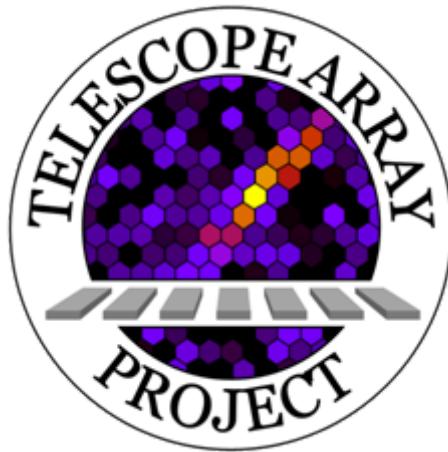


テレスコープアレイ実験 (宇宙線望遠鏡の調整と観測)



東京工業大学
常定 芳基

共同研究者

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(o) Waseda University, Shinjuku, Tokyo, 169-8050 Japan

(p) Tokyo Institute of Technology, Meguro-ku, Tokyo, 152-8550 Japan

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(s) University of Utah, 115 S 1400 E, Salt Lake City, UT 84112, USA

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(u) Yamanashi University, 4-4-37 Takeda, Kofu, Yamanashi, 400-8510 Japan

(v) Tokyo Univ. of Science, Noda, Chiba, 278-8510 Japan

(w) Utah State University, Logan, UT 84322-1400, USA

(x) University of Denver, Denver, CO 80208, USA

(y) University of Hawai'i System, Manoa, Hawai'i, USA

(z) Los Alamos National Lab., Los Alamos, NM, USA

(O) Yonsei University, Seoul 120-749, South Korea

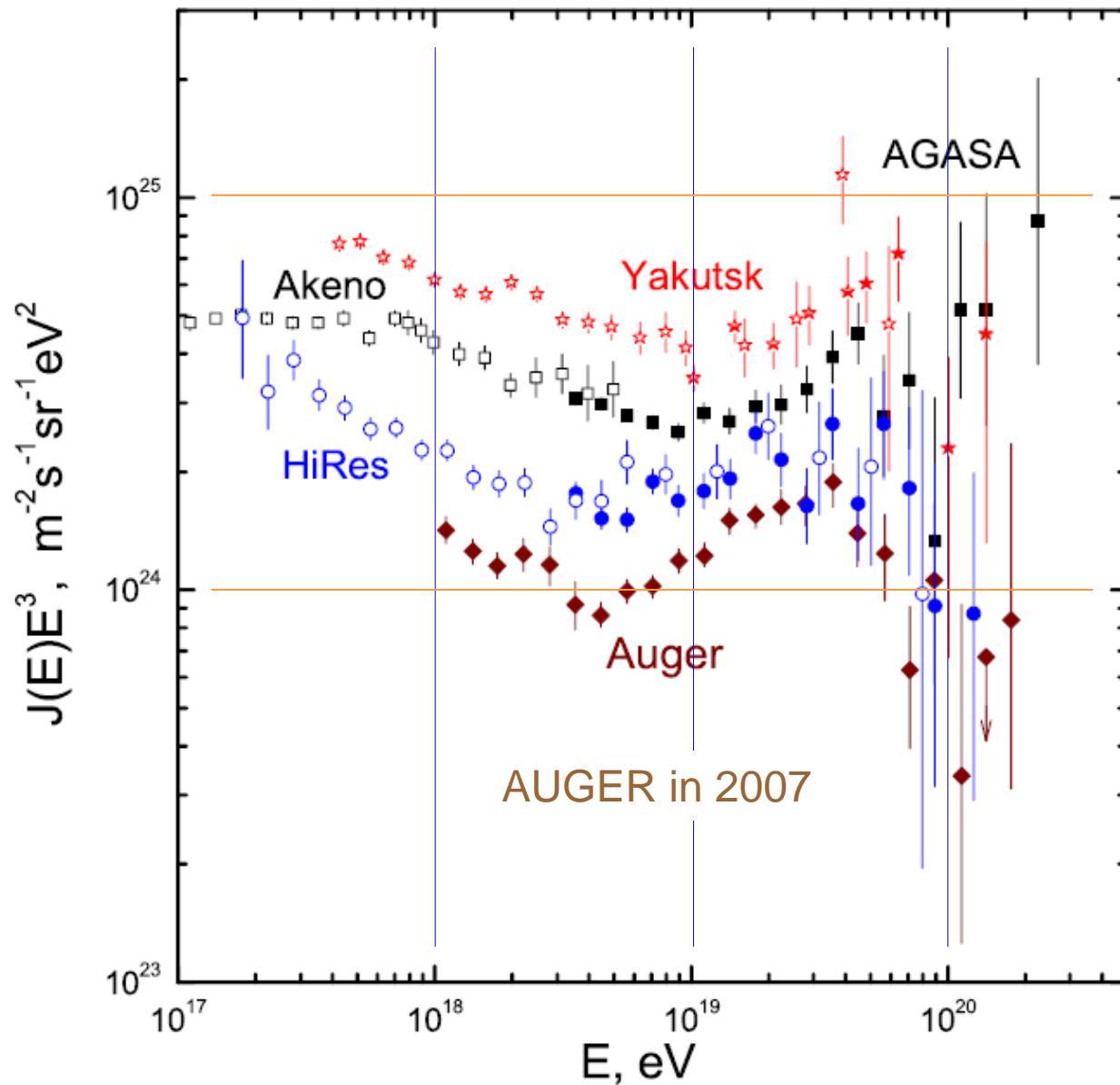
(1) Hanyang University, Seoul 133-791, South Korea

(2) Ewha Womans University, Seoul 120-750, South Korea

(3) Tata Institute of Fundamental Research, Mumbai 400005, India

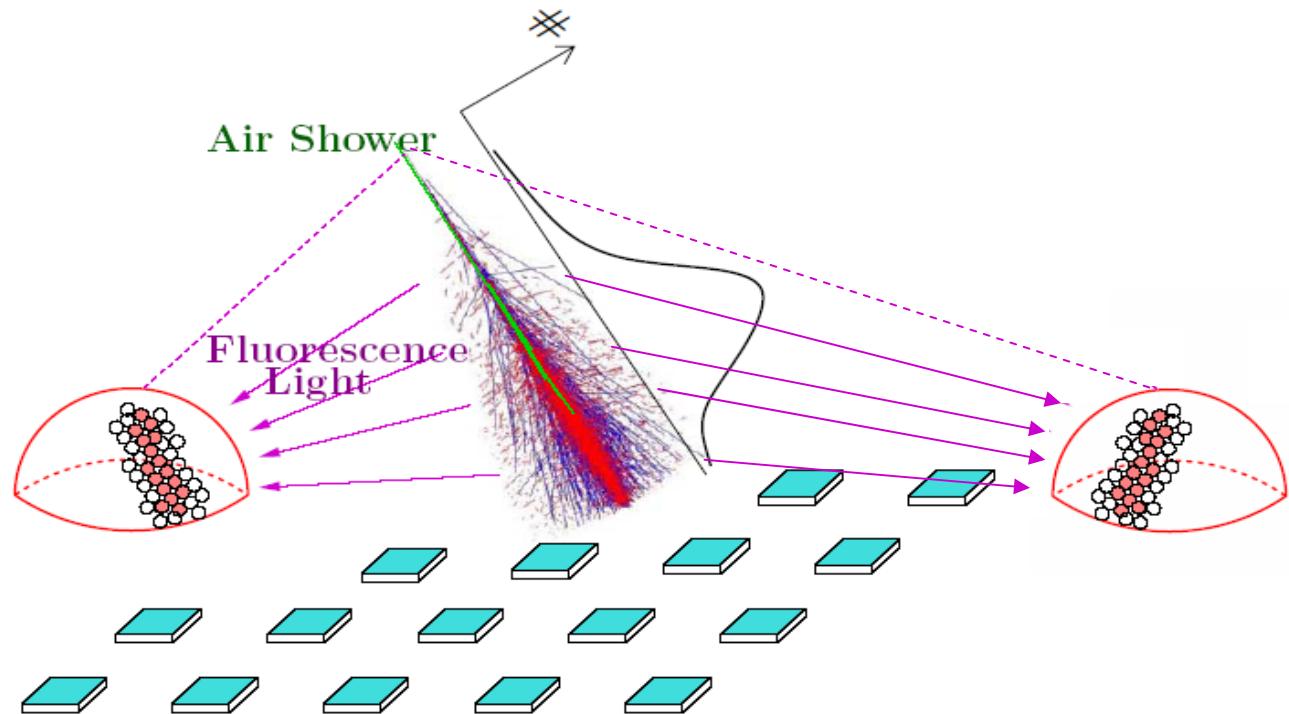
26の研究所/大学(日本、米国、韓国)
約120名

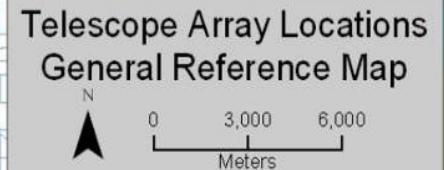
最高エネルギー領域宇宙線のエネルギースペクトラム



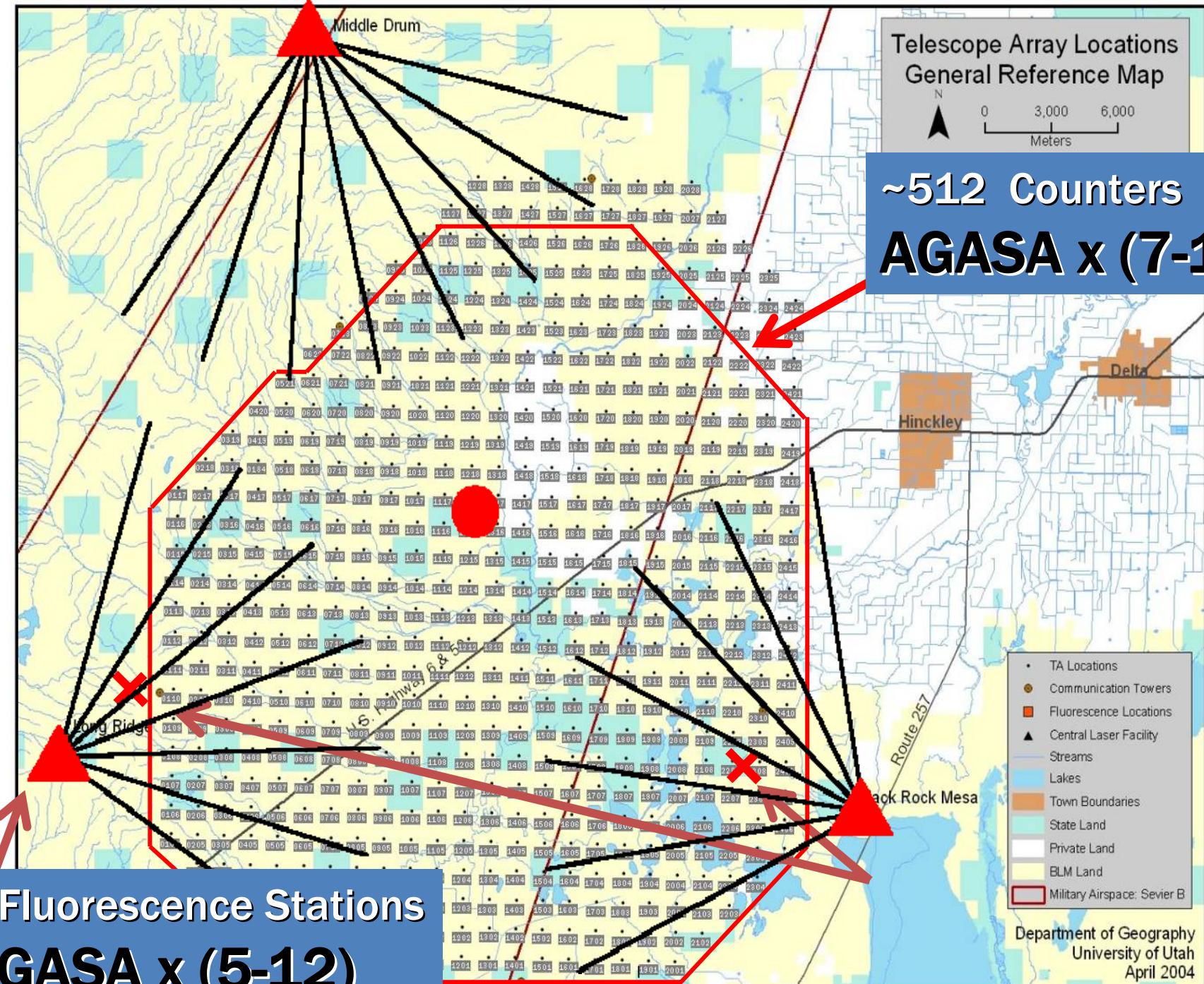
宇宙線望遠鏡実験(TA)

