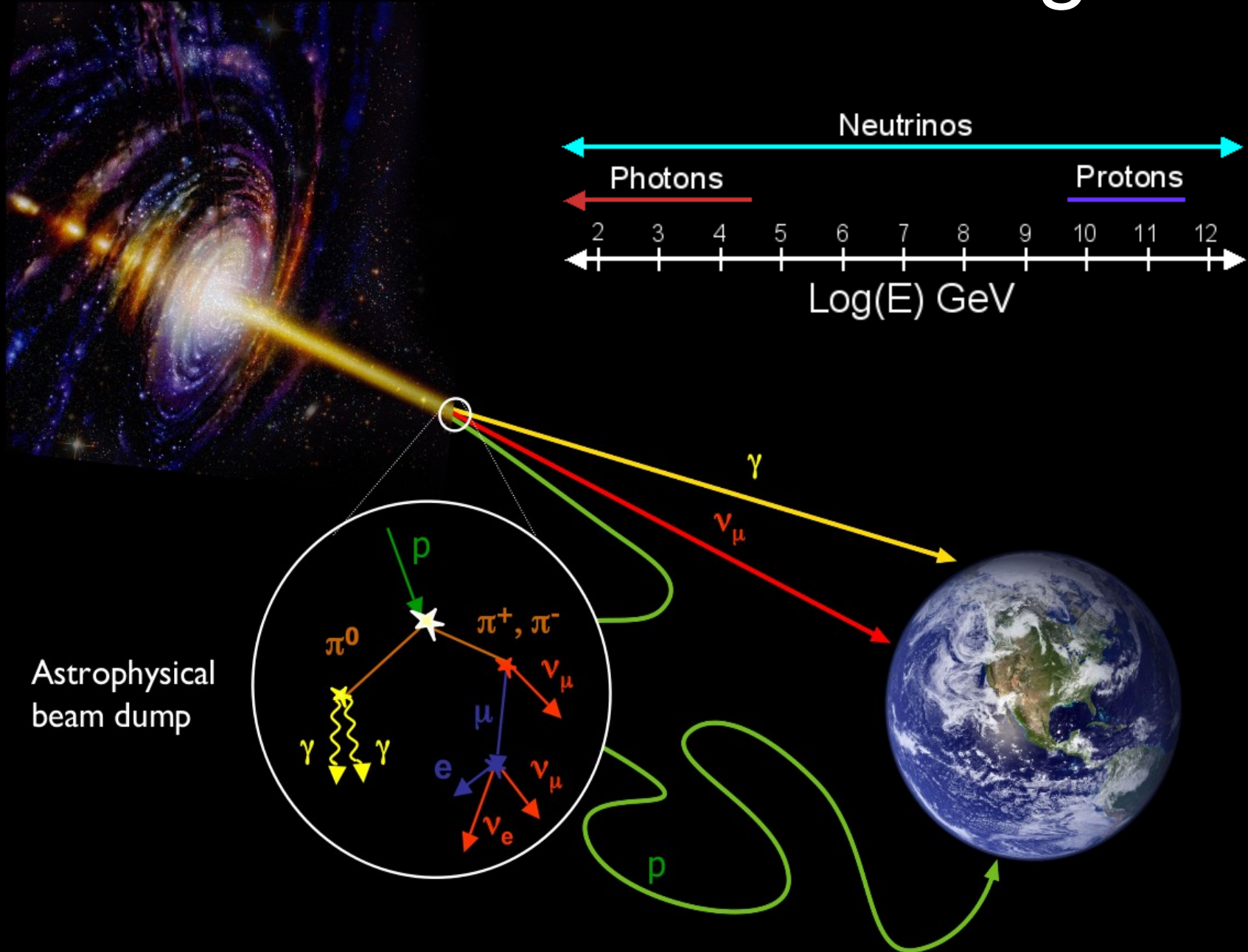


Searches for Neutrino Point Sources with AMANDA-II and IceCube

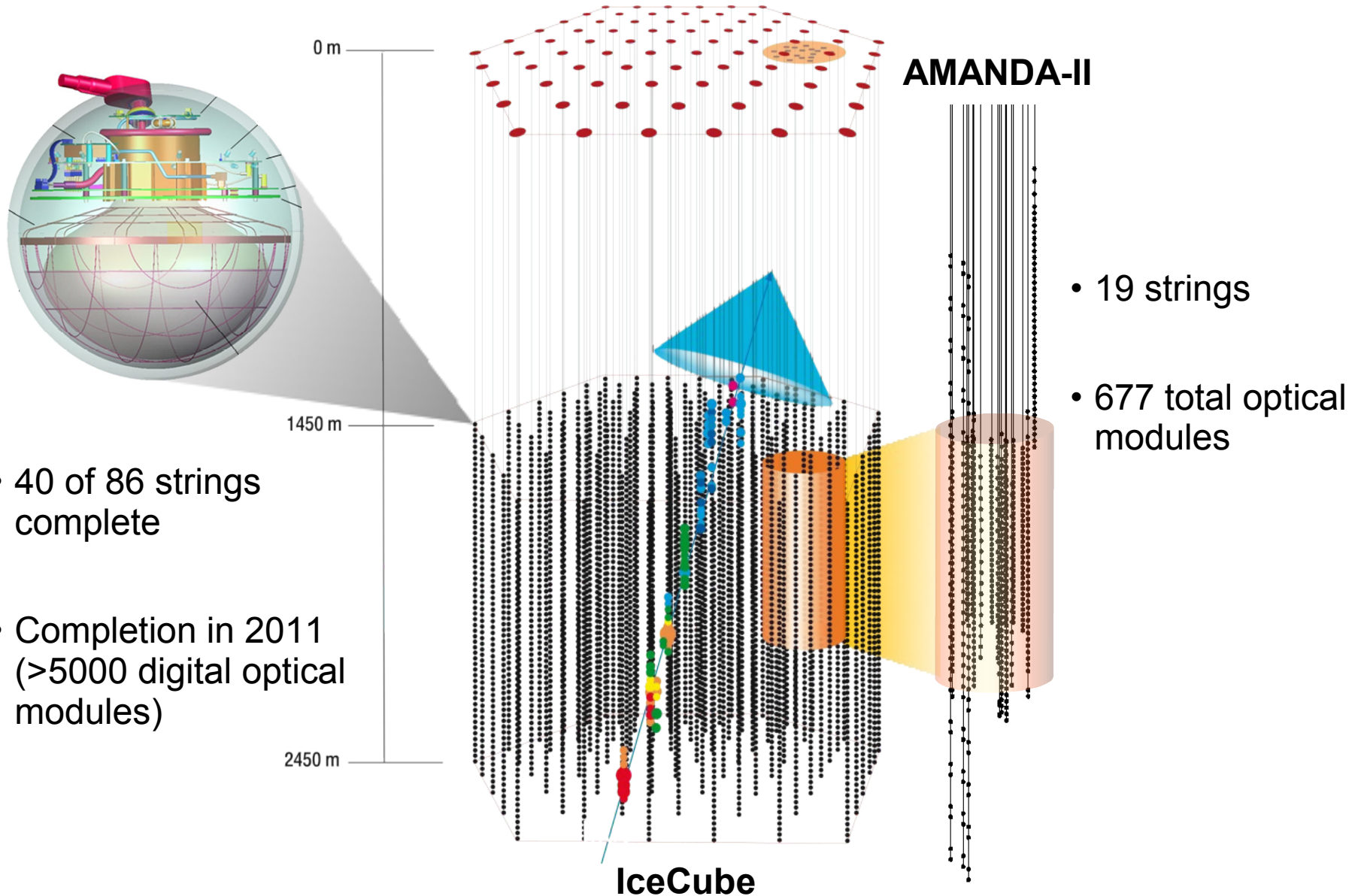
Jim Braun for the IceCube Collaboration

