D^+ meson production in dependence of Event activity using Run3 data

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Outline

- Physics Motivation
- Analysis validation code
- Validation plots
- Analysis Strategy and Data Sample
- Topological and Kinematical Selections cut
- Task Used
- Results
- Summary and Outlook

Physics Motivation

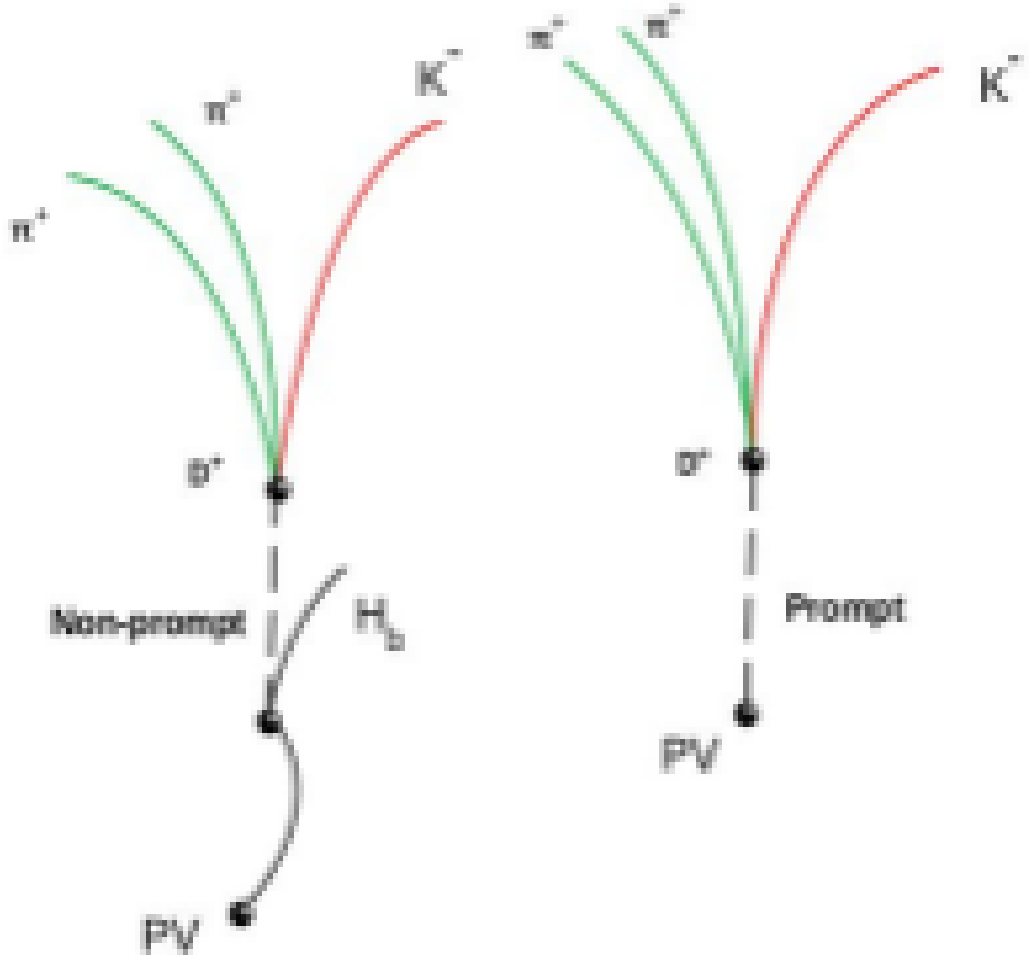
- Heavy quarks, like charm and beauty, are mostly produced in primary hard scattering processes between the partons of the incoming nuclei, which occur in the early stages of the collisions.
- The time scales for heavy-quark production (≤ 0.07 fm/c for $c\bar{c}$ and ≤ 0.02 fm/c for $b\bar{b}$ pairs) are shorter than the QGP formation time, which is about 0.3–1.5 fm/c at LHC energies.
- They experience the full space-time evolution of the QCD medium.
- The main aim is the measurements of the yields of prompt D+, mesons (i.e. produced via the hadronisation of charm quarks or from the decays of excited charmed hadron states) as a function of charged-particle multiplicity in pp collisions at $\sqrt{s}$ = 13.6 TeV

