Charged-particle multiplicity distribution of Heavy flavor decay leptons in proton-proton collisions using Pythia8 at LHC energies

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Motivation

- ✓ Heavy quarks (i.e, charm and bottom) are produced at the very early stage of high energy nucleon-nucleon and heavy-ion collisions.

- ✓ Heavy quarks are very sensitive probe to study the mechanisms of parton-energy loss, the hadronisation and the transport properties of the medium produced in high energy heavy-ion collisions.

- ✓ The production of heavy quarks through the hard process, can be described via the theoretical model Quantum Chromodynamics (QCD) calculations.

- ✓ In LHC energy, the study of heavy flavour particles production with semi-hard multiparton interactions contributes in event multiplicity in high energy p-p collisions.

- ✓ The present study is for the production of leptons (electrons & muons) from heavy-flavour (HF) meson decay as a function of charged-particle multiplicity in p-p collisions at $\sqrt{s} = 13$ TeV using PYTHIA8 event generators.

Outline

I. Transverse momentum (p_T) distribution for Heavy Flavor Decay Electrons (HFE) and Heavy Flavor Decay Muons (HFM) in different multiplicity classes.

II. Results: Relative HFE vs. relative multiplicity
and Relative HFM vs. relative multiplicity.

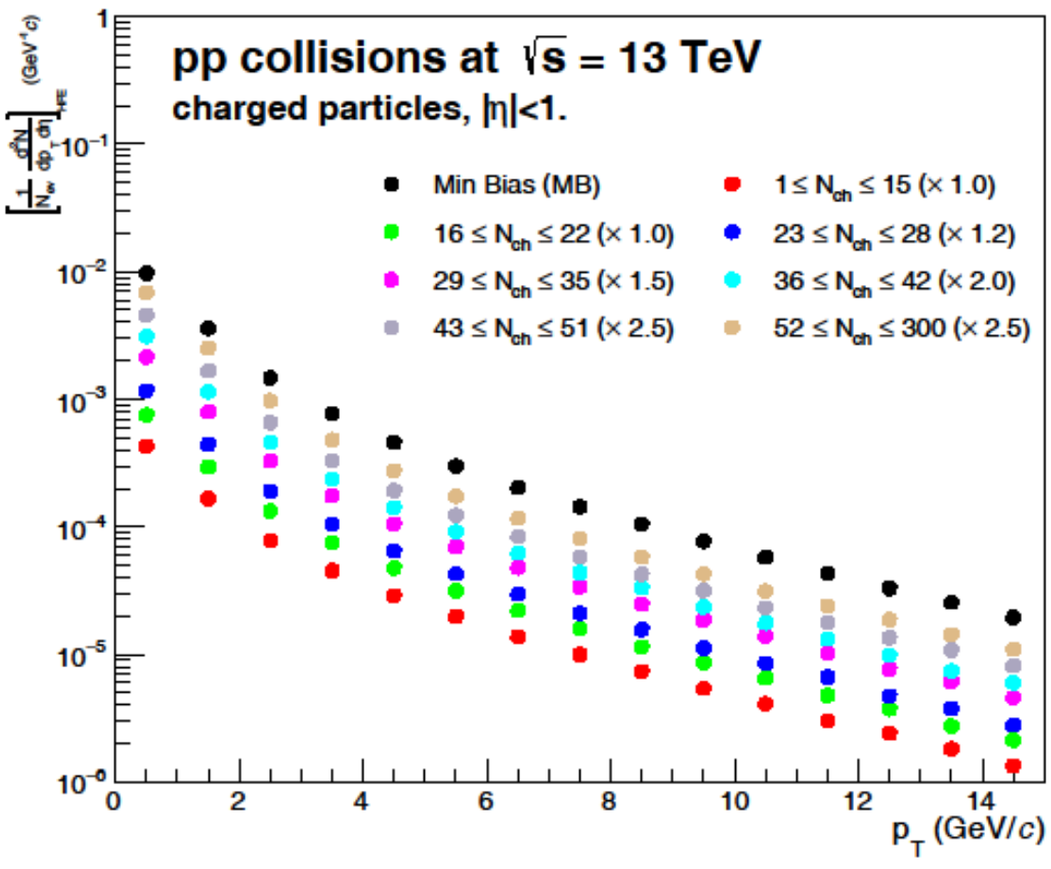
III. The charged-particle multiplicity dependence of $\mathrm{relative} < \mathrm{p_T} >$ and $< \mathrm{p}_T{}^2 >$ with respect to Minimum Bias (MB) events.

