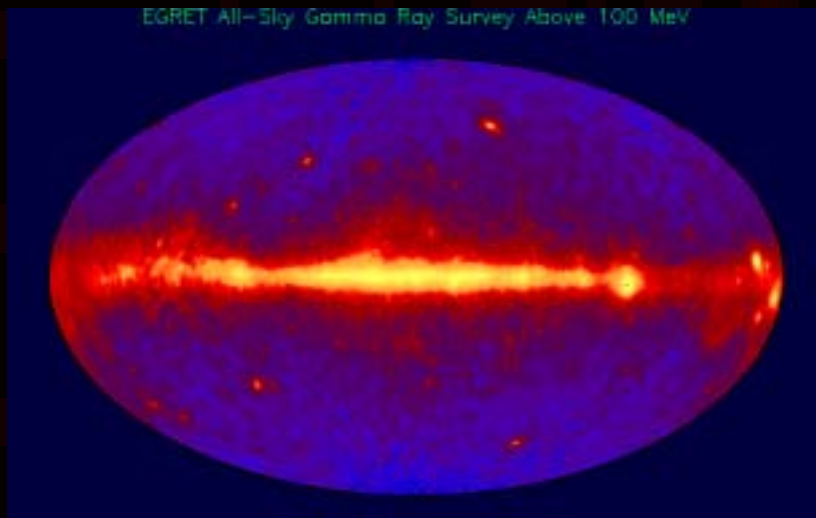
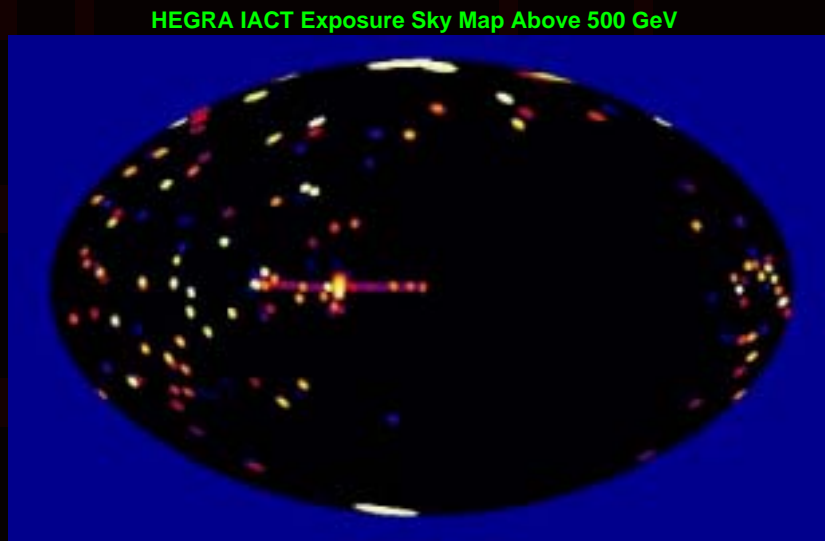


G. Pühlhofer: Scans of the TeV gamma-ray sky
with the HEGRA system of Cherenkov Telescopes

>100 MeV



> 500 GeV ?



Scans of the TeV gamma-ray sky with the HEGRA system of Cherenkov telescopes

Gerd Pühlhofer, MPI-K Heidelberg, Germany
for the HEGRA collaboration

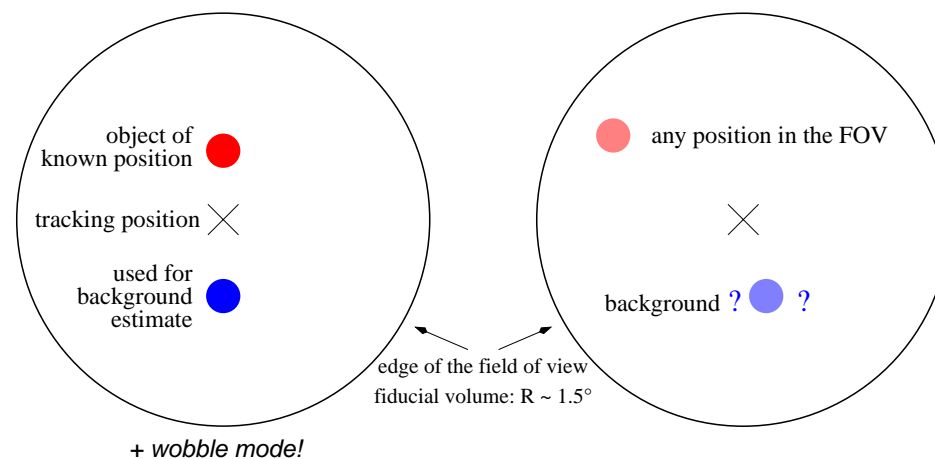
Outline

- Background estimate using contemporaneous data
 - "Flatfielding"
- Data set, search strategies, cuts
- Towards a HEGRA 4-6 sigma TeV gamma ray source candidate list
 - some preliminary results

