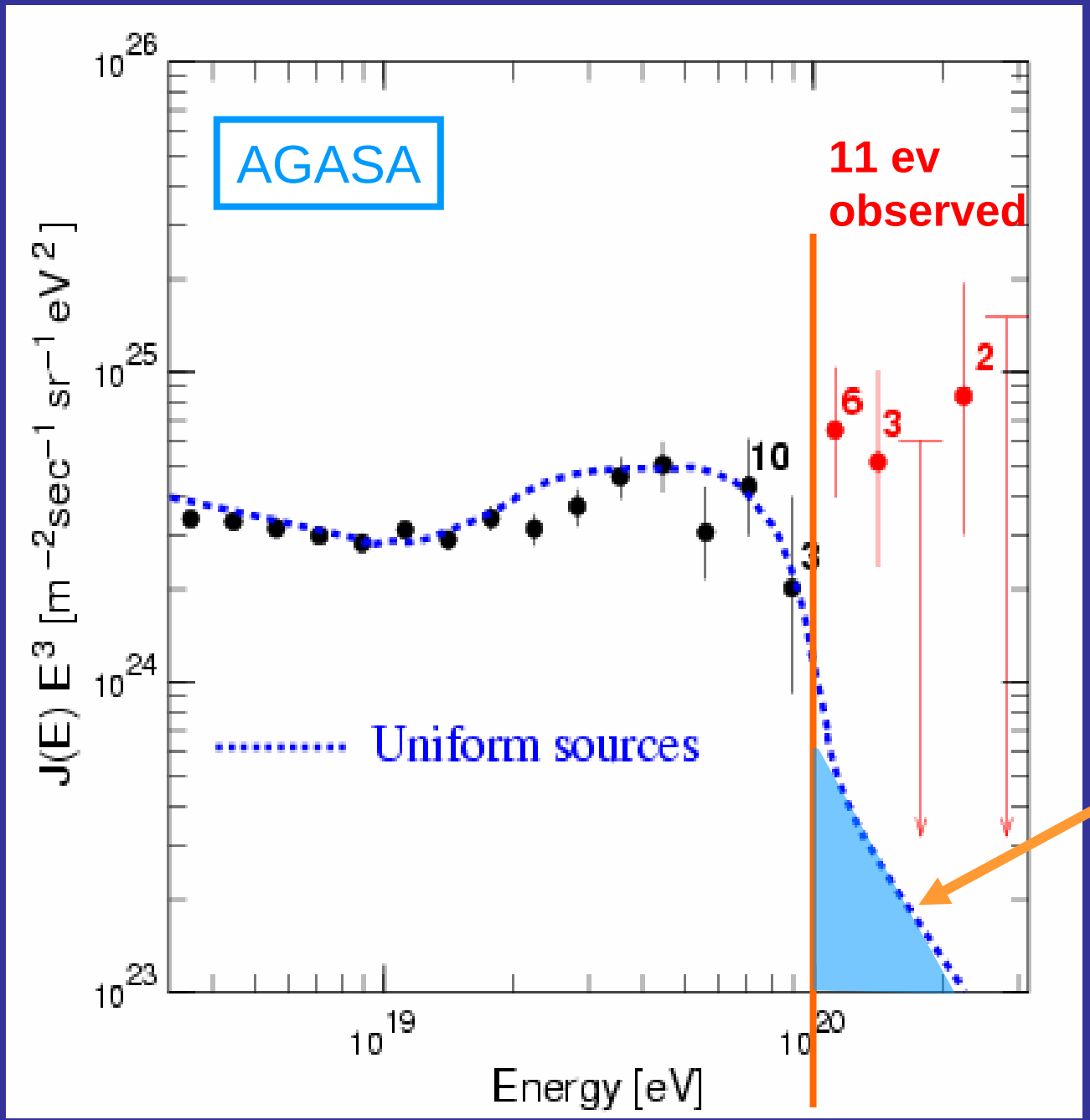
Status of the Telescope Array

H. Sagawa (ICRR)
on Behalf of TA Collaboration
@ KASI Daejeon, Korea
19 May, 2006

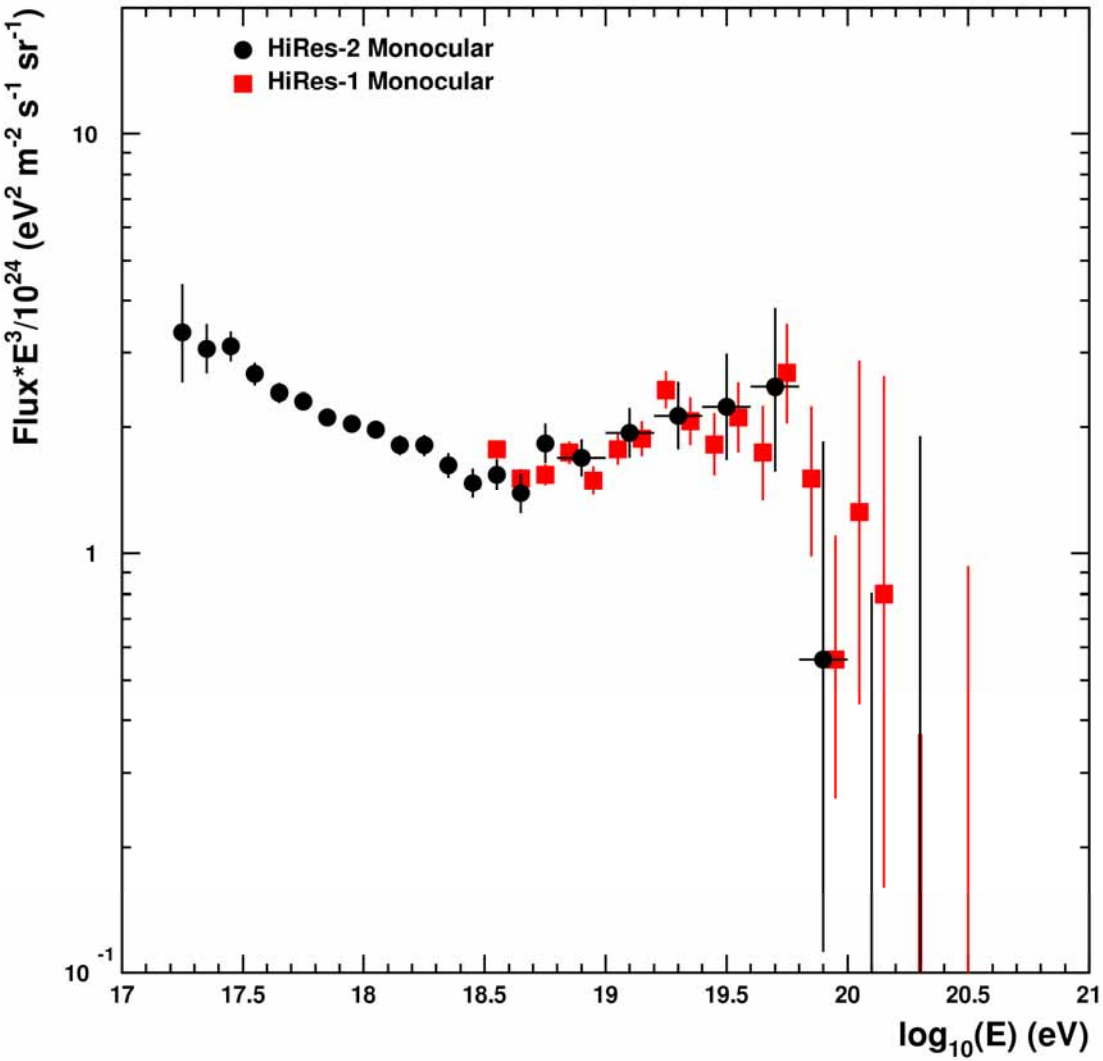


~2 ev
expected

4.0 **σ**

by S.Yoshida
@ 29th ICRC Pune
Rapporteur talk

HiRes (mono)

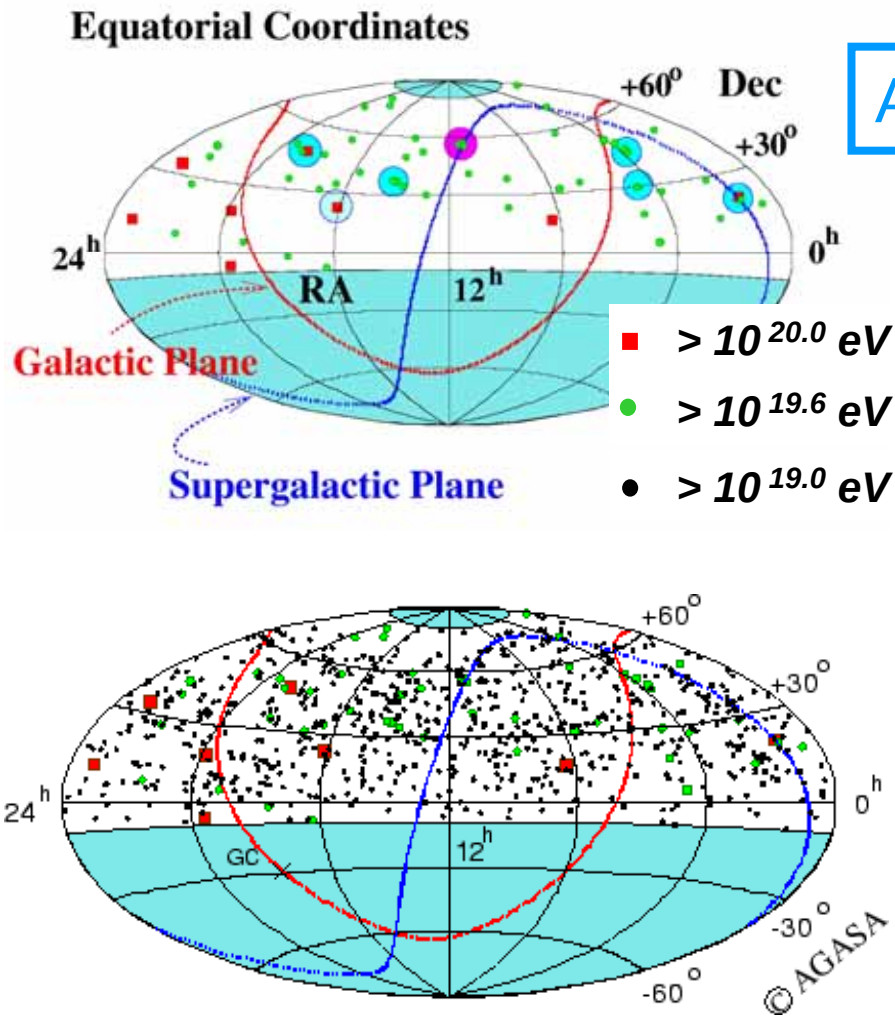


"GZK" Statistics

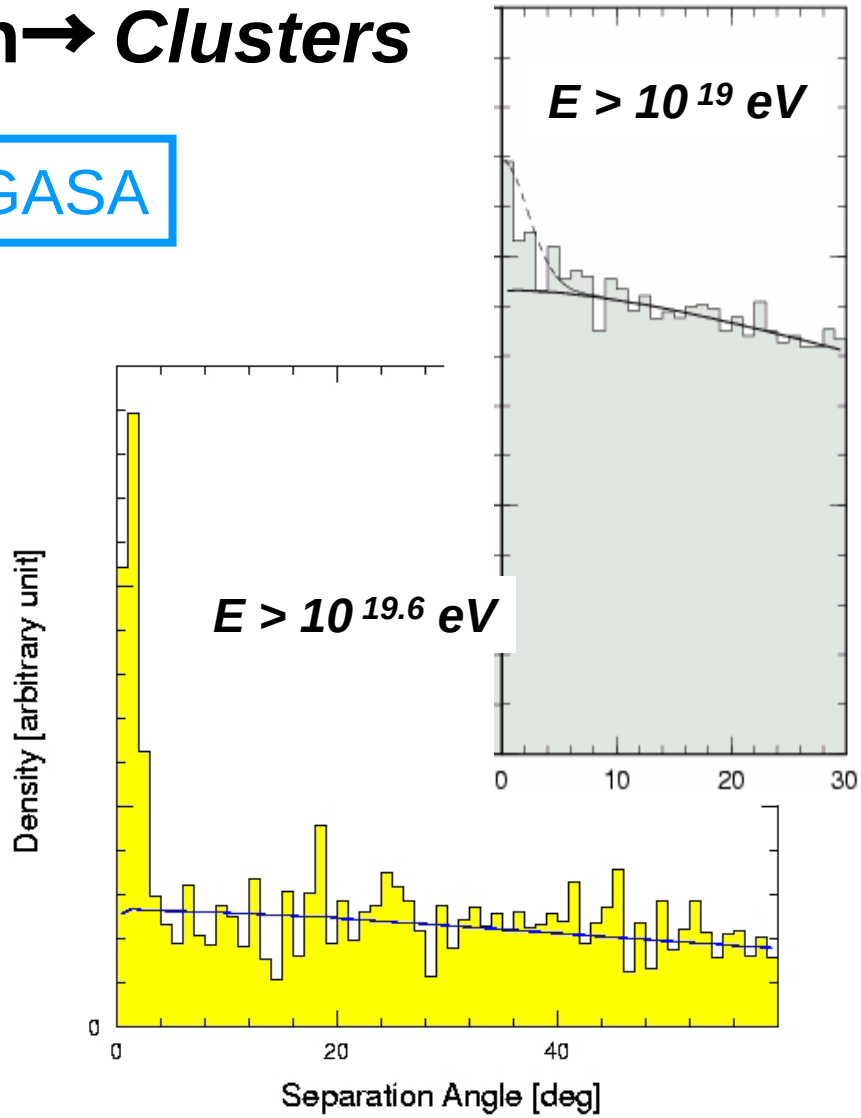
- Expect 42.8 events
- Observe 15 events
- ~ 5 σ

Bergman (this conference)

Arrival direction distribution→ *Clusters*



AGASA



Sensitivity and angular resolution

Experiment	Aperture (km^2 sr)	Rel.	Angular Resolution
AGASA	162	(=1)	1.6^0
TA: 24 x 24 ground array	1371	(9)	~1.0^0
TA: Fluorescence	670	(4)	0.6^0
TA: Hybrid	165	(1)	0.4^0

AGASA x 12 in total aperture,
A factor of (2 – 4) better angular resolution and
Coincidence measurement (=AGASA).

