

Point source/GRB report

Teresa Montaruli

UW - Madison

tmontaruli@icecube.wisc.edu



★ Point Sources

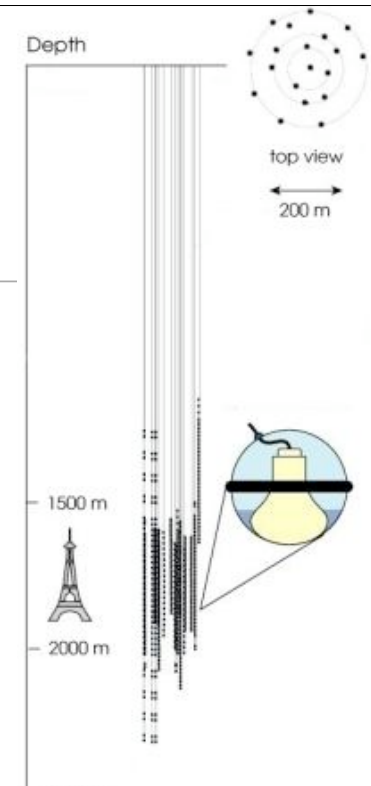
- Positive signal: the Moon
- 22 strings results
- 40 strings readiness for unblinding and reach

★ GRBs

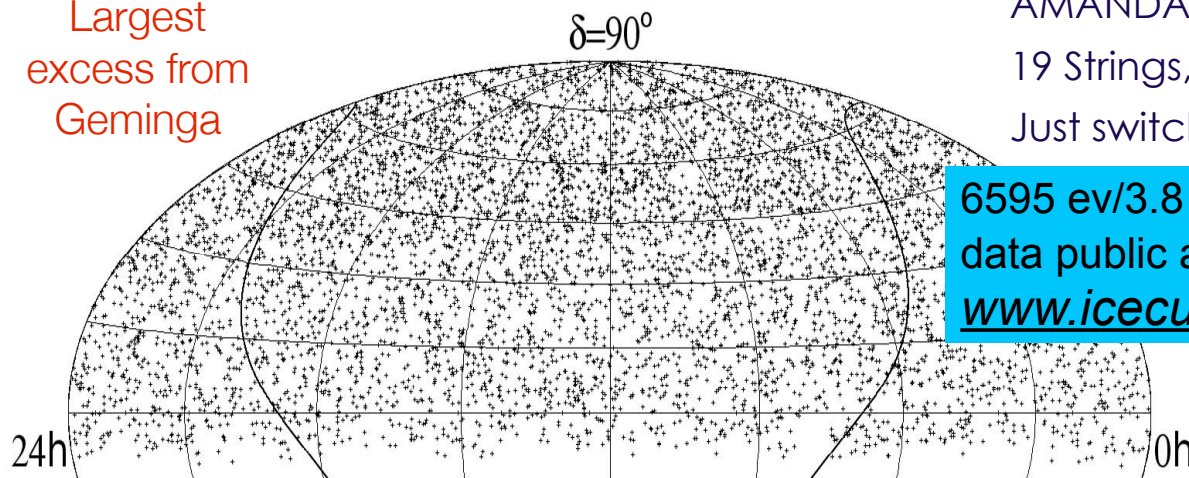
★ Status of ToO programs

Scientific Advisory Committee
Madison, May 20, 2009

Goodbye AMANDA



Largest
excess from
Geminga

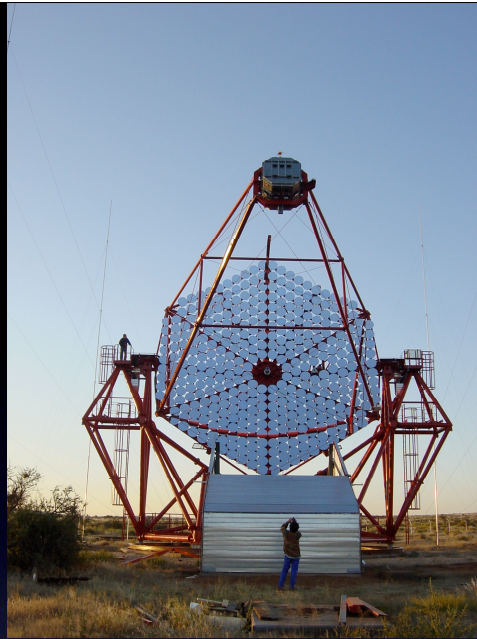


AMANDA (1996-2009), completed in 2000
19 Strings, 677 Modules, 8 inch PMTs
Just switched off

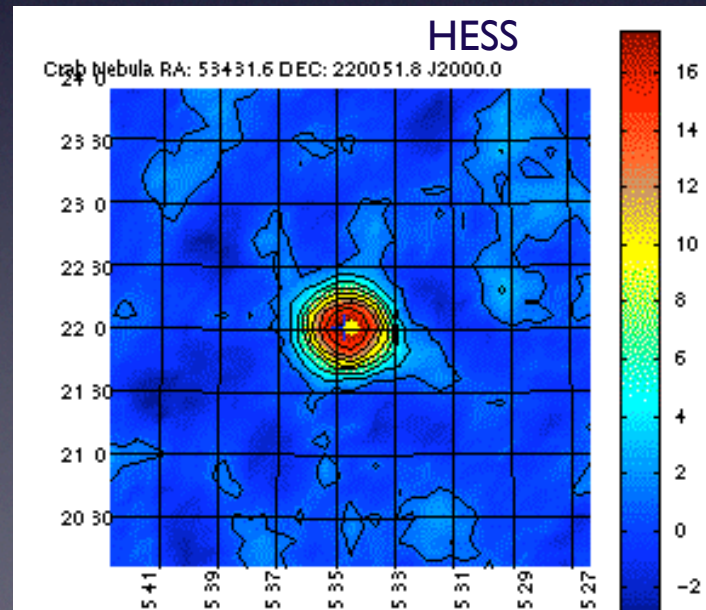
6595 ev/3.8 yr
data public at [http://
www.icecube.wisc.edu/science/data](http://www.icecube.wisc.edu/science/data)

