An engineering review of the ISIS facility extracted proton beam windows.

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Agenda

- Introduction to ISIS
- TS1 Proton Beam Window (PBW)
  - EPB1 – TS1 Interface
  - Configuration
  - Monitoring
- TS2 Proton Beam Window (PBW)
  - EPB2 – TS2 Interface
  - Configuration
  - Monitoring
- Window Replacement (TS1 vs TS2)
- Summary/Comparison
- Future work

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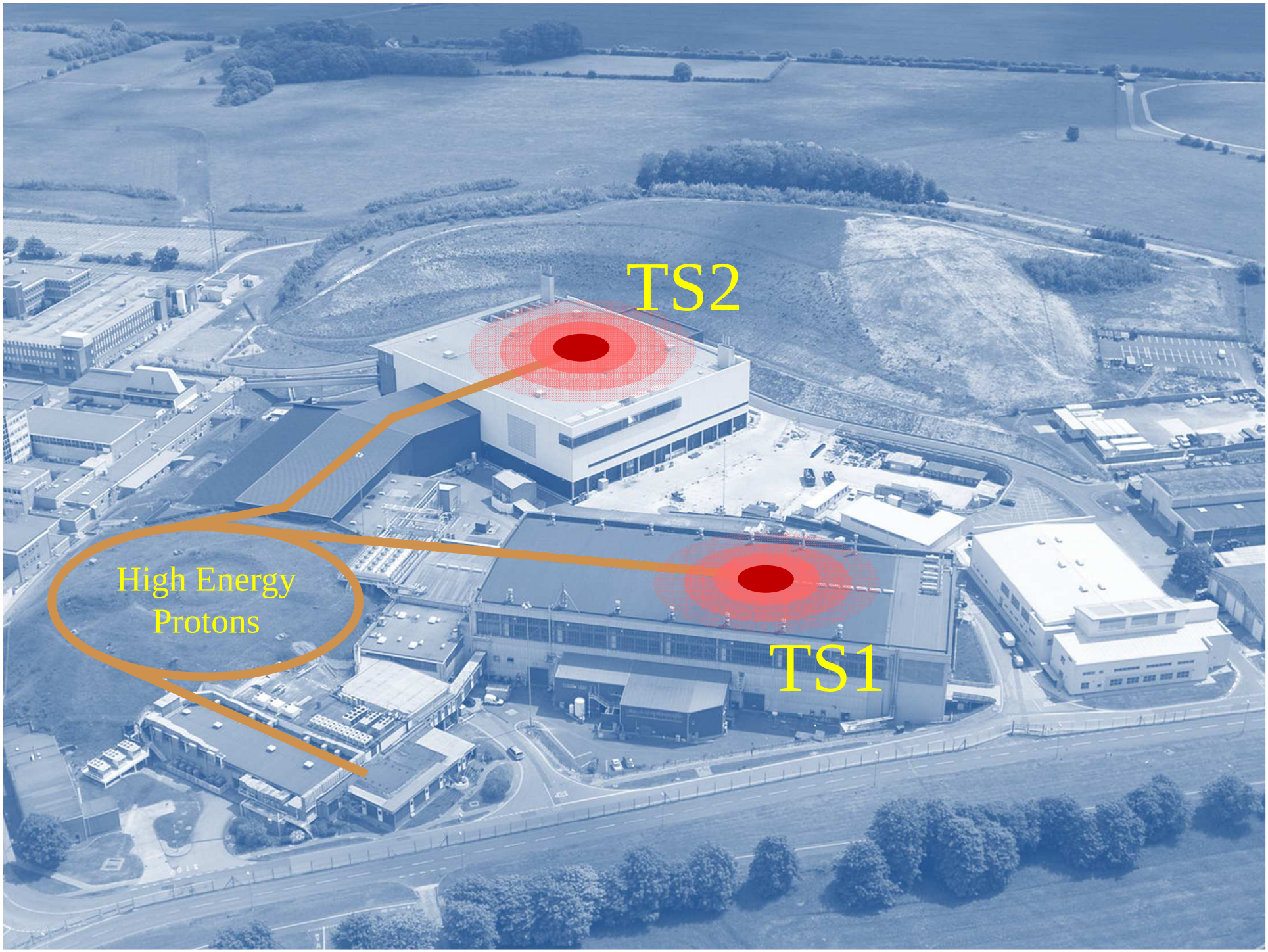
Harwell Science & Innovation Campus


ISIS Facility


TS2
High Energy
Protons
TS1

TS1

SYNCHROTRON

EPB2

TS2

ISIS First Target Station (TS1)

- In operation since Dec 1984
- Target – 12 tungsten plates clad in tantalum
- Typically 160 μA of 800 MeV protons
- Maximum power density ~400 MW/m^3
- Peak energy per pulse ~11 MJ/m^3/pulse
- 4 out of 5 pulses (50Hz)
- Beam sigma of ~17mm (overall beam spot diameter ~70mm)

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ISIS Second Target Station (TS2)

- In operation since 2008
- Target - tungsten cylinder clad in tantalum
- Typically 40 μA of 800 MeV protons
- Maximum power density ~700MW/m^3
- Peak energy per pulse ~70MJ/m^3/pulse.
- 10 Hz (1 out of every 5 pulses)
- Beam sigma of ~6mm (overall beam spot diameter ~36mm)

