

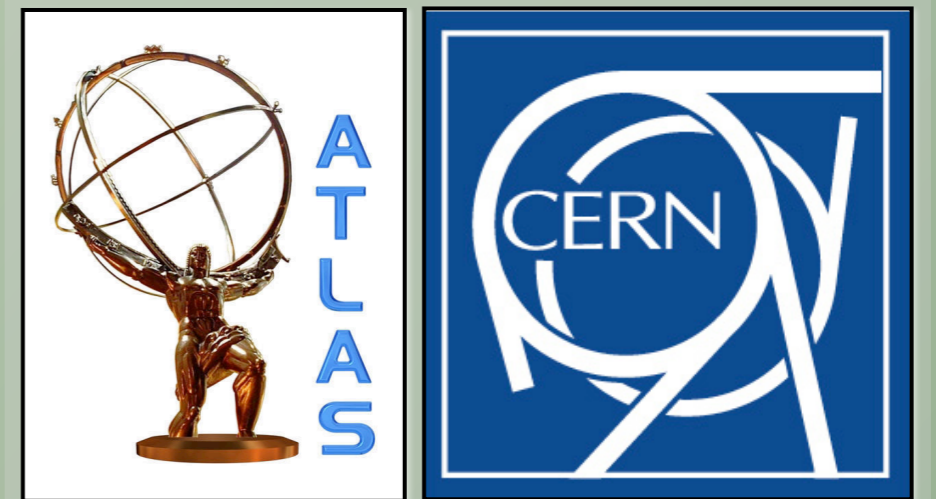
Punch-through detection using ‘Muon Spectrometer Showers’ & MET resolution and tails

Atlas Hadronic Calibration Workshop 23-27 June 2009

Johan Lundberg, with David Berge
CERN, 2009

slide 2-6: Slides for MET session, Friday, 26 2009

slide 8-27: Submitted material

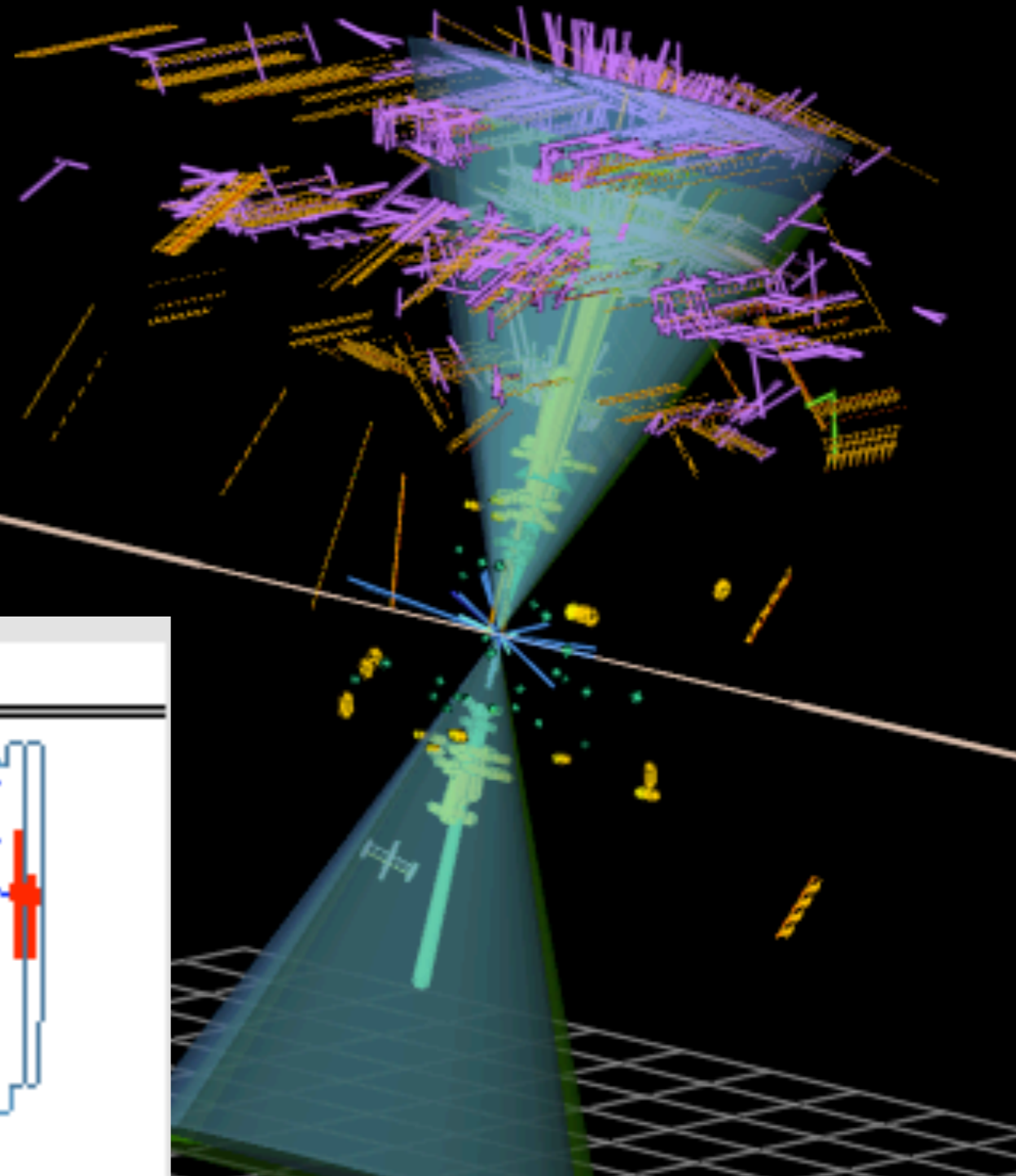
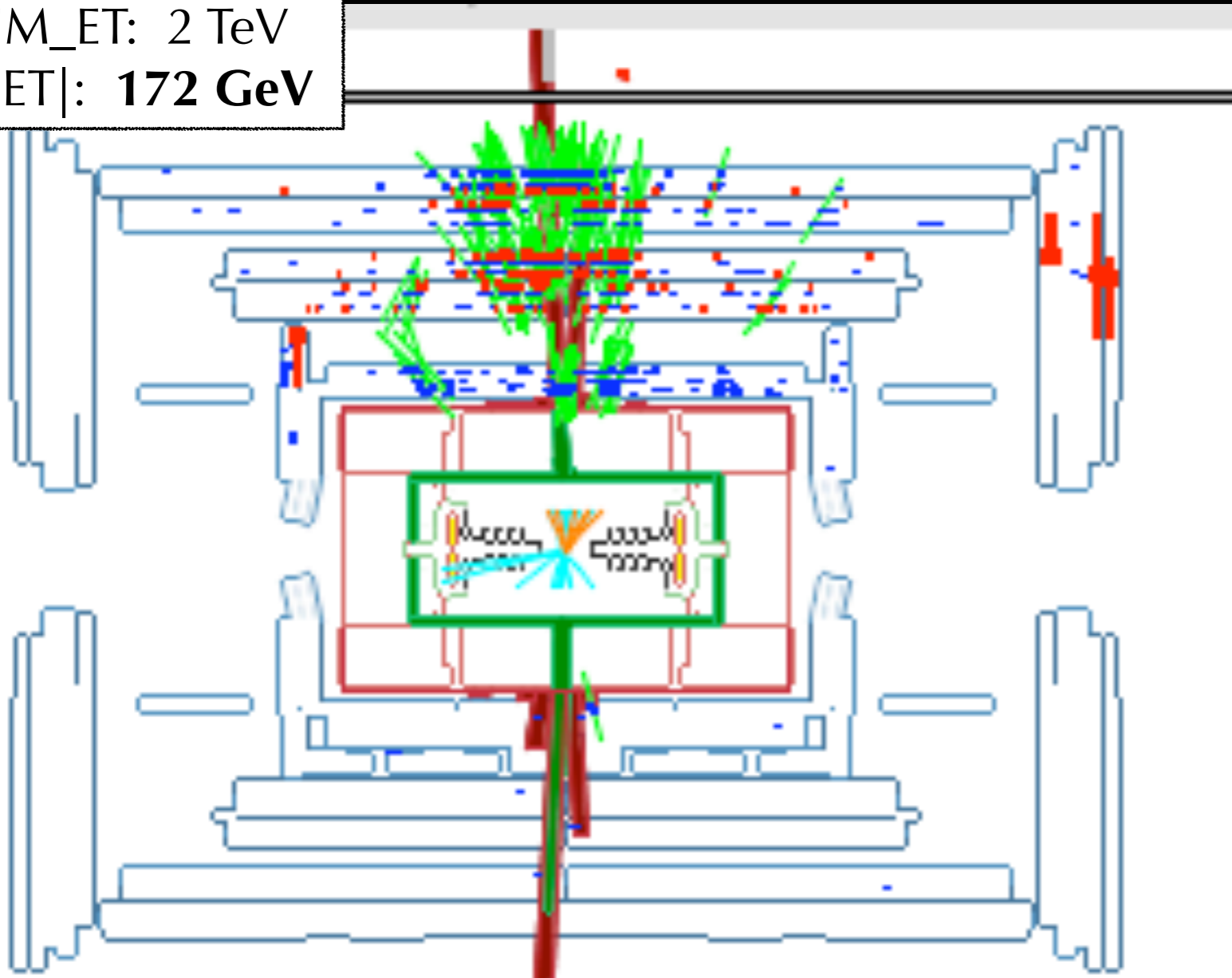


2 Study of relation between very large Fake MET (eg. > 100 GeV) and many muon system hits

Example of a suspected punch-through event with many muon hits

Event 271117

ETA: 0.0
SUM_ET: 2 TeV
|MET|: 172 GeV

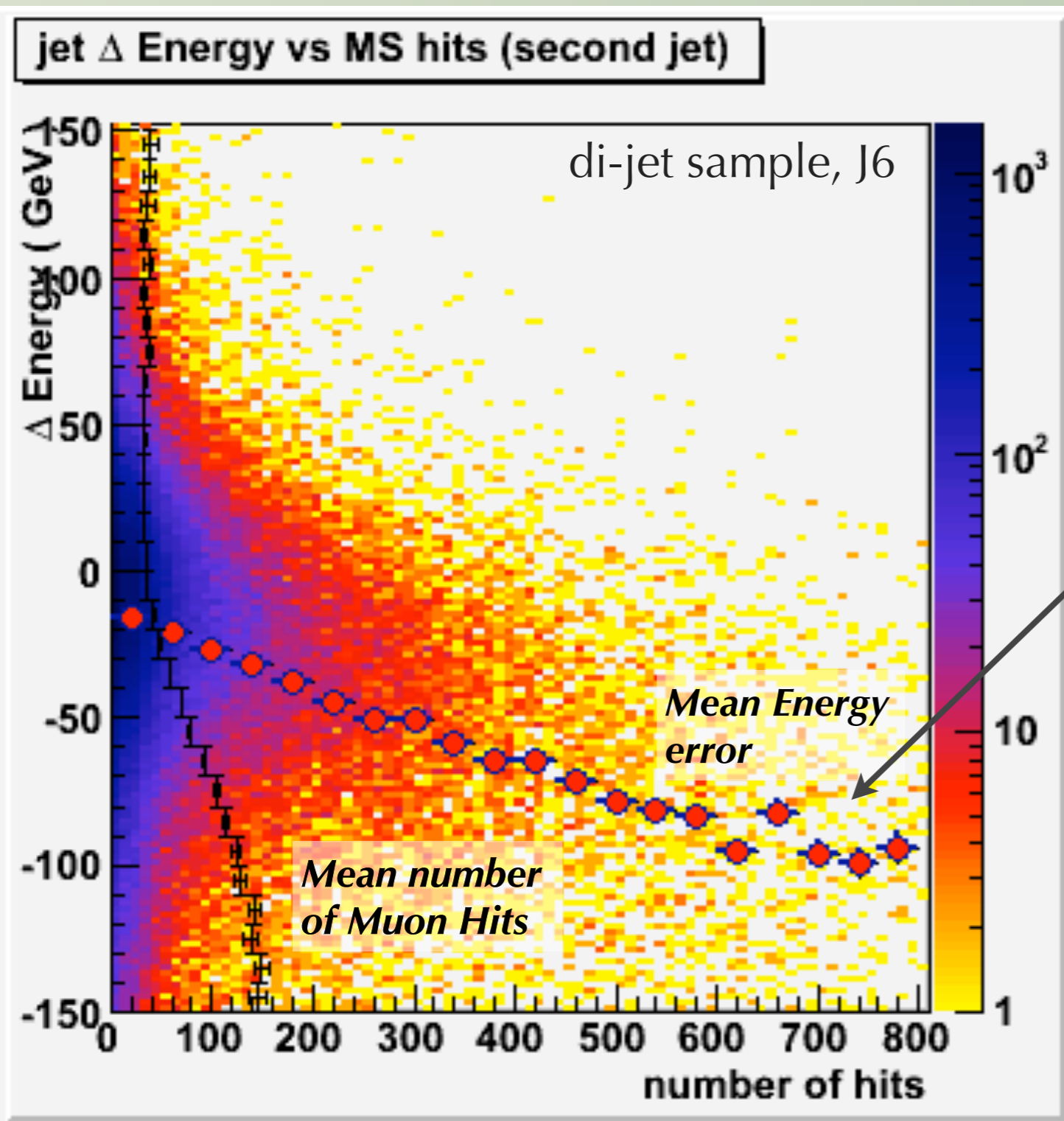


MuonSpShowerContainer
contains, for the muon spectrometer,

- counts of hits
- counts of muon segments within a cone around jet axes

Developed and used before by Frank Paige, Stephane Willocq, Ketevi Assamagan, ...

Correlation between jet Energy Error (Rec-Truth) and muon shower hits



Energy error: $\Delta E = \text{True-Reco Jet energy}$ vs the number of Muon shower hits for second jet.

There's a clear correlation, but also a very large spread.

For very high numbers of muon hits the mean energy error is ~ 100 GeV

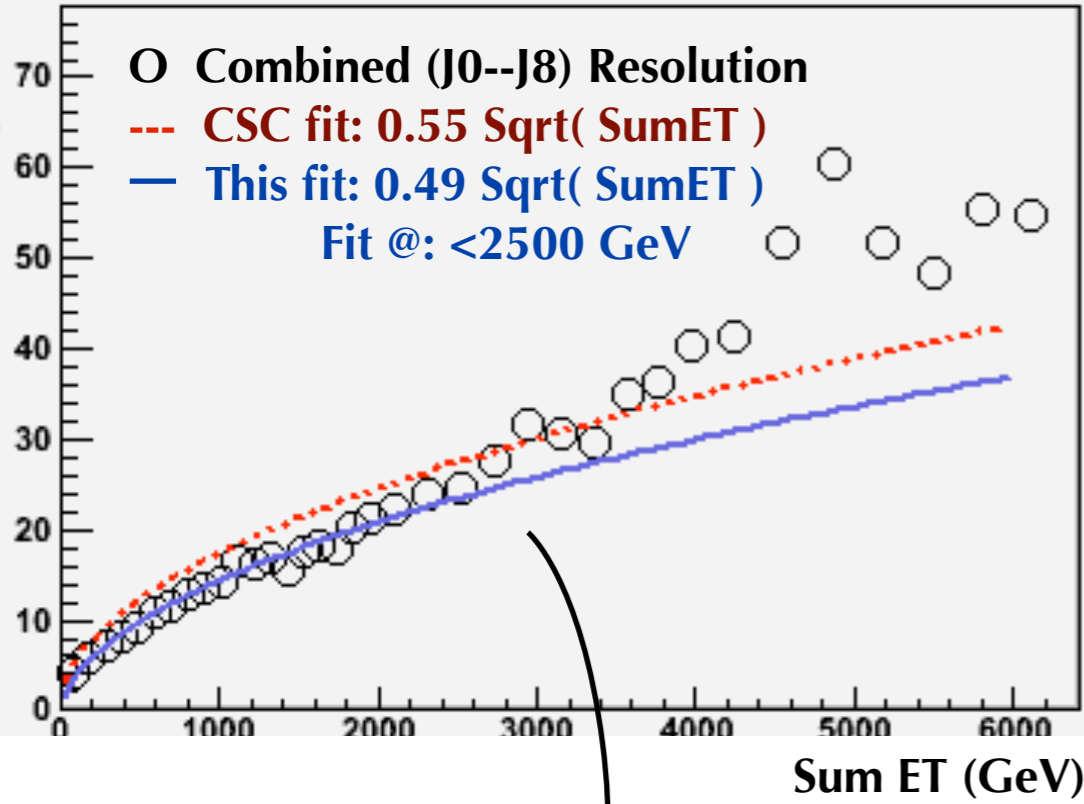
For high ET samples muon shower hits are insensitive to pileup (ref to backup slides)

