University of Zurich[UZH]

An Inquiry into the Nature and Distribution of Proton Partons

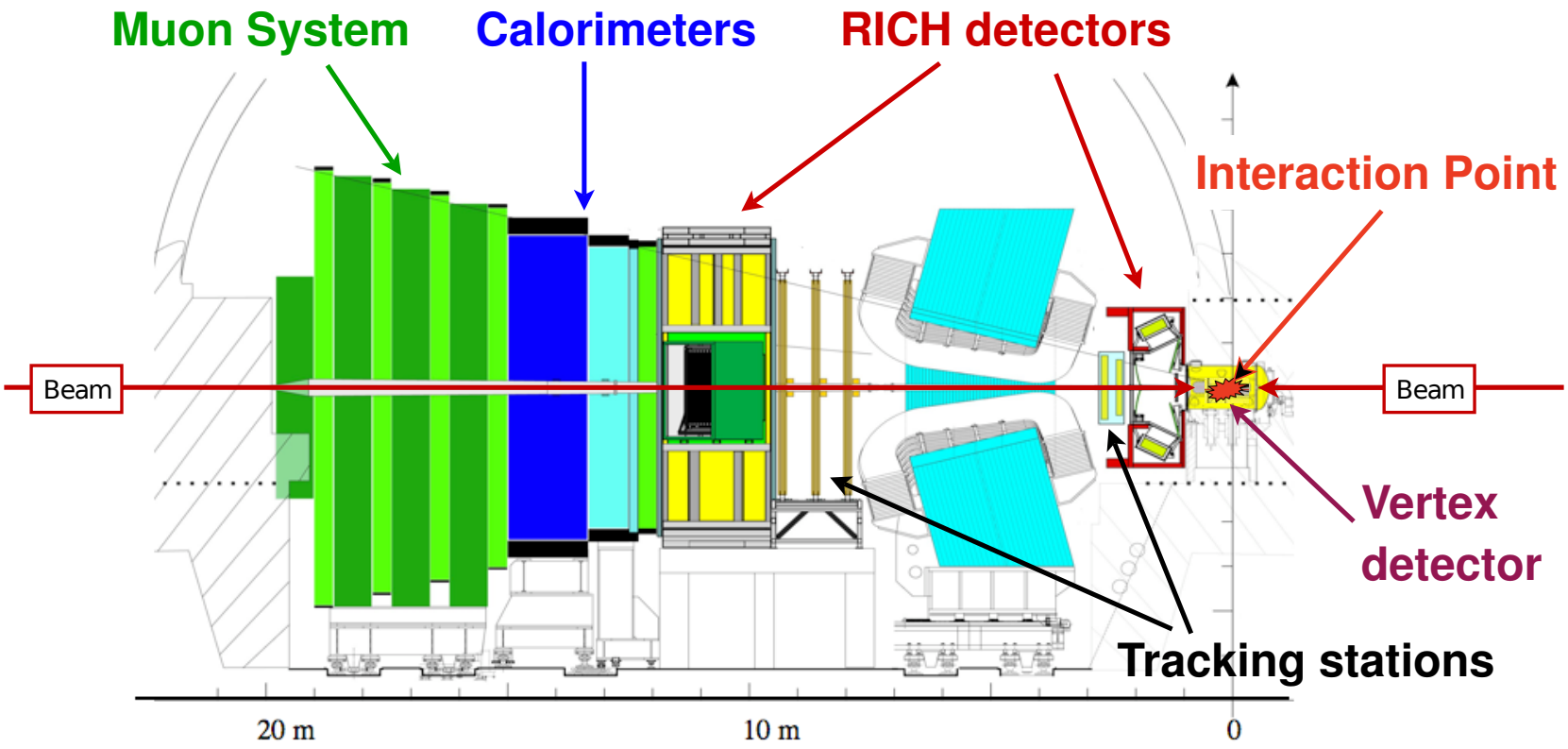
Nicola Chiapolini

Physik-Institut
University of Zurich

PhD-Seminar ETHZ & UZH

August 29, 2011

The LHCb Experiment: Proton Proton Collisions at 7 TeV



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- can look at low momentum μ: $p_\mu > 3\,\text{GeV}$
- Luminosity: $37\,\text{pb}^{-1}$ (2010), $\approx 690\,\text{pb}^{-1}$ (2011)