AMANDA-II 7 yr
arXiv:0809.1646

Looking
for point-
sources

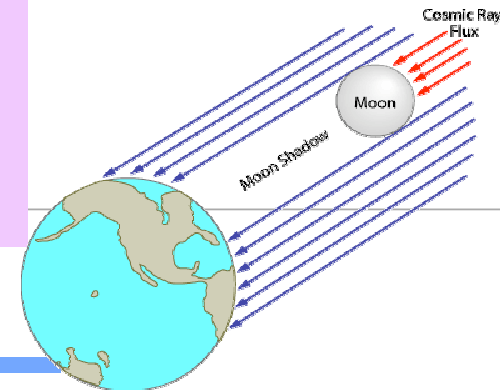


Checking the PSF with a Standard candle



First Moon shadow in a neutrino telescope

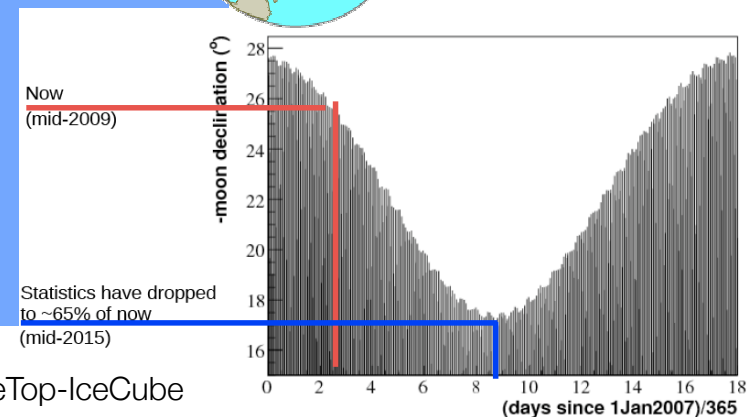
Preliminary



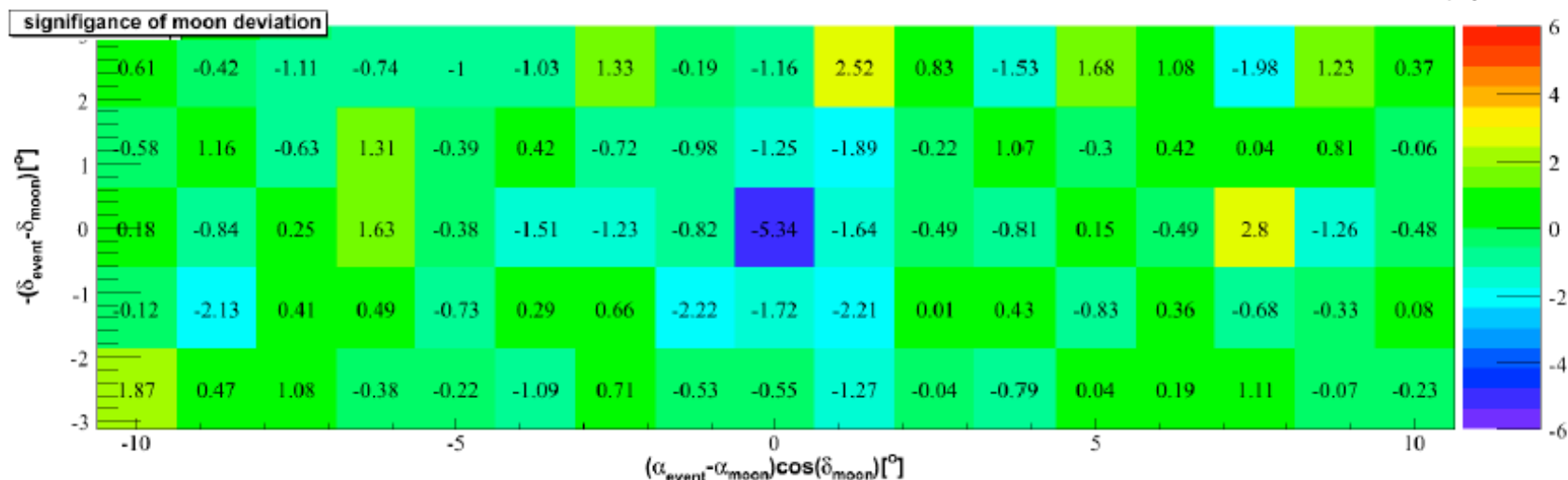
8 months of IC40 data, 9M muons,
13 cycles

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

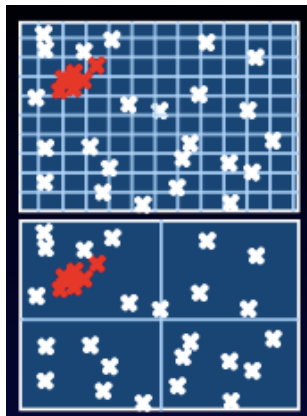


Test of hypothesis and relevant discriminating variables

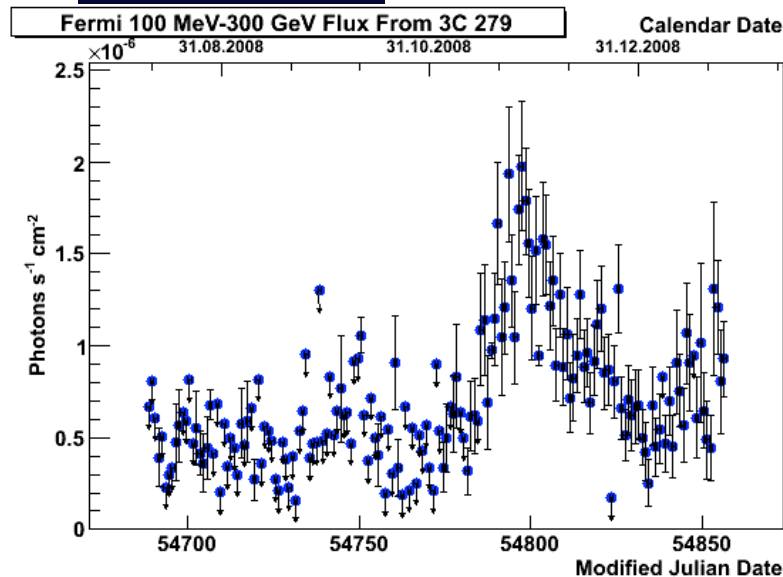
binned methods not optimal



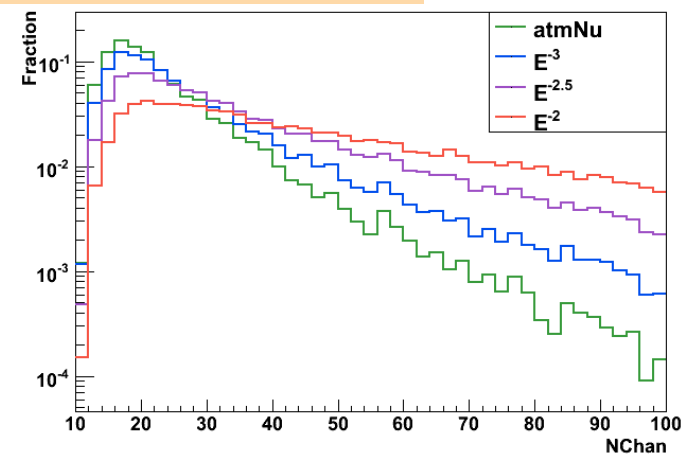
LH ratio methods exploit the power of all variables characterizing signal against background



False Discovery Risk minimized by usage of scrambled data samples



Energy related variable



Time dependence

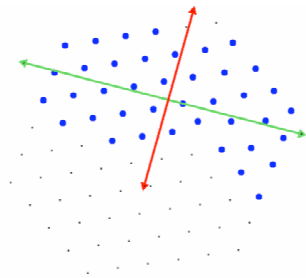
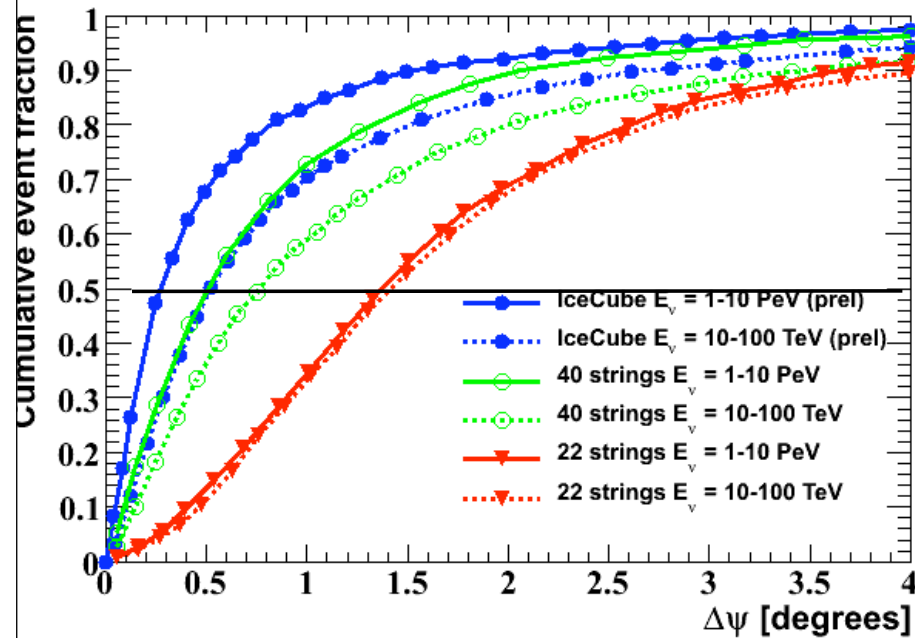
$$\mathcal{S}_i = \frac{1}{2\pi\sigma^2} e^{-\frac{|\vec{x}_i - \vec{x}_s|^2}{2\sigma^2}} \cdot P(Nch|\gamma) \cdot \frac{1}{\sqrt{2\pi}\sigma_w} e^{-\frac{(\phi_i - \phi_o)^2}{2\sigma_w^2}}$$

