# Prompt hadron production at LHCb

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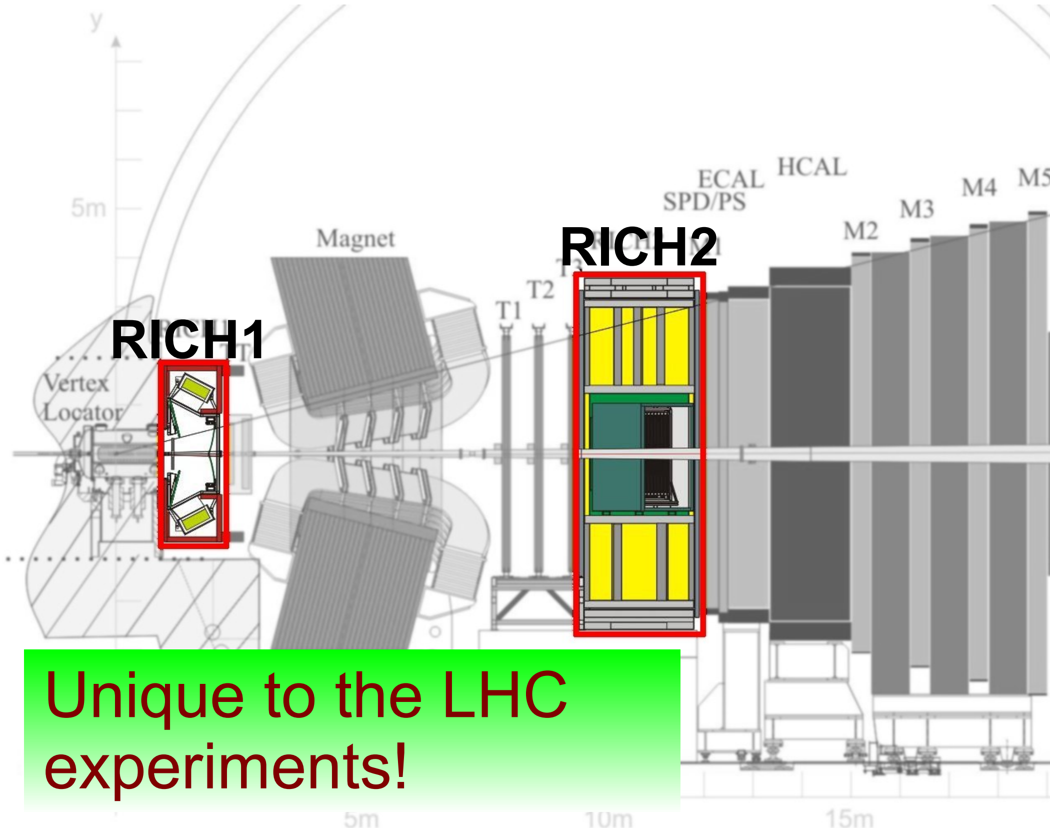
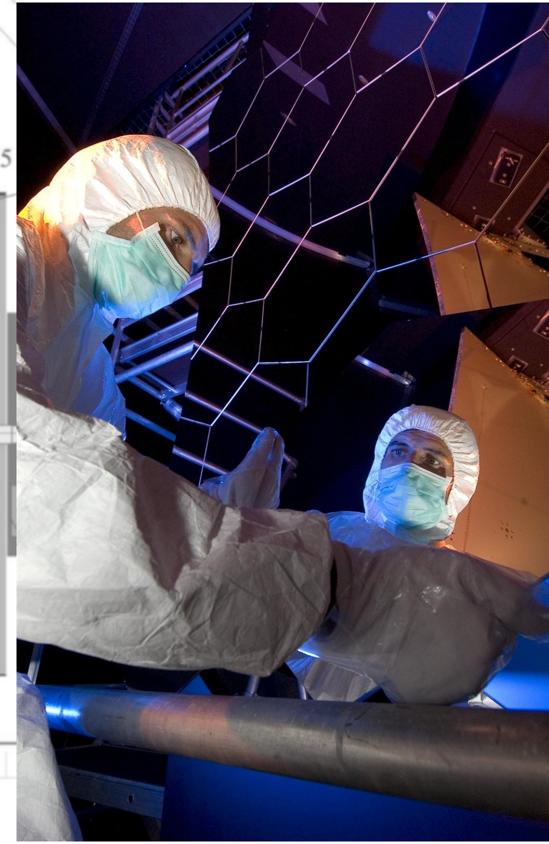
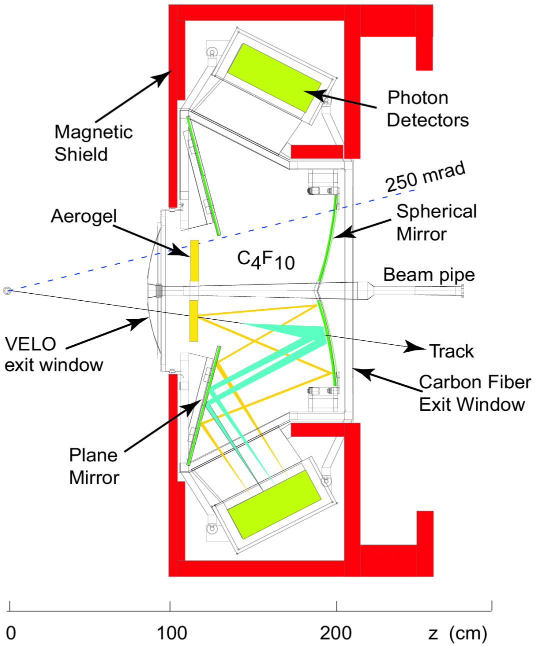


