



ICEPP
The University of Tokyo



Wrap-up

Mixed granularity

Pion PP and NoPP

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Mixed granularity with software compensation

Simulation Study on Mixed Granularity

- Evaluate jet energy resolution for mixed granularity with software compensation
 - In the previous study by Lan, software compensation was not applied for the case of mixed granularity
- For mixed granularity, ideally SC parameters should be optimized layer by layer.
 - Need to modify iLCSoft for doing this
- Check reproducibility from previous study.
- Study with using common SC parameters for whole layers

/cvmfs/ilc.desy.de/sw/ILDConfig/v02-00-01/StandardConfig/production/PandoraSettings/PandoraSettingsDefault.xml

$$\omega(\rho) = p_1 \exp(p_2 \rho) + p_3,$$

$$p_1 = p_{10} + p_{11} \times E_{sum} + p_{12} \times E_{sum}^2$$

$$p_2 = p_{20} + p_{21} \times E_{sum} + p_{22} \times E_{sum}^2$$

$$p_3 = \frac{p_{30}}{p_{31} + e^{p_{32} \times E_{sum}}}$$

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3e-06 -0.0220423 0.120368 -0.0286773</SoftwareCompensationWeights>
</SoftwareCompensation>
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<PhotonPlugin>LCPhotonId</PhotonPlugin>
<ElectronPlugin>LCElectronId</ElectronPlugin>
<MuonPlugin>LCMuonId</MuonPlugin>
```

Procedure

- ILCSoft version : v02-00-01, ILD model : ILD_I5_v02
- Prepare the geometries
 - All $30 \times 30 \text{mm}^2$
 - Inside 24 layers $30 \times 30 \text{mm}^2$, outside 24 layers $60 \times 60 \text{mm}^2$
 - All $60 \times 60 \text{mm}^2$
- Calibration by using muon, electron and kaon events
- Software compensation training or not
- Simulate di-jet events from quark pairs in DD4hep

/cvmfs/ilc.desy.de/sw/x86_64_gcc49_sl6/v02-00-01/lcgeo/v00-16-01/ILD/compact/ILD_common_v02/SHcalSc04_Barrel_v04.xml

All 30mm
(All 60mm replaced
grid_size 3 → 6)

```

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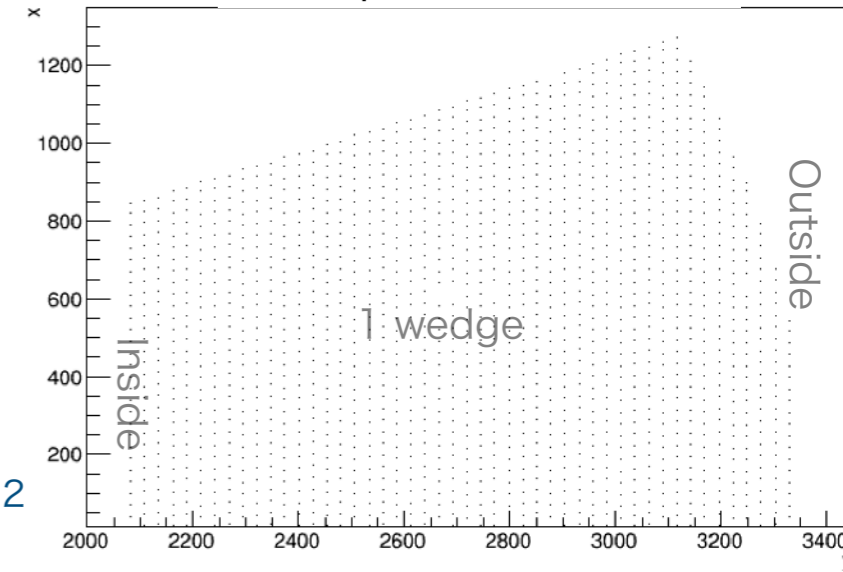
Half by half of
30mm and 60mm

```

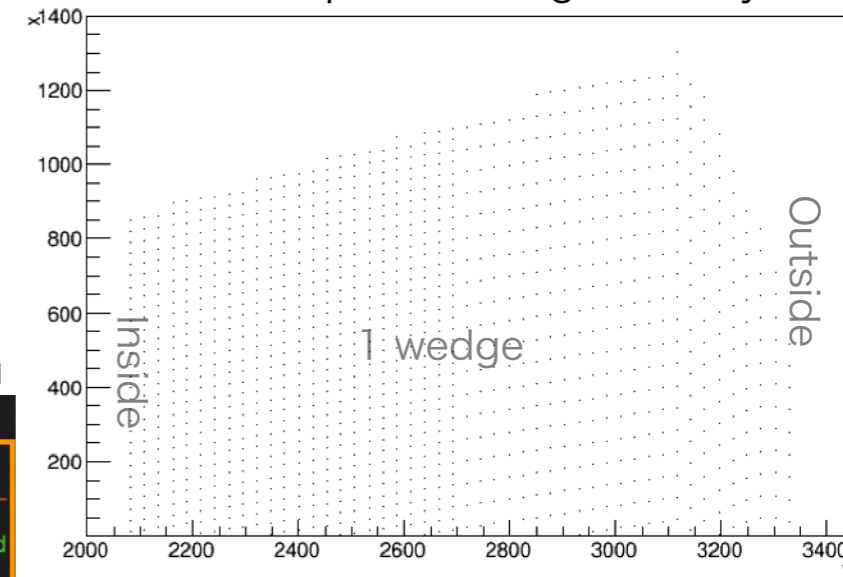
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  </readout>
</readouts>
    
```

↓ z is beam axis, x and y are its vertical axes

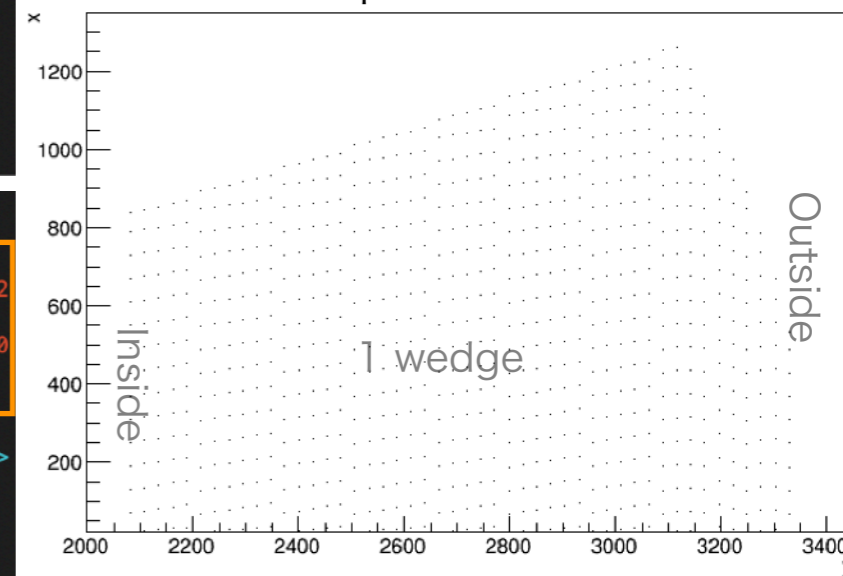
Hit map of all 30mm tiles



Hit map of mixed granularity



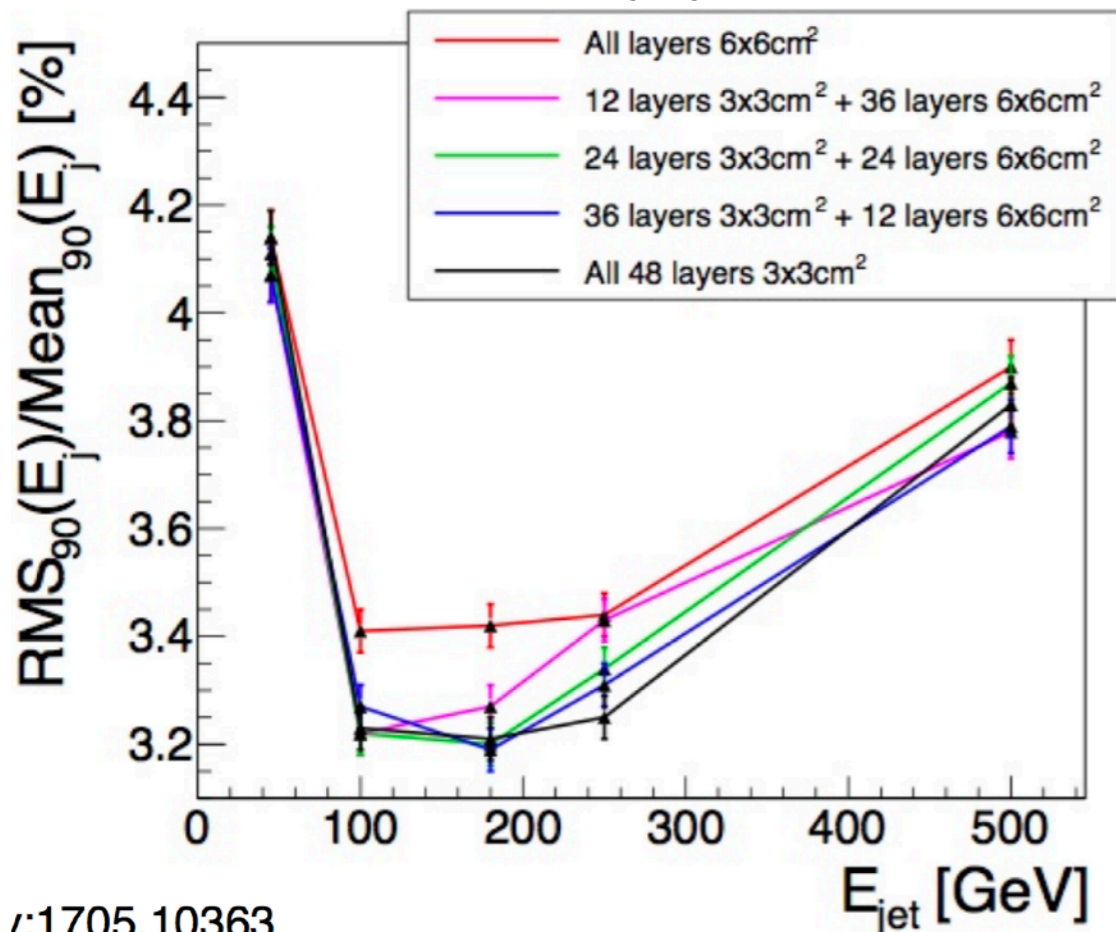
Hit map of all 60mm tiles



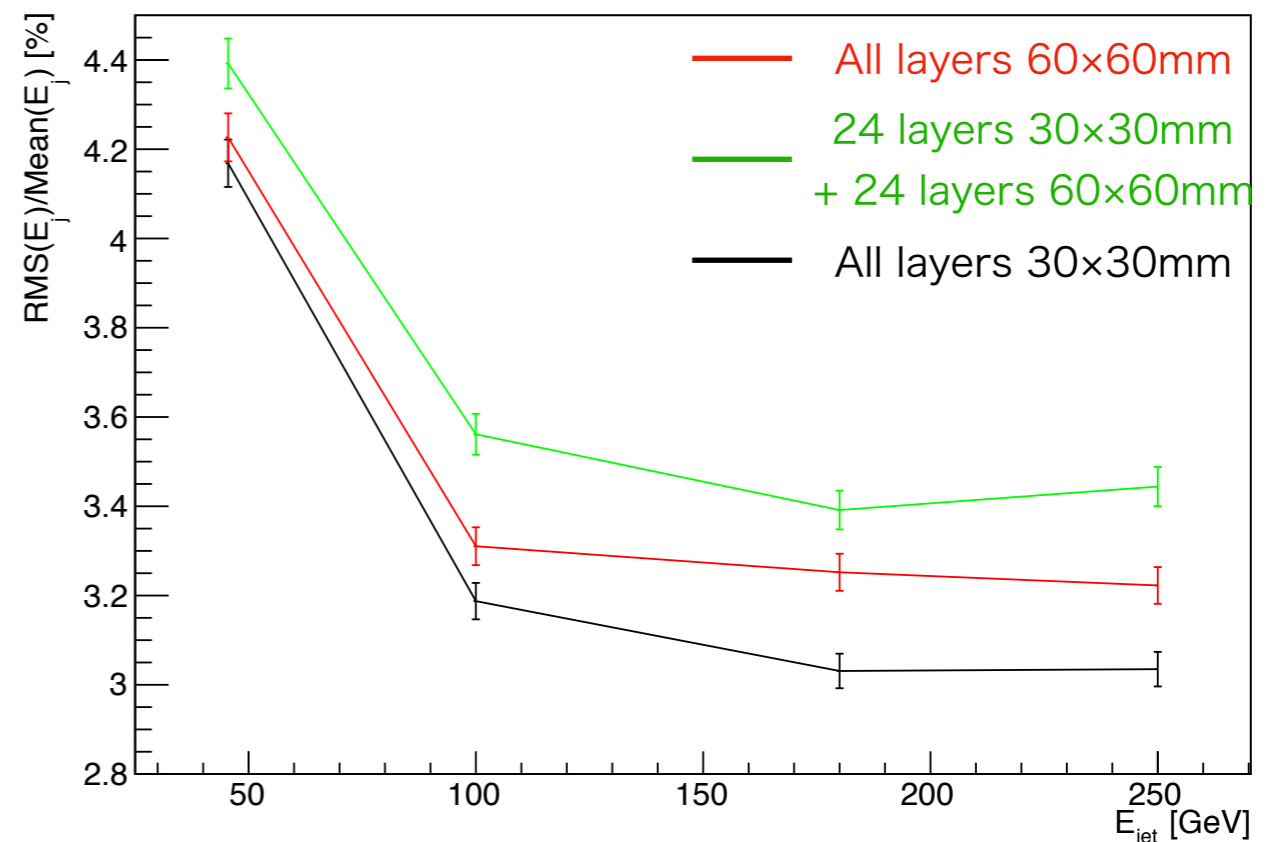
Results w/o SC

- New geometry of all layers $30\times 30\text{mm}^2$ and all layers $60\times 60\text{mm}^2$ has almost the same results compared to previous study.
- Half by half of 30mm and 60mm gets worse.
 - Due to the difference of iLCSoft or ILD model version?
 - Due to something wrong with multi segmentation?

Jet energy resolutions for different granularity (w/o SC)
Previous study by Lan



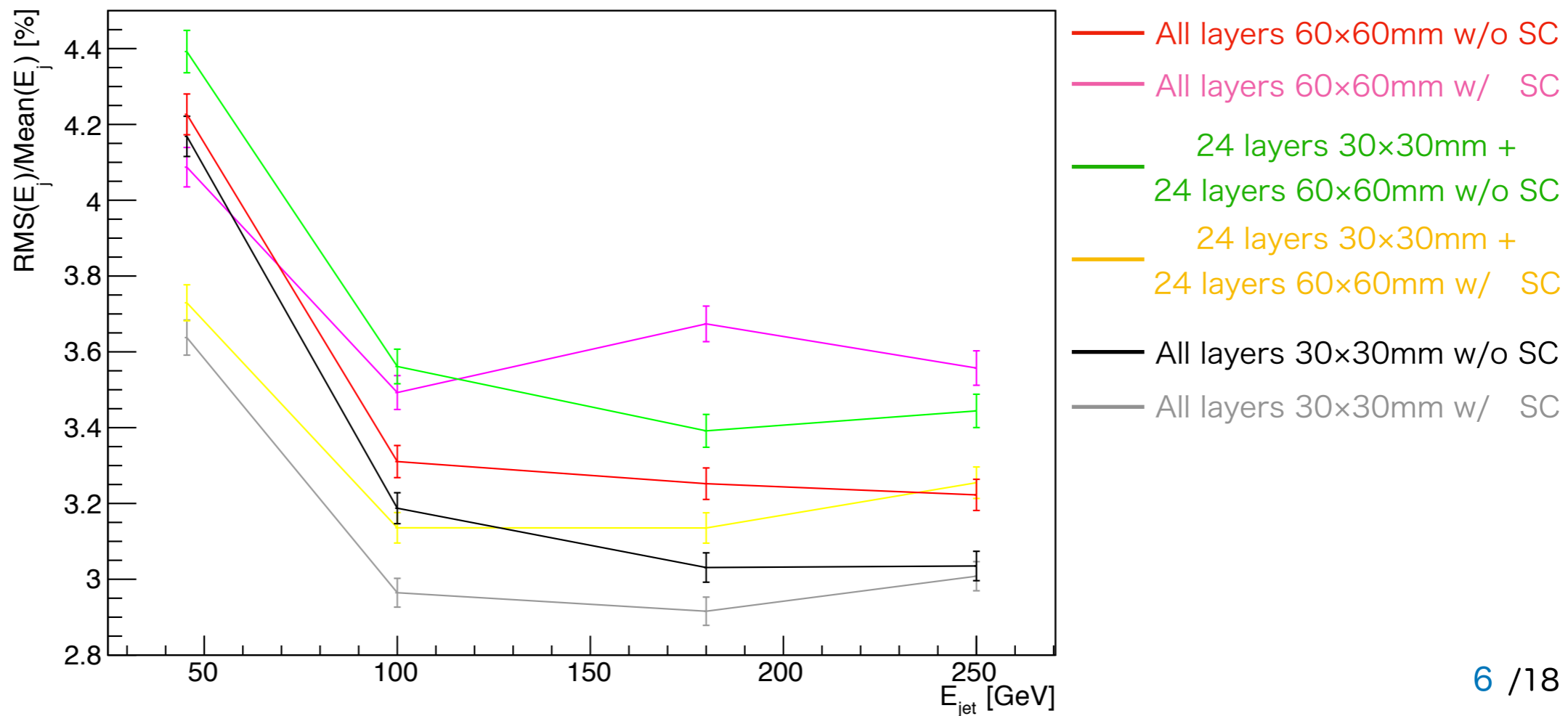
Jet energy resolutions for different granularity (w/o SC)
New geometry



Results of new geometries

- Reasonable improvement for all 30×30mm² tiles configuration with SC.
- Slight improvement for half 30×30mm² and half 60×60mm² configuration with SC.
- Even worse for all 60×60mm² configuration with SC
- ➔ It seems that SC is not correctly working for 60×60mm² tiles
- ➔ Need to apply different SC parameter layer-by-layer and to optimize SC parameter for 60×60mm² layer.