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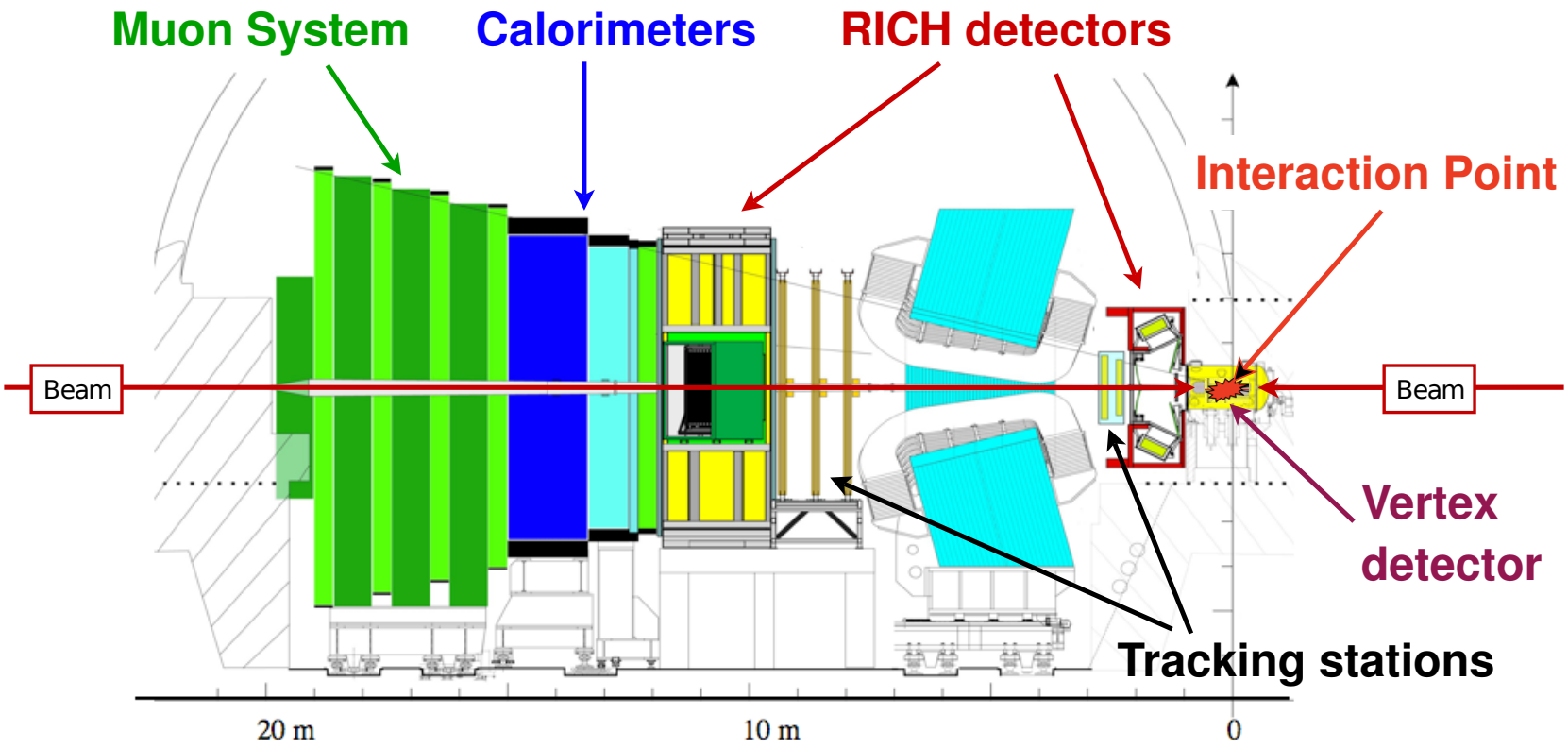

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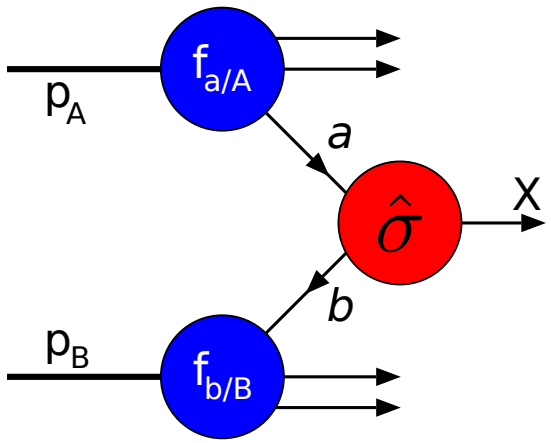
Scattering Process at LHC

cross-section calculation

- parton parton scattering described by perturbative QCD
- needs parton distribution functions
- parton distribution functions determined from measurements



$$\sigma_{AB\to X} = \int dx_a dx_b \cdot f_{a/A} f_{b/B} \cdot \hat{\sigma}_{ab\to X}$$

parton distribution function

parton parton scattering

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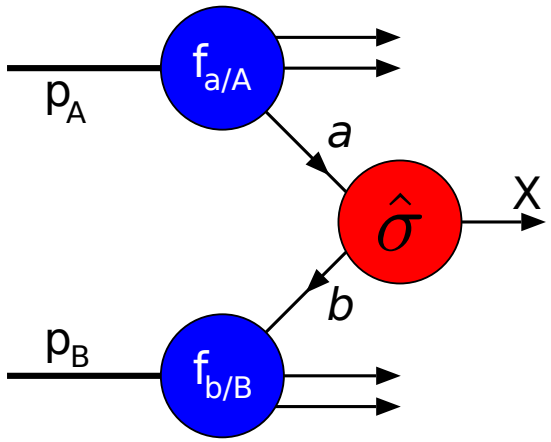

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Parton Distributions

depend on

- momentum transfer Q^2
- fraction of momentum carried by struck parton $x_{a,b}$
- not on process

$$x_{a,b} = \frac{M}{\sqrt{s}} \cdot e^{\pm y} \qquad Q^2 = M^2$$

- LHCb probes two distinct regions
- low x region so far only explored by HERA
- measurements evolved with DGLAP to higher Q^2

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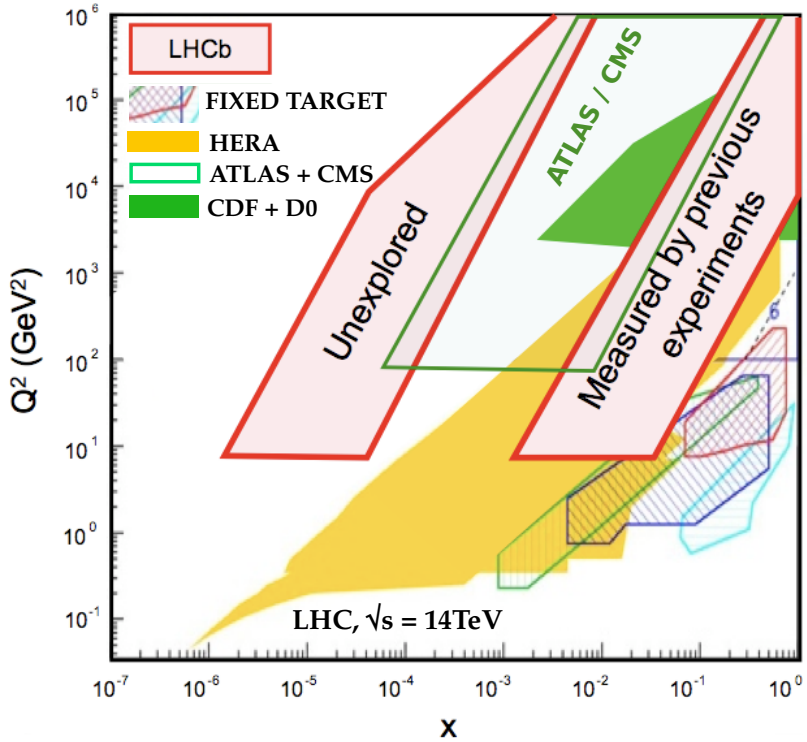

