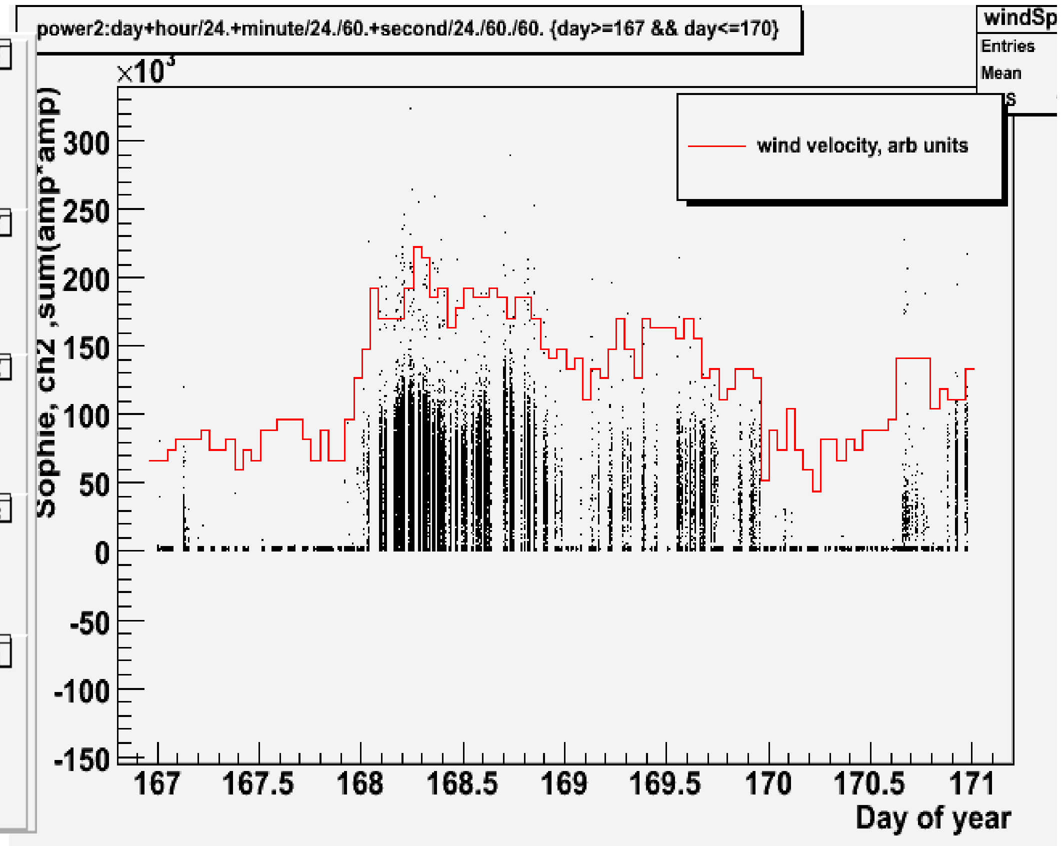
South Pole Noise - surface noise
Human made noise

- Snow mobile – near MAPO:
  noise is repeating every ~0.067 seconds, or 900 "sparks" per minute. Or For a 2 cylinders engine this correspond to 450 RPM.
- Measured a lot of interesting noise patterns during summer.
- Complaints from SP users on Overall increase in EMI at pole (<100MHz).
- Collecting winter data to estimate noise from VLF beacon, meteor radar and other surprises….
- ARA will have the advantage of being away from all of this. Or will it….??



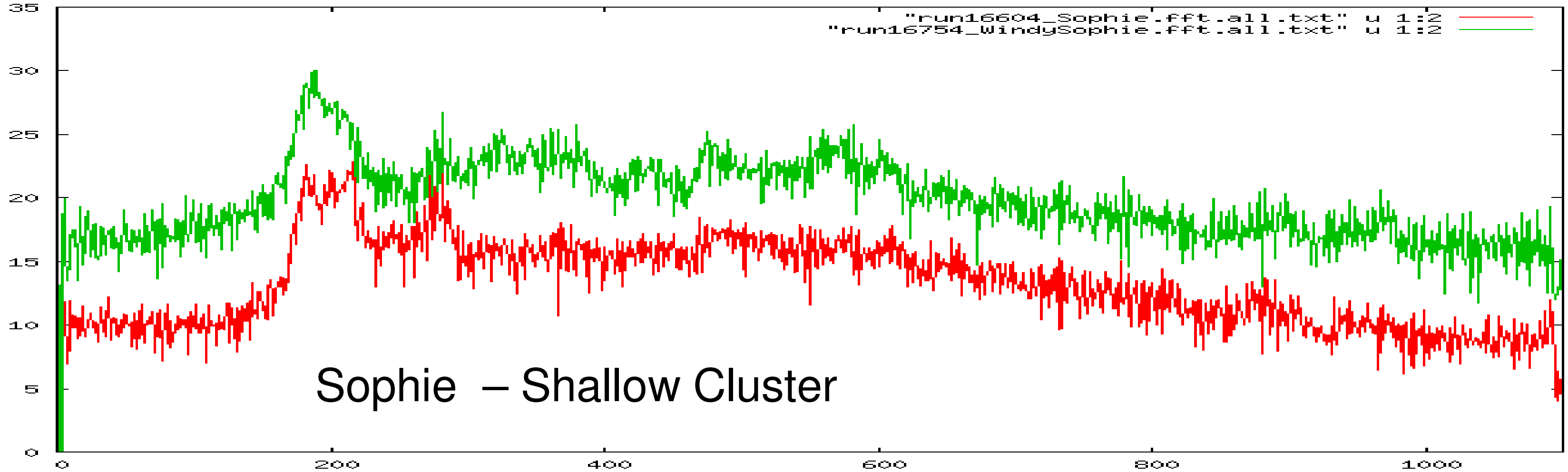
Wind generated RF noise:



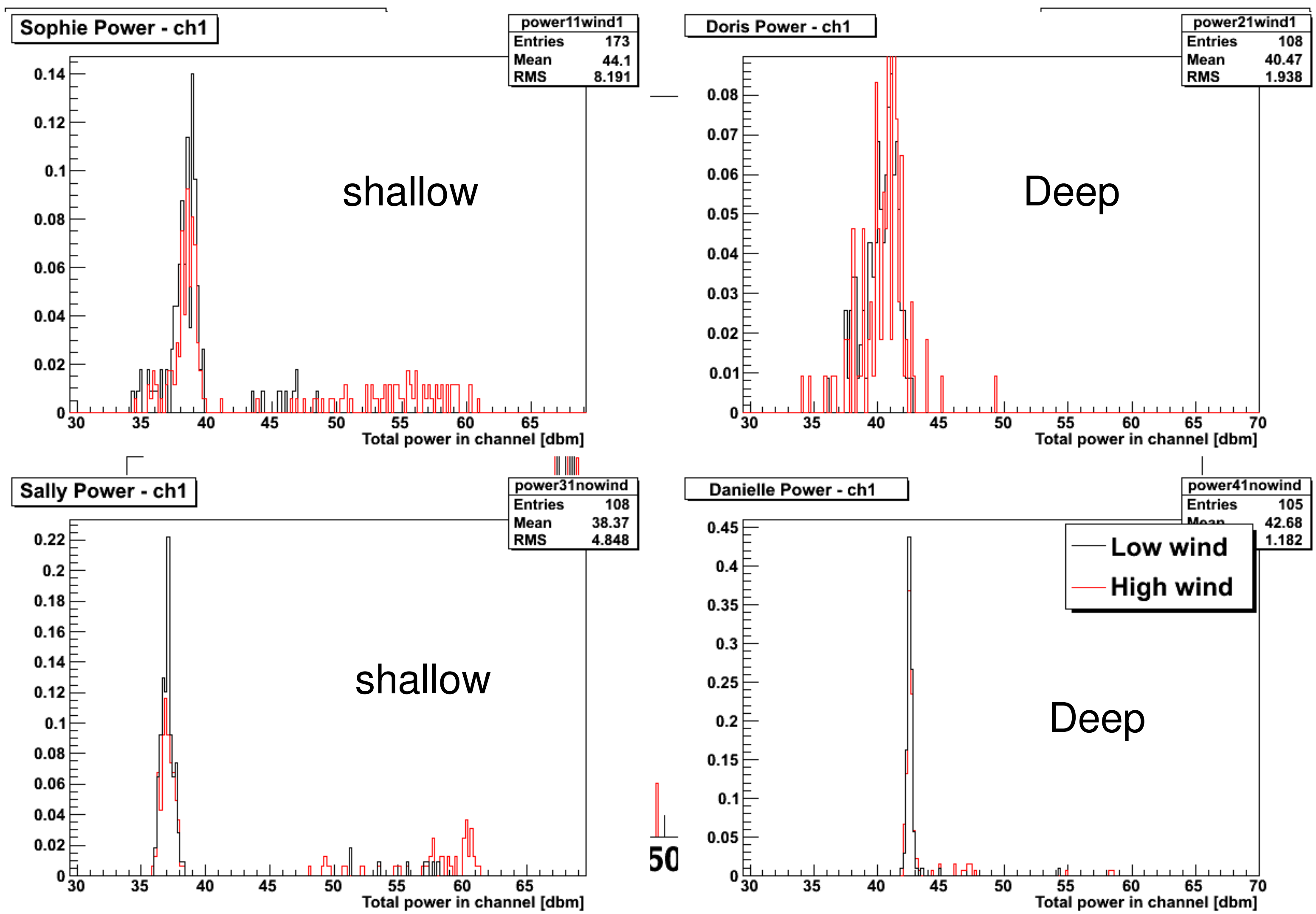


Latham, "The electrification of snow storms" (1963)
New model: Gordon, Taylor (2008) : E>25 KV/m near surface

