



Science & Technology Facilities Council

ISIS

Tests of Carbon Foils on ISIS

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ISIS

Ion Source: 50mA peak, 200 μ s, 50 pps

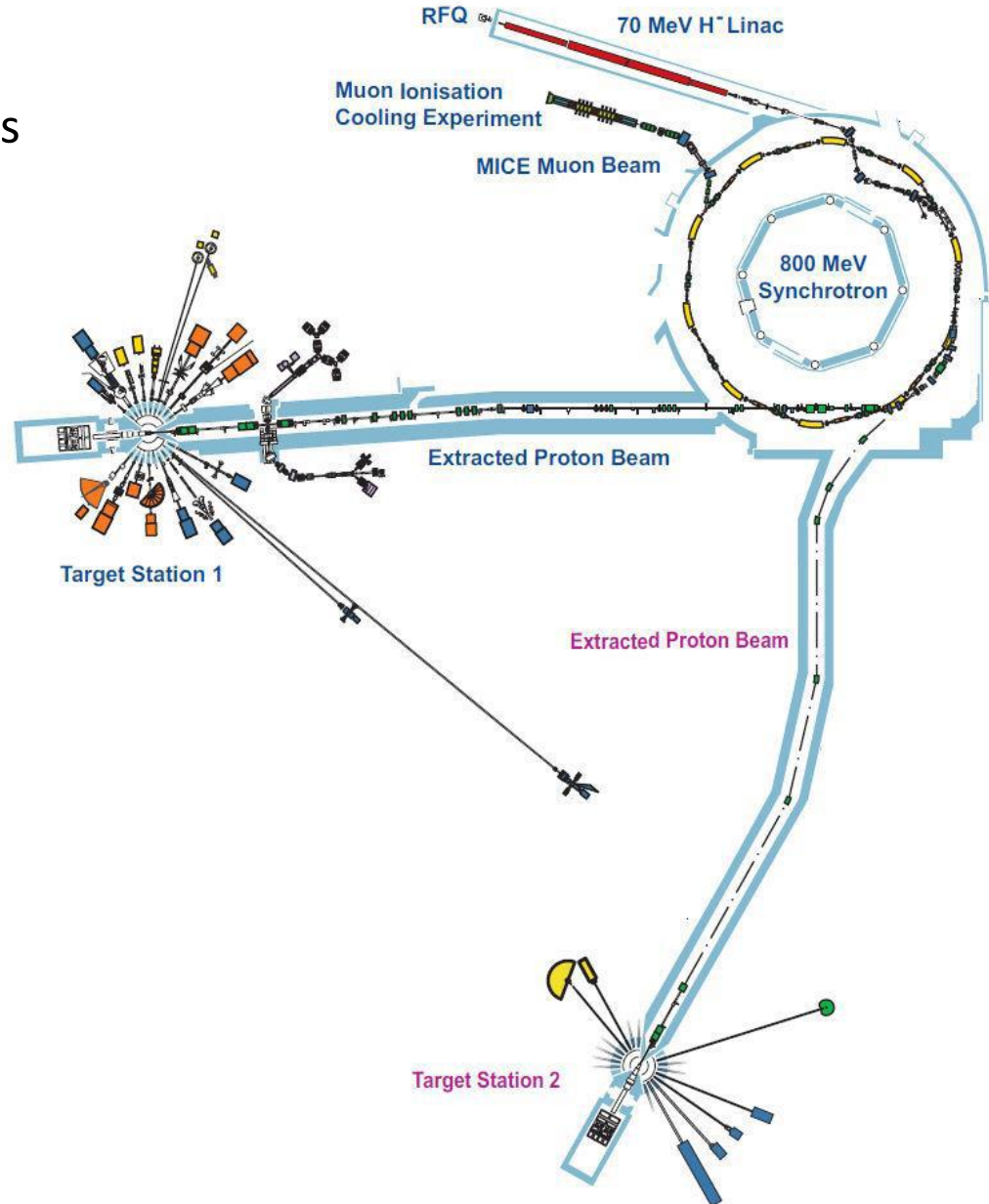
RFQ: 4-rod, 665 keV

Linac: 70 MeV H^- , 202.5 MHz, 25 mA output

Synchrotron: 800 MeV protons,

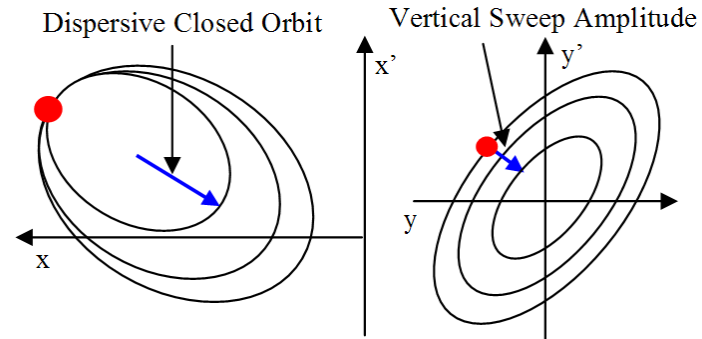
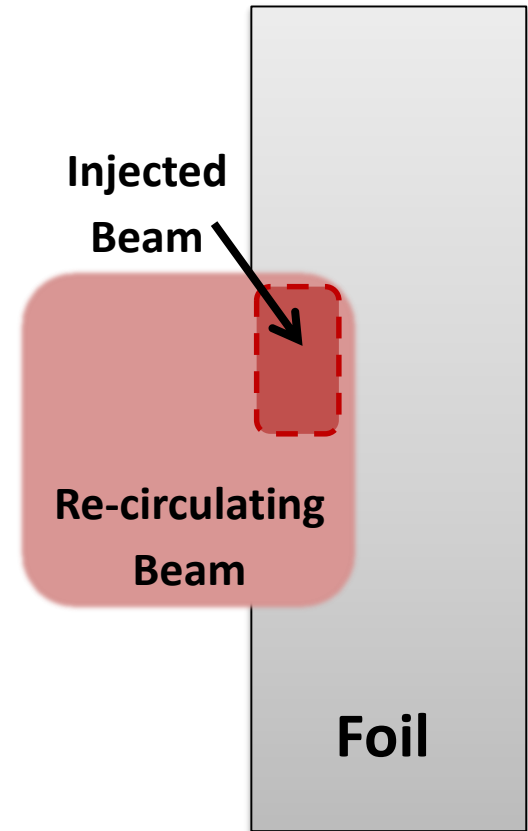
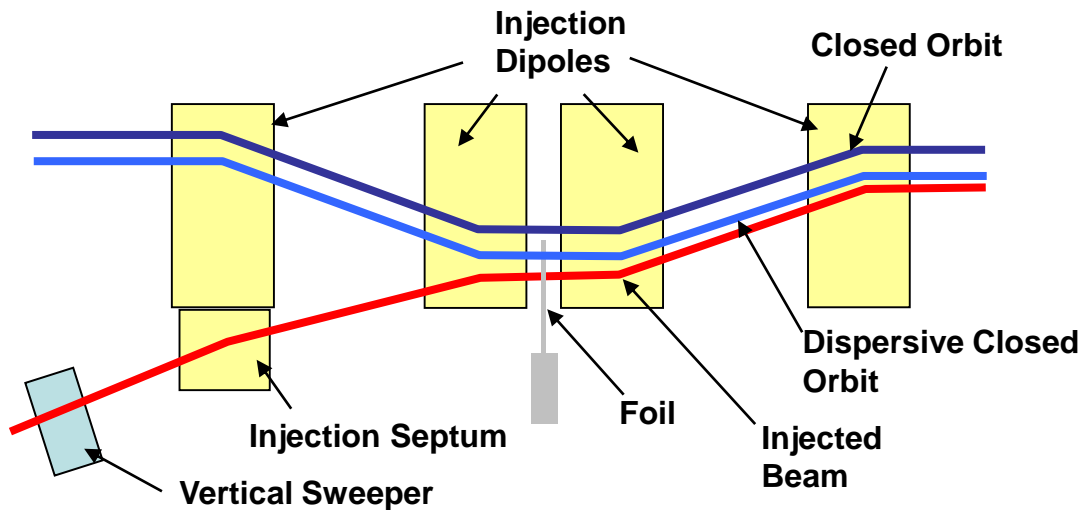
3.0×10^{13} ppp, ~ 200 kW

