

Using Track based missing Et tools to reject fake MET background

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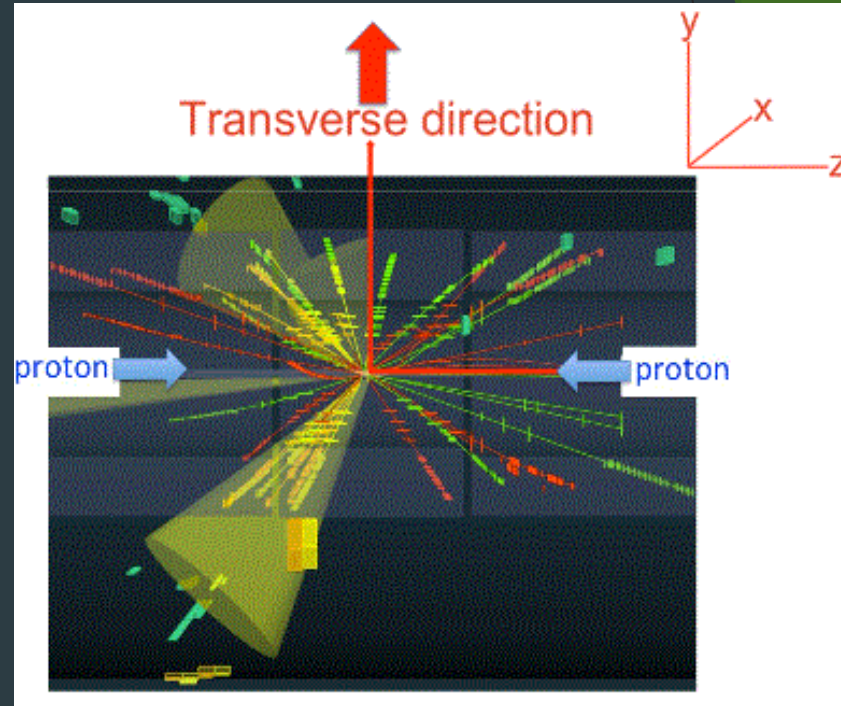
UMichigan-CERN Semester Program

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Introduction

Missing Transverse Energy (E_T^{miss})

- ▶ In p-p collision at the LHC, a significant, unmeasured amount of energy escapes in z-direction.
- ▶ Total initial and final momentum is zero in transverse direction
- ▶ Imbalance of energy in transverse direction signals presence of weakly/non-interacting particles such as neutrinos



$$E_T^{miss} = \sqrt{(p_x^{miss})^2 + (p_y^{miss})^2}$$

$$p_x^{miss} = - \sum_{i=1}^{N_{\text{contrib}}} p_{x,i}$$
$$p_y^{miss} = - \sum_{i=1}^{N_{\text{contrib}}} p_{y,i}$$

Input Variables

- ▶ http://atlas-computing.web.cern.ch/atlas-computing/links/buildDirectory/nightlies/dev/AtlasOffline/rel_0/InstallArea/doc/xAODMissingET/html/index.html#met_edm
- ▶ *mpx* momentum component p_x
- ▶ *mpy* momentum component p_y
- ▶ *pt* tranverse momentum p_T

xAOD::Missing ET

- ▶ double xAOD::MissingET::mpx () const

$$p_x^{\text{miss}} = - \sum p_x$$

- ▶ double xAOD::MissingET::mpy () const

$$p_y^{\text{miss}} = - \sum p_y$$

- ▶ double xAOD::MissingET::met () const

$$E_T^{\text{miss}} = \sqrt{(p_x^{\text{miss}})^2 + (p_y^{\text{miss}})^2}$$

- ▶ double xAOD::MissingET::sumet () const

$$\sum E_T = \sum p_T$$

- ▶ double xAOD::MissingET::phi () const

$$\phi(E_T^{\text{miss}})$$

Goal

- ▶ Performance study of track-based MET (trackMET) as opposed to calorimeter based MET (caloMET) for Run2 (Run1 already tested)
- ▶ Track selection study to reject tracks coming from background (mostly QCD)
- ▶ Using the ZH- \rightarrow vvbb channel and MC14_13tev* samples.

Why Track MET?

- ▶ Provide an alternative measurement to calorimeter-based MET (caloMET)
 - ▶ Different detector has different unrelated systematic effect
- ▶ Can associate tracks to primary vertex,
 - ▶ Calculate MET and SumPt based on primary vertex of the event ,thus more correlated to true MET of the main physics process - important in pileup case
- ▶ Will deteriorate less than calorimeter based variables as instantaneous luminosity increase
- ▶ Has less effect due to cosmic muon and beam background
- ▶ Trackmet tool could be used in rejecting these background in W/Z analysis :
 - ▶ QCD jet background
 - ▶ Cosmic background
 - ▶ Pileup background
 - ▶ Beam halo background

Why TrackMET?: Continue

- ▶ Some analysis it is used:
 - ▶ BSM: $H \rightarrow ZZ \rightarrow \nu\nu qq$
 - ▶ SM: $ZH \rightarrow \nu\nu bb$, $H \rightarrow WW \rightarrow l\nu l\nu$
 - ▶ $ZH \rightarrow bbxx$ (invisible)
- ▶ Disadvantages :
 - ▶ --See only charged particles
 - ▶ --Smaller geometrical coverage ($|\eta| < 2.5$ Compared to calorimeter $|\eta| < 4.5$)
 - ▶ --Momentum resolution get worse in higher Pt (expected in Run2, need a way to fix that)

How to reject background using the trackMET info?

- ▶ Use correlation between MPT and MET and correlation between MPTphi and METphi to reject QCD background
- ▶ Use different track selection to separate unwanted tracks from signal track

Selection Cut in Run1 and Run2

- ▶ Run1
 - ▶ Loose track selection/tight track selection
- ▶ Select good tracks for this measurement
 - ❑ Select tracks from primary interaction
 - ❑ Remove tracks from conversion
- ▶ Too loose or too tight could worsen Track MET resolution
- ▶ Track selection cut for reconstructing track MET (Run1):
 - ❑ $|\text{Track_z0}$ respect to primary vertex $|\lt 20$ mm
 - ❑ $|\text{Track_d0}$ respect to primary vertex $|\lt 2$ mm
 - ❑ $\text{Track_Pt} > 0.5\text{GeV}$, $\text{Track_Pt} < 300\text{GeV}$
 - ❑ Number of pixel hits ≥ 2
 - ❑ Number of SCT hits ≥ 6
 - ❑ $\text{Track MET} = -1 * (\text{Vector sum of the selected track momentum})$