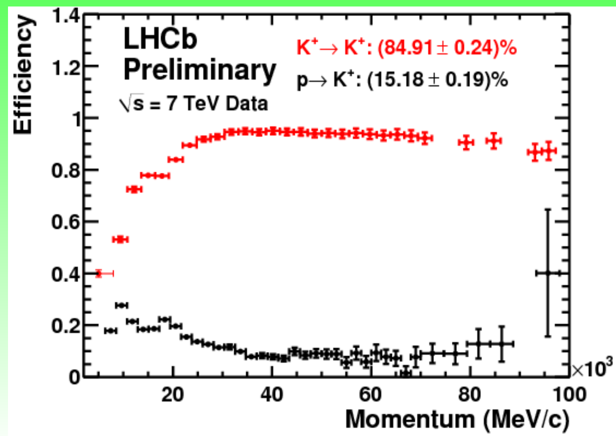
2 Ring Imaging CHerenkov (RICH) detectors provide charged particle identification in a momentum range of 2 - 100 GeV

# RICH Detectors




RICH detectors provide excellent Particle Identification

Vital for K/π/p discrimination and good tagging efficiency



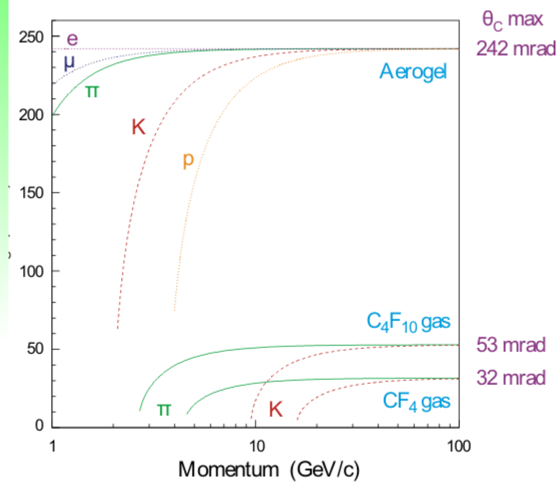

3 Radiators needed

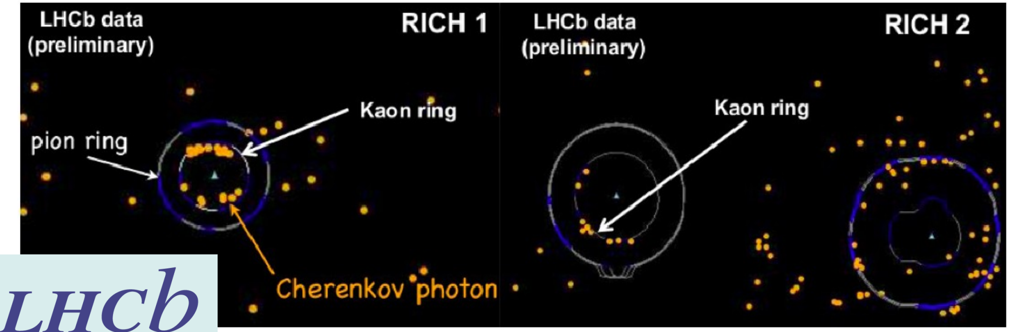
RICH1 (2<p<60 GeV):

