# The LHCb alignment and alignment monitoring framework

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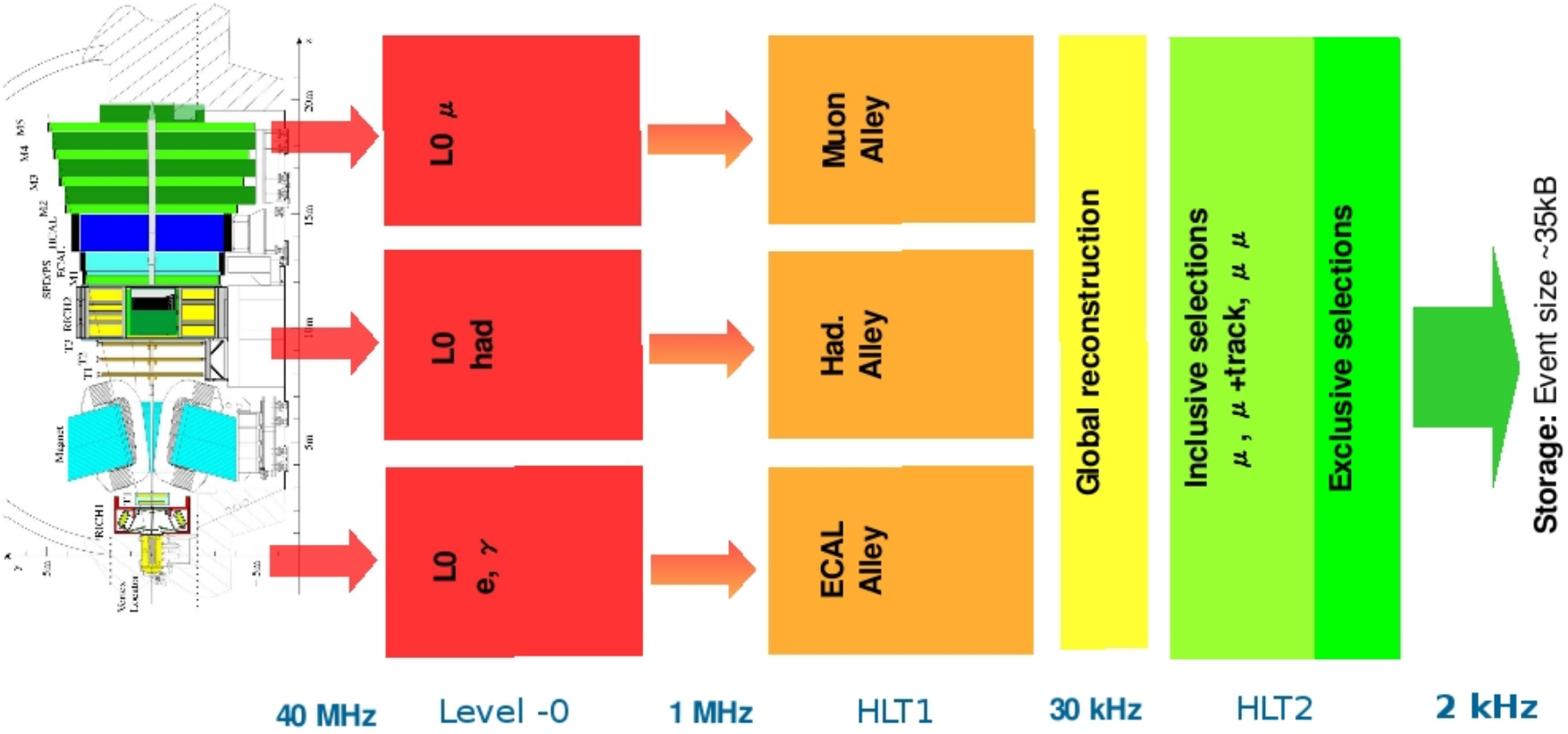
3rd LHC Detector Alignment Workshop