For all plots (unless stated): dijet samples:
 user09.KojiTerashi.mc08.105017.
 J*_pythia_jetjet.recon.DPD_NOSKIM.
 e344_s479_r635_DPDMaker000164_p1

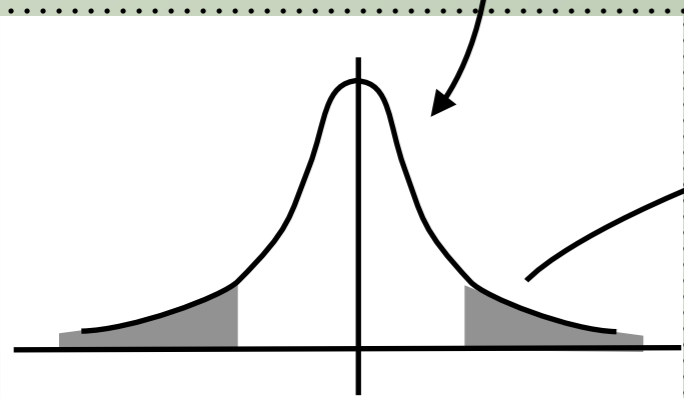
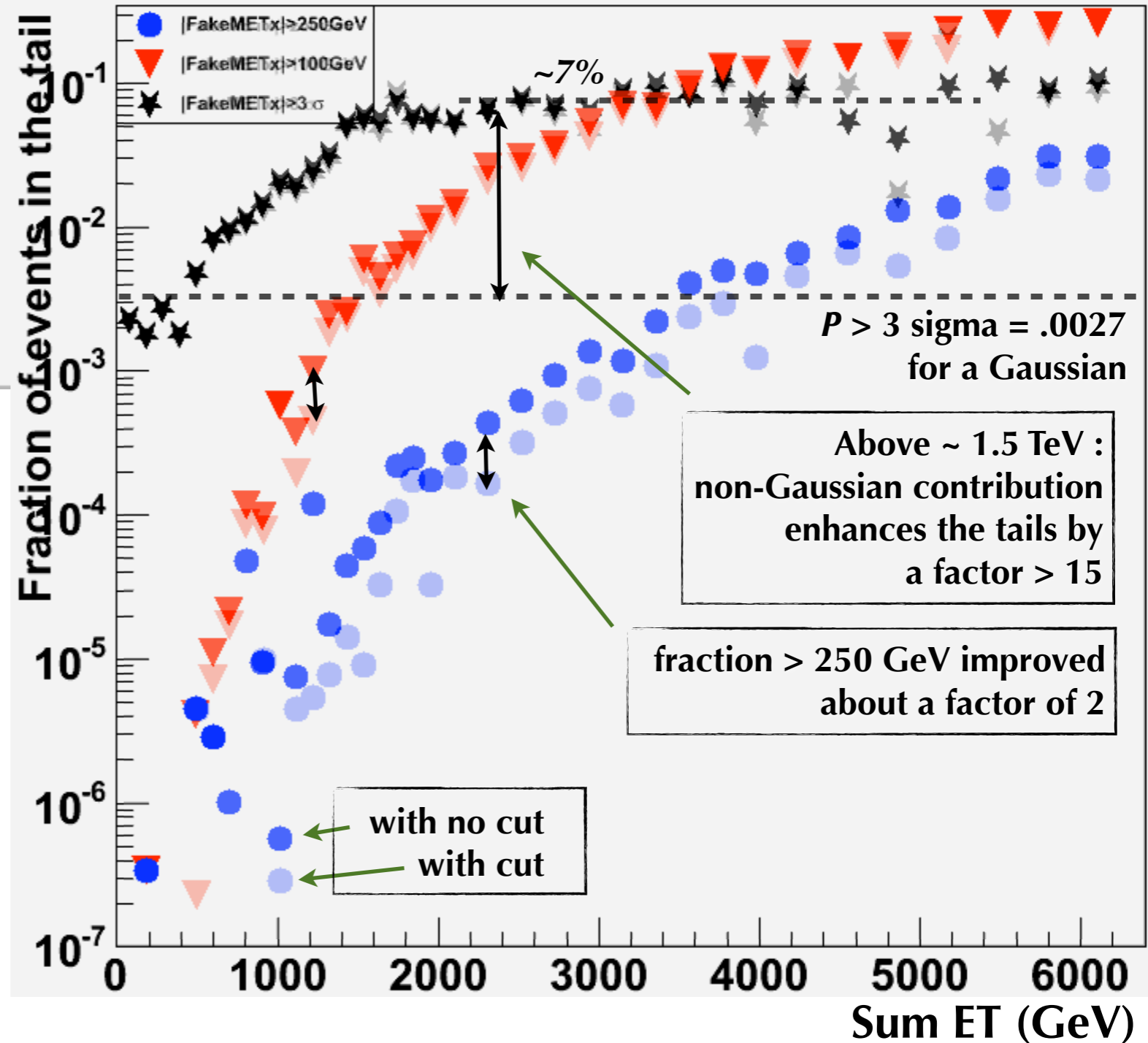
For pileup comparisons:
 user09.MichiruKaneda.mc08.105017.
 J*_pythia_jetjet.recon.DPD_NOSKIM.
 e344_s479_d150_r642_DPDMaker000164_p1

Fraction of di-jet events appearing in MET tails
 ...compared to all events at the same Sum ET

METx resolution, GeV

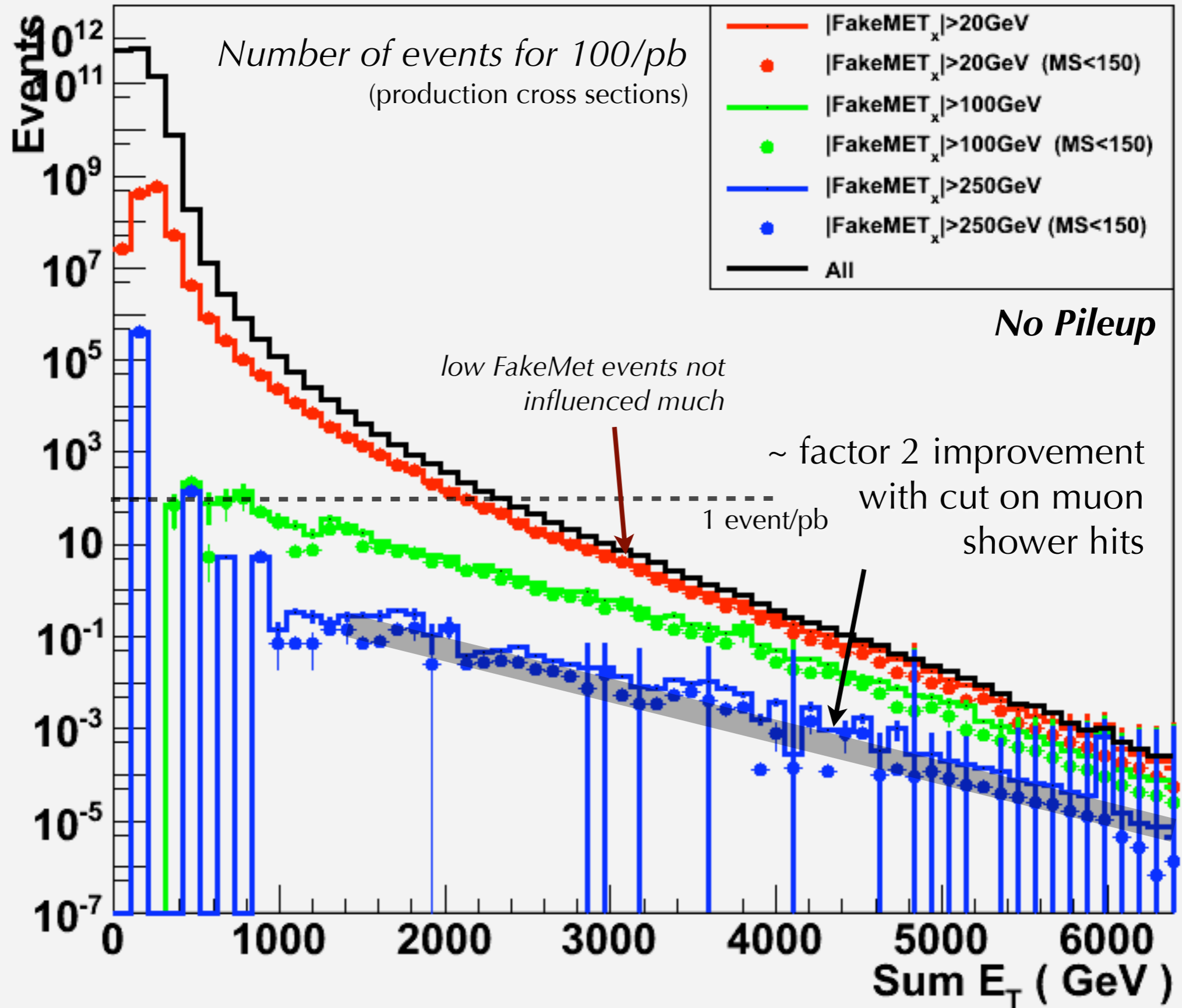


*With and without a cut:
 Muon Shower Hits < 150*



- FakeMET > 250 GeV
- ▼ FakeMET > 100 GeV
- ★ FakeMET > 3 sigma

Number of events for different fake MET cuts

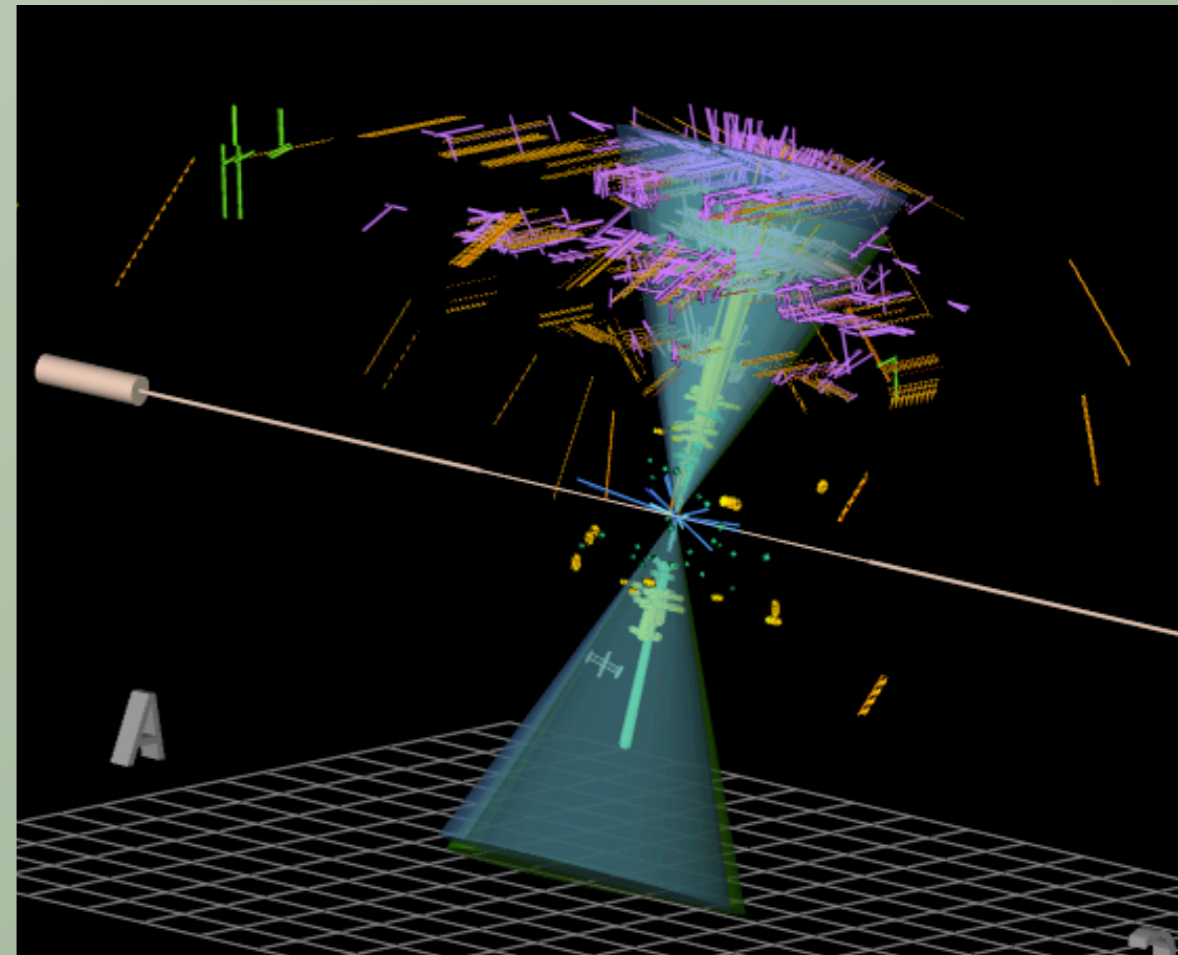


Summary

- *Muon shower hits are correlated to fake MET, with large noise and spread.*
- *Above ~ 1.5 TeV the fake MET tails are not Gaussian: The amount of events with fake MET >3 sigma is enhanced by a factor $> \sim 15$.*
- *In very High fake MET events (>250 GeV) about 50% have a very high count (>150) of Muon shower hits.*
- *Muon Spectrometer hits and large Fake MET insensitive to Pileup.*
- *Rate of these events expected to be low*

Questions

- *Could we cut/flag such events in e.g. SuSy analyses?*
- *Could we use muon spectrometer showers for calibration improvements?*



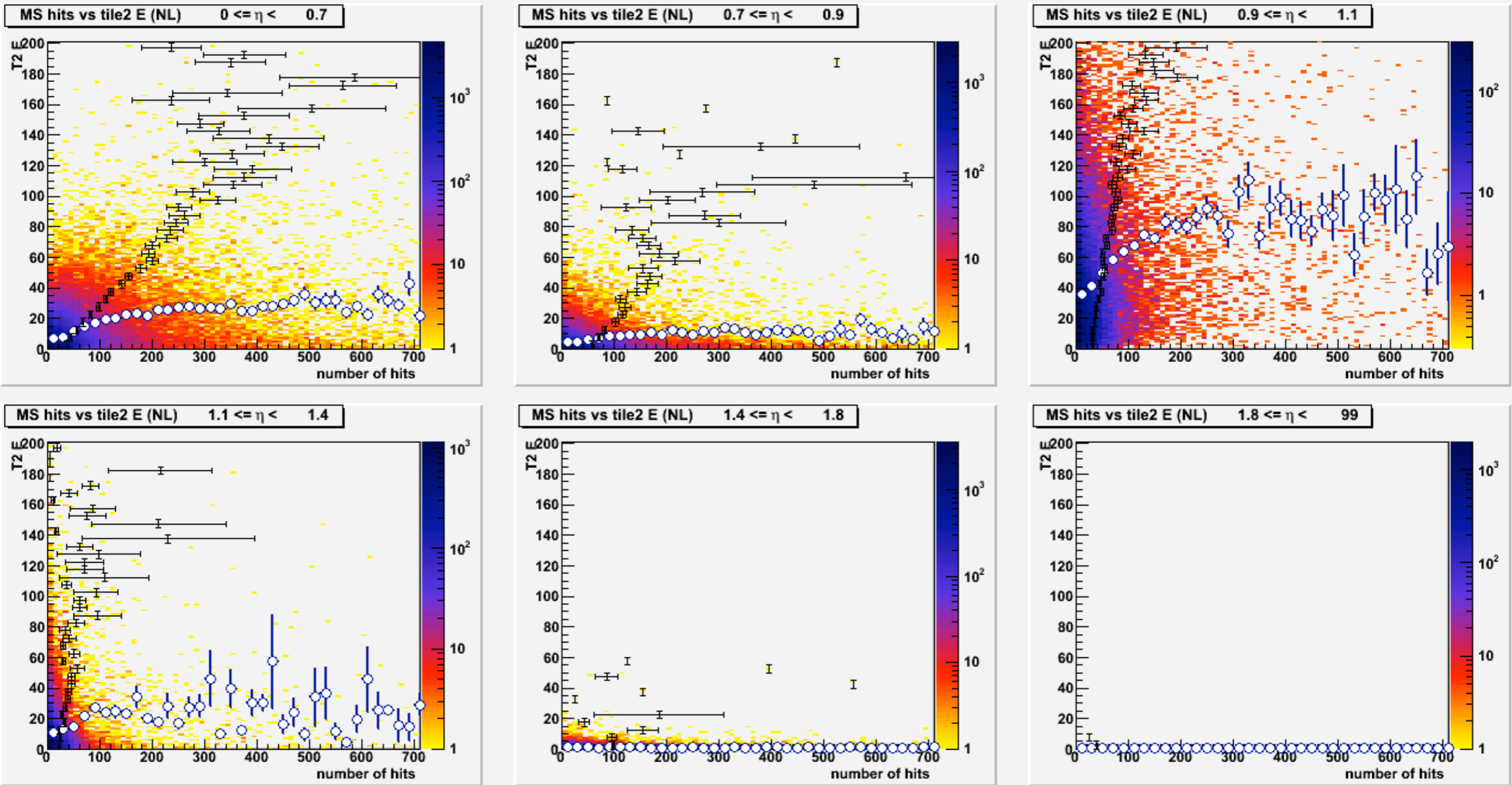
Standard cone jet,
Cone7 H1 TowerJets
phi/eta box : half size = 0.4

dijet samples:
user09.KojiTerashi.mc08.105017.J*_pythia_jetjet.recon.
DPD_NOSKIM.e344_s479_r635_DPDMaker000164_p1

