

Tau ID Systematics with Min-Bias Events, and Overlay Status

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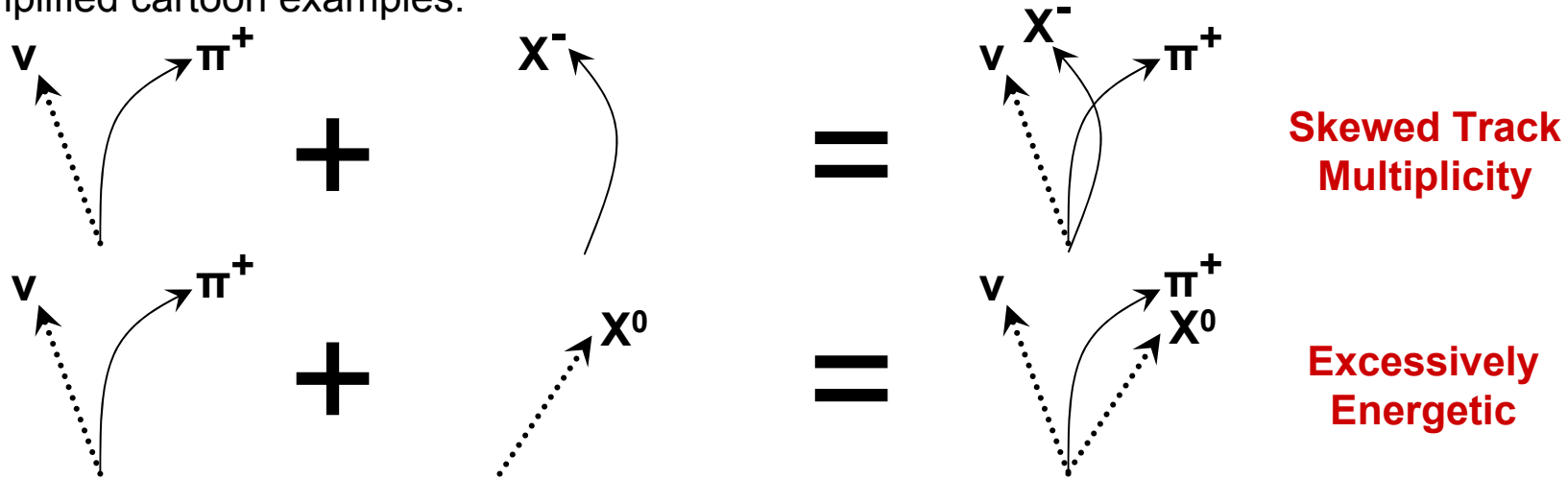
ATLAS Tau Workshop



Motivation

No one has ever run at 14 (or 10) TeV before...

- What effect will the soft processes in hadron collisions at this energy have on the hadronic tau identification in ATLAS?
- Simplified cartoon examples:



Our Monte Carlo Generators (alone) are not so helpful here

- Collect minimum-bias (and even zero bias) events from ATLAS collision data and overlay these events with single particle hadronic taus generated by a particle gun
- Run the offline reconstruction; the impact (i.e., relative difference) on the hadronic tau ID efficiency can then be observed

Important note on a common misconception:

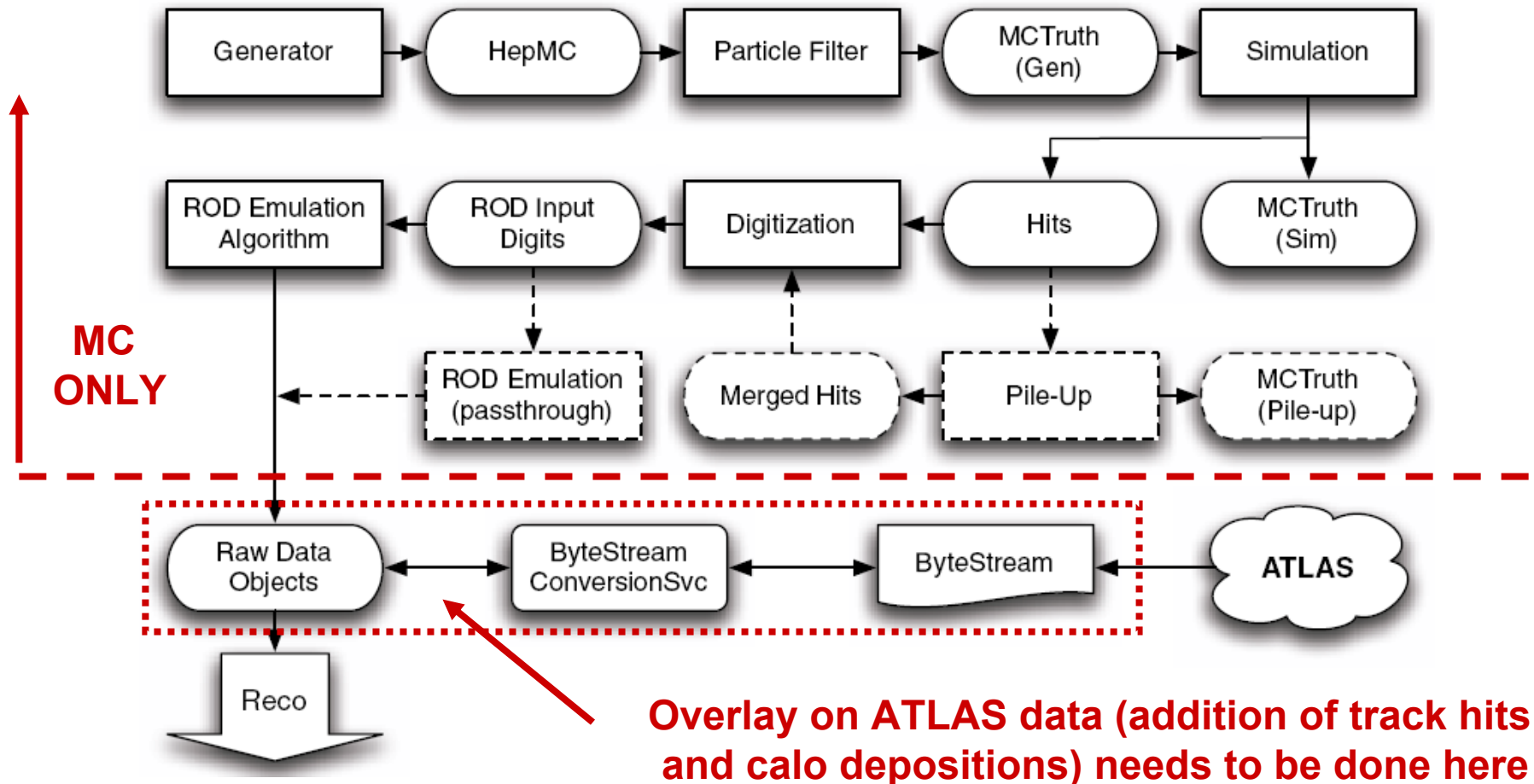
- Do not confuse with “embedding” techniques for $Z \rightarrow \tau \tau$ background estimation
- The primary use-case and implementation is very different

Monte Carlo on Data

Quite different from MC-on-MC “pile-up”

Use the Pile-up Group’s tools to overlay single taus on ATLAS data

- Very latest version of the Pile-up Group’s overlay tools were released with 14.2.25.9
- In lieu of collision data: study overlay with MC (use overlay transforms, but with purely MC samples); study overlay of MC on ATLAS cosmics data



Samples Used

A request for centrally produced overlay validation samples in 14.2.25.9 has been made...

