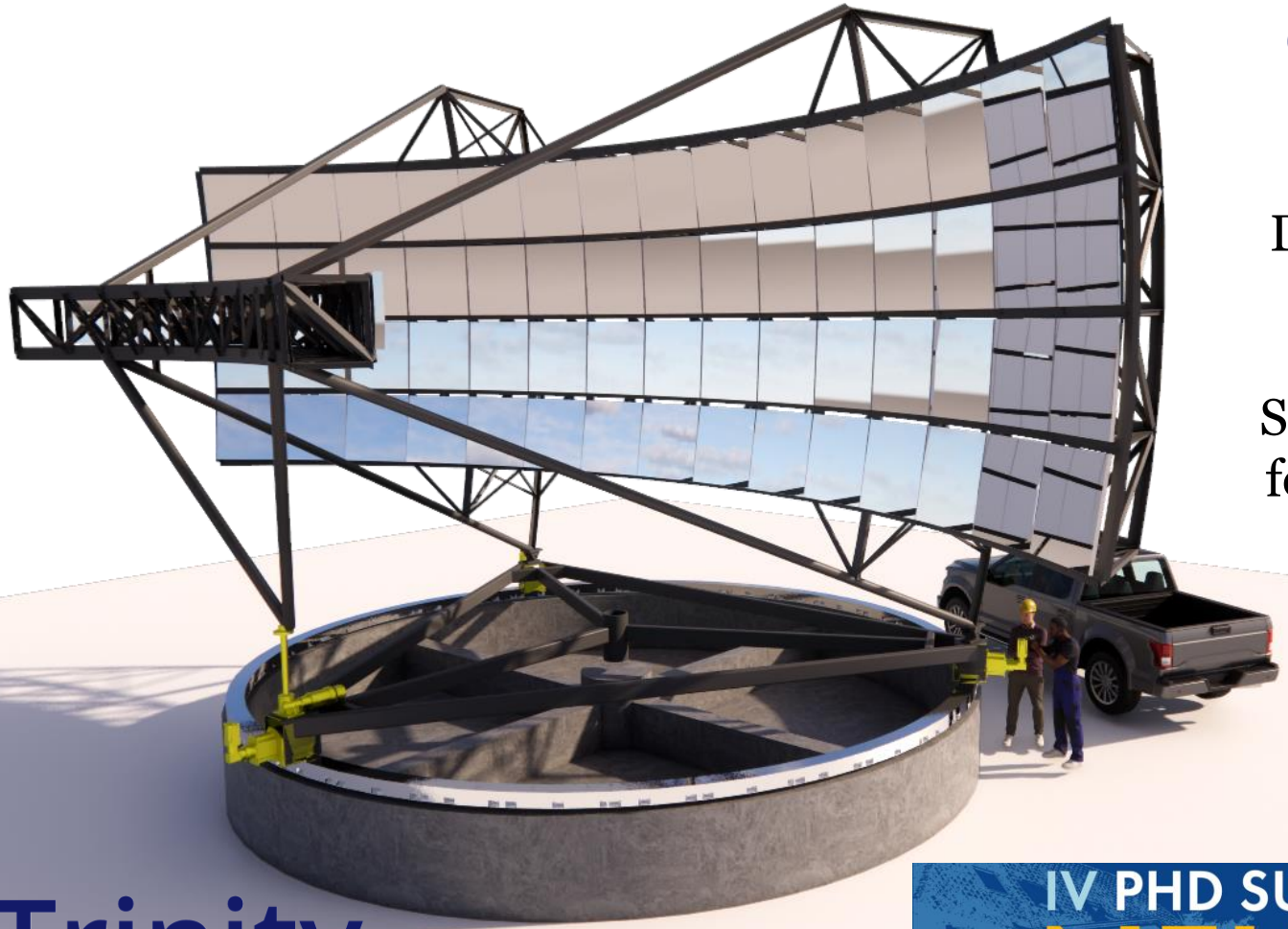
Neutrino Detection Forecasts: Estimates for the Trinity Observatory



David A. Raudales O. for the Trinity Collaboration

School of Physics and Center for Relativistic Astrophysics, **Georgia** Institute of **Tech**nology

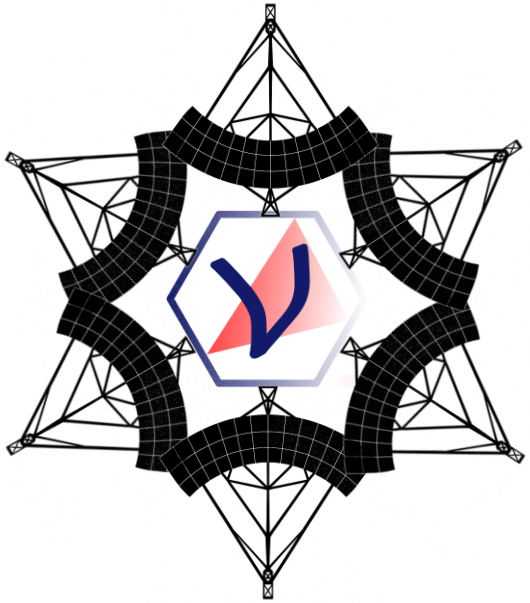
trinity-observatory.org

Trinity

IV PHD SUMMER SCHOOL ON
NEUTRINOS
HERE, THERE & EVERYWHERE

How does Trinity detect neutrinos?

How can Trinity contribute to GRB physics?



What makes Trinity different from other neutrino telescopes?

Could Trinity observe blazar flares?

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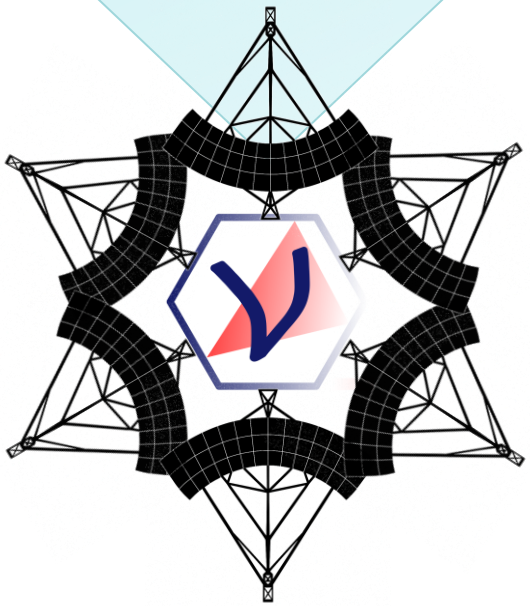

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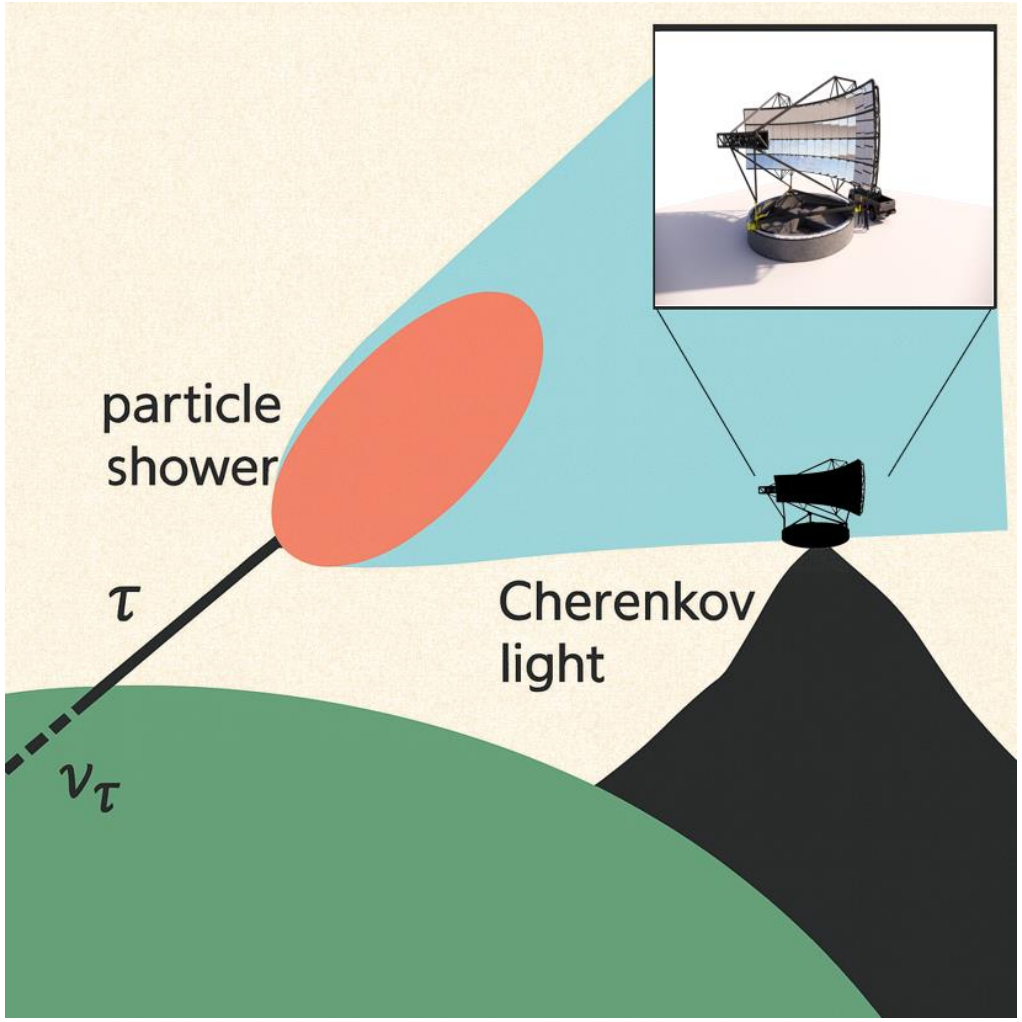

- Earth-skimming neutrino detection technique with an air shower imaging telescope.

- Imaging technique well proven by the gamma-ray community.

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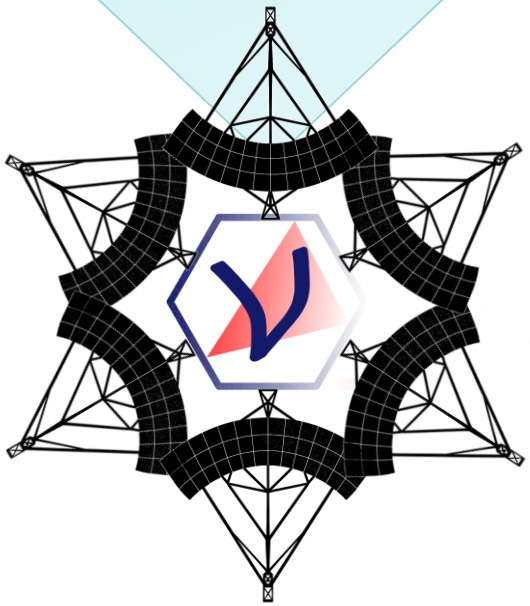

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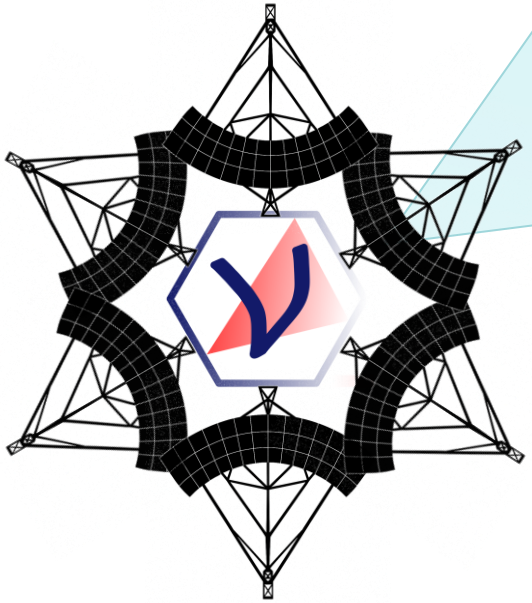

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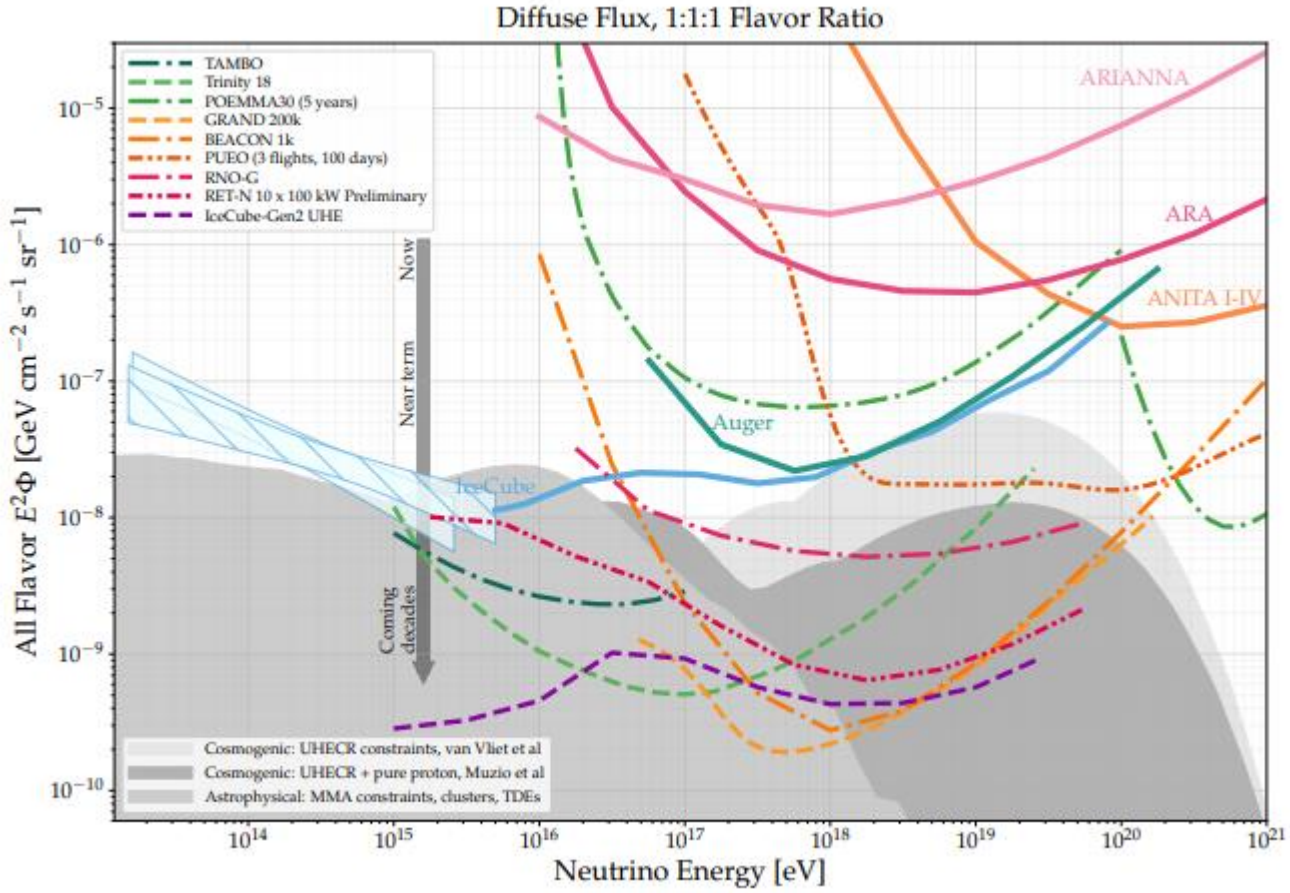