IV. Introduction of new factors: R_{cp} and R_{pp}.

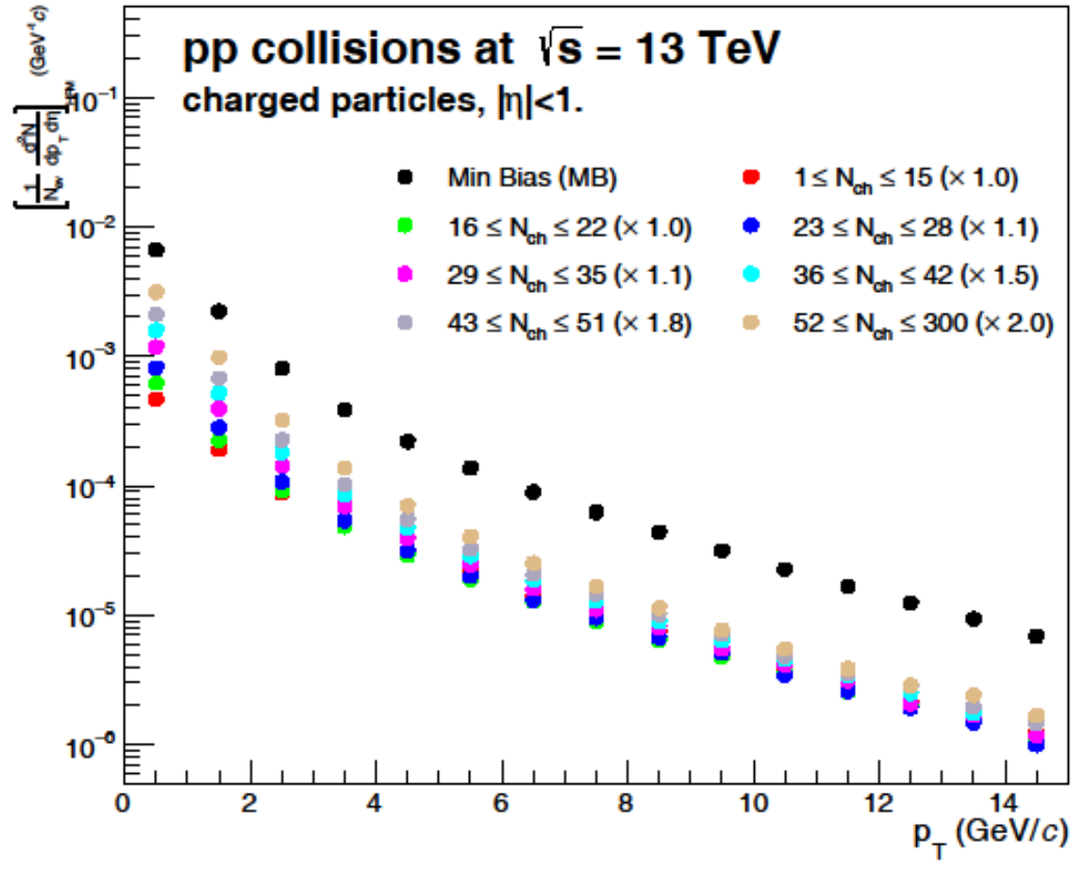
V. Summary and Future Plan.