Cosmo 2008

Astronomical Messengers



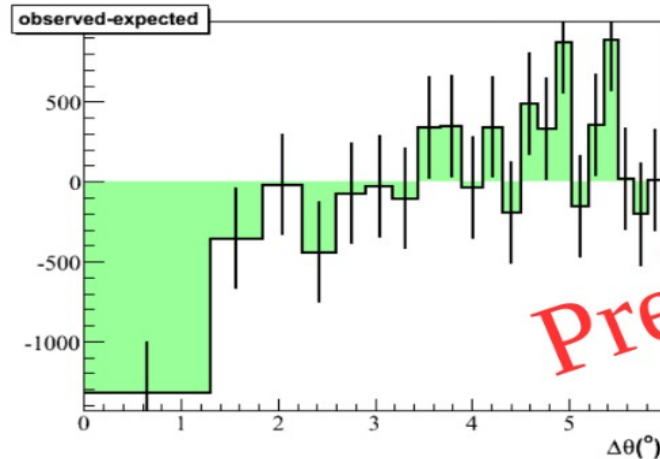
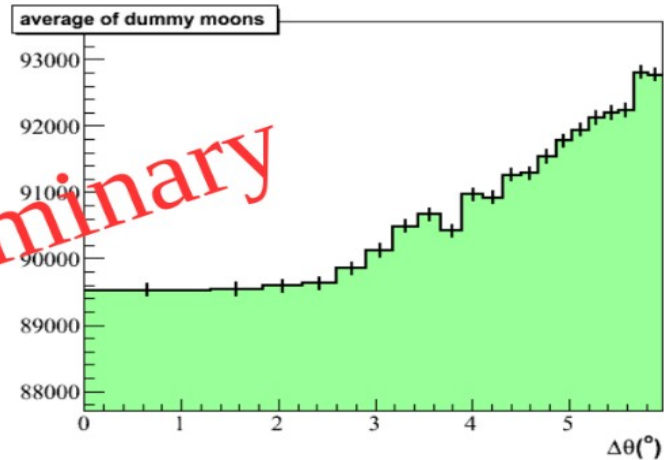
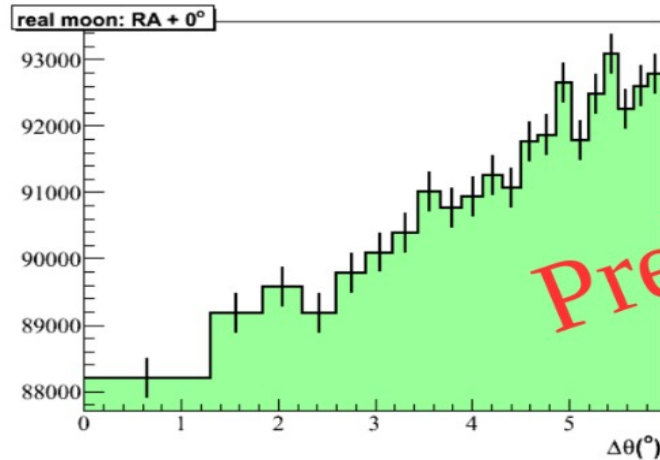
IceCube





