

Event-by-Event mean p_T fluctuations in identified particle in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.36$ TeV

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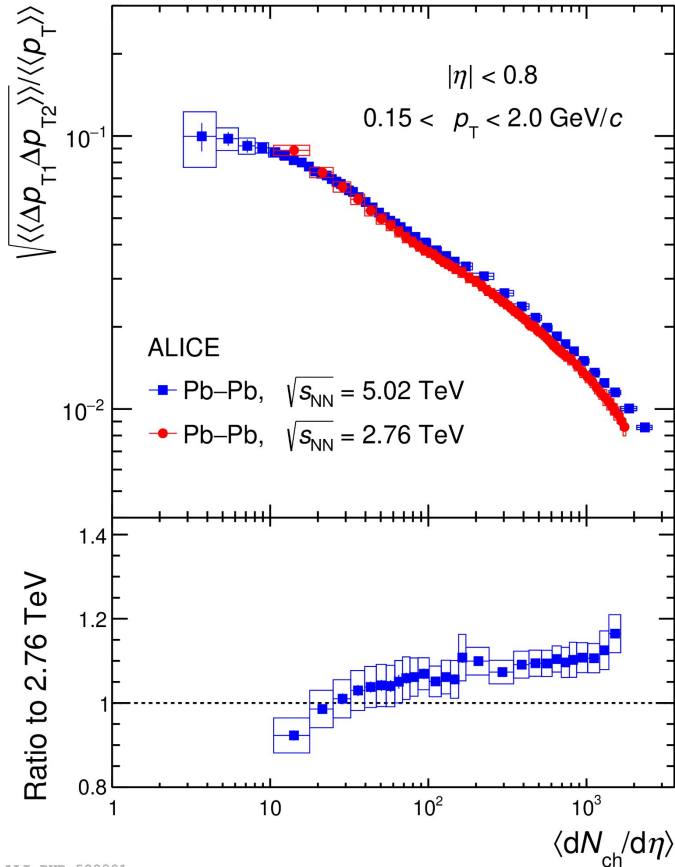
²VECC, kolkata



ALICE-STAR India Collaboration Meeting
July 1th - 4th, 2025



Motivation



- EbyE $M(p_T)$ in heavy-ion collisions are composed of statistical and dynamical contributions.
- To study the origin of dynamical fluctuations scaled dependence of $\langle p_T \rangle$ fluctuations are studied in terms of two particle correlator C_m .
- Fluctuations of $\langle p_T \rangle$ arise from many kind of correlations among the p_T of final state particles, such as resonance decays, jets etc.
- For Pb-Pb collisions, significant dynamical fluctuations as well as a strong decrease with multiplicity are observed.

Observable

→ Two particle p_T correlator using cumulant method:

$$\langle \Delta p_i \Delta p_j \rangle = \left\langle \frac{Q_1^2 - Q_2}{N_{ch}(N_{ch} - 1)} \right\rangle - \left\langle \frac{Q_1}{N_{ch}} \right\rangle^2$$

→ Mean p_T : $\langle \langle p_T \rangle \rangle = \left\langle \frac{Q_1}{N_{ch}} \right\rangle$

here,

$$Q_1 = \sum p_T$$

$$Q_2 = \sum (p_T * p_T)$$

- p_T : transverse momentum of particle
- N_{ch} : number of particles
- Angular bracket denotes average over events in a multiplicity class

Analysis Details

Collision system

Pb-Pb, $\sqrt{s} = 5.36$ TeV

- Data: LHC23zzf apass4 (Events - 46.3 M)
- MC : LHC24g3_medium (Events - 12.47 M)

Event Selection

- coll.has_mcCollision()
- $|V_z| < 10$ cm
- sel8()
- cent -> coll.centFT0C()
- isPhysicalPrimary()

Pile up cuts

- kNoTimeFrameBorder
- kNoITSROFrameBorder
- kNoSameBunchPileup
- kIsGoodZvtxFT0vsPV
- kIsVertexITSTPC
- kIsVertexTOFmatched

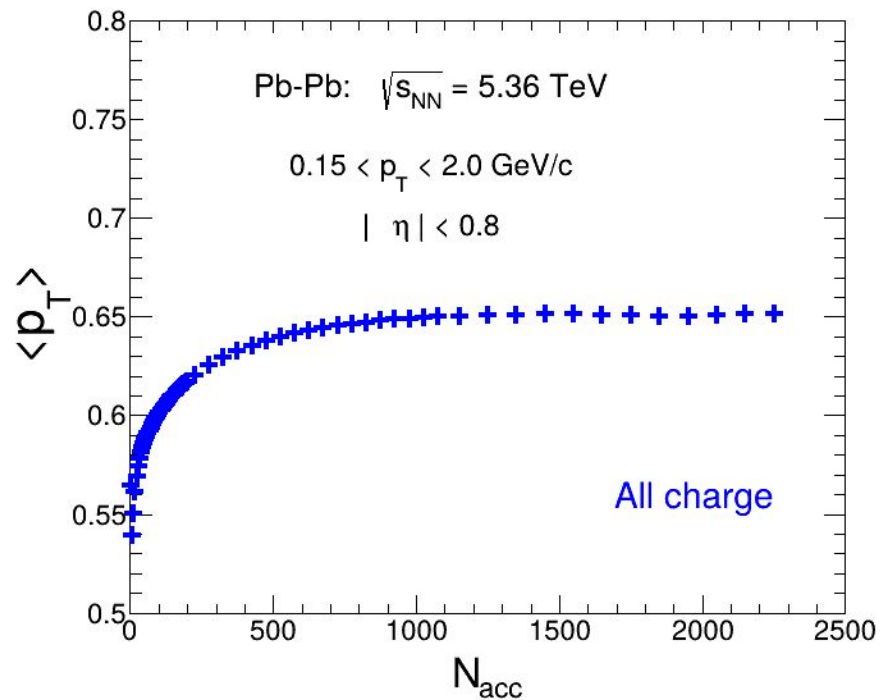
Track Selection

- track.isGlobalTrack()
- $|\eta| < 0.8$
- $0.15 < p_T < 2.0$ GeV/c
- track.sign() = 0

