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Luminometers for future collider experiments

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The luminosity is a key parameter of each collider. Its precise and fast
measurement is essential for the physics program. The FCAL collaboration develops the technologies of compact and fast calorimeters with low average power consumption to measure the luminosity both with high precision using small angle Bhabha scattering and bunch-by-bunch using beamstrahlung pairs. For the precision device, called LumiCal, sensors are made of silicon, and for the fast device, called BeamCal, several options of radiation hard and very fast sensors, like GaAs or single crystal sapphire, are considered. A small Moliere radius facilitates
the measurement of Bhabha events in the presence of background and allows the detection of single high energy electrons on top of the widely spread background of beamstrahlung. Beside the luminosity measurement, the capability of detecting high energy electrons at low angles is important for many search experiments.

Two multi-plane prototypes of a luminometer were studied in beams of electrons and muons with momenta around 5 GeV at CERN and DESY. The results for the longitudinal and the transverse shower profiles are compared with Geant4 simulations of the setup and used to determine the effective Moliere radius of the prototypes. Recently developed ultra-thin detector planes demonstrate a very small effective Moliere radius approaching the technological limit. Dedicated multi-channel ultra-low power readout ASIC are under development in 130nm CMOS, comprising an analogue front-end and fast 10-bit ADC in each channel, followed by fast serialization and data transmission. Laboratory tests with prototypes confirmed the basic functionalities and established excellent agreement with simulations. In addition, an ASIC with a dual readout scheme for BeamCal allowing for a fast feedback to the accelerator and simultaneously data taking and calibration is under development.

The talk will give a summary of results about design optimisation, beam-tests and the status of the readout ASICs.

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