For pileup comparisons:
user09.MichiruKaneda.mc08.105017.J*_pythia_jetjet.recon.
DPD_NOSKIM.e344_s479_d150_r642_DPDMaker000164_p1

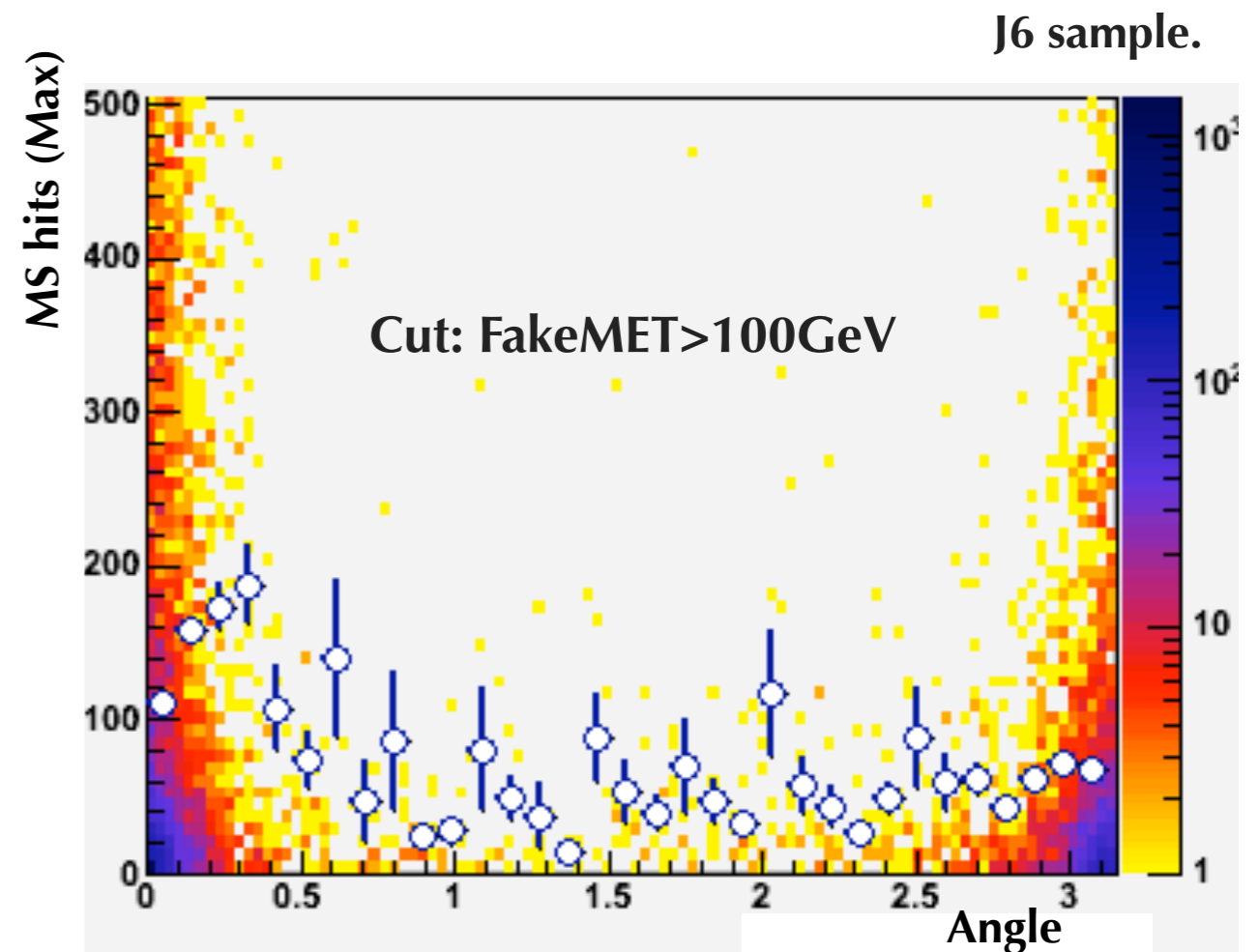
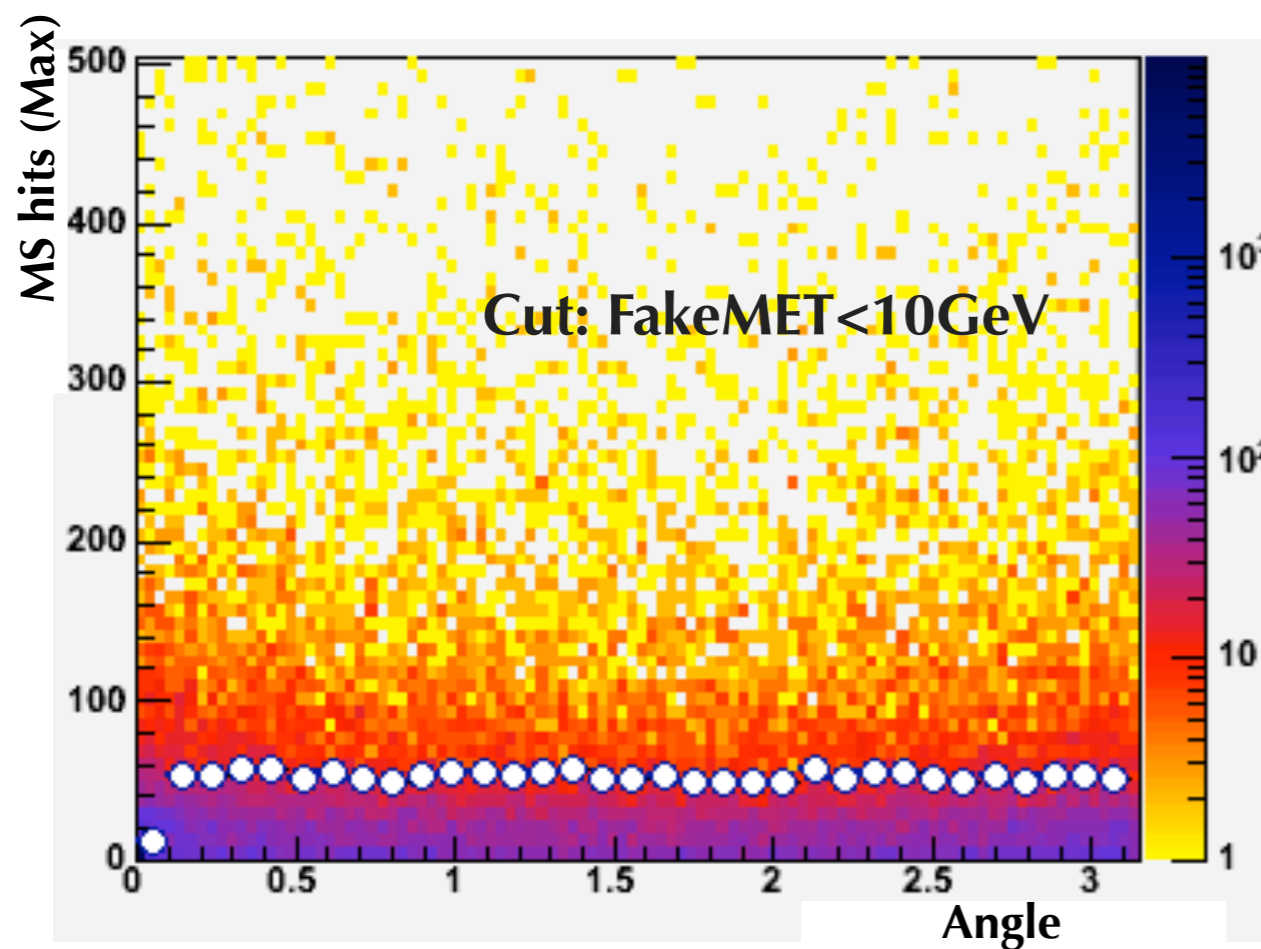
offline 15.1

Outer TileCal layer energy deposition, Second Jet, vs number of muon Hits



Correlation; MET to Jet angle vs Number of muon shower hits Can we use muon hits to find large fake MET events

*It's clear that FakeMet in dijets points towards one of the leading jets (often 2:nd).
The angle between fake MET and the jet (out of the 4 leading) with the highest number of muon shower hits.*



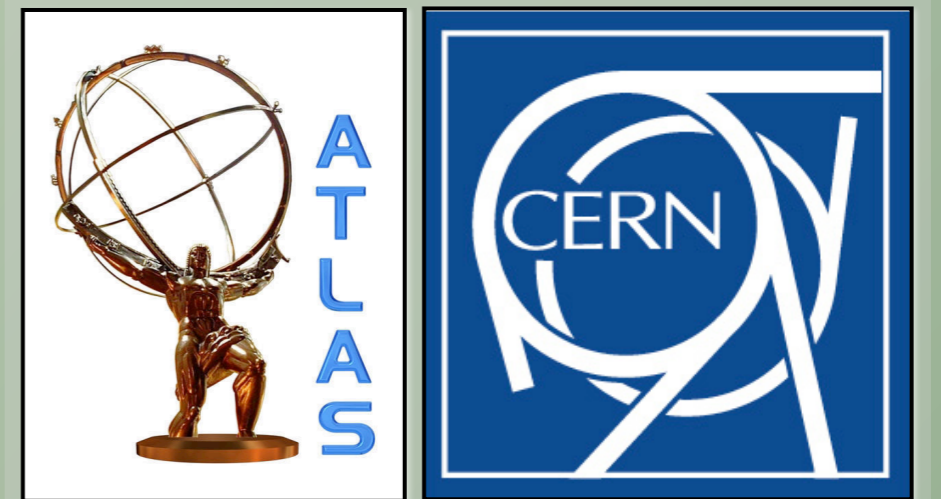
*Could be useful to make
cleaning cuts in this space
- Needs testing with
example analyses*

Submitted material

Punch-through detection using ‘Muon Spectrometer Showers’
& MET resolution and tails

Atlas Hadronic Calibration Workshop 23-27 June 2009

Johan Lundberg, with David Berge
CERN, 2009



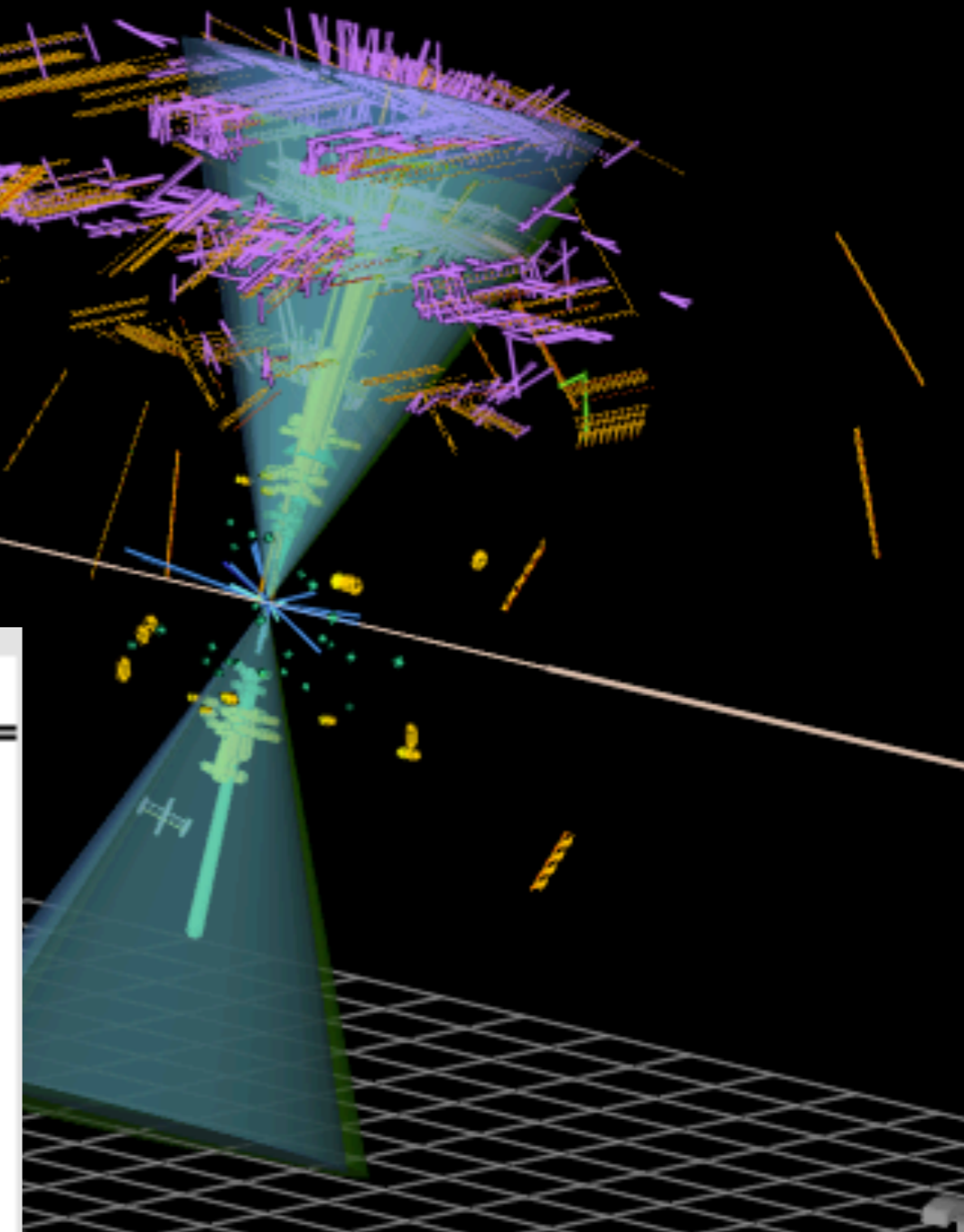
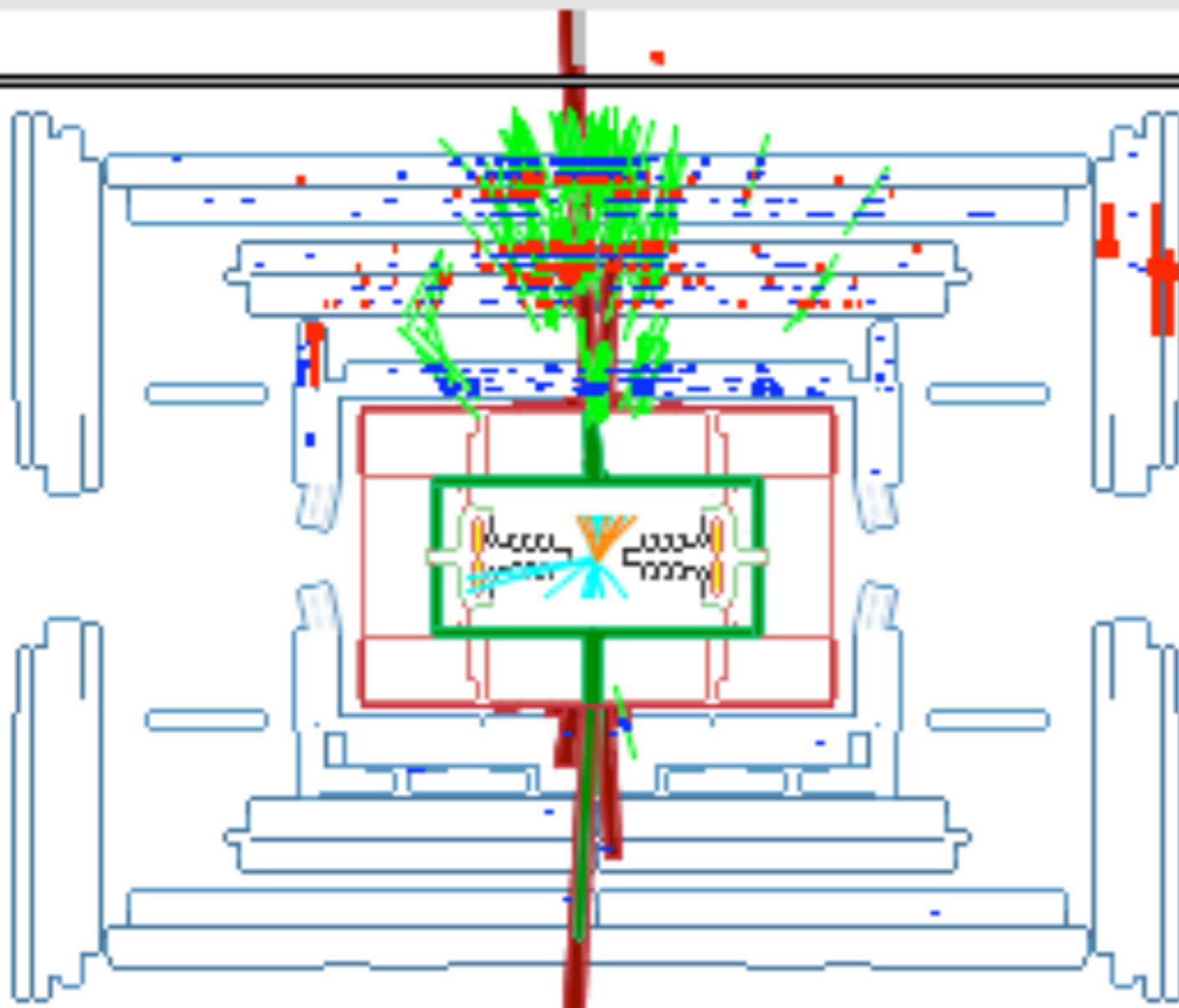
- *Summary/Conclusion*
- *MuonSpShowerContainer, what is it? Correlation to Jet Energy Error*
- *Fit of Jet Resolution*
- *Fraction and Number of events in MET tails, with and without Cut on MuonSpShower hits*
- *+ Fit resolution, Fraction and number of events with Pileup*

