EMTiming Project

Project overview

Do no harm. Checks on the CEM detector:

- **Pedestals**
- **e/p from W's**

Performance of the existing system:

- **Calibrations and Monitoring**
- **Time resolution:**
  - **Inclusive data (π^0)**
  - **e from W's and Y's**
- **Noise level**

Quick physics benefits from the project:

- **Beam halo rejection**
- **Rare events**

Project Overview

What is already installed

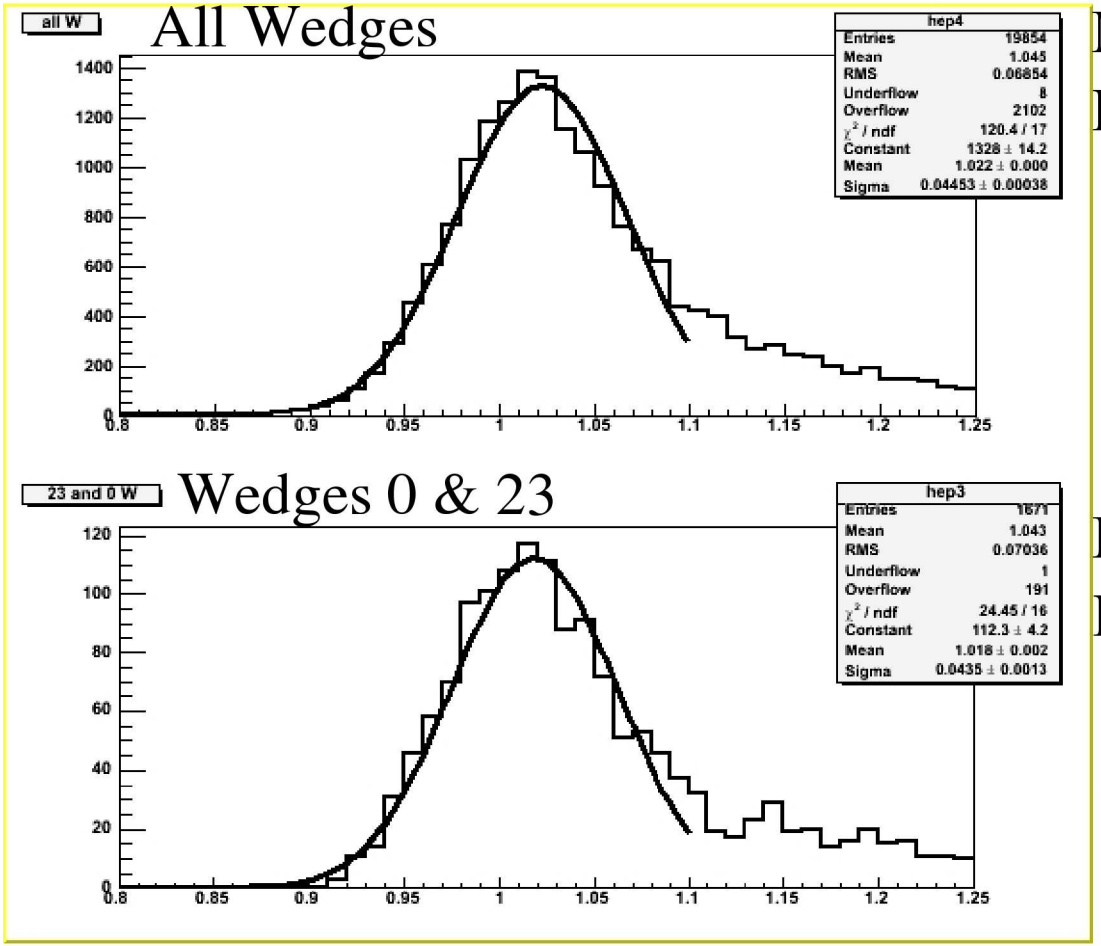
- **All of the PEM**
- **4 wedges in CEM**
- **All long cables from collision hall to readout crate**
- **Readout crate with all TDC boards**

Readout software

Online monitoring (ObjectMon)

CEM check: E/P

E/P plot: check if EMTiming affects energy readout



Mean = 1.022 ± 0.000

RMS = 0.0445 ± 0.004

Mean = 1.018 ± 0.002

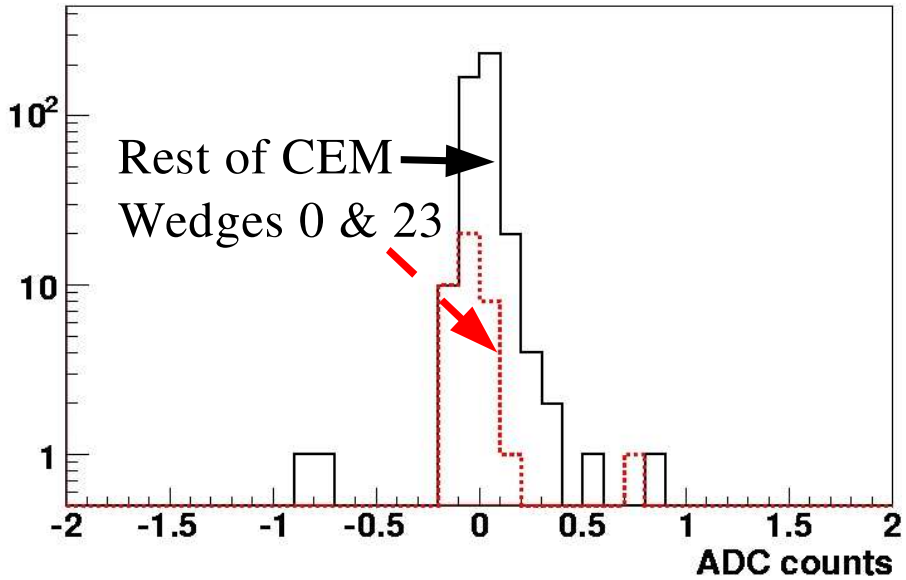
RMS = 0.0435 ± 0.013

No difference between wedges 0, 23 and the rest of the CEM

CEM check: pedestals

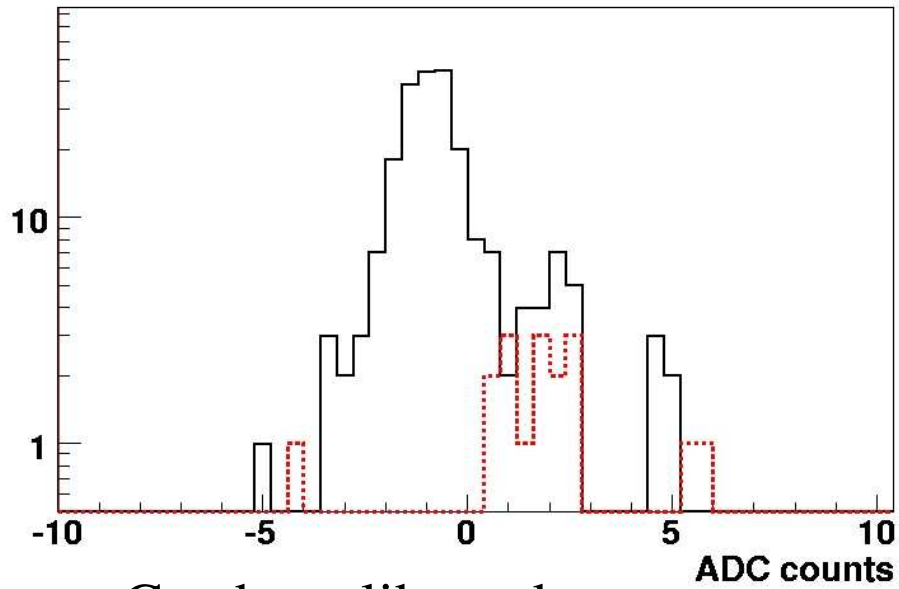
Pedestals for each tower before and after the installation

