# All-Metal Water Target with Spherical Window

W. Gelbart[a,1], R. R. Johnson[b], B. Abeysekera[c] L. Matei[d], D. Niculae[e]

[a]Advanced System Desgin, Garden Bay, BC, Canada
[b]Best Cyclotron Systems, Vancouver, BC, Canada
[c]PharmaSpect, Burnaby, BC, Canada
[d]Best Theratroncics, Ottawa, ON, Canada
[e]Horia Hulubei National Institute for Physics and Nuclear Engineering, Magurele 077125, Romania.

## Introduction

The use of a prefabricated target window assembly greatly simplifies the window installation. The window module is sealed by metal knife-edges, thus eliminating any elestomers in the target construction.

Spherical Havar window offers high strength at reduced thickness and does not require helium cooling.

The target body is of platinum-plated silver.

The target assembly includes an integral beam collimator and a four-sector mask.

## Material and Methods

The window module consists of a hydroformed Havar foil (Hamilton Precision Metals, Inc.) electron beam welded to copper-stainless ring. The whole assembly is platinum plated (DNS Platinum Plating Solution, Johnson Matthey) after welding (FIG. 1).


FIGURE 1. Electron-beam welded window module

The window ring is machined from a silver-soldered copper-stainless bar. The copper that is left in totally annealed state, provides the sealing area (FIG. 2).

During the process of hydroforming the 50 micron thick Havar is stretched providing a gradually changing thickness from full at the edges to 28 microns in the centre. In tests the windows withstood a pressure of over 200 bar (at room temperature.)

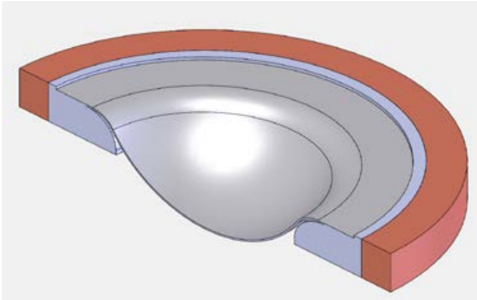

FIGURE 2. Cross-section of the window showing the bi-metallic construction of the ring

The target body is cast from pure silver. Casting was done directly from a 3D printed wax pattern that incorporated all the features, including cooling cannels (FIG. 3). Target volume is 3 cc with additional expansion and evaporative cooling space above it. All the surfaces that come in contact with the target material are platinum plated.

Sectional view of the target assembly is shown in FIG. 4. The target is designed for an operation with a ~13mm diameter beam, collimated to 10mm.

The water cooled conical collimator forms an integral part of the target. In front of the collimator a four sector silver mask allows a precise centering of the beam on the target (FIG. 5).

FIGURE 3. Cast silver target body and hardened stainless knife-edge-ring before pressing

[1]Corresponding author, E-mail: gelbart@asd-inc.ca

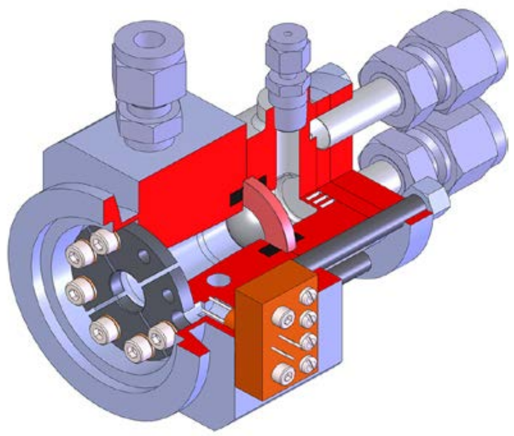

FIGURE 4. Sectional view of the target showing the mask, collimator and the window module.

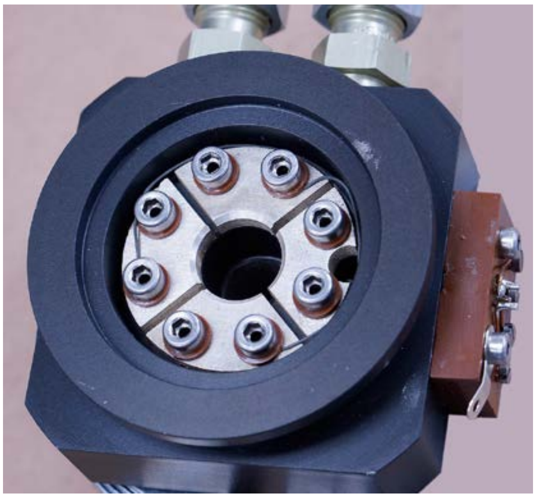

FIGURE 5. Target front showing the silver sector mask and the collimator

The knife edge seals, as separate rings, are machined from 440 steel hardened to Rc 60. The two rings are pressed directly into the target body and the collimator block to form a vacuum-tight metal to metal seals. The window module is clamped between the two seals with the knife edges embedded into the copper periphery of the bimetallic window ring.

This approach allows for a quick and efficient window module change at the end of the window life cycle.

**Results and Conclusion**

Tests are being performed to determine the number of window module changes the knife edges can survive. The results will be available soon, but preliminary experiments indicate more than 10 cycles.

Most water (and gas) targets undergo scheduled window changes to prevent a failure due to radiation damage to the window foil. In many cases the elastomer o-rings that seal the window foil fail even earlier. An interval of 3 to 6 months between window changes is typical under most operating conditions, but less frequent changes are possible with the metal seals.

The target is expected to operate at beam powers of over 2 kW with pressures over 50 bar.

Runs are scheduled during May 2014 to determine the target performance under bombardment.

A technique for a niobium coating of the target chamber is being developed. This coating can be placed instead or in addition to the platinum plating. The results will be reported.

**References**


1. J. L. Peeples: Design and Testing of Thermosyphon Batch Targets for Production of $^{18}$F. *Doctor of Philosophy Dissertation, Department of Nuclear Engineering, North Carolina State University.* Raleigh, North Carolina, 2008.

2. R. Strangis, C.G. Lepera: Reliable Fluorine-18 [$^{18}$F$^{-}$] Production At High Beam Power, *Proceedings of the Eighteenth International Conference on Cyclotrons and their Applications.* Giardini Naxos, Italy, 2007.

3. M. H. Stokely *et al*: High Yield Thermosyphon Targets for Production of $^{18}$F-Fluoride, *Proceedings of the Eleventh Workshop on Targetry and Target Chemistry*. Cambridge, UK, 2006.

4. C.W. Alvord, A.C. Williamson, T.L. Graves, S.S. Zigler: *Nucl. Inst. Methods Phys. Res. B* **241**(1–4), pp. 708–712, 2005.

5. M.S. Berridge, R. Kjellström: *Appl. Radiat. Isotopes* **50**, pp. 699–705, 1999.



[1]Corresponding author, E-mail: gelbart@asd-inc.ca