MICE Target Mechanism CM38 – Napa Valley

P J Smith on behalf of the MICE target team

Overview

Running on ISIS:

A summary of running on ISIS.
Future Run Plans.
Software Updates.
Replacement of patch/broken fibres.
The Requirement for new fibre runs.

Target in R78:

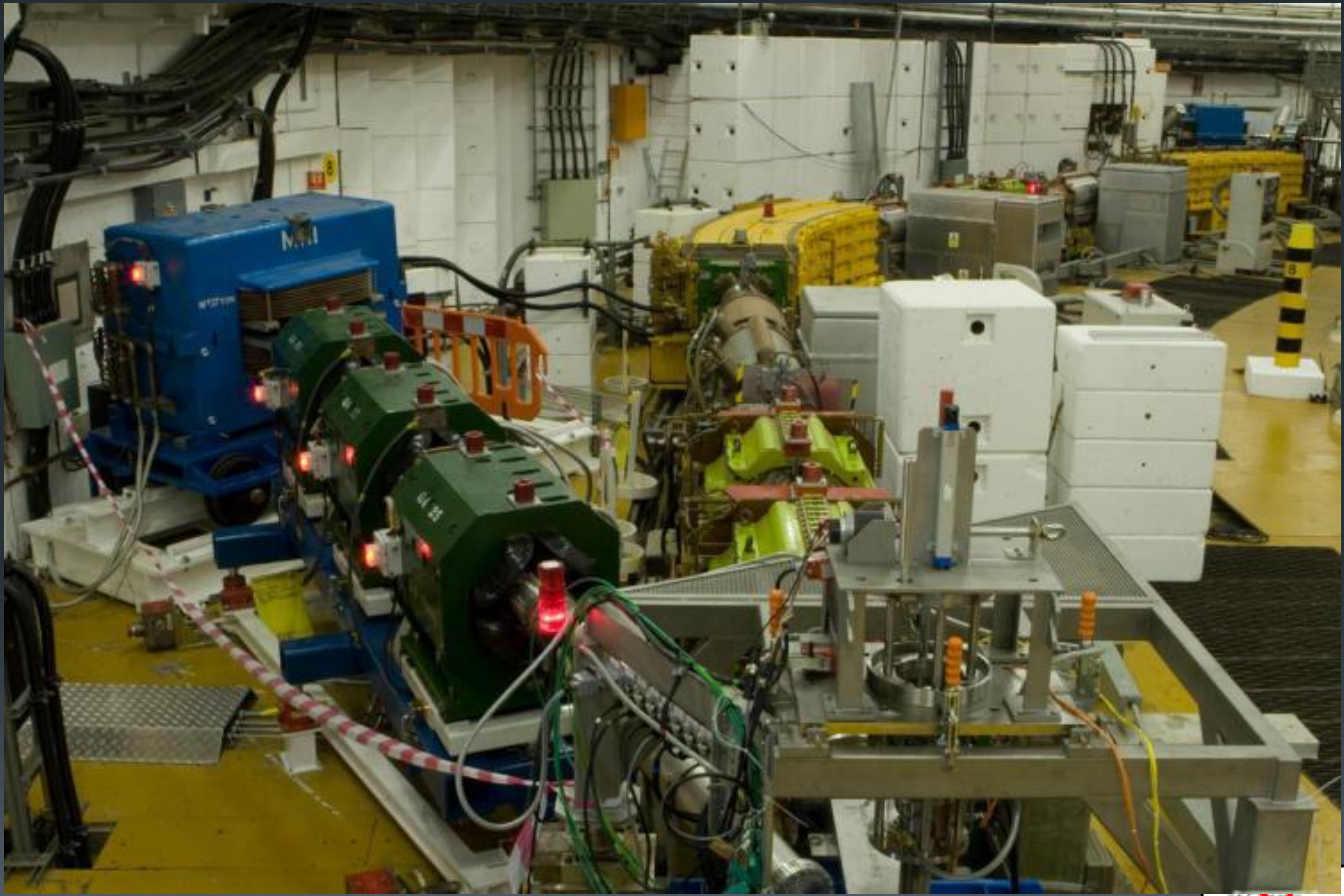
The 'S' series Runs

New Stator Build

Photos.
Stator Inventory.

Conclusions

Running on ISIS



Summary of Running

The last presentation that I believe the target team gave to the collaboration was in June 2012 –Glasgow. I’m not going to give details of every time the target has been run since that date but here are some highlights:

The principle runs that I could ascertain from the MICE log are:

Autumn ’12 Quite a bit of running on and off.
Feb ‘13 Target Activation Run – 4V beamloss.
Aug ‘13 PID/TOF Calibration.
Oct ‘13 EMR Run.