Transverse momentum (p_T) spectra of HFE & HFM for different multiplicity classes

Heavy flavour decay electron in $|\eta| < 1.$



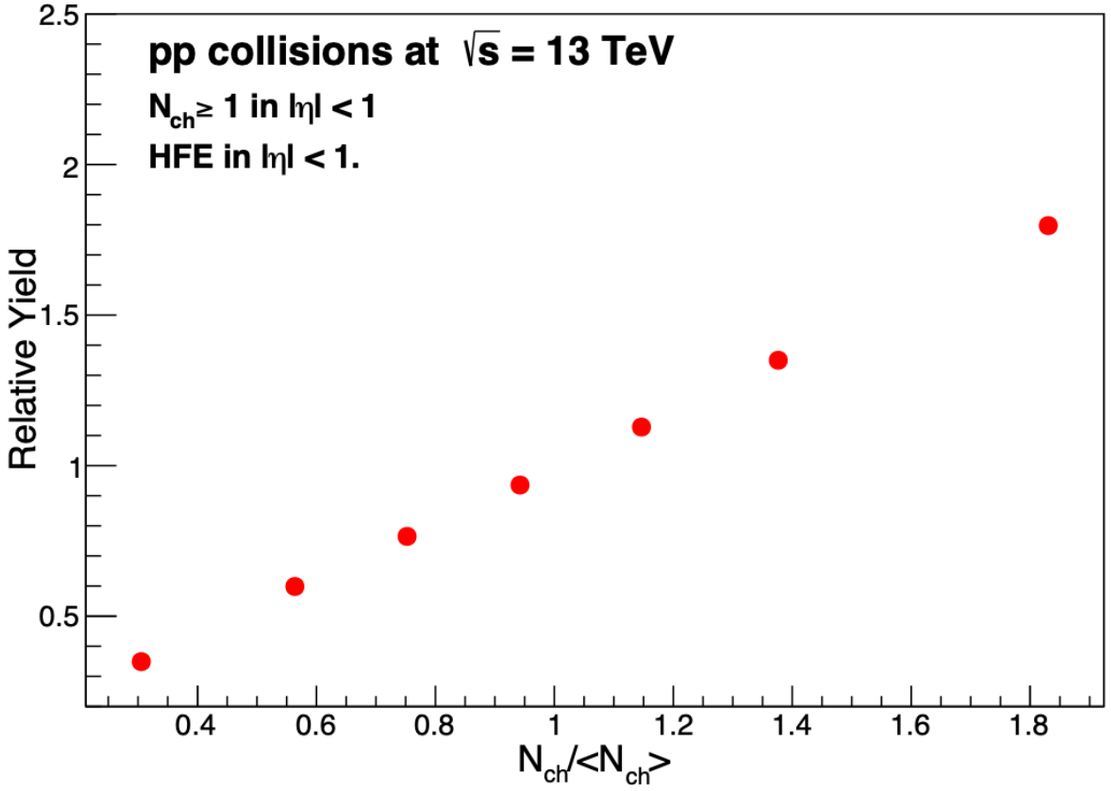
Heavy flavour decay muon in $2.5 < \eta < 4.$



