Status of CANGAROO-III 2nd telescope

CANGAROO collaboration

CANGAROO III

CANGAROO-III project

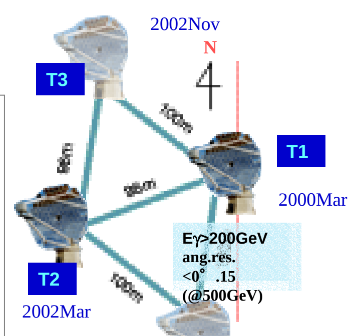
Woomera,SA

31° 06'**S** 137° 47'**E**
160m a.s.l

Level plain

desert climate

CANGAROO experiment started in 1992



CANGAROO-III
Four 10m telescopes

Construction schedule

2000.3 T1(C-III 1st telescope) completion
(extension from the C-II 7m telescope)

2001 production of the 2nd telescope (T2)

2002.3 construction of T2

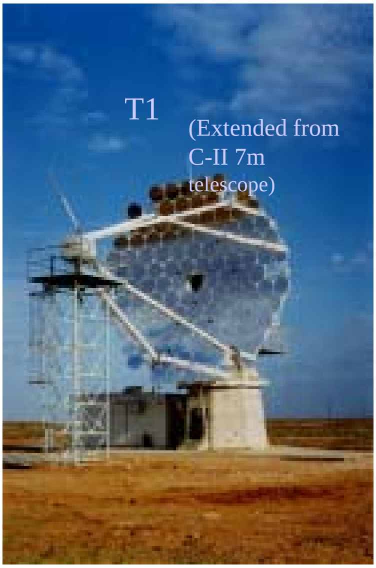
2002.11 tune-up of T2
construction of the 3rd telescope(T3)

.12 start stereo observation with T1 &T2

2003 production of the 4th telescope(T4)

2003.4 construction of T4
stereo observation with all 4 telescopes

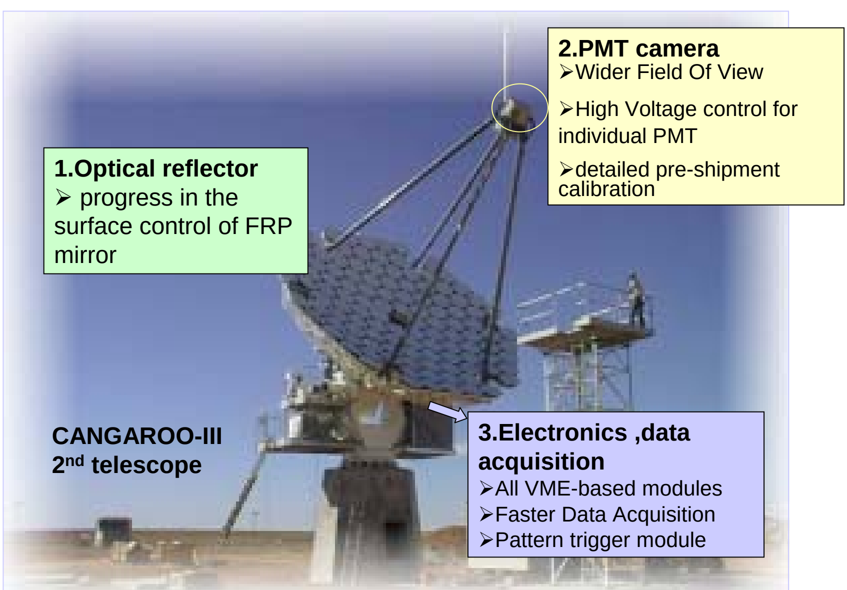
CANGAROO-III telescope basic design



	T1	T2
Main mirror	Parabolic	
Mounting	Alt-azimuth	
Max tracking speed	0°.5 /sec	1°.0 /sec
Focal length	8m (F=0.8)	
# of mirrors	114	
Spot-size (FWHM)	0°.20	(~0°.15*)
FOV	3°.0	4°.2
Pixel size	0°.115	0°.168
# of PMTs	552	427
Readout electronics	TDC & ADC	