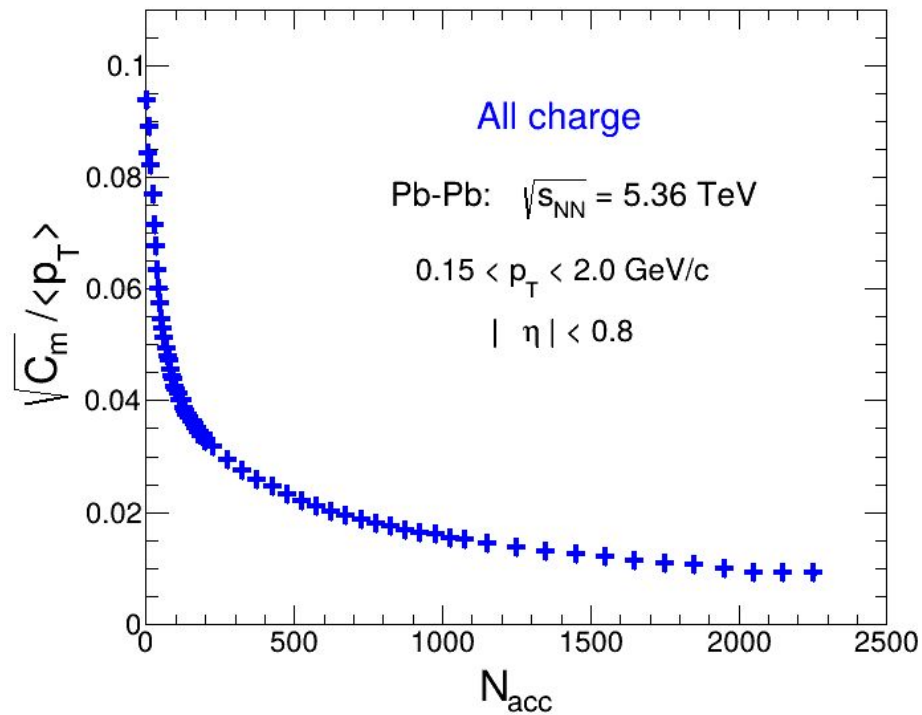
all charge

data

$\langle p_T \rangle$ vs N_{acc}

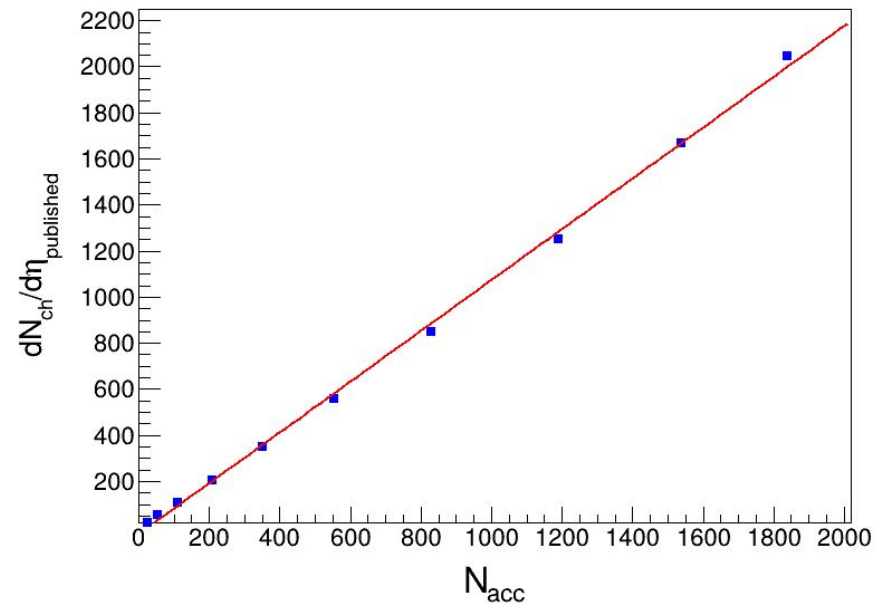


Two particle correlator vs N_{acc}



How $\langle dN_{ch}/d\eta \rangle$ is calculated from N_{acc} :

centrality	$\langle N_{acc} \rangle$	$\langle dN_{ch}/d\eta \rangle_{pub}$
0-5%	1838	2047
5-10%	1539	1668
10-20%	1191	1253
20-30%	828.4	848
30-40%	555	559
40-50%	352	351
50-60%	207.6	205
60-70%	111.8	110
70-80%	54.26	53
80-90%	24.39	23.2



$$dN_{ch}/d\eta = p_0 + p_1 * N_{acc}$$

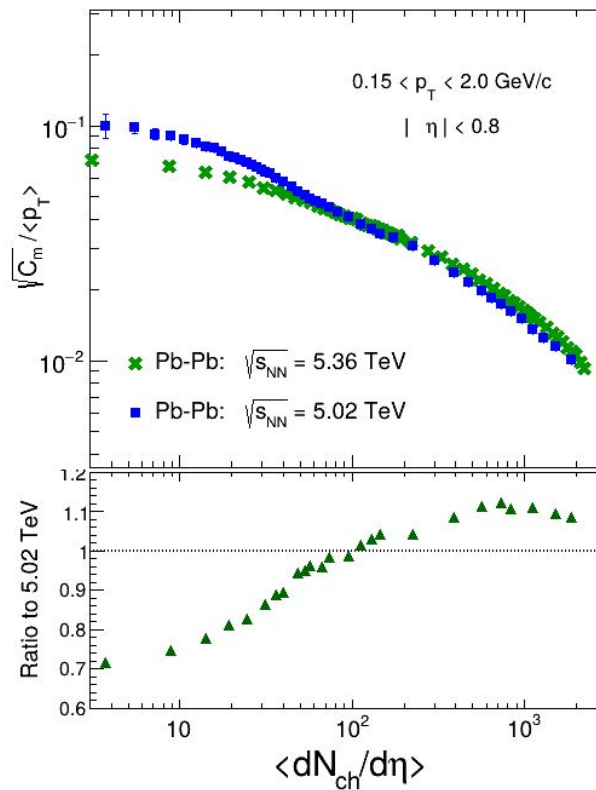
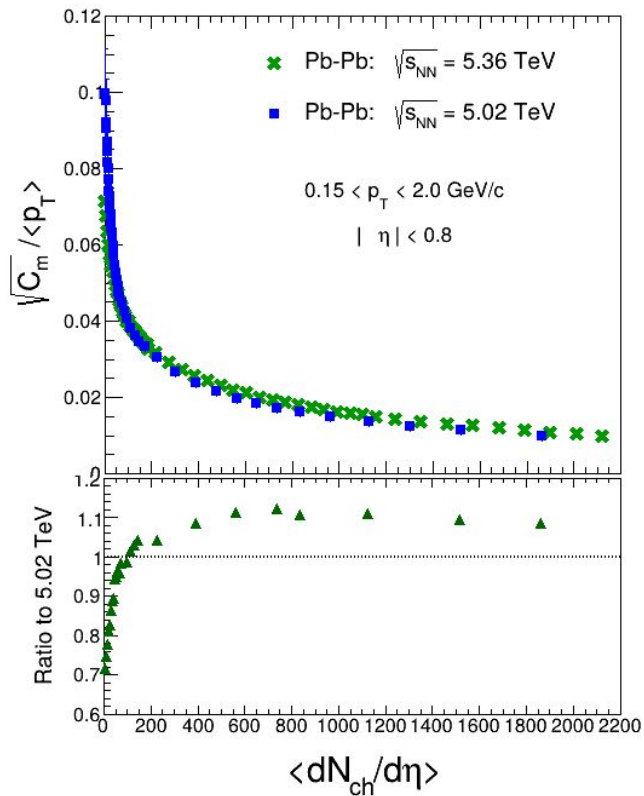
$$p_0 = -27.18063, p_1 = 1.102598$$