Plus many minor runs for equipment testing/shifter training and to test the target after system changes had been made.

And we were due to run:

Dec ’13/Jan 14 - Double Dip Rate Running WITH BEAM but this has yet to happen.

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Summary of Running

Double Actuation Rate.

We had a request to run the target at double rate - nominally on ISIS it has been operated at 128/50 seconds.

In principle this is not a problem as the target was designed to run at 50/64 Hz (0.78 Hz). The R78 target has always been operated at 0.83Hz at a full shaft displacement of about 48mm. Typically when on ISIS the shaft goes through a displacement of about ~30mm.

We have demonstrated that the ISIS target will run at double rate with the frame raised for an extended period of time on several occasions over the last couple of months. We now need to demonstrate this with beam.

Running at a higher rate reduces the acceleration so both the target's timing and the beam bump may require altering slightly to give optimum target performance. The last couple of attempts have been thwarted by technical issues. The next opportunity could be at the end of the User Run – early April?

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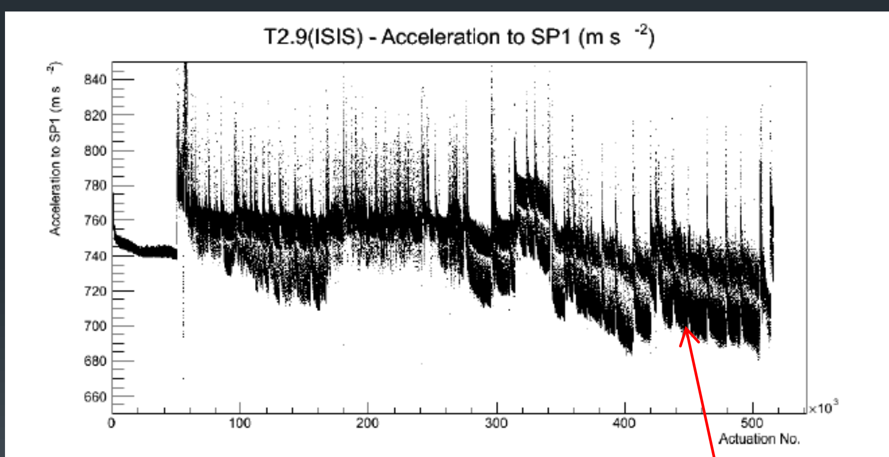
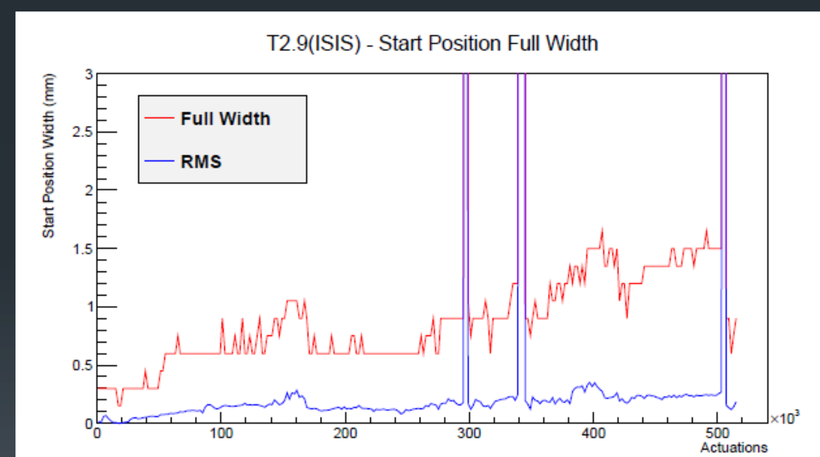
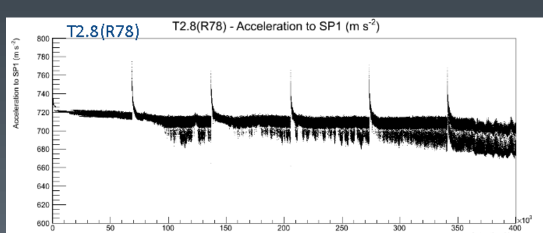
Summary of Running

We are running T2.9 (DLC/Vespel) on ISIS - installed 13th Sept 2011, and by June 2012 this had completed ~240k pulses. We are still running the same target and this has now completed 520k pulses.

This target/bearing combination should have a lifespan of ~1m actuations. (Dependent upon no serious deterioration in target DAQ data.)







This change to a double band structure is typical during wear

T2.8 - In R78 ran for 1m (500k shown)

The start position is one indicative measure of wear. We like to see the full width <1.5mm.

Future Run Plans

The question is:

How much running of the target do we envisage taking place over the next few months?

