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$[^{18}O]$Water Target for $[^{18}F]$Fluoride Production on Kirams-13

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Abstract

KIRAMS-13 designed to produce Radio-Isotope (RI) for Positron Emission Tomography (PET). $[^{18}O]$water targets were constructed to produce high yield of $[^{18}F]$fluoride from enriched $[^{18}O]$water. Targets are designed to install on the 13MeV KIRAMS-13 medical cyclotron. The aluminum body, half sphere titanium back targets are characterized a small volume and operate at medium pressure. The double-foil helium windows were installed, which can safely accommodate proton beam to the $[^{18}O]$water. Target construction and performance are presented and new target model, which is in progress, for better performance to get higher yield production of $[^{18}F]$ will be presented. The satisfied final target design will be provided with KIRAMS-13.

1. Introduction

Fluorine-18 is the most widely used radio-isotope in positron tomography. Enriched $[^{18}O]$water target have been constructed for $[^{18}F]$fluoride production for many years. Material of the target, shape of cavity for $[^{18}O]$ and cooling mechanism have been changed as the research has performed. All different structures of targets were developed to get better performance for good yield. Materials were choose to overcome $[^{18}F]$ impurity, Shape of the cavity has been changed to overcome the phase change problem and cooling methods are getting smarter to make the target work in more high energy circumstance. We have constructed two kinds of targets. One is simple titanium half sphere cavity with double-system[1,2] and the other is niobium target, geometry of cavity is relatively not simple, with water-cooled grid support[3].

2. Material and Method

2.1. Double foil titanium target

The titanium double foil was adopted for windows which thickness is 75 ㎛. Helium gas flows between the double foil to cool down the windows. Its flow rate is 30 *l/min* at 15℃. The half sphere Ti cavity volume where the [^{18}O] will keep is 2cc. Thickness of half sphere wall is 1 ㎜. Outer side of this wall will be cooled by impinging water jet. Temperature of the water is 15℃ and the impinging flow rate is 0.1 ㎏/s. The target design shows at fig. 1. Whole body except cavity and double foil is made of aluminium. Diameter of foil window and the cavity beam entrance are 16 ㎜.

Heat transfer analysis of this target was performed. All conditions were idealized very simple and rough to get only temperature distribution when 12.5 MeV and 50 ㎂ proton beam is irradiate. Constant heat source was used instead of incident beam and all physical properties did not vary with temperature. The result of heat transfer analysis shows in fig. 2.