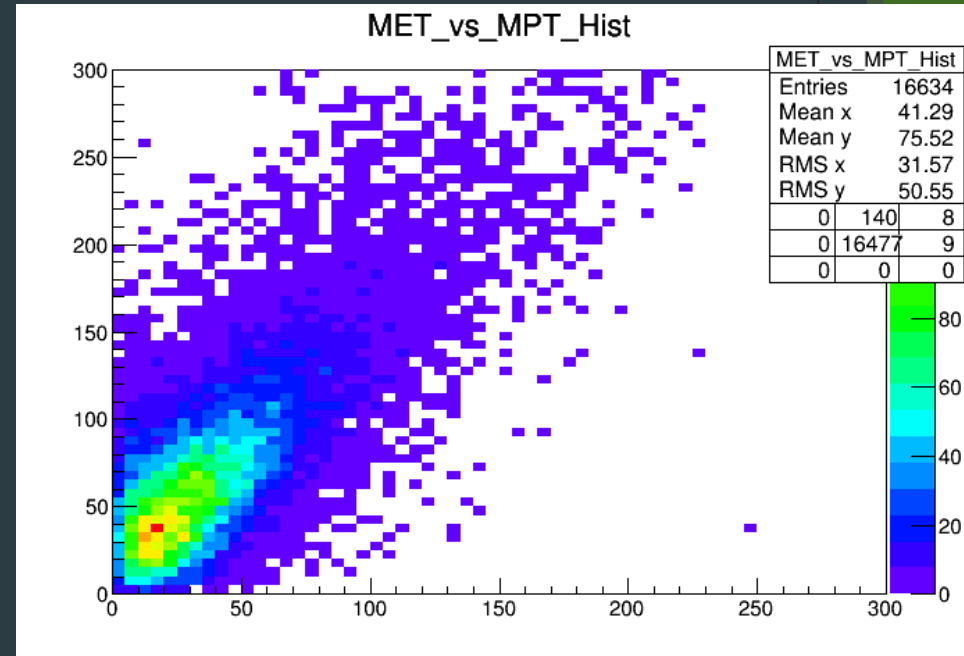
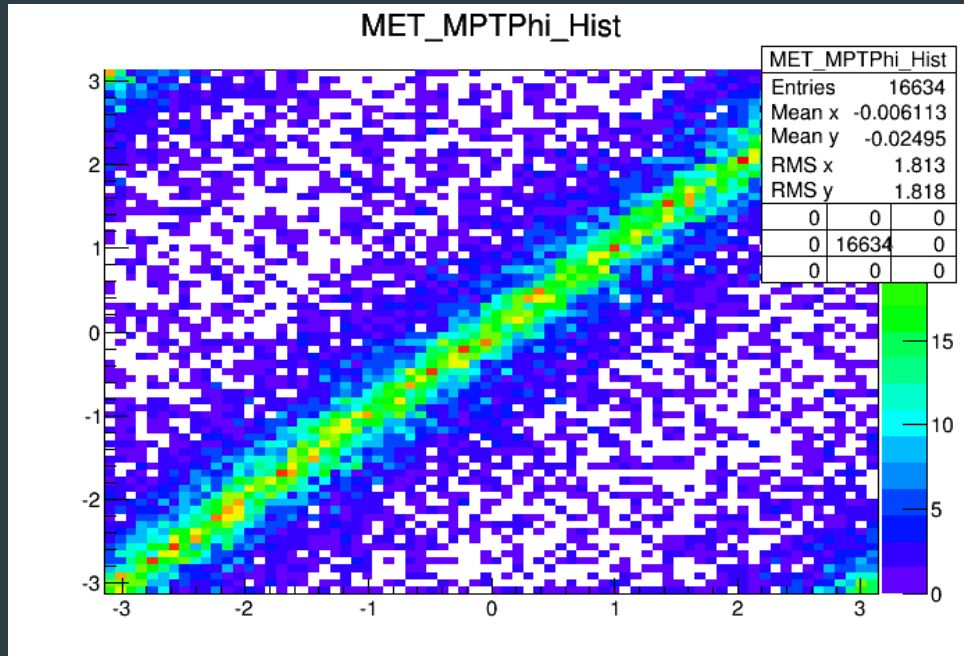
Track Selection: Run2

- ▶ Mostly follow the same cut as in Run1
- ▶ Currently studying suitable cut for Run2

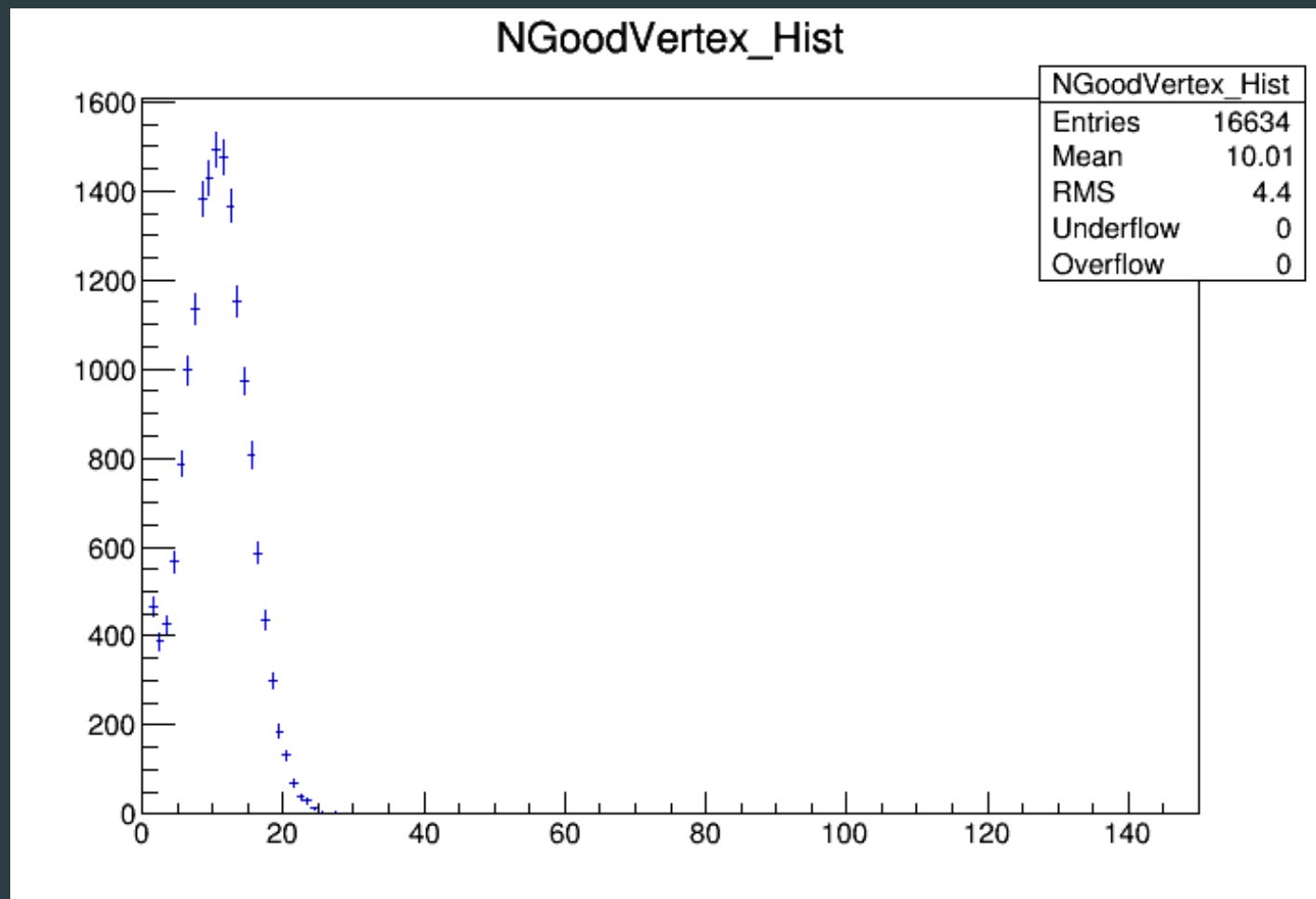
Run 1 Performance (H->ZH->vvbbb)

- ▶ Pretty successful in providing alternate measurement to caloMET and rejecting fake QCD backgrounds in Run1 ($\sqrt{s}=8\text{tev}$)

