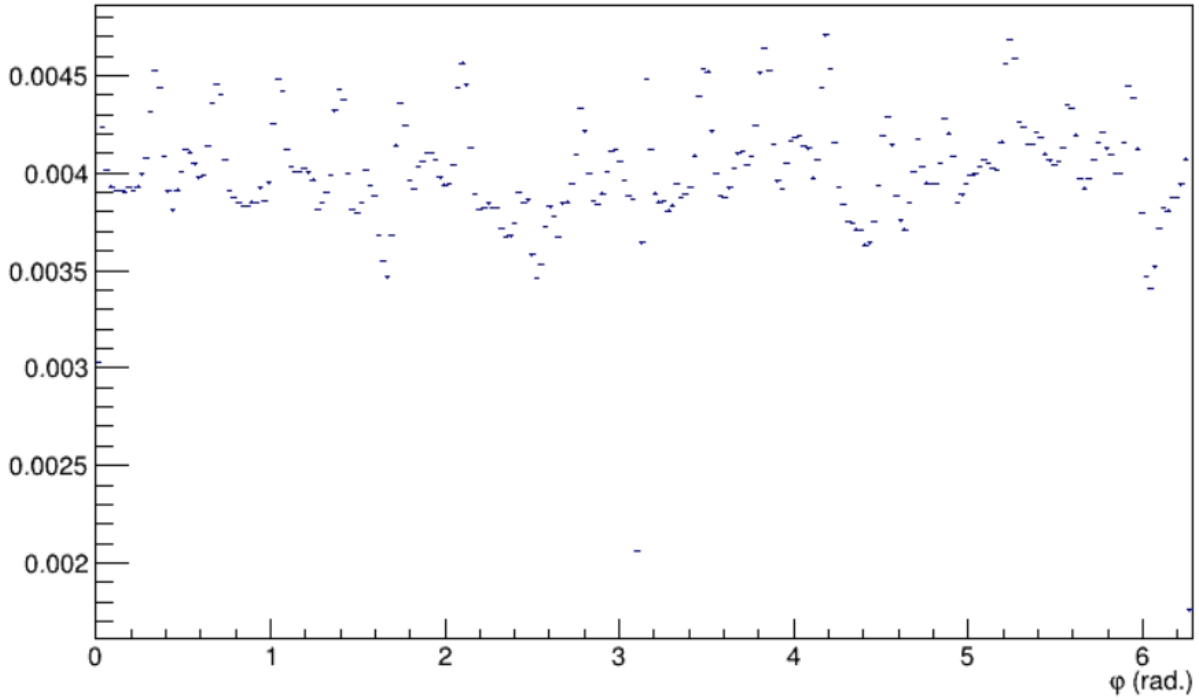
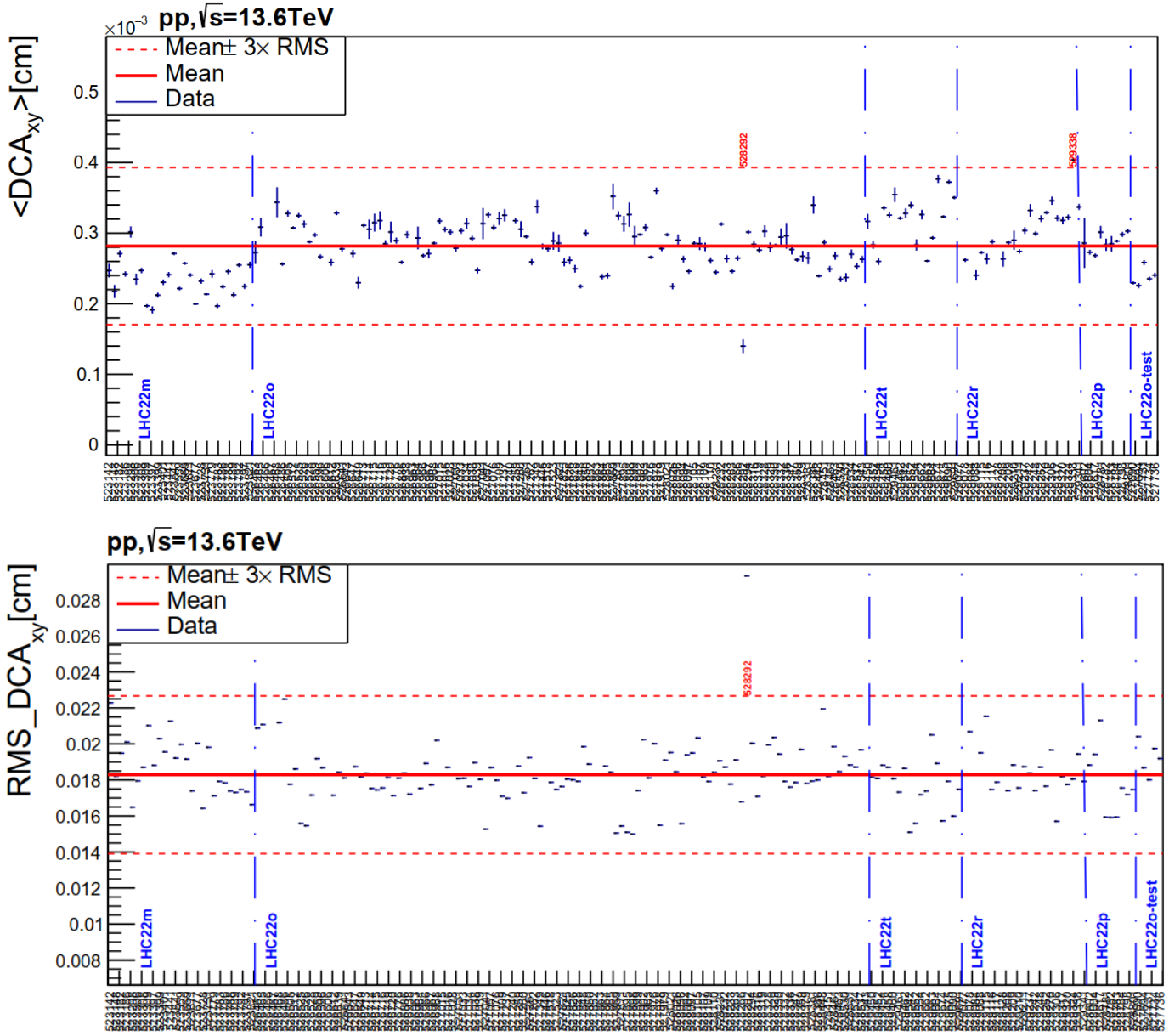
New Analysis Cut for REF

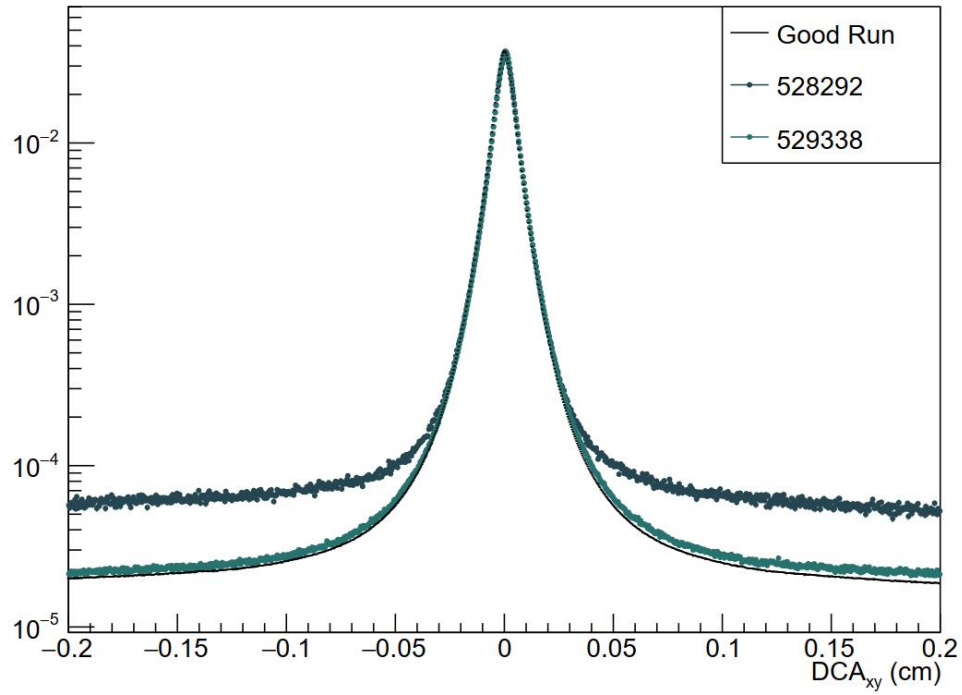
- Track Cut For REF
  - $\chi^2_{TPC} < 4$
  - $ncls_{TPC} > 90$
  - $ncls_{ITS} > 2$
  - $-1cm < DCA_{xy} < 1cm$
  - $-3cm < DCA_Z < 3cm$
  - $0.2 < p_T < 3GeV/c$