- Many of these validation datasets are not yet ready
- Locally generated many of the requested datasets ourselves
- Used the geometry ATLAS-GEO-03-00-00
- Use the conditions tag OFLCOND-SIM-00-00-06
- Overlay of datasets conducted using official 14.2.25.9 transforms
- Results presented here are for the ZERO pile-up scenario

Datasets generated

- Dataset 105001 (minimum bias) ~50k events
- Dataset 107622 (single tau; pT=100) ~50k events
- Dataset 107233 (single muon; pT=100) ~12.5k events
- Dataset 107061 (single electron; pT=100) ~12.5k events

ATLAS Data used

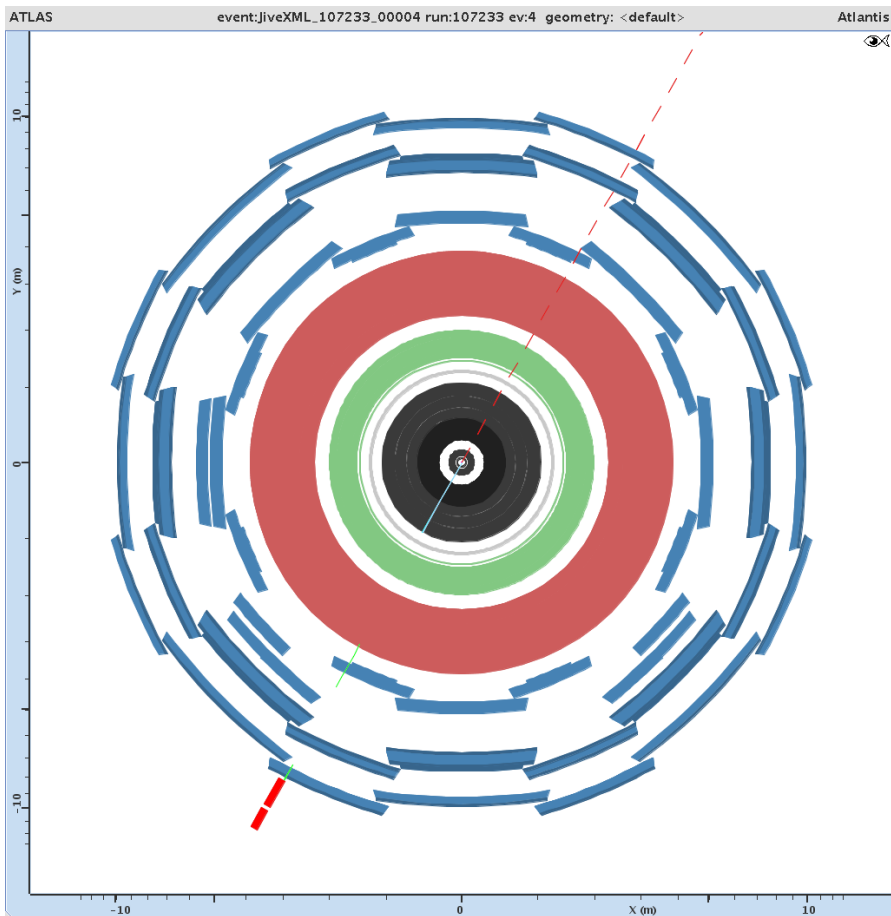
- Run 91900 (“CosmicMuon” and “IDCosmic” streams)
- Run 92160 (“L1Calo” stream)

Something simple...

A single high- p_T MC muon event overlaid onto a min-bias MC event

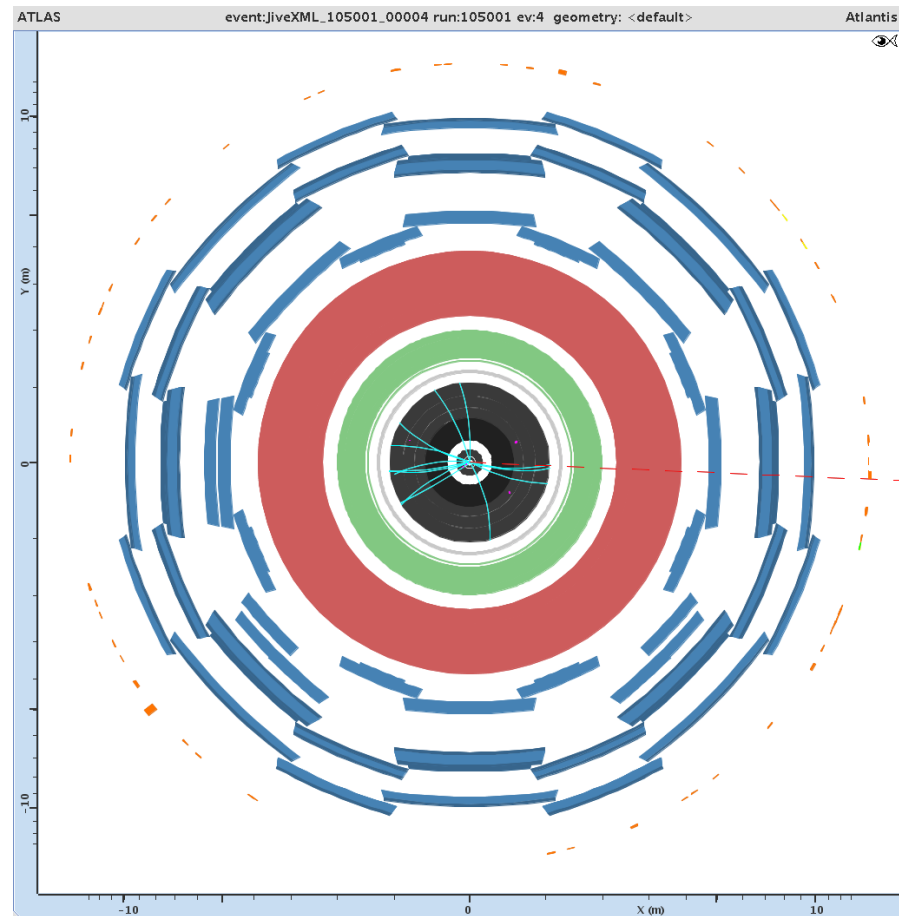
- Single Track; expect little to no activity in the calorimeters

Muon $p_T=100$ GeV



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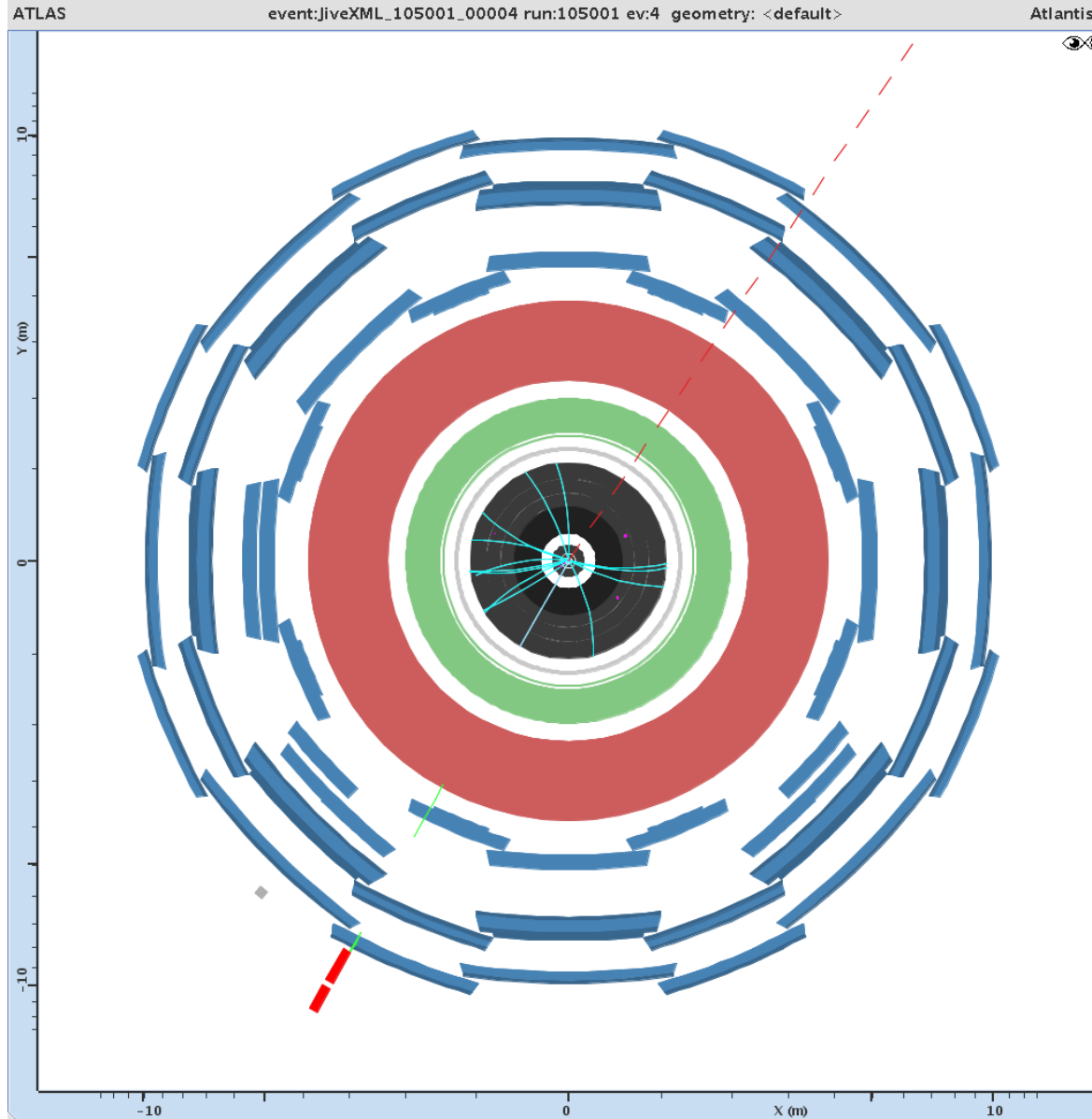
Min-Bias