Electroweak Cross-Section Measurements

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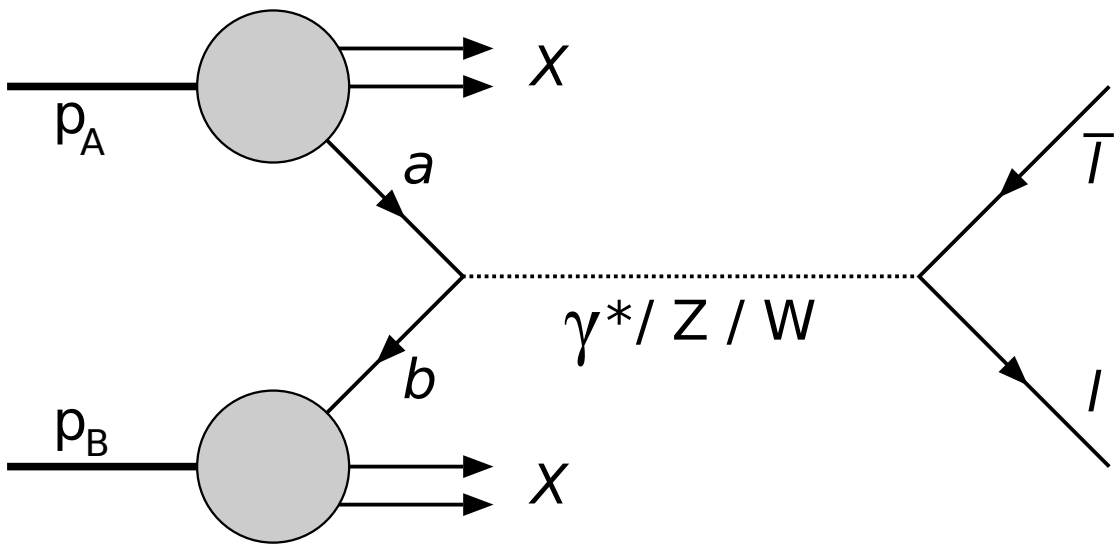
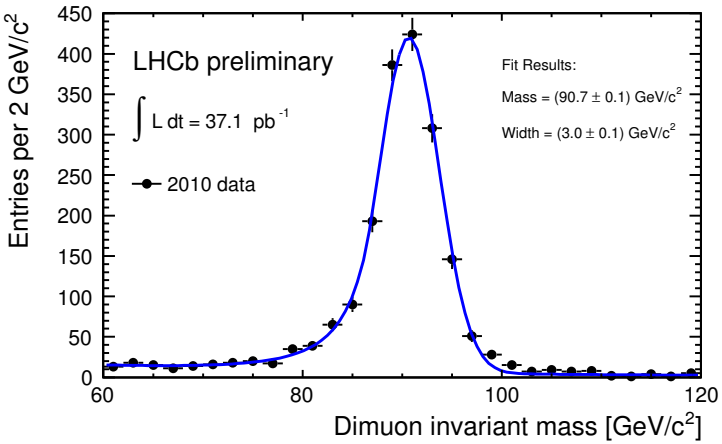
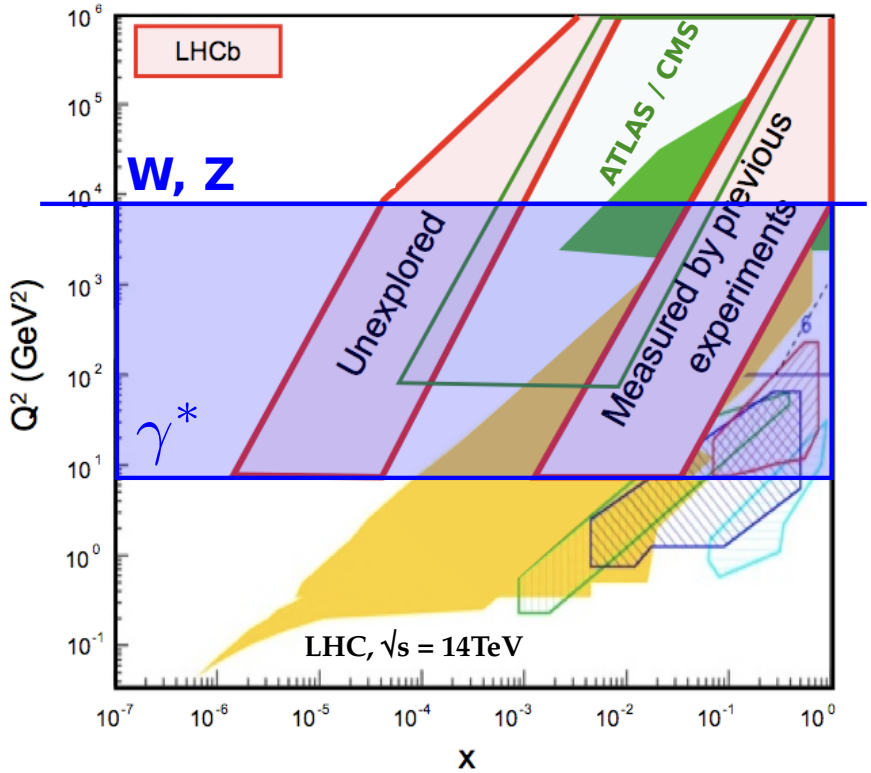