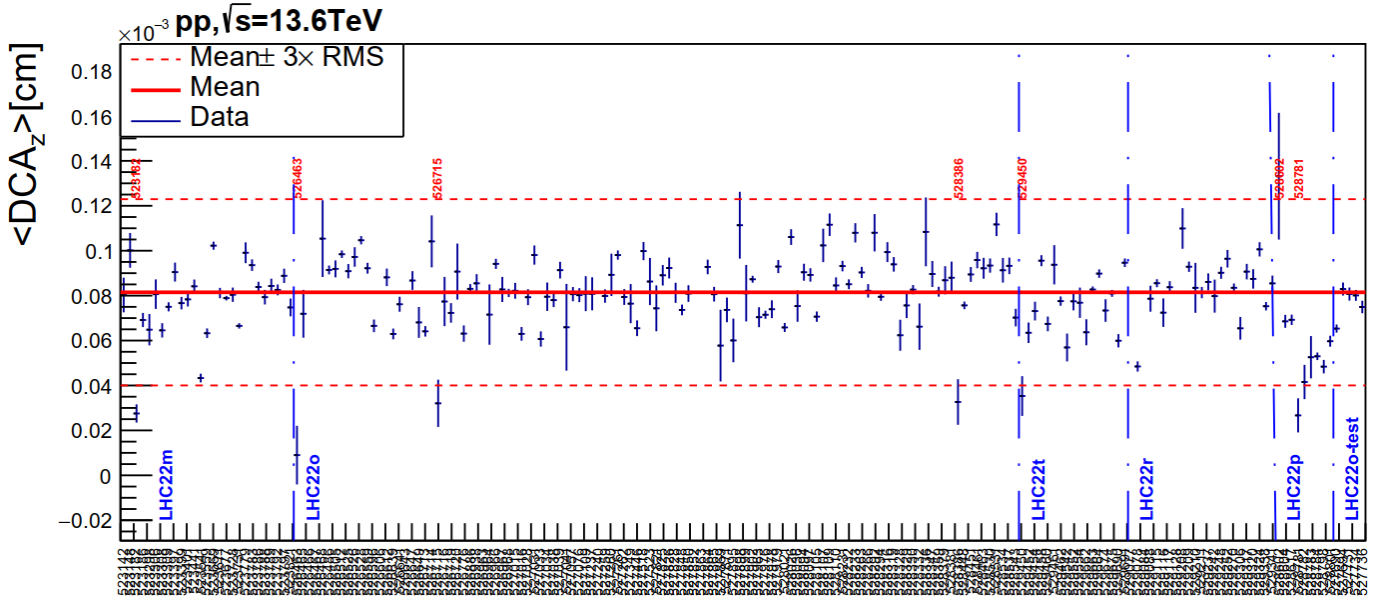
- Now, the ϕ distribution is much more flat.

DCA_{XY} QC


pp,√s=13.6TeV
×10⁻³
Mean± 3× RMS
Mean
Data
<DCA_xy>[cm]
528292
529338
LHC22m
LHC22o
LHC22t
LHC22r
LHC22p
LHC22o-test
pp,√s=13.6TeV
Mean± 3× RMS
Mean
Data
RMS_DCA_xy [cm]
528292
LHC22m
LHC22o
LHC22t
LHC22r
LHC22p
LHC22o-test


Good Run
528292
529338
DCA_xy (cm)