Snowmass 2022

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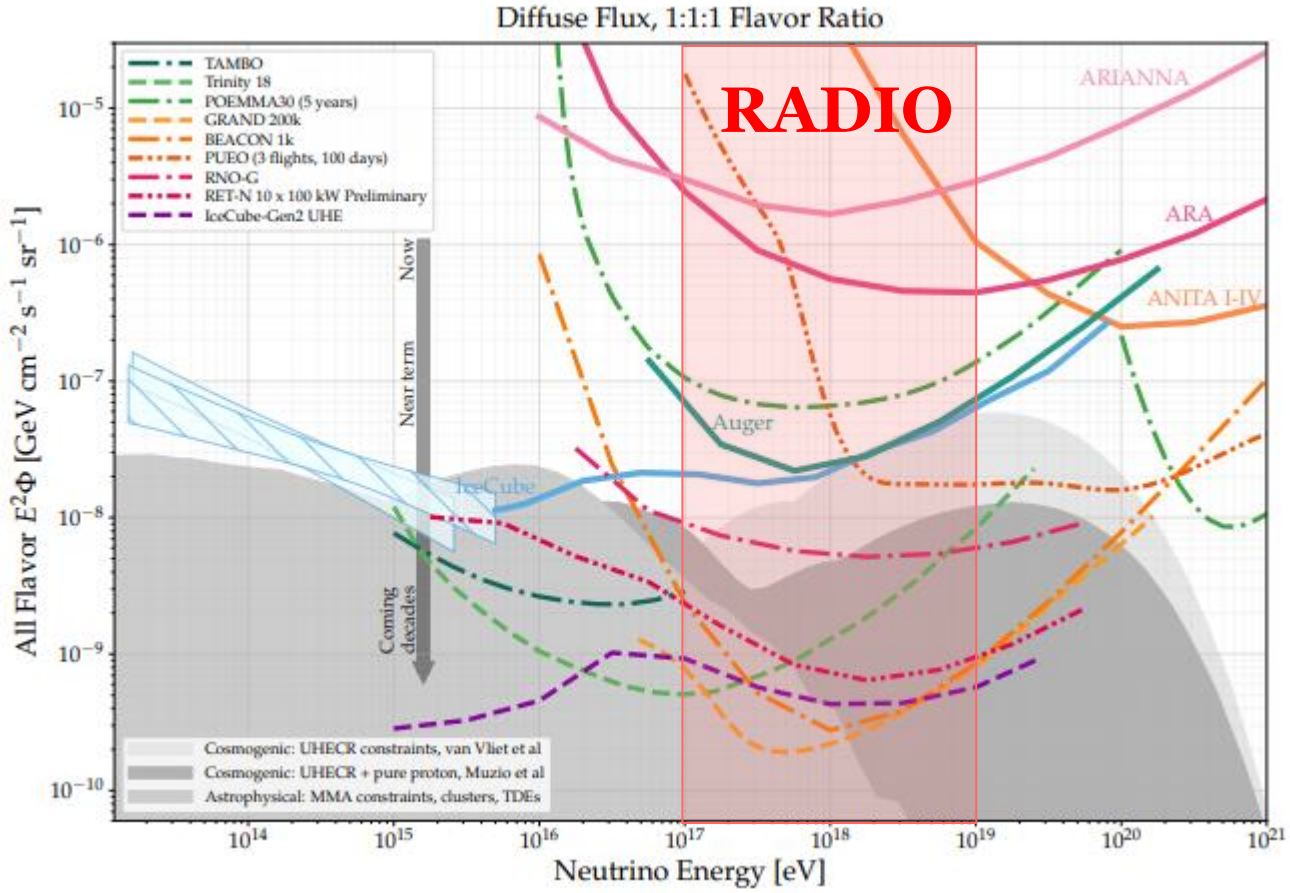

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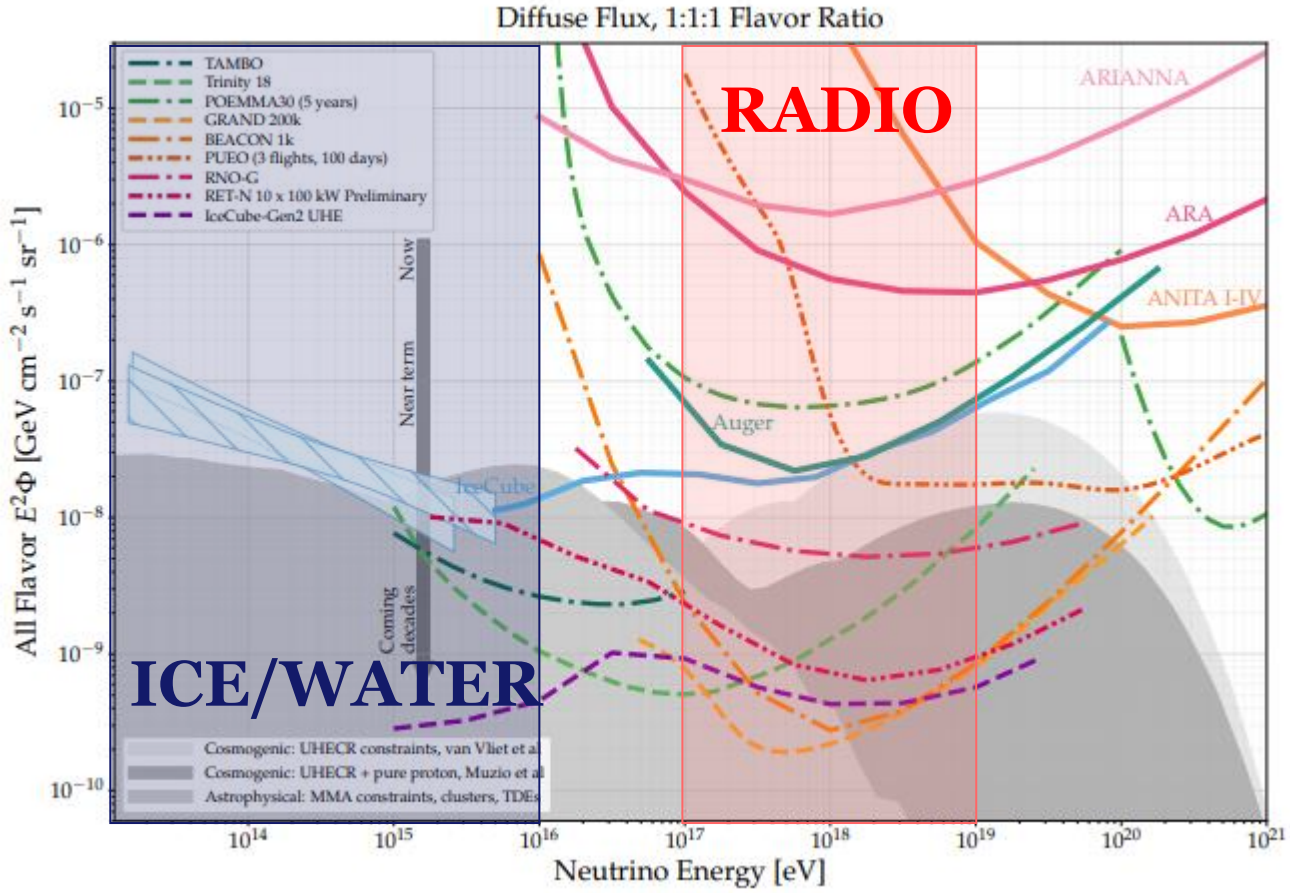

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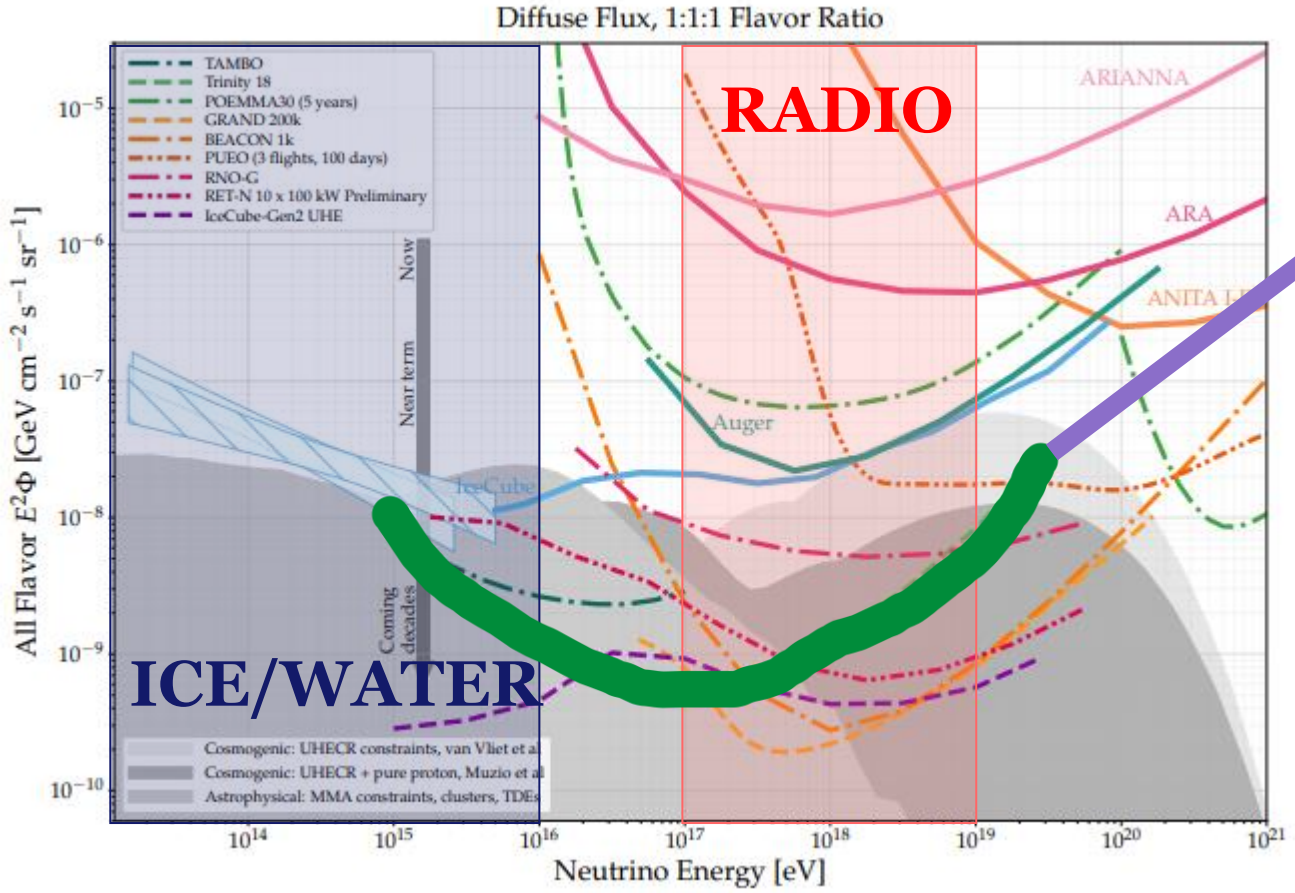

Snowmass 2022

- Closes the gap between ice/water Cherenkov telescopes and radio detectors

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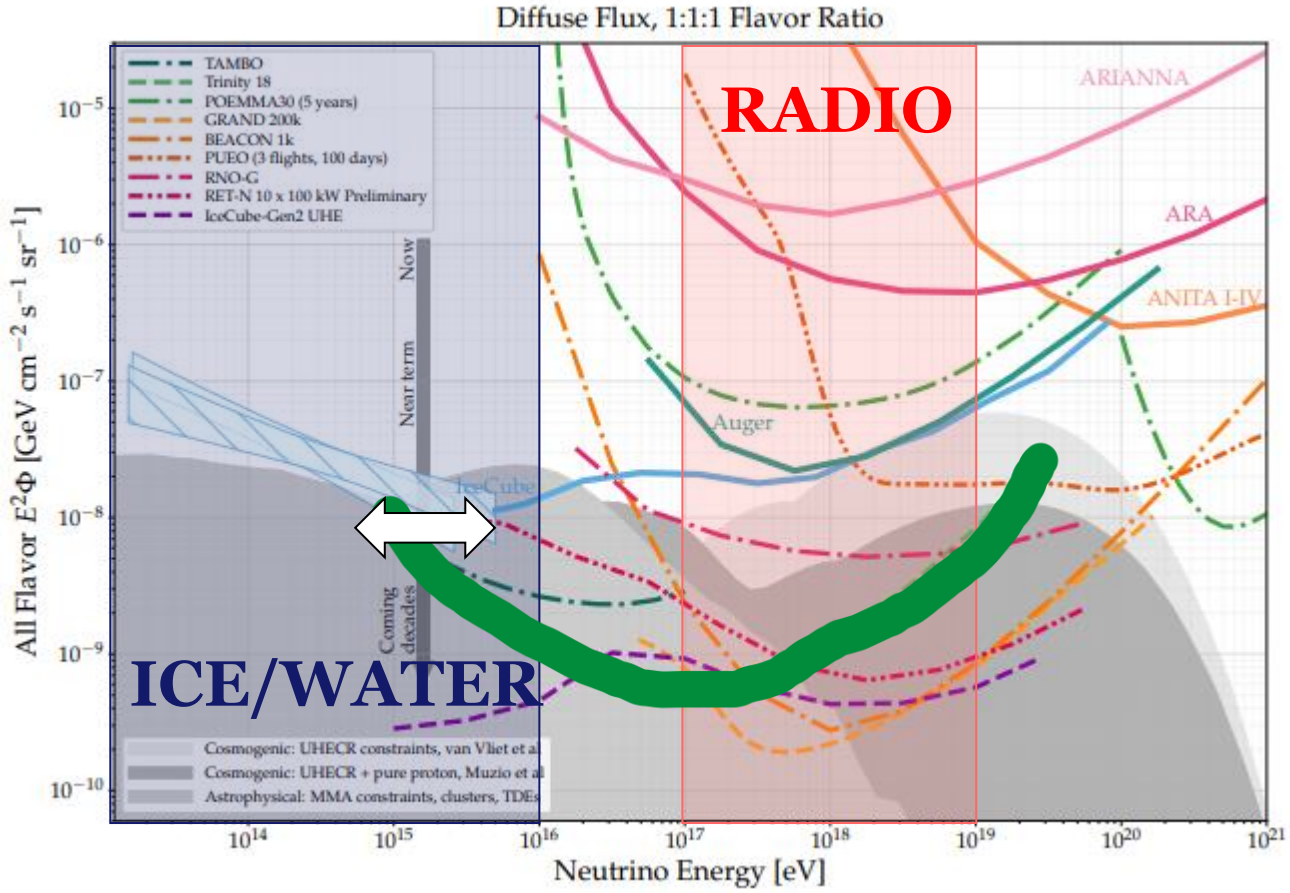

Snowmass 2022

- Closes the gap between ice/water Cherenkov telescopes and radio detectors
- Overlap with IceCube ensures neutrino detection.

