Isotropic and Point-Source Sensitivity Studies for *Trinity*

Andrew Wang[a], Mahdi Bagheri[a], Anthony M. Brown[c], Michele Doro[b], Eliza Gazda[a], Chaoxian Lin[a], Nepomuk Otte[a], Ignacio Taboada[a]

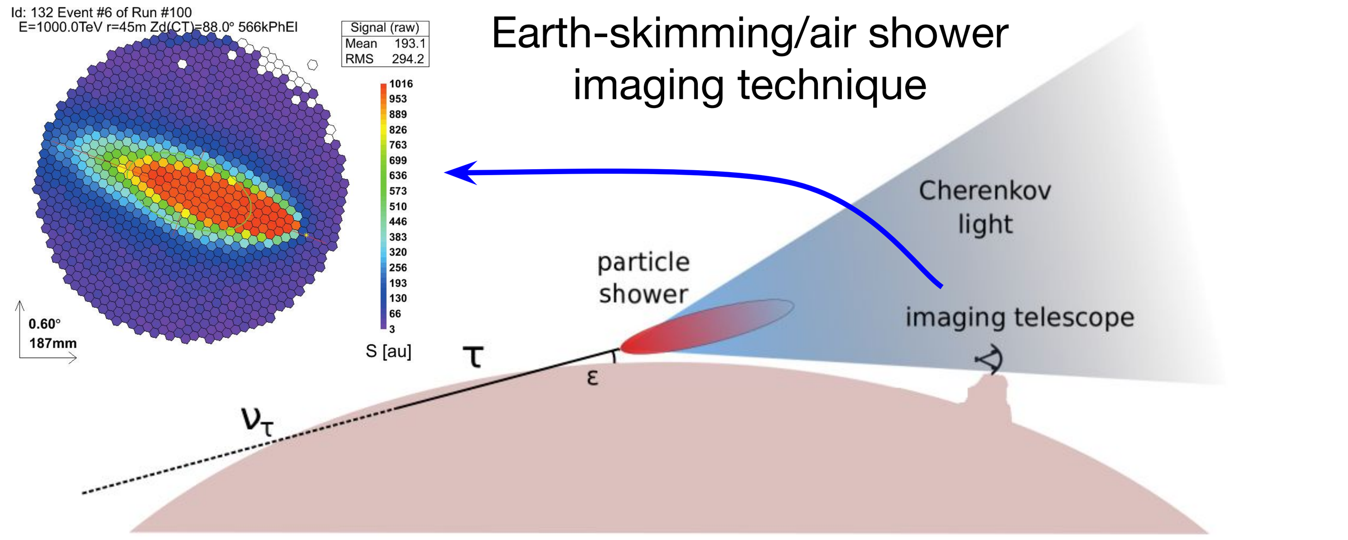
[a]Georgia Institute of Technology, School of Physics & Center for Relativistic Astrophysics, Atlanta, Georgia, USA;

[b]Università di Padova (UniPD), Dipartimento di Fisica e Astronomia (DFA) G. Galilei, Padova, Italy;

[c]Centre for Advanced Instrumentation, Durham University, South Road, Durham, DH1 3LE, UK