- Aerogel, n~1.03
- $C_4F_{10}$, n~1.0014

RICH2 (p>20 GeV)

- $CF_4$, n~1.0005



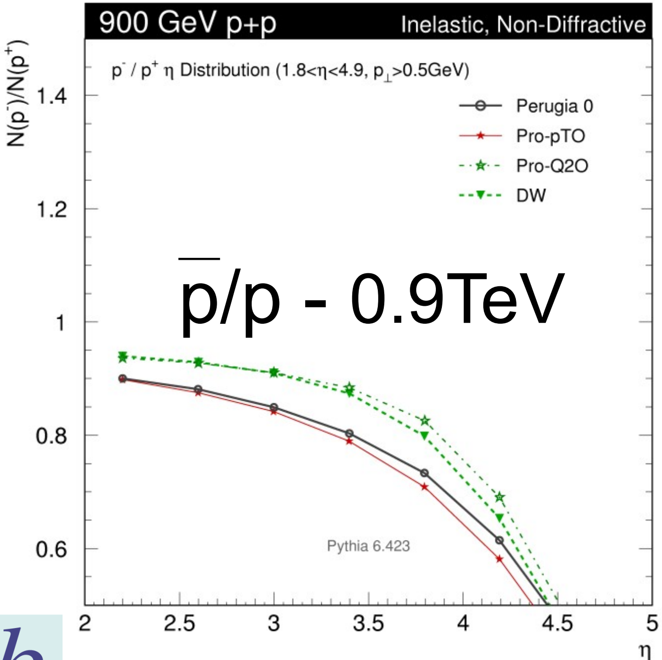

DLL(x-y) = Delta Log Likelihood between x and y particle hypotheses

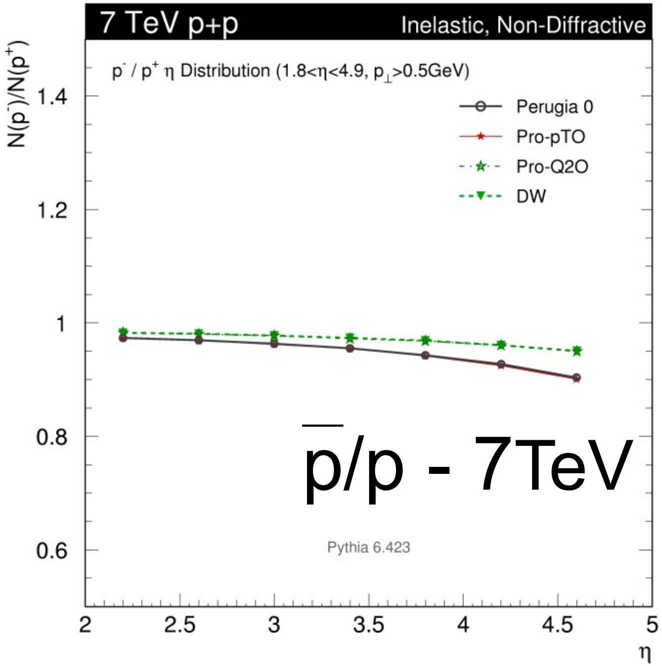
# Motivation

Hadron ratios carry information on
- Baryon number transport
- Hadronisation mechanisms
- Monte Carlo Tuning

No need to know absolute luminosity!

