Snake Array

Pierre Sokolsky
University of Utah
UHECR2018, Paris

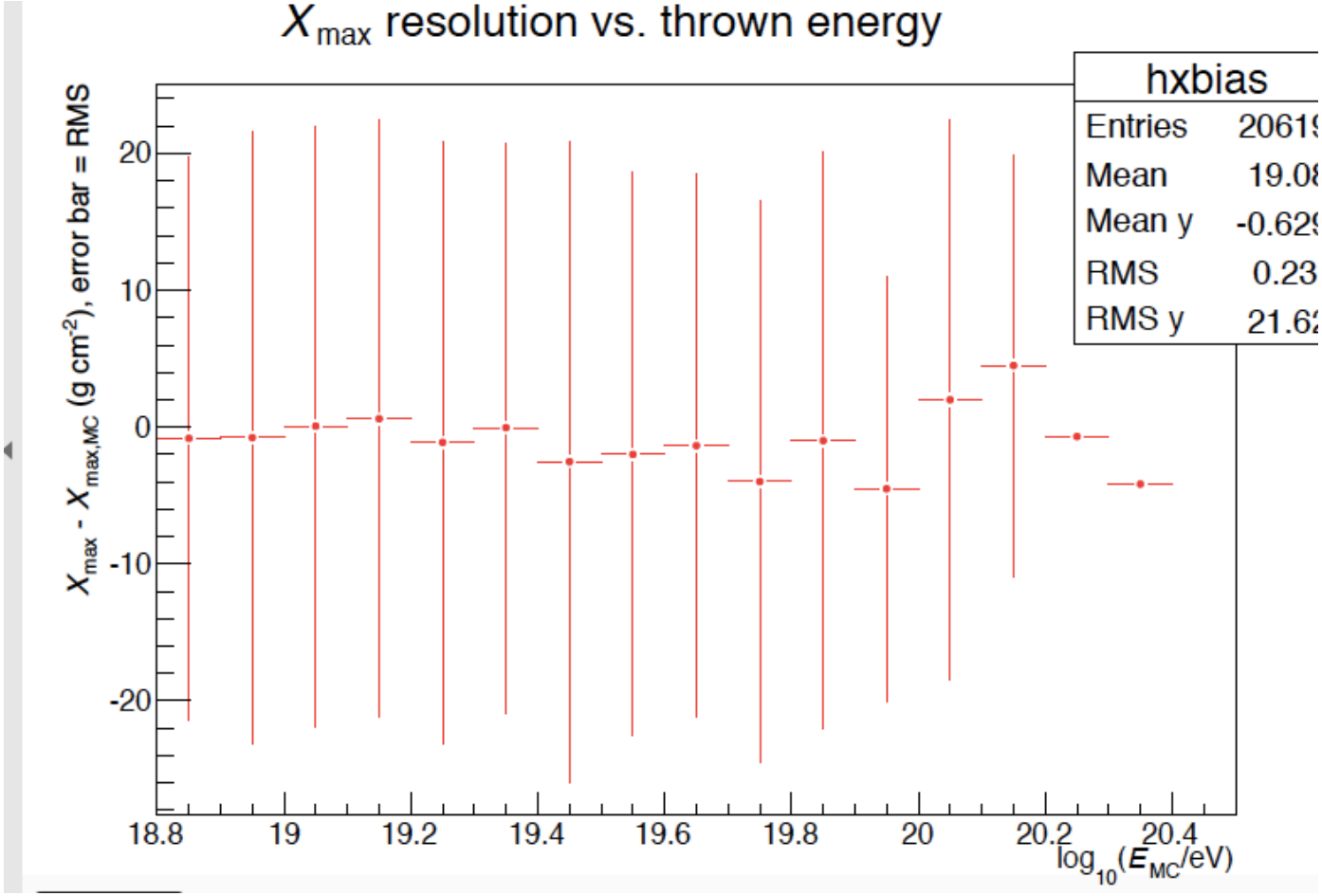
What are the important experimental measurements that could make a clear difference?

- Field took off partly because we had a clear goal that had the chance of producing “new physics” – GZK and post GZK flux.
- Moving to the extreme is the best hope for simplification.
- Can we make a “precise” measurement of composition above 3x10^19 eV?
- Flux “must” simplify -> major impact on acceleration models. “Does Fe return?”
- Can we do it with “guaranteed” resolution and minimal technical development?

