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HYPERON Ω PRODUCTION IN *pp* COLLISIONS AT ENERGY 8 TeV

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Abstract. *Because strange quark produced copiously in pp collisions, strange hyperon production is one of the ideal tools to investigate the hadronization process and baryon transport theory. We are especially interested in the hyperon Ω production because this baryon contents only strange quark. Our new studies of the pure strange hyperon Ω produced in pp collision at* $\sqrt{s} = 8$ *TeV are shown in this report. The following strategy is used to reconstruct the strange hyperon Ω. In the LHCb experiment, the hadrons p, π and K are identified by the RICH detector with* P_T *threshold* > 100 *MeV. Only Lambda particles (from channel* $\Lambda \to p + \pi$*) with* $P_T > 500$ *MeV are chosen to combine with kaon daughter particle in order to reconstruct a strange hyperon Ω. The reconstructed particles are accepted as Ω candidates in the case it satisfies several criteria such as its invariance mass must be located within the window mass* ± 50 *MeV/c*^{2} *around the nominal value. More than 63 millions selected events are used for this analysis and about 8100 hyperon Ω candidates are reconstructed.*

Keywords: Hyperon Ω, strange production.

Classification numbers: 29.85.Fj.

I. INTRODUCTION

Besides main study purpose about B physics of LHCb experiment, strange quark production also is an interest subject because it allows to verify the process happening in the collision. The measurements of hyperons productions or of the anti-hyperons to hyperons ratio can be used to constrain theories, particularly the transport of baryon number from *pp* collisions to final state. The LHCb experiment has great advantage to be can detect in the large rapidity region where the differences between the fragmentation models reveal themselves [1], whereas general purpose experiments like CMS and ATLAS are covering the central region $|y| \leq 2$. In this paper, we report on the measurement of the production of Ω particles; the Ω's are pure strange particle decaying into Λ and K. These new results are reconstructed from full real compacted data at energy 8 TeV.

II. APPARATUS

The LHCb detector [2] is a single arm forward spectrometer located on the Large Hadron Collider (LHC) at CERN. The angular acceptance is $10-300$ mrad in the $x-z$ plane, $10-250$ mrad in the $y-z$ plan and rapidity range $1.9 < y < 4.9$. The detector, as shown in Fig. 1, is composed of sub-detectors and each type has a specific purpose.

The tracking system consists of the VELO surrounding the pp interaction region, an upstream tracking station (TT), and three downstream tracking stations (T1 to T3). The dipole magnet whose bending power is 3.7 T.m on average. The VELO consists of 21 silicon micro-strip modules providing the measurement of the radial r an azimuthal ϕ coordinates. The TT stations also use the micro-strip technology with vertical and stereo strips at $\pm 5^o$ with respect to the vertical. The three tracking stations behind the magnet have silicon micro-strip detectors in the region close to the beam (the Inner Tracker (IT) region) and straw drift tubes in the outer region (the Outer Tracker (OT) region). The momentum resolution increases from δp/p = 0.35% at low momenta to $\delta p/p = 0.55\%$ for 120 GeV/c tracks.