DCA_Z QC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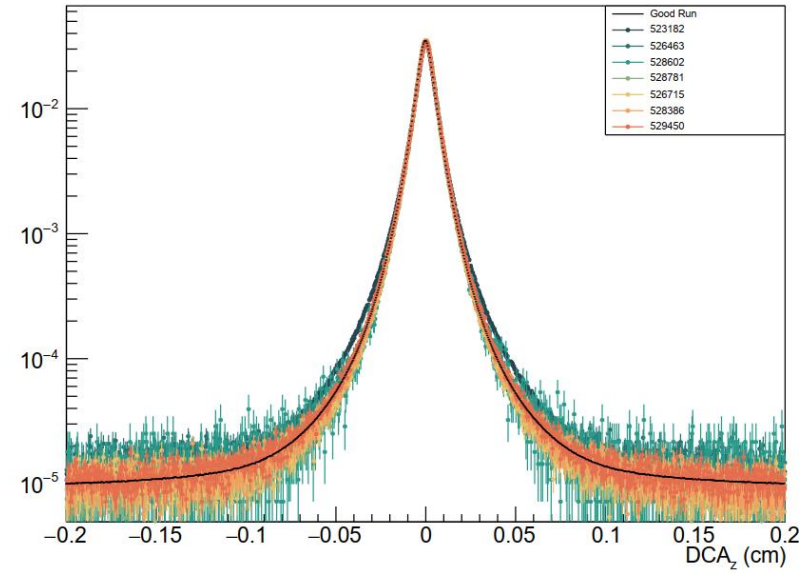
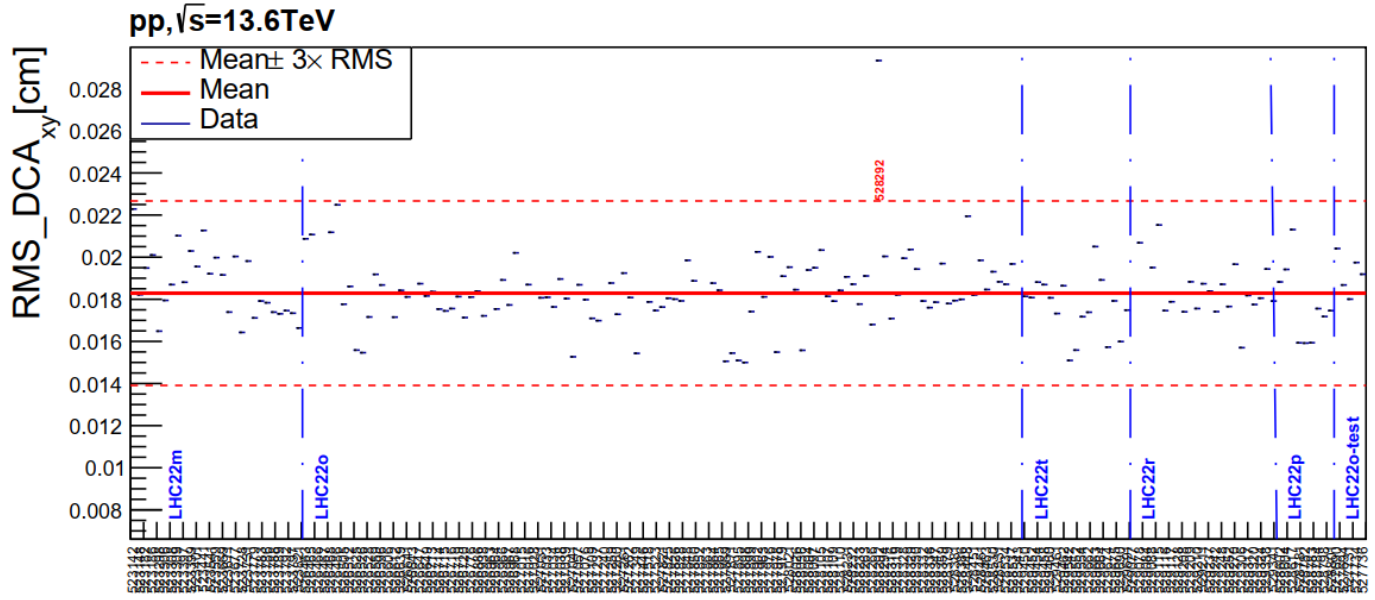
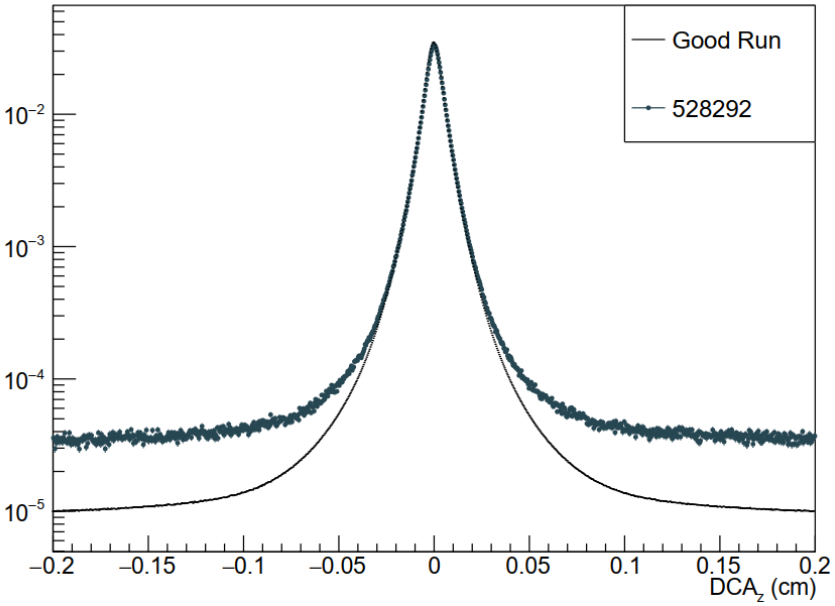
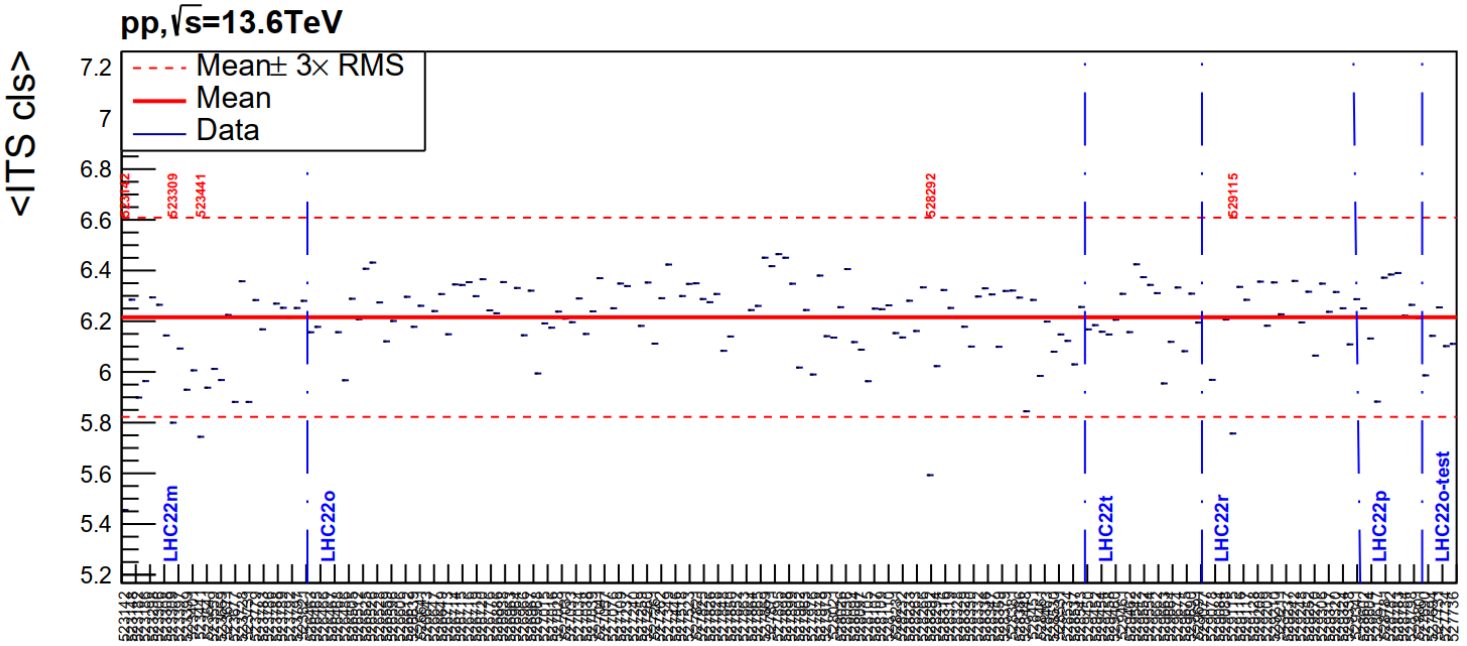
×10⁻³
Mean± 3× RMS
Mean
Data
<DCA_z>[cm]
LHC22m
LHC22o
LHC22t
LHC22r
LHC22p
LHC22o-test

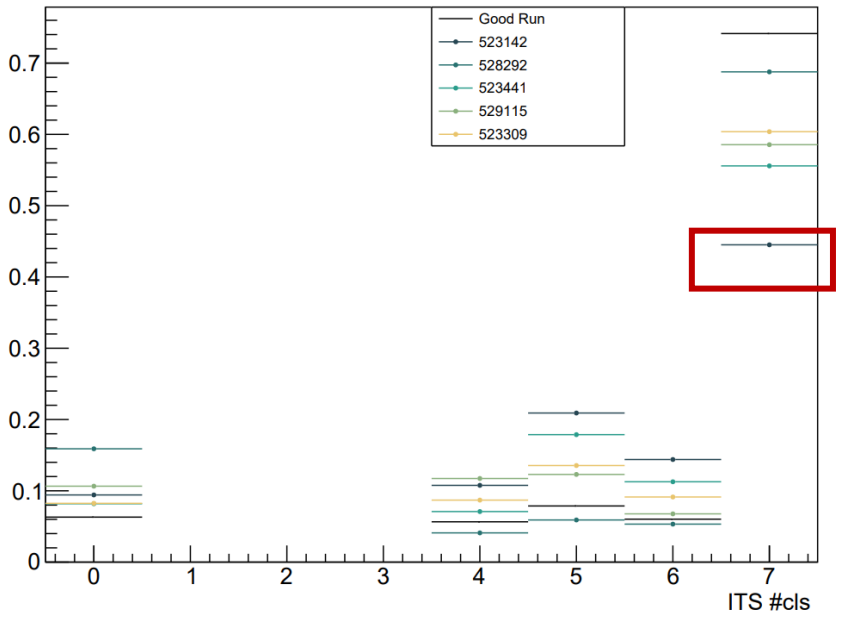

Good Run
523182
526463
528602
528781
526715
528386
529450
DCA_z (cm)


pp,√s=13.6TeV
Mean± 3× RMS
Mean
Data
RMS_DCA_xy[cm]
528292
LHC22m
LHC22o
LHC22t
LHC22r
LHC22p
LHC22o-test

