First minimum bias physics results at LHCb

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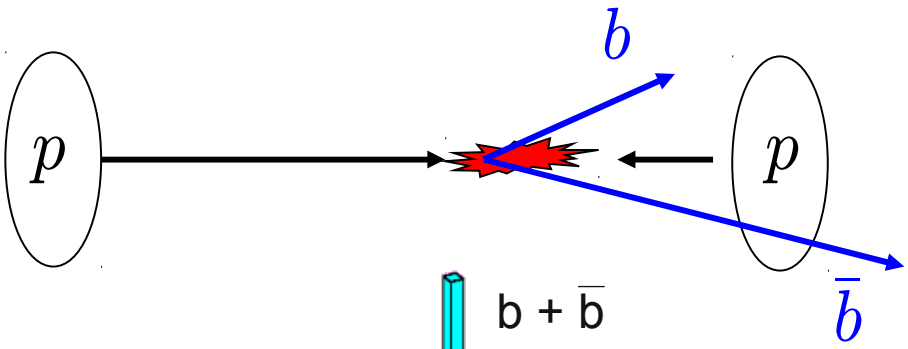
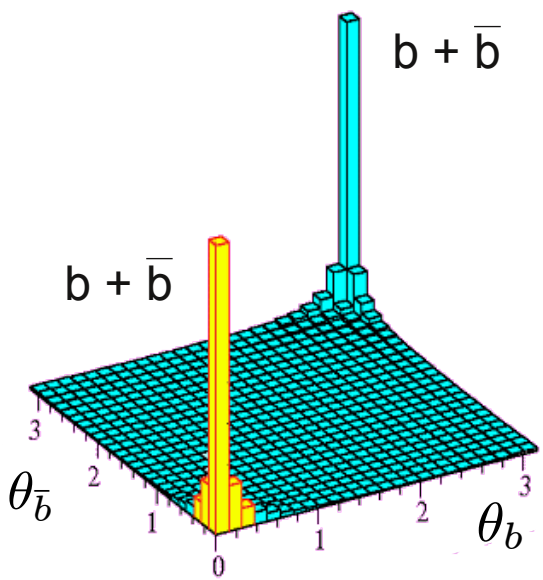
On behalf of the LHCb collaboration

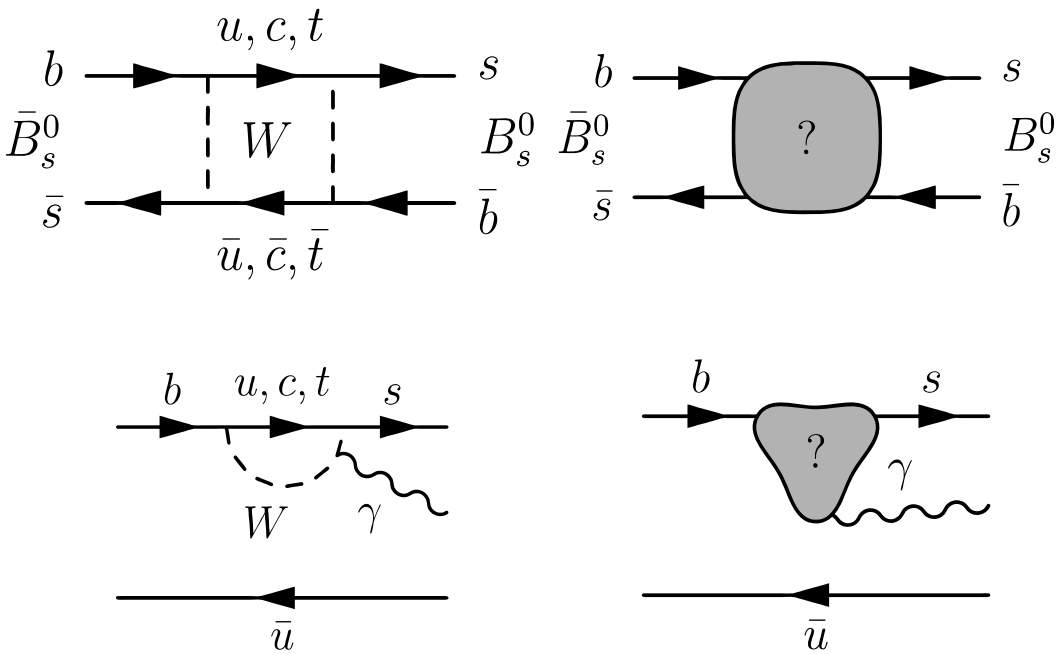
The LHCb experiment

LHC is a large source of B-Mesons: 10^{12} $b\bar{b}$-pairs per year

Physics Goal of LHCb: Looking for effects of New Physic through precision measurements of B decays

