

EXTERNAL HIGH CURRENT TARGETRY FOR RADIOISOTOPE PRODUCTION

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ABSTRACT

A prototype high current 12 kW (400 μ A at 30 MeV) solid target system for radioisotope production has been constructed for use with the new TRIUMF/EBCO TR30 cyclotron. Improvements in target body design and construction allow a surface area of 43mm \times 100mm for plating target materials which are kept below 160°C during the irradiation process. The existing 6kW system employing pneumatic transfer and remote controlled manipulation of the target and shuttle requires very few changes to incorporate this upgrade. With such increases in target current limits the potential of the new breed of cyclotrons, such as the TR30, can be more fully utilized.

1. SOLID TARGET SYSTEMS AT TRIUMF

Two commercial compact cyclotrons exist at TRIUMF for the production of radioisotopes, PET research, etc. A large part of this production proceeds on "Solid Target Systems" (STS). These systems irradiate plated materials on a water cooled target body (for more details of the technology involved see Ref. [1,2]).

The traditional targets used for the STS are shown in Fig. 1. The beam is deliberately diffused over the active surface area (~30 \times 70 mm) by a combination of magnetic defocusing and by aligning the horizontal axis of the target at 7° to the beam to produce a 1:8 magnification factor. Under these conditions the targets are capable of accepting a proton beam up to 200 μ A at 30 MeV (6 kW). Water cooled collimation systems, placed immediately before the target, are responsible for the well defined edges of the irradiated plate surface. Under this arrangement, these targets routinely receive almost 200 μ A while spilling less than 40 μ A on the collimators. The surface temperature of the targets stays below 140° if sufficient water flow (15 litres per minute) is maintained.

The targets are transferred to the target stations from the hot cells along pneumatic transport systems. Targets are briefly placed within carriers ("rabbits") for the journey. At each target station, a manipulation sys-

tem removes the target and places it in a vacuum box connected to the beamline. Cooling water is connected to the target through the manipulator arm which holds the target securely in place during the irradiation process. An O-ring, placed around the body of the target, seals against a flange on the vacuum box. After the pump-down procedure (typically taking 10-15 mins) the main beamline valve is opened to the target station and the irradiation can proceed. This procedure is reversed to return the irradiated targets to the hot cells for processing. Complete remote operation of the system is achieved with a programmable logic controller.

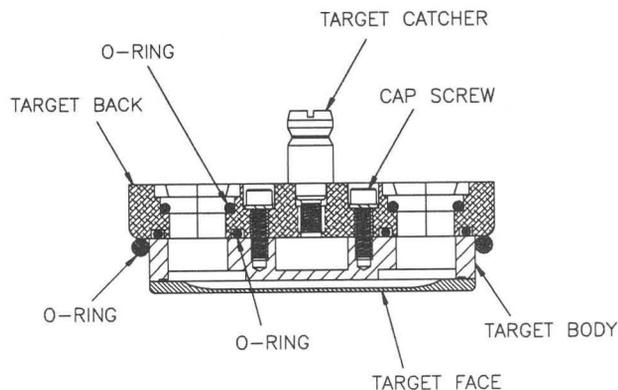


Fig. 1. A 200 μ A target used on the TRIUMF STS.

Over the years minor improvements to this system have been made. Choices of materials and electrical com-

ponents that are more radiation resistant have reduced the repair/maintenance requirements. Shortcomings, inherent to the original system, have been ironed out one-by-one. For example, the original design incorporated O-rings for sealing the cooling water *on the manipulator head*. This necessitated a routine replacement every two weeks since these items were very susceptible to radiation damage at this location. New targets now incorporate these O-rings on the targets and are changed routinely during the target preparation.

While work continues towards ever improving this target system it became obvious to us that an absolute limit had been reached with regard to beam current on these targets. Because of the thin silver face of the target, necessary to conduct heat efficiently, the water pressure has to be kept at no more than 6 bars to prevent any bulging of the material. Cooling power and beam currents are therefore limited to about 6kW or 200 μA at 30 MeV on these targets. Since modern cyclotron systems can deliver much more than this it is highly desirable to have targetry that can accept these higher powers.

2. HIGHER CURRENT TARGETRY

Methods of increasing the power rating of targets include moving the beam over surfaces or having rotating targets. A much simpler method, in principle, is simply to increase the target surface area and water cooling requirements. For our system this has the advantage of minimizing the changes required to the existing hardware (only three components have to be modified – and these can all be accomplished in situ).

Figure 2 shows the prototype 12kW solid target assembly [3]. Here we have maximized the target surface area available for irradiation (43×100 mm) while keeping the target body still within the geometrical limitations of the present rabbit system for transportation. Water cooling requirements have been doubled to allow correspondingly higher power levels. The beam incident on the target face is diffused to twice the area thereby keeping the collimator to target ratio the same. The power density remains the same at the centre of the target.

Another specific improvement is to the target body material which we have constructed from aluminum (rather than the traditional copper) so that the new targets are in fact lighter (500 g) than before and are not a problem for the pneumatic transfer system. Aluminum is also a better choice of material in terms of residual radiation after radioisotopes have been produced. The aluminum is soft soldered to the silver target face after the aluminum body is copper plated. A central rib is connected between the target silver face and the body. This gives added strength and an additional route for cooling to the target.

The remote manipulation of the target on the 6kW targets involves grasping and locking onto a target “nipple”. Due to the geometrical limitations of the new target design, the nipple has been replaced by an insert as shown in Fig. 2 with the corresponding changes to the

manipulator head.

Tests with modified 6kW targets show that this style of target performs equally well as the traditional (copper bodied) targets.

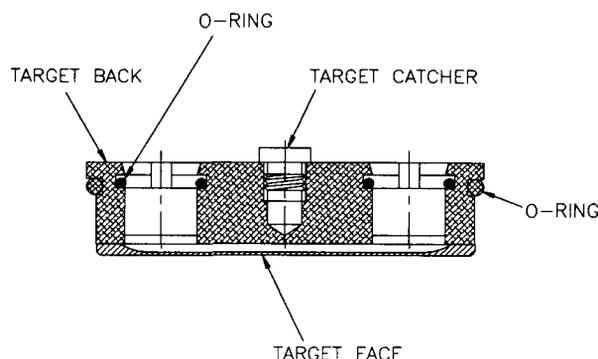


Fig. 2. Higher current (12kW) solid target.

3. CONCLUSION

To address the increasing requirements for radioisotope production on external targetry the TRIUMF TR30/CP42 solid target system is being upgraded to 12 kW (400 μA at 30 MeV protons). This is being achieved primarily by a corresponding increase in surface area and water cooling and is designed such as to utilize most of the existing STS hardware. The first complete prototype will be installed later this year on the TR30 system.

4. REFERENCES

- 1) Pinto, G., *et al.*, “Target Systems for Radioisotope Production,” in **Proceedings of the 7th Conf. on the Applications of Accelerators in Research and Industry**, Denton, Texas, 1982.
- 2) Burgerjon, J.J., *et al.*, “A High Power Target System for Radioisotope Production,” in **Proceedings of the 11th Conference on Cyclotrons and their Applications**, Tokyo, 1986.
- 3) Gelbart, W.Z. and Stevenson, N.R., “High Current Targetry for Radioisotope Production,” in **Proceedings of the Fourth Int. Workshop on Targetry and Target Chemistry**, Villigen, Switzerland, 1991.