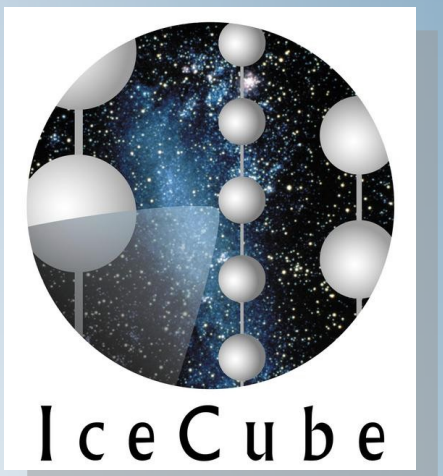


Neutrino Point Sources: Search Strategies and Results from IceCube

Sirin Odrowski, Max-Planck-Institut für Kernphysik
for the IceCube collaboration

TeVPA 2010, Paris

KLAUS TSCHIRA STIFTUNG
GEMEINNÜTZIGE GMBH

Overview – Results from 22 Strings

- Maps
  - Map of the Northern Hemisphere
  - UHE optimized map (also above the horizon)
  - Low energy optimized – IC22+AMANDA (Galactic Plane)
- Search for neutrino emission inside an extended region
  - Test for the Cygnus region applied to IC22+AMANDA
- Correlation studies
  - Correlation of UHE neutrinos with UHECR
- Stacking
  - Starburst Galaxies, Blazars, Pulsars, ...
- Time-optimized searches
  - Periodicity test for LSI +61 303
  - Search for UHE neutrinos in coincidence with flares from 3C 279
  - Search for neutrino flares from selected sources using the Time Clustering Algorithm
  - Periodicity test for microquasars
  - MW triggered search for neutrino flares

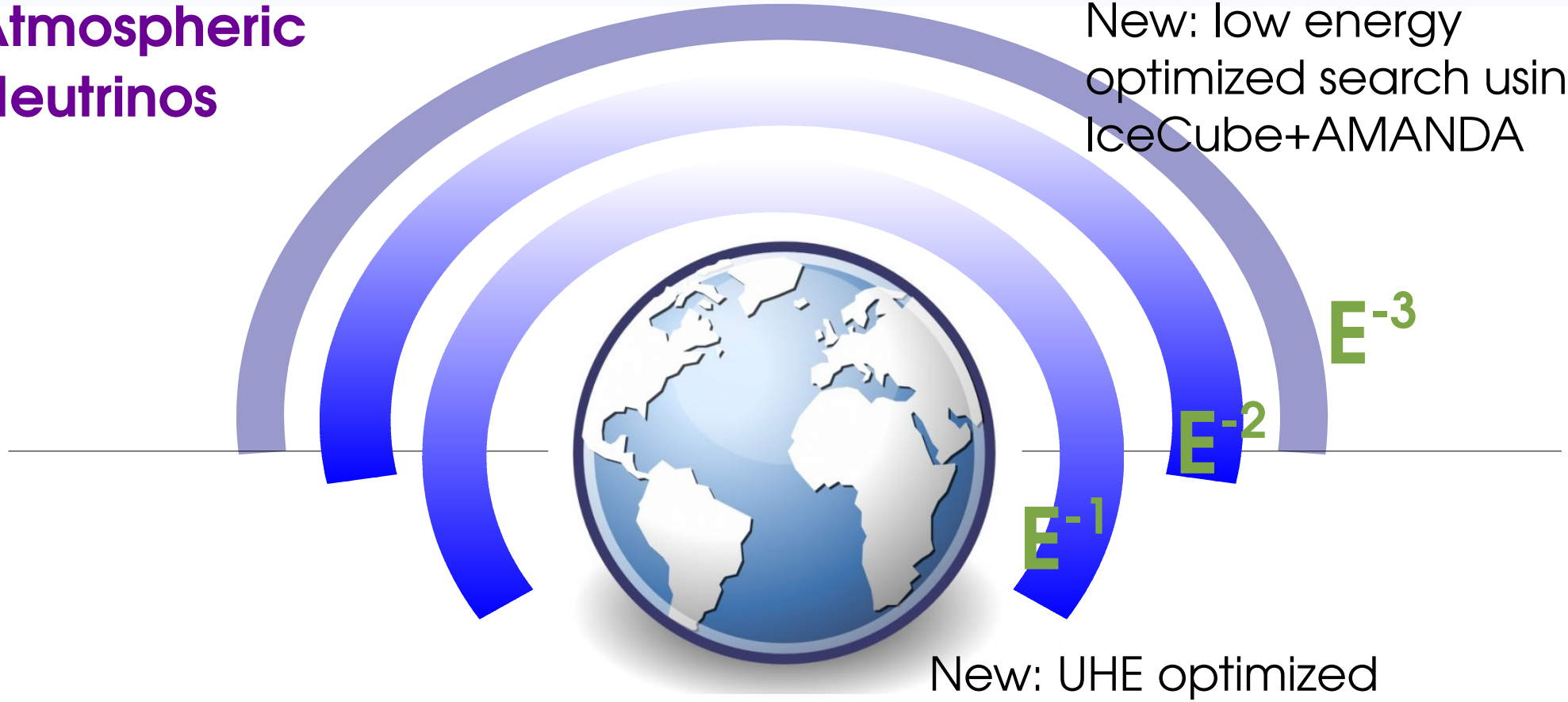
Overview – Results from 40 Strings

- Maps
  - Map of the full sky
- Stacking
  - MILAGRO sources, Starburst Galaxies, nearby Galaxy clusters
- Time-optimized searches
  - Search for neutrino flares from selected sources using the Time Clustering Algorithm
  - Periodicity test for microquasars
  - MW triggered search for neutrino flares
  - All-sky neutrino flare search