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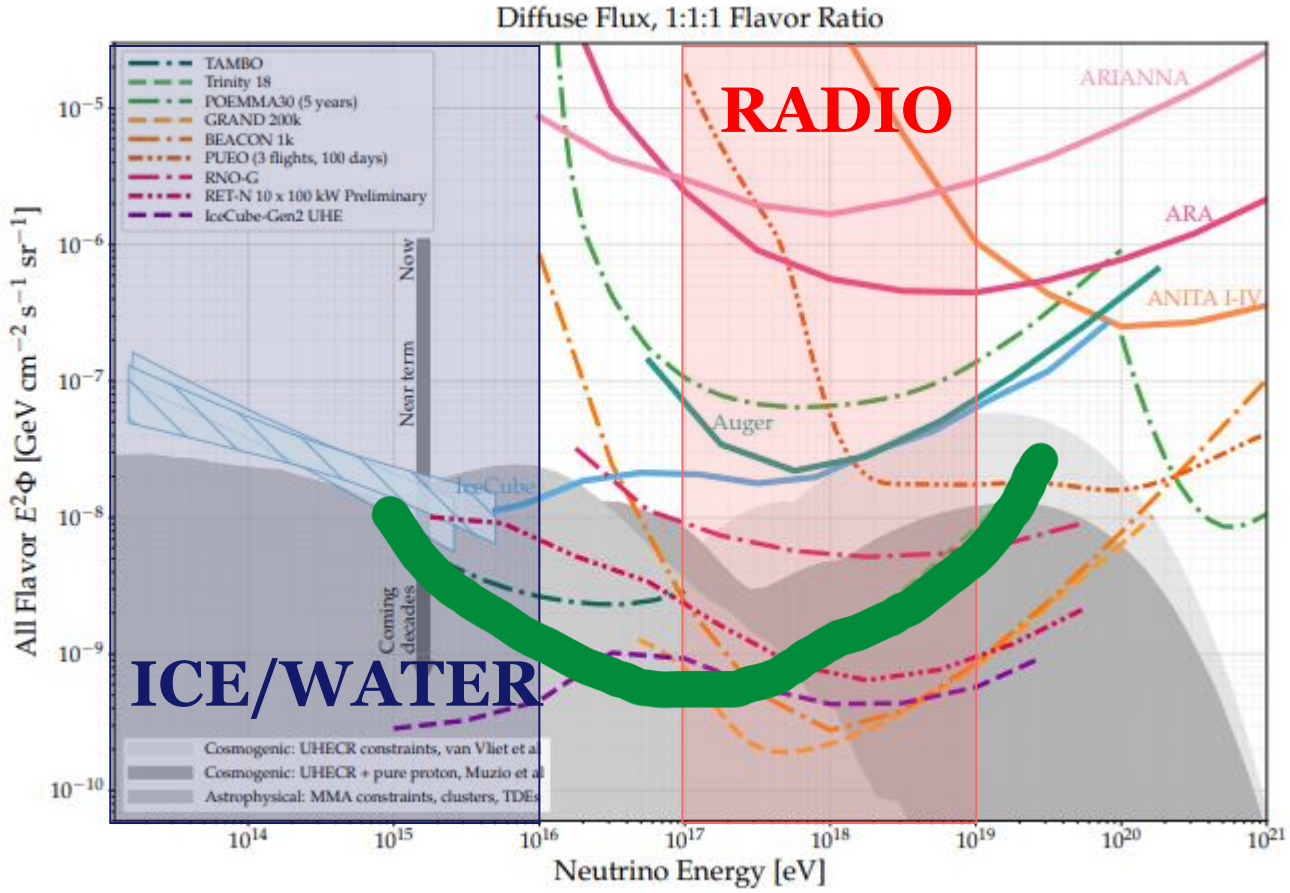

- Expect no background.

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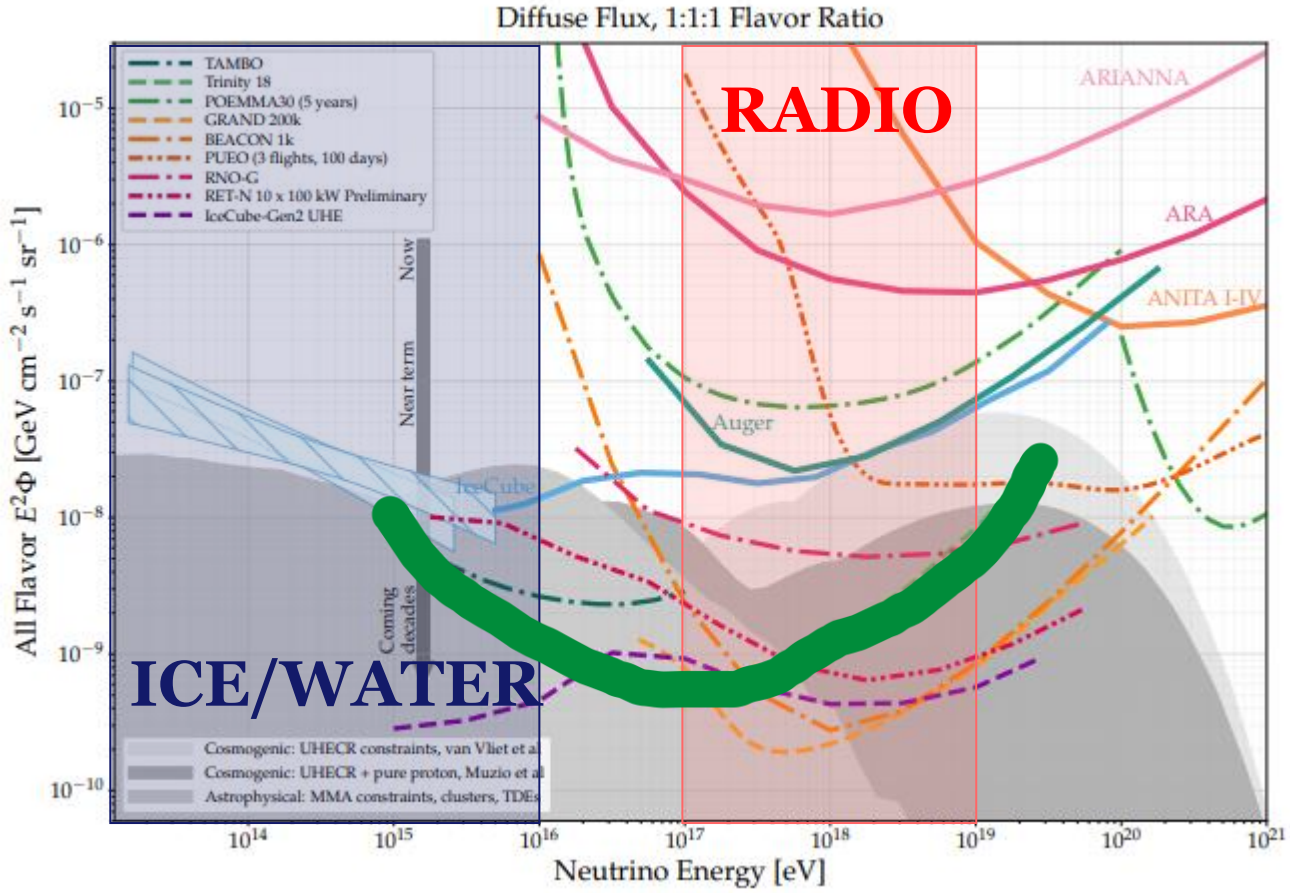

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- Camera yields 0.3° angular resolution.

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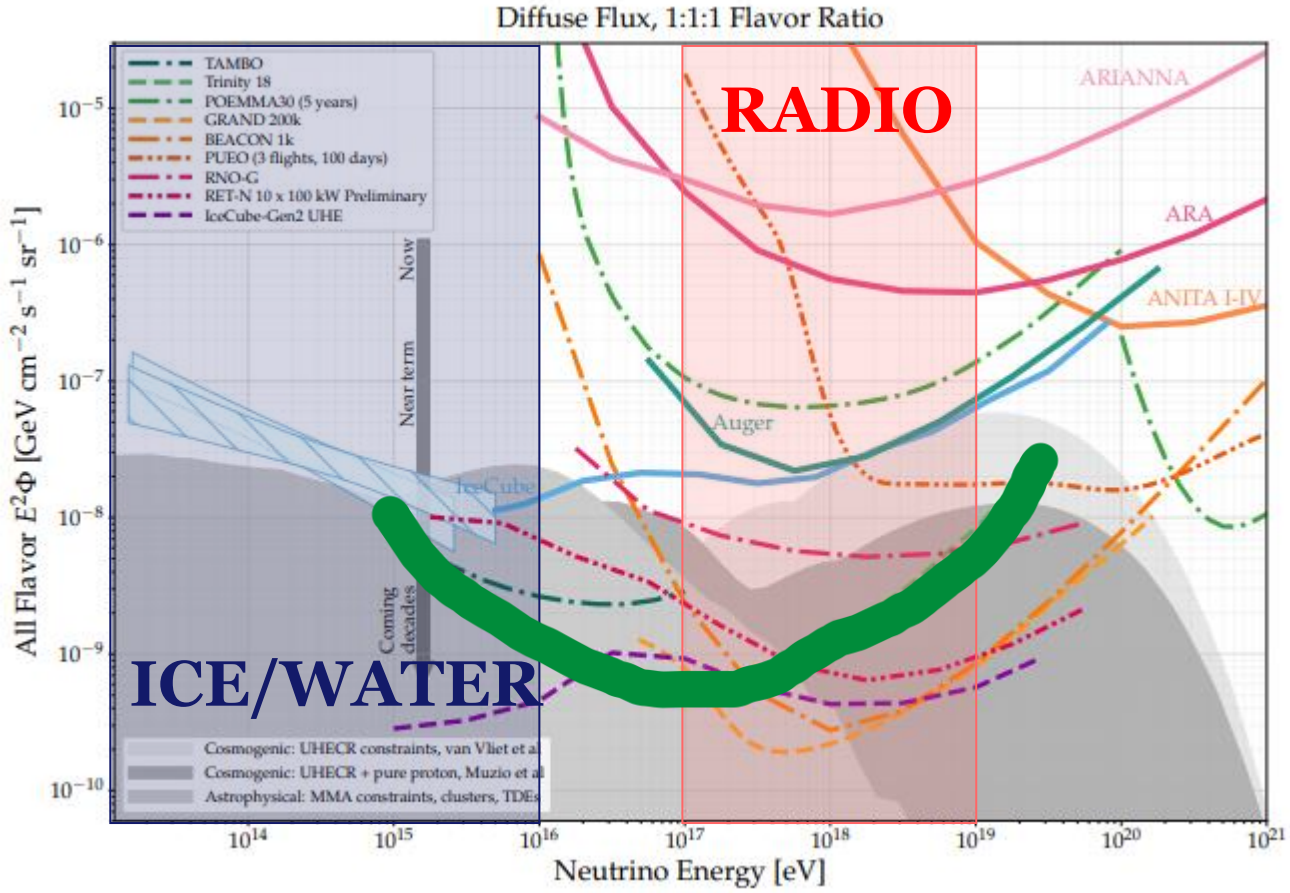

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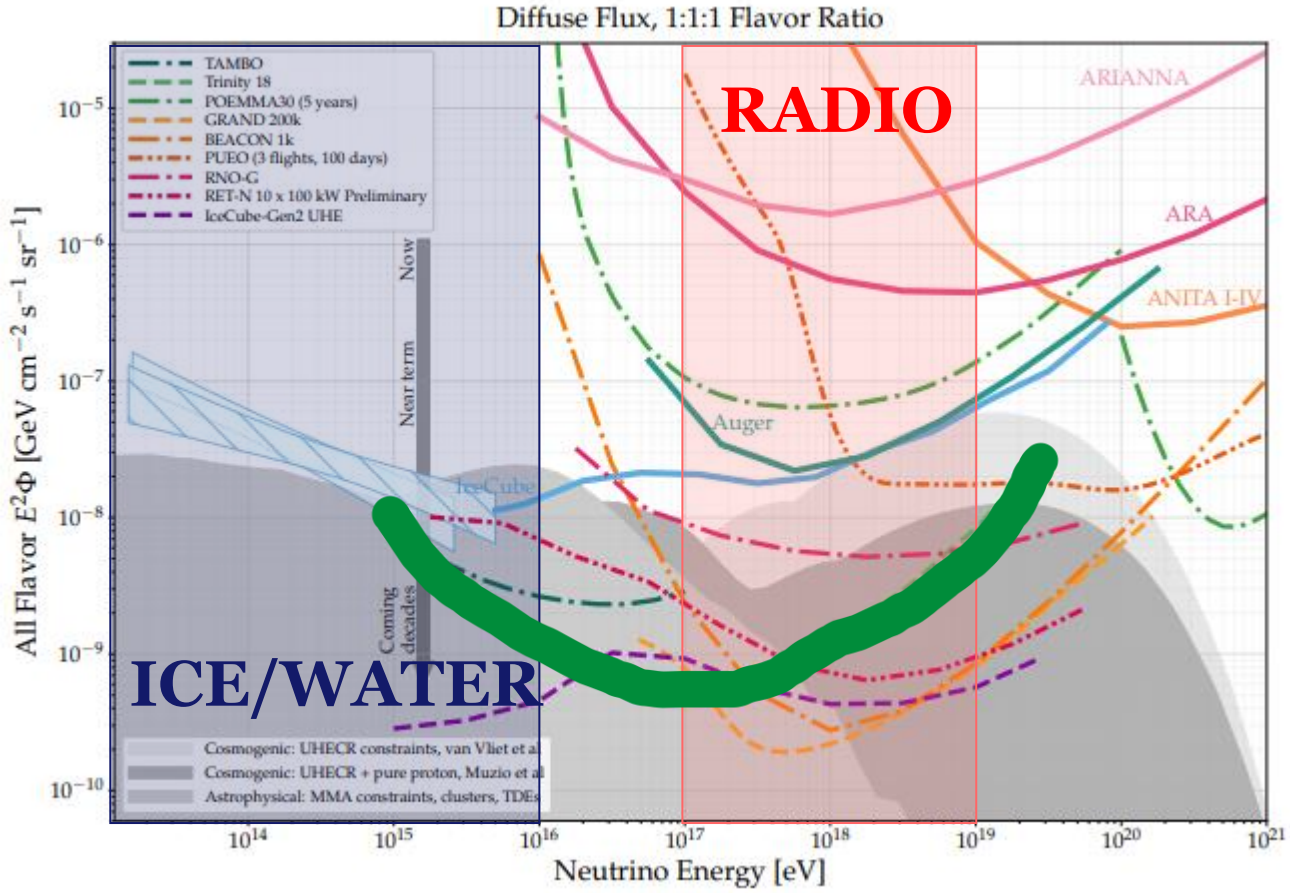

