Update: EMC Non-Linearities

William Panduro Vazquez
Imperial College London
Overview

- Non-linearities refresher
- Reminder of parameterisation method
- Distortion functions extracted
- Comparison of distorted/undistorted MC digi spectra
- Results of fits to $\pi^0$s – measurement significance
- Conclusions and the future…
**EMC Non-Linearities**

- Incoming signals given different amplifications depending on their energy.
- Two effects result in threshold digis registering anomalously high energy:
  - Amplifier Saturation
  - Range Switching
- Results in non-linear regions in digi energy spectrum
- Potential effect on measurement
- Corrections made since this plot – worst case scenario
Extracting Correction Functions

- In order to generate data-realistic NL use method outlined by S. Menke in BAD 527 to extract additive distortion function.

- Proceed as follows:
  - Integrate NL spectrum
  - Extrapolate integrated ideal spectrum using 4th order polynomial (blue curve)
  - Compare points on two curves where integrals are the same
  - Shift in digi energy is the difference between these two points.
  - Extract correction function from this using linear interpolation to scan over entire NL spectrum

- Apply to MC by fitting correction function to fill a lookup table in *EmcWaveformsToDigis.cc*

- Solely for lowest energy NL region at this point
Distortion Functions - I

- Fitted simple function which can easily be parameterised for lookup table.
- Use quartic for all regions except endcap (where a quadratic works better).
- In rings 9 to 16 effect is so small it is drowned out by noise. Assume to be flat, no correction.
Reasonable parameterisation within error
Samples based on these functions have now been generated
First look at effects on digi spectra…
Comparison Digi Spectra

100 MeV $\pi^0$s
- Generated 100,000 $\pi^0$s using same seeds for both distorted and undistorted cases.
- Digis extracted from Standard distribution (black) plotted against those from the Non-Linear sample (red).

200 MeV $\pi^0$s
Comparison Digi Spectra

300 MeV $\pi^0$s

400 MeV $\pi^0$s
Comparison Digi Spectra

500 MeV $\pi^0$s

600 MeV $\pi^0$s
Comparison Digi Spectra

- Non-Linearities appear restricted solely to desired regions.
- Pile-up does not appear to be significant
- Scale of Non-Linearities would appear to match data reasonably well
- Do these data-realistic NL produce any shifts in measured quantities?

1 GeV $\pi^0$s
$\pi^0$ Mass Comparison
$\pi^0$ Mass Width Comparison
Fit Signal Fraction Comparison
Conclusions

- Parameterisation method appears sound
- Need to scan across EMC to confirm we are producing different scale NL – more stats!
- No parameterisation so far for higher energy regions:
  - 400 MeV boundary - contaminated with crosstalk
  - 3.2 GeV boundary – small effect, difficult to extract correction
  - Could experiment with scaled versions of lower energy functions – hopefully eliminate concerns over significance to measurement
- Final step… Produce module independent of *EmcWaveformsToDigis.cc* for use in SP