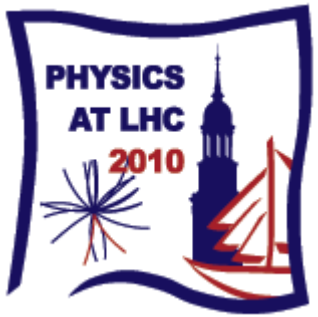
Low mass dimuons and prospects for early B physics at CMS



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CMS Collaboration

Outline

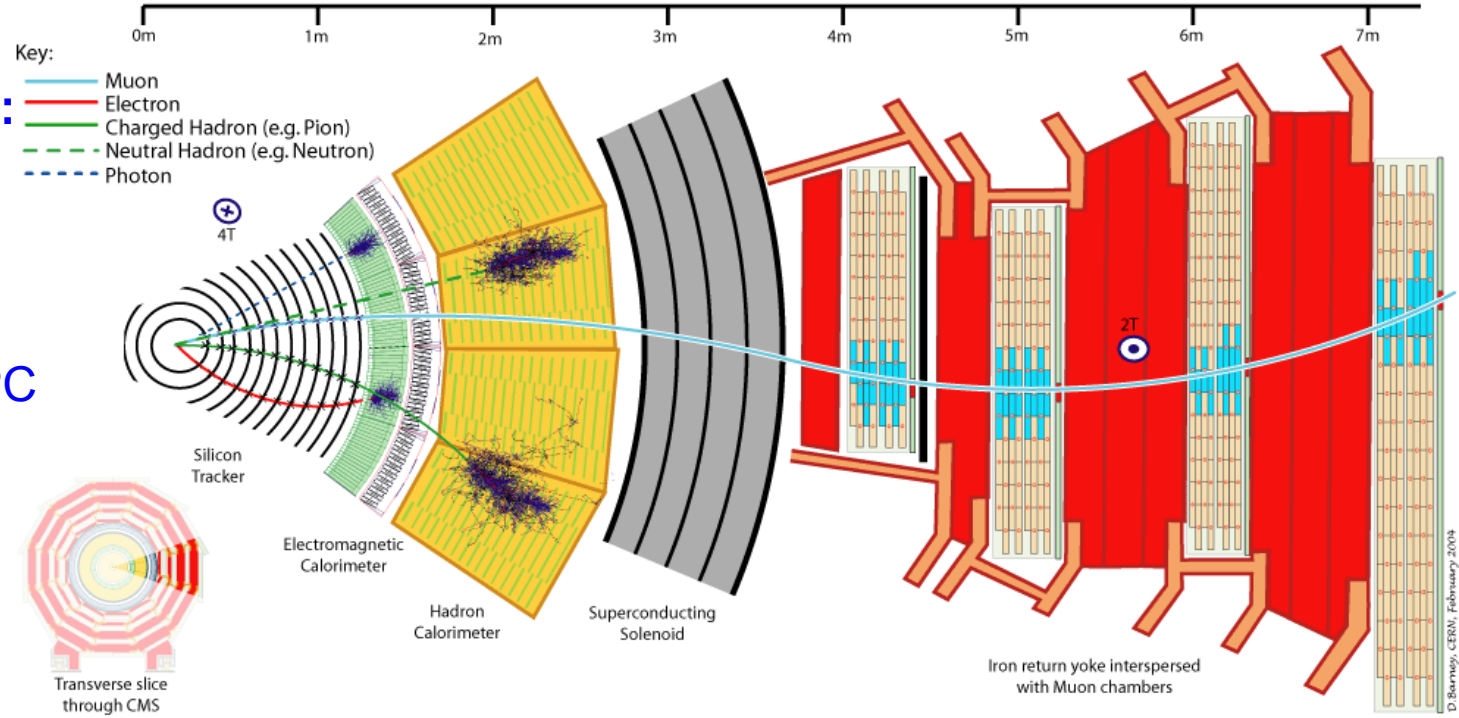
- Muons in CMS
- How to select good data
- From one muon to a J/ψ
- Mass distributions for low mass dimuons
- Prospects for B physics in CMS

With some brand new plots here and there…

CMS detector and muon reconstruction

Detectors responsible for muon reconstruction:

- Tracker (pixel + strips)
- Barrel: Drift Tubes (DT) + RPC
- Endcaps: Cathode Strip Chambers (CSC) + RPC

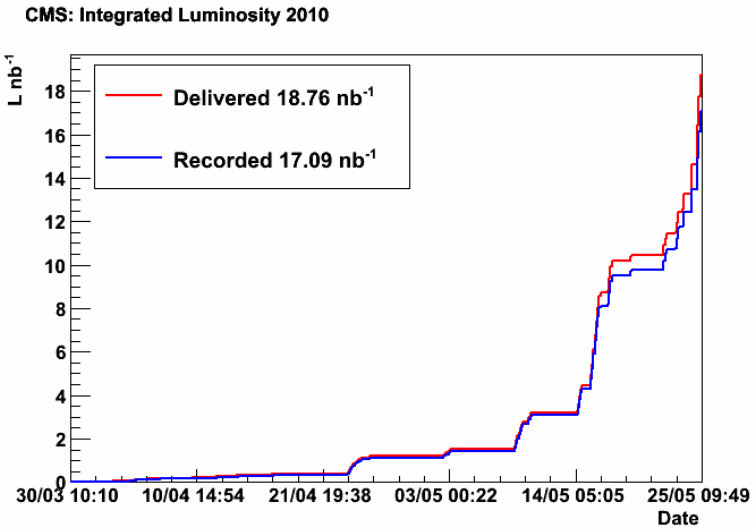


Three different kinds of muons:

- Standalone muons : track reconstructed in the muon system only
- Global muons (GM): standalone muon associated to inner track
- Tracker muons (TM): inner track associated with a signal in the muon system

