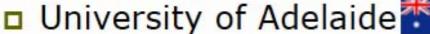




谷森 達 (京都大学)

For the CANGAROO Team **2006年共同利用報告会**

CANGAROO team









Australian National University



Ibaraki University



Ibaraki Prefectural



Konan University



Kyoto University



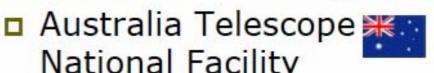
STE Lab, Nagoya



University

National Astronomical Observatory of Japan





Tokai University

National Facility



ICRR, University of Tokyo



Yamagata University



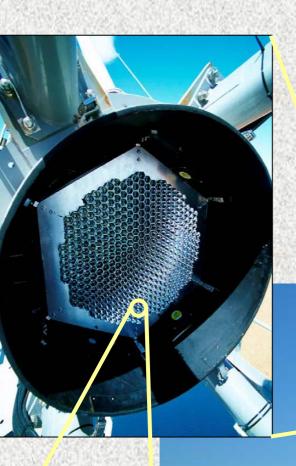
Yamanashi Gakuin University



Hiroshima University

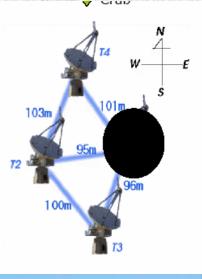


CANGAROO-III望遠鏡



·口径10m(114枚の鏡) 4台 ・回転放物面、焦点距離8m ・427本の光電子増倍管を 並べた解像型カメラ 視野4°



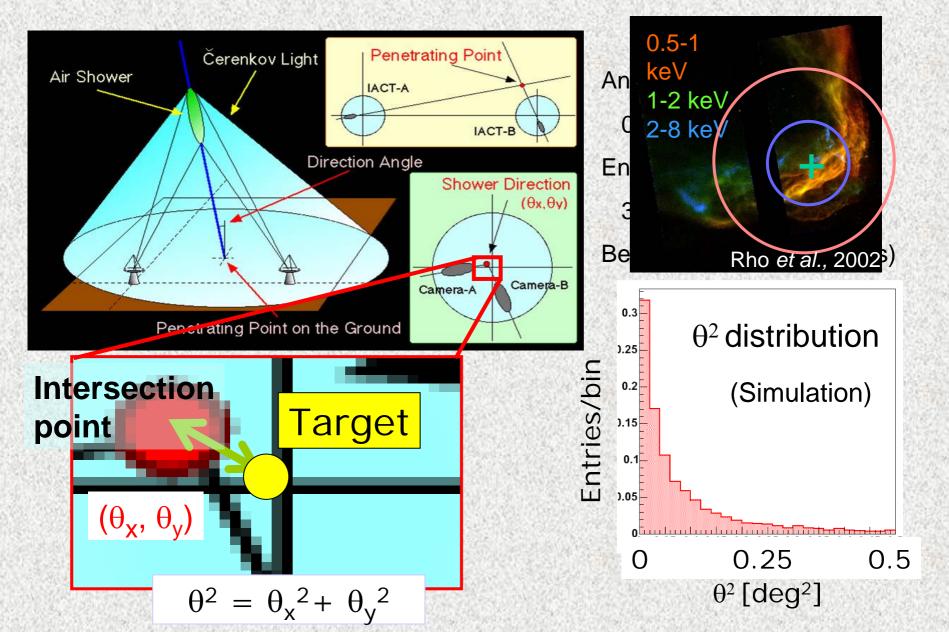


直径3/4インチ 427本

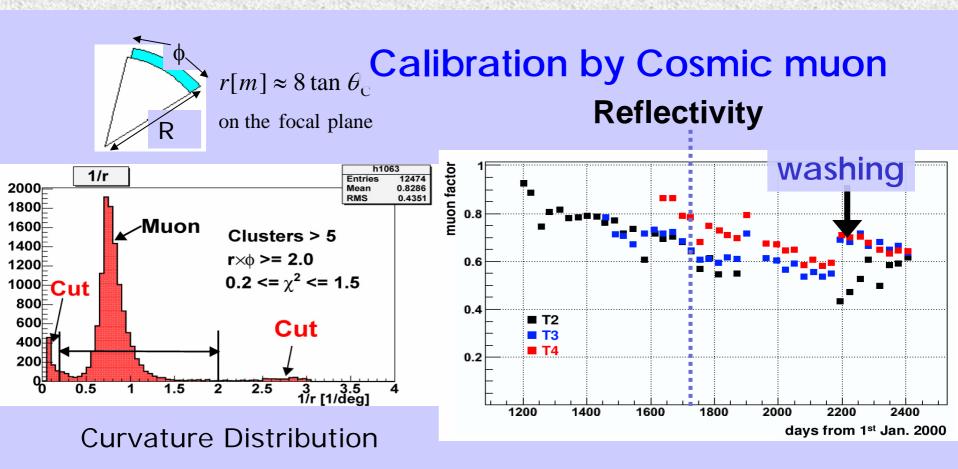




Stereo observation



Performance of Telescopres

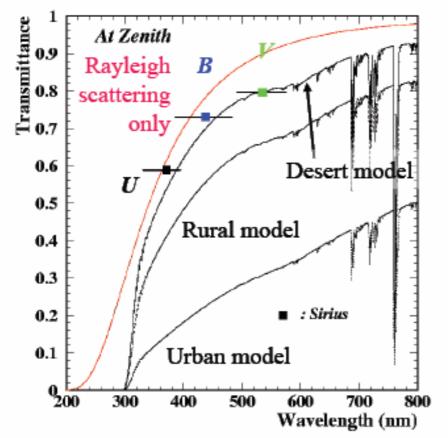


1-7 GeV: 1/r >= 1.0 [1/deg] > 7 GeV: 1/r < 1.0 [1/deg]

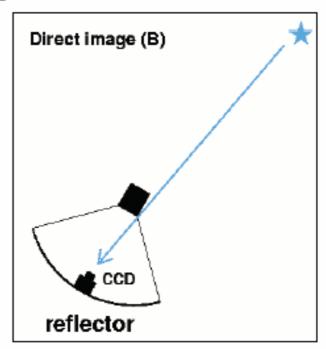
R. Kiuchi et al., Energy Budget in the High Energy Universe, Kashiwa, Feb. 2006