FFT – Wind vs. No wind



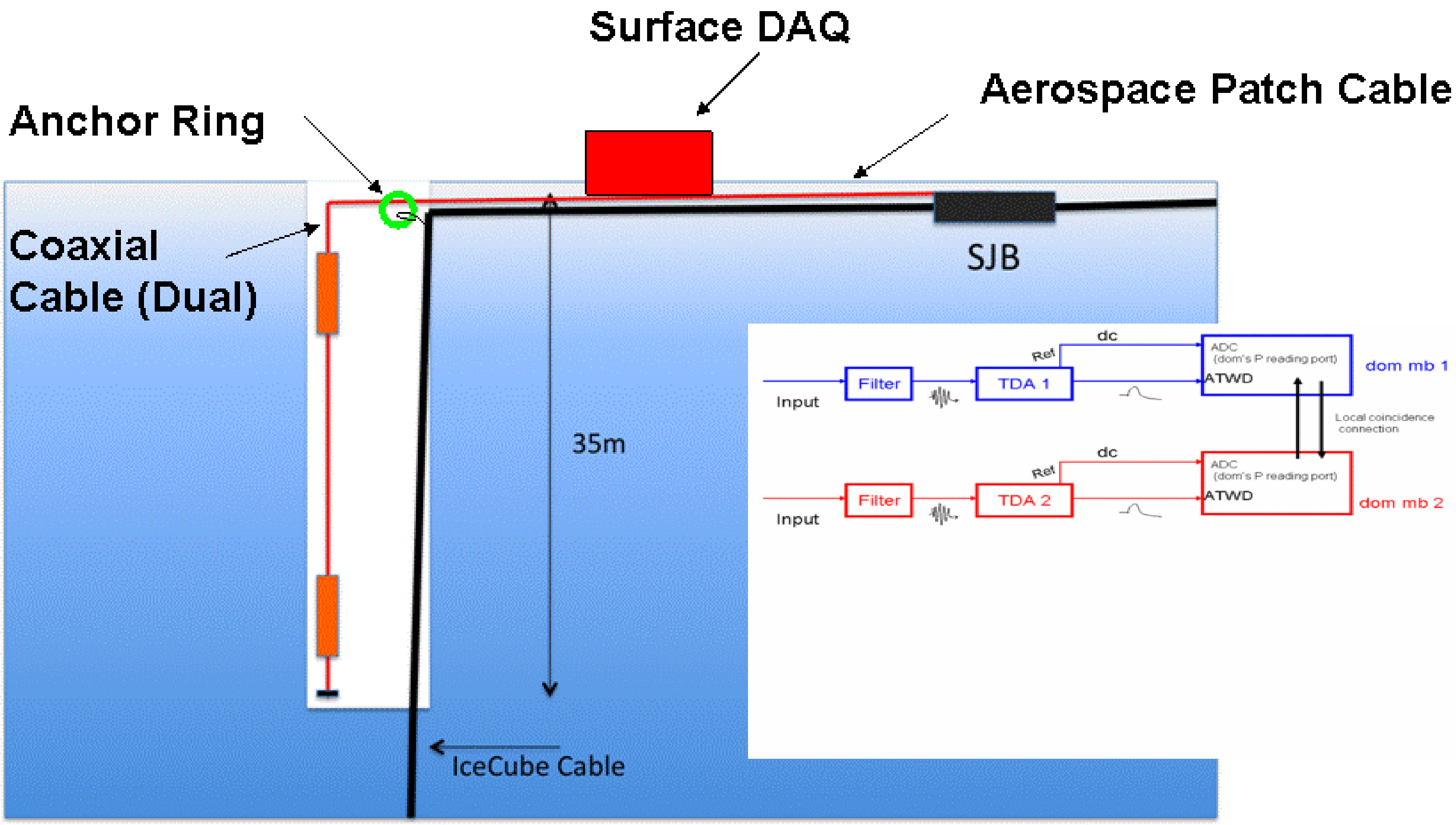
Power distribution, ch1, all drms



Ice optics

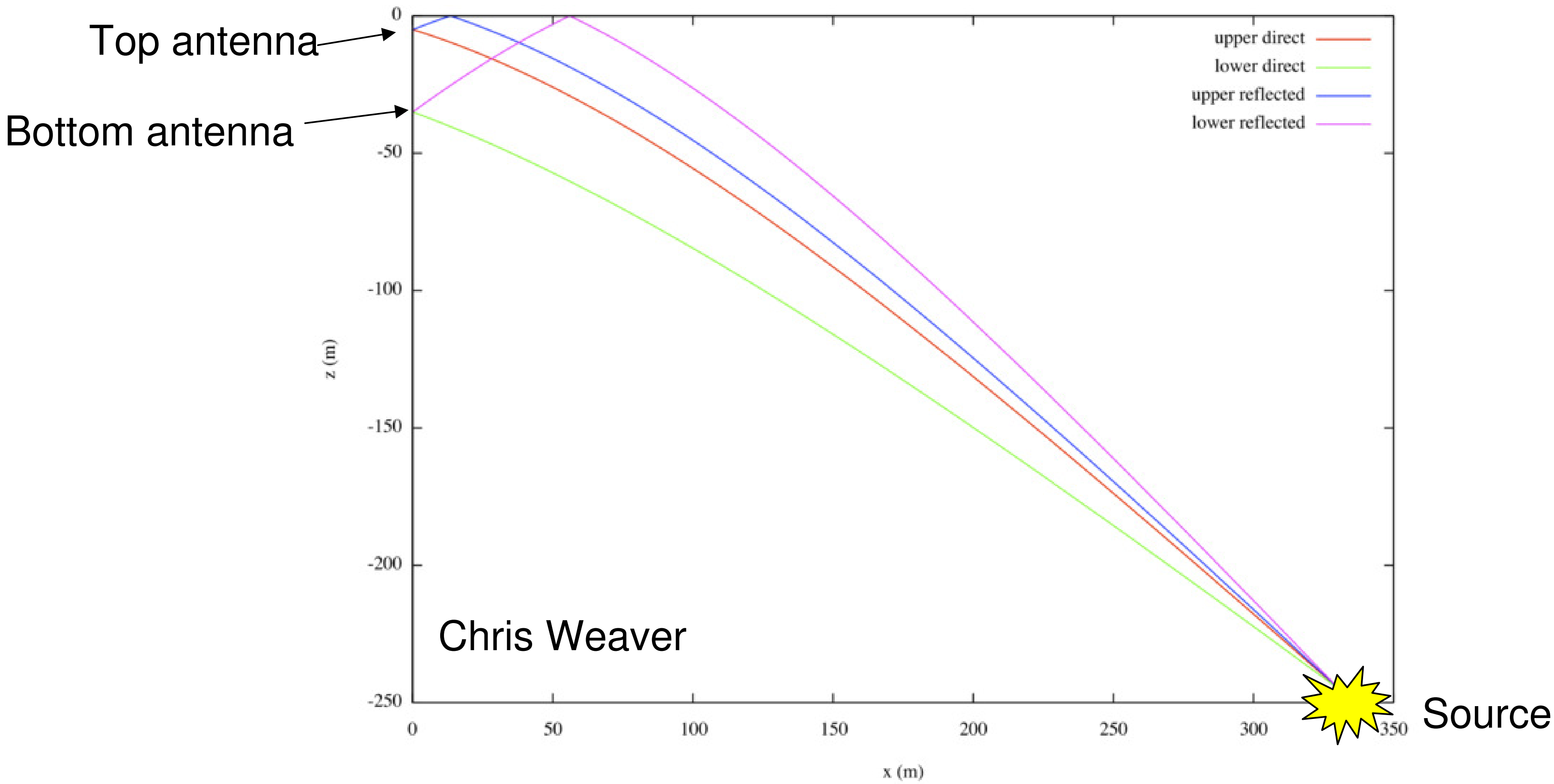
- Good understanding of Ice properties required

