KM3NeT point-like sources

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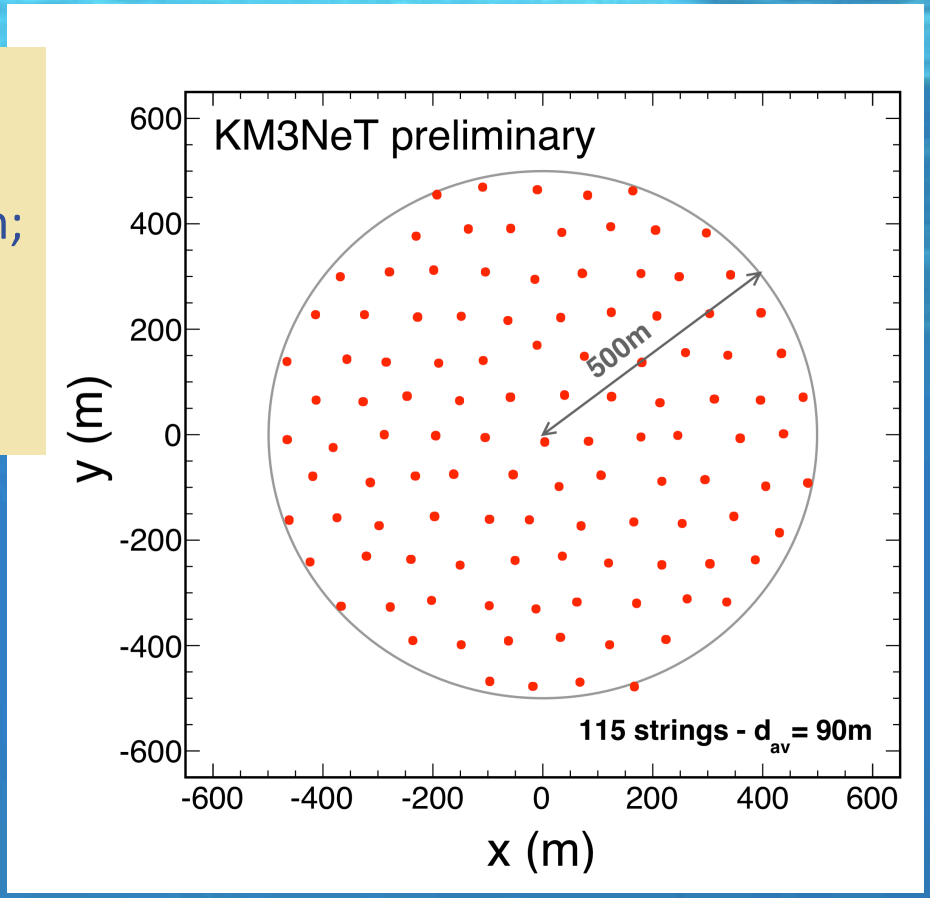
Detector Layout

KM3NeT building block
- ✓ 115 strings x blocks;
- ✓ average distance between strings: 90 m;
- ✓ number of OMs per string: 18;
- ✓ distance between OMs: 36 m;
- ✓ Volume of a single block: 0.5 km^3.

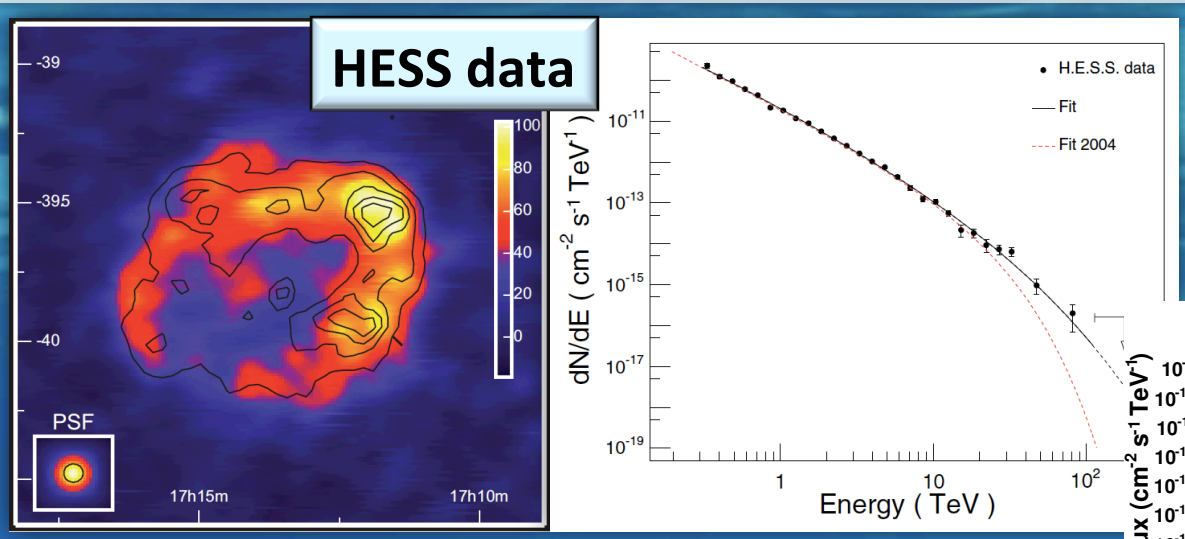


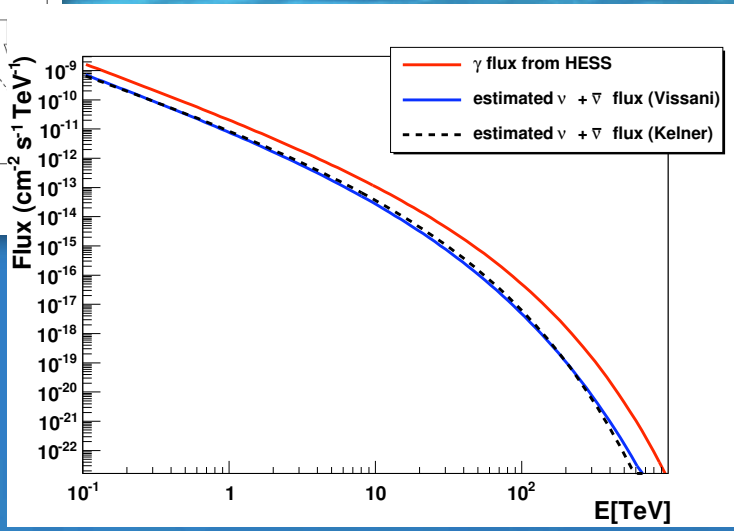
KM3NeT phase1.5 → 2 building blocks
KM3NeT phase2 → 6 building blocks

Part I

Analysis of specific sources (VelaX and RXJ1713.7-3946) simulated as neutrino emitting homogeneous disks

SNR RXJ1713.7-3946





Good reference case:

- ✓ High γ-ray flux measured
- ✓ γ-ray spectrum measured up to about 100 TeV
- ✓ Visible for about the 80% of the time by KM3NeT