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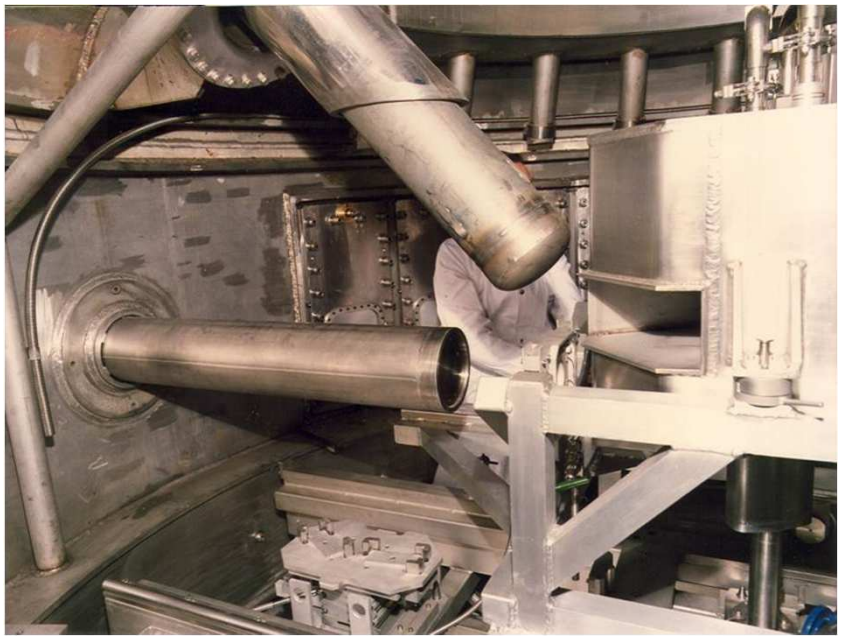
TS1 Proton Beam Window (PBW)

- Double window with water flowing between.
- Ø 145 mm, 3500 mm long
- Each window ~3mm thick Inconel 718.
- Windows welded to austenitic stainless steel support tubes.
- Beam heat input ~ 2500W .
- Water cooled, 26 litres/min.
- First one operated for ~25 years, replaced in 2010.



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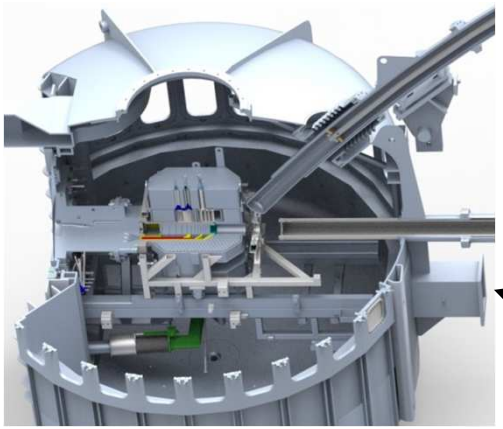
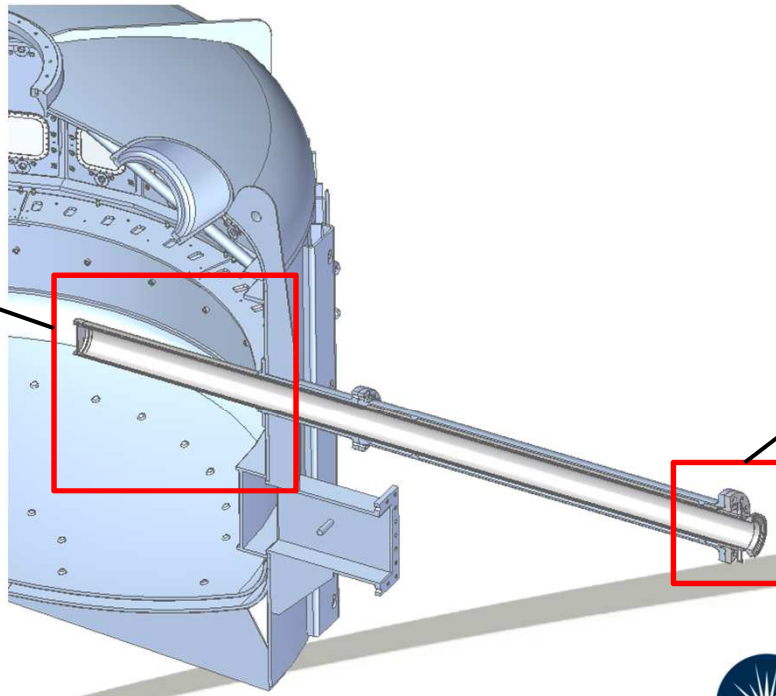
EPB1 – TS1 Interface

- Passes thought the monolith shielding and target void vessel.
- 546 mm from the Target face
- Flange built into the shielding wall (EPB tunnel)