Run 110261 Event 32883
Tue Jan 29 09:39:35 2008

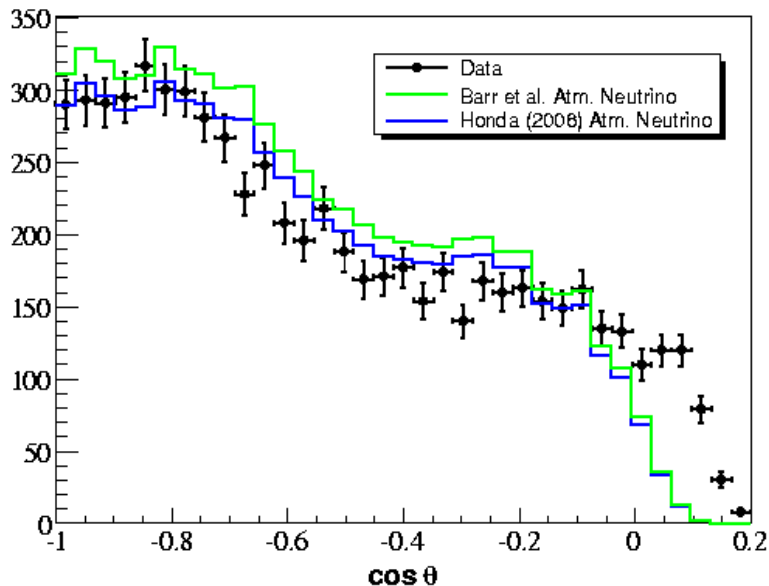
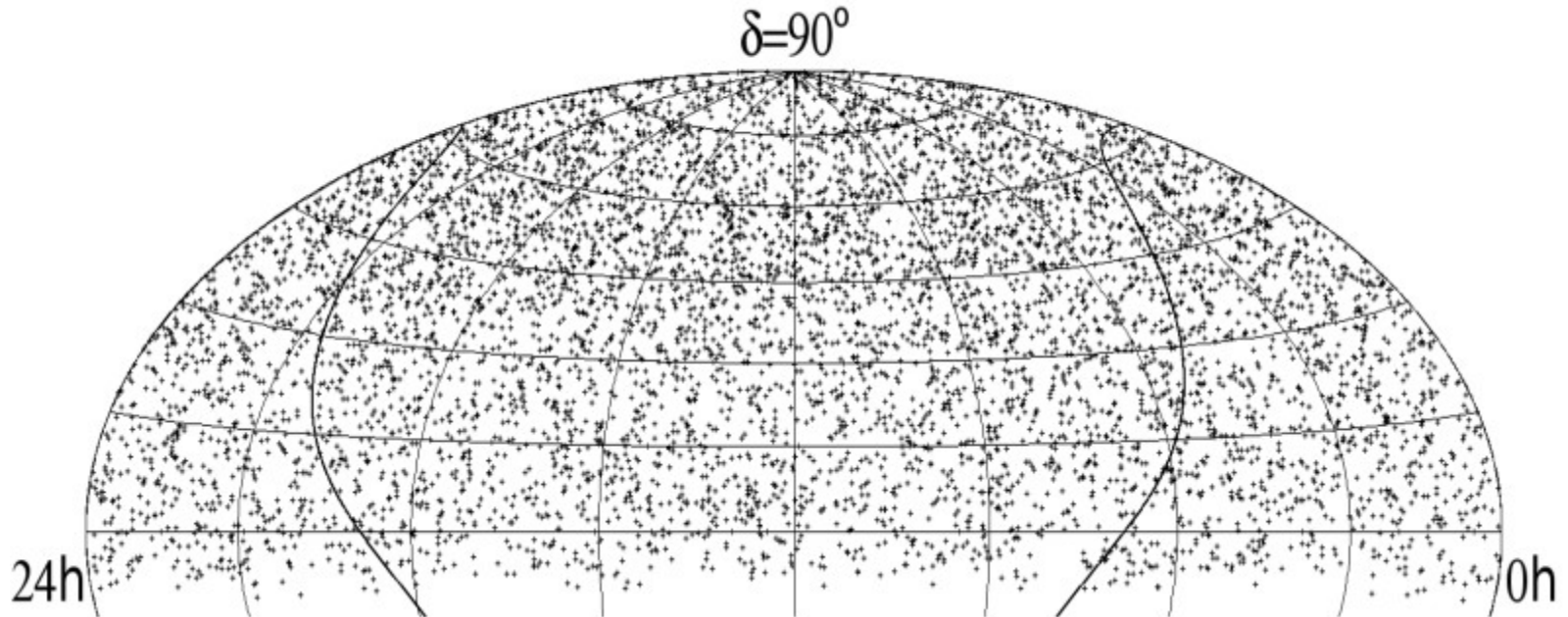
Moon Shadow



observed: 88202 events
expected: 89522 events
deficit: -1320 events
error: 315 events
significance: -4.2σ

- IceCube observes the cosmic ray shadow of the moon at 4.2σ
 - Poster by Laura Gladstone

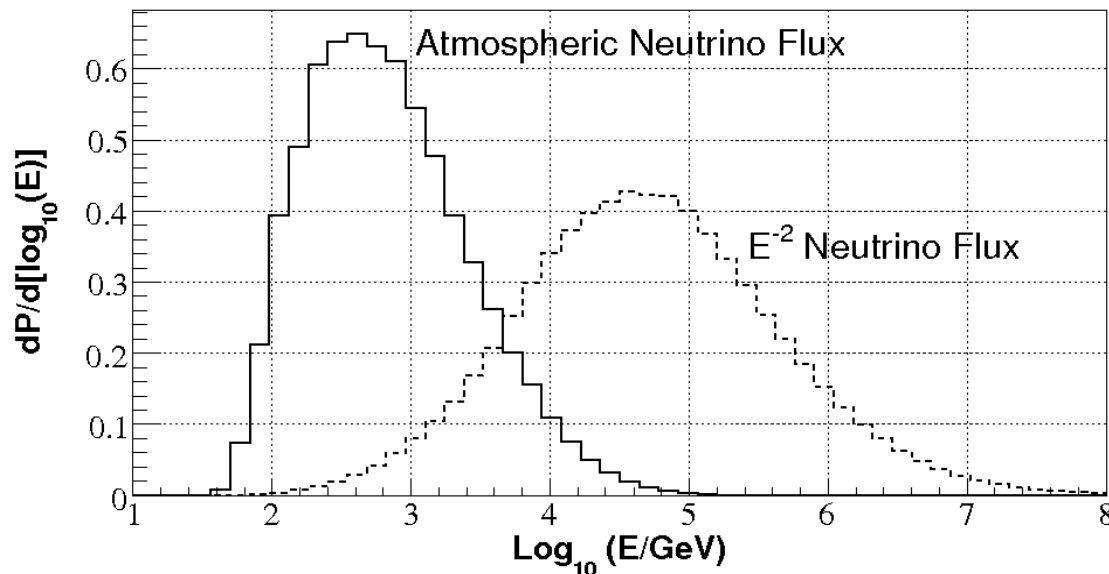
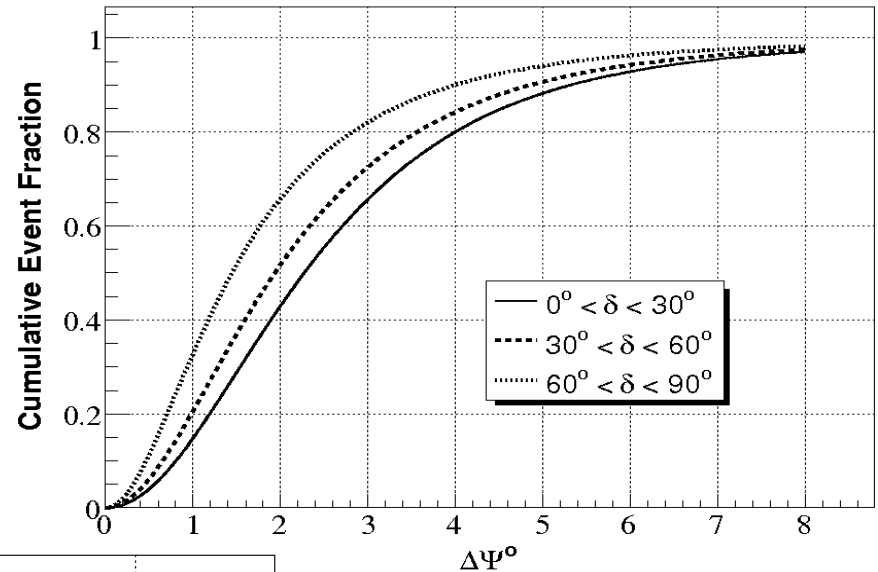
AMANDA-II Sky Map