Something simple...

A single high-pT MC muon event overlaid onto a min-bias MC event

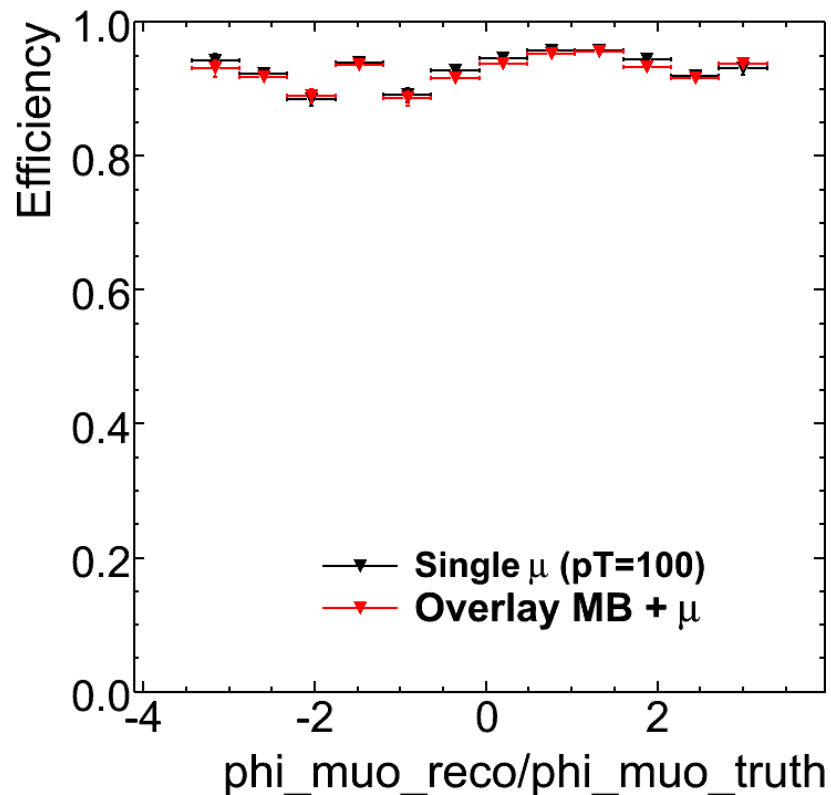
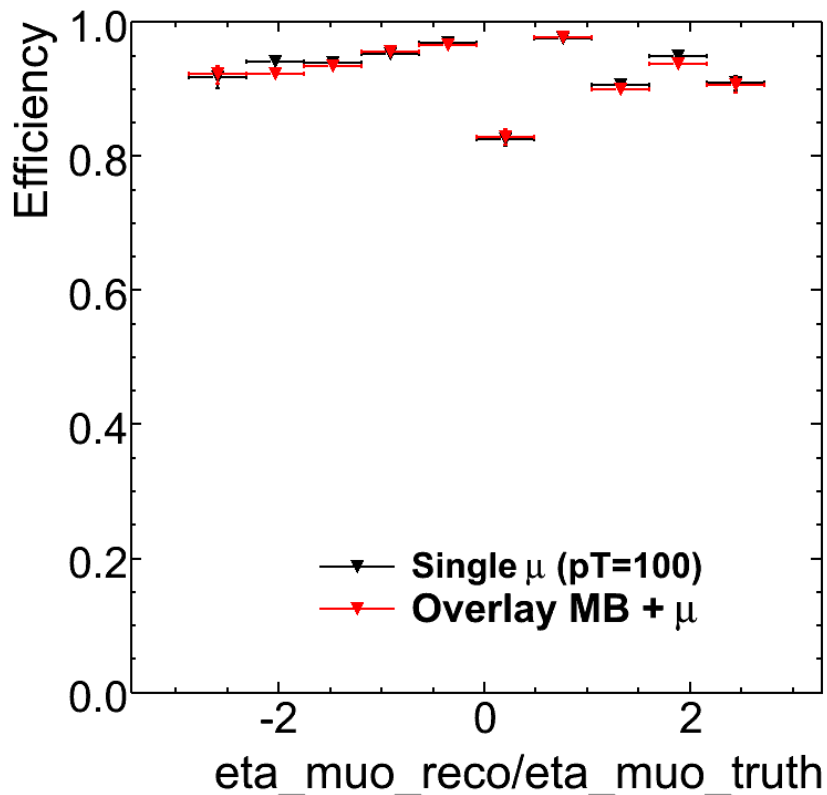
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Single Muon ID Efficiency