Backup

- *Estimation of MET resolution: $\sigma(\text{Truth} - \text{Rec})$
With/Without pileup, With/Without cuts on Muon Spectrometer Shower hits*
- *Number of dijet events for 100/pb
For normal dijet and pileup samples*
- *Number of Muon Spectrometer Shower hits vs eta, and Jet Energy*
- *Number of Muon Spectrometer Shower hits vs Jet Energy Error for
different eta-bands*
- *Cleaning (e.g. for SuSy context) using MET to Jet Angle vs muon
spectrometer shower hits. (with and without pileup)*
- *Muon spectrometer shower hits vs Jet Energy Error for 3 leading jets.*
- *Tools etc.*

Summary/Conclusion

- *Muon spectrometer shower hits are correlated to fake MET and jet energy error, with large noise and spread.*
- *Above ~ 1.5 TeV the fake MET tails are not Gaussian: The amount of events with fake MET >3 sigma of fitted MET resolution is enhanced by a factor $> \sim 15$.*
- *In very High fake MET events (>250 GeV) about 50% have a very high count of (>150) of Muon shower hits.*



Example of a suspected punch-through event with many muon hits

Event 271117

ETA: -0.00

SUM_ET 2 TeV

|MET|: 172 GeV

METx: -62 GeV

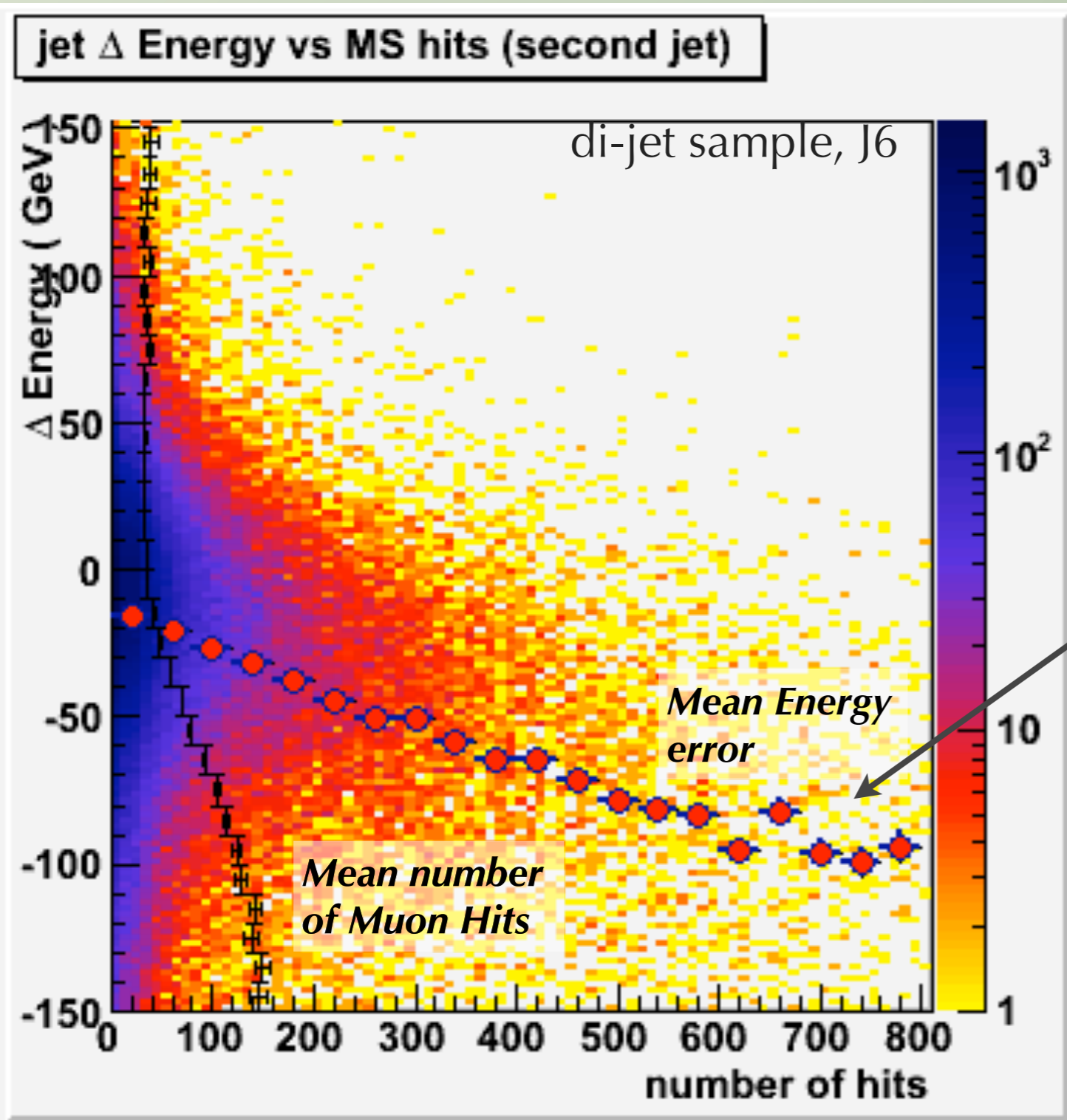
METy: 160 GeV

13 MuonSpShowerContainer

contains, for the muon spectrometer,

- counts of hits
- counts of muon segments
within a cone around jet axes

Developed and used before by Frank Paige, Ketevi Assamagan, ...



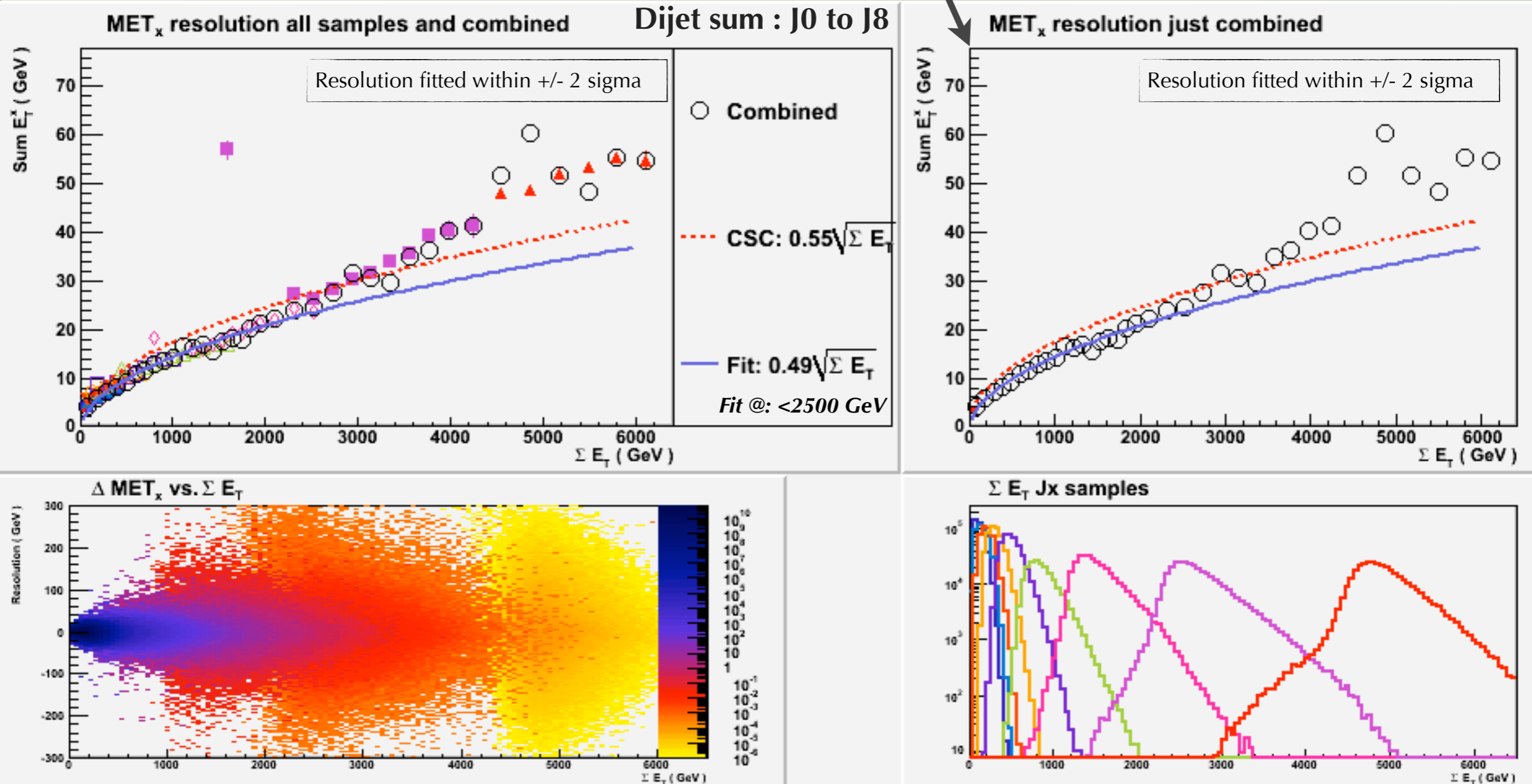
Energy error: $\Delta E = \text{True-Reco Jet energy}$ vs the number of Muon spectrometer shower hits for second jet.

There's a clear correlation, but also a very large spread.

For very high numbers of muon hits the mean energy error is ~ 100 GeV

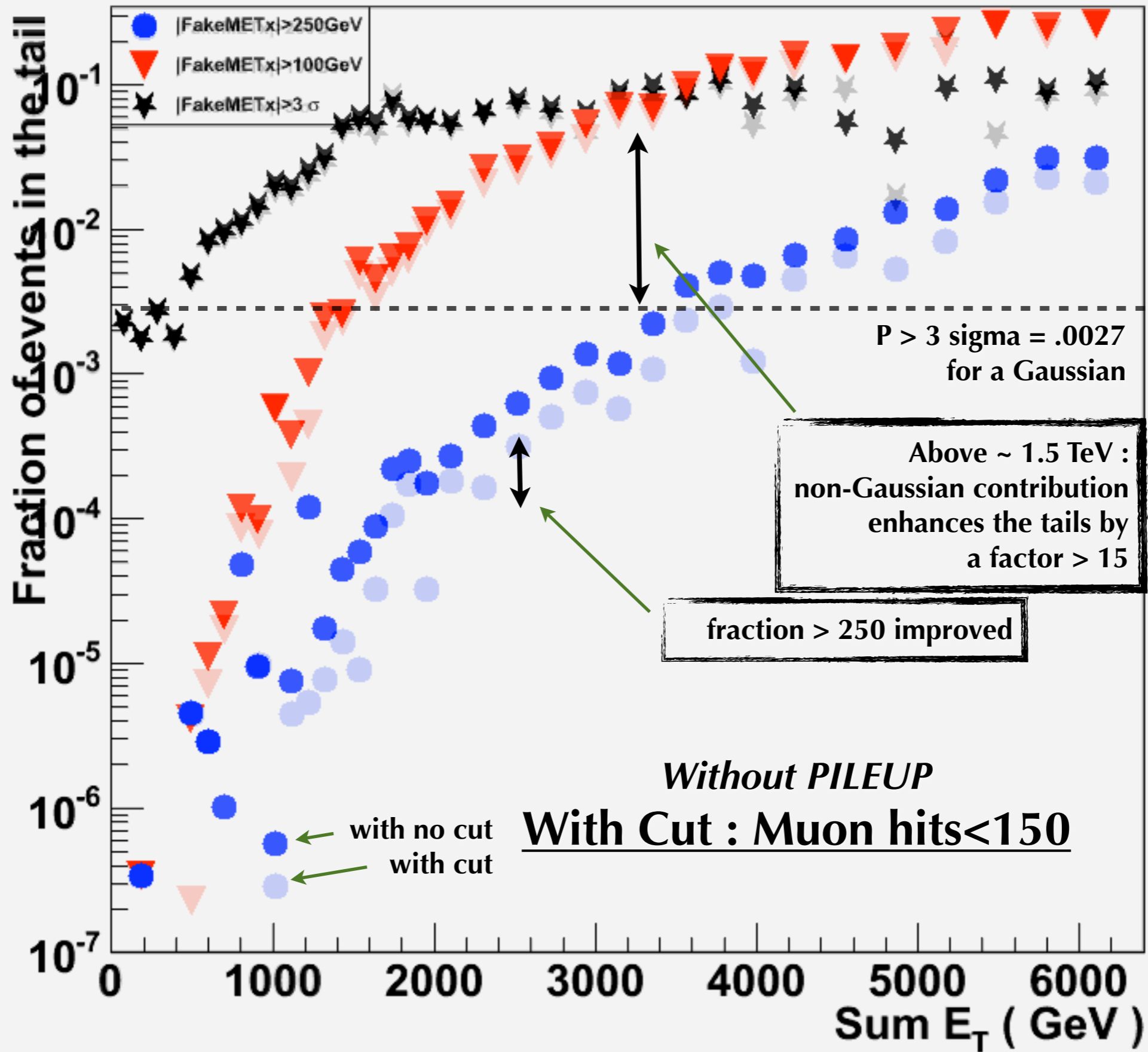
For high ET samples muon spectrometer shower hits are insensitive to pileup (ref to backup slides)

