

Nuclear Physics at Beijing Rare Isotope Facility (BRIF)

Youbao Wang /China Institute of Atomic Energy
on behalf of BRIF collaboration

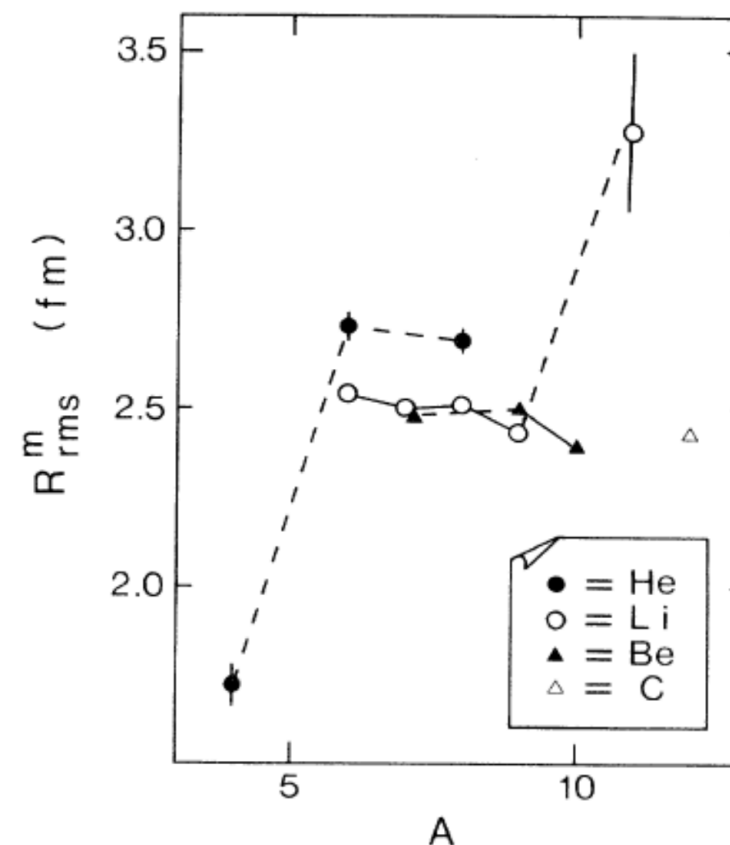
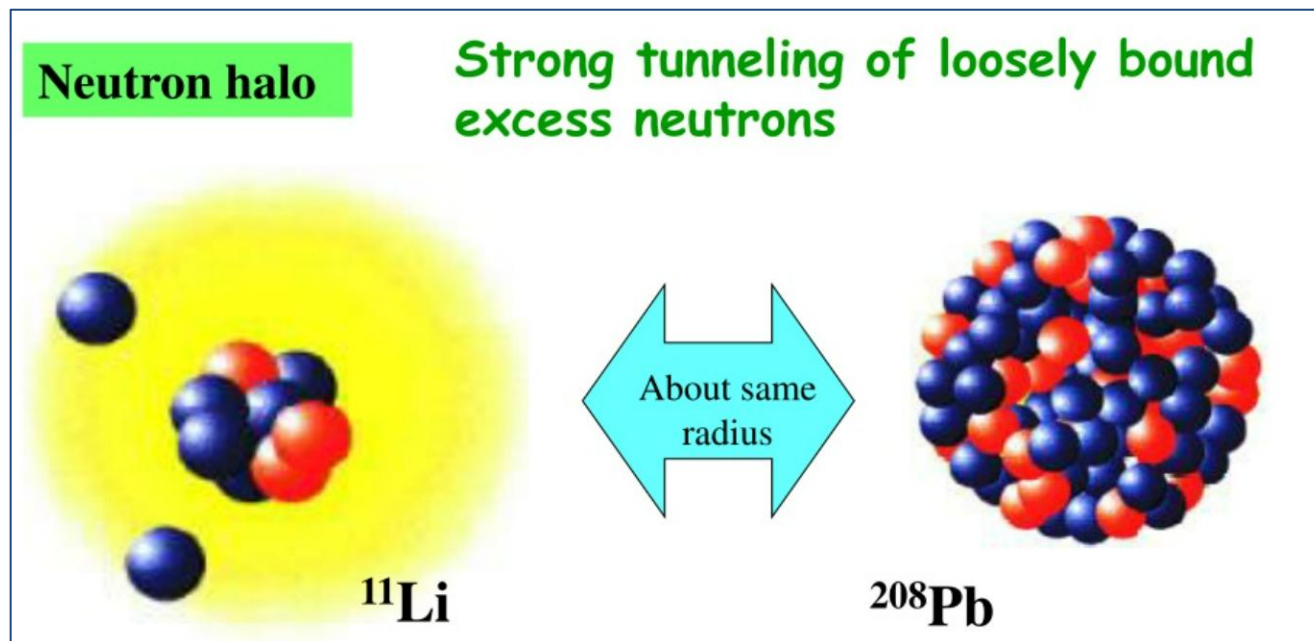
HALO-40, Beijing
Oct. 13, 2025

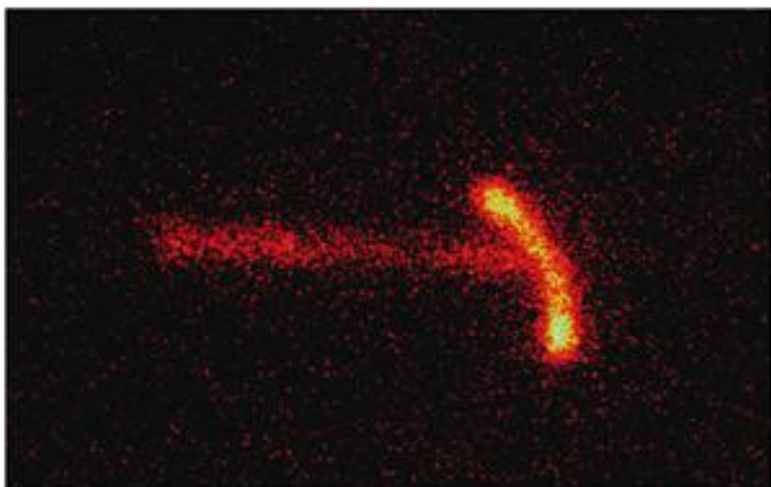
- Introduction
- Beijing Rare Isotope Facility (BRIF)
- Recent RIB Development and Experiments
- Current and planned Activities
- Summary

Measurements of Interaction Cross Sections and Nuclear Radii in the Light p -Shell Region

I. Tanihata, H. Hamagaki, O. Hashimoto, Y. Shida, N. Yoshikawa, K. Sugimoto, O. Yamakawa, T. Kobayashi, and N. Takahashi

Phys. Rev. Lett. **55**, 2676 – Published 9 December 1985





A two-proton decay recorded by Optical Time Projection Chamber. A ^{45}Fe ion enters the chamber from the left. The two bright, short tracks are protons of approximately 0.6 MeV.

Phys. Rev. Lett. 99, 102501(2007)

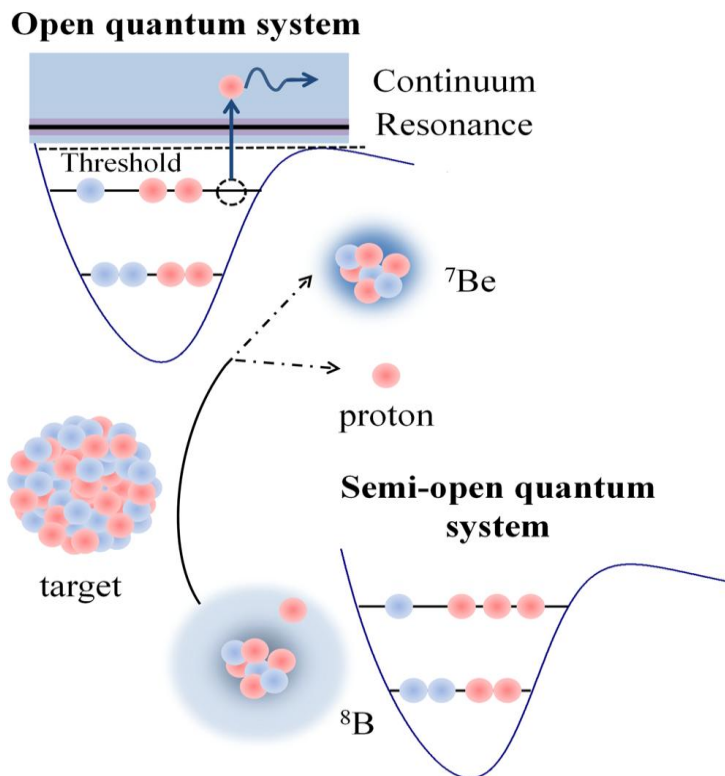
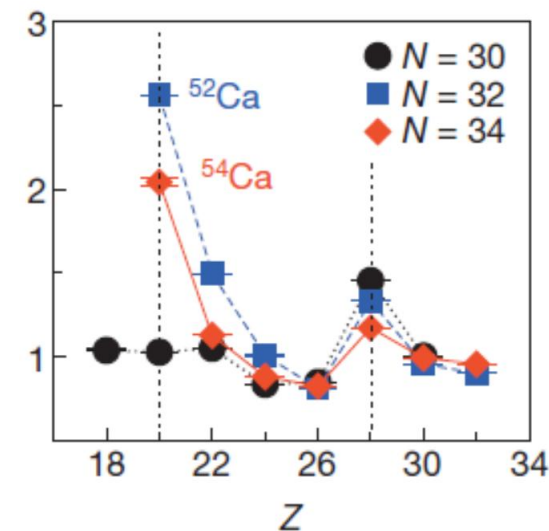
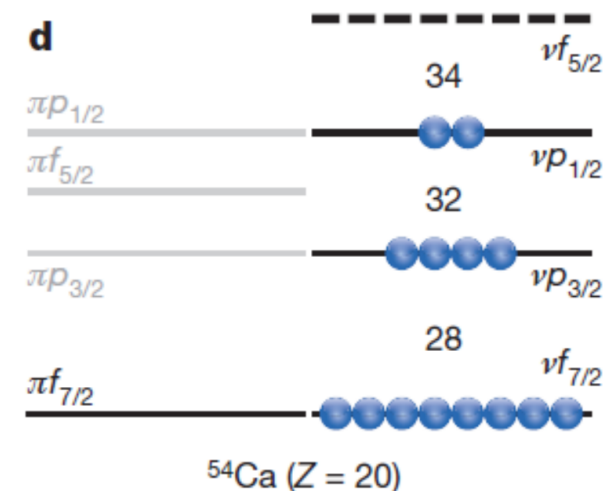
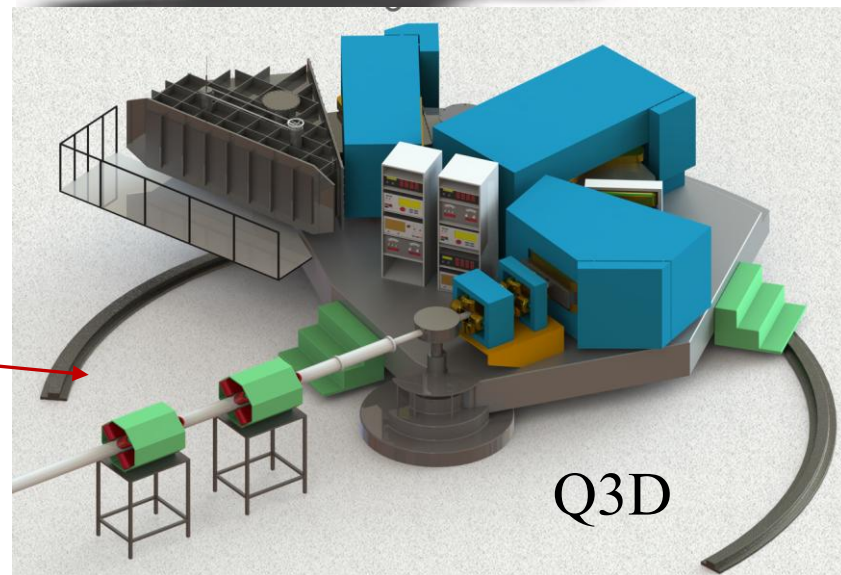
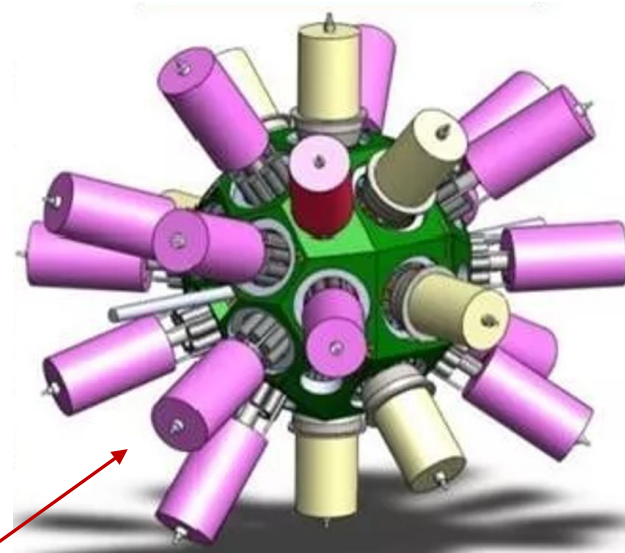
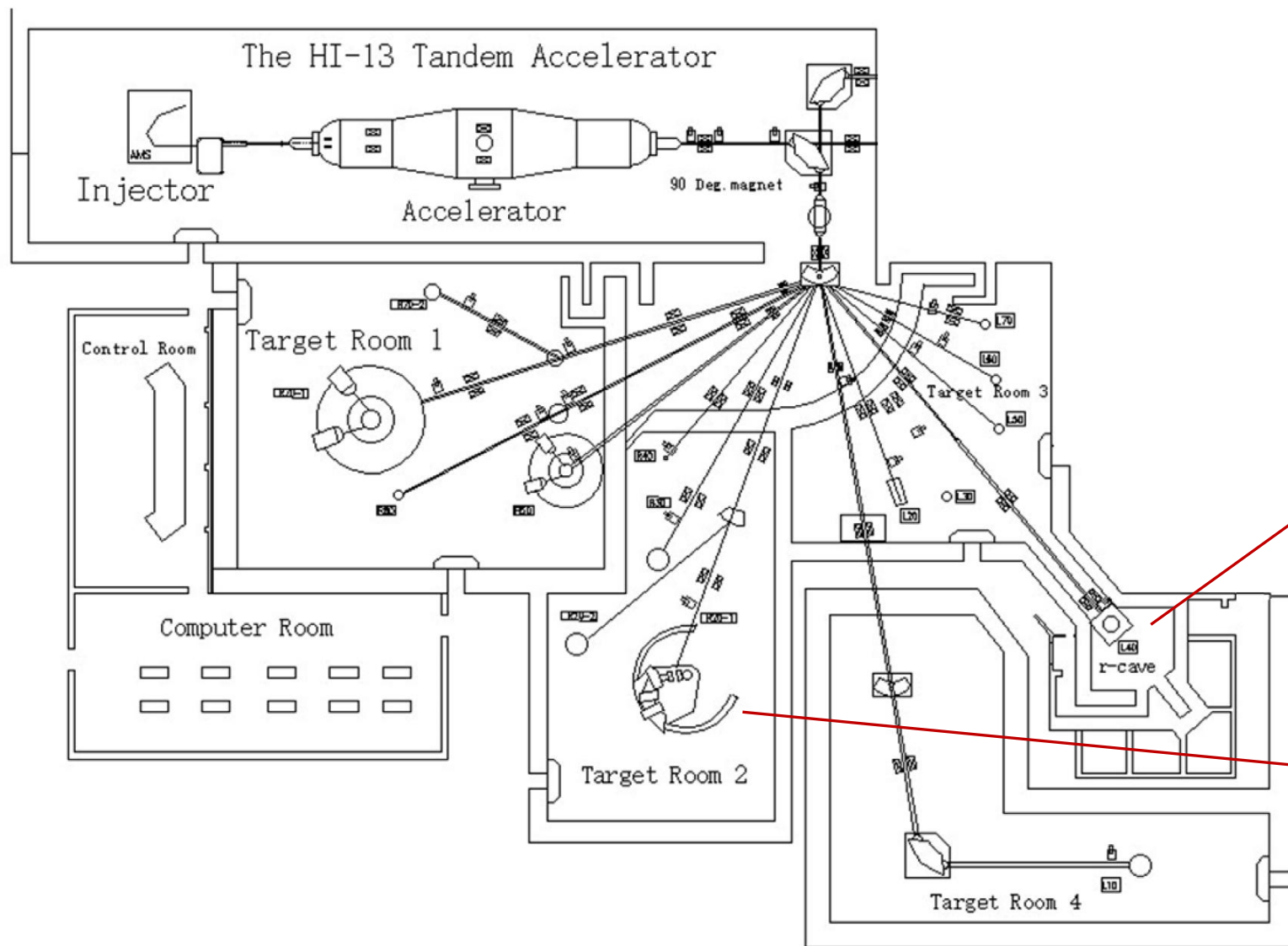


