Welcome and Intro:
Some things we are look at here at CWRU

Corbin Covault,

Grad Students:
Andrew Ferguson, Danielle LaHurd,
Sean Quinn, Ryan Lorek

Undergrads:
Dane Pittock (graduated), Logan Smith,
Abbott Vanhuizen, Emily Shelton

Engineer: Bob Sobin

(Don Driscoll, Kent State)

Coffee, juice, snacks sponsored by

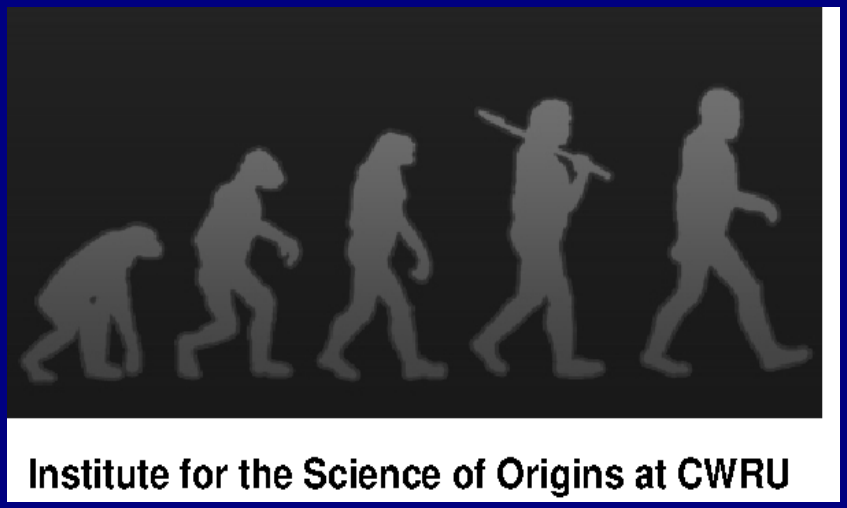
The Center for Education and Research in Cosmology and Astrophysics (CERCA)

http://cerca.case.edu

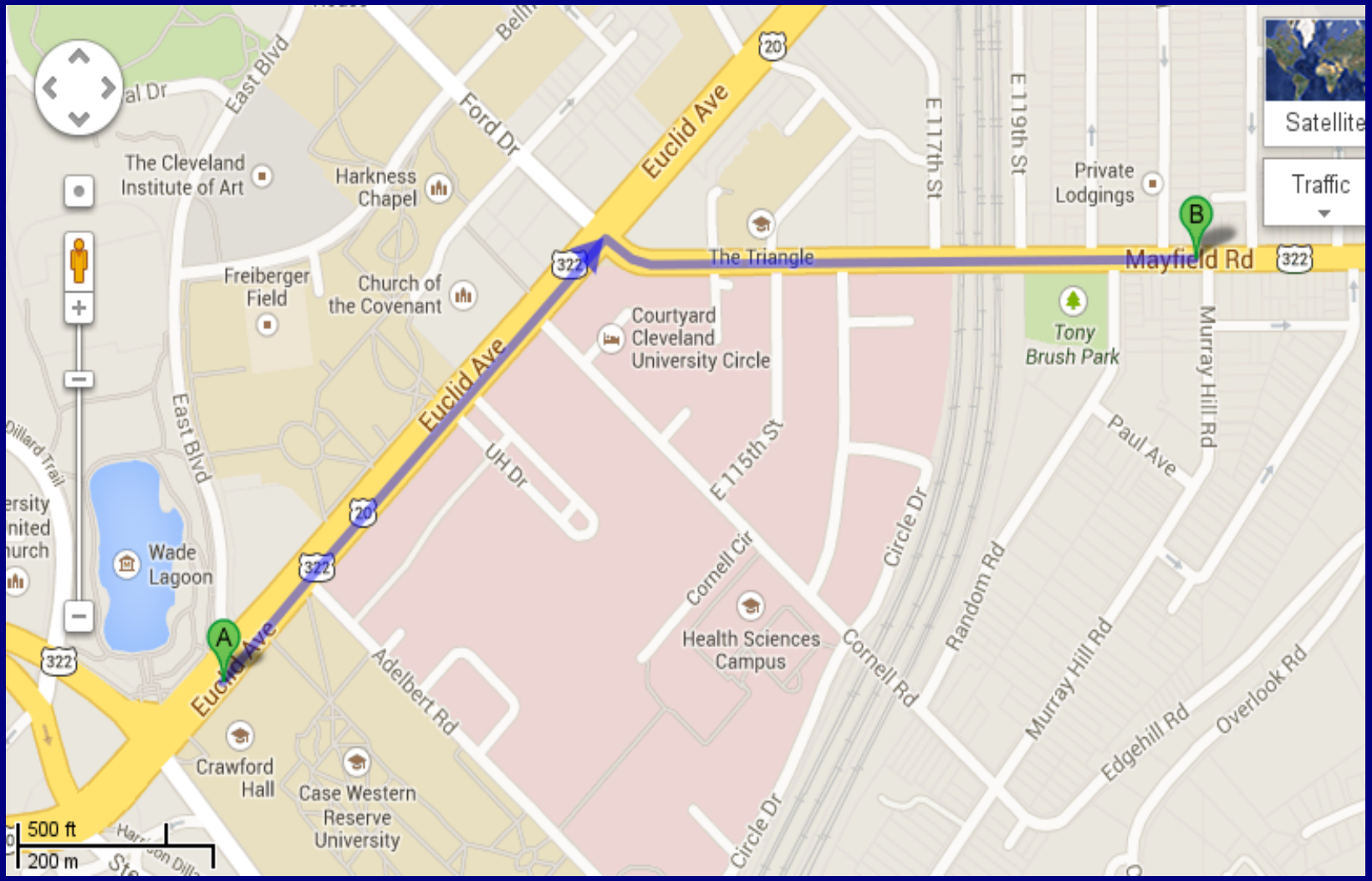
AND

The Institute for the Study of Origins (ISO)

http://www.case.edu/origins

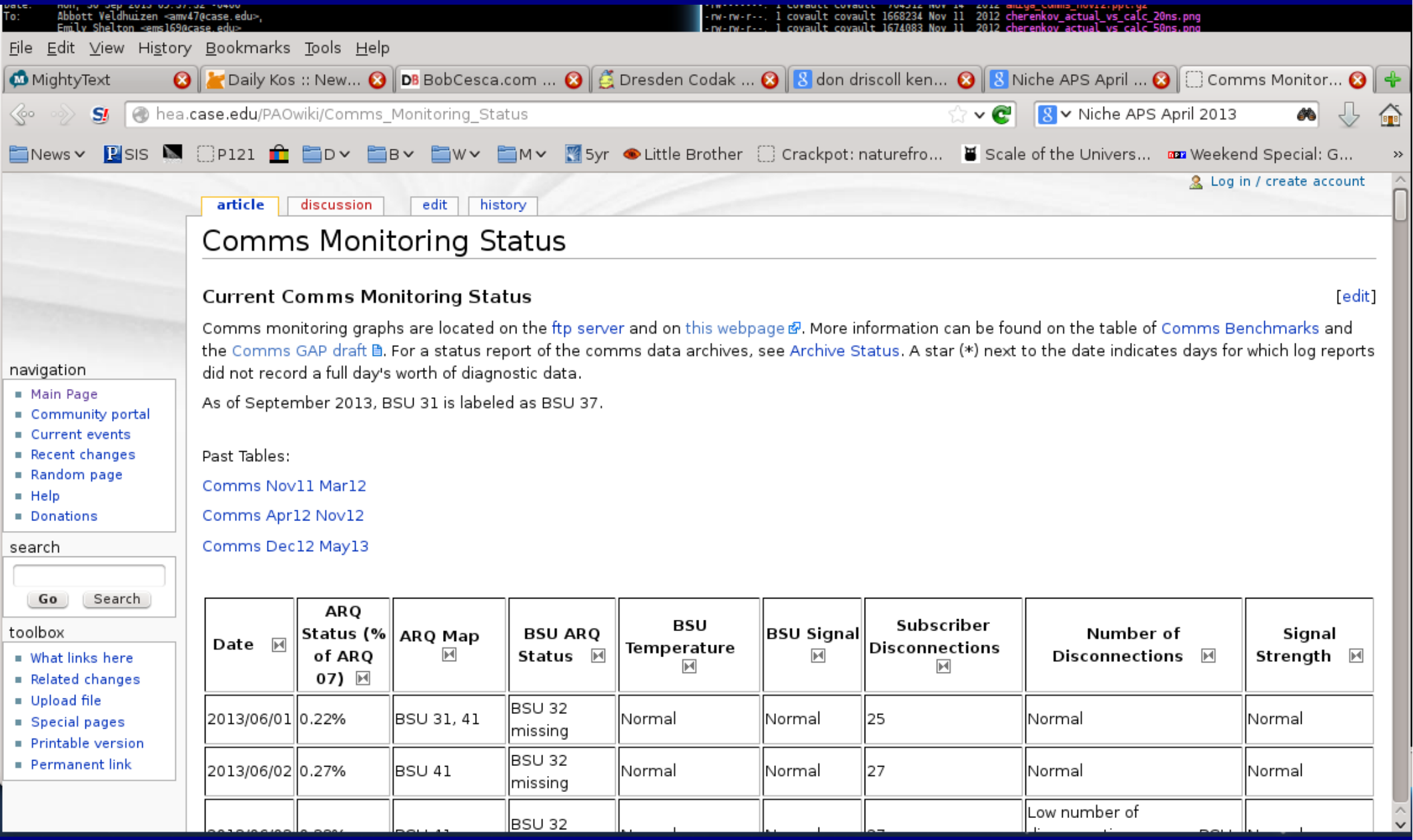


Dinner at La Dolce Vita
12112 Mayfield Road
Little Italy



Some things going on at CWRU:

Comms performance monitoring andintegration into Monitoring task: (Danielle LaHurd).



