# TEST PRODUCTION OF Ti-44 USING RFT-30 CYCLOTRON

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*Abstract*

RFT-30 30 MeV cyclotron has been developed for the production of radioisotopes and their applications. Fluorine-18, which is a widely-used positron emitter, has been produced regularly since 2015. In addition, research on the production of generator radioisotopes has been performed using this cyclotron. A generator means a device used to extract the positron-emitting daughter radioisotope from a source of the decaying parent radioisotope such as $^{44}$Ti and $^{68}$Ge.

In this research, Sc targets were proton-irradiated in order to produce $^{44}$Ti. Gamma spectra of irradiated targets were measured to confirm the production of Ti-44.

## INTRODUCTION

Cyclotron-based production of generator radioisotopes has been researched for several tens of years [1,2]. A generator concept is a device that contains a parent radioisotope (RI) with relatively long half-life. A positron-emitting daughter RI can be extracted from it and used for its application. The generator can enable continuous research of positron emitter applications for a sufficiently long time without daily-production of RI using a cyclotron.

In Korea Atomic Energy Research Institute (KAERI), the production of RIs such as $^{44}$Ti for Ti/Sc generator and $^{68}$Ge for Ge/Ga generator has been researched recently using RFT-30 30 MeV cyclotron. Here, we present a test and actual production of $^{44}$Ti via proton irradiation of Scandium (Sc) targets. Sc targets were proton-irradiated, and then, characterized using gamma spectroscopy to confirm the production of $^{44}$Ti.

## EXPERIMENTAL

Sc disks with a diameter of 50 mm and a thickness of 0.5 mm (Sc 99.5%, Goodfellow, England) were used as irradiation targets. Sc disks were installed at the end of the beam-line (Fig. 1), and then irradiated with a proton beam generated form a RFT-30 cyclotron at Advanced Radiation Technology Institute of KAERI. The irradiation process was carried out with water cooling in a vacuum chamber. The energy of the proton beam was ~30 MeV, and total doses were 12 and 1750 μAh. The average beam current was 10 and 30 μA, respectively.

Gamma spectrum of proton-irradiated Sc disks was measured with multi-channel analyzer (MCA).

## RESULTS AND DISCUSSION

Main nuclear reaction which can be induced by the proton irradiation of Sc is $^{45}$Sc(p, 2n)$^{44}$Ti. $^{44}$Ti nuclei are created by the direct (p, 2n) reaction and $^{44}$Sc nuclei are produced by following $\beta^+$ decay with a half-life of 59.1 year.

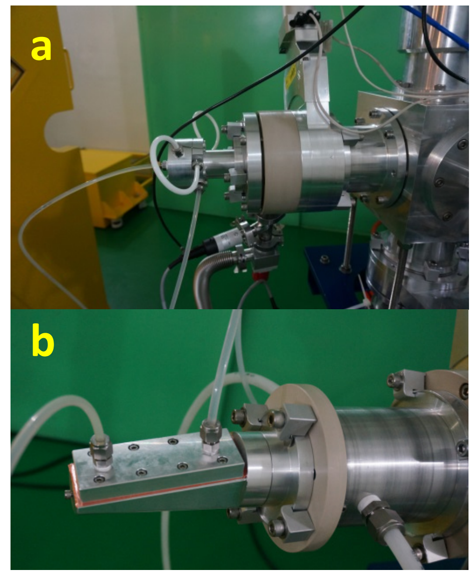


Figure 1: Installation of targets at the end of a beam-line: test target (a) and inclined target for actual production (b).

For the test production, Au-coated Sc disk was proton-irradiated. Au coating was introduced to prevent the corrosion of Sc by the cooling water. Gamma spectrum of an irradiated Sc target is shown in Figure 2. Irradiated Sc with Au coating showed several peaks centered at 67.87, 78.32, 1237 keV, emitted from $^{44}$Ti. This result indicated that $^{44}$Ti was successfully produced. The appearance of a peak centered at 511.0 keV, corresponding to the annihilation of β+, also proves the production of positron-emitting radioisotopes.

Some other peaks corresponding to $^{44}$Sc (1157 keV) which is a daughter radioisotope of $^{44}$Ti, and $^{197}$Hg (268.7 keV) which is produced from Au coating are also appeared.

However, it was found that Sc target was severely damaged by the proton beam because of high beam current density. In order to resolve this problem, we fabricated and installed inclined target system (Fig. 1b). If we used inclined target, the irradiated area is greatly increased so that we can lower the beam current density. In addition, the penetration length is also increased so that much more nuclear reactions can be induced. The inclined target was proton-irradiated with a dose of 1750 μAh and separation of $^{44}$Ti is under processing.



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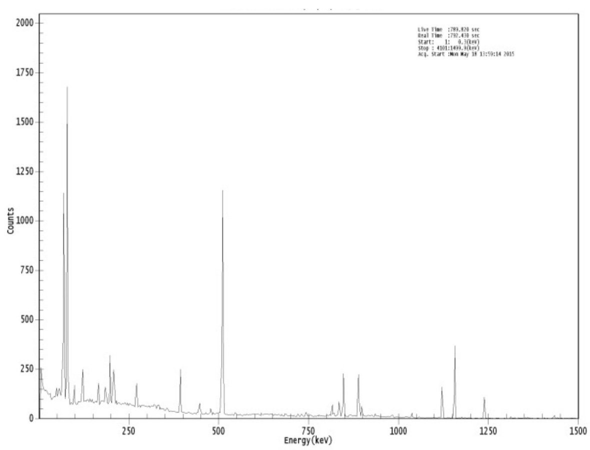


Figure 2: Gamma spectrum of proton-irradiated Sc.

## CONCLUSION

$^{44}$Ti was successfully produced by the proton irradiation of a Sc target. If we increase the dose, sufficient amount of $^{44}$Ti can be produced for the research on radiopharmaceuticals using $^{44}$Ti. $^{44}$Ti/Sc can be used as a generator, which enables the research on β+ emitter application without everyday-production using a cyclotron.

## REFERENCES

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