The answer to this question this will shape what we determine to do with the target on ISIS in the near future – keep or replace?

> Double dip rate test and beam-bump adjustment
> (4 hours @ 2.8k/hr) = 11k actuations
>
> Activation Study (8 hours @ 2.8k/hr) = 23k actuations
>
> Monthly Testing – 4 hrs/year = 13k actuations

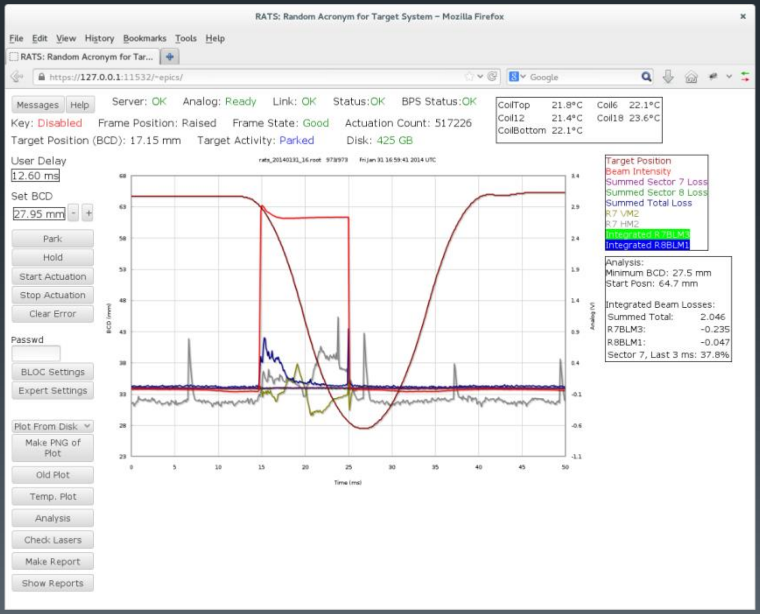
What else?

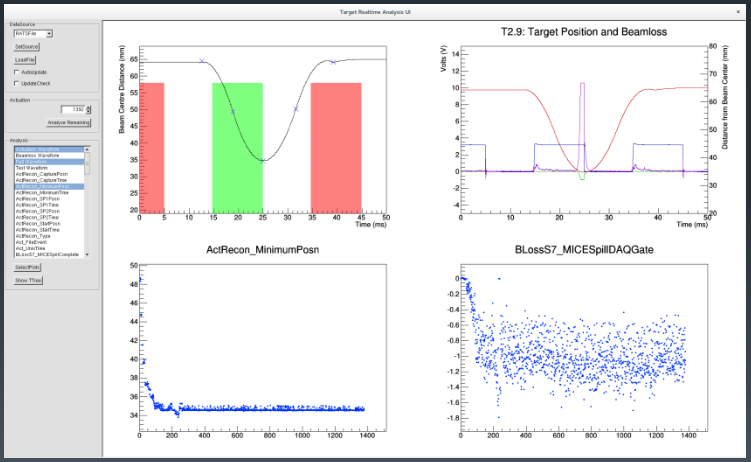
Software Updates

A section of the code for the GUI software has been updated so that the screen now refreshes more frequently.

This should prove useful with double actuation rate running.

We are monitoring the situation with respect to the performance of the target GUI (aka your feedback!)