“Best” composition stand-in

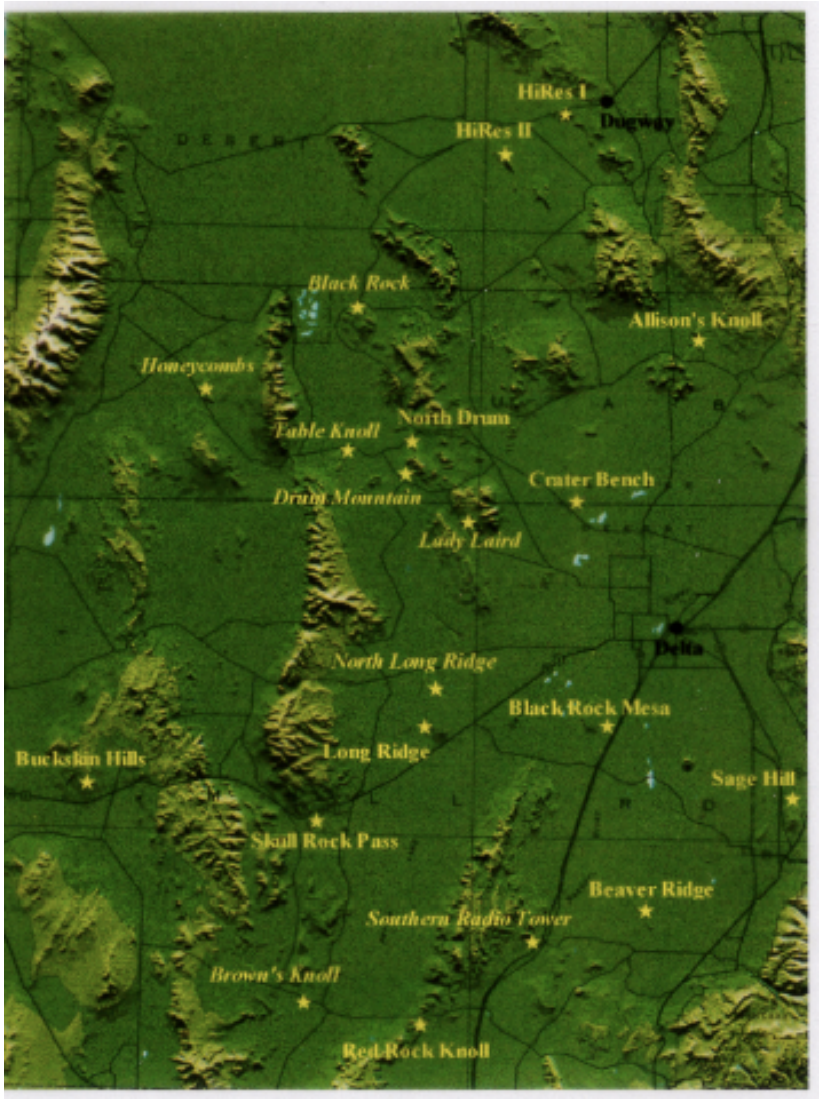
- Hadronic model uncertainties will not likely be reduced at energies >3x10^19 anytime soon.
- Best bet is to measure shape of Xmax distribution (sigma(Xmax) if you like).

