ALICE-India Meeting 07.02.2016

Heavy flavour azimuthal correlation

Jitendra Kumar

Supervisor: Prof. Raghava Varma

IIT Bombay, Mumbai

D meson azimuthal correlation

at 7 TeV(pp) & 5.02 TeV(p-Pb)

- D^+ Jitendra
- D^* Sandro/Sonia
- D^0 Fabio/**Somnath**

Paper ⇒ collaboration review

at 13TeV

- D^+ Shyam **(IITB)**
- D^* Mandeep/Sonia /Fatiha **(Jammu Uni. / Utrecht)**
- D^0 Bharti/Samrangi **(IITB/VECC)**

✳ 3 Outline

- ☑ Physics Motivation
- ☑ Analysis method
- ☑ Pass2 and Pass4 (pp data) D^+-h results comparison
- ☑ Pool by Pool ME correction for D^+-h correlation
- ☑ Summary
- ☑ QA trend of automatic tracking efficiency*

ALICE

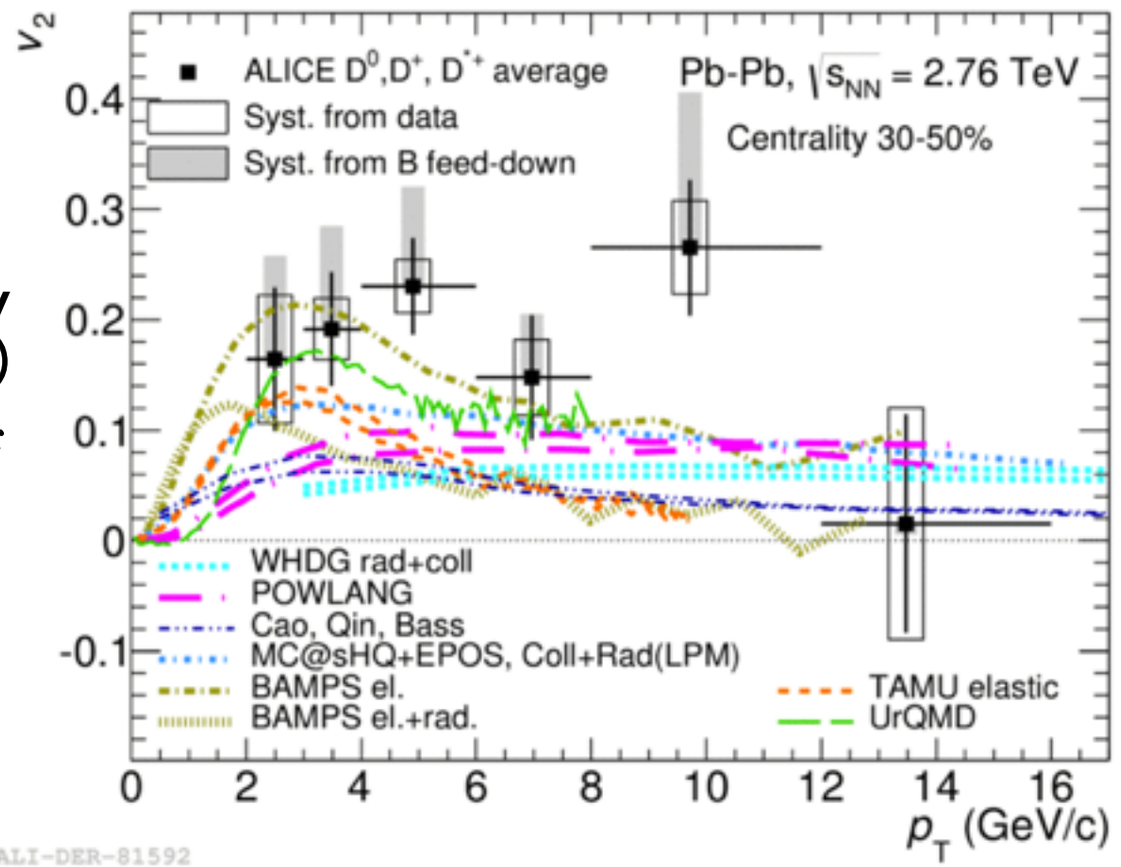
Heavy flavours (HF) in heavy-ion collisions

- Heavy quarks are produced in hard scatterings at the initial stage of the collision
  - ➡ They experience the complete evolution of the medium formed in heavy-ion collisions
  - ➡ Tool to study the hot and dense QGP (Quark-Gluon Plasma)
- Energy loss for heavy quarks predicted to be different from that experienced by gluons/LQ

→ **measurements show that heavy quarks strongly interact with the medium (energy loss + flow)**

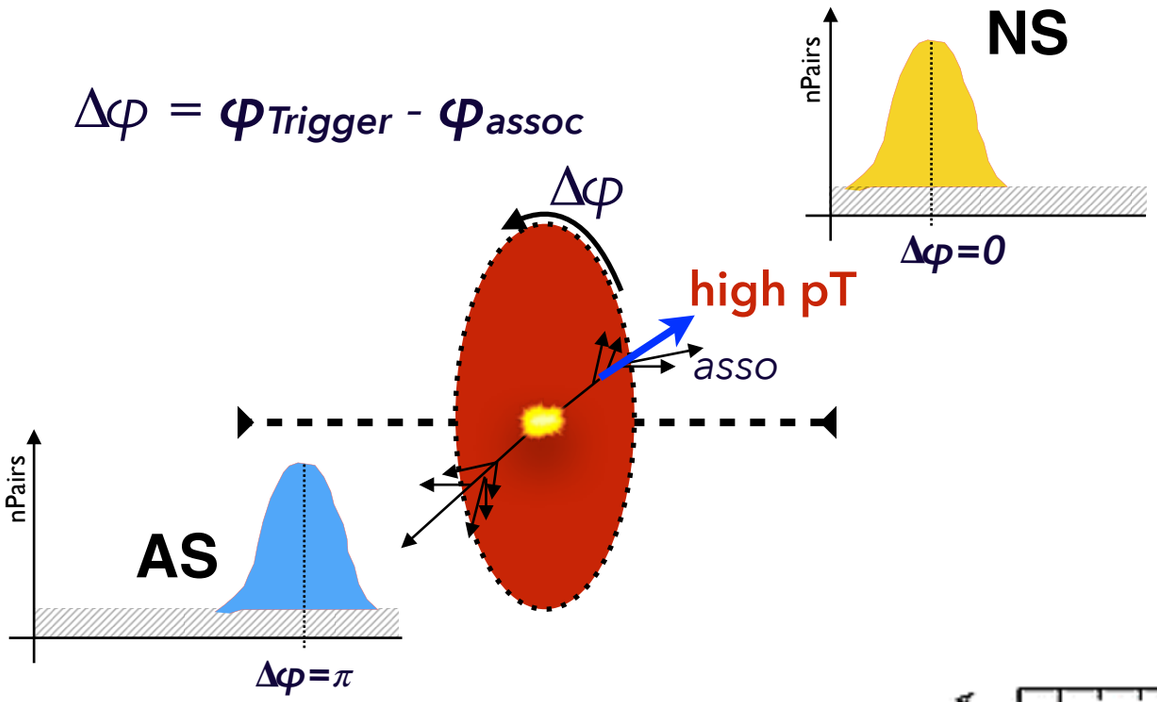
Non-zero D-meson v_2 in $2 < p_T < 6$ GeV/c

Phys. Rev Lett. 111 (2013) 102301



✳ 5 Physics Motivation

Azimuthal correlation in heavy-ion collisions



between high-p_T trigger hadrons and other hadrons produced in heavy-ion collisions are sensitive to:

- In-medium partonic energy loss:
  path-length dependence of energy loss
  - ➡ surface bias
  - ➡ away-side suppression
- Possible modification of jets:
  modified parton shower and fragmentation

ALICE results (light-flavour sector): hadron-hadron correlations

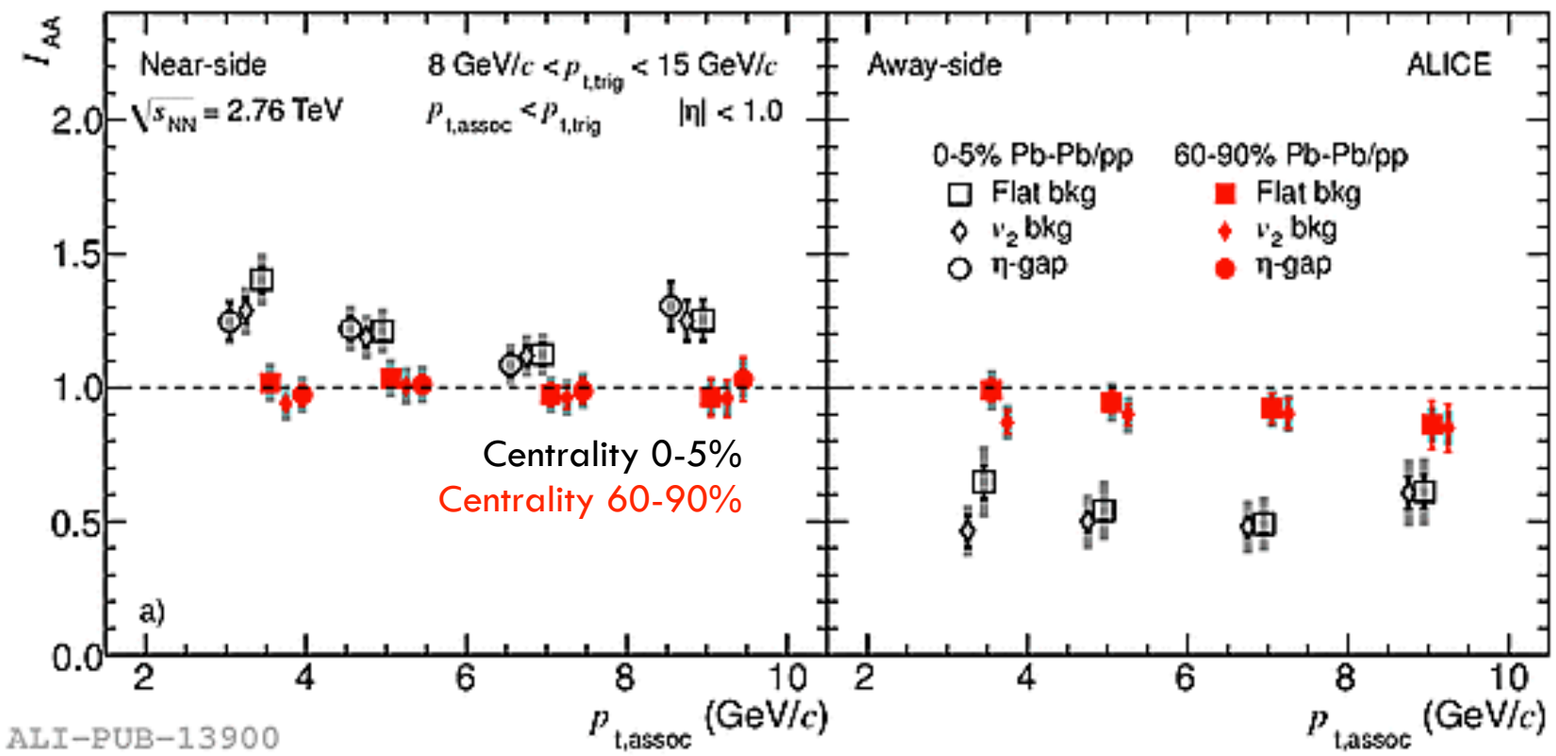
$$I_{AA} = Y_{PbPb} / Y_{pp}$$

Pb-Pb collisions (0-5%)

- Near side: 20% enhancement
- Away side: 50% suppression

I_{AA} of heavy flavours ?

Phys. Rev. Lett. 108 (2012) 092301



6 Physics Motivation

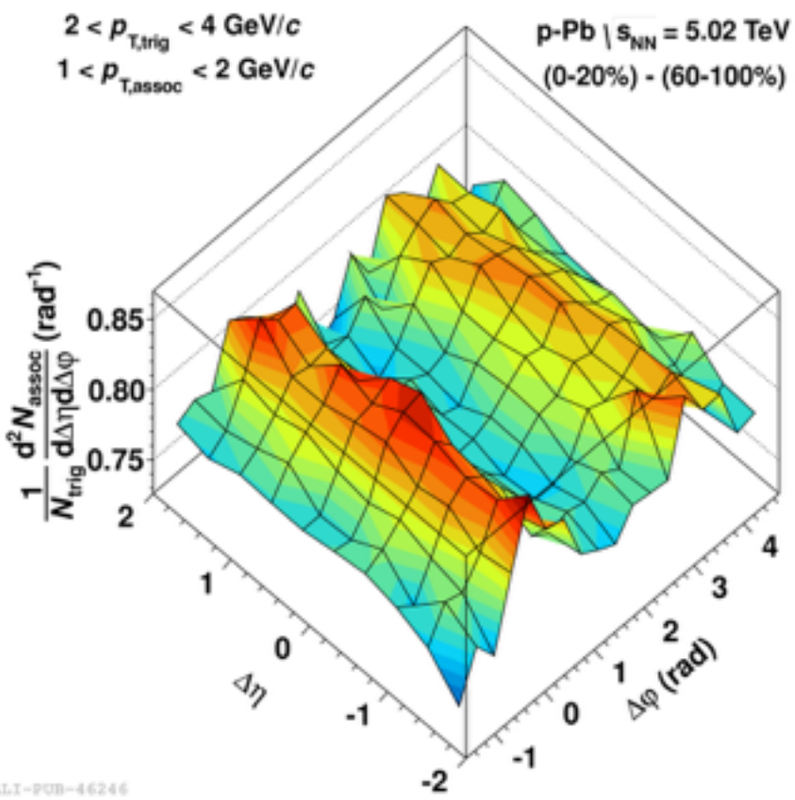
Azimuthal correlations in p-Pb collisions

- Long-range correlations in p-Pb collisions have been observed at the LHC (CGC[1]? Hydrodynamics[2] ?)

- **ALICE: di-hadron correlations (light-flavour sector)**

Similar effect present in the heavy-flavour sector ?

Phys.Lett.B 719 (2013) 29-41



HF in pp collisions

- Information on different HF production mechanisms
- Reference for p-Pb and Pb-Pb collisions

1) K. Dusling and R. Venugopalan, Phys. Rev. D 87 (2013) 094034
2) P. Bozek, Phys. Rev. C 85 (2012) 014911

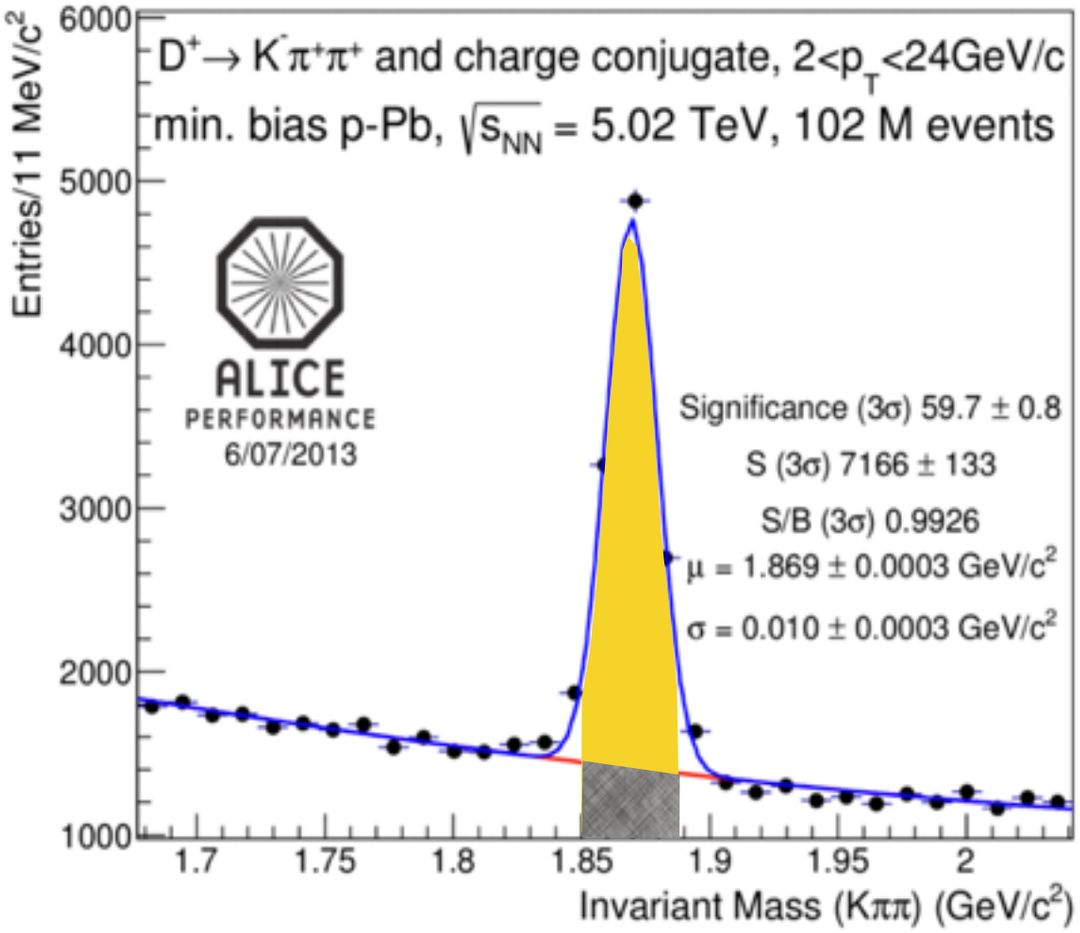
✳ 7 Data/cuts

- ☑ Data: pp at 7TeV (pass2, pass4)
- ☑ Number of events: 310M
- ☑ D^+/Track cuts: Standard
- ☑ D^+/Track efficiency included (pass4)

✳ 8 Analysis Strategy

Step1. D^+ meson signal extraction

Invariant mass analysis via hadronic decay channel $D^+ \rightarrow K^-\pi^+\pi^+$ (topological cuts)



Way to build correlation using D^+ signal only (or background removal)

Choice 1 Extract D^+ signal only (**±1,2,3σ**) from invariant mass plot and and then proceed for the correlation.

@ Mass level

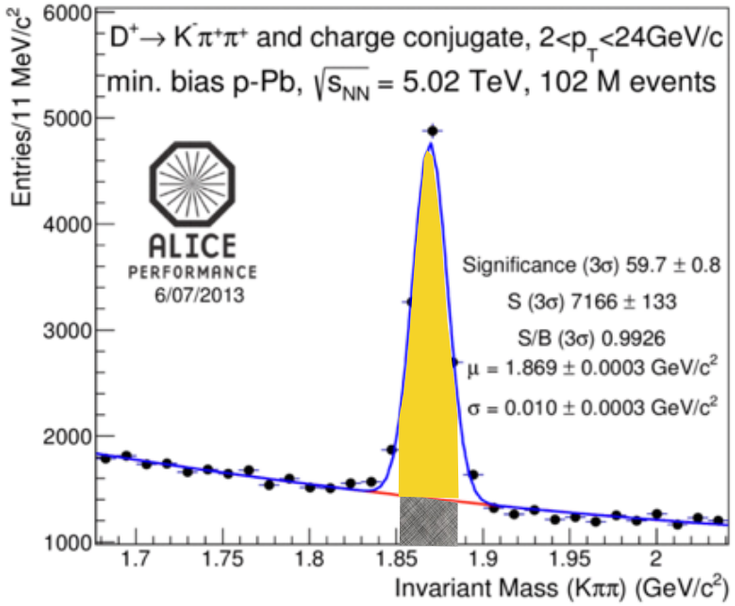
Choice 2 Calculate $\Delta\varphi$ **(±3σ)** in signal region and use Side Band (left and right part of spectrum) for background correlation and remove them from signal region (**"Side Band Subtraction"** method).

