Search for neutrinos from flaring blazars

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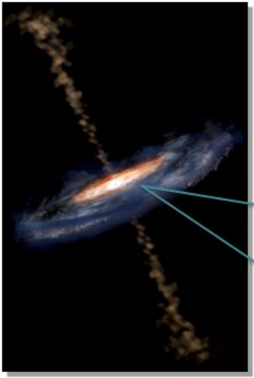
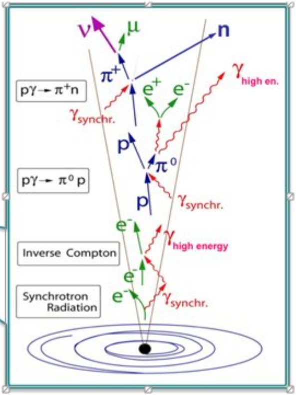
Neutrinos from AGN



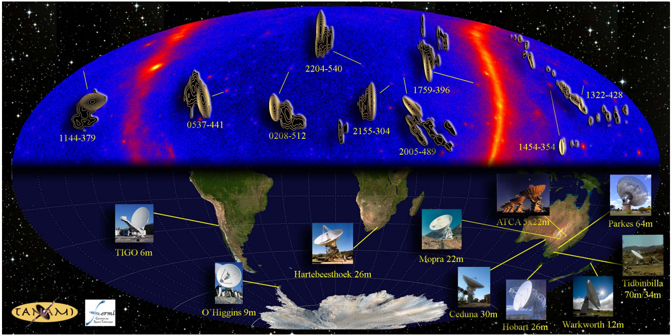
Credit: S. Signoret, Univ. Arizona.



