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Hybrid Photon Detectors for the LHCb Ring Imaging Cherenkov Detectors

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Hybrid Photon Detectors (HPD) have been chosen for the Ring Imaging Cherenkov (RICH) detectors of the LHCb experiment. Photons impinging on a multi-alkali S20 photo-cathode deposited on a quartz window produce photo-electrons that are accelerated by a 20 kV potential onto a silicon pixel sensor anode. The sensor is segmented into 8192 pixels of size 0.0625 mm x 0.5 mm that are electronically ORed together into 1024 super-pixels of 0.5 mm x 0.5 mm. The cross-focusing electron optics has a demagnification factor of five, resulting in an effective pixel size of 2.5 mm x 2.5 mm at the photo-cathode. The silicon sensor is bump-bonded to a pixel chip fabricated using 0.25 μm deep submicron radiation-tolerant technology, which amplifies and digitizes the anode signals and operates at the LHC speed of 40 MHz. The sensor/chip assembly is mounted inside the HPD vacuum envelope.

Mass production of 484 HPDs for the LHCb experiment has commenced, in close collaboration with industry. Measurements of HPD properties carried out using dedicated laboratory test facilities will be presented. These measurements will include supply currents, threshold scans, maps of the pixel chip, the depletion voltage of the silicon anode, the signal rate versus the applied high voltage, the demagnification of the electron optics and the image distortions due to magnetic fields. Stability studies under accelerated ageing of quantum efficiency, dark count and ion feed-back rates are shown. Finally, results from studies of the HPD performance in particle test beams using Cherenkov light will be reported.

Author: Dr SOLER, Paul (University of Glasgow)

Presenter: Dr SOLER, Paul (University of Glasgow)

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