Science & Technology Facilities Council
ISIS

Tests of Carbon Foils on ISIS

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ISIS

Ion Source: 50mA peak, 200 µs, 50 pps

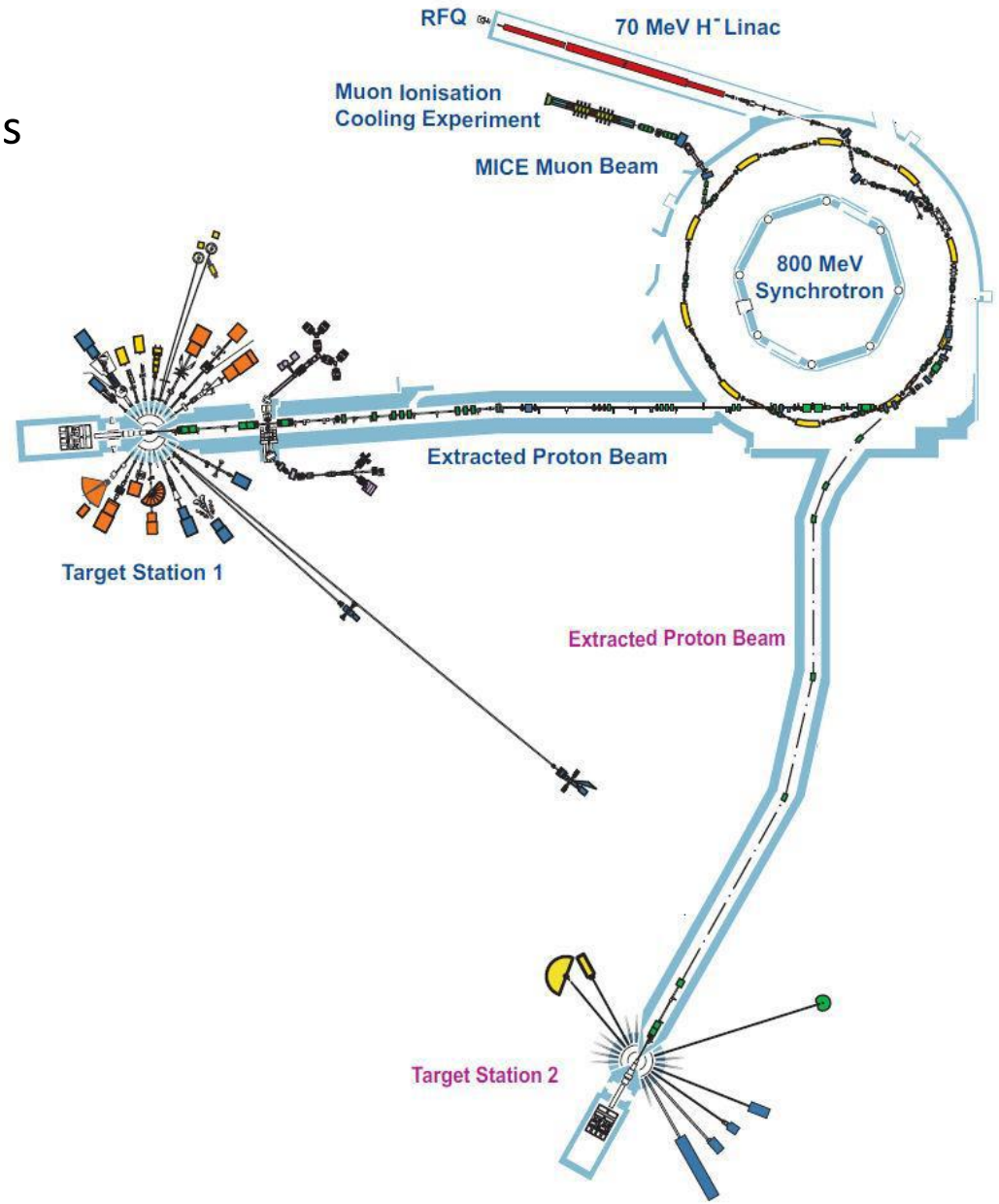
RFQ: 4-rod, 665 keV

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

Synchrotron: 800 MeV protons,

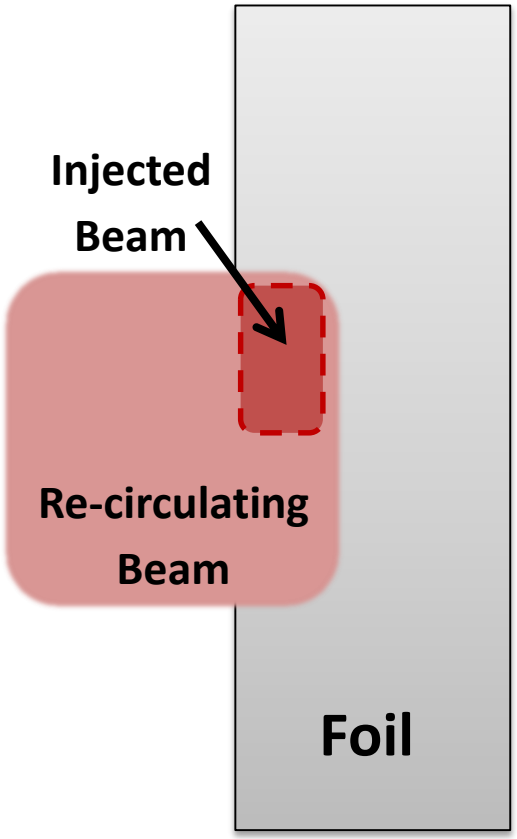
$3.0x10^{13}$ ppp, ~200kW

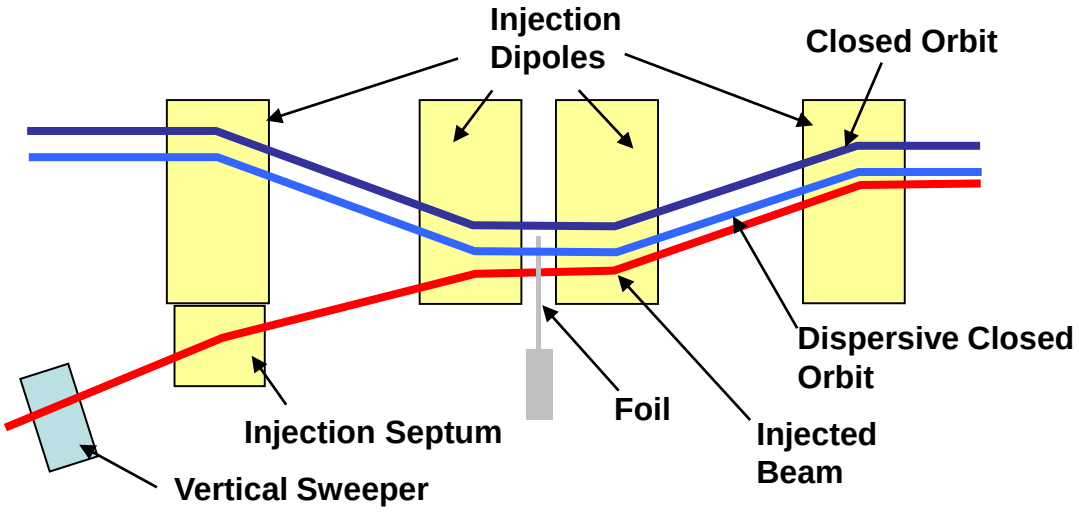
4x 40day user cycles per year

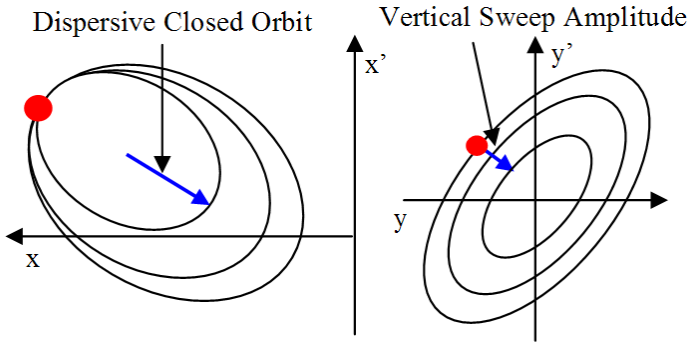


ISIS Injection

- Four dipole 65mm chicane
- ~200 ug/cm^2 Al_2O_3 foil
- Vertical ‘sweeper’ magnet
- Horizontal painting achieved by closed orbit movement
- ~30 foil recirculations