4x 40day user cycles per year



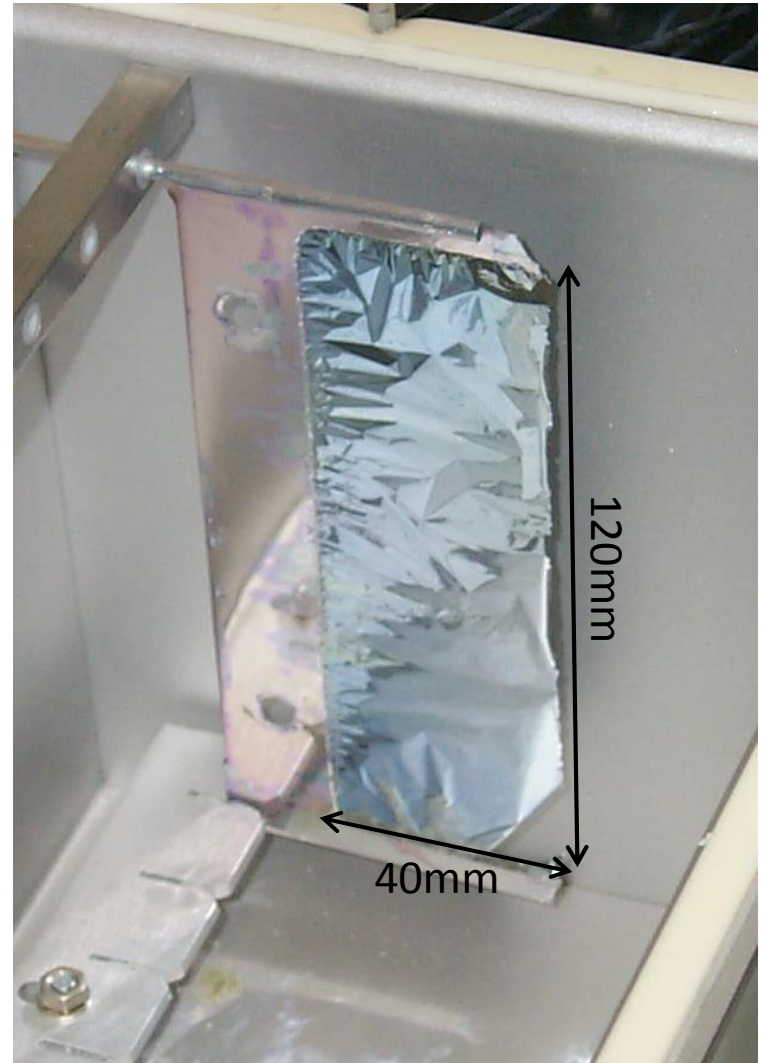
ISIS Injection

- Four dipole 65mm chicane
- $\sim 200 \text{ ug/cm}^2 \text{ Al}_2\text{O}_3$ foil
- Vertical 'sweeper' magnet
- Horizontal painting achieved by closed orbit movement
- ~ 30 foil recirculations

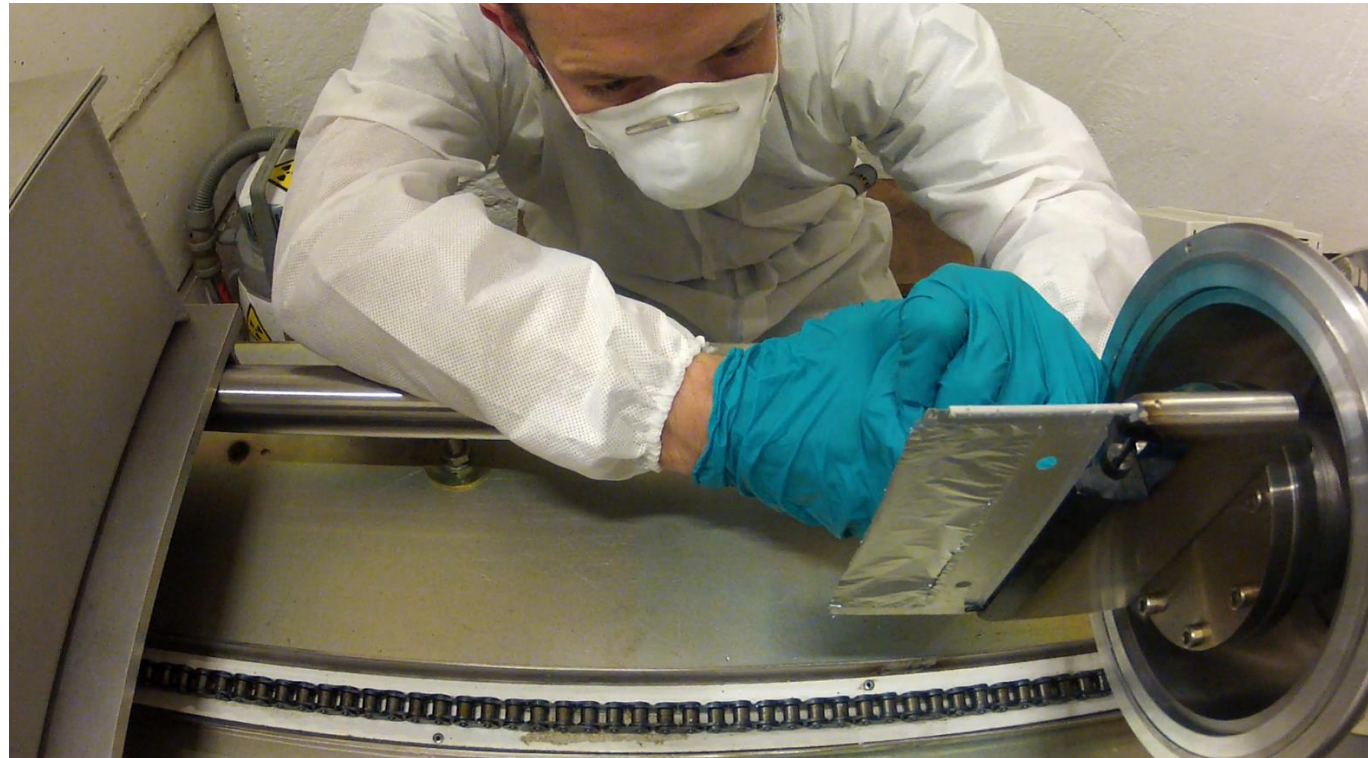


Stripping Foil

- $\sim 200 \text{ ug/cm}^2 \text{ Al}_2\text{O}_3$ foil
- Produced in-house by chemical etching



