Predicting MET Tails in Early Data

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Background

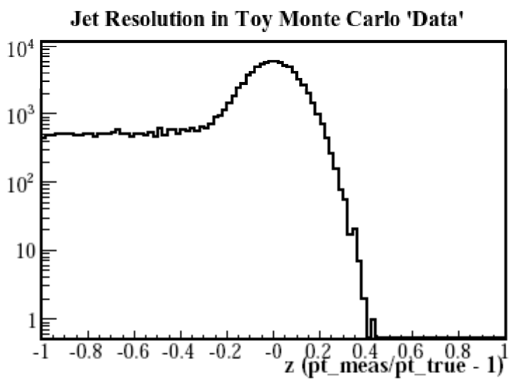
- Due to the intrinsic detector resolution, small amounts of MET will be observed in any given event. Additionally, MET may be observed due to reducible detector effects.
  - Such MET will be referred to as 'fake MET'
  - Possible sources of fake MET include detector imperfections or mis-modeled material.
- To develop techniques to understand and reduce fake MET, Monte Carlo samples with fake MET (cell killed samples) have been created.
  - These samples have detector imperfections added at the digitization level.
    - This gives a consistent trigger response for the celled killed and normal Monte Carlo
- Using the cell killed samples to replace data, direct photon events are used to map the detector response to jets as a function of position and momentum in 'data' and Monte Carlo.
- The jet resolution measured in this manner can then be used to predict the MET distributions in other data samples with jets.

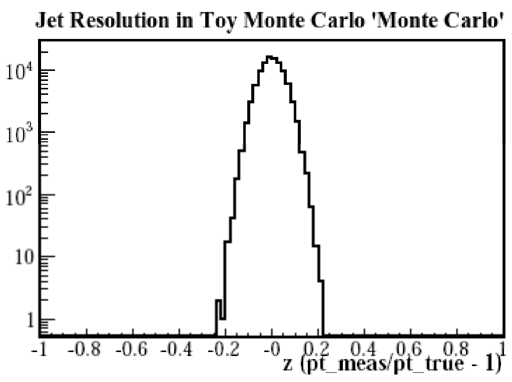
Method for Predicting MET Tails

The following is a toy Monte Carlo illustration of how direct photon events may be used to predict MET tails:

The jet resolution (z) is estimated from data using p_T balance in direct photon events as a function of jet p_T and position in the detector:

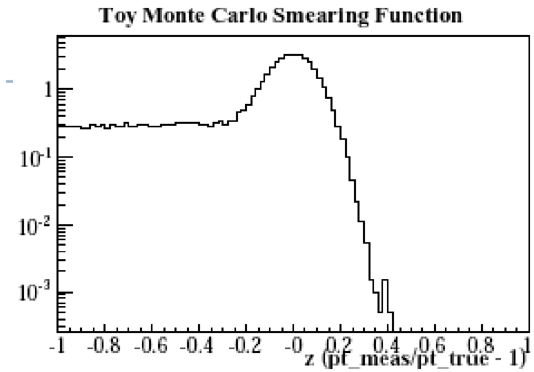
$$z = \frac{p_{T jet} - p_{T\gamma}}{p_{T\gamma}} = \frac{p_{T jet}}{p_{T\gamma}} - 1$$



