The 1st Radioisotope Separation Experiment for the Sr-82 Production in KOMAC

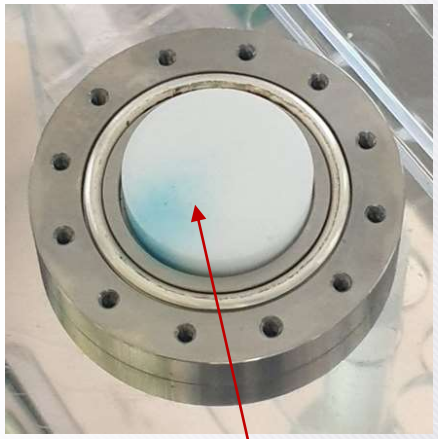
Kye-Ryung Kim[a], Sang-Pil Yoon[a], Yeonji Lee[a], Yong-Sub Cho[a], Yeong-Su Ha[b]
[a]Korea Atomic Energy Research Institute
[b]*Osong Medical Innovation Foundation (K-Bio)*
(kimkr@kaeri.re.kr)

01 INTRODUCTION

- Production of radioisotopes such as Sr-82, Cu-67, Ge-68, etc. is one of KOMAC's major accelerator applications.[1]
- The construction of target irradiation facilities for the production of radio-isotopes at KOMAC using 100-MeV linac was completed in 2016, and chemical process facilities were completed in March of this year and licensed.[1-2]
- The Sr-82 is the parent nuclide of Rb-82 used for the diagnosis of myocardial infraction, and it is manufactured and supplied to users in the form of a Sr-82/Rb-82 generator.
- KOMAC has been developing Sr-82 production technology using a high-energy proton accelerator since 2019.
- In this paper, we will deal with the first separation and purification experiment in which the separation and purification process developed so far is applied to an irradiated target.

02 EXPERIMENT – Target Irradiation

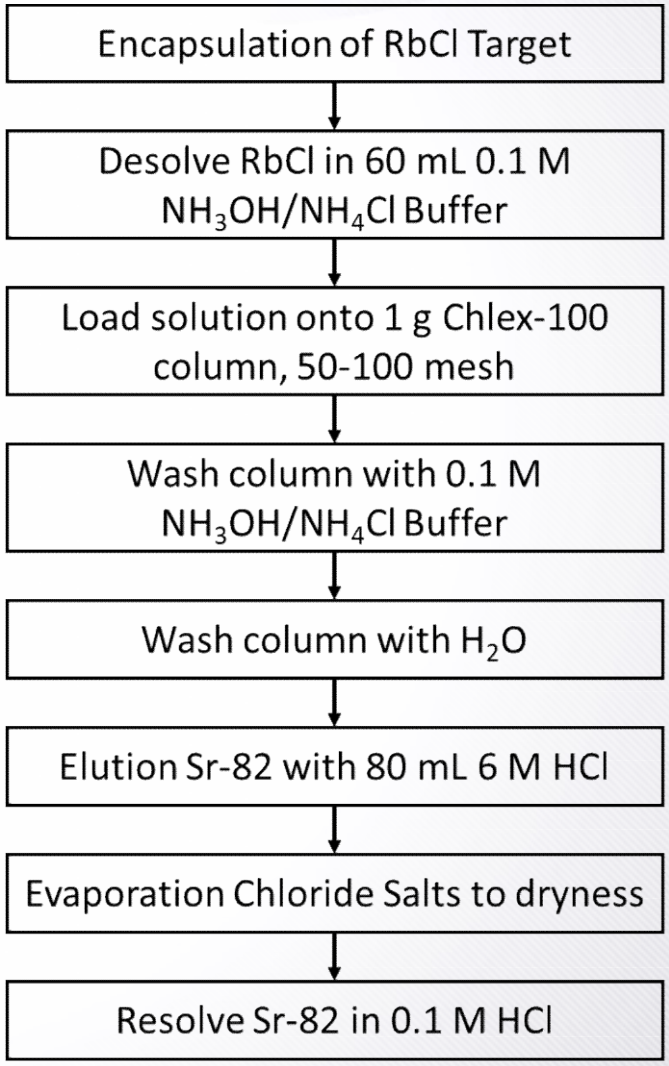
- Target : RbCl Pellet
  - RbCl Pellet
    - Size : diameter 3 cm, thickness 0.75 cm
    - Weight : 14.5 g
  - Cladding
    - Material : STS304
    - Helicoflex Seal
    - Size : diameter 6 cm, thickness 1.5 cm
- Nuclear Reaction : $^{85}Rb\ (p,4n)^{82}Sr$
- Proton Beam Irradiation Condition
  - Energy : 100 MeV (~67 MeV to Target)
  - Peak Current : 1 mA
  - Pulse Width : 200 usec
  - Repetition Rate : 2 Hz
  - Irradiation Time : 1, 2 hours



