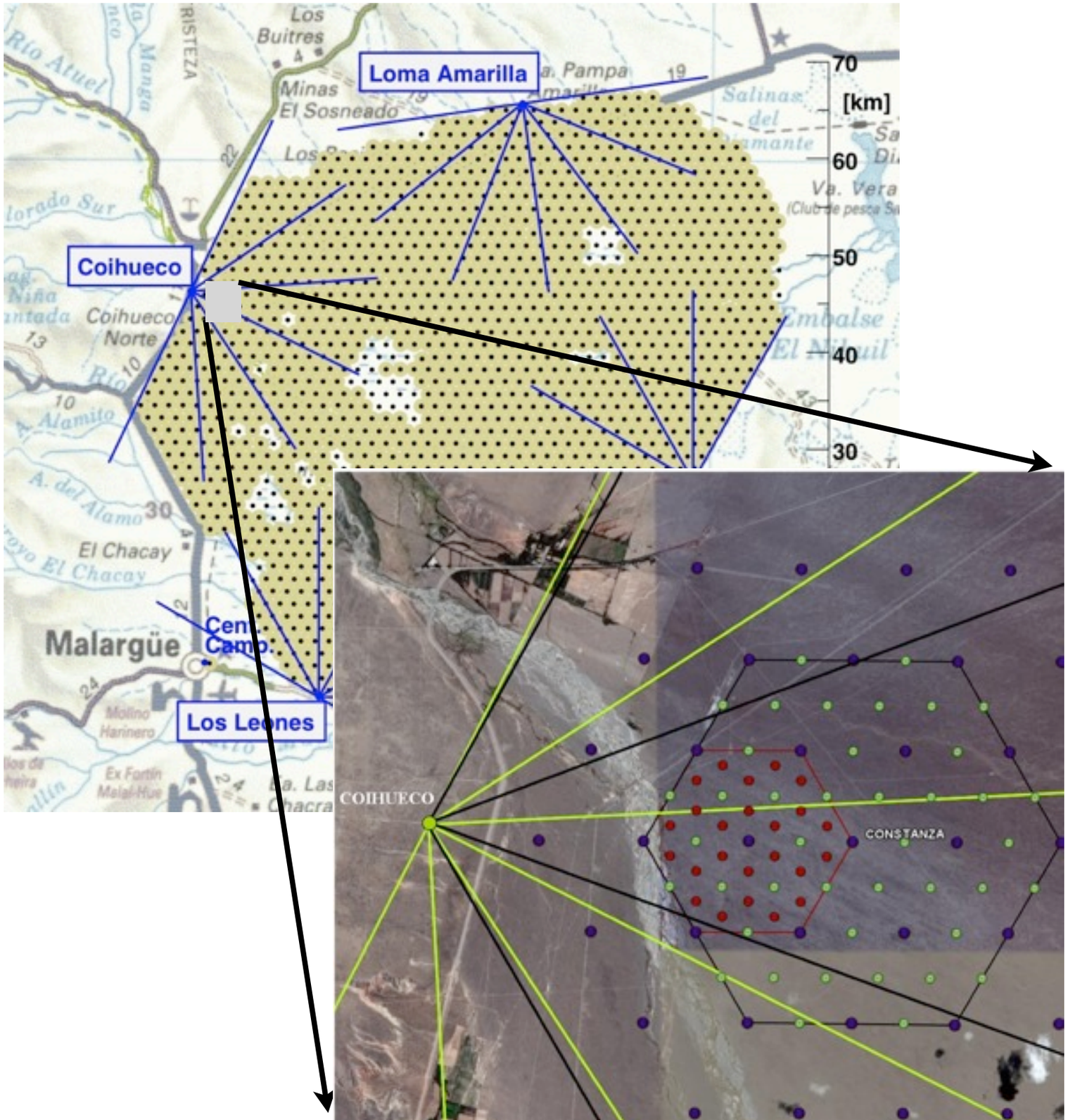
Some Comments on the Auger Reconstruction for the Infill Array

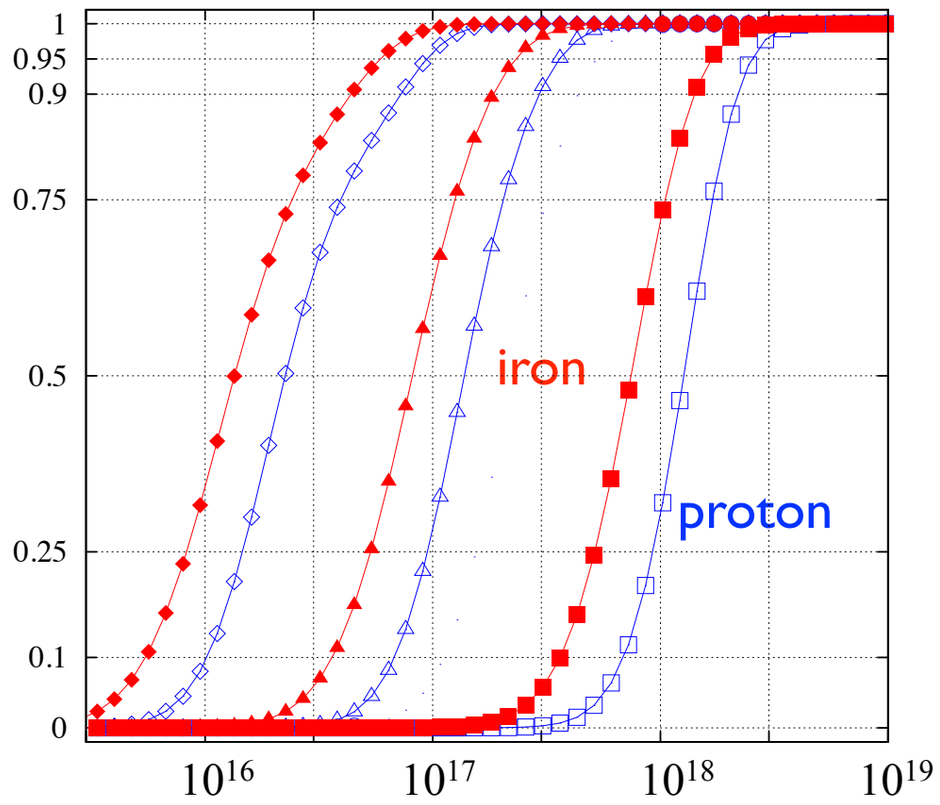
Jan Weseler, Markus Roth, (Ralph Engel),
for the Pierre Auger Collaboration