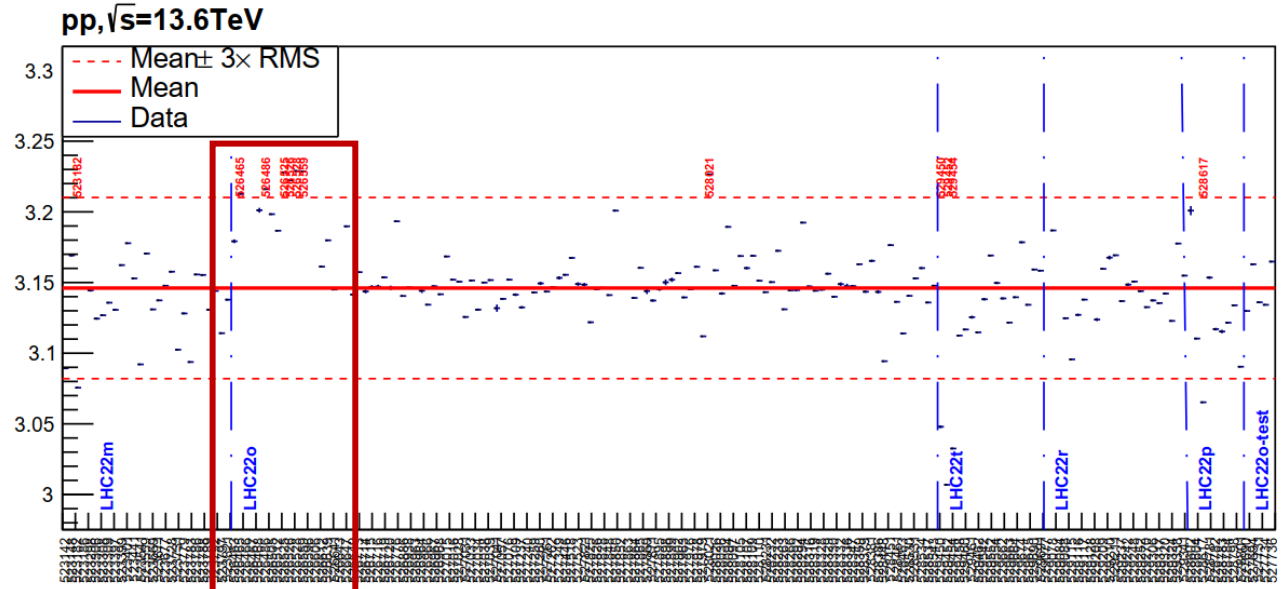

Good Run
528292
DCA_z (cm)

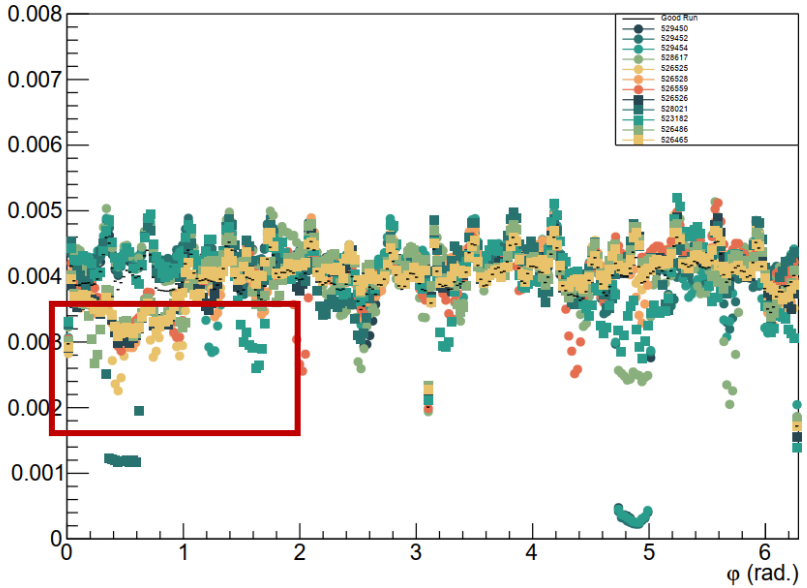
ITS QC

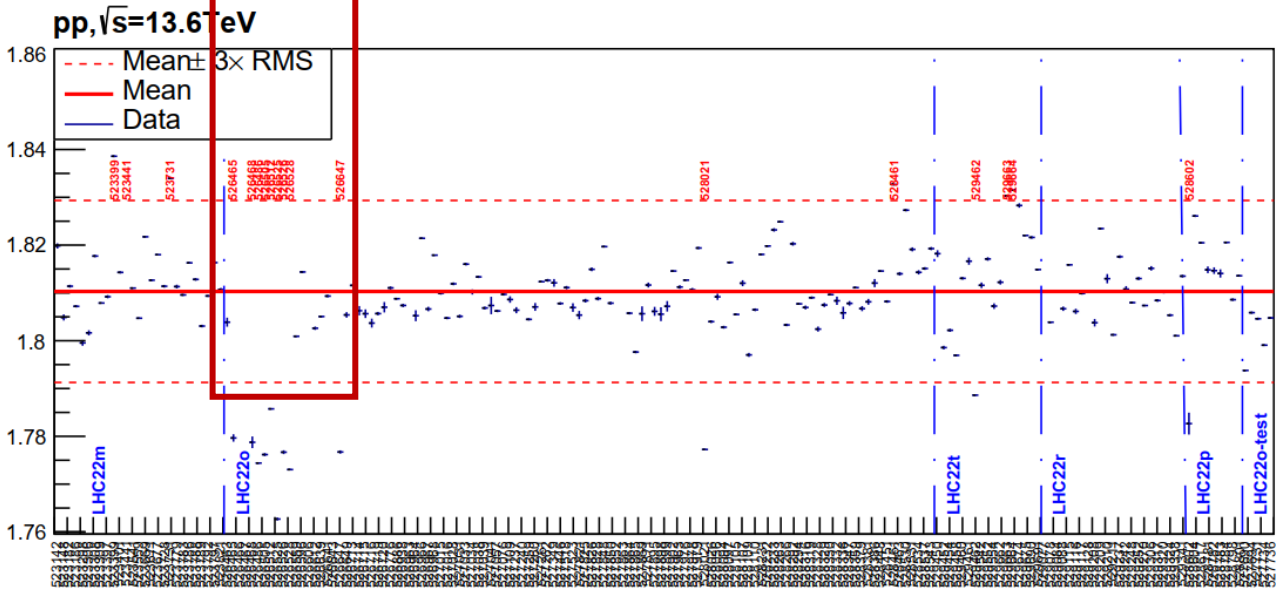

pp,√s=13.6TeV
Mean± 3× RMS
Mean
Data
<ITS cls>
523142
523309
523441
528292
529115
LHC22m
LHC22o
LHC22t
LHC22r
LHC22p
LHC22o-test