Jet energy resolutions for different granularity(w/ and w/o SC)



Summary

- Simulate the JER of different configurations of granularity w/ and w/o software compensation
- Results w/o SC partly reproduce the previous results.
 - The case of mixed granularity gets worse due to geometry?
- All 30×30mm and half by half cases have improvements by applying SC, but all 60×60mm case gets worse.
 - It seems that SC is not working yet for 60mm×60mm² tiles
- Need optimization for SC parameters dedicated for 60mm×60mm² tiles

Prospects

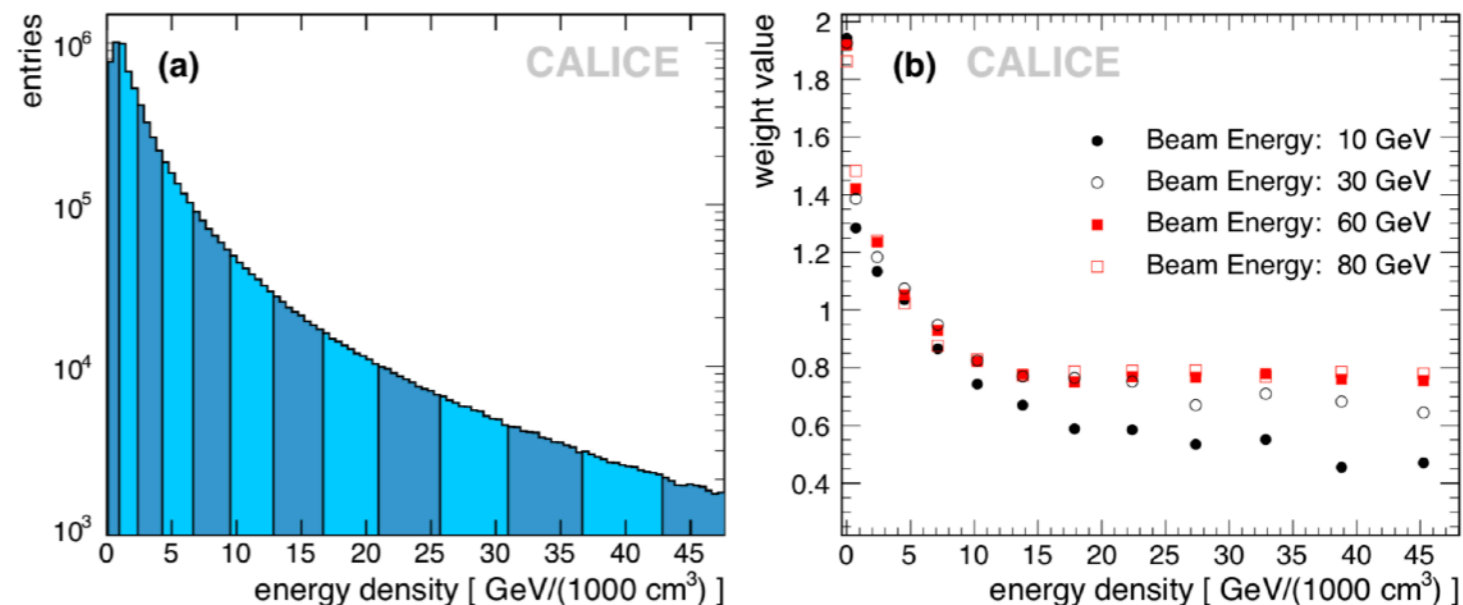
- Apply local software compensation
 - Correct the difference of energy deposition b/w electromagnetic shower and hadronic shower
 - Compensate each energy density
- Need to reconsider the functions or weights for larger tile and mixed granularity
 - Because Energy density of larger tile is different with that of standard 30×30mm² tile.
- Procedure
 - Apply SC directly at the step of reconstruction
 - First reconstruct without SC, then apply SC by using root macro or something
 -

$$\omega(\rho) = p_1 \exp(p_2 \rho) + p_3,$$

$$p_1 = p_{10} + p_{11} \times E_{sum} + p_{12} \times E_{sum}^2$$

$$p_2 = p_{20} + p_{21} \times E_{sum} + p_{22} \times E_{sum}^2$$

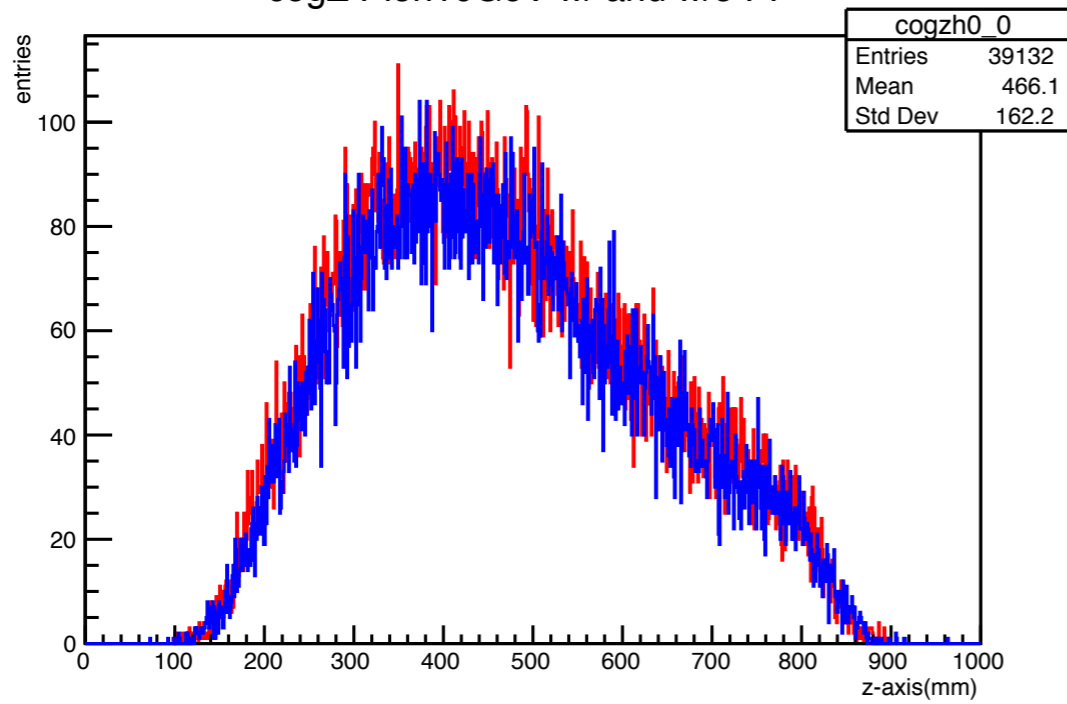
$$p_3 = \frac{p_{30}}{p_{31} + e^{p_{32} \times E_{sum}}}$$



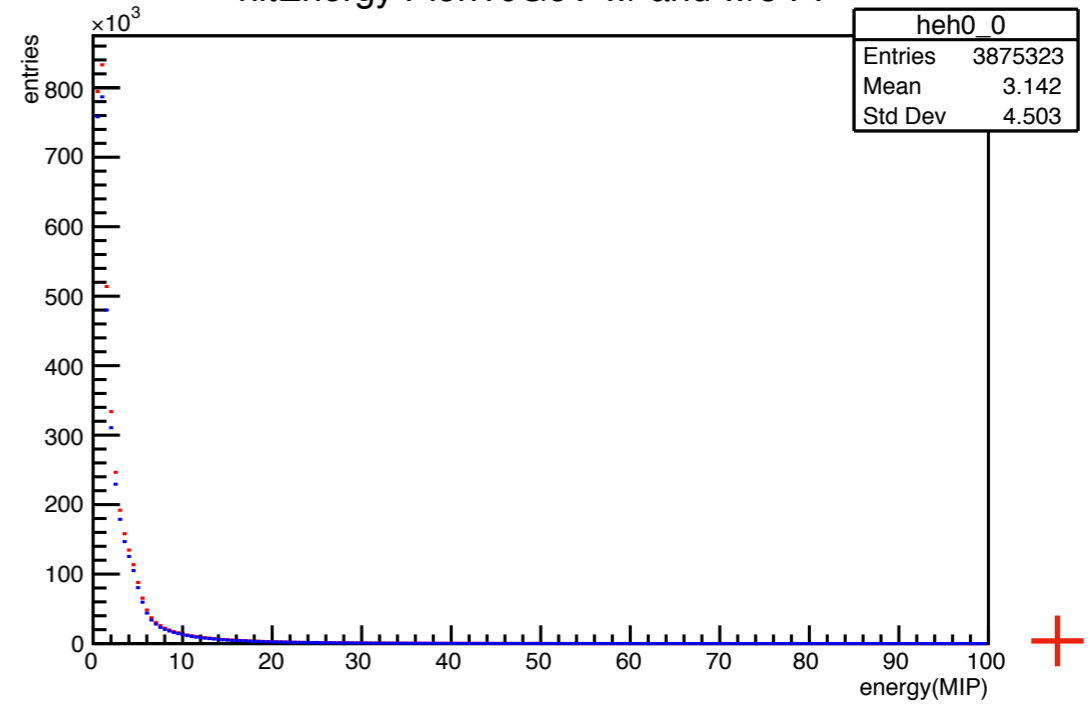
Pion PP and NoPP with new constants

Pion 10 GeV

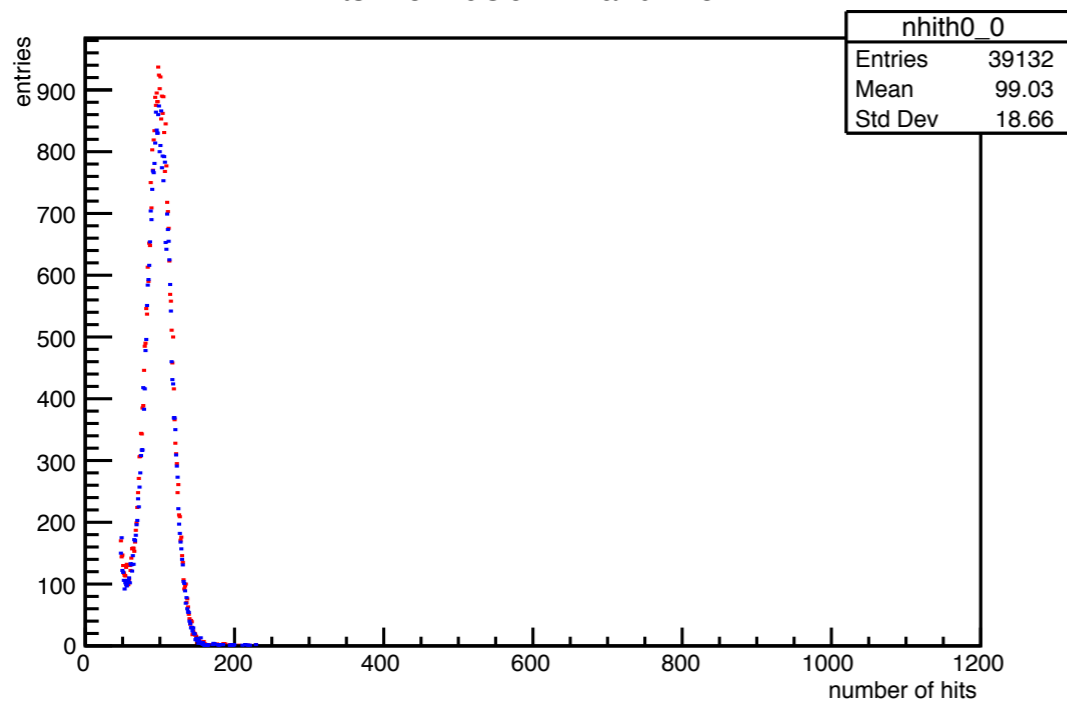
cogZ Pion10GeV w/ and w/o PP



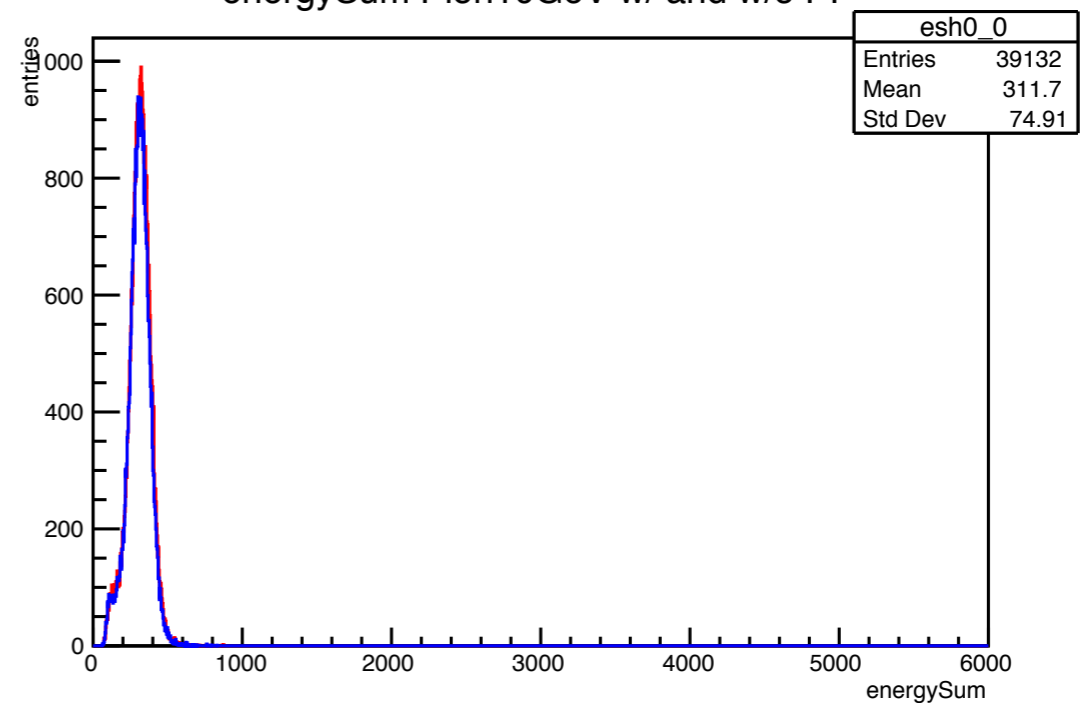
hitEnergy Pion10GeV w/ and w/o PP



nHits Pion10GeV w/ and w/o PP

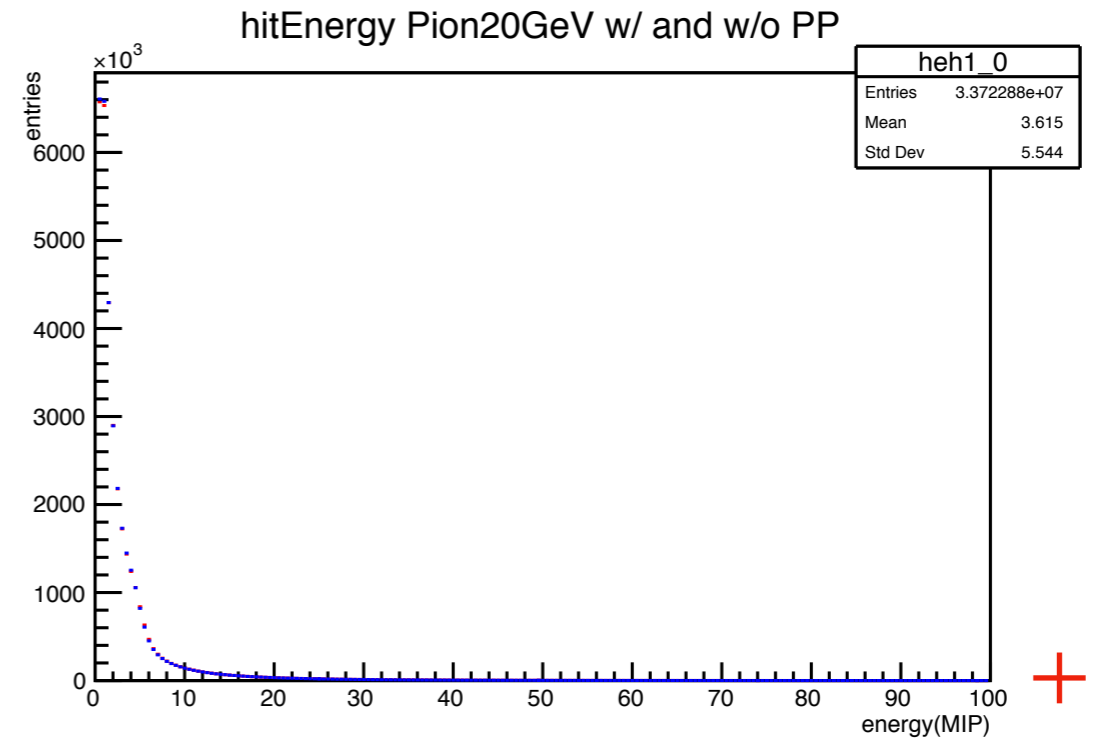
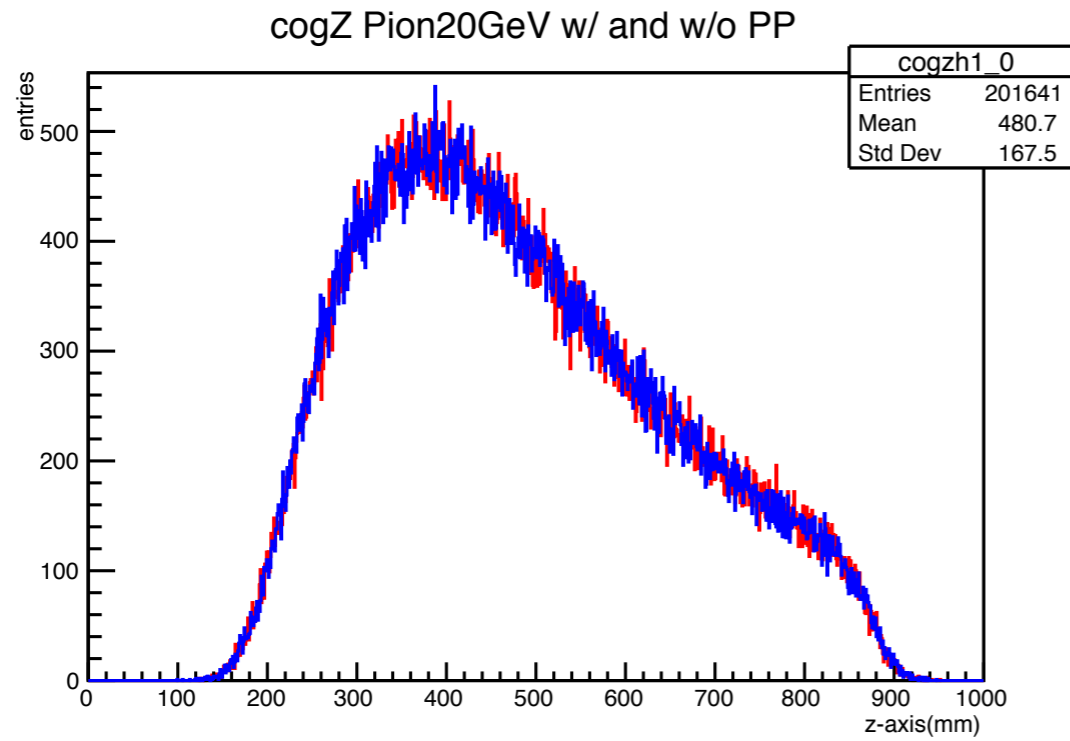