Deployed Configuration
(Sketch)

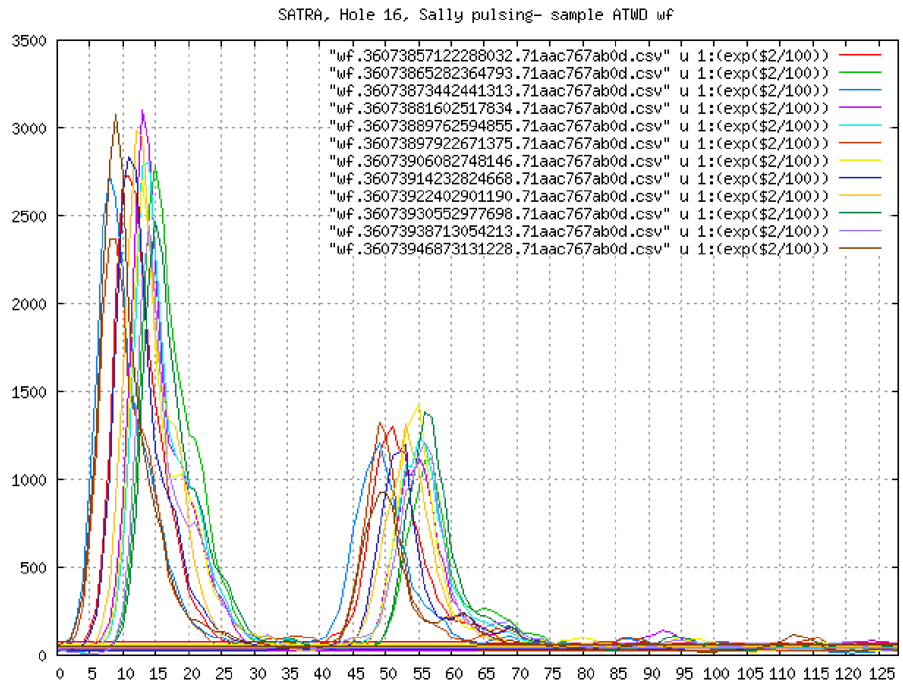


Perry Sandstrom

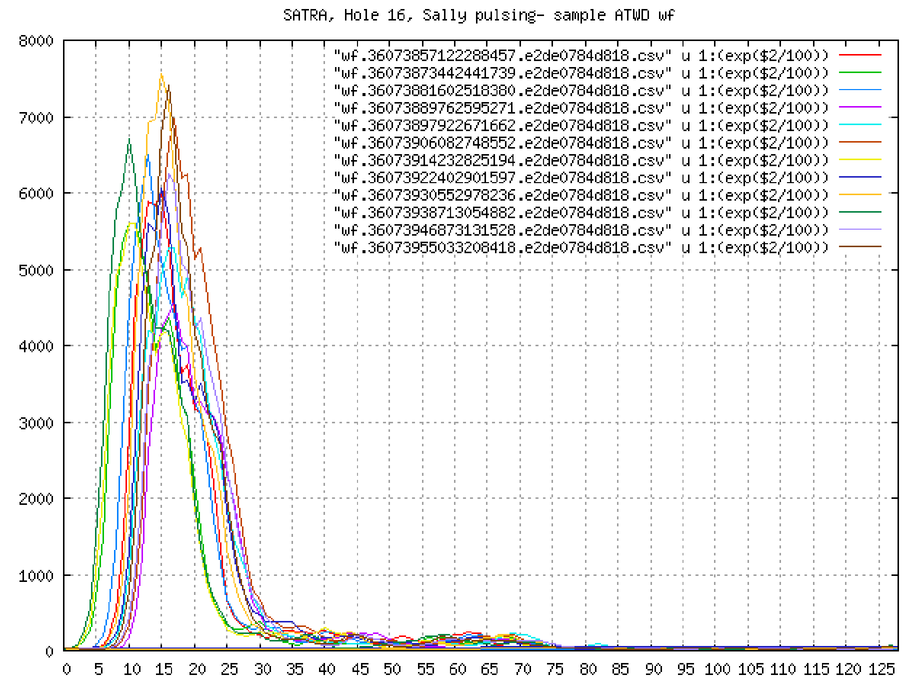
Simulated time delays (hole 16)
Ray Traces



Some WF recorded in hole 16:



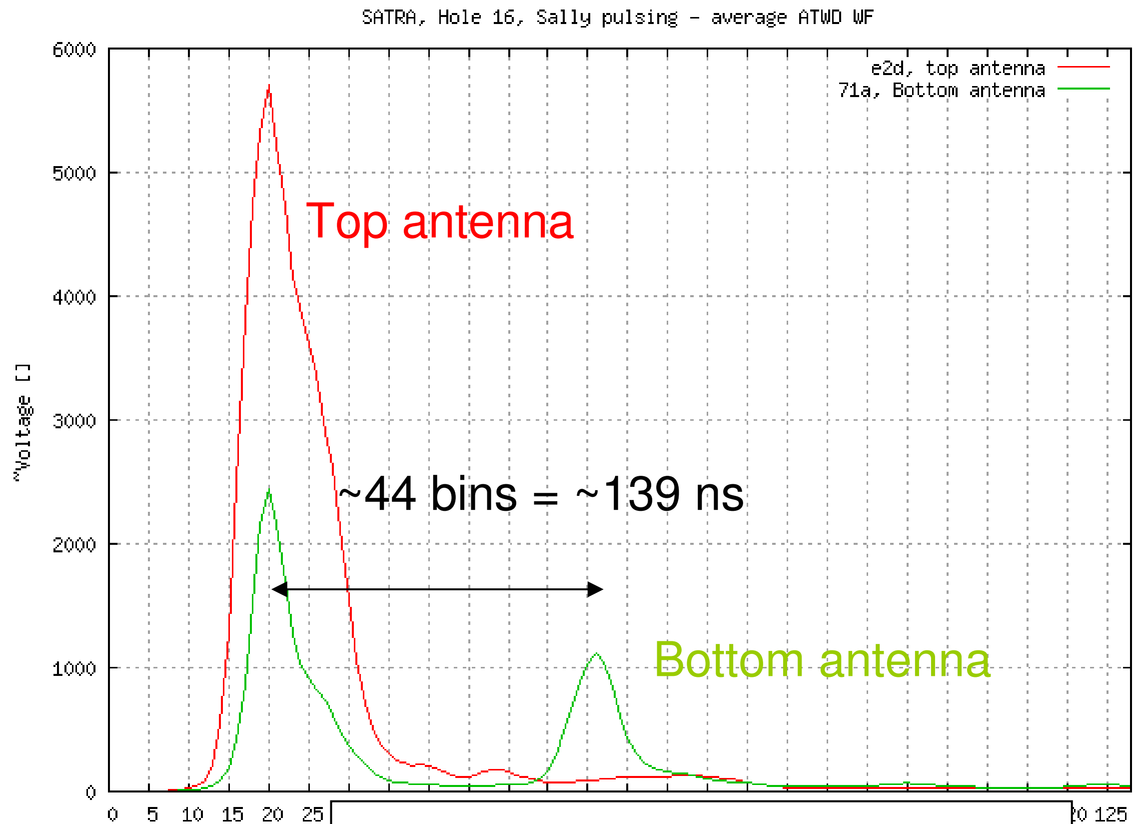
Bottom antenna -35m



Top antenna -5m

Time difference between direct and indirect ray:

Average WF recorded in hole 16:



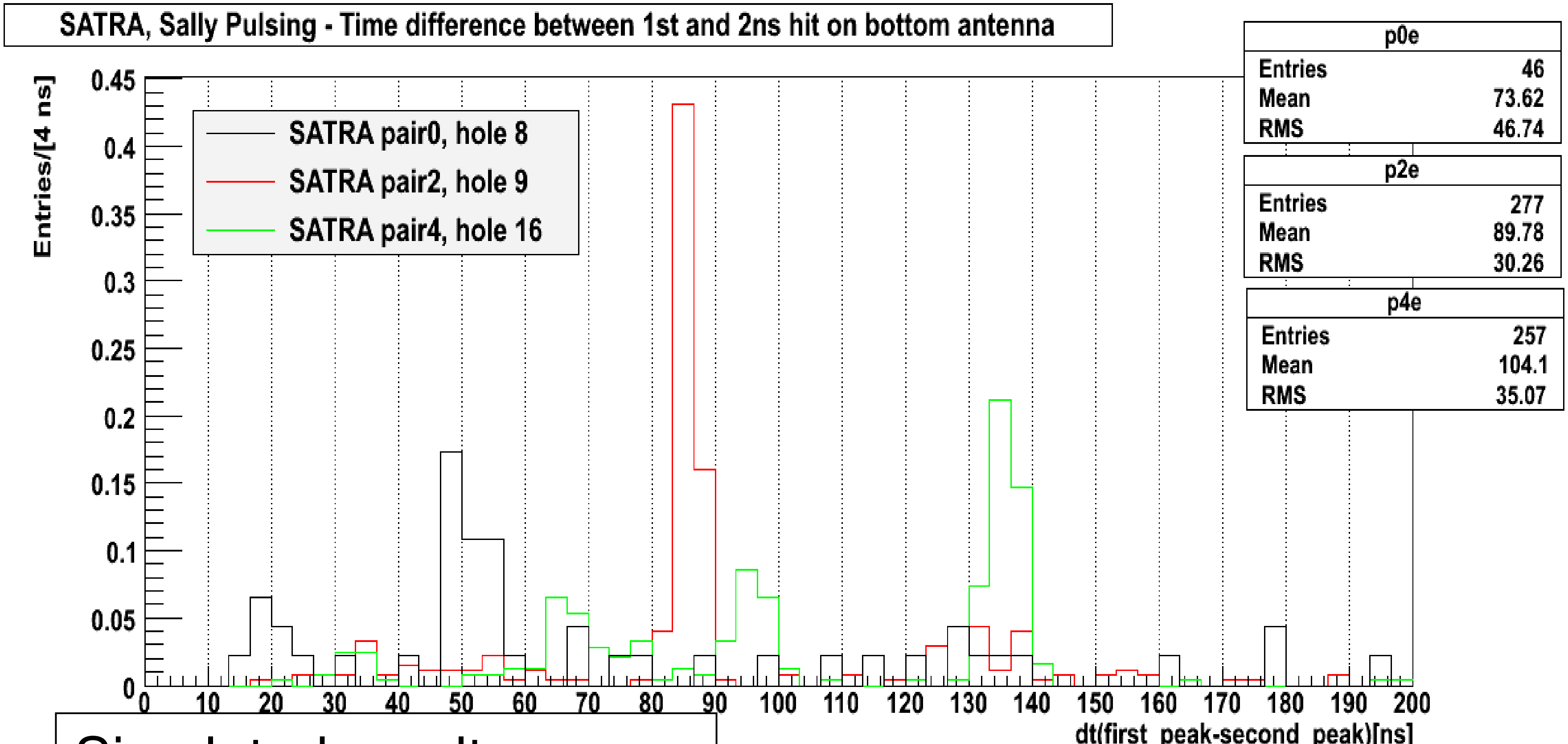
Simulated results:

Top antenna ~14ns

Bottom Antenna ~137ns

Time difference between first and second hit

Bottom antennas only



<u>Simulated results:</u>

Hole 8: ~62 ns

Hole 9: ~88 ns

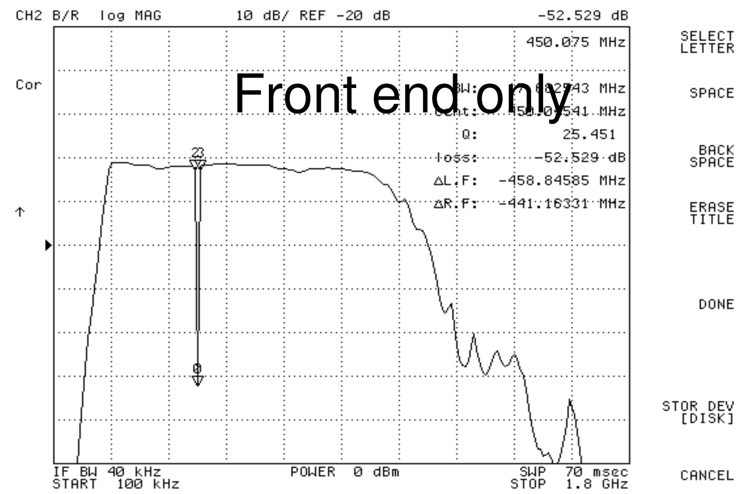
Hole 16: ~137 ns

More AURA/SATRA analysis and status on Wednesday:

- Background studies
- Event reconstruction
- en route neutrino limits
- Transmitters performances
- SATRA results
- Attenuation length measurement
- n(z) measurements

Backup Slides

RF signal



<u>Antennas:</u>

- Broad band dipole antennas
- Centered at 400 MHz

<u>Front end electronics contains:</u>

- 450 MHz Notch filter
- 200 MHz High pass filter
- ~50dB amplifiers (+20 dB in DRM)

<u>LABRADOR digitizer:</u>

Each antenna is sampled using two 1GHz channels to total of 512 samples per 256 ns (2 GSPS).

<u>Digitizer active range:</u>

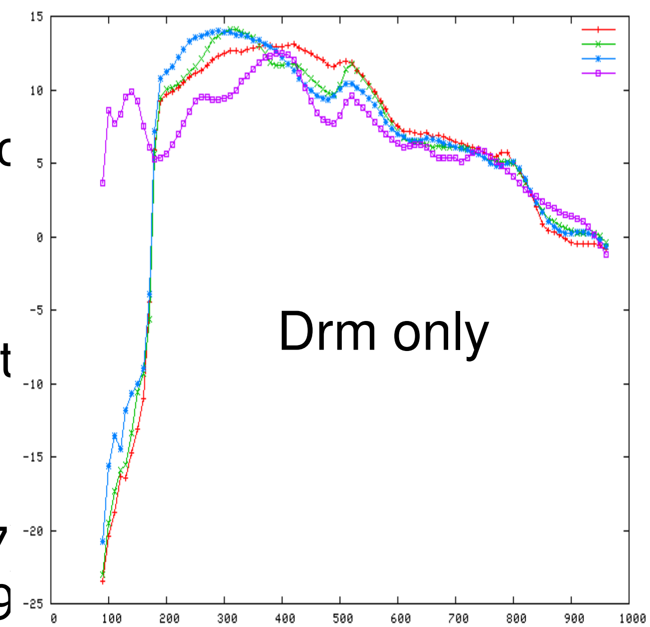
Dynamic range ~1200 counts of (1.1 or 0.6 mv/count

Nyquist of 3-6 counts.

Max amplitude:

15 dbm → -55dbm = 3E-6 mW before amps (07

10 dbm → -60 dbm= 1E-6 mW before amps (09

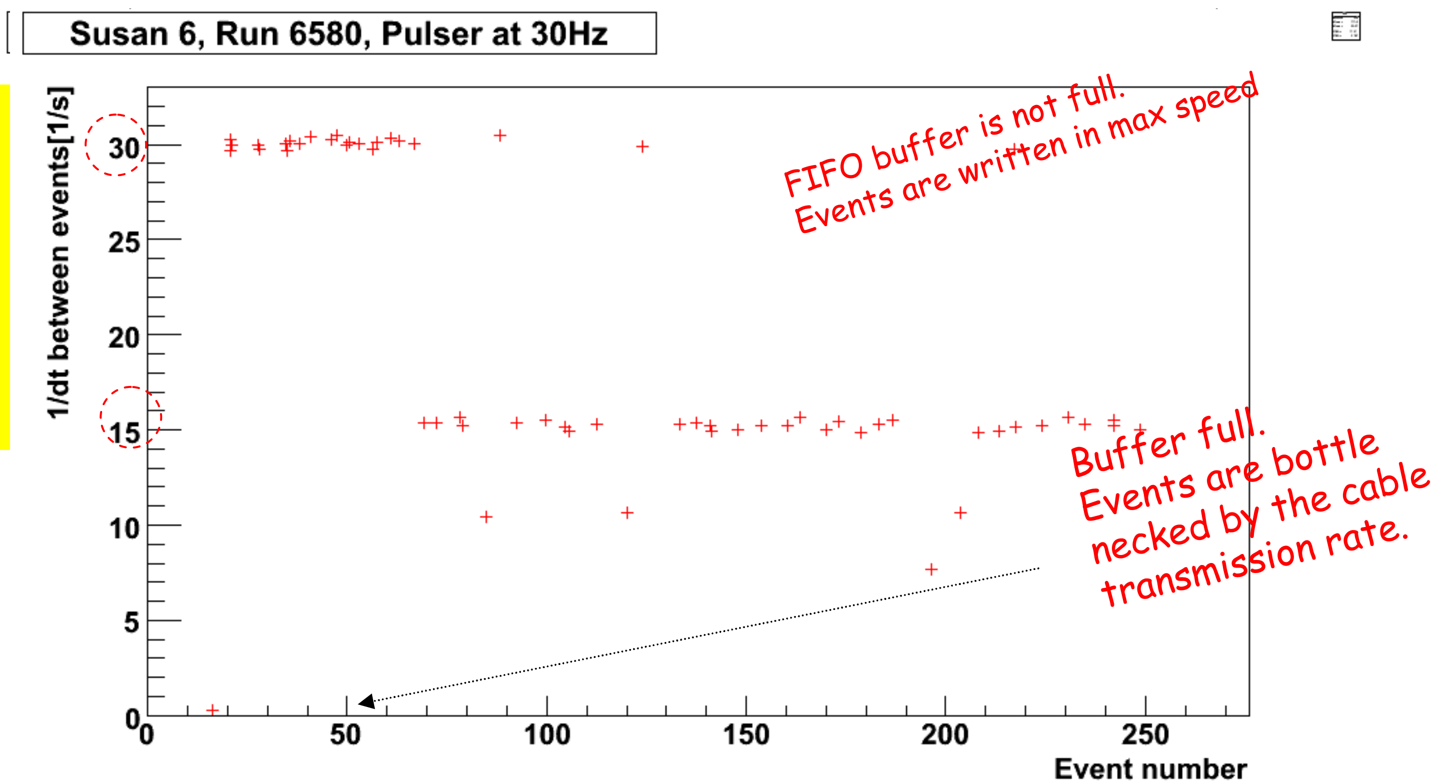


Limited trigger rate

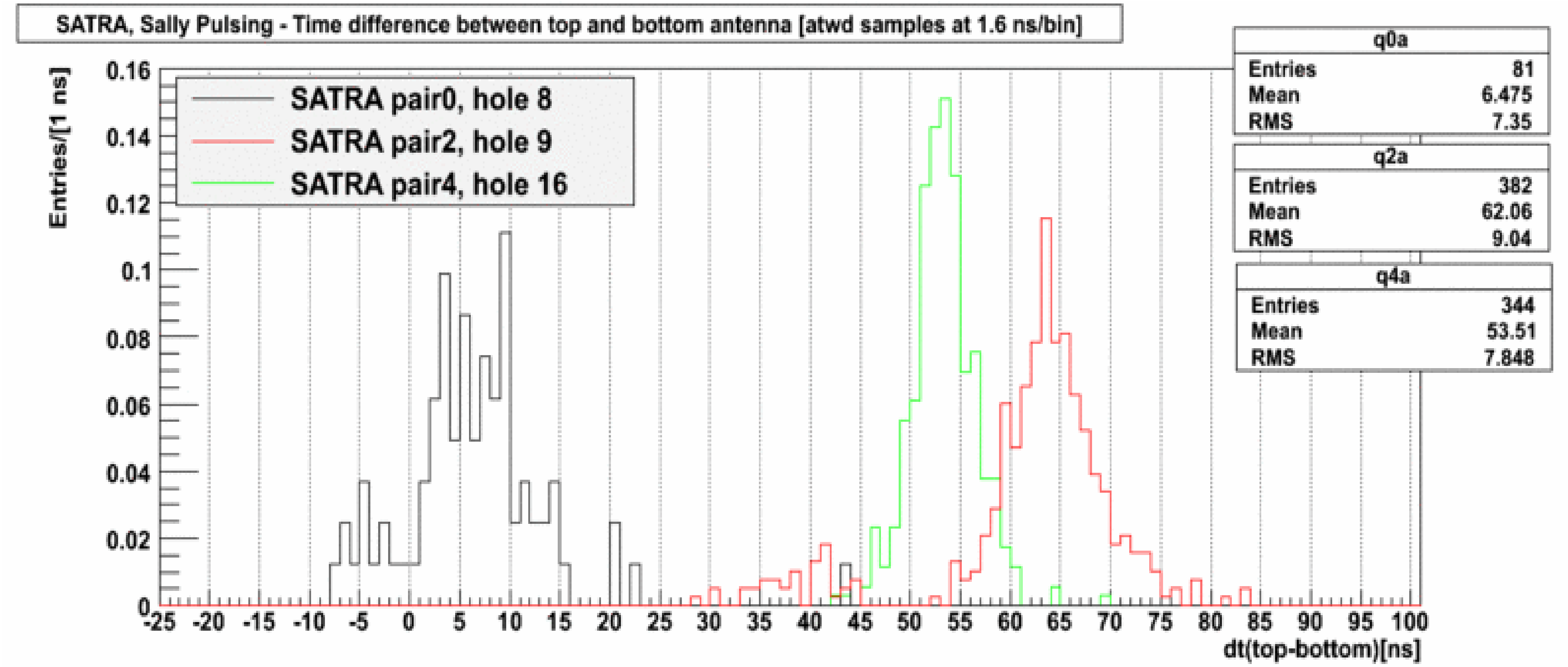
- Current packet size ~ 5 Kbytes
- Surface cable transmission rate 90KBytes/sec ~ 18 Hz
- Absolute limit Flasher interface ~800 Kbytes/sec ~150Hz
- Limits how low we can get on threshold

Case A:
cluster triggers
on 30 Hz source.

on noise.



Time difference between top and bottom antennas:

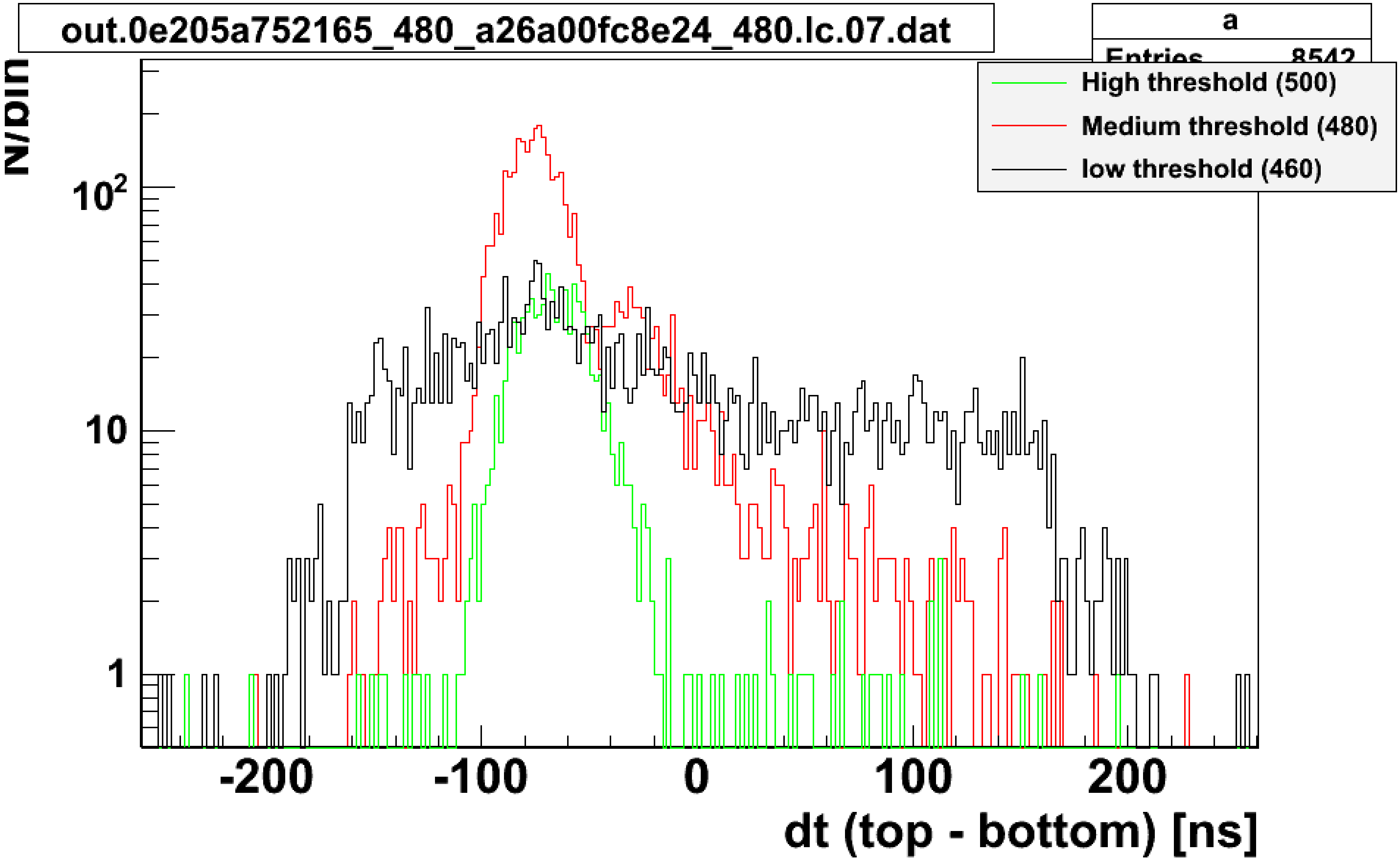


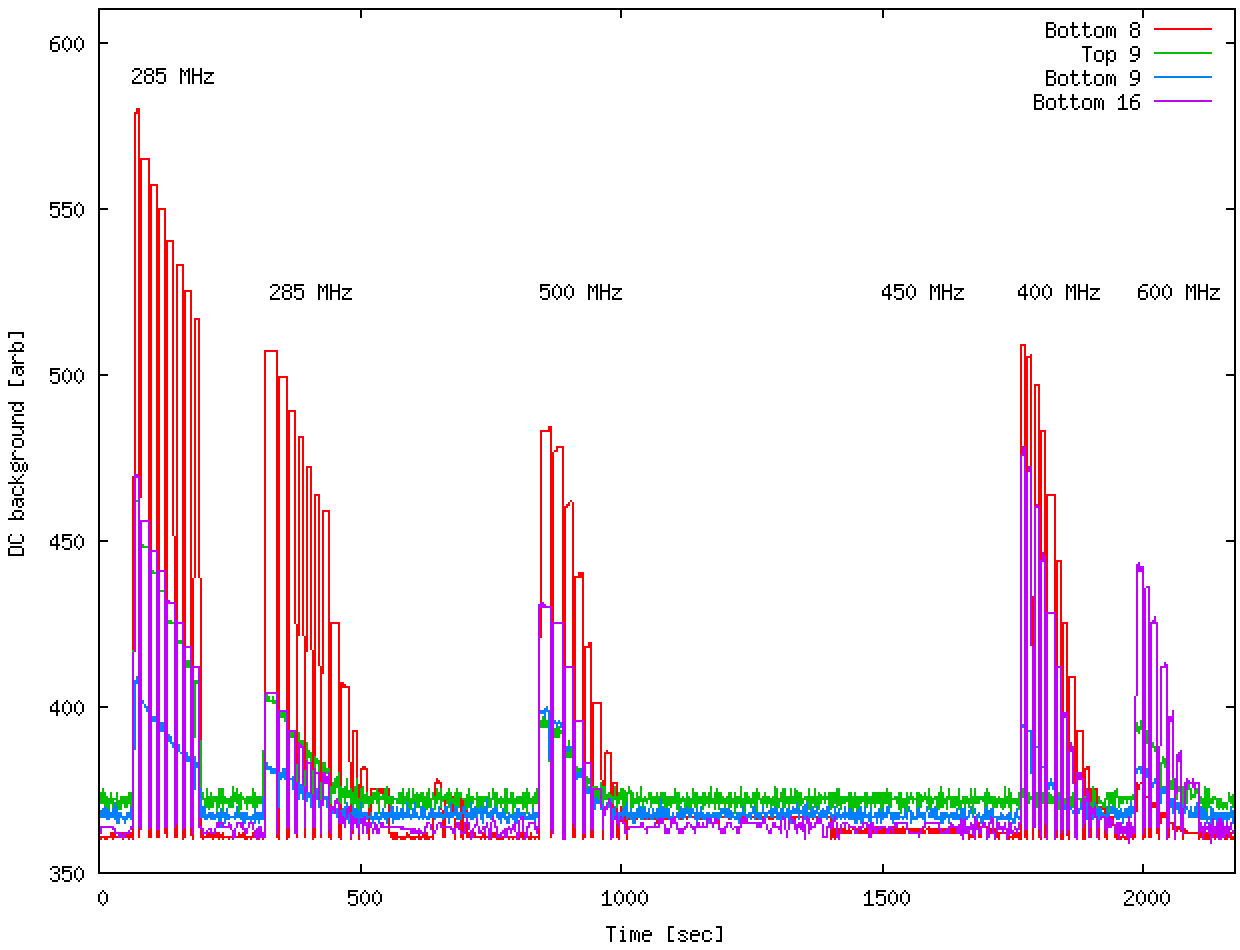
Simulated results:

Hole 8: ~7.2 ns

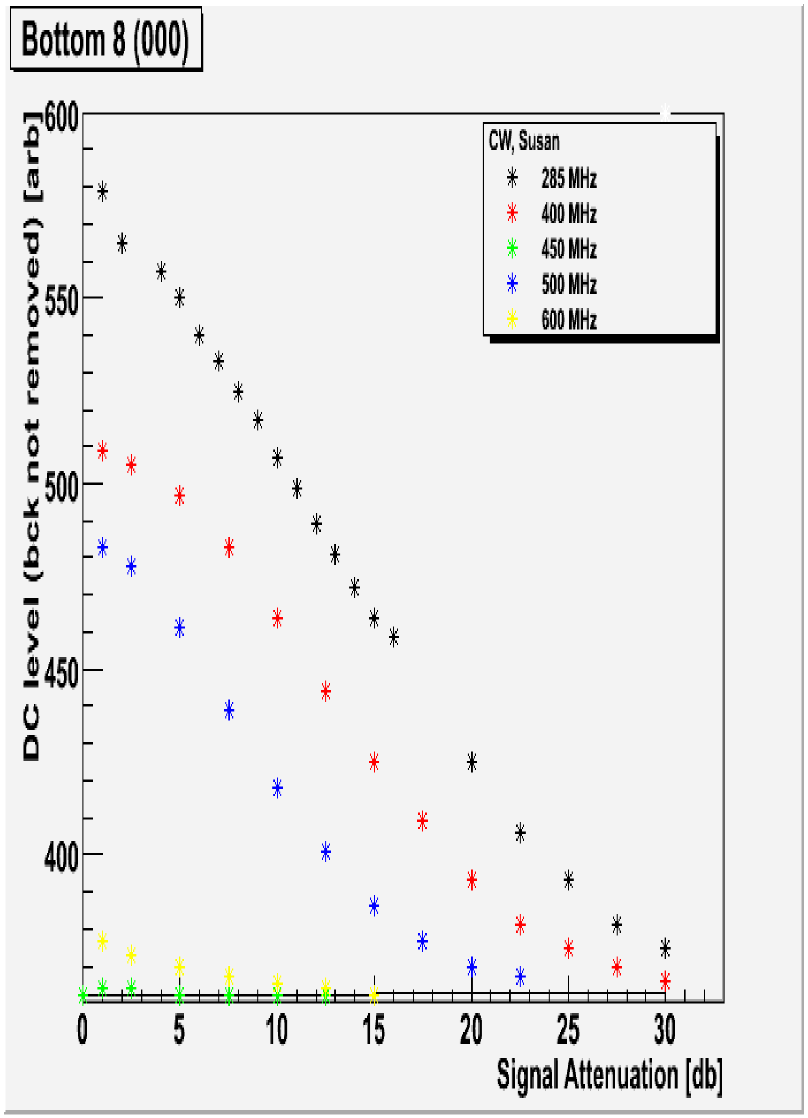
Hole 9: ~28 ns

Hole 16: ~49 ns

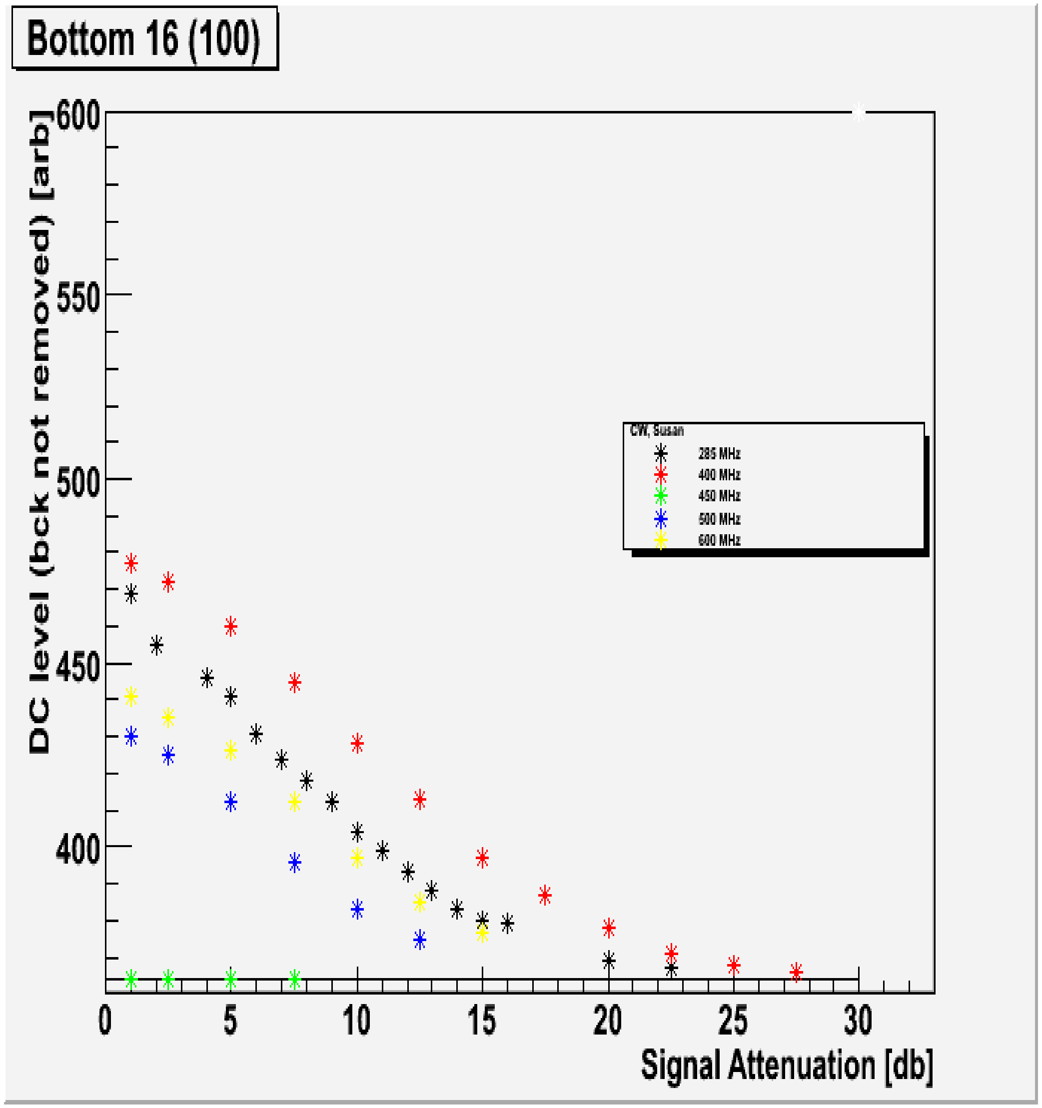

out.0e205a752165_480_a26a00fc8e24_480.lc.07.dat
a
Entries 8542
N/bin
10^2
10
1
-200
-100
0
100
200
dt (top - bottom) [ns]
High threshold (500)
Medium threshold (480)
low threshold (460)



285 MHz
285 MHz
500 MHz
450 MHz
400 MHz
600 MHz
Bottom 8
Top 9
Bottom 9
Bottom 16
DC background [arb]
600
550
500
450
400
350
0
500
1000
1500
2000
Time [sec]

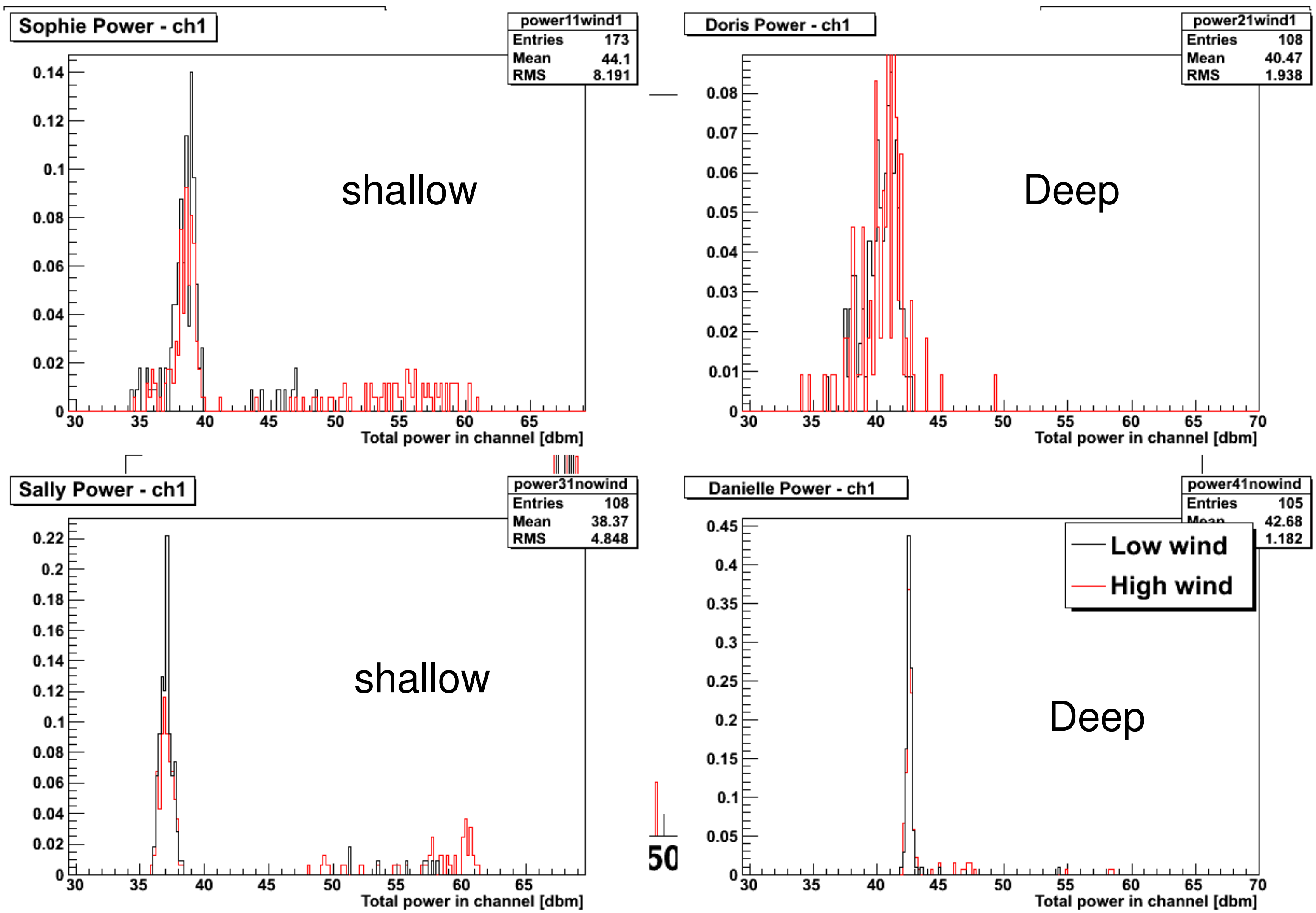


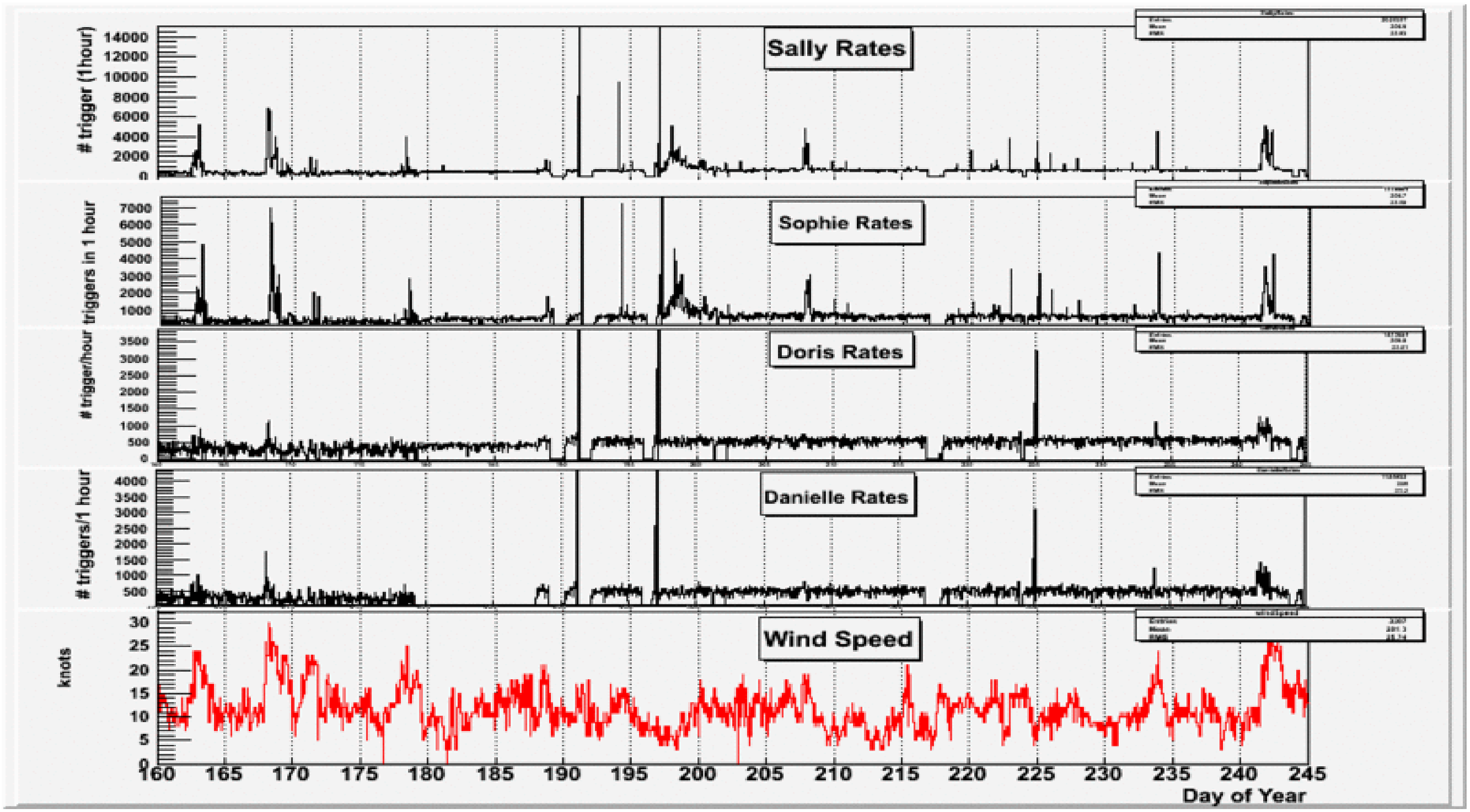
Bottom 8 (000)
CW, Susan
285 MHz
400 MHz
450 MHz
500 MHz
600 MHz
DC level (bck not removed) [arb]
Signal Attenuation [db]