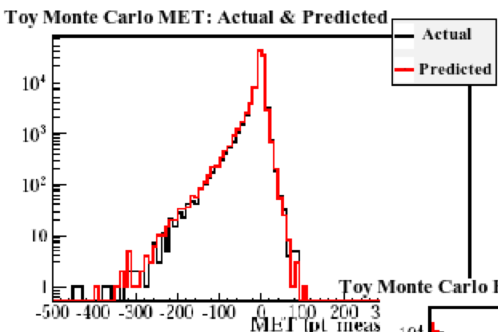


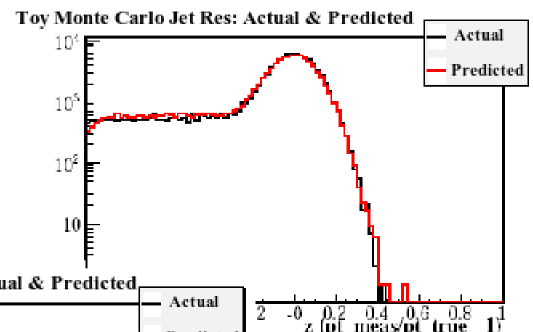
The measured resolution is compared to the resolution in Monte Carlo events. Differences will be seen due to mis-modelling of the detector, dead or noisy cells, etc.

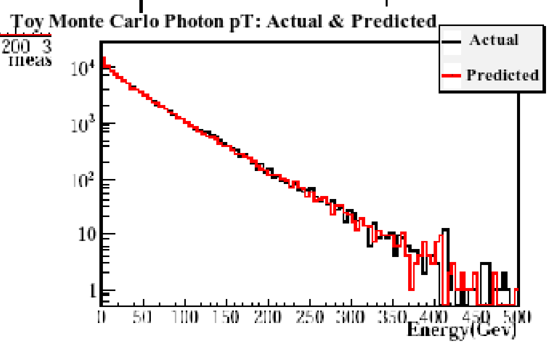
A smearing function is created that takes the normal Monte Carlo resolutions to the ones seen in data.[1]



Distributions from the smeared Monte Carlo predictions of data can then be compared with actual data as seen here in the Toy Monte Carlo results:







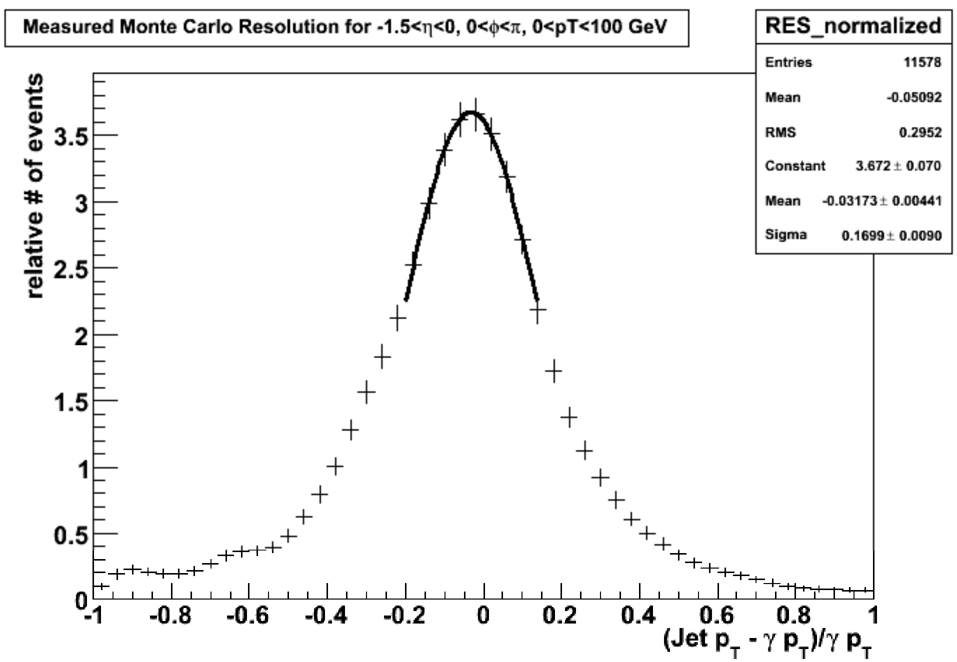
This smearing function can be applied to other Monte Carlo Samples with jets.

