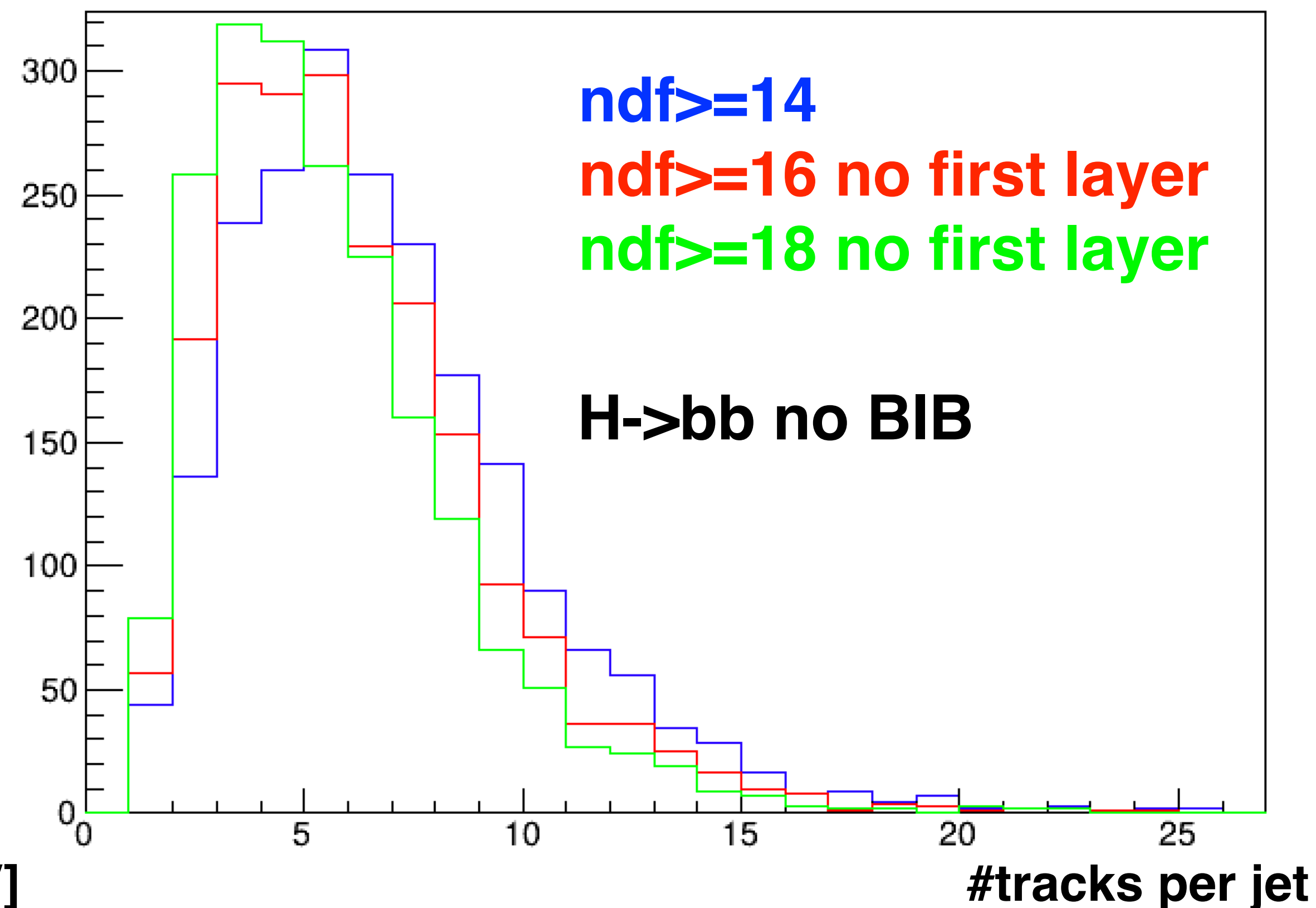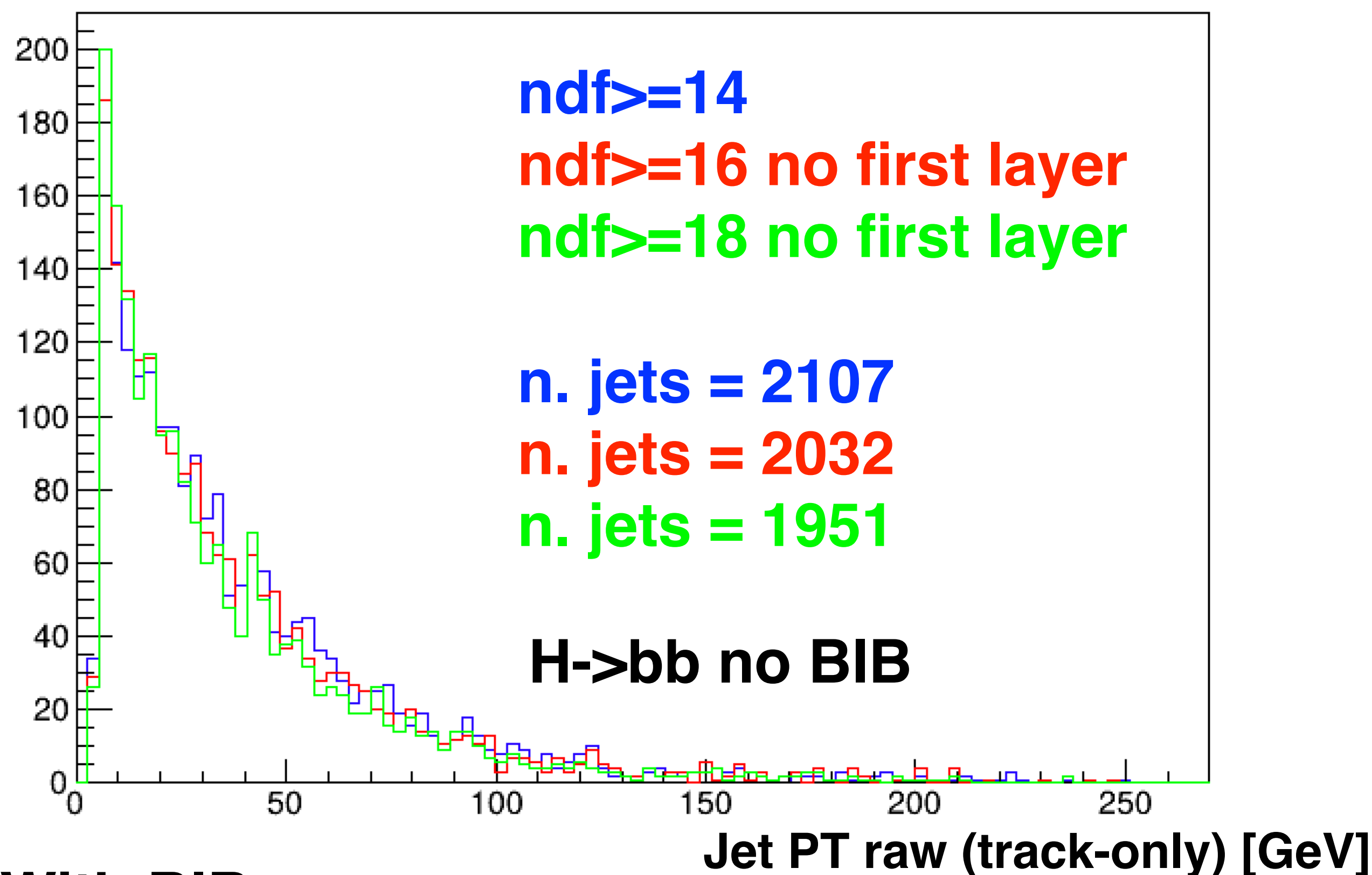# Jet reconstruction and tagging with MUSIC detector

Lorenzo Sestini for the MUSIC team
INFN-Firenze

Physics and Detector simulation and MuCol WP2 meeting, 28/1/2025

Jet reconstruction: flow

- Track reconstruction and selection (ACTS + custom processor for filtering)

- Calorimeter hits selection and clustering (custom DDCaloDigi + PandoraPFA)

- Particle Flow (PandoraPFA)

- Jet clustering with kt R=0.5 (FastJet)

- Fake jet removal (analysis with ROOT)

- Jet direction correction (analysis with ROOT)

- Jet PT correction (analysis with ROOT)

- Primary/Secondary vertex reconstruction (LCFIPlus)

- Jet tagging (analysis with ROOT)

ndf>=14
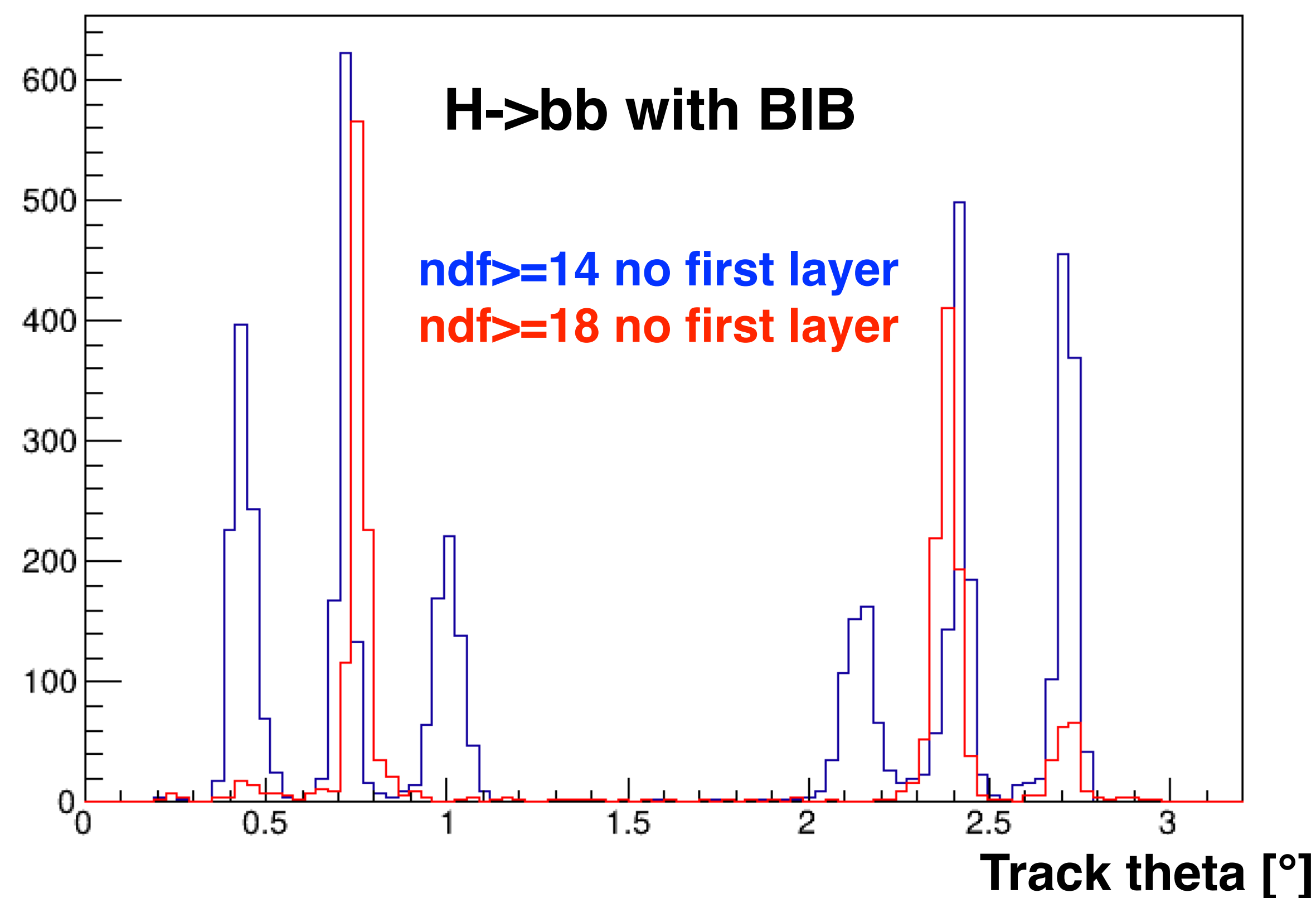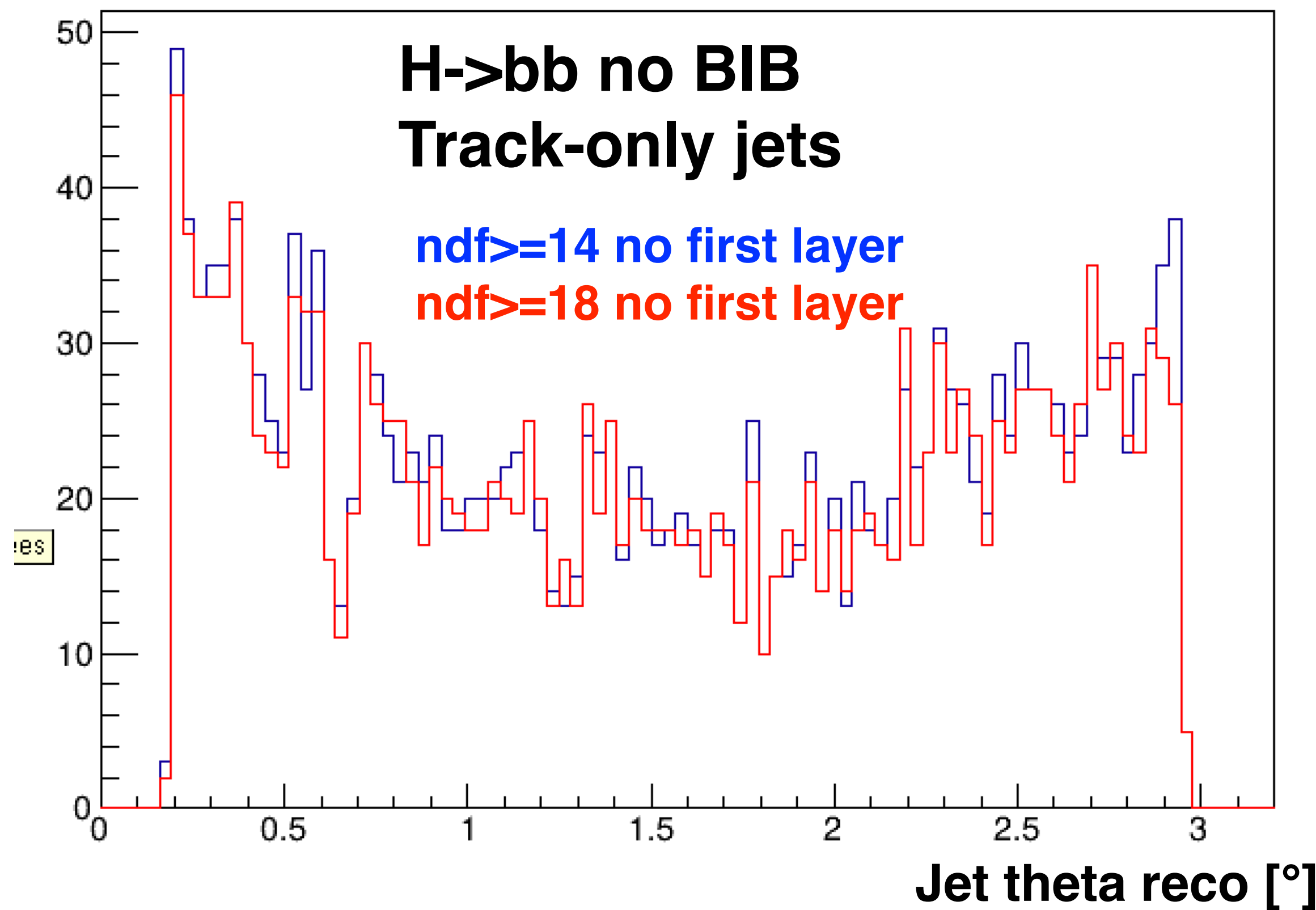ndf>=16 no first layer
ndf>=18 no first layer

