Point source/GRB report

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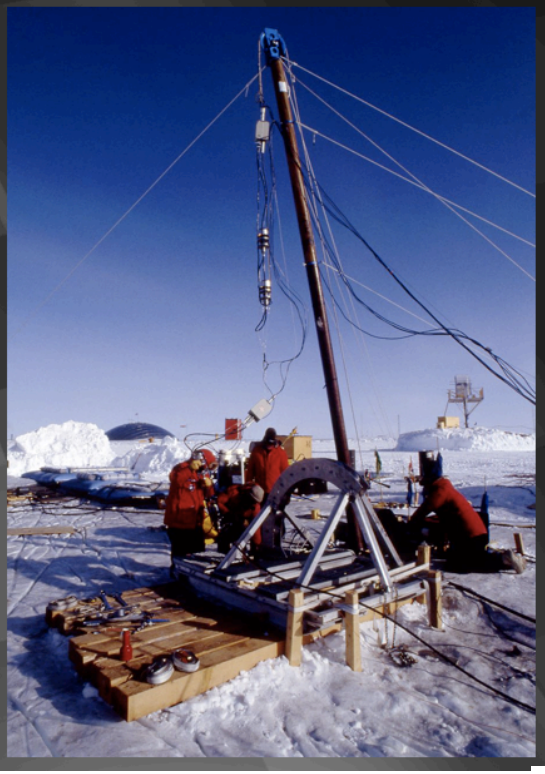
★Point Sources
- Positive signal: the Moon
- 22 strings results
- 40 strings readiness for unblinding and reach

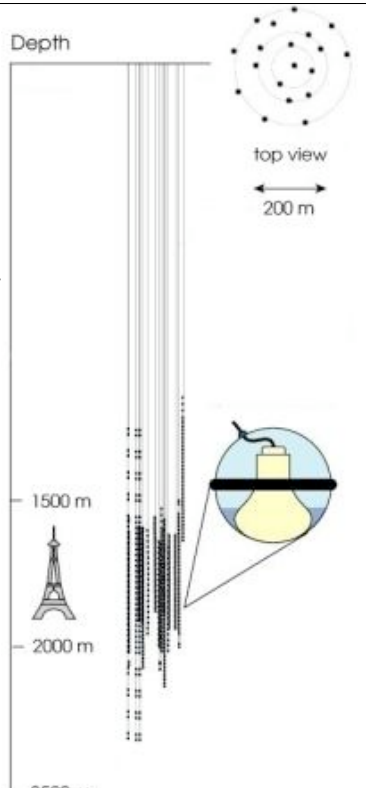
★GRBs

★Status of ToO programs

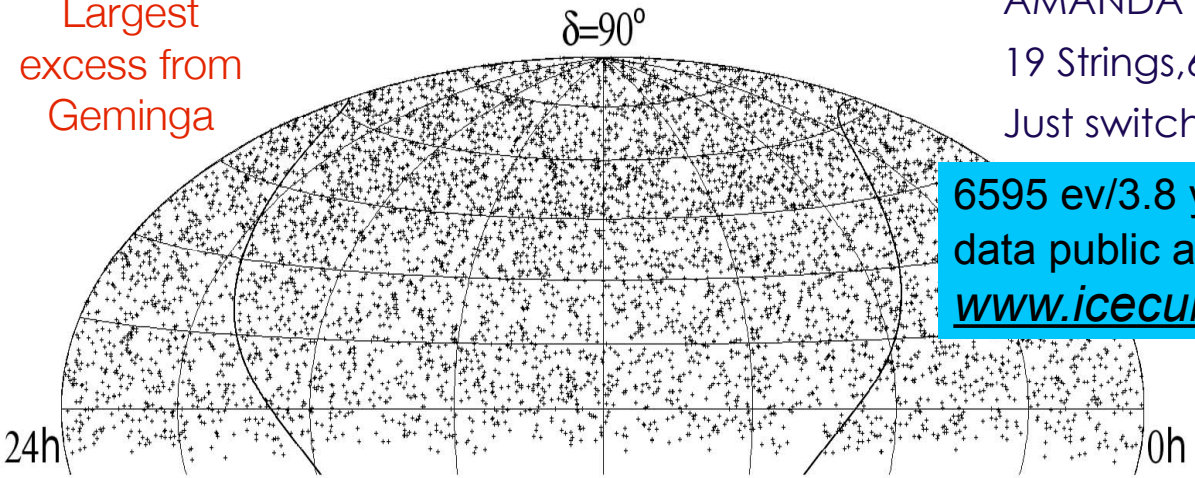
Scientific Advisory Committee
Madison, May 20, 2009

Goodbye AMANDA





Largest excess from Geminga



AMANDA (1996-2009),completed in 2000

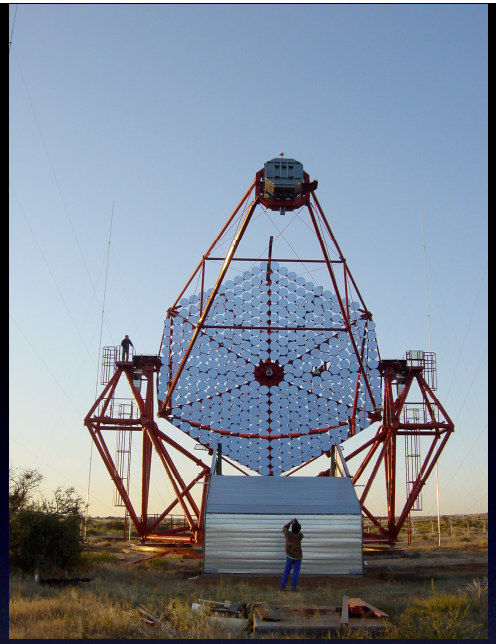
19 Strings,677 Modules, 8 inch PMTs

Just switched off

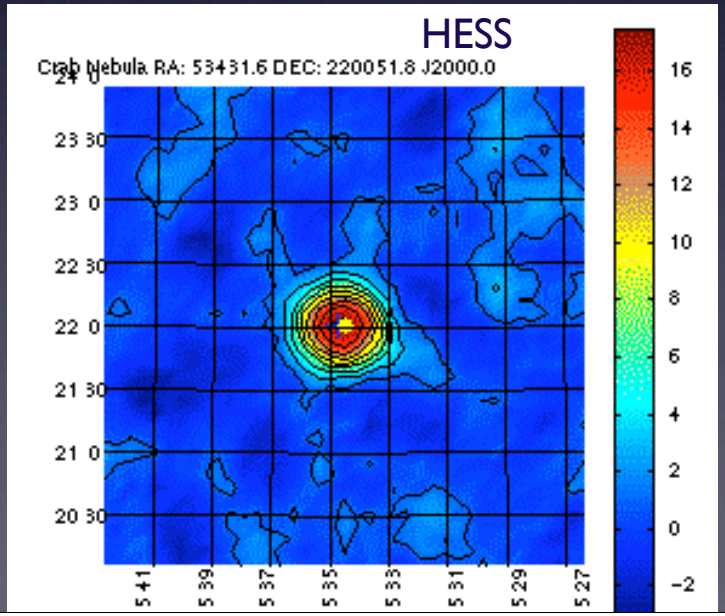
6595 ev/3.8 yr
data public at *http://www.icecube.wisc.edu/science/data*