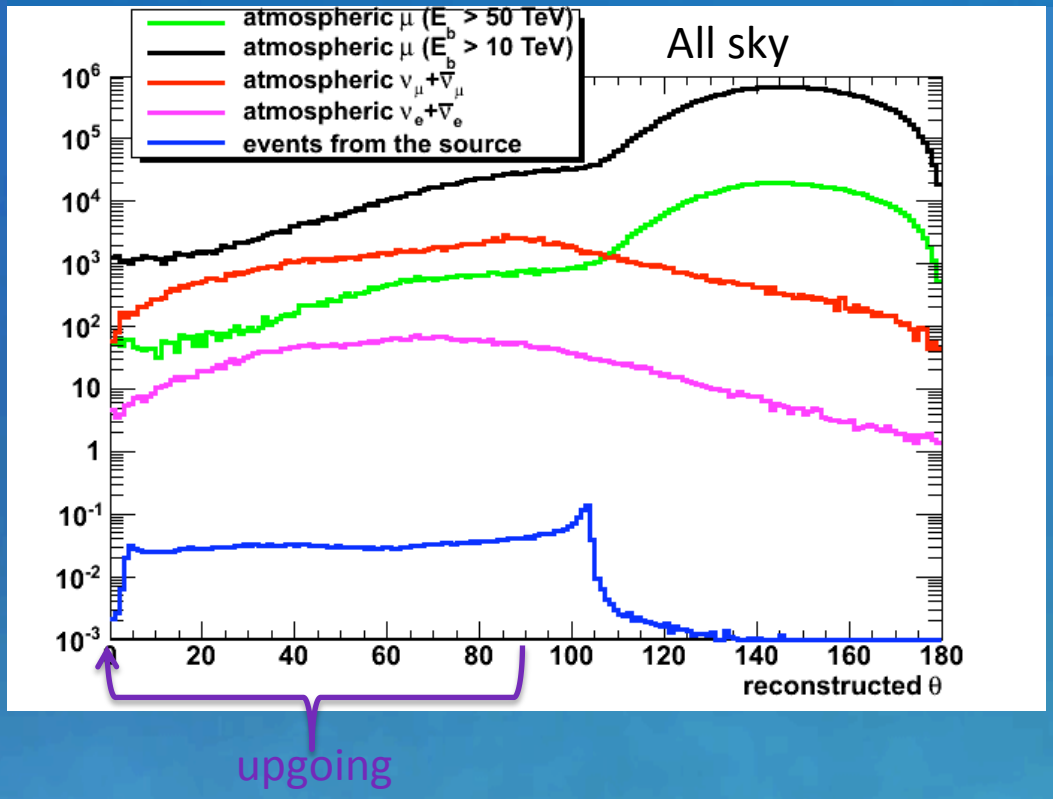
Source simulated as a neutrino emitting homogeneous disk of 0.6° radius and a neutrino spectrum calculated following Kelner et al., PRD 74 (2006) 034018

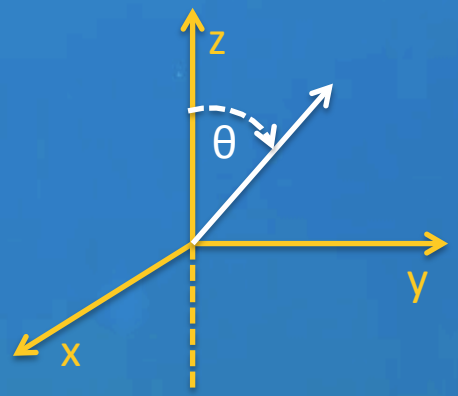
$$\Phi(E) = 16.8 \times 10^{-15} \left[\frac{E}{TeV}\right]^{-1.72} e^{-\sqrt{\frac{E}{2.1TeV}}} GeV^{-1} s^{-1} cm^{-2}$$

Theta distributions

Background added

- Atmospheric muon and electron (anti-)neutrinos weighted with Honda+ Enberg + knee correction (PRD 89 (2014) 062007)
- Atmospheric muons generated with two thereshold 10 TeV (livetime 34 days) and 50 TeV (livetime 3 years)

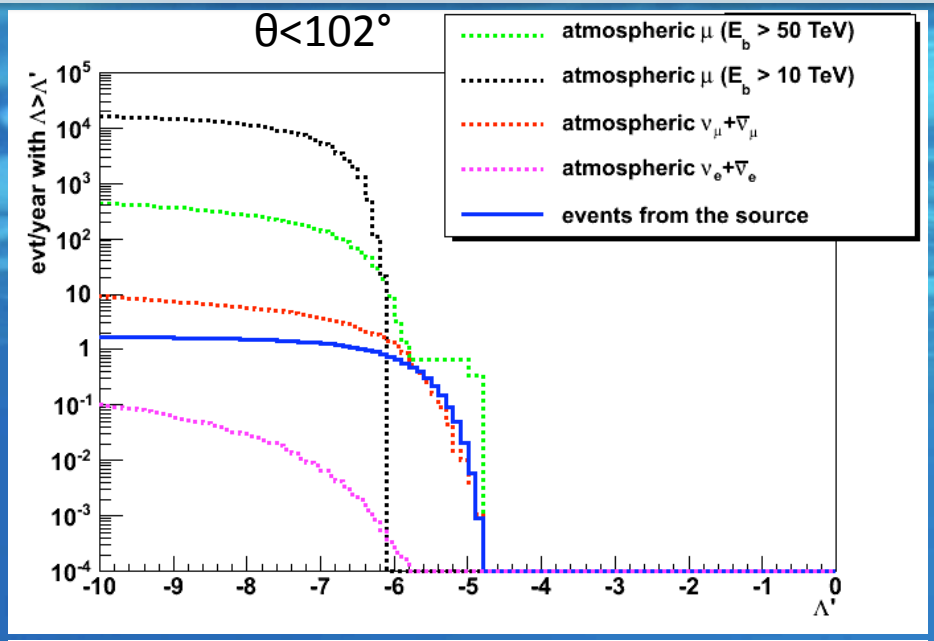


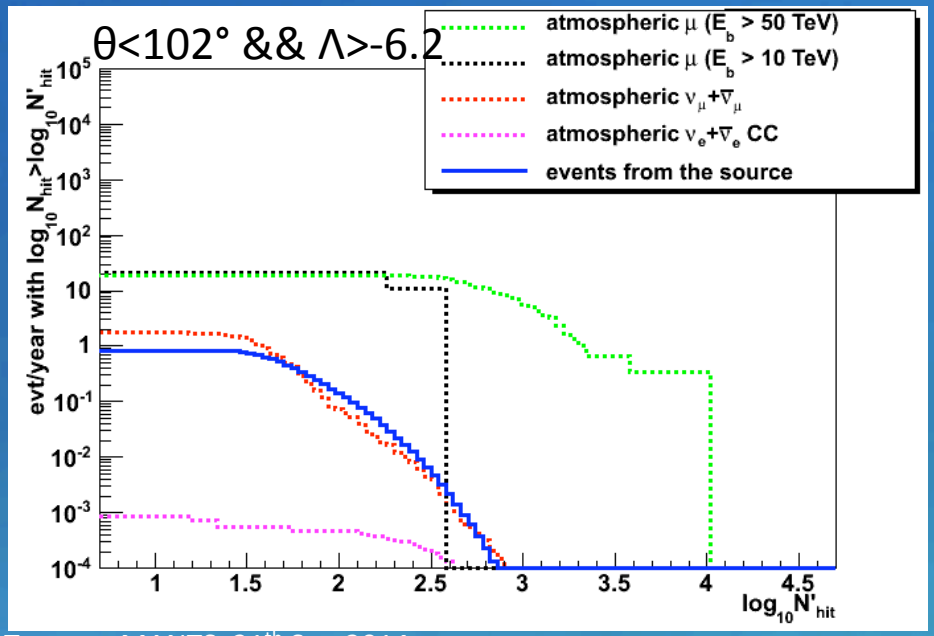


events for 1 block and 1 observation year

Optimal cut θ<102° (preliminary cut-and-cout analysis)