space

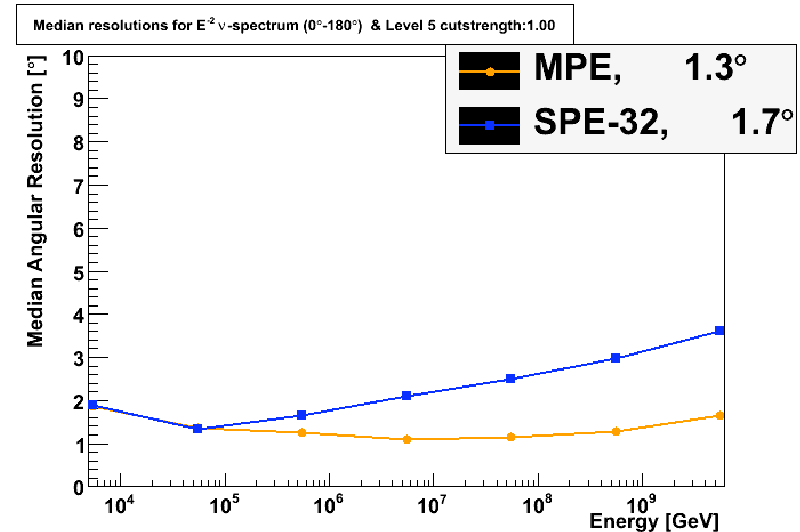
energy

time

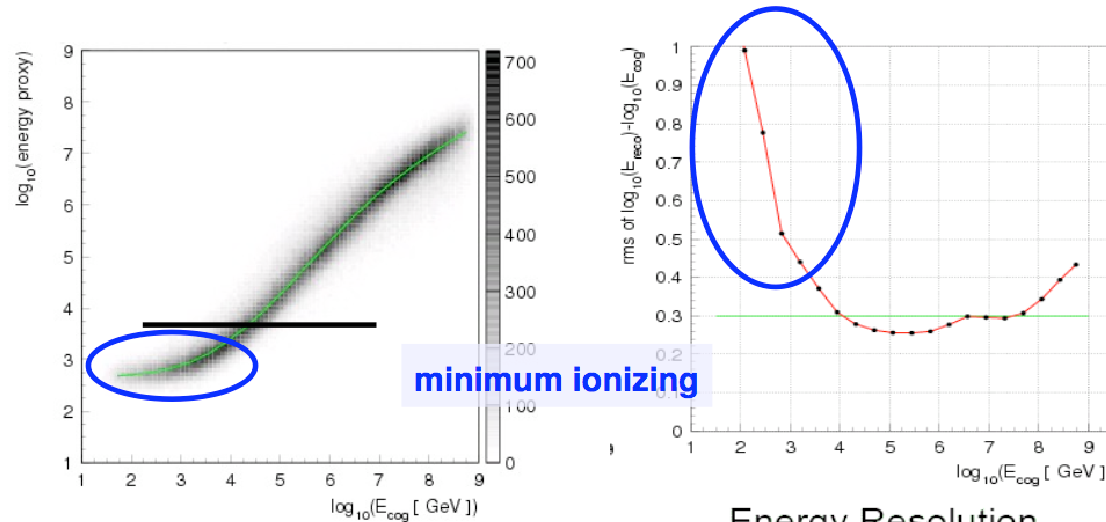
The PSF of the growing detector



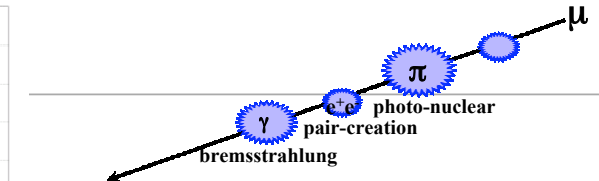
Improved track reconstruction respect to IC22 using multiple pulse times.



Getting to know charge and energy variables better

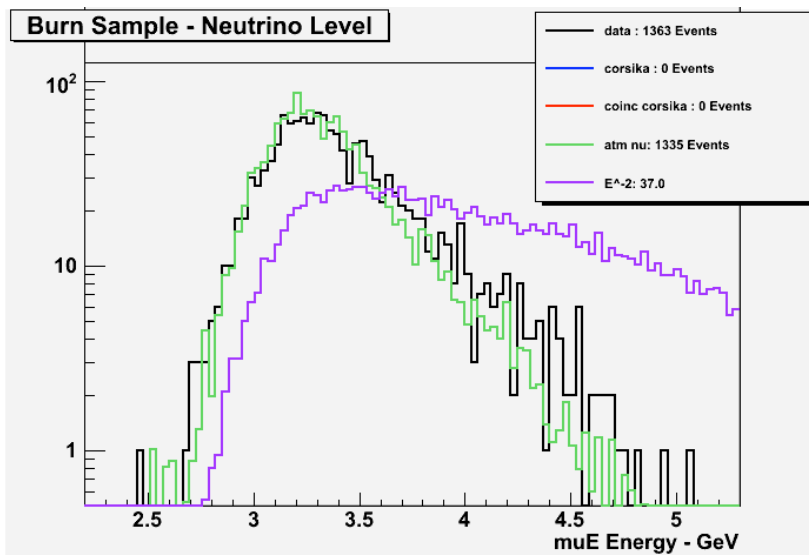


Source: D. Chirkin, UW

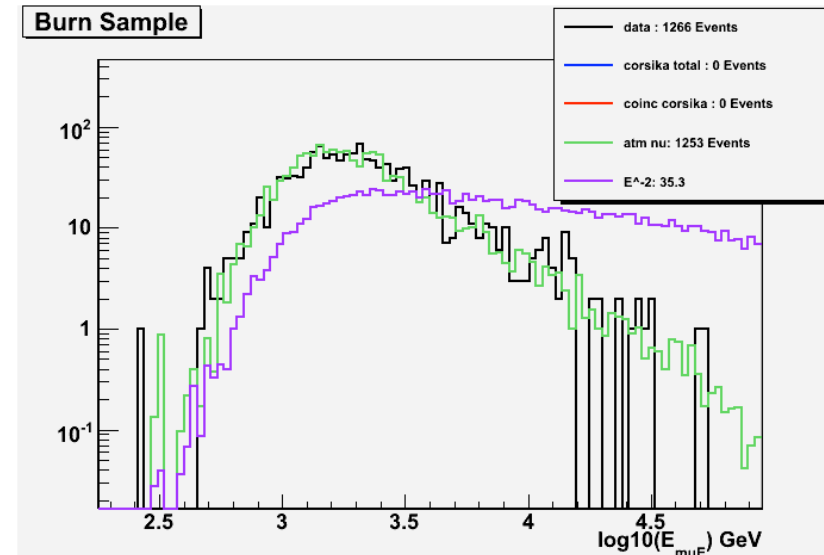


Found a problem in pulse first level reconstruction of FADC charge => solution use only ATWD. It works!
 Now testing a the new project extracting pulses

