Imperial College London

MICE Particle Rate and ISIS Beam Loss

Adam Dobbs, MICE CM27, 7th July 2010

Outline

I. Introduction
II. Analysis Methodology
III. Review: High Beam Loss Results from Nov 2009
IV. New: High Beam Loss Results from June 2010
V. Conclusion

1. Introduction

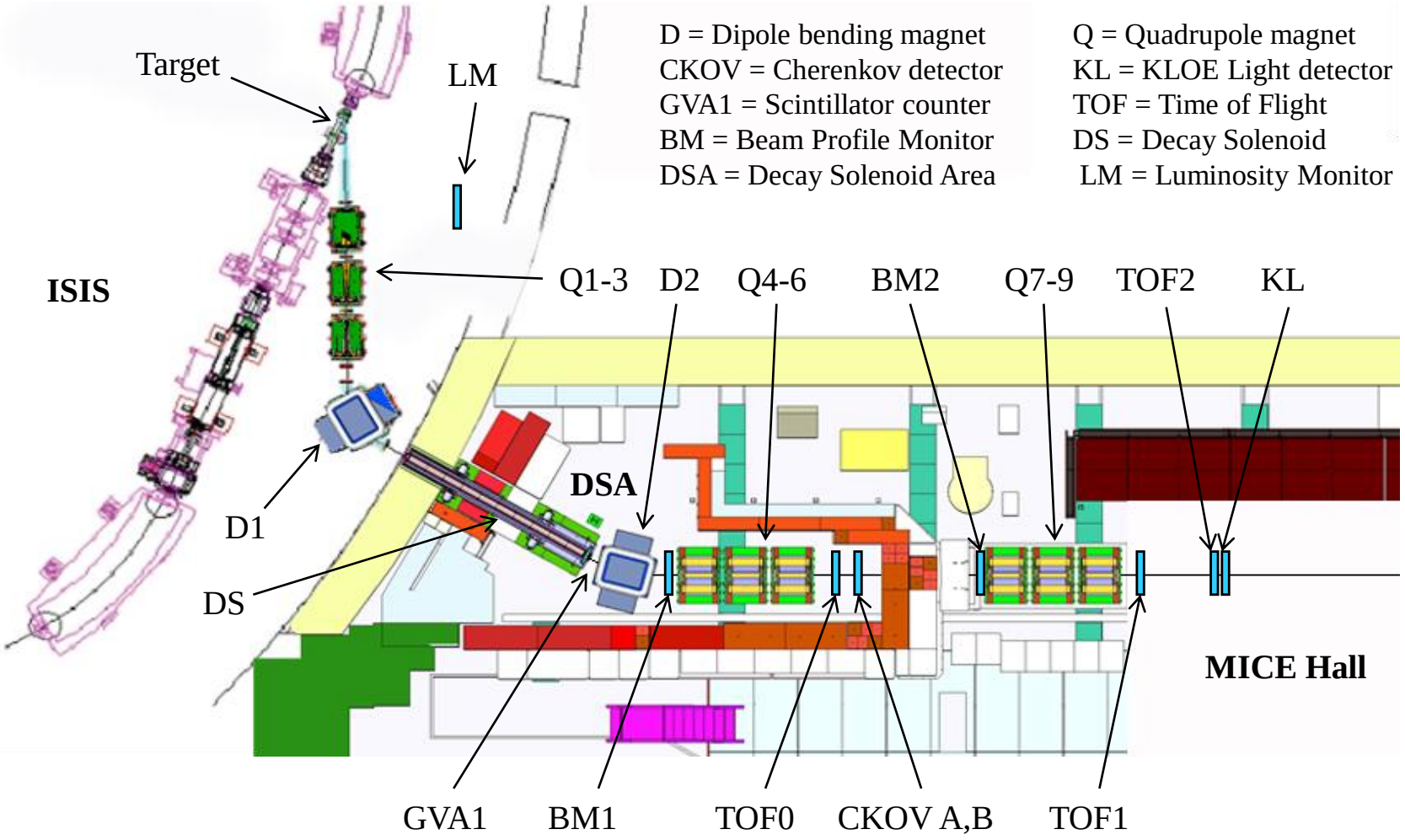
Why study MICE Particle Rate and ISIS Beam Loss

The MICE Beamline

Why study beam loss and particle rate?

- Muons are generated in the MICE beamline by the decay of pions.
- These pions are produced by inserting a titanium target into the circulating ISIS proton beam, producing a hadronic shower captured by the first quad triplet and transported down the beamline.
- The action of the target causes protons to be lost from the circulating ISIS beam – “beam loss”.
- This beam loss potentially disrupts the beam for other ISIS users and activates the machine, making maintenance more difficult.
- The more beam loss, the more particle rate → a tension of needs, we need to understand how the two relate!