Karlsruhe Institute of Technology

Infill array of water Cherenkov detectors



Simulated acceptance



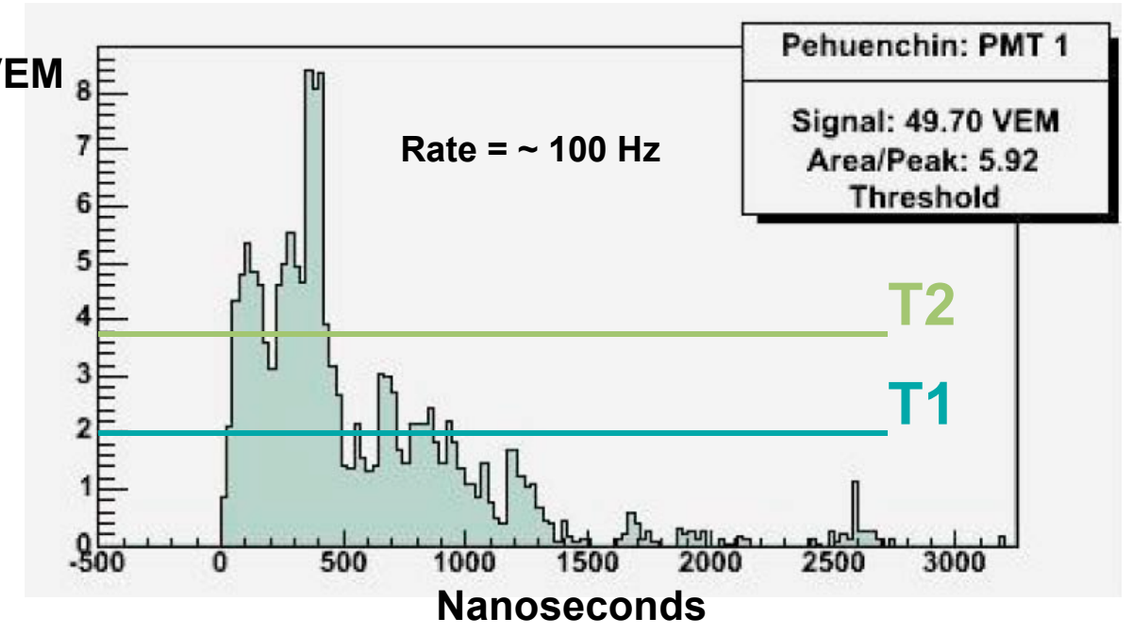
433m 750m 1500m

Threshold for infill array ~$10^{17.5}$ eV

Trigger for surface detector stations

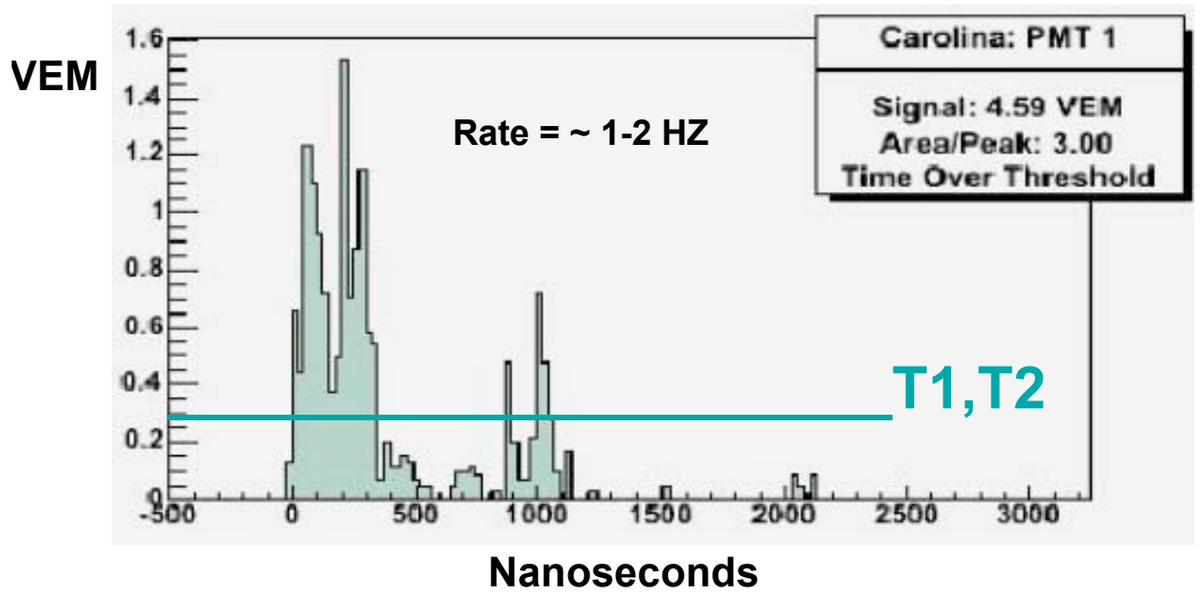
Threshold trigger

T1: one PMT above 1.75 VEM (100Hz)
T2: all three PMT above 1.75 VEM (20 Hz)