Stereo Xmax resolution

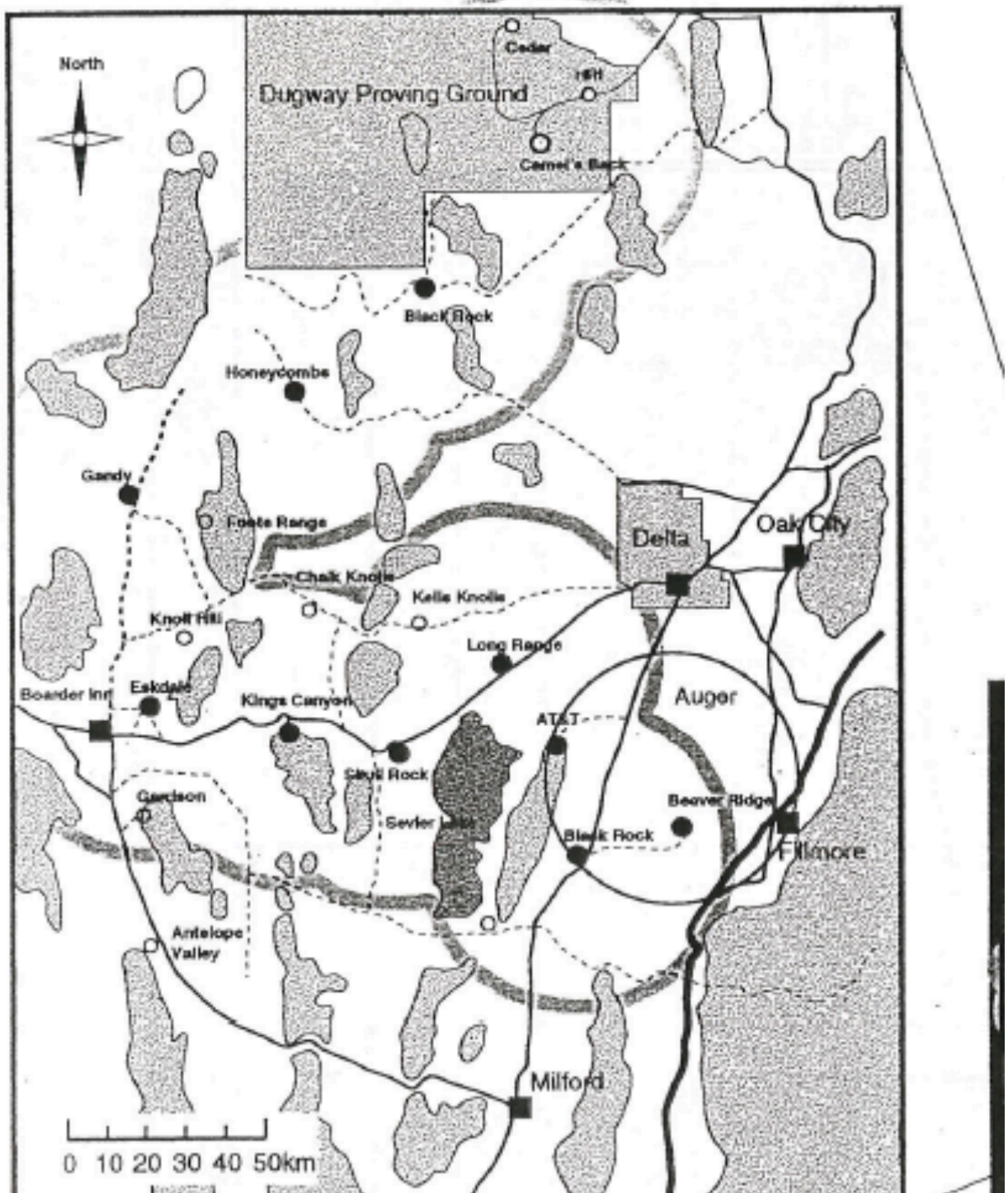


Before TA there was the Snake Array

- Discussions between Gene Loh, M. Teshima and myself.
- Maximize FD Stereo, no SD.
- Optimization -> minimize redundacy – only 2 detector stereo -> linear array of detectors.
- Site survey was done and > 10 sites found
- ~ 30-40 km apart.