Current MICE beamline

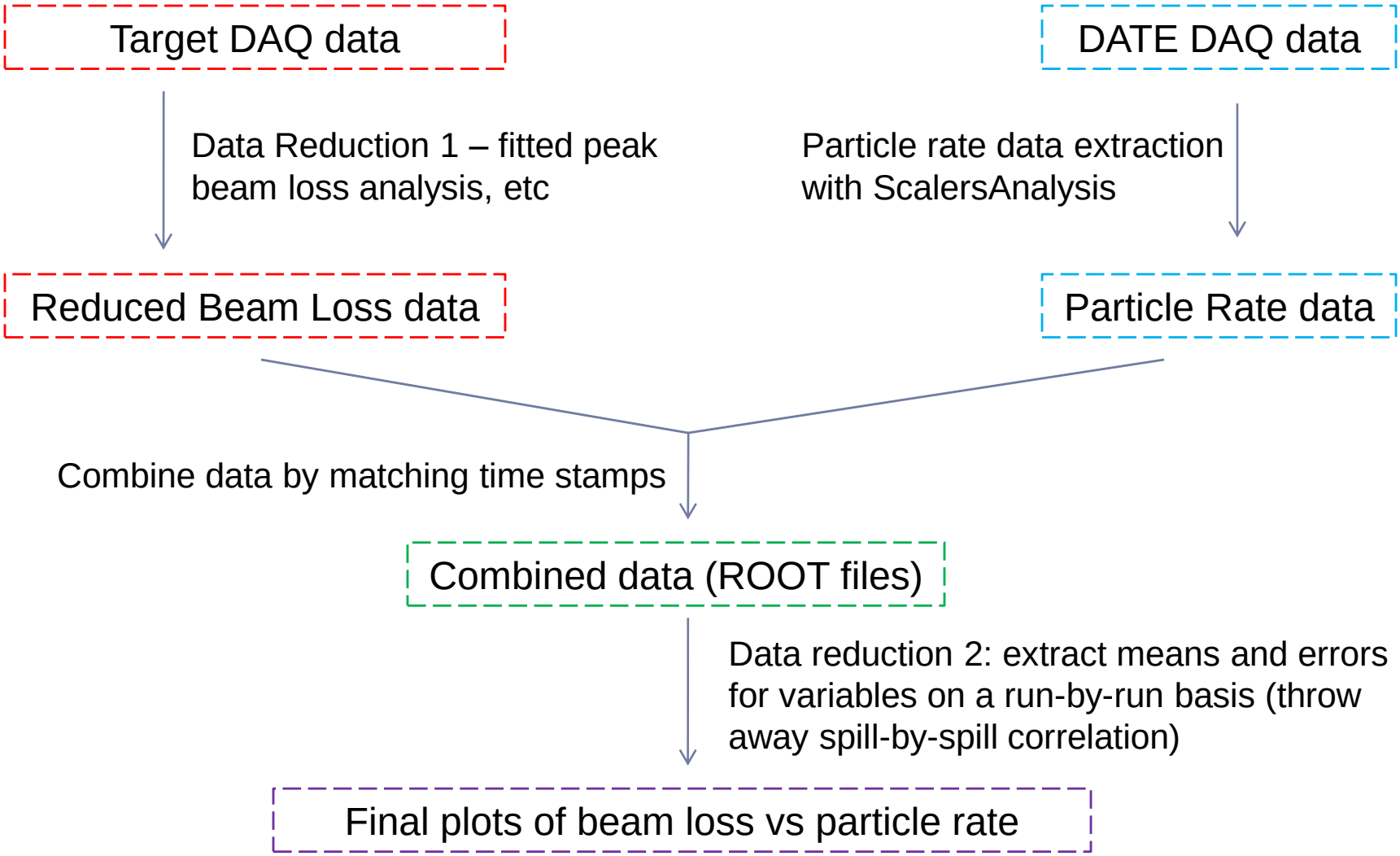


2. Analysis Methodology

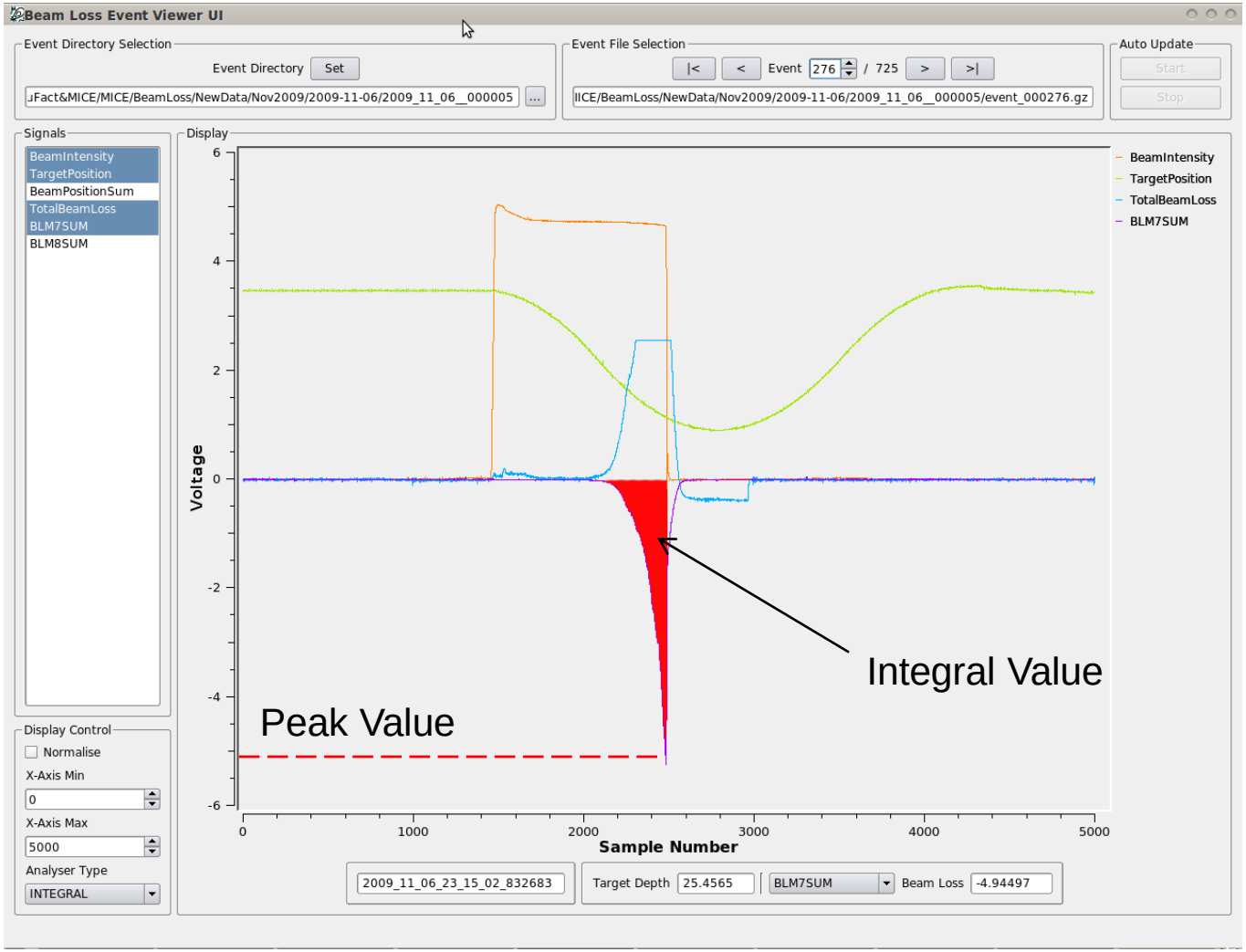
Beam Loss Analysis

Combined Analysis

Beam Loss vs Particle Rate Analysis Flow Diagram



Beam Loss Analysis Methods



Target DAQ data

Data Reduction 1 – fitted peak beam loss analysis, etc

Reduced Beam Loss data

Combined Data Table for Run 1231

Row	blEventTime	prEventTime	TgtDepthMM	BLSec7int	gval
0	1257549277.23	1257549277	25.513715744	-4.66822004318	1586
1	1257549282.36	1257549282	25.5209751129	-4.1176199913	1521
2	1257549287.47	1257549287	25.5209751129	-4.91044998169	1585
3	1257549292.59	1257549292	25.5040550232	-4.85503005981	1583
4	1257549297.72	1257549297	25.5233898163	-4.68155002594	1477
5	1257549302.83	1257549302	25.5064697266	-4.94497013092	1609
6	1257549307.95	1257549308	25.5088844299	-4.10094976425	1523
7	1257549313.07	1257549313	25.513715744	-4.51522016525	1467
8	1257549318.19	1257549318	25.5209751129	-4.95216989517	1493
9	1257549323.31	1257549323	25.5185451508	-4.35855007172	1575
10	1257549328.43	1257549328	25.5209751129	-4.90884017944	1479
11	1257549333.55	1257549333	25.5161304474	-4.84698009491	1530
12	1257549338.68	1257549338	25.5185451508	-4.49002981186	1576
13	1257549343.8	1257549343	25.0041046143	-4.67418003082	1426
14	1257549348.91	1257549349	25.5016403198	-4.71962976456	1480