Shift in Pedestals RMS



Important for energy resolution

Shift in Pedestals



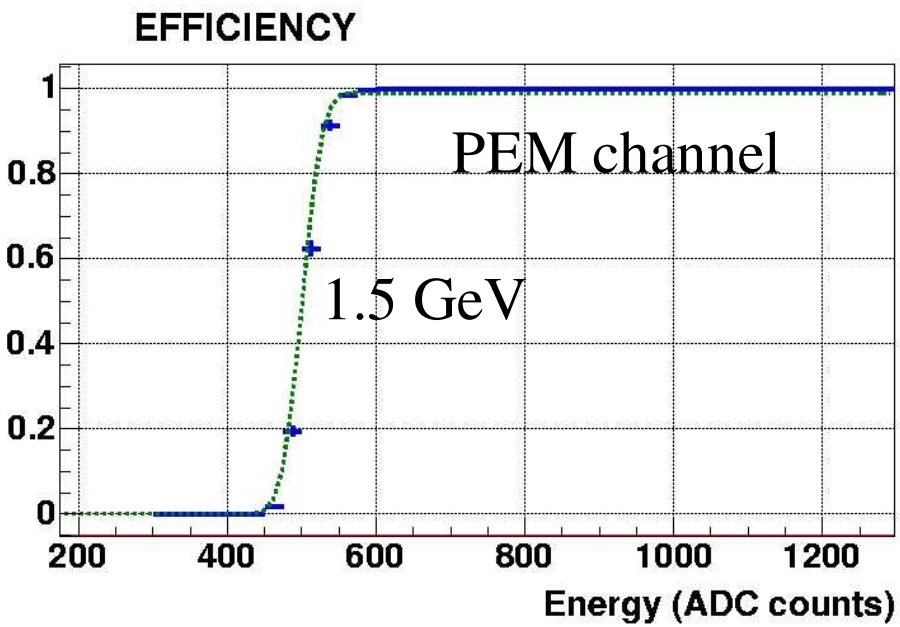
Can be calibrated out

Shifts in Pedestals and Pedestals RMS are consistent with the rest of the CEM

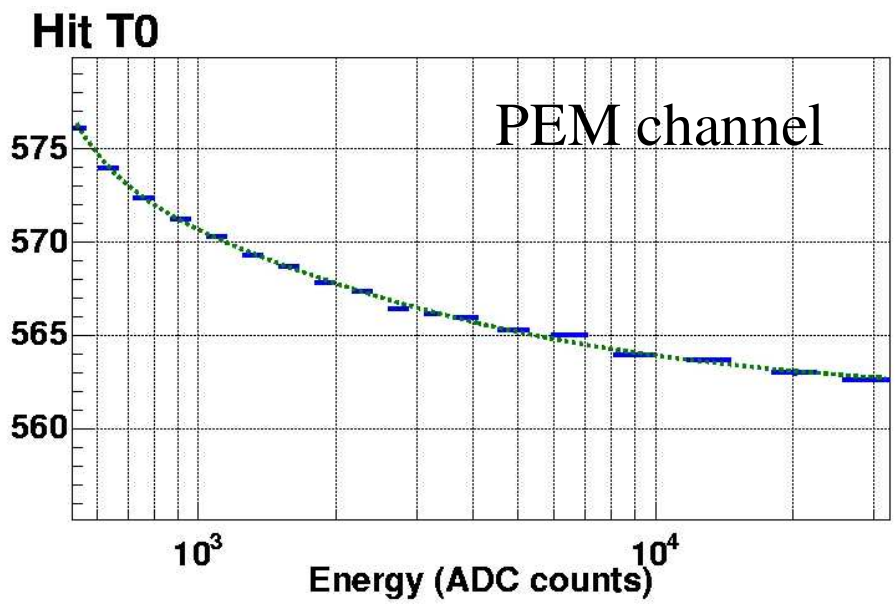
Calibrations and Monitoring

We monitor channel efficiencies and calibrate out time detector effects

Efficiency curves show most problems right away

