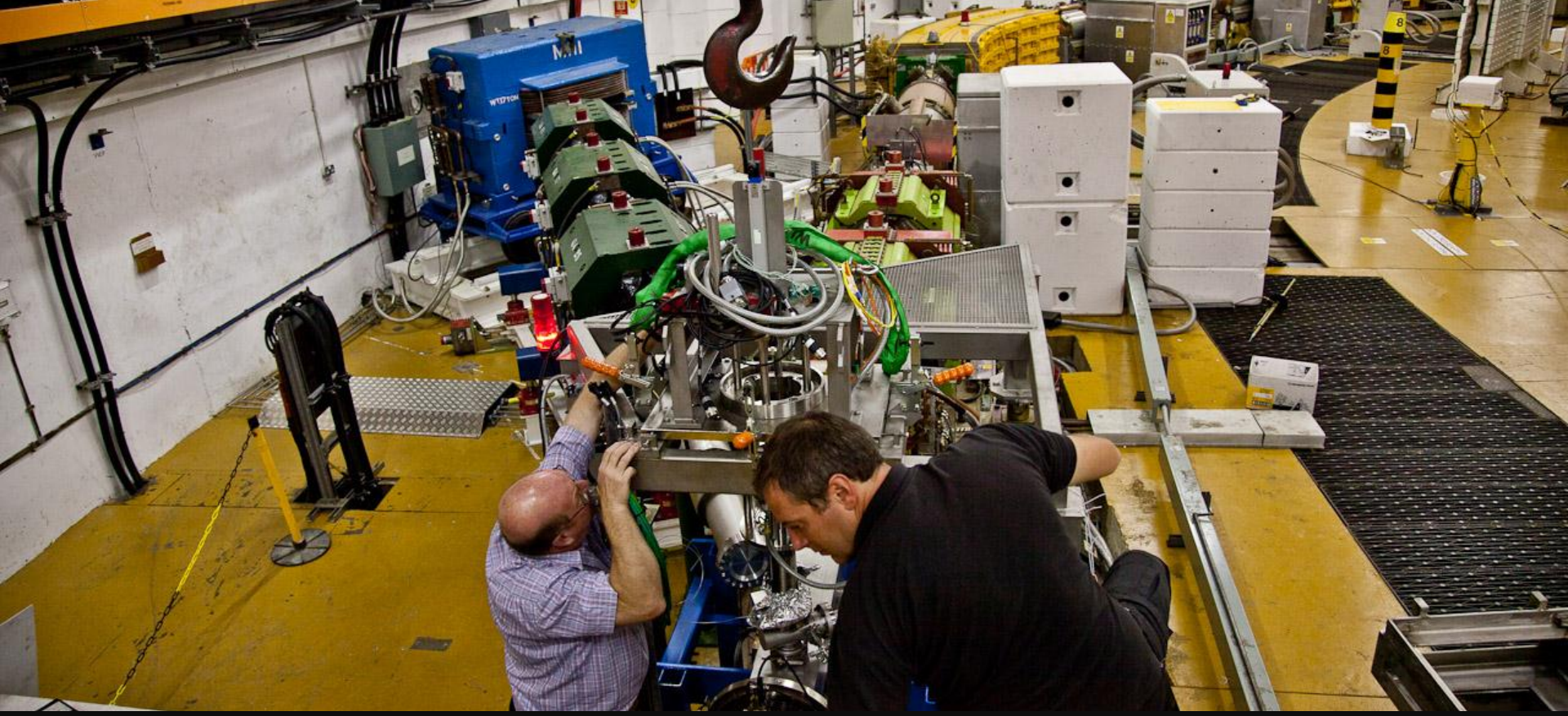


Target Status

Edward Overton on behalf of the
Target Team

At the end of CM30....

- T1 was operational on ISIS
  - Re-commissioned on 26/01/2011
  - Pulse shapes looked normal

- Testing of T2 was being undertaken in R78..
  - Dust production/migration had been demonstrably eliminated up to 4 million actuations
  - VESPEL/DLC design approved for use in ISIS
  - T2.8 was continuing testing
  - Phase 2 FPGA controller was undergoing test