RbCl Pellet

02 EXPERIMENT – Chemical Process

- **KOMAC has been developing Sr-82 production technology using a high-energy proton accelerator since 2019. The separation and purification process of Sr-82 has been developed using stable isotope compounds such as RbCl or $SrCl_2$ until the approval of the RI production facility.**
- **The process procedure was developed by referring to the research results of foreign research institutes such as BNL and ARROMAX, [3] and detailed conditions were determined by reflecting the ICP-MS analysis results for each stage of the process.**



02 EXPERIMENT – Chemical Process

- KOMAC has been developing Sr-82 production technology using a high-energy proton accelerator since 2019. The separation and purification process of Sr-82 has been developed using stable isotope compounds such as RbCl or $SrCl_2$ until the approval of the RI production facility.
- The process procedure was developed by referring to the research results of foreign research institutes such as BNL and ARROMAX, [3] and detailed conditions were determined by reflecting the ICP-MS analysis results for each stage of the process.

Encapsulation of RbCl Target

↓

Desolve RbCl in 60 mL 0.1 M NH_3OH/NH_4Cl Buffer

↓

Load solution onto 1 g Chlex-100 column, 50-100 mesh

↓

Wash column with 0.1 M NH_3OH/NH_4Cl Buffer

↓

Wash column with H_2O

↓

Elution Sr-82 with 80 mL 6 M HCl

↓

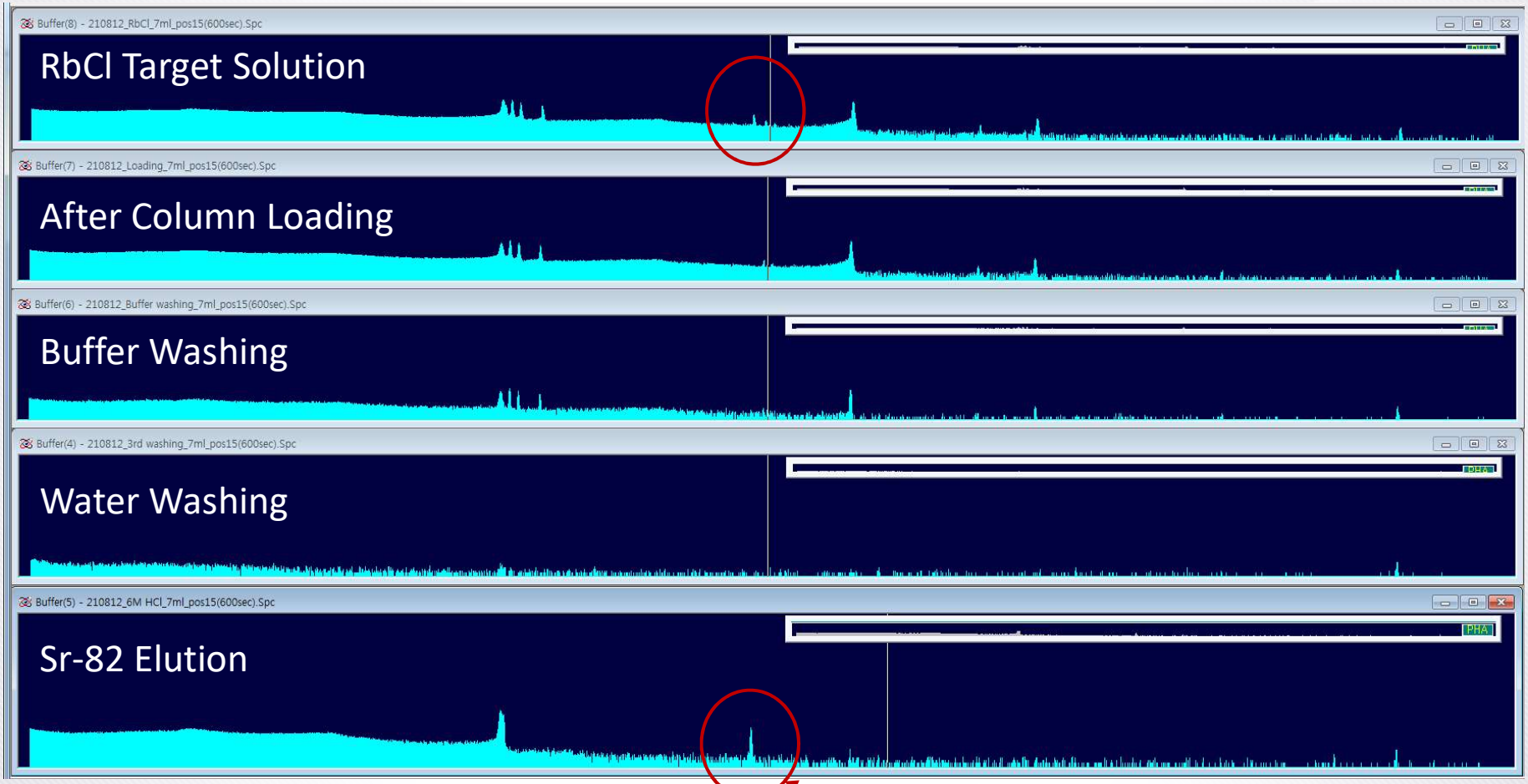
Evaporation Chloride Salts to dryness

↓

Resolve Sr-82 in 0.1 M HCl

02 Experiment – RI Hood

03 RESULTS – HPGe Spectroscopy

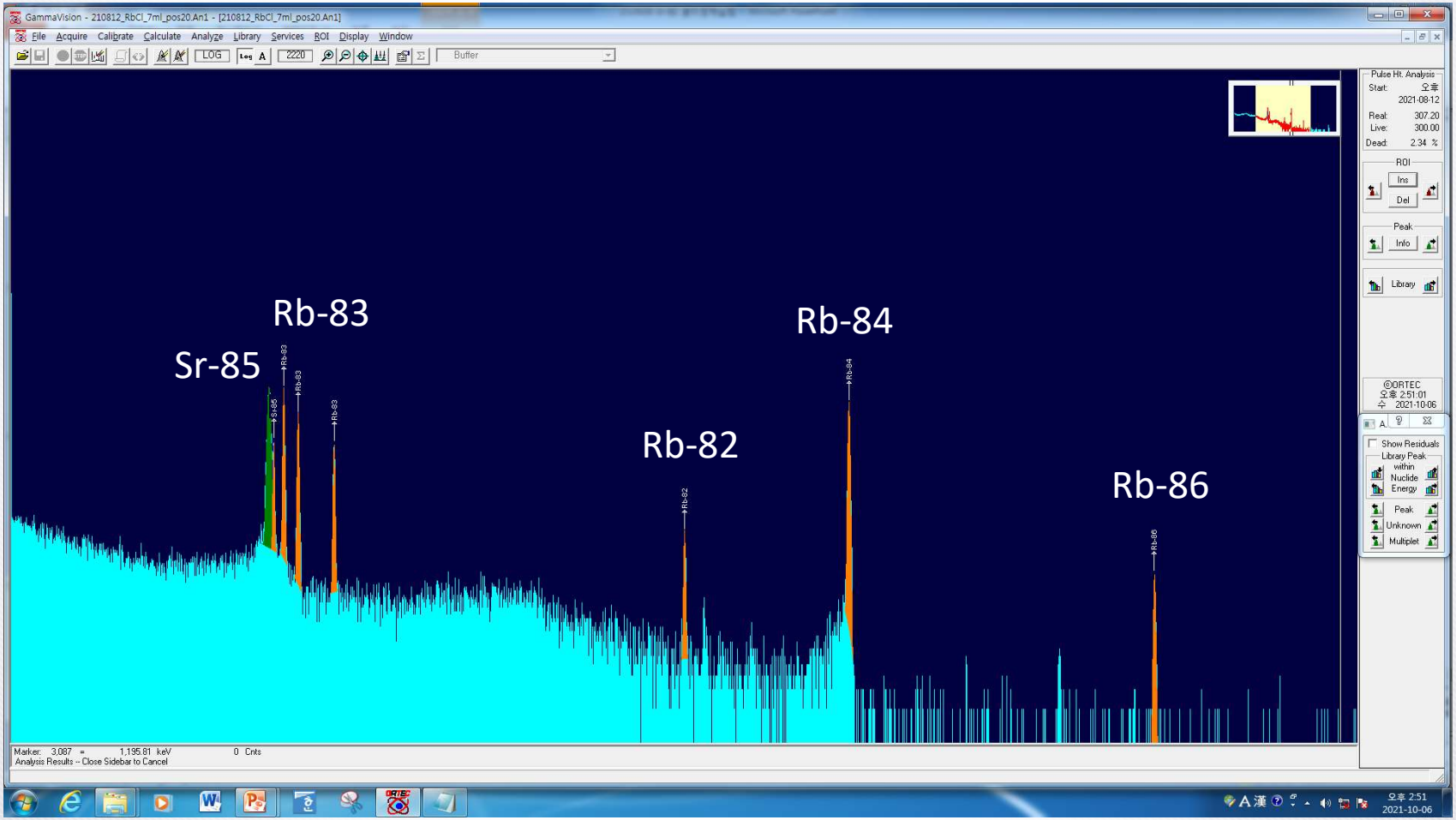


Sr-82 Activity = Rb-82 Activity

(@ Perpetual Equilibrium, T1/2 : Sr-82 (25.5 days) >> Rb-82 (75 sec))

