Beam Performance and Systematic Studies

Week in the Woods, Ely, Minnesota 2005

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Introduction

GOAL: Determine and quantify sources of systematic uncertainties on MINOS measurements originating from non-ideal beam conditions. Sources of uncertainties we know so far are:

1. **Live time and efficiency of the beam data logging process and efficiency of ND-FD-Beam matching algorithims.**
2. **Batch-batch variation in beam position at the target**
3. **Beam width variation at the target.**
4. **Absolute calibration and uncertainty on beam intensity measurements.**
5. **Stability and performance of secondary beam monitors.**

BeamData Performance

Problem with BPM data logging was fixed on May 4th - previously BPM data was unreliable with 25% failure rate due to early reset of the BPMs.

Group 1 SWICs VME sequencer switched off on May 15/16 - lost 10545/35568 spills. (MTGT not in this group). Add sequencer monitoring.

Failure of minos-acnet.fnal.gov caused loss of data for $\sim$ 1/2 day from May 1-31st. New dedicated system ordered to isolate data logging from monitoring. Backup process to run on minos0X.

Recent device readout failure rates:

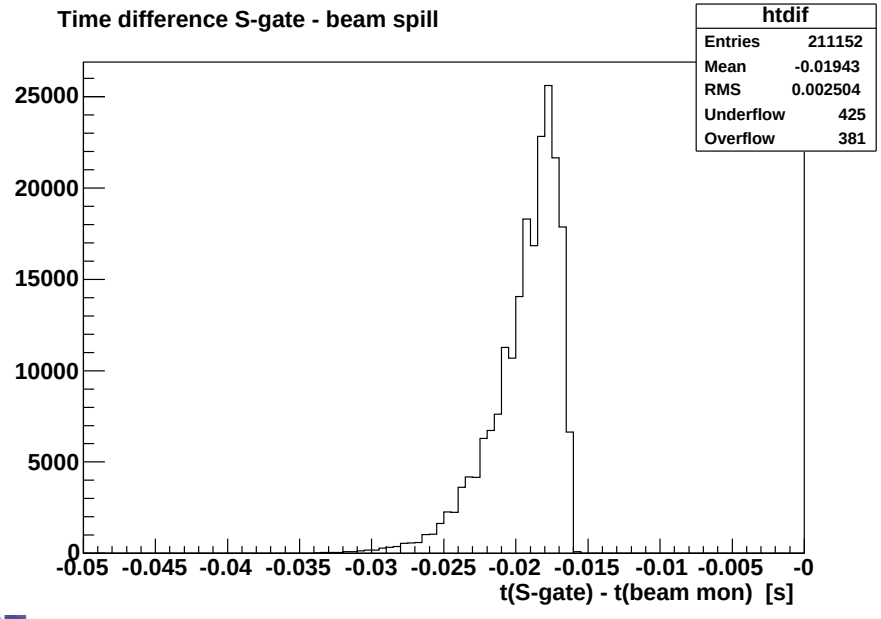
Dates	**May 17-31,2005**
Total spills	**360268**
TORTGT	**8 (2×10^{-5})**

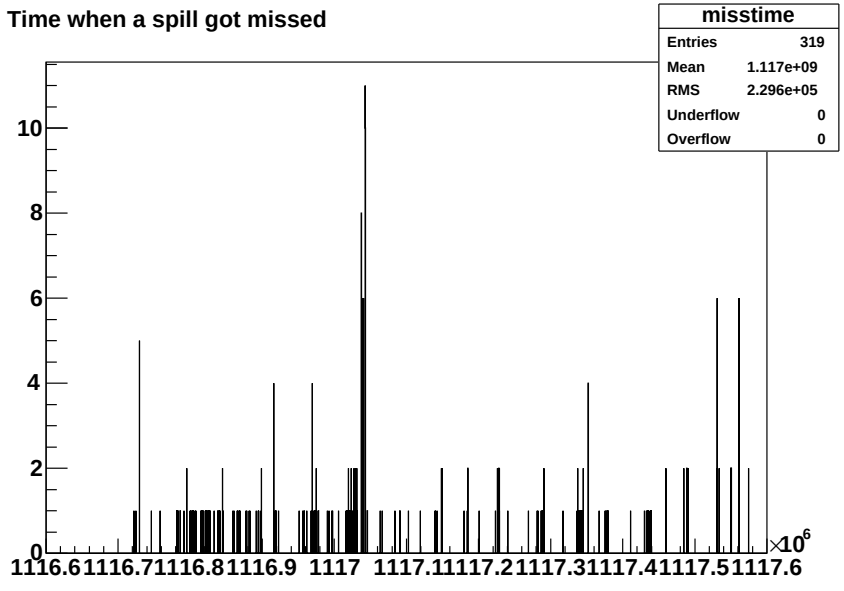
HPTGT	**39 (1×10^{-4})**
MTGT	**21 (6×10^{-5})**
HAD/MU	**13 (4×10^{-5})**

Beam-ND data matching

The best timestamp is the GPS timestamp obtained from the profile and mu/had monitor front-end VME which are triggered by the $A9. If no reliable VME timestamp is obtained use the DAE timestamp which is triggered by a 15Hz TCP/IP multicast of $A9 ($\mathcal{O}(100ms)$).

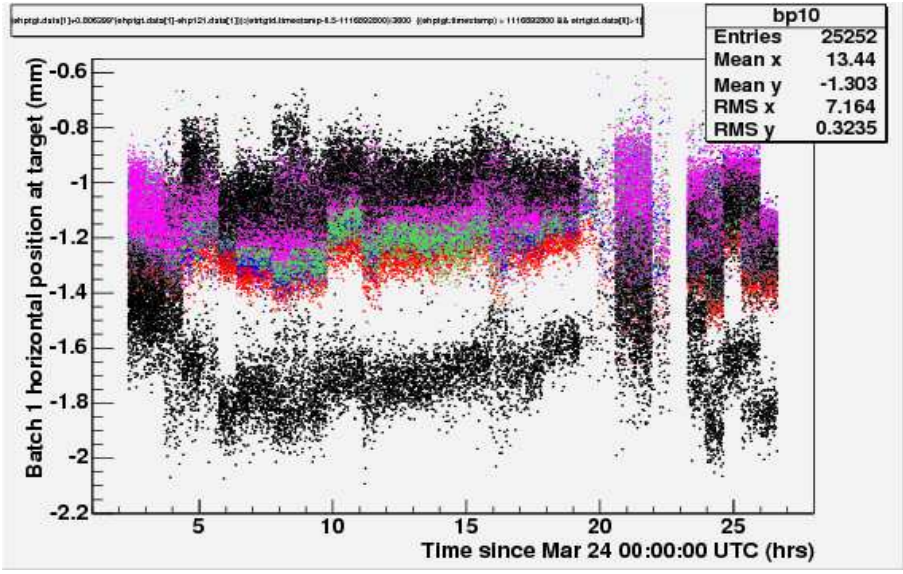
ACTION ITEM: During May pLE data running, failed to match 319 of 211471 spills (0.15%).