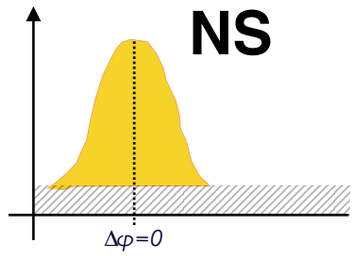
☛ **@ Correlations level**

✳ 9 Analysis Strategy

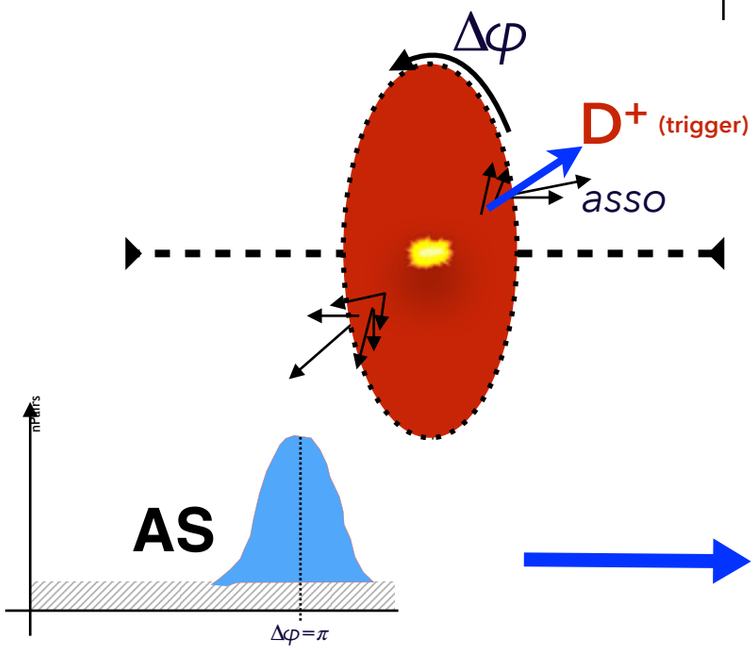
Step2. Azimuthal correlations ($\Delta\varphi$-$\Delta\eta$)

D^+ and charged particles



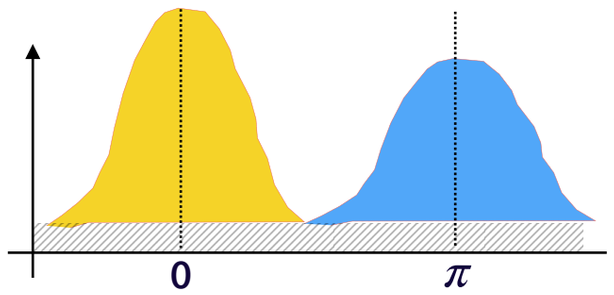


$\Delta\varphi = \varphi_{D+} - \varphi_{assoc}$



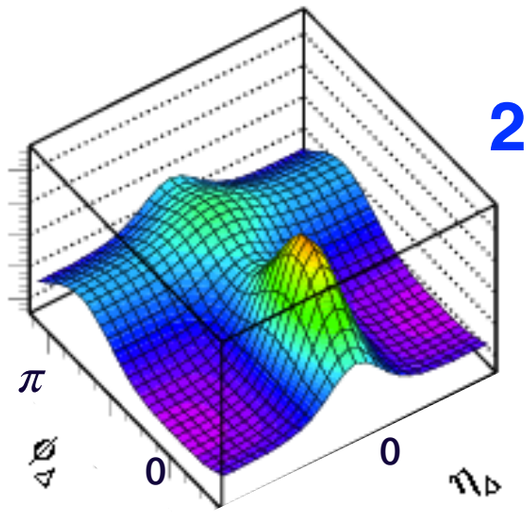
Pattern in pp, p-Pb and Pb-Pb collisions ?

1D



$\Delta\varphi = \varphi_{D+} - \varphi_{assoc}$

2D



$\Delta\varphi = \varphi_{D+} - \varphi_{assoc}$

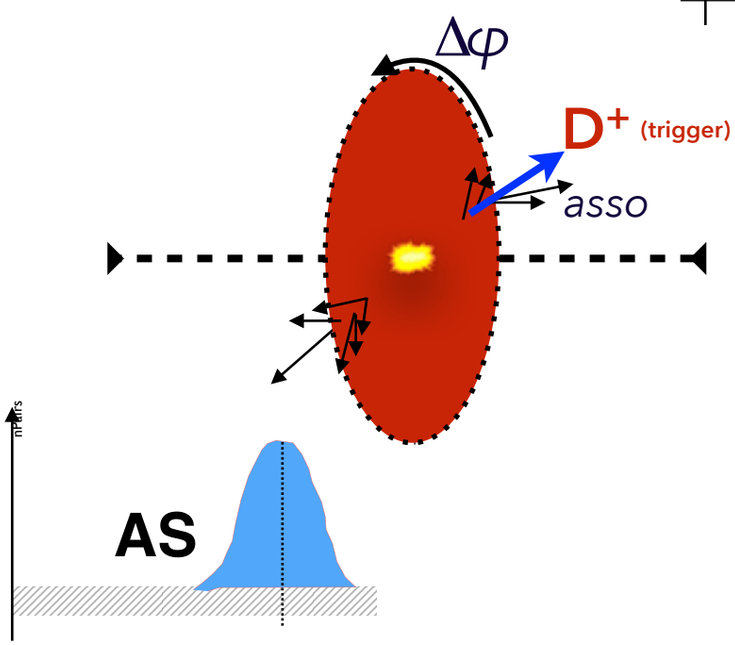
$\Delta\eta = \eta_{D+} - \eta_{assoc}$

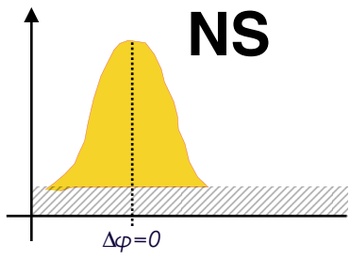
Analysis Strategy

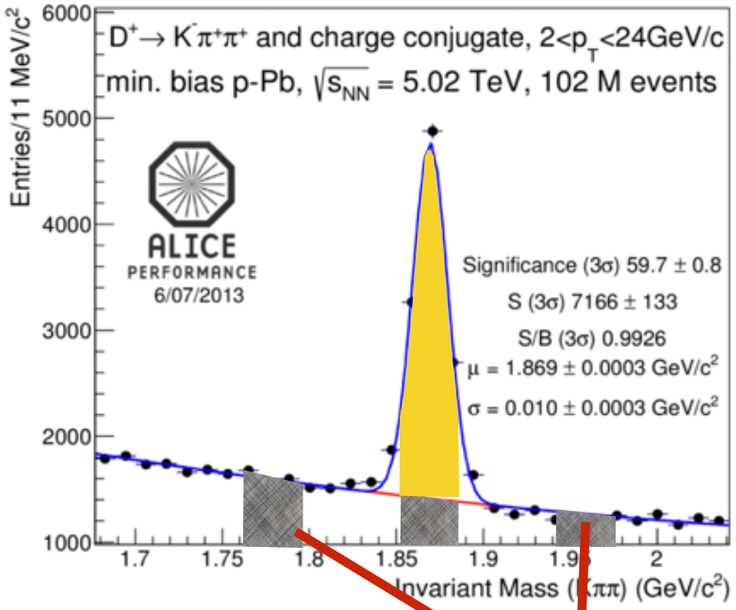
Step3. Subtraction of background azimuthal correlations ($\Delta\varphi$-$\Delta\eta$)

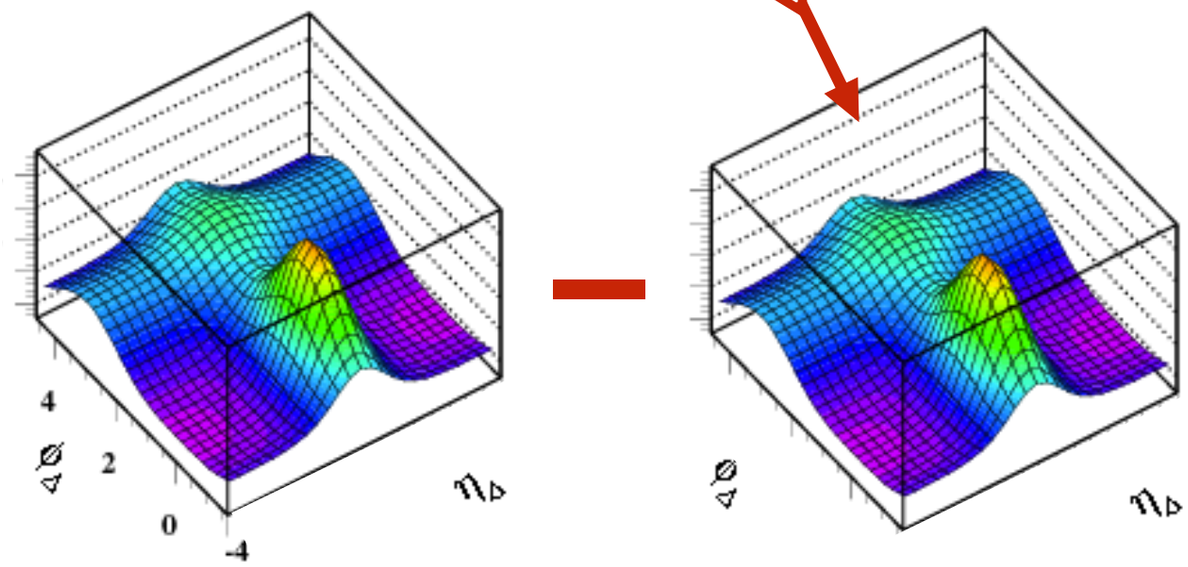
Using side bands of D^+ invariant mass

$$\Delta\varphi = \varphi_{D+} - \varphi_{assoc}$$



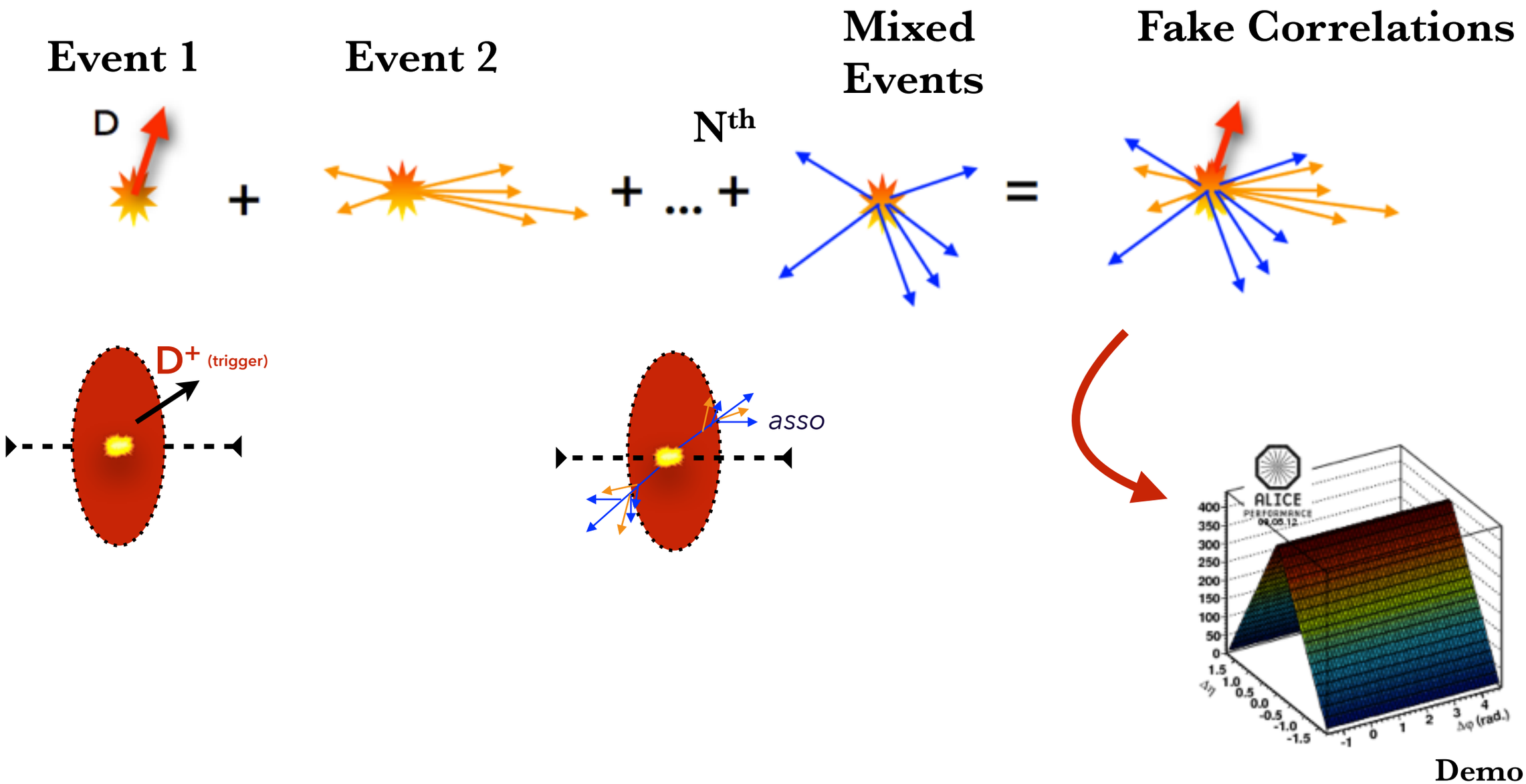






Step4. Corrections

- Detector inhomogeneity and acceptance: **Mixed Event**
- D^+ efficiency
- Charged particle(tracks) efficiency
- Feed down correction



Demo Plot

Analysis Strategy

ALICE

Correlations are build in different pT interval of D^+ and charge particles

D^+	Charged Particles
Low p_T (3-5 GeV/c)	p_T (> 0.3 GeV/c)
Mid p_T (5-8 GeV/c)	p_T (> 1.0 GeV/c)
High p_T (8-16 GeV/c)	p_T (0.3-1.0 GeV/c)

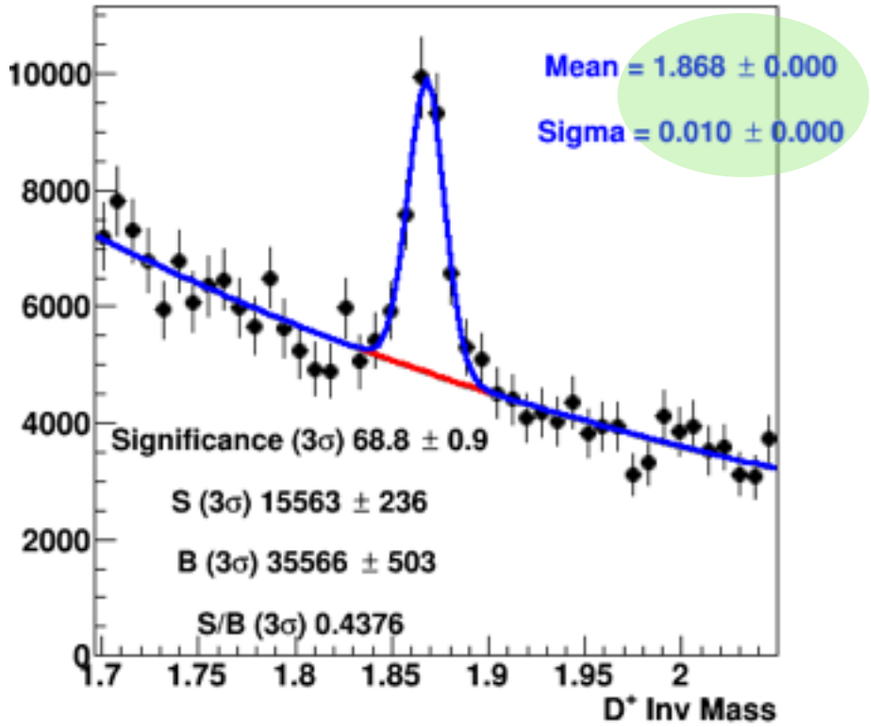
✳13 Check1

- ☑ Pass2 and Pass4 (pp data) results comparison
- ☑ Invariant mass plots
- ☑ Correlations results comparison

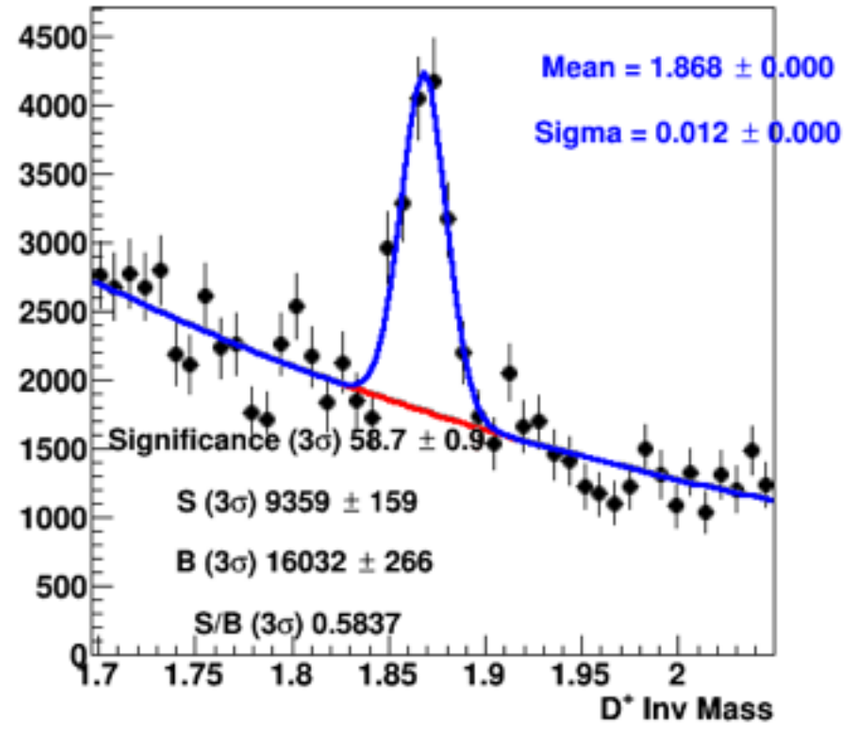
✳14 D+ Invariant Mass (3-5 GeV/c)