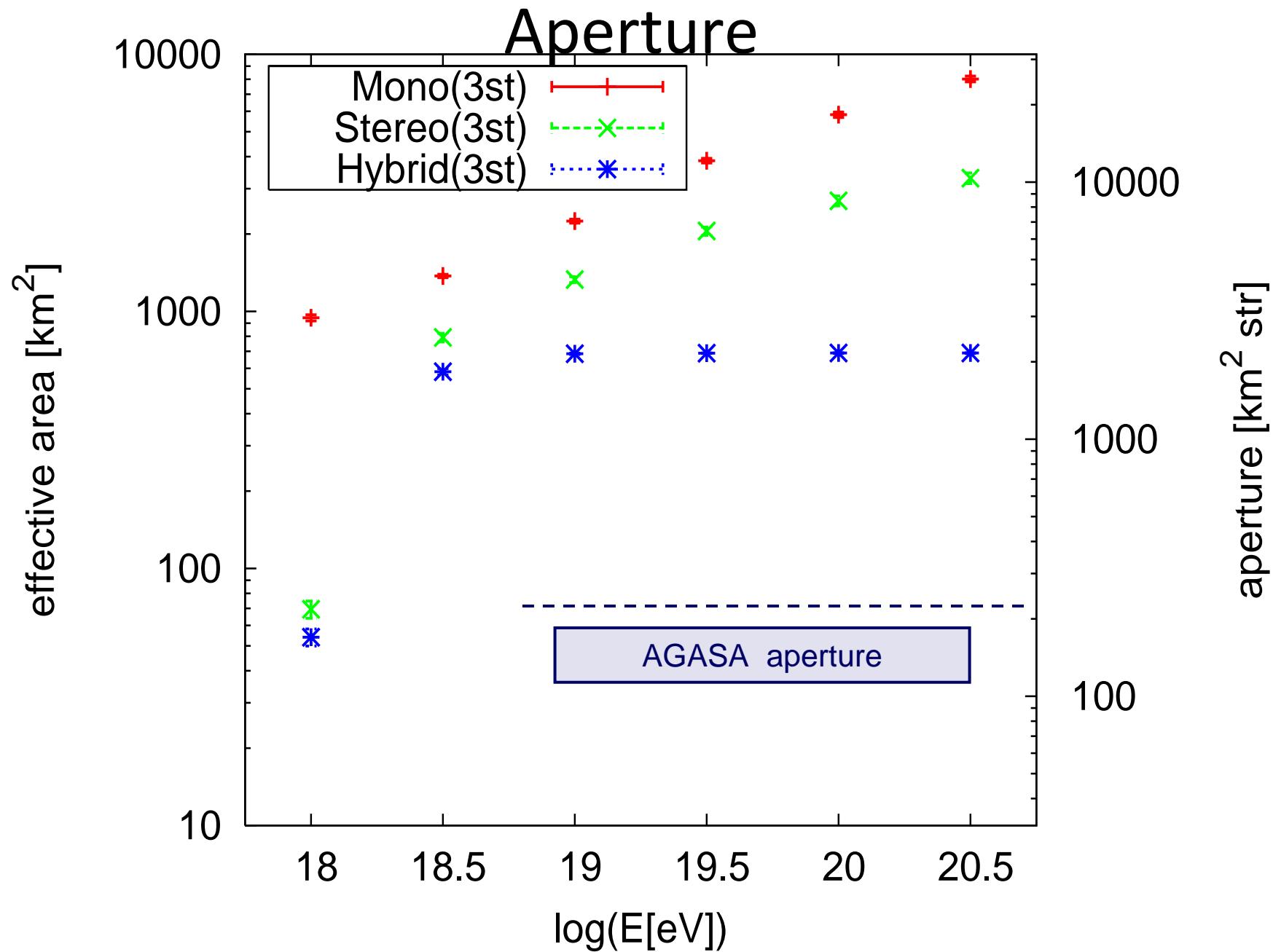
- ・ターゲット: 最高エネルギー領域宇宙線: $10^{18} - 10^{20}$ eV ~ それ以上
- ・「ハイブリッド」観測:
 - ・大気蛍光望遠鏡 (FD) Fly'sEye/HiRes タイプ 3ステーション
 - ・地表粒子検出器 (SD) AGASA タイプ 512台



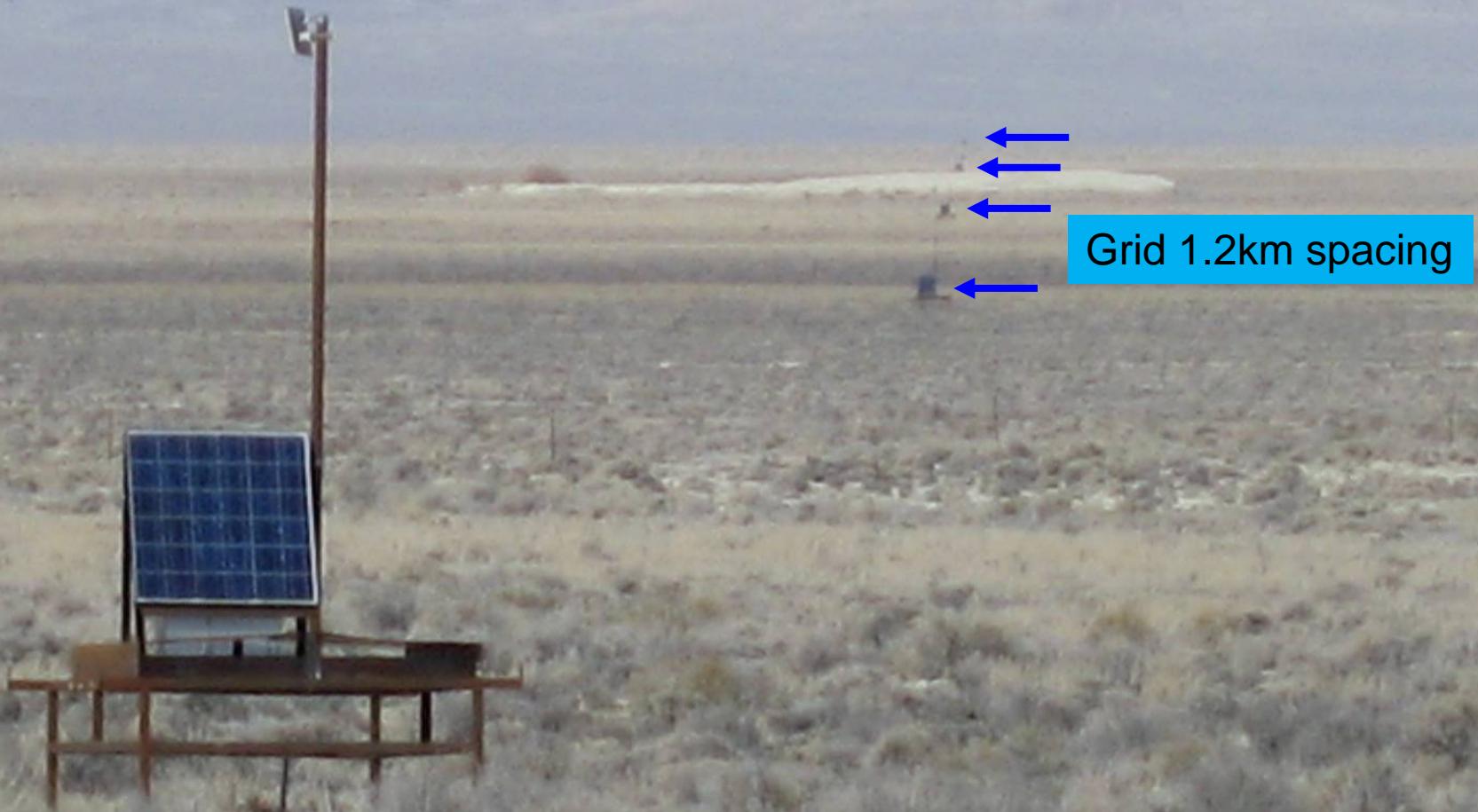


**~512 Counters
AGASA x (7-13)**

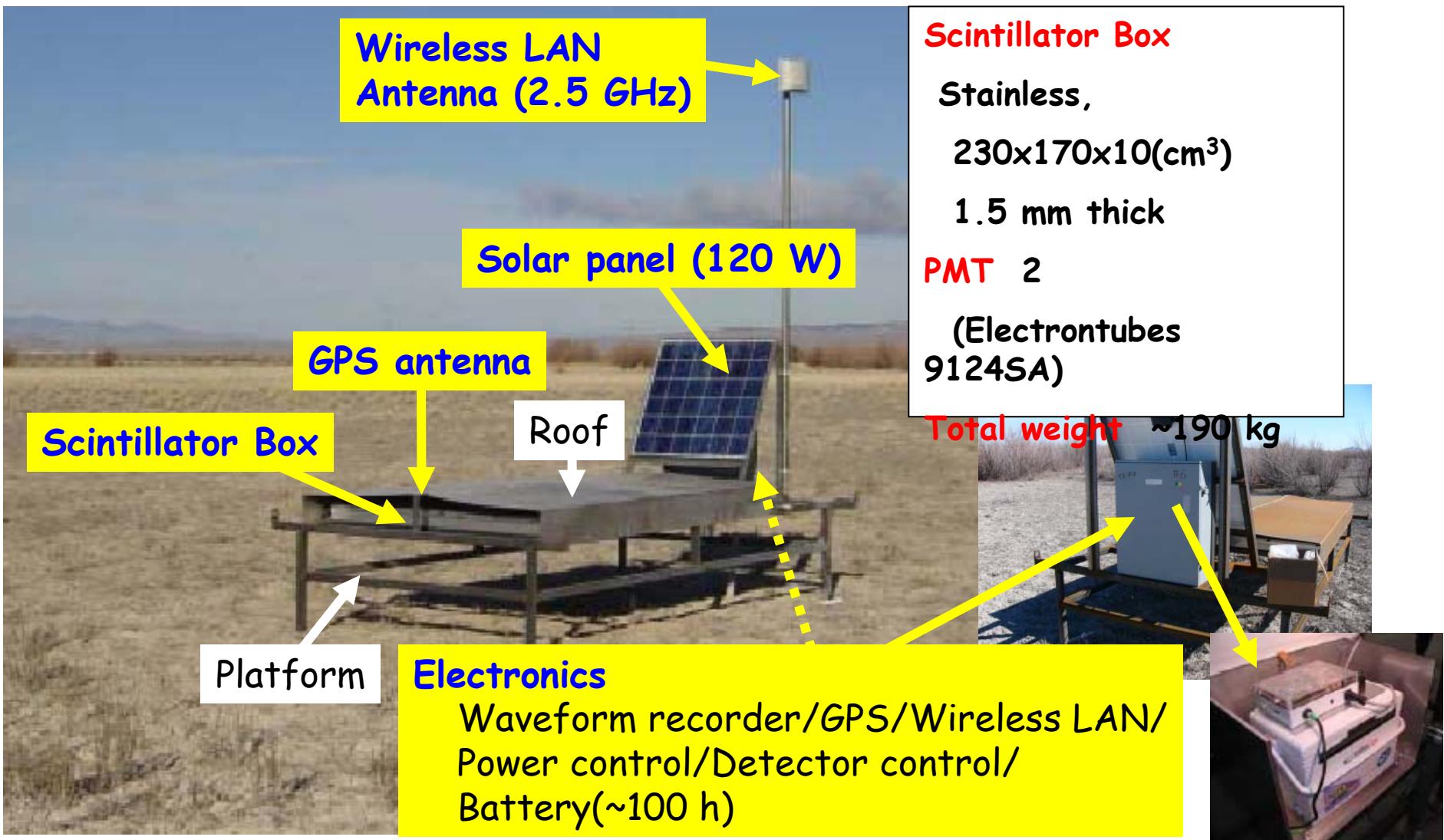




TA-SD



Surface Detector (SD)





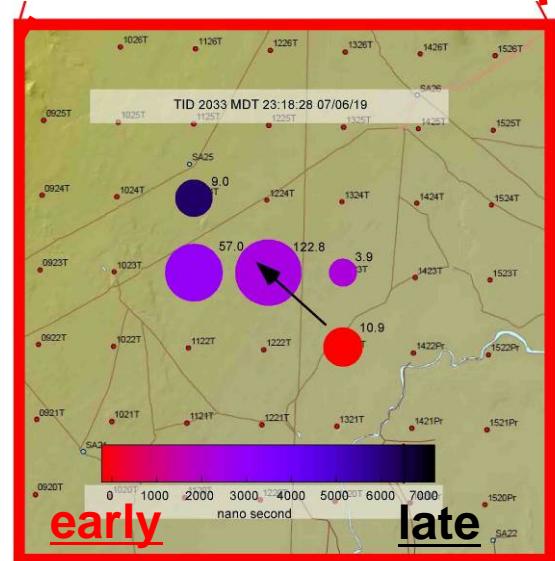
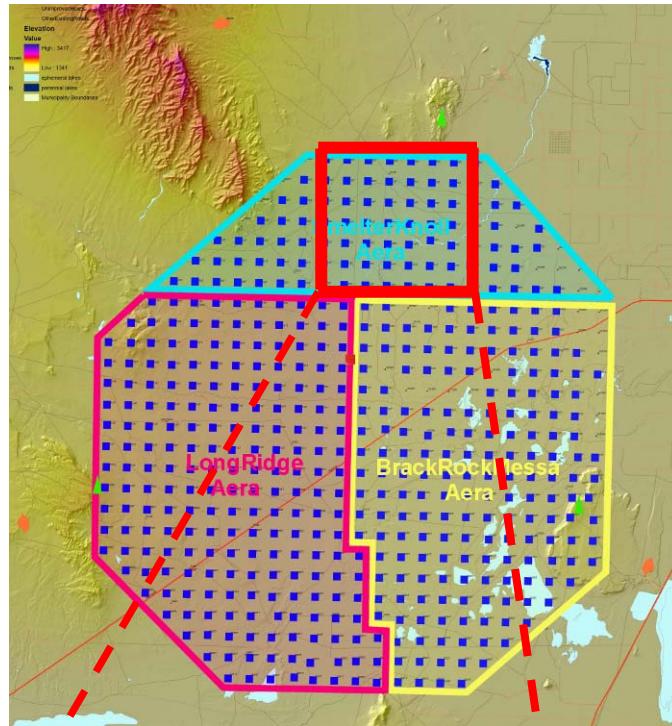
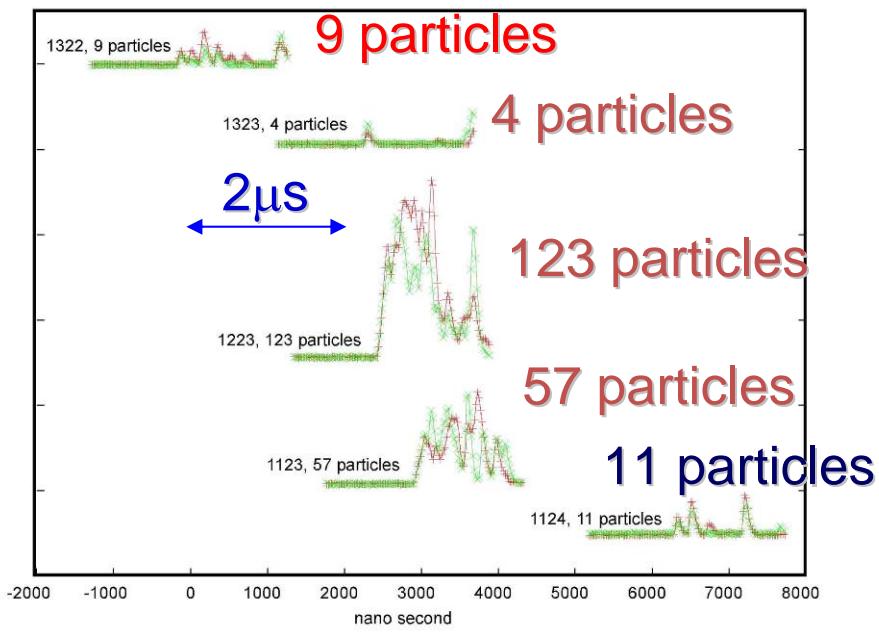
485 SDs Deployed (~95%)
25:Private property
2 :Deploy point became a pond