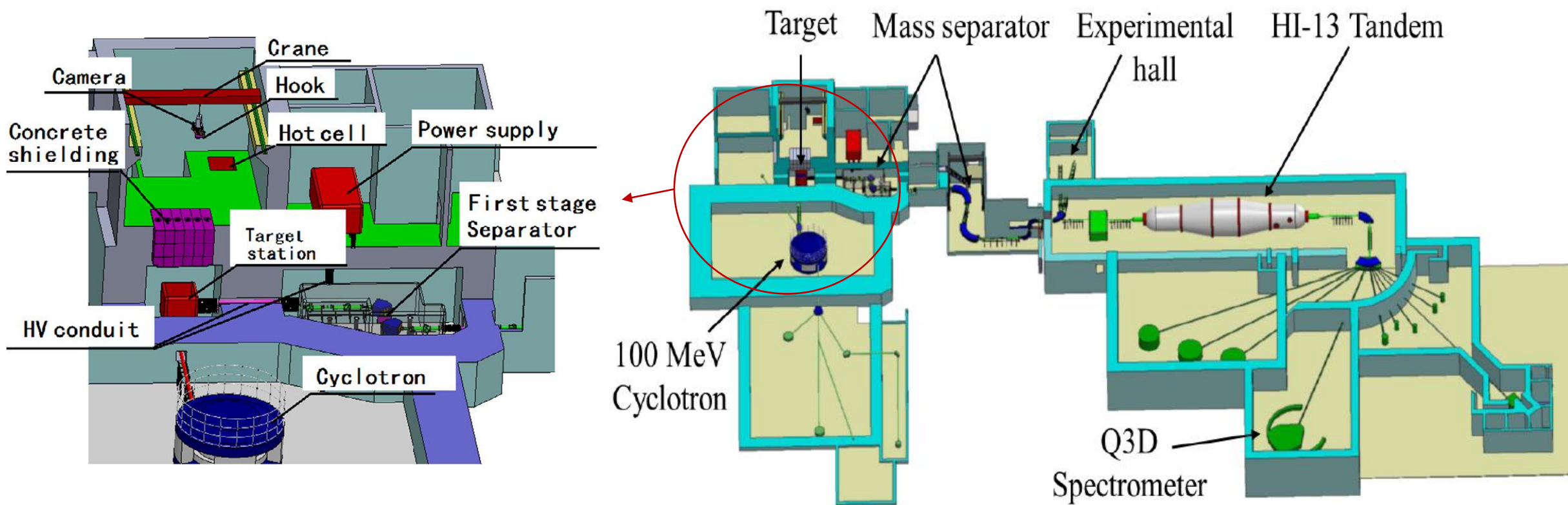
Fig. 1 | Illustration of ^8B breaking up into ^7Be and proton. In the initial state, the nucleons in ^8B occupy bound single particle orbits in the potential well. Although located in the potential well, the halo proton is extremely weakly-bound in an extended distribution around the centrum ^7Be core. It hence can be regarded as a semi-open quantum system. During the collision, ^8B is excited to the unbound states above the breakup threshold (either resonant or non-resonant), forming an open quantum system.

Nature Communications | (2022) 13:7193



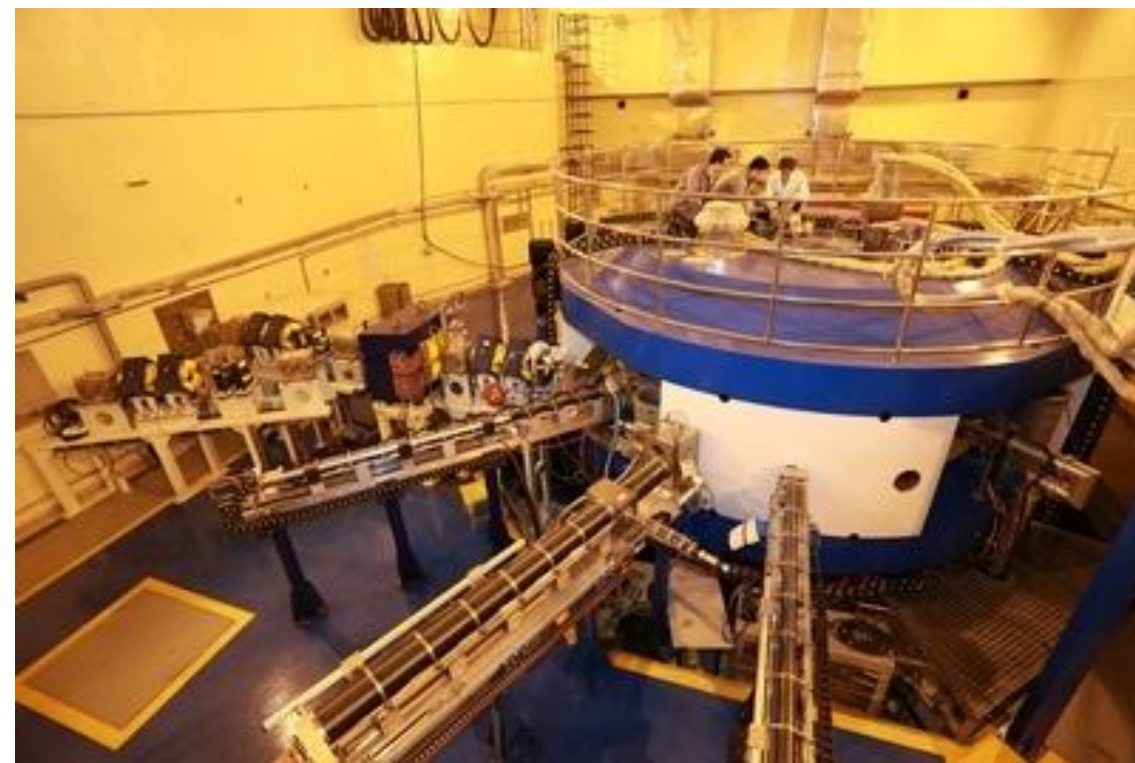
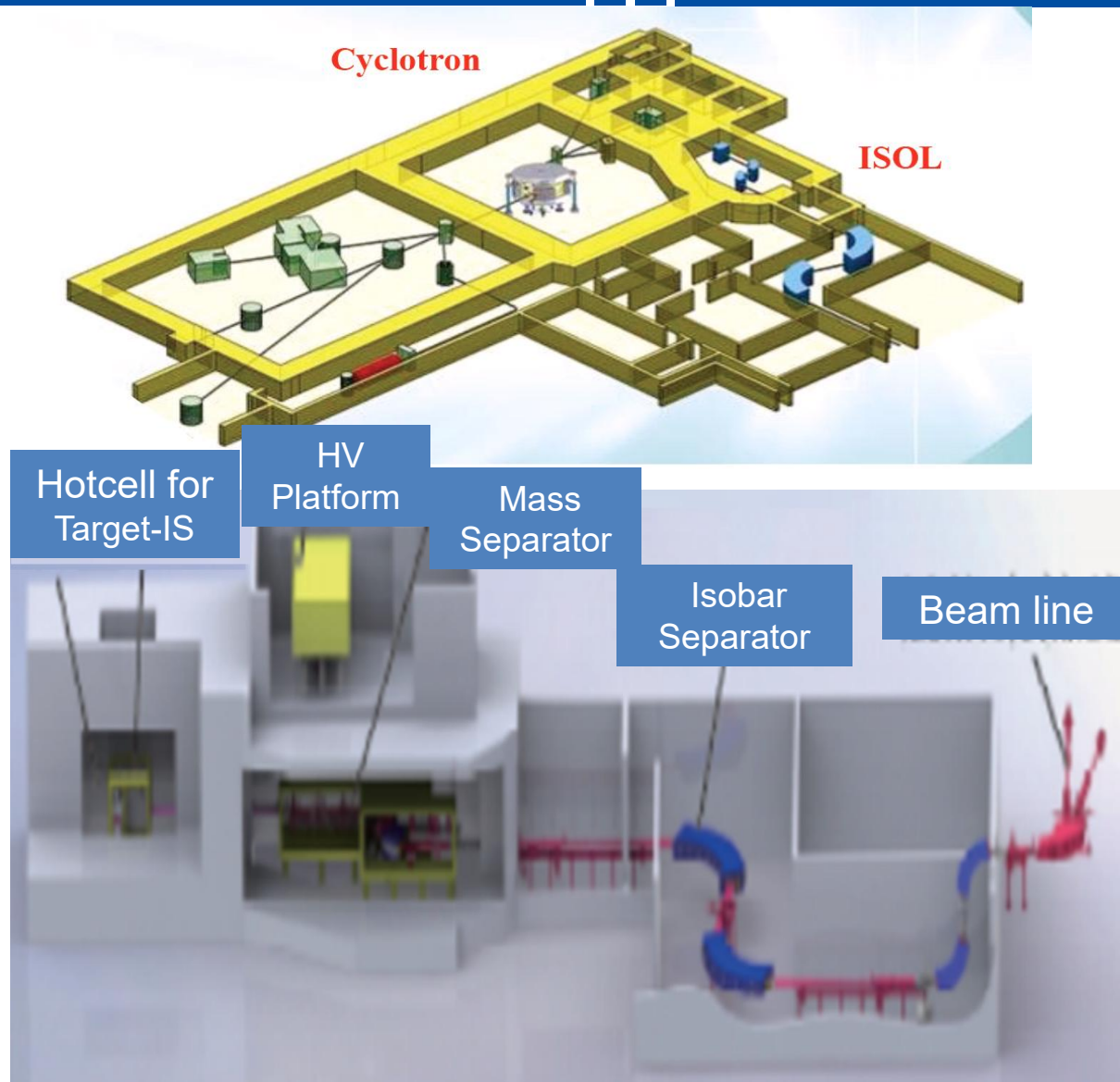
Nature | (2013) 502:207





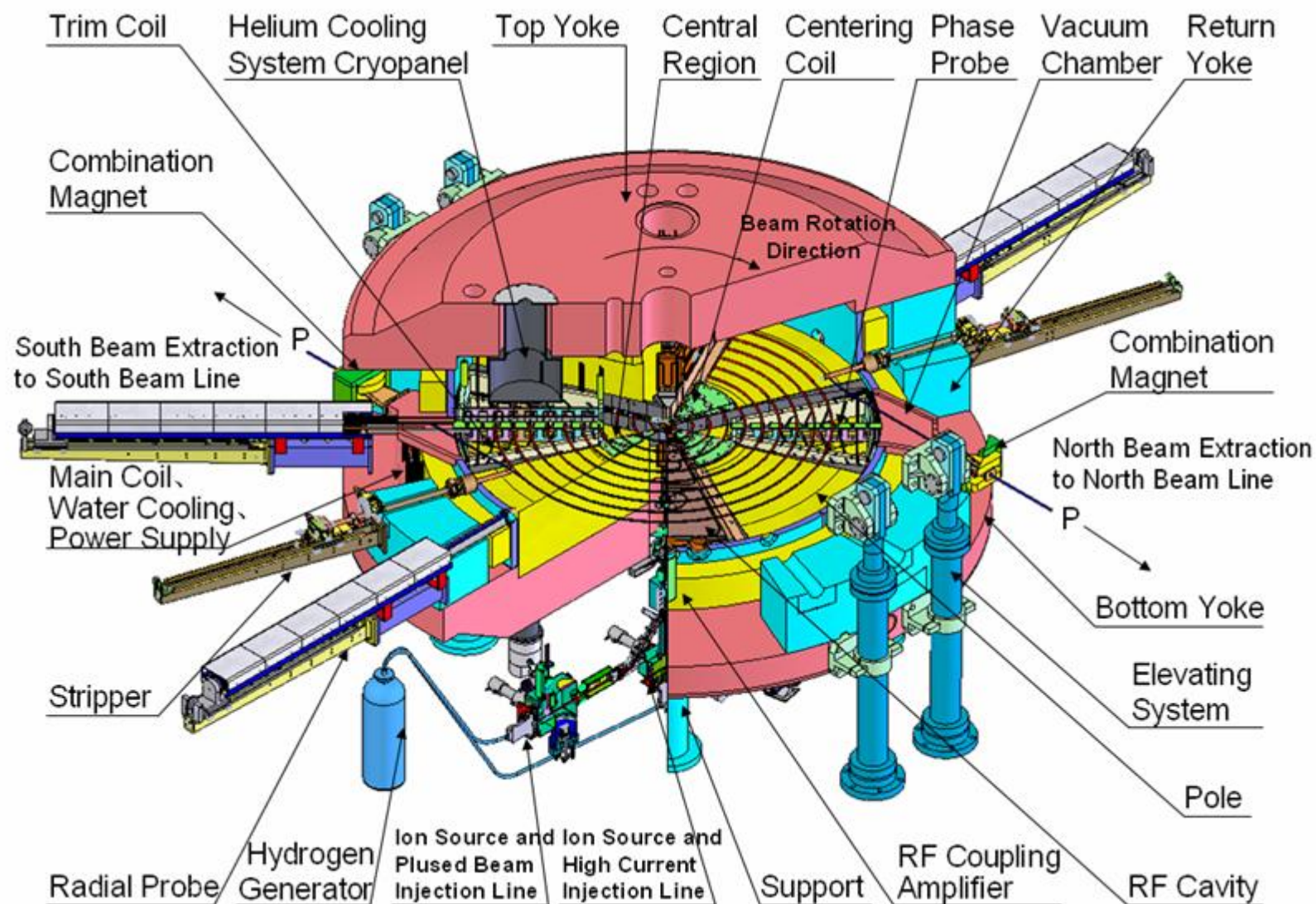
- ◆ 100 MeV proton cyclotron, Kilowatt Target-Ion Source assembly
- ◆ Charge Exchange cell + high-resolution ISOL
- ◆ HI-13 Tandem for post acceleration

