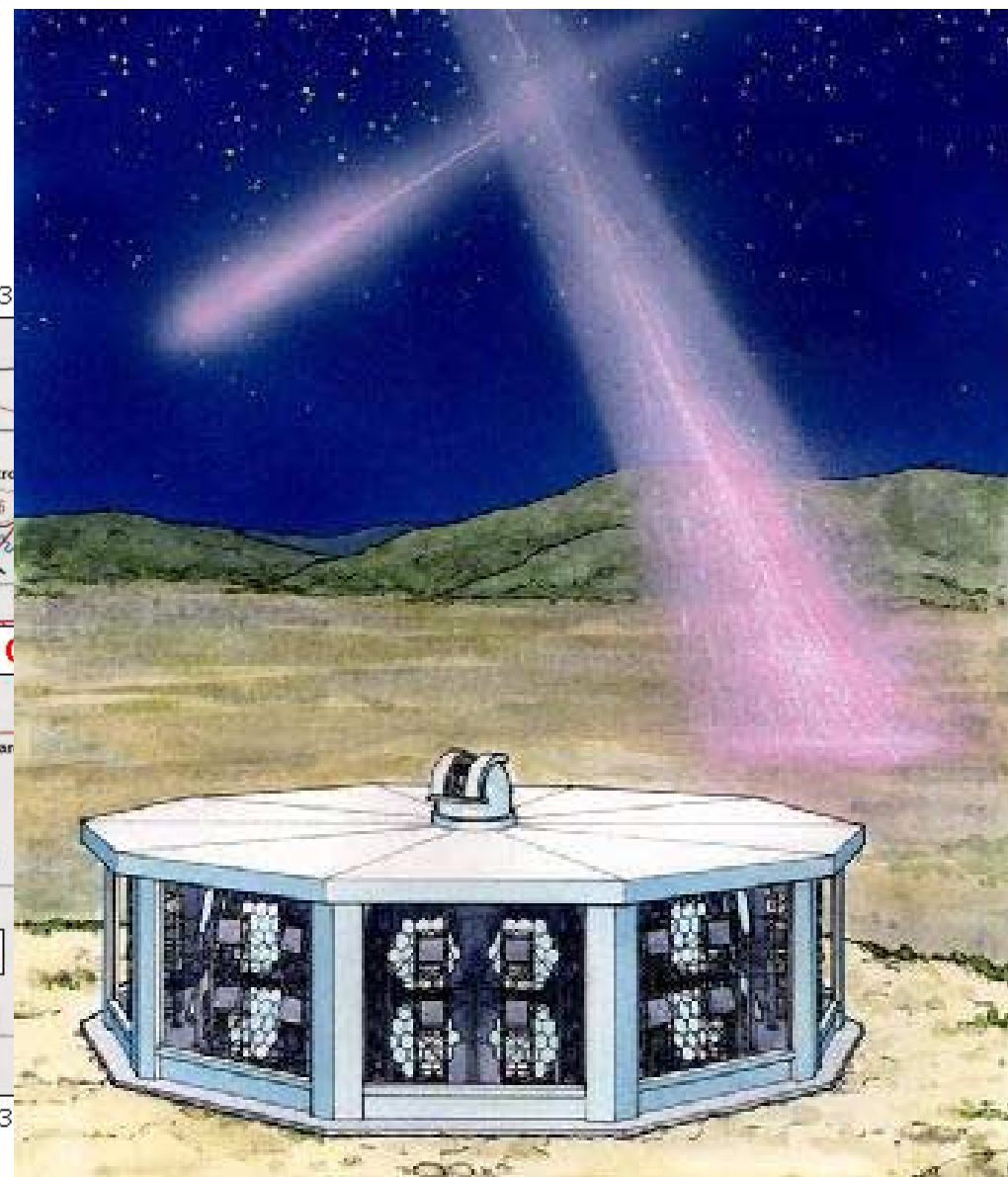
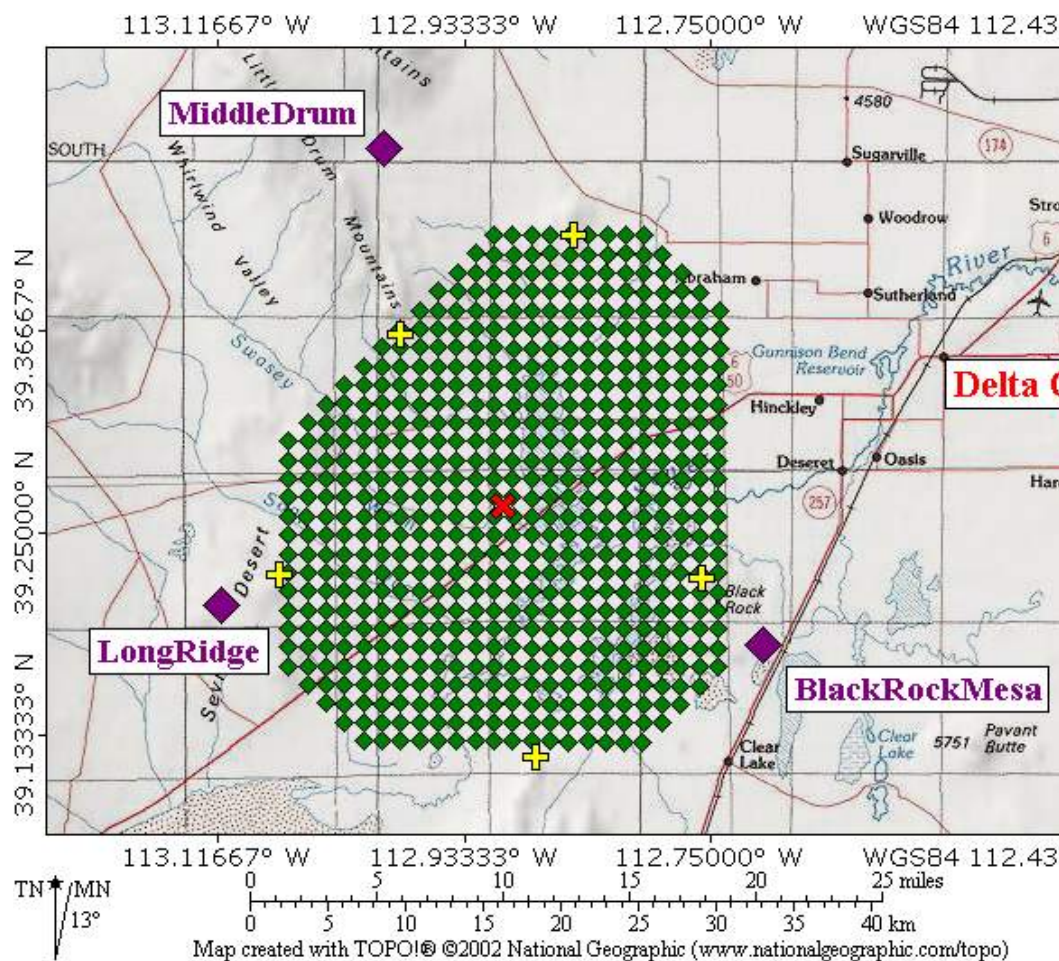


Current Status of the TA Experiment

M. TAKEDA (ICRR)
& The TA Collaboration



< The TA Collaboration >



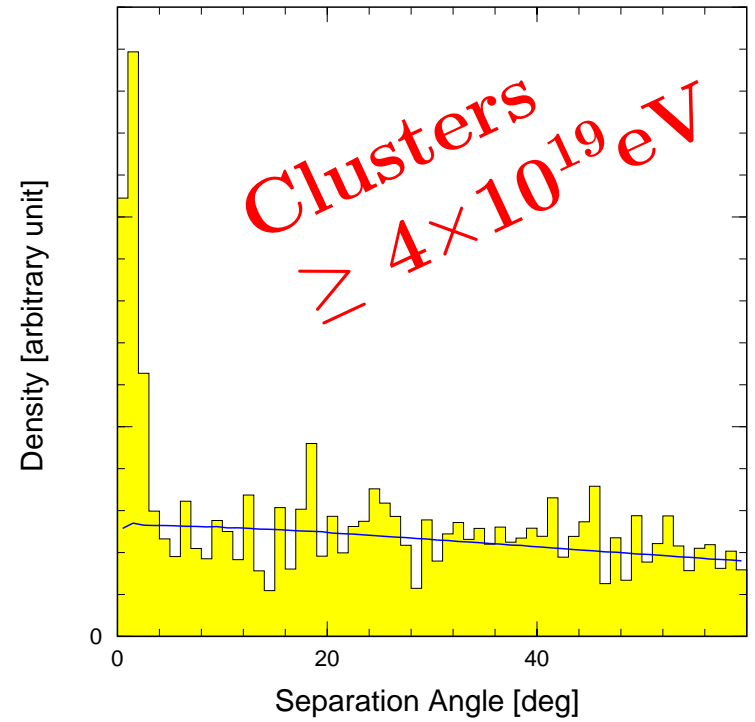
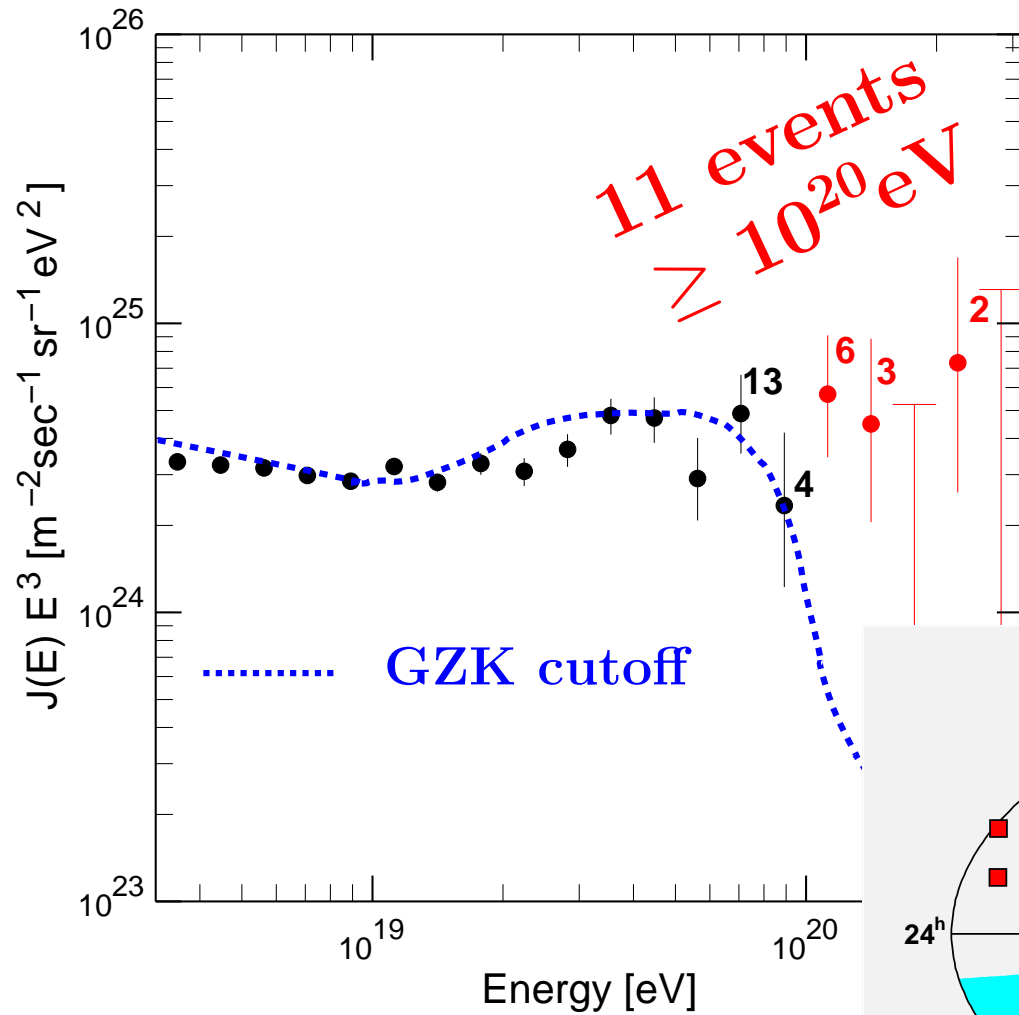
H.Kawai^a, S.Yoshida^a, H.Yoshii^b, K.Tanaka^c, F.Cohen^d, E.Kido^d, M.Fukushima^d, N.Hayashida^d, K.Hiyama^d, D.Ikeda^d, M.Ohnishi^d, H.Ohoka^d, S.Ozawa^d, H.Sagawa^d, N.Sakurai^d, T.Shibata^d, H.Shimodaira^d, M.Takeda^d, A.Taketa^d, M.Takita^d, H.Tokuno^d, R.Torii^d, S.Udo^d, H.Fujii^e, T.Matsuda^e, M.Tanaka^e, H.Yamaoka^e, K.Hibino^f, T.Benno^g, M.Chikawa^g, T.Nakamura^h, M.Teshimaⁱ, K.Kadota^j, Y.Uchihori^k, K.Hayashi^l, Y.Hayashi^l, S.Kawakami^l, K.Matsumoto^l, Y.Matsumoto^l, T.Matsuyama^l, M.Minamino^l, T.Nonaka^l, S.Ogio^l, A.Ohshima^l, T.Okuda^l, N.Shimizu^l, H.Tanaka^l, D.R.Bergman^m, G.Hughes^m, S.Stratton^m, G.B.Thomson^m, K.Endoⁿ, N.Inoueⁿ, S.Kawanaⁿ, Y.Wadaⁿ, K.Kasahara^o, M.Fukuda^p, T.Iguchi^p, F.Kakimoto^p, S.Machida^p, R.Minakawa^p, Y.Murano^p, Y.Tameda^p, Y.Tsunesada^p, J.W.Belz^{q,s}, J.A.J.Matthews^r, T.AbuZayyad^s, R.Cady^s, Z.Cao^s, P.Huentemeyer^s, C.C.H.Jui^s, K.Martens^s, J.N.Matthews^s, J.D.Smith^s, P.Sokolsky^s, R.W.Springer^s, S.B.Thomas^s, L.R.Wiencke^s, T.Doyle^t, M.J.Taylor^t, V.B.Wickwar^t, T.D.Wilkerson^t, K.Hashimoto^u, K.Honda^u, T.Ishii^u, K.Ikuta^u, T.Kanbe^u,

(a) Department of Physics, Chiba University, Chiba 263-8522, Japan
(b) Department of Physics, Ehime University, Matsuyama 790-8577, Japan
(c) Faculty of Information Sciences, Hiroshima City University, Hiroshima 731-3194, Japan
(d) ICRR, University of Tokyo, Kashiwa 277-8582, Japan