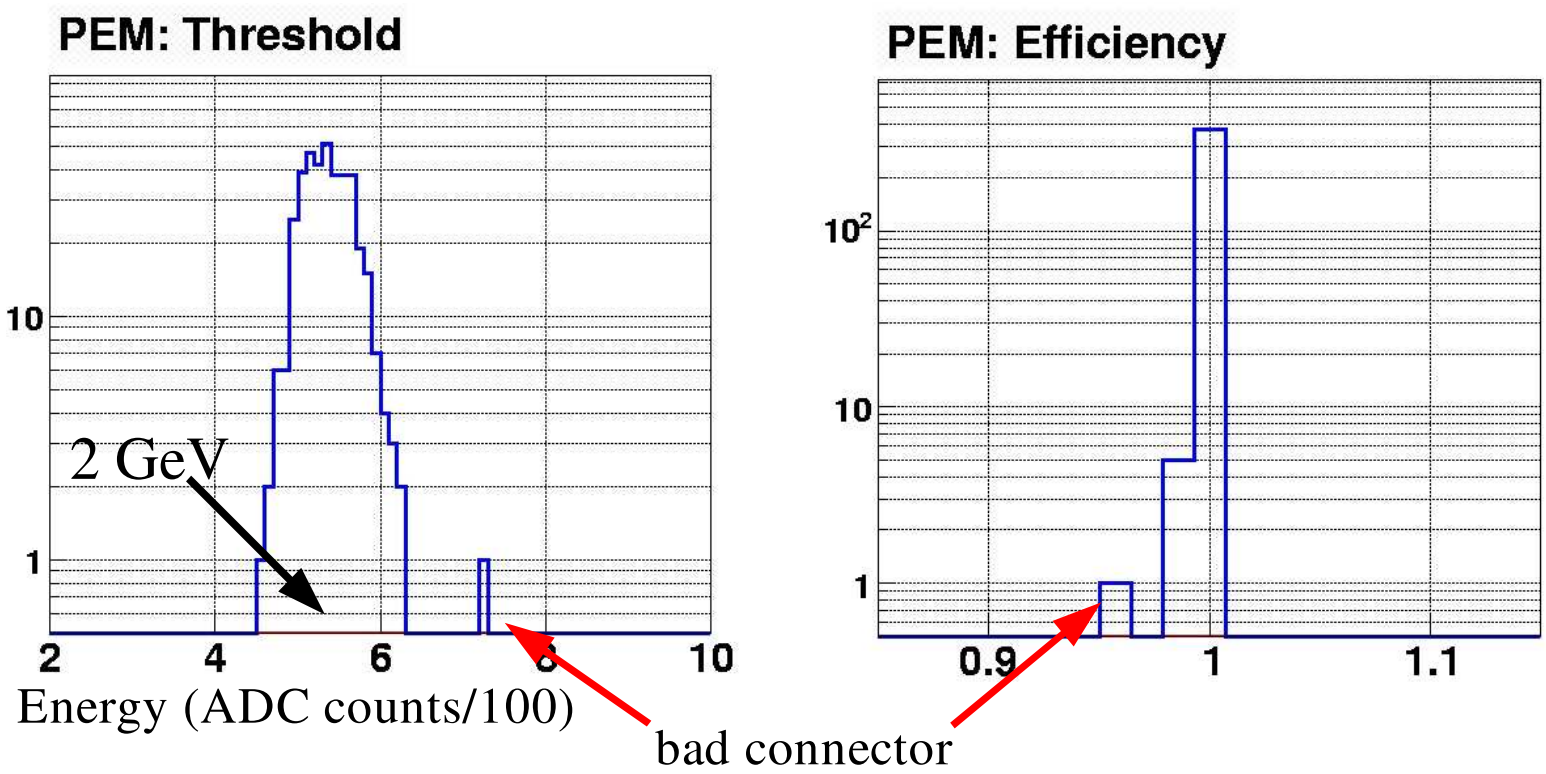


T0 as a function of energy is the dominant effect on resolution



The best way to find a bad channel is to compare above curves among all channels

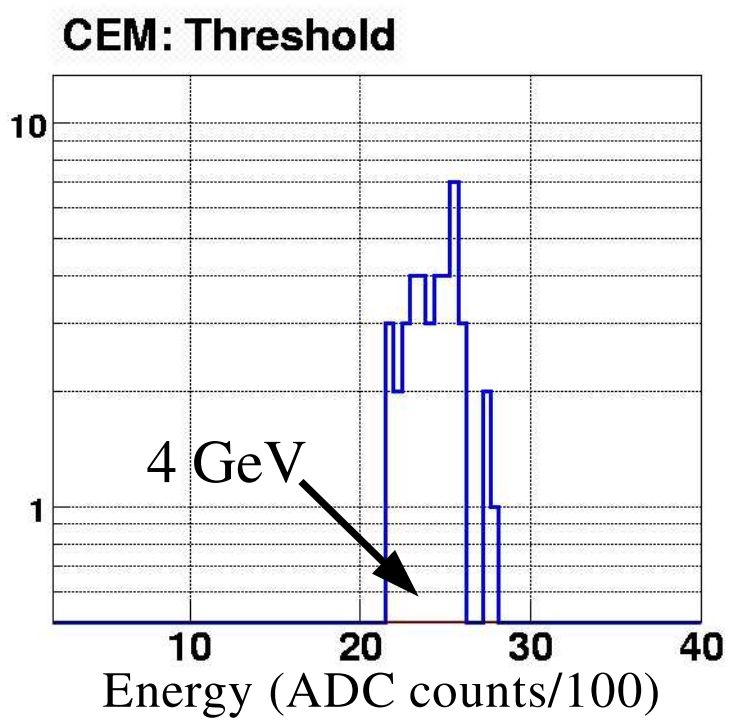
Monitoring: Plug Detector

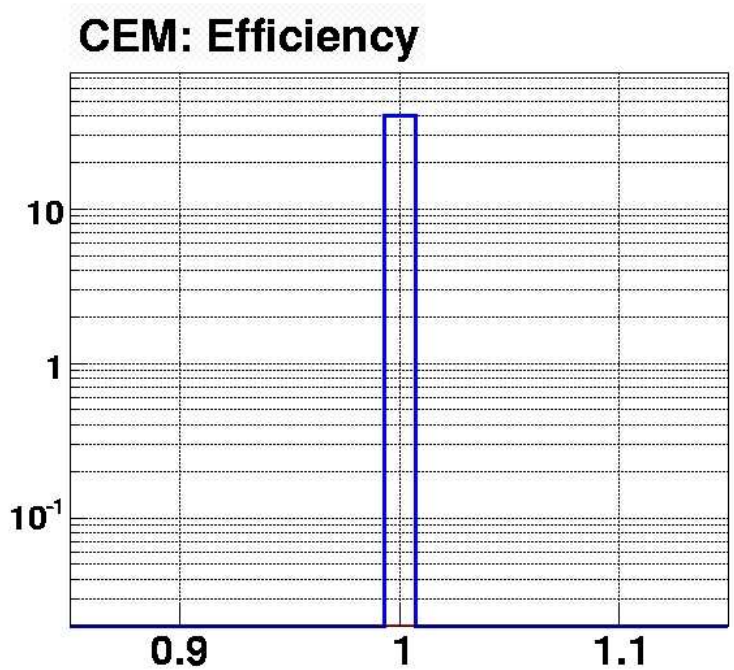


Channels are 100% efficient, in plug detector there is 1/768 lines with a problem (fix~30 min).

Threshold ~ 2 GeV (or 500 ADC Counts)