- 6595 neutrino candidates selected from $O(10^{10})$ events obtained during 2000-2006 (3.8 years livetime)
- Mostly atmospheric neutrinos

Search for Extraterrestrial Neutrinos

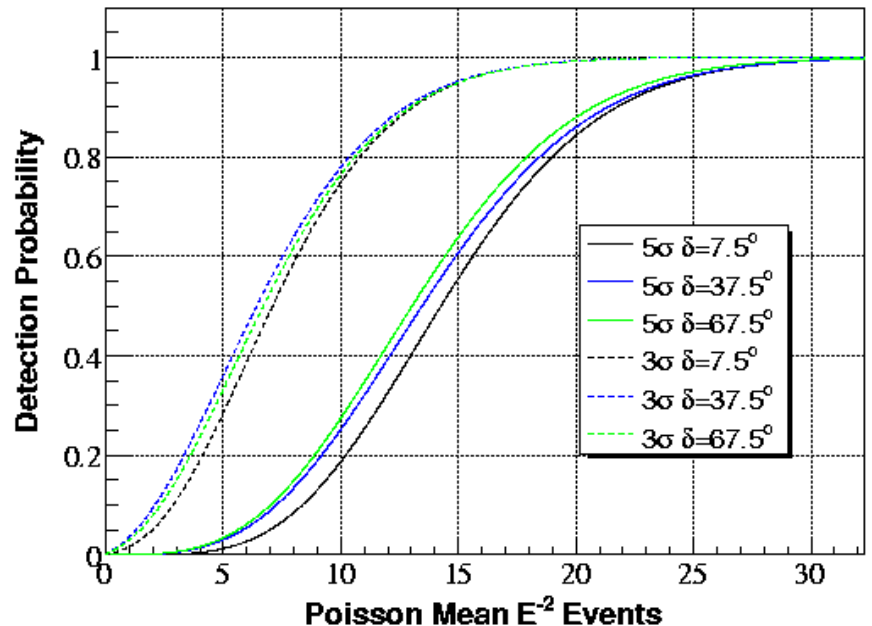
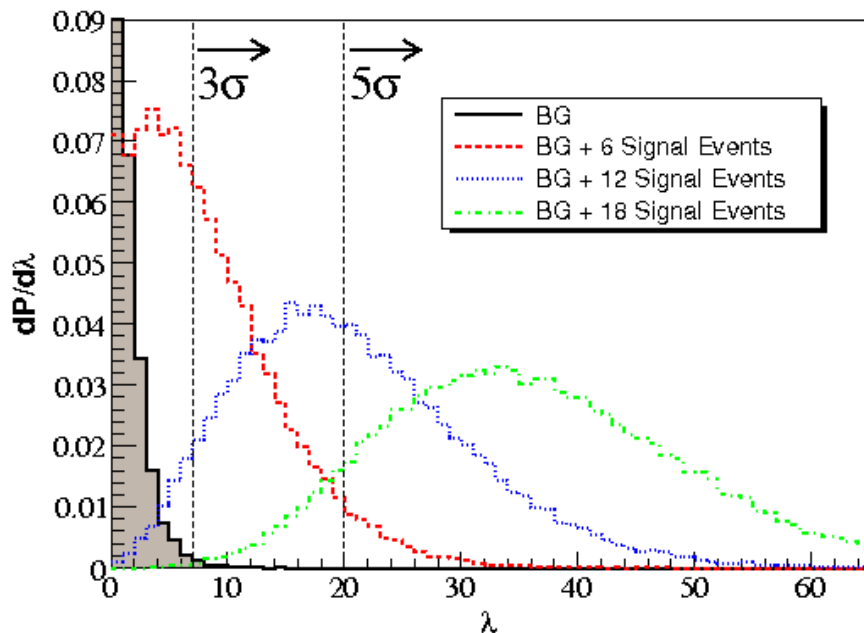
- Atmospheric neutrinos are the main background
- Search for excesses:
 - Direction
 - Event Energy