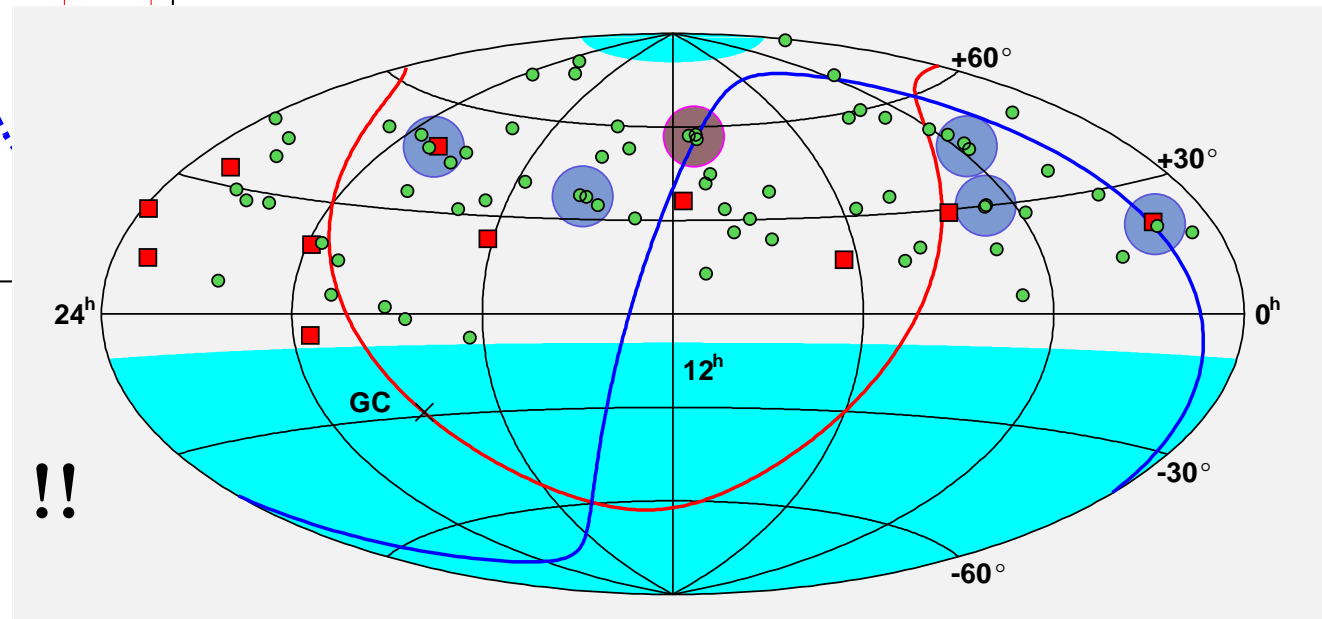
(e) KEK, High Energy Accelerator Research Organization, Tsukuba 305-0801, Japan
(f) Faculty of Engineering, Kanagawa University, Yokohama 221-8686, Japan
(g) Department of Physics, Kinki University, Osaka 577-8502, Japan
(h) Faculty of Science, Kochi University, Kochi 780-8520, Japan
(i) Max-Planck Institute for Physics, 80805 München, Germany
(j) Faculty of Engineering, Musashi Institute of Technology, Tokyo 158-8557, Japan
(k) National Institute of Radiological Sciences, Chiba 263-8555, Japan

(l) Department of Physics, Osaka City University, Osaka 558-8585, Japan
(m) Rutgers University, NJ 08854, USA
(n) Department of Physics, Saitama University, Urawa 338-8570, Japan
(o) Faculty of Systems Engineering, Shibaura Institute of Technology, Tokyo 108-8548, Japan
(p) Department of Physics, Tokyo Institute of Technology, Tokyo 152-8551, Japan
(q) University of Montana, MT 59812, USA
(r) University of New Mexico, NM 87131, USA
(s) University of Utah, UT 84112, USA
(t) Utah State University, UT 84322, USA
(u) Faculty of Engineering, Yamanashi University, Kofu 400-8511, Japan

< AGASA Results >

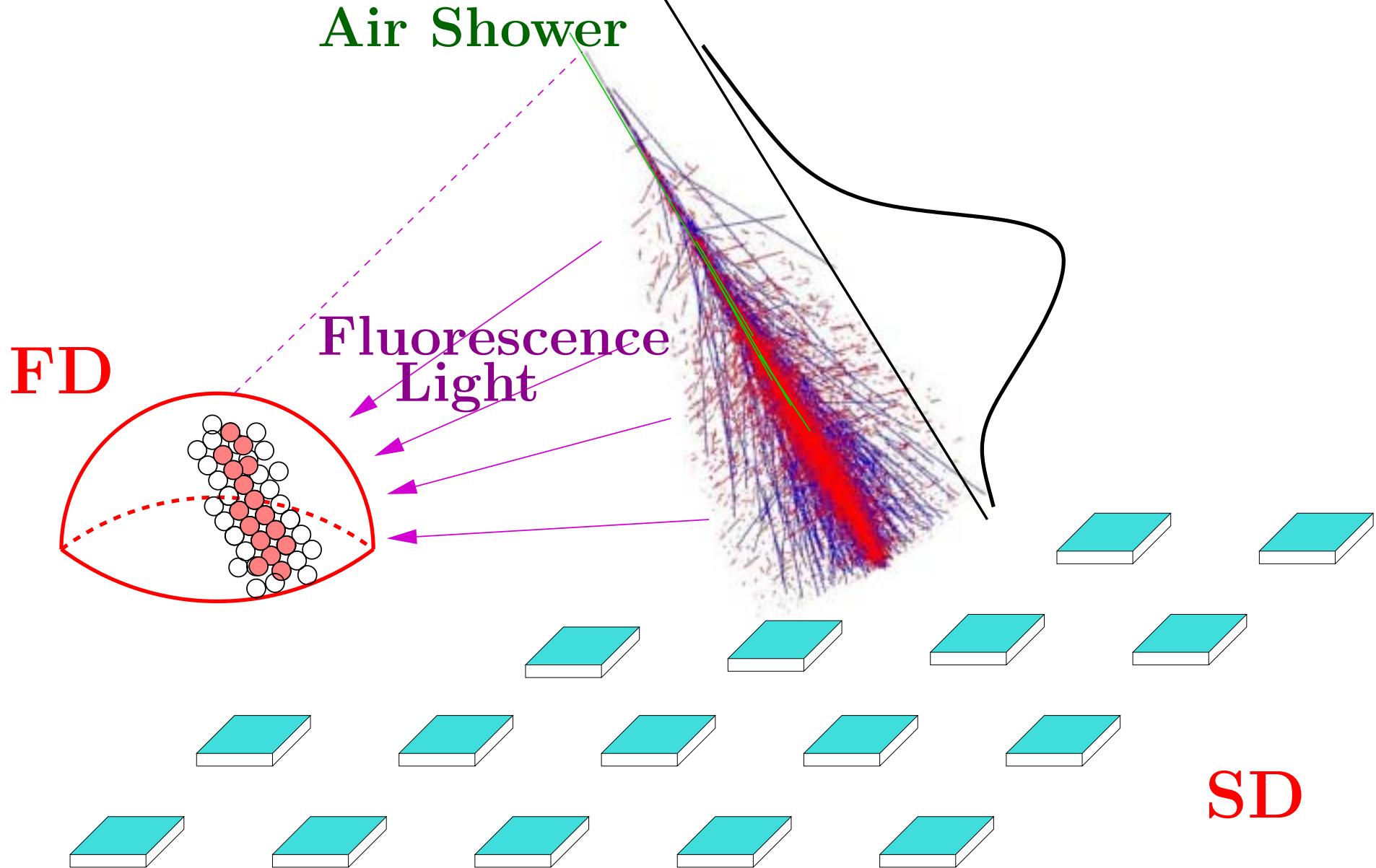


⇒ Much More DATA !!



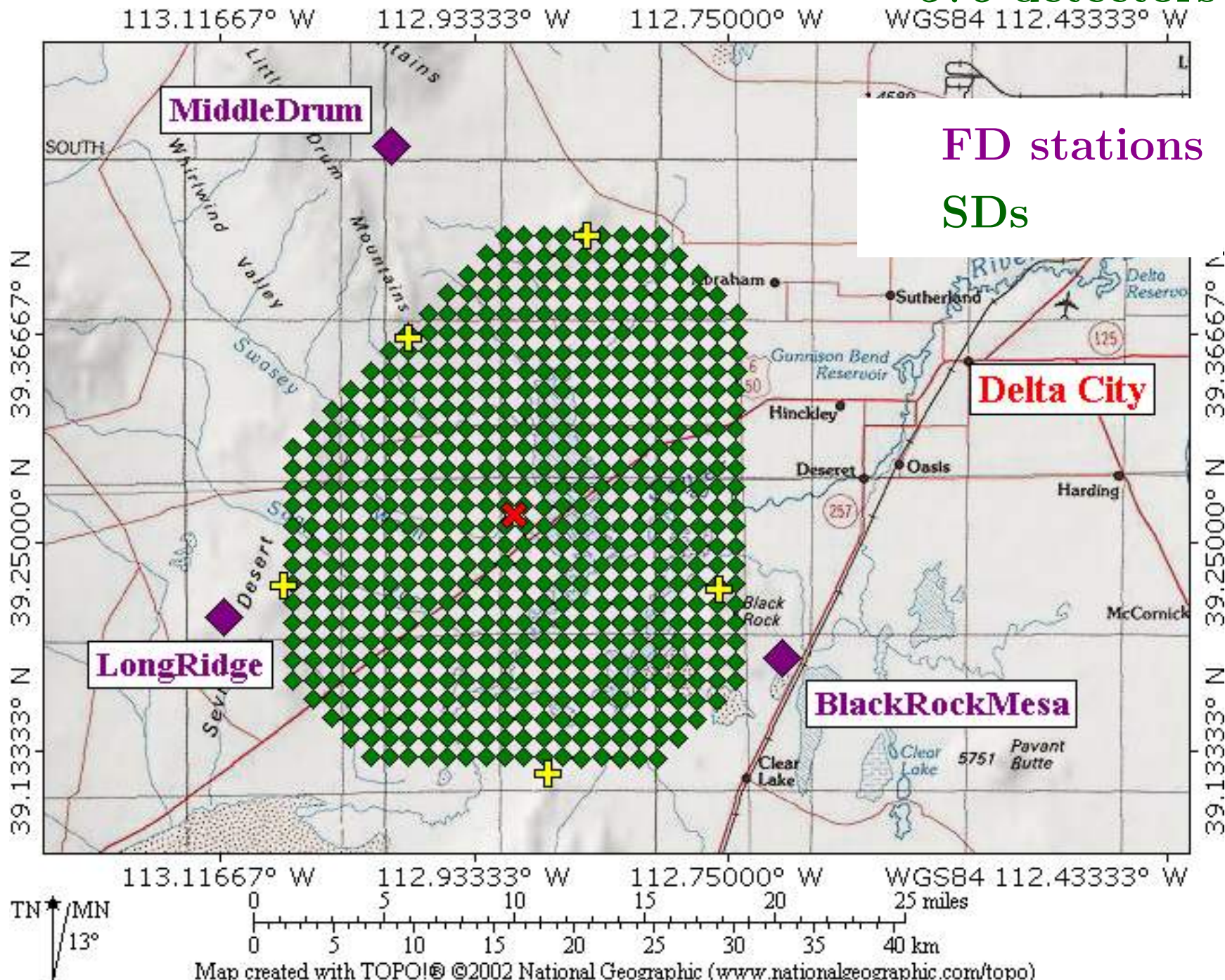
< TA Concept >

≈ 9 x AGASA



< Detector Arrangement >

3.0m², 1.2km grid
576 detectors

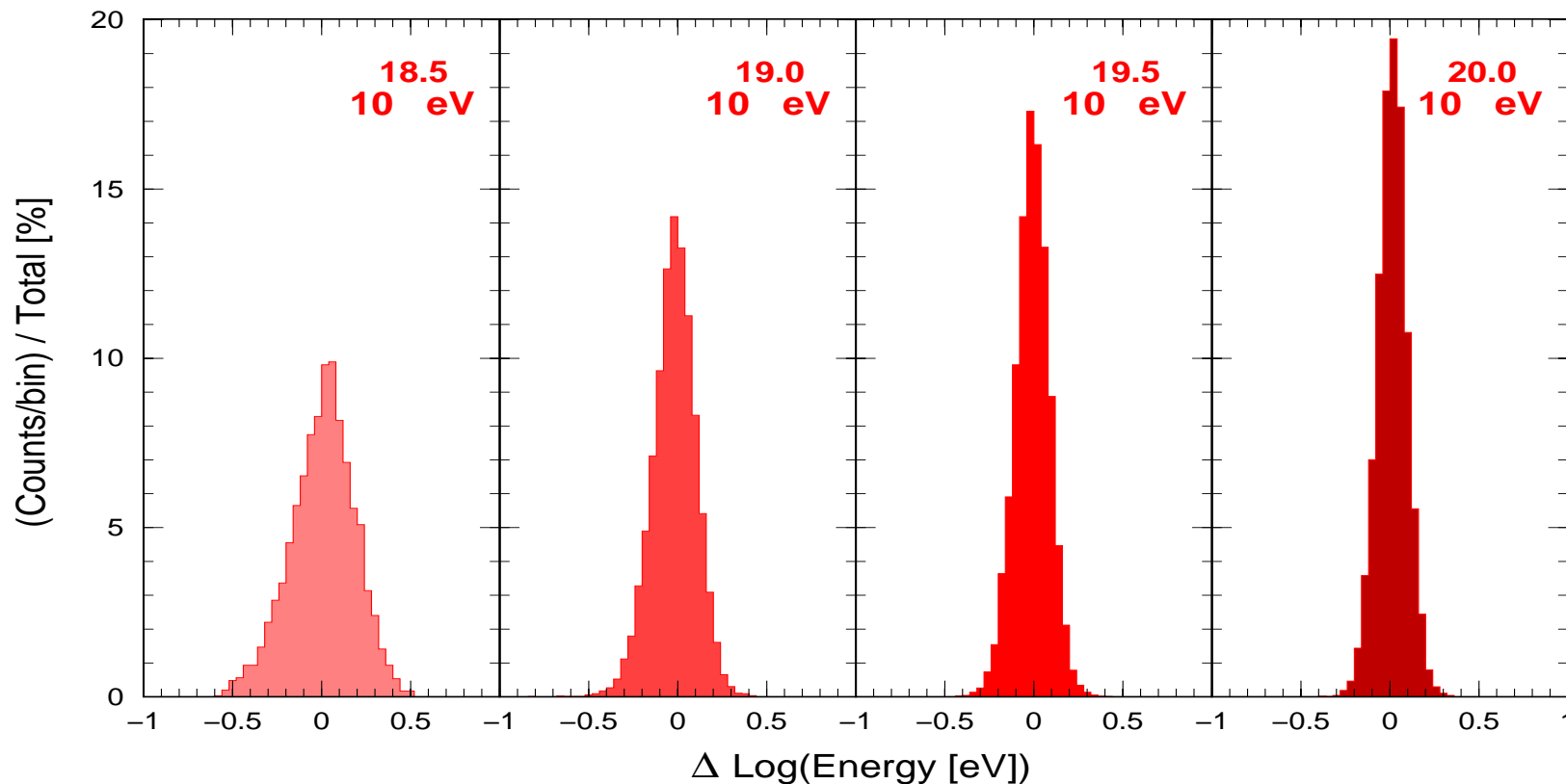
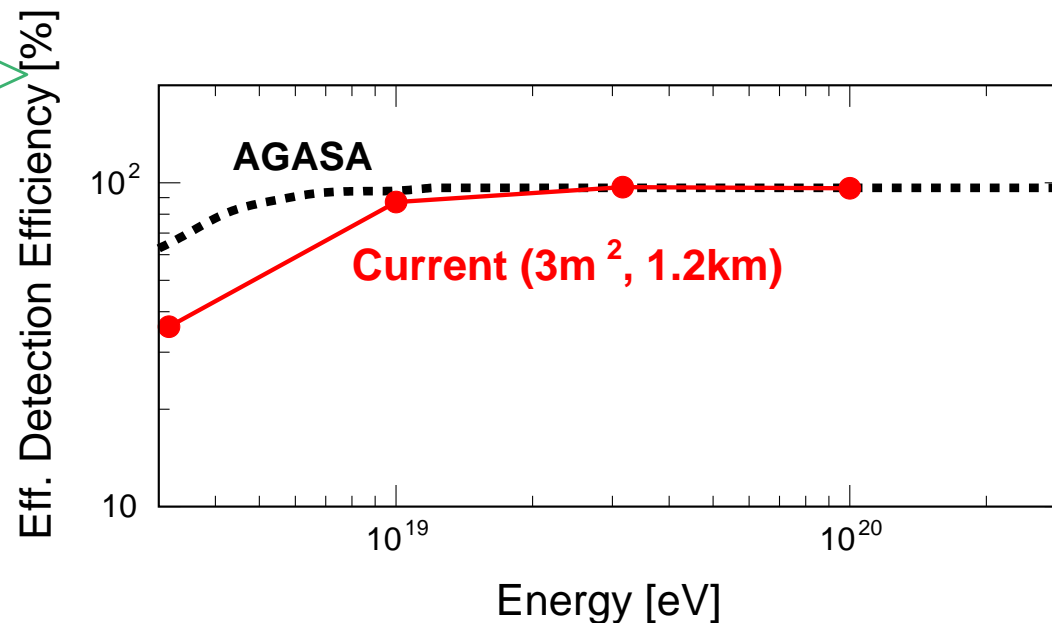


