The LHCb RICH Upgrade: Development of the DCS and DAQ system

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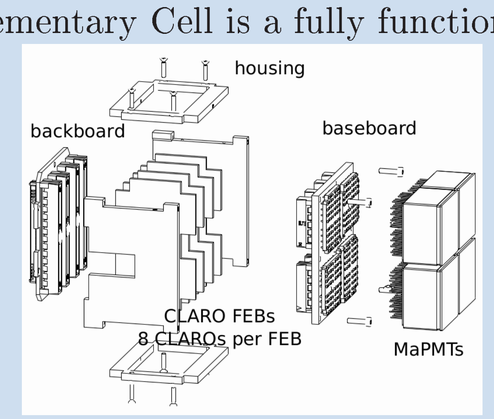
The LHCb RICH detectors Upgrade

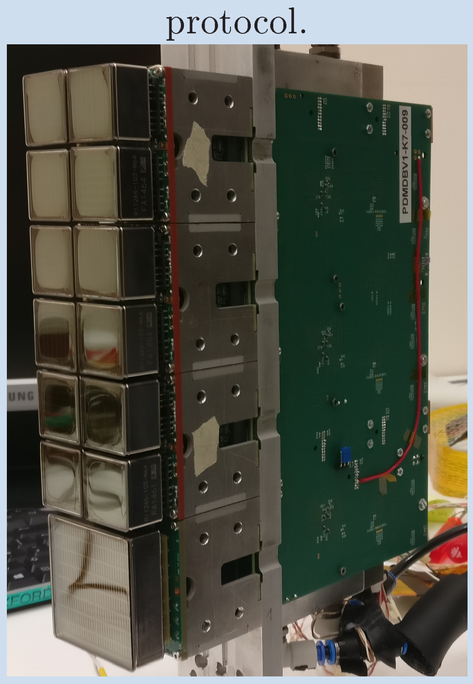
- Brand new front-end electronics compliant with the common upgraded LHCb readout architecture and allowing to readout the RICH detectors at the full LHC bunch crossing rate of 40 MHz.
- HPDs have embedded readout electronics at 1 MHz ⇒ new fast, sensitive to single photons, large active area, excellent granularity and radiation hard photon detectors: R13742 and R13743 MaPMTs from Hamamatsu.
- Significant modifications to RICH1 optics and mechanics to reduce peak occupancy given the higher LHCb luminosity of $2 \times 10^{33}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$.

The Photon Detector Modules

The Elementary Cell is a fully functional unit.



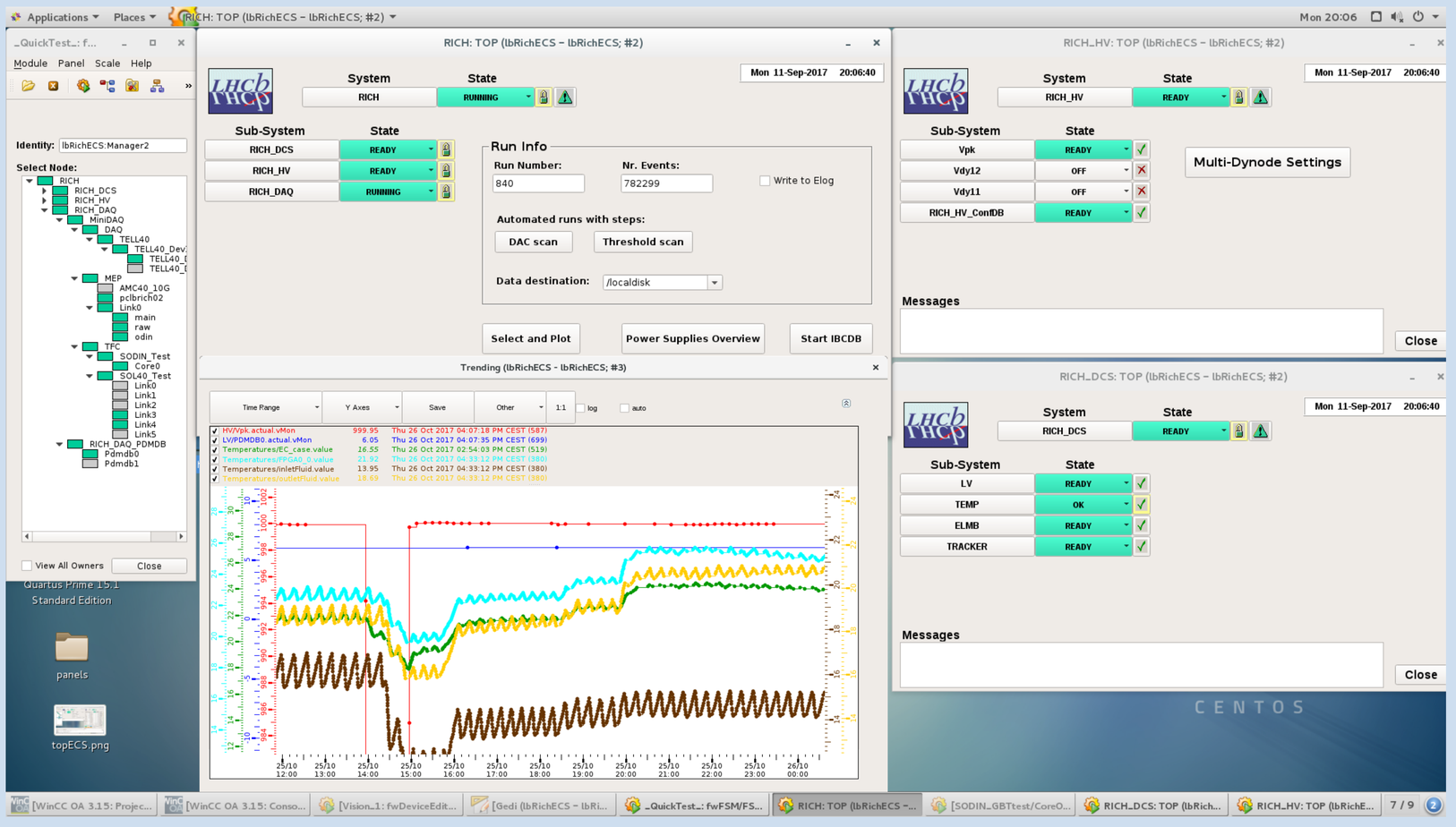
The Photon Detector Module (PDM) is the smallest logical unit allowing the interface of the RICH components with the upgraded LHCb readout architecture through the GBT protocol.