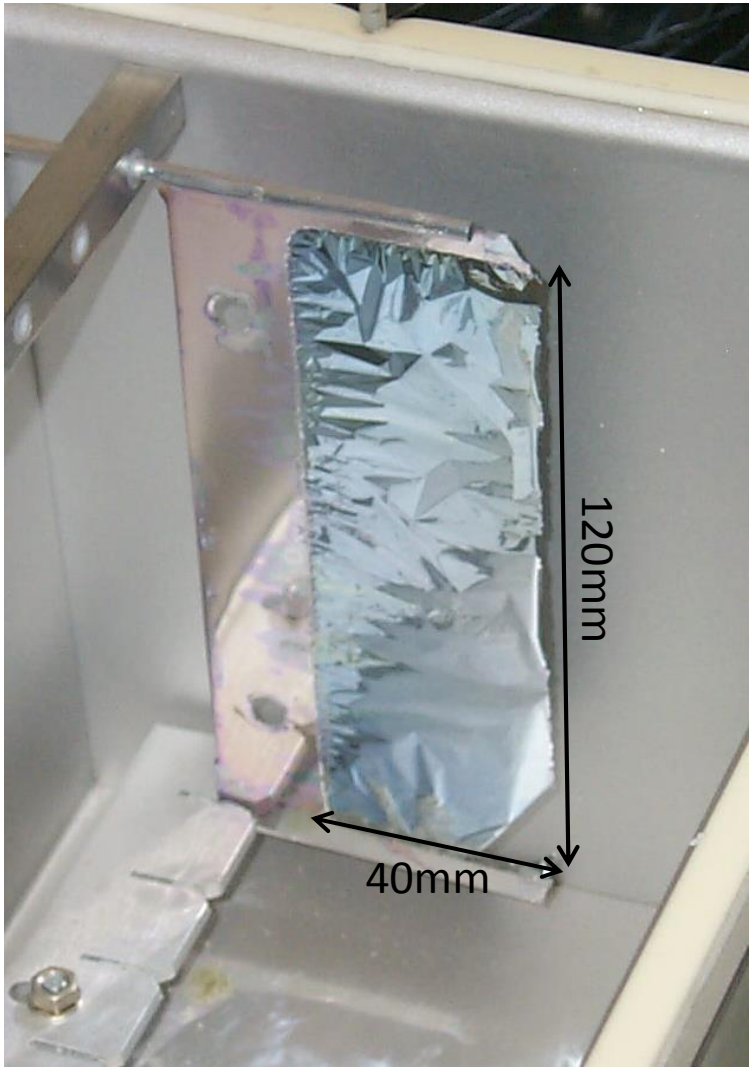




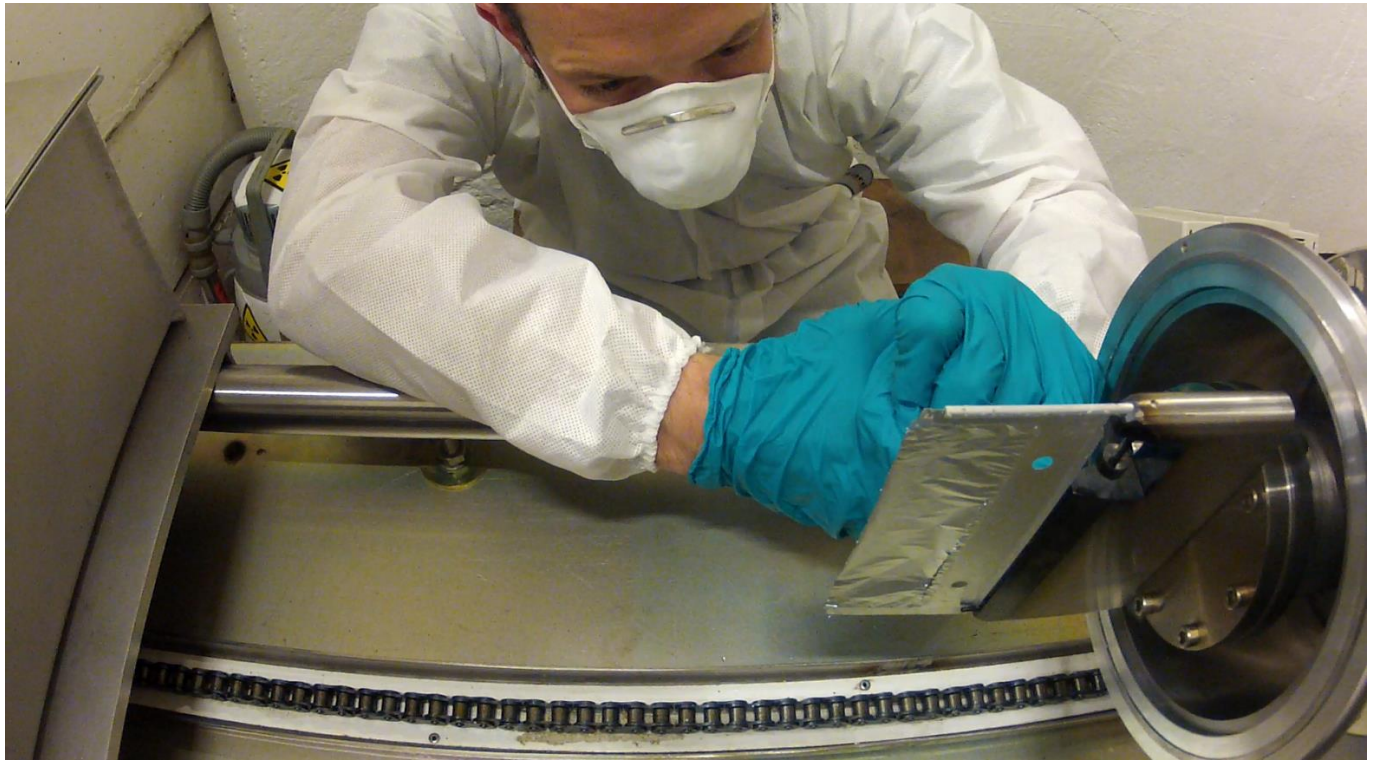


Stripping Foil

- ~200 ug/cm^2 Al_2O_3 foil
- Produced in-house by chemical etching



Foil Installation

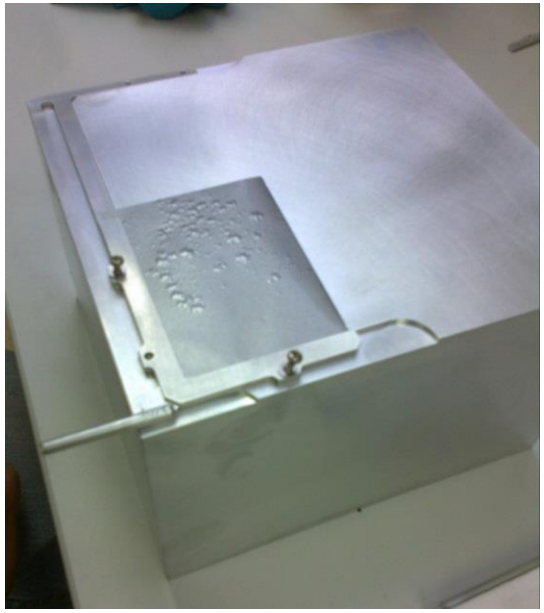


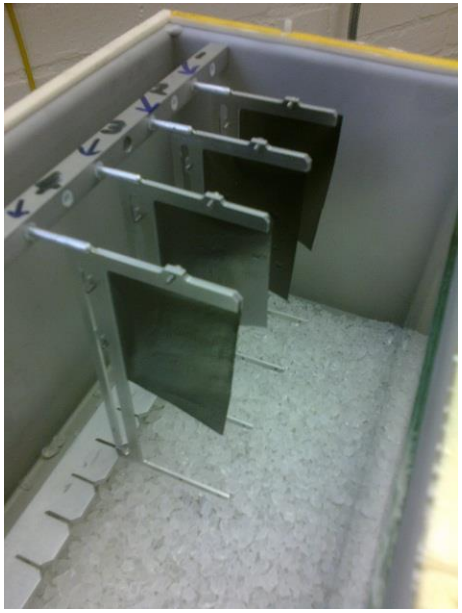