from pointed observations



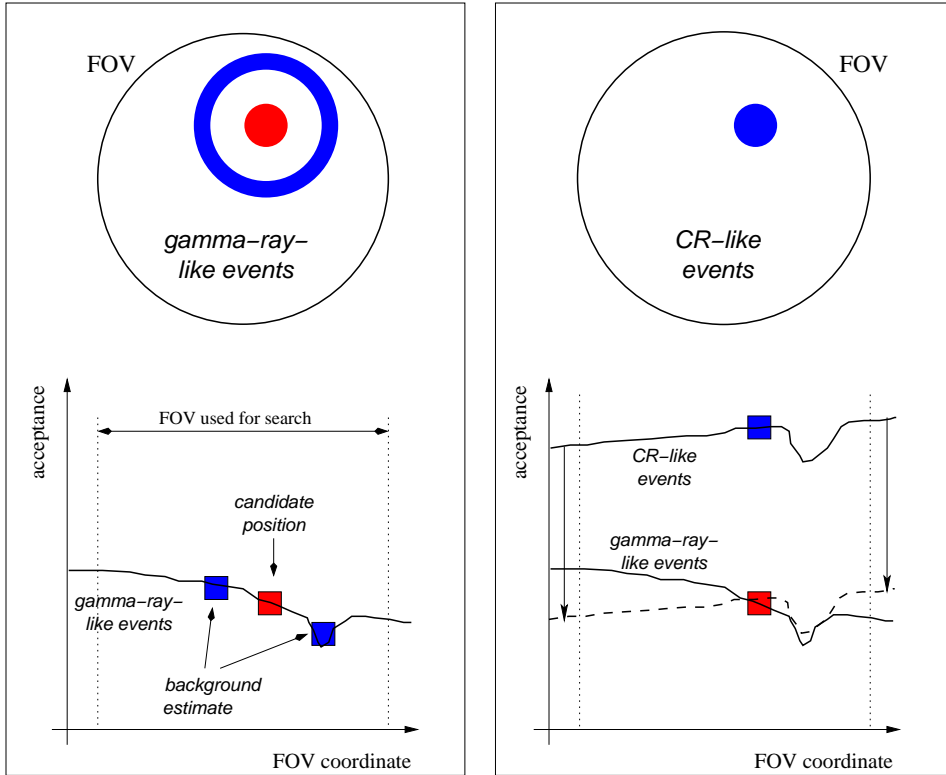
to sky maps



Background determination, flatfielding

FOV background
"ring model"

SHAPE background
"template model"



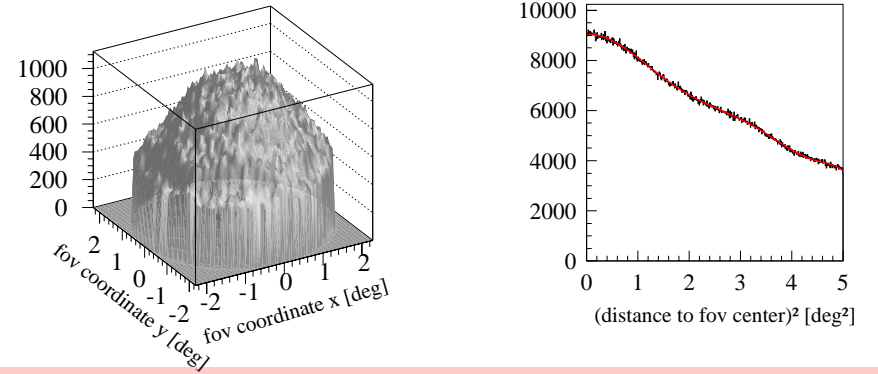
acceptance change ↔ normalisation + acceptance difference

two background estimates with different systematics
not relevant however for short exposures: Sqrt(On) dominated