U. F. Katz, C. Spiering, arXiv: 1111.0507

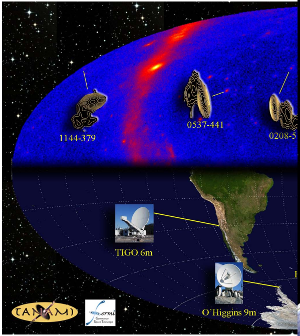
MultiMessanger Analysis

- TANAMI



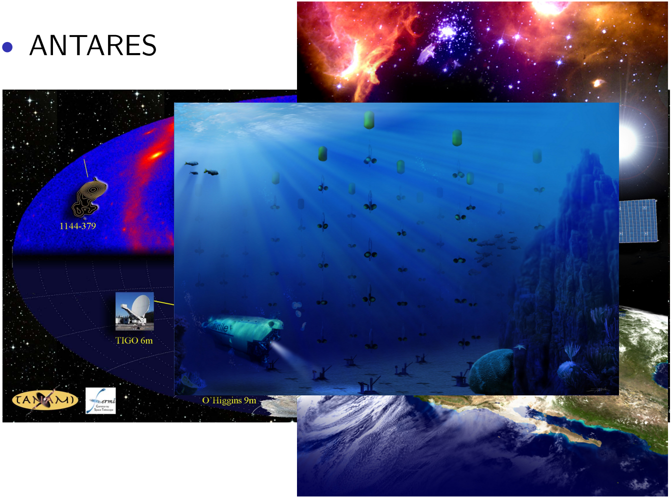
MultiMessanger Analysis

- *Fermi*/LAT



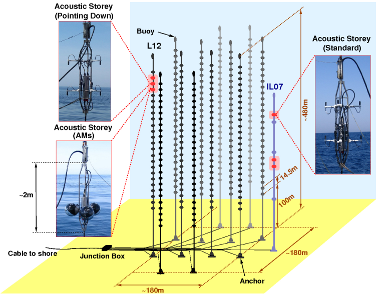
MultiMessanger Analysis

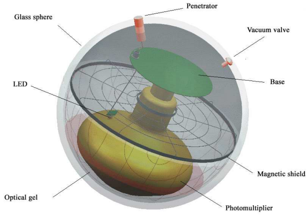
- ANTARES



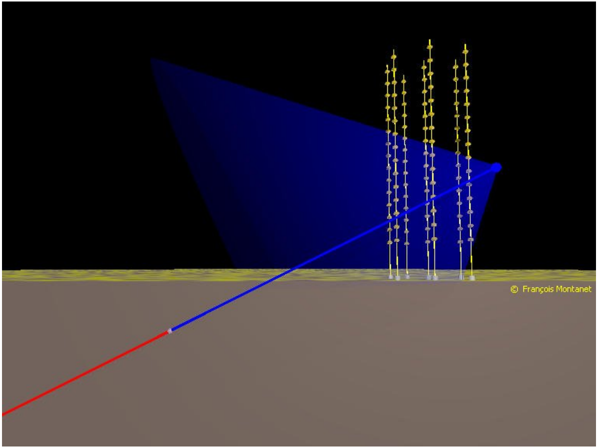
The ANTARES Detector

- located in 2500 m depth
- 12 vertical detection lines (a ≈ 450 m)
- 885 optical modules (OMs)
- 25 storeys per line (a 3 OMs)

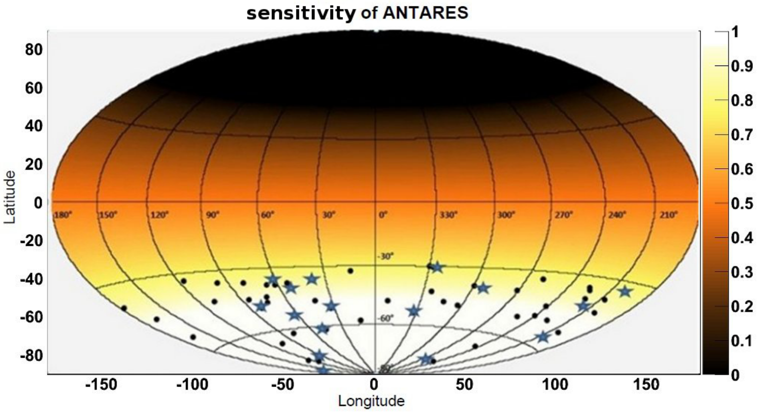




Detection principle



Source sample

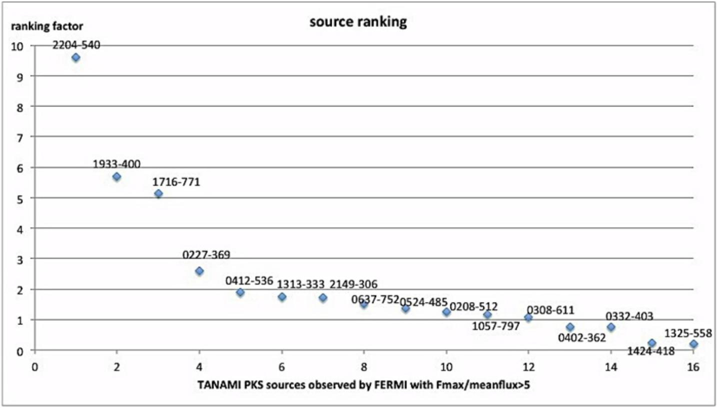


Sky in equatorial coordinates:

• TANAMI sources

⋆ selected sources for this analysis

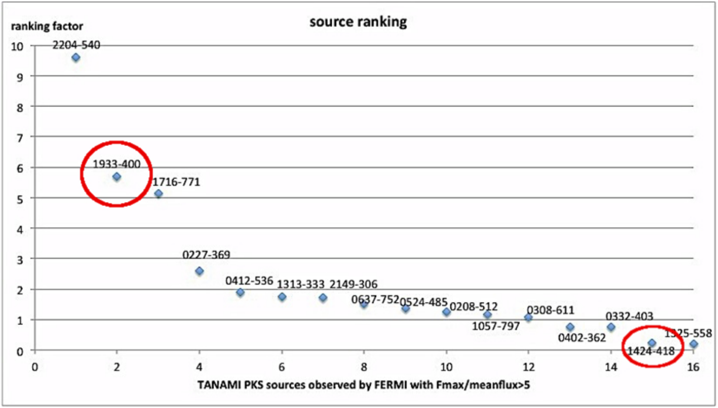
Source sample



Selection criteria:

$$\frac{F_{max}}{meanflux} \cdot \frac{1}{n} \qquad (1)$$

Source sample



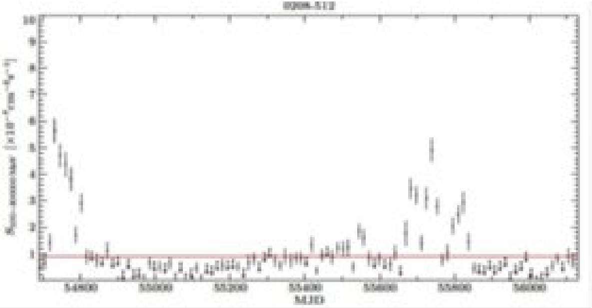
Selection criteria:

$$\frac{F_{max}}{meanflux} \cdot \frac{1}{n} \quad (2)$$

Aim of the analysis

Enhance sensitivity in finding neutrinos from AGN in a stacked search combining

- angle
- energy
- time information



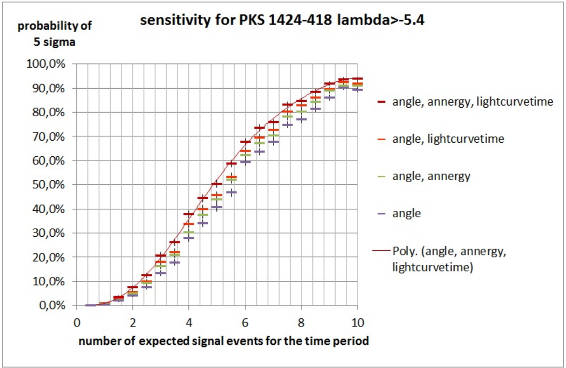
Method

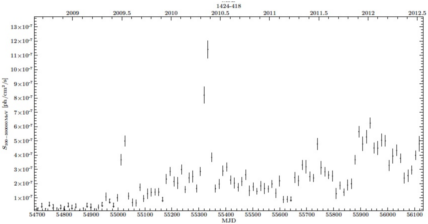
Maximize the likelihood of the data

$$L(n_s) = \prod_{i=1}^{N} \left[\frac{n_s}{N} S_i + (1 - \frac{n_s}{N}) B_i \right] \tag{3}$$

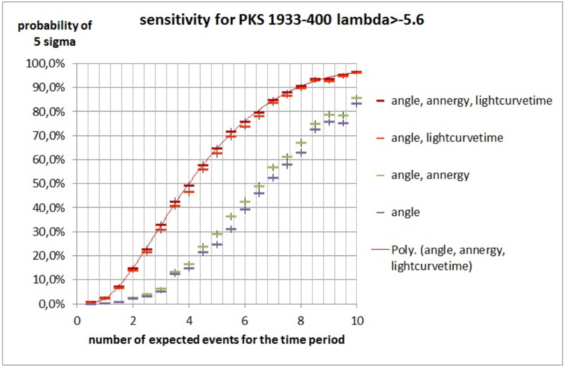
- n_s unknown contribution of the signal events
- N number of events
- S_i signal probability density
- B_i background probability density

Result

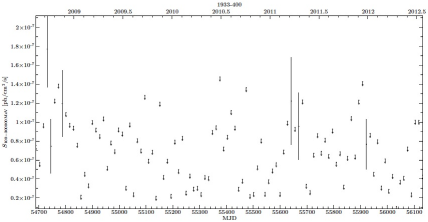

sensitivity for PKS 1424-418 lambda>-5.4
probability of 5 sigma
100,0%
90,0%
80,0%
70,0%
60,0%
50,0%
40,0%
30,0%
20,0%
10,0%
0,0%
0
2
4
6
8
10
number of expected signal events for the time period
angle, annergy, lightcurvetime
angle, lightcurvetime
angle, annergy
angle
Poly. (angle, annergy, lightcurvetime)


