



H.E.S.S.

High Energy Stereoscopic System

MPI Kernphysik, Heidelberg

Humboldt Univ. Berlin

Ruhr-Univ. Bochum

Univ. Hamburg

Landessternwarte Heidelberg

Univ. Kiel

Ecole Polytechnique, Palaiseau

College de France, Paris

Univ. Paris VI-VII

CEA Saclay

CESR Toulouse

GAM Montpellier

LAOG Grenoble

Paris Observatory

Durham Univ.

Dublin Inst. for Adv. Studies

Charles Univ., Prag

Yerewan Physics Inst.

Univ. Potchefstroom

Univ. of Namibia, Windhoek



Physics with H.E.S.S.

Cosmic ray origin and acceleration

- Supernova remnants
- Starburst galaxies
- Unidentified galactic sources/surveys
- Clusters of galaxies

Astrophysics of compact objects

- AGNs
- Micro-Quasars & Stellar-mass black holes
- Pulsars
- Gamma ray bursts

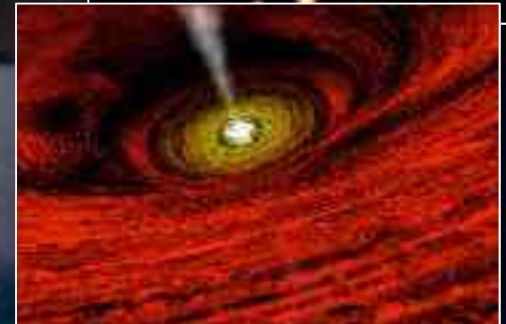
Cosmology

- Diffuse extragalactic radiation fields via cutoff in AGN spectra and AGN halos
- Clusters of galaxies

Astroparticle physics

- Neutralino annihilation in DM halos

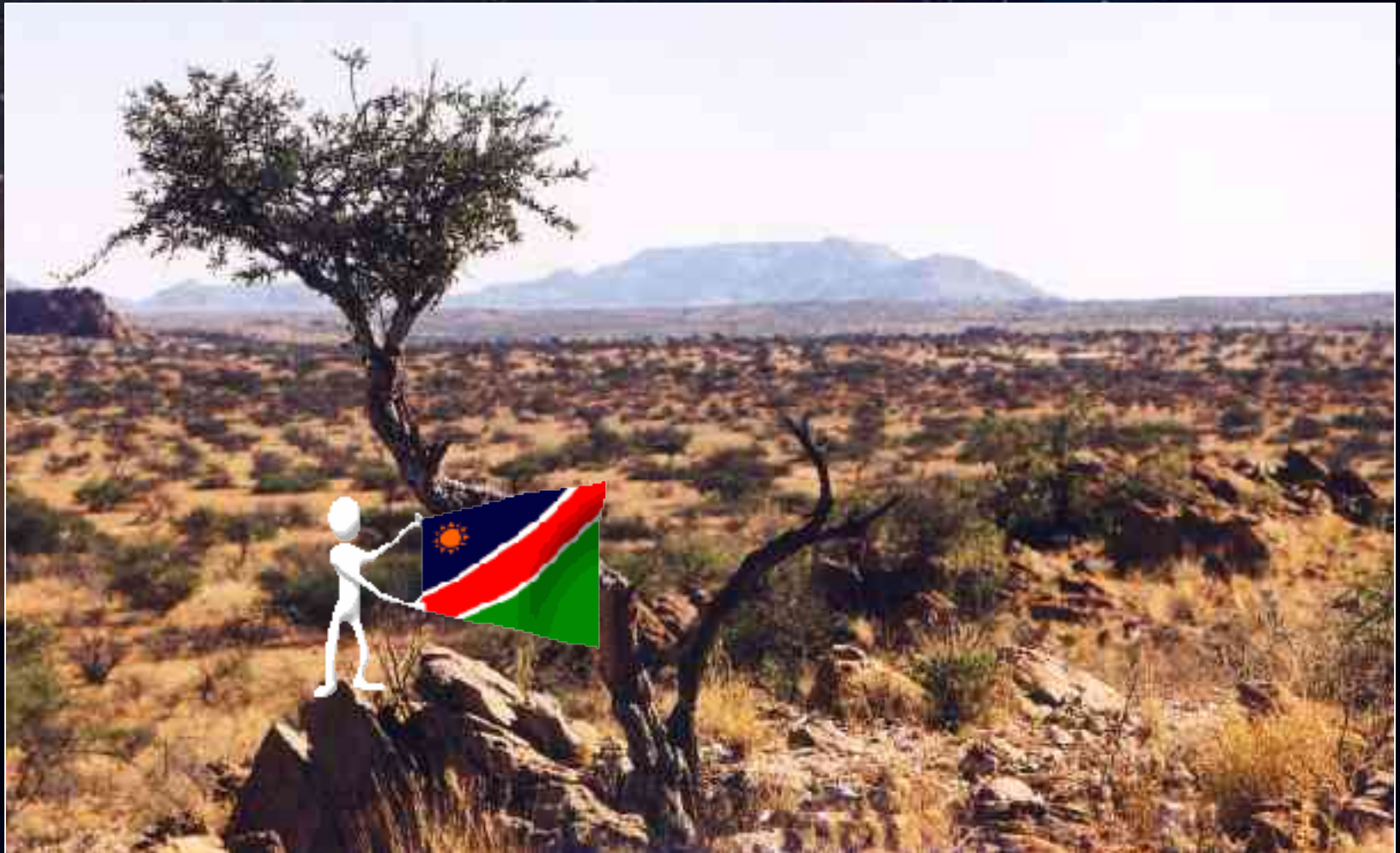
- Southern hemisphere
- Relatively large field of view
- Optimized for 100 GeV – 10 TeV



The site

Farm Goellschau, Khomas Highland, Namibia

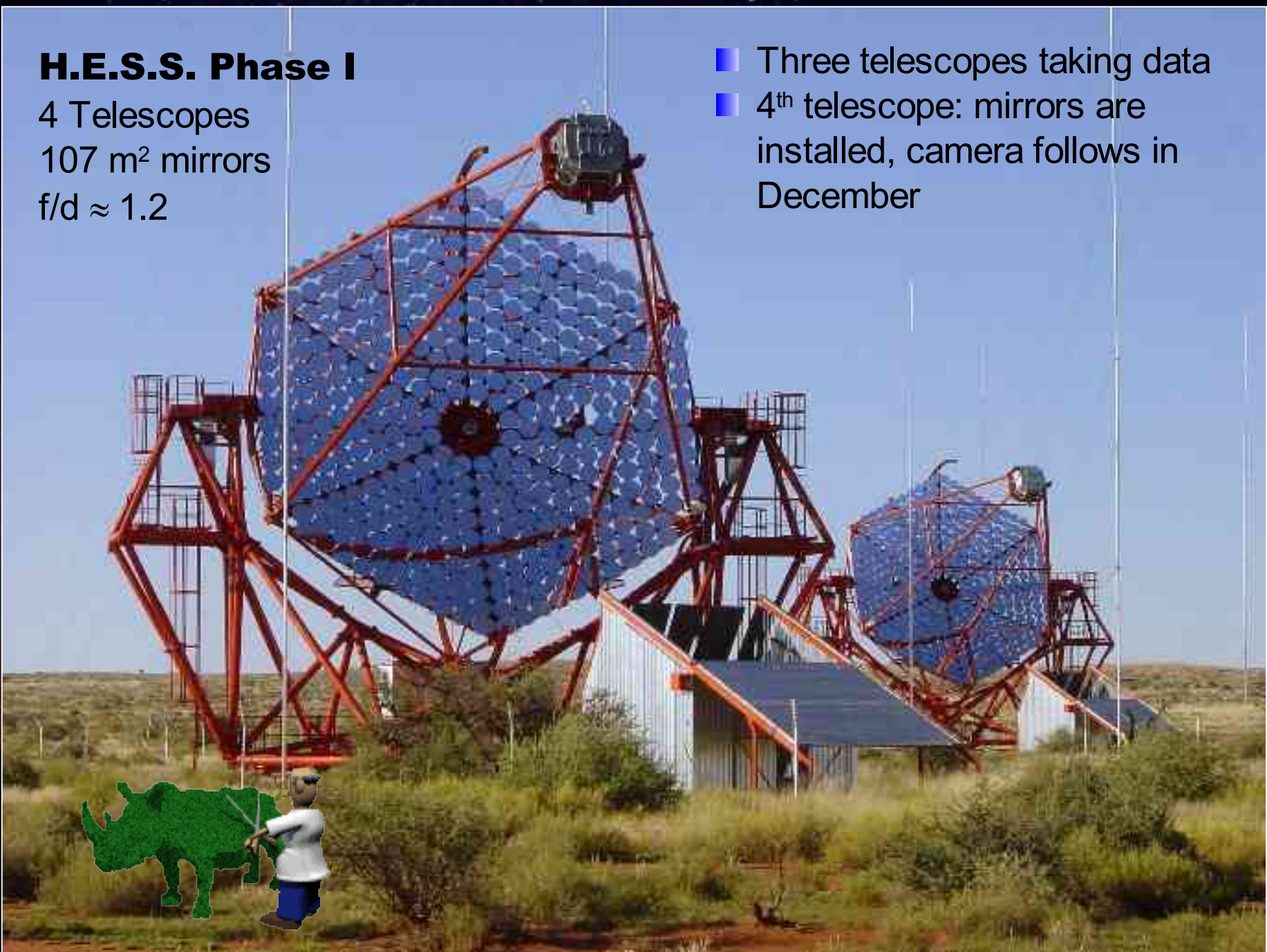
Coordinates 23°16' S, 16°30' E, 1800 m asl
100 km from Windhoek, near Gamsberg