22 Strings: Sensitivity vs Spectral Index

Atmospheric Neutrinos

New: low energy optimized search using IceCube+AMANDA

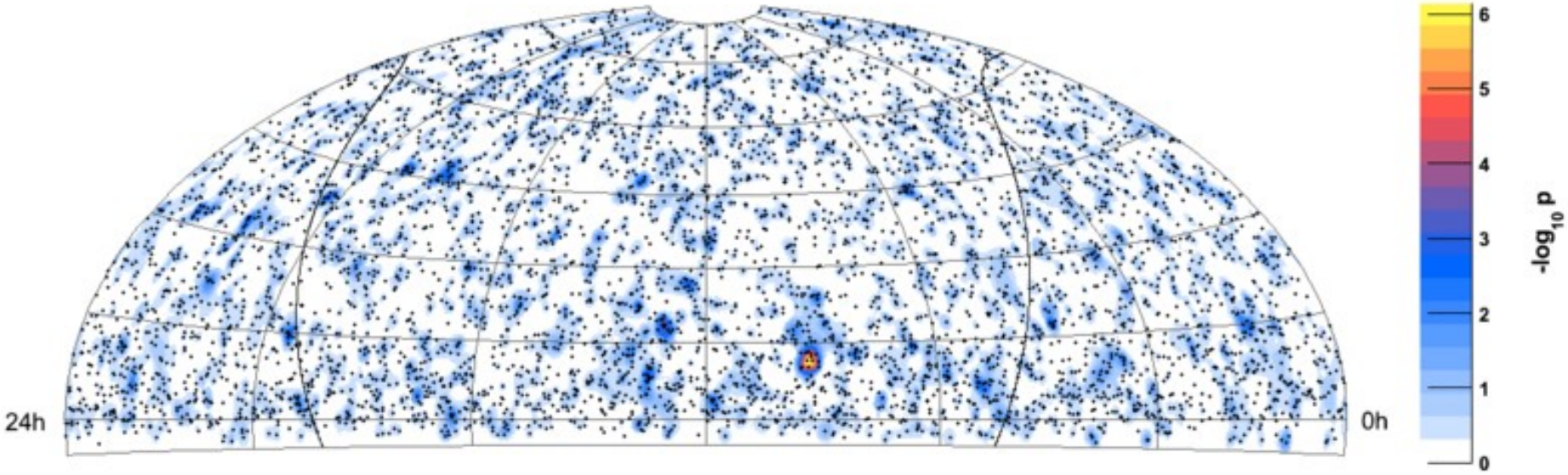


New: UHE optimized search above the horizon

Atmospheric Muons

22 Strings: sky map

Livetime: 275.7 days
Astrophys.J.701:L47-L51,2009



Hottest Spot: RA=153.375, Dec=11.375
Pre-trial -log10(p-value) = 6.13995
Best-fit # of source events = 7.67455
Best-fit spectral index = 1.65

Post-trial p-value: 1%, no evidence of a neutrino source

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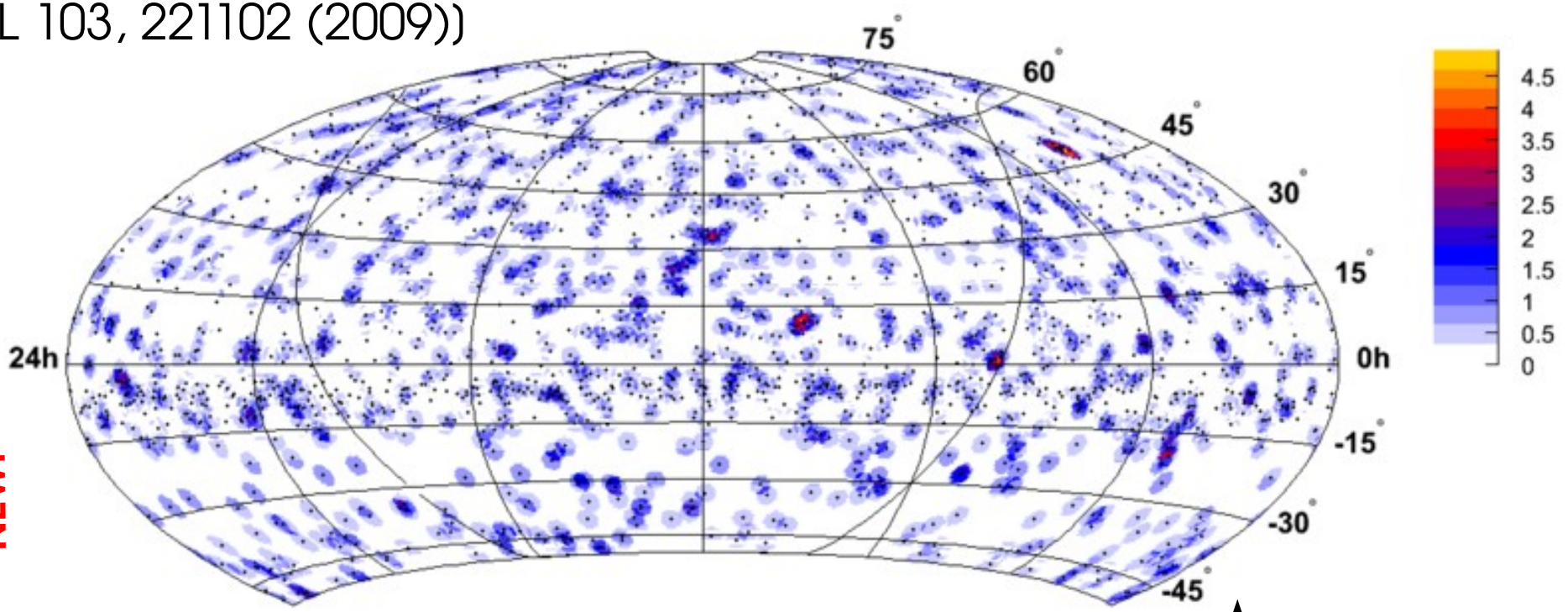
for the IceCube collaboration

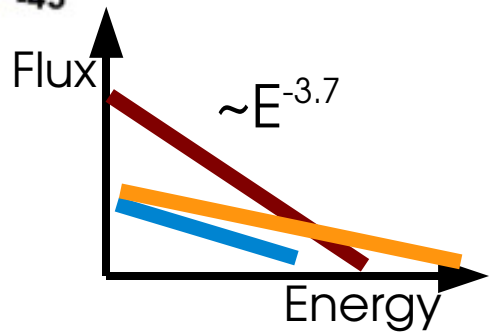
22 Strings: UHE optimized search

(PRL 103, 221102 (2009))



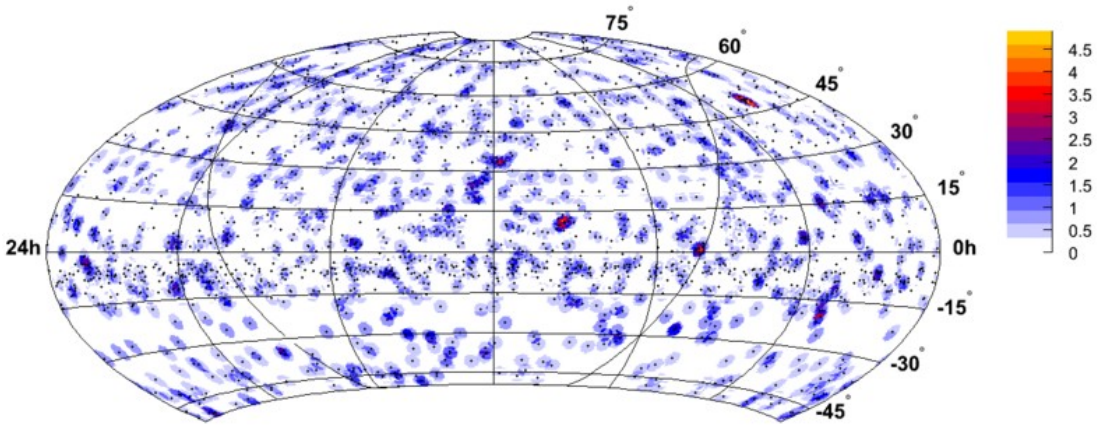
NEW!