# Outline

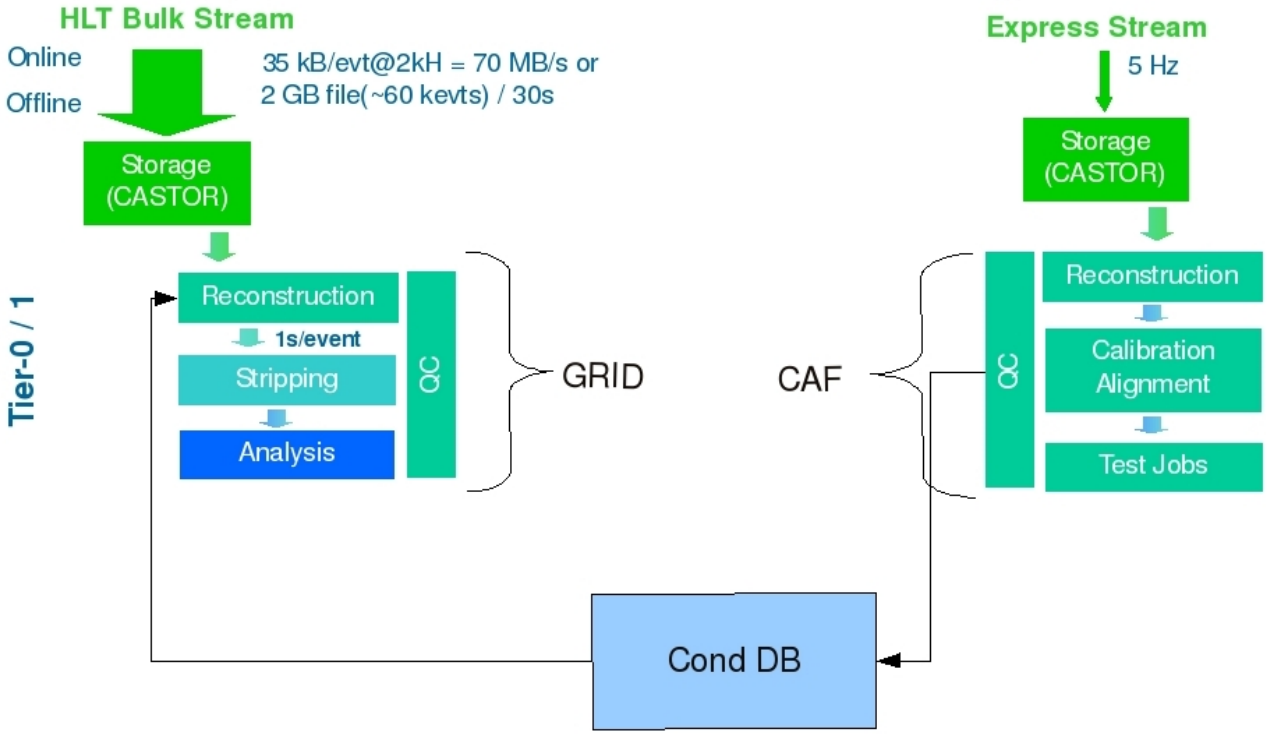
- LHCb data flow
- Calibration & Alignment framework
- Monitoring
- Summary

# Trigger: data rates




Monitoring: random sampling of events from 2 kHz
Express stream: specific event selection of 5 Hz

# LHCb: data flow



# Alignment Strategy

## Conditions

*VeLo retracted during injection*

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*VeLo retracted during injection*