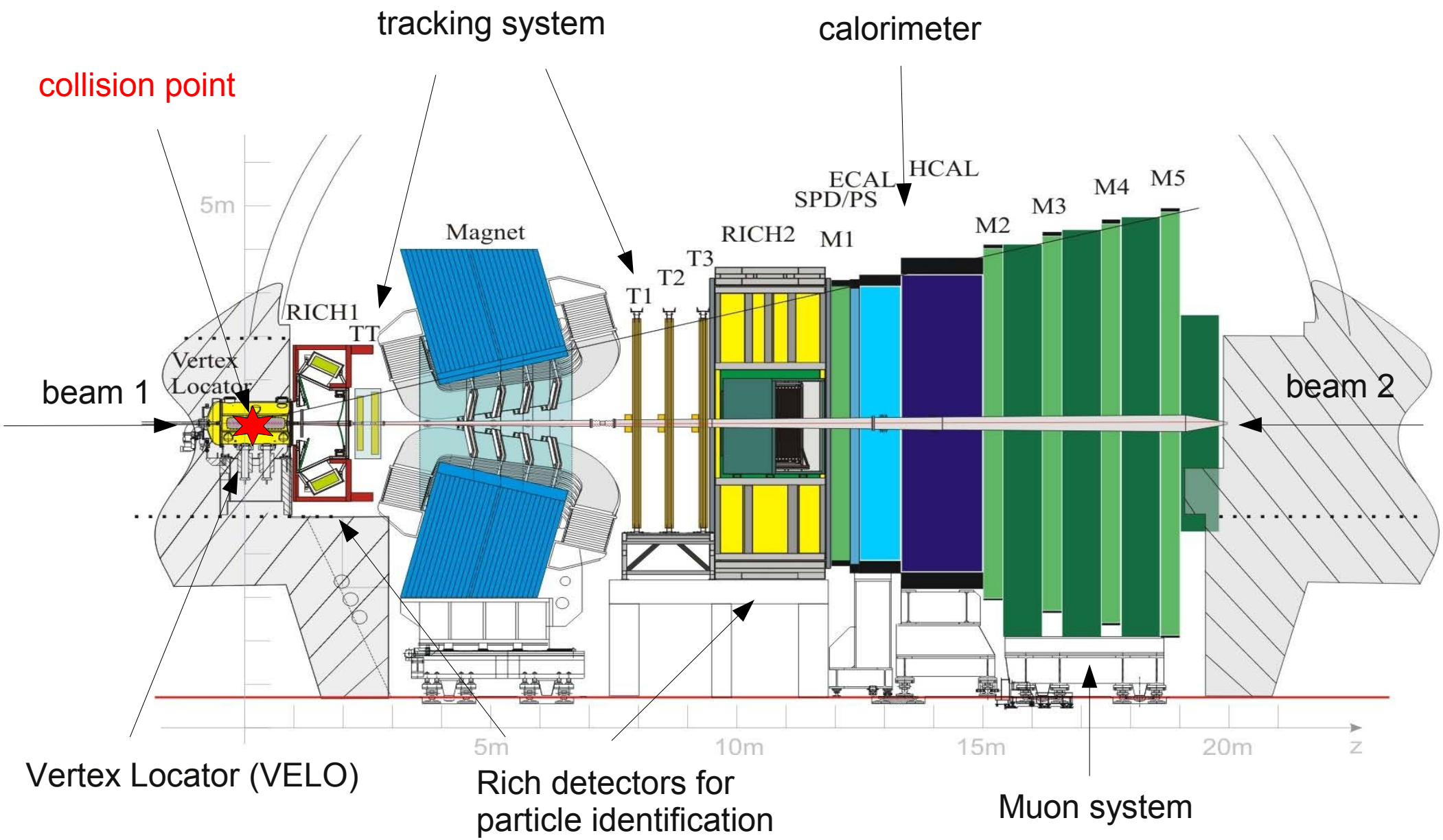






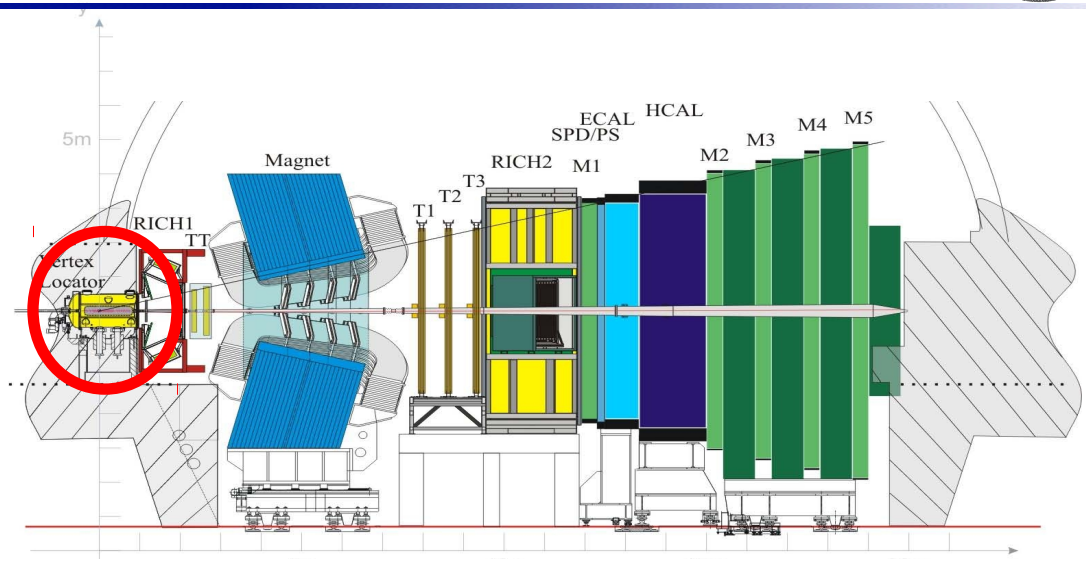
But also: forward minimum bias physics

The LHCb detector



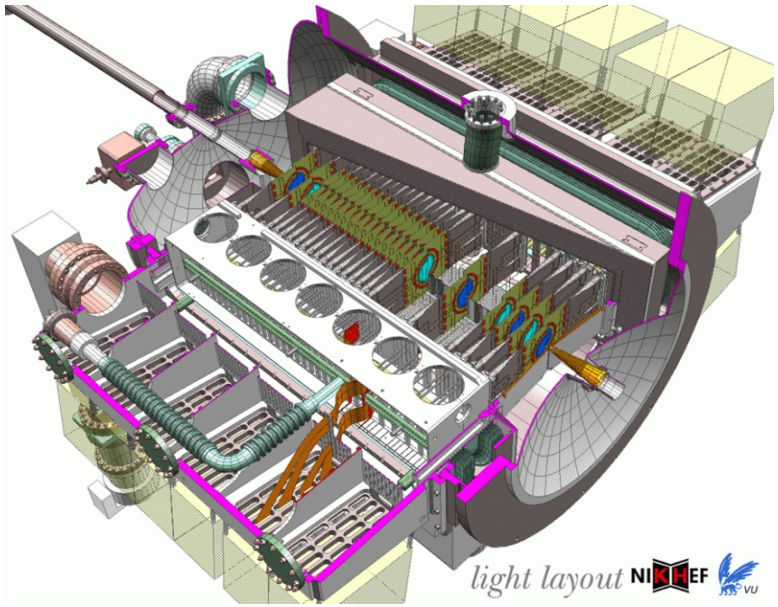
The Vertex detector

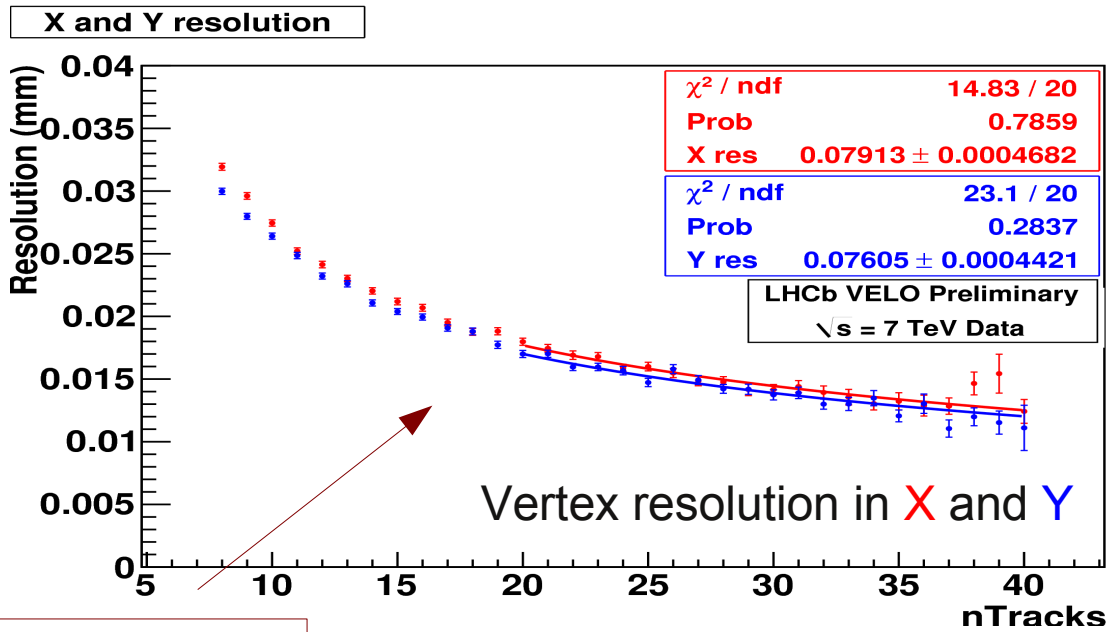
Need excellent vertex resolution for measurement of proper time



Vertex Locator (VELO):

- 21 sensors
- moves in for stable beam
- approaches beam at 8mm





~15 μm vertex resolution

Particle Identification with RICH

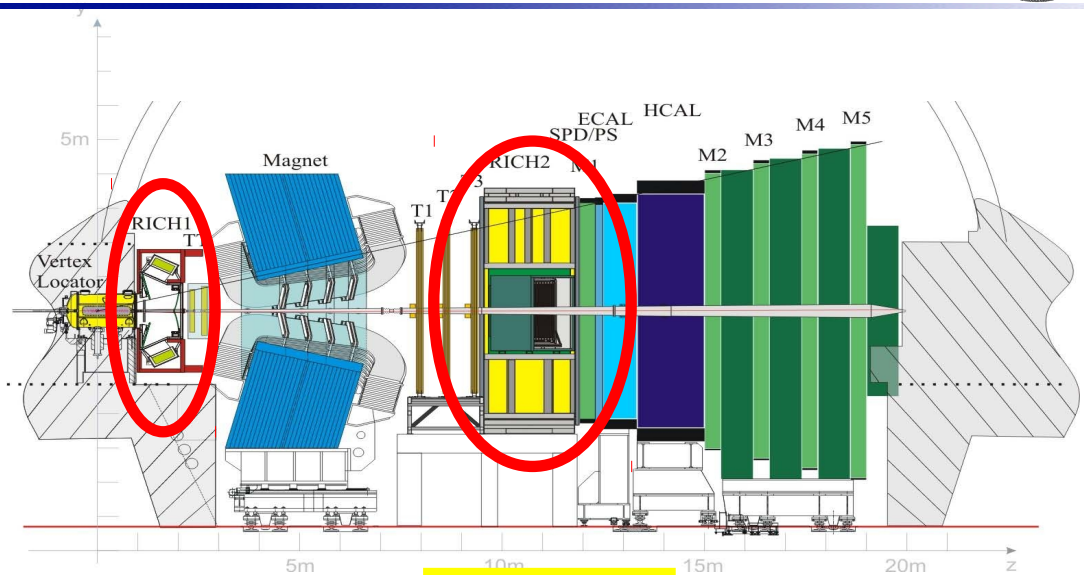
Particle Identification for background reduction

Cherenkov detectors (RICH):