Hottest Spot: RA=103.5, Dec=1.0
pre-trial p-value: $2.9*10^{-5}$
bin content: 8 events (1.19 expected)

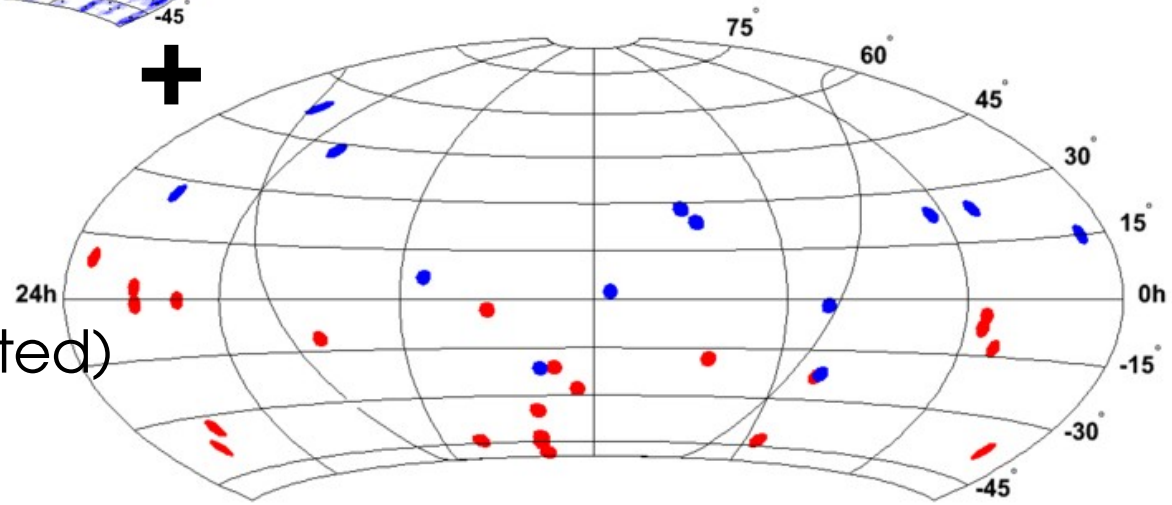


post-trial p-value: 37.4%, no evidence of a neutrino source

22 Strings: UHECR correlation



Red: Auger, 22 events (>57 EeV)
Blue: HiRes, 13 events (>56 EeV)

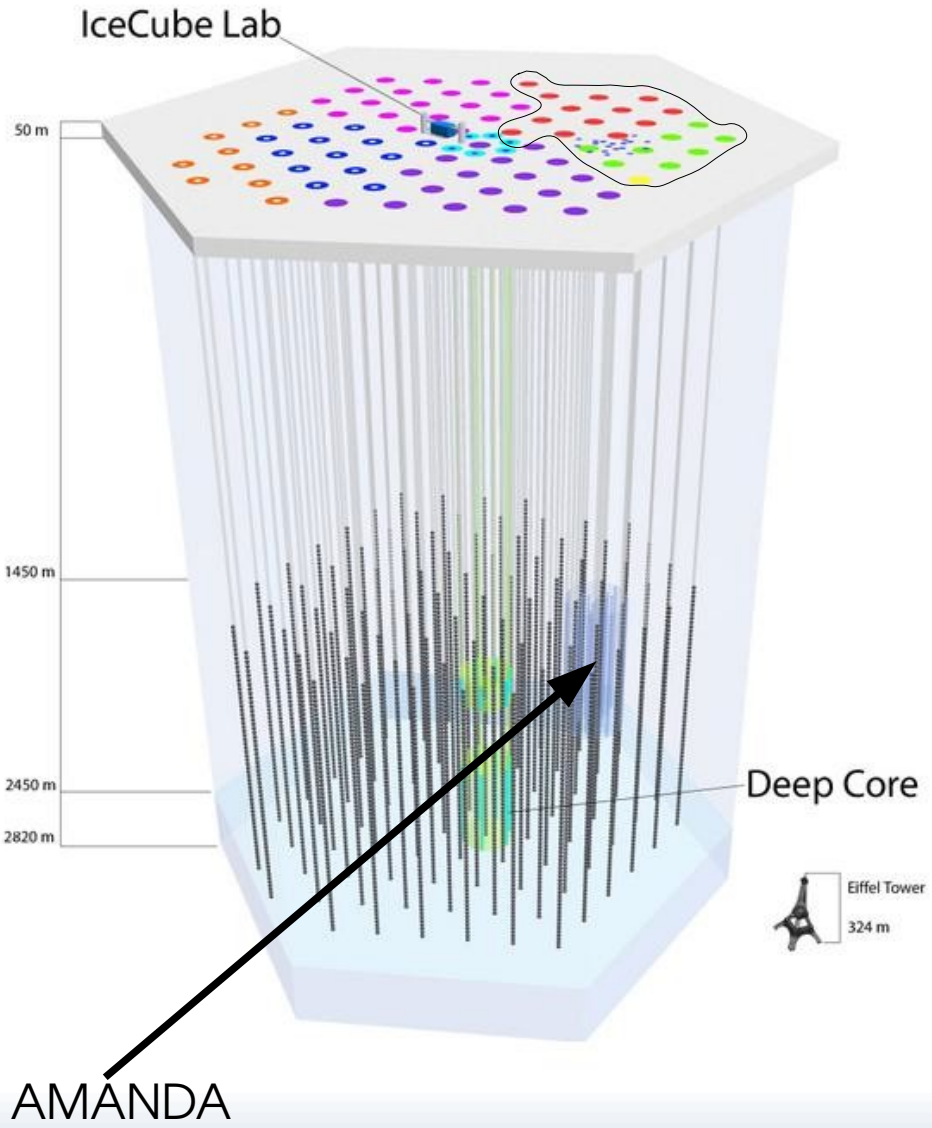


35 bins of 3°:
60 events (43.7 expected)
p-value: 0.009786, not significant

(R. Lauer, PhD thesis)