SD Test run

• Sample of Air shower event by SD

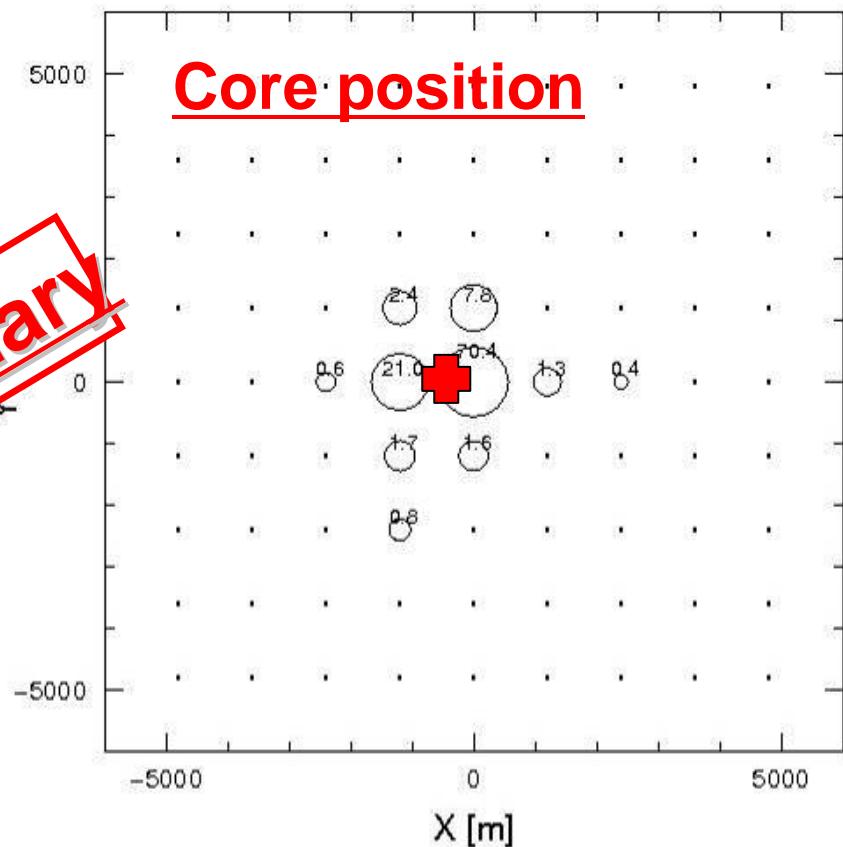
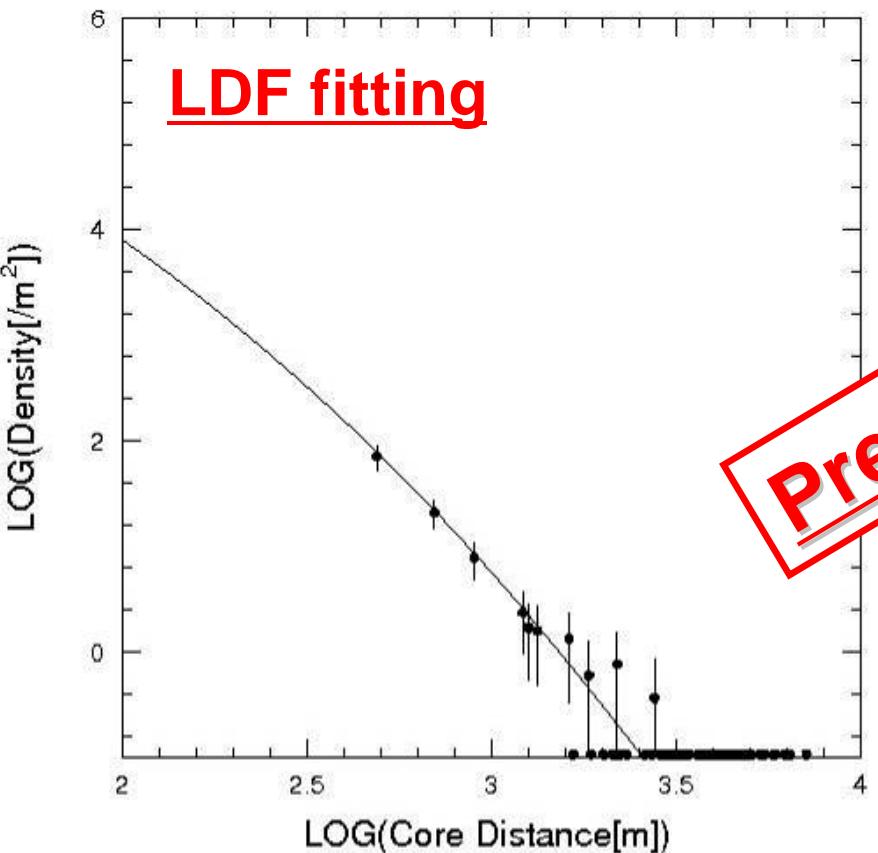
- Observed on
19.Jul.2007
- Trigger condition :
 - At least three SDs
 - more than 3MIPs

TID 2033 MDT 23:18:28 07/06/19



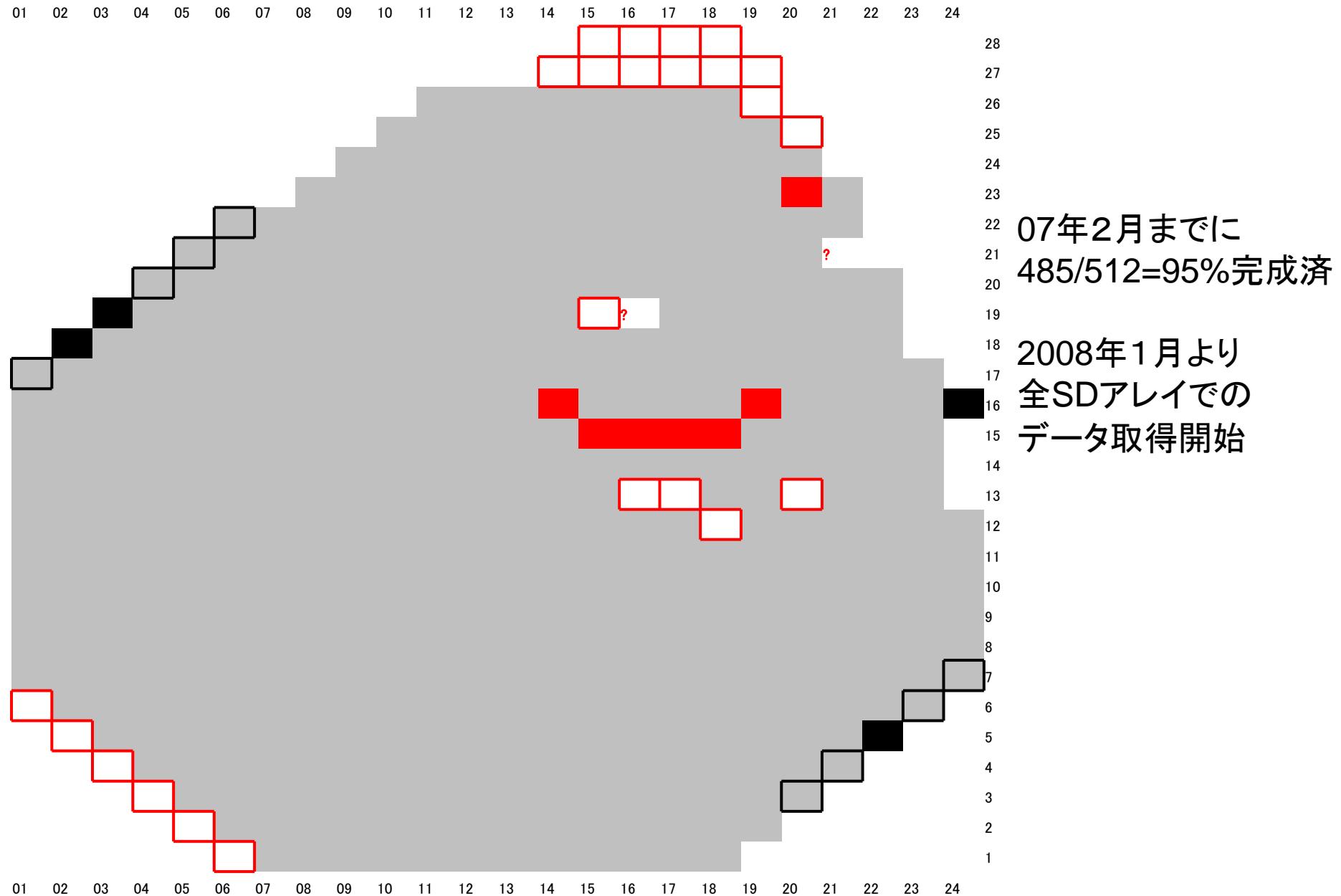
Another example

observed on 2007/07/04



Log(E[eV])=19.1
Zenith=36.3[deg]
Azimuth=241.2[deg]

SD Deployment

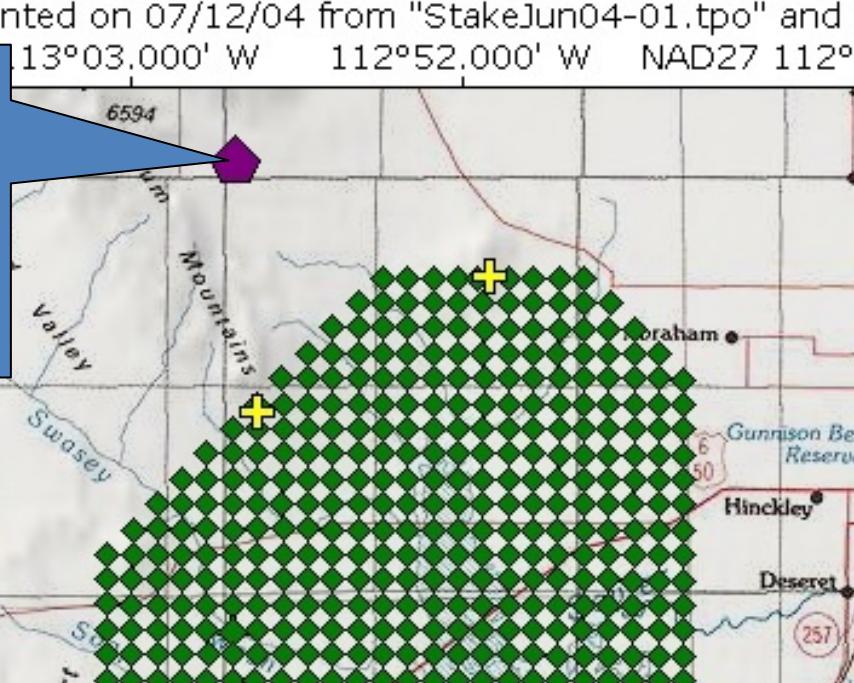


TA-FD

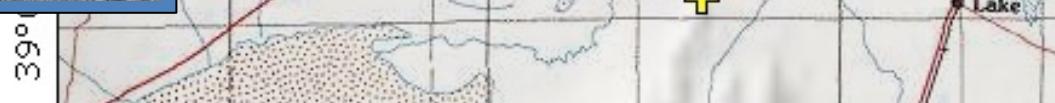
TOPO! map printed on 07/12/04 from "StakeJun04-01.tpo" and "Untitled.tpo"