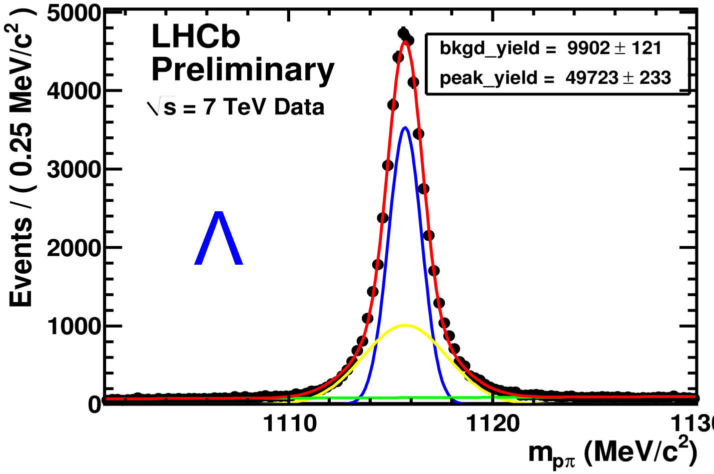
P. Skands http://home.fnal.gov/~skands/

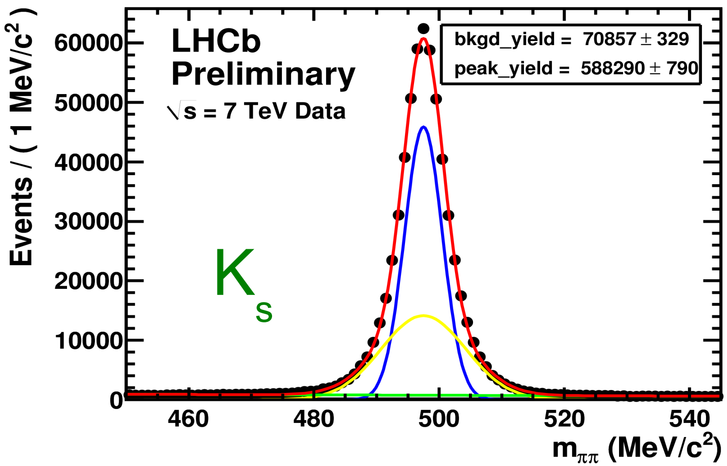


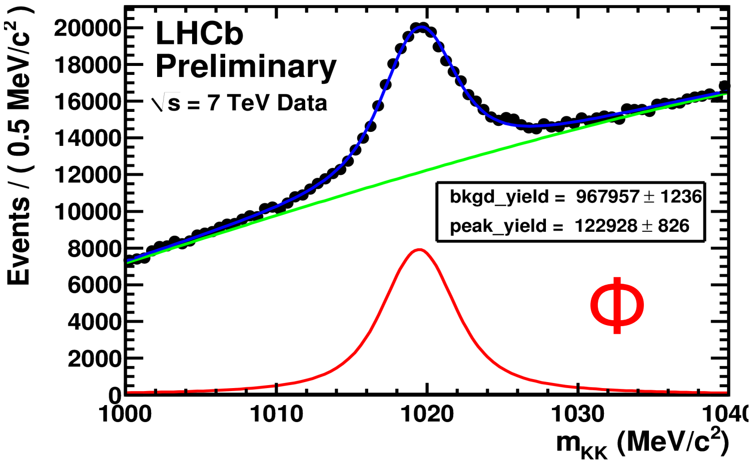



# PID Calibration

- Pure samples of protons selected with RICH particle ID
- Need to select samples of K and π to keep contamination under control
- Cuts tuned on MC but real efficiencies and *mis*ID are extracted from data using calibration samples of $\Lambda \rightarrow p\pi$, $\Phi \rightarrow KK$, $K_s \rightarrow \pi\pi$