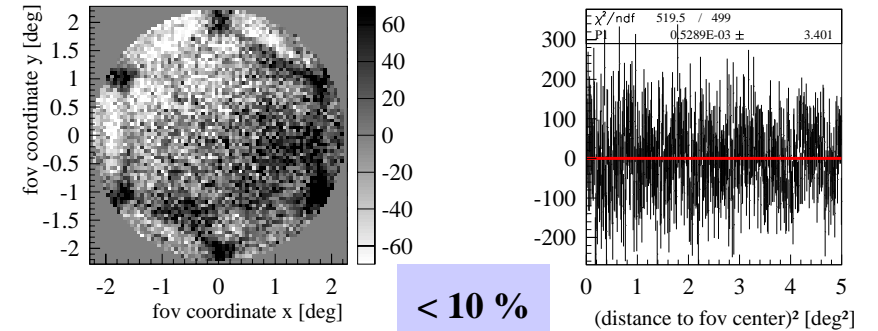
→ systematic FOV studies, acceptance functions

Radial profiles

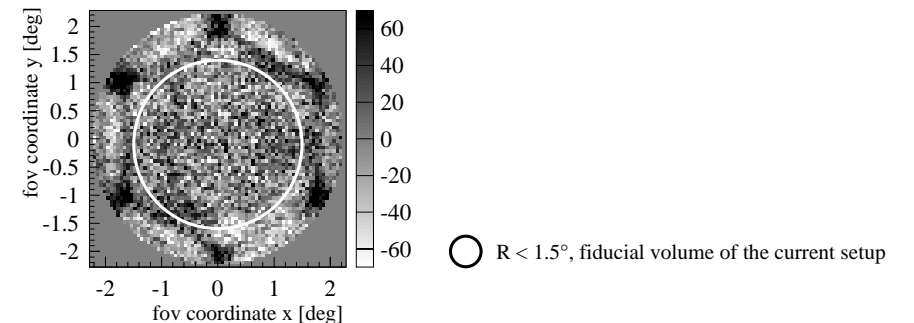
Raw acceptance profile



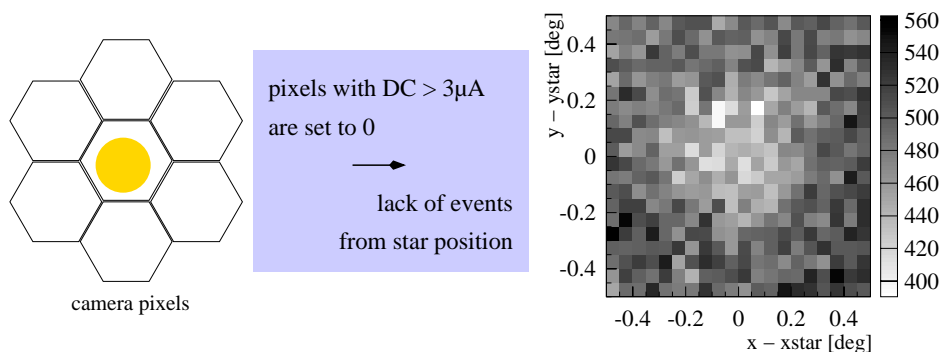
Residuals after radial correction



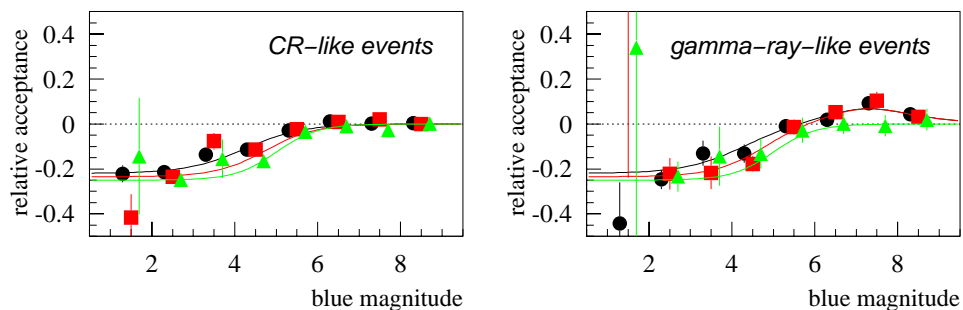
Residuals after some additional gradient correction