Snowmass 2022

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- Deep point source sensitivity.
- Proves the imaging technique as a valid method for UHE neutrino searches

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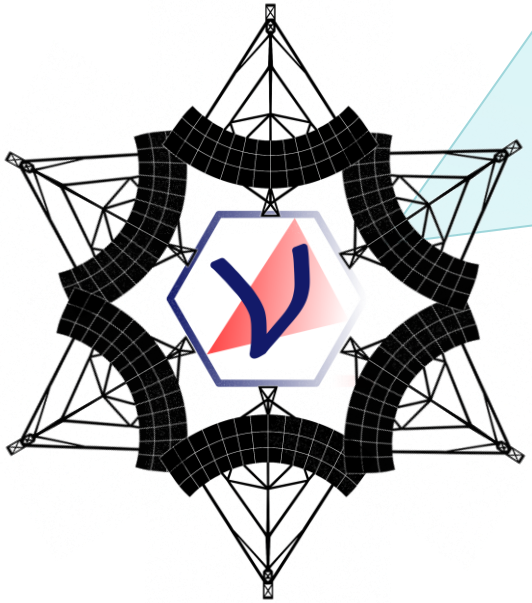

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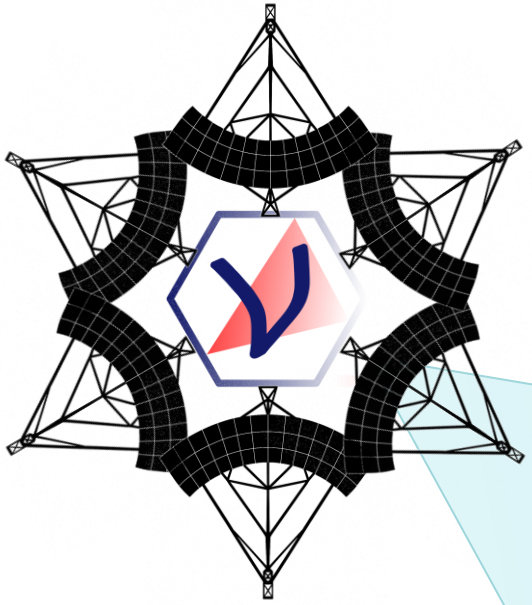

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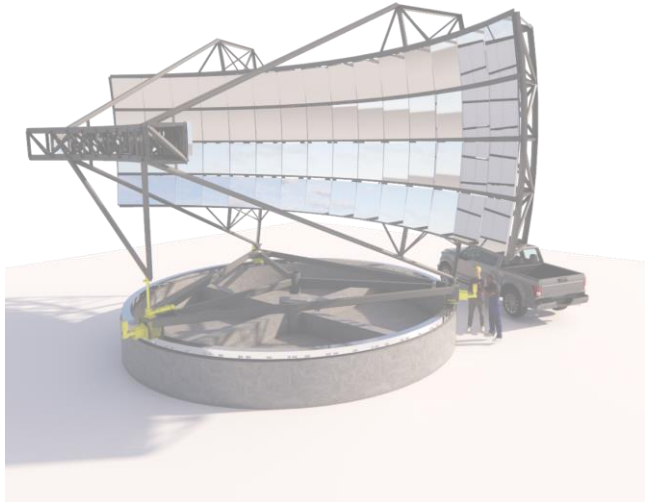

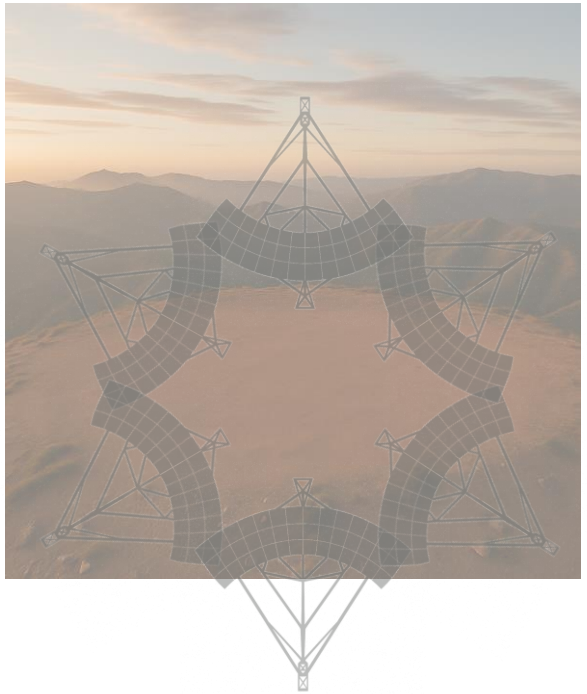

- Area -> 1 sq meter
- Field of View -> 3.87°x3.87°
- Resolution -> 0.24 °

2021 Demonstrator Funding

2023 Data Taking

Demonstrator

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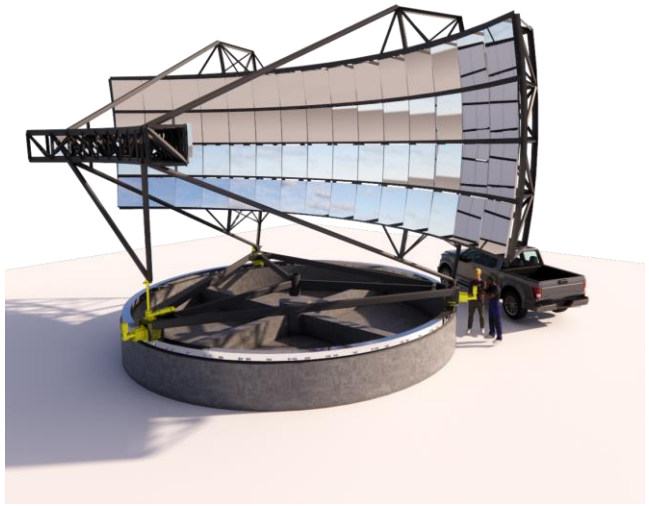
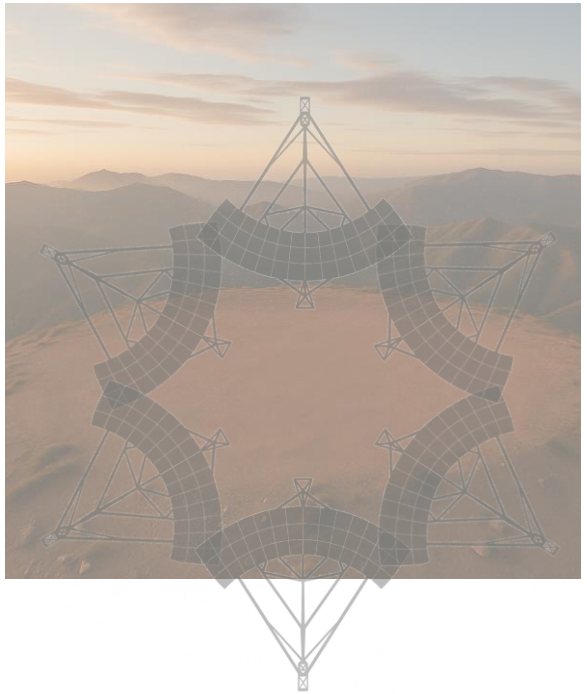


- Area -> 16 sq meter
- Field of View -> 60°x5°
- Resolution -> 0.3 °



2021 Demonstrator Funding

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2026 Trinity One Funding (?)

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Trinity One

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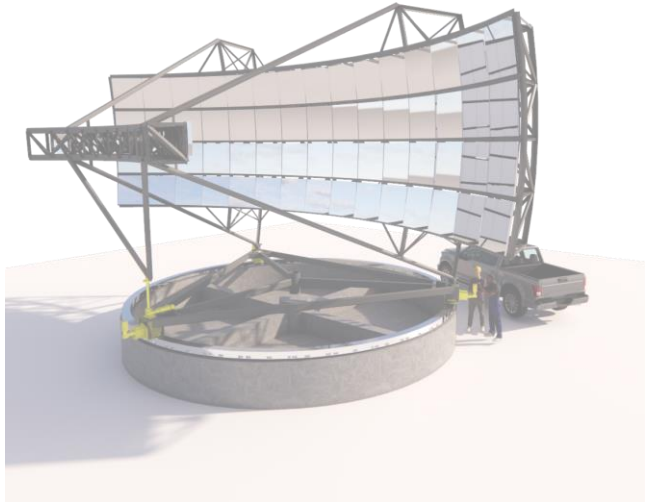

- Area -> 16 sq meter
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- 3 sites
- 6 telescopes per site

2021 Demonstrator Funding

2023 Data Taking

Demonstrator

2026 Trinity One Funding (?)

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2031 Trinity Observatory Funding (?)

Trinity Observatory

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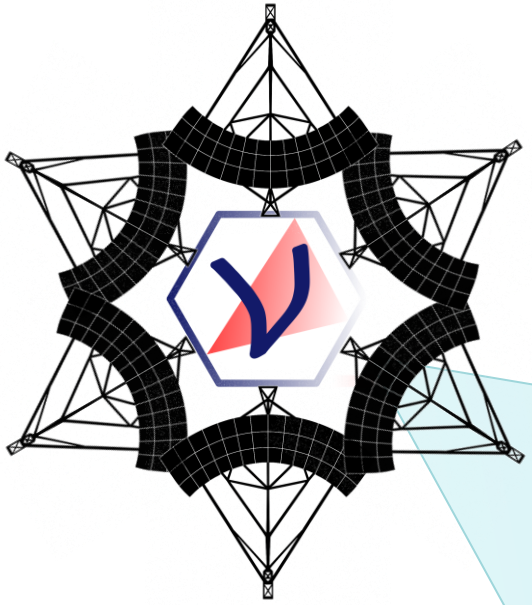

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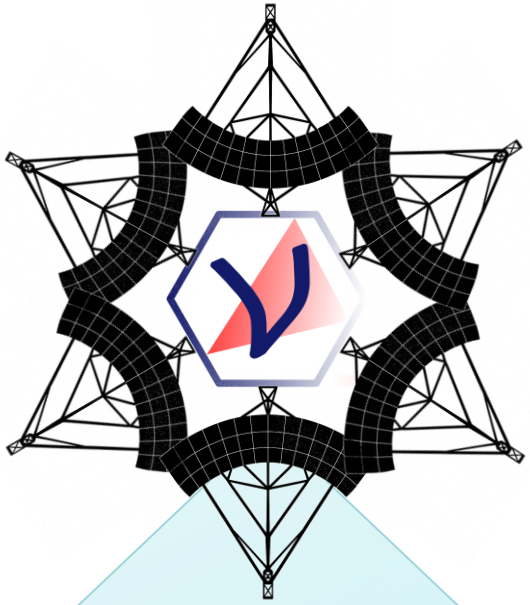