AMANDA-II 7 yr
arXiv:0809.1646

Looking for point-sources

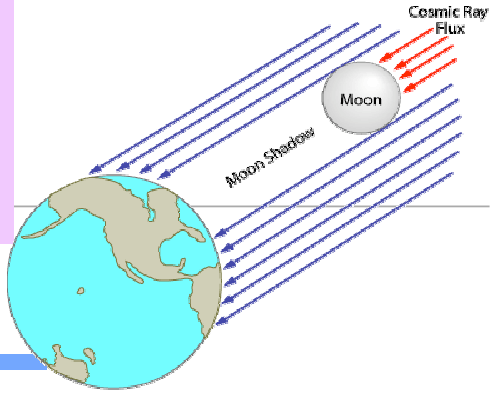


Checking the PSF with a Standard candle

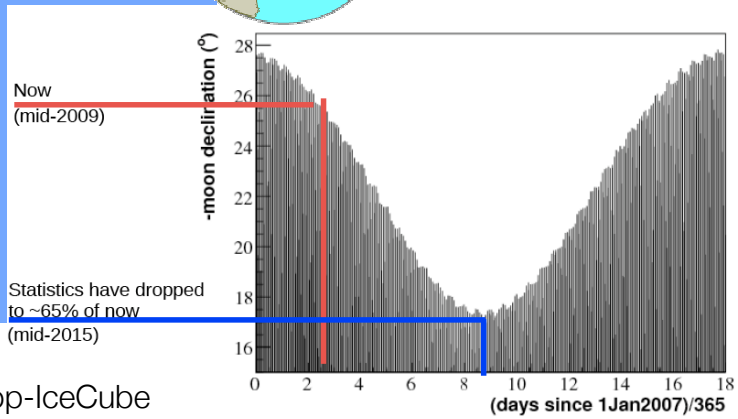


First Moon shadow in a neutrino telescope

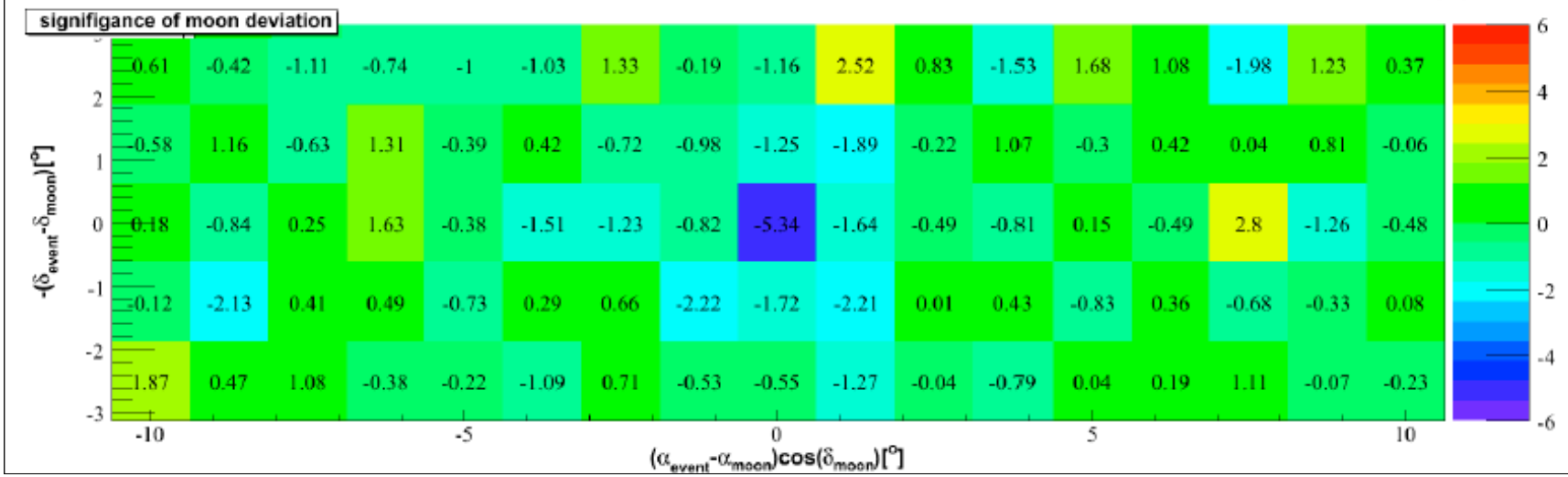
Preliminary



8 months of IC40 data, 9M muons,
13 cycles
0.7° radius bins around Moon position
Check of absolute positioning and coordinate transformations



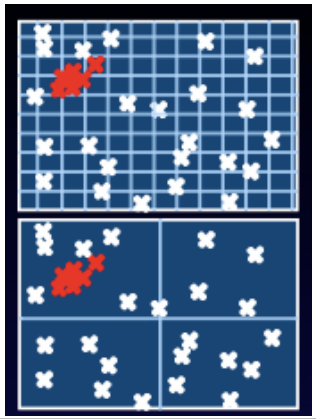
(L. Gladstone's talk at APS) In a more vertical direction we use IceTop-IceCube



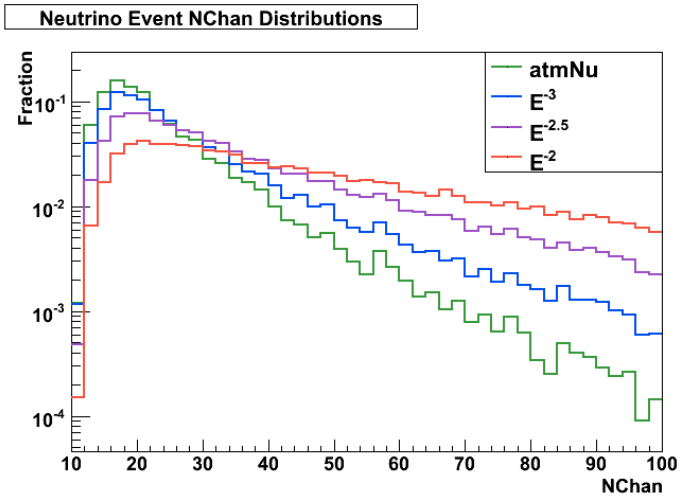
Test of hypothesis and relevant discriminating variables

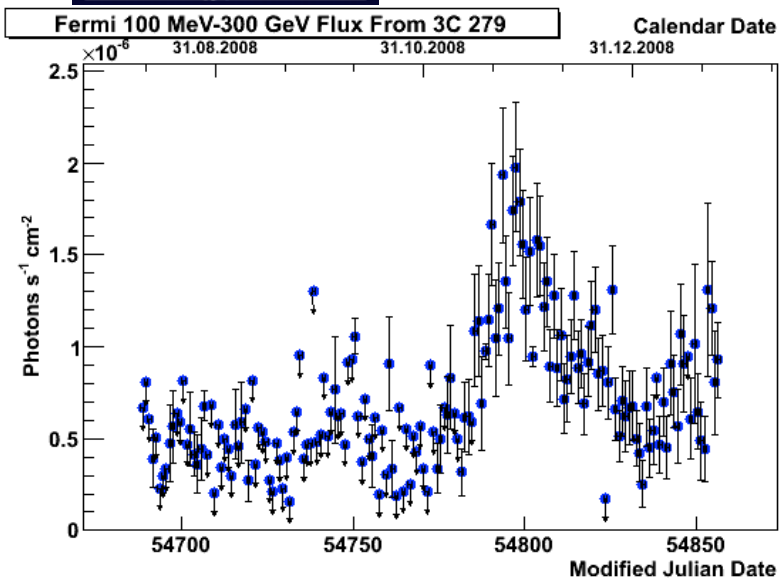
binned methods not optimal

LH ratio methods exploit the power of all variables characterizing signal against background