Remarks

- Scintillator surface detectors (SD) and atmospheric fluorescence telescopes (FD)
  - Experiment with the size of ~10 times of AGASA ; ~10 super GZK events/year
  - Observation by independent detectors (SD&FD)
  - Aim at systematic error of energy measurement of <10%
    - (ex. AGASA +-18%)
  - Scintillator detectors
    - Measure Electromagnetic component (90%)
      - Model dependece: small

- Originally TA was funded by JSPS (Japan Society for the Promotion of Science)
- Funding started in JFY2003
- Construction period (JFY2003~JFY2006)
- Regular observation should start in JFY2007 (2007 April ~)

The Telescope Array (TA) Collaboration

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Apparatus of TA project

Millard county in Utah (39.1ºN, 122.9ºW)

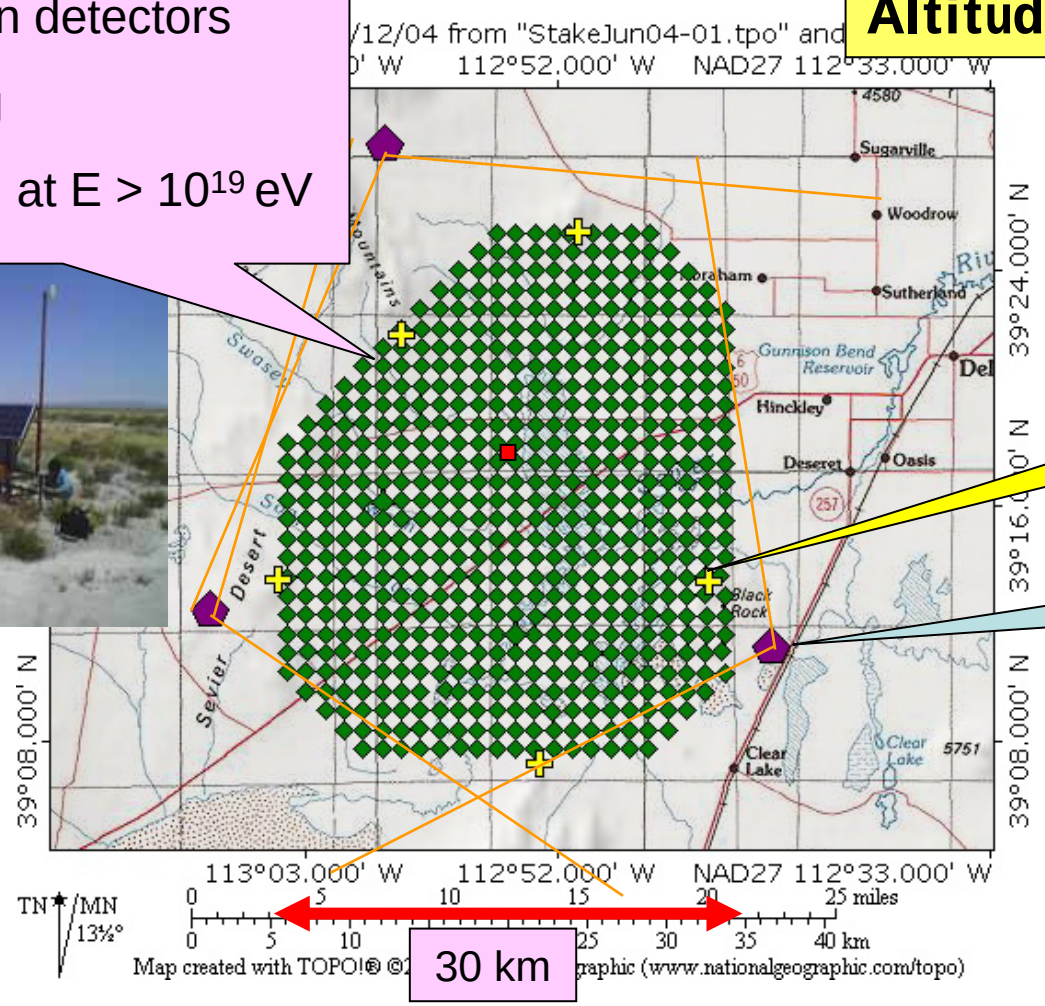
Altitude of 1400 m

Surface Detector (SD)

576 scintillation detectors

1.2 km spacing

100% trigg. eff. at E > 10^{19} eV

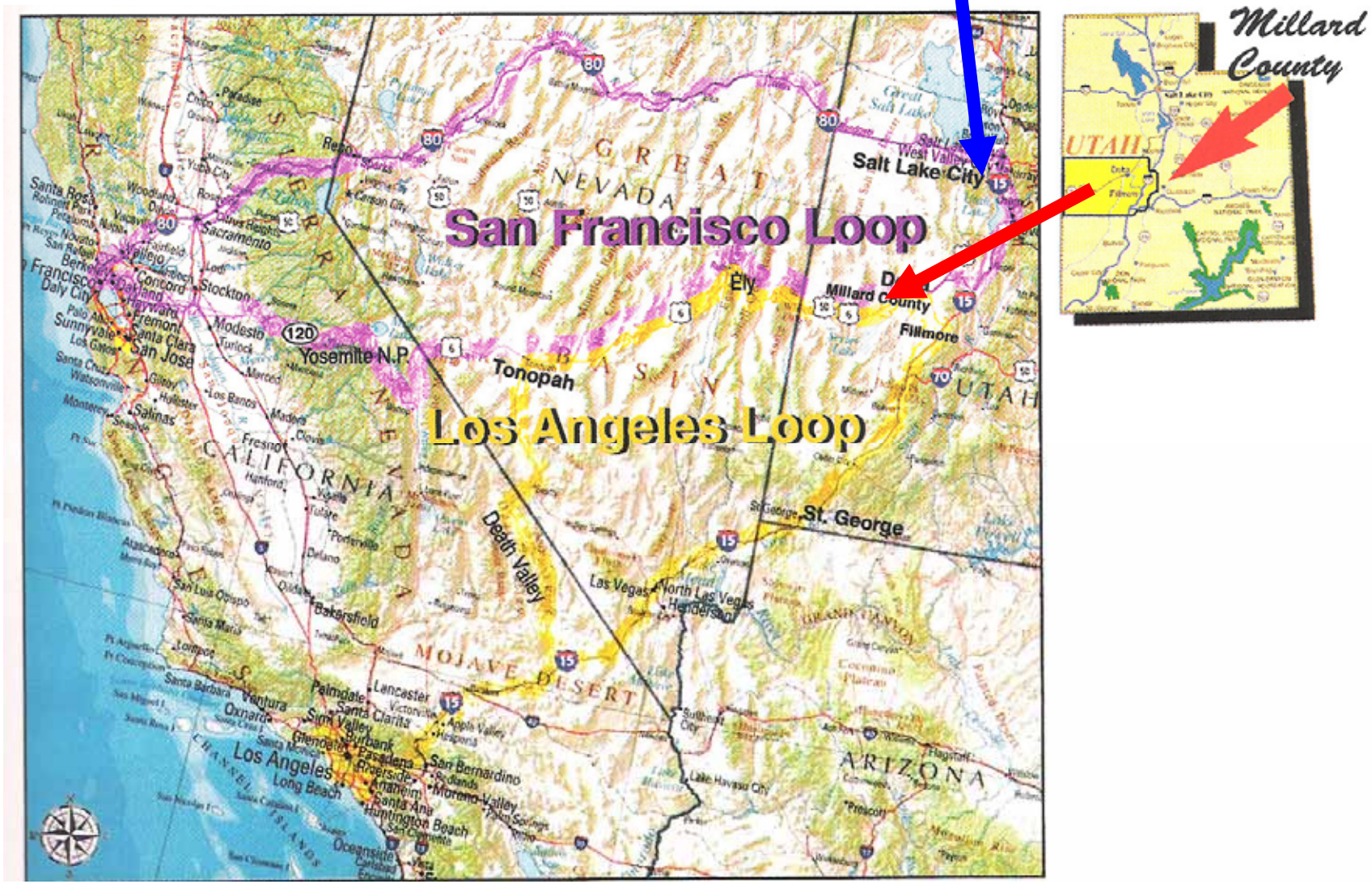


5 communication towers

3 FD stations

30 km

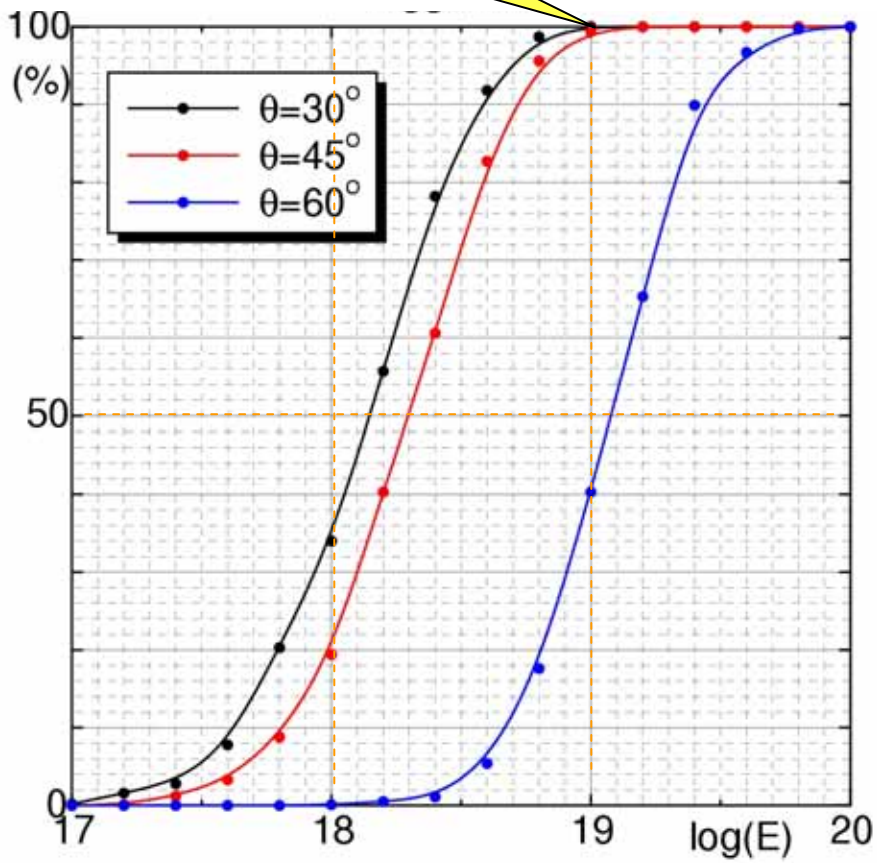
Salt Lake City



Surface Detector (SD)