n. jets = 2107
n. jets = 2032
n. jets = 1951

H->bb no BIB

Jet PT raw (track-only) [GeV]

ndf>=14
ndf>=16 no first layer
ndf>=18 no first layer

H->bb no BIB

#tracks per jet

With BIB:
ndf>=14: 154k tracks per event
ndf>=16 no first layer: 35k tracks per event
ndf>=18 no first layer: 4.6k tracks per event

ndf= number of degree of freedom in the track fit

Track selection

H->bb no BIB
Track-only jets

ndf>=14 no first layer
ndf>=18 no first layer

Jet theta reco [°]

H->bb with BIB

ndf>=14 no first layer
ndf>=18 no first layer
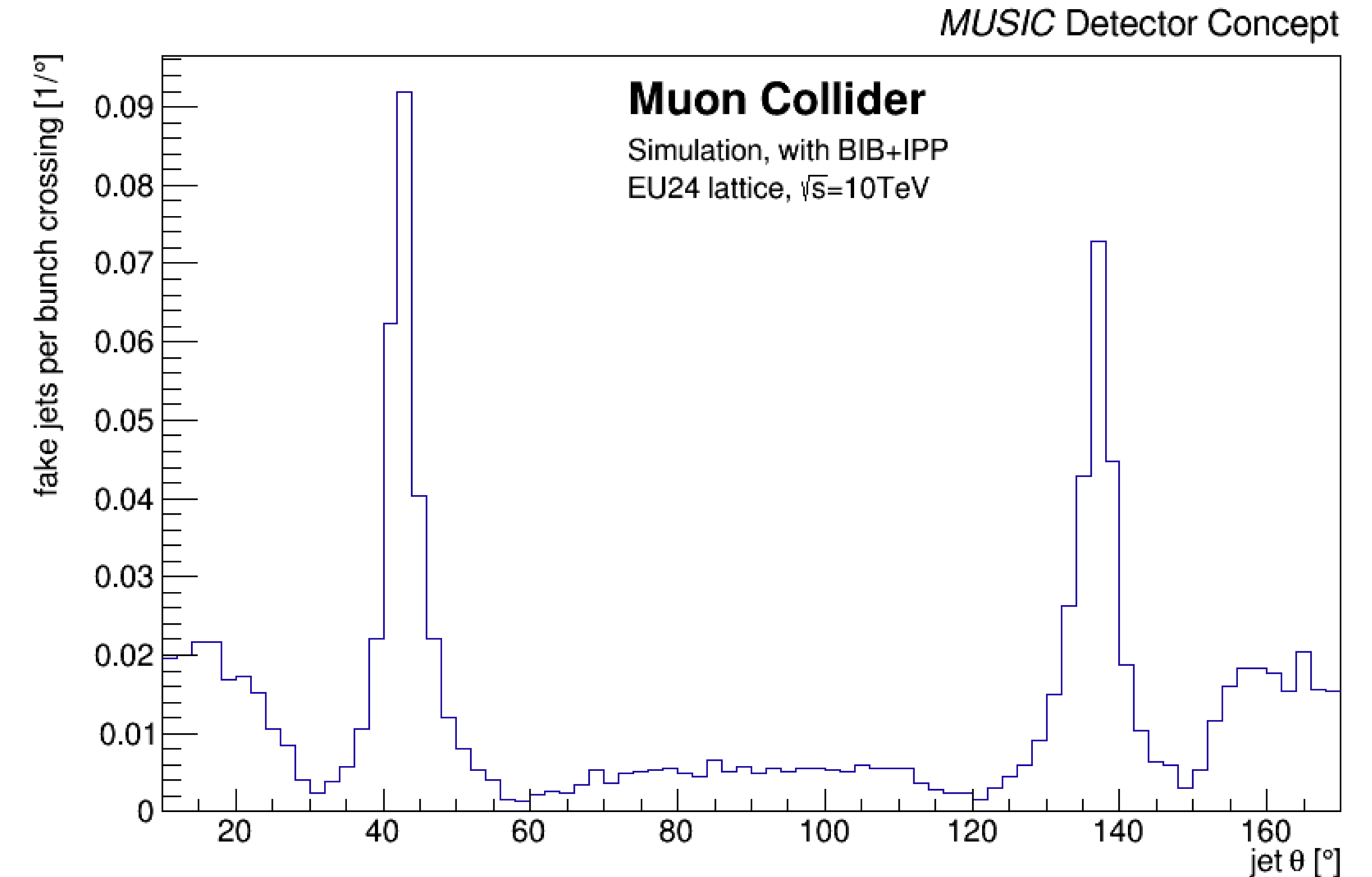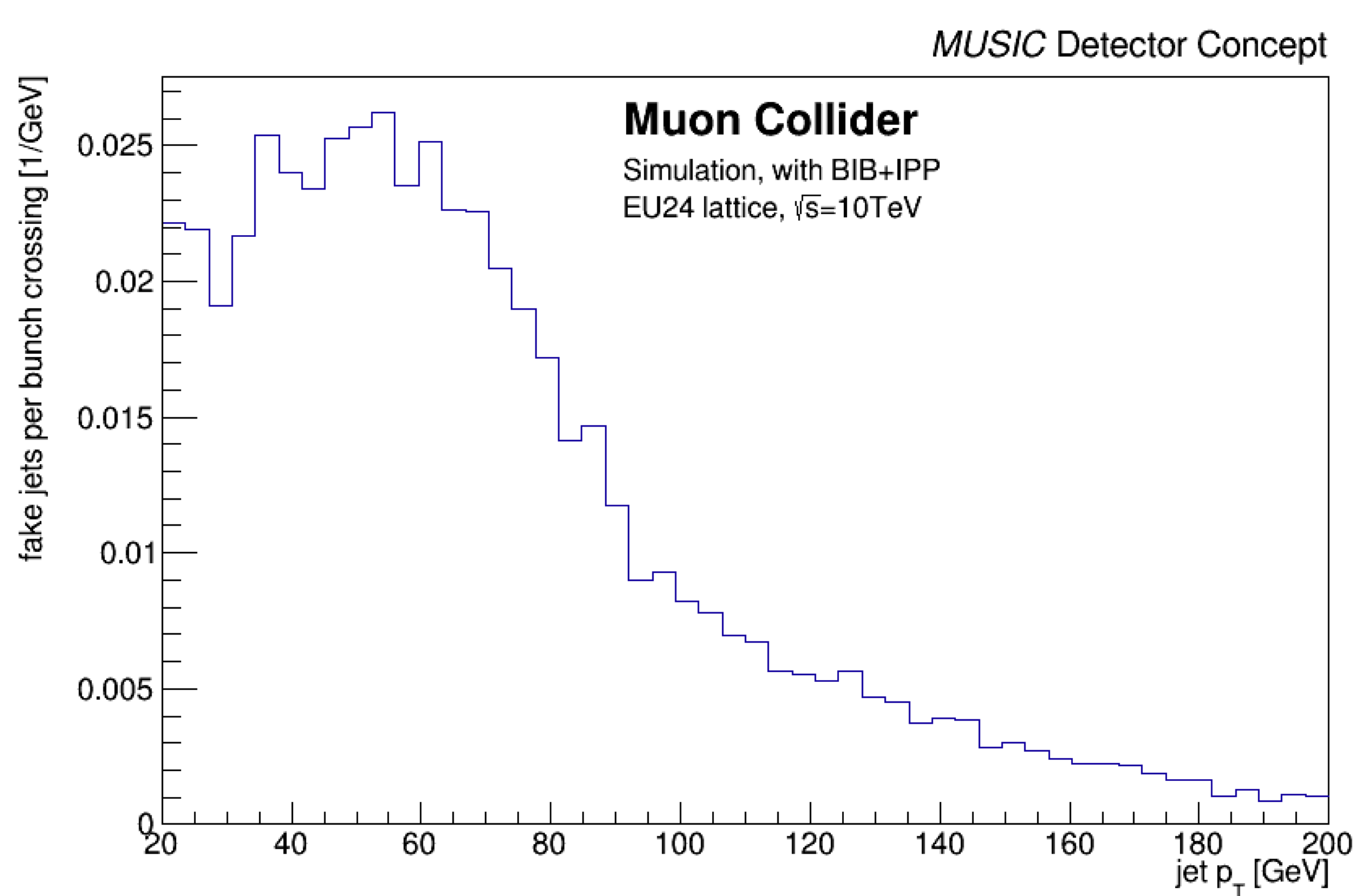
Track theta [°]

- The track filter does not change significantly the jet kinematic and efficiency, by removing most of the BIB combinatorial tracks

