MOM Report

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MICE CM28
Sofia, Bulgaria, Oct 4, 2010

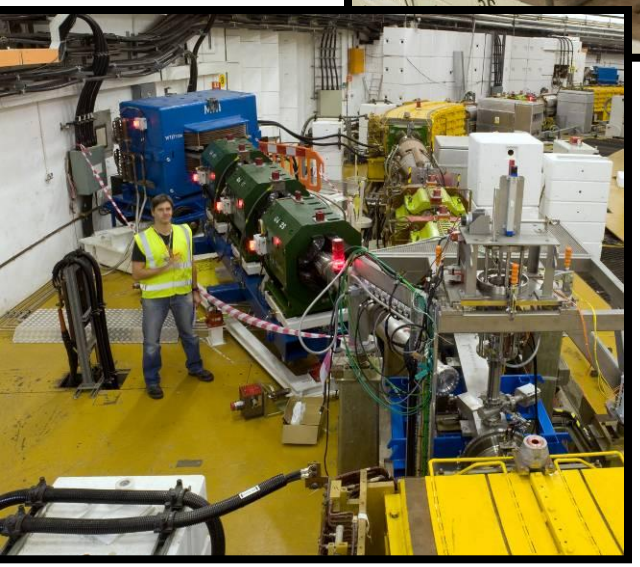
Outline

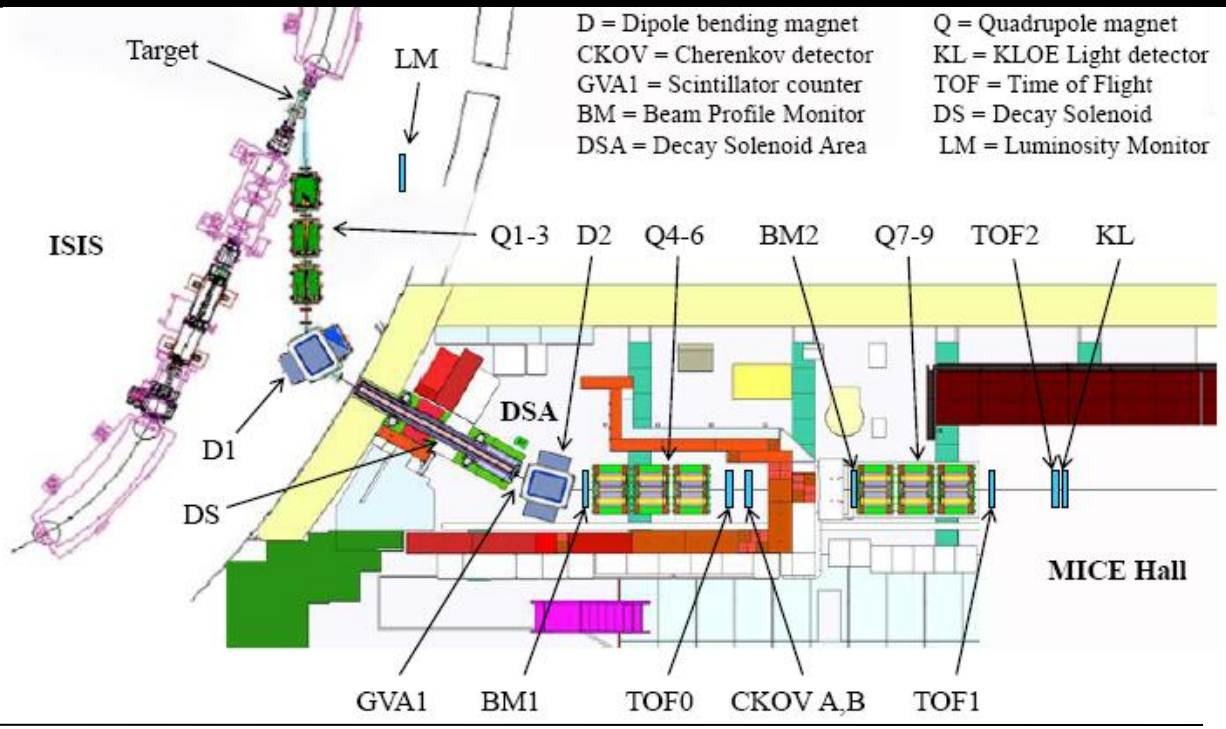
- ***Progress since last CM***
- ***Daily Operations***
- ***During Shutdown***
- ***Conclusions***

Progress Since July CM

- ***Finished the second half of the ISIS User Run***
  - ***Step I Data-Taking and Analysis***
  - ***See many upcoming talks (M. Apollonio, C. Rogers, M. Rayner, S. Blot, Y.Karadzhov)***
- ***And Machine Physics period***
  - ***Particle Rate v Beam Loss Study up to 10V losses in ISIS***
  - ***A. Dobbs***
- ***Improvements in Running***
  - ***Operations procedure efficiency improved***
  - ***Upgrades to DAQ***
  - ***Configuration Database Used***
    - ***Input run conditions from previous runs***
    - ***Moving to running w/o Run Conditions Summary Spreadsheet***
  - ***DAQ included in Alarm Handler***
    - ***Easier to identify DAQ errors & take appropriate action***
    - ***Alerted to when ISIS drops out***
- ***Long ISIS Shutdown started – Through March 2011***

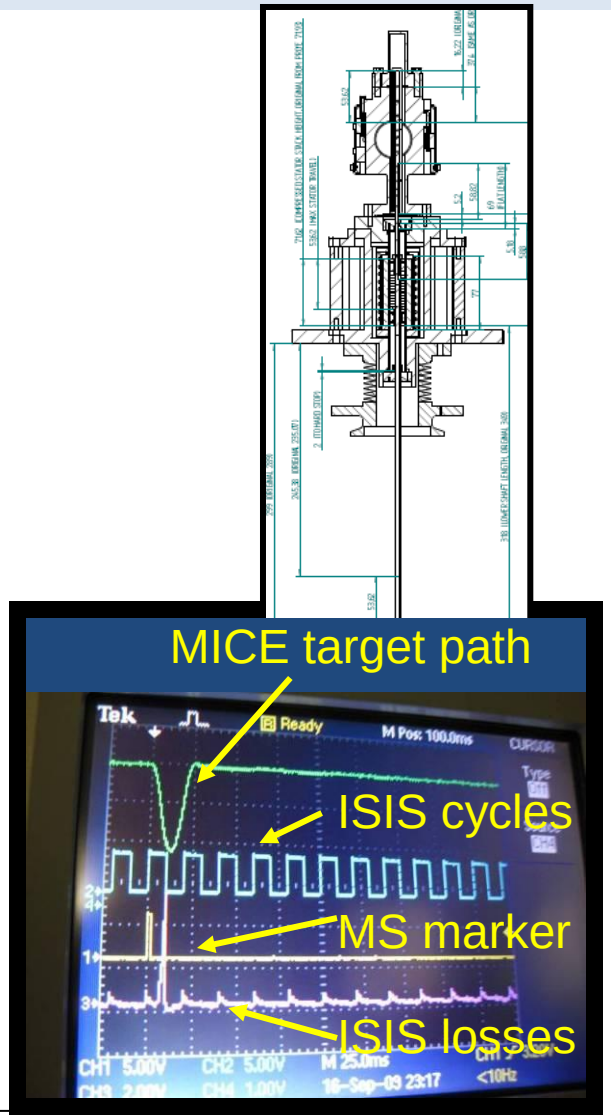
MICE Beam Line





Status: Target & Luminosity Monitor

- ***This target installed in ISIS August 2009 (UK)***
  - ***Run at base rate & 50 Hz (Normal User Run)***
- ***Target is working beautifully***
  - ***Stability checked every 10,000 pulses***
- ***Target Operation (K. Long):***
  - ***570,000 pulses to date in ISIS***
  - ***Offline target ran 2.15 M actuations***
  - ***Need online & offline targets***
- ***Luminosity Monitor working***
  - ***Stable through User Run***
  - ***New data analysis (D. Forrest)***

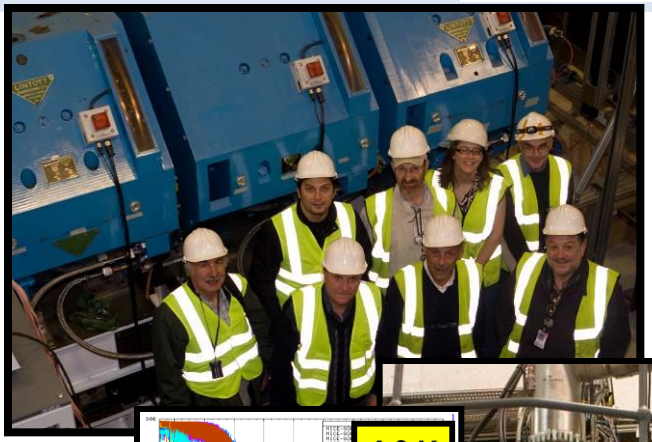


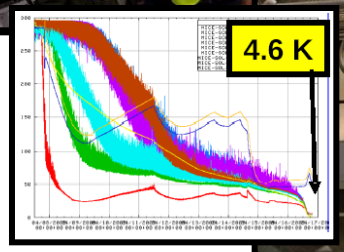
Status: Beam Line

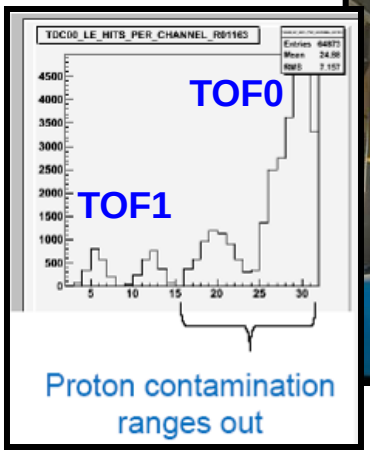
- ***Conventional Magnets***
  - ***All operational and working well***
  - ***Current reliably stable during User Run***
- ***Decay Solenoid (PSI/RAL)***
  - ***5 T superconducting solenoid magnet***
  - ***Increases downstream particle flux by factor of ~5***

