CANGAROO

Masaki Mori
Institute for Cosmic Ray Research

シンポジウム「法人化後の宇宙線研究所研究プロジェクトについて」

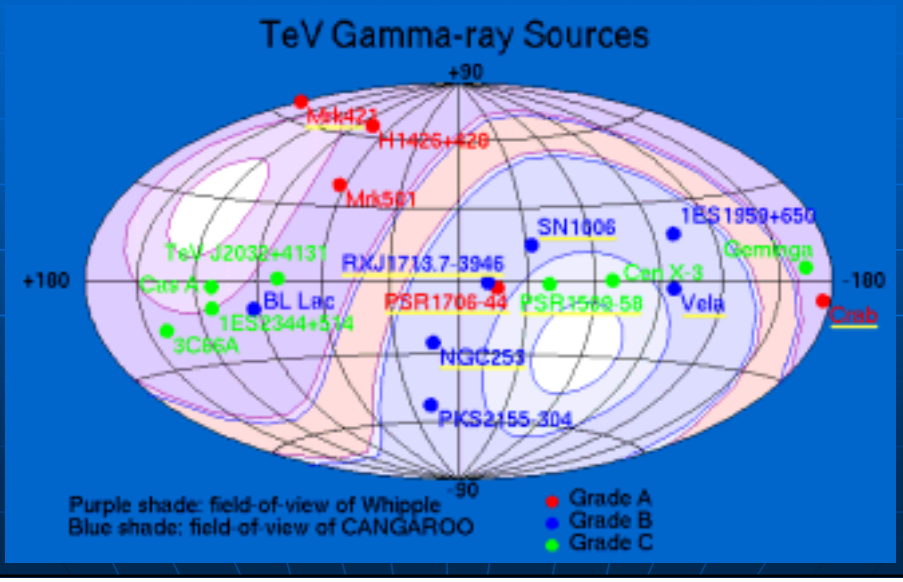
Symposium “ICRR Projects after university reform in 2004”

February 01, 2003 @ICRR

CANGAROO team

- University of Adelaide
- Australian National University
- Ibaraki University
- Ibaraki Prefectural University
- Kanagawa University
- Konan University
- Kyoto University
- Nagoya University
- National Astronomical Observatory of Japan
- Osaka city University
- Institute of Physical and Chemical Research
- Shinshu University
- Institute for Space and Aeronautical Science
- Tokai University
- Tokyo Institute of Technology
- Yamagata University
- Yamanashi Gakuin University

TeV gamma-ray sky in 2002



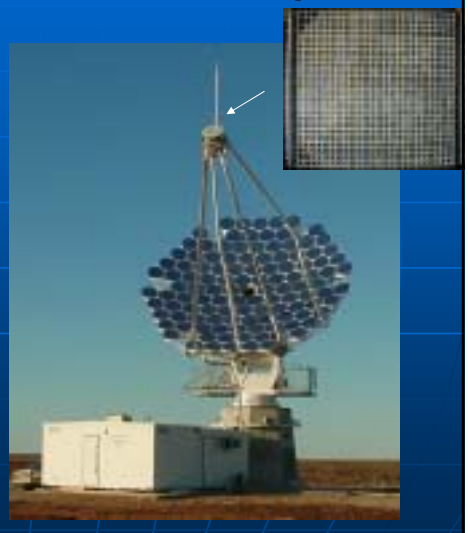
(Yellow: CANGAROO)

TeV sources

4 Pulsar nebulae	Crab Vela PSR 1706-44 PSR1509-58
8 Blazars	Mrk 421 Mrk501 1ES2344+514 PKS2155-304 3C66A BL Lac 1H1426+428 1ES1959+65
3 Supernova remnants	SN1006 Cas A RX J1713.7-3946
1 X-ray Binary	Cen X-3
1 Starburst galaxy	NGC253