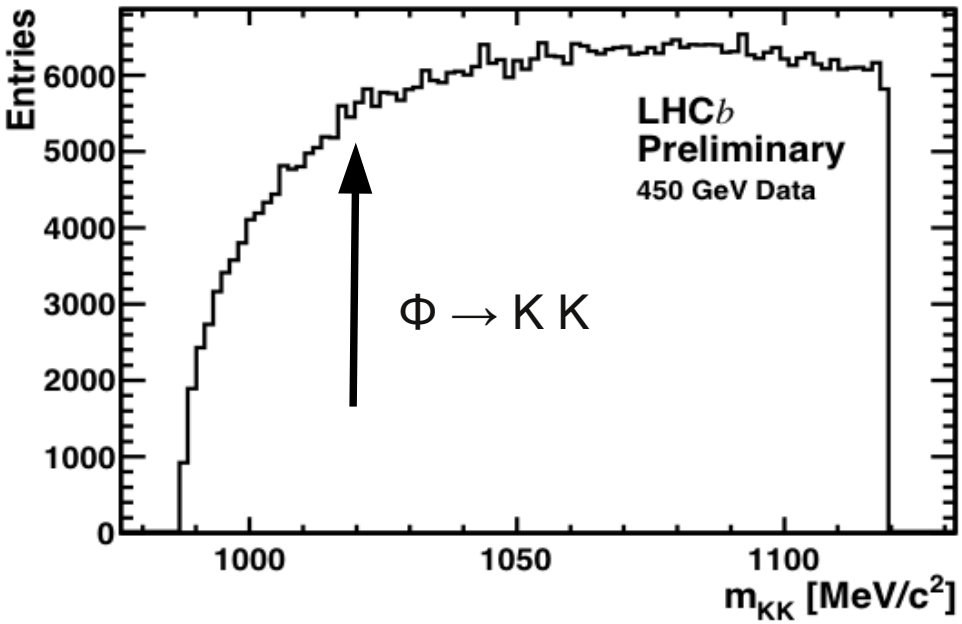
cover different momentum spectra

RICH1: up to ~ 70 GeV

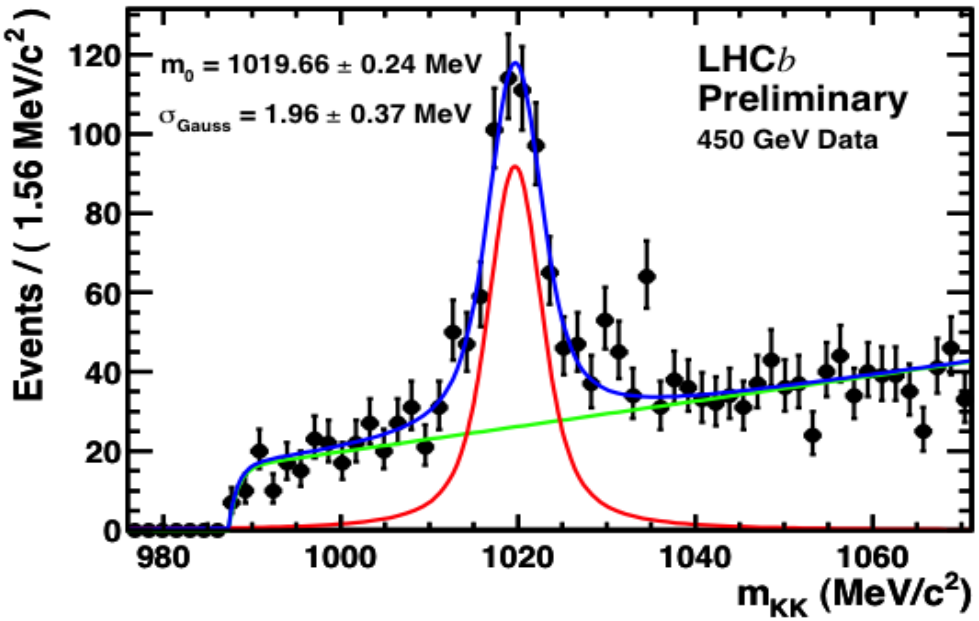
RICH2: beyond 100 GeV



without RICH



with RICH

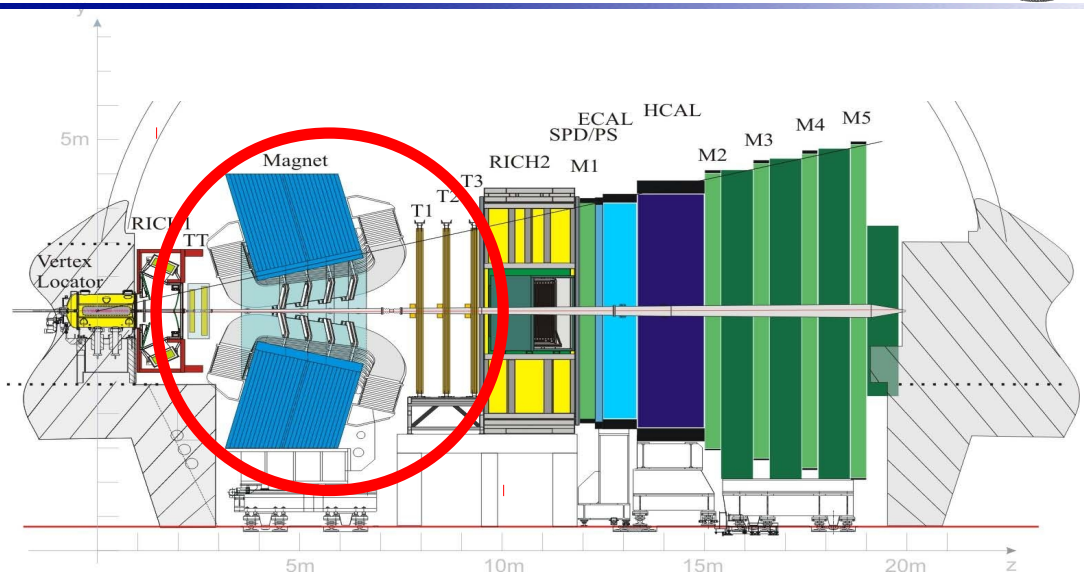


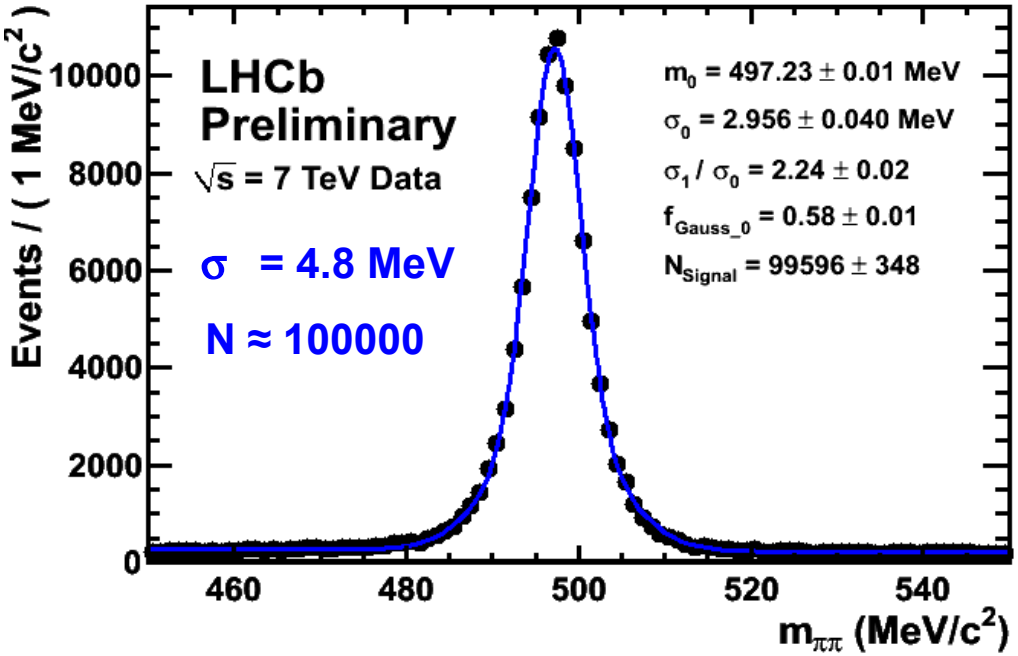
Tracking performance

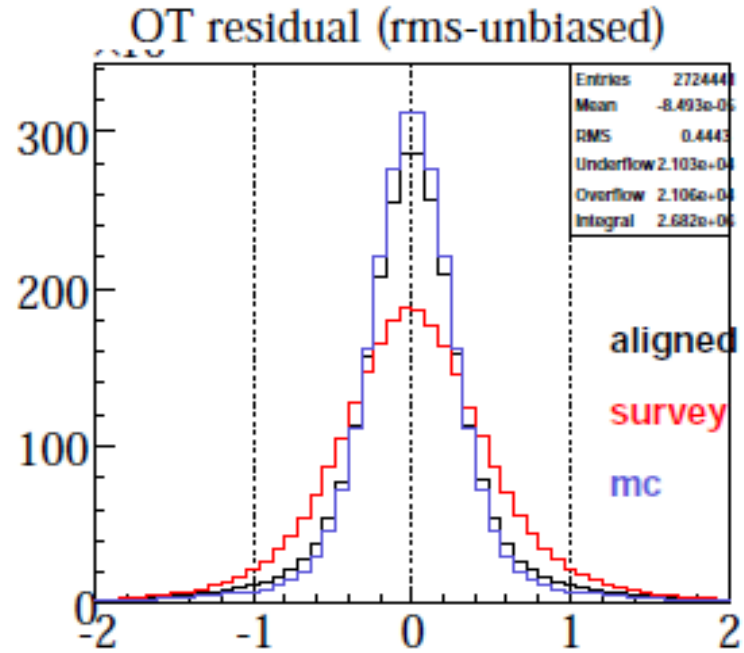
Need very good momentum and mass resolution

Tracking system:

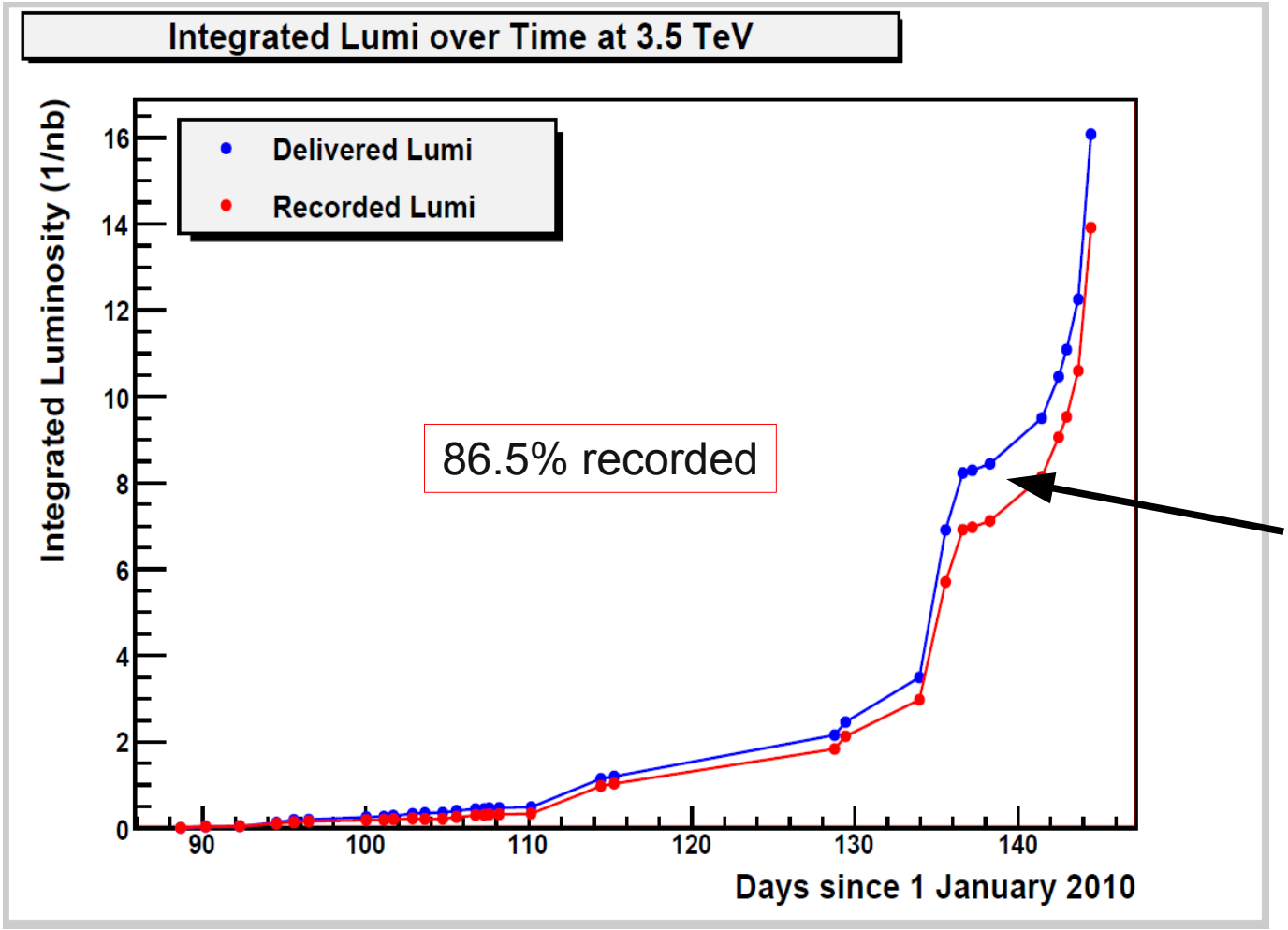
magnet with ∫B dl = 4Tm
2 stations before magnet
3 stations behind magnet







LHCb operation



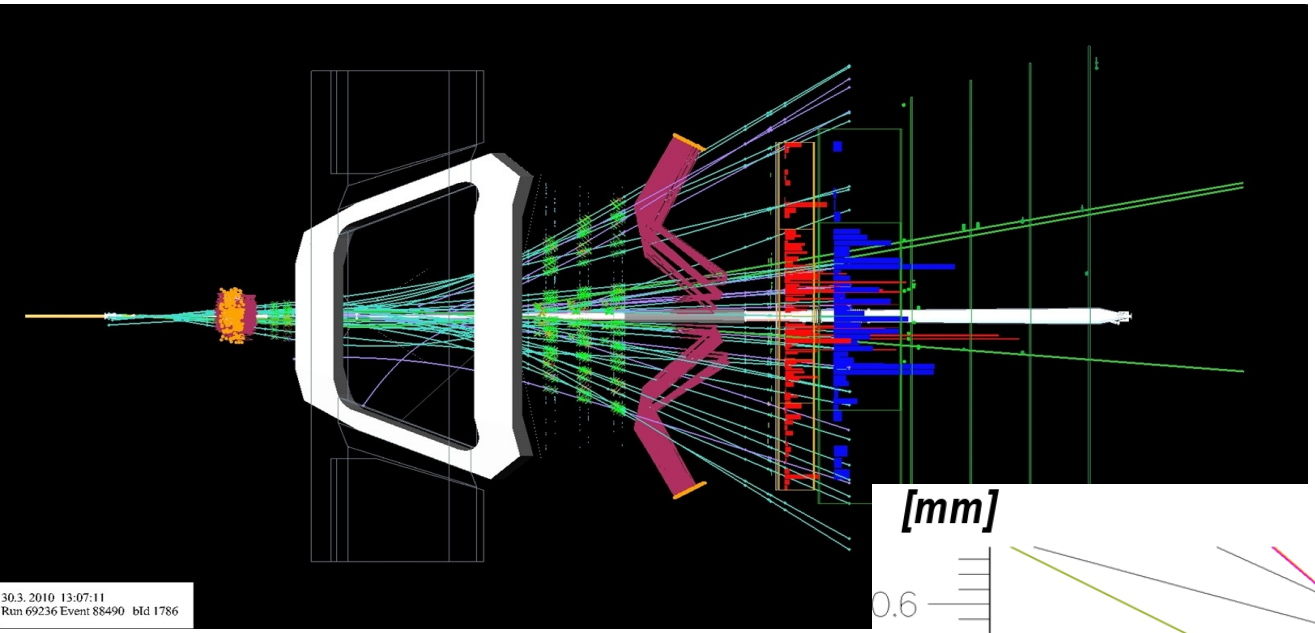
today 15 nb^{-1} recorded

Difference due to VELO movement at beginning of each run

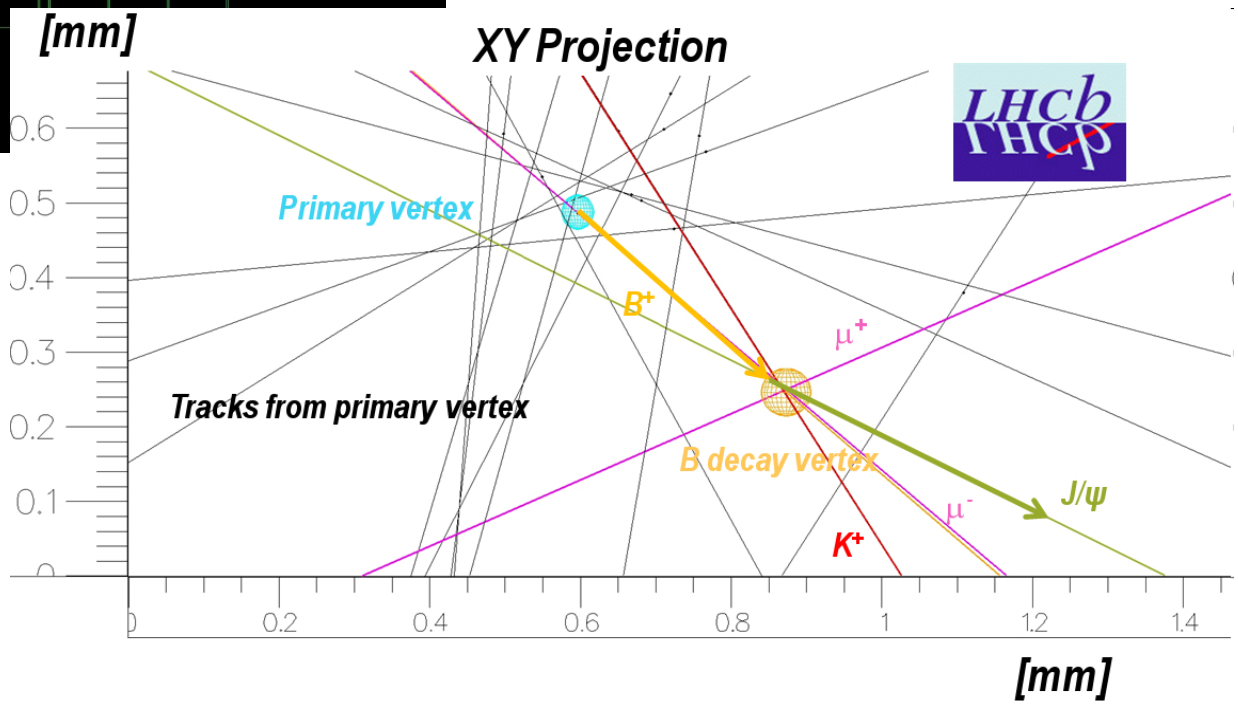
For 2010/2011 run we expect 1 fb^{-1}: ~$2.5 \cdot 10^{11}$ B-Mesons @ $\sqrt{s} = 7\,TeV$