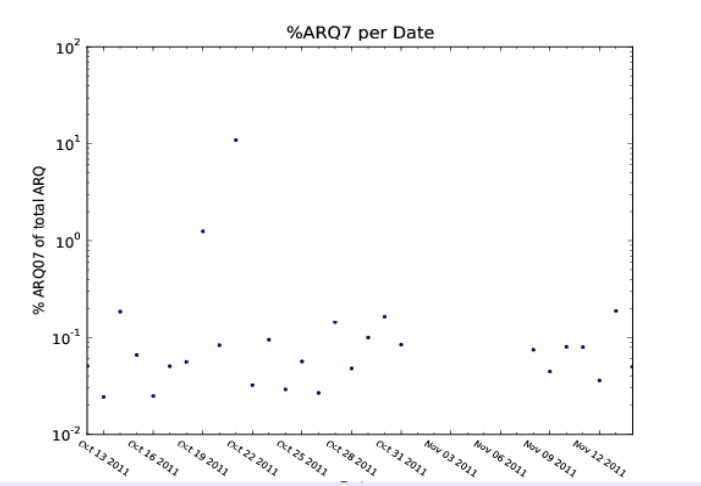
Date	ARQ Status (% of ARQ 07)	ARQ Map	BSU ARQ Status	BSU Temperature	BSU Signal	Subscriber Disconnections	Number of Disconnections	Signal Strength
2013/06/01	0.22%	BSU 31, 41	BSU 32 missing	Normal	Normal	25	Normal	Normal
2013/06/02	0.27%	BSU 41	BSU 32 missing	Normal	Normal	27	Normal	Normal
			BSU 32				Low number of	

Comms Monitoring page: hea.cwru.edu/PAOwiki

Comms Monitoring Graphs

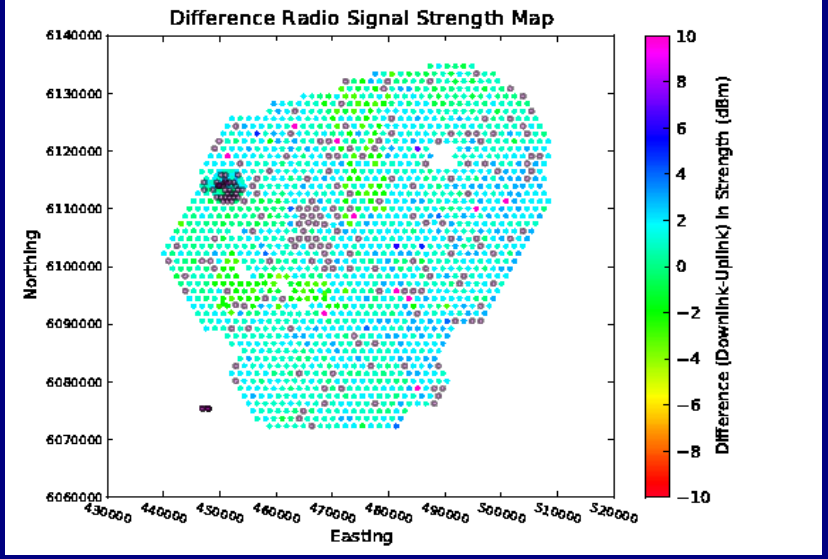
Below is the weekly ARQ percent. Links to specific dates can be found beneath the

More details can be found on the CWRU PAOwiki (cuyam).



Data is available for the following dates. Please click the date to access the graphs

2011-11-14
2011-11-13
2011-11-12
2011-11-11
2011-11-10
2011-11-09

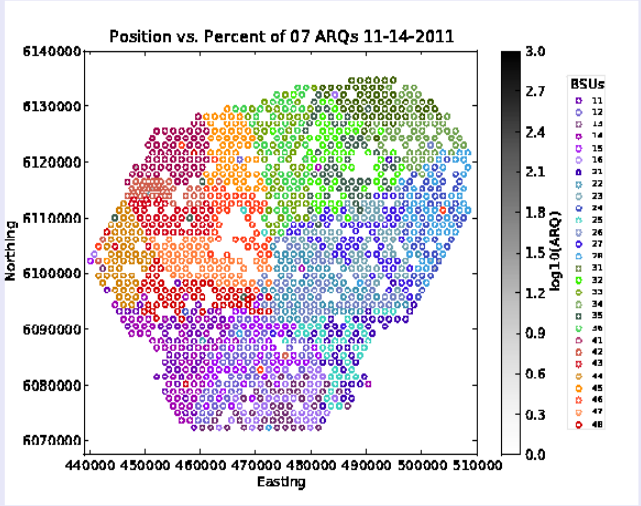


MiFi News SIS P1 D W M T 5yr Little

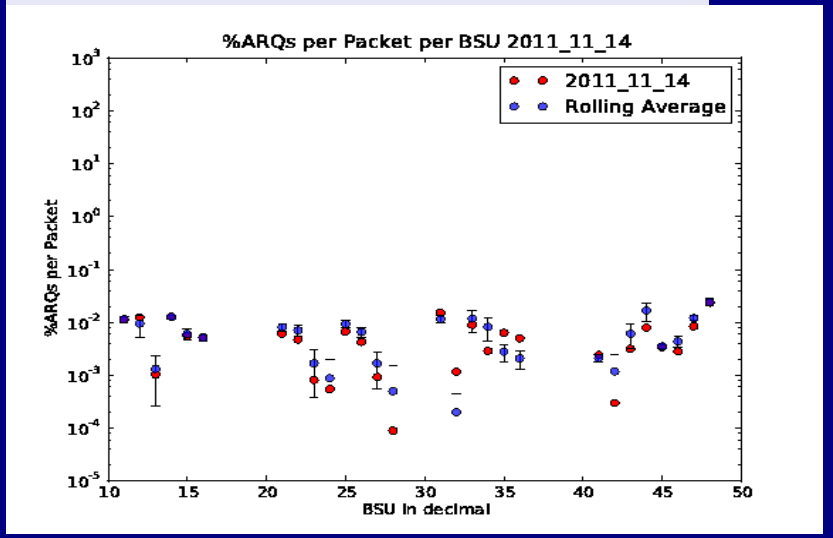
Comms Graphs for 2011 11 14

Click graphs to download high-resolution pdfs.

ARQ Map



BSU



Some things going on at CWRU:

Education/Outreach: Auger mini-visitor's center. Rockefeller lobby (Sean Quinn).

CWRU Work in GPS Time Tagging: (Sobin, Ferguson)

- Characterization of I-Lotus M12M GPS board.

- Development and implementation of test stand for M12M at CWRU using Xilinx Coolrunner CPLD, 150 MHz oscillator.

Recent work at CWRU to upgrade GPS test stand with oscillator at 290 MHz: (Bob Sobin, Andrew Ferguson)

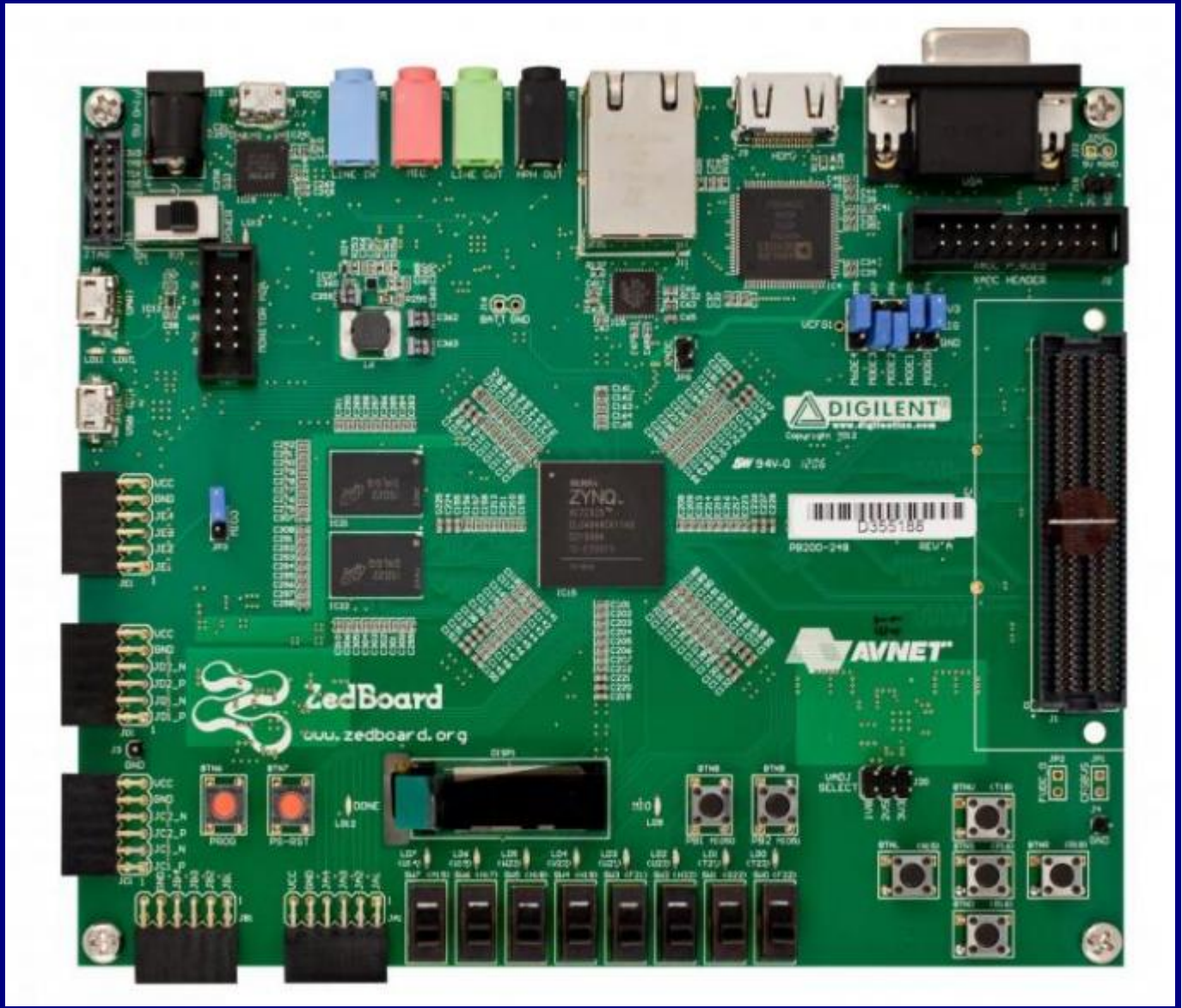
- Timing tagging implemented on "Zedboard" development kit with Xilinx FPGA board, Zynq-7000 processing core, USB interface.