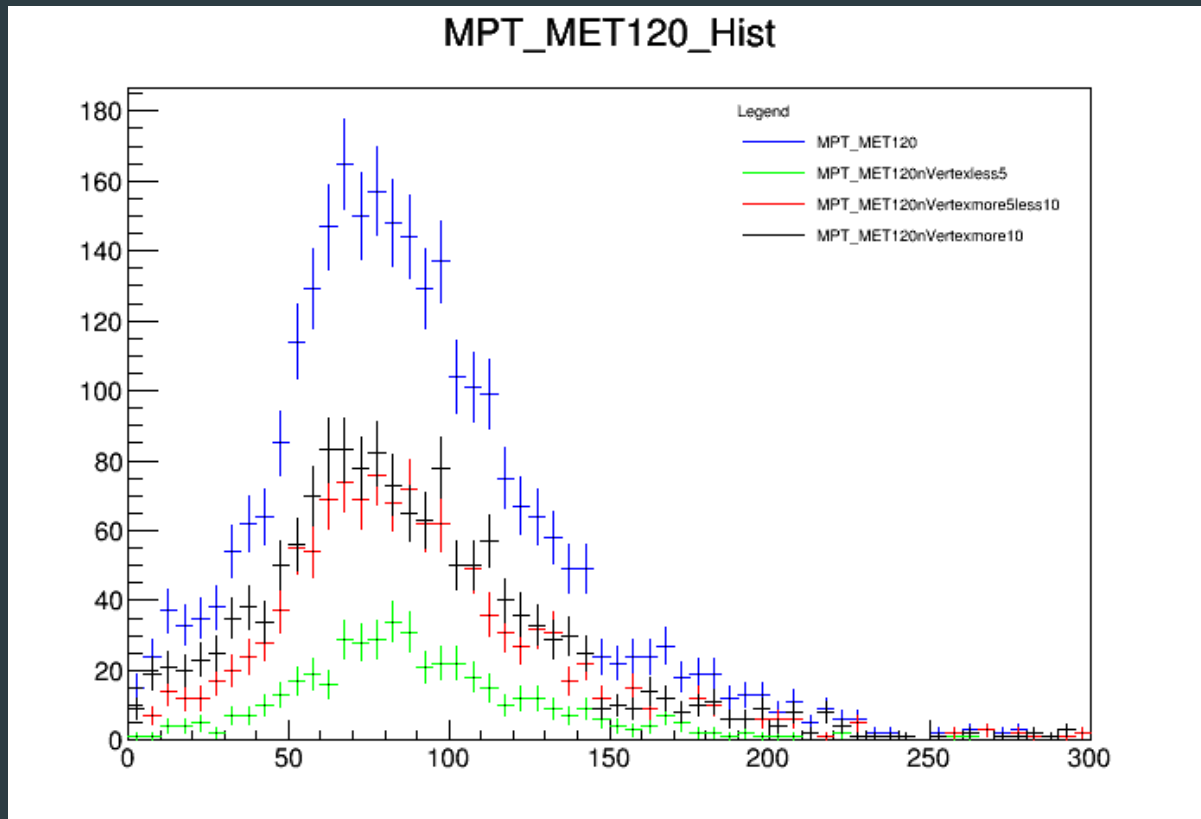
Run1Plots:METvsMPT and METphivsMPTphi



Run1Plots: Number of Vertex



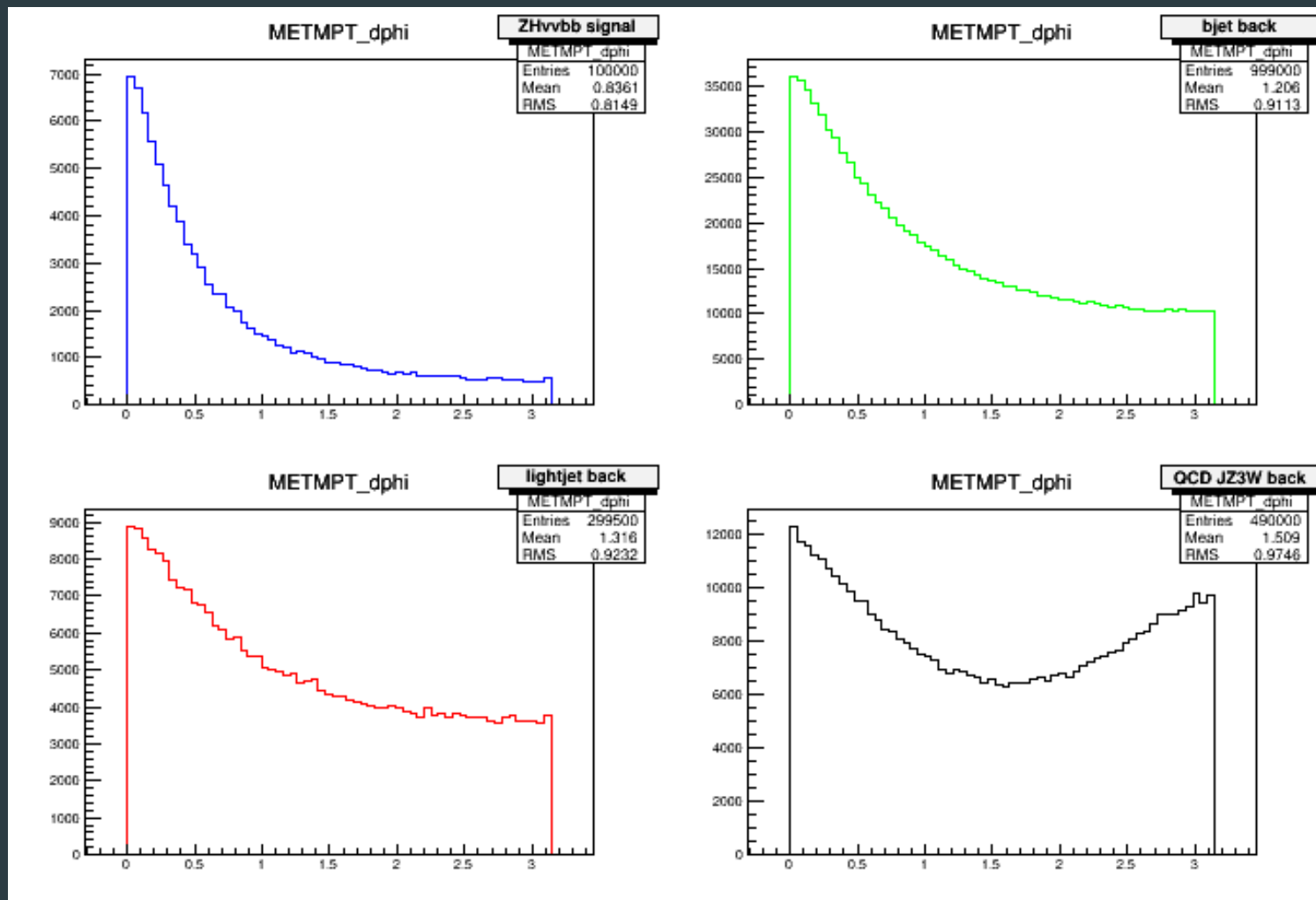
Plots Run1: MPT in different NPV (with cut MET > 120GeV)



