Trinity

Trinity Sensitivity Studies

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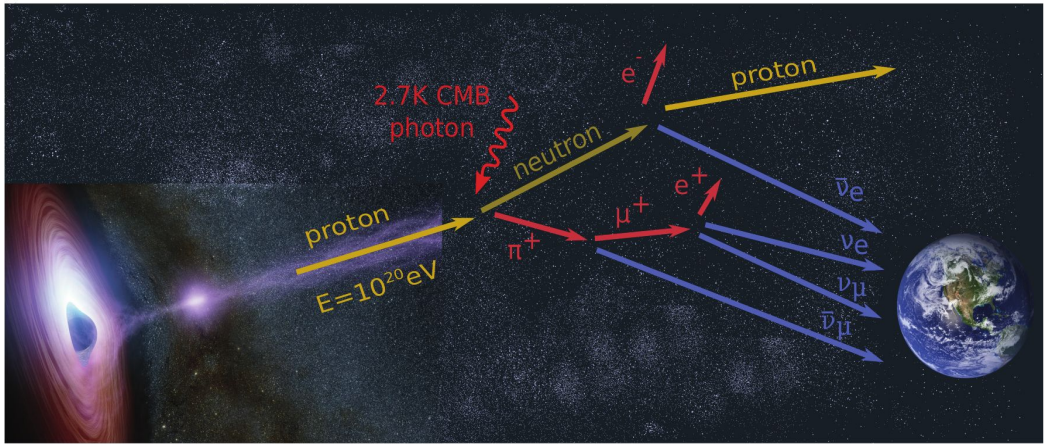
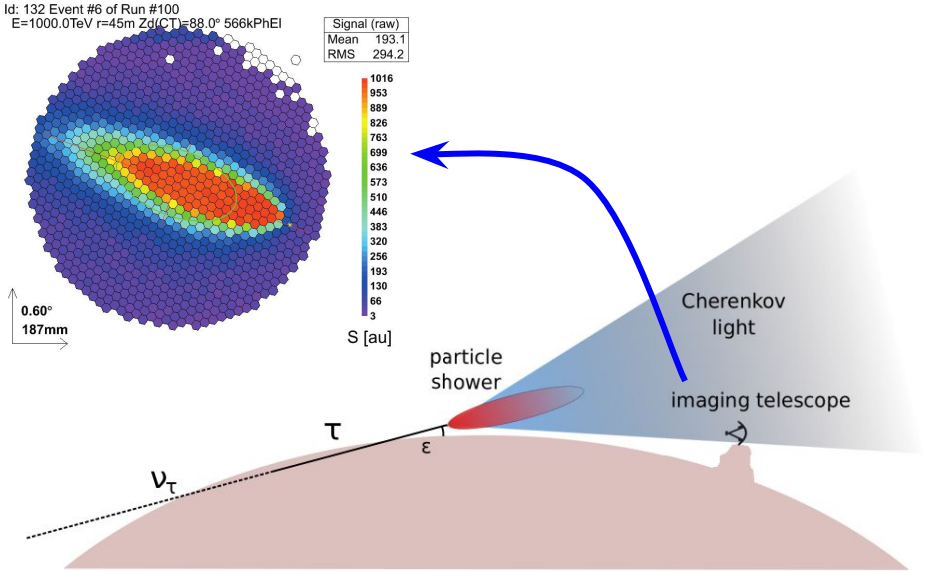
Introduction

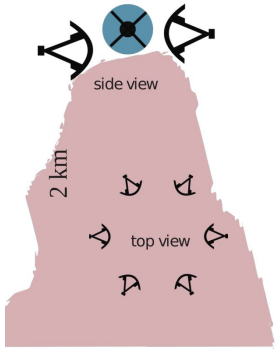
- Neutrino astrophysics is a rapidly developing field.
- IceCube detection of astrophysical neutrinos warrants extension into higher energies.
- Ultrahigh-energy (UHE; >10 PeV) neutrinos hold answers to possible sources and new avenues for particle physics.
- Produced when UHE cosmic rays interact with CMB photons but are yet to be detected.

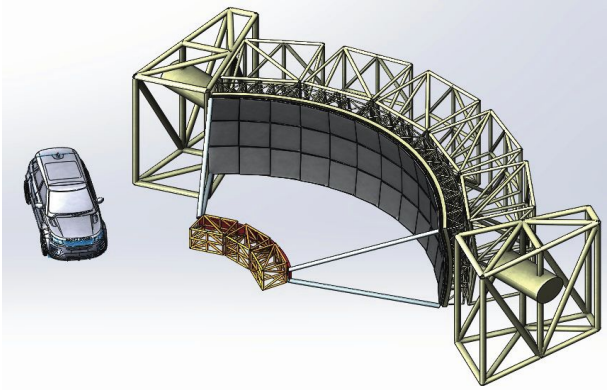


Trinity Overview

- UHE neutrino instrument with lowest energy threshold.
- Baseline configuration constitutes 3 sites, 6 telescopes each, with 360° azimuth coverage.
- Each telescope has 5° x 60° field of view, 36 m^2 mirror surface, and >10 m^2 light collection area in any direction.
- Telescope camera has 0.3° angular resolution with 3,300 silicon photomultiplier (SiPM) pixels.
- Raised to an altitude of 2 km with each telescope pointing at the horizon.