for each value of N_{acc} we get $\langle dN_{ch}/d\eta \rangle$

all charge

data

Two particle correlator vs $\langle dN_{ch}/d\eta \rangle$

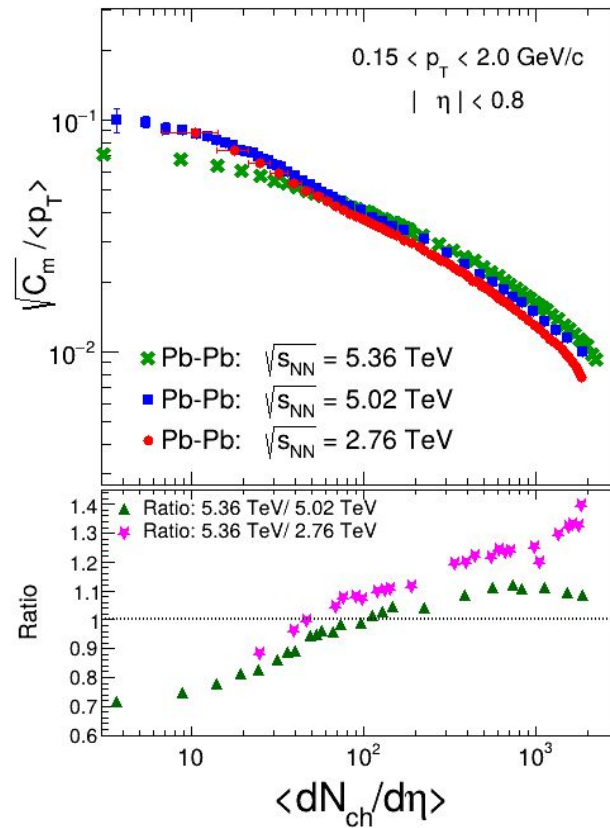
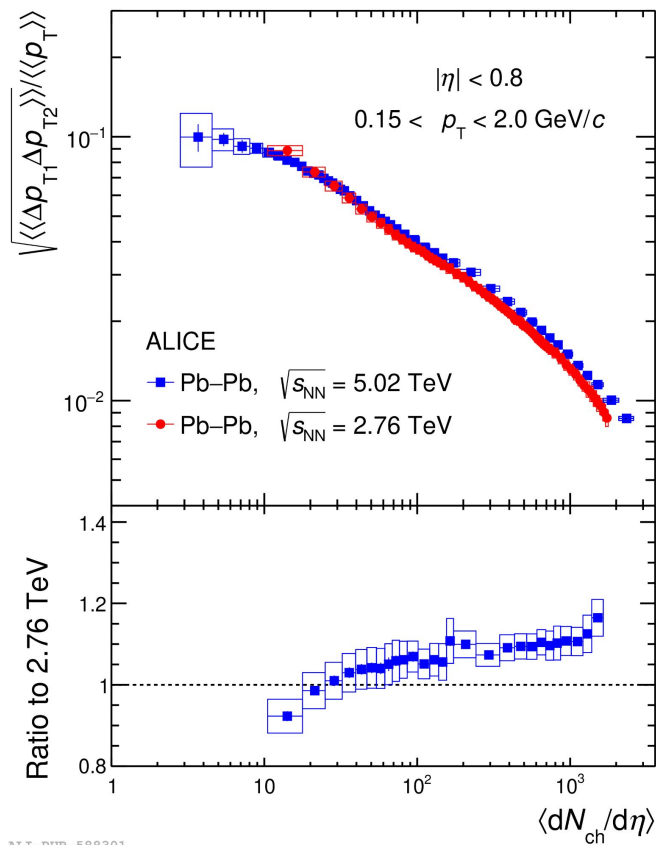


all charge

data

Two particle correlator vs $\langle dN_{ch}/d\eta \rangle$

published



Particle Identification

$$p < p_{th}$$

For tracks without TOF information.

$$-2.0 < N\sigma_{\text{TPC - species}} < 2.0, |N\sigma_{\text{TPC}|_{\text{oth}}} > 2.0$$

For tracks with TOF information.

$$-2.0 < N\sigma_{\text{TPC - species}} < 2.0, -2.0 < N\sigma_{\text{TOF - species}} < 2.0, |N\sigma_{\text{TPC}|_{\text{oth}}} > 2.0$$