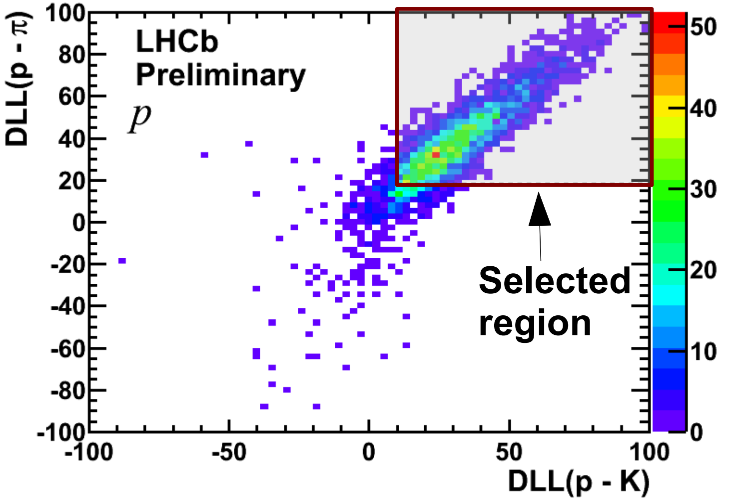



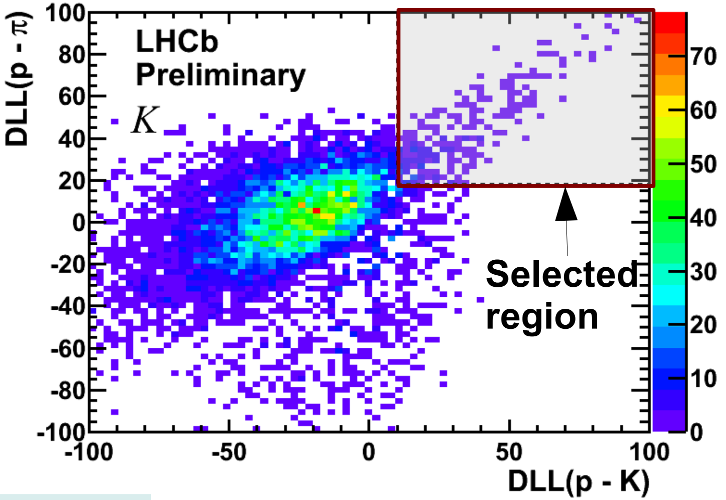



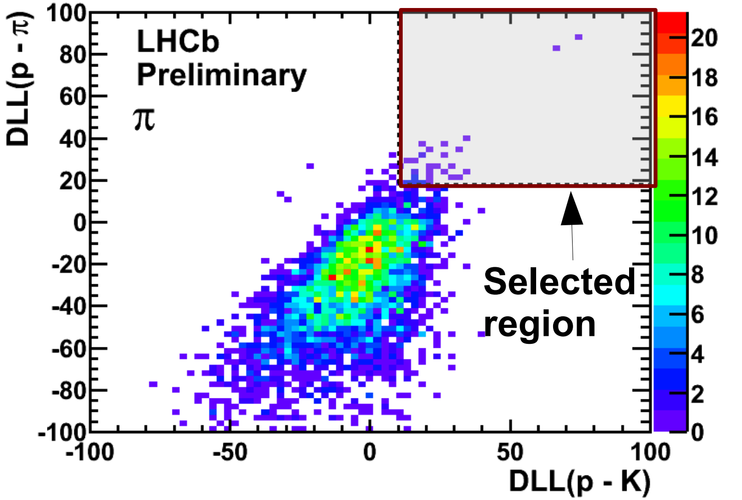
# Selecting Protons

Tracks from calibration samples demonstrate that protons are effectively selected

Contamination from K and π is also quantified



# Analysis strategy

## Contamination correction

**From data**

$$\begin{pmatrix} p_{Sel} \\ K_{Sel} \\ \pi_{Sel} \end{pmatrix} = \begin{pmatrix} p \to p & K \to p & \pi \to p \\ p \to K & K \to K & p \to K \\ p \to \pi & K \to p & \pi \to \pi \end{pmatrix} \begin{pmatrix} p_{True} \\ K_{True} \\ \pi_{True} \end{pmatrix}$$

$$\begin{pmatrix} p_{True} \\ K_{True} \\ \pi_{True} \end{pmatrix} = \begin{pmatrix} p \to p & K \to p & \pi \to p \\ p \to K & K \to K & p \to K \\ p \to \pi & K \to p & \pi \to \pi \end{pmatrix}^{-1} \begin{pmatrix} p_{Sel} \\ K_{Sel} \\ \pi_{Sel} \end{pmatrix}$$

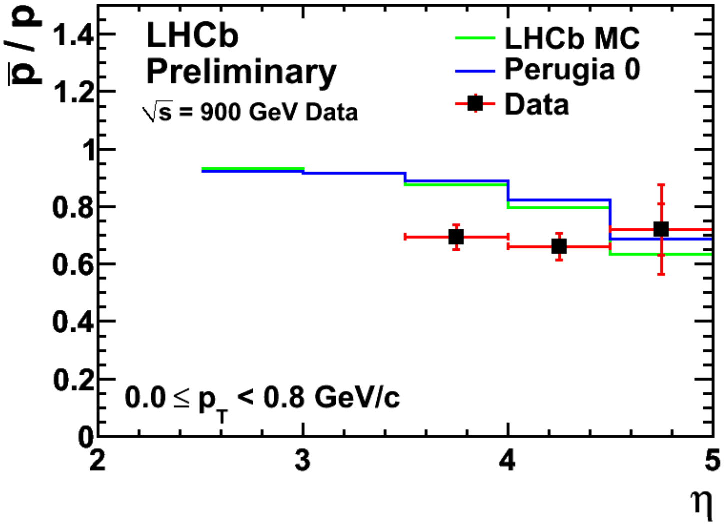
All corrections are applied independently for each ($P_T$,η) bin and particle charge