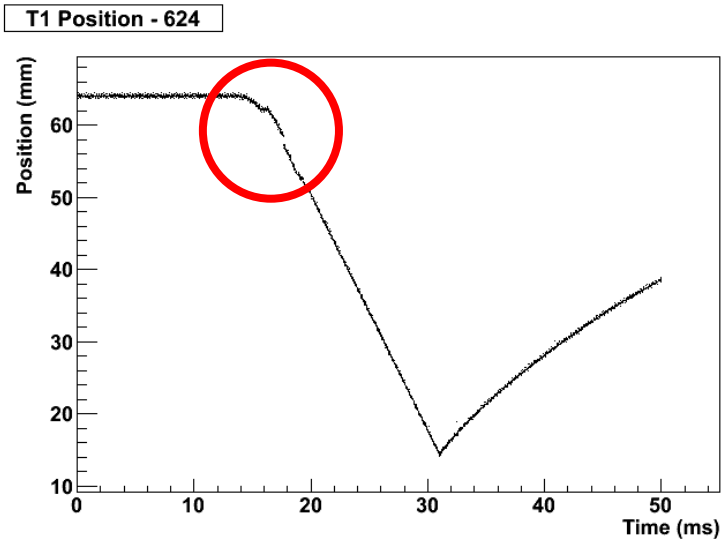
- New stator design well underway

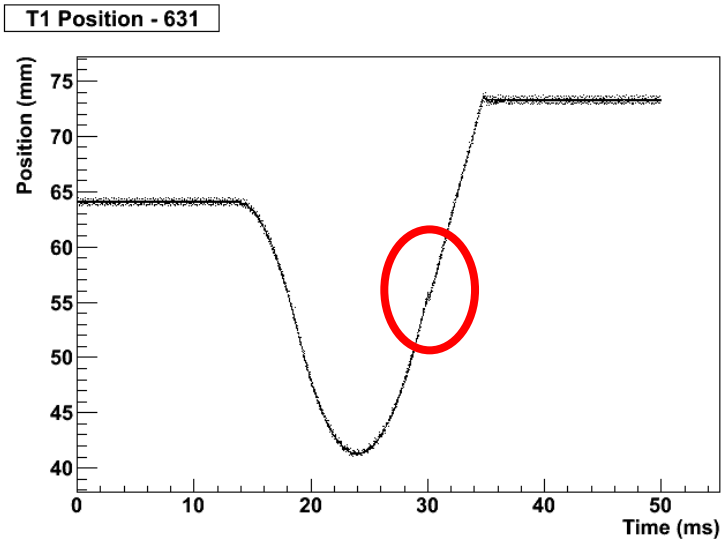
CM31

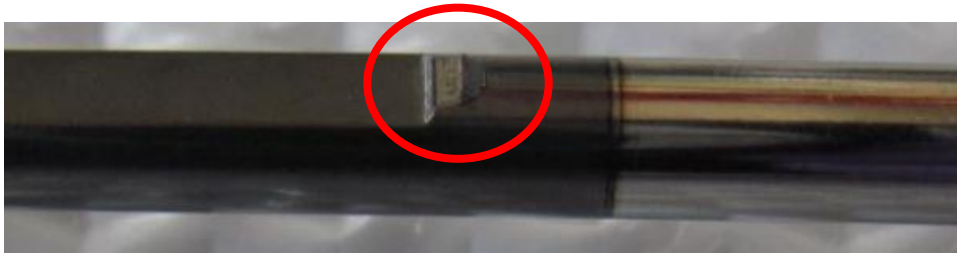
- T1 on ISIS has failed.
  - Target controller lost track of target position
  - Caused controller to drive target incorrectly, resulted in target becoming jammed in upper bearing.
- T2.9 Has been installed on ISIS
  - Same stator as used for R78 tests
  - Fitted with a new bearings and a new shaft
  - This combination shows a lifetime in excess of 1 million actuations
- Phase 2 FPGA controller has been moved to MLCR
  - Presently being integrated with ISIS and MICE interlocks.
  - Second controller installed in R78, and a third is under test in Sheffield
- New target/controller have run for 2 shifts successfully.
  - Begun looking into ISIS beam bump.
- New stator is beginning production. Have had a minor setback which now seems to be resolved.

T1 Failure

- T1 Failed on Wednesday 13th July
- Controller lost track of target position, visible as glitches in recorded position.
- These glitches caused the controller to drive target incorrectly
- Final glitch resulted in target being thrown upwards into bearing.
- This caused the shaft to become jammed in the bearing
- Upon inspection the shaft had visible damage to DLC coating.