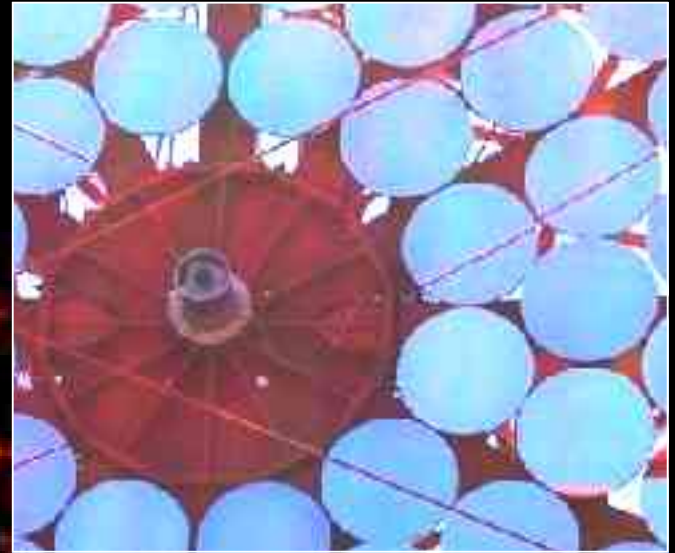
H.E.S.S. Phase I

4 Telescopes
107 m² mirrors
f/d \approx 1.2

- Three telescopes taking data
- 4th telescope: mirrors are installed, camera follows in December



Optics



before alignment

- Spot well within one pixel
- Spot size changes very little with telescope pointing
- Psf well understood, reproduced by simulations
- All telescopes identical
- Psf stable over > 1 y, no re-alignment required
- Absolute pointing good to $\sim 10''$, $2-3''$ with guide telescope



after alignment

Camera

960 Pixels of 0.16°

5° Field of view (1.4 m)

Readout integrated in camera body

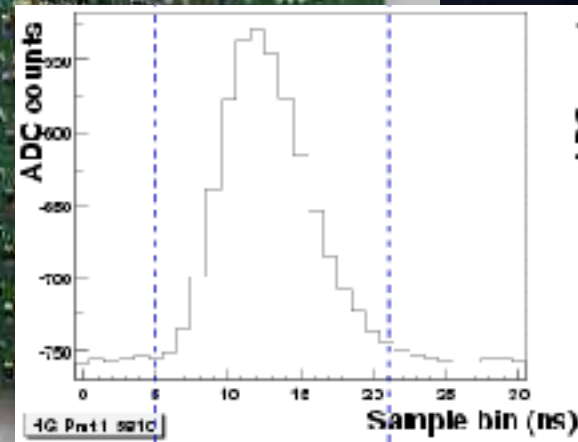
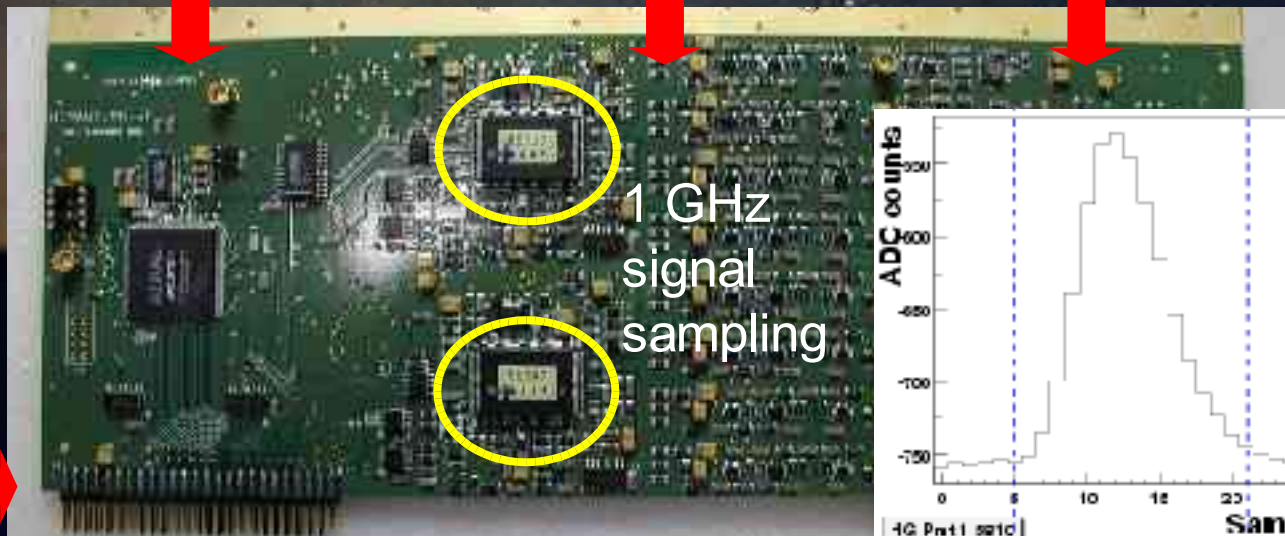




