Strangeness production in pp collisions at $\sqrt{s} = 13$ TeV measured with ALICE

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**PHYSICS MOTIVATION**

- Strange hadrons are useful probes to investigate particle production mechanisms in high-energy collisions. Since there is no net strangeness content in the colliding system, all particles with non-zero strangeness quantum number are created in the course of the collision.
- In the context of the strangeness enhancement (J. Rafelski and B. Muller, PRL 48, 1068 [1982]; P. Koch, J. Rafelski and W. Greiner, PLB 133, 151 [1984]), the study of the excitation function for strange and especially multi-strange particles is of particular interest.
- A recent study of the strangeness production in pp collisions at $\sqrt{s} = 7$ TeV as a function of multiplicity reveals the importance of such measurements in understanding changes in production mechanisms and in understanding the larger colliding systems.
- A further interesting observable to be investigated at this energy is the baryon/meson ratio of $\Lambda K_S^0$ to study the baryon/meson anomaly.

**IDENTIFICATION OF STRANGE PARTICLES IN ALICE**

We measure the strange hadrons ($K^0_S, \Lambda, \Sigma^+$ and $\Omega^-$) and their anti-particles, which are identified in ALICE via the detection of their weak decay products. The $K^0_S$ and $\bar{K}^0_S$ are characterized by a distinctive V-shaped decay topology and are known as V0 while the $\Sigma^+$ or $\bar{\Sigma}^-$ decay into a charged meson and a $\Lambda$, which further decays into a proton and a pion. Since the reconstruction of a $\Sigma^+$ and $\Omega^-$ requires the detection of the three charged daughter tracks, these are known as cascades.

The V0 finding procedure consists of the following steps:

1. charged tracks reconstructed using the ITS and TPC and having a large impact parameter (IP) to the primary vertex are selected as candidate decay daughter (daughter ‘secondary’ tracks)
2. all these tracks are combined with other secondary tracks having opposite charge
3. selections based on topological variables, such as distance of closest approach (DCA) between the two tracks, fiducial volume for the secondary vertex position and cosine of pointing angle (PA) are applied (pictorial representation in Figure 1)

The cascade finding procedure consists in:

1. looking for all V0 candidates that has a large impact parameter with respect to the primary vertex, point to the cascade decay vertex and has a reconstructed mass within a region around the PDG mass value
2. combining these V0 candidates with all possible secondary tracks (bachelor candidates) using TPC RD
3. applying selections based on topological variables are applied impact parameter of the bachelor, distance of closest approach between V0 mother trajectory and the bachelor and cosine of pointing angle

**DATA TAKING AND PERFORMANCE**

The following results have been obtained using the first data collected by ALICE in pp collisions at $\sqrt{s} = 13$ TeV delivered by LHC at the beginning of June 2015. Data were collected requiring a hit in the SPD or in one of the two V0 scintillators. Events with the following characteristics have been selected:

- vertex reconstructed not only using the TPC but also the SPD
- reconstructed vertex no more than 10 cm away from the center of ALICE in the $z$ direction
- no pile up present based on the SPD
- About 55x10^7 events have been analyzed, resulting in 49x10^8 events after all the selections.

Special extraction and MC data sample generation

To ensure tracks used for secondary vertex determination are of sufficient quality, the following set of track selections has been applied:

- tracks whose parameters have been successfully determined in all steps of the reconstruction procedure based on a Kalman Filter algorithm
- tracks that have been reconstructed using information from at least 70 clusters in the TPC (out of a maximum possible value of 158)
- IP rejection $\Delta R > 0.1$.

In both cases (V0 and cascade) the selection cuts are optimized in a second step to improve the signal over background ratios. The adopted values for cut on the topological variables are reported in Table 1.

The invariant-mass distributions shown in Figure 2 are integrated in the full measured transverse momentum range and in rapidity range $|y| < 0.5$. The values of S/B and significance, estimated fitting the invariant mass distribution with a Gaussian plus a first degree polynomial function, are reported in Table 2.

For the acceptance-efficiency factor calculation a production using the Monte Carlo (MC) Event generator PYTHIA6 (tune Perugia-2011) has been considered for the V0 in the case of multi-strange baryons, due to low yields, special MC productions have been generated reconstructing only events that contain at least one cascade in order to use computing resources more efficiently. All the simulated events are propagated through full ALICE geometry with the GEANT3 transport code.

**Table 1**

<table>
<thead>
<tr>
<th>$K^0_S$</th>
<th>$\Lambda$</th>
<th>$\Sigma^+$</th>
<th>$\Omega^-$</th>
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</thead>
<tbody>
<tr>
<td>$p_T$ (MeV/c)</td>
<td>0.15</td>
<td>0.10</td>
<td>0.05</td>
</tr>
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<td>$E$ (GeV)</td>
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<td>0.10</td>
<td>0.15</td>
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**Table 2**

<table>
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**Outlook**

- Measure the transverse momentum spectra with statistical error in the bins containing lowest number of entries not greater than 5%
- Extract the yields and compare to the lower energy collision measurements to study their excitation function
- Compare the $p_T$ shape of the spectra and the yields to predictions of MC event generators inspired on perturbative QCD, such as PYTHIA6.