# PUPPI testing different vertex association scenarios

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# Sample & Setup

/QCD_Pt_300to470_TuneCP5_14TeV_pythia8/Phase2HLTTDRSummer20ReRECOMiniAOD-**NoPU**_111X_mcRun4_realistic_T15_v1-v1/GEN-SIM-DIGI-RAW-MINIAOD

/QCD_Pt_300to470_TuneCP5_14TeV_pythia8/Phase2HLTTDRSummer20ReRECOMiniAOD-**PU140**_111X_mcRun4_realistic_T15_v1-v1/GEN-SIM-DIGI-RAW-MINIAOD

/QCD_Pt_300to470_TuneCP5_14TeV_pythia8/Phase2HLTTDRSummer20ReRECOMiniAOD-**PU200**_111X_mcRun4_realistic_T15_v1-v1/GEN-SIM-DIGI-RAW-MINIAOD

Global tag: 111X_mcRun4_realistic_T15_v1

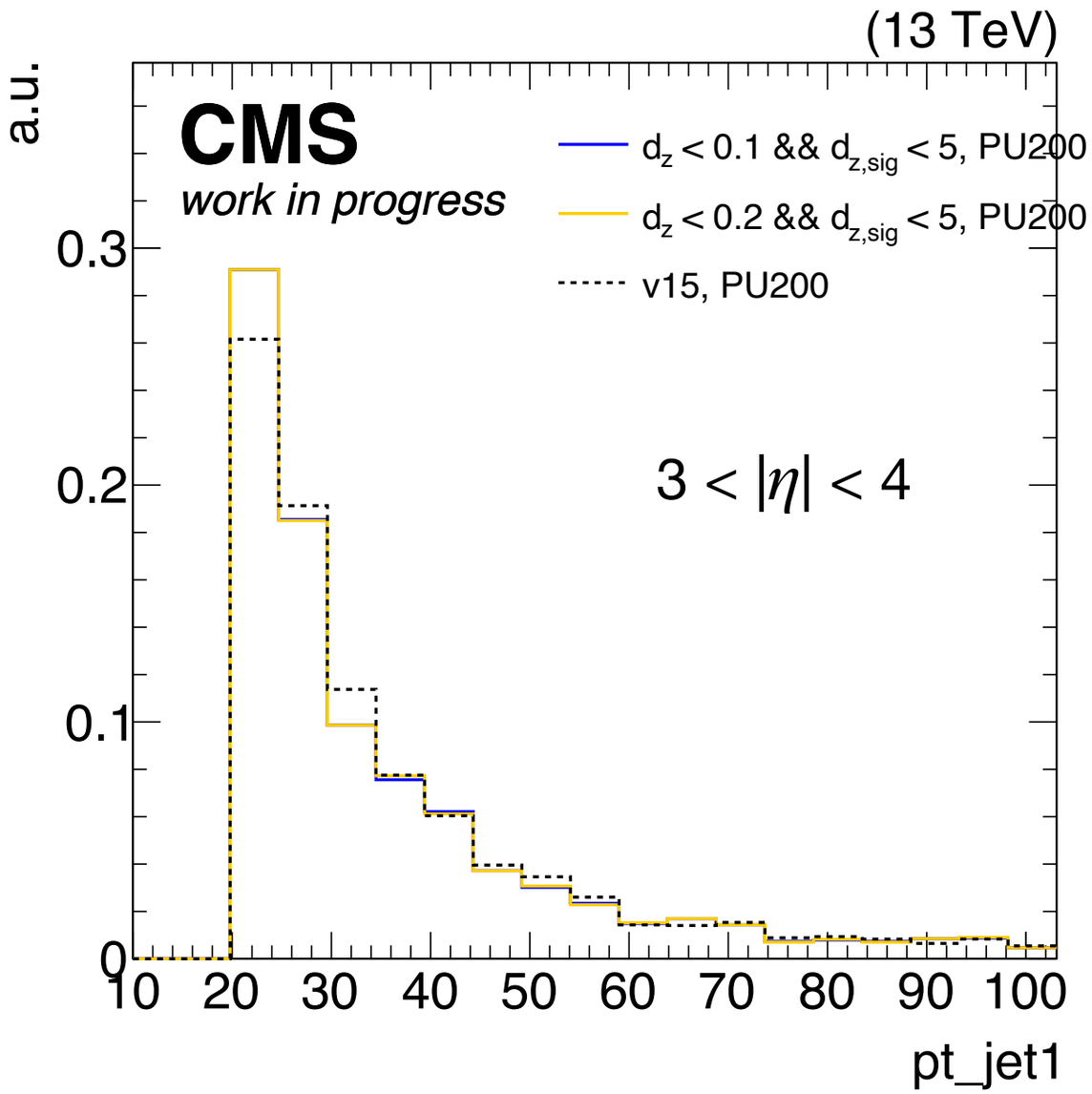
Era: eras.Phase2C9

Geometrie: Configuration.Geometry.GeometryExtended2026D49_cff

Code and Framework:
https://github.com/abenecke/UHH2/tree/CMSSW11X_vertexing_dz0p1_dzsig5
https://github.com/abenecke/cmssw/tree/CMSSW11X_vertexing_PR

**Note: For all samples events are rejected if LV is not the first element in the collection. This is done by calculating the minimal distance between MC truth z position and vertex z position.**

# Different scenarios



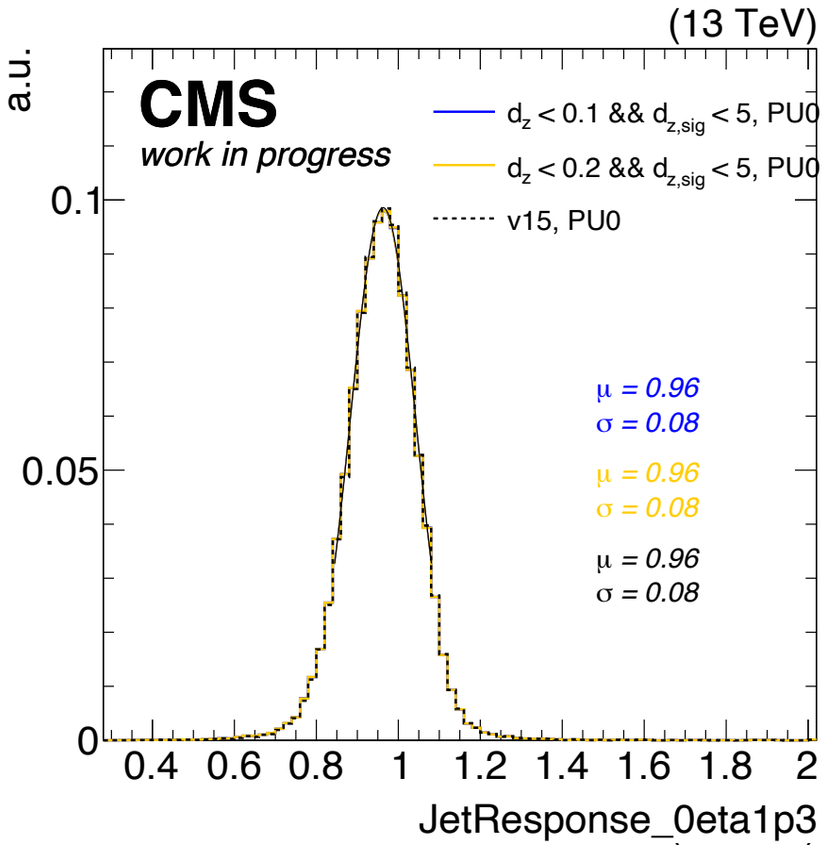

- Three different scenarios tested:
  - UL v15 PUPPI
  - PR vertex assignment with dz < 0.1 && dzsig < 5
  - PR vertex assignment with dz < 0.2 && dzsig < 5
- First look into 4D vertex collection w/o timing
- In PR we find the closest vertex for each track that fulfills dz and dzsig

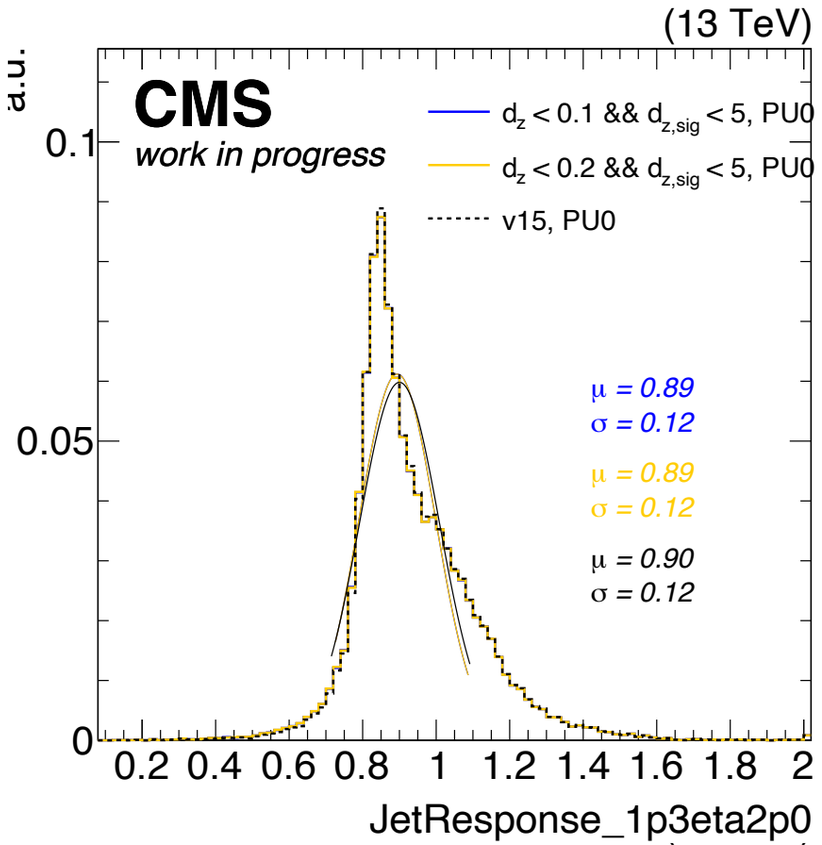
# Comparison of jet response

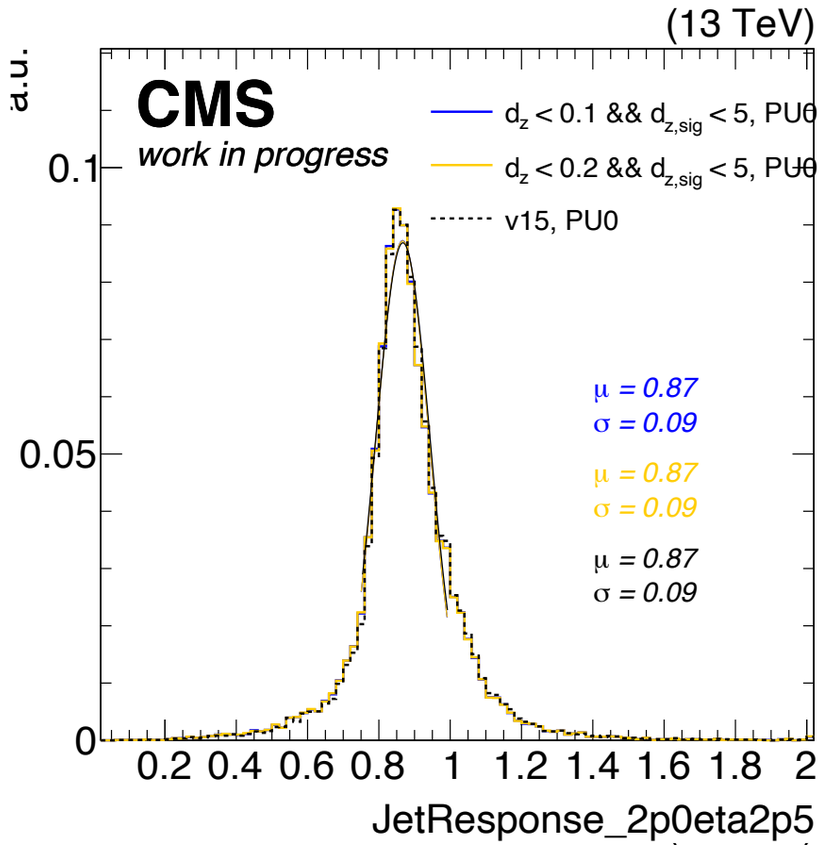
Only small difference observed in the different $\eta$ bins.

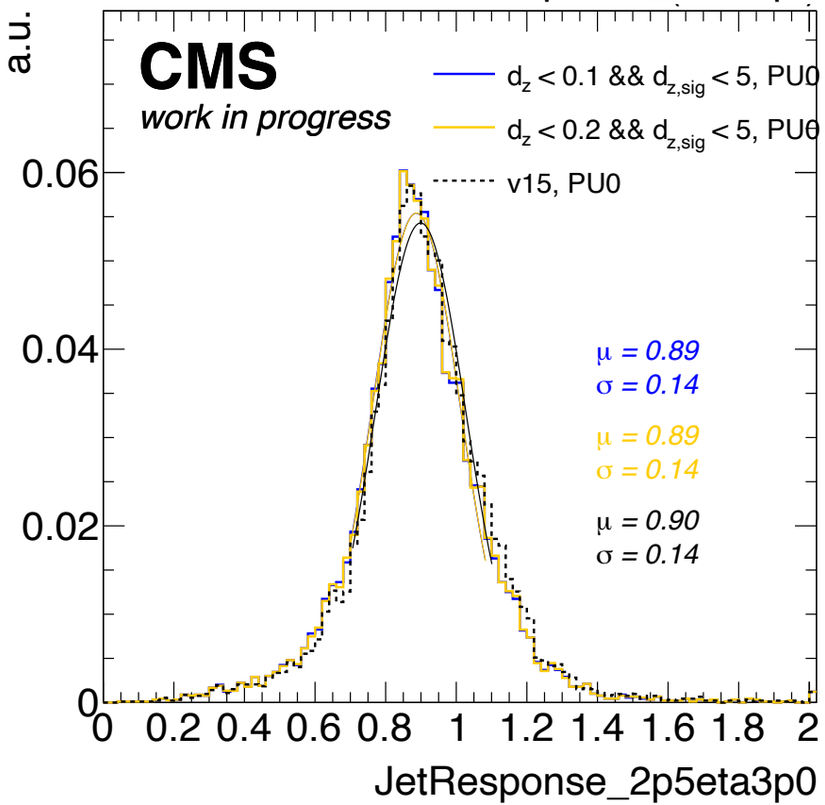
For PU of 200 in the high $\eta$ region a bit more difference; v15 better than dz.