Atmospheric transmission measurement





Take star images at various zenith angles with a cooled CCD camera



Data compatible with "Desert model" of MODTRAN4
Systematic errors under study

γ/h separation by Fisher discriminant

Linear combination of image parameters (x_i)

$$F \equiv \sum_{i} \alpha_{i} x_{i}$$

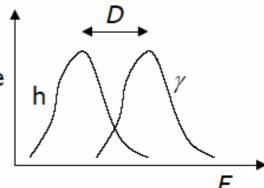
Difference between signal (γ) and background (h)

$$D \equiv \langle F_{\gamma} \rangle - \langle F_{h} \rangle$$

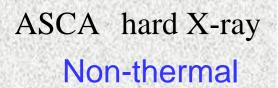
Determine α_i which maximize separation (solvable using correlation matrix)

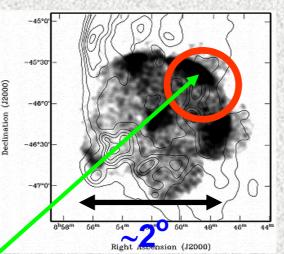
$$S \equiv \langle D \rangle^2 / \langle (D - \langle D \rangle)^2 \rangle$$

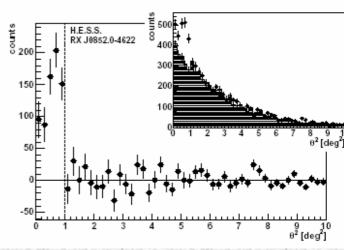
- With calculated α_i for a known source, the (appropriately normalized) combination F could be the "Fisher discriminant" for other sources.
- We use widths and lengths of multiple telescopes for image parameters (x_i).