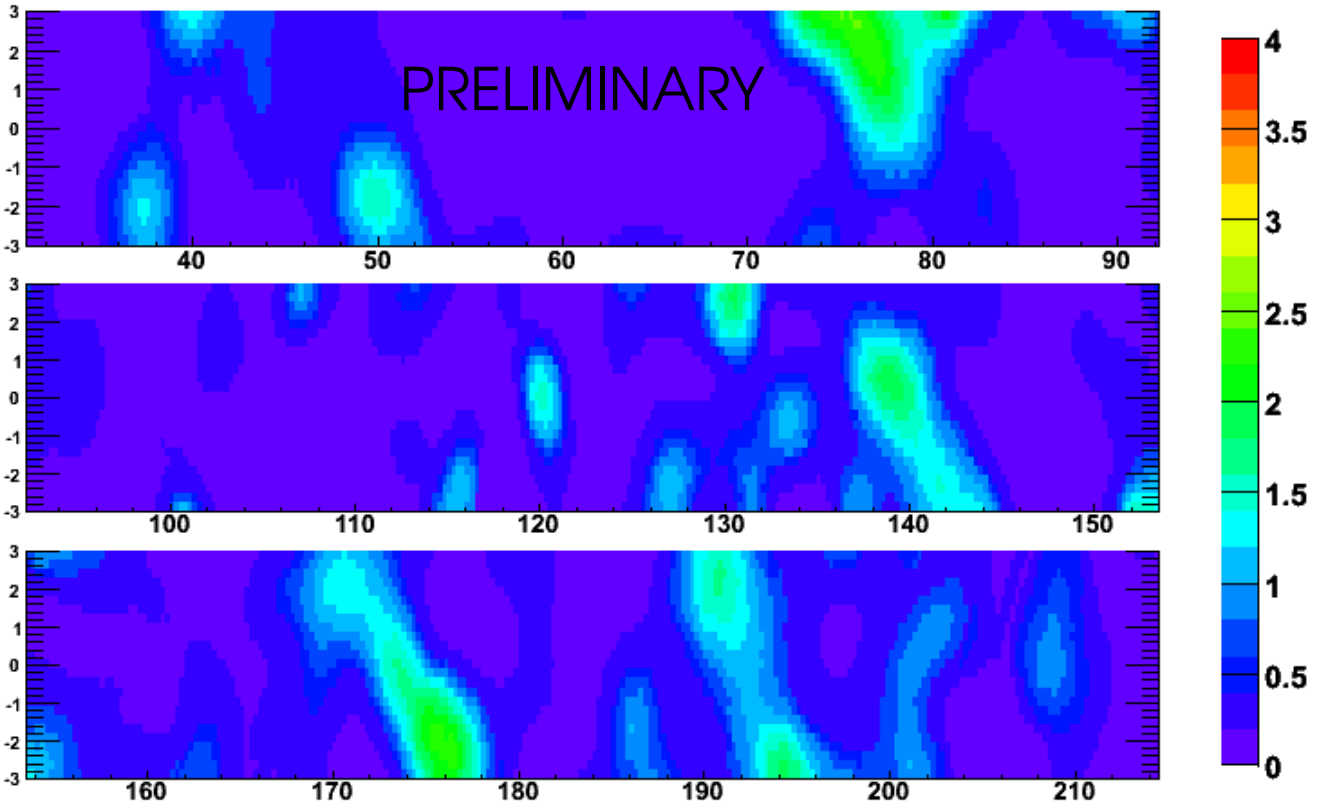
22 Strings + AMANDA

- Best sensitivity for soft spectra sources: IC22+AMANDA
  - additional acceptance at low energies – more events
  - First data analysis with a combined neutrino telescope



22 Strings + AMANDA: Galactic Plane

(Y.Sestayo et al, VLVnT 2009, (Athens))

