Physics with first LHCb data

Olivier Schneider
on behalf of LHCb
Physics with first LHCb data

- Introduction
  - motivation and physics goals of LHCb
- Preliminary results
  - $K_S$ production cross section (2009 data)
  - $\Lambda/\Lambda$ production ratio (2010 data)
- First exciting look and prospects
  - open charm
  - quarkonium
  - open beauty
  - other beast
- Summary

LHCb detector status and performance given in plenary talk by A. Golutvin (+ F. Maciuc, D. Wiedner, P. Xing)

Details will be given in parallel sessions:

- W. Bonivento: minimum bias
- J. Marks: open charm
- J. Cogan: $J/\psi$ production
- J. Serrano: rare decays with dimuons
- G. Conti: CP violation in B decays
Two approaches to New Physics search

- New Physics (NP) models introduce new particles at the TeV scale or above, which could
  - be produced and observed directly as **real particles** with specific signatures
  - appear as **virtual particles in loop processes**, leading to observable deviations from the pure Standard Model expectations

- TeV scale accessible at LHC:
  - “direct” and “indirect” approaches are complementary and both needed
Strengths of indirect approach

- Can access higher scales and therefore see effect earlier:
  - Third quark family inferred by Kobayashi and Maskawa (1973) to explain small CP violation measured in kaon mixing (1964), but only directly observed in 1977 (b) and 1995 (t)
  - Neutral currents (ν+N→ν+N) discovered in 1973, but real Z discovered in 1983

- Can access the phases of the new couplings:
  - NP at TeV scale needs to have a “flavour structure” to provide the suppression mechanism for already observed FCNC processes → once NP is discovered, it is important to measure this structure (including new phases)

\[ \Delta m_s \neq \Delta m_s^{SM} \propto |V_{ts}^2|, \quad \phi_s \neq \phi_s^{SM} = -\arg(V_{ts}^2) = 2\beta_s \]

\[ \begin{align*}
  B_s \to \phi\phi \text{ decay: “Penguin” diagram} \\
  B_s \to B_s^0 \text{ oscillations: “Box” diagram}
\end{align*} \]
Strategy for indirect NP search

- Measure FCNC transitions where New Physics is more likely to emerge, especially in $b \rightarrow s$ transitions which are less constrained by current data
  
  - Operator Product Expansion:

  \[
  H_{\text{eff}} = -\frac{4G_F}{\sqrt{2}} V_{tb} V_{ts}^* \sum_i \left[ C_i(\mu)O_i(\mu) + C_i'(\mu)O_i'(\mu) \right]
  \]

  - New Physics may
    - modify $C_i^{(\mu)}$ short-distance Wilson coefficients
    - add new long-distance operators $O_i^{(\mu)}$
  
  - e.g. probe helicity structure in $b \rightarrow s\gamma$ and $b \rightarrow s\mu\mu$

- Improve measurement precision of CKM elements
  
  - Compare measurements of same quantity, which may or may not be sensitive to NP
  
  - Extract all CKM angles and sides in many different ways
    - any inconsistency will be a sign of New Physics

Single B decay measurements with NP discovery potential

Precision CKM metrology, including NP-free determinations of CKM angle $\gamma$
Selected key measurements:

- Search for $B_s \rightarrow \mu\mu$
- Mixing-induced CP violation in $B_s \rightarrow J/\psi\phi$, $B_s \rightarrow \phi\phi$, ...
- Charmless 2-body $B$ decays
- CKM angle $\gamma$ from tree-level $B$ decays
- $B_s \rightarrow \phi\gamma$ and other radiative $B$ decays
- Asymmetries in $B^0 \rightarrow K^*\ell^+\ell^-$ decays

Roadmap:

- Main assumptions:
  - 2 fb$^{-1}$ per year ($=10^7$ s), 25 ns bunch crossing
  - $\sqrt{s} = 14$ TeV, $\sigma_{bb} = 500 \mu$b
LHCb detector

VELO: Vertex Locator
TT, T1-3: Tracking stations
RICH1-2: Ring Imaging Cherenkov detectors
ECAL, HCAL: Calorimeters
M1-5: Muon stations

