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Simulation of Secondary Emission Calorimeter for Future Colliders

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Ever increasing collision energies in current and future colliders demand for radiation hard calorimeters. Calorimeters based on secondary electron emission process from dynode metals was proposed in 1990s as radiation hard alternative to overcome this difficulty. Since the discovery of secondary emission of electrons from metal surfaces, there has been many approaches to quantify this process by using semi-empirical models, including Monte Carlo studies. These Monte Carlo studies, however, usually do not include secondary emission process as a part of physics, governing the shower development and the probabilistic nature of the emission process. In this study, we present a Geant4 calorimeter simulation based on a newly developed physics class, which was derived from a probabilistic approach found in the literature. By developing this physics class inside Geant4 we were able to determine the yield and energy spectrum of secondary emission electrons from metal surfaces. We were also able to determine the calorimeter response to energetic particles by using the showers they create inside the calorimeter layers consisting of dynode structures. We first provide a comparison between data and simulation of a thin foil for the yield and secondary electron energy spectrum. We then give response, linearity, and resolution for a generic sampling calorimeter based on a secondary emission electron process together with results from a scintillating sampling calorimeter for comparison.

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