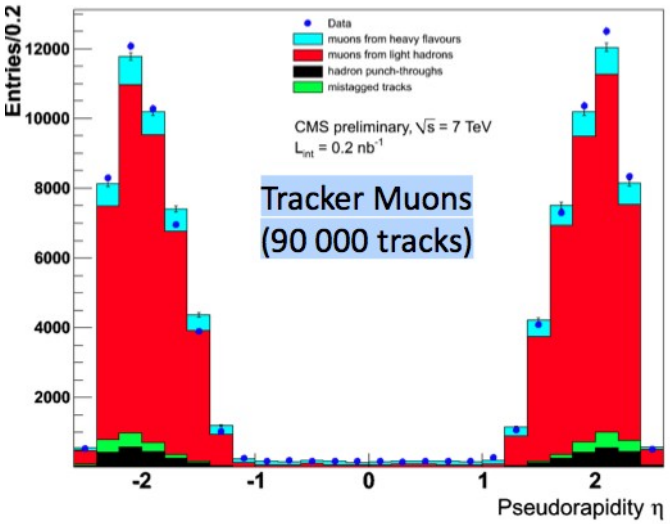
Focus on GM and TM (momentum range)

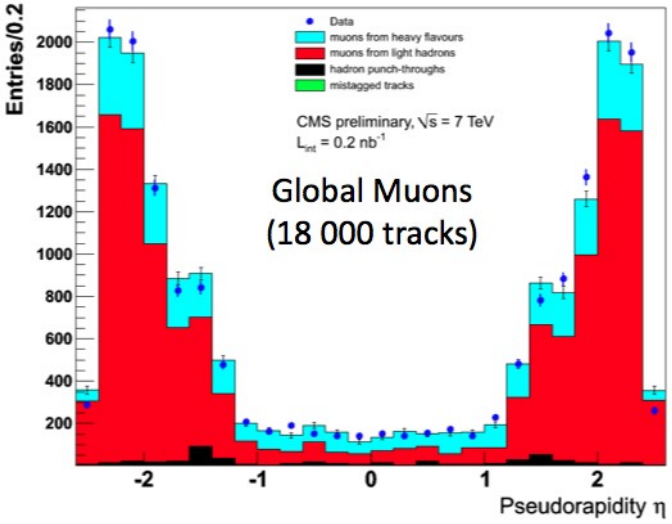
Luminosity & data quality strategies

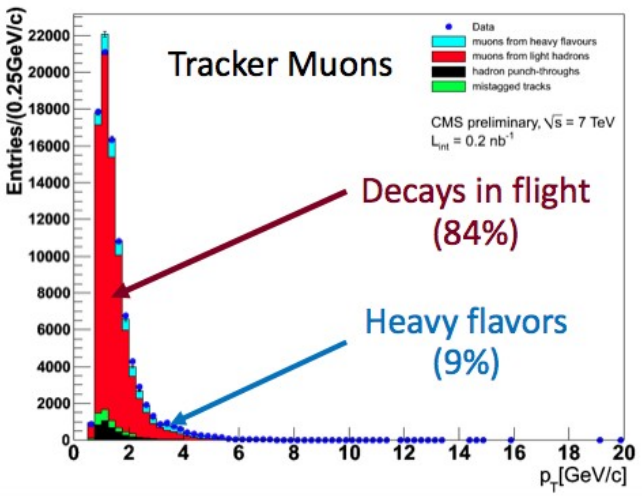


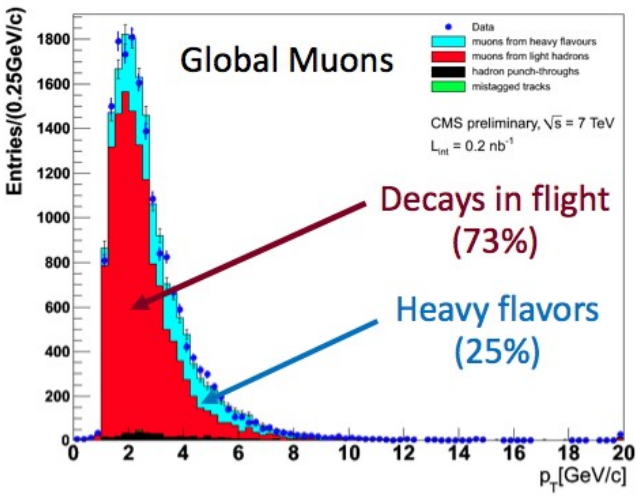
- First test bed to iron our data quality machinery for physics analysis
- Perform data quality checks on all our subdetectors + reconstructed objects
- Data are certified with run granularity
- For muon studies, we generally ask for good flags for all the muon-involved subdetectors + muon reconstruction

How do the first muons look like?