before correction

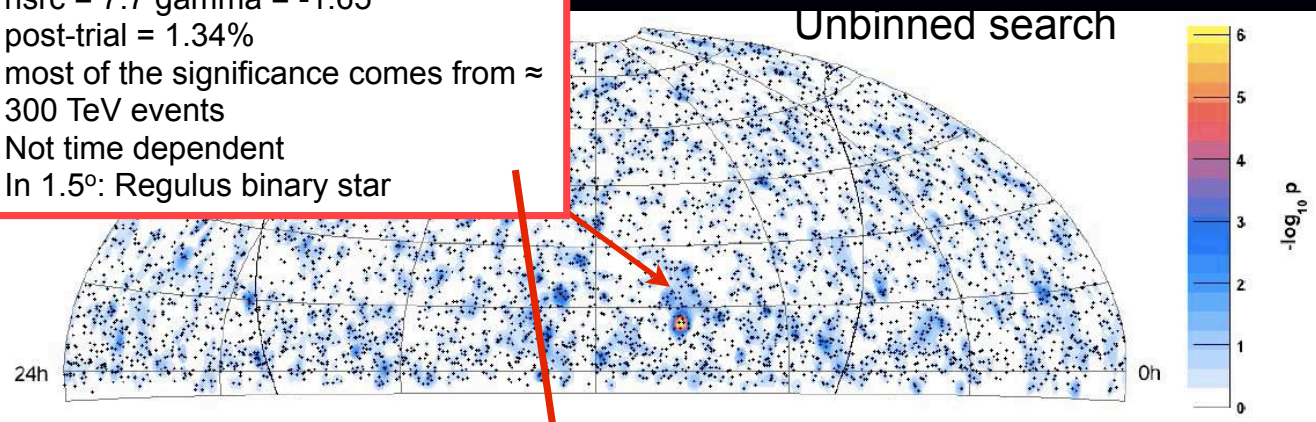


after correction



Unblinded IceCube Sky Maps (22 strings)

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



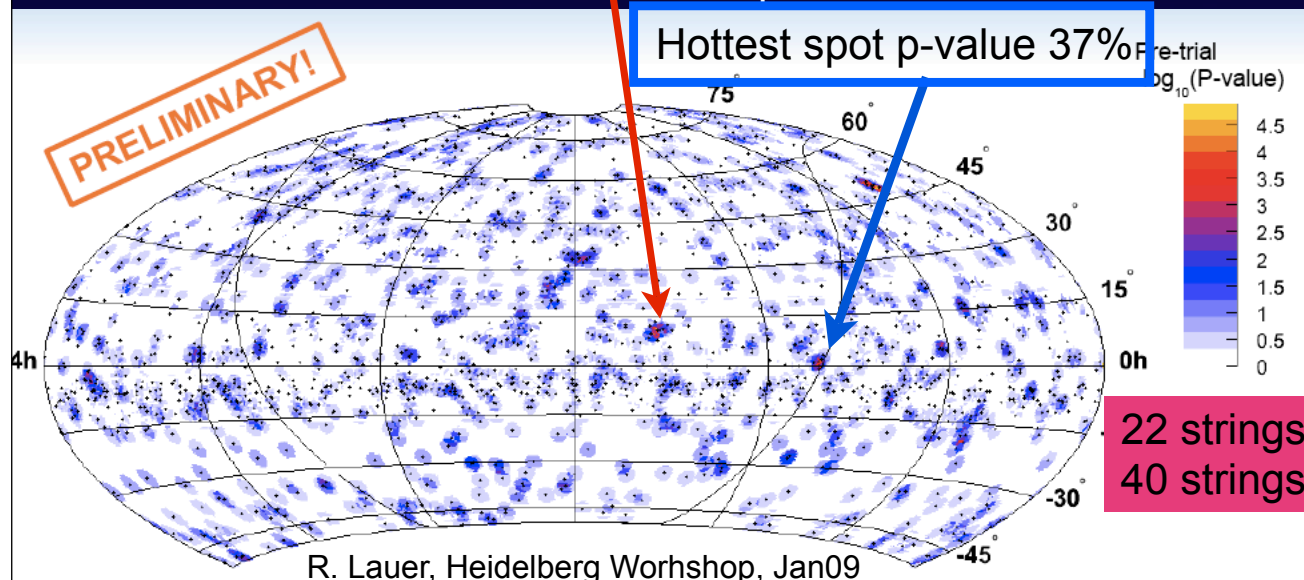
Neutrino Flux needed
 for this significance
 ($\text{TeV}^{-1} \text{ cm}^{-2} \text{ s}^{-1}$)

$$E^{-2} \quad 2.2 \times 10^{-11}$$

$$E^{-1.65} \quad 3.6 \times 10^{-12}$$

5114 events/276 days

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

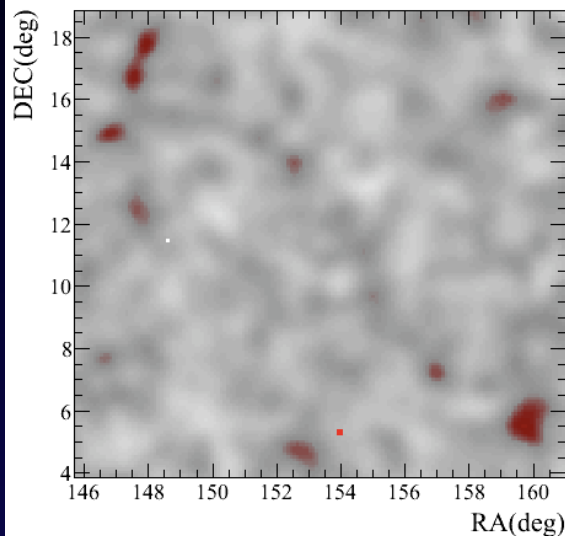


22 strings: paper ready for submission
 40 strings at ICRC2009

Hot spot in other experiments

Spectral Fitting (Not working yet):

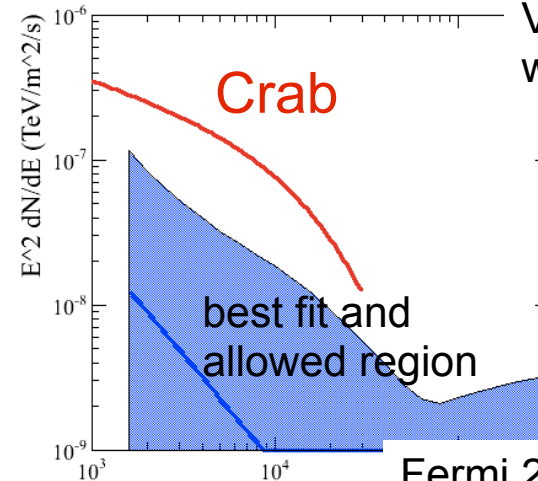
RA:153.35 DEC:11.35



Black Markers are locataions of Fermi/GLAST BSL Sources

Source	RA	Dec	Significance	Excess	Error
Selected Point	153.35	11.35	-0.217791	-96.8125	444.52
Local Maximum	153.85	11.75	1.01911	455.344	446.803

Fit Spectrum: $(0.26 \times 10^{-7}) (E/1\text{TeV})^{-3.50} \exp(-E/891.3)$



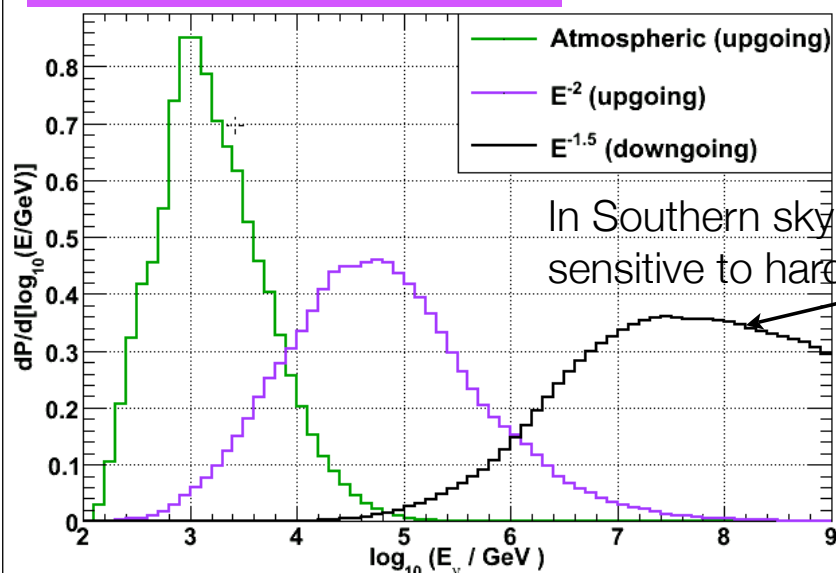
Hot Spot triggered observations with VERITAS and future with H.E.S.S.