Time over threshold trigger

T2: at least two PMTs above 0.2 VEM
for 13 bins (325 ns)
in sliding window of 120 bins (3 μs)



T3: coincidence trigger of at least 3 stations (central data acquisition)
T4: compactness, T5 quality selection trigger (software)

Event and calibration information

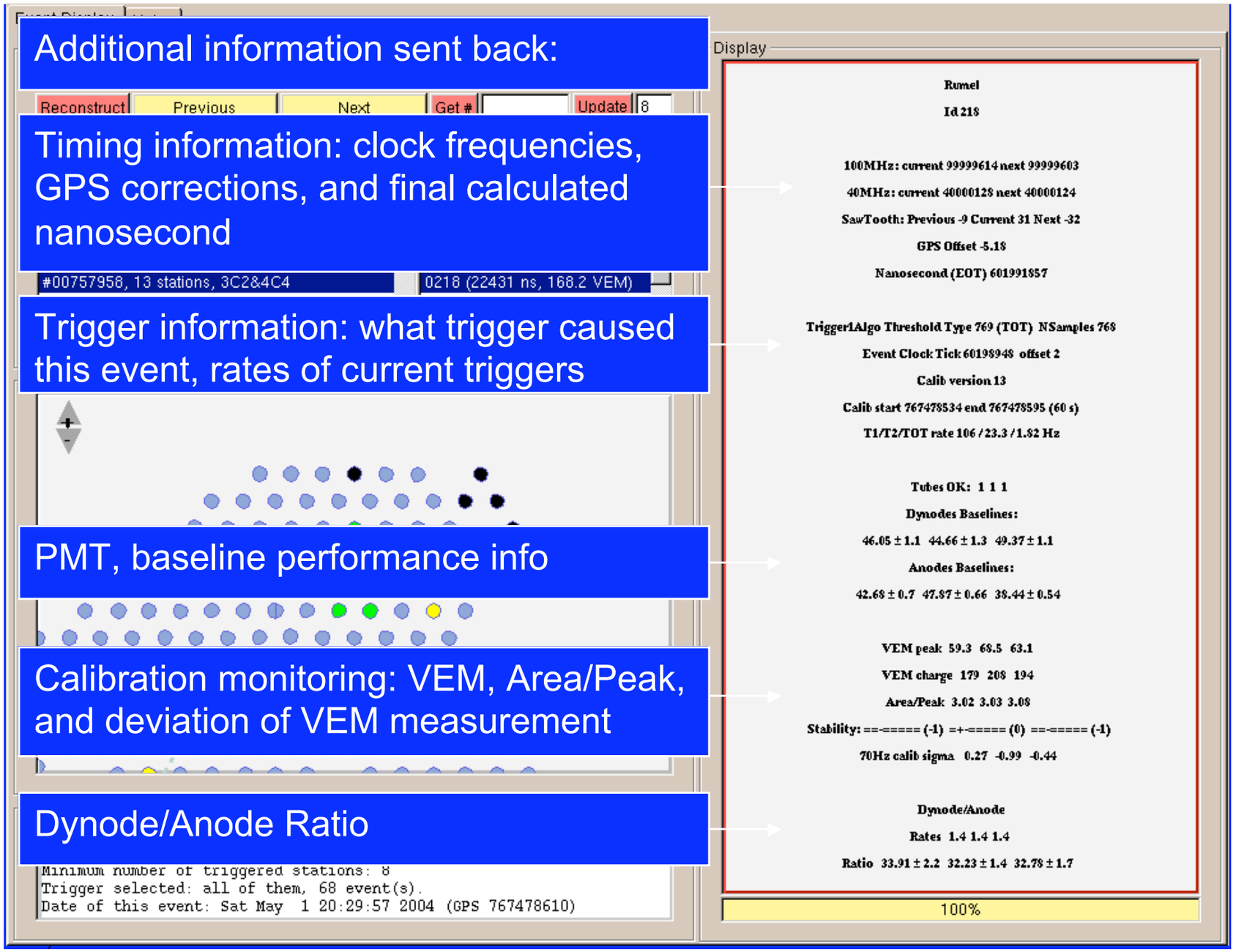
• Create histograms of all low-energy particles every minute, and send back with each event. Histograms are high quality, high statistics (~100,000 events)

• Atmospheric muons provide a perfect calibration tool – abundance of vertical muons produce a peak in the histogram which allows determination of the absolute energy scale for each PMT