Carbon Foils

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

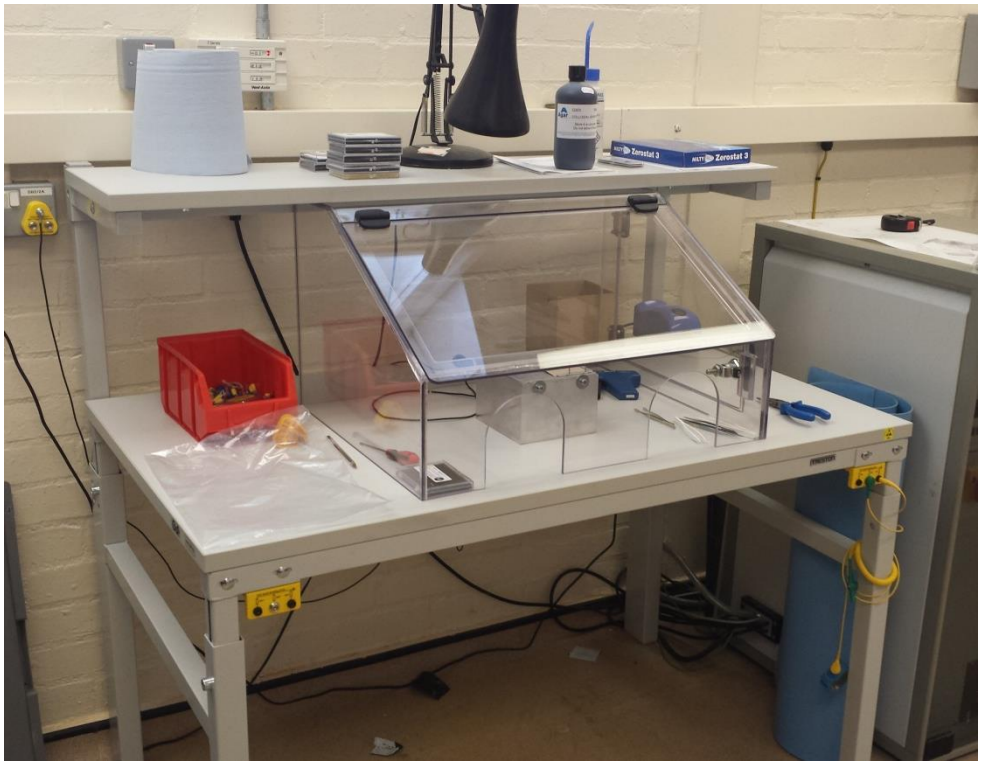
New foils

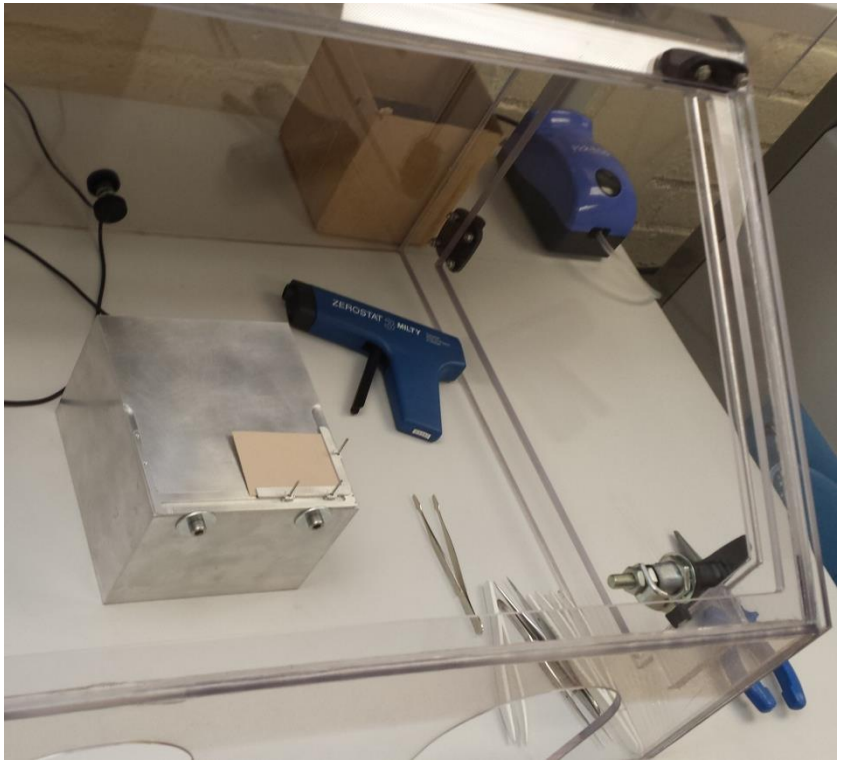
- 50x65 mm, 100µg/cm²
  - 5x Hybrid Boron-Carbon
  - 5x Diamond-Like Carbon
- Frames manufactured at RAL