Digital signal processing

Analog signal processing

Trigger circuitry

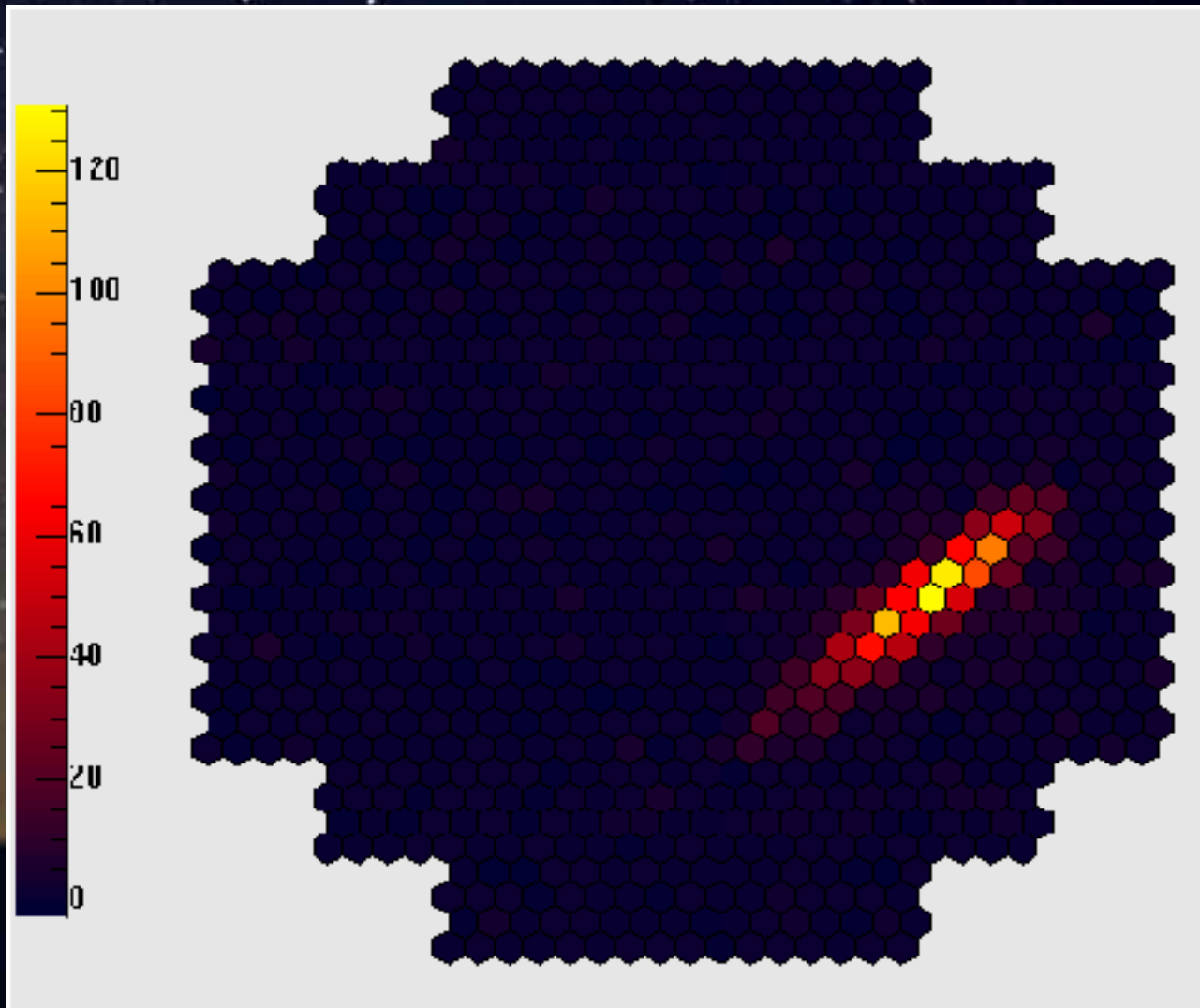




Operation



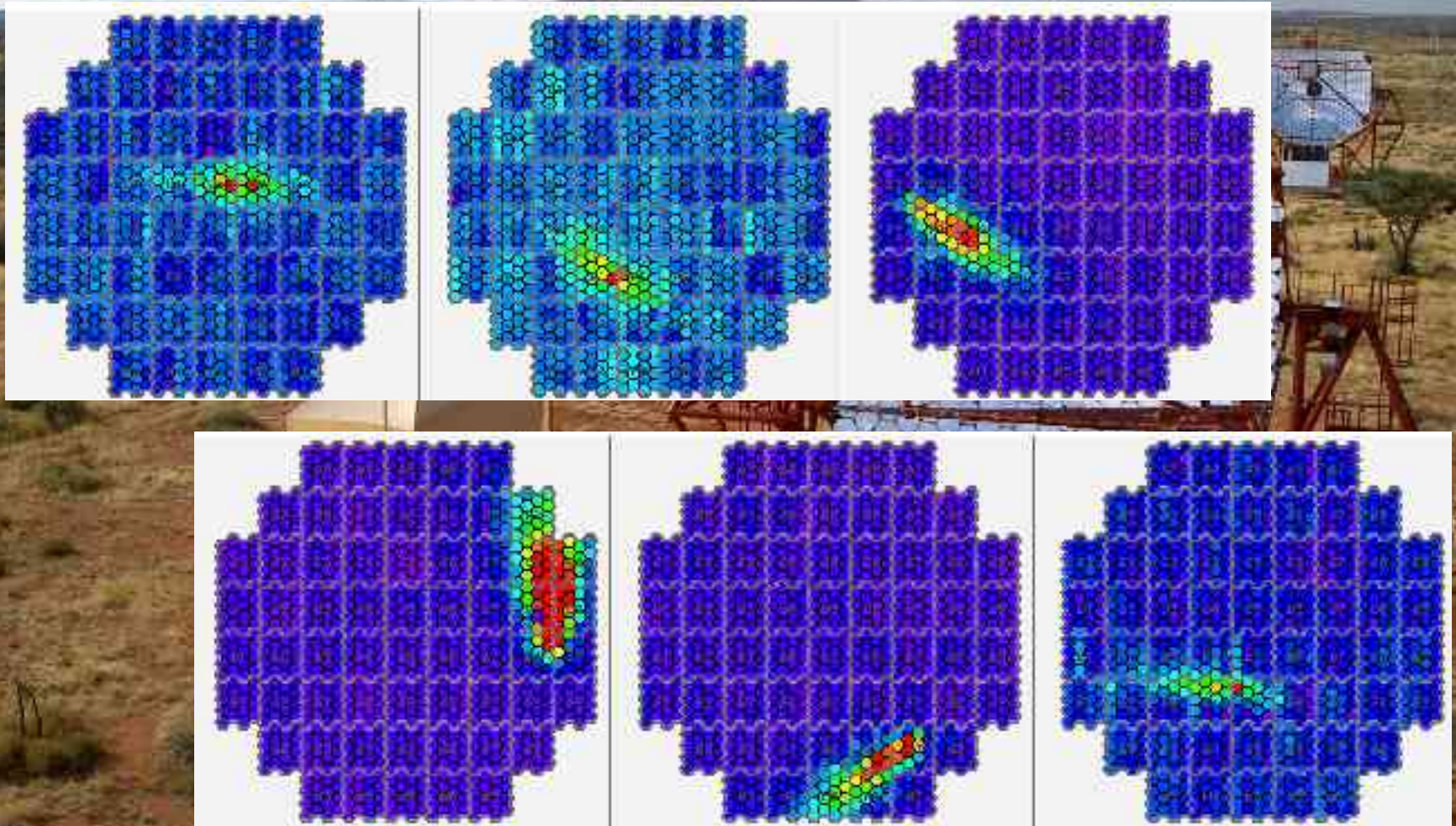
First events (June 11, 2002)



Since Sept. 2003 in 3-Telescope mode

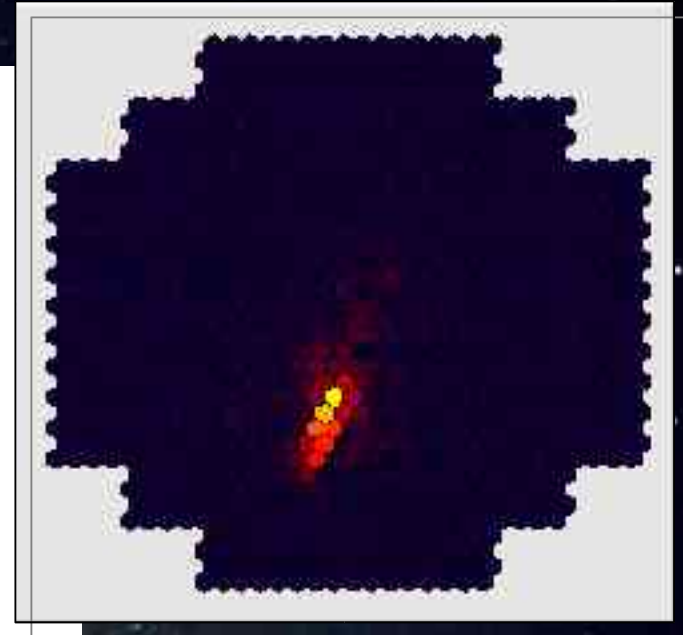
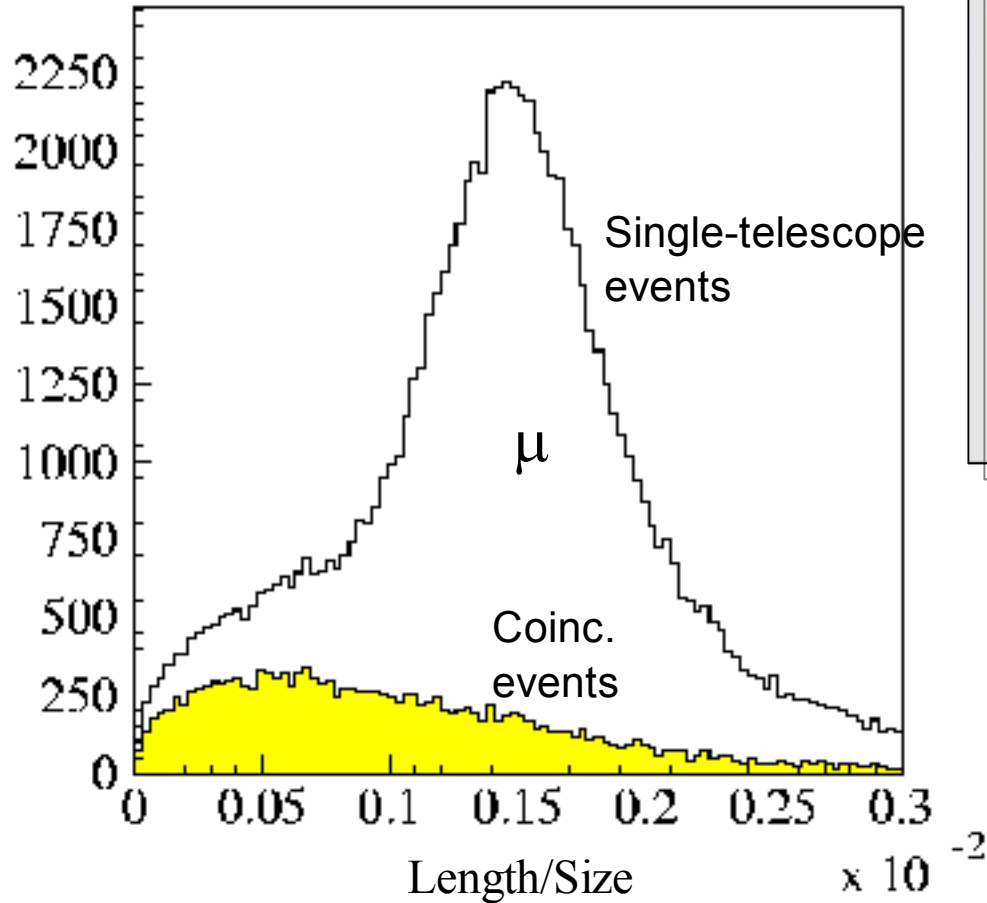
Telescope trigger: 3 pixels $>$ 4 pe, \sim 2 kHz

Array trigger: 2 of 3 telescopes, \sim 200 Hz

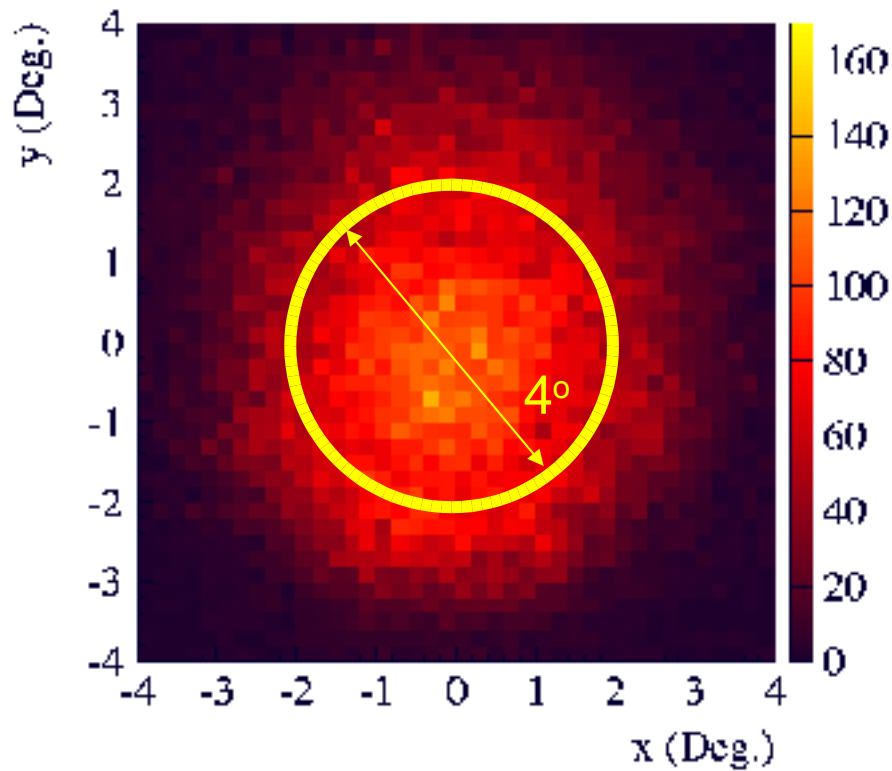


seen PKS 2155 flares in online monitoring in all telescopes ...