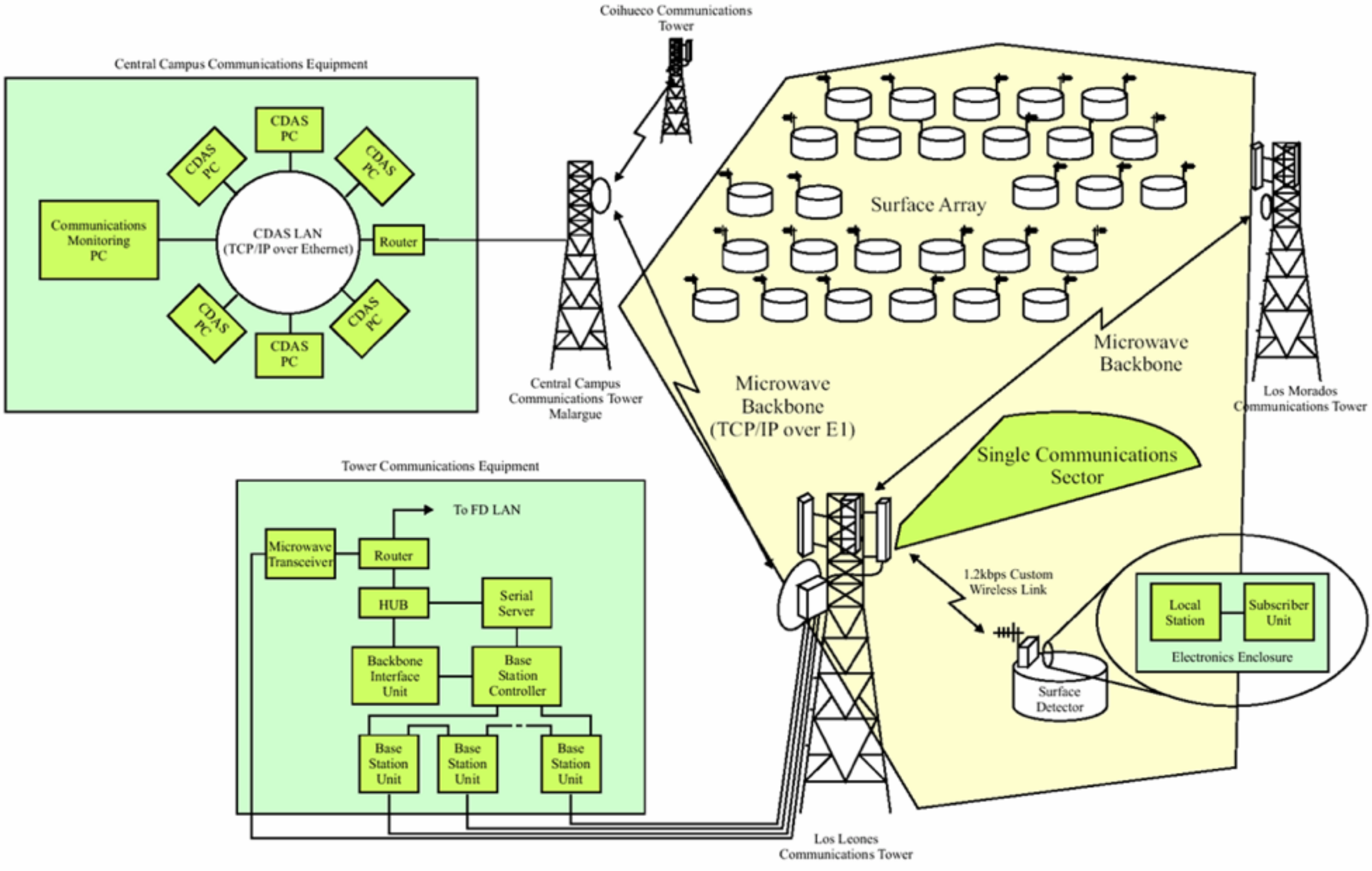
• Also histogram the detector baselines (zero scale) to monitor detector performance, as well as average pulse shape to monitor the water quality

Calibration and monitoring data sent back with each event

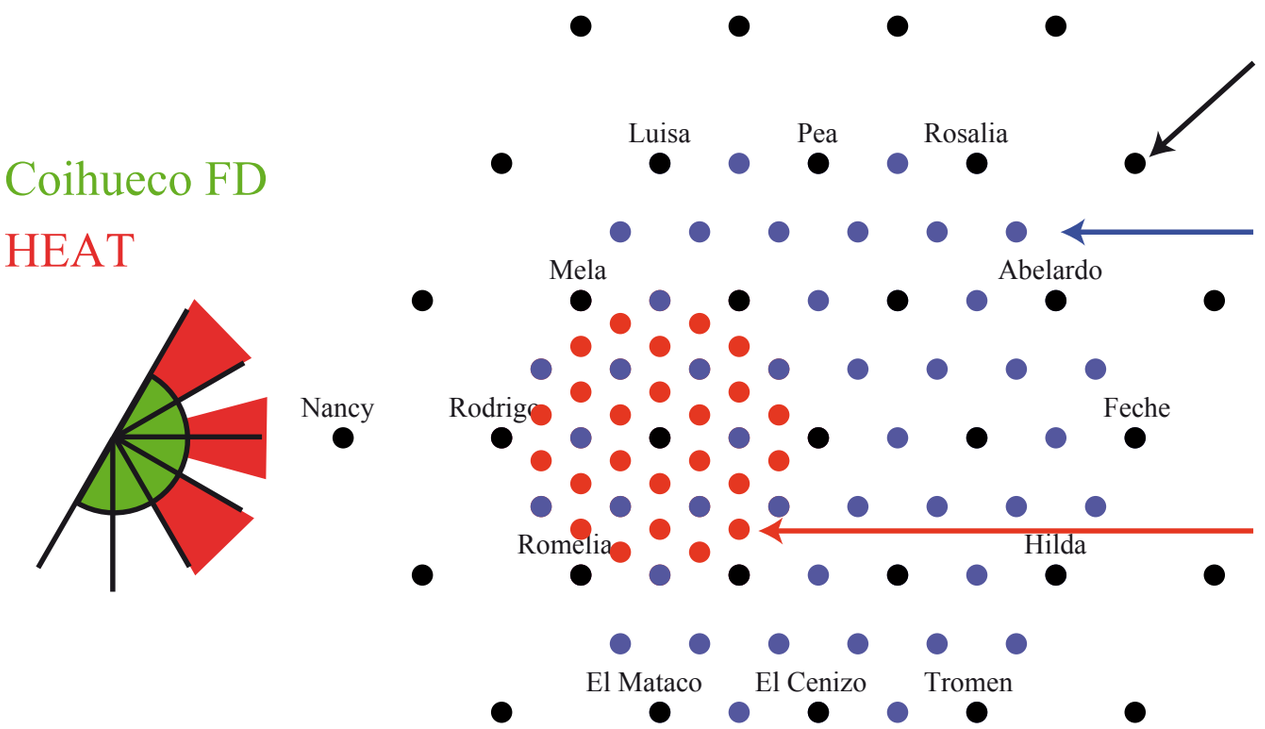
Data stored for 10s in each tank (ring buffer)