1 cm

Experiment optimized for B physics:
– angular coverage
– efficient trigger for hadronic and leptonic modes
– precision tracking and vertexing (mass, proper time)
– excellent particle identification

\[ \tau_B = 1.5 \text{ ps} \]
Day 1 at 7 TeV

pp collision at 3.5+3.5 TeV, March 30, 2010

Event display, top view
Charged track acceptance

- **7 TeV data (~10M events):**
  - use “micro-bias” trigger: at least one charged track seen in the detector
  - select events with one reconstructed primary vertex (PV)
  - look at raw distribution of charged tracks traversing VELO and tracking stations (i.e. with well measured $p$)
    - illustrative of LHCb acceptance

- **Eventually:**
  - MC will need to be tuned to reproduce minimum bias data (but not crucial for core physics program)
2010–2011 run at 7 TeV

- Beam energy at half of design value
  - bottom and charm production cross sections (from PYTHIA 6.4) divided by ~2
    - no dramatic effect on physics reach
  - Most previous MC predictions assumed $\sigma_{bb} = 0.5$ mb anyway

- Design luminosity for LHCb: $2 \times 10^{32}$ cm$^{-2}$ s$^{-1}$ on average
  - expected to be reached in 2011
  - lower luminosities in 2010 allow for lower trigger thresholds
LHCb trigger scheme

At design luminosity:
- trigger optimized for B physics

At low luminosity in 2010 (up to few $10^{31}$ cm$^{-2}$s$^{-1}$):
- trigger thresholds can be lowered significantly
- large gain in D efficiency
  → great window of opportunity for charm physics!

Inclusive selections:
topological, $\mu$, $\mu$+track, $\mu\mu$, $D \rightarrow X, \phi$

Exclusive selections:
- full detector information available for inclusive and exclusive selections

<table>
<thead>
<tr>
<th>charm</th>
<th>hadr. B</th>
<th>lept. B</th>
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<tbody>
<tr>
<td>nominal L</td>
<td>~ 10%</td>
<td>~ 40%</td>
</tr>
<tr>
<td>low L (2010)</td>
<td>40–50%</td>
<td>75–80%</td>
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Trigger strategy for first data

<table>
<thead>
<tr>
<th>Interaction rate</th>
<th>L0 output rate</th>
<th>HLT1 output rate</th>
<th>HLT2 output rate</th>
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<tbody>
<tr>
<td>&lt; 2 kHz</td>
<td>&lt; 2 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 25 kHz</td>
<td>&lt; 25 kHz</td>
<td>2 kHz</td>
<td></td>
</tr>
<tr>
<td>&lt; 300 kHz</td>
<td>&lt; 300 kHz</td>
<td>10 kHz</td>
<td>2 kHz</td>
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— No real rate reduction at L0, so far (minimum bias trigger + random trigger)
— Running HLT1 in rejection mode since ~2 weeks

$L_{\text{int}} \sim 14 \text{ nb}^{-1}$ recorded so far
First physics and luminosity

First physics results = production measurements!
  — strangeness, charm, bottom, …

Luminosity determination is needed to turn results into cross sections
  — direct methods (measurements of the beam themselves):
    • e.g. beam imaging using beam-gas interactions
      – expect 5–10% precision by end 2010
  — indirect methods (measurements of physics process with known cross section)
    • e.g. quasi-elastic dimuon production via two-photon fusion ($pp \rightarrow pp\mu\mu$)
      – expect ~2% precision by end 2011

Used 2009 pilot run data at $\sqrt{s} = 0.9$ TeV to demonstrate feasibility of absolute cross section measurement:
  — measurement of prompt $K_S$ production cross section with luminosity obtained from beam-gas method

M. Ferro-Luzzi, NIM A 553 (2005) 388
Luminosity with 2009 data

- Luminosity for N pairs of colliding bunches:
  \[ L = f \sum_{i=1}^{N} \frac{n_{1i} n_{2i}}{4\pi \sigma_{xi} \sigma_{yi}} \]

  - some refinement needed to above formula because colliding bunches:
    - may differ in transverse sizes, may collide with an offset, and cross at a small angle

- Idea:
  - get the bunch currents from machine measurements (BCT)
  - measure (with VELO) beam sizes, positions and angles using beam-gas interactions:
Luminosity with 2009 data

- Vertex resolution significant, need to deconvolute
  - example: transverse profiles measured in y for one pair of bunches
    (red = observed, green = resolution, yellow = after deconvolution)