LHCb event displays

minimum bias event @ LHCb

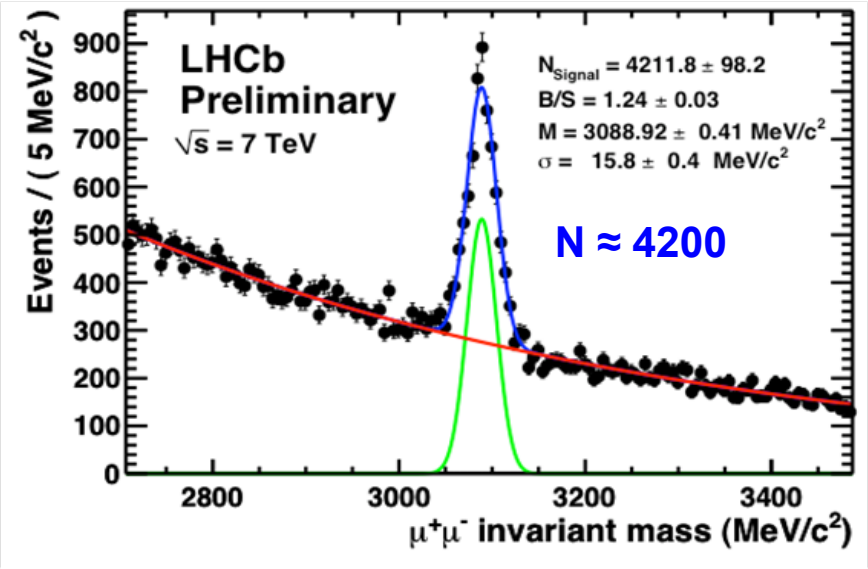


b - event @ LHCb

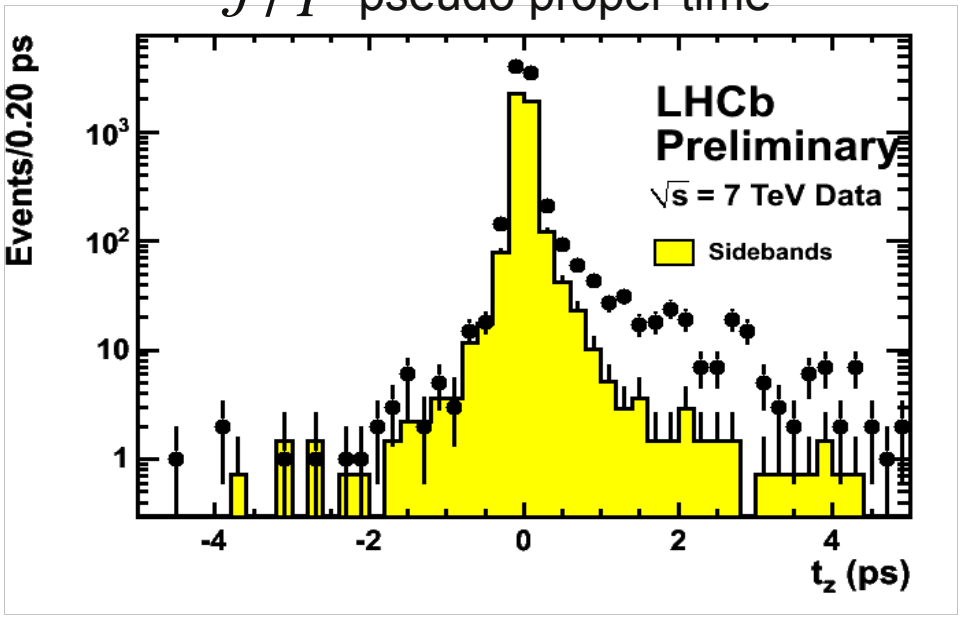


First hints for beauty

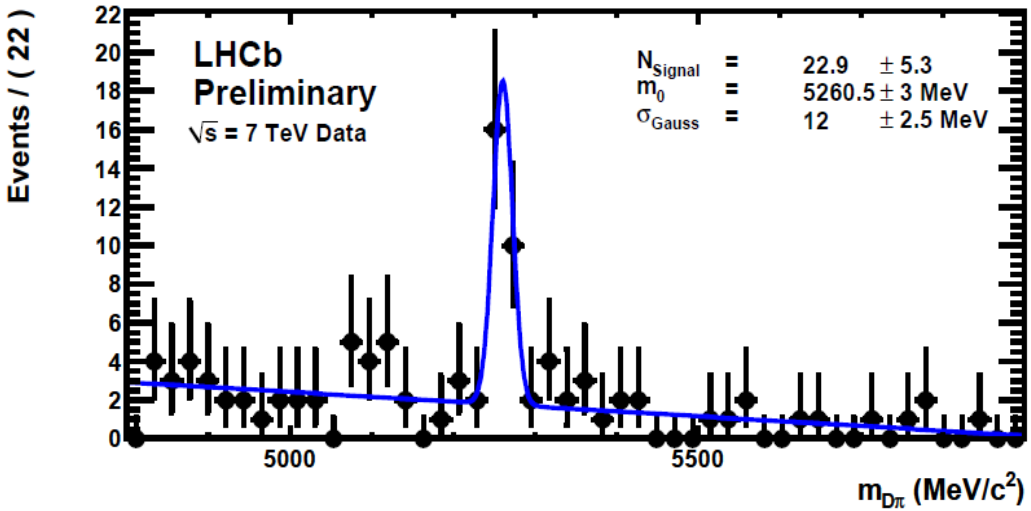
$J/\Psi \rightarrow \mu\,\mu$



J/Ψ pseudo proper time



$B^0 \rightarrow D^+\pi^- \quad + \quad B^+ \rightarrow D^0\pi^+$



Minimum bias physics at LHCb

First Physics at LHCb:

Production measurements

Particle – Antiparticle asymmetries

Multiplicities of charged particles

In this talk:

K_S cross section at 0.9 TeV

$\bar{\Lambda}/\Lambda$ ratio at 0.9 TeV and 7 TeV

Motivation:

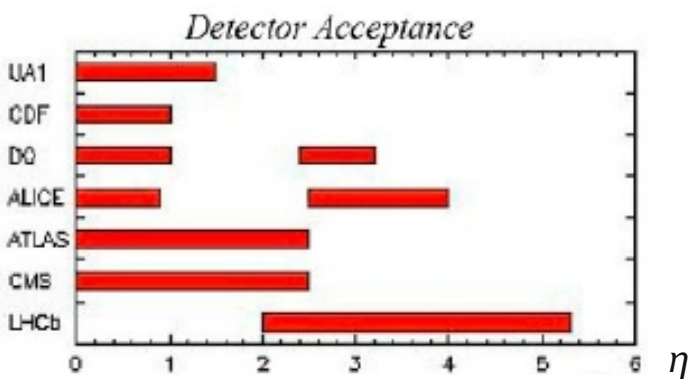
strange quarks are no valence quarks
→ good test field for fragmentation models

Antiparticle-particle ratios help to understand:
- which partons carry the baryon number
- the baryon number flow in inelastic collisions

K_S cross section measurement

$$\frac{d^2\sigma(p_T, y)}{d\,p_T\,d\,y} = \frac{N(p_T, y)}{\int \mathcal{L}\,dt \cdot \epsilon_{rec}(p_T, y) \cdot \epsilon_{trig}(p_T, y)}$$

$\int \mathcal{L}\,dt$	integrated luminosity	measured in data
$N(p_T, y)$	Number of prompt $K_S \rightarrow \pi^+ \pi^-$	measured in data
$\epsilon_{rec}(p_T, y)$	Reconstruction efficiency	determined from MC (cross-check with data)
$\epsilon_{trig}(p_T, y)$	Trigger efficiency	determined from MC (cross-check with data)



LHCb covers unique rapidity range!

rapidity $y = \frac{1}{2}\log\frac{E+p_L}{E-p_L}$

Luminosity measurement

direct measurement of luminosity based on beam currents:

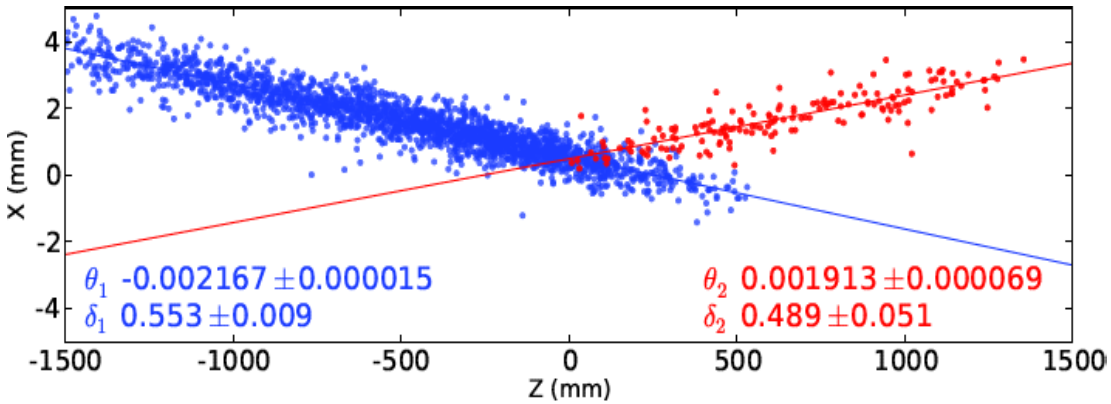
$$\mathcal{L}_{int.} = f \cdot \sum_{i=0}^{N} \frac{n_{1;i} \cdot n_{2;i}}{4\pi \cdot \sigma_i^x \cdot \sigma_i^y}$$

