VELO DQM and Central Exclusive Dimuon Production at LHCb

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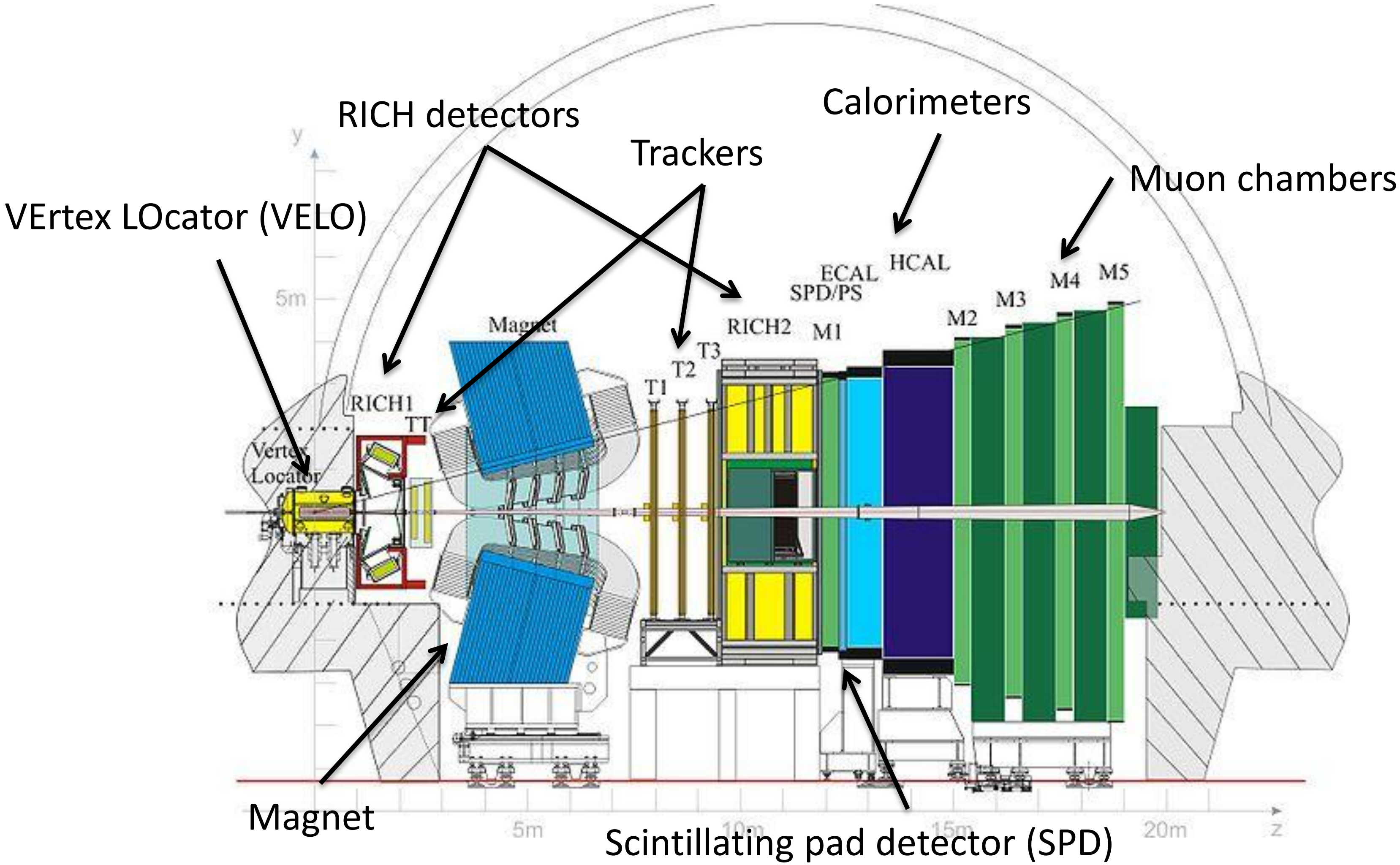
Outline

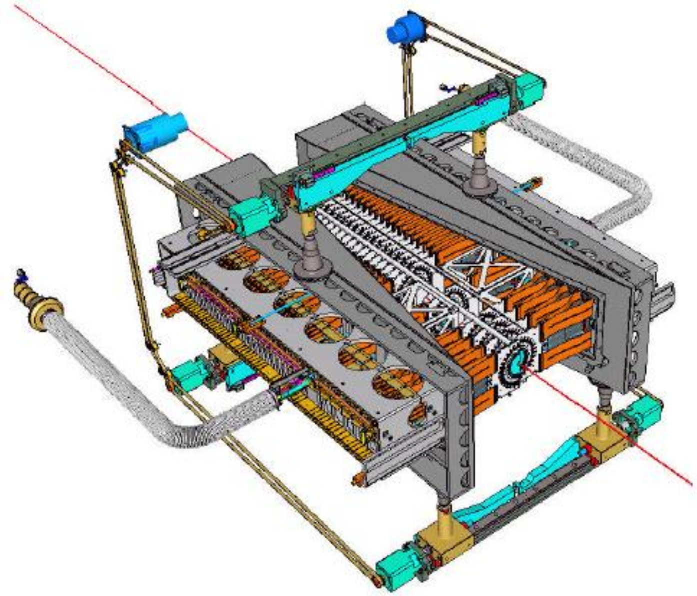
1. Brief introduction to LHCb and the VErtex LOcator (VELO)
2. Update of VELO DQM TWiki and GUI
3. Analysis of central exclusive dimuon production at LHCb

