MSCA

Marie Skłodowska-Curie Actions

Neutrino follow-up of GRB190114C

Gwenhaël de Wasseige

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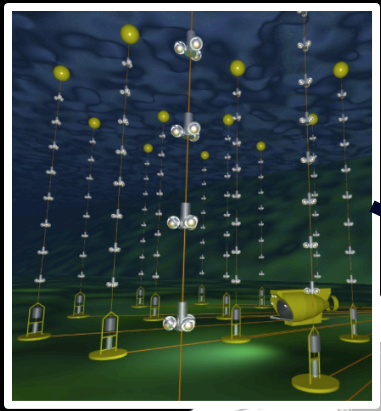
Neutrino follow-up of GRB190114C

Why relevant in short:
estimate the hadronic fraction of the detected EM flux

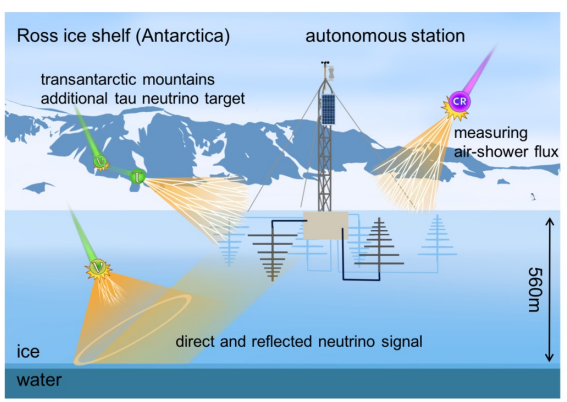
Gwenhaël de Wasseige

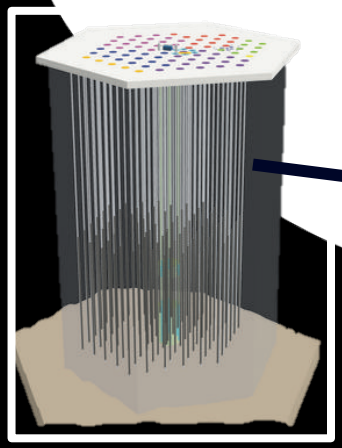
Neutrino telescopes



ANTARES

ARIANNA





IceCube

Unfortunately...

GRB190114C was not in an ideal position for these telescopes.

- IceCube:
  - $[t_0 - 150s, t_0 + 1h]$ in [100 TeV, 20 PeV]
- ANTARES:
  - $[t_0 - 350s, t_0 + 1250s]$ in [300 TeV, 3 PeV]
- ARIANNA:
  - $[t_0 - 150s, t_0 + 1h]$ in [100 TeV, 100 EeV]