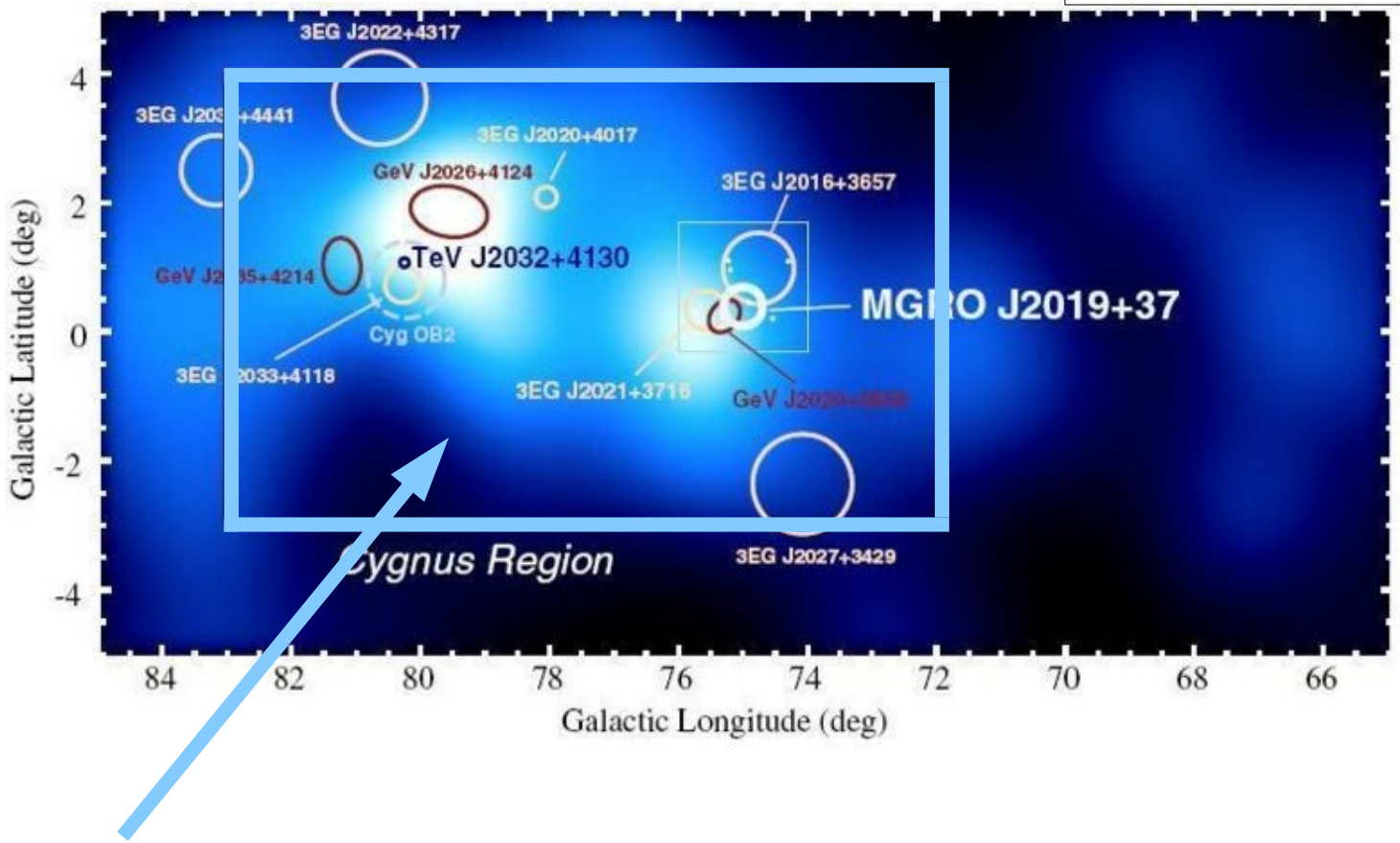


Hottest spot: l=75.875, b=2.675 (galactic coordinates)
pre-trial p-value: 0.0037

Post-trial p-value: 95%, no evidence of a neutrino source

22 Strings+AMANDA: Cygnus Region

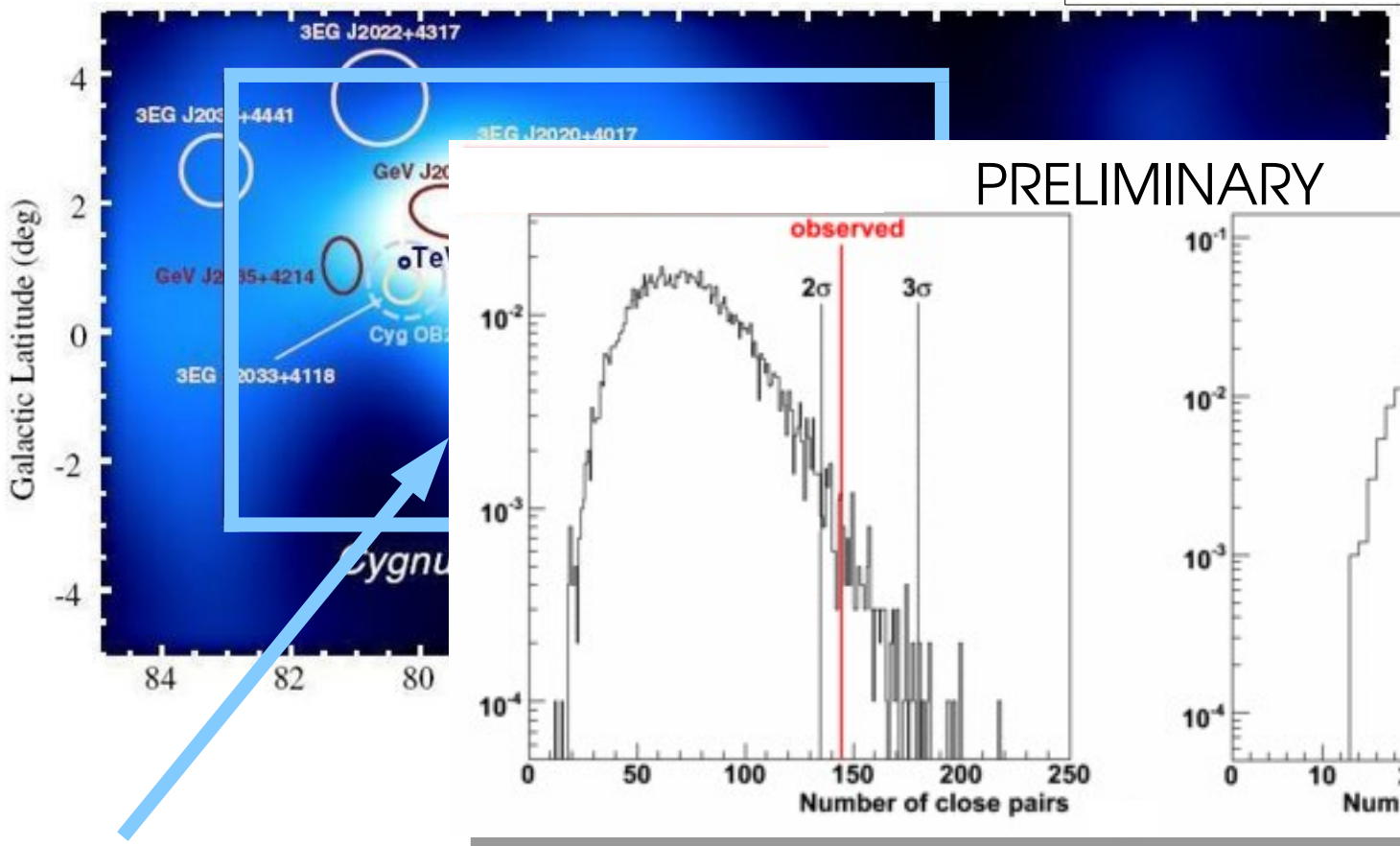
(Y.Sestayo et al, VLVnT 2009, (Athens))



2-point correlation
for extended region

22 Strings+AMANDA: Cygnus Region

(Y.Sestayo et al, VLVnT 2009, (Athens))