*estimation

Contents -improvement in the hardware of the 2nd telescope-

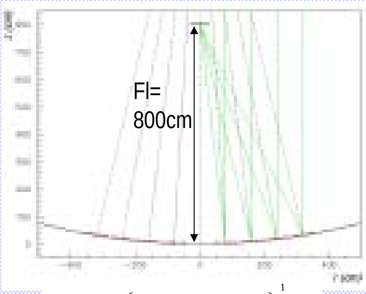


Optical reflector - design ,tessellated paraboroid-

Requirement for the reflector

- **~0°.15 FWHM (~pixel size)**
- **High reflectance at 300-400nm**

Spherical mirrors on paraboloid

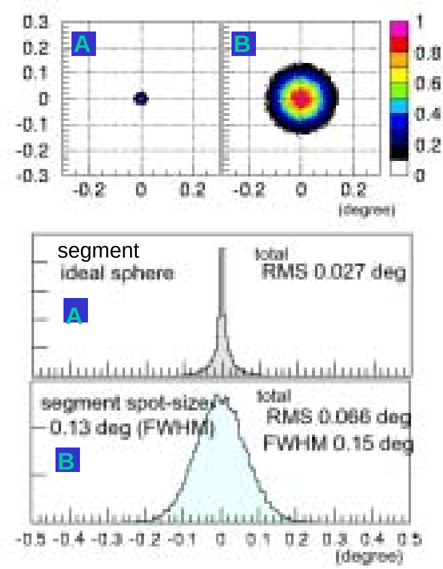


$$CR(r) = \left\{ \left(\mathrm{fl} - \frac{r^2}{4\mathrm{fl}} \right)^2 + r^2 \right\}^{\frac{1}{2}} \times 2$$

CR:**16.0-17.2m**

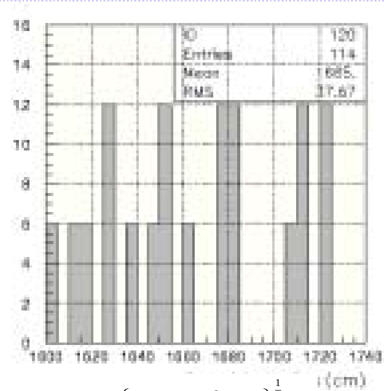
(16.6m as average)

Finite spot-size



Optical reflector – curvature radii-

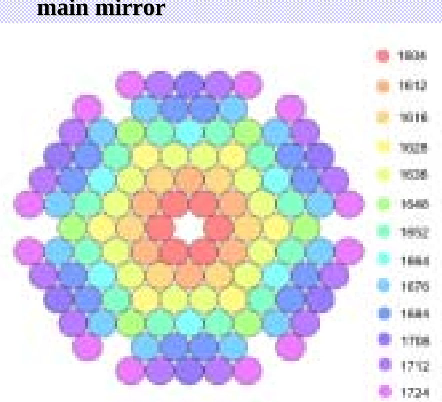
Distribution of curvature radii (design value)



$$CR(r) = \left\{ \left(\mathrm{fl} - \frac{r^2}{4\mathrm{fl}} \right)^2 + r^2 \right\}^{\frac{1}{2}} \times 2$$

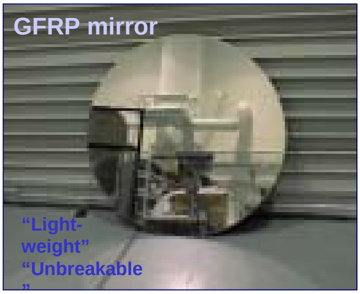
$$n(r)dr \propto rdr$$

Position assignment on the main mirror

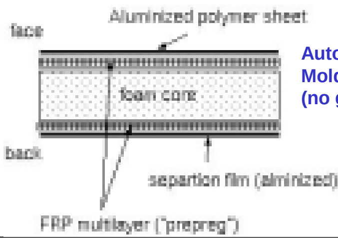


- Each mirror's position on the main mirror is assigned according to "resulted" curvature radius.

Optical reflector (1) -spherical mirror segments,design and formula-



Cross section of GFRP mirror



Autoclave Molding (no grind)

Material: CFRP → GFRP

(Glass Fiber Reinforced Plastic)

Diameter: 78cm

Weight: **5.6kg** + 1.1kg(back base)

Molding: vacuum bag + **autoclave**

Curvature radius: 16.0 ~ 17.2m

Spot size : ~0° .13 in FWHM(typical)

Reflector metal : Aluminum

Surface protection: Fluoroplastic painting

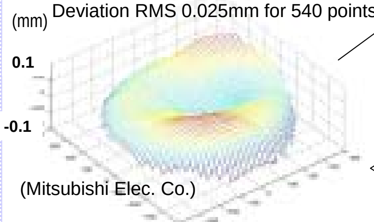
Reflectivity: 80% @ 400nm

Alignment : tilt around 2 orthogonal axes
stepping motor control

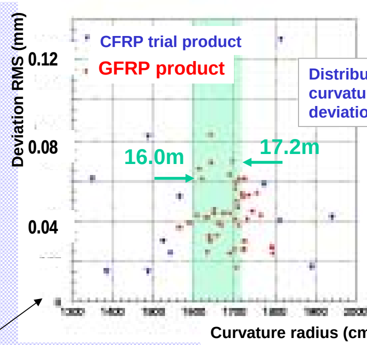
Optical reflector (2) -small mirror segments,surface accuracy-

3D form measurement

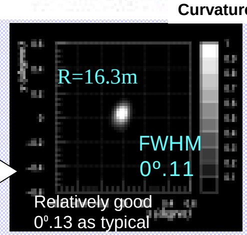
- Surface height of the mirror is measured with 0.005mm accuracy for 540 points
- Two-parameters-- "**best-fit curvature radius**" and "**deviation from the sphere**"-- are obtained.