Timetable of BRIF



**BRIF Construction Period:
2011-2016**

Proton cyclotron: CYCIAE100



➤ **CW mode, high current:**

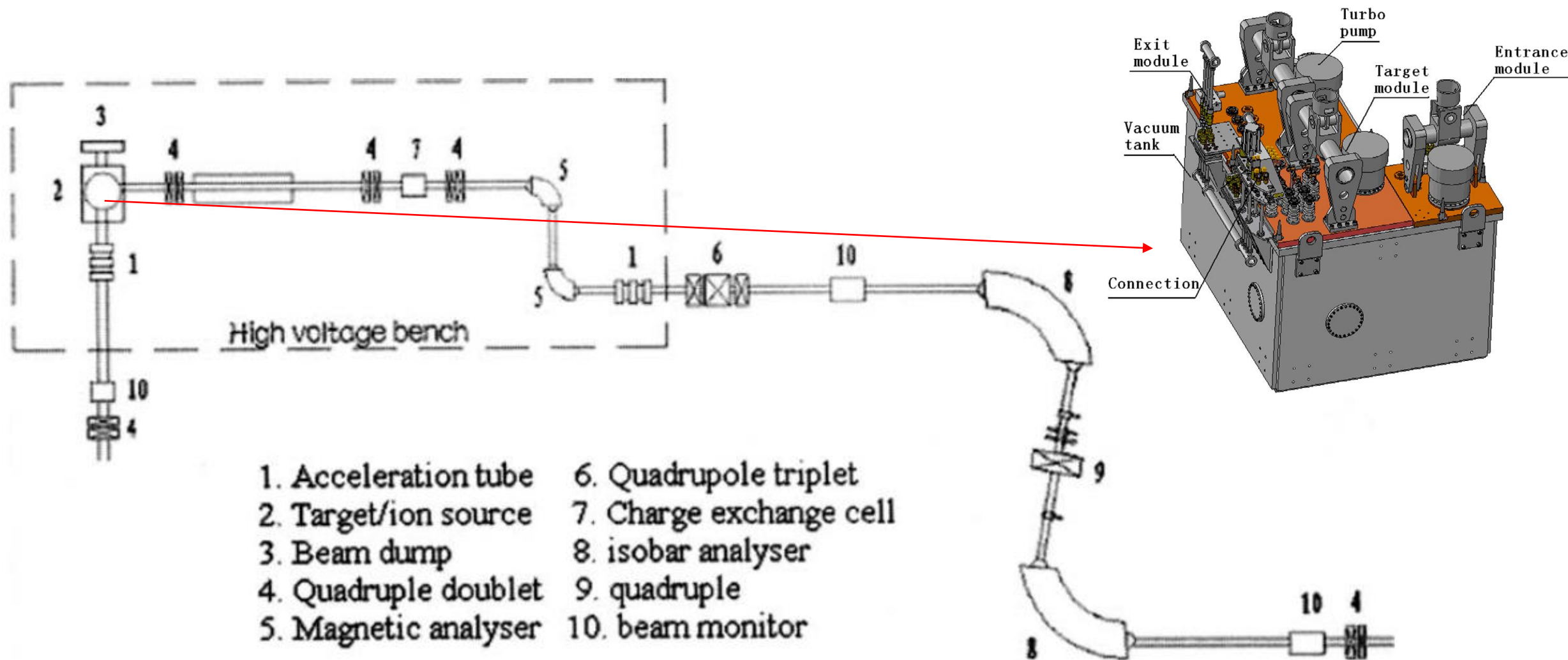
200~500 μA

➤ **Energy variable:**

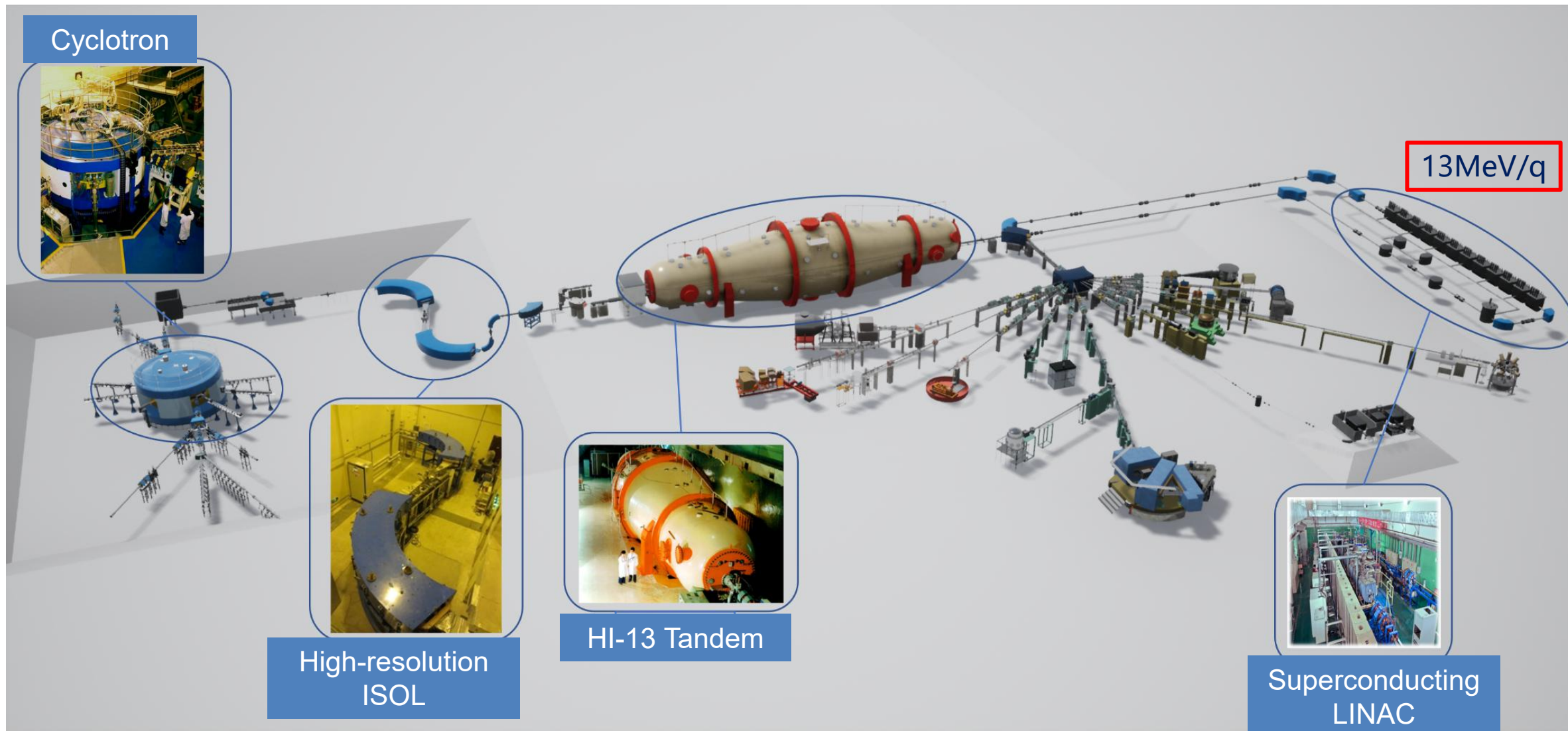
70~100MeV

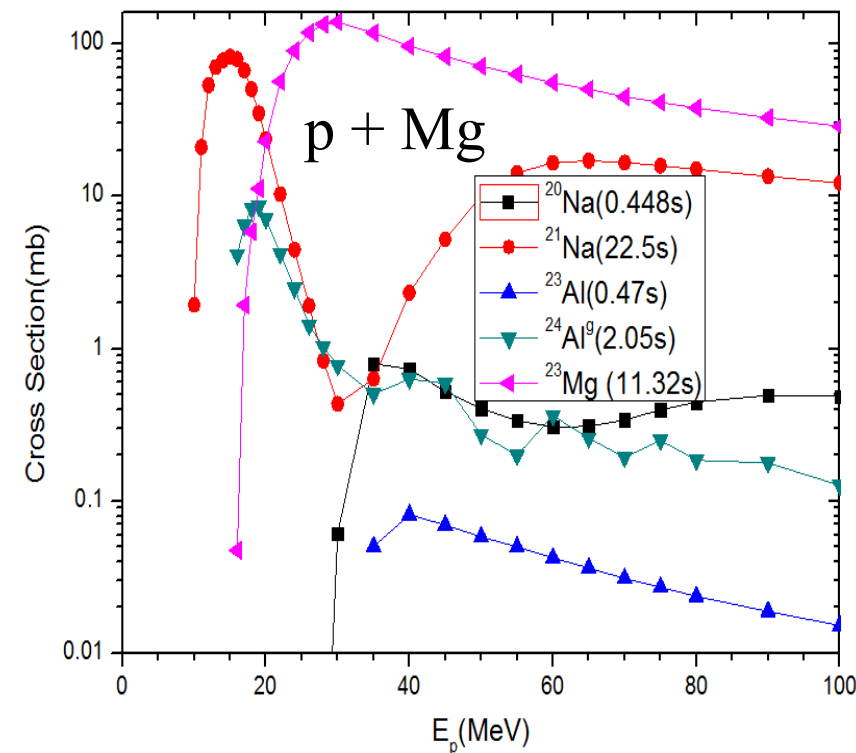
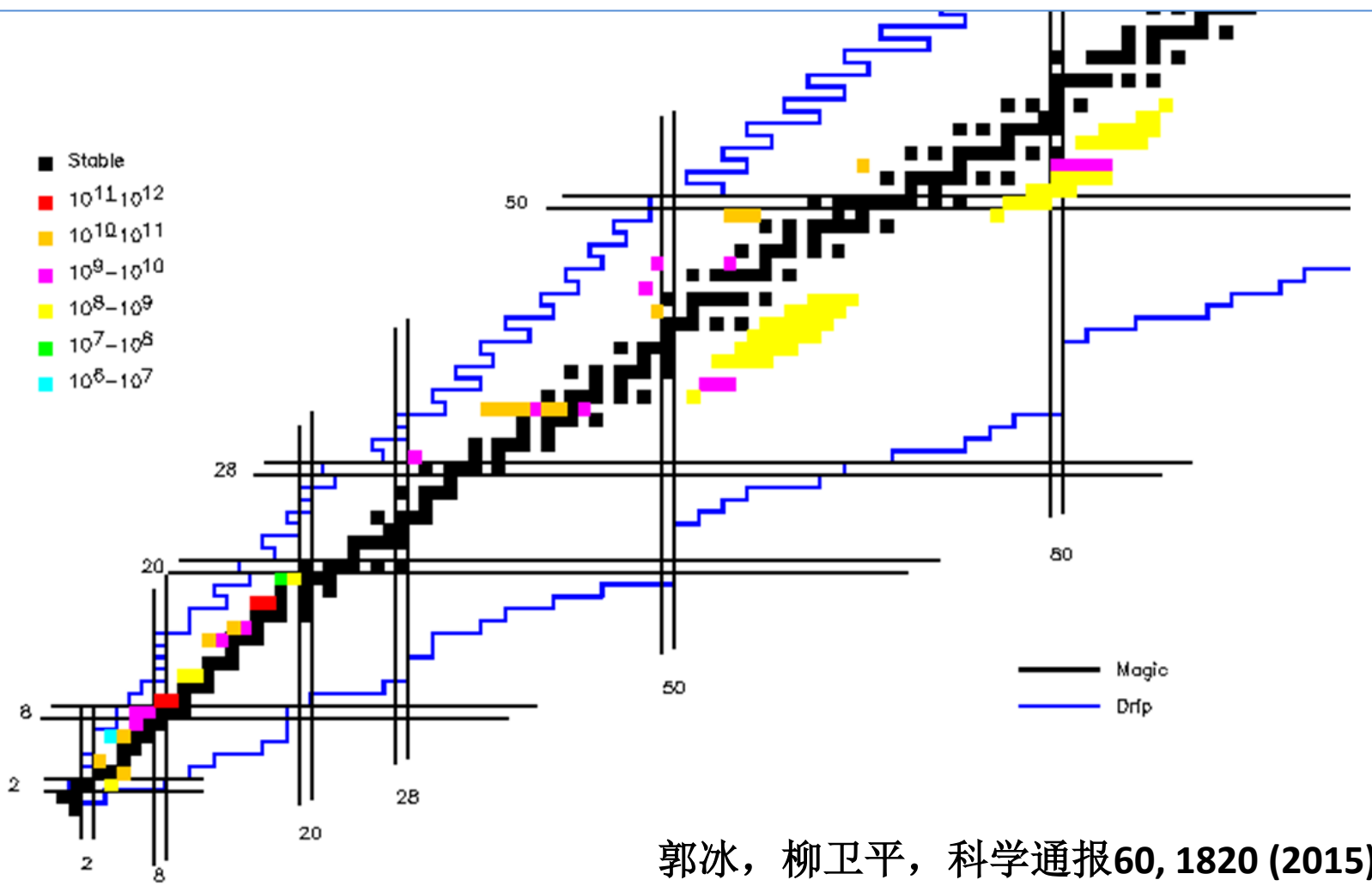
Tianjue Zhang et al.
NIM B 266, 4117(2008)