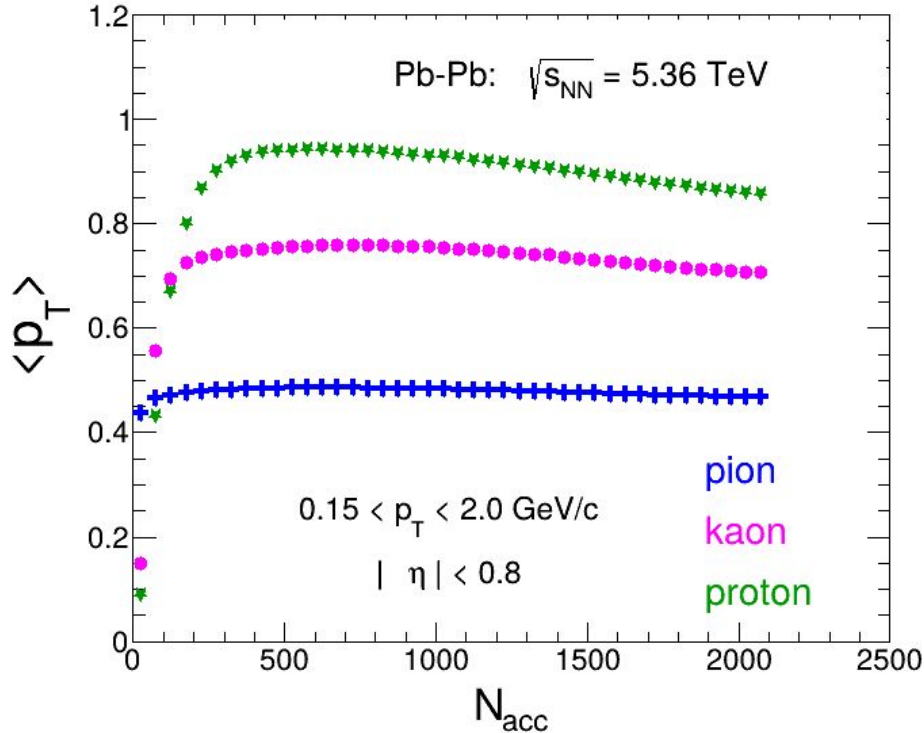
here species represents any of the π , K, or p, and oth represents any of the other two species.

$$p > p_{th}$$

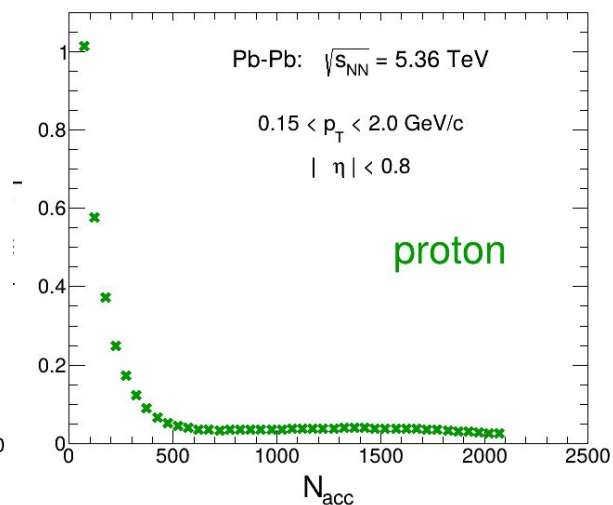
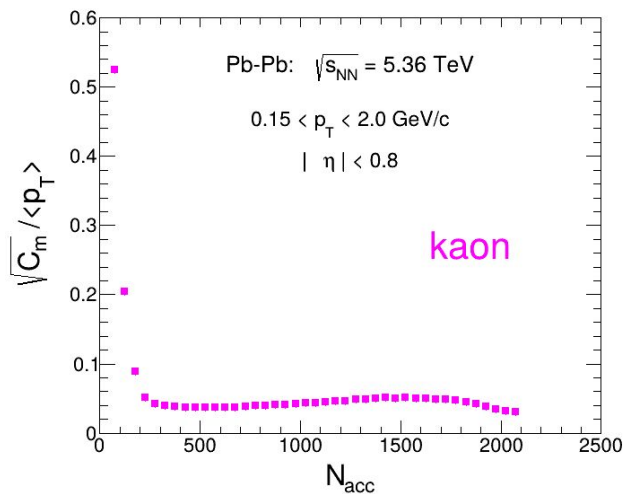
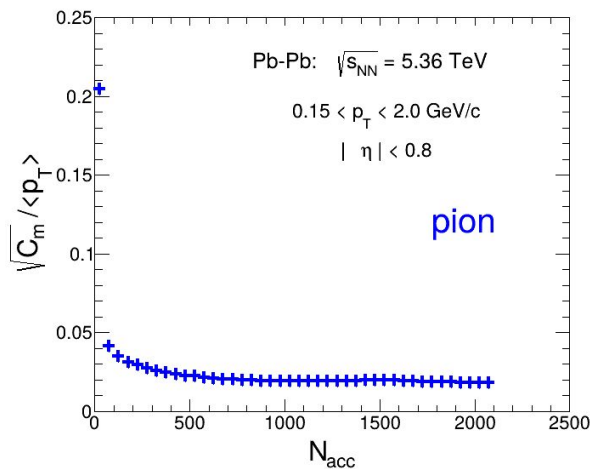
For tracks with TOF information.

$$-2.0 < N\sigma_{\text{TPC - species}} < 2.0, -2.0 < N\sigma_{\text{TOF - species}} < 2.0, |N\sigma_{\text{TPC-TOF}|_{\text{oth}}} > 2.0$$

here $|N\sigma_{\text{TPC-TOF}}| = \sqrt{((N\sigma_{\text{TPC}})^2 + (N\sigma_{\text{TOF}})^2)}$



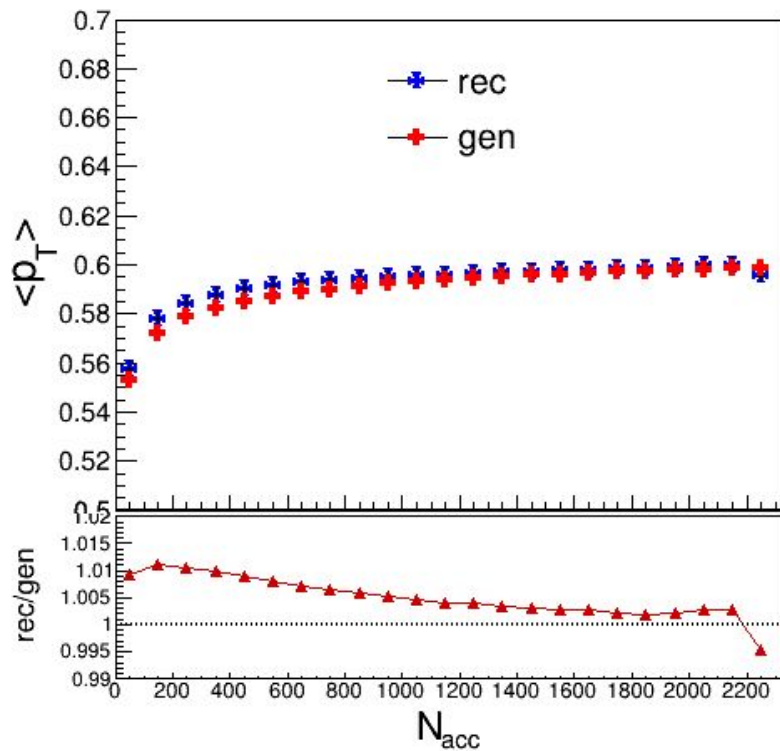
- Species composition affects mean p_T ; Heavier particles contribute more to higher p_T .
- $\langle p_T \rangle_{\text{proton}} > \langle p_T \rangle_{\text{kaon}} > \langle p_T \rangle_{\text{pion}}$