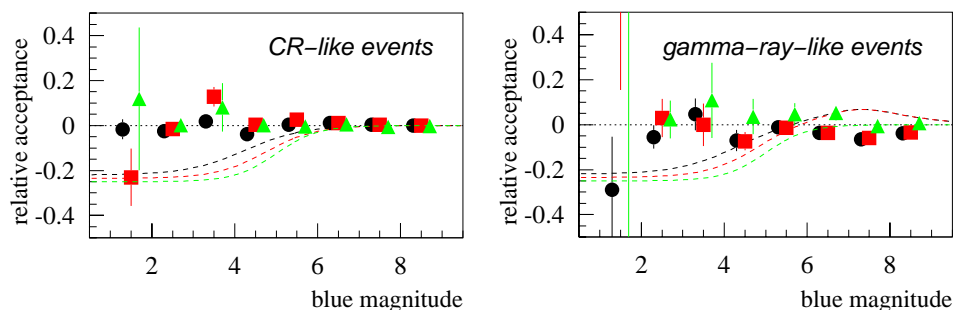
Stars in the field of view



Stars without bright neighbours



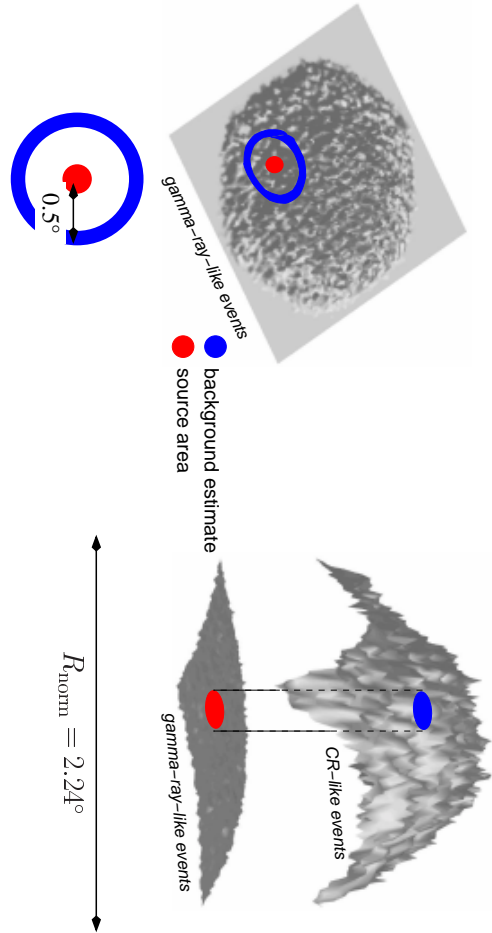
After acceptance correction (all stars)



- All data late 1996 - end 2001,
 - ≥ 3 telescopes in the configuration,
 - ≥ 3 telescopes in event
 - ≈ 5000 hrs of DST data
- stereo reconstruction:
 - (, algorithm 3"), $d\vartheta \sim 0.09^\circ$
- angular cuts:
 - A loose:** $\vartheta < 0.14^\circ$
 - robust, slightly extended sources, sources with cutoff spectrum (poor ang. resolution)
 - B tight:** $\vartheta < 0.11^\circ$ and less (depending on event structure)
 - a bit more sensitive to point sources
- shape cuts:
 - γ-candidates:** $0 < \text{mean scaled width} < 1.1$
 - CR-candidates:** $1.3 < \text{mean scaled width} < 2.0$
- search FOV:
 - $R < 1.5^\circ$, exclude strong sources Crab, Mrk 501, Mrk 421
- grid structure:
 - galactic coordinates, spacing 0.125° for angular cuts A, 0.063° for cuts B

Data, analysis methods II

FOV background "ring model" SHAPE background "template model"



$$\alpha = \frac{A_{\text{on}}}{A_{\text{off}}} \cdot \frac{1/\beta_{\text{on}}}{1/\beta_{\text{off}}}$$

↓
1/7

$$\alpha = \frac{\sum_{i \in \gamma\text{-like}}^{R < 2.24^\circ} 1}{\sum_{i \in \text{CR-like}} 1} \cdot \frac{1/\beta_{\gamma\text{-like}}}{1/\beta_{\text{CR-like}}}$$

↓
~ 1/10

$$\beta_{\text{on}} = \frac{\sum_{i \in A_{\text{on}}} 1}{\sum_{i \in A_{\text{off}}} \frac{1}{acc_i}}$$

$$\beta_{\text{off}} = \frac{\sum_{i \in A_{\text{off}}} \frac{1}{acc_i}}{\sum_{i \in A_{\text{off}}} 1}$$