Search for Extraterrestrial Neutrinos

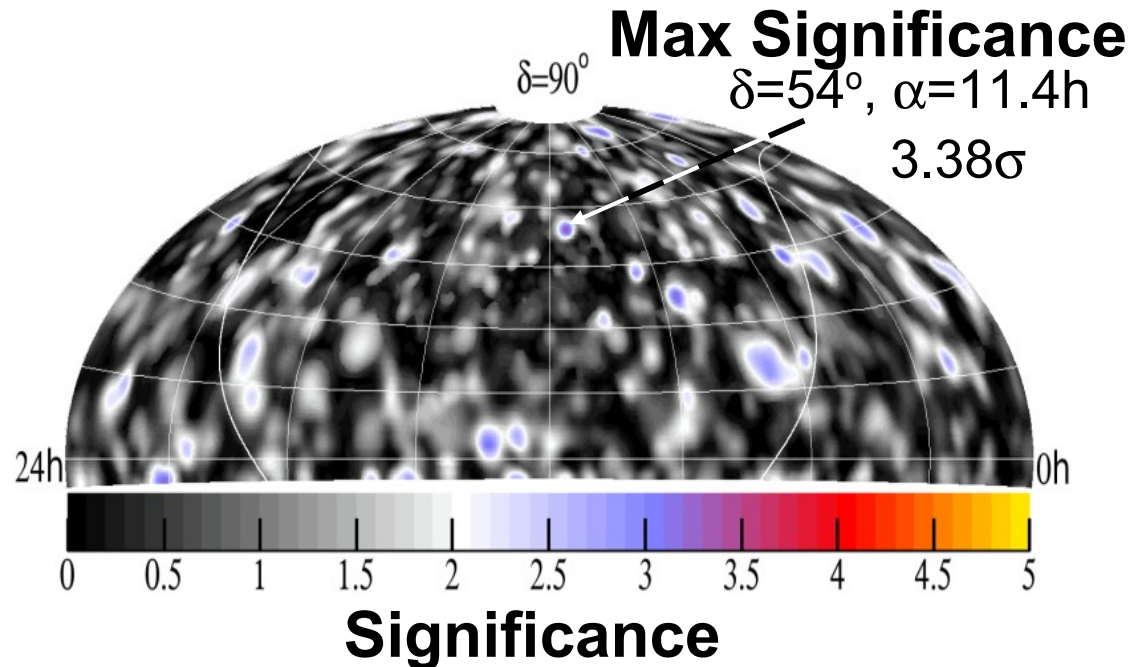
- Use unbinned maximum-likelihood search method
 - Incorporate event angular resolution and event energy estimate

$$\mathcal{L}(\vec{x}_s, n_s, \gamma) = \prod_{i=1}^N \left(\frac{n_s}{N} \mathcal{S}_i + \left(1 - \frac{n_s}{N}\right) \mathcal{B}_i \right) \quad \lambda = -2 \cdot \text{sign}(\hat{n}_s) \cdot \log \left[\frac{\mathcal{L}(\vec{x}_s, 0)}{\mathcal{L}(\vec{x}_s, \hat{n}_s, \hat{\gamma})} \right]$$



Astropart. Phys. **29**, 299 (2008)

All-Sky Search



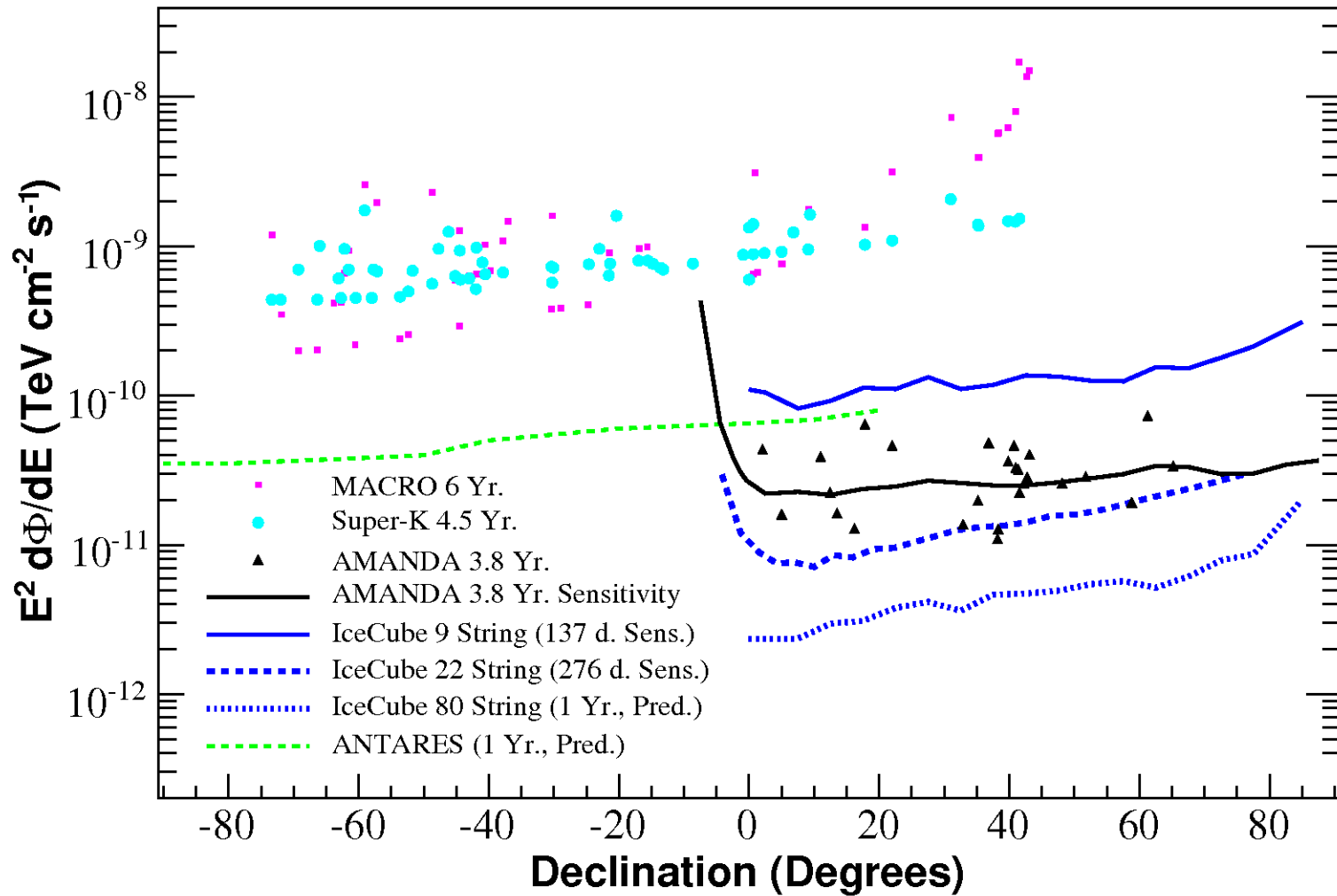
95 of 100 data sets randomized in RA have a significance $\geq 3.38\sigma$