- The filter cannot remove tracks in the barrel-endcap transition region
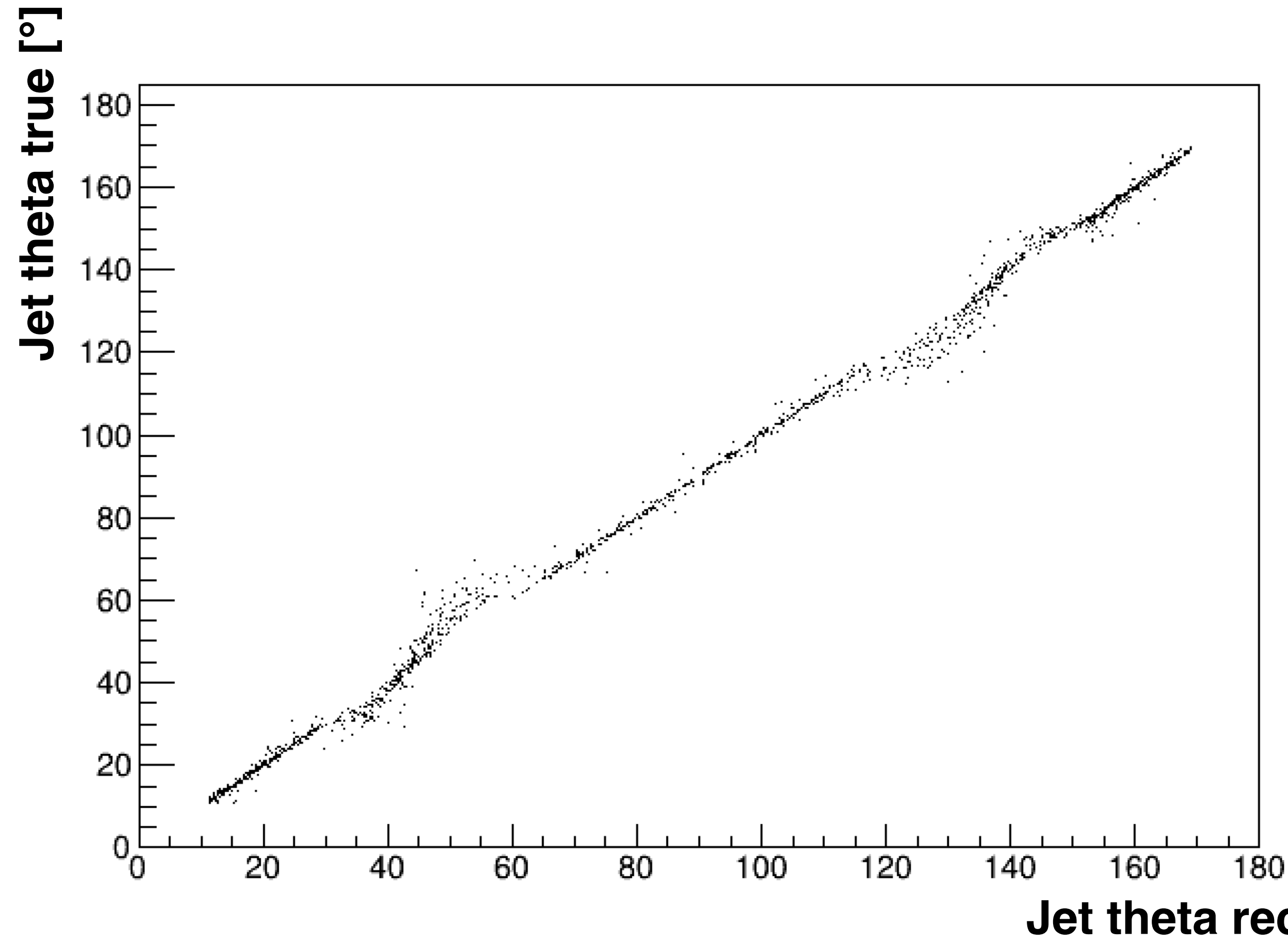
Fake jets removal
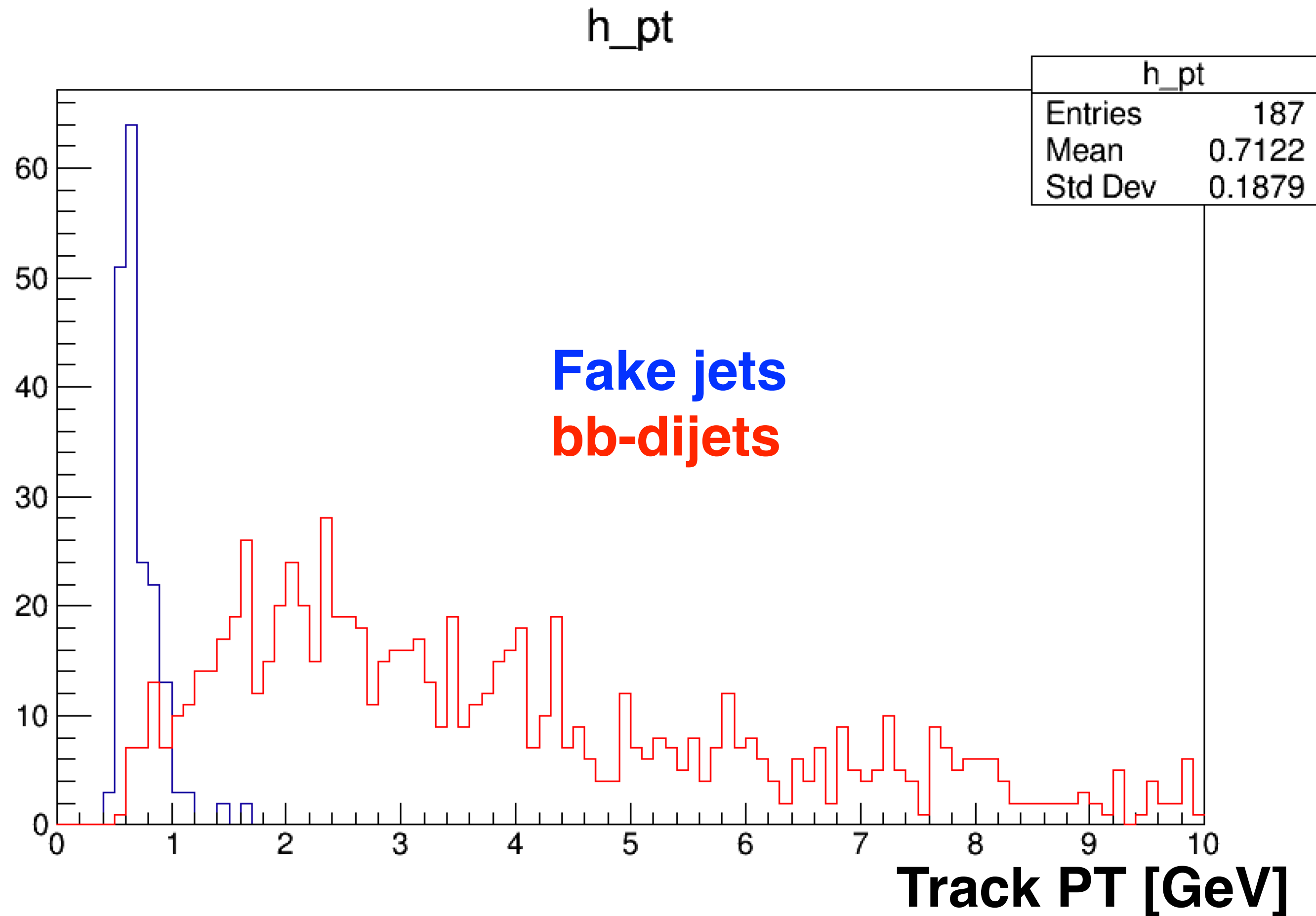
Fake jets