energySum Pion10GeV w/ and w/o PP

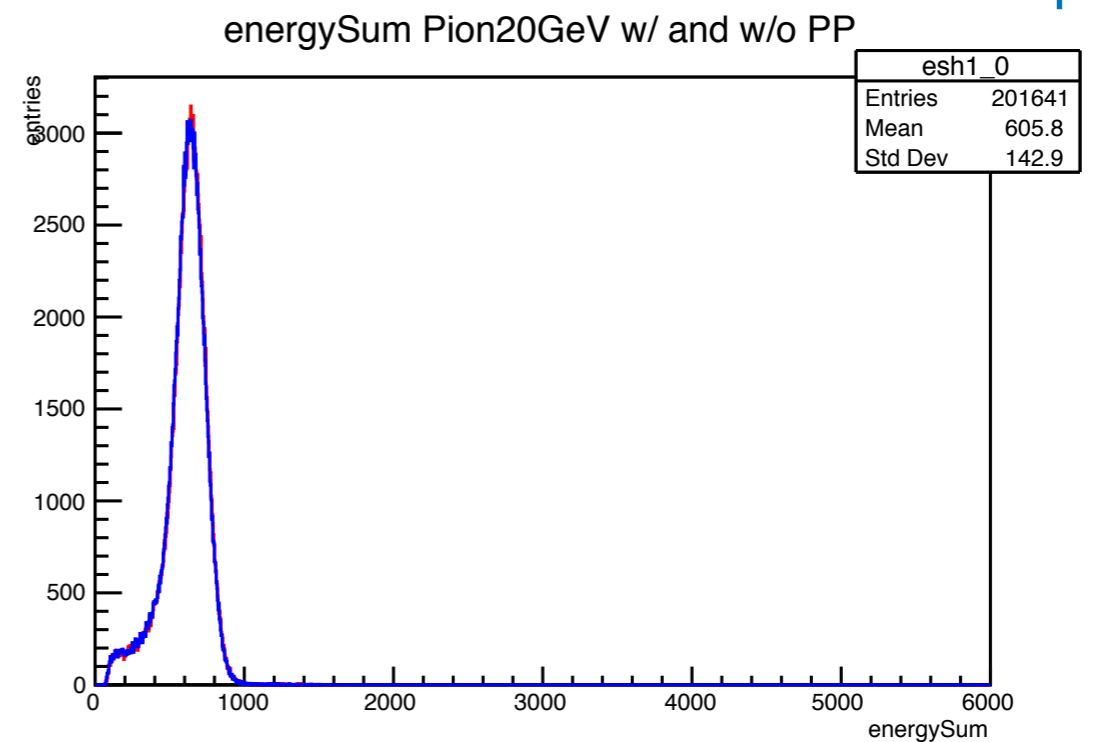
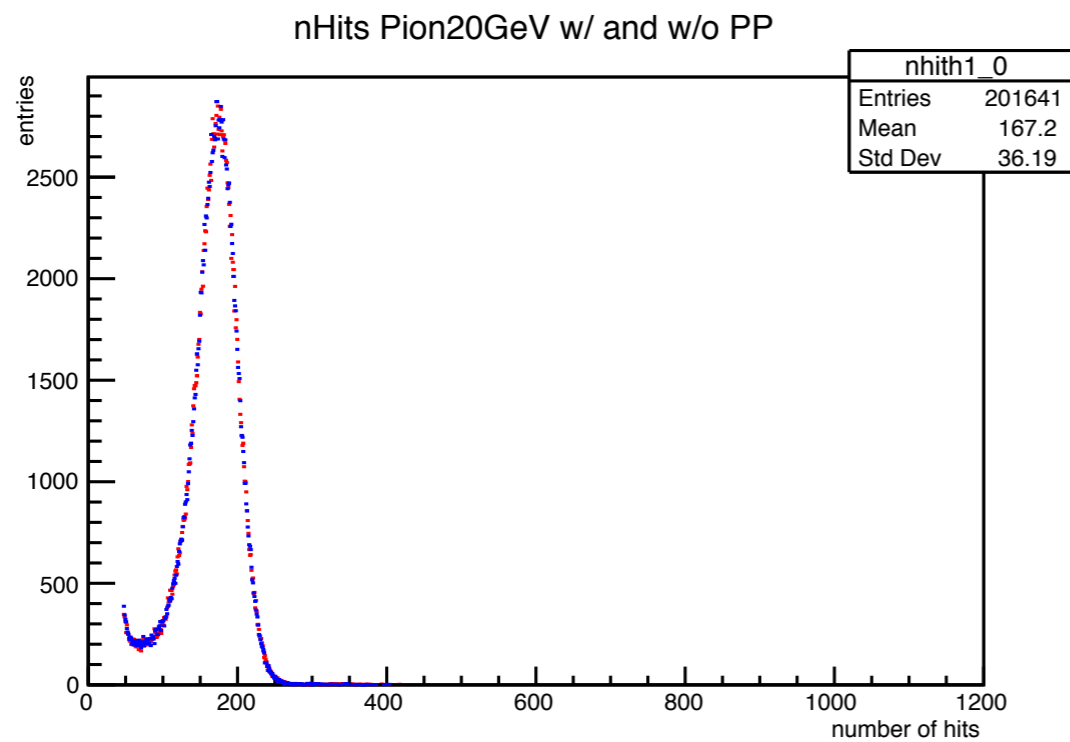


+ PP
+ No PP

Pion 20 GeV

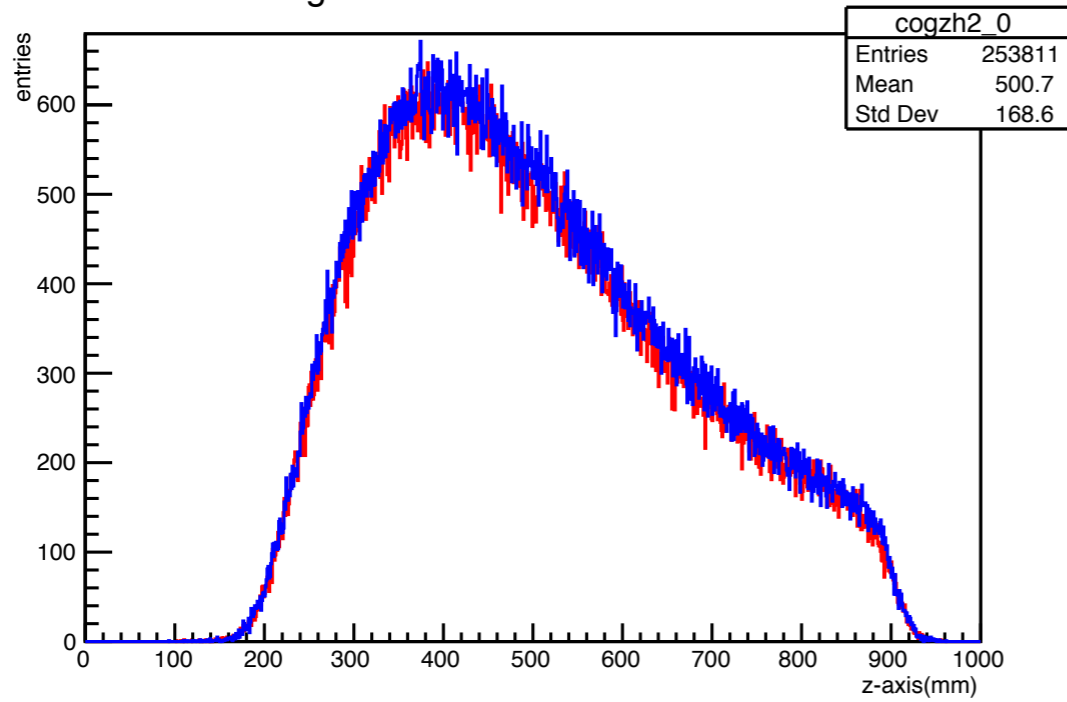


+ PP
+ No PP

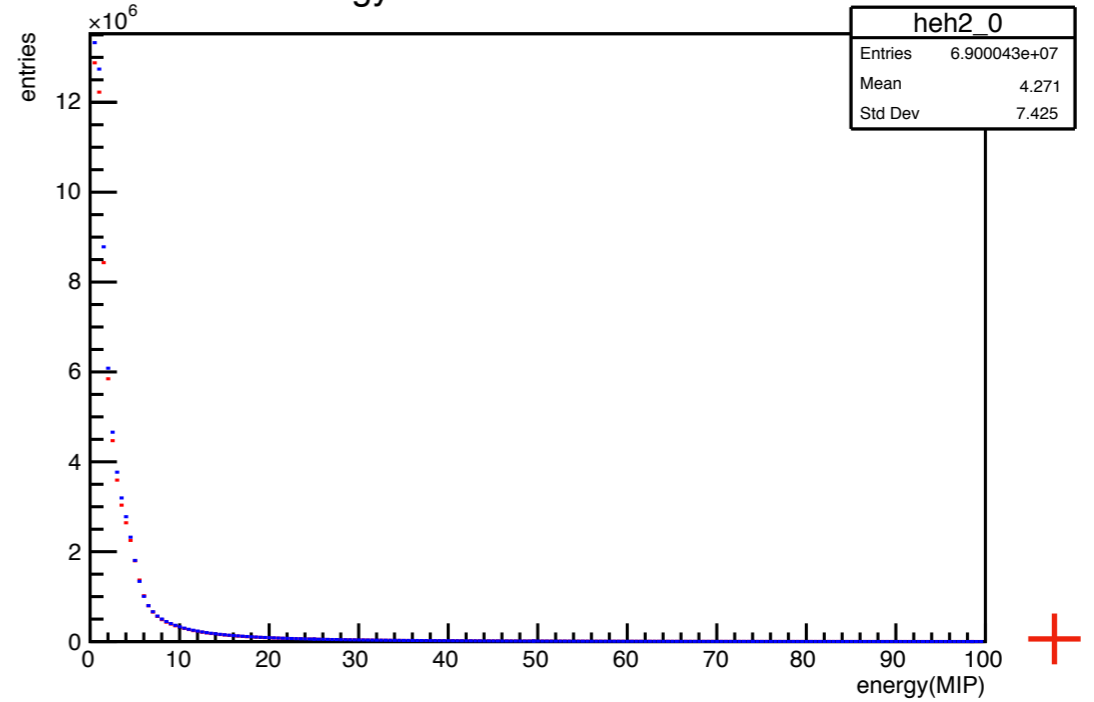


Pion 40 GeV

cogZ Pion40GeV w/ and w/o PP

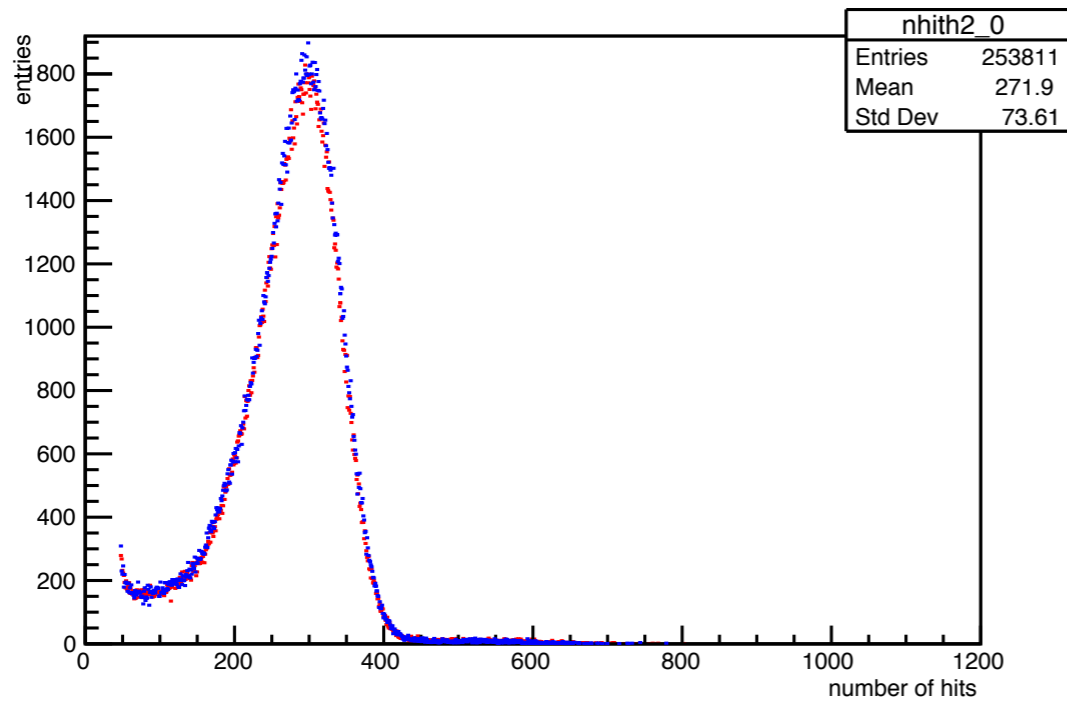


hitEnergy Pion40GeV w/ and w/o PP

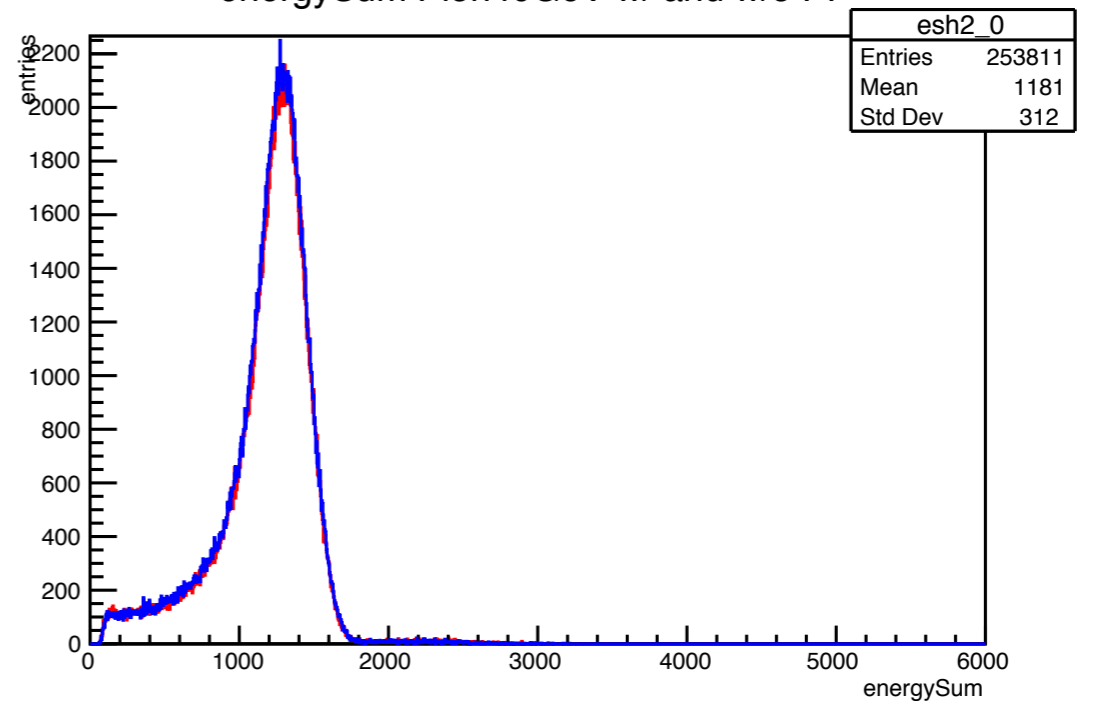


+ PP
+ No PP

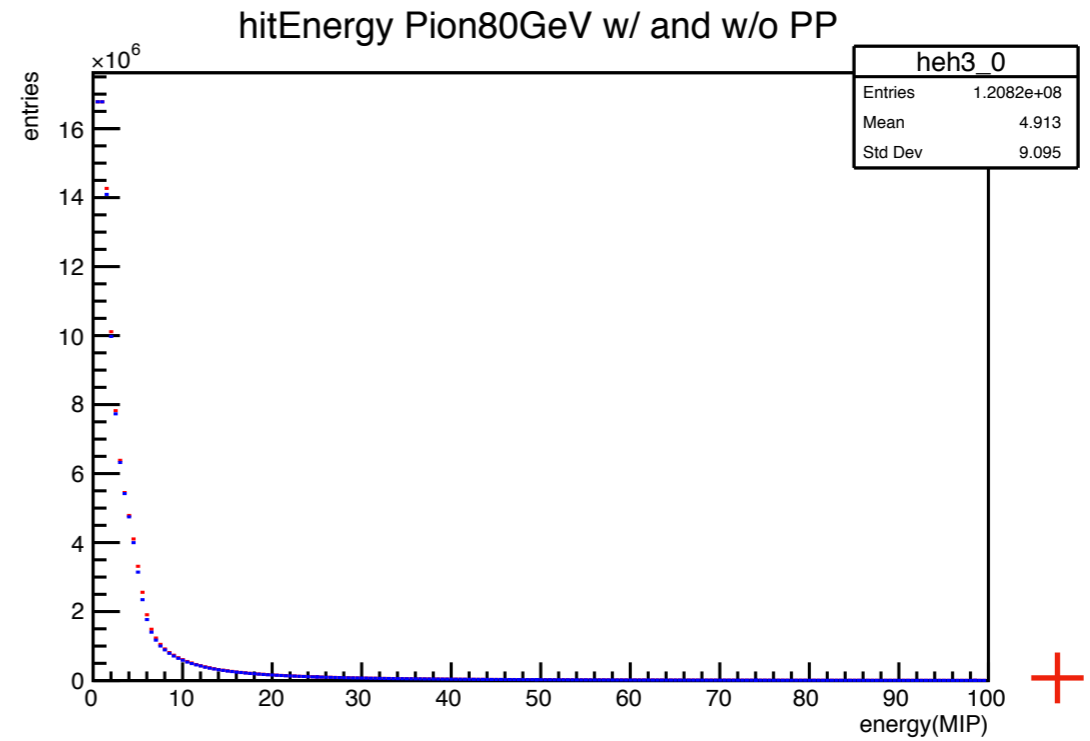
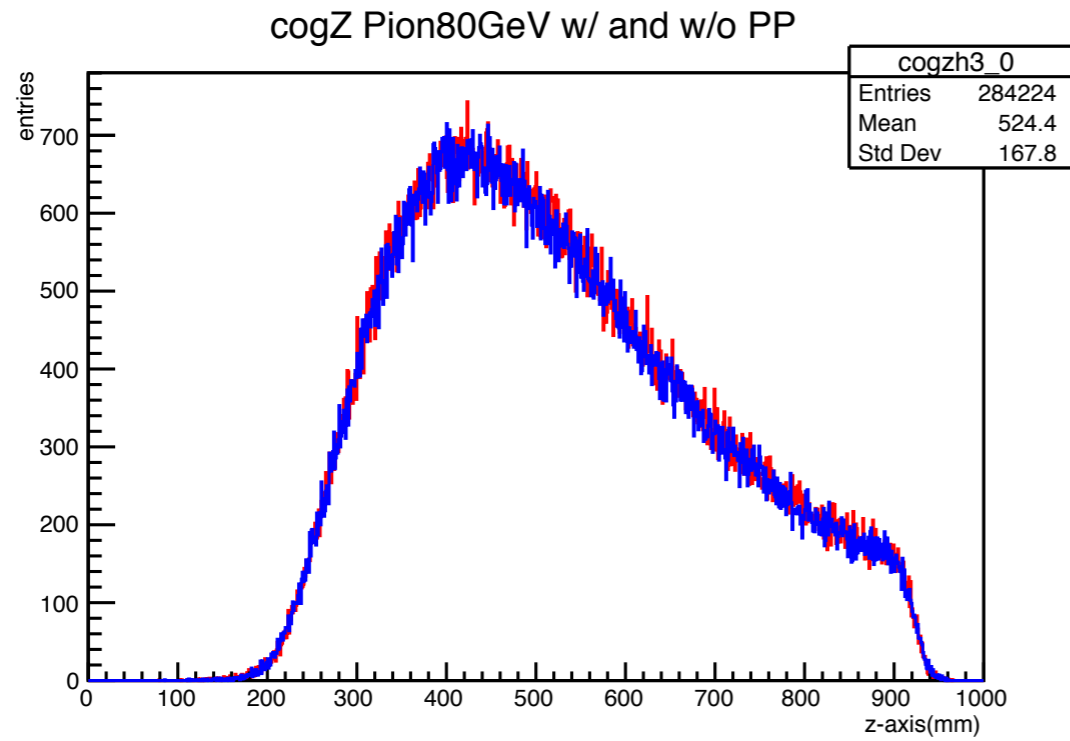
nHits Pion40GeV w/ and w/o PP



