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Detection Challenges in the LUXE Strong-Field QED Experiment

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LUXE (Laser Und XFEL Experiment) is a new experiment that is part of the DESY high-energy physics on-site program. It aims to combine a high-intensity optical laser with the 16.5 GeV electron beam of the European XFEL to explore the uncharted terrain of Quantum Electrodynamics (QED) at the strong-field frontier.

The experiment will measure the spectra of electrons, positrons, and photons resulting from the interaction of the two beams. The expected ranges of these measurements will depend on the laser power and focus, with a frequency of 1 Hz bunch crossing. These measurements must be performed in the presence of a low-energy, high radiation background. To meet these challenges, the experiment will use Cherenkov radiation detectors, scintillator screens, sapphire sensors, and lead-glass monitors for backscattering off the beam dump to handle high-rate electron and photon fluxes. A four-layer silicon-pixel tracker and a compact electromagnetic tungsten calorimeter will be used to measure the positron spectra. The layout of the experiment and the expected performance of each detector system under the harsh radiation conditions will be presented.

The experiment could be constructed to start operating by 2030 in Hamburg, using an existing 40 TW laser system to collect and analyze the first scientific data. It will then be upgraded to a 350 TW system to study the non-perturbative regime in detail.

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