With and without overlay on min-bias MC sample

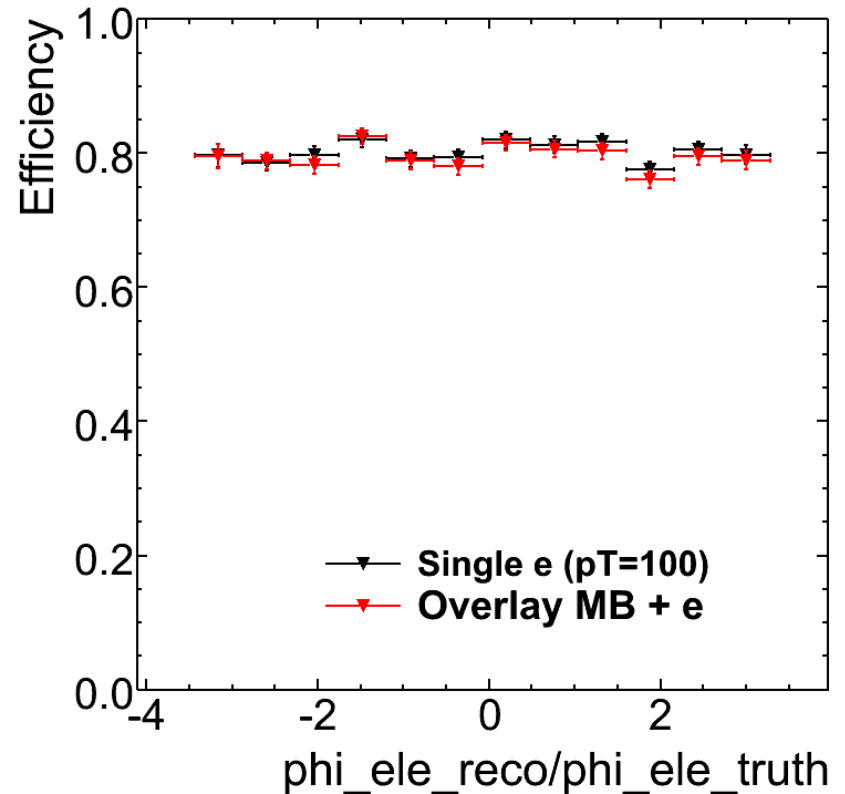
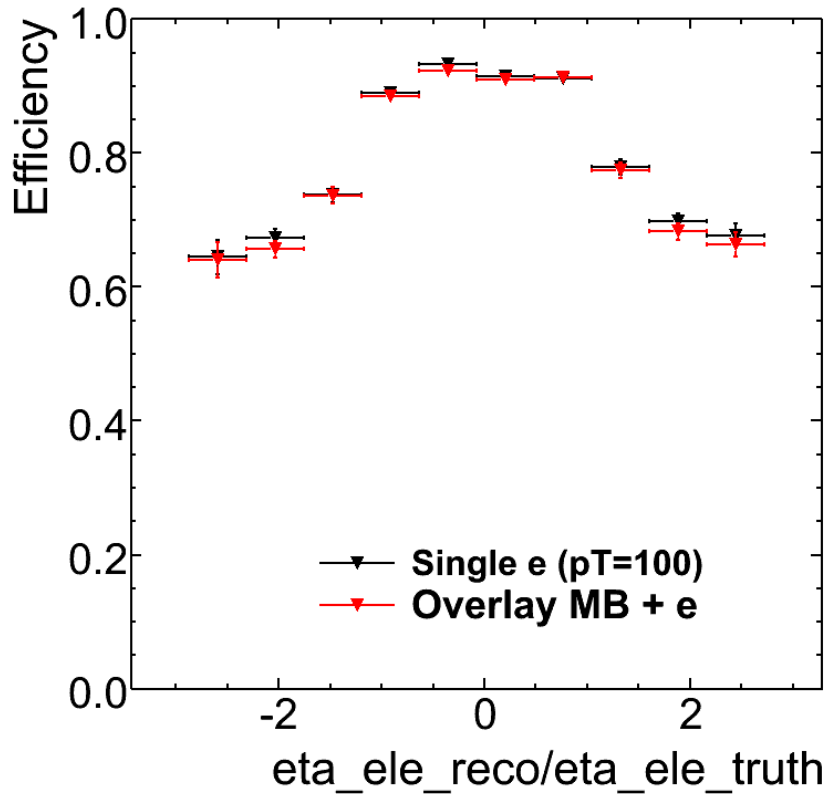
- Staco muons: $|\eta| < 2.5$, $p_T > 15$, isolated, isCombined, $0 < \chi^2 < 100$
- Most interested in the relative efficiencies
- Again, this is the ZERO pile-up scenario



Single Electron ID Efficiency

A single high- p_T MC electron event overlayed onto a min-bias MC event

- Single electrons ($p_T=100$ GeV) generated with the particle gun
- Electron selection: $|\eta| < 2.5$, $p_T > 15$, isolated, isEM_Medium
- In the ZERO pile-up scenario



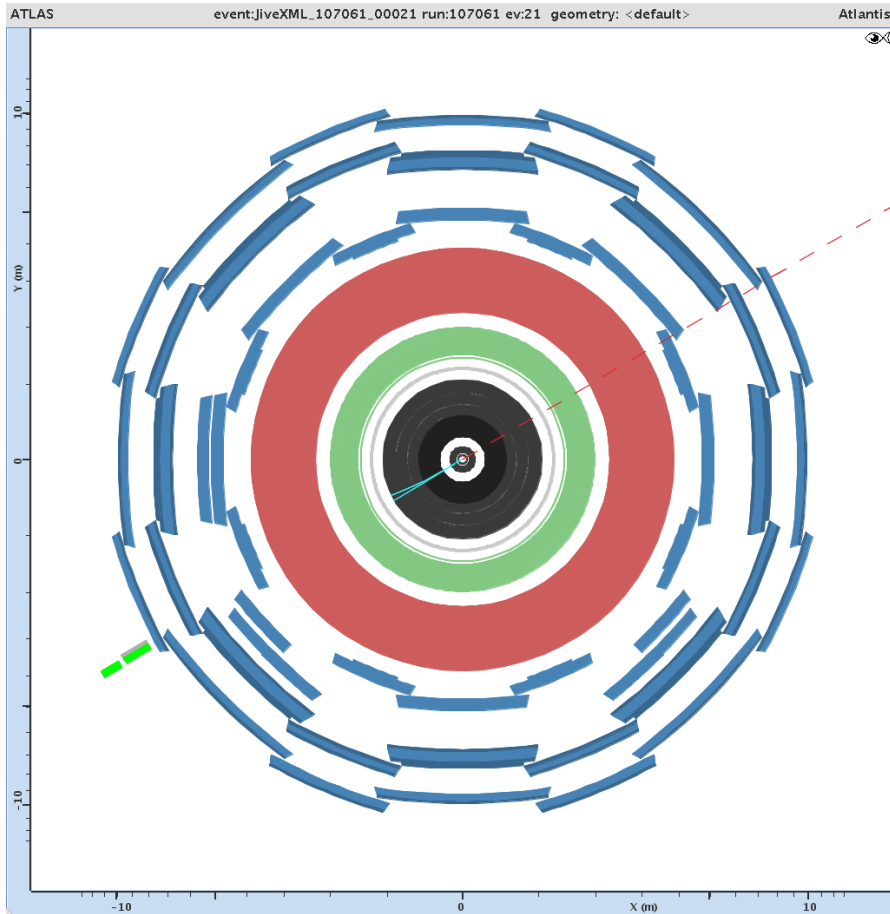
A Little More Complicated...

A single high- p_T MC electron event overlaid onto a min-bias MC event

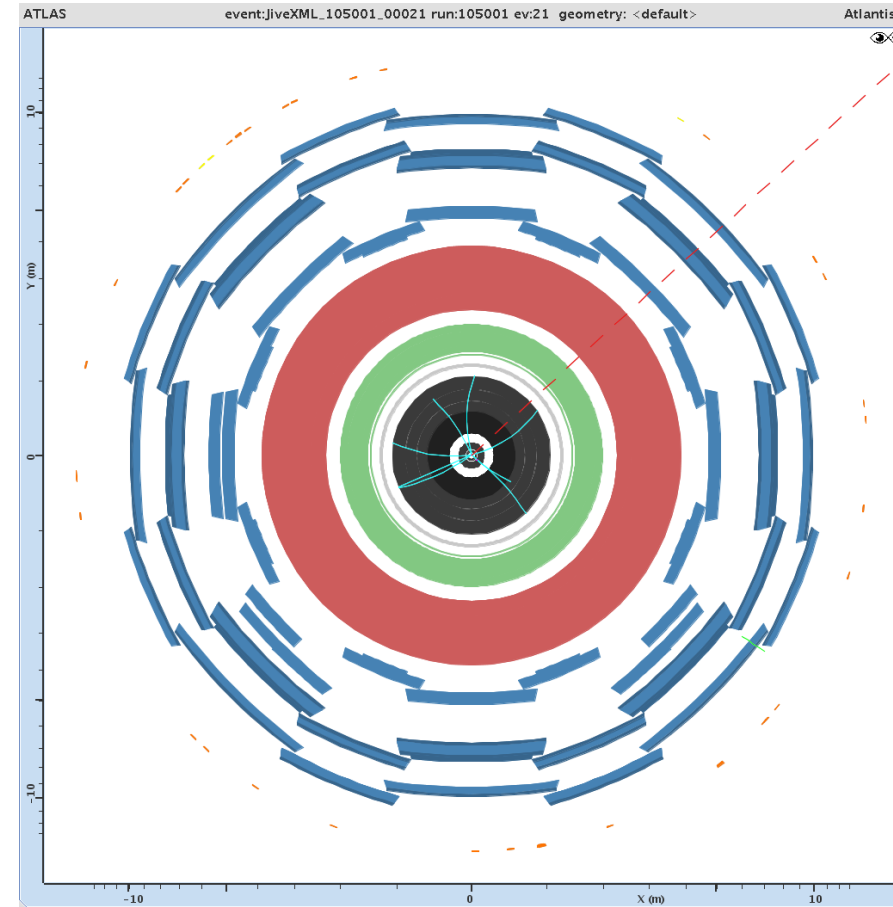
- Track + EM Calo Deposition; expect little to no hadronic activity