Summary

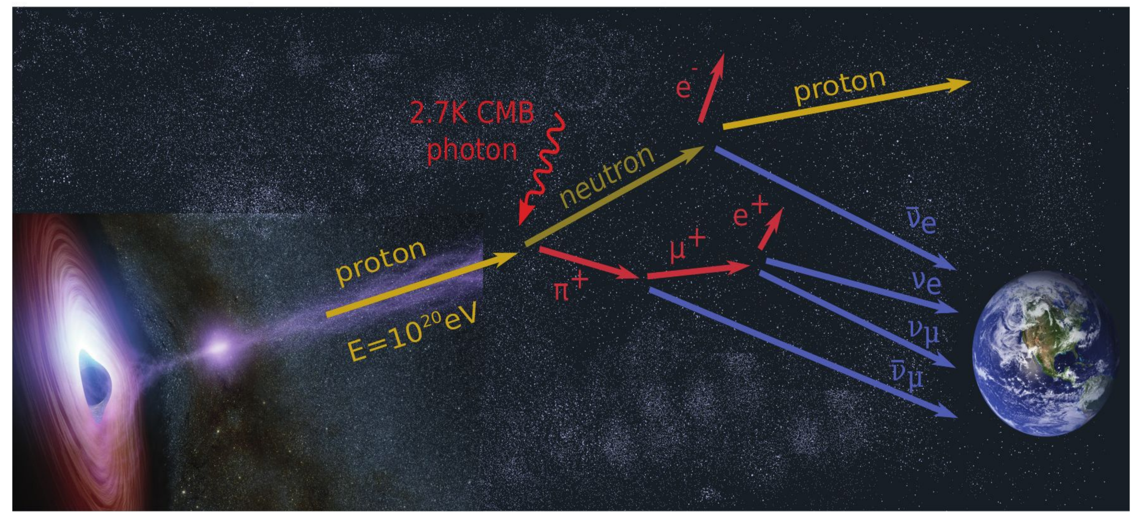
- *Trinity* is an ultra-high energy (UHE; >10 PeV) neutrino instrument.
- Detects Earth-skimming tau neutrinos via air-shower imaging.
- Low energy (10^6 GeV) threshold overlaps with IceCube.
- Distinguishes between different diffuse astrophysical neutrino flux cutoff scenarios.
- Sensitive to transient neutrino sources.



Science Cases

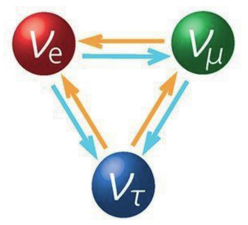
Ultra-High Energy (UHE) Cosmic Ray Composition

- UHE neutrinos are produced in interactions of UHECR with CMB photons.
- UHECR Protons produce more UHE neutrinos (GZK mechanism).
- Heavy elements produce fewer UHE neutrinos (photodisintegration).
- Neutrino flux depends on source evolution.



Astrophysical Neutrinos

- *Trinity* will measure the IceCube-detected astrophysical neutrino flux to higher energies.
  - Spectral shape and flux measurements will help identify or exclude source classes.
  - Possible detection of sources.



Neutrino-Flavor Mixing at Ultra-High Energies (>10^8 GeV)

- Comparison of fluxes measured with techniques sensitive to different flavors (Earth-skimming is only sensitive to tau neutrinos).

Design

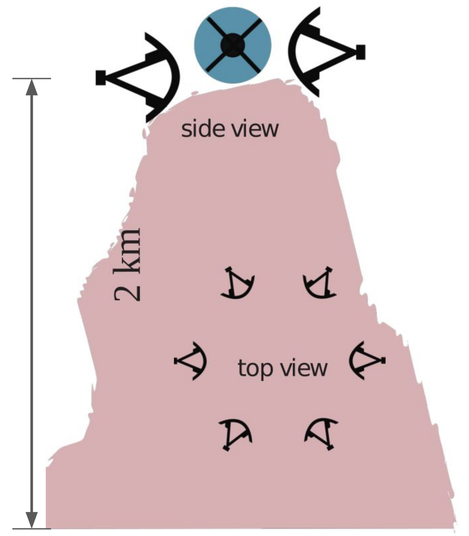
Baseline Configuration

- 3 sites; 6 telescopes at each site provide 360° azimuth coverage.
- Positioned 1-2 km above ground for unobstructed view of horizon.