< TA-SD Performance >

- Detection Efficiency \Rightarrow
Constant above 10^{19} eV

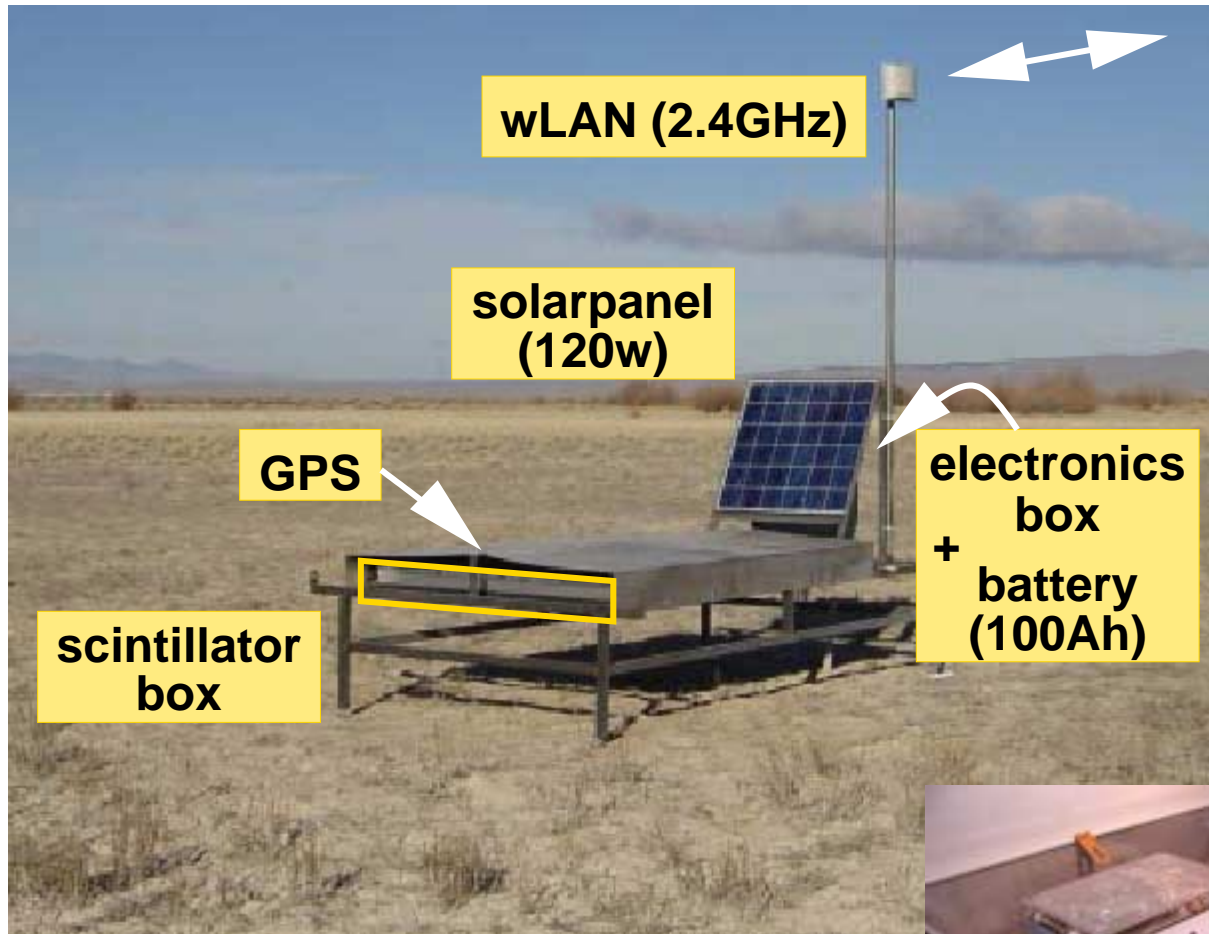
- Energy Resolution \Downarrow

Comparable to AGASA



< Surface Detector >

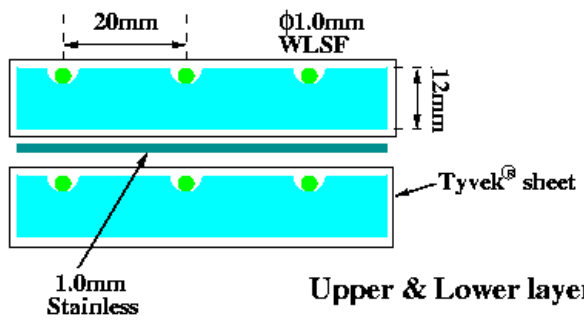
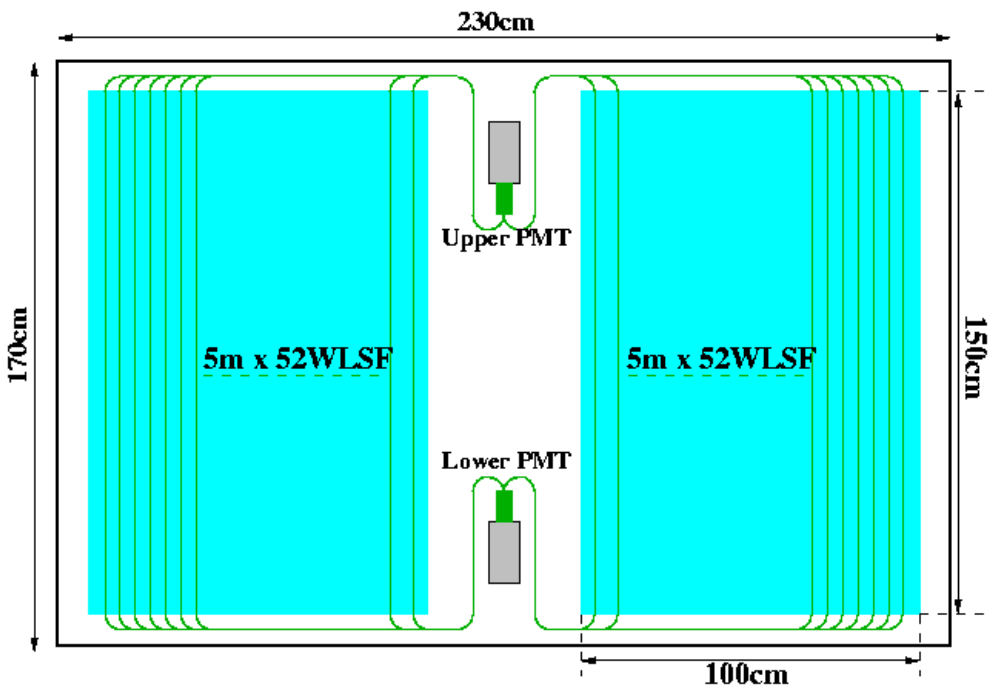
~200kg



- 3m^2 (12mm \times 2layers)
- PMTs: ET 9123SA \times 2
- WLSF: 1.0mm ϕ
(2cm separation)



< SD Construction >



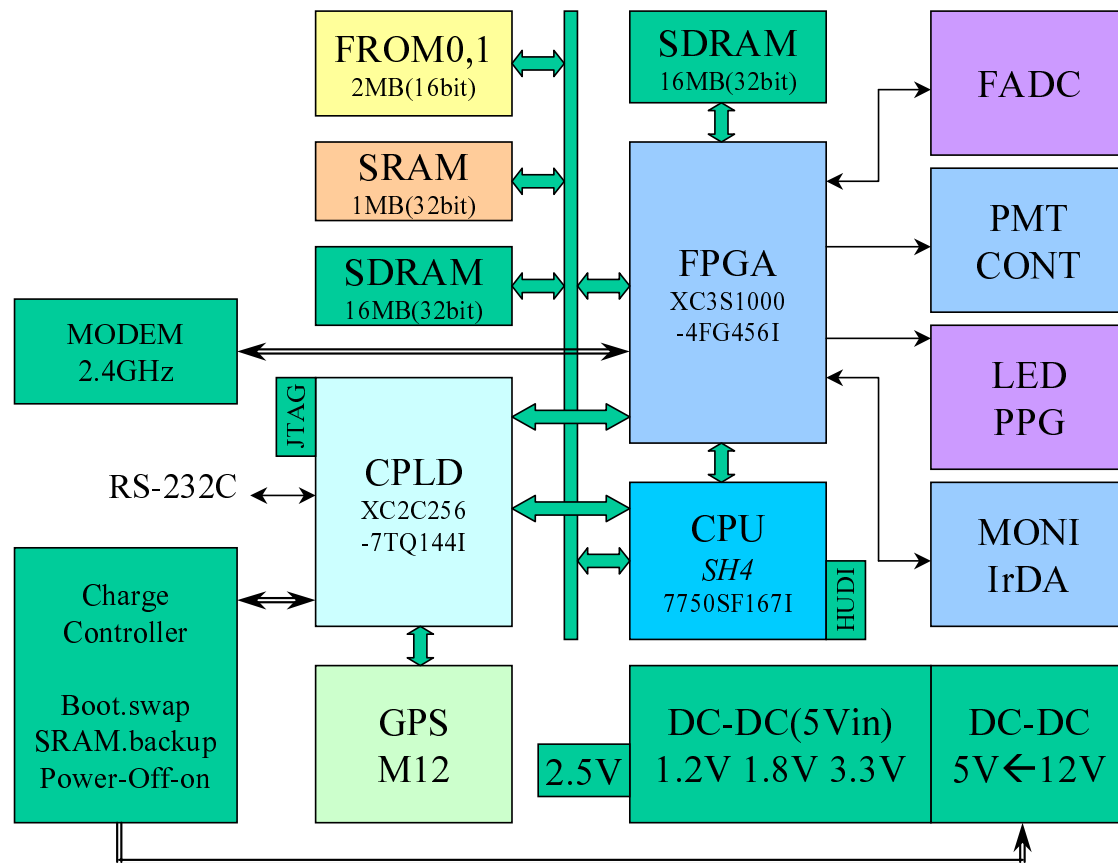
Upper & Lower layer are divided in



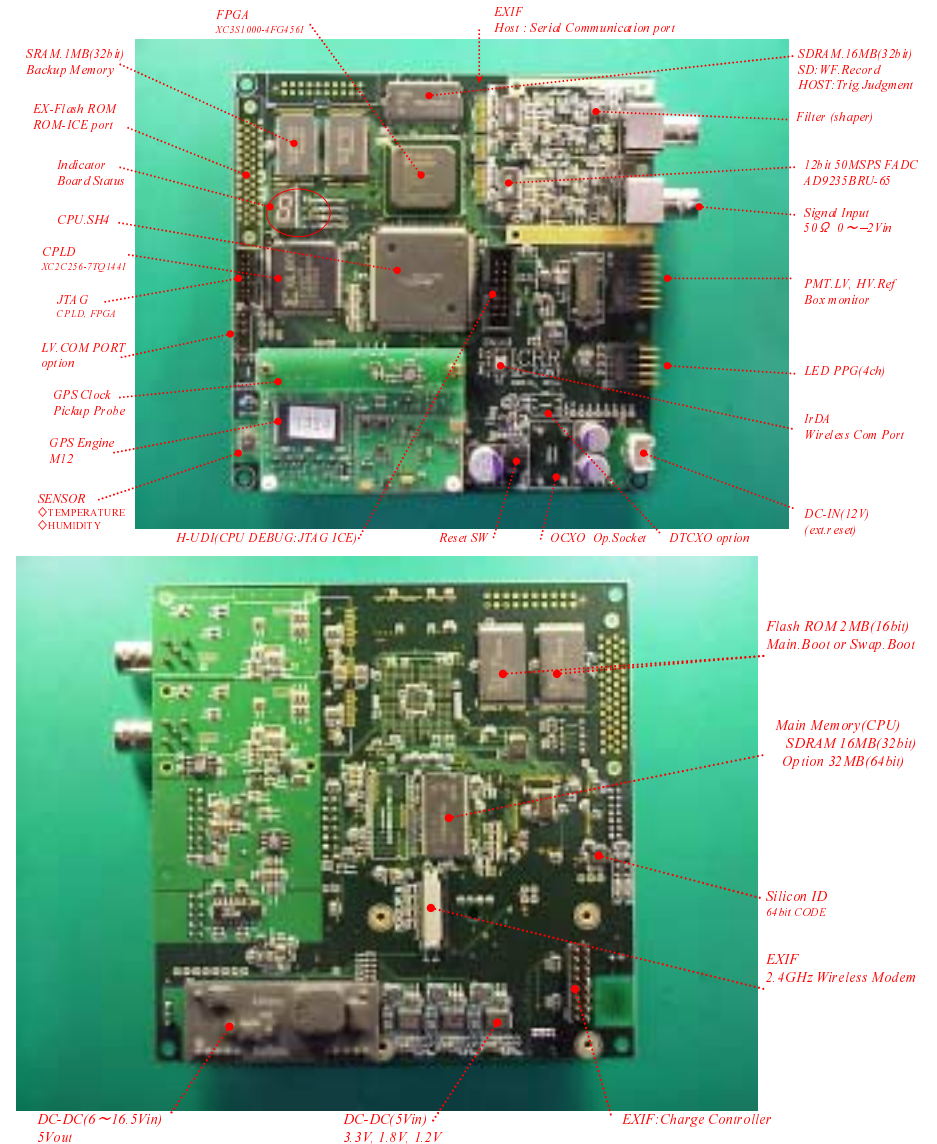
transported 246 SD boxes
and assembled in Delta, Utah



