Muon Stability at CalDet

MINOS Collaboration Meeting

Fermilab
April 2002

Contents

Introdction

- Cosmic muon rate at Far Detector $\sim$500 per strip-end per month
  - Important that strip response is stable over this timescale

- At CalDet, have been looking at MEU under various conditions:
  - with extreme gain changes
  - with temperature
  - with time

ADC Corrections

Correct for:

- Path length through scintillator
  - correction:

$$< ds >= \left(\frac{ds}{dz}\right)\left(\frac{\Delta y}{\frac{\Delta y}{\Delta z}+\left|\frac{dy}{dz}\right|}\right)$$

(from NuMI-L-694; R.Lee, S.Seun)

  - use average track angles for all hits in an event

- PMT drift using light injection
  - use drift points taken every 20 mins throughout run
  - relate all runs to a fixed point in the past
  - Use simplest correction:

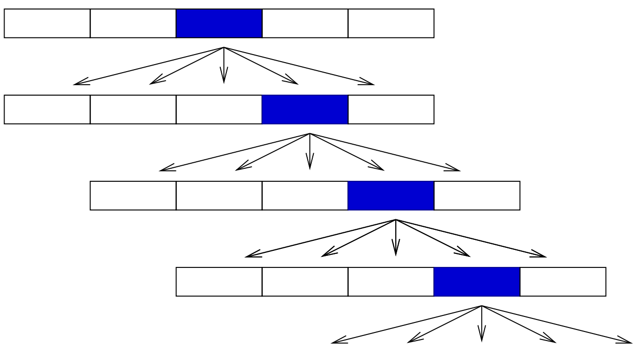
$$adc_{corrected} = \frac{adc_{t_2} \times (adc_{drift}/pin_{drift})_{t_1}}{(adc_{drift}/pin_{drift})_{t_2}}$$

Event Selection

Look at each event in turn and apply the following selection criteria:

- Number of hits in event ≥ 16
- Minimum track length $= 8$ planes
- ≤ 2 hit strips in 5 per plane
- Only use strips where both ends readout
- For beam events:
  - Track angles < 10 degrees wrt beamline
  - Only take events during spill
  - First hit must be in central strips

To find a track: Find a hit in strip n, look for another hit in the next plane (of same orientation) within n$\pm$m strips, etc...



Obtaining MIP values

- Selected hits are histogrammed per strip-end

- Have been used using a $L \otimes P$ fit to obtain value for histogram peaks

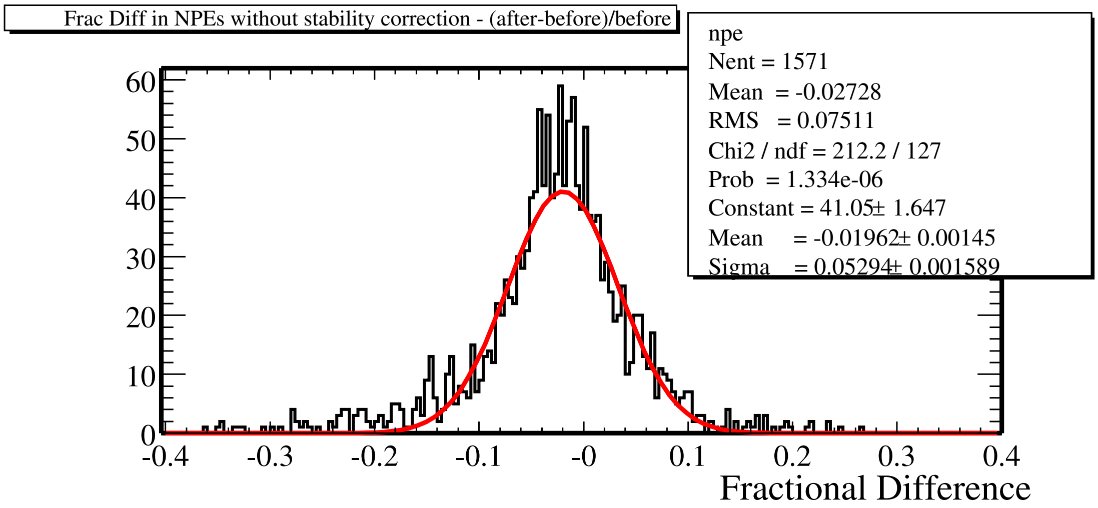
- Recent investigations show truncated mean method is more stable when dealing with low #entries ($<$2000)
  – see reconstruction talk

