Production of Np isotopes from ^{238}U beam at BigRIPS

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Property of Neptunium(Np)

- Np is atomic number $Z = 93$ after uranium (U)
- Np does not exist naturally in nature and can be produced artificially.

(but Np may be produced in uranium mine as a natural reactor in Oklo, Africa)

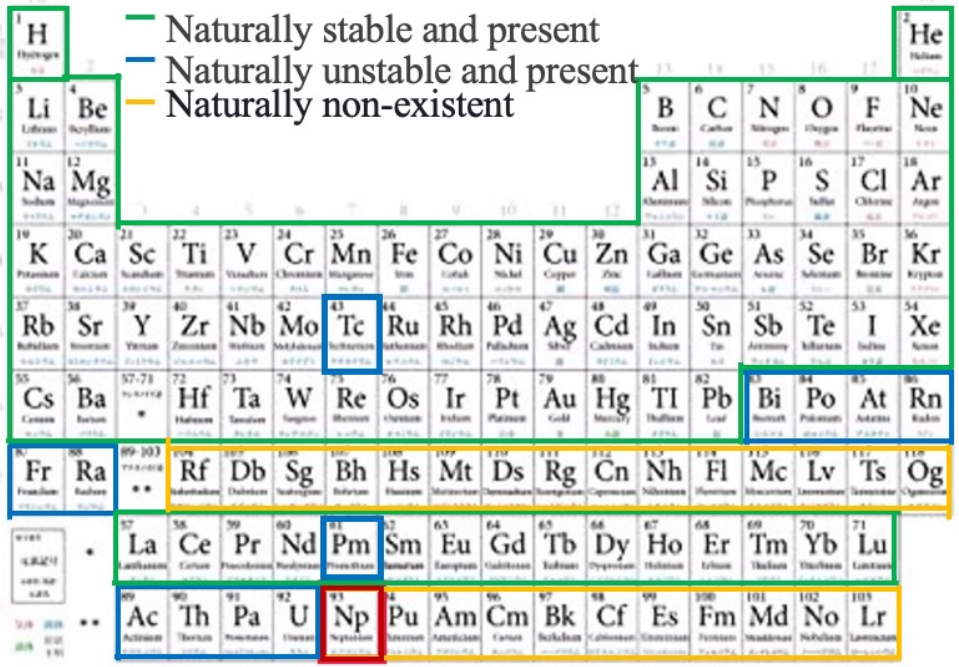


Fig.1: Periodic Table.

Np generation pathway

- Np can be produced by nuclear reactions in reactors and atomic bombs.
- Radioactive waste from nuclear power generation and ^{237}Np has a half-life of 2.14 million years.

Find a way to transmutation quickly.

Production of Np is important

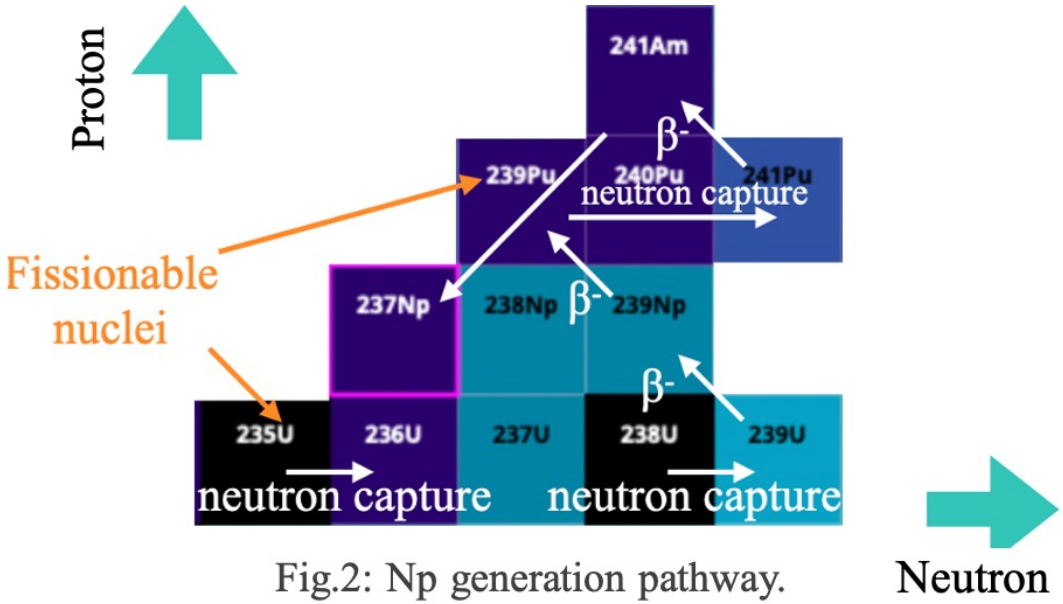


Fig.2: Np generation pathway.