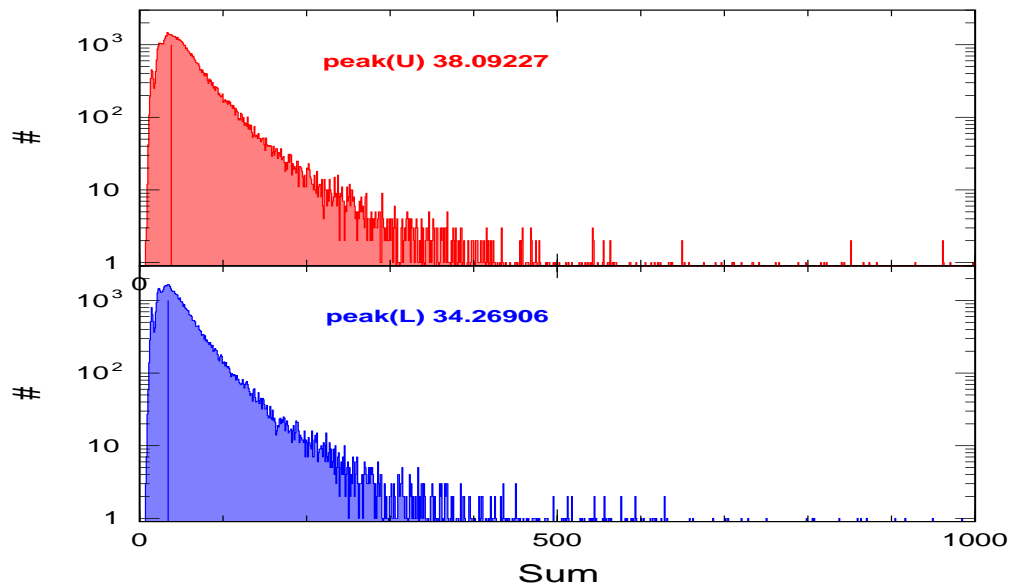
< SD Electronics >



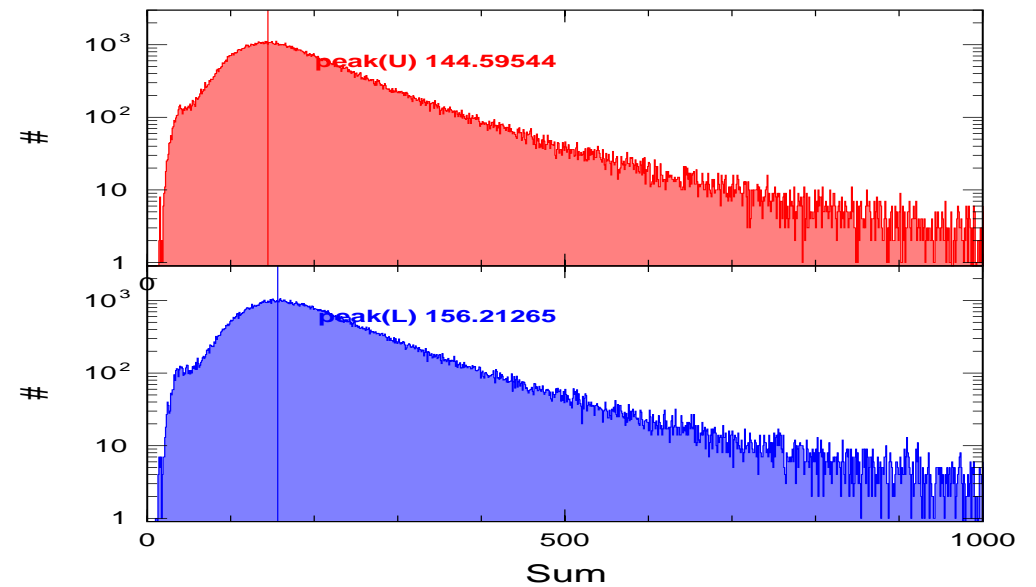
- **Input:** $0 \sim -2V$ ($Z_{in} = 50\Omega$)
- **Filter:** LowPass (9.7MHz -3dB)
- **FADC:** 12bits 50MSPS
- **Waveform:** $5.12\mu s \times 16K \text{ events} = 83ms$



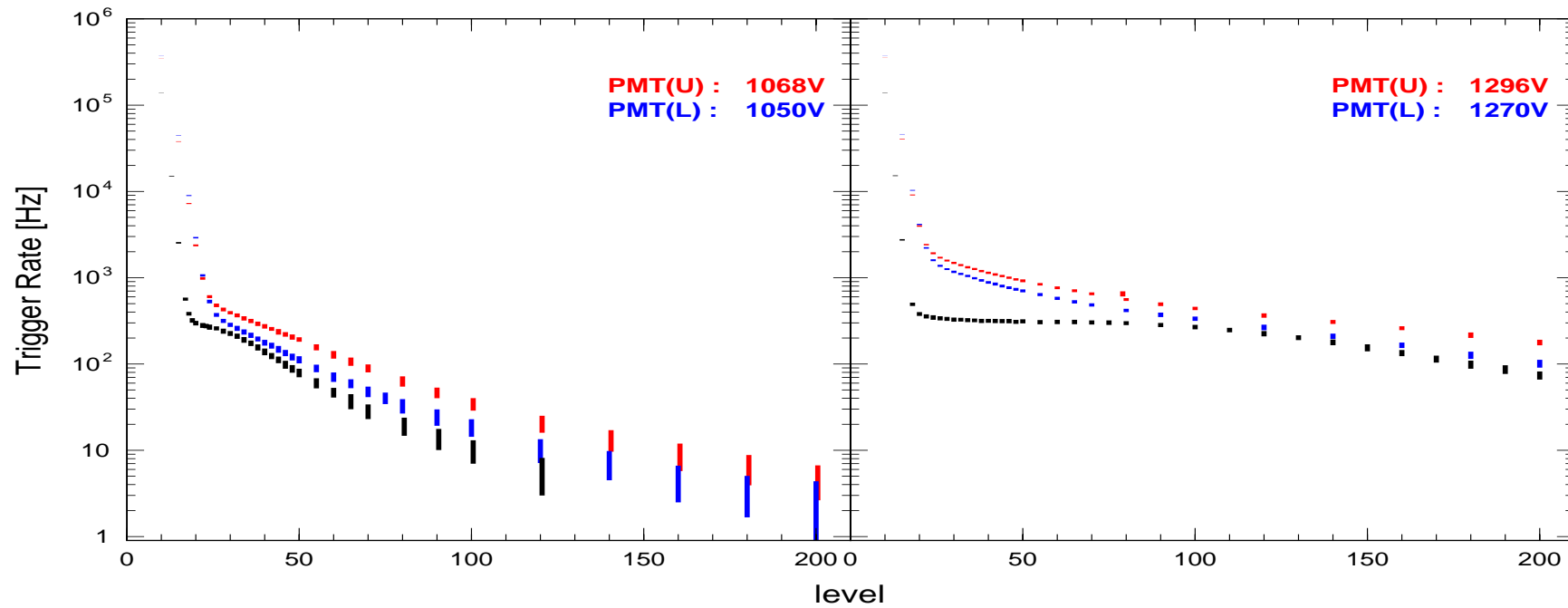
< SD 1 MIPs data >



SD #143 @ Gain 10^6



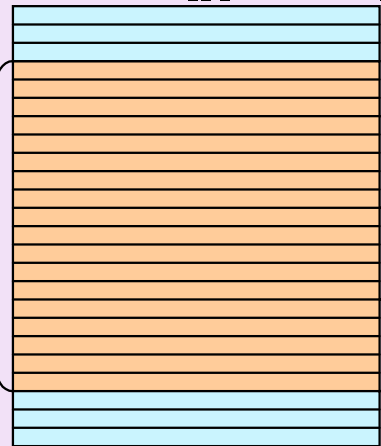
SD #143 @ Gain 4×10^6



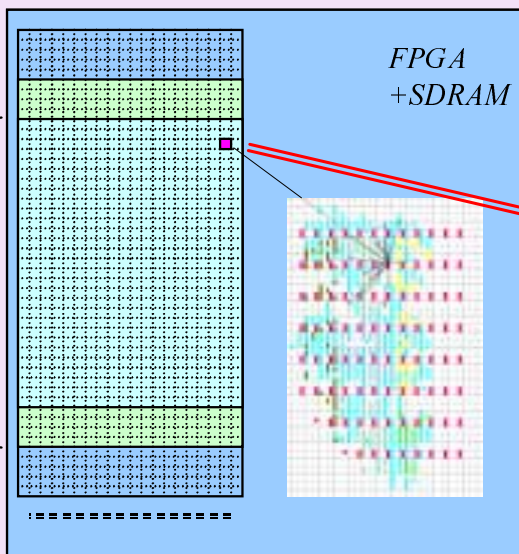
< SD Trigger Scheme (1/2) >

Host

Hit.TBL[][256x10]

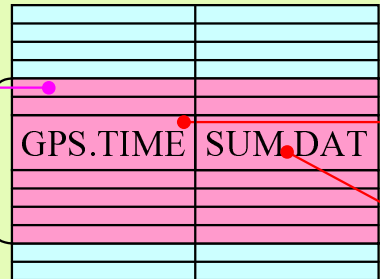


Trig Judgment

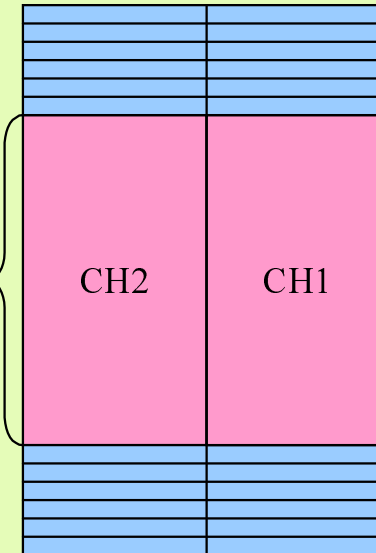


Detector

WF_TBL[32K][2]



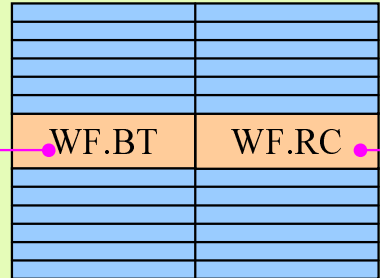
WF[32K][128]



Hit.time

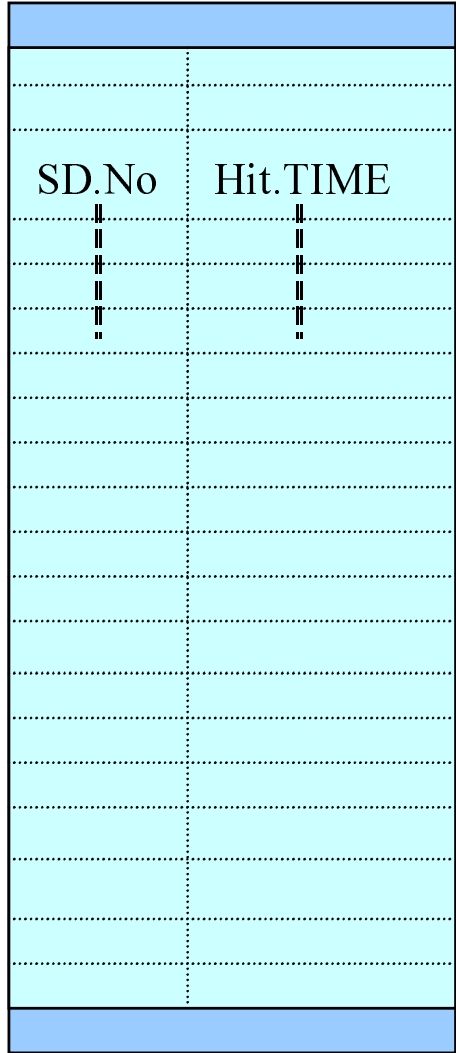
Search.time

WG_TBL[600][2]

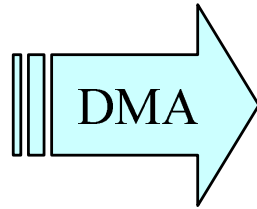


< SD Trigger Scheme (2/2) >

Hit.TBL[][256x10]