Energy distribution



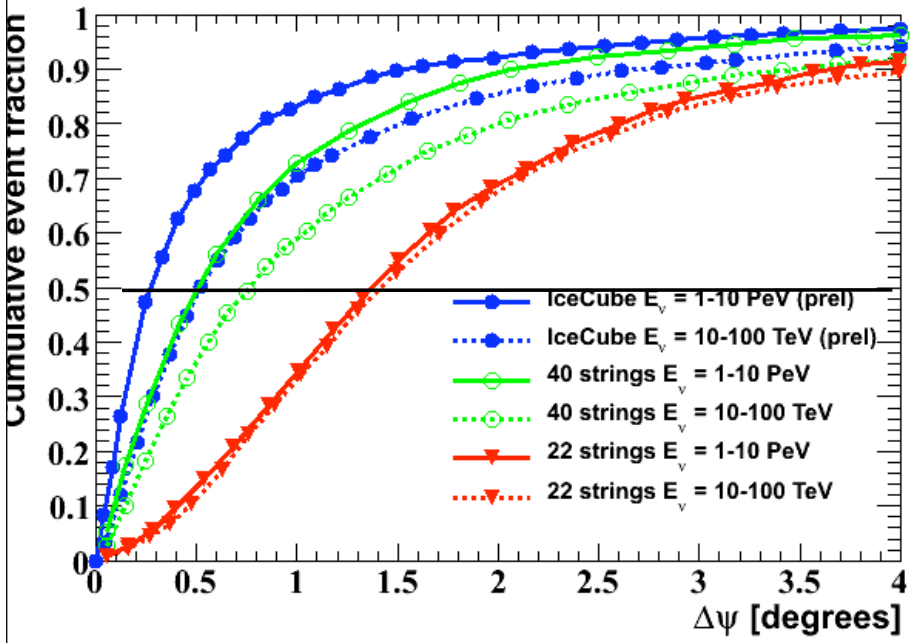


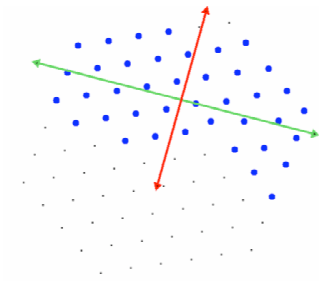
Time dependence

$$\mathcal{S}_i = \frac{1}{2\pi\sigma^2} e^{-\frac{|\vec{x}_i - \vec{x}_s|^2}{2\sigma^2}} \cdot P(Nch|\gamma) \cdot \frac{1}{\sqrt{2\pi}\sigma_w} e^{-\frac{(\phi_i - \phi_o)^2}{2\sigma_w^2}}$$

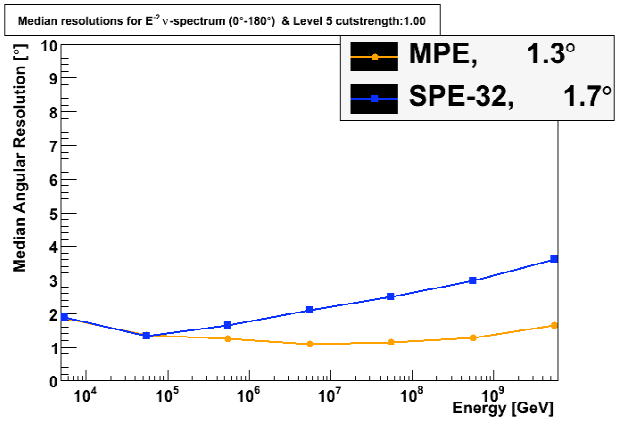
space energy time

The PSF of the growing detector

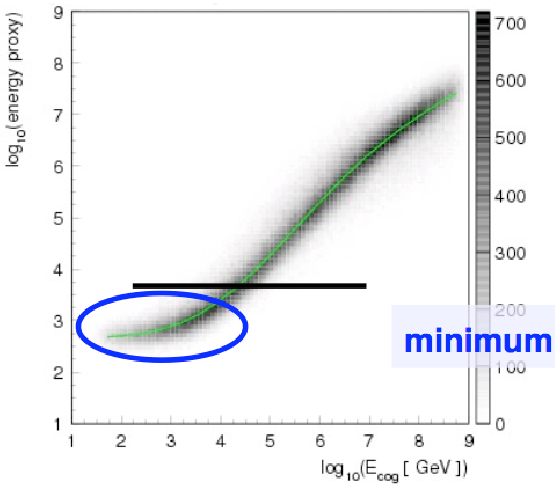




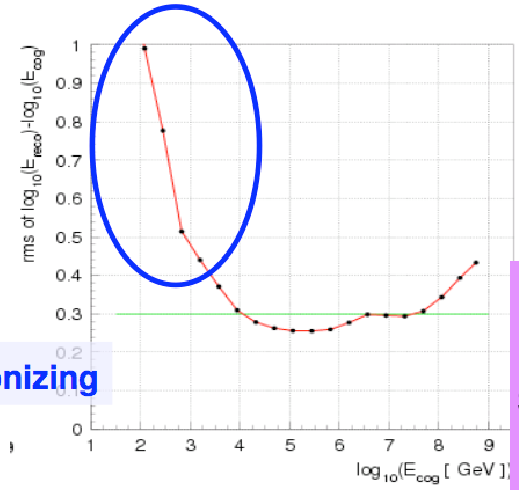
Improved track reconstruction respect to IC22 using multiple pulse times.



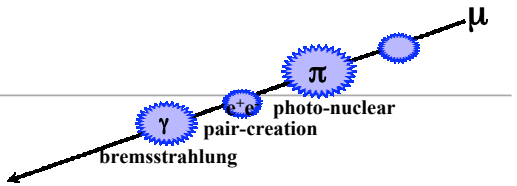
Getting to know charge and energy variables better



minimum ionizing



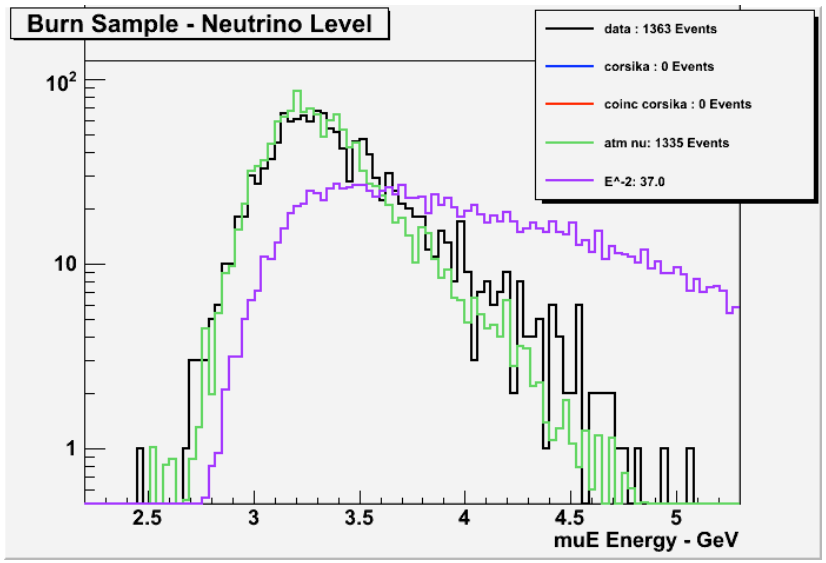
Energy Resolution
$\sigma(\log_{10}E) \sim 0.3$



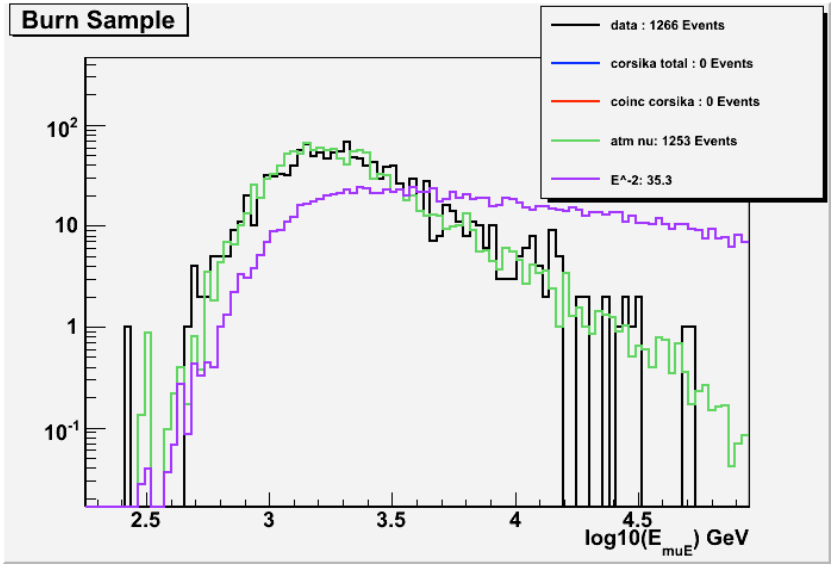
Found a problem in pulse first level reconstruction of FADC charge => solution use only ATWD. It works! Now testing a the new project extracting pulses