Lambda and Nhit distributions (1° from the source)



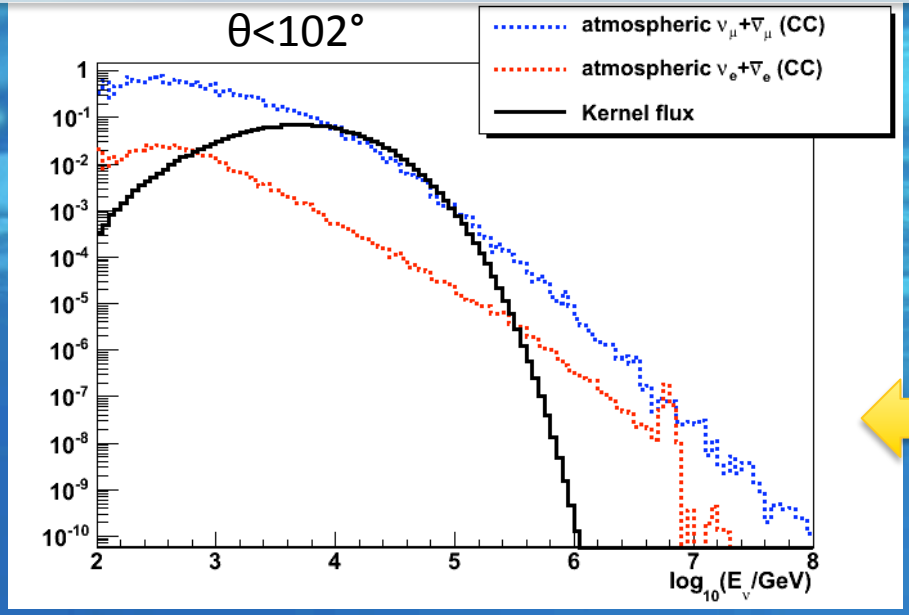


Cumulative Λ distribution:
Λ → goodness of fit criterion

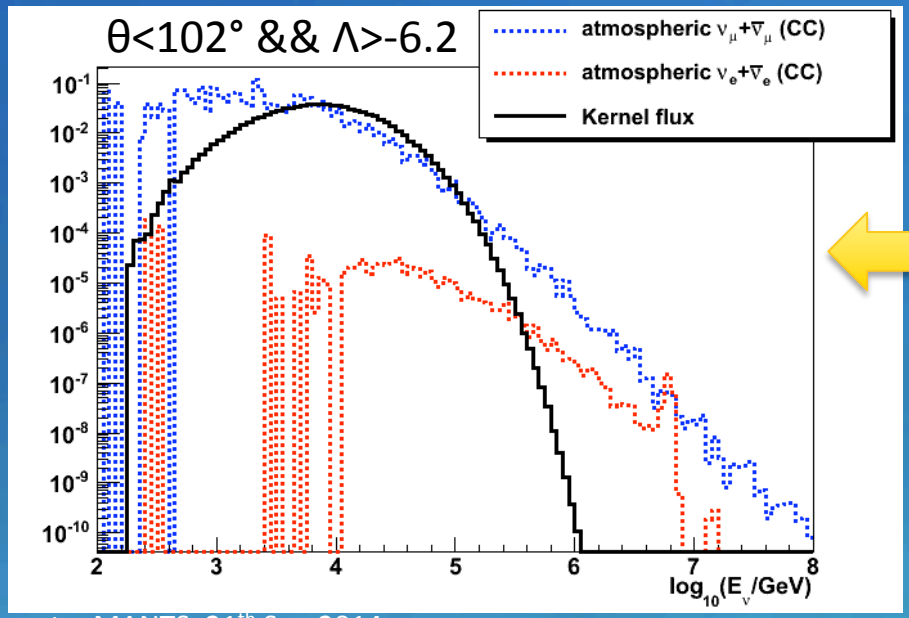
Optimal cut Λ >-6.2 (preliminary cut-and-cout analysis)

Cumulative N_{hit} distribution:
N_{hit} → rough energy estimate

Energy distributions (1° from the source)



After the cut on θ



After the cut on Λ

Unbinned method

- Number (**n**) of expected background events in the detector for a chosen time window calculated with the cuts fixed from the binned analysis
- Probability density function for signal ($\mathbf{P_{sig}}$) and background ($\mathbf{P_{bg}}$) events estimated from the MC as a function of the distance from the source **α**
- 50000 background samples with n events created and for each sample the maximum value of likelihood ratio LR found ($\mathbf{n_{sig}}$ is a free parameter):

hypothesis of signal+background

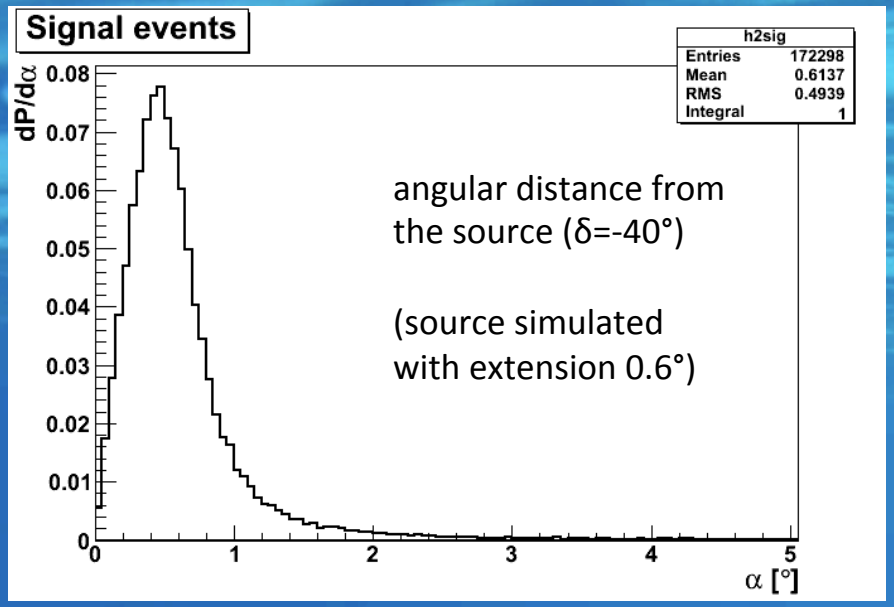
$$LR = \log\left[\frac{P(data \mid H_{bkg+sig})}{P(data \mid H_{bkg})}\right] = \sum_{i=1}^{n} \log \frac{\frac{n_{sig}}{n} \times P_{sig}(\alpha_i, Nhit_i) + \left(1 - \frac{n_{sig}}{n}\right) \times P_{bkg}(\alpha_i, Nhit_i)}{P_{bkg}(\alpha_i, Nhit_i)}$$