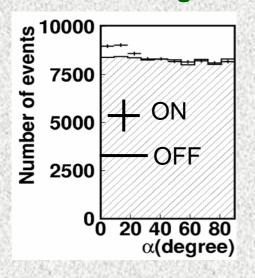
RX J0852.0-4622 TeV Gamma Ray Detection

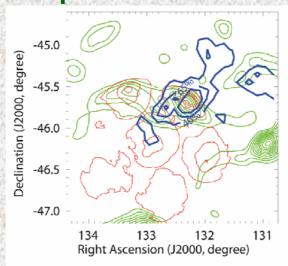


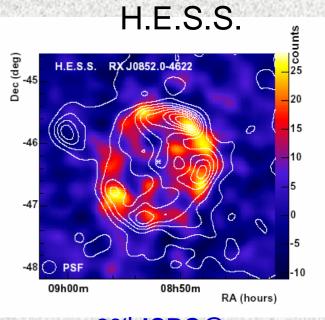




CANGAROO-II single Telescope



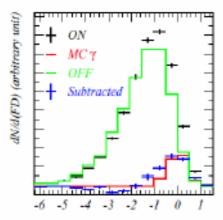




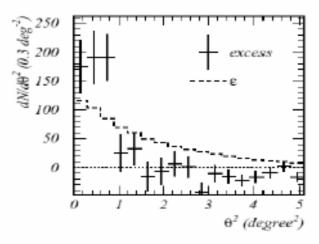
29th ICRC@ pune

SNR RX J0852.0-4622

CANGAROO-III Stereo (Whole SNR Observation)



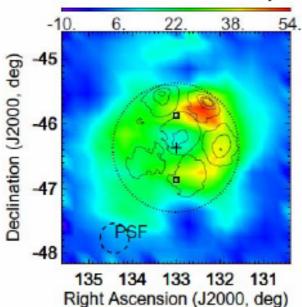
Fisher discriminant



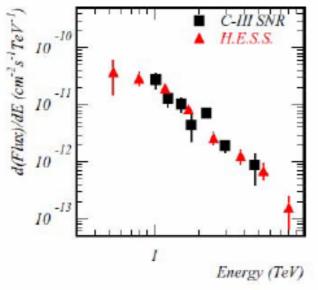
θ2 from SNR center

- Distance ~1 kpc (NANTEN: Moriguchi et al. ApJ 2005)
- Stereo (T2 & T3 &T4 wobble)
- 1,129 min. ON, 1,081 min OFF (2005 Jan/Feb)
- Independent analysis (ICRR, Kyoto)

Excess event map

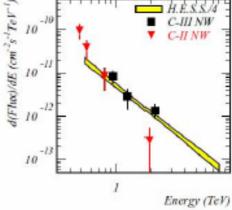


SNR RX J0852.0-4622: spectrum



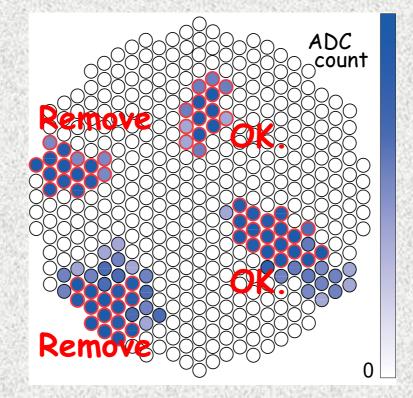
$$\begin{split} \frac{dF}{dE} = & [2.5 \pm 0.6(stat.) \pm 0.6(sys.)] \times 10^{-11} \\ & \cdot \left(\frac{E}{1~\text{TeV}}\right)^{2.2 \pm 0.3(stat.) \pm 0.3(sys.)} \text{ [cm$^{-2}$s$^{-1}$TeV$^{-1}]} \end{split}$$