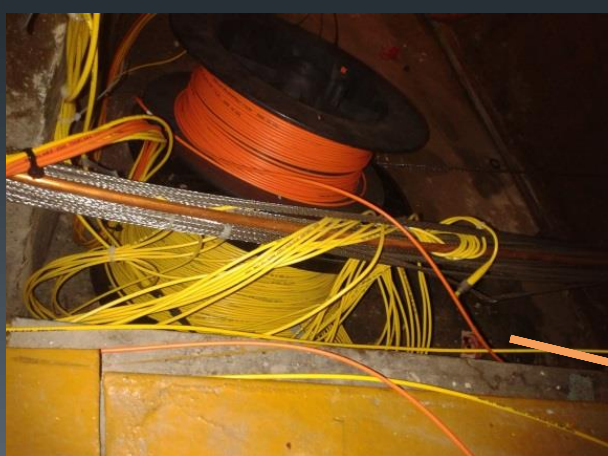


Optical Fibres

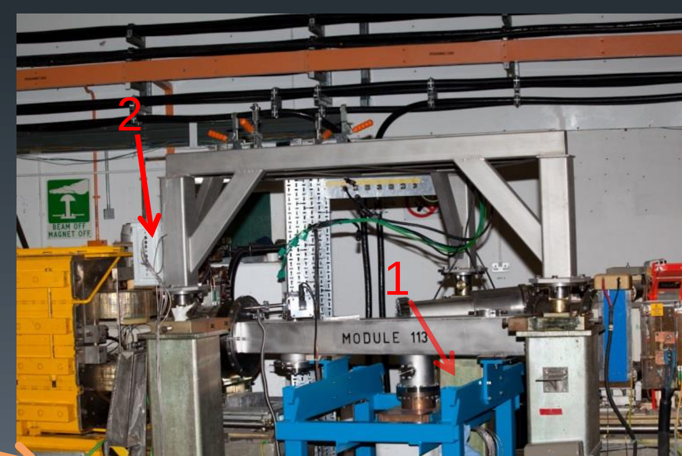
The optical cables that run between the controller and the target were installed late 2007- early 2008 – so they have been in for 5-6 years.

The cables did not follow the prescribed route and consequently there was a significant excess of cable that was left stored underneath the dipole just behind the target.

Patch cables were deliberately added to the end of the route as those lengths of cable were perceived to be at higher risk from both radiation and mechanical damage. (1→2)



Excess fibres stored underneath the dipole behind the target. This is not what it was planned to look like!



Optic Fibre Patch Cable Replacement

During 2013 was the first time that we noted a gradual but significant degradation in the amplitude of the return signals from the optical fibres. This was closely monitored during running and the electronics gain adjusted prior to each shift. It was clear that this issue needed resolving as we were running out of headroom on the amplifier gains.

As a consequence of the signal drop off we replaced the patch fibres between the optics block and the main fibres during November 2013. One of the fibres needed to be replaced a month later due to mechanical damage.

Semi -regular replacement of these fibres was envisaged when the target was installed – hence the location of the patch panels, so this has worked well.

But it raises the question over whether any damage is being done to the excess of fibre that is currently being stored underneath the ISIS beamline. Some indication of higher activation in SP7 area but data on this is intermittent.

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Optic Fibre Patch Cable Replacement

Before we did the replacement: Values –

Laser Power A = 48,214 -- 1.00mW
Laser Power B = 43,085 -- 1.20mW
Laser Power I = 48,319 – 1.00mW

We replaced the fibre and did not change the controller gain, but adjusted the lasers to get close to the previous values.

Laser Power A = 47,888 -- 0.44mW
Laser Power B = 43,098 -- 0.60mW
Laser Power I = 47,962 -- 0.27mW

So an estimate of the % improvement in light yield:
A = 227%, B=200%, I = 370%

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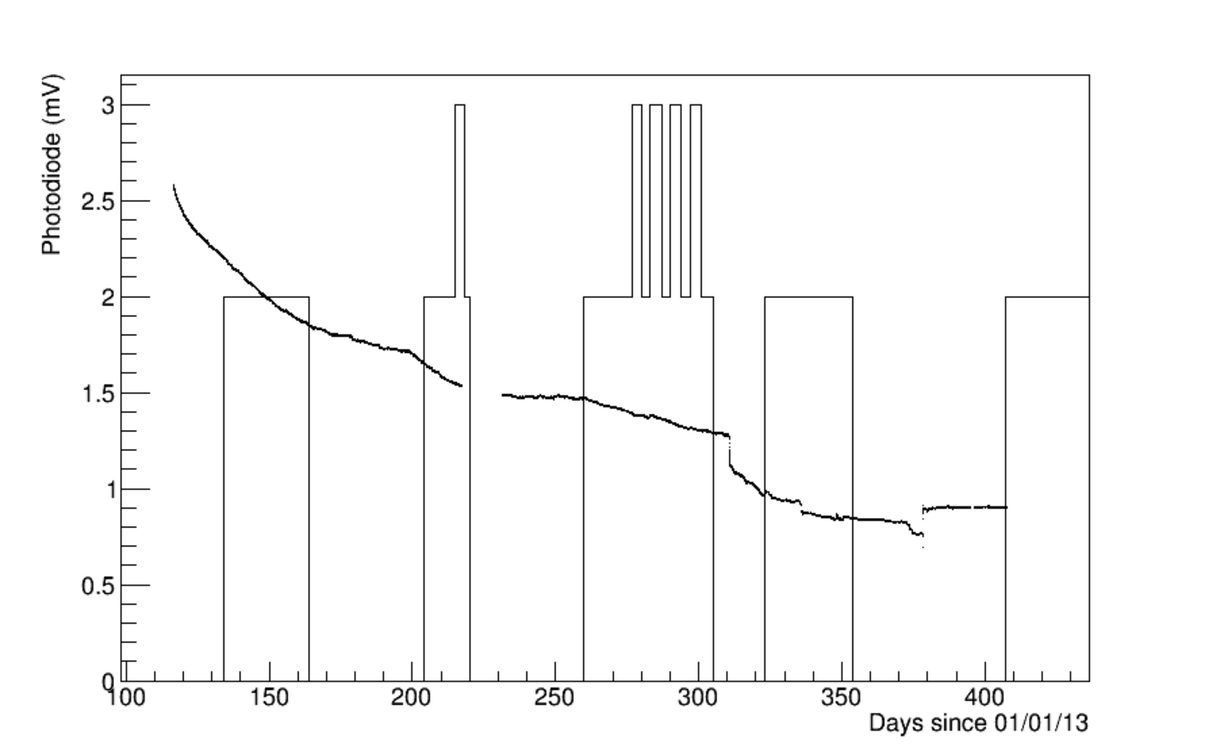
Optic Fibre Patch Cable Replacement