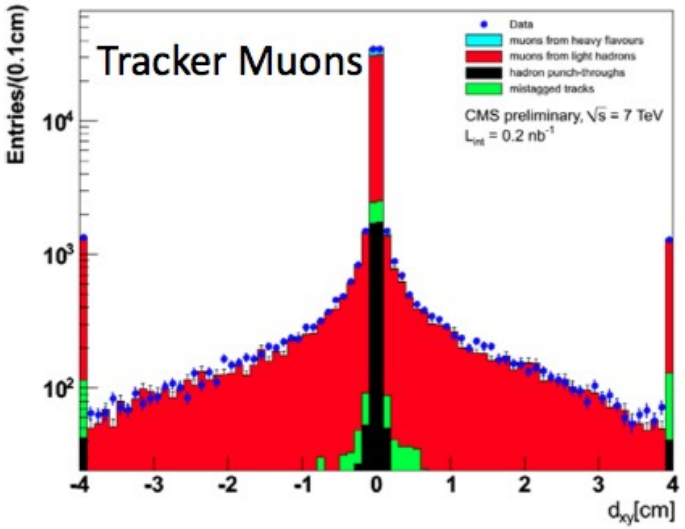




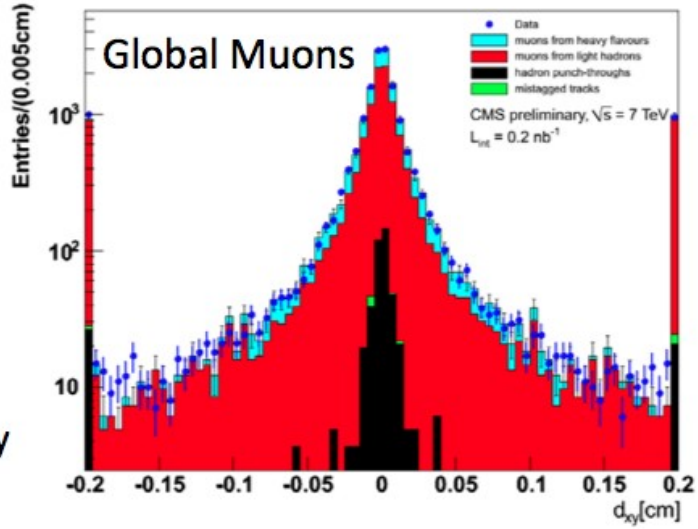


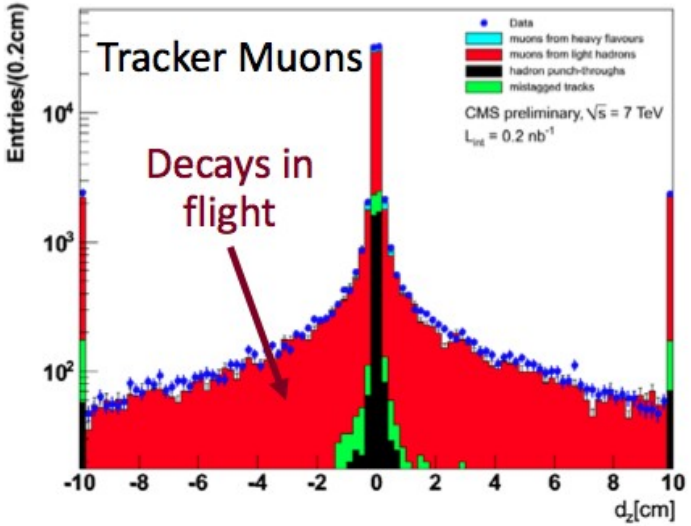


Impact parameter