Electron $p_T=100$ GeV

Min-Bias



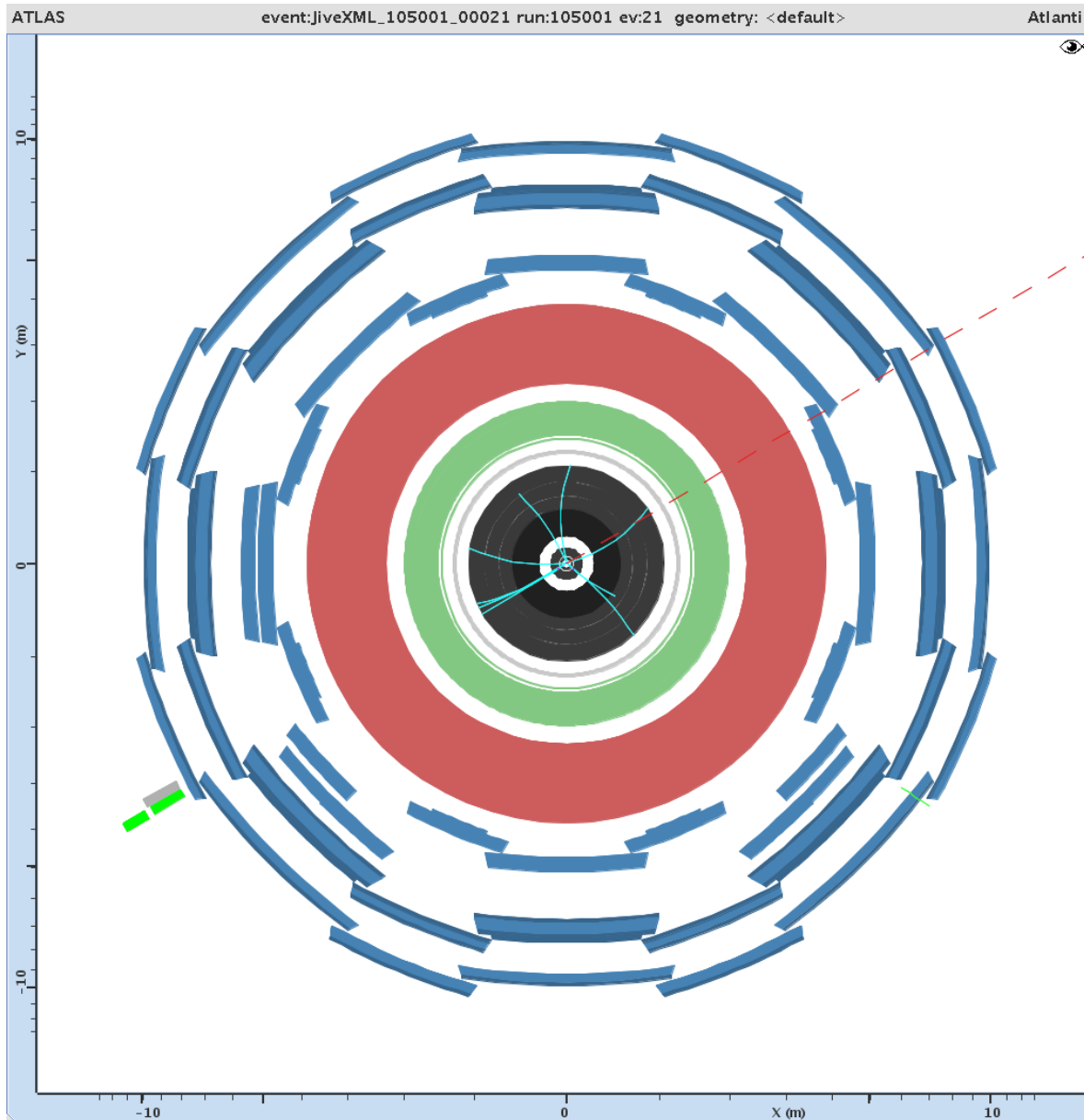
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A Little More Complicated...

A single high- p_T MC electron event overlaid onto a min-bias MC event

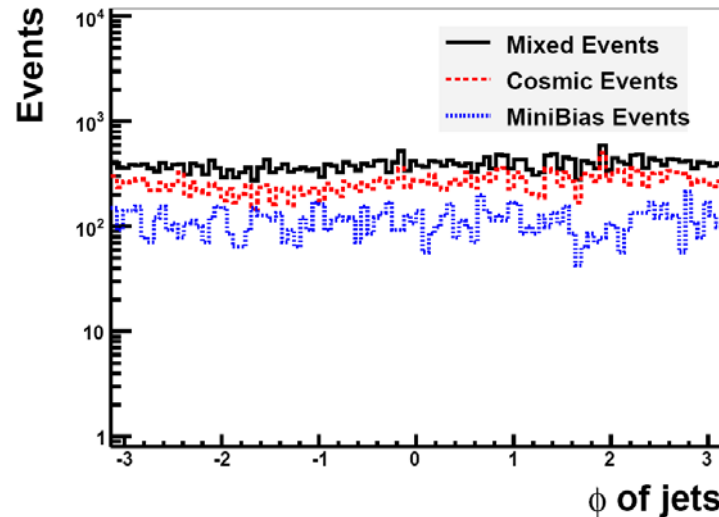
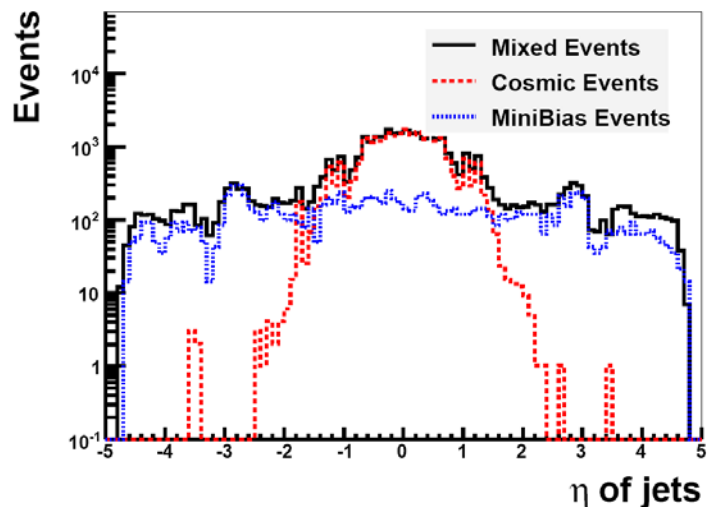
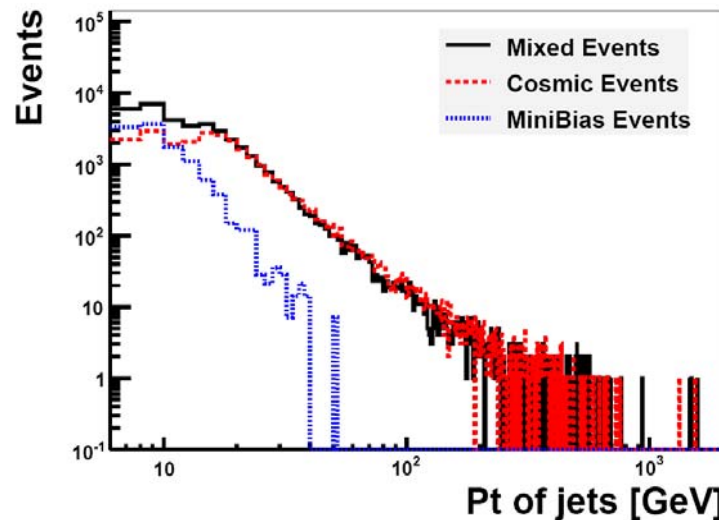
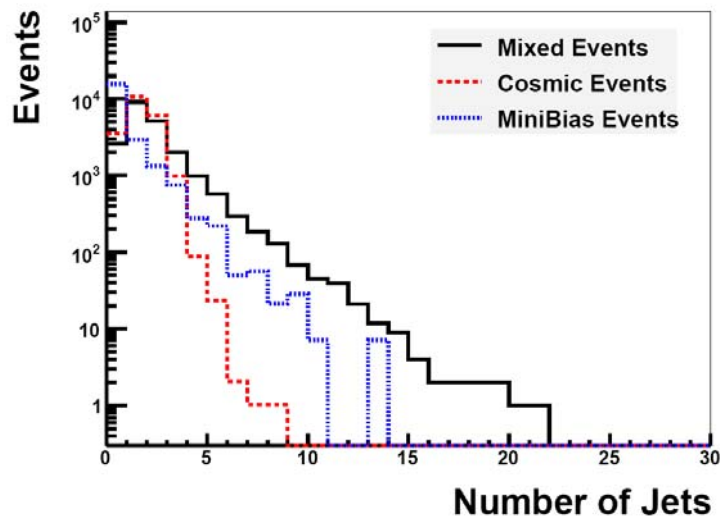
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Overlay of Minimum Bias onto Cosmic Data