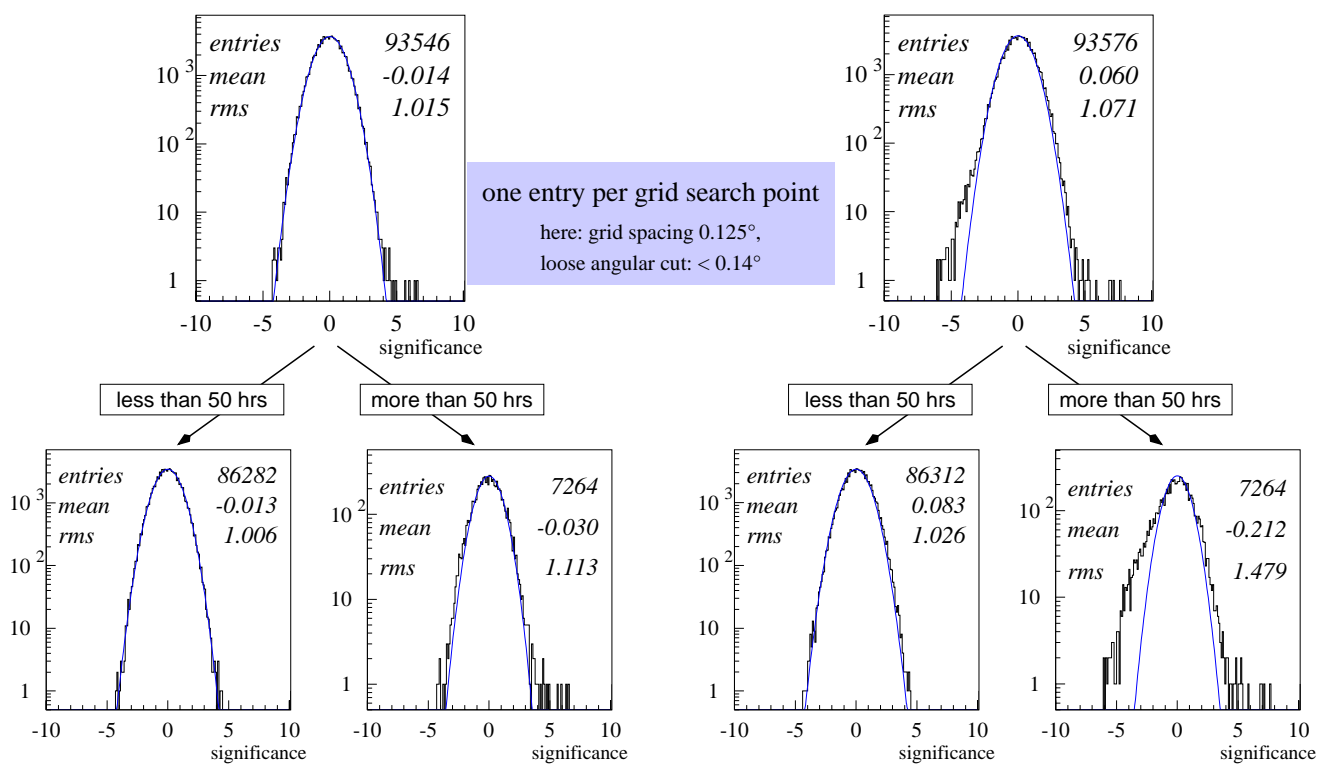
$$\beta_{\gamma\text{-like}} = \frac{\sum_{i \in \gamma\text{-like}} 1}{\sum_{i \in \gamma\text{-like}} \frac{1}{acc_i}}$$

$$\beta_{\text{CR-like}} = \frac{\sum_{i \in \text{CR-like}} \frac{1}{acc_i}}{\sum_{i \in \text{CR-like}} 1}$$

significance: Li&Ma likelihood formula

Significance distributions

FOV background (ring model) SHAPE background (template model)

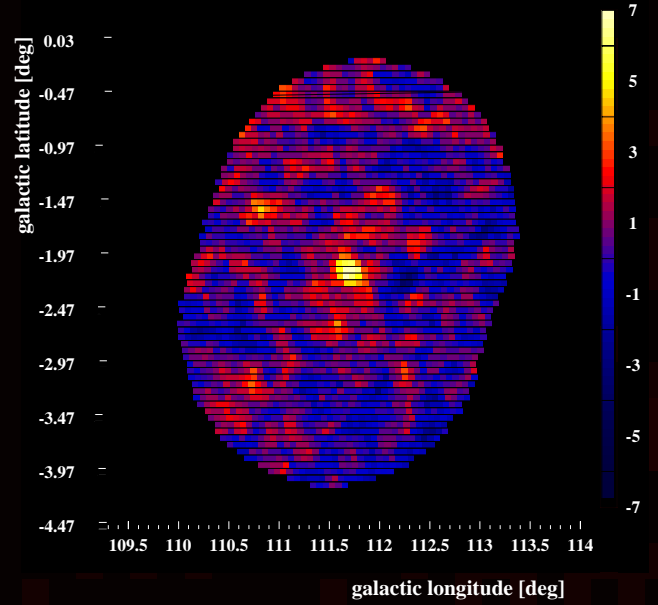
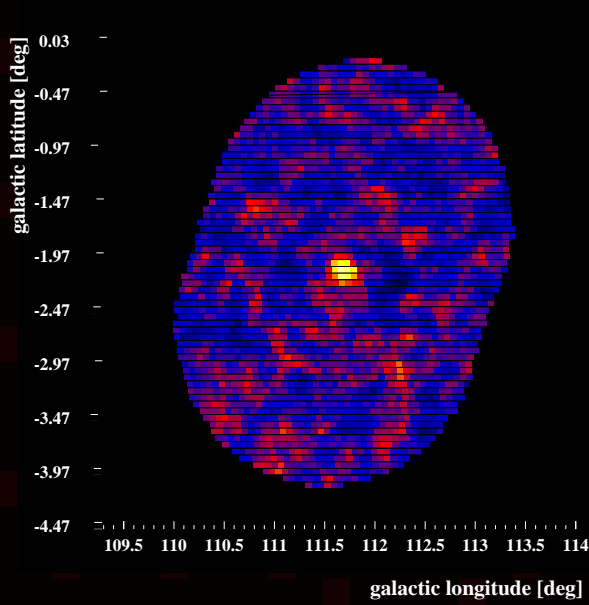