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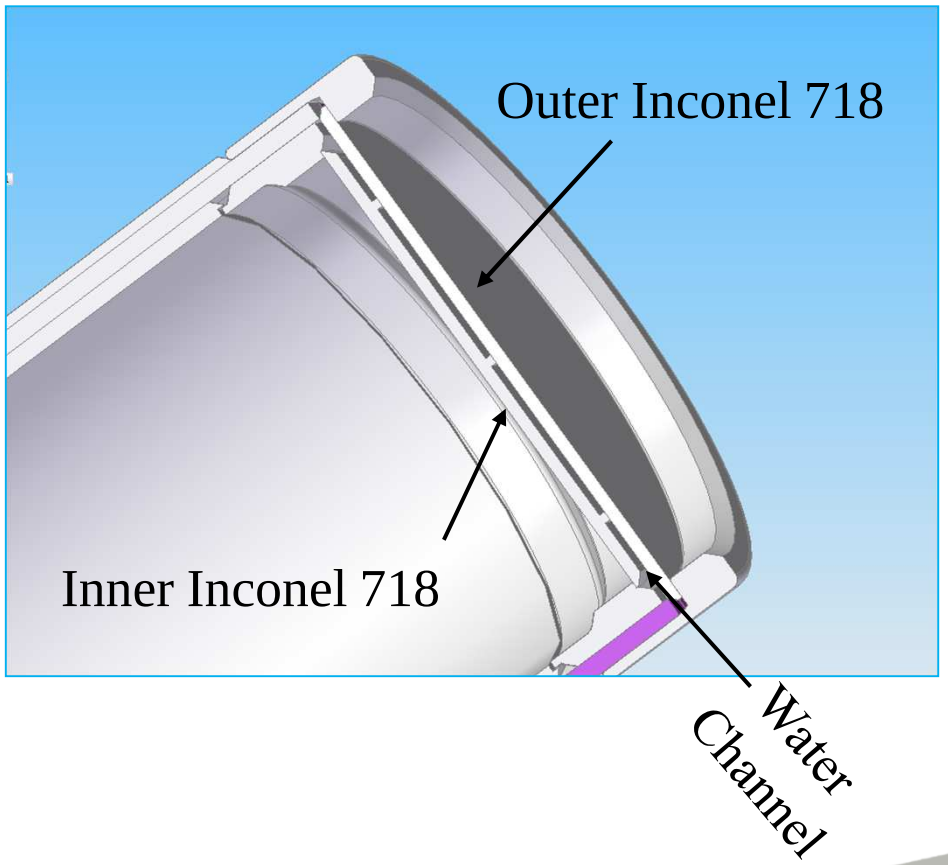
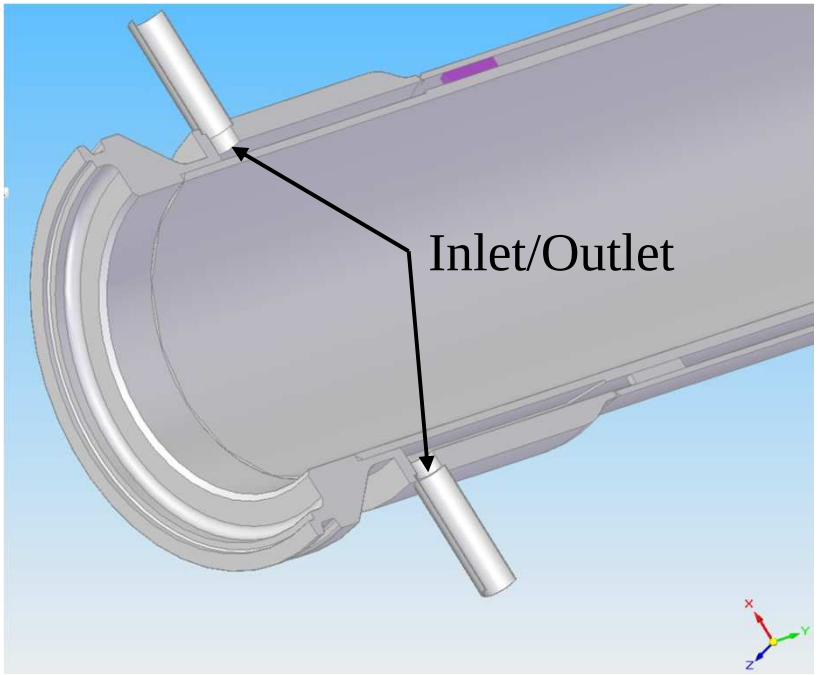
TS1 PBW Configuration

