LHCb RICH Online-Monitor and Data-Quality

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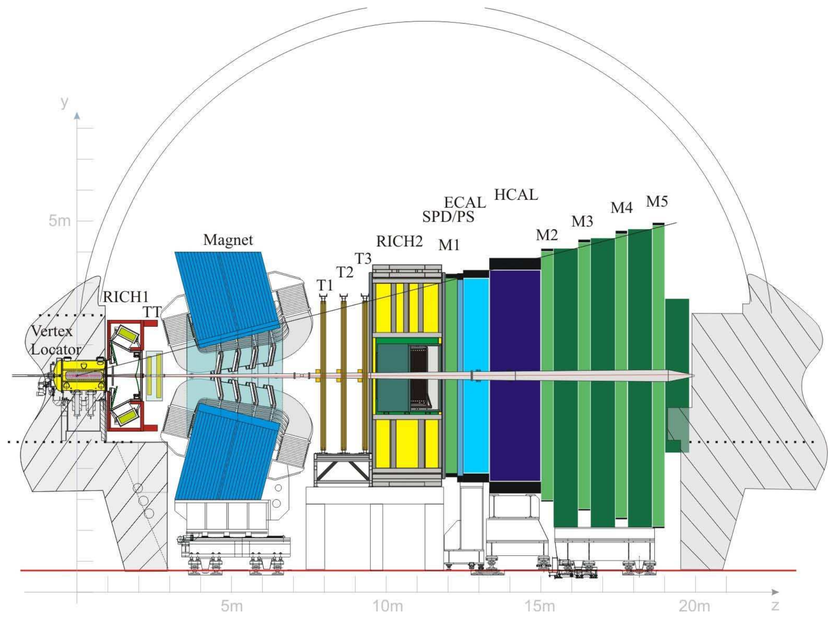
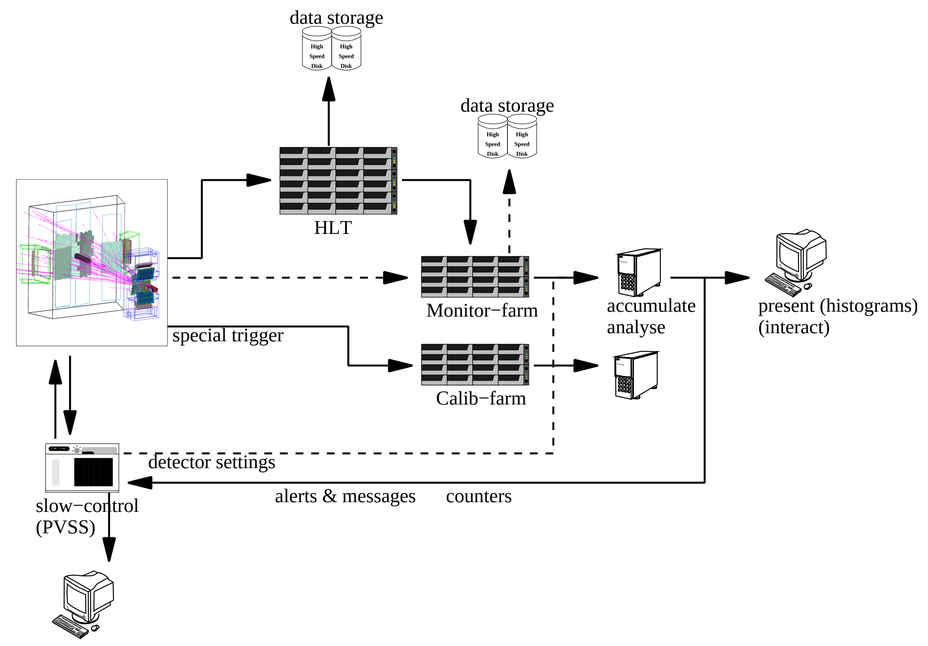
On behalf of the LHCb RICH Collaboration

The LHCb Experiment



- Dedicated experiment for heavy flavour physics.
- Precision measurements of charm- and bottom- sector.
- Search for New Physics, CP violation, Rare Decays.
- Complementary approach to direct searches by ATLAS and CMS.