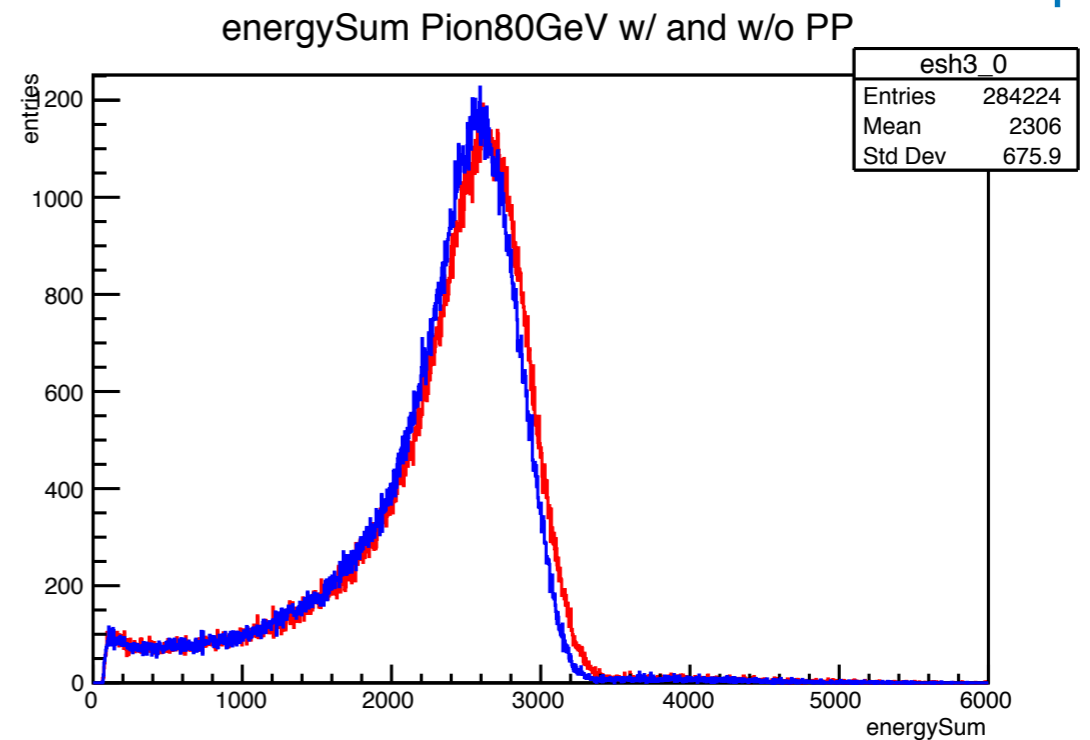
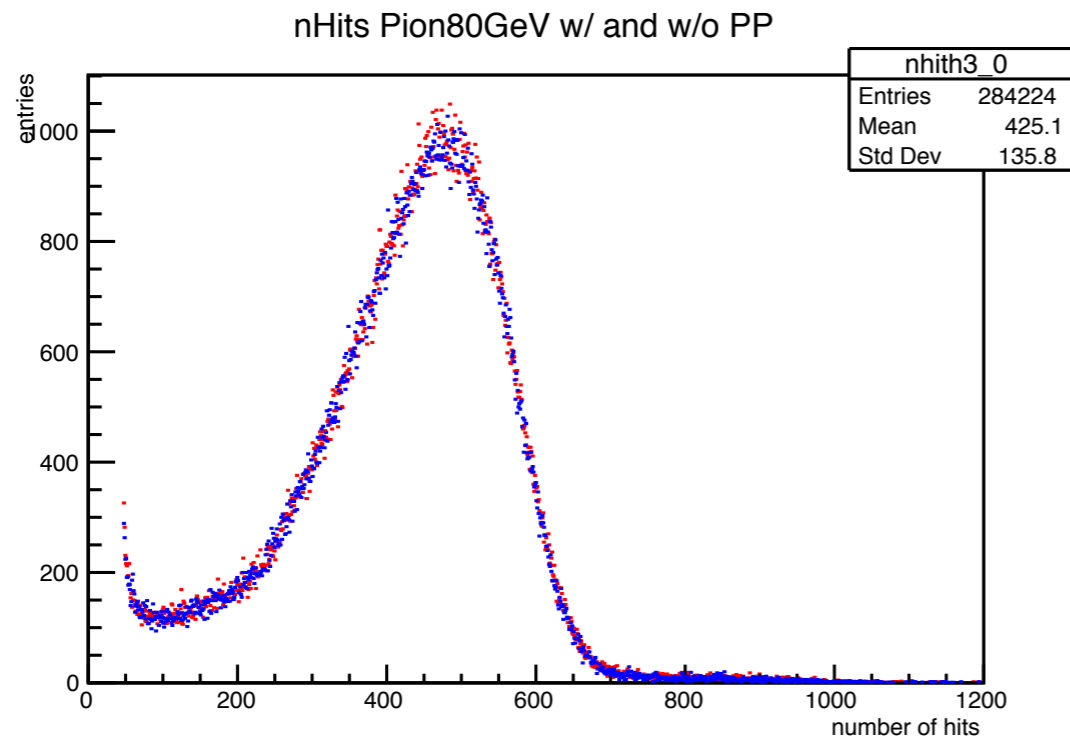
energySum Pion40GeV w/ and w/o PP



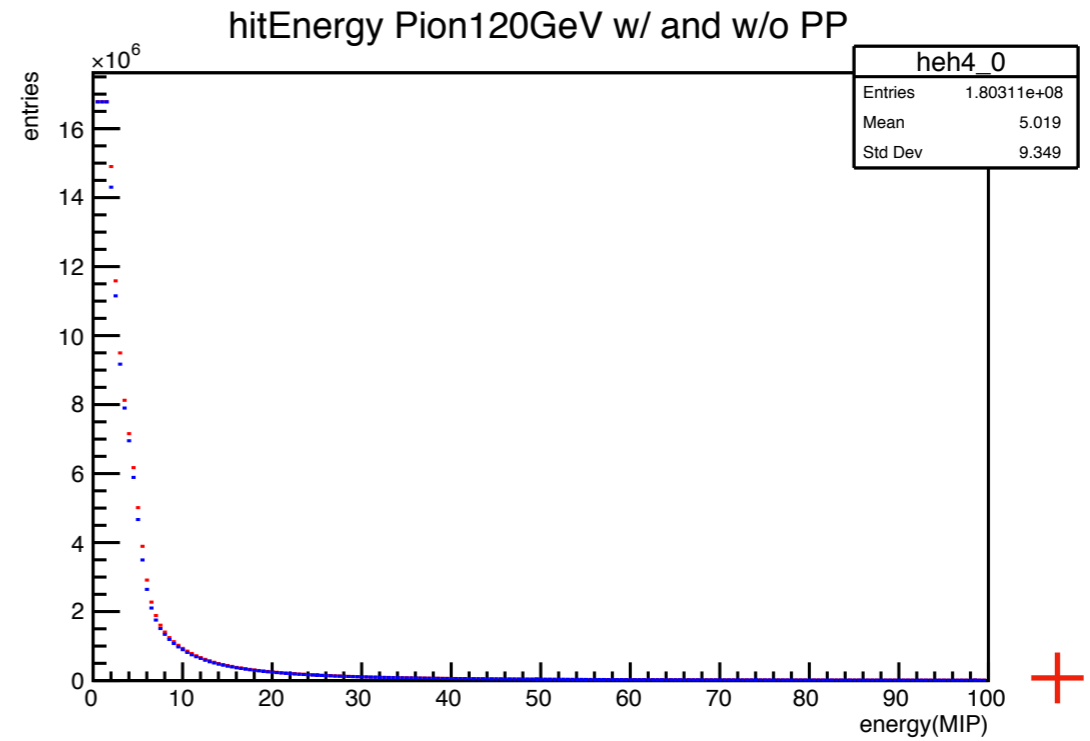
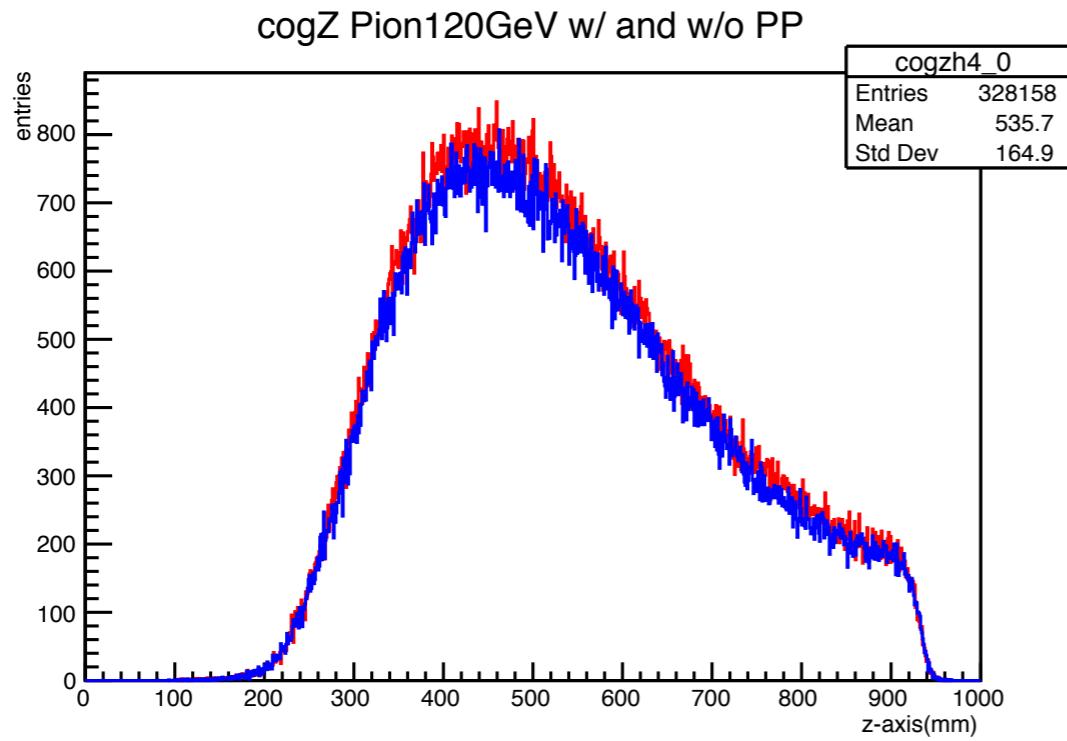
Pion 80 GeV



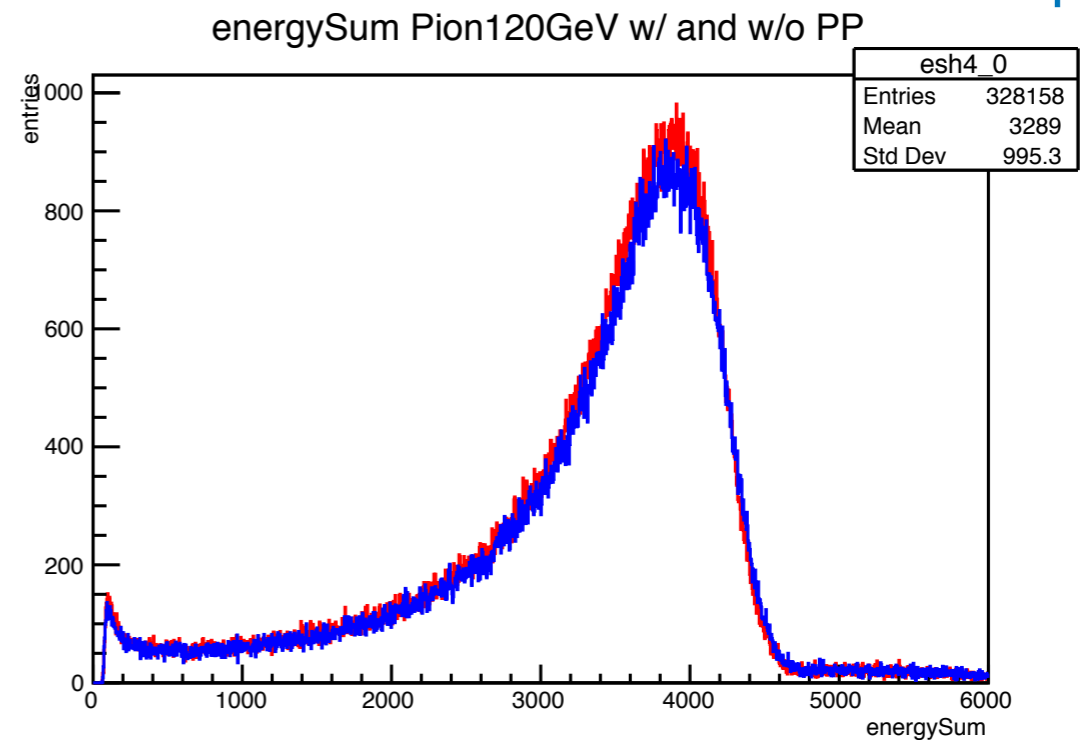
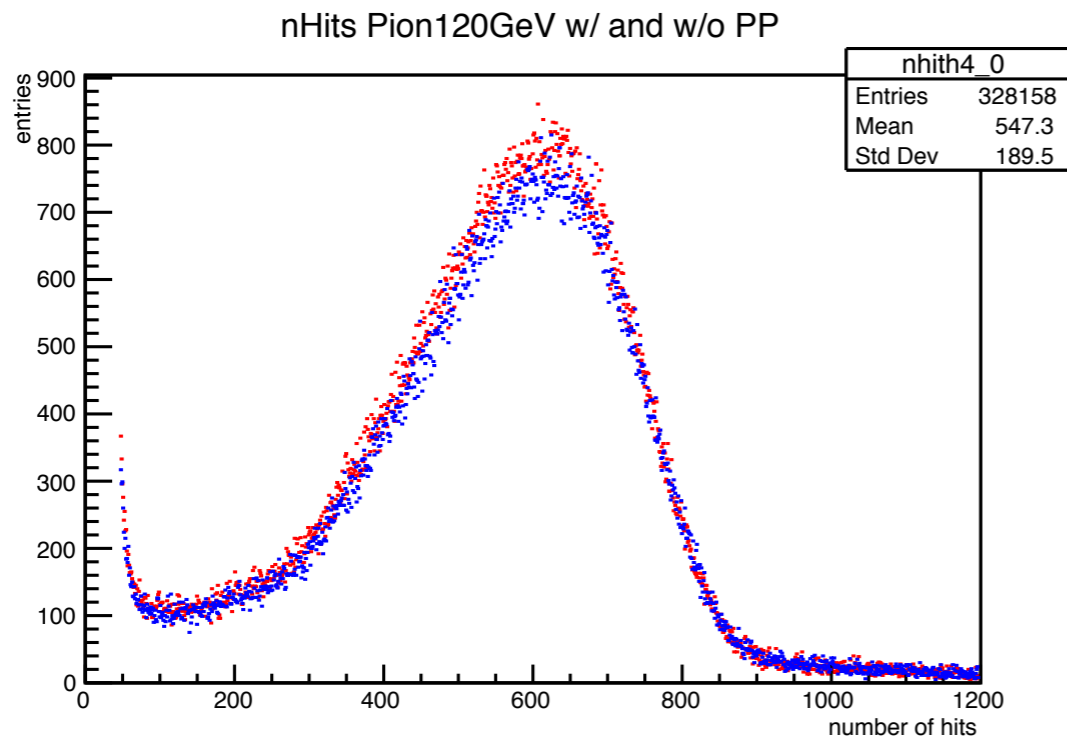
+ PP
+ No PP