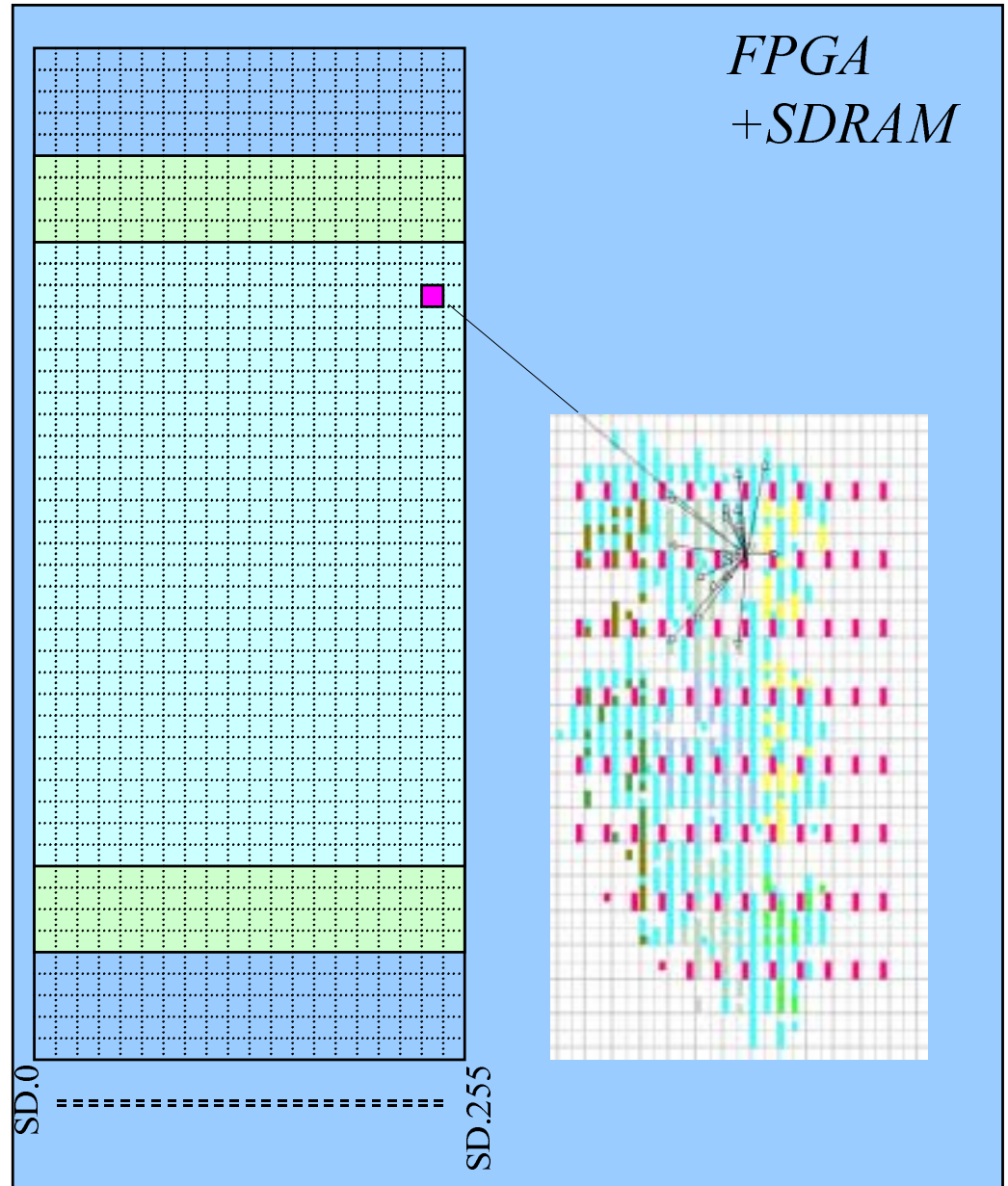


Hit.TBL[2560] T=100msec



100ms / 3.2us = 32K.Hit2Time.slot

Hit2Time.conv + Trig Judgment < 10msec

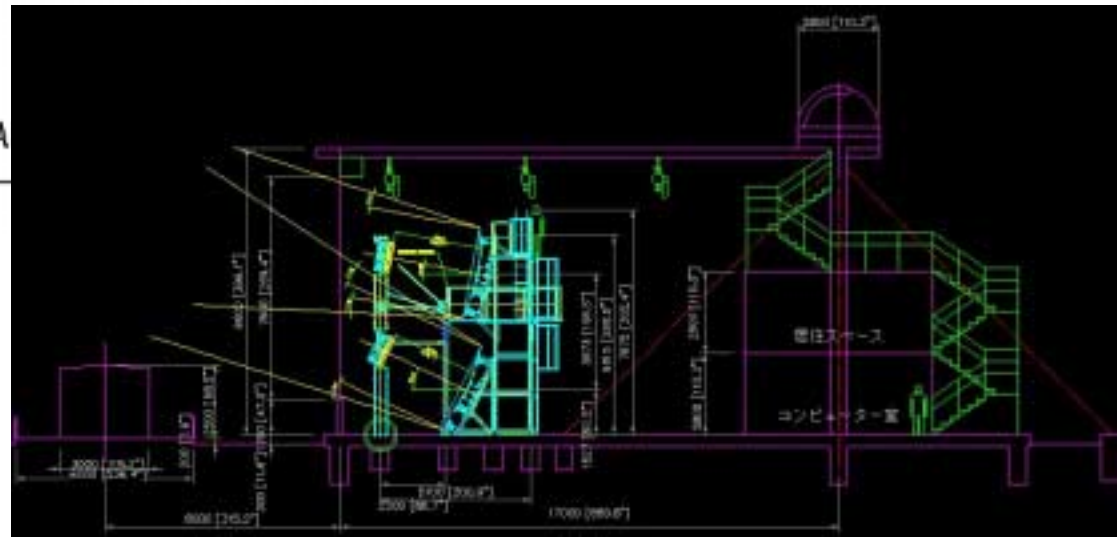
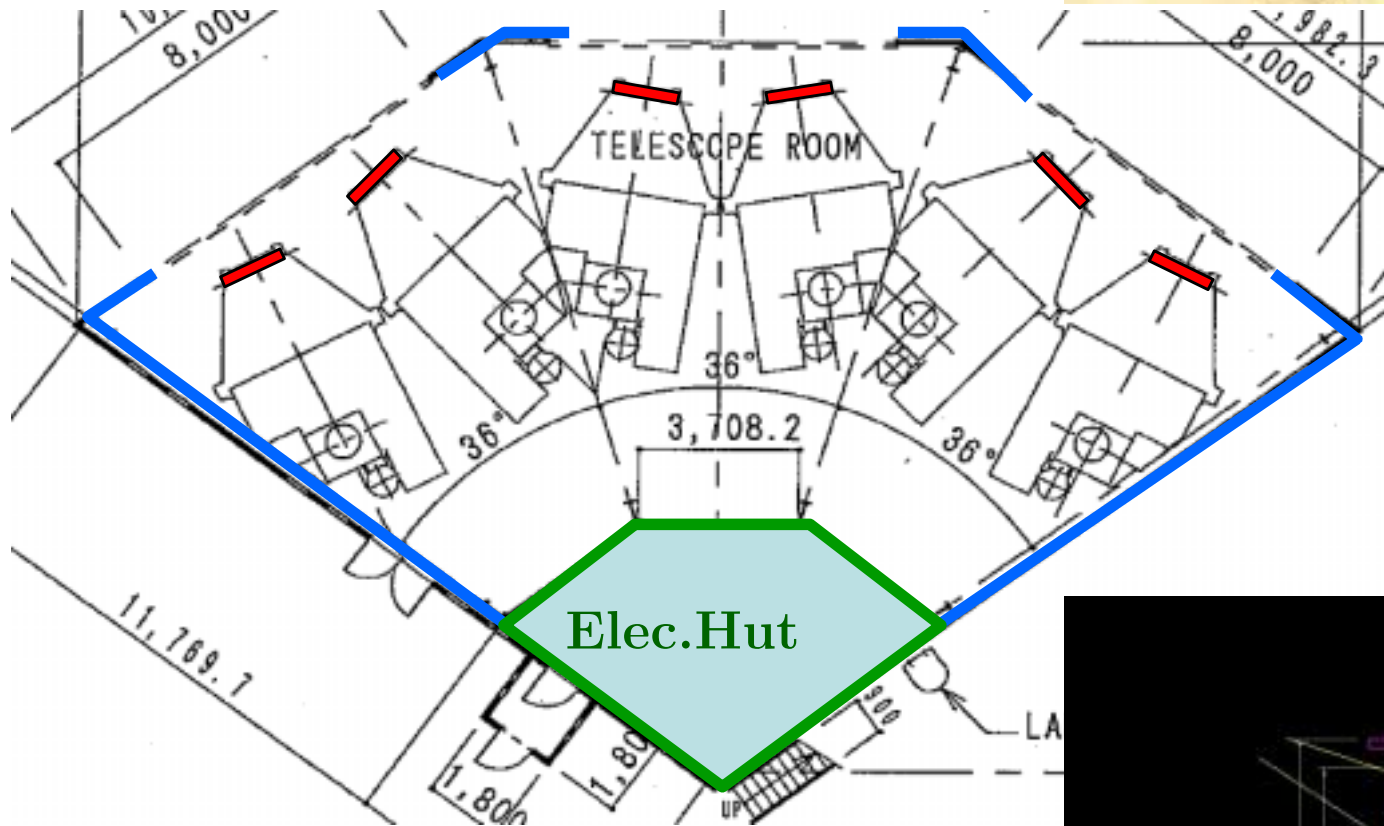
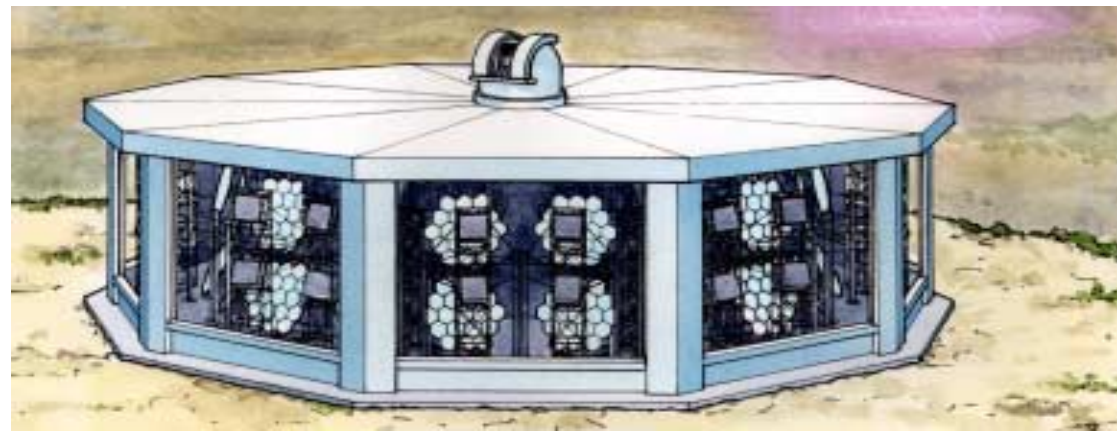


< FD Station Building >

Azm: $18^\circ \times 6 = 108^\circ$

Elv: $3^\circ \sim 18^\circ$ (Upper)

$17.7^\circ \sim 33^\circ$ (Lower)



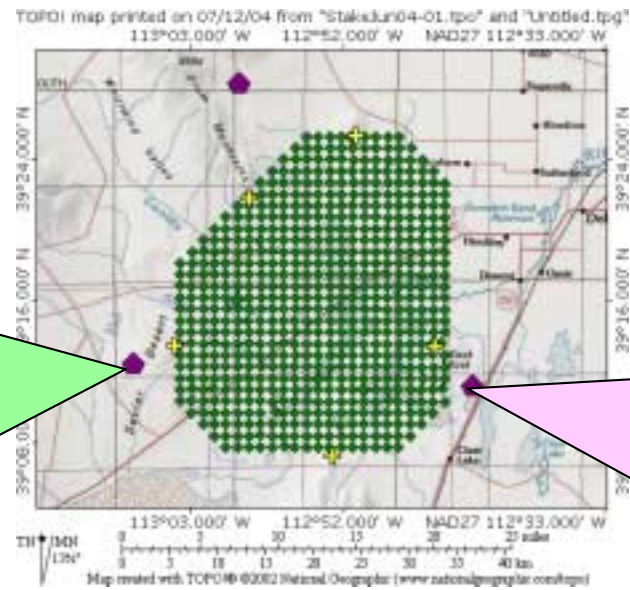
< FD Station Construction >

Long Ridge

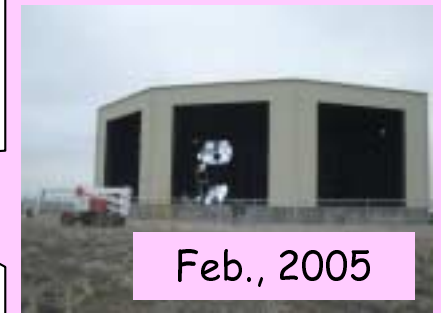


July, 2005

↓ HiRes as 3rd station



Black Rock Mesa

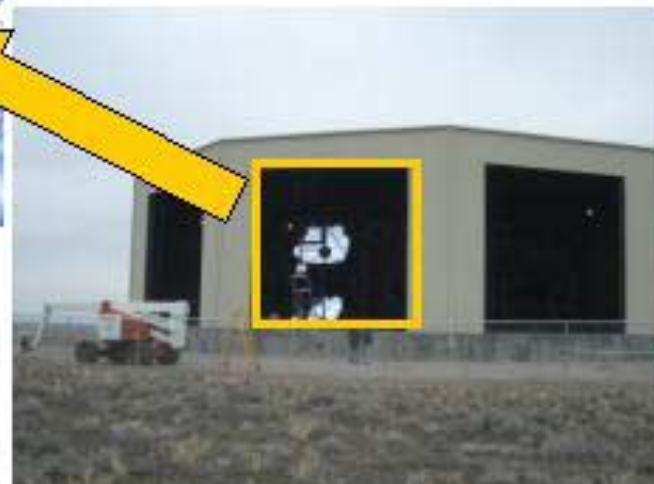
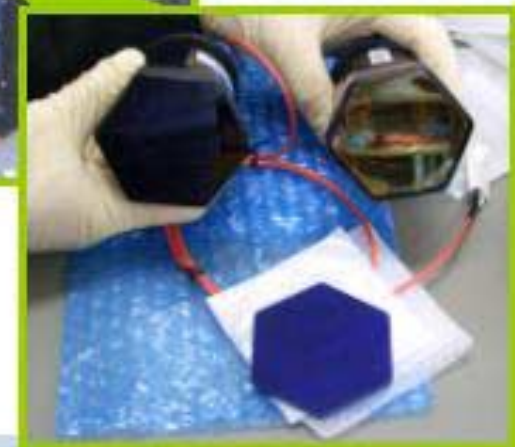
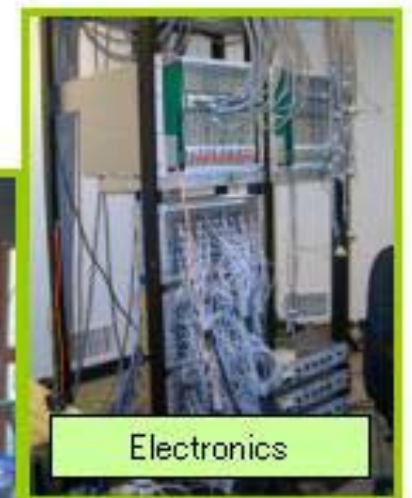
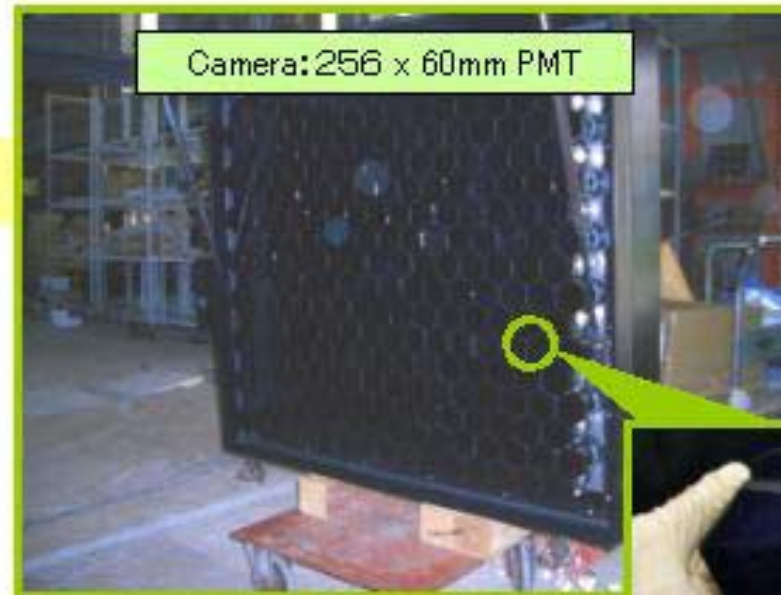
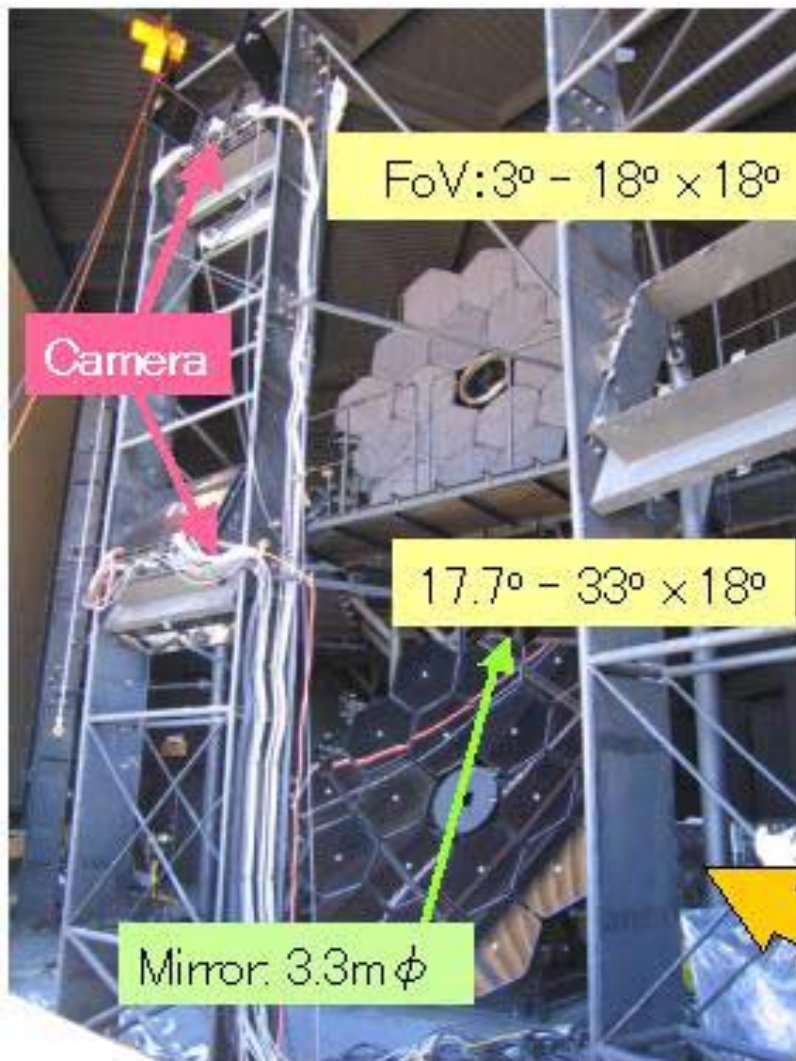