Example for a very deep exposure: Cassiopeia A

FOV background (ring model)

SHAPE background (template model)

grid spacing: 0.063° tight angular cuts < 0.11°



bins are correlated

Towards a TeV source candidate list

only shown here: all candidates > 4 sigma in the ring model, loose angular cut survey

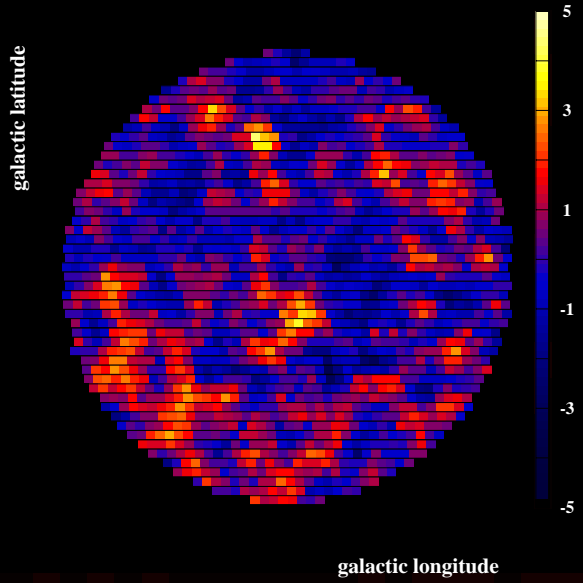
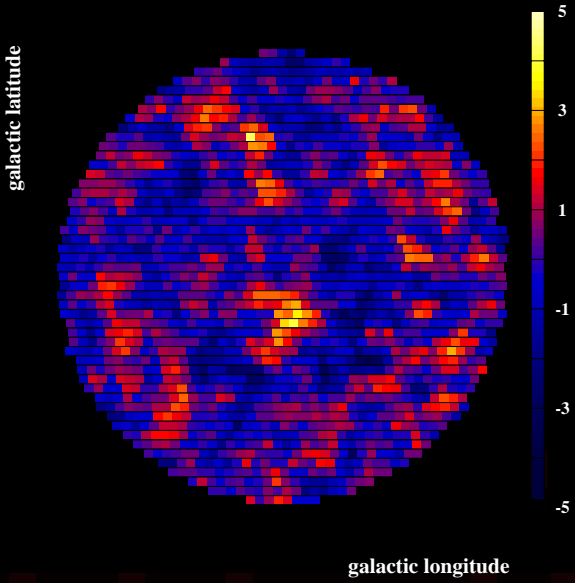
l [°]	b [°]	$\sigma_{\text{ring},0.14^\circ}$	N_{on}	N_{off}	$\sigma_{\text{templ},0.14^\circ}$	$\sigma_{\text{ring},0.11^\circ}$	counterpart
111.76	-2.06	6.56	1397	7719	7.7	6.6	Cas A
77.39	64.81	5.94	370	1749	6.94	6.03	H 1426
80.20	1.06	4.78	825	4586	5.33	4.64	Cyg unident.
<i>censored</i>		4.6	492	2606	5.24	4.64	IC 443 ?
		4.45	144	620	4.48	4.6	
		4.35	233	1146	3.83	4.12	
		4.2	63	221	4.16	3.71	
		4.14	83	327	4.13	3.8	
	4.13	23	56	3.42	3.61		

Example for a map with marginal significances: the IC 443 field of view

FOV background (ring model)