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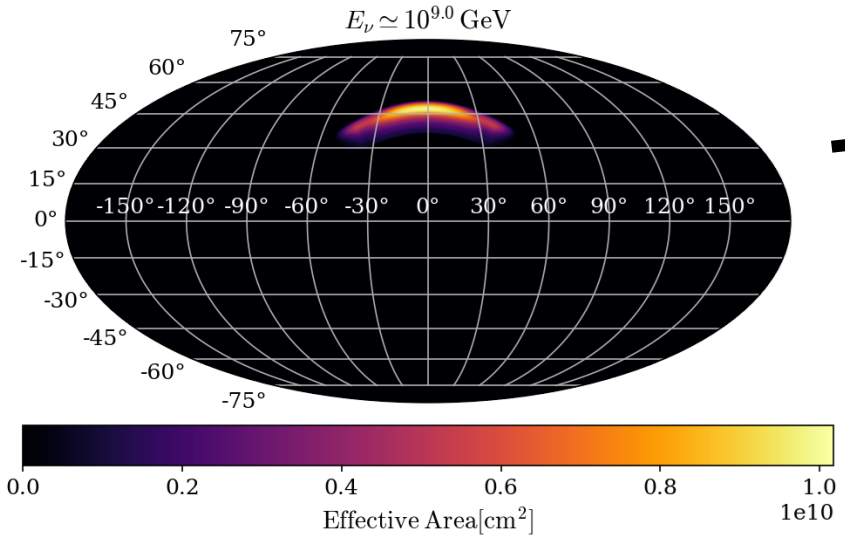
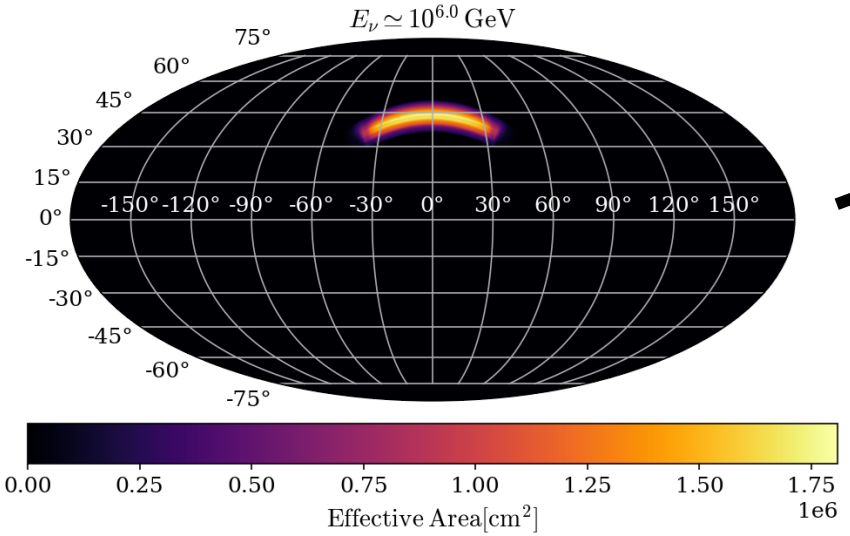
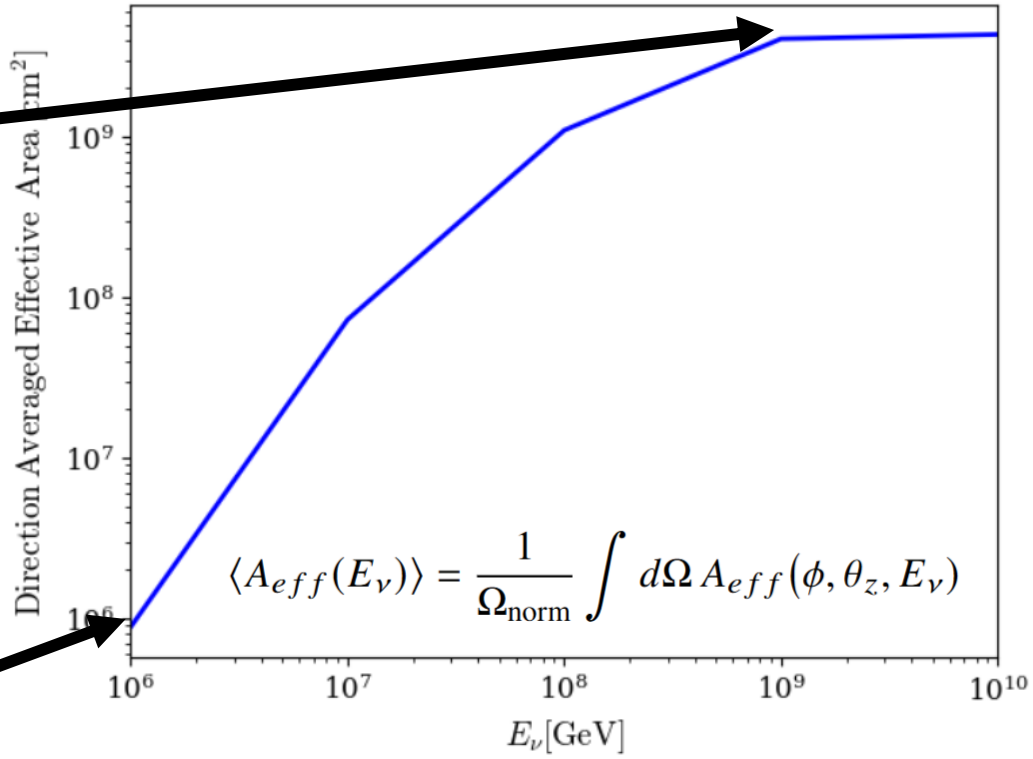
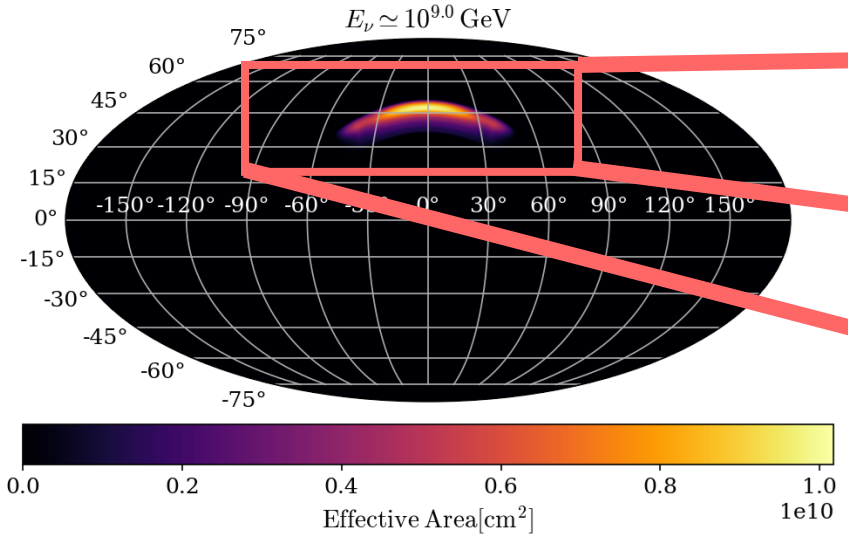


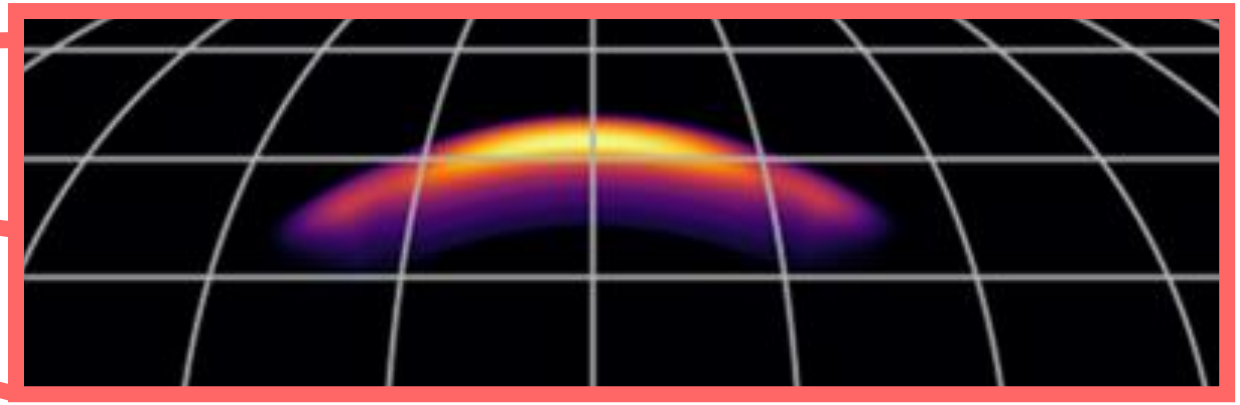


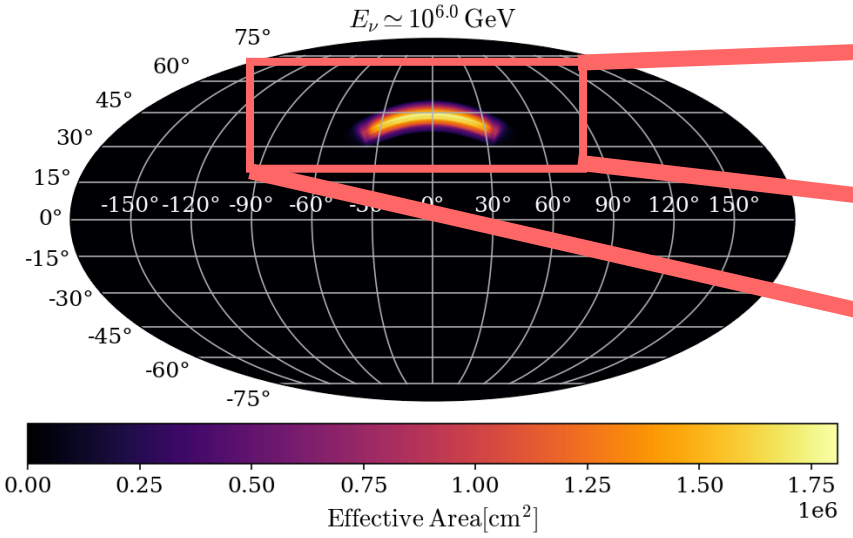


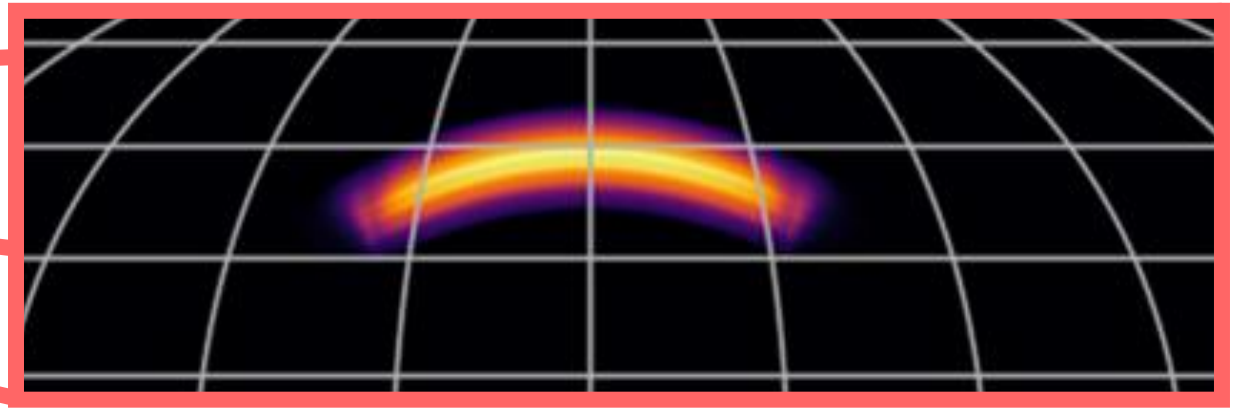
- Simulations with Corsika and NuTauSim

What is Trinity's detection capability?









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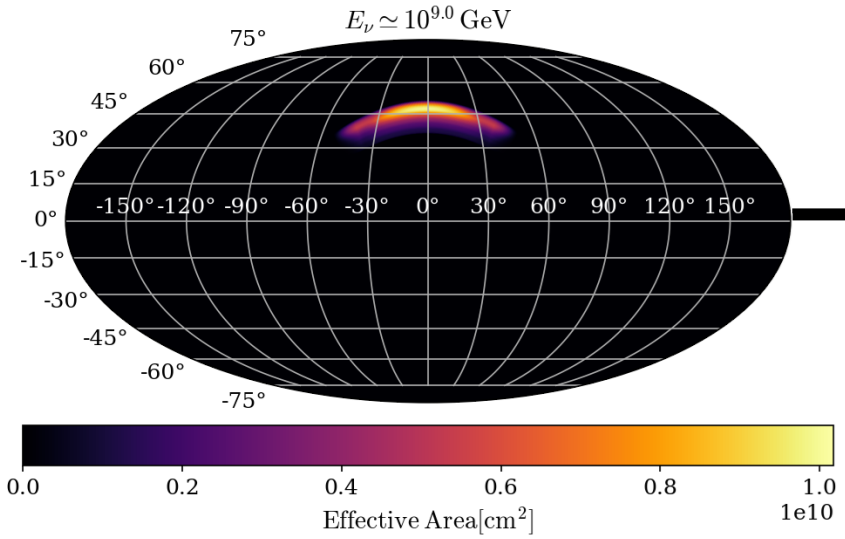
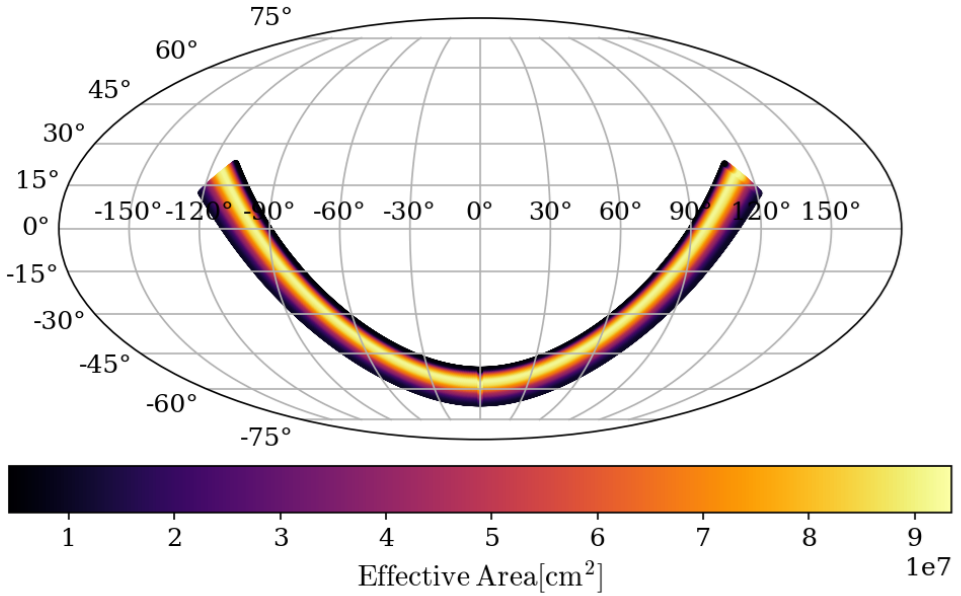
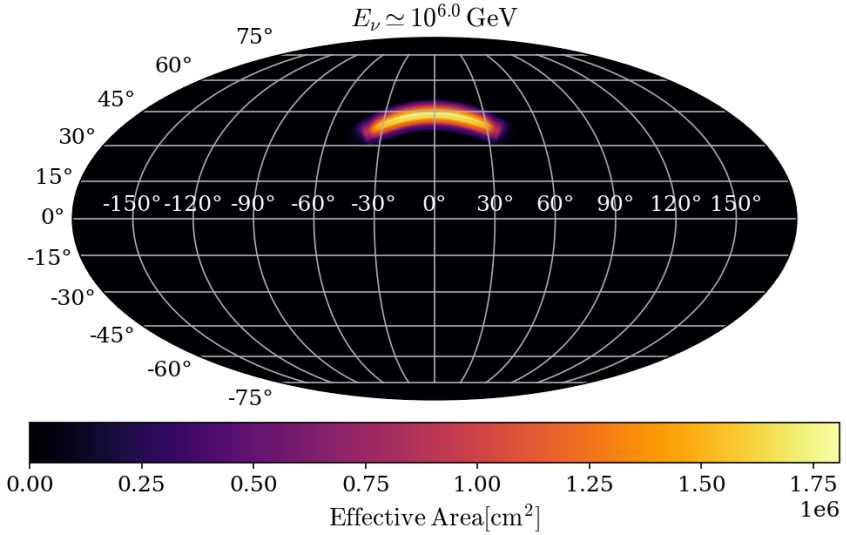


Accesible sky with repointing





$$\mathcal{A}(\phi, \theta_z) = \frac{1}{N} \int dt \int dE_\nu A_{eff}(\phi, \theta_z, E_\nu) E_\nu^{-2}$$