FRONT END SECTION



BACK END SECTION



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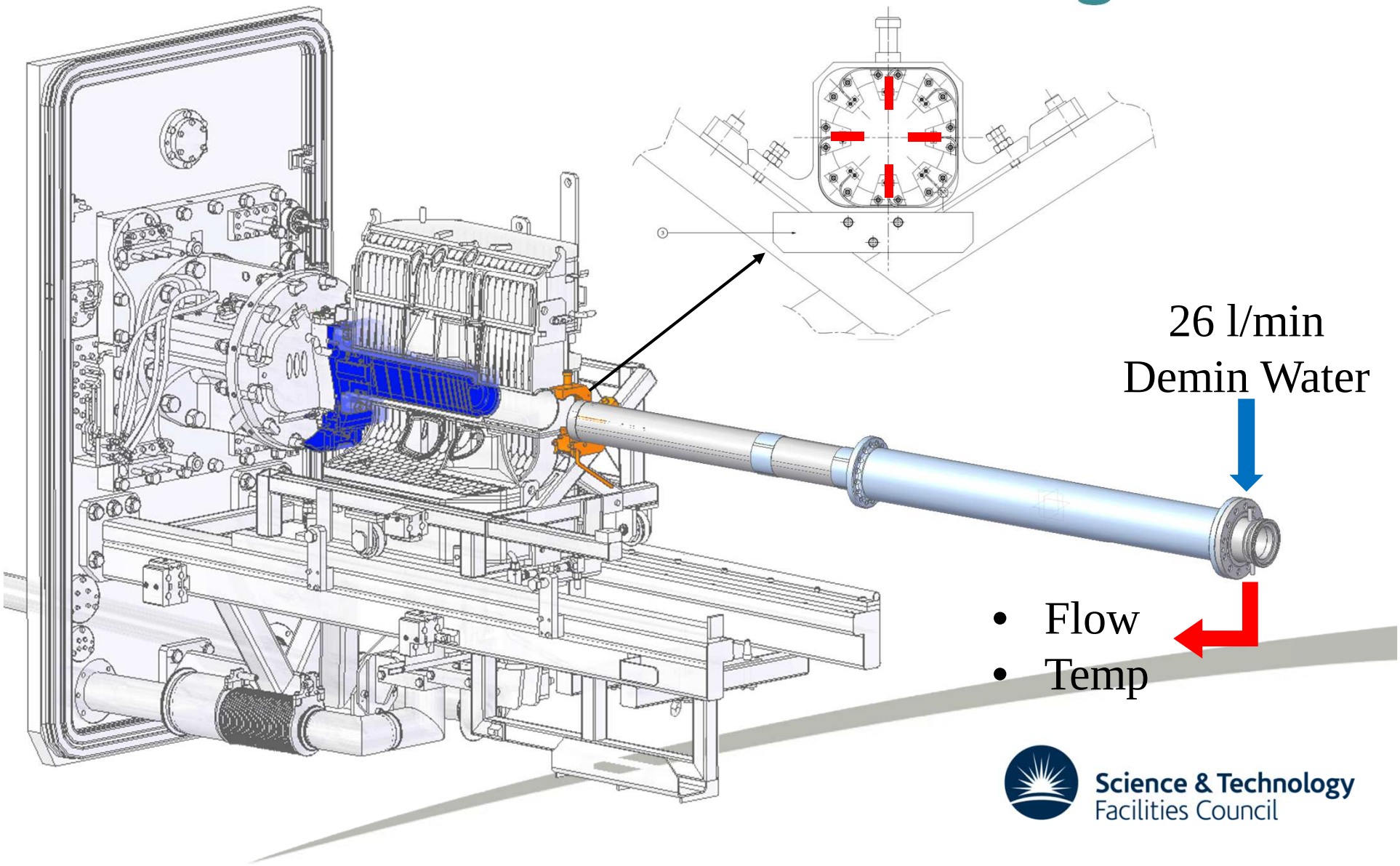
TS1 PBW Monitoring



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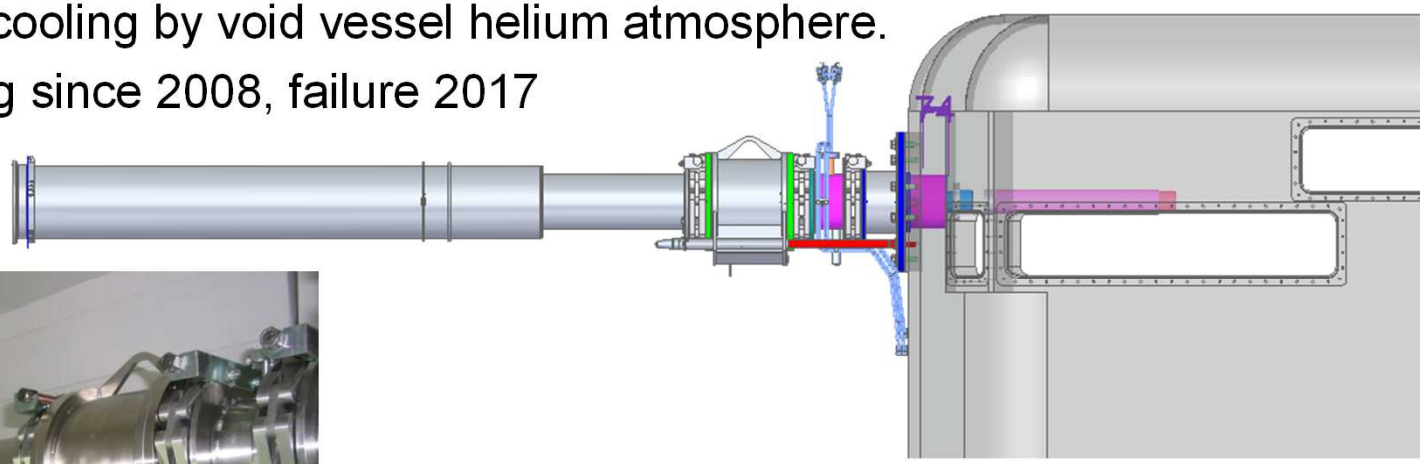
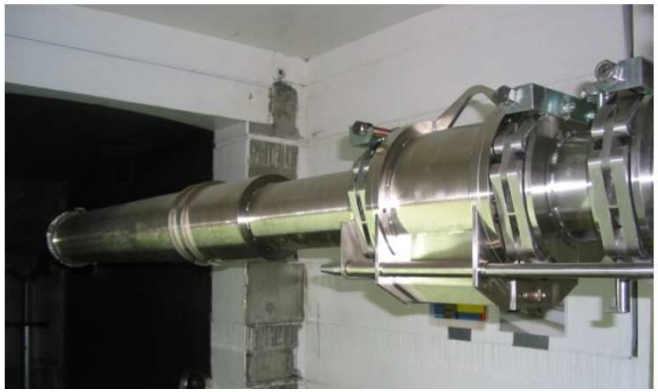
TS2 Proton Beam Window (PBW)