113°03.000' W 112°52.000' W NAD27 112°

Middle Drum



Long Ridge



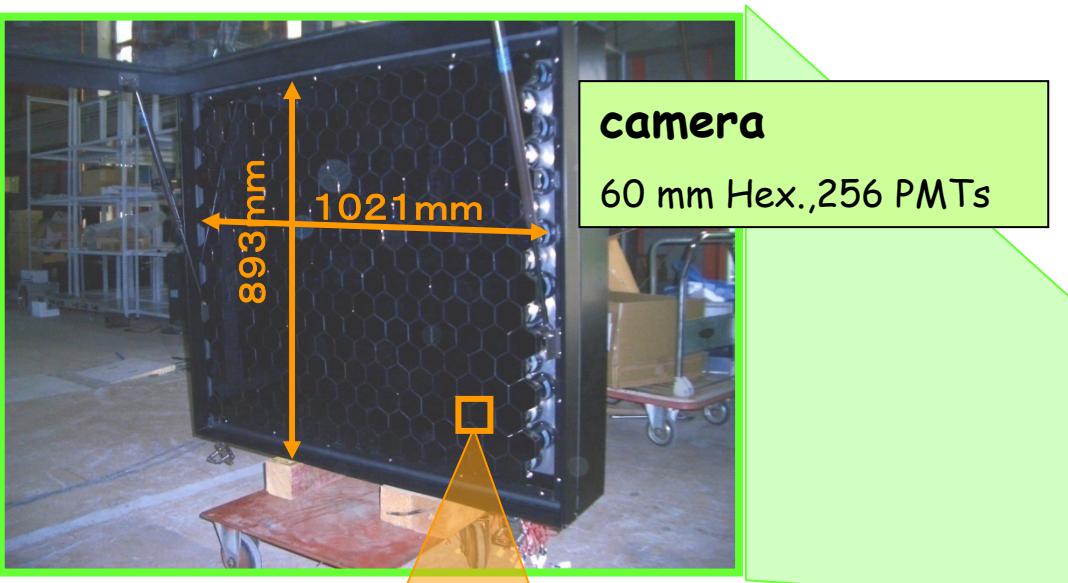
Black Rock Mesa



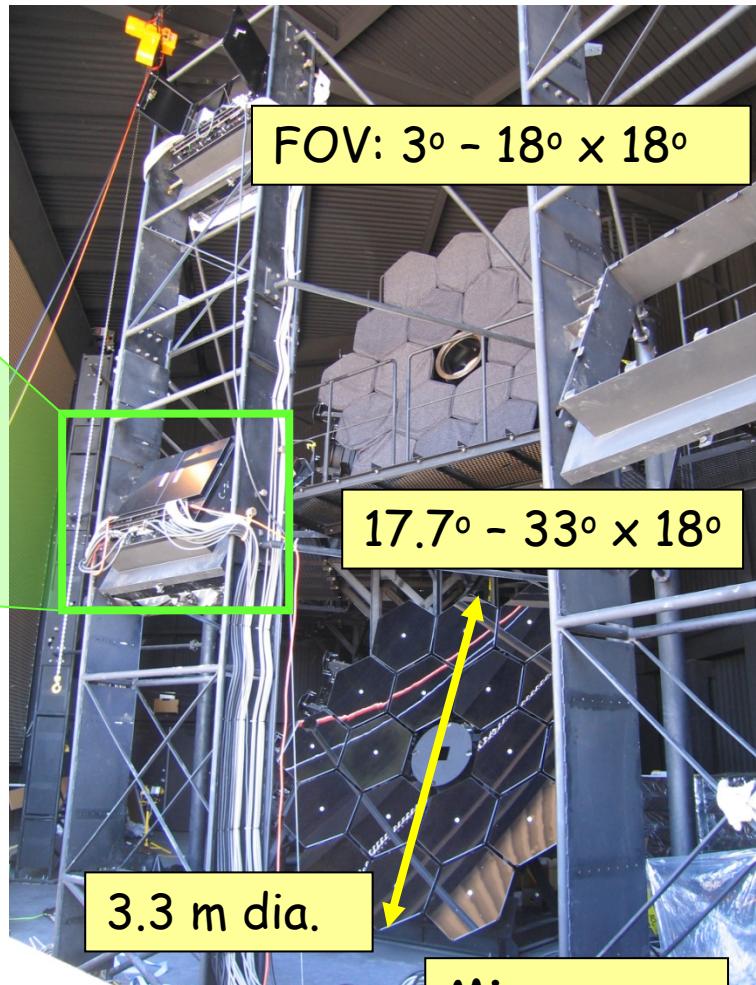
TN ★ / MN
13°

0 5 10 15 20 25 30 35 40 km
113°03.000' W 112°52.000' W NAD27 11

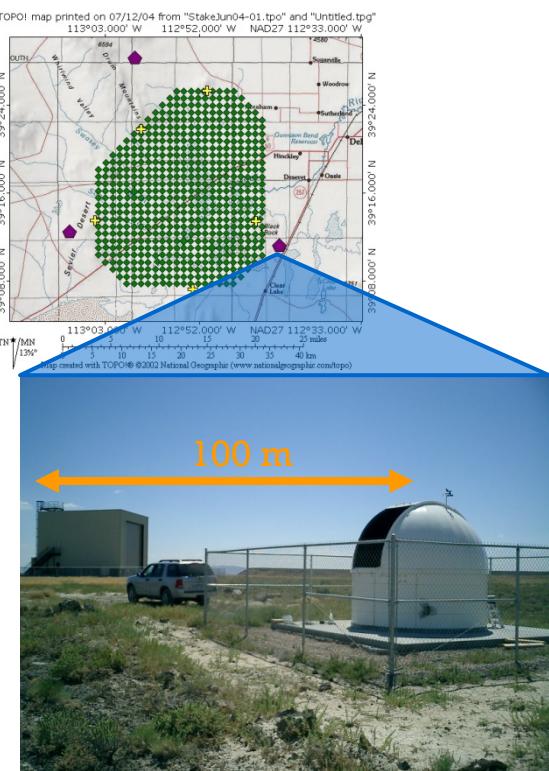
TA-FD



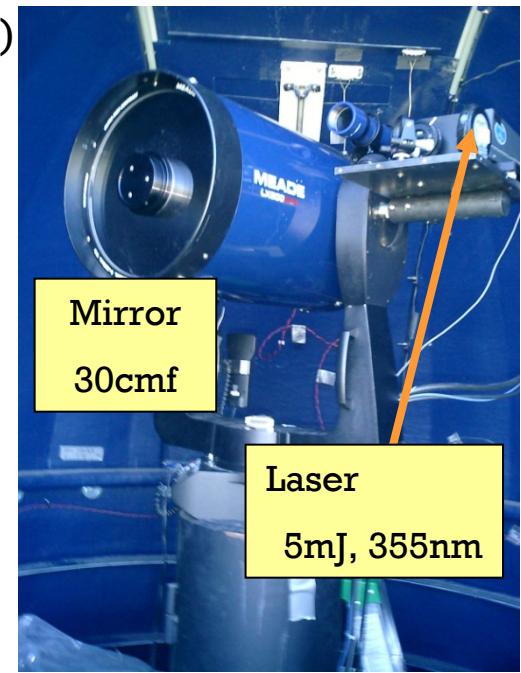
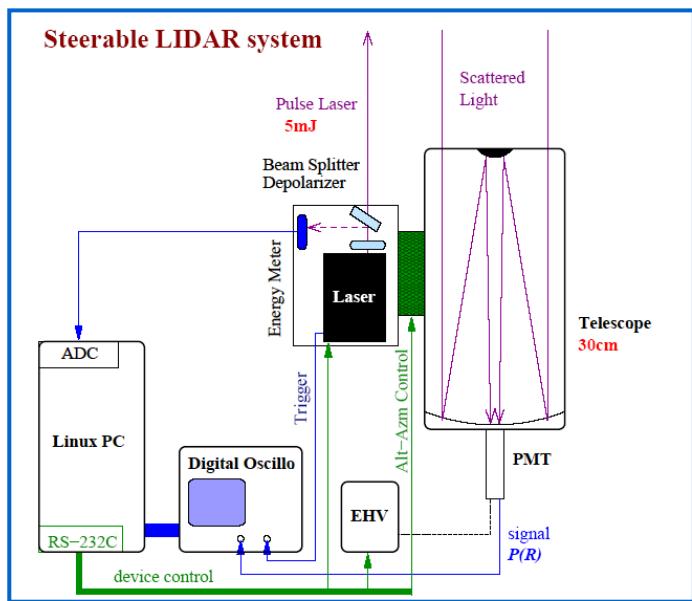
Filter: BG3



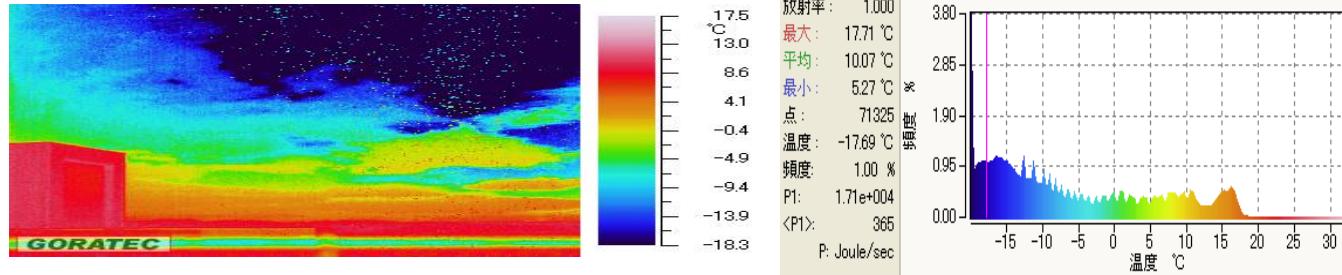
LIDAR & cloud monitor



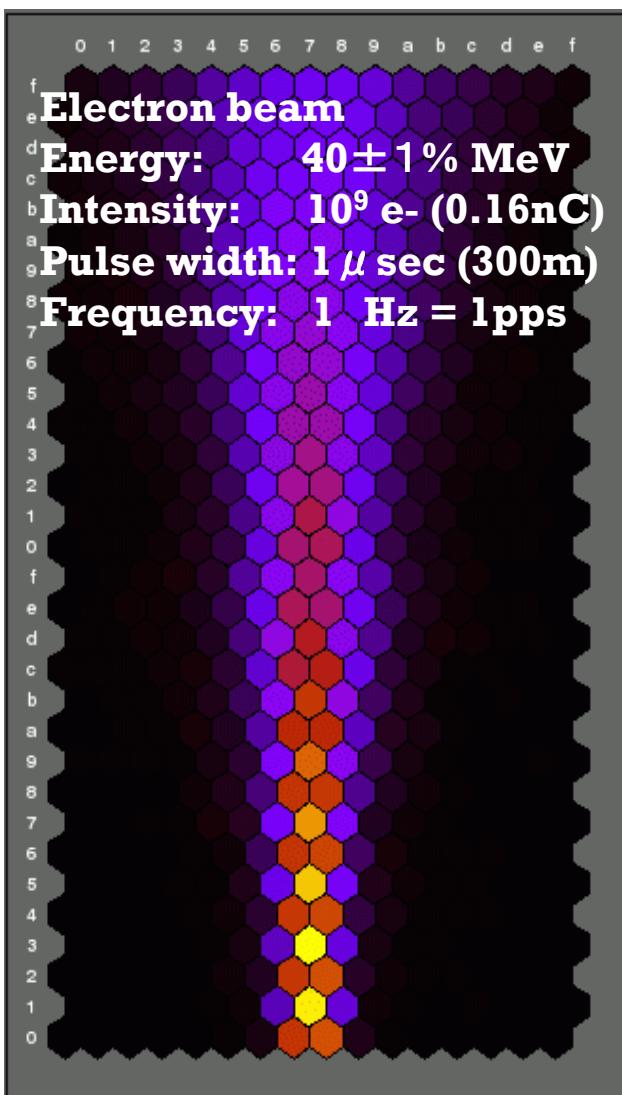
Extinction coefficient Vertical Aerosol Optical Depth (*VAOD*)



IR camera(AVIO TVS-600S)
FOV: 25.8° x 19.5°
no. of pixels : 320 x 236
sensitivity :8-14mm

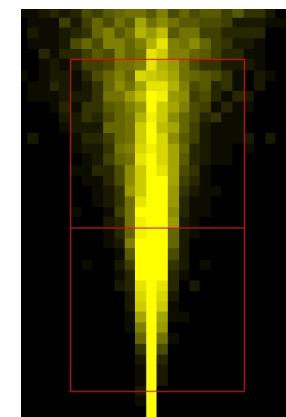


TA-LINAC



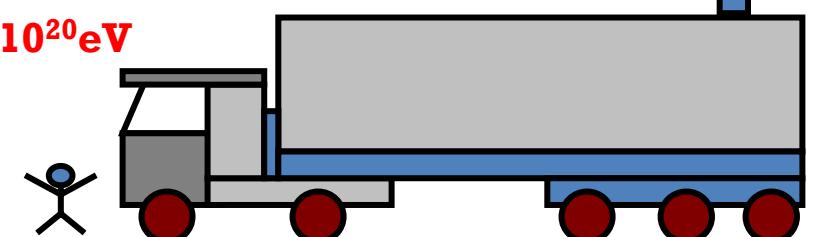
Fluorescence yield	10%
Atmospheric	10%
Photon to ADC	10%

→ **Energy resolution** 20% → 14%



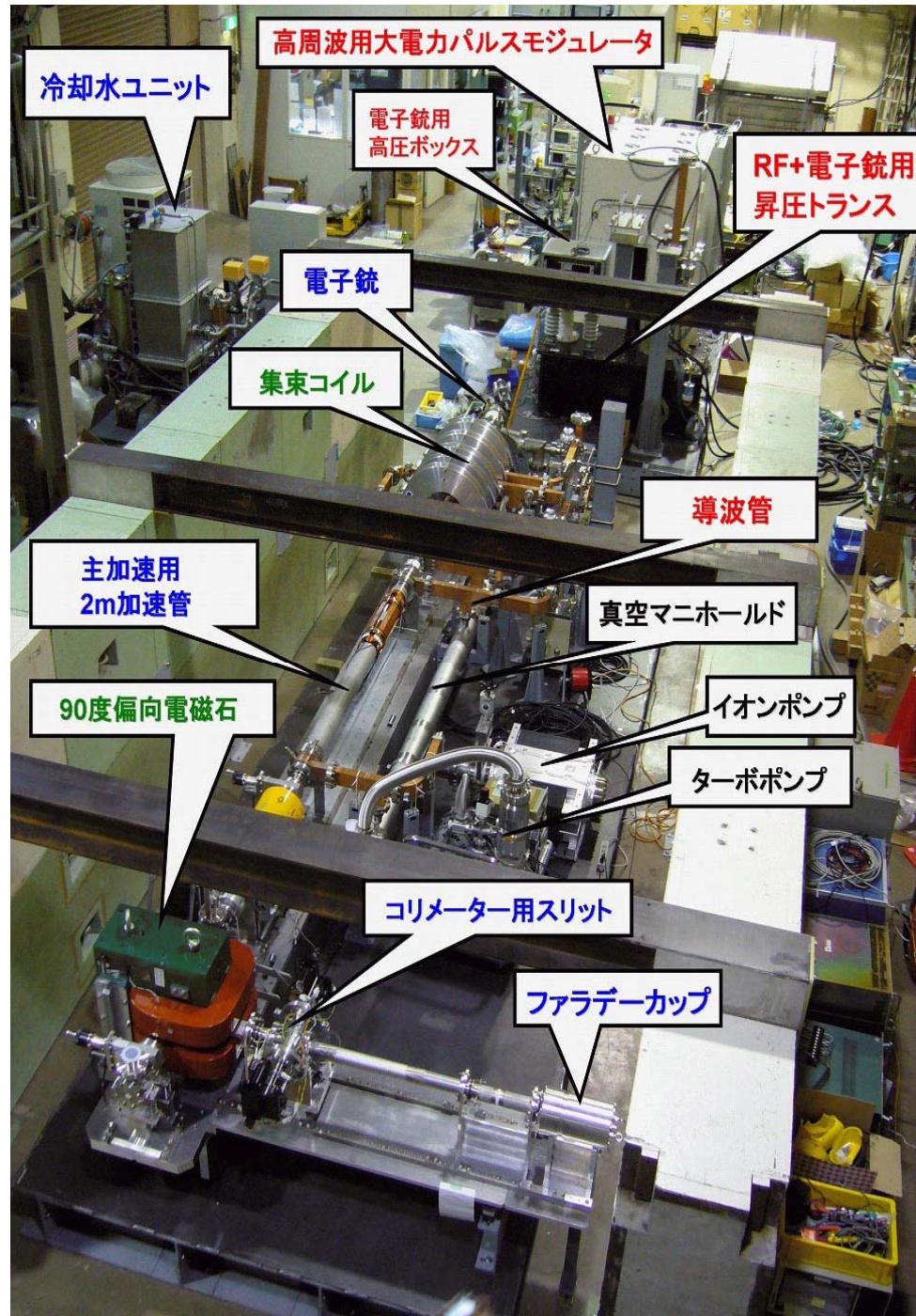
100m away: $40\text{MeV} \times 10^9 \sim 10^{16}\text{eV}$

