Abstract

The production of 550 hybrid photon detectors to be used within the LHCb RICH detectors has recently finished. Photonis-DEP have succeeded in consistently improving the tube quantum efficiency, by a relative 27% with respect to pre-series and prototype tubes, when integrated over the energy spectrum.

Introduction

The LHC beauty experiment (LHCb) is one of the four main experiments at the Large Hadron Collider (LHC)1. LHCb will precisely measure CP violation in the decays of hadrons containing b-quarks.

The RICH Detectors

The two Ring Imaging CHerenkov (RICH) subdetectors provide information on the velocity of relativistic charged particles by detecting and imaging the Cherenkov light they emit while travelling through a medium with velocity \( v > c/n \).

Eyes for the RICH

We need single-photon sensors, covering the four detector planes, which total 3.3 m² in area.

550 Hybrid Photon Detectors (HPDs) are used. HPDs are the eyes of LHCb.

Vacuum Quality Monitoring

Gain introduced by ion feedback, caused by any degradation in vacuum quality, is measurable through the variation of photocurrent with cathode potential. To quantify the improvement we integrate over the energy spectrum, revealing an average improvement of 27% over our expectations from pre-series HPDs.

Quantum Efficiency

The fraction of light falling on the HPD that is converted to photoelectrons is the Quantum Efficiency (QE), \( q(\lambda) \). Measurements of the QE are performed by the manufacturer, Photonis-DEP, for all HPDs and repeated by LHCb for 10% of HPDs.

Our expectation was that the QE for all pre-series HPDs would be atypical, low vacuum quality and consistent with helium as the main residual gas. The QE measurement performed at LHCb, the current, \( I_{PD} \), on a reference photodiode, is compared with that drawn by the HPD, \( I_{HPD} \), under the same light conditions.

Gain introduced by ion feedback, caused by any degradation in vacuum quality, is measurable through the variation of photocurrent with cathode potential. To quantify the improvement we integrate over the energy spectrum, revealing an average improvement of 27% over our expectations from pre-series HPDs.

As photons from the RICH 1 Aerogel radiator are heavily weighted towards the red end of the spectrum, we weight the QE and perform the integration again, and see a 41% improvement.

References


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