In this experiment, Np is produced by the reaction including proton capture.

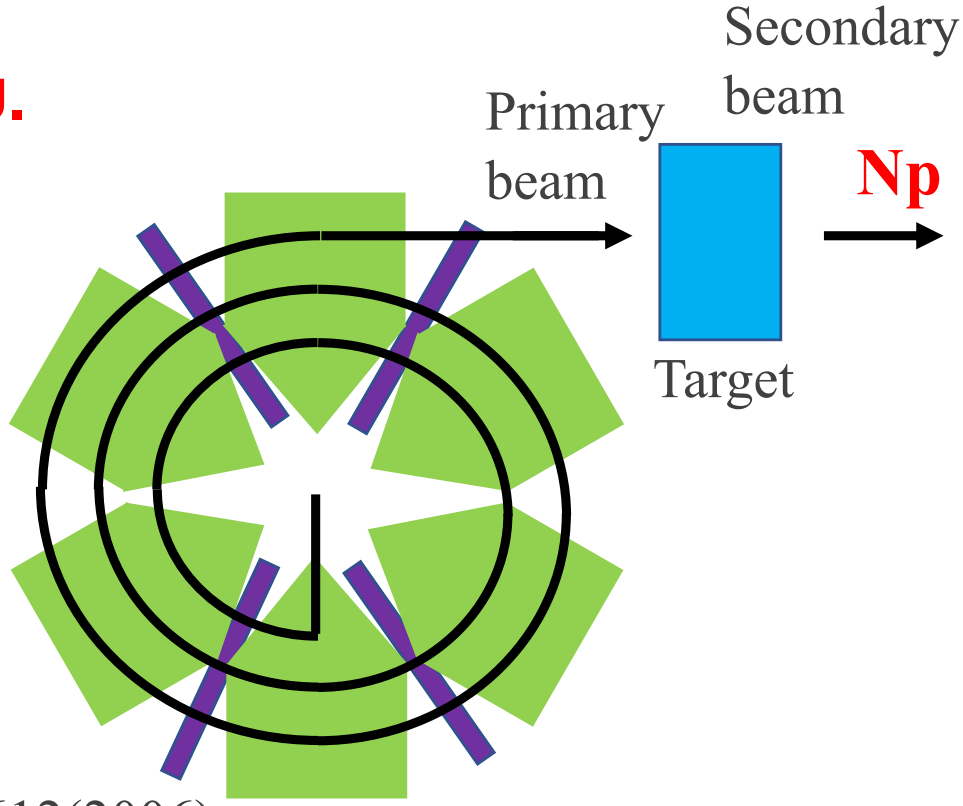
Introduction

Generation of Np beams

All RIs from hydrogen (H) to U can be supplied as a secondary beam at RIBF in RIKEN.

There are plans to use ^{237}Np as a beam at RIKEN. The plan is not only be a solution to the nuclear waste problem, but would also lead to the discovery of new nuclei.

We want to make a beam over U.
Let's make a beam with Np!