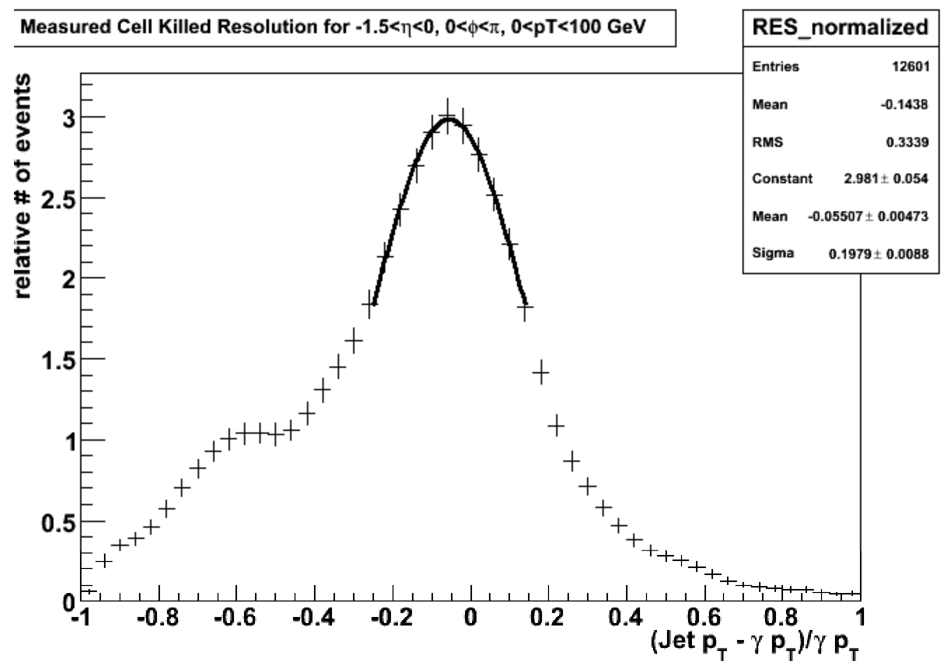
MET tails that are not predicted by the smeared Monte Carlo are then postulated to be from sources other than detector effects.

[1] In the toy Monte Carlo it is found that by taking the jet p_T resolution distribution from the Cell Killed sample and replacing the Gaussian part by a narrower Gaussian an appropriate smearing function is obtained. The Gaussian portion of this smearing function has standard deviation of: $\sigma_{smearing} = (\sigma_{cellKilled}{}^2 - \sigma_{normalMC}{}^2)^{1/2}$

Full Simulation: Measured Resolutions

- The resolution measured in a bin with an introduced detector problem is seen here.
- As expected, the resolution has a widened Gaussian distribution and non Gaussian tails as compared to the regular Monte Carlo.