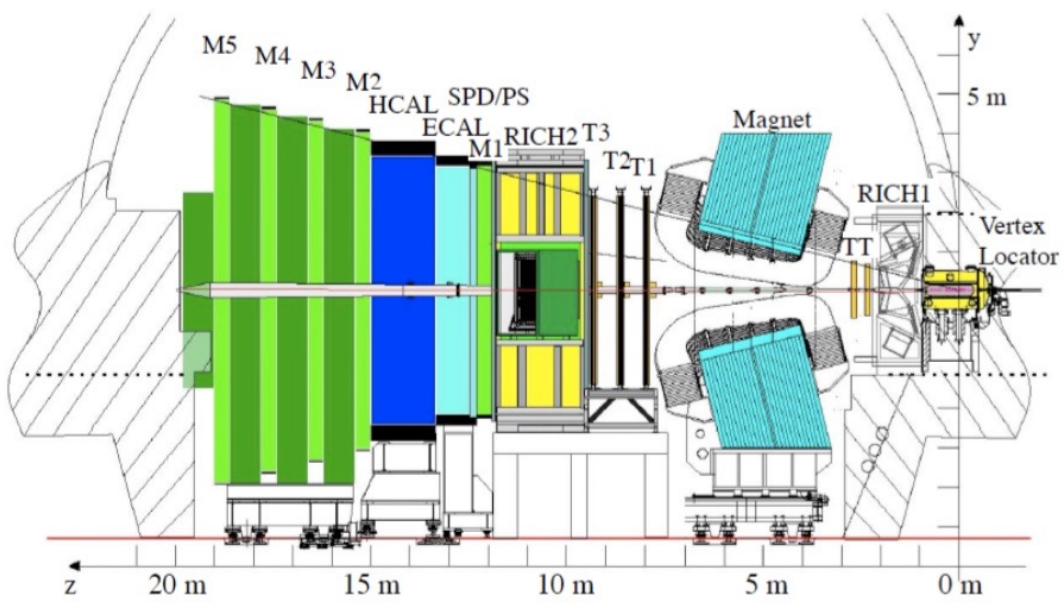


Fig. 1. Layout of the LHCb spectrometer [3].

Non electromagnetic particles are identified using Ring Imaging Cherenkov counters RICH1 and RICH2. The calorimeters (ECAL, HCAL) are designed to absorb electrons, photons and hadrons. They provide energy and position measurements of particles that allow to compute the transverse energy (E_T) of particles that is used in the first level trigger (L0) to select the event of high transverse energy (E_T). In addition, the calorimeters also contribute to the identification of electrons, photons against hadrons.

III. ANALYSIS AND RESULTS

The baryon Ω's are pure strange hyperon particle (compose three strange quark), so they are selected to search. Moreover, these baryons decay into Λ and K in the following main channel $\Omega \to \Lambda + K$ (67.8%) and subsequently 63.9% of its lambda daughter decays into p and π ($\Lambda \to p + \pi$) (Fig. 2). Two decay channels seem not related to each other, but in fact, they only are "one decay channel" of strange quark $s \to u + W^-$. Hence, the Ω are reconstructed from these two decay channels.

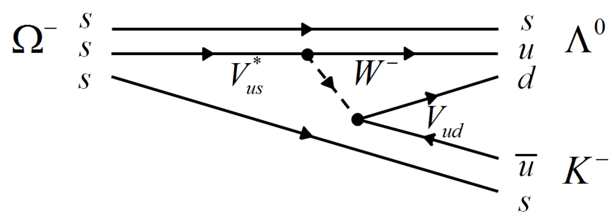


Fig. 2. Quark transition $s \to u + W^-$, $W^- \to \bar{u} + d$ in hyperon Ω decay.

First of all, Λ particles are reconstructed from their decays $\Lambda \to p + \pi$. In order to reconstruct the precise Λ decay vertices, we require the daughters' tracks to be of good quality ($\chi^2_{track}/ndof < 3$) and their tracks don't point to the primary vertex: their impart parameter with respect to the primary vertex (χ^2_{IP}) is required to be larger than 9 for "long-long" proton and pion tracks and larger than 4 for "down-down" tracks to ensure this condition. All tracks must satisfy ProbNNghost < 0.5 to reject ghost track that contribute almost in background under peak. The transverse momentum P_T is required to be above 500 MeV/c for Lambda and proton. Each particle must be identified by the RICH and the likelihood separation $\mathrm{DLL}_{p\pi} > 1$ and $\mathrm{DLL}_{pK} > -1$ are applied for pion and proton. Then, the Λ candidates are accepted in the case their invariant mass is compatible with the one in the mass window of 6 MeV/c^2 around its PDG value. The reconstructed Λ vertices must also be of good quality $\chi^2_{vtx}(\Lambda) < 15$. The direct momentum of the Λ particles also are required not point to the primary vertex with a condition $\min \chi^2_{IP}(\Lambda) > 0.15$.

For a good reconstruction of the Ω candidates, the reconstructed Ω vertices must be of good quality; given the fact that this vertex is obtained by extrapolating the momentum of a neutral particle (the Λ) we demand that the $\chi^2_{vtx}$of the reconstructed Ω to be less than 25. As the directions of the Ω and of the Λ are close, the cosine of their angle must be larger than 0.9996. The separation between the Λvertex and the primary vertex must be above 10σ, the one between the Ω vertex and the primary vertex must be above 2σ.