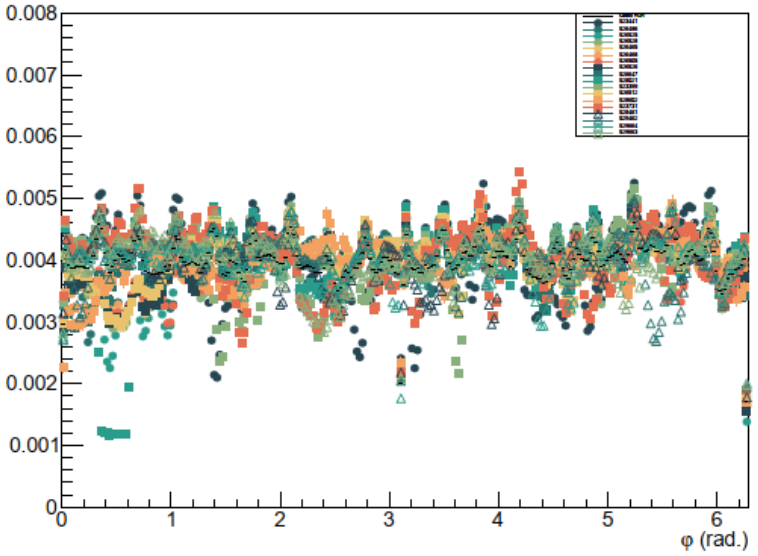

Good Run
523142
528292
523441
529115
523309
ITS #cls

ϕ QC

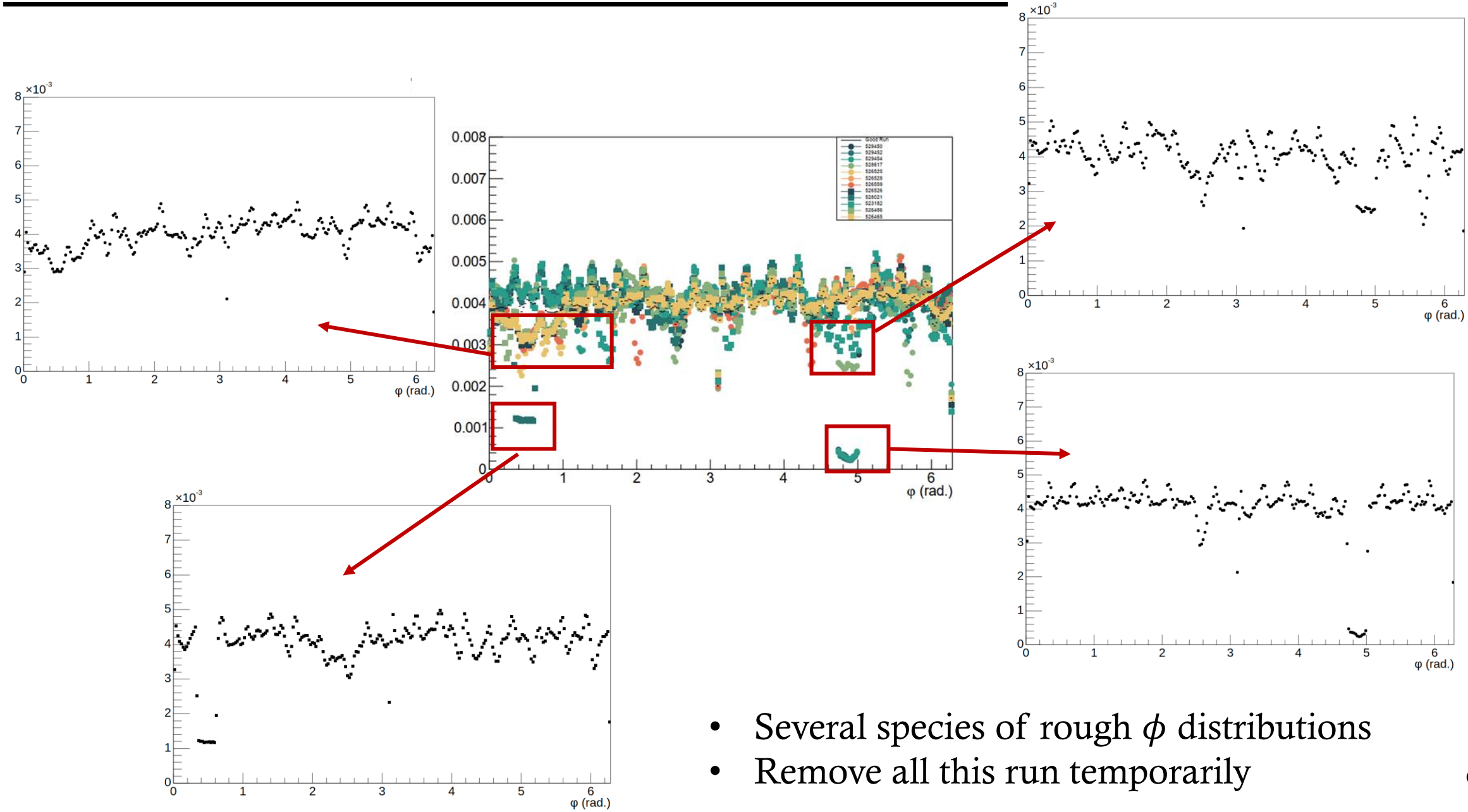

pp,√s=13.6TeV
Mean± 3× RMS
Mean
Data
<ϕ>
LHC22m
LHC22o
LHC22t
LHC22r
LHC22p
LHC22o-test


φ (rad.)


pp,√s=13.6TeV
Mean± 3× RMS
Mean
Data
RMS ϕ
LHC22m
LHC22o
LHC22t
LHC22r
LHC22p
LHC22o-test


φ (rad.)