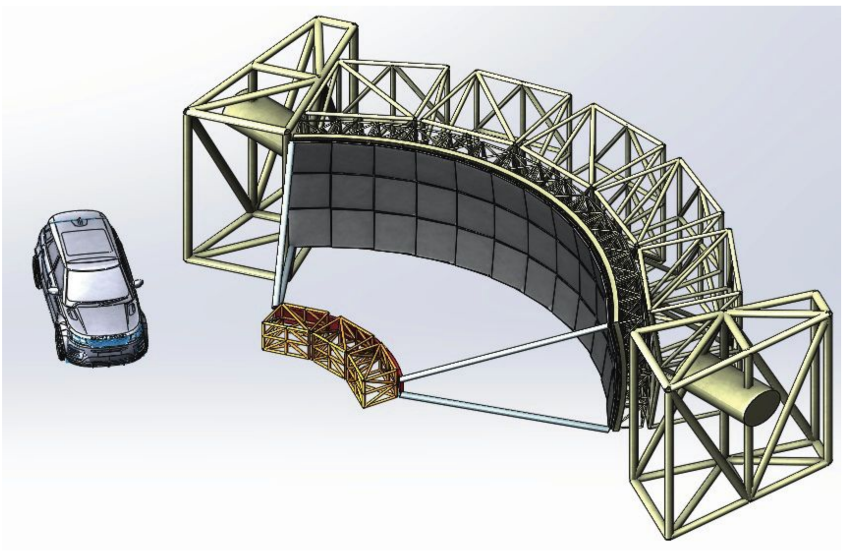
Trinity Telescope

- 5° x 60° field of view, 36 m^2 mirror surface, >10 m^2 light collection area in any direction.
- 0.3° angular resolution, 3,300 pixel silicon photomultiplier (SiPM) camera.
- Readout with 100 MS/s digitizers.

