Measurement of Atmospheric Tau Neutrino Appearance with IceCube/DeepCore

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Detector

The DeepCore array of IceCube allows to detect neutrino interactions down to energies of around 5 GeV, and from all directions.

Event Signatures

IceCube cannot directly determine a neutrino's flavor in an event, but can separate between more track-like signatures (charged current $\nu_\mu$ interactions) and cascade-like signatures (charged current $\nu_\tau$ and $\nu_e$ neutrinos and neutral current events).

Analysis

Analysis 1:
- data driven background templates
- higher purity selection
- optimized for disappearance
- 3y sample with ~41k events
- 18 systematic parameters in the fit

Analysis 2:
- simulated background templates
- higher statistics selection
- optimized for appearance
- 3y sample with ~62k events
- 18 systematic parameters in the fit

Results

Measured $\nu_\tau$ normalization:
- Analysis 1: 0.59 $\pm$ 0.31 $-0.25$
- Analysis 2: 0.73 $\pm$ 0.31 $-0.24$

- similar precision to the results of Super-K and OPERA
- consistent with the standard oscillation picture
- future experiments like PINGU and ORCA, or the IceCube upgrade necessary to achieve constraints < 10%