Production of electrons from heavy-flavour hadron decays in pp collisions at $\sqrt{s} = 13$ TeV as a function of charged-particle multiplicity with ALICE

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Motivation
- High-multiplicity pp collisions at the LHC exhibit features resembling those seen in relativistic heavy-ion collisions and point to the need for revisiting the prevailing models of the particle production mechanism in pp collisions.
- The study of the multiplicity dependence of heavy-flavour production in pp collisions provides insight into their production mechanism and into the interplay between hard and soft processes in particle production.
- In addition, at the LHC energies, multiple parton interactions also plays a significant role in the heavy-flavour production.

ALICE detectors
- Detectors used for electron identification in low and intermediate transverse momentum range ($0.5 < p_T < 4.5$ GeV/c).
- Tracking and particle identification (PID), vertexing
- Silicon Pixel Detector (SPD) - Multiplicity measurement
- V0 detector: Triggering and multiplicity measurement

Total number of events analyzed: $\sim 155$ M minimum-bias pp collisions at $\sqrt{s} = 13$ TeV

Inclusive electron identification
- The charged-particle identification (PID) in the TPC is based on the specific energy loss measurement, $dE/dx$, of a particle in the gas detector while the TOF detector uses its time of flight. The electron sample is selected within the optimized TOF PID cut ($|\eta| < 3$ and TPC PID cut $1 < n_{\text{tracklet}} < 3$) to remove the hadron contamination from the sample, where $s$ is the difference of the measured signal in the detector from the expected value for electrons.

Photonic background subtraction
- The photonic background electrons which mainly come from the Dalitz decay of light neutral mesons ($\pi^0$ and $\gamma$) and $\gamma$ conversions in the detector material, are subtracted from the inclusive electron sample using the photonic electronic tagging method.
- To identify electrons from photonic sources ($N_{\text{photonic}}$), opposite signed partners ($e^+ - e^-$) are paired in an invariant mass spectrum. The like sign (LS) pairs are used to estimate and subtract the random combinatorial background from the unlike sign pairs (ULS),

$$N_{\text{photonic}} = N_{\text{ULS}} - N_{\text{LS}}$$

where $\epsilon_{\text{tag}}$ is the photonic electron tagging efficiency obtained from MC simulations.

Multiplicity estimation
- Multiplicity estimator - Silicon Pixel Detector (SPD) tracklets within $|\eta| < 1 (N_{\text{tracklet}})$
- The number of SPD tracklets $< 1$ depends on the $Z$ vertex due to:
  - Inhomogeneous acceptance and dead modules of SPD
  - Changes in the number of active modules in the SPD versus each data taking period
- To obtain the true SPD tracklet number ($N_{\text{tracklet}}$) the SPD efficiency was equalized along the $Z$ vertex for each event by scaling the distribution of $N_{\text{tracklet}}$ vs. $Z$ vertex with respect to a particular reference value of $N_{\text{tracklet}}$ at a particular $Z$ vertex.

The self-normalized yield of electrons from heavy-flavour hadron decays is calculated using the following formula:

$$y = \frac{N_{\text{tracklet}}(e^+ e^-)}{N_{\text{tracklet}}(e^{\mu} \nu)}$$

where, $\nu$ denotes the multiplicity class, $\epsilon_{\text{trigger}}$ is the minimum bias trigger efficiency estimated for INEL $> 0$ events which is defined as inelastic events with at least 1 charged particle within $|\eta| < 1$.

$N_{\text{tracklet}}$ is the number of electrons from heavy-flavour hadron decays, $\epsilon_{\text{tracklet}}$ is the number of events and $\nu$ is the reconstruction efficiency.

Results
- The self-normalized yield shows a faster than linearly increasing trend.
- Higher $p_T$ intervals show tendency for steeper increase.

The the self-normalized yield is compared to $1/\sqrt{s}$ measurements and PYTHIA8.2 predictions at $\sqrt{s} = 8$ TeV and with the self-normalized yield of $\mu$ from open heavy-flavour hadron decays at $\sqrt{s} = 8$ TeV at forward rapidity.

Summary
- The self-normalized yield of electrons from heavy-flavour hadron decays is measured in the transverse momentum interval $0.5 < p_T (GeV/c) < 4.5$ GeV/c.
- The self-normalized yield shows a faster than linearly increasing trend and higher $p_T$ intervals tend to have a faster increase in yield.
- The results are comparable with $1/\sqrt{s}$ measurements and PYTHIA8.2 predictions at $\sqrt{s} = 13$ TeV.
- Muons from open heavy-flavour hadron decays at $\sqrt{s} = 8$ TeV at forward rapidity seem to be much less affected due jet bias and autocorrelation effects at low multiplicity.

References:
1. JHEP 09 (2010) 091
3. JHEP 09 (2015) 148