At the end, in order to select the prompt Ω (Ω come from interaction point), two cuts are applied: one is the cosine of the angle between the Ω momentum and its flight path to be applied, requiring that this cosine be larger than 0.9999 and the other one is fisher discriminant $IP > 0.2$ [4]. The mass, phase-space coverage and $\cos\theta$ distributions are shown in figures 3 and 4.

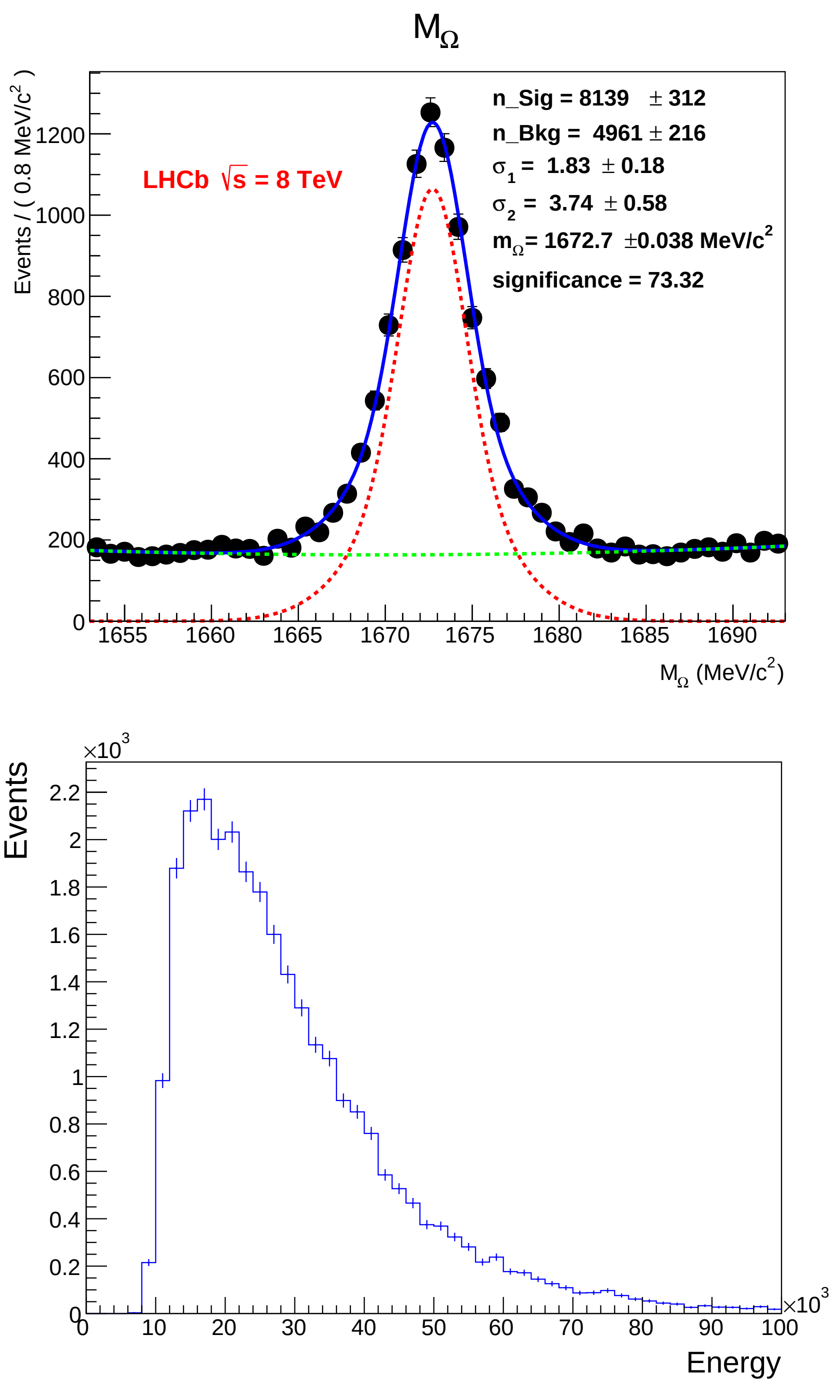
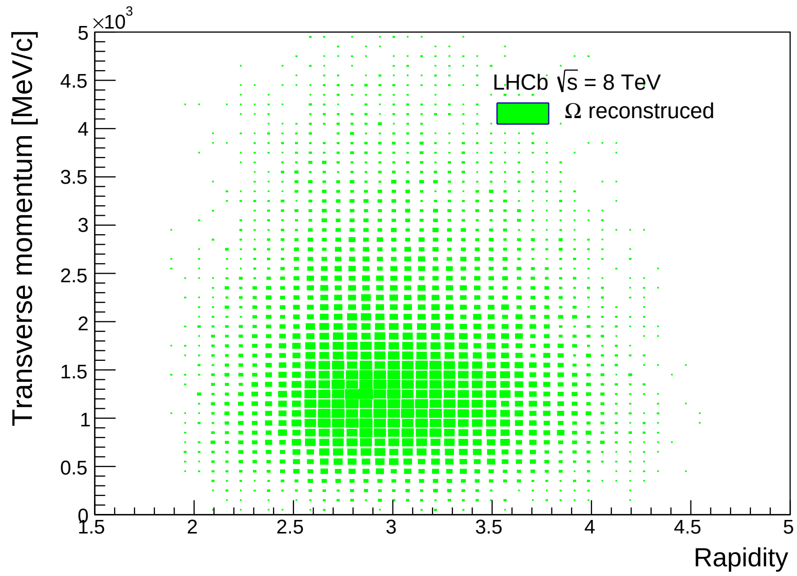