Trigger Efficiency vs E_o

100% (**>10^{19}eV**) for θ **< 45°**



Detector configuration

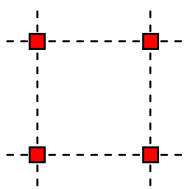
square deployment

1.2km spacing

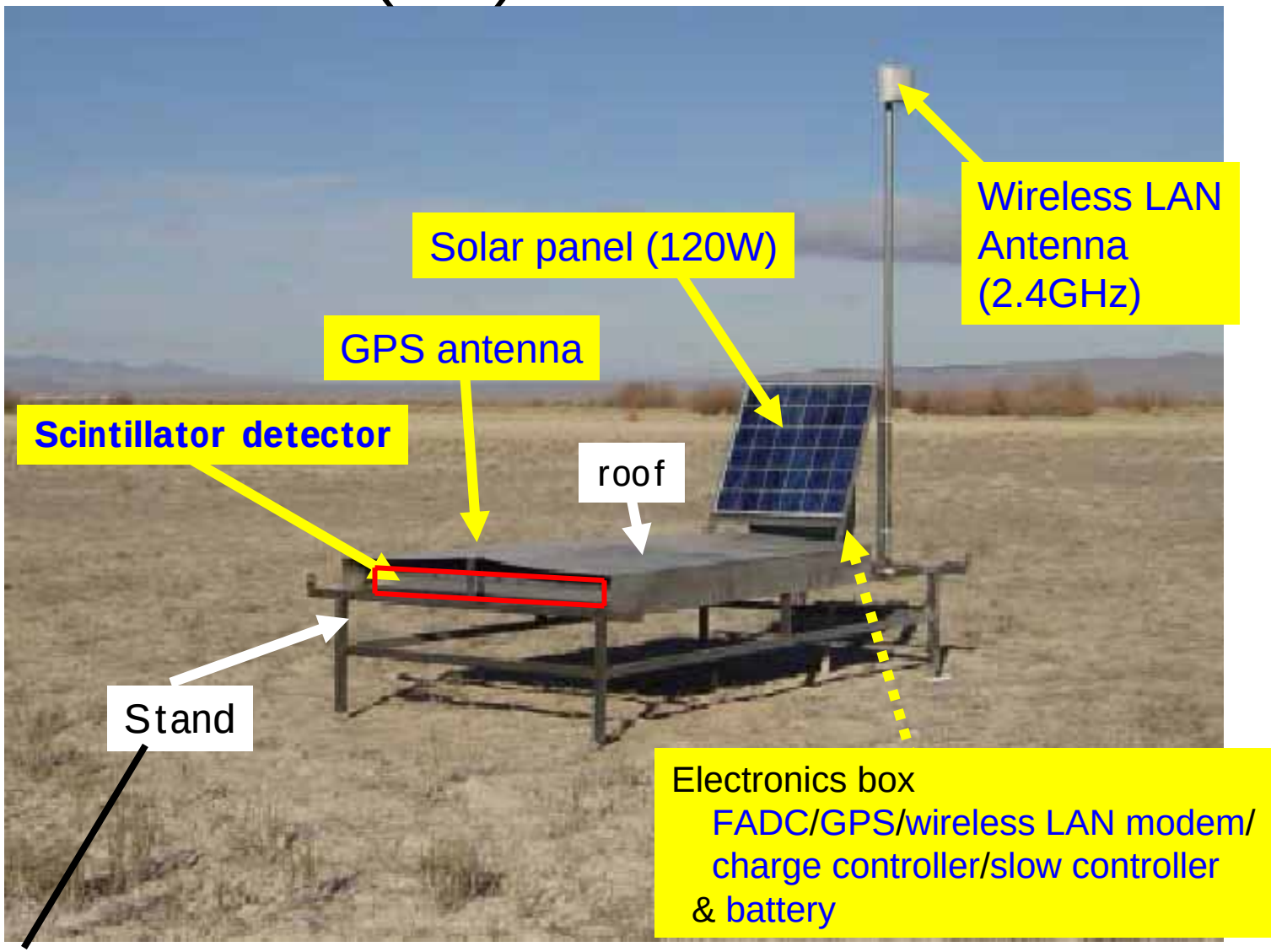
3m^2 size

Triggering condition

adjacent 4fold coincidence of SDs (>=1 particle/SD)



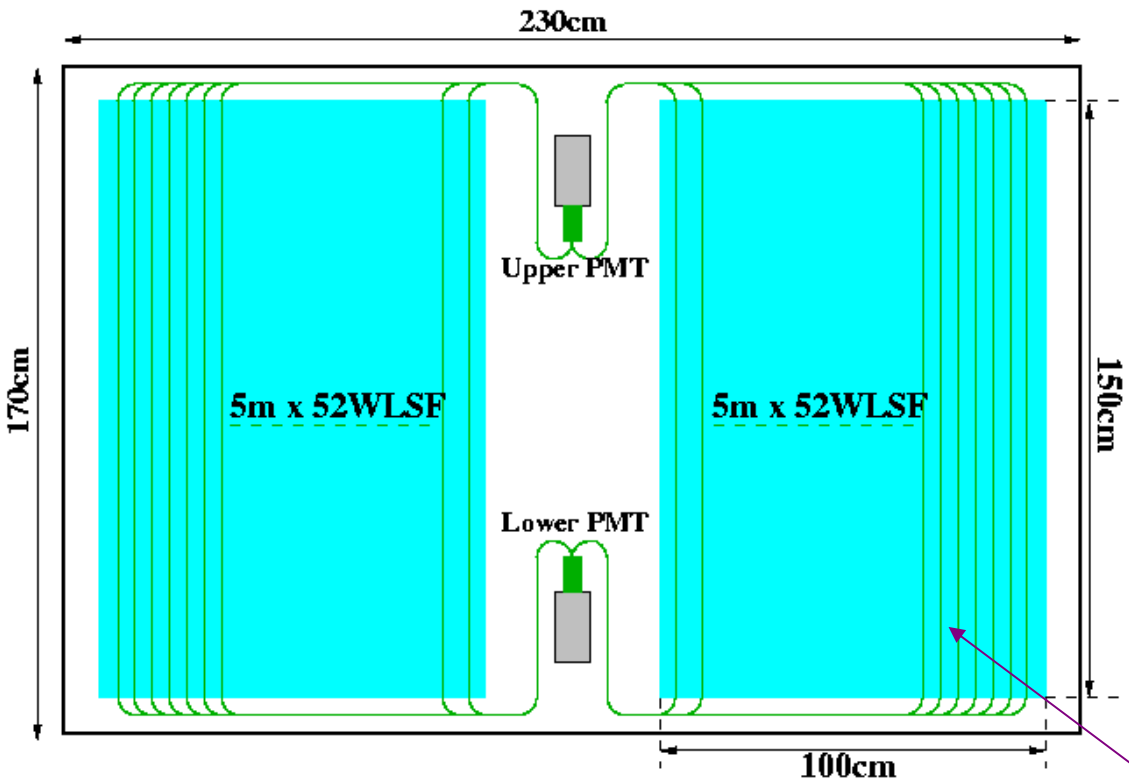
Surface Detector (SD)



Stand, suppor of panel, roof, pole of antenna are fabricated by the company in Utah.

One of 18 SDs deployed as Test array on Dec. in 2004

Scintillation Detector



Scintillator

3m^2 area 1.2cmt 2 layers

WLSF

1.0mm ϕ 2 cm interval

Output

2 PMTs

(upper PMT + lower PMT)

Scintillator box

230 x 170 x 10(cm^3)

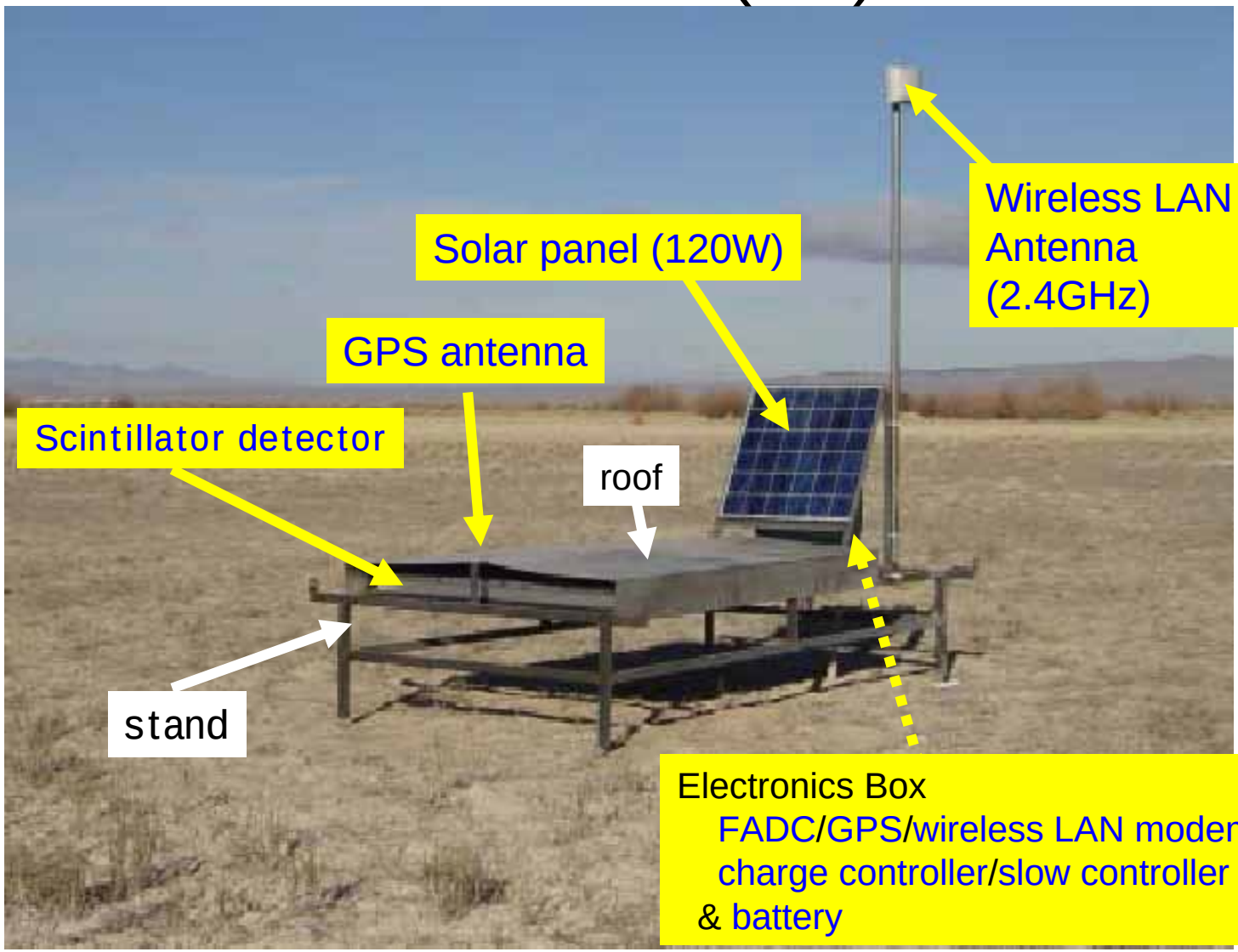
Total weight ~200 kg

Assembly of scintillation detectors

- Started in May of 2005 **@ ICRR in Japan**

- **Assembled ~350 scintillation detectors in 2005**
- **Will assemble 150 scintillation detectors in 2006**

Scintillator Surface Detector (SD)

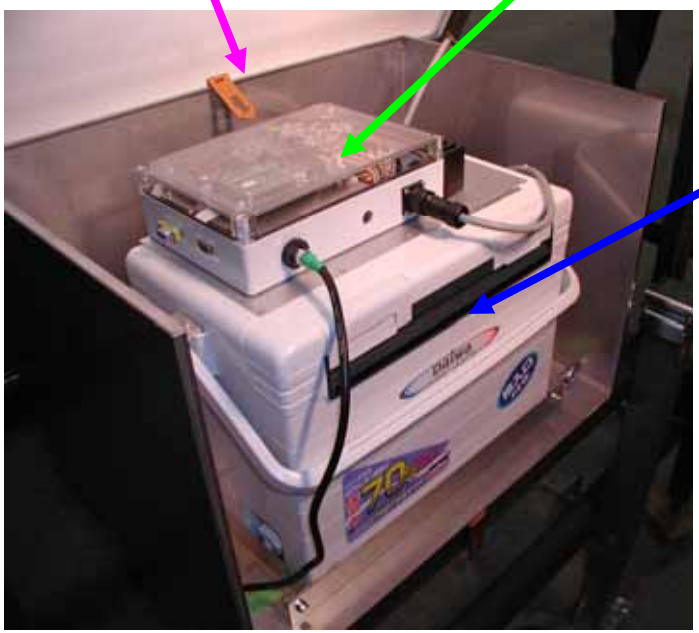


Power Generation

Solar Panel

size~1m^2

Electronics box (ready-made)



Battery box (ready-made)