Comparison with C-II



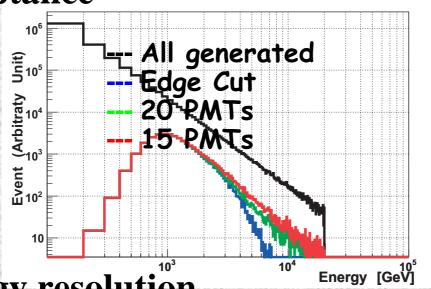
RXJ0852 独立解析と Edge Cut の見直し(京大)

- ADCの値が大きい方から15本のPMTを選ぶ
- この15本が縁になければ残す

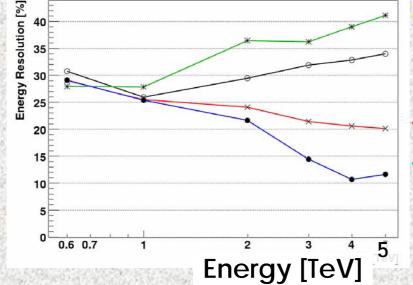


Edge Cut の改良

Acceptance



Energy resolution



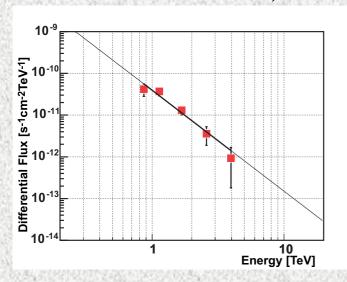
← Edgeの処理 無

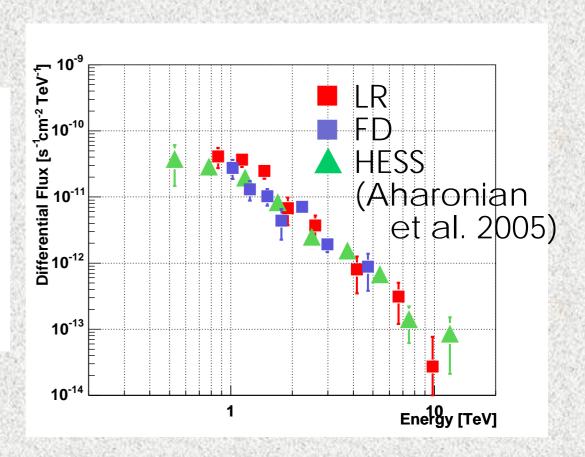
← 15本のEdge cut ~20%

← 従来のEdge cut

クロスチェック(京大)

• Edge Cut (lilkelihood)





Best Fit Parameters

f_B	0.40 ± 0.04	0.01	$f_B = 0.40$
	(free)	(fixed)	1 cm-2 s-1
磁場	5.8 \pm 0.3	32.5 ± 0.9	log ₁₀ E ² dF/dE [eV cm- ² s- ¹]
(μG)	⇒弱い	⇒まだ弱い	-0.5 dg -0.5
		$(cf. > 100 \mu G)$	-5 -2.5 0 2.5 5 7.5 10 12.5 5
べきγ	2.37 ± 0.01	2.38 ± 0.01	log ₁₀ <i>E</i> [eV]
			<i>I</i> _B =0.01
$E_{ m max}$	$37 \pm 2 \text{ TeV}$	$18 \pm 2 \text{ TeV}$	S Z- S- 1
			실 병 0.5
Total	0.18 ± 0.02	~ 0.003	log ₁₀ E ² dF/dE [eV cm ⁻²]
energy	x 10 ⁴⁸ erg	x 10 ⁴⁸ erg	-0.5
@200pc		CRのSNR起源には	-5 -2.5 0 2.5 5 7.5 10 12.5 5
	電子記道では難しい	小さすぎる	log ₁₀ <i>E</i> [eV]

