

The high voltage distribution system for the RICH photon detectors at LHCb

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We present the High Voltage, HV, distribution system for the Hybrid Photon Detectors (HPDs) of RICH1 and RICH2, at LHCb (484 HPDs in total). The HVs (-20 kV, -19.7 kV and -16.4 kV) are supplied by printed circuit boards specially developed to prevent electrostatic discharges and/or corona effects using the limited available volume of the HPD arrays. The circuits that will be presented allow for the splitting, distribution, protection and monitoring of the high voltages. Each board is covered with silicone rubber, which prevents electrostatic breakdown. The complete characterization of the boards will be shown against the main important parameters.

Summary

Particle identification in the LHCb experiment will be performed by two Ring Imaging Cherenkov Detectors, RICH1 and RICH2, where two arrays of Hybrid Photon Detectors (HPDs) will be allocated. The HPDs will be mounted on column structures. RICH1 will have 196 HPDs, arranged in 2 arrays, each with 7 columns of 14 HPDs per column. RICH2 will have 288 HPDs, also arranged in 2 arrays, each with 9 columns of 16 HPDs per column. The area covered by both arrays of HPDs is about 2.6 m²; the active diameter of a single HPD photocathode is 72 mm.

The photoelectrons produced by incident photons in the HPD photocathode are accelerated and focused by a cross focusing electrostatic field onto a silicon pixel array anode. Three high voltages (HV) are required for the electron optics: -20 kV, -19.7 kV and -16.4 kV. At the silicon anode, the electrons are detected and read out with CMOS pixel readout chip, each channel containing an amplifier discriminator network. A binary readout of the signals from each pixel is then performed and the data are transmitted via optical fibre to the control room. The front end readout, its voltage biasing and the HPD HV distribution are located on the columns supporting the HPDs.

At this conference we will describe the distribution scheme which delivers the HVs to the HPDs of both RICH detectors. This distribution consists of a series of HV circuit boards specifically designed to provide the three bias voltages, including protective networks. An accurate test system has been developed to fully characterize the boards. The layout includes an "analogue boundary scan" to perform accurate characterization and testing. Results will be presented on the behaviour of the leakage current from the silicone rubber that covers the boards when operated in a humidity-controlled environment.

The maximum radiation levels across the HPD regions are expected to be about 30 kRad (Total Ionizing Dose -TID) and 3×10^{12} n/cm² (1MeV equivalent Non-Ionizing Energy Loss -NIEL) over the ten years of running. These values include a safety factor of 2. We have therefore tested the radiation-hardness properties of most of the components used and some prototype boards covered with the insulator.

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