Foil Installation



Carbon Foils

- Much more robust than Al_2O_3
- Commercially available
- In use at J-Parc and SNS
- Planned for CSNS and CERN PSB



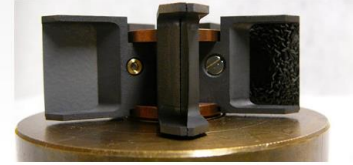
New foils

- 50x65 mm, 100 $\mu\text{g}/\text{cm}^2$
 - 5x Hybrid Boron-Carbon
 - 5x Diamond-Like Carbon
- Frames manufactured at RAL



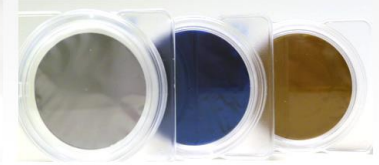
HOME COMPANY PRODUCTS SERVICES CONTACT

Products



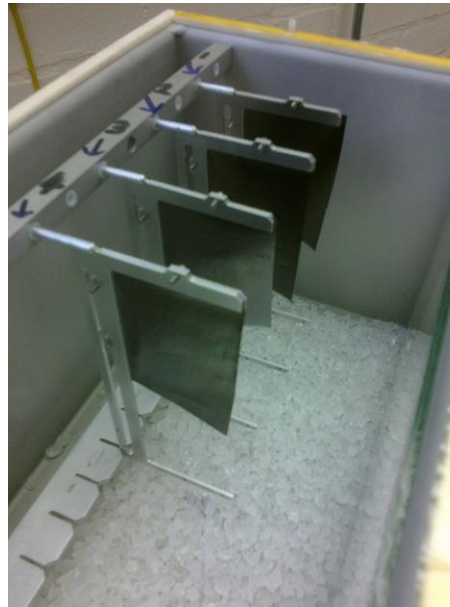
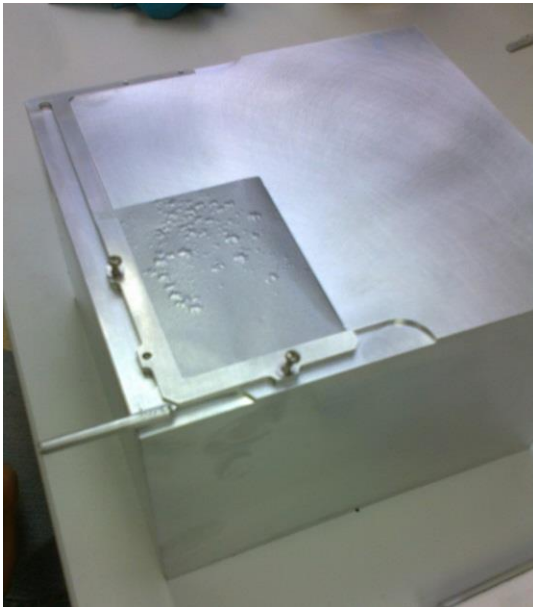
Diamond-Like Carbon (DLC)

MICROMATTER™ DLC foils consist of homogeneously distributed carbon nano-particles, which gives them outstanding physical properties. DLC shows high electrical resistivity, remarkable hardness, and good thermal conductivity. In addition, DLC's mechanical strength makes the foils easier to handle and users are reporting that DLC foils are proving to be a superior choice in a number of applications.

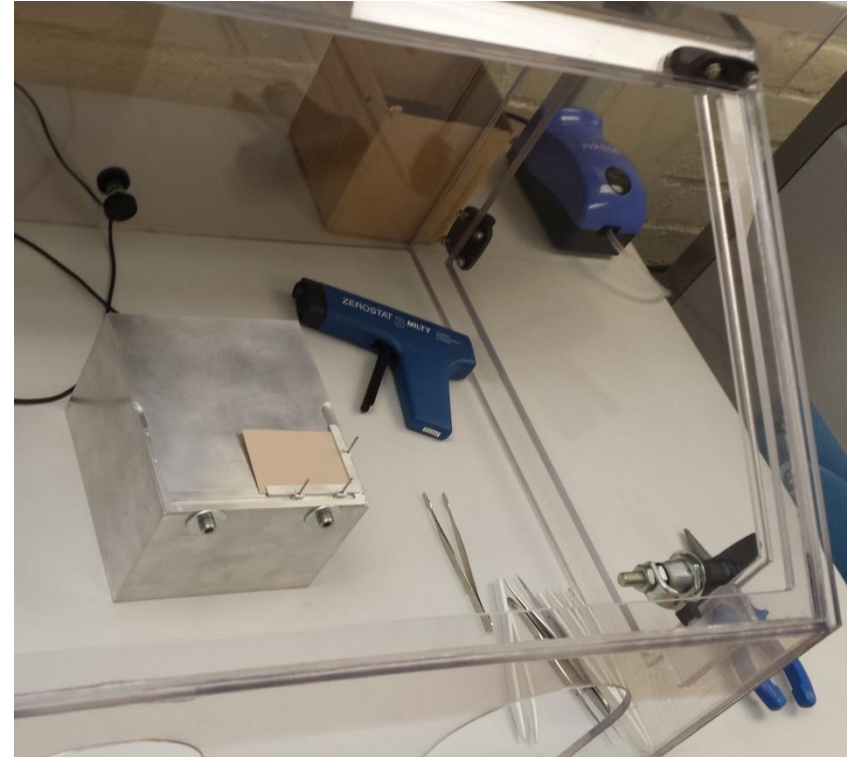
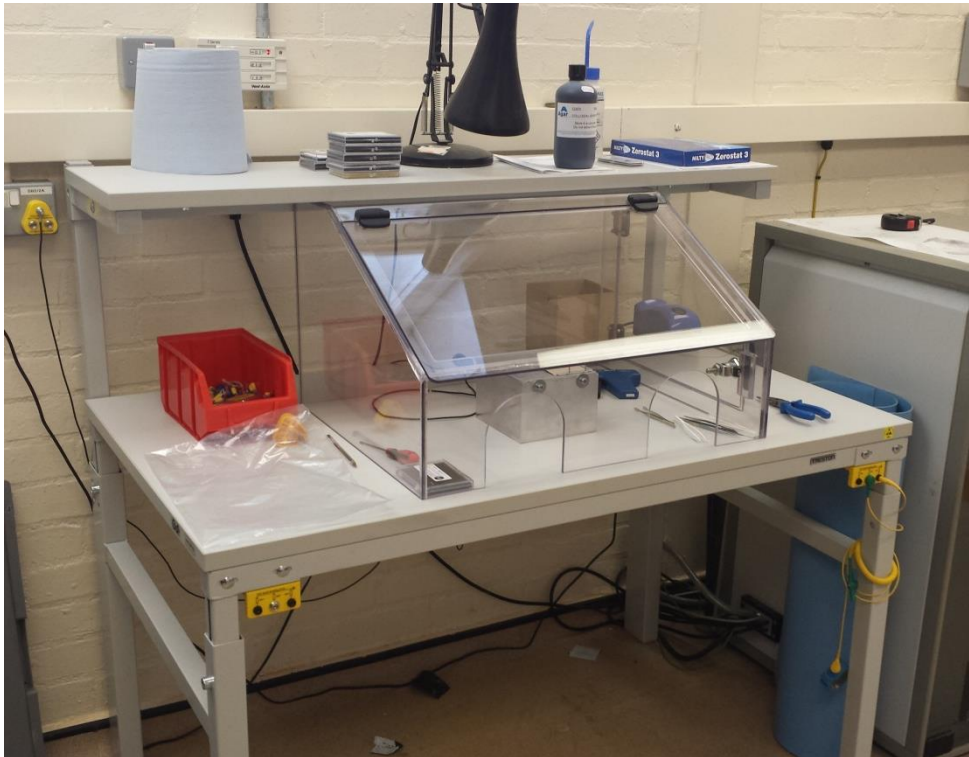