SHAPE background (template model)

grid spacing: 0.063° tight angular cuts $< 0.11^\circ$



bins are correlated

Summary and Outlook

- What was achieved

- With HEGRA, $\approx 3.5\%$ of the TeV γ -ray sky was scanned
- No strong new sources (except TeV J2032+4131) were found in the current search setup

- Things to do

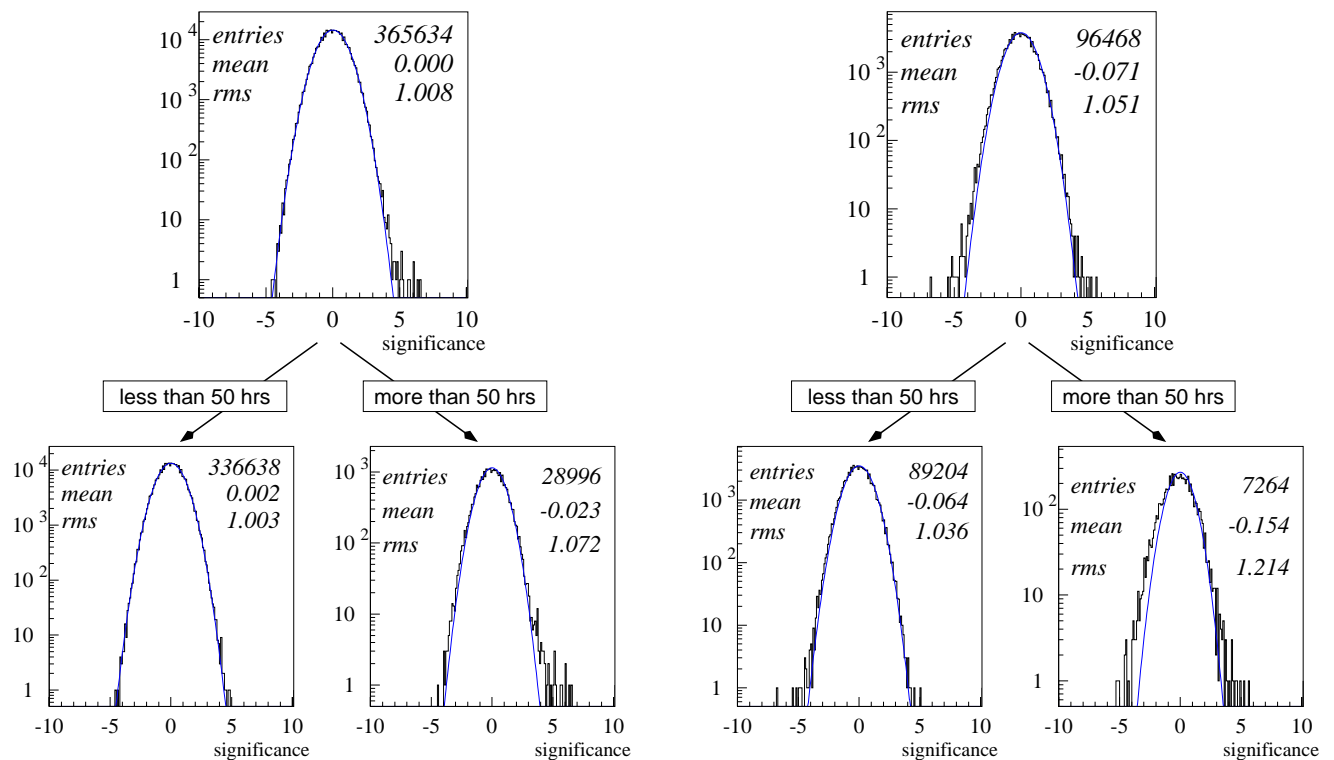
- Maybe fix the shape background (template model) deep exposure issue
- Include 2002 data
- Extend to larger FOV radii
- Create TeV source candidate list with possible counterparts
- Provide some interesting targets for the new experiments

Backup transparencies

Significance distributions (cont.)