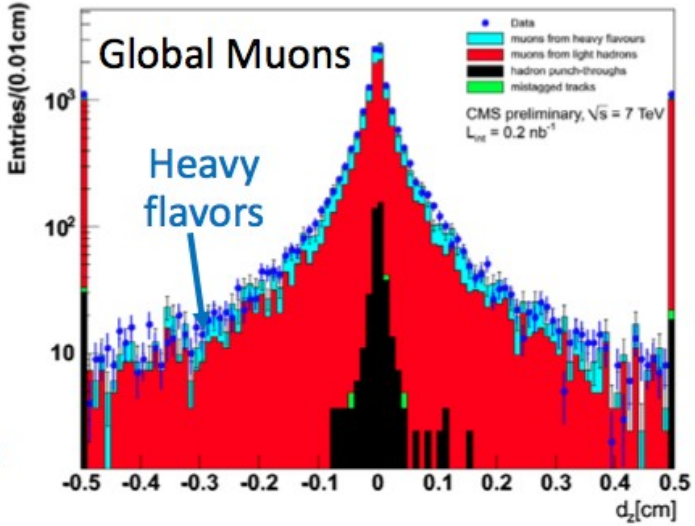


d_{xy}

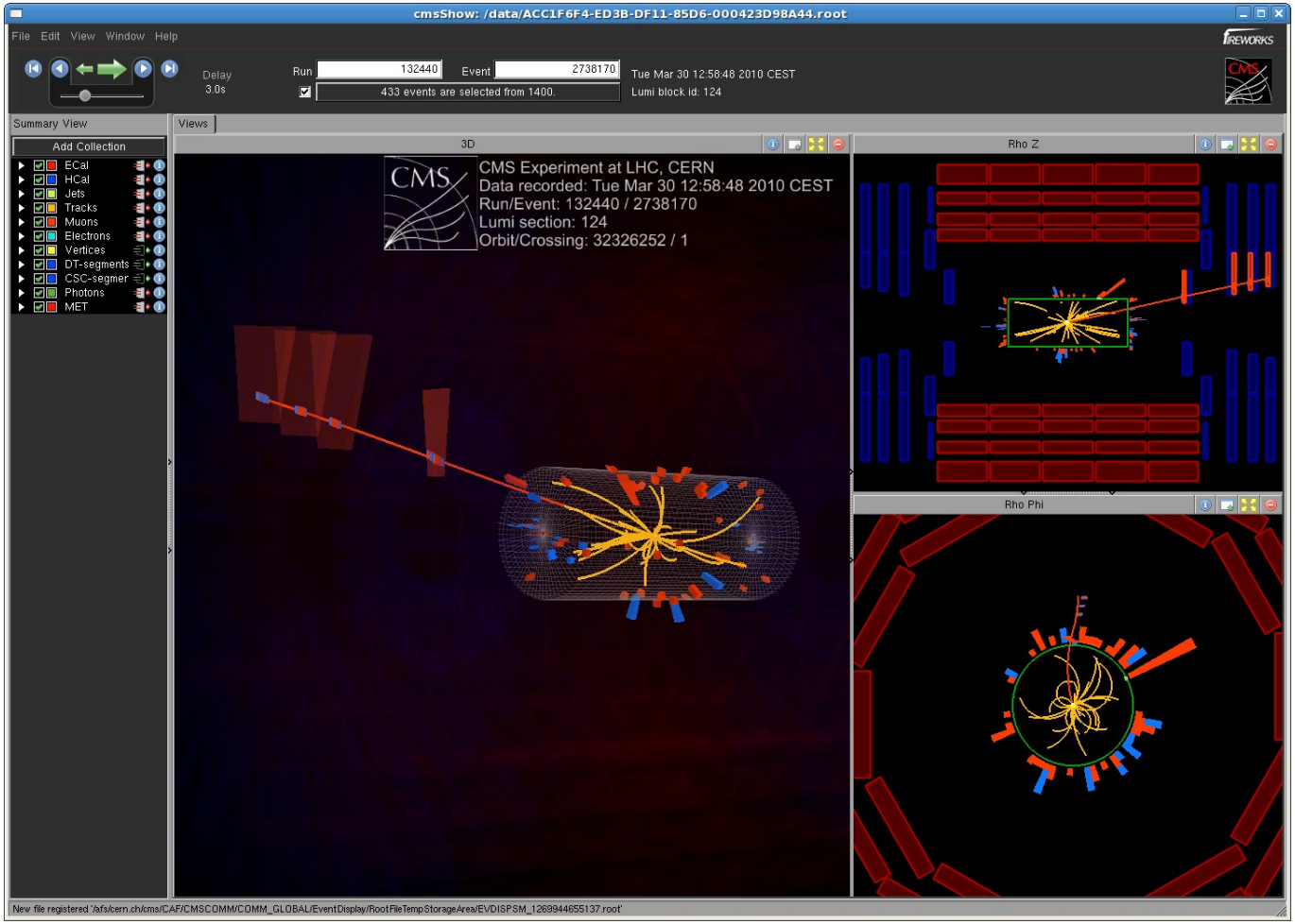




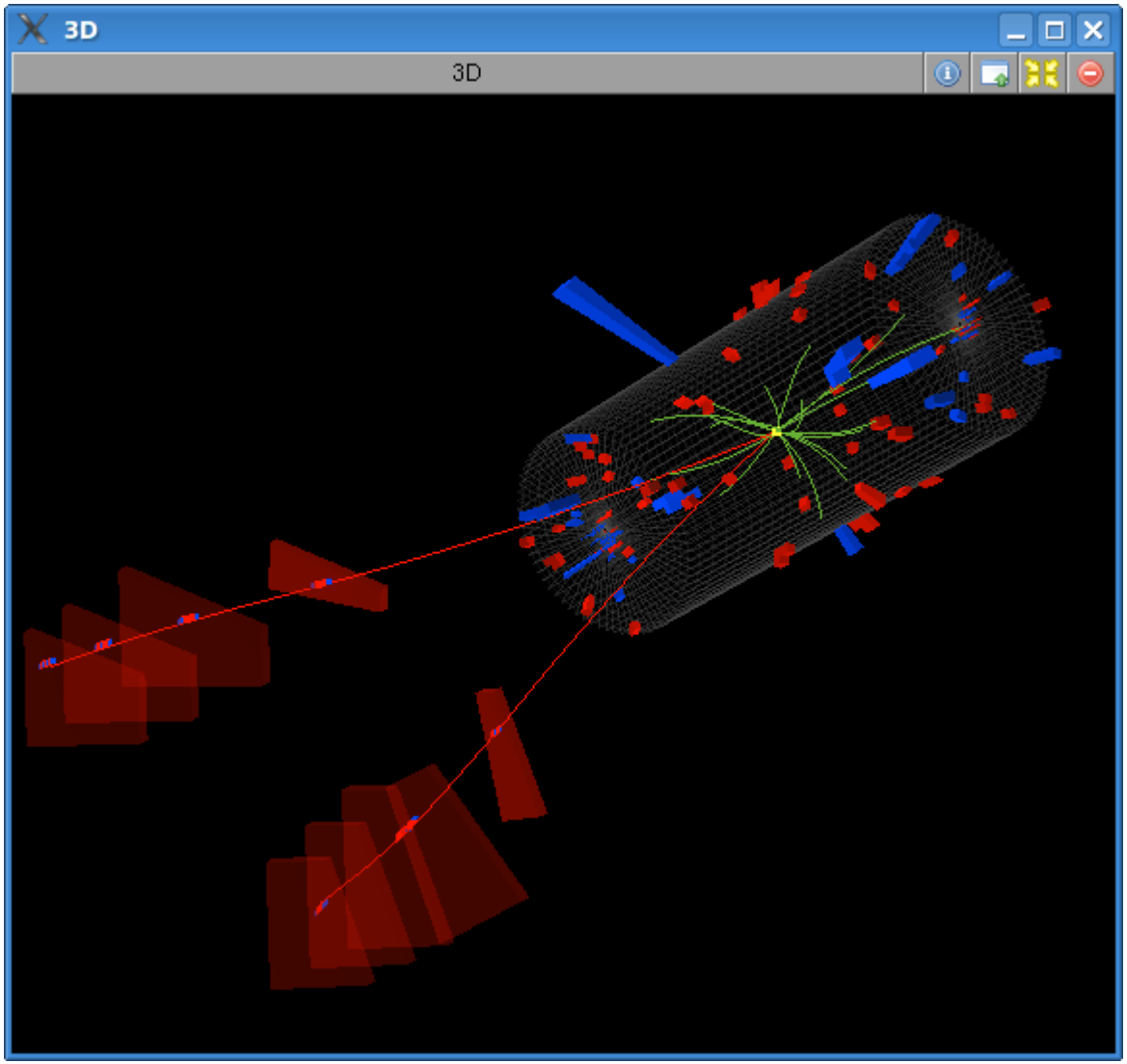
d_z



From one muon...