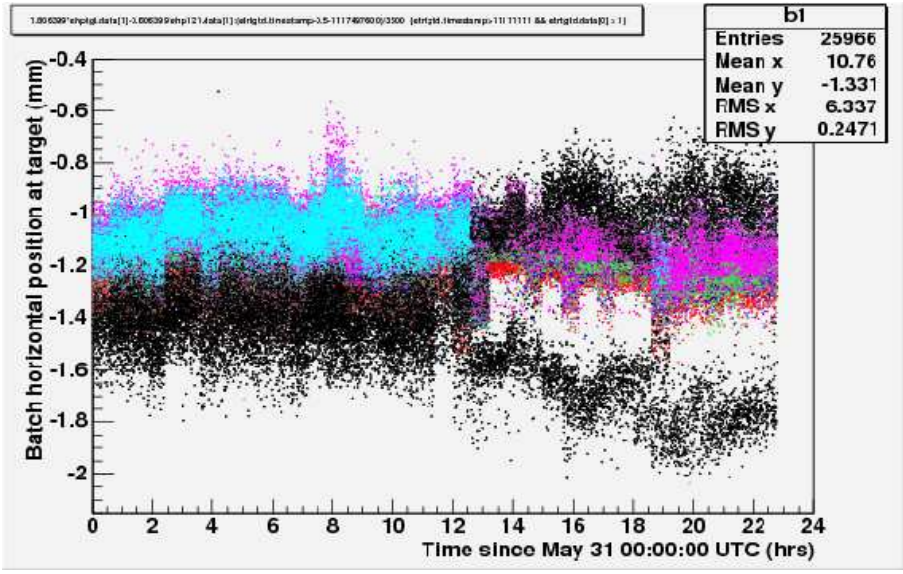


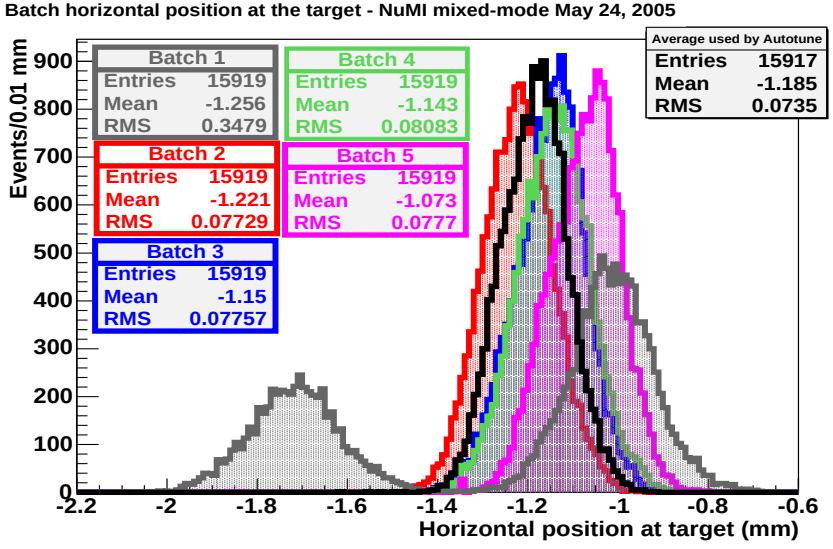


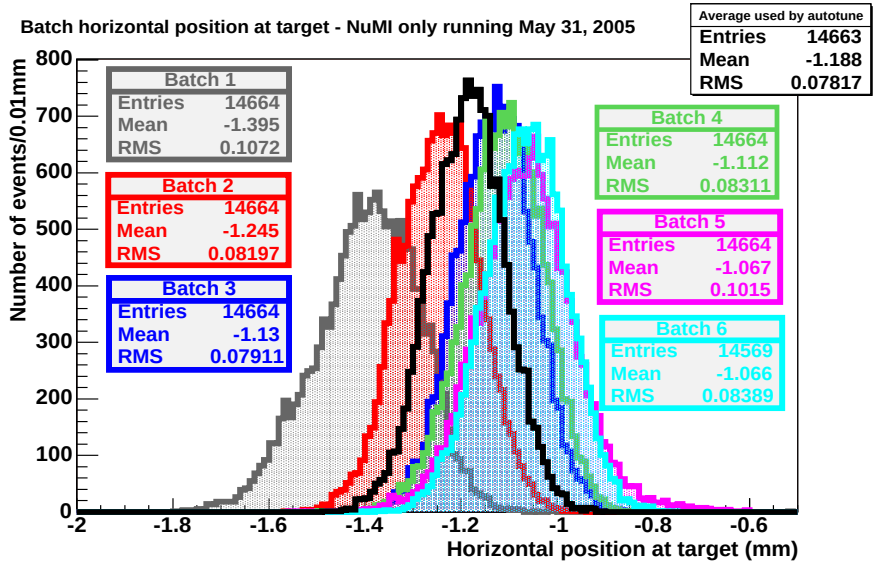
PRIMARY BEAM PERFORMANCE

Batch-batch beam positions

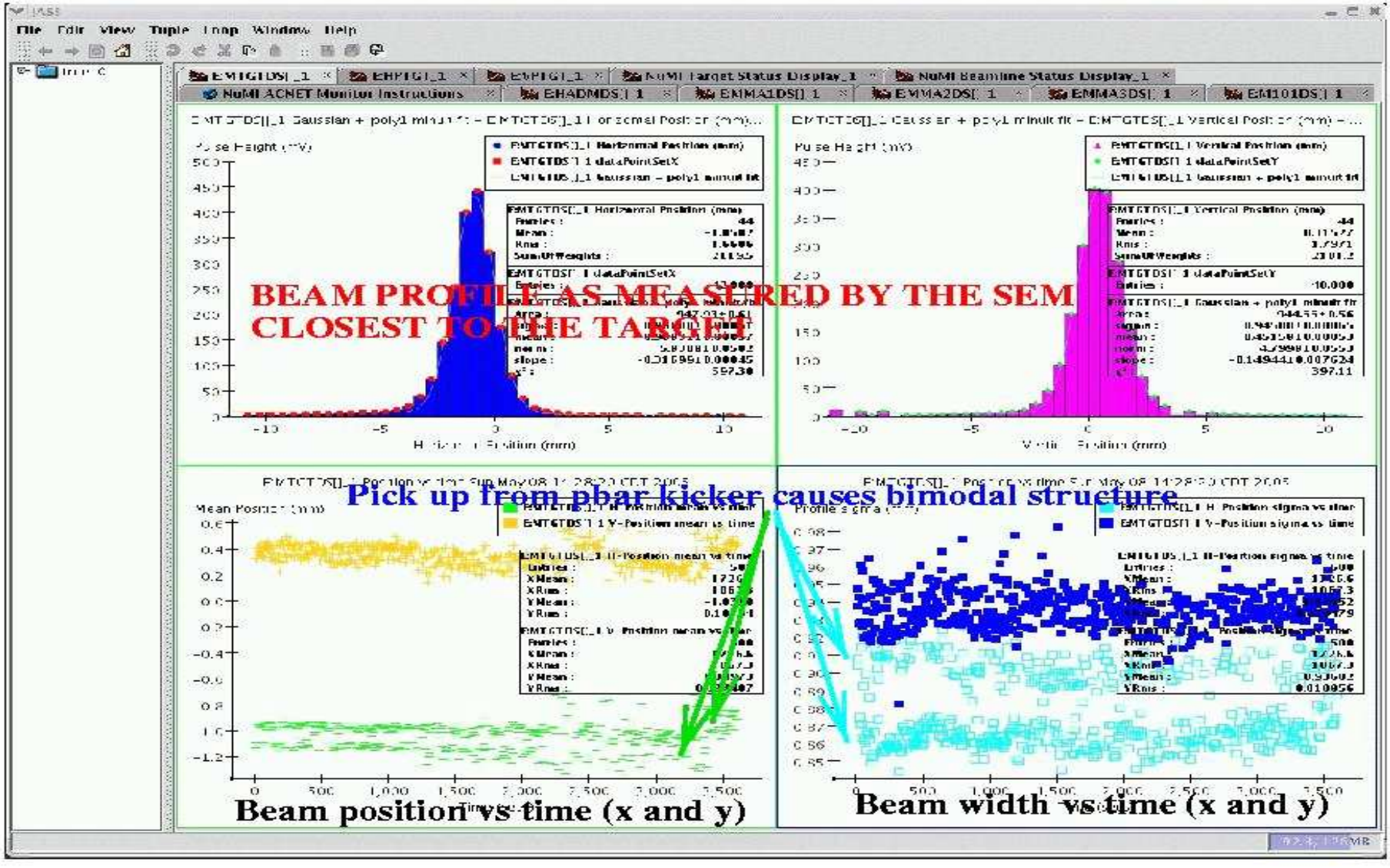




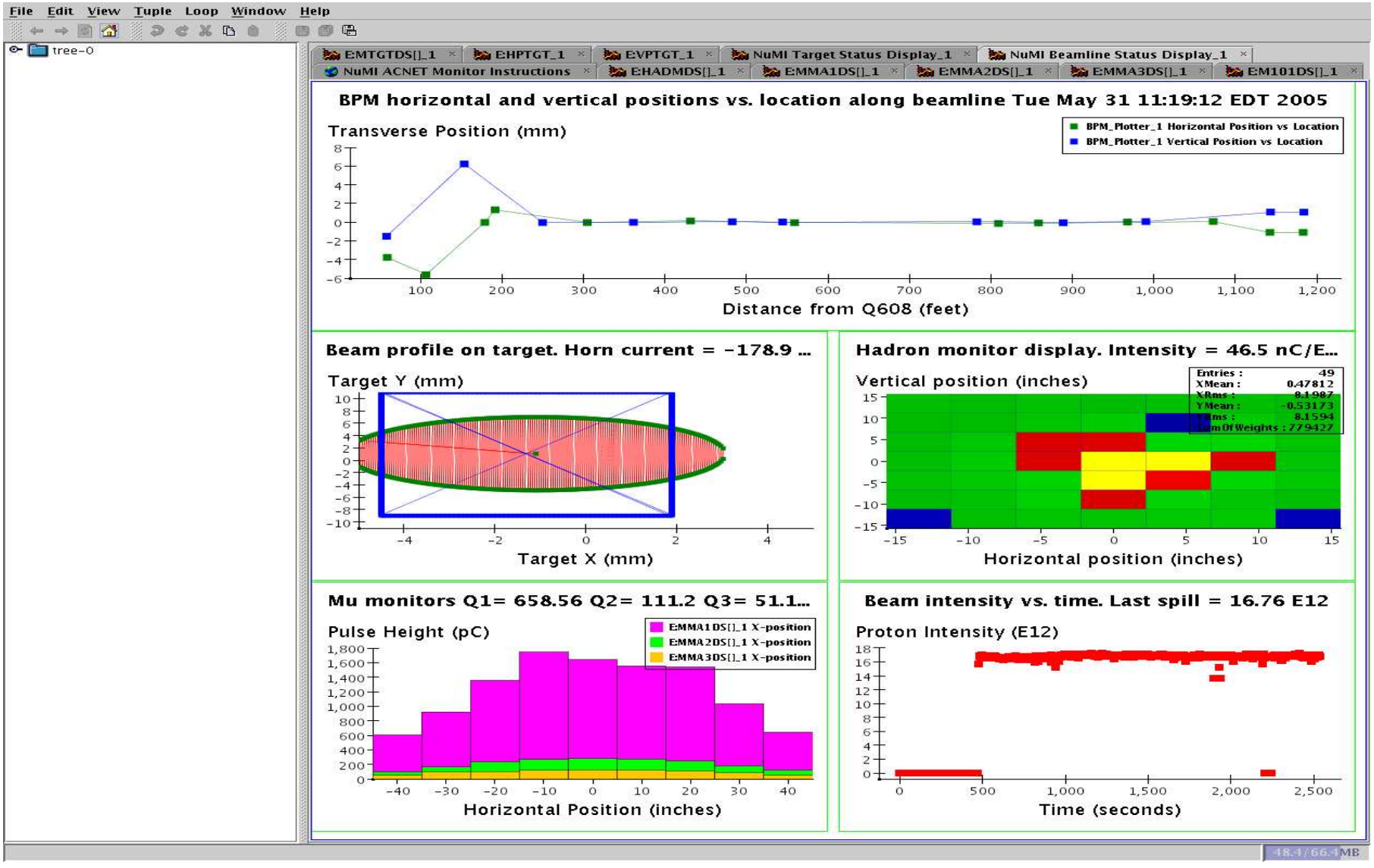