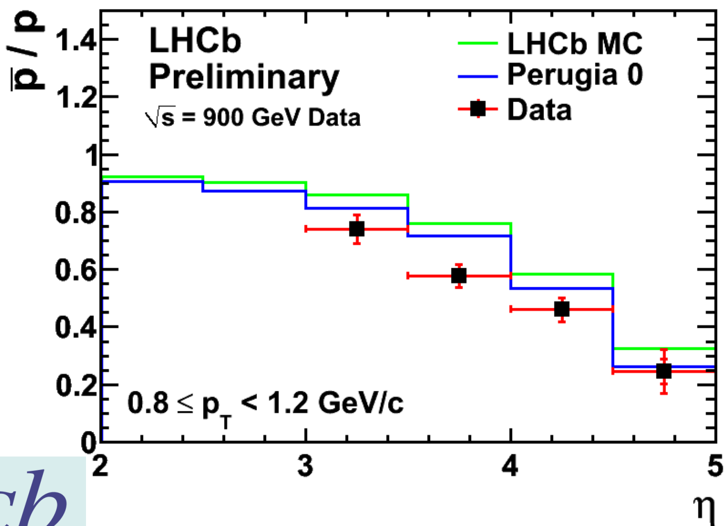
Different interaction cross-sections in the material between p and $\bar{p}$, particularly at low momentum
Therefore limit analysis to tracks with P > 5 GeV
and correct using MC

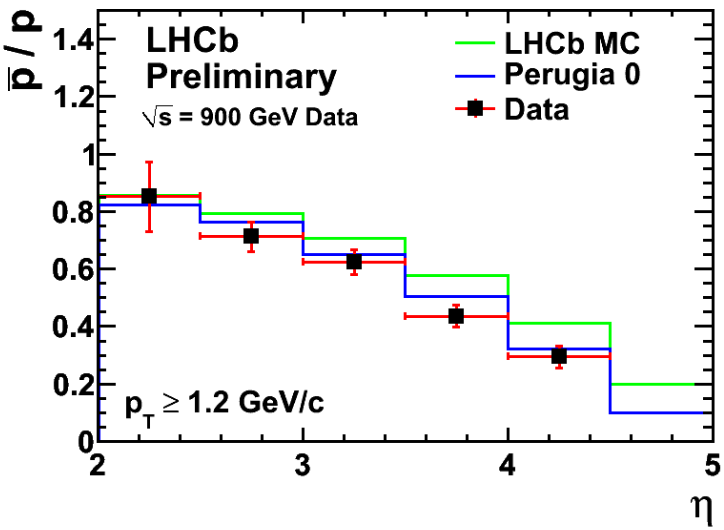
# Preliminary Results – √s=0.9 TeV

CERN-LHCb-CONF-2010-009

Baryon transport higher than predictions and consistent with $\overline{\Lambda}/\Lambda$ analysis (CERN-LHCb-CONF-2010-011)



