



Contribution ID: 1009

Type: Poster Presentation

High precision reconstruction of electromagnetic showers in the nuclear emulsions of the OPERA experiment

We present an automatic procedure developed to reconstruct electromagnetic (EM) showers in the nuclear emulsions of the OPERA long baseline neutrino experiment.

OPERA was designed to investigate muon neutrino oscillations using so called Emulsion Cloud Chambers (ECC). Electronic detectors completed the ECC, where lead plates constituting the target mass were interleaved with nuclear emulsion films providing the high spatial resolution.

The reconstruction and measurement of EM shower is not trivial because it is very difficult to distinguish electrons belonging to the shower from back-ground tracks and the reconstruction of low energy electrons is a very delicate job in nuclear emulsions. Thus EM showers study is usually performed by reconstructing shower track segments in emulsion films and trying to associate segments from film to film; it is also complemented by visual inspections.

The presented technique aims to reduce the load of visual inspections by means of a very detailed image analysis. Image acquisition is performed by a CCD camera mounted on a motorized stage and it is performed with a $1\ \mu\text{m}$ pitch in depth. Silver grains are recognized and used to reconstruct the tracks produced by charged particles. This precise 3D tomographic technique has a spatial resolution of $0.1\ \mu\text{m}$ and an angular resolution of $1\ \text{mrad}$. Those accuracies are useful to reduce visual inspection keeping a track reconstruction efficiency close to 100% and a purity close to 95%.

Primary electron/photon energy can be correlated to the number of reconstructed tracks in emulsion and the calibration is optimized using a sample of Monte Carlo events. The identification and reconstruction efficiencies on electromagnetic showers will be shown. The procedure is used to study short lived particle decay candidate events in ECC, possibly associated with tau and charm production.

Experimental Collaboration

OPERA collaboration

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Session Classification: Poster session

Track Classification: Neutrino Physics