Two-stage high-resolution ISOL

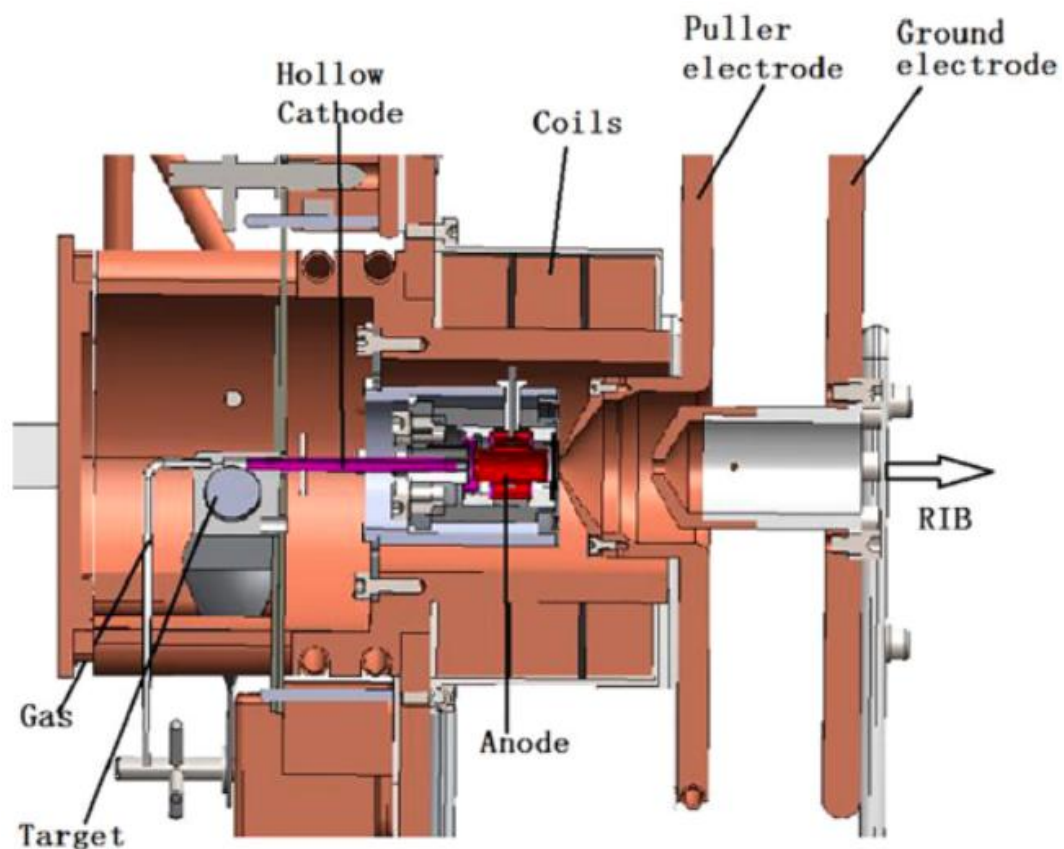


Baoqun Cui et al., NIM266, 4113(2008)

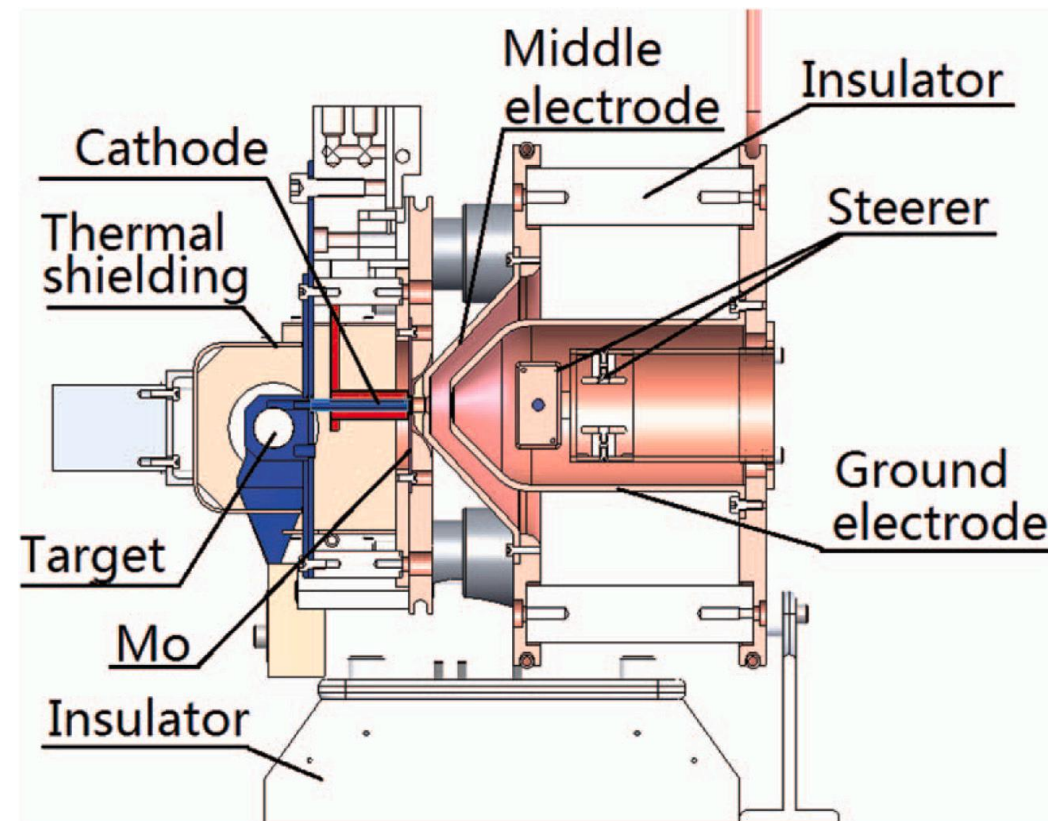




Proton induced fusion
 evaporation for p-rich RIBs;
 Proton induce fission of ^{238}U for
 n-rich RIBs.



FEBIAD Ion Source
(Forced Electron Beam Induced Arc Discharge)



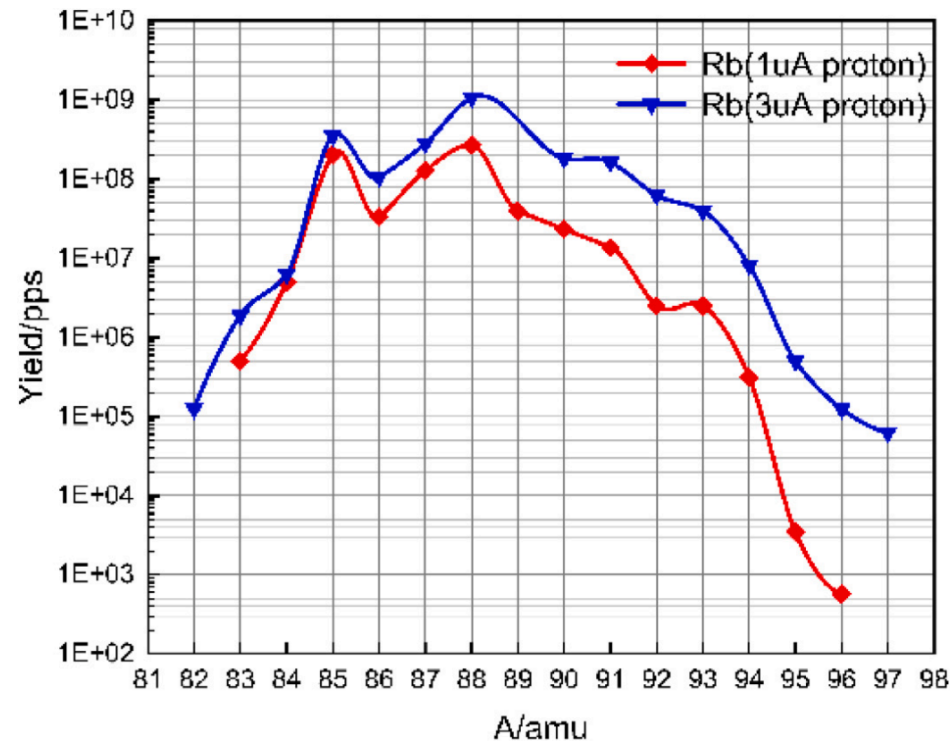
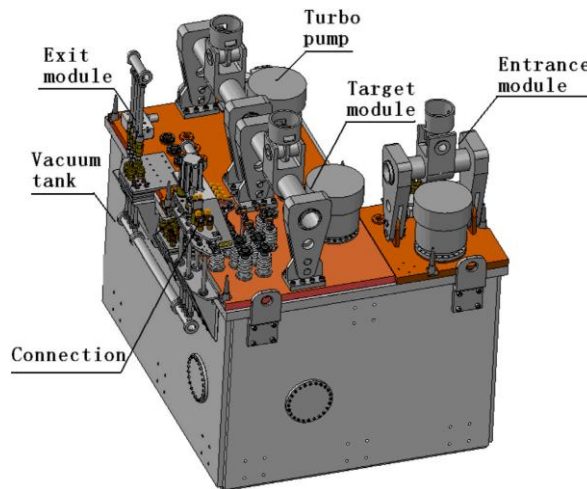
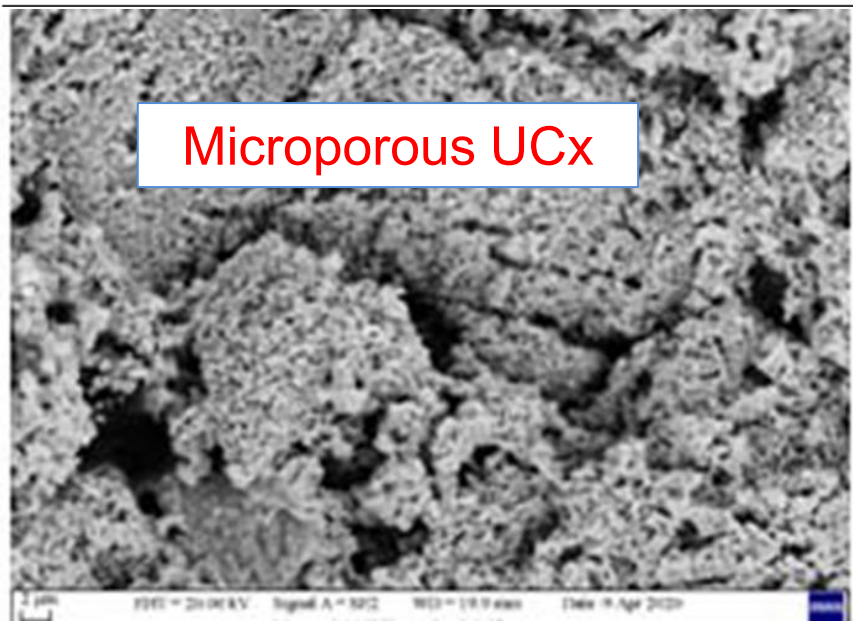
Surface Ion Source

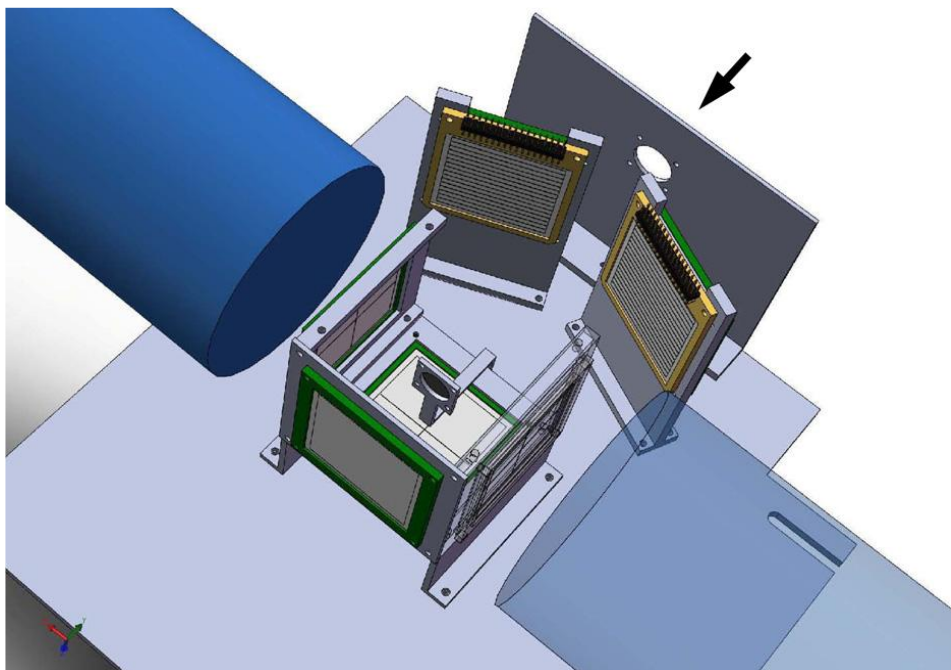
B. Tang et al, NIM B 463, 154 (2020)

The radioactive isotope yields of SiC target measured in front of the 300 kV acceleration column.

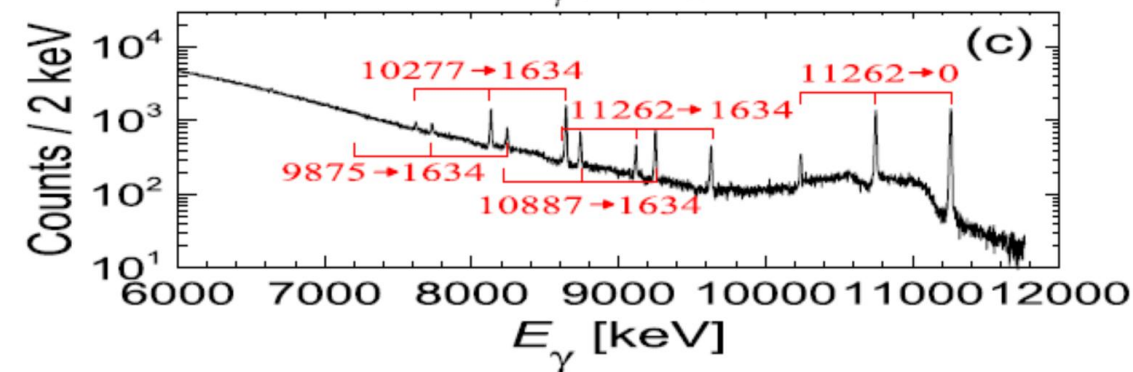
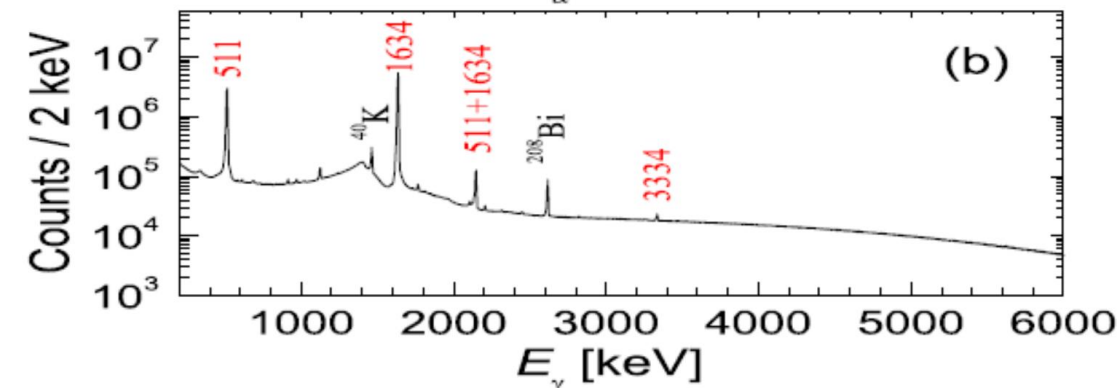
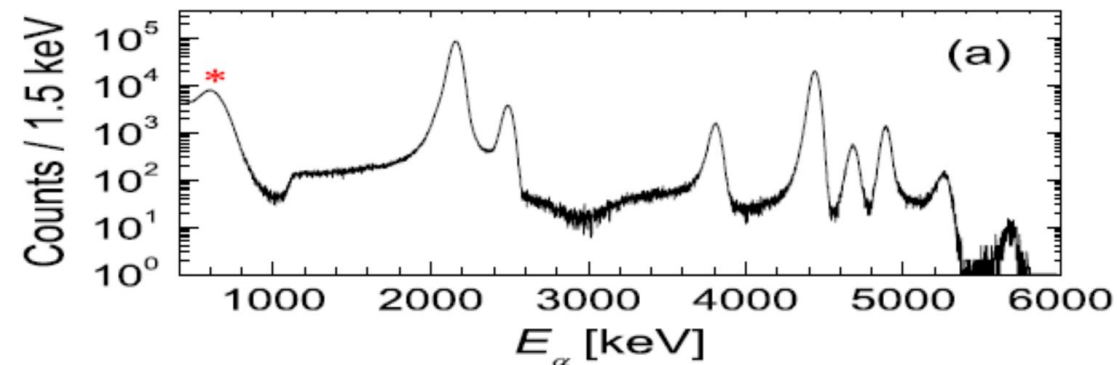
RIB	Half life	Proton/ μ A	Yield/pps
$^{20}\text{Na}^+$	0.448 s	15	2.1×10^5
$^{21}\text{Na}^+$	22.5 s	15	1.6×10^7
$^{22}\text{Na}^+$	2.6 y	15.5	4.4×10^9
$^{24}\text{Na}^+$	14.9 h	15	2.3×10^8
$^{25}\text{Na}^+$	59.1 s	15.5	2.9×10^6
$^{26}\text{Na}^+$	1.07 s	10	1.7×10^4
$^{23}\text{Al}^+$	0.47 s	13.5	2.2×10^2
$^{25}\text{Al}^+$	7.183 s	15.5	7.2×10^3
$^{26g}\text{Al}^+$	7.16×10^5 y	13.5	8.7×10^7
$^{26m}\text{Al}^+$	6.35 s	10	1.5×10^4
$^{28}\text{Al}^+$	2.245 min	15.5	2.7×10^4

Target	RNB	Ion source
CaO	37,38,43,45,47K	Surface IS
MgO	20,21,22,24,25Na	Surface IS
SiC	^{16}N , ^{27}Al , $^{20-25}\text{Na}$	FEBIAD
UCx	^{88}Rb , ^{90}Rb , ^{140}Cs , ^{142}Cs	FEBIAD

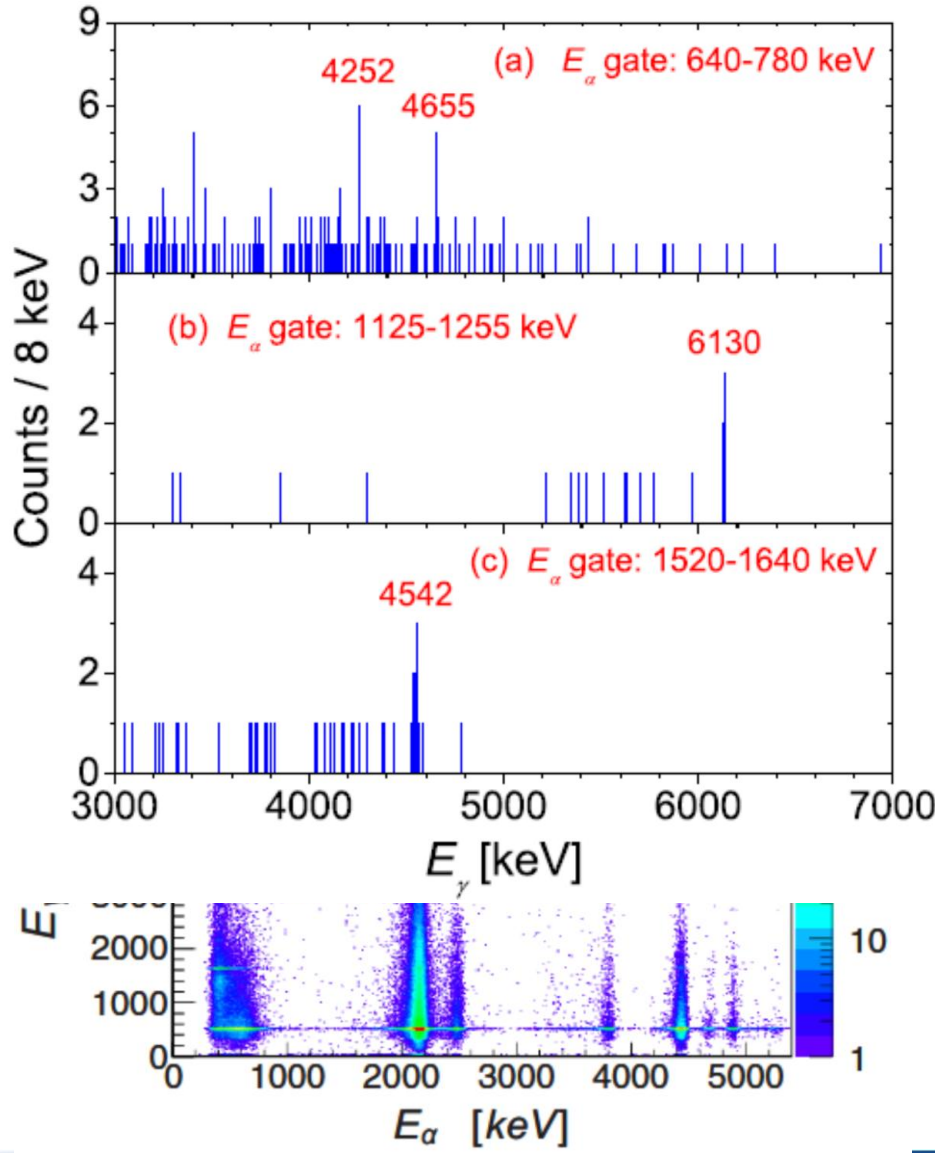




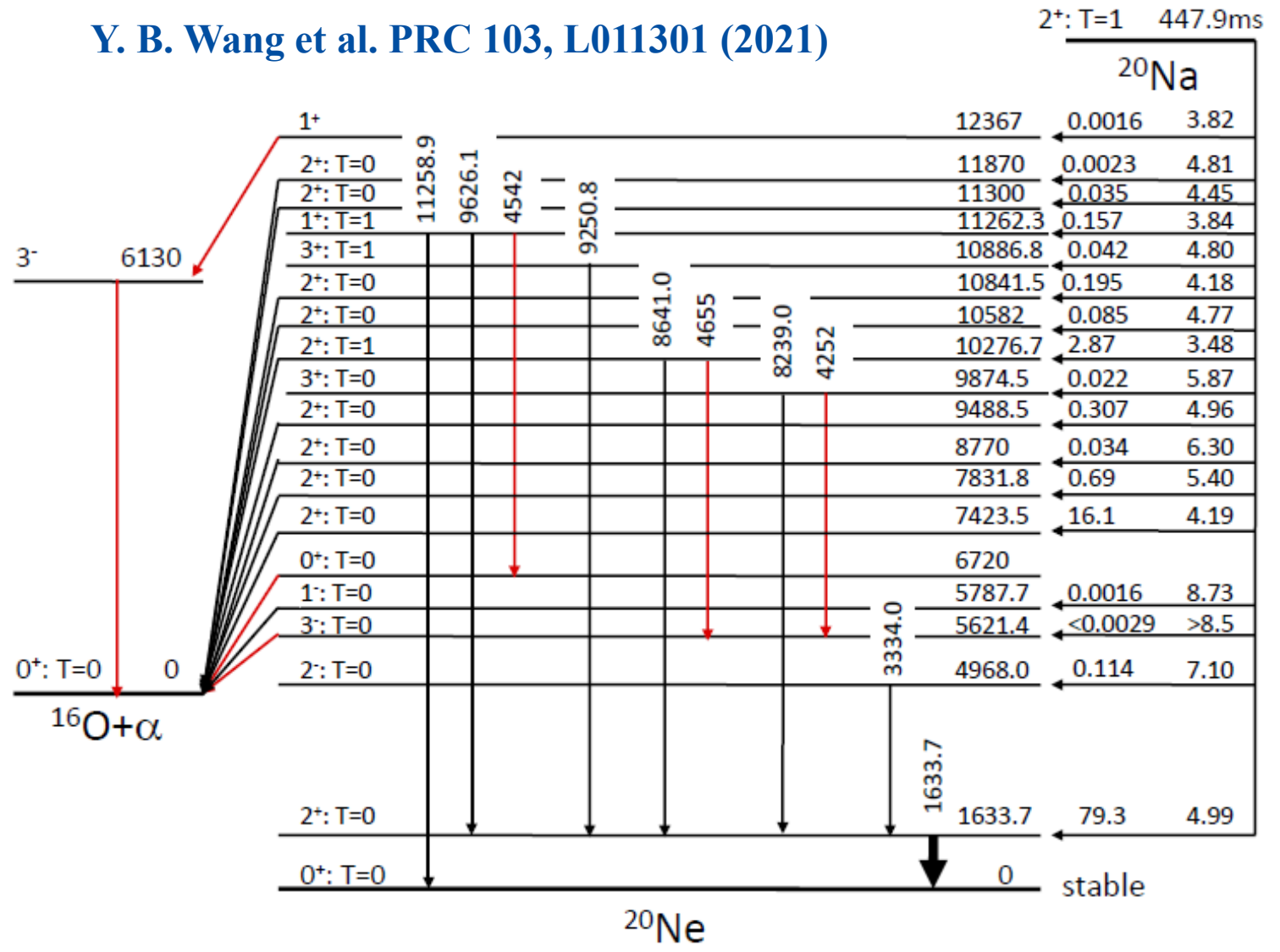
- Silicon box for β , two 175% HPGe for γ
- two DSSDs for α particles
- Simultaneous measurement of β , γ and α for triple coincidence
- Implantation rate: $\sim 1.5 \times 10^4$ pps

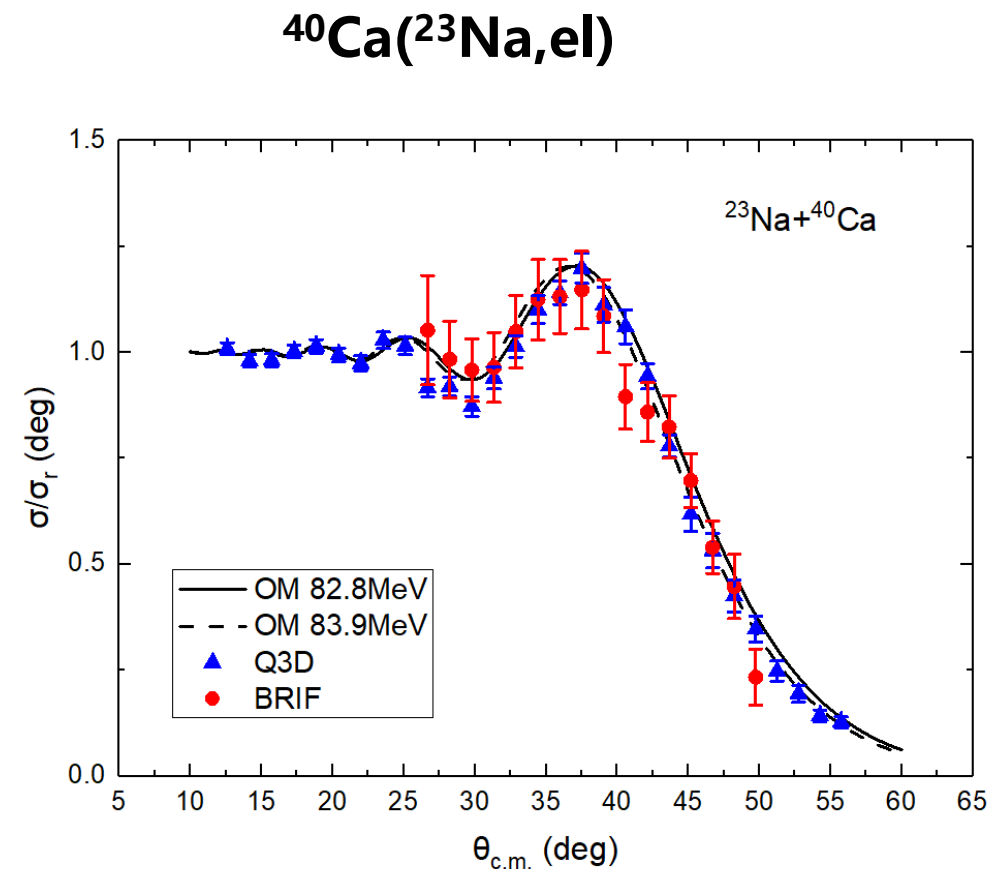
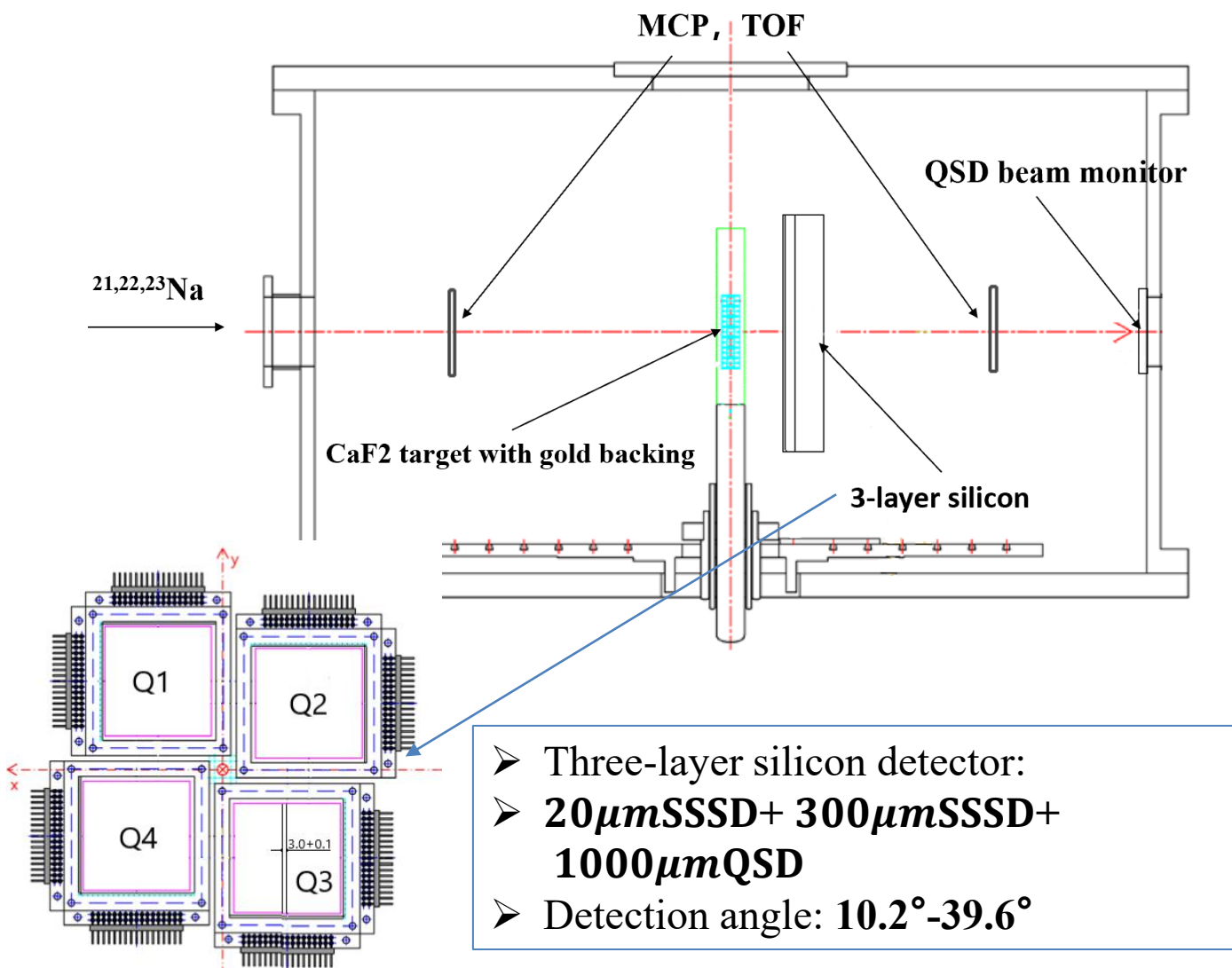


Direct observation of β - γ - α exotic decay mode



Y. B. Wang et al. PRC 103, L011301 (2021)

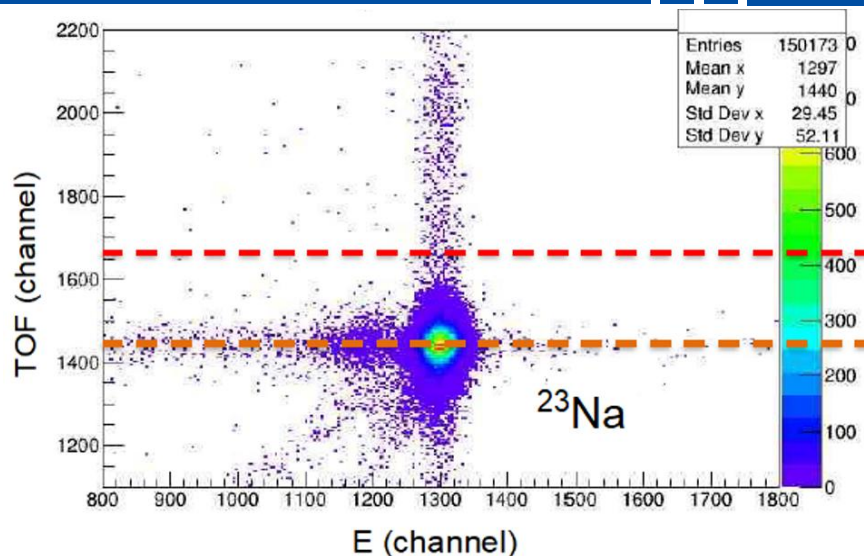




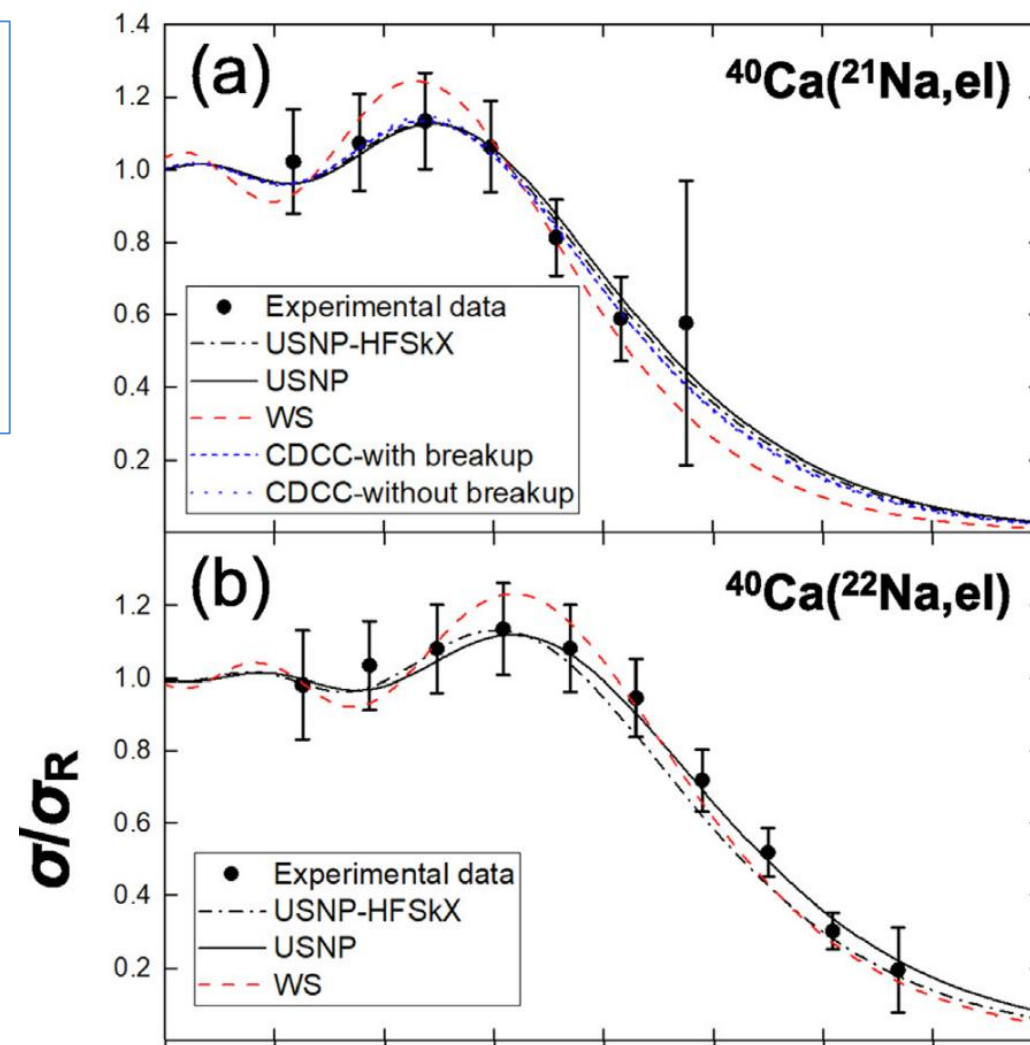
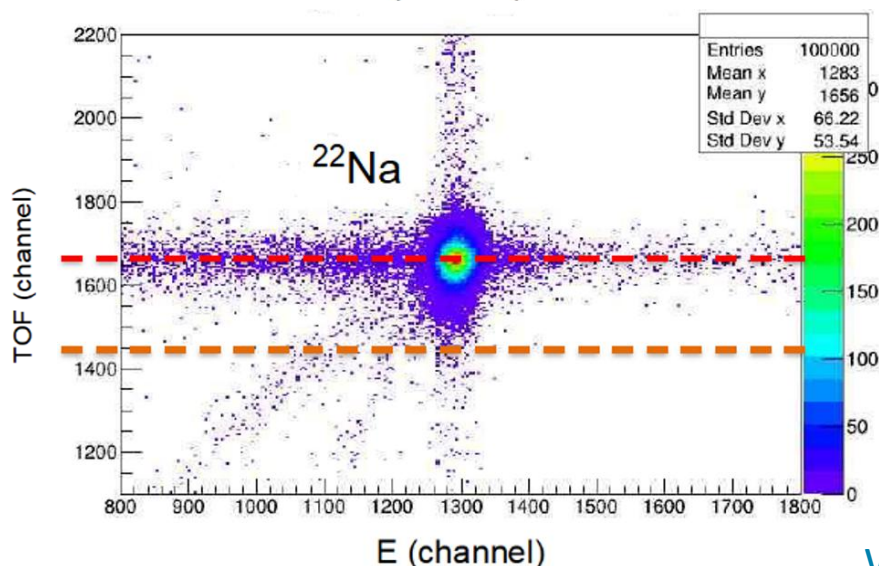
Nan W et al., Nucl. Sci. Tech. 32, 53(2021)

Nan Wei's talk, on October 15

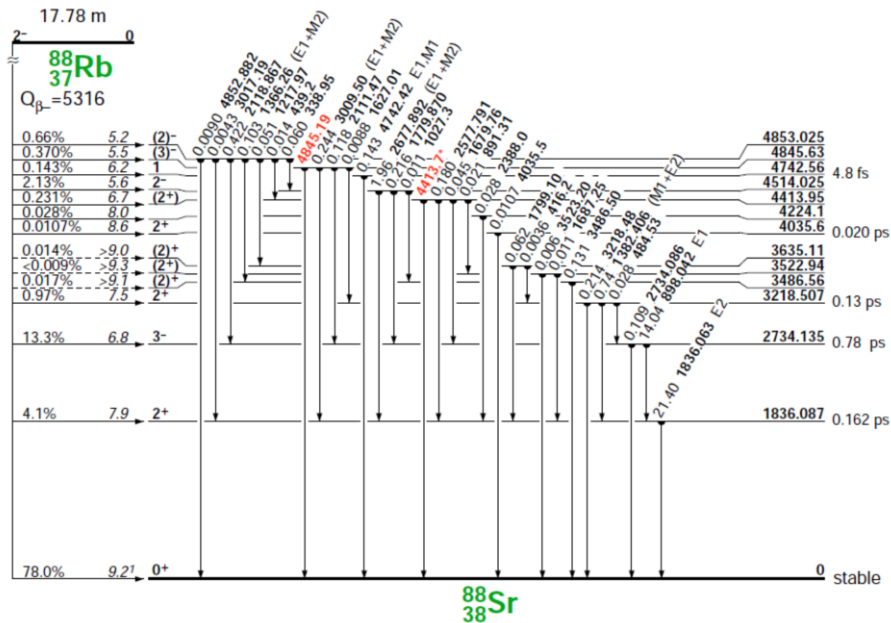
Elastic scattering with post-accelerated $^{21,22}\text{Na}$



➤ ^{22}Na : 87 MeV,
 2.5×10^5 pps
 ➤ ^{21}Na : 91 MeV
 1.2×10^4 pps

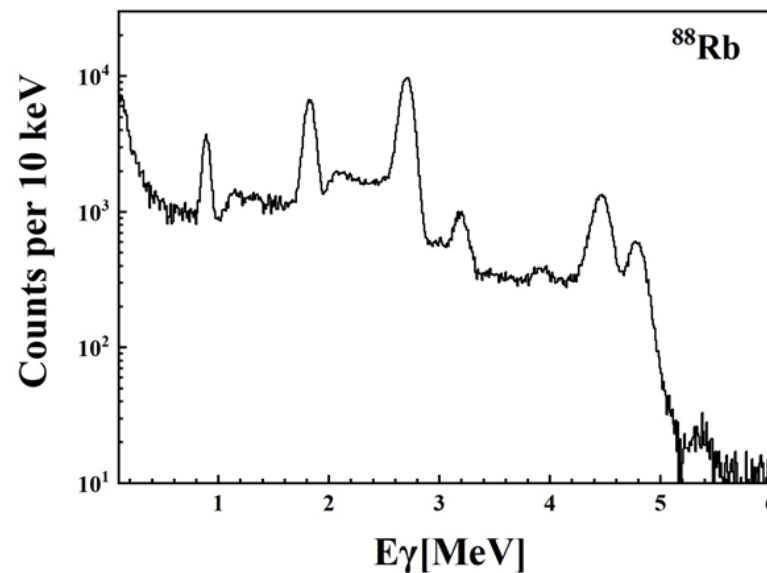
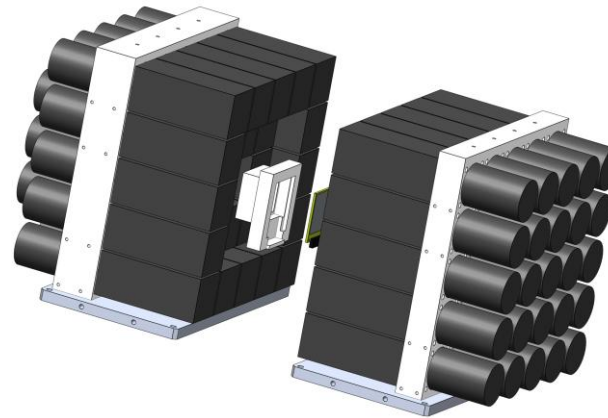


Wei Nan et al. Science Bulletin 70 (2025) 2925–2928



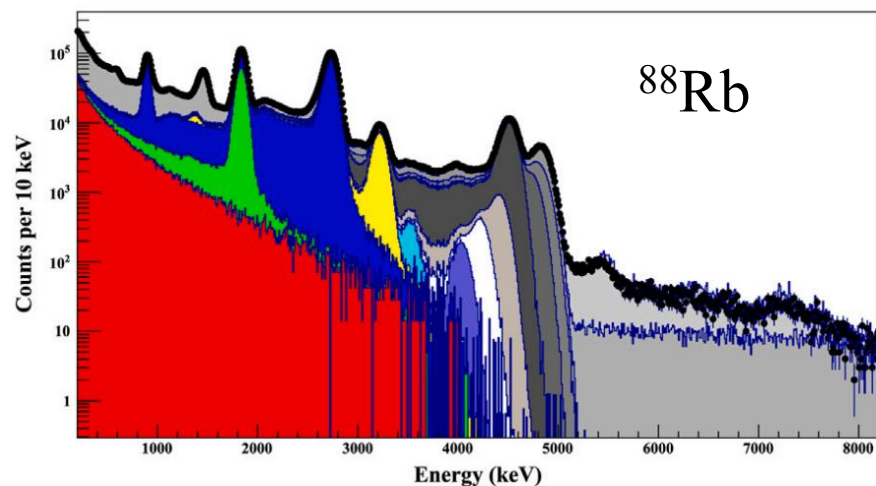
Measurements have been done for ^{88}Rb , ^{90}Rb , ^{140}Cs , ^{142}Cs isotopes

Large Module BGO Detector Array (LAMBDA)

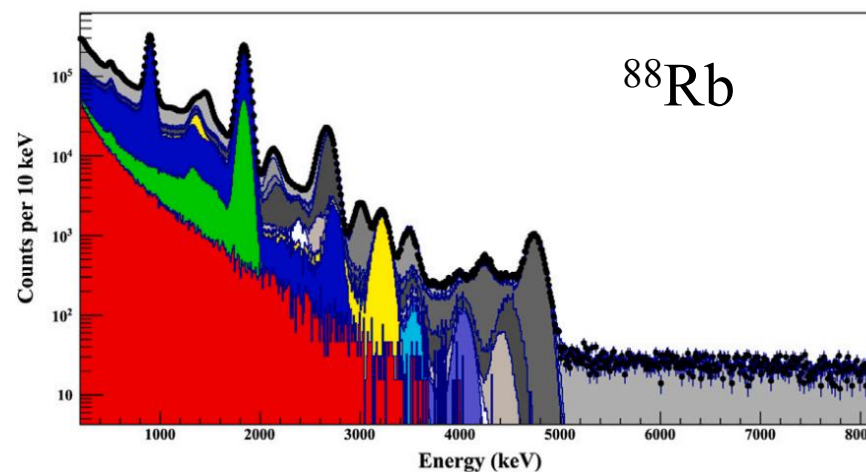


β feeding of ^{88}Rb

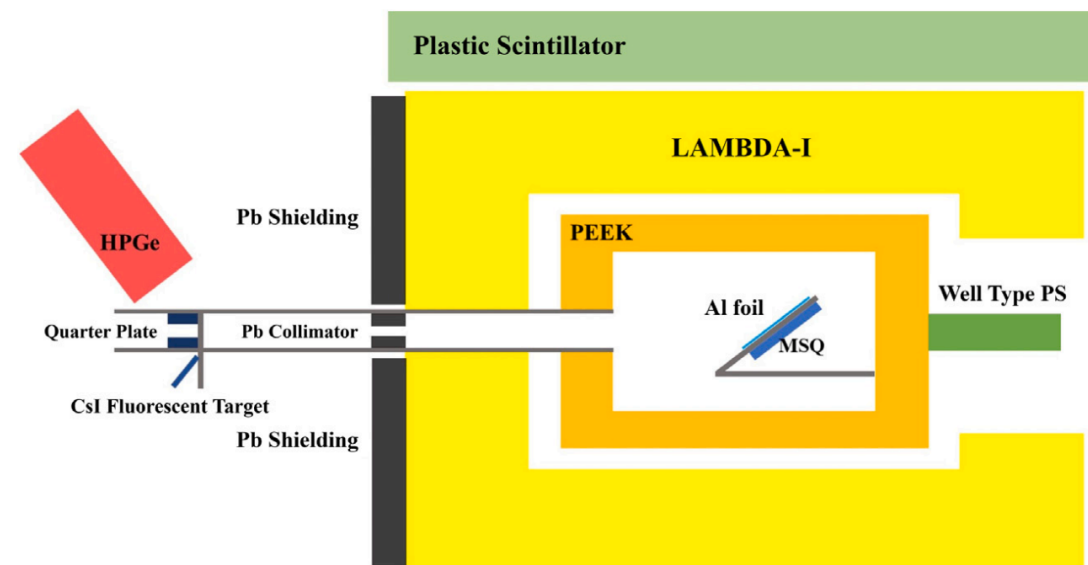
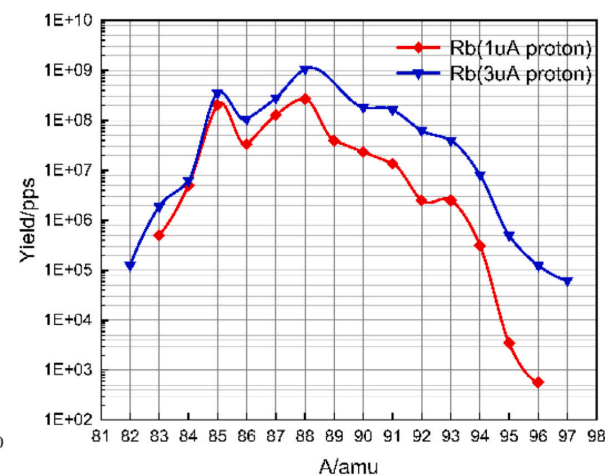
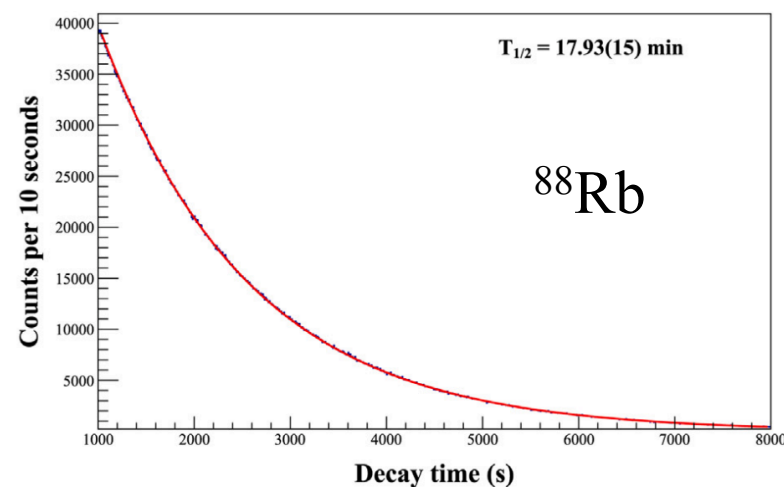
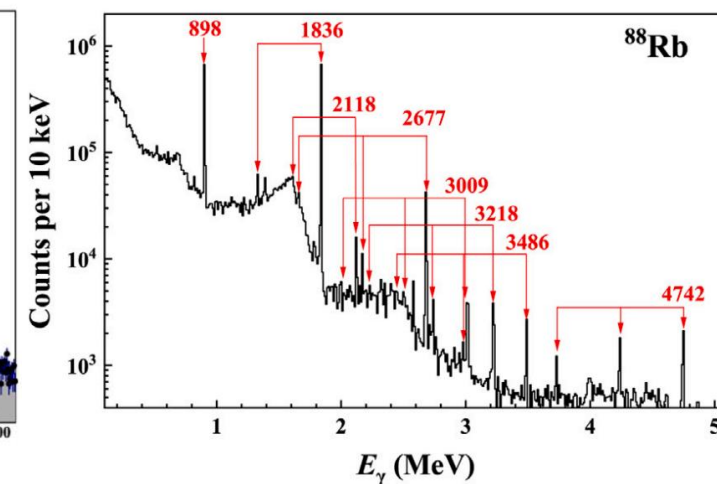
Ex (keV) in ^{88}Sr	Branching ratio (%)		
	LAMBDA	MTAS	ENDSF
0	77.8	78.2	76.51
1836	4.2	4.22	4.94
2734	13.0	12.8	13.59
3218	1.10	1.06	1.038
3486	0.00	0.02	0.016
3524	0.04	0.03	<0.003
3634	0.01	0.04	0.005
4035	0.02	0.014	0.0137
4224	0.10	0.008	0.03
4413	0.21	0.47	0.254
4514	2.20	1.87	2.319
4742	0.23	0.22	0.178
4845	0.41	0.59	0.401
4853	0.81	0.46	0.726

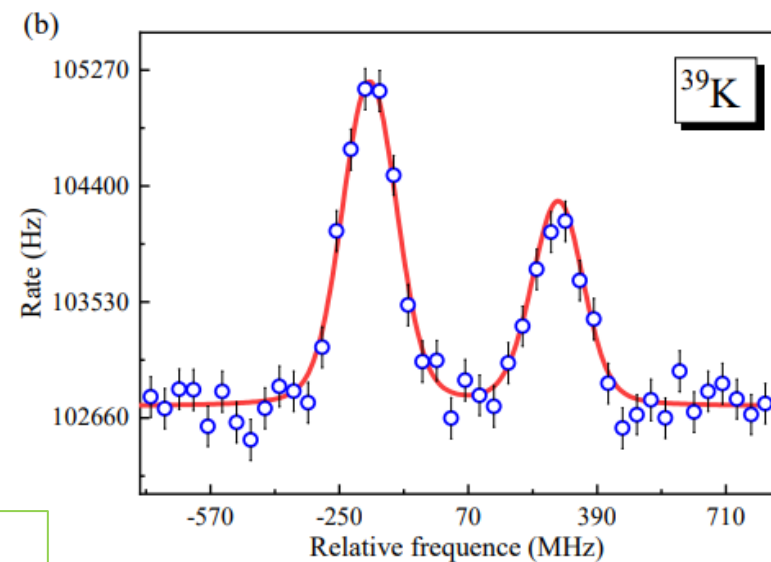
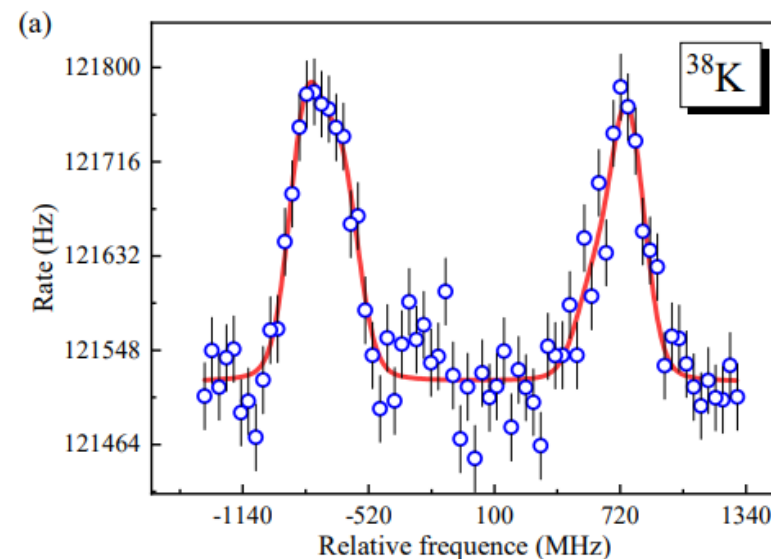
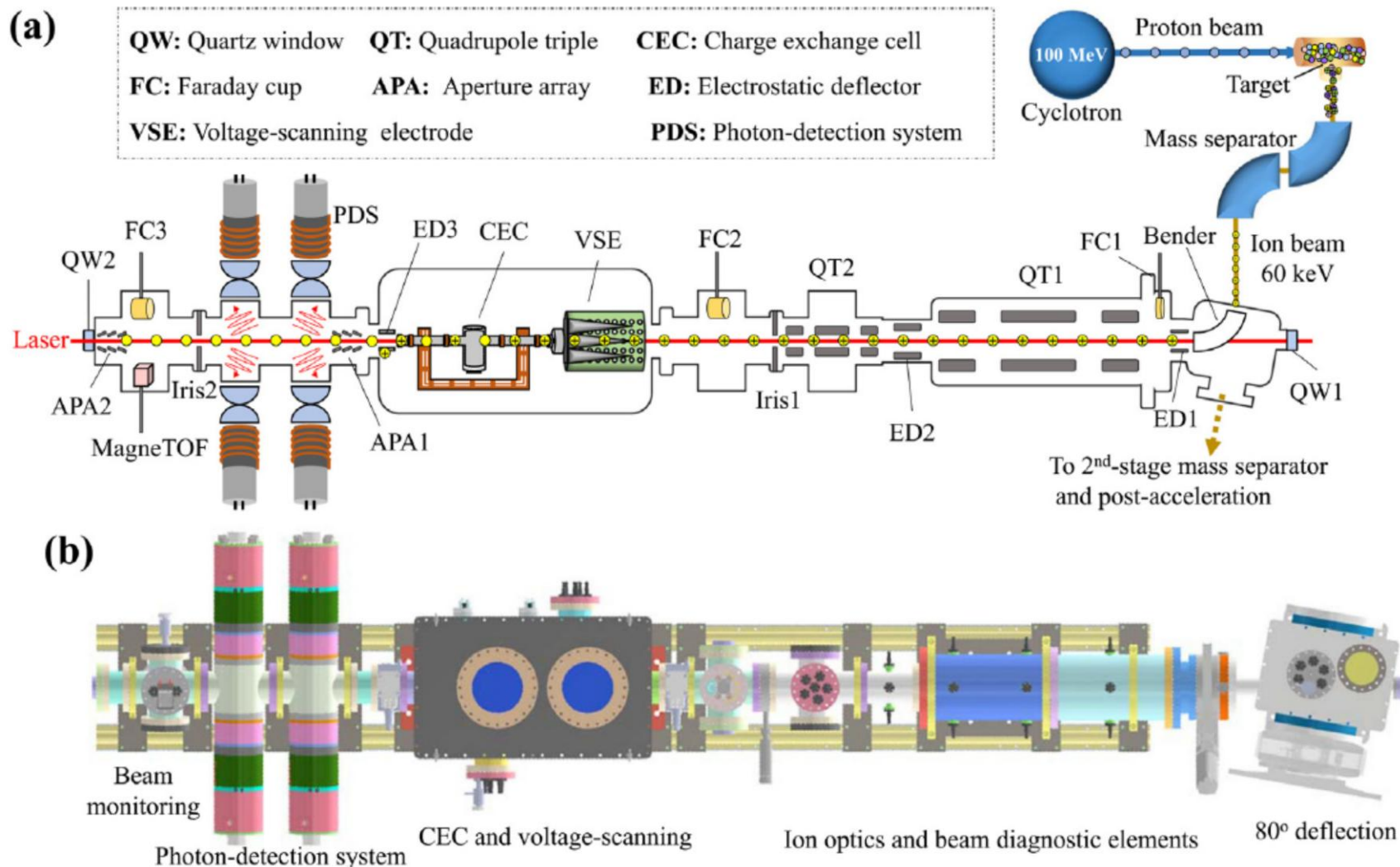


(a) Fitted result of sum channel.



(b) Fitted result of single channel.





S. J. Wang, et al., NIM A, 1032, 166622 (2022)

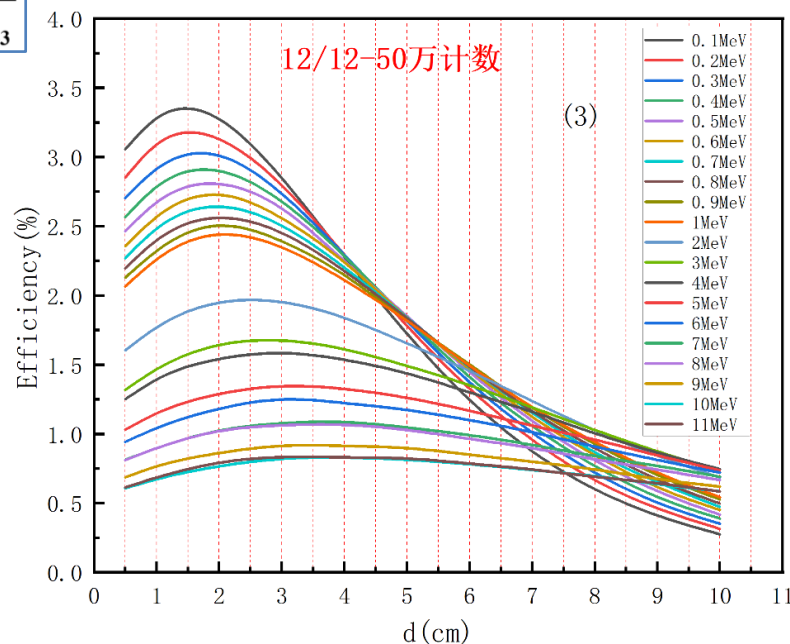
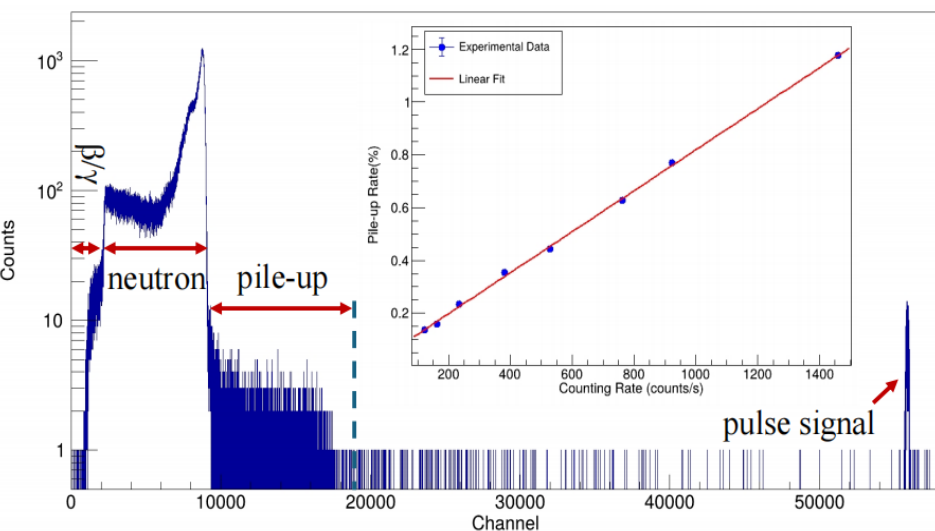
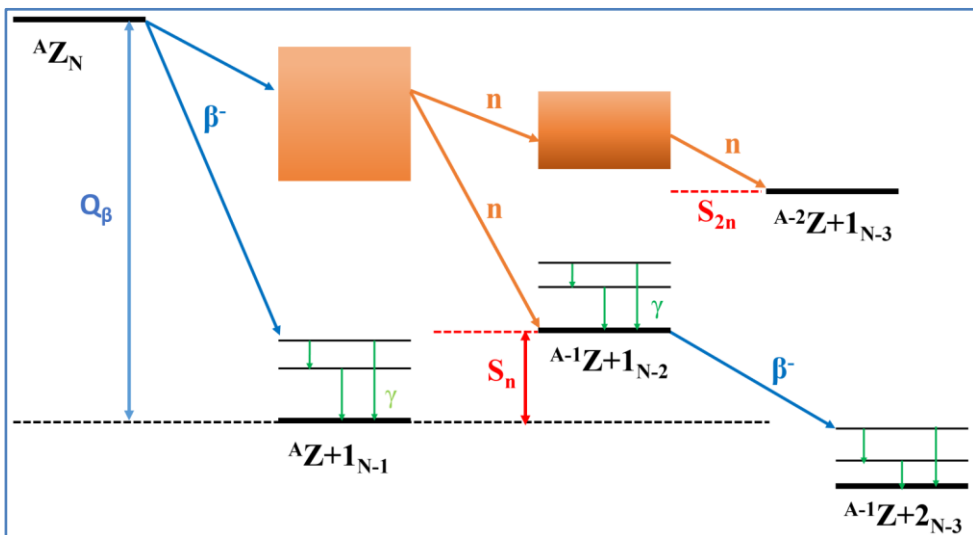
Long Helium-3 Neutron Array (LHENA)

LHENA for Pn @BRIF

- GEANT4 simulation
- ^3He counter testing
- Design and set-up
- On-line eff. calibration



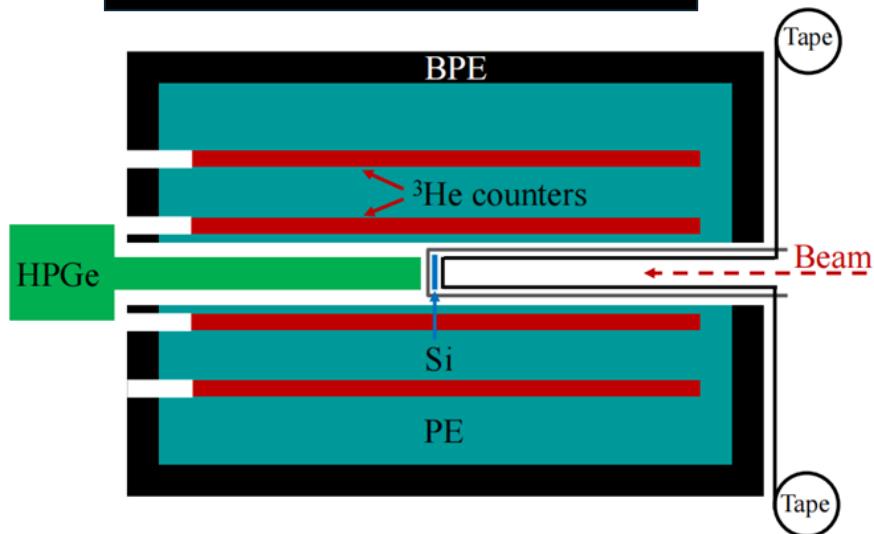
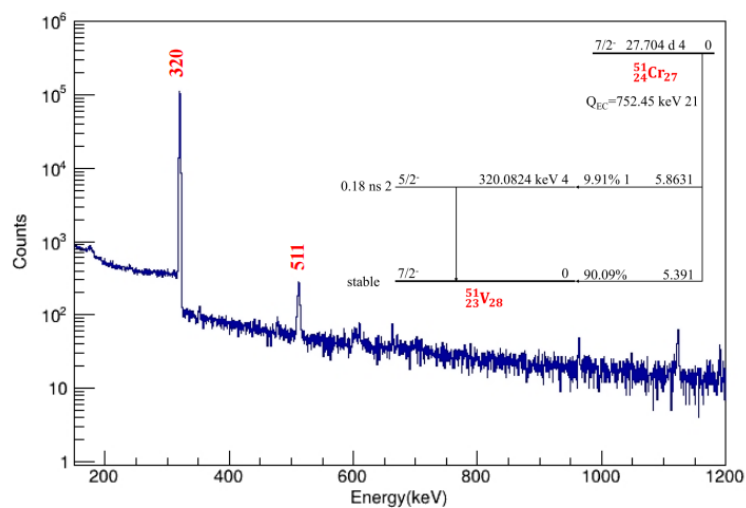
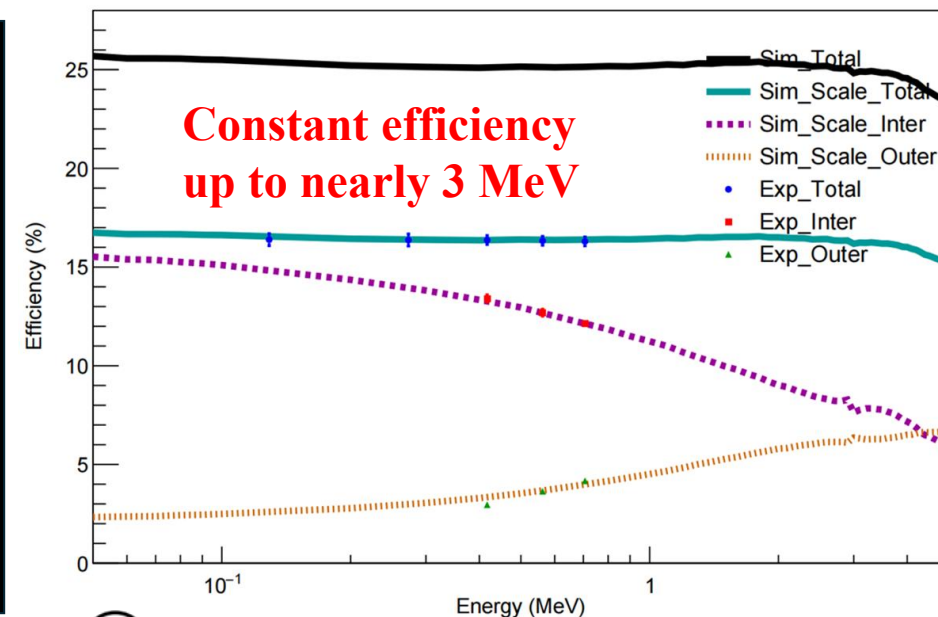
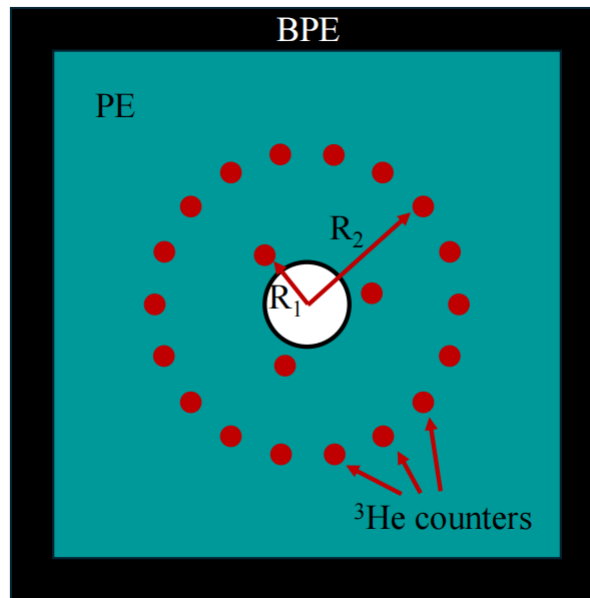
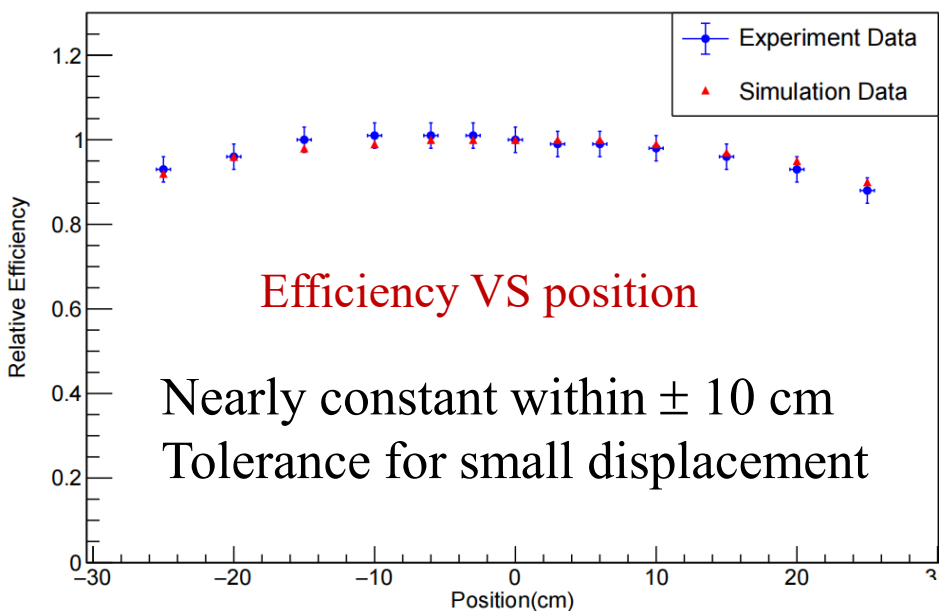
21 ^3He tubes
 800 × $\phi 25.4\text{mm}