



Measurement of V^0 **production ratios in pp collisions at** $\sqrt{s} = 0.9$ **and 7TeV**

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on behalf of LHCb collaboration

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Paper to be submitted very soon to JHEP, today still preliminary results.

- Motivation
- Detector and data samples
- Analysis procedure
- Results
- Summary







- Strange quark production powerful probe for hadronisation processes at pp colliders;
- **D** Large number of $\Lambda \to p\pi^-$, $\bar{\Lambda} \to \bar{p}\pi^+$, $K_s^0 \to \pi^+\pi^-$ available.
- The ratio $\overline{\Lambda}/\Lambda$ allows the study of the transport of baryon number from pp collisions to final state hadrons and the ratio $\overline{\Lambda}/K_S^0$ is a measure of baryon-to-meson suppression in strange quark hadronisation - bins of p_T and y.



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LHCb detector



- Look for New Physics through precise measurements of CP violation and rare decays in the b-sector.
 - Forward single arm spectrometer - large and correlated bb quark production in the forward region.
- Coverage: 15-300(250) mrad





LHCb detector





The analysis presented relies exclusively on the tracking detectors.



Pseudorapidity range (Pfl) ÉCOLE POLYTECHNIQUE ÉÉDÉRALE DE LAUSANNE

LHCb important contribution in the forward region where production models were extrapolated not only in energy but also in rapidity.



LHCb fully instrumented in the forward region: tracking, ECAL, HCAL, counters lumi, muon, hadron PID







- Data sets at two collision energies $\sqrt{s} = 0.9$ TeV and $\sqrt{s} = 7$ TeV, with both polarities of the dipole magnet.
- **O**.3 nb⁻¹ $\sqrt{s} = 0.9$ TeV 48% "UP" polarity, 1.8 nb⁻¹ at $\sqrt{s} = 7$ TeV, 67% field "UP".
- At 0.9 TeV to protect the detector, the two halves of the VELO were retracted along the x axis; reduction of the detector acceptance - about 0.5 units of y.
- MB trigger more than 99% efficient for events with at least two tracks reconstructed through the full tracking system







Combinatorial background is reduced with a Fisher discriminant:

 $F_{IP} = a \log_{10}(d_{IP}^+/1mm) + b \log_{10}(d_{IP}^-/1mm) + c \log_{10}(V_{IP}^0/1mm)$

optimised for significance $S/\sqrt{S+B}$. FIP > 1, a = b = -c = 1

• $\Lambda(\bar{\Lambda}) \pm 4.5 MeV/c^2$ veto around the PDG K_S^0 mass after re-calculation of each candidate's invariant mass with $\pi^+\pi^-$ hypothesis.







 V^0 yields from fits to the invariant mass distributions (double Gaussian signal peak over a linear background).





Significant differences between kinematic distributions in data and MC. MC V^0 candidates are

weighted to match the (p_T, y) distributions in data





E Efficiency estimated from simulation for prompt V^0

$$\epsilon = \frac{N(V^0 \to d^+ d^-)_{Observed}}{N(pp \to V^0 X)_{Generated}}$$

Prompt V^0 defined in MC taking in to account the lifetimes of their ancestors

$$\sum_{i=1}^{n} c\tau_i < 10^{-9} \mathrm{m}$$

- Solution F_{IP} favours prompt V^0 , the non-prompt contamination, from the simulation: 2-6% Λ and $\overline{\Lambda}$ and 1% for K_S^0 . Corrections to the ratios of order 1%.
- The V⁰ production ratios measured independently for each magnetic field polarity, obtaining consistent results. The field "UP" and "Down" results are combined to maximise statistical significance.





Sources of systematic uncertainty	$ar{\Lambda}/\Lambda$	$ar{\Lambda}/K_S^0$
Correlated between field Up and Down:		
Material interactions	0.02	0.02
Diffractive event fraction	0.01 - 0.02	0.01 - 0.02
Primary vertex finding	< 0.02	< 0.01
Non-prompt fraction	< 0.01	< 0.01
Track finding	negligible	0.01
Uncorrelated:		
Kinematic correction	0.01 - 0.05	< 0.03
Signal extraction from fit	0.001	0.001
Total	0.02 - 0.06	0.02 - 0.03





- Due to the primary vertex requirement, only ~ 3% of the selected V⁰ are produced in diffractive events (PYTHIA 6 and PYTHIA 8).
- Complete removal of diffractive events only produces a change of 0.01-0.02 in the ratios across the measurement range.
- Minimal requirements for PV reconstruction can be approximated in MC by requiring at least 3 charged particles from the collision with lifetime $c\tau > 10^{-6}$ mm, momentum p > 0.3 GeV/*c*, polar angle 15 < θ [mrad] < 460.









Strong p_T dependence of the ratio Λ/K_s^0 .







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 $\Delta y = y_{beam} - y$

Excellent agreement between the two energies and STAR result.

R. Mureşan, V^{0} ratios – p.15/16







- Transport of baryon number measured using Λ/Λ. Good agreement with Perugia 0 at low rapidity. At high rapidity, results favour Perugia NOCR.
- The ratio $\overline{\Lambda}/K_S^0$ is significantly larger at LHCb than predicted by MC, particularly at high p_T .
- Excellent agreement between LHCb's results at both energies and with STAR's results. The broad coverage of LHCb's results in Δy provides a unique data set, complementary to previous measurements.
- LHCb's ratios are consistent with results published by ALICE and CMS.