Battery

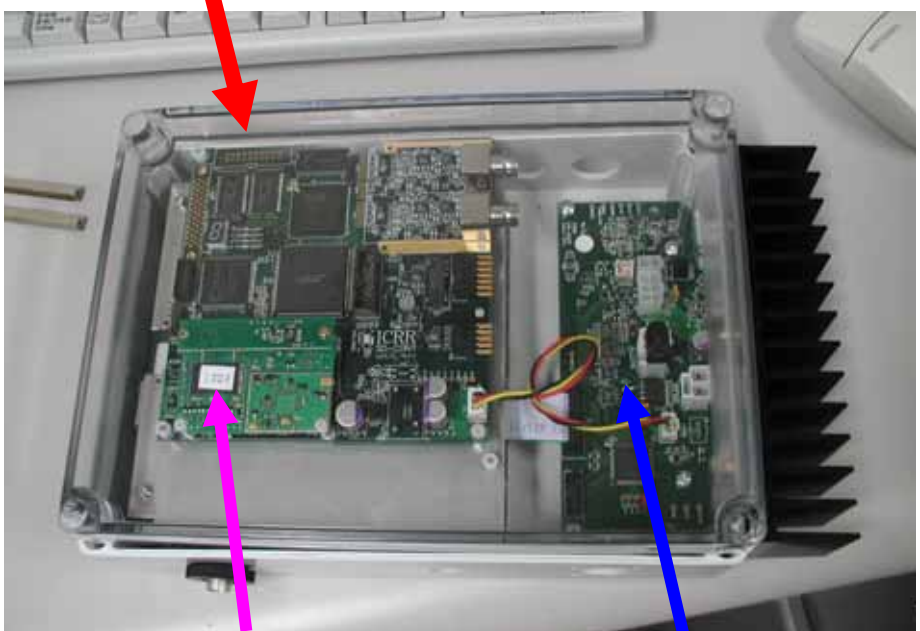
SD electronics

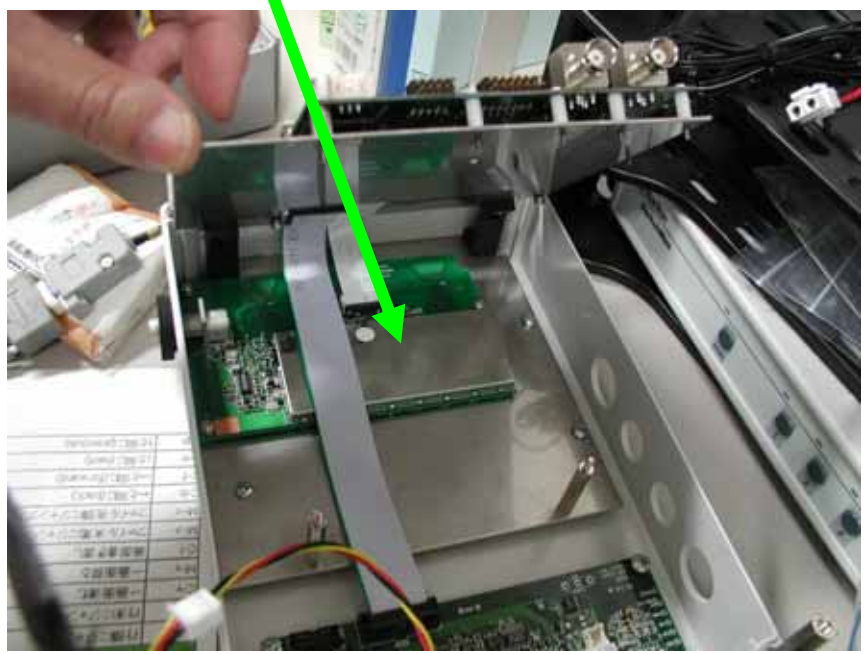
- Finished ~1/4 of mass production (~140)

FADC board

Wireless LAN modem

2.4GHz



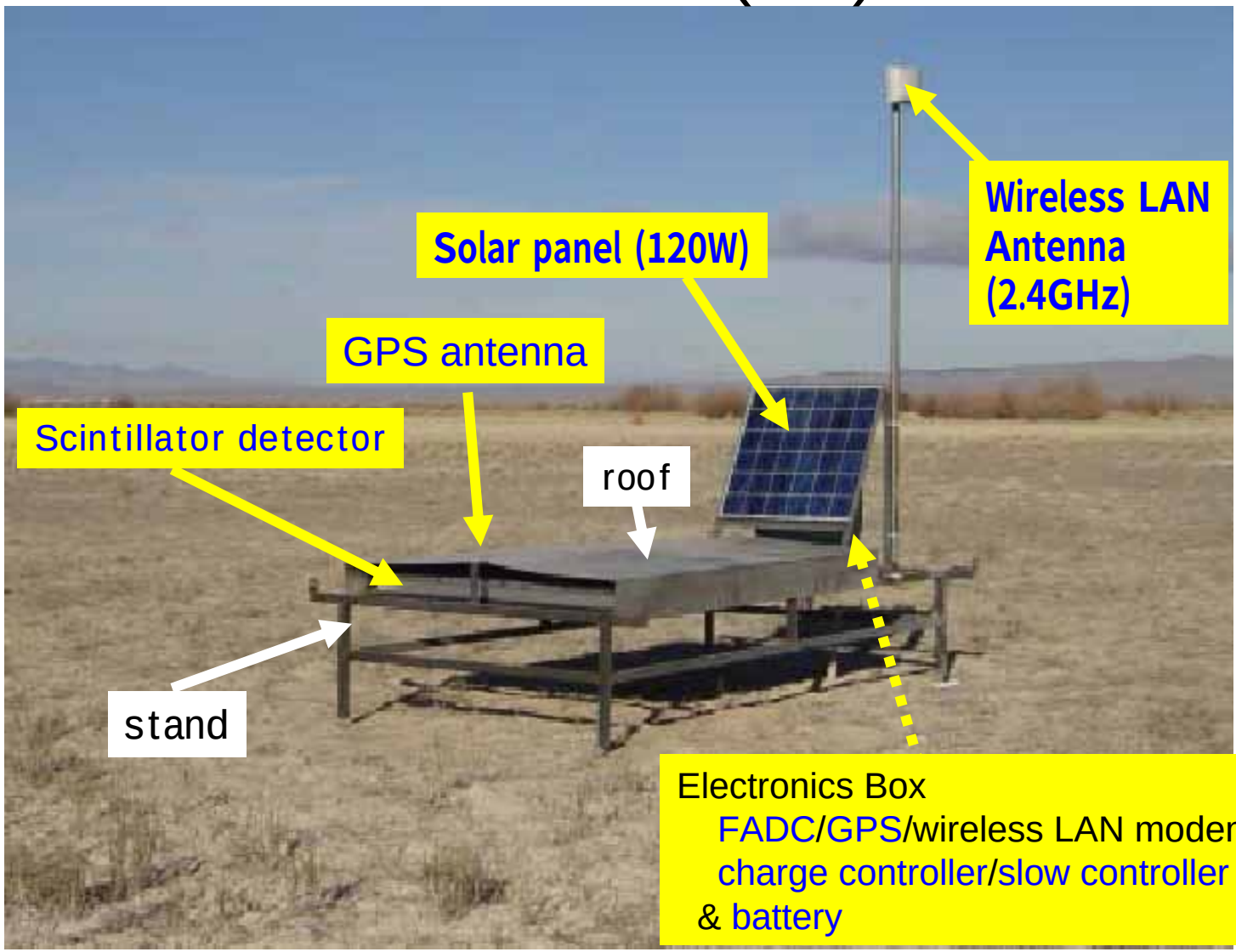


GPS

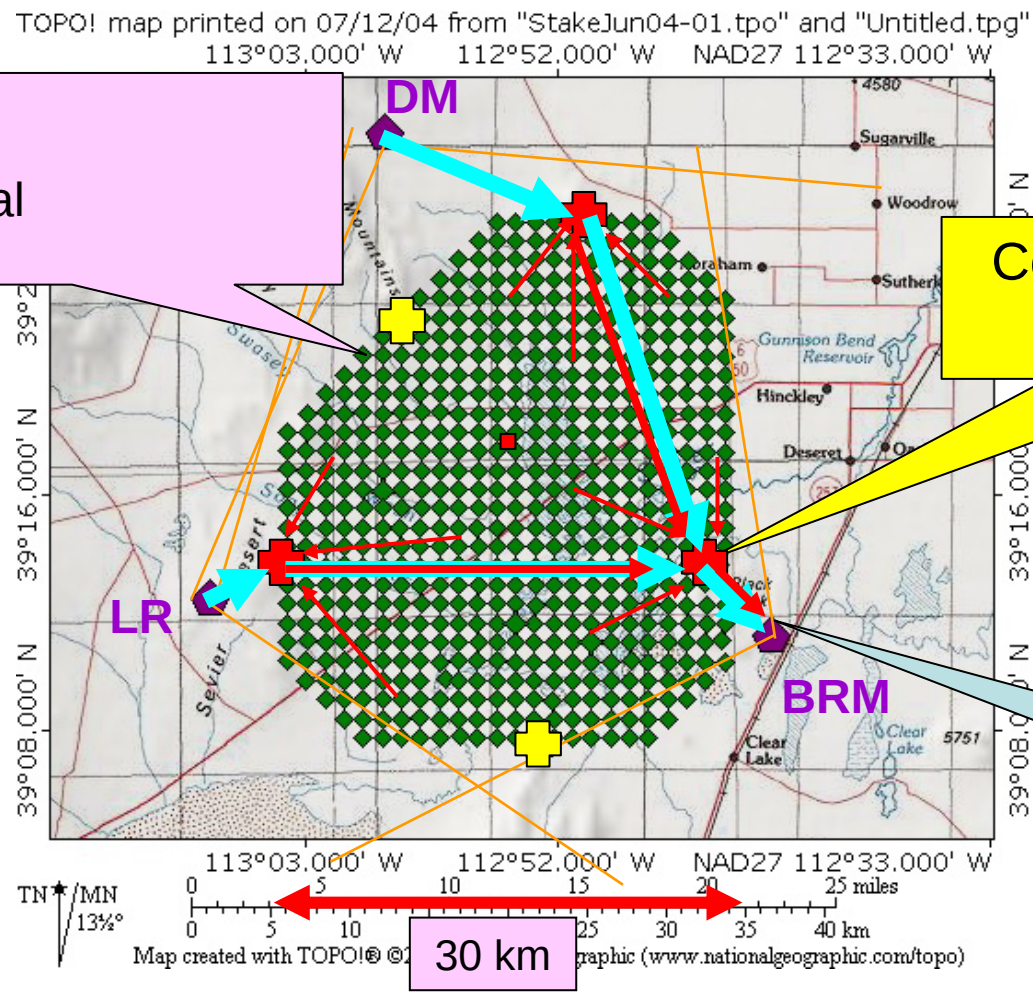
~10ns

Charge Controller for the battery

Surface Scintillator Detector (SD)



Communication Towers



576 SDs

1.2 km interval

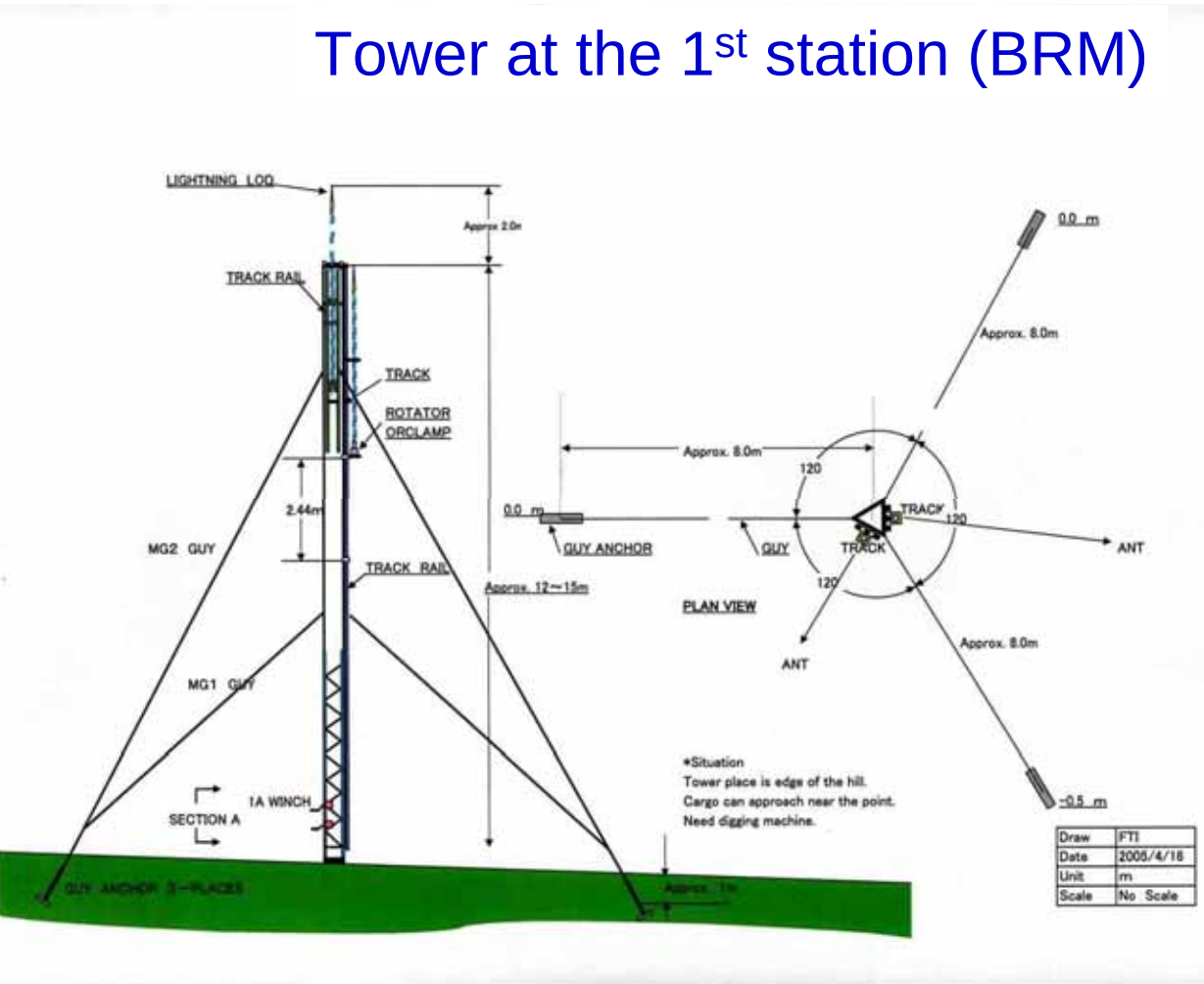
Comm. Towers (3+2)
Height ~15m

FD stations (3)