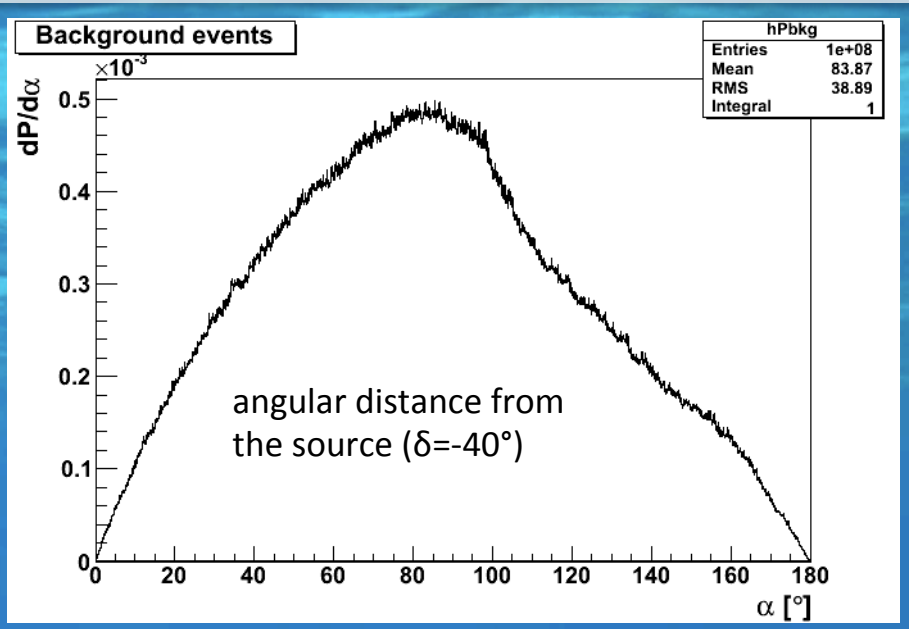
hypothesis of background only

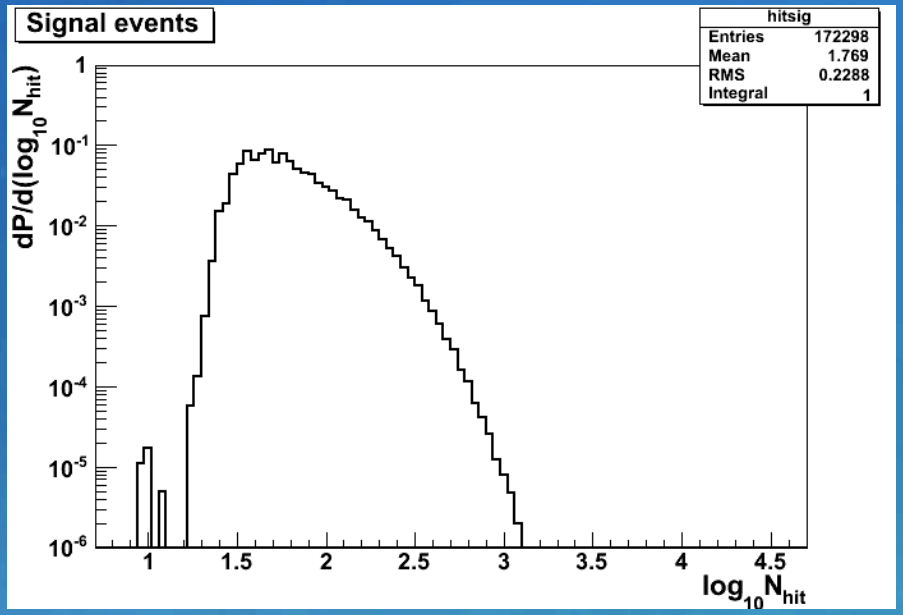
P(α,Nhit)=P(α)*P(Nhit)

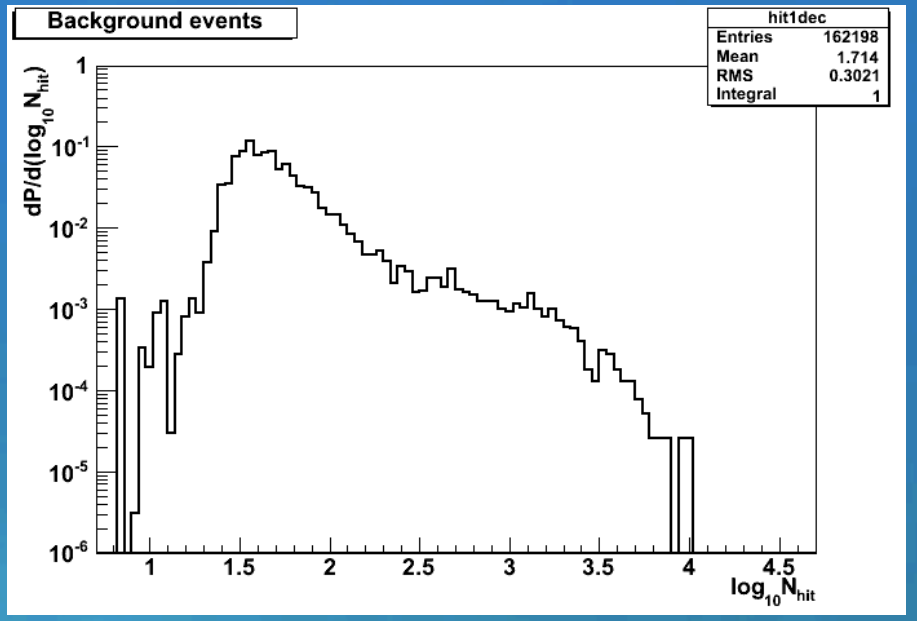
- LR evaluated for samples containing only bkg events and for samples with signal events added to the bkg events
- LR used as a test statistic