Source	μ_{90}	P-value
Crab	9.27	0.10
MGRO J2019+37	9.67	0.077
Mrk 421	2.54	0.82
Mrk 501	7.28	0.22
LS I +61 303	14.74	0.03
Geminga	12.77	0.0086

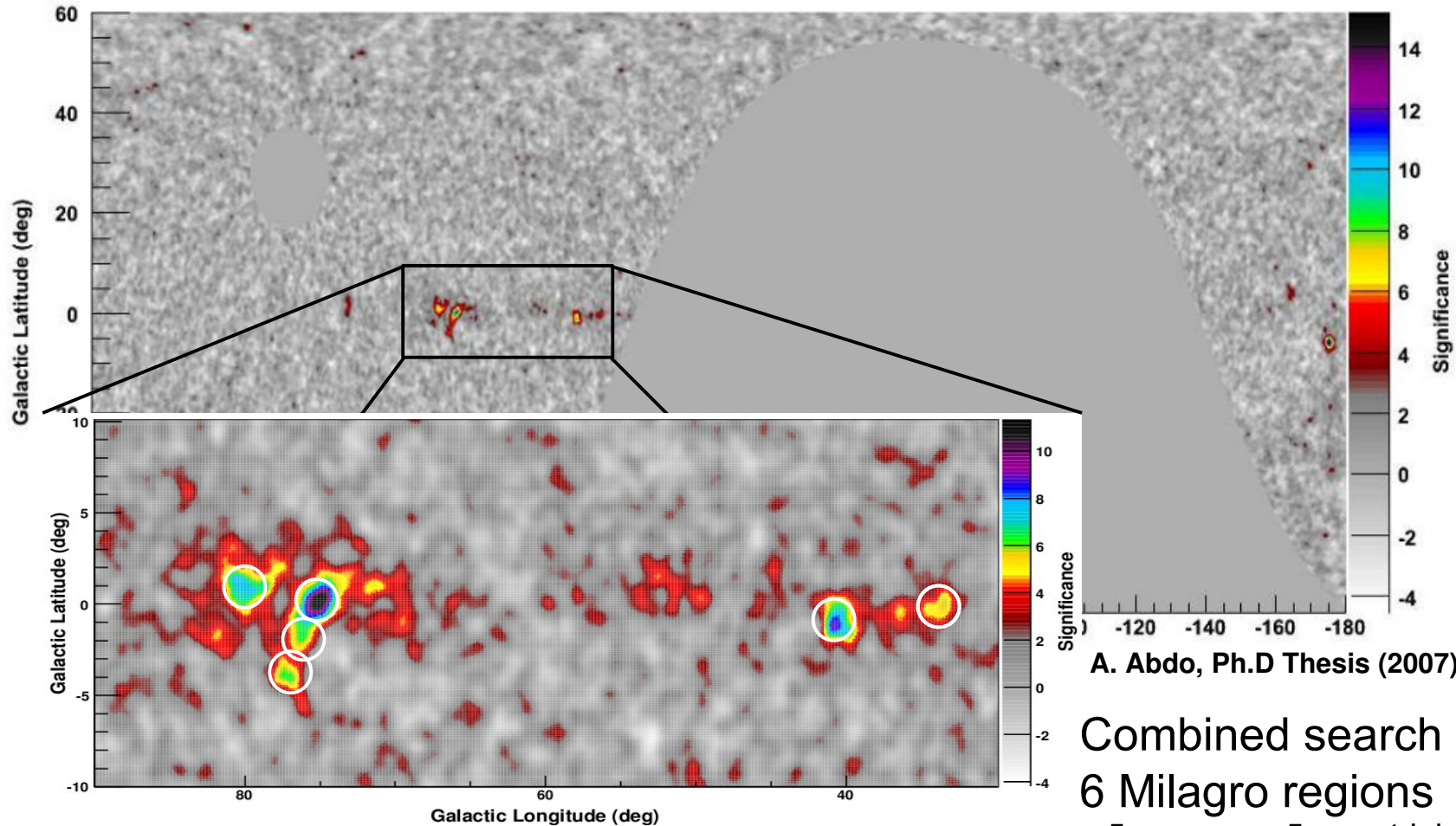
$$E^2\Phi < \mu_{90} * 10^{-11} \text{ TeV cm}^{-2} \text{ s}^{-1}$$

The probability of obtaining $p \leq 0.0086$ for at least one of the 26 sources is 20%