Pion 120 GeV

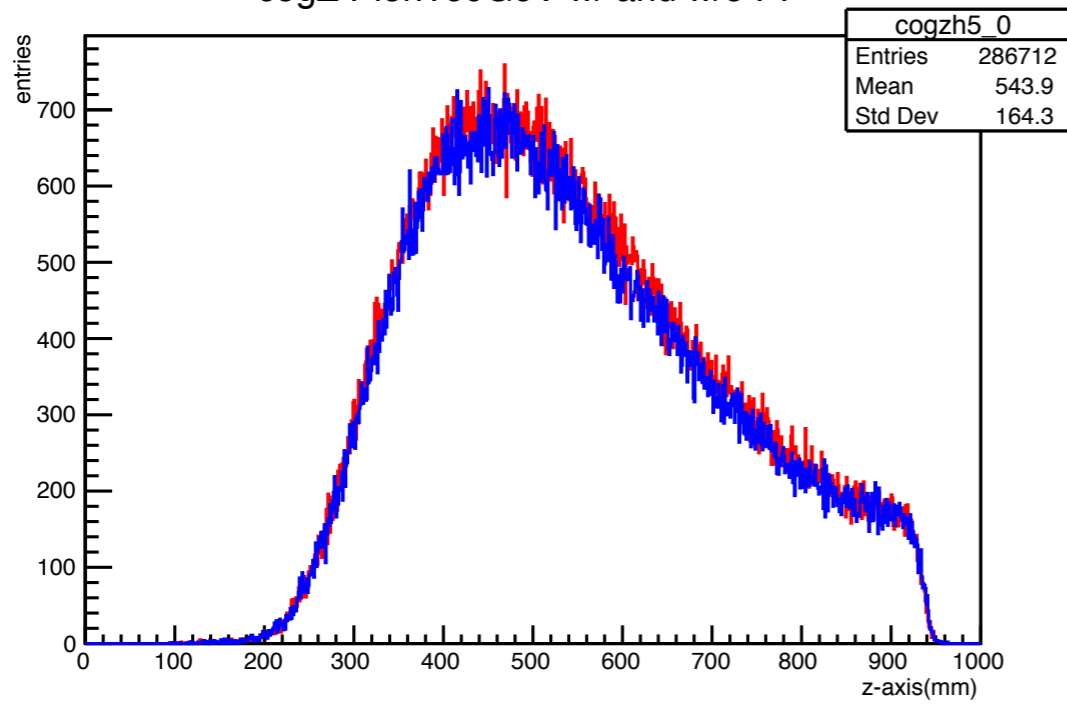


+ PP
+ No PP

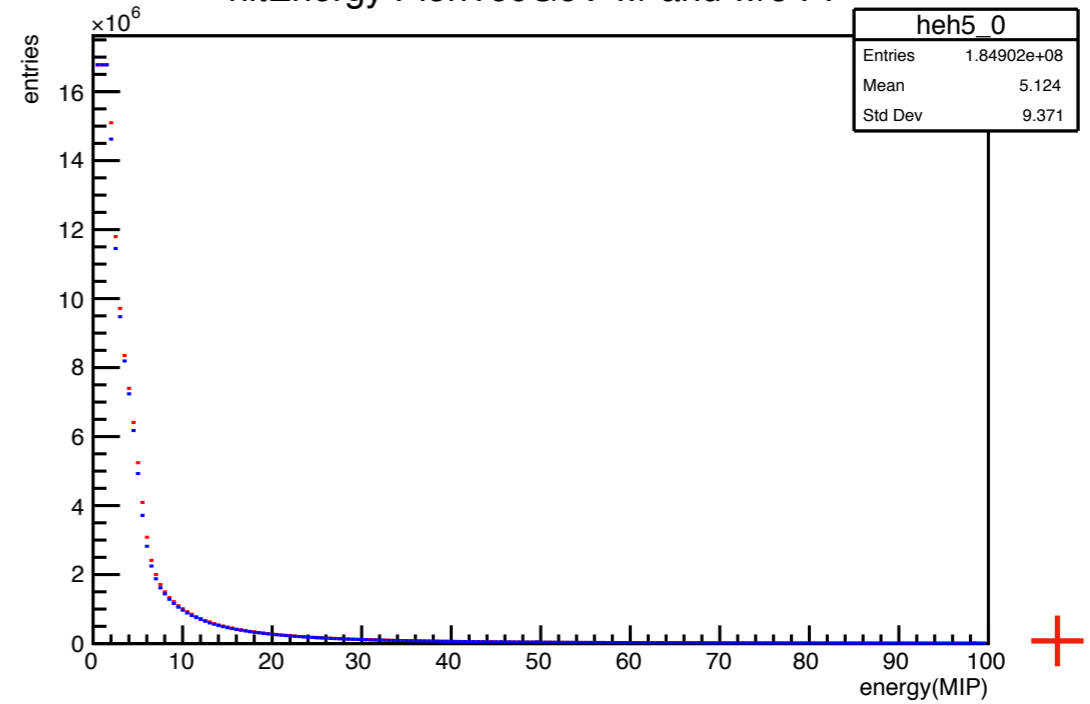


Pion 160 GeV

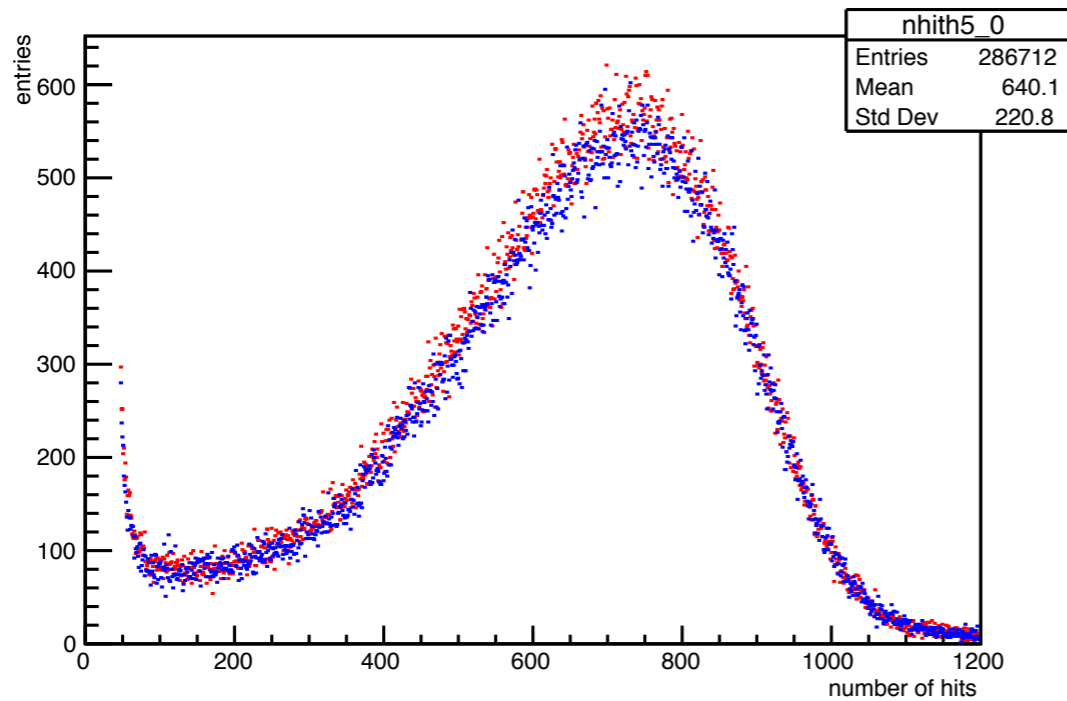
cogZ Pion160GeV w/ and w/o PP



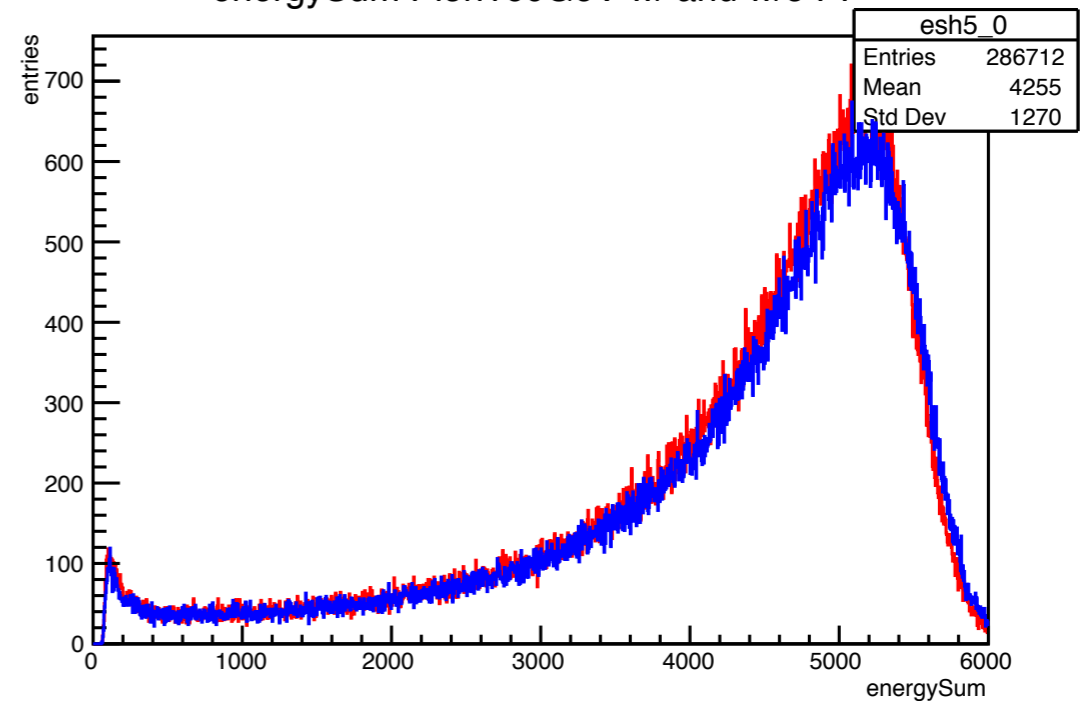
hitEnergy Pion160GeV w/ and w/o PP



nHits Pion160GeV w/ and w/o PP



energySum Pion160GeV w/ and w/o PP

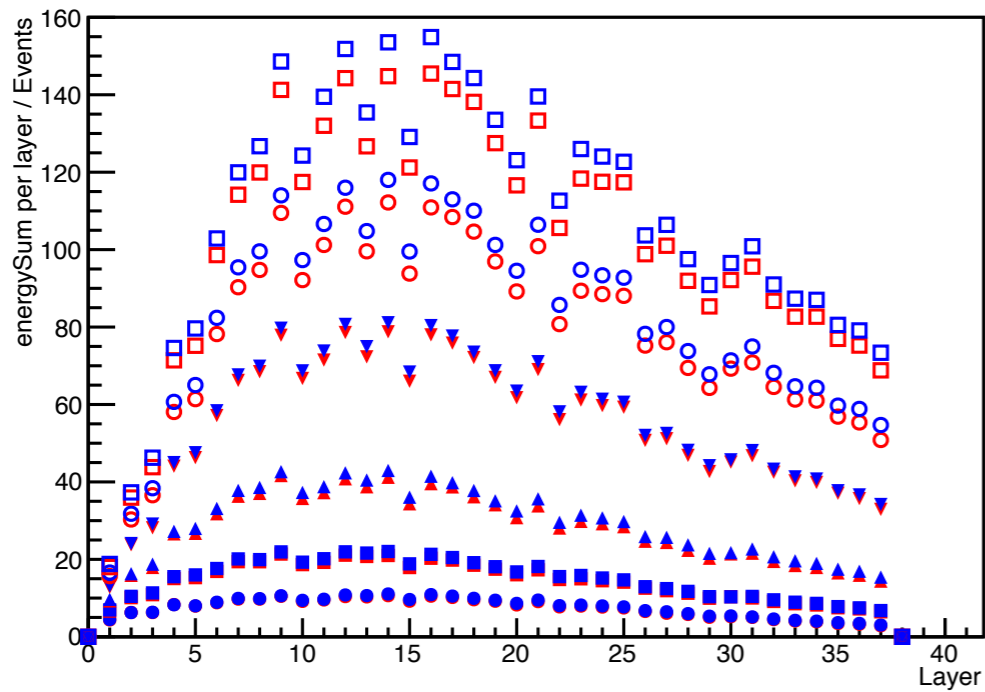


+ PP
+ No PP

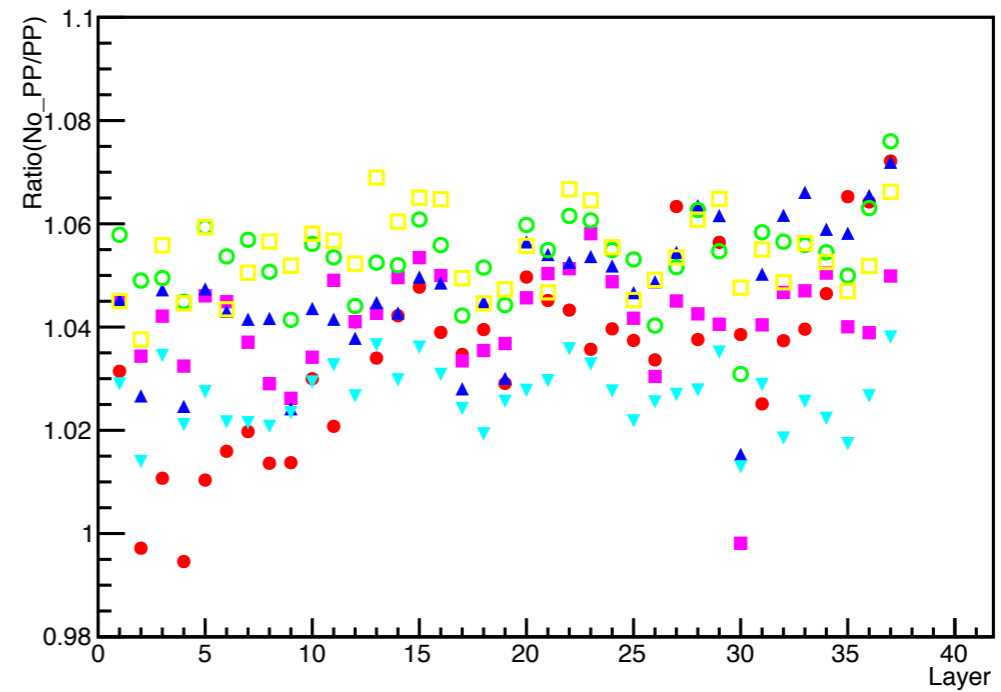
Shower profile

Previous constants

Energy per layer Pion w/ and w/o PP

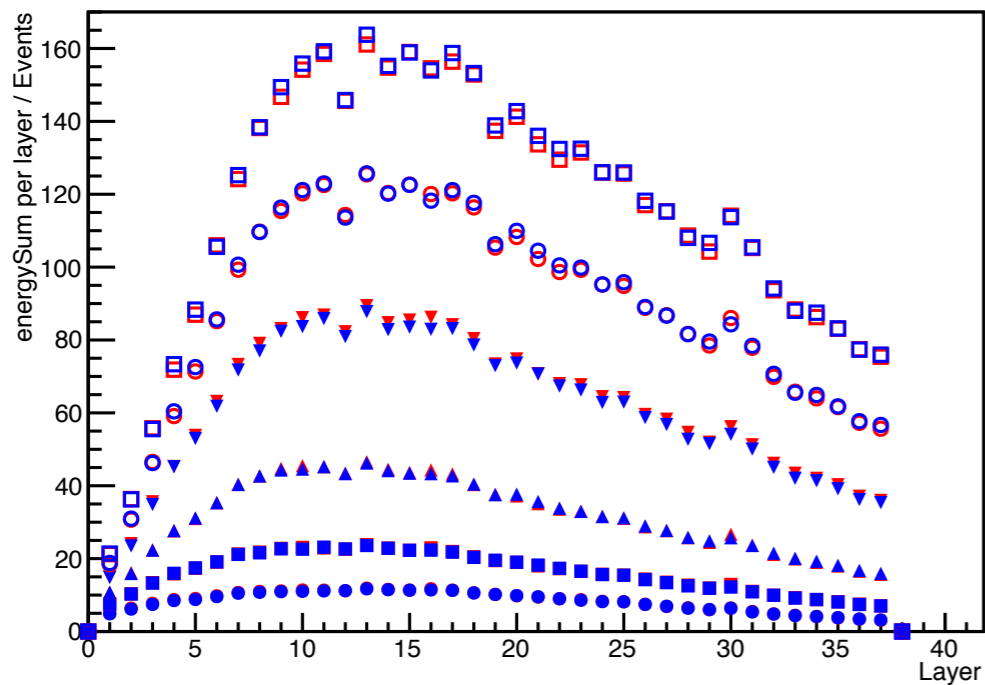


No_PP/PP ratio of energy per layer Pion

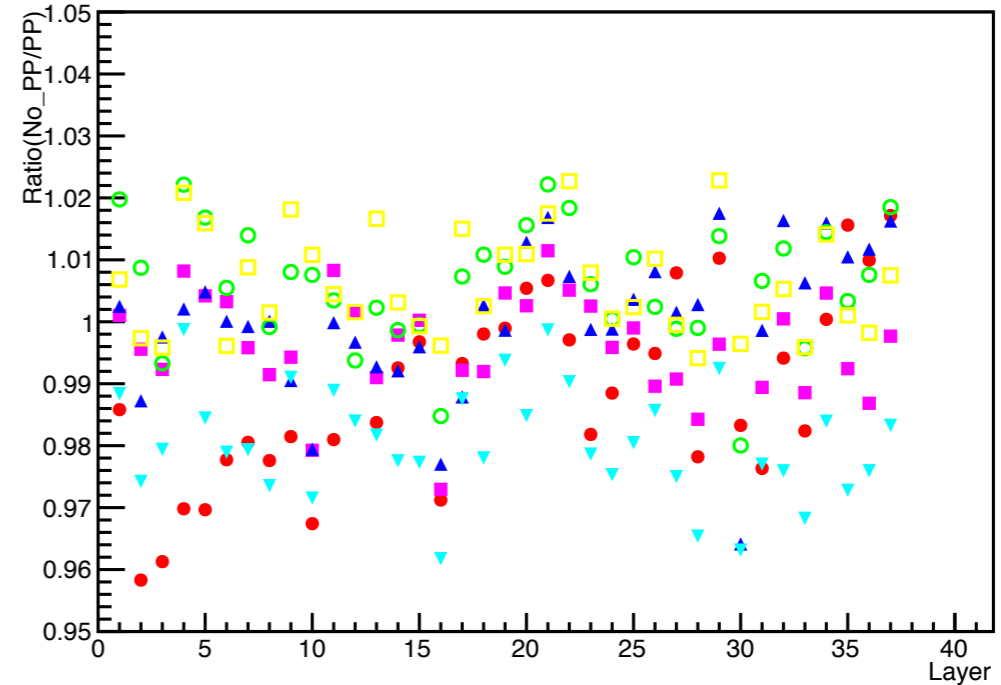


New constants

Energy per layer Pion w/ and w/o PP



No_PP/PP ratio of energy per layer Pion



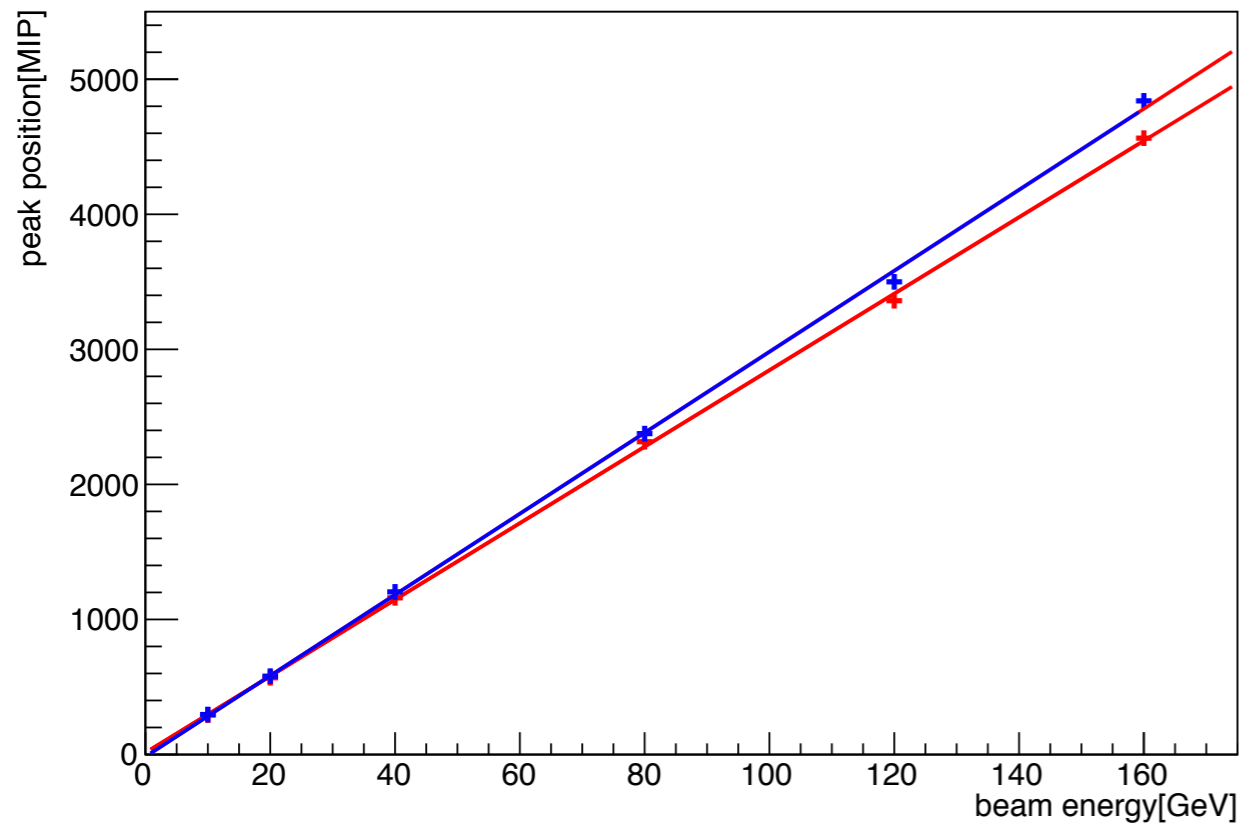
Linearity

- Good linearity
 - Old constants
 - PP : (Gradient) 28.3 (Intercept) 13.8
 - NoPP : (Gradient) 30.0 (Intercept) -15.9
 - New constants
 - PP : (Gradient) 32.0 (Intercept) 23.7
 - NoPP : (Gradient) 31.9 (Intercept) 4.6