- 0.5mm thick 5083-O aluminium alloy window
- Ø57 mm, 630 mm (nose section)
- Friction welded joint to austenitic stainless steel support tube.
- Beam heating 10W total.
- Passive cooling by void vessel helium atmosphere.
- Operating since 2008, failure 2017





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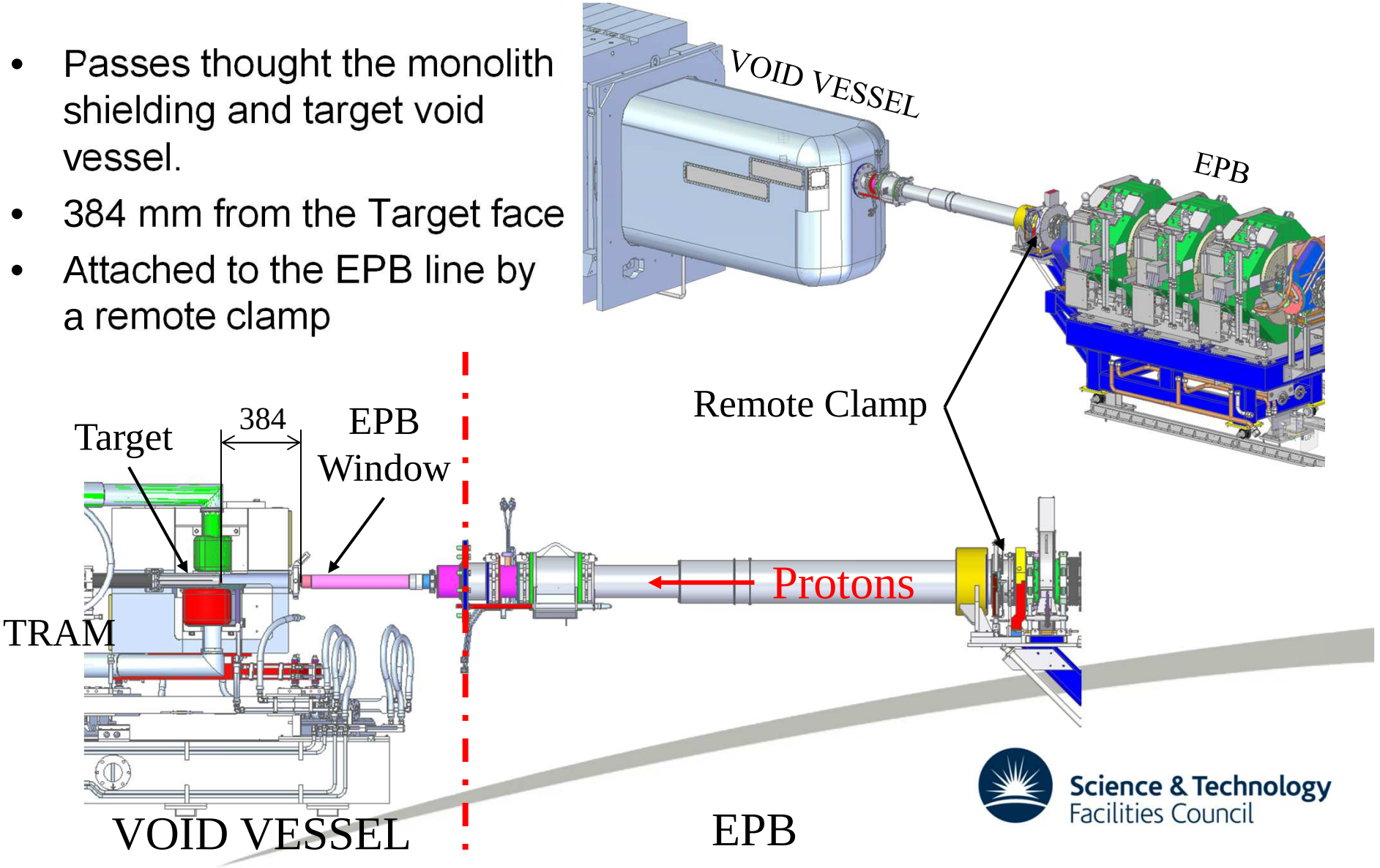
EPB2-TS2 Interface

- Passes thought the monolith shielding and target void vessel.
- 384 mm from the Target face
- Attached to the EPB line by a remote clamp