On average 1.96 fake jets per bunch crossing

Can be further removed with analysis requirements, jet tagging, stronger identification cuts (but less efficiency) etc.
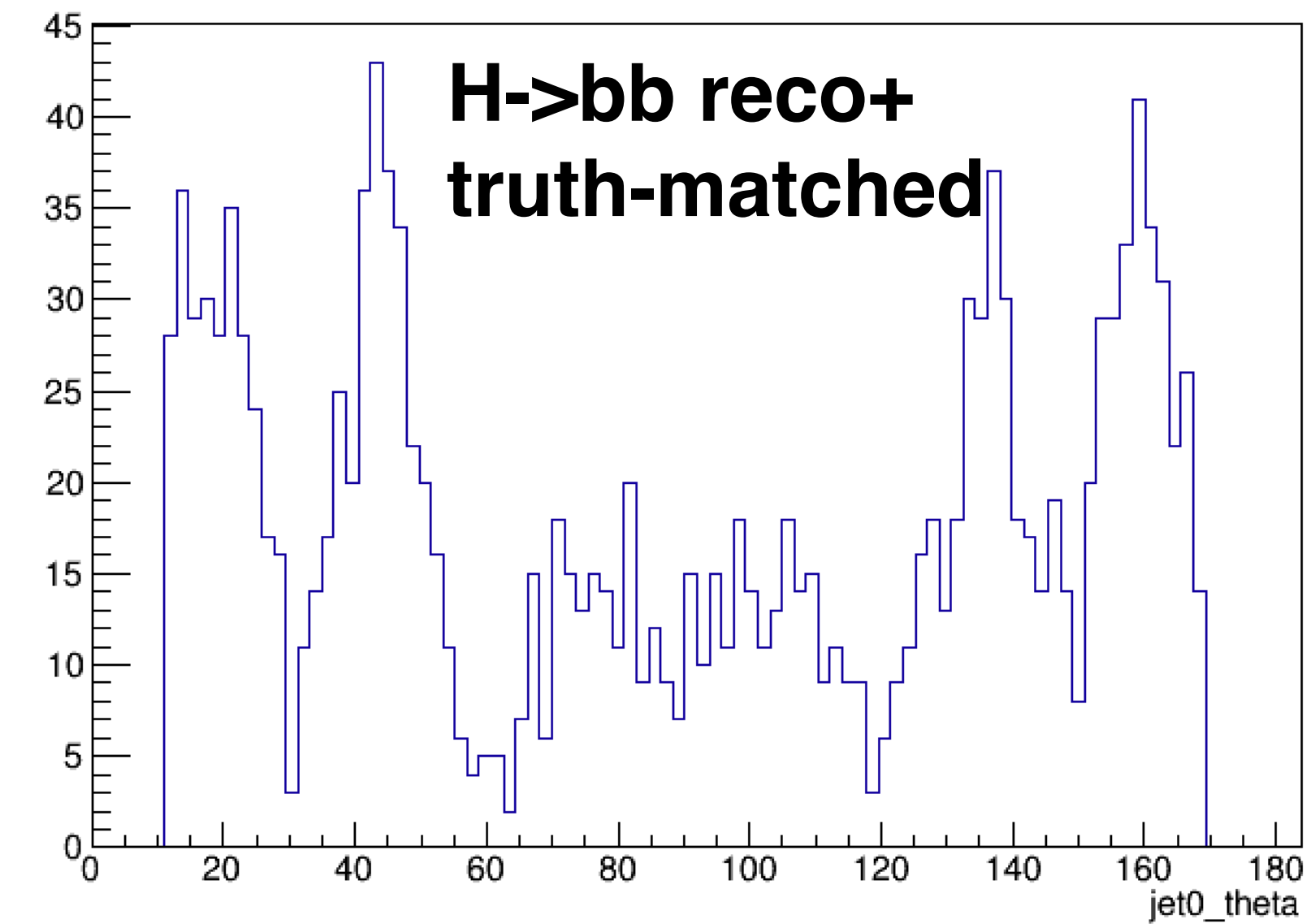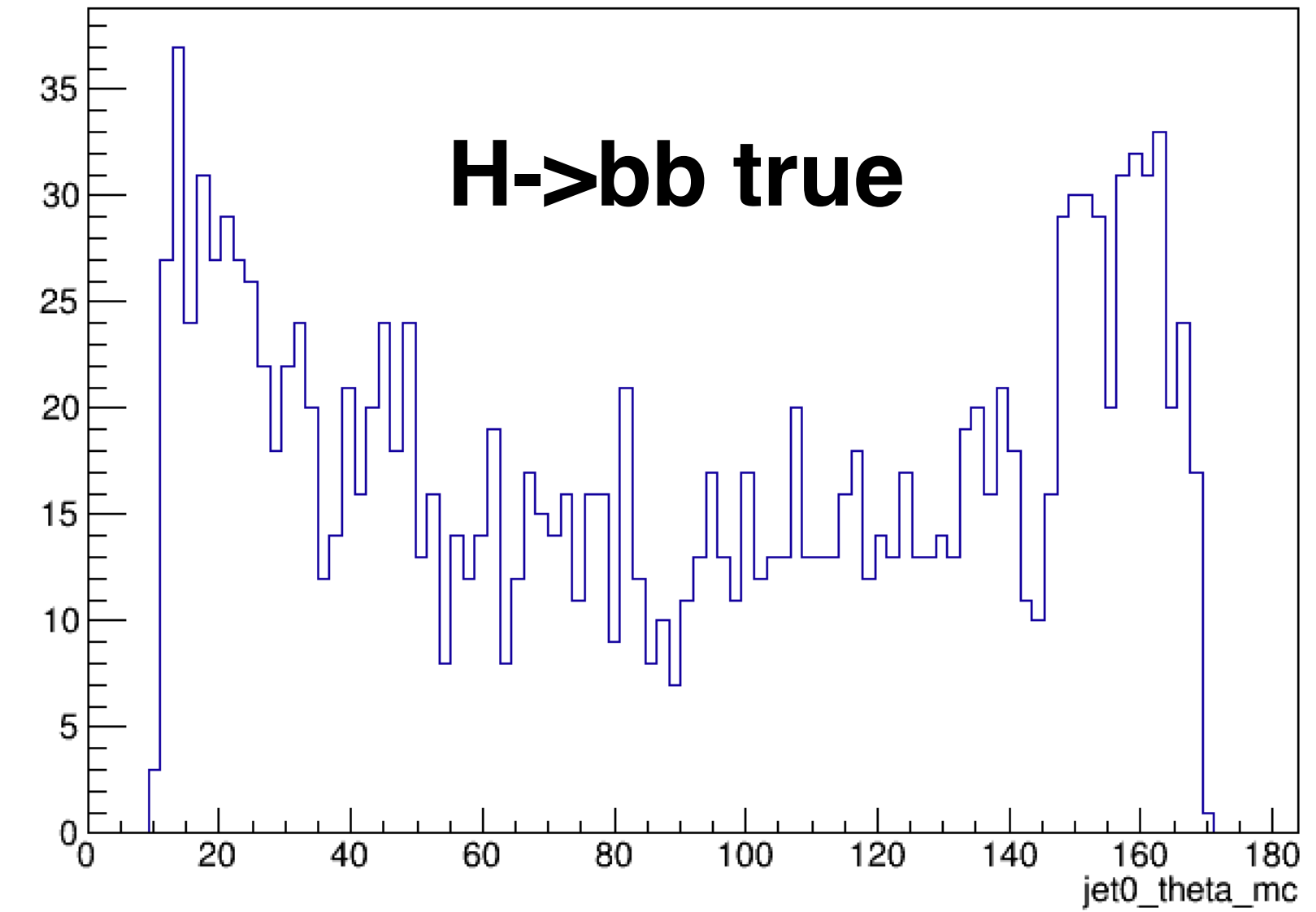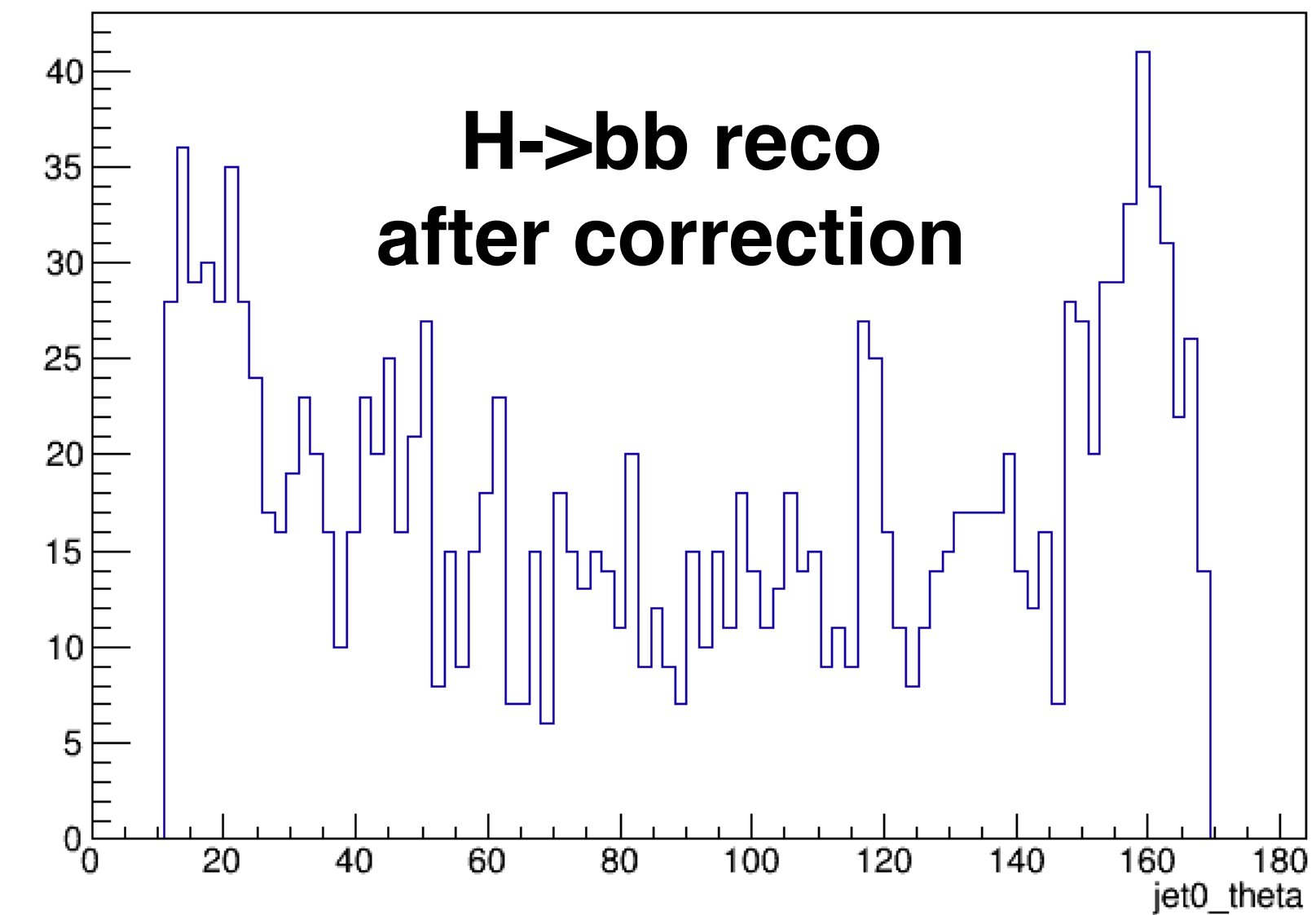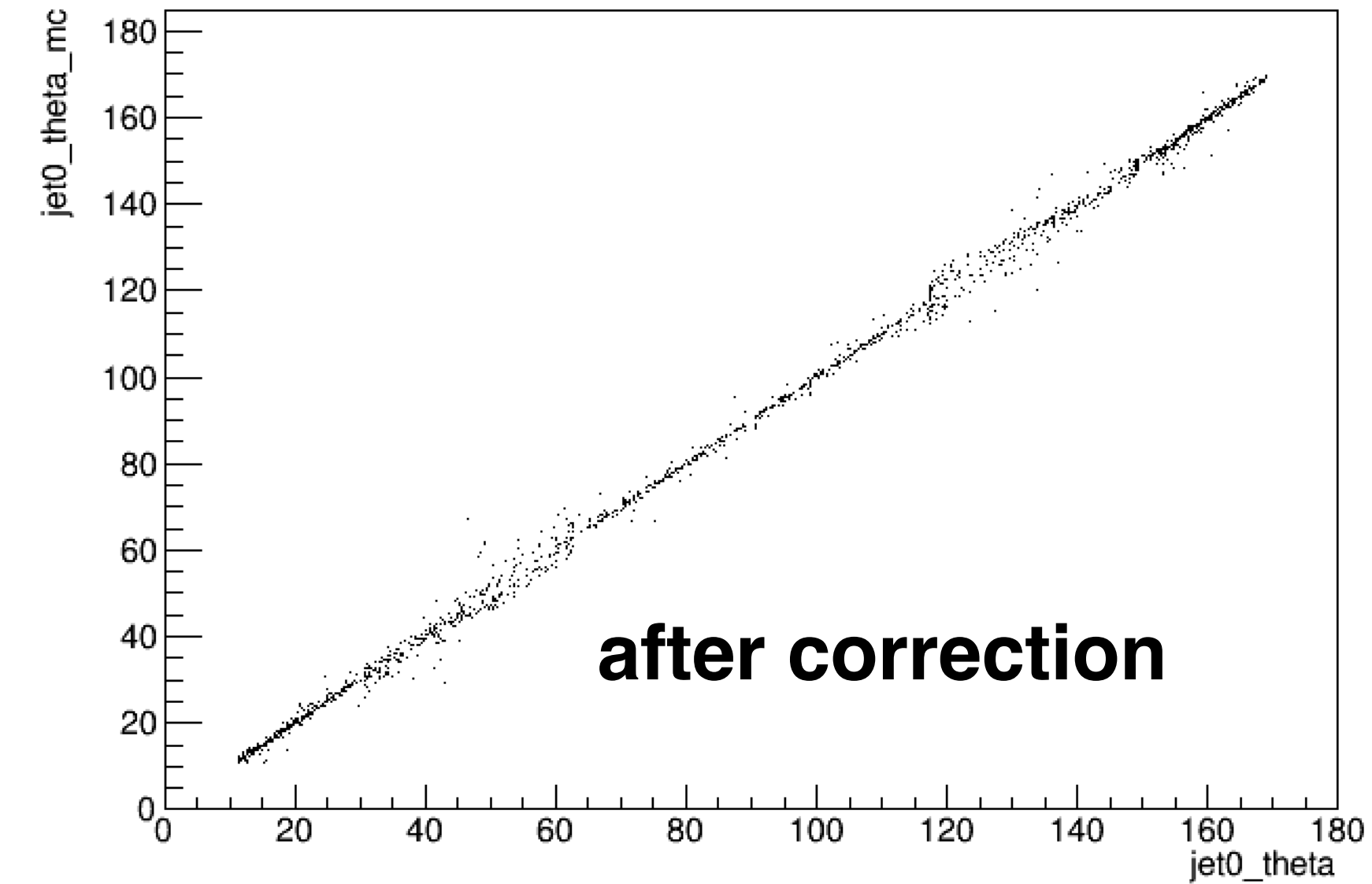
Jet direction