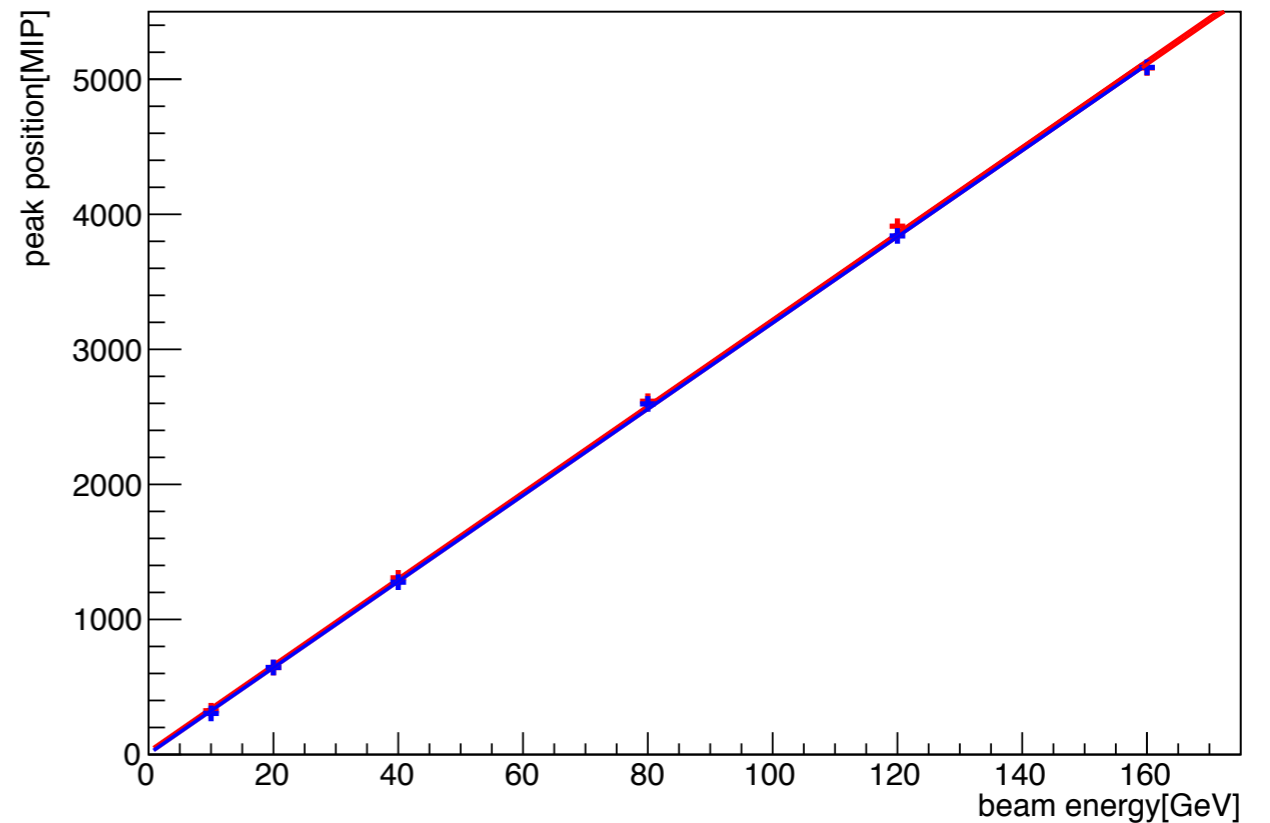
+ PP

+ No PP

energySum plot with old constants



energySum plot with new constants

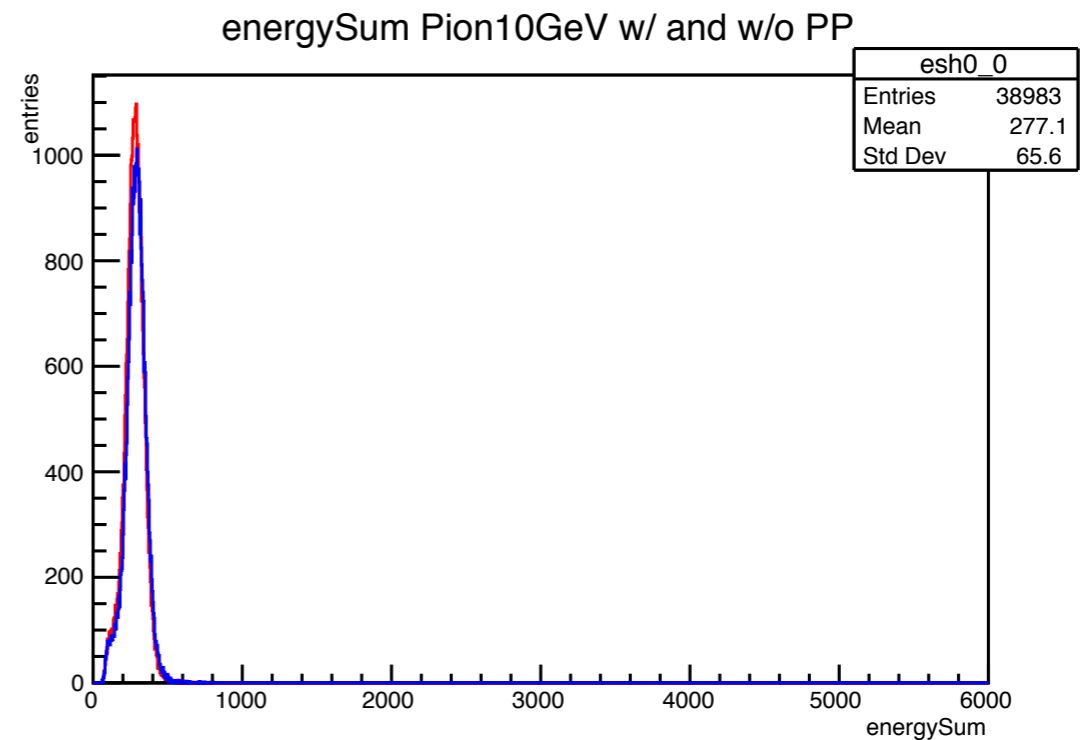
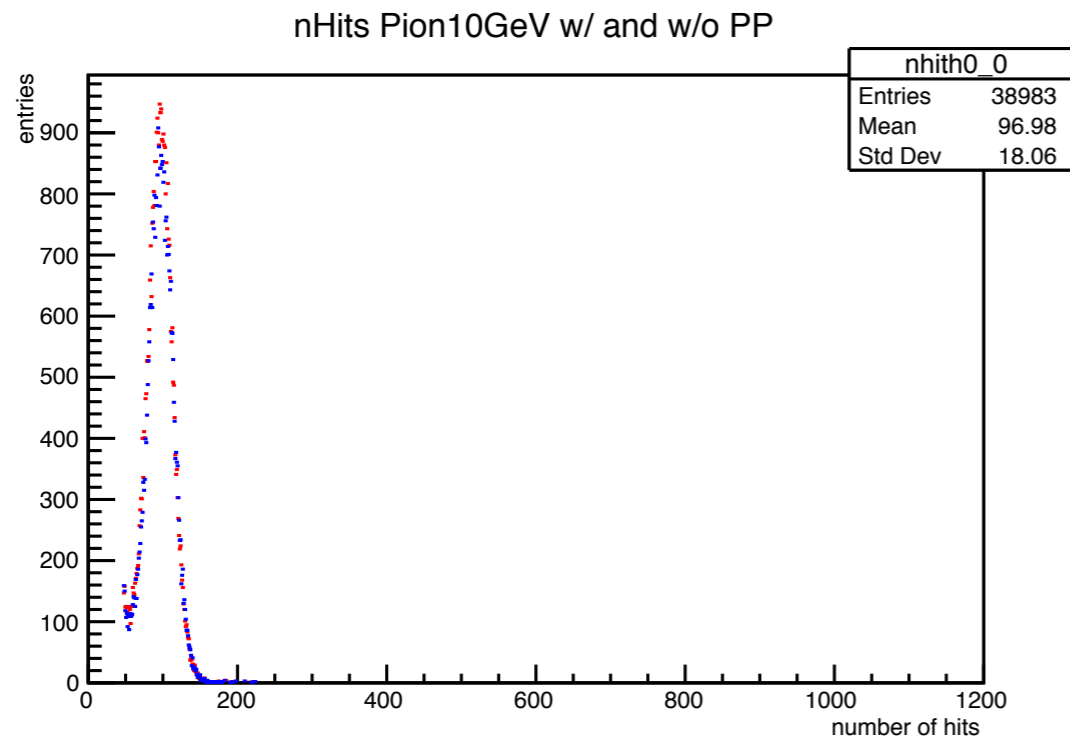
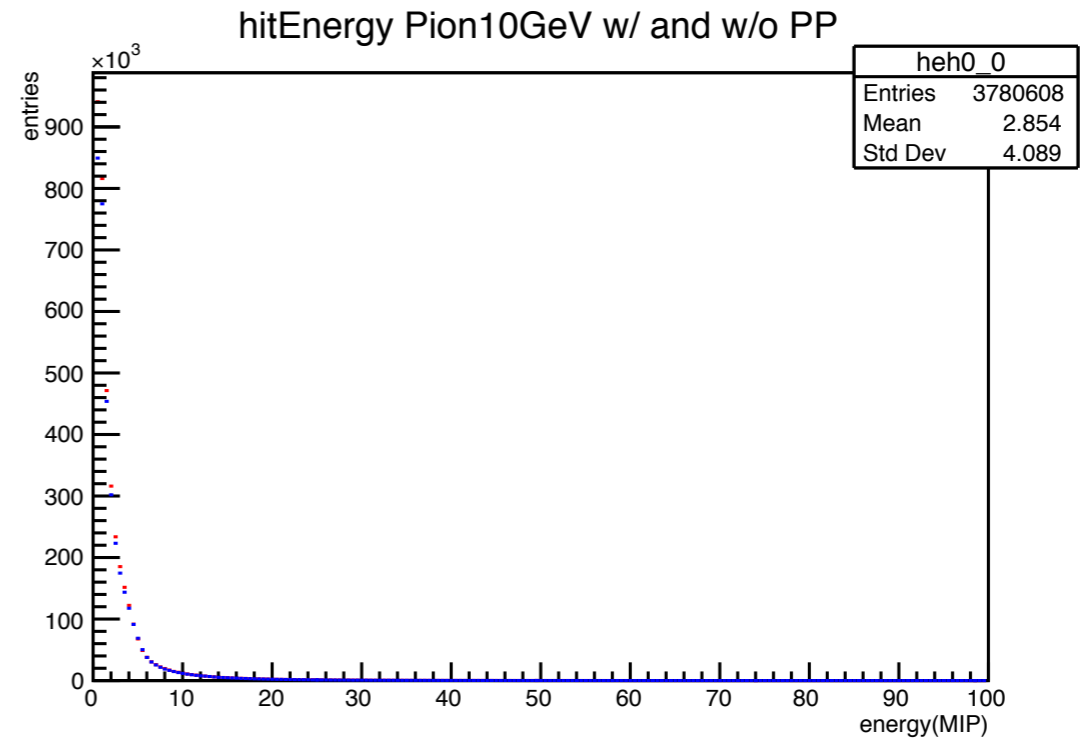
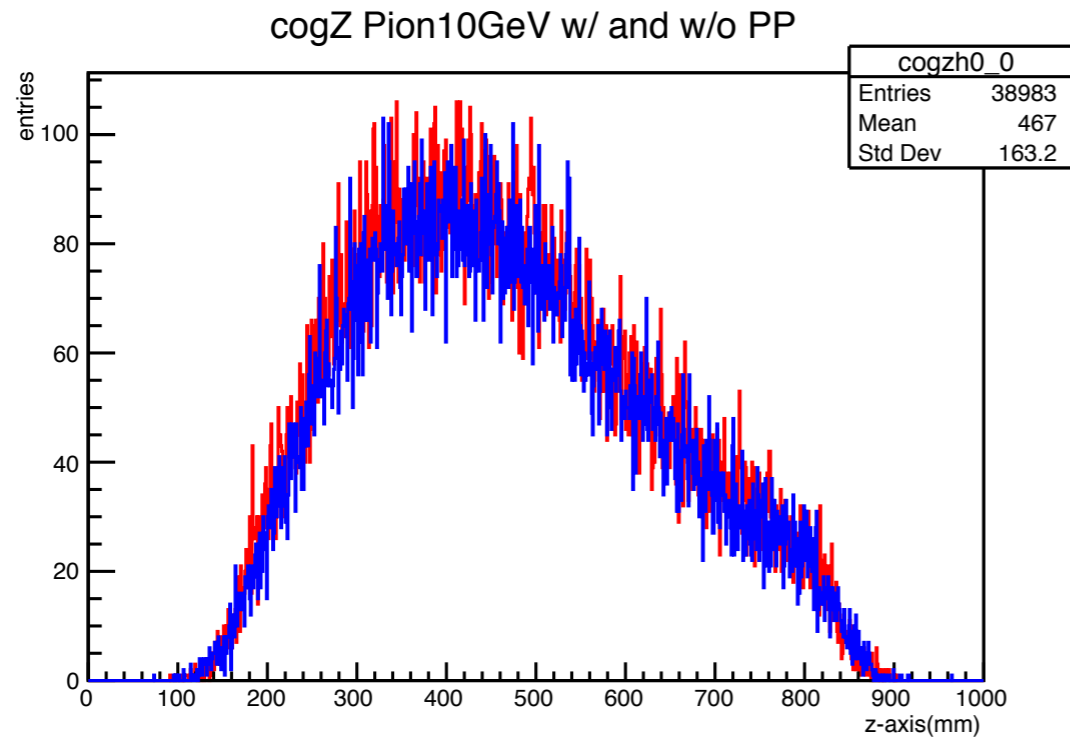


Summary

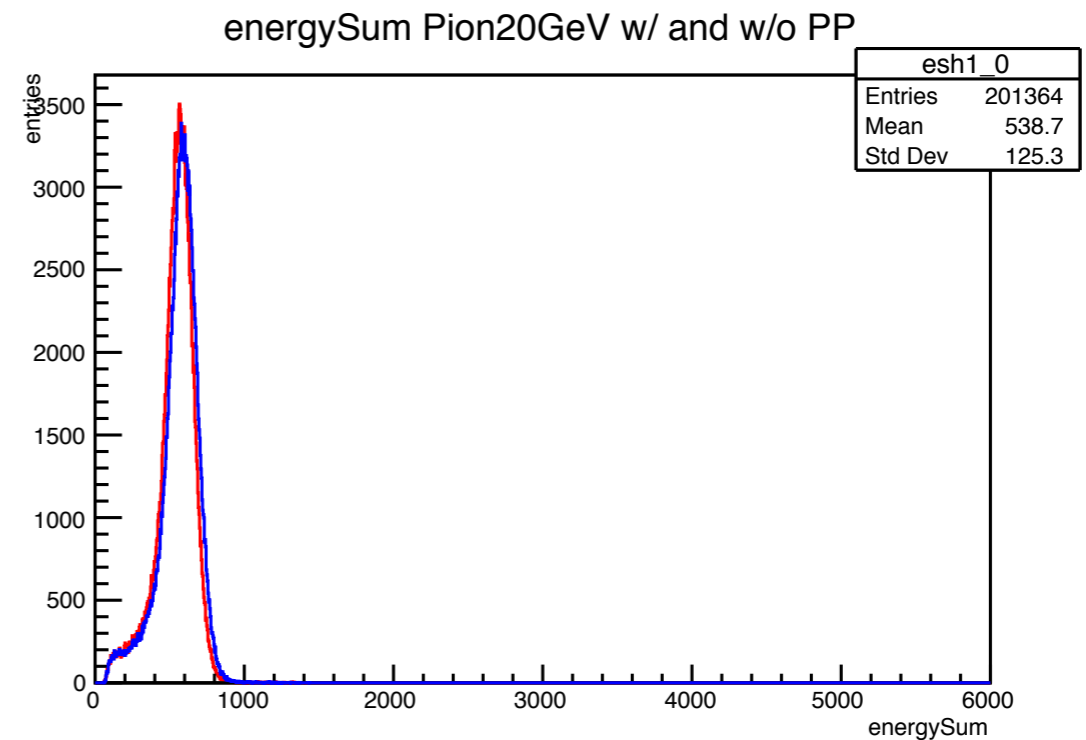
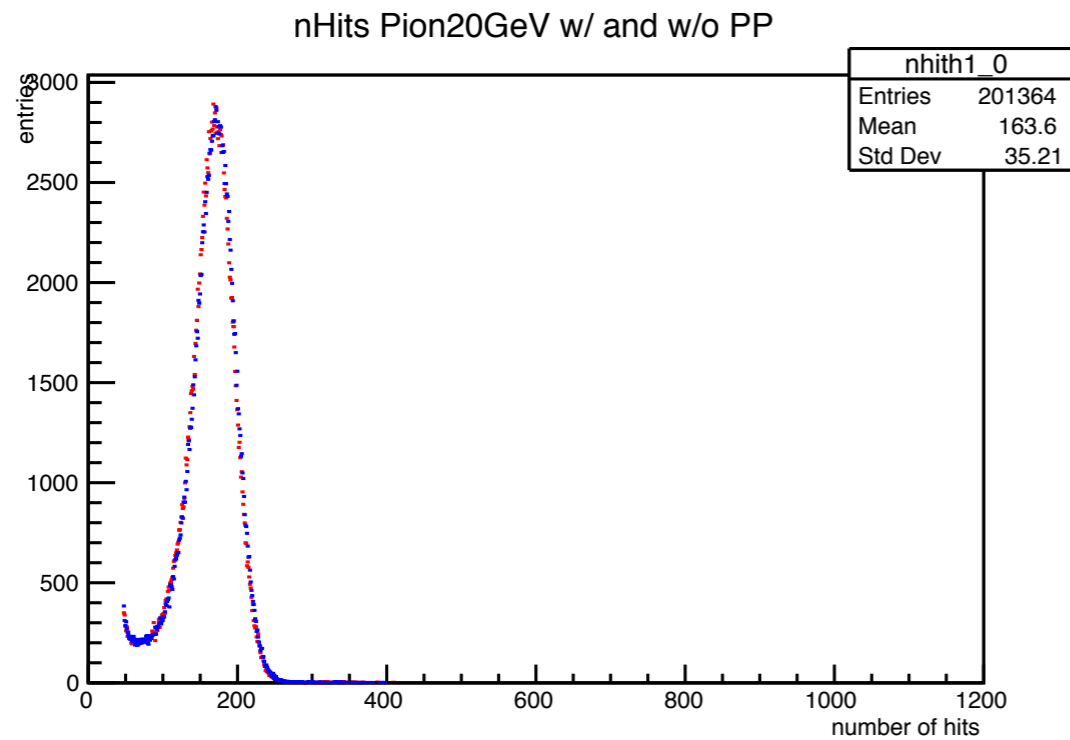
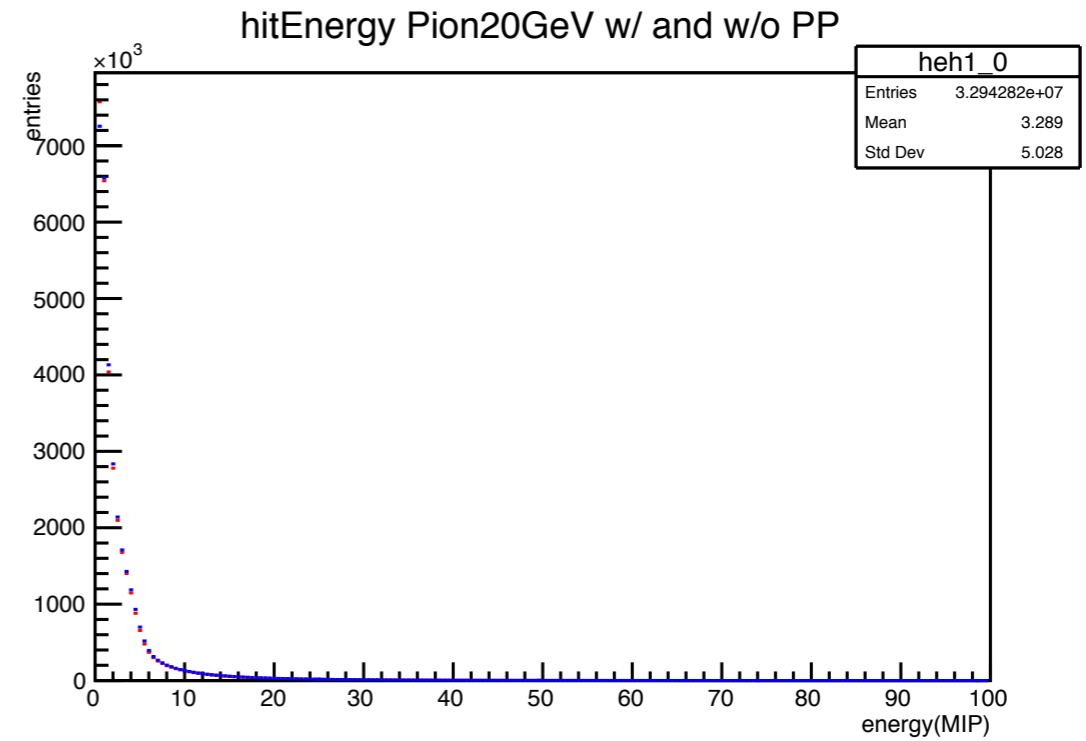
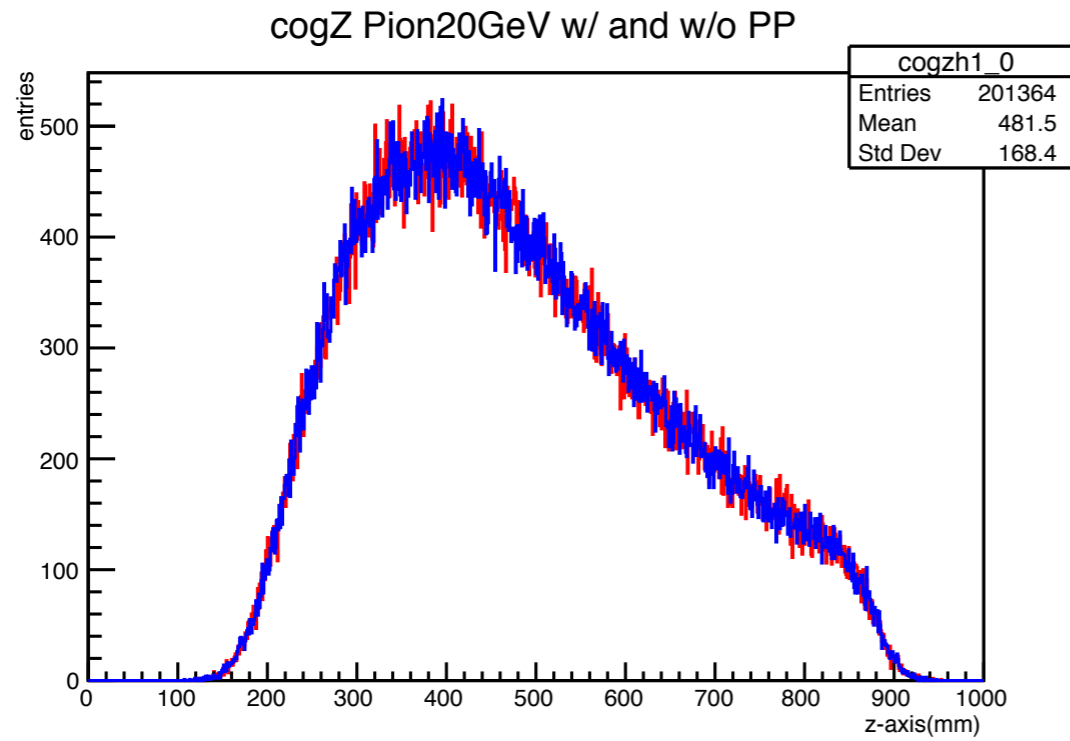
- Almost the same behaviors can be seen b/w PP and NoPP at all energies.
 - There are no shifts at energySum distributions
 - NoPP/PP ratio of shower profile is around 1 at each layer and energy.
- Good linearity for both of PP and NoPP
 - Both lines of PP and NoPP are overlapped well.