Electroweak Cross-Section Measurements

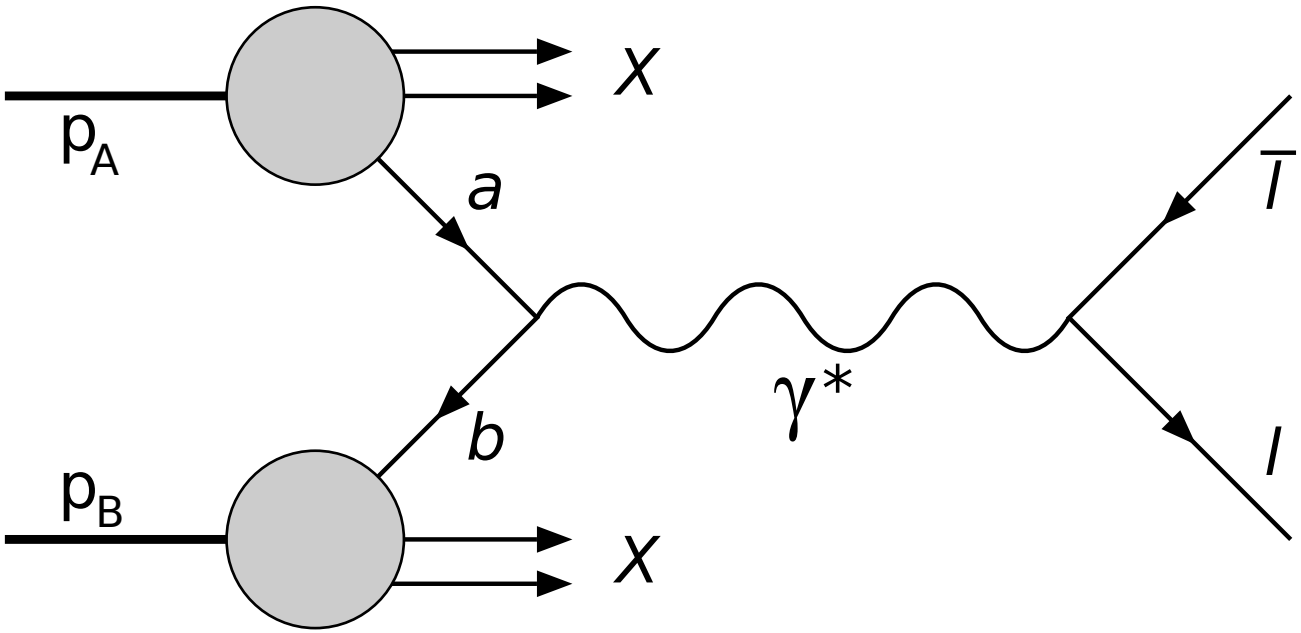
- W,Z measurements presented at conferences
- photons allow to study large kinematic area



see A. Bursche's talk



Drell-Yan Process



Look at μ final states only

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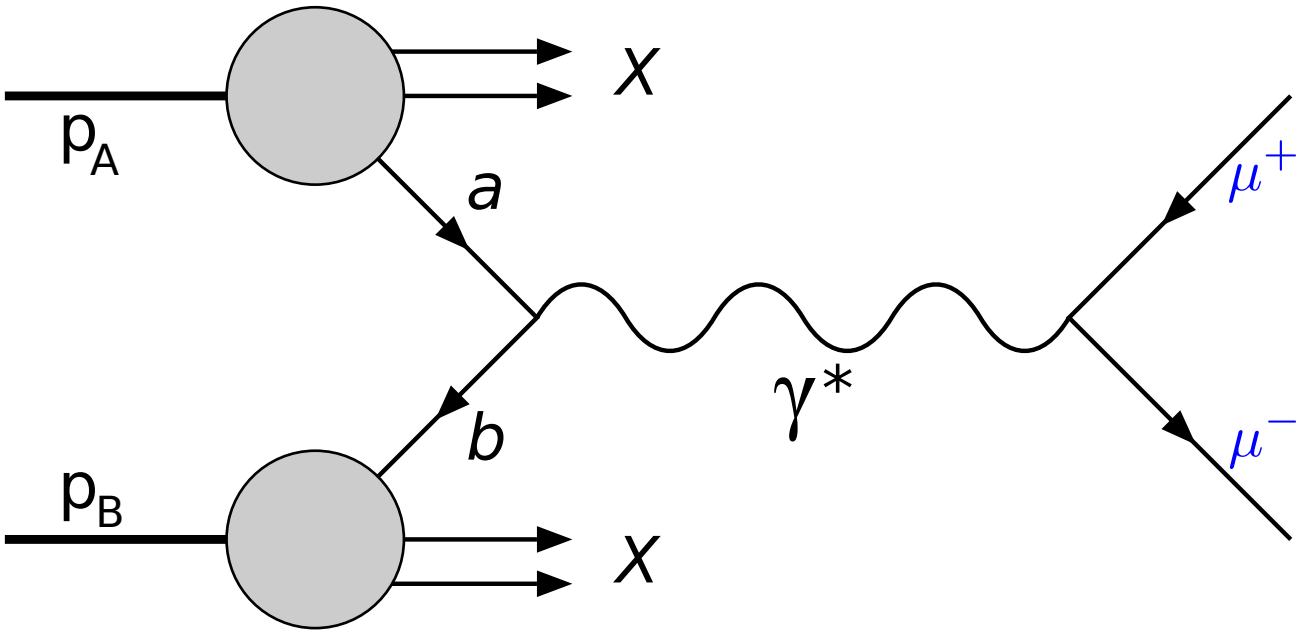

Look at μ final states only

Drell-Yan cross-section

Goal: measure the Drell-Yan cross-section

- differentially in η and in different mass bins
  $5-10; 10-20; 20-40; 40-80\,\text{GeV}$
- with minimal use of Monte Carlo