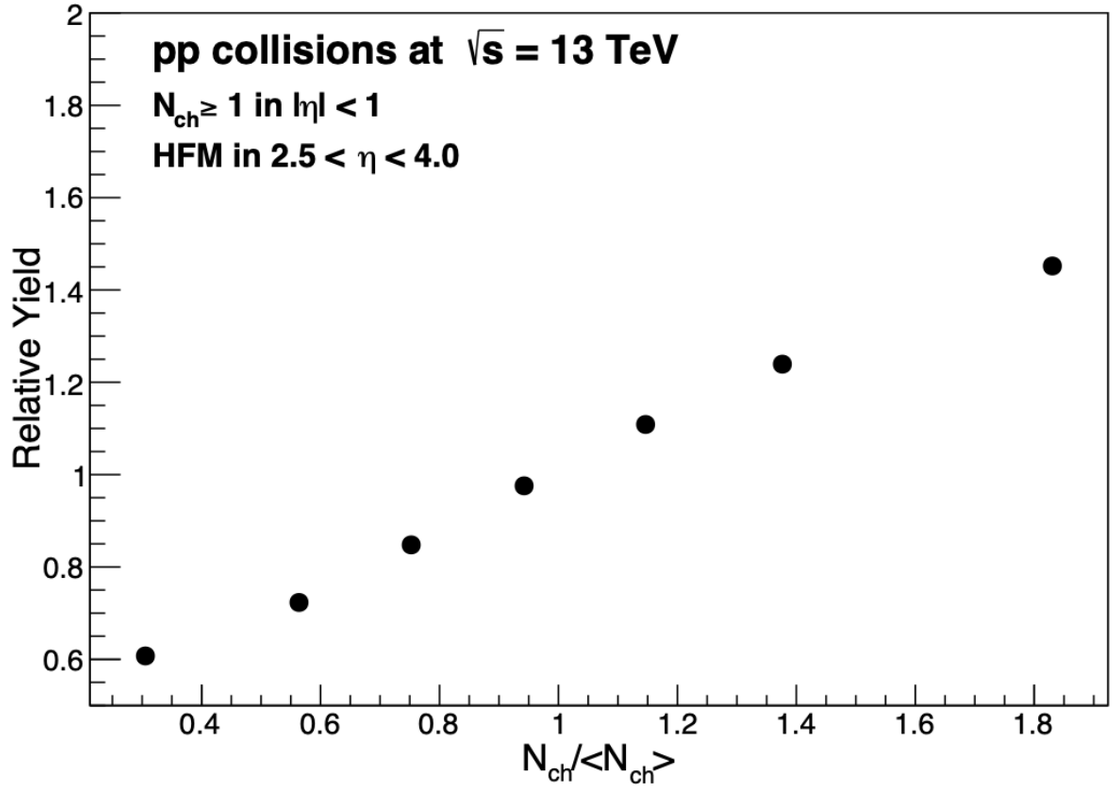
Division of Multiplicity bins: the number of events in each bin is almost equal.

Relative HFE & HFM vs. relative multiplicity

Heavy flavour decay electron in $|\eta| < 1$.