  Prompt D^+

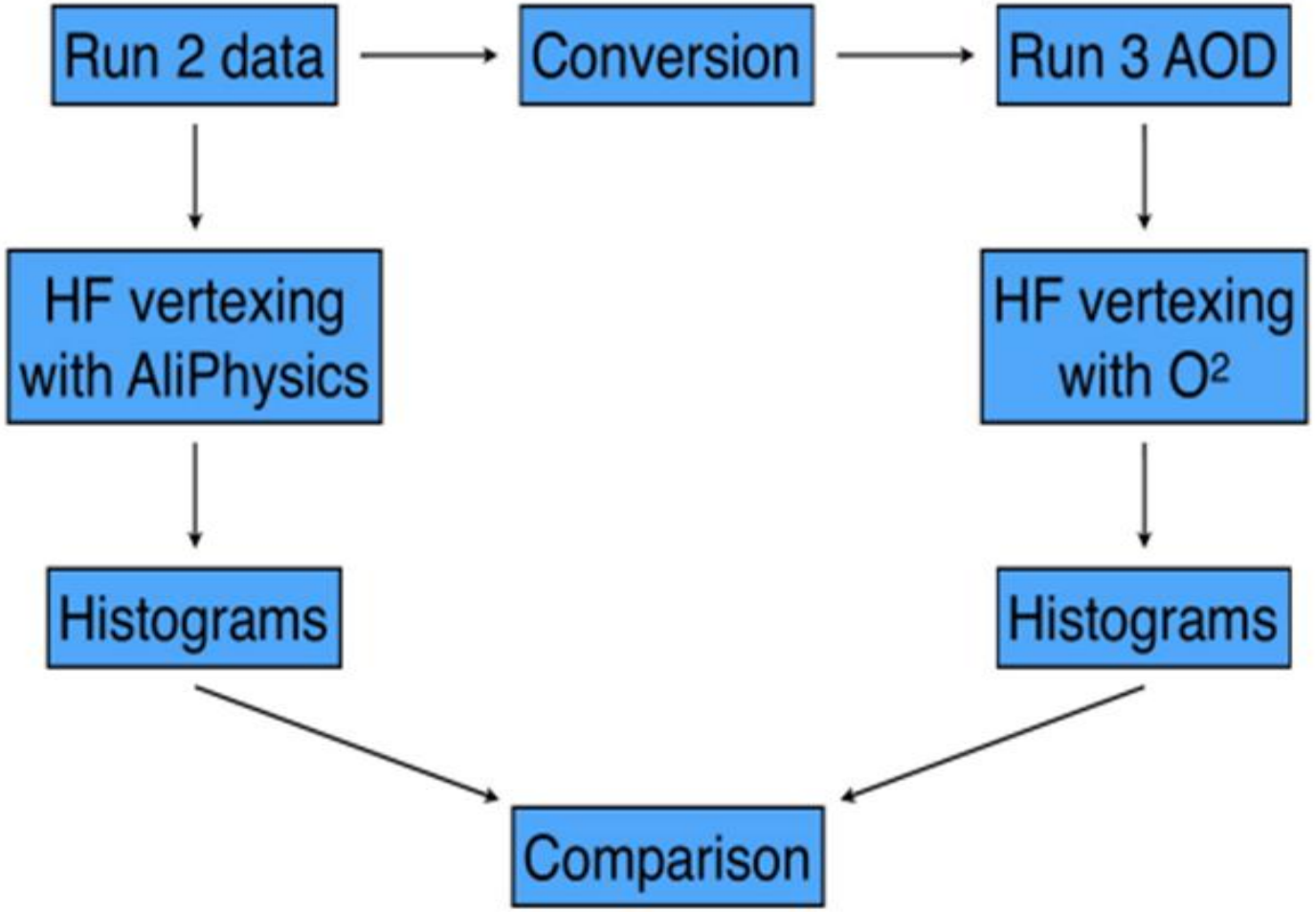
  - Comes **right from the primary vertex**
  - Typical decay length: a few hundred µm
  - Small impact parameter

- This allows us to explore the interplay between hard and soft QCD processes are studied in pp collisions.
- The measurements of the production of open heavy-flavor hadrons in pp-collision are used as reference for the studies in nucleus-nucleus collisions.

Scope: Higher Multiplicity, Large statistics, precision measurement as a function of p_T