3D form measurement data
-Deviation from ideal sphere-



Distribution of curvature radius and deviation RMS value



Conventional Spot-size test

- *There seems to be some progress in the surface control .*
- *"typical" spot size of recently produced GFRP mirror is 0° .13 in FWHM with more than 80% acceptability.*

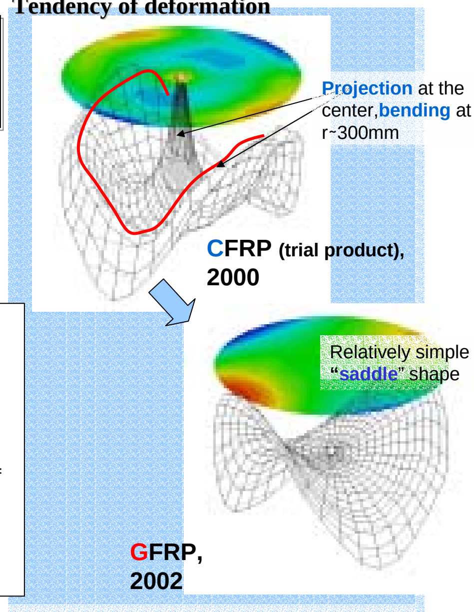
Optical reflector –FRP development-

Surface accuracy of FPR mirror is determined by the **balance** of **rigidity** of composite materials

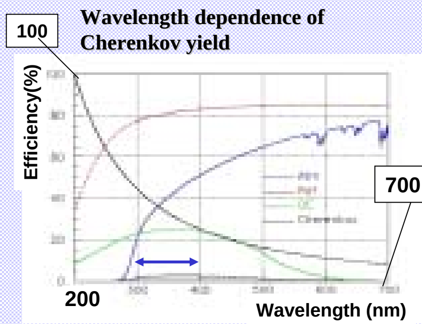
- **Recoil** of the core
- ⇕
- **Repression** of FRP sheets

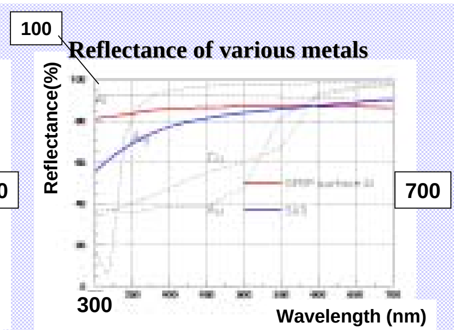
- add/subtract components of multi-layer
- change layer thickness
- Chaｒge rigidity of material (core,FRP)
- ………etc.

Tendency of deformation



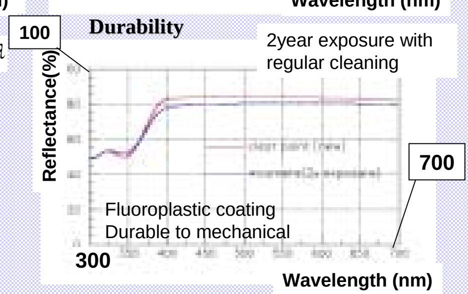
Optical reflector (3) -reflectance-





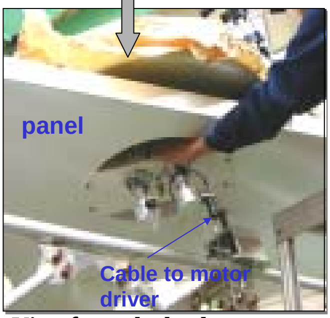
$$\text{Cherenkov yield} \propto \int_{\lambda_1}^{\lambda_2} \lambda^{-2} T(\lambda) \mathrm{Ref}(\lambda) QE(\lambda) d\lambda$$

- **High reflectance** at *shorter (300-400nm) waveband* is required due to strong wavelength dependence of Cherenkov spectrum
- **Durability** under desert climate
- **Aluminum** (easily oxidized and corroded)+ surface protection