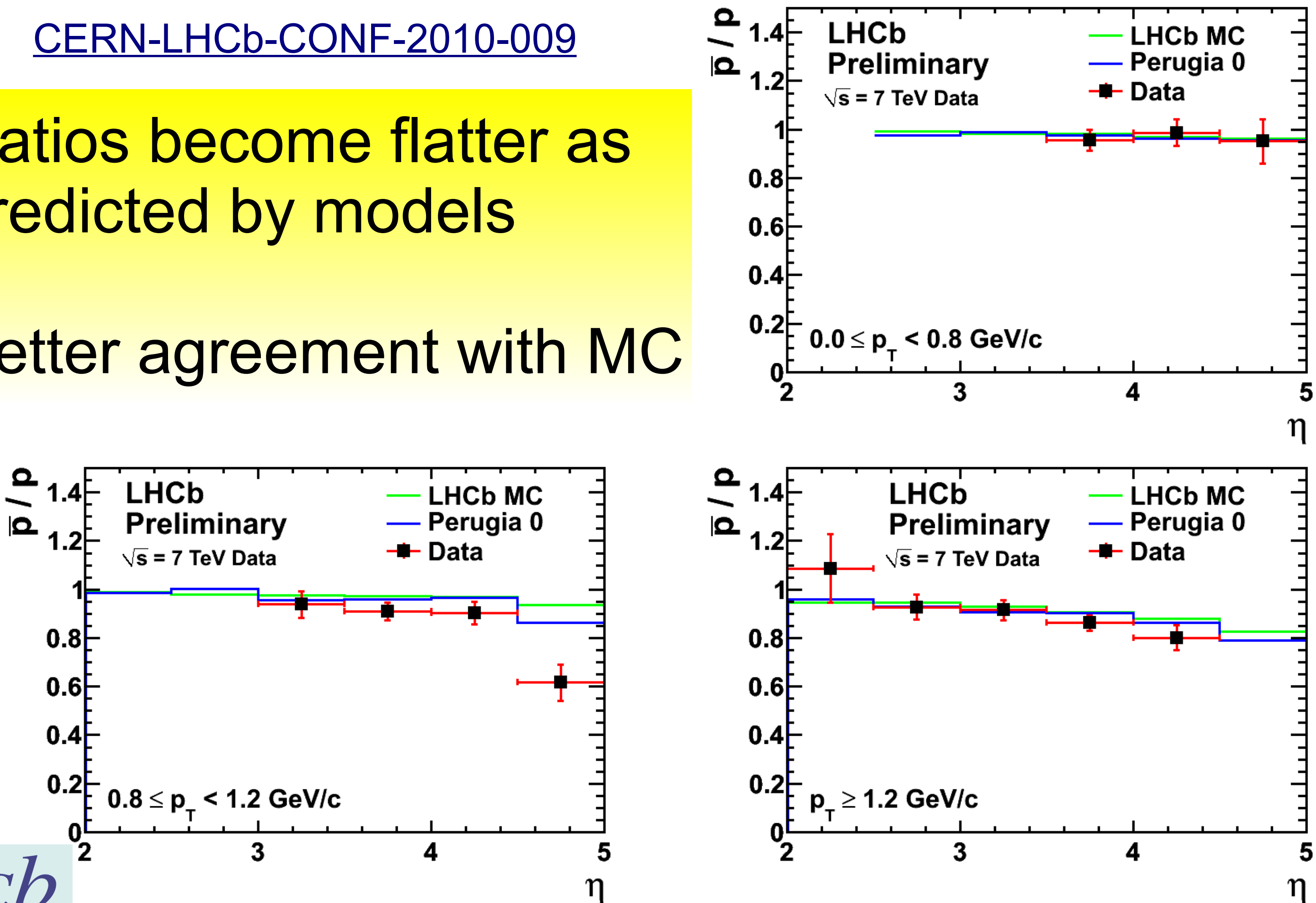



# Preliminary Results – $\sqrt{s}$=7 TeV

CERN-LHCb-CONF-2010-009

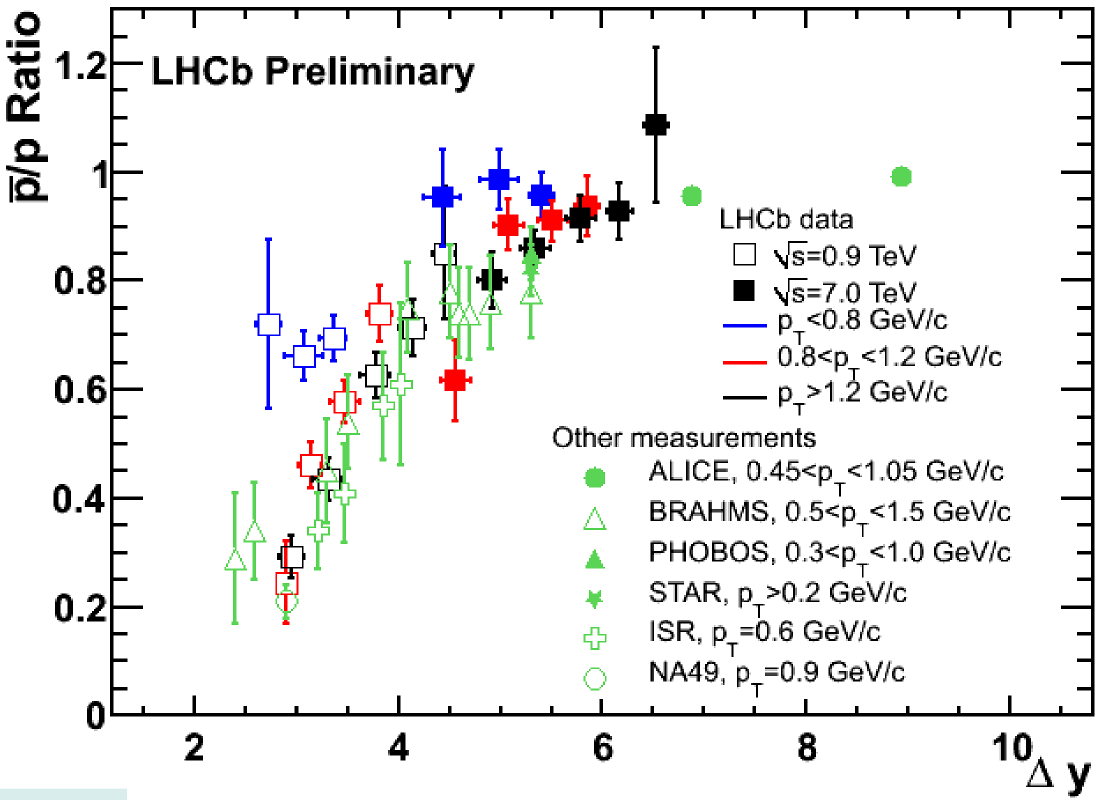
Ratios become flatter as predicted by models