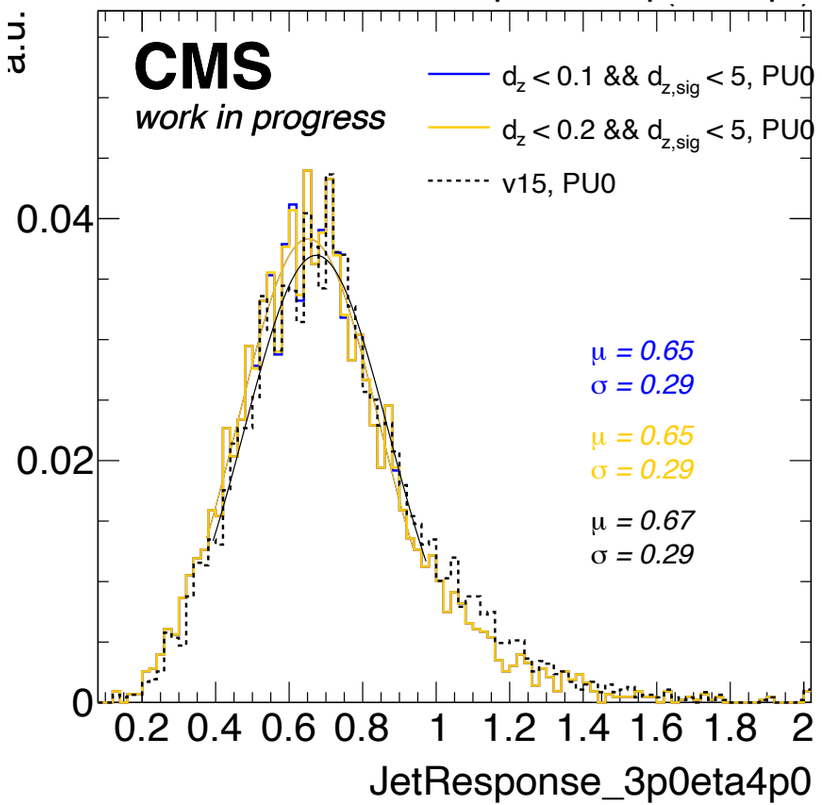
# Jet response 0PU

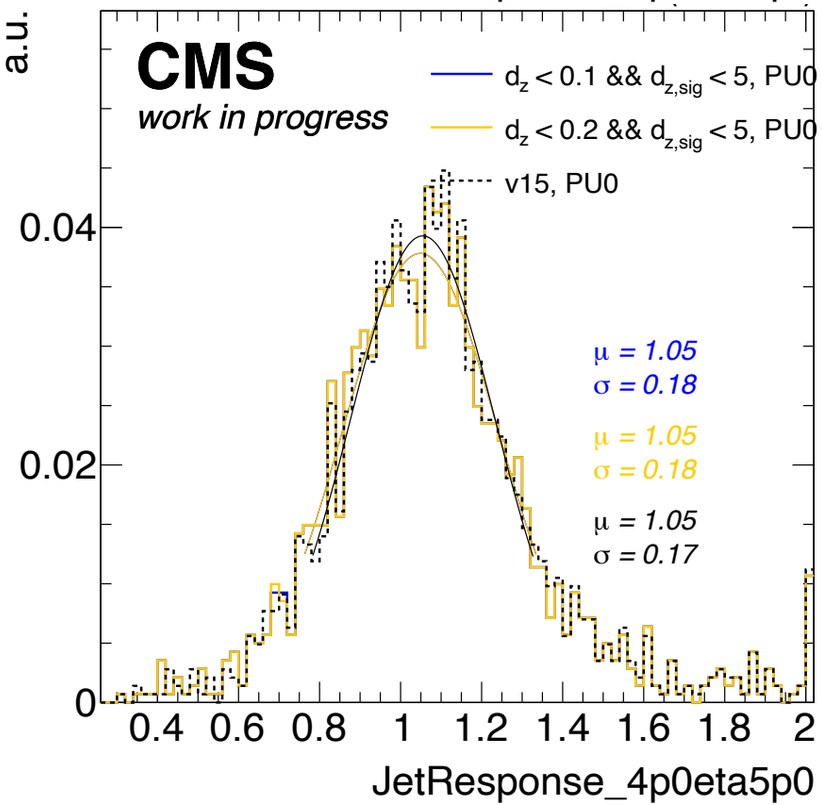


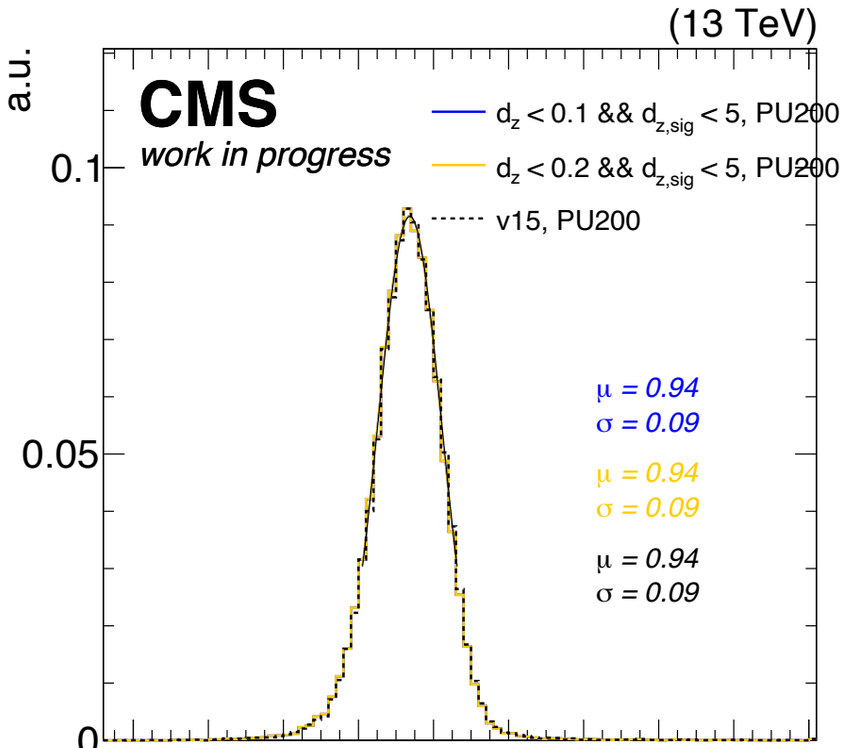



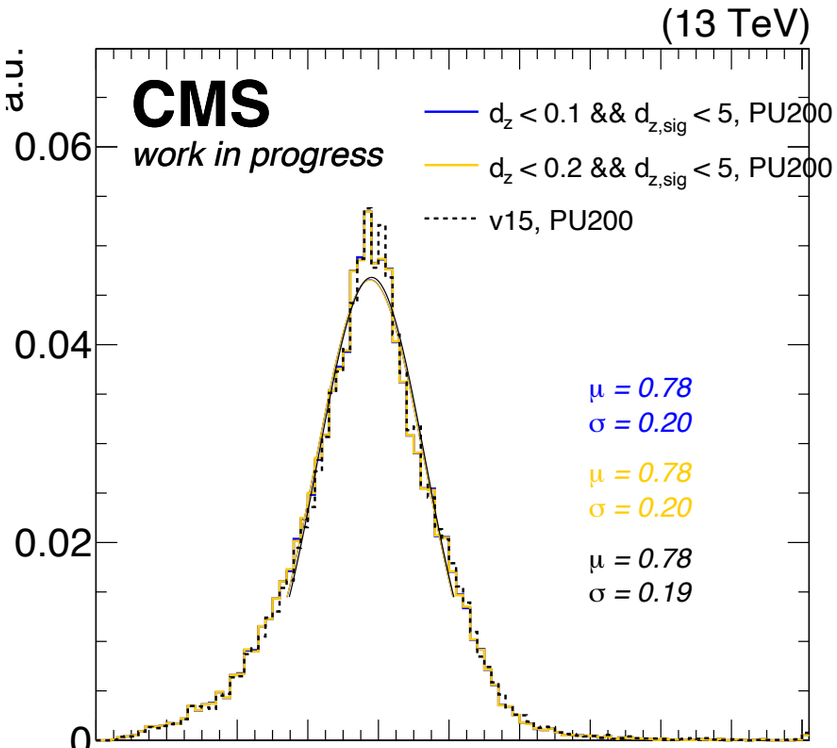



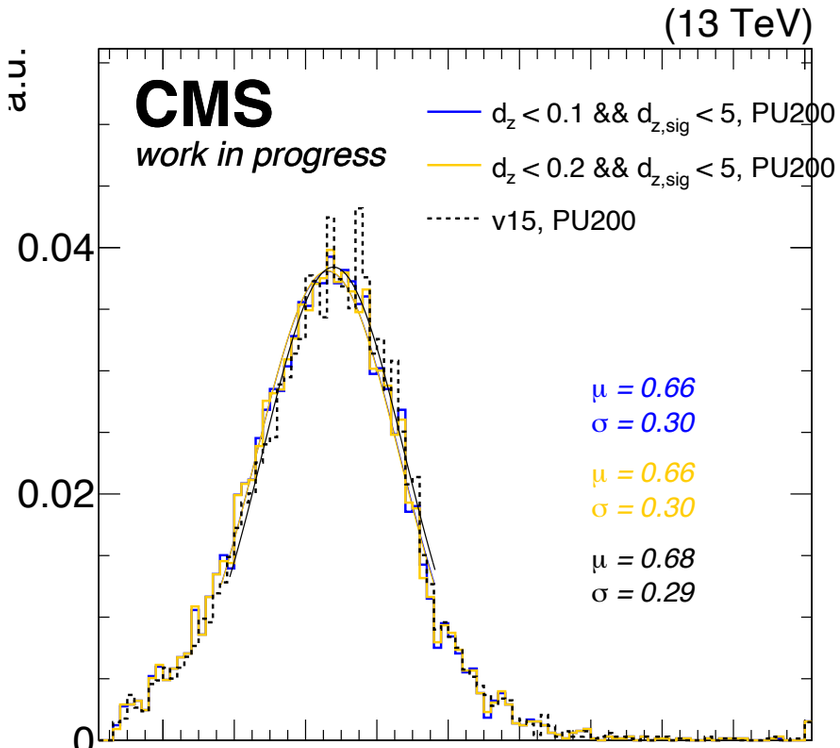



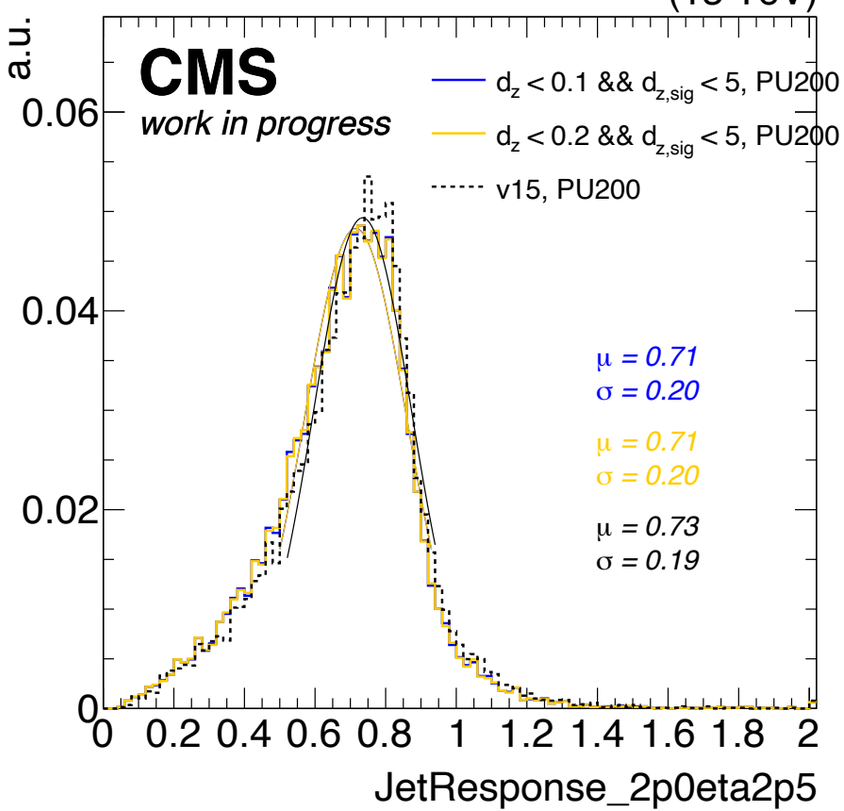



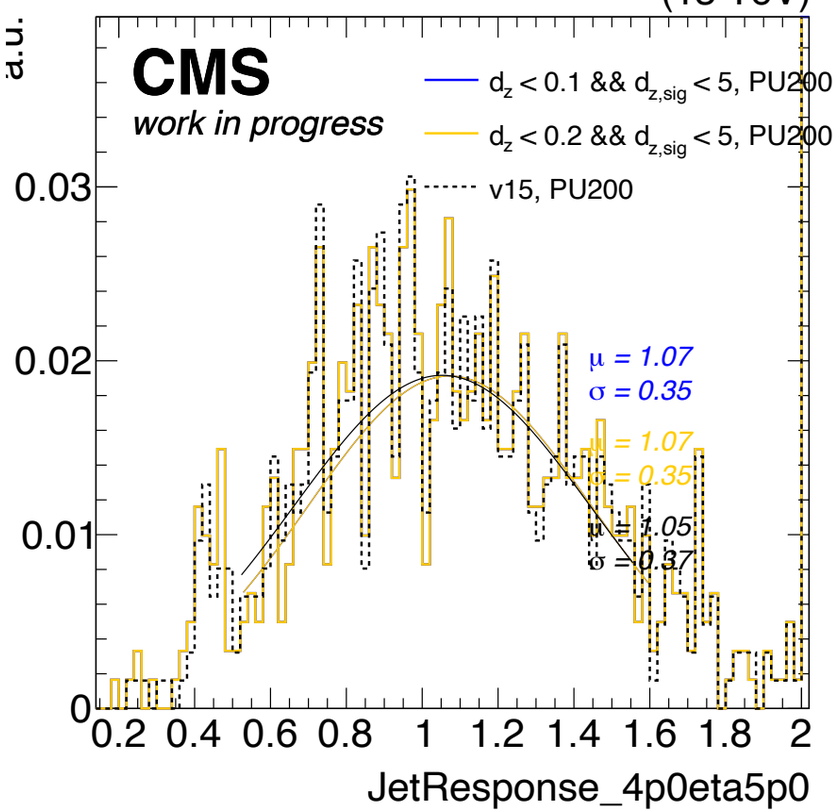
# Jet response 200PU

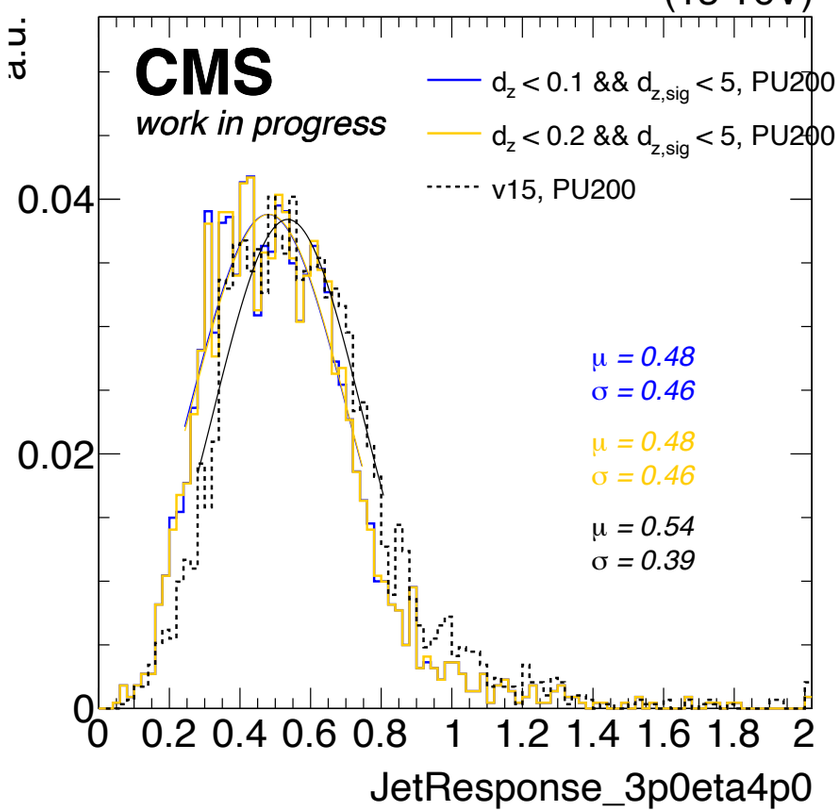


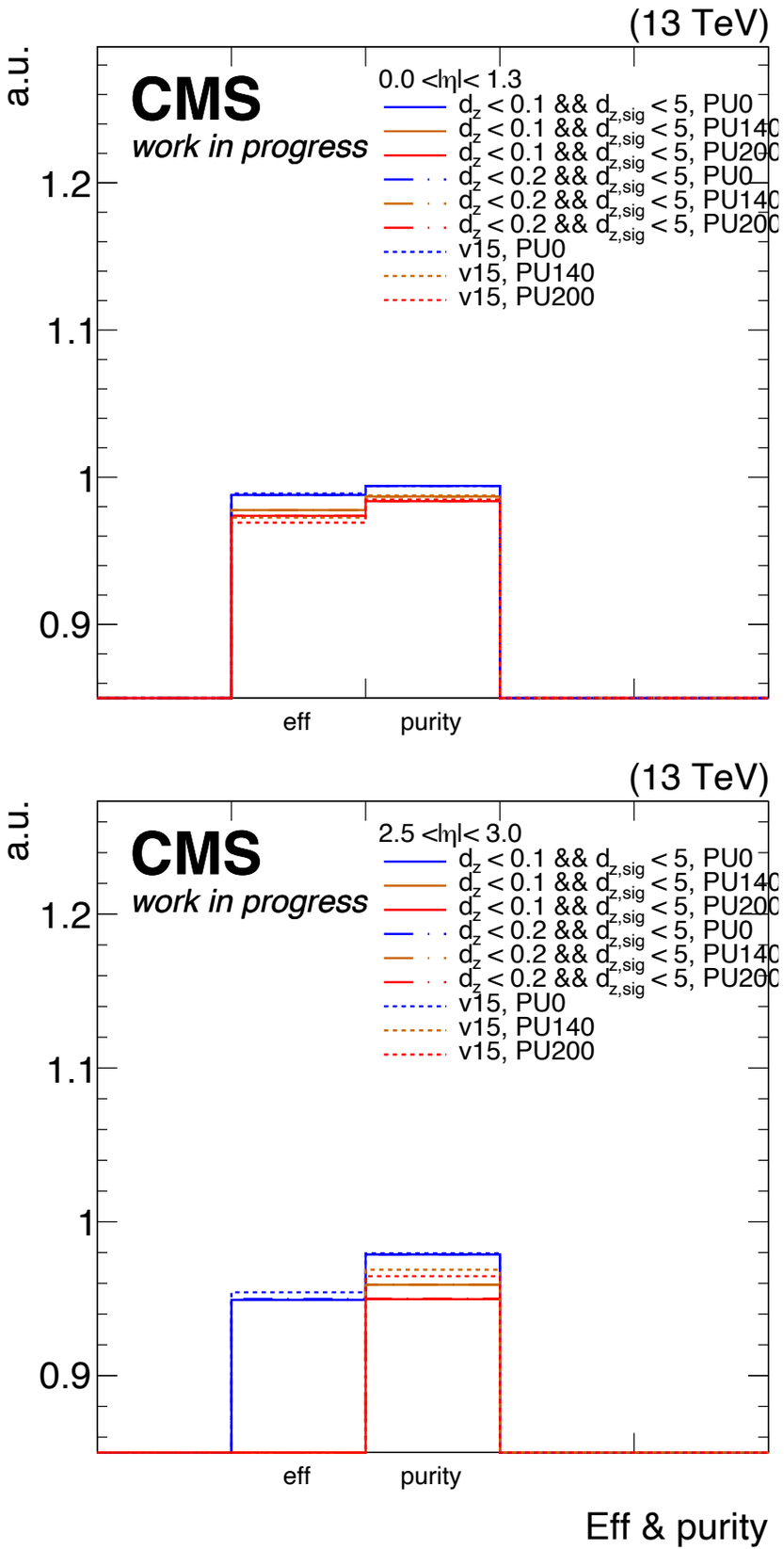



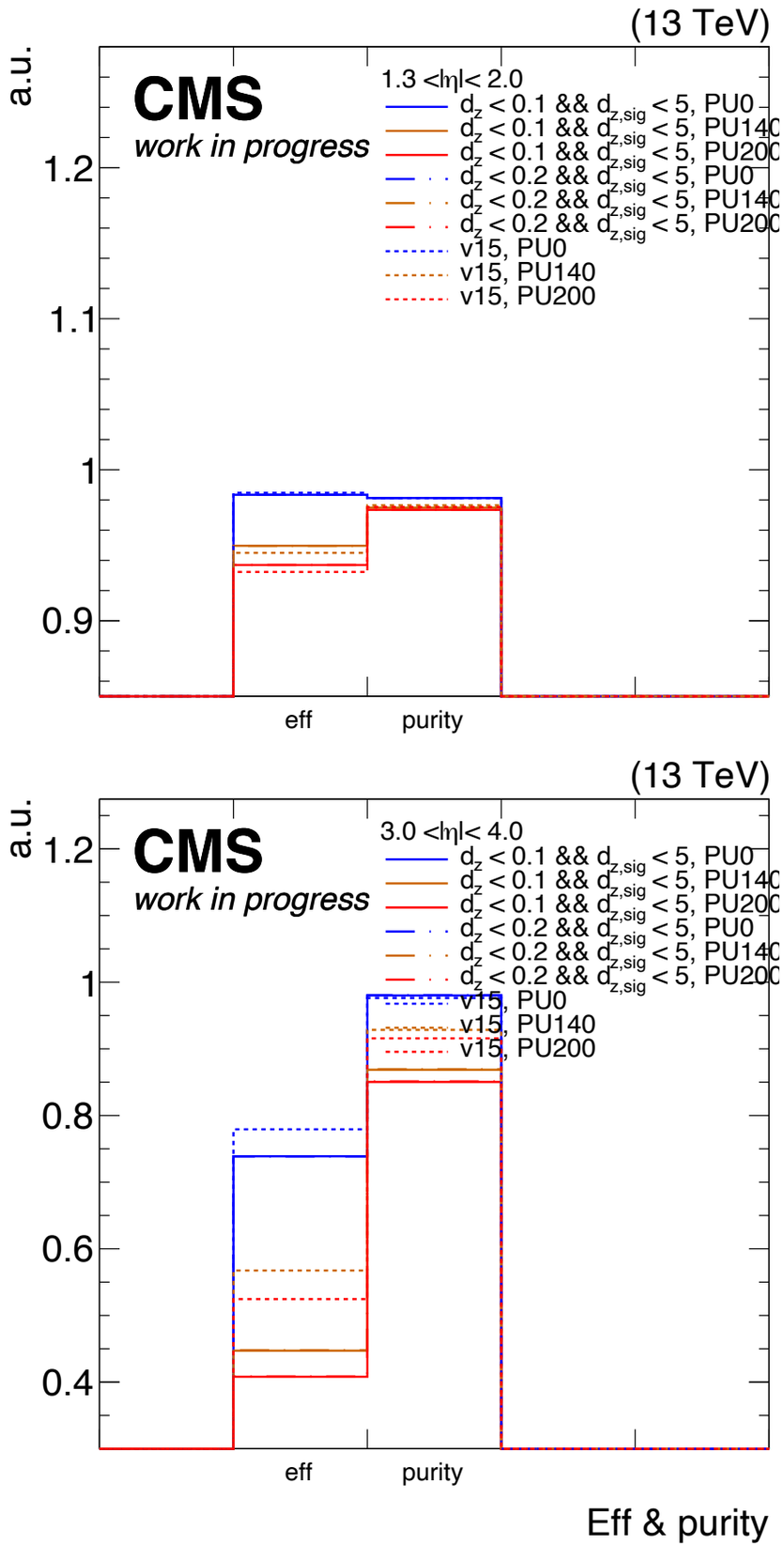



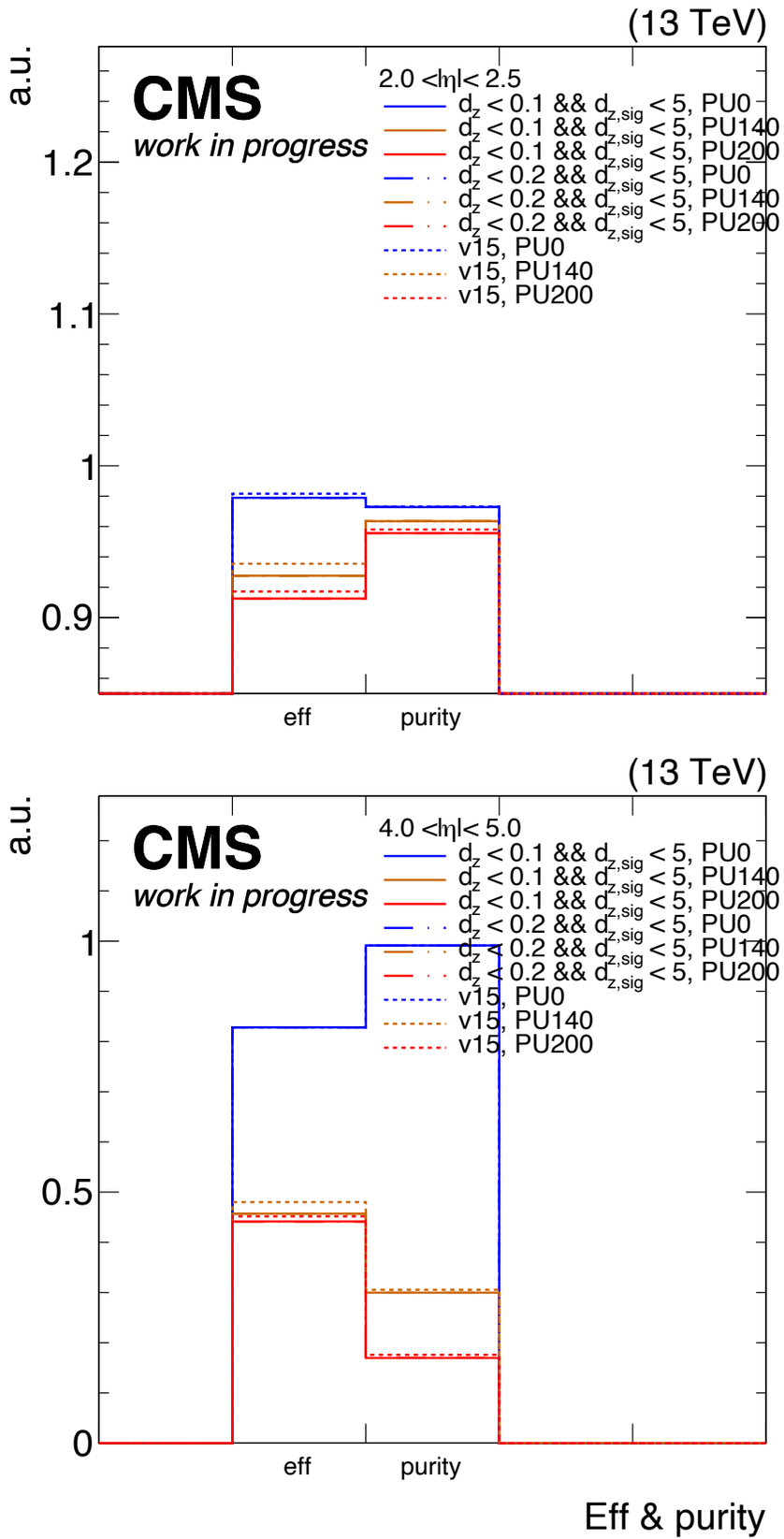
# Efficiency and purity

Small differences in $|\eta|$ <2.0. Better eff and purity in $|\eta|$>2.0 for v15 than dz.

# Efficiency and purity







Eff & purity




Eff & purity



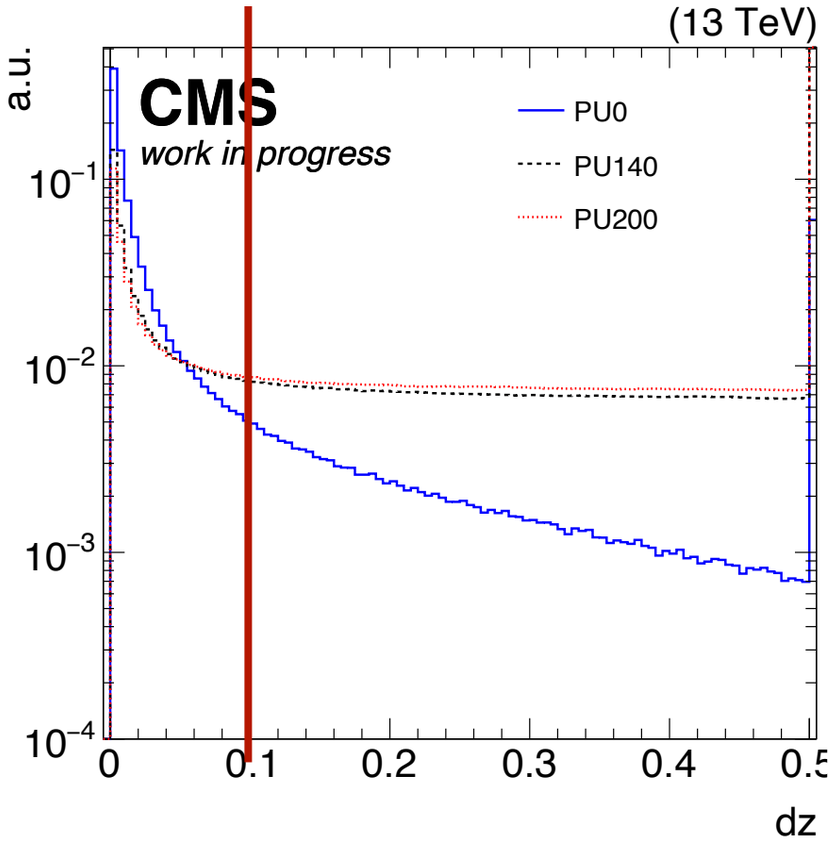

Eff & purity

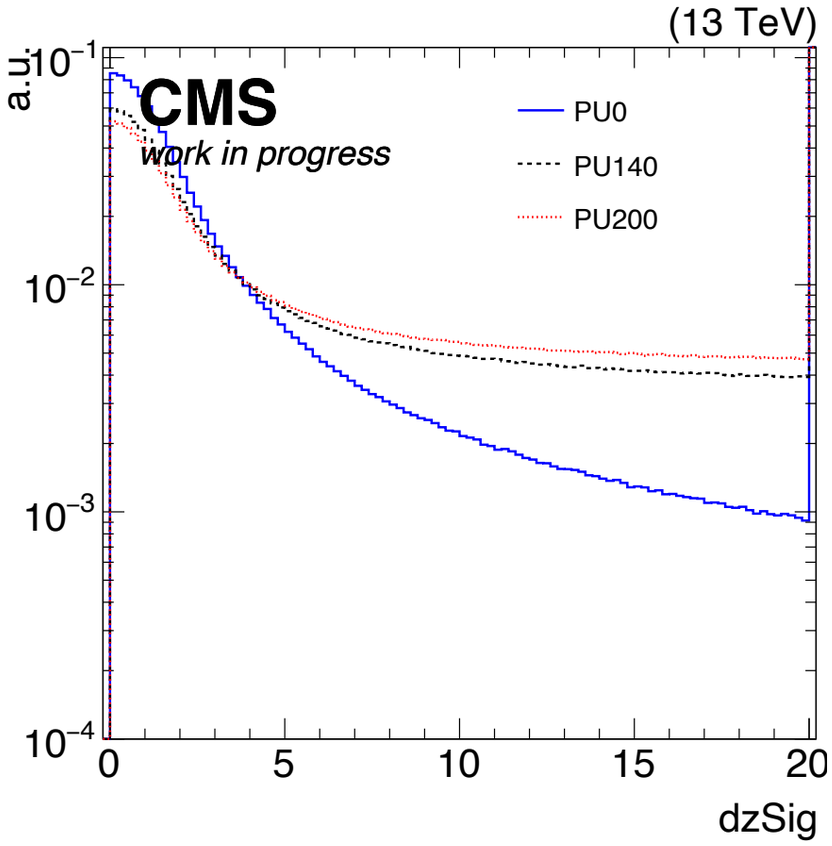
# Track-Vertex Variables

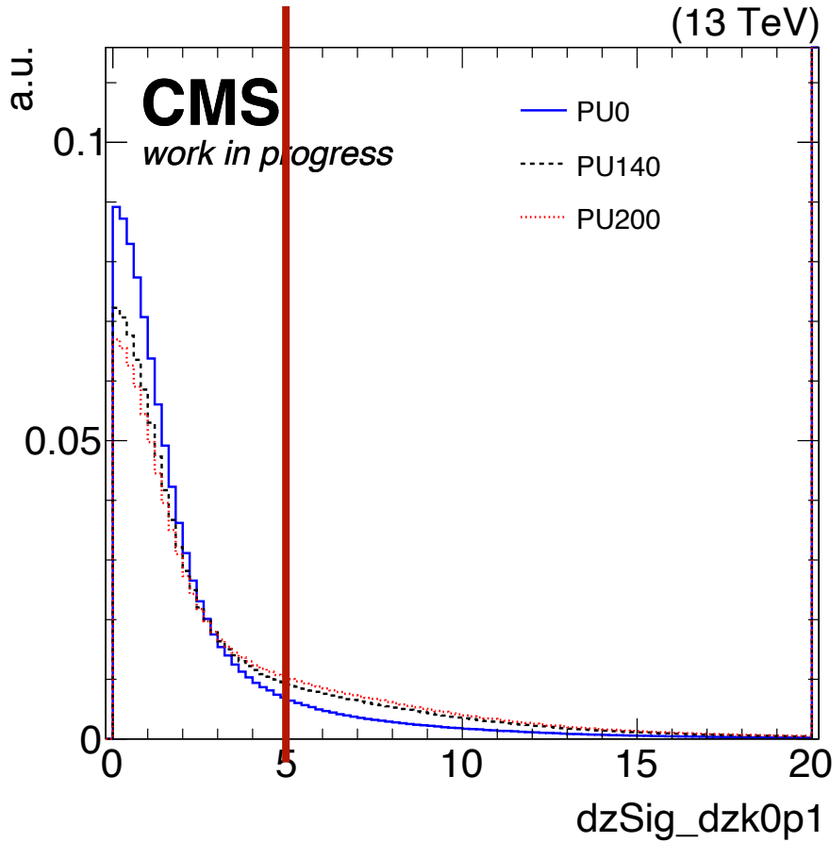
# 3D vertex collection

In the following dz, dzsig and dzsig(dz<0.1) are shown first inclusive than in different $\eta$ bins. Track vertex association to closet vertex in z that fullfills dz<0.1 && dzsig<5. Three PU scenarios are compared while the 0 PU scenario can give us a hint on the resolution of the variables. Variables are shown without PUPPI weights. Small differences between the $\eta$ bins.