Source: D. Chirkin, UW

before correction

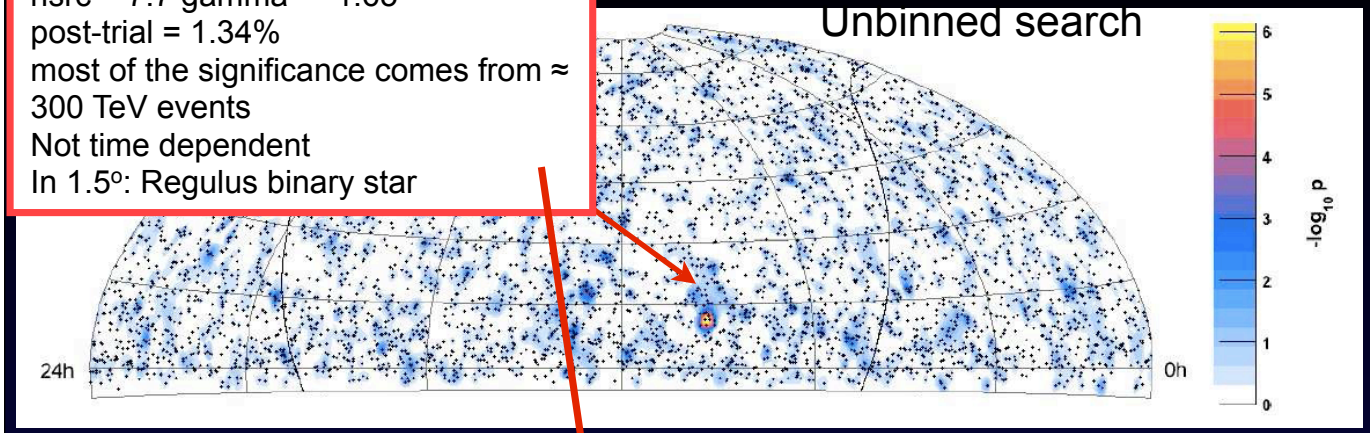


after correction



Unblinded IceCube Sky Maps (22 strings)

nsrc = 7.7 gamma = -1.65
post-trial = 1.34%
most of the significance comes from ≈ 300 TeV events
Not time dependent
In 1.5°: Regulus binary star



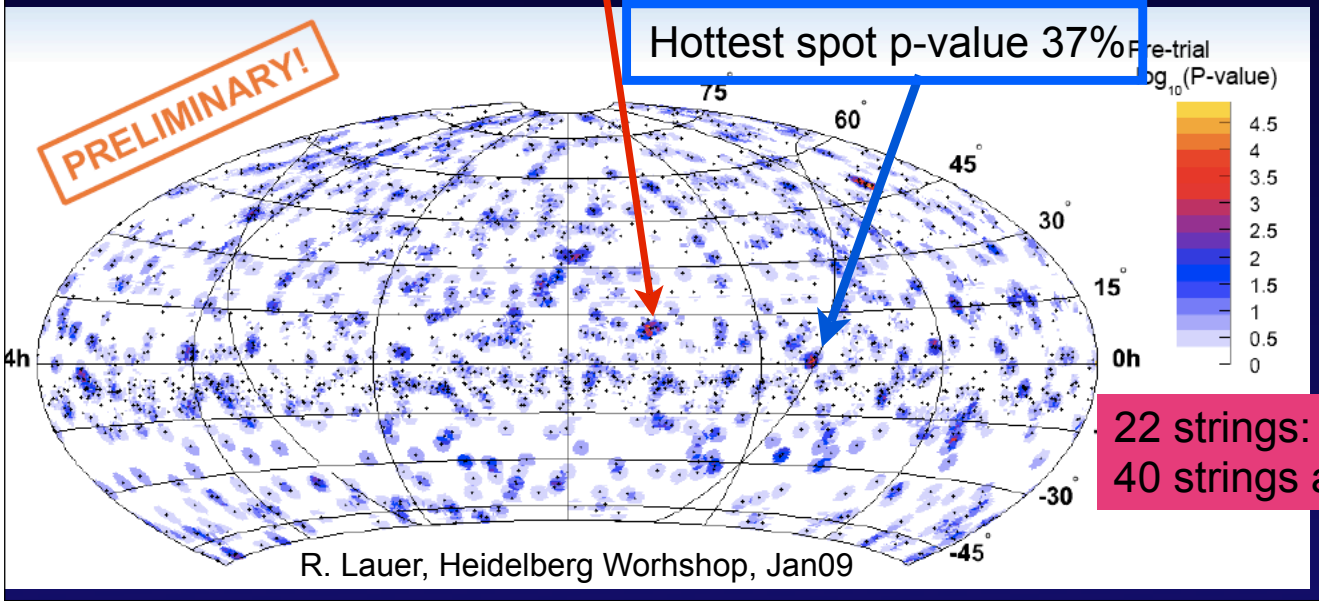
Neutrino Flux needed for this significance ($TeV^{-1}\ cm^{-2}\ s^{-1}$)

E^{-2} 2.2×10^{-11}
$E^{-1.65}$ 3.6×10^{-12}

5114 events/276 days

Hot Spot triggered observations with VERITAS and future with H.E.S.S.

Binned search extends FoV to Southern hemisphere and 35% less sensitive in Northern hemisphere

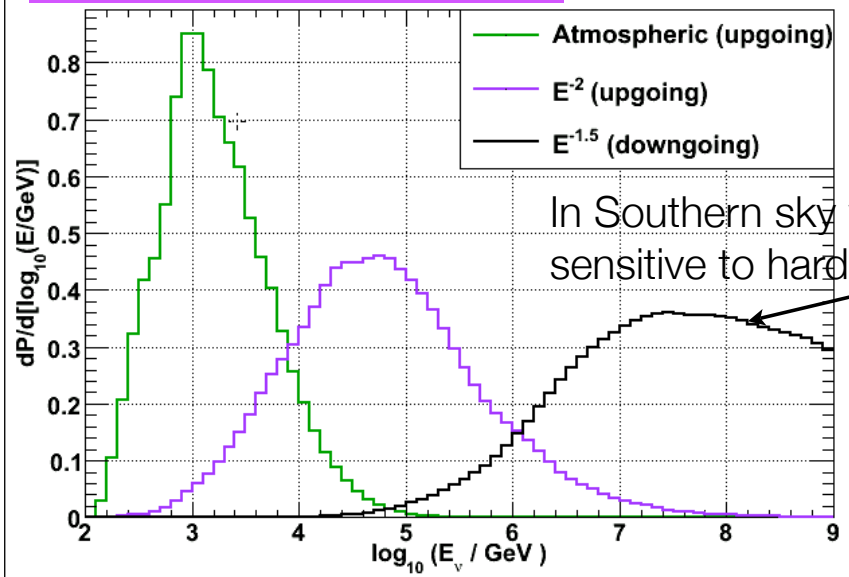


22 strings: paper ready for submission
40 strings at ICRC2009

R. Lauer, Heidelberg Worhshop, Jan09

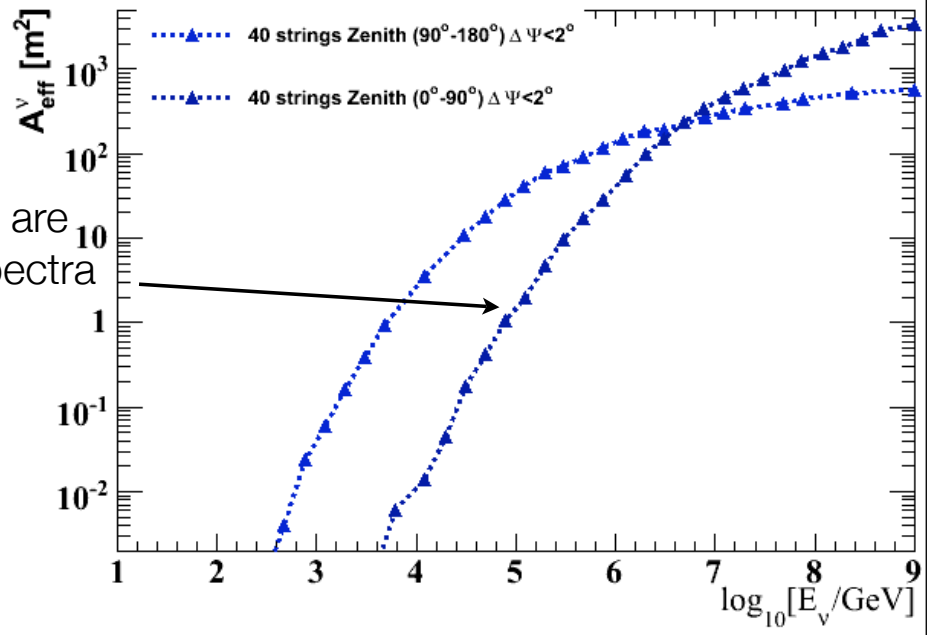
40 strings events for point-source analysis