Communication setup of Auger Observatory



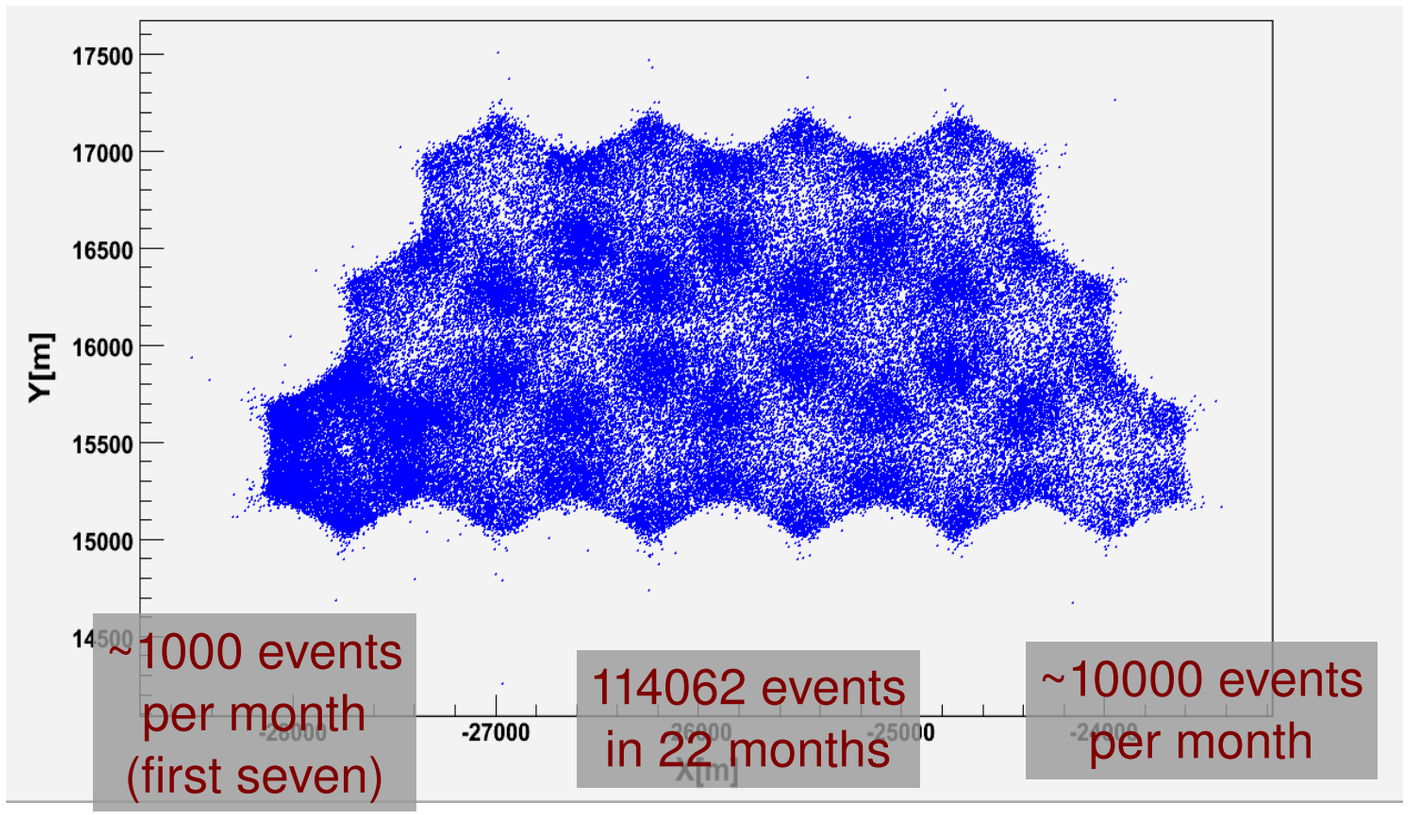
Layout of infill array (water Cherenkov detectors)