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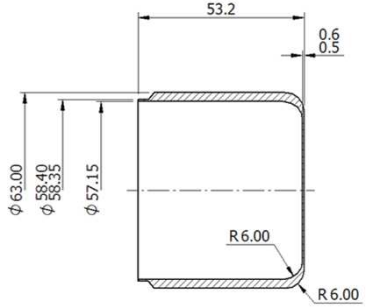
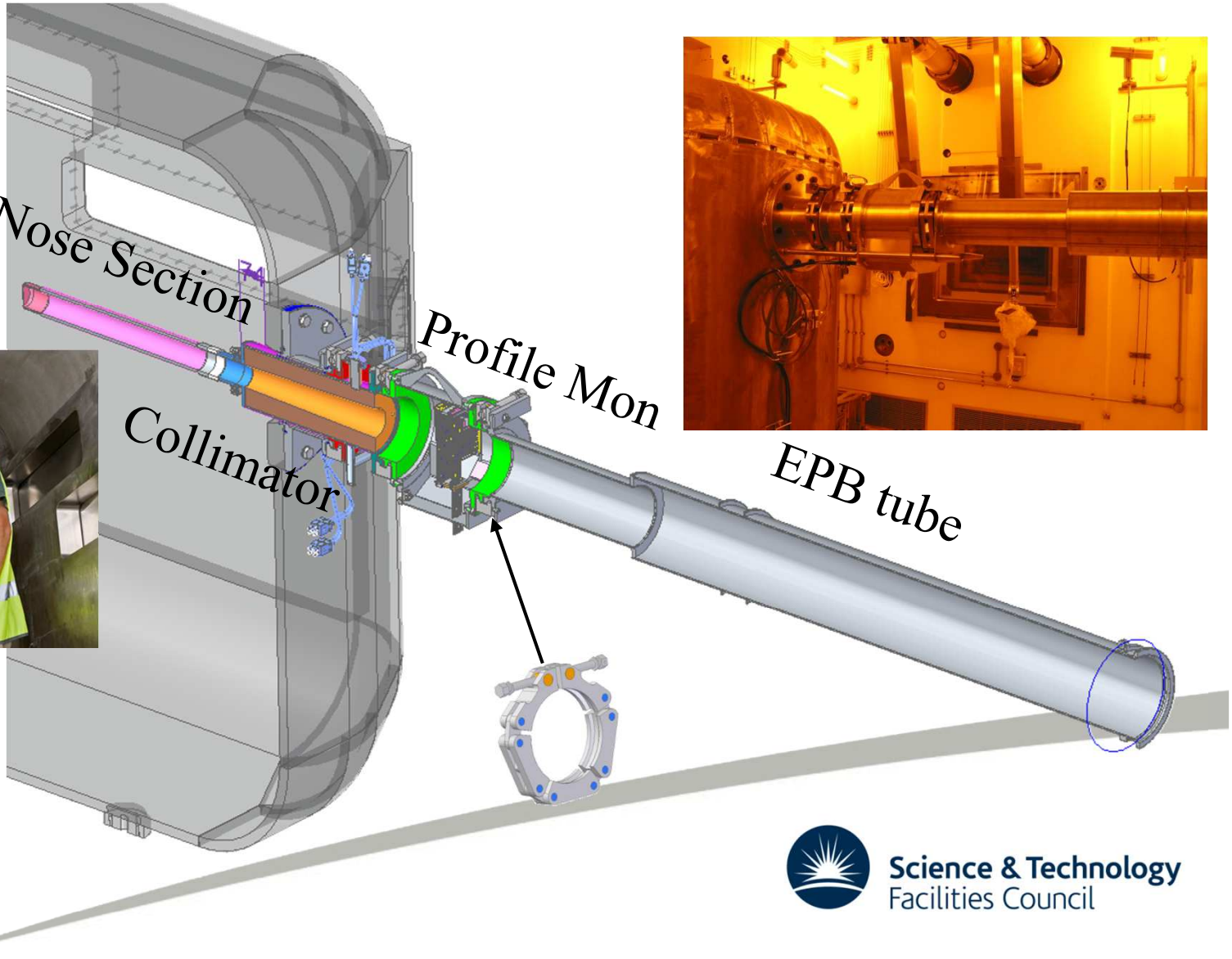
TS2 PBW Assembly