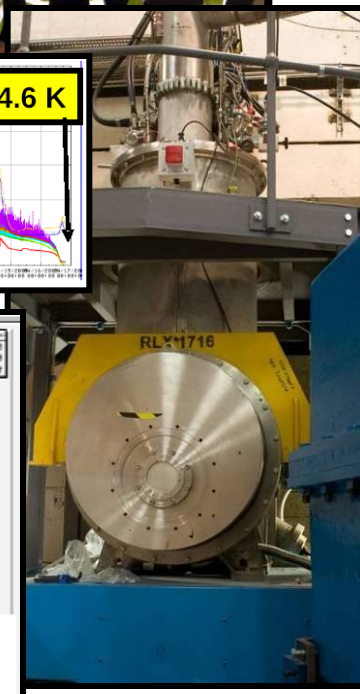
Decay Solenoid cold, stable, and operational for entire User Run June – August 2010

- ***Proton Absorber installed downstream of Decay Solenoid***
  - ***15, 29, 49, 54mm***
  - ***Successfully eliminated proton contamination in positive μ beams***









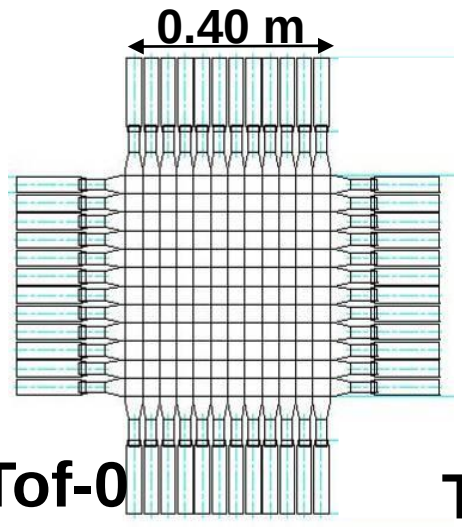
Step I: Running

- ***Goals***
  - ***Commission and calibrate beam line detectors***
    - ***Luminosity Monitor***
    - ***TOF0, TOF1, TOF2, CKOVs, KL***
    - ***FNAL beam profile monitors***
  - ***Commission beam line magnets***
  - ***Take data for each point in ε-p matrix***
    - ***MICE beam designed to be tunable***
    - ***Understand beam parameters for each configuration***
  - ***Compare data to simulation of beam line***
  - ***Prepare for Steps with cooling***
- ***Method***
  - ***Dedicated data-taking run from June 22 – August 12***
  - ***Special Machine Physics study periods***

Step I:
TOF Detector Commissioning

- *TOF0, TOF1, TOF2 are in beam line*
- *Two planes of 1 inch orthogonal scintillator slabs in x and y*
  - *Timing information & beam profile data*
  - *2D grid provides spatial information*

- ***Essential in beam line commissioning***

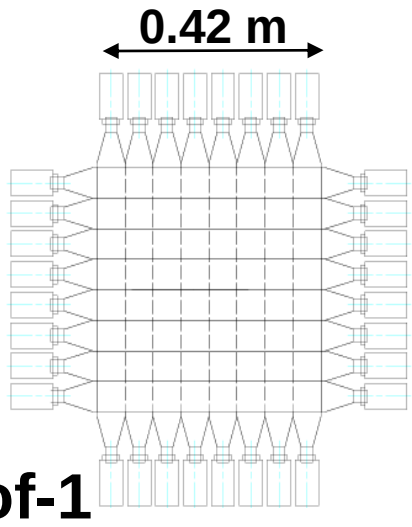


Tof-0

10 x 4cm scintillator bars

σ_x = 1.15 cm

σ_t = 50 ps

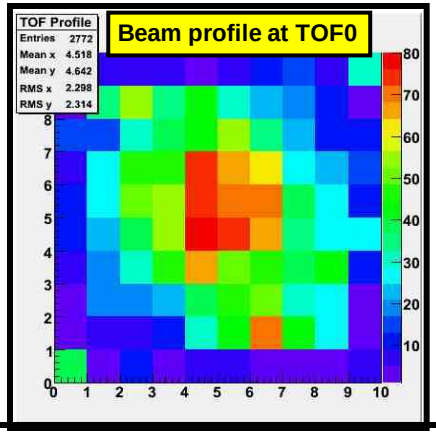


Tof-1

7 x 6cm scintillator bars

σ_x = 1.73 cm

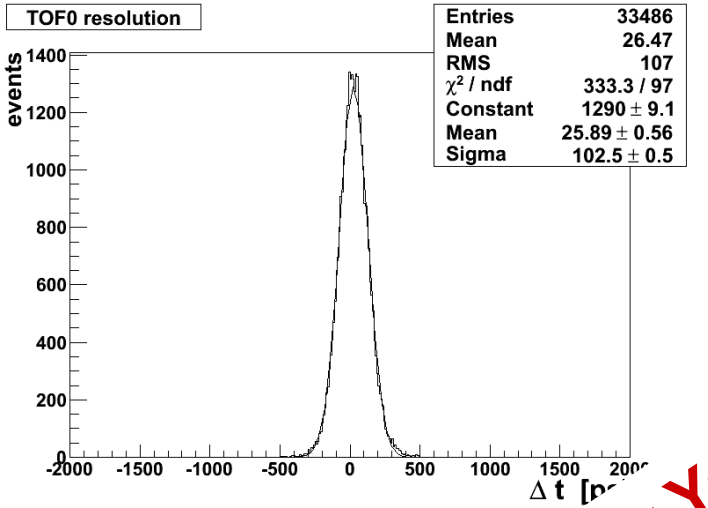
σ_t = 50 ps

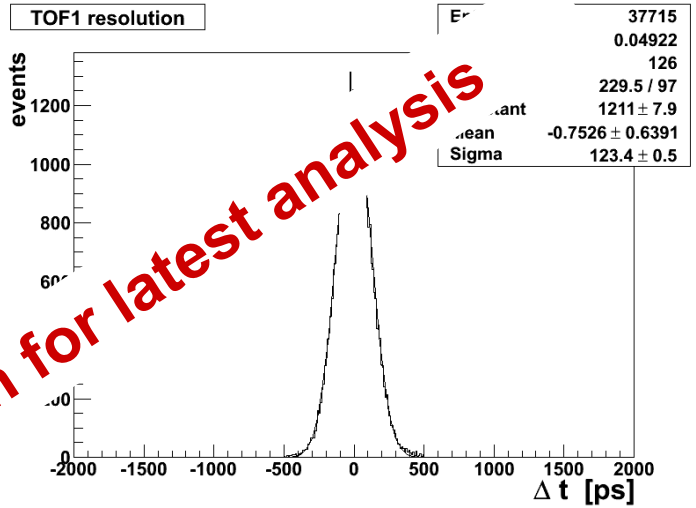


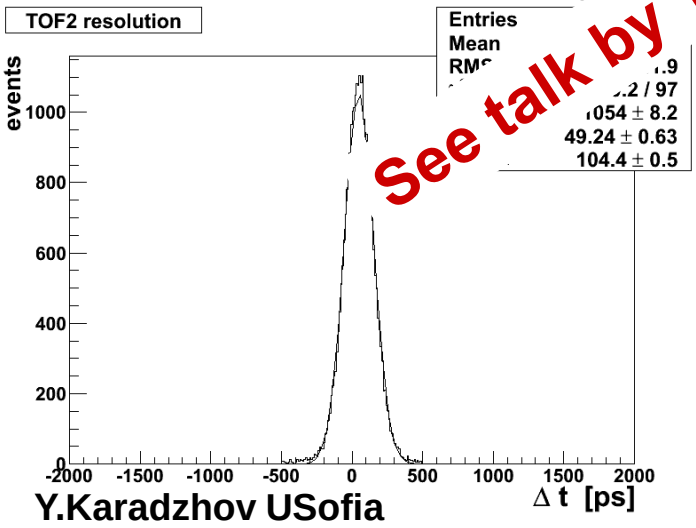
TOF Detectors Used to Calculate Beam Optics Parameters

- ***Define good muon sample with timing***
- ***Find muon (x,y) from TOF0 & TOF1 spatial information***

Step I:
TOF Detector Commissioning







Y.Karadzhov USofia

See talk by Yordan for latest analysis

- *Time resolution after calibration:*
- *TOF0 – 51ps*
- *TOF1 – 62ps*
- *TOF2 – 52ps*
- *Resolution meets design goals for TOFs*