In Northern sky we are sensitive to E^{-2} spectra



In Southern sky we are sensitive to hard spectra

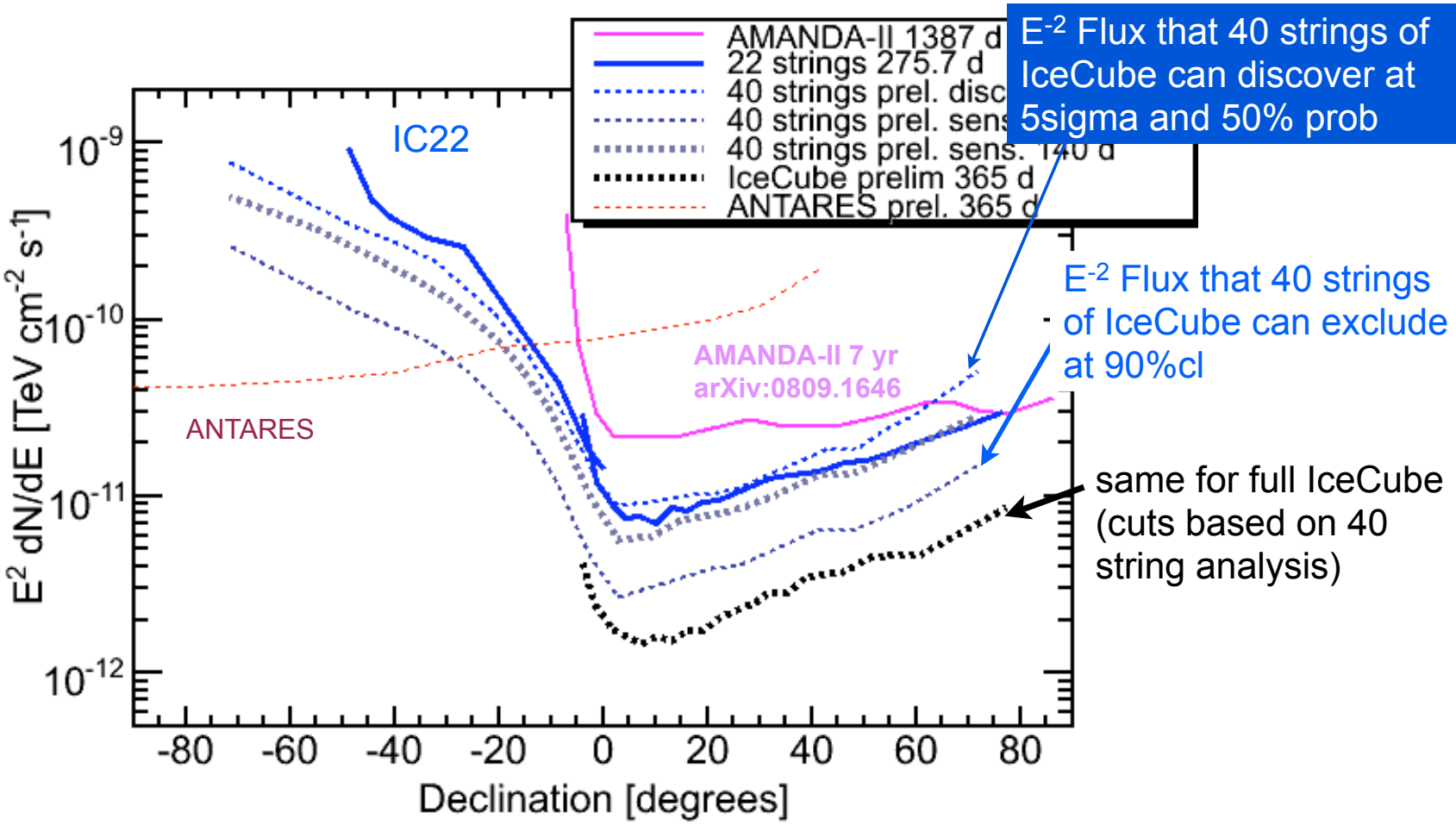
$$N_\mu = \int A^\nu_{eff}(E_\nu, \theta_\nu, \phi_\nu) \frac{d\Phi_\nu}{dE_\nu d\Omega_\nu} dE_\nu \, d\Omega_\nu$$



Filter level: 23Hz, 35% reconstructed as upgoing still dominated by misreconstructed atmospheric muon background

Cut level:
Downgoing events : **70 ev/day** (mainly atm muons) after tight E-related variable zenith dependent cuts
Upgoing events: atmospheric neutrino background + 5% contamination of muons
35 ev/day

What fluxes accessible by experiments?



E^{-2} Flux that 40 strings of IceCube can discover at 5sigma and 50% prob

E^{-2} Flux that 40 strings of IceCube can exclude at 90%cl

same for full IceCube (cuts based on 40 string analysis)

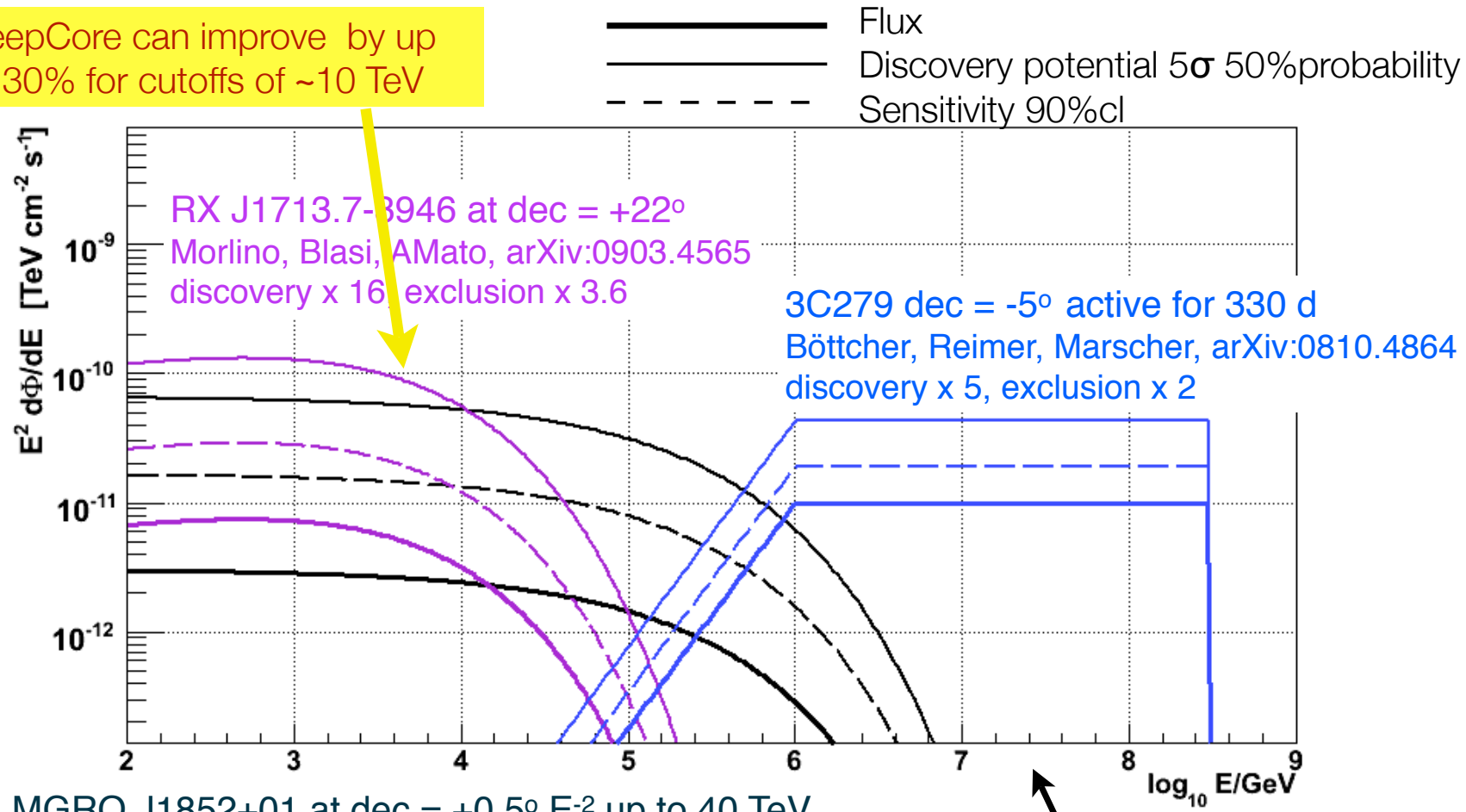
In IC22 about a factor of 2 better than AMANDA 7 yrs