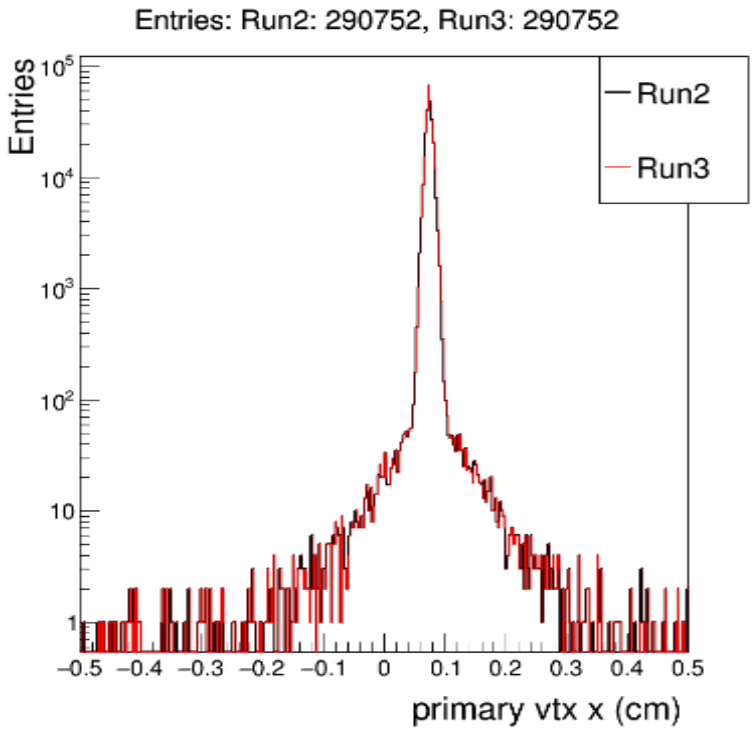


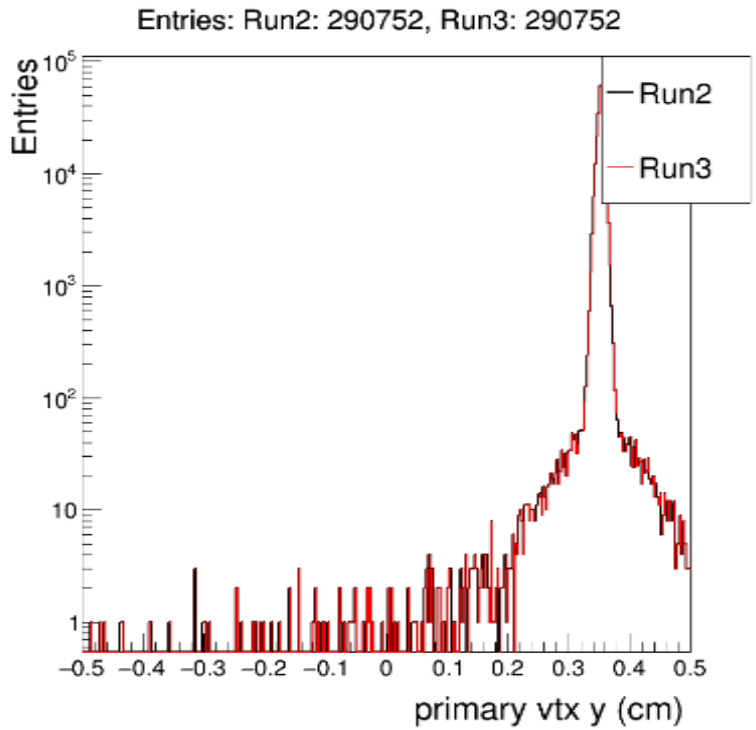
Analysis Validation Code

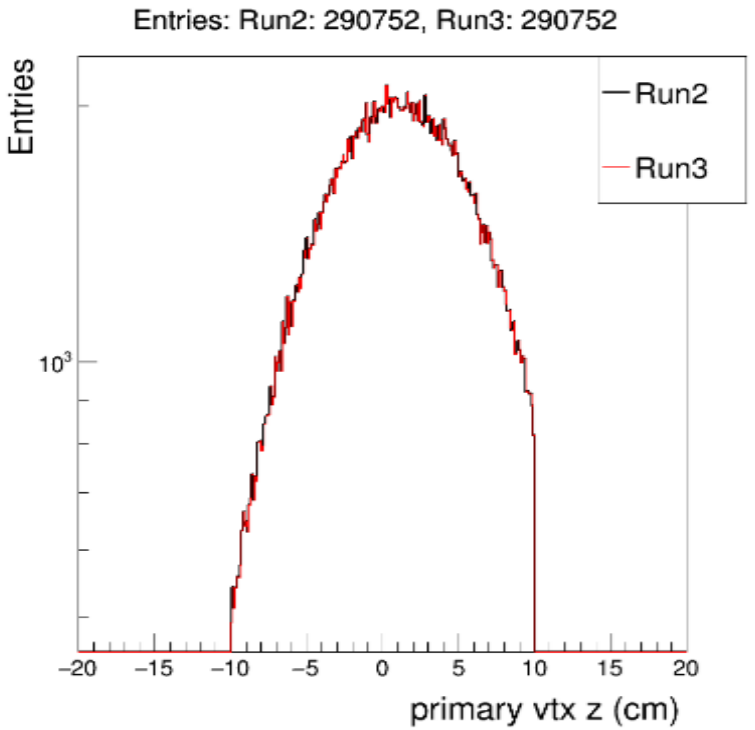


Validation plots: Run 2 ESDs (pp@5TeV)