Monitoring: Central





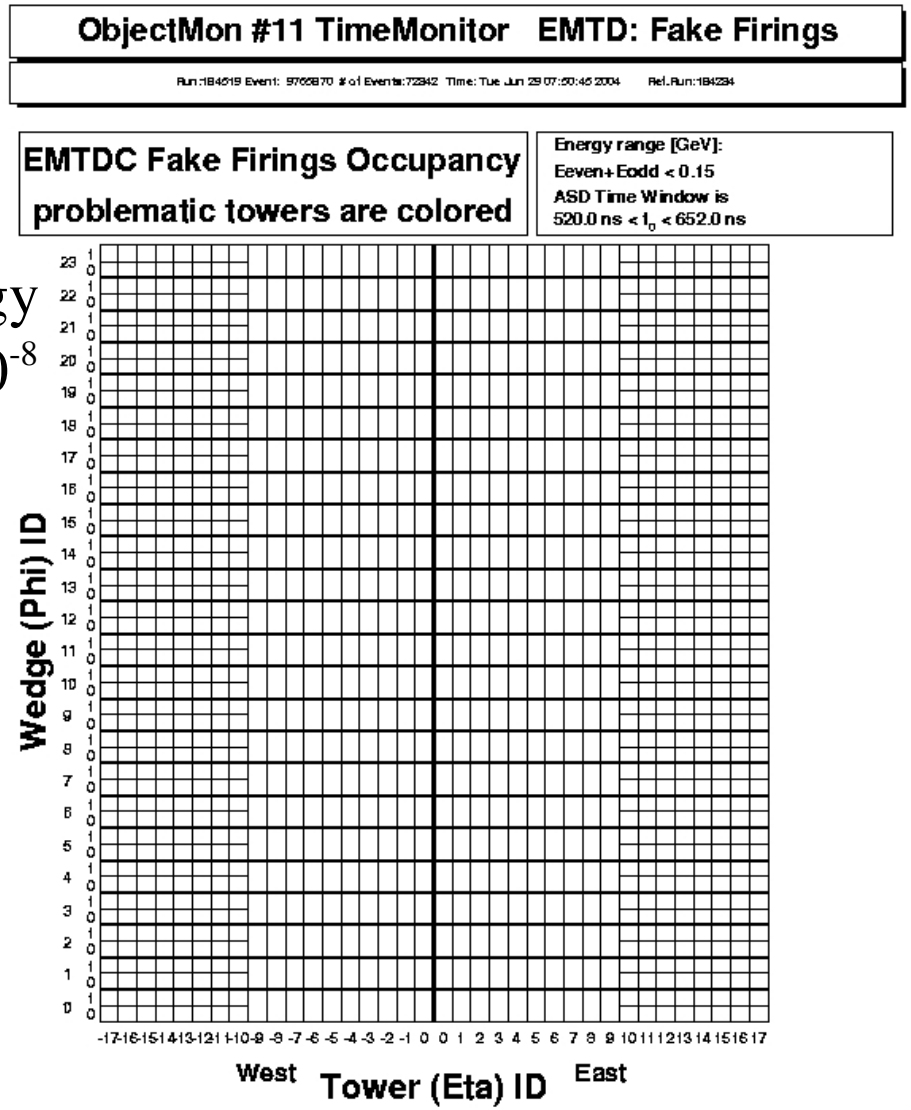
All channels are 100% efficient. No problems in all 40 channels.

Threshold ~ 4 GeV (or 25K ADC counts)

Noise Levels

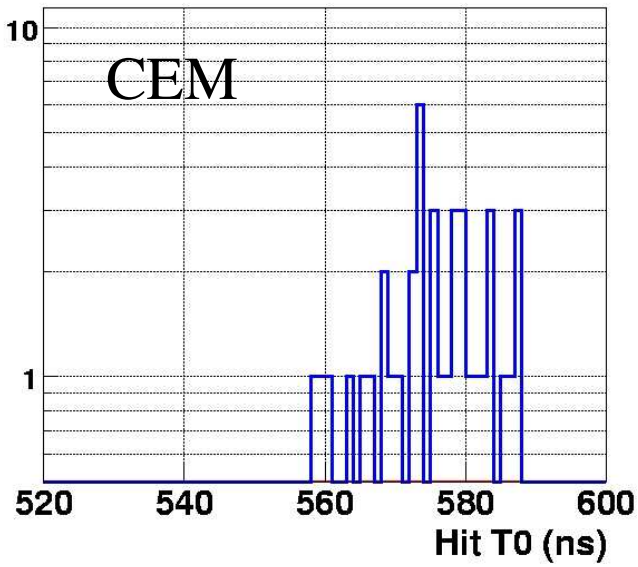
No TDC hits for events with no energy

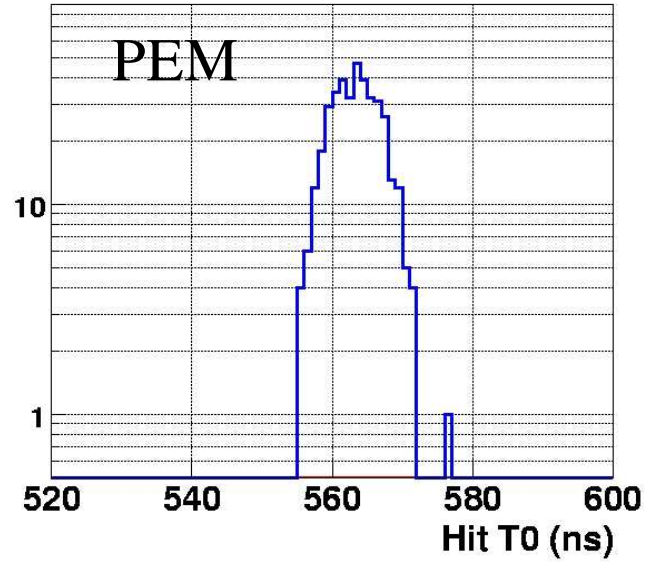
424 channels x 72842 events => 3×10^{-8}



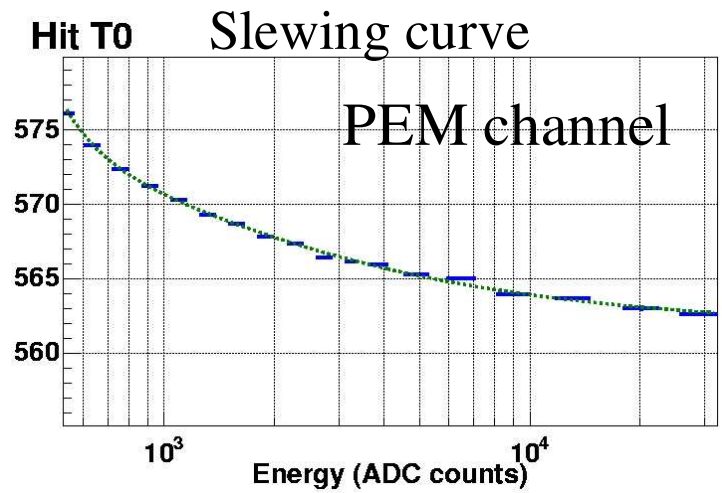
Resolution Contributions

T0 (E --> ∞) for all channels





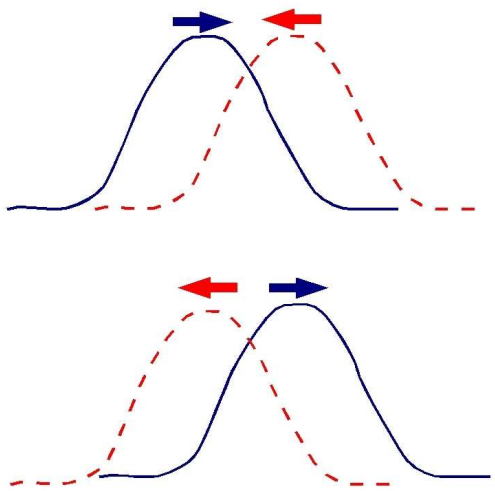
Difference between channels and energy slewing are the dominant effects on the resolution