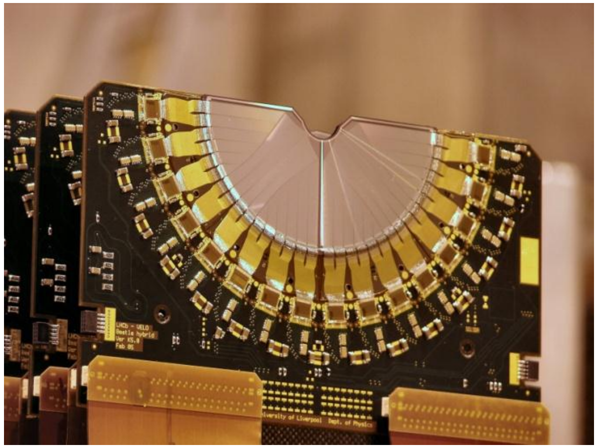
The LHCb Experiment



The VELO detector

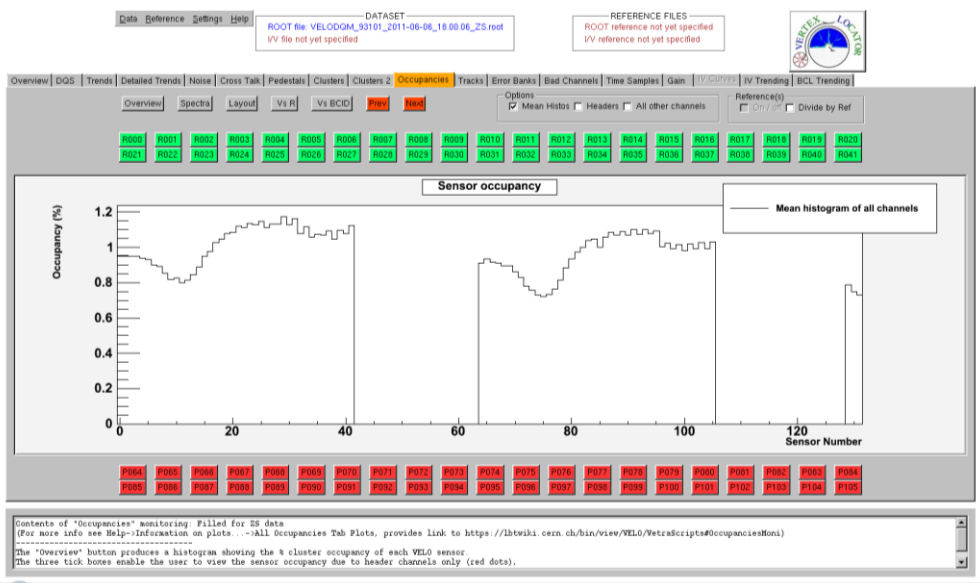
- Silicon strip detector made up of 2 retractable halves of 21 modules each
- Each module has both an r and ϕ sensor
- Needed to precisely locate both primary and secondary vertices