Primary vertex distributions: perfect agreement in the distributions

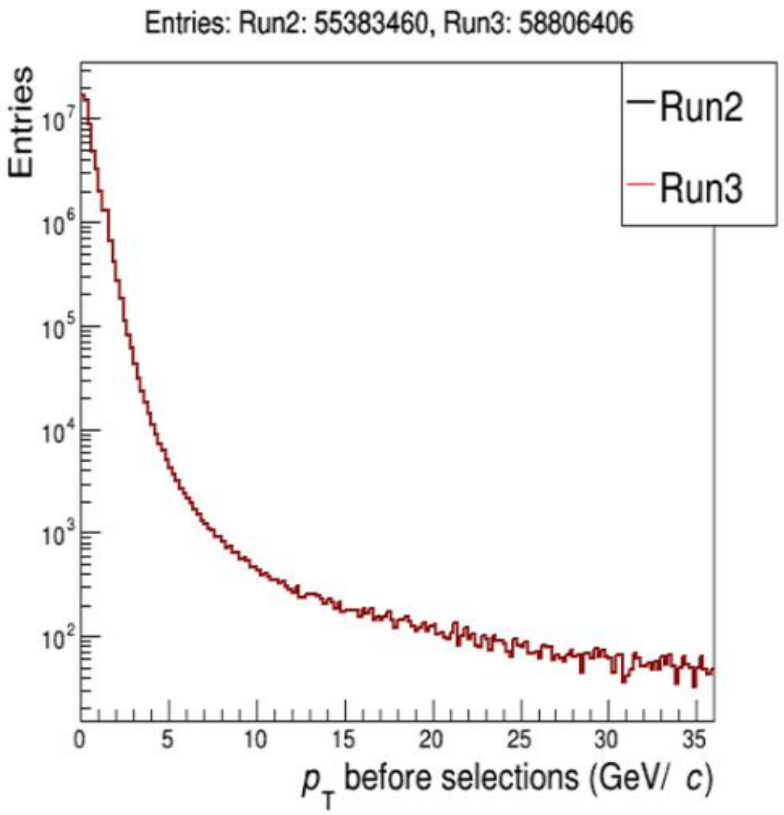


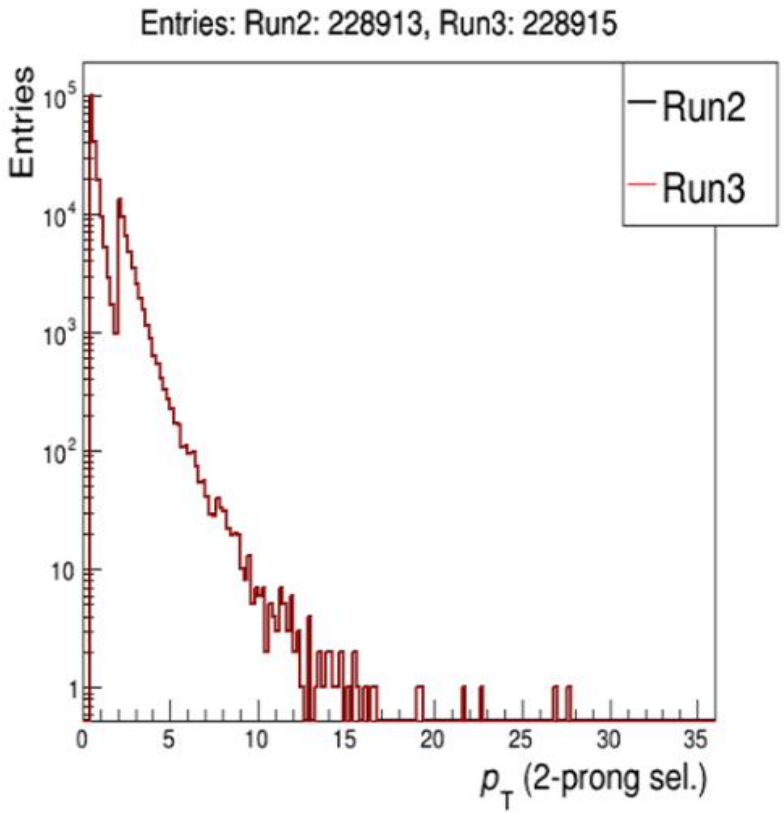


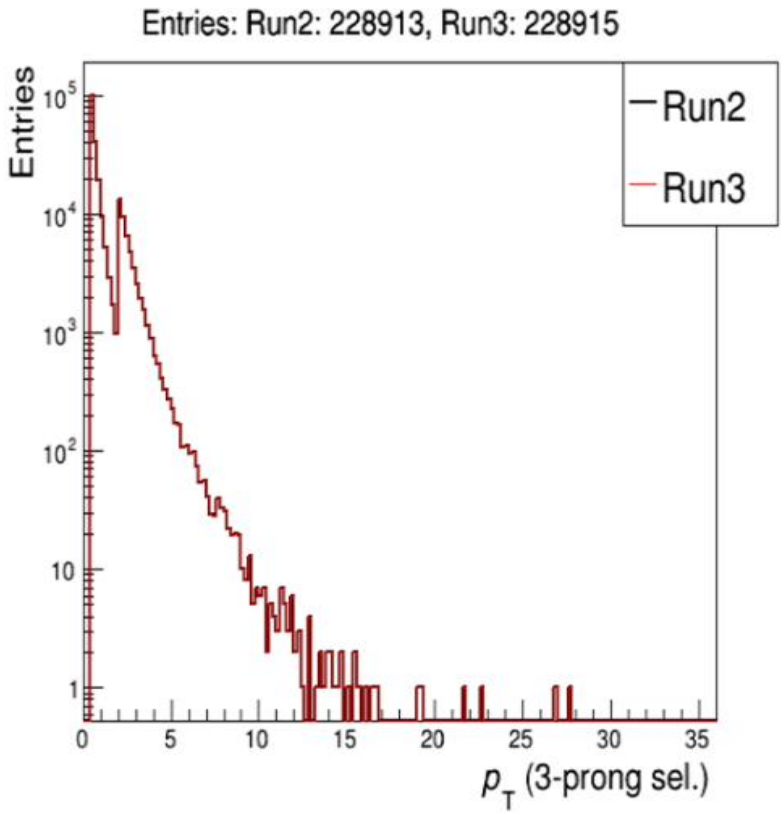


Validation plots: Run 2 ESDs (pp@5TeV)