10km away: $\sim 10^{20}\text{eV}$



TA-LINAC

年内にビームテストを行う



FD観測

March	2ステーション(24台)設置完了(エレキは一部未設置) テスト観測(複数台での動作確認)
April	DAQの改良
May	テスト観測@ BRM,LR (DAQ check)
June	観測@ BRM,LR 9 nights (34 hours)
July	Observation @ BRM,LR 5 nights (15 hours)
Aug.	Observation @ BRM,LR 8 nights (27 hours)
Sep.	Observation @ BRM,LR 11 nights
Oct.	DAQ改良 全望遠鏡の準備完了
Nov.	完全な形で観測開始 @ BRM,LR

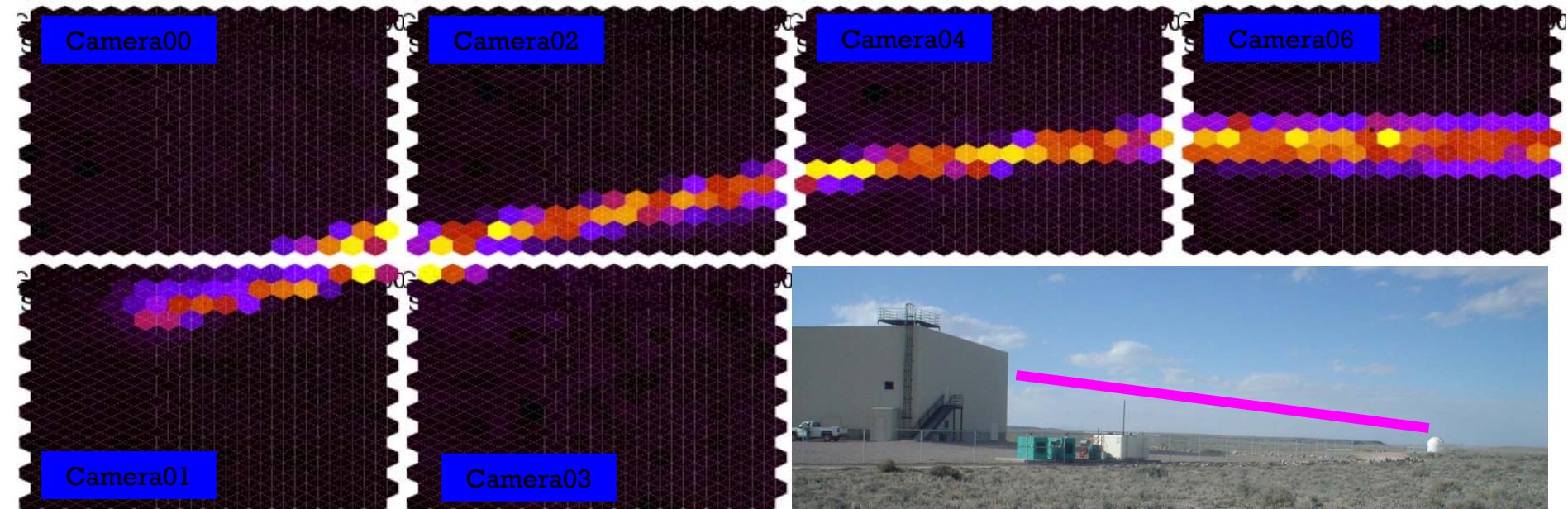


3.6Hz @ BRM
1.4Hz @ LR



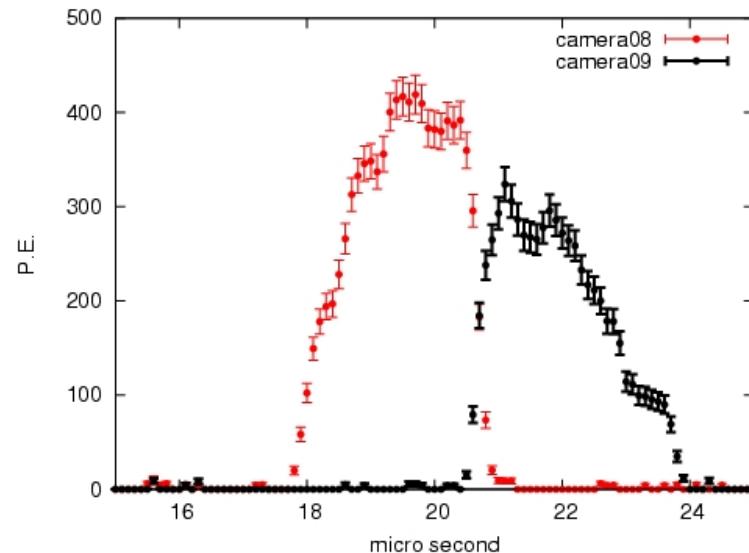
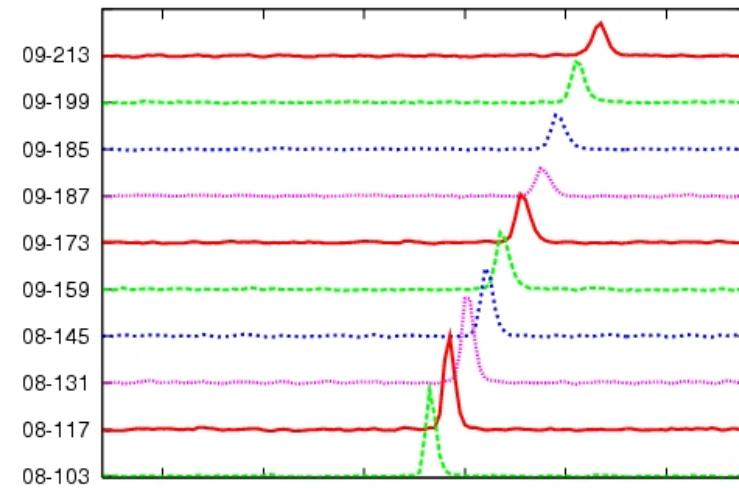
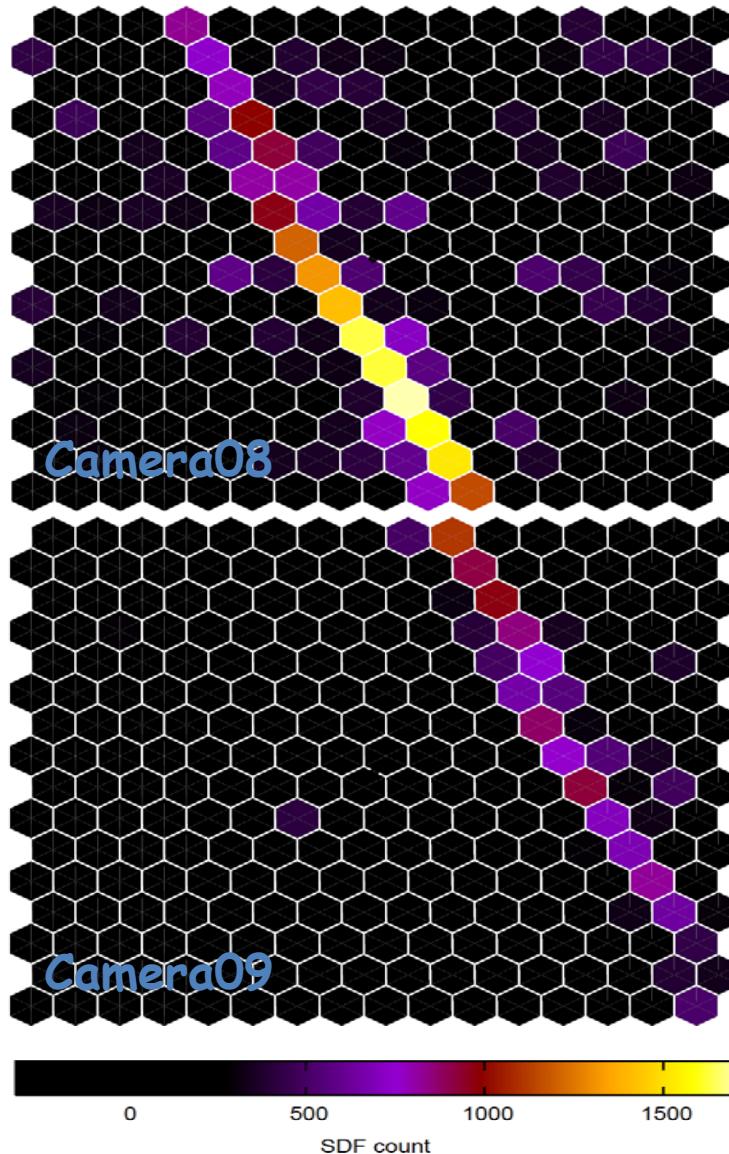
テスト観測@BRM in Mar.

ステーション全システムの動作を確認



The First FD “Fine” Event

June 20, 08:18:21(UTC), trigger ID 0000169

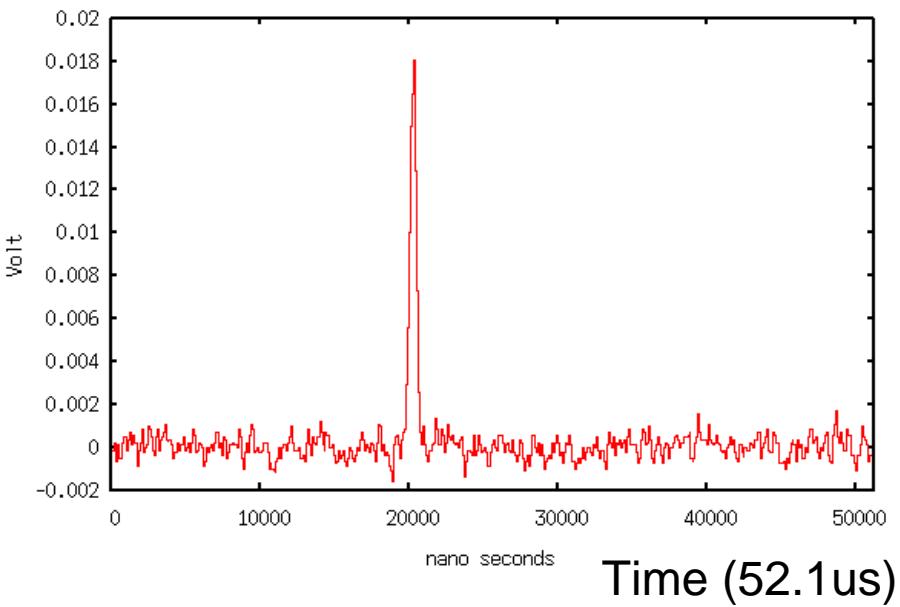


Air shower development?