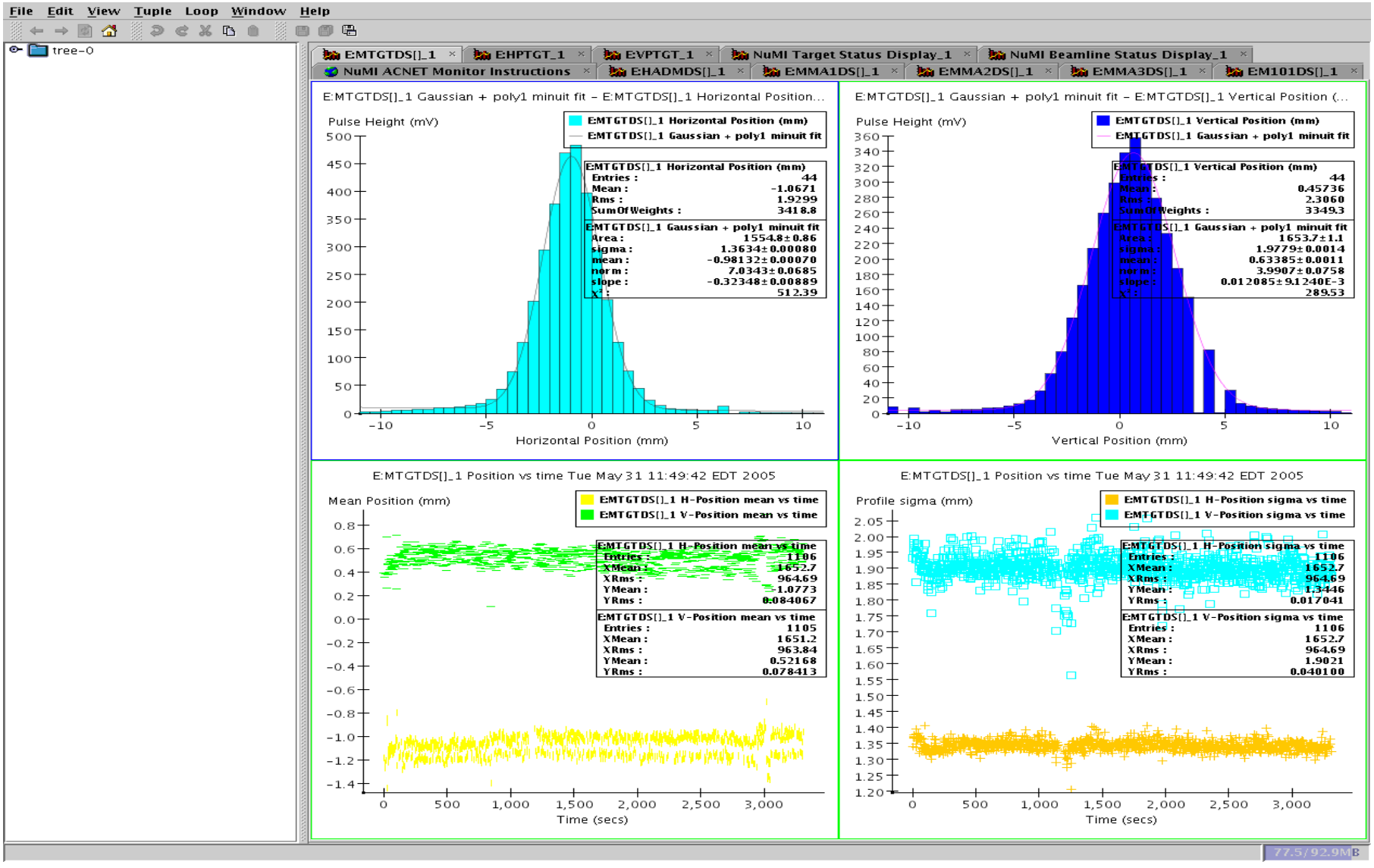
Beam width at the target-GOOD



Beam conditions - May 31

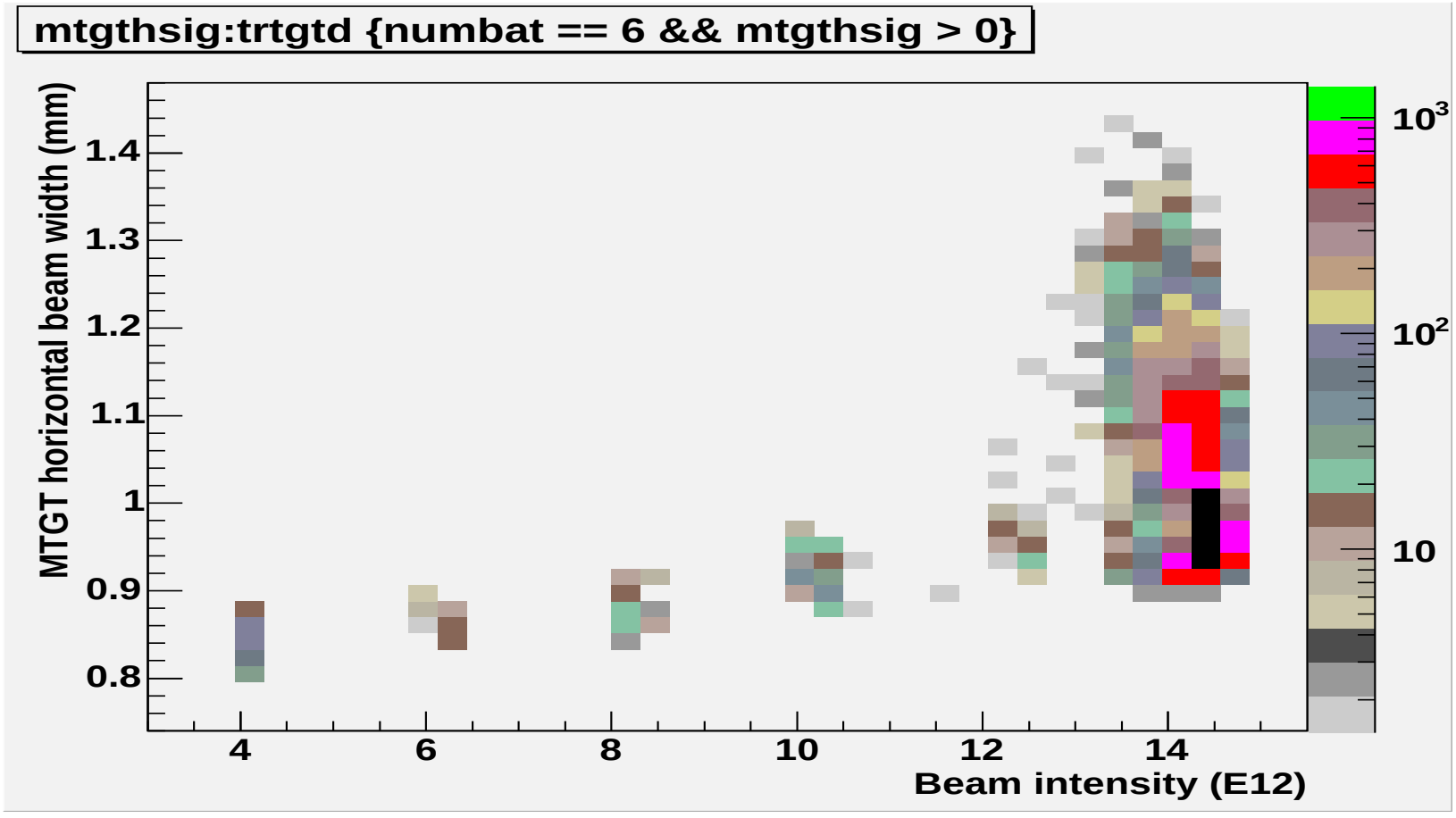


Beam width at the target-May 31

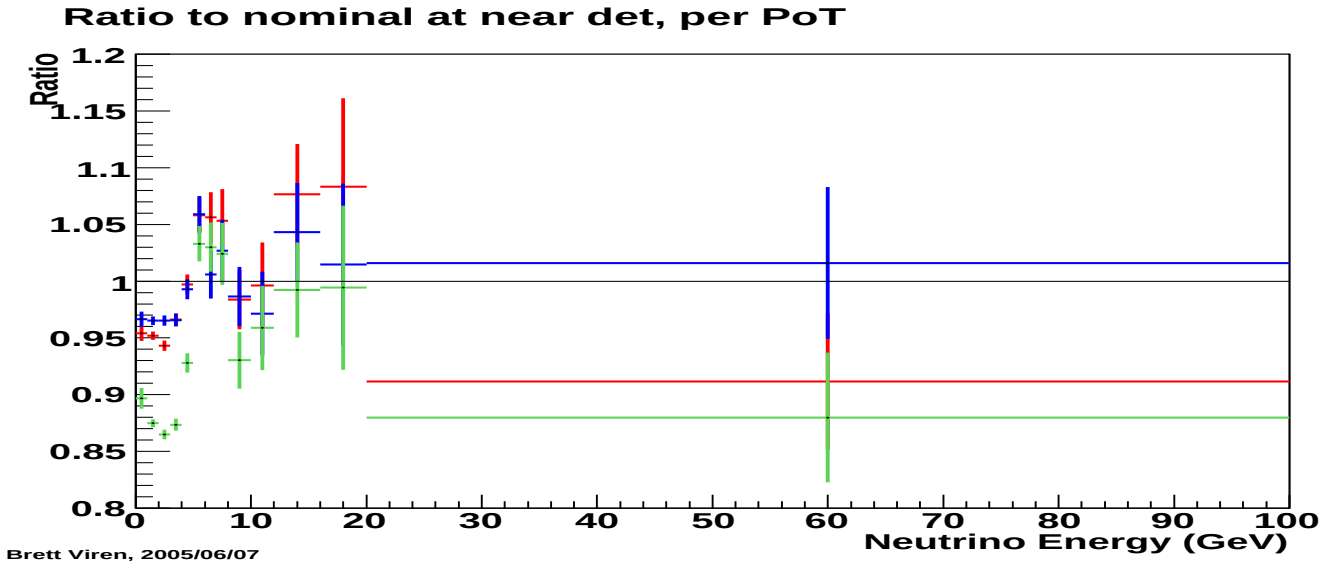


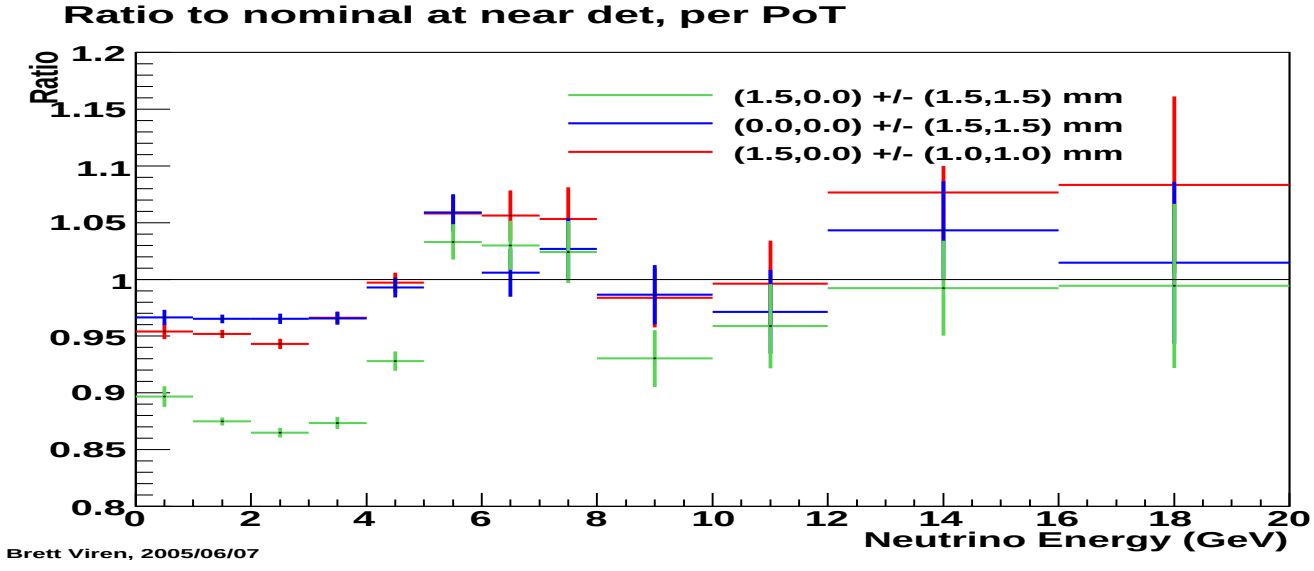
Beam width vs intensity