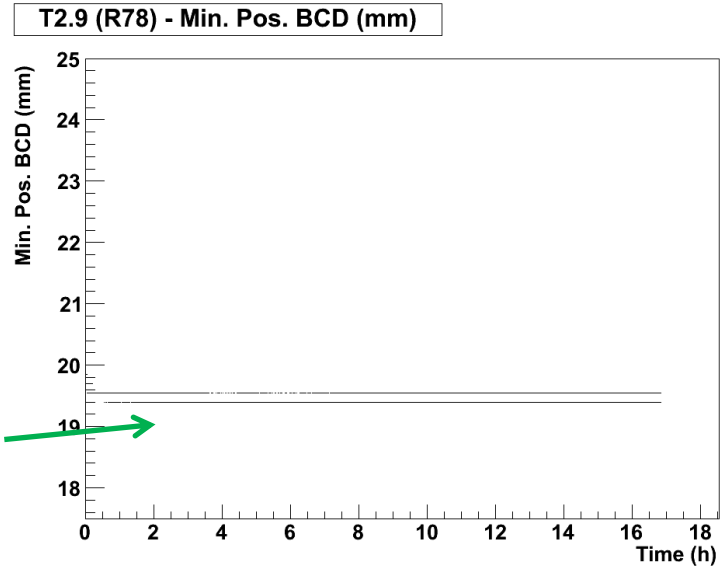


T1: Cause of Failure

- A problem occurred within the position monitoring system.
- Possible candidates are:
  - Mechanical damage to readout vane/optics block?
    On inspection seems okay. Will do a full test in Sheffield. T2.9 uses a different optics block.
  - Fibre optic degradation?
    No reference point, makes it difficult to compare. Brightness is now monitored by controller and will provide an early warning system.
  - Controller electronics problem?
    Hard to see how this could be intermittent, but will be tested. Entire control system has been replaced with the Phase II FPGA controller.
  - Intermittent Laser / Fibre optics problem?
    Looped the laser signals back from ISIS and tested for 16 hours. No dropouts detected.
- Have not found a “smoking gun”. Attempting to eliminate all possible causes, but could take some time.

T1 replaced with T2.9

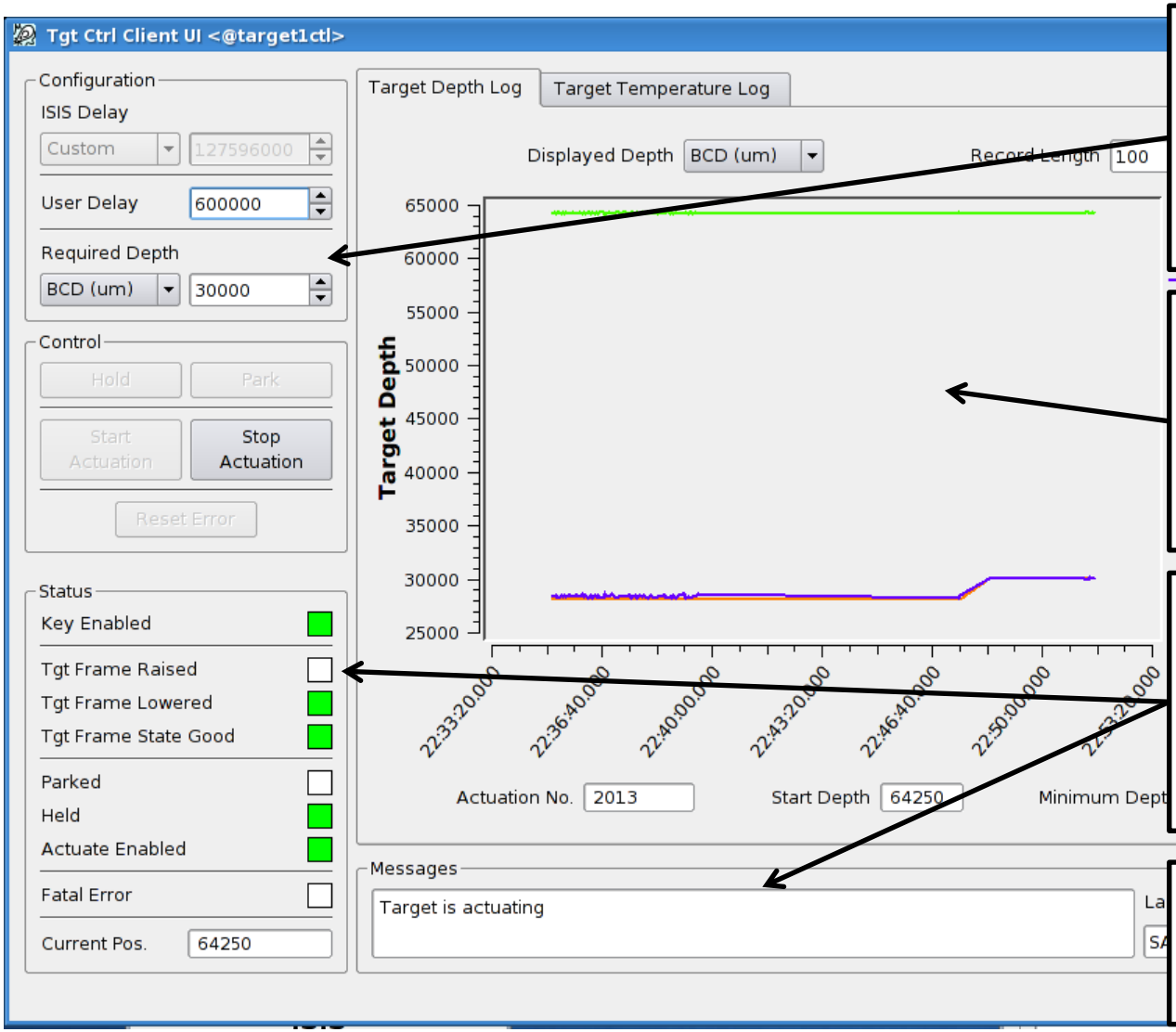
- Replaced T1 with stator from R78 (T2)
- Using DLC/VESPEL design which has achieved 1M+ Actuations on T2.4 to T2.8
- T2.9 has been fitted with a new shaft and bearings
- T2.9 was installed on 13th September
  - Tested in R78 for 50K actuations, looks OK.