XRF Calibration Standards

For over 40 years, MICROMATTER™ has earned a reputation for quality. Today, leading institutions in over 50 countries use MICROMATTER™ standards to calibrate their X-ray fluorescence (XRF) systems. MICROMATTER™ standards are most often used for instrument calibration and quality control in the fields of air pollution and thin coatings. They are also useful as a source of pure element spectra for use in background subtraction routines, and as a routine check of x-ray detector resolution and overall system performance.

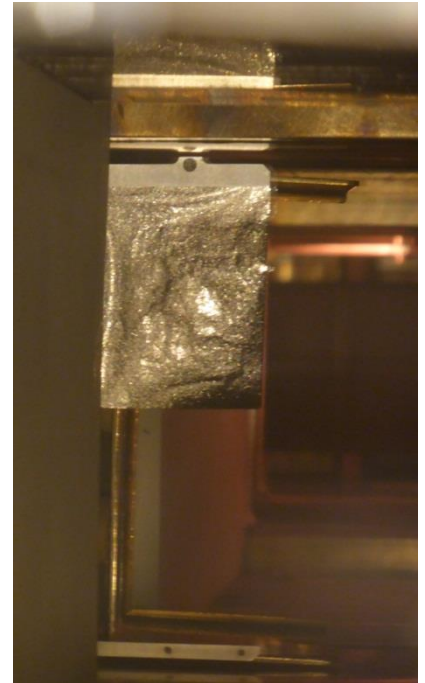
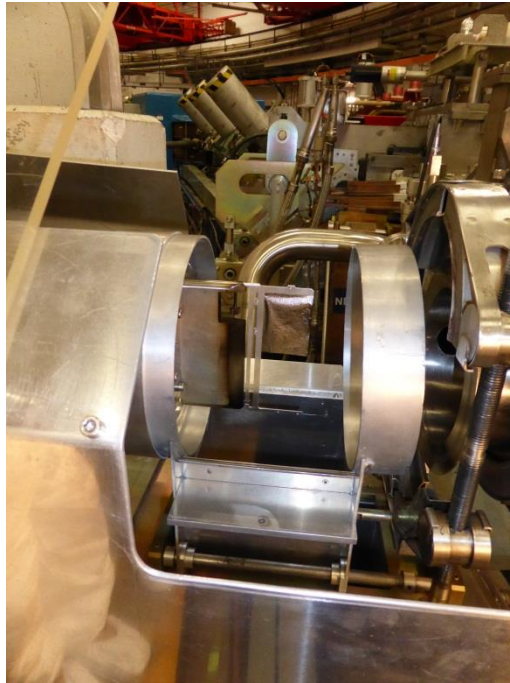


Mounting Bench



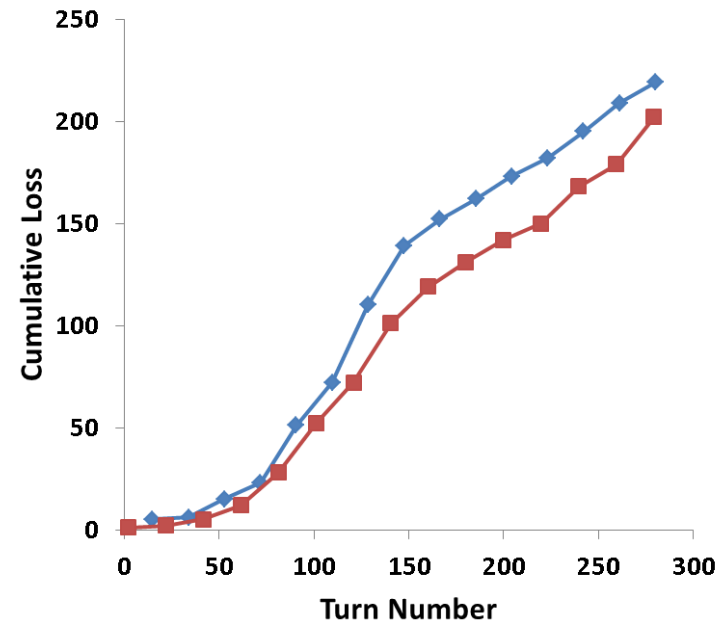
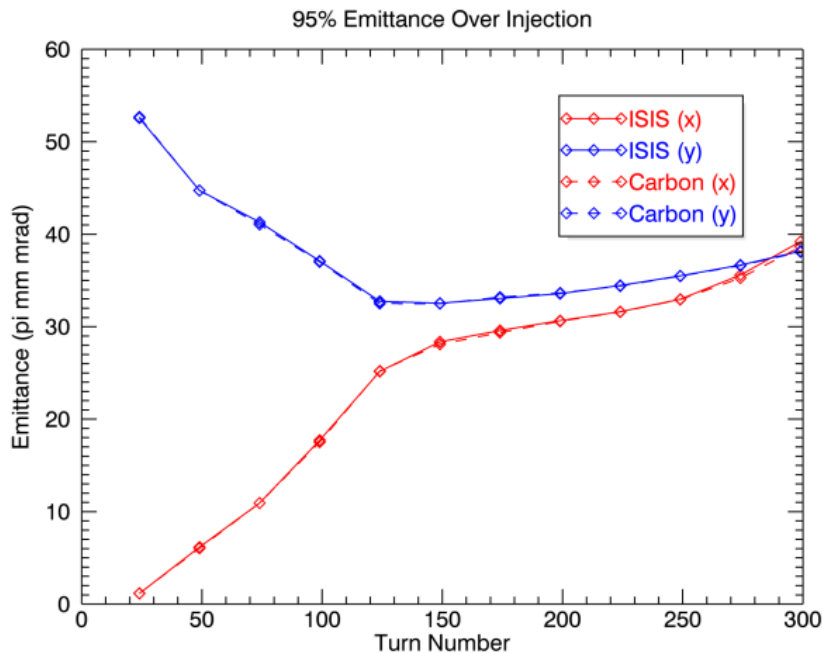
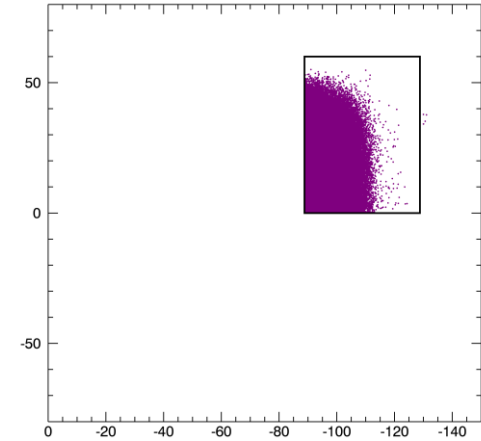
First Test