VELO Data Quality Monitoring

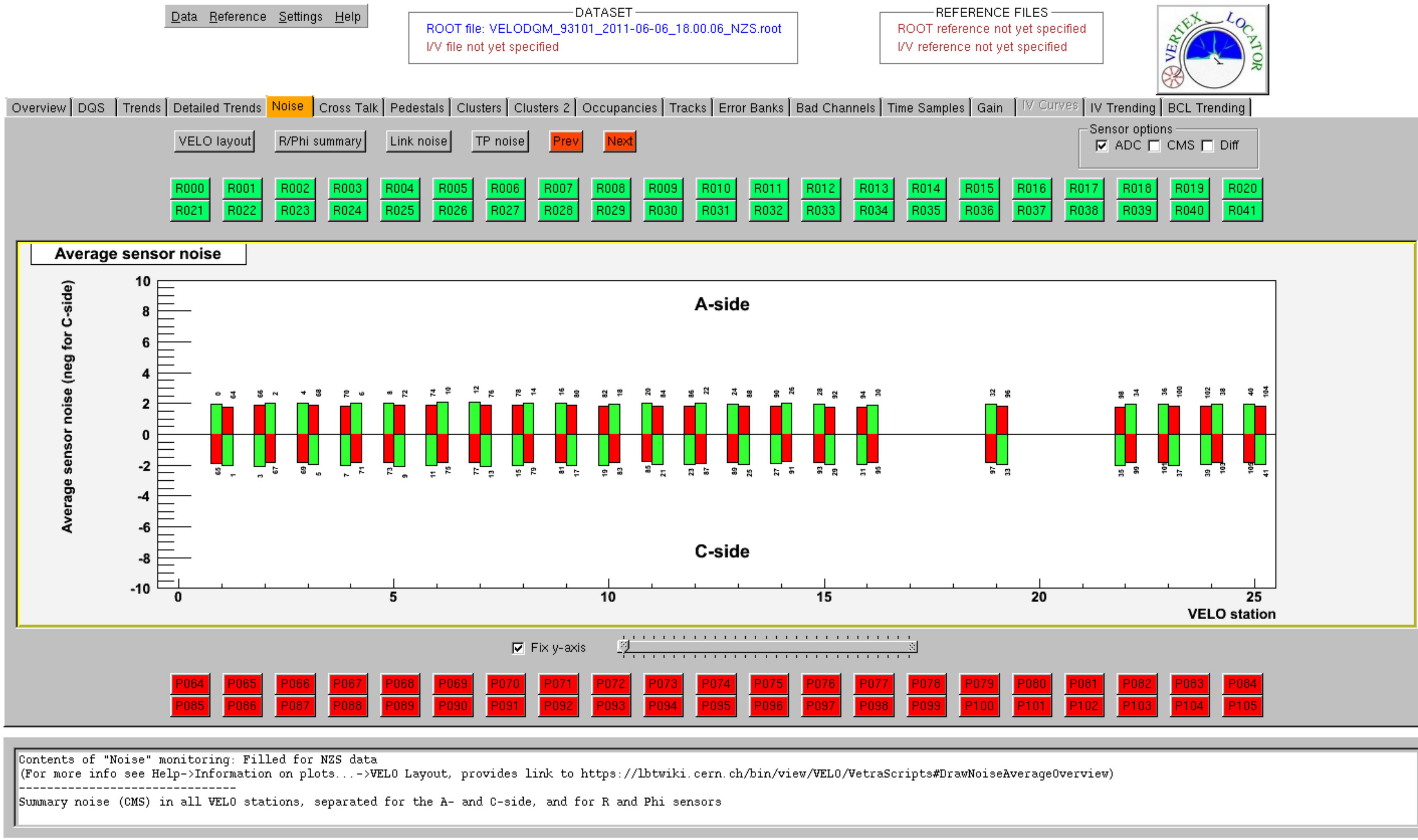
- A number of macros are used to produce plots detailing VELO performance during a run.
- The plots are usually (and most easily) accessed from the VELO monitoring GUI.



