LHCb Status

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CHIPP Meeting
EPFL, Sep. 8th, 2008
• Heavy-flavor physics experiment at LHC
• ~700 collaborators from 15 countries (~50 institutes)
• correlated $b\bar{b}$ production in the forward (or backward) direction at the LHC => single-arm forward spectrometer
• LHCb runs at $L=2\times10^{32}\text{ cm}^{-2}\text{s}^{-1}$ to suppress multiple interactions in bunch crossing
LHCb Physics Program

- **Heavy-flavor physics**
  - precision physics in the b-quark sector
    - access to $B$, $B_s$ and $B_c$
    - measure all quark-mixing phases; improved tests of CKM matrix \(\Rightarrow\) sensitivity to physics beyond the standard model
  - rare decays
- **charm and tau physics**
- **Beyond SM physics**
- **Early physics results will include production rates at LHC energies**
Excellent tracking performance with VELO + Tracking stations placed before and after the magnet:

**Trigger Tracker (TT)**

**Inner Tracker (IT)**

**Outer Tracker (OT)**

**Electromagnetic (ECAL) and Hadron (HCAL) Calorimeters**

**Muon detector stations (M1-M5)**

**Interaction Point**

**Precision vertexing:**

**Vertex Locator (VELO)**

**Particle identification:**

**RICH1 and RICH2**
Excellent triggering performance with VELO + Tracking stations placed before and after the magnet:

**Trigger Tracker (TT)**

**Inner Tracker (IT)**

**Outer Tracker (OT)**

Precision vertexing:

**Vertex Locator (VELO)**

Electromagnetic (Ecal) and Hadron (Hcal) Calorimeters

Muon detector stations (M1-M5)

High-precision tracking performance with VELO + Tracking stations placed before and after the magnet:
Magnet Tracking stations
VELO RICH1 TT
RICH2
ECAL
HCAL
Muon M1-M5
IP
Tracking stations
Swiss Contributions

40 collaborators from University of Zürich and EPFL

1. Vertex Locator (VELO)
   • readout links and LV
   • TELL1 readout electronics board (common to most LHCb sub-detectors)

2. Silicon Tracker (Project leaders: O.Steinkamp, M.Needham)
   • Trigger Tracker
   • Inner Tracker

3. Physics studies (LHCb physics coordinator: T. Nakada; Heavy Flavor group convener: O.Schneider)

4. Newly elected Collaboration Board chair: U. Straumann
VELO

- 21-layer Silicon-based vertex detector
- 2D sensitive area only 8.2mm from LHC beam
  => installed in a secondary LHC vacuum
- ~180k channels
- Used for vertexing (resolution: 10µm in r, 50µm in z) and track seeds
VELO Status

- Installation complete
- Detector is running
- Commissioning underway (seen first tracks from LHC injection tests)
Trigger Tracker

- 143k channels
- 183µm pitch, 50µm single-hit resolution

- 4-layer Silicon detector (0°, +5°, -5°, 0°), providing tracking before the magnet
Trigger Tracker Status

- Installation is complete
- Detector is running
- Commissioning under way
- Ready for 2008 run
Inner Tracker

- 3x 4-layer Silicon detector for innermost part of 3 tracking stations after the magnet (outer part: straw tubes)
- arranged in 3x 4 boxes around the beam pipe
- 2\% of area, but 20\% of the tracks => Silicon technology for high occupancy
- 130k channels, 198\(\mu\)m pitch
Inner Tracker Status

- Fully installed
- Detector is running
- Commissioning under way
- Seen first cosmic and beam-related events
LHCb Installation Status

• Completed installation of all sub-detectors (except Muon station 1)
• Commissioning done at sub-detector level
• Currently exercising data acquisition in global readout mode
  • all sub-detectors with cosmics trigger
  • all sub-detectors with LHC injection test beams (“TED” data)
Cosmic data

- First tracks seen in cosmic events
- Trigger from calorimeters and/or muon detector
- Tracks seen in the Inner Tracker (hit map cumulated over one data-taking run)
Tracking in cosmic event

Golden cosmic track with OT, IT, Spd, Prs, Ecal, Hcal, Muons
LHC injection tests

• Data taken during LHC injection tests, with beam dump on TED (situated before the LHCb detector at Point 8)

• Seen activity and tracks in most detectors
  e.g. VELO tracks

Direction of particles opposite to “natural” direction of LHCb detector

run: 30933
event: 21
Alignment Test

1. Use track seeds in VELO
2. Extrapolate VELO tracks to TT and IT (magnet off)
3. Plot residual of closest hits in TT and IT

=> see correlation peaks!

- Successful test of **time** and **spatial** alignments between sub-detectors! (+ validation of offline reconstruction)
Commissioning Status

- Essentially ready for 2008 run

- Current effort on:
  - time alignment
  - fine tuning the operations procedure under beam conditions

- For 2009 physics run
  - complete installation of muon station 1
  - several hardware improvements planned for the Winter shutdown
Upgrade options

- Issues after 5 years ($L_{\text{int}}=10\text{fb}^{-1}$ at $L=2\times10^{32}\text{ cm}^{-2}\text{s}^{-1}$):
  - significant time for doubling dataset
  - sub-detectors near end of lifetime (radiation)

- Upgrades considered for 2013 and 2017 shutdowns:
  - front-end electronics running at 40MHz $\Rightarrow L=1\times10^{33}\text{ cm}^{-2}\text{s}^{-1}$
  - replace all sub-detectors with improved radiation hardness and accepting higher occupancy

- Physics goal: high precision test of new physics discovered at the LHC
Conclusion

- Excellent progress towards LHCb readiness for 2008 data taking run
- Hope for first physics results soon
- Looking forward to real B physics events...

...but already considering detector upgrade