- Saturday 25th July
 - No problems, positive feedback from operators
 - Installed foil looked good



Expectations

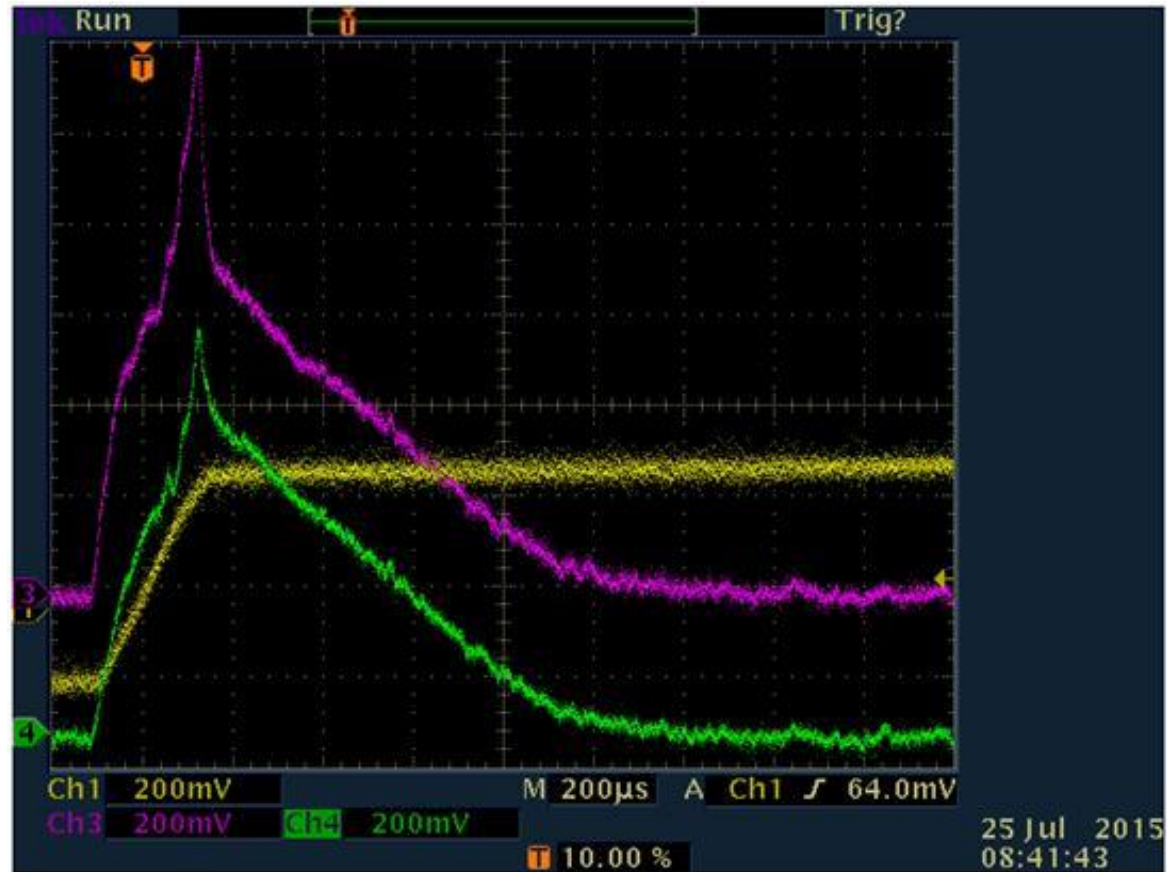
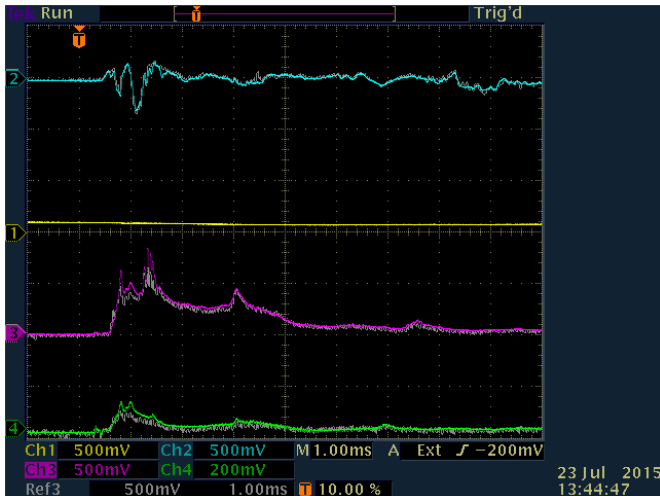
- Efficiency unchanged - 99.9%
- Half size = half re-circulations
 - Slight reduction in emittance and loss before 0ms