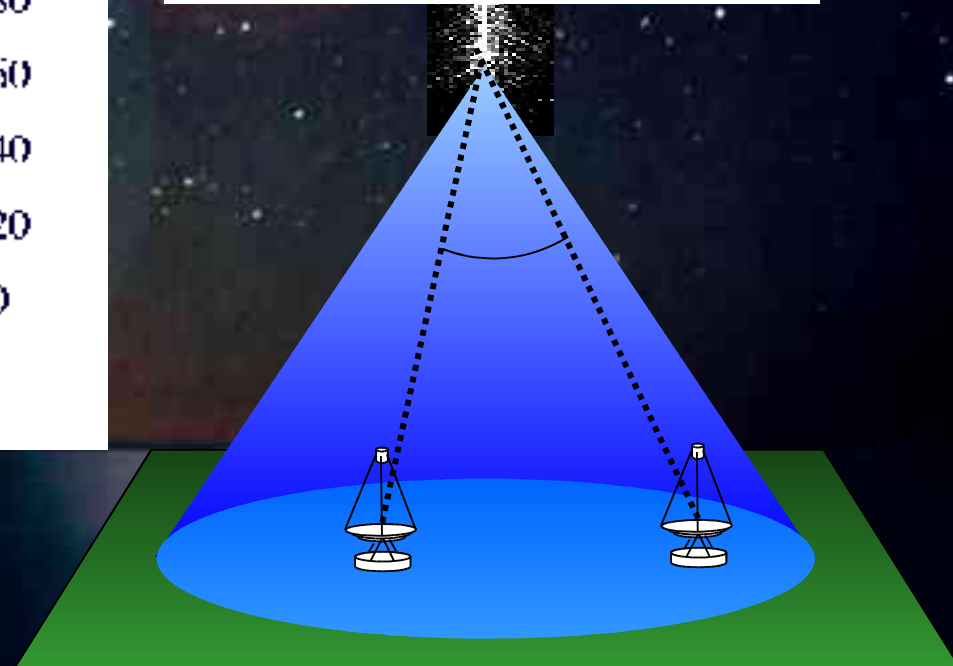
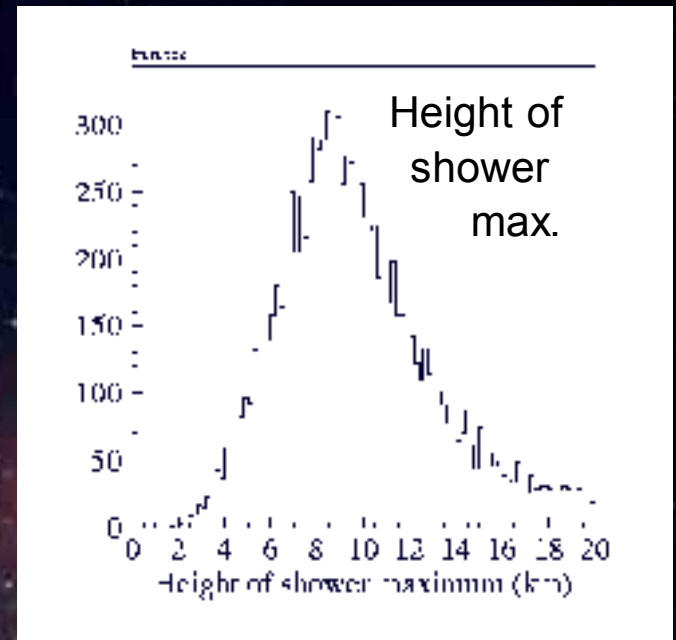
Getting rid of muons: 2-Telescope coincidence



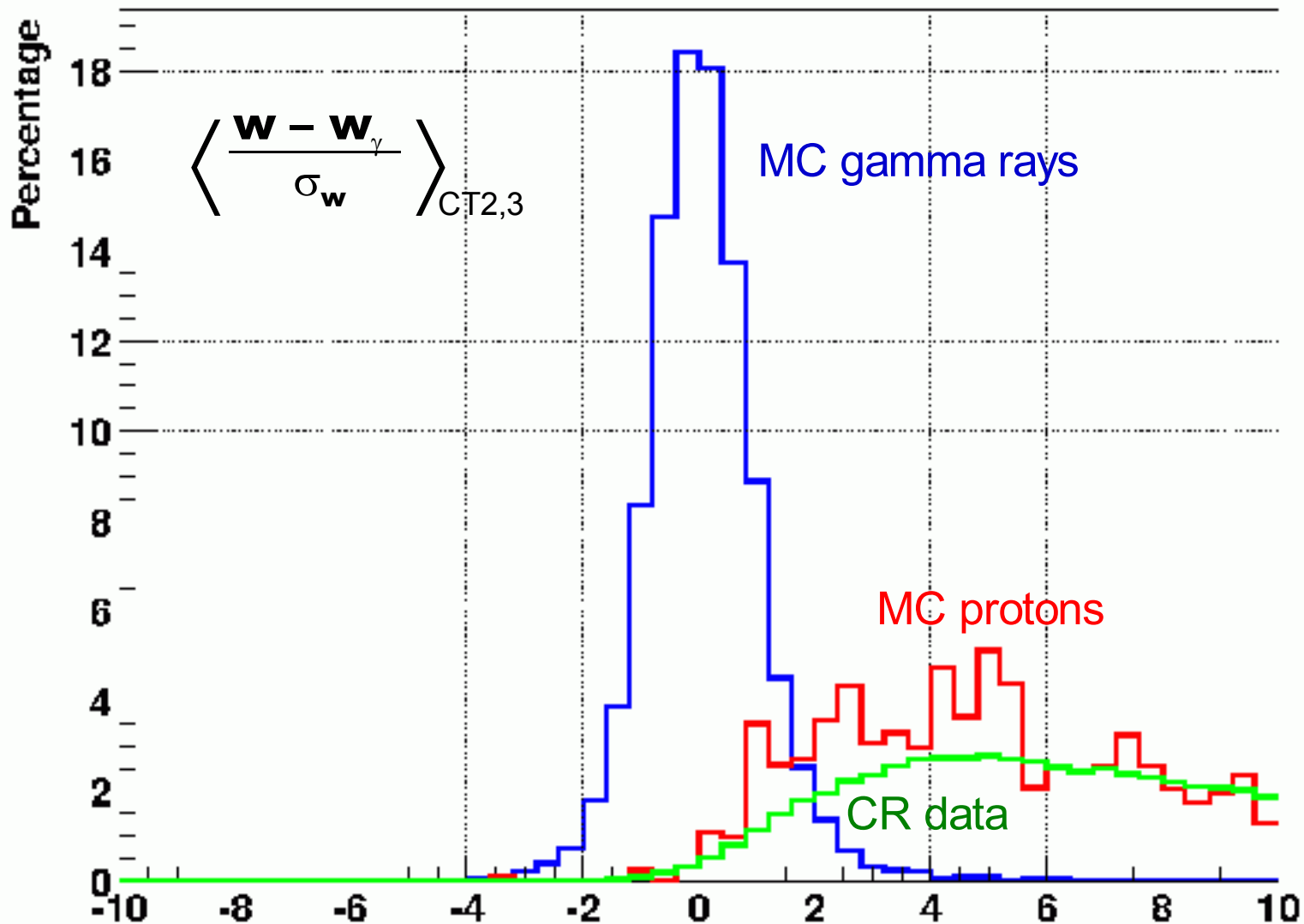
Stereo analysis ... technical plots (uncorr. raw data)



Reconstructed shower directions
relative to telescope axis



Getting rid of cosmic rays



Targets

(CT3, Jan. – Aug. 2003)

Strategy

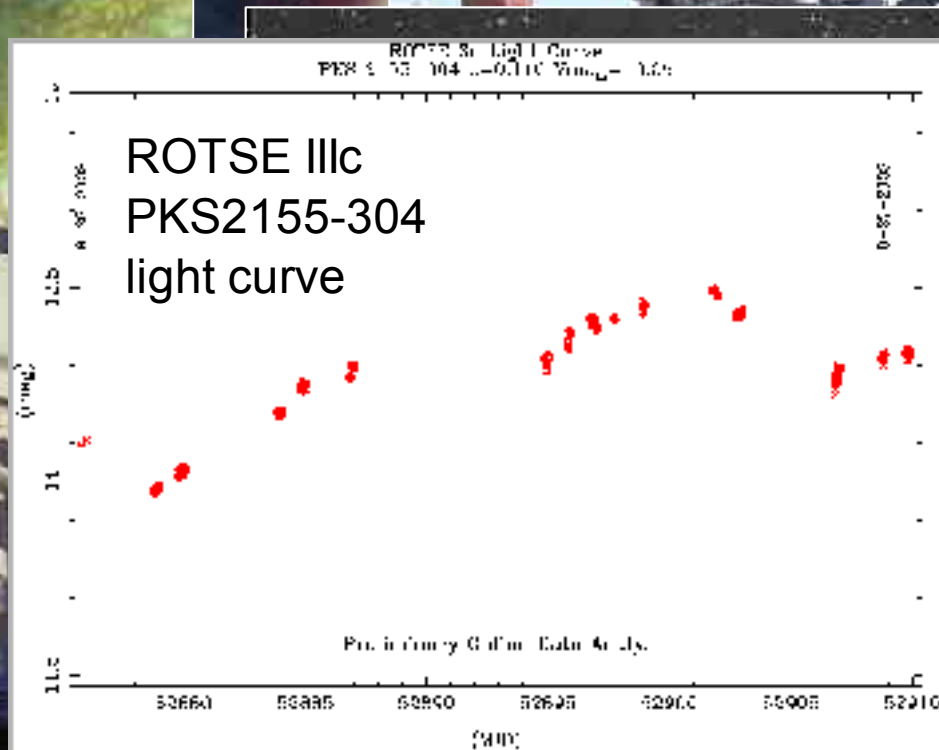
- confirm known sources
- study interesting ones in detail
- add new target objects