Test history of T2.x in R78 since 2010:

Target #	Pulses (K)	Comment
2.4 (FPGA I)	1000	Improved Shaft, minimal dust. Sticking.
2.5	4000	Improved Shaft, minimal dust. Weekly inspections, no sticking
2.6	1100	No weekly inspections – realistic running. Minimal Dust but some sticking observed towards end of run.
2.7	1300	Matched clearances to T2.5, some sticking observed towards end of run.
2.8a	1000	Increased clearances, some sticking observed towards end of run.
2.8b (FPGA II)	2.8a + 1500	Installed newer controller with improved algorithms. Extended target lifetime. Inspection at 1500k actuations

Phase 2 FPGA controller installed in MLCR



Direct control of target
- Set target delay
- Change depth
- Start/Stop actuation
- Hold/Park target

Limited readout of data from last actuation:
- Starting position
- Minimum position

... With more written to disk

Read status of target:
- Frame state
- Parked / Held
- Actuating
- Errors

Beam loss and full trajectory is recorded by the old analogue DAQ.

FPGA Controller: Interlocks

Target Frame

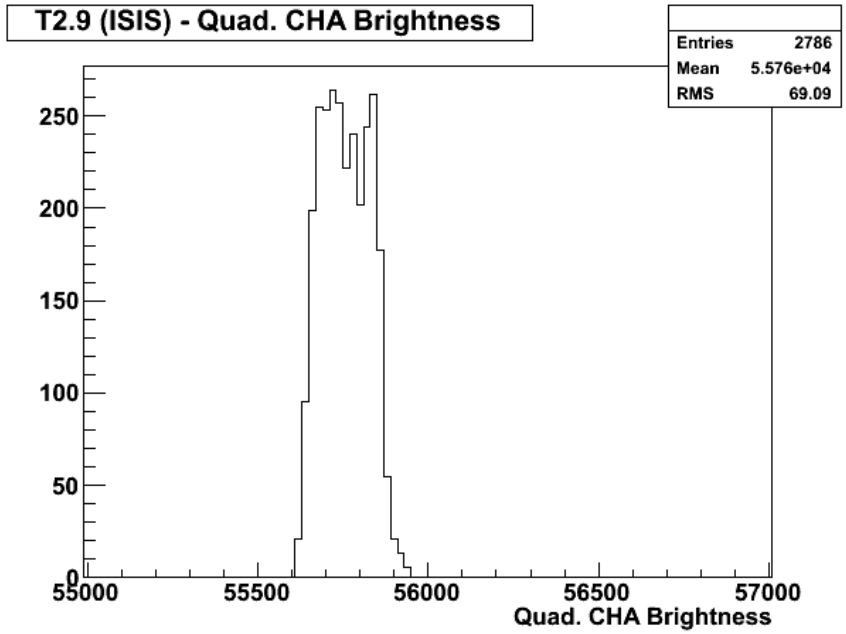
- Prevent lowering of the frame until the controller is satisfied it is safe.
- Automatic raising of the frame in the event of a problem (dropped target, etc...)
- Daresbury are updating the frame control to handle this input properly.

ISIS Beam Protection System (BPS)

- Prevents injection if:
  - Actuation takes too long (>40ms)
  - Target is dropped
  - Actuation appears unusual
- In the event of a BPS error the controller sends an error message to the GUI.
- ISIS have approved the system at the ISMP meeting
- Looking into adding an interlock to prevent the target tripping the system when mice is not running. This will most likely will be from an interlock on the target frame.