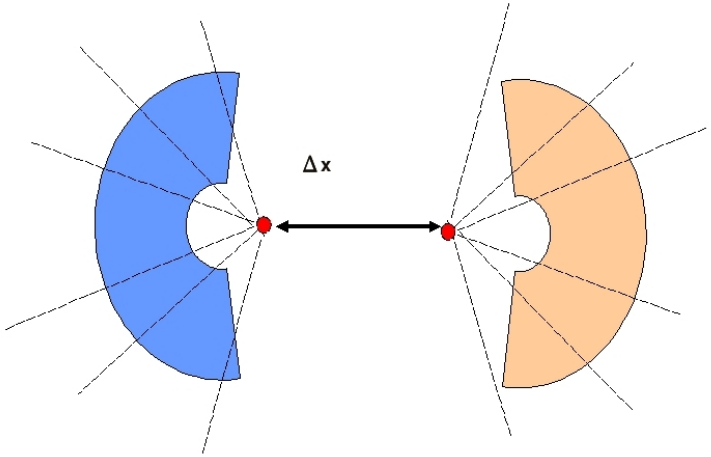
- At each fill, *Online*:
  - VeLo half alignment
  - center VeLo around PV
- During data taking:
  - local alignment of VeLo, IT, OT tracking detectors
  - alignment of OT, IT etc w.r.t. VeLo
- start offline reconstruction

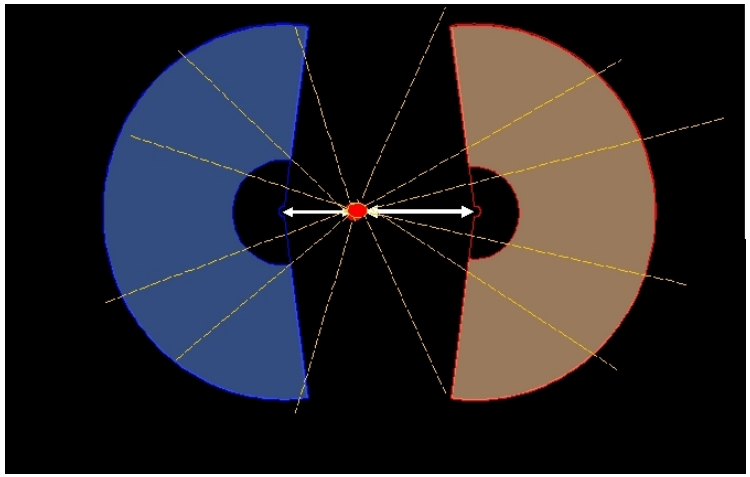
# Online Monitoring & Express Stream

## VeLo Online Alignment

- Vertex detector retracted during injection
- Stable beams: move in VeLo
- Center VeLo around PV

- reconstruct PV with each VeLo half
- 2D difference in PV position: monitor half-alignment
- Monitor position of Velo wrt to PV



# Online Monitoring & Express Stream

Express stream:

- Use 100 $\mathrm{k}$ events for $\mathcal{A}$ & $\mathcal{C}$
- Express stream: special triggers for $\mathcal{A}$ & $\mathcal{C}$
  - tracks from beam-halo events
  - monitoring: primary vertices, $\mathrm{J}/\psi$ mass resolution
  - alignment: RICH mirrors, IT boxes, etc
- calibration: space-drift time, PID, Ecal energy...

# Alignment & Calibration Framework

- based on Gaudi:
- can use standard LHCb reconstruction
  - calculate variation of total $\chi^2$ as function of track- & alignment parameters
  - derive track-dependent calibration parameters (*e.g.* energy calibration of ECal)
- calculate alignment/calibration parameters
- iterate (when needed)
- save & store parameters in condition database
- test new conditions: decide on updating and
- deploy new conditions to online, T0 & T1 centers

# Monitoring

- 50 Hz from online track reconstruction
  - monitor residuals,
  - track-$\chi^2$
  - $T_0$
  - histograms saved in “savesets”
- from offline reconstruction
  - similar histograms
  - histos collected in savesets
- from Calibration and Alignment farm
  - iterations allow for more elaborate monitoring
  - *e.g.* SVD analyses
  - perform space-driftime calibration for OT
  - histograms saved in “savesets”