- Measured luminosity for good runs used in $K_S$ analysis:
  \[ L_{\text{int}} (2009) = 6.8 \pm 1.0 \, \mu\text{b}^{-1} \]

Dominated by systematic uncertainties:

<table>
<thead>
<tr>
<th></th>
<th>Currents</th>
<th>Widths</th>
<th>Positions</th>
<th>Angles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12%</td>
<td>5%</td>
<td>3%</td>
<td>1%</td>
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</table>
Reconstruct $K_S \rightarrow \pi^+\pi^-$ pointing back to primary vertex (PV), in bins of $p_T$ and rapidity $y$:
- beam-gas subtracted,
- background-subtracted
- efficiency corrected using MC tuned/reweighted to the data

**DD analysis:**
- use only downstream (D) tracks with hits in TT and T, ignore VELO info
- pseudo-PV determined from $K_S$ direction and beam axis

**LL analysis:**
- use only long (L) tracks with VELO hits
- PV determined from reconstructed tracks

**Statistically most precise analysis:**
- $K_S$ long-lived
- VELO retracted by 15 mm from its nominal closed position (large beam sizes and crossing angle)

Clean and high-resolution signal + extend reach at low $p_T$ and $y$
Prompt $K_S$ production (2009)

Results of both analyses in agreement → take most precise result in each bin

<table>
<thead>
<tr>
<th>Mass resolution (MeV/c²)</th>
<th>DD</th>
<th>LL</th>
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<tbody>
<tr>
<td>~ 9.3</td>
<td></td>
<td></td>
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<tr>
<td>~ 4.0</td>
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<table>
<thead>
<tr>
<th>Total yield in beam-beam</th>
<th>DD</th>
<th>LL</th>
</tr>
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<tbody>
<tr>
<td>4864 ± 84</td>
<td>1196 ± 36</td>
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<thead>
<tr>
<th>Total yield in beam-gas</th>
<th>DD</th>
<th>LL</th>
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<tr>
<td>56 ± 10</td>
<td>15 ± 6</td>
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Main systematics:
- signal extraction
- tracking efficiency
- selection efficiency
- efficiency variation within phase-space bin
- luminosity

2009 data, beam-beam LHCb preliminary

2009 data, beam-gas LHCb preliminary

Physics at LHC 2010, DESY

O. Schneider, June 9, 2010
Prompt $K_S$ production cross section

\[ \frac{d^2\sigma}{dp_T dy} \text{ (mb/(GeV/c))} \]

$2.5 < y < 3.0$

$3.0 < y < 3.5$

$3.5 < y < 4.0$

\[ \sqrt{s} = 0.9 \text{ TeV} \]

LHCb preliminary

Compare with:
- PYTHIA 6 tunings
- earlier measurements

Physics at LHC 2010, DESY

O. Schneider, June 9, 2010
2010 data: zoo expanding rapidly

Many fully reconstructed mass peaks:
- \( \pi^0 \to \gamma\gamma \)
- \( \eta \to \gamma\gamma, \pi^+\pi^-\pi^0 \)
- \( \omega \to \pi^+\pi^-\pi^0 \)
- \( \eta' \to \pi^+\pi^-\gamma \)
- \( K_S \to \pi^+\pi^- \)
- \( K^*0 \to K^-\pi^+ \)
- \( \Lambda \to p\pi^- \)
- \( \Xi^- \to \Lambda\pi^- \)
- \( \Omega^- \to \Lambda K^- \)
- \( \phi \to K^+K^- \)
- \( D^0 \to K^-\pi^+\pi^0, K^-\phi^+ \)
- \( D^+ \to K^-\pi^+\pi^+\pi^- \)
- \( D^+ \to K^-\pi^+\pi^+\pi^- \)
- \( D^+ \to K^-\pi^+\pi^+\pi^- \)
- \( D^+ \to K^-\pi^+\pi^+\pi^- \)
- \( D_s \to K^-K^+\pi^+ \)
- \( \psi(2S) \to \mu^+\mu^- \)
- \( B^{0/+} \to D^{0/+}\pi^-/+ \)

Important for calibration:
- detector
- trigger
- physics

O. Schneider, June 9, 2010
Prompt $\bar{\Lambda}$ and $\Lambda$ production

- Production ratio interesting to study baryon transport:
  - models disagree, but predict dependence vs $\eta$ and vs $\sqrt{s}$
Prompt $\bar{\Lambda}$ and $\Lambda$ production