Step I Running: Data Summary

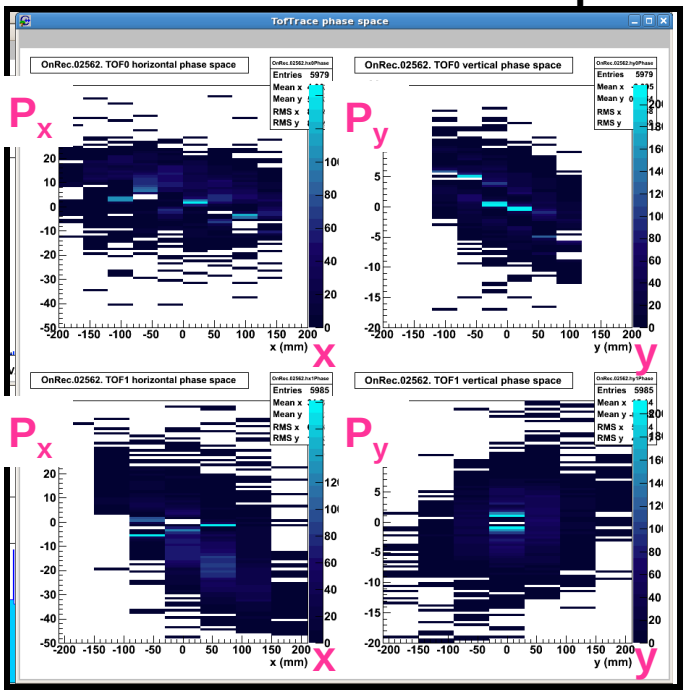
- *Record amount of data taken this summer*
  - *Over 335,000 dips of target into ISIS*
  - *Over 13,000,000 particle triggers*

- *Emittance-momentum matrix scan*
- *Beam line studies:*
  - *Quad scans*
  - *Dipole scans*
  - *DS scan*
  - *Neutrals*

- *Online tuning of beam with online reconstruction using beam optics parameters*

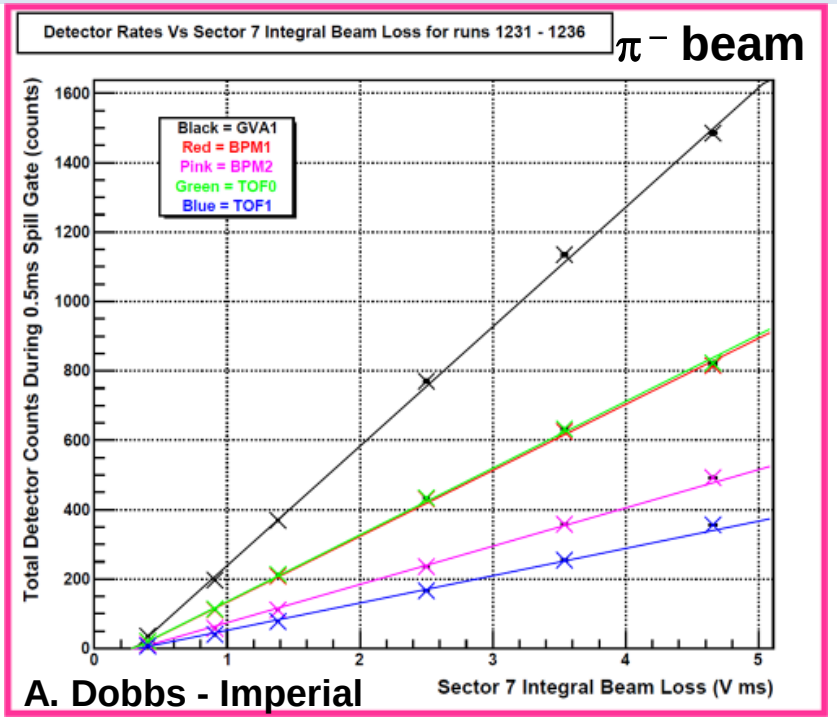
- *Reference run each day*
  - *400 pulses 6-200 (ε-p)*
- *Target test run each day*
- *All hardware stable*

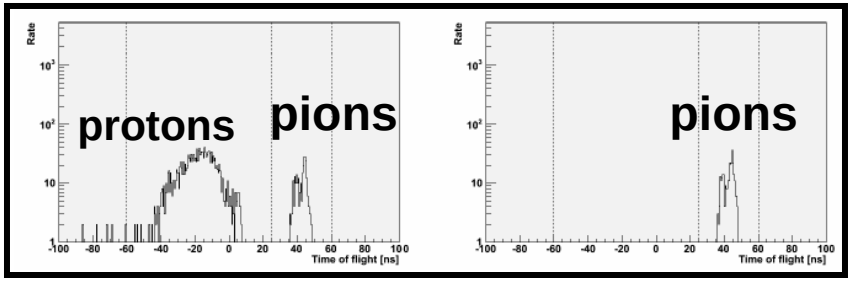
Muon Beam Online Phase Space



Step I: Beam Studies

- *Particle Rate vs Losses*
  - *Goal of ~500 muons/spill*
  - *Systematically study particle rates in MICE vs ISIS beam loss*
  - *Initially used pion optics (plot to right)*
    - *recently μ beam*
  - *Linear relationship over beam loss range of ~500 mV – 4700 mV*
  - *Up to 10 V running!*
- *Target operation studies*
- *Proton absorber*
  - *Time-of-flight between GVA1 & TOF0*
    - *See protons and pions*
    - *Dashed lines → cuts used for PID*
  - *Determined absorber setting for each beam line in ε-p matrix*
  - *Proton absorber works*