We Need Following Ingredients

- luminosity
- acceptance
- efficiencies (trigger, tracking, ...)
- selection
- purity
- theory predictions

fitting template functions to data

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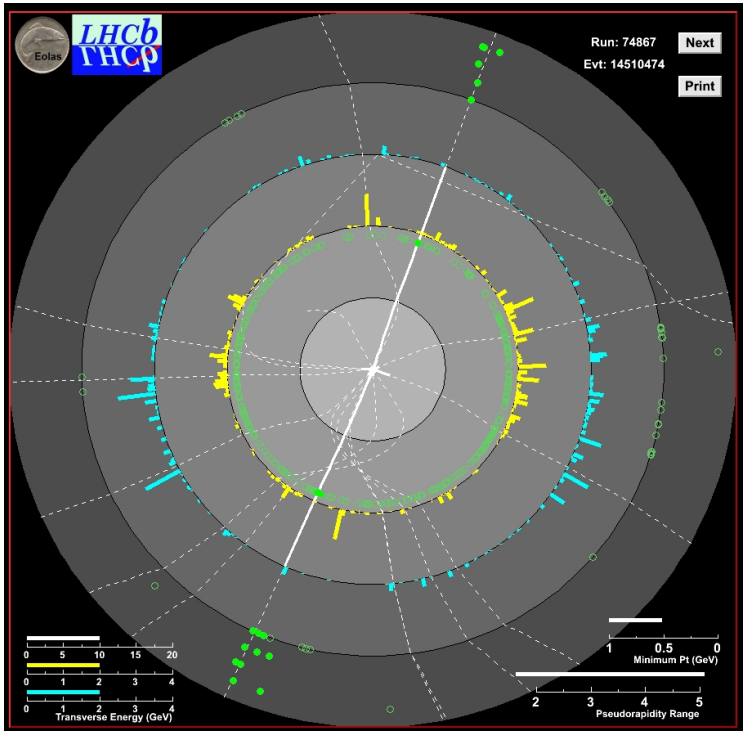
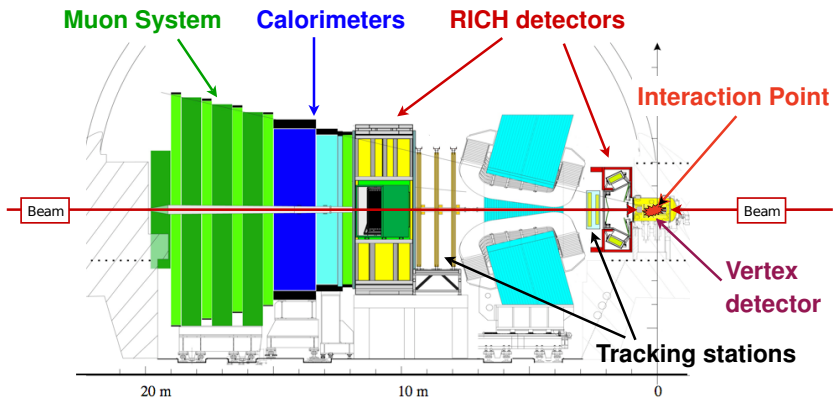
Drell-Yan Selection



$$r \Leftrightarrow Z$$
$$\varphi \Leftrightarrow \varphi$$



- trigger on two μ (M > 2.5 GeV)
- require minimal momentum for $\mu = 10$ GeV
- select only good quality tracks and vertices

Drell-Yan Backgrounds

MisID

K, π identified as μ

- decay in flight
- punch through

Template Sources

- events with same sign μ
- minimum bias data

heavy quark

μ from other process

- mostly B- and D-meson decays
- high impact parameters

Template Sources

- data with large impact parameter
- simulation

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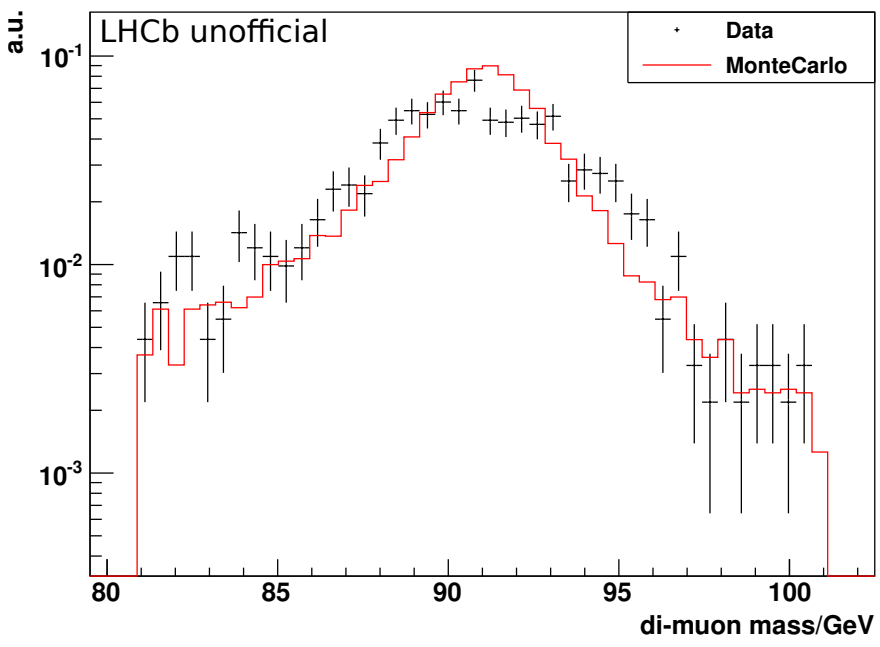
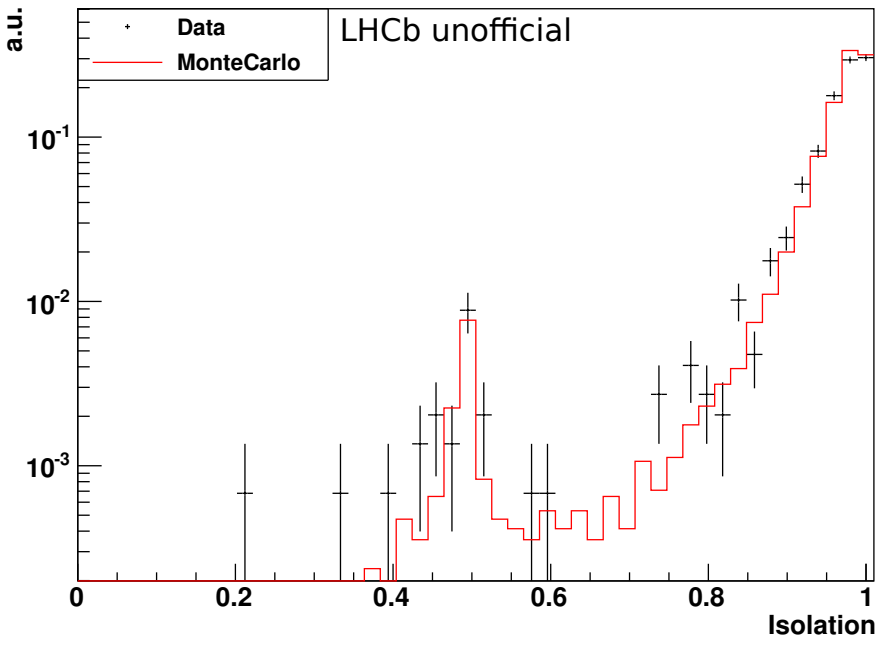
Validating Signal MonteCarlo