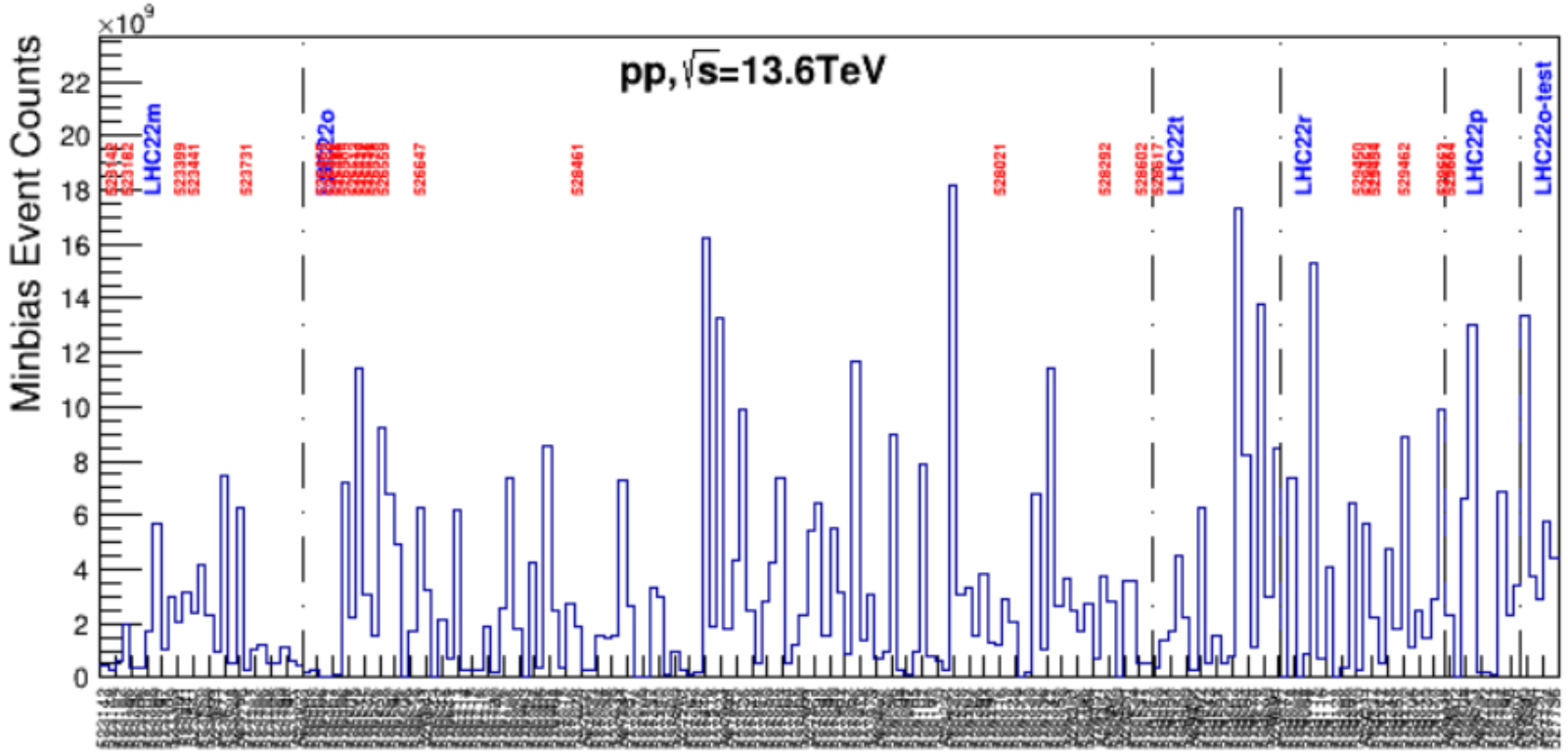
More Detail



- Several species of rough ϕ distributions
- Remove all this run temporarily

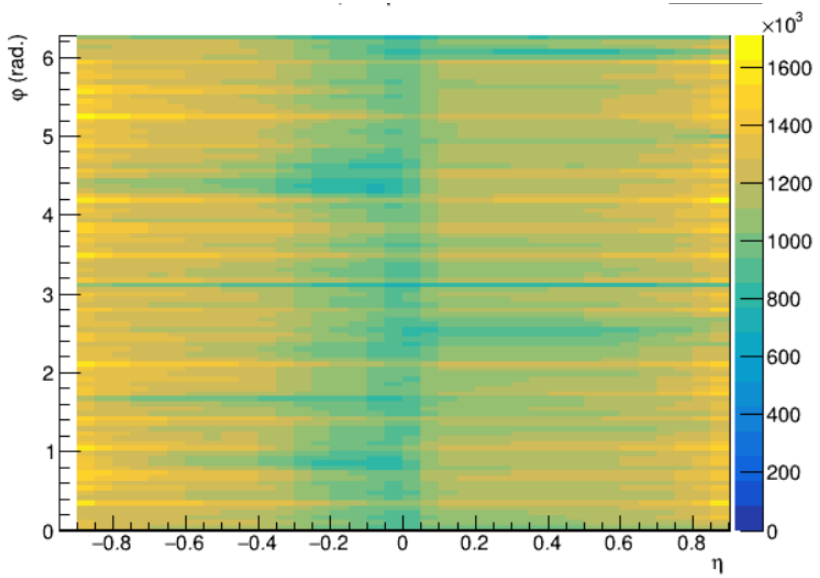
QC conclusion

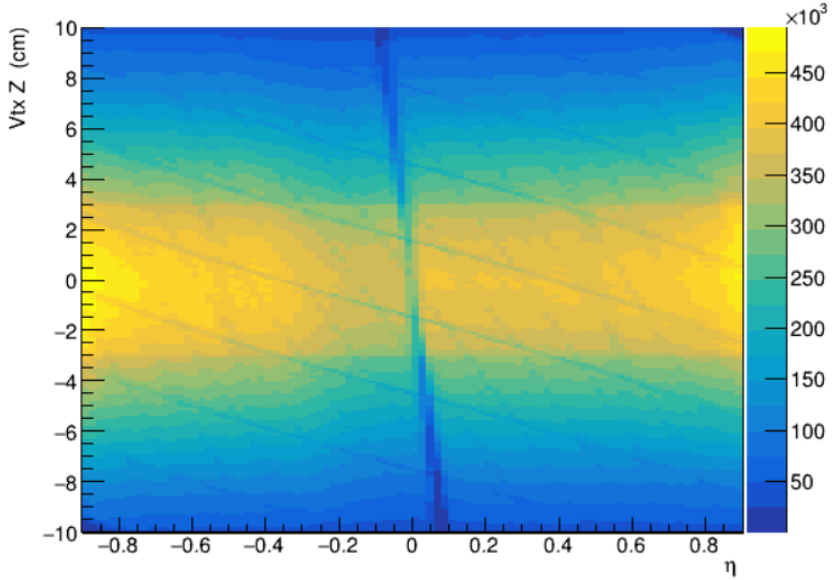
- Bad run:523142, 523182, 523399, 523441, 523731, 526465, 526468, 526486, 526505, 526512, 526525, 526526, 526528, 526559, 526647, 528021, 528292, 528461, 528602, 528617, 529450, 529452, 529454, 529462, 529663, 529664

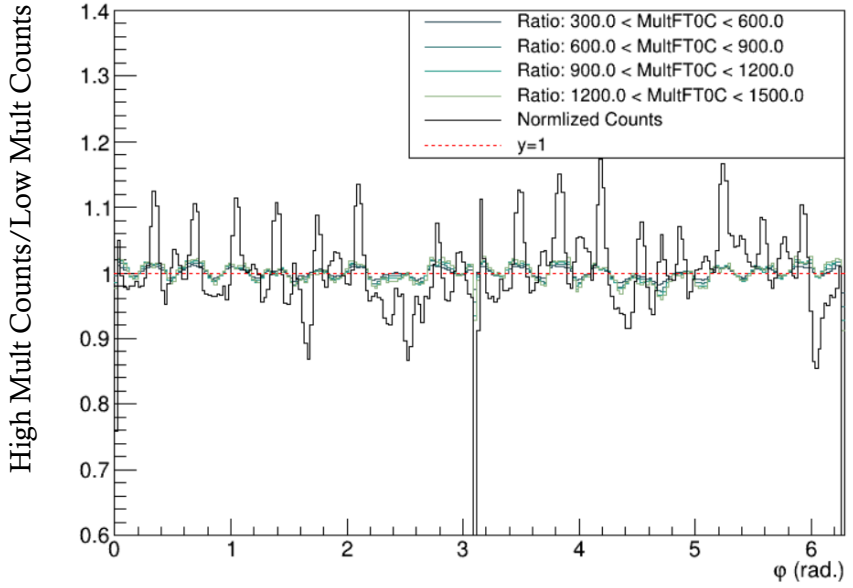


- Total 183 runs used:
  - 606 billion min-bias events
- 26 Bad Runs
  - 114 billion min-bias events
  - Mostly removed for problematic ϕ distribution

Non-uniform Correction







- Counts Ratios vary with ϕ because the gap of TPC acceptance
- Correction for Vtx_z, η, $FT0C$

Methods in this report

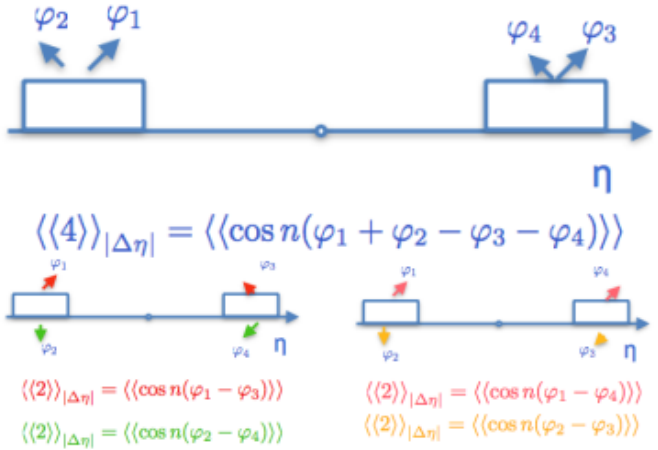
1-sub-event

$$
\begin{aligned}
c_n\{2\} &= \langle\langle 2\rangle\rangle \\
c_n\{4\} &= \langle\langle 4\rangle\rangle - 2\cdot\langle\langle 2\rangle\rangle^2 \\
c_n\{6\} &= \langle\langle 6\rangle\rangle - 9\cdot\langle\langle 2\rangle\rangle\cdot\langle\langle 4\rangle\rangle + 12\cdot\langle\langle 2\rangle\rangle^3 \\
c_n\{8\} &= \langle\langle 8\rangle\rangle - 16\cdot\langle\langle 6\rangle\rangle\langle\langle 2\rangle\rangle - 18\cdot\langle\langle 4\rangle\rangle^2 \\
&\quad +144\cdot\langle\langle 4\rangle\rangle\langle\langle 2\rangle\rangle^2 - 144\cdot\langle\langle 2\rangle\rangle^4
\end{aligned}
$$

$$
v_n\{2\} = \sqrt{c_n\{2\}} \quad v_n\{4\} = \sqrt[4]{-c_n\{4\}} \quad v_n\{6\} = \sqrt[6]{\frac{1}{4}c_n\{6\}}
$$