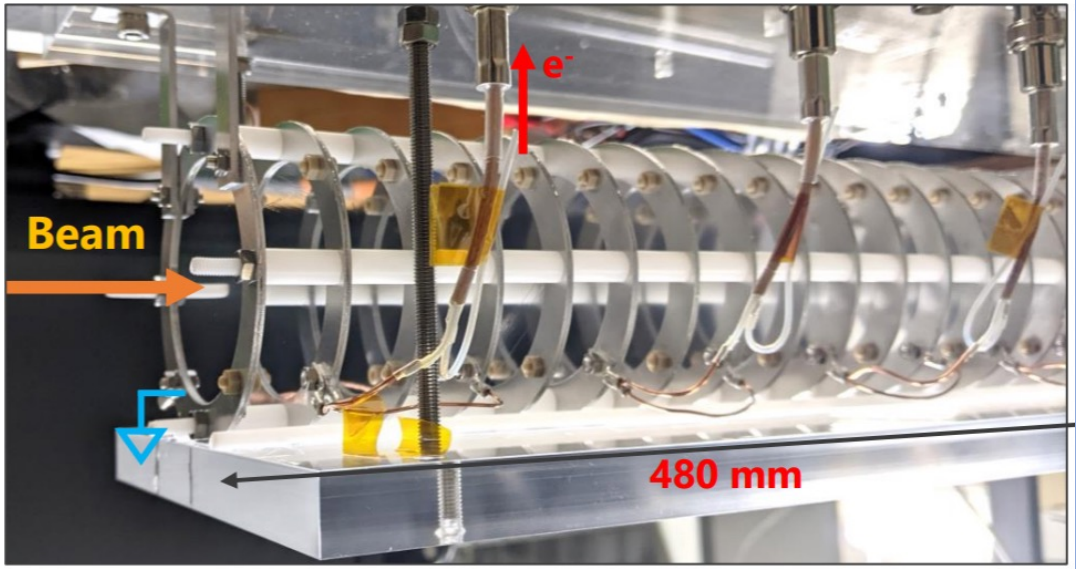


GSI

Recently, isotopes of $^{234\text{-}238}$Np can be created by a proton pick up reaction on 1GeV/u ^{238}U at GSI[1].

[1] E. Casarejos *et al.*, Phys. Rev. C **74**, 044612(2006).

Experiment

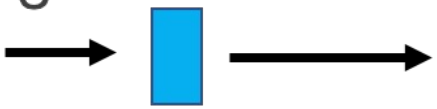


New ionization chamber at F7

IC type	Argon-based	Xenon-based
Mixture	**Argon 90%** CH_4 10%	**Xenon 70%** CH_4 30%
High voltage [V]	400	800
Electron drift velocity W [cm/μs]	4.9	3.5
Gas flow	Yes	No
Pressure [Torr]	620	620
Total gas thickness [mg/cm^2]	76.5	198