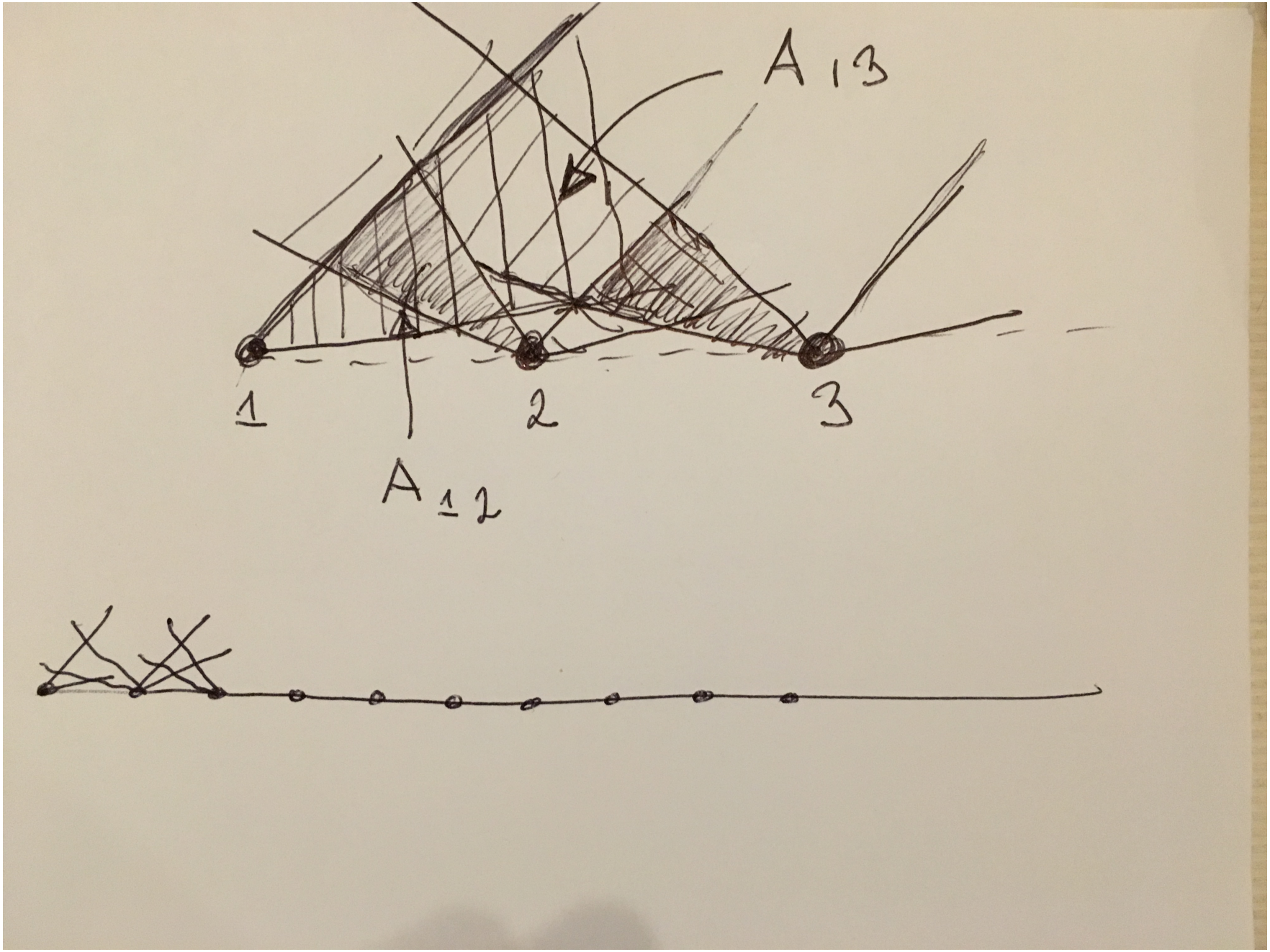

HiRes I
Dugway
HiRes II
Black Rock
Allison's Knoll
Honeycombs
North Drum
Table Knoll
Crater Bench
Drum Mountain
Lady Laird
Delta
North Long Ridge
Black Rock Mesa
Long Ridge
Buckskin Hills
Sage Hill
Skull Rock Pass
Beaver Ridge
Southern Radio Tower
Brown's Knoll
Red Rock Knoll