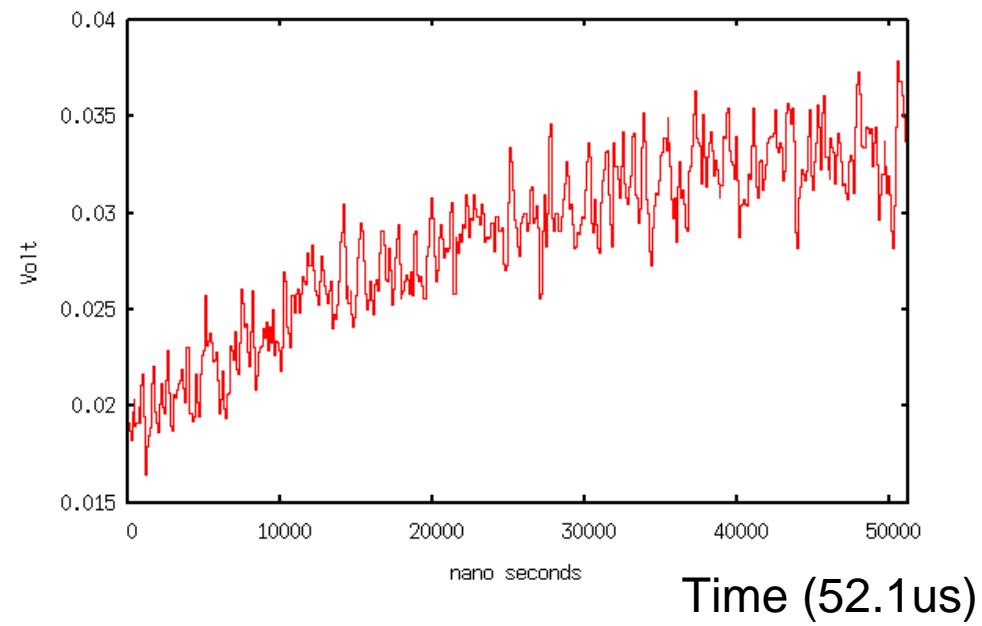
ゴミイベント

波形、タイミングでのセレクションが可能

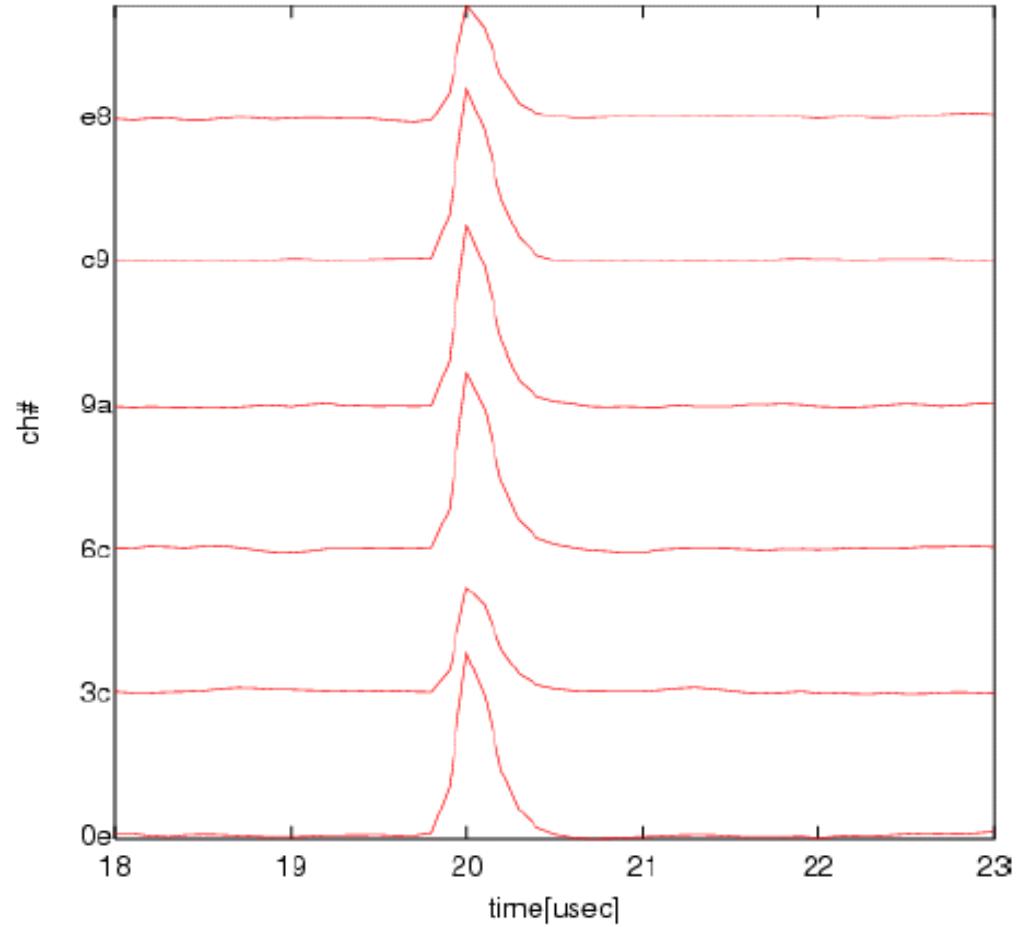
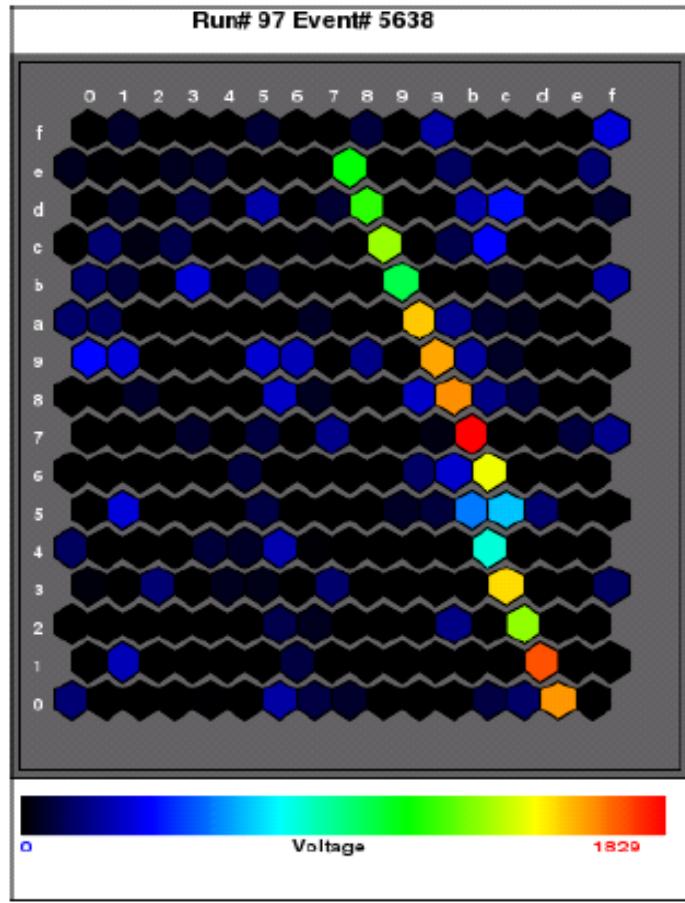
シャワーイベント



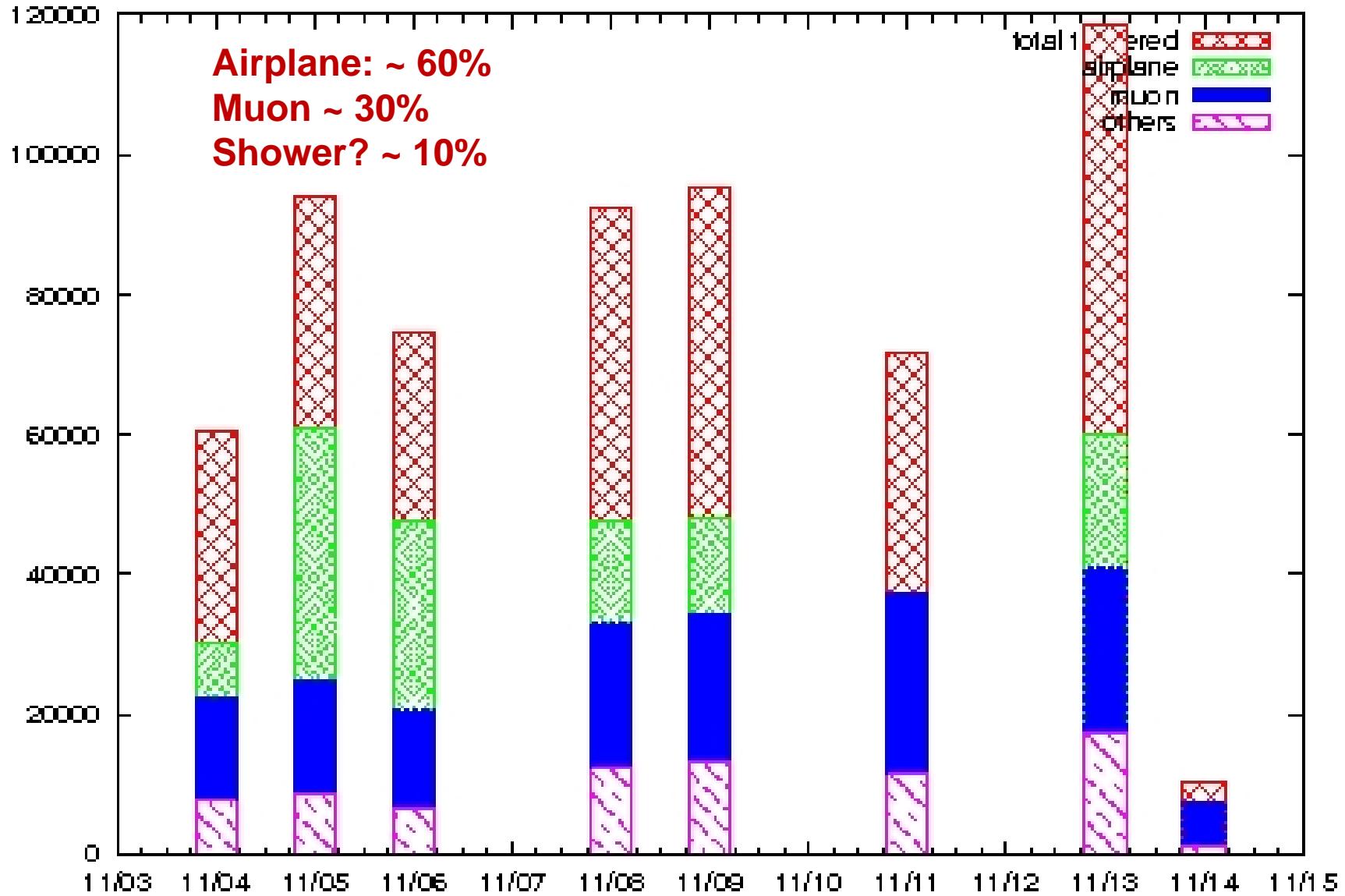
飛行機イベント



ミューオンによるトリガー

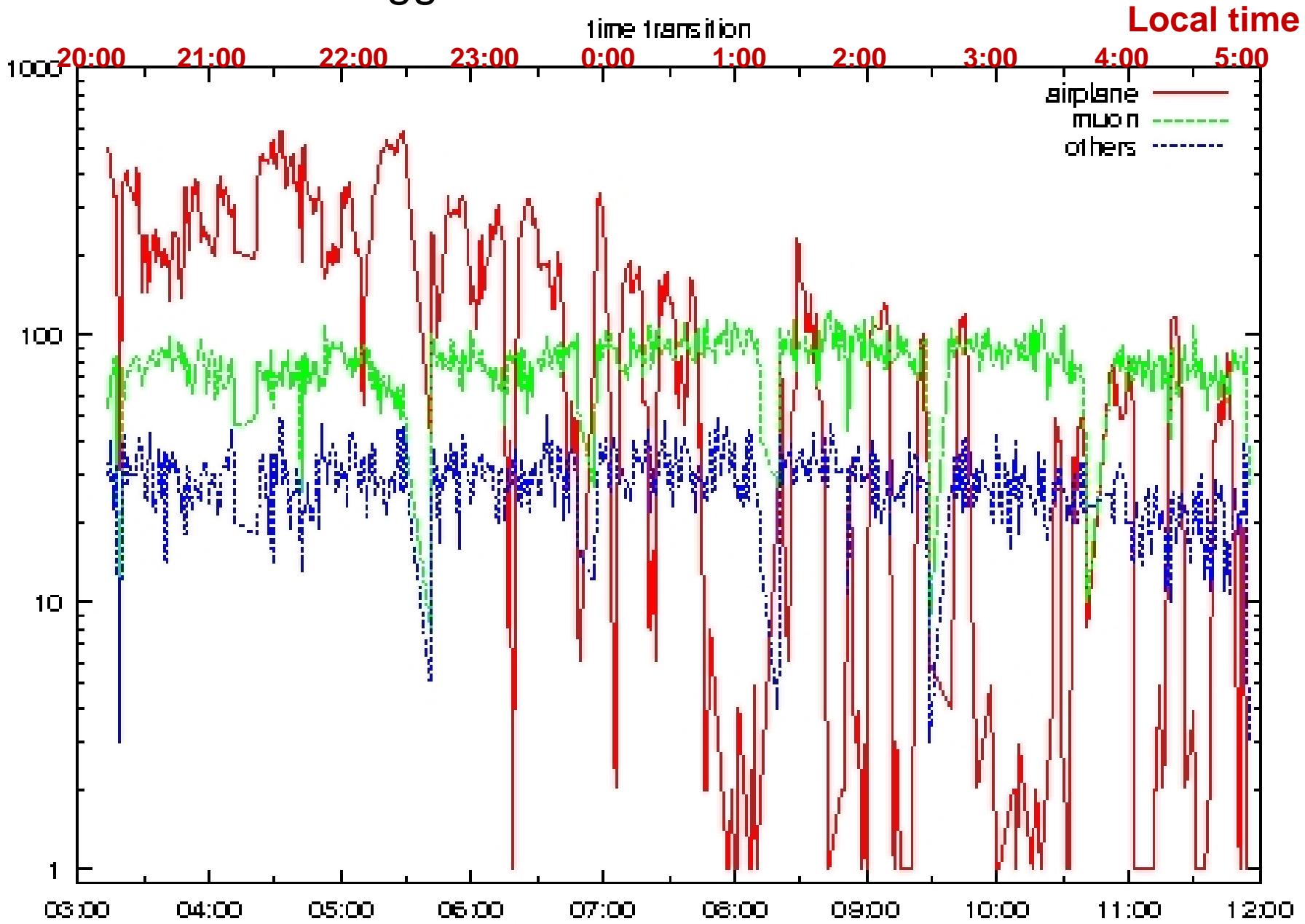


Trigger / day @ BRM Nov/05~14 UTC



11/07: Not analyzed 11/10&12: No observations 11/14: bad weather (cloudy)