0 = ISIS Off + MICE Off

2 = ISIS running

3 = ISIS + MICE running

Loopback Test results: Still Running. Loopback is at the end of the long fibre runs and does not include patch cables at synch end.

The cause in the drop of the signal over time is unclear. Not necessarily rad damage but justifies the need to monitor signals.

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Optic Fibre Cable Replacement

Requirement for New Fibres: There are two concerns:

1) The excess of fibres at the end of the 07' install are vulnerable and are at risk of damage – both mechanical and radiation.
2) We only have one known good spare channel for the target system.

The target is a critical system for MICE and losing fibres to the target just before a run could mean a significant delay to the experiment.

We feel that there is:

1) A critical case for re-installing the fibres as per the original plan – the plan deviated significantly in the synch.

2) That there should be twice as many fibres laid as are required to give a significant number of spare channels in case of accidental damage to the fibres .

We need both funds and manpower to manage the re-install.

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Target in R78

Target in R78 - History

S1.1, 25/9/2012 to 6/11/2012 1.5M actuations. Things looked OK up to ~500K, after which the performance dropped of suddenly. We saw a rapid decrease in acceleration and a large increase in the number of capture corrections. Towards the end of the test we saw an increase in 10s gaps, presumably caused by sticking during capture corrections. Therefore we increased hold current.

S1.1r2, 14/11/2012 to 17/11/2012 - 80k. We saw that loose magnets were possibly the cause and cleaned the mechanism. The acceleration rapidly decreased and the starting position returned to the width observed in the previous test (within around 8K of starting the test). We ran for a total of 80k, but there was significant sticking / friction which caused a very large number of gaps > 10s and resulted in regular errors.

S1.2, 05/12/2012 to 12/02/2013 - 3M. First successful test. Saw good performance, saw steady broadening of starting position, and a sudden change to double banded acceleration, which was expected from the increase in start position. Everything was fairly stable right up to the end of the test.

S1.3, 1/03/2013 to 28/03/2013 - 1.8M, using 3 phase acceleration @ 77V. Again saw good performance throughout test. Acceleration was around 850m/s/s and starting position width was fairly steady at just over 1mm.

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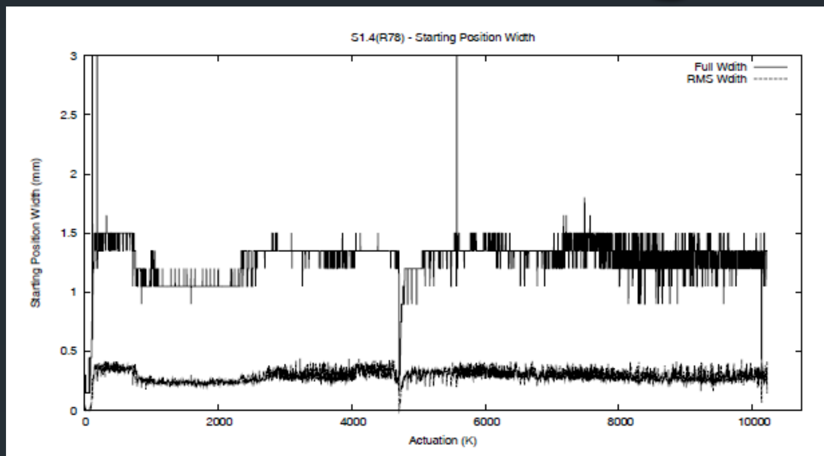
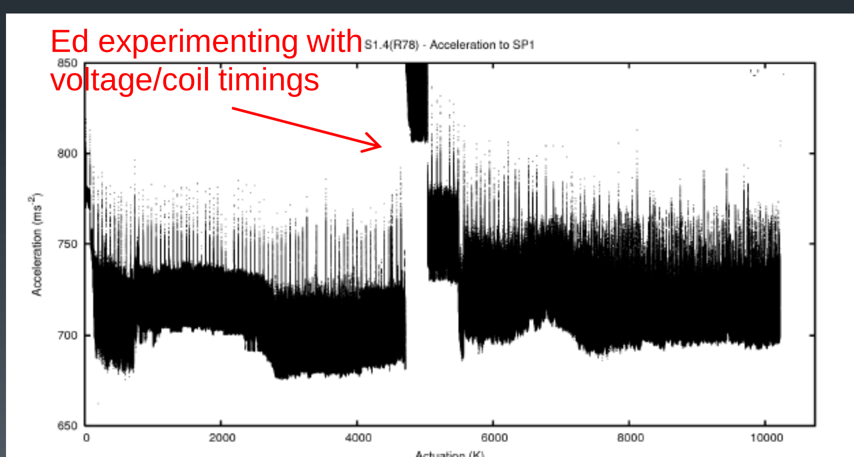
The S1.4 'Mega'-Run