IC40 factor of 2 better than IC22: 35 upgoing events/day and 69 downgoing events/day

IC80 ~ factor of 4-5 better than IC22

Sensitivity and Discovery potential to specific flux models in 40 strings of IceCube

DeepCore can improve by up to 30% for cutoffs of ~10 TeV



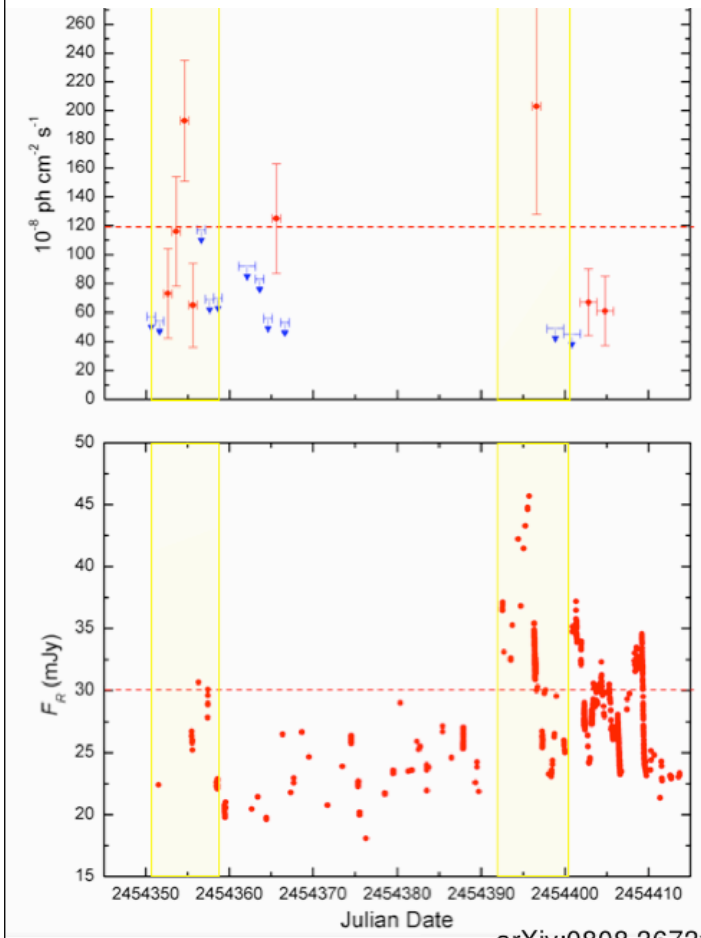
MGRO J1852+01 at dec = +0.5° E^{-2} up to 40 TeV
Gonzalez-Garcia, Halzen, Mohapatra, arXiv:0902.1176
discovery x 21, exclusion x 6
3 Pevatrons can be stacked: full IceCUbe can discover them in about 5 yrs

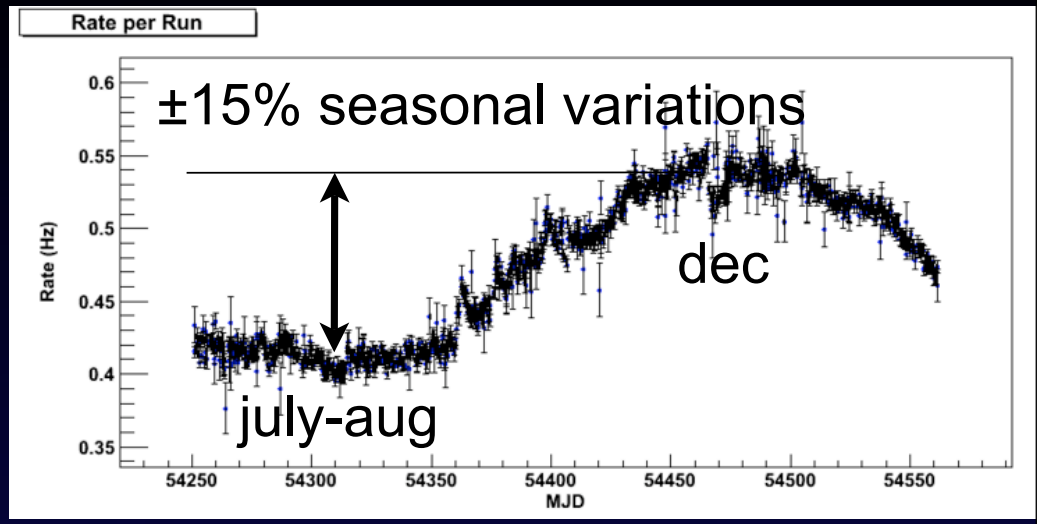
HE extension can help by > 30%

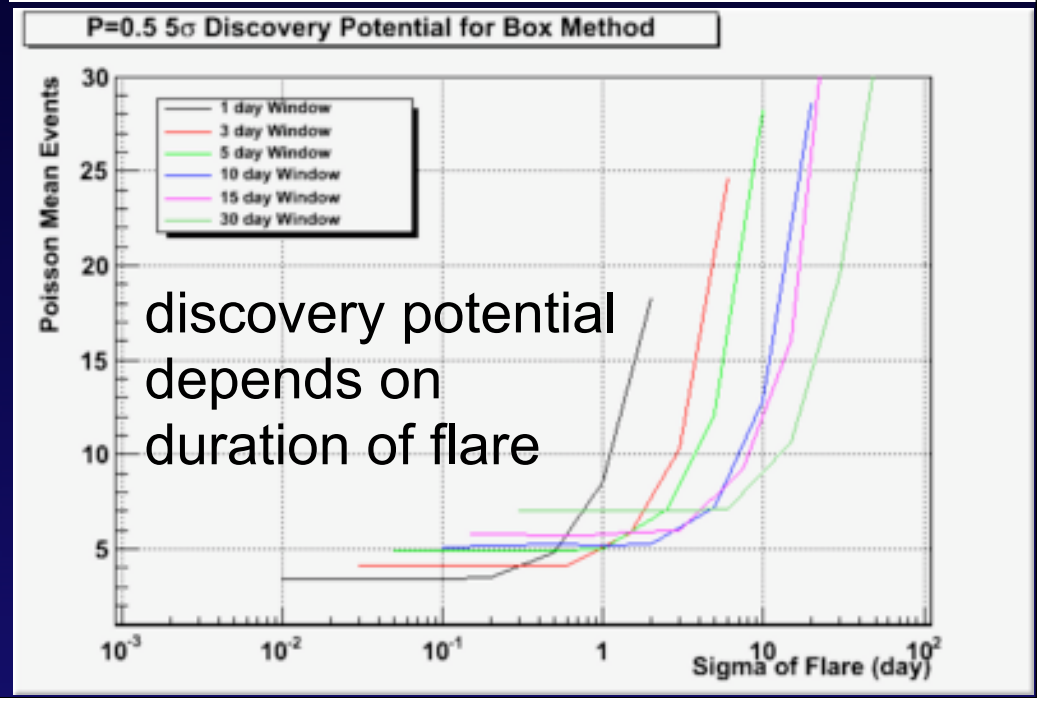
Search for flares in Jun 2007-Apr 2008

7 flares from Cyg X-1 and 6 blazars:
3-5 events needed for discovery for
flare search windows 5-10 days.