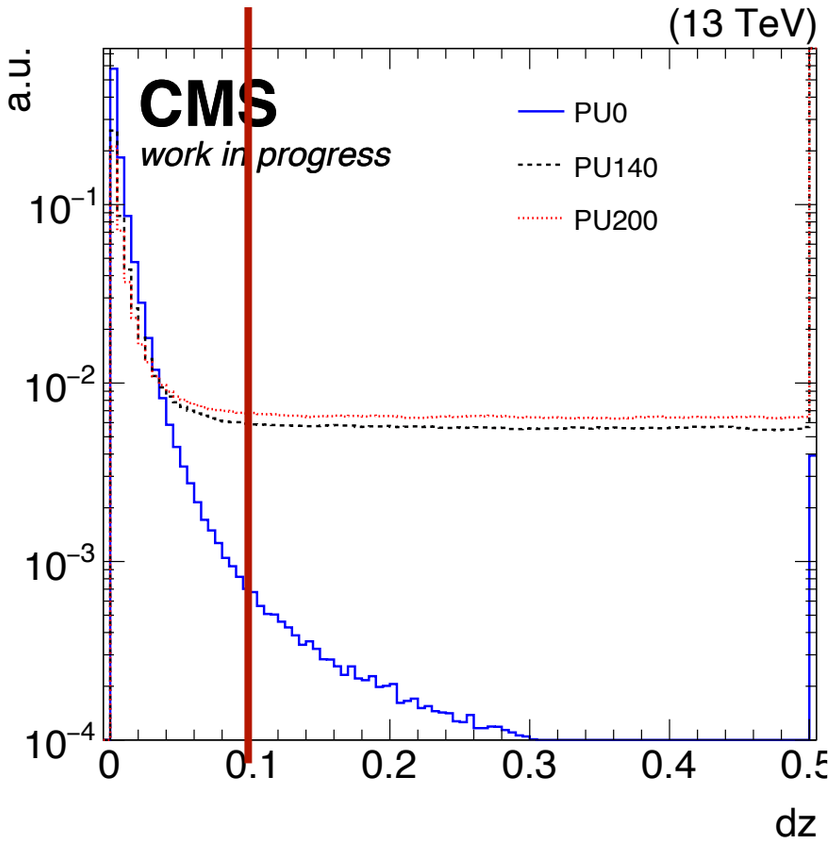
# General

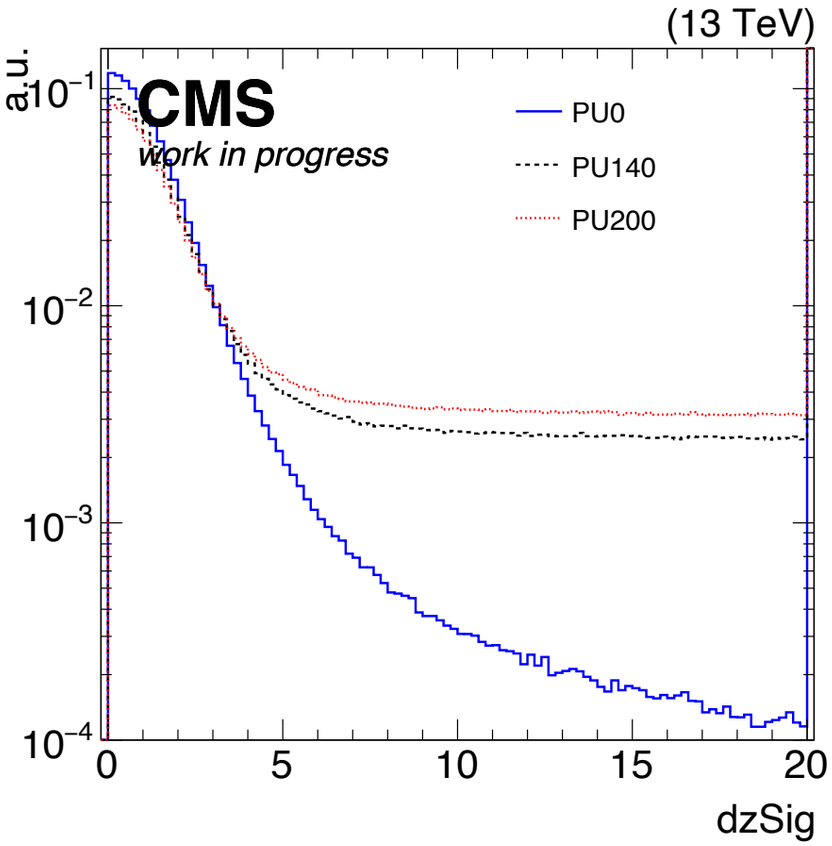

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dz

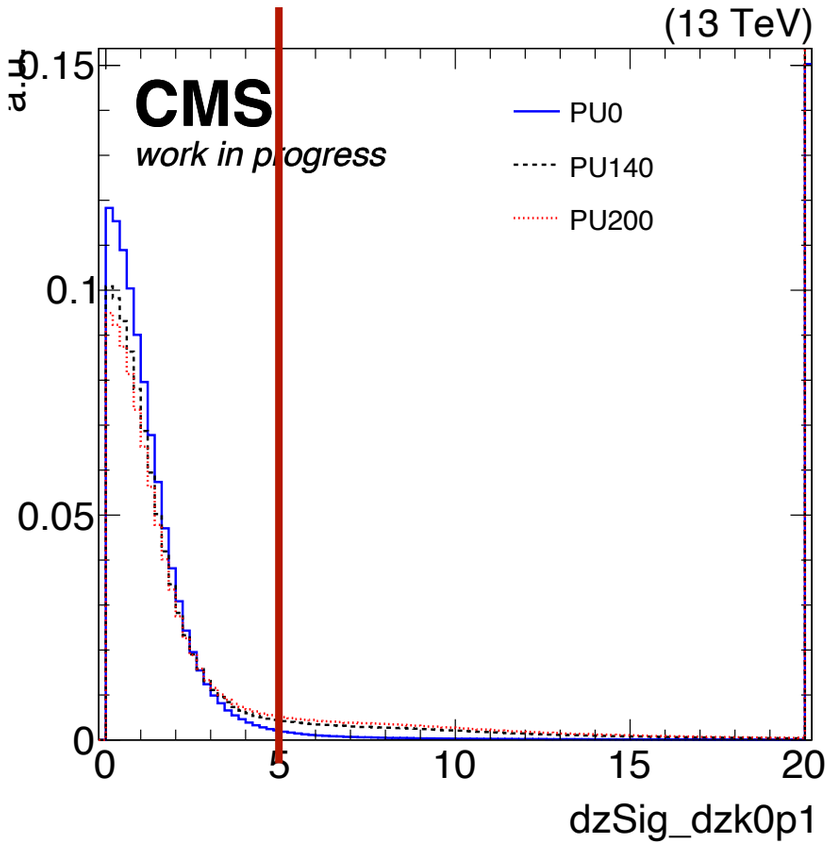

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig


(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig_dzk0p1

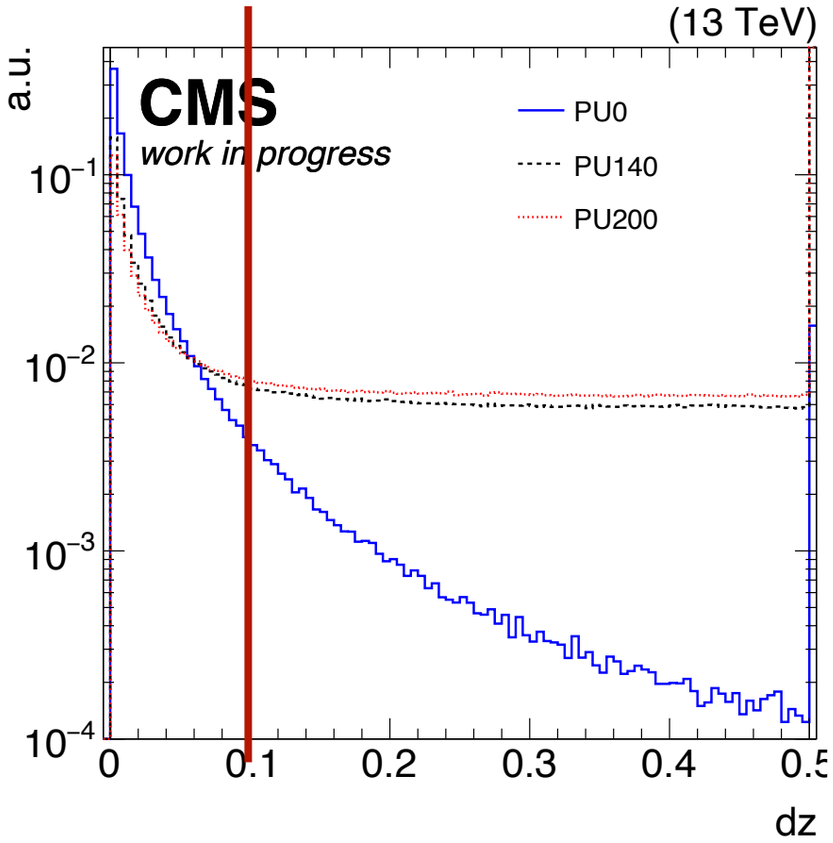
# $|\eta| < 1.3$

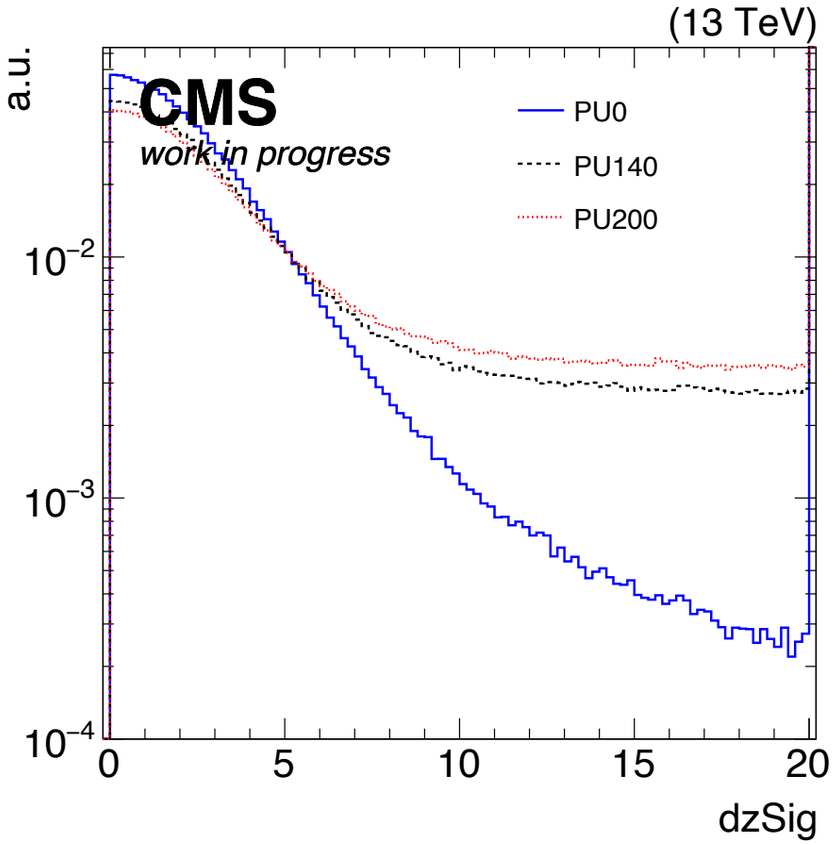

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
0
0.1
0.2
0.3
0.4
0.5
dz

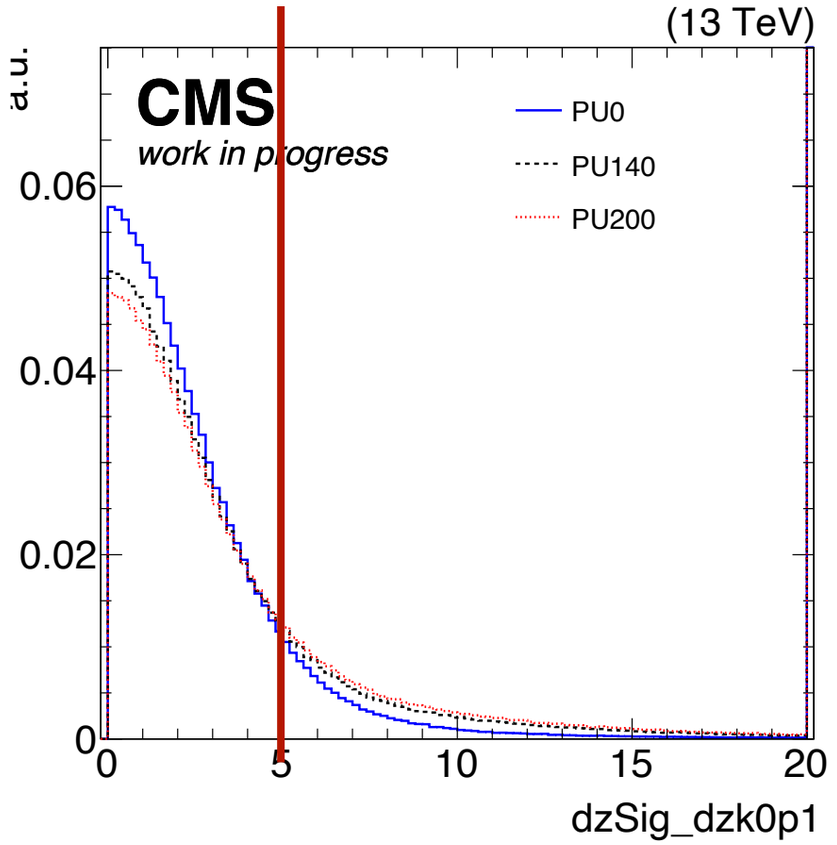

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
0
5
10
15
20
dzSig


(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
0.15
0.1
0.05
0
0
5
10
15
20
dzSig_dzk0p1

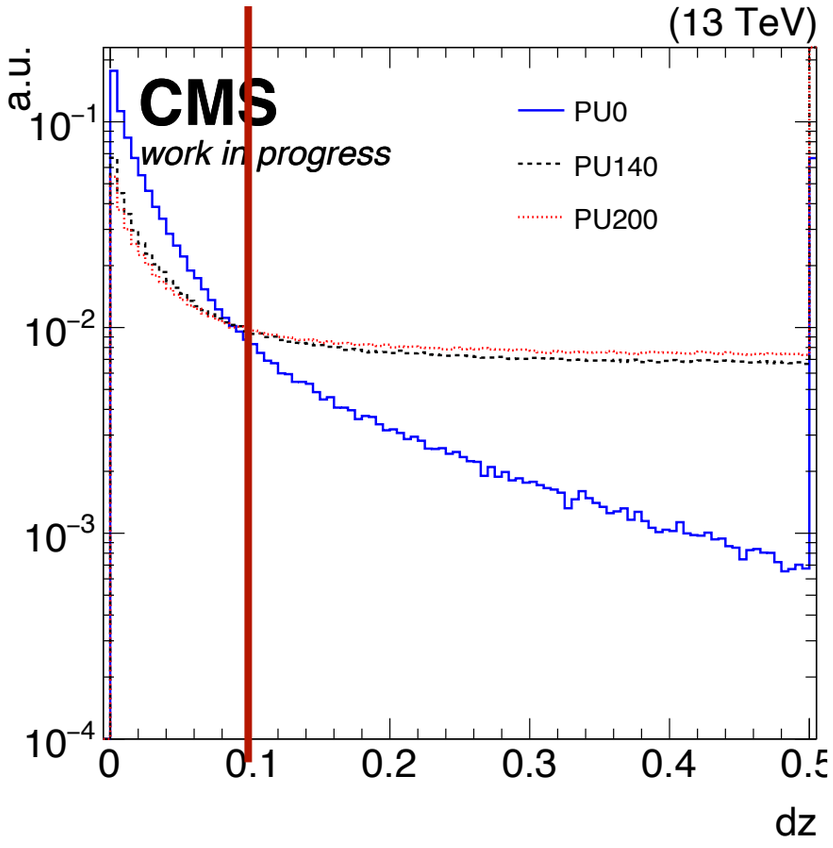
# $1.3 < |\eta| < 2.0$

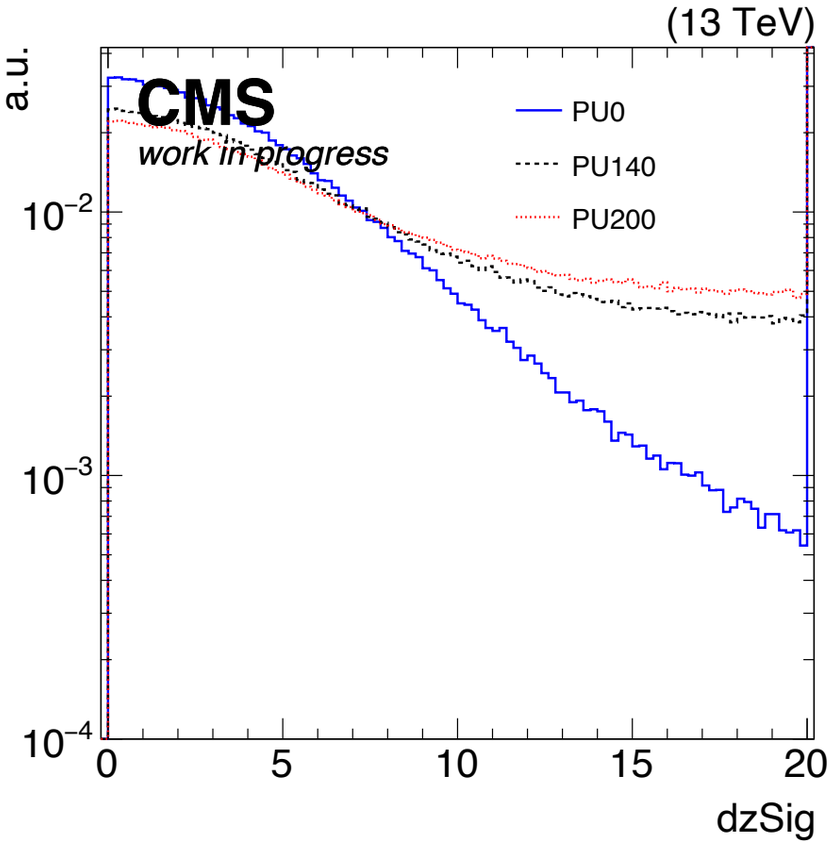

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dz

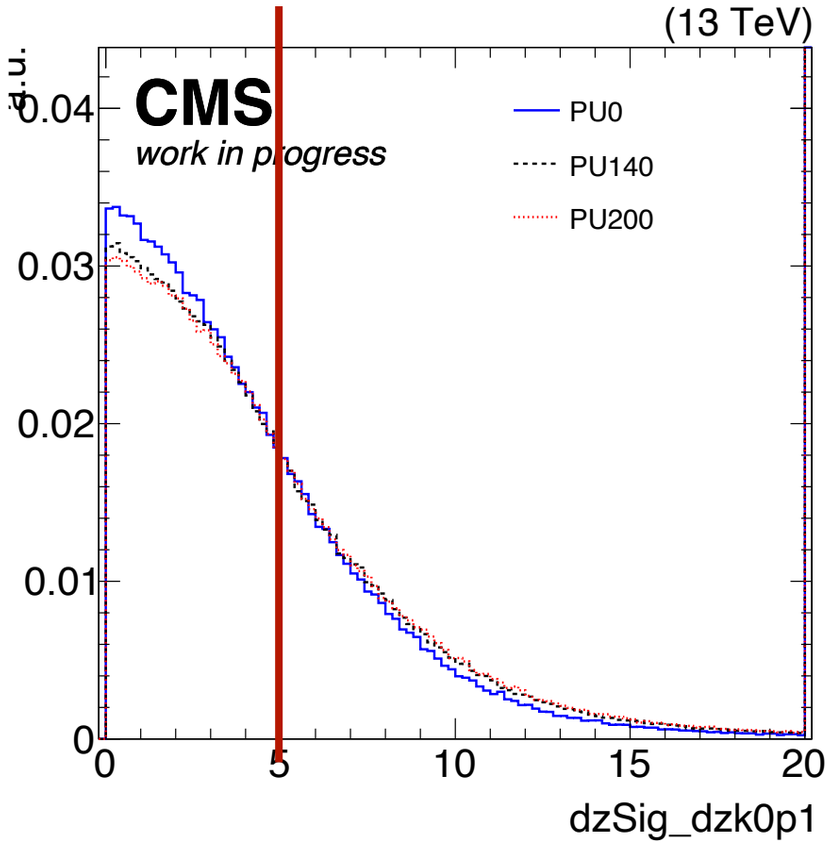

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig


(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig_dzk0p1

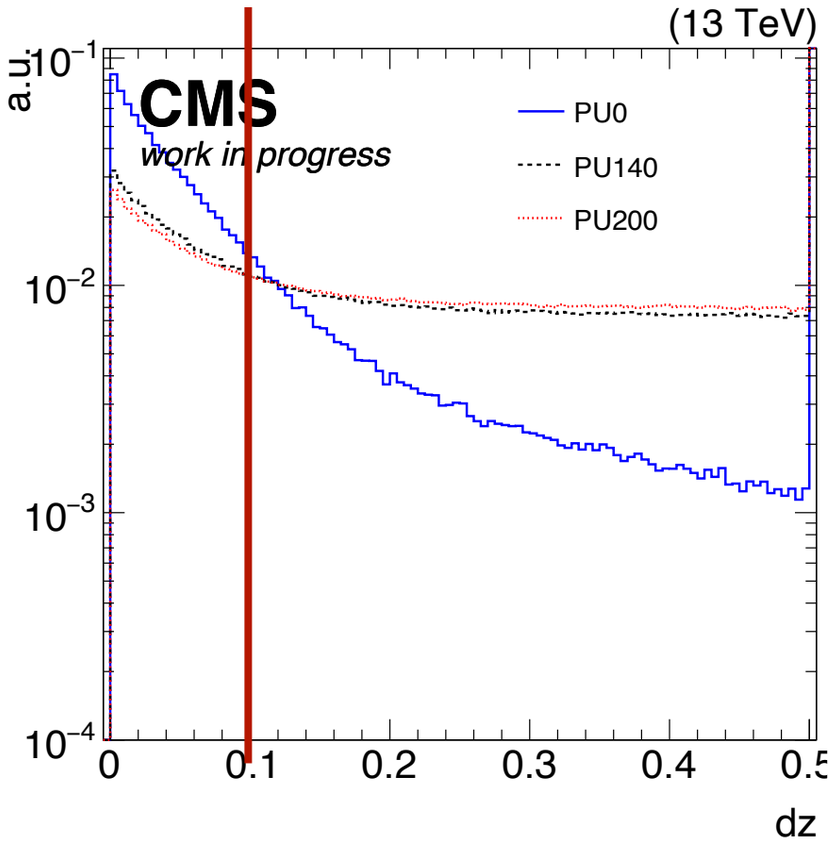
# $2.0 < |\eta| < 2.5$

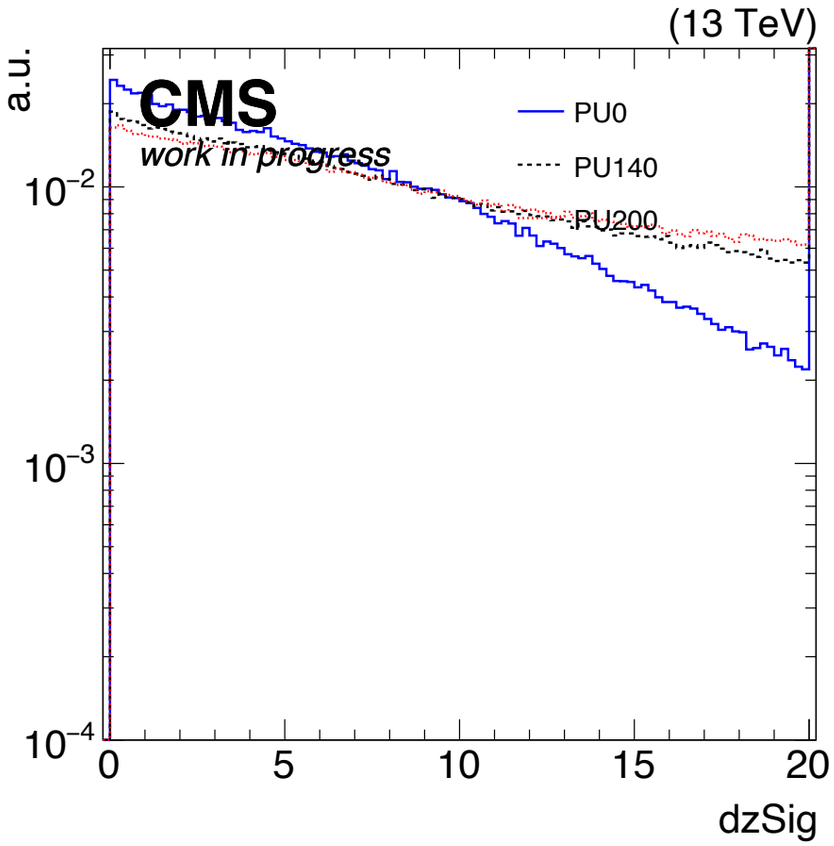

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dz

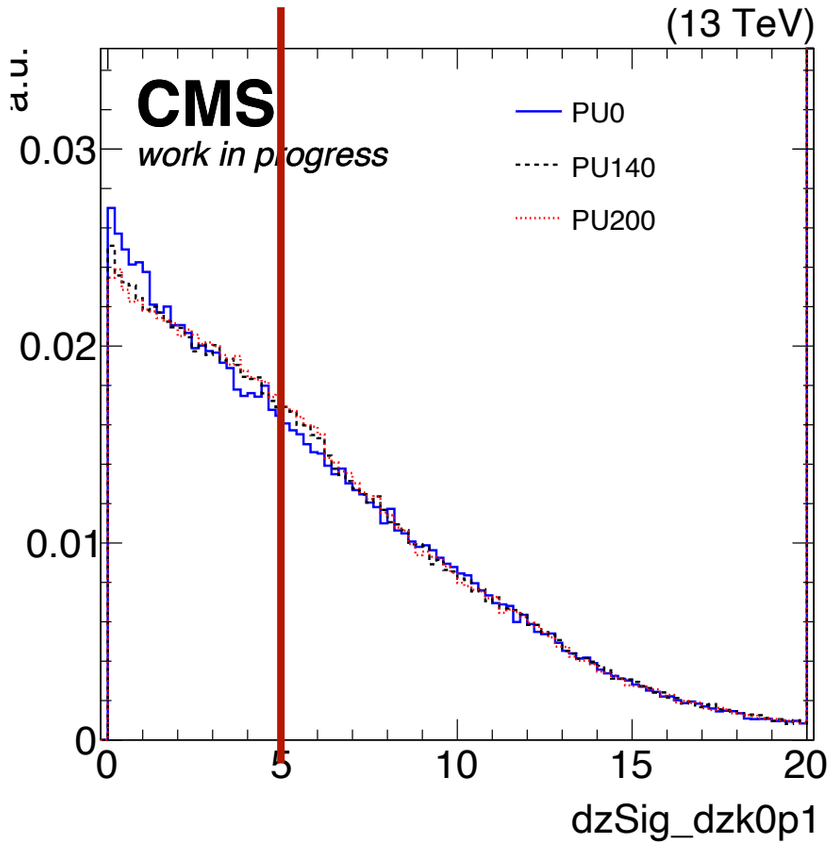

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig


(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig_dzk0p1

# $2.5 < |\eta| < 3.0$

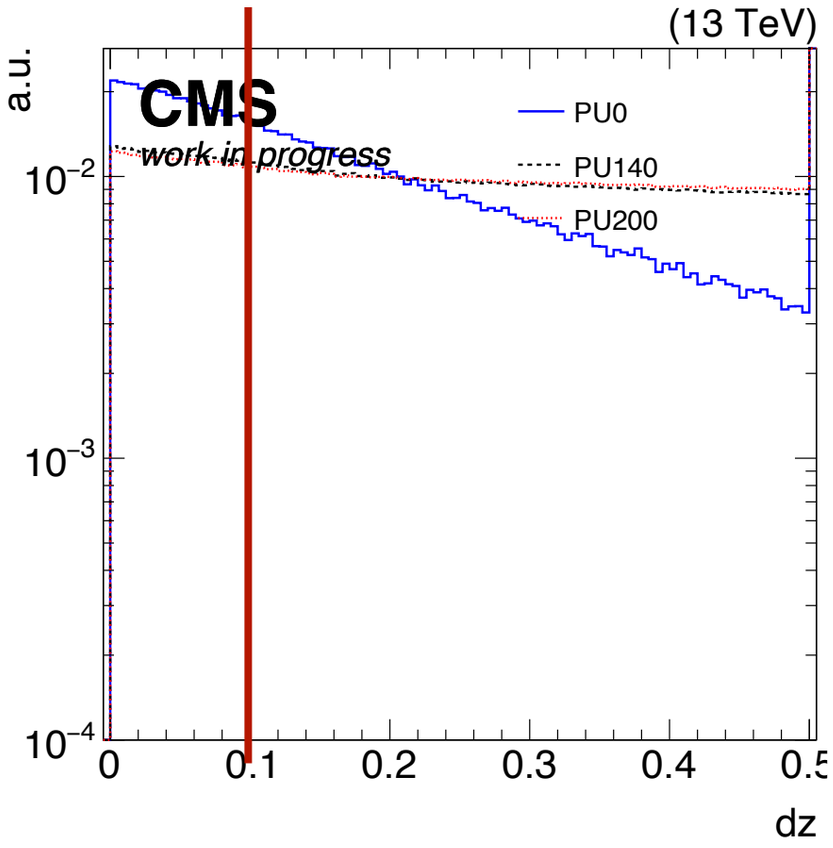


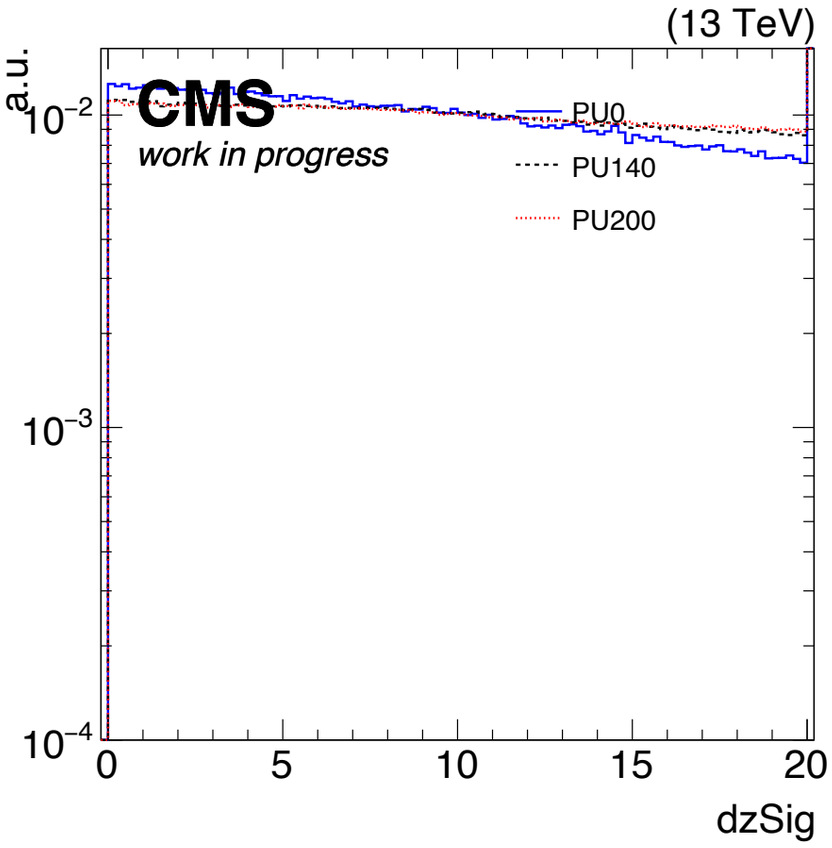



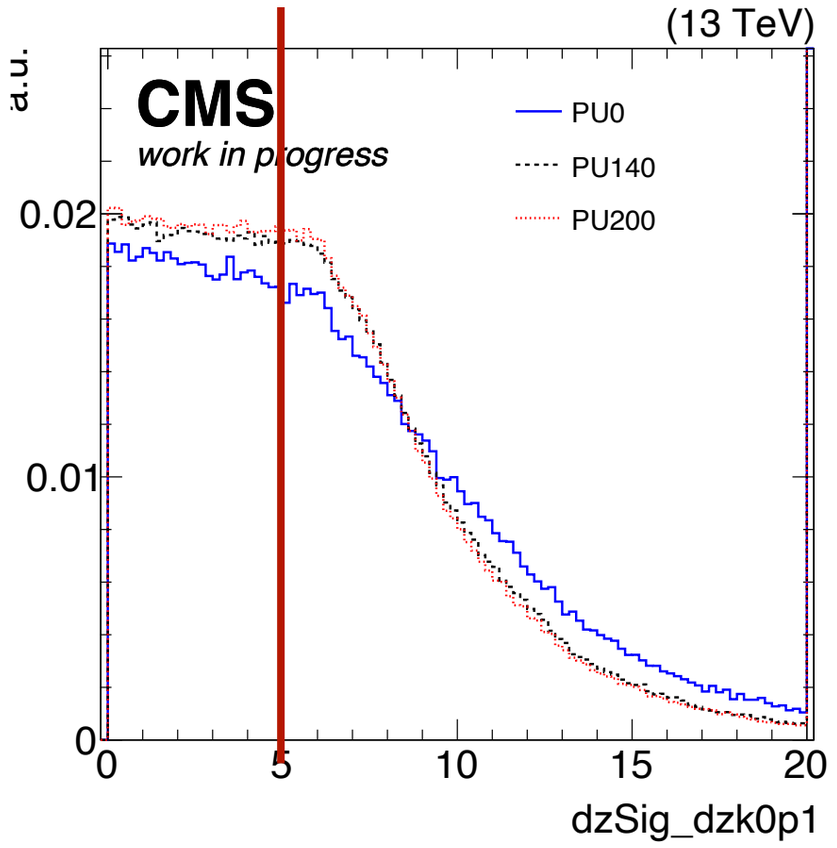




The dzsig cut might be too tight, since no significant difference between 0PU (blue) and 200PU (red) is visible. This could result in reduced eff.

