The LHCb RICH System Upgrade Commissioning

Edoardo Franzoso

University and INFN Ferrara, on behalf of the LHCb RICH Collaboration

12th LHC students poster session - Nov 29, 2022 CERN

The LHCb RICH system Upgrade

LHCb relies on the Ring Imaging Cherenkov (RICH) detector system for the charged hadron identification in a wide momentum range (2 - 100 GeV/c). The RICH systems have been upgraded to sustain an increase of the readout rate from 1 MHz to 40 MHz and the expected luminosity of \( L = 2 \times 10^{35}\) cm\(^{-2}\)s\(^{-1}\) foreseen during Run 3.

- **Figure 1:** Side view of the Run 3 LHCb experiment. Column Commissioning
- **Figure 2:** Left: HPD plane of the LHCb RICH 1 detector for Run 3. Right: MaPMT plane of the LHCb RICH 1 detector for Run 3.

**Photon-Detection chain**

- **Figure 10:** Left: Simulated photon hit time in RICH1, a time gate of 3.125 ns is highlighted.
- **Figure 11:** Linearity of the number of hits in the high occupancy region of RICH2 versus the number of inelastic pp collisions per bunch crossing in simulation. Overall, RICH2 hits are more stable (less dependence on PV position and magnetic field) and do not show a saturation effect.

**Conclusions**

The LHCb RICH detector system is converging to the final part the commissioning at Point 8. The RICH system has already proved to be reliable and consistent during the first collisions in 2022. The software reconstruction is expected soon, as well as the Cherenkov angle resolution to evaluate the detector performance.

**References**


RICH System Commissioning

- **Figure 3:** RICH 1 optics modifications.
- **Figure 4:** Left: Hamamatsu MaPMTs the R12355 (B-Type) on the left and R13999 (H-Type) on the right. Right: CLARO ASICS.

**Photon-Detection chain**

- **Figure 5:** Left: Columns with 6 PDMs. Right: RICH2 Photodetector plane.

**Luminosity**

- **Timeline RICH1**
  - Installed end of 2021 – beginning of 2022
  - Commissioned in the following months

- **Timeline RICH2**
  - Installed in early 2021
  - Commissioned throughout 2021
  - First light at the end of 2022

**Fine Time Alignment**

- **Figure 12:** Values of the RICH1 anode currents in time during a mu scan. The plateau for different mu values set by the LHC during the fill are clearly visible.

**Column Commissioning**

- All the components accepted by the QA procedure were assembled in the RICH columns during the commissioning performed at CERN.

**First Collisions**

- **Figure 7:** Distribution of RICH2 thresholds of the CLARO detector converted into absolute charge [fC]. The threshold settings can be compared to the plot gains of 950 V/pC, 1950 V/pC and 3900 V/pC as determined from PQQA.

**End of life**

- **Figure 8:** Left: RICH1 hit time distribution showing the global occupancy during data taking with beam. Right: same plot for RICH2

**Modular design** to facilitate maintenance and operations

- **Figure 11:** The RICH detectors variables can be used as a cross check with the PLUME detector for the luminosity estimation and can provide counters both from the control system and from reconstructed quantities at the HLT level to reduce the uncertainty on the luminosity estimate from LHCb.

- **Figure 9:** Single event display for a RUN taken with beam. Cherenkov rings are clearly visible in both RICH1 (left) and RICH2 (right).

Studies have been performed on simulated samples to validate the linearity of the Cherenkov photon hits in the detector planes with respect the number of primary vertices.

**Conclusion**

- The RICH detectors variables can be used as a cross check with the PLUME detector for the luminosity estimation and can provide counters both from the control system and from reconstructed quantities at the HLT level to reduce the uncertainty on the luminosity estimate from LHCb.

- Studies have been performed on simulated samples to validate the linearity of the Cherenkov photon hits in the detector planes with respect the number of primary vertices.