H->bb true

H->bb reco+
truth-matched

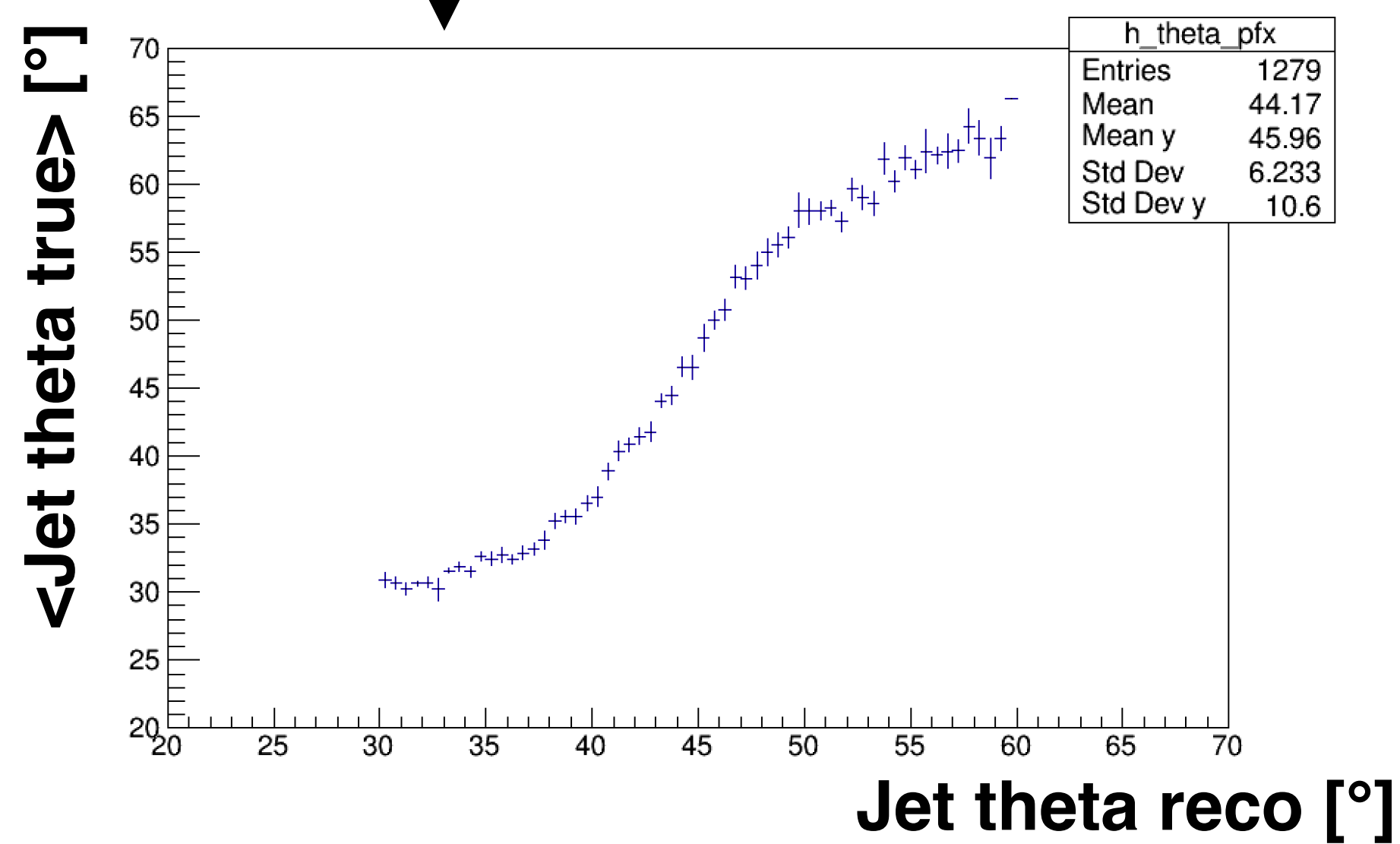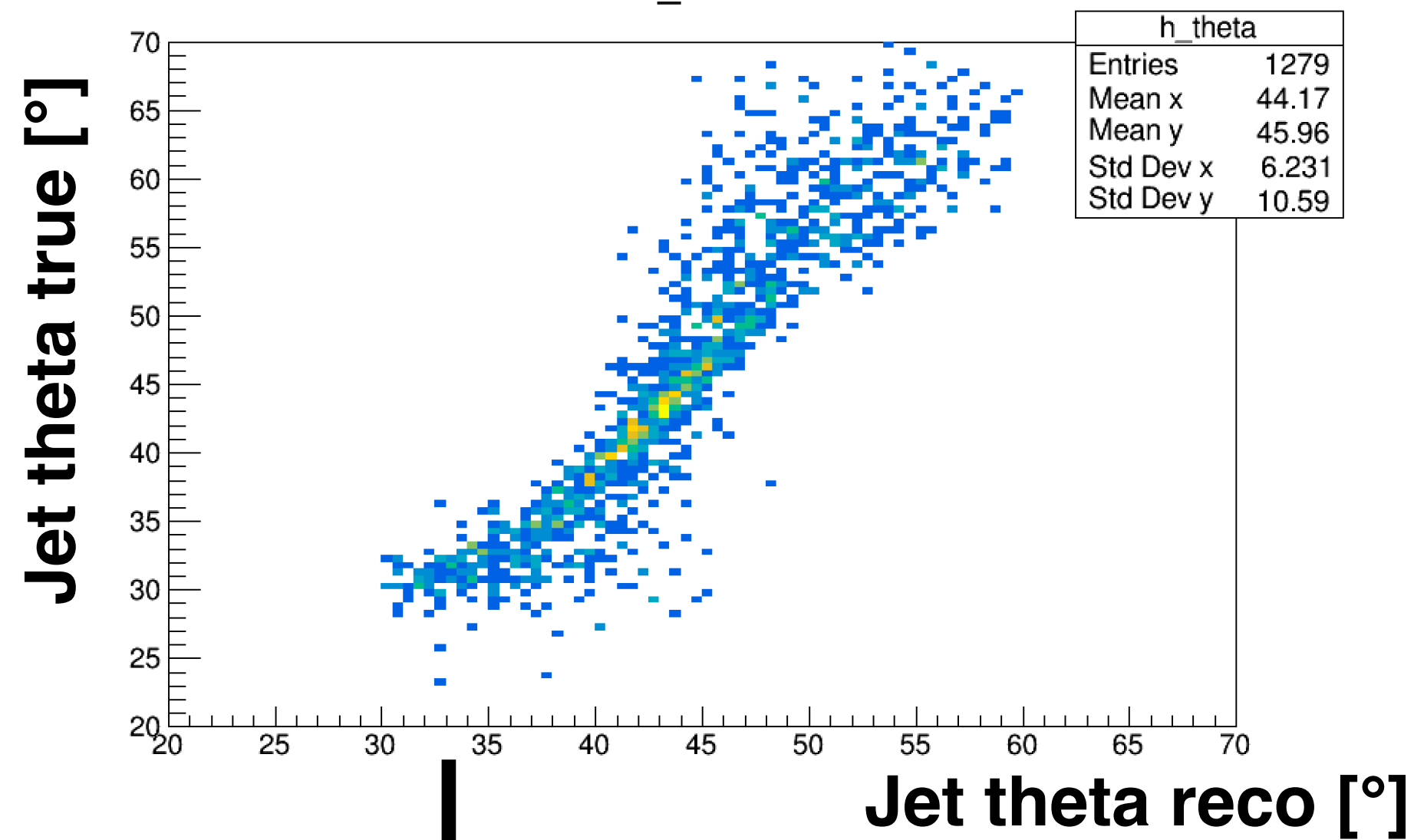**Jet direction distorsion barrel-endcap transition regions:**
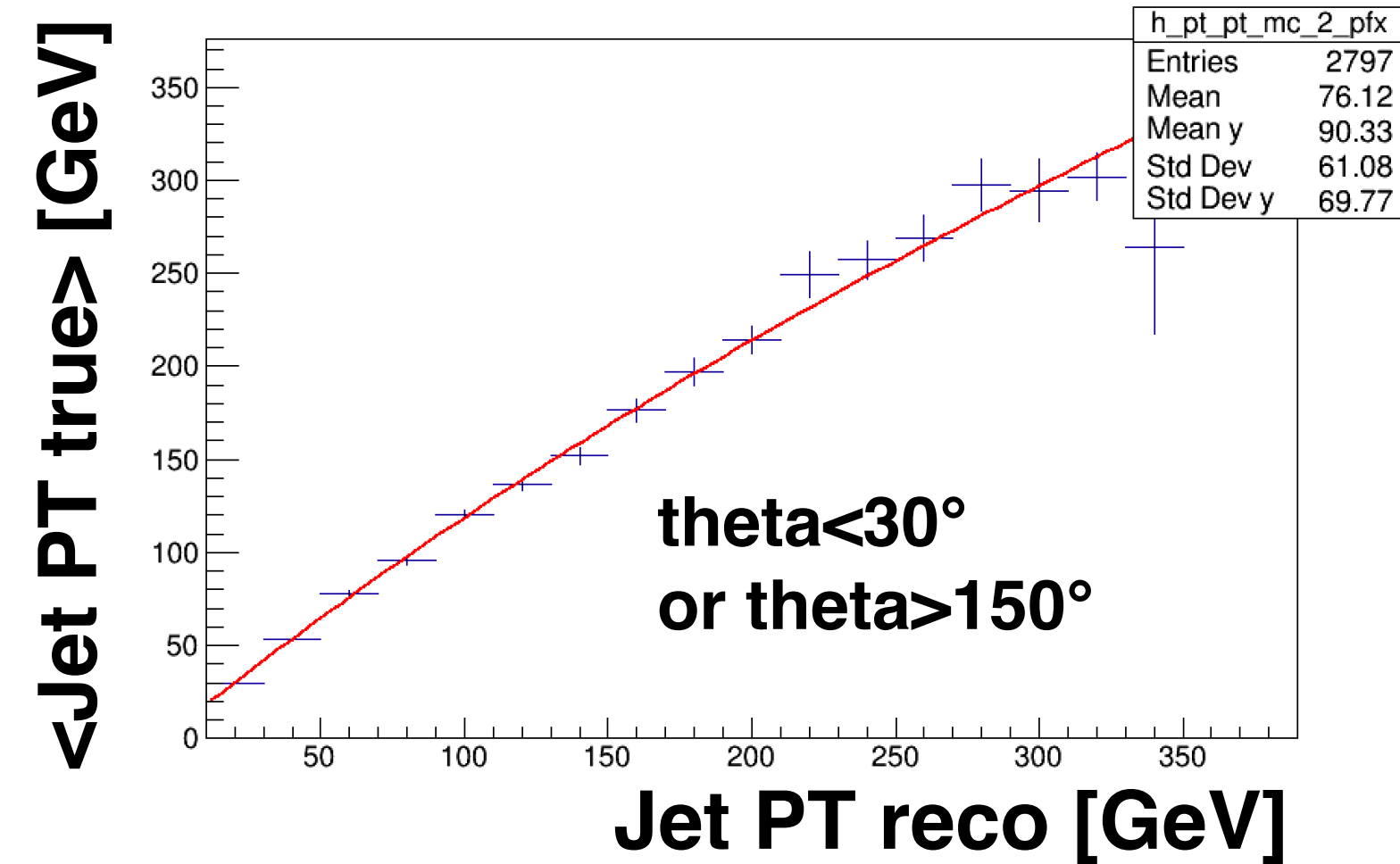**30°<theta<60°**
120°<theta<150°

Jet direction correction

h_theta	
Entries	1279
Mean x	44.17
Mean y	45.96
Std Dev x	6.231
Std Dev y	10.59

h_theta_pfx	
Entries	1279
Mean	44.17
Mean y	45.96
Std Dev	6.233
Std Dev y	10.6

after correction

**H->bb reco
after correction**

Jet PT correction

bb-dijet

h_pt_pt_mc	
Entries	12726
Mean x	81.46
Mean y	81.43
Std Dev x	58.77
Std Dev y	68.97

Jet PT true [GeV] / Jet PT reco [GeV]

h_pt_pt_mc_0_pfx	
Entries	4624
Mean	65.39
Mean y	82.67
Std Dev	51.02
Std Dev y	68.96

60°<theta<120°

<Jet PT true> [GeV] / Jet PT reco [GeV]

h_pt_pt_mc_1_pfx	
Entries	4443
Mean	106
Mean y	77.11
Std Dev	55.09
Std Dev y	65.53

30°<theta<60°
or 120°<theta<150°

<Jet PT true> [GeV] / Jet PT reco [GeV]

h_pt_pt_mc_2_pfx	
Entries	2797
Mean	76.12
Mean y	90.33
Std Dev	61.08
Std Dev y	69.77

theta<30°
or theta>150°

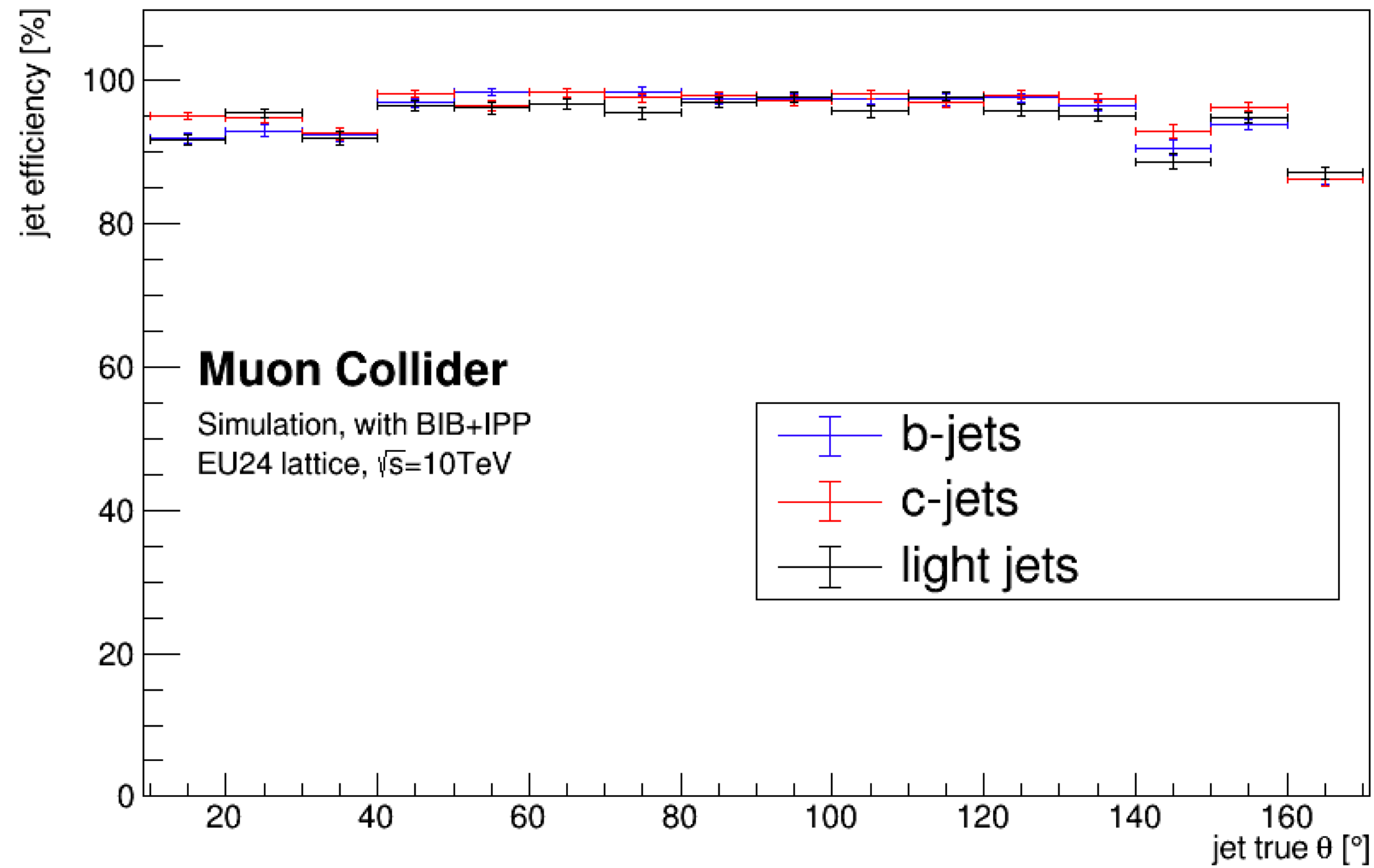<Jet PT true> [GeV] / Jet PT reco [GeV]