Backup

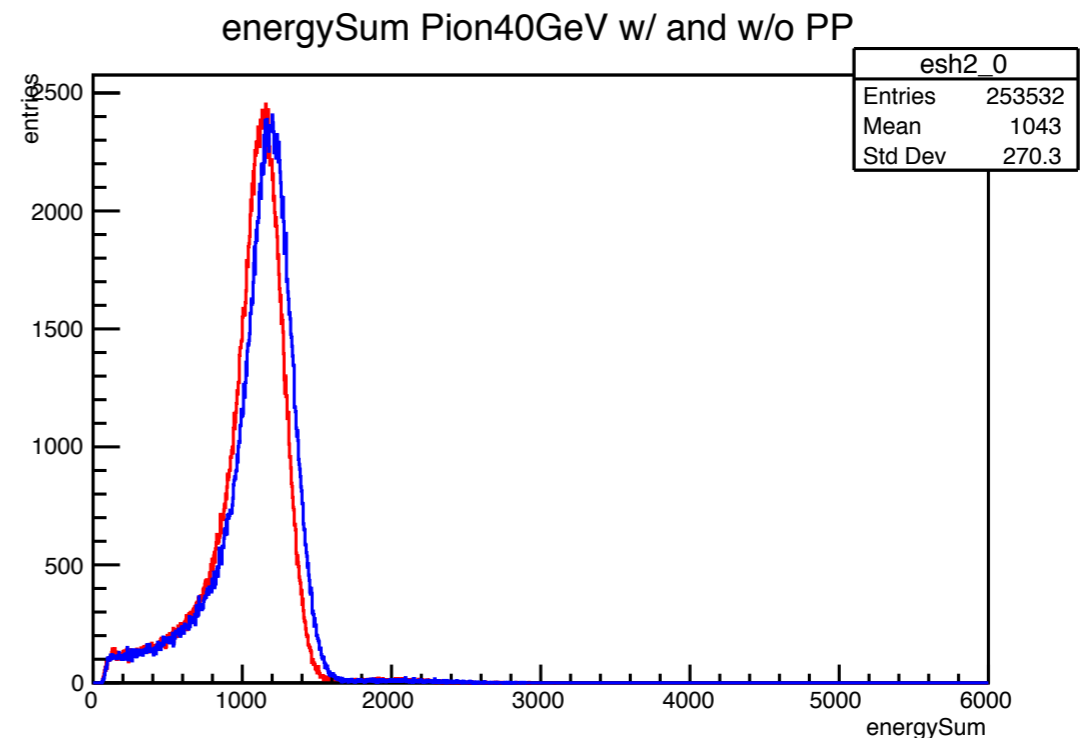
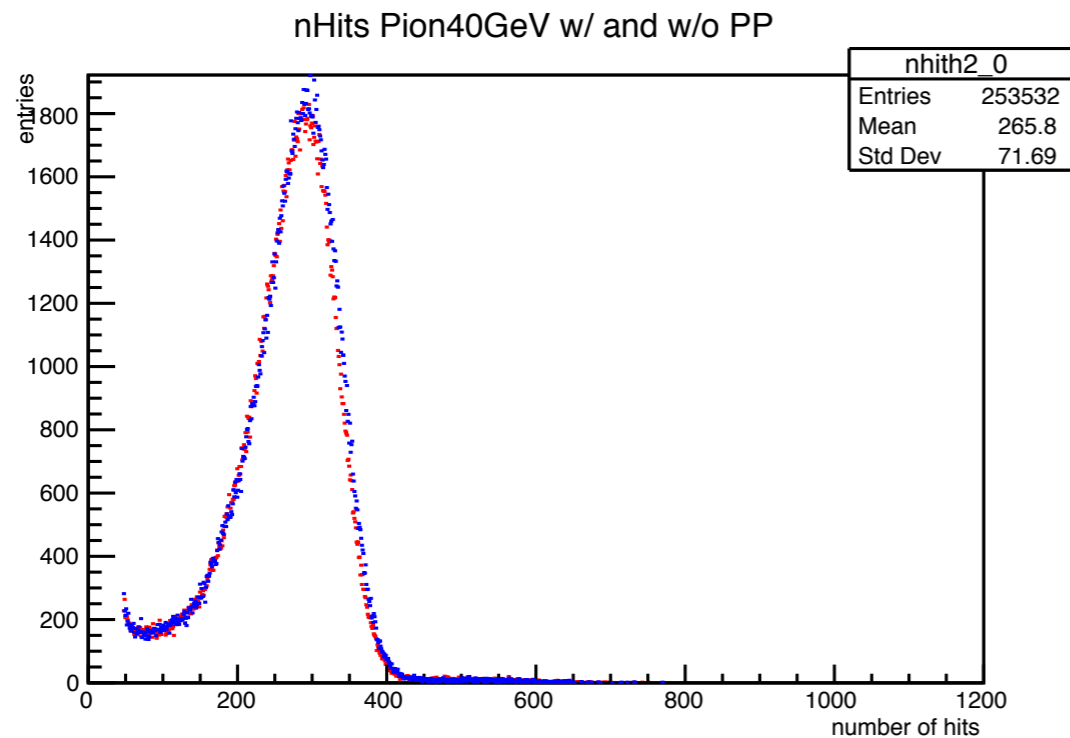
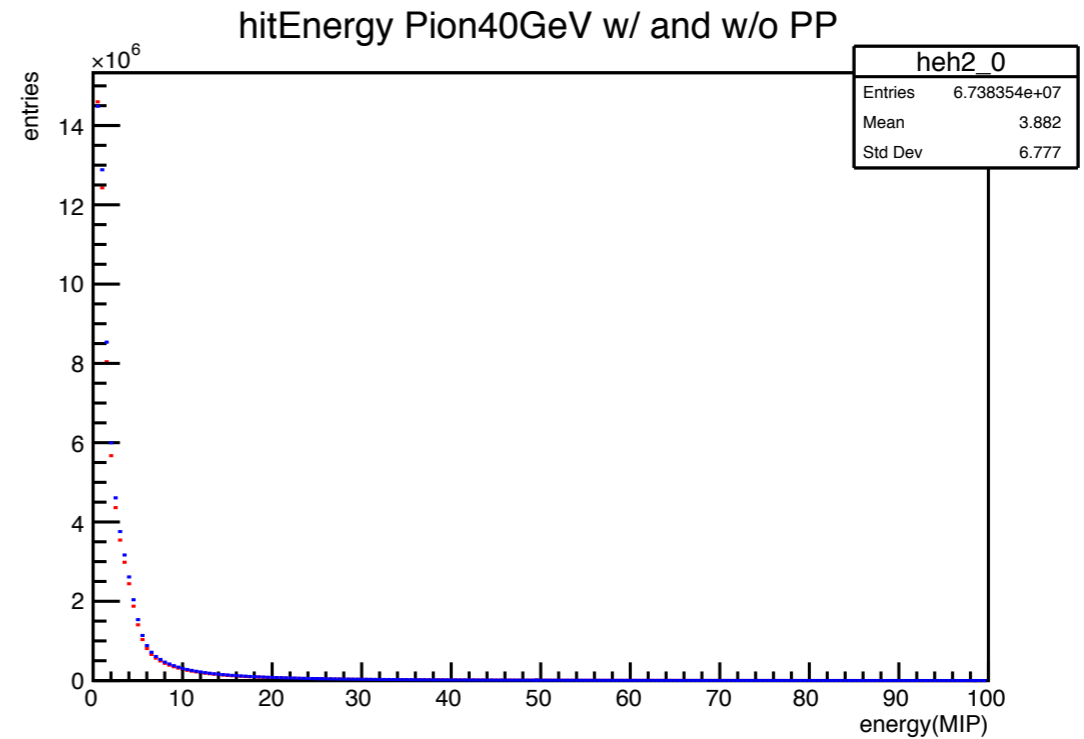
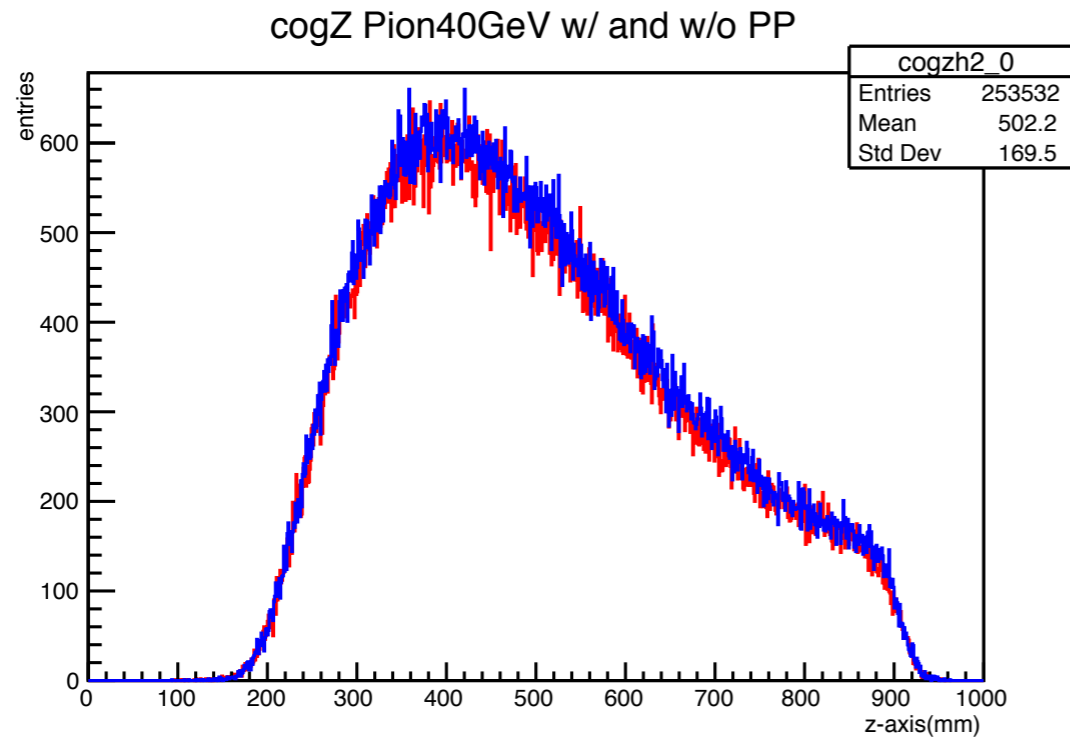
Pion 10 GeV with old constants