ALICE

Pass 2

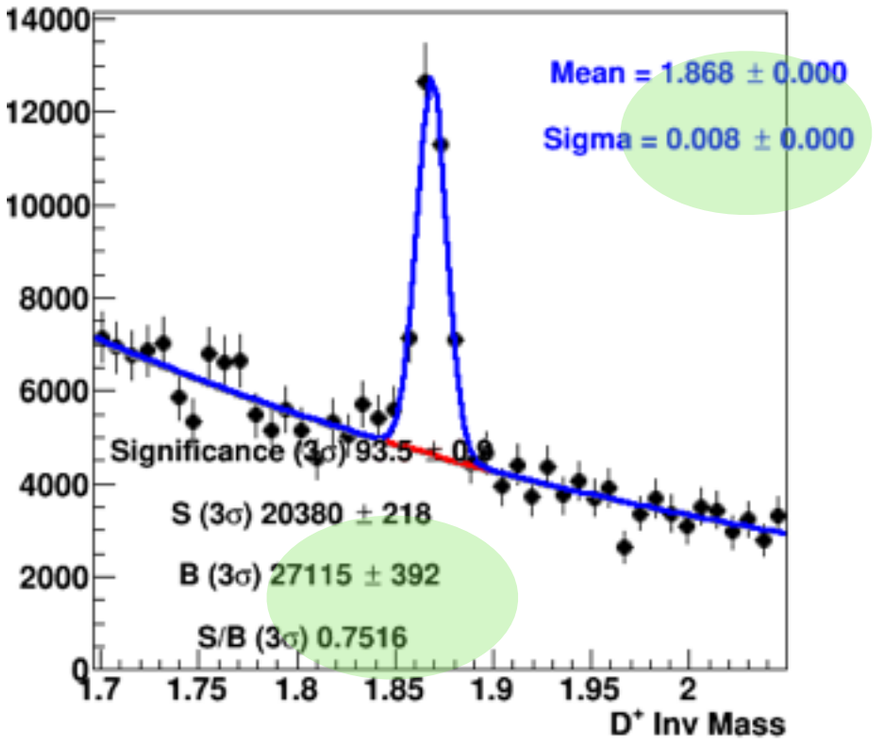


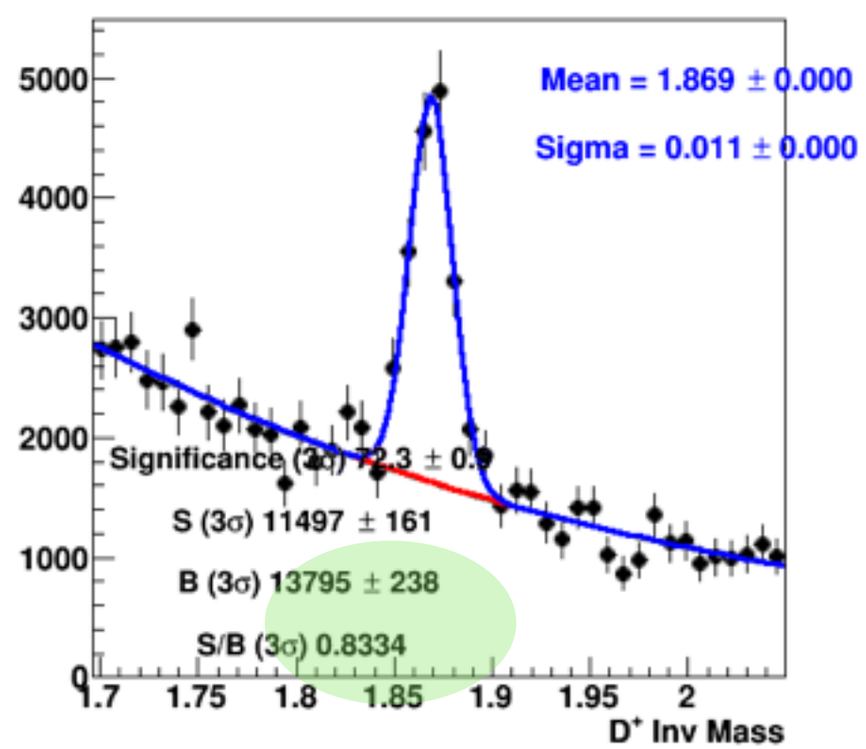
3-4 GeV/c^2



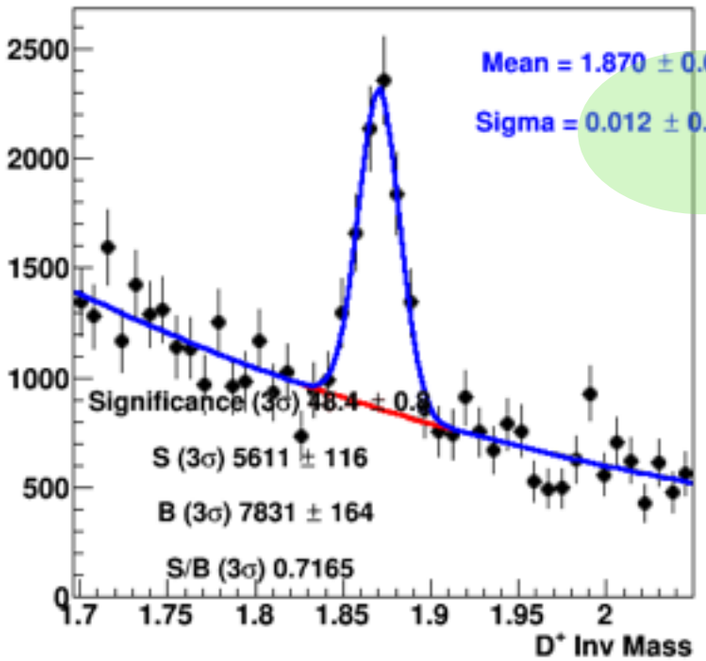
4-5 GeV/c^2

Pass 4

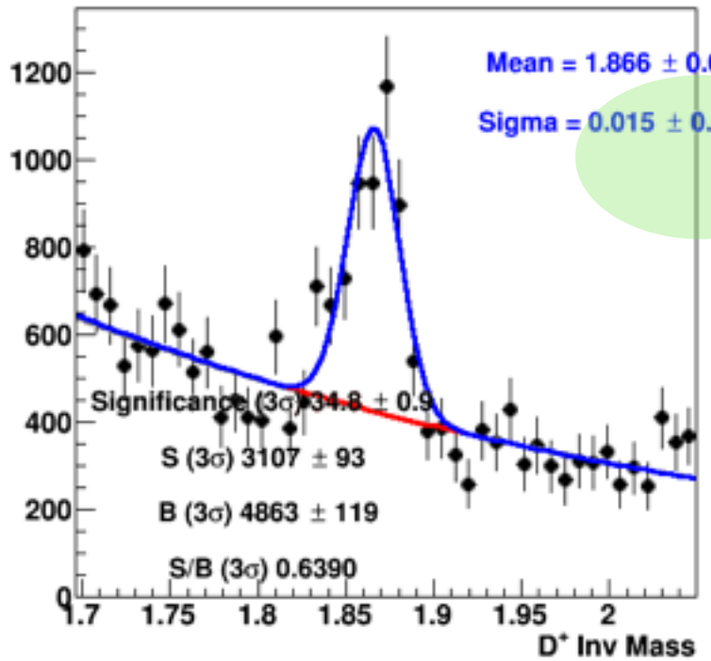




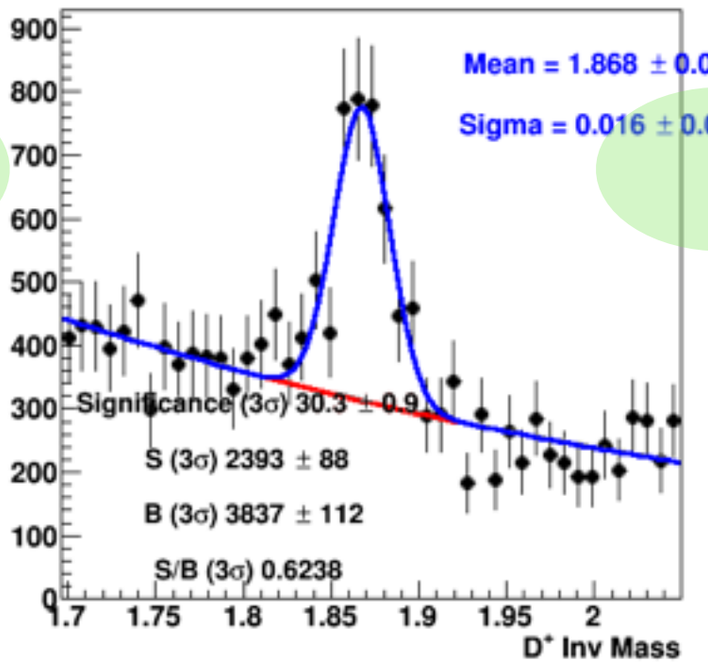
✳15 D+ Invariant Mass (5-8 GeV/c)



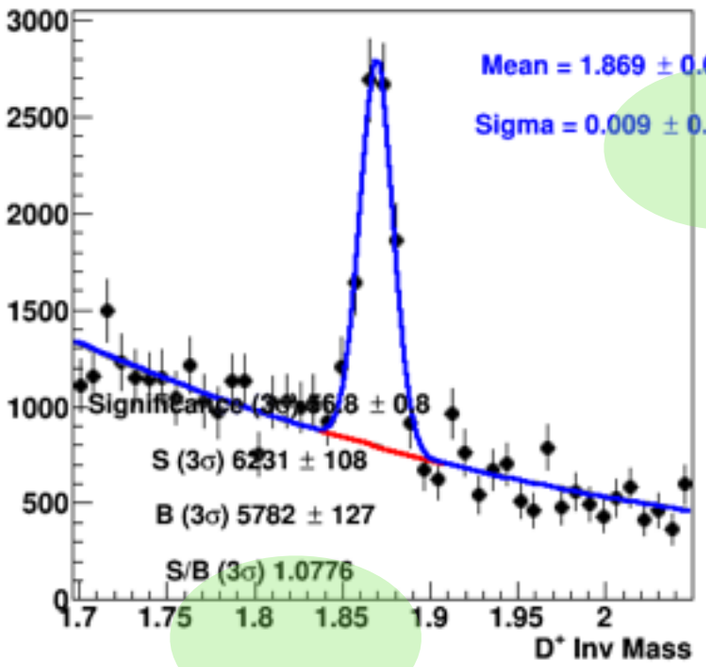
5-6 GeV/c^2

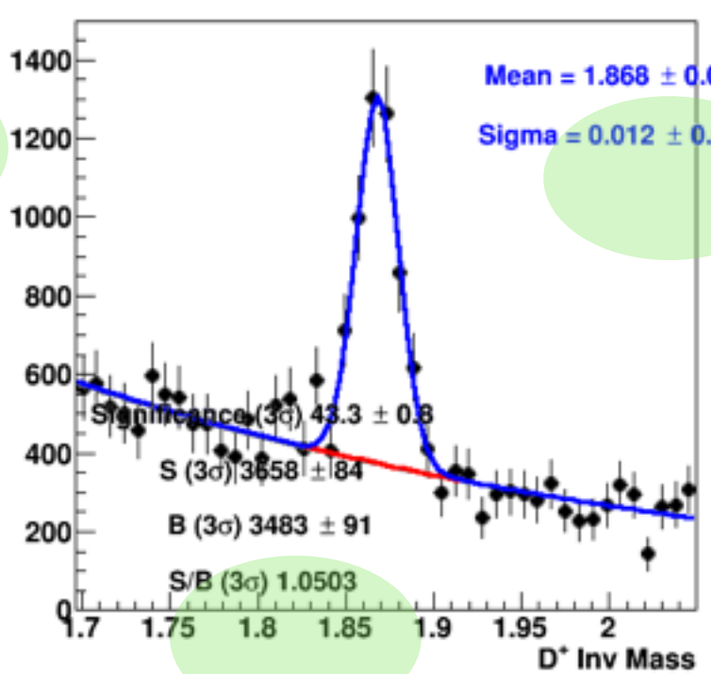


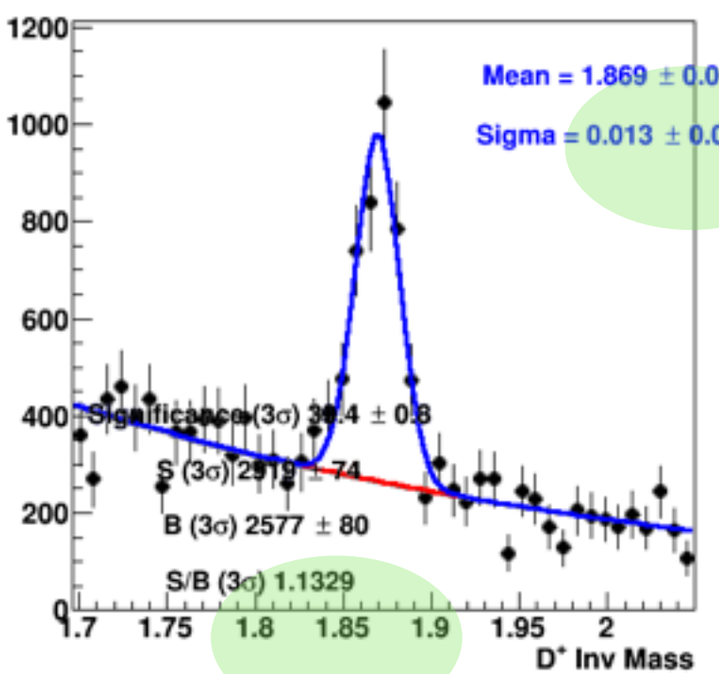
6-7 GeV/c^2



7-8 GeV/c^2



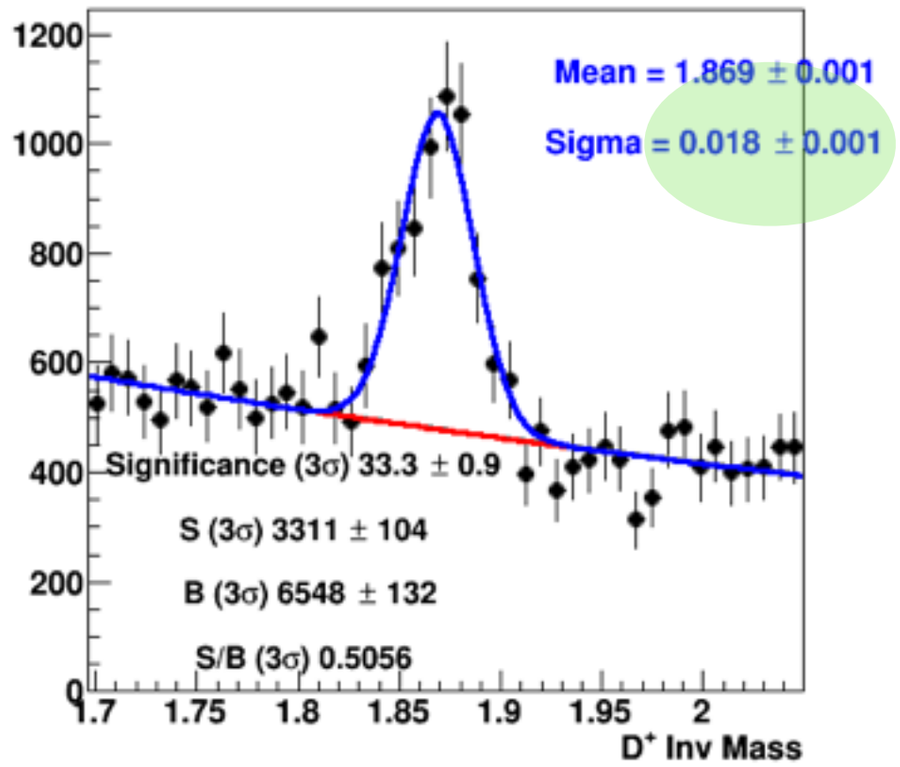




✳16 D+ Invariant Mass (8-16 GeV/c)

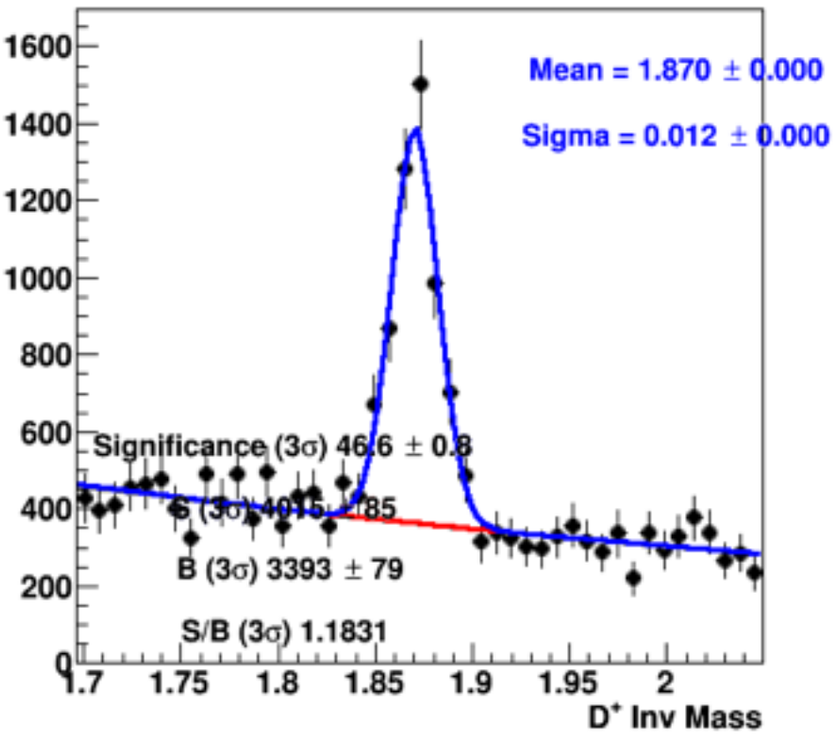
ALICE

Pass 2



8-16 GeV/c^2 (merged)