Feb., 2005

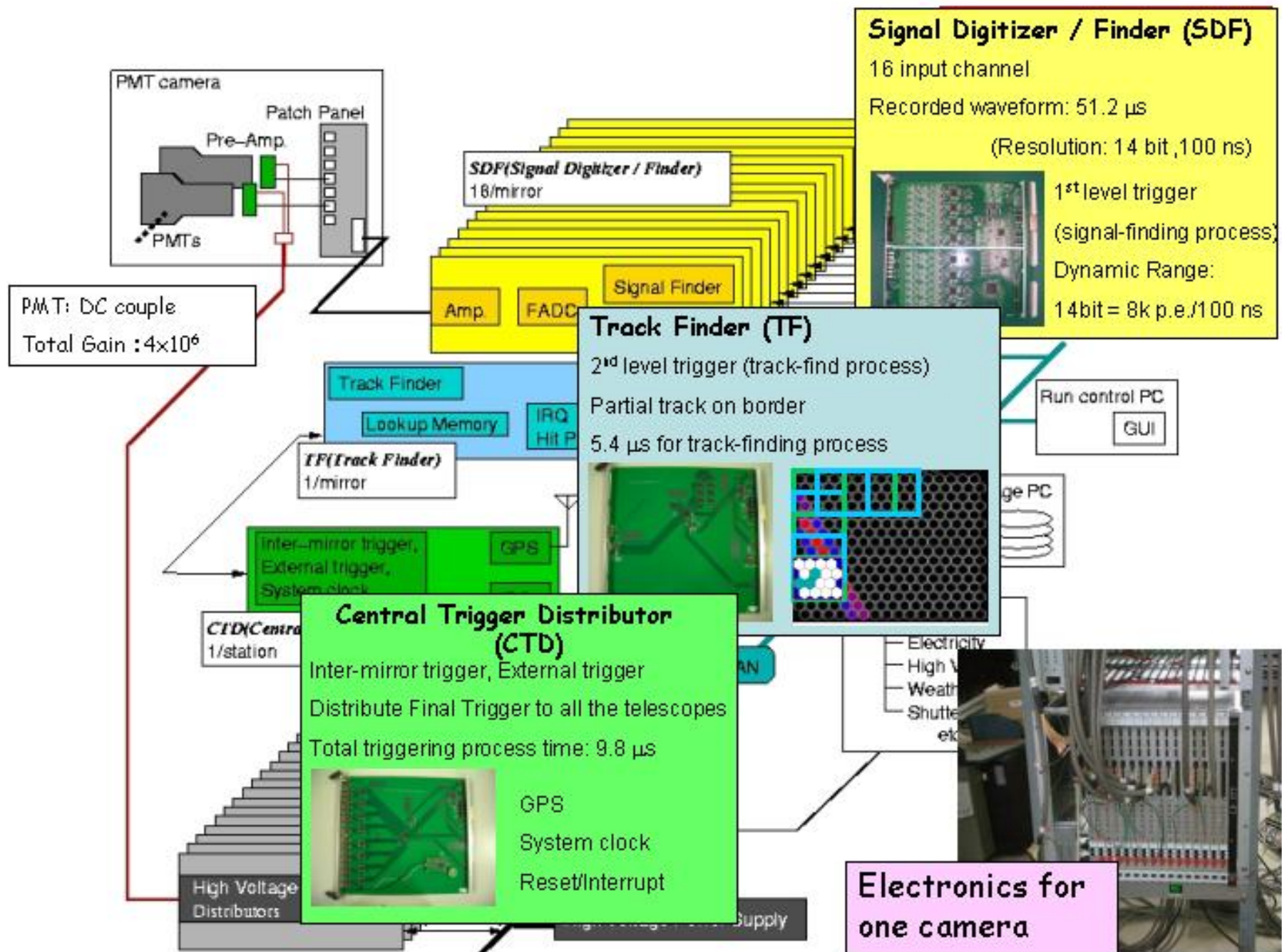
March, 2006



< Fluorescence Detector >



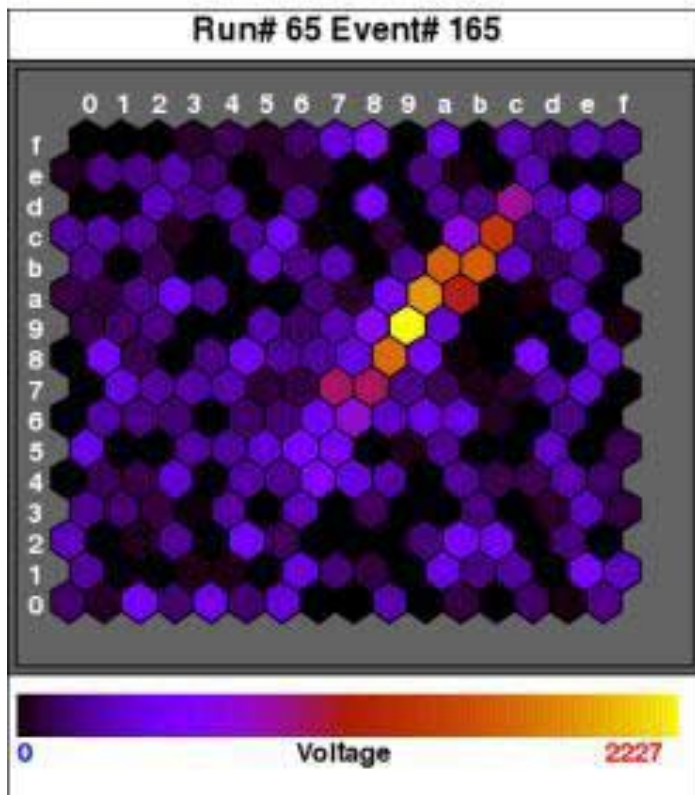
< FD Electronics >



< FD Test Observation >

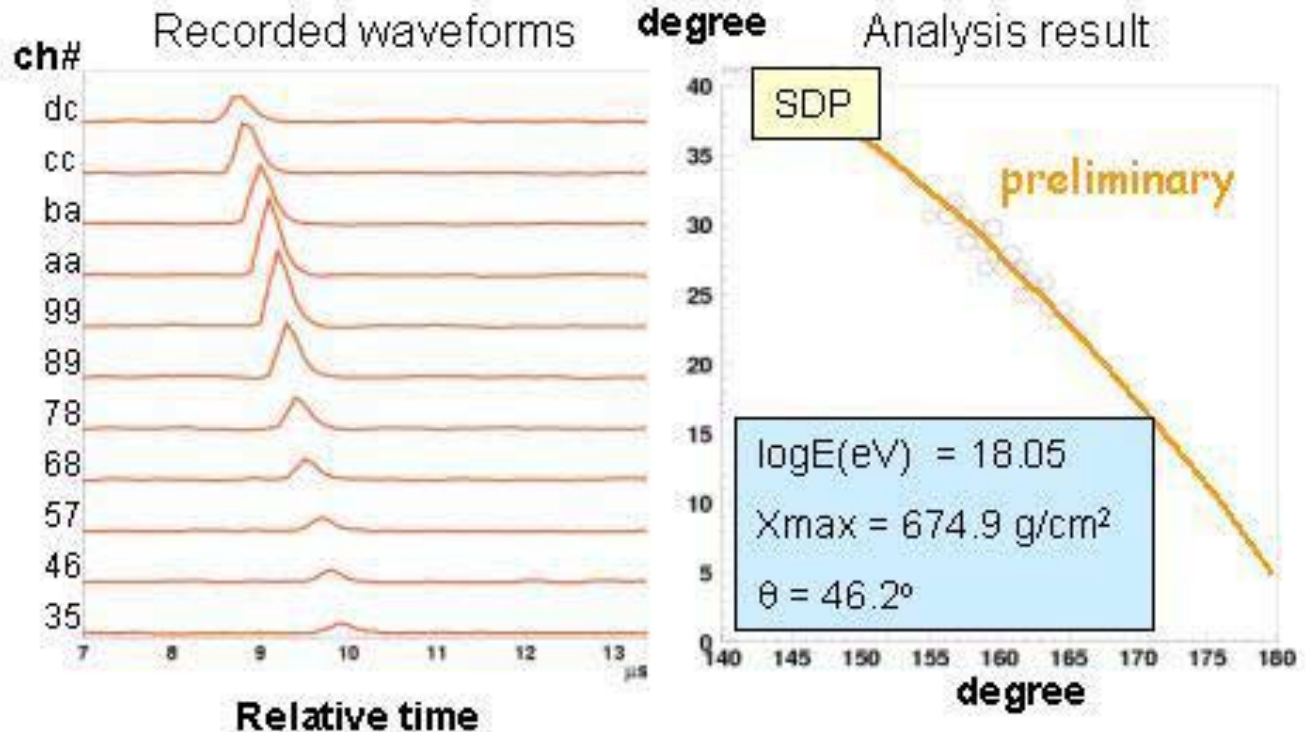
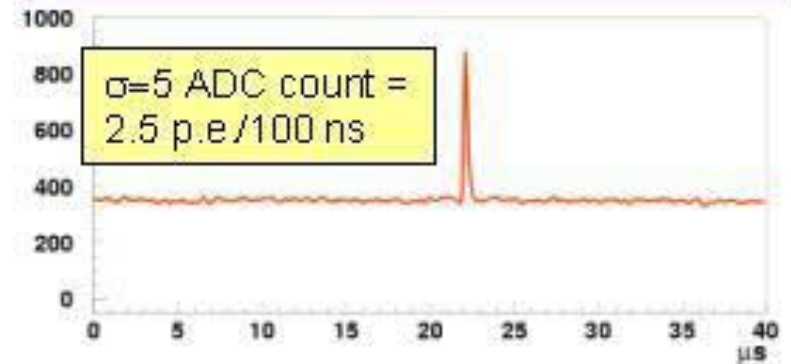
- ◆ 3-13 July, 2005 @ Black Rock Mesa site
- ◆ Single telescope with 256ch PMTs camera
- ◆ Total observation time: 31.5 hours
- ◆ 1st level trigger threshold: 6 – 6.5 sigma
- ◆ Trigger rate: 0.6 – 1.5 Hz

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



Typical waveform with fluorescence light

(RUN65, TRIG165, CH89)



< FD Calibration Scheme >

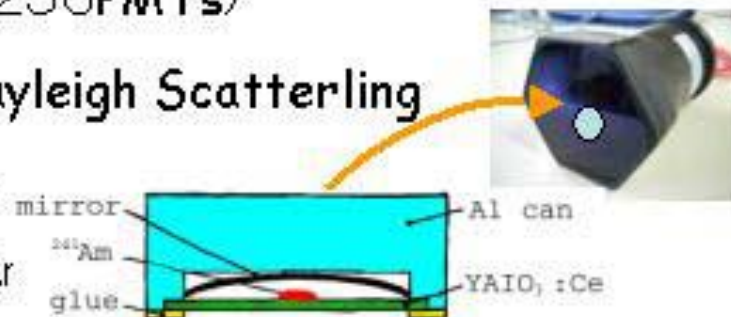
□ Absolute Calibration

3PMTs / 1 camera (256PMTs)

CRAYS: Laser + Rayleigh Scatterling

YAP: stable source

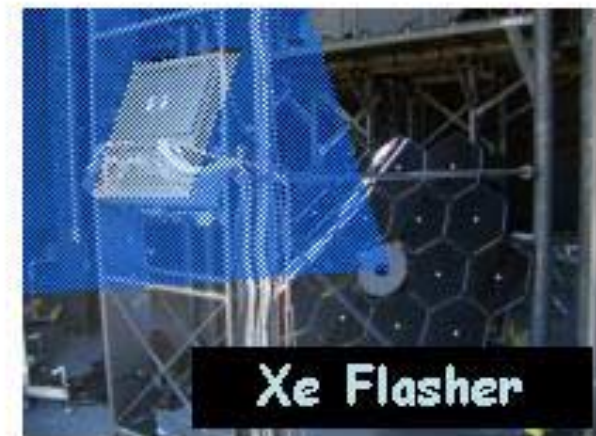
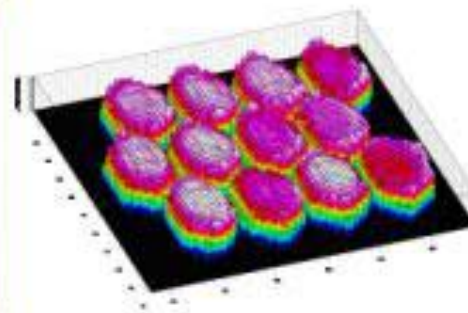
YAP ($\text{YAIO}_3:\text{Ce}^{241}\text{Ar}$)



□ Relative Calibration

Xe Flasher : Gain calibration + HV adjust.

XY Scanner : 2D uniformity check



UV LED (365nm, ϕ 4mm) \times 8, 1mm accuracy

< Atmospheric Monitoring >

back scattering (LIDAR)

$$P = P_0(\Delta l) \frac{A}{4\pi R^2} T \frac{d\sigma_{\theta=180}}{d\Omega}$$

$$T = \exp\left[-2 \int_0^R \sigma(r') dr'\right]$$

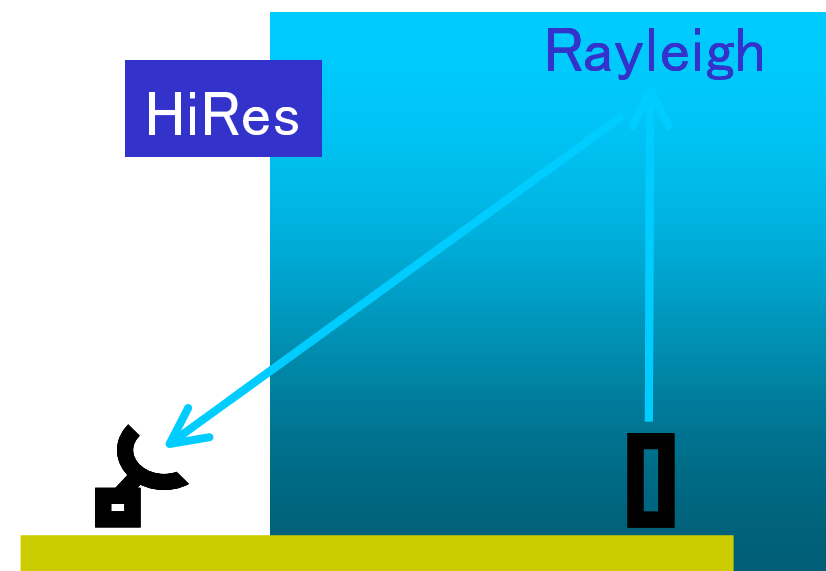
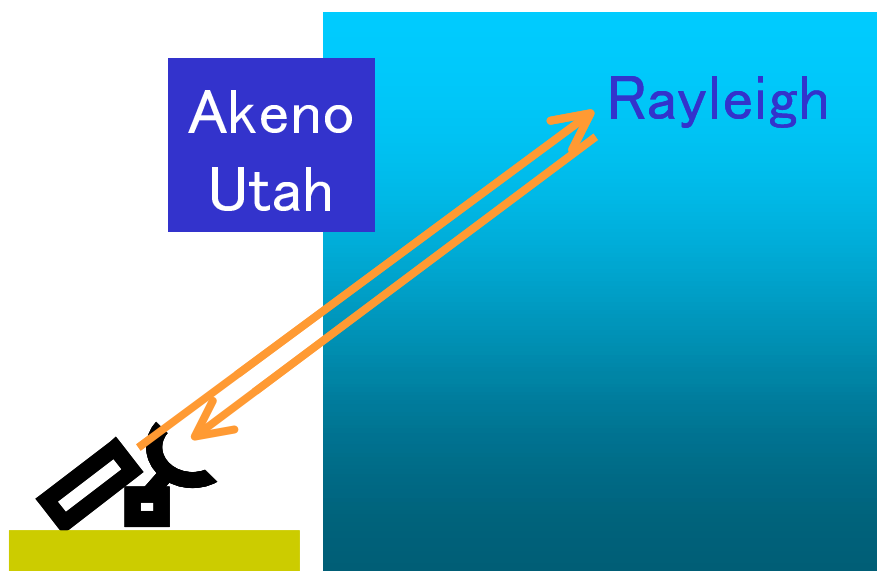
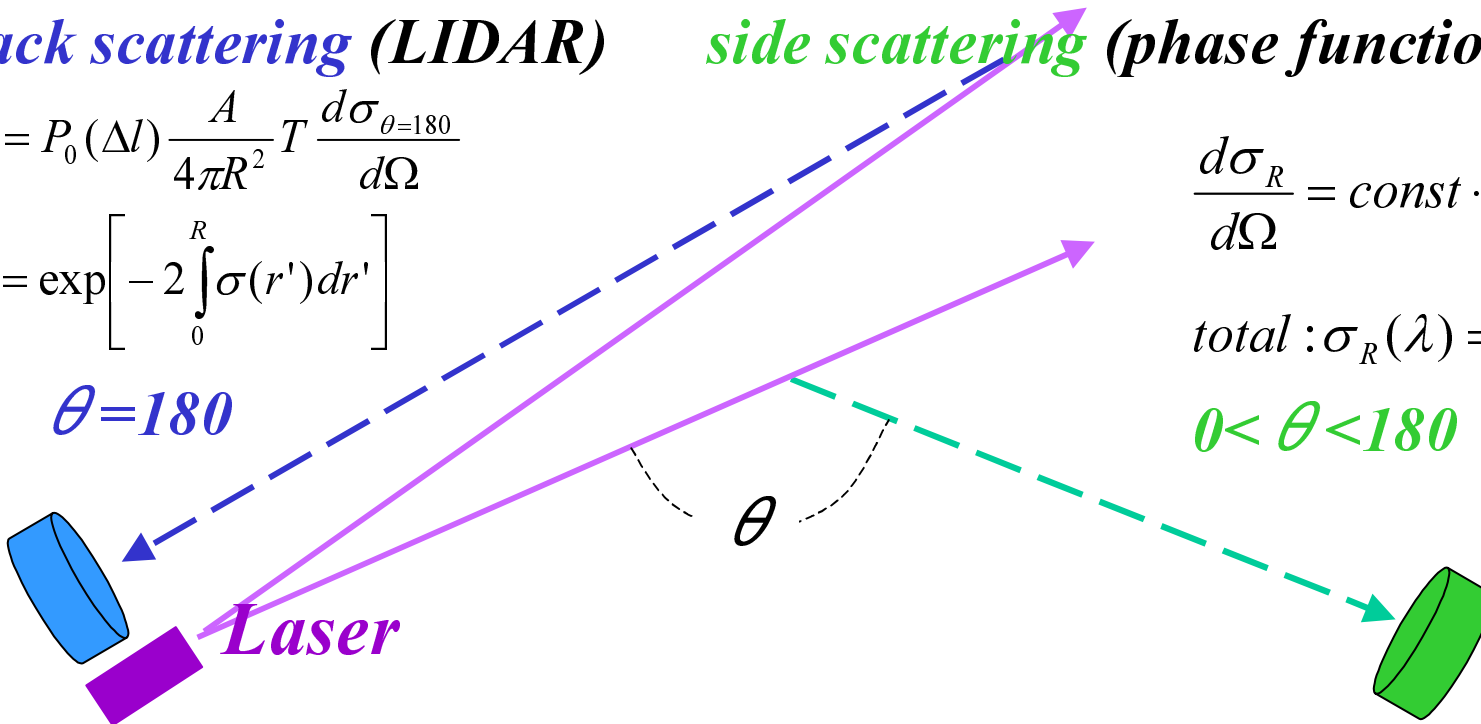
$\theta = 180$