Fig. 3. Total number of Ω obtained in this analysis, mass (above) and energy distributions (bottom).



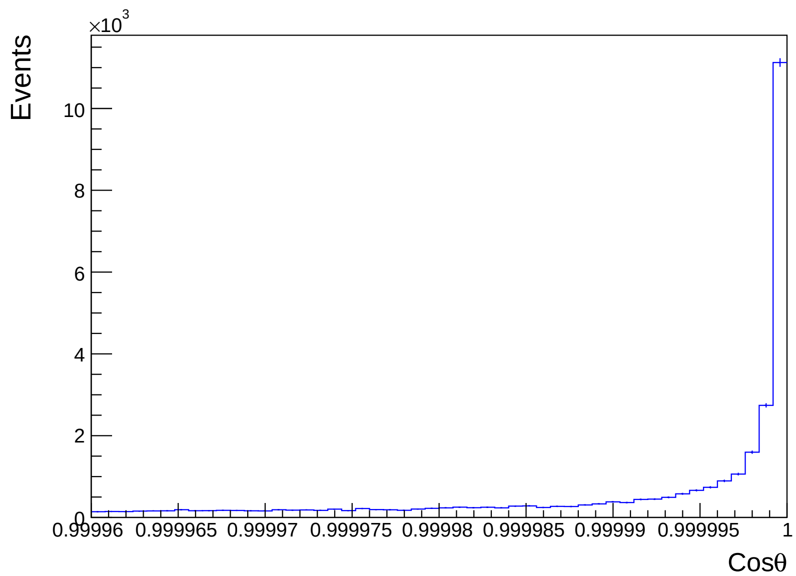


Fig. 4. Total number of Ω obtained in this analysis, phase-space coverage distribution (above) and $\cos\theta$ distributions (bottom).

With 63.4 million events have been analyzed from Stripping data 20, we have obtained about 8 thousands yield Ω particles. This criteria selection is estimated an optimal analysis condition to maximize the signal significance and minimize background. Some candidates of pure strange hyperon Ω are shown in Table 1. In the near future, we have intention to combine our results at energy 7 and 8 TeV.

Table 1. Candidates strange hyperon Ω.

Mass (GeV)	P_T (GeV)	Rapidity	$\cos\theta$
1646.41	1032.65	2.13339	1
1670.86	1784.1	3.26185	0.999999
1671.86	2485.63	2.95552	0.999998
1659.77	567.25	3.19615	0.999998
1671.82	2120.76	3.3513	0.999996
1661.38	776.208	3.25462	0.999994
1670.51	1616.24	2.8229	0.999993
1654.15	1622.14	3.48801	0.999992
1669.45	991.09	2.93126	0.999977
1713.83	946.904	3.1402	0.999961

IV. CONCLUSIONS

We have presented some preliminary physics results using the data Stripping 20 at energy collision in the center of mass $\sqrt{s} = 8$ TeV. The efficiency of cuts (mass; transverse momentum; significant impact parameters) has been studied. In the next step, we intend to measure the inclusive production cross sections of these strange hadrons.

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