Fermi 2 AGNs but
153.2 24.6 deg
154 5.25
Inside 2.5 deg > 50 QSO!!!

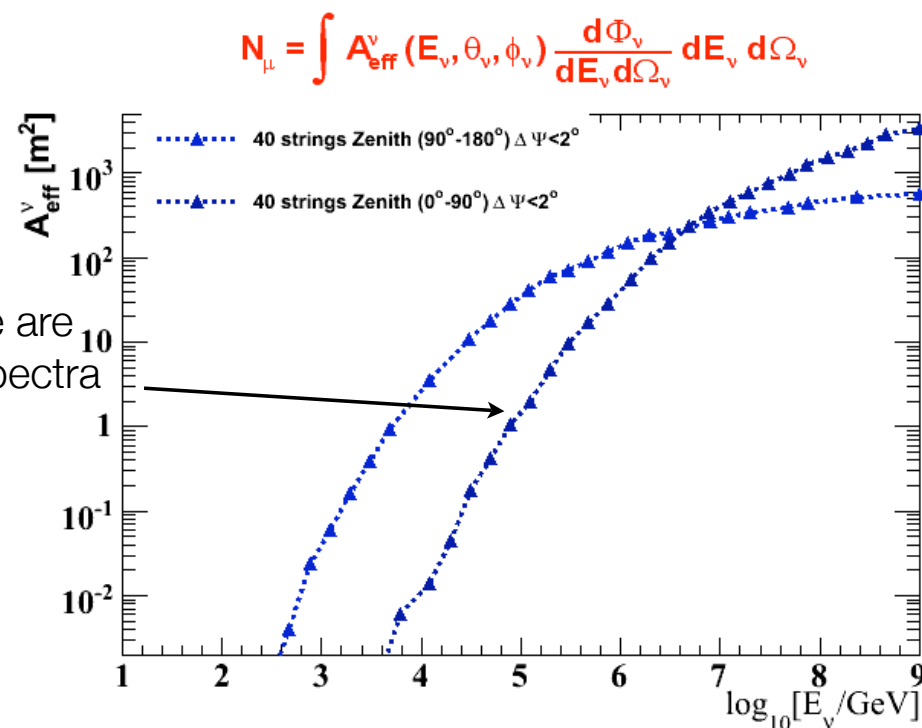
Closest object: Regulus binary with white dwarf and B7 star that could eject matter (ejection disk rather than accretion) and B fields of about 10 kG (Bierman has a model already!)

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



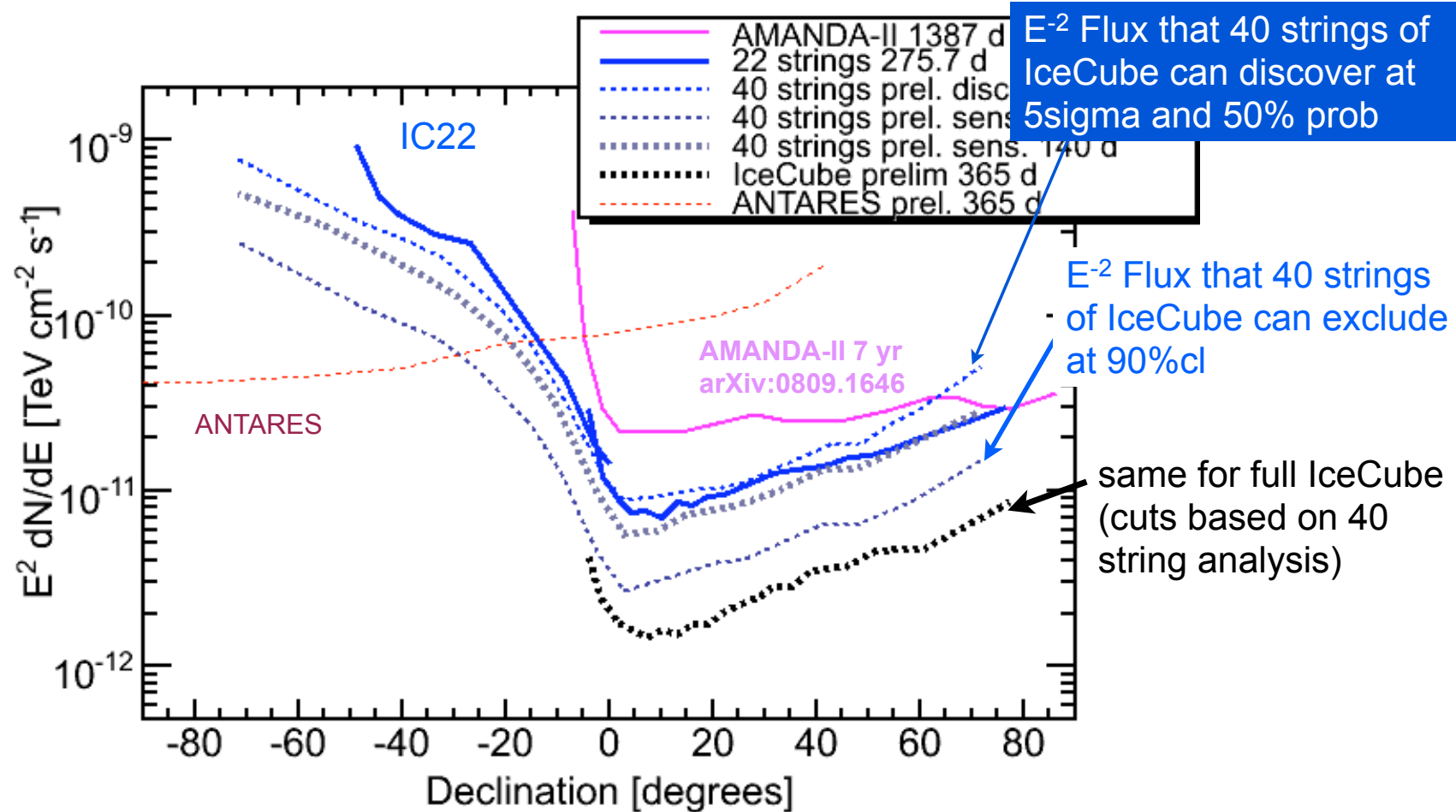
Filter level: 23Hz, 35% reconstructed as upgoing still dominated by misreconstructed atmospheric muon background

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?