345MeV/u
$^{238}U^{86+}$

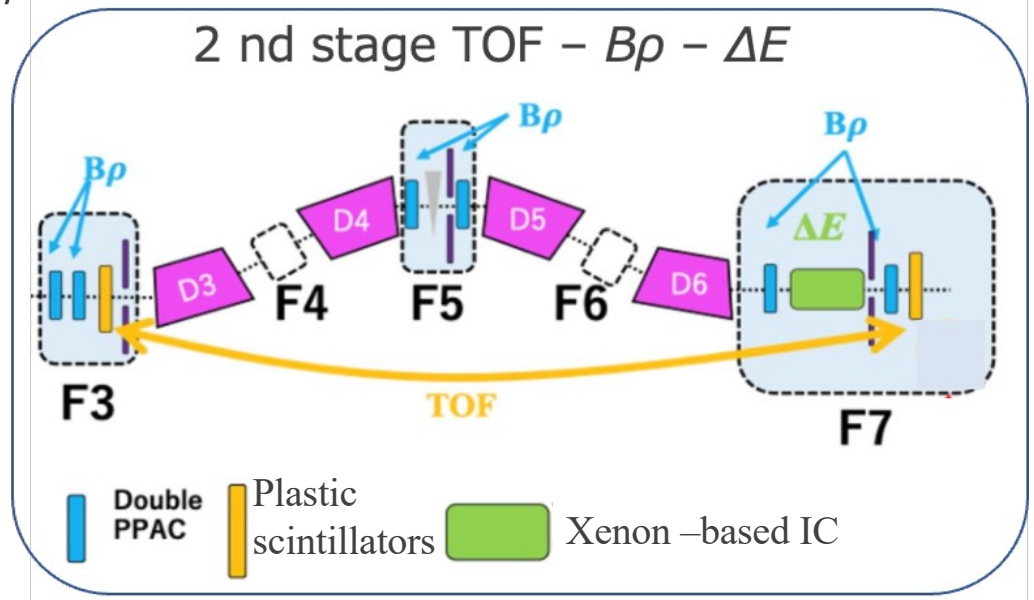
Secondary beam including Np



1 st stage

^{9}Be1mm

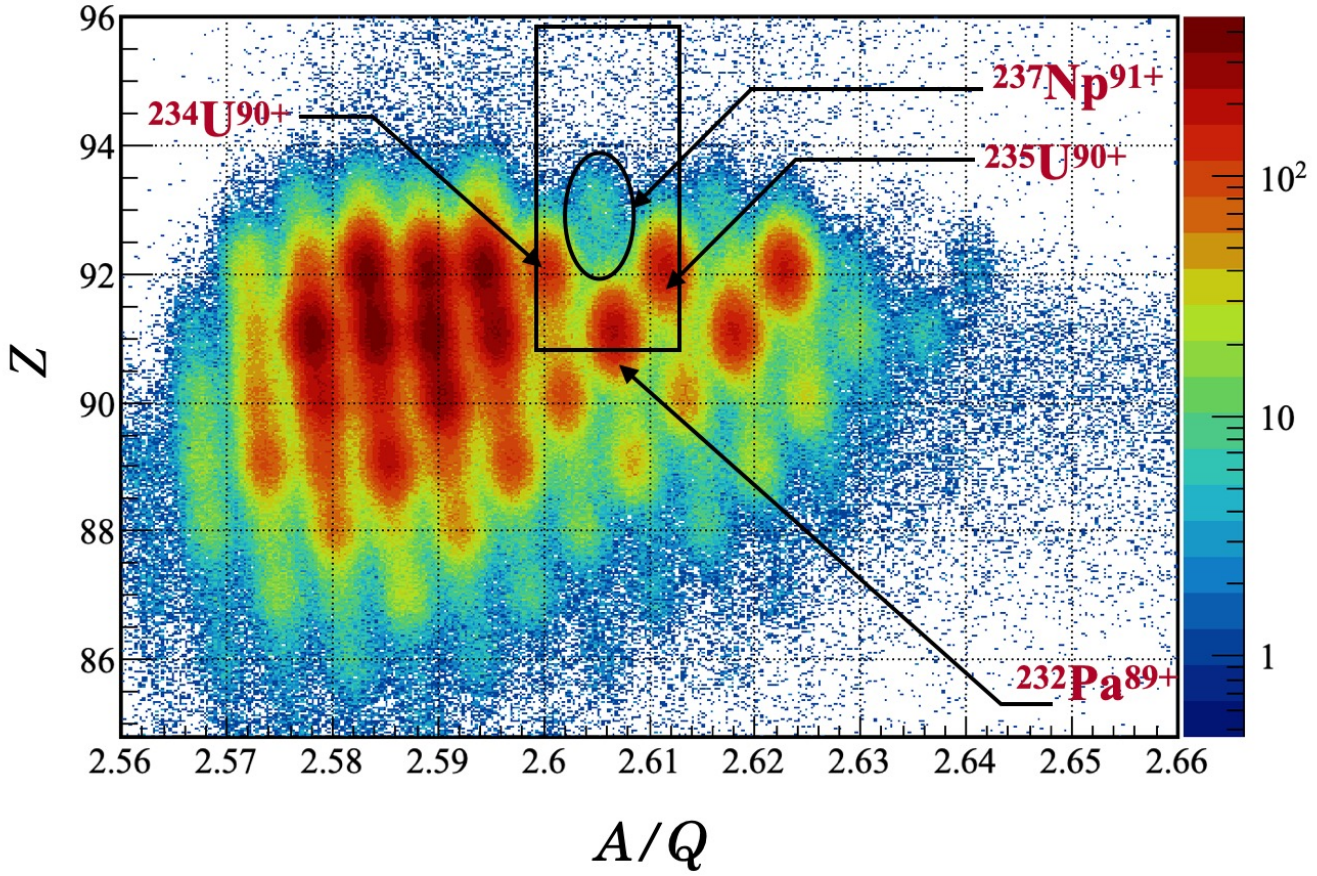
Beam intensity
0.0013pnA



Data Analysis

Particle identification was performed by using TOF-$B\rho$-ΔE method.
The relative resolution of high Z region was 0.43% with Xe gas IC and A/Q was 0.0057%.

There are Pa and U around Np → The number of Np was counted by using three-dimensional fitting.



Results

nuclide	counts	transmission(%)	production [mb]	EPAX2.15 [mb]
^{237}Np	3.9×10^{3}	0.96	0.77	0.263
^{238}Np	1.1×10^{3}	0.81	0.038	0.265
^{232}Pa	1.2×10^{5}	0.85	17	9.37
^{233}Pa	8.8×10^{4}	0.83	16	8.27
^{234}U	7.5×10^{4}	0.34	12	24.7
^{235}U	9.3×10^{4}	0.74	16	25.8
^{236}U	8.9×10^{4}	4.16	38	26.3