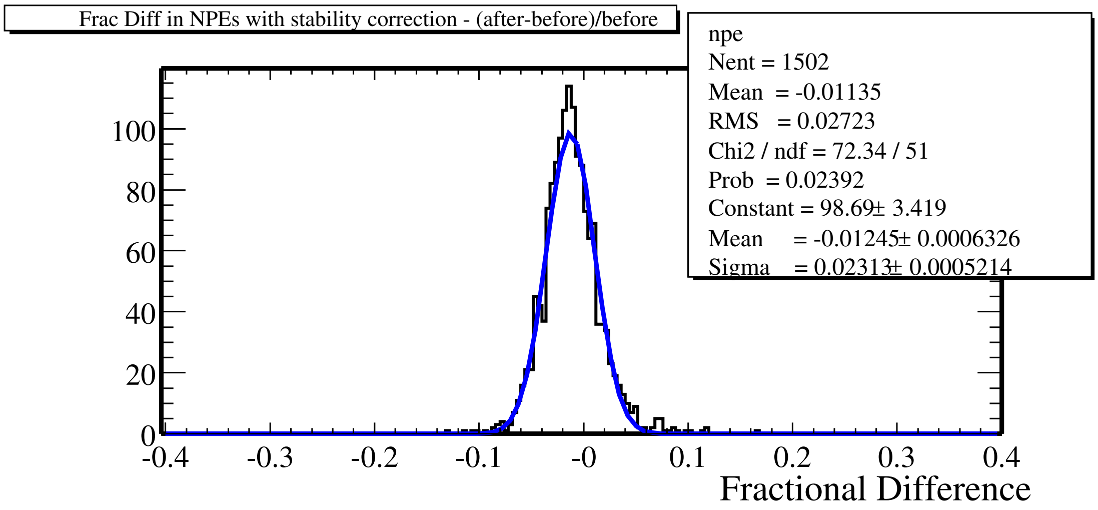
- For the following stability measurements, truncated means used for MIP values

  – Histograms truncated at 90%

Stability with Gain Change

– During test-beam, HV settings increased by ∼20%
– Look at two 3 GeV runs, two weeks apart, straddling HV change
– Plots show fractional difference in MIP values with and without drift point correction:





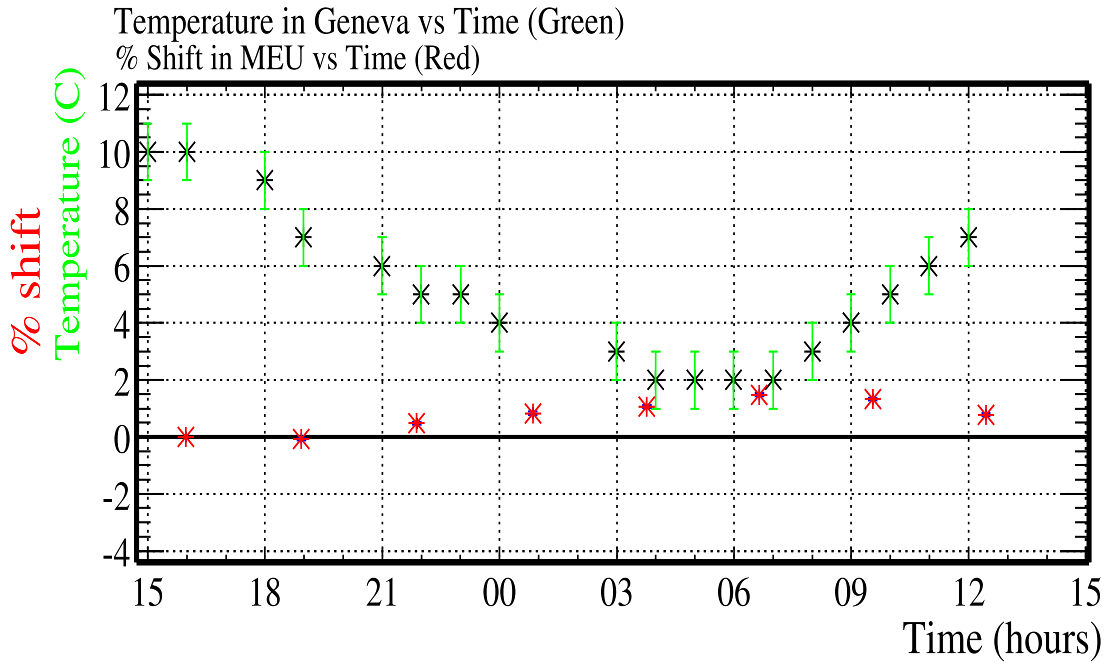
– Distribution narrows significantly
– Mean remains inconsistent with zero...