Pass 4

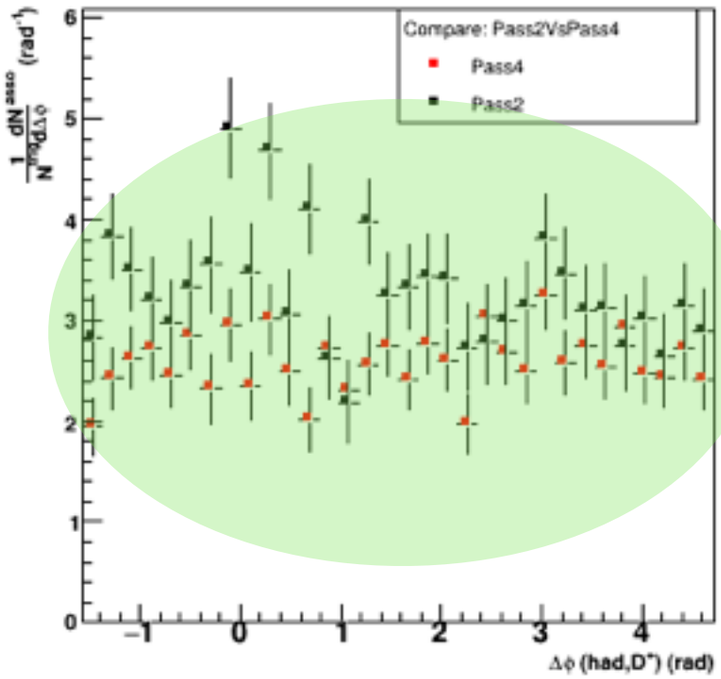


✳17 Pass2 Vs Pass4 correlations

Hadron p_T > 0.3 GeV/c

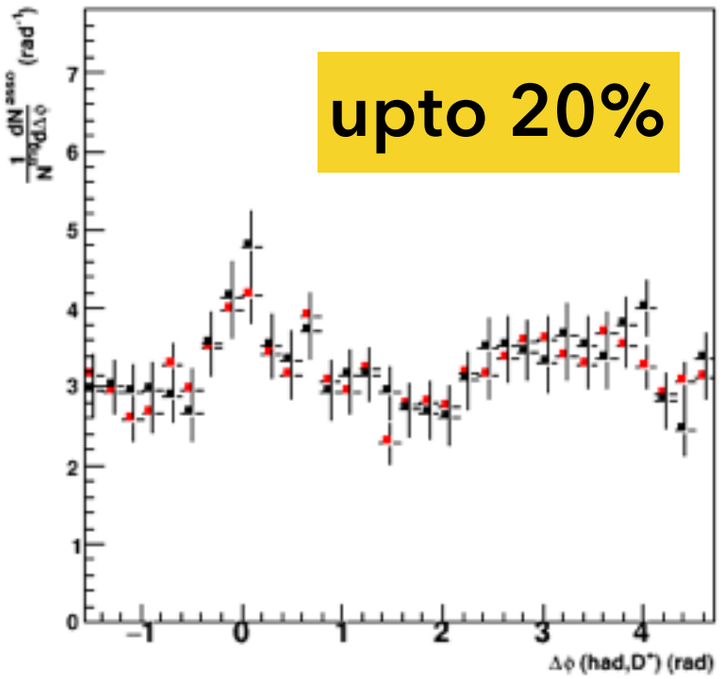
ALICE

D⁺: 3-5 pT GeV/c



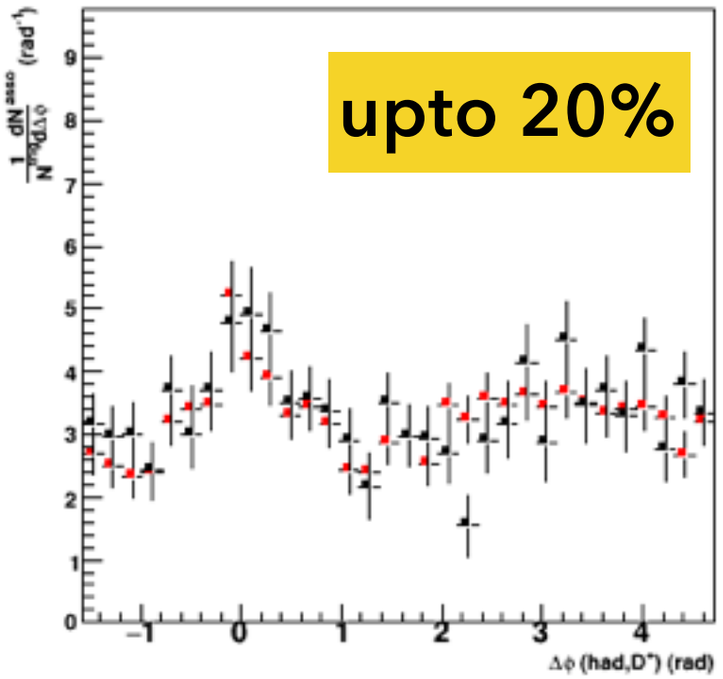
D⁺: 5-8 pT GeV/c

upto 20%



D⁺: 8-16 pT GeV/c

upto 20%

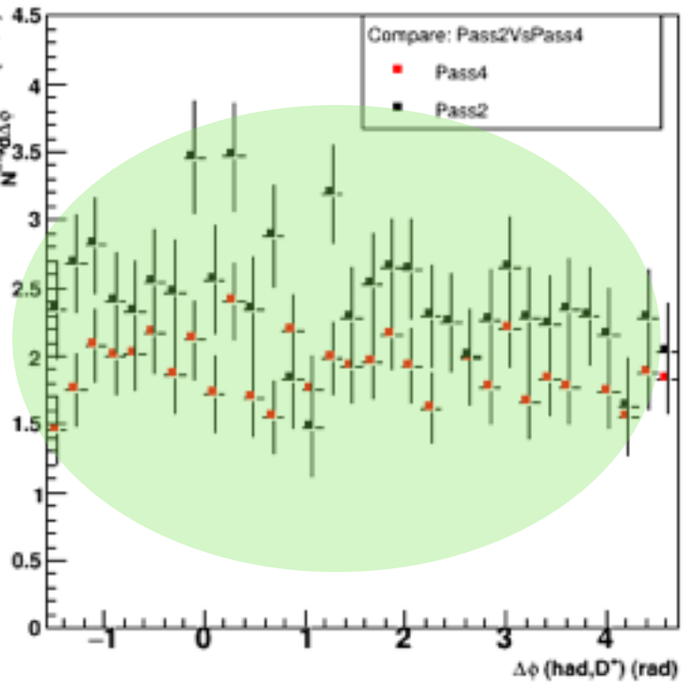


✳18 Pass2 Vs Pass4 correlations

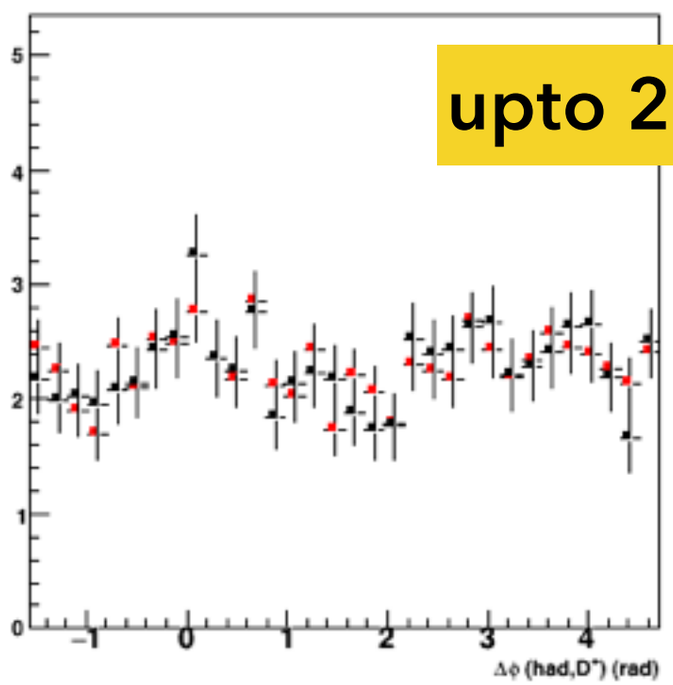
Hadron p_T 0.3-1.0 GeV/c

ALICE

D^+: 3-5 pT GeV/c

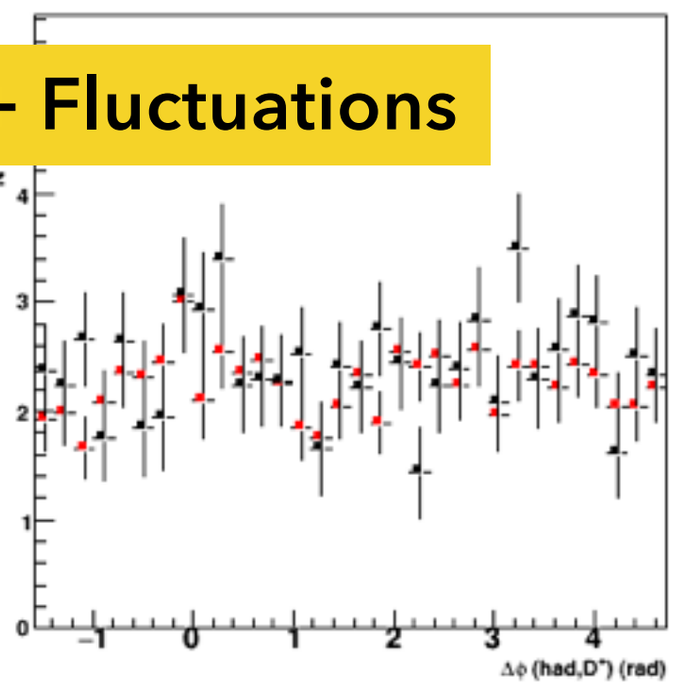


D^+: 5-8 pT GeV/c



upto 20% + Fluctuations

D^+: 8-16 pT GeV/c

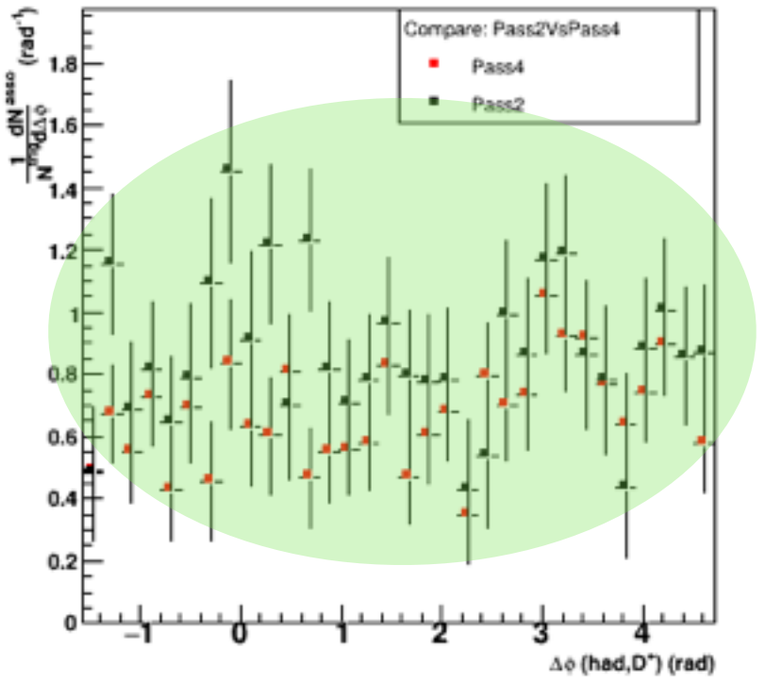


✳19 Pass2 Vs Pass4 correlations

Hadron p_T > 1.0 GeV/c

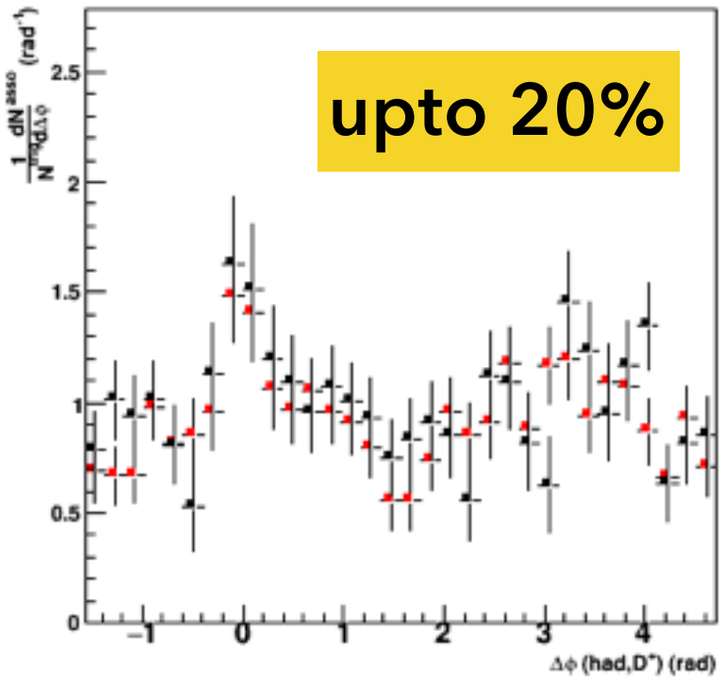
ALICE

D⁺: 3-5 pT GeV/c



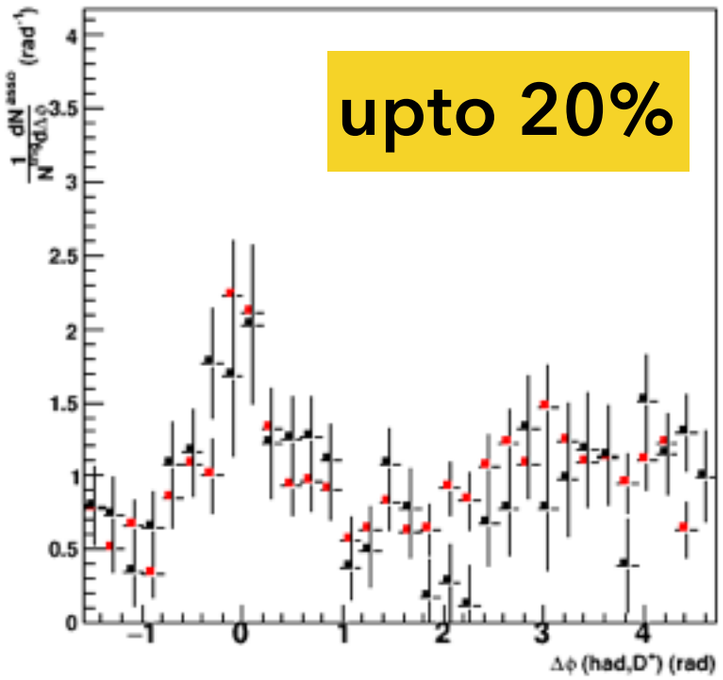
D⁺: 5-8 pT GeV/c

upto 20%



D⁺: 8-16 pT GeV/c

upto 20%



✳20 Pass2 Vs Pass4 Summary

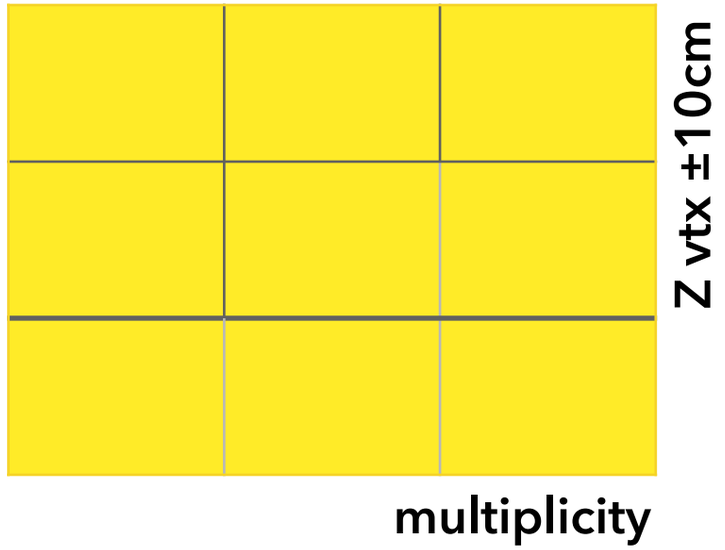
- ☑ Improved S/B ratio observed for pass4 data
- ☑ Correlations at Low pT are much different
- ☑ Other pT bin correlations are upto 20% different

- ☑ Pool by Pool ME correction for D^+-h correlations (pass4 data)
- ☑ Correlations results comparison

Pool by Pool Check

☑ Pool by Pool ME correction for D^+-h correlations (pass4 data)

Event Pool =



Method earlier

$$fCorr^{2D} = \frac{1}{N_{trig}} \frac{\sum_{i=0}^{nPool} SE_i^{2D}}{\frac{1}{norm}\sum_{i=0}^{nPool} ME_i^{2D}}$$

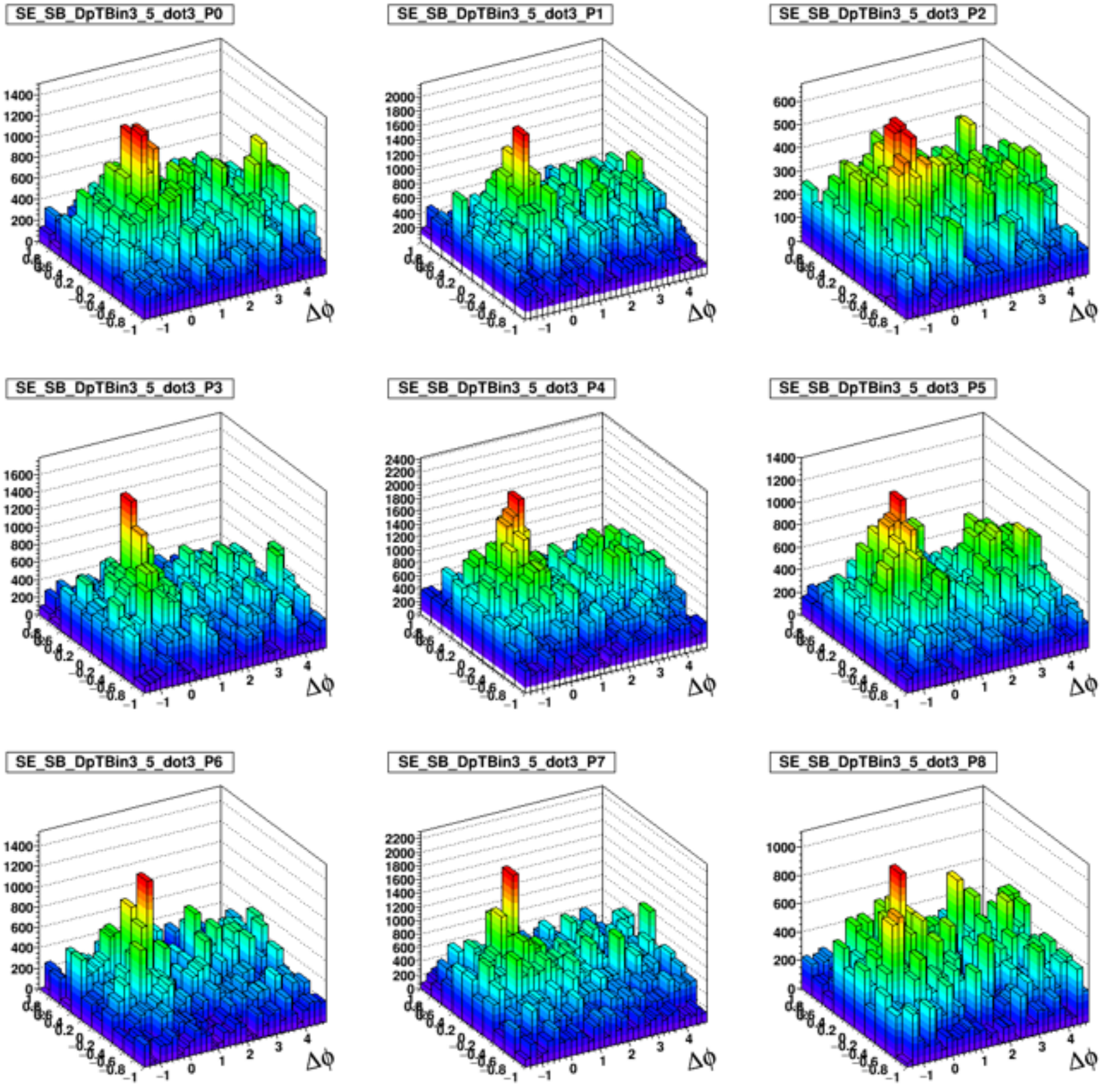
Method now

$$fCorr^{2D} = \frac{1}{N_{trig}} \sum_{i=0}^{nPool} \frac{SE_i^{2D}}{\frac{1}{norm} ME_i^{2D}}$$

✳23 Pool by Pool: 2DSE (Single+Bkg)

D^+: 3-5 pT GeV/c Hadron p_T > 0.3 GeV/c

ALICE

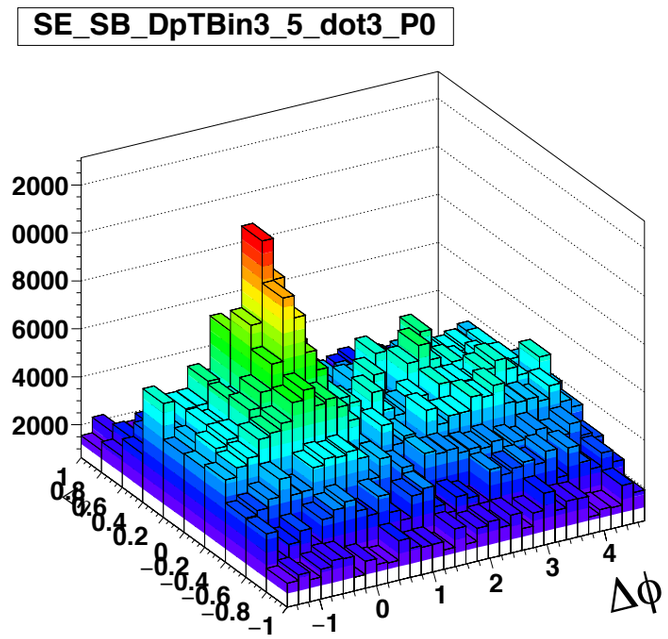


✳24 ∑Pool: 2DSE (Single+Bkg)

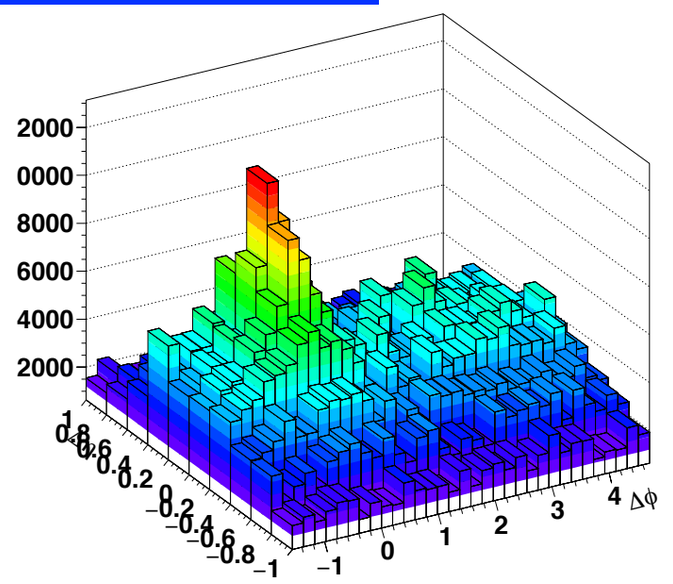
Hadron p_T > 0.3 GeV/c

ALICE

D^+: 3-5 pT GeV/c



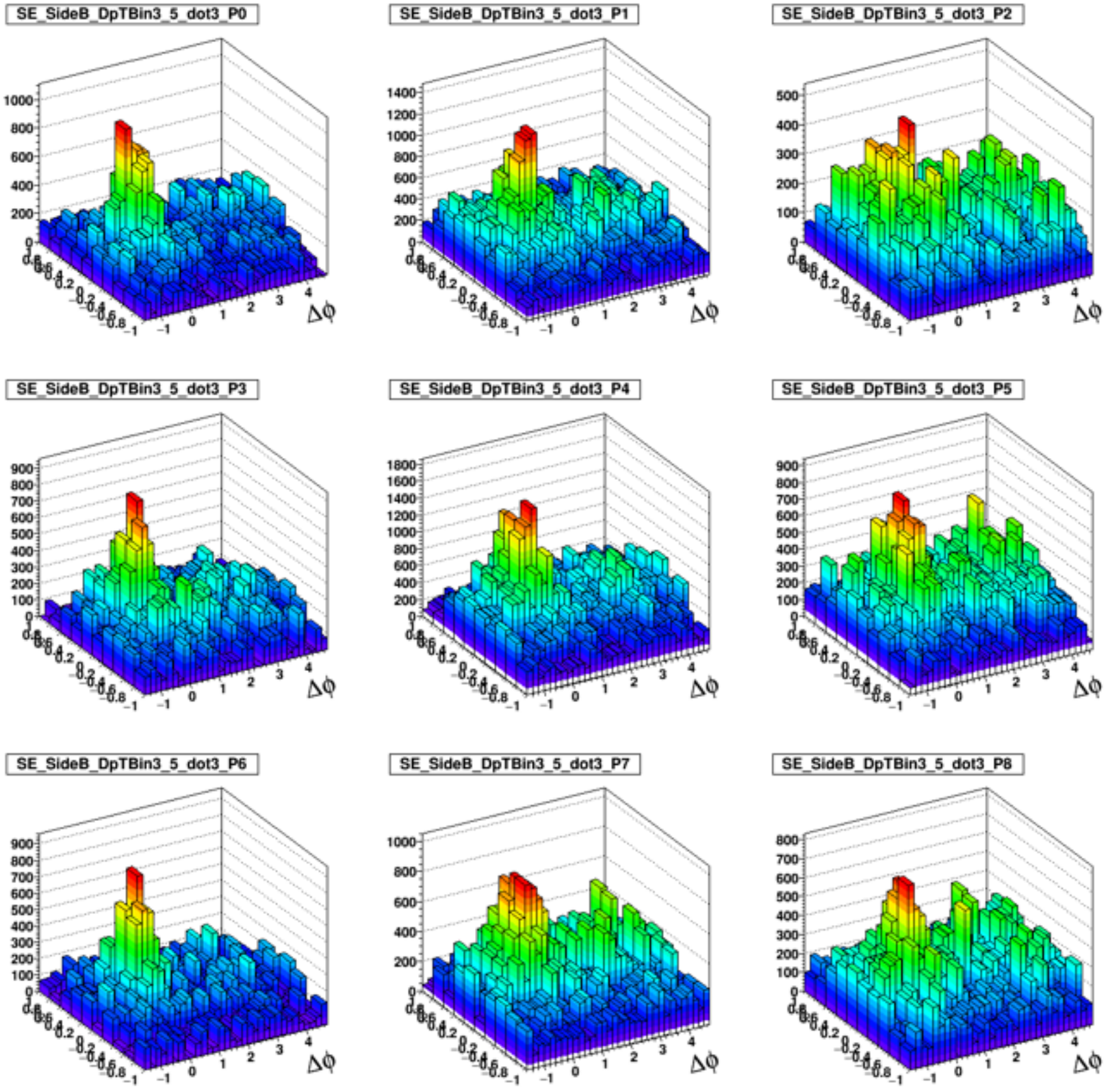
wPool: 2DSE (Single+Bkg)



