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The Compton Slope Parameter and the Compton and Two Photon Spectrometer

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The nuclear Equation of State (EOS) represents the interactions of dense nuclear matter and is used to study astrophysical objects like neutron stars. It is directly correlated with neutron skin thickness, which is a phenomenon describing the layer of outermost neutrons observed to envelop large nuclei. The most accurate way to study neutron skin thickness is through Parity Violating Electron Scattering (PVES); however, such experiments contain error contributed by the Beam-Normal Single-Spin Asymmetry (BNSSA), which describes the small, normal component of a particle beam's polarization due to any slight bends within the path of the beam itself. The BNSSA is proportional to the Compton Form Factor (CFF), which is in turn proportional to the Compton Slope Parameter (CSP).

In order to constrain the nuclear EOS, neutron skin thickness must be measured. Currently, the extraction of the neutron skin of heavy nuclei is hindered by the 20% error in theoretical predictions of the BNSSA due to assumptions about the CSP, which depends on the energy deposited into a target during elastic Compton scattering. This is responsible for a systematic error in the nuclear EOS, reducing its accuracy and hereby forcing its conformity with the precision of the CSP. To reduce the error of the Compton Slope Parameter, it is crucial to separate elastic and inelastic Compton scattering events, which can be discerned with the high energy resolution NaI detector, CATS (Compton and Two Photon Spectrometer).

CATS detector calibrations, tests, and runs were executed during July and August of 2024. Such data collected included cosmic ray data and in-beam data, however, data of Compton scattering from Carbon-12 is anticipated to be collected in the near future. The experimental results will be cross-examined with a Geant4 software detector simulation, allowing the extraction of the CSP and the hopeful reduction in its uncertainty.

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