Experimental Limits



Milagro Stacking



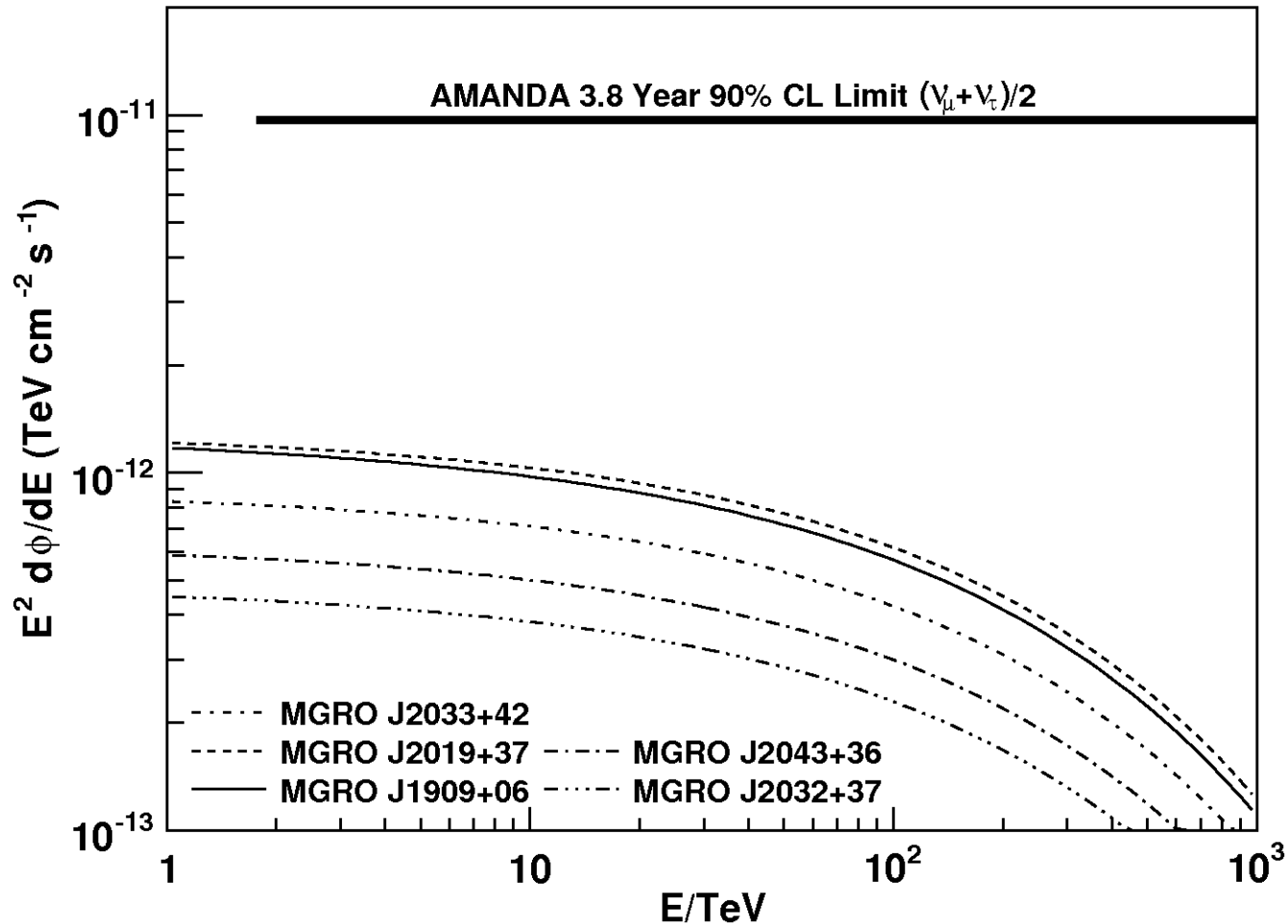
A. Abdo, Ph.D Thesis (2007)

Combined search over
6 Milagro regions

5 sources $> 5\sigma$ pre-trials

- Improves per-source flux sensitivity and discovery potential by a factor of 4 compared to a fixed-point search for any of the six sources

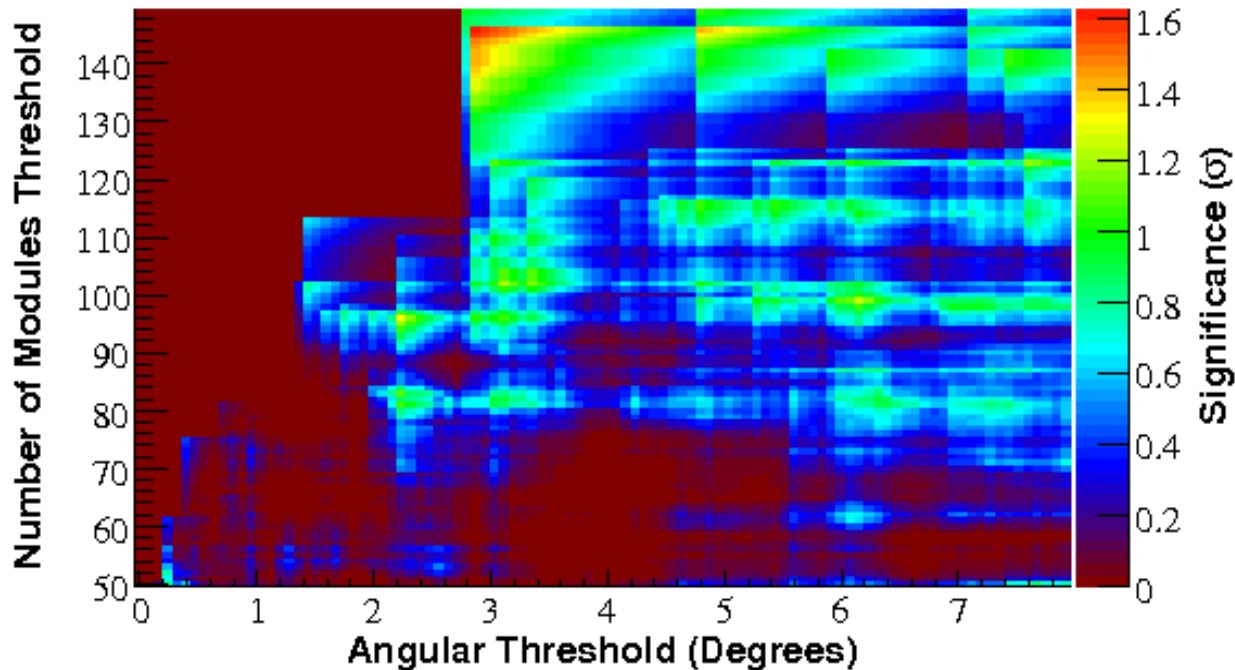
Milagro Stacking



Halzen, Kappes, O'Murchada [arXiv:0803.0314]