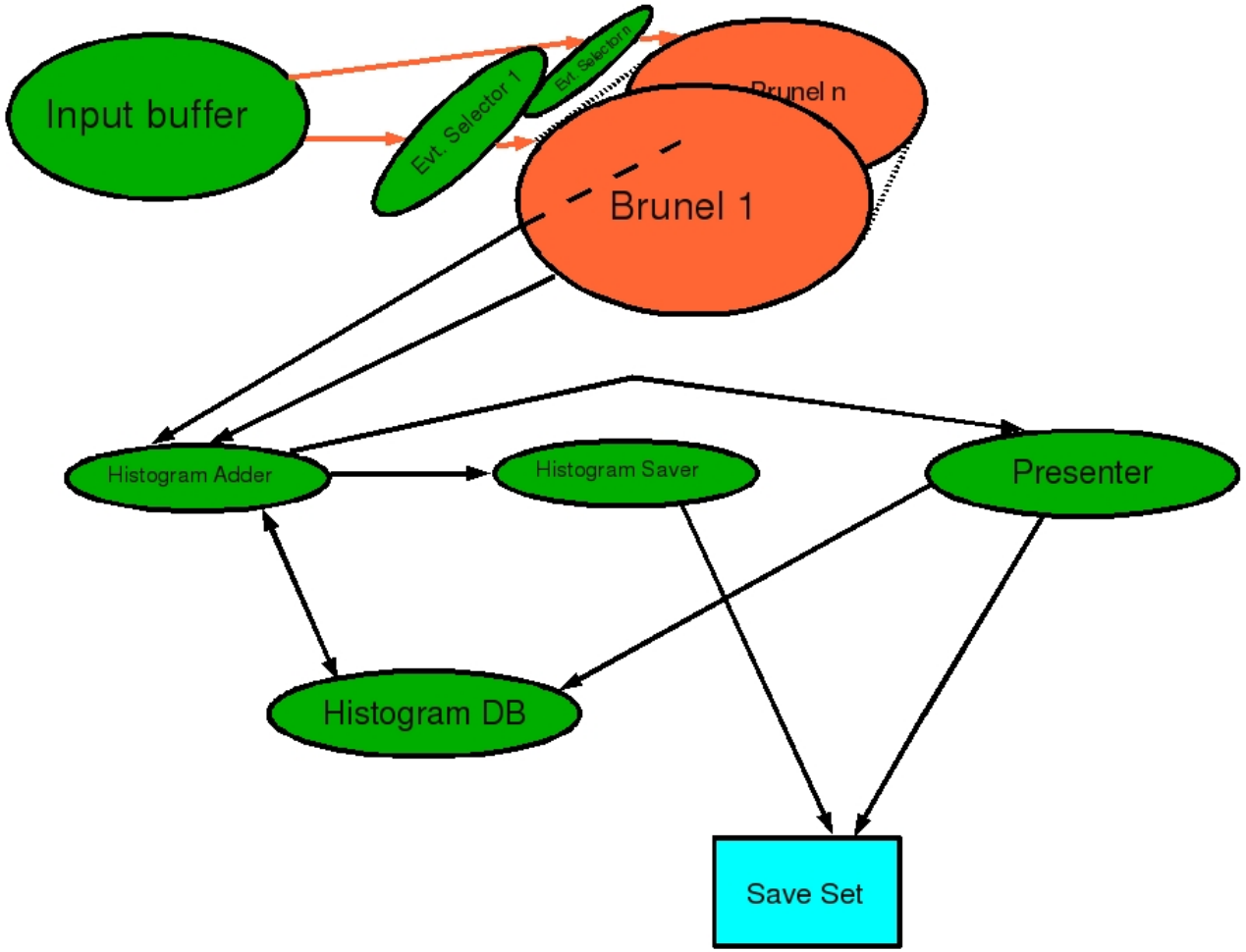
# Online Track Reconstruction & Monitoring

## prerequesites

- Distributed Information Manager (DIM)
- *n* instances of BrunelOnline
- Adder (adds identical histograms from reco process)
- Saver (produces 'save-set' of histograms)
- OMA (analysis library)
- HDB: Histogram DataBase
- Presenter