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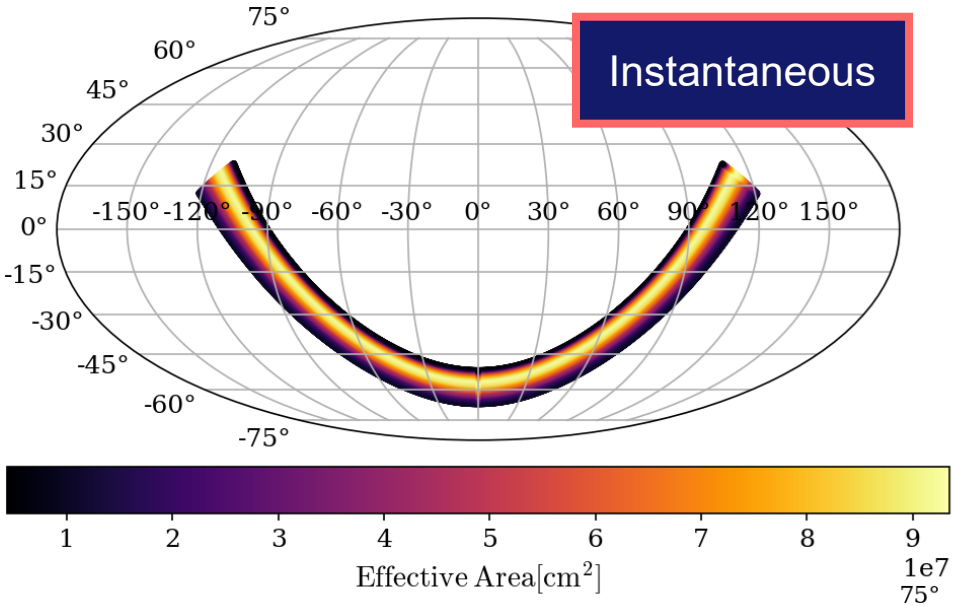

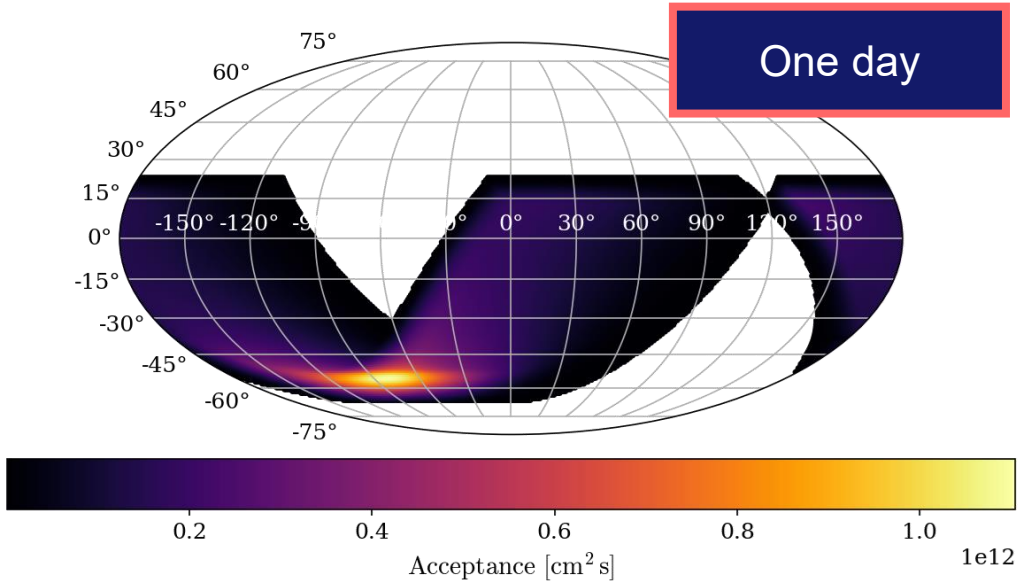

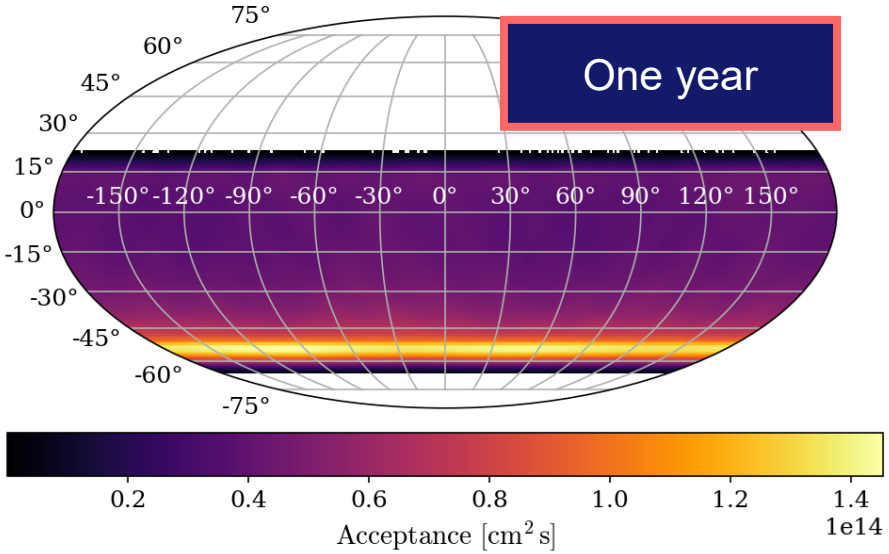

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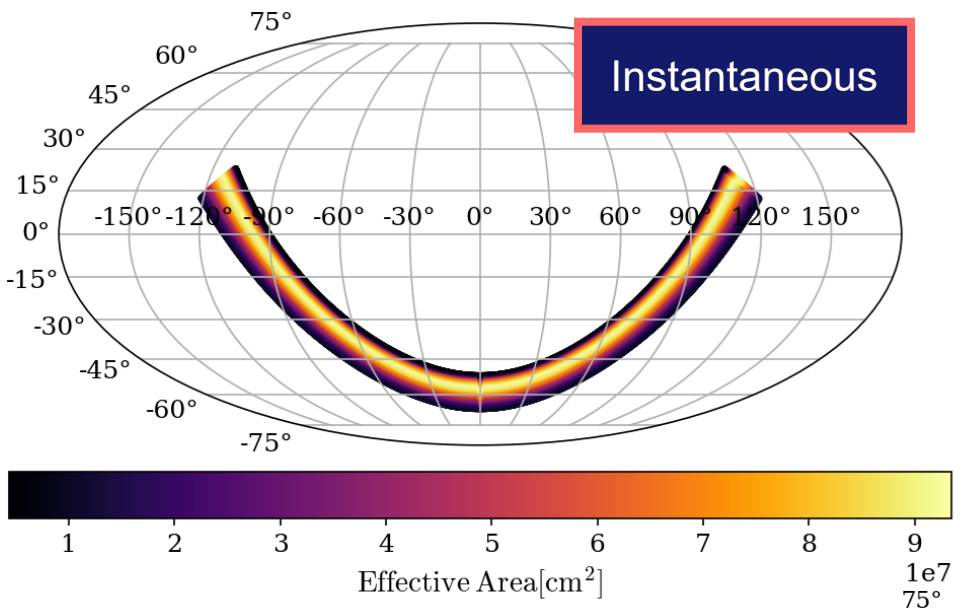
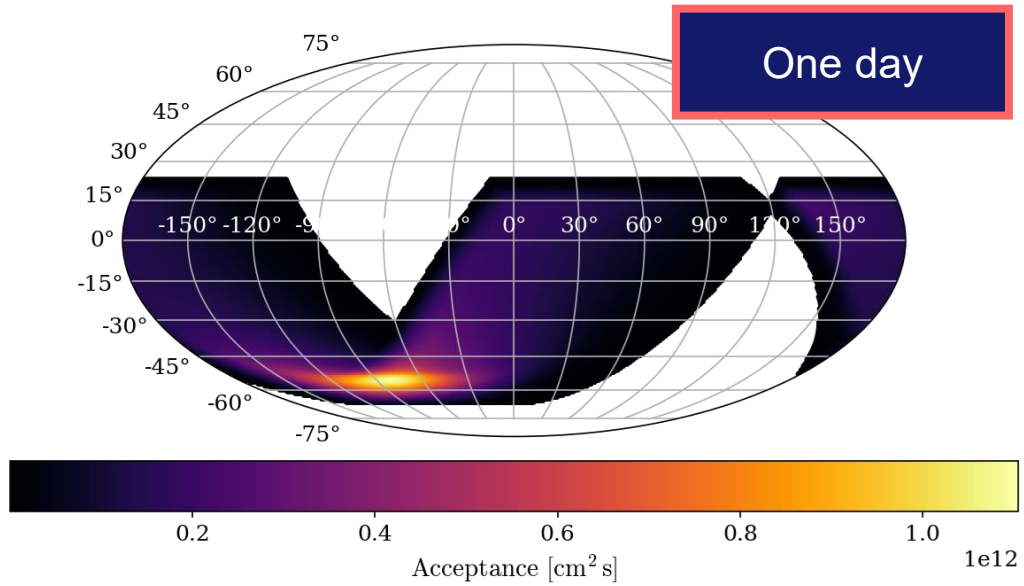
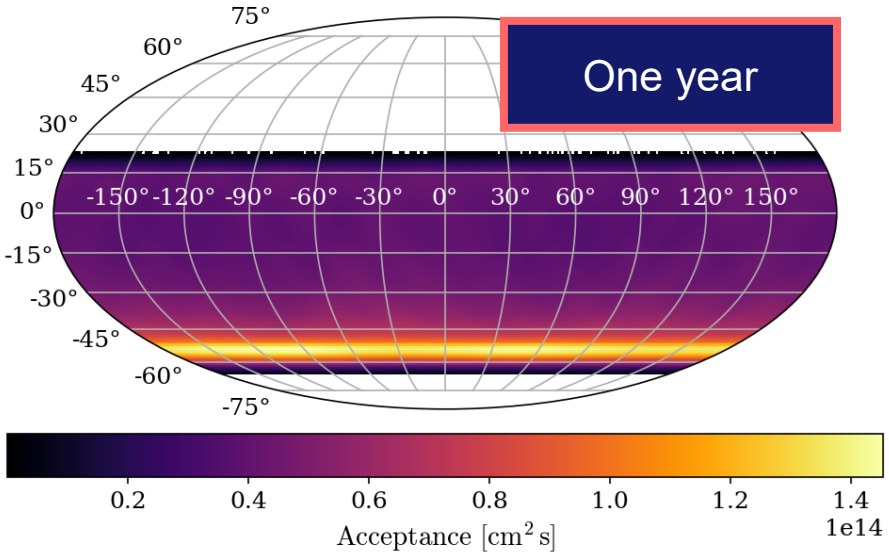




20% duty cycle



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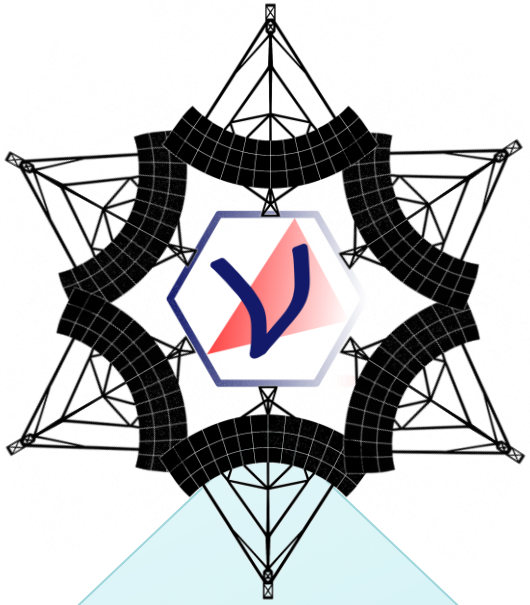

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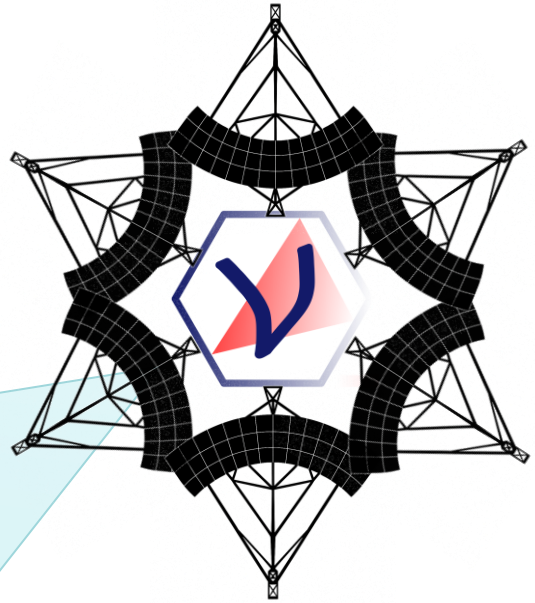

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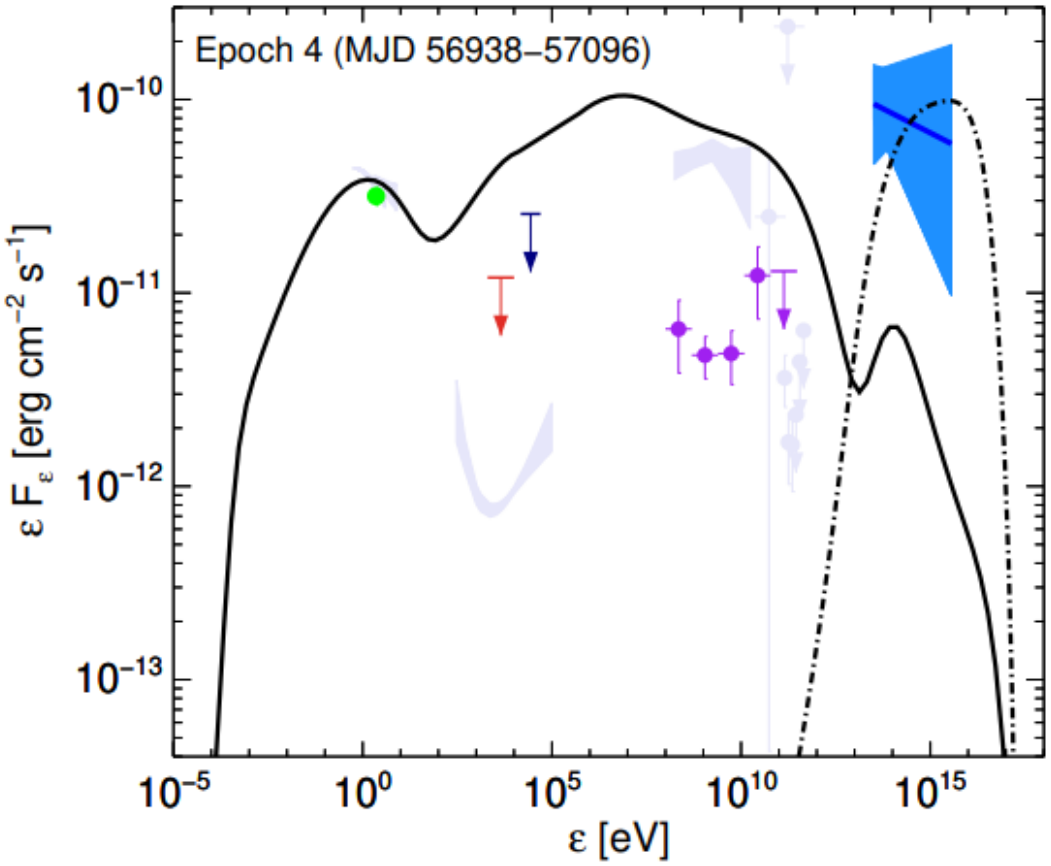