NB: Independant of Booster problems beam width will change with intensity/batch. Width vs intensity when we have 5 batches observed on May 23rd:

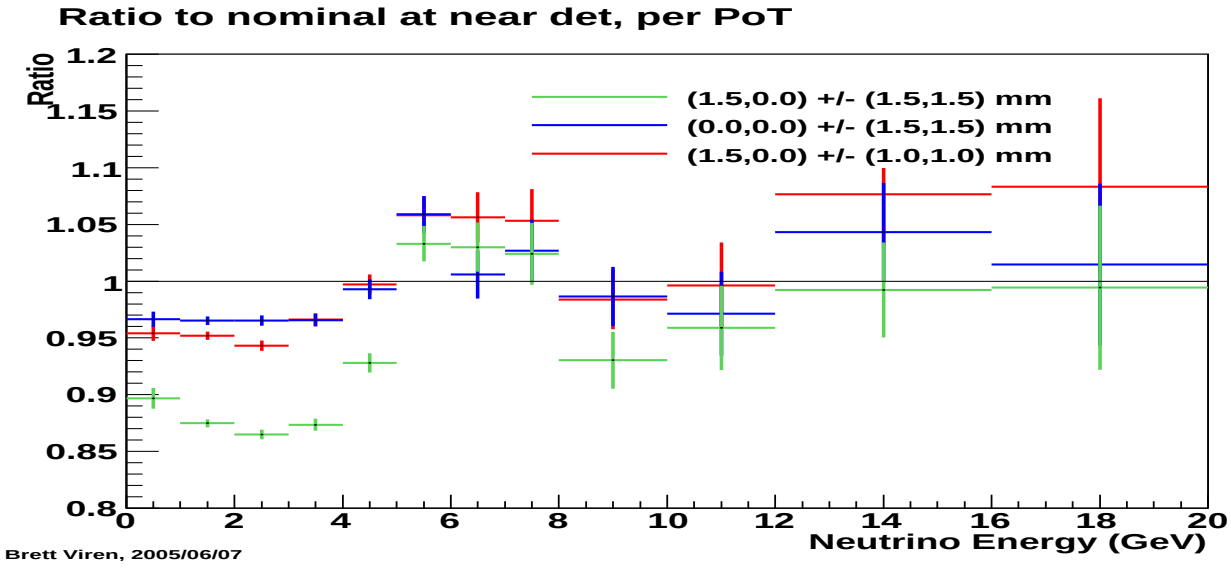


Beam systematics - ND spectrum

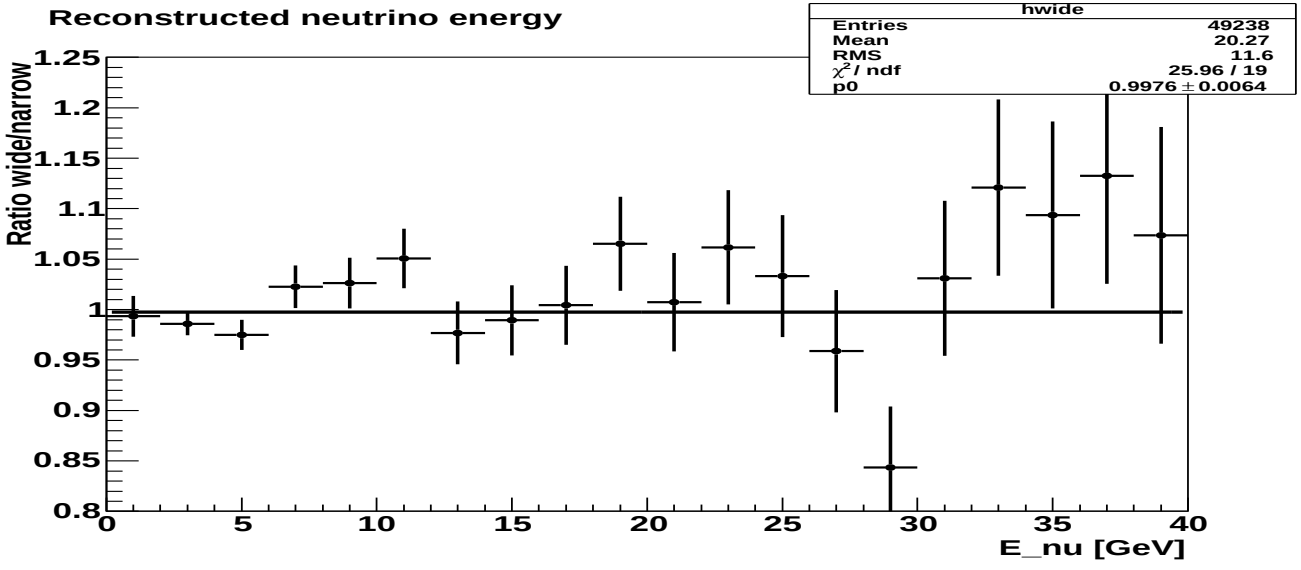




Beam systematics - DATA!