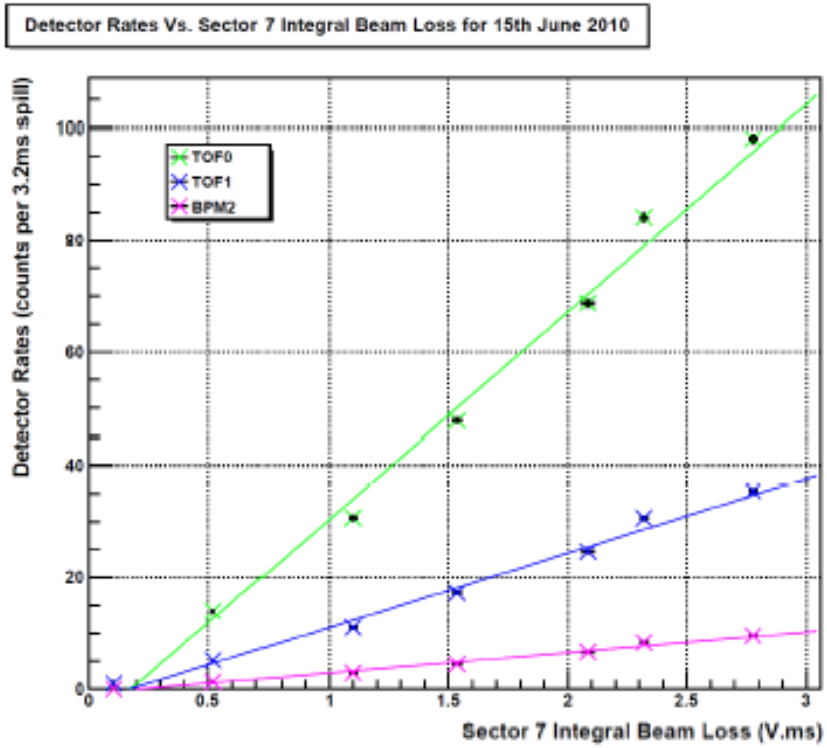


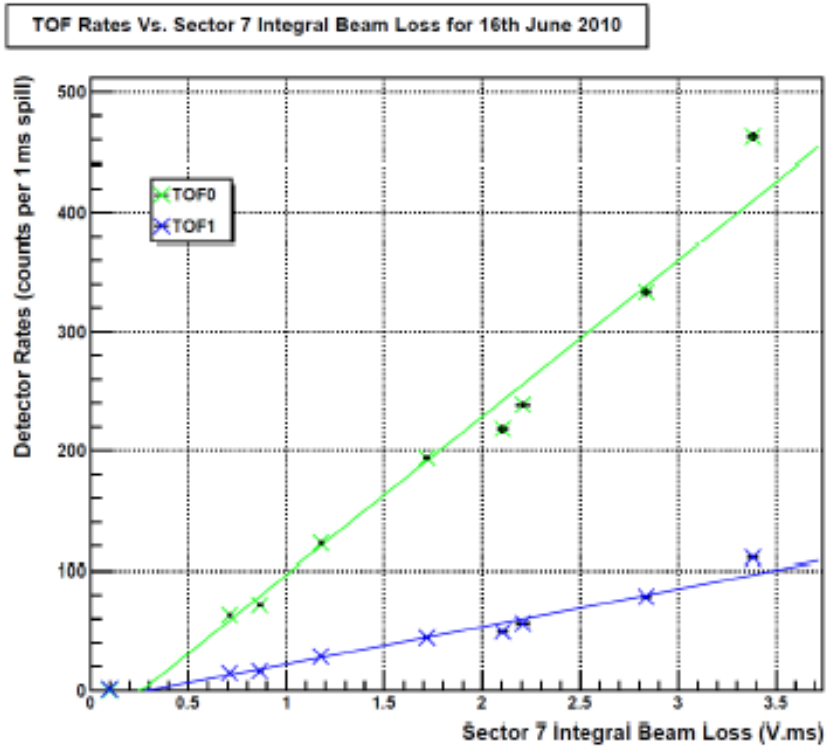


Raw Time of Flight

Beam Studies: Particle Rate

- **Muon beam particle rate v losses – A. Dobbs**





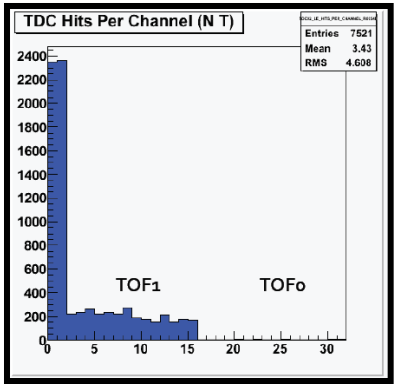
So at 2V beam loss observe ~

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

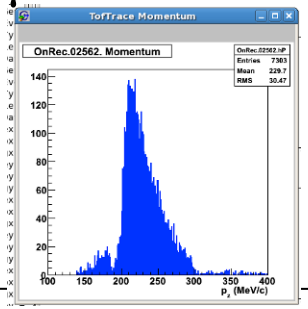
Step I Running: Beam Line Studies

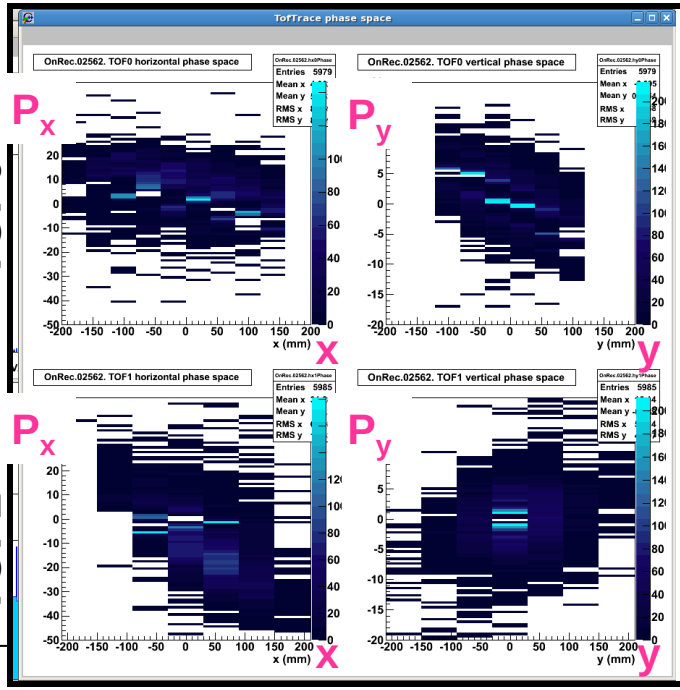
- ***Beam line studies:***
  - ***Neutrals***
    - *Observe neutrals causing trigger in TOF1*
    - *Even with all magnets off*
    - *Only when dip target and beam stop lowered – scales with beam loss*
  - ***Dipole scans***
    - *D2 kept constant – selects same momentum as for negatives without proton absorber*
    - *Proton absorber does not affect trigger rate*
  - ***Quad scans***
    - *Check beam line alignment*
      - *We observe offset in X,Y in TOF1*
      - *Being investigated*
    - *Characterize effect of each magnet*
  - ***DS scan***
  - ***Online Optimization***
    - *Muon PID w/TOFs*
    - *Momentum*
    - *Phase space plots*