Yingchun Zhu's studies (Cone4H1Topo Jets)

- See her numerous talks on the overlay (overlay onto L1Calo cosmics data)
- <http://indico.cern.ch/getFile.py/access?contribId=6&resId=0&materialId=slides&confId=52469>



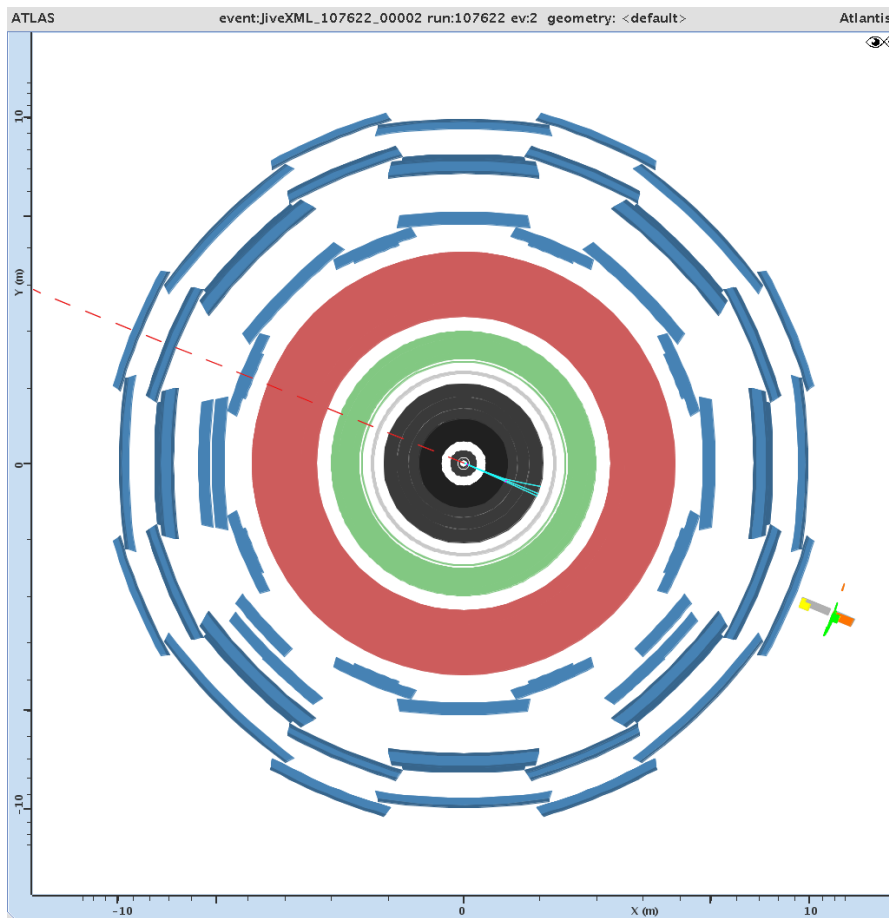
Single Tau Overlay

A single high- p_T MC tau event overlaid onto a min-bias MC event

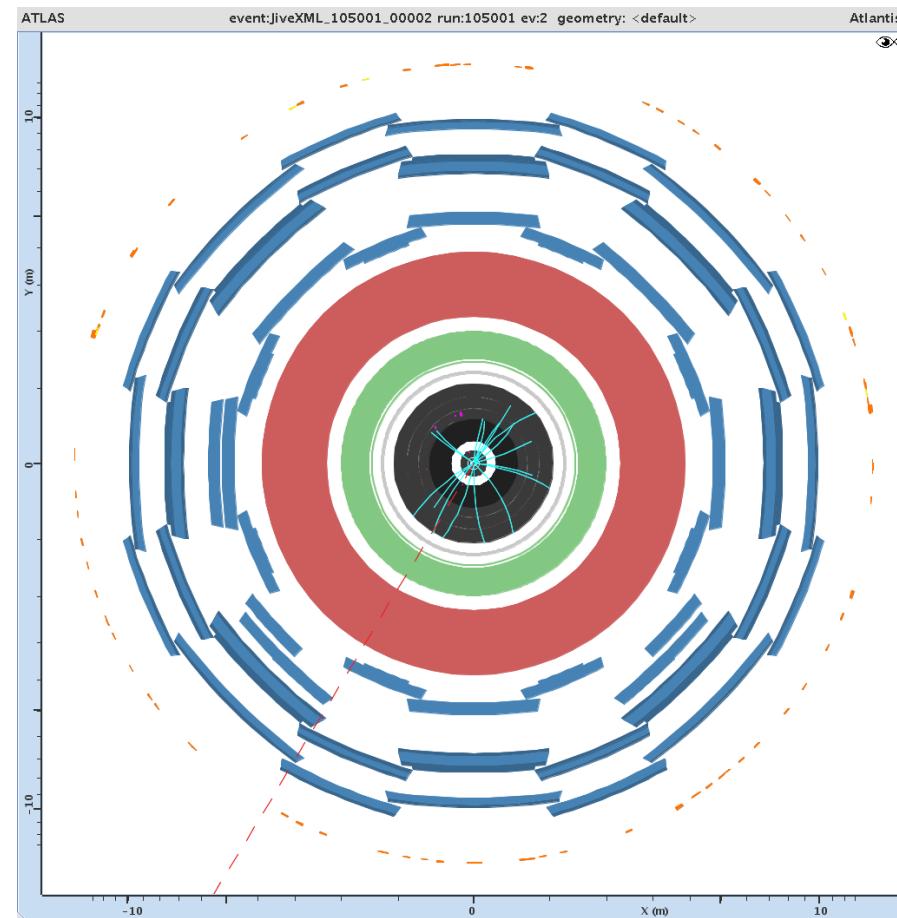
- Higher track multiplicity; energy depositions in EM and HAD calorimeters