# $3.0 < |\eta| < 4.0$

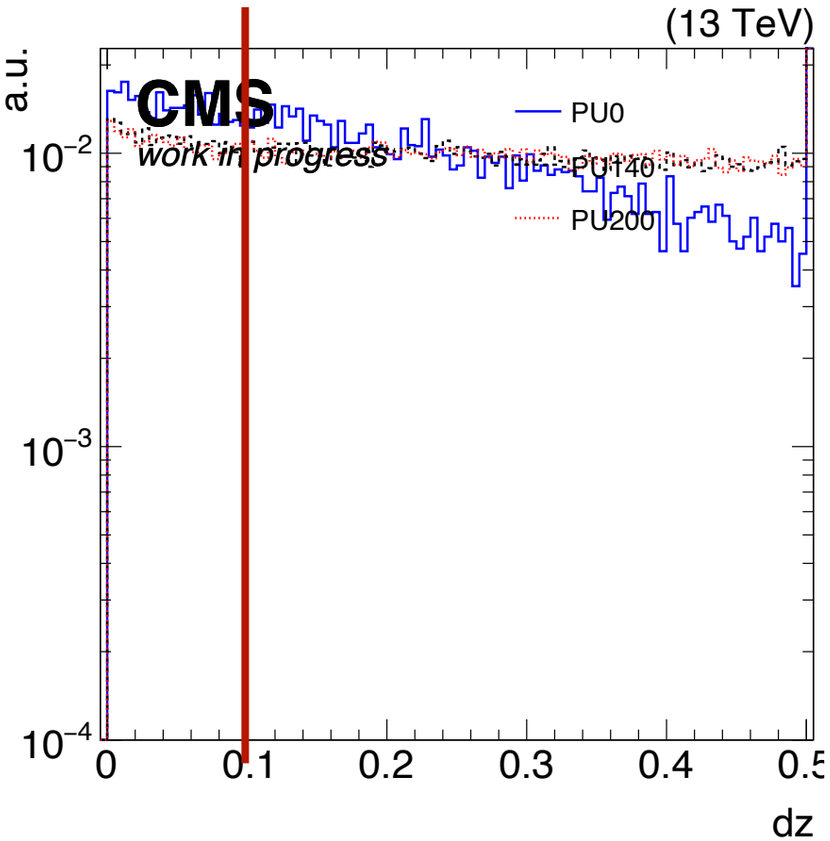


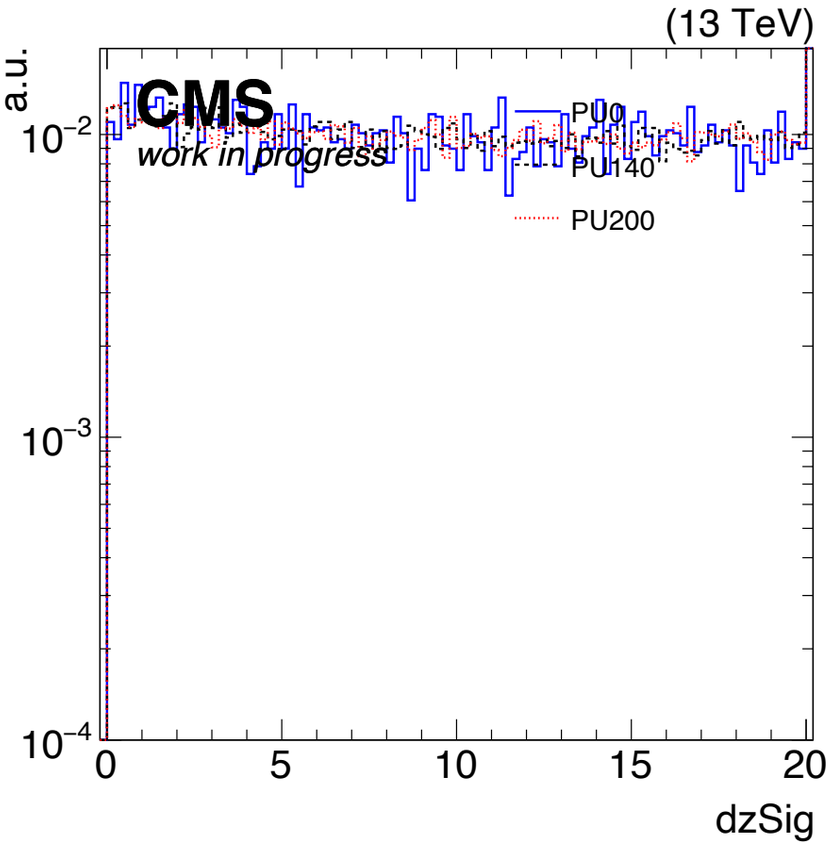



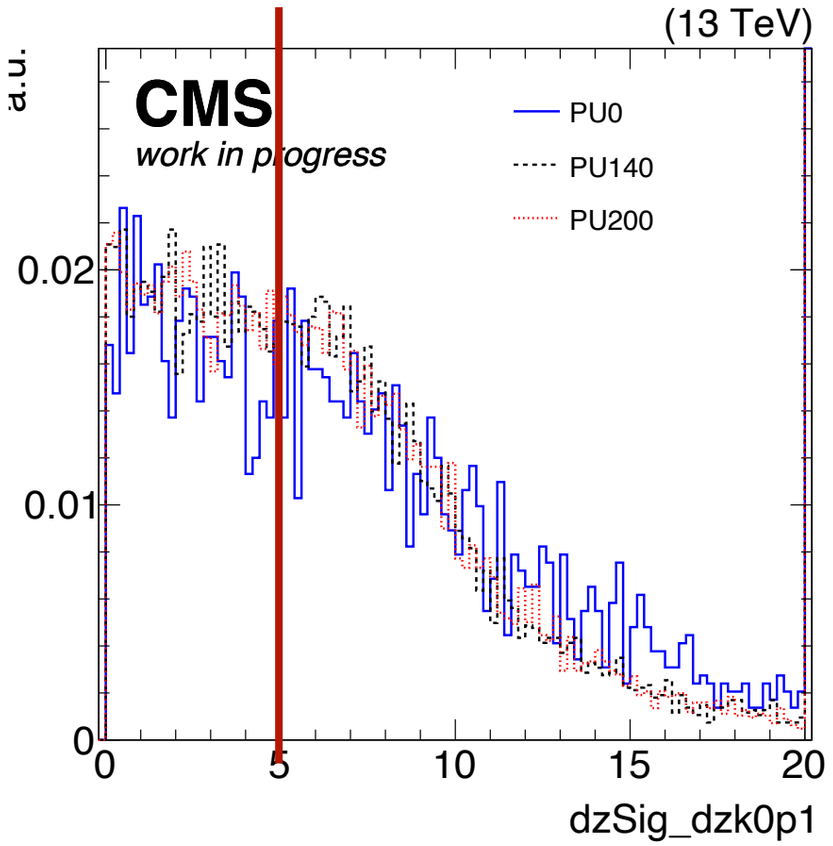




The dz+dzsig cut might be too tight, since the 0PU (blue) scenario shows a broader spectrum. This could result in reduced eff.

# $4.0 < |\eta| < 5.0$



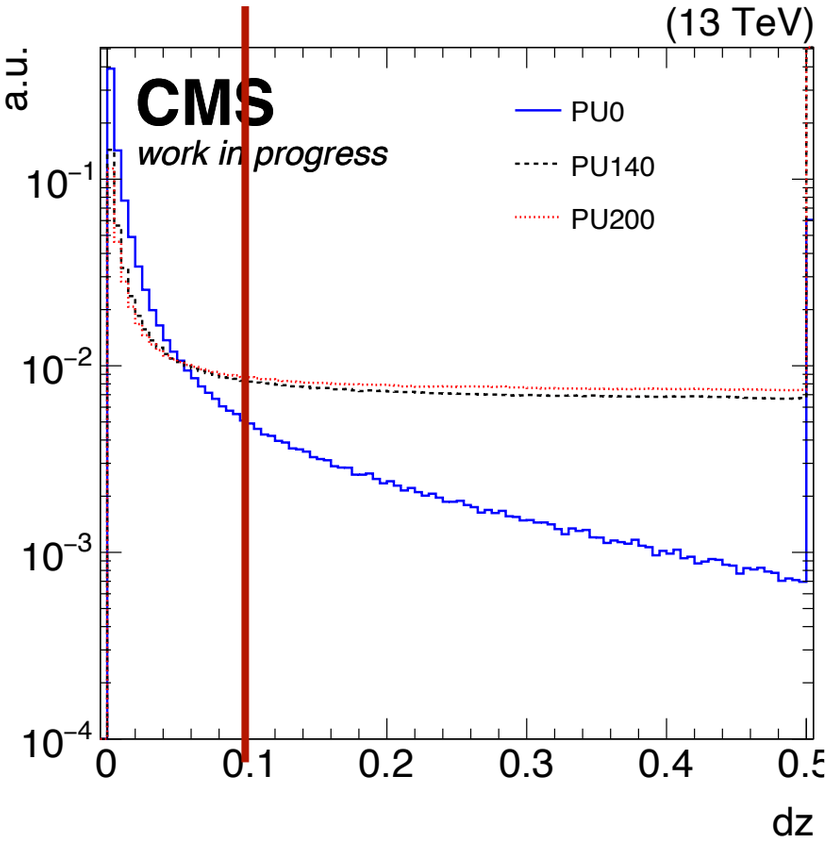



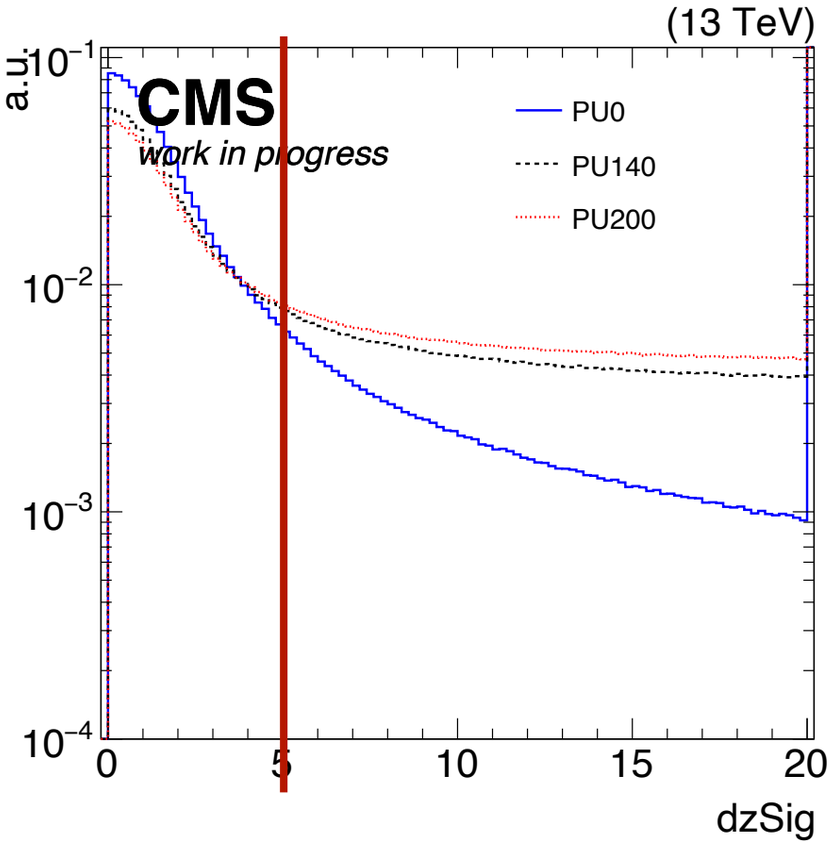

The dz+dzsig cut might be too tight, since the 0PU (blue) scenario shows a broader spectrum. This could result in reduced eff.

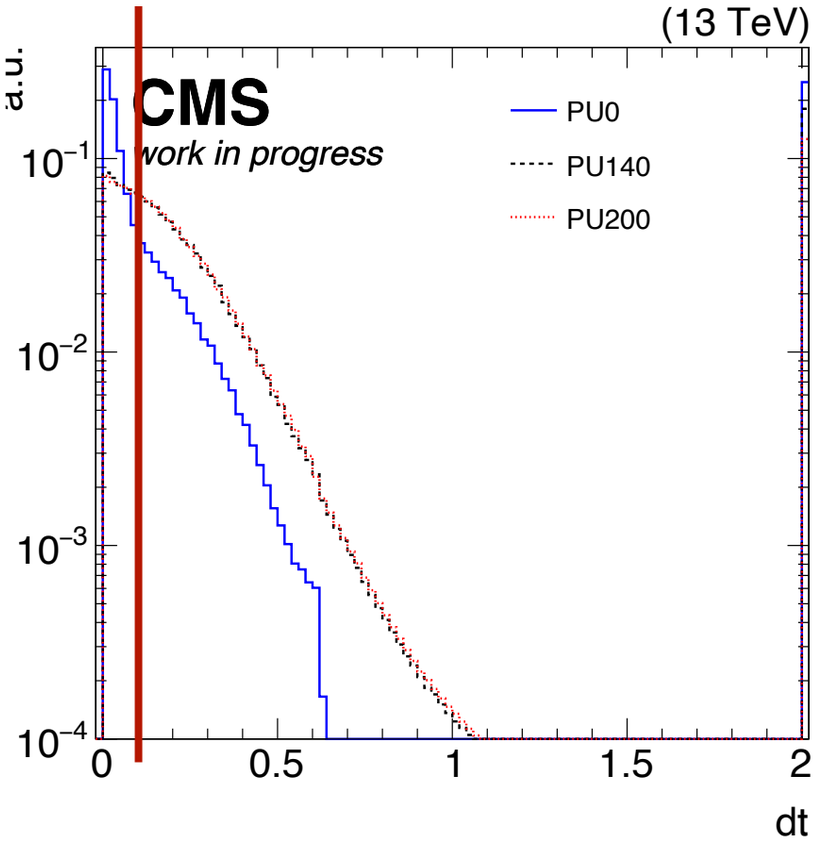
# 4D vertex collection

Similar picture as for 3D vertex collection. In the high $\eta$ region the dzsig cut might not be useful. Also the dt requirement could still be optimised.

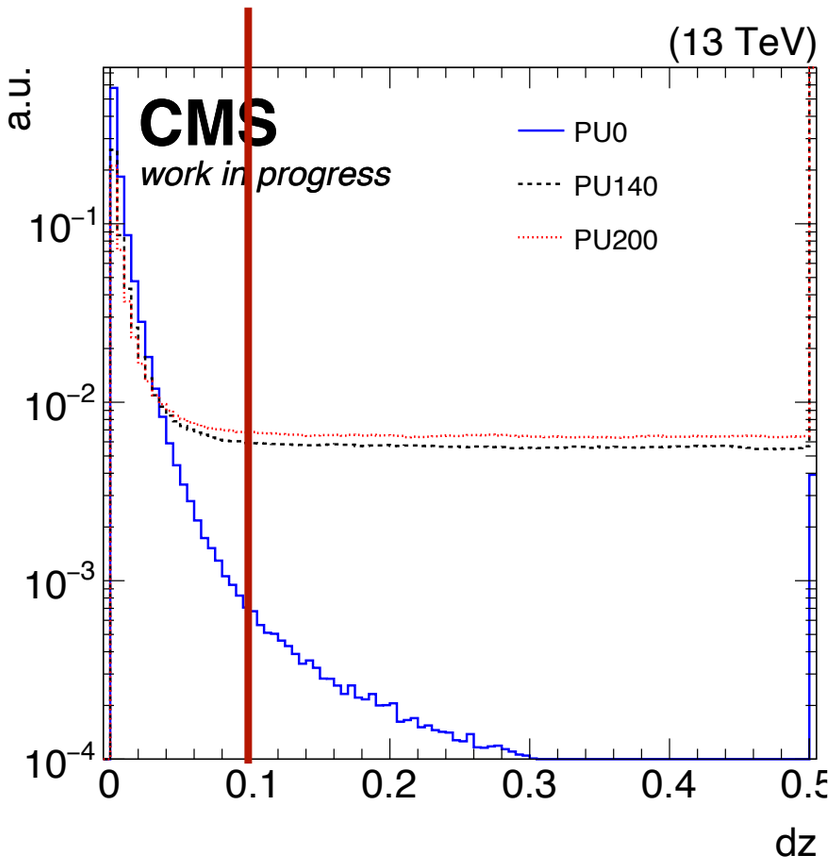
# General

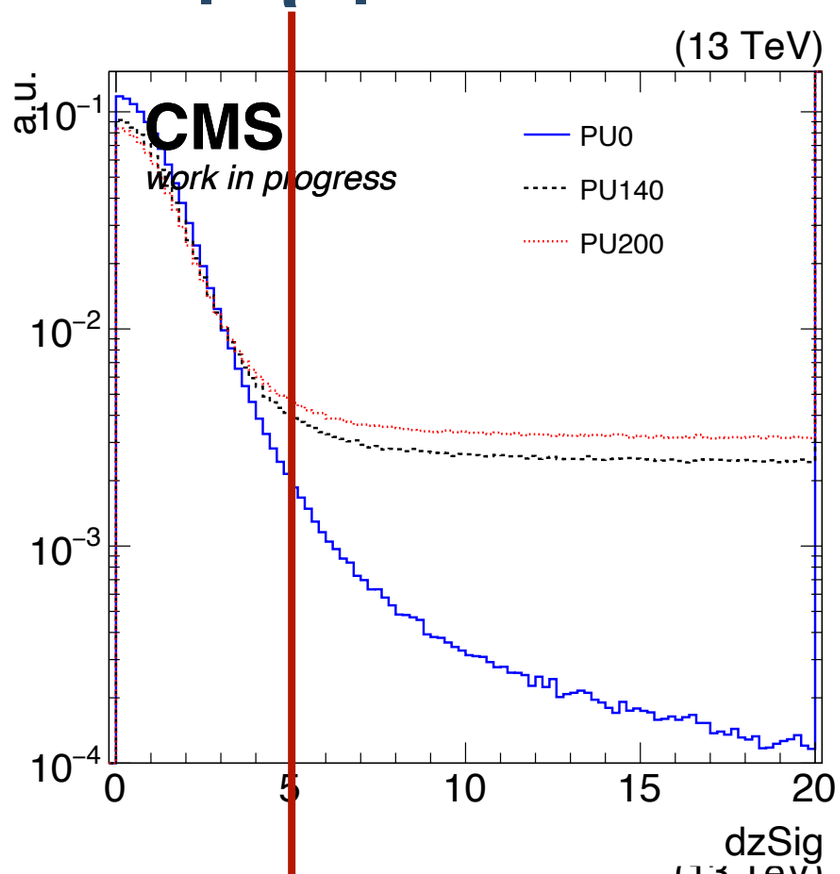

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dz

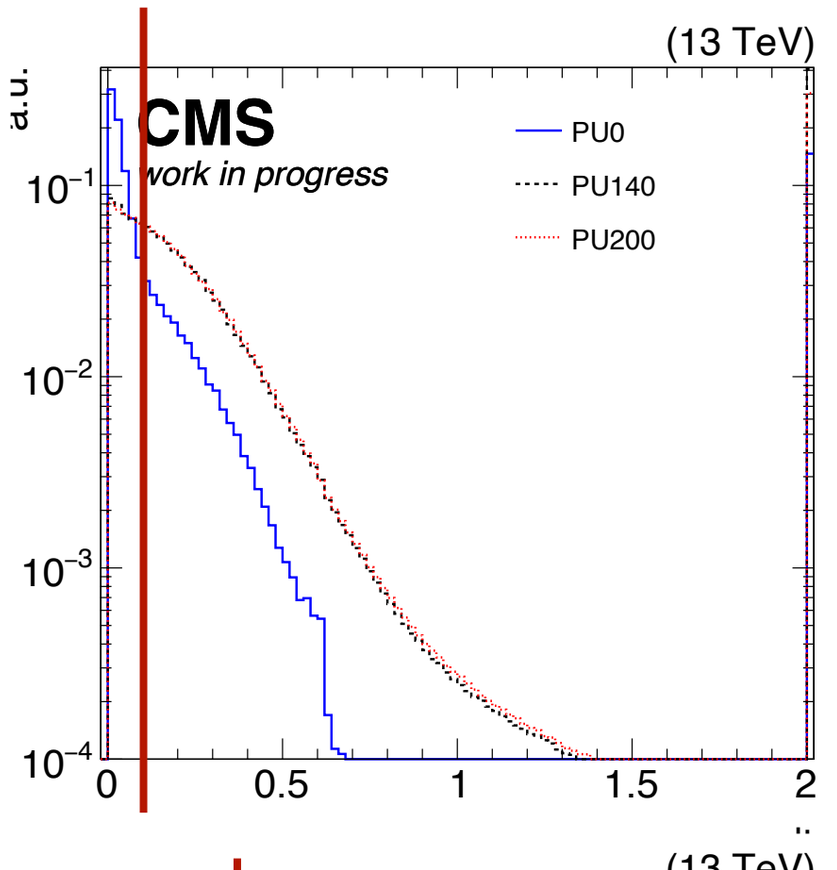

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig


(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dt

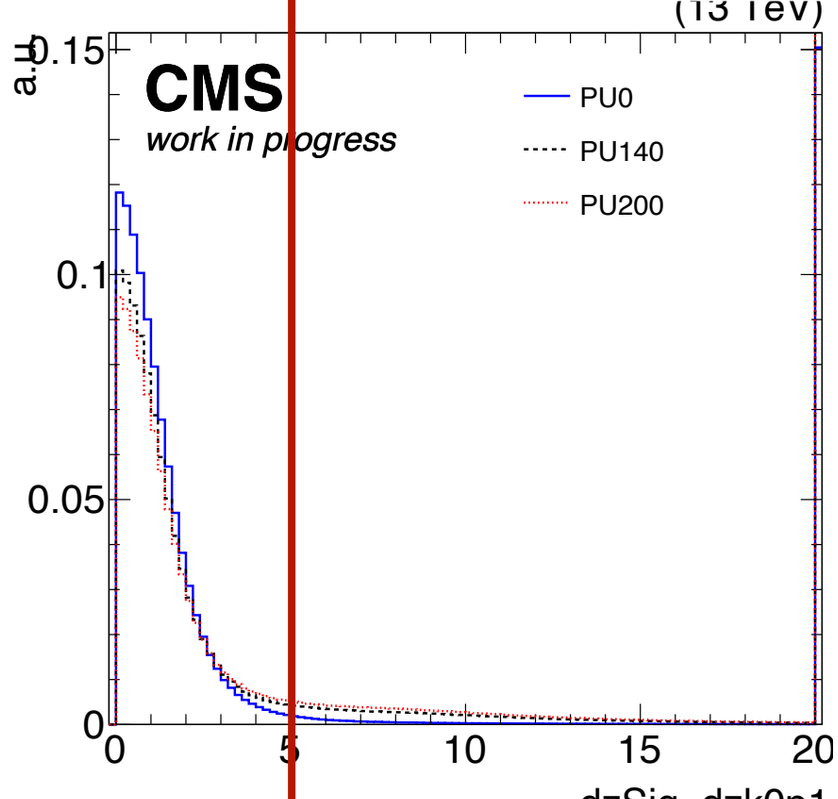
# $|\eta| < 1.3$

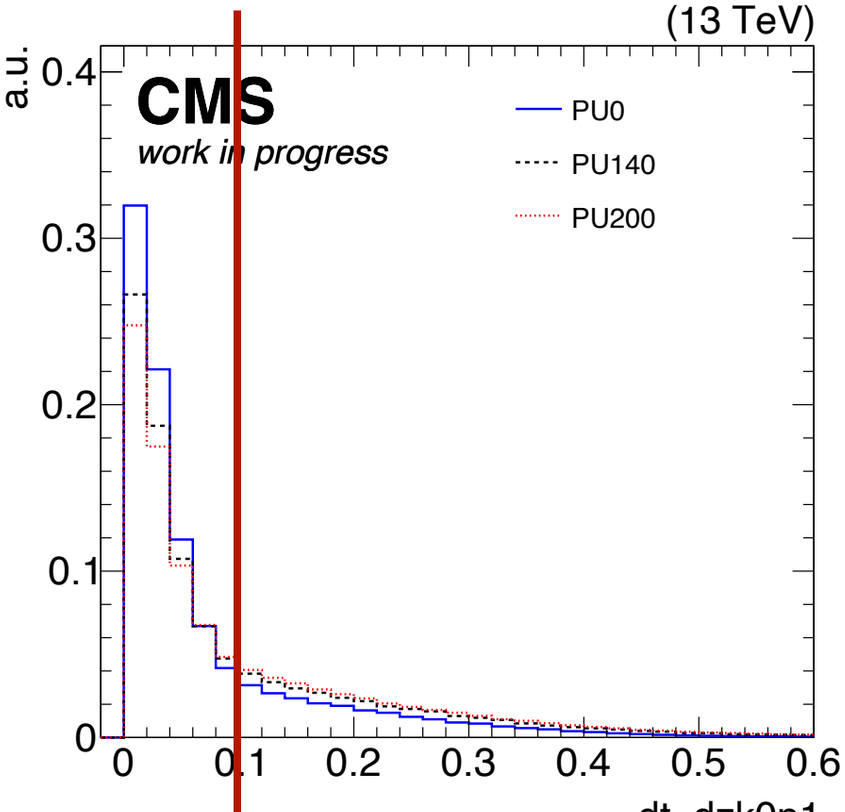

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dz


(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig

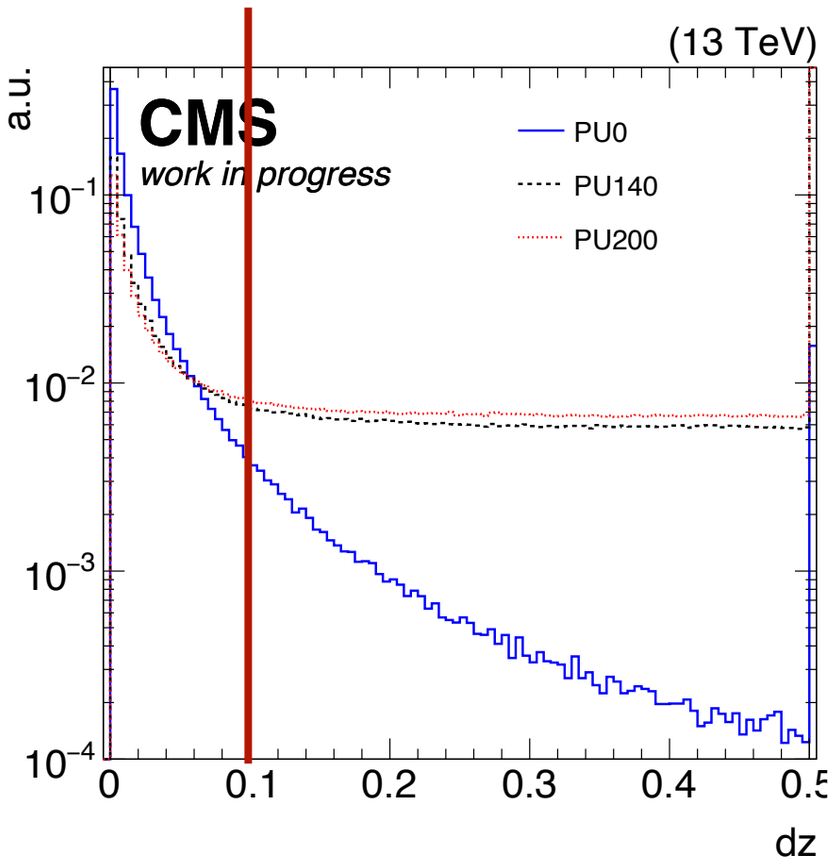

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.