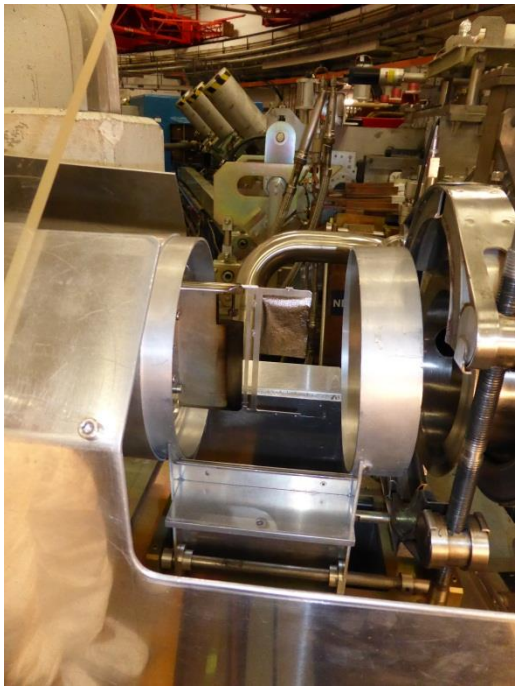
Mounting Bench





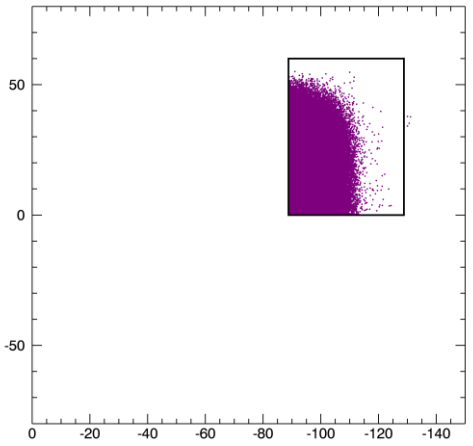
First Test

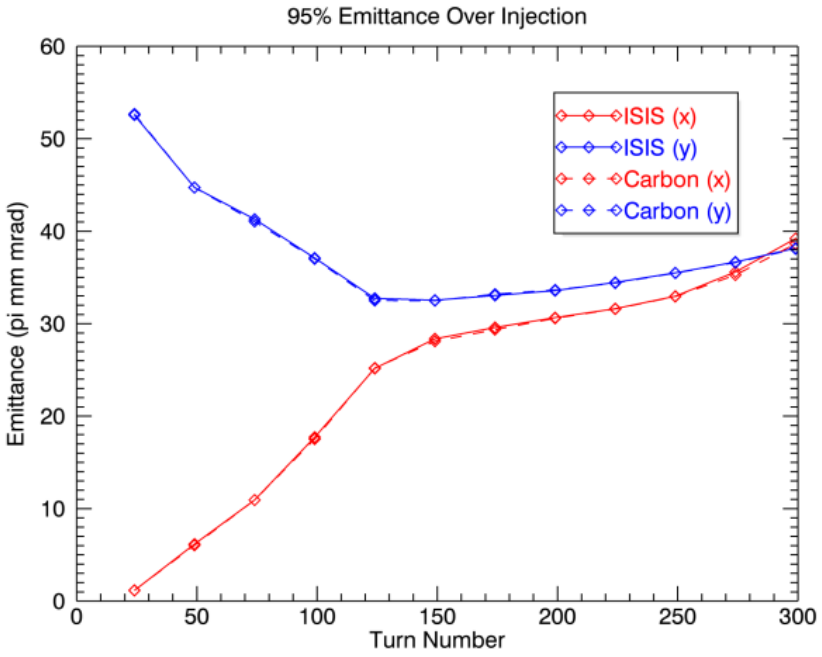
- Saturday 25th July
  - No problems, positive feedback from operators
  - Installed foil looked good