- We use this three ways:

  (1) To develop fastest possible bench test stand,

  (2) As engine for production test stand for environmental stress tests,

  (3) as prototype for UUB time-tagging prototyping.



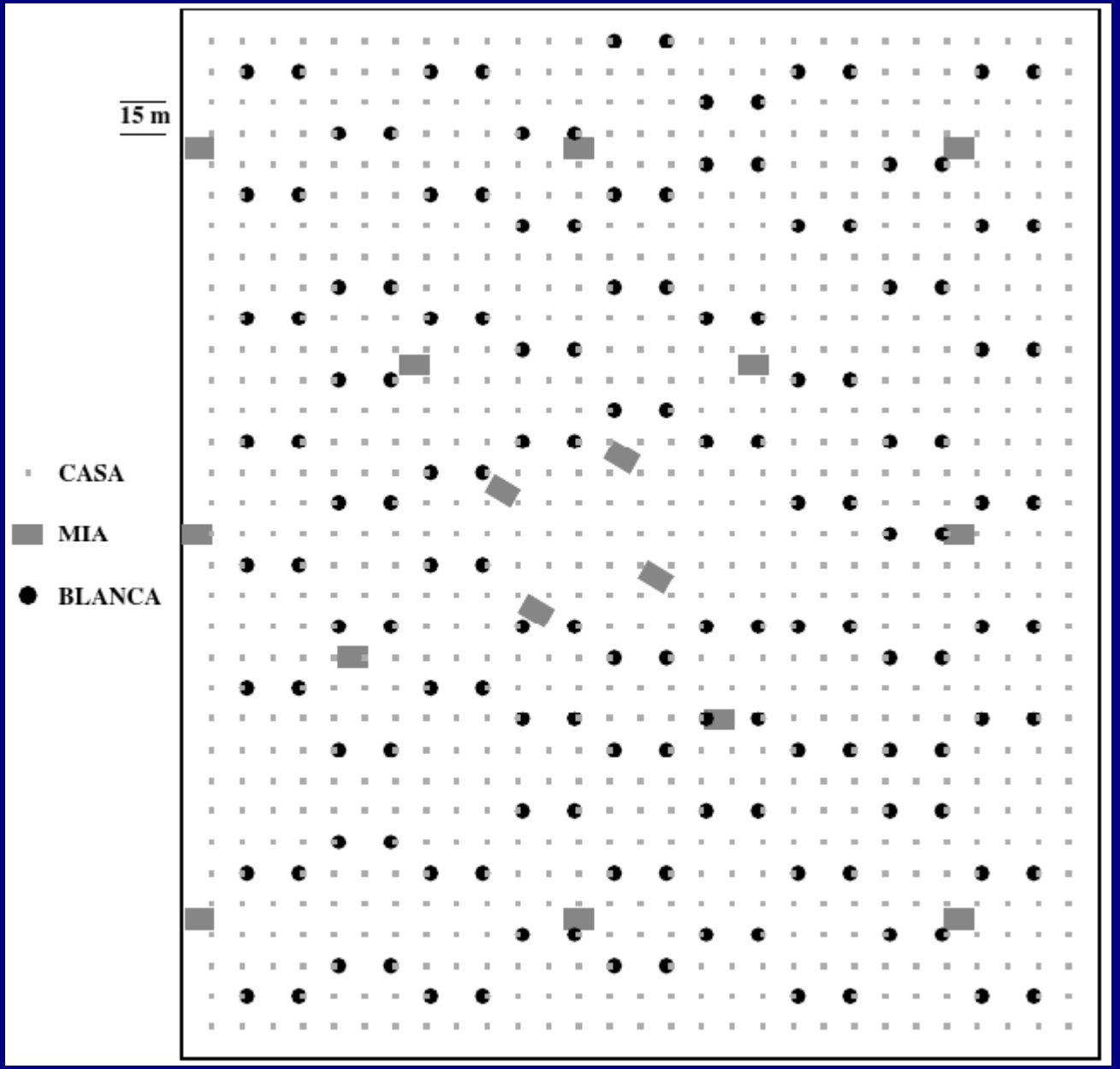
CWRU group looking at using an array of sampling Cherenkov detectors as a potential future upgrade for to Auger SD

Point to make:

You can get Xmax from Cherenkov timing but with different systematics relative to FD.

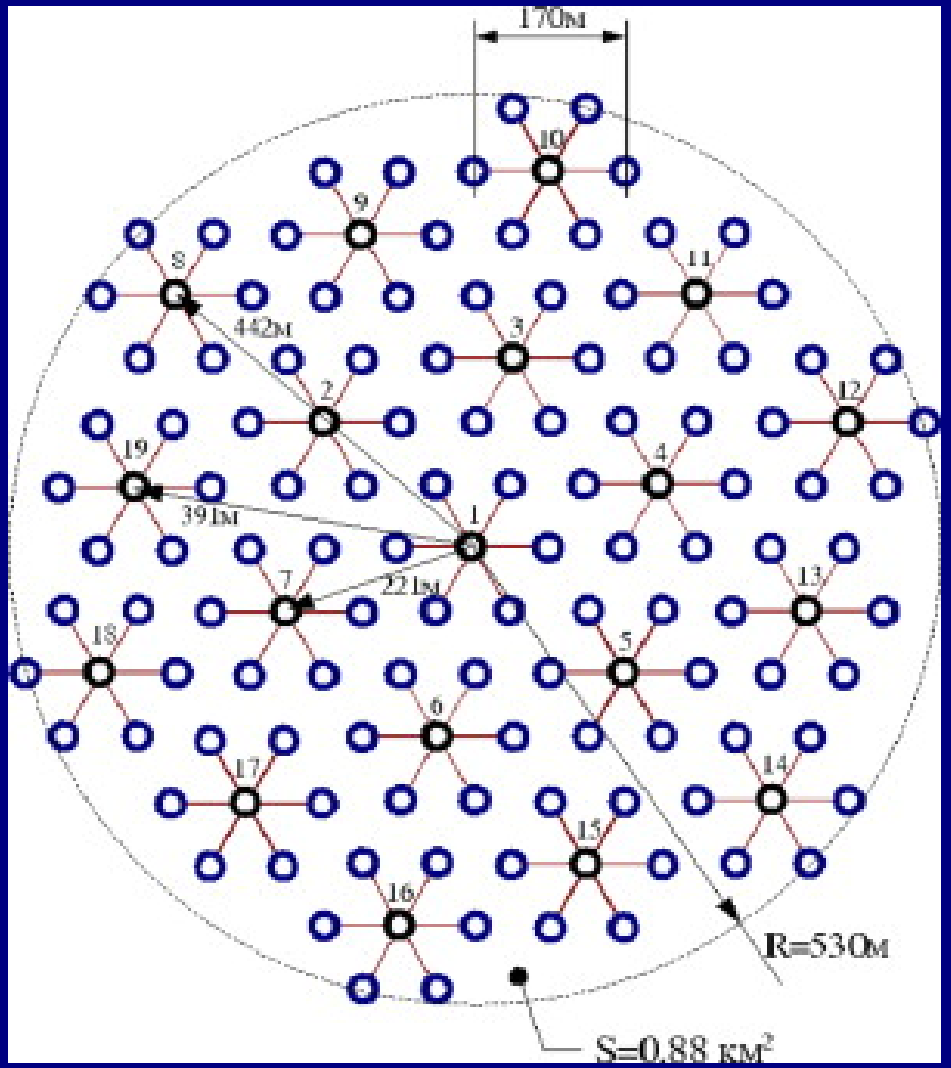
Sampling Cherenkov for CR physics: *Not a New Idea*

- CASA-BLANCA (1997 Dugway UT) 35m spacing, 0.2 sq km.