where t_0 is the Swift-BAT trigger

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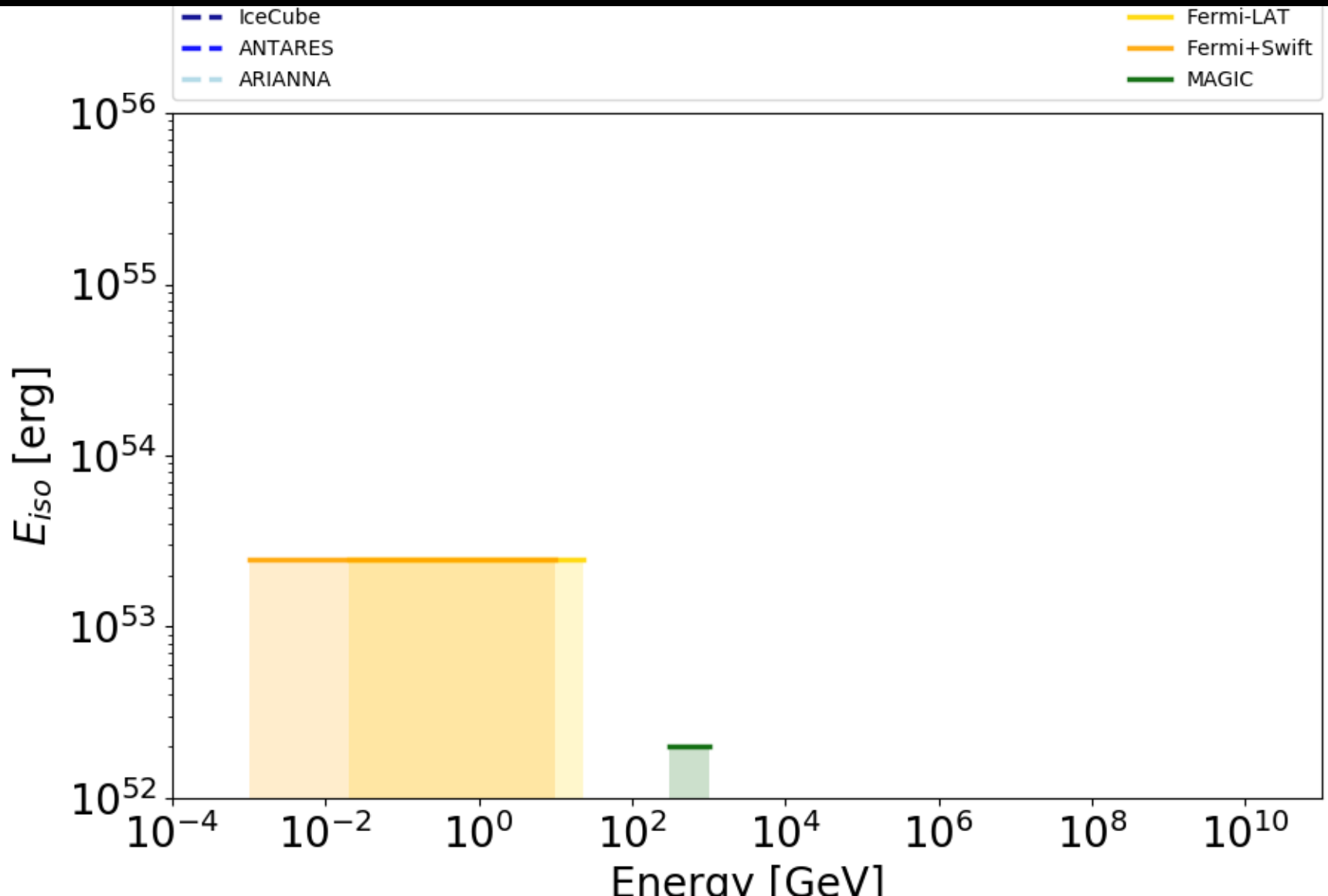
No significant detection