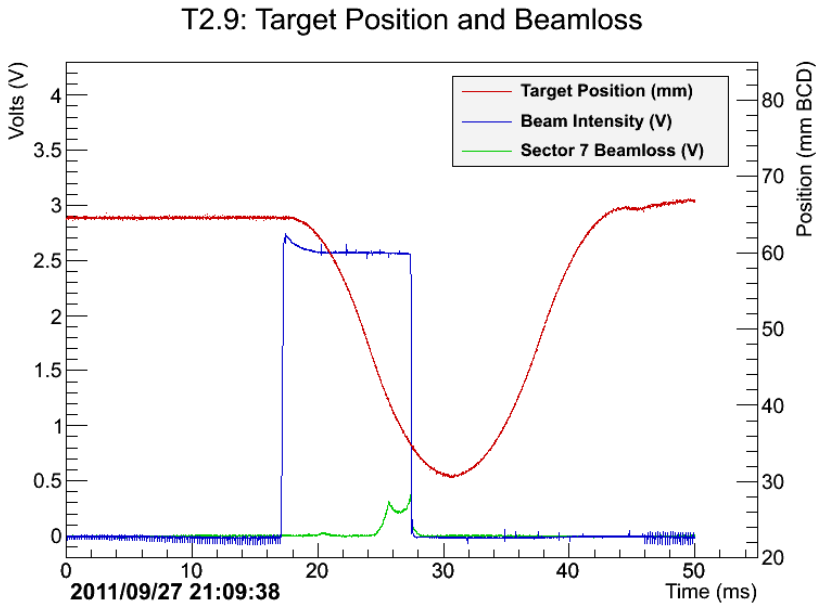
FPGA Controller: Improved Monitoring

- FPGA controller reads out a digital summary after each actuation. This is written to disk.
- Includes information such as the minimum position reached and duration of the actuation.
- Brightness of optical fibres from optics block added to readout.
- Brightness now monitored in Sheffield. Warnings raised if it drops below 55,500. (ADC output, 16 bit - out of 65535)
- BPS status is also monitored over this interface.



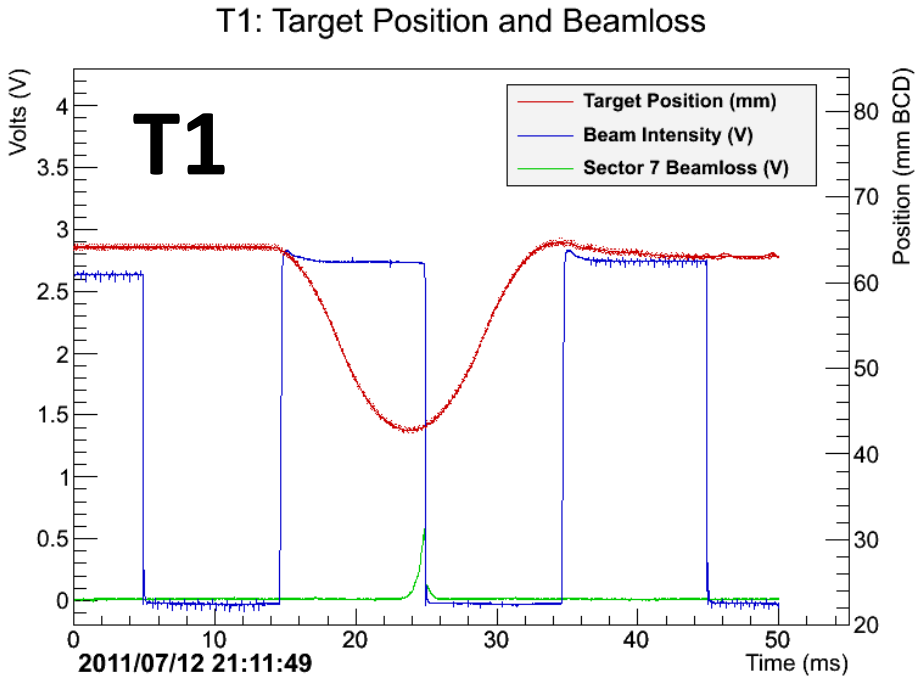
T2.9: Commissioning (Tue 27th Sept.)