First Beam

- 10% Diluted beam, $3e12$ ppp
- 40% Injection efficiency

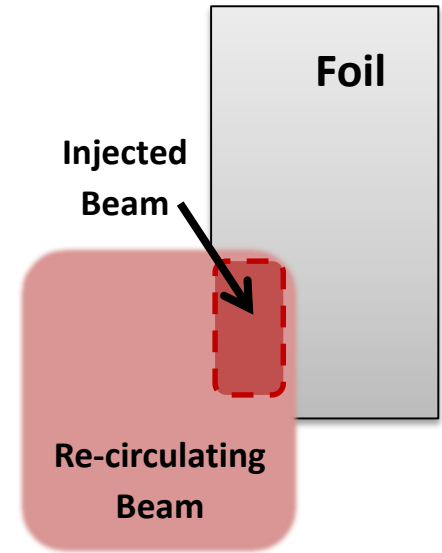
Ring BLM Sum
BLM Sum-1&2
R5IM



Optimisation

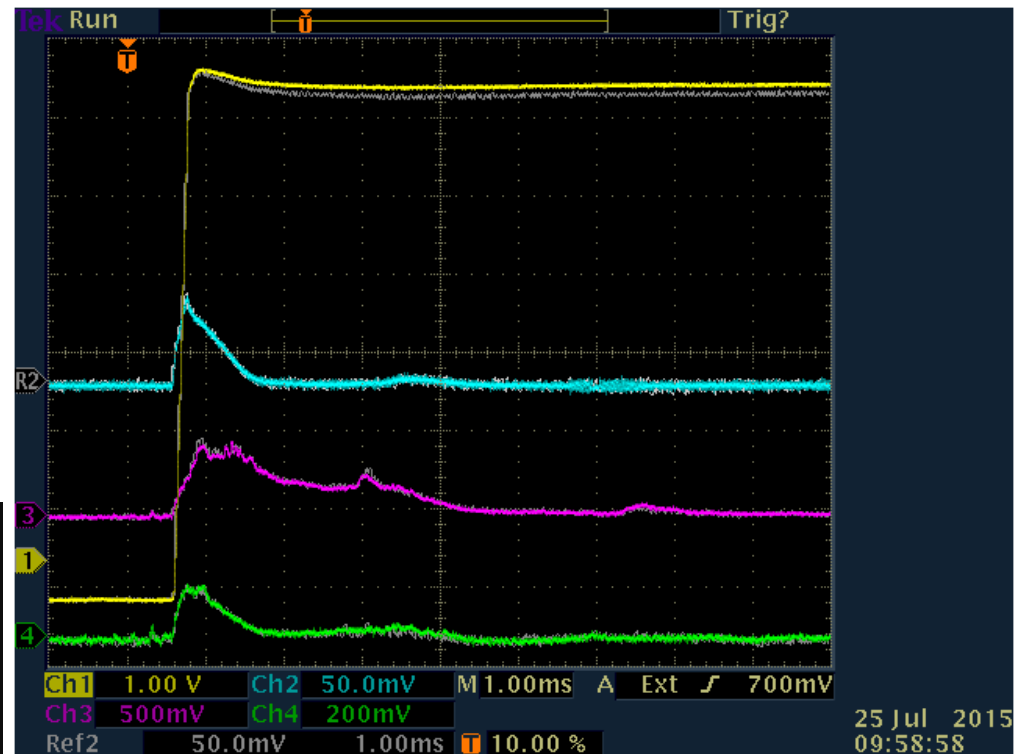
- Injected beam position raised 9mm
- Closed orbits adjusted for new injection position
- Beam spot shape tuned with HEDS quads

Total of 0.7 mAh – almost 4hrs of 180 μ A beam
Necessary to insert foil further during shift



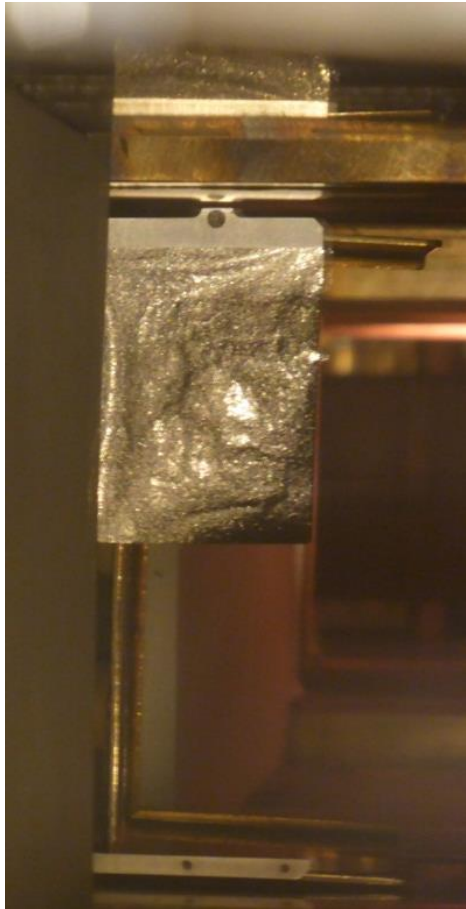
Target 1 Beam		
	50.0 Hz	
IHT5 :	2.43E+13 ppp	97.3 %
R5-0mS:	2.36E+13 ppp	96.1 %
R5-2.5mS:	2.27E+13 ppp	100.0 %
R5-9.5mS:	2.29E+13 ppp	98.9 %
EIM1:	2.26E+13 ppp	Trans 100.0 %
EIM5:	2.27E+13 ppp	Muon 96.3 %
EIM6:	2.18E+13 ppp	
Overall Efficiency T1	89.9 %	