Object	Time (incl. off)	Type	Detected by
PSR B1706-44	43 h	Pulsar	Cangaroo, Durham
VELA	26 h	Pulsar	Cangaroo
SN 1006	107 h	SNR	Cangaroo
RXJ 1713	50 h	SNR	Cangaroo
Sgr A	34 h	Gal. center	Cangaroo, VERITAS
Cen X3	32 h	X-Ray Binary	Durham
PKS 2155	92 h	AGN	Durham
PKS 2005	52 h	AGN	
M87	32 h	AGN	HEGRA
NGC 253	34 h	Starburst-Gal.	Cangaroo

plus ~ 10 sources with less exposure

Since Sept. 03: data fully calibrated & analyzed a few h after being taken

ROTSE III Telescope on the H.E.S.S. site



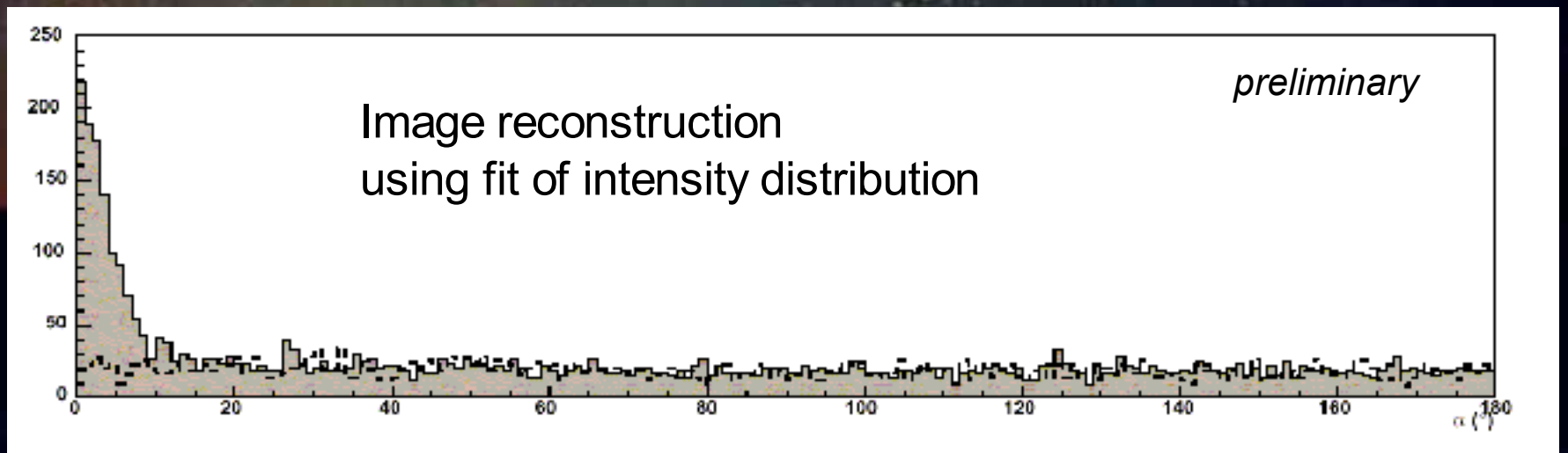
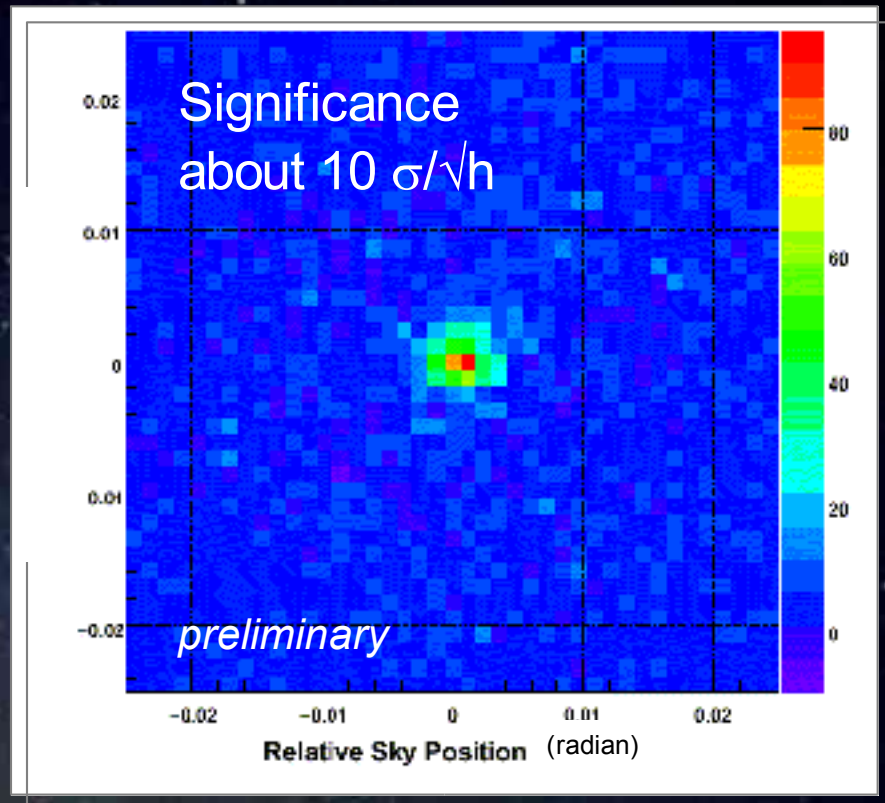
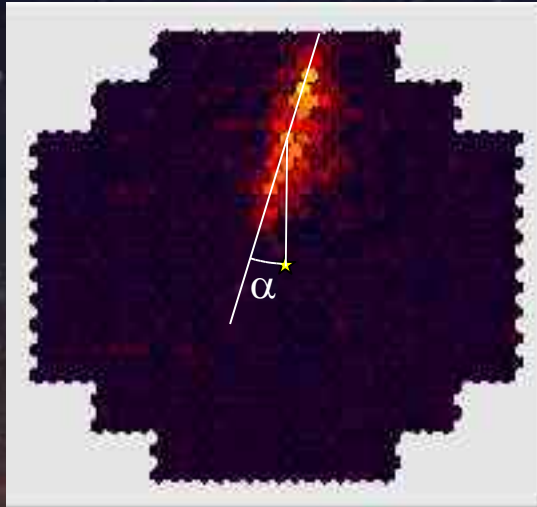


First results

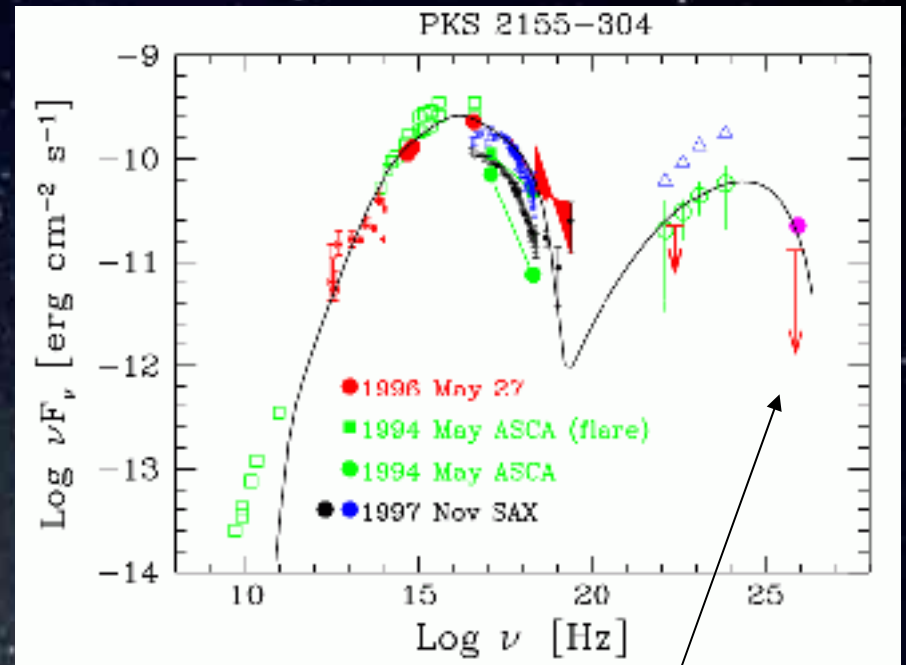
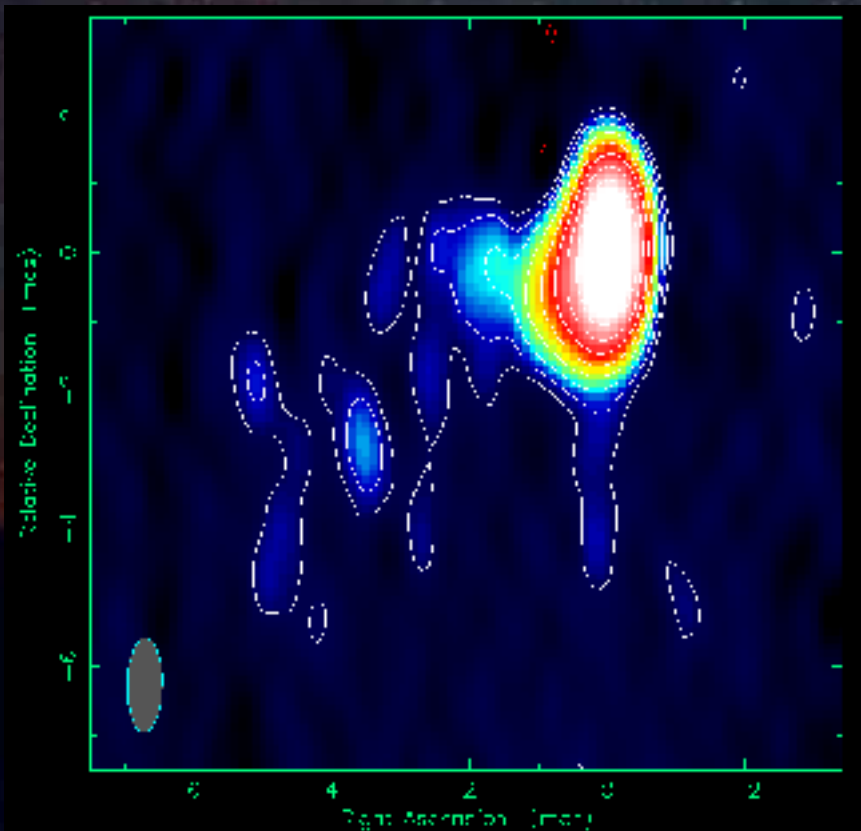
(ICRC 2003 status)