Estimation of MET resolution: $\sigma(\text{Truth} - \text{Rec})$



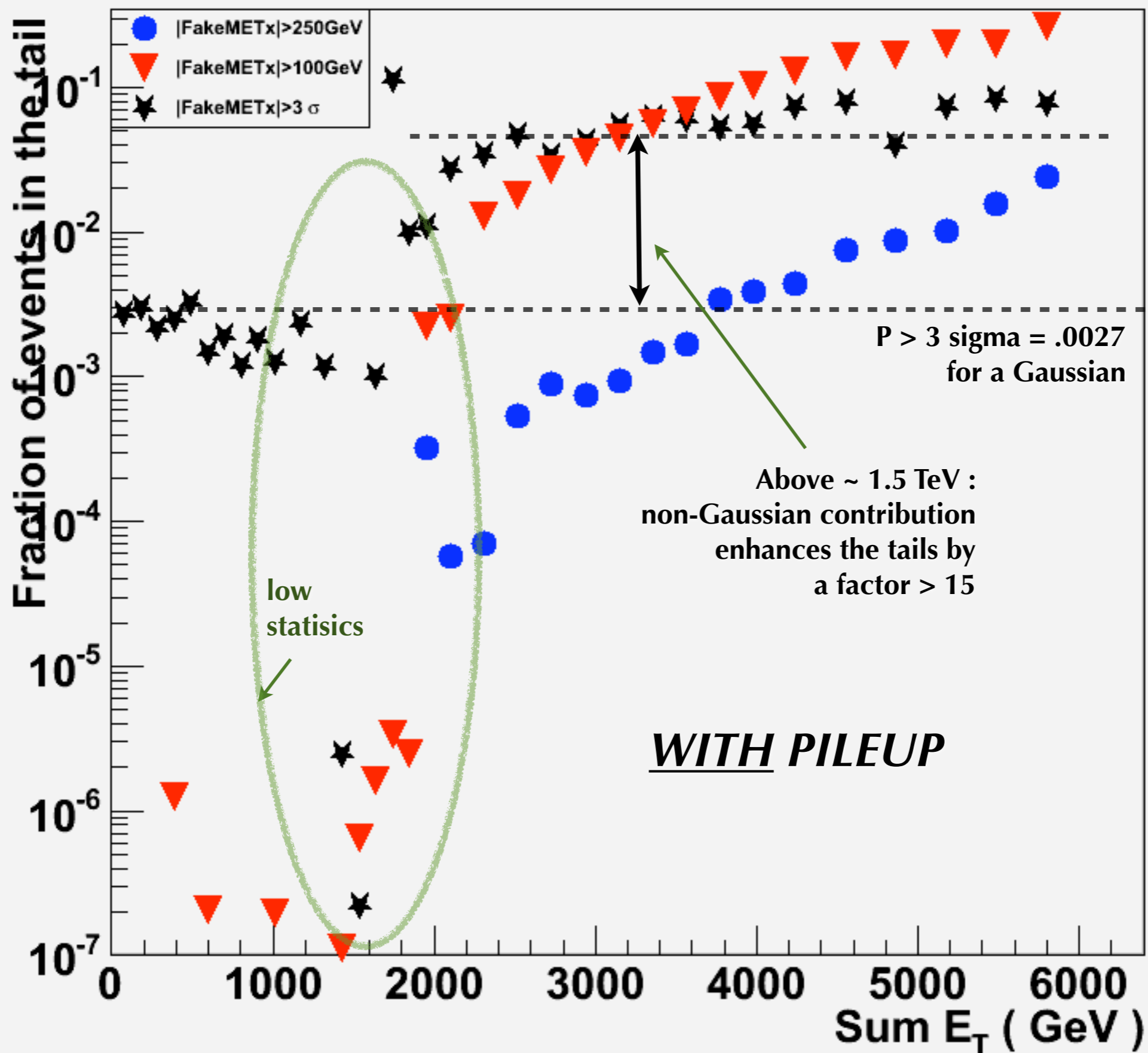
*Dijet sample,
No PILEUP*

Fraction of events which have large fake MET compared to all events at the same SumET

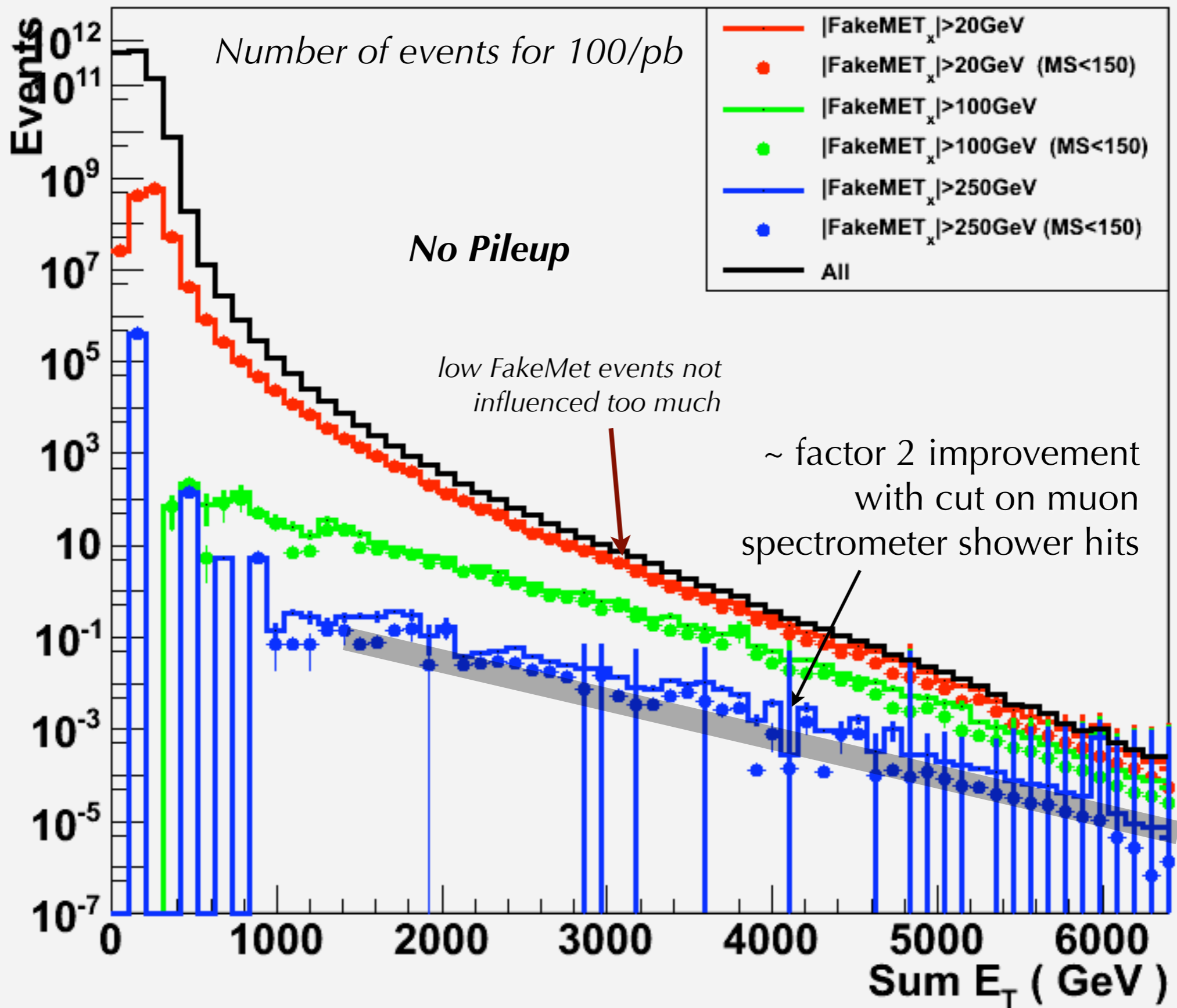


Fraction of events which have large fake MET

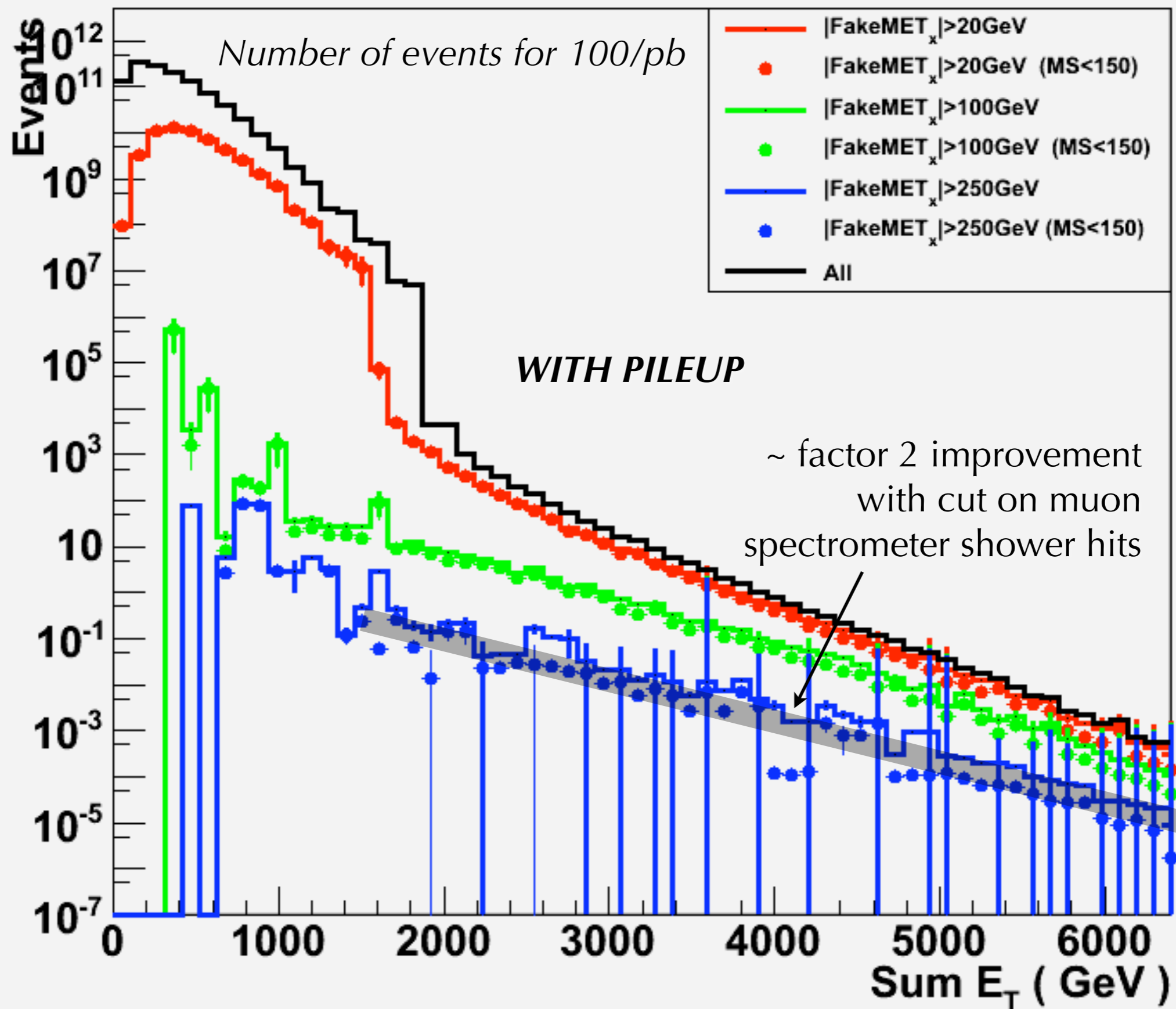
compared to all events at the same SumET



Number of events for different fake MET cuts



Number of events for different fake MET cuts



More detailed slides

- *Estimation of MET resolution: $\sigma(\text{Truth} - \text{Rec})$
With/Without pileup, With/Without cuts on Muon Spectrometer Shower hits*
- *Number of dijet events for 100/pb
For normal dijet and pileup samples*
- *Number of Muon Spectrometer Shower hits vs eta, and Jet Energy*
- *Number of Muon Spectrometer Shower hits vs Jet Energy Error for different eta-bands*
- *Cleaning (e.g. for SuSy context) using MET to Jet Angle vs muon spectrometer shower hits. (with and without pileup)*
- *Muon spectrometer shower hits vs Jet Energy Error for 3 leading jets.*
- *Tools etc.*

Estimation of MET resolution: $\sigma(\text{Truth} - \text{Rec})$

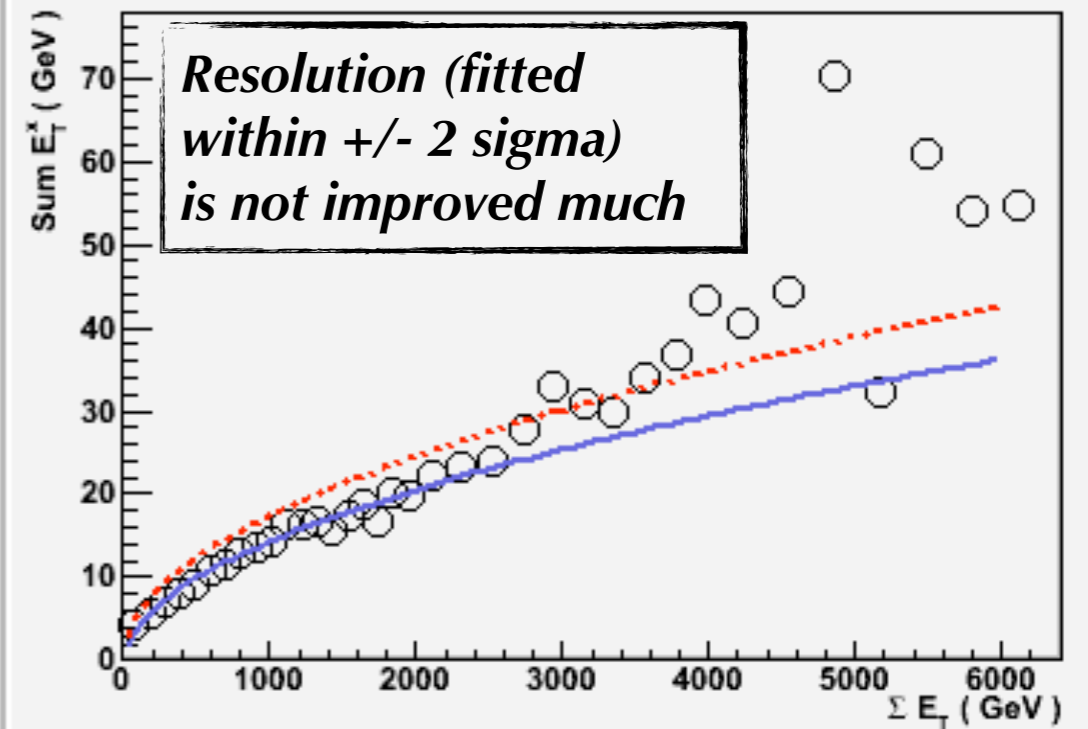
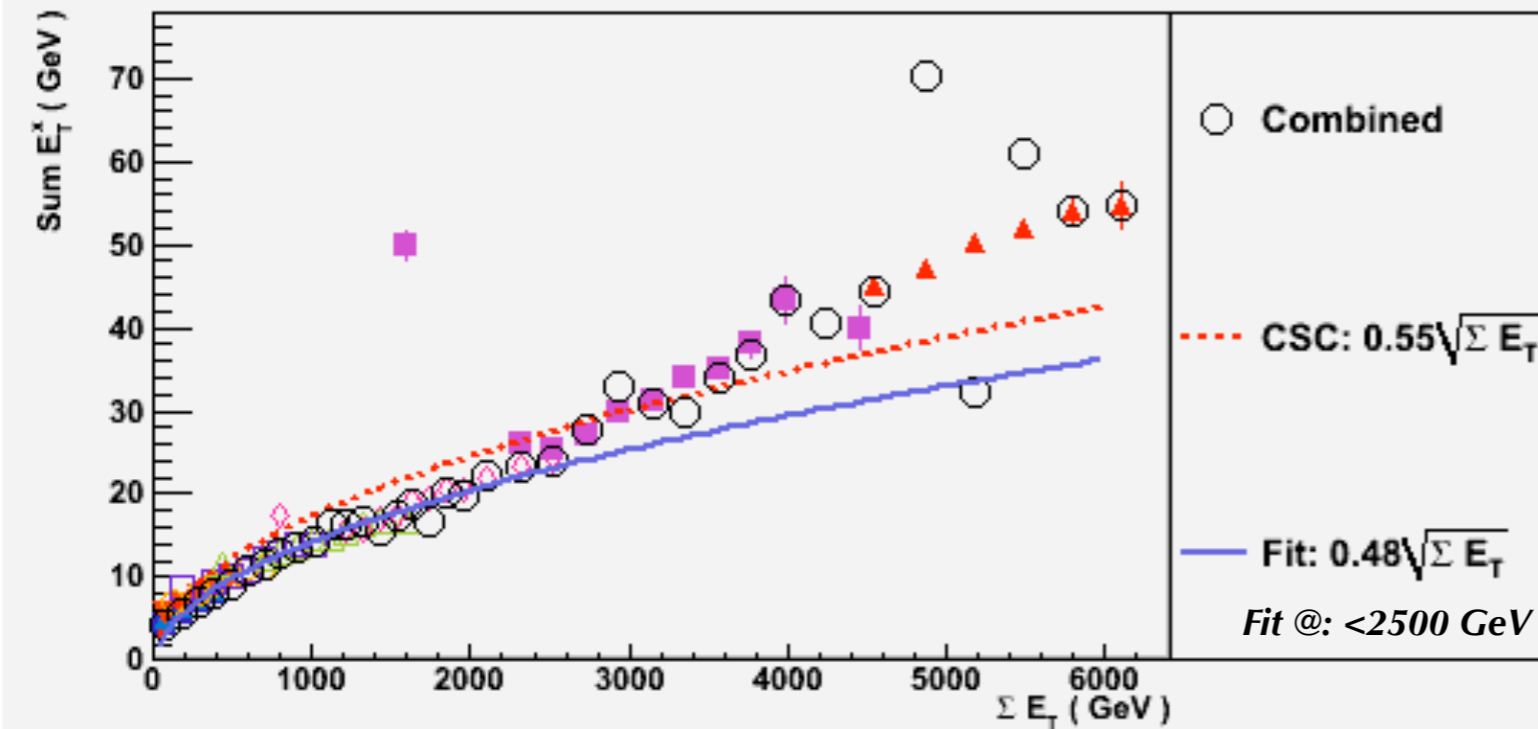
No PILEUP