Intensity
Inj Loss
Sum Loss
Sum-Collimators



Foil Condition

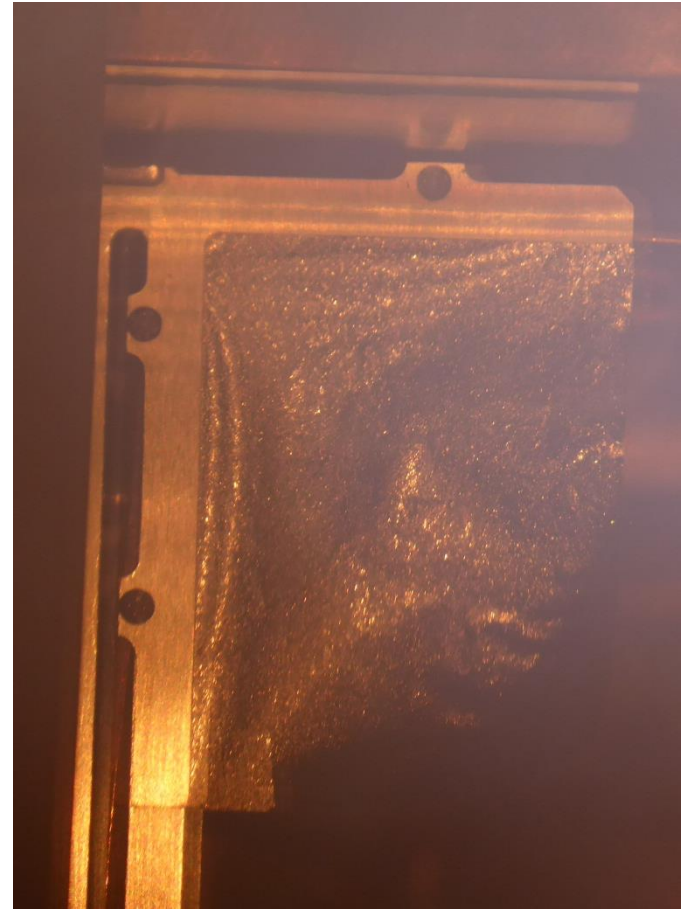
- Foil inspected Monday am



Before

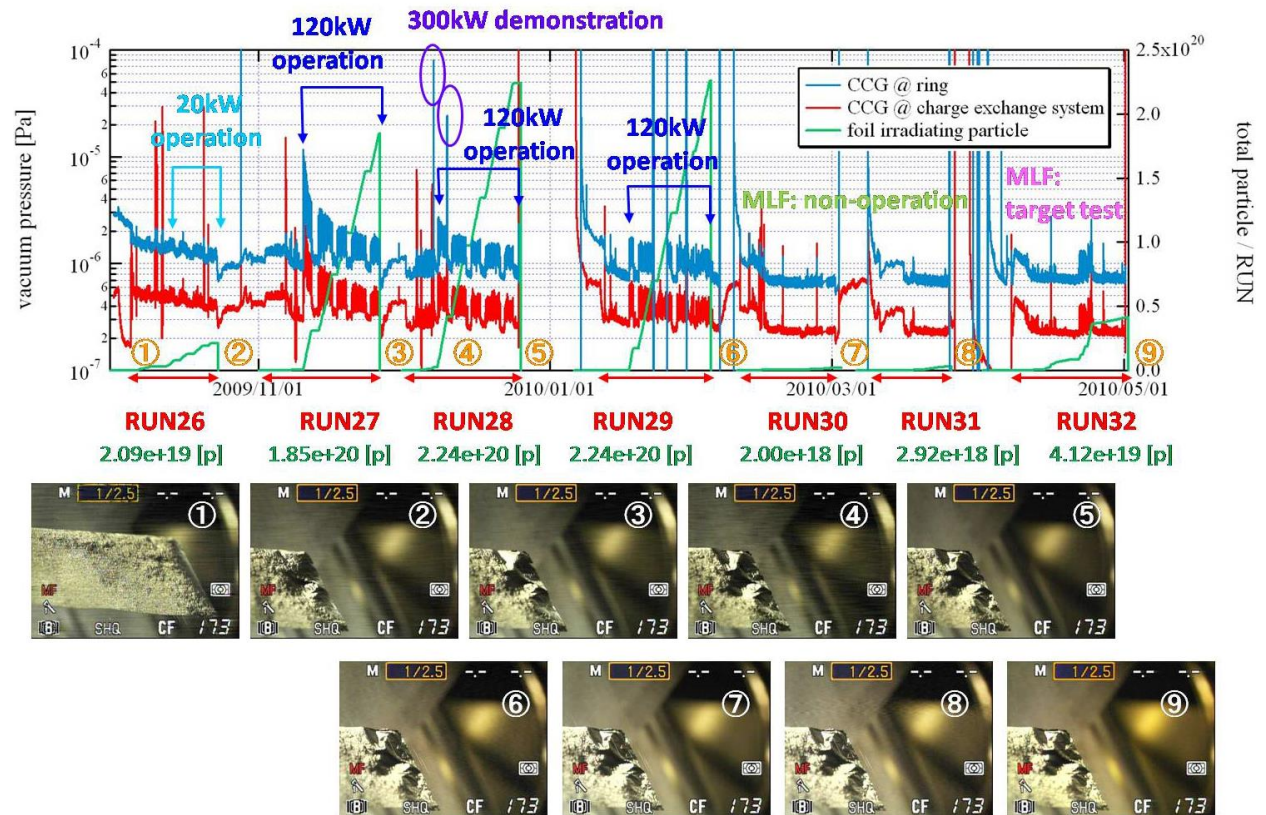


After



J-Parc

- 180 MeV, 25 Hz – Peak foil temp $\sim 500\text{K}$
- Stable after 7×10^{20} injected particles
 ≈ 3 days of 50 Hz beam for ISIS



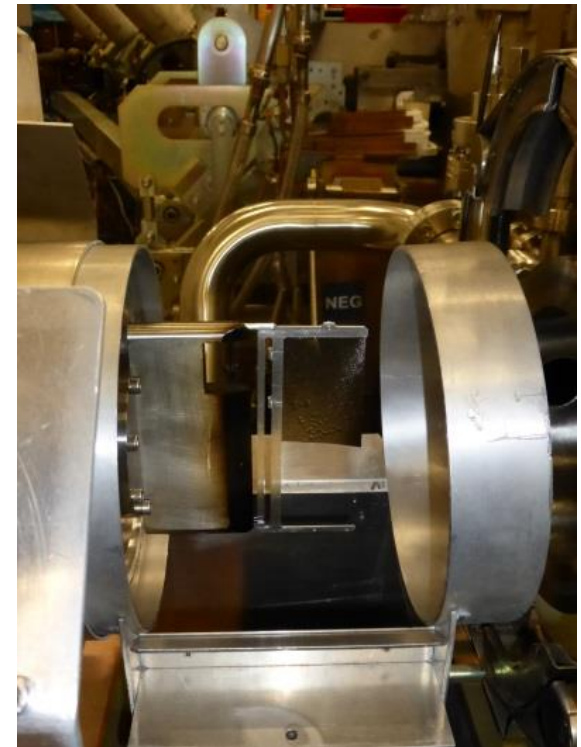
Removal and Mounting



- Foil removed Thursday 10th August
- Vacuum did not remove foil

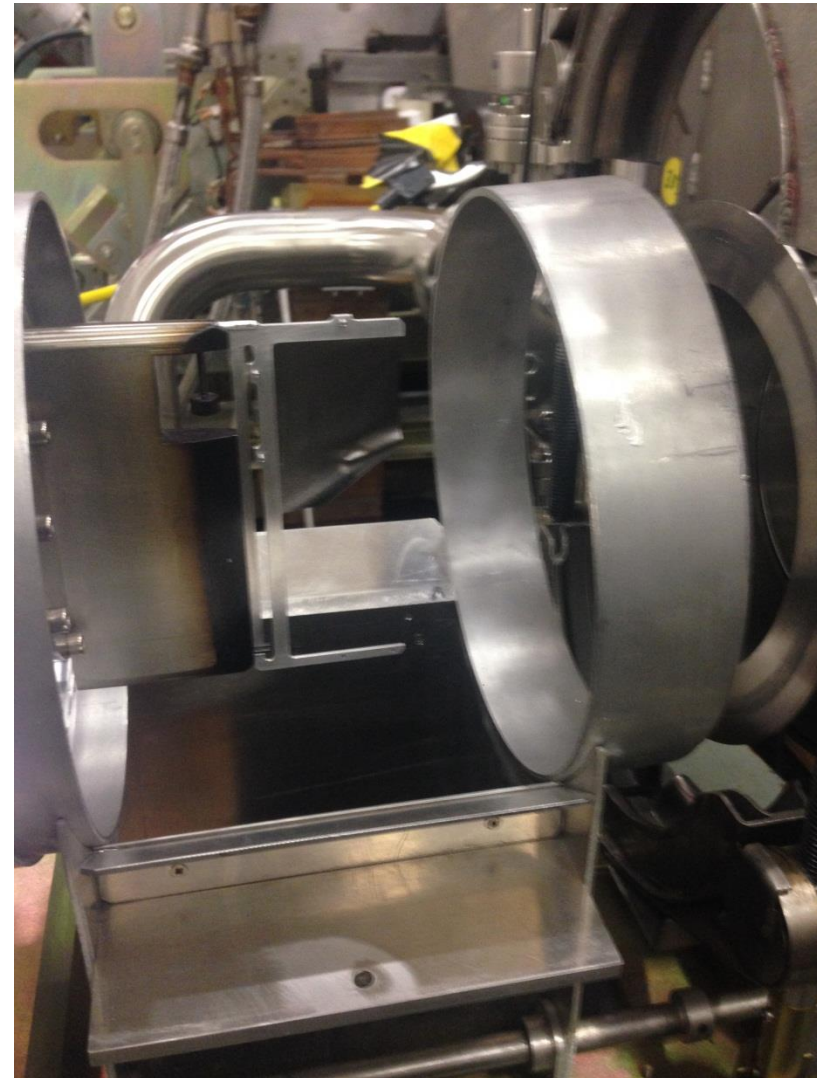
- New foil mounted ready for two-week startup period

