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Differentiable Geant4: Incorporating Multiple Coulomb Scattering for Detector Optimization

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Applying automatic differentiation (AD) to particle simulations such as Geant4 opens the possibility of addressing optimization tasks in high energy physics, such as guiding detector design and parameter fitting, with powerful gradient-based optimization methods. In this talk, we refine our previous work on differentiable simulation with Geant by incorporating multiple coulomb scattering into the physics engine of the simulation. The introduction of multiple scattering adds layers of complexity: discontinuities induced by conditional statements and stochastic behavior become even more pronounced, posing significant challenges for computing reliable unbiased derivatives with reasonable variance. These findings help build towards realistic optimizations of detectors with complete electromagnetic physics in Geant4.

Authors: KRUPA, Jeffrey (SLAC);   AEHLE, Max (University of Kaiserslautern-Landau (RPTU), MODE Collaboration);   NOVAK, Mihaly (CERN);   HEINRICH, Lukas Alexander (Technische Universitat Munchen (DE));   KAGAN, Michael (SLAC National Accelerator Laboratory (US))

Presenter: KRUPA, Jeffrey (SLAC)

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