✳25 Pool by Pool: 2DSE (Sidebands)

D^+: 3-5 pT GeV/c Hadron p_T > 0.3 GeV/c

ALICE

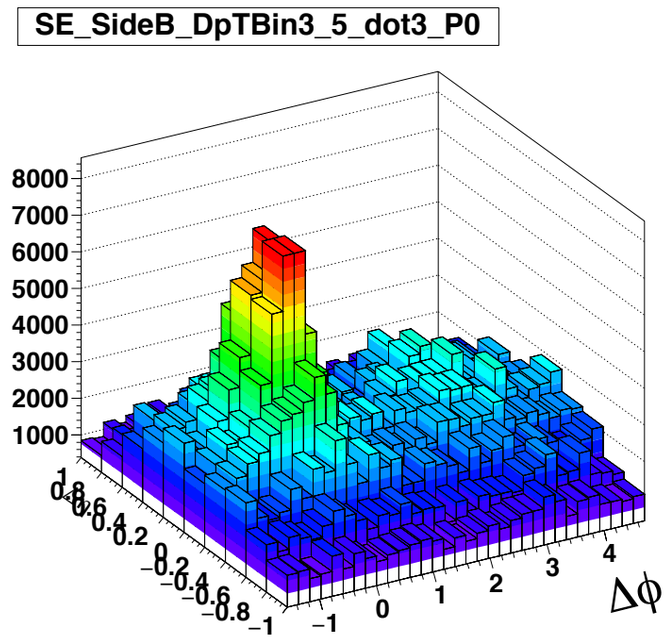


✳26 ∑Pool: 2DSE (Sidebands)

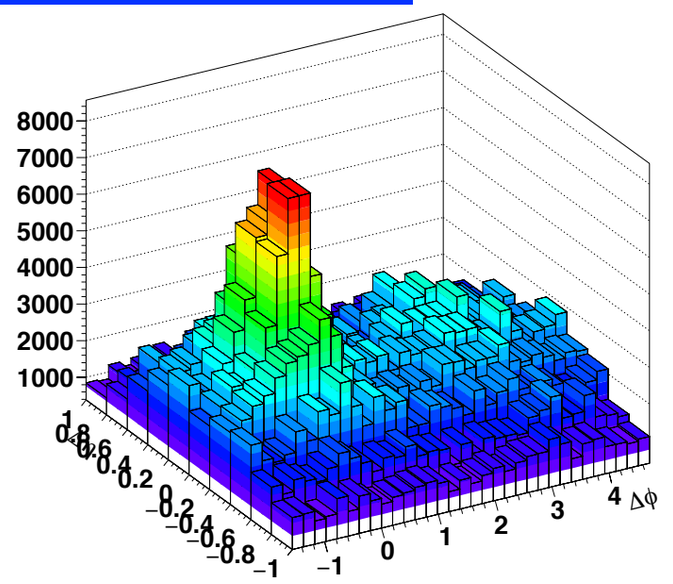
Hadron p_T > 0.3 GeV/c

ALICE

D^+: 3-5 pT GeV/c



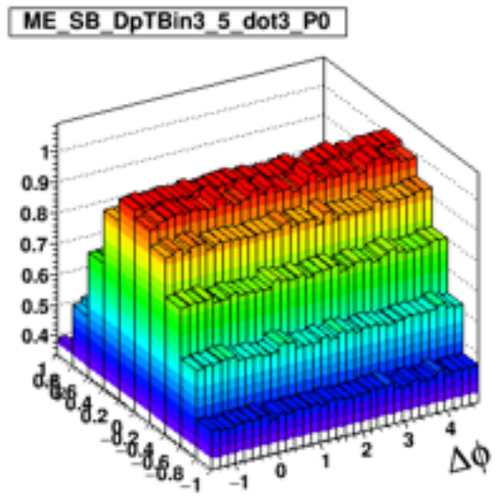
wPool: 2DSE (Sidebands)

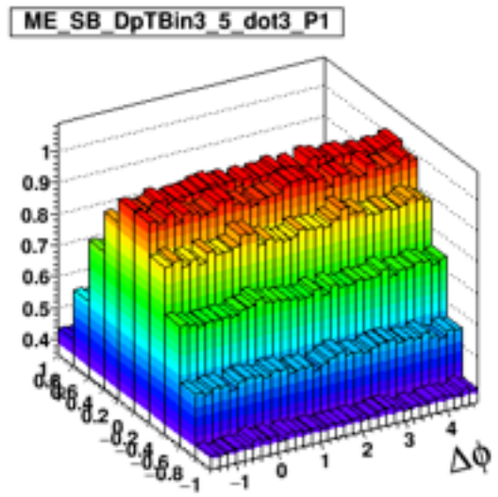


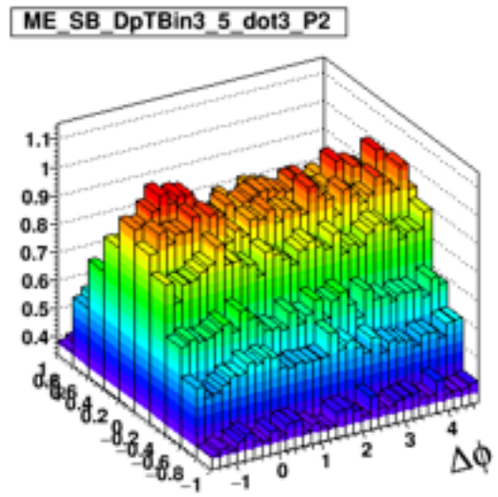
✳27 Pool by Pool: 2DME (Single+Bkg)

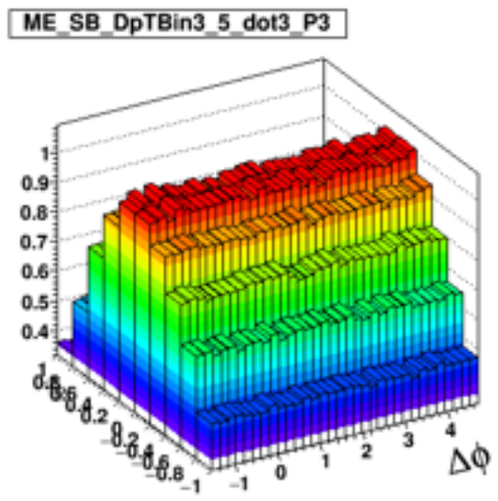
D^+: 3-5 pT GeV/c Hadron p_T > 0.3 GeV/c

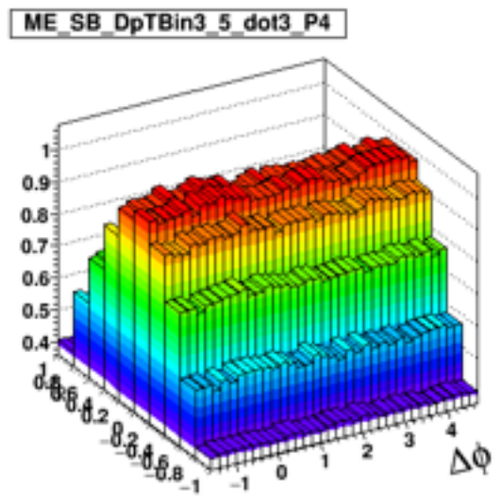
ALICE

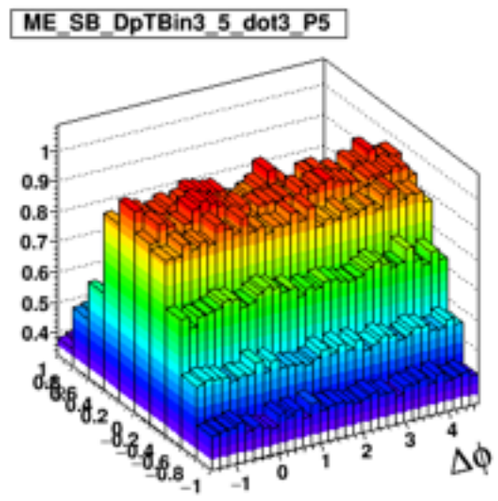


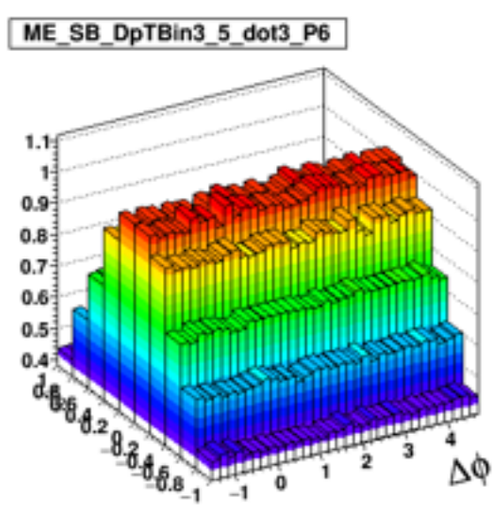


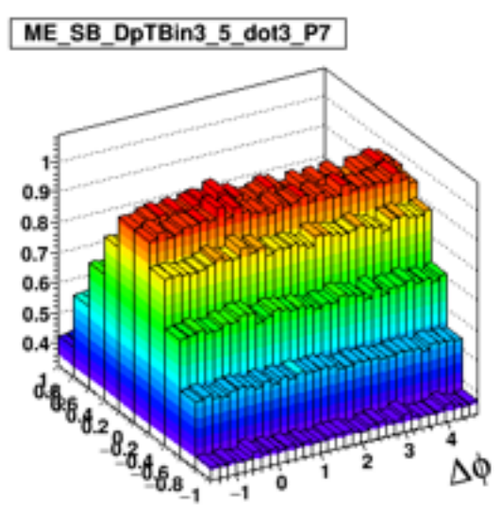


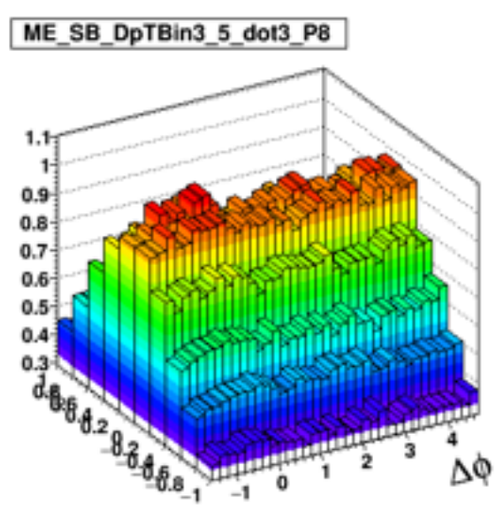










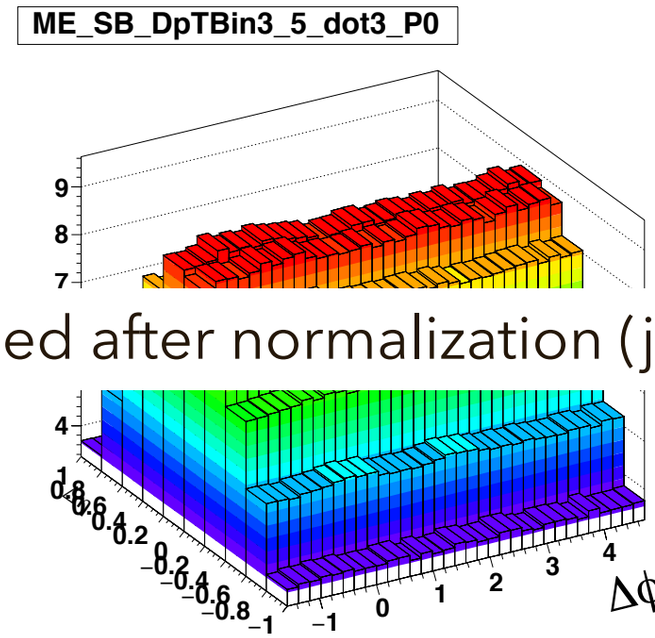


✳28 ∑Pool: 2DME (Single+Bkg)

Hadron p_T > 0.3 GeV/c

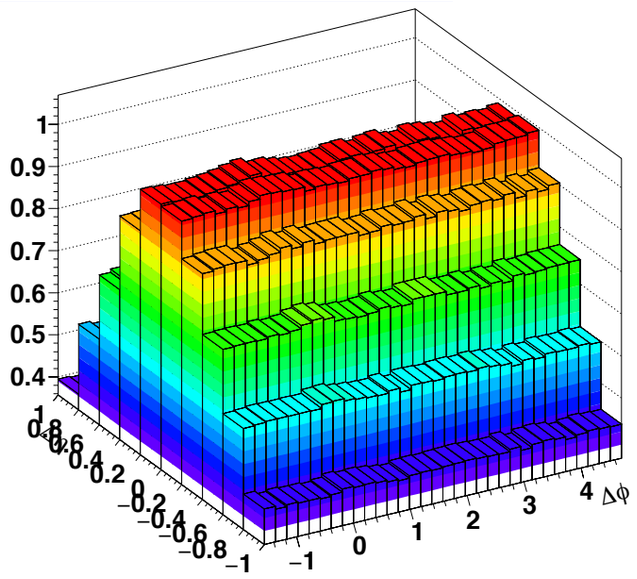
ALICE

D^+: 3-5 pT GeV/c



9 bin added after normalization (just to compare)

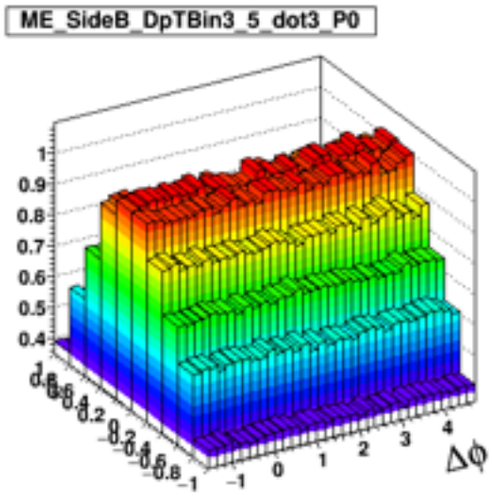
wPool: 2DME (Single+Bkg)

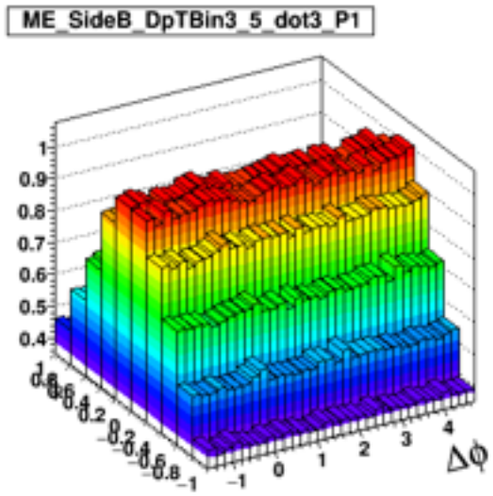


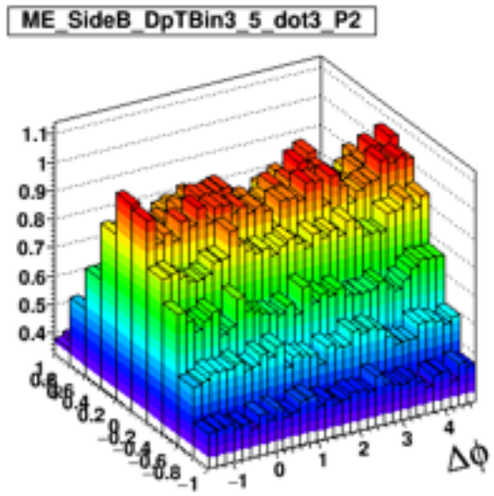
Pool by Pool: 2DME (Sidebands)

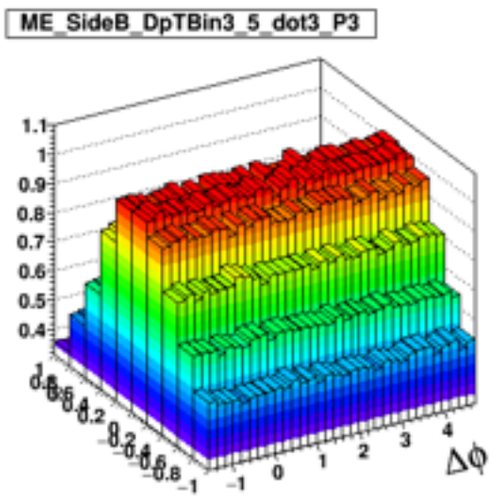
D^+: 3-5 pT GeV/c Hadron p_T > 0.3 GeV/c

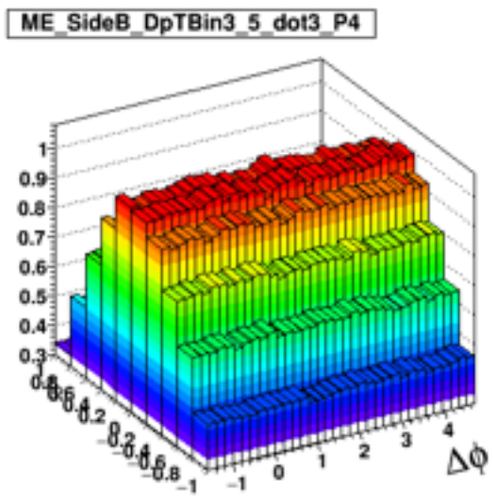
ALICE

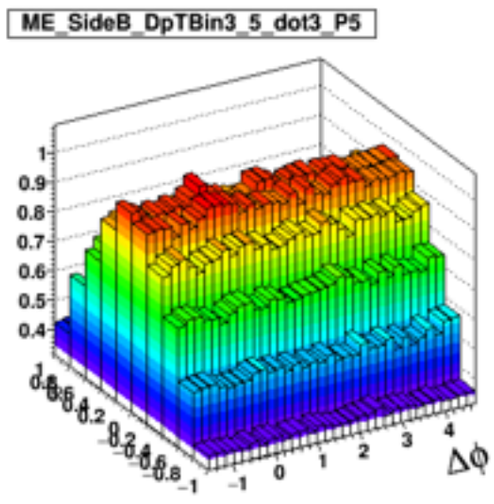


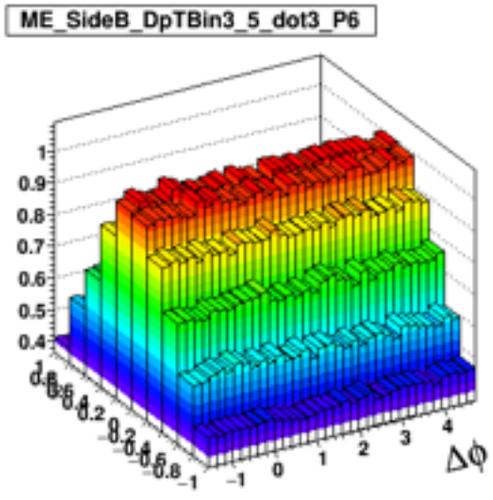


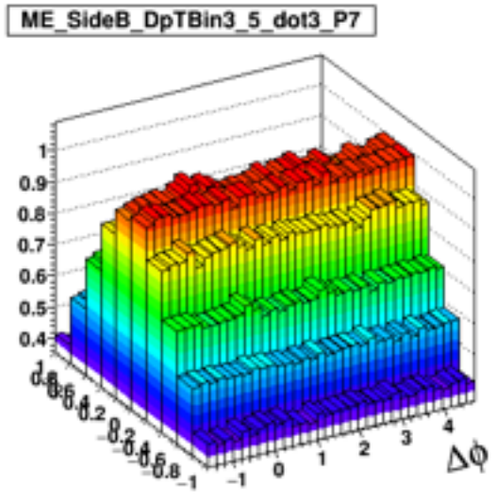


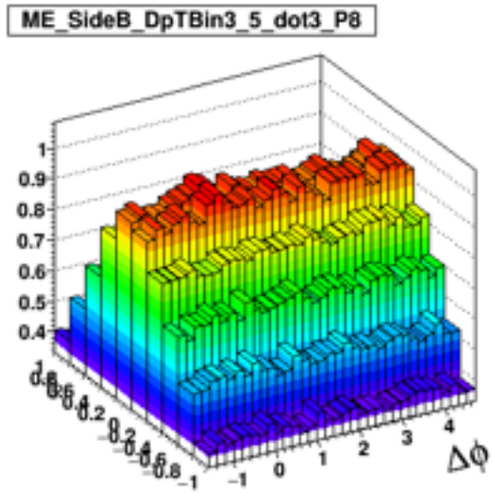










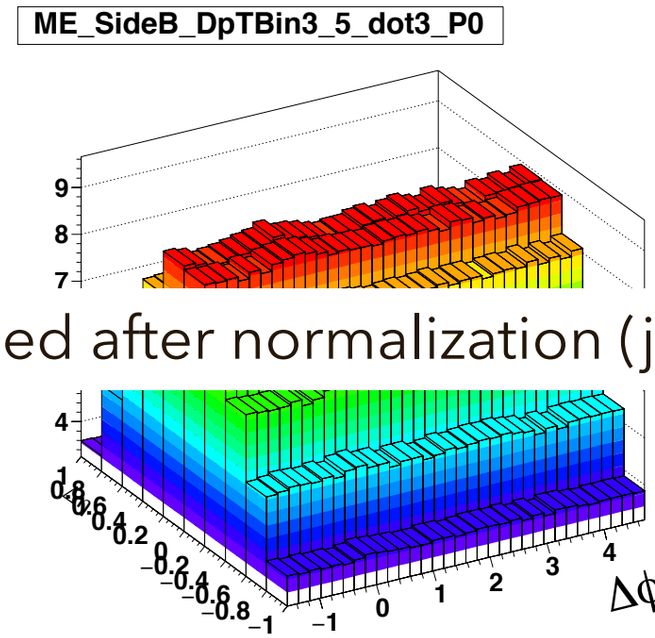


∑Pool: 2DME (Sidebands)