- choose known di-muon peak (Υ, Z)
- check mass peak
- look at variables of interest

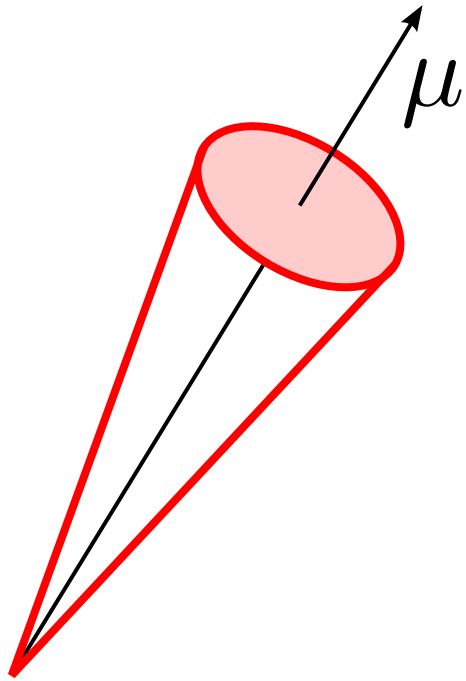




Isolation

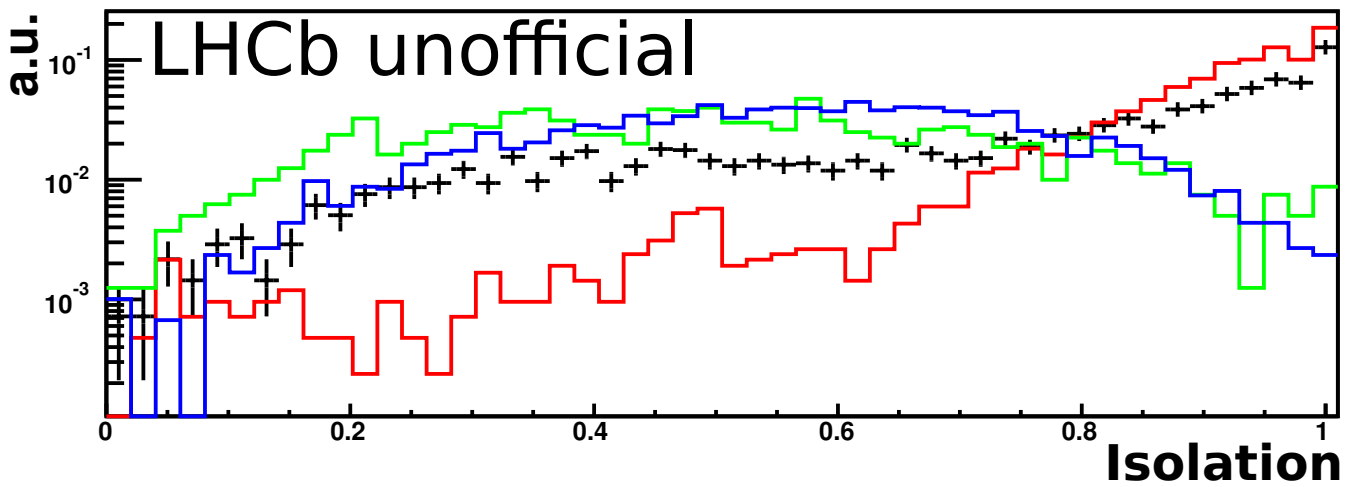
$$\text{Isolation} = \frac{{P_T}^{\mu - \textit{in Jet}}}{{P_T}^{\textit{full Jet}}}$$

- range: $0 \leq \text{Isolation} \leq 1$
- signal: only μ in cone
  $\Rightarrow$ peak at 1
- background: cone contains particles
  $\Rightarrow$ broad distribution
- use minimum of both μ