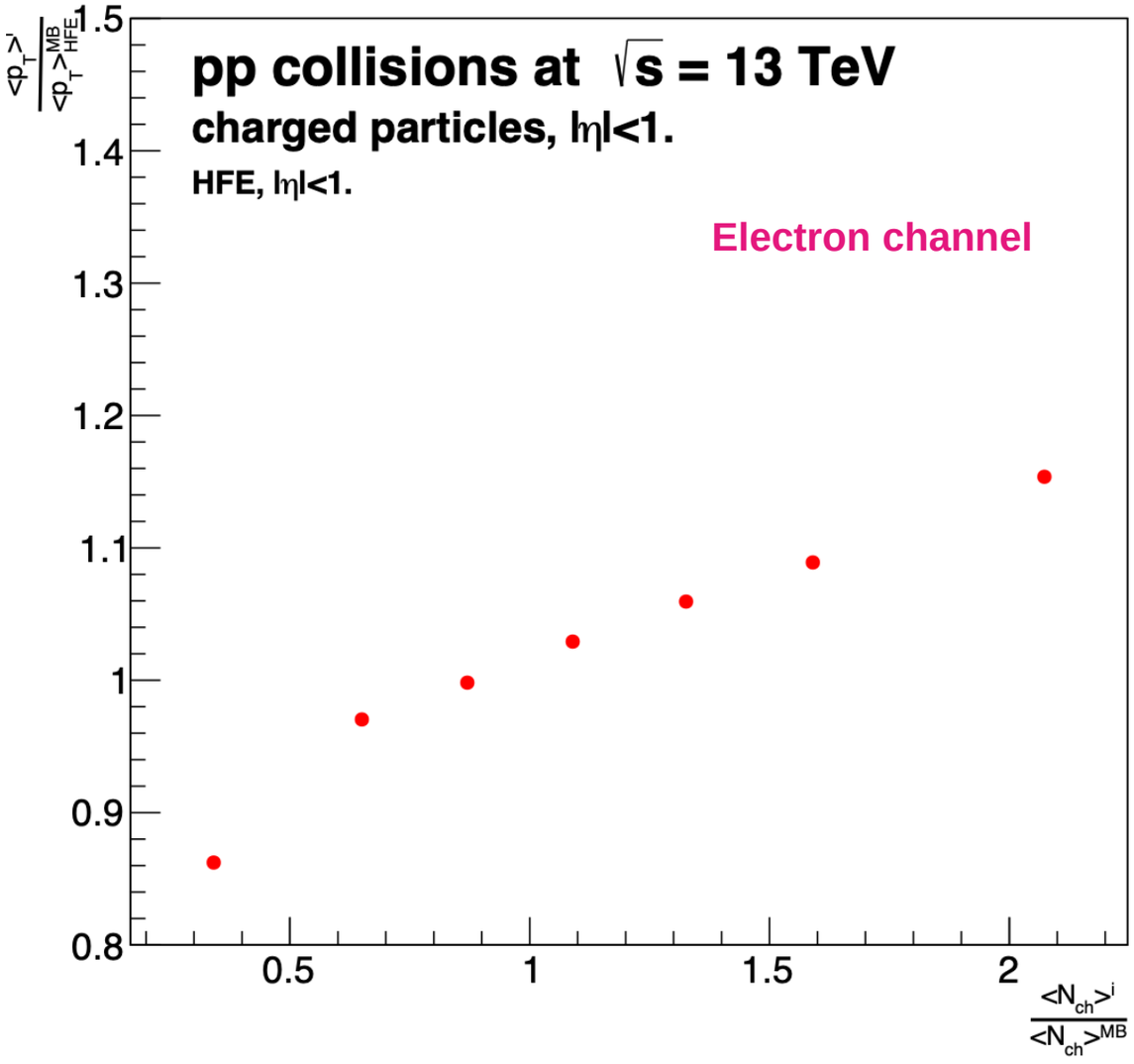


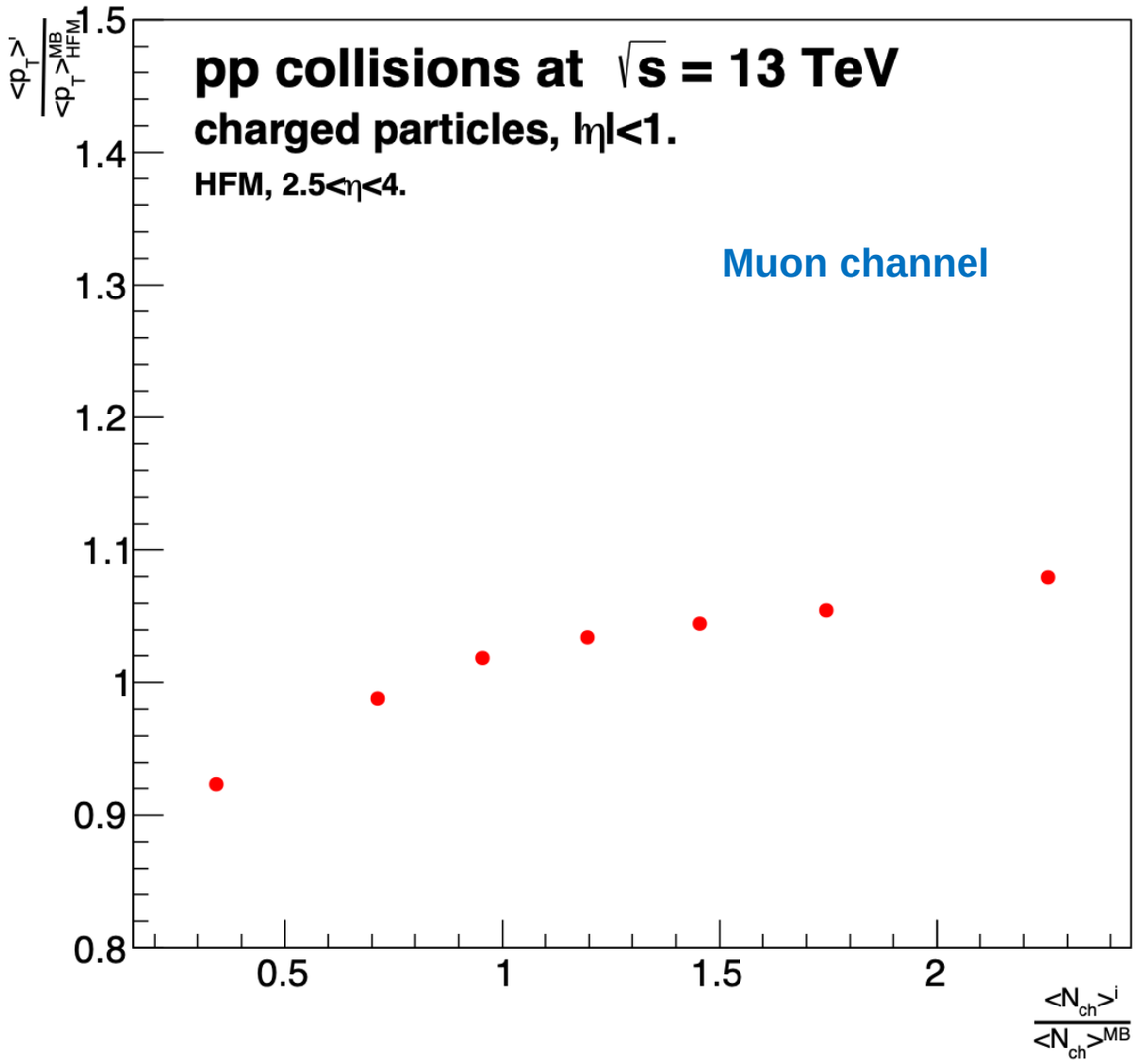
Heavy flavour decay muon in $2.5 < \eta < 4$.