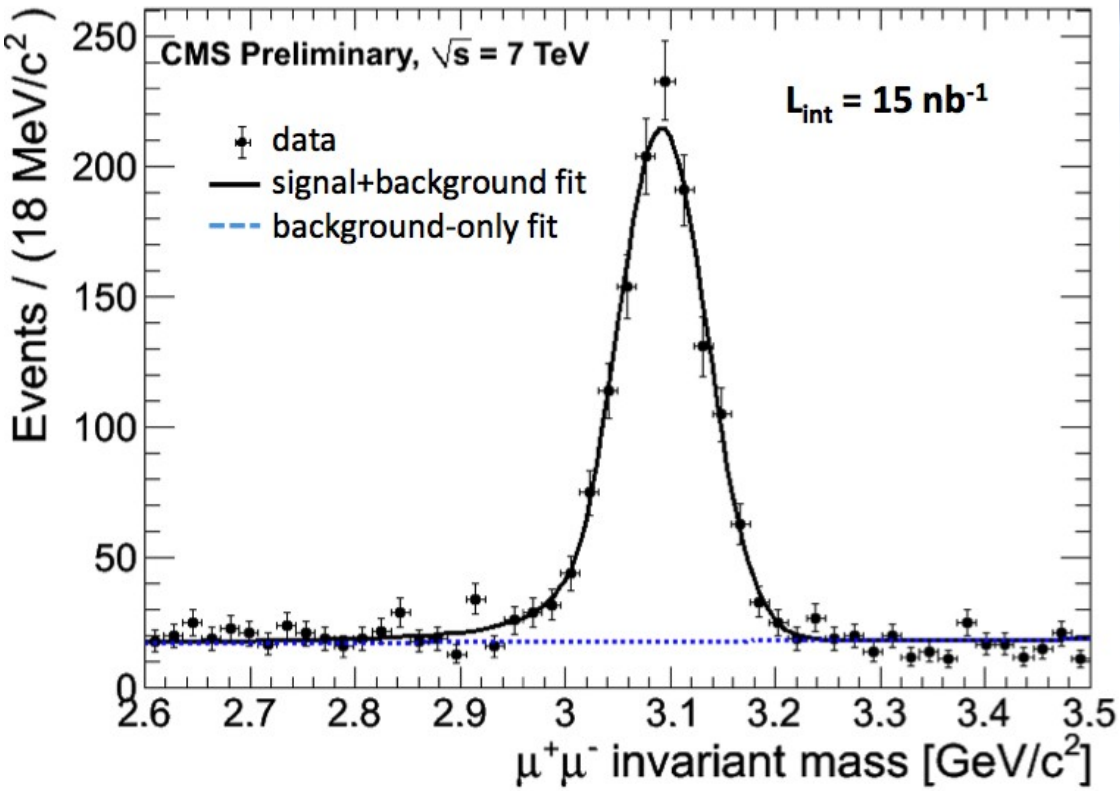


To two muons...



To a J/ψ peak!

- Tracks selection based on:
  - Impact parameter
  - χ^2
  - N. hits in tracker
  - Common vertex requirement
- No trigger selection
- Extended ML fit with
  - Crystal Ball signal
  - Exponential background



Fit results

Signal events = 1230 ± 47

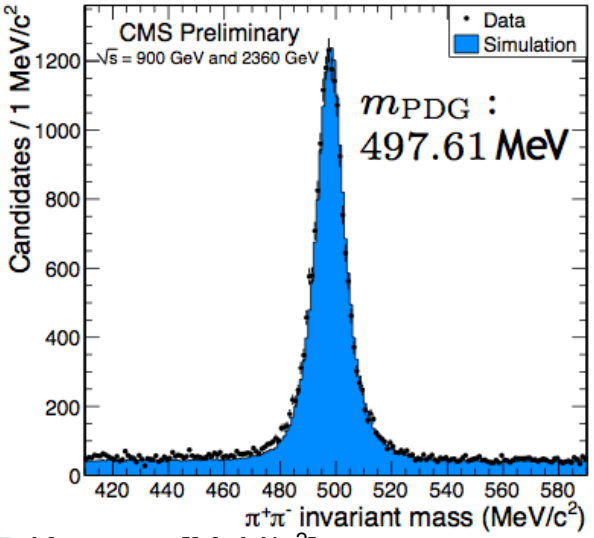
Sigma = 42.7 ± 1.5 (stat.) MeV

M_0 = 3.092 ± 0.001(stat.) GeV

S/B = 5.4 (M_0 ± 2.5σ)

χ^2/ndof = 1.1

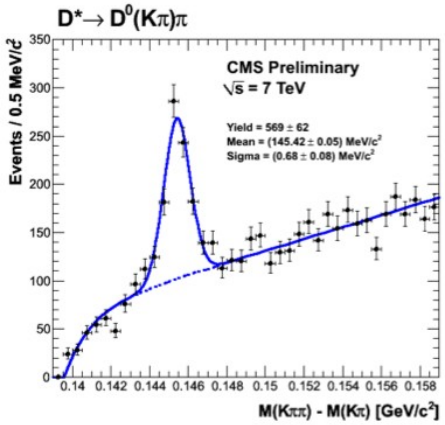
Miscellanea for flavor physics

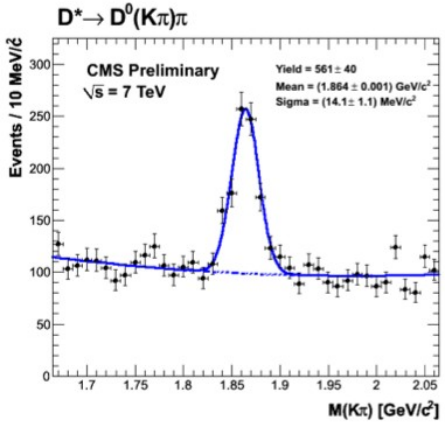


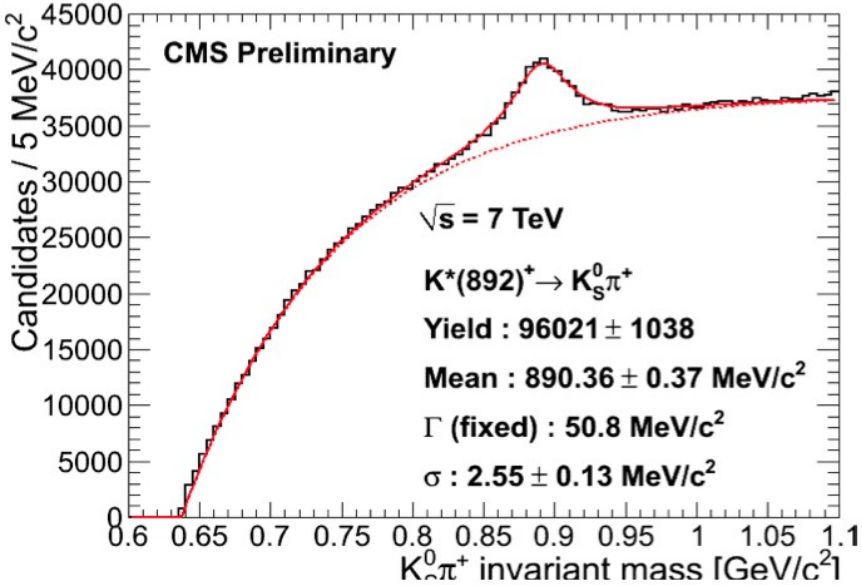
K_s [MeV/c^2]