Starting position for the target remained consistent throughout the run.



Acceleration broadens slightly but it looks consistent. (Perhaps it even improves with age like a good wine!)

S1.4 ran from April 2013 to Dec 2013.

There were a couple of stops for visual inspections, and a few shutdowns due to software updates, power outages etc.

We would have happily continued running this target beyond 10m actuations but we needed to continue with other tests.

The target was disassembled and inspected in Jan 2014.

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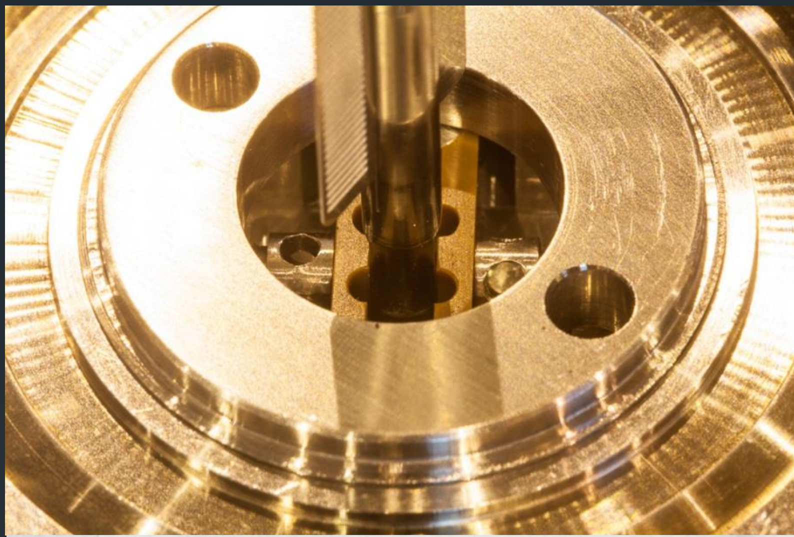
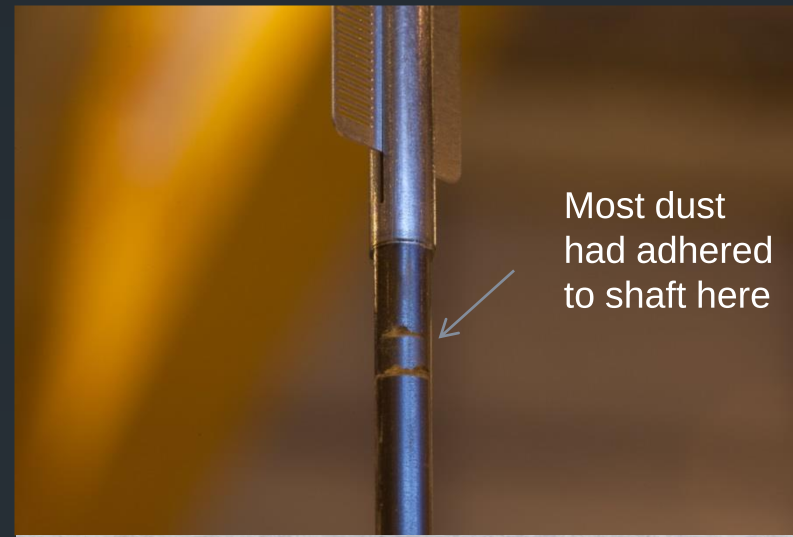
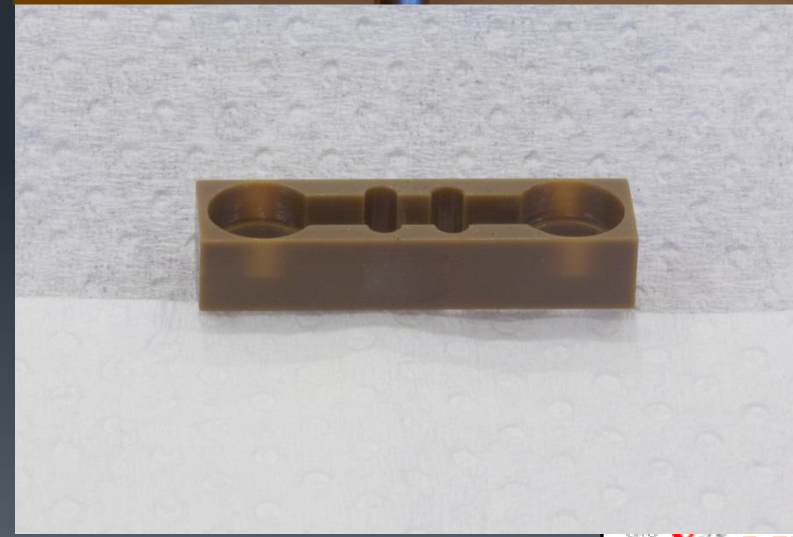
The S1.4 ‘Mega’-Run