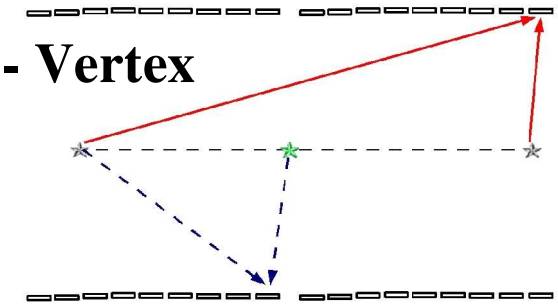
Resolution Contributions

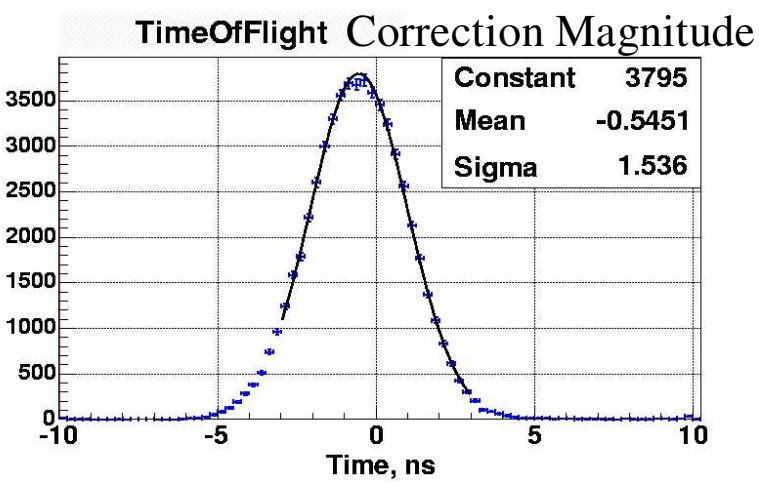
"Event" corrections: "When" and "Where" the collision happened.