side scattering (phase function method)

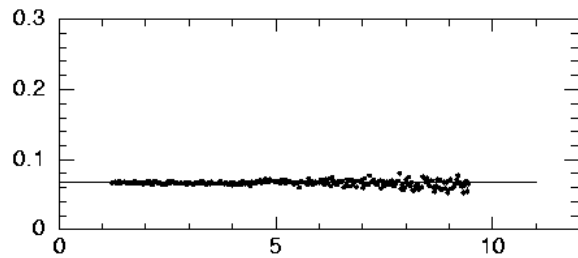
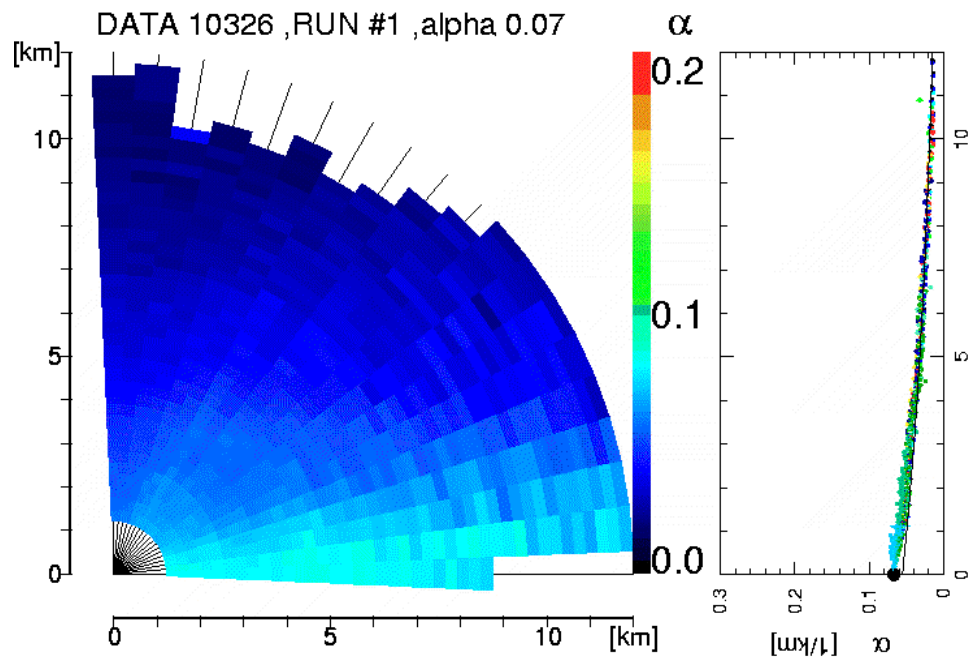
$$\frac{d\sigma_R}{d\Omega} = \text{const} \cdot (1 + \cos^2 \theta)$$

$$\text{total : } \sigma_R(\lambda) = \frac{8\pi}{3} \sigma_{\theta=\pi}$$

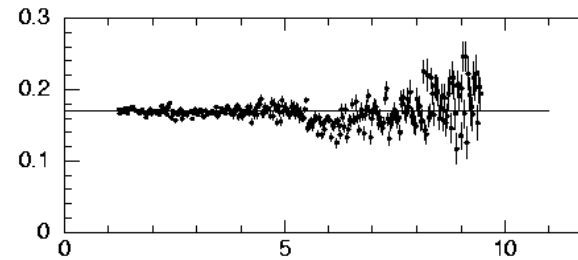
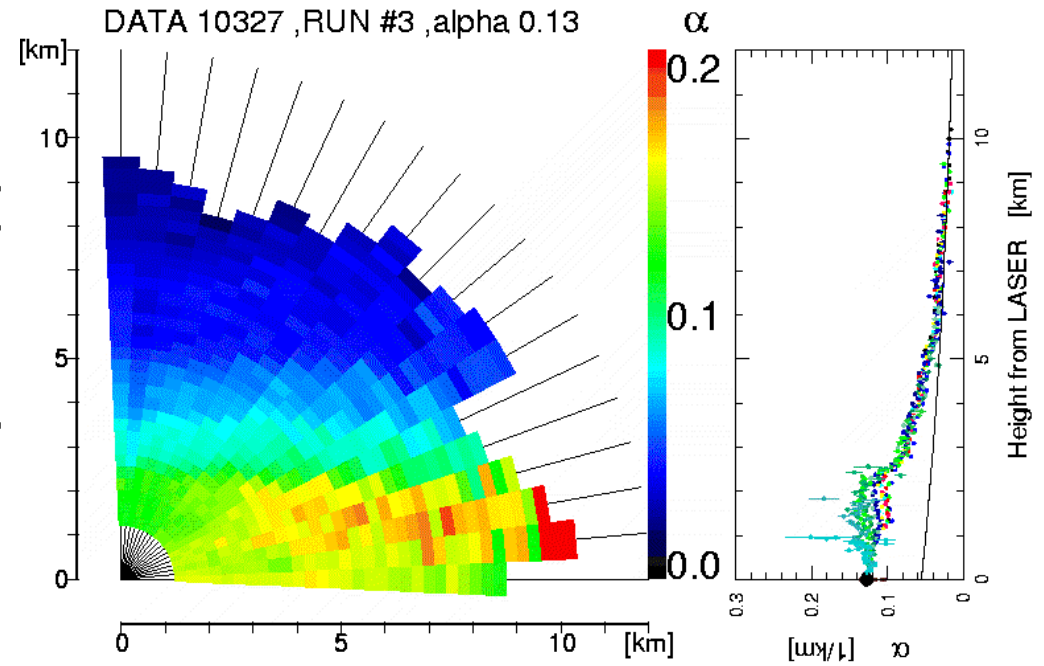
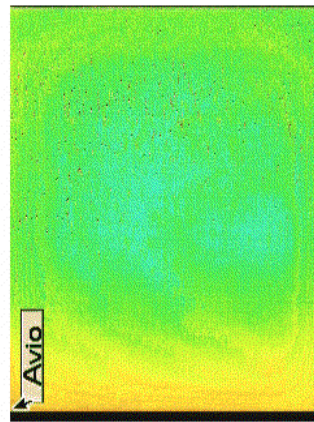
$0 < \theta < 180$



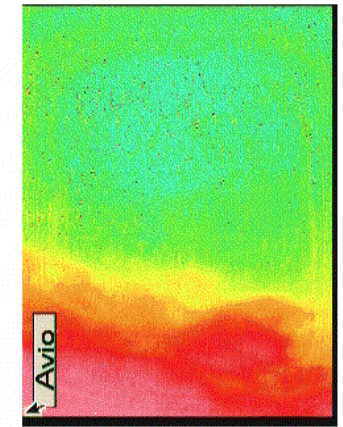
< Atmospheric Monitoring @ Akeno >



Clear Night



Hazy Night



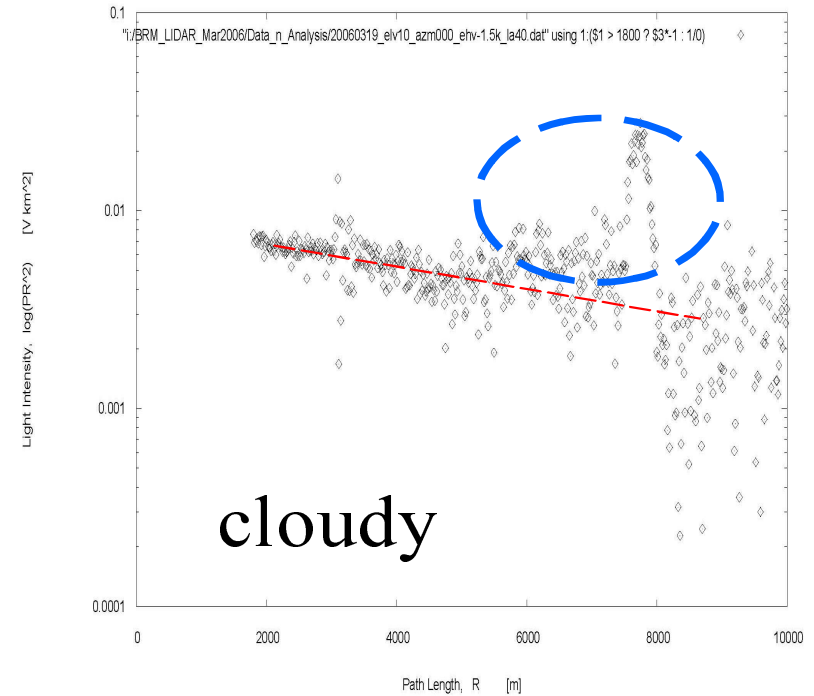
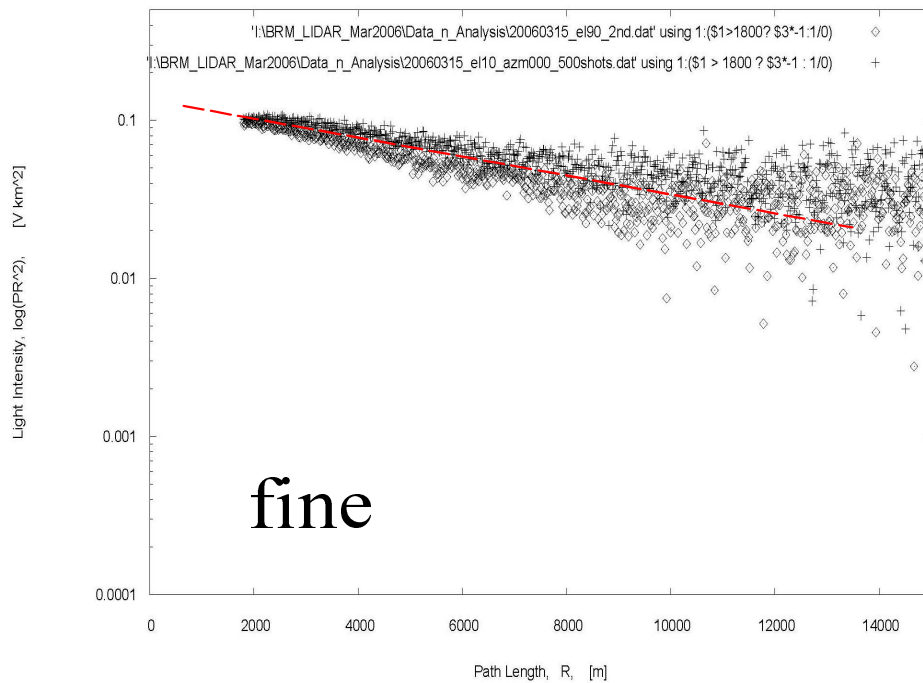
< Atmospheric Monitoring @ Delta >