2-point correlation
for extended region

p-value: 0.0119,
not significant

40 Strings: Sensitivity vs Spectral Index

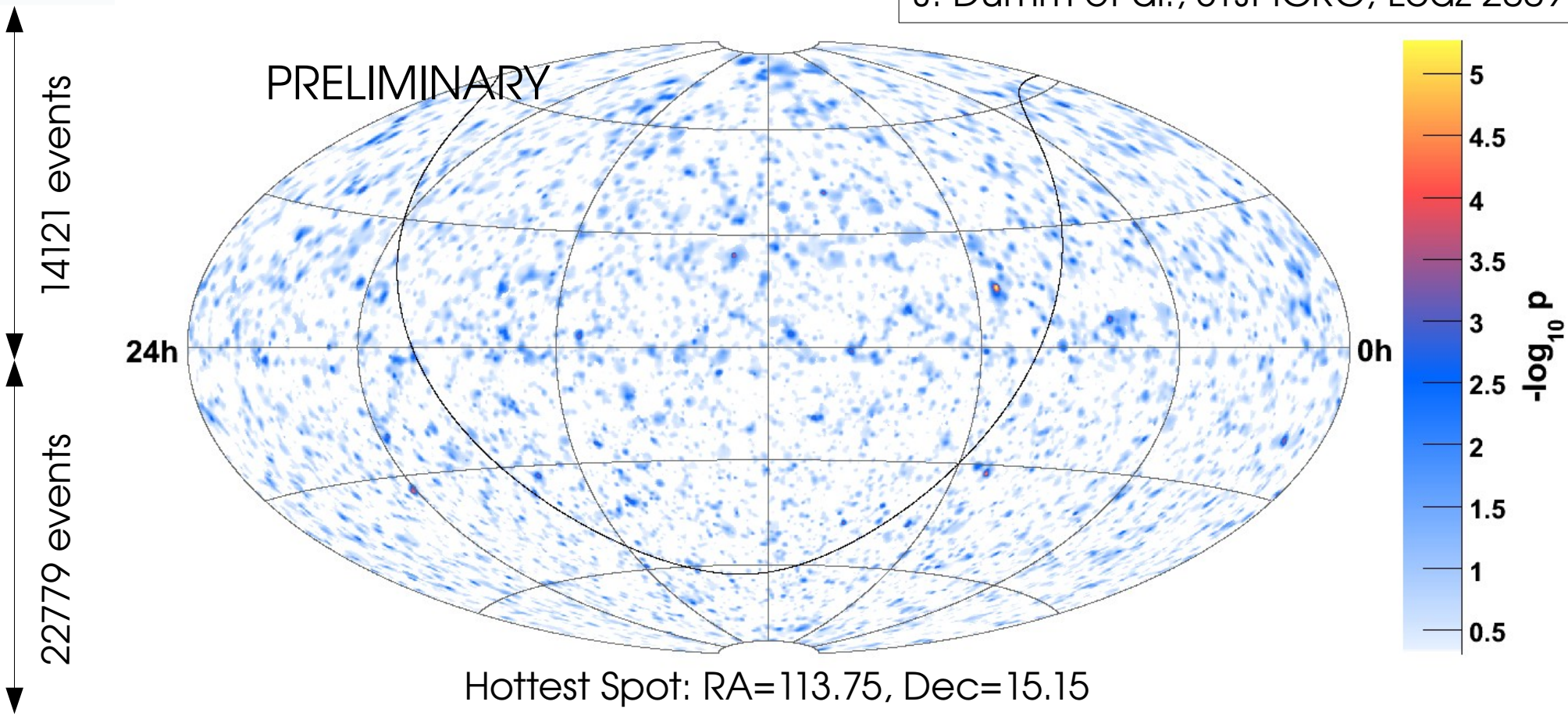
Atmospheric Neutrinos

Atmospheric Muons

New: Extension to the whole sky

40 Strings: Sky Map

Livetime: 375.5 days
Description of the analysis:
J. Dumm et al., 31st ICRC, Łódź 2009



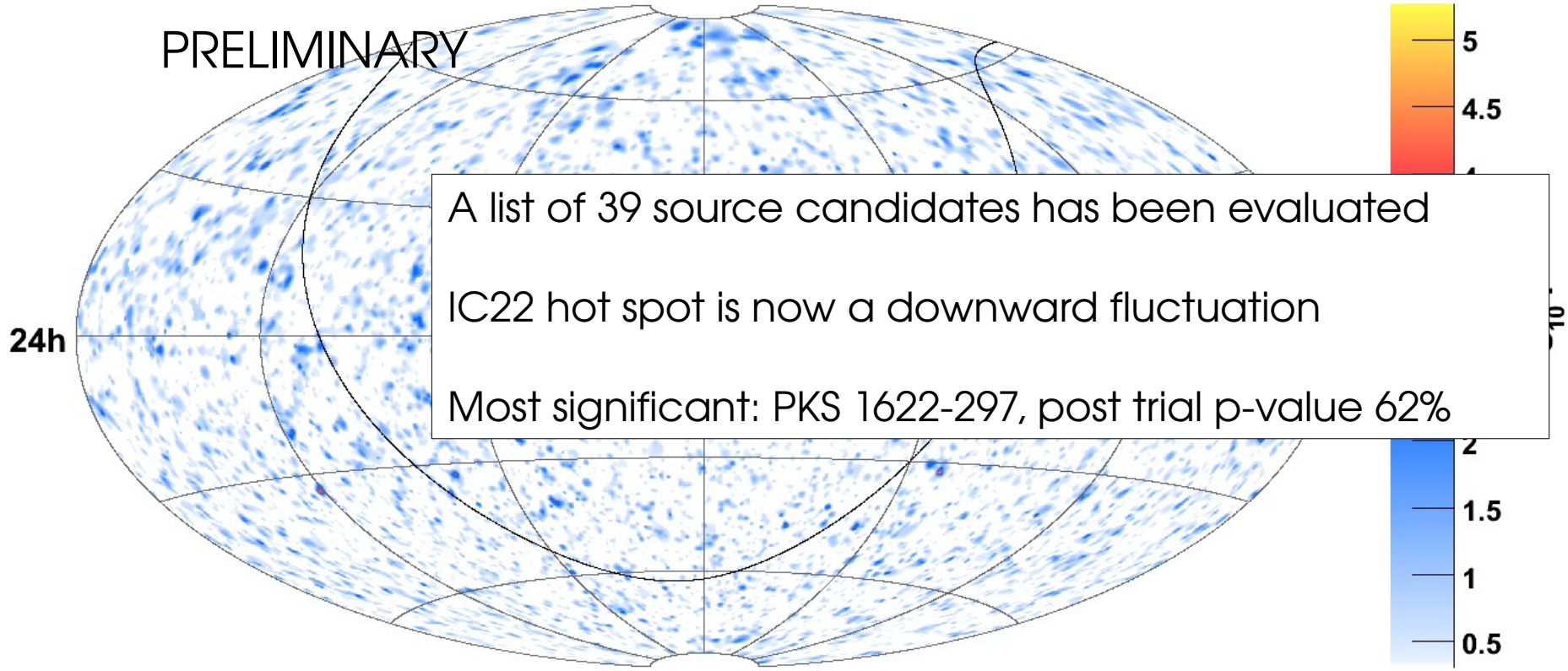
Hottest Spot: RA=113.75, Dec=15.15
Pre-trial -log10(p-value) = 5.28
Best-fit # of source events = 11.0
Best-fit spectral index = 2.05

Post-trial p-value: 18%, no evidence of a neutrino source

TeVPA 2010, Sirin Odrowski
for the IceCube collaboration

40 Strings: Sky Map

Livetime: 375.5 days
Description of the analysis:
J. Dumm et al., 31st ICRC, Łódź 2009



A list of 39 source candidates has been evaluated

IC22 hot spot is now a downward fluctuation

Most significant: PKS 1622-297, post trial p-value 62%

Hottest Spot: RA=113.75, Dec=15.15
Pre-trial -log10(p-value) = 5.28
Best-fit # of source events = 11.0
Best-fit spectral index = 2.05