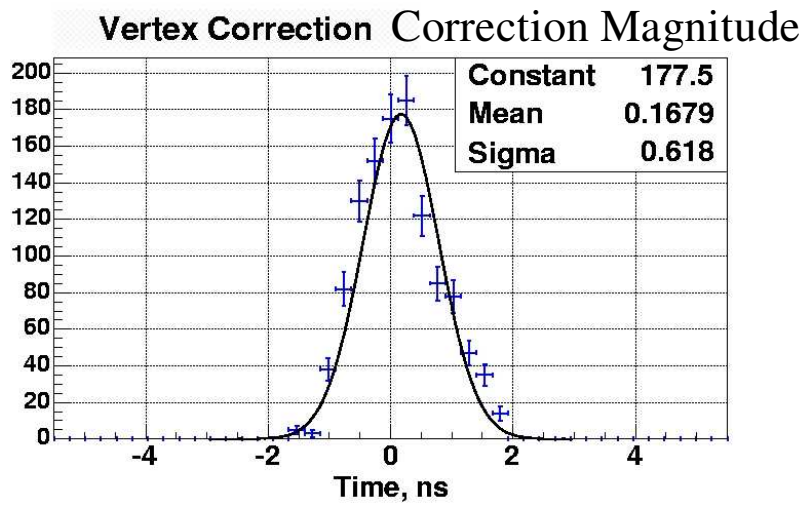
"When" - TOF



"Where" - Vertex



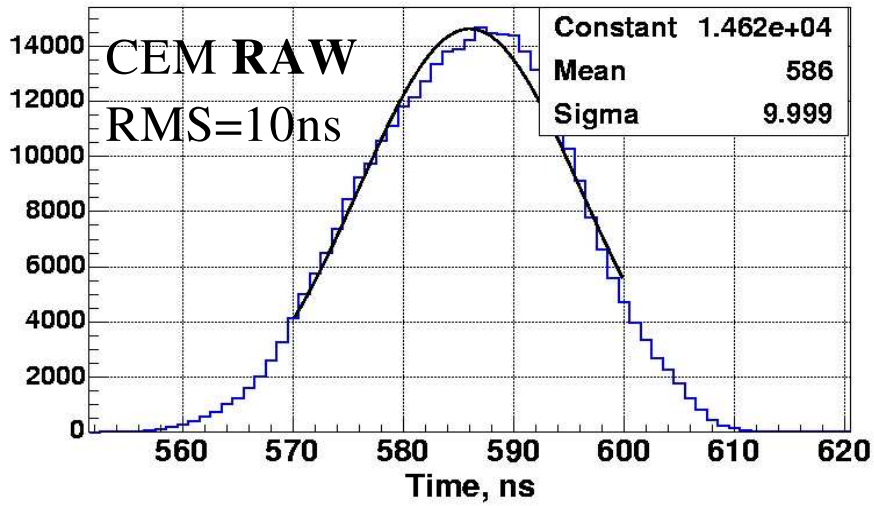


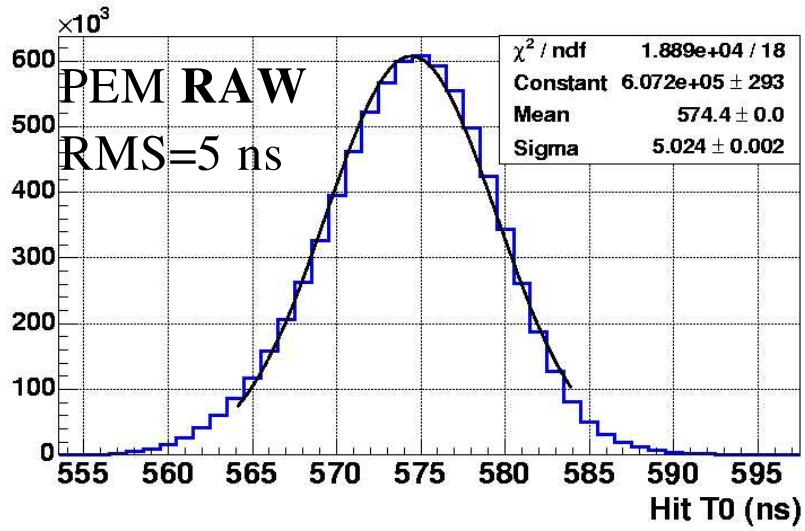


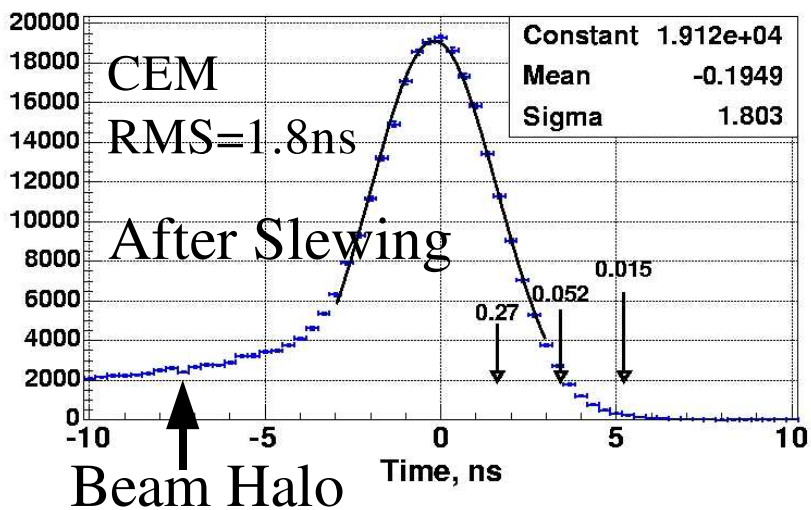
Time of Flight and Vertex from W's

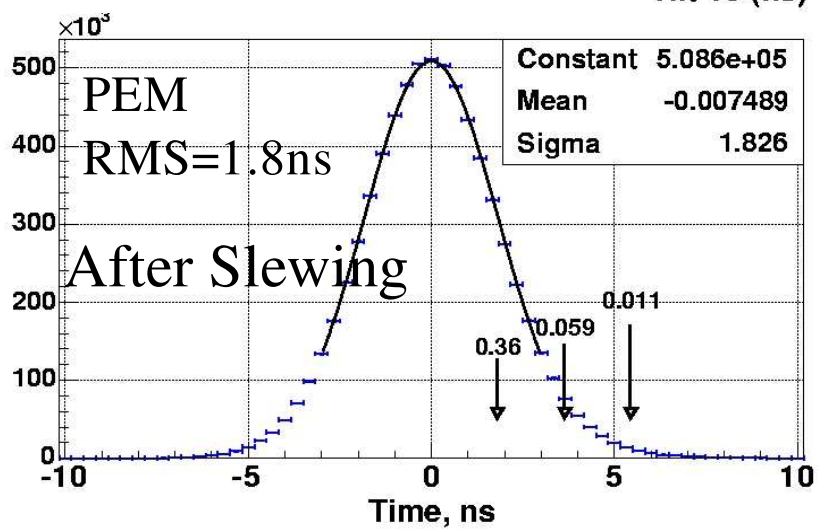
Resolution: Slewing Corrections

Inclusive Data streamA: RMS = 1.8 ns after slewing correction.