Evaluated on dijet samples
Flavour-specific correction (b, c and light)

Jet efficiency
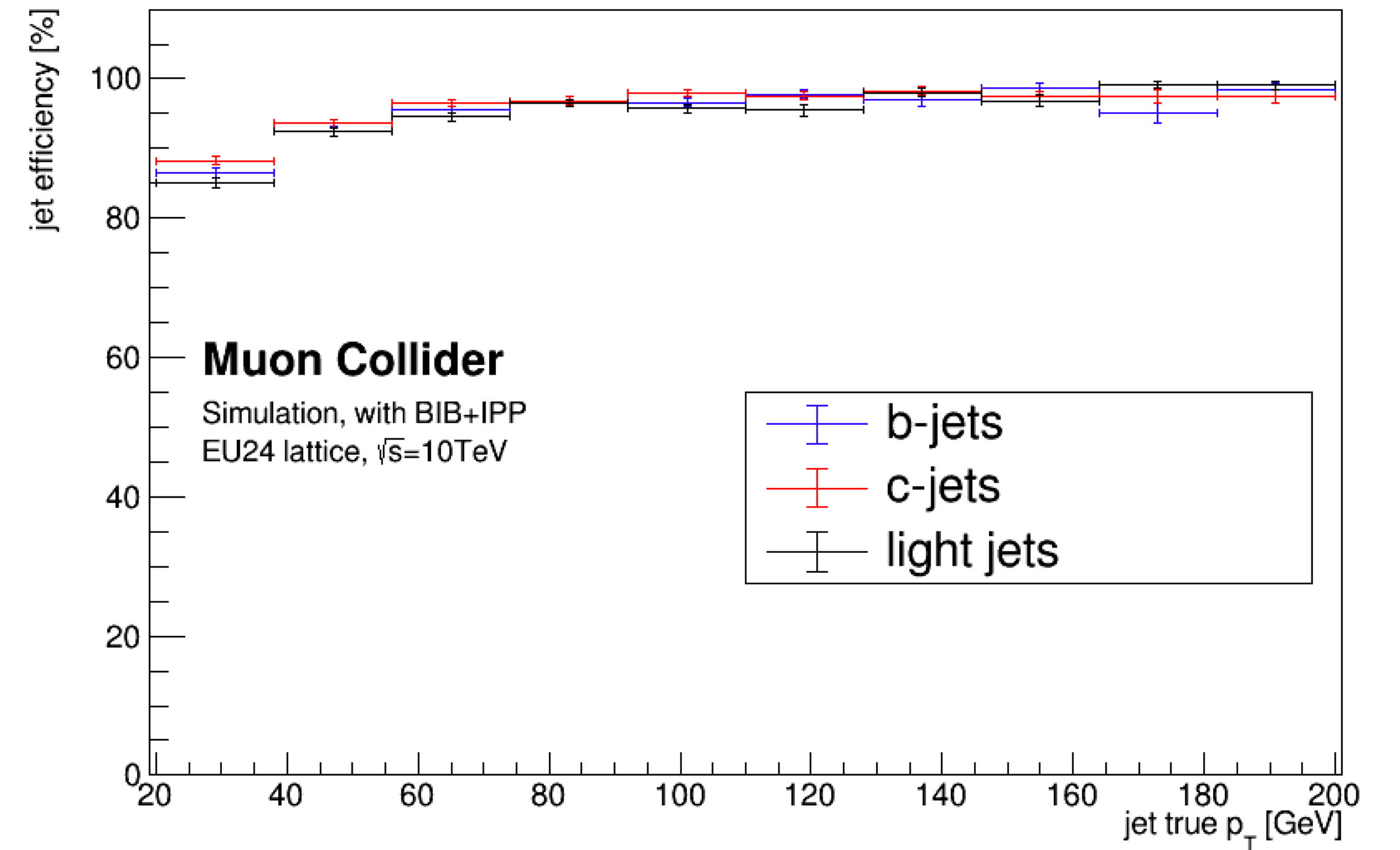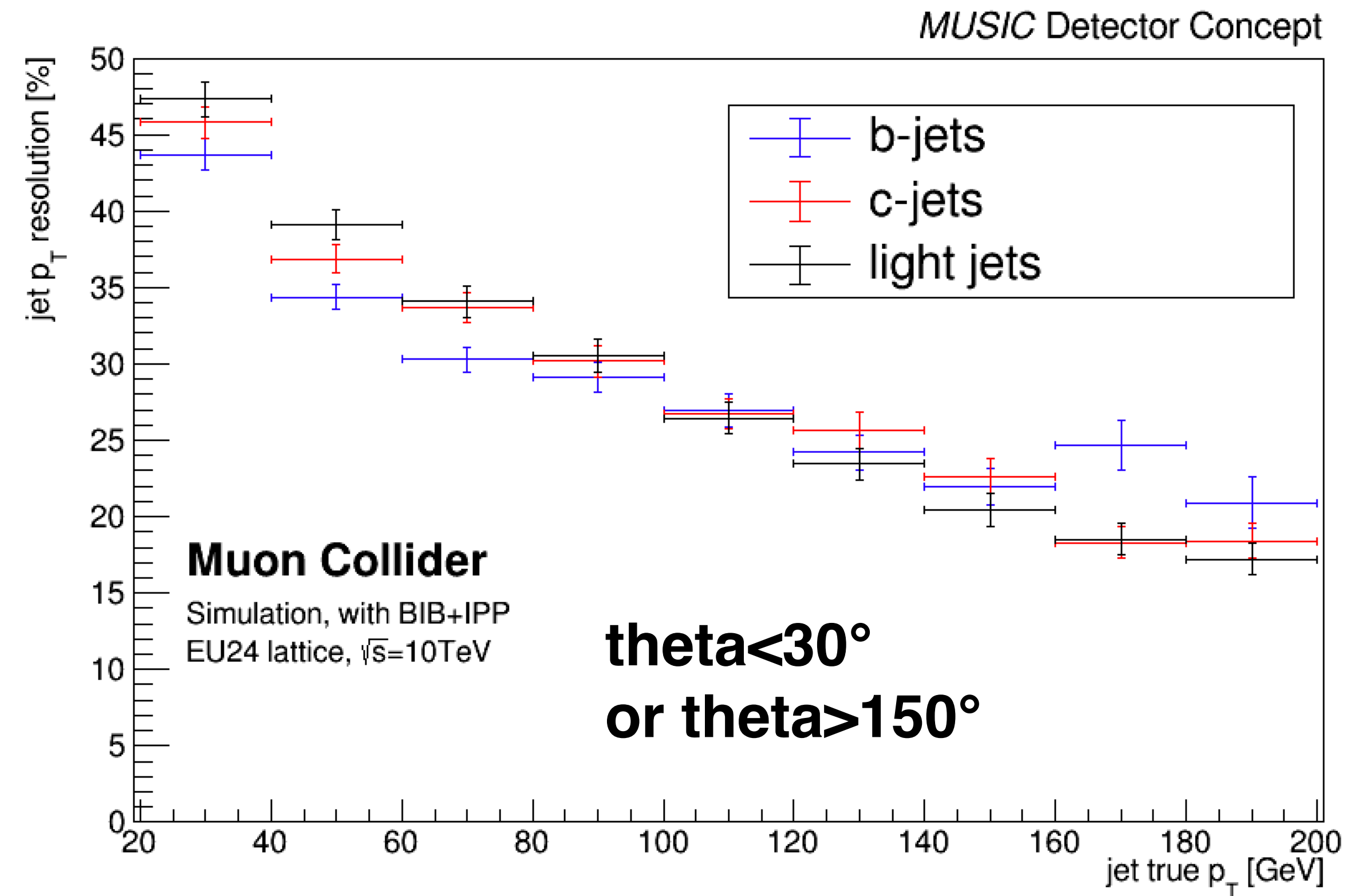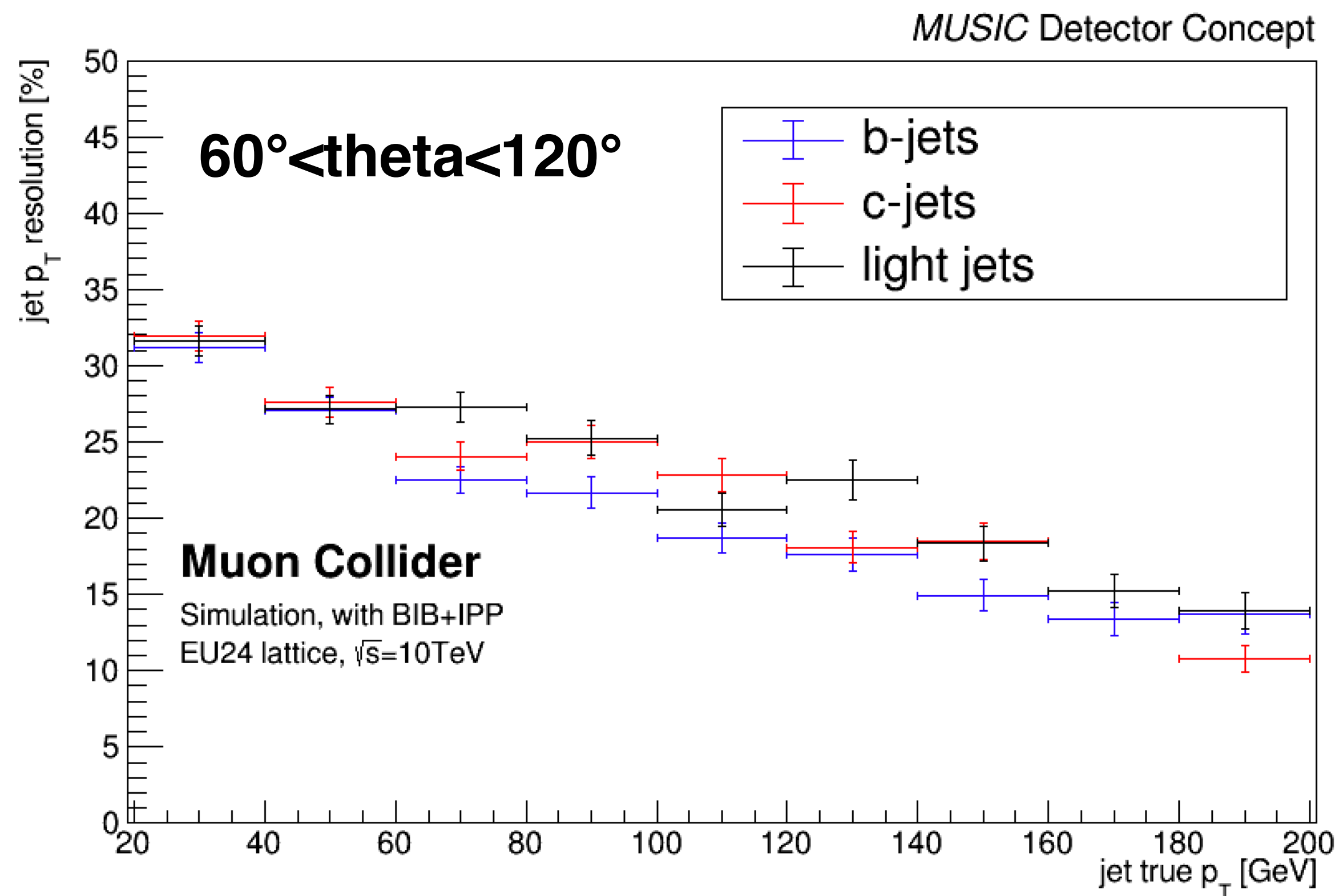
Jet PT resolution
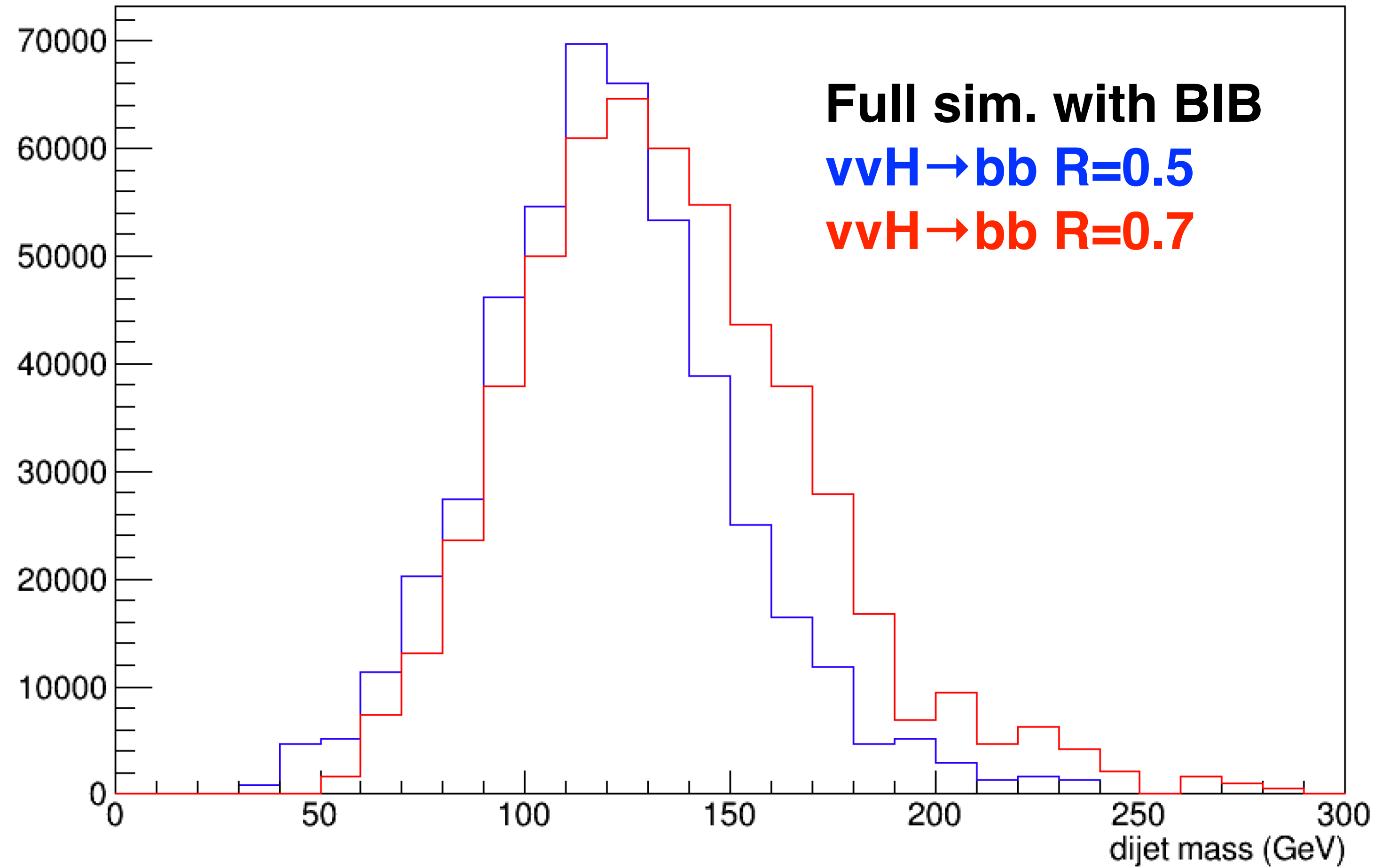

