RI PRODUCTION PLAN USING 100-MeV PROTON ACCELERATOR AT KOMAC

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The KOMAC (Korea Multi-purpose Accelerator Complex) finished the construction of the 100-MeV proton accelerator at the end of 2012 and started its operation from 2013. Among the possible utilization fields of proton beam, RI production is a very attractive and promising field because high energy and high current proton beam is required to do it. The existing accelerator-based RI production facilities in Korea, cyclotrons, can provide 50-MeV proton beam at maximum. For the new RIs, Sr-82 and Cu-67, production, higher energy of proton more than 50 MeV is required. LANL (Los Alamos National Laboratory) and BNL (Brookhaven National Laboratory) have been operating the RI production facilities, IPF (Isotope Production Facility) and BLIP (Brookhaven Linac for Isotope Production) to meet users' demands for Sr-82 and other RIs in USA and worldwide. The KOMAC has very similar beam parameter, beam power, and structure to the linear accelerator of the IPF. KOMAC made a plan for the development of new RI production technologies using 100-MeV proton accelerator. The construction of RI production facility is mostly completed. The RI production facility is composed of target manufacturing and test equipment, target irradiation chamber including target transport system, hot-cells and RI hoods for target handling, chemical processing, such as separation and purification, and measurement and qualification systems of RIs.

I. TARGET MANUFACTURING AND TESTING

RbCl and Rb metal can be used as target materials for the production of Sr-82. And ZnO can be used for the Cu-67 production. Optimum energy range for Sr-82 and Cu-67 are 50~95 MeV and 70~95 MeV according to our calculation results. The energy loss for each target is about 15~20 MeV, the target thicknesses are about 10 mm. The diameter of the target is 50 mm in active area. The RbCl and ZnO powder is dried to remove the moisture inside using dry-oven at ~600 ℃. And it is pressed for the pellet-shape.

For the inspection of the target inside, X-ray CT will be used. To check the leaks in the welds and thin windows, we will use a bubble testing method.

II. TARGET IRRADIATION AND TRANSPORT SYSTEM

To generate nuclear reactions for RI production, high-energy proton beams have to be bombarded to the target. The maximum proton beam energy and average current are 100 MeV and 300 μA at the target room. The energy can be changed by controlling the DTL power and cooling water thickness before incidence to the target. The cooling water and additional shielding structures are used to shield the radiations produced during the proton beam irradiation and to remove the heat load from the target. To maximize these effects, the target transport pipe is filled with water and the target assembly is moved from hot-cell to the position for irradiation and vice versa in the water. The radiation level of the water is monitored regularly and the conductivity of the water is monitored to check the damage of the target during proton beam irradiations.

III. HOT-CELLS FOR CHAMICAL PROCESSING AND TARGET HANDLING

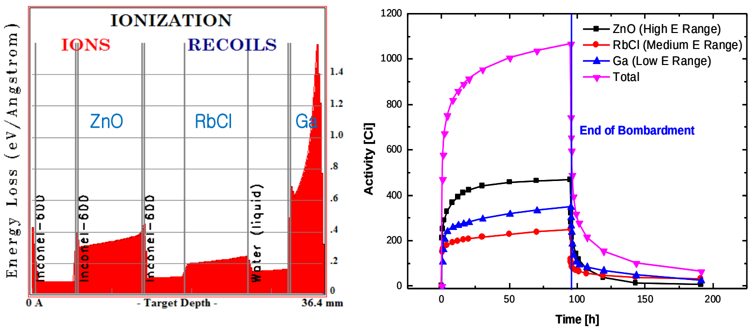
There are two kinds of hot-cell, for the target handling and chemical processing, are located in two rooms. The hot-cell for target is divided two separated space for targets before and after irradiation. To reduce the radiation level of the hot-cell surface of outside, the wall is made of 15-cm thick lead and the view window is 37-cm thick lead glass, the thickness is equivalent to the 10-cm lead. After irradiation, highly activated target will be stayed in the target room for one or two days to reduce the activation level of the target and it will be moved to the hot-cell for the transportation to the hot-cell for the chemical processing using the cask of 10-cm lead wall. The hot-cells for the chemical processing is composed of three rooms, the 1st is for the docking of the cask, the 2nd is for the disassembling and the 3rd is for chemical processing, separation and purification. The lead wall thickness is 10-cm and a set of master-slave manipulator is installed in the chemical processing hot-cells. Two different kinds of RIs can be processed simultaneously. The small amount of RIs can be processed in the RI hoods for convenience at the beginning of the development.

IV. QUALIFICATION OF RI

Purified RI has to be qualified. To develop and improve the RI production technologies we have to measure the specific activity, production yield, purity, impurity density, etc. using HPGe radiation spectroscopy, ICP-MS, HPLC, Dose calibrator, etc. These apparatuses already installed in the analysis room.

V. RI PRODUCTION CAPACITY

According to the calculation results, production yields of Cu-67, Sr-82 and Ge-68 are 144.6, 97.9 and 33.1 μCi/μAh for 1-hour proton beam irradiation. As shown in Fig. 1 three different RIs can be obtained using multi-stacked target assembly. Target materials are ZnO for Cu-67, RbCl for Sr-82 and Ga for Ge-68. Their thicknesses will be optimized through some calculations and basic experiments considering the half-lives and production plan.



	^{67}Cu	^{82}Sr	^{68}Ge
Energy [MeV]	95~70	60~43	28~
Half-life [d]	2.6 d	25.5 d	270.8 d
Yield @ EOB [μCi/μAh]	144.6	97.9	33.1

Fig.1. Calculated RI production yields for Cu-67, Sr-82 and Ge-68 with 1-hour proton beam irradiation.

TABLE I. RIs under development by KOMAC

Nuclide	Column Header Goes Here	Column Header Goes Here
Applications	PET, Cardiac Disease Diagnostics (Sr-82/Rb-82 Generator)	Cancer Therapy
Usual Does	~10 mCi /70 kg	~40 mCi /70 kg
Half Life	25.4 day	61.9 hrs
Reaction	$^{Nat}Rb(p,xn)^{82}Sr$	$^{68}Zn(p,2p)^{67}Cu$
Radiation	511 keV, 776.5 keV (from Rb-82)	91.266 keV, 93.311 keV, 184.577 keV
Target	RbCl, Rb metal	ZnO

II. CONCLUSIONS

KOMAC made a plan for the development of new RIs using 100-MeV proton accelerator. The construction of the production facility will be finished in a few months. The production technologies for Sr-82 and Cu-67 including Sr082/Rb-82 generator of very small activities will be developed in nest several years using these facilities.

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