- Use only long tracks in 2010 data recorded with “microbias” trigger

- $\sqrt{s} = 0.9$ TeV
  - VELO “half closed” (10mm)

- $\sqrt{s} = 7$ TeV
  - VELO closed
Efficiency corrected ratio, in rapidity bins:

At 0.9 TeV:
- ratio low, dropping with $y$
- not reproduced by PYTHIA reference tunes

At 7 TeV:
- ratio larger, ~ flat in $y$
- prediction in fair agreement
Untagged 2-body $D^0$ signal

Check: measurement of $D^0$ lifetime

- make very pure $D^0 \rightarrow K^-\pi^+$ selection ($S/B \sim 22$)
- proper-time distribution with simple exponential
- use only tail, where efficiency is constant
  - $\tau(D^0) = 0.398 \pm 0.026$ ps (6.5% stat. precision)
  - result does not depend on where the fit starts and agrees with the known $D^0$ lifetime of $0.4101 \pm 0.0015$ ps
D⁰ mixing measurements

- Often need flavour-tagged D⁰ decays:
  - reconstruct D⁺ → D⁰π⁺ decay, cut on reconstructed Δm = m(D⁺) – m(D⁰)
  - expect > 10 × BABAR statistics in 0.1 fb⁻¹

- Mixing through lifetime difference:
  \[ y_{CP} = \frac{\tau(D^0 \rightarrow K^-\pi^+)}{\tau(D^0 \rightarrow K^-K^+)} - 1 \]

- CP-violating observable A₆:
  \[ A_6 = \frac{\tau(\bar{D}^0 \rightarrow K^-K^+)}{\tau(D^0 \rightarrow K^-K^+) + \tau(D^0 \rightarrow K^+K^-)} \]

- Time-dependent analysis of wrong-sign tagged D⁰ → Kπ decays:
  - interference between DCS decays and mixing+ CF decays (mixing parameters y’ and x’²)
Search for direct CPV in charm

- Interesting modes are:
  - singly Cabibbo-suppressed decays, where NP may enter in gluonic Penguin
  - 3-body decays, where Dalitz plot analysis allows for many local CP asymmetries to be probed

- $D^+ \rightarrow K^+ K^- \pi^+$ is an excellent candidate:
  - use Cabibbo-favoured $D_s^+ \rightarrow K^+ K^- \pi^+$ and $D^+ \rightarrow K^+ \pi^- \pi^+$ decays as control channels
  - expect several million events in 0.1 fb$^{-1}$
    (an order of magnitude more than B-factory samples)
Studies with $J/\psi \rightarrow \mu^+\mu^-$

- Abundant $J/\psi$ signal = gold mine:
  - data-MC and data-PDG differences
    (in bins of many variables) provide
    many crucial calibration handles, to
    be exploited to improve performance:
    - alignment, tracking studies
    - material effects ($dE/dx$)
    - B-field systematic effects
    - momentum resolution, mass scale
    - lepton identification

- $J/\psi$, $\psi(2S)$, … signals open large parts
  of the physics program:
  - quarkonium production, polarization, spectroscopy, …
  - bottom physics with both incl. and excl. $b \rightarrow J/\psi$ modes
In each bin of J/ψ phase space (p_T and y):

- combined fit to mass and pseudo proper-time t_z allows separation of prompt J/ψ and b → J/ψ components

\[ t_z = (z_{J/\psi} - z_{PV}) \frac{m_{J/\psi}}{p_{z,J/\psi}} \]

Extract differential production cross sections:

- prompt J/ψ very interesting in its own right:
  - colour-octet model predicts well cross sections seen at Tevatron, but not polarisation
- make first measurement of b → J/ψ production:
  - important for initial tuning of b spectrum in LHCb Monte Carlo

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O. Schneider, June 9, 2010
Asymmetric distribution with clear long-lived signal from $b$-hadron decays
In each $p_T$ or $y$ bin, $J/\psi$ yield extracted from mass distribution
— shown before any correction (e.g. efficiency correction)
— spectrum contains prompt $J/\psi$ and $b \to J/\psi$

$2.5 < y < 4.0$

$0 < J/\psi$ Transverse Momentum (MeV/c) $< 12$ GeV/c

— above is illustrative of the capability, measurement expected soon
Looking for b hadrons: D\(^0\) IP