Post-trial p-value: 18%, no evidence of a neutrino source

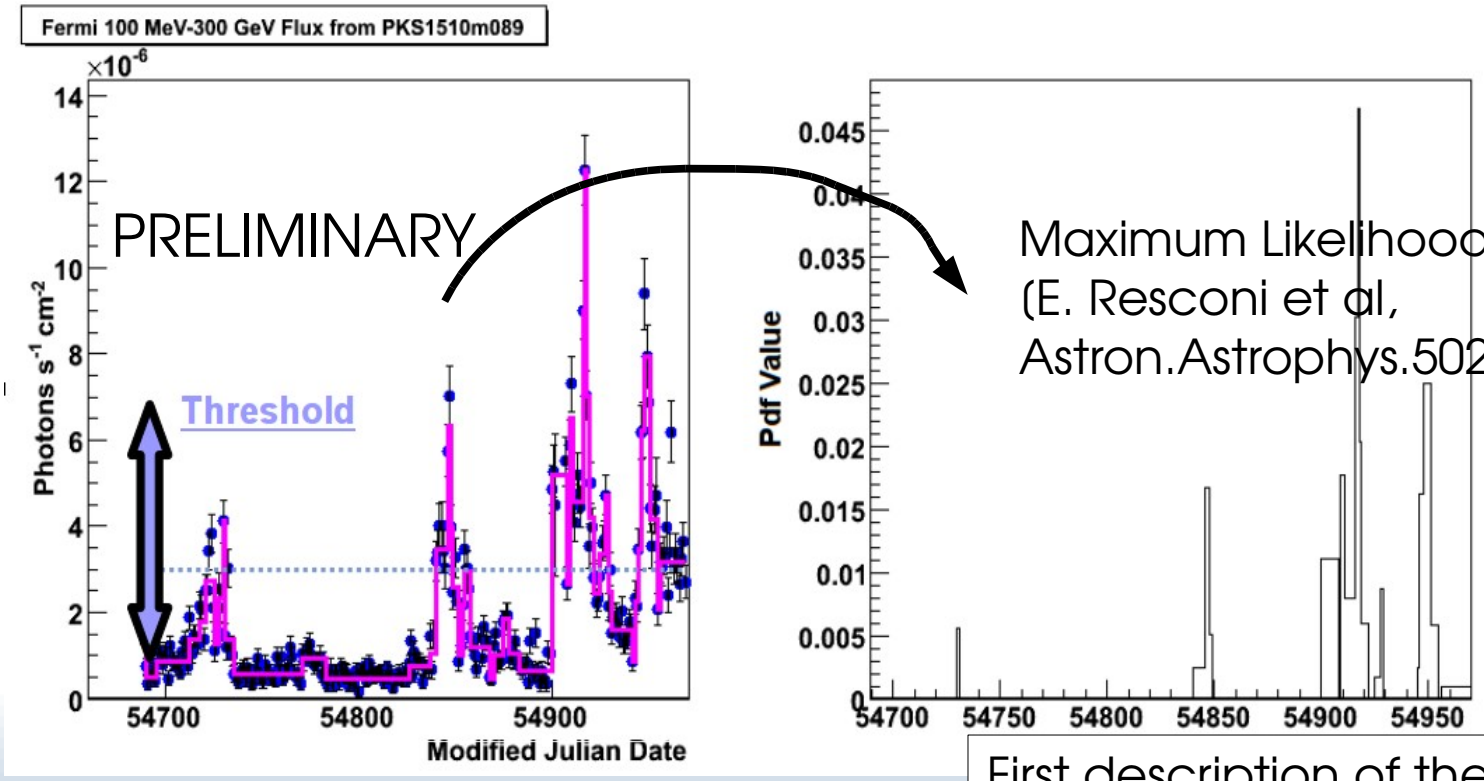
TeVPA 2010, Sirin Odrowski
for the IceCube collaboration

MW triggered search for neutrino flares

Goal: Search for neutrino flares in coincidence with GeV/TeV gamma ray flares

$$\mathcal{L}_i = (N_s/N)*\mathcal{S}(x_i, E_i)+(N-N_s)/N*\mathcal{B}$$

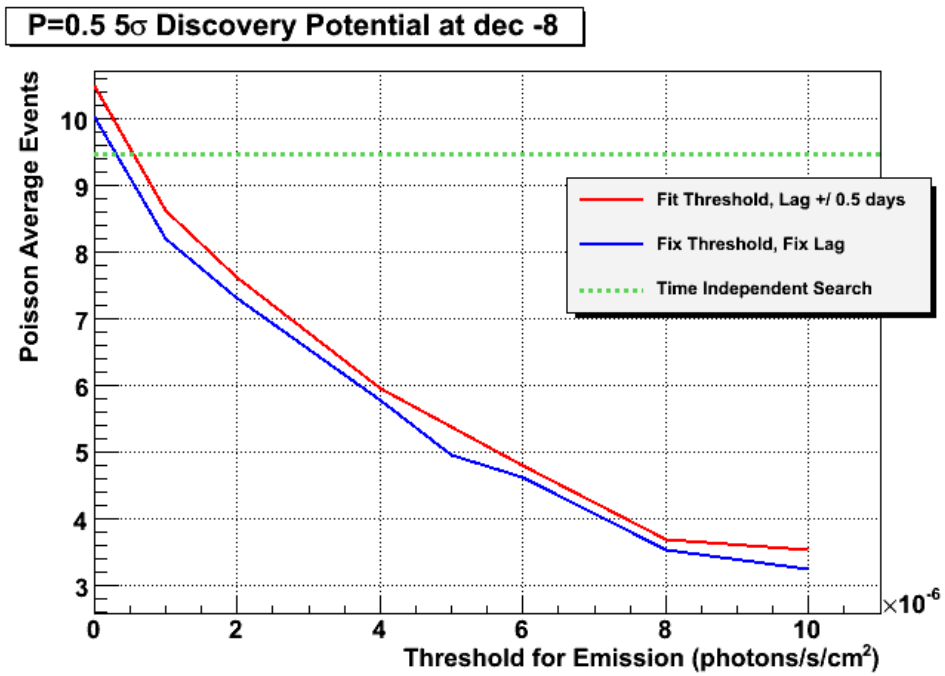
Now: $\mathcal{S}(x_i, E_i) \rightarrow \mathcal{S}(x_i, E_i, t_i)=\mathcal{S}(x_i, E_i)*\mathcal{T}(t_i)$

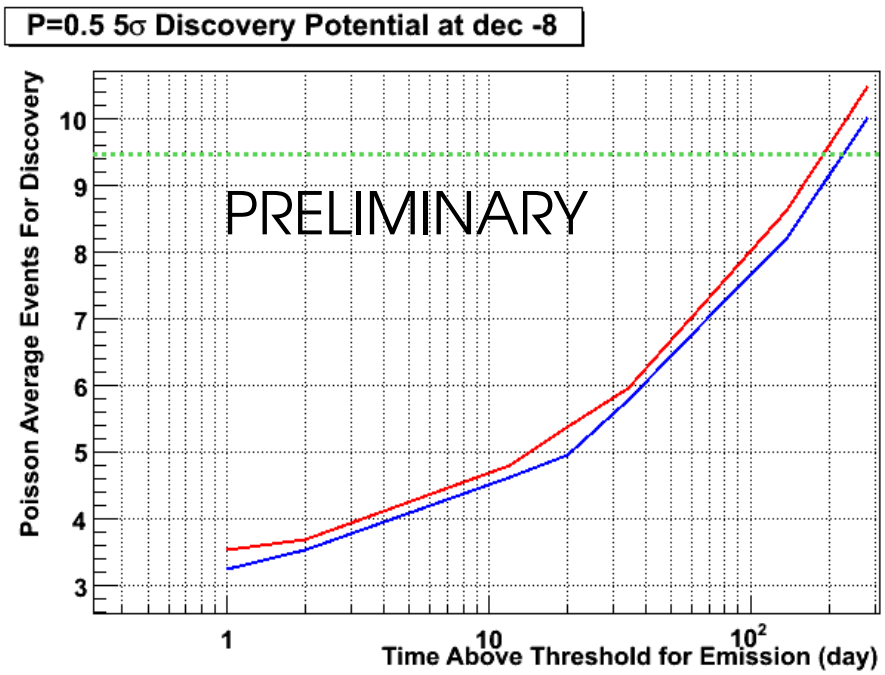


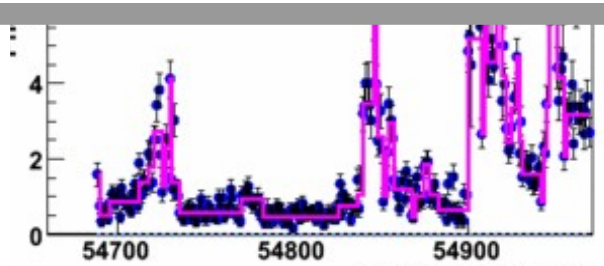
First description of the analysis:
M. Baker et al., 31st ICRC, Łódź 2009,
paper in preparation