- p_t Shape : very good agreement

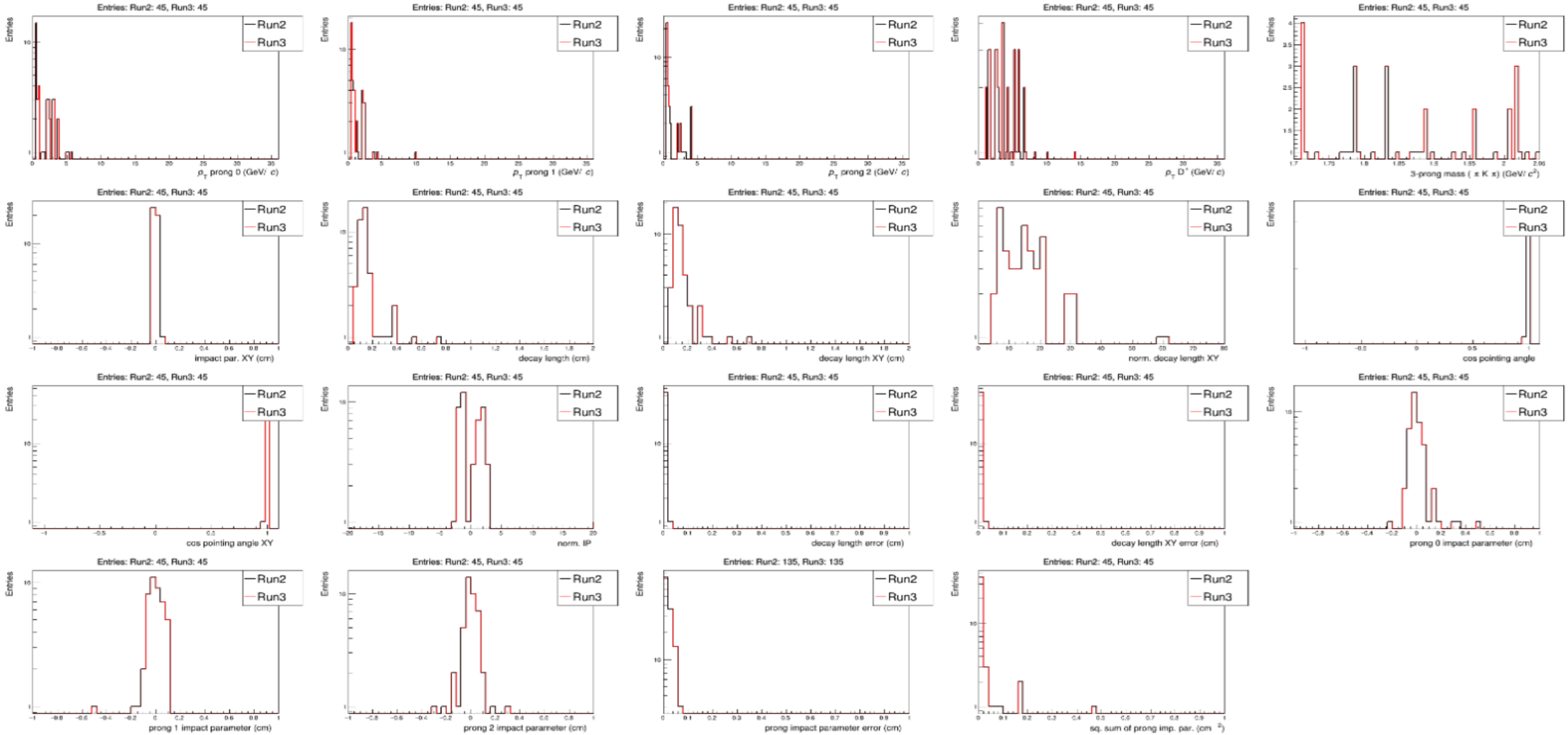






Validation plots: Run 2 ESDs (pp@5TeV)

Camparison : D^+ Cut Variables



Run 3 data Analysis

Analysis Strategy and Data Sample used

D-mesons reconstructed in ALICE central Barrel.

- $D^0 \rightarrow K^- \pi^+$ (BR 3.88%, $c\tau$=123 μm)
- $D^+ \rightarrow K^- \pi^+ \pi^+$ (BR 9.38%, $c\tau$=312 μm)
- $D^{*+} \rightarrow D^0 \pi$ (BR 67.7%, strong decay)

