Commissioning of the LHCb RICH Detector

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Outline

LHCb and its RICHes
What is Commissioning and Commissioning Strategy
RICH Commissioning, a (hi)Story
First Results
Conclusions and Outlook

The two RICH detector planes

RICH1 detector challenge: very small material budget
(see Neville, Tito and Fabio)

RICH2 detector challenge: not fully assembled in the lab. and transported
(see Neville)

Most of the commissioning is focused on the Optoelectronic, Control and Data Acquisition and Calibration Systems

HPDs array as in one photodetector plane for RICH2
RICH1 two arrays are...
Commissioning means to set-up (the present) the detector for physics and to run (the future) it for an initial period.

- Do as much preparation as possible in the laboratory
- Prototyping
- System (hardware and software) development and testing: two main tools:
  - SSB1 (Small Simple Box) for column mounting, integration and testing
  - SSB2, one column RICH complete system (from HPDs to data storage) for software development, testing, stability, etc.
- Test-beams experiments
- Maximum possible safety for the final system (and for people, of course!)

Safety

• Regular Meetings (everyday coffees and weekly phone-conferences)

• Hard and soft interlocks enabled from the beginning

• Monitoring systems
  • Vessel, HPD boxes, electronics and electrics temperature, pressure and humidity sensors
  • Voltages and currents

• Distributed and smart alerts, alarms, feedbacks and reactions

• No development at the pit (at least we tried as much as we could…)

(see Mario)
A closer look and a (hi)story of RICH2 commissioning,
(looking forward to do the same for RICH1 soon!!)
RICH2 optics are mounted and aligned

- Central carbon fibre tube to allow for the beam pipe
- Mirror support and fine adjustment
- Panels honeycomb structure
- Spherical mirrors array
- Flat mirrors array
RICH2 is closed and transported to the pit
RICH2 columns assembly
Columns are installed
From your keyboard to your screen (ECS)

- RICH Online monitoring
  - Storage
  - Online network
    - 10^4 Hz
    - 10^6 Hz
  - ELMB cards
    - System monitoring
      - 10^0 Hz
      - 10^-1 Hz
    - Power LV, HV
      - 10^-8 Hz
      - 10^-1 Hz
      - 10^-10 Hz
  - 288 HPDs
    - L0 configuration
      - 144 L0
      - Run commands
        - 10^6 Hz

To your screen

RICH Starting Procedure

...or the so called “one click startup”...
(well, two clicks at the moment!)
First electrical images from RICH

With Si bias off HPD on-chip detectors provide a nice source of signal to check the data flow.

Threshold set

In reality HPDs are staggered to achieve maximum active area.
What is shown, is the “chips space” rather than the “photocathode space”.

Here 144 x 8192 pixels (~1.2 millions channels, clocked at 40 Mhz) are coloring our life!
First photoelectrons from RICH

With Si bias on, nothing… (the few “noisy pixels” will be masked by the L0s)

then let’s switch on the HPD high voltage and inject a bit of controlled light

… then,…

FIAT LUX (first photons detected)

High Voltage was ramped very slowly and with the full system on, in order to monitor in real time the HPDs behaviour.

Excellent!
This is the distribution of the total number of phel per event (~2.4 Millions active channels).

A red light emitting monomode fibre injects a controlled quantity of photons in the vessel.
RICH2 is routinely running

- To test and to improve its calibrations, stability, reliability, robustness;
- To exercise HPDs and keep them powered and under high voltage;
- Gain experience (also in critical situations) and confidence;
- And possibly to acquire useful data to prepare the future (see Antonis and Claus).

Example: when the magnet is on, HPD images are distorted

system to monitor and correct for the distortion
First optical images from RICH2

We shine a defined pattern on the photodetector without and with magnetic field.

The shadows from the mumetal shields

A DLP projector together with an optical system to ensure low light levels and safe operation was used.
Conclusions

LHCb RICH detectors are well under way for a successful commissioning:

RICH2 is deep in its commissioning phase and it is ready for global commissioning;

RICH1 is at its last stages of installation and integration and will jump speedily in the commissioning, as the whole opto-electronic, control and readout system is identical to RICH2.

We are NOT looking forward,

we are DYING to see the light from the LHC particle beams!
Acknowledgements

It is difficult to convey an idea of the enormous amount of work, new technologies, R&D, tests, sweat and years, which embeds a 20 min presentation …and the amount to come...

I wish I managed a bit!

Whatever the case, I would like to respectfully thank all the people who worked, are working and will work on our project and on whom behalf I am here today.