Tau $p_T=100$ GeV

Min-Bias



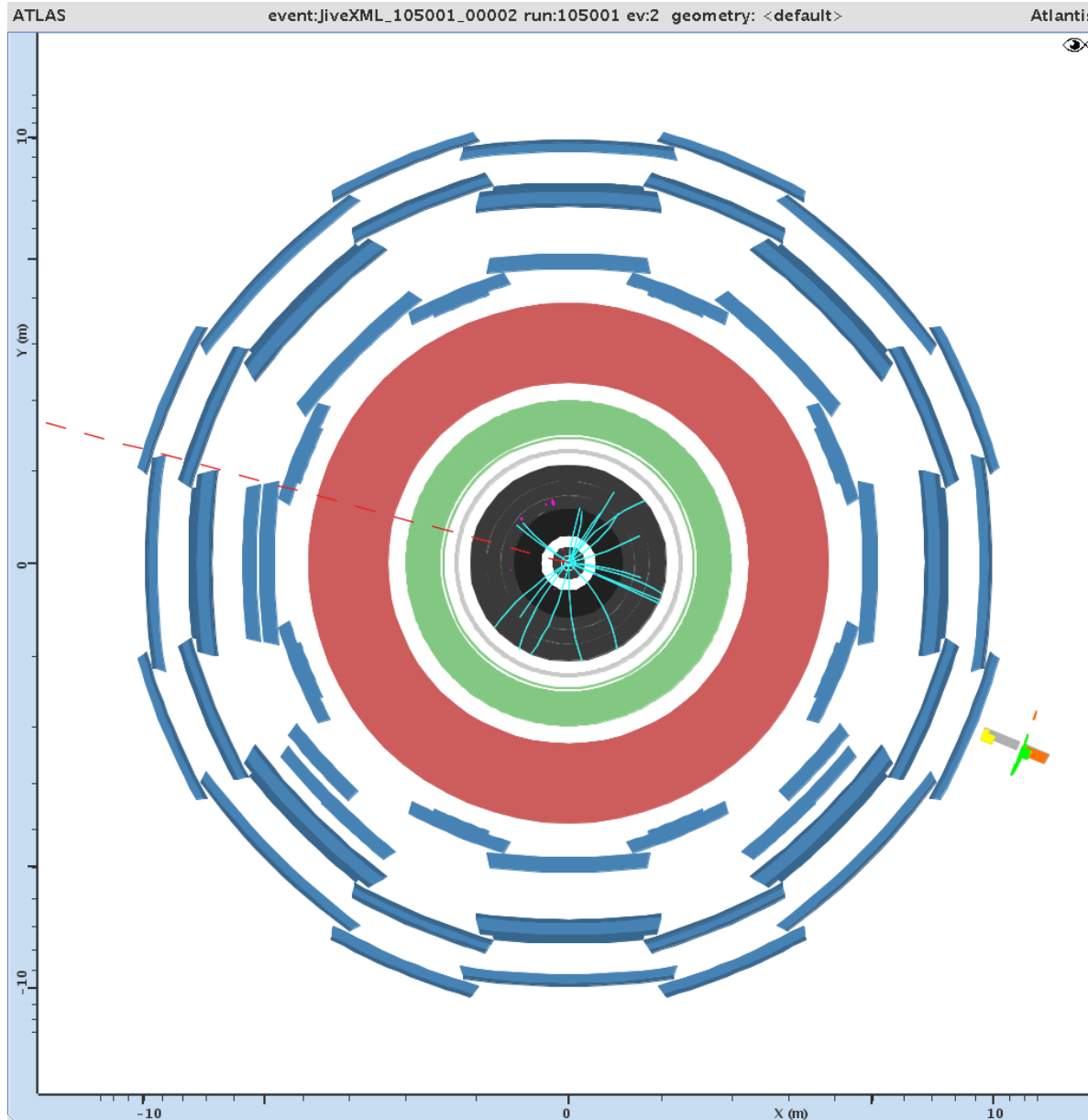
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Single Tau Overlay

Single high-pT MC tau event overlaid onto min-bias MC event

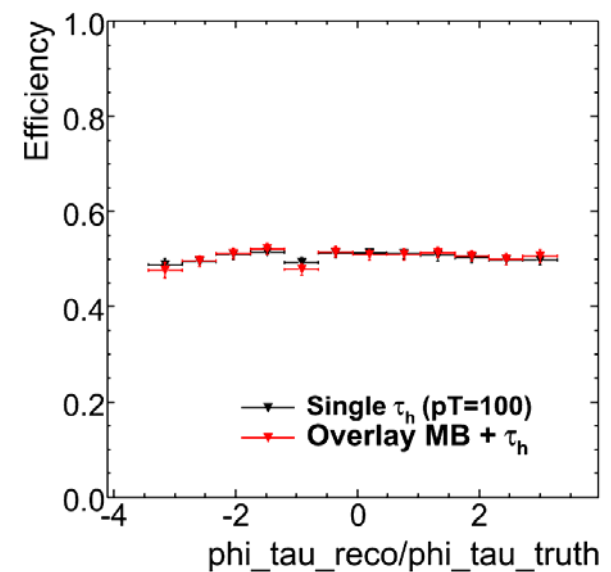
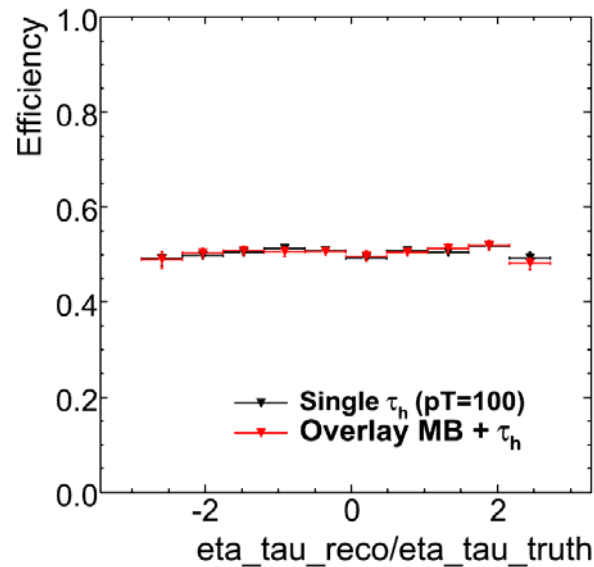
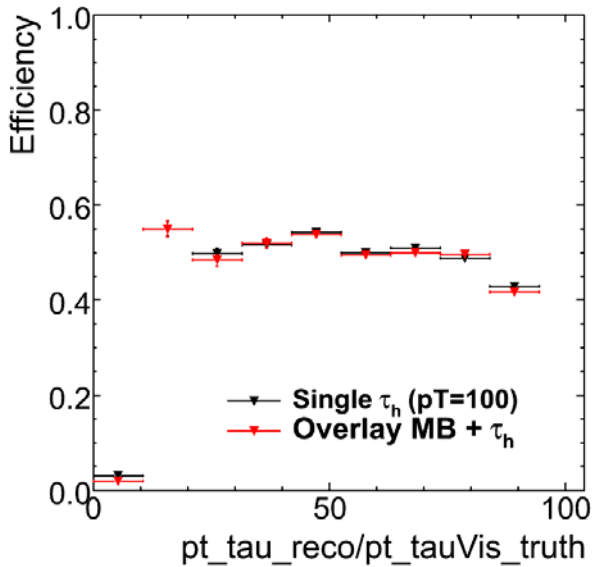
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Hadronic Tau ID Efficiency