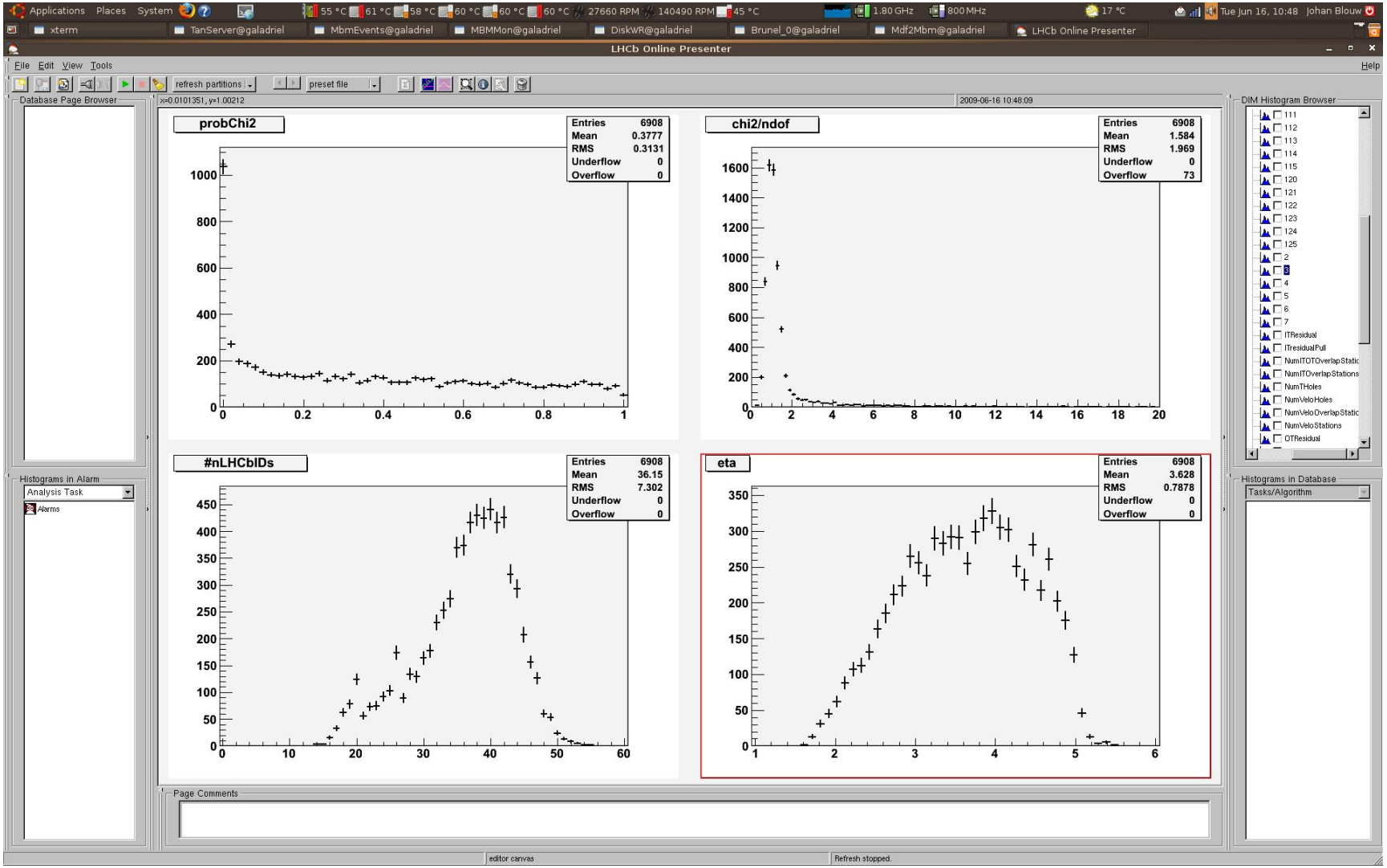
# Online Track Reconstruction & Monitoring