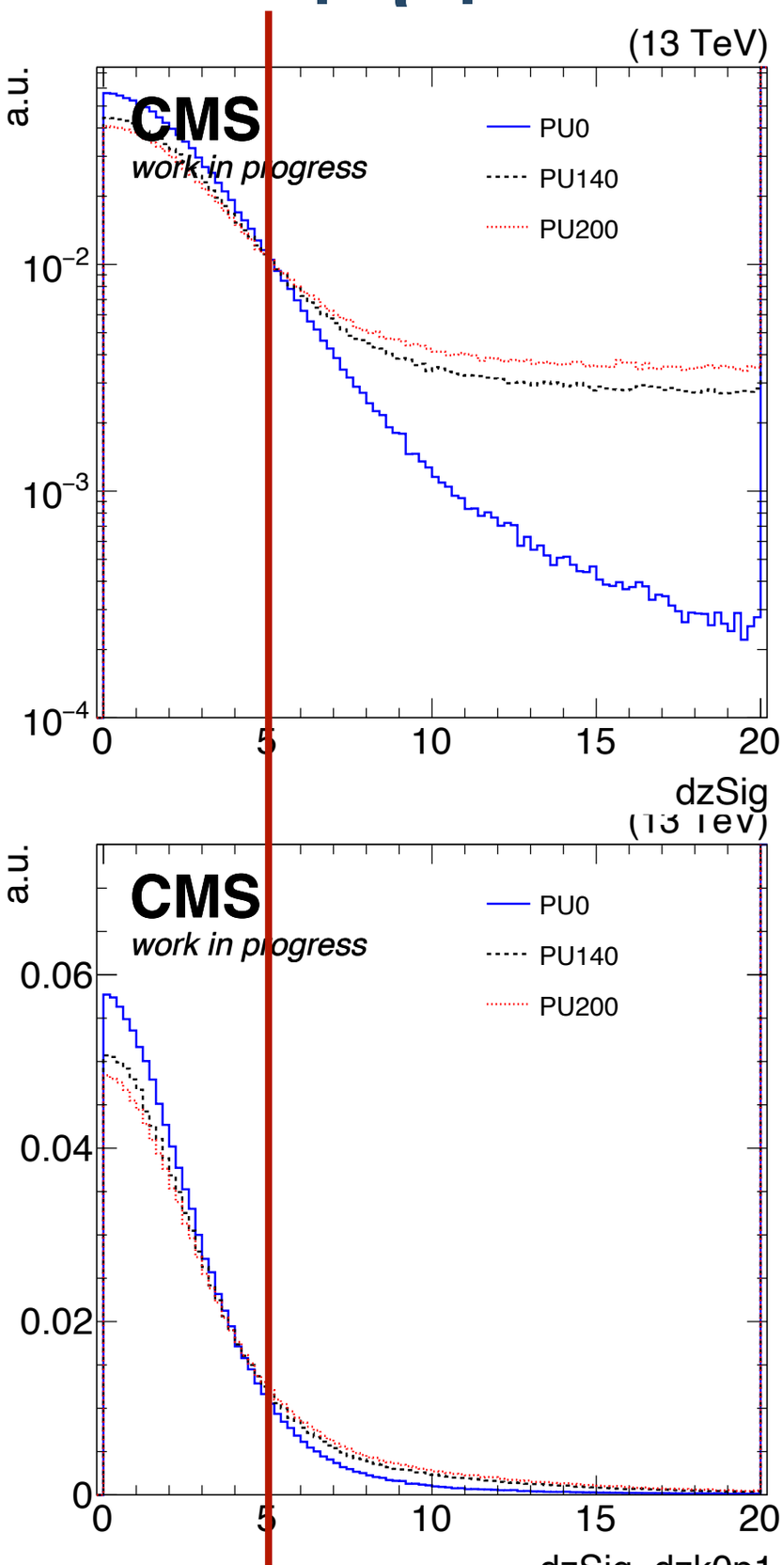
$d_z < 0.1$

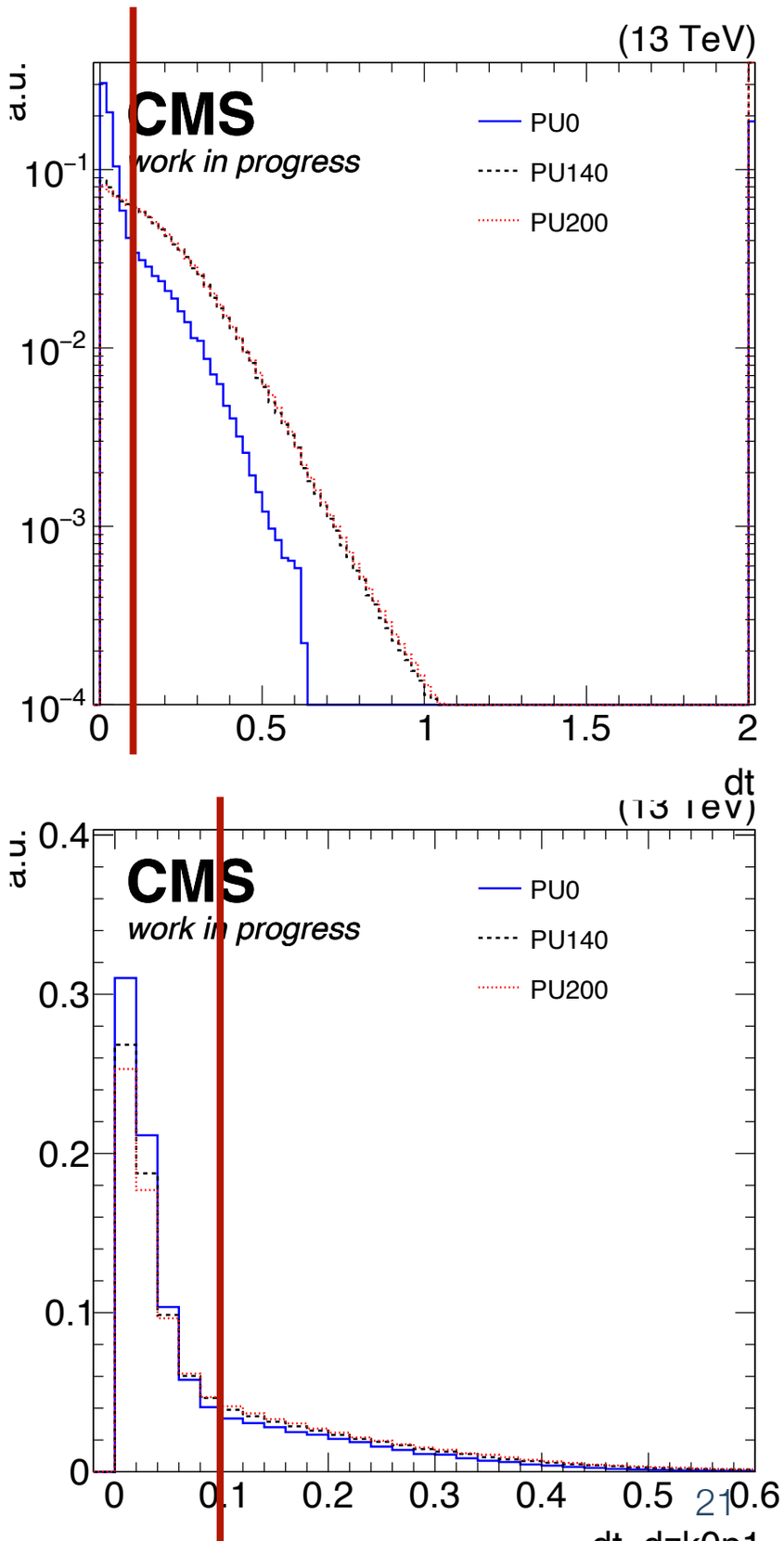

(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dzSig_dzk0p1


(13 TeV)
CMS
work in progress
PU0
PU140
PU200
a.u.
dt_dzk0p1

# $1.3 < |\eta| < 2.0$

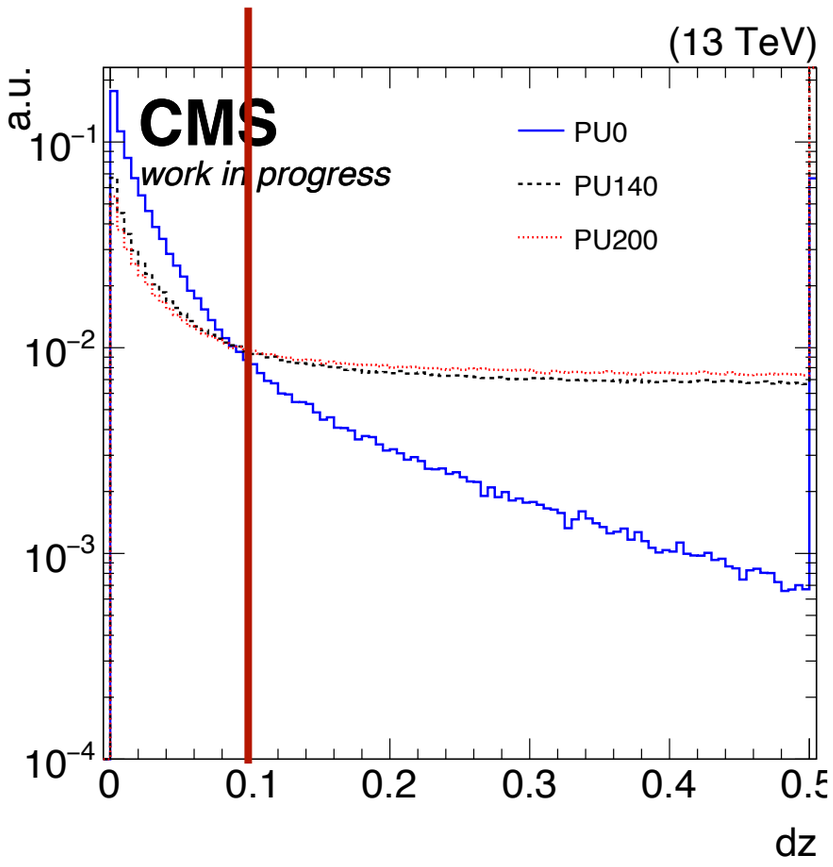


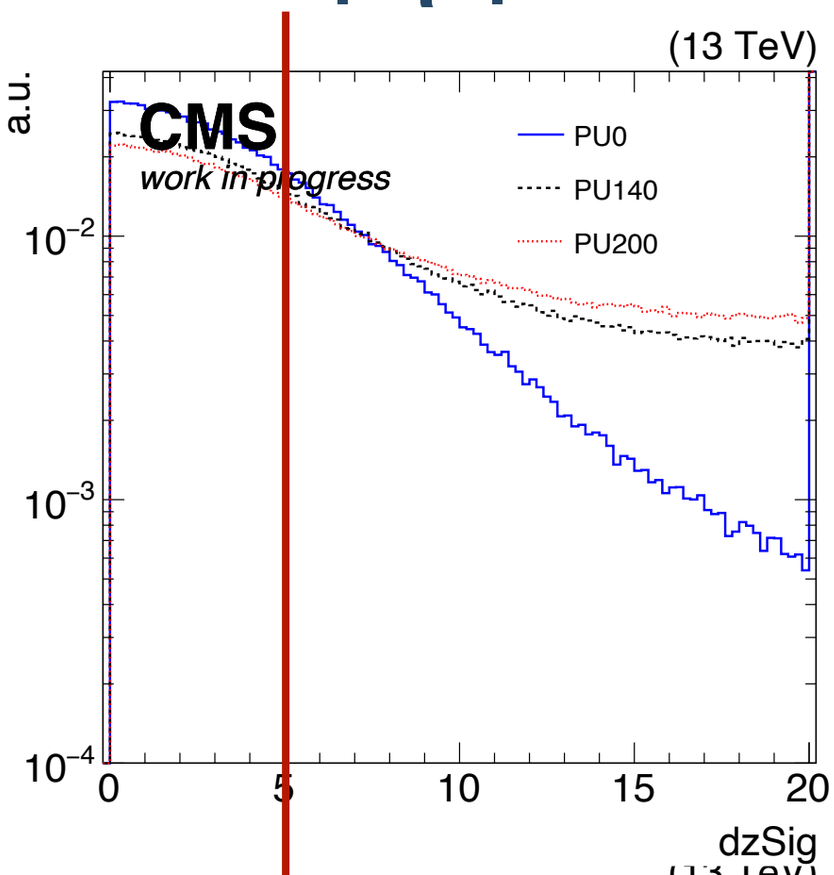



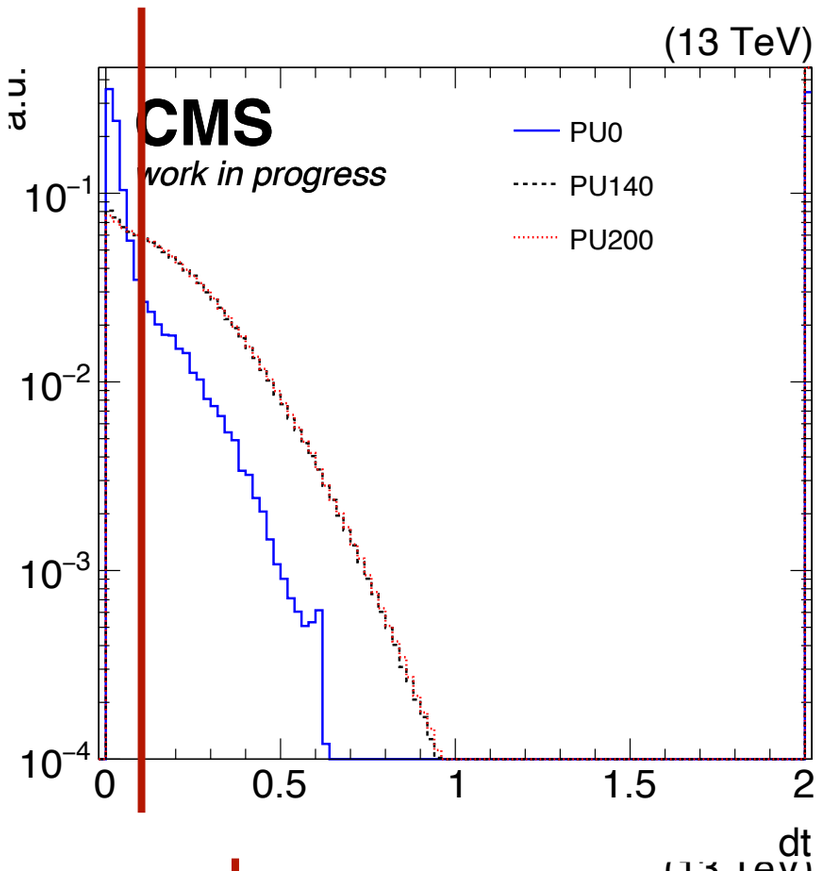




$d_z < 0.1$

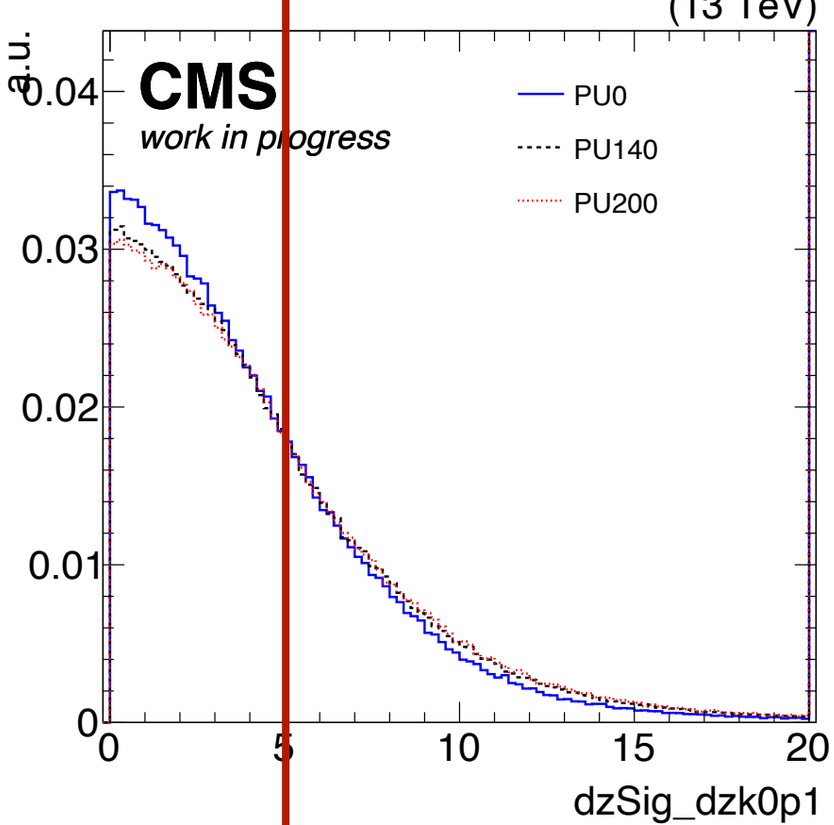
# $2.0 < |\eta| < 2.5$

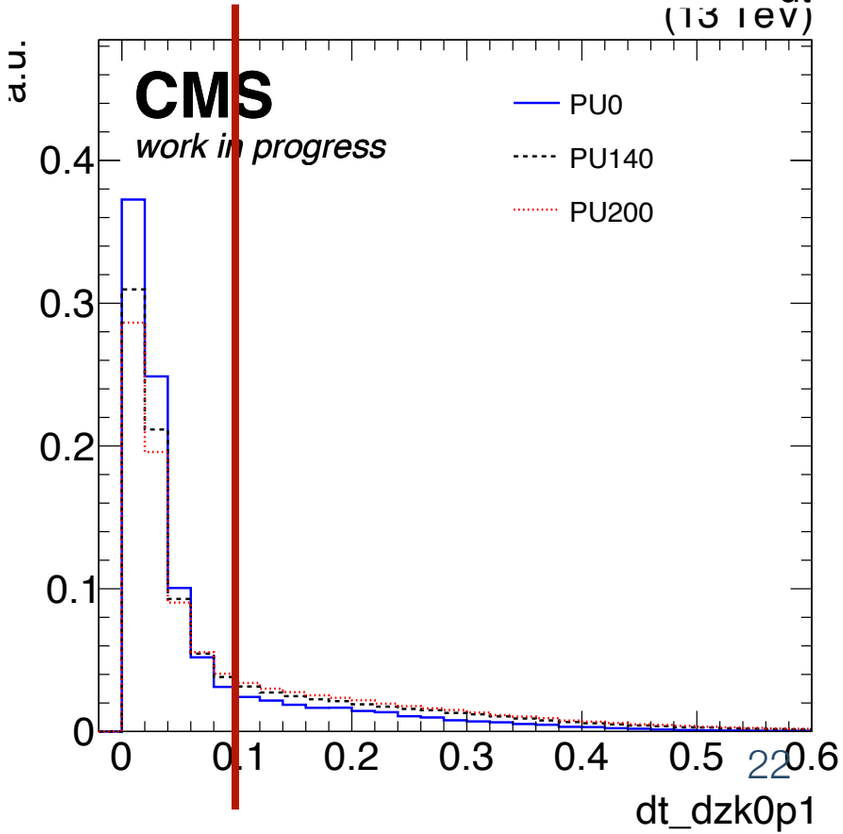


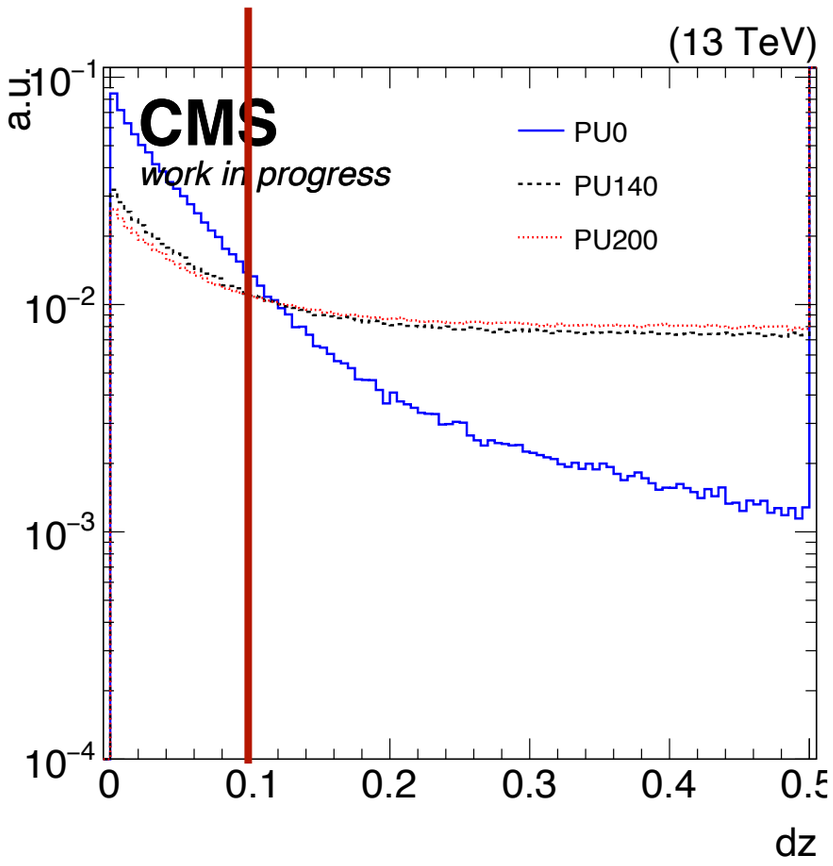



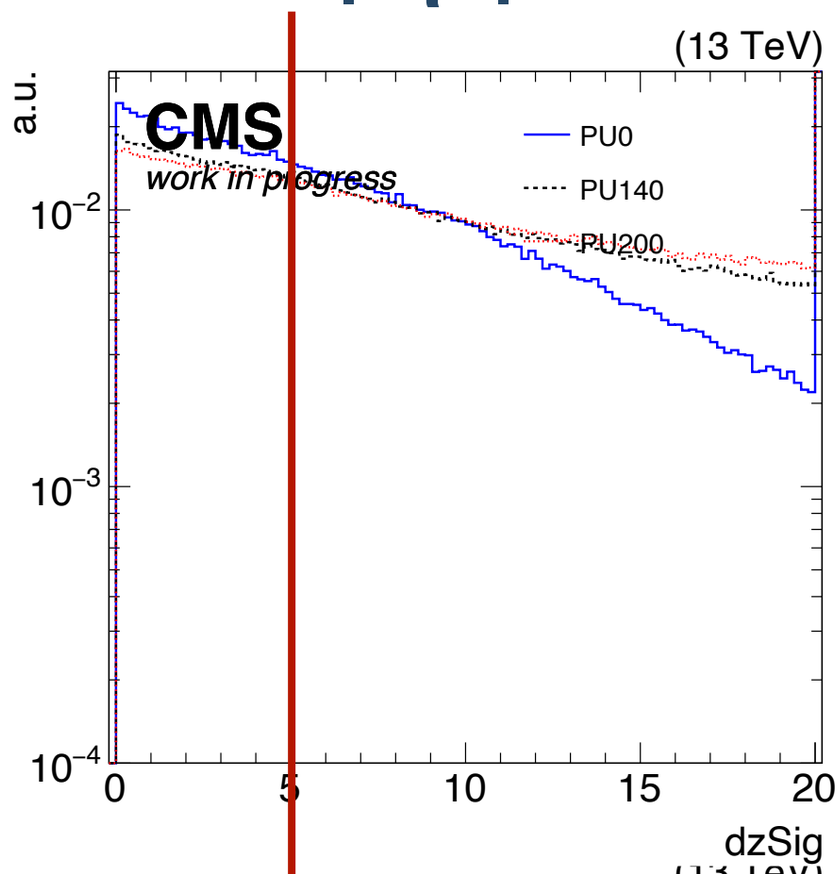

$d_z < 0.1$

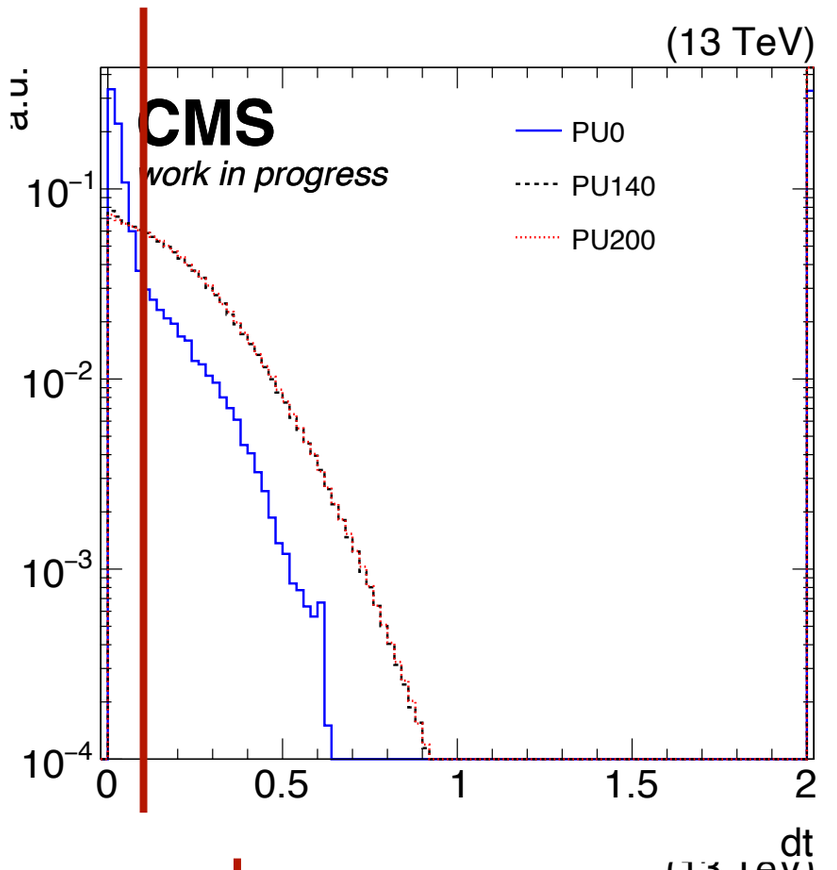


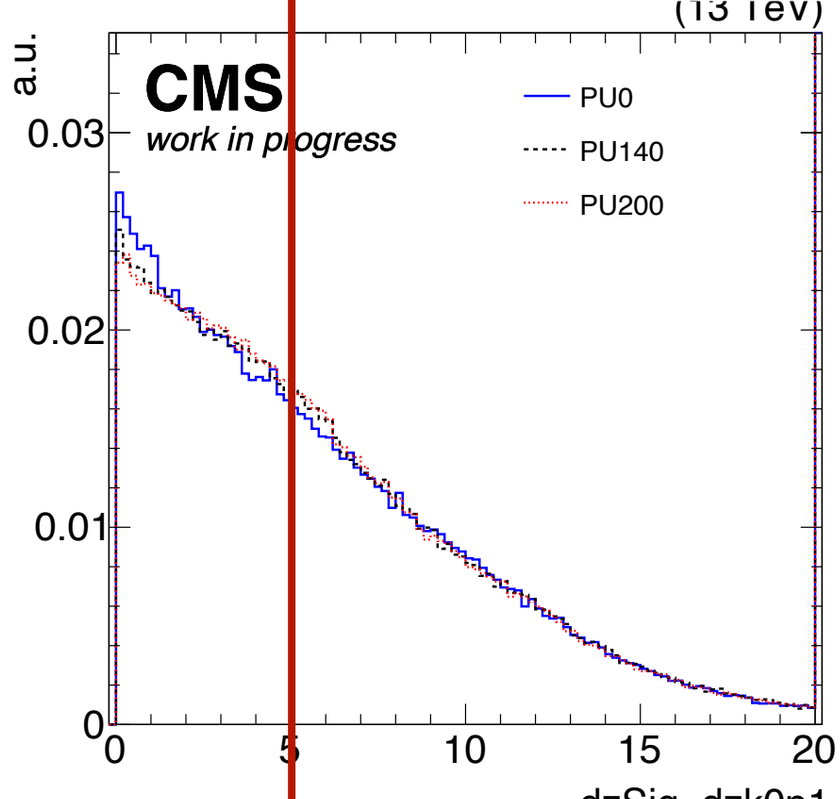
# $2.5 < |\eta| < 3.0$

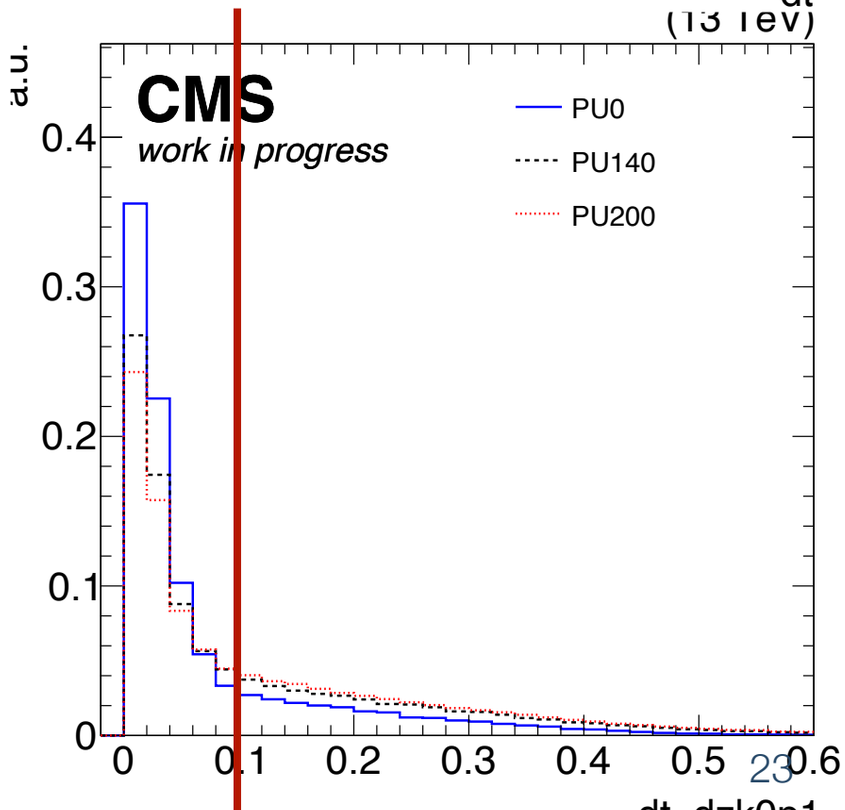