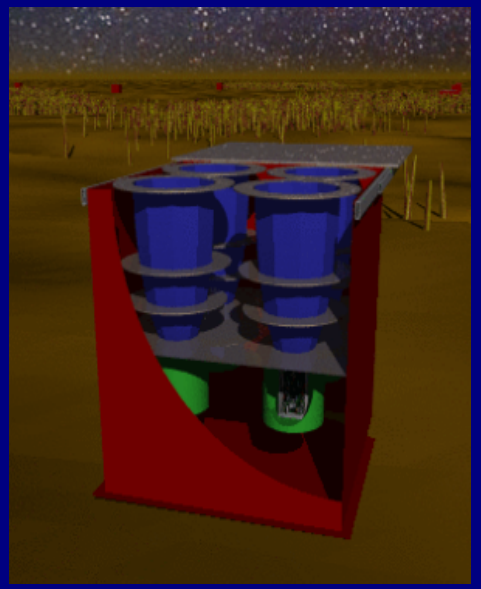
Sampling Cherenkov for CR physics: *Not a New Idea*

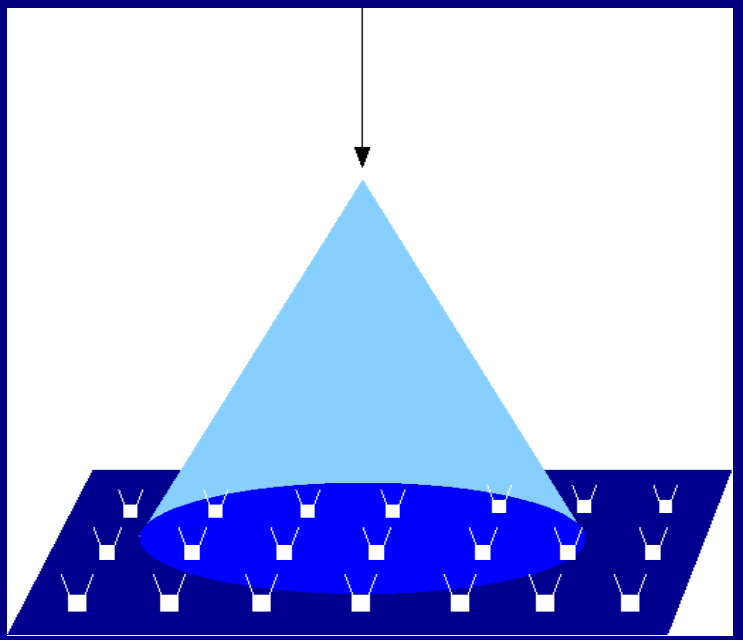
Tunka-133 (2011, Siberia) 100m spacing, about 1 sq km.



The SCORE and HiSCORE Cherenkov Array under development (Russia, Germany)

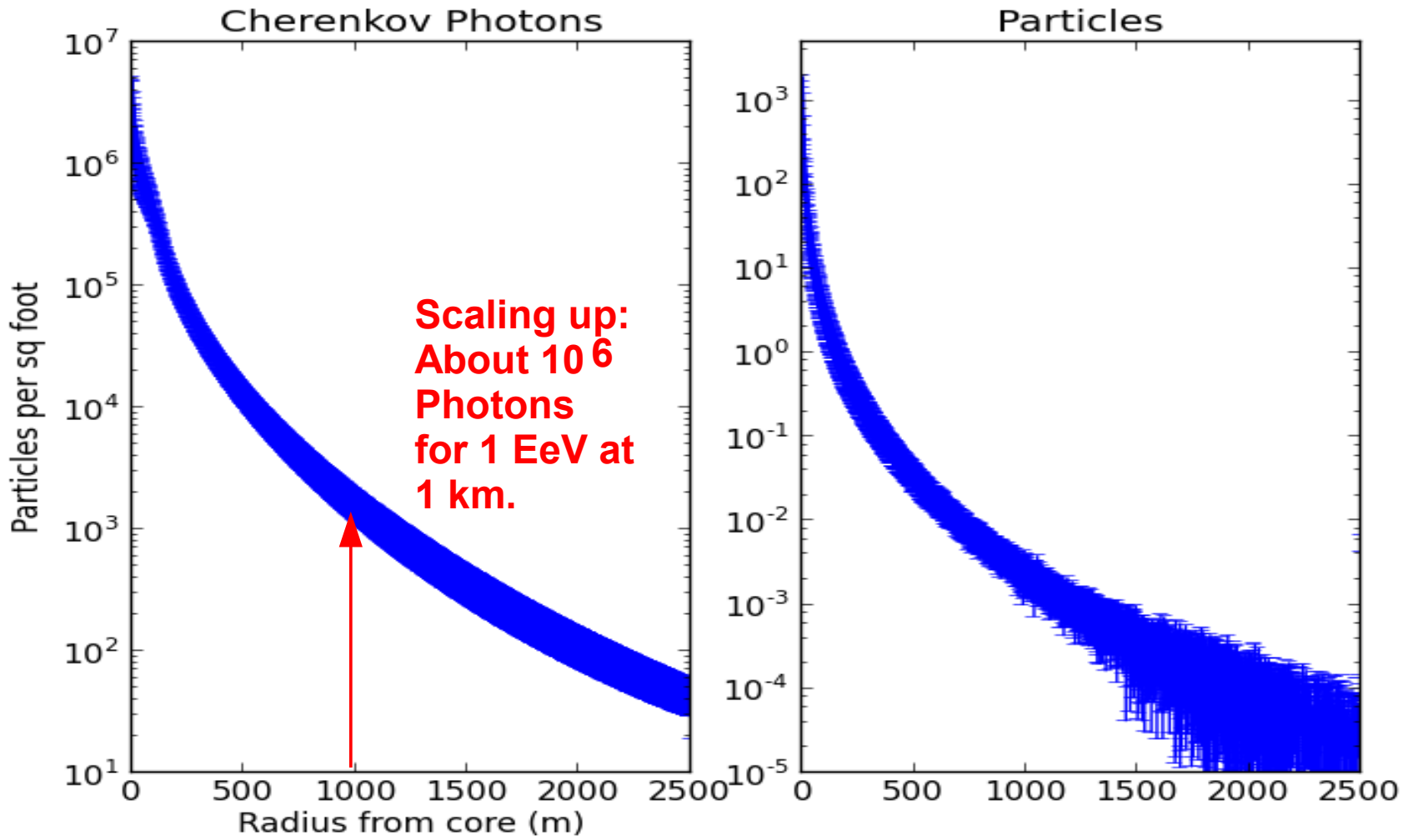
- Construction underway for HiSCORE (Siberia) 2012-2020:
  - 150m spacing (at Tunka site).
  - 10 and then 100 square km areas, two stages.
  - Gamma-ray astronomy 100 TeV to 10s of PeV.
  - Cosmic ray physics: Energy, anisotropy, composition, they claim reach to 1 EeV.