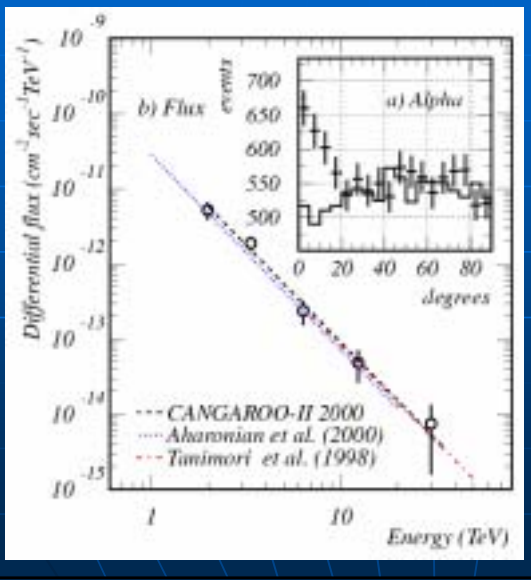
CANGAROO 10m telescope

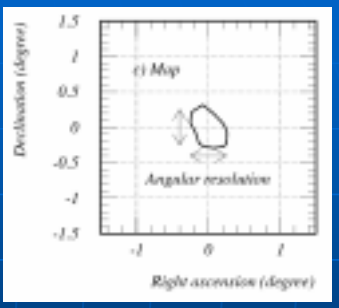
- Upgraded in 2000
- 114 x 80cm CFRP mirror segments *(first plastic-base mirror in the world!)*
- Focal length 8m
- Alt-azimuth mount
- 552ch imaging camera
- Charge and timing electronics



(March 2000)

Crab nebula





"Standard candle" is observed as it should be
– Our telescope is working properly!

C. Itoh, Ph.D. thesis 2003

CANGAROO-II observations

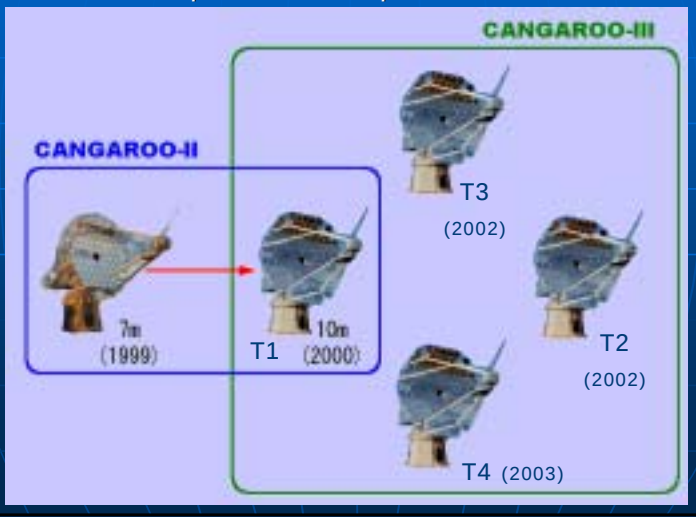
	Signal	Publish
SNR/Pulsar Crab	○	
SNR RX J1713.7-3946	○	○ (Nature)
AGN Mrk421	○	○ (ApJL)
Starburst galaxy NGC253	○	○ (AApL)
Pulsar PSR 1706-44	○	Δ
SNR SN1006	○	Δ
PSR 1259-63/SS2833	↓	Δ
AGN PKS2155-304, PKS2005-489	↓	Δ
SNR RX J0852-4622	Δ	
SNR RCW86	Δ	
Galactic Center/Sgr A*	Δ	
Galactic jet object SS433	Δ	
EGRET unID 3EG J1234-1318	Δ	
Galaxy Small Magellanic Cloud	Δ	
Vela pulsar	Δ	