 \Box $\pi^0 \rightarrow \gamma \gamma \ \mathcal{C}Fit$

陽子起源

- Data
 - TeV HESS = 9点, CANGAROO-III = 8点
- 仮定
 - 陽子のspectrum

$$\propto E^{-\gamma}e^{-E/E_{\text{max}}}, \gamma=2.1$$

• SNR:

$$d=200$$
pc $\Rightarrow \sim 0.2 \Box/cc$

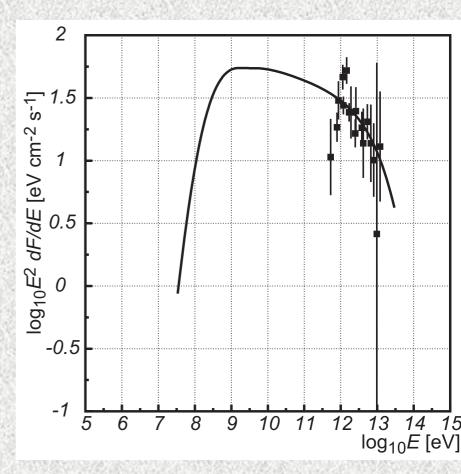
- Parameter: E_{max}
 - Best fit

$$E_{\text{max}} = 155 \pm 94 \text{ TeV}$$

– Total energy:

$$E_{\rm p} = 0.98 \times 10^{50} \, \rm erg$$

~ 10% SN ⇒ 効率よすぎる? <mark>電子起源よりは可能性が高い</mark>



Starburst galaxy NGC253

3-fold, 2004 Oct, 1179min (ON), 753min (OFF)

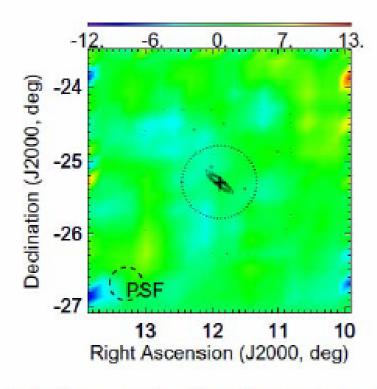


Fig. 3. Excess count map. The rainbow map is the excess count. The black contour is DSS2 (second version of Digital Sky Survey) data. The dotted circle is 0.5 degree radius. The point spread function is shown in left-below corner (the dashed line).

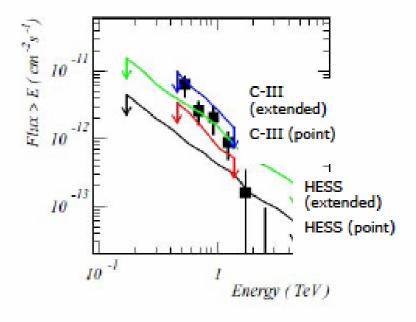


Fig. 4. Integral fluxes. The points with error bars are the CANGAROO-II's ones (see text for the detail). The black curve is 99% upper limit (UL) by H.E.S.S. for point source assumption. The green is that for 0.5 degree diffuse source. The red is 2σ UL for this observation for point source assumption and the blue for 0.5 degree diffuse.

2006 Targets

• Jan	RX J0852.0-4622	24hr
• Feb	RX J0852.0-4622, HESS J1303-631	57hr
• Mar	HESS J1303-631, PSR 1509-58	33hr
• Apr	HESS J1303-631, PSR 1509-58	60hr
• May	PSR 1509-58, HESS J1804-216	58hr
• Jun	PSR 1509-58, HESS J1804-216, A366	67 74hr
• Jul	HESS J1804-216, A3667, PKS2155-3	304 71hr
• Aug	A3667, PKS2155-304, A4038	70hr
• Sep	A4038, SMC	82hr
• Oct	SMC	30hr
• Nov	SMC	30hr