Mass 497.68 ± 0.06

Width 7.99 ± 0.14

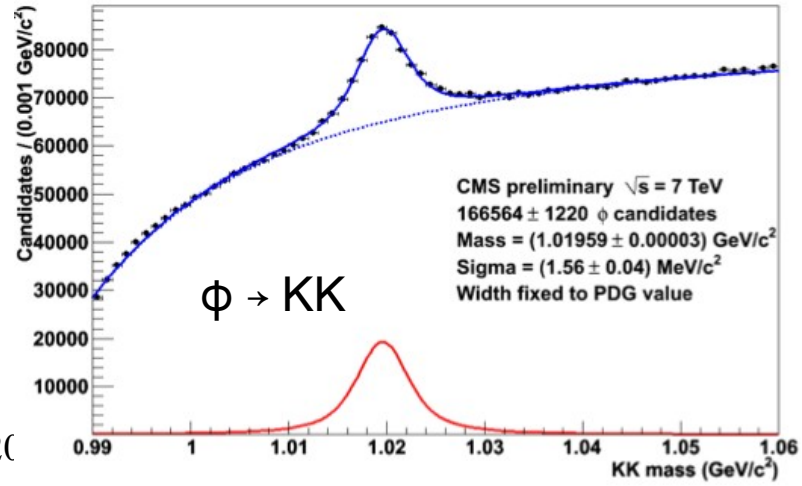






All these are ingredients for B physics!

(errors are all statistical)



The early flavor physics program

We are planning to move in two directions:

- **Quarkonia analyses**
  - Total and differential cross section of (dimuon) J/ψ
  - Υ production cross section
  - Later on: polarization, χ_{cJ}, ...
- **B decays analyses**
  - $B \rightarrow J/\psi\, K^{(*)}$
  - $B \rightarrow J/\psi\, \phi$
  - $b\bar{b}$ correlations
  - Later on: $B \rightarrow \mu^+\mu^-$

J/ψ total cross section measurement

We want to measure

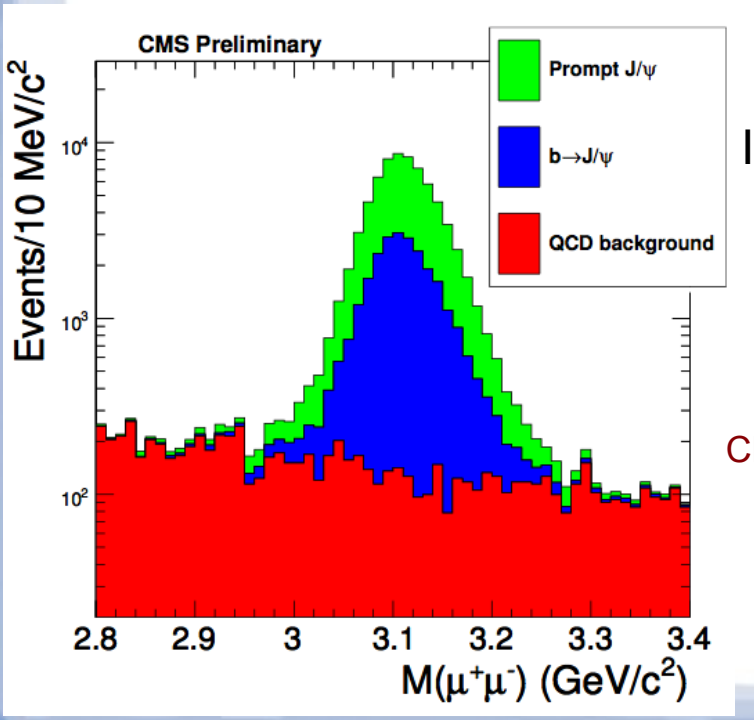
N. reconstructed QQ from mass fit

$$\frac{d^2\sigma}{dp_T dy}(Q\bar{Q})\cdot BR(Q\bar{Q}\to\mu^+\mu^-) = \frac{N_{Q\bar{Q}}}{\int Ldt\cdot A\cdot \varepsilon_{trigger}\cdot \varepsilon_{reco}\cdot \Delta p_T\cdot \Delta y}$$

Integrated luminosity

Signal acceptance

Determined with tag & probe method



CMS-PAS-BPH-07-002

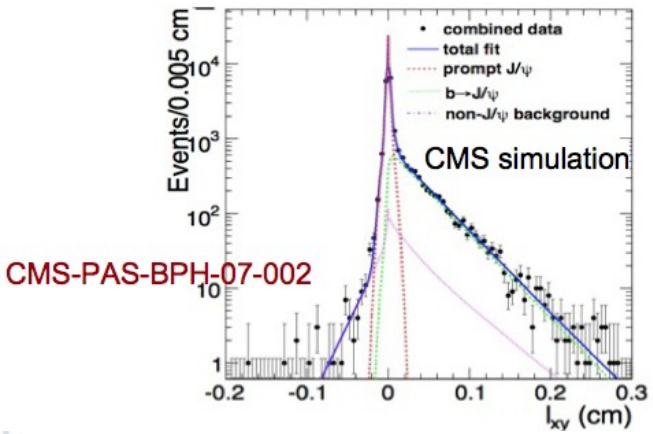
- Acceptance strongly dependent on polarization
- Can be performed with ~0.1 pb^{-1}