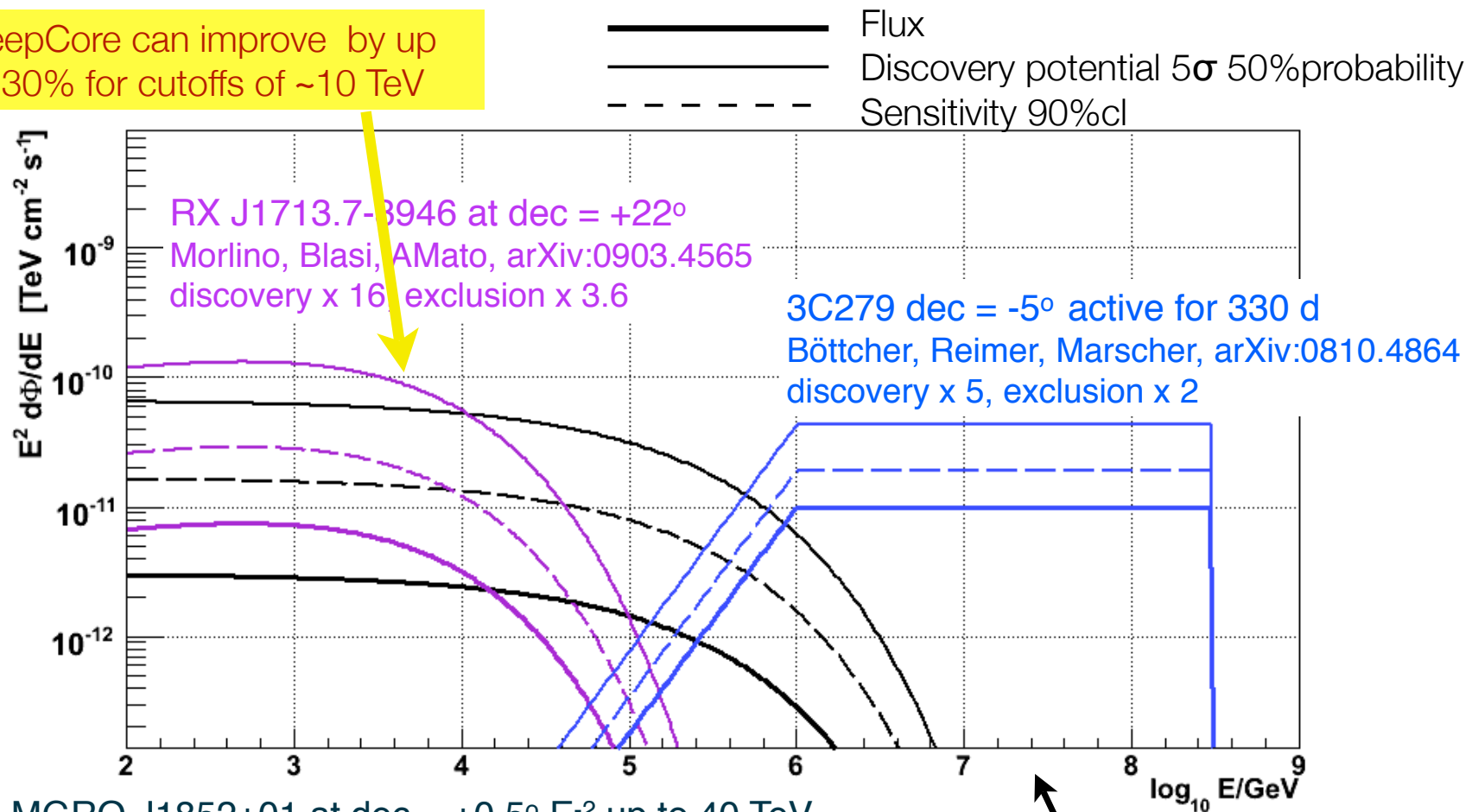
In IC22 about a factor of 2 better than AMANDA 7 yrs

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



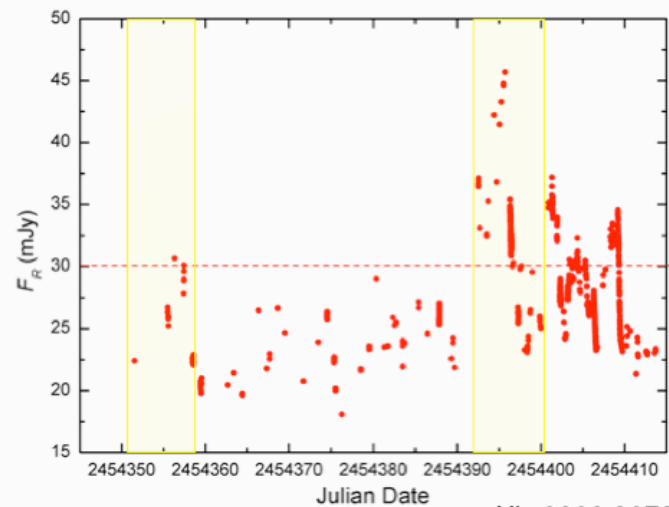
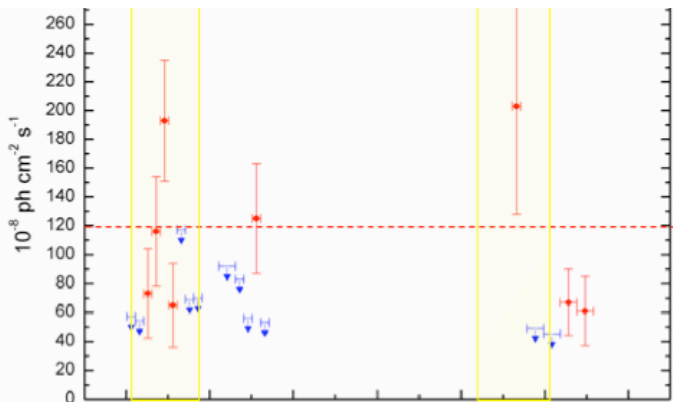
MGRO J1852+01 at dec = $+0.5^\circ$ E^{-2} up to 40 TeV
 Gonzalez-Garcia, Halzen, Mohapatra, arXiv:0902.1176
 discovery x 21, exclusion x 6
 3 Pevatrons can be stacked: full IceCube can discover them in about 5 yrs