Search for Event Autocorrelations

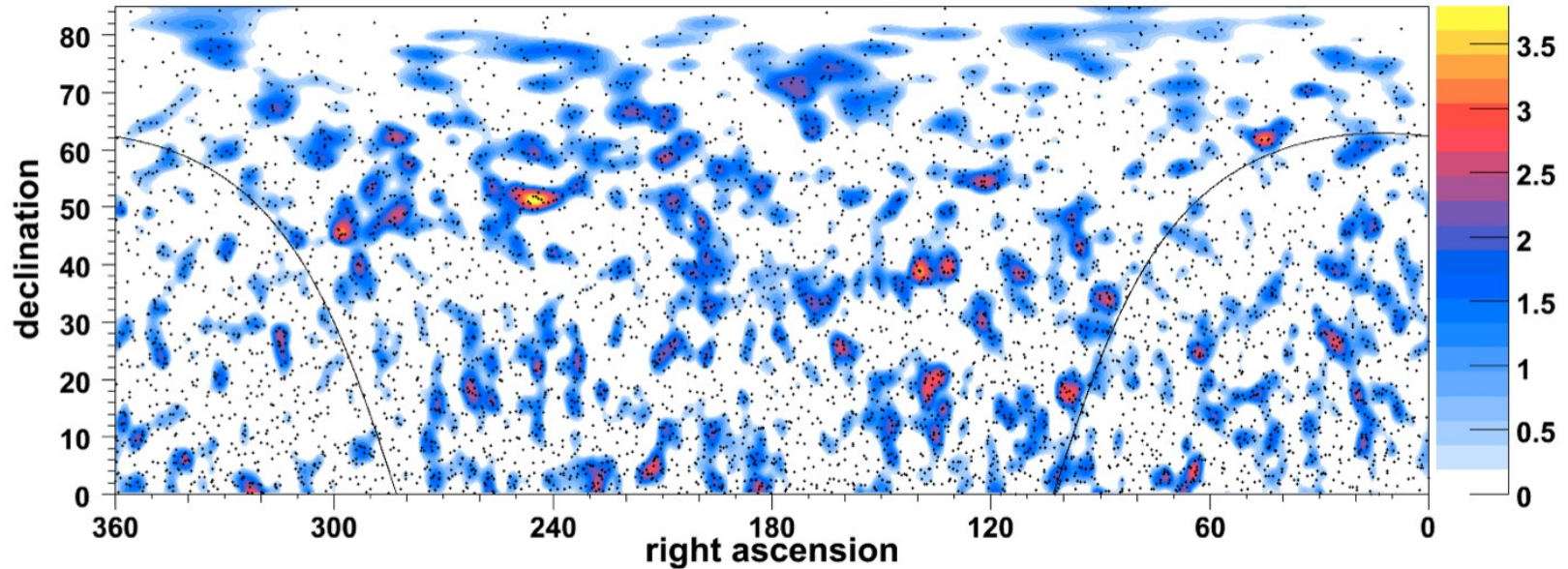
- Search for event clustering at angular scales comparable to detector resolution
 - Signal scenario: A number of small event clusters
- Method: Count the number of event pairs given a maximum angular separation and minimum Nch and compare to distributions from data with randomized RA



- Max significance: 1.6σ
- 99 out of 100 sets of randomized data have a max significance of 1.6σ or greater

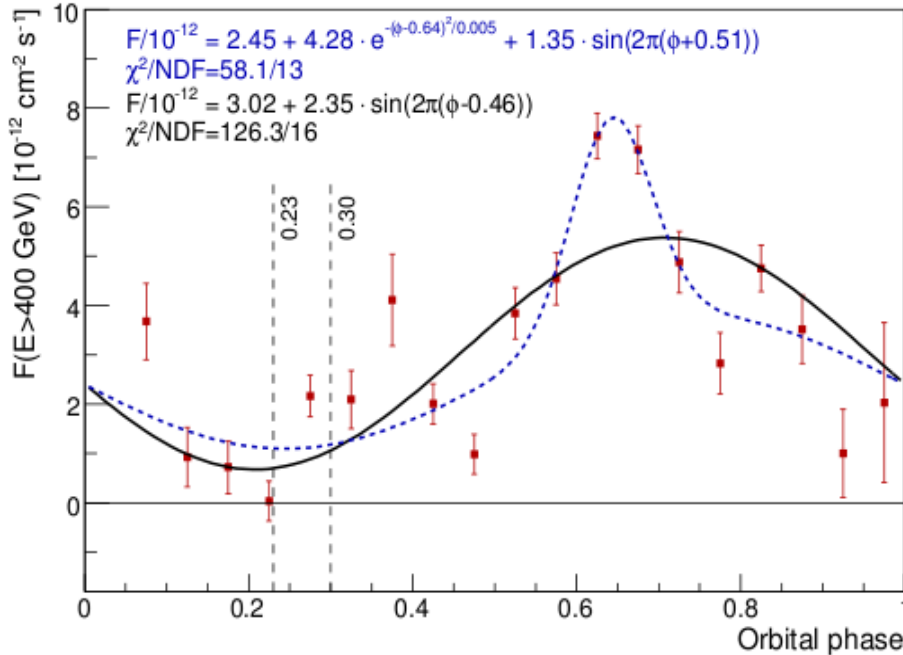
IceCube

22 string simulated skymap (~5000 events) sigma



- 22 string IceCube analysis nearly complete
- Current 40 string configuration improves angular resolution and sensitivity

Time-Dependent Searches



J. Albert et al. arXiv:0806.1865v1

- Use time dependence to improve signal-to-noise
 - Periodic analysis for LS I +61 303
 - Multi-messenger Approach
 - Look for correlations with gamma ray flares

Conclusions

- No evidence of neutrino point sources observed by AMANDA in 3.8 years of livetime.
 - Currently the most stringent flux limits
- 22 string IceCube analysis (~ 280 d) will improve this sensitivity by a factor of 2
- Further IceCube construction should yield an order of magnitude improvement in sensitivity within a few years