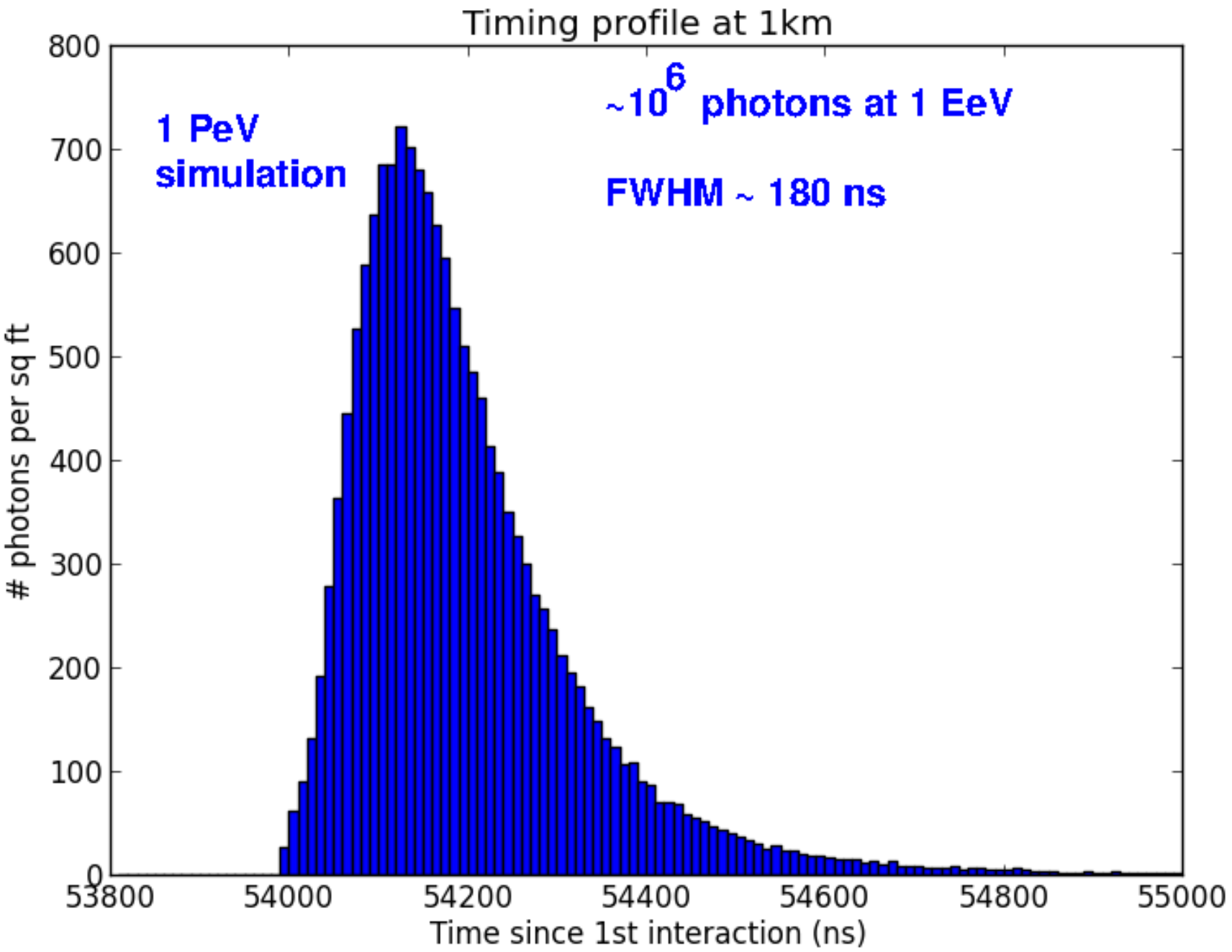


- We expect Cherenkov radiation to arrive in a plane wave with a pulse 10s of ns width near the core and up to ~microsec or more width several km away.
- Photon flux near core should be about 10^16 m^-2s^-1 (close to the solar photon flux at twilight).
- Intensity/Lateral distribution information beyond few hundred meters provides largely composition-independent energy measurement ~<10% systematics resolution depending on how well you can calibrate.
- Timing provides Xmax (electromagnetic) composition measurements with resolution and composition discrimination comparable to fluorescence but with a completely different set of systematics especially at high energies.

(Lateral Distribution)

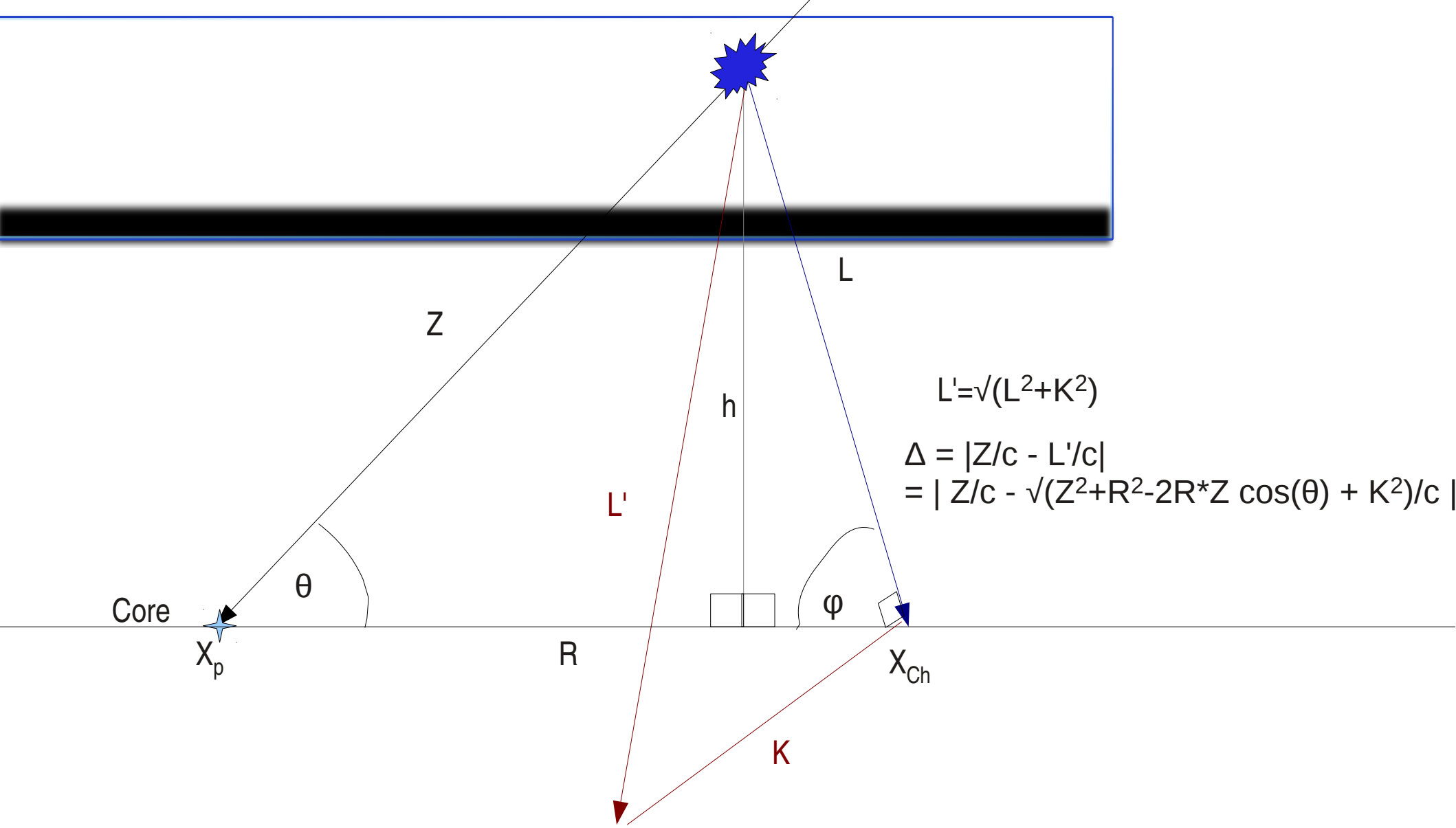


10 CORSIKA simulations (with NO thinning) of 1PeV vertical showers (errors are statistical).

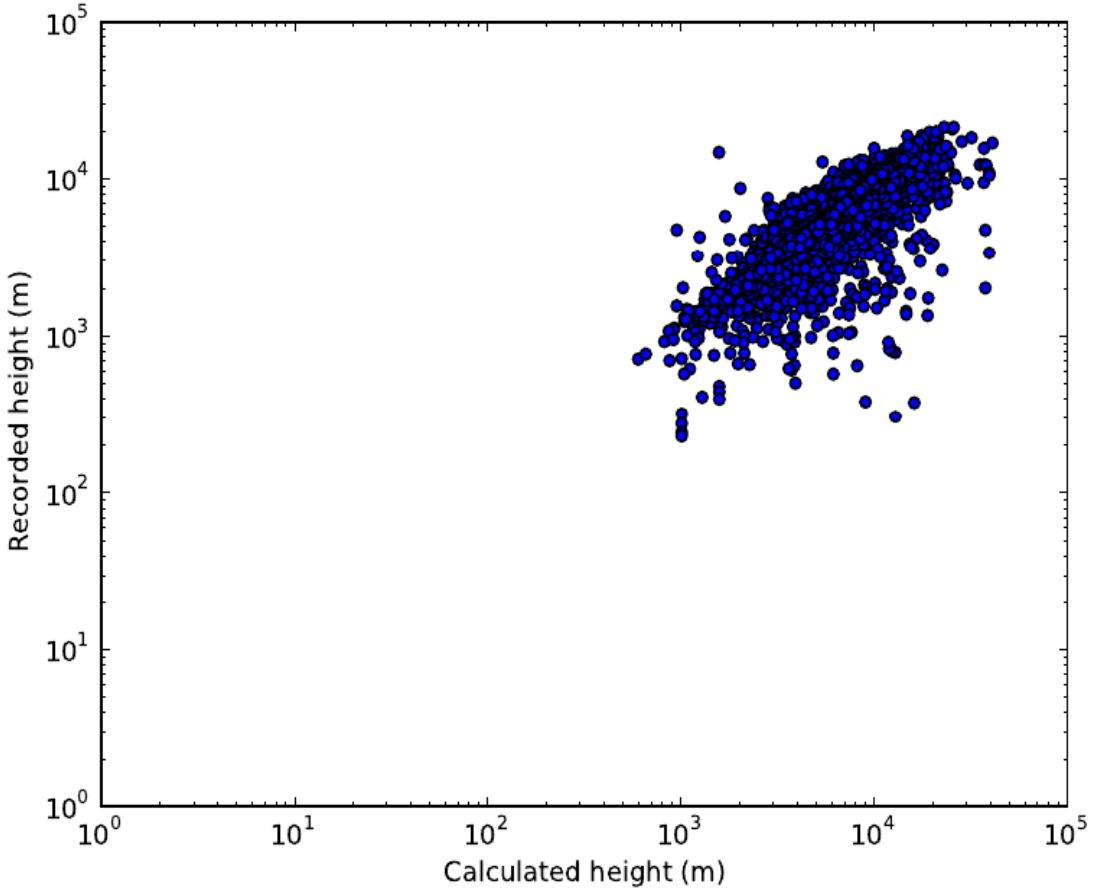

Timing profile at 1km
1 PeV
simulation
~10^6 photons at 1 EeV
FWHM ~ 180 ns
photons per sq ft
Time since 1st interaction (ns)
0
100
200
300
400
500
600
700
800
53800
54000
54200
54400
54600
54800
55000