1424-418
2009
2009.5
2010
2010.5
2011
2011.5
2012
2012.5
MJD

Result



sensitivity for PKS 1933-400 lambda>-5.6
probability of 5 sigma
100,0%
90,0%
80,0%
70,0%
60,0%
50,0%
40,0%
30,0%
20,0%
10,0%
0,0%
0
2
4
6
8
10
number of expected events for the time period
angle, annergy, lightcurvetime
angle, lightcurvetime
angle, annergy
angle
Poly. (angle, annergy, lightcurvetime)

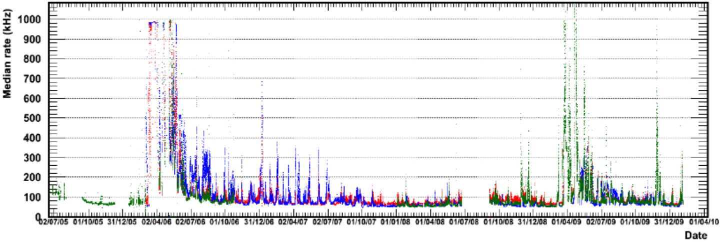


1933-400
2009
2009.5
2010
2010.5
2011
2011.5
2012
2012.5
MJD

Follow-up Master thesis

Problem:

- Highly variable background from environmental conditions.



⇒ optimize MC for every single run (rbr MC)

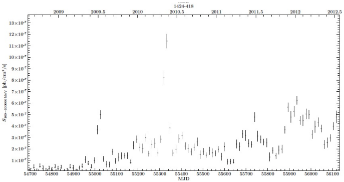
Follow-up Master thesis

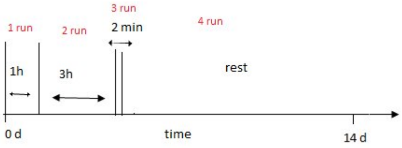
Aim:

- Increase sensitivity by taking duration of run into account?

Idea:

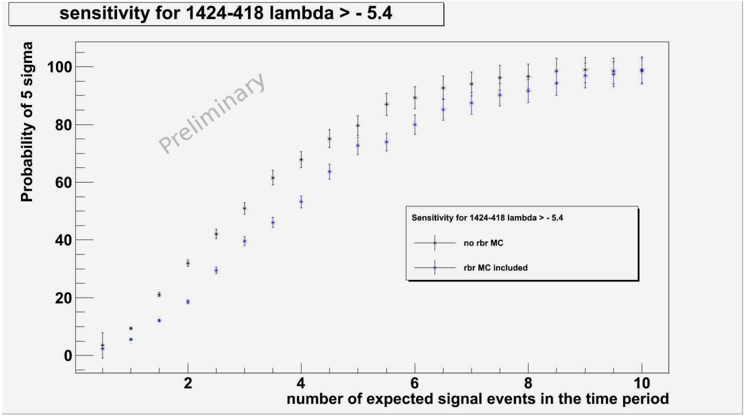
- weight every neutrino event by the duration of its run





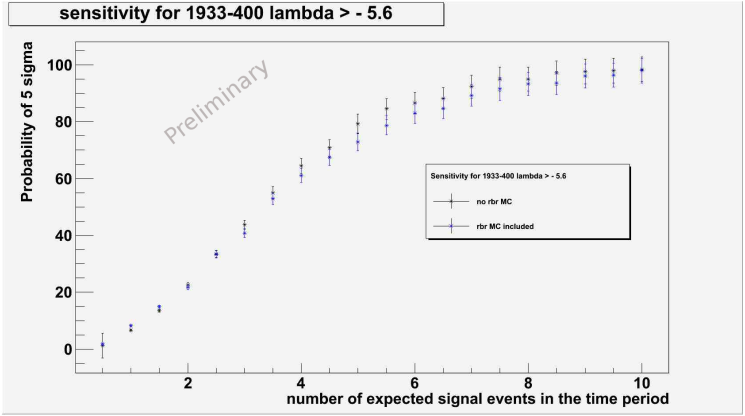
Follow-up Master thesis

Result:



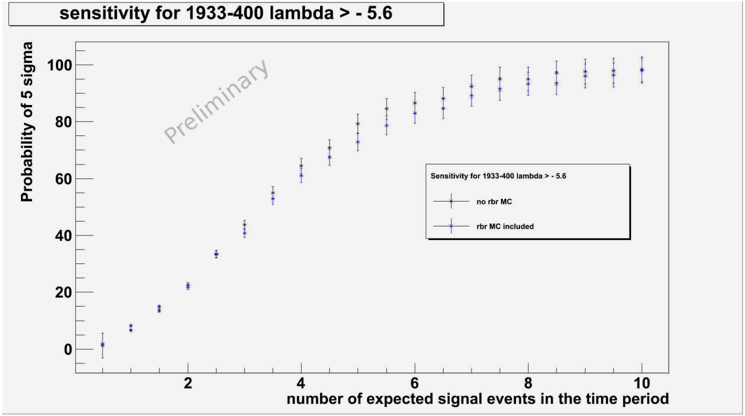
Follow-up Master thesis

Result:



Follow-up Master thesis

Result:

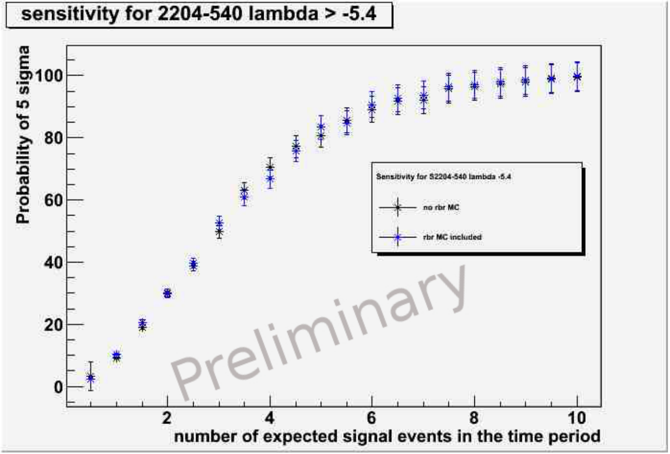


Summary

- Time correlation between γ and ν increases the sensitivity dramatically
- For rbr MC analysis no difference in sensitivity could be found for highly ranked sources.
- Sensitivity shift is due to bad detector contributions and high noise rates.

Backup

		signal event	background event
expectation μ		0.5, 1.0, 1.5, ..., 10.0	#
S-term	angle	from E^{-1} MC (angle1, angle2, ...) height from E^{-1} MC	~ sin α
	energy	(energy1, energy2,...)	from $E^{-3.6}$ MC energy height from E^{-1} MC
	time	from cumulated lightcurve	random
B-term		from E^{-1} MC $\frac{1}{5^{\circ 2}\pi}\cdot$ energy height from $E^{-3.6}$ MC	from $E^{-3.6}$ MC $\frac{1}{5^{\circ 2}\pi}\cdot$ energy height from $E^{-3.6}$ MC


sensitivity for 2204-540 lambda > -5.4
Probability of 5 sigma
number of expected signal events in the time period
Sensitivity for S2204-540 lambda -5.4
no rbr MC
rbr MC included
Preliminary

Source ranking

Sources are weighted according to:

- select sources with $\frac{F_{max}}{meanflux} > 5$
- Count the number n of bins flux $>$ meanflux $+ 3\,\sigma$
- ranking:

$$\frac{\mathbf{F_{max}}}{\mathbf{meanflux}} \cdot \frac{\mathbf{1}}{\mathbf{n}}$$