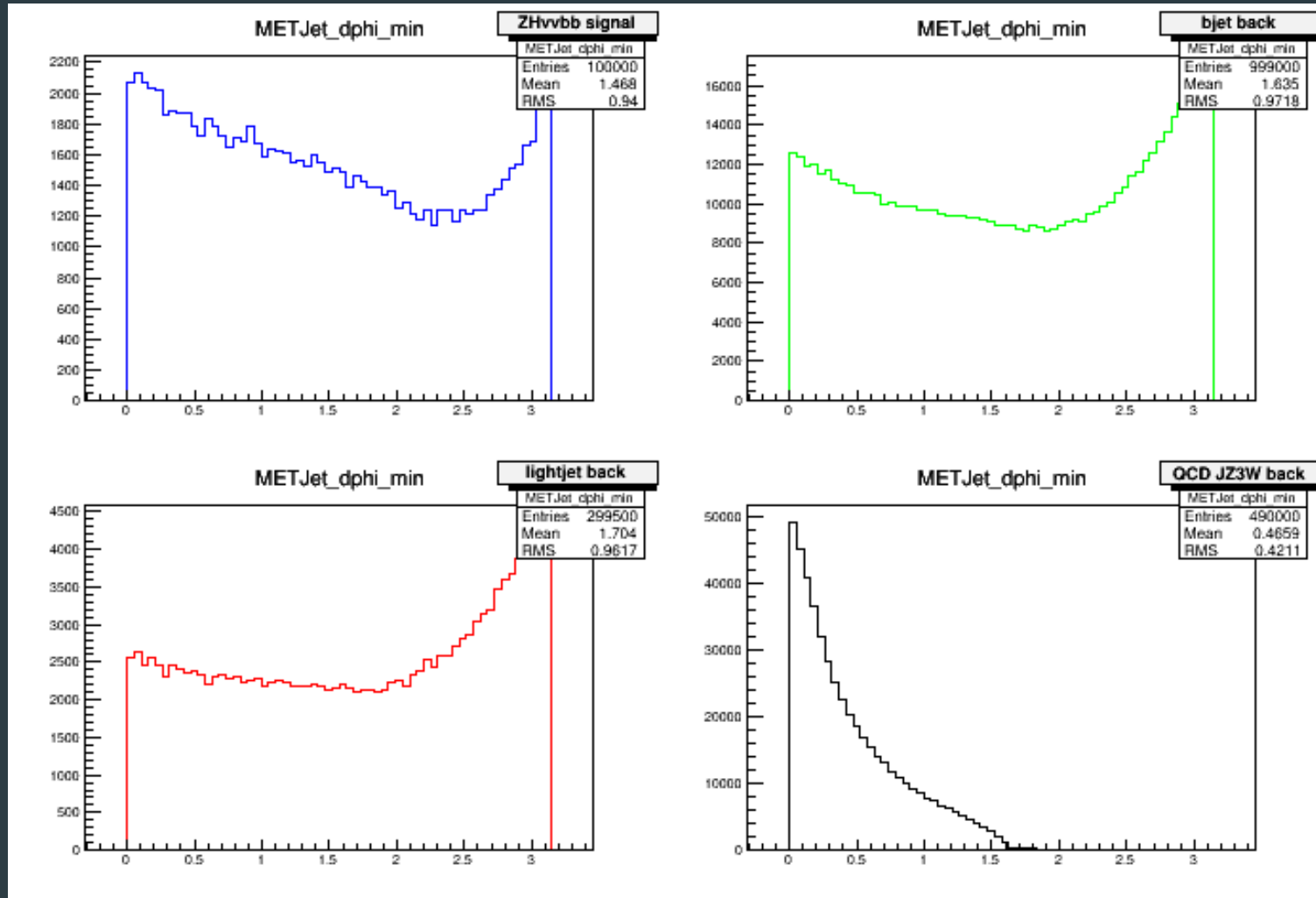
Looking forward to Run2

- ▶ Performance study of different Run2 MC samples
 - ▶ QCD (JZ3W)
 - ▶ Higgs/Z+jet(bb/jj)
 - ▶ Higgs→ZH125 →nubbb at different pileup effect ($\mu=30$, 50ns trigger vs $\mu=80$, 25ns trigger)

