# Detecting Tau Neutrino Oscillations at EeV Energies

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## Abstract

It is suggested that a large scale UHE cosmic ray detector of the fluorescence type (Fly's Eye style as implemented in Hi-Res or the Auger Project, or from space as with OWL or Airwatch) may be able to observe a unique signature due to tau neutrinos. This signature comes about due to the initial charged current tau neutrino interaction producing a large shower, flying some distance, and then decaying in a second larger shower with typically twice the energy. Near horizontally incoming tau neutrinos provide the best change for this observation, where long flight paths in the atmosphere serve to discriminate between tau events, strongly interacting showers, and showers generated by either electron or muon neutrino interactions.

Tau neutrinos are generally expected at the energies under study for resolving the SHE cosmic ray anomaly, because many suggested processes which produce the observed cosmic rays beyond the G-Z-K cutoff also produce copious neutrinos. We now have good evidence that the muon neutrino oscillates, and probably the electron neutrino as well. Despite the probable lack of source production of tau neutrinos, generation of tau neutrinos via oscillations, given the long flight distances, seems likely (though not inescapable, as for example if the oscillations presently seen are to sterile neutrinos). We present estimates of detection rates which demonstrate that if the tau neutrinos are present in the cosmic ray beam at a substantial fraction of the total, then experiments may well detect them.