Existing tank array 1500m

Infill array 750m^2
42 additional detectors
Area ~ 23.5 km

Infill array 433m
24 additional detectors
Area ~ 5.9 km^2



Status: upper half of 750m infill deployed and in data taking

core position distribution
without threshold cut

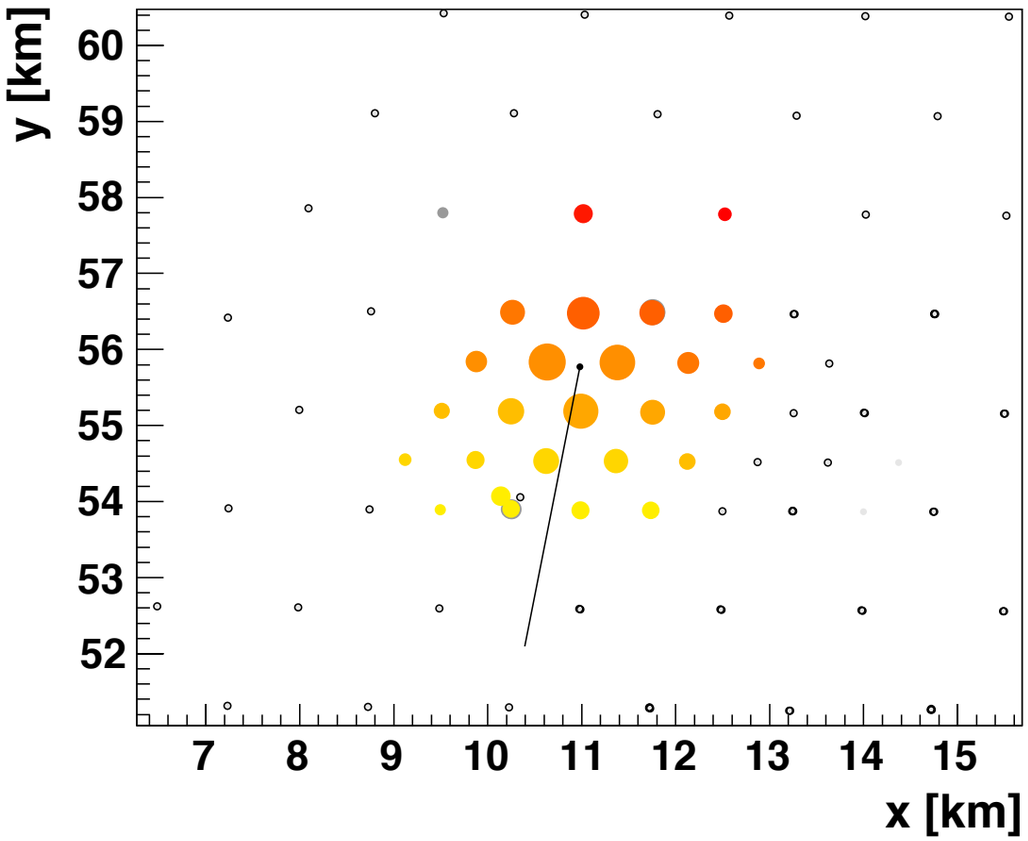
Reconstruction procedure

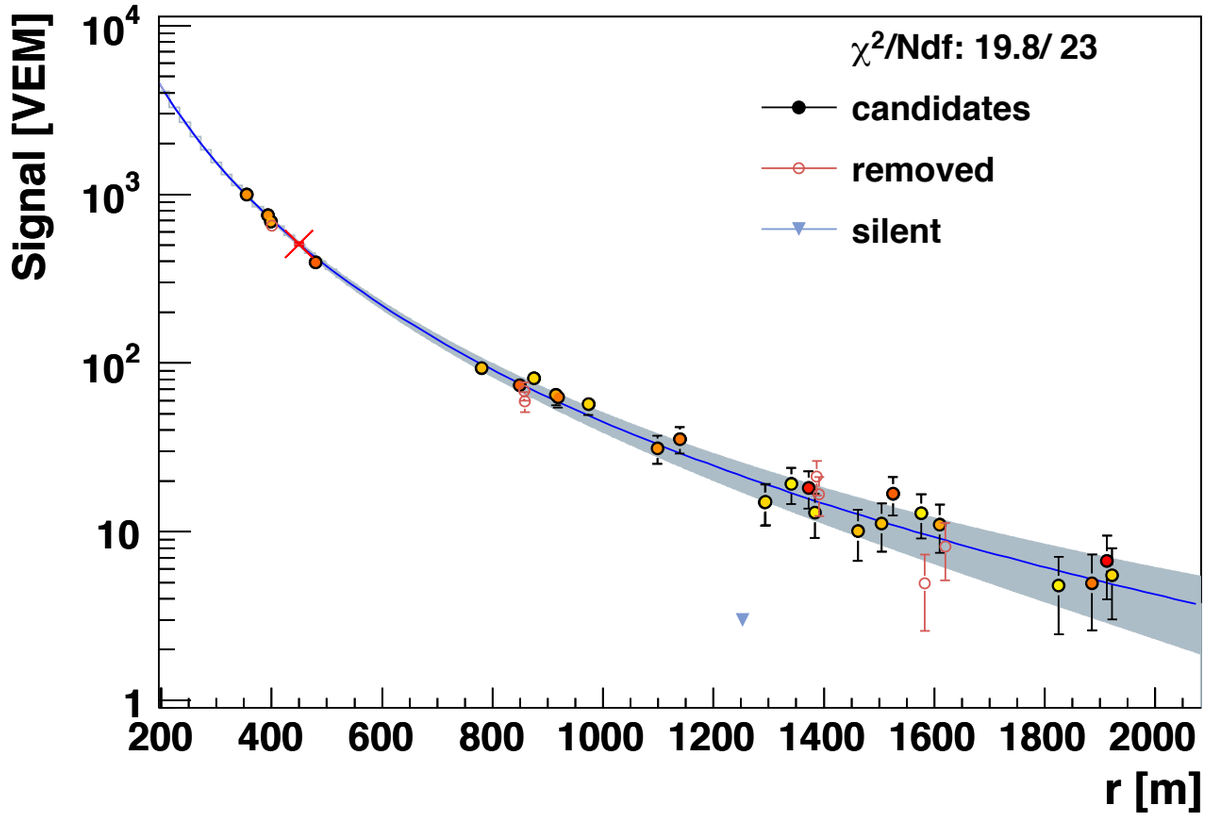
- Event trigger & data taking
- Quality cuts and event reconstruction
    - Station selection
    - Trace cleaning
    - Baseline subtraction
    - Geometry/lateral distribution fit
    - Determination of arrival direction, S(450), curvature
- Constant Intensity cut
- Energy calibration with FD
- Calculation of on-time (T2 files)
- Determination of trigger threshold and spectrum

