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Pion Photoproduction Analysis in the Water Test Cherenkov Experiment (WCTE)

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The Water Cherenkov Test Experiment (WCTE) at CERN was designed to provide controlled measurements of processes central to large-scale water Cherenkov detectors such as Hyper-Kamiokande. Using a water target together with a high-precision tagged-photon beam, WCTE recorded detailed data on charged-pion hadronic scattering, secondary neutron production, and Cherenkov-light emission from secondary charged particles. With data-taking now complete, analysis efforts are underway across simulation, reconstruction, and event characterization.

My PhD research focuses on the simulation and analysis of pion photoproduction events in WCTE. The goal is to develop a framework capable of identifying both inclusive and exclusive pion-production channels and comparing observed distributions with theoretical models and Monte Carlo simulations. The resulting constraints will improve neutrino–nucleus interaction modelling and strengthen the precision of oscillation measurements in water Cherenkov detectors.

Pion photoproduction provides a sensitive probe of nucleon and nuclear structure in the non-perturbative regime of QCD and plays a central role in modelling neutrino interactions and backgrounds, particularly neutral-pion signatures that mimic electron-like Cherenkov rings. A detailed understanding of its kinematics, cross-sections, and final-state topologies is therefore essential for hadronic and neutrino-physics applications.

In this presentation, I will show initial studies using WCTE Monte Carlo samples and preliminary visualizations of photon-tagged data, including early event displays. I will outline the planned reconstruction strategy —such as first attempts using an existing likelihood fitter and describe the broader analysis roadmap toward isolating pion-photoproduction channels and extracting physics results from the full dataset.

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