- Select D\(^0\) → K\(^-\)π\(^+\)
  - minimum bias sample
  - two PIDed tracks with min. IP forming good vertex

- Fit sideband-subtracted D\(^0\) IP distribution:
  - free double bifurcated Gaussian for prompt component
  - MC shape for B→D component

- Yields:
  - 15’827 ± 262 prompt D\(^0\)
  - 1’331 ± 354 secondary D\(^0\)

Largest b-hadron signal so far!
Form right-sign $D^0\mu^-$ combinations:
- fit $D^0$ IP distribution:
  - $14.0 \pm 1.9$ non $D^0$ background (shape from $D^0$ mass sideband)
  - $16.2 \pm 5.7$ prompt $D^0$ (shape from data)
- $85.3 \pm 10.6 \ B \to D^0\mu^-\nu X$ (shape from MC)

Clean  $8\sigma$ signal
wrong-sign $D^0\mu^+$

- Form wrong-sign $D^0\mu^+$ combinations:
  - fit $D^0$ IP distribution:
    - $10.2 \pm 1.5$ non $D^0$ background (from $D^0$ mass sideband)
    - $16.7 \pm 4.9$ prompt $D^0$ (shape from data)
    - $0 \pm 1.1$ non prompt $D^0$ (shape from MC)
  - **No signal**

Physics at LHC 2010, DESY

O. Schneider, June 9, 2010
Semileptonic B decays

- Large branching fraction, suitable for early cross section measurement:
  - with 100 nb⁻¹, expect 2.8k B → D⁰μ⁻νX signal events with good purity
  - measurement complementary to b→J/ψ result

- B_d → D⁻μ⁺ν and B_s → D_s⁻μ⁺ν decays useful for:
  - B_d and B_s oscillations (Δm_d and Δm_s), flavour tagging studies and calibration
  - CP violation in B_d and B_s mixing:
    - measurement of ΔA_{fs} = (a_{fs}(B_s)–a_{fs}(B_d))/2 where detector asymmetry will be drop out if D⁻ and D_s⁻ to same K⁺K⁻π⁻ final state
    - will provide constraint “orthogonal” to recent D0 measurement of A_{sl}^b = (a_{fs}(B_s)+a_{fs}(B_d))/2
    - expect statistical precision on ΔA_{fs} of 2 × 10⁻³ (similar to that of D0 on A_{sl}^b) from MC study assuming 0.1 fb⁻¹ and σ_{bb} = 500 μb
First B candidate seen in LHCb!

\[ B^+ \rightarrow J/\psi \ K^+ \]

\[ J/\psi \rightarrow \mu^+ \mu^- \]
B^+ \rightarrow J/\psi \ K^+ \ candidate

All observables far from cut values defined before data-taking

Tracks from primary vertex (PV), refitted through PV

Primary vertex

B decay vertex

J/\psi

K^+

\mu^+

\mu^−
Exclusive $B \rightarrow J/\psi X$ selections

- $B^+ \rightarrow J/\psi K^+$
- $B^0 \rightarrow J/\psi K^{*0}$
- $B_s \rightarrow J/\psi \phi$

$\sqrt{s} = 7$ TeV Data

$(J/\psi$ mass constraint applied $) \sim 13 \text{ nb}^{-1}$
Mixing-induced CPV in $B_s \rightarrow J/\psi\phi$

- Golden mode $B_s \rightarrow J/\psi\phi$ is strange counterpart of $B^0 \rightarrow J/\psi K^0$
  - Phase $2\beta_s$ can be accessed with $B_s \rightarrow J/\psi\phi$ in the same way as $2\beta$ with $B^0 \rightarrow J/\psi K^0$
- Phase $2\beta_s$ small in SM, hence very sensitive to NP contributions:
  - $2\beta_s = 0.036 \pm 0.002$ rad (SM)
  - Some NP models predict large phase $\phi_s(J/\psi\phi) \neq -2\beta_s$
- LHCb expectation:
  - With 1 fb$^{-1}$ and full time and angular analysis of flavour-tagged $B_s \rightarrow J/\psi\phi$ decays:
    $$\sigma(\phi_s(J/\psi\phi)) \sim 0.07$$
  - Pure CP modes can be added, e.g. $B_s \rightarrow J/\psi f_0(980)$, $f_0(980) \rightarrow \pi^+\pi^-$
First signal combining two modes:
- $B^0 \rightarrow D^+ \pi^-$
- $B^+ \rightarrow D^0 \pi^+$