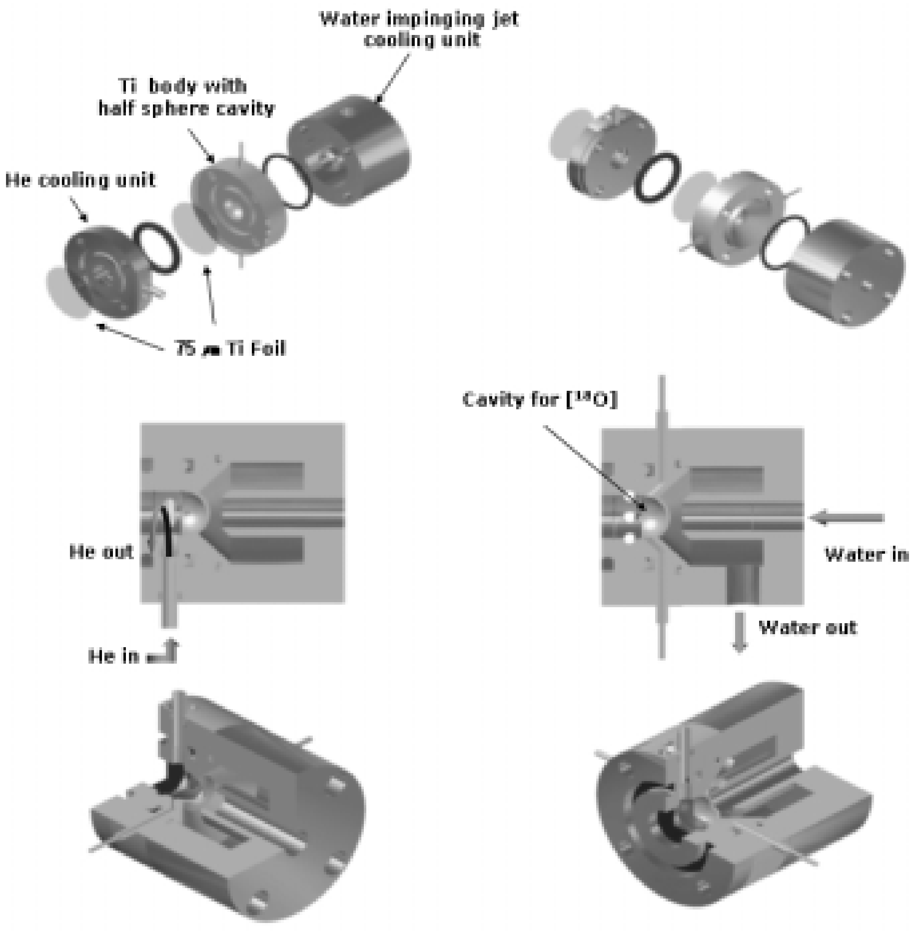

Fig. 1: Construction schematic view of Ti target

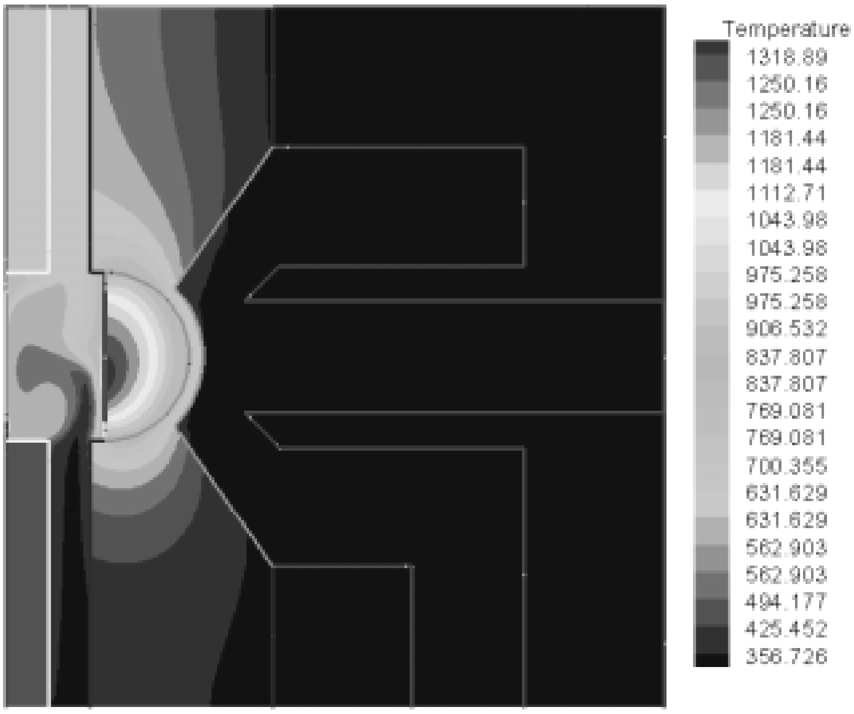

Fig. 2: Temperature contour of target(12.5 MeV, 50 ㎂)

The temperature of the target is below the melting point of titanium.

2.2. Water cooled gird supported niobium target

The niobium target has flat Nb cavity structure. Both open sides of the Nb cavity will covered with 50 ㎛ Nb foils. Structure of the cavity was constructed with two connected open layers. The layer place just on the direction of the beam has circular shape with diameter of 12 ㎜ and the cavity layer which is place just before the circular one has fan shape. The shape of the cavity shows in fig.3. The fan shape is expected to gather bubbles to the upper side which grows during proton beam irradiate in [^{18}O]. And the wider area of the back side

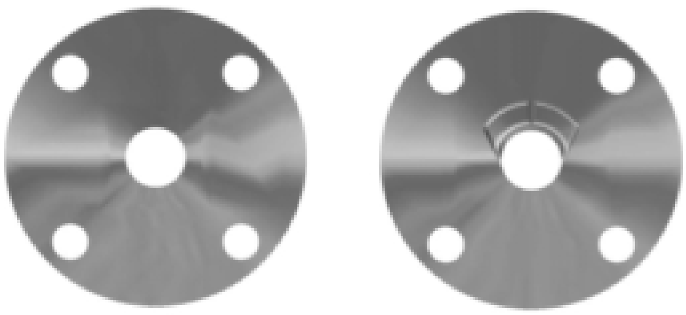

Fig. 3: Schematic view of Nb cavity

will increase the cooling performance.

Grids and whole body except cavity part are made of aluminum. Two grids are place on each side of the cavity. front side one has 97 holes of 1 ㎜ diameter with 0.2 ㎜ spacing in hexagon. And the back side one has 37 holes of 2 ㎜ diameter with 1 ㎜ spacing array in hexagonal shape. Grids are installed to cool down the cavity and prevent the thermal expansion on high pressure of the Nb foils. Fig. 4 shows the construction views of Nb target.