-> UL on the flux

where t_0 is the Swift-BAT trigger

Converting the UL to constraints on E_{iso}



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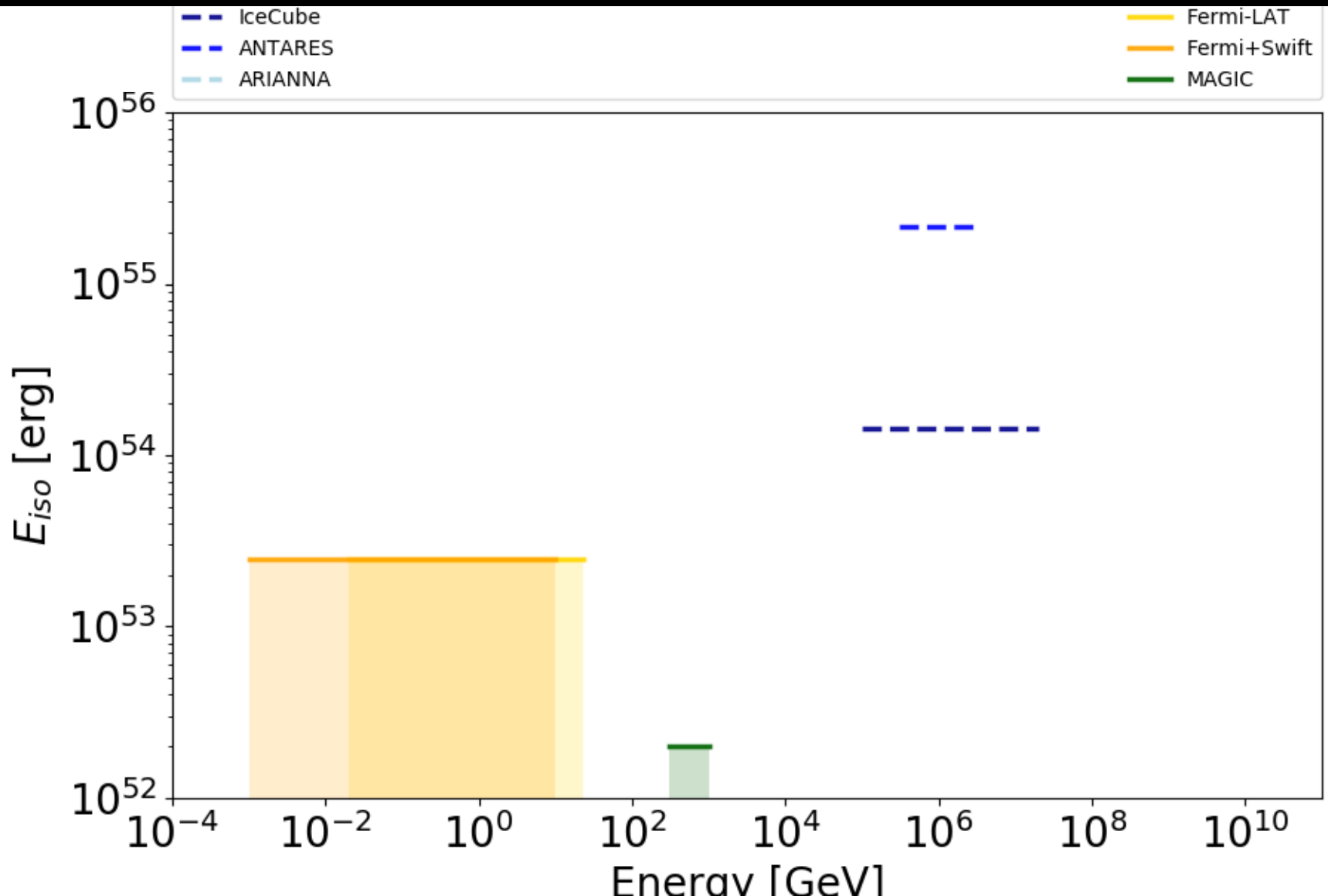

Do we expect neutrinos from GRBs?

- From previous neutrino searches from GRBs:

  Classical GRB: < 1 % of the diffuse flux seen by IceCube

- Let's not over-interpret the results:
  - Constraints are much weaker at EeV
  - Constraints are much weaker at GeV-TeV
  - Constraints are weaker for longer-lasting emission
  - Not applied to other transients