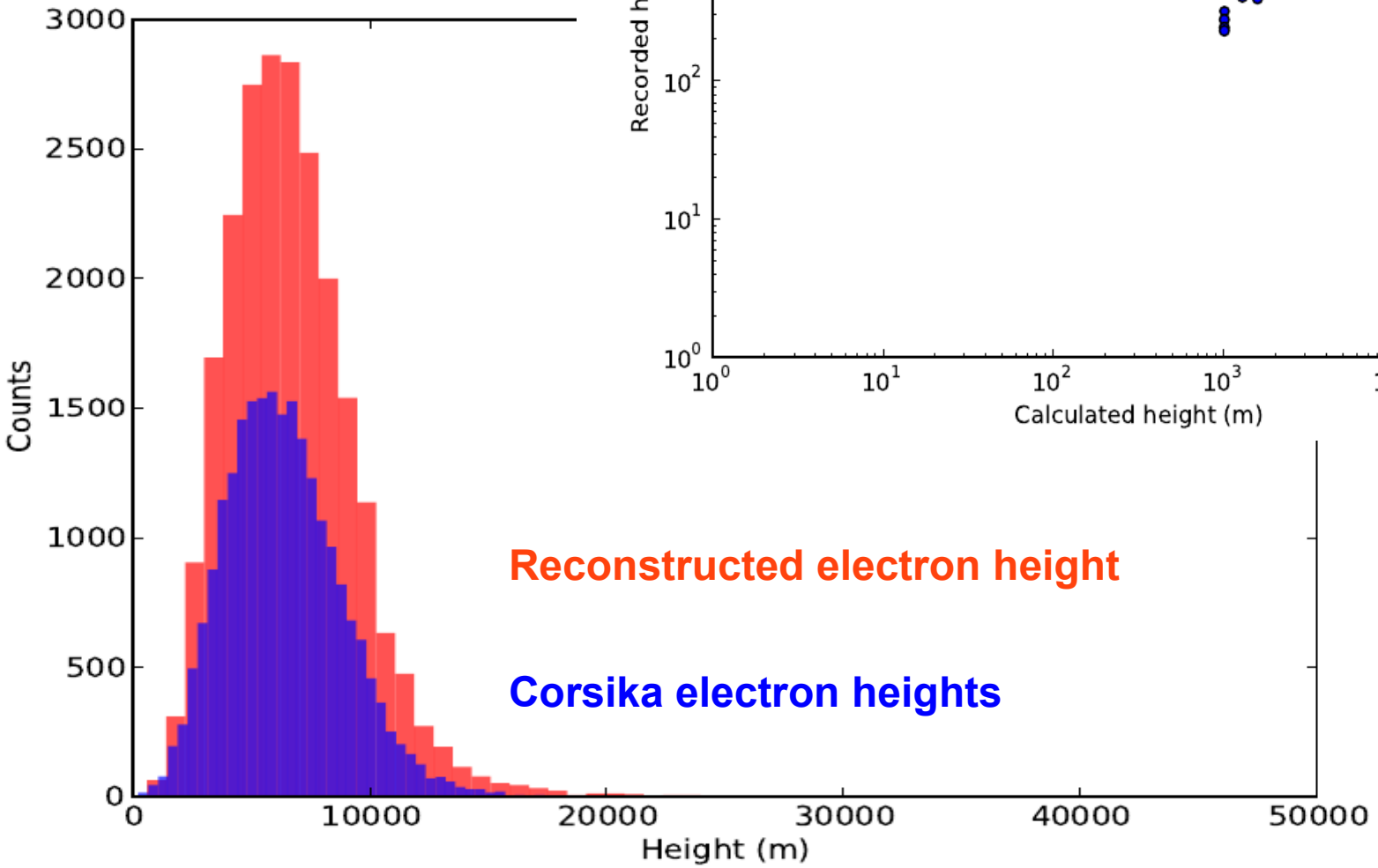
Cherenkov-SD Array

- An array of “bare PMT” Cherenkov detectors (similar to Tunka and HiScore or some other PMT/concentrator.
- Cherenkov detectors (1 or 2 PMTS) co-located with SD stations.
- Cherenkov detectors do not need to generate array triggers.
- Cherenkov signal traces read out at SD for night-time array triggers
- Cherenkov intensity + SD gives you energy measurement.
- Cherenkov timing + SD core and arrival direction gives you Xmax.



Timing from even a single Cherenkov station constrains geometry and provides a measure of Xmax. Multiple stations provide over-constrained measurements of increased accuracy.