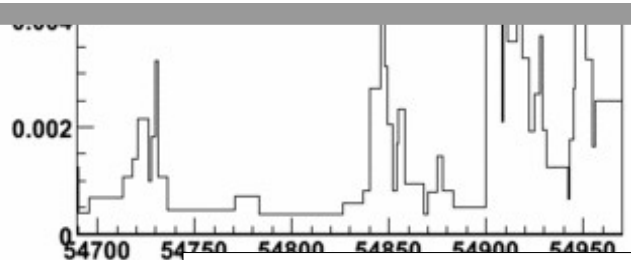
MW triggered search for neutrino flares

Goal: Search for neutrino flares in coincidence with GeV/TeV gamma ray flares









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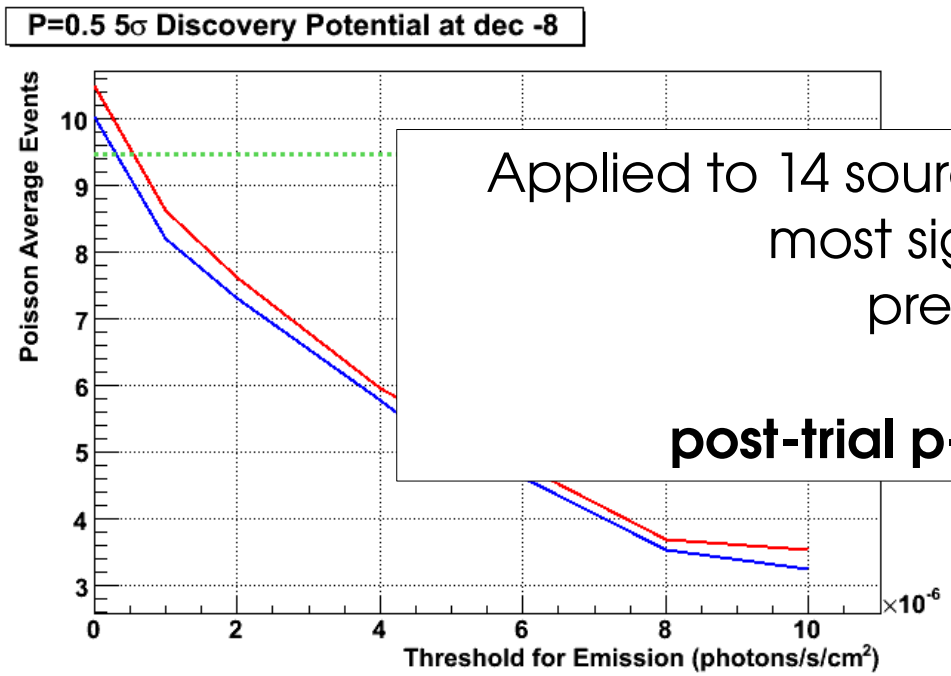
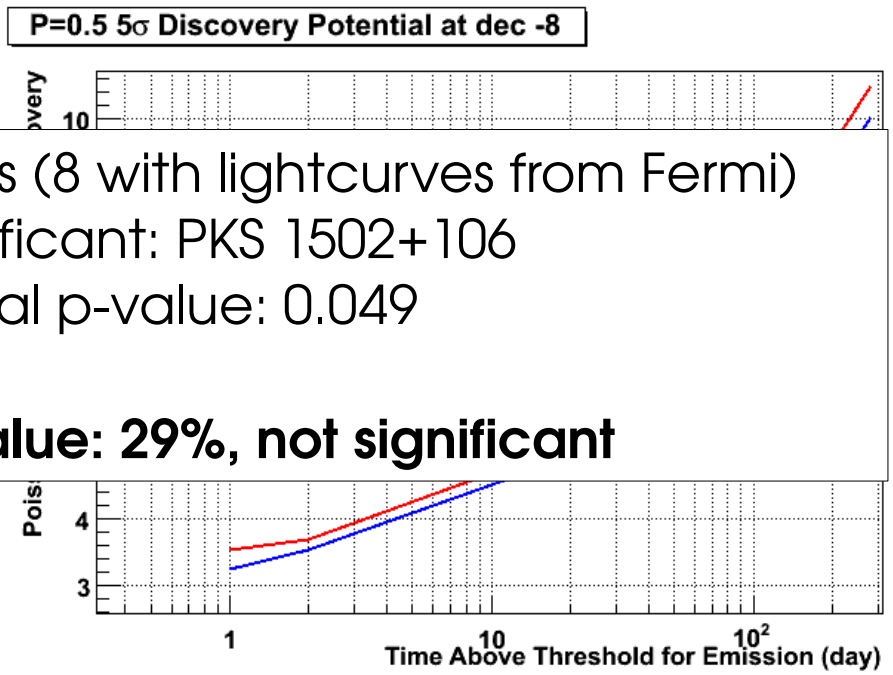
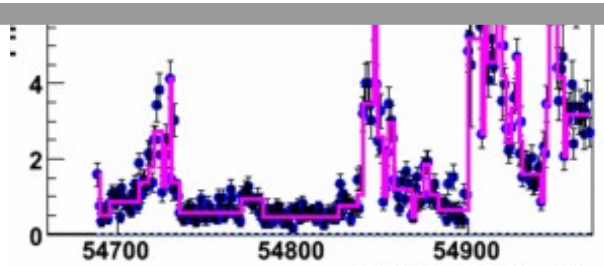
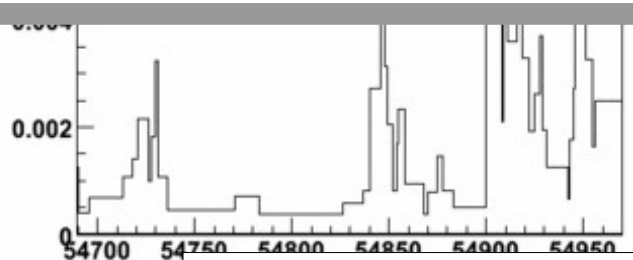




Applied to 14 sources (8 with lightcurves from Fermi)
most significant: PKS 1502+106
pre-trial p-value: 0.049

post-trial p-value: 29%, not significant





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M. Baker et al., 31st ICRC, Łódź 2009,
paper in preparation

Summary

- No neutrino source yet
- But: several interesting analyses and methods
  - Searches optimized for different source spectra
  - Dedicated searches, for example for the Cygnus region
  - Time optimized searches
  - ...
- More 40 strings analyses are underway
- Analyses of 59 string data can start soon
- New opportunities to search for point sources using DeepCore: see talk by Claudine Colnard