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Requirements and Concepts of Si-W ECAL design

Requirements

The ECAL must be able to measure the energy, position and angle of photons and electrons with good precision, and must be able to resolve them from nearby particles.

It must also be integrated into a larger-scale detector, consisting of several different systems. To ensure that the detector as a whole has good performance, the ECAL must be relatively thin, should have as few insensitive areas as possible, and should not generate too much heat (to prevent the need for bulky cooling systems).

General conceptual design

To satisfy these requirements, the Si-W ECAL is designed as a tungsten-silicon based sampling calorimeter. The tungsten absorber plates reduce the size of EM showers in the device, due to the small Moliere radius (9mm) and short radiation length (3.5mm) of the tungsten. This helps to avoid overlapping of showers produced by nearby particles.

Silicon detectors have been chosen to measure the progression of the EM shower within the ECAL. Silicon detectors have the advantage that they are thin (limiting the effective Moliere radius of the ECAL), and relatively easily segmented into small active regions, giving the high granularity required. They are also easy to operate, and quite insensitive with respect to environmental conditions.

The total thickness of the ECAL will be around 23 radiation lengths (corresponding to 18cm), giving adequate containment even of high energy EM particles. Around 30 layers of silicon will be used, giving an energy resolution of about 0.16 / sqrt(E). The sampling fraction in the earlier layers will be higher than in latter layers, enhancing the resolution and the identification efficiency of low energy (~100 MeV) photons.

In a final detector, the ECAL will consist of around 2400m2 of silicon sensors, and will have a total mass of about 100 T (mostly in tungsten). It will have a "barrel" section (an octagonal tube with an inner radius of ~1.8m and a thickness of ~20cm), closed by two octagonal "endcaps". The ECAL will be hung from the front face of the hadronic calorimeter (HCAL). The region between the ECAL and the interaction point will be instrumented with various "tracking" detectors which sense the passage of charged particles.

-- DanielJeans - 17-Jun-2010

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