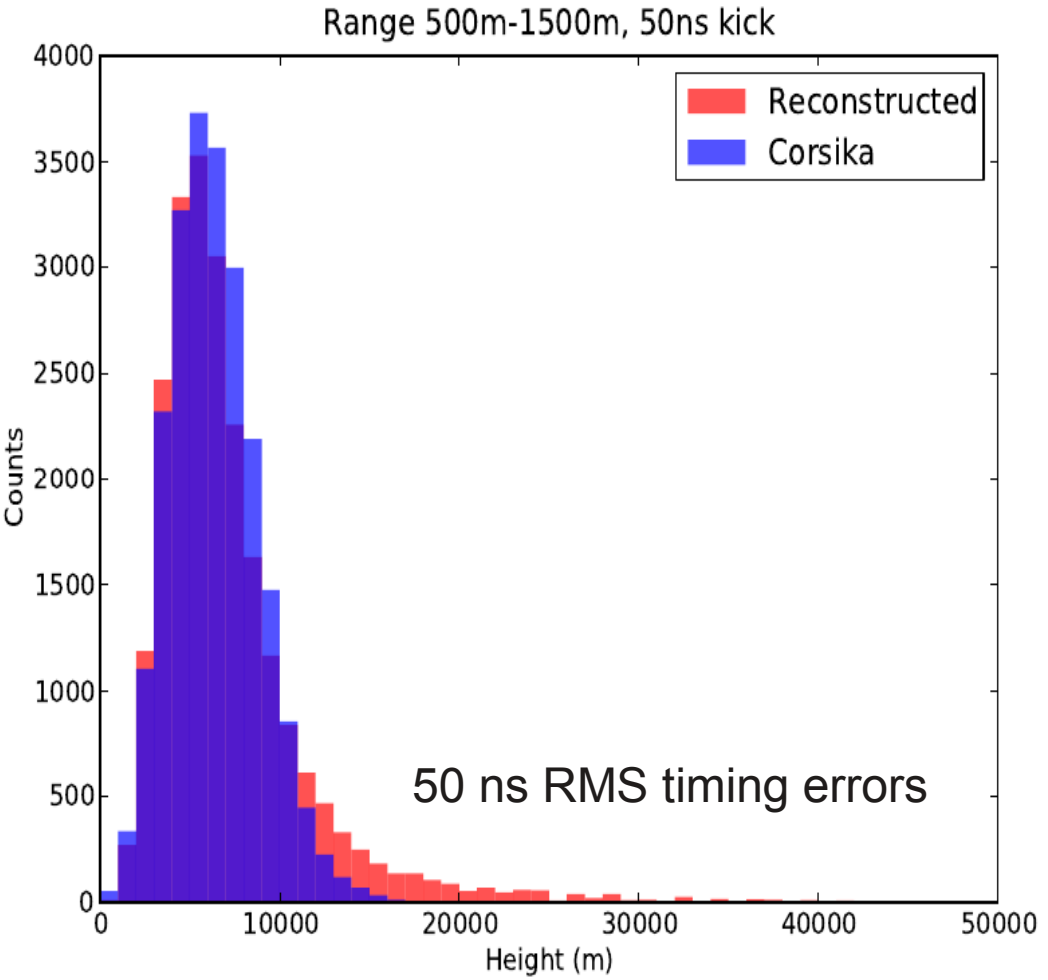


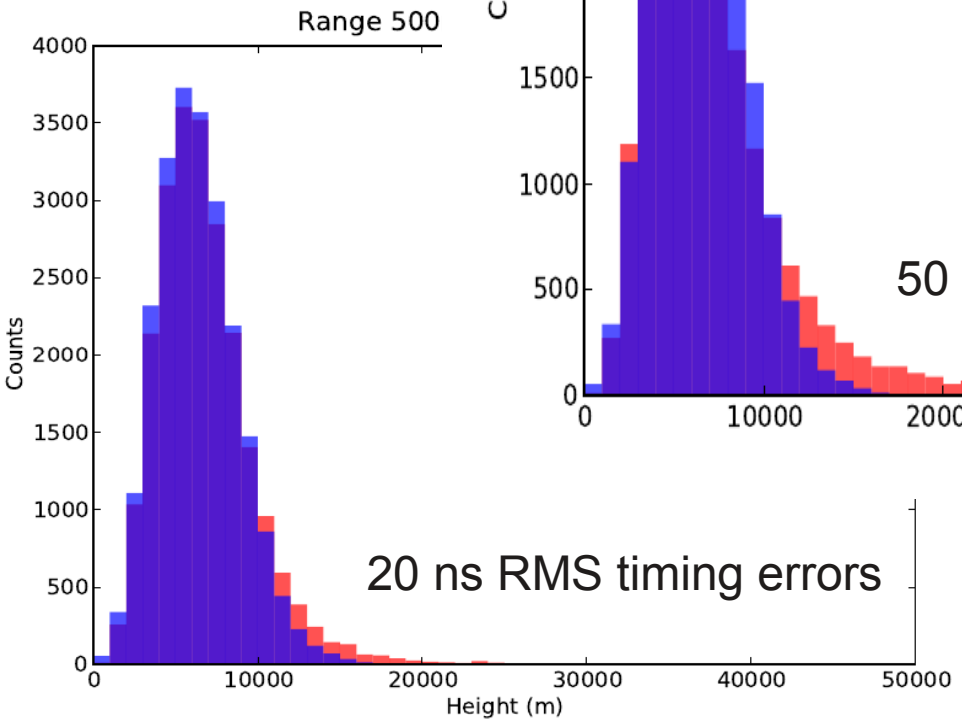
Reconstructed electron height

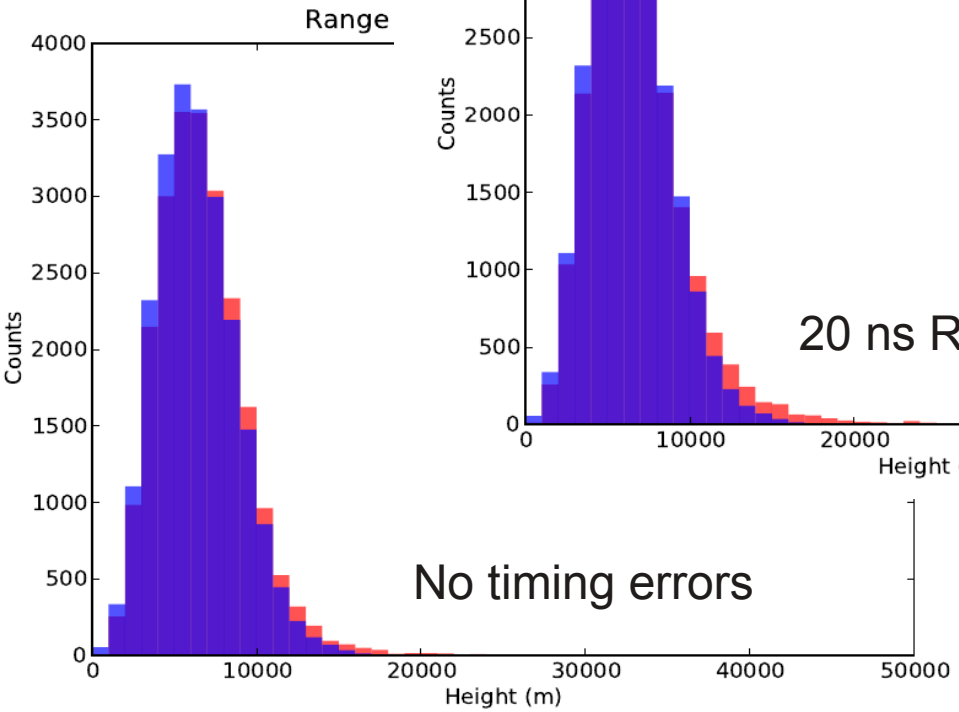
Corsika electron heights

Performance Issues

- “Back of the envelope” scaling from simulations at PeV energies suggest that 1 km spacing array of 0.1 square meter Cherenkov detectors would provide ***both*** energy resolution ***and*** X_max resolution on par with those from FD at ~1 EeV energies.
- Scaling up simulations requires some care: many of photons.
- Worries:
  - Will rapid increase in timing spread beyond ~1 km wreck both timing and intensity measurements?
  - Will intrinsic spread in shower profile dominate timing uncertainties? Can we characterize this?
  - How many stations are needed and in what pattern to effectively over-constrain timing to required uncertainties?
  - What kind of dynamic range is really needed?







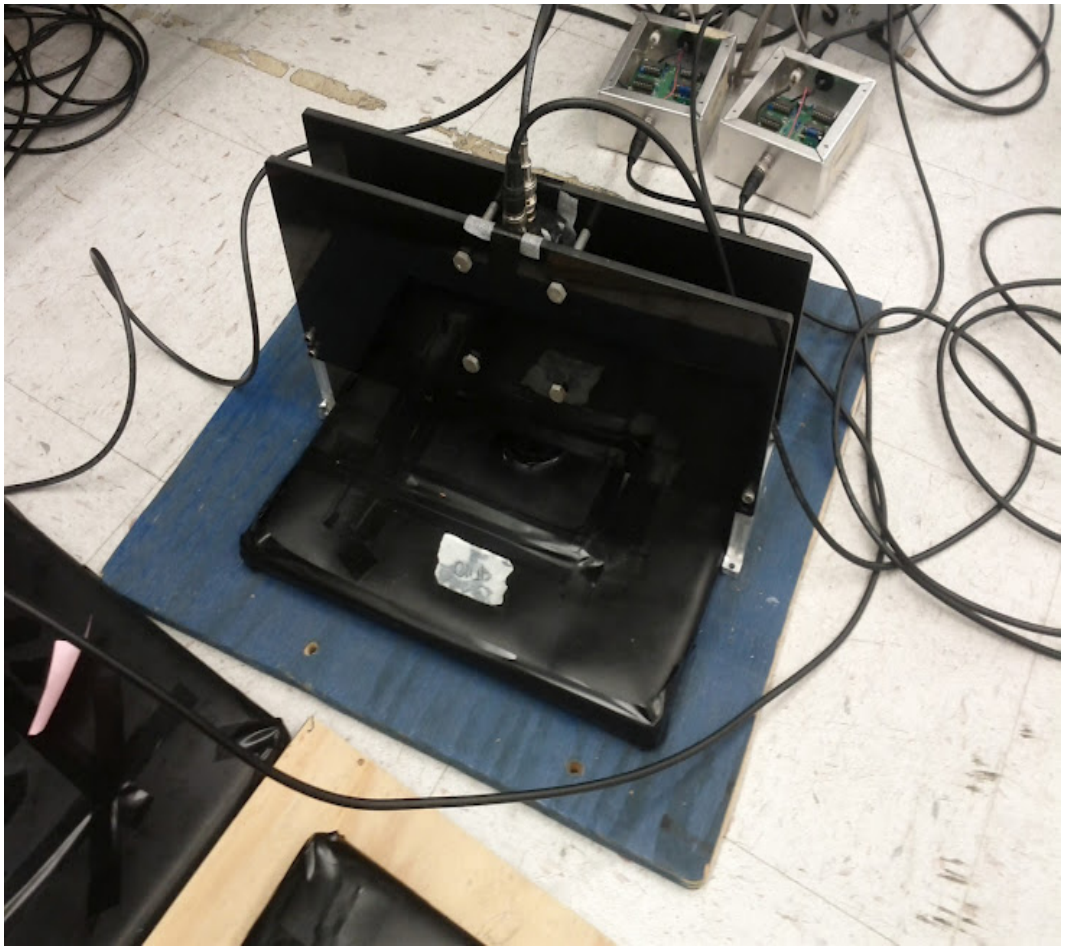
Perhaps to get <20 ns Timing for profile 100's of ns FWHM

(undergraduate project)

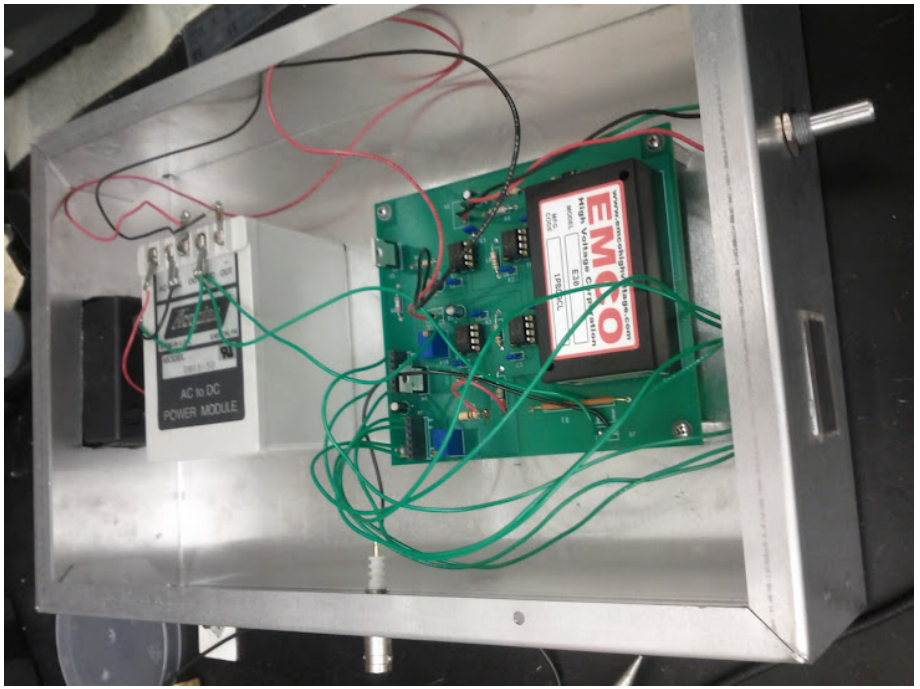
- Proof-of-concept using a single light concentrator in the center of four scintillating particle counters.
- We have simulated several PeV showers to predict detector performance.
- Beginning work to modify prototype for potential deployment at the RDA to look at the same showers with both detectors.