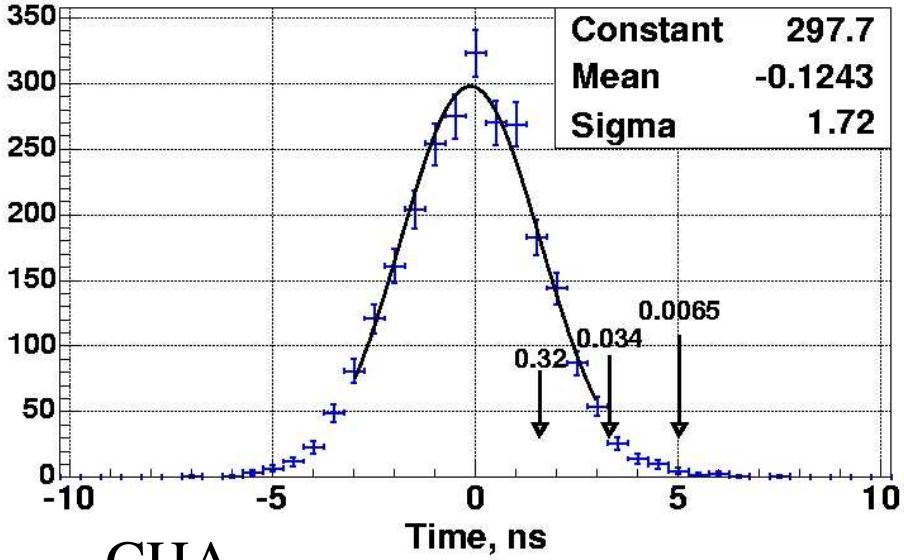




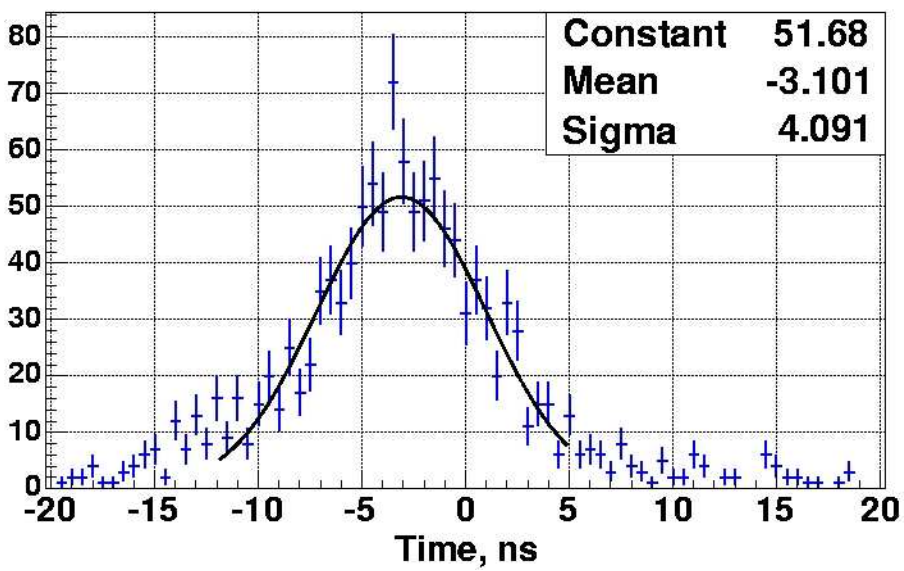


W Electrons: Resolution

CEM



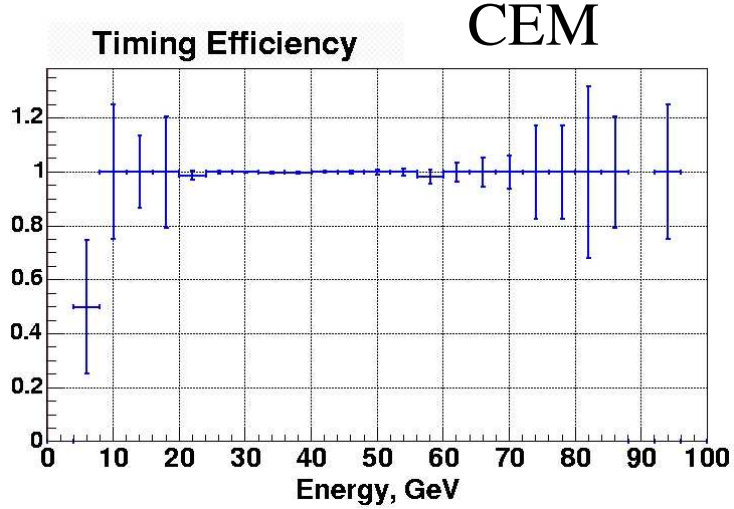
CHA



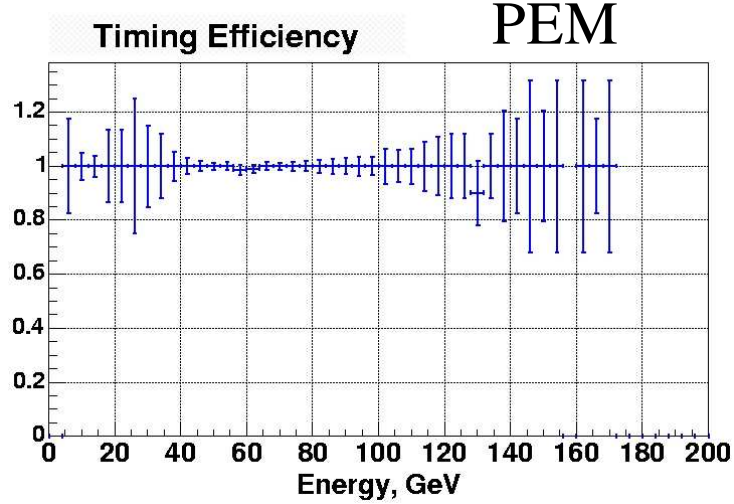
Slewing corrections only
Resolution for W electrons:
CEM ~1.7 ns CHA ~4 ns

W Electrons: efficiency

CEM



PEM



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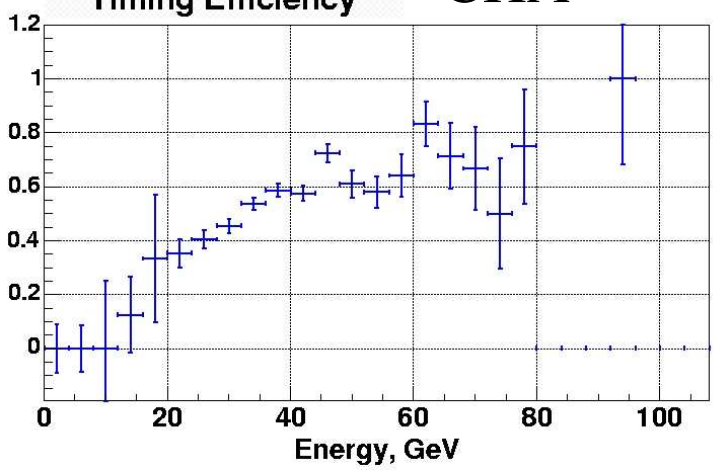
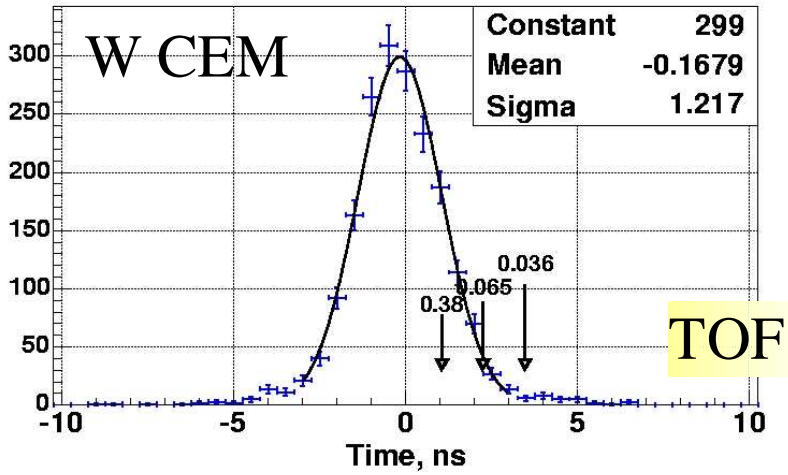
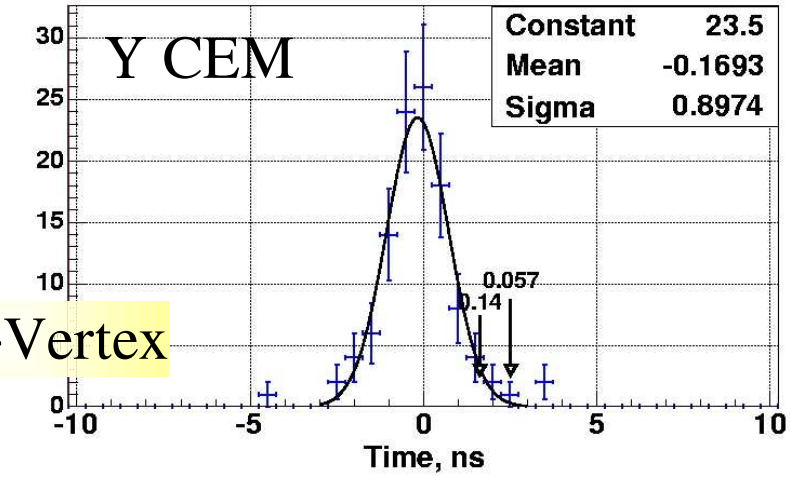


- CEM Threshold - ~4 GeV
- PEM Threshold - ~1.5 GeV
- Fully efficient after threshold

- CHA is ~70% efficient for E > 40 GeV
- CHA curve strongly depends on electron selection cuts