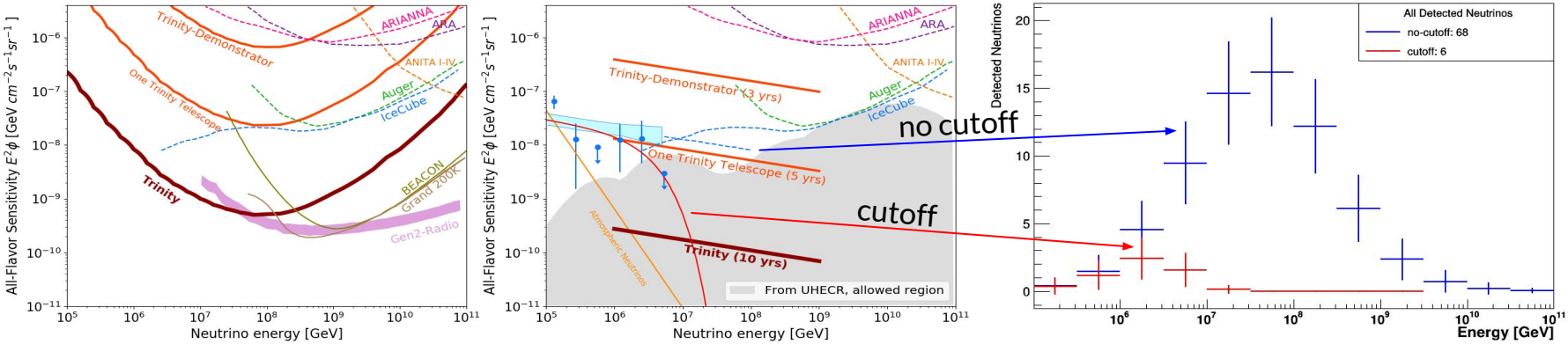






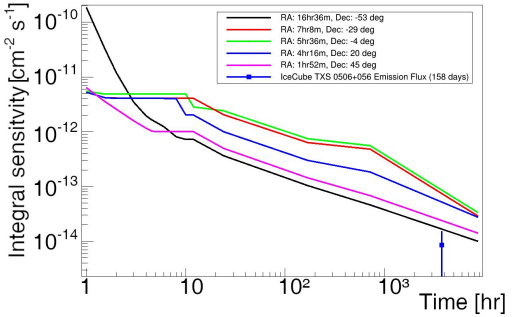
Diffuse-Flux Sensitivity

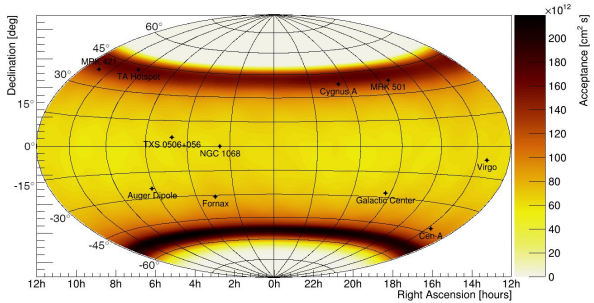
- Simulated ten-years worth of observation for baseline configuration, five-years for a single telescope, and three-years for the *Trinity*-demonstrator.
- Assumed 20% duty cycle alongside diffuse neutrino spectral index of -2.
- Low energy threshold overlaps IceCube measurements which guarantees detection and extension into higher energies.
- *Trinity* is sensitive to different spectral index cutoff scenarios.
- Will detect 70 events with pure power-law and only 6 with a cutoff at ~10^6 GeV in ten-years.

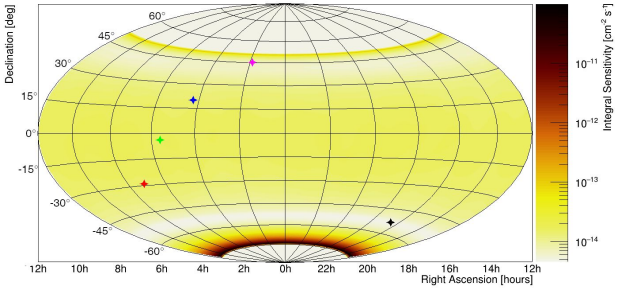


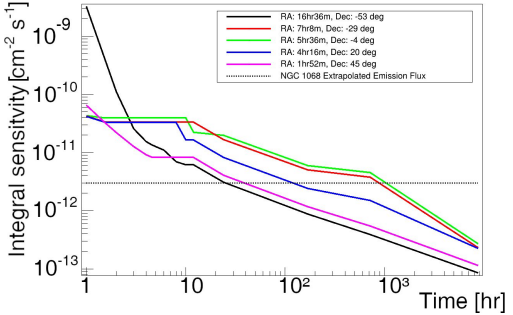
Point-Source Sensitivity

- Only one *Trinity* site considered; located Frisco Peak, UT.
- 360° acceptance band projected onto the sky and integrated over time.
- Sun/moon cycles taken into account for observations longer than a day.
- Maximum sensitivities at -53° and 40° declination.
- Selected five sources between -53° and 45° declination to study transient sensitivities.
- Extrapolated fluxes from TXS 0506+056 and NGC 1068 compared to simulated sensitivities.









Thank You!

Backup Slides

Sensitivity Calculations

- Defined as the neutrino flux required for a single detection within a given time frame.
- Depends on tau neutrino interaction, tau emergence, air-shower formation, and light detectability.
- Tau neutrino interaction and tau emergence calculated with NuTauSim.
- Multiplied by factor of three to account for sensitivity to tau neutrinos only; assumed 1:1:1 flux flavor mixing.

$$\Phi(E_\nu) = \frac{3E_\nu^{-\gamma}}{T \times \int_{E_{\nu,\min}}^{E_{\nu,\max}} A\,(E_{\nu'})\,E_{\nu'}^{-\gamma}\,dE_{\nu'}}$$

$$A(E_\nu, \epsilon) = \int_{A'} \int_{\Omega} \int_{E_\tau} P(E_\tau | E_\nu, \epsilon) \cdot \sin(\epsilon) dE_\tau dA' d\Omega$$

Additional Sensitivity Figures