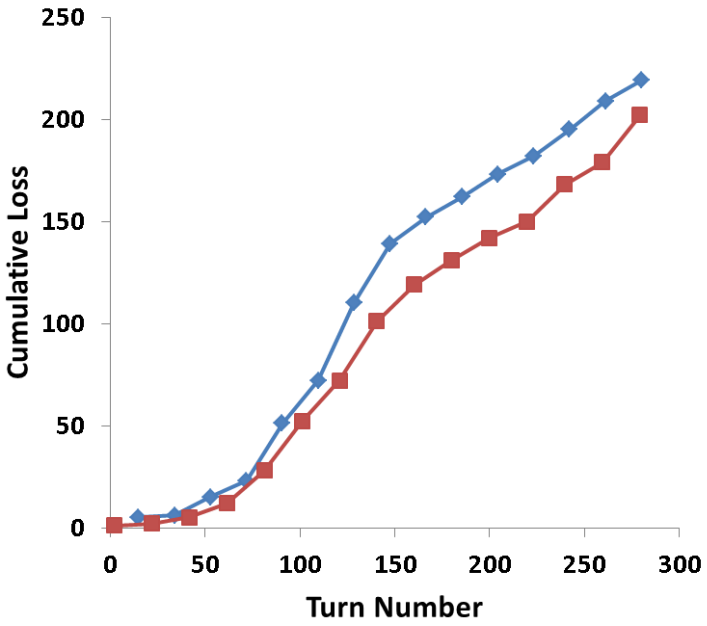


Expectations

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



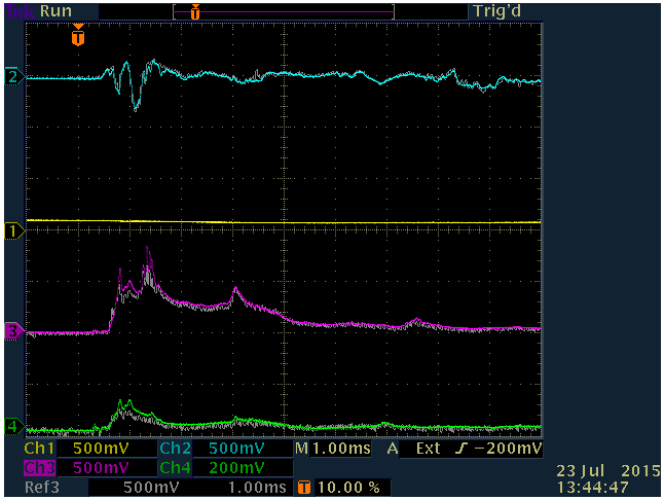




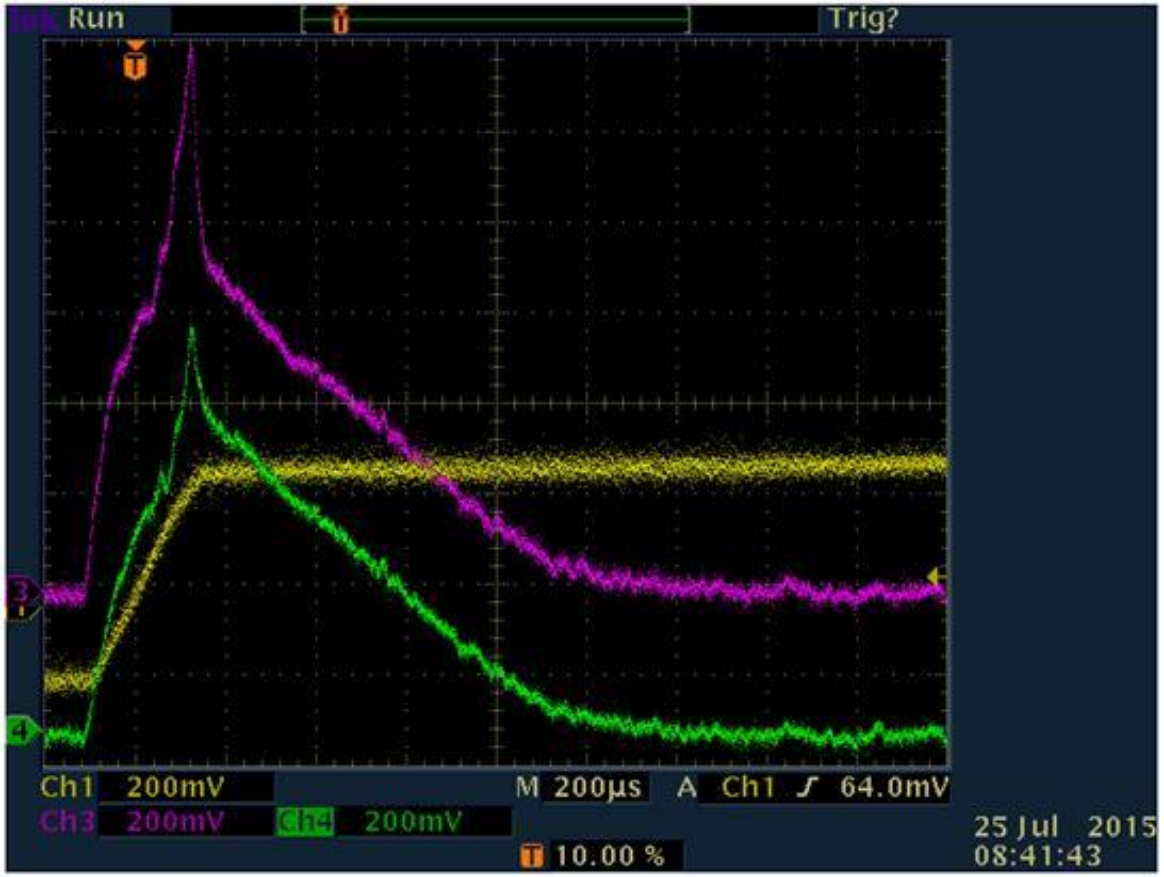
First Beam

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

Ring BLM Sum
BLM Sum-1&2
R5IM

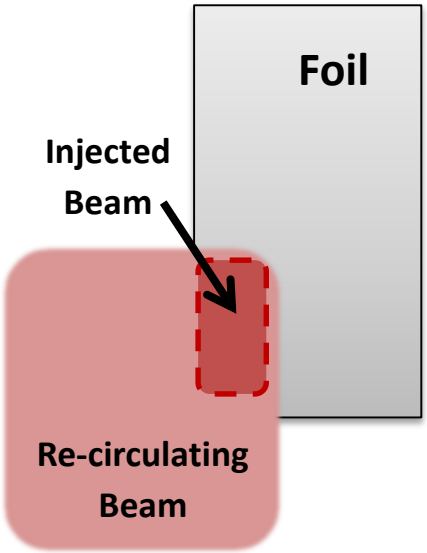


Operating Losses



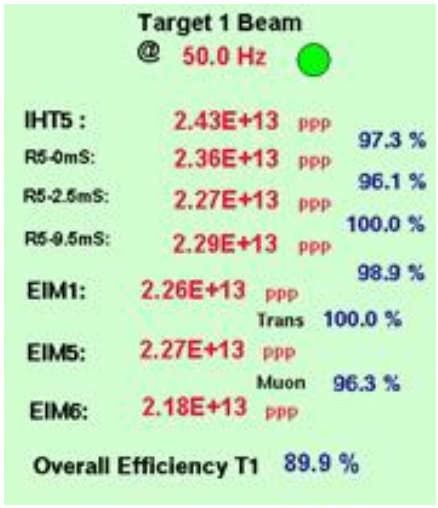
Optimisation