PT resolution = width of the distribution $(PT^{reco} - PT^{true})/PT^{true}$

Higgs mass: jet radius

Full sim. with BIB
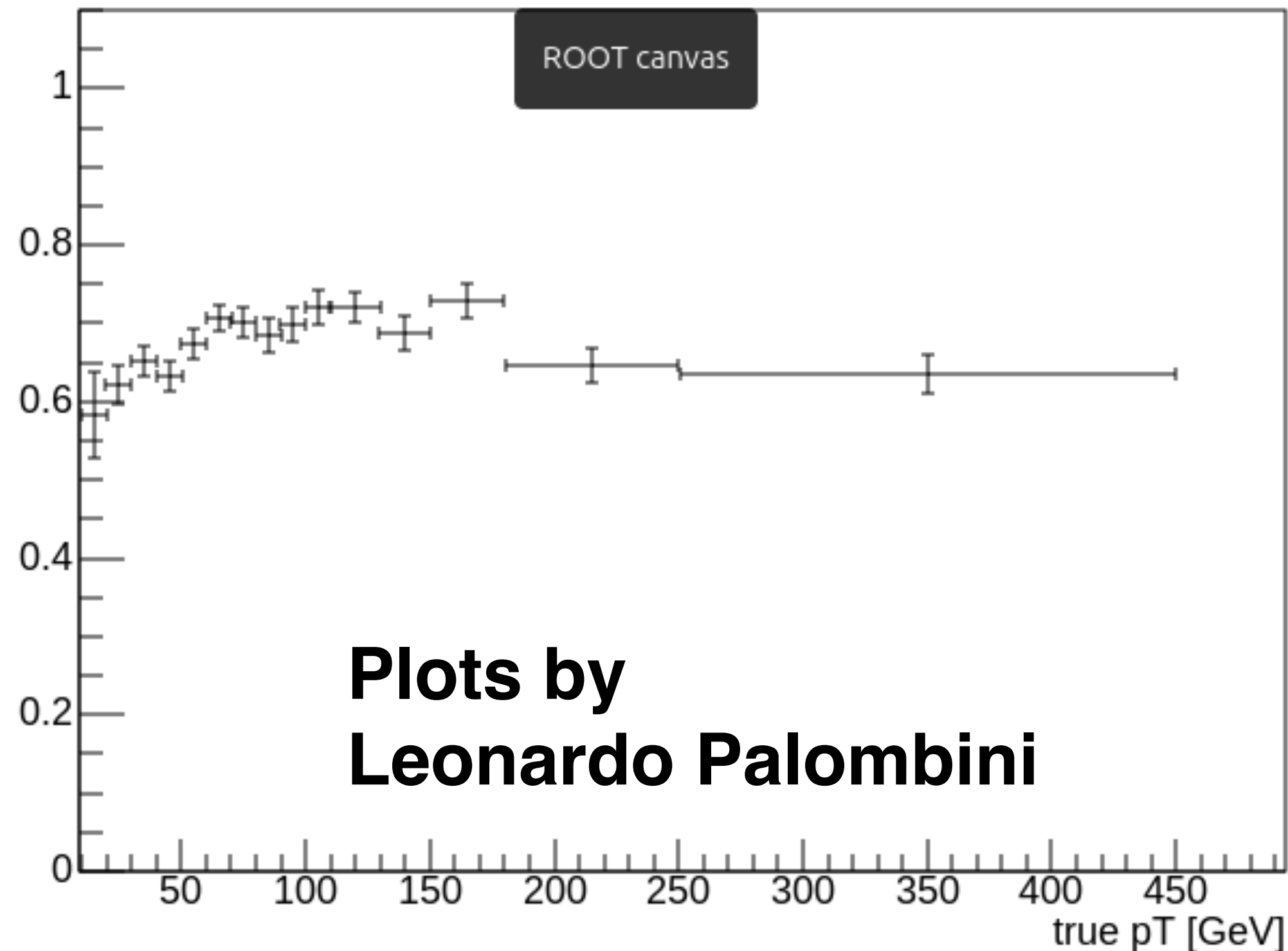vvH→bb R=0.5
vvH→bb R=0.7

Efficiency 8%
lower with R=0.7
wrt R=0.5

Higgs mass

vvH→bb
vvqq

Higgs mass peak resolution 29%
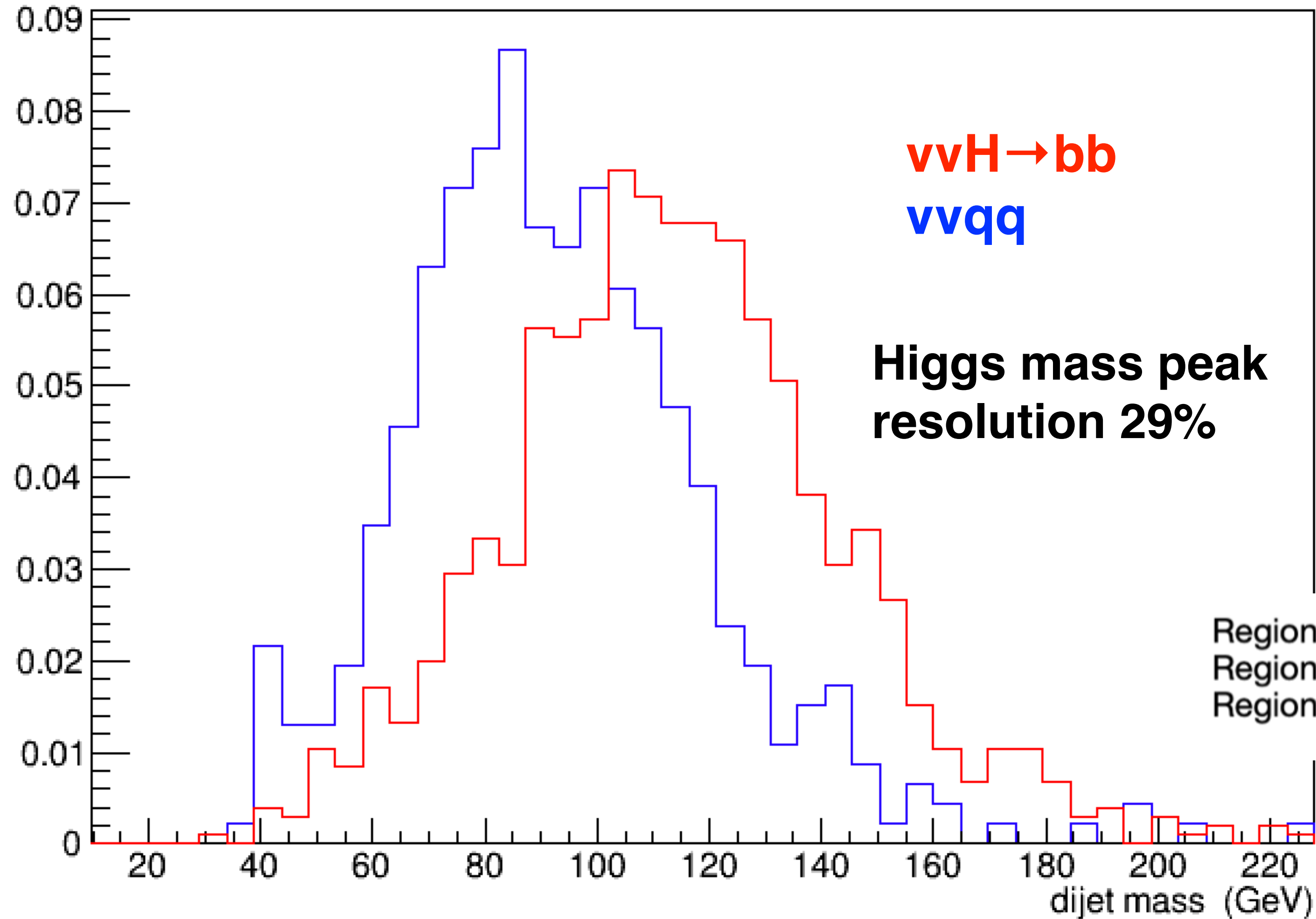
Jets region	H->bb mass resolution
0+0	17.7%
0+1	27.0%
0+2	22.8%
1+1	34.1%
1+2	38.1%
2+2	41.7%