Better agreement with MC



# Preliminary Results Comparison

Results over the wide LHCb Δy spread show consistency with other experiments




Δy=y(beam)-y(Λ,p)

Indications of $P_T$ dependence

CERN-LHCb-CONF-2010-009

# Systematics

Ratio measurements have relatively low systematic uncertainty (it cancels at the first order)

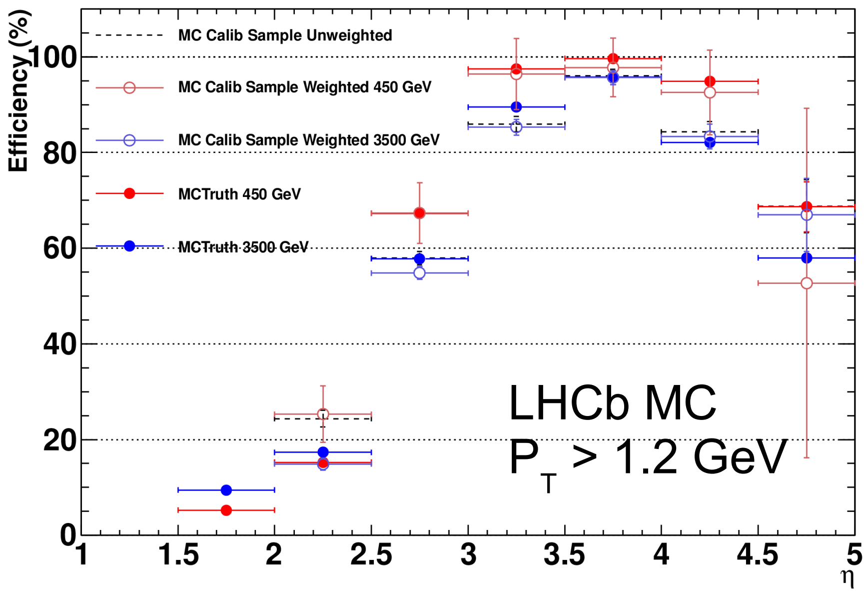
Systematics considered:

- PID (Dominant)
- Material interactions (very important for protons)
- Detector description
- Ghosts (fake tracks)
- Non-prompt contamination
- Tracking asymmetries
- Magnet polarity differences

# Improvements

Several aspects are being studied in detail to finalise the analysis:

- Data-driven bin-by-bin DLL cuts retuning
- PID efficiencies have been re-weighted according to event multiplicity and momentum distribution




- Ghost estimation now relies more on data
- Better translation of results in terms of rapidity and rapidity loss

# Conclusions

- Preliminary results indicate:
  - Higher baryon transport
  - Possible $P_T$ dependence
- Analysis is crucial to understand PID, currently being finalised towards a paper

- It will be extended to provide further ratios such as $K^-/K^+$ and $\pi^-/\pi^+$ , $K/\pi$ is under investigation

LHCb explores a unique kinematical region and provides valuable physics results and input to theoretical models