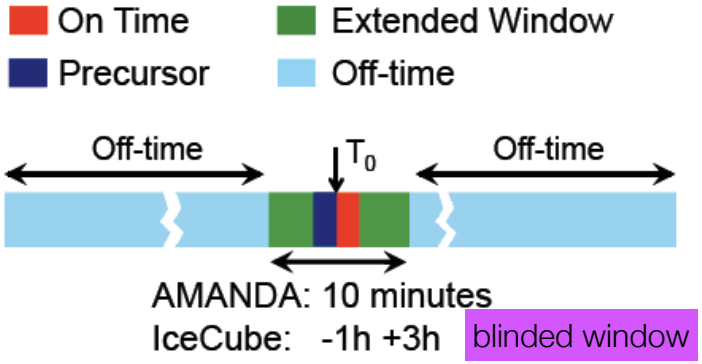
S5 0716+71 AGILE arXiv:0808.3673

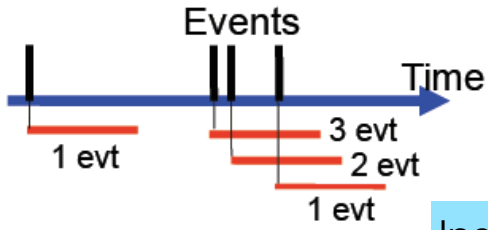






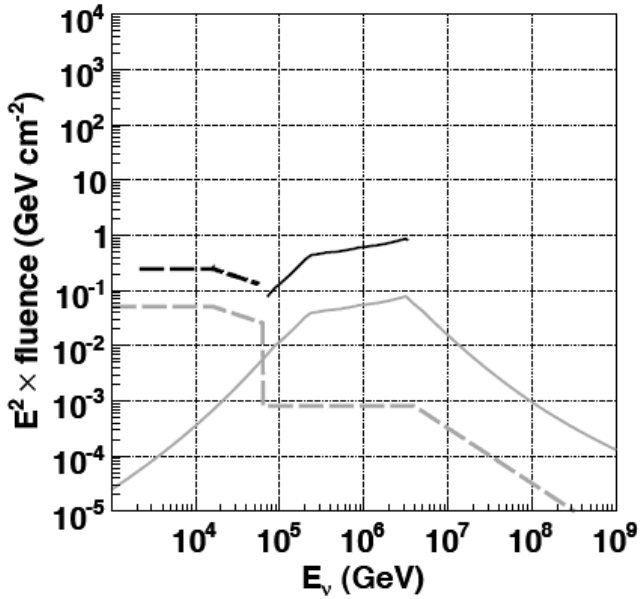
GRB analysis in 22 strings



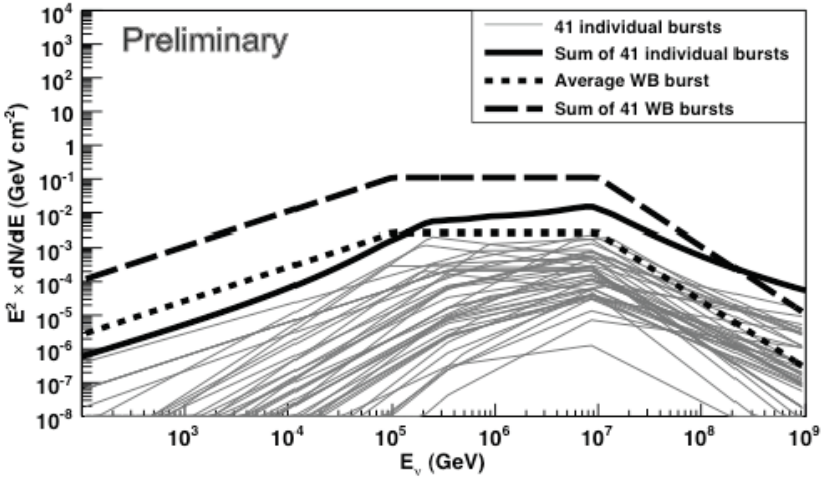


Individual and average neutrino fluxes for 4 GRBs during 22 string operation: **0.033 prompt muon events** expected (**1.5 in 40 strings** that extends FoV to Southern sky)

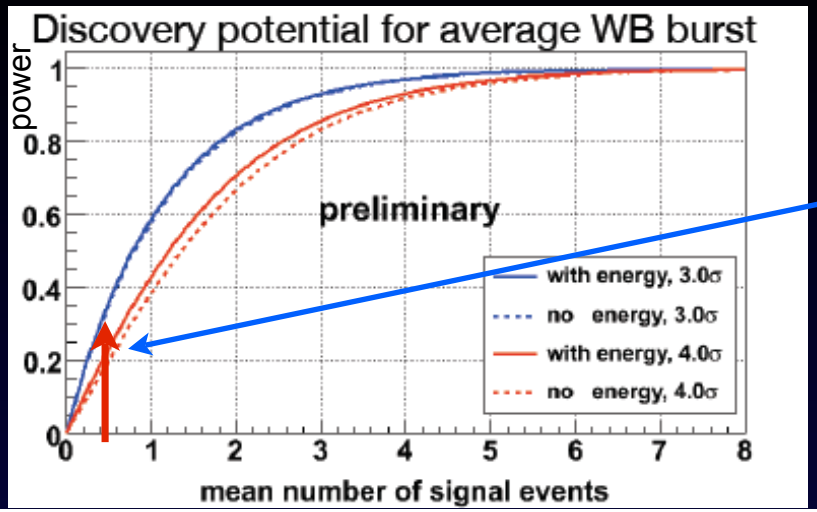
Triggered Search



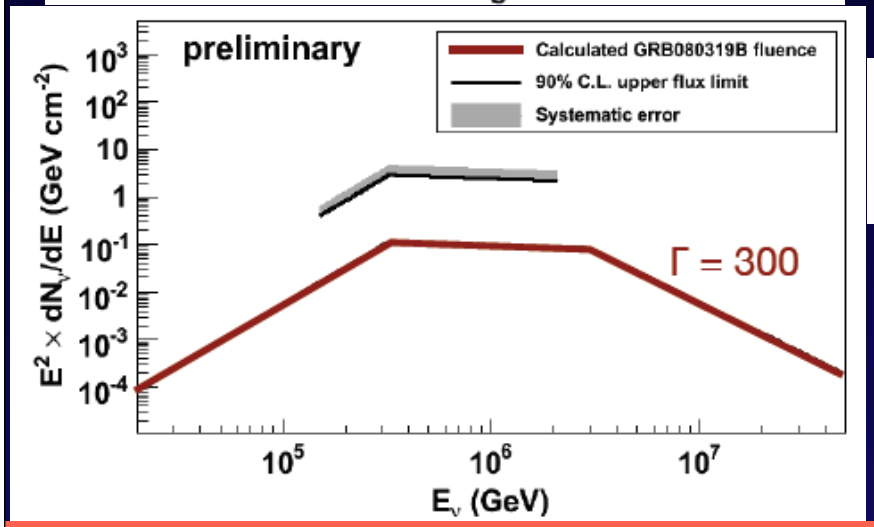
Rolling Search



Naked eye GRB



Expected events from prompt emission (Waxman & Bahcall, 1999) ≈0.5 ev in IC22 30% probability of 3 sigma discovery