❑ Selection based on decay vertex and PID

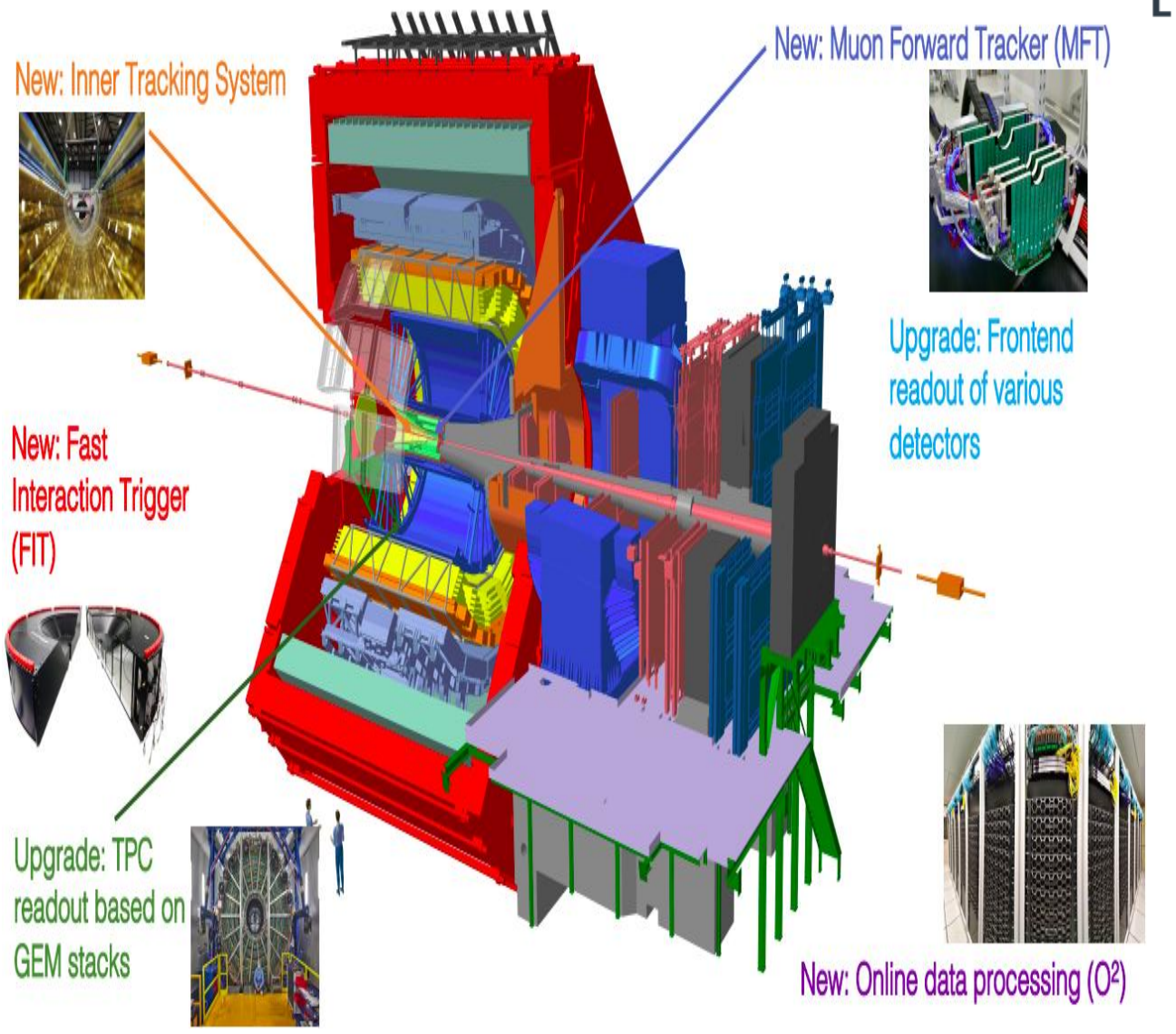
- ❑ **Inner Tracking System (ITS): tracking and vertexing**
- ❑ **Time Projection Chamber (TPC): tracking and particle identification**
- ❑ **Time Of Flight (TOF): particle identification**

Data sample:

- HF_LHC22o_pass6_minBias_medium_2P3PDstar : 4 Runs
- Selected events: 60 Billions

Analysis Strategy:

- Decay Channel $D^+ \rightarrow K^-\pi^+\pi^+$ (with B.R. = (9.38±0.16)%)
- **D^+-meson** candidates were filtered by applying kinematical and topological cuts.
- Particles are identified using **PID** information from **TPC** and **TOF** to reduce background at low p_T



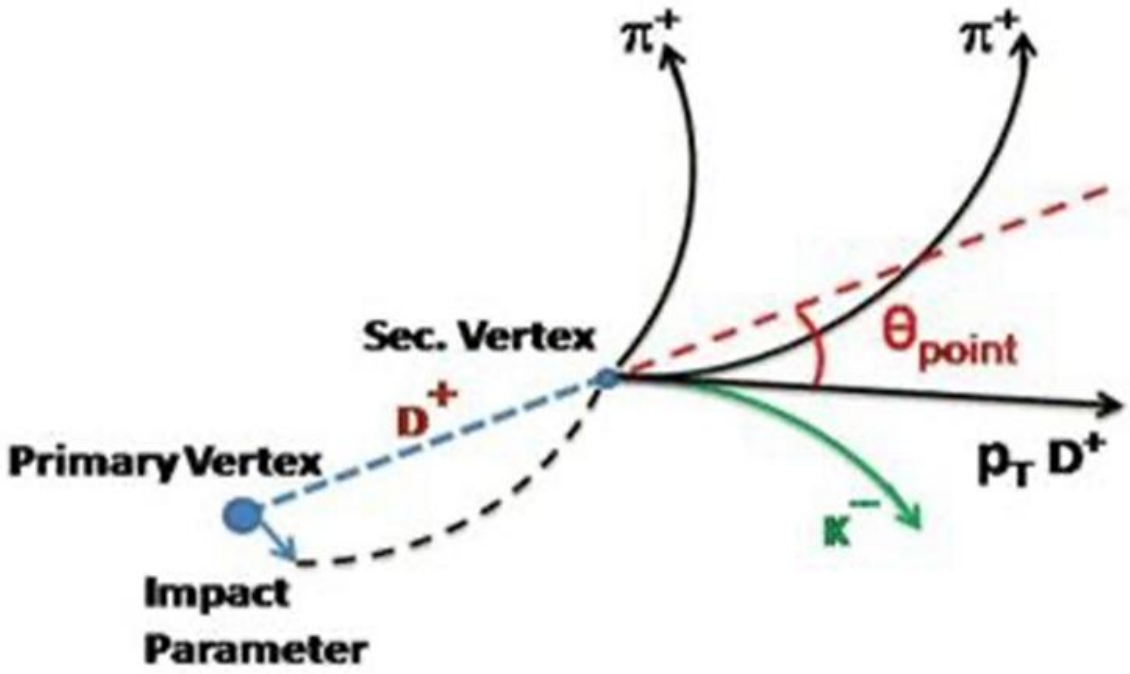
Topological and kinematical Cut Variables