With and without overlay on min-bias MC sample

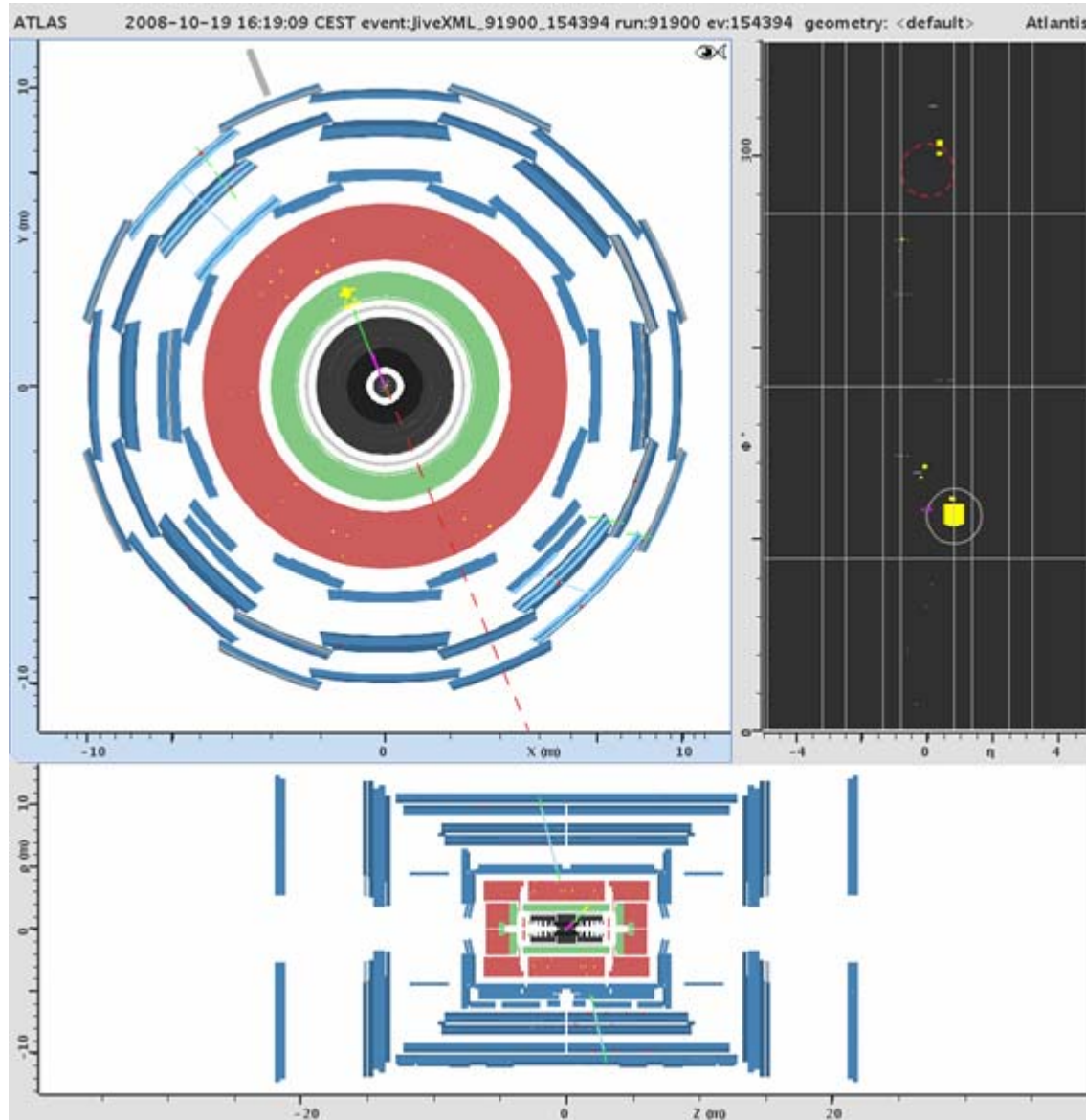
- Used tauRec seeded candidates
- Note: my selection of Truth-level taus may not be optimal here
- Most interested in the relative efficiencies
- Again, this is the ZERO pile-up scenario



Single Tau on Cosmic Data

MC Single Tau ($p_T=100$) on event from ID Cosmics “stream”

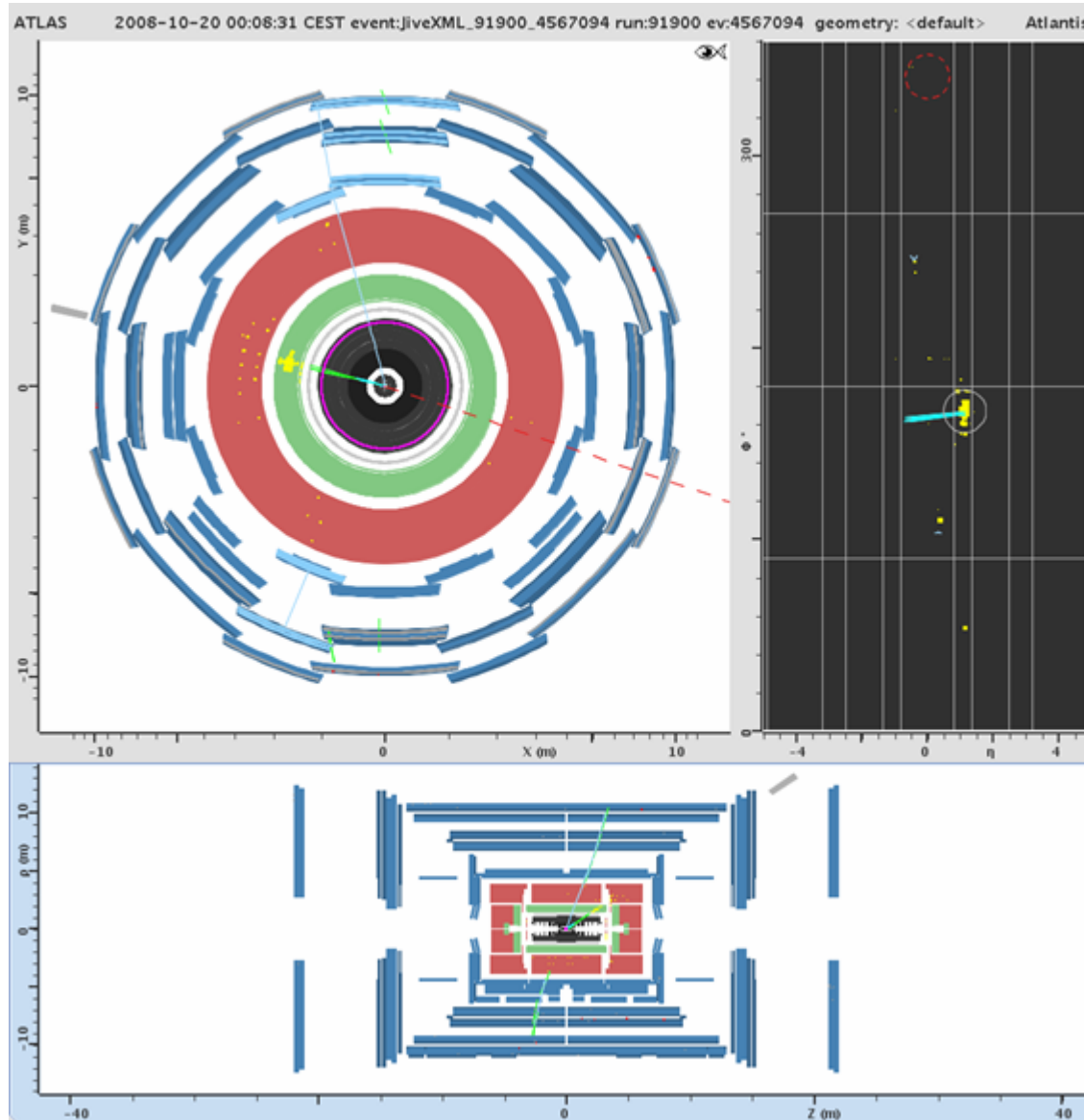
- Looks to be a 1-prong hadronic tau decay



Single Tau on Cosmic Data

MC Single Tau ($p_T=100$) on event from CosmicMuon “stream”

- Looks to be a 3-prong hadronic tau decay



Conclusions

Overlaying single tau events on minimum-bias data can help us to understand hadronic tau ID systematic uncertainties

- Generous trigger bandwidth allocated for min-bias events; expecting a large number of events; can start looking at this from Day 1
- Could be quantified by the relative differences in ID efficiencies (perhaps derive an N-dimensional efficiency matrix with bins of VispT, eta, phi, #tracks, etc...)

The overlay tools in 14.2.25.9 appear to be working very well

- Will continue the validation of MC+MC and MC+Data
- The cosmics statistics available (and on the way) with ID+Calo should allow for a very thorough study
- Need access to bytestream / RDOs (Run overlay at the CERN Analysis Facility)

Future studies

- Increase the sophistication of the hadronic tau analysis
- Consider additional single tau pT values (20, 50, 300, 500, 800 GeV)
- “Turn on” pile-up and consider the following three scenarios:
 - a) Lumi = 10^{32} , BC=450 ns, SF=2
 - b) Lumi = 10^{33} , BC=75 ns, SF=5
 - c) Lumi = 2×10^{33} , BC=25 ns, SF=5