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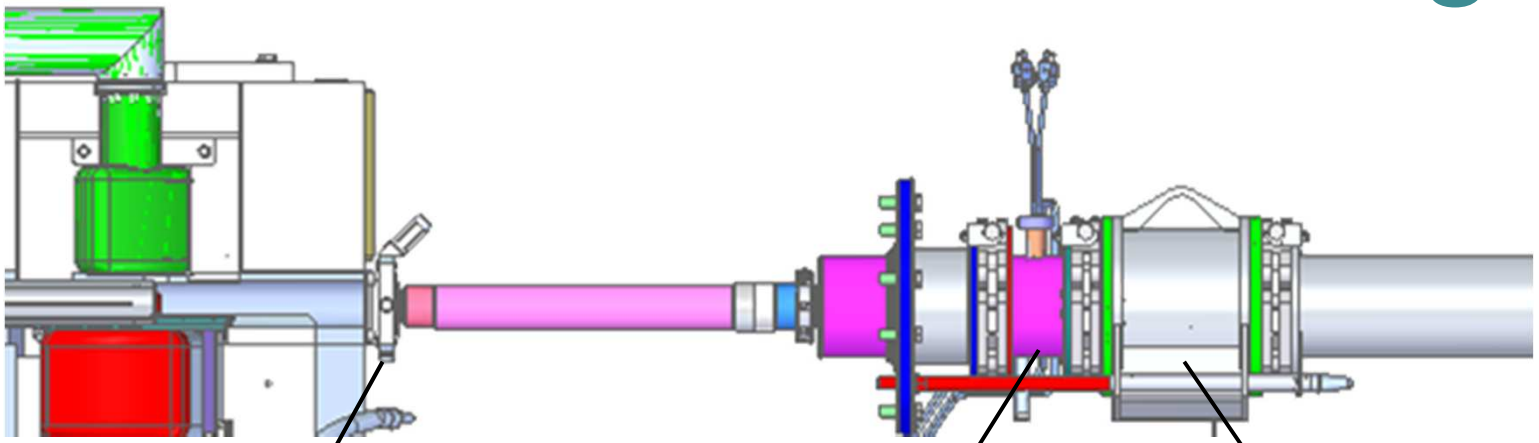
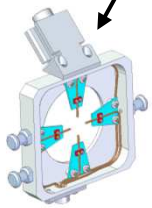
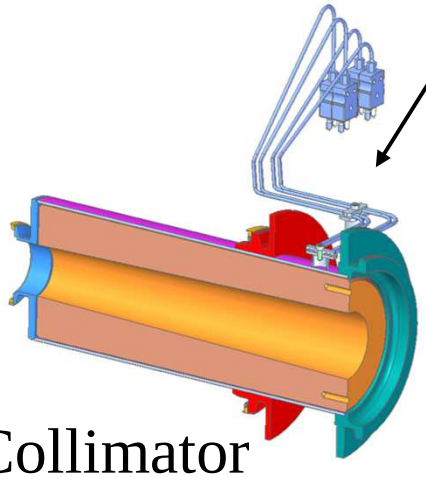
TS2 PBW Monitoring

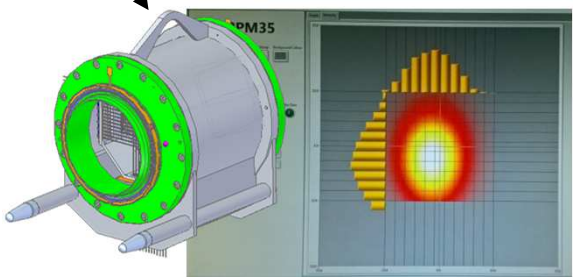




Halo Monitor



Collimator
(thermocouples)



Profile Monitor

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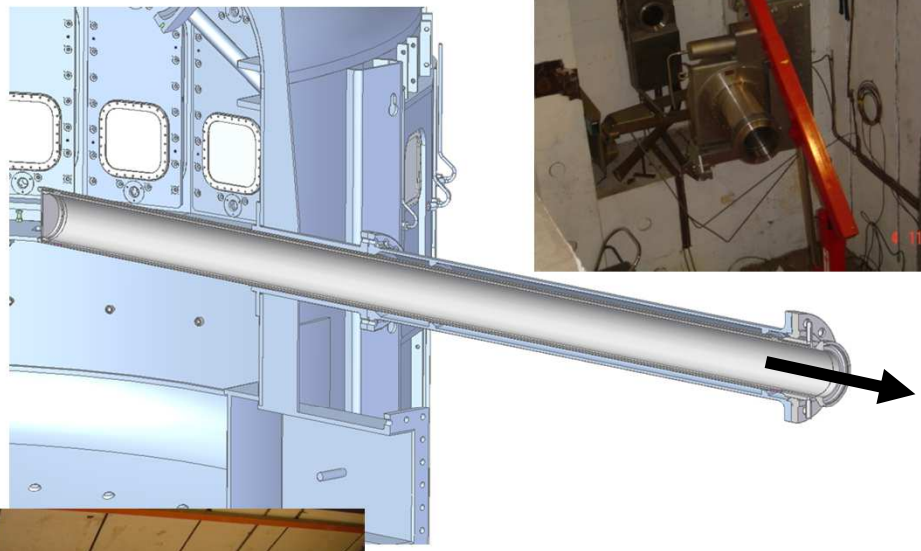
TS1 PBW Replacement