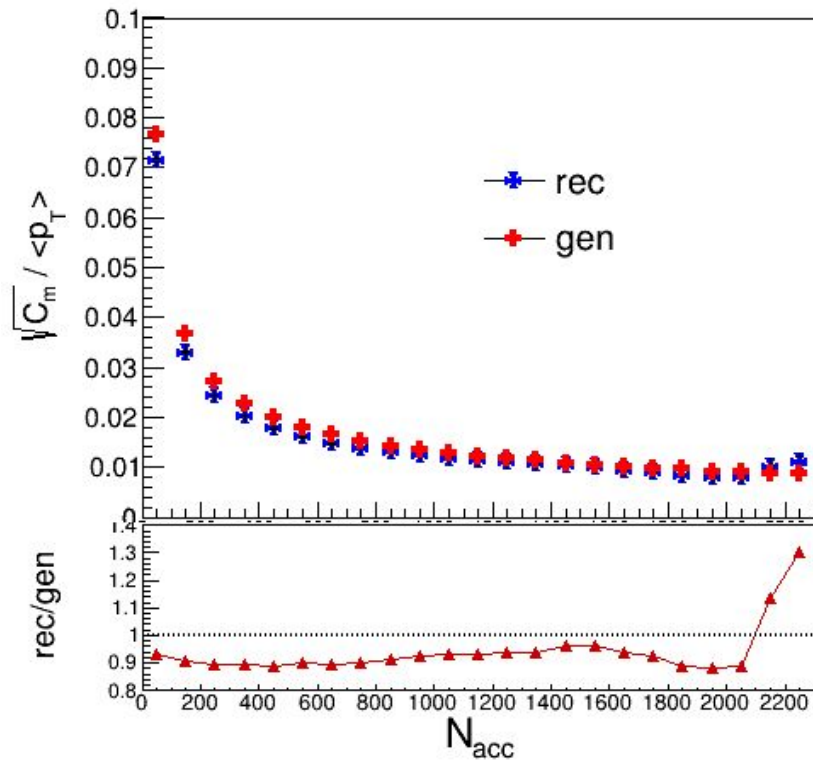
all charge

MC

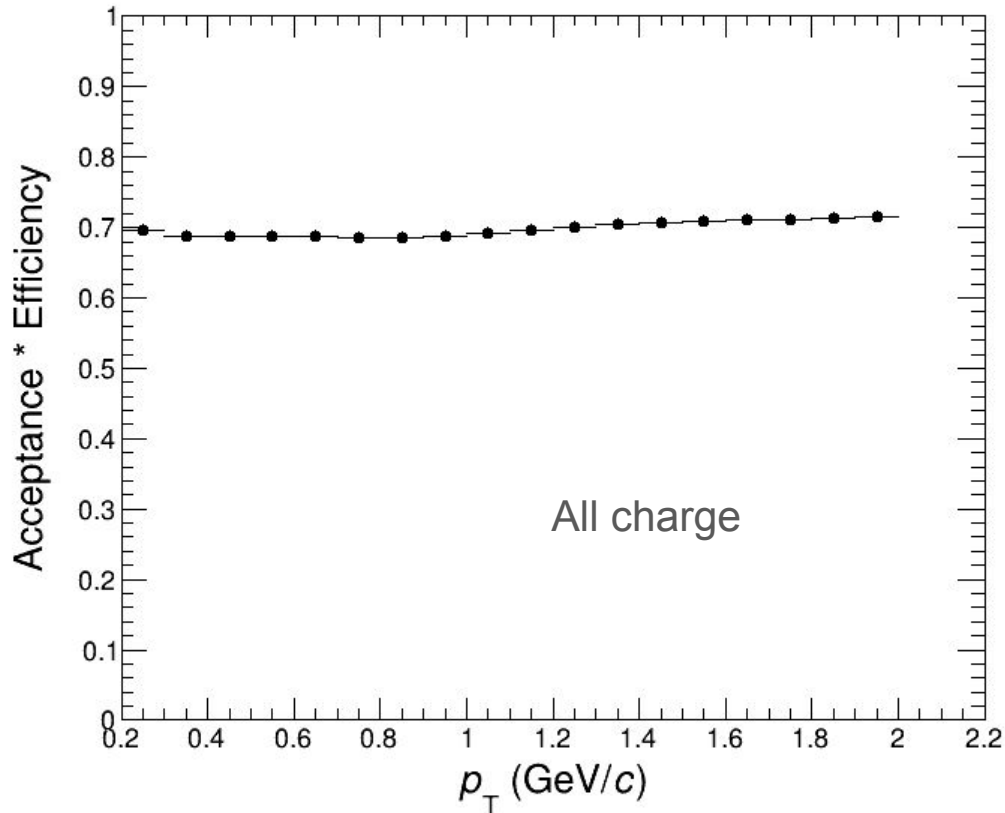
$\langle p_T \rangle$ vs N_{acc}



Two particle correlator vs N_{acc}



Efficiency (all charge)



$$efficiency = \frac{\text{reconstructed no. of particles}}{\text{generated no. of particles}}$$

Particle Identification: (pion) $|y| < 0.5$

$0.15 < p < 0.65 \text{ GeV}/c$

For tracks without TOF information.

$$|N\sigma_{\text{TPC}}|_{\pi} < 2.0, |N\sigma_{\text{TPC}}|_k > 2.0, |N\sigma_{\text{TPC}}|_p > 2.0$$

For tracks with TOF information.