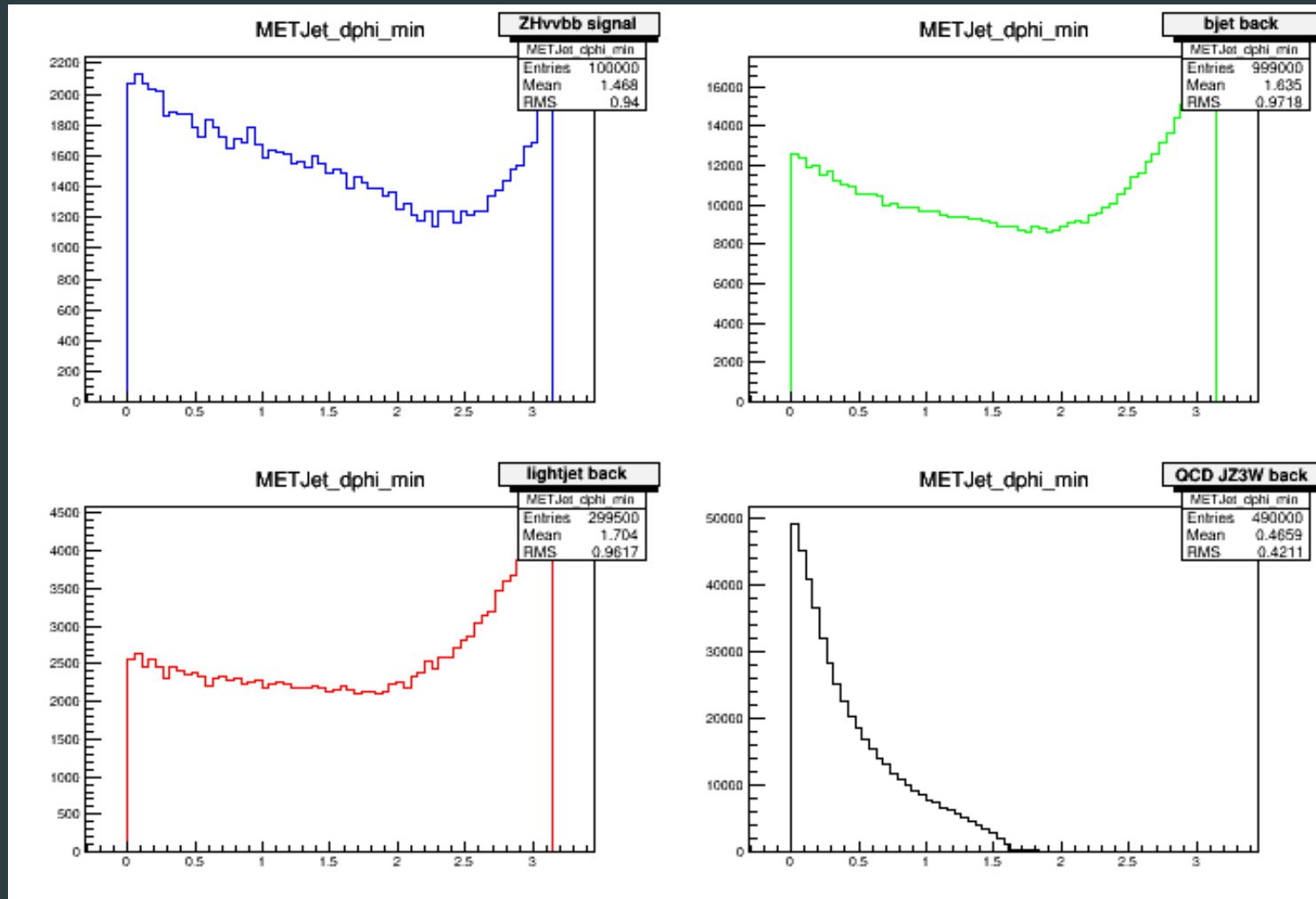
Run2Plot: METMPTdphi



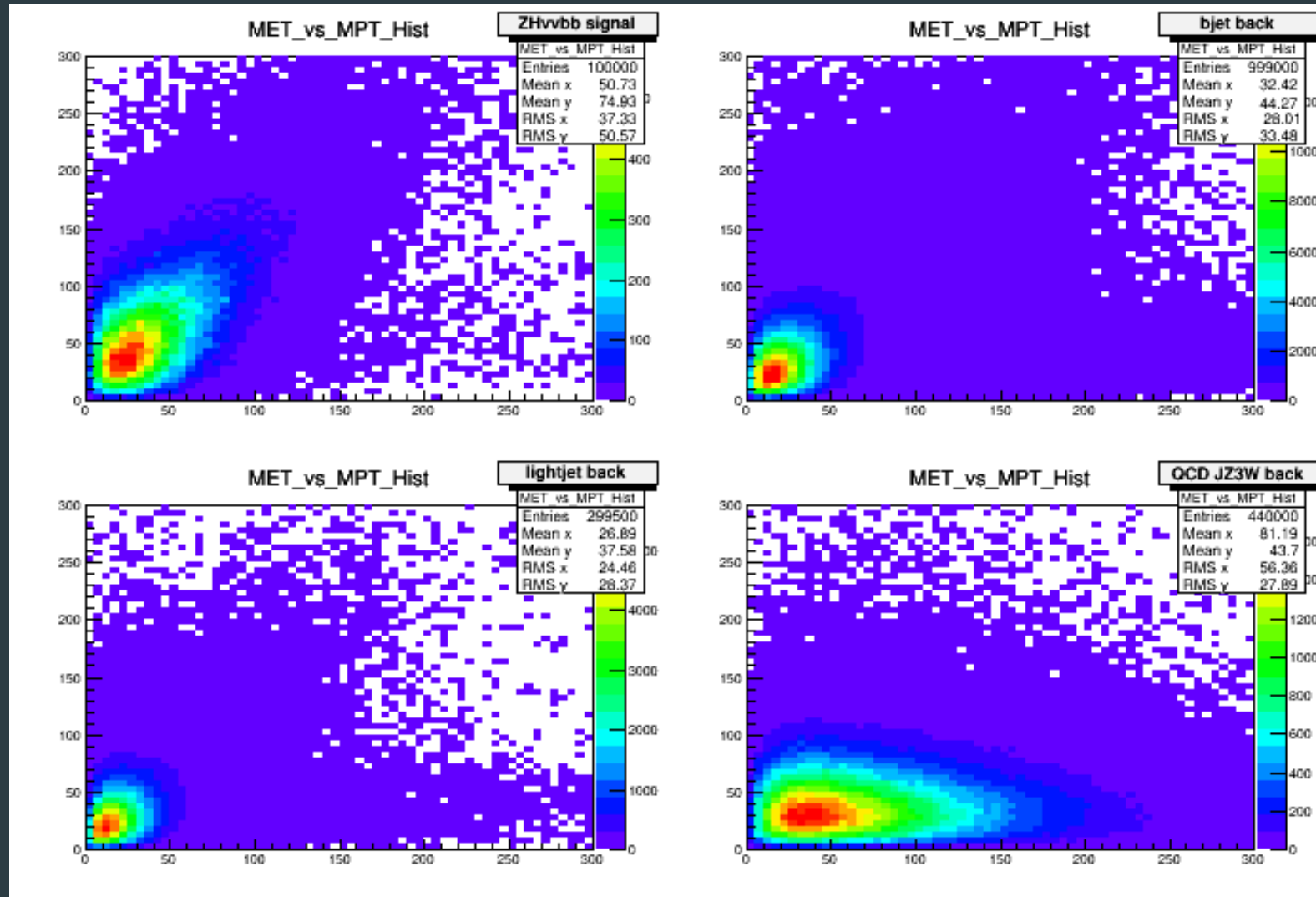
Run2Plots: METJetdphimin



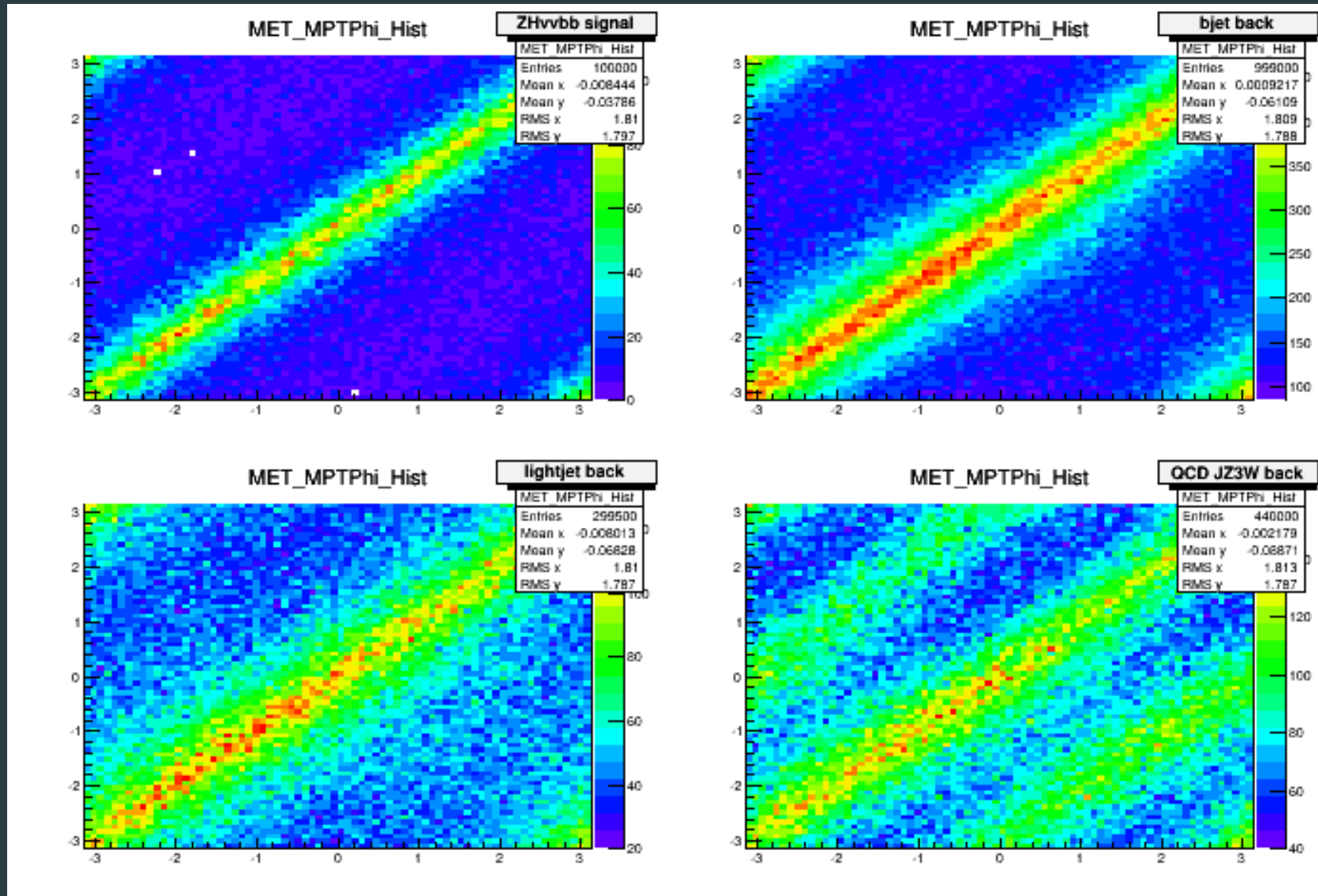
Run2 Plots: METJetdphi_min



Run2 Plots: METvsMPT (non PV)



Run2Plots:METphivsMPTphi



Run2 Issue

- ▶ Increased number of pileup non-significantly degrade trackMET performance
 - ▶ Need to apply different track selection to reduce increased pileup effect (since some tracks are 'soft tracks')
- ▶ Trigger performance
 - ▶ Different trigger affect the performance of trackMET in Run2
 - ▶ Trigger group still haven't decided suitable trigger yet, will see confirmation in coming weeks

Conclusion

- TrackMet could help in rejecting processes which are source of fake MET, such as QCD Di-jets, cosmics, pile-up effects...
It can be a powerful tool in W/Z analysis, and any other processes with real MET.
- ❑ Currently testing the migrated version of xAOD MET package and implementation of xAOD TrackMET is underway.
- ❑ Study of improvement on QCD jet rejection as well as Bjet background

Cultural Activity?