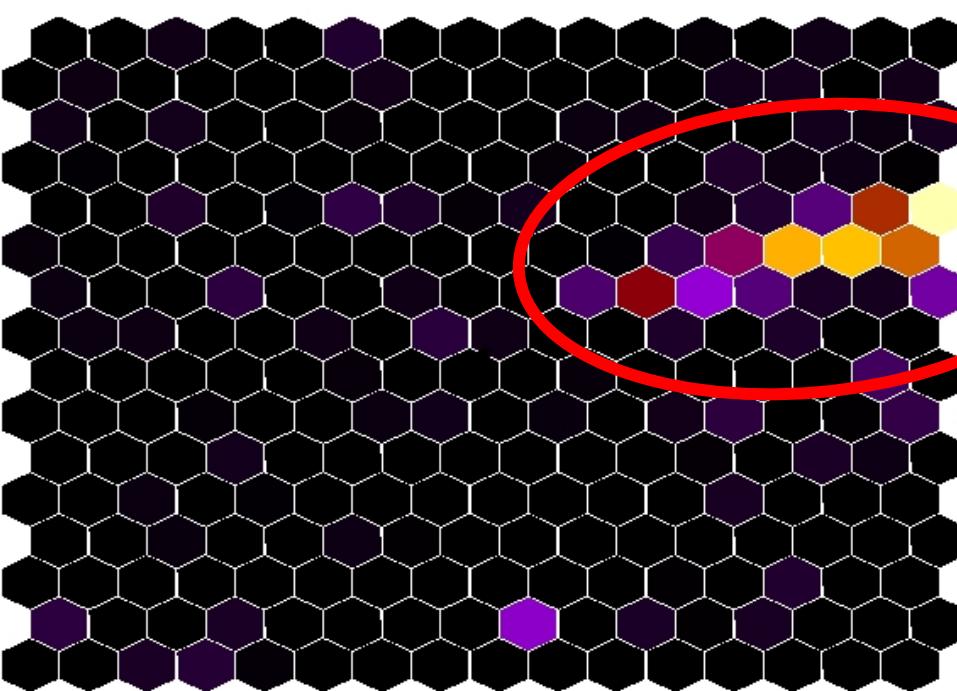
trigger rate @ LR Nov/09 UTC



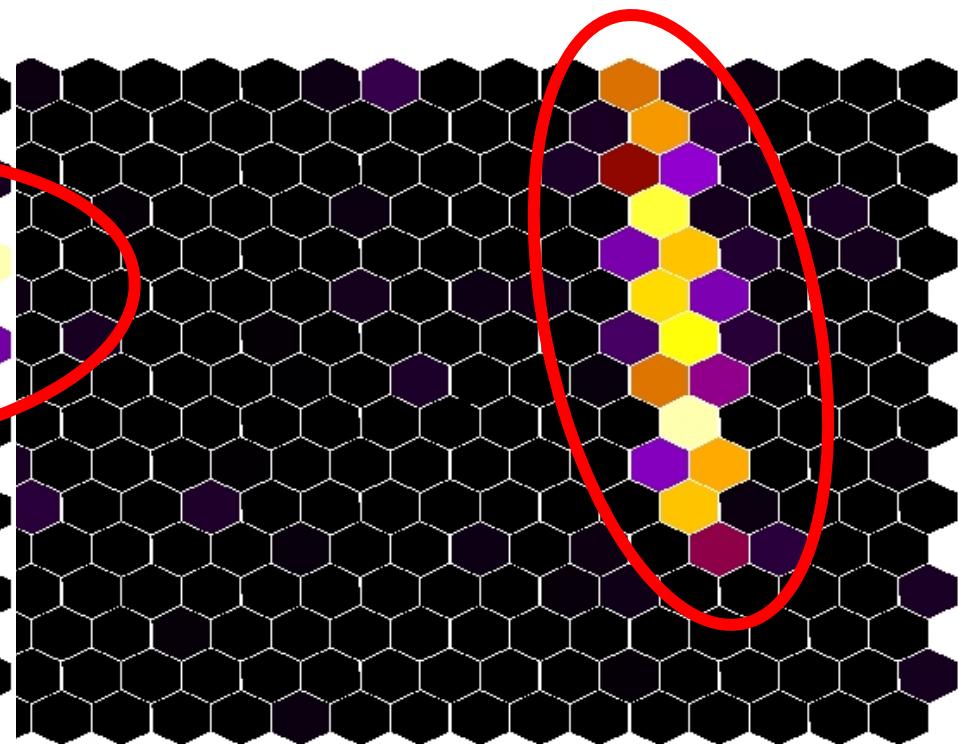
Stereo event Nov/05 UTC

ENERGY log E = 19.0 eV

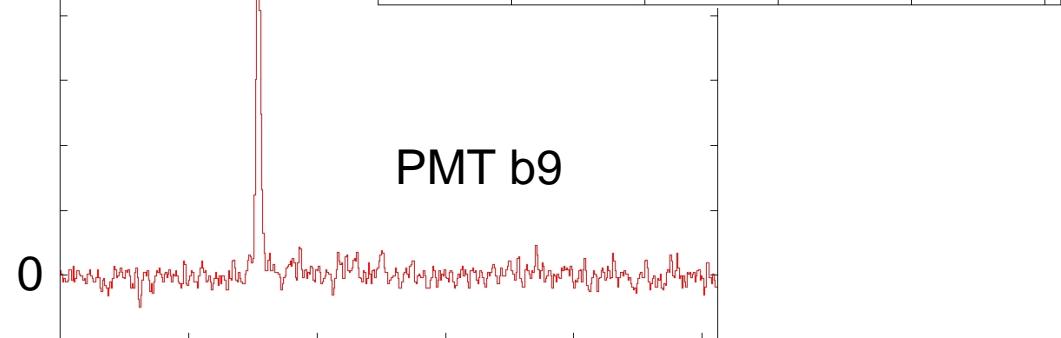
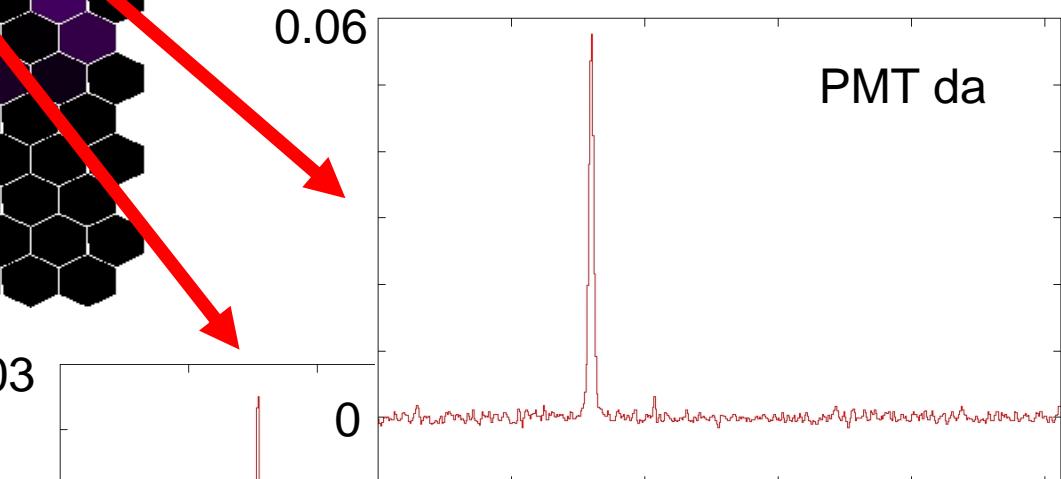
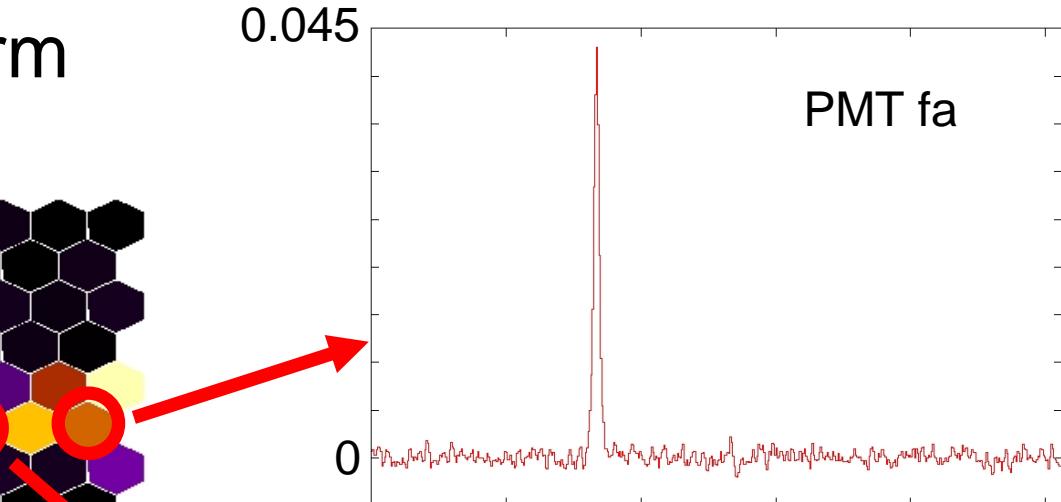
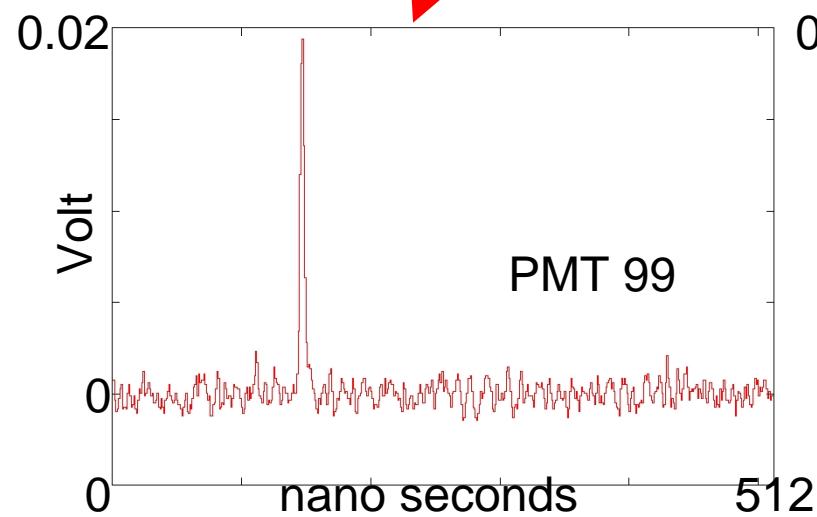
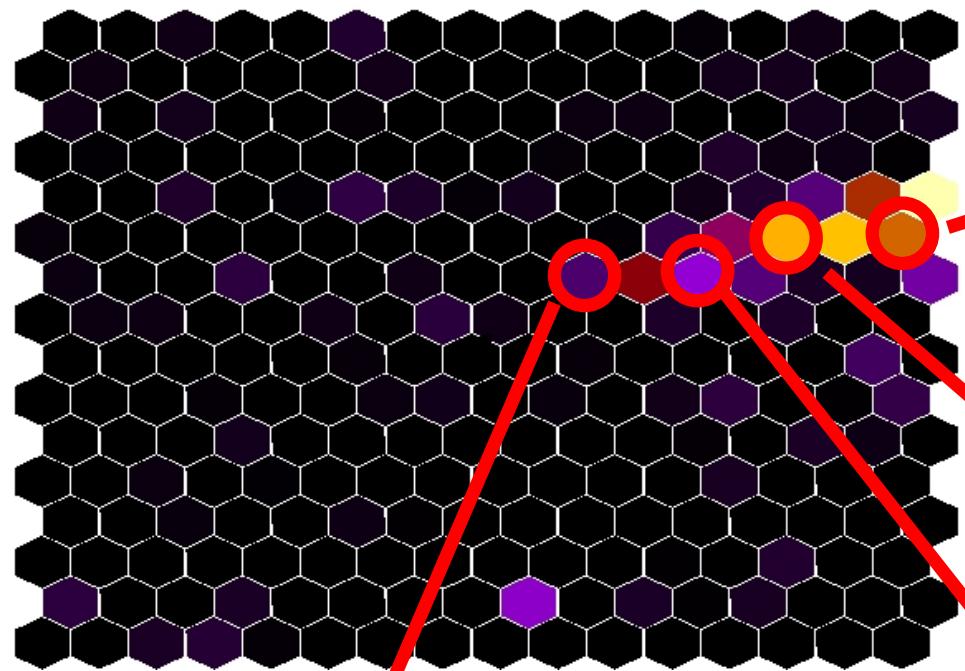
LR CAMERA05



BRM CAMERA00

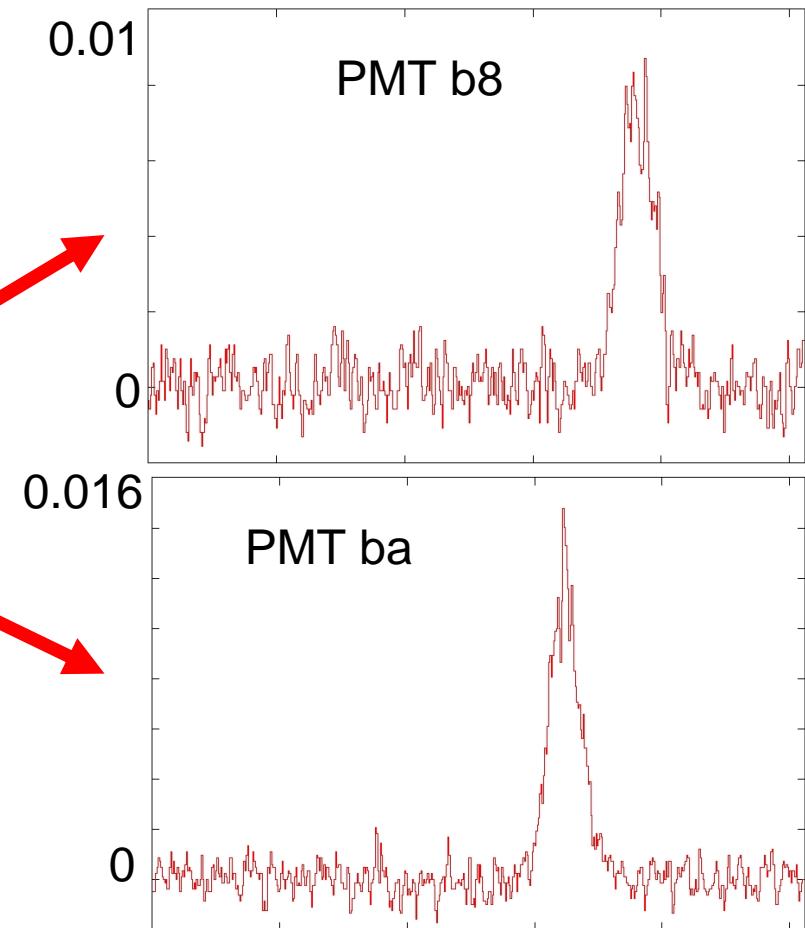
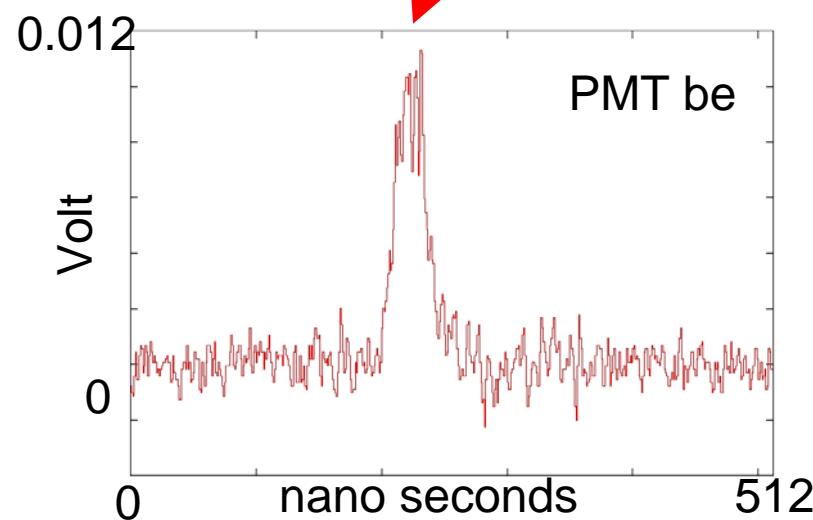
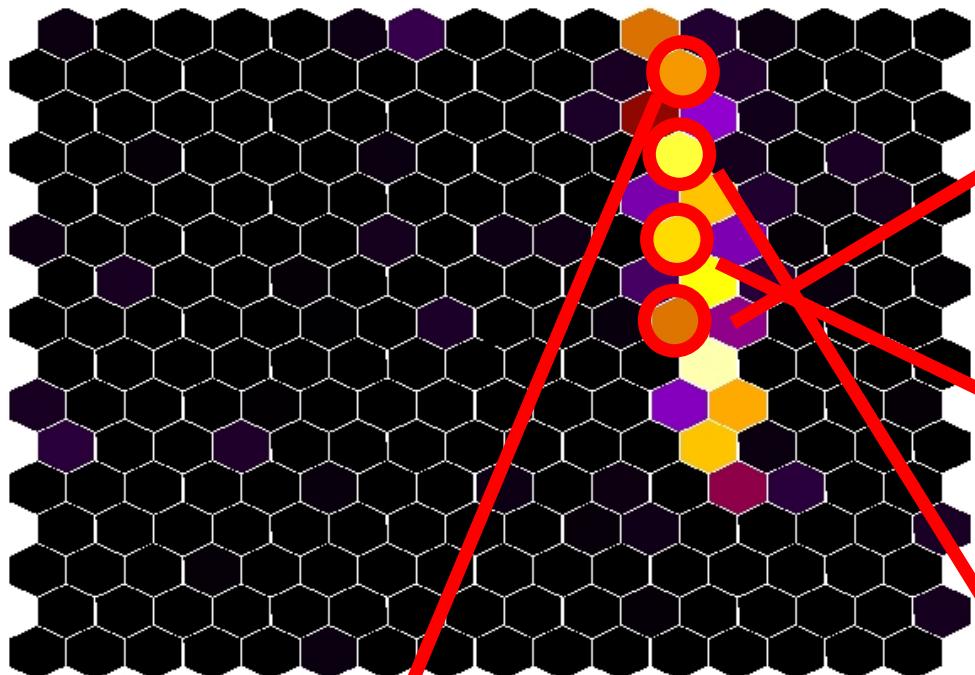