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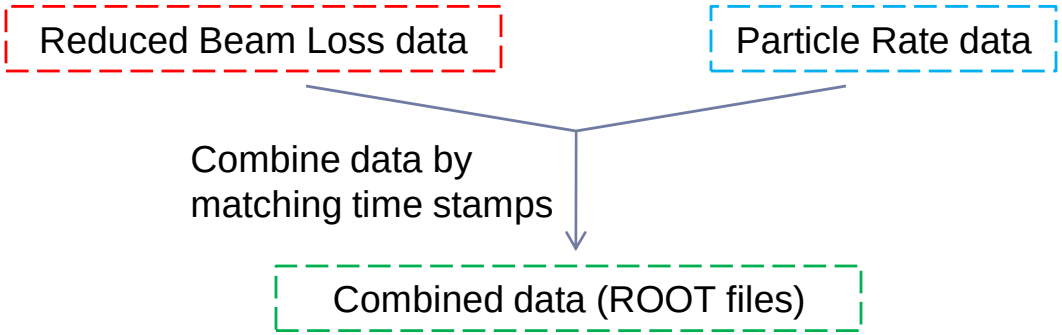
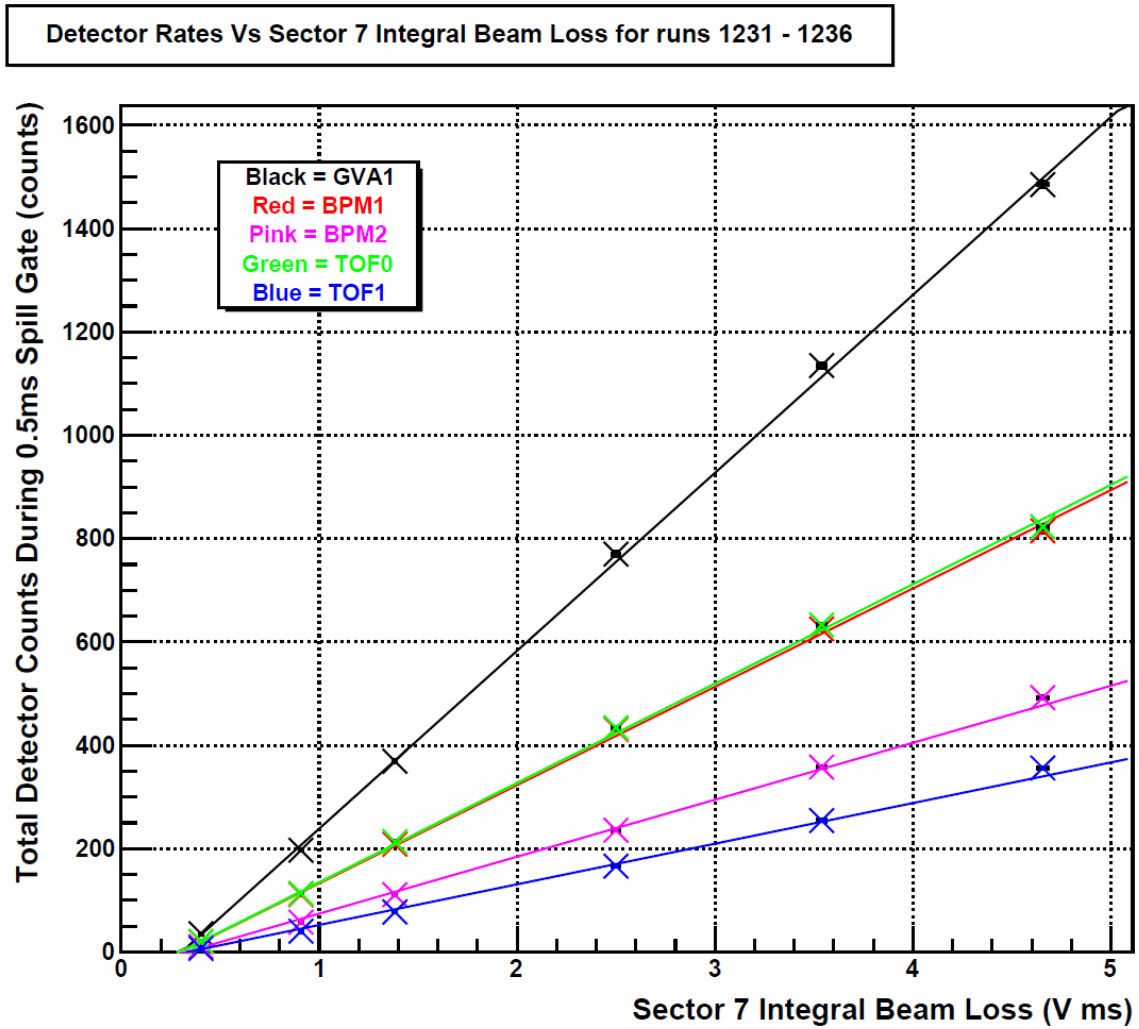


3. Review: November 2009 Results

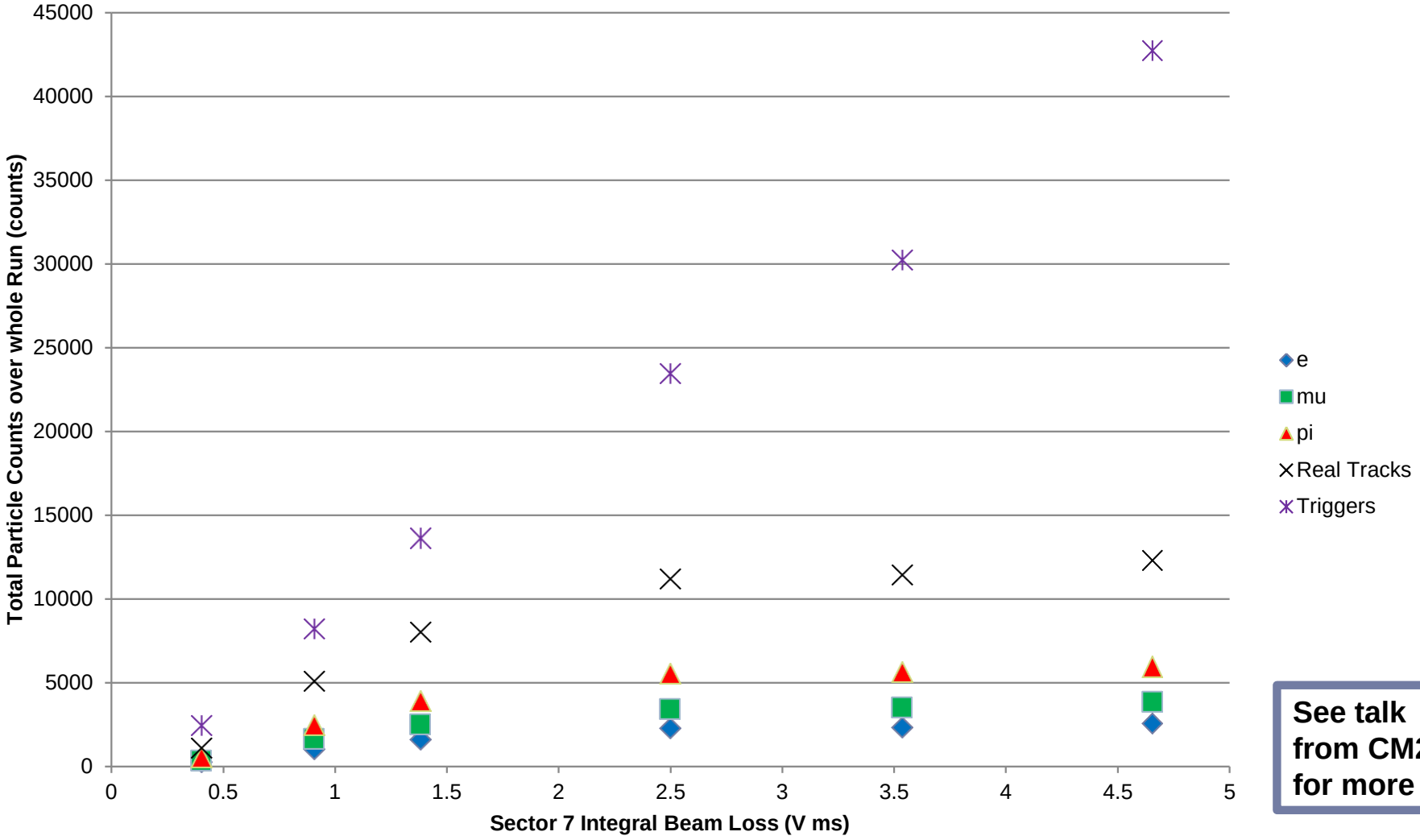
Total Rates Vs. Beam Loss

Reconstructed Rate per Species Vs. Beam Loss

All Detectors



Particle Rate Vs Beam Loss using Reconstructed TOF Tracks only for runs 1231 - 1236



See talk from CM26 for more

4. New: June 2010 Results

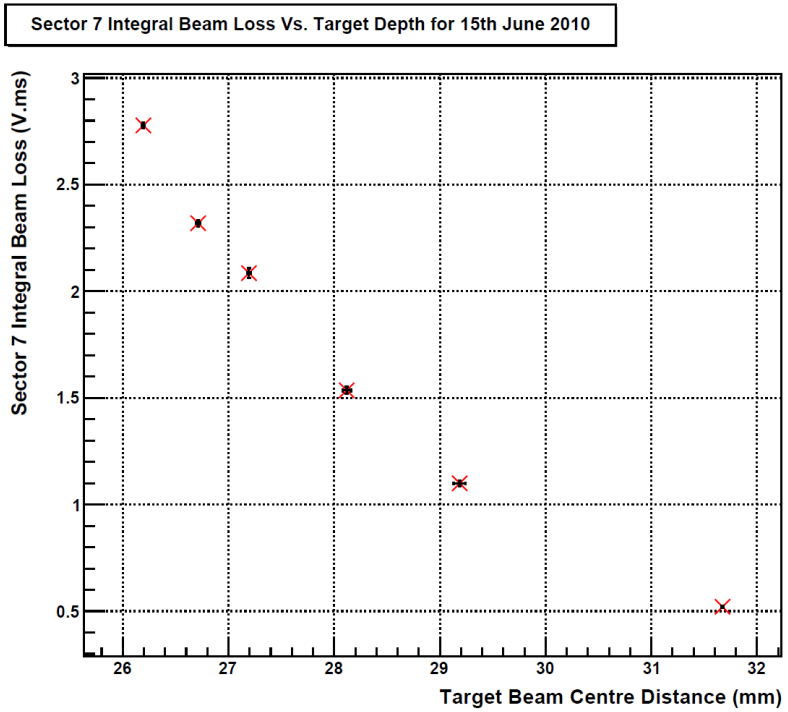
Study Conditions
Beam Loss Vs Target Depth
Total Rates Vs. Beam Loss
Reconstructed Rate per Species Vs. Beam Loss