Unbinned method for the SNR RXJ1713.7-3946









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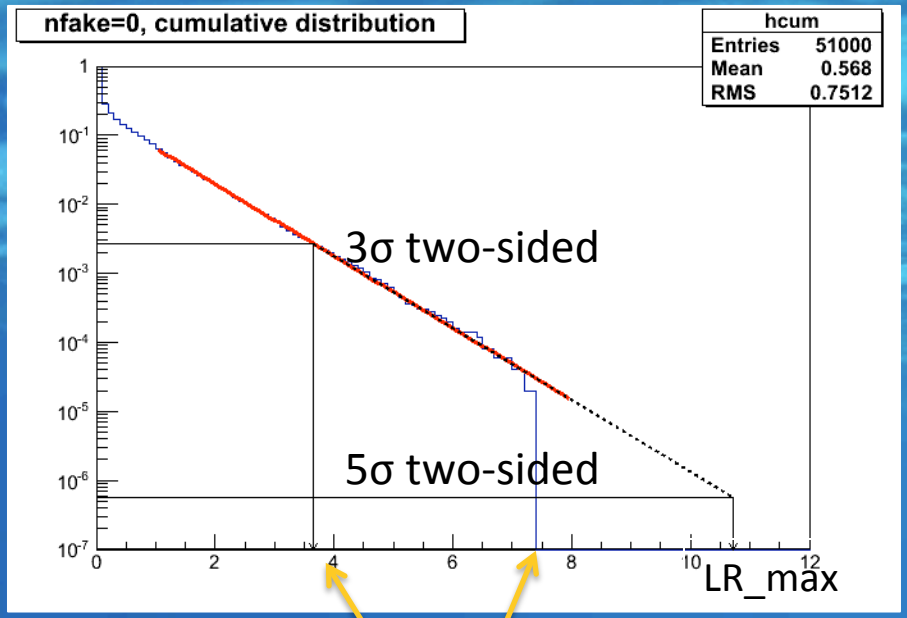
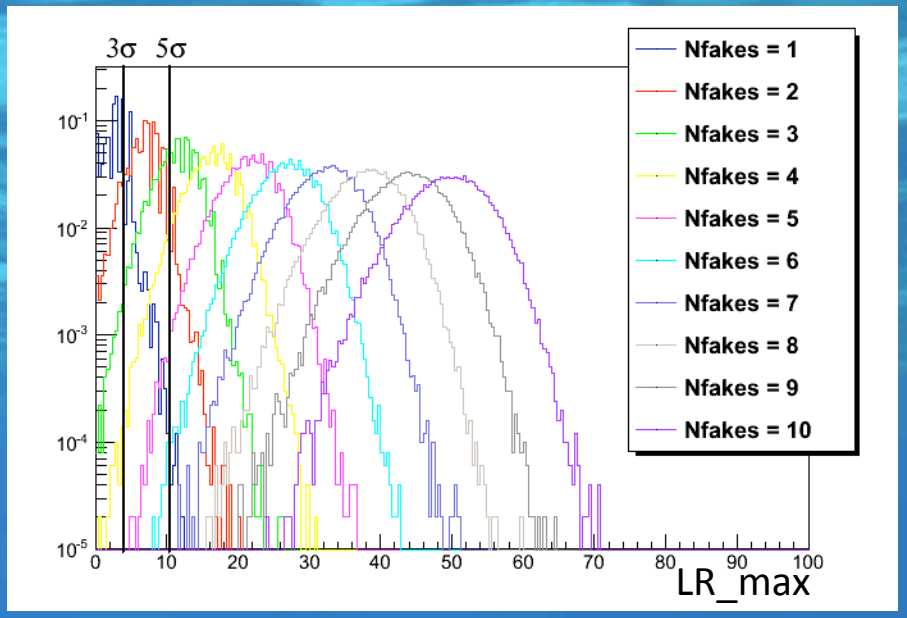
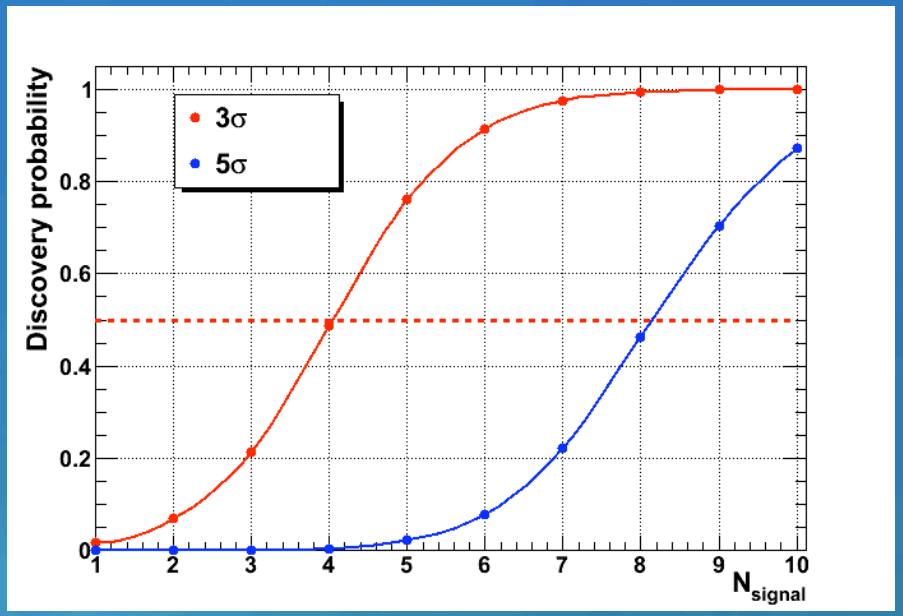
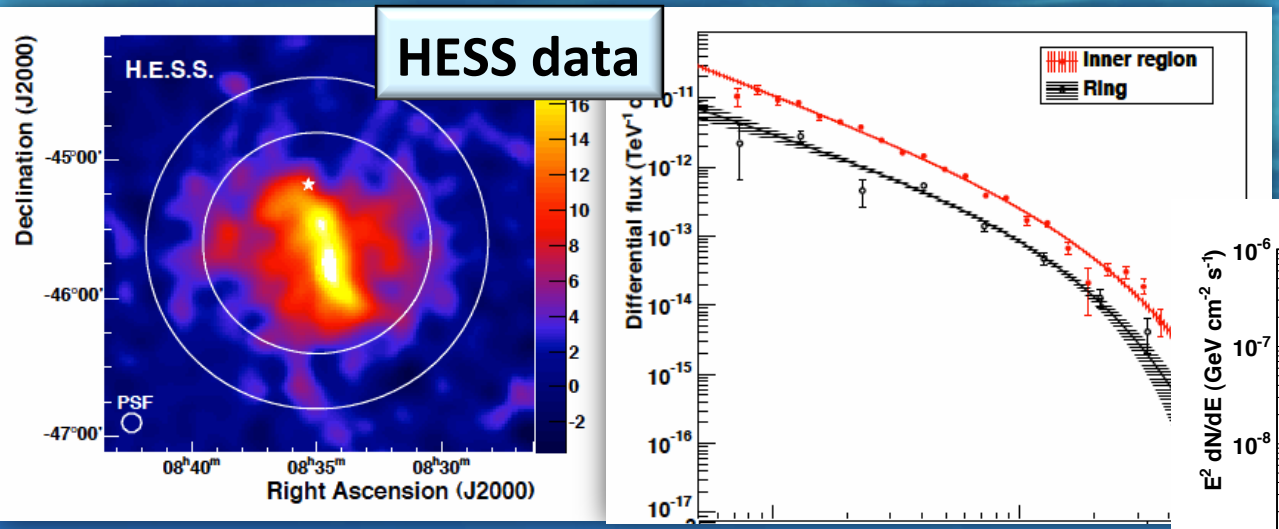




- Critical values LR3σ LR5σ extracted from the analysis of sample with only background events
- The LR_max distributions for each number of "Nfake" signal events added to the background sample are integrated for LR_max>LR3s and LR_max>LR5s obtaining the discovery probability