Neutrals in MICE

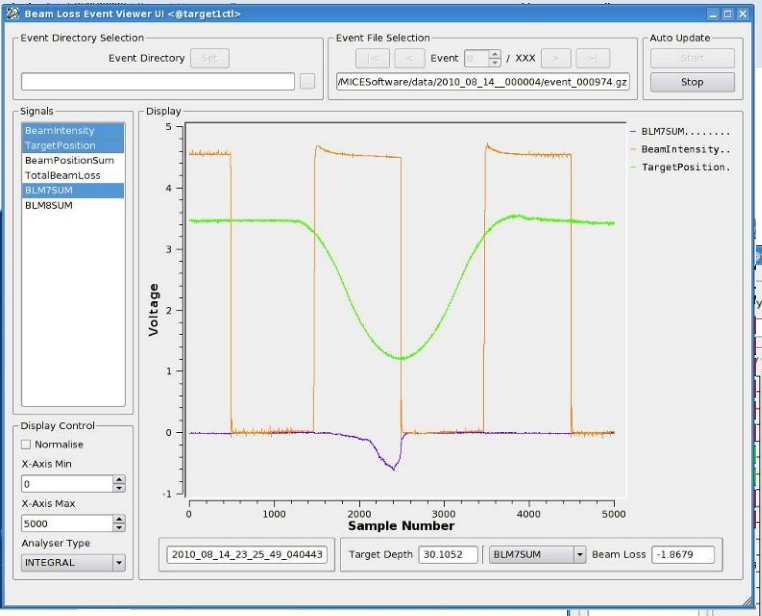


μ Momentum

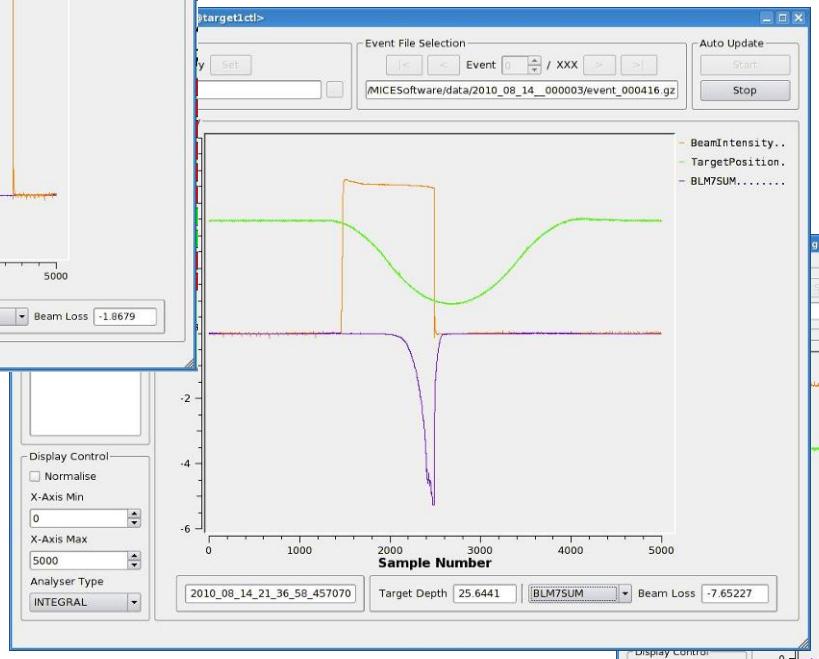




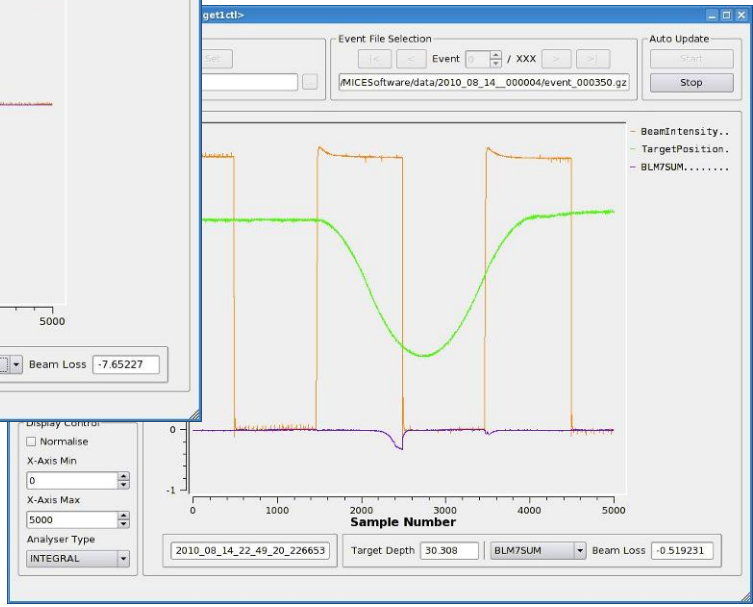
Step I: Target delay study



Target dipping early



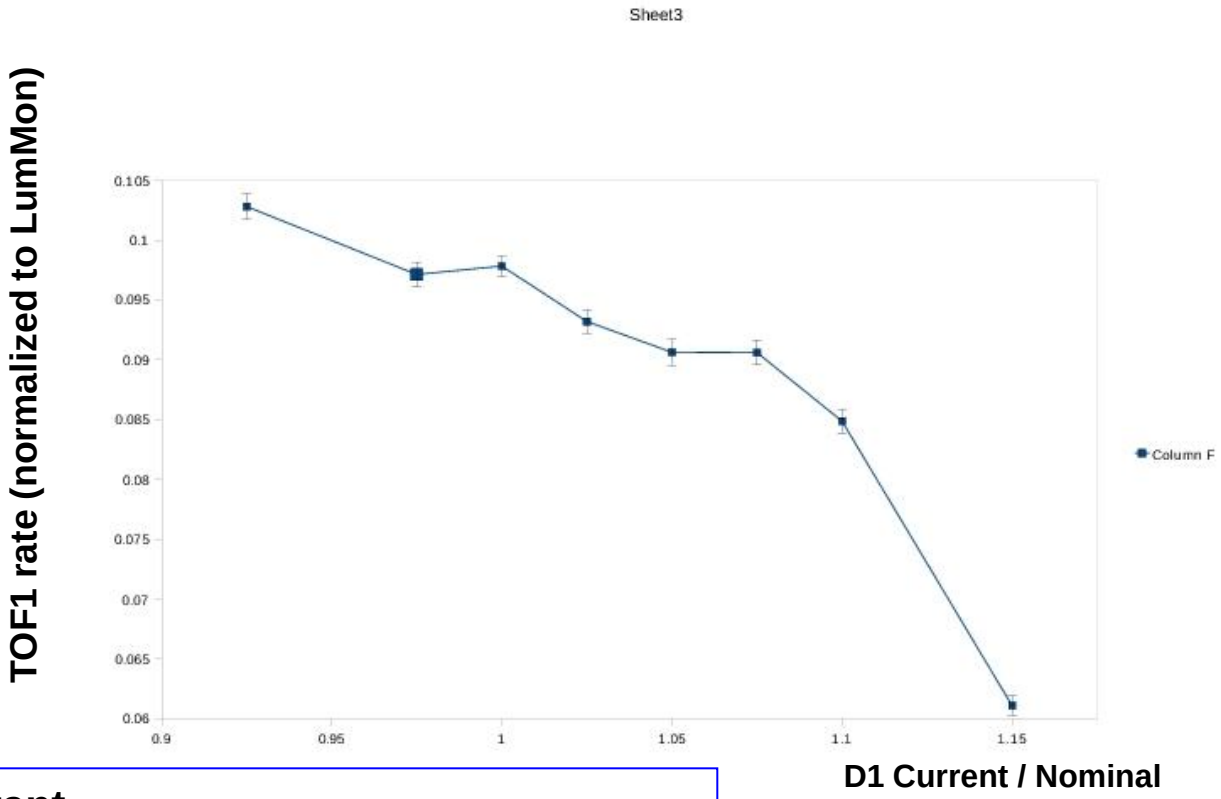
normal



- https://micewww.pp.rl.ac.uk/elog/MICE+Log/1455

late

Step I Running: D1 Scan



D2 kept constant,
selecting the same momentum as for negatives
(without proton absorbers)

Page 1

By Chris Heidt

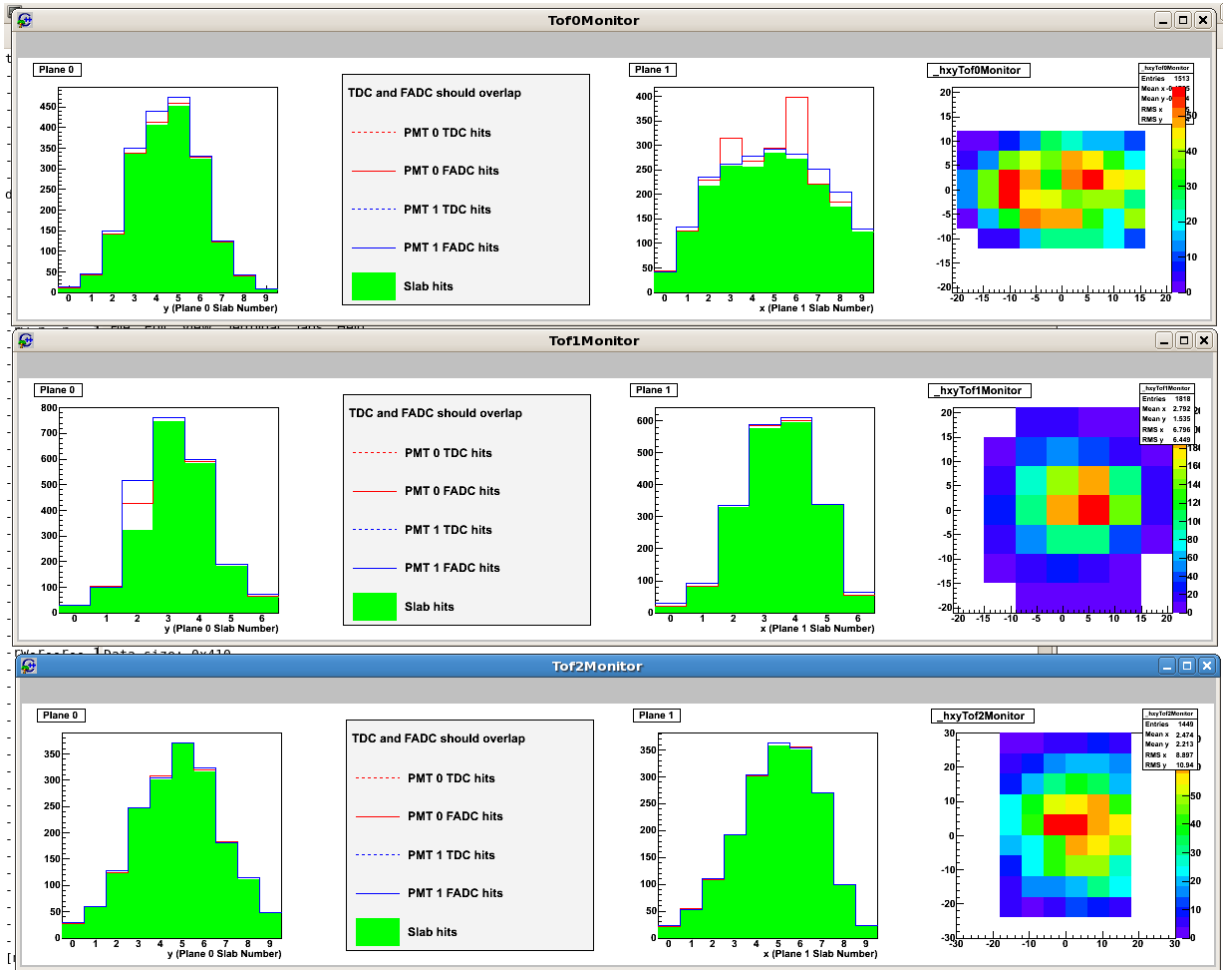
Step I Running: Online Tuning

- ***Online Optimization***
  - ***Chris Rogers and Mark Rayner spent 2 days in MLCR***
  - ***A lot of improvement in Online Software***
  - ***Work still in progress***
- ***Main Goal***
  - ***Comparison data /Simulation (G4MICE)***

- ***Put stress on some issues***
  - ***CDB entry available only at the end of the RUN !***
    - ***No way to use Quad currents from CDB***
    - ***Emphasize the need for CAM data in data stream***
  - ***DAQ must be stable…***
    - ***Huge progress achieved last week (faulty board replaced)***
  - ***Speed of data access over socket***
    - ***Plot lag***
  - ***Memory leaks present in code***

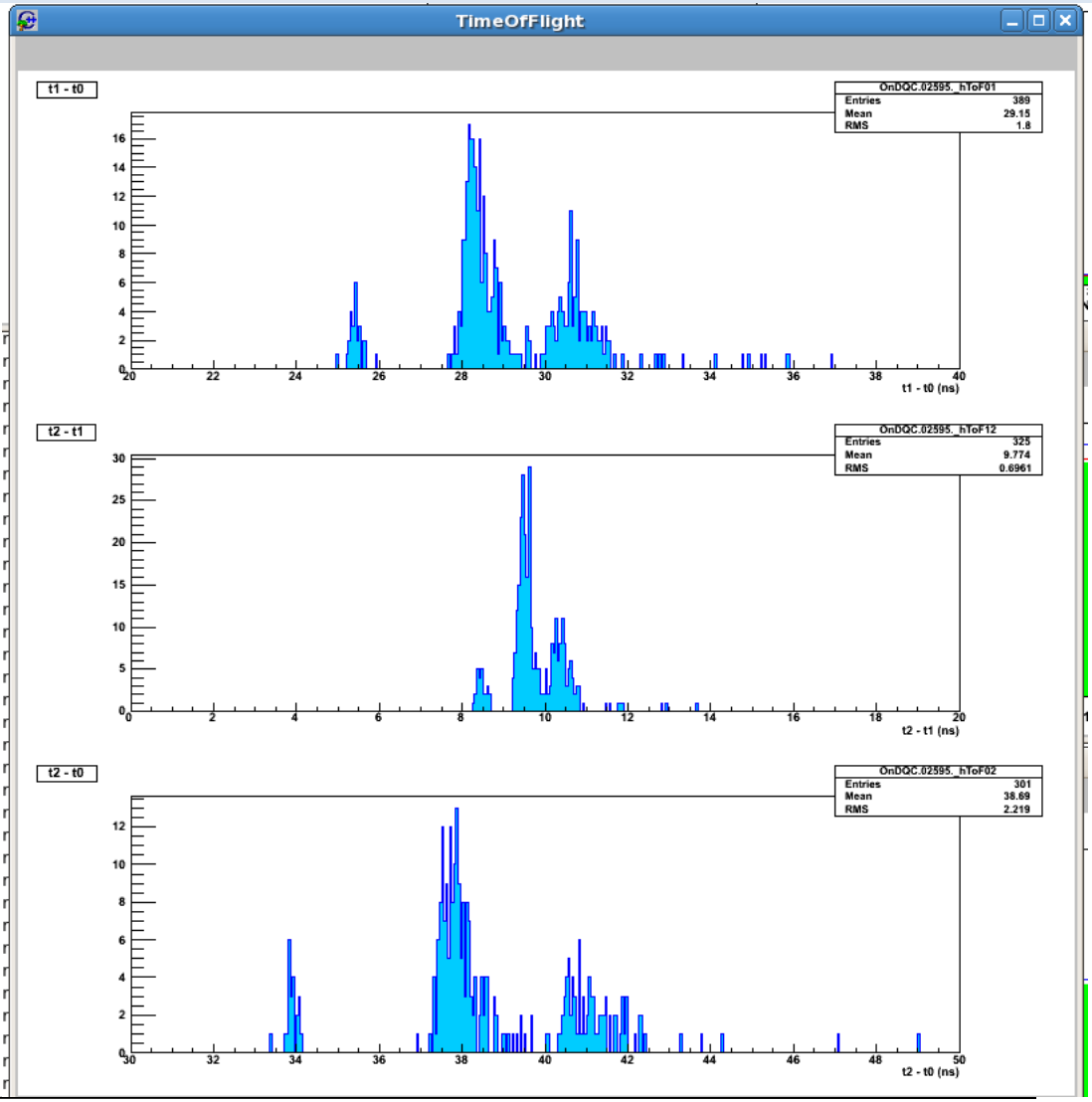
Online: Data Quality Check

- *TOF Monitor – y, x, combined distributions for TOFs*
  - *TOF0 (top plots)*
  - *TOF1 (middle plots)*
    - *One noisy slab*
  - *TOF2 (bottom plots)*