Bottom 16 (100)
CW, Susan
285 MHz
400 MHz
450 MHz
500 MHz
600 MHz
DC level (bck not removed) [arb]
Signal Attenuation [db]

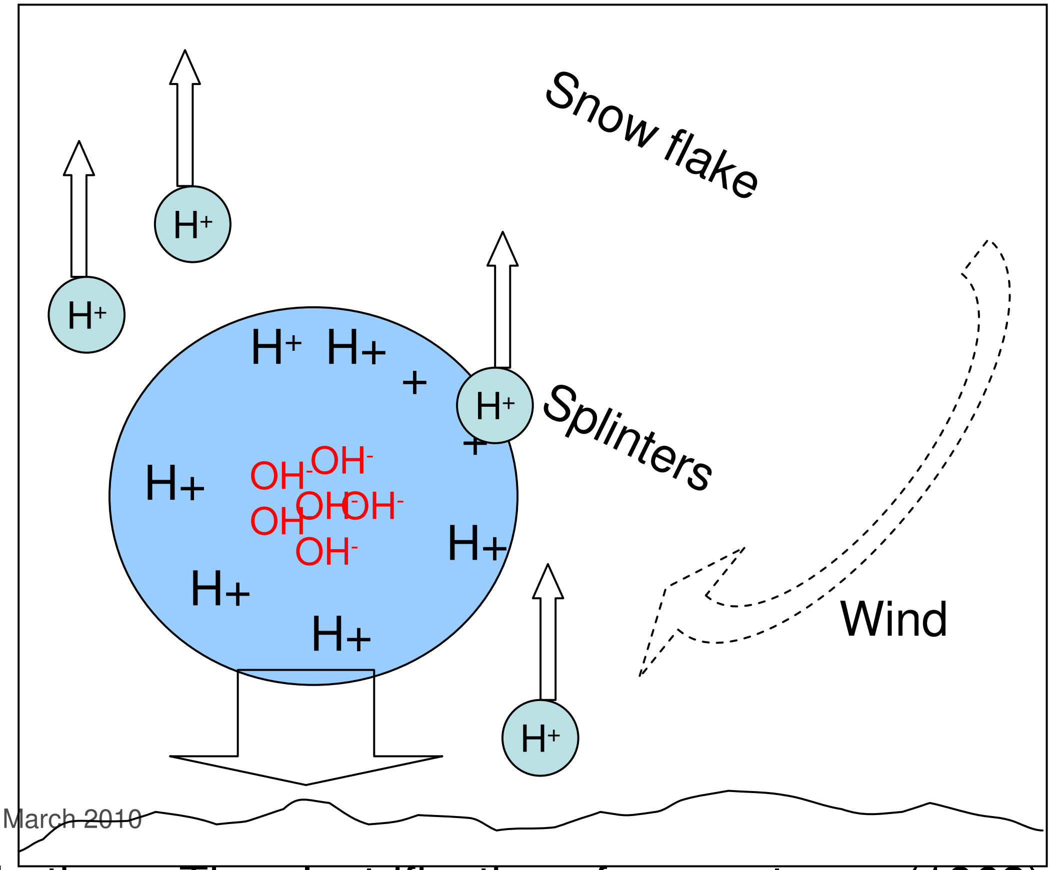
Power distribution, ch1, all drms




Sally Rates
trigger (1hour)
Sophie Rates
triggers in 1 hour
Doris Rates
trigger/hour
Danielle Rates
triggers/1 hour
Wind Speed
knots
Day of Year

Wind generated EMI

H+ more mobile than OH-
Positive charge excess in colder ice ~2dt mV
High E field near surface measured.
Modeled >25KV/m

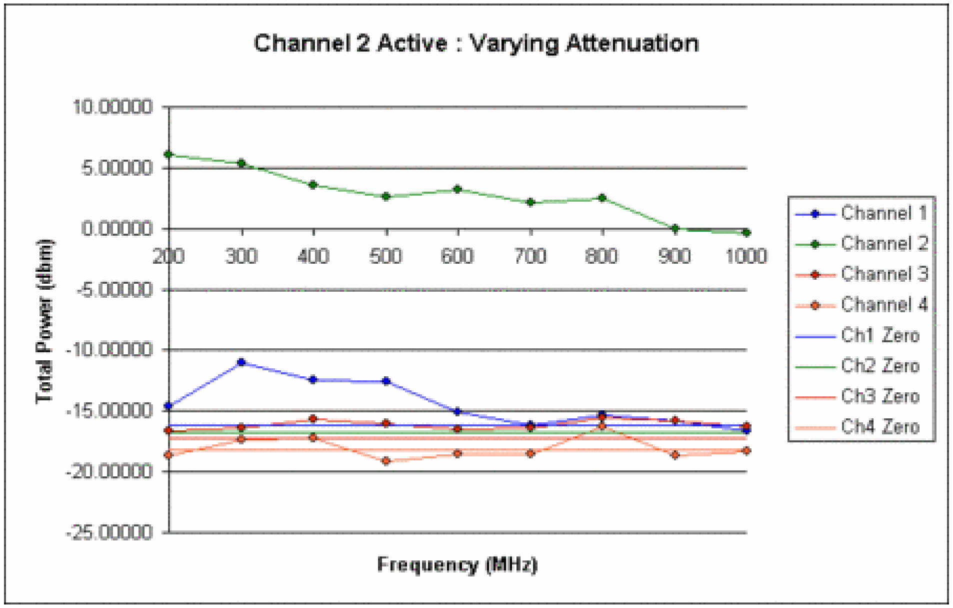


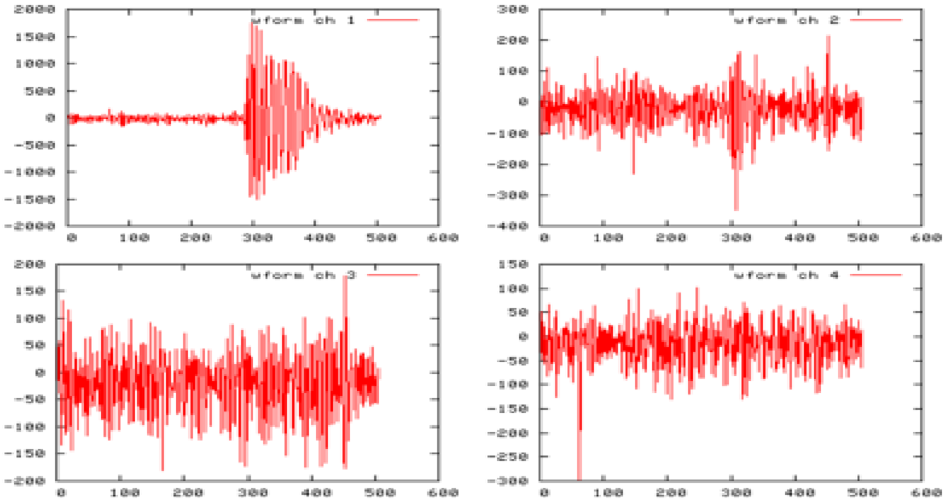
Latham, The electrification of snow storms (1963)

Cross talk

- For– Channels 1 and 2 both cause and experience the majority of the cross-talk, while channels 3 and 4 are far less susceptible and are unable to cause a large degree of crosstalk in any other channel.

- Less visible for fast pulses





http://wiki.icecube.wisc.edu/index.php/DRM_Channel_Cross-Talk