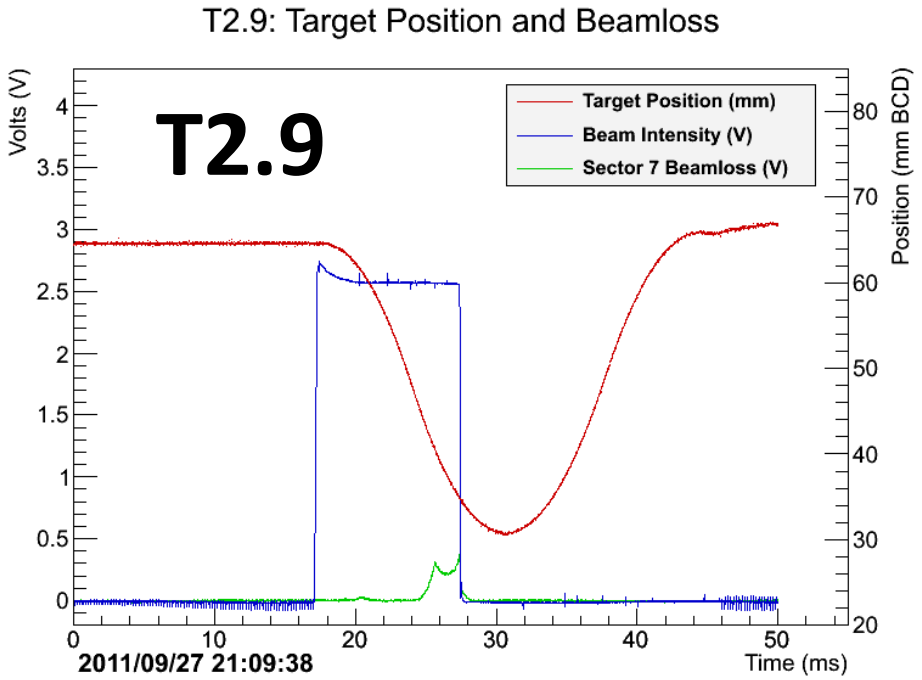
- Needed to test system with beam to ensure the system was fully operational, with live signals from ISIS and to MICE DAQ.
- Main goals:
  - Connect target up to ISIS signals and Check operation
  - Find Location of ISIS beam
  - Scan ISIS beam in depth and time



- Found preset values in target (delays, markers) needed minor changes.
- Updated target quick-start checklist

... Compared to T1 in July



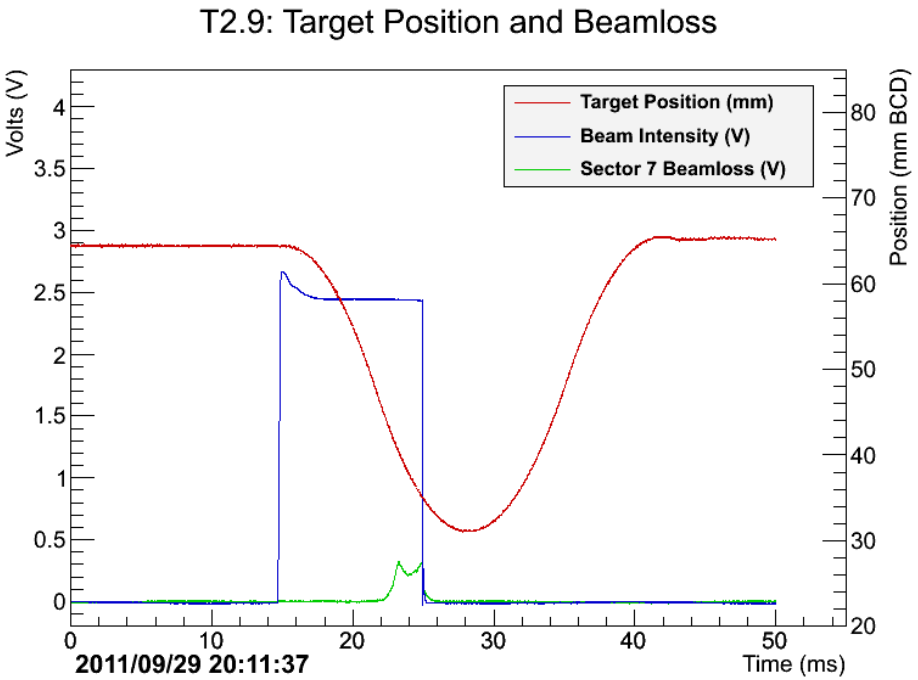


- T2.9 Shows double peak in beam loss, probably caused by scraping the beam.
- Maximising second peak required pushing apex back, in user run would be interfering with next spill.
  - ISIS crew informed us beam is in an unusual condition with lots of losses.
  - The acceleration of the T2.9 is 746ms^{-2} (compared to 774ms^{-2} for T1). Measured around the minimum position.

Beam Bump studies (Thurs 29thSept.)

- ISIS use vertical steering magnets to move the beam closer/further away from the MICE target.
- Can operate in steps of 1ms, moving the beam 2mm / 4mm closer / further away from target.
- The mice beam line was operational for this test and the main DAQ was working.
- So far a brief look at the beam loss, Adam Dobbs has kindly volunteered to do a more complete analysis.