stereo event waveform LR CAMERA 05

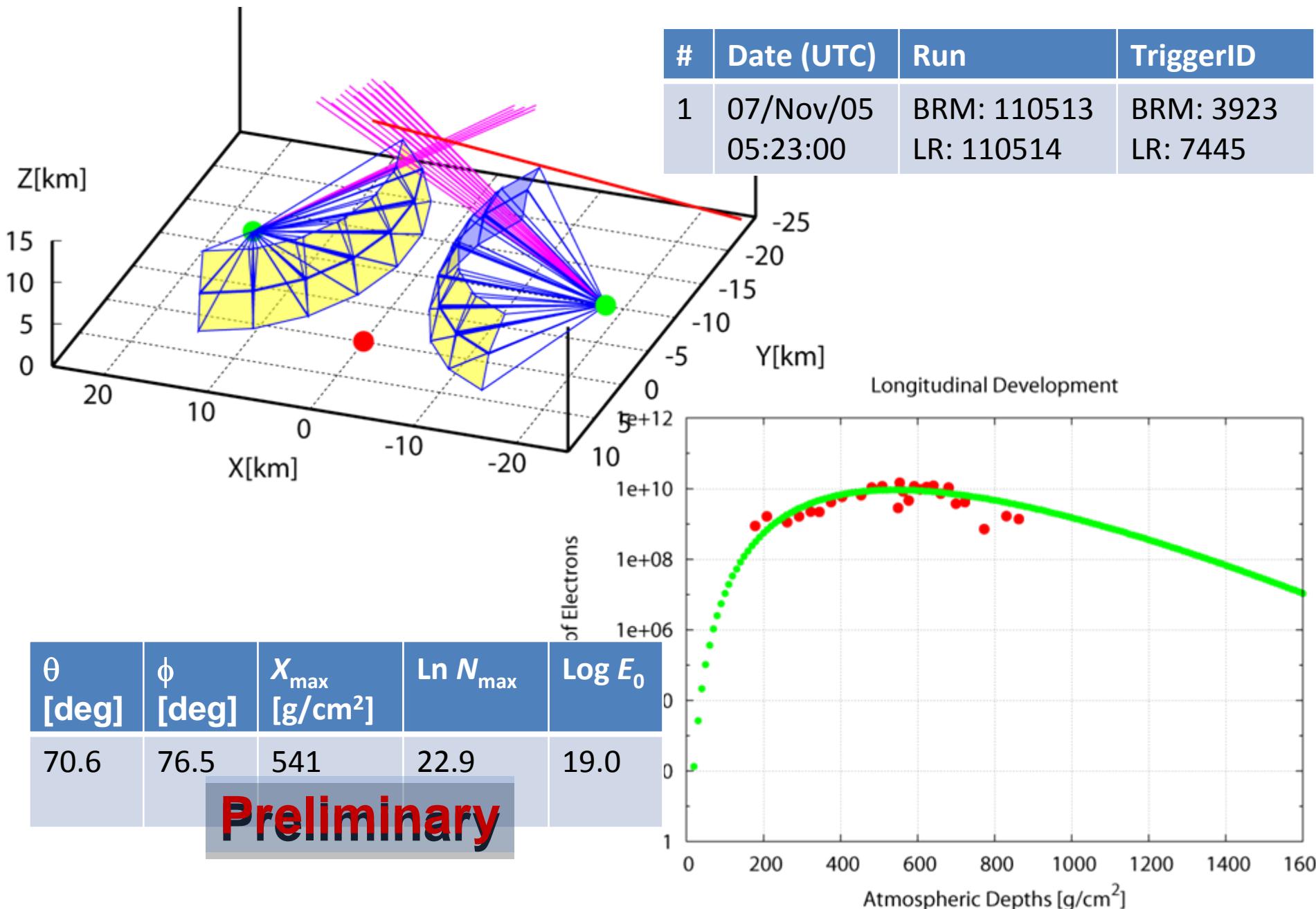


stereo event

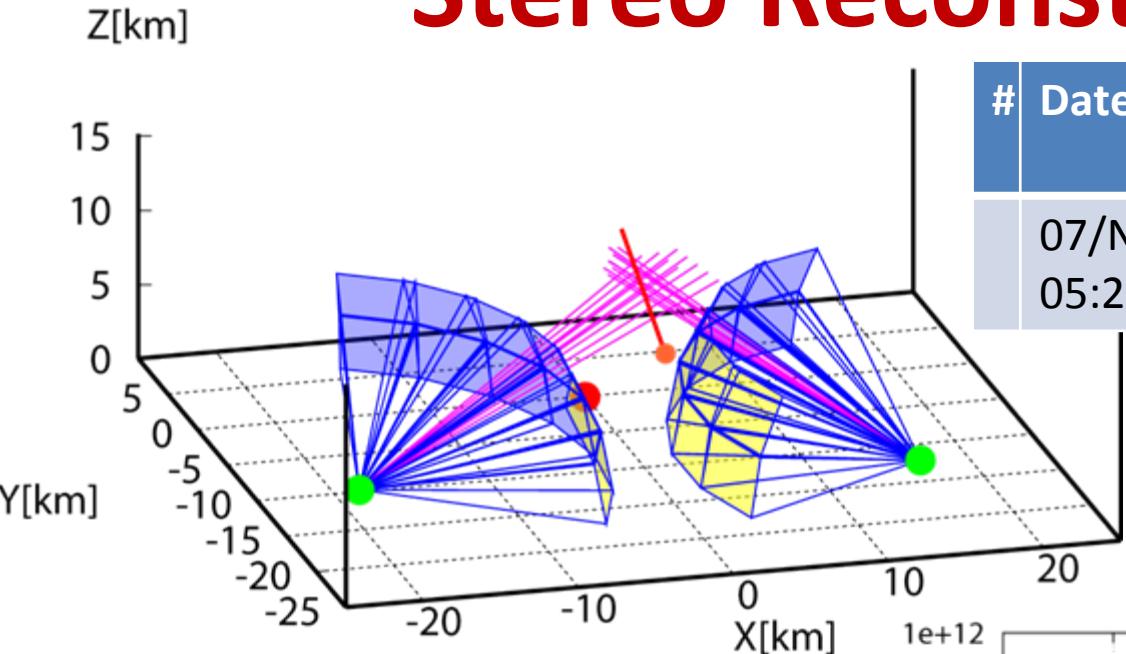
waveform BRM CAMERA 00



Stereo Reconstruction

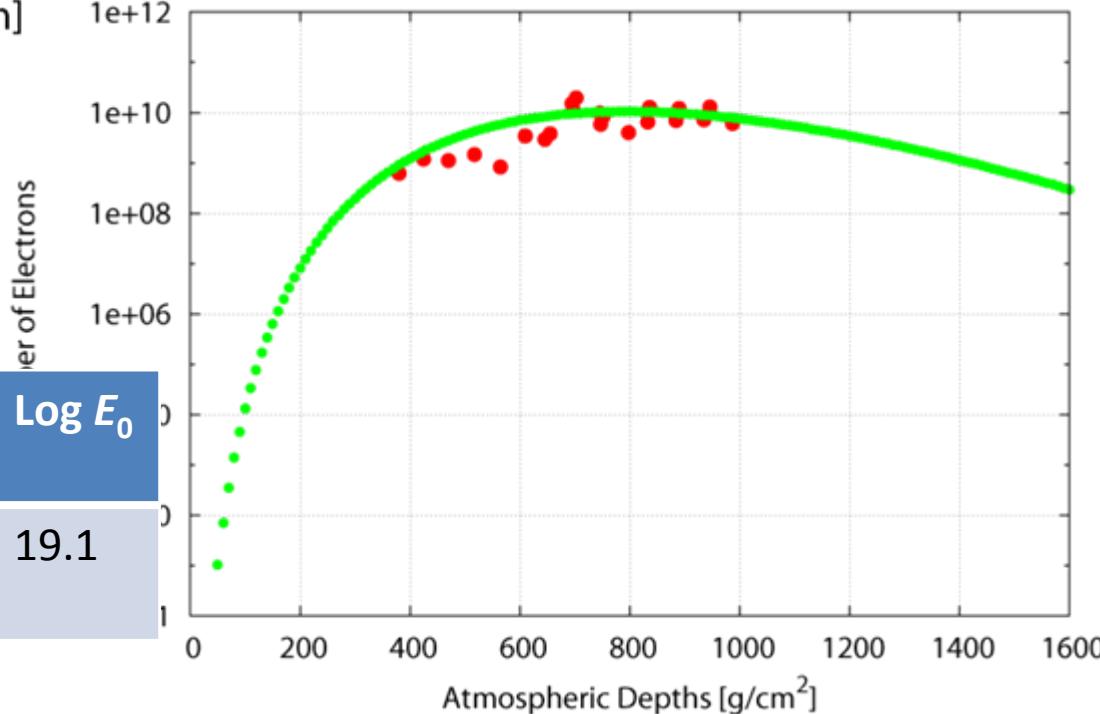


Stereo Reconstruction



#	Date (UTC)	Run	TriggerID
	07/Nov/11 05:26:09	BRM: 111115 LR: 111113	BRM: 4193 LR: 8188

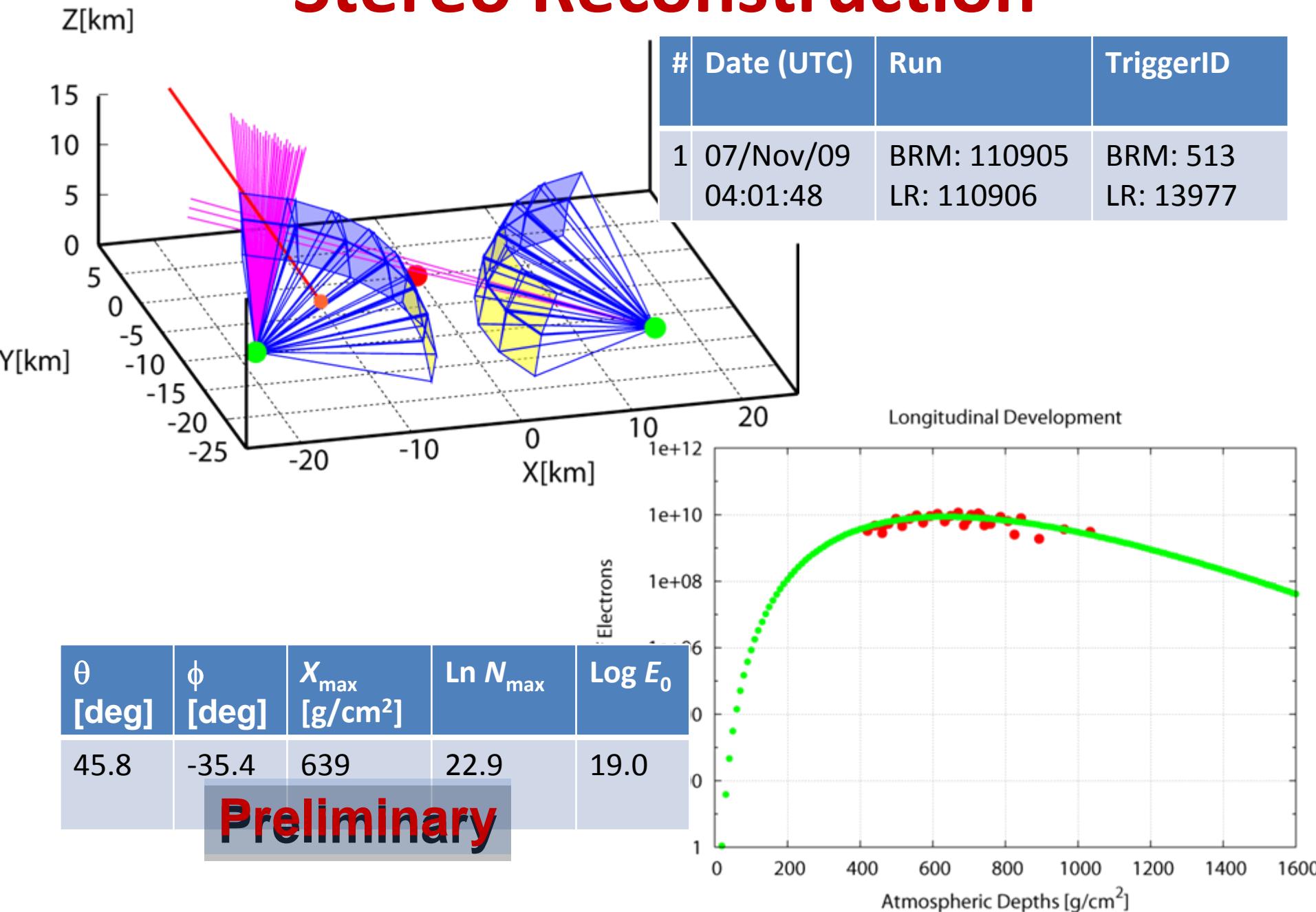
Longitudinal Development



θ [deg]	ϕ [deg]	X_{\max} [g/cm ²]	$\ln N_{\max}$	$\log E_0$
41.9	-8.7	794	23.1	19.1

Preliminary

Stereo Reconstruction



まとめ

- SD: 年内にも完成
- FD: 3ステーション完成
 - 2007年11月より定常観測に入った
→ 2008年1月より TA full configuration
による観測開始！
- キャリブレーション進行中
 - SD: 粒子測定、タイミング測定
 - FD: LIDAR, LINAC, Central Laser, ...
- データ解析スタート