LIDAR data at Black Rock Mesa : 20060315, elev=10, 90deg, 500shots

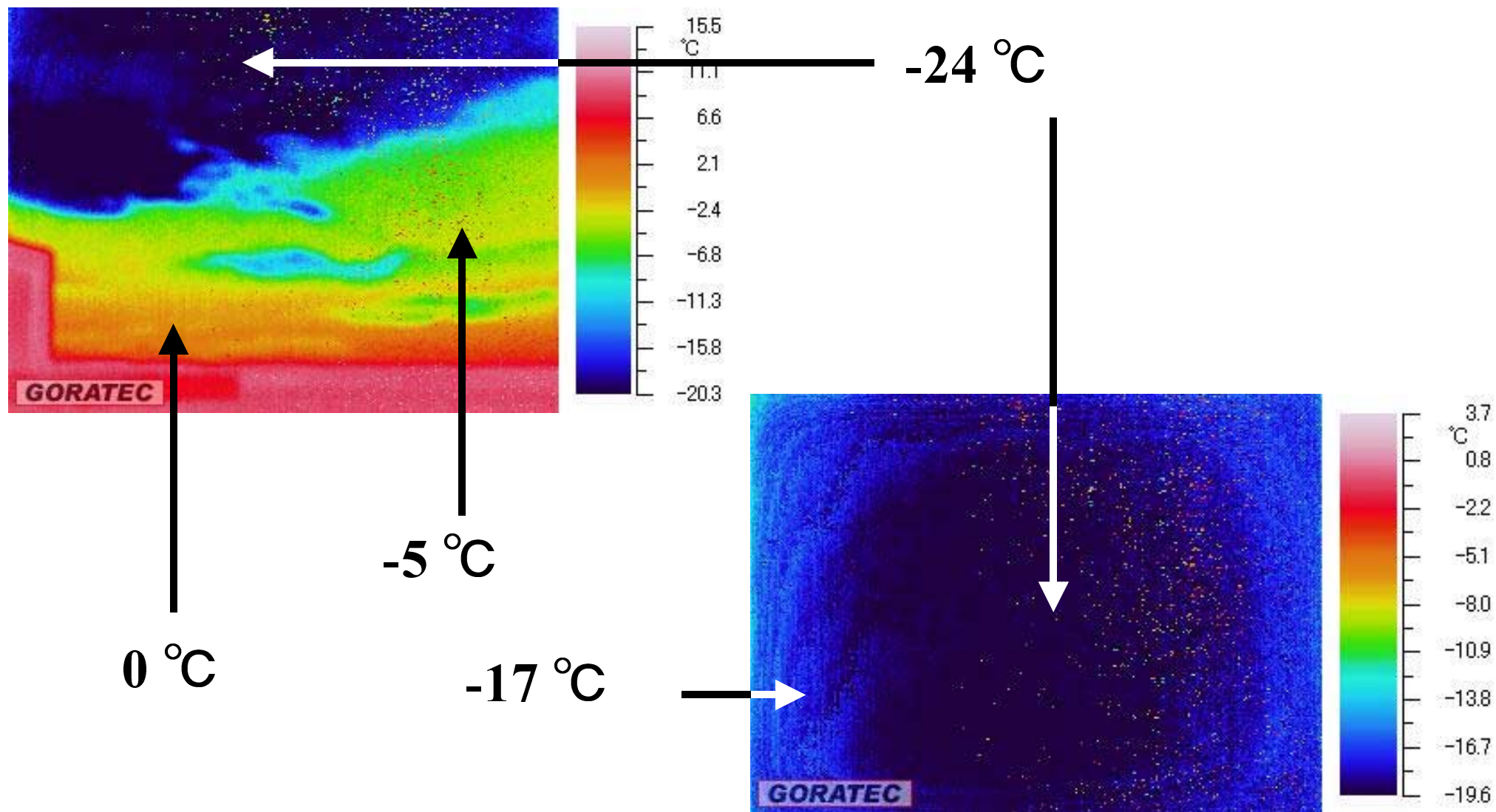


LIDAR data at Black Rock Mesa : 15/Mar/2006 elevation 10, 45deg, 500shots

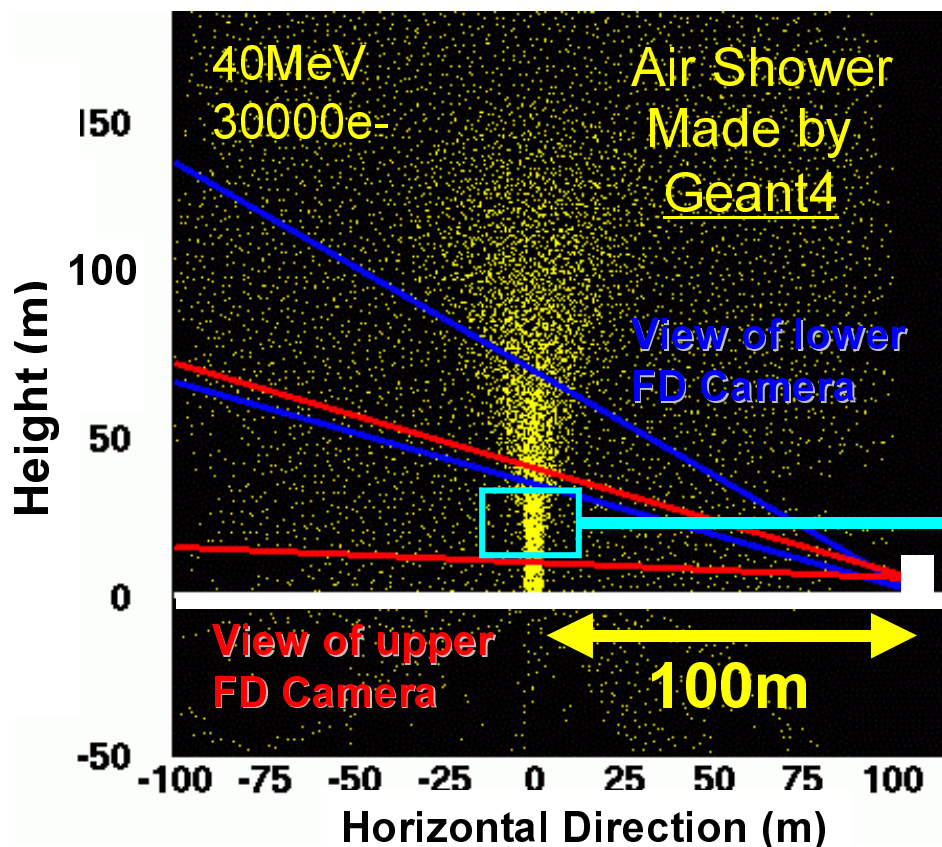


< Cloud Monitoring @ Delta >

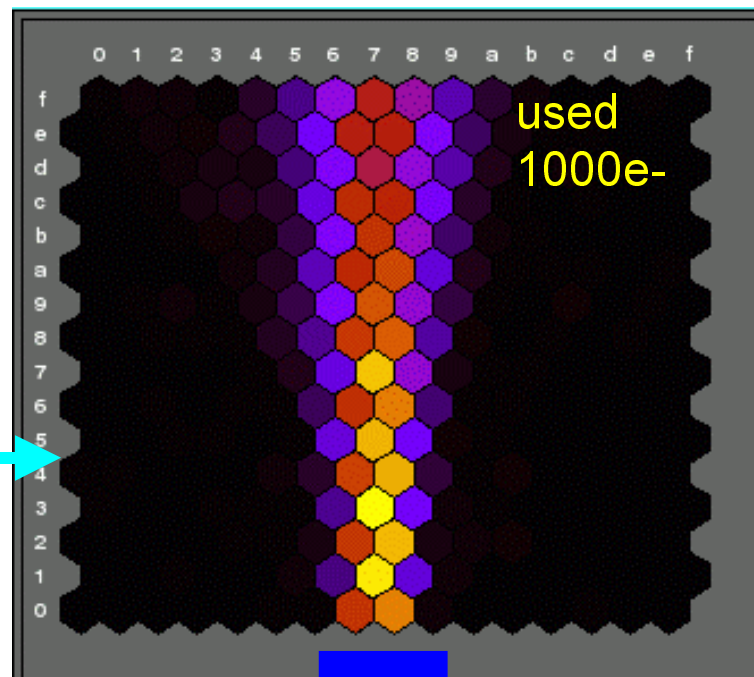
- Sensitivity: $8\mu\text{m}-14\mu\text{m}$ ($-20^{\circ}\text{C}-300^{\circ}\text{C}$)
- FoV: $25.8^{\circ}(\text{H})\times 19.5^{\circ}(\text{V})$ (320×236 pixels)



< LINAC for End-to-End Calibration >



Air Shower event made by Geant4



Spec of Linac Beam

Energy : 40MeV($\pm 1\%$)

Option : 10,20,30MeV

Frequency : 1Hz

Current : $10^9 e^-$ (0.16mA)

Power : 6.4mJ/pulse

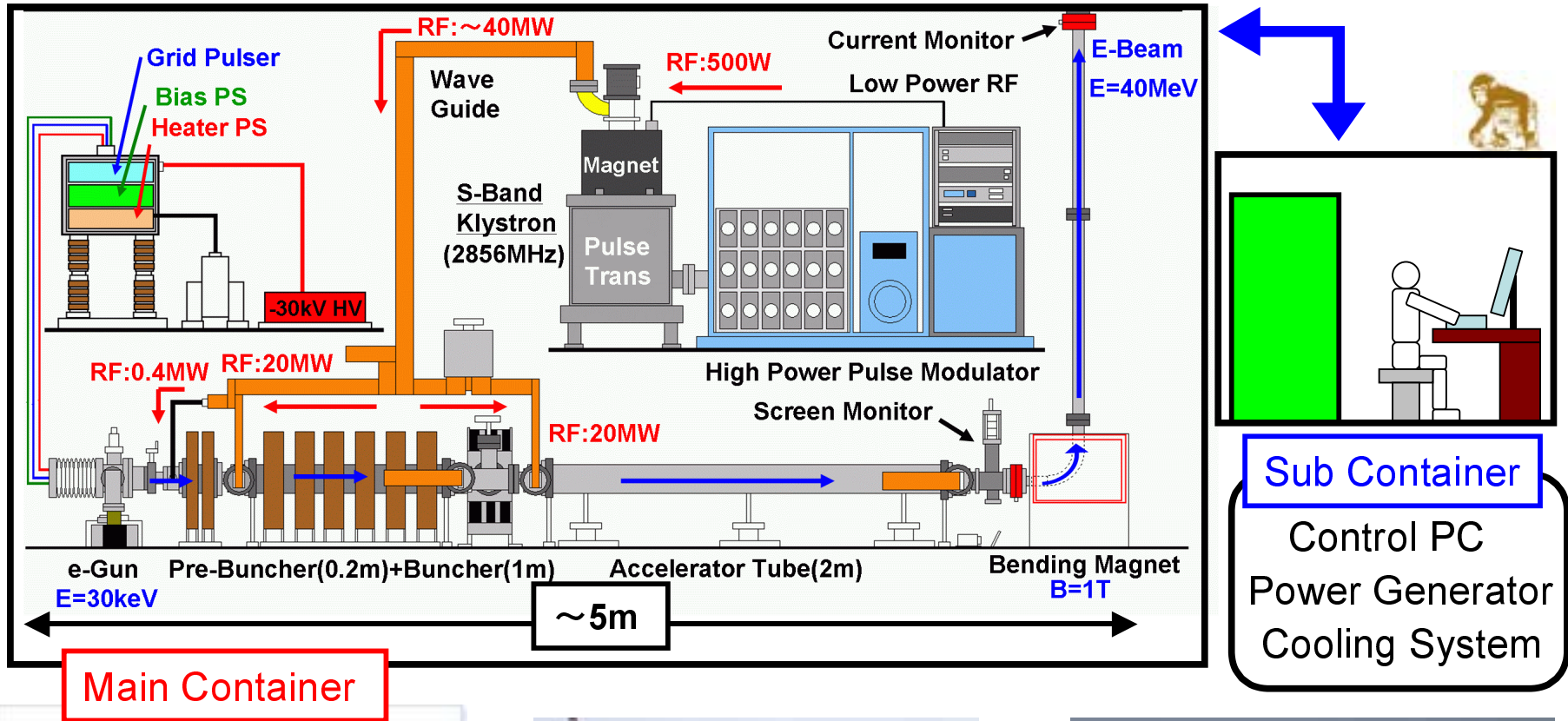
$$(\text{ADC})^{\text{DATA}} \rightarrow (\Delta E)^{\text{DATA}}_{\text{recon}}$$

|| ? || ?

$$(\text{ADC})^{\text{MC}} \rightarrow (\Delta E)^{\text{MC}}_{\text{recon}}$$

We know ! $= (\Delta E)^{\text{MC}}_{\text{true}}$

< LINAC Design >

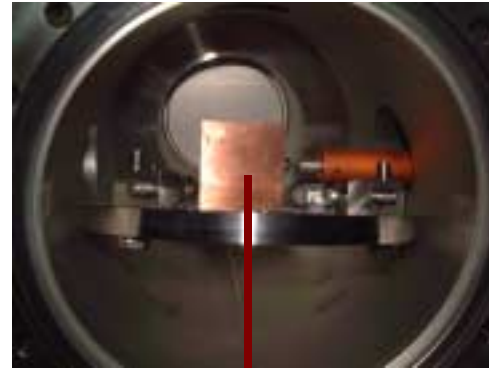
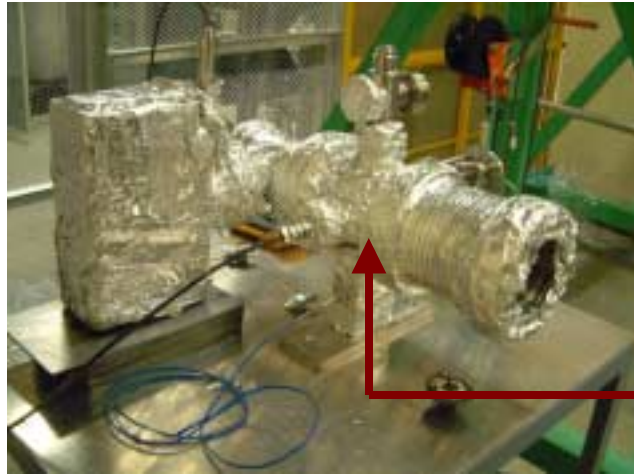


?
or



< LINAC Lab.Test >

Electron Gun Test @ KEK (Feb.2006 – Mar.2006)



Beam Capture (Cu)

Setup Value

HV DC -30kV

Grid Pulse -110V

Bias Voltage +50V

Frequency 10-30Hz

Vacuum 1.5×10^{-5} Pa

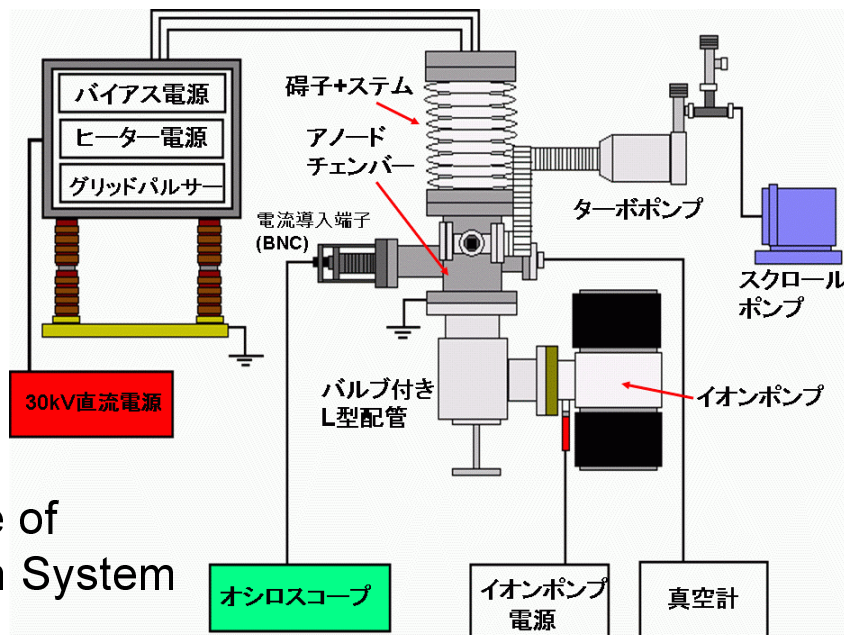
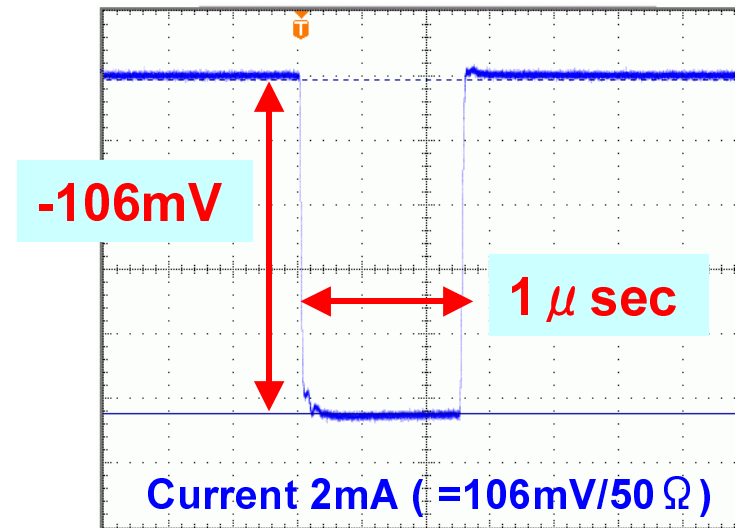


Figure of E-Gun System



Waveform of E-Gun Beam Signal

< TA Status Summary & Schedule >

- Site preparation is done.
- 1st mass production & assembly in JAPAN:
 - SD: completed
 - FD: in progress
- This summer,
 - About 130 SDs are deployed in Delta Desert.
 - FD assembly & observation will start at BRM.
- This year, we hopefully obtain EHE events with FD+SD hybrid method.

< TA “old” Members in Delta Desert >

We are small collaboration, but now many “young” PDs & students join us.



2003/10/28