Stability with Temperature

Have also looked at data over short timescales:

- Cosmic data taken over a 24 hour period
  - Run split up into three hour chunks and analysed
  - Stability corrections not yet applied
  - Temperature data for Geneva obtained

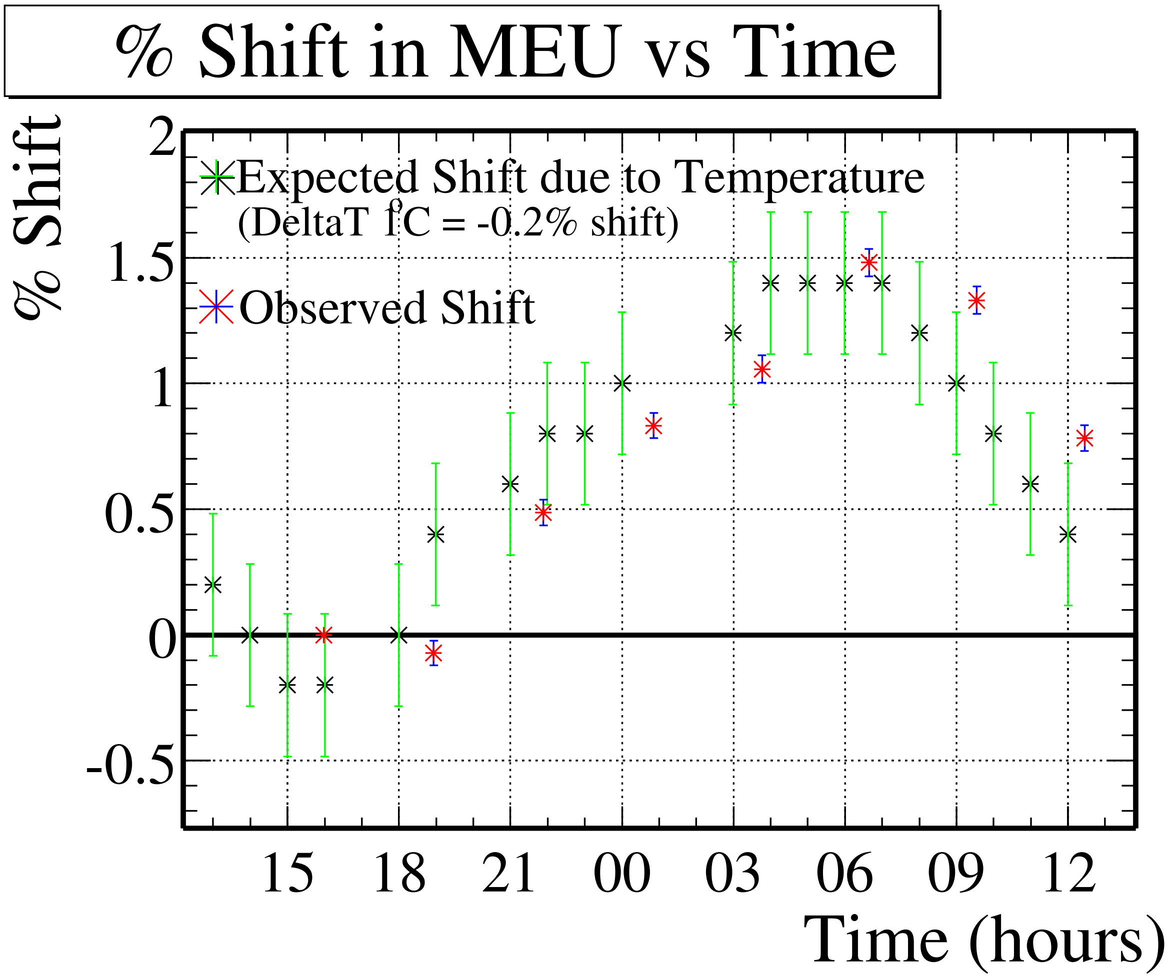
  - Plot:
    - Fractional difference in MIP values vs time
    - Temperature in ^{o}C vs time