Signal: ○ detected, ↓ upper limit, Δ under analysis

Publish: ○ published, Δ in preparation

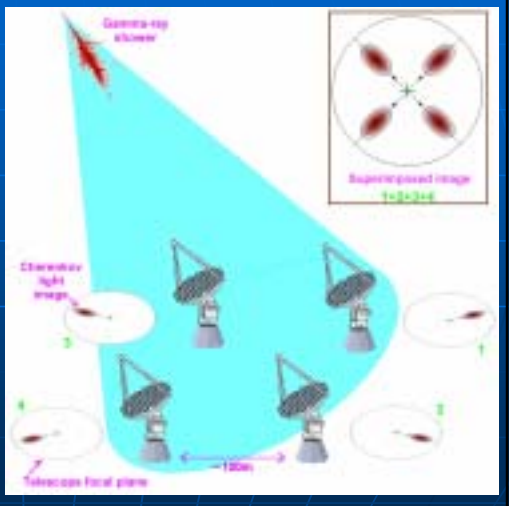
CANGAROO-III project

- 4 x 10m telescopes to be completed in 2003



Merit of stereo observation

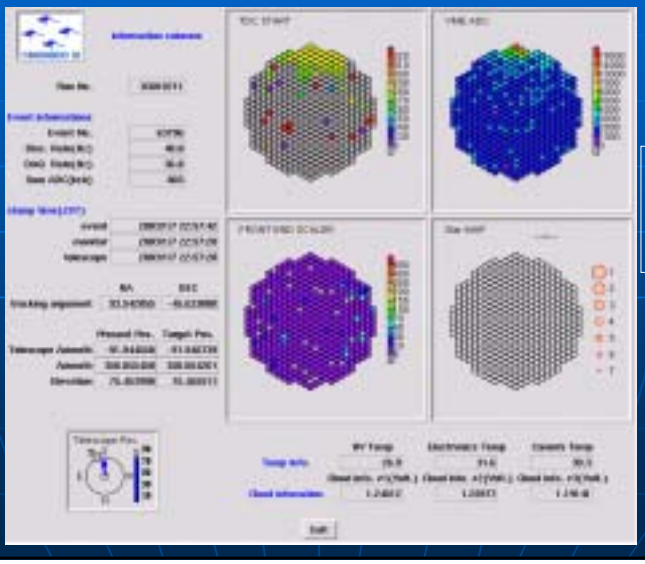
- Cherenkov shower pool: ~300mϕ
- Stereo $\Rightarrow$ Info. on distance to showers
- Better angular resolution $\Delta\theta = 0.2° \rightarrow 0.05°$
- Better energy resolution $\Delta E/E = 30\% \rightarrow 15\%$



10m telescope No.2

- Completed in 2002
- Improved FRP mirror segments
- Focal length 8m
- 427ch imaging camera
- Faster electronics (charge and timing)