The increasing trend is showing for both the cases.

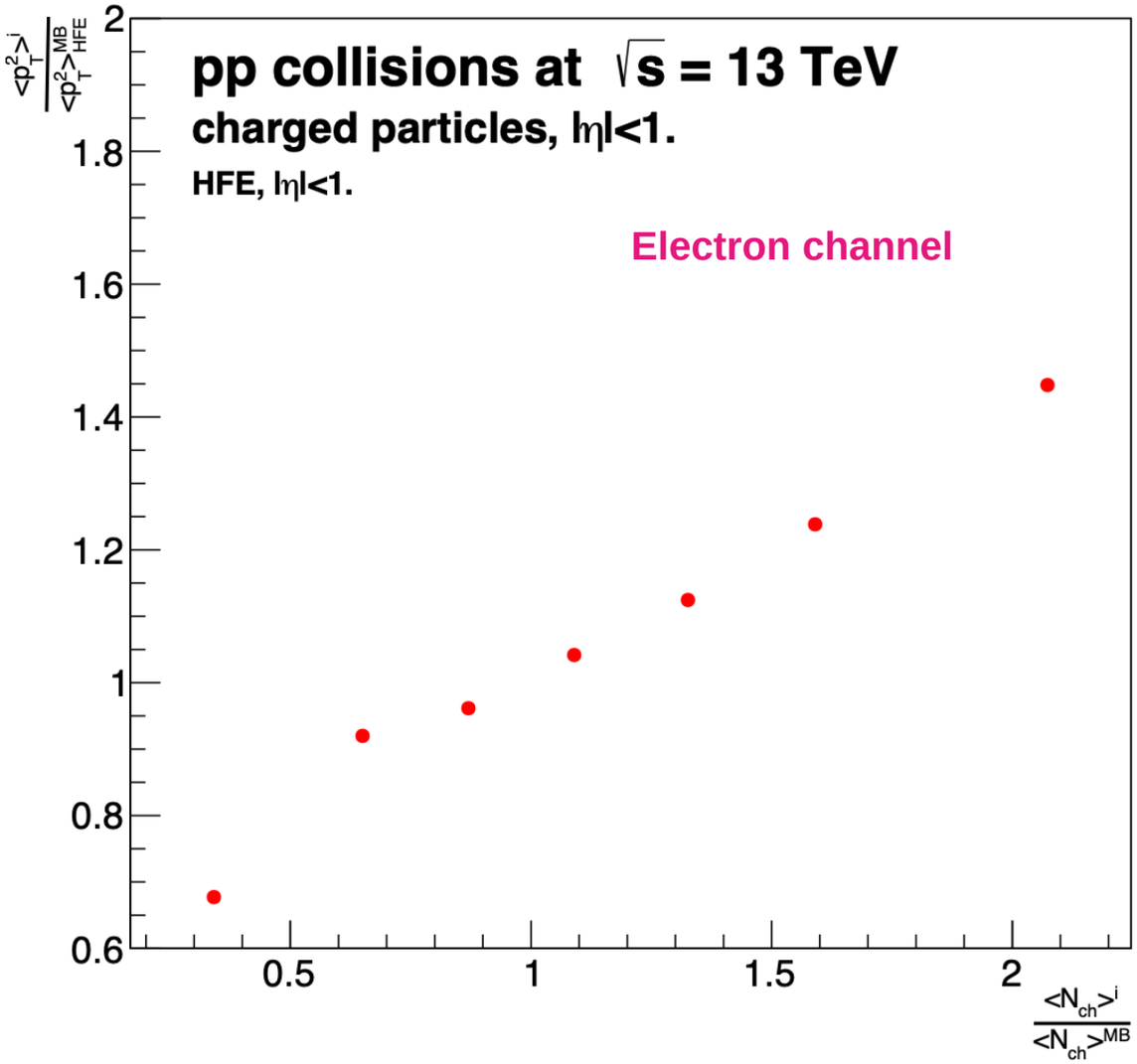
$\frac{<p_T>}{<p_T>_{MB}}$ of HF decay lepton as a function of relative charged-particle multiplicity $\left(\frac{<N_{ch}>}{<N_{ch}>_{MB}}\right)$