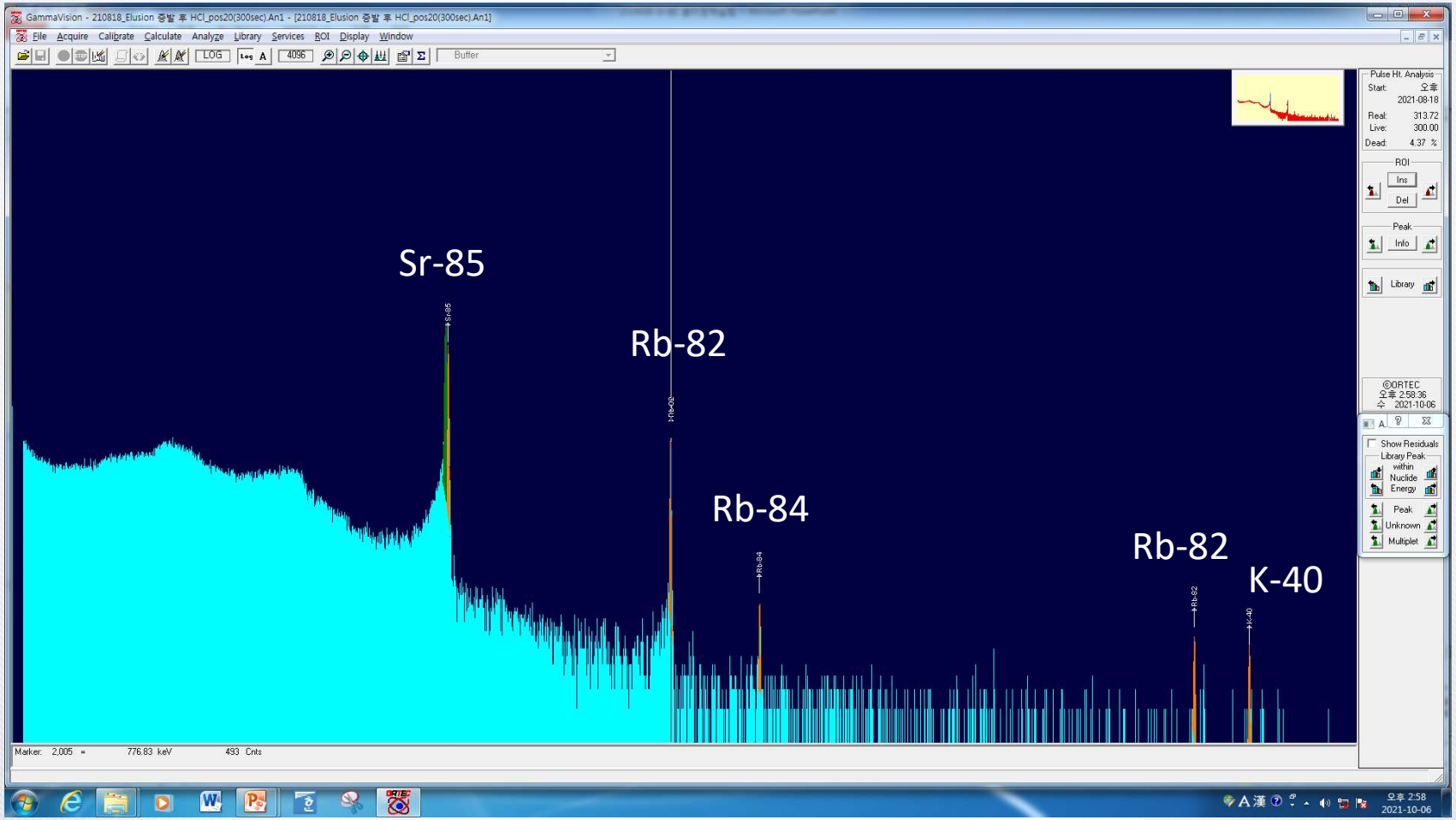
03 RESULTS – HPGe Spectroscopy

- **RbCl Target Solution**



03 RESULTS – HPGe Spectroscopy

- **Eluted Sr-82 in 0.1 M HCl**



03 RESULTS – HPGe Spectroscopy

- **RbCl Target Solution**

Nuclides	Gamma Energy [keV]	Activity [Bq]	Activity [uCi]	Activity @ EOB [uCi]
Sr-85	514.01	52177.10	1.41	
Rb-83	520.41	405200.00	10.95	
Rb-83	529.64	411017.78	11.11	
Rb-83	552.65	399012.11	10.78	
Sr-82/Rb-82	776.52	96975.54	2.62	7.99
Rb-84	881.61	407150.35	11.00	
Rb-86	1077.00	111913.69	3.02	

- **Eluted Sr-82 in 0.1 M HCl**

Nuclides	Gamma Energy [keV]	Activity [Bq]	Activity [uCi]	Activity @ EOB [uCi]
Sr-85	514.01	49657.54	1.34	
Sr-82/Rb-82	776.52	83676.13	2.26	6.89
Rb-84	881.61	582.07	0.016	
Sr-82/Rb-82	1077.00	82881.06	2.24	6.83

- **Separation & Purification Yield : ~ 85 %**
- **Sr-85/Sr-82 : ~0.60**

04 CONCLUSION

- The first RI separation and purification process experiment on irradiated target in KOMAC was successfully performed.
- Through this experiment, the effectiveness of the separation and purification process developed for the production of Sr-82 was validated.
- The separation & purification yield is more than 85 % for this experiment.