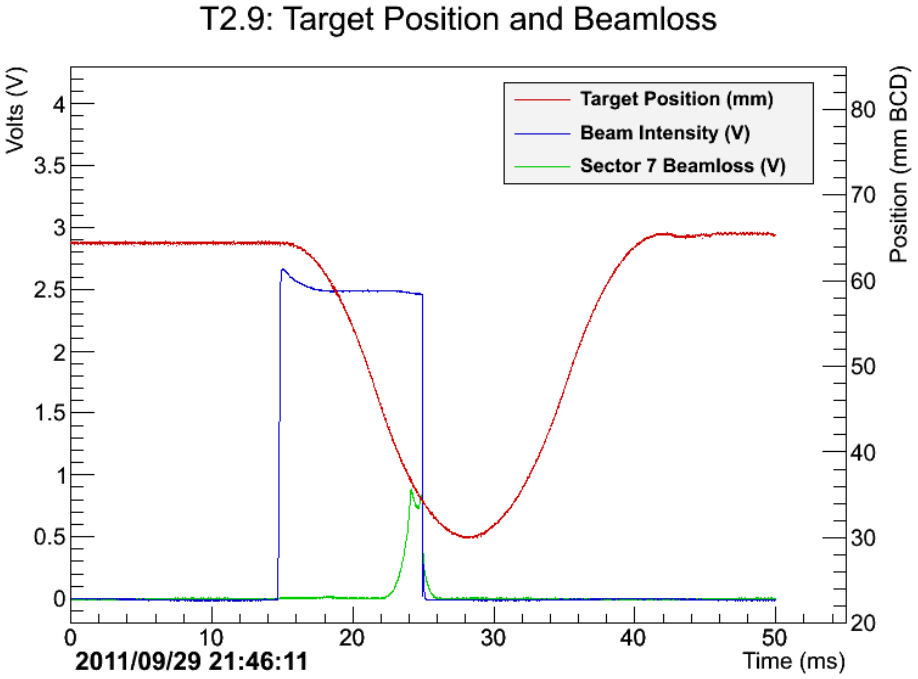
Beam Bump studies (Thurs 29th)



No Beam Bump
- Dip depth: 31mm BCD
- User delay: 600000
- Same configuration as Tuesday 27th September

- First tested with no beam bump
- Saw same double peak structure as on Tuesday
- Beam was in same condition as on Tuesday 27th Sept.

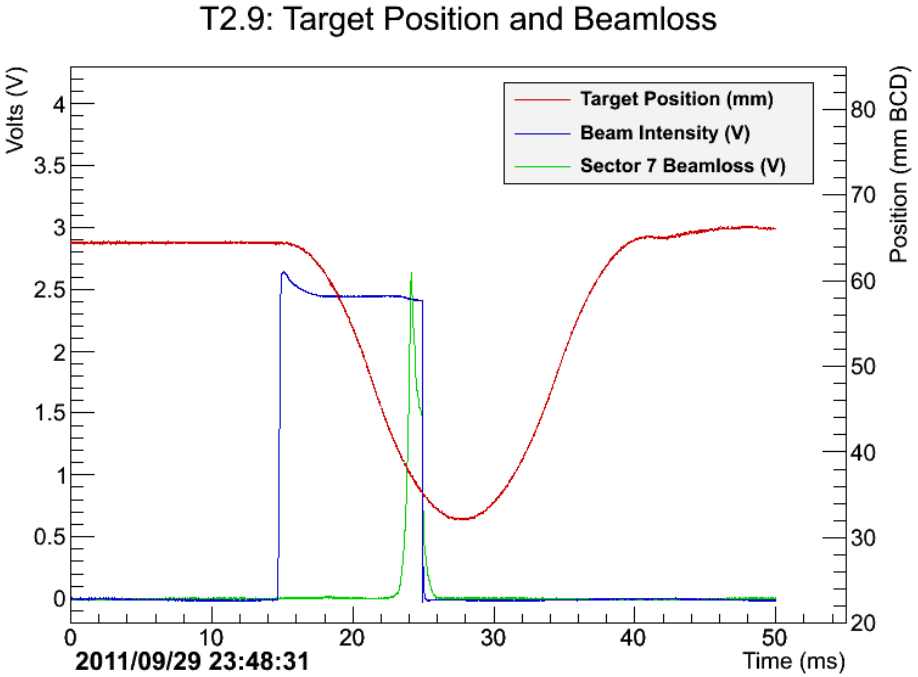
Beam Bump studies (Thurs 29th)



- Moved beam away from target 2mm between 6 and 8 ms.
- Dip depth: 30 mm BCD
- User delay: 600000

- Next tried to use beam bump to reduce early peak in beam loss
- Used beam bump to move beam away from target 2mm between 6 and 8 ms.
- This reduced the early beam loss by a noticeable amount.
- Allowed us to dip the target deeper for the same overall beamloss
- Double peak structure still there, but shifted to later in spill.