Time period used: 01.10.2008 - 15.04.2009

Cut	N_{events}	Ratio
T3		
Vert: $\Theta \leq 60^{\circ}$		
T4		
T5: 750m crown		
No saturation (R_{opt} only)		

Example for high energy event





Event 6622155 :-)

Time 908430395 s 556237000 ns

3TOT & 4C1; 6T5

Candidates: 26 (Acc: 2, Bad: 28)

E =) × 10^{19} eV

(θ, ϕ) = (47.8 ± 0.1, 260.9 ± 0.1) deg

S(1000 m) = 507.4 ± 8.2 (± 6.7) VEM

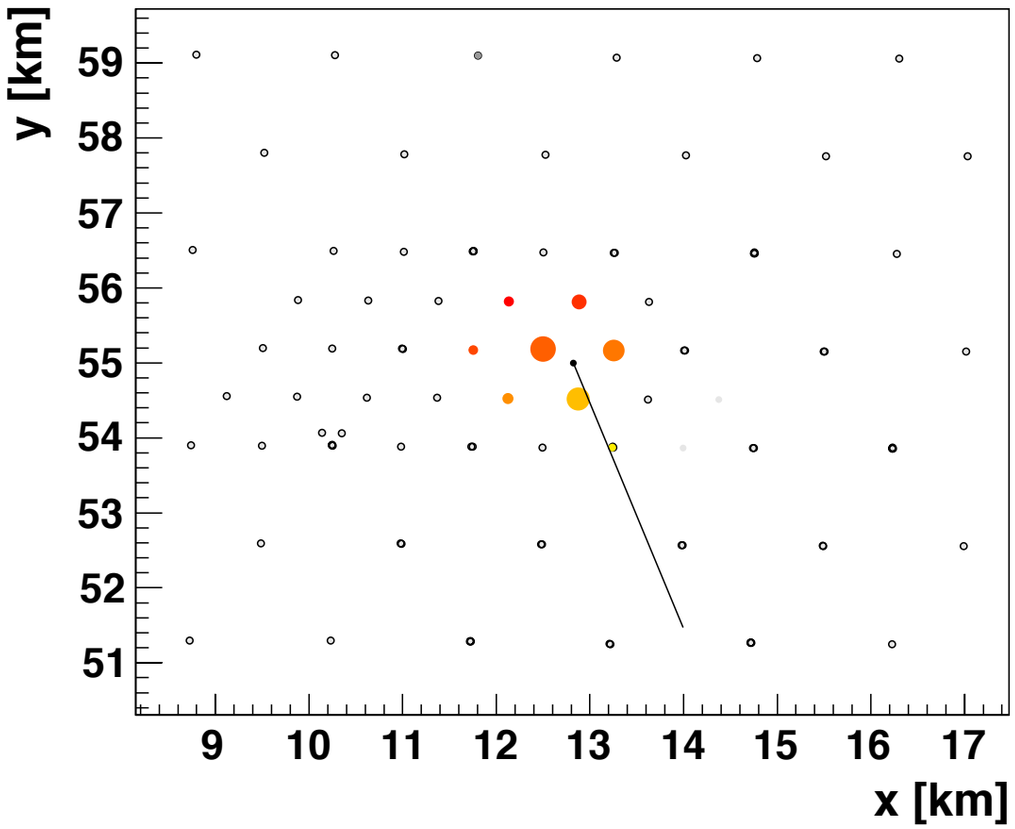
(x,y) = (10.98 ± 0.00, 55.77 ± 0.01) km

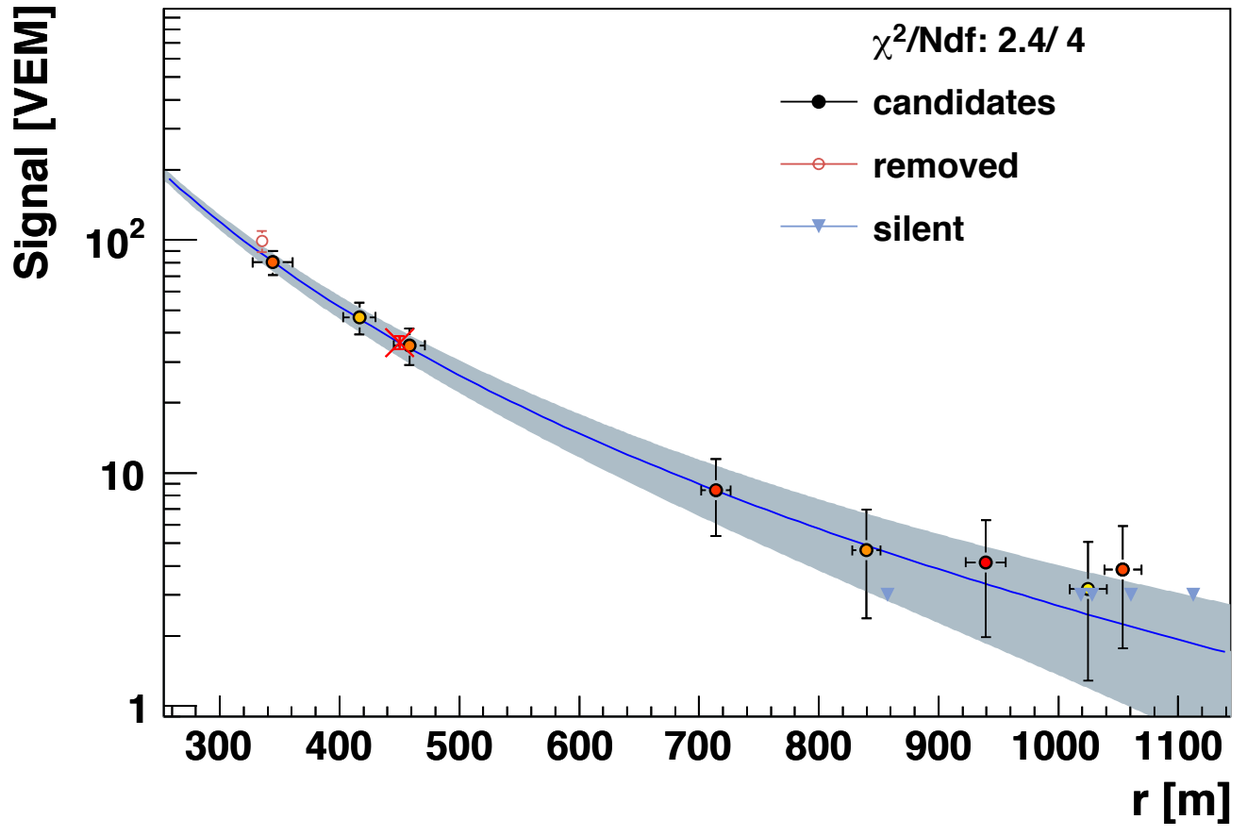
β (fixed) = -2.04 (± 0.14)

R = 12.73 ± 0.57 km

r_{opt} = 480.53 m

Example for low energy event





Event 6553851 :-)

Time 907151517 s 587515000 ns