10 million actuations. Very Clean. No migration of any dust below the mechanism.
Important milestone and if repeatable has implications for operations.

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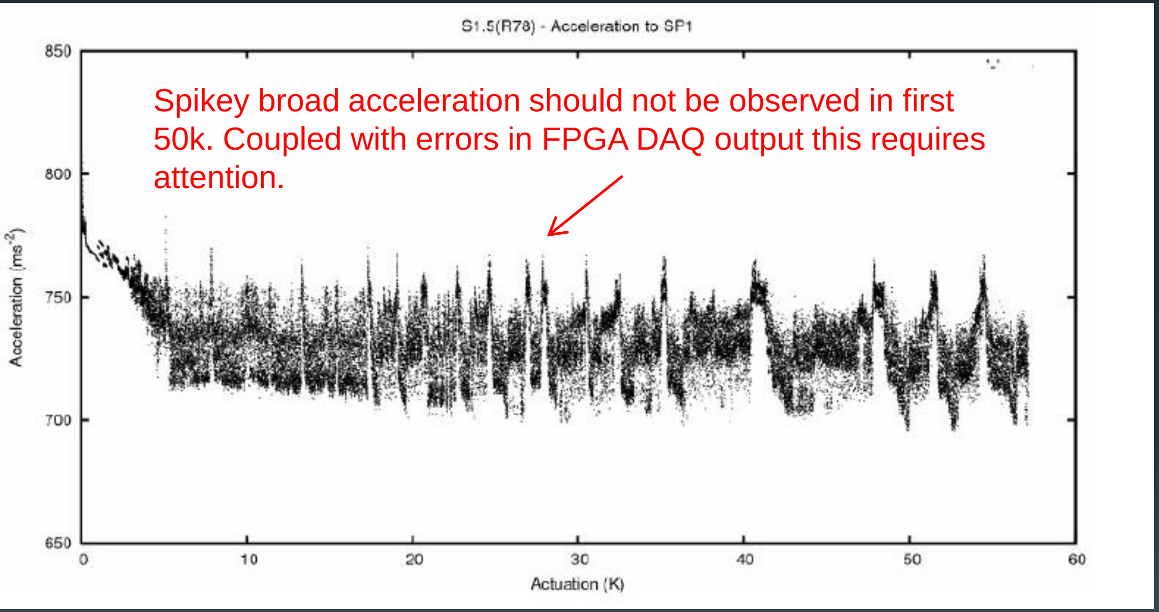
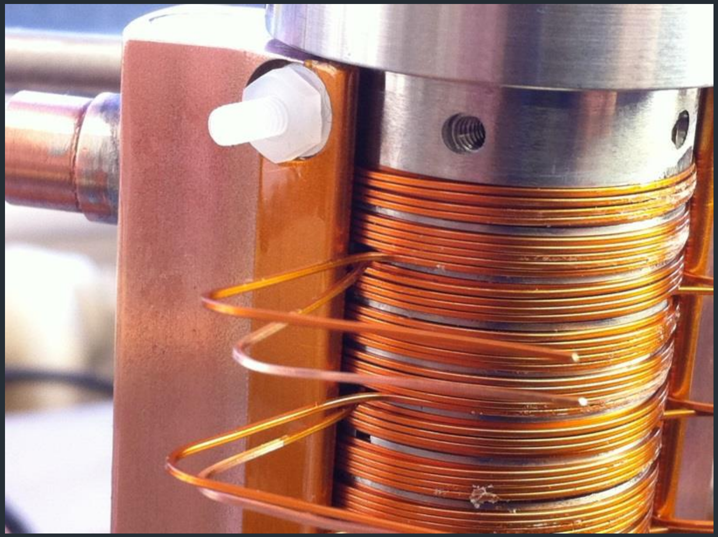
S1.5 Run