30 km

Communication Tower

Tower at the 1st station (BRM)



Use the same SD electronics ww/o FADC for The communication at the tower

Temporary tower used for Engineering Array Test in Dec. 2004

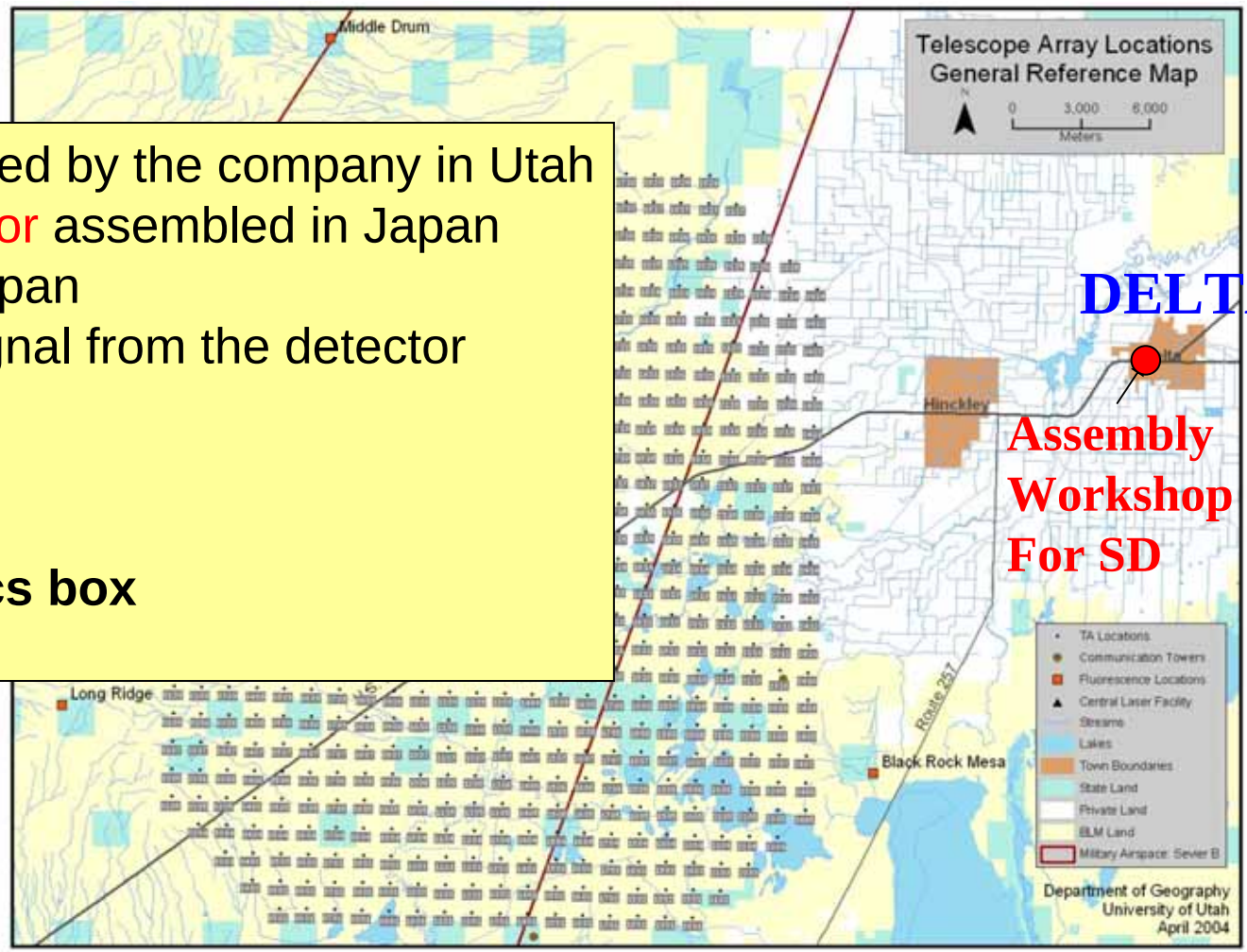
Non-directional antenna

Full assembly of SD

Place：Cosmic Ray Center in DELTA in Utah

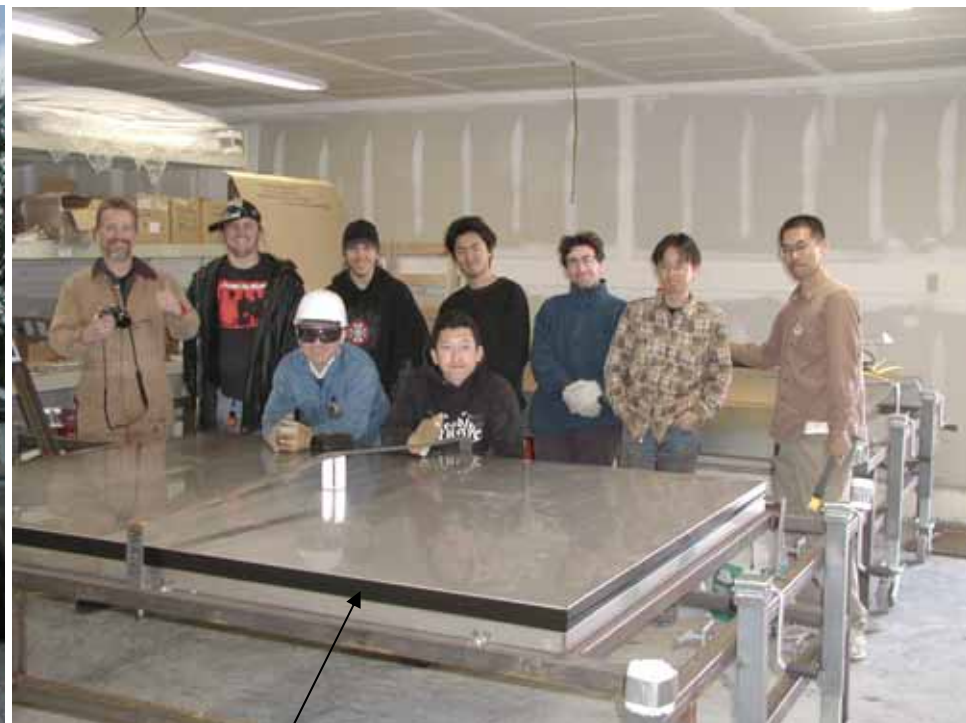
On the stand fabricated by the company in Utah
Put scintillator detector assembled in Japan
Set **PMT** tested in Japan
Check cosmic ray signal from the detector

Then install
Solar panel
Battery & electronics box
battery



First mass assembly: Jan~Mar in 2006
~10 workers

Cosmic Ray Center



Scintillator detector

246 Surface Detectors

Cosmic Ray Center

Install SD electronics to ~130 SDs from early in June

Schedule of SD deployment

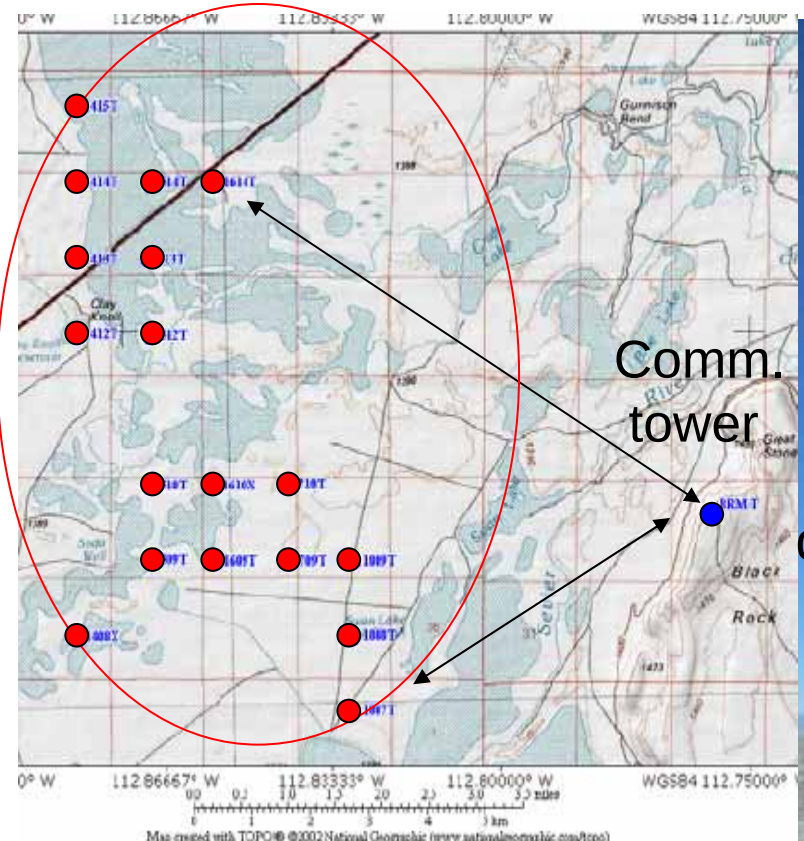
- Animal survey before the permission from BLM (Bureau of Land Manager) is going on.
- If the result of the survey is ok,

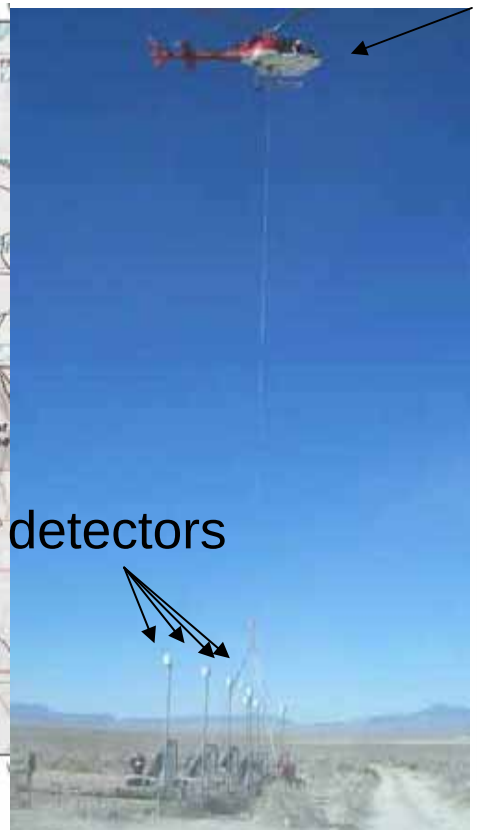
- Construction of communication towers
  - Construct 3 towers in two weeks in July

- Deployment of SDs
  - ~130 SDs in August (first deployment in 2006)
    - Deployment +tuning by helicopter in two weeks
  - Totally 516 SDs will be deployed by Feb. end in 2007

Deployment of Test Array and Result

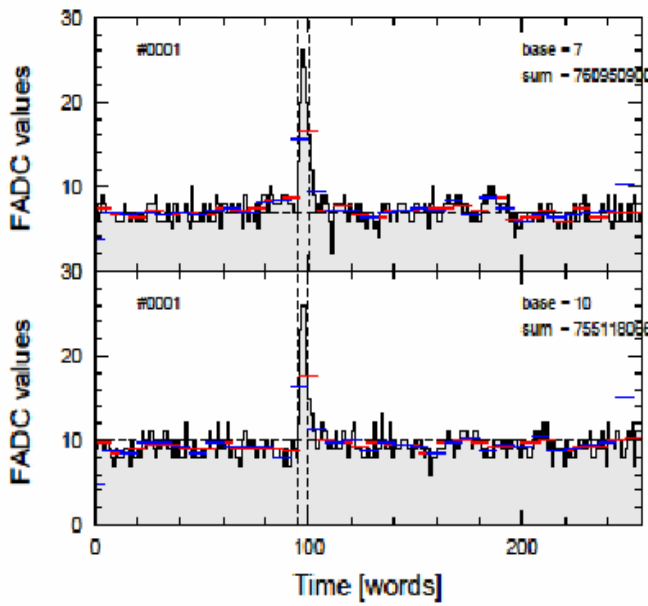
- 18 SDs were deployed on December in 2004.
- Long distance communication was successful.
- Wave form of cosmic ray data were taken.
- Deployment method was established. (by helicopter)