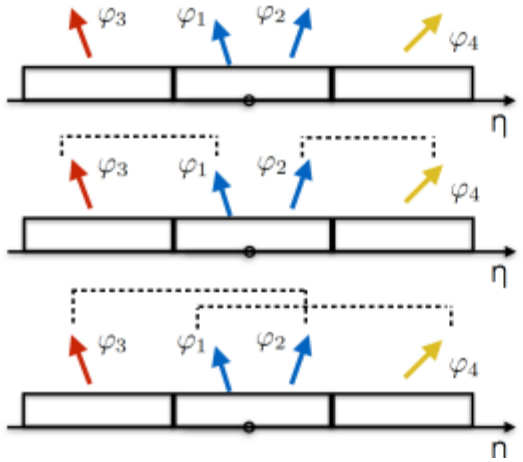
2-sub-event

$$
\begin{aligned}
\langle\langle 4\rangle\rangle_{|\Delta\eta|} &= \langle\langle\cos n(\varphi_1+\varphi_2-\varphi_3-\varphi_4)\rangle\rangle \\
\langle\langle 2\rangle\rangle^2_{|\Delta\eta|} &= \langle\langle\cos n(\varphi_2-\varphi_3)\rangle\rangle\langle\langle\cos n(\varphi_1-\varphi_4)\rangle\rangle \\
\langle\langle 2\rangle\rangle^2_{|\Delta\eta|} &= \langle\langle\cos n(\varphi_1-\varphi_3)\rangle\rangle\langle\langle\cos n(\varphi_2-\varphi_4)\rangle\rangle \\
c_n\{4\}_{|\Delta\eta|} &= \langle\langle 4\rangle\rangle_{|\Delta\eta|} - 2\cdot\langle\langle 2\rangle\rangle^2_{|\Delta\eta|}.
\end{aligned}
$$



3-sub-event

$$
\begin{aligned}
\langle\langle 4\rangle\rangle_{3-\text{sub}} &= \langle\langle\cos n(\varphi_1+\varphi_2-\varphi_3-\varphi_4)\rangle\rangle \\
\langle\langle 2\rangle\rangle^2_{3-\text{sub}} &= \langle\langle\cos n(\varphi_2-\varphi_3)\rangle\rangle\langle\langle\cos n(\varphi_1-\varphi_4)\rangle\rangle \\
\langle\langle 2\rangle\rangle^2_{3-\text{sub}} &= \langle\langle\cos n(\varphi_1-\varphi_3)\rangle\rangle\langle\langle\cos n(\varphi_2-\varphi_4)\rangle\rangle \\
c_n\{4,3-\text{subevent}\} &= \langle\langle 4\rangle\rangle_{3-\text{sub}} - 2\cdot\langle\langle 2\rangle\rangle_{3-\text{sub}}\cdot\langle\langle 2\rangle\rangle_{3-\text{sub}}
\end{aligned}
$$



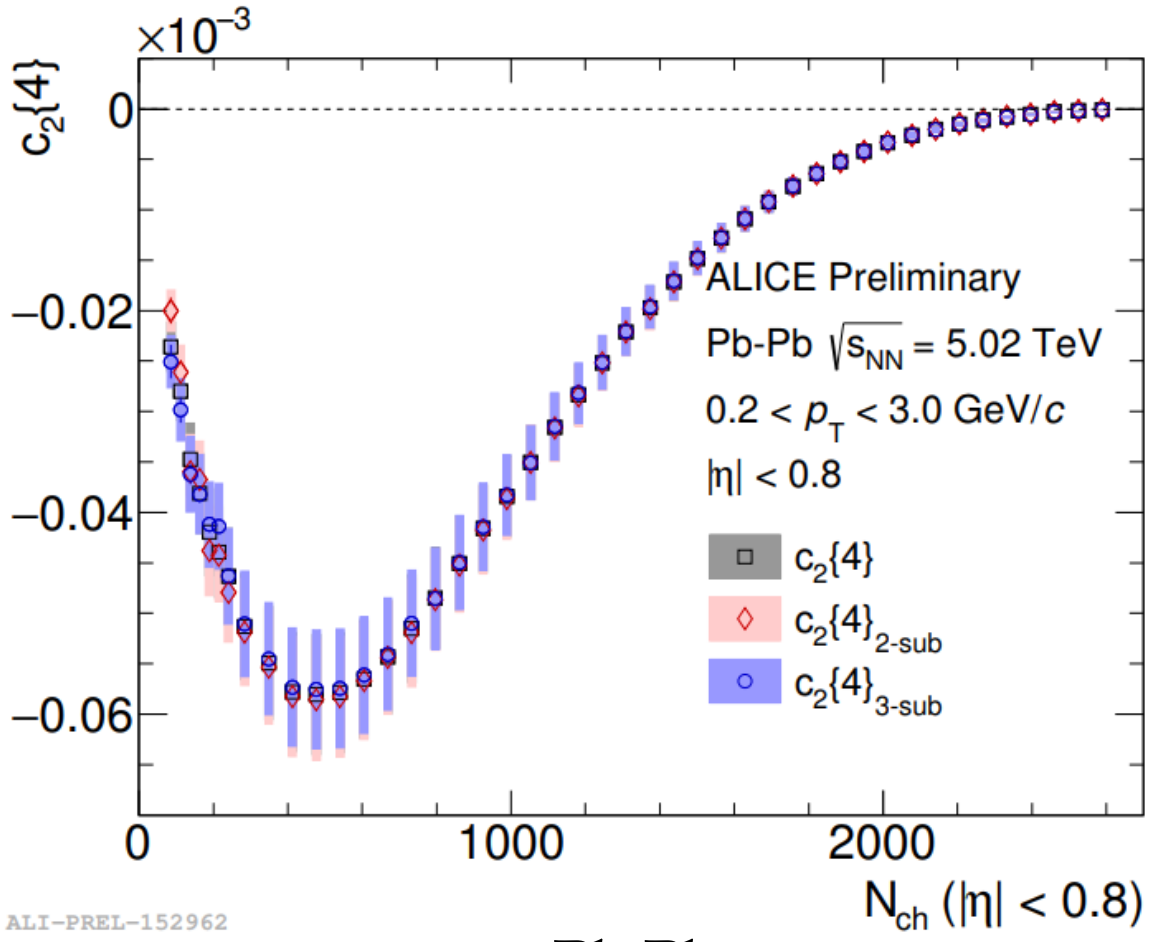
$$\langle\langle 4\rangle\rangle_{3\text{sub}} = \langle\langle\cos n(\varphi_1+\varphi_2-\varphi_3-\varphi_4)\rangle\rangle$$

$$\langle\langle 2\rangle\rangle^2_{3\text{sub}} = \langle\langle\cos n(\varphi_1-\varphi_3)\rangle\rangle\langle\langle\cos n(\varphi_2-\varphi_4)\rangle\rangle$$