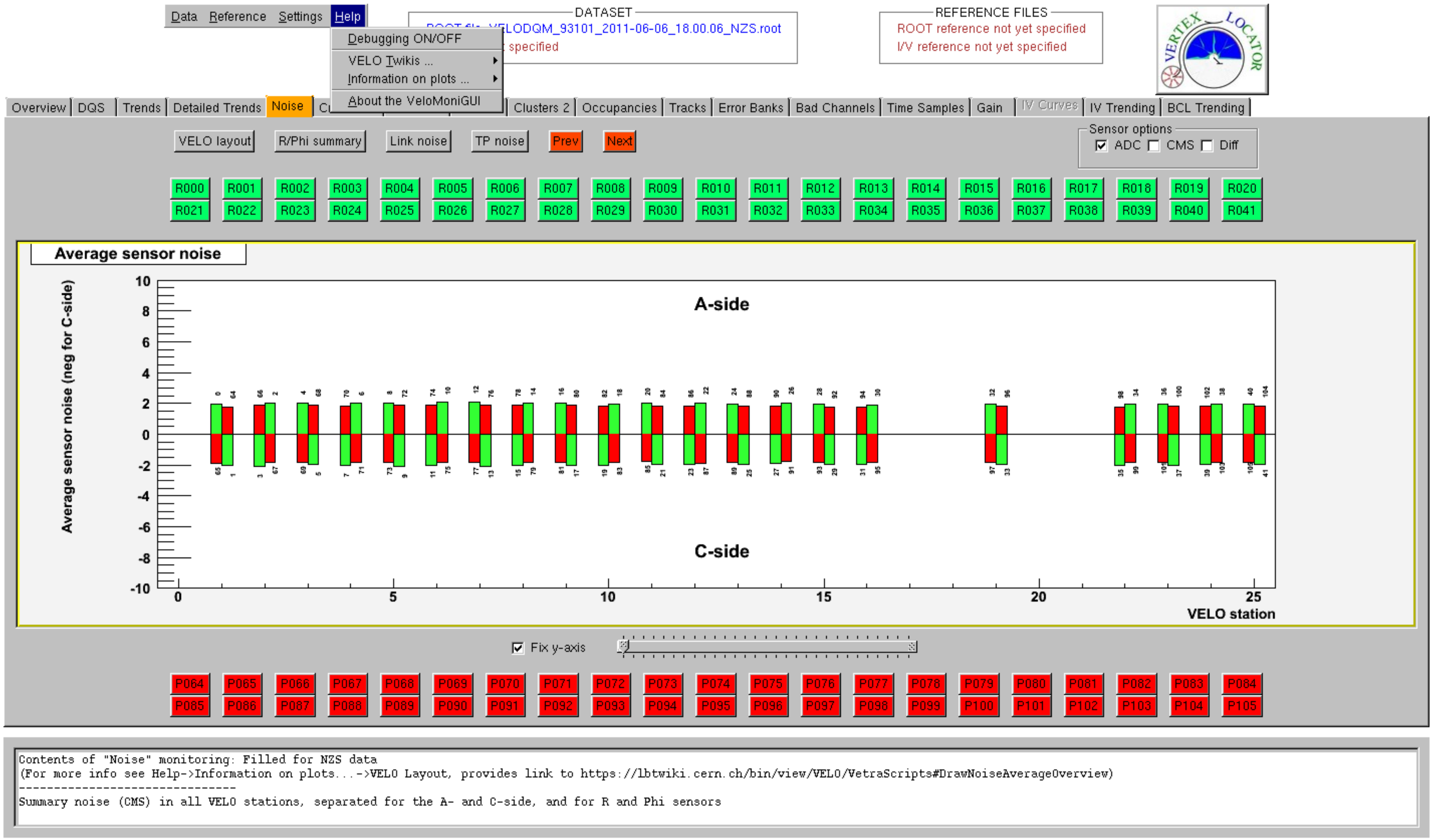
Update to VELO GUI TWiki page

- There are 16 tabs in the GUI using a total of 20 macros
- Updated/wrote documentation for each macro including:
  - A summary of plots produced by the macro
  - Usage
  - Ideal behaviour
  - Examples of ideal and bad plots
  - Known problems