MiniDAQ integration

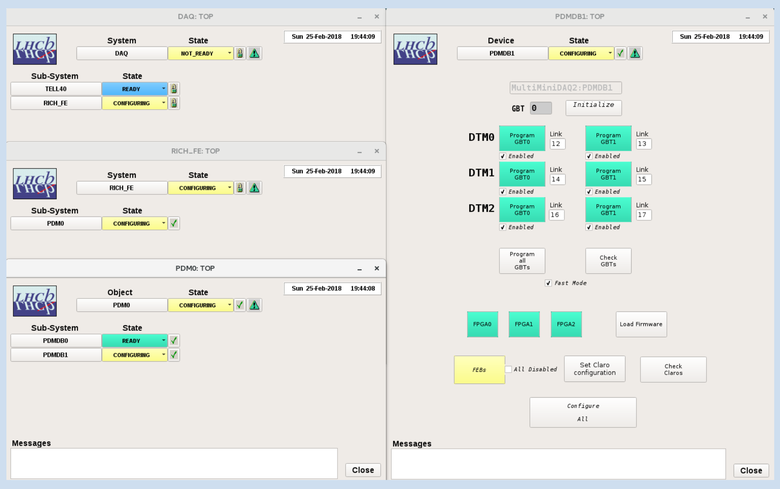
- The MiniDAQ, developed by the Online group, emulates the behaviour of the upgraded LHCb readout.
- Firmwares development: most of the functionality required by the RICH have been moved to the TELL40 side.
- Two testbeams have been successfully carried out using MiniDAQ1 and MiniDAQ1+MiniDAQ2 configurations.
- Now using two MiniDAQ2 for routine activities in the RICH Upgrade SysLab at CERN:
  - ECS and TFC commands from/to the digital boards to/from the SOL40;
  - data from the digital boards sent to two different TELL40s.
- Installation of a PDM in RICH2, readout and operated by a MiniDAQ2, ongoing.
- Moving towards the final architecture:
  - from firmwares side;
  - from the control side, implementing an LHCb-like FSM.
- Parallel developments with the Online group.

Prototype of the RICH Upgrade Experiment Control System



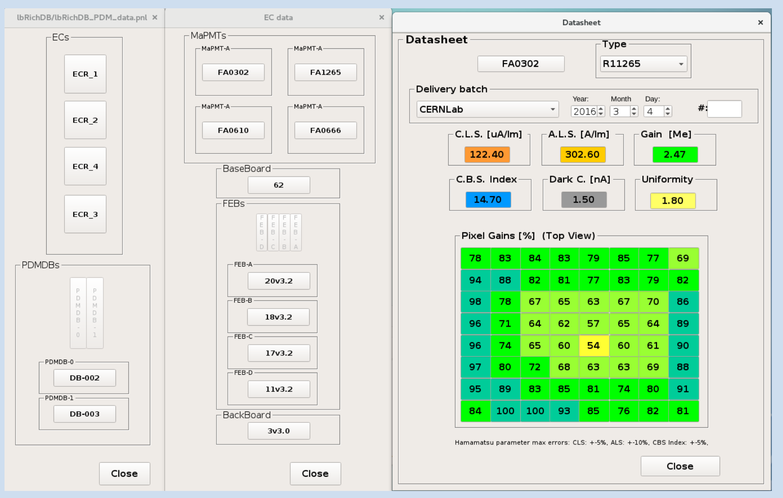
- Developed within the JCOP framework using WinCC-OA, it integrates in a single FSM the DCS, HV and DAQ partitions.
- It allows the control and monitoring of the LV and HV power supplies, monitoring of the temperatures implemented using an ELMB, configuration of the RICH front-end and the control of the data acquisition exploiting the MiniDAQ FSM provided by the Online group.
- Automated actions: emergency switch off if any temperature is outside allowed limits, sequential configuration of the RICH front-end.
- Run control has been implemented allowing to acquire run with steps required to perform calibration of the RICH detectors.
- It has been used as debugging tool during testbeam operations and to perform DAQ integration tests and thermal studies of the setup at CERN.
- It is interfaced with the RICH Upgrade Inventory, Bookkeeping and Connectivity DataBase (IBCDB): plans to load front-end configuration parameters from it during commissioning phases.
- Ongoing developments to change the structure of the DAQ partition taking into account the final architecture of the LHCb DAQ control tree in the Upgrade.

Front-end configuration



- Sequential and automated operations through WinCC-OA ctrl scripts.
- Implementing parallelizations of CLAROs configuration to speed-up the system towards the optimal operations of the RICH Upgrade detectors.

RICH Upgrade IBCDB



- It stores the information and the history of all the RICH upgrade components (MaPMTs QA data etc.), allowing for hardware traceability.
- It stores front-end and DAQ configuration parameters.
- It is interfaced with ROOT.