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

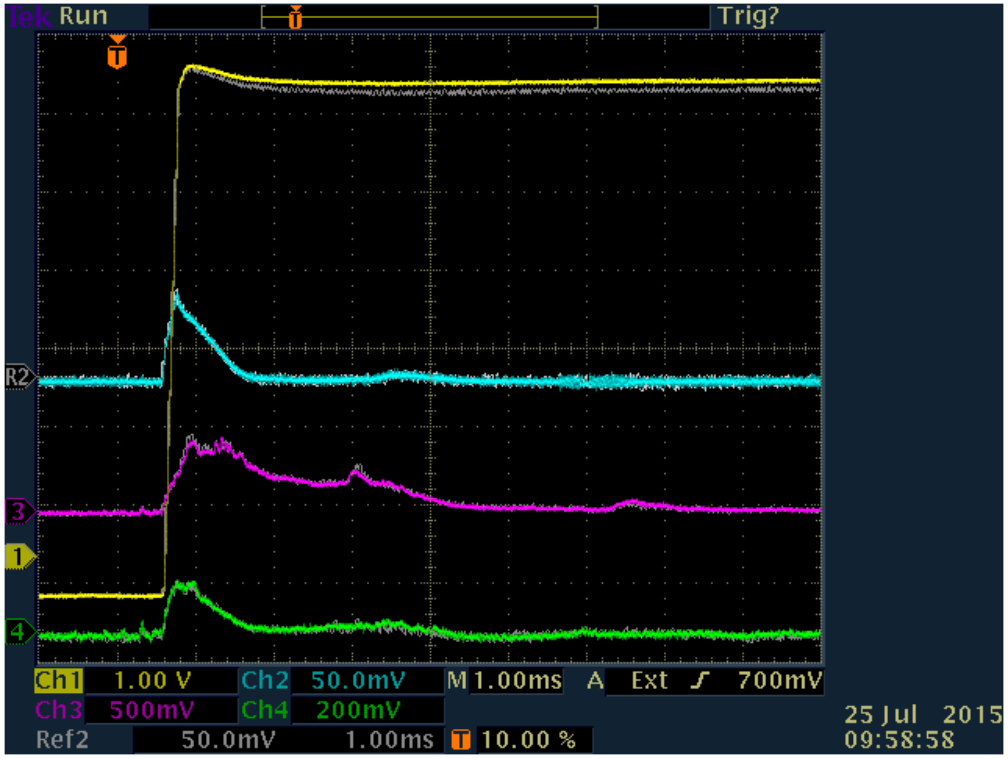


Total of 0.7 mAh – almost 4hrs of 180 µA beam

Necessary to insert foil further during shift

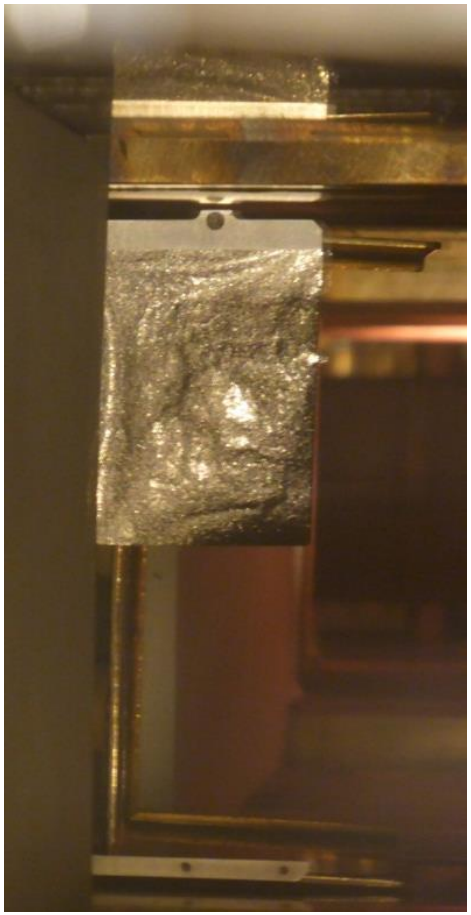


Intensity
Inj Loss
Sum Loss
Sum-Collimators



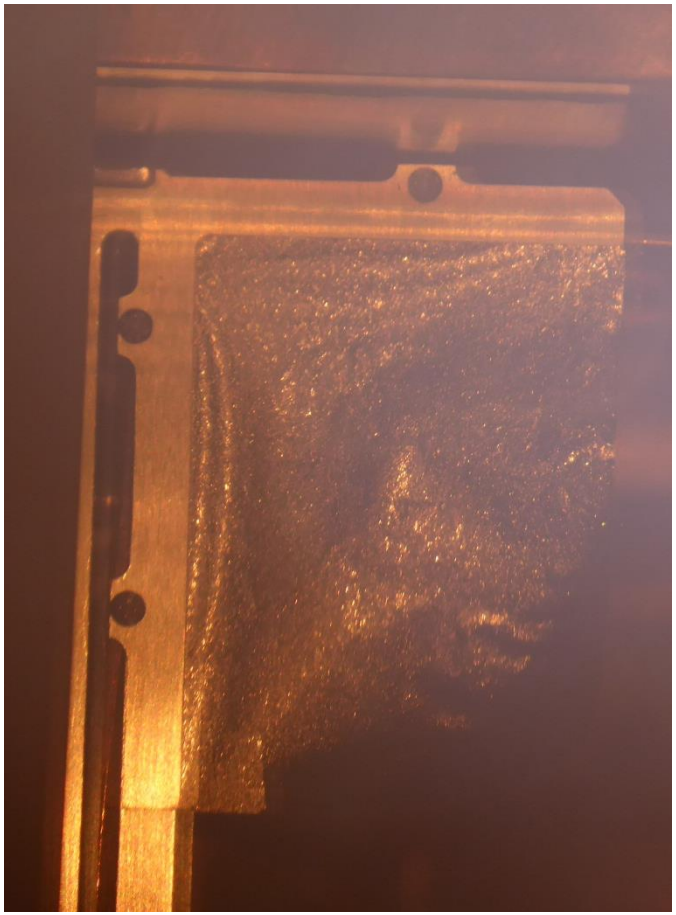
Foil Condition

- Foil inspected Monday am



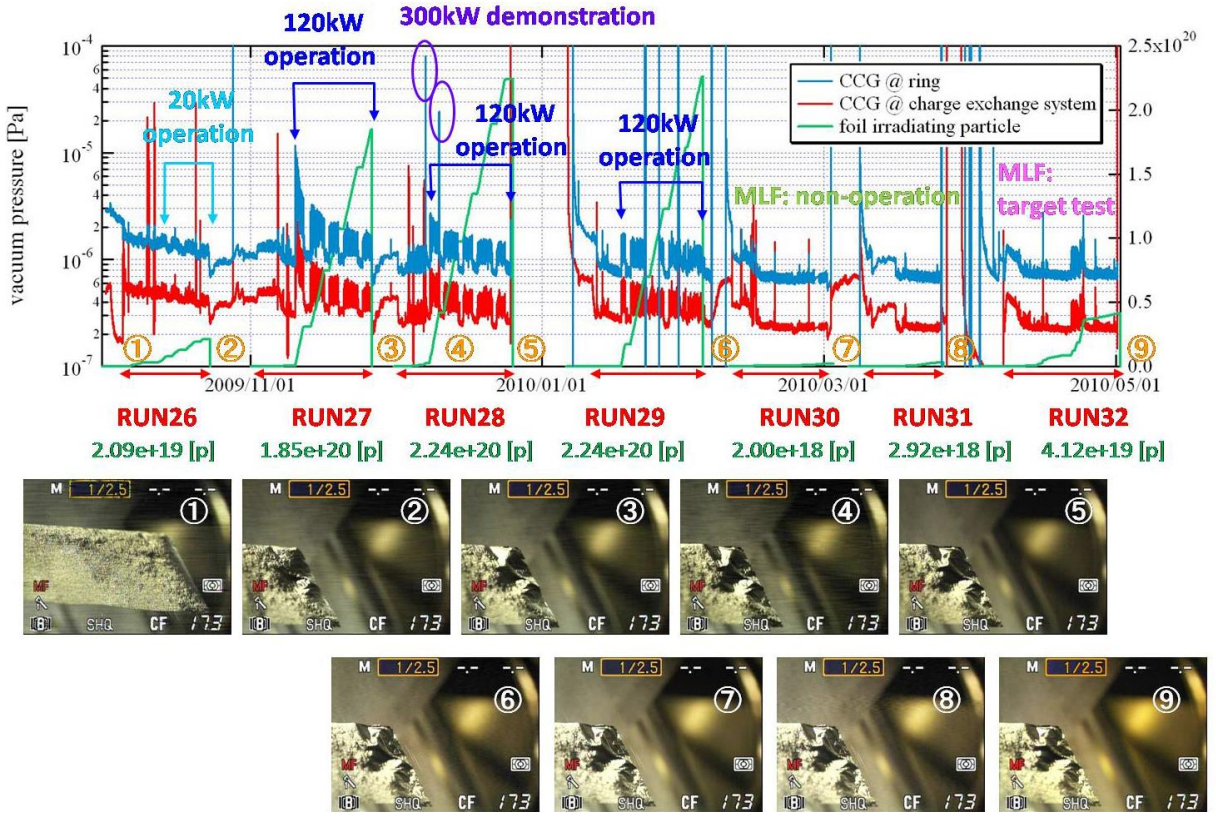