Pion 20 GeV with old constants

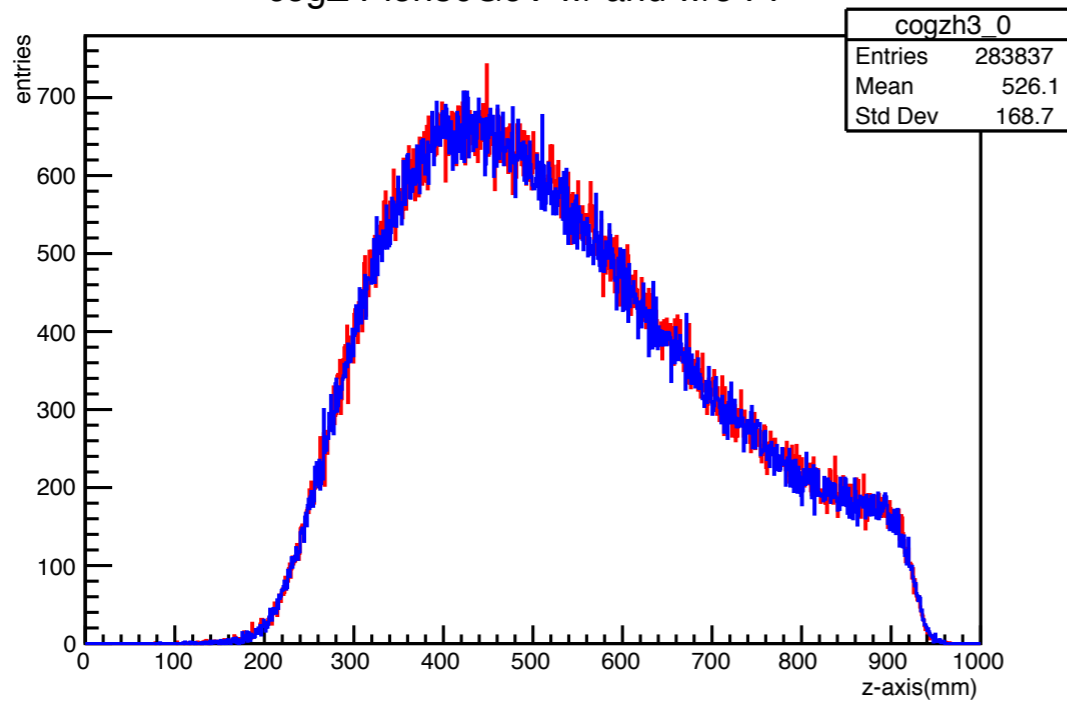


Pion 40 GeV with old constants

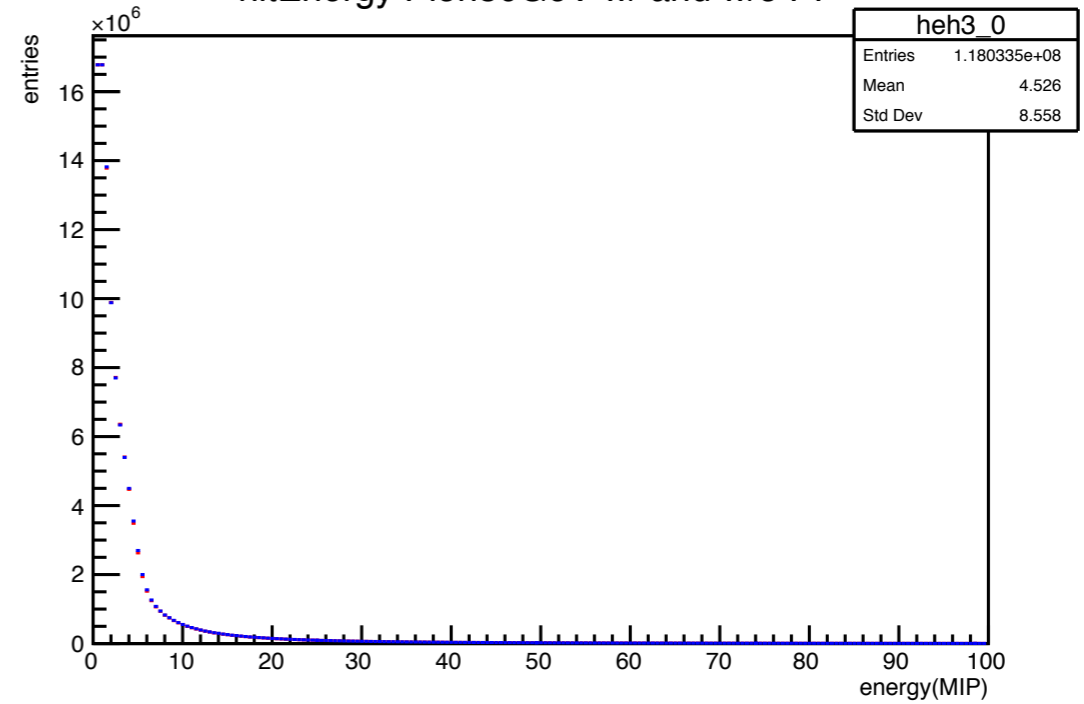


Pion 80 GeV with old constants

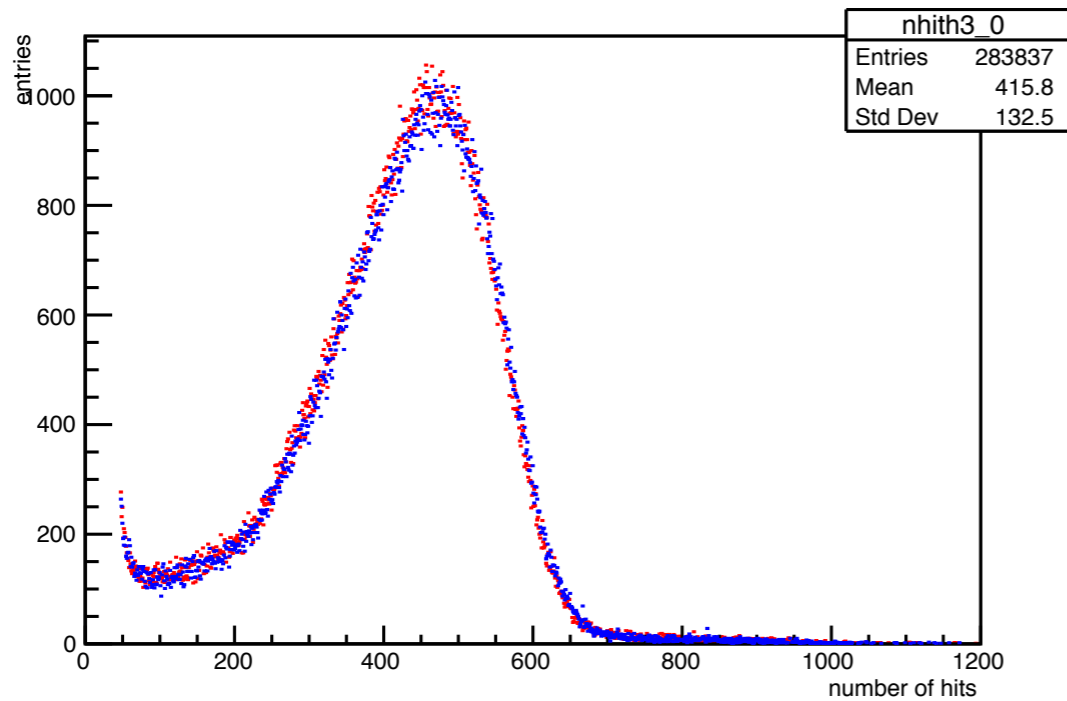
cogZ Pion80GeV w/ and w/o PP



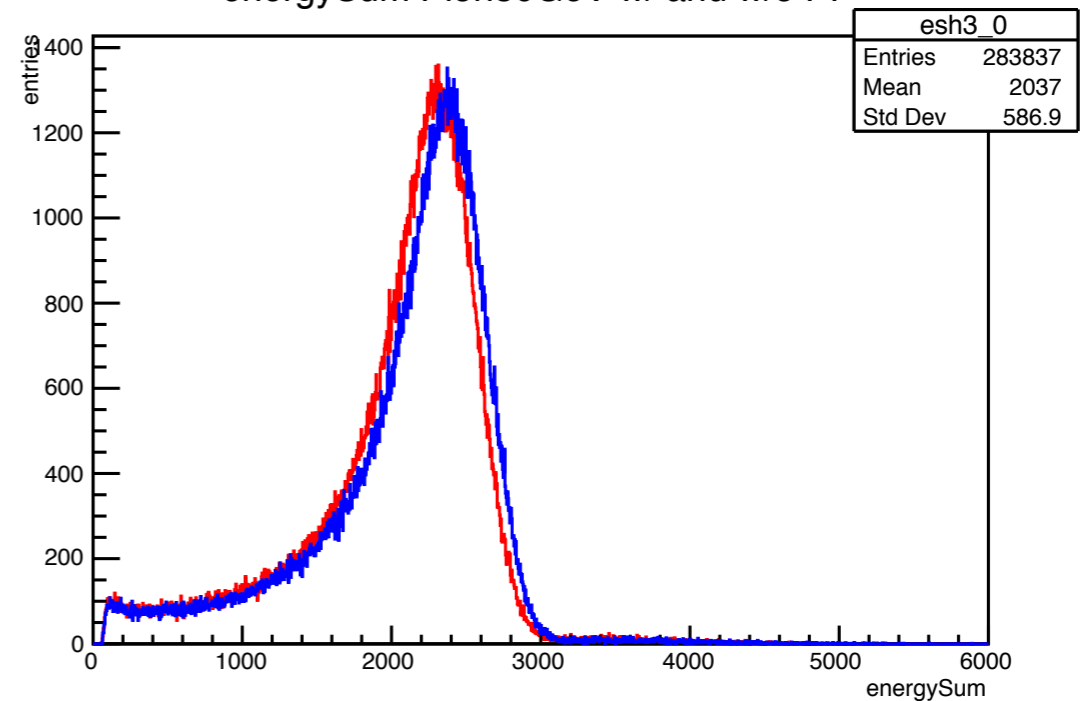
hitEnergy Pion80GeV w/ and w/o PP



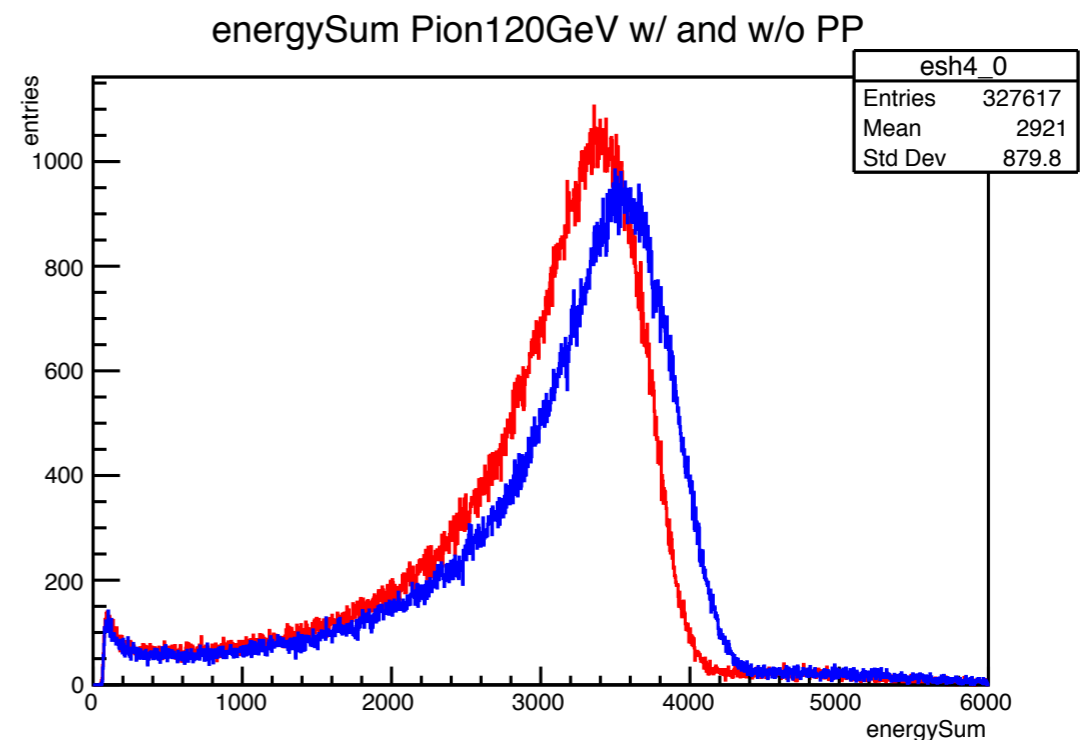
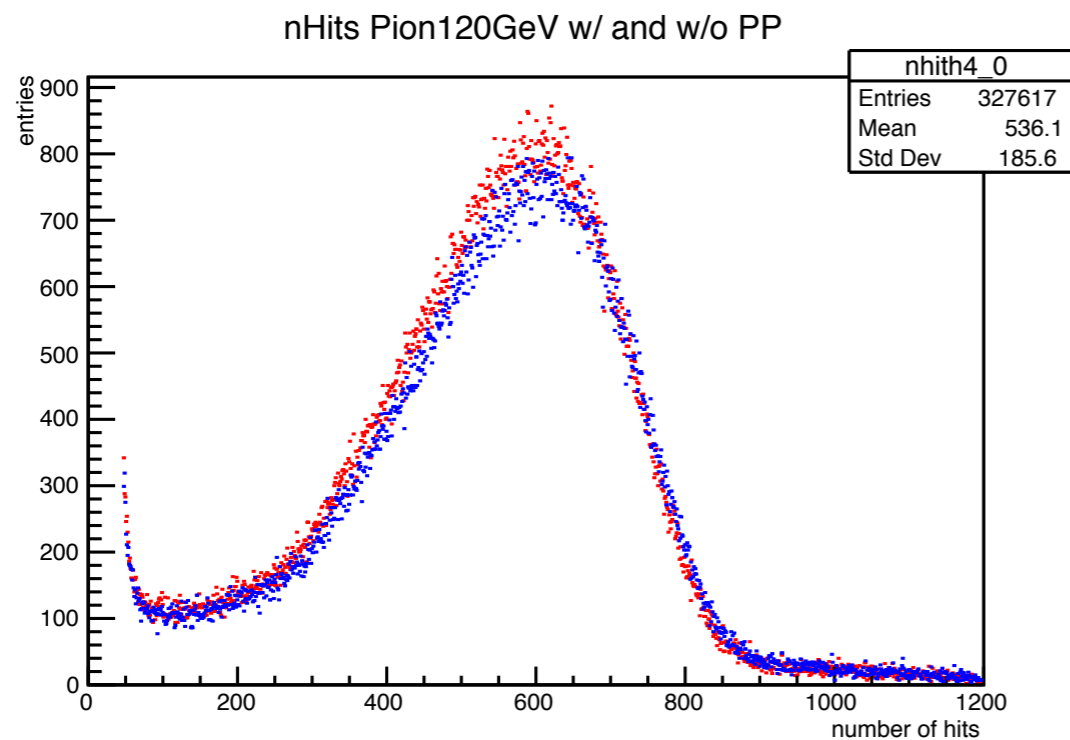
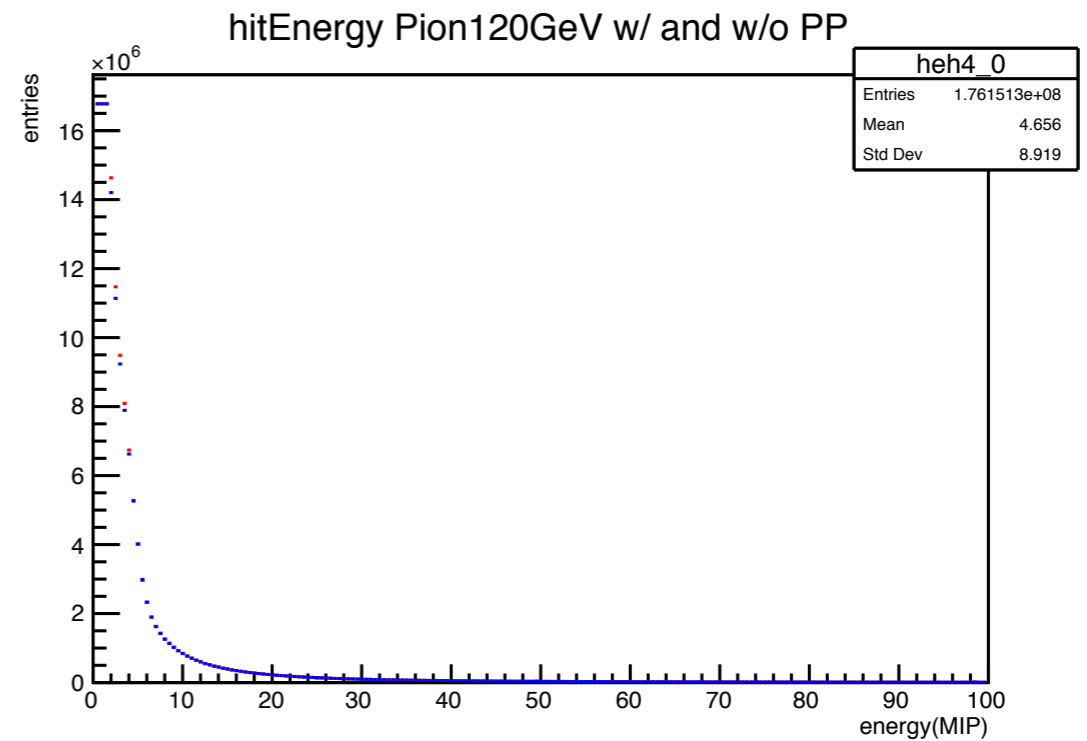
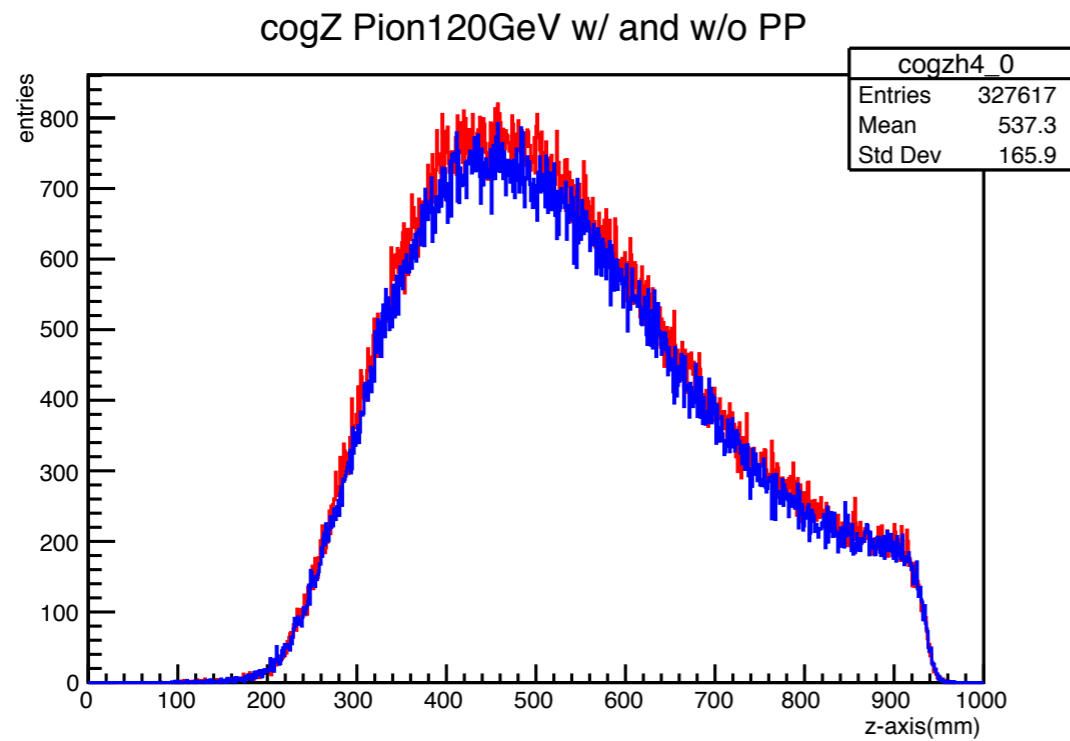
nHits Pion80GeV w/ and w/o PP



energySum Pion80GeV w/ and w/o PP

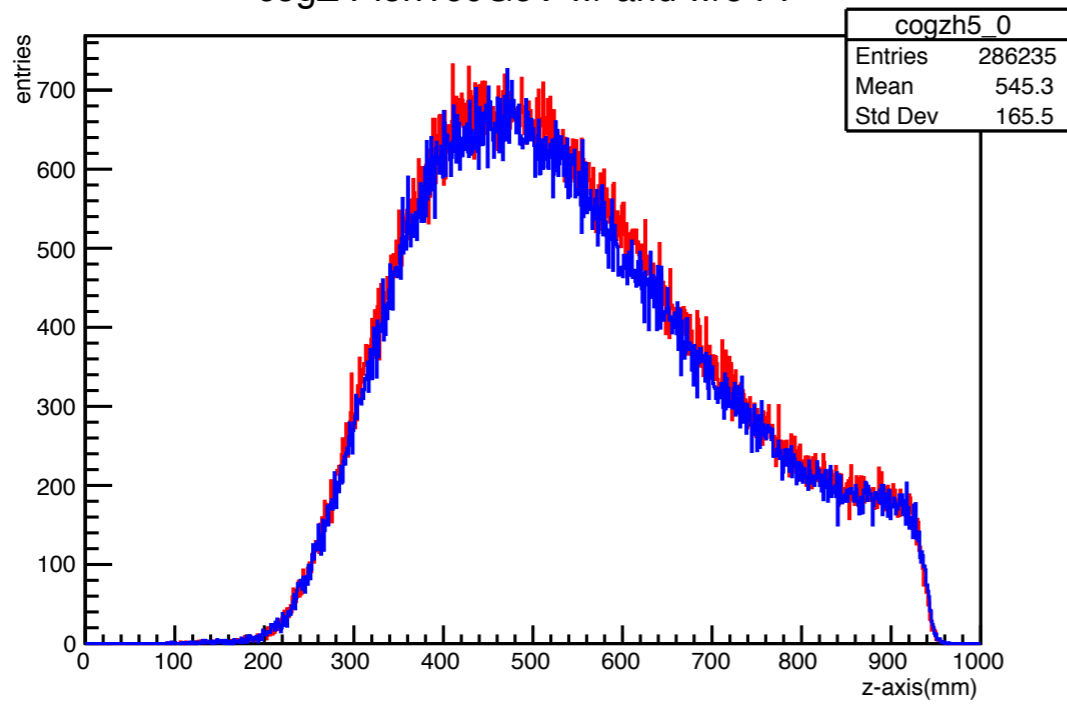


Pion 120 GeV with old constants

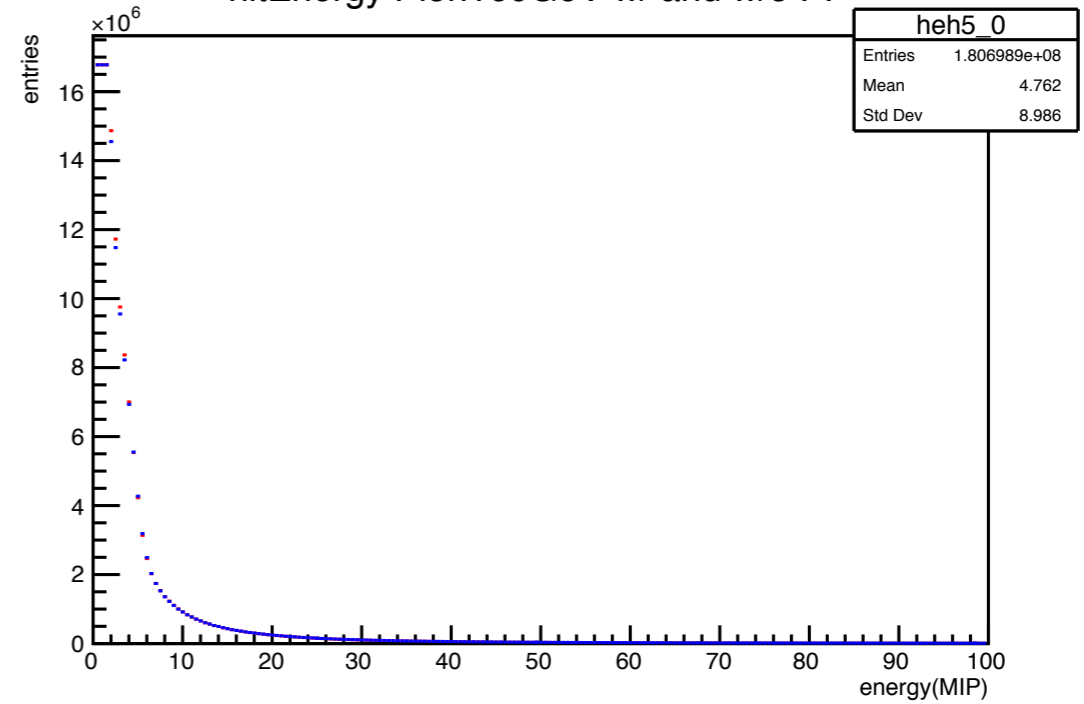


Pion 160 GeV with old constants

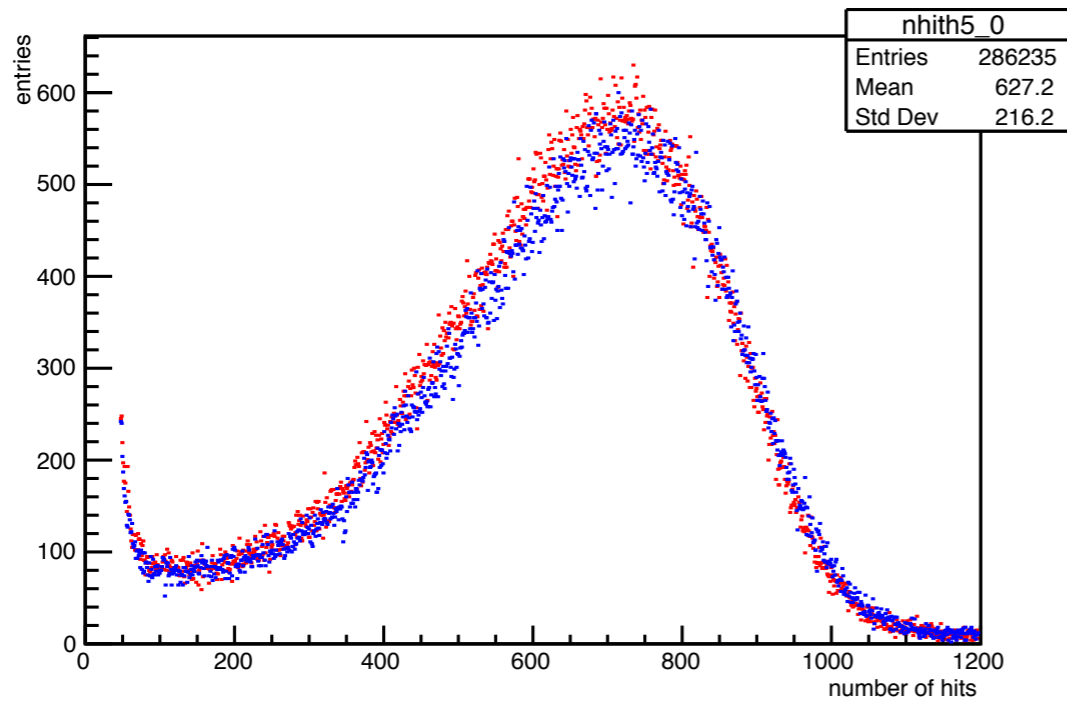
cogZ Pion160GeV w/ and w/o PP



hitEnergy Pion160GeV w/ and w/o PP



nHits Pion160GeV w/ and w/o PP



energySum Pion160GeV w/ and w/o PP