Single site configuration

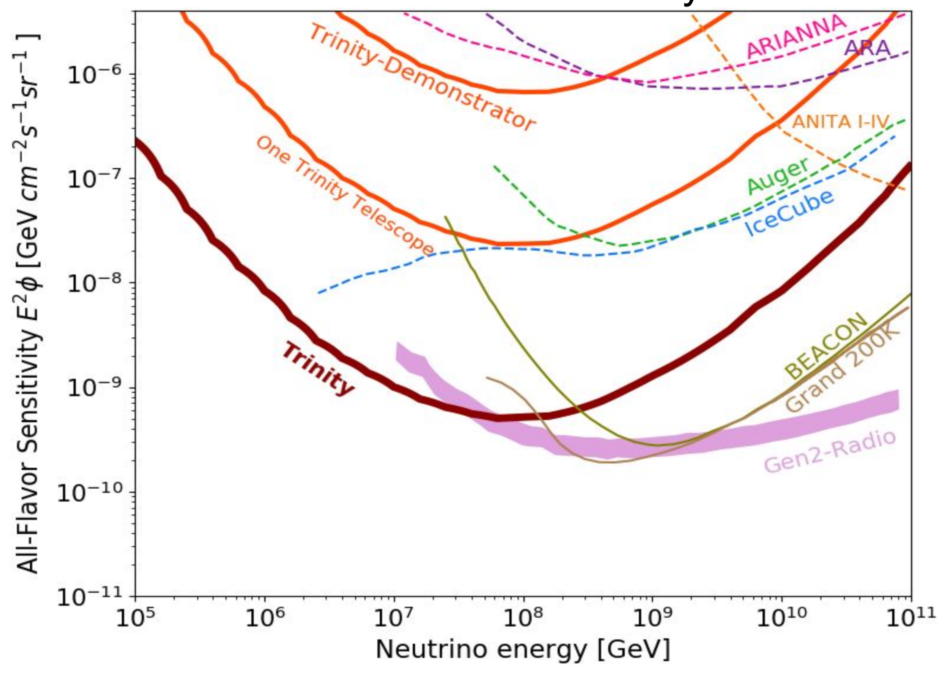


Telescope model



Diffuse-Flux Sensitivity

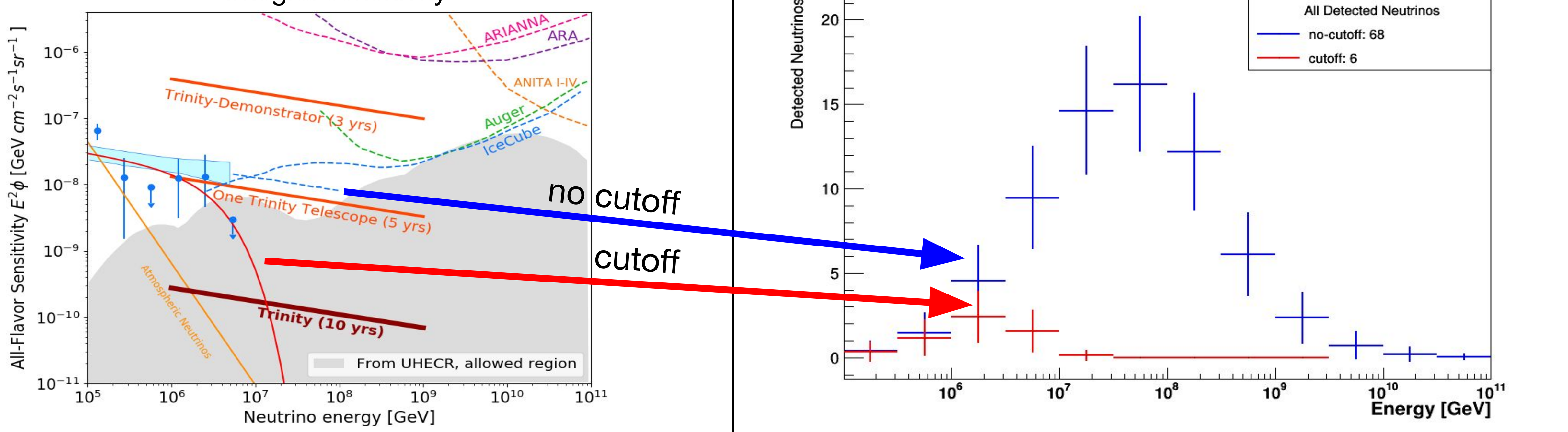
Differential sensitivity



- Simulated ten-year long observation for baseline configuration, five-years for a single telescope, and three-years for the *Trinity*-demonstrator.
- Assumed 20% duty cycle and spectral index of -2.
- Detections result in sensitive measures of spectral cutoff.
- Expect 70 events for pure power-law and 6 events for cutoff at ~10^6 GeV.