Before

After



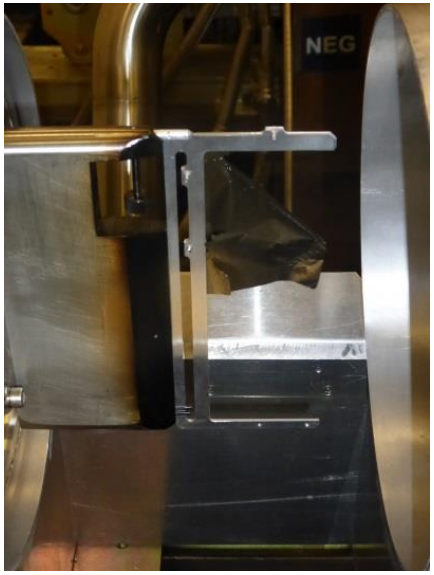
J-Parc

- 180 MeV, 25 Hz – Peak foil temp ~ 500K
- Stable after 7E20 injected particles
  - **≈ 3 days of 50 Hz beam for ISIS**



BEAM STUDY RESULTS WITH HBC STRIPPING FOILS AT THE 3-GeV RCS IN J-PARC, M Yoshimoto, IPAC'10

Removal and Mounting



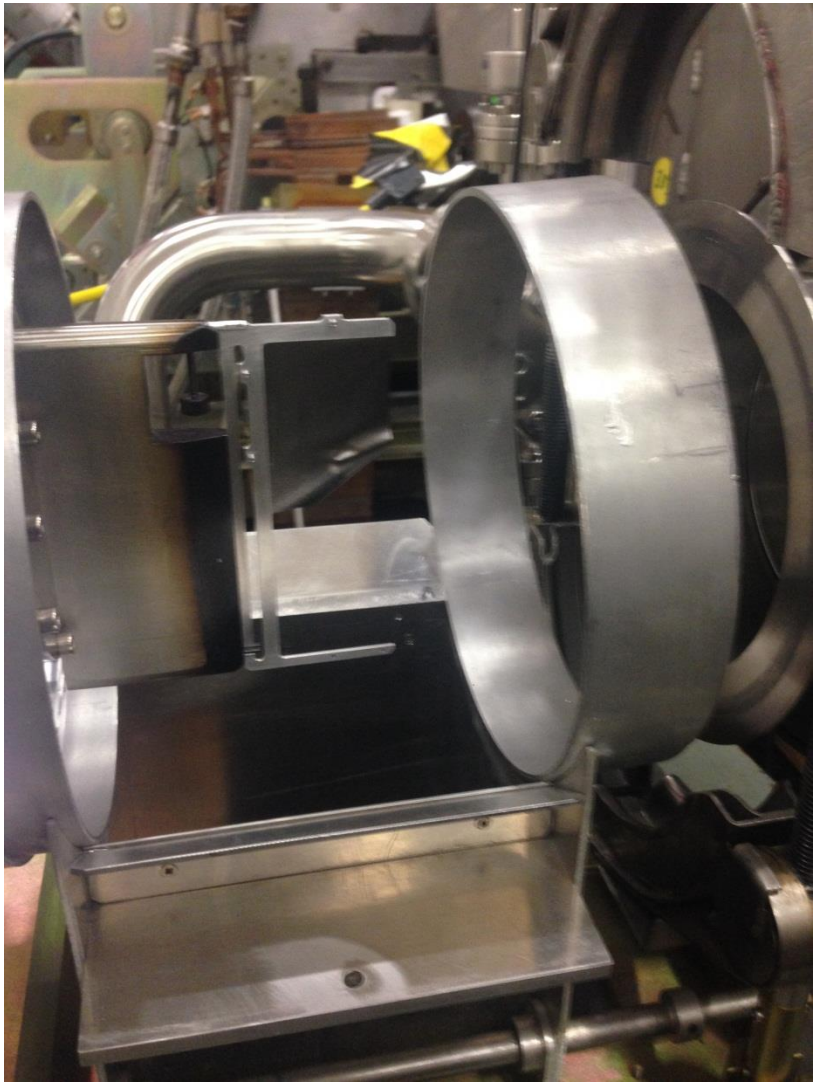
- Foil removed Thursday 10th August
- Vacuum did not remove foil