Single Track Selections

- $|\eta| < 0.8$.
- $p_T > 0.3$ GeV/c in pp collisions.
- TPC clusters ≥ 70
- $\chi^2/ndf < 2$ in the TPC
- Min DCAxy=0 ,Max DCAxy=10

Candidate preselection

- $Cos\theta_{point} > 0.95$
- Decay length>0.02



$D^+ \rightarrow K^-\pi^+\pi^+$

Topological and Kinemetical Cuts

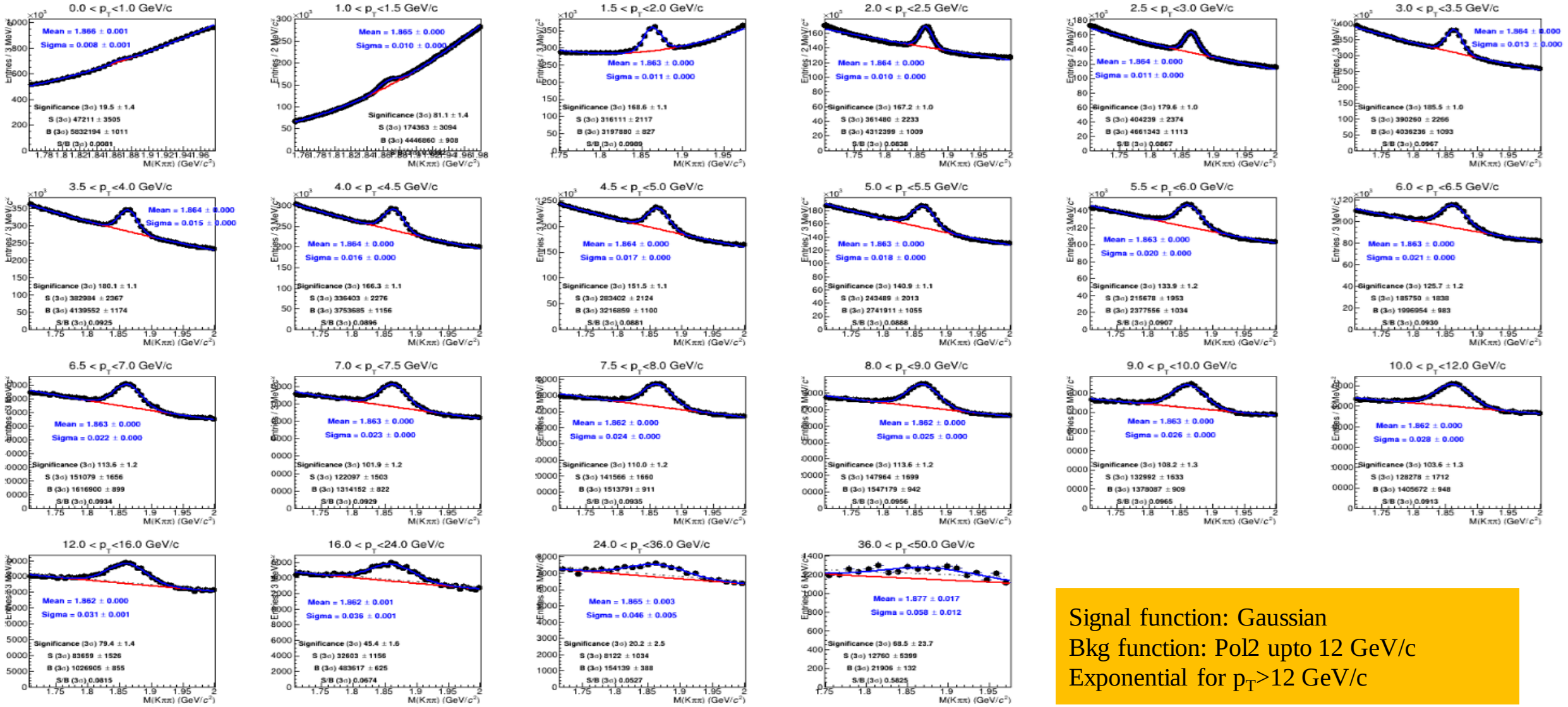
p_T (GeV/c)	ΔM (GeV/c^2)	p_T π (GeV/c)	p_T K (GeV/c)	Decay length (cm)	Cos pointing angle	Cos pointing angle XY
0-1	<0.2	>0.3	>0.4	>0.1	>0.995	>0.998
1-2	<0.2	>0.4	>0.4	>0.05	>0.980	>0.990
2-3	<0.2	>0.5	>0.5	>0.05	>0.980	>0.990
3+	<0.2	>0.5	>0.5	>0.05	>0.970	>0