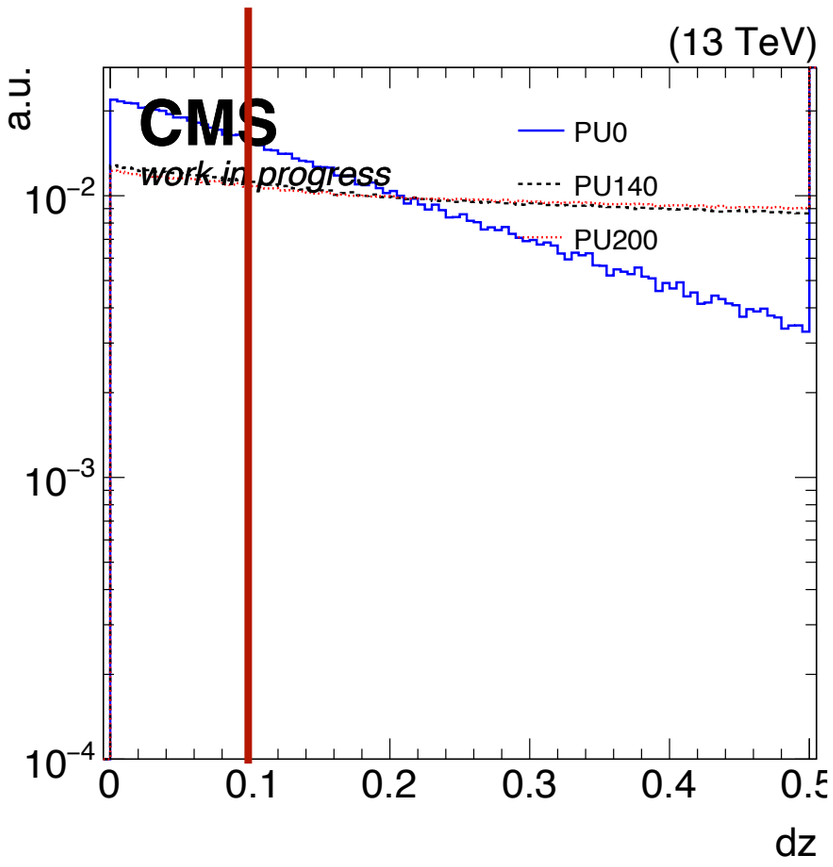



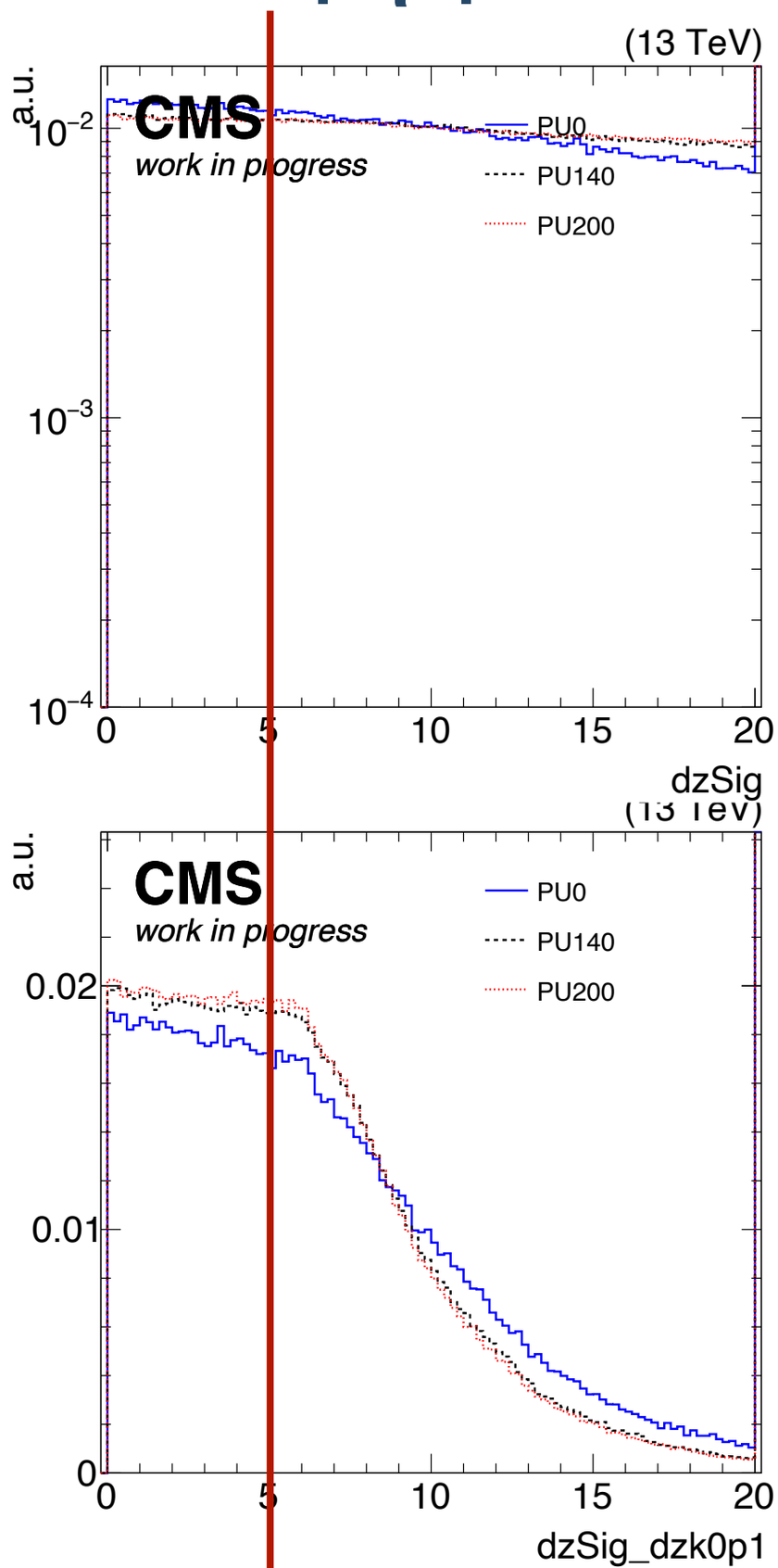

$d_z < 0.1$

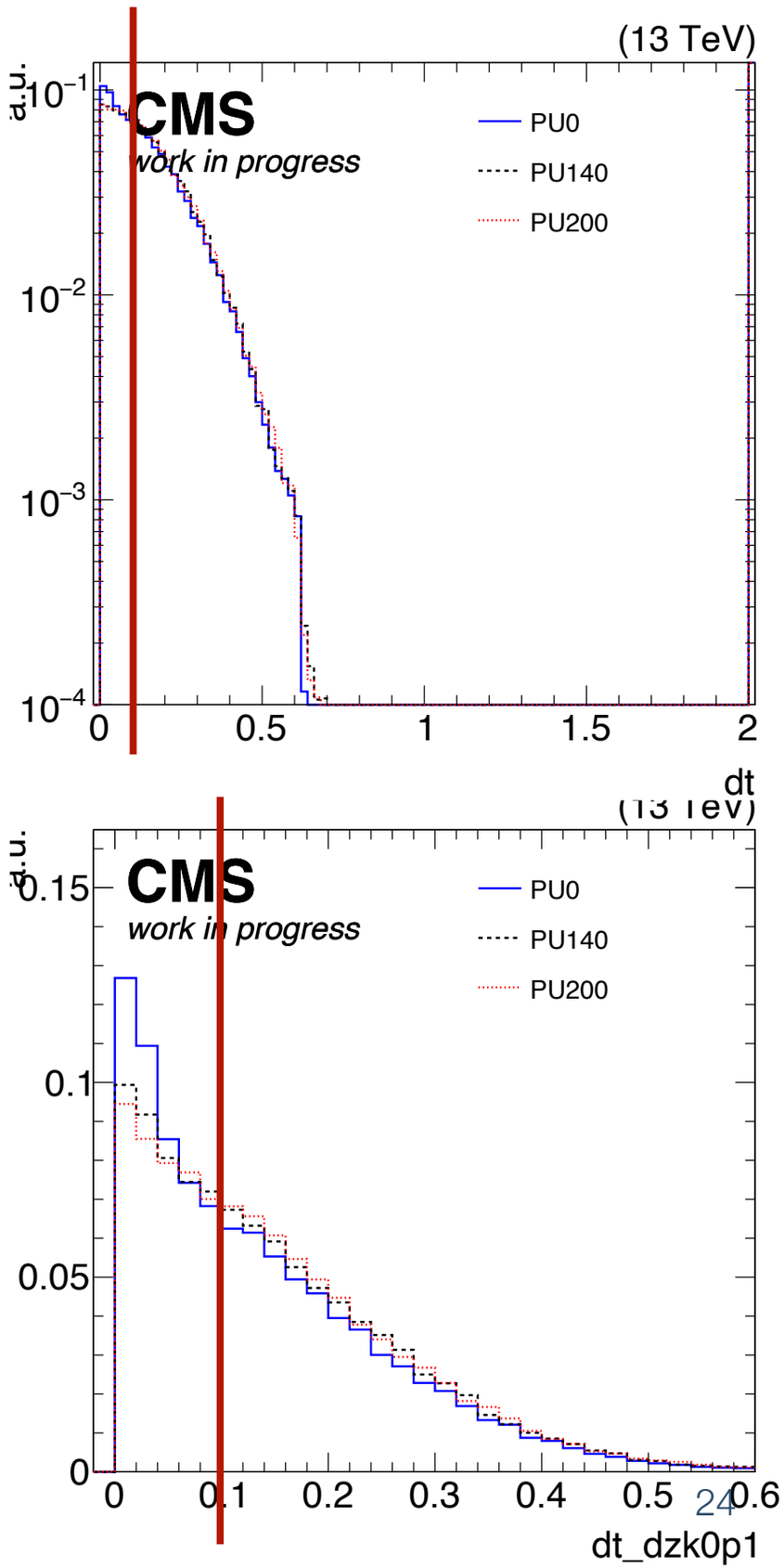


# $3.0 < |\eta| < 4.0$

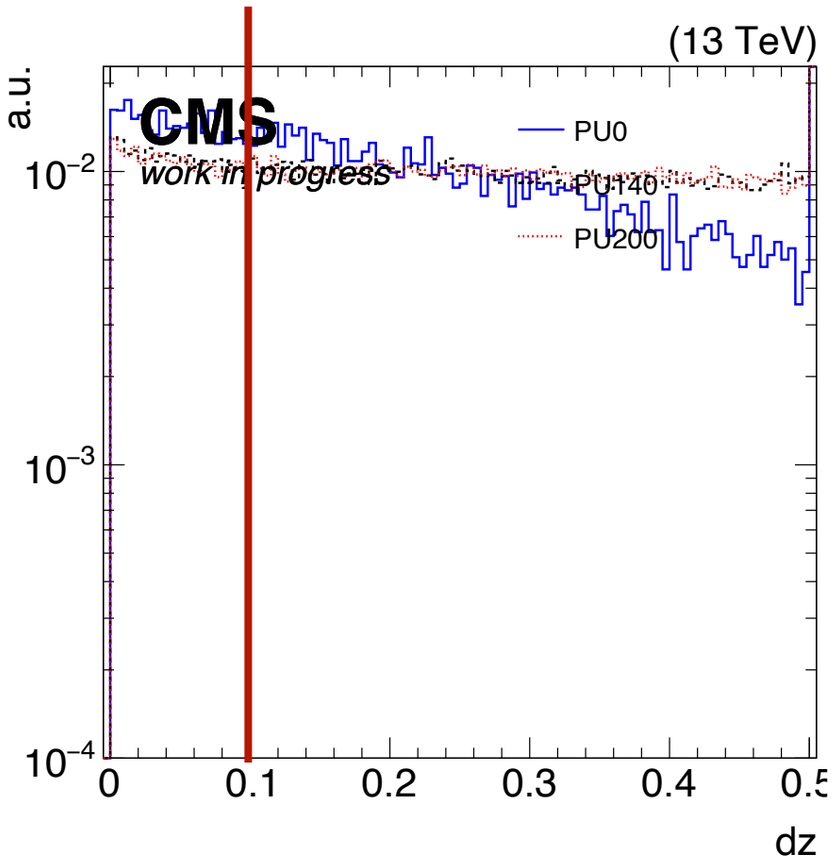


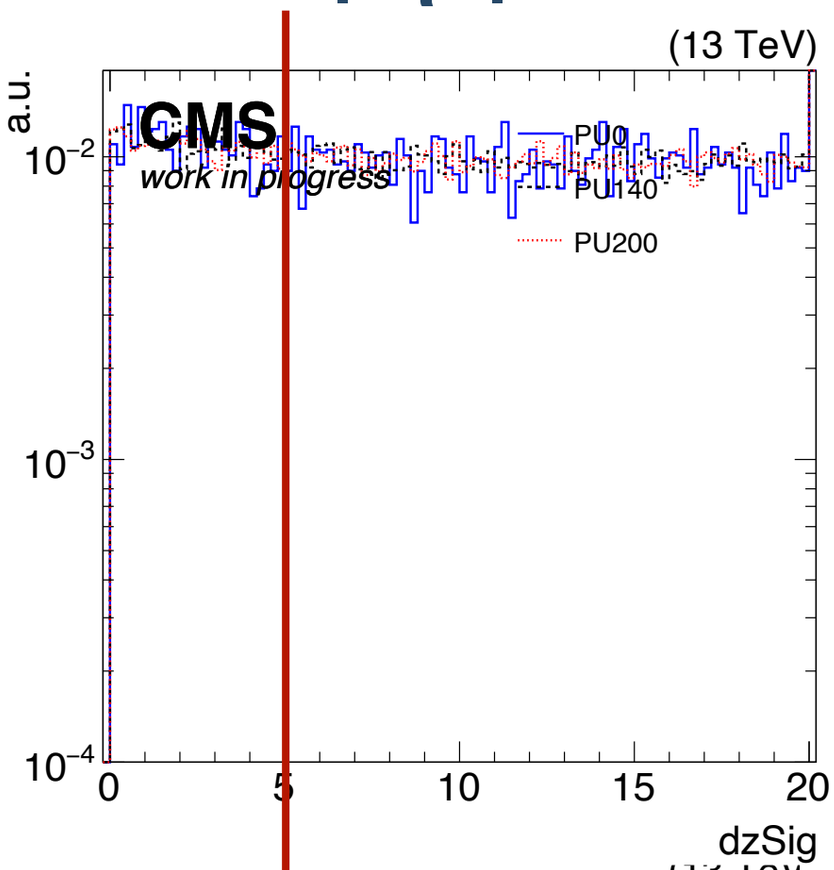



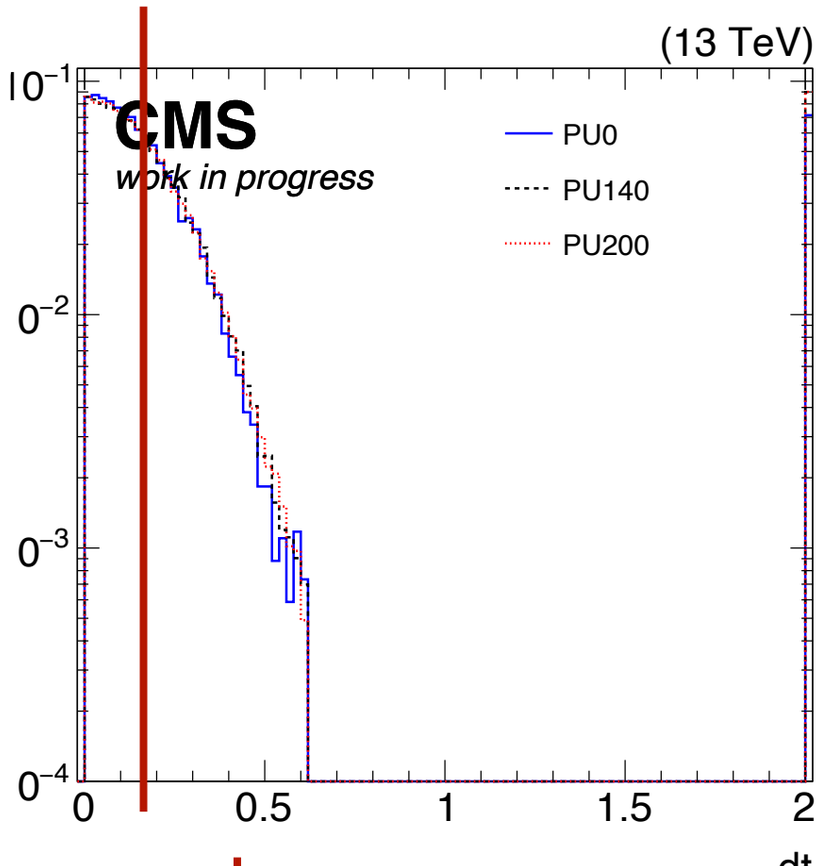




$d_z < 0.1$

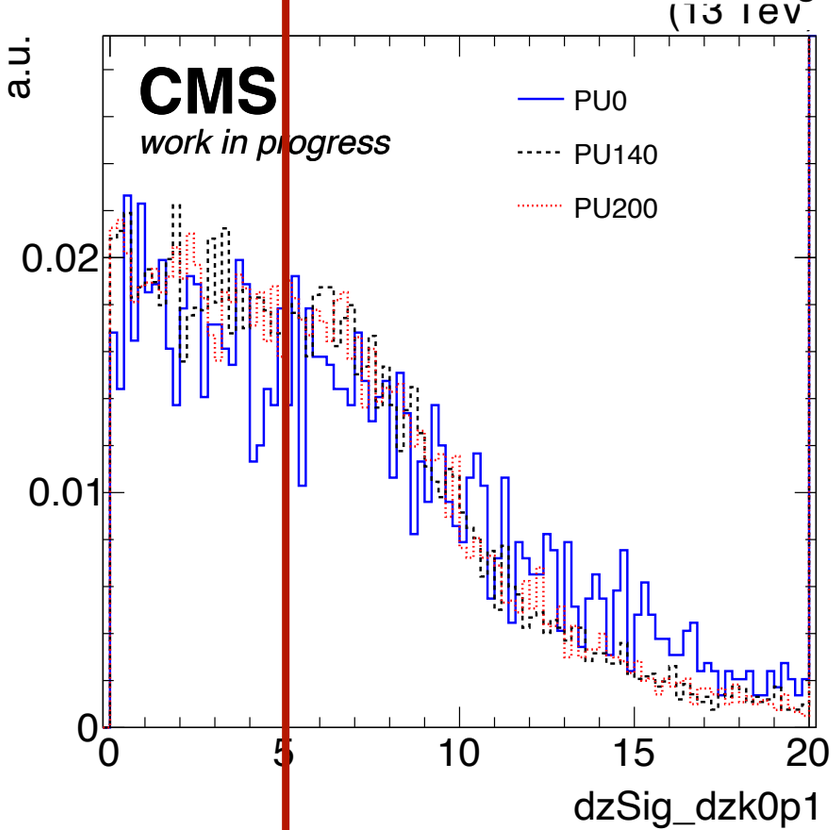
# $4.0 < |\eta| < 5.0$

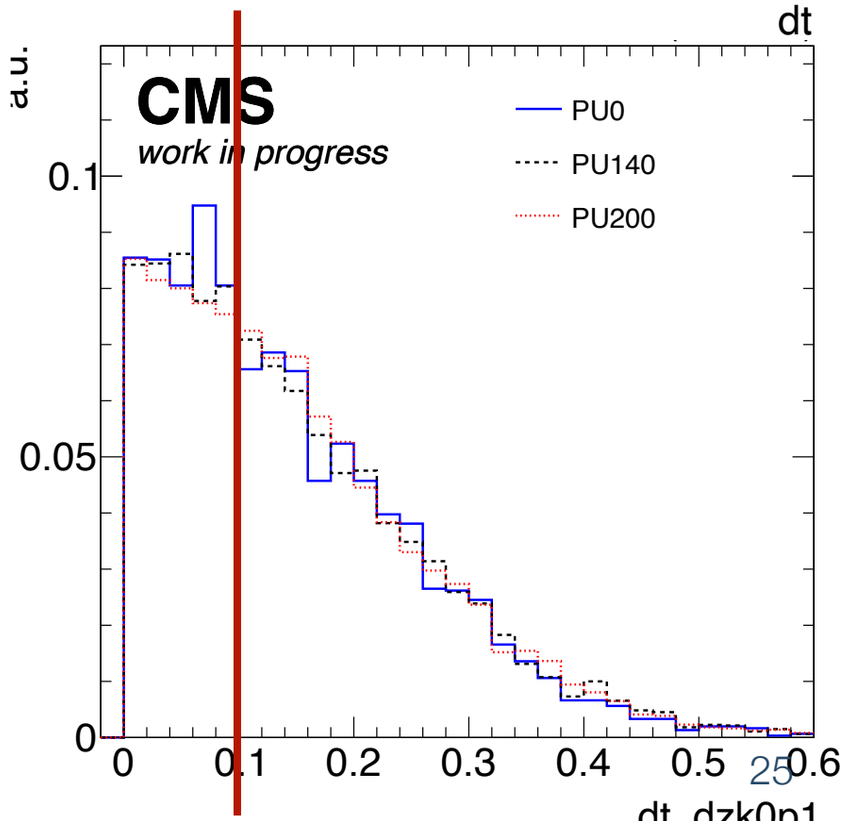



$d_z < 0.1$

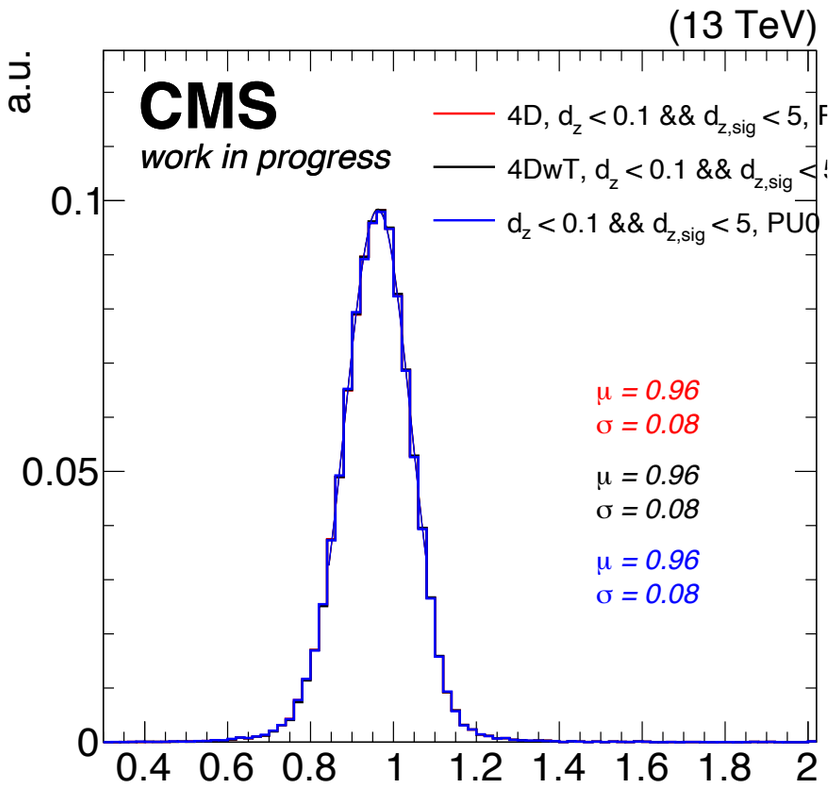


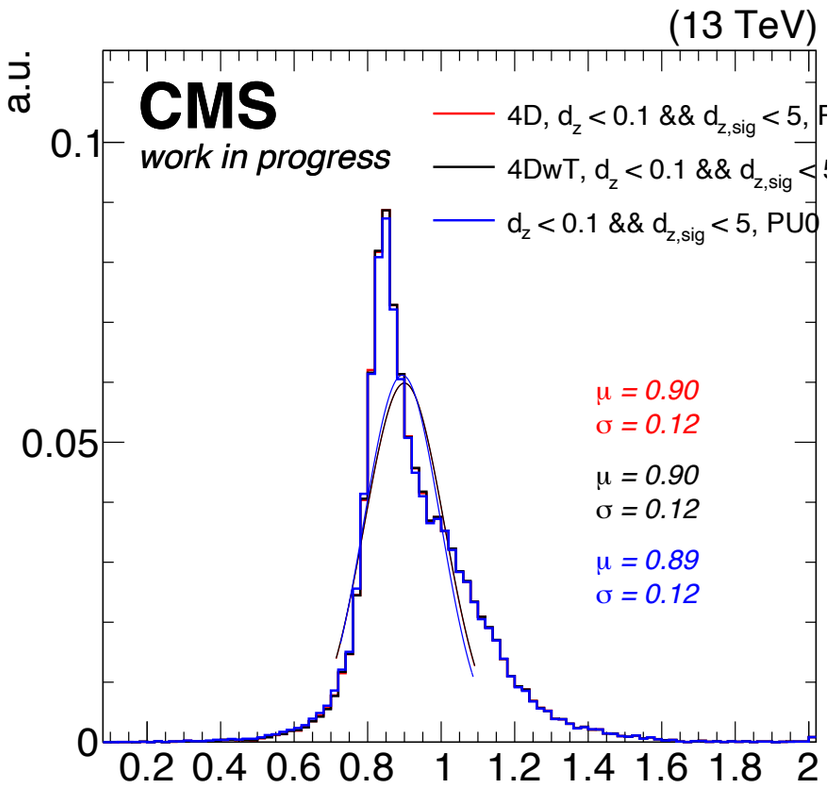



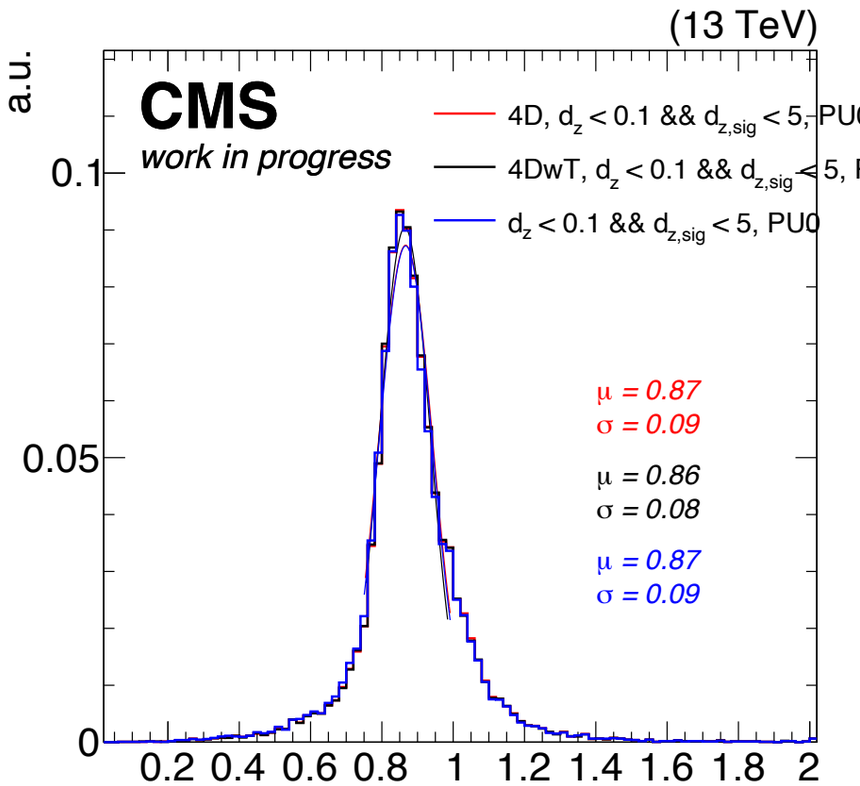
# Comparison of response

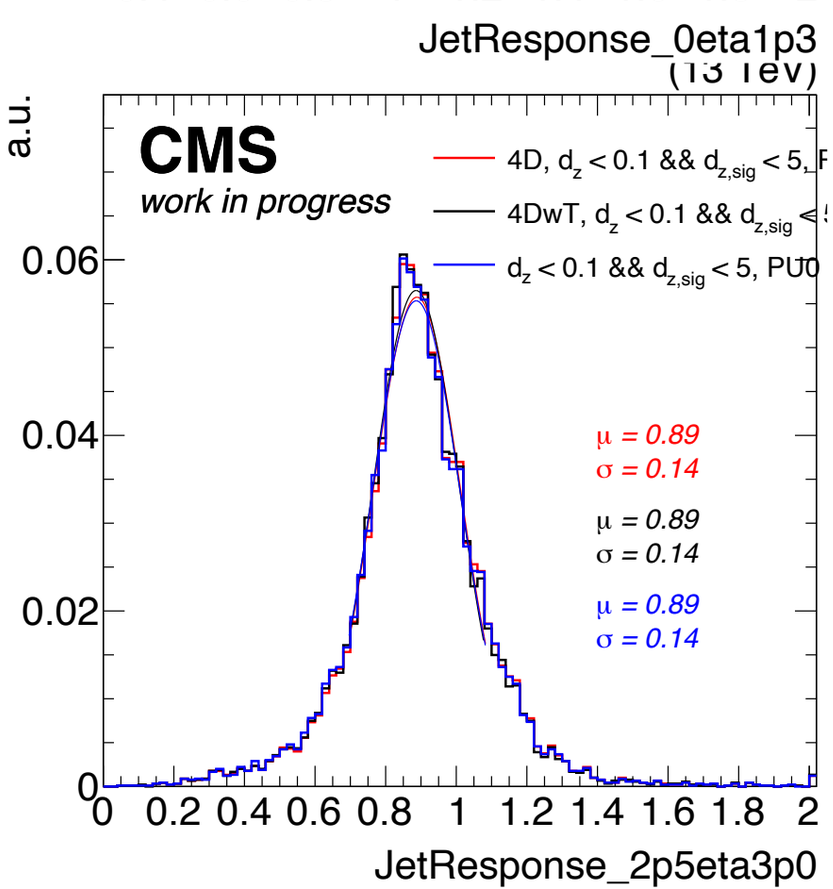
No big differences between the 3D dz version and the 4D dz version. Although in the high $\eta$ region a difference in the width and mean of the fit is visible.