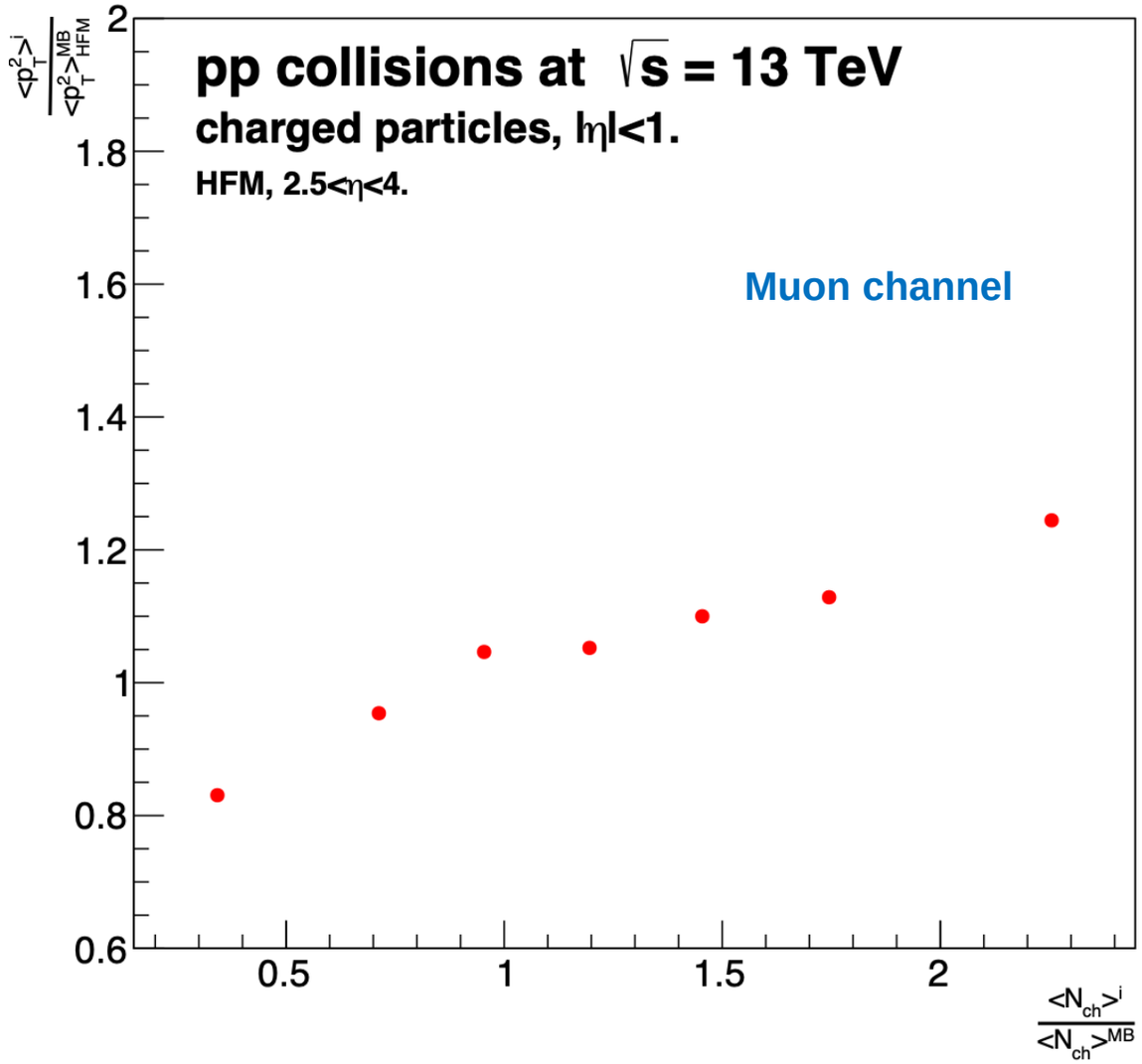




Relative $< p_T >$ of Heavy Flavor Decay leptons (hardness) as a function of relative of charged-particle multiplicity (softness).

$\frac{<p_T^2>}{<p_T^2>_{MB}}$ of HF decay lepton as a function of relative charged-particle multiplicity $\left(\frac{<N_{ch}>}{<N_{ch}>_{MB}}\right)$





This observation shows the production mechanism of Heavy Flavor Decay leptons in high multiplicity p-p collisions at $\sqrt{s} = 13$ TeV.

Introduction of new factors: R_{cp} and R_{pp}

$$R_{cp} = \frac{< N_{ch} >_{1-15}}{< N_{ch} >_{52-300}} \frac{[(1/N_{evt})dN/dp_T d\eta]_{52-300}}{[(1/N_{evt})dN/dp_T d\eta]_{1-15}}$$

$$R_{pp} = \frac{< N_{ch} >_{MB}}{< N_{ch} >_{52-300}} \frac{[(1/N_{evt})dN/dp_T d\eta]_{52-300}}{[(1/N_{evt})dN/dp_T d\eta]_{MB}}$$

- We can study these two factors (ratio) as a function of p_T of in two leptonic channels.
- The p_T dependency can be measured at p_T< 2 GeV/c and high p_T> 6 GeV/c.
- This simulation study may be give a direction about the nuclear modification factor (R_{AA}), which we could observe in heavy-ion collision generally.

Summary and Future Plan

- The p_T-distribution of highest multiplicity bin is approaching Minimum-Bias distribution.

- The relative $< p_T >$ and $< p_T^2 >$ for leptons are showing an increasing trend with respect to relative charged-particle multiplicity. It follows the published simulation and experimental results. More exercise is needed!!

- In this simulation study, the results for R_{cp} and R_{pp} could give some analogy about medium effect in p-p collision at the highest LHC energy.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Thank you