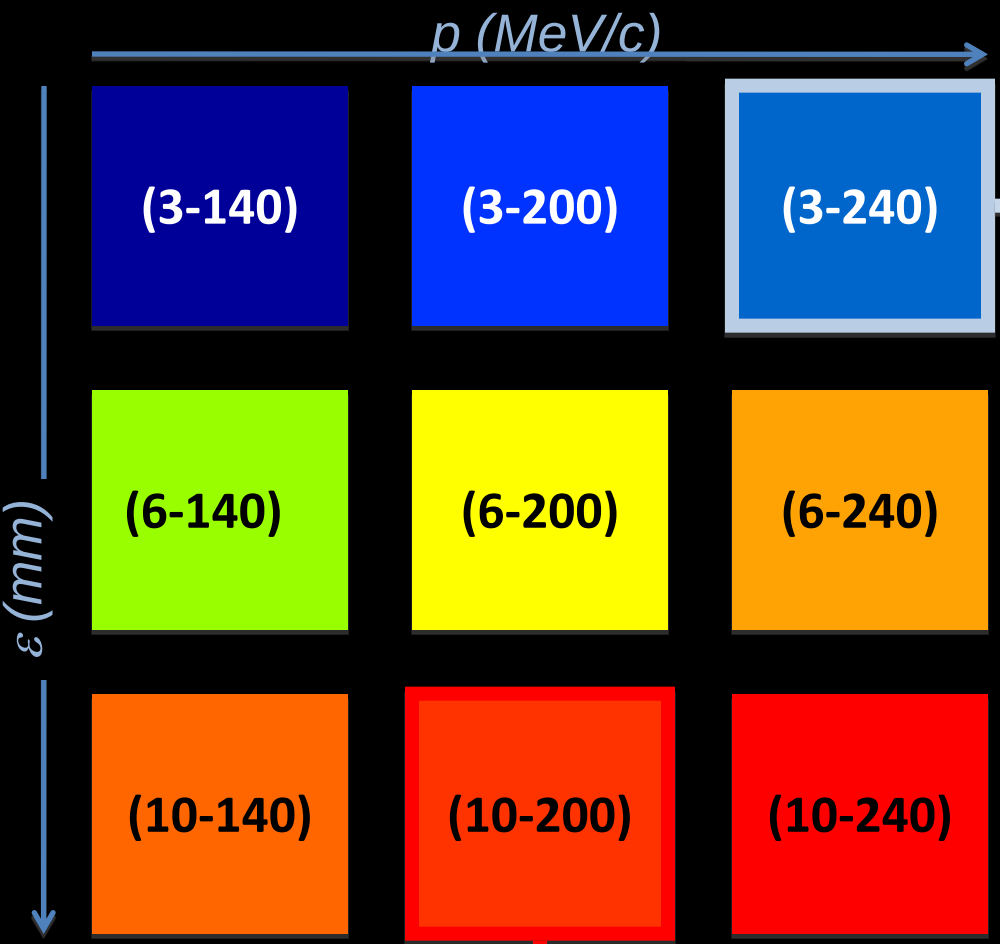


Online: Data Quality Check

- *Time of Flight plots*
  - *TOF1-TOF0 (top plot)*
  - *TOF2-TOF1 (middle plot)*
    - *Note separation capability*
  - *TOF2-TOF0 (bottom plot)*
- *Run 2595*
  - *TOF Calibration positron beam (300 MeV/c at target)*



Step I Goal:
Fill in ε-p matrix data



- Finding the element (3-240) means finding BL settings that produce MICE optics at the upstream end of the diffuser for a beam of 3 mm at p=240 MeV/c

- The element (10-200) is the BL optics producing a MICE beam with 10 mm at p=200 MeV/c

ε-p Matrix

- **Several Beam line optics**
  - **Prepared by Marco Apollonio**
  - **Available on MICE Wiki (Chris Tunnell)**

  http://mice.iit.edu/wiki/index.php/Beamline_Optics

	140 MeV/c	200 MeV/c	240 MeV/c
3 mm rad	M0	M0	M0
6 mm rad	M0 & M1	M0 & M1	M0 & M1
10 mm rad	M0 & M1	M0 & M1	M0 & M1

M0 and M1 correspond to different way to obtain the right distribution in phase-space after the diffuser according to G4BeamLine

Main Goal:

Comparison Data / Simulation

6 mm, 200 MeV/c Optics

P0=408.6 / PSol=238.0

	Momentum (MeV/c)	M0 Current (A)	M1 Current (A)
Q1	405.93	102.38	102.38
Q2	405.71	127.91	127.91
Q3	405.49	89.00	89.00
D1	405.27	323.15	323.15
Decay Solenoid	405.04	668.63	668.63
D2	237.87	94.15	94.15
Q4	236.31	158.10	197.26
Q5	236.31	212.02	264.24
Q6	235.83	140.57	159.68
Q7	211.89	138.67	126.37
Q8	211.60	209.82	222.75
Q9	211.11	179.18	185.11

Step I Running: ε-p Matrix Scan

- **Several different optics – M0, M1**
- ***Main Goal: Comparison Data/Simulation***

Negative polarity

	140		200		240	
	M0	M1	M0	M1	M0	M1
3	39,434		57,763		57,361	
6	52,440	45,284	61,652	50,522	39,417	45,942
10	42,490	53,006	50,446	27,814	43,870	45,212

Positive polarity

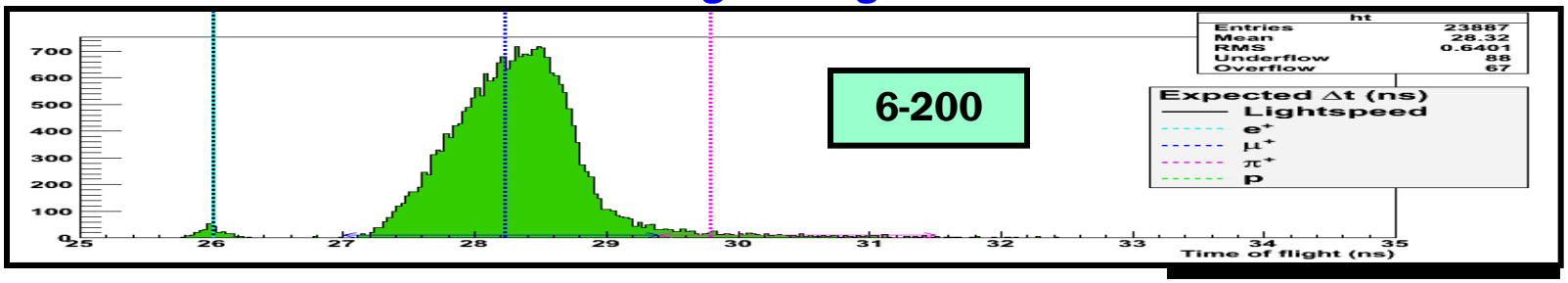
	140		200		240	
	M0	M1	M0	M1	M0	M1
3	80,160		171,600		236,630	
6	104,040	103,042	302,897	225,200	120,911	77,177
10	85,090	98,460	120,000	80,000	105,172	68,576