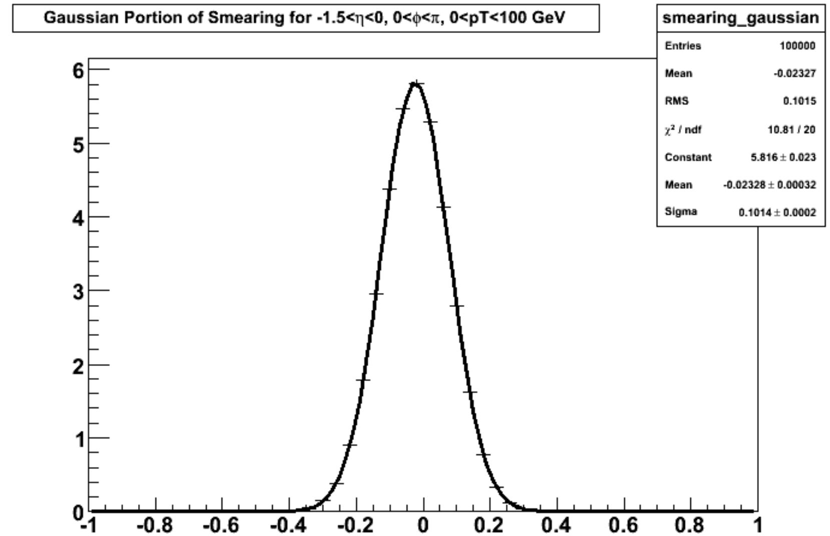




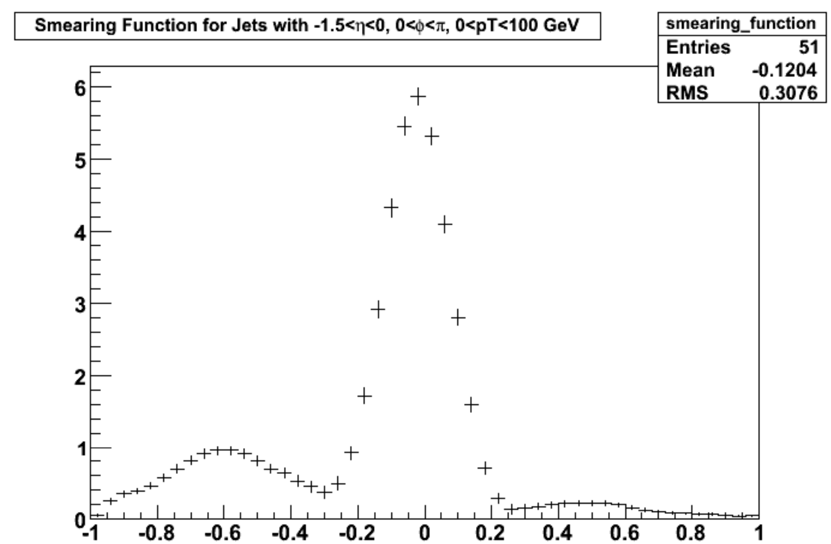
Full Simulation: Smearing Function

- Using the same technique as the toy Monte Carlo, the Gaussian part of the smearing distribution is given by:

$$\sigma_{smearing} = (\sigma_{cellKilled}{}^2 - \sigma_{normalMC}{}^2)^{1/2}$$

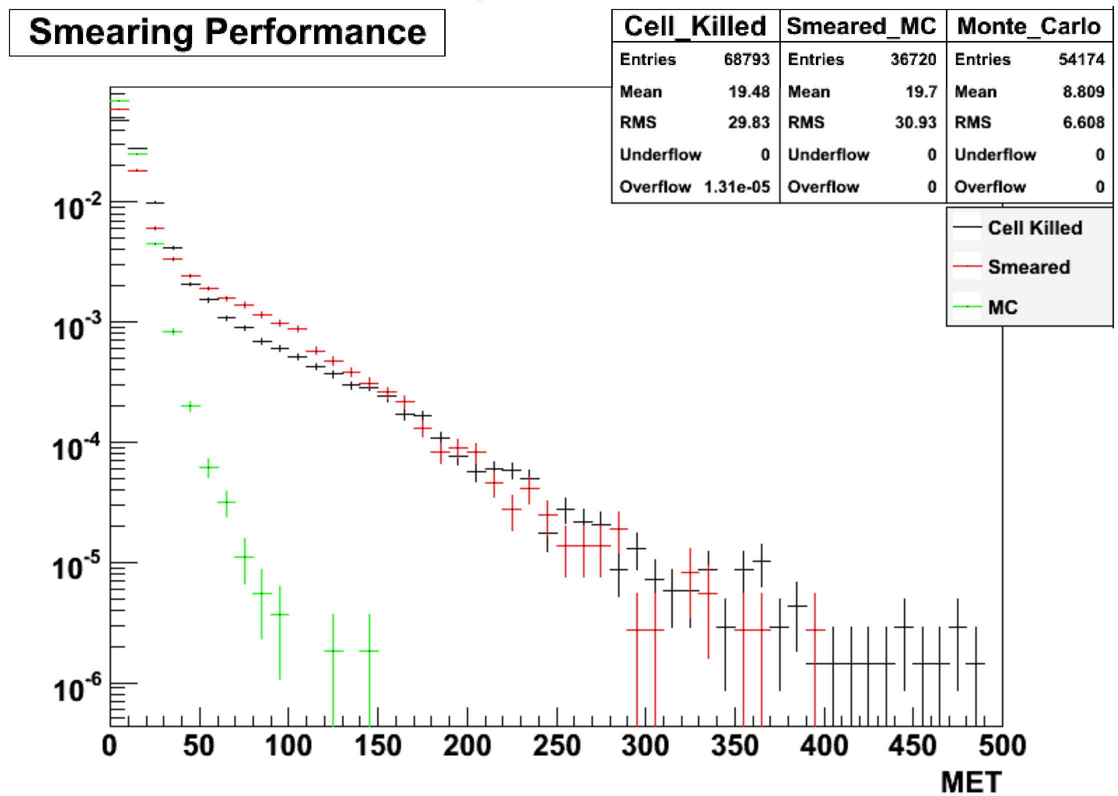


- The full smearing function can then be obtained via: $s=(d-d_{gaus})+s_{gaus}$ where
  - s = the smearing histogram
  - d = the jet resolution measured in 'data'
  - $s(d)_{gaus}$ = the Gaussian portion of s(d)
  - $\int s_{gaus} = \int d_{gaus}$ over the range -1 to 1



Full Simulation: Results

- After smearing all jets in an event, the MET is re-calculated.
- If the re-calculated MET is associated to a jet in the sample bin, the event is selected.
  - The jet associated with the MET is chosen via a Δphi match
- The projection of the recalculated MET onto the jet is seen here
  - This is used as a measure of how well MET from jets in this bin are predicted
  - The smearing method is able to recreate the cell killed tails!