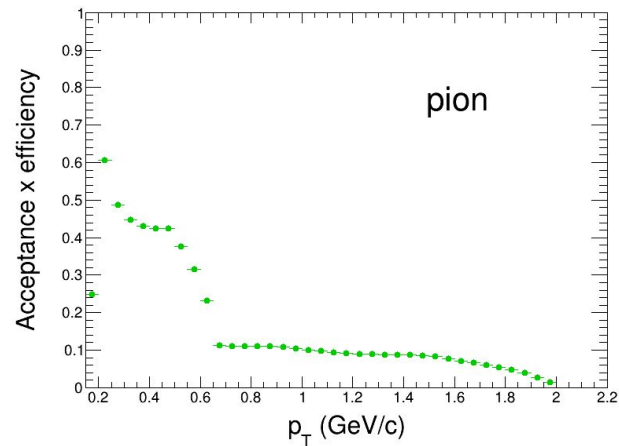
$$|N\sigma_{\text{TPC}}|_{\pi} < 2.0, |N\sigma_{\text{TOF}}|_{\pi} < 2.0, |N\sigma_{\text{TPC}}|_k > 2.0, |N\sigma_{\text{TPC}}|_p > 2.0$$

$0.65 < p < 2.0 \text{ GeV}/c$

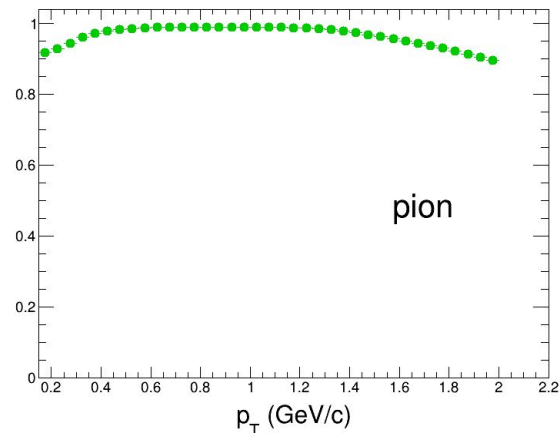
For tracks with TOF information.

$$|N\sigma_{\text{TPC}}|_{\pi} < 2.0, |N\sigma_{\text{TOF}}|_{\pi} < 2.0, |N\sigma_{\text{TPC-TOF}}|_k > 2.0, |N\sigma_{\text{TPC-TOF}}|_p > 2.0$$

Efficiency

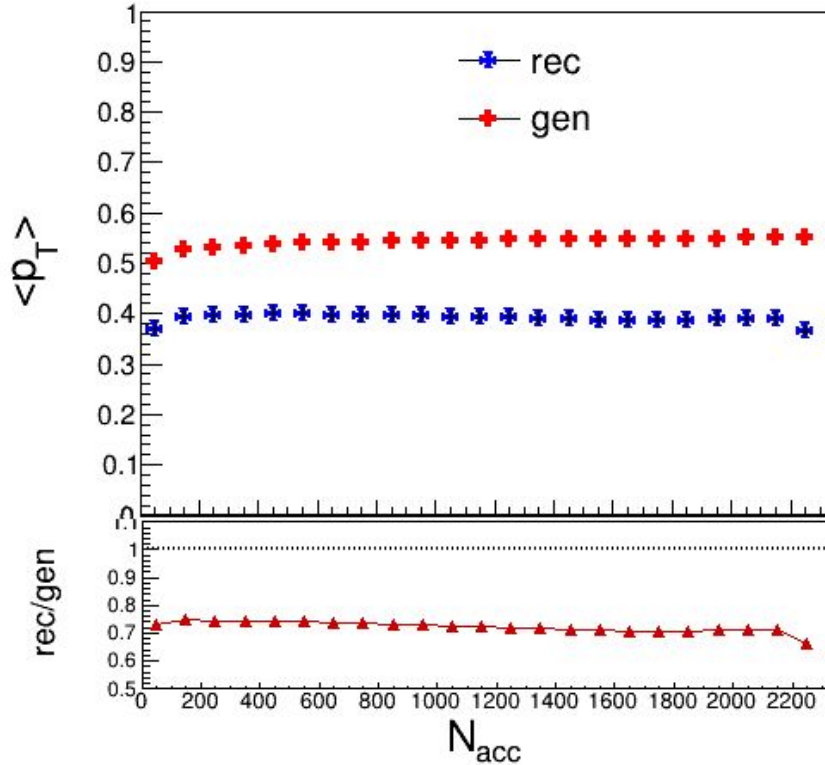


Purity

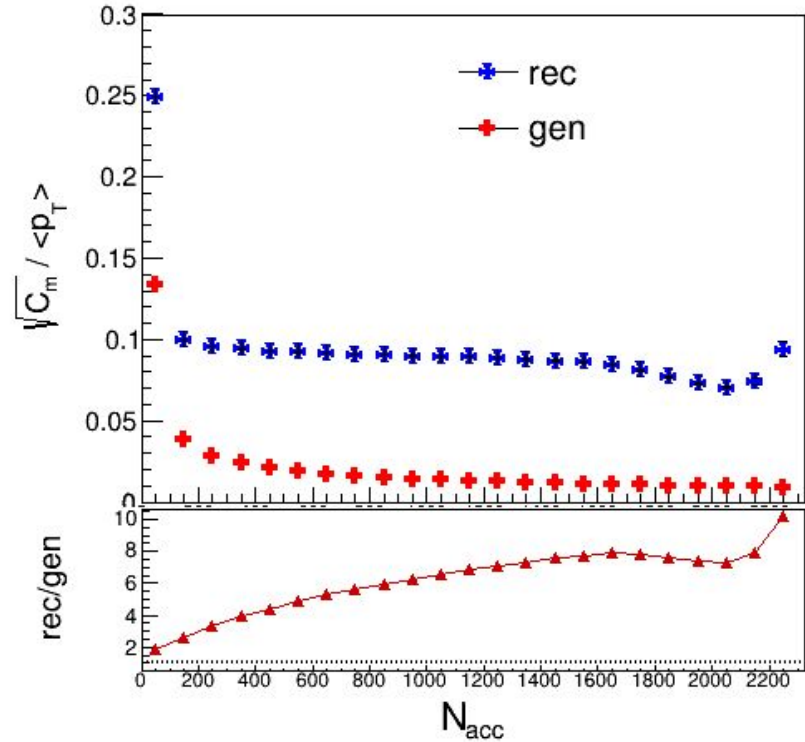


pion

$\langle p_T \rangle$ vs N_{acc}



Two particle correlator vs N_{acc}



Particle Identification: (kaon) $|y| < 0.5$

$0.15 < p < 0.65 \text{ GeV}/c$

For tracks without TOF information.

$$|N\sigma_{\text{TPC}|_k} < 2.0, |N\sigma_{\text{TPC}|_\pi} > 2.0, |N\sigma_{\text{TPC}|_p} > 2.0$$

For tracks with TOF information.