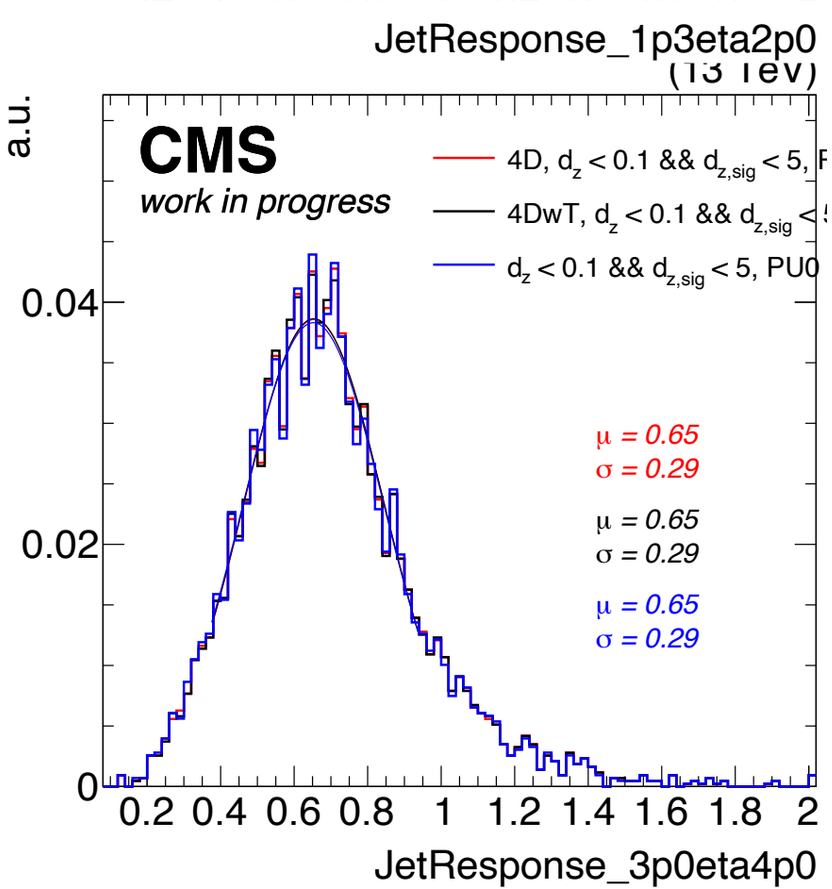
# Jet response 0PU

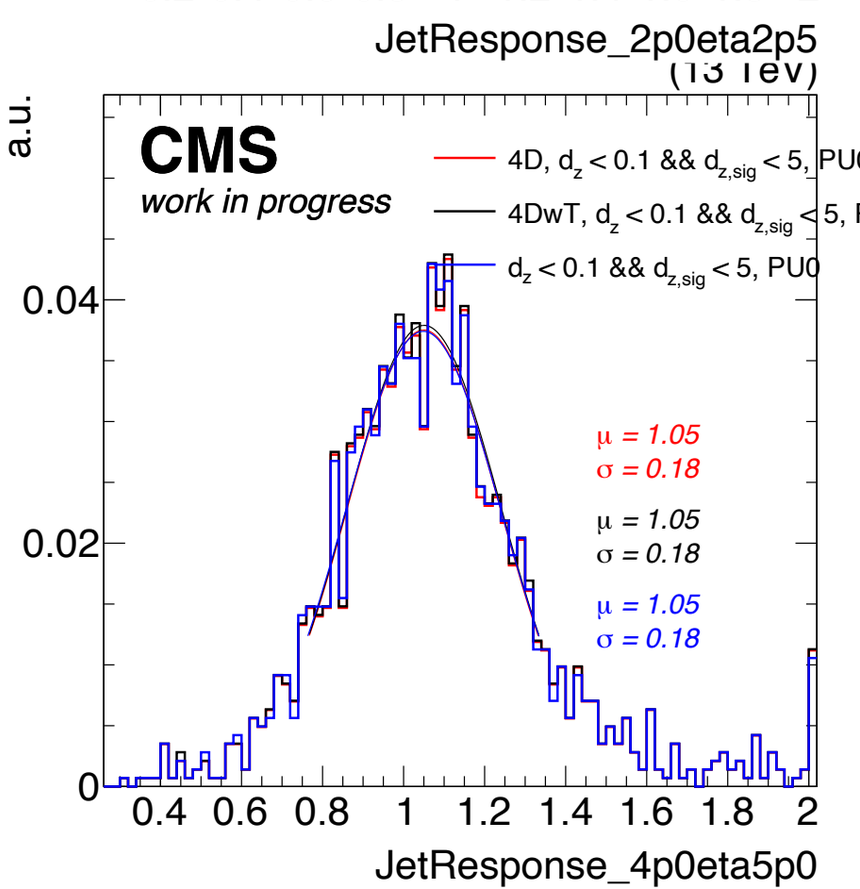


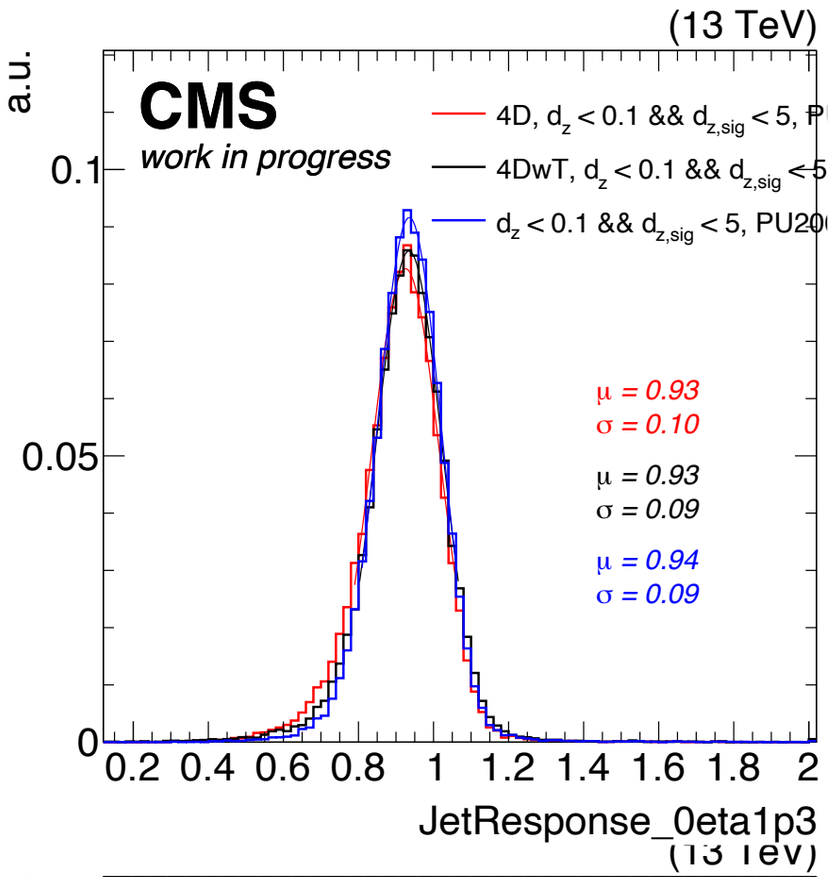



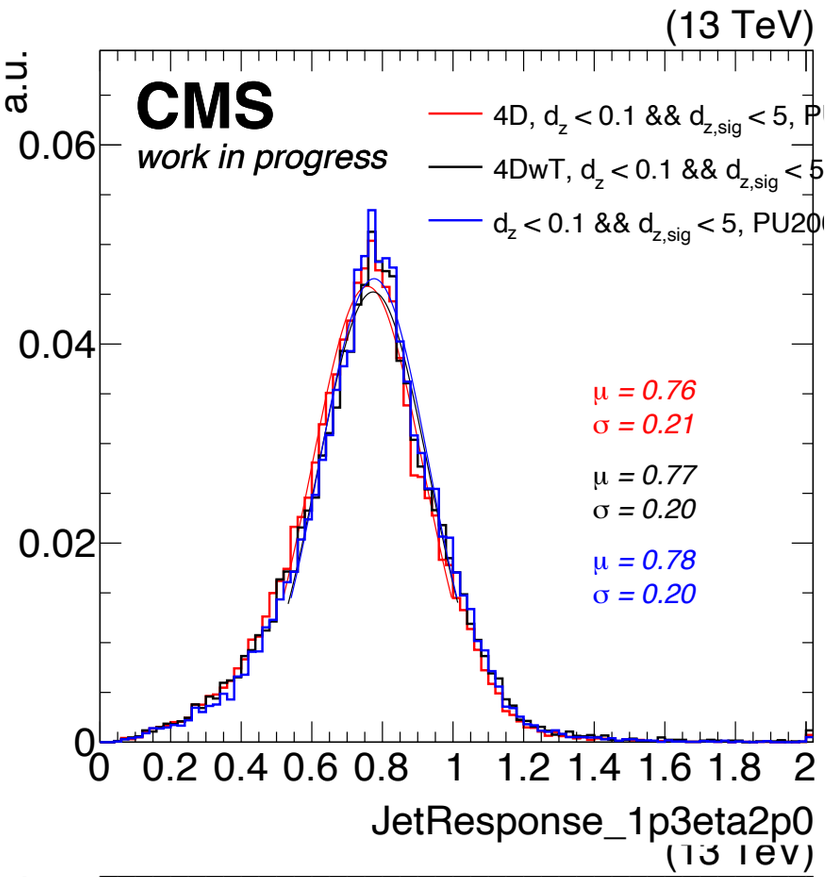



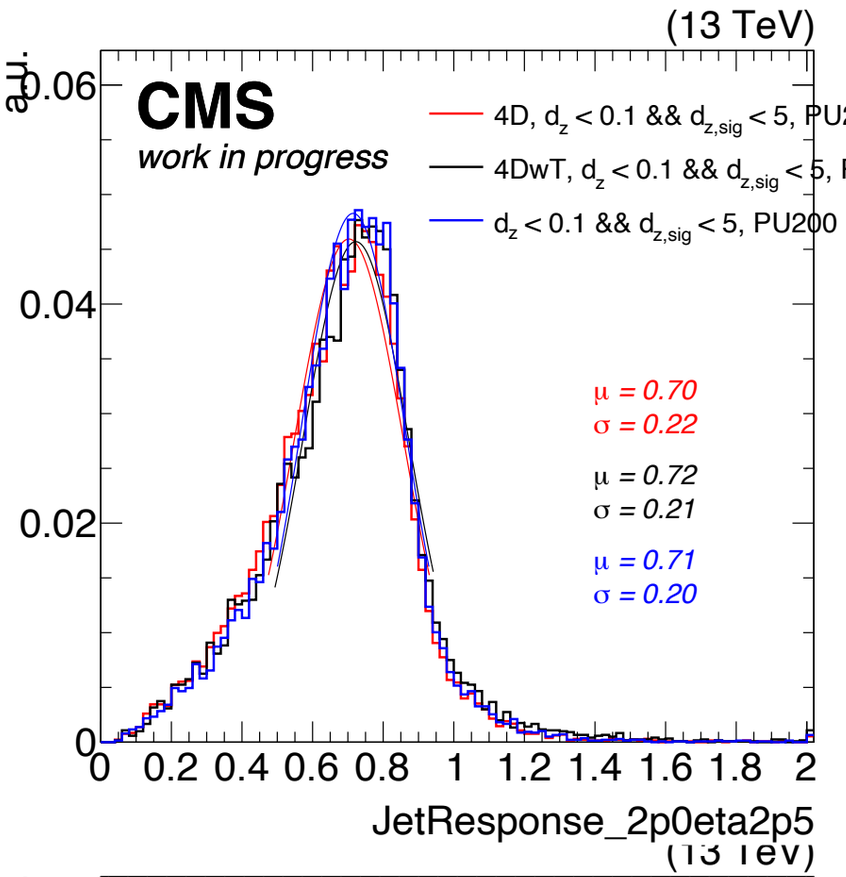



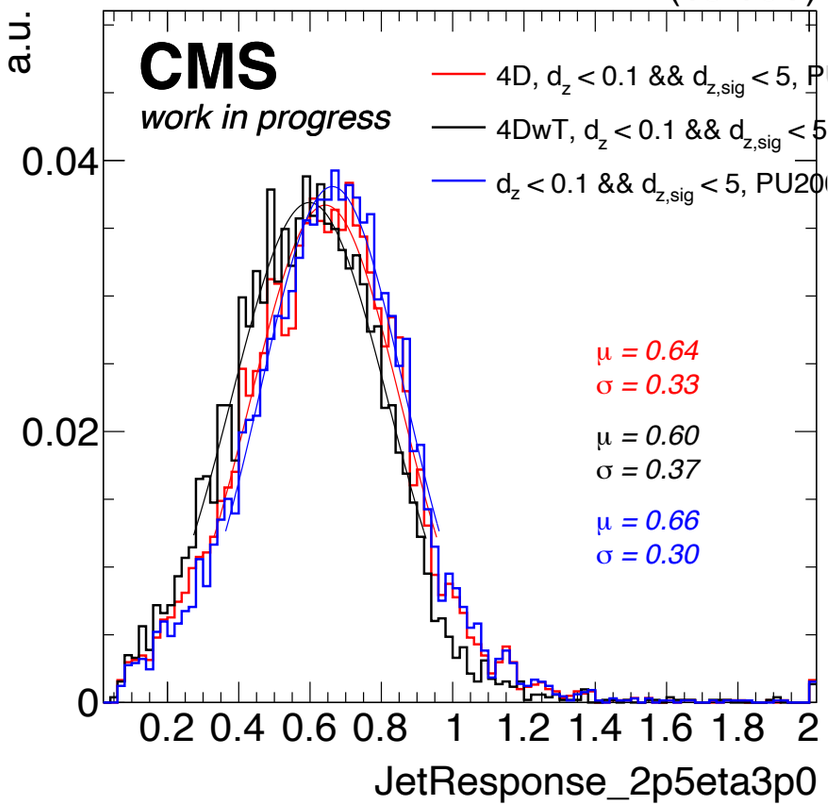



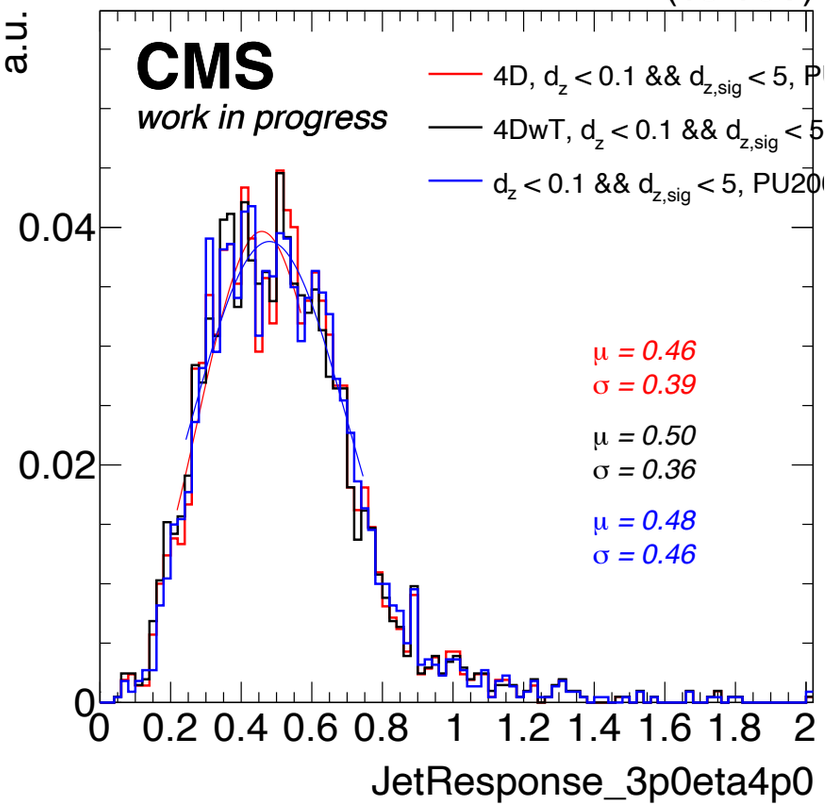
# Jet response 200PU

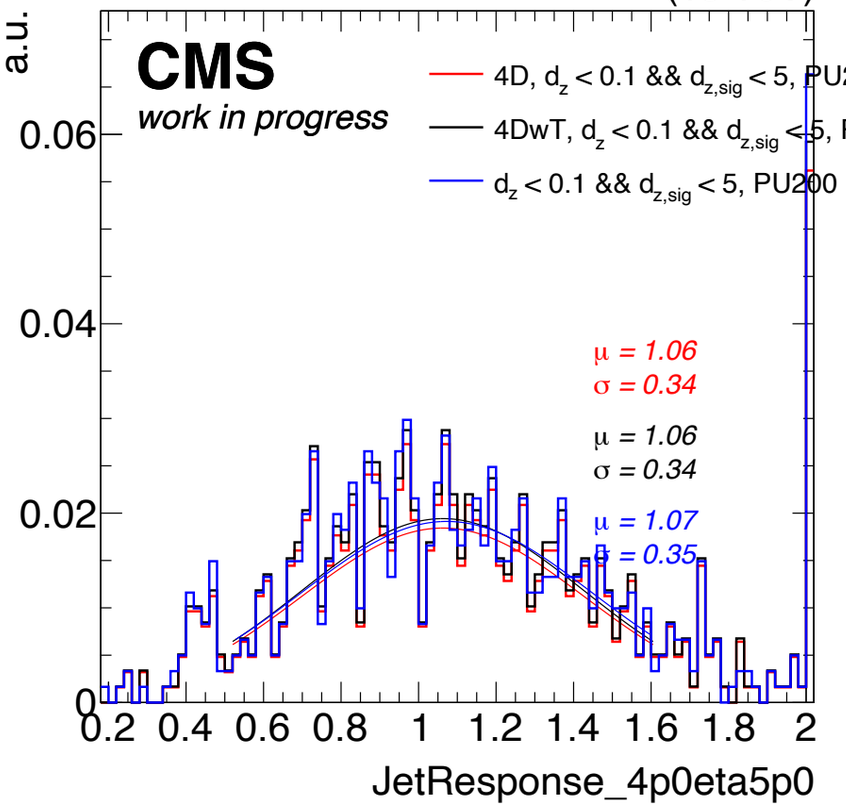


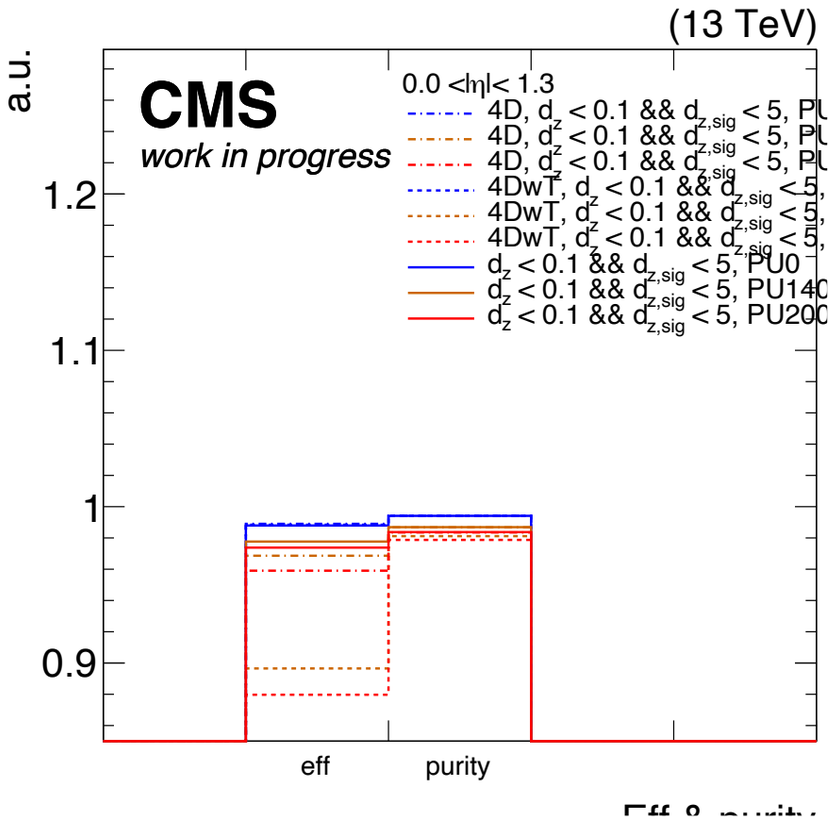



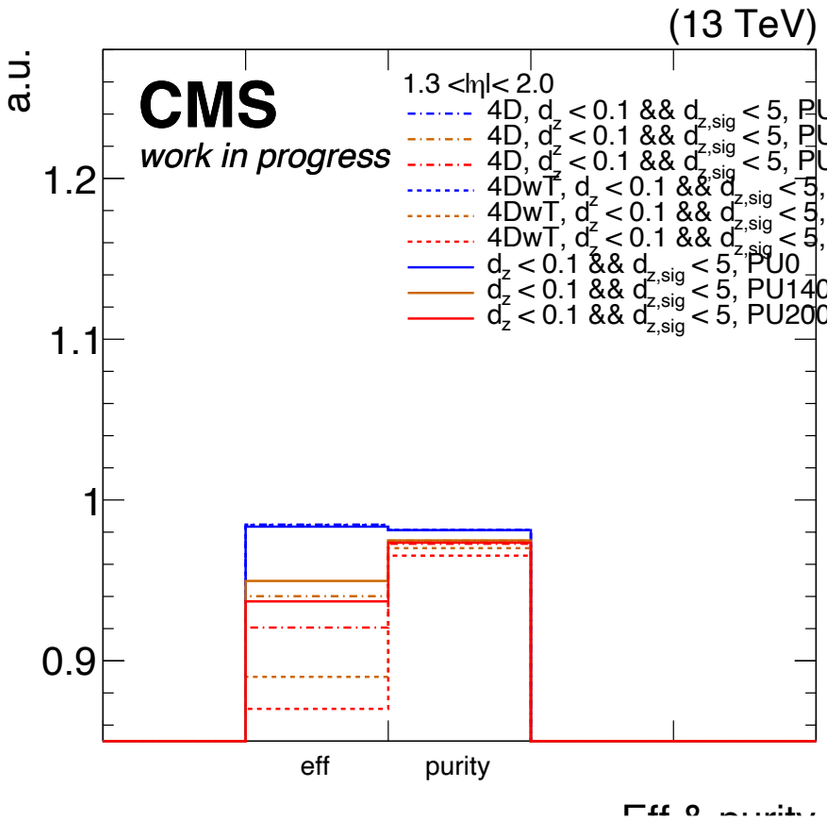



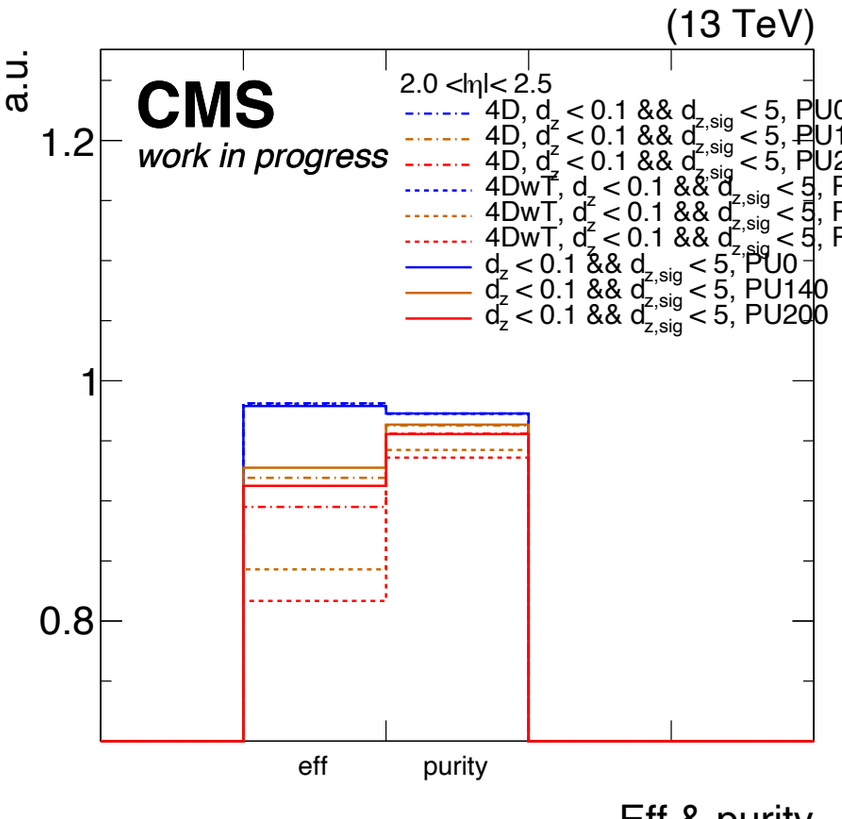
# Efficiency and purity

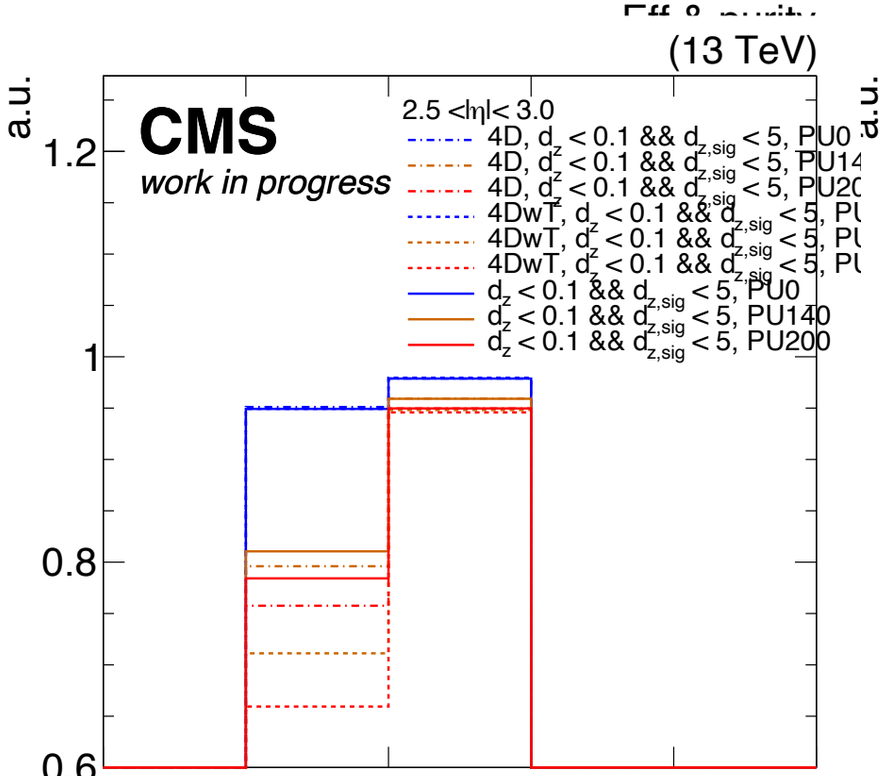
4D vertex collection has a lower efficiency compared to 3D, especially when applying a timing requirement.

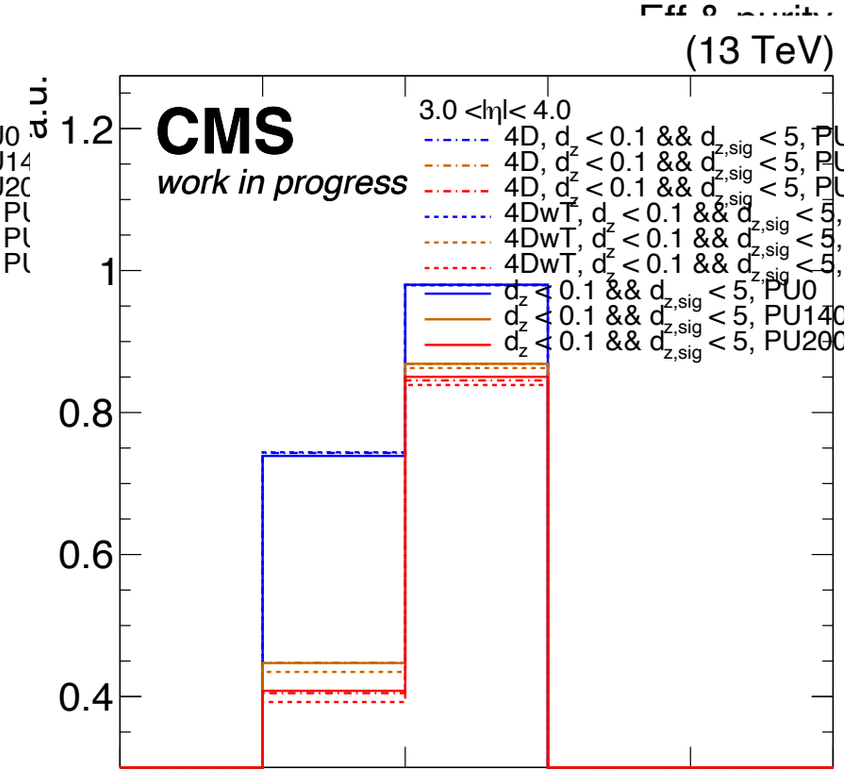
# Efficiency and purity

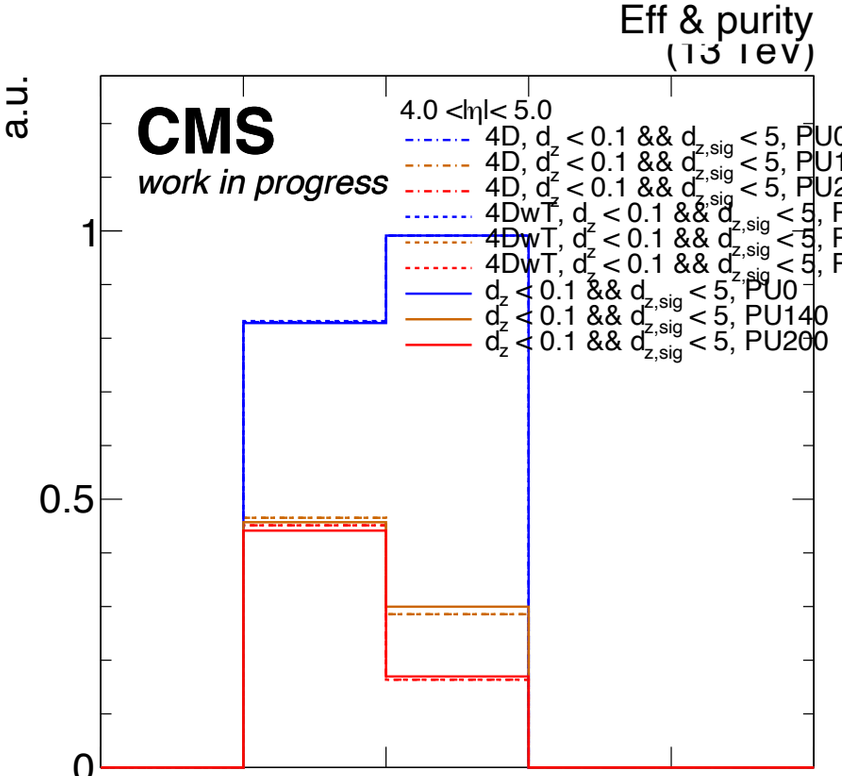