$n_{1;i}$ $n_{2;i}$ Number of protons in bunch 1, 2

σ_i^x σ_i^y Transverse bunch size

f Revolution frequency

- bunch currents from machine
- beamsize, positions and angles measured with VELO using beam-gas interactions



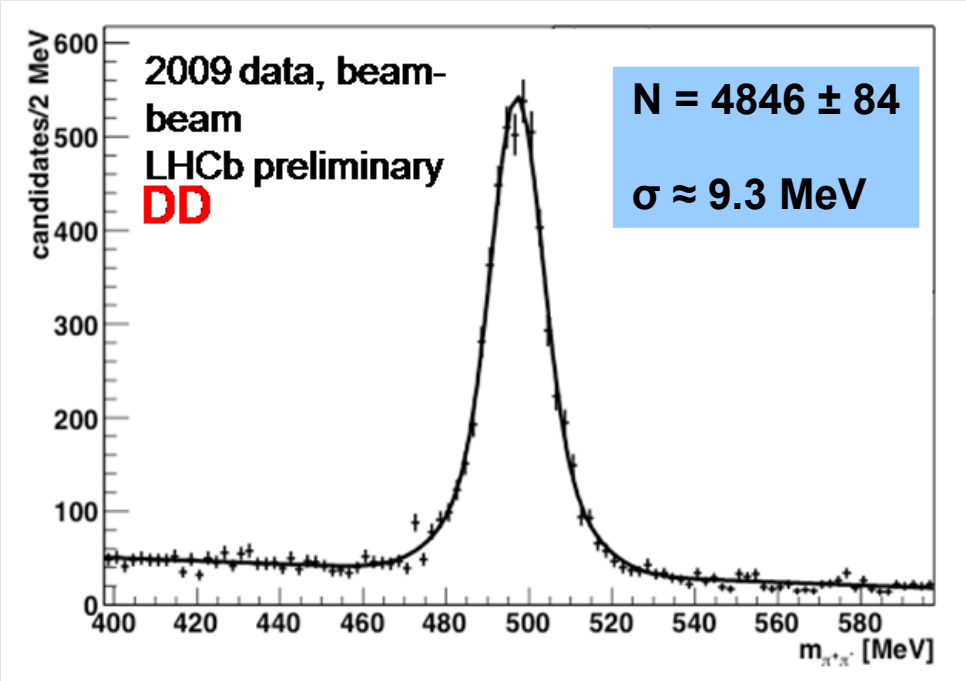
Integrated luminosity for K_S analysis:

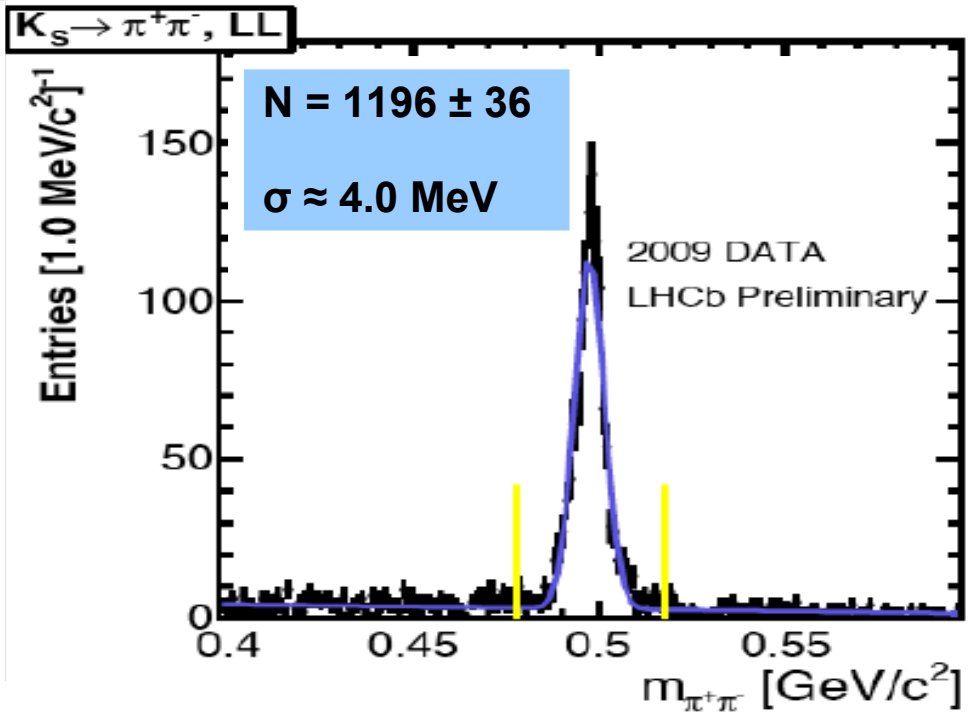
$$\mathcal{L}_{int.} = (6.8 \pm 1.0)\,\mu b^{-1}$$

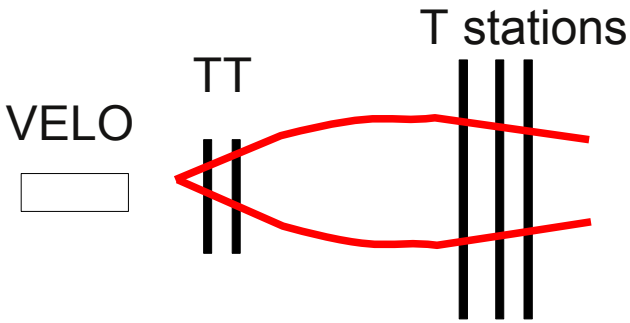
Total uncertainty of 15% dominated by beam currents:

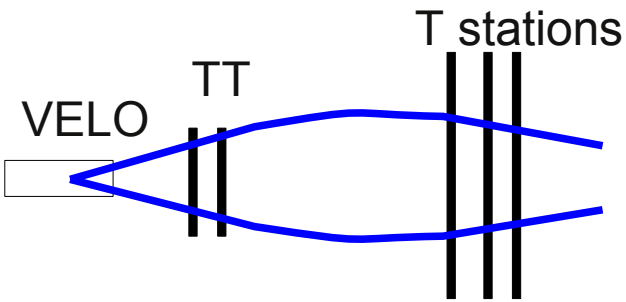
Currents	Widths	Positions	Angles
12%	5%	2%	1%