3TOT & 4C1; 6T5

Candidates: 8 (Acc: 1, Bad: 27)

E = ( ) × 10^{17} eV

(θ, ϕ) = (31.9 ± 0.4, 288.4 ± 0.8) deg

S(1000 m) = 36.3 ± 2.4 (± 0.1) VEM

(x,y) = (12.82 ± 0.01, 55.00 ± 0.02) km

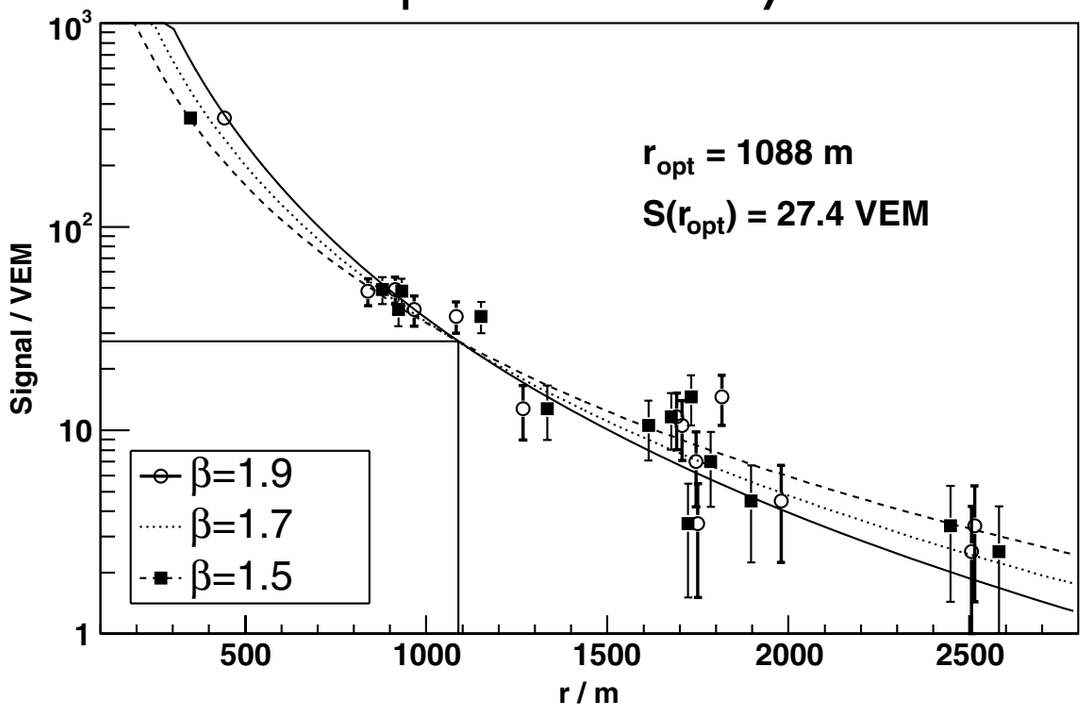
β = -2.19 ± 0.17 (± 0.23)

R = 7.30 ± 1.30 km

r_{opt} = 447.69 m

Determination of optimum distance

Example for full array



Details: Newton et al.
Astropart. Phys. 26 (2007)

$R_{opt} = 436.4 \pm 31.93$ m
$\Rightarrow$ Proposed energy estimator: S450

$$S(r) = S_{450}\left(\frac{r}{450m}\right)^{\beta}\left(\frac{r+700m}{450m+700m}\right)^{\beta+\gamma}$$

Events in infill area

This plot and all following slides have been deleted