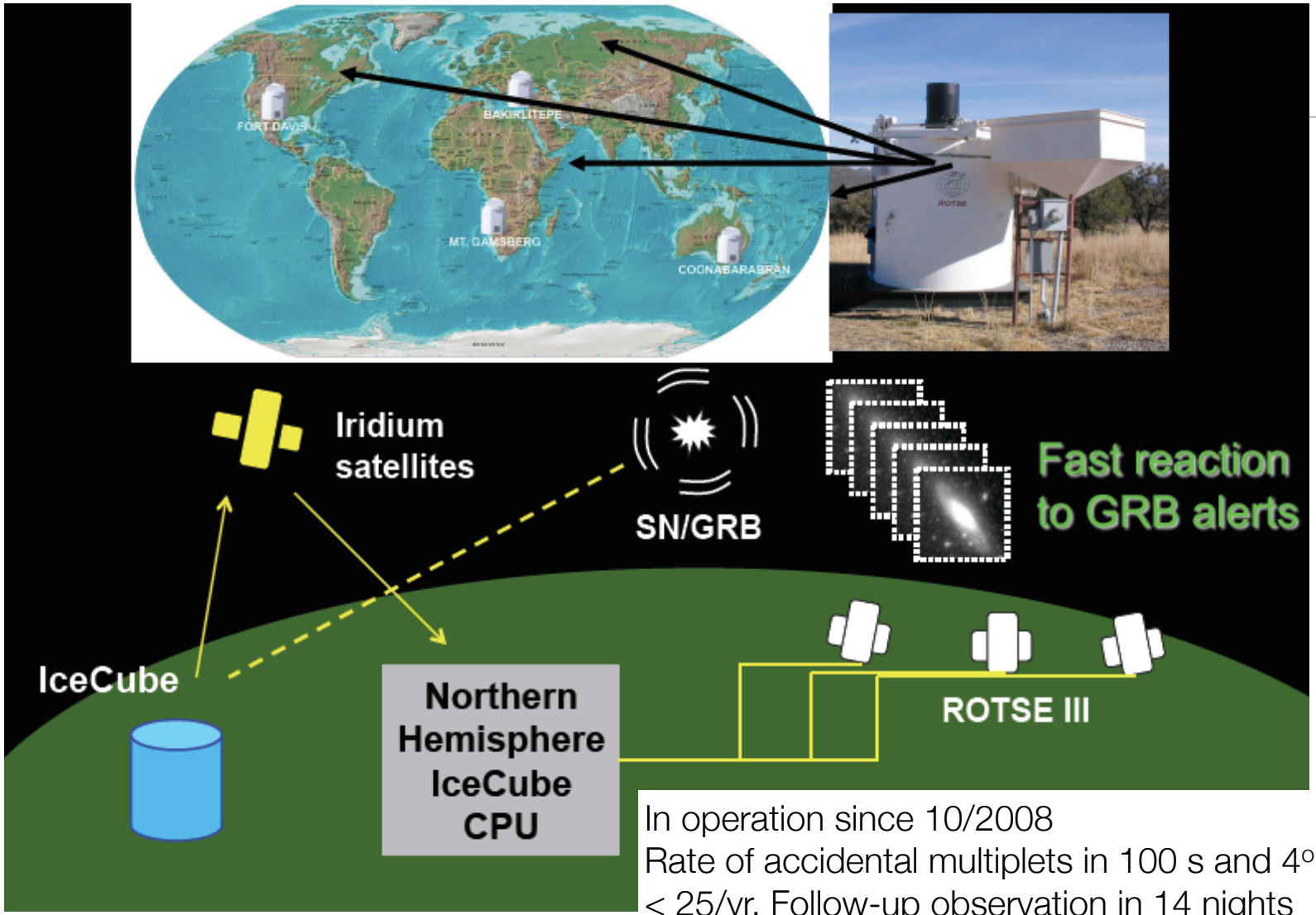
Expect 0.1 events in 9 strings (1 event in 80 strings) for the naked-eye GRB 080319B arXiv:0902.0131

IceCube HE extension may improve by 40% the sensitivity for >PeV

Scenario for 110 strings: 2 additional rings of 12 strings, 48 DOMs/string

Effective area 2.2 km^2 > PeV

Optical follow up with ROTSE-III



In operation since 10/2008
Rate of accidental multiplets in 100 s and 4º < 25/yr. Follow-up observation in 14 nights
14 alerts are being analyzed

Other ToO with MAGIC

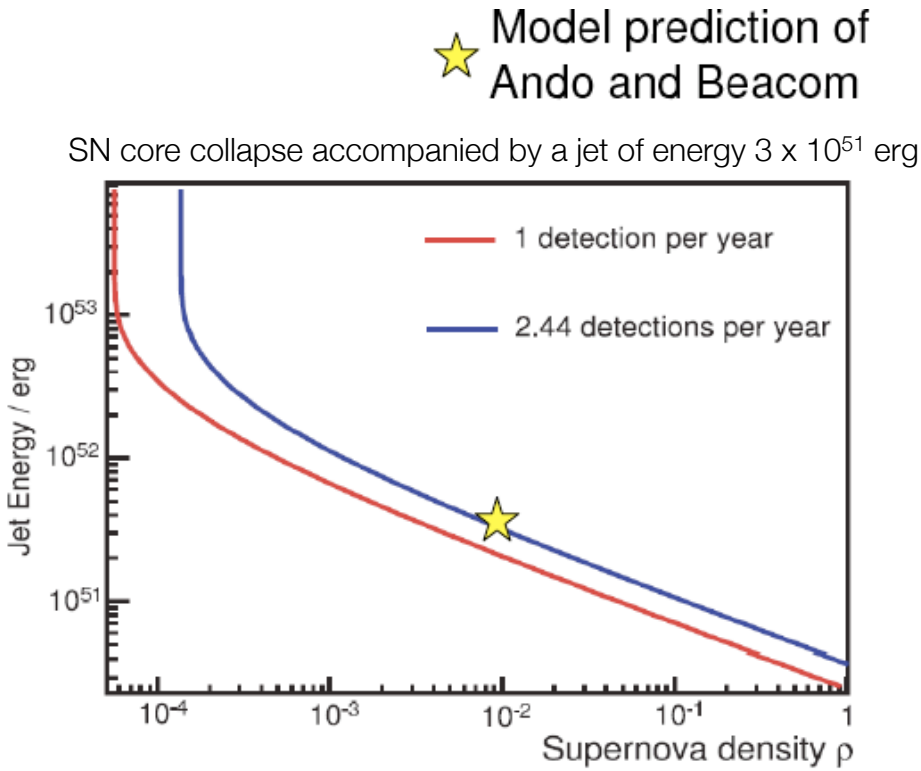
Astrophysical limits to SN models

- If no SN is detected 40 strings limit the rate of neutrino-producing SNe is smaller than $\rho = 3.\ 10^{-6}$ Mpc^{-3} yr^{-1} (90%cl)

- A neutrino doublet in coincidence with a SN @ 20 Mpc in 10 s corresponds to 3.5σ

- A coincidence in 300 s with a GRB corresponds to 4.4σ

Kowalski & Mohr, Astrop Phys 27 (2007)



Summary

Main pointing capability verification: we see the Moon shadow with 5σ

22 strings point-source analysis shows a hot spot at the level of 1%. 40 string analysis ready

Astrophysics neutrino discovery at 5σ could require 5yrs of IceCube if predictions are based on gamma observations, but already now exclusion limits severely constrain CR acceleration models from SNRs and extragalactic sources

GRBs: 1 yr of full IceCube in coincidence with Fermi (2πsr) leads to observation of WB flux at 5σ

some of the hot spot events