HE extension can help by > 30%

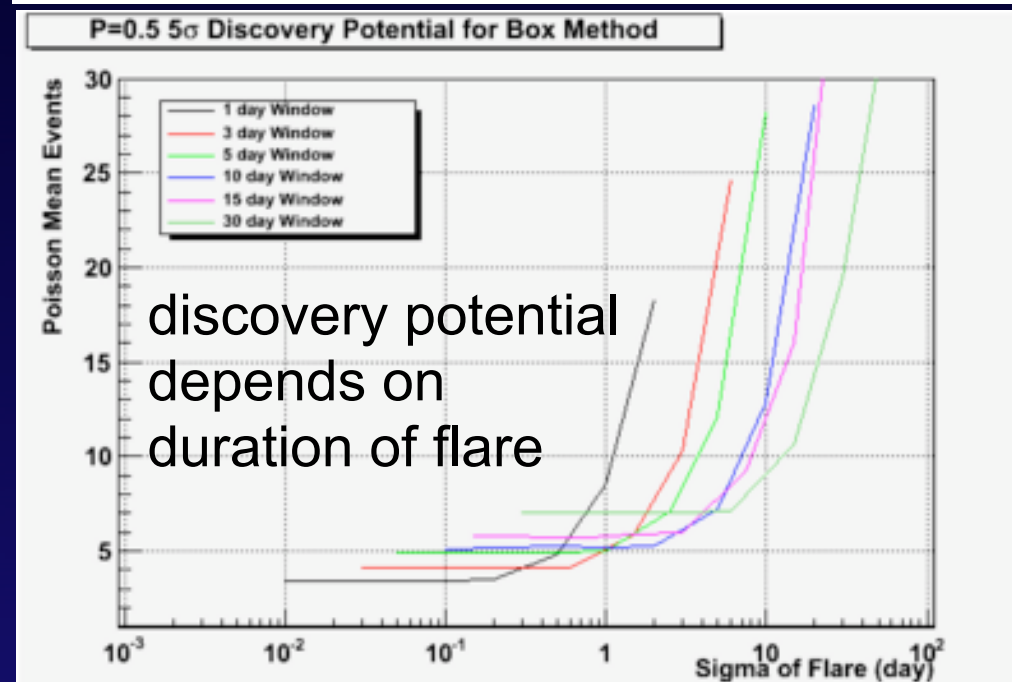
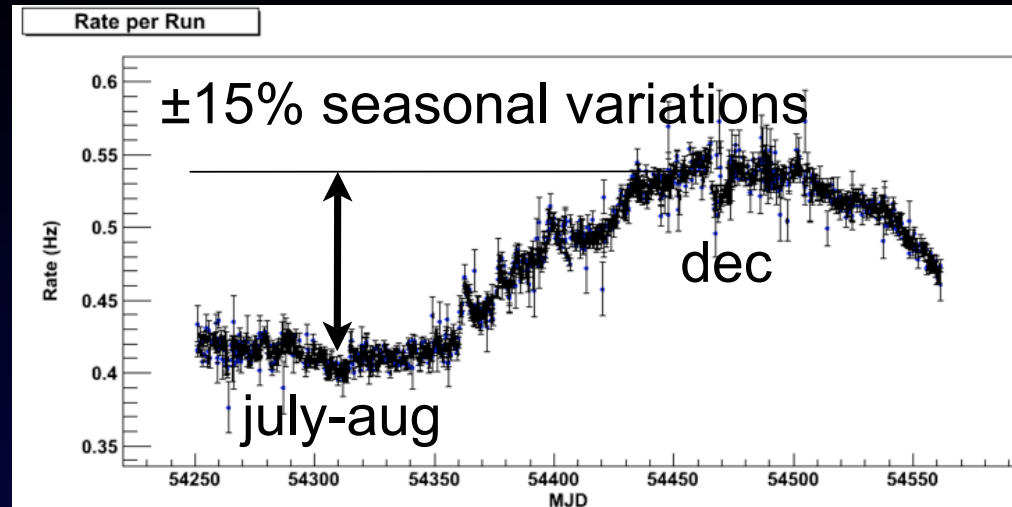
Search for flares in Jun 2007-Apr 2008

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

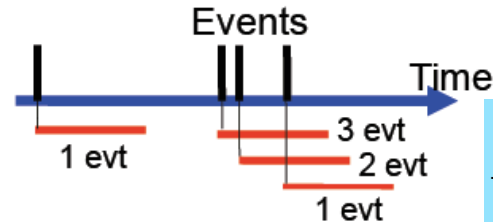
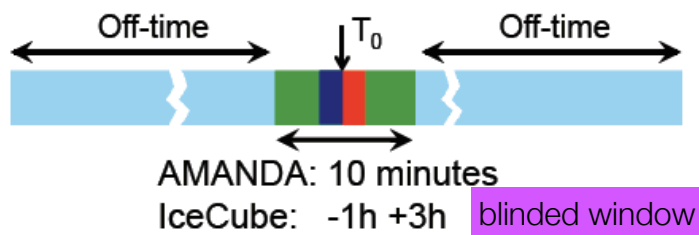


arXiv:0808.3673v1



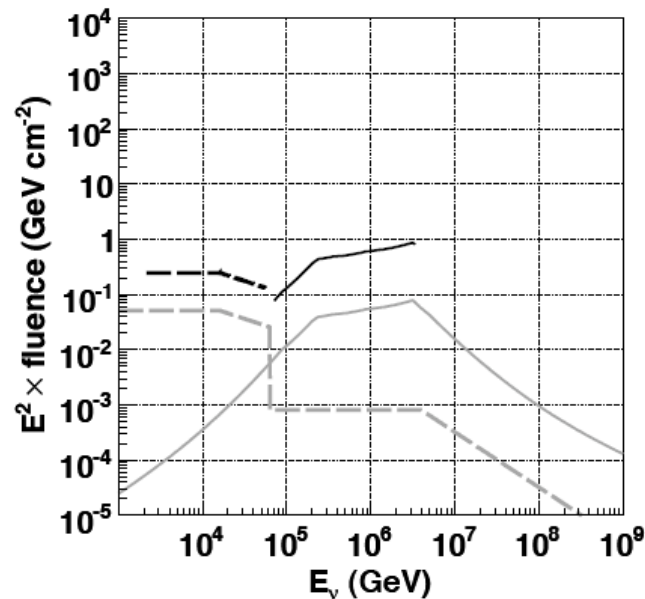
GRB analysis in 22 strings

■ On Time ■ Extended Window
■ Precursor ■ Off-time

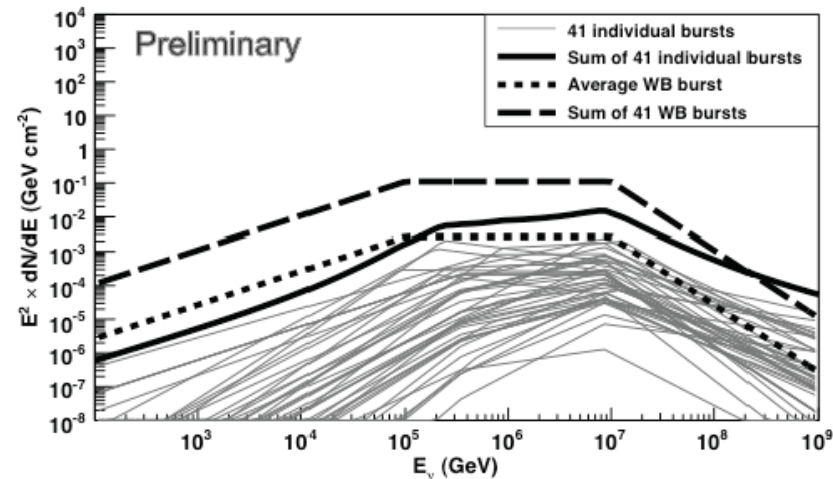


Individual and average neutrino fluxes for 4 GRBs during 22 string operation (05/31/2007-04/05/2008)
 0.033 prompt muon events expected (1.5 from 86 GRBs in 40 strings that will also extend FoV to Southern sky)