Vela X



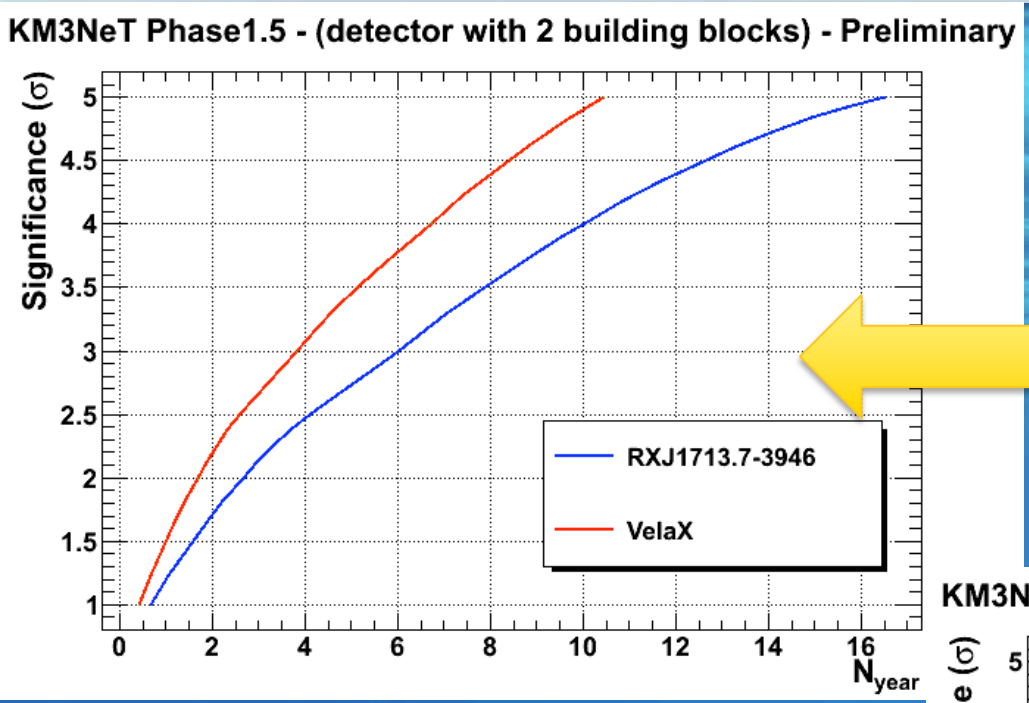
- Neutrino spectrum calculated following Vissani at al. prescription[1] assuming a 100% hadronic emission and a transparent source

  $d\Phi_\nu/dE_\nu = N * (E_\nu/1TeV)^{-\Gamma} \exp(-E_\nu/E_{cut})$

  - $N = 0.72\ 10^{-14}\ GeV^{-1}s^{-1}cm^{-2}$
  - $\Gamma = 1.36$
  - $E_{cut} = 7$ TeV
- Source simulated as a neutrino emitting homogeneous disk of 0.8° radius

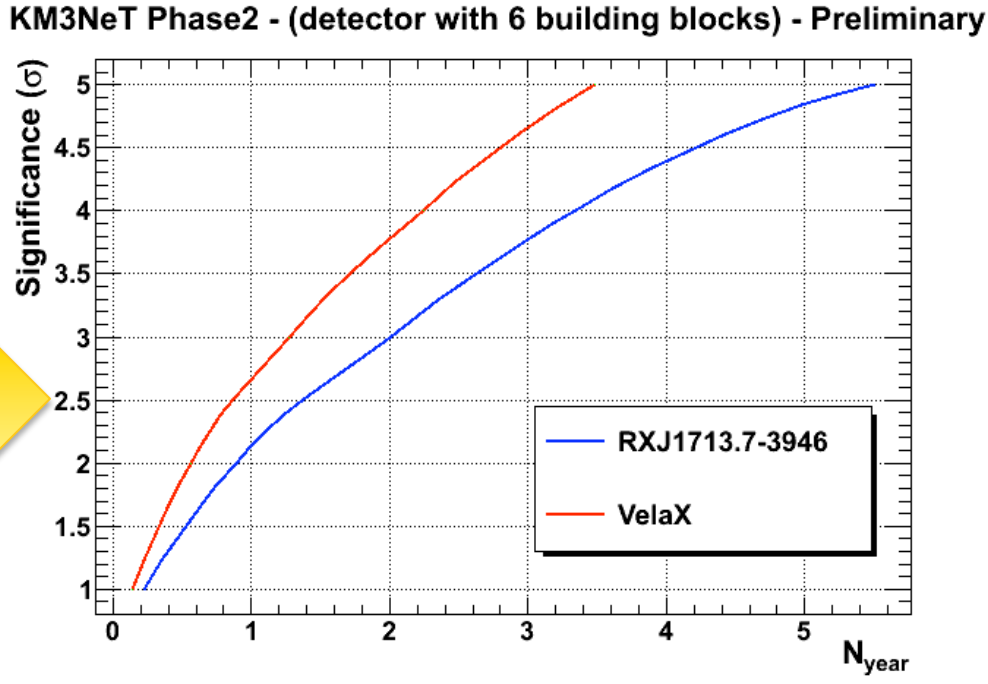
① F.L. Villante and F. Vissani, PRD 78 (2008) 103007; F. Vissani and F.L. Villante, NIM A588 (2008) 123; F. Vissani, Astr. Phys. 26 (2006) 310

Vela X and RXJ1713.7-3946 disc. years



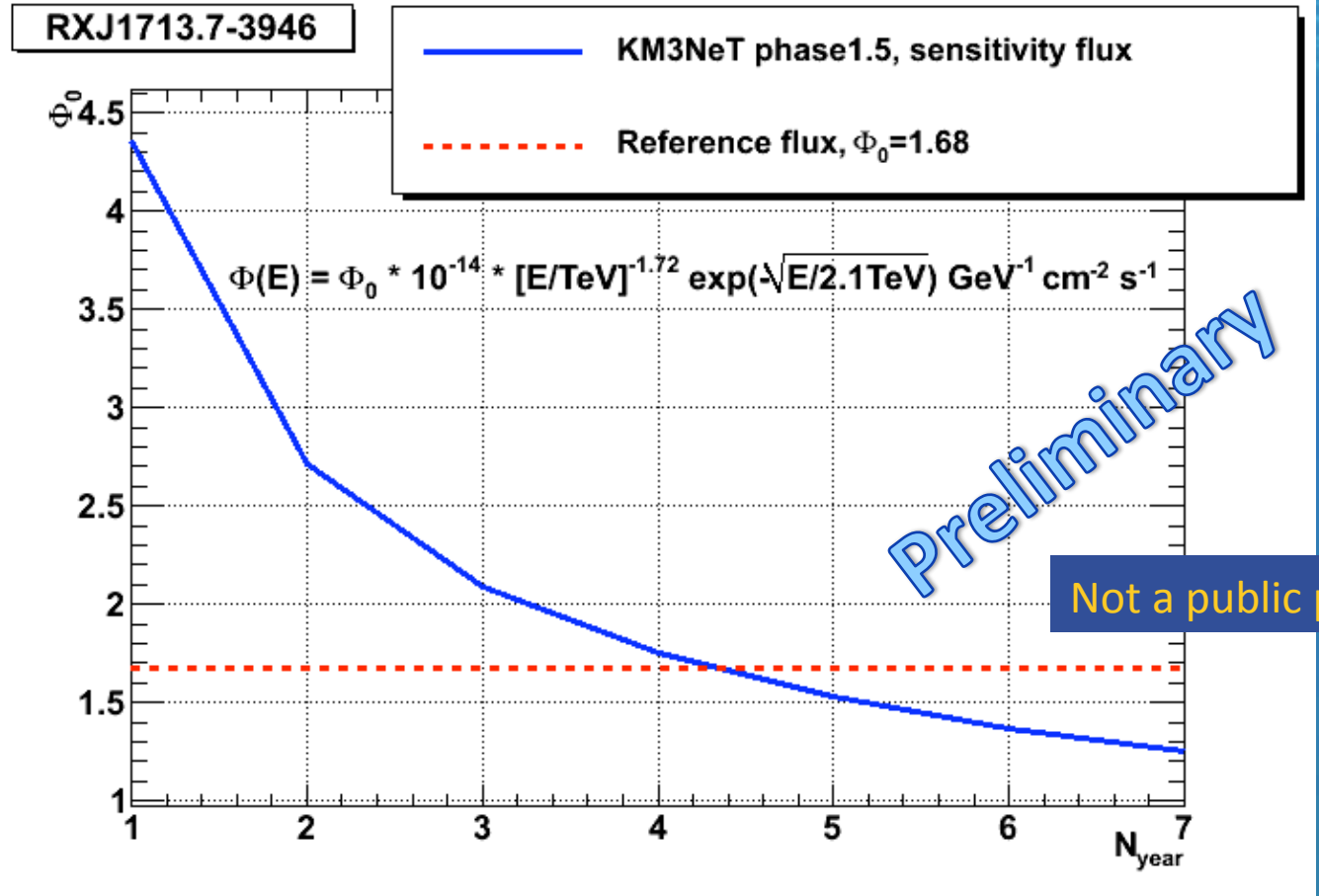
3σ in about 4years for the VelaX and 6years for the RXJ1713.7-31946 for KM3NeT phase1.5