## prerequesites



# Example of monitoring plots

## FEST: Full Experimental System Test



# Example of monitoring plots

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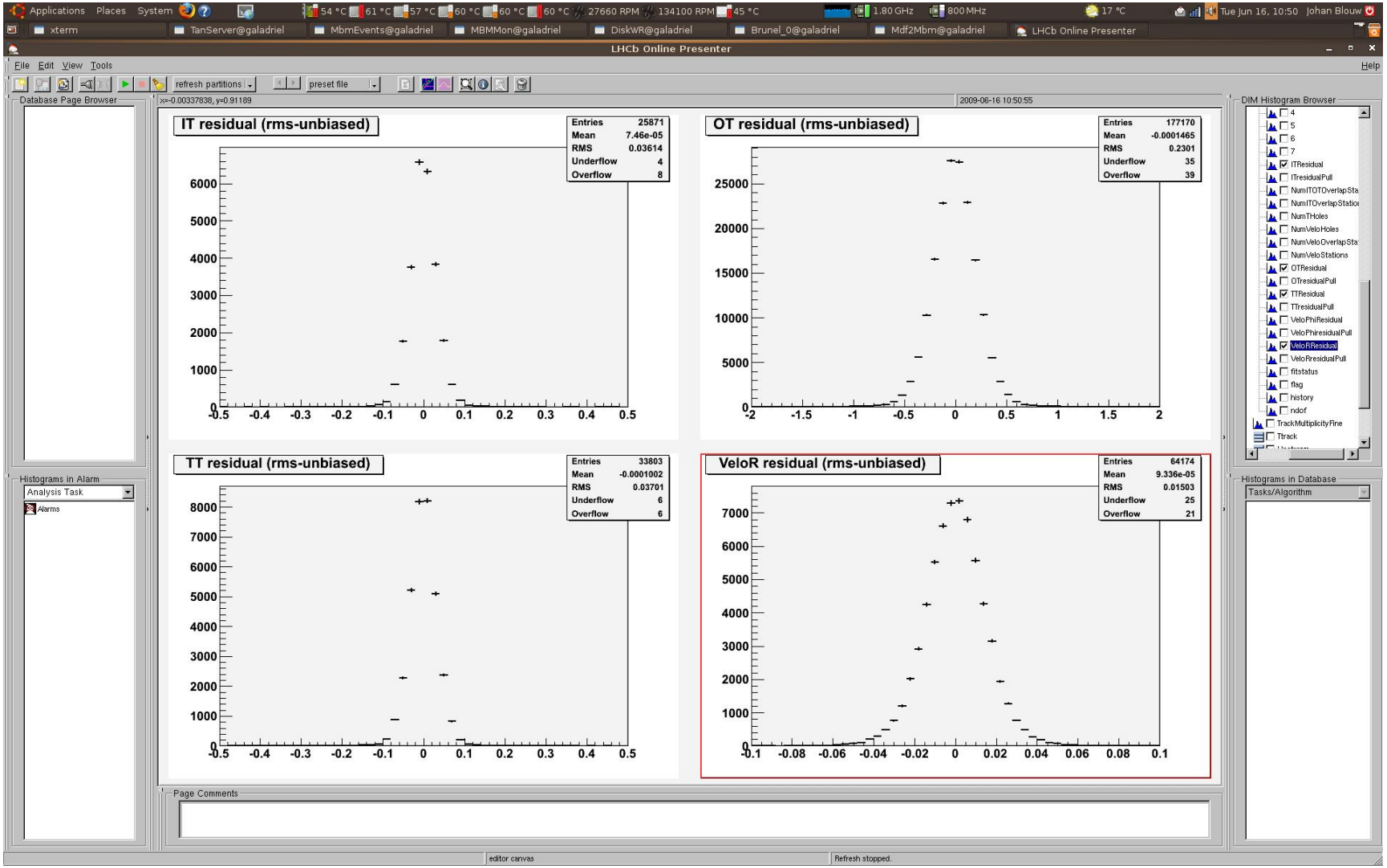
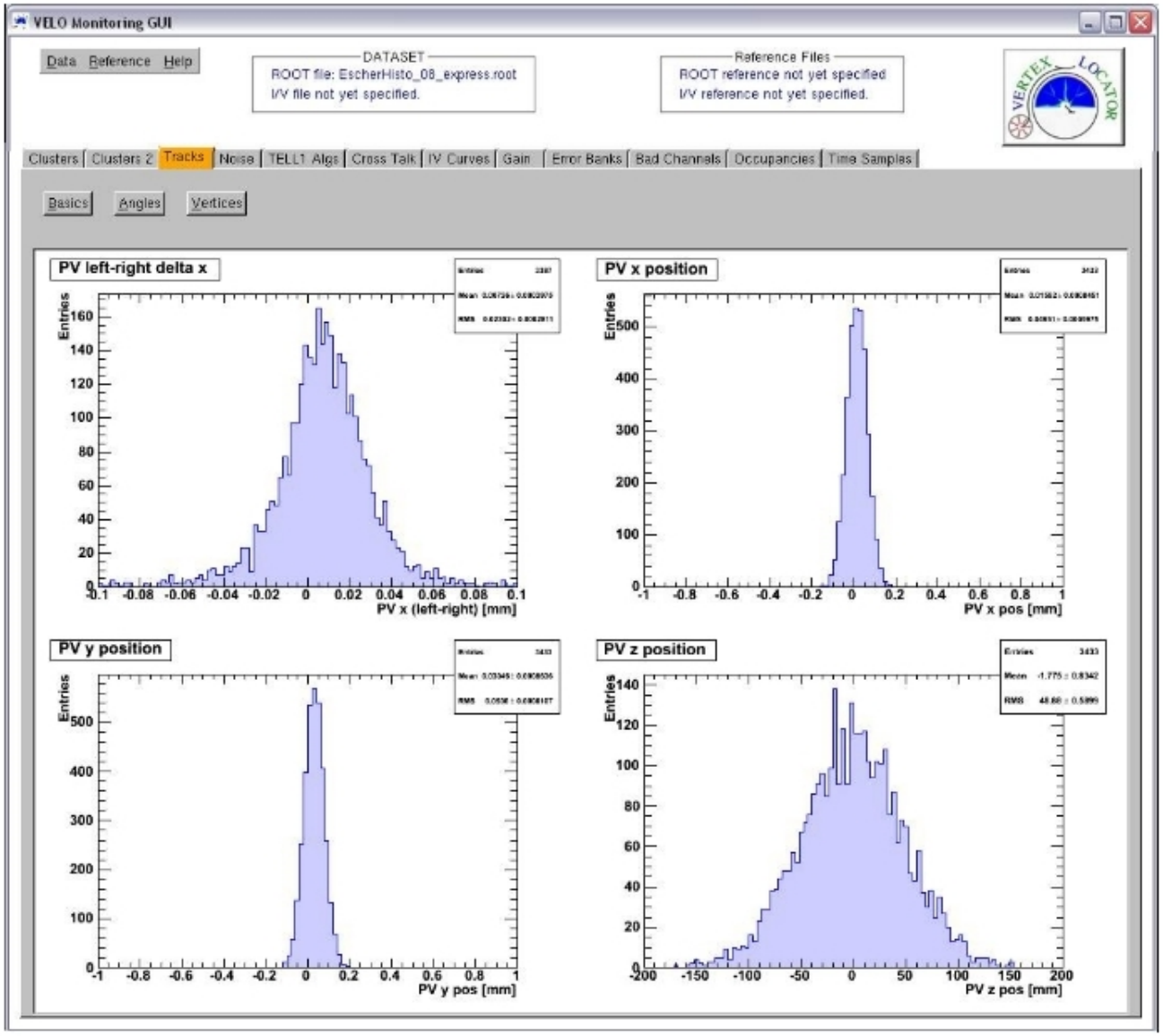


# Example of monitoring plots

## VeLo offline monitoring



# Summary

- 2 data streams online: 2 kHz from HLT and 5 Hz Express Stream
- distribute data to reconstructions sites
- monitor track-based quantities (on- and offline)
- monitoring of alignment-related quantities (CAF)
- automatic comparison of online histos against reference histos
- creation and deployment of conditions data base slice

We are ready to align LHCb after first collisions!!