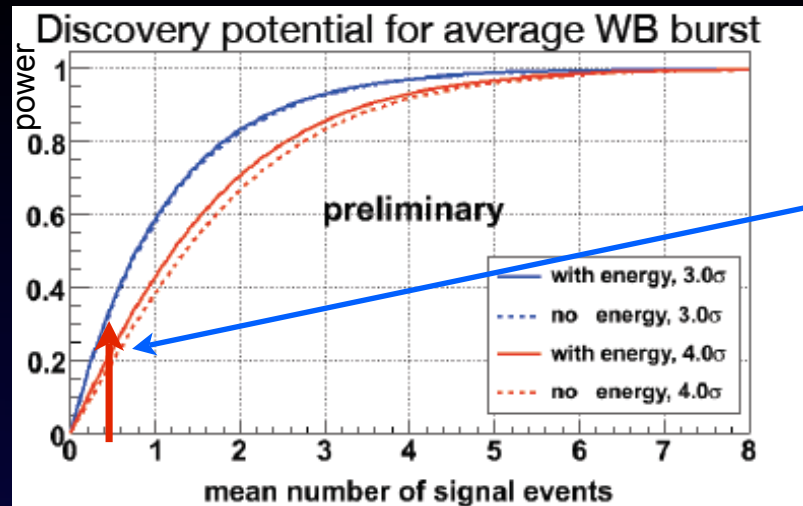
Triggered Search



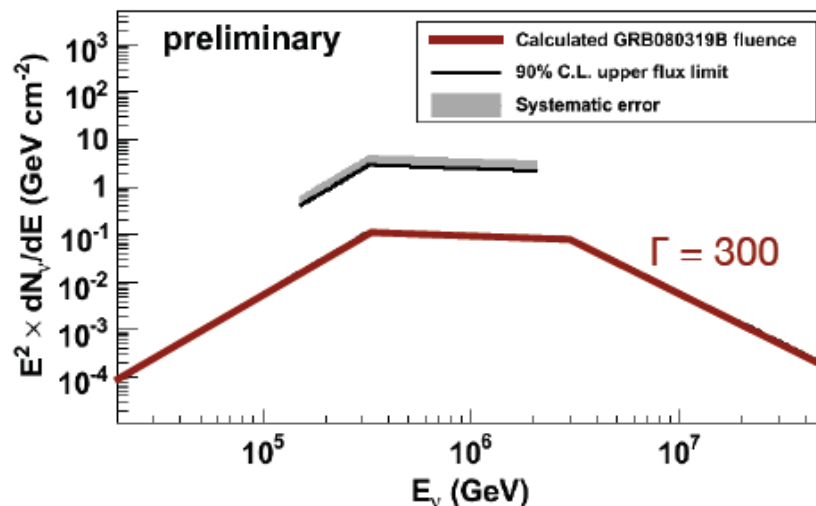
Rolling Search



Naked eye GRB



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



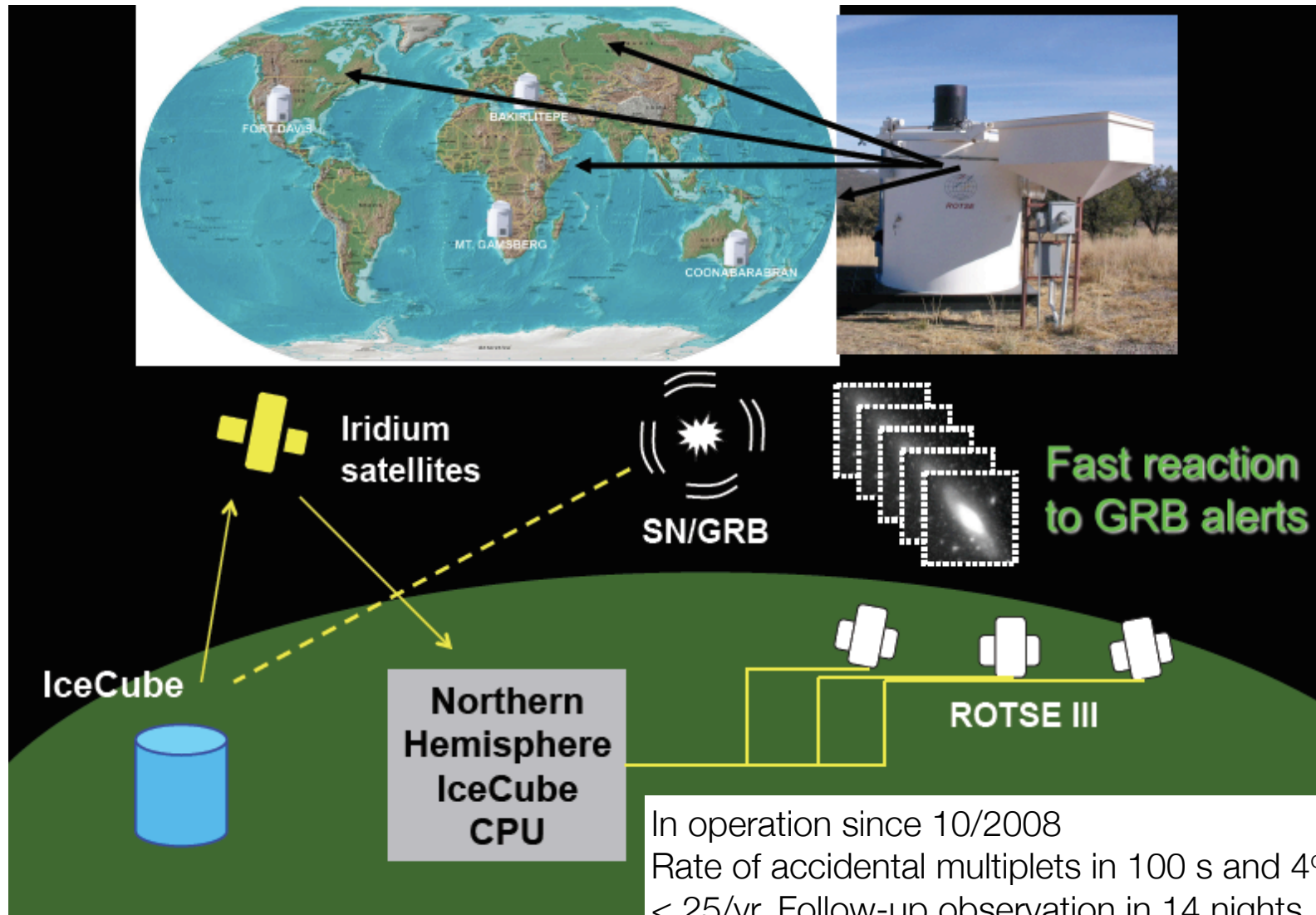
Expect 0.1 events in 9 strings (0.27 (1) event in 40 (80) strings) for the naked-eye GRB 080319B
arXiv:0902.0131

IceCube HE extension may improve by 40% the sensitivity for $> \text{PeV}$

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

Effective area $2.2 \text{ km}^2 > \text{PeV}$

Optical follow up with ROTSE-III



Other ToO with MAGIC

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

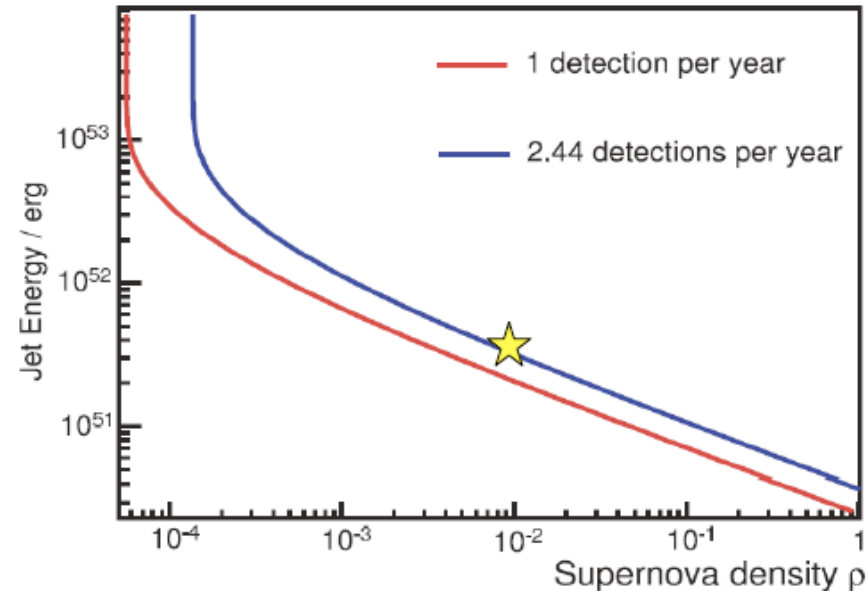
Astrophysical limits to SN models

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

★ Model prediction of Ando and Beacom

SN core collapse accompanied by a jet of energy $3 \times 10^{51} \text{ erg}$



Summary

some of the hot spot events

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 exclusion takes less time

GRBs: 1 yr of full IceCube in coincidence with Fermi ($2\pi\text{sr}$) leads to observation of WB flux at 5σ

Systematic errors improve doing a lot of analysis!