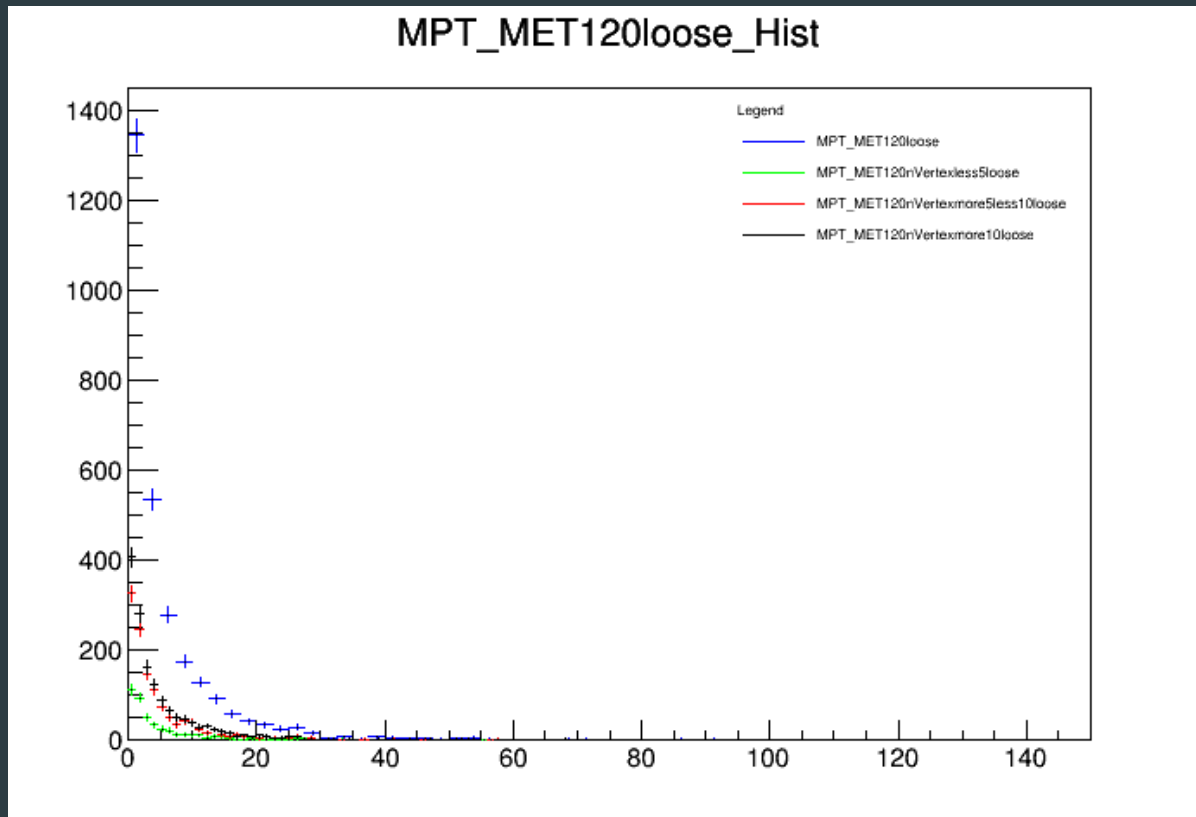


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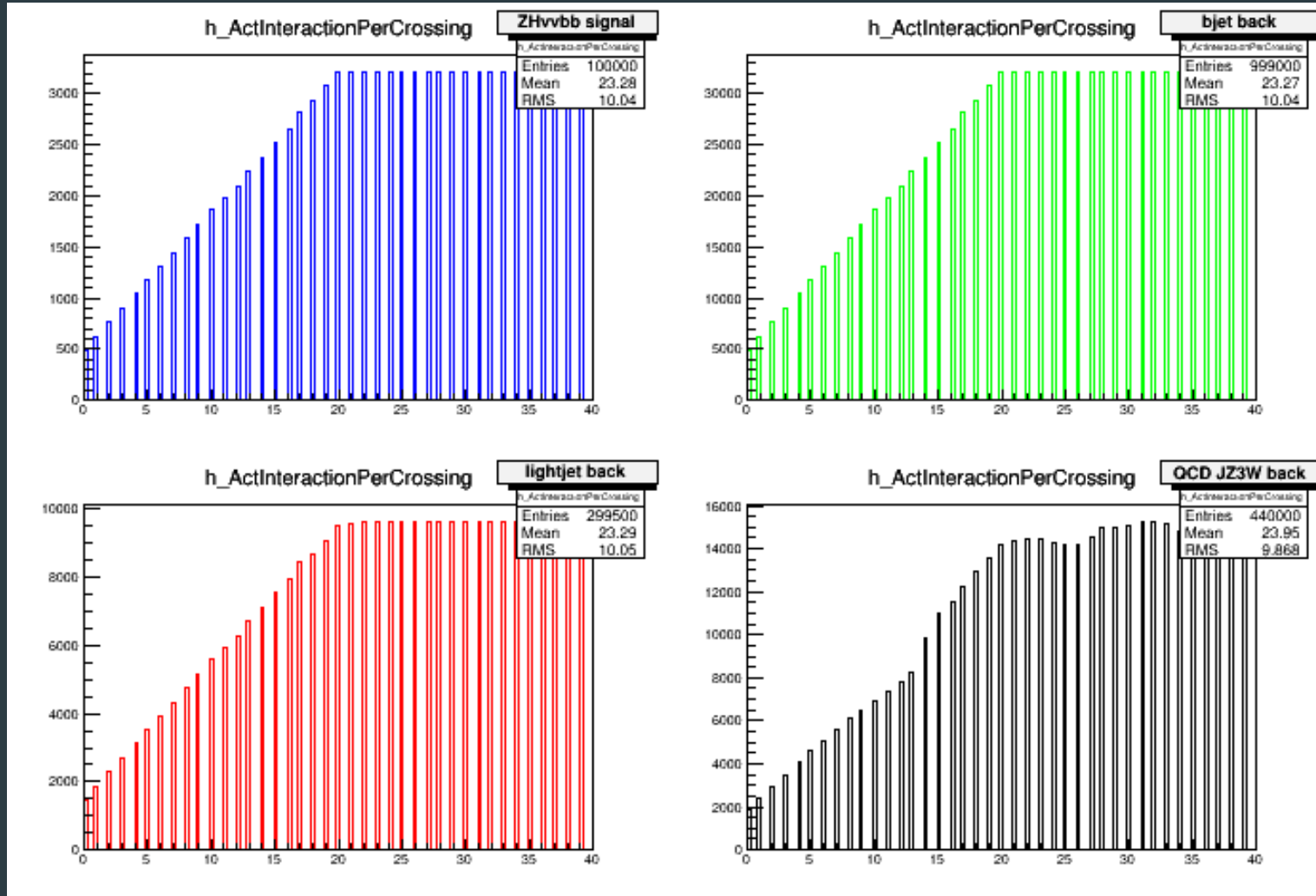
The background features a dark blue-grey color on the left side, transitioning into a series of overlapping, semi-transparent green geometric shapes on the right side. These shapes are in various shades of green, from a muted forest green to a bright lime green, creating a dynamic, layered effect.