# Summary

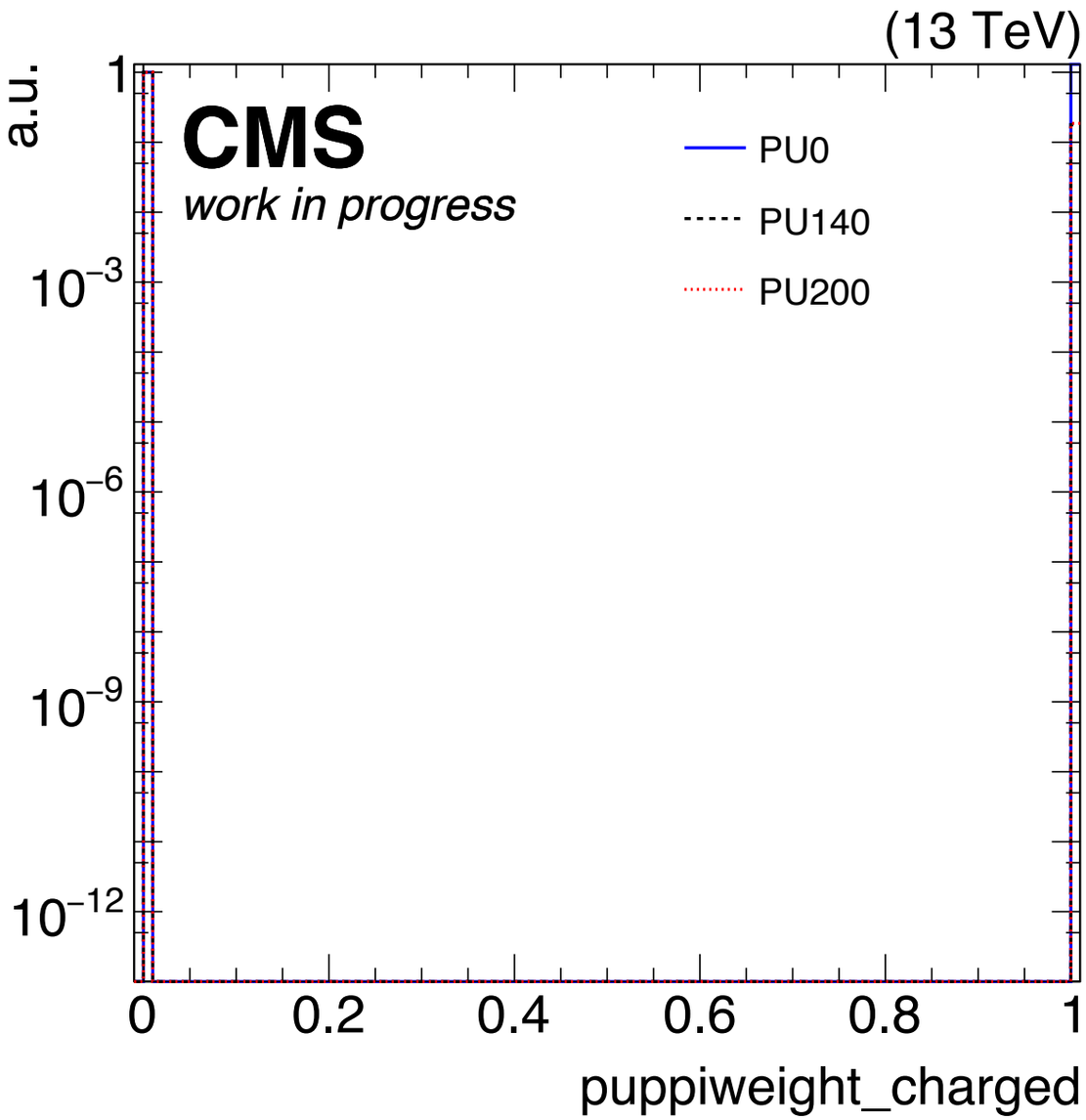
- Showed different track-vertex association scenarios with the new PR
- Phase-2 sample with three different PU (0, 140, 200) scenarios were studied.
- With 3D vertex collection: v15 tune seems to perform slightly better than dz
- With 4D vertex collection: efficiency reduced compared to 3D dz version, especially with time requirement

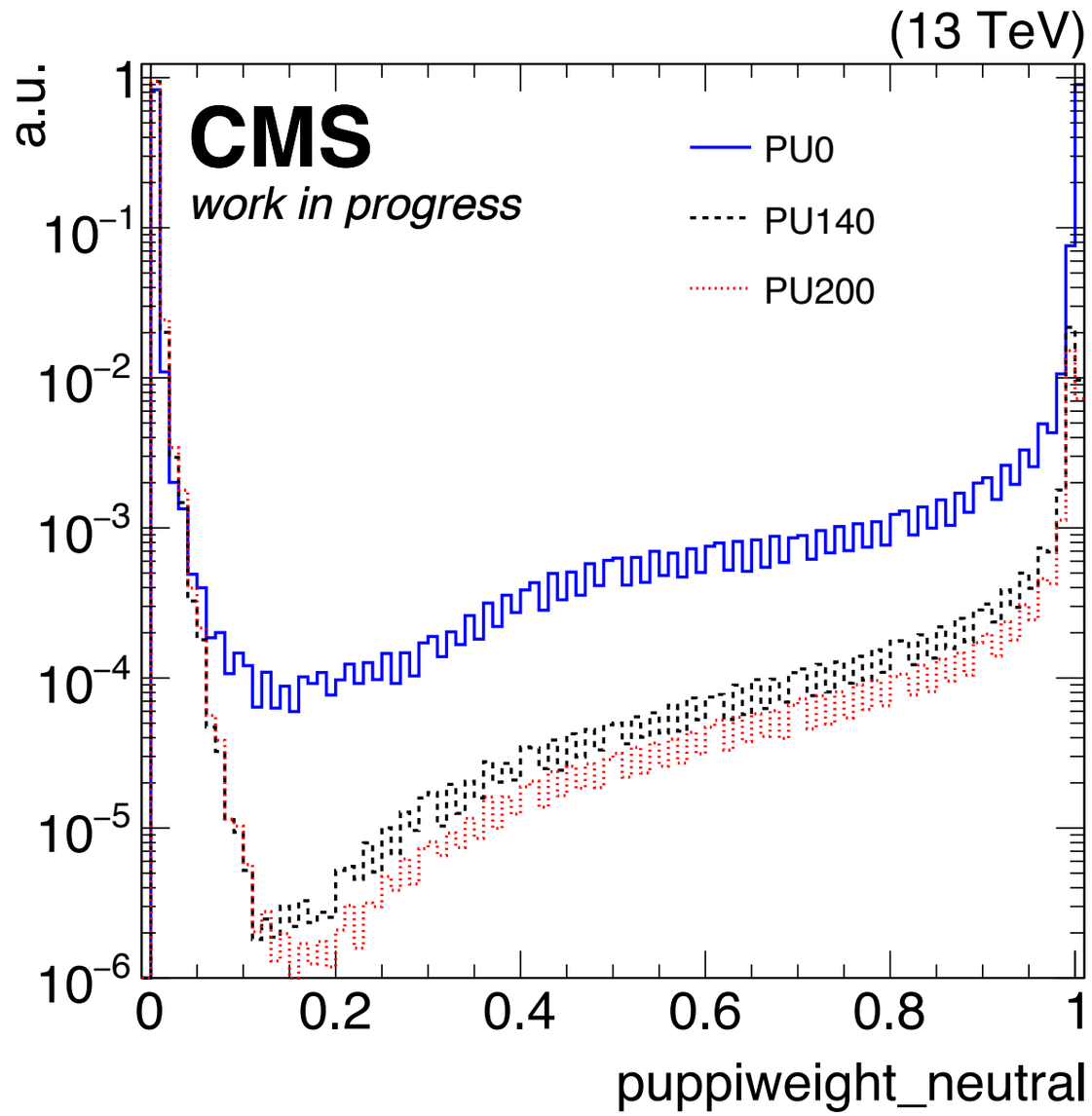
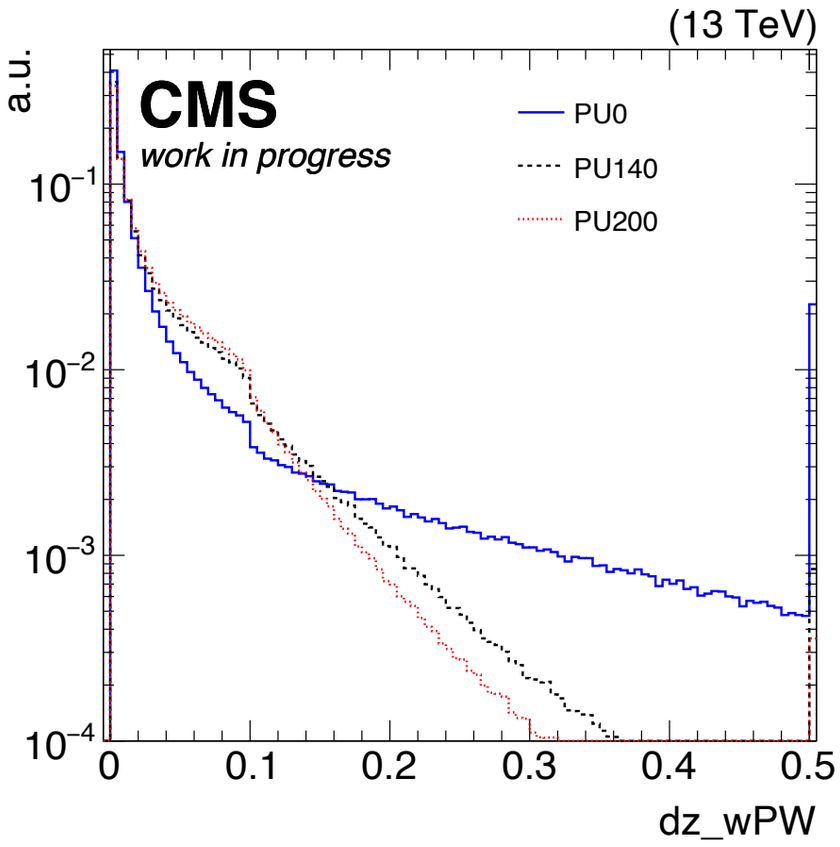
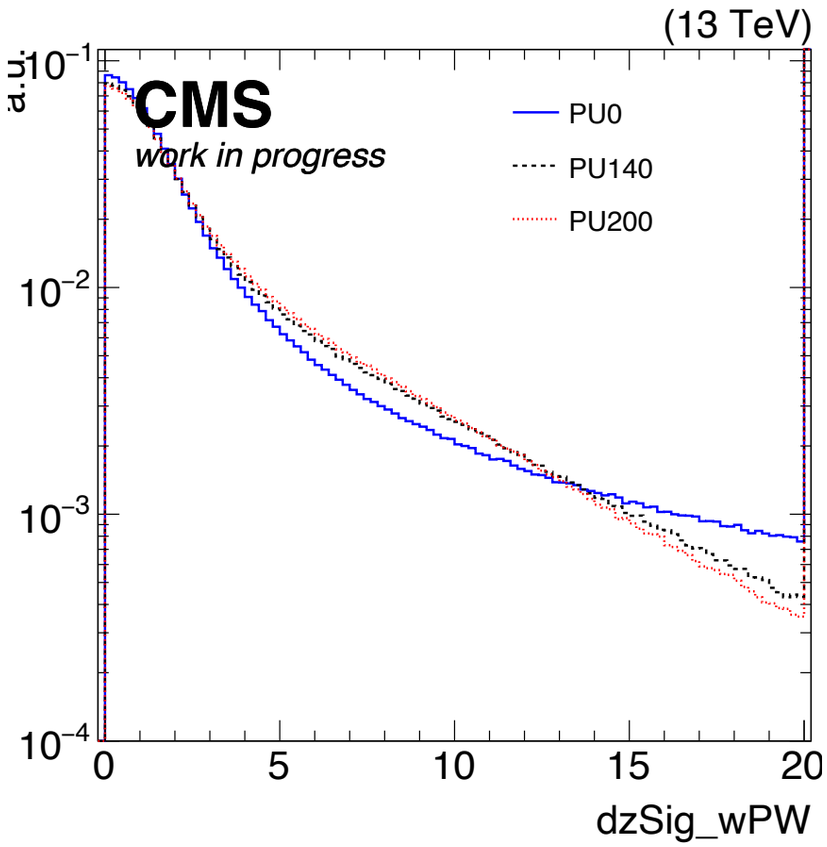
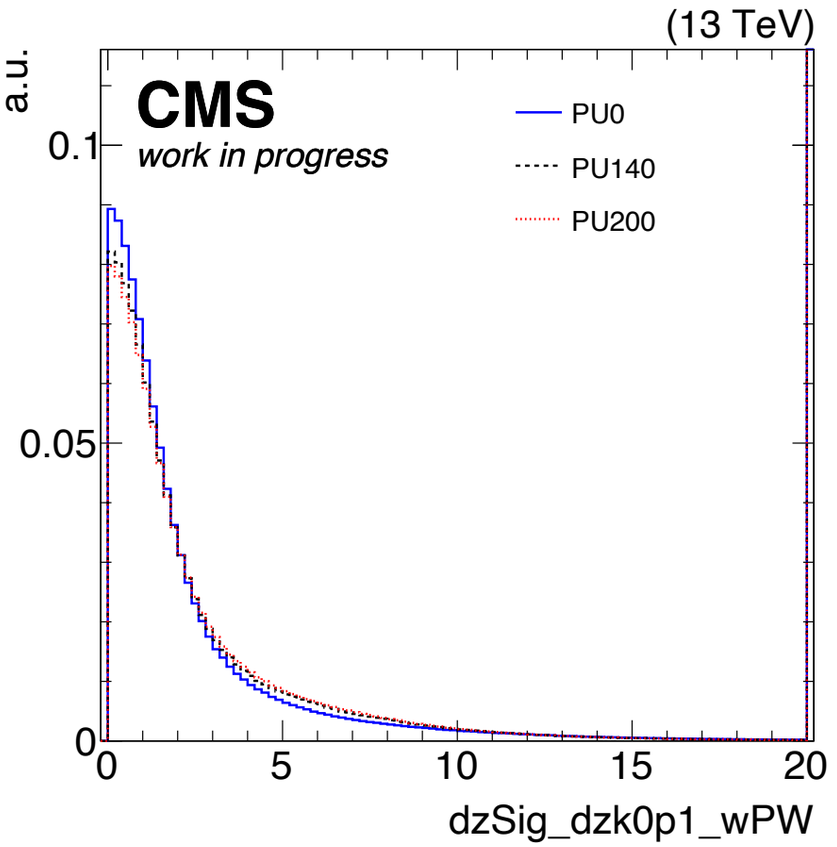
- Test dz scenarios also on Run3 samples?
- Optimize dz+dzsig and allow $\eta$ dependent requirements?

# Backup

# Puppi weight, 3D

# Puppi weight






# Track-vertex association variables with puppiweight