Online Data-Flow



- Dedicated farm for online monitoring, including full event reconstruction.
- Dedicated farm receiving special calibration triggers, e.g. flash lasers in abort-gap to test HPD response.
- Low bandwidth “Express Stream” to monitor trends over long run periods.
- Performance monitoring with full statistics during reconstruction.

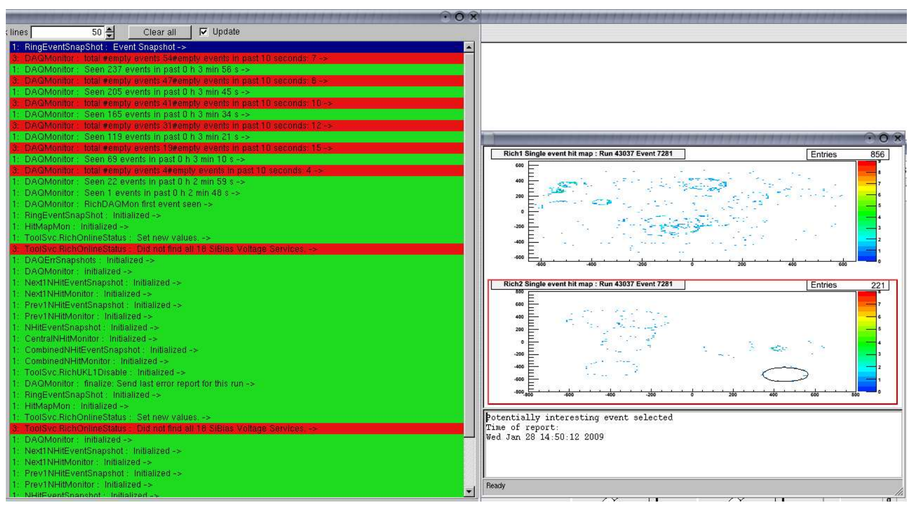
Online Monitoring and Data Quality

- Particle ID crucial to most LHCb analyses.
- RICH detectors very complex: ≈ 500 photo-detectors (HPD) with 1024 channels each.
- Automated analysis and alarms to alert shifters and experts.

Multi-staged approach to identify potential issues as early as possible:

1. low level: Data integrity, occupancy vs time, . . .
2. mid level: Testpatterns, refractive index from trackless rings, . . .
3. high level: Full event reconstruction and PID performance using exclusive decays, . . .