Backup

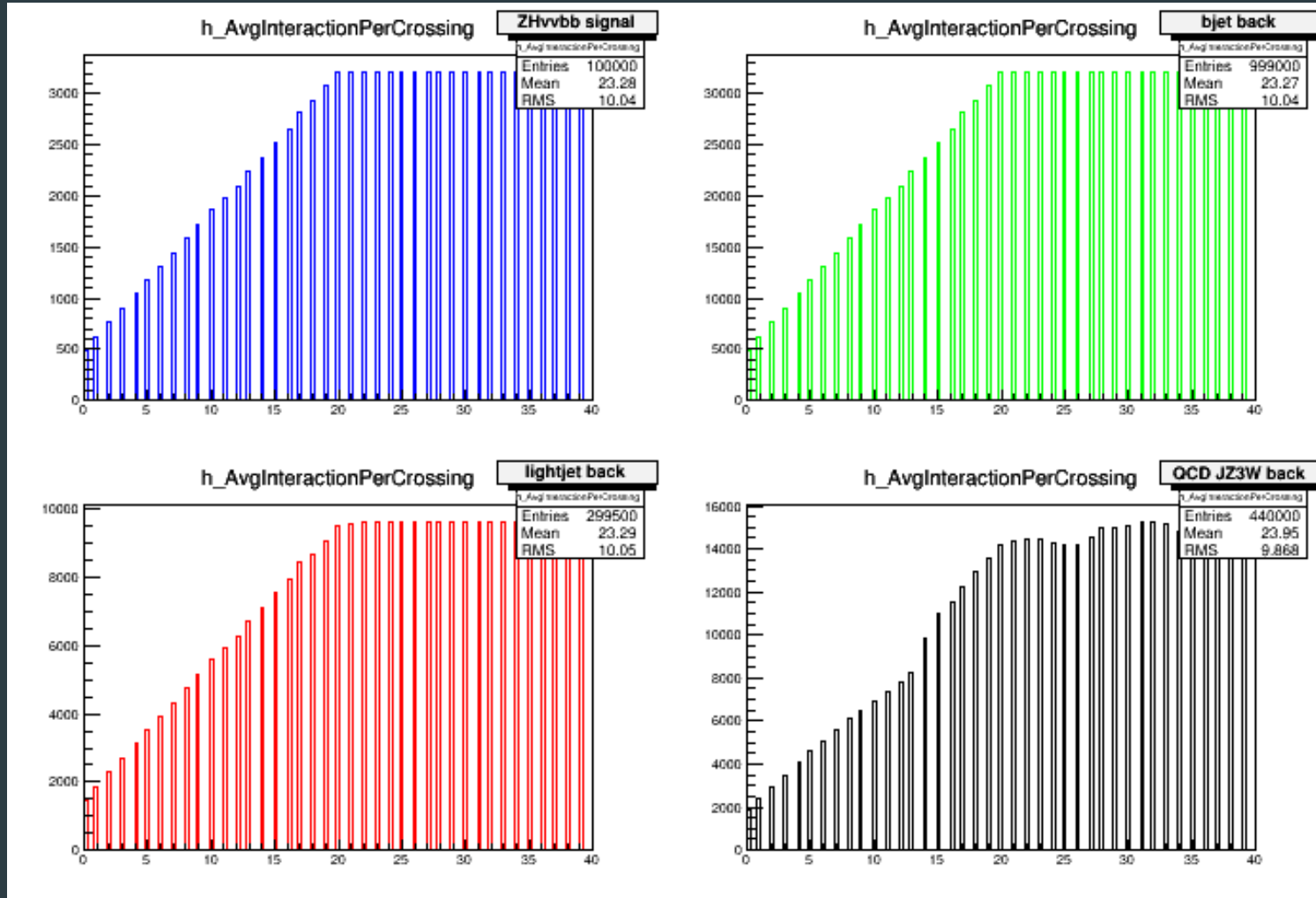
Run1Plots: MPT in different NPV (with cut MET>120GeV) (loose selection)