Event selection K_S analysis





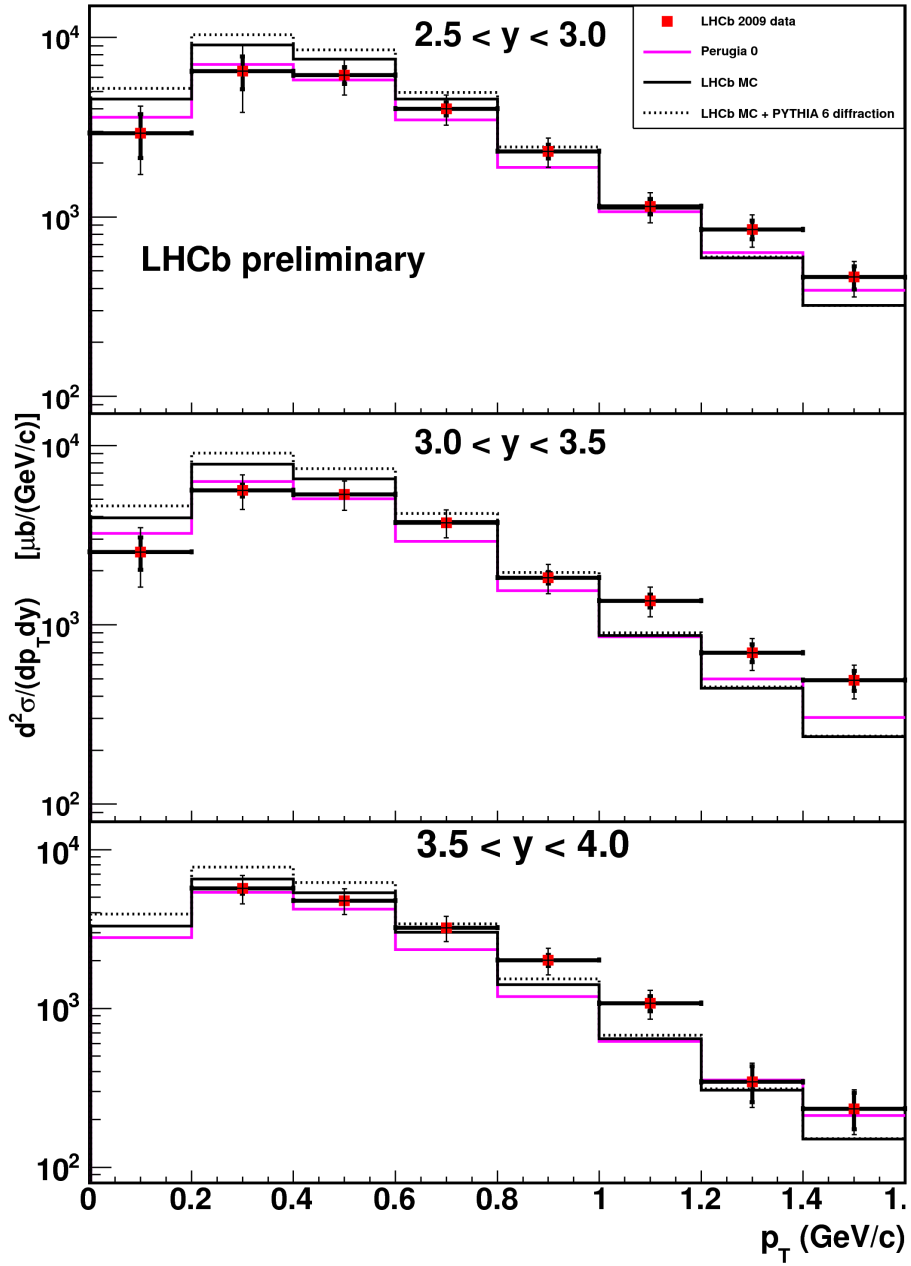




Signal extraction from fit

Take most precise result for each bin in p_T and y

Result K_S analysis



Compared to MC:
data seems to be slightly harder than different Pythia tunings

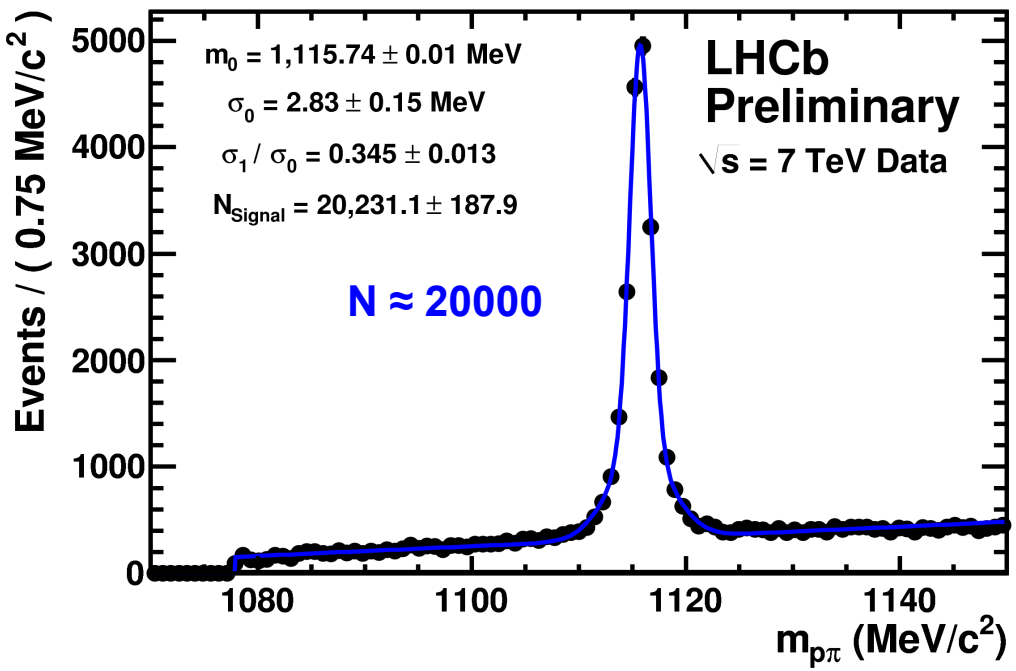
Systematic uncertainties:

- luminosity ~15%
- data/MC agreement ~10%
- fit stability ~4%
- stability of selection cuts ~4%
- trigger ~2,5%

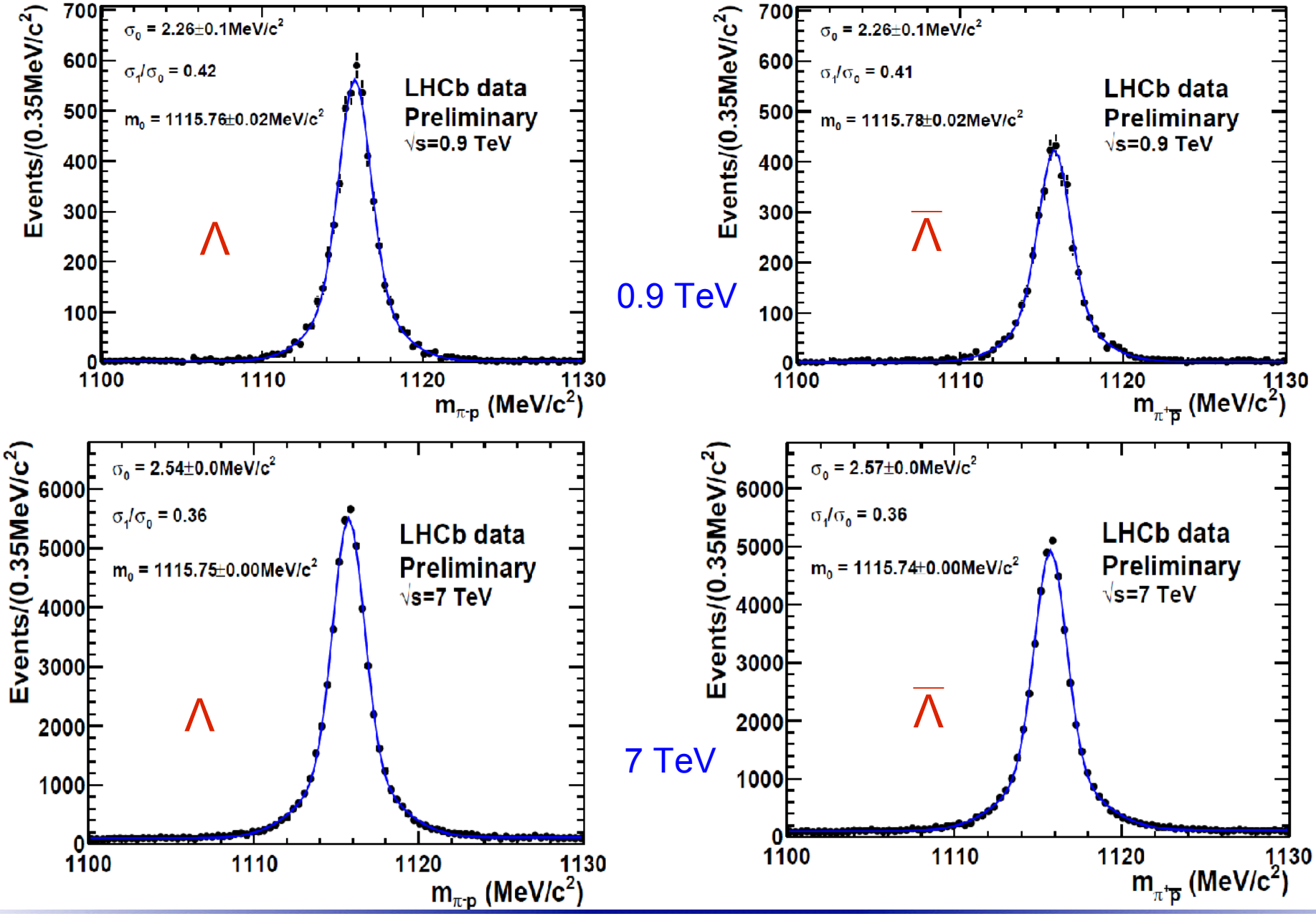
$\overline{\Lambda}/\Lambda$ event selection

- Measurement of $\frac{\overline{\Lambda}}{\Lambda}$ production ratio
- For 900 Gev and 7 TeV
- Only tracks with hits in vertex detector
- select Λ which come from primary vertex