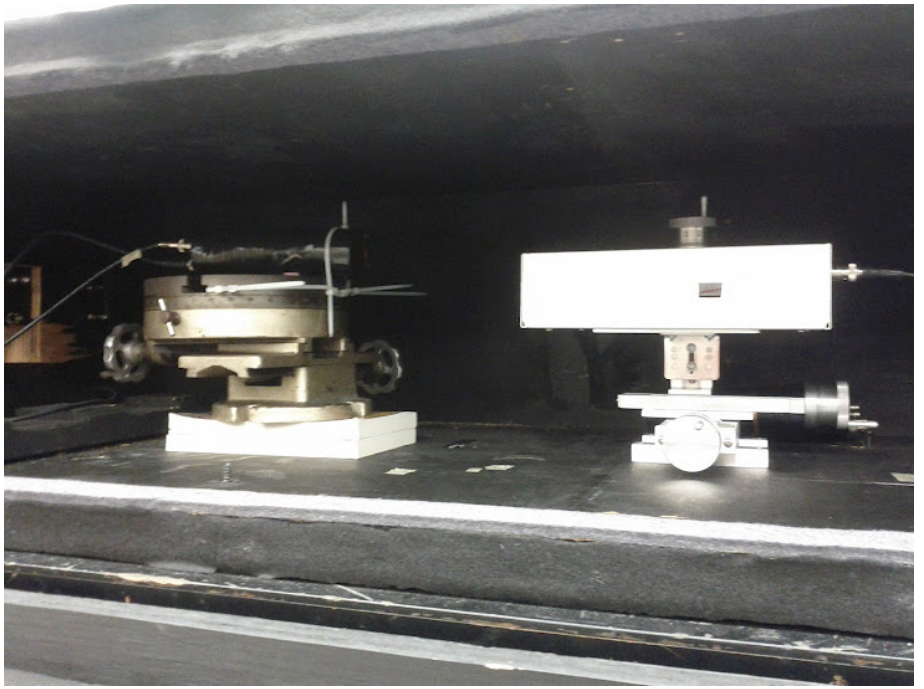
Construction

Winston cone concentrator



Scintillator counter (one of four) for Local trigger.

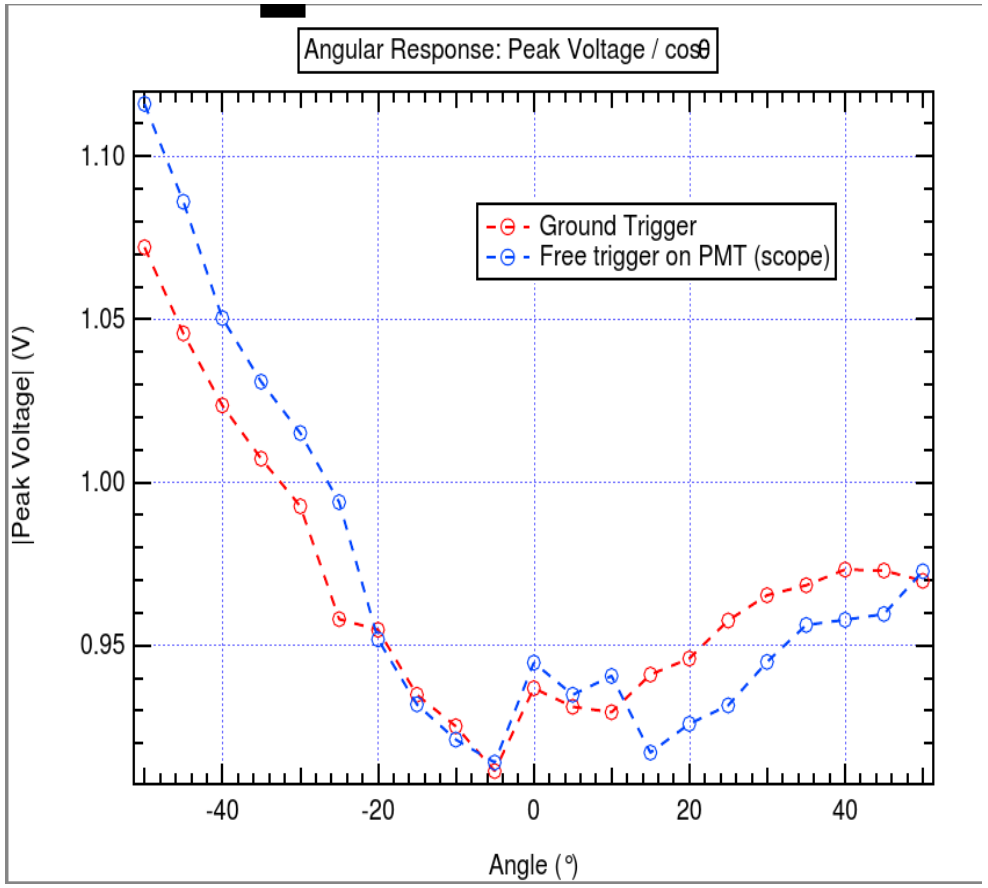


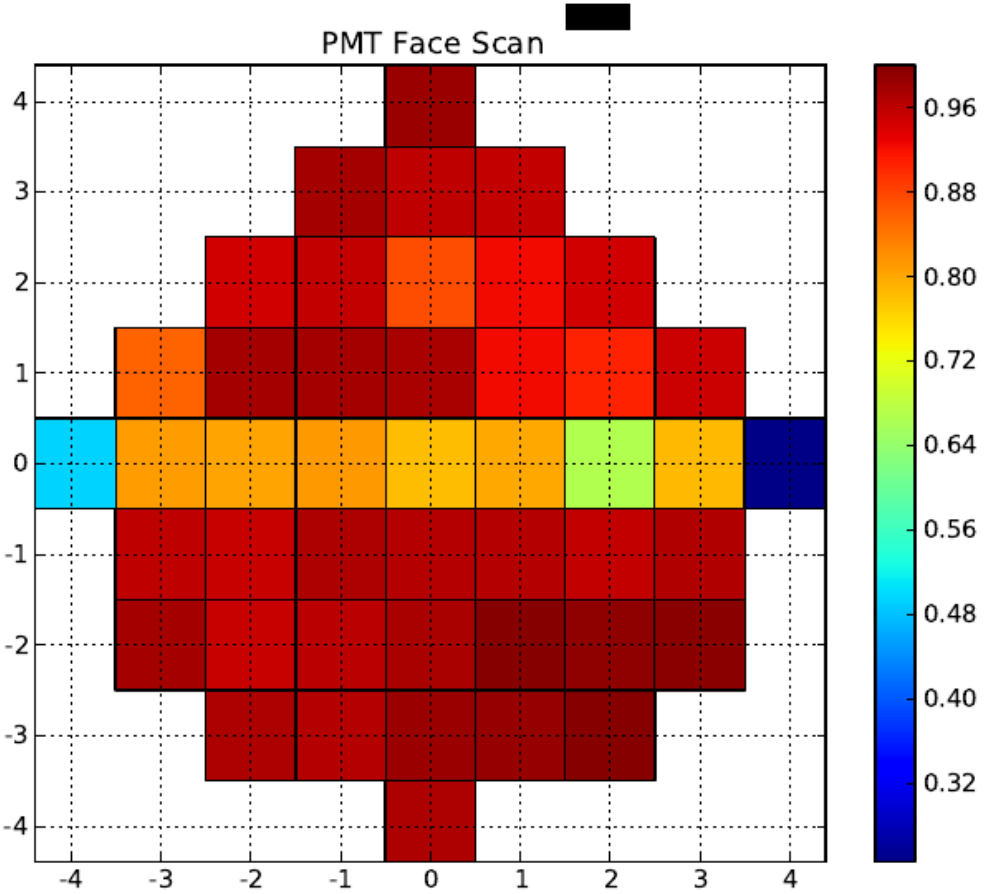


Portable HV supply

Pulsed light source and dark box
To characterize performance of PMT.

(Work of Scott Quinn)





(R)adio Extension

- Integrate and test local trigger: Calibrate scintillator trigger rates.
- Deploy Cherenkov detector with light concentrator under a dark sky, compare rates and measured photon densities to predictions. Make sure we know what we are doing with PeV showers first.
- Continue development to provide a small number of Cherenkov stations to be deployed in the RDA:
  - Array configuration, number of stations,
  - Data acquisition, storage and readout by CDAS,
  - Shutter control.

- Arguably, Cherenkov doesn't provide anything that you are not already getting from FD. Energy and X_max both infered from electromagnetic component.
- However systematics on Cherenkov are quite different from FD. (e.g., atmospherics, timing reconstruction, etc.) So SD-Cherenkov Hybrid provides an independent measure of these quantities for a relatively low cost impact.
- Cross-checks can be done for FD, SD, and Cherenkov can be done at the same time on the same shower.

- Some approaches to FD (and SD) enhancement allow for the prospect of Cherenkov measurements, so perhaps these prospects should be considered in selecting among different options.
- Independent measure of Xmax (electromagnetic) might be worth it, especially at the highest energies – very different systematics relative to FD.
- Plan to follow standard “R&D” pathway: Tests in RDA, then one or two stations in Malargue, coordination with HiScore prototype deployment and FD upgrade activities.

- APS April Meeting 2013: *The Non-Imaging CHErenkov Array (NICHE): A TA/TALE extension to measure the flux and composition of Very-High Energy Cosmic Rays:* Authors: D. Bergman, Douglas; J. Krizmanic; P. Sokolsky.
- Different design: self-triggering, higher-density (~100 meters), composition via time-spread vs. pulse arrival timing.