TXS 0506 2014-2015 Flare

Petropoulou, M. et al. Astrophys.J. 891 (2020) 115

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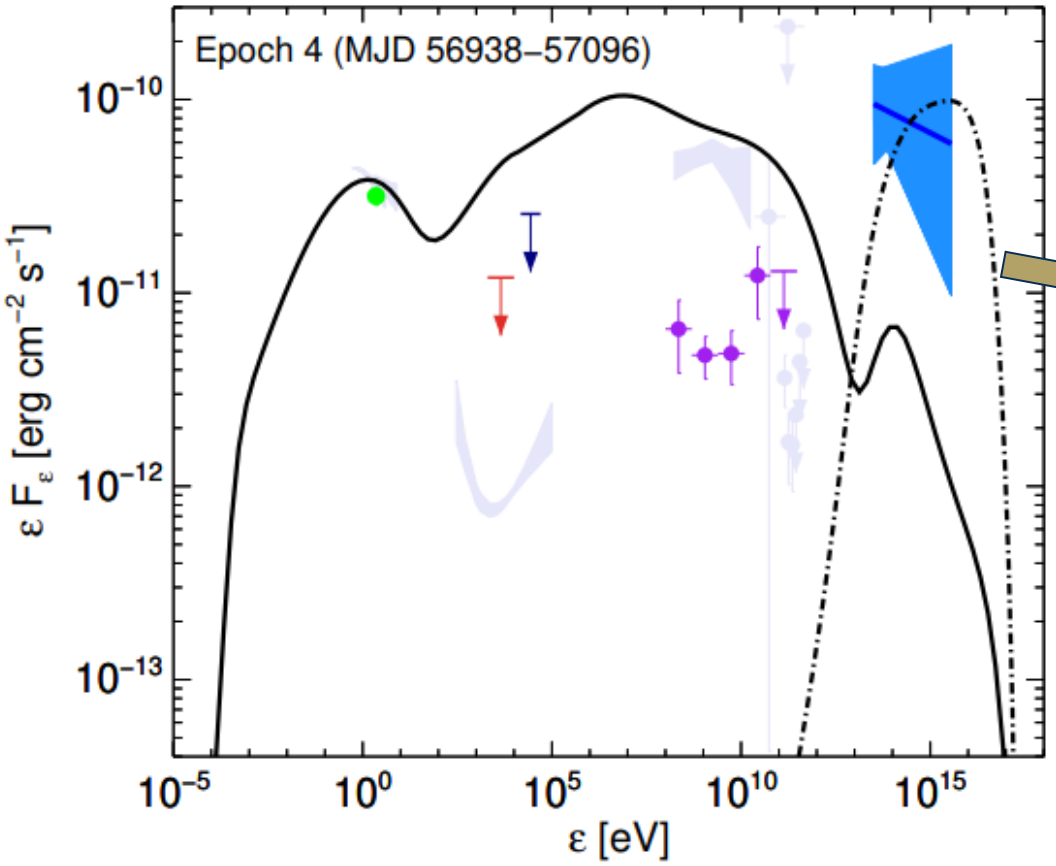

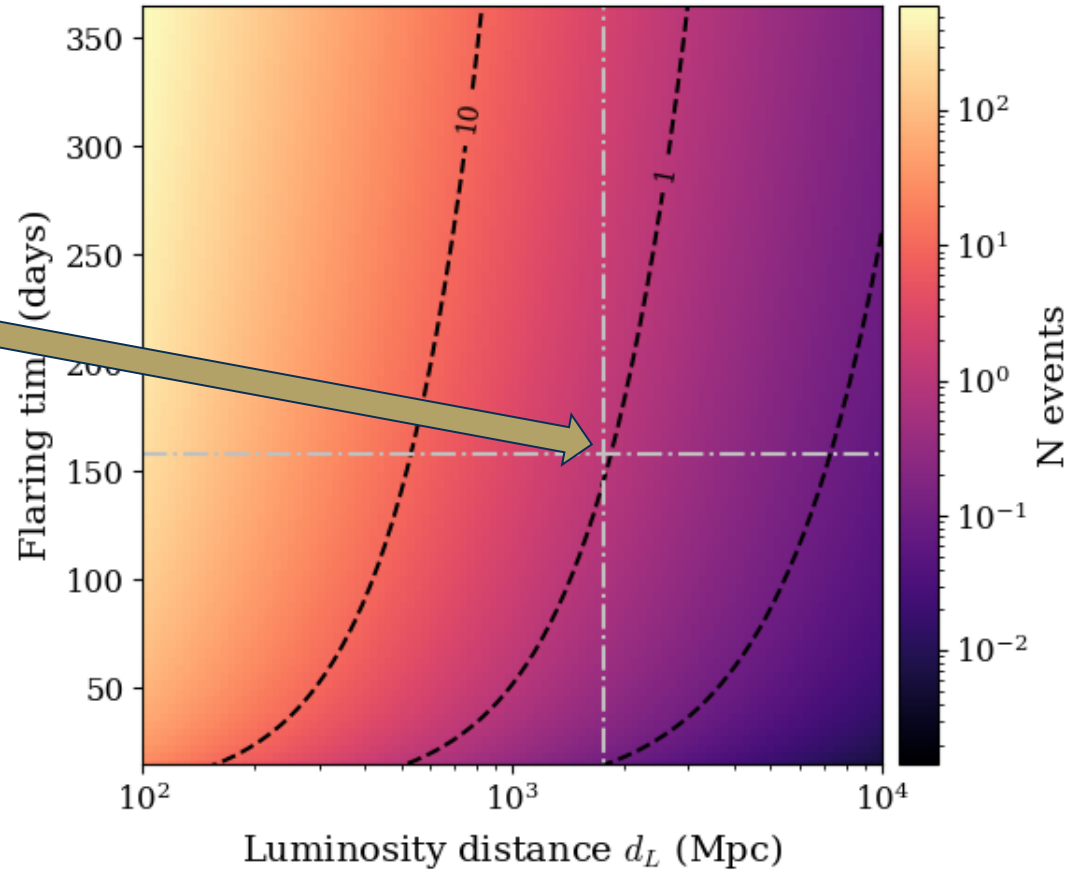

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$$N_\nu = T_{obs} \int dE_\nu F_\nu(E_\nu) \langle A_{eff}(E_\nu) \rangle$$

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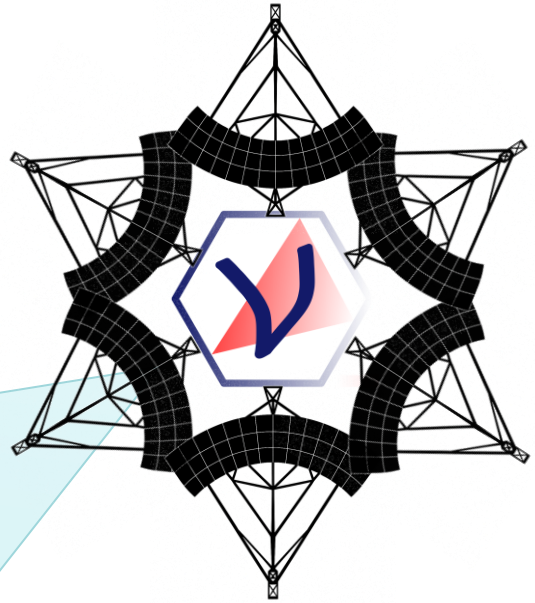

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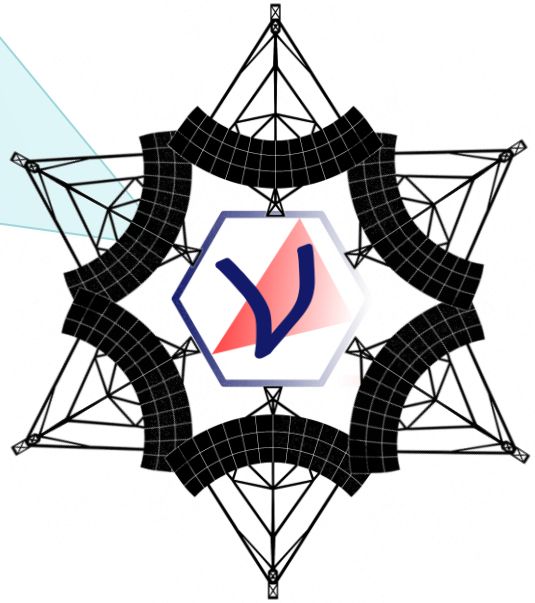

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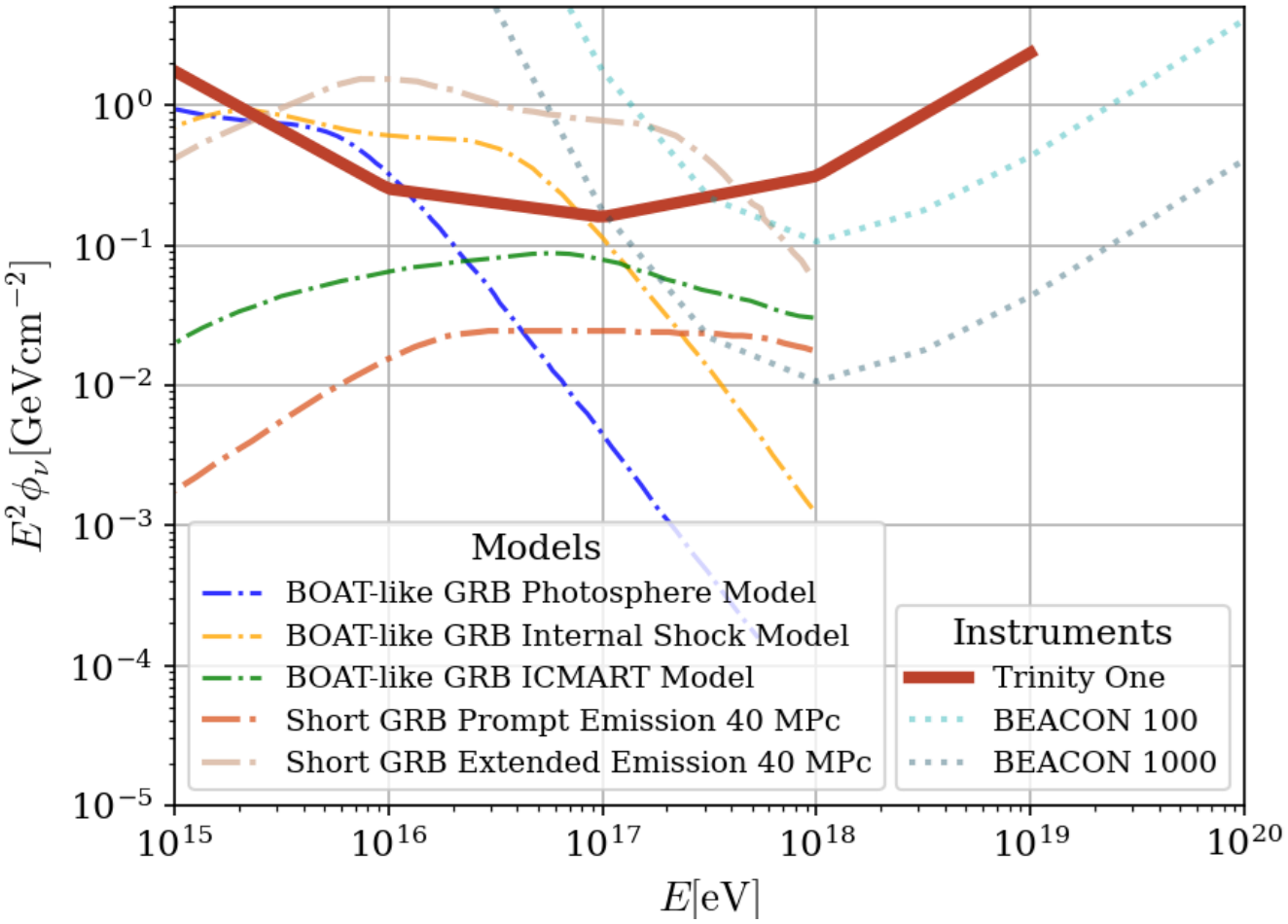
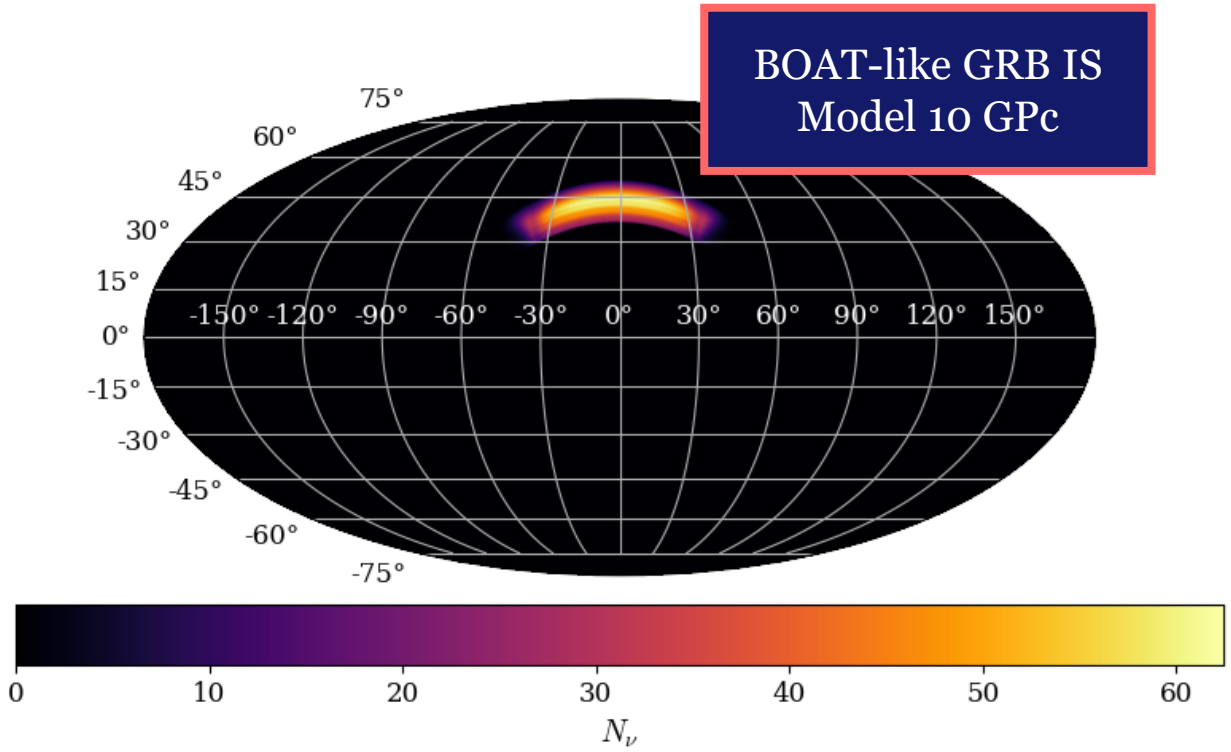
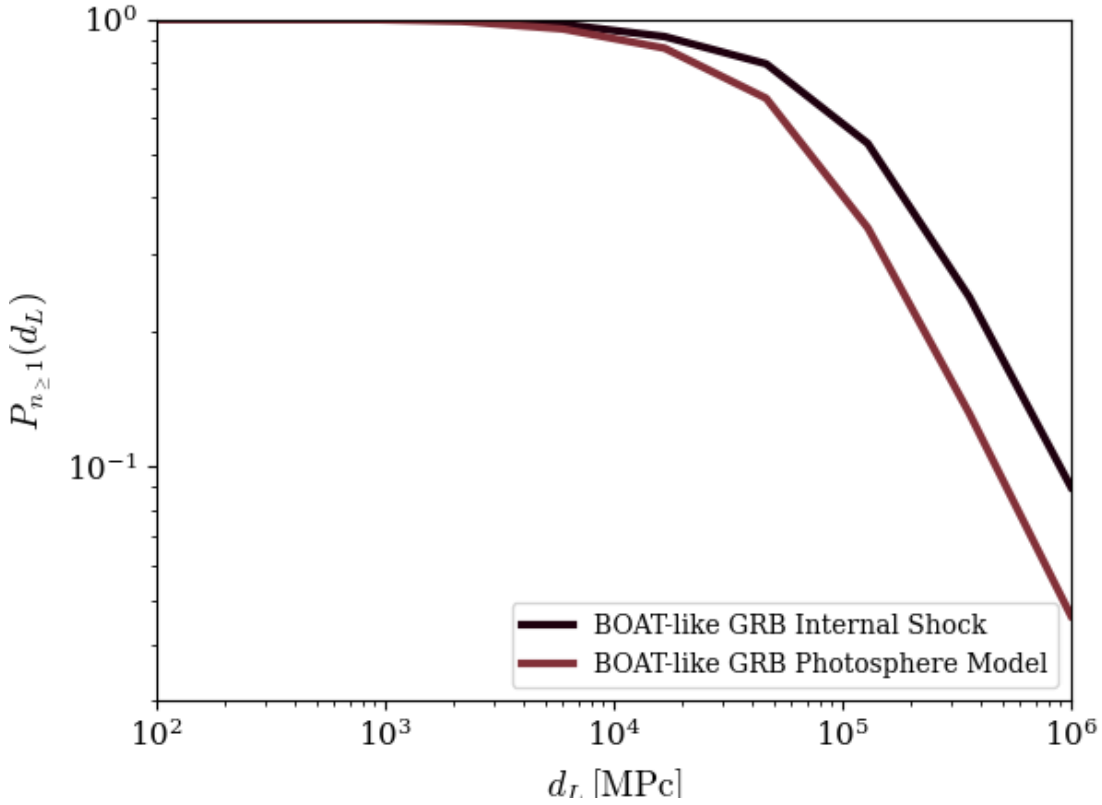