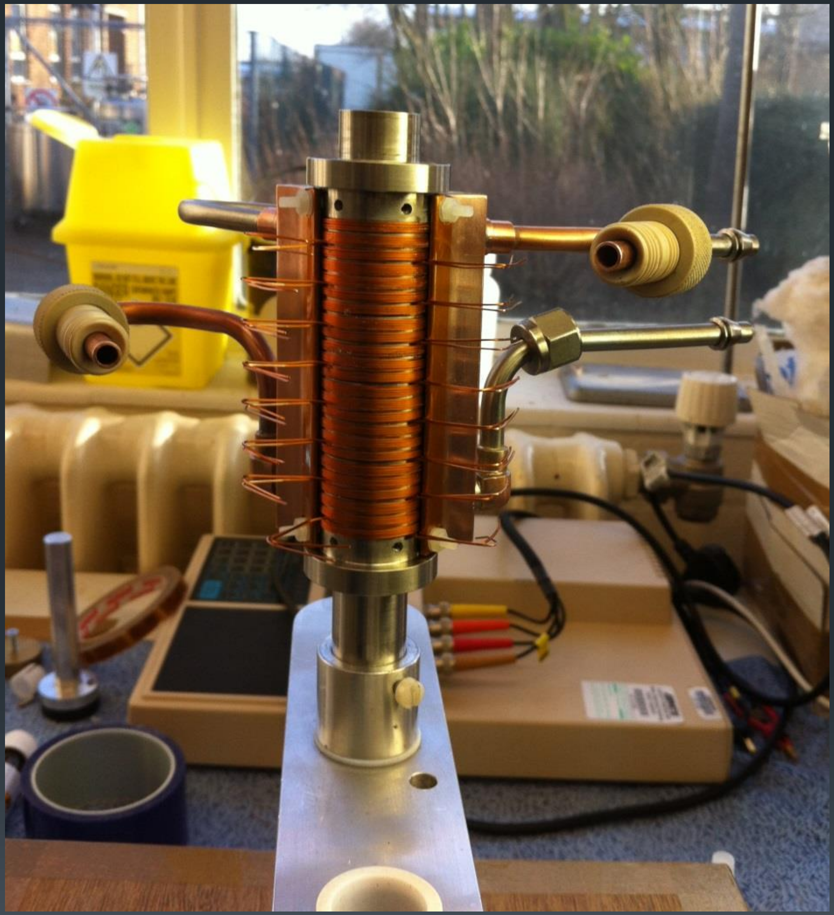
On the basis of the success with 1.4 we refurbished the target and set it running again in late Jan 2014. However, from the DAQ data it was clear that something is not quite right with this run. Stopped at 750K.



We disassembled the target on 19/02/2014 to take a look but nothing obvious was found. The target was refitted with new bearings and is now running again. Too early to draw any conclusions.

New Stator Build – S2





Next Steps: Field Mapping
-> Permanent Casing
-> Potting.

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Stator Inventory

1) T2.9 - ISIS - Maybe 500k pulses left at most before it requires swapping out.

2) S1 – R78 – This stator would be good for installation onto ISIS with a bearing swap. With another good run in R78 we would be in a strong position to negotiate a longer lifetime limit on ISIS with this stator.

3) T1 –Storage – Ready for installation on ISIS. Officially this has a 1m lifetime limit but this is a better stator than T2 and generally has a longer bearing lifetime. We may be able to negotiate a longer lifetime based upon DAQ data.

4) S2 – Under Construction. This needs field mapping, potting and then an extensive period of testing before we will be in a position to ascertain whether it is as good as S1.

Longer term it may prove necessary to retire the T series, particularly if significant periods of running are required. In this case an S3 may be needed.

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Conclusions

The target on ISIS is looking ok but we need to consider how much this particular target is going to be run over the forthcoming months to determine our course of action with it.

Operating the target at double actuation rate without beam has been successful. We now need to prove that it can operate at this rate with beam and make any necessary changes to the beam bump.

Our first 'S' series stator has successfully completed an extremely long run in R78 and we feel that it would be suitable for using on ISIS if necessary, but ideally we would like to do some more tests in R78 first.

We are particularly concerned about the situation with the fibre optic cables in the sync. We feel that it is only a matter of time before these become damaged and leave the target un-operational. Clearly this is a critical item and needs to be addressed but we are lacking the resources to deal with it quickly.