Double-grid [^{18}O]water target for KIRAMS-13

Bong Hwan Hong, Dong Hyun An, Jong Seo Chai, In Su Jung, Hong Suk Chang, Min Goo Hur, Min Yong Lee, Sang WookKim, Seong Seok Hong, Yu Seok Kim, Won Taek Hwang

Korea Institute of Radiological & Medical Sciences Radiological & Medical Sciences Research Center
215-4, Gongneungdong, Nowon-Gu, Seoul 139-706, Korea

1. Introduction

Fluorine-18 is widely used radio-isotope in positron emission 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 chosen 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 developed the double-grid [^{18}O]water titanium target. Double-grid system has better structural strength than double-foil system and better cooling performance than single water cooled grid support system.

2. Structure of double-grid target

Fig. 1 shows the structures of the double-grid target. Material of cavity and foils are titanium. The shape of cavity has two different geometries along beam incident direction. Front volume has a cylindrical shape and rear cavity has a fan shape with larger volume to gather ascent vapor bubbles and increase heat transfer area. Total volume of cavity is 1.6 ml. Both open sides of cavity are blocked with 50 μm titanium foils. Two aluminum grids are placed out side of each foil. Front water cooled type gird is directly place in the vacuum beam line. Grids were adapted to cool foils and prevent their thermal expansion under high pressure.

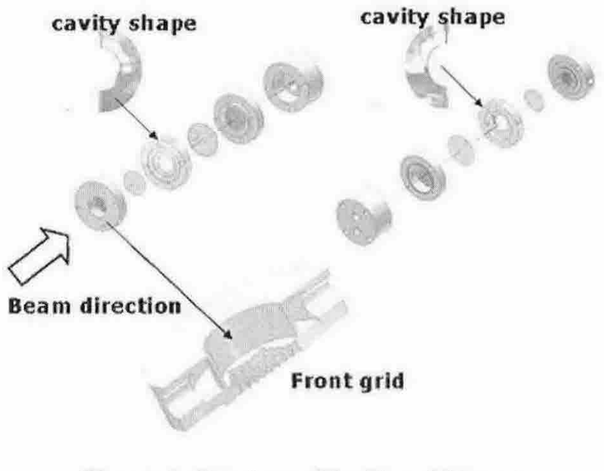

Figure. 1. Structure of double-grid target

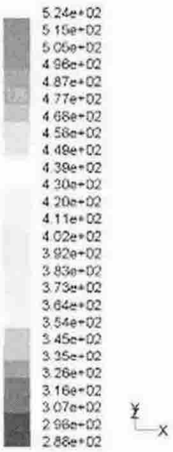

Figure. 2. Simulation result of the front grid and foil

3. Heat transfer simulation

CFD simulation had performed to study the heat distribution and heat flux on front Al grid and Ti foil. Simulation was simplified with axisymmetric model. Cooling water flow rate is 0.33 kg/s and temperature is 288.15K. Front Al grid and Ti foil are considered as a heat source. 1kW was give to each heat source. Outer walls have adiabatic condition and Ti foil bottom side has constant temperature 473.15K.

Result of the simulation at Fig.2 shows us the maximum temperature is below the melting point of Al and Ti.

4. Target test and result

The double-grid target designed for the 13MeV cyclotron KIRAMS-13. 13MeV proton had bombard to target with beam current 10 μA, 20 μA, 30μA and 40 μA for 1 hour. [^{18}F] yield and pressure were measured. Yield and pressure increase almost linearly as the beam current increases.

Corresponded pressure data to beam current is significantly lower than any other water target(Fig. 4). This result represent that the cooling performance of double grid system much better than any other water target.

Yield data is also satisfied as it shown at fig. 4. Double-grid prevents the expansion of the Ti foil. For that reason volume of the cavity is uniform and linear yield result is expected.

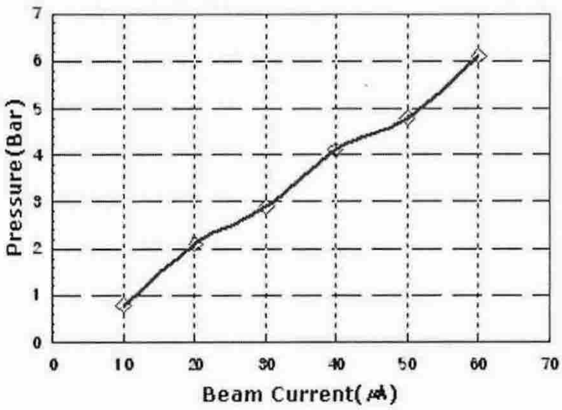

Figure. 3. Target pressure along incident beam current

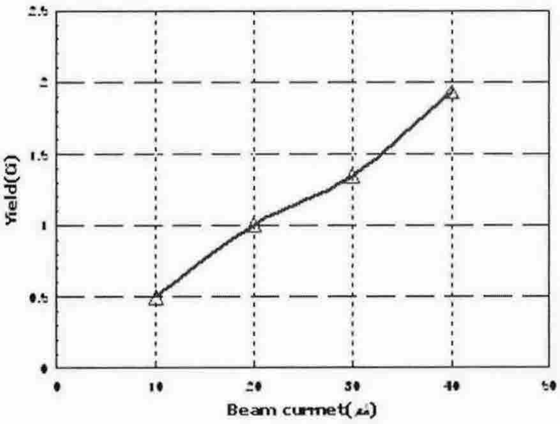

Figure. 4. [^{18}F] yield along incident beam current

5. Conclusion

The yield of the double-grid target is about 50Ci/µA·hr. Thanks for the good cooling performance target could be run at higher current beam more than 60µA without failure.

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