Jet-Finding:
anti-k_T, $R = 0.5$

Isolation Distributions

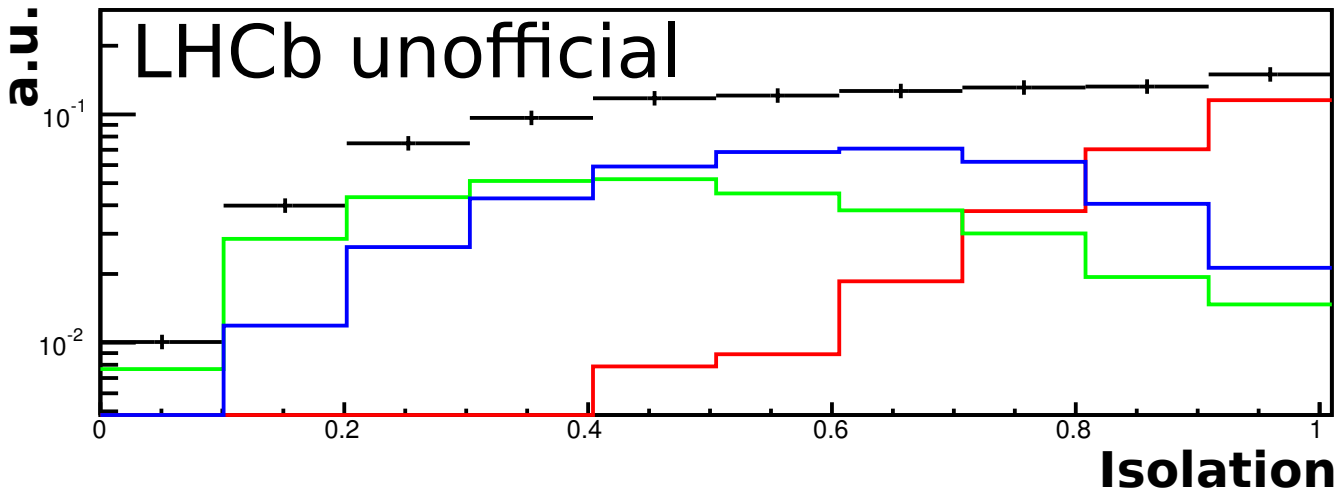


Measured
Signal
MisID
Heavy Quark

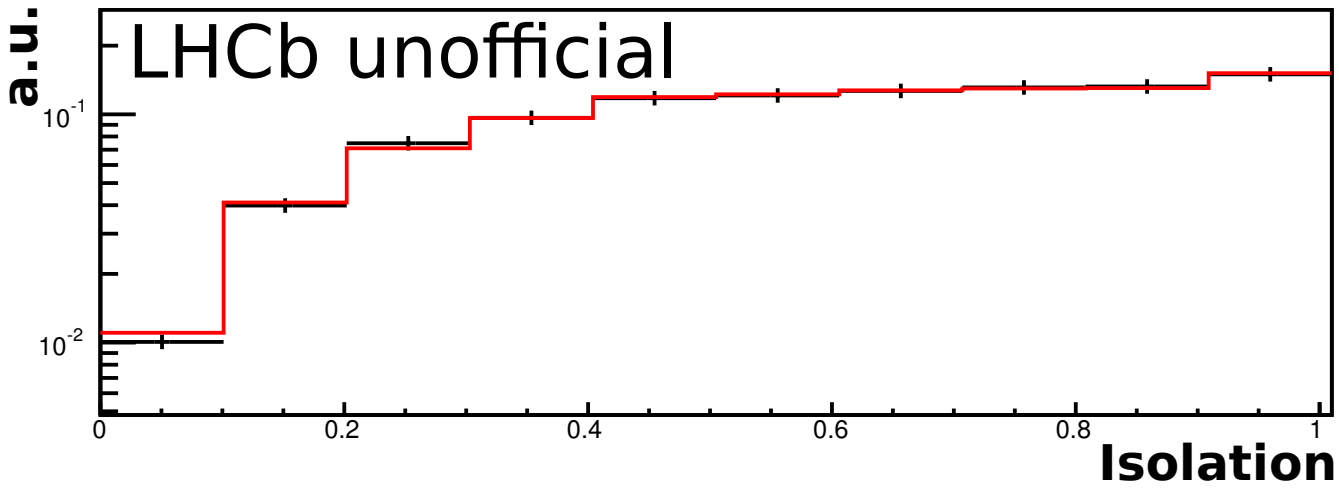
Signal: Monte Carlo
MisID: template from same sign events
Heavy Quark: template from Monte Carlo

all distributions normalized to 1

Fitting the Distributions

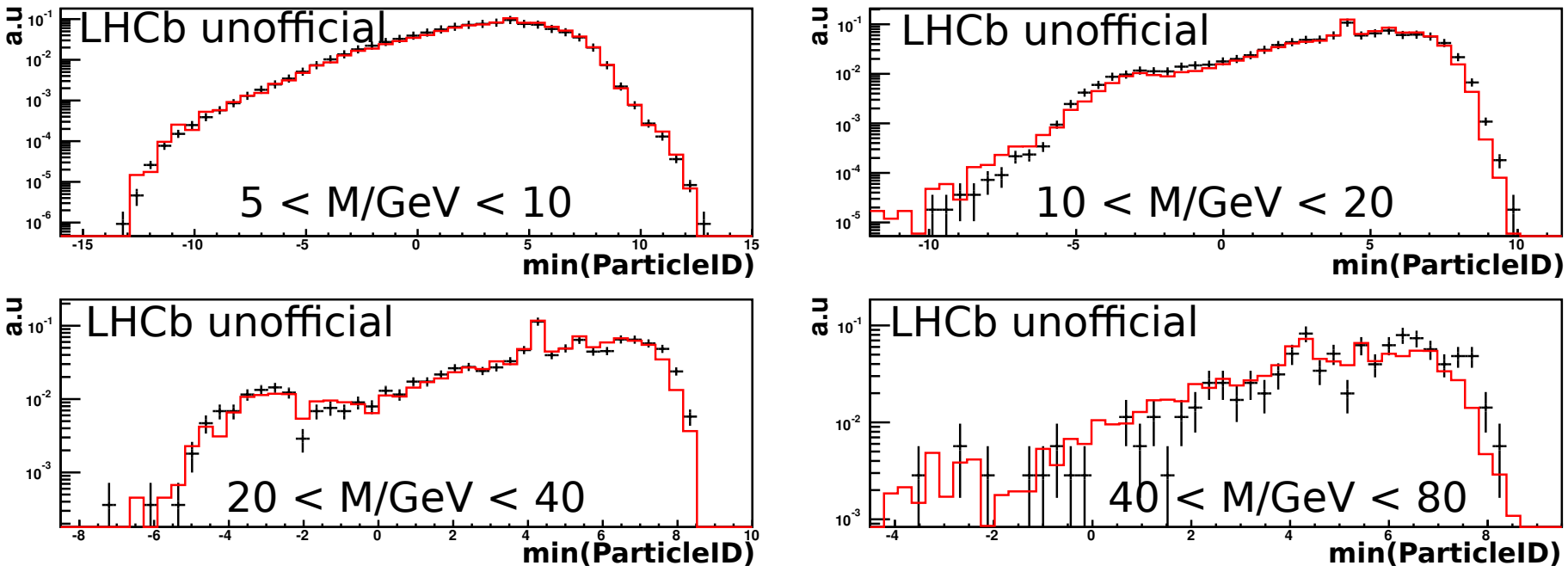


Measured
Signal
MisID
Heavy Quark



Measured
Sum

Using Fractions from Isolation-Fit for ParticleID



ParticleID: log-likelihood for μ vs. π

First Approximate Results

- $\gamma \to \mu\mu$
- bins of invariant mass

5-10 GeV	30443 events at 8.2% purity
10-20 GeV	7770 events at 32.1% purity
20-40 GeV	939 events at 72.5% purity
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(Luminosity: $37\,\mathrm{pb}^{-1}$)