Region 0 (central): 60<theta<120
Region 1 (barrel-endcap transition): 30<theta<60 or 120<theta<150
Region 2 (forward): theta<30 or theta>150

dijet mass (GeV)

Jet tagging

SVX efficiency vs true pT (>10 GeV) - no BIB

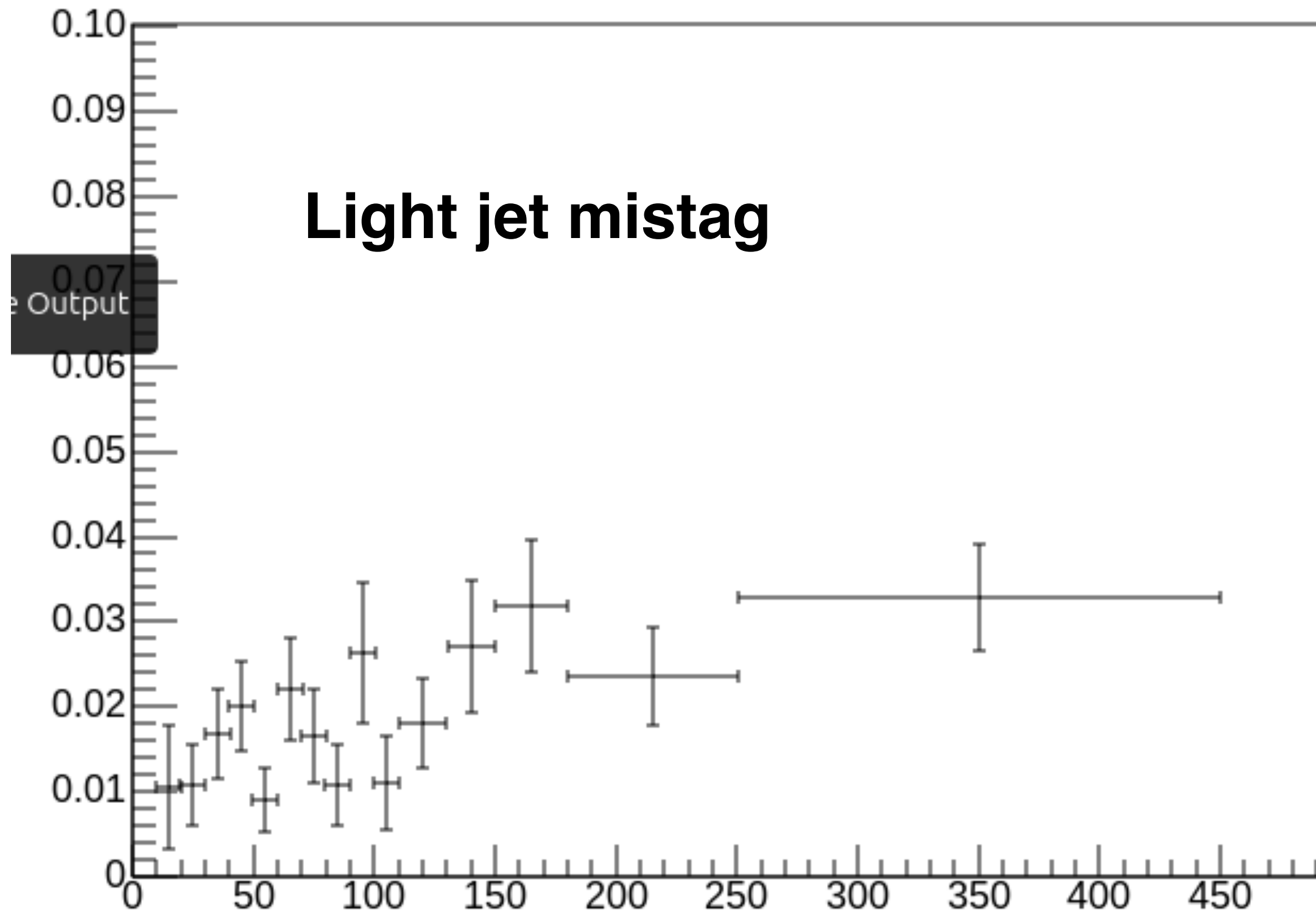SVX efficiency vs true η - no BIB

**Plots by
Leonardo Palombini**
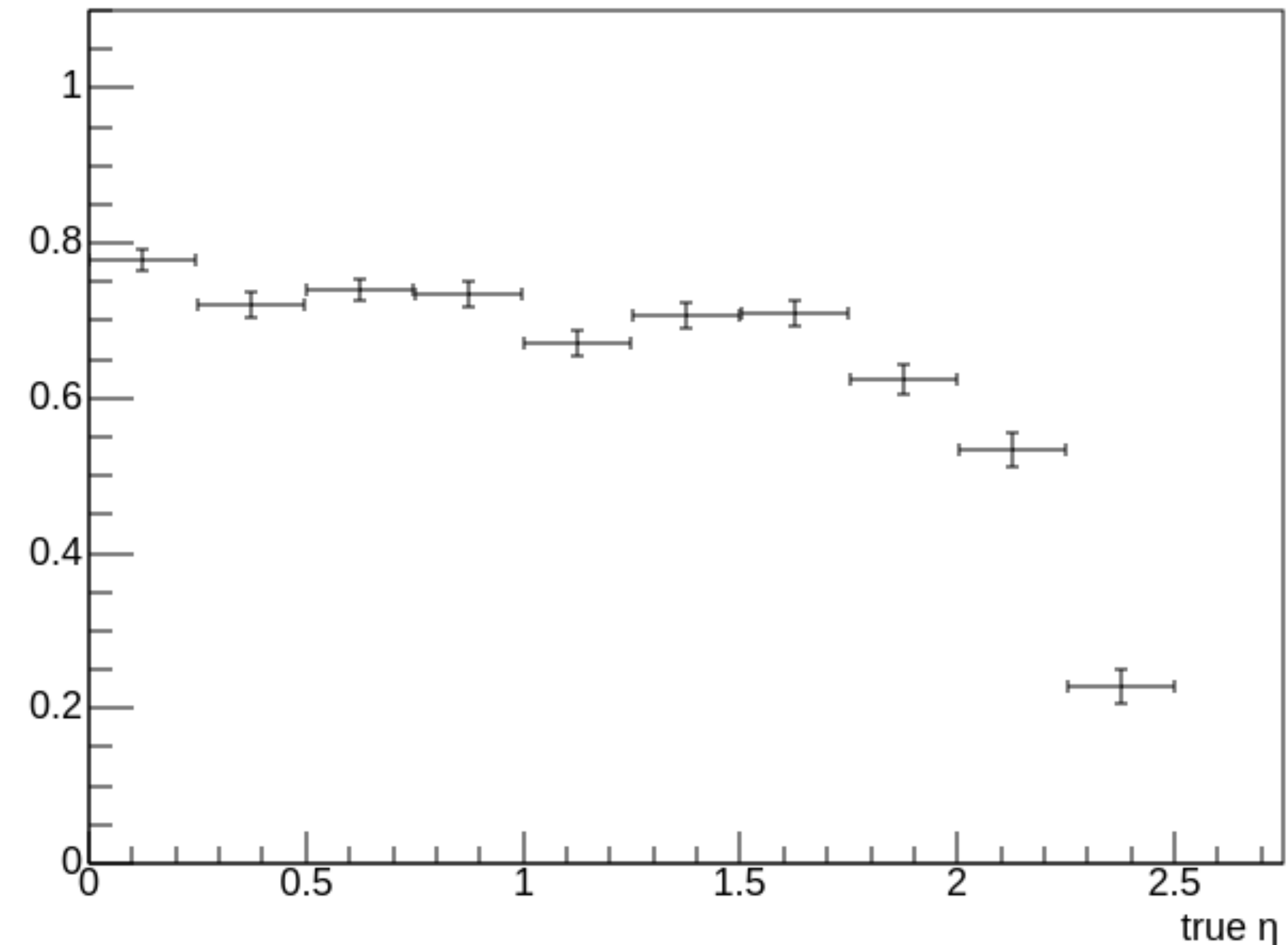
Regional tracking:
- Tracks are reconstructed a second time using hits within the jet cones
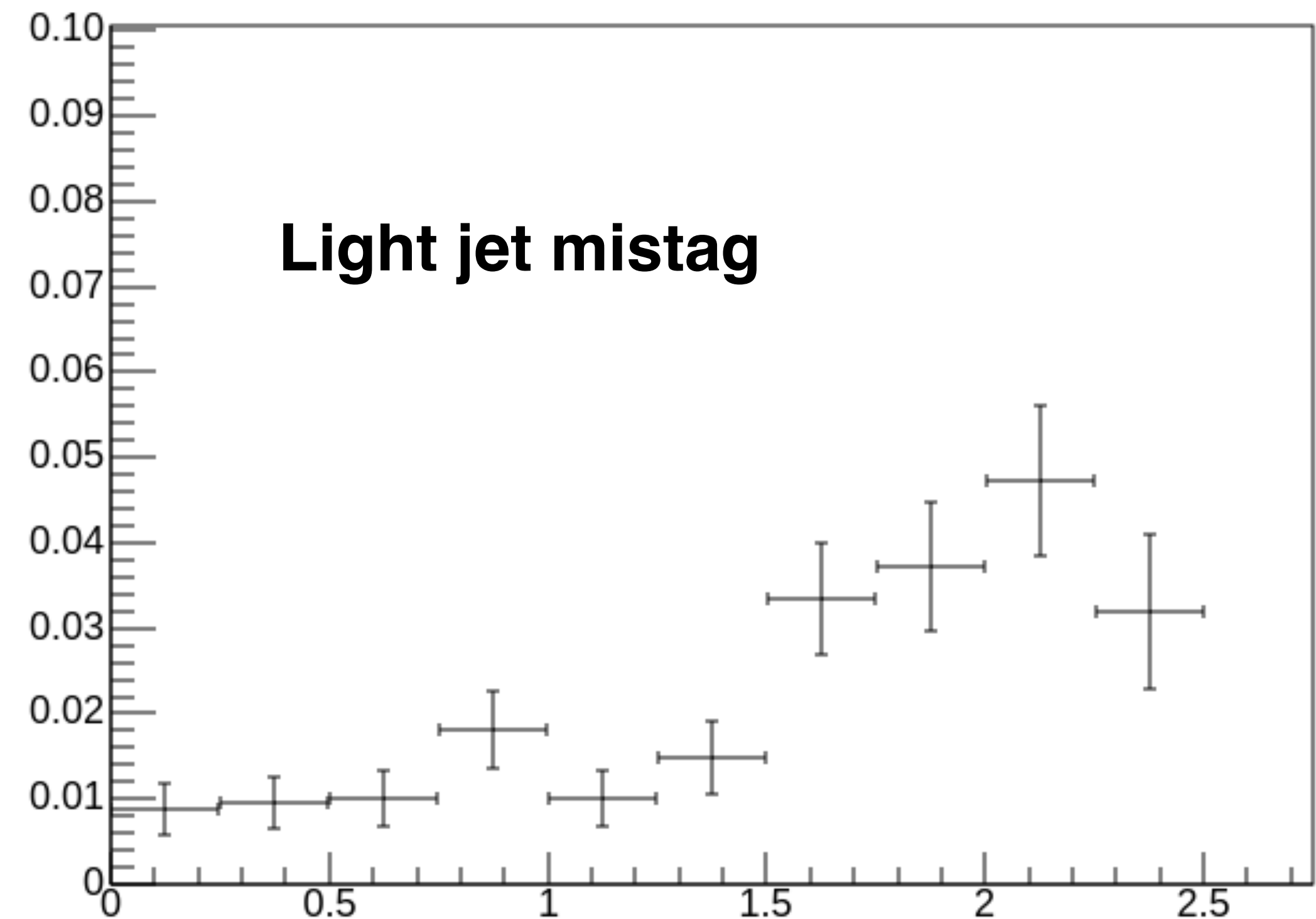- Looser requirements are applied (e.g. first layer is included)

Secondary Verteces are reconstructed: jet is tagged if SV is inside the cone

Jet tagging

SVX efficiency vs true pT (>10 GeV) - no BIB

Light jet mistag

SVX efficiency vs true η - no BIB

Light jet mistag

c-jets efficiency 20-30%

**Plots by
Leonardo Palombini**

Jet tagging

trdze {njet==2}

Plots by Leonardo Palombini

h	
Entries	24317
Mean	−0.005352
Std Dev	0.366

all tracks d0 [mm]