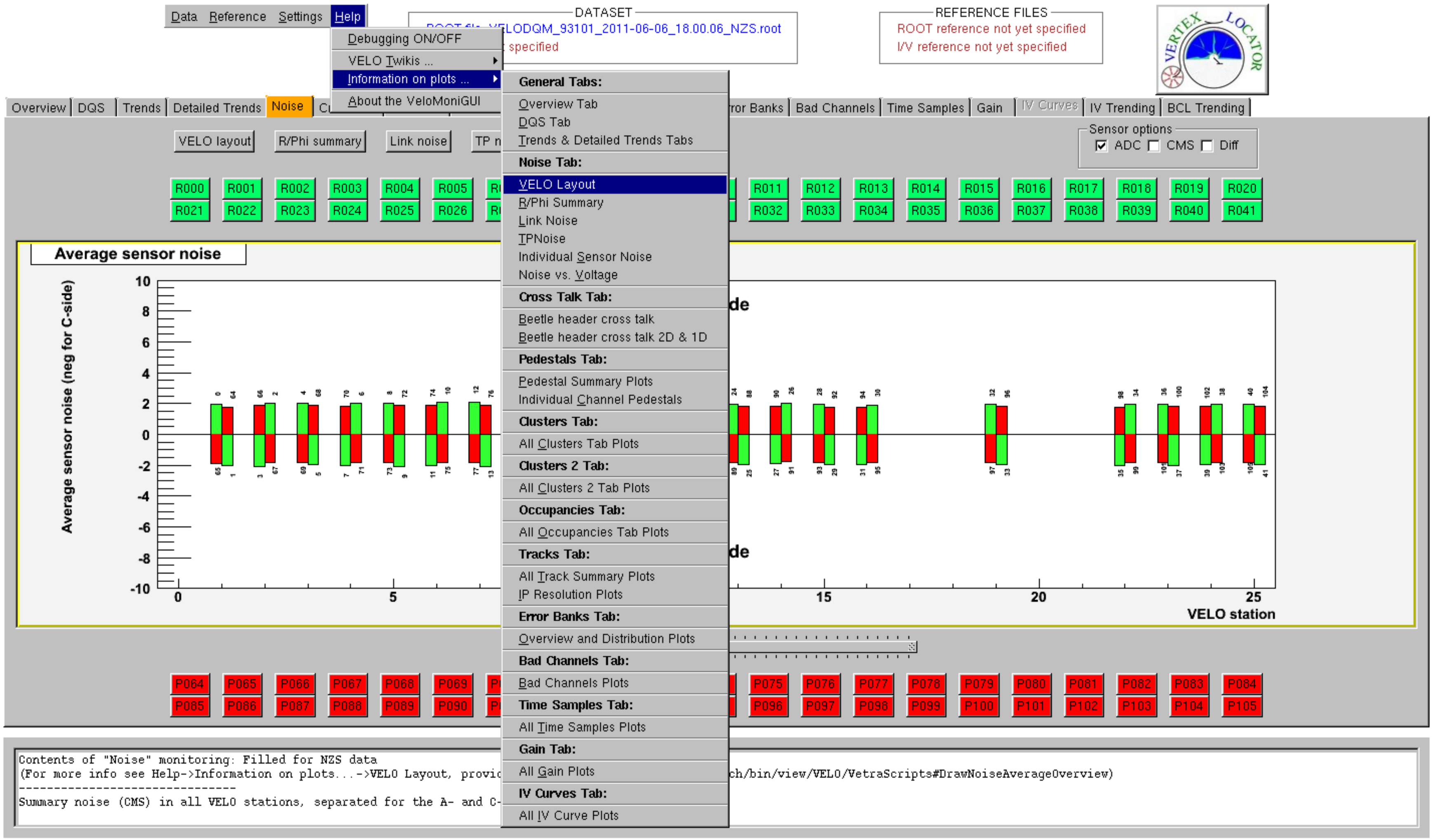
Update to the monitoring GUI



Update to the monitoring GUI



Update to the monitoring GUI



Update to the monitoring GUI

drawNoiseAverageOverview.C macro

Summary

This gives an overview of the average sensor noise in the VELO layout. It plots the average sensor noise for every sensor, with the A-side above the y-axis and the C-side below the y-axis. The R sensors are coloured green and the Phi sensors are coloured red. It's also possible to check noise histograms before and after Common-Mode Suppression (CMS).

Usage (with NZS file)

In the GUI:

In the "Noise" tab, click on "VELO layout". There are check boxes in the upper left corner for ADC and CMS noise histograms.

In stand alone mode:

In ROOT, run as follows:

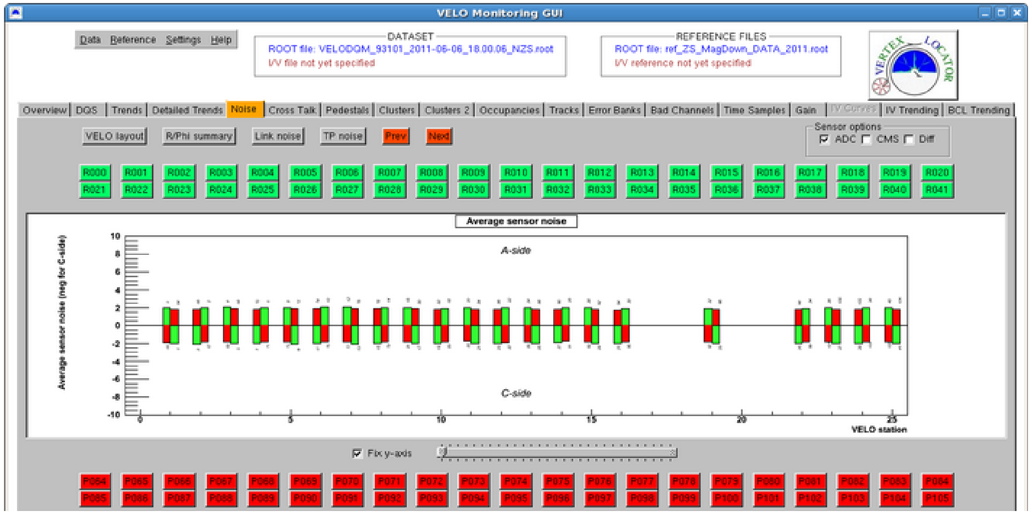
```
>.L drawNoiseAverageOverview.C
drawNoiseAverageOverview( "myinputfile.root" )
```

This script is also used by the monitoring GUI to display the very same histograms it produces in standalone. The drawNoiseAverageOverview.C macro produces a single plot. The macro needs as input a file with NZS data produced by the NoiseMon algorithm in the Velo/VeloDataMonitor package, containing the directory: structure *Vetra/Noise/ADCCMSuppressed/TELL1_NNN/* and *Vetra/Noise/DecodedADC/TELL1_NNN/* with histograms *RMSNoise_vs_ChipChannel* and *RMSNoise_vs_Strip*.