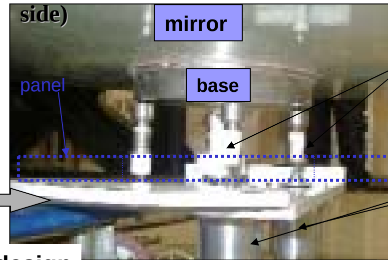
Optical reflector (4) –alignment system-

Axis alignment system



View from the back

Contact point(view from the side)



design

Tilt around 2 orthogonal axes

Resolution : 2.86x10^{-4} degree

Dynamic range: ±2.86 degree

test

- Smooth motion
- Repeatability
- Travel distance linearity

⇩

~0°.02 alignment accuracy

- Metal base is attached to the back surface of the mirror.
- The base is sustained by central screw cramp(fixed point) and 4 shafts.
- Two of them are linear actuator shaft whose length are controlled remotely using stepping motor.

S.Kabuki

Imaging camera (1) (2nd telescope)

Camera structure design

- Weight　: **110kg**
- Hexagonal arrangement　427 PMTs
- **Field of view : 4°** (0.168°　/pixel)

PMT module design (427 PMTs)

- ¾ inch PMT(R3479,HPKK) +Preamp(MAX4107)

Light-guide design

- Winston cone shape
- Reflectance ~**80** % (at **300~400**nm)

High Voltage supply

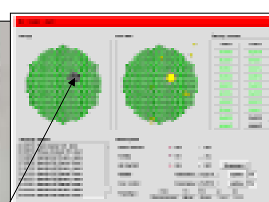
- GUI monitor program
- voltage controlled for individual PMT

Details are described in the poster by
S.Kabuki (T09)

New camera structure

PMT+Preamp assembly

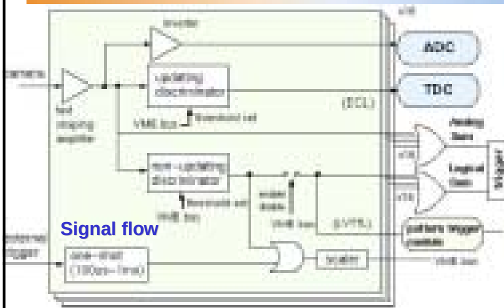
Light-guide



HV monitor program

HV off for bright stars

Electronics(1) front-end data acquisition

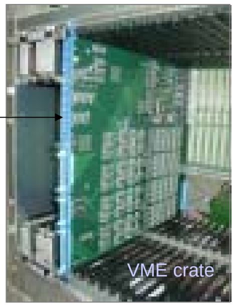


- **Lower threshold** means higher *trigger rate*, higher deadtime ratio
- shorter signal processing time--**faster data acquisition** is required for the observation with lower energy threshold.

VME-based modules

- Front-end
  Discriminator/scaler
- Charge ADC
  16bit ADC chip for each channel
  Readout time:10-20µsec/board
- TDC
  1ns resolution

Custom-built VME-base front-end module



Acceptable trigger rate ~**530**Hz
(20% deadtime level)

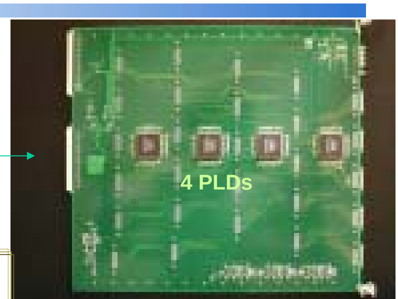
Details are described in the poster by
D.Nishida (T17)

Electronics(2) Pattern trigger module

The second strategy to cope with *high trigger rate*

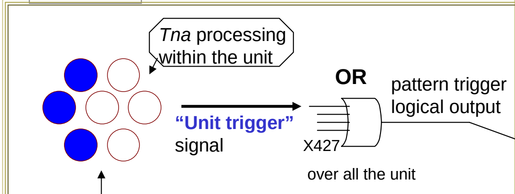
Suppress "junk" trigger at **online** level

Pattern trigger module using PLD
(**P**rogrammable **L**ogic **D**evice)



Pattern trigger module(VME9U)
427channel input ,1ch NIM output

Algorithm



Transplant familiar "**clustering**" into hardware

- **Pattern trigger(secondary)**
- **Normal trigger(primary)**

Details are described in the poster by
K.Nishijima (T18)

Current status of the 2nd telescope

Completion of the 2nd telescope

Camera assembly

Installation of electronics

summary

- The 2nd telescope of the CANGAROO-III project is now waiting tune-up for the operation.
- Hardware of the 2nd telescope is considerably improved.
- Tune-up of the 2nd telescope and construction of the 3rd telescope are both scheduled for November.

Test assembly of the 3rd telescope (2002Aug, in Japan)