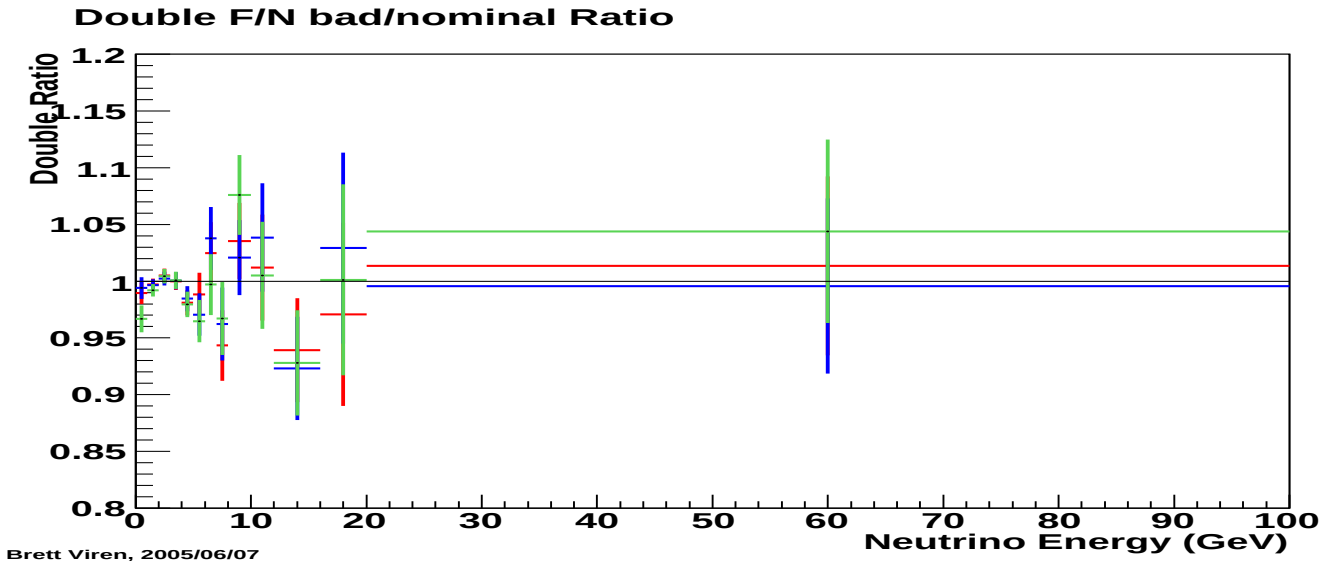


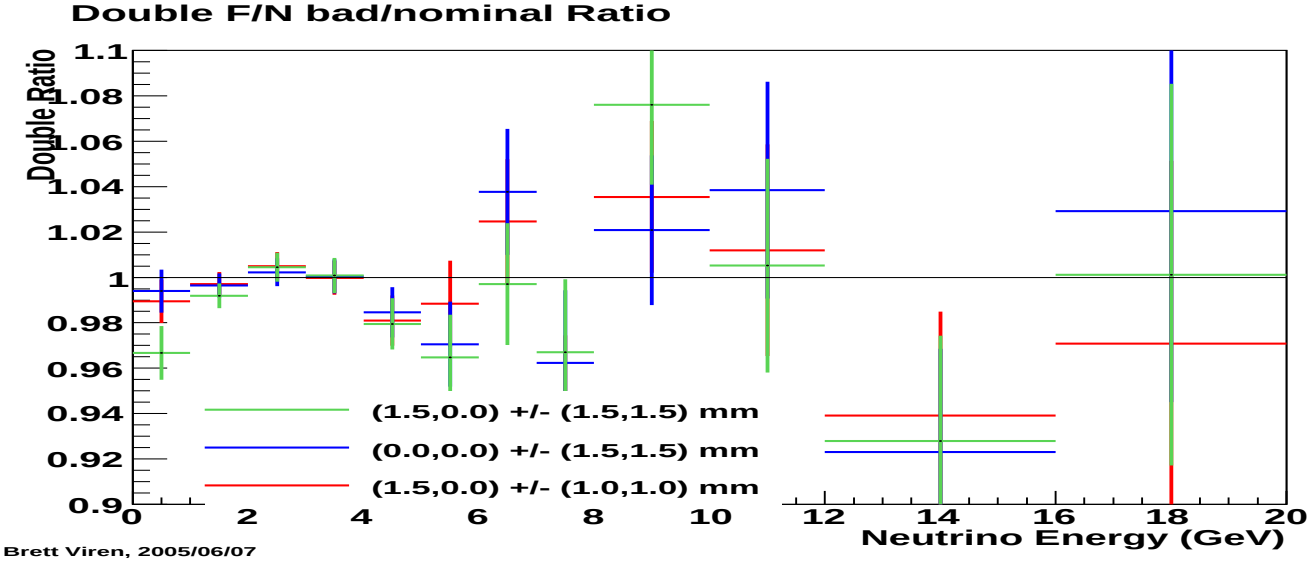
⇐ **GNUMI v17**



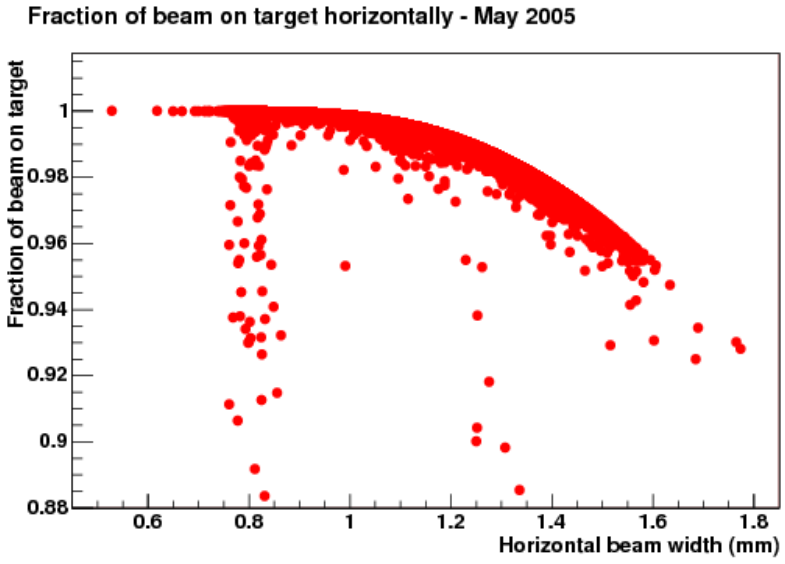
⇐ **May pLE data**

Beam systematics - ND/FD ratio

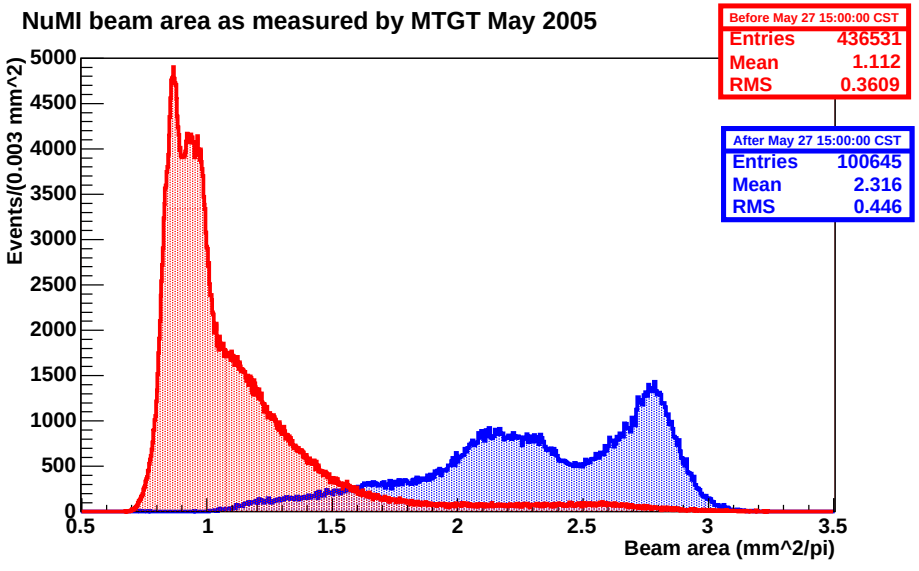


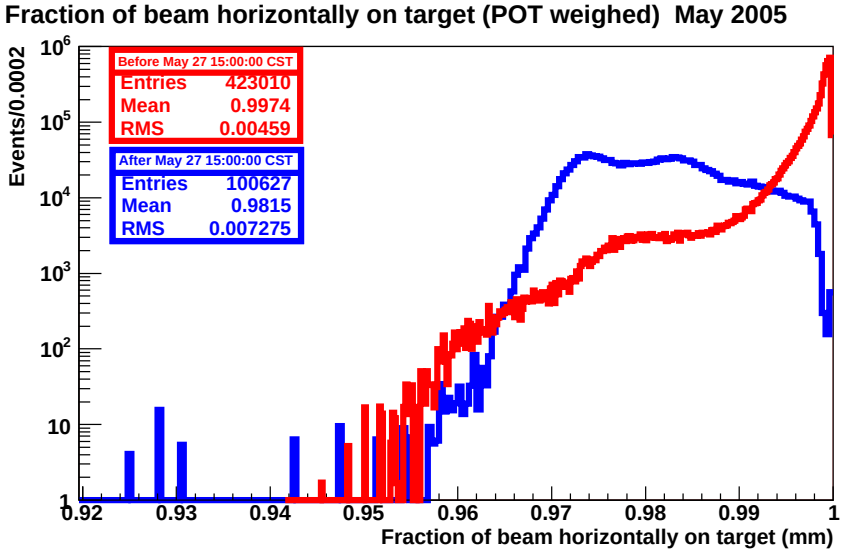


Beam systematics - Normalization



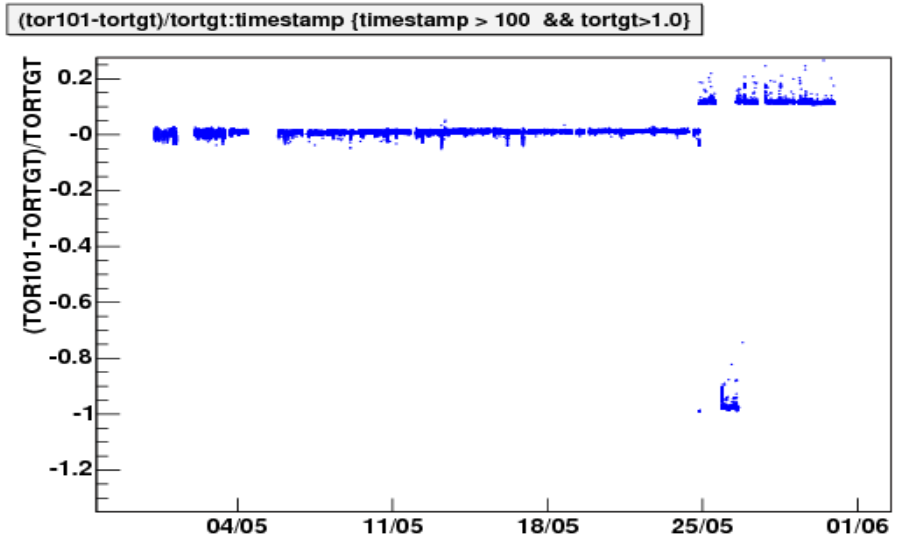
Total spills	604,727 (May 2005)