FOV background (ring model)
high density grid (0.063°), gamma-ray-like events

FOV background (ring model)
low density grid (0.125°), CR-ray-like events

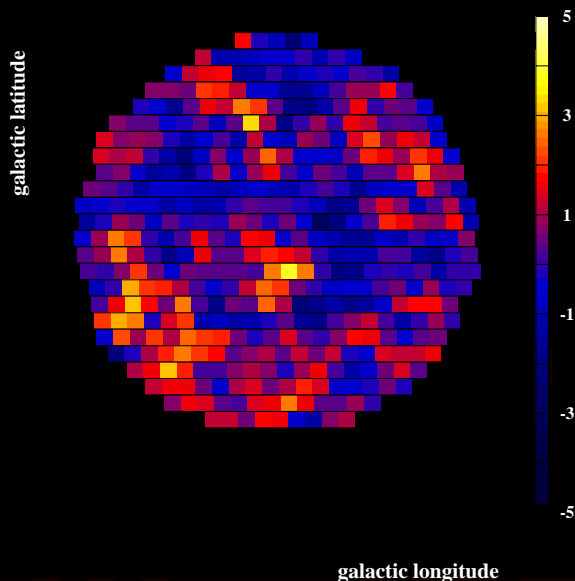
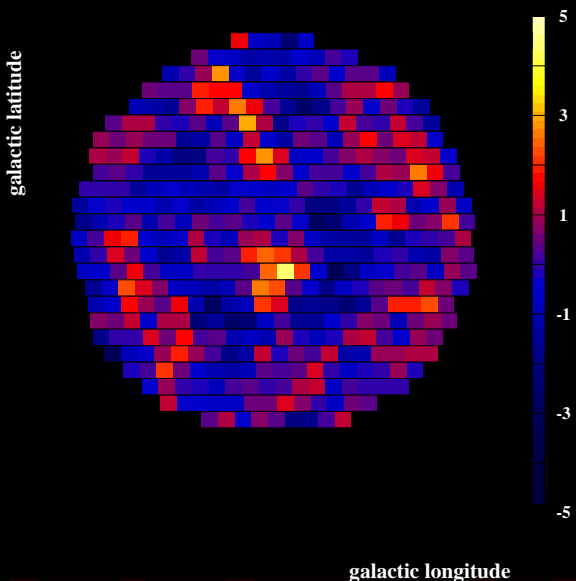


Example for a map with marginal significances: the IC 443 field of view

FOV background (ring model)

SHAPE background (template model)

grid spacing: 0.125° loose angular cuts $< 0.14^\circ$



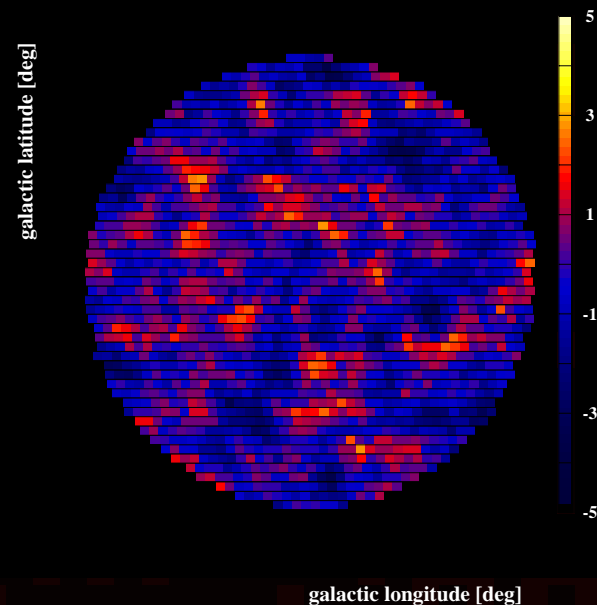
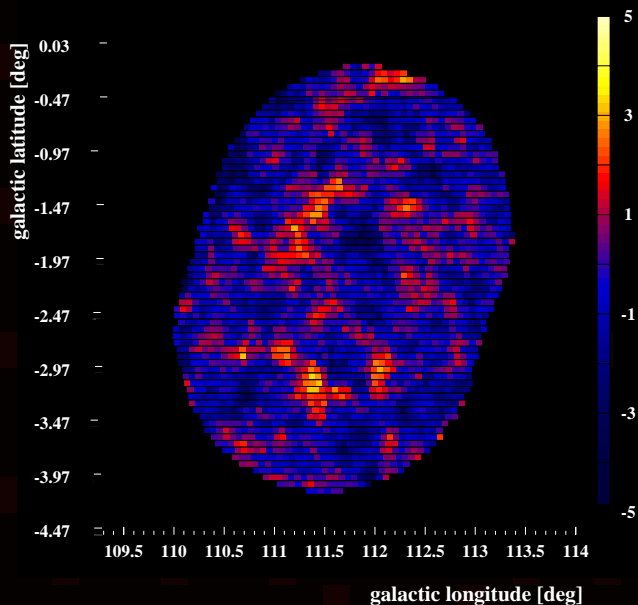
bins are correlated

Background maps

Cas A, CR-like events, ring model

IC 443 FOV, CR-like events, ring model

grid spacing: 0.063° tight angular cuts $< 0.11^\circ$



bins are correlated