Inspired by K. Murase's slide

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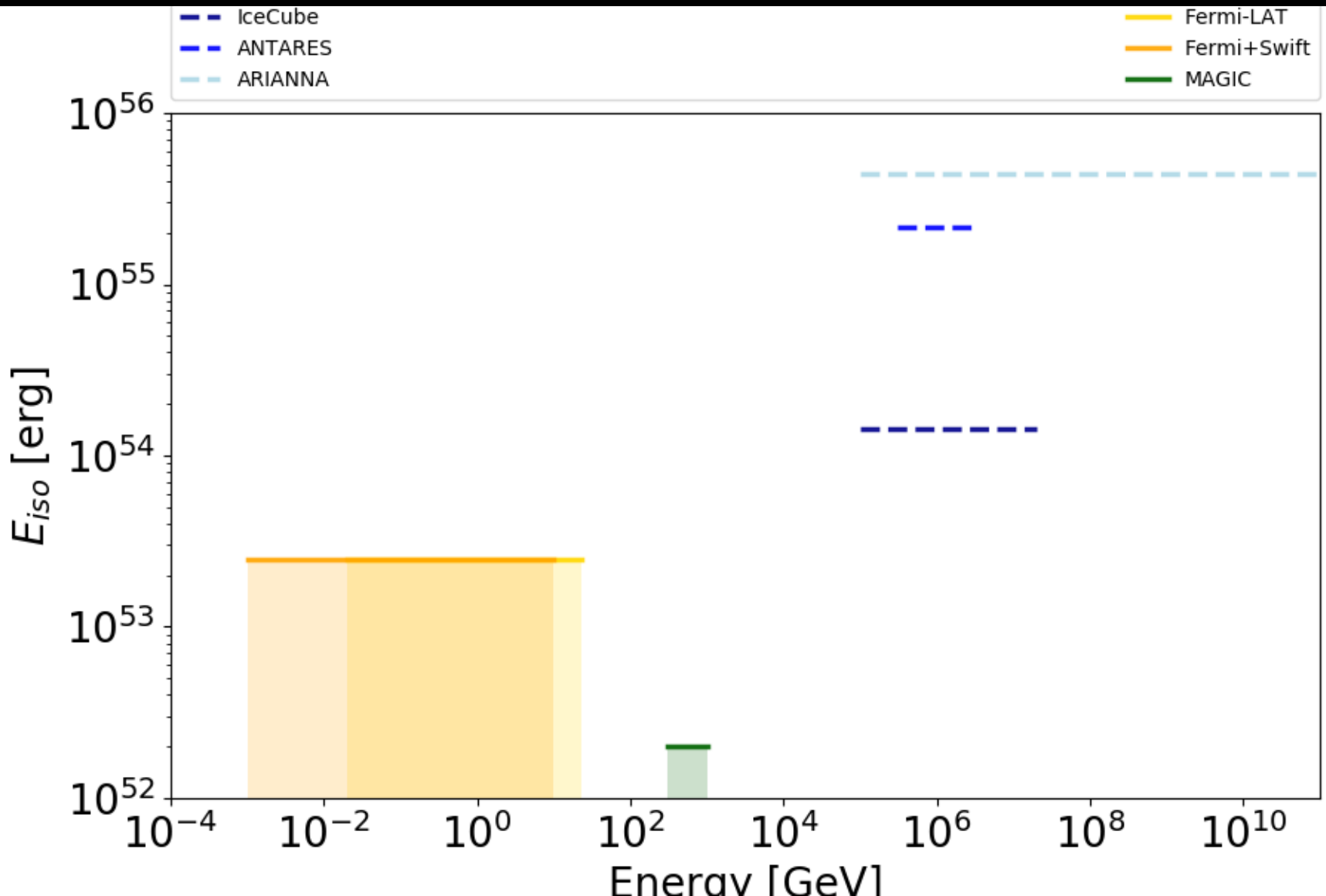