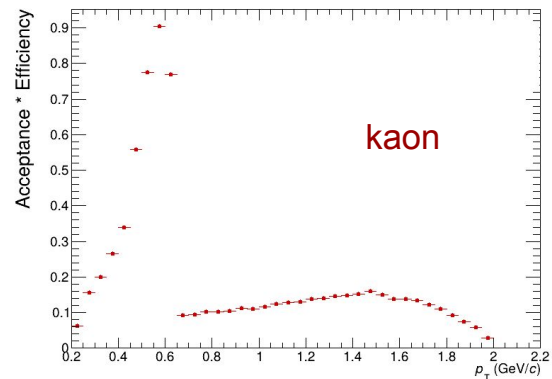
$$|N\sigma_{\text{TPC}|_k} < 2.0, |N\sigma_{\text{TOF}|_k} < 2.0, |N\sigma_{\text{TPC}|_\pi} > 2.0, |N\sigma_{\text{TPC}|_p} > 2.0$$

$0.65 < p < 2.0 \text{ GeV}/c$

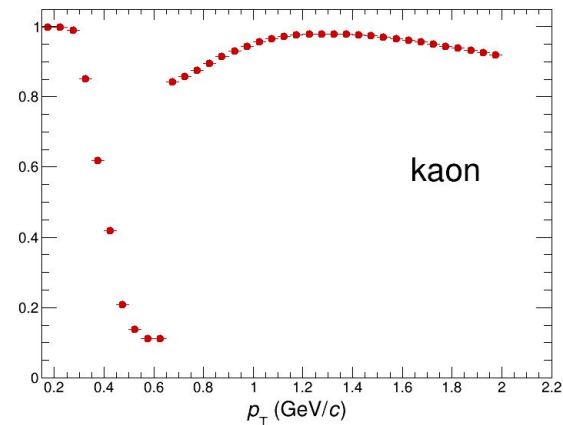
For tracks with TOF information.

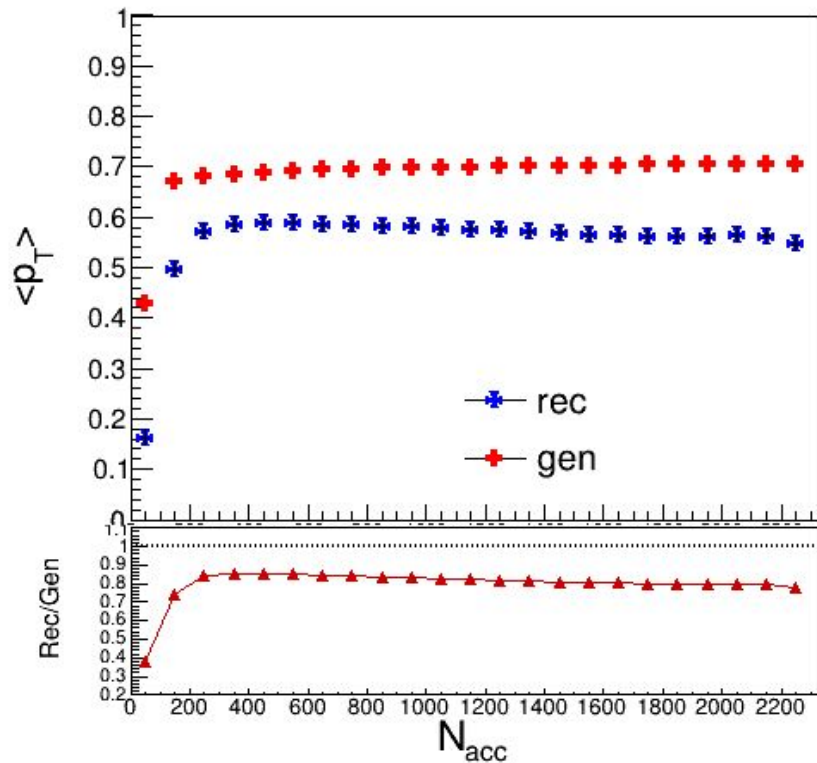
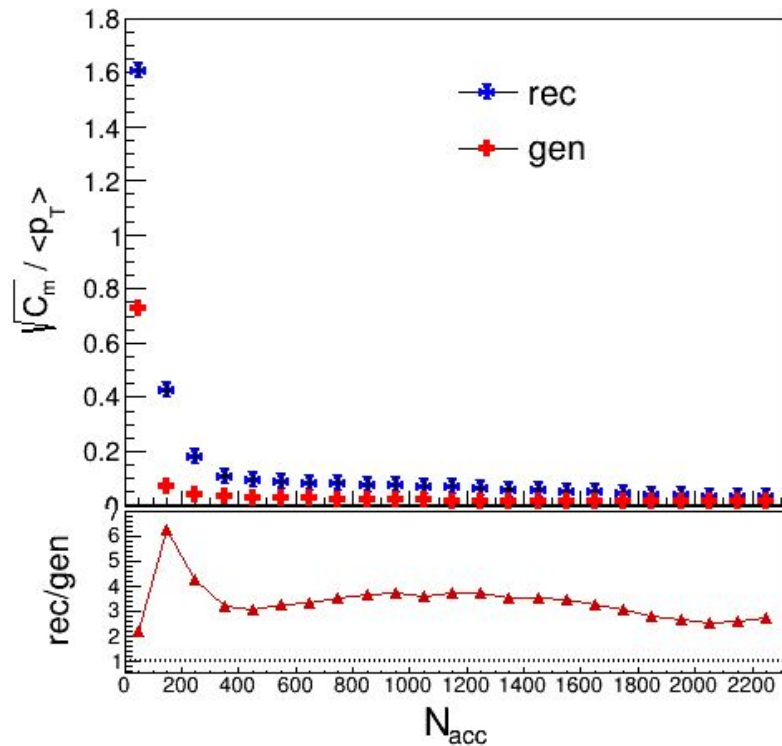
$$|N\sigma_{\text{TPC}|_k} < 2.0, |N\sigma_{\text{TOF}|_k} < 2.0, |N\sigma_{\text{TPC-TOF}|_\pi} > 2.0, |N\sigma_{\text{TPC-TOF}|_p} > 2.0$$

Efficiency



Purity



$\langle p_T \rangle$ vs N_{acc}

 Two particle correlator vs N_{acc}


Particle Identification: (proton) $|y| < 0.5$

$0.15 < p < 1.0 \text{ GeV}/c$

For tracks without TOF information.

$$|N\sigma_{\text{TPC}|_p} < 2.0, |N\sigma_{\text{TPC}|_\pi} > 2.0, |N\sigma_{\text{TPC}|_k} > 2.0$$

For tracks with TOF information.