- The Sr-82 obtained through this experiment was used for the column adsorption experiment for Sr-82/Rb-82 generator development currently in progress.
- We will try to improve the process yield and the activity of Sr-82 continuously.
- For the higher activity Sr-82, the longer target irradiation time is essentially required.

05 Acknowledgement & Reference

- **Acknowledgement**

  This work was supported by MSIT (Ministry of Science and ICT) and by the National Research Foundation of Korea (NRF) under Grant number NRF-2017M2A2A2A05016601.

- **Reference**

[1] Kye-Ryung Kim, Myung-Hwan Jung, Sang-Pil Yoon, Yi-Sub Min, Yong-Sub Cho, “Medical RI development plan of KOMAC”, Journal of Korean Physics Society, Vol.71, No.11, pp.818-823. 2017.

[2] Yi-Sub Min, Jeong-Min Park, Myung-Hwan Jung, Hyeok-jung Kwon, “Status of RI Production Facilities using the Proton Beam in KOMAC”, Transactions of the Korean Nuclear Society Autumn Meeting, Yeosu, Korea, October 25-26, 2018.

[3] Yeong Su Ha, Sang-Pil Yoon, Han-Sung Kim, and Kye-Ryung Kim, “Comparative study of ^{82}Sr separation/ purification methods used at Brookhaven National Laboratory and ARRONAX”, Journal of Radiopharmaceuticals and Molecular Probes, Vol. 5, No.2, pp.71-78, 2019.