Crab Nebula (CT3)



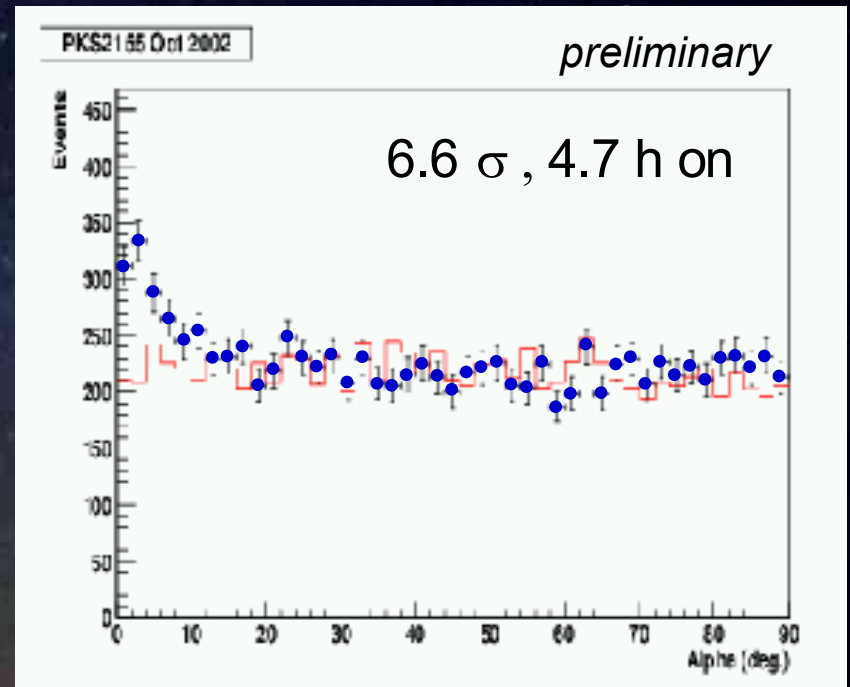
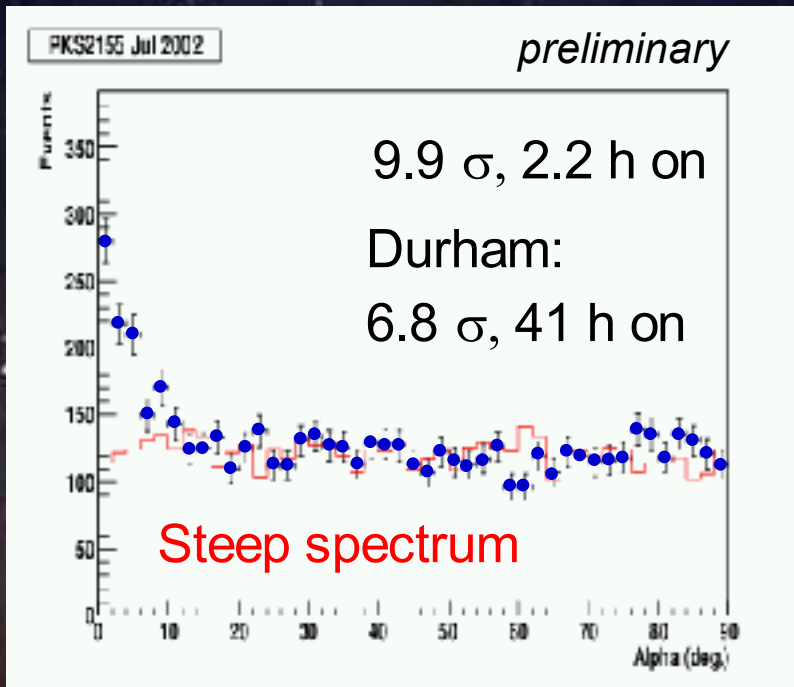
PKS 2155 ($z = 0.116$)



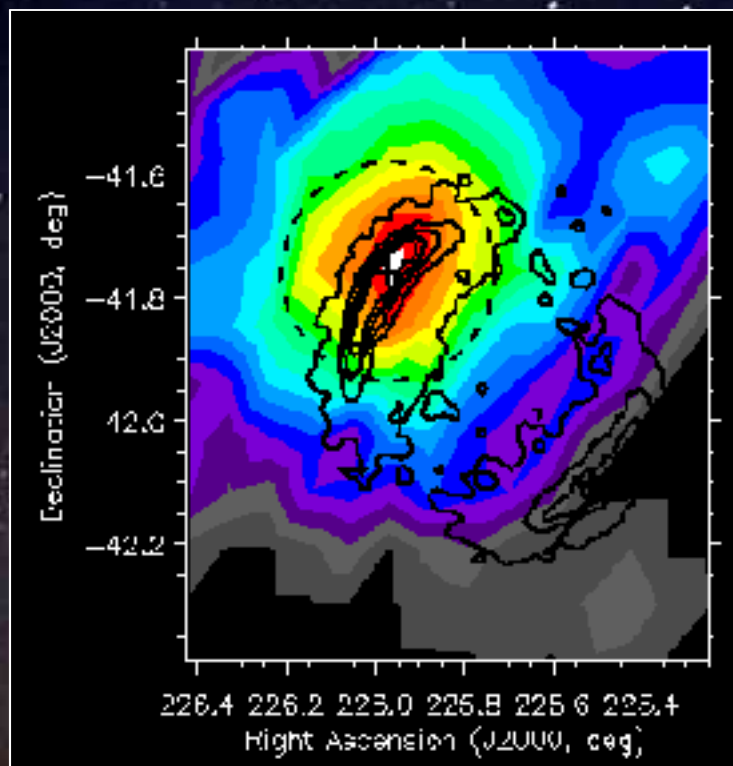
Chadwick et al.,
APJ 513, 161 (1999)

L. Costamante,
G. Ghisellini,
astro-ph/0112201

PKS 2155 ($z = 0.116$)

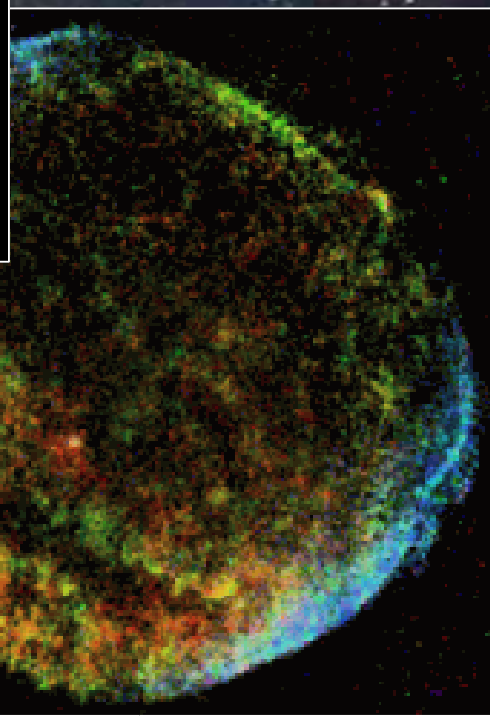


Supernova 1006



CANGAROO

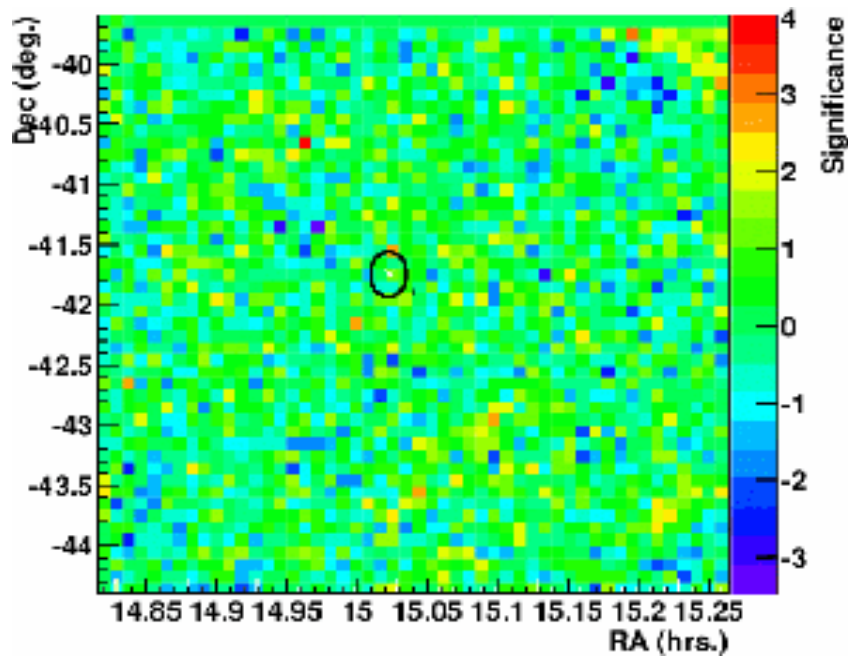
50 light years
5° diameter



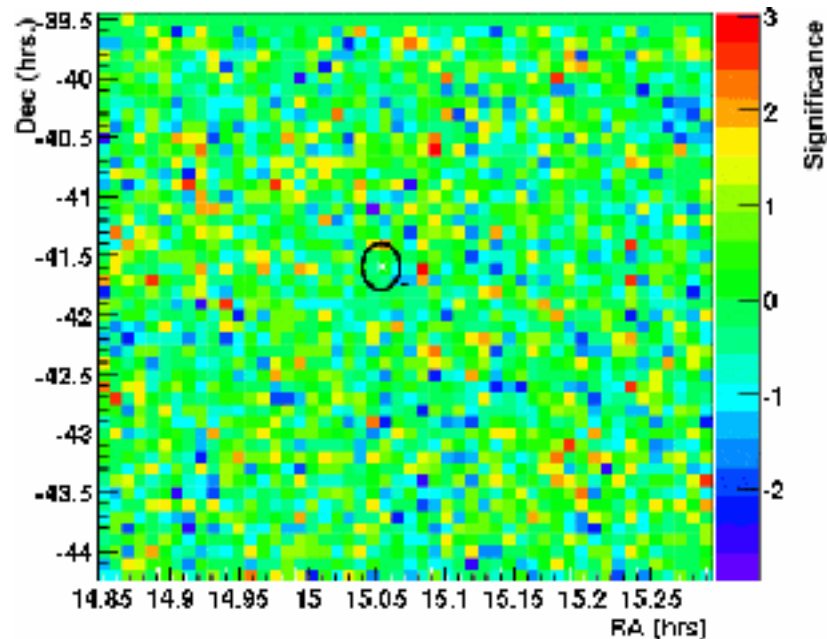
以後七月以前、客星入羽林中
 一條院寛弘三年四月二
 日、突西、夜以降騎官中有大客星、如熒惑、光明如燧
 燧夜正見南方、或云、騎陣將軍星變未體增光獻054後
 泉院天喜二年四月中旬以後丑時、客星出背參辰、見東
 方、字天關星、大如熒星、二條院永萬二年四月廿二日、