Hadron p_T > 0.3 GeV/c

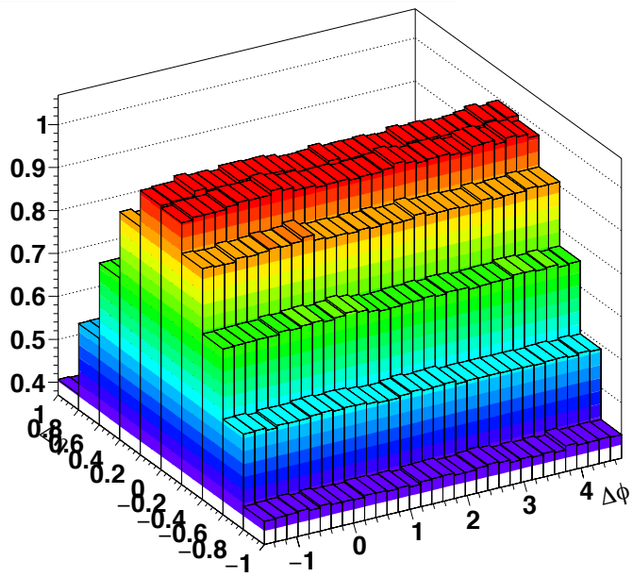
ALICE

D^+: 3-5 pT GeV/c



9 bin added after normalization (just to compare)

wPool: 2DME (Sidebands)



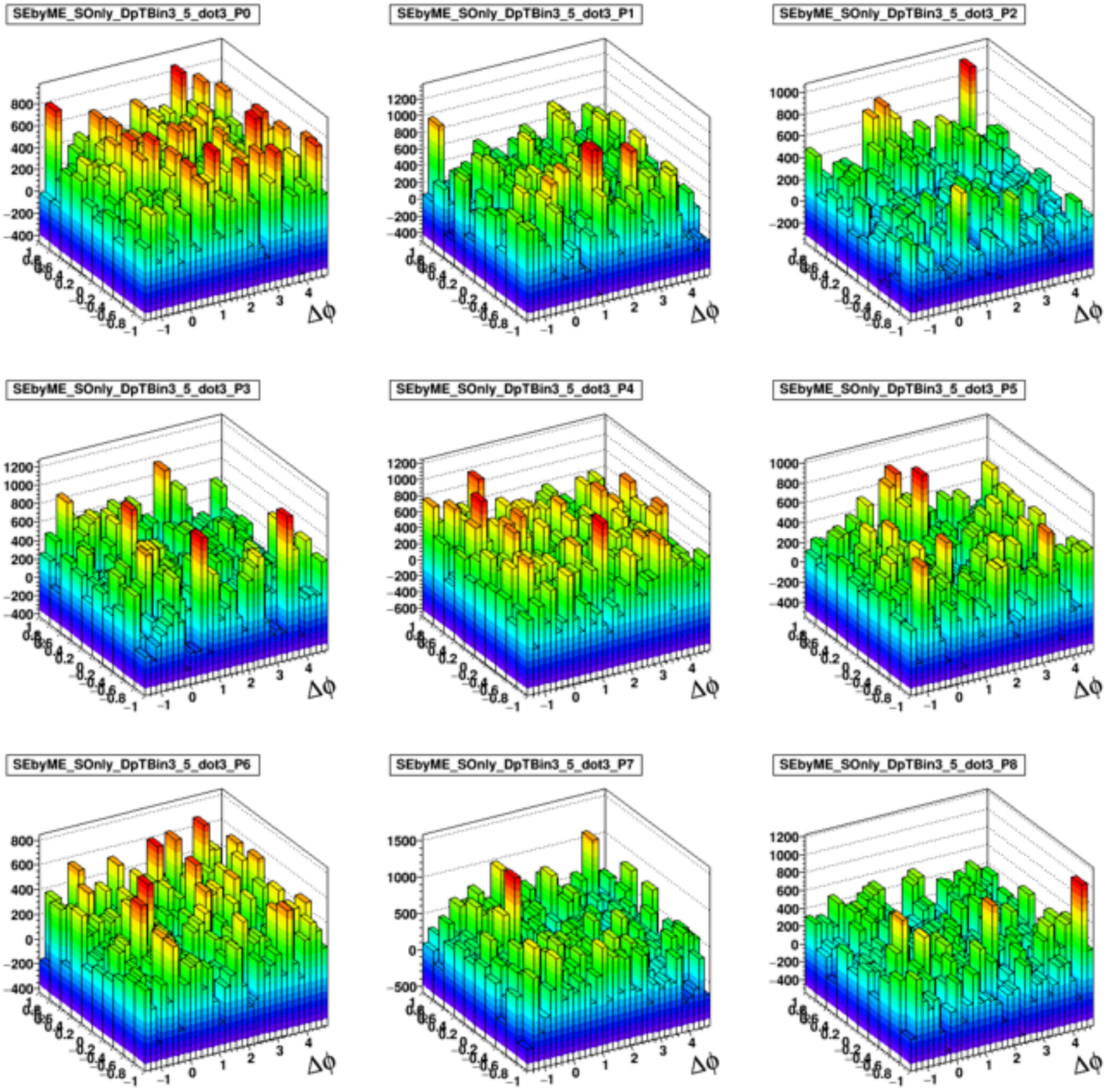
✳31 Pool by Pool: 2DSEbyME (Signal)

D⁺: 3-5 pT GeV/c Hadron p_T > 0.3 GeV/c

ALICE

$$fCorr_i^{2D} = \frac{SE_i^{2D}}{\frac{1}{norm} ME_i^{2D}}$$

-ive entries because of different and low stats in S+bkg and sideband regions

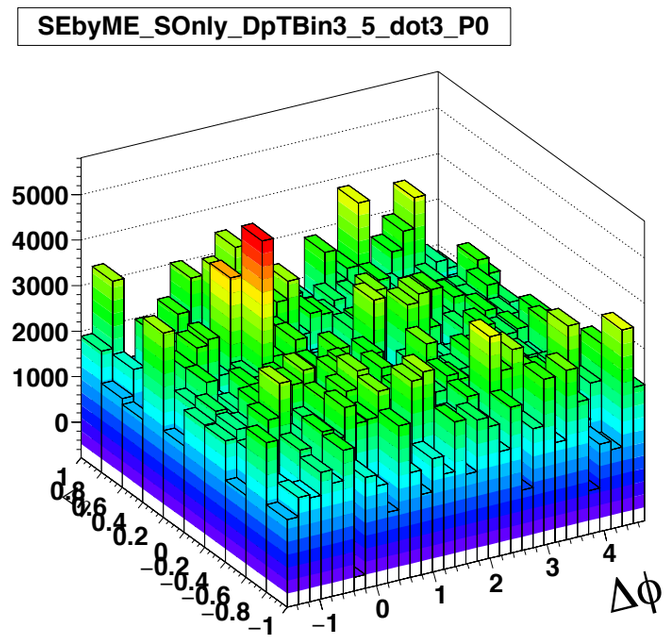


✳32 ∑Pool: 2DSEbyME (Signal)

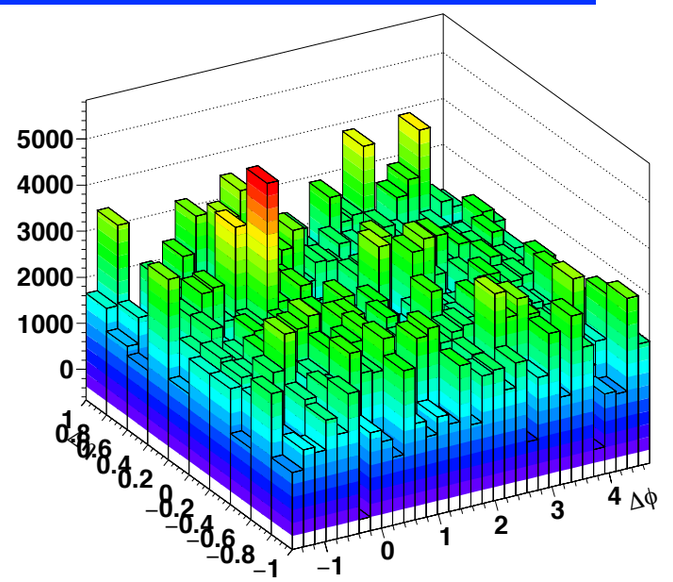
Hadron p_T > 0.3 GeV/c

ALICE

D^+: 3-5 pT GeV/c



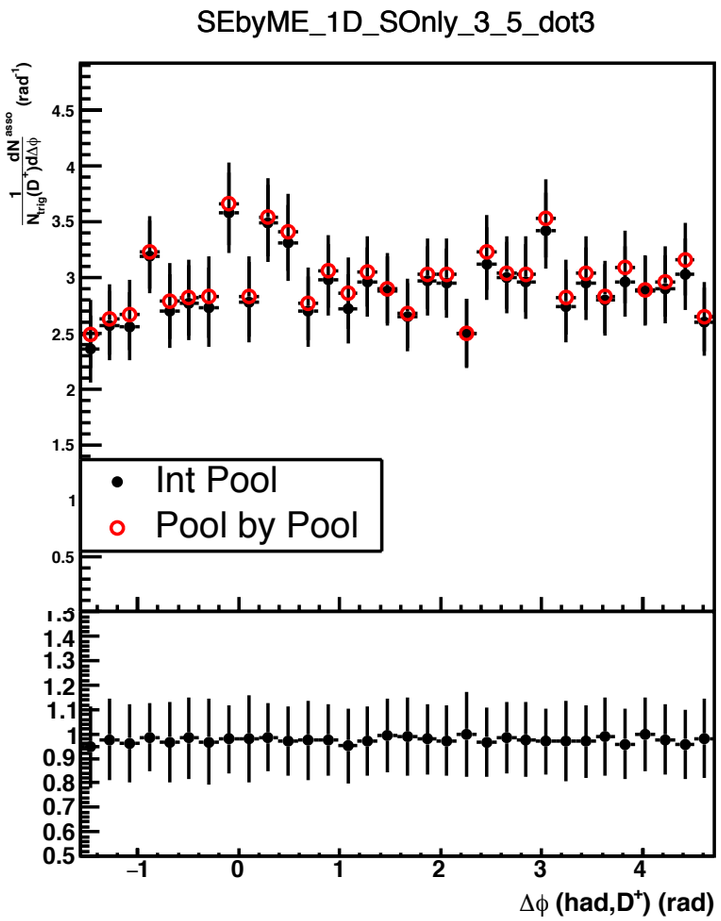
wPool: 2DSEbyME (Signal)



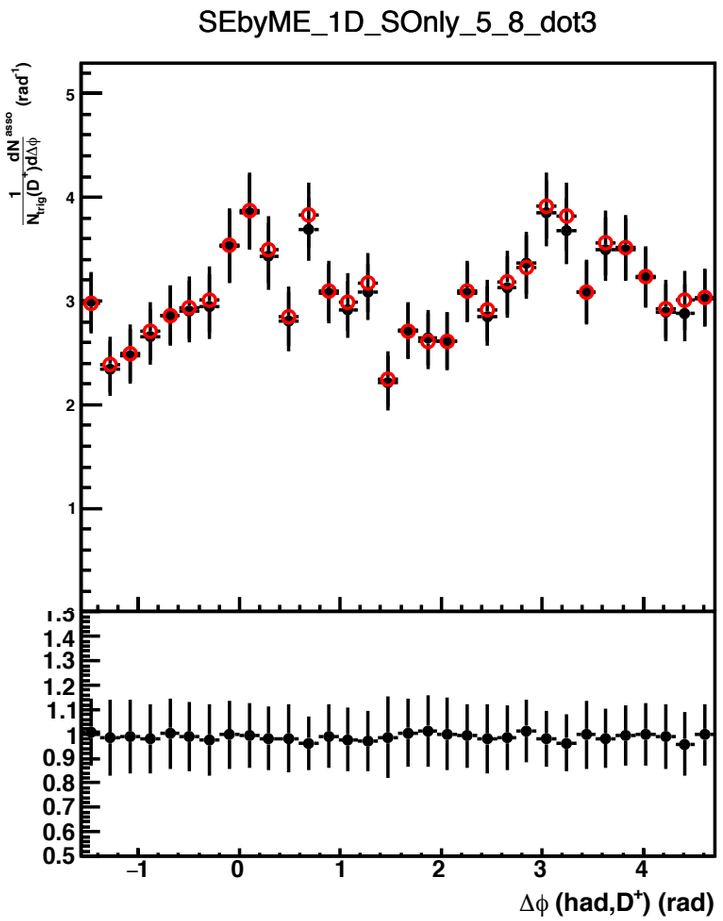
✳33 w/ Vs w/o Pool by Pool Comparison

Asso p_T > 0.3 GeV/c

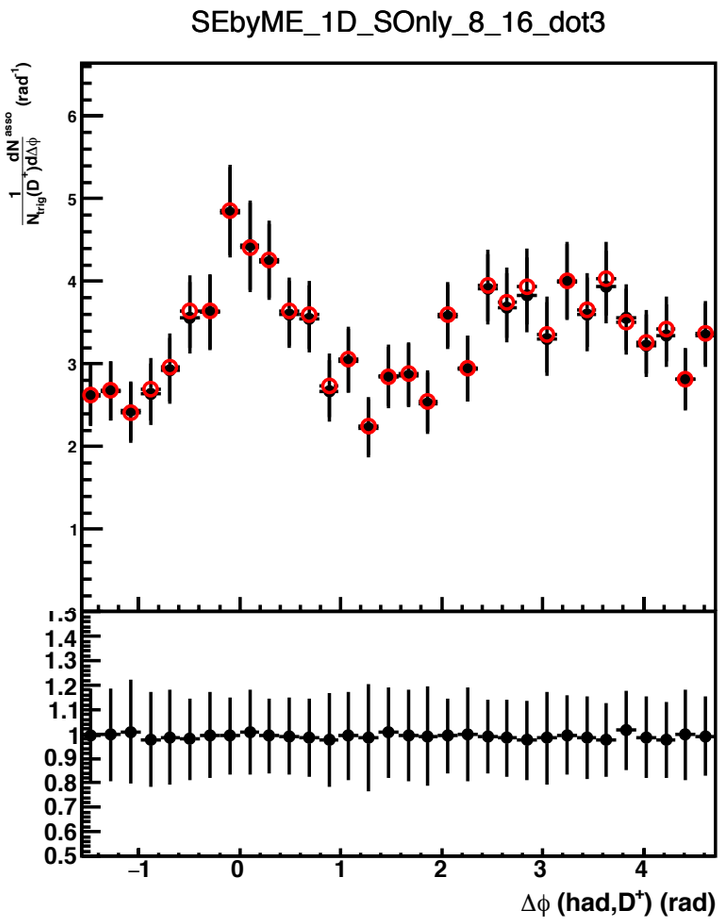
Low p_T (3-5 GeV/c)



Mid p_T (5-8 GeV/c)



High p_T (8-16 GeV/c)

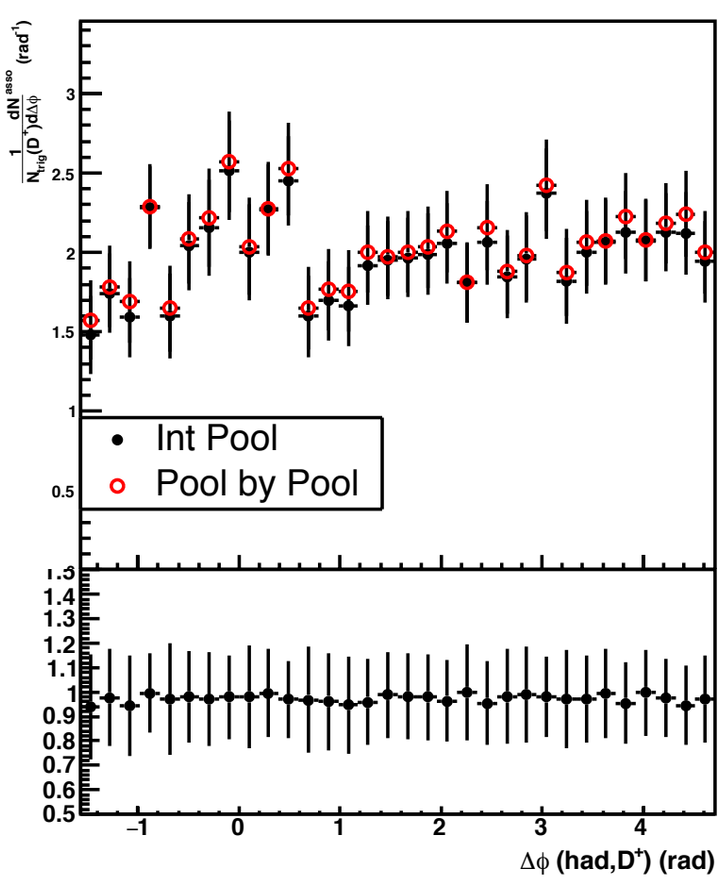


- Data points are consistent but some points for PoolbyPool is higher (2-3%)

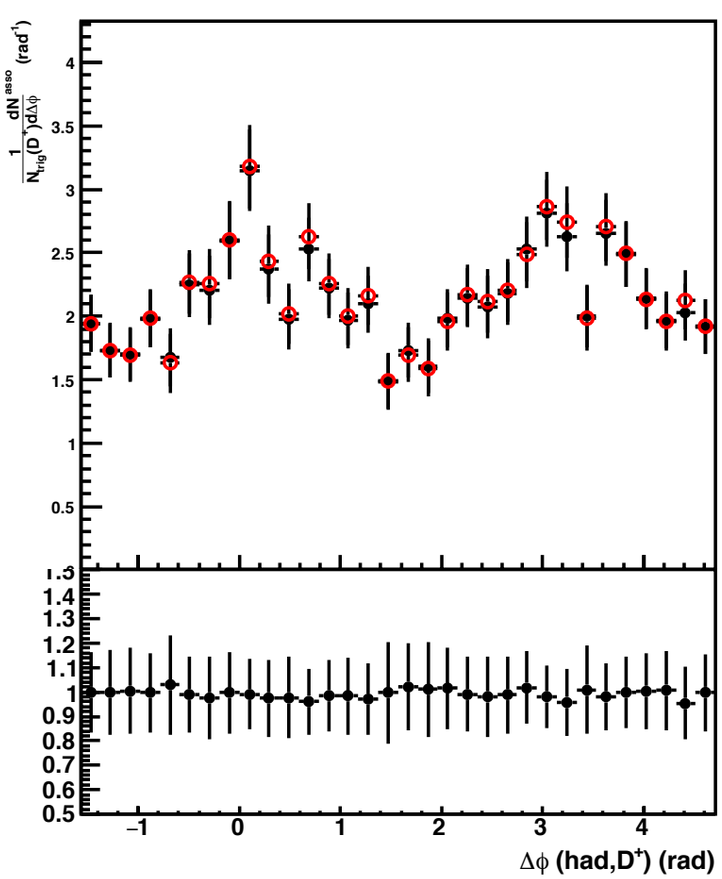
✳34 w/ Vs w/o Pool by Pool Comparison

Asso p_T > 0.5 GeV/c

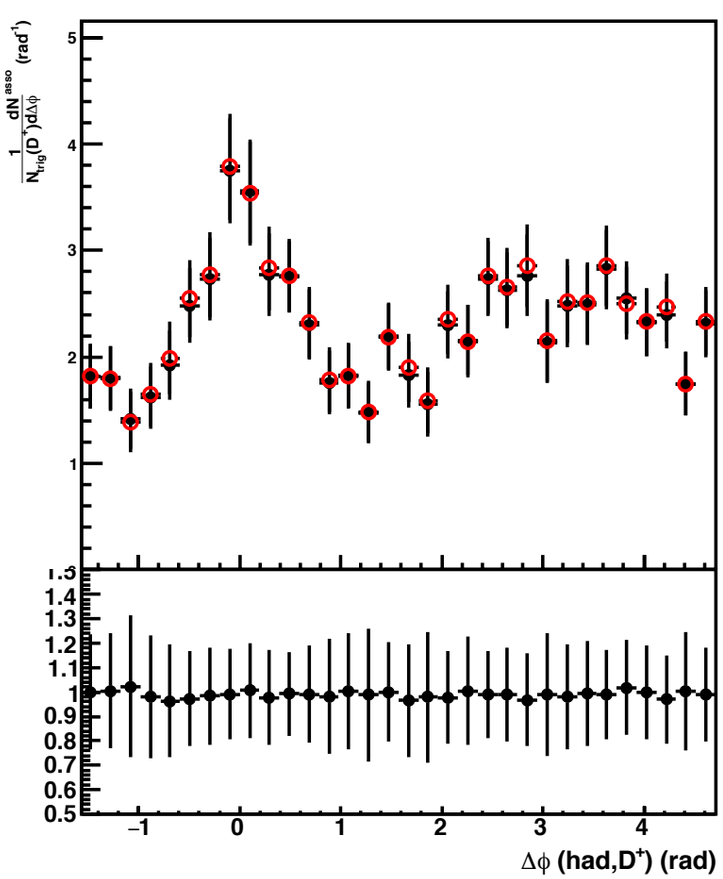
Low p_T (3-5 GeV/c)