$>$1E12	538,043
Valid beam width	537,176
Valid BPM	524,441
$>$ 99% on target	420,858 (80%)

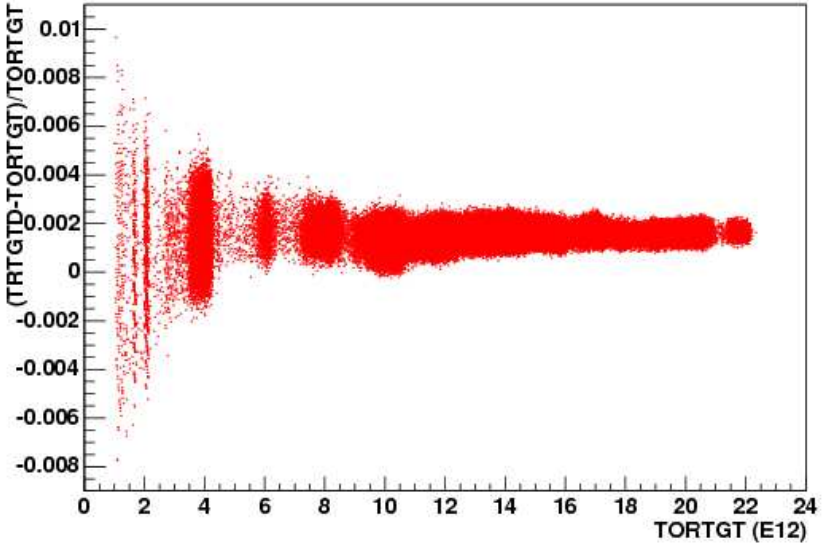


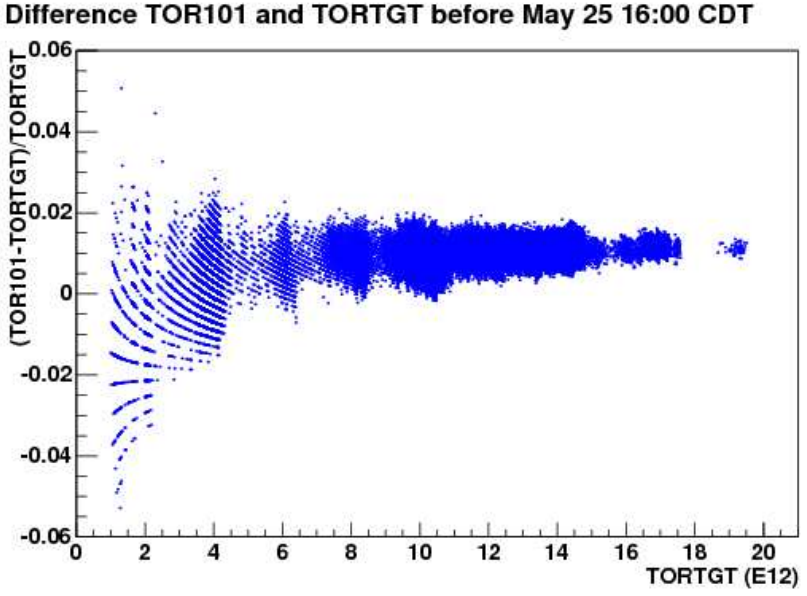


Beam systematics - Normalization

Difference between TOR101 and TORTGT prior to May 25 16:00 is $\sim 1\% >$ 5E12 . TOR101 integration gate width changed the last week of May but was recalibrated early June.