Integral sensitivity

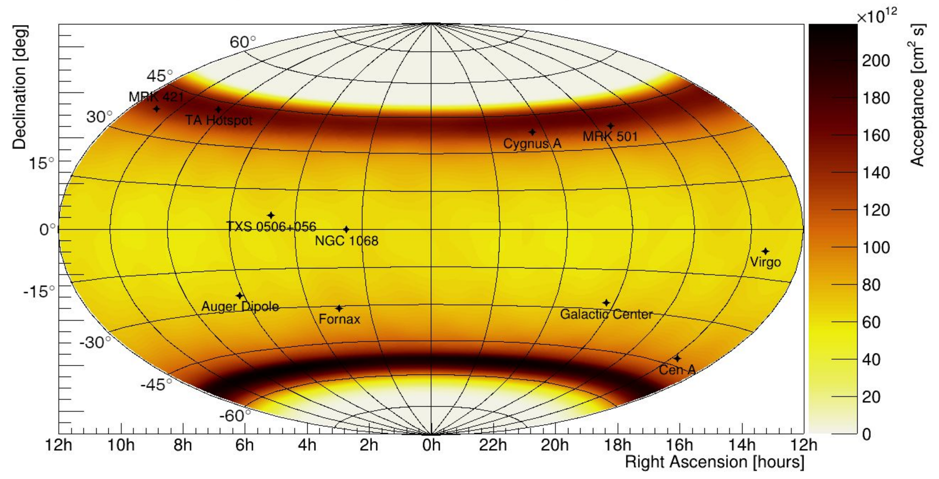
Detections based on cutoff



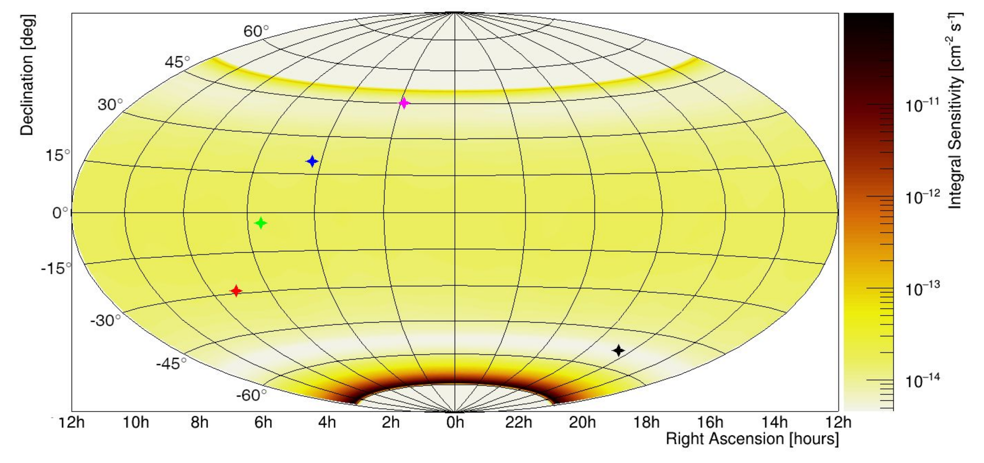
Point-Source Sensitivity

- We considered only one *Trinity* site at Frisco Peak, UT.
- 360° acceptance band projected onto the sky and integrated over time; sun/moon cycles taken into account.
- Maximum sensitivities at -53° and 40° declination.
- We selected five sources between -53° and 45° declination to study transient sensitivity.
- IceCube-detected fluxes from TXS 0506+056 and NGC 1068 extrapolated and compared to transient sensitivities.

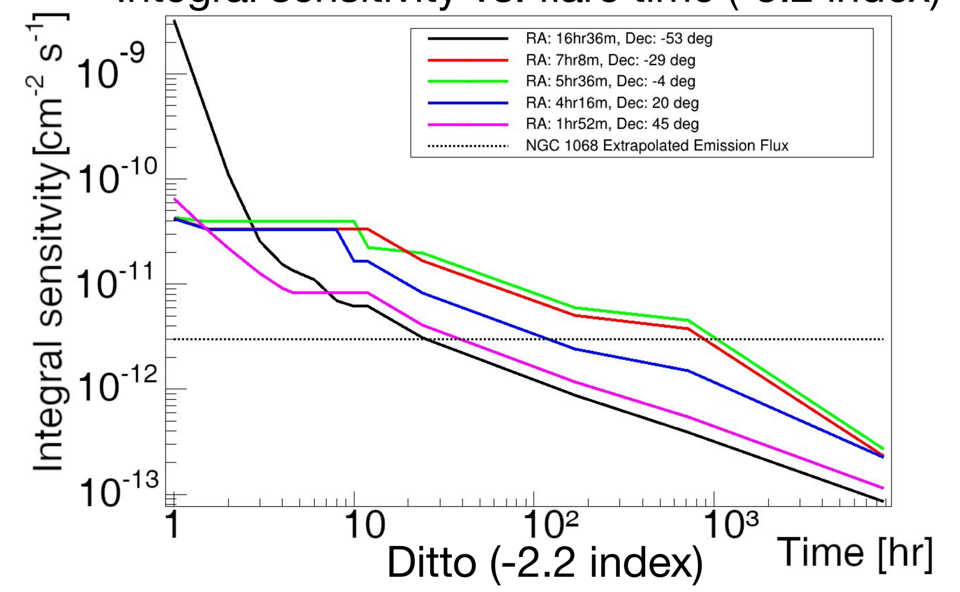
1 yr acceptance skymap



1 yr sensitivity skymap



Integral sensitivity vs. flare time (-3.2 index)



Ditto (-2.2 index)