3. Result & discussion

The KIRAMS-13 was designed to provide 50 ㎂ of 13 MeV protons. Average yield of titanium target with double foil system is 50 mCi/㎂·hr at 12.5 MeV proton beam. Not enough tests have been performed to predict the endurance of target. Nb target is just ready to install on KIRAMS-13. Water cooled grid supported system is expected to give us a good product.

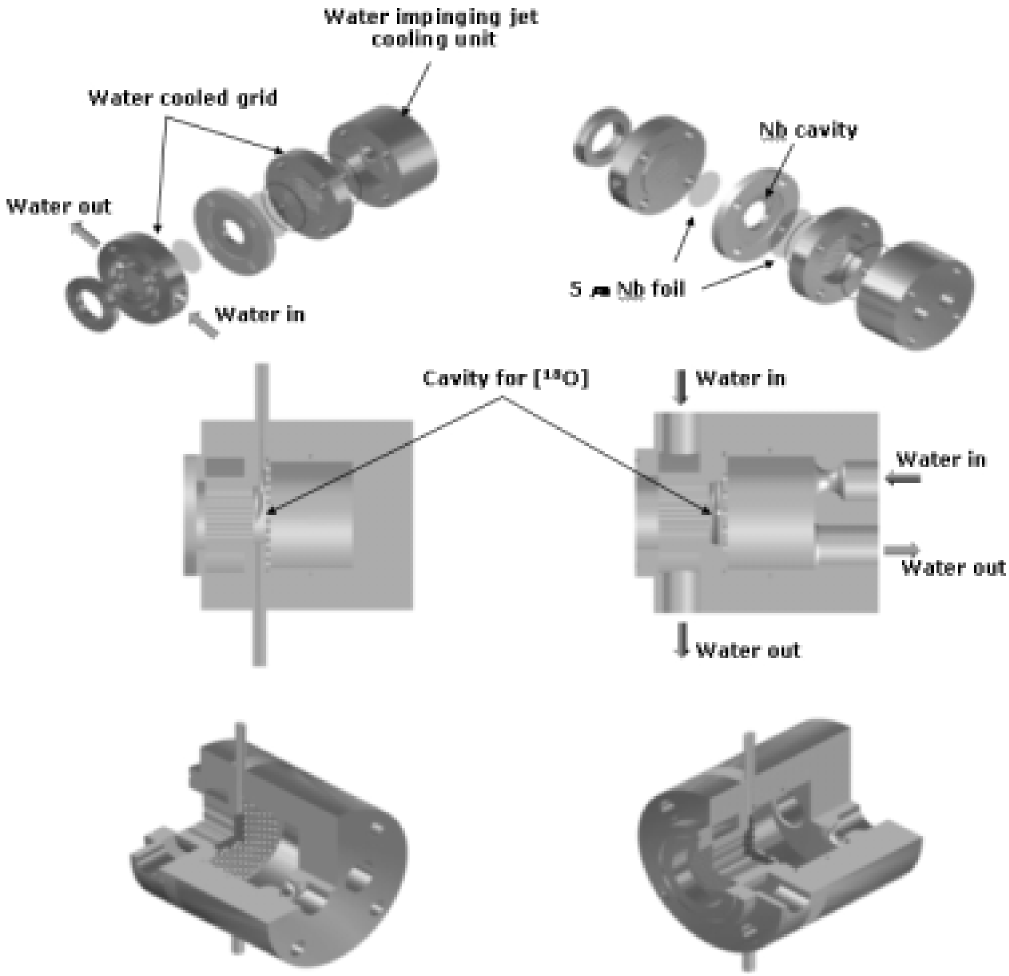

Fig. 4: Construction Schematic view of Nb target

4. References

1. T. Ohlsson, A. Sandell, R. Hellborg, K. Håkansson, C. Nilsson, S.-E. Strand, "Clinical useful quantities of [^{18}F]fluoride produced by 6 MeV proton irradiation of a $H_2{}^{18}O$ target," Nuclear Instrument and Method in Physics Research A 379, 341-342 (1996).
2. Marc S. Berridge, Rolf Kjellström' "Design use of silver [^{18}O]water targets for [^{18}F]fluoride production," Applied Radiation and Isotopes 50, 699-705 (1999).
3. T.E. Rrarnhart, A.K. Converse, K.A. Dabbs, R.J. Nickles, K. Buckley, S. Jivan, T.J. Ruth, A.D. Roberts, A.N.Other, "Water-cooled grid support for high-power irradiation with thi n target windows," Applied Radiation and Isotopes 58, 21-26 (2003).