Telescope Array Station arrangement, Utah USA

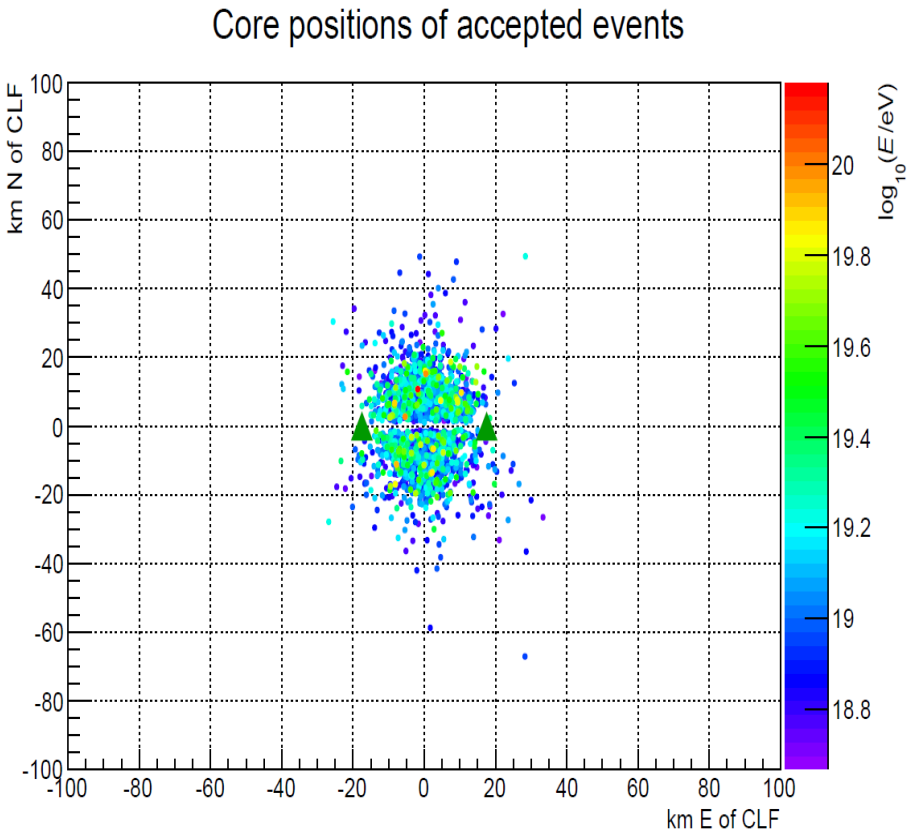


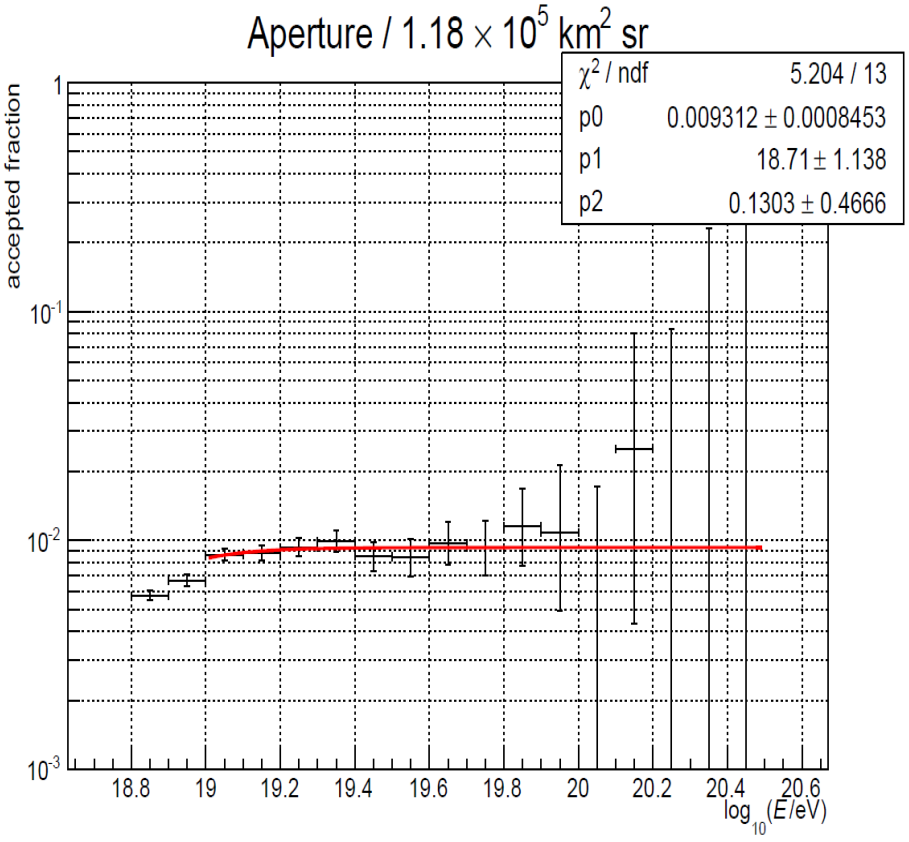
Refine “Snake” based on TA stereo

- Use current stereo reconstruction and data cuts.
- Guaranteed Xmax and Energy resolution.
- Aperture verified – cross calibrated with hybrid results.
- Linear array minimizes “non-productive” aperture.