from Meigetsuki

HESS Observations of SN 1006 *preliminary*



CT3
4.5 h live on source
1.0 σ excess



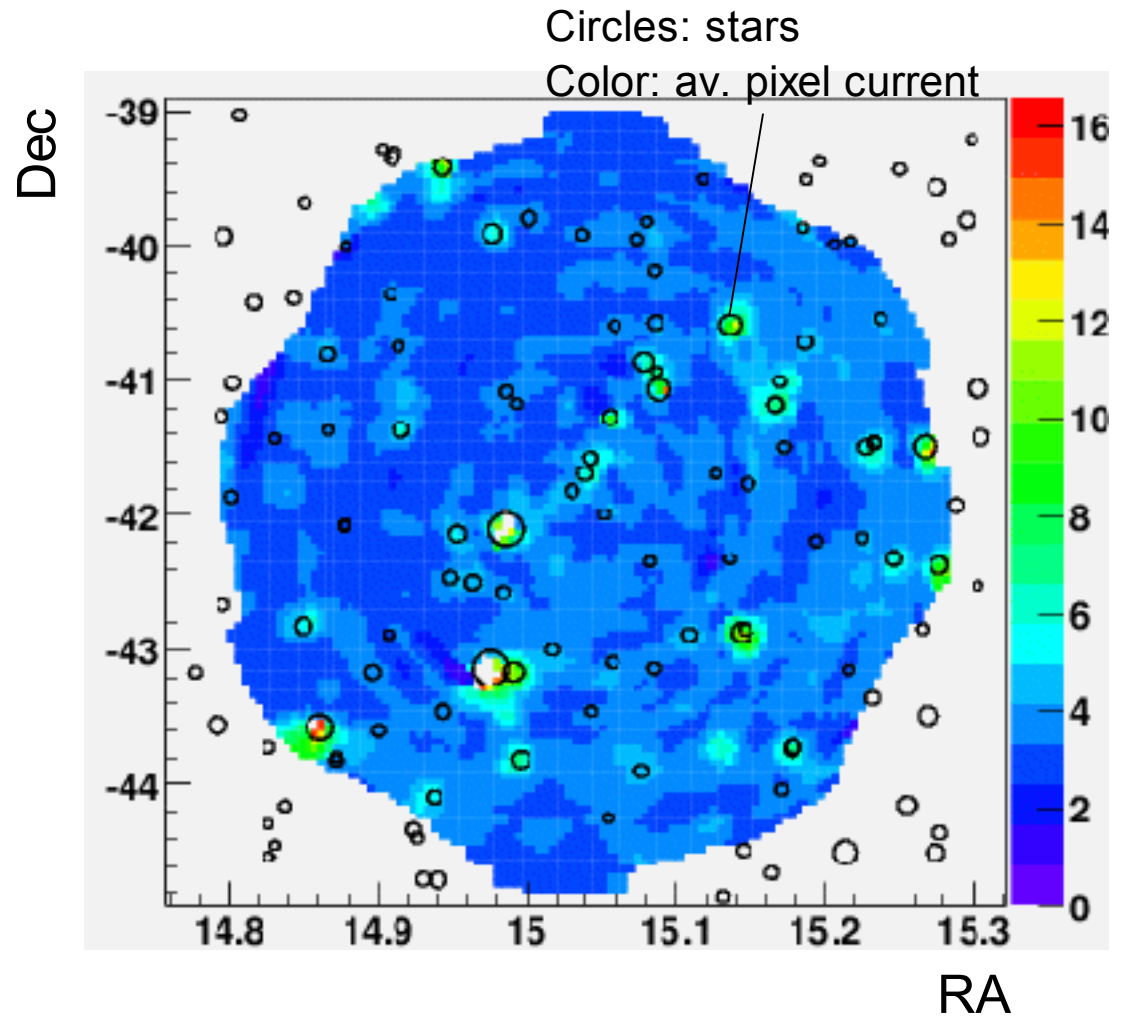
CT2
2.5 h live on source
-1.3 σ excess

Should easily see source assuming CANGAROO flux ...

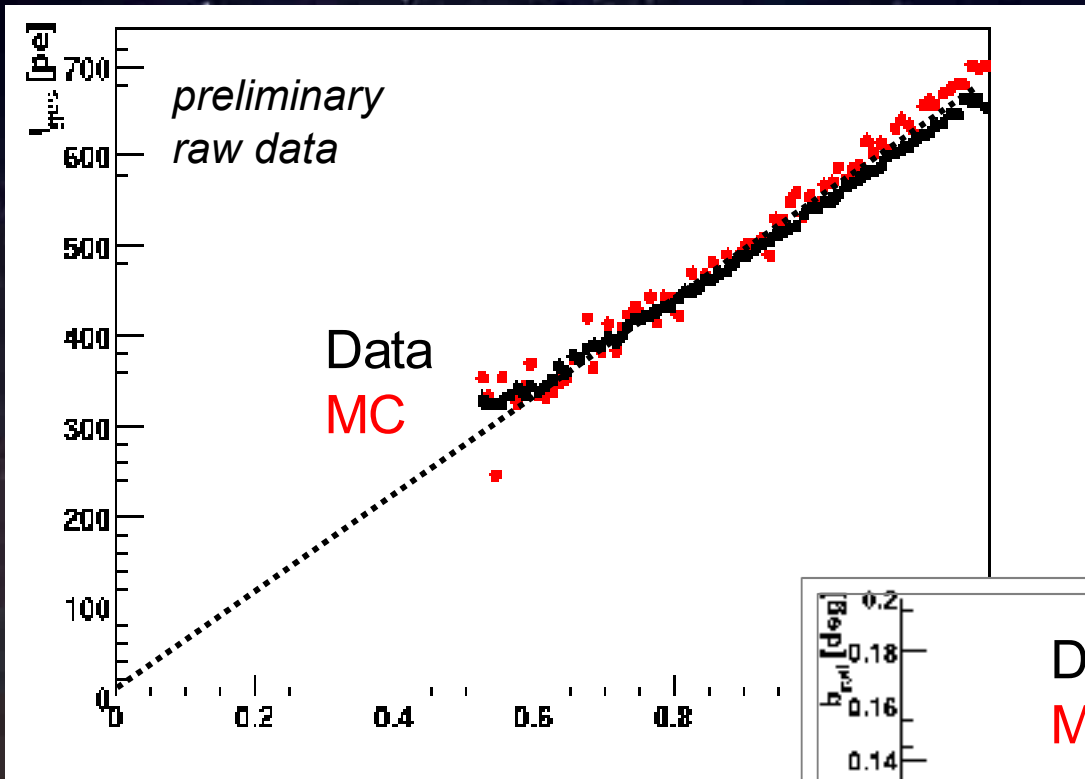
Pointing ok ?

Calibrated with stars, should be good to $\sim 10''$

Nevertheless:
Checked with pixel currents for all runs

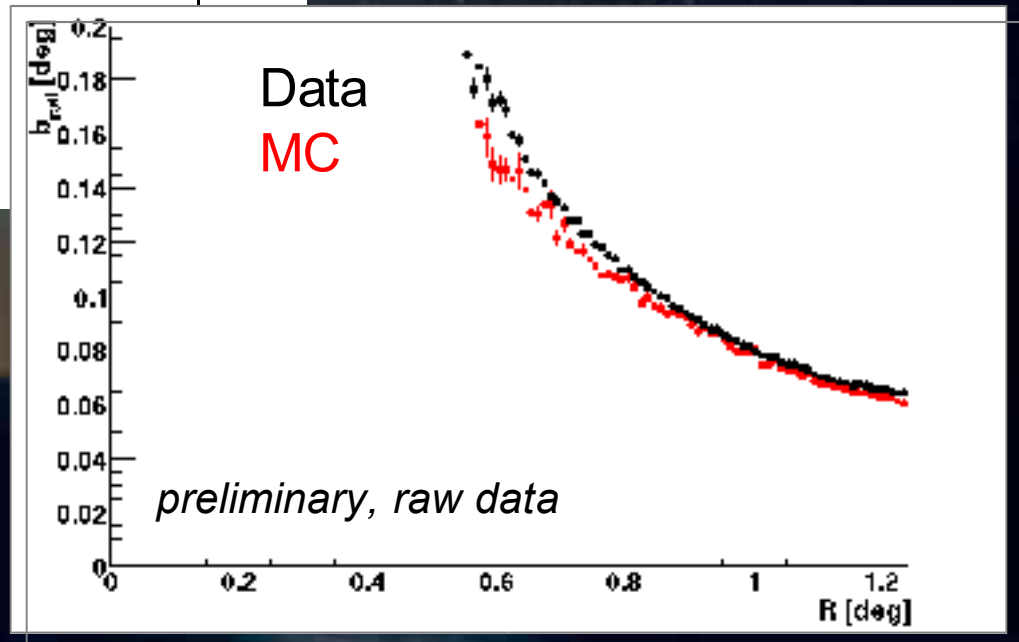
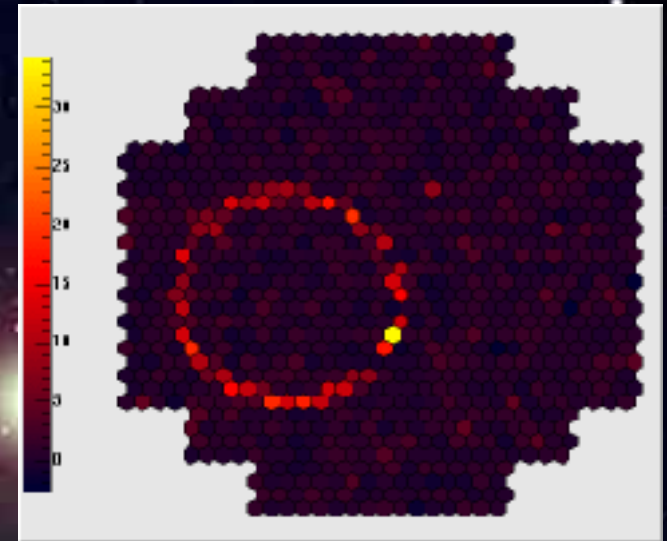


Do we understand the imaging ?