With a Cut :
Muon Spectrometer Shower hits < 150

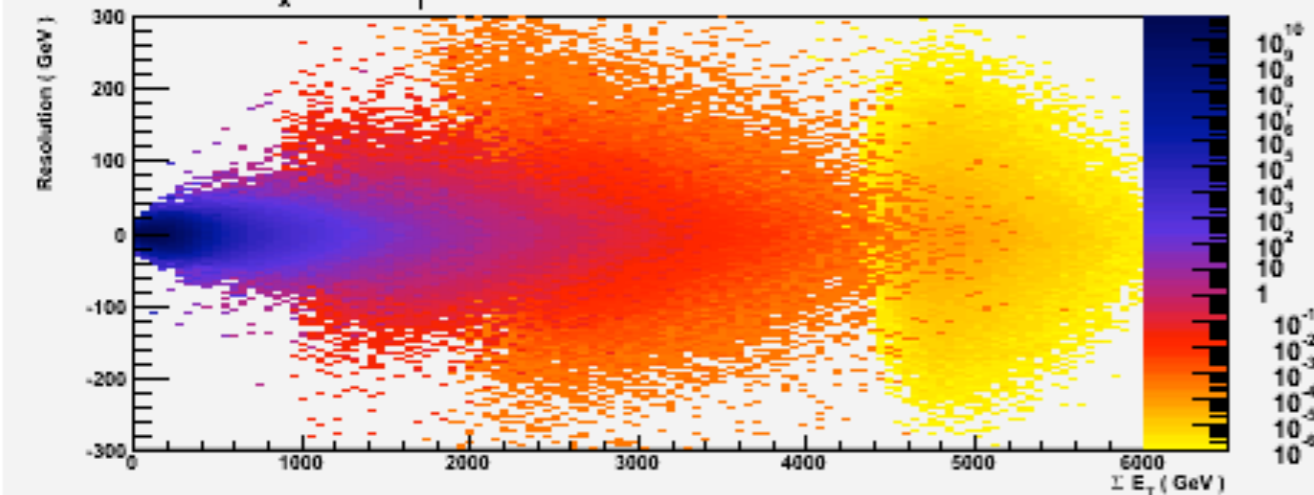
MET_x resolution all samples and combined

Dijet sum : J0 to J8

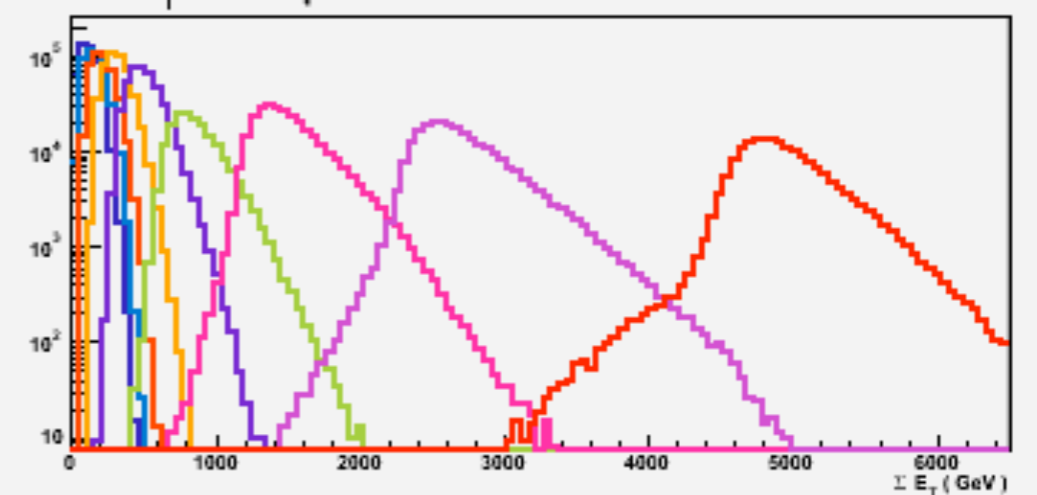
MET_x resolution just combined



Δ MET_x vs. ΣE_T



ΣE_T Jx samples



Estimation of MET resolution: $\sigma(\text{Truth} - \text{Rec})$

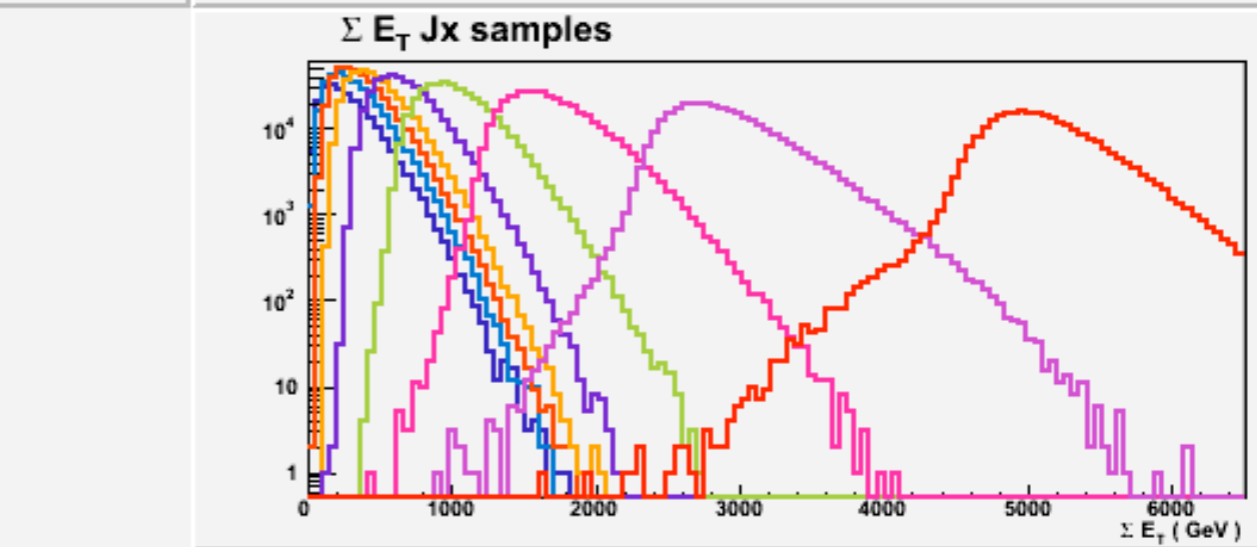
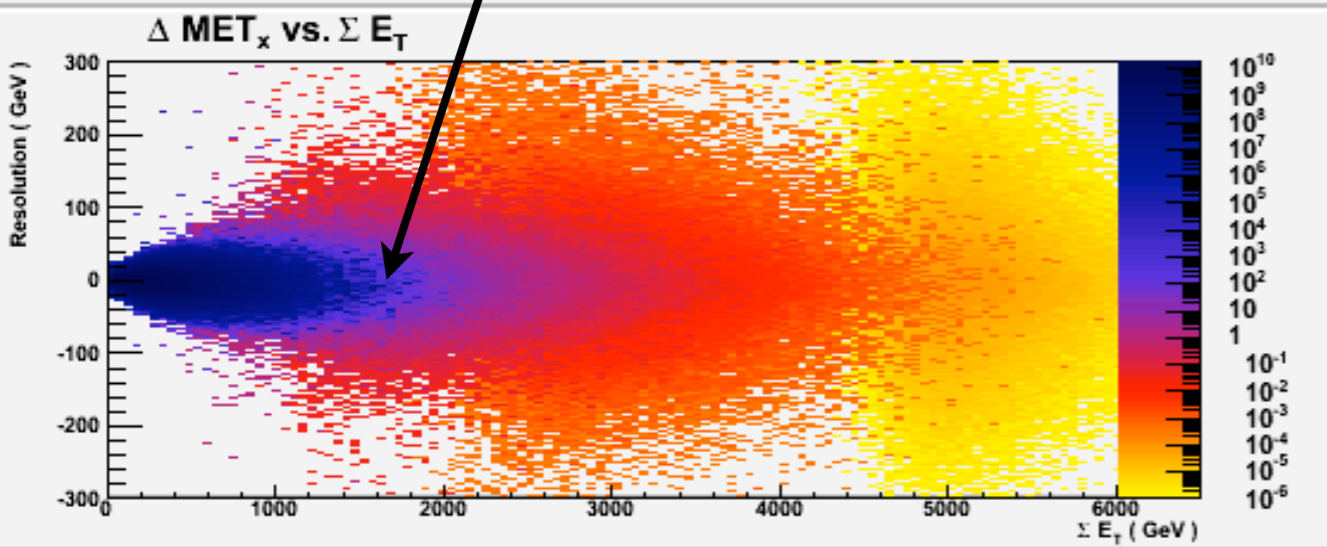
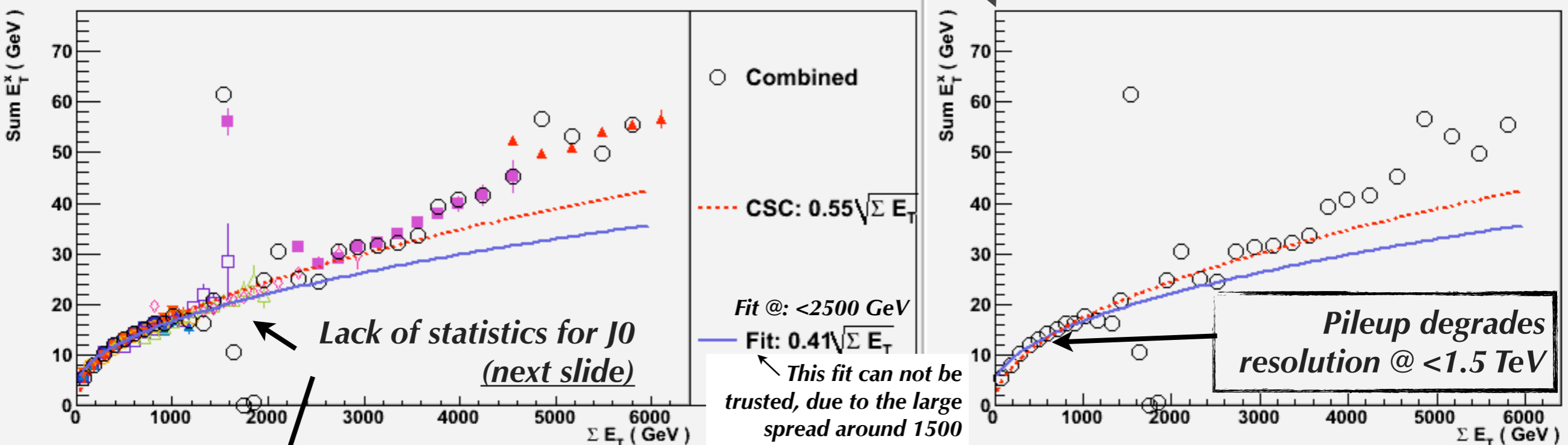
WITH PILEUP

Without any cut
(Pileup sample influenced the same way)

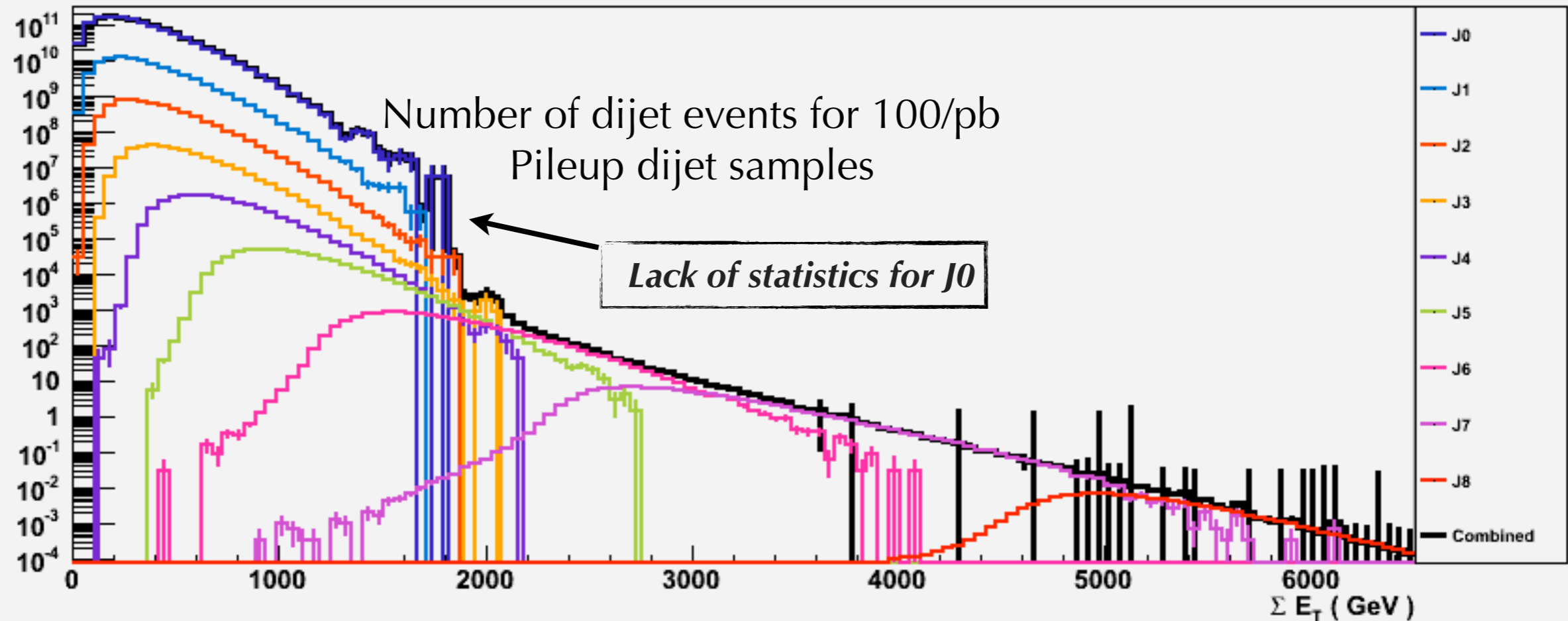
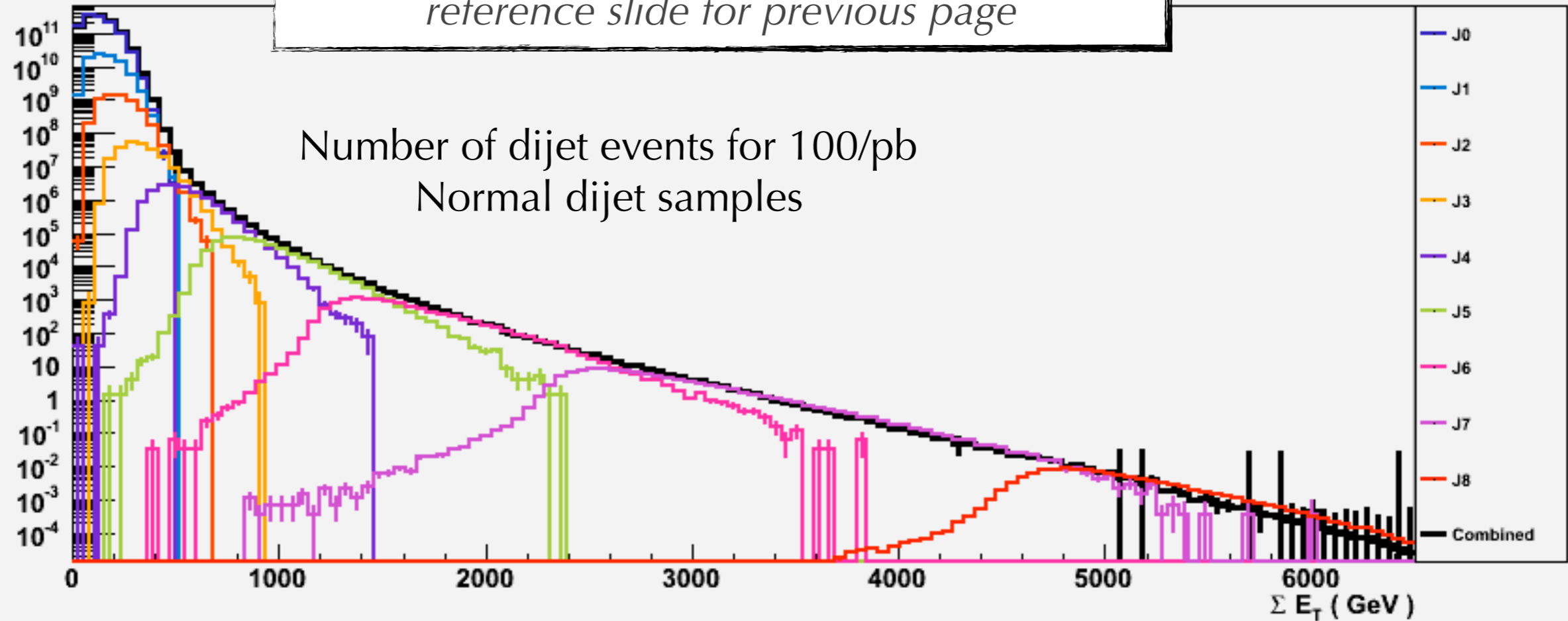
MET_x resolution all samples and combined