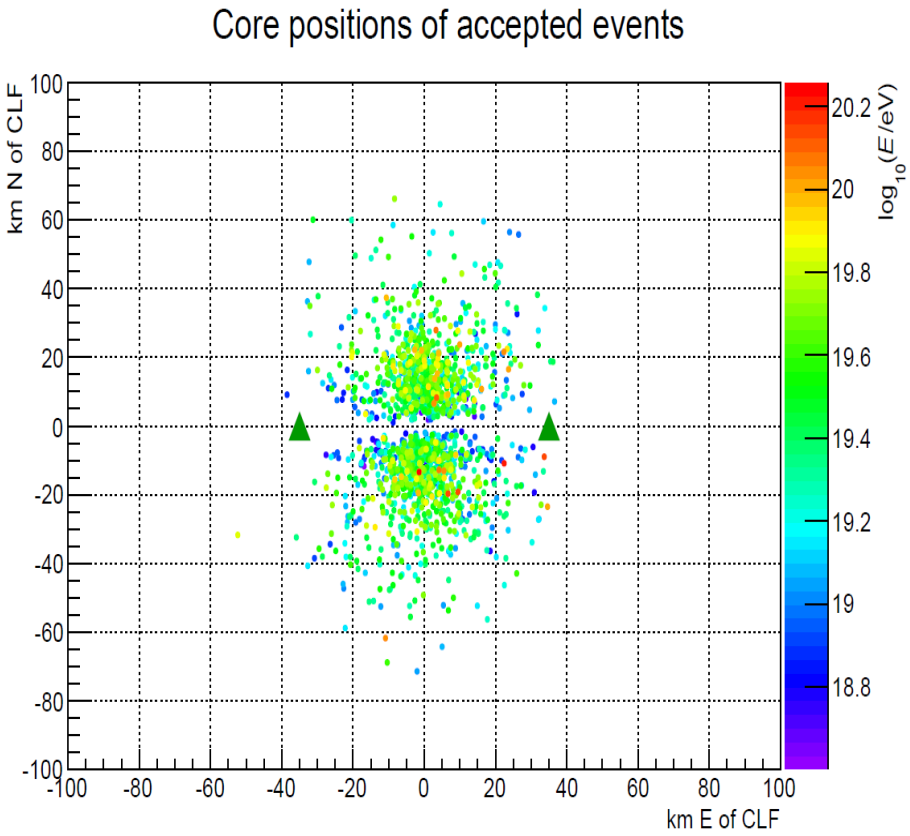

A 13
1
2
3
A 12

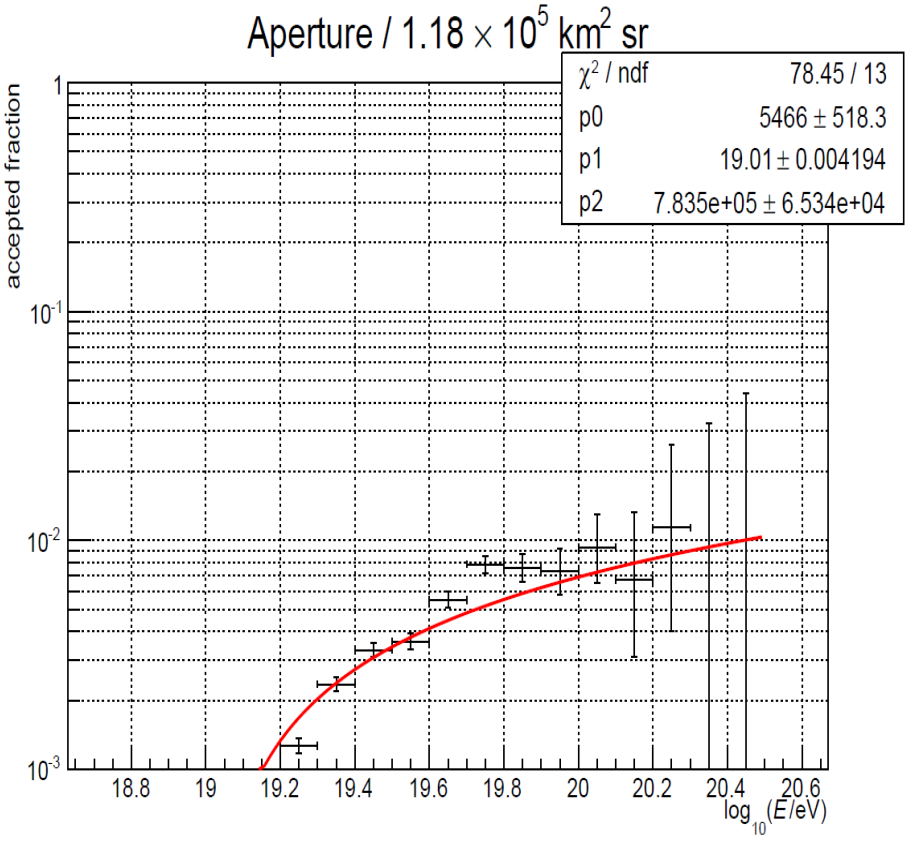
35km spacing, head-on



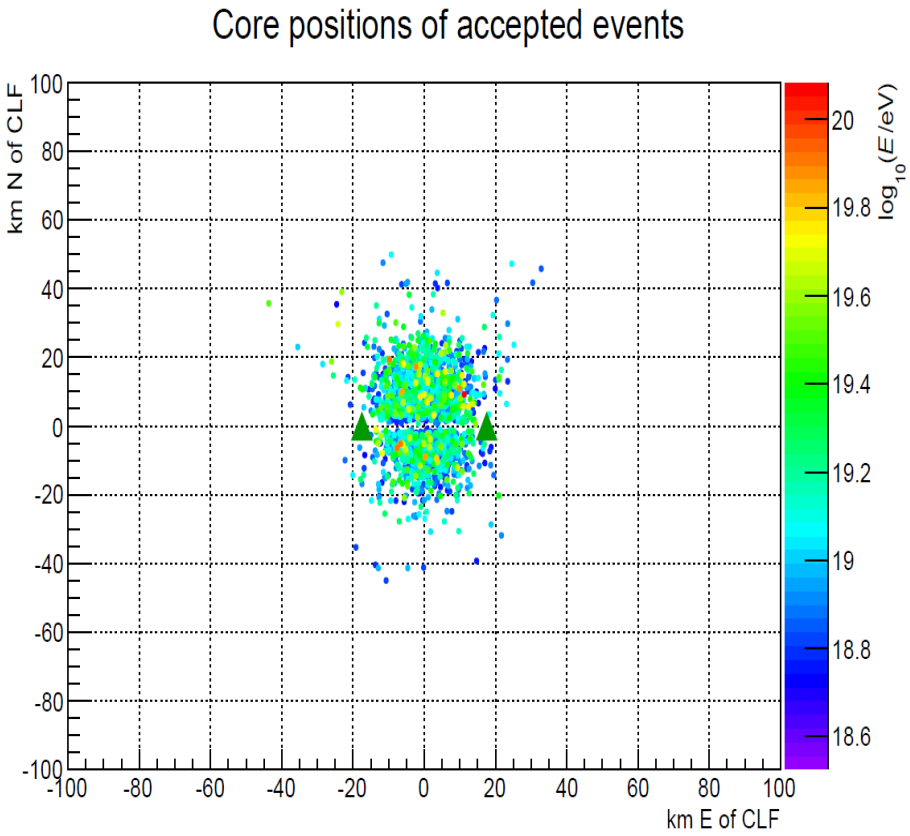


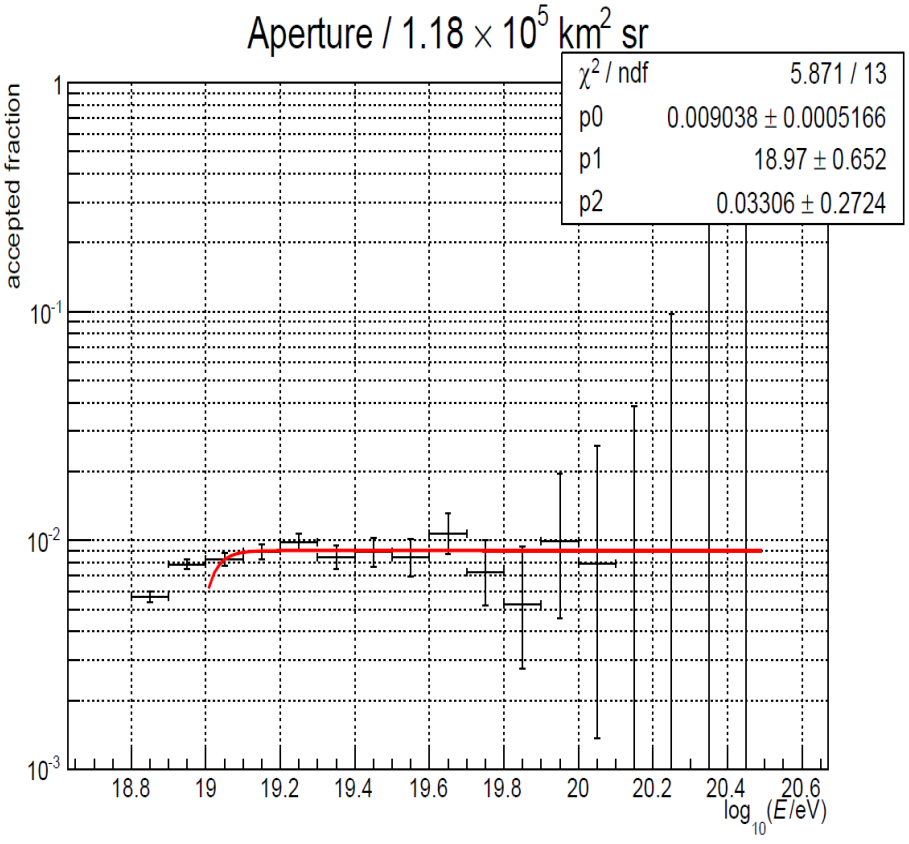
70km spacing, head-on



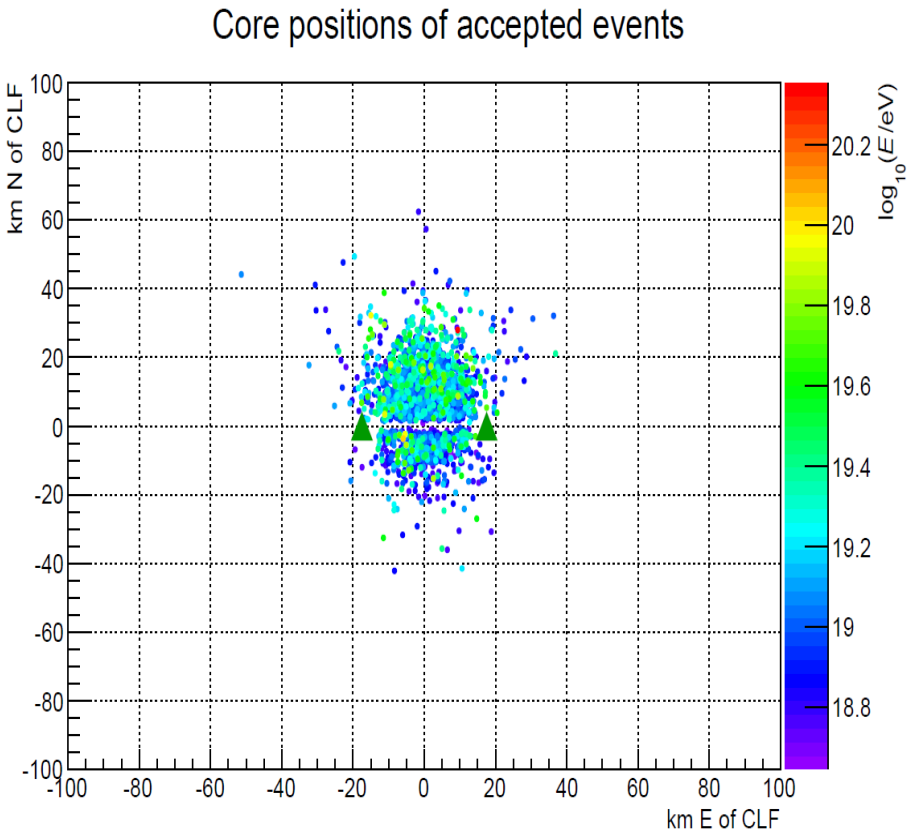


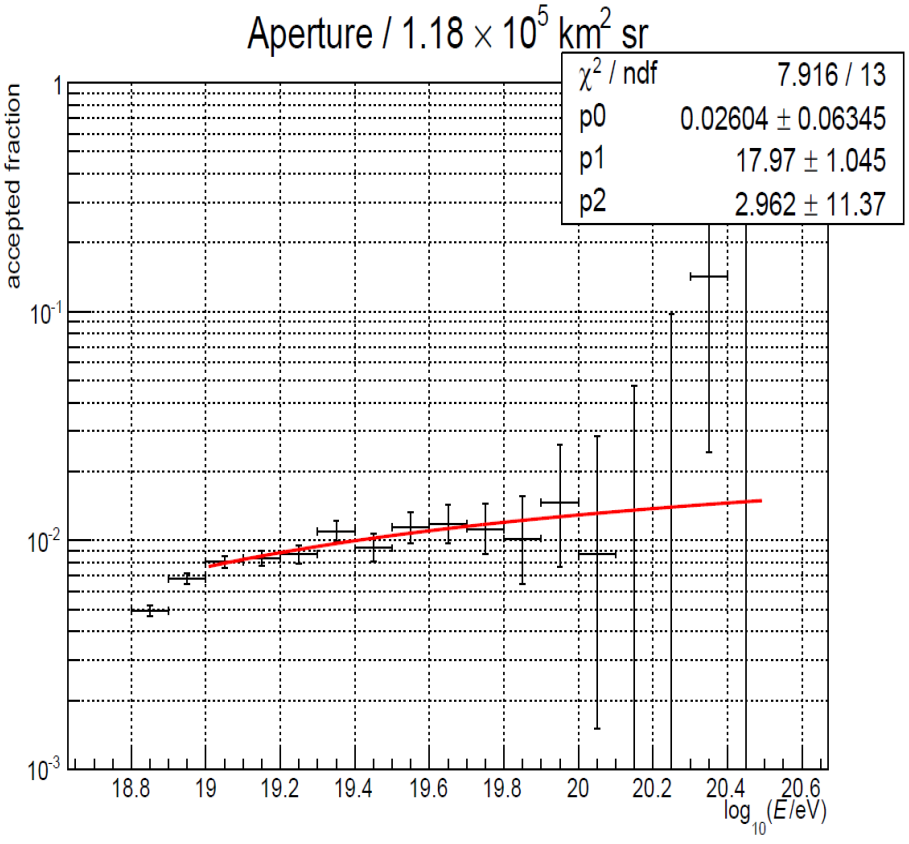
35km, 20° combined rotation





35km, 40° combined rotation





Estimated reconstructed and quality cut aperture

- Pair of stations 35 km, 40 degree angle -1.5x10^3 km2str @ 5x10^{19} eV