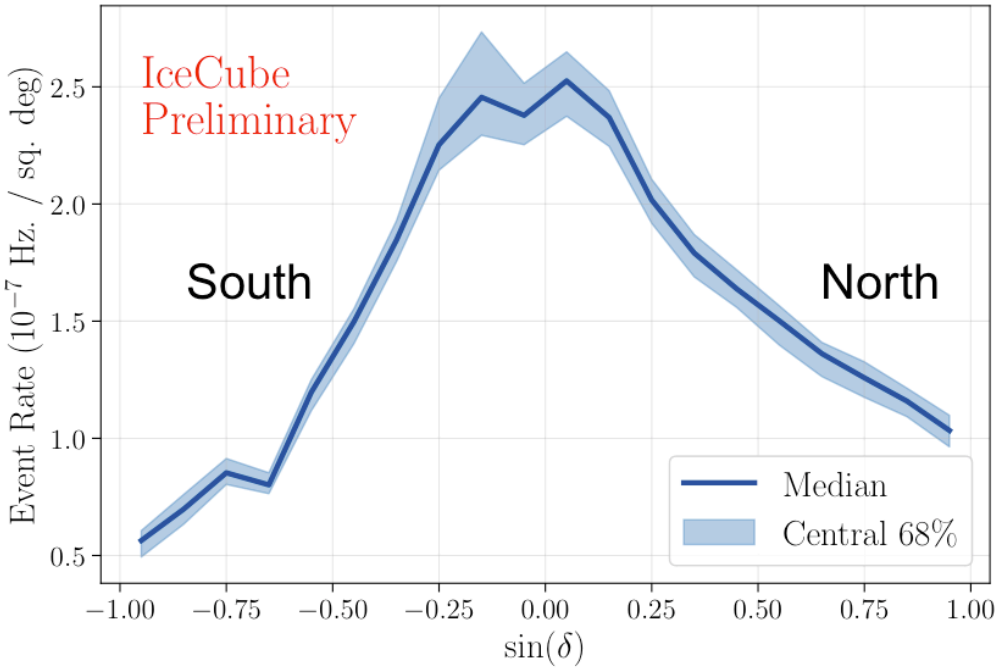
In the future

- Other localizations may lead to more stringent constraints
- KM3NeT will improve the sensitivity in the sub-GeV to PeV range

  -> improved constraints for all phases of the GRB
- More radio neutrino telescopes coming (GRAND, RNO,…)

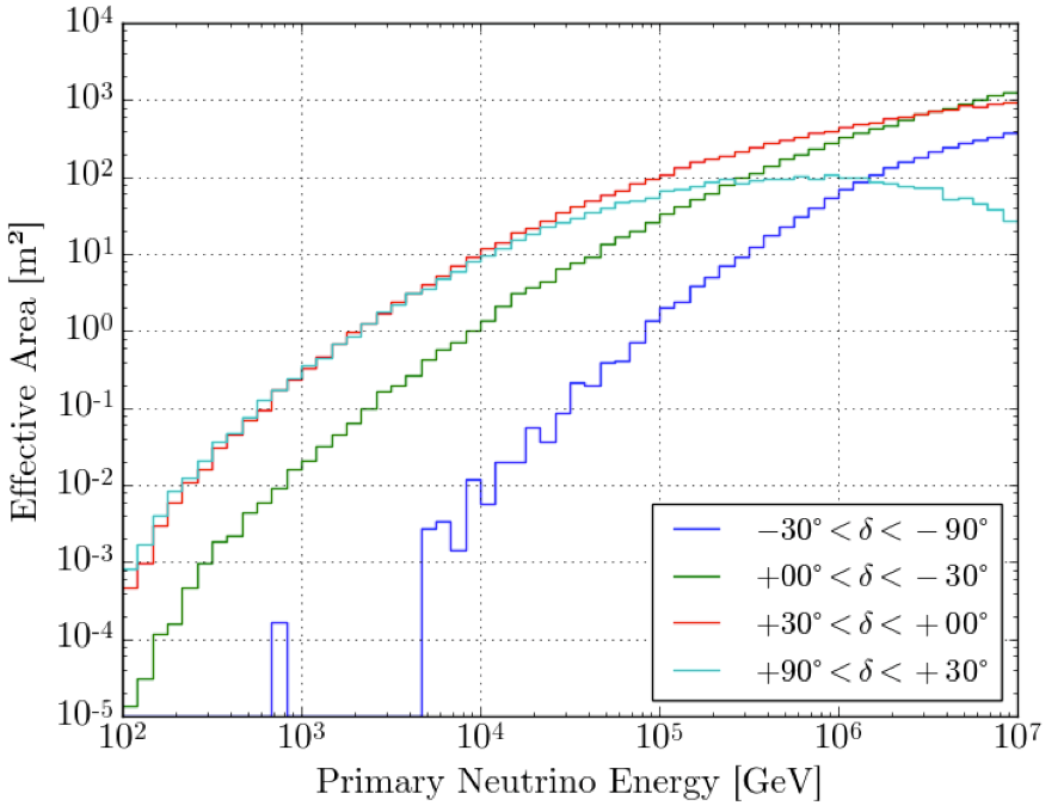
Thanks!