$$E_\nu^2 S(E_\nu) = \frac{2.44}{\Delta(\log_{10} E_\nu)} \frac{3}{\ln(10)} \frac{E_\nu}{A_{\text{eff}}}$$

- Comparable sensitivity to radio counterparts with a single telescope
- Ideal energy range for GRB model constrain

How can Trinity contribute to GRB physics?





$$P_{n\geq 1}(d_L) = \frac{1}{\Omega_{\rm norm}} \int_\Omega d\Omega p_{n\geq 1}(\phi, \theta, d_L) \Longrightarrow p_{n\geq 1}(\phi, \theta, d_L) = 1 - \exp\left(-N_\nu(\phi, \theta, d_L)\right)$$

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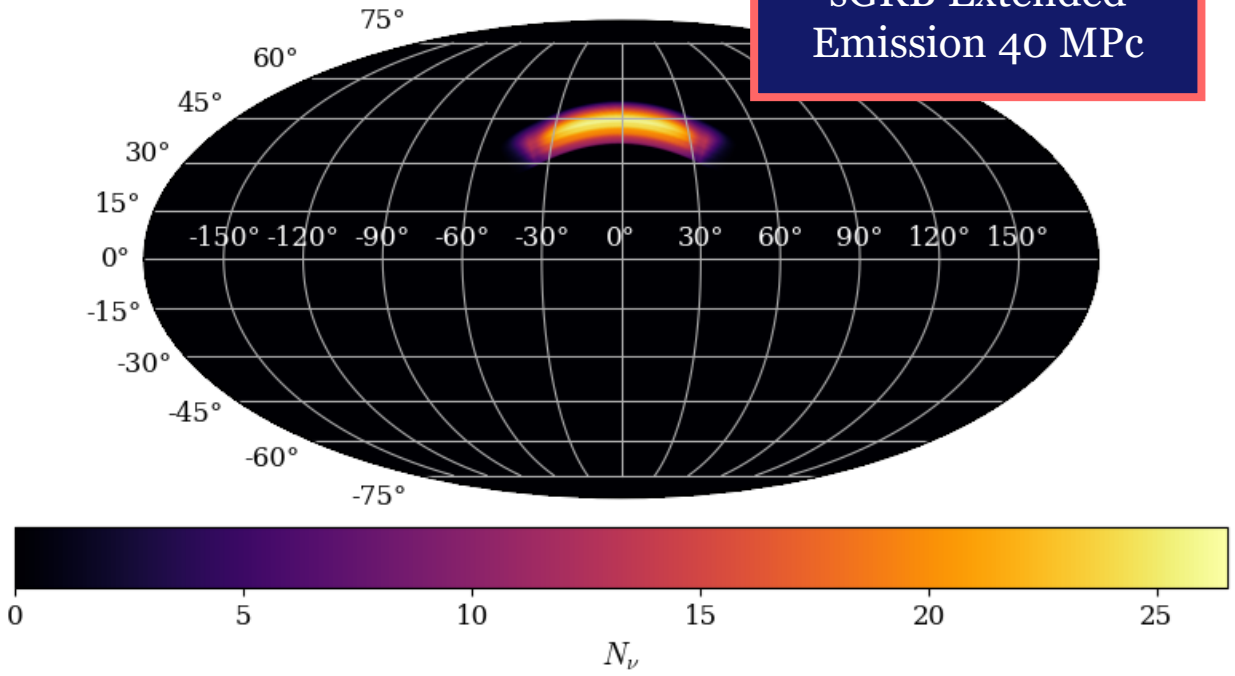

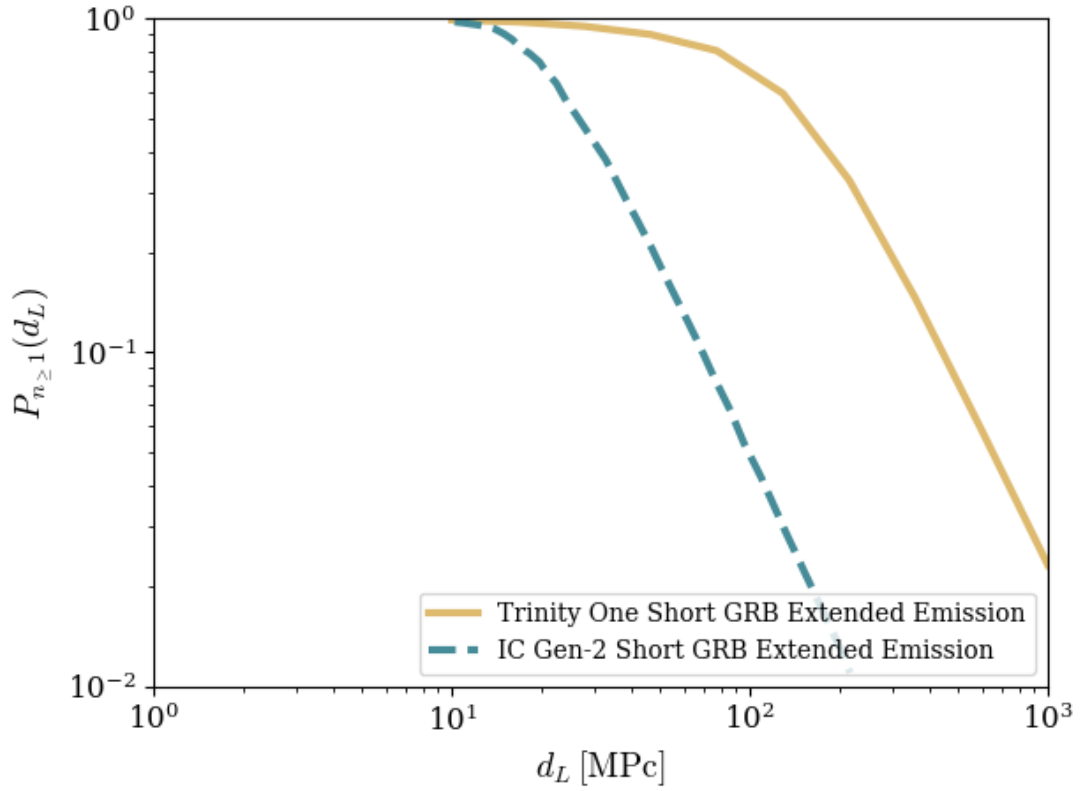

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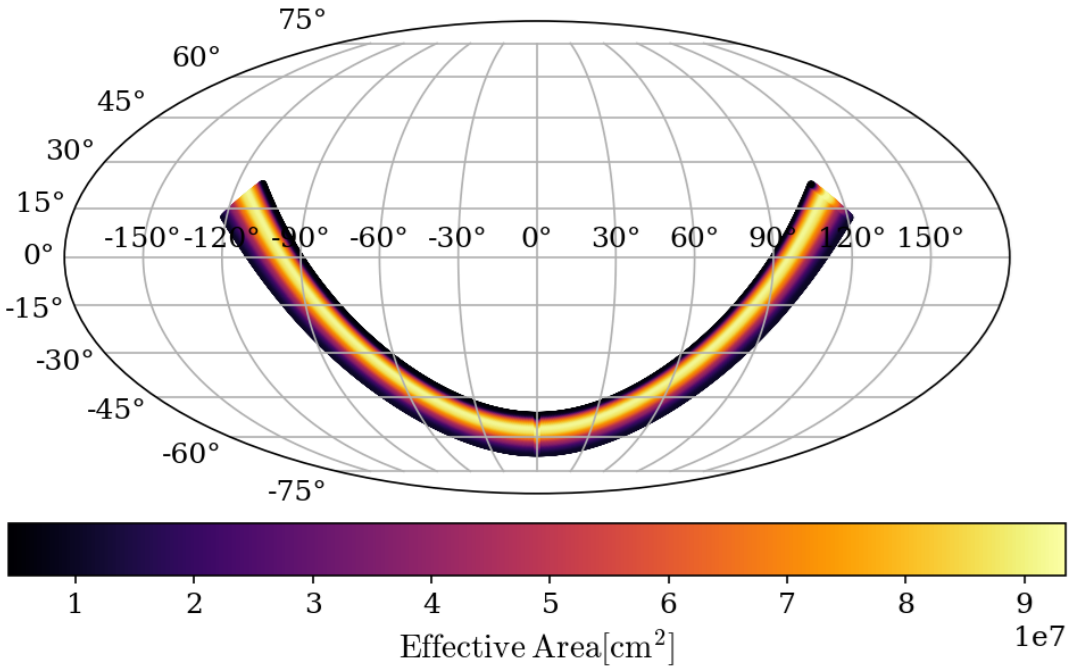
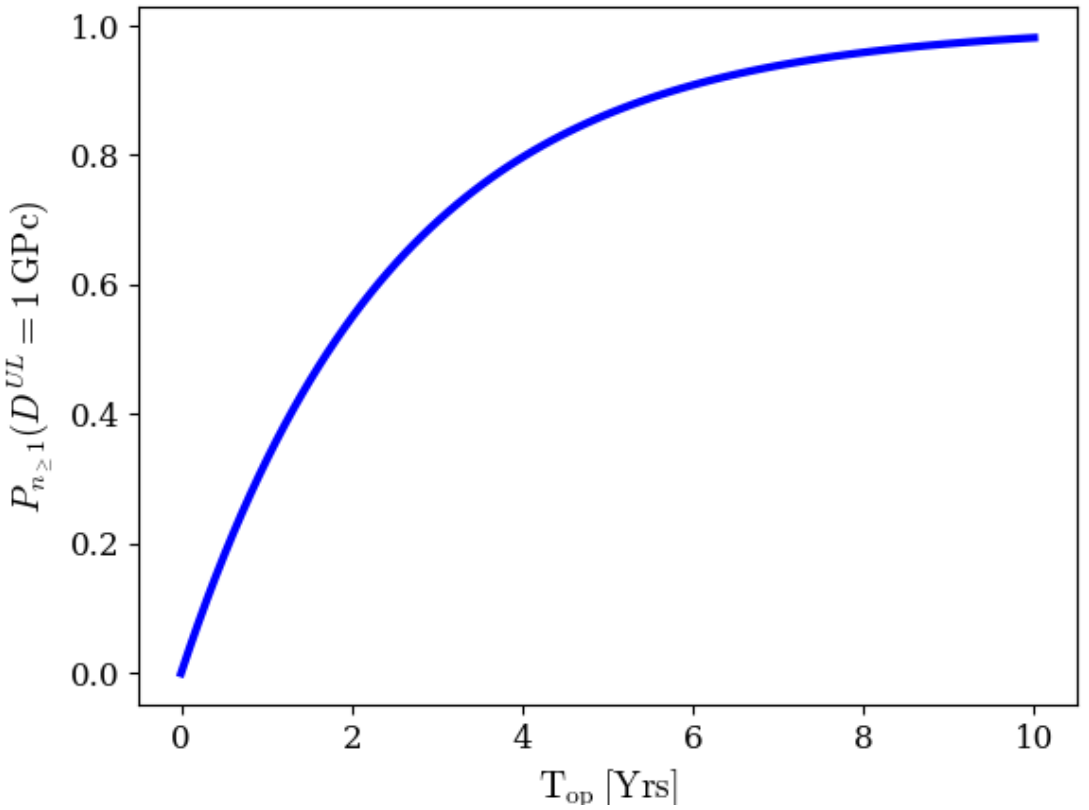


- Follow ups from gravitational waves observatories expected

- 1 GPc Upper Limit



Summary

- Demonstrate Earth-skimming as a UHE neutrino detection method.
- Leverage high sensitivity and sharp angular resolution for point-source studies.
- Use azimuthal rotation to boost neutrino detection rates.
- Work in progress, stay tuned…

Going to ICRC next week? Check out our poster on Trinity One

Right after some of our first data analysis run from the Trinity Demonstrator!

Questions?

draudales@gatech.edu

I appreciate your feedback!

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