Long Term Plans

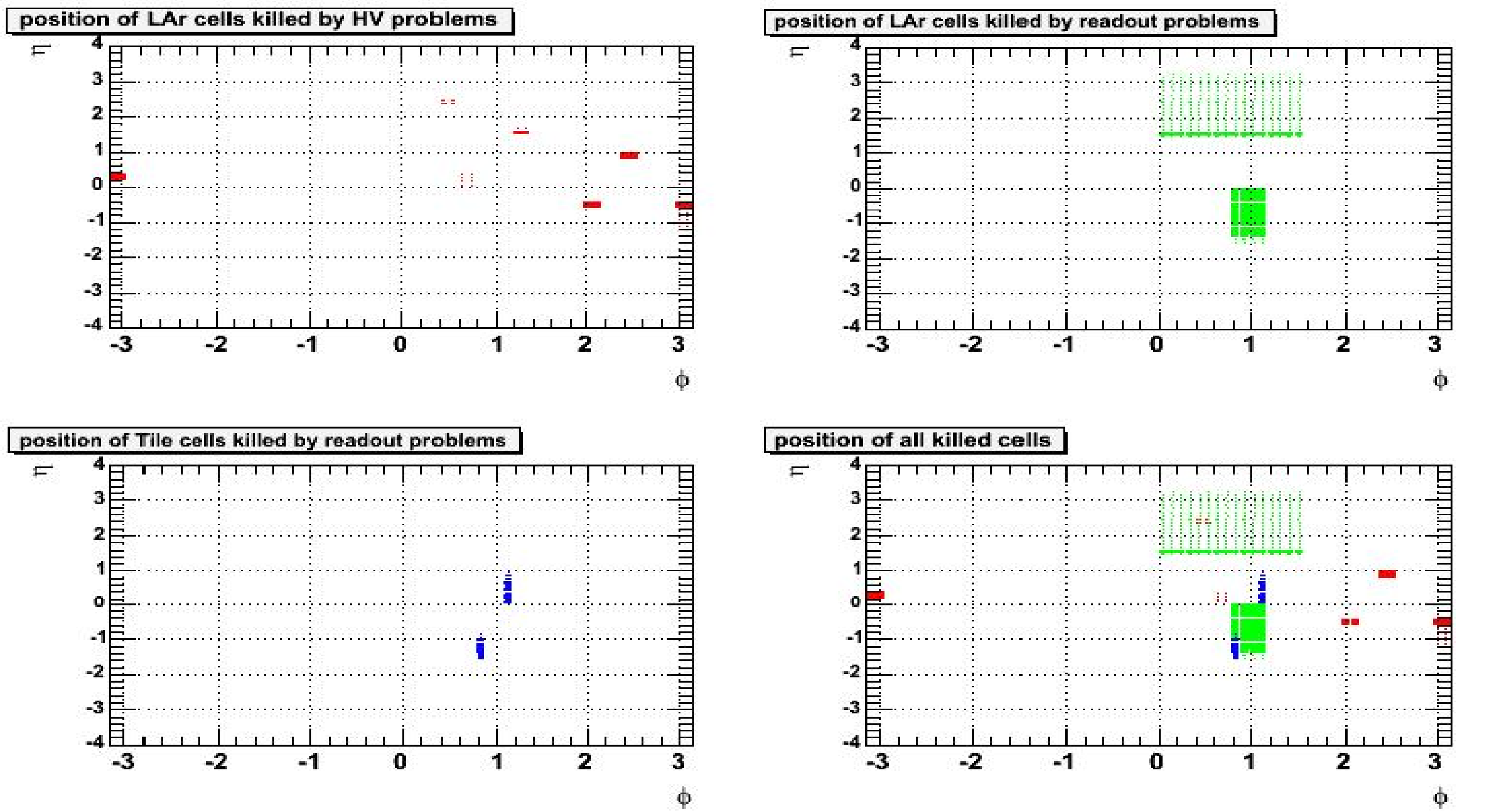
- Continue first test using full simulation
  - Refine the method using photon jet events
  - Test method on dijet events
  - Test method on events with real MET
- Pick bins using data driven methods
  - Possible to use cuts based on comparison of track jet p_T to calorimeter jet p_T (or p_T of sum of topoclusters)
    - In the EtMiss csc note, we showed that problematic regions can be found using track jet cuts
- Compare method with different jet algorithms (or using a sum of topoclusters)
    - In the csc note, performance for topoclusters was shown to be superior to that of jets when matching track jets to calorimeter signals.
    - Will test if a similar benefit is found for calculating resolution using direct photons.
- Compare methods to compute resolutions
  - One recoiling jet or sum of recoiling jets?
  - Absolute value of jet p_T or projection of p_T onto photon axis?

Backup Slides

Overview of Introduced Detector Problems

- The signal from a list of channels are set to zero during digitization.
- These channels correspond to 0.1% of LAr EM HV lines, 2 LAr FEC, and two Tile drawers (one barrel, one extended barrel).
  - This gives two dead crates in LAr at (eta, phi) = (-1.5-0.0, 0.8-1.2) and (2.5-3.2, 0.0-1.6) as well as one dead region in the HEC at (eta, phi) = (1.5-3.2, 0.0-1.6).
- Note that this does not necessarily correspond to a physical situation
  - Killing one HV line would reduce the signal in the LAr cells by ~50% not 100%
  - However, this is a way to introduce MET tails not otherwise in the Monte Carlo.
- The channels affected are plotted in the next slide.

Location of Introduced Detector Problems



Using Track Jets to Bin the Detector

- Track jets are matched to energy summed in the calorimeter with $\Delta R<0.2$ of the track jet axis
- If the track jet $p_T >$ calorimeter p_T the track jet is flagged as unmatched.
- Bins may then be created based on regions with a high number of unmatched jets. This will allow us to focus on problem regions.
- An example of such a study on a cell killed sample is seen below.