Event selection: background rate



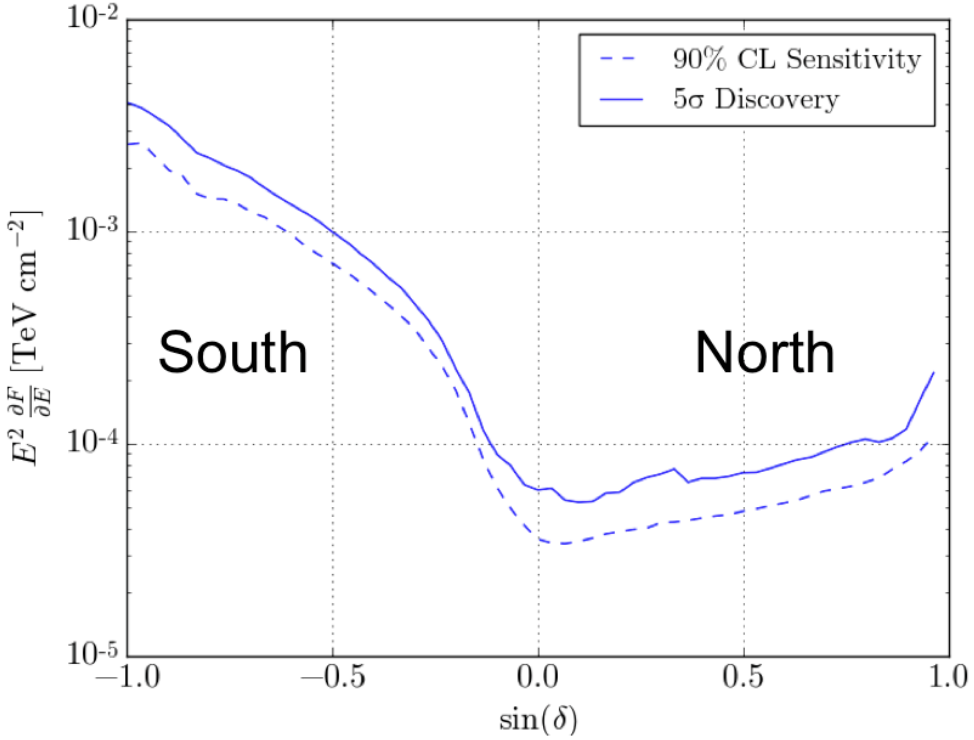
- Low-latency "GFU" event selection, originally developed for gamma-ray follow-up
- Time from neutrino interaction to reconstructed event (energy, direction, and direction uncertainty estimate) arriving in Madison: **mean latency 0.5 min**
- Event rate (mostly atmospheric neutrinos from North and atmospheric muons from South) varies with declination and time of year
- Across full sky: one event every ~3 minutes
- Within ~1° angular resolution: one event every few weeks (depending on dec.)