- Additional aperture for 70 km, 40 degree angle pair ~ . 7x10^3 km2str
- Total 12 + (13) aperture 2.2x10^3 km2str
- Total for 10 sites ~ 2.2x10^4 km2str
- Assuming 15% on time – effective aperture is 3.3x10^3 km2str.
- Extrapolating from TA stereo data, expect ~1000 well-reconstructed events > 3x10^{19} eV in 10 yr run

Cost estimate: Assume HiRes/UtahTA costs.

- Mirror and frame: HiRes and FAST experience 15 – 30 kS/mir
- PMT + HV: 60k$/mir
- Electronics/15k$/mir
- Housing 10k$/mir
- Site cost :(pair of 14 mirror stations)
- Mirror + frame 840k$
- PMT + HV 1680k$
- Electronics 420k$
- Housing 280k$
- Tot: 3220 k$
- Add misc calibration, labor, site survey etc 1000k$
- Total site cost ~~ 4.0 -4.5 M$

Total Snake Cost

- Could build Snake for ~ 45-50M$
- Would provide “well-reconstructed, good resolution Xmax data” = Auger SD aperture.
- Based on TA stereo data, expect ~ 1000 well reconstructed events above 3 x 10^19 eV in ~ 10 years.

Additional

Correlation between SD composition estimator (Xi) and Xmax for hybrid TA data

Xi vs Xmax