CANCELLED



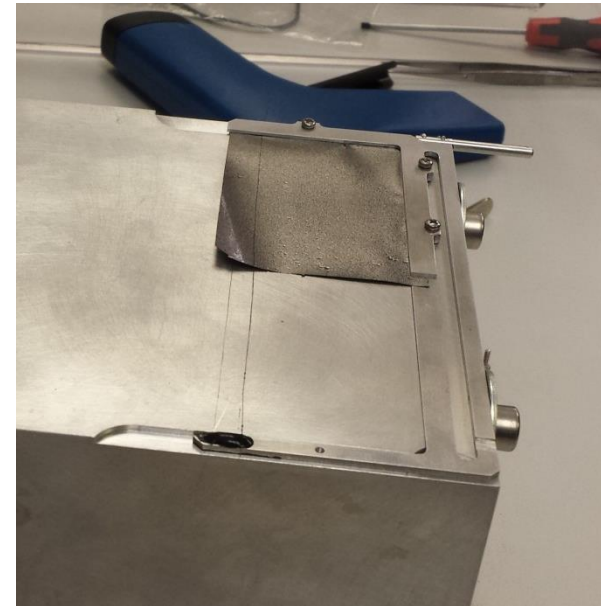
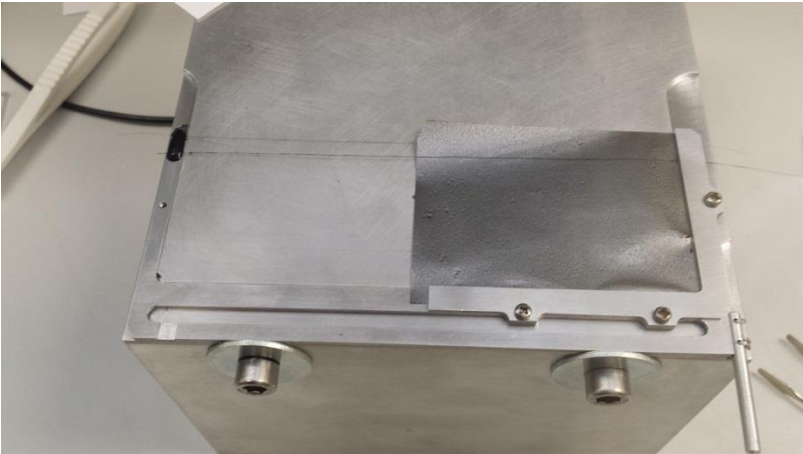
Third test – 16th October

- Installed at end of user run
- Quick setup, injection spot +2mm V
- Injection losses appeared after 5.5 hrs of 50Hz beam.
- Foil curled



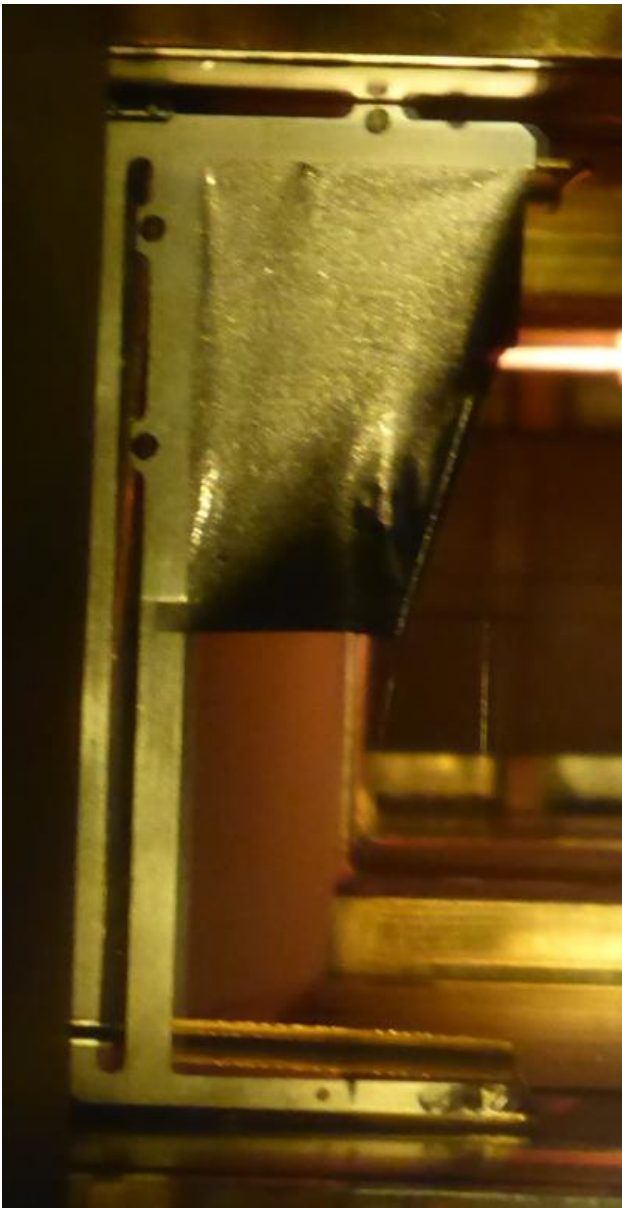
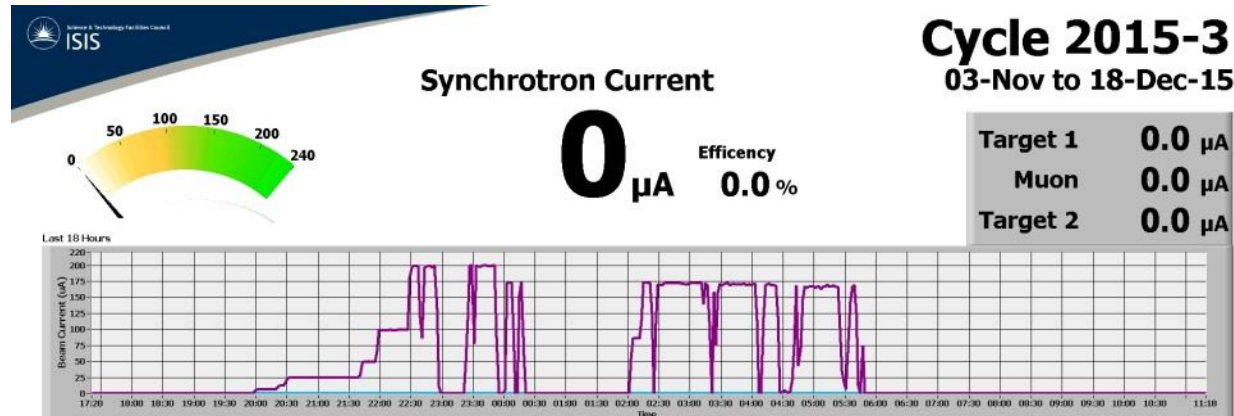
Fibres

- Two bunches of 10-20 carbon fibres
- Glued with Aquadaq



Failure

- Again, ~6 hrs of full-power beam
- Fibre detached from frame



Summary

- Similar result from 3 foil tests:
 - Significant foil deformation after 5-6 hours of 50 Hz beam ($T \approx 500\text{K}$)
- Single test of supporting fibres was unsuccessful
- Operators very happy with foils
 - Easy to mount/install
 - Fibres more problematic

Next Steps

- Improve fibre mounting
- Test a full length foil
 - Possibility for one more test before Xmas
- Review holder design and mounting method
 - Curve/corrugate foil?
- Off-line foil heating tests?

Graphene?

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