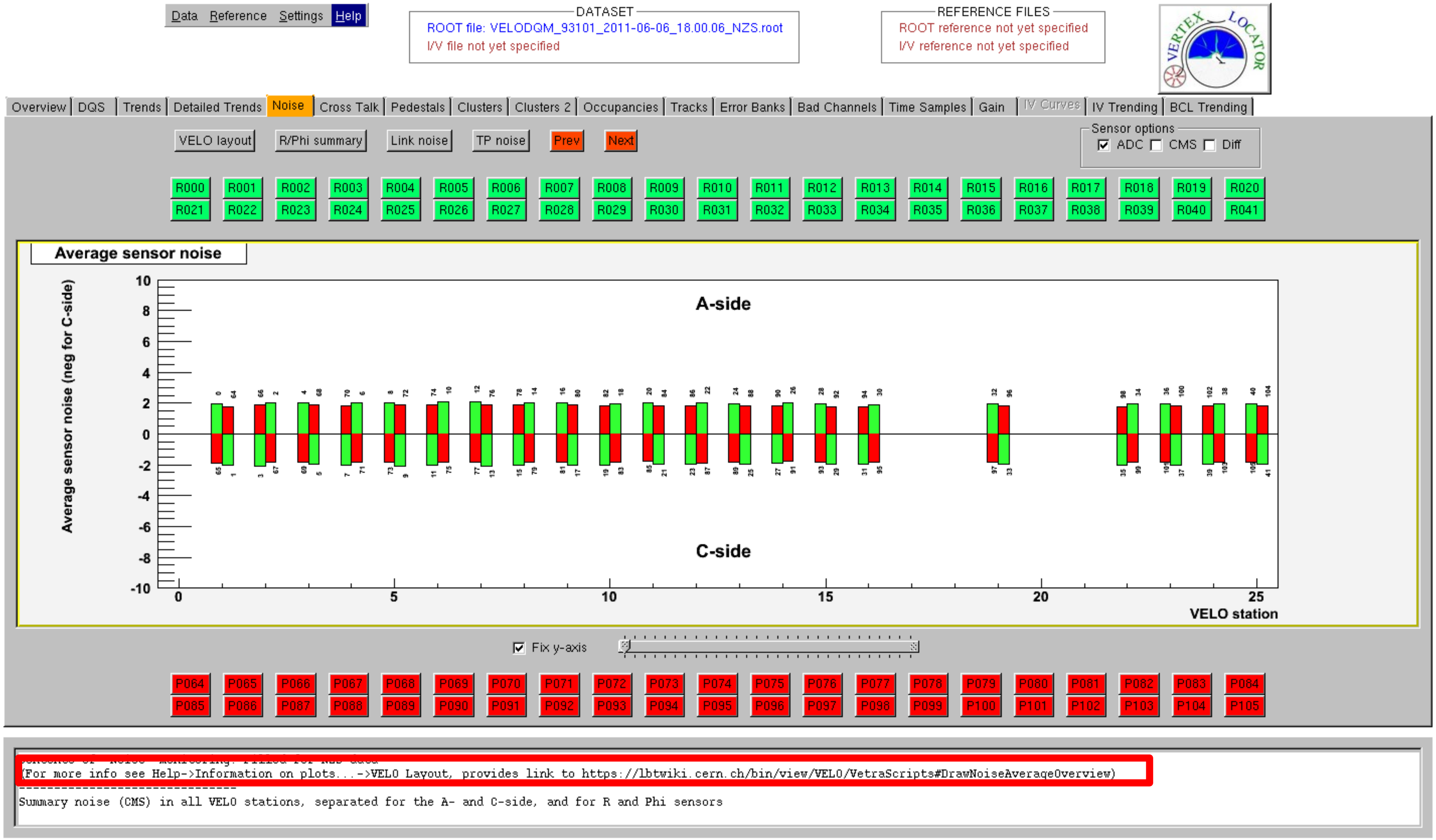
Ideal Behaviour

Ideally the noise should be around 2 (for summer 2011) with all of the sensors having roughly equal noise. If there is a sensor missing (see bad plots below) or if one or more of the sensors has unusually high noise compared to the rest then this should be reported in the e-log.

Ideal plots



Update to the monitoring GUI



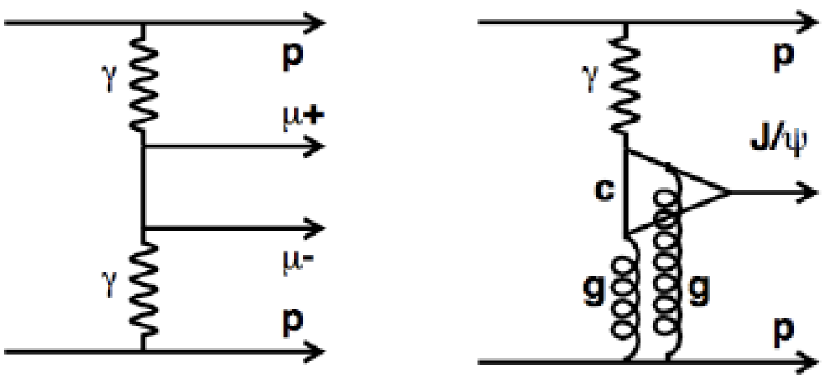
3. Analysis of Central Exclusive Dimuon Production at LHCb

(carried out with G.P. McGread, University of Cambridge)

What is central exclusive dimuon production?

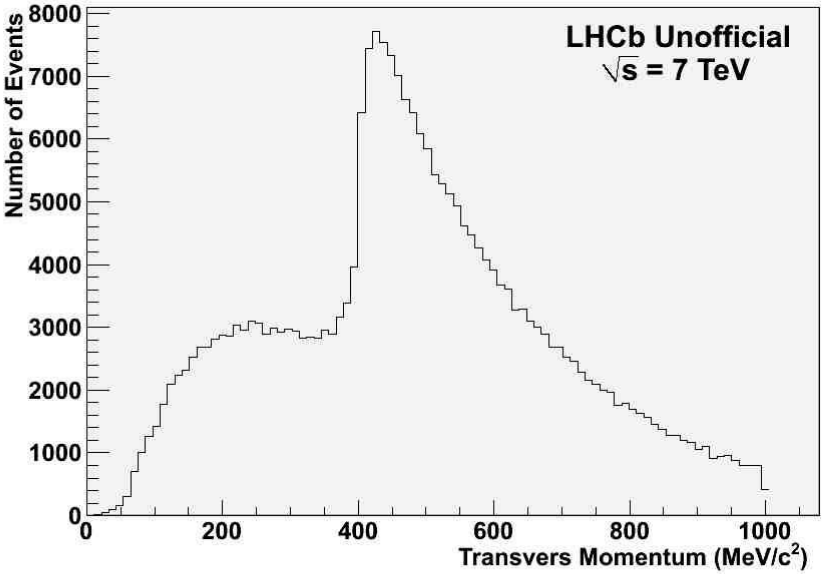
- Central = Particles are produced far from the beam line
- Exclusive = Class of reactions whereby the colliding particles remain intact. Additional particles are produced by photon and/or gluon propogators,

  i.e. A + B → A + X + B
- Dimuon = Two muons, a $\mu^+\mu^-$ pair, are produced
- At LHCb we are studying: $p + p \rightarrow p + \mu^+\mu^- + p$
- Examples:



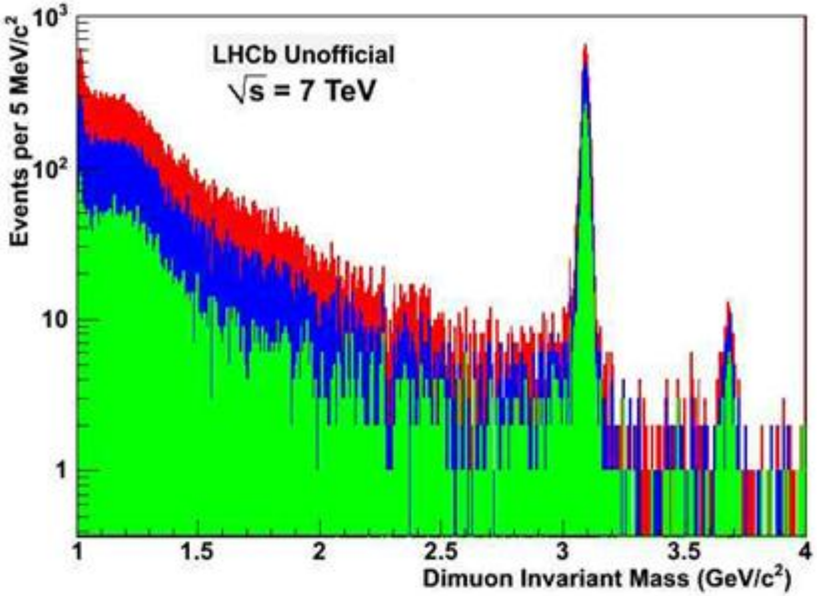
Online cuts to the data

- Hardware Trigger Settings:
  - Less than 10 SPD hits.
  - Single muon with a transverse momentum, $p_t > 400$ MeV/c^2 or two muons both with $p_t > 80$ MeV/c^2.
- Software Trigger Settings:
  - Invariant mass of dimuon candidate is > 1 GeV/c^2 and its $p_t < 900$ MeV/c^2 or its mass is > 2.7 GeV/c^2.