Deployment by helicopter

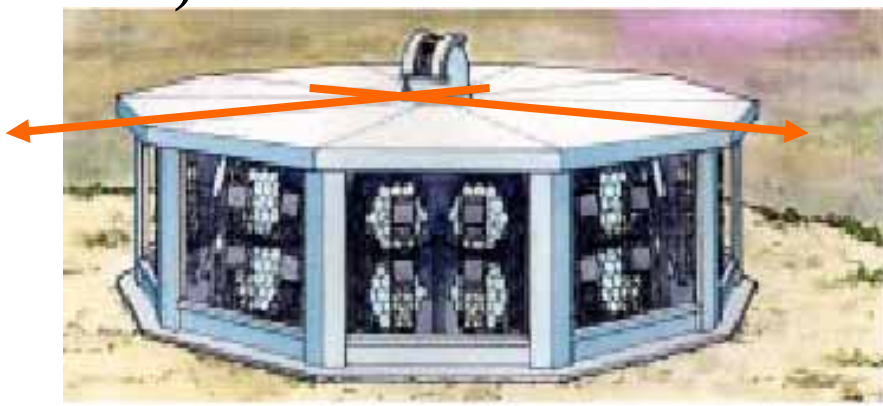
Wave form

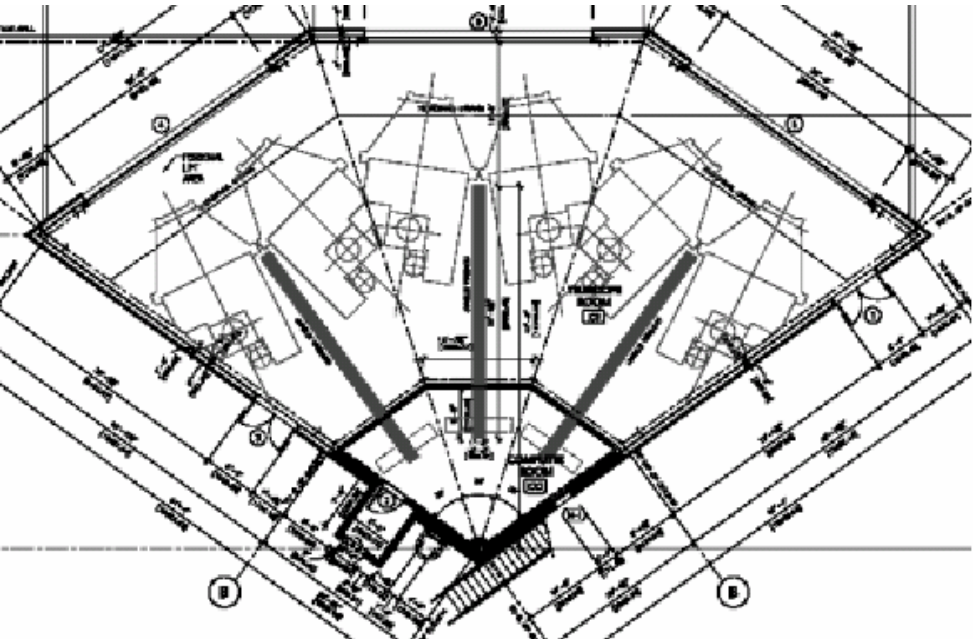


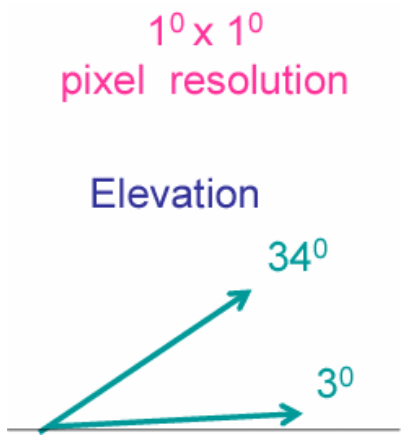
Fluorescence telescope

Atmospheric Fluorescence Telescope

1 station : 2 x 6 = 12 telescopes (or cameras)
(azimuthal covrage: 108^{o})



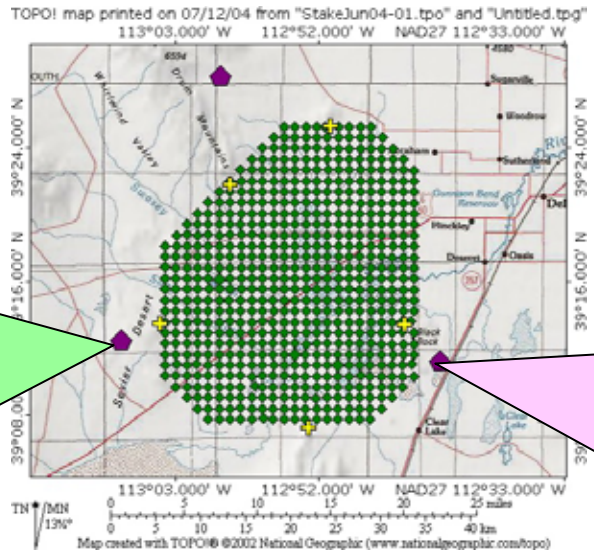




covered by 2 cameras

FD : Status of construction

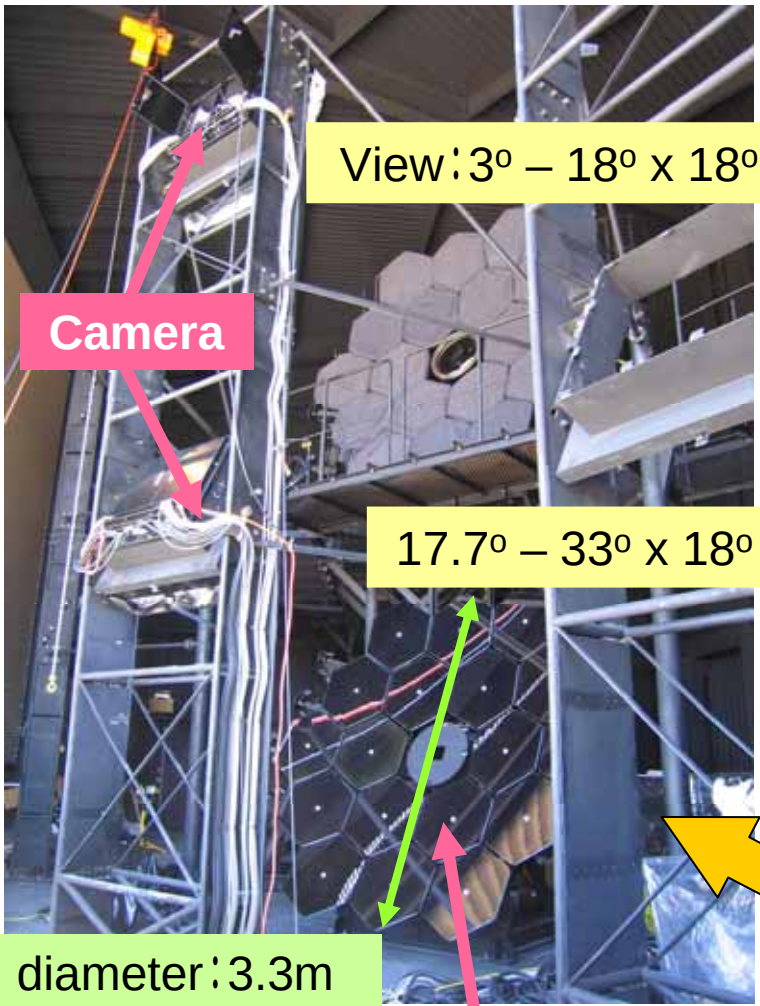
Long Ridge



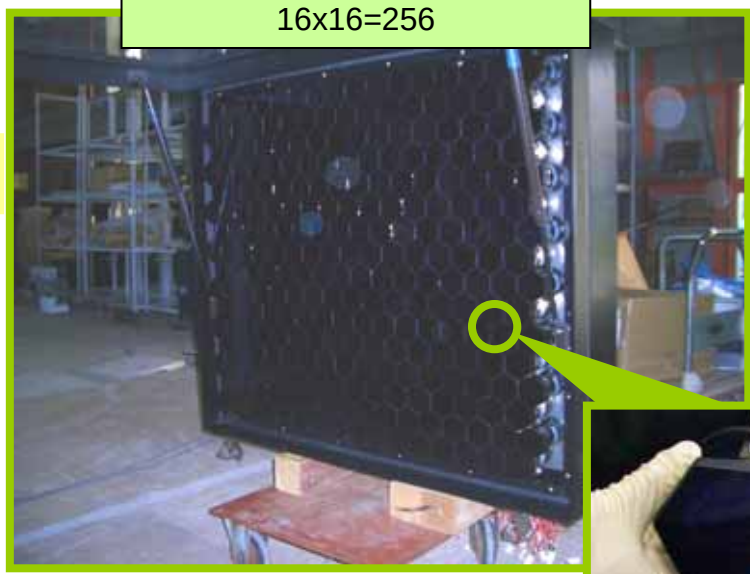
Black Rock Mesa

March, 2006

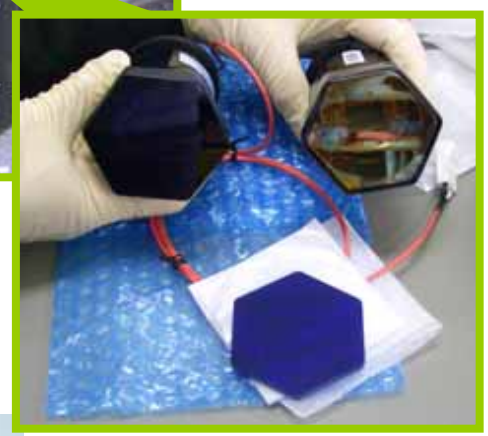
FD : Telescope

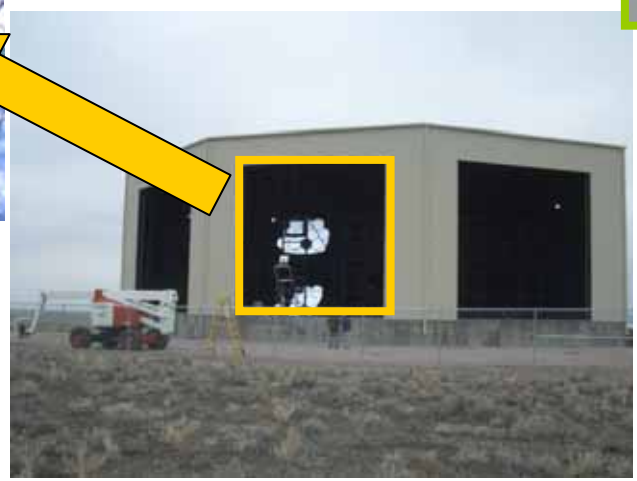


Camera :
50mm photomultipliers
16x16=256



Electronics





Composed of 18 spherical hexagonal segmented mirrors

Electronics

PMT camera

Patch Panel

Pre–Amp.

PMTs

PMT: DC coupling

Total gain : 4×10^6

SDF(Signal Digitizer / Finder)
16/mirror

Amp.

FADC

Signal Finder

Signal Digitizer / Finder (SDF)

16 input channel

Recorded waveform: 51.2 μs

(Resolution: 14 bit ,100 ns)

1st level trigger

(signal-finding process)

Dynamic Range:

14bit = 8k p.e./100 ns

Track Finder

Lookup Memory

IRQ
Hit P

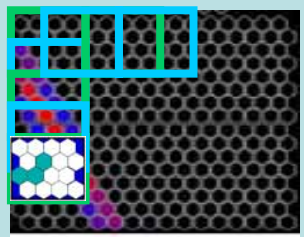
TF(Track Finder)
1/mirror

Track Finder (TF)

2nd level trigger (track-find process)

Partial track on border

5.4 μs for track-finding process



Run control PC

GUI

Inter–mirror trigger,
External trigger,
System clock

GPS

CTD(Centra
1/station

Central Trigger Distributor (CTD)

