# Development of Lu-177 Large-Capacity Production System

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## 1. Introduction

In these days, Therapeutic radionuclides such as Lutetium-177($^{177}$Lu) are emerging as an important factor for treatment of the malignant tumor such as breast, prostate, colon, and brain. Its demand is also increasing because of its high theranostics potential. $^{177}$Lu emits β$^-$ particles ($E_{\beta,\,max}$ = 498 keV) with a soft tissue penetration range of less than 3 mm and γ-rays ($E_\gamma$ = 208 keV (11.0%) and 113 keV (6.4%)) suitable for imaging with a detector.

$^{177}$Lu can be produced in high yield by the $^{176}$Lu (n, γ) $^{177}$Lu reaction. However, this production method has a limitation in that carrier $^{176}$Lu are mixed and by-products $^{177m}$Lu with a long half-life ($t_{1/2}$ = 160 d) are produced. In this respect, no-carrier added (nca) $^{177}$Lu is preferred in medical fields as it has high specific activity and high radionuclide purity. The nca $^{177}$Lu can be produced by the $^{176}$Yb (n, γ) $^{177}$Yb → $^{177}$Lu reaction by irradiating neutrons to an enriched $^{176}Yb_2O_3$ target. The critical process is the radiochemical separation of nca $^{177}$Lu from macroscopic amount of Yb target with adjacent atomic number.

As the demand of lanthanide nuclides (including $^{177}$Lu) increases, numerous researchers have devoted themselves to developing faster and more efficient separation techniques. In particular, the separation technology based on ion exchange to improve selectivity have been developed. In ion exchange technology, generally, α-HIBA and $NH_4^+$ is used as a complexing agent and a separating ion, respectively. However, P.S. Balasubramanian reported that $^{177}$Lu was separated from neutron-irradiated ytterbium using a cation exchange resin (Dowex-50X8, 200-400 mesh) with α-HIBA and $Zn^{2+}$ ion as a separating ion.

Based on this, a prototype device for producing Lu-177 was manufactured. In the case of the prototype, it consisted of a total of 3 parts : LC pump, separation column, valve & purification. However, in the case of large-capacity production device, the valve and purification parts were divided into 4 parts. The reason for this is the ease of replacement of each part in case of device failure.

## 2. Configuration of the device

An automatcd systcm for scparating, purifying, recovering Lu-177 nuclides is under development. The equipment was designed in consideration of rapid processing for n.c.a Lu-177 and the safety of working staffs. The design of equipment is shown in Fig. 1.

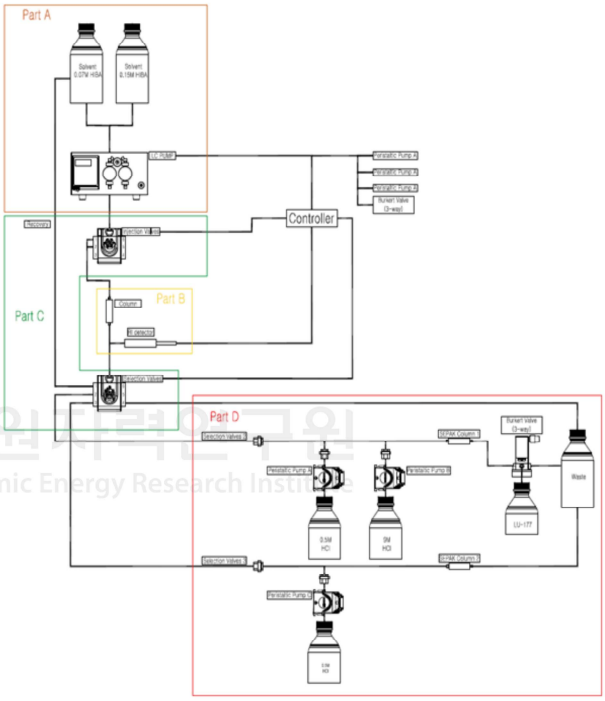


Fig. 1. Schematic diagram of Lu-177 separation and purification device

The equipment for large-scale production consists of 4 parts : pump and control(part A), separation and detector(part B), valve & recovery(part C), and purification(part D). The part A, which is responsible for controlling the separation process and replenishing the separation- eluents, will be installed outside of hot cell. The part B is shielded using acrylic(β-ray shielding) and lead(γ-ray shielding) for accurate measurement of radioactivity. The part C consists of a switching valve, a selection valve, a syringe pump, and a structure that can fix each part. The part D consists of a peristaltic pump, a three-way valve, a concentration column, a media bottle, and is a system that is controlled according to the signal from detector. The designed model of each part is shown in Fig. 2.

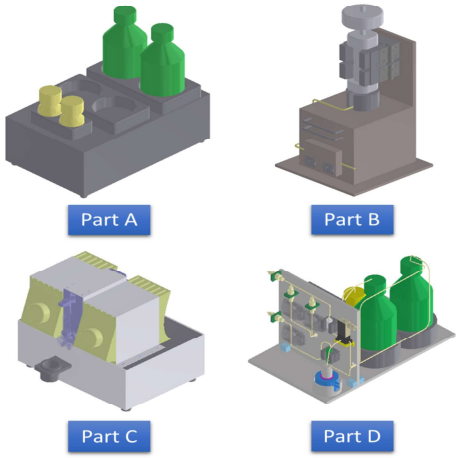


Fig. 2. Configuration of the Lu-177 large-scale production system

### 3. Configuration of system program

The system program was developed by using LabVIEW 2021. The screen of the program consists of Auto Test, Manual Control, Sequence Editor, Easy Sequence, Viewer. The UI of general process is shown in Fig. 3.

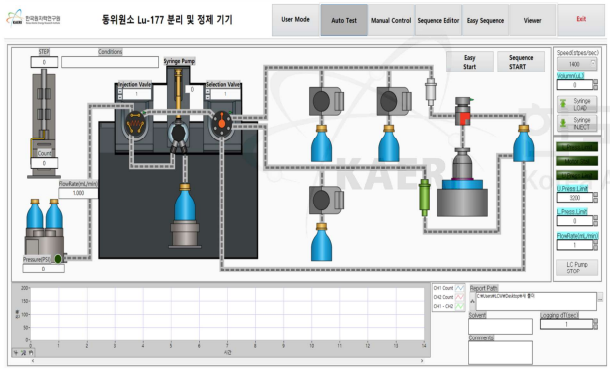


Fig. 3. User Interface of production system program

### 4. Conclusion

Currently, large-scale production system is being manufactured. At the time of the presentation, the system will be manufactured and more detail process also will be discussed.

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