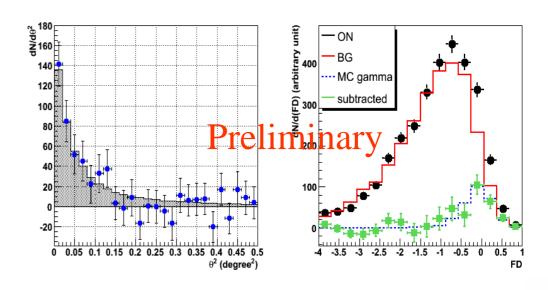
Flare of Blazar PKS 2155-304

東海大、京大、ICRR

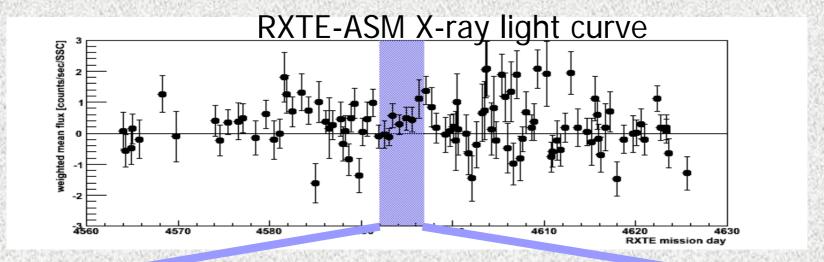
- Nearby high-frequency BL Lac (z=0.117)
- TeV flare report by H.E.S.S. in July-Aug 2006 (ATel#867)
- 1,053 min (wobble), 3-fold
- Analyzed by independent teams (ICRR, Tokai, Kyoto)

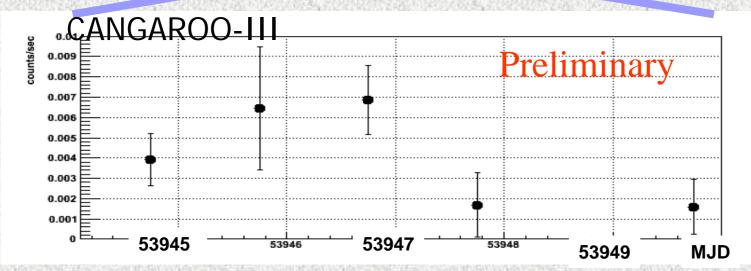
	obs. time(h	zenith	trigger rate	shower rate	live time
7/28	3.9	20.4	12.1	8.0	3.5
7/29	2.0	12.1	6.2	6.8	0.9
7/30	4.0	22.2	12.5	8.1	3.5
7/31	3.9	21.7	11.6	7.6	3.6
8/2	3.9	21.5	11.9	7.8	3.5
total	17.6	20.4	11.4	7.8	15.0

2006-July



Light curve





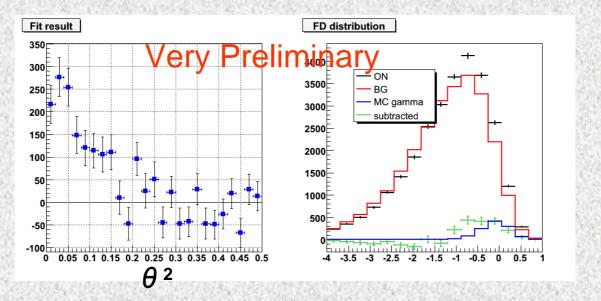
2006-August Also we have detected!

Up and coming sources...

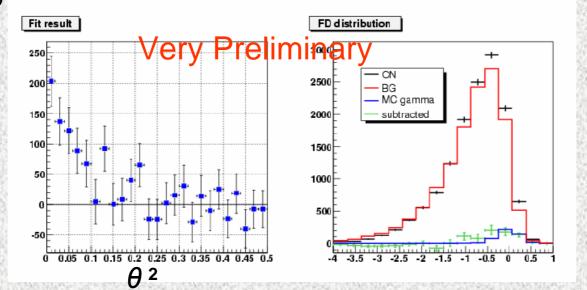
- MSH 15-52
 - Pulsar wind nebula (PSR 1509-58)
 - H.E.S.S.: 25% Crab, extended (~6'x2')
 - Observation: 40hr in 2005, 90hr in 2006
- HESS J1804-216
 - G8.7-0.1(SNR) / PSR J1803-2137
 - H.E.S.S.: 25% Crab, extended (~12')
 - Observation: 90hr in 2006
- HESS J1303-631
 - Unidentified
 - H.E.S.S.: 17% Crab, extended (~10')
 - Observation: 70hr in 2006

From above three sources, signals have been detected.

