Proposals for ISIS Target Station 1 upgrade

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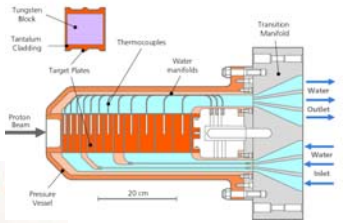
Aims of the Upgrade

- Increase of at least a factor of two in useful neutrons
- Produce a robust design that maximises operational availability

Constraints

- Existing instruments: time structure and wavelength band
- Moderator heights cannot change
- Critical heat flux of 3MW/m^2
- Stress limits (Von Mises) in Tungsten and Tantalum of 275MPa and 75MPa respectively
- Existing infrastructure i.e. extracted proton beam & void vessel
- Current shielding and background levels
- Existing services and plant capacity

Figure 1.
A X-section of the current TS1 target (right) and the full target assembly on a test rig (below).



Current Design

- D_2O cooled W plate target
- Moderators
  - 2 x H_2O (0.5 L) Gd poison + Boral decoupler
  - CH_4 (0.5 L) Gd poison + Boral decoupler
  - H_2 (0.8 L) no poison + Boral decoupler
- Reflector - Rods of Beryllium (D_2O cooled)
- 17 Neutron Beam lines

Upgrade target candidates

The neutronic model of the TS1 target station allowed the evaluation of the candidate target categories developed by the neutronics team.

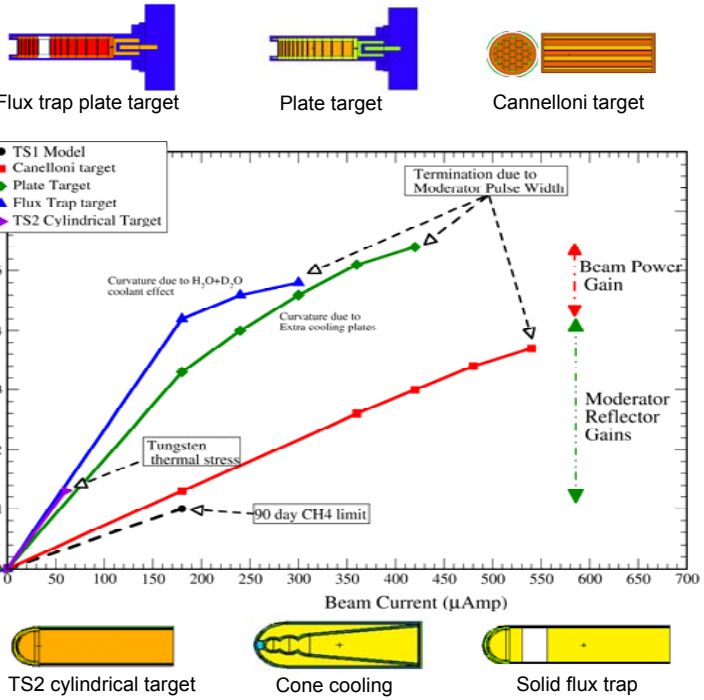


Figure 2. (Approximate) Relative Gain Factor Vs Proton Beam Current [1], framed by some of the investigated target configurations

TS1 Target Upgrade Model

The current TS1 Target Upgrade model includes:

- Target of tungsten plates or cylinders clad in tantalum
- Possible flux trap in middle
- Cooling provided by water flowing between plates / discs

Engineering Design

- Cooling flow design
- Number of plates
- Target X-section geometry
- Methods of manufacture
- Maximum beam power limit
- Cladding investigations [2]
- Analysis work
- Surface heat flux
- Temperature distributions
- Thermal stresses
- Transient effects
- Fatigue studies

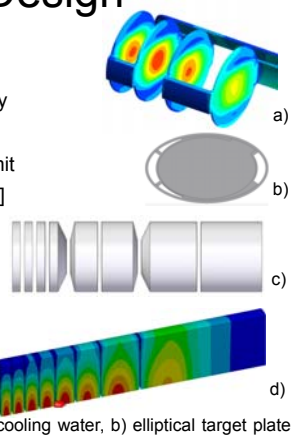


Figure 3. a) heat flux contours in cooling water, b) elliptical target plate with cooling channels, c) schematic showing chamfered flux traps & d) temperature distribution in a cylindrical plate target

Conclusions

- Constraints keep beam current under ~300 μA
- Limited neutronic advantage to increasing power above 180 μA
- A plate style target appears best option for ISIS
- Replacement of legacy design for target housing offers several benefits
- Reflector and moderators updates give greatest scope for significant gains

References

[1] ISIS Internal presentation: "TS1Upgrade_TargConfig-GS_May2013" – Goran Skoro and Stuart Ansell (2013)
[2] Thermo-Mechanical Analysis of ISIS TS2 Target – Dan Wilcox et al – 5th High Power Targetry Workshop (2014).

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