Mid p_T (5-8 GeV/c)



High p_T (8-16 GeV/c)

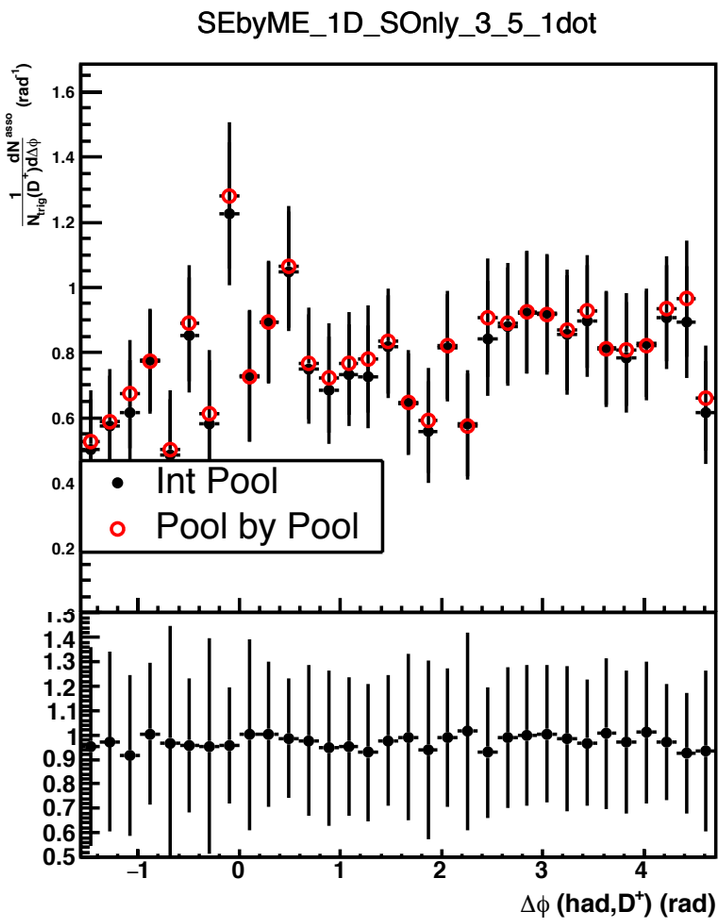


- Data points are consistent but some points for PoolbyPool is higher (2-3%)

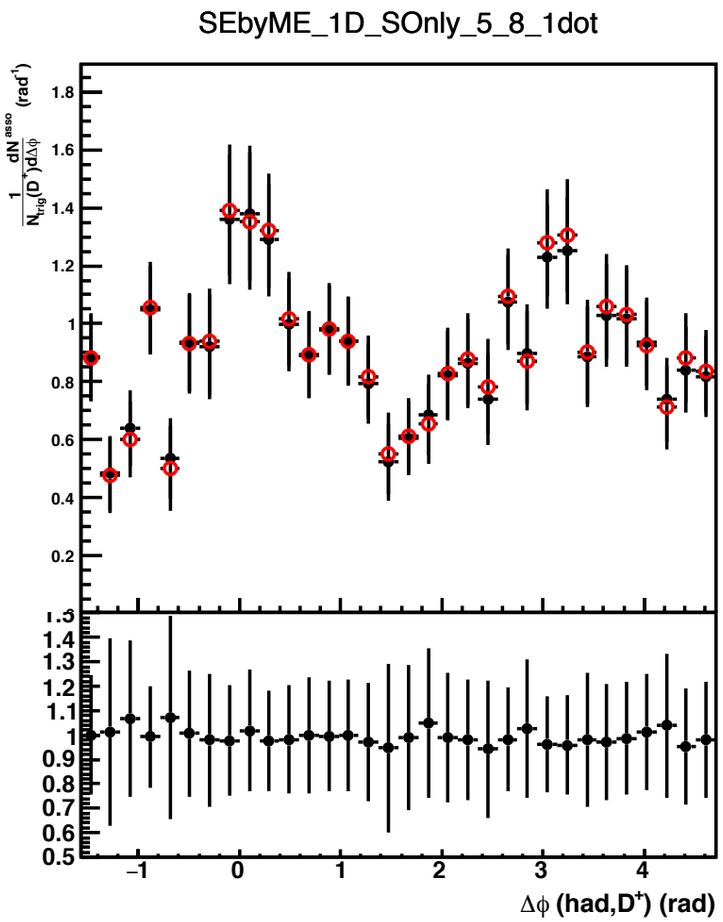
✳35 w/ Vs w/o Pool by Pool Comparison

Asso p_T > 1.0 GeV/c

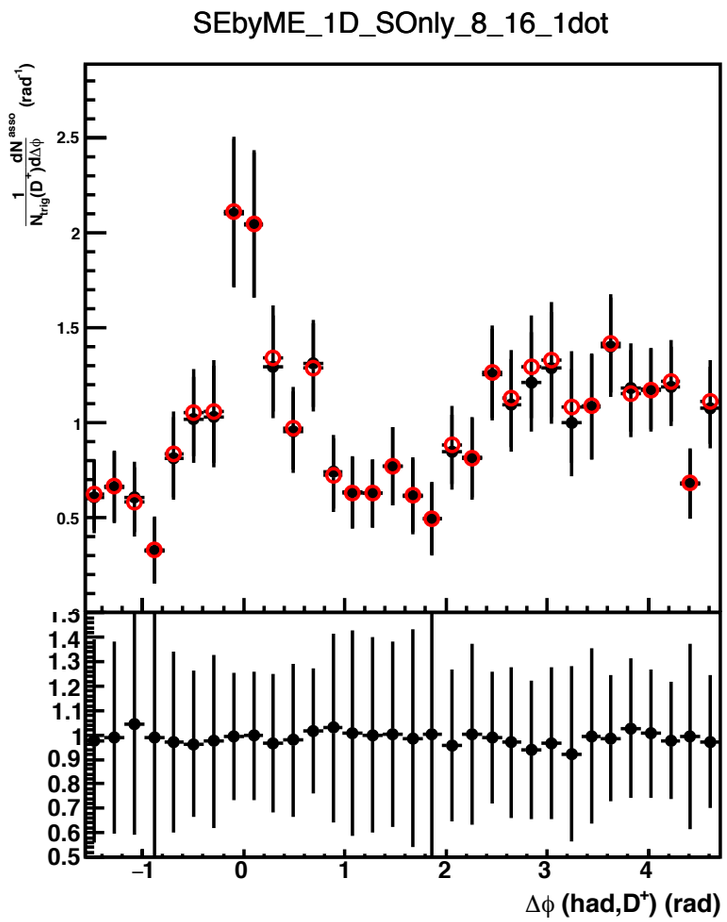
Low p_T (3-5 GeV/c)



Mid p_T (5-8 GeV/c)



High p_T (8-16 GeV/c)

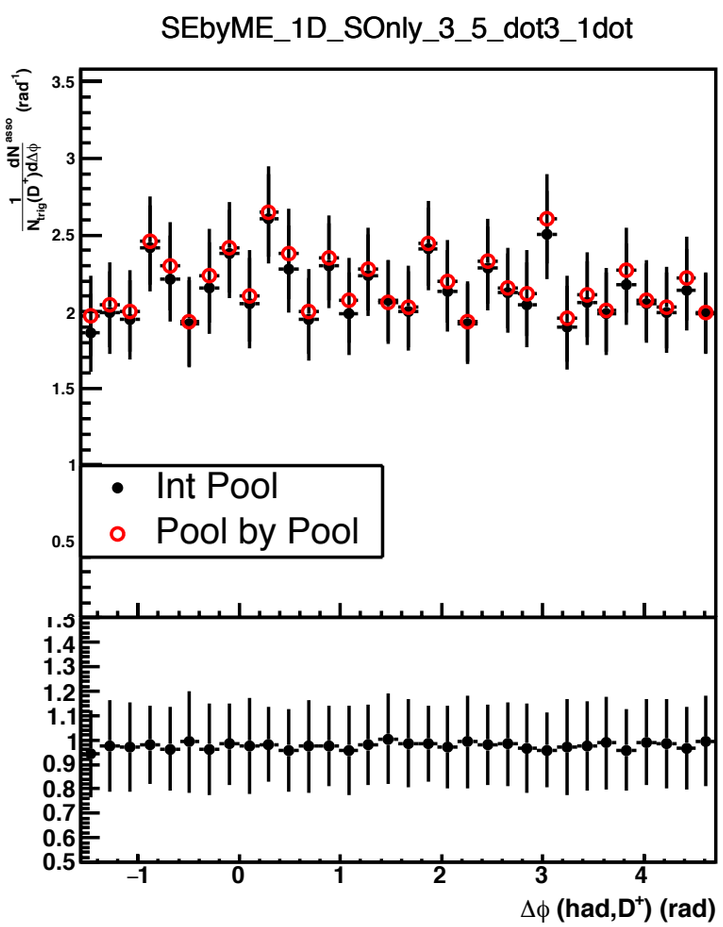


- Data points are consistent but some points for PoolbyPool is higher (2-5%)

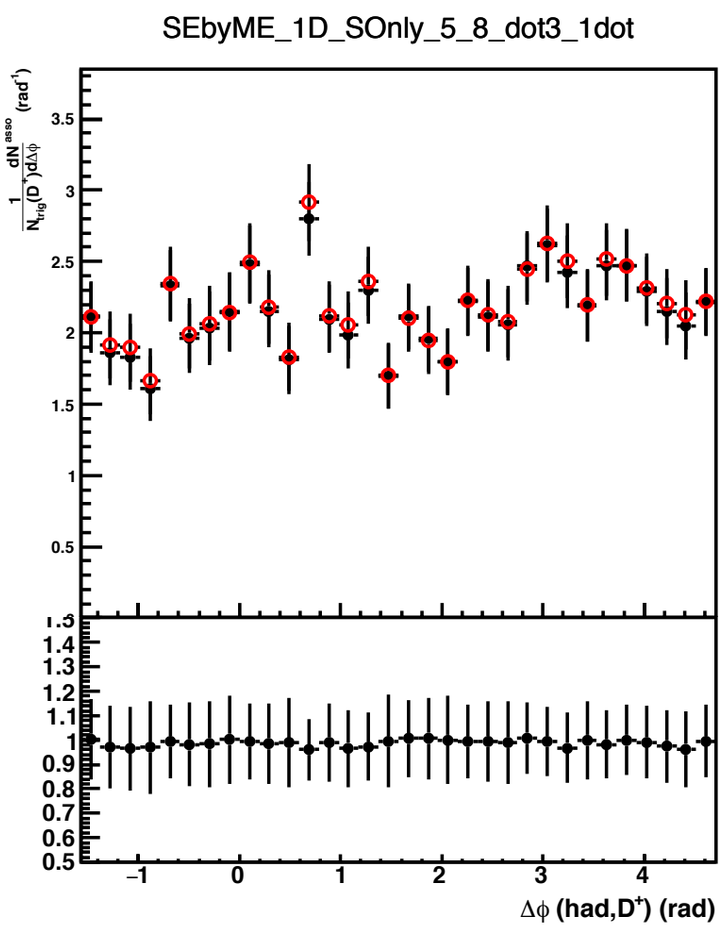
✳36 w/ Vs w/o Pool by Pool Comparison

Asso p_T > 0.3-1.0 GeV/c

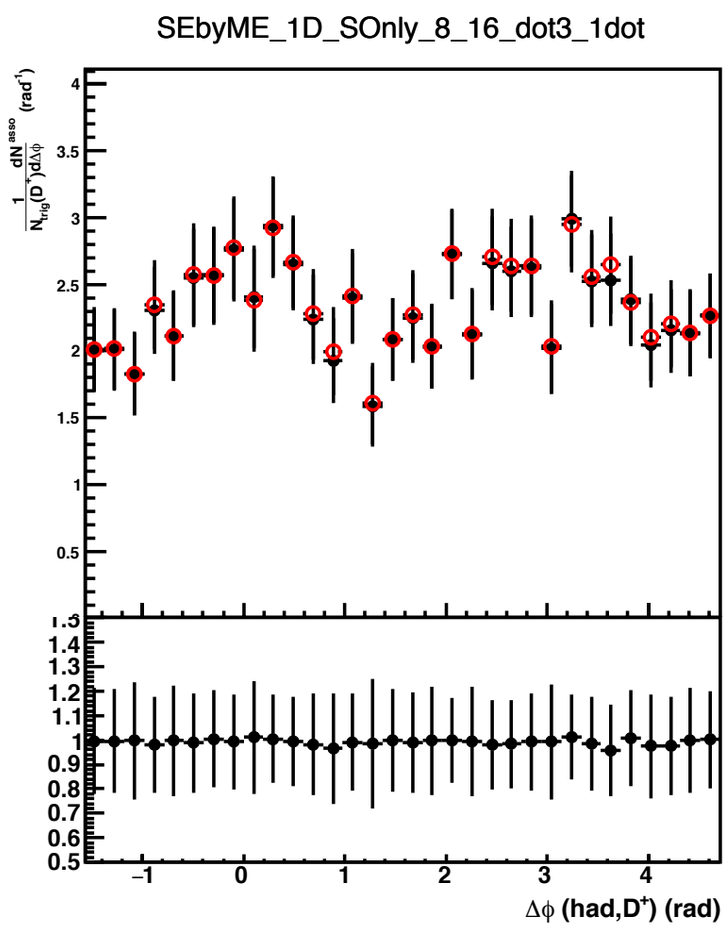
Low p_T (3-5 GeV/c)



Mid p_T (5-8 GeV/c)



High p_T (8-16 GeV/c)



- Data points are consistent but some points for PoolbyPool is higher (2-3%)

Pool by Pool Summary

- ☑ Pool by Pool Vs wPool correction is consistent (pass4 data).
- ☑ Other pT ascco threshold correlations are in backup slides.

To-do-list

- ☑ Re-checking results for pass2 (w/ and w/o PoolbyPool correction).

Full results/backup slides

https://indico.cern.ch/event/483679/session/1/contribution/0/attachments/1220363/1783779/DhPoolbyPoolMECorrUpdate.pdf

Automatic Efficiency QA updates

Single Track Efficiency

Motivation: http://www.iopb.res.in/aliceindia2015/ai2015_talks/d2s1/4_jitendra.pdf

- ☑ Automatic trending of tracking efficiencies (on web).
- ☑ Running on upcoming MC productions to get various efficiency (as a QA).
- ☑ To provides general efficiency maps for different analyses (**challenging**)

Outline:

- All relevant codes are committed for Auto-QA
- Task is now running for MC productions
- **(e.g. LHC15g3c, results analyzed and seems everything OKEY)**
- Afs account and weblink is now active (http://aliqatks.web.cern.ch/aliqatks/, test directory)
- Final script is ready and active for auto-output to the afs/weblink (TEST is done)

Code are committed under PWGPP

Main Classes

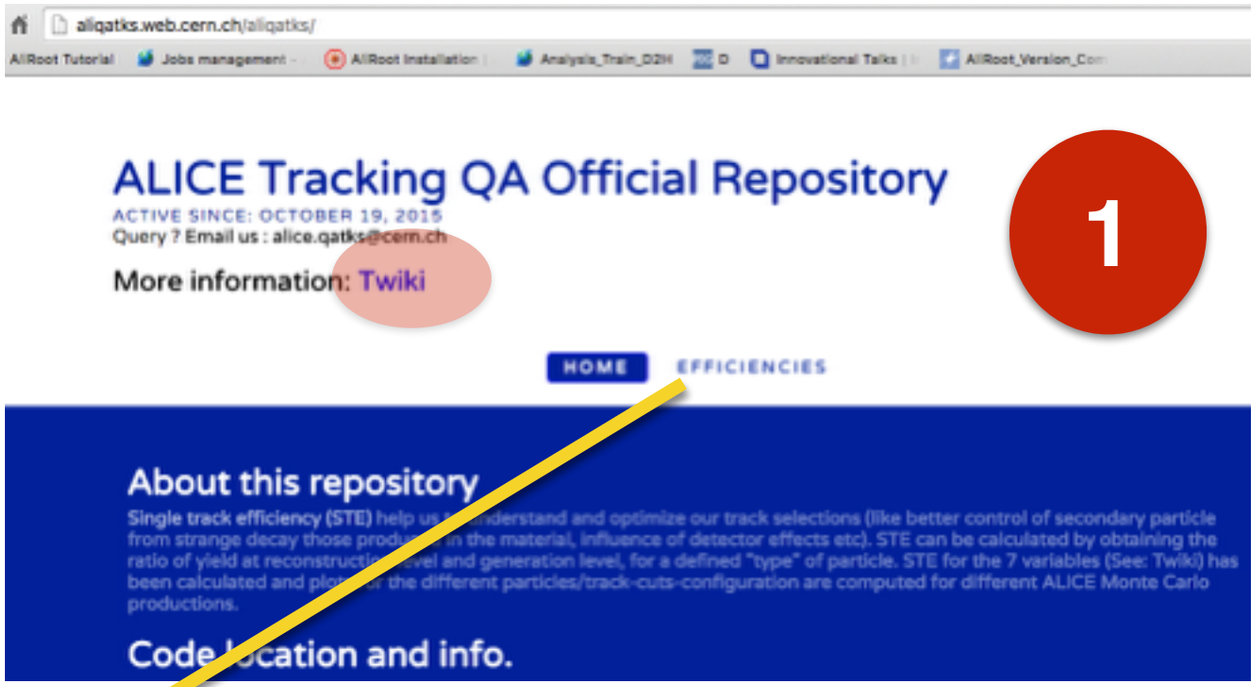
1. Main efficiency class: EvTrkSelection/AliCFSingleTrackEfficiencyTask.cxx (h)
2. Detail about event and particle/track level selections: EvTrkSelection/AliSingleTrackEffCuts.cxx (h)
3. Efficiency task configuration: EvTrkSelection/macros/AddSingleTrackEfficiencyTask.C (+ Combined Addtask)
4. Run macro: EvTrkSelection/macros/RunCFSingleTrackEfficiencyTask.C
5. Example result extracting macro: EvTrkSelection/macros/RebinCFContainer.C