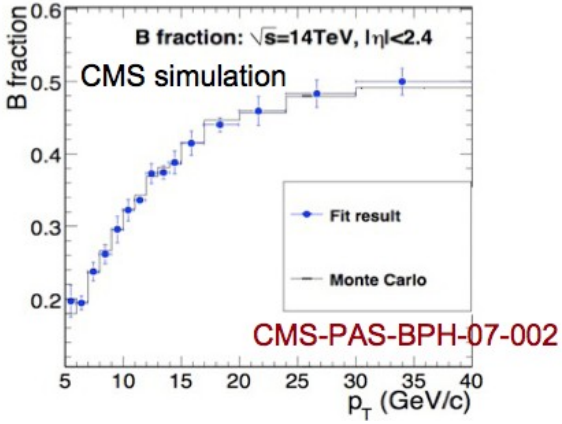
J/ψ cross section: b fraction measurement

Separate J/ψ production:

- Prompt: direct production
- Non-prompt: mainly from b decays

Determine each contribution with a 2D ML fit in mass and decay length



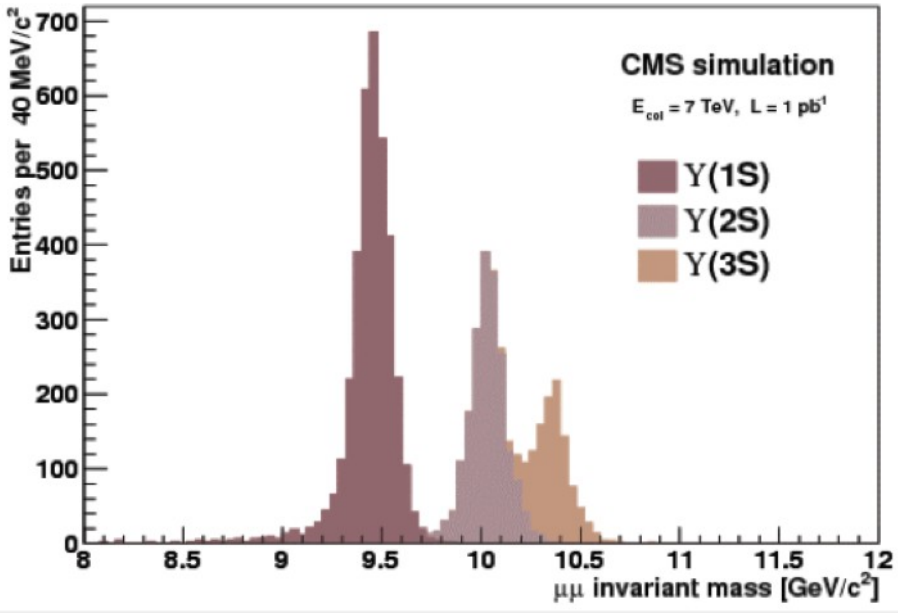


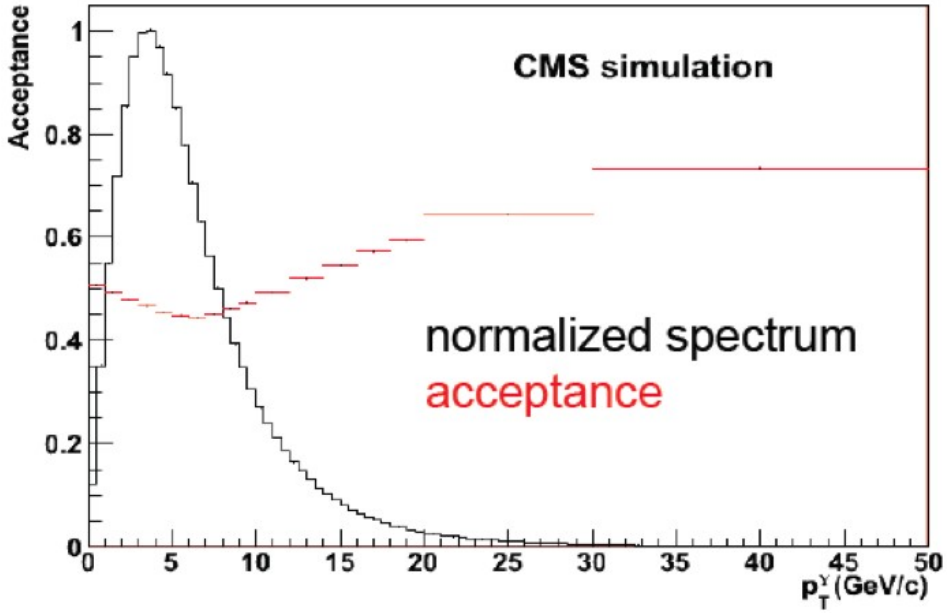
Need to have good control on alignment and PV resolution

Possible with ~ 1 pb^{-1}

Y cross section measurement

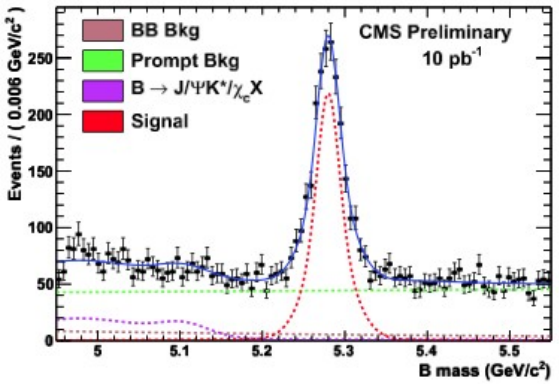
- Expect ~10^3 events per pb^{-1}
- First measurement planned for ~ 1 pb^{-1}
- Measure Y(2S) and Y(3S) cross sections relative to the Y(1S)
- This is the natural extension of the J/ψ analysis to higher p_T