Event selection: effective area

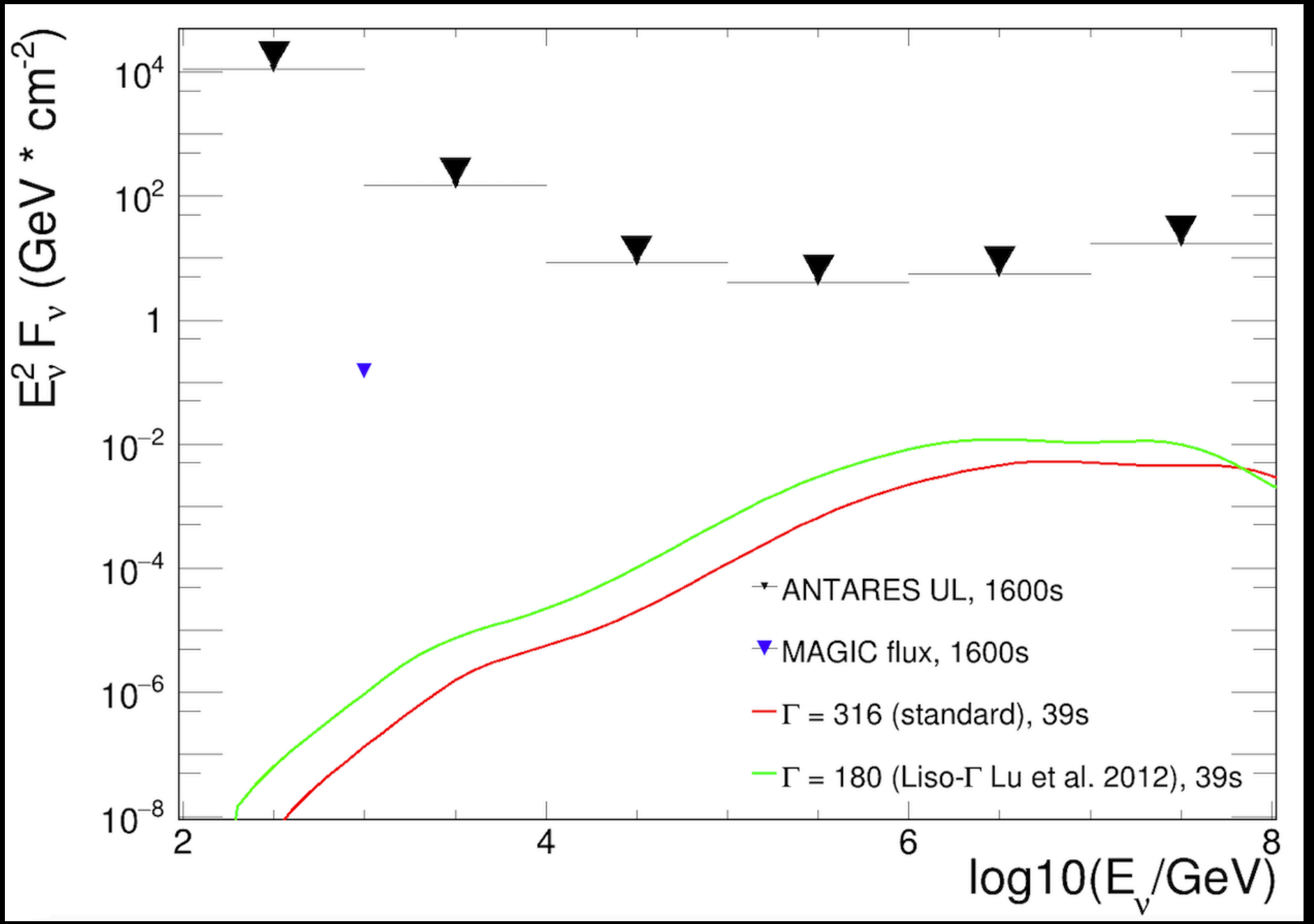


- **Full sky (4π) sensitivity**
- Greater effective area in Northern hemisphere than Southern hemisphere (harder cuts used in South to reduce atmospheric muons)

Point source sensitivity (Example for 10^5 second duration search window)



- Sensitivity better in North than South; best sensitivity near celestial equator
- "Sensitivity": expected value of upper limit
- "Discovery potential": minimum necessary for 5σ discovery in 50% of realizations
- Method: un-binned maximum likelihood (J. Braun et al. Astropart. Phys. 33, 3, 2010)


$E_\nu^2 F_\nu$ (GeV * cm^{-2})
10^4
10^2
1
10^{-2}
10^{-4}
10^{-6}
10^{-8}
2
4
6
8
log10(E_ν/GeV)
ANTARES UL, 1600s
MAGIC flux, 1600s
Γ = 316 (standard), 39s
Γ = 180 (Liso-Γ Lu et al. 2012), 39s