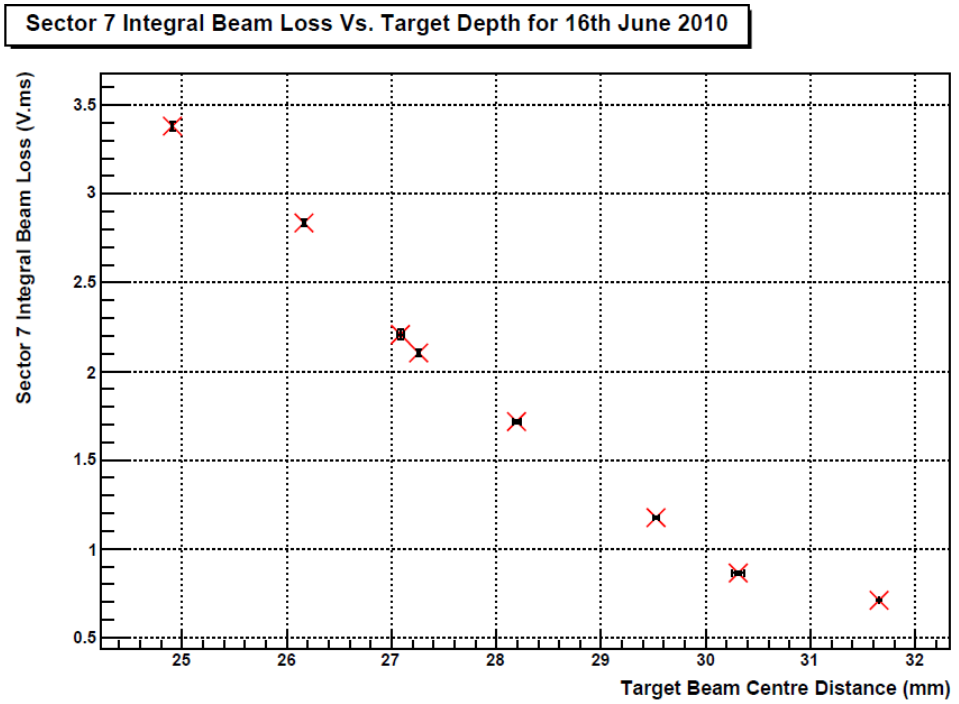
Notes on June 2010 studies

- Two studies conducted on two days, 15th and 16th
- No Q3 on either day due to power supply failure

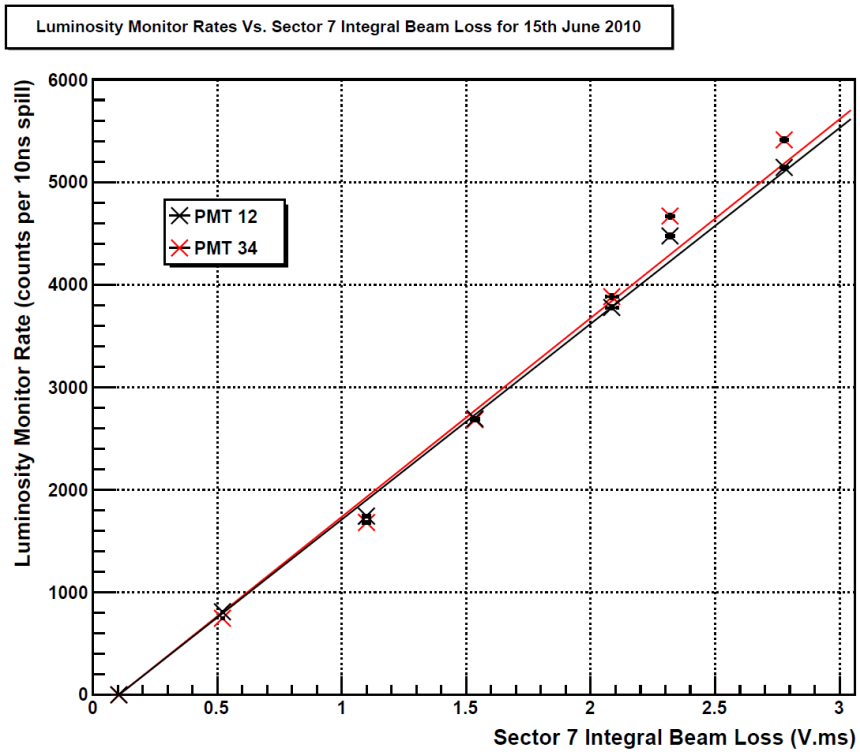
	15th June 2010	16th June 2010
Optics	-ve $\pi \rightarrow \mu$ 1st quad doublet	+ve $\pi \rightarrow \mu$ 1st quad doublet
DATE spill gate	3.2ms	1ms
Lumi gate	10ns	10ns
Proton Absorber	No	No

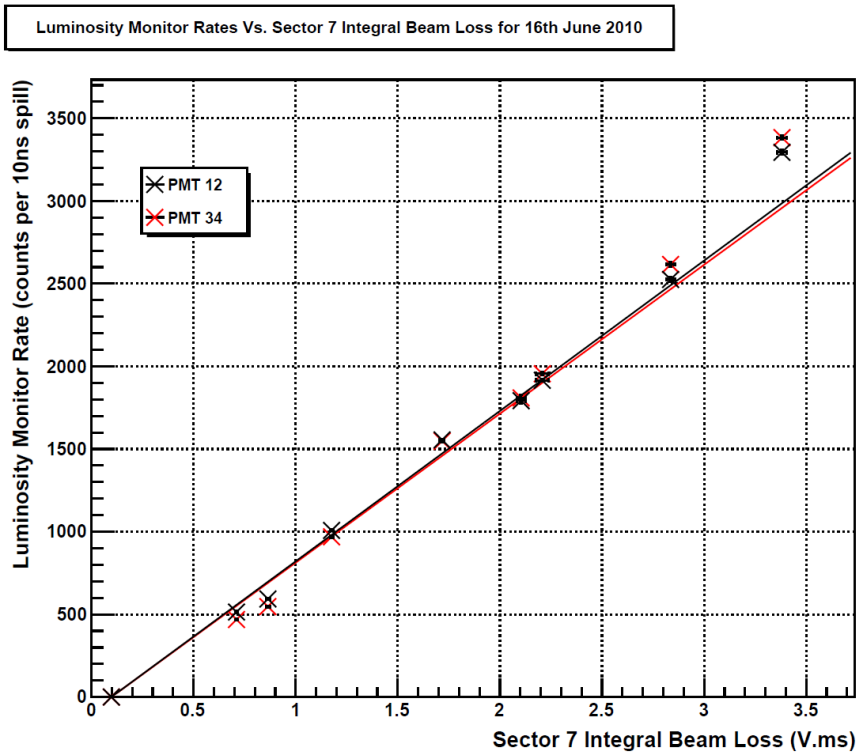
Target Depth Vs Beam Loss





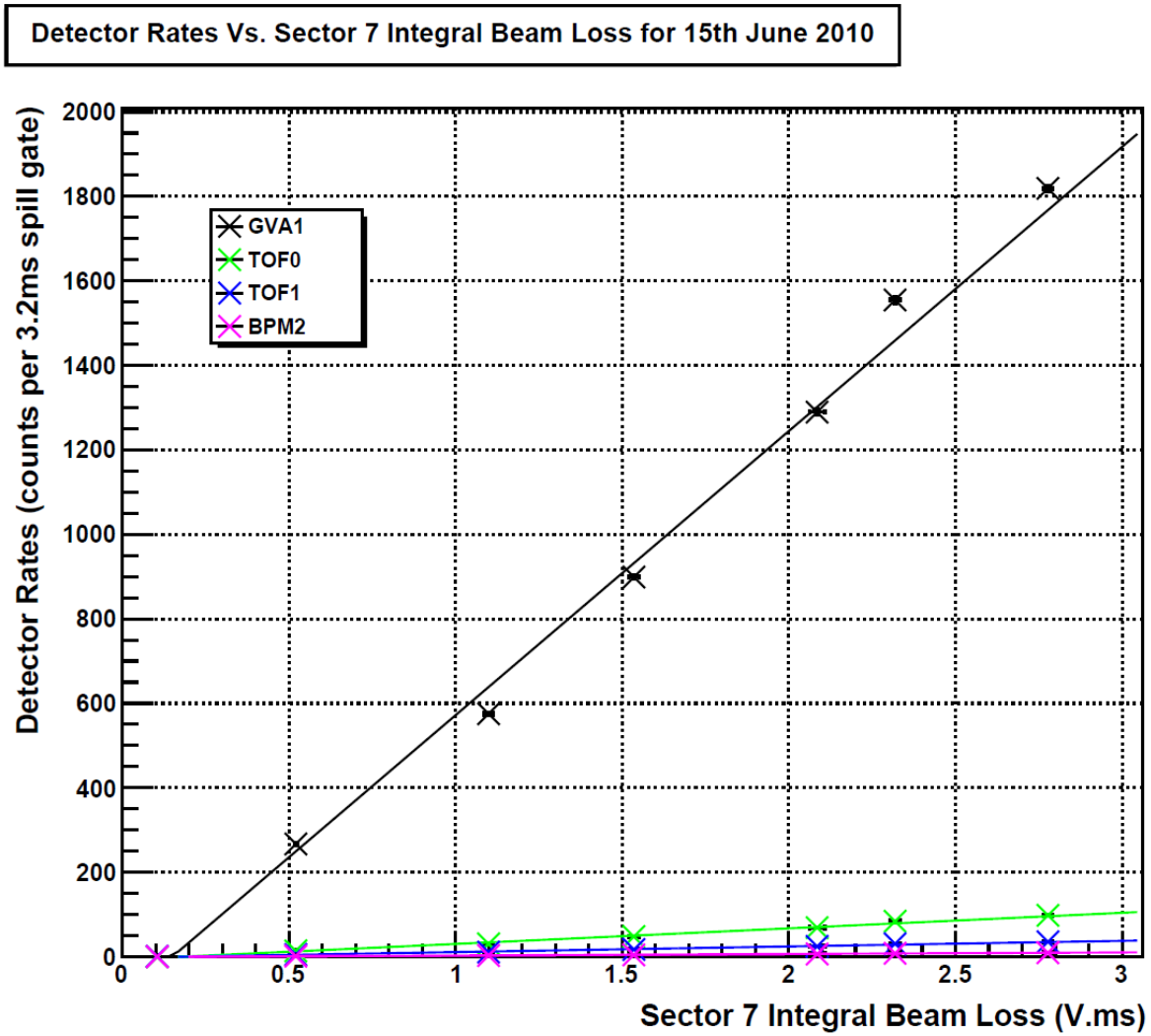
Luminosity Vs. Beam Loss



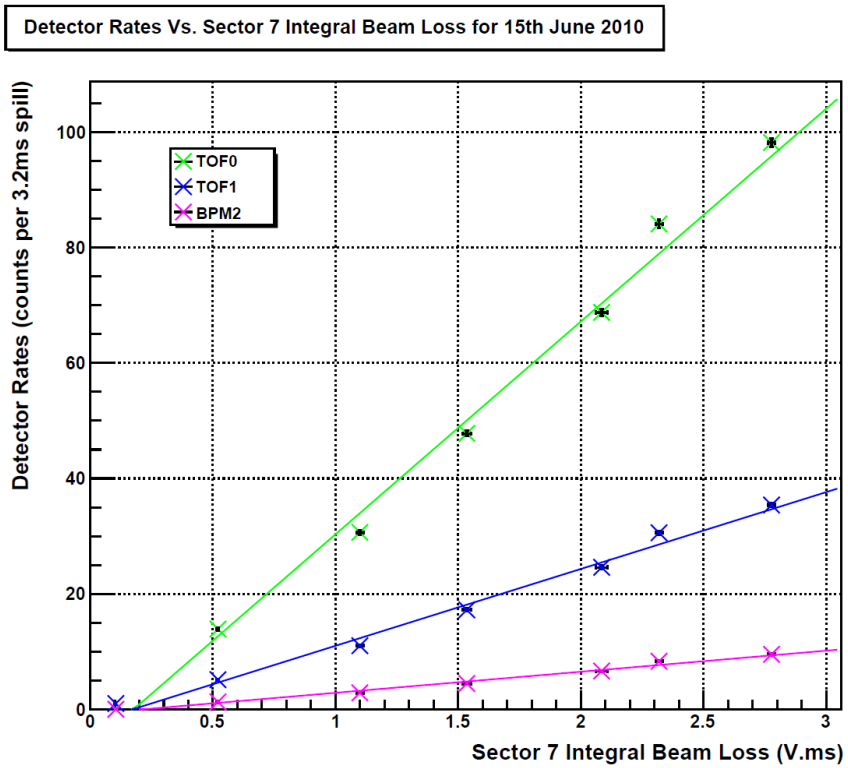


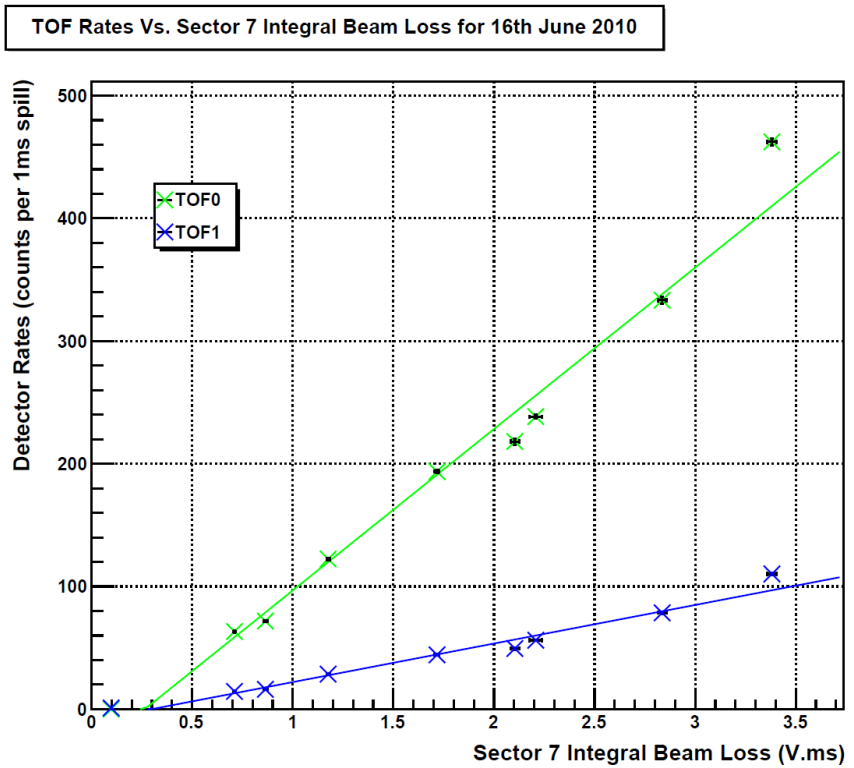
NB Note the change in scale – Why? Is it real?

All Detectors Vs. Beam Loss 15th June



TOF Detectors 15th & 16th June10

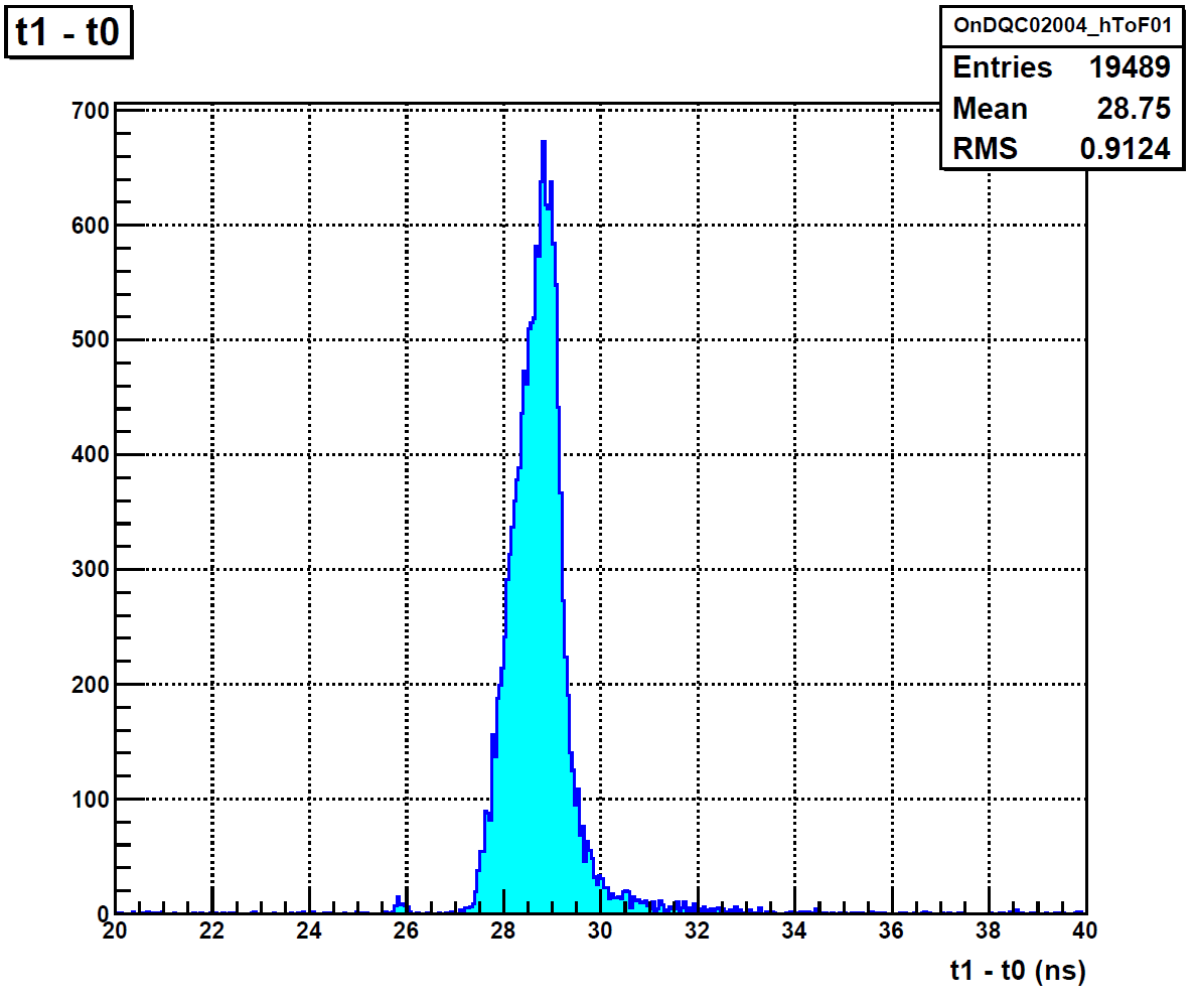




So at 2V beam loss observe ~

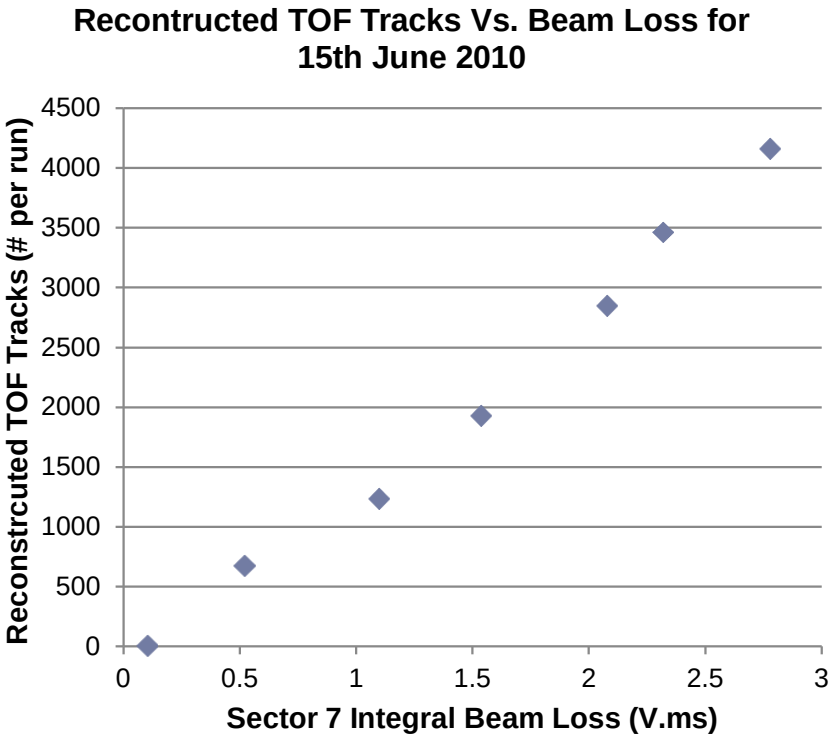
8 TOF1 hits per 1ms spill for –ve
50 TOF1 hits per 1ms spill for +ve

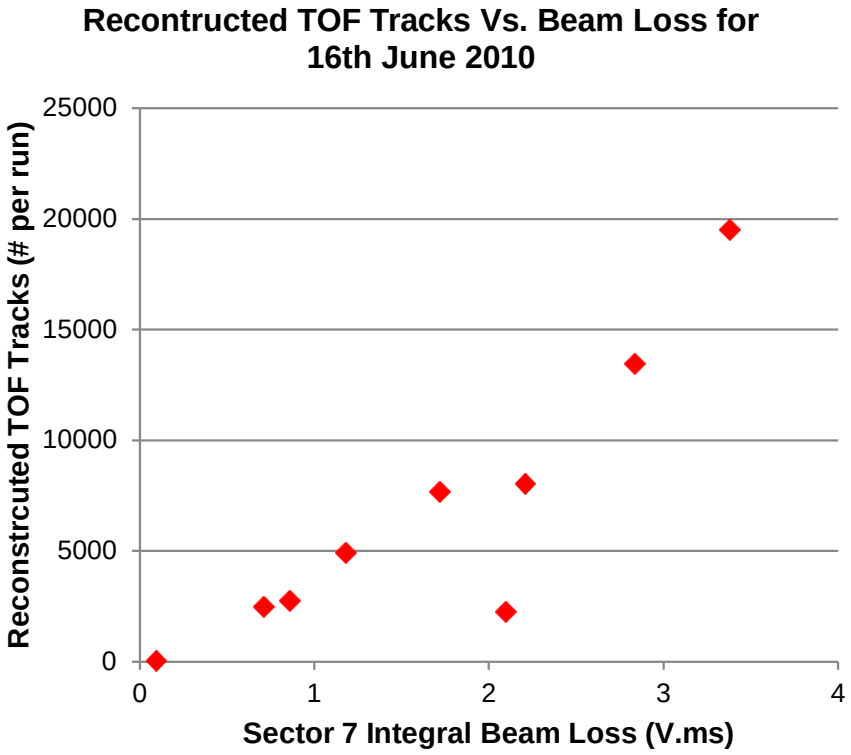
TOF PID for Run 2004 (16th June 2010)



- Large peak is mainly muons with perhaps some pion contamination in tail
- Small peak to the left is positrons

Reconstructed TOF Tracks Vs. Beam Loss

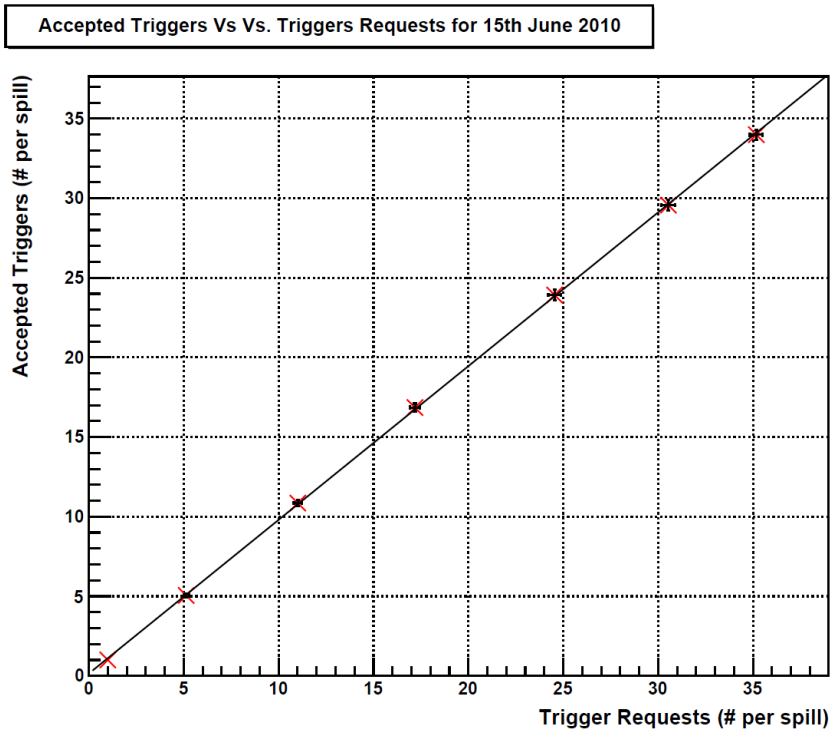


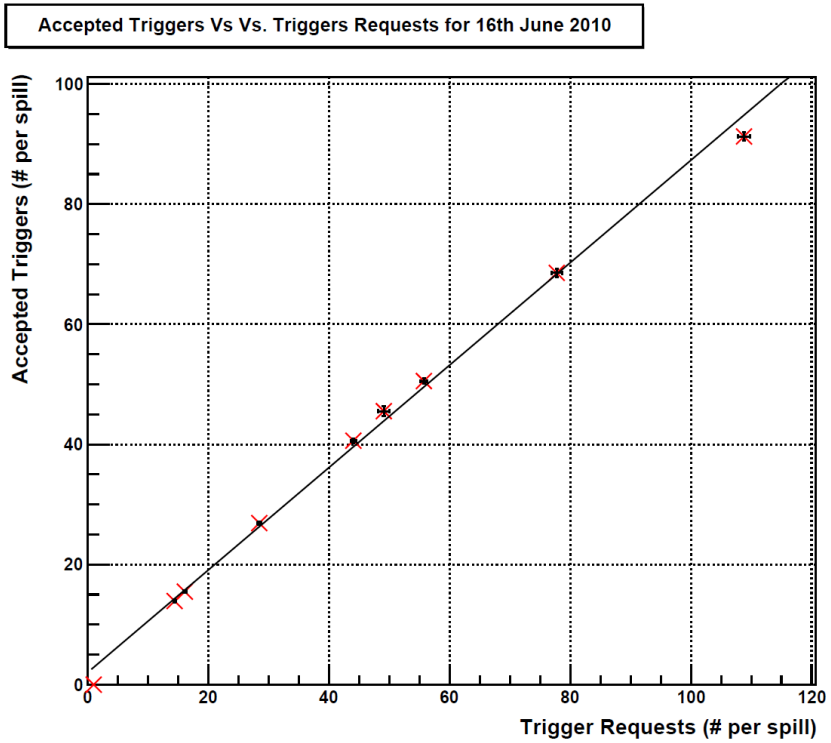


Bad: Reduction by ~ 50% to 66% over rate observed in Scalers (rate per run here, each run is ~ 400 spills). TofRec class claims ~ 80% – 90% efficiency.

Good: No saturation at high beam loss this time, ~ linear

Estimating Dead Time





There is a dead time effect but it is not enough to explain difference between reconstructed rates and scalers by itself.

5. Conclusion

Summary

Open Issues and Future Plans

Summary

- Beam Loss varies approximately linearly with target BCD for 25mm $\leq$ BCD $\leq$ 30mm, for 'normal' short target delay
- Particle Rate in the MICE Beamline scales approximately linearly with increasing Beam Loss up to 5V.ms in (Sector 7 Integral)
- At 2V beam loss for $\pi \rightarrow \mu$ optics observed:
  - 8 TOF1 hits per 1ms spill for –ve
  - 50 TOF1 hits per 1ms spill for +ve

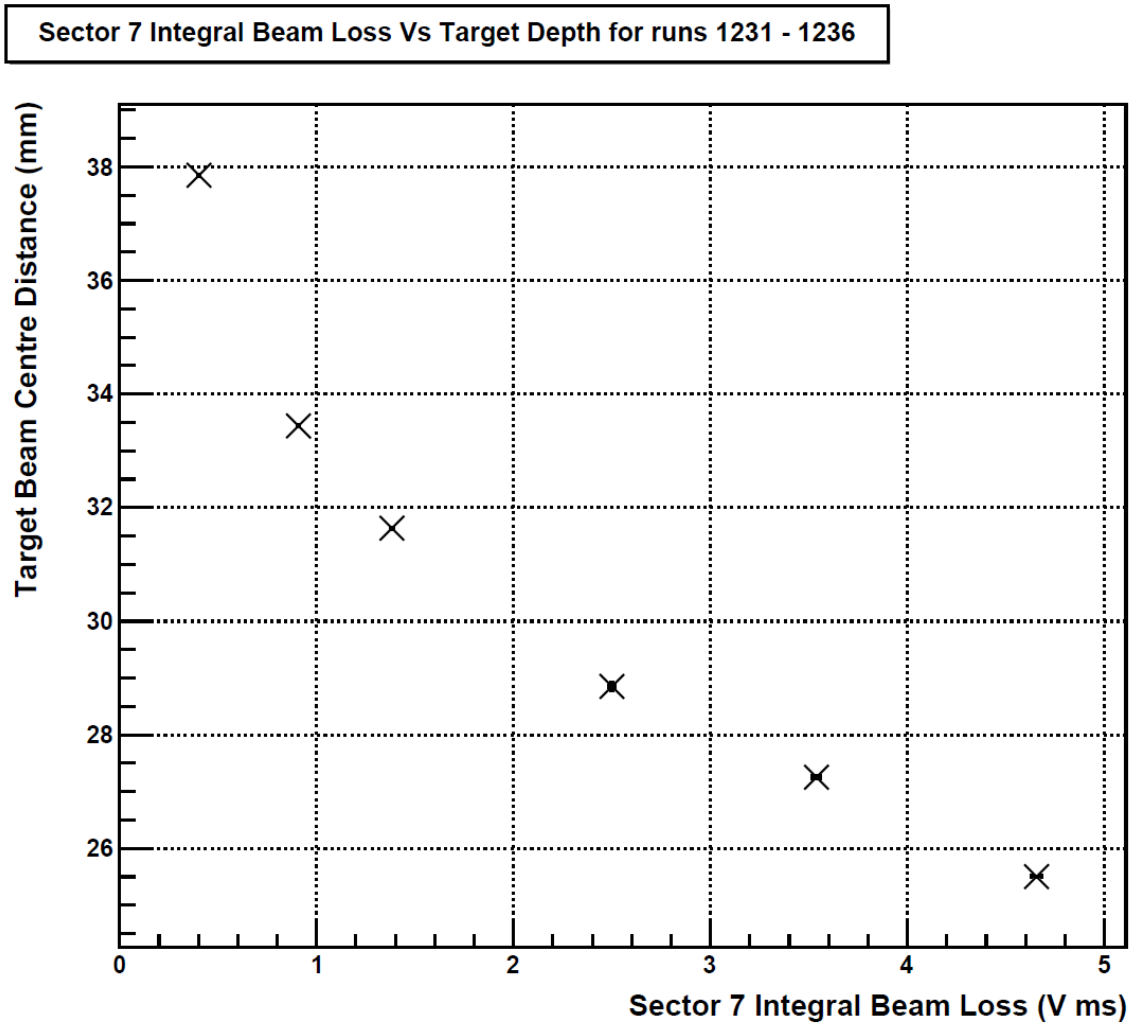
NB Remember doublet optics, strange lumi behavior and losses due to reconstruction when interpreting this

Open Issues and Future Plans

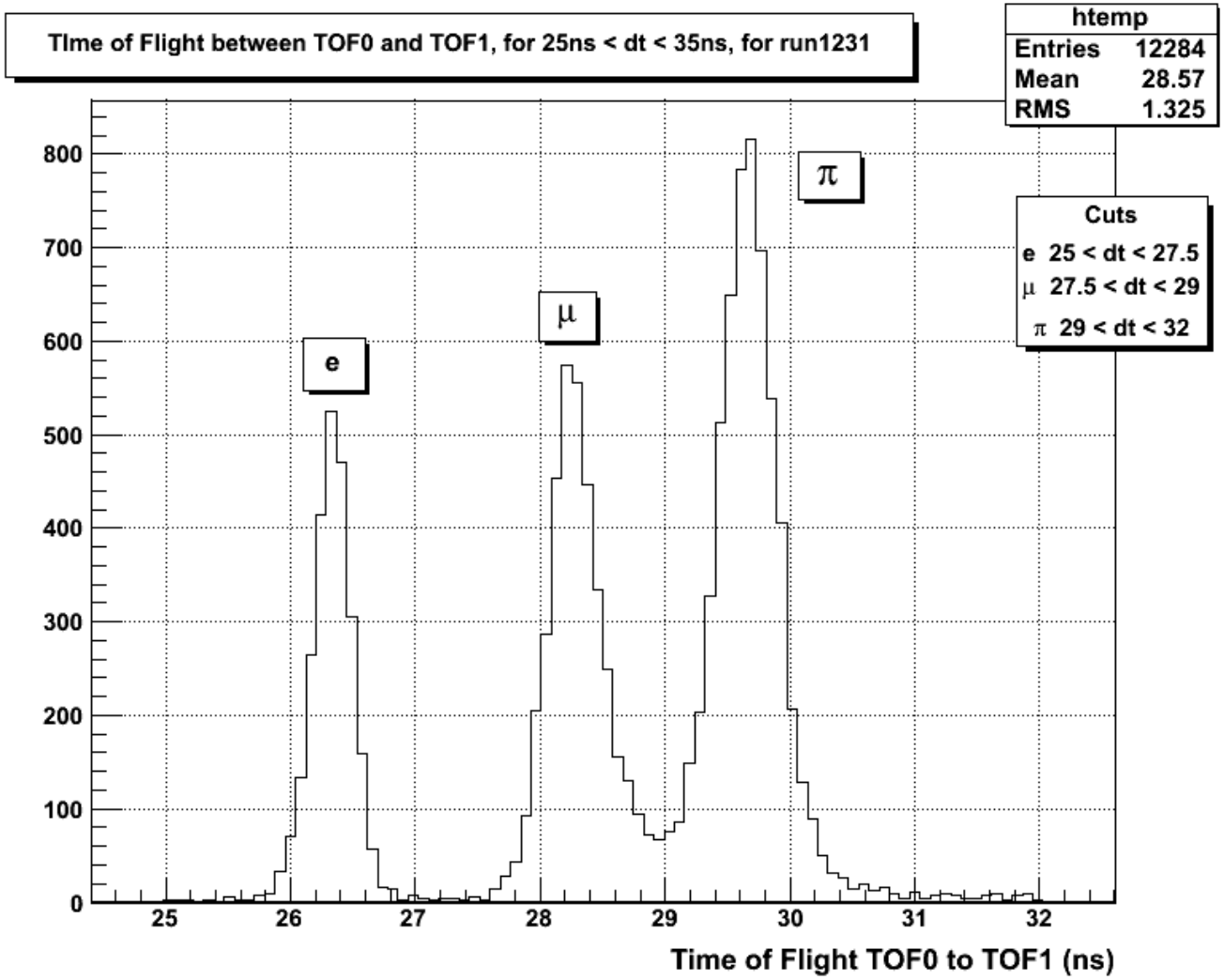
- No more data runs planned in nearer future (thesis) – however will always be interesting if our beam loss limits are increased
- Luminosity Monitor – why the scale change?
- TOF reconstruction – understand why seem to lose particles c.f. Scalers
- Beam line rates with G4BeamLine simulations
- Use ORBIT to understand loss patterns around ISIS and relate beam loss to protons-on-target

Spares

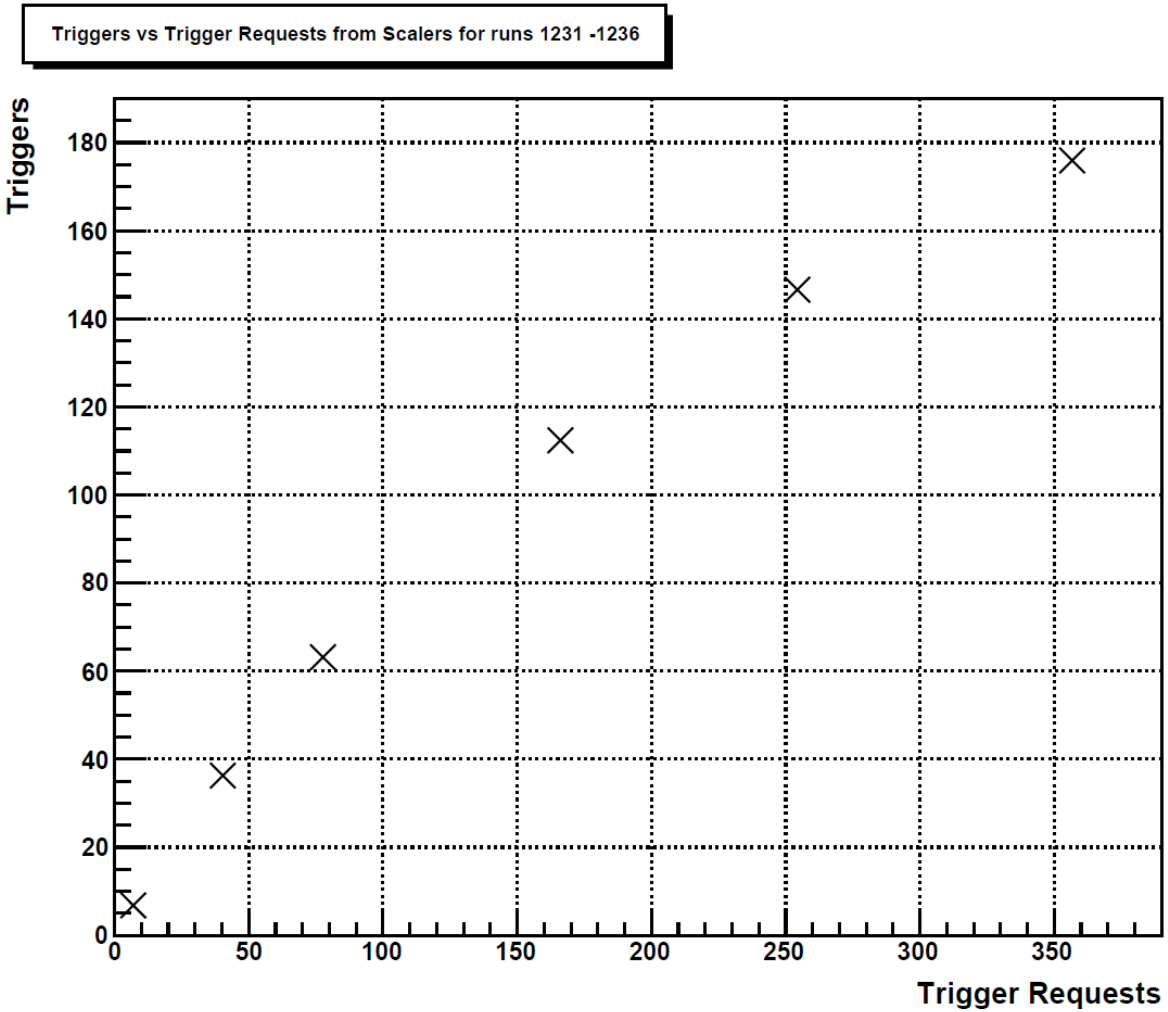
Target Depth Vs Beam Loss



Preliminary TOF Analysis



A possible solution... deadtime



Particle Rate Vs Beam Loss using TOF1 Scaler for Absolute Rate and Reconstructed TOF Tracks for Relative Abundances of Species for runs 1231 - 1236