Dijet sum : J0 to J8

MET_x resolution just combined

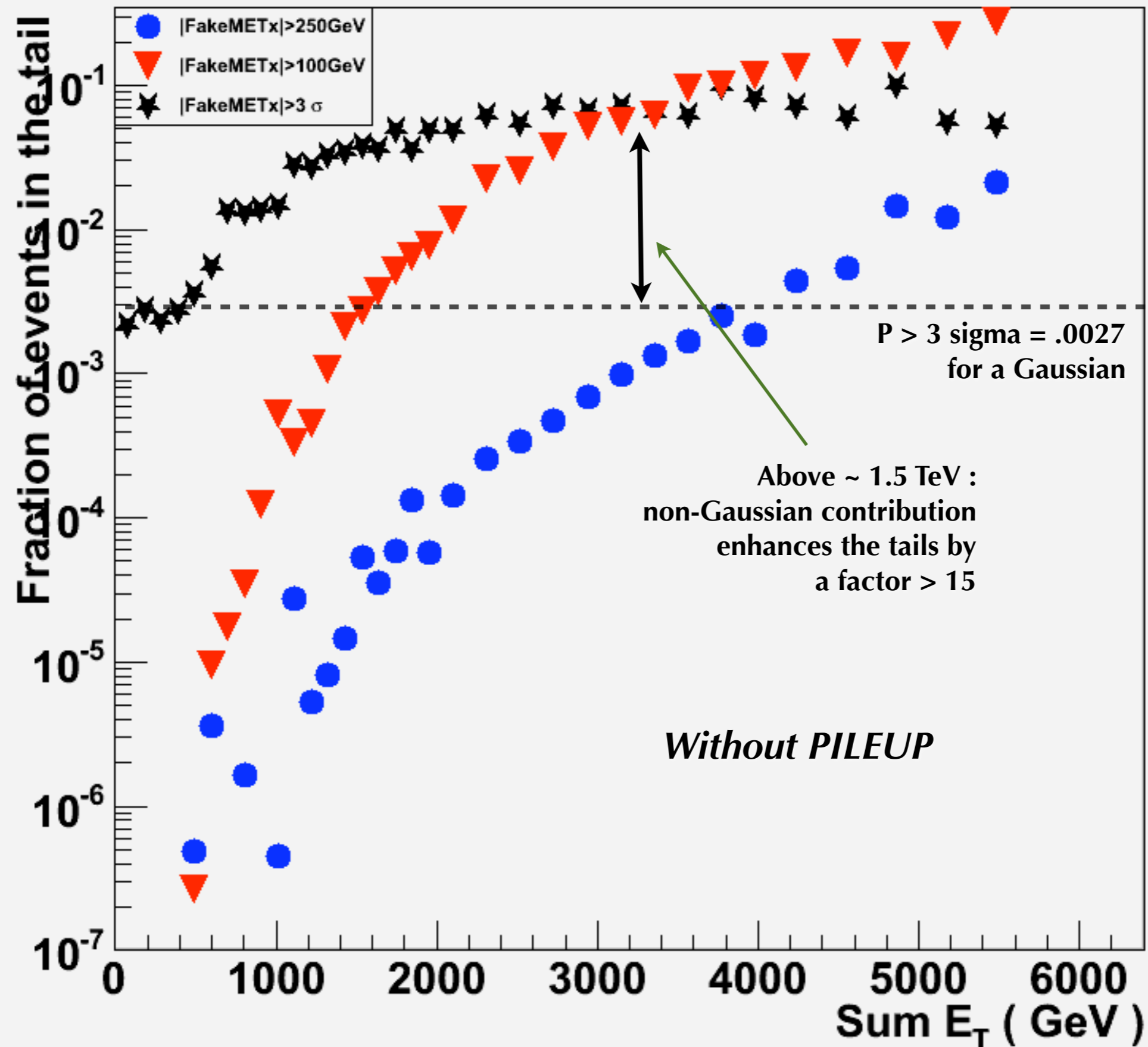


reference slide for previous page

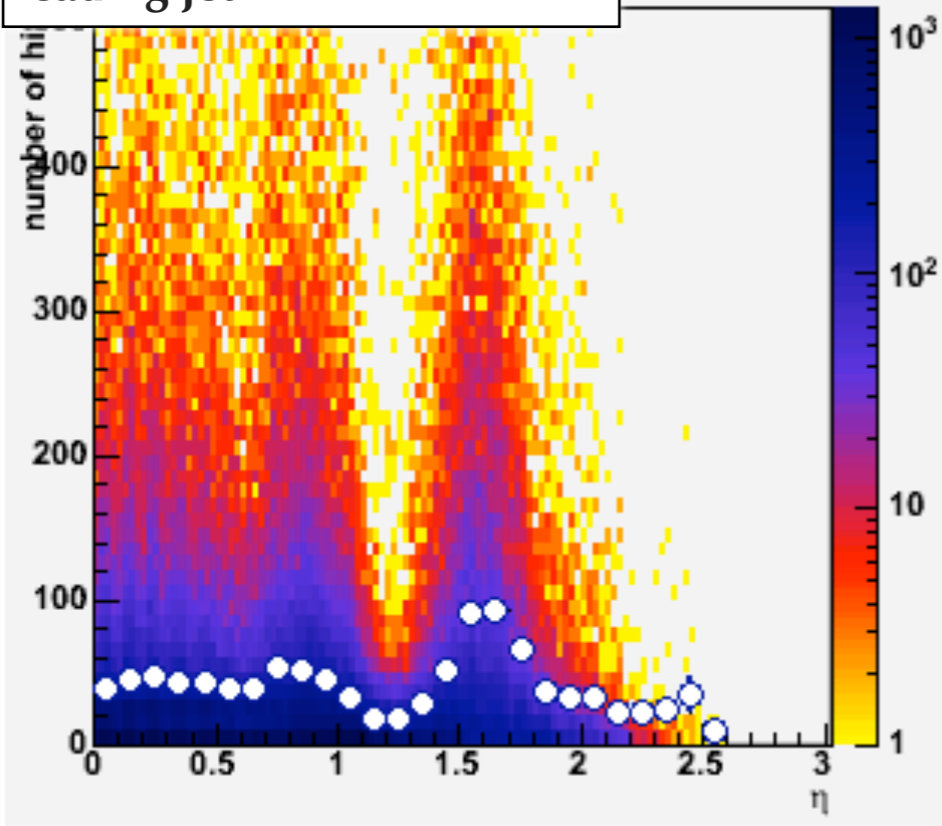


Fraction of events which have large fake MET

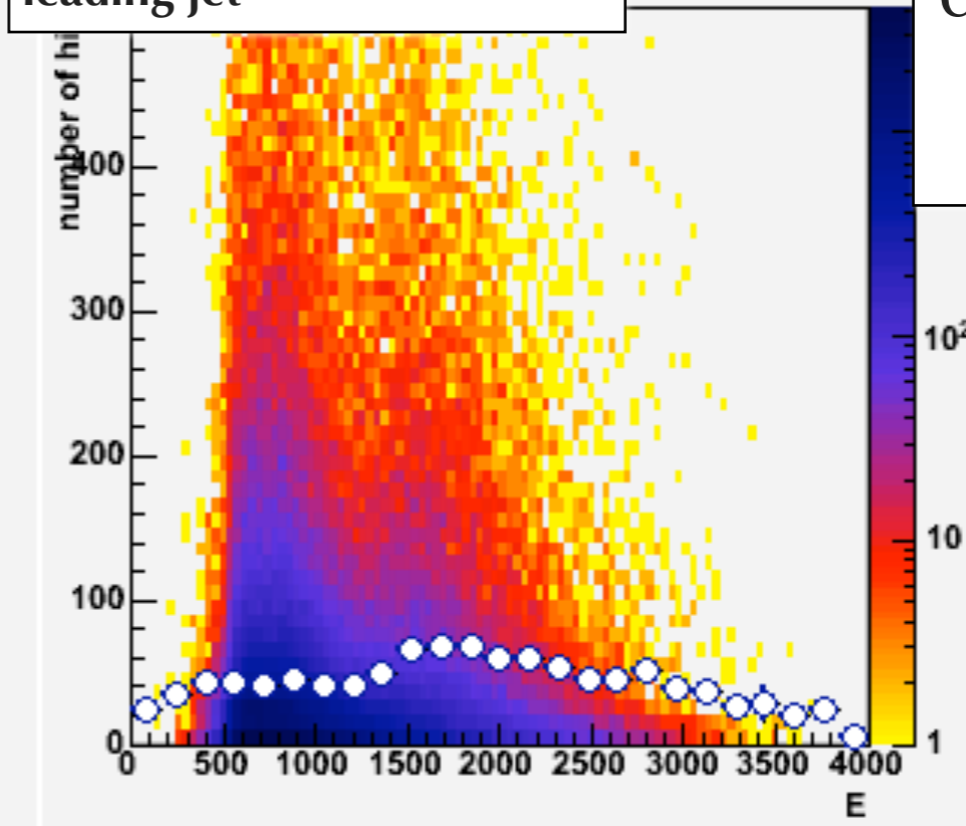
compared to all events at the same SumET