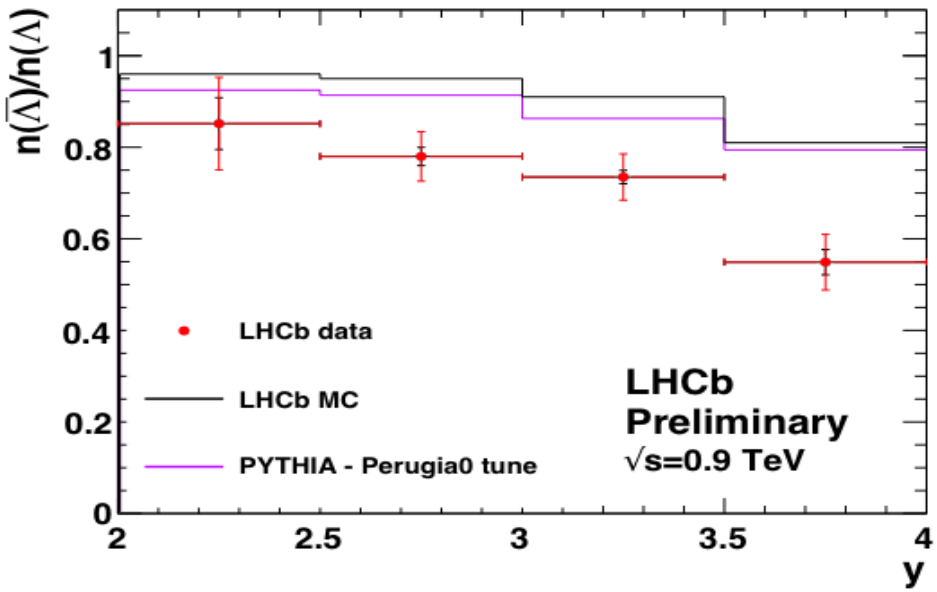
$$\Lambda \rightarrow p^{+}\pi^{-} \quad + \quad \overline{\Lambda} \rightarrow p^{-}\pi^{+}$$

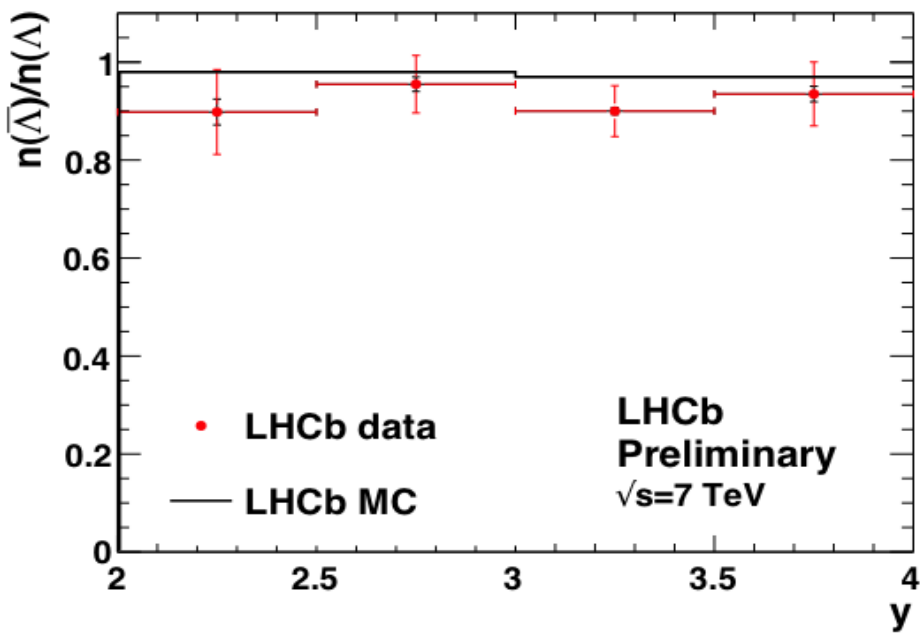


$\bar{\Lambda}/\Lambda$ yield measurements



Result $\bar{\Lambda}/\Lambda$ analysis





- statistical and systematic errors are included
- no distinction between inelastic and diffractive events
- corrected for non prompt Λ

For 900 GeV:
data tends to be lower than different Phythia models

For 7 TeV:
good agreement with Monte Carlo

Systematic uncertainties:

Re-weighting of MC p_T distributions to match data:
~ 2%

Difference in material interaction cross section below 10GeV:
~2%

Conclusion

- LHCb had a great start of data taking

- Unique rapidity and p_T range accessible

- First results of minimum bias physics:

  K_S differential production cross section seems to be slightly harder than MC models

  $\bar{\Lambda}/\Lambda$ production ratio tends to be lower than MC tunings at 900 GeV

  In good agreement with predictions for 7 TeV

- More studies in progress:

  proton/anti-proton ratio, meson/baryon ratio

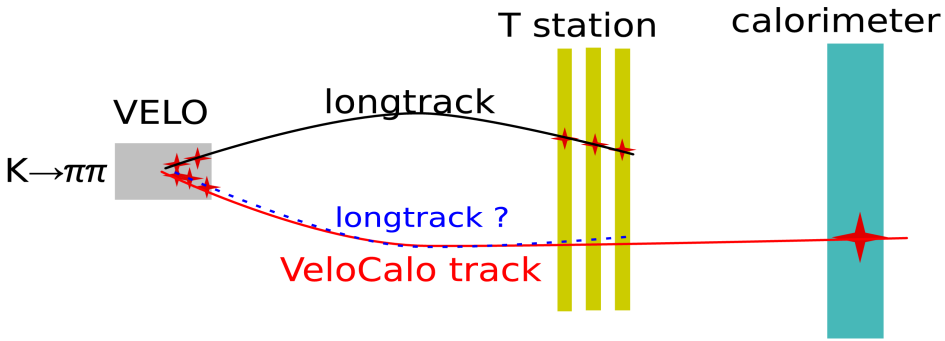
  J/Ψ cross section, $b\bar{b}$ cross section, B-physics


Thank You!
UXB

BACKUP

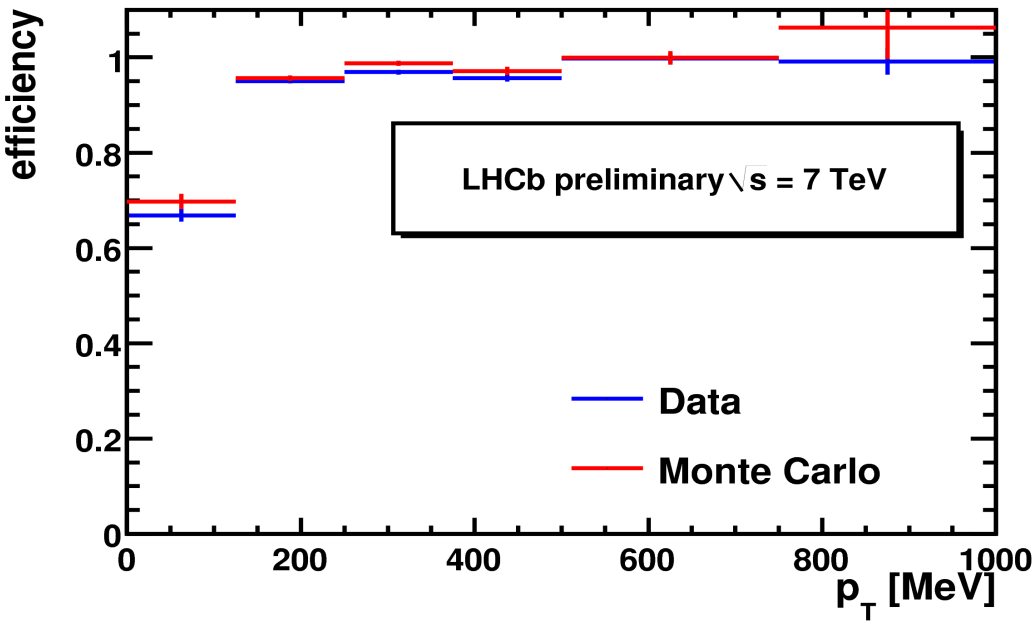
Tracking Performance

$$\epsilon = \frac{\#\,tracks^{\;VeloCalo\;\wedge long\;track}}{\#\,tracks^{\;VeloCalo}}$$



take Velo-Calo track of K_S daughter and check if there is a corresponding long track

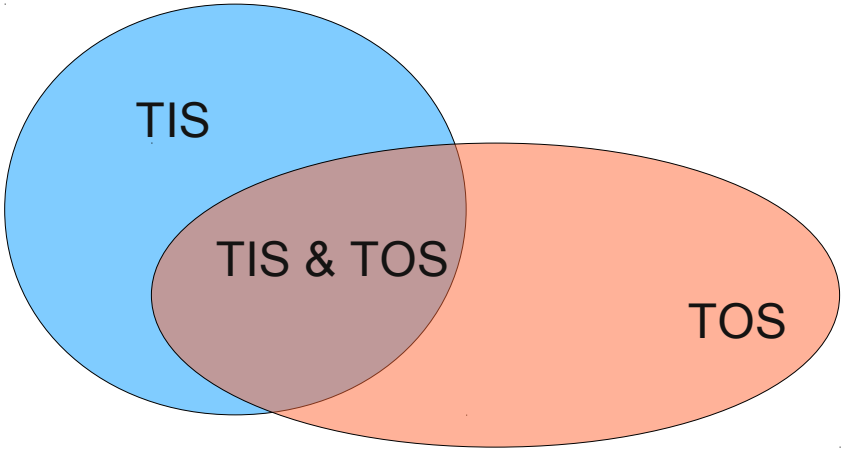
→ probing the T station efficiency



Trigger Efficiency

Trigger efficiency determined on MC

→ cross check with data



using two independent types of trigger decisions:

Trigger independent of signal

Trigger on signal

$$\epsilon_{trig}(p_T, y) = \frac{N_{TIS \wedge TOS}}{N_{TOS}}$$