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
Agenda

• Introduction to ISIS
  – TS1 vs TS2 – EPB1 vs EPB2

• TS1 EPB Window
  – EPB1 – TS1 Interface – Configuration, materials – Cooling system, heat deposition, water flow, etc…
  – Monitoring and measurements (temps, water flow, etc.)

• TS2 EPB Window
  – Same bullet points as TS1???

• Windows Replacement (TS1 vs TS2)
• TS2 EPBW Failure
• Future work/further investigation
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)
**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/m³
- Peak energy per pulse ~70MJ/m³/pulse.
- 10 Hz (1 out of every 5 pulses)
- Beam sigma of ~6mm (overall beam spot diameter ~36mm)
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.
EPB1 – TS1 Interface

- Passes through the monolith shielding and target void vessel.
- 546 mm from the Target face
- Flange built into the shielding wall (EPB tunnel)
TS1 PBW Configuration

FRONT END SECTION

INNER INCONEL 718

OUTER INCONEL 718

WATER CHANNEL

BACK END SECTION

INLET/OUTLET
TS1 PBW Monitoring

- Flow
- Temp

26 l/min Demin Water
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
EPB2-TS2 Interface

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

Remote Clamp

Target

EPB

Protons

VOID VESSEL

TRAM

EPB

VOID VESSEL
TS2 PBW Assembly

Nose Section

Profile Mon

Collimator

EPB tube
TS2 PBW Monitoring

Halo Monitor

Collimator (thermocouples)

Profile Monitor
TS1 PBW Replacement

- 6 month shutdown
- High dose
- Mobile specialist tooling
TS2 PBW Failure and Replacement  
(Dan Coates talk)

- 2 month shutdown
- In cell, no rad dose
## Summary

### TS1 PBW
- **Material**
  - Inconel 718
- **Thickness**
  - 2 Plates 3 mm thick, separated by 1.5 mm water channel
- **Current**
  - 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
- **Current**
  - 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*
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
Thank you – Questions?