HESS J1804-216



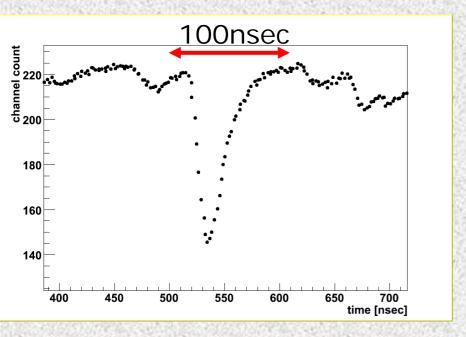
PSR1509



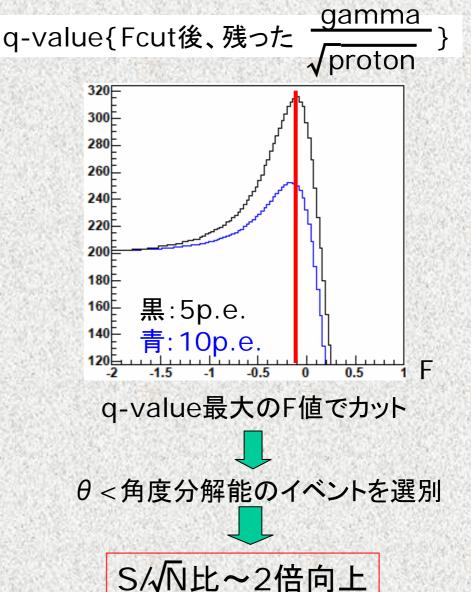
Flash ADC(京大)

500MHz Flash ADC

Flash ADCで記録した信号の波形

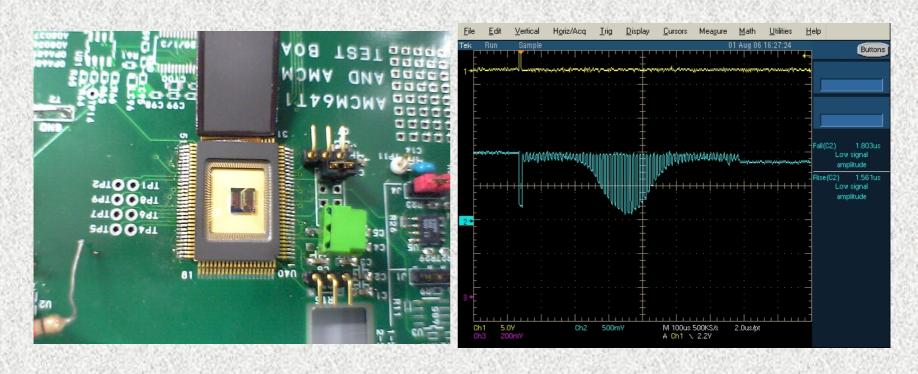


現地で試験



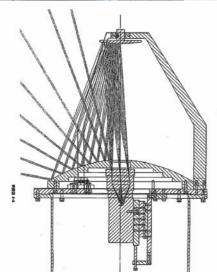
Capacitor Array (京大)

- •KEK回路室との共同開発 2年後を目標
- •1 GHサンプリング
- •回路とPMTの一体化、

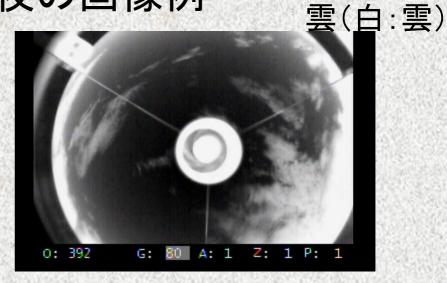


赤外線雲モニター(東海大)

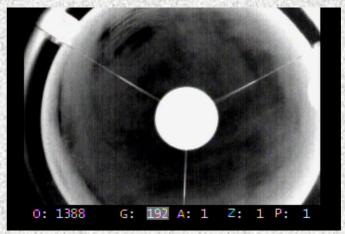




夜の画像例



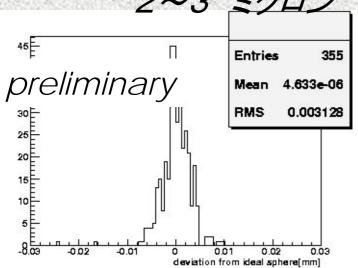
全天薄雲(白:雲)

