Detection Technique

- UHE tau neutrinos interact within 10 km - 100 km in the ground.
- The tau emerges from the ground and decays in the atmosphere.
- Development of a Cherenkov light emitting particle shower.
- A Cherenkov telescope images the air shower.
- Reconstruction of the neutrino’s arrival direction and energy from recorded image.

Earth-Skimming and Air-Shower Imaging Technique

- UHE tau neutrinos interact within 10 km - 100 km in the ground.
- The tau emerges from the ground and decays in the atmosphere.
- Development of a Cherenkov light emitting particle shower.
- A Cherenkov telescope images the air shower.
- Reconstruction of the neutrino’s arrival direction and energy from recorded image.

Baseline Configuration

A system of wide field-of-view Cherenkov telescopes

- 3 sites.
- 6 telescopes provide 360° azimuth coverage at each site.
- Positioned 1-2 km above ground.
- Unobstructed view of the horizon.
- Acceptance comes from large azimuthal field-of-view requiring wide field of view telescopes.

Trinity Telescope

- 5° x 60° field of view.
- 36 m² mirror surface.
- >10 m² light collection area in any direction.
- 0.3° optical resolution.
- 3,300 pixel silicon-photomultiplier camera.
- 29 mm diameter pixels.
- Non-imaging light concentrators focus light to 6 mm SiPMs and limit aberration to < 0.3°.
- Readout with 100 MS/s digitizers.

Science Cases

Composition of ultra-high energy cosmic rays

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

Astrophysical Neutrinos

Trinity will measure the IceCube detected astrophysical neutrino flux to higher energies.
- Spectral shape and flux levels will help identify and 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).

Prototype Telescopes

Demonstrator telescope

- 1 m² mirror area.
- Demonstrate technologies.
- Establish remote operation.
- Develop analysis.

Trinity full prototype

- Final telescope.
- Most sensitive UHE neutrino instrument.
- Already sensitive to astrophysical neutrinos.

Expected Performance

Assumed configuration:

- 18 telescopes
- 3 sites
- 10 years of operation
Highest sensitivity in the observational gap between TeV and EeV.
Trinity is sensitive to PeV neutrinos.

Astrophysical Neutrinos

Trinity is sensitive to different cutoff scenarios.

Trinity will observe all major sources expected to emit neutrinos.
Significant overlap in sky coverage with all major multi-messenger instruments.

Sensitivity to Transients

- Sensitivity to transients at 5 different sky locations.
- For one Trinity site with full 360° azimuth field of view (6 telescopes).
- Powerlaw spectrum with -2 index assumed.
- Observational gaps due to the moon and sun are taken into account.