Inter-mirror trigger, External trigger

Distribute Final Trigger to all the telescopes

Total triggering process time: 9.8 μs

GPS

System clock

Reset/Interrupt

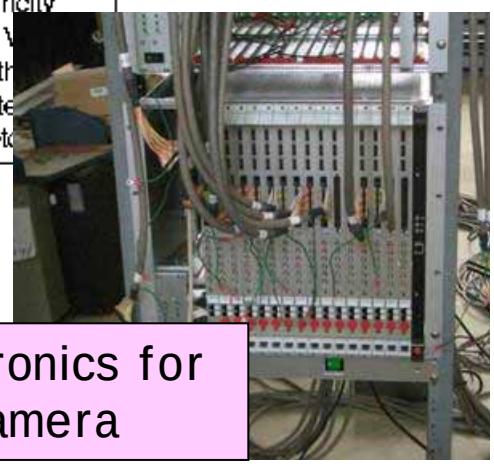
Electricity

High V

Weath

Shutte

etc



High Voltage
Distributors

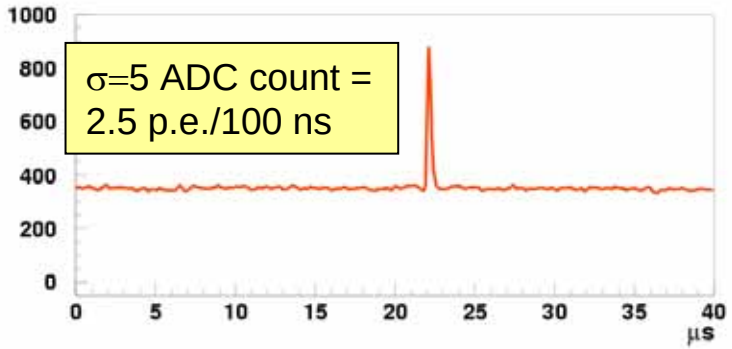
Supply

Electronics for one camera

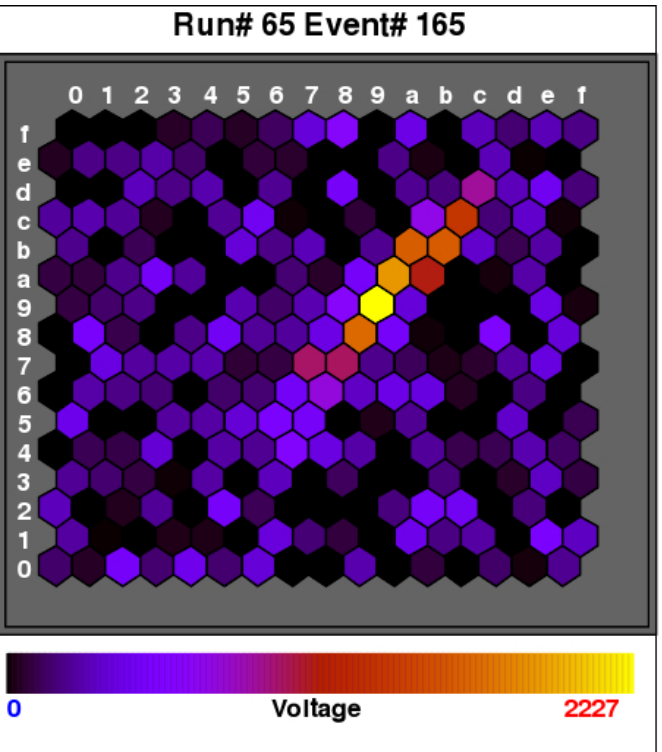
Test observation @ Millard county, Utah

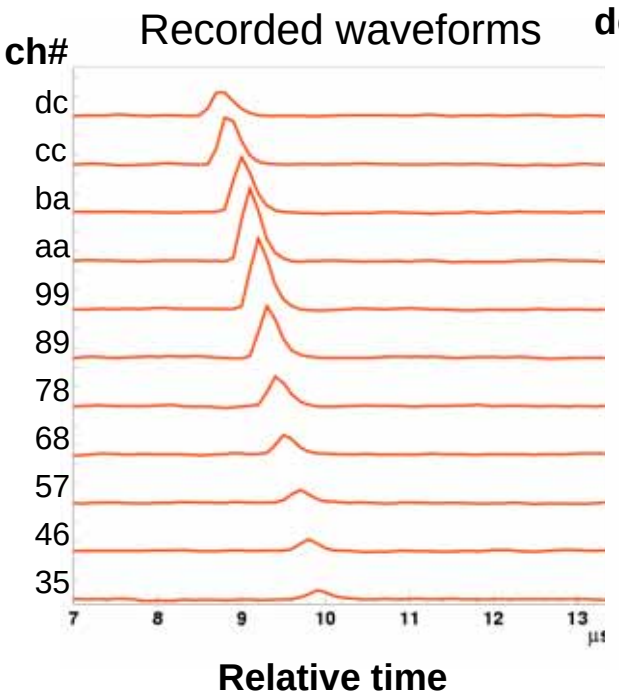
- 3-13 July, 2005 @ Black Rock Mesa site
- Single telescope with 256ch PMTs camera
- Total observation time: 31.5 hours
- 1st level trigger threshold: 6 - 6.5 sigma
- Trigger rate: 0.6 - 1.5 Hz

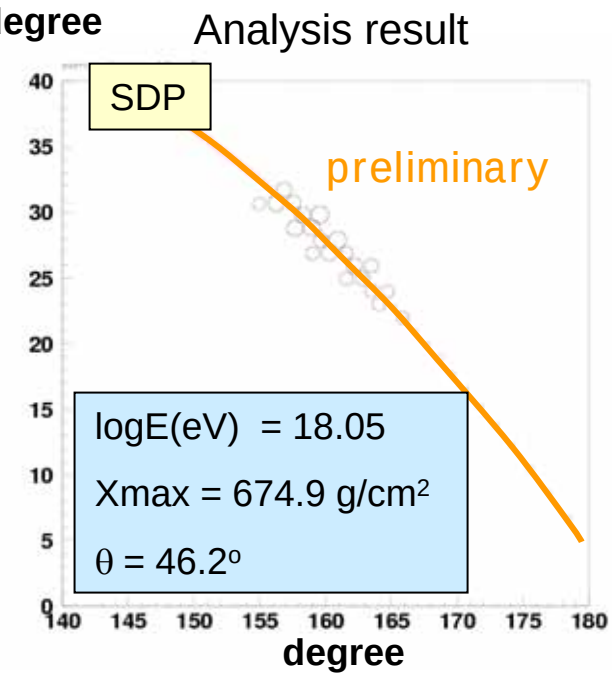
Typical waveform with fluorescence light
(RUN65,TRIG165, CH89)



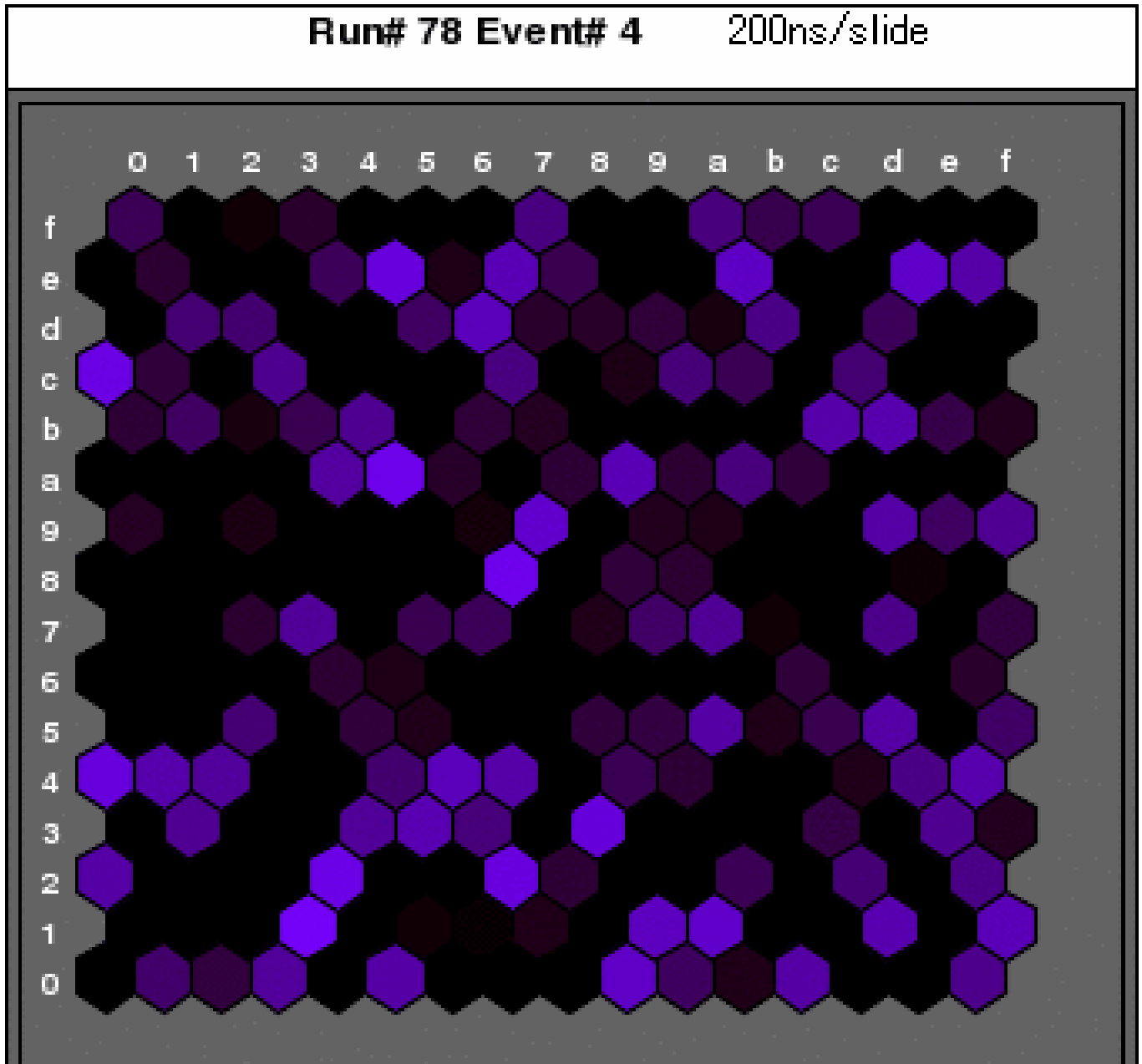
An observed shower-like track (11 July, 2005)







Fluorescence event (animation : 200ns/slide)



Calibration of cameras

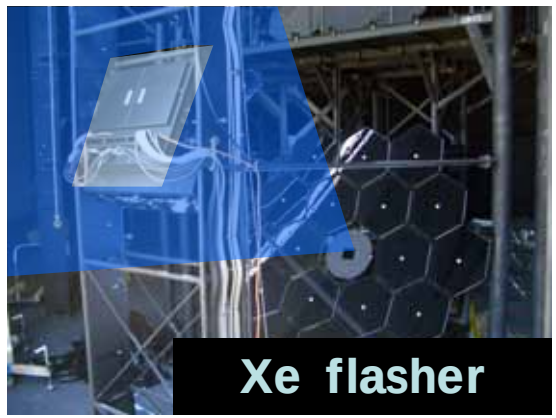
- absolute calibration with CRAYS and YAP

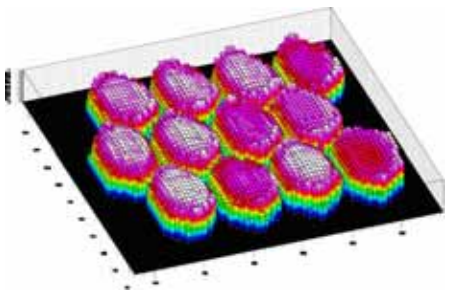
  3 calibrated PMTs / 256 PMTs (1 Camera)

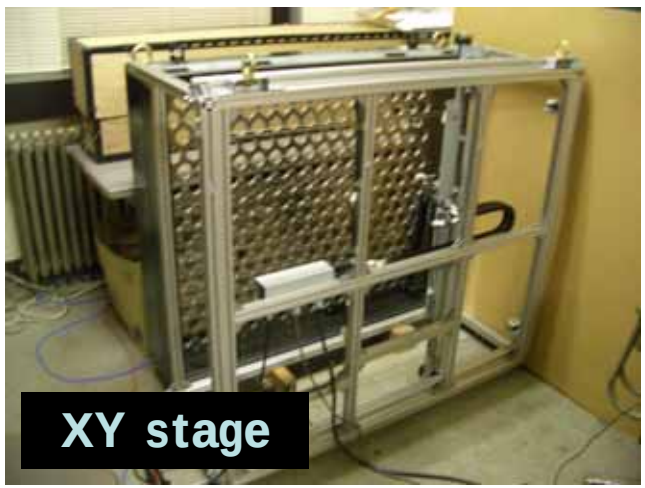
  CRAYS：absolute light source by Rayleigh scattering

  YAP：stable pulse light source

- make the whole camera uniform by Xe flasher
- measurement of two-dimensional distribution of the whole camera by XY scanner







XY stage

whole camera: ~2 hours (4mm step)