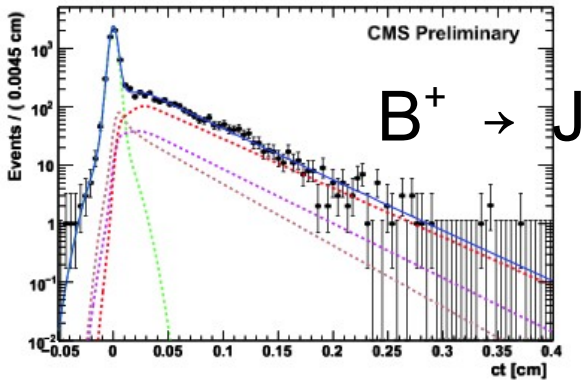




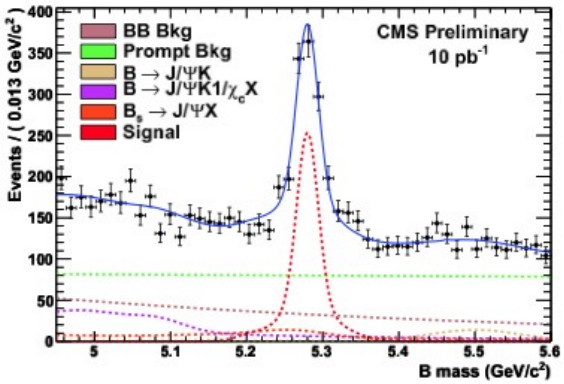
B → J/ψ K(*) analysis

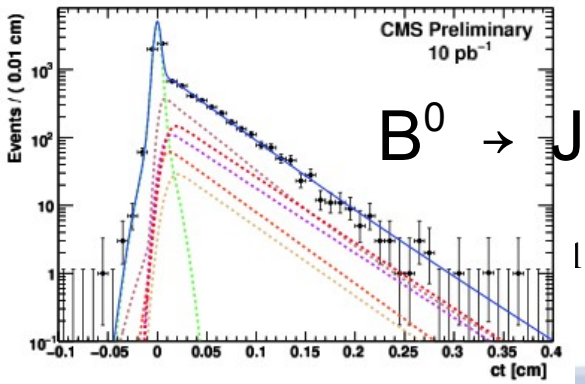
- First accessible channel to study B selection criteria in data
- Can be used as a control sample for the B physics program later on
- J/ψ selection: interplay with the quarkonia analyses
- Strategy is to perform a fit in the invariant mass and lifetime distributions





$B^+ \rightarrow J/\psi\ K^+$





$B^0 \rightarrow J/\psi\ K^*$

Study performed at 10 TeV

Expected events in 10 pb^{-1}

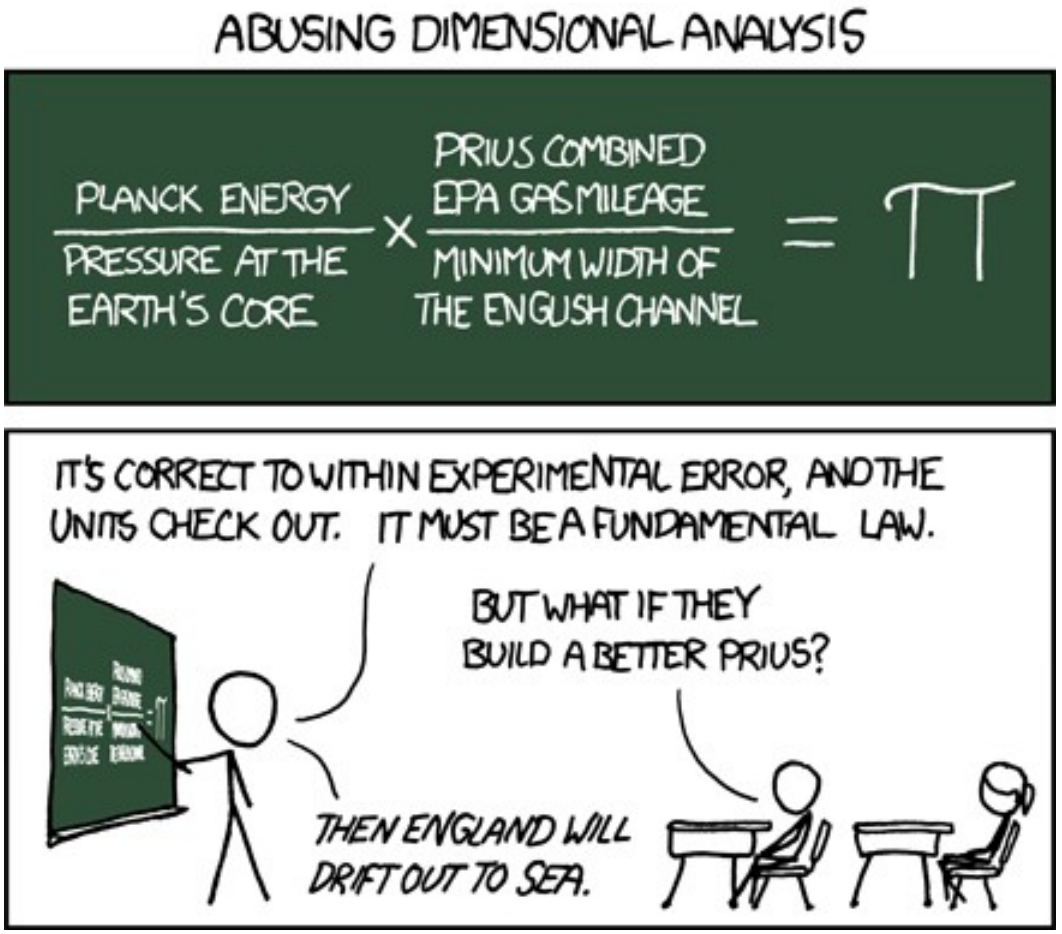
$B^+ \rightarrow J/\psi\ K^+$ 1731 ± 46

$B^0 \rightarrow J/\psi\ K^*$ 890 ± 39

Conclusions

- The B physics mosaic in CMS is shaping up:
  - J/ψ & Υ studies provide a first insight on our analysis capabilities
  - Acceptance, efficiency, luminosity measurements are all key ingredients that we need to control in order to have results
  - Creating expertise and a community with real data "sensibility" is a key element of these early studies
- We are hunting and observing many final states of interest for our physics program
- The O(1) pb^{-1} integrated luminosity is a "threshold" where many analyses become feasible

Looking for fundamental laws to test with the first data



Courtesy of R. Munroe

Questions?