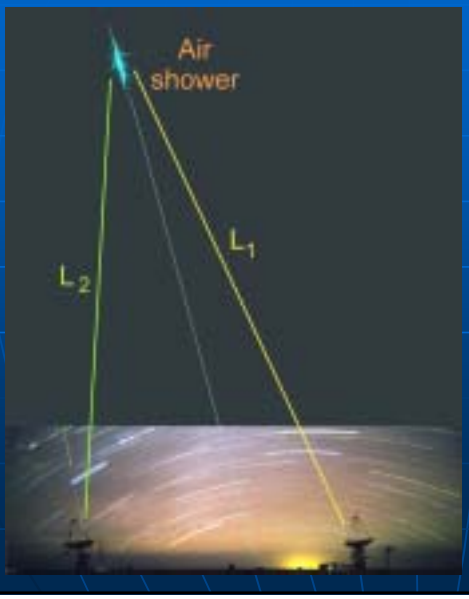
T2 event samples

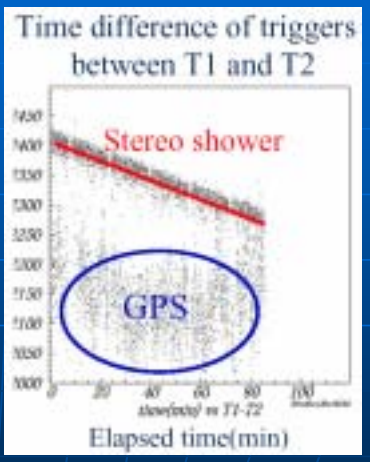


TDC ADC

Scaler Star

Stereo observation





$\Delta t = (L_1 - L_2)/c \propto \cos A \cos h$

GPS: 1pps

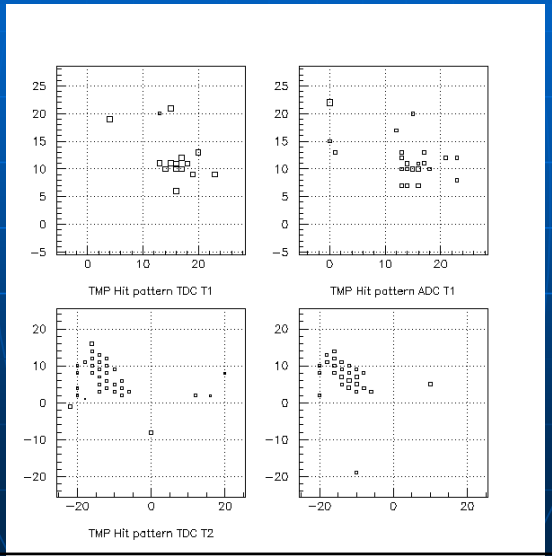
Stereo sample

T1 TDC

T1 ADC

T2 TDC

T2 ADC



Present status: Three 10m telescopes in Woomera

Started operation in Dec. 2002

Assembled in Dec. 2002

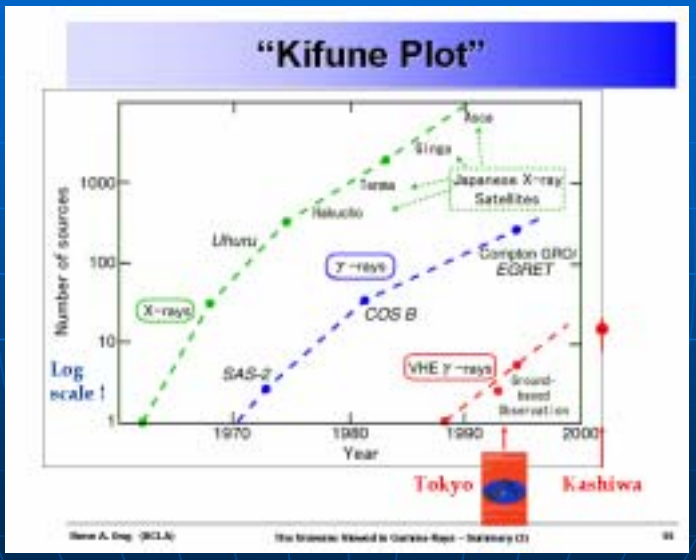
In operation since 2000

Next several years

- Systematic study of SNRs
- Survey of the galactic plane
- International/multiwavelength coordination

- Present fund ends in 2004 March
- We need running fund!
- T1 mirror & electronics: replacement is necessary!

Number of sources vs. year



©R. Ong, 2002, "The Universe viewed in Gamma-rays", Kashiwa, 2002 Sep

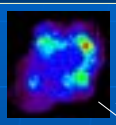
Next CANGAROO

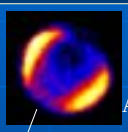
- R&D for 15m class telescope
  - Light, durable plastic mirror
    → the reflector can be larger
  - Mountain altitude? ← Lower threshold
  - Lower energy gamma-rays, overlapping the satellite (GLAST) region

GLAST	IACT
50MeV-100GeV	100(→20?)GeV-100TeV
All sky survey	Deep survey

Systematic study of SNRs

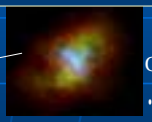
RX J1713.7-3946 (CANGAROO) | **SN1006** (CANGAROO) | **RCW86** (CANGAROO under analysis)

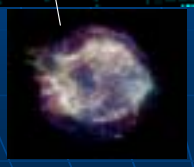

ASCA

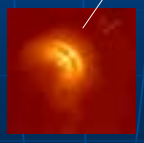

ASCA

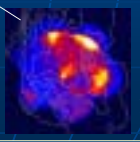

ROSAT

Crab nebula
("Standard candle")


Chandra
+ optical

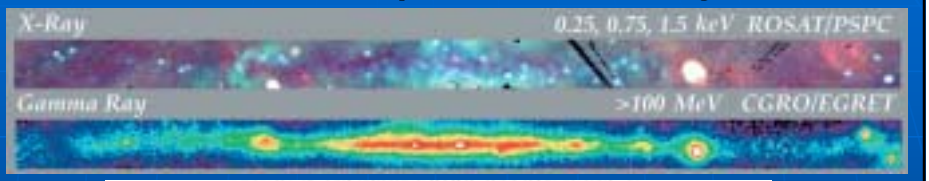

Chandra

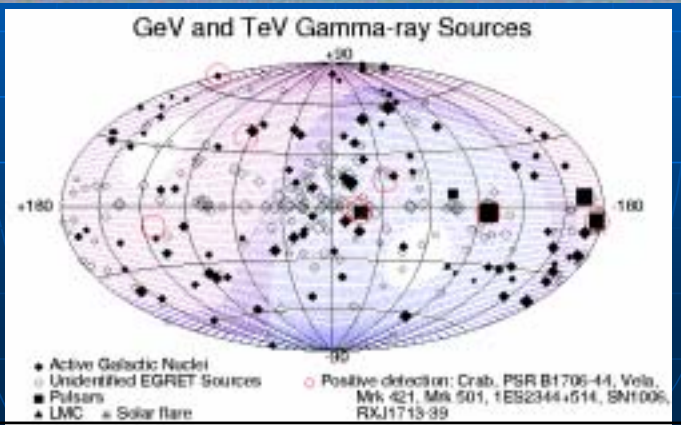

Chandra


ROSAT

Cas A (HEGRA) | **Vela** (CANGAROO) | **RX J0852-46** (CANGAROO under analysis)

Galactic plane survey





International coordination

- Continuous observation of time variable objects (ex. Blazars)
- Multiwavelength campaign