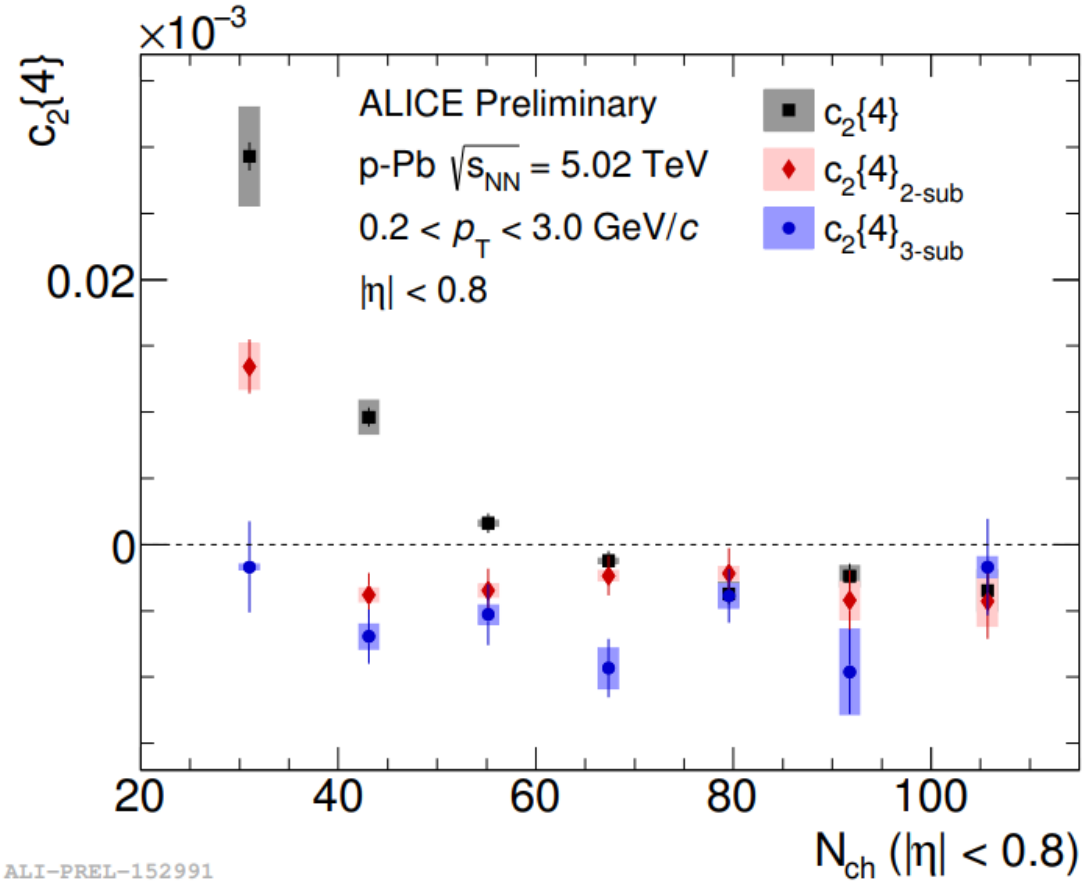
$$\langle\langle 2\rangle\rangle^2_{3\text{sub}} = \langle\langle\cos n(\varphi_1-\varphi_4)\rangle\rangle\langle\langle\cos n(\varphi_2-\varphi_3)\rangle\rangle$$

If more sub events applied, non-flow will be suppressed.

In published results



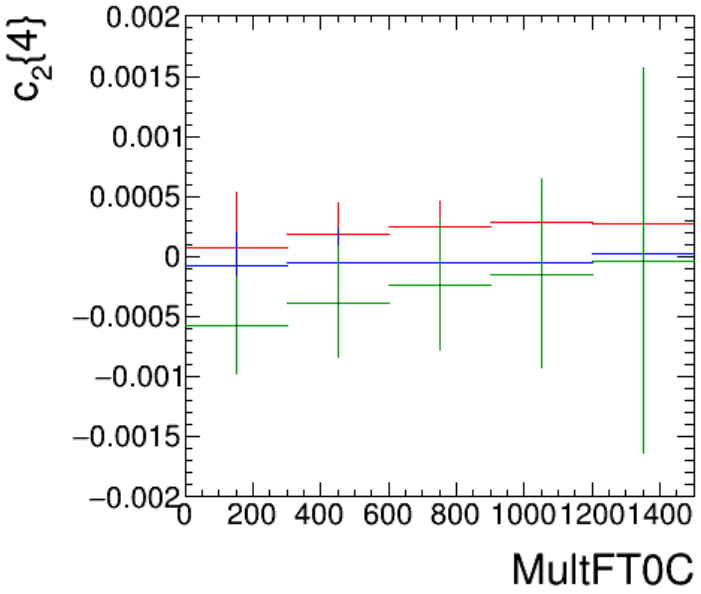
Pb-Pb

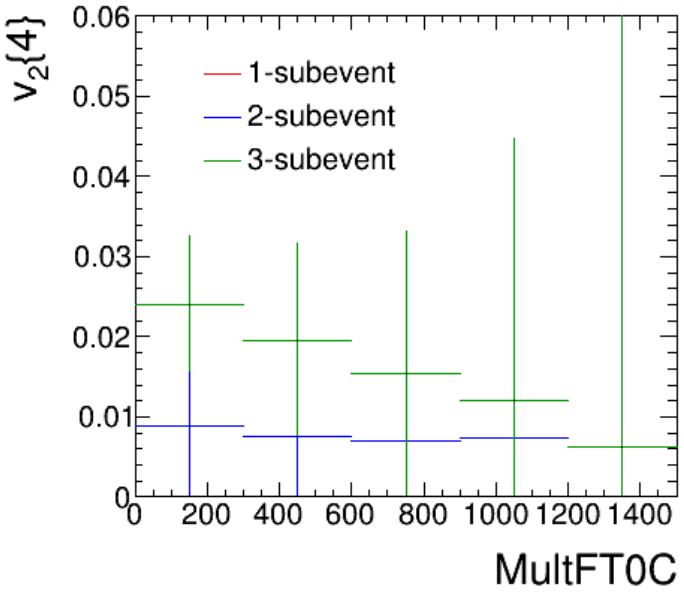


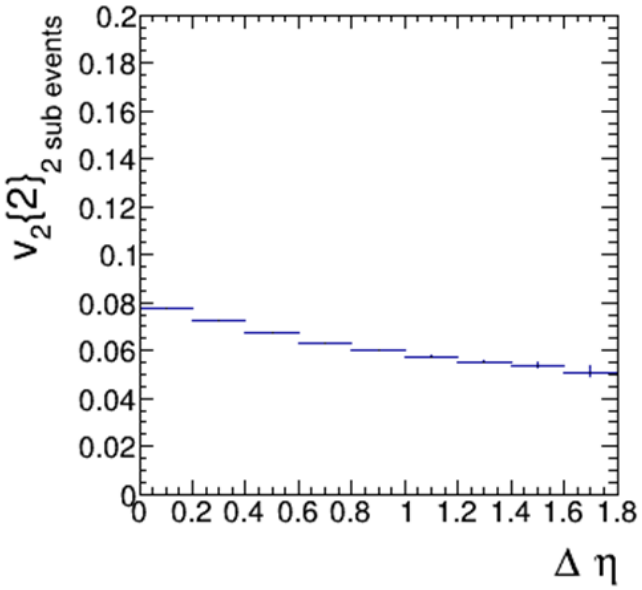
pp

[ALICE measurements of flow coefficients and their correlations in small (pp and p-Pb) and large (Xe-Xe and Pb-Pb) collision systems - CERN Document Server]

Results in This Analysis







- Similar decreasing trend is found in the cumulant result.
- In the $v_2\{2\}_{2\ sub\ events}$, v_2 decreases as $\Delta\eta$ increases because short-range non-flow sources are suppressed.
- In $c_2\{4\}$, uncertainties are large but histograms is flat.
  - May there problem in uncertainty estimation?
  - Try bootstrap

Summary

- Detail QC for non-uniform acceptance has been performed.
- Non-uniform acceptance is corrected at 3 dimensions ($Vtx_z,\ \eta,\ FT0C$).
- In 4-particle-correlation, different sub-event methods are applied to check non-flow effect in the reference flow measurement.
  - Strong non-flow effects are observed. Even 2-sub-event 4-particle-event method is affected by the non-flow badly.
- There may exist problems in uncertainty estimation. Bootstrap will be applied.