- 6 month shutdown
- High dose
- Mobile specialist tooling



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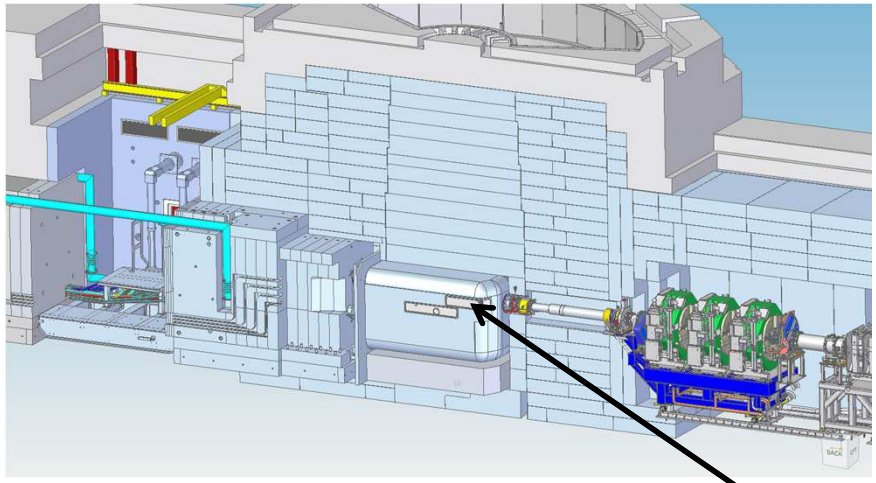
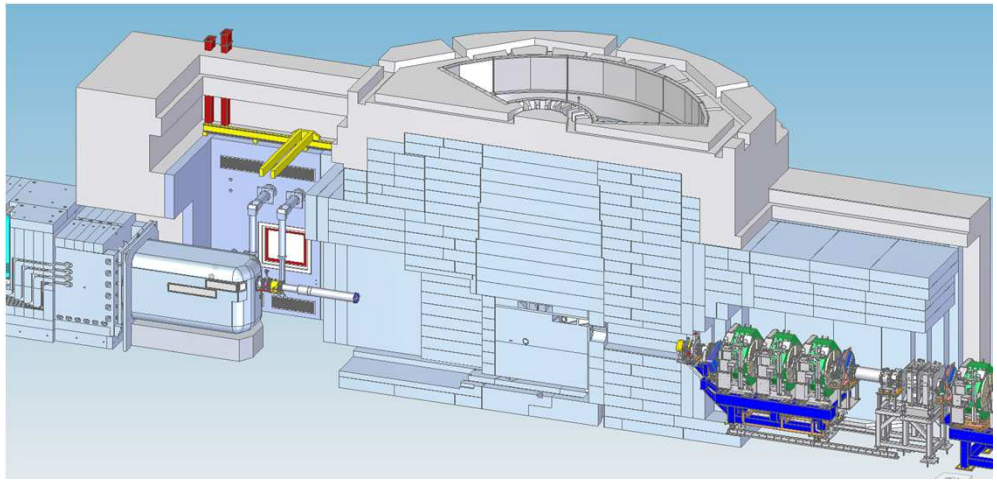
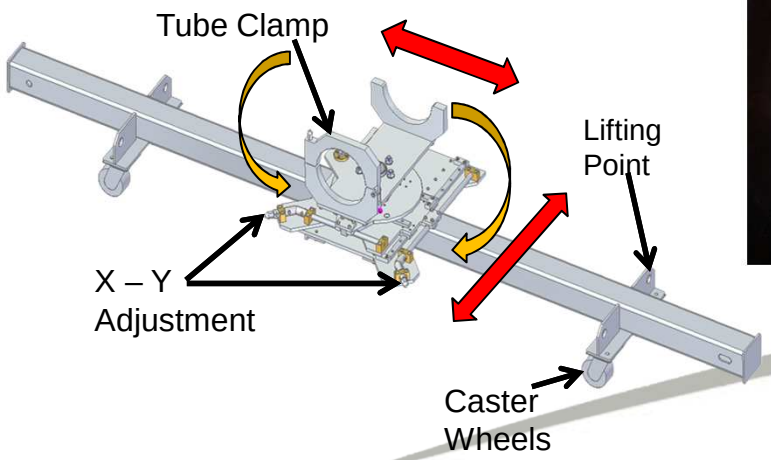
TS2 PBW Failure and Replacement (Dan Coates talk)







- 2 month shutdown
- In cell, no rad dose

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Summary

TS1 PBW

- Material
  - Inconel 718
- Thickness
  - 2 Plates 3 mm thick, separated by 1.5 mm water channel
- 160 µA
- Heat deposition
  - 2500 W
- Cooling
  - Water Cooling, 26 l/min
- Distance to the target
  - 546 mm
- Replacement
  - 6 month shutdown
  - High rad levels (7.8 Sv/h on contact)
- Estimated Life Span
  - 25+ years

TS2 PBW

- Material
  - Al Alloy 5083
- Thickness
  - 0.5 mm
- 40 µA
- Heat deposition
  - 10 W
- Cooling
  - Passive cooling, helium
- Distance to the target
  - 383 mm
- Replacement
  - 2 month shutdown
  - In cell
- Estimated Life Span
  - 6 years*

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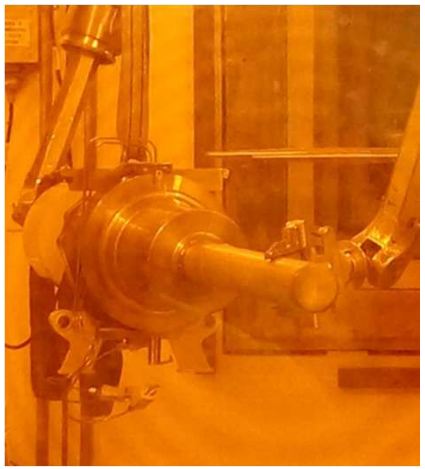
Future Work

- Remove the PBW from the Hot Cell
- Test Sample cycle loading
- Improve life assessment procedures
- Better understanding of radiation damage and embrittlement mechanisms in PBW
- Post Irradiation Examination



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Thank you – Questions?

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