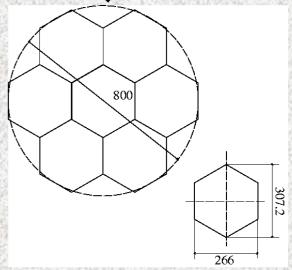


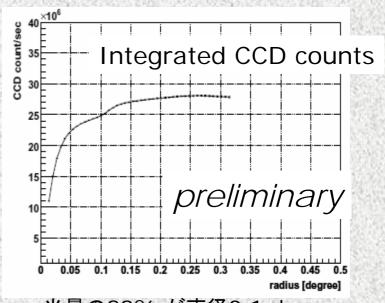
金属鏡開発(東海、ICRR)



球面からのずれ: 2~3 <u>ミクロン</u>







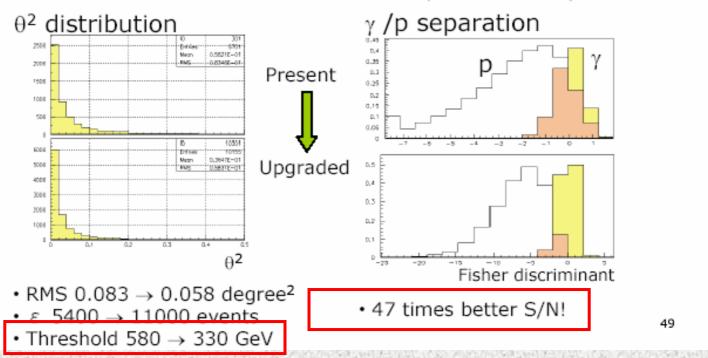
光量の89% が直径0.1 degree に含まれる。

Near future: upgrade of CANGAROO-III

- Upgrade of mirrors (FRP process limited spotsize.)
- Upgrade of T1 camera & electronics

[Requesting budget]

Expected sensitivity after upgrade (Monte Carlo simulation assuming 1'-spotsize mirrors)



将来計画、第1ステップ 鏡の交換、1号機の復帰 (特推 に応募)、国際観測ネットワーク構築

第2ステップ国際協か?

18年度ICRR共同利用: CANGAROO関連

代表者	校費(千	旅費(千	
森(ICRR)	円) 1,000	円) 1,600	
榎本(ICRR)	3,000	400	
谷森(京都)	100	500	
西嶋(東海)	200	800	
内藤(山梨学院	100	200	
	50	200	
梶野(甲南)	100	200	
郡司(山形)	50	300	
櫛田(東海)	50	200	
大石(ICRR)	100	300	
計	4,750	4,700	

旅費 海外 約300万 国内 約66万 執行済み 未執行 約60万 (2回目の全体打ち合わせ用) 校費 回路修理 100万 PMT(40本)320万 消耗品等 50万 執行分 約70万

他に研究会経費 (茨城大、3月開催予定)

活動状況

シフト、 ICRR 8 京都 9 東海 12 茨城 2 山形
 1 甲南 1 北里 1 Adelaide 2 (月3人)

- 科研費 A1件、B 1件 C 1件 特定 1件(公募) 若手B 2件 DC 2件 日豪共同事業(旅費)
- 05年度 修論 東海 1, 茨城 2、京都 1、 ICRR 3, 山形 1,
- 博士論文 京都 1

まとめ

- 観測は順調に行っている。VELA領域、SMC領域 サーベイを行う。
- RXJ0852,形態学的観測が可能、他の波長との比較 が可能となる。
- AGN,PKS2155のフレア連続観測が出来た。今後、国際観測ネットワークへ!!
- 10%Crab天体の観測が実現。
 PSR1509, HESS1303, HESS1804
- 新型回路、金属鏡など次期に向けた開発が進行。