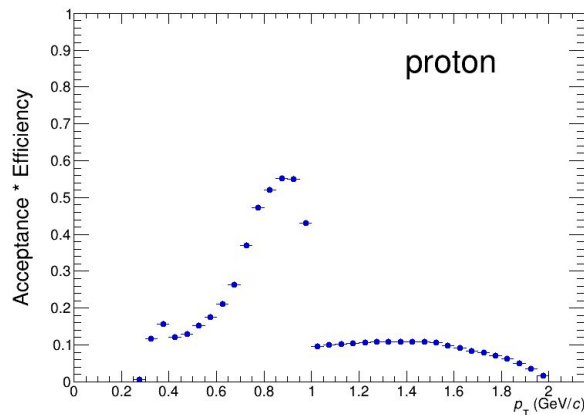
$$|N\sigma_{\text{TPC}|_p} < 2.0, |N\sigma_{\text{TOF}|_p} < 2.0, |N\sigma_{\text{TPC}|_\pi} > 2.0, |N\sigma_{\text{TPC}|_k} > 2.0$$

$1.0 < p < 2.0 \text{ GeV}/c$

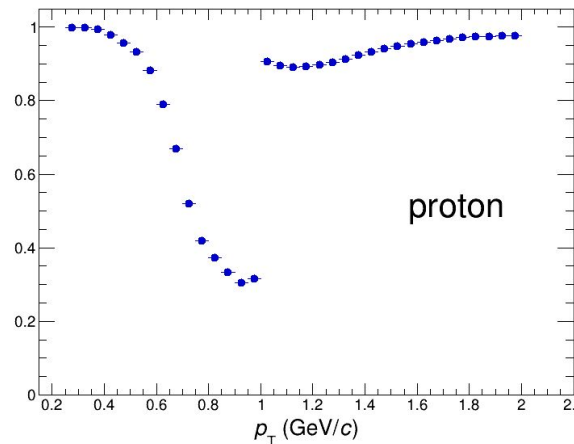
For tracks with TOF information.

$$|N\sigma_{\text{TPC}|_p} < 2.0, |N\sigma_{\text{TOF}|_p} < 2.0, |N\sigma_{\text{TPC-TOF}|_\pi} > 2.0, |N\sigma_{\text{TPC-TOF}|_k} > 2.0$$

Efficiency

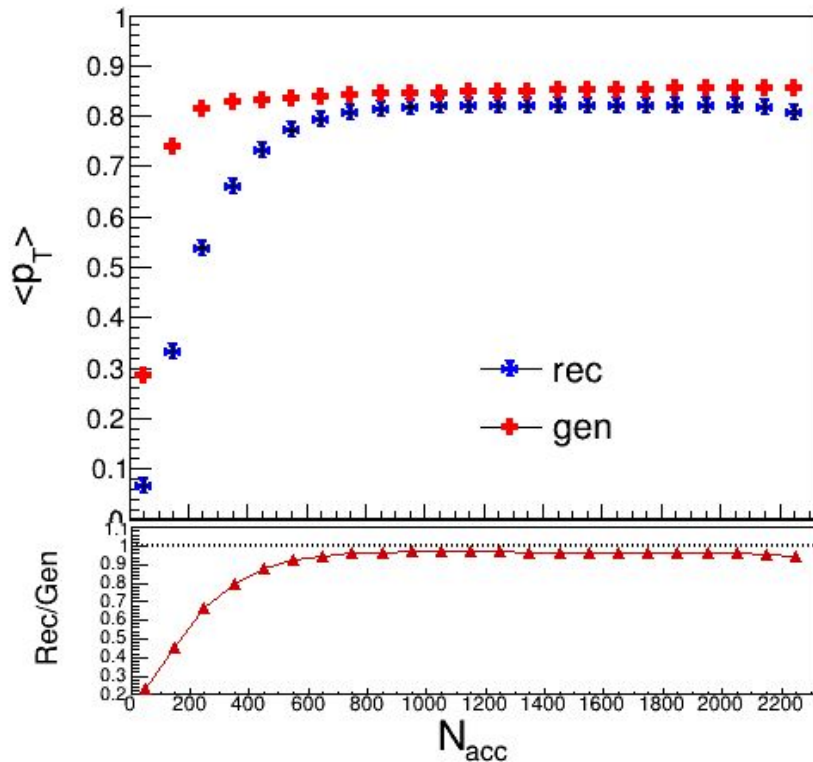


Purity

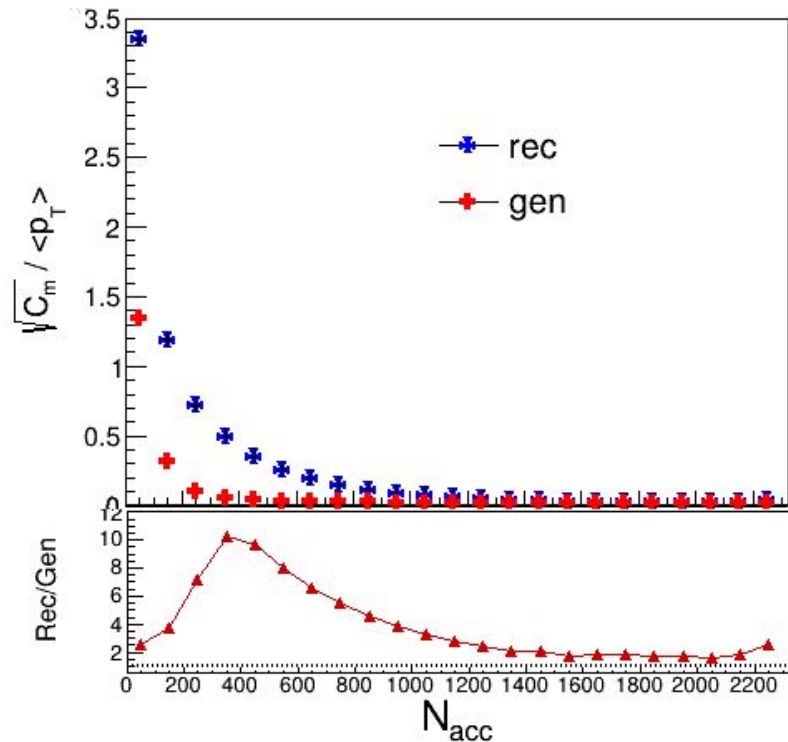


proton

$\langle p_T \rangle$ vs N_{acc}



Two particle correlator vs N_{acc}



Outlook:

- To do efficiency correction on pid, all charge particles.

Thank You