5σ in about 3.5years for the VelaX and 5.5years for the RXJ1713.7-31946 for KM3NeT phase2



RXJ1713.7 sensitivity

- Sensitivity as a function of the number of observation years
- Sensitivity calculated using the Feldman-Cousins approach and the binned (cut-and-count) method

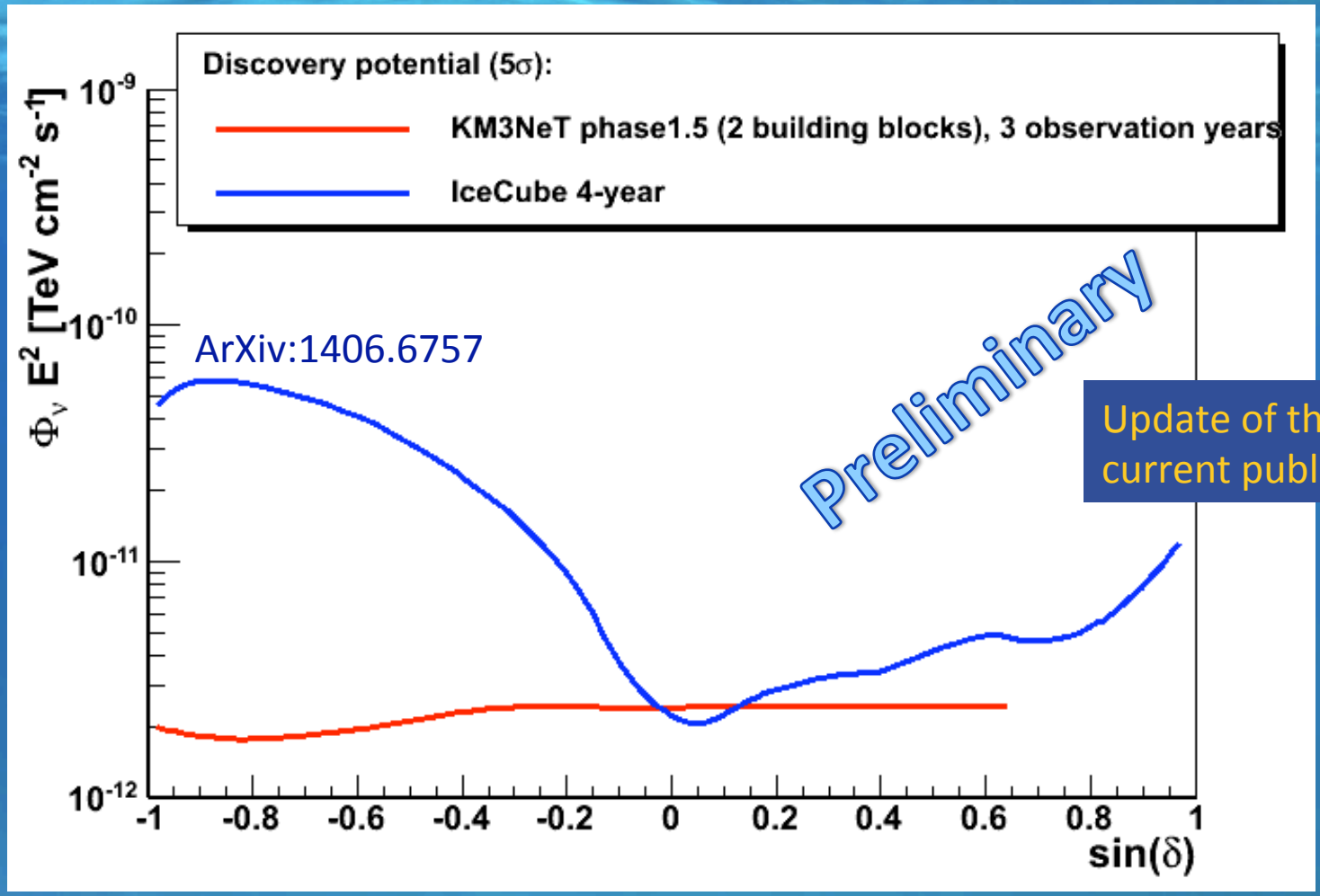


Part II
Analysis of generic point sources with E^{-2} spectrum

Discovery for point source E^{-2} spectrum as a function of δ

Discovery potential as a function of the declination:

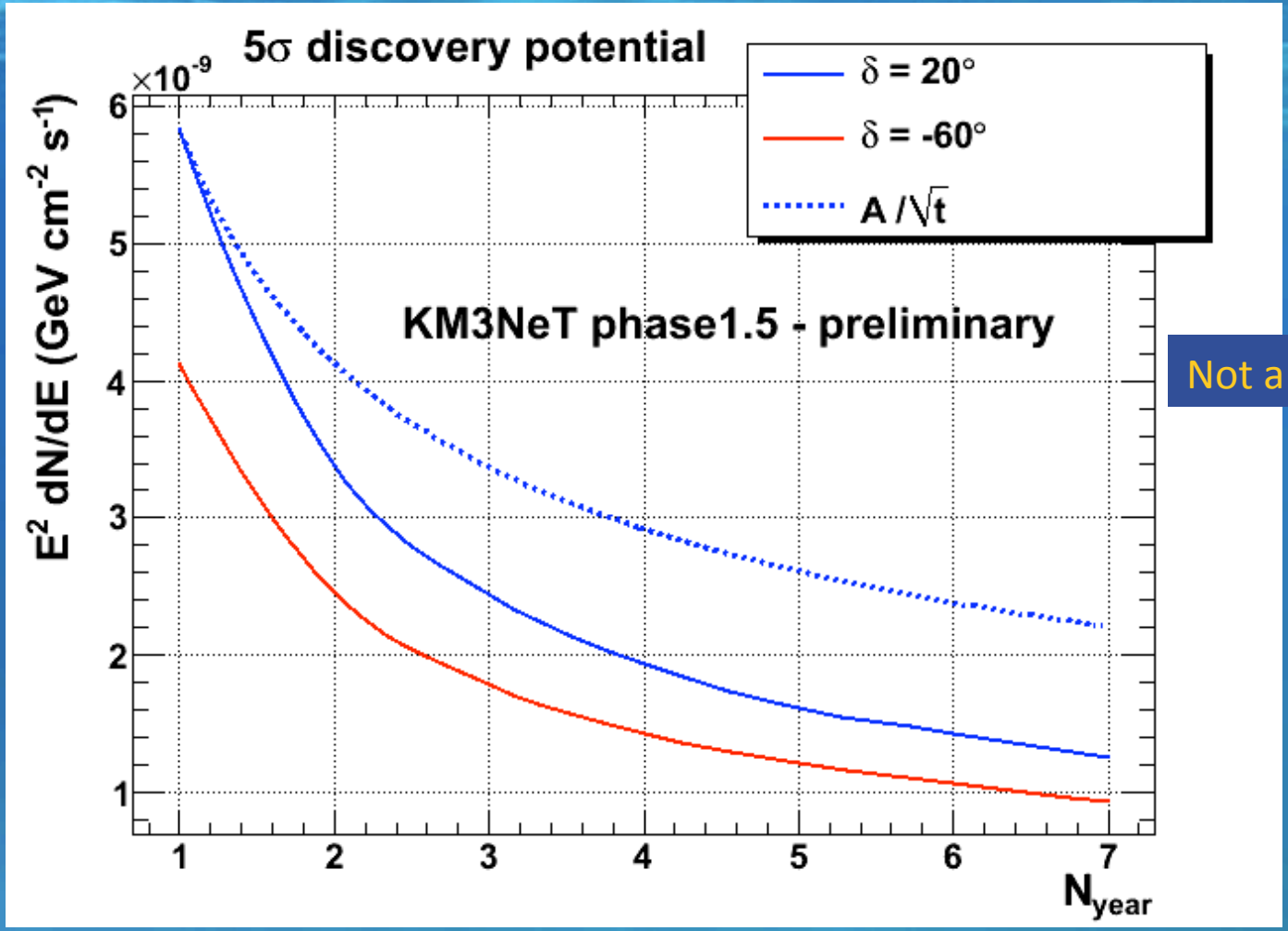
- point-source with E^{-2} spectrum



Discovery vs observation years

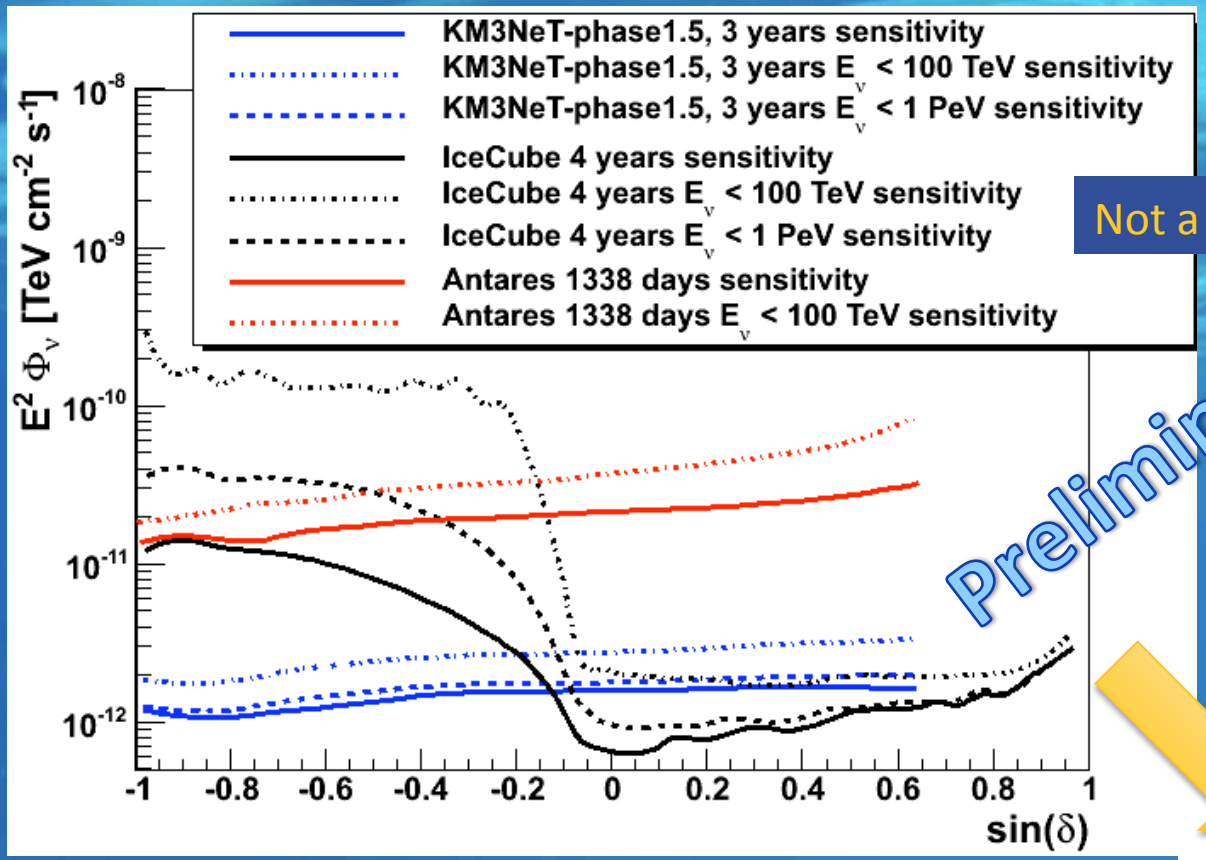
Discovery potential as a function of the observation years:

- point-source with E^{-2} spectrum
- for reference the √time is plotted



Not a public plot

Sensitivity for point source E^{-2} spectrum as a function of δ

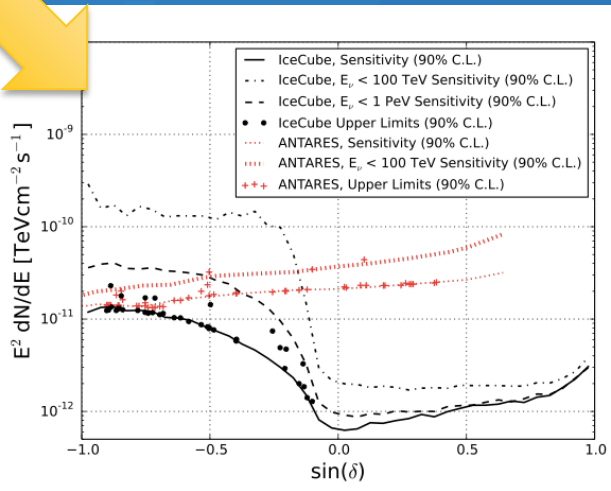


Not a public plot

Preliminary

Warning:
different method used!!!

IceCube values from Albrecht Karle



Caveat: the KM3NeT sensitivity is calculated with the Feldman-Cousins approach and the binned (cut-and-count) method … room for improvement

To do list

- Other potential sources and stack analysis
- Add the source morphology study (at the moment flat extension)
- Sensitivity with the unbinned method

BACKUP SLIDES