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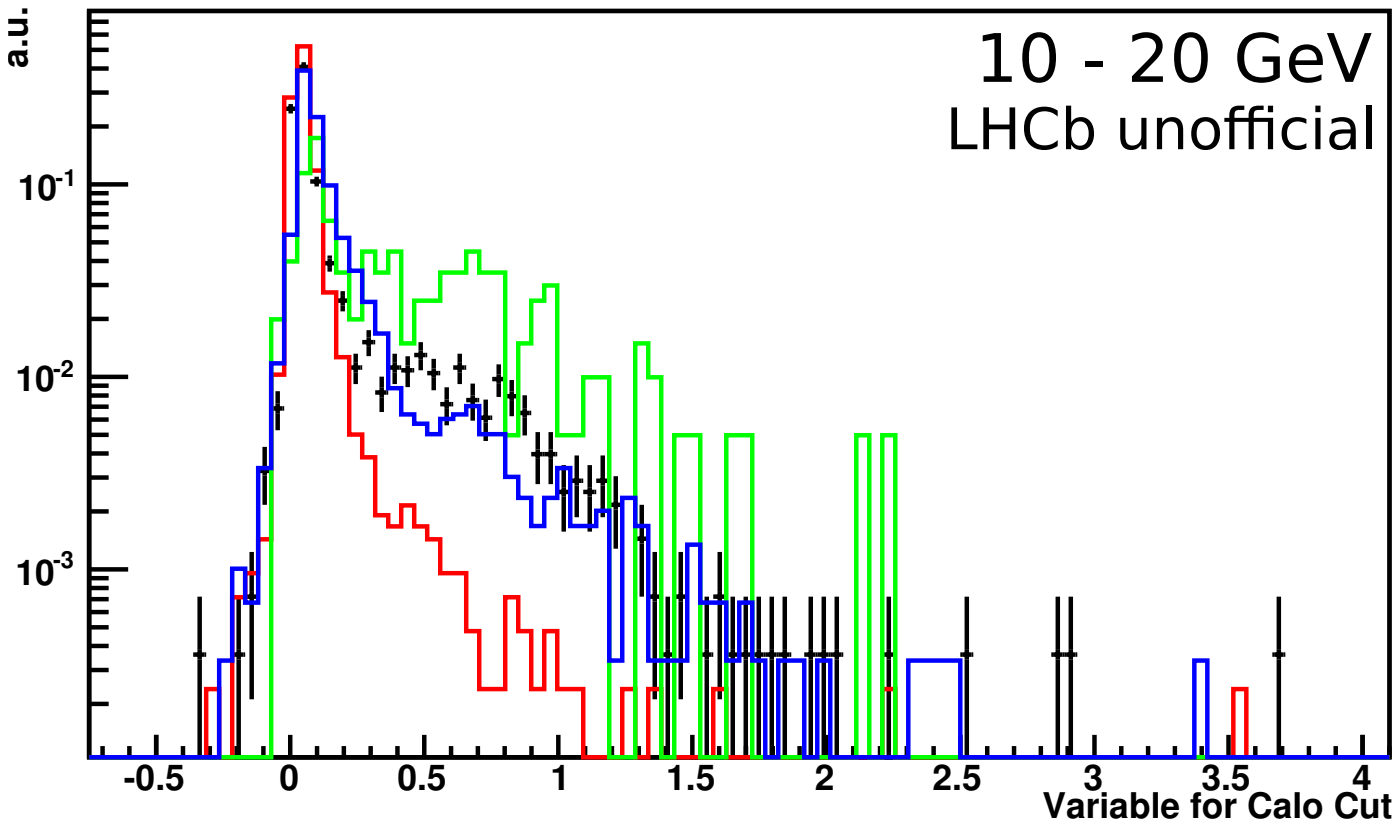
Using Calorimeter Info

punch-through reduced substantially in W and Z analysis
$\Rightarrow$ try for Drell-Yan



Measured
Signal
MisID (SameSign)
Heavy Quark

Stability of Fits

bins	SameSign hqMC	SameSign hqData	MinBias hqMC	MinBias hqData
10	ok	almost	ok	problems
25	ok	almost	problems	problems
30	ok	almost	problems	problems

We were very lucky with the initial settings.

Adding trigger cuts limits the failing fits to lowest mass bin.

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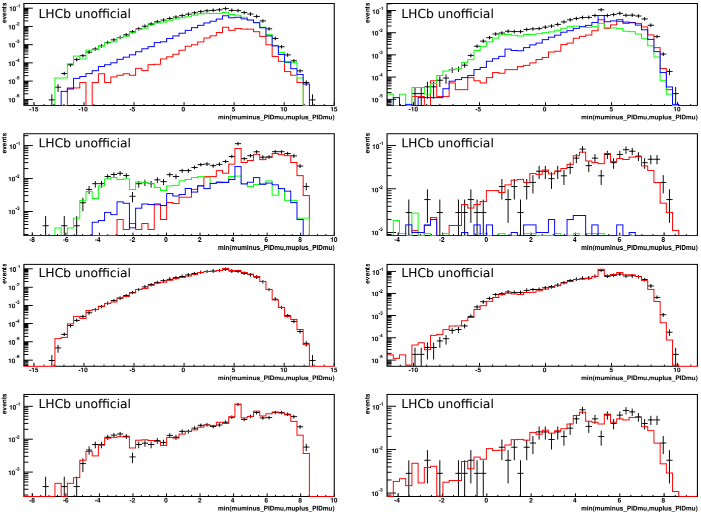
Summary

- LHCb measures Drell-Yan cross sections in unique pseudorapidity range
- provides important input for determination of parton distribution functions at low Bjorken-x
- able to produce first approximate results
- need to investigate several problems further

We hope to have results in the next few months.

Backup


LHCb unofficial
LHCb unofficial
events
min(muminus_PIDmu,muplus_PIDmu)
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