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Input to the European Strategy for Particle Physics: Strong-Field Quantum Electrodynamics

The attached document sets out the intention of the strong-field QED community to carry out, both experimentally and numerically, high-statistics parametric studies of quantum electrodynamics in the non-perturbative regime, at fields approaching and exceeding the critical or 'Schwinger'field of QED. In this regime, several exotic and fascinating phenomena are predicted to occur that have never been directly observed in the laboratory. These include Breit-Wheeler pair production, vacuum birefringence, and quantum radiation reaction. This experimental program will also serve as a stepping stone towards studies of elusive phenomena such as elastic scattering of real photons and the conjectured perturbative breakdown of QED at extreme fields. State-of-the-art high-power laser facilities in Europe and beyond are starting to offer unique opportunities to study this uncharted regime at the intensity frontier, which is highly relevant also for the design of future multi-TeV lepton colliders. However, a transition from qualitative observational experiments to quantitative and high-statistics measurements can only be performed with large-scale collaborations and with systematic experimental programs devoted to the optimisation of several aspects of these complex experiments, including detector developments, stability and tolerances studies, and laser technology.

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