Muon hits VS eta
leading jet

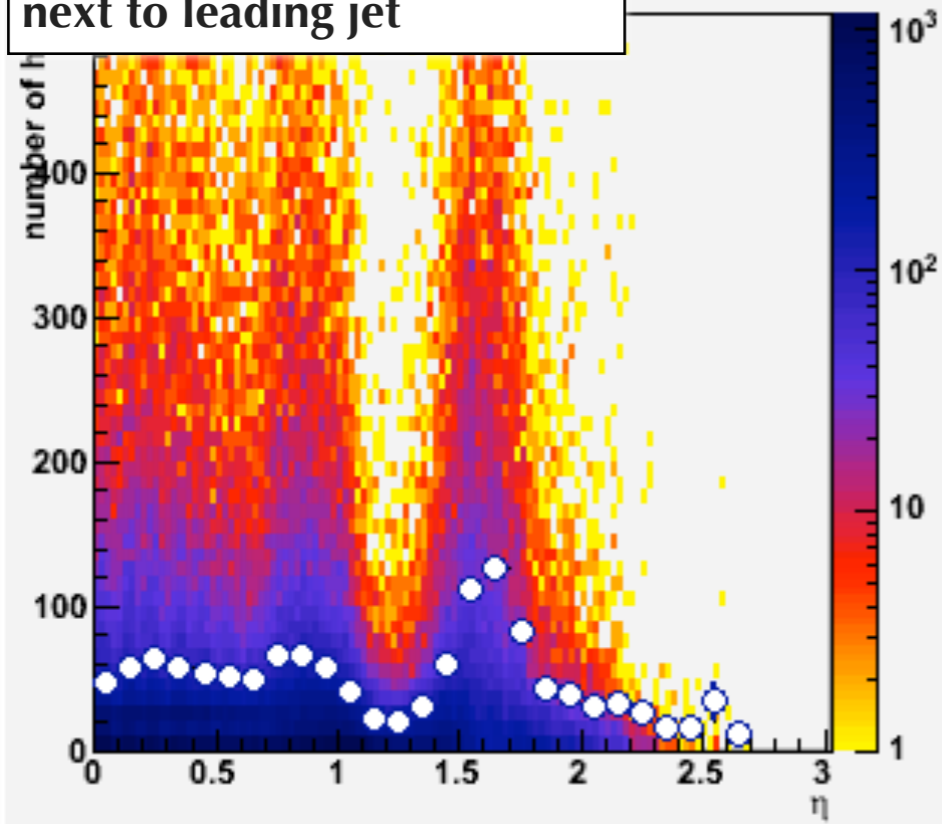


Muon hits VS rec E
leading jet

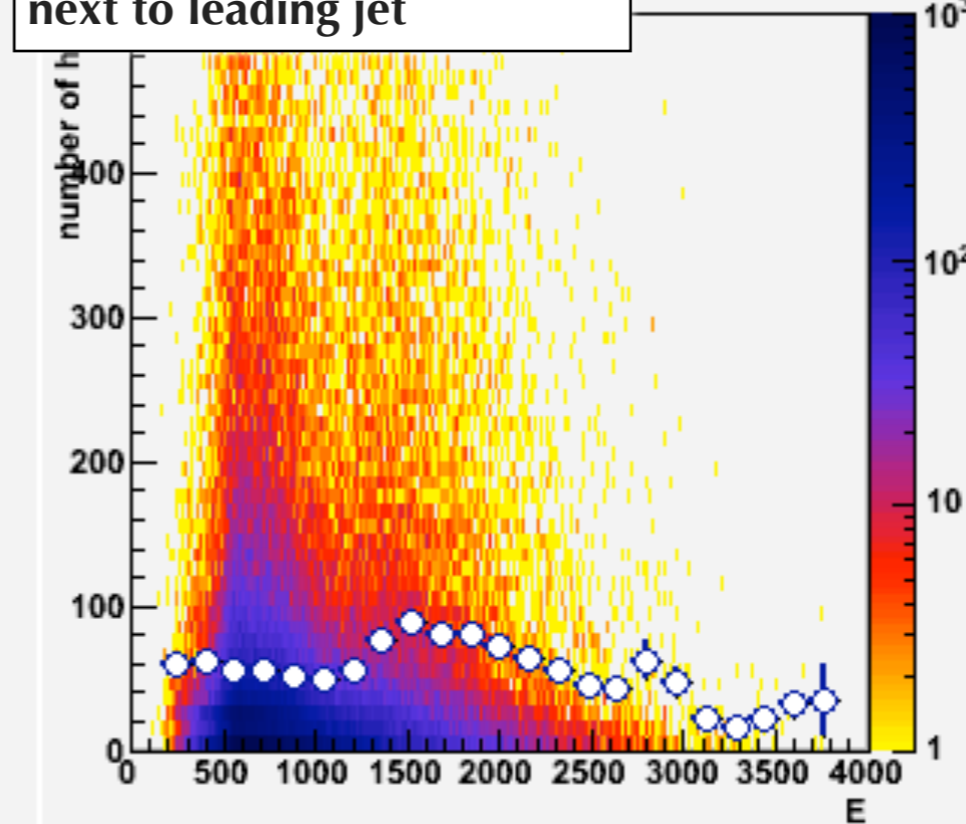


di-jet sample, J6.
*reconstructed
variables*

Muon hits VS eta
next to leading jet



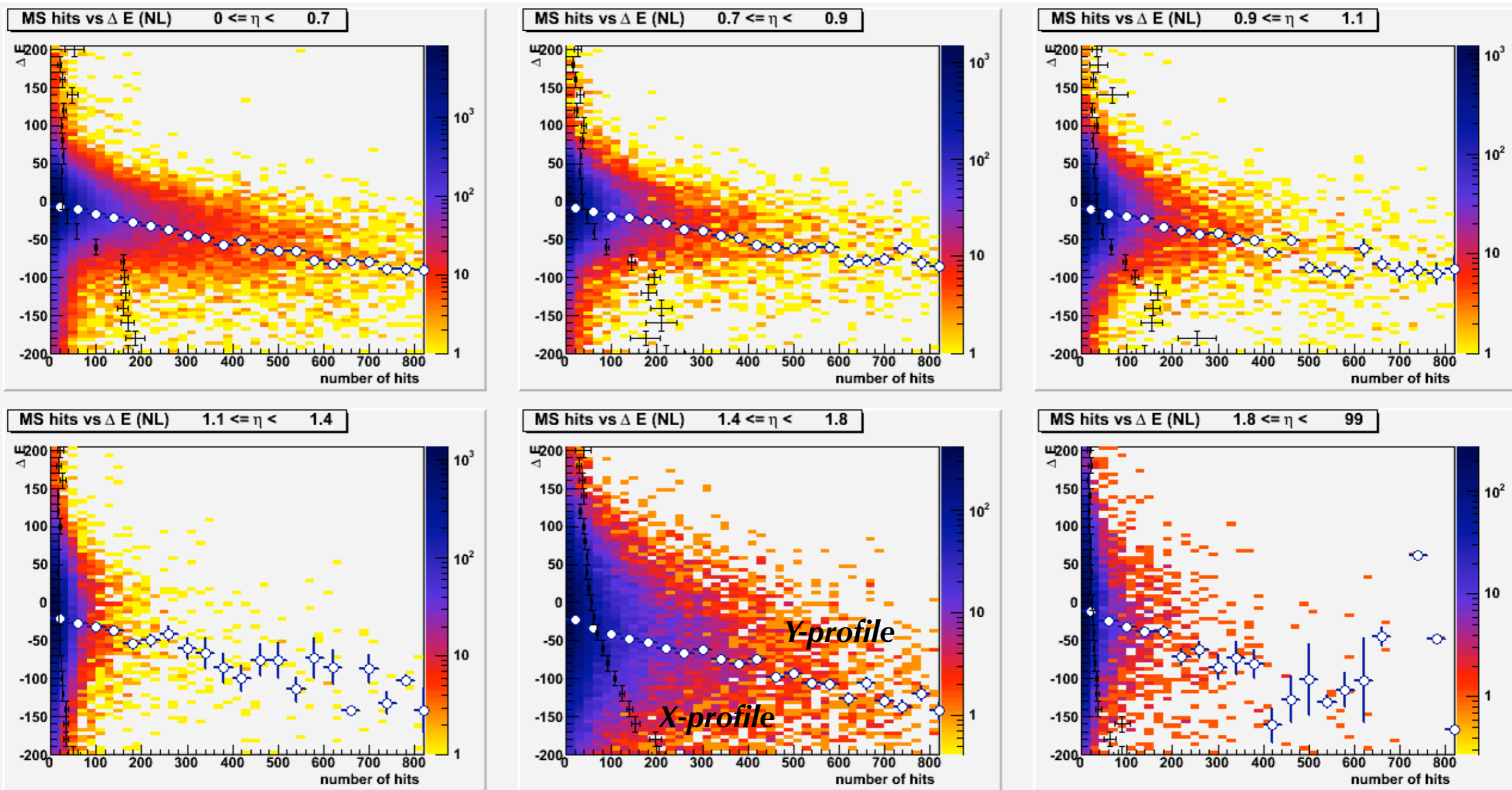
Muon hits VS rec E
next to leading jet



Energy error as function of number of hits for second recojet.

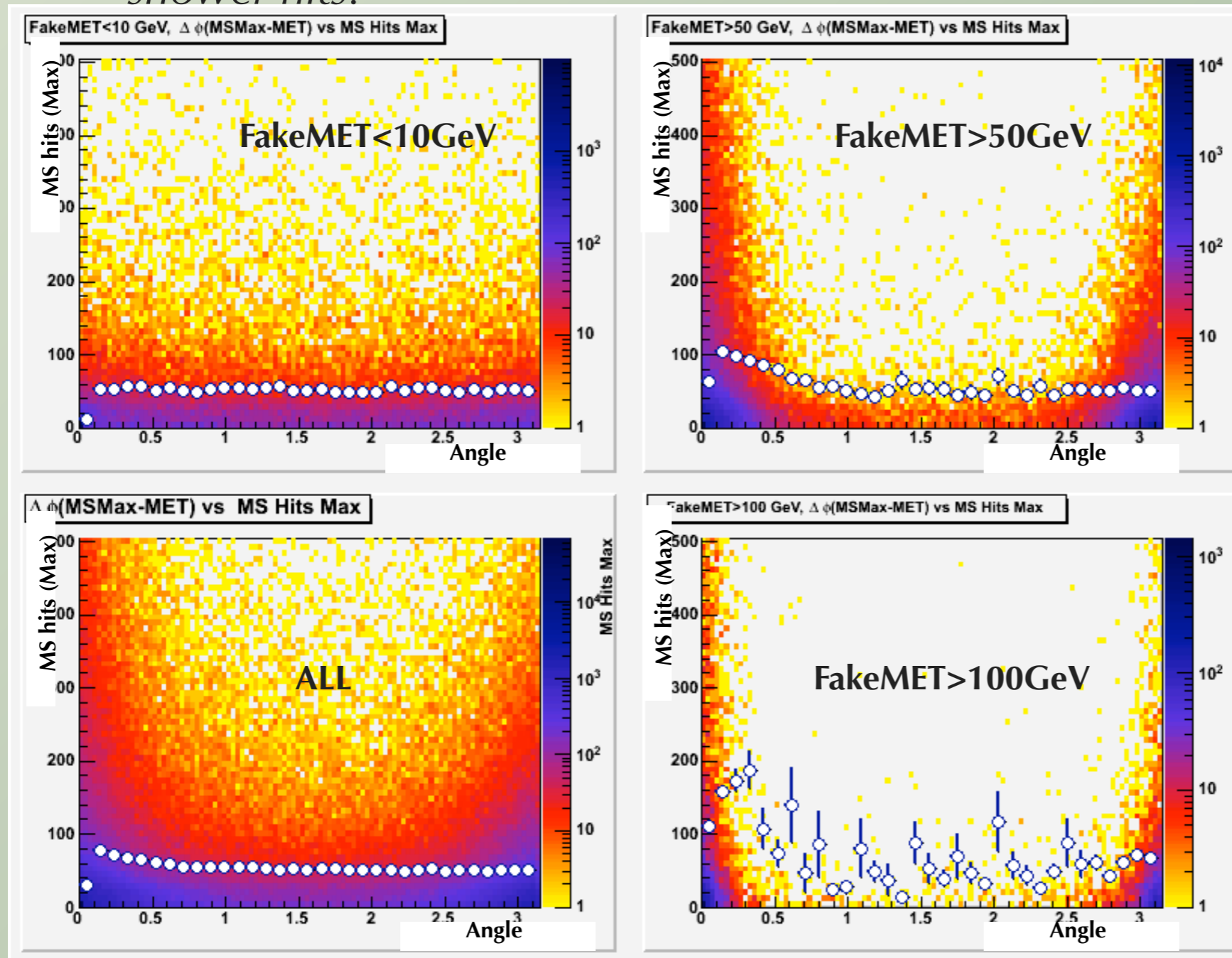
The correlation is quite similar with respect to eta

di-jet sample, J6.



Can we use muon hits to find large fake MET events for cleaning, e.g. in a susy analysis?

It's clear that FakeMet in dijets point towards one of the leading jets (often 2:nd). The following slides show the angle between fake MET and the jet (out of the 4 leading) with the highest number of muon spectrometer shower hits.

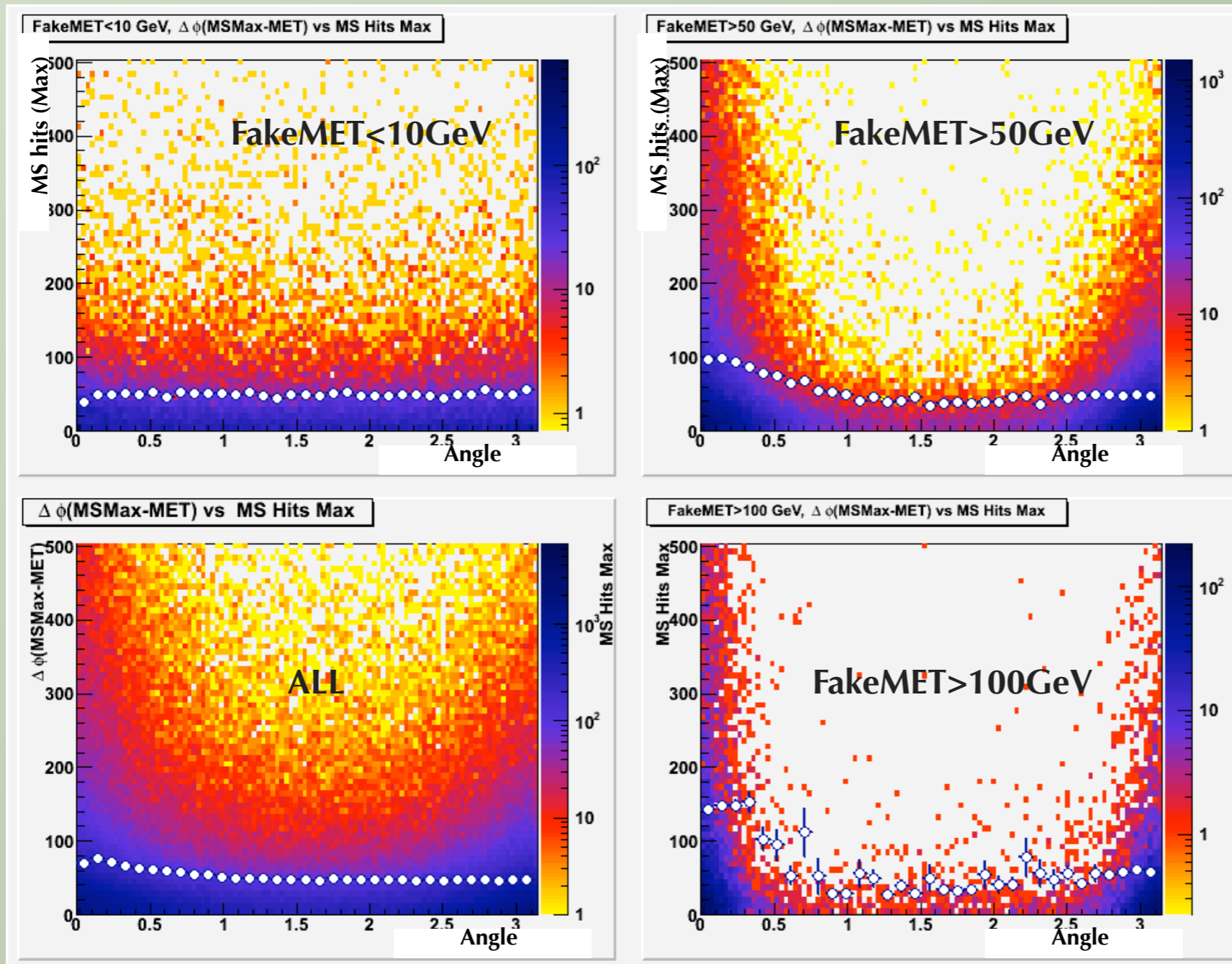


J6.

*Could be useful to make cleaning cuts in this space
- Needs testing with example analyses*

Now, the same as last slide, but **with pileup**. It's very similar (colour scale is different) - Again, pileup not exciting for J6, but adds to the low MS-hits regions at lower energies

J6.



Could be useful to make cleaning cuts in this space
- Needs testing with example analyses

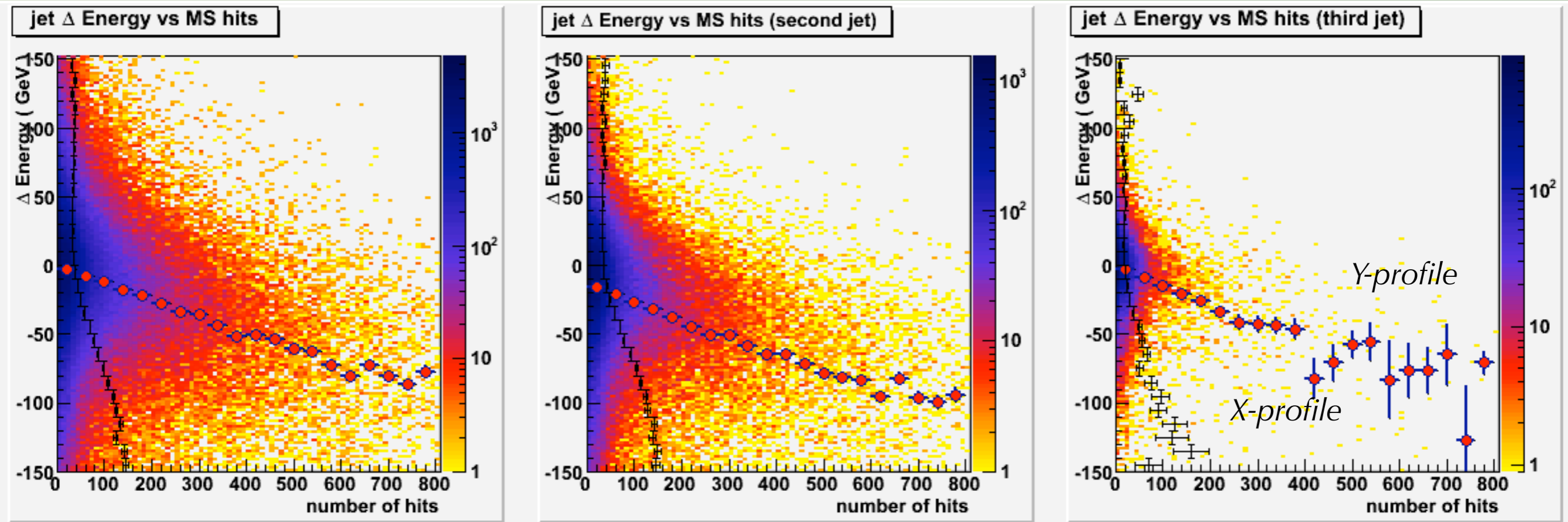
28 MuonSpShowerContainer

contains, for the muon spectrometer,

- counts of hits
- counts of muon segments within a cone around jet axes

This object has been developed and used in before by Frank Paige, Ketevi Assamagan, ...

di-jet sample, J6



Delta E = True-Reco Jet energy vs the number of Muon spectrometer shower hits for the respective jet

For high ET samples muon spectrometer shower hits are insensitive to pileup (ref to backup slides)

Samples and tools

Normal dijet sample

user09.KojiTerashi.mc08.105017.J8_pythia_jetjet.recon.DPD_NOSKIM.
e344_s479_r635_DPDMaker000164_p1

Pileup sample used:

user09.MichiruKaneda.mc08.105017.J8_pythia_jetjet.recon.DPD_NOSKIM.
e344_s479_d150_r642_DPDMaker000164_p1

Tools:

SFrame for histograms and plots

(<https://twiki.cern.ch/twiki/bin/view/Main/SFramePage>)

Athena-JiveXML, Atlantis
VP1