Electrons from W's and Y's

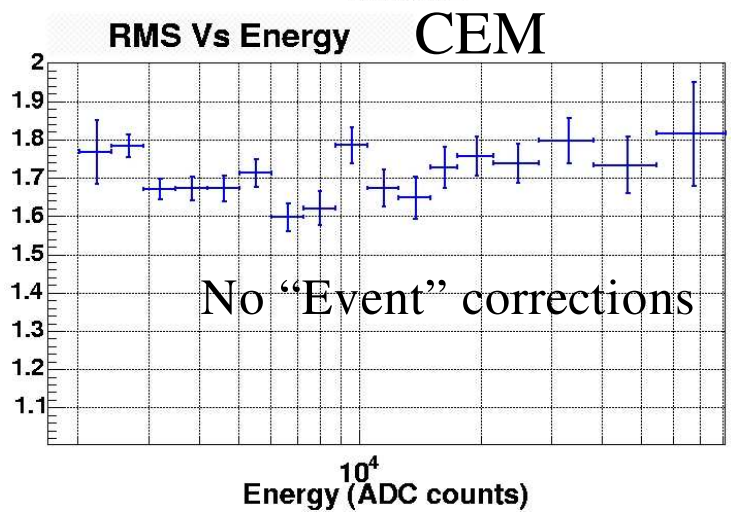




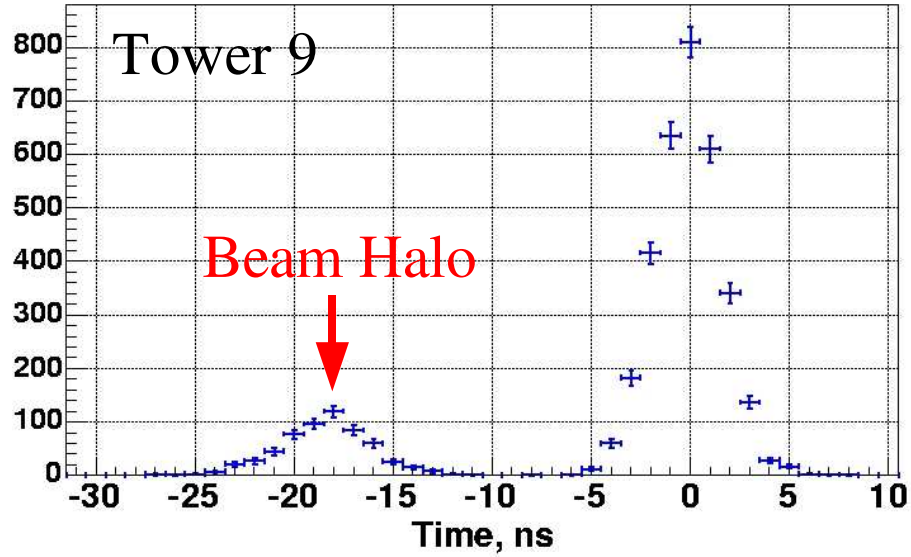
TOF +Vertex

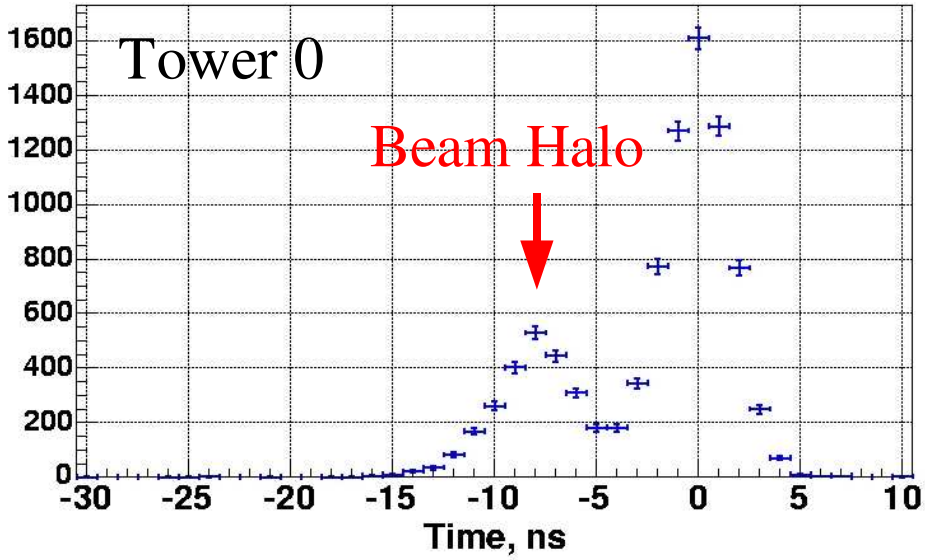
- "Event" corrections ~0.5 ns
- "Event" corrections are analysis dependent

- Resolution is energy dependent.
- Resolution – from 0.9 to 1.2 ns



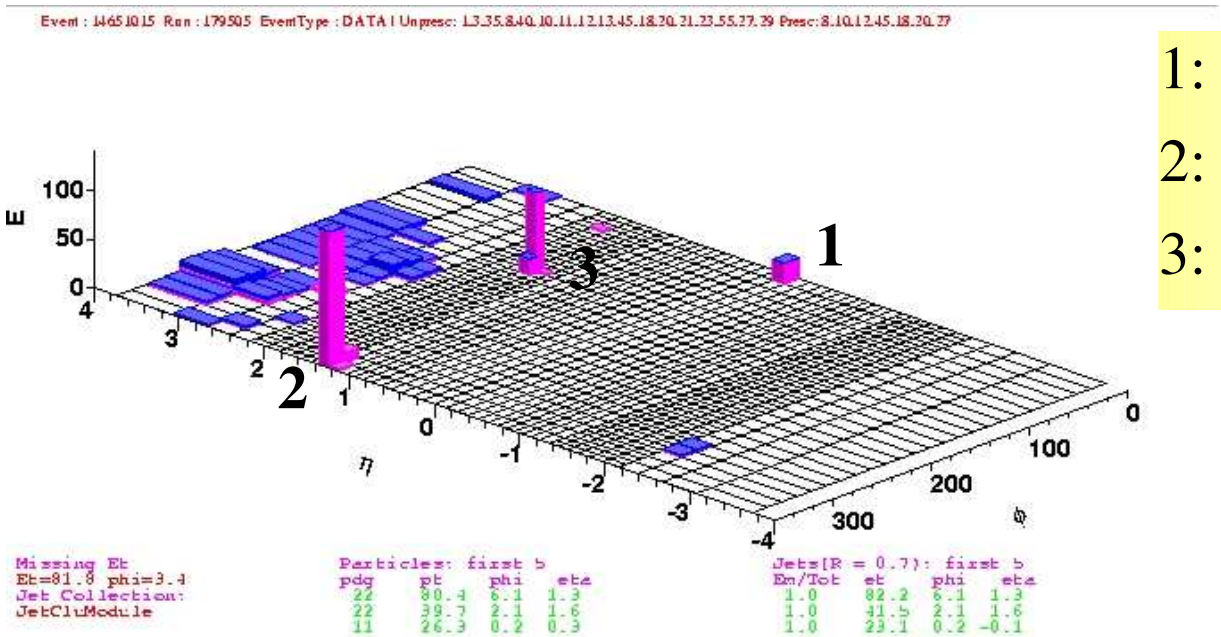
Beam Halo





- Beam Halo: CEM wedges 0 & 23.
- The halo peak moves closer to the primary one as halo traverses towers from east to west.
- Two peaks indistinguishable in the West Tower 3 --> Resolution suffers.
- Halo peak time < primary peak.

Rare 3e Event



1: T_{HAD} = -13.6ns, T_{EM}=1.57ns

2: T_{HAD} = ---------, T_{EM}=3.22ns

3: T_{HAD} = ---------, T_{EM}=0.63ns

1: E= 20 GeV P_T= 26GeV (z=-67cm, eta=0.2 phi=0.3)

2: 100GeV 64 (Phoenix Track: eta=1.48 phi=6.05)

3: 40 GeV 30 (Phoenix Track: eta=1.85 phi=2.08)

Met = 82 GeV at phi=3.14

M(p2+p3) = 84 GeV (Z candidate with P_T=48GeV)

Mt(p1+MET) = 108 GeV (W candidate with P_T=54GeV)

EMTiming System

Exist: 384 channels in PEM and 40 channels in CEM. System is working as expected (1 side of 1 PEM channel needs fixing).

In CEM we did not detect any changes caused by our system.

Did not have to access hardware for ~7 months.

Calibrations are automatic: resolution is < 1.8 ns and can go as low as 0.9 ns.

Noise level is non-existent

We hope to finish the installation of the rest of the CEM during upcoming shutdown.