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Monte-Carlo Event Generation in XRTS Analysis

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X-ray Thomson scattering (XRTS) is a powerful diagnostic technique for probing matter under extreme conditions, such as those generated by high-intensity laser interactions in the High-Energy Density (HED) regime. Facilities like the HIBEF endstation at the European XFEL enable such experiments, offering unprecedented access to strongly coupled plasmas and warm dense matter. The interpretation of XRTS spectra typically relies on theoretical models for the dynamic structure factor, derived from linear response theory or time-dependent density functional theory (TDDFT), which are directly linked to the measured differential scattering cross section.

In this talk, we explore a novel approach to XRTS data analysis based on Monte Carlo event generation, a technique widely employed in particle physics for simulating collision events and detector responses. By generating synthetic scattering events consistent with theoretical models and instrumental resolution, we demonstrate how this method can provide an event-level perspective on detector signals, offering enhanced insight into fluctuation phenomena, background contributions, and the full statistical character of the measurement. This approach opens new pathways for interpreting complex XRTS data in regimes dominated by strong fields, non-equilibrium dynamics, and plasma collective effects.

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