Tasks used for Analysis

Chain of tasks (central tasks + HF ‘core’ task)

- o2-analysis-timestamp
- o2-analysis-event-selection
- o2-analysis-trackselection
- o2-analysis-track-propagation
- o2-analysis-pid-tpc-full
- o2-analysis-pid-tof-base
- O2-analysis-pid-tof-full
- o2-analysis-hf-candidate-creator3prong_Run3_DplusOnly_Data
- o2-analysis-HfPIDCreator_PiKa
- o2-analysis-hf-task-dplus

D^+ Invariant Mass Distribution in different pt bins



Signal function: Gaussian
Bkg function: Pol2 upto 12 GeV/c
Exponential for p_T>12 GeV/c

Summary and Outlook

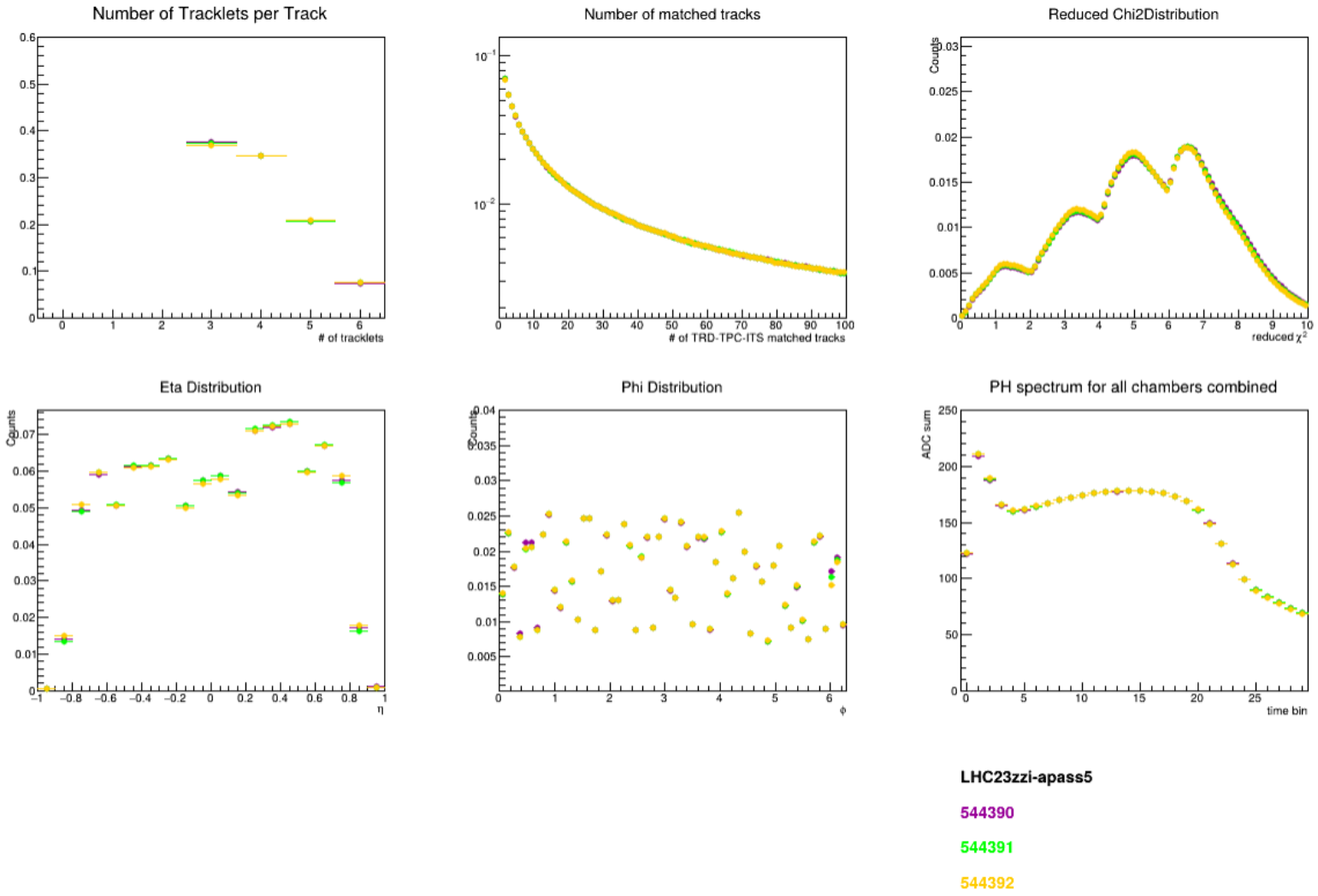
- Tested D+ task in hyperloop: Working properly with Run2 converted data
- Tested Dplus task in Run3 AnalysisValidation: perfect agreement between AliPhysics and O2Physics environment.
- Analysed Run3 data from pp collisions at √s = 13.6 TeV.
- Invariant Mass Distribution of D^+ in different p_T bins.
- At low p_T background is significantly higher which reduce signal significance.

Outlook

- Machine learning techniques will be used to improve signal-background separation, particularly in the low p_T region.

Service Work

- Besides my analysis, I am also contributing to **service work** focused on Asynchronous Quality Control (AQC) for the TRD.



Thank for your kind attention