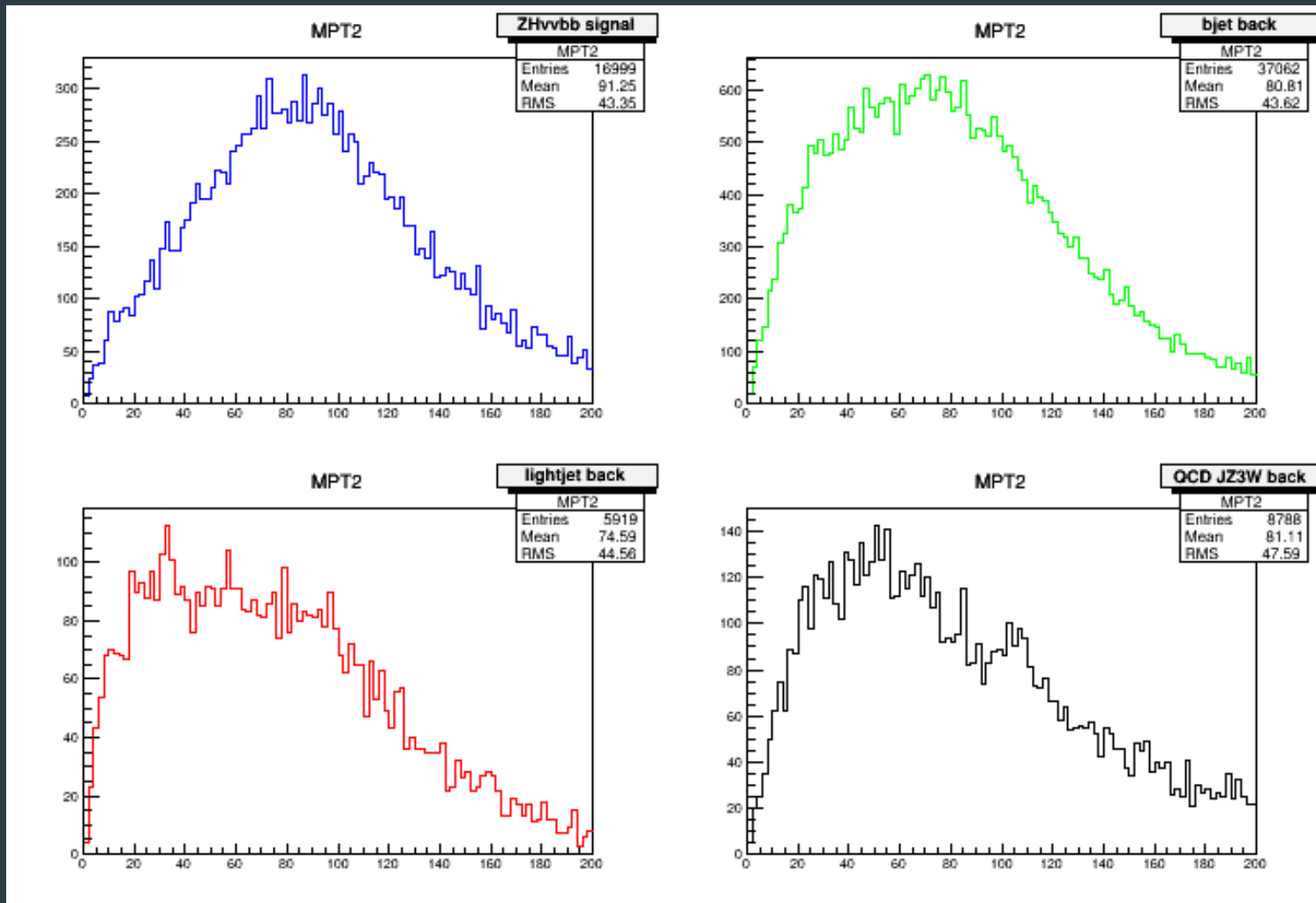
Run 2: Actual Interaction Per Crossing



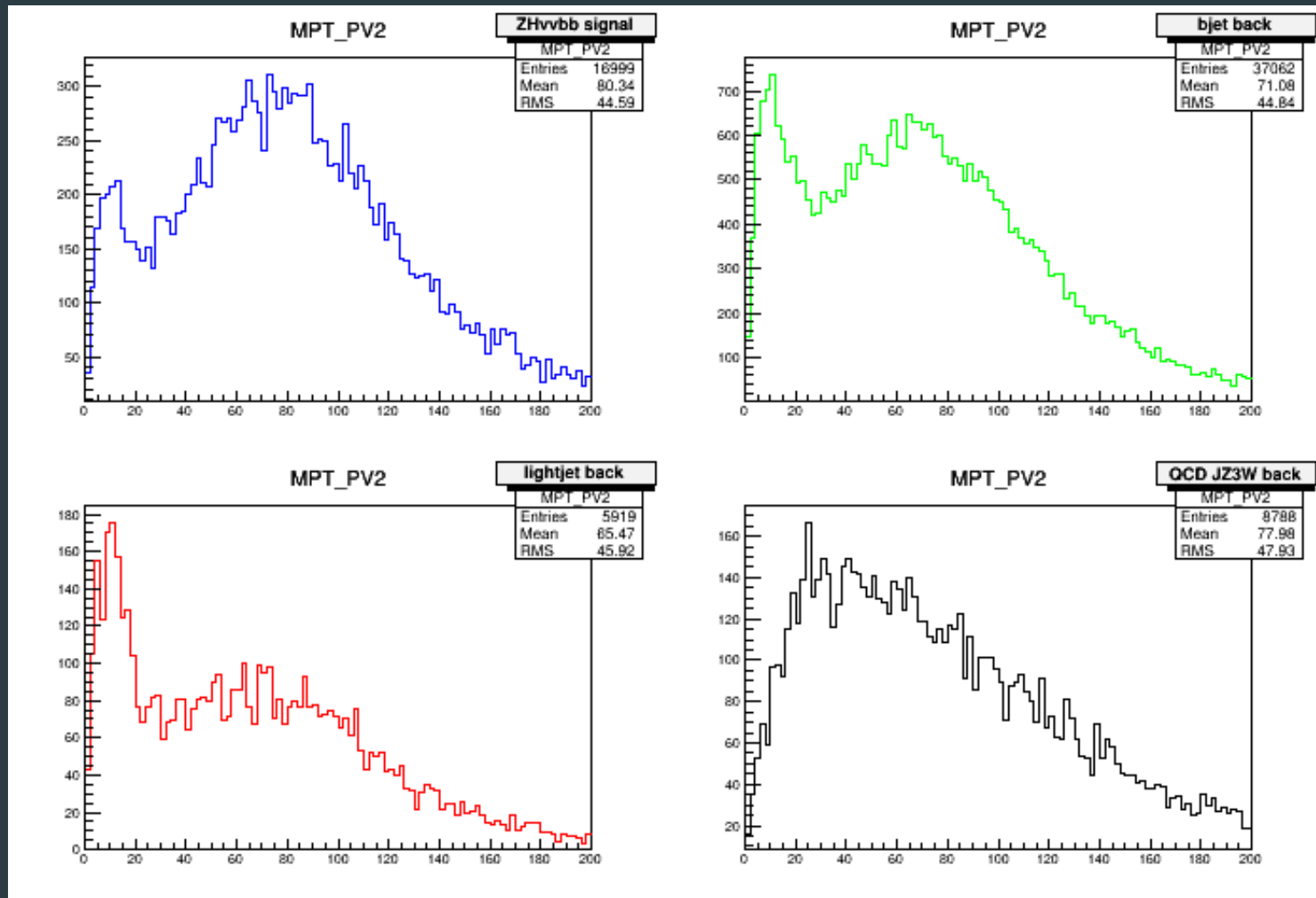
Run2: Average Interaction Per Crossing



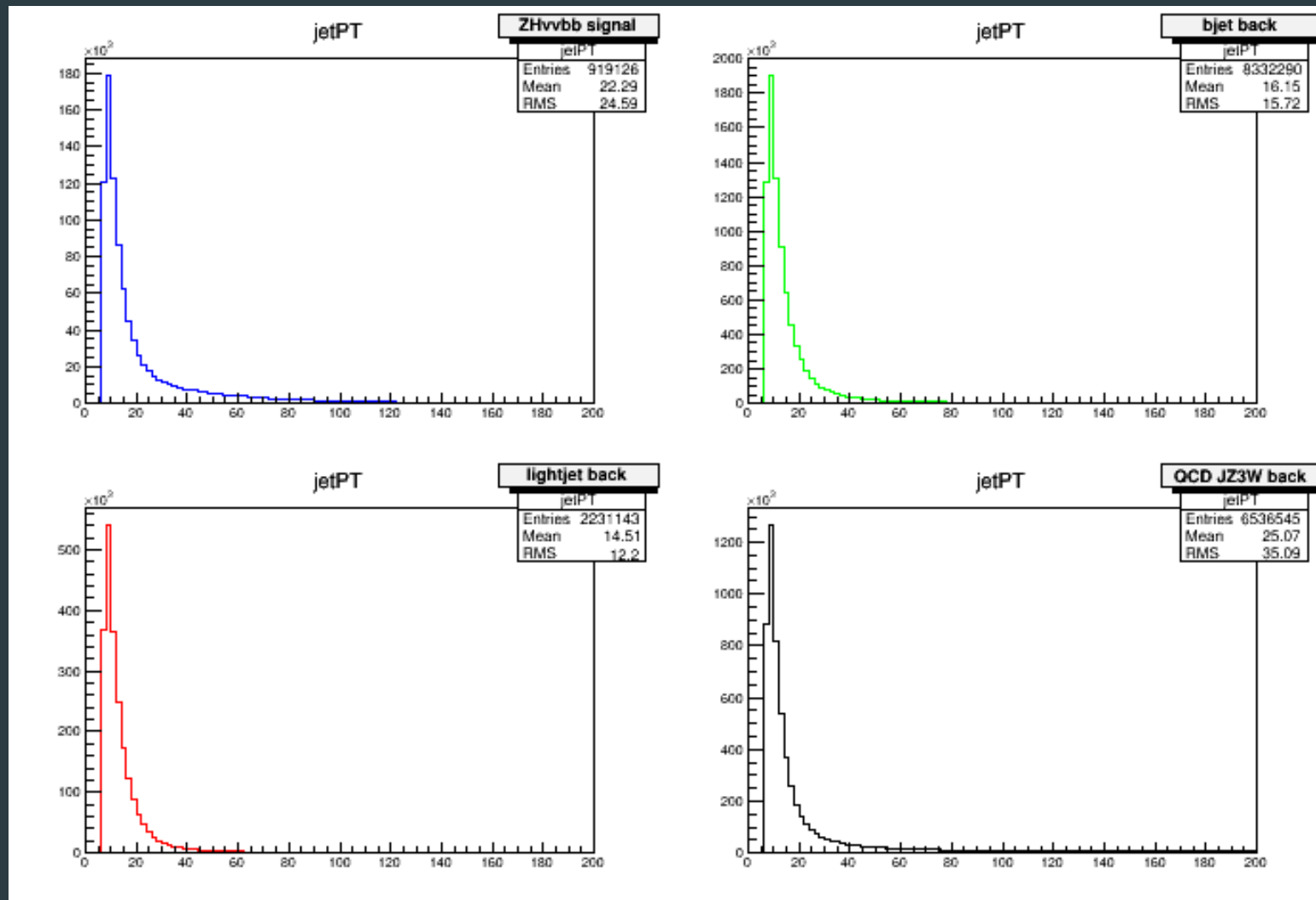
Run2: MPT2



Run2: MPT_PV2



Run2: JetPT



Run2: Nvertex (If Ntrack < 3)