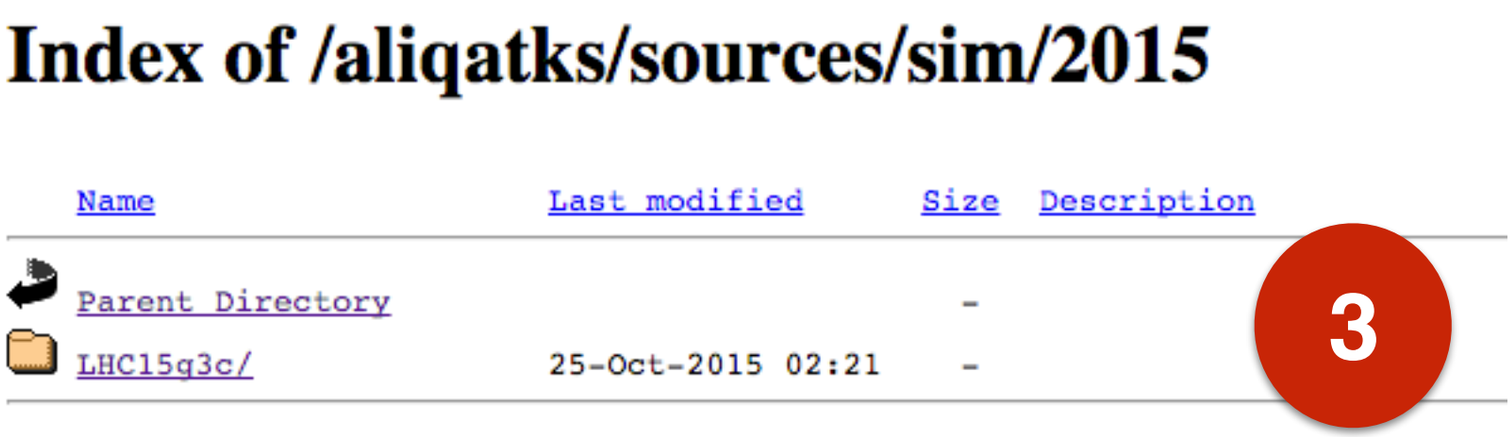
AutoQA

6. Automatic QA run level 1: EvTrkSelection/macros/CalcSingleTrackEffQA.C
7. Automatic QA run level 2: EvTrkSelection/macros/SingleTrackEffTrend.C
8. Automatic QA period level: EvTrkSelection/macros/periodLevelQAEff.C
9. Automatic QA script: QA/detectorQAscripts/TKS.sh

AFS and Web page link

http://aliqatks.web.cern.ch/aliqatks/





AFS and Web page link

http://aliqatks.web.cern.ch/aliqatks/

aliqatks.web.cern.ch/aliqatks/sim/2015/LHC15g3c/passMC/

Apps | AliRoot Tutorial | Jobs management | AliRoot Installation | Analy

Index of /aliqatks/sim/2015/LHC15g3c/

Name	Last modified	Size	Description
Parent Directory		-	
000225000/	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
	08-Nov-2015 08:25	-	
000225051/	08-Nov-2015 08:25	-	
000225052/	08-Nov-2015 08:25	-	
000225105/	08-Nov-2015 08:25	-	
000225322/	08-Nov-2015 08:25	-	
000225576/	08-Nov-2015 08:25	-	
000225578/	08-Nov-2015 08:25	-	
000225579/	08-Nov-2015 08:25	-	
000225580/	08-Nov-2015 08:25	-	
Trending/	08-Nov-2015 08:26	-	
periodLevelQA.log	08-Nov-2015 08:26	5.8K	
periodLevelQAEff.C	08-Nov-2015 08:26	35K	
trending.root	08-Nov-2015 08:26	105K	

Index of /aliqatks/sources/sim/2015

Name	Last modified	Size	Description
Parent Directory		-	
LHC15g3c/	25-Oct-2015 02:21	-	

3

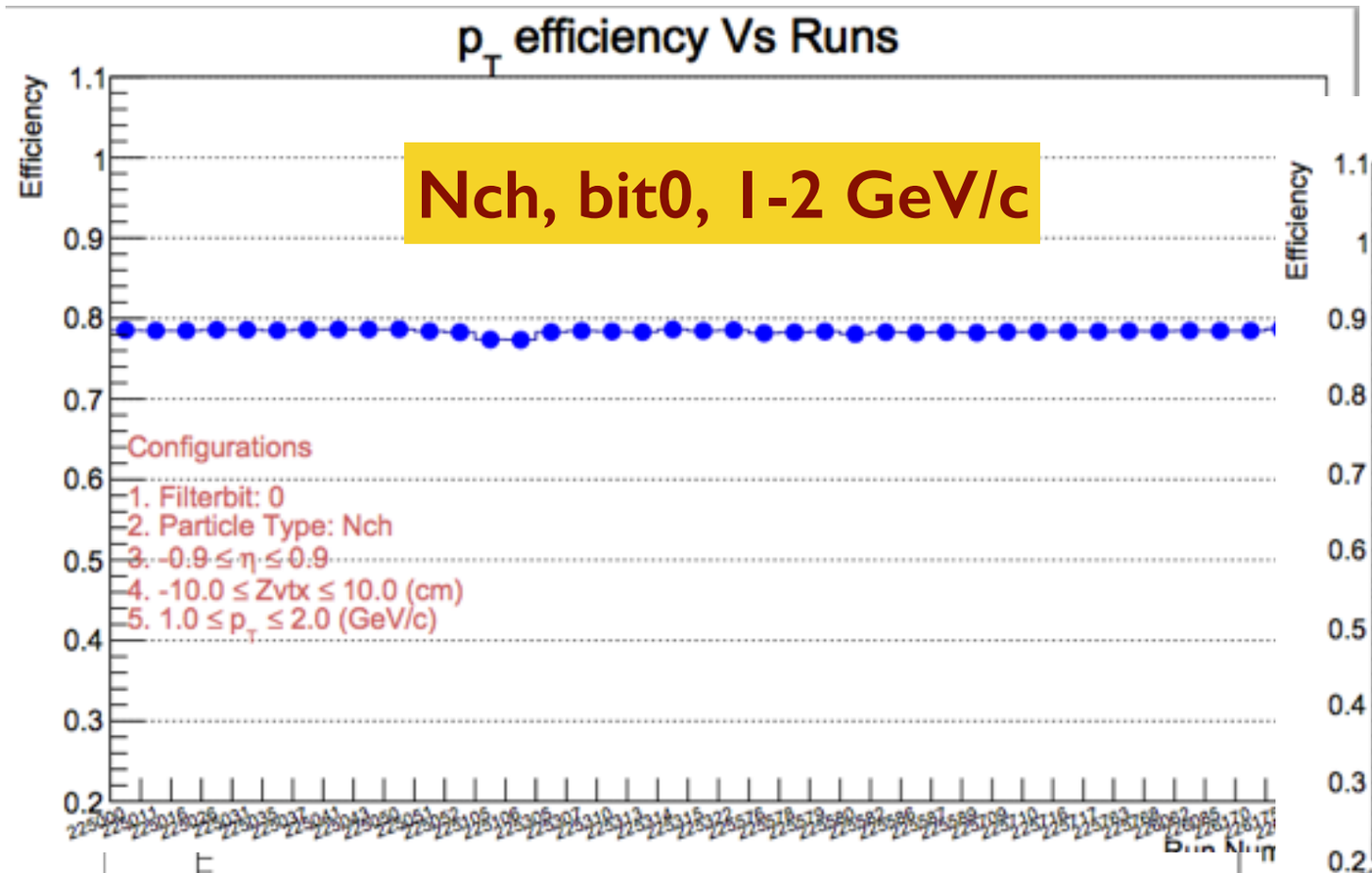
4

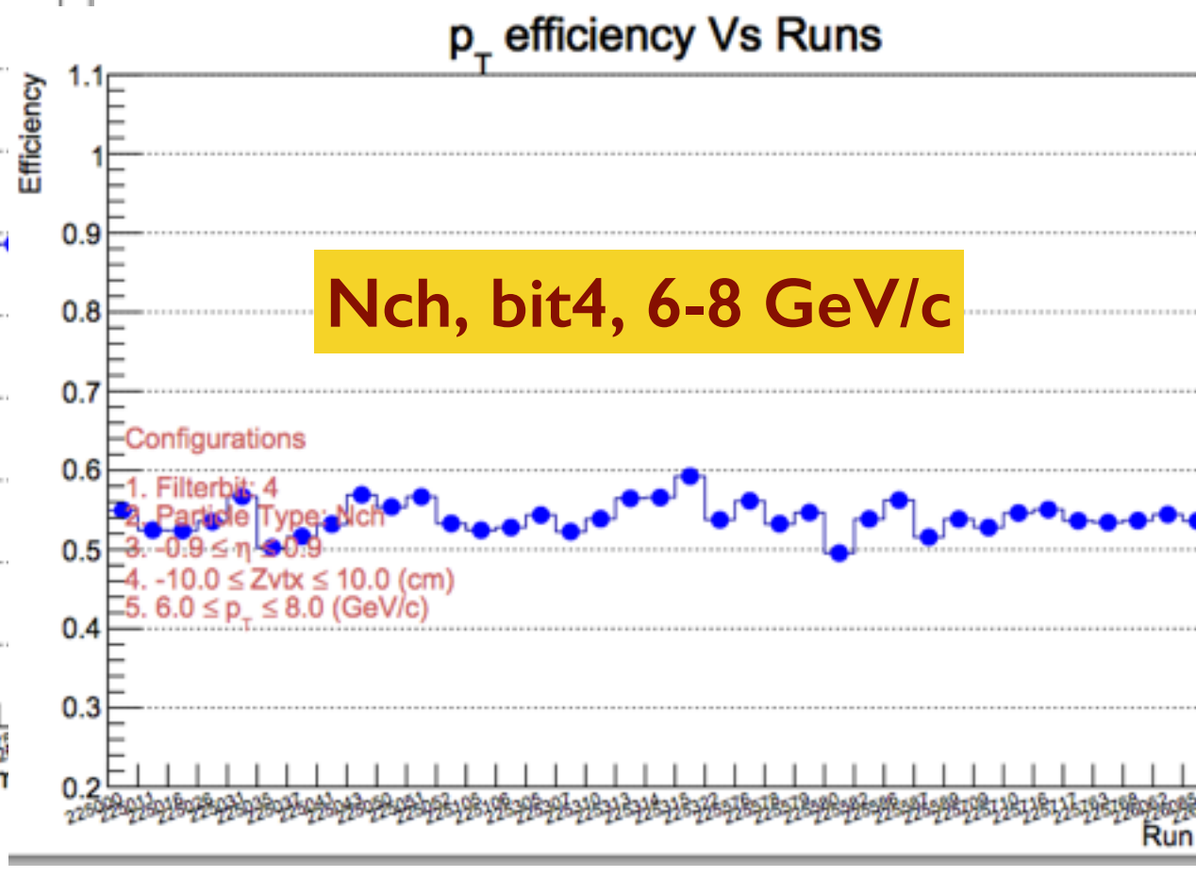
Period Level QA:

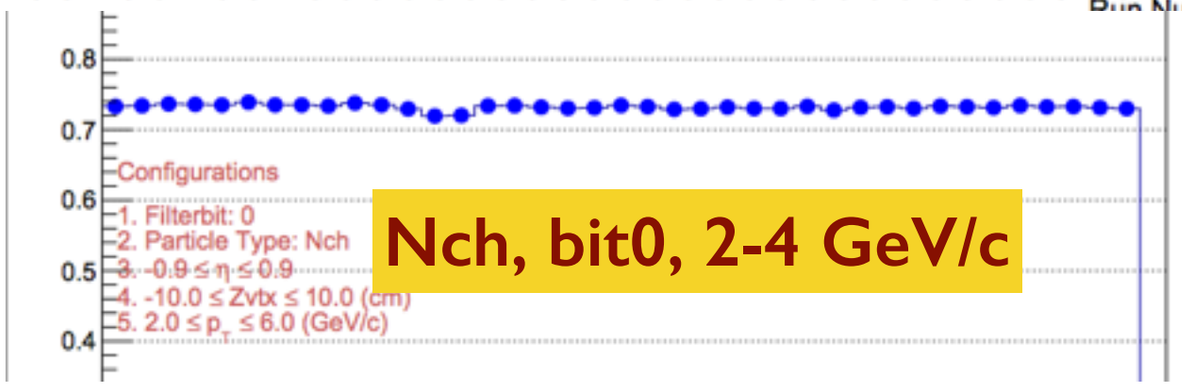
Different efficiency trends run by run for

- different particles (p, K, π, e-, muons)
- different kinematics range (pt, eta..)
- different track cuts (e.g. filter-bits)

.. are stored in PDFs and .root format







See backup slide for default cuts

run by run QA:

Different efficiency trends run by run for

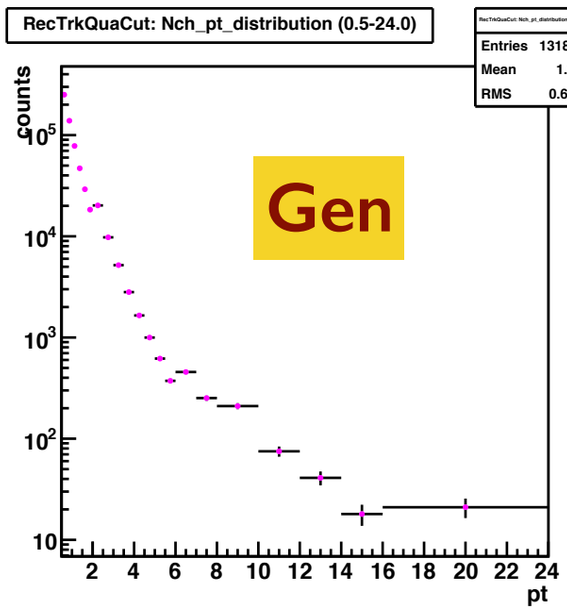
- different particles (p, K, π, e-, muons)
- full kinematics range
- different track cuts (e.g. filterbits)

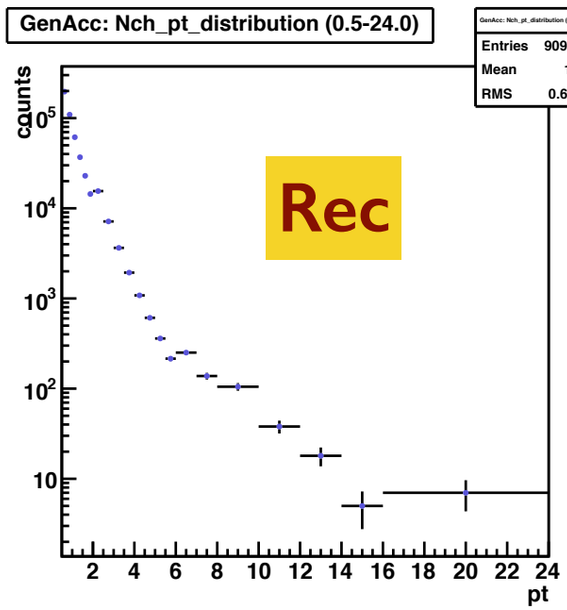
.. are stored in PDFs

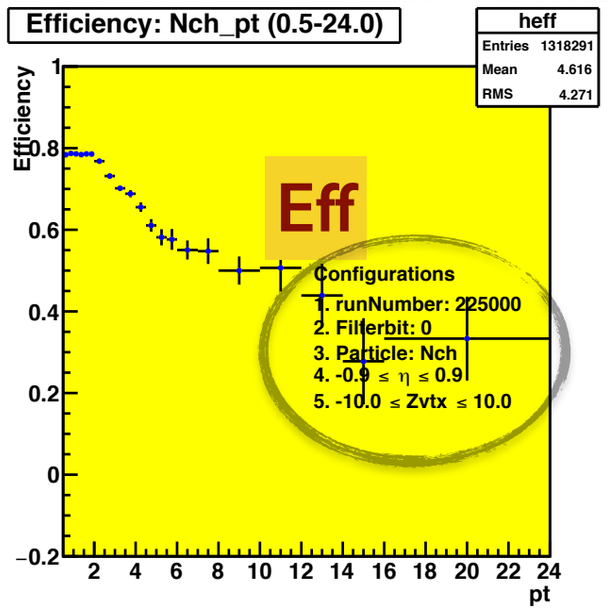
Index of /aliqatks/sim/2015/LHC15g3c/passMC

Name	Last modified
Parent Directory	
CalcSingleTrackEffQA.C	08-Nov-2015 08:2
Electron_eta_Efficiency_RecTrkQuaCutByGenAcc_fbit0_225000.pdf	08-Nov-2015 08:2
Electron_pt_Efficiency_RecTrkQuaCutByGenAcc_fbit0_225000.pdf	08-Nov-2015 08:2
Kaon_eta_Efficiency_RecTrkQuaCutByGenAcc_fbit0_225000.pdf	08-Nov-2015 08:2
Kaon_pt_Efficiency_RecTrkQuaCutByGenAcc_fbit0_225000.pdf	08-Nov-2015 08:2
Nch_eta_Efficiency_RecTrkQuaCutByGenAcc_fbit0_225000.pdf	08-Nov-2015 08:2
Nch_pt_Efficiency_RecTrkQuaCutByGenAcc_fbit0_225000.pdf	08-Nov-2015 08:2
Nch_pt_Efficiency_RecTrkQuaCutByGenAcc_fbit4_225000.pdf	08-Nov-2015 08:2
[illegible] fbit0_225000.pdf	08-Nov-2015 08:2
bit0_225000.pdf	08-Nov-2015 08:2
c_fbit0_225000.pdf	08-Nov-2015 08:2
_fbit0_225000.pdf	08-Nov-2015 08:2
	08-Nov-2015 08:2
	08-Nov-2015 08:2
	08-Nov-2015 08:2

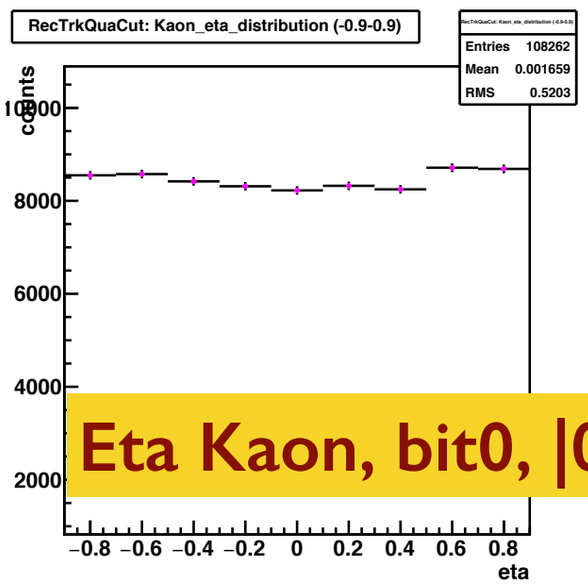
Pt Nch, bit0, 0.3-24 GeV/c

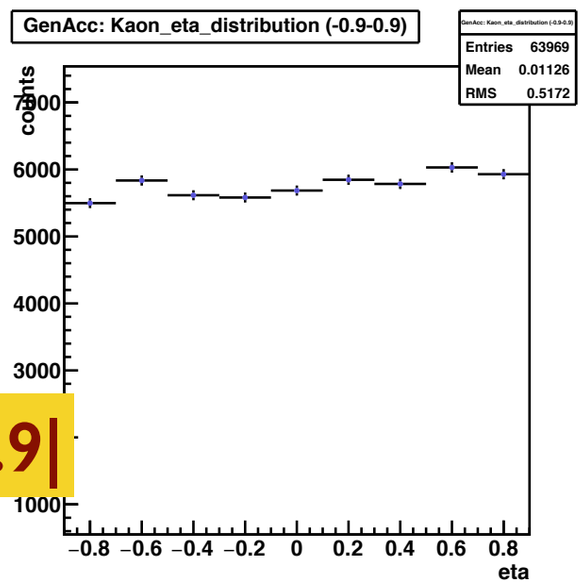


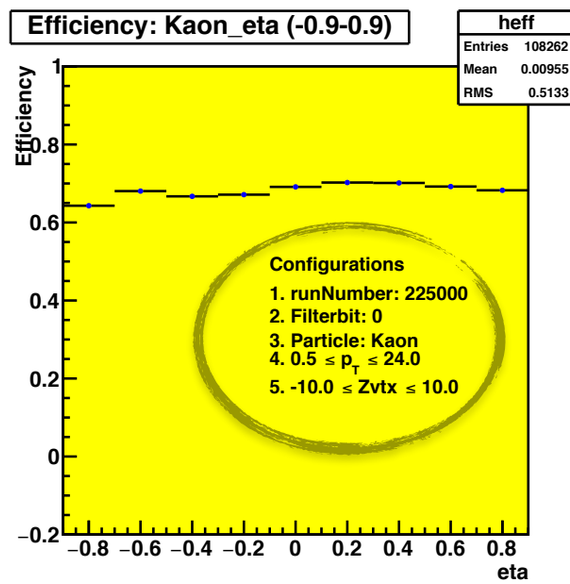




Eta Kaon, bit0, |0.9|







Thank you !

Backups ! (default track cuts)

QualityCuts->SetRequireSigmaToVertex(kFALSE);
QualityCuts->SetMinNClustersTPC(70);
QualityCuts->SetMinNClustersITS(2);
QualityCuts->SetRequireTPCRefit(kTRUE);
QualityCuts->SetRequireITSRefit(kTRUE);
QualityCuts->SetClusterRequirementITS(AliESDtrackCuts::kSPD,AliESDtrackCuts::kAny);
QualityCuts->SetMinDCAToVertexXY(0.);