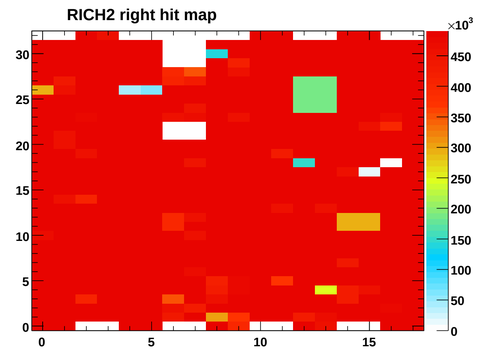
A Shifter’s View



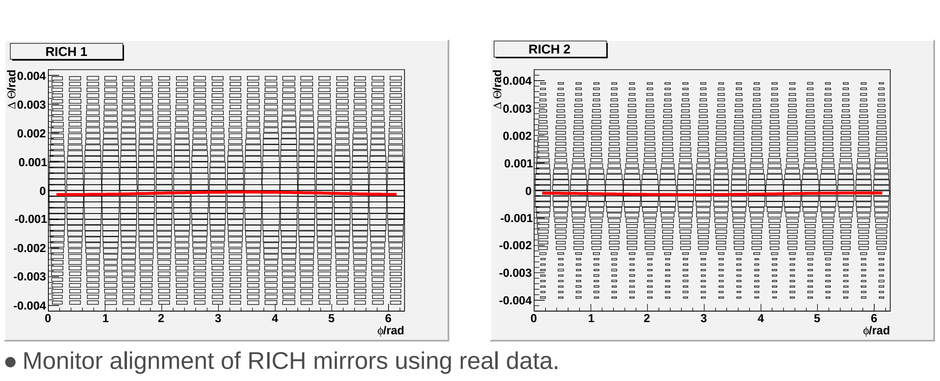
- Client / server based error reporting tool: CAMERA
- Use colours to indicate severity of issues.
- Attach further information to messages (e.g. event snapshots, more detailed error messages, . . .)

Testpattern Monitoring

- Use special calibration trigger:
  activate 4 corner pixels of Si sensor
  → Test response in low occupancy regions.
- Visualise response of each monitored pixel.
- Expect uniform distribution
  any change in colour indicates
  inefficient sensors.
- Automated alerts if HPDs don’t respond
  as expected or if efficiency drops.



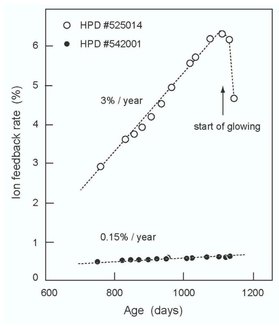
Alignment Monitoring



- Monitor alignment of RICH mirrors using real data.
- Any deviation from fitted straight line indicates mis-alignment.

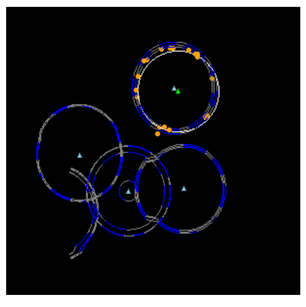
Photodetector Monitoring

- Initial photo-electron gets accellerated in HPD vacuum.
- Ion-feedback occours if the photo-electron hits an residual ion
  → large hit cluster in centre of HPD.
  ⇒ Rate related to vacuum quality
- Most HPDs show increasing rate with shallow gradient.
- Few HPDs have steeper gradient
  – Closely monitored by HPD experts.

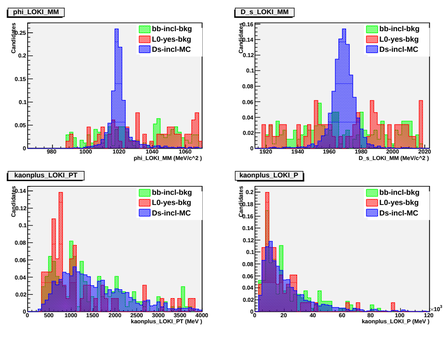


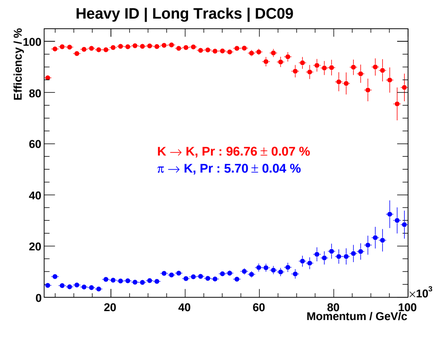
Trackless Cherenkov Rings

- Find rings independent of track seeding
  → Markov Chains.
- Ring radius related to refractive index
  → Monitor gas pressure and temperature.
  → Correlate with other slow-control info.



Particle ID Monitoring





- Use suitable exclusive final states to determine particle type from kinematic constraints:
  – $D^{*} \longrightarrow D\pi$
  – $\Lambda \longrightarrow p\pi^{\pm}$
  – $D_s^{\pm} \longrightarrow \Phi\{\longrightarrow K^{+}K^{-}\}\pi^{\pm}$
- Compare particle type from kinematics with PID information
- Automated analysis and alarms to alert experts when performance degrades.