Beam Bump studies (Thurs 29th)

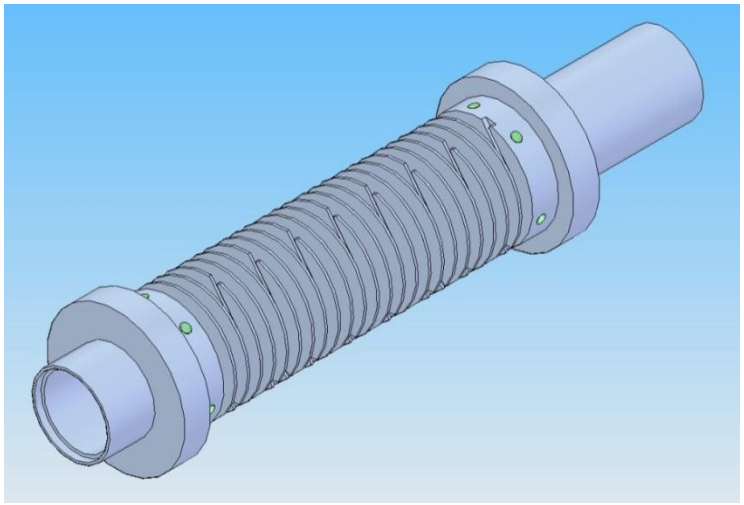


- Moved beam 4mm away from target between 6ms and 8ms.
- Then moved beam towards target 2mm between 8ms and 9ms.
- Dip depth: 32mm BCD
- User delay: 600,000

- Also tested moving beam towards target by 2mm between 8 and 9ms. Then moving beam towards target between 8ms and 10ms.
- Caused significant beam loss during last couple of ms, but very little before that.
- Had to move the target to 32mm BCD to reduce losses.

Status of the new stator

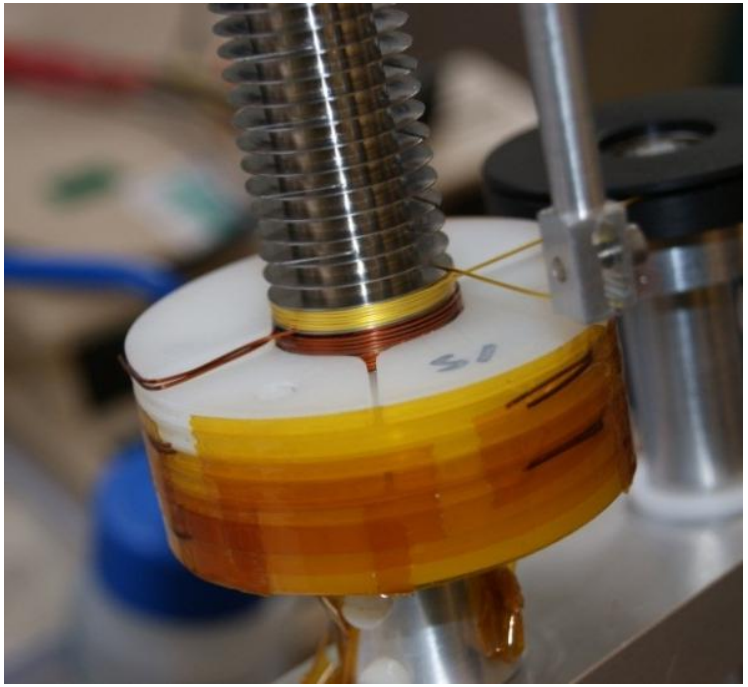
- An improved stator design is beginning production which should:
  - Improve magnetic field uniformity (increase reliability)
  - Increase acceleration (by bringing the wire closer to the magnets)
- Three bobbins have arrived from ac precision and oxford.
- Have had difficulty winding the wire onto the bobbin:



  - Wound coils would break down when 1000 Volts is applied between the coils and the body (this is part of the QA test).
  - Breakdown is believed to be caused by the sharp edges of the slits damaging the insulation of the wire.

Status of the new stator

- Breakdown problem has been tackled by smoothing the edges within the bobbin.
- New bobbins have redesigned slits to allow smoother transition of wire into the root of the winding groove
- So far 6 coils have been wound successfully.
- 7th coil used wire from the end of the reel and failed QA.
- Winding of silver wire was successful. But the manufacturer sent the wrong diameter. This has been sent back and are now awaiting new wire.



- Now have a viable technique, but Geoff and Eammon are waiting on the delivery of more wire.
- Next need to complete first bobbin and use it as a test bed for remaining procedures (wiring, cooling, potting)
- Once the first stator is made testing can begin in R78

Summary

- T1 failed on Wednesday 13th July. This was caused by the controller loosing track of target position and jamming the shaft in the upper bearing
- T2.9 has been installed on ISIS with the new FPGA controller
  - DLC/VESPEL design has demonstrated reliability to 1 million+ actuations
  - New controller and target have been commissioned and worked well
  - Fully interlocked system is well underway
- Tested the beam bump
  - Was very effective at reducing early beam losses.
  - Unfortunately ran out of time, but would like to study beam bump further:
- A new stator is being constructed
  - Had issues with coils breaking down which is now resolved.
  - Once the bobbin is wound this will be used as a test bed for the remaining procedures.
  - After the first stator is complete testing will resume in R78