The RICH detectors of the LHCb experiment

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On behalf of the LHCb RICH collaboration

Particle ID provided by Ring Imaging CHERENKOV detectors covering a wide momentum range (1–100 GeV/c)

Essential to enhance the signal/background ratio in the selection of physics channels and provide efficient tagging of hadrons

Three radiators in two detectors required for $\pi$/K/p separation

Pixel Hybrid Photon Detectors

Pixel HPDs developed in collaboration with industry

Vacuum tube with silicon pixel readout

Quartz window with S20 photocathode

200–600 nm wavelength coverage

Encapsulated 32×32 pixel silicon sensor

Bump-bonded binary readout chip

2.5×2.5 mm$^2$ granularity, factor 5 demagnification at 20 kV

484 HPDs over a total area of 3.3 m$^2$

RICH Performance (Test–Beam)

Performance of the RICH system verified in a 80 GeV/c charged particle beam at CERN

LHC–like 25 ns bunch spacing

Final RICH hardware and DAQ

CF$_{10}$ used as Cherenkov radiator

Near final LHCb reconstruction software used for the analysis

Full simulation results for photon yield and Cherenkov angle $	heta_C$

Performance of the RICH system verified in a 80 GeV/c charged particle beam at CERN

Particle Identification Performances

Cherenkov photon and rings reconstructed on HPDs planes

$B^0 \to K^- K^+$ of special interest (can be used in a measurement of $\gamma$, sensitive to new physics)

No distinguishing features for main background

Some resonant background within the signal

Really need PID to select pure signal

Very good $\pi$ suppression while maintaining 97% K efficiency

RICH Radiators

Radiator length (mm) 50 950 1800

Detected photons/track 1.03 1.0014 1.0005

Momentum range (GeV/c) 1–10 <70 <100

Aerogel

CF$_{10}$

CF$_{4}$

Refractive index

Number of hits

$\beta_C$ signal without RICH PID

$\beta_C$ signal using RICH PID

Detector length (mm)

RICH 1

RICH 2

Number of hits

Number of events