Expect soon:
- $B_s \rightarrow D_s \pi^-$
- $B \rightarrow DK$ Cabibbo-suppressed modes

Main physics goal:
- «New Physics free» determination of CKM angle $\gamma$ using interference between $b \rightarrow c$ and $b \rightarrow u$ tree-level diagrams in $B_{(s)} \rightarrow D_{(s)} K$
- combined precision expected with 1 fb$^{-1}$:

$$\sigma(\gamma) \sim 7 \text{ degrees}$$
B_s \rightarrow \mu \mu

- **Very rare loop decays, helicity suppressed**
  - Standard Model BR = (3.35\pm0.32)\times10^{-9}
  - Can be strongly enhanced in many NP models, e.g. MSSM with large $\tan\beta$

- **Easy to trigger and reconstruct:**
  - checks performed with J/ψ → μ⁺μ⁻ signal

- **But main issue is background rejection ...**
Quoted sensitivity relies on MC

- MC compared with data where possible:
  - muon misID checked with true pions and protons from $K_S$ and $\Lambda$
  - dimuon combinatorial checked with background in $J/\psi \rightarrow \mu^+\mu^-$ selection
  - mass resolutions studied with available mass peaks
  - separation power of geometrical variables (e.g. IP significance) checked with 2-body $K_S$ and $D^0$ decays

- All checks performed so far indicate that sensitivity obtained from MC is realistic

\[ B_S \rightarrow \mu\mu \]

Exclusion limit at 90% CL for $\sqrt{s} = 7$ TeV

- 0.1 fb$^{-1}$ ⇒ improve on current Tevatron limit
- 1 fb$^{-1}$ ⇒ exclude BR values down to $7 \times 10^{-9}$
  or observe 5σ signal with BR = 3.5 × SM

(Need 10 fb$^{-1}$ at 14 TeV for 5σ observation of SM signal)
Electroweak boson production

- **LHCb coverage:**
  - interesting pseudo-rapidity region where $W^+/W^-$ ratio varies rapidly
  - small $y$ overlap with ATLAS/CMS
  - unique area of $(Q^2, x)$ plane

- **Measurements of interest:**
  - $Z^0/W^\pm$ ratio
    - precisely predicted (< 1%)
    - should aim at 1% measurement with 0.1 fb$^{-1}$ → test SM
  - $W^+/W^-$ ratio
    - sensitive to $u/d$ ratio
  - $W, Z$ production cross sections
    - can constrain PDFs, down to $\sim6\times10^{-4}$ at $\sqrt{s} = 7$ TeV

O. Schneider, June 9, 2010
Selection:

- good track ($\chi^2$, $\sigma_p/p$, …) identified as muon
- $p_T > 30 \text{ GeV/c}$ and $A_{pT} > 0.8$

$$A_{pT} = \frac{p_T - p_T^{\text{rest}}}{p_T + p_T^{\text{rest}}}$$

$p_T^{\text{rest}}$ = transverse momentum of vector sum of all charged tracks, excluding the selected track

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**MC, $W \rightarrow \mu \nu$ signal**

**Data, ~14 nb$^{-1}$**

4 candidates

**Data, ~8 nb$^{-1}$, without muID cut**
$W^+ \rightarrow \mu^+\nu$ candidate

$\eta = 2.51$

$p_T = 35.4$ GeV/c

$A_{pT} = 0.92$

- **z–φ view**
- **standard 3D view**

**ECAL**

**HCAL**

**muon chambers**
LHCb will deploy its core physics within next year with the first fb⁻¹:
- Lower $\sqrt{s}$ for 2010–2011 run not a big penalty
- At low luminosity, take opportunity to give more trigger bandwidth to charm

Initial production measurements:
- Absolute $K_S$ production cross section at 0.9 TeV
- $\bar{\Lambda}/\Lambda$ production ratio at 0.9 and 7 TeV
- very soon:
  - prompt $J/\psi$, $b \rightarrow J/\psi$, $B \rightarrow D^0\mu X$
  - charm and bottom hadrons in fully reconstructed modes

Indirect New Physics searches at LHCb:
- several highly-sensitive physics observables in B and D sectors, accessible with data from 2010–2011 run
- active preparation using existing calibration/control signals while looking forward to more statistics!