- New foil mounted ready for two-week static period

CANCELLED

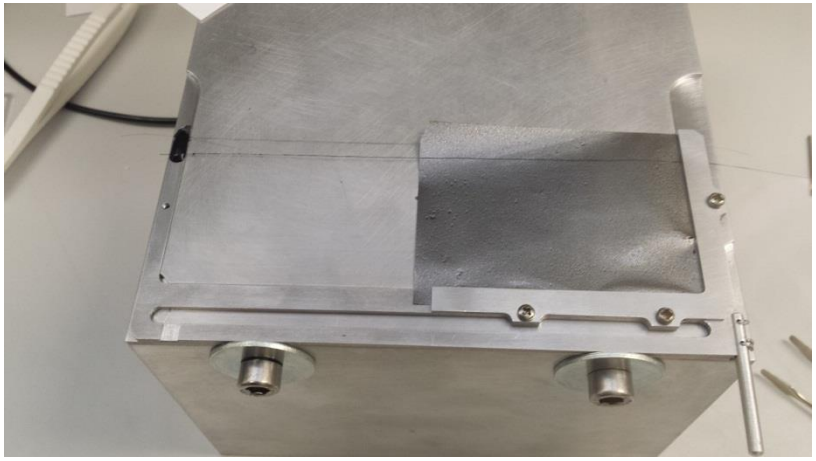
Third test – 16th October

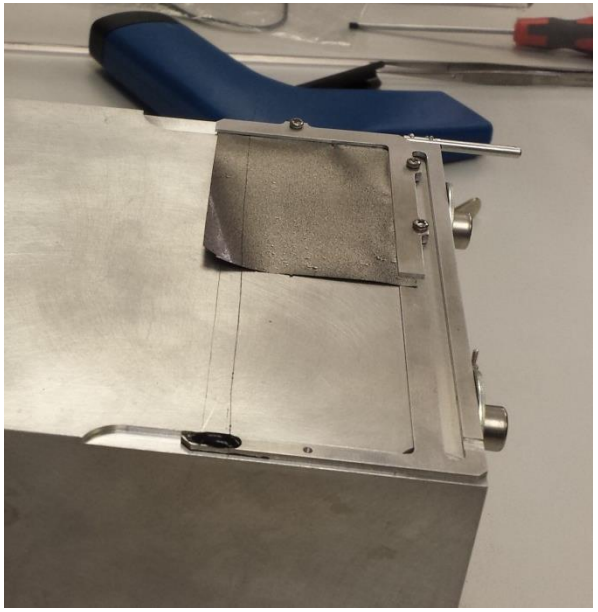
- Installed at end of user run
- Quick setup, injection spot +2mm V
- Injection losses appeared after 5.5 hrs of 50Hz beam.
- Foil curled



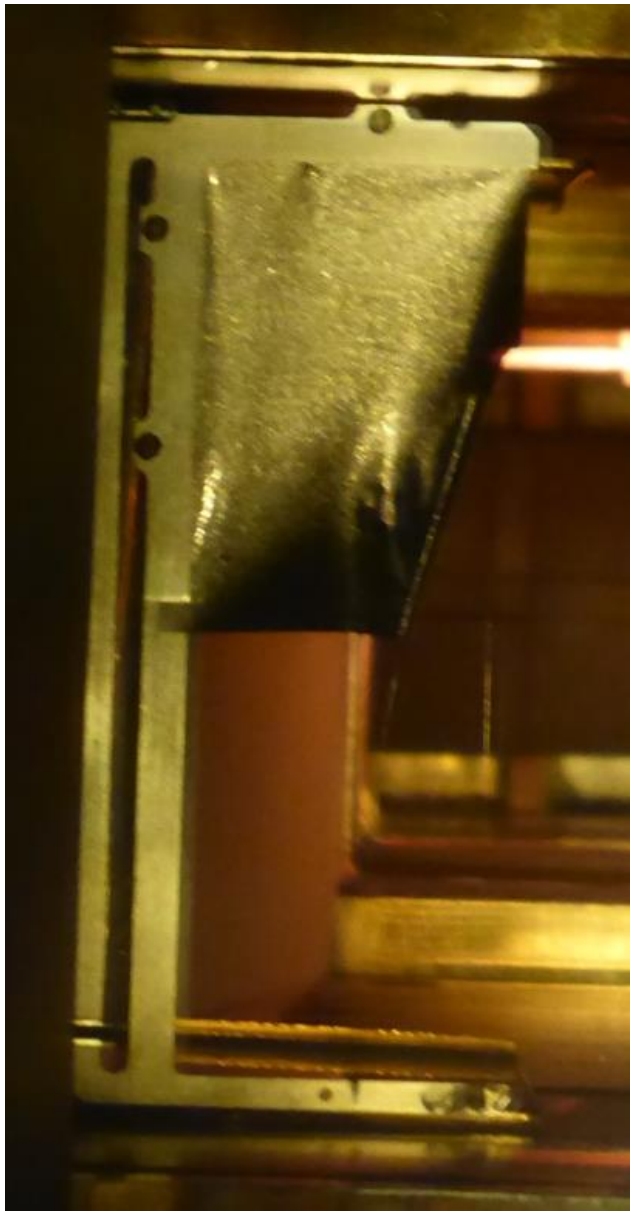
Fibres

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

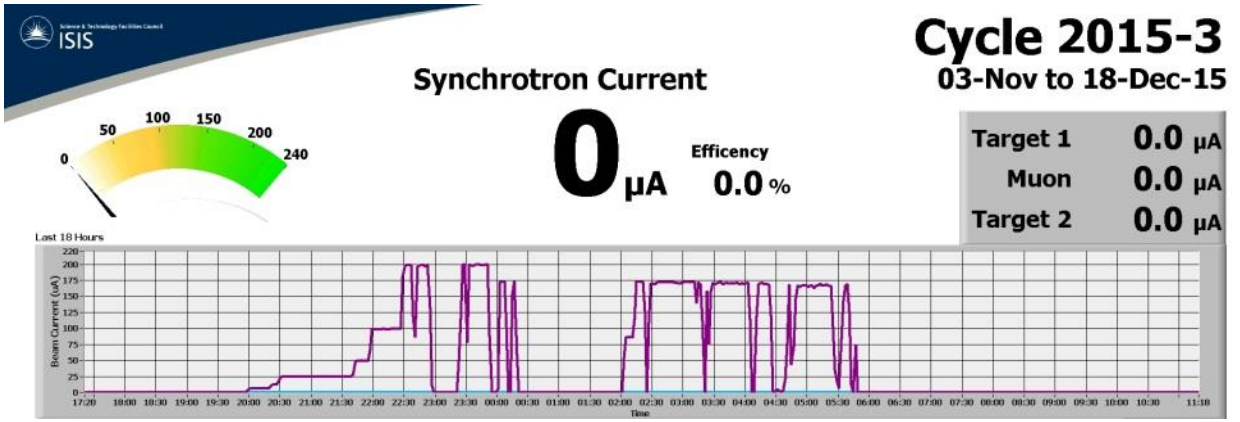




Failure



- 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 ≈ 500K)
- 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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