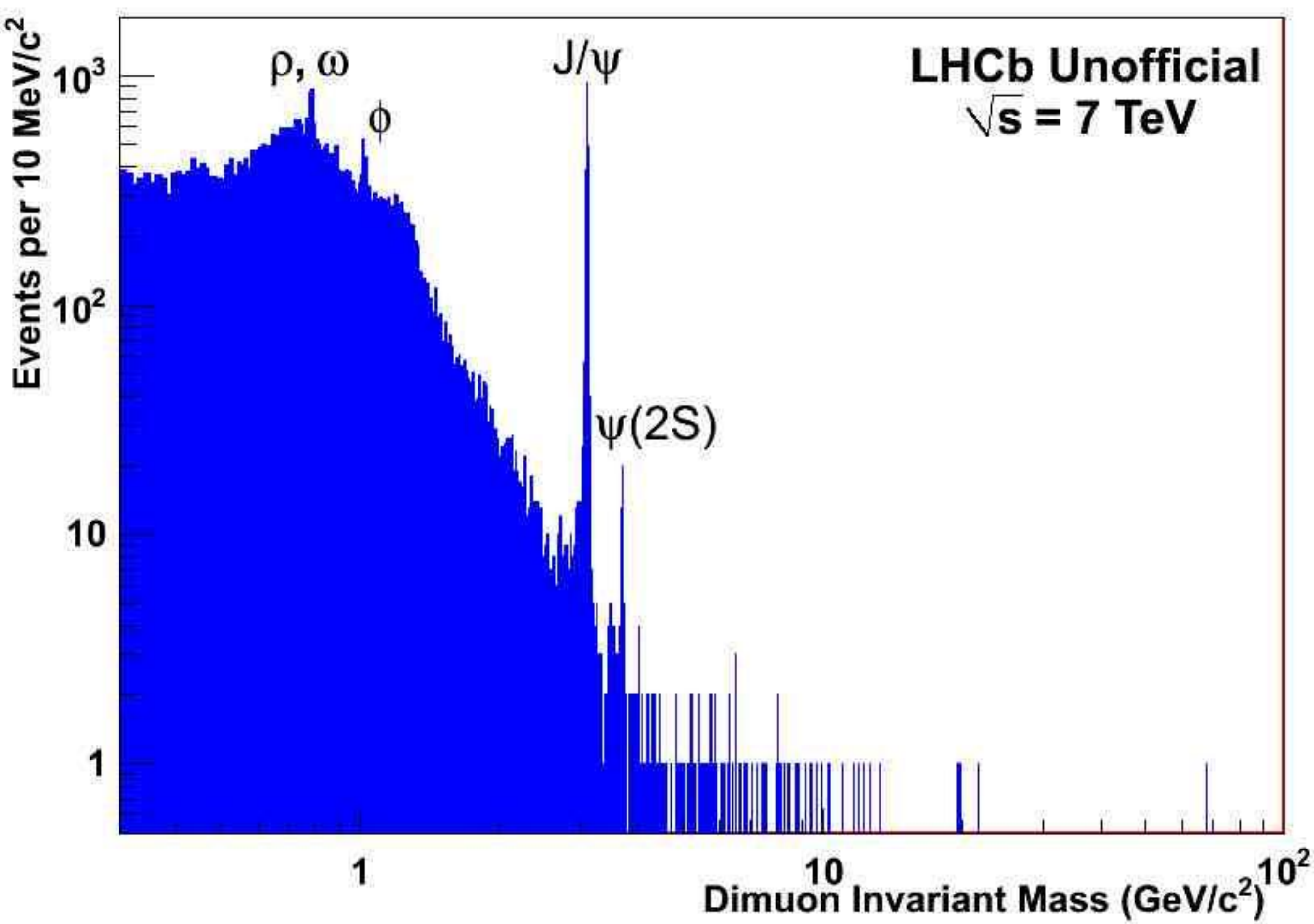


Offline cuts

- Red = All dimuon candidates passing the triggers
- Blue = Required that; the number of long tracks = 2, number of backward tracks = 0 and the pseudorapidity is in the range $2<\eta<4.5$
- Green = Additional requirement that the total number of tracks = 2

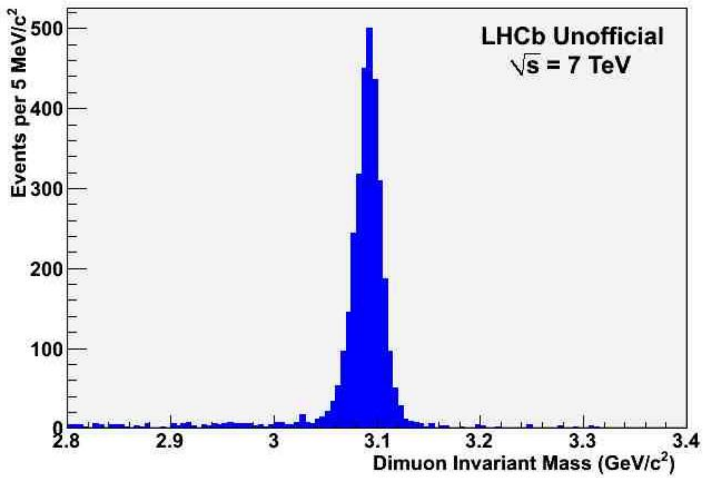


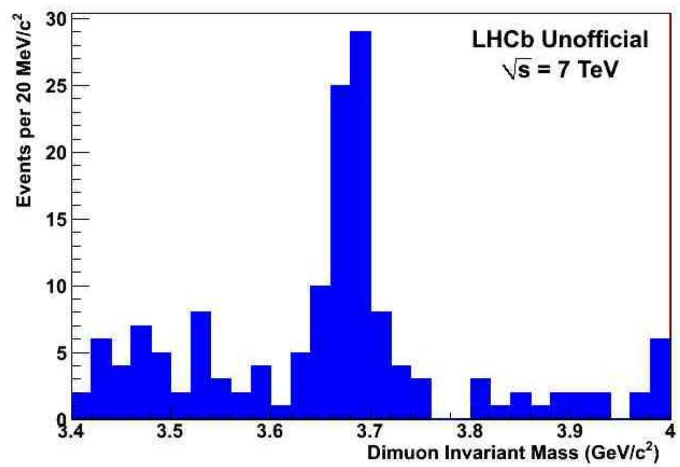
Dimuon Invariant Mass Spectrum



Invariant Mass Distributions of J/Ψ and Ψ(2S)

- J/Ψ:
  - Gaussian fit gives mean of 3090.9±0.3 MeV/c^2
  - PDG value of mass is 3096.916±0.011 MeV/c^2
- Ψ(2S):
  - Gaussian fit gives mean of 3678±3 MeV/c^2
  - PDG value of mass is 3689.09±0.04 MeV/c^2





Conclusions

- We can see clear signals of $\psi(2S)$, J/ψ, ϕ and ρ, ω from 2011 LHCb data.
- More analysis needed in order to determine the exclusivity of these events.
- It is also necessary to calculate the efficiencies, purity, effective luminosity and background so that the cross sections can be calculated, $\sigma = (pN)/(\varepsilon L_{eff})$.

- Special thanks to Dr. Ronan McNulty, Stephen Farry and Gráinne McGread.