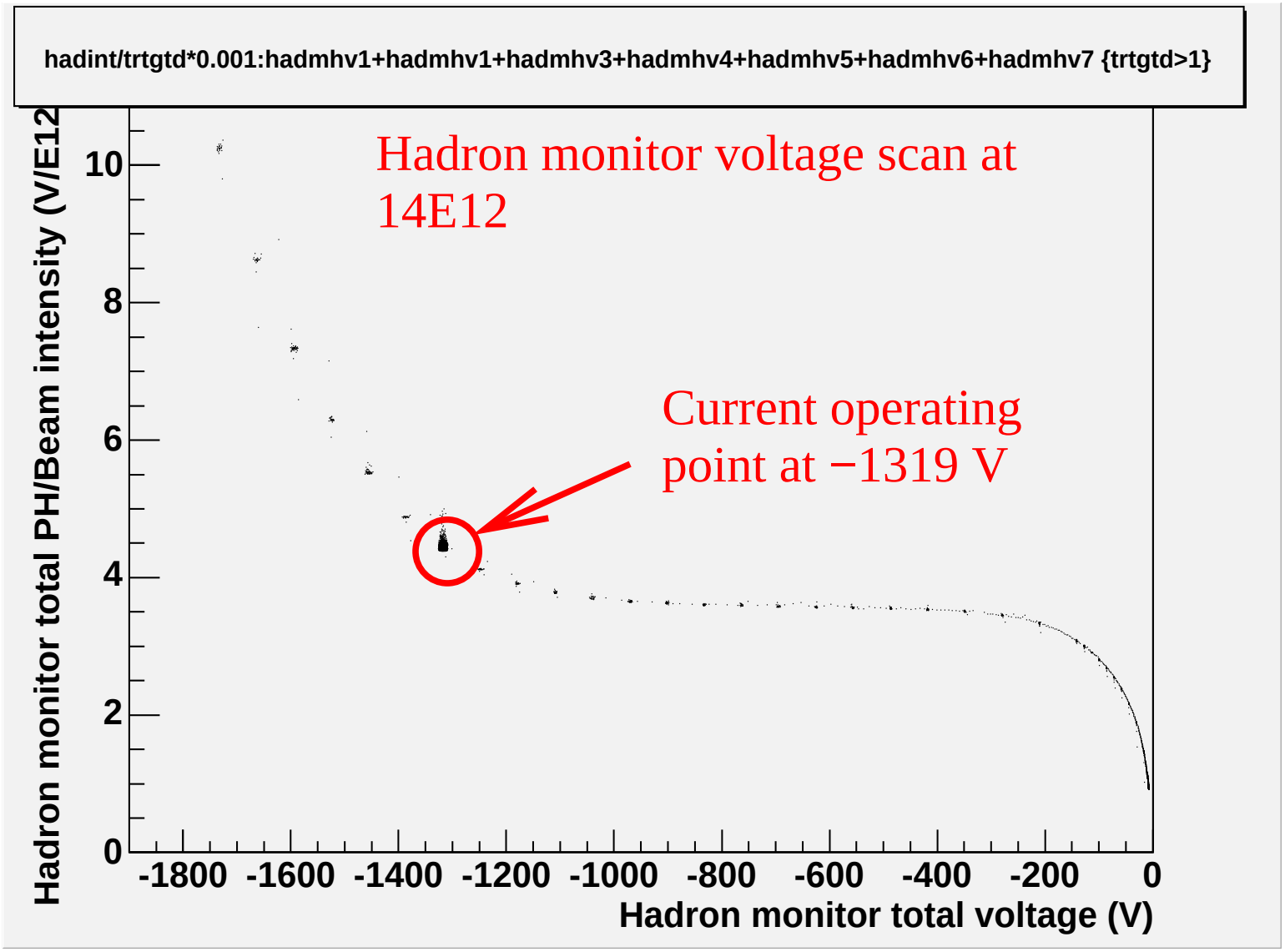






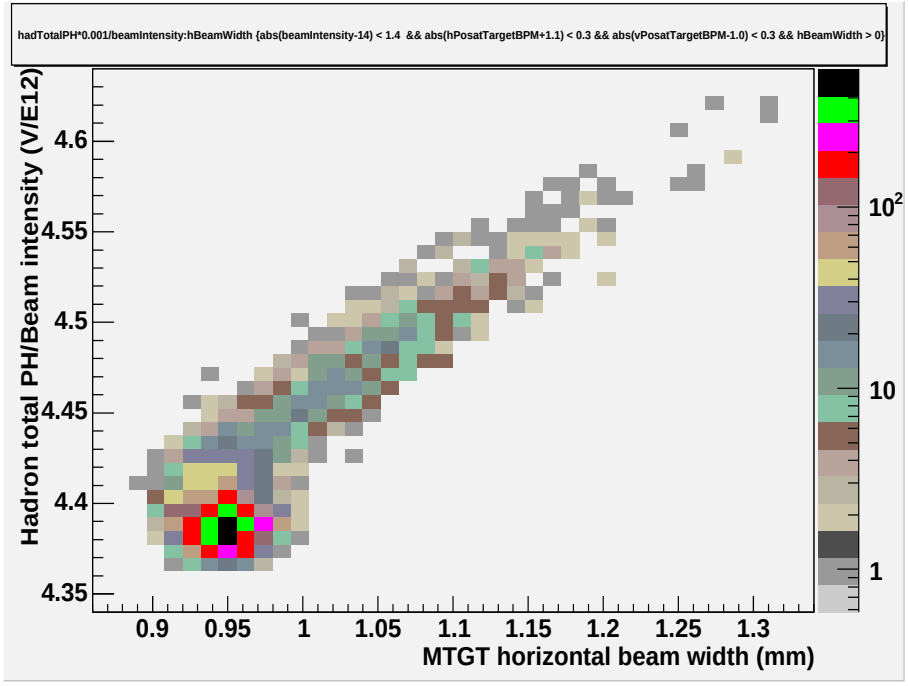
MONITORING THE SECONDARY BEAM

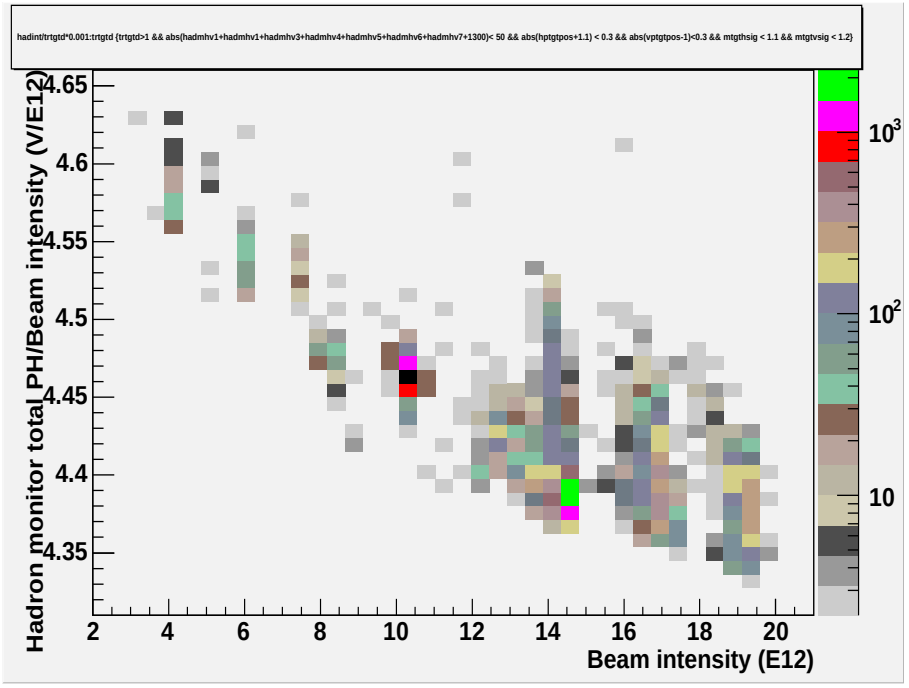
Hadron monitor response



Hadron monitor stability

For beam centered on the target within ± 0.3 mm, we observe a depenance of the hadron monitor signal on width and intensity:

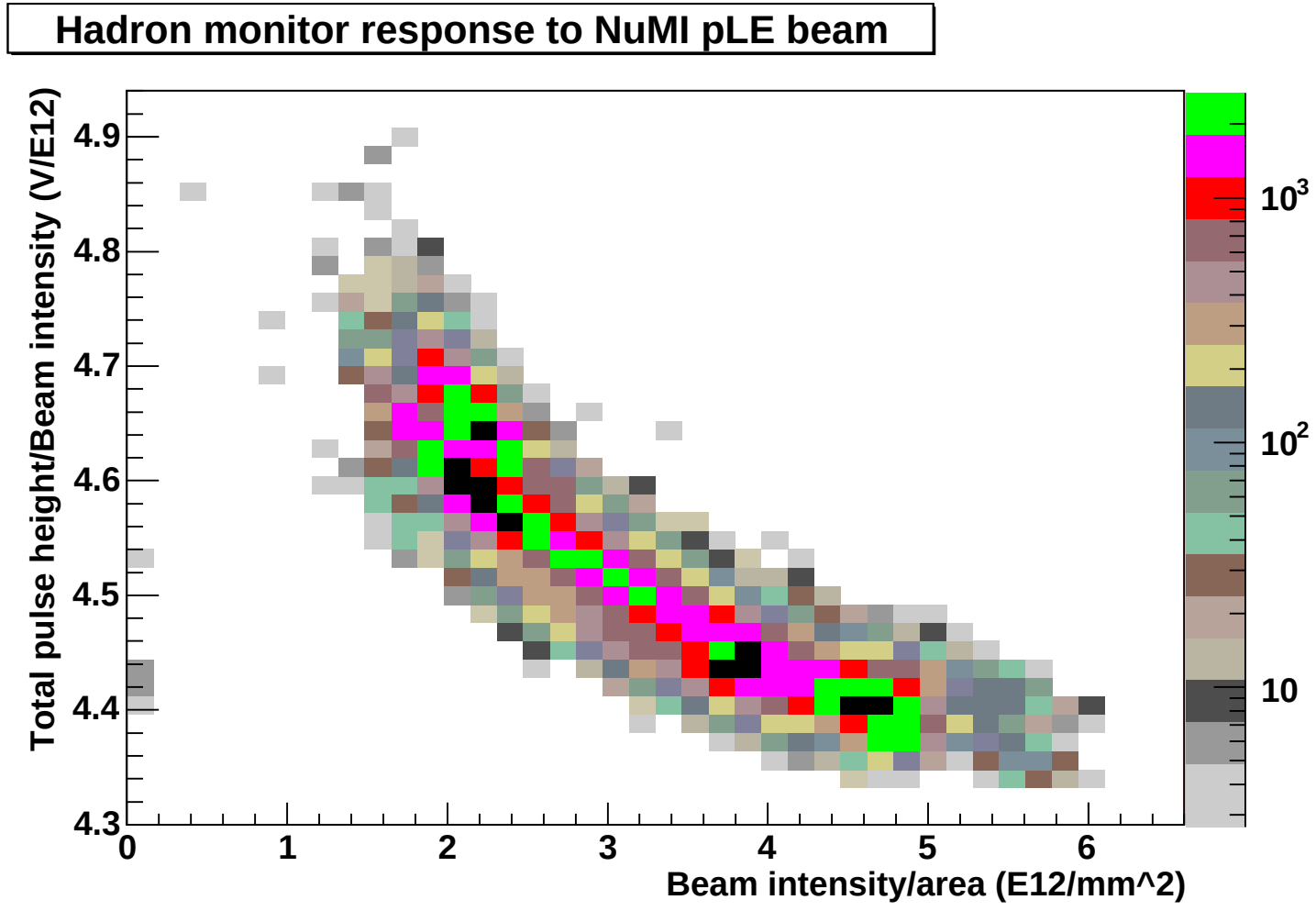




$$POT = 14 \pm 1.4$$

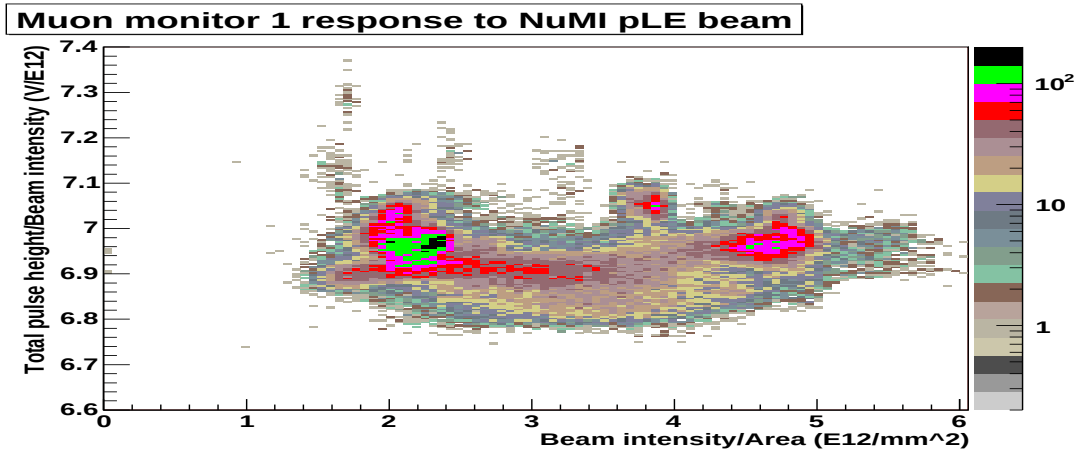
$$\sigma_H < 1.1, \sigma_V < 1.2$$

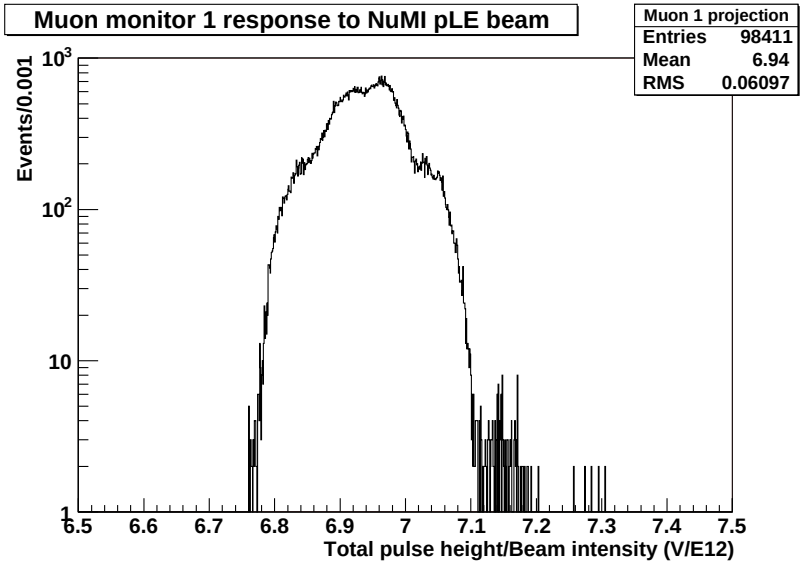
Hadron monitor stability

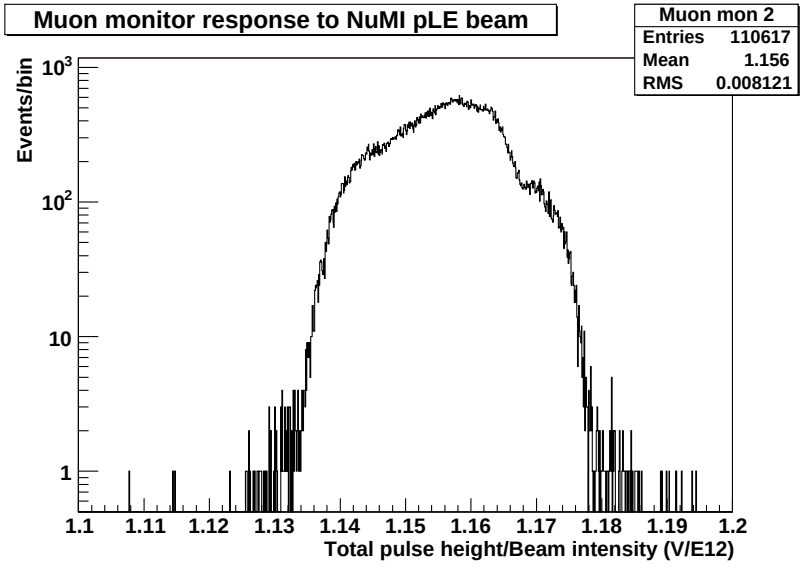


ACTION ITEM: Improve hadron mon response by changing voltage settings?

Muon monitor stability







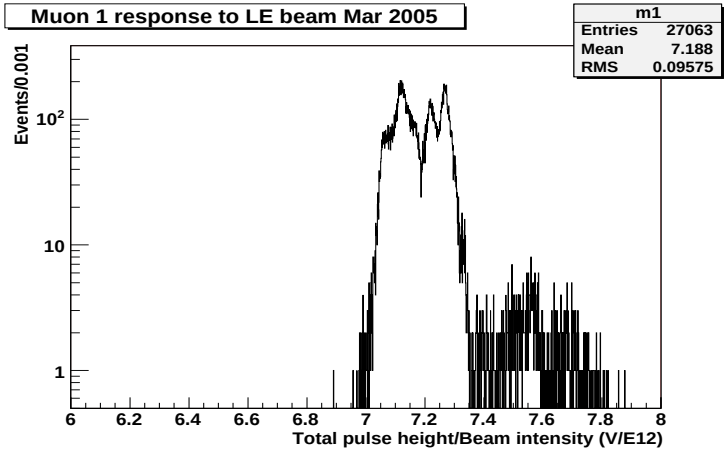
Muon monitor 1 & 2 are stable at the 1% level.

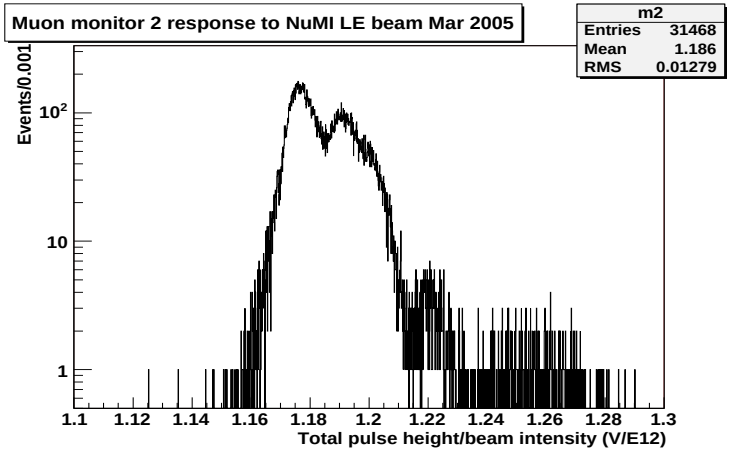
Using μ monitors to track beam

May, pLE $d_T = 10$cm, $I_H = -185$kA. Mar, LE $d_T = 2$cm, $I_H = -200$kA.

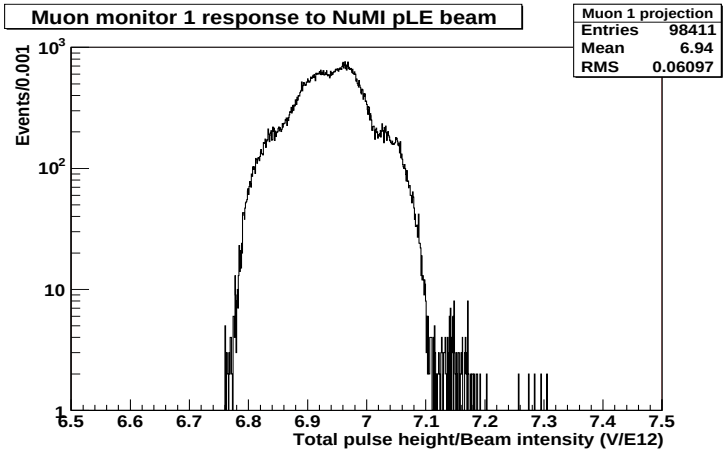
Muon 1 | **Muon 2**

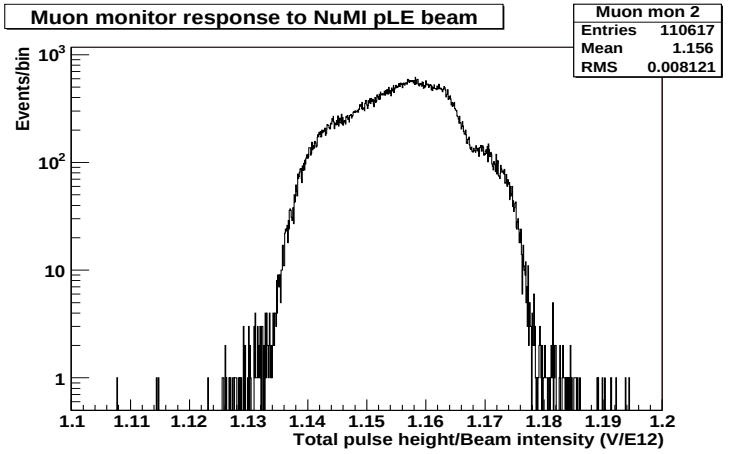
LE 3/05





pLE 5/05





3.5% reduction **1.5% reduction**

ACTION ITEM: seems larger than expected 2% reduction in ν peak

Action items

- Commission new BeamData logging system and initiate backup process.
- Determine MINOS DAE/XML-RPC livetime (how ??).
- Identify the cause of missing BeamData-ND spills.
- Optimize VME response time for more accurate timestamps (?????).
- Determine beam fraction in tails of beam profile and on baffle.
- Need more GNUMI runs with varied beam conditions and much more statistics.
- ND data-data comparisons.
- Optimize hadron and muon monitor beam response.