Ring intensity

Ring width



Explanations

Instrument

- Problem in our hardware or software: unlikely, continue checks
- Problem in flux normalization: unlikely, see Crab

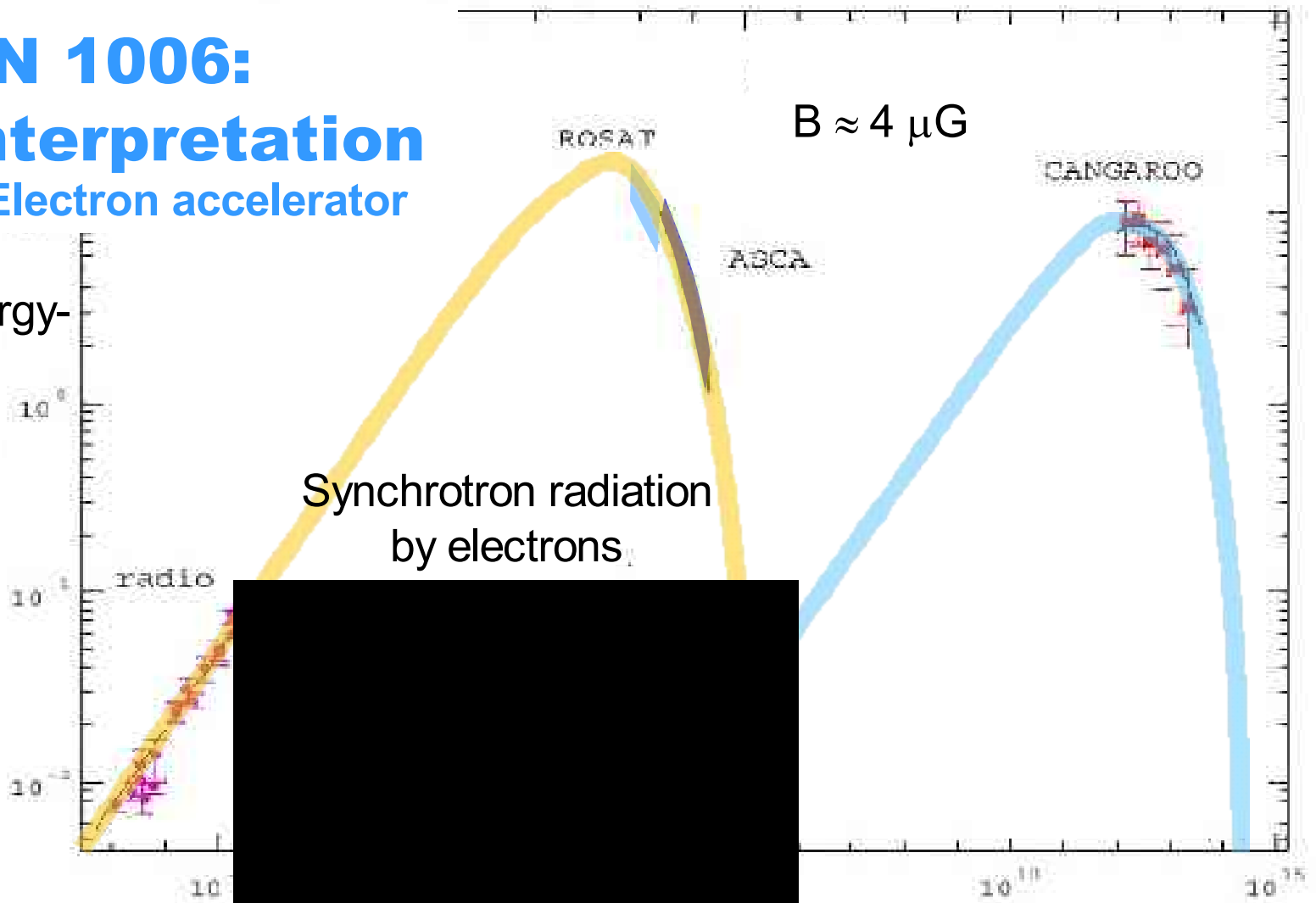
Physics

- Variable background (or foreground) source
- Spectrum drops below CANGAROO threshold (1.7 to 3 TeV)
 - H.E.S.S. upper limits for 1.7, 3 TeV below CANGAROO flux
- Time dependence of flux
 - Seems unlikely for source of 50 LY size ... but actual X-ray features are smaller ...
 - Electron source: cooling time of one year or less requires very high B fields O(mG)
 - Hadron source: requires extremely dense/compact target

SN 1006: Interpretation

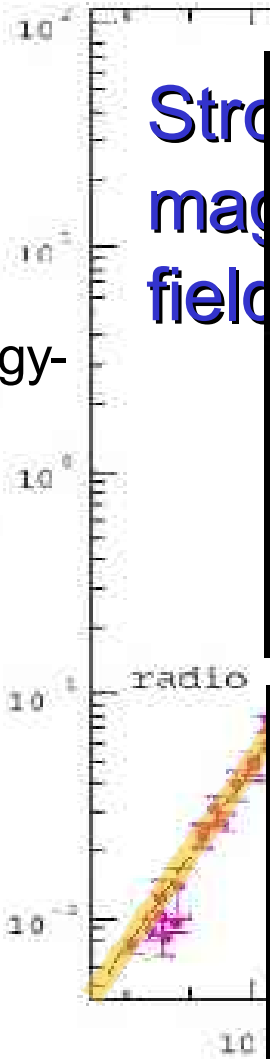
1) Electron accelerator

Energy-flux

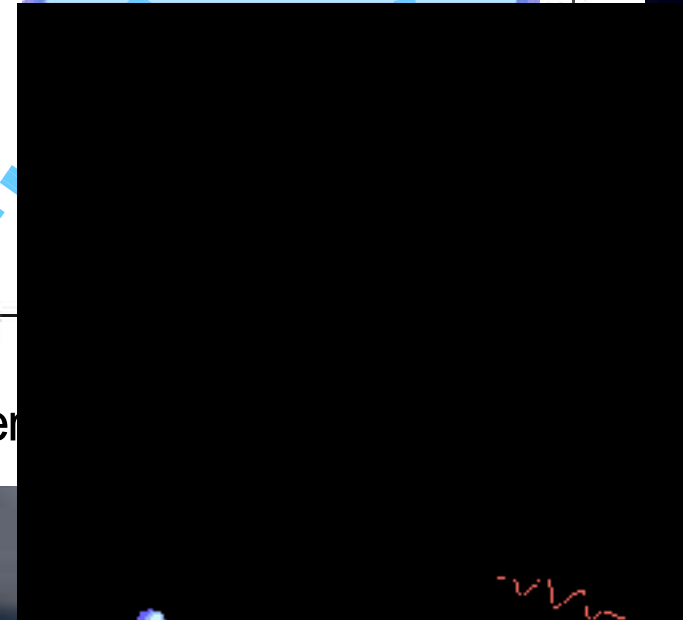
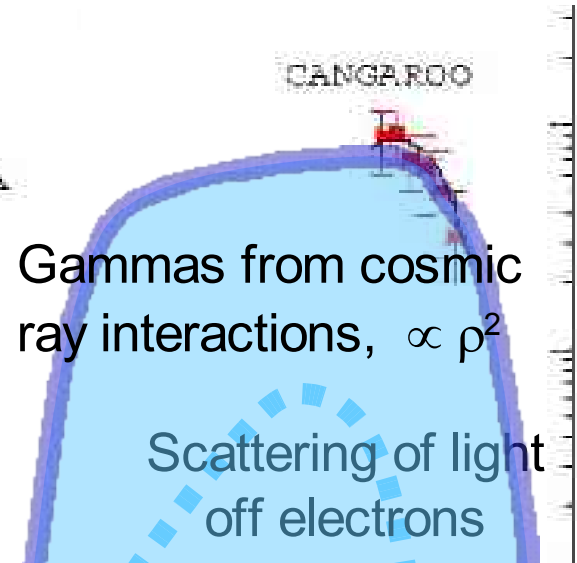


Strong
magnetic
field

Energy-
flux



II) Proton accelerator





bmb+f - Förderschwerpunkt

Astro-Teilchenphysik

Großgeräte der physikalischen
Grundlagenforschung

- **H.E.S.S. is on its way; telescopes well understood**
- **Single-telescope data since Fall 2002, only small part of data presented here**
- **... no new sources, a bit puzzled about SN 1006 ...**
- **Now taking data with 3 telescopes and stereo trigger**
- **Full 4-telescope array by early 2004**
- **Phase II designs under preparation**