- Light output decreases with temperature

Stability with Temperature

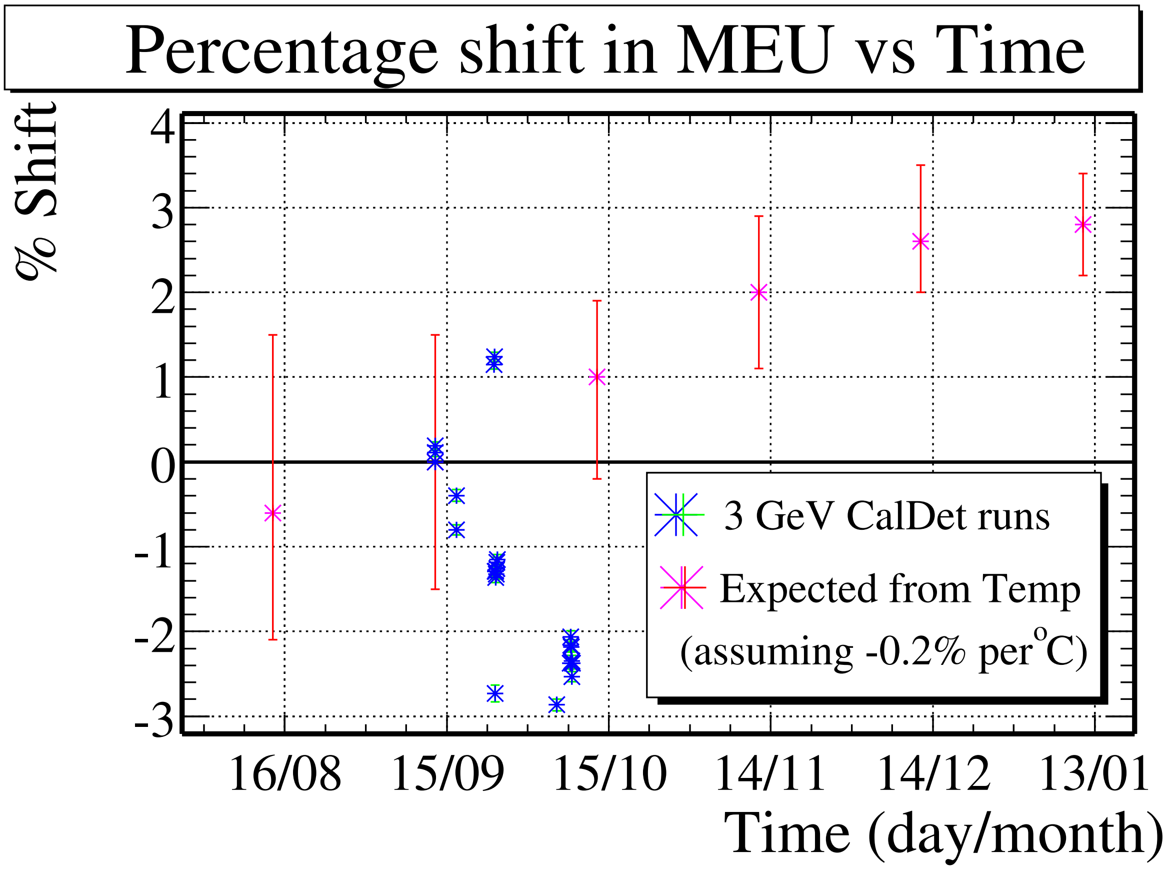
- Can also assume a value for %Shift per ΔT:
  - Assume -0.2% per ^{o}C



- Good agreement between expected and data
- Temperature trend in test beam area ∼2 hours behind external trend

Longer Term Stability

- Plot below contains:
  - All ± 3 Gev runs taken during CalDet
  - Expected MIP shifts (from monthly temperature trends in Geneva)



  - 3 GeV runs:
    - Drift point corrected
    - MIP shifts inconsistent with expected pattern due to temperature

Summary

- Drift points have been shown to correct for large gain change to 1-1.5%
- Over 24 hours, MIP values vary with temperature
  - Variation seen: $\sim$1.5% (max to min)
  - Temperature changes in test-beam hall follow $\sim$2 hours behind "Geneva"
- Longer term gain variations are worrying
  - Investigate with cosmics