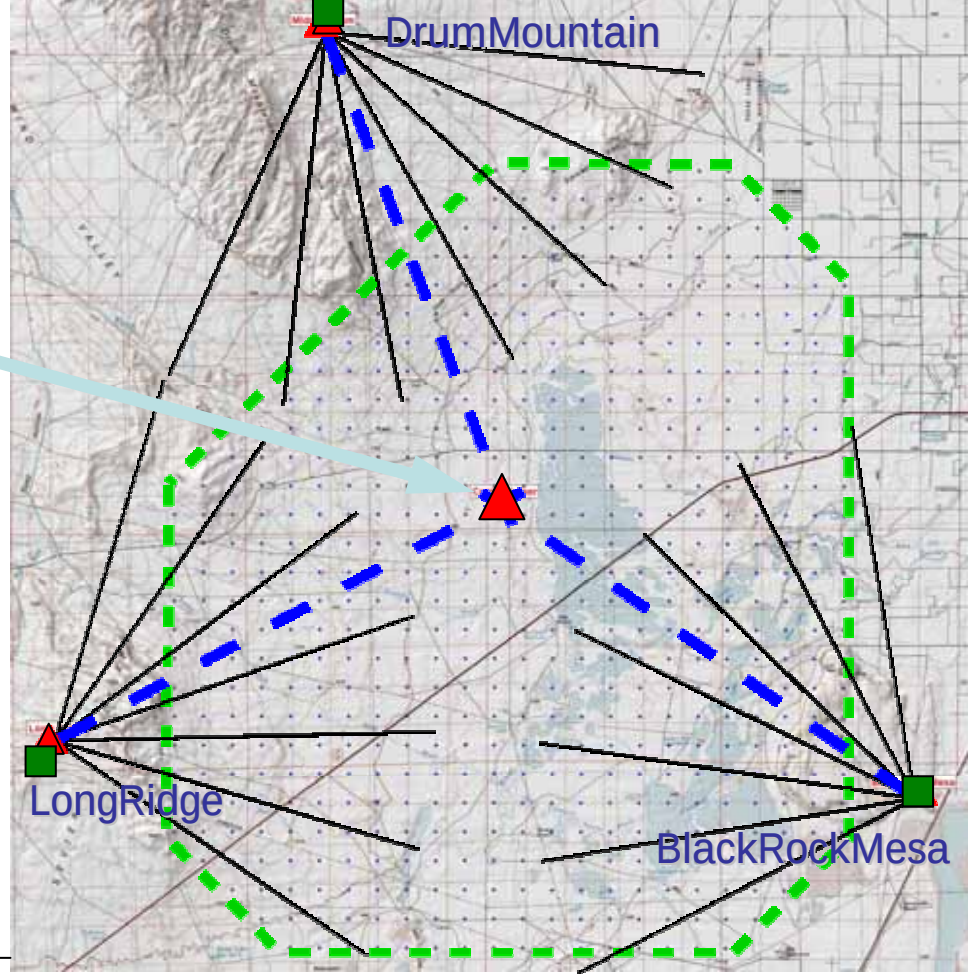
Atmospheric monitor

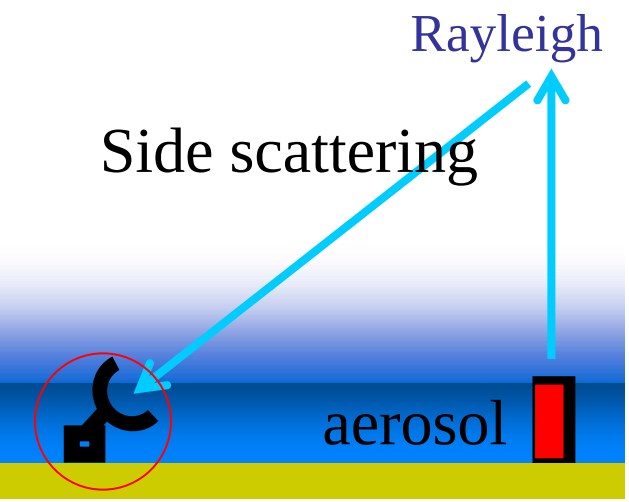
Central Laser Facility

Emit Nd:YAG Laser 355nm vertically

Observe by FD

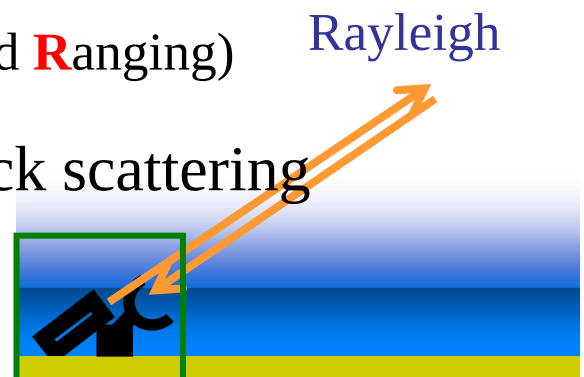
Equal distance from three FD stations :~20.85Km





Set LIDAR at each FD station

(**LI**ght **D**etection **A**nd **R**anging)

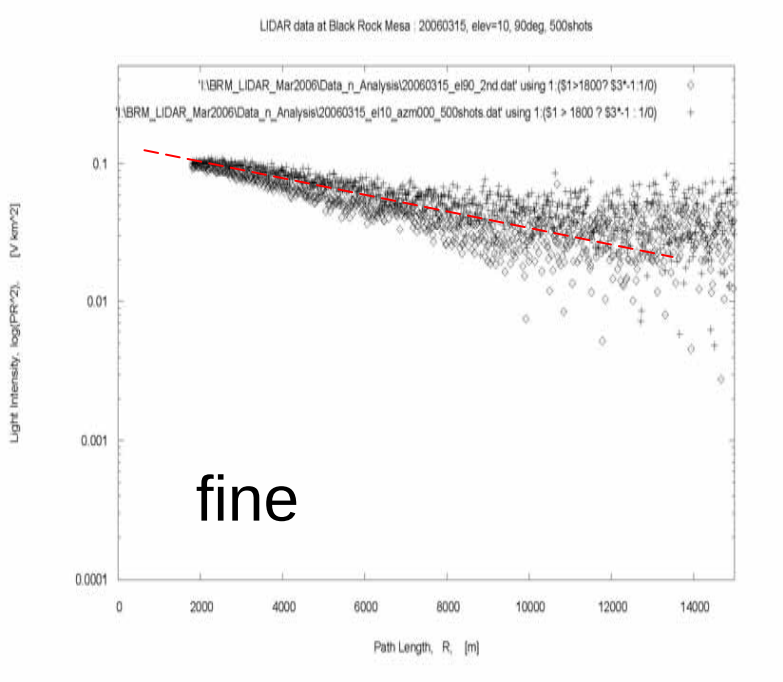


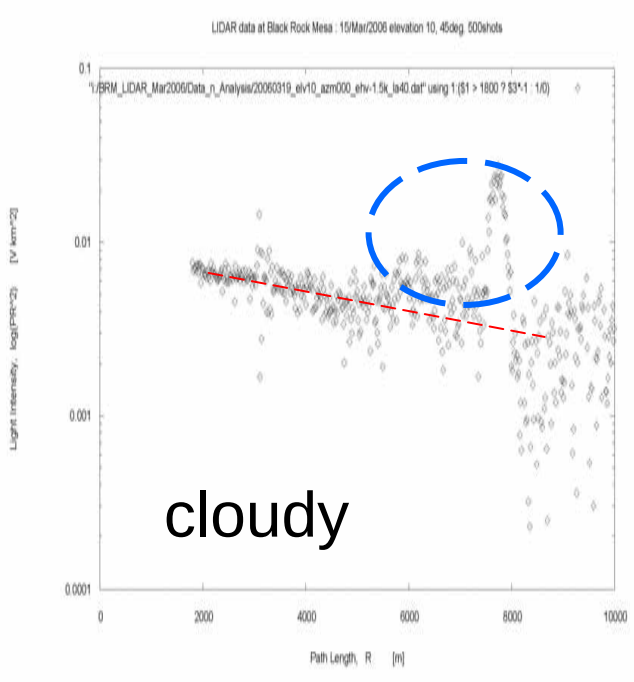
LIDAR system at Black Rock Mesa

March 2006 at BRM

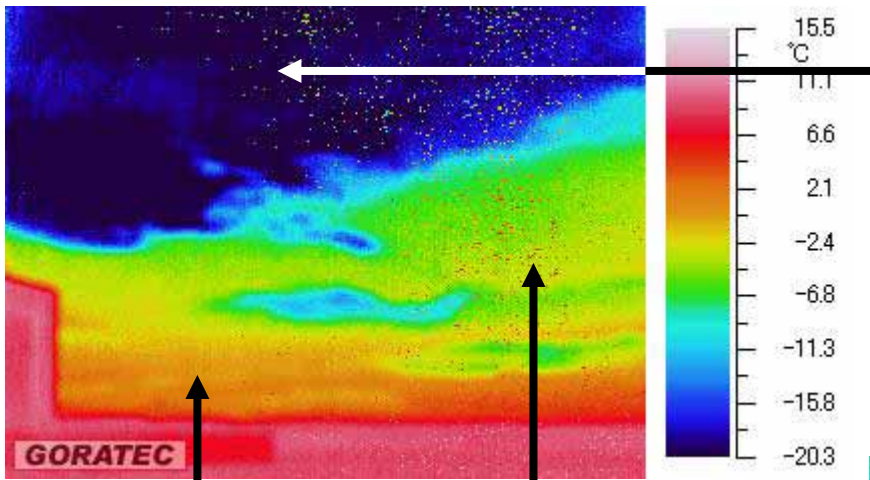
Unstable weather !

Another Trolls at BRM before spring !





IR Camera cloud monitoring

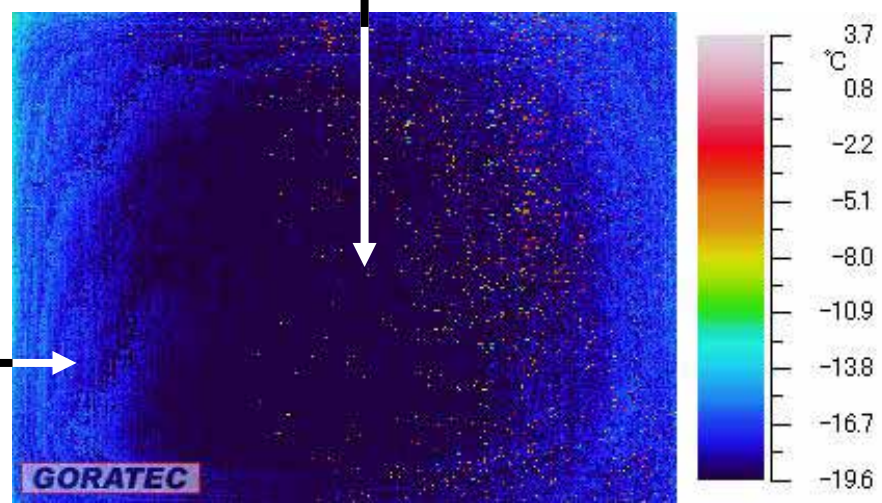


-24 deg.

-5 deg.

0 deg.

-17 deg.

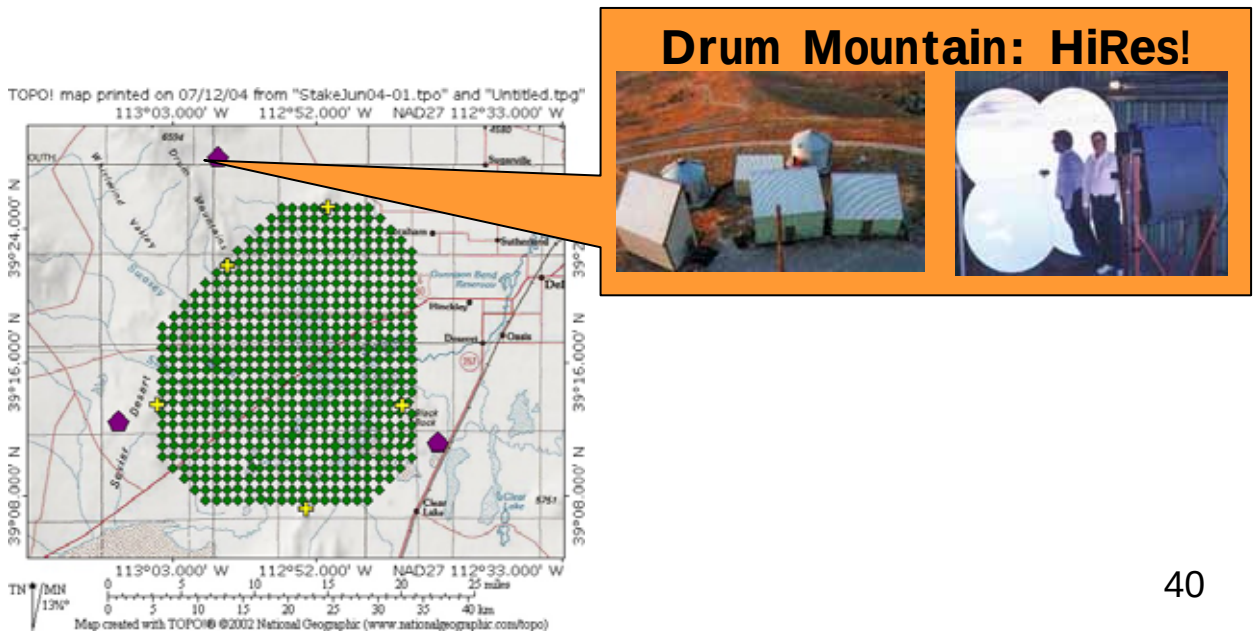


Schedule of FD

- BRM (1st station: southeast)
  - Mirror setting in July
  - Camera setting in August
  - Tuning and test of observation
- LR (2nd station: southwest)
  - The building of the station: complete in May
  - 1 telescope setting in May
  - 6 telescope structures: complete by fall
- Comlete all setup and test by Mar 2007

TA/TALE

- TA/TALE proposal applied to NSF was approved.
  - Proposal for the U.S. Part of the Telescope Array (TA) Experiment, Including the TA Low Energy Extension (TALE)
- HiRes will be moved to the 3rd station of TA.
  - HiRes was shut down this April.



The End