	140 MeV/c	200 MeV/c	240 MeV/c
3 mm rad	M0	M0	M0
6 mm rad	M0 & M1	M0 & M1	M0 & M1
10 mm rad	M0 & M1	M0 & M1	M0 & M1

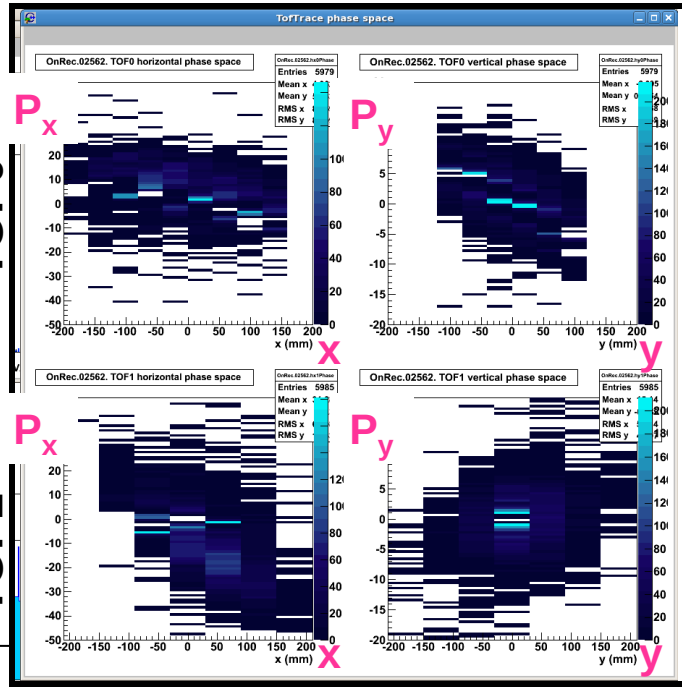
Tables show number of triggers recorded in TOF1 for each beam line configuration in the ε-p matrix during Summer User Run

Step I: Beam Studies

- ***Emittance measurement using TOF detectors - M. Rayner***
  - ***Good muons selected using timing information***



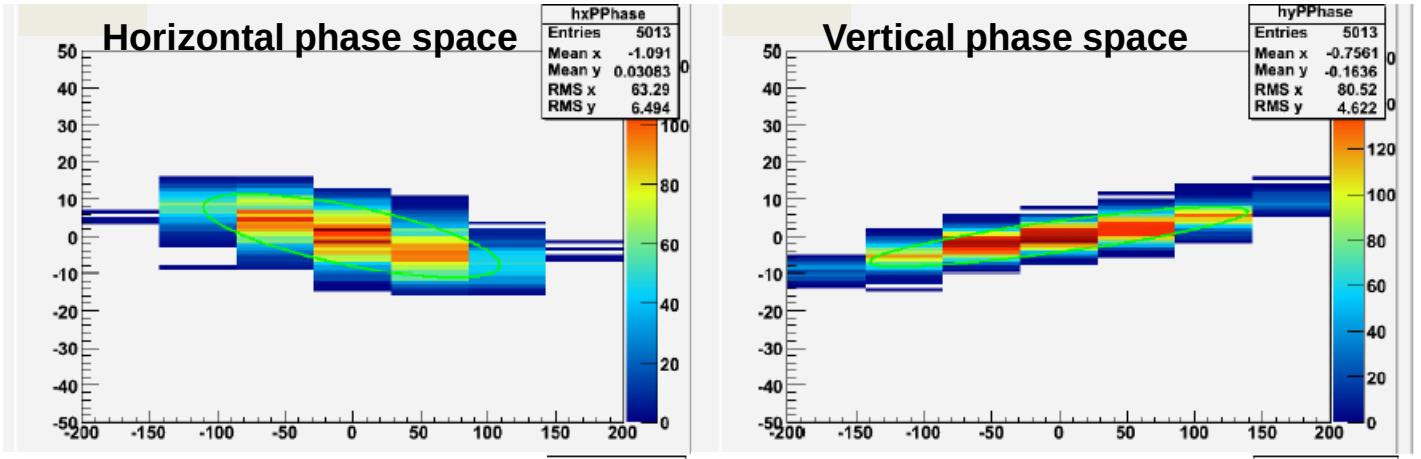
  - ***Use TOF0 & TOF1 as (x,y) stations***
  - ***Initial path length assumed given beam line transfer matrix***
  - ***Each particle tracked through Q789***
  - ***Momentum estimated***
  - ***Infer x', y' → (x,x') (y,y')***
  - ***Phase space parameters calculated***
  - ***Iterated until true position/momentum known for each muon***
  - ***Compared to MC – reasonable agreement***



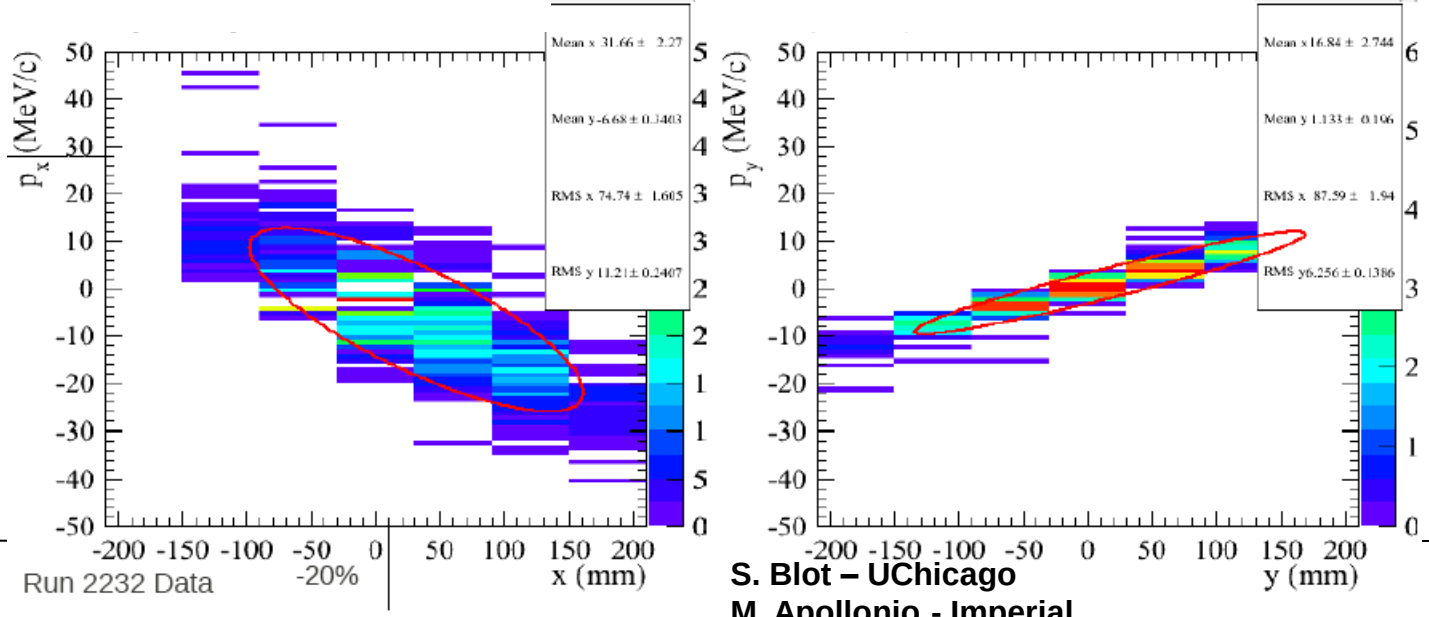
Step I: Data vs MC Comparison

- *Analyzing recent data*
- *Quad scan (Q789) with 6-200 data – Q789 current at -20% of nominal*

MC

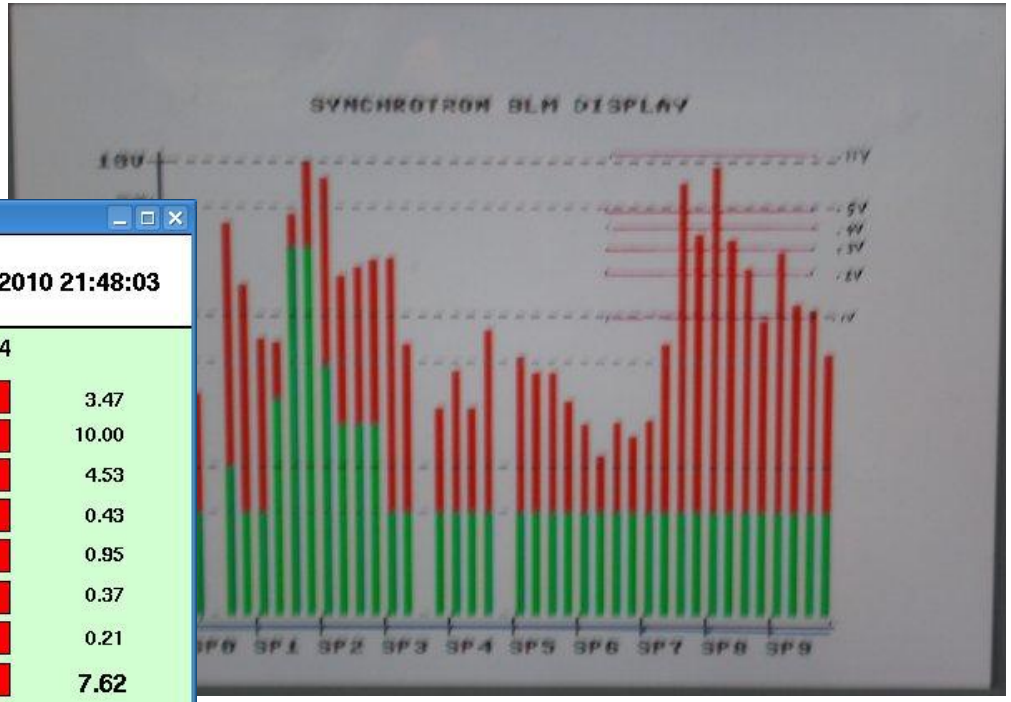


Data



S. Blot – UChicago
M. Apollonio - Imperial

High beam loss → 10 V tests



ISIS Controls - Window ACTIVE <@LULU>

MICE Ring BLM Display 14-AUG-2010 21:48:03

	BLM1	BLM2	BLM3	BLM4
R0	0.59		8.39	3.47
R1	1.37	1.41	8.24	10.00
R2	10.00	3.64	4.12	4.53
R3	4.79	1.22	0.00	0.43
R4	0.69	0.41	1.22	0.95
R5	0.96	0.61	0.62	0.37
R6	0.32	0.21	0.28	0.21
R7	0.27	1.06	**10.00**	**7.62**
R8	**10.00**	6.04	3.22	1.77
R9	4.29	1.93	1.96	0.95

Last Trips SPs 0 - 4 14-Aug-10 21:47
SPs 5 - 9 14-Aug-10 21:47

Enable Update

Masking

Timer

BACK

- https://micewww.pp.rl.ac.uk/elog/MICE+Log/1449
- https://micewww.pp.rl.ac.uk/elog/MICE+Log/1447

Step I: Results

- ***Goals***

✓ – ***Commission and calibrate beam line detectors***
  - *Luminosity Monitor*
  - *TOF0, TOF1, TOF2, CKOVs, KL*
  - *FNAL beam profile monitors*

✓ – ***Commission beam line magnets***

✓ – ***Take data for each point in ε-p matrix***
  - *MICE beam designed to be tuneable*
  - *Understand beam parameters for each configuration*

✓ – ***Compare data to simulation of beam line***

✓ – ***Prepare for Steps with cooling***

- ***Muon Beams Produced Routinely***
  - ***Run at high beam losses (2-3V)***
  - ***Produces ~50 μ^+/~8 μ^- per target dip (every ~3 sec)***
  - ***Reached a maximum of 10V loss during Machine Study***

Daily Operations

- ***Operational efficiency improved***
  - ***Run on weekdays – 8:00 – 20:00***
    - ***Start-up took ~30 min instead of 1.5 -2 hours***
    - ***Shut-down ~20 min***
  - ***Hall closed down to work***
  - ***2 shifters, MOM, BLOC***
  - ***Key exchange(s) with ISIS minimized***
  - ***Safety still key & maintained***

- ***Post-run review***
  - ***How did it go?***
  - ***What can we do better? – see afternoon session on Running in 2011***
  - ***Shifter input***
  - ***MOM/BLOC input***
  - ***Run planning in advance key to success***
  - ***Each data study needs a champion***

ISIS Shutdown Now

- *Systems gradually turned off*
  - *Detector HV*
  - *Cryogenics off – DS left to warm up*
  - *Hall AC units off (much quieter now)*
- *Magnet polarity measured*
  - *D1, D2, Q1,Q2,Q3,Q4,Q5,Q6 done*
  - *Plan to measure Q7,8,9*
- *He leak search done*
  - *Biggest leak on top of buffer tank*
- *Work on TOFs*
  - *TOF0 refurbished by Milano group*
    - *11 PMTs replaced*
  - *TOF1 → Milan for PMT refurbishment*
- *Survey done on TOFs, KL, GVA1*
- *Hall work intensified – M. Hills, T.Hayler*
  - *PPS system*
  - *Network access in Hall*
  - *LH2 system*

MICE Geometry: TOF Survey

- ***Need to understand exactly where detectors are***
- ***See Geometry session later***

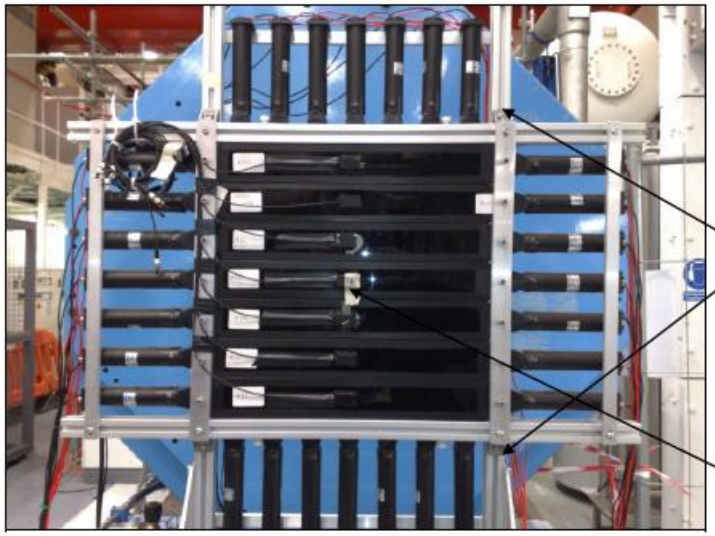
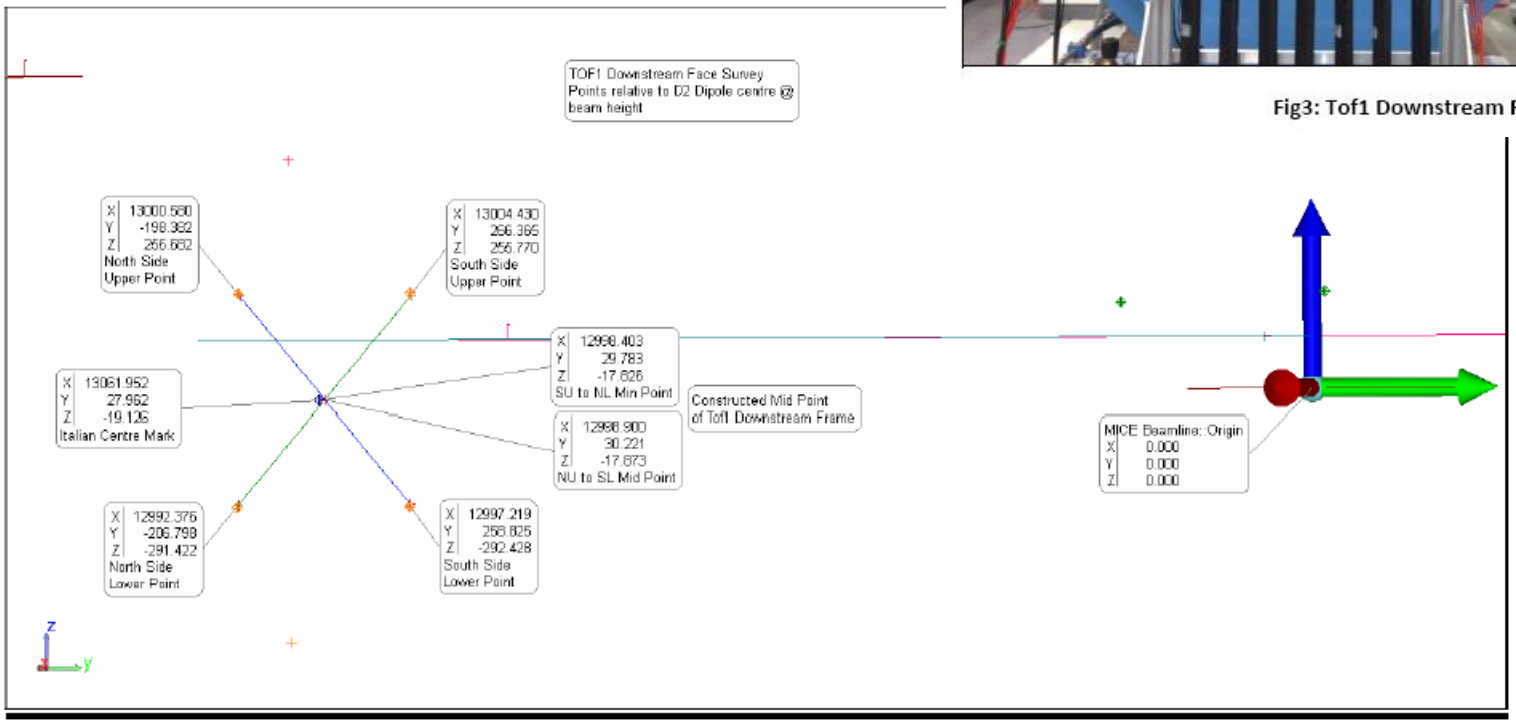


Fig3: Tof1 Downstream Face

Results

As-built 3D measured data of TOF1 assembly



During Shutdown

- ***Intense work happening in Computing/Software***
  - ***Welcome David Colling (ICL)***
    - ***new head of MICE Software***
  - ***Many new people from RAL, Imperial***
  - ***Working very hard to take inventory of what we have, what we need, & how to implement it***
  - ***Particular emphasis on improving G4MICE – talk by C. Rogers***
- ***Operations organization & communication tools being implemented***
  - ***New Redmine tool – see talk by C. Tunnell***
  - ***Issue tracking – task assignment & completion record***
  - ***Documentation & information for operations***
- ***Documentation overhaul in progress***
  - ***Bringing shifter instructions & manuals up to date***
  - ***Lessen confusion during running***
- ***Current MOM – Pavel Snopok (UCR)***

Conclusions

- ***Summer Run period very successful***
  - ***Beam line and associated detectors fully operational***
  - ***Step I data-taking complete!***
  - ***Data analysis under way***

- ***Long shutdown***
  - ***Opportunity for infrastructure improvements***
  - ***Software, computing, Hall, documentation***

- ***Focus on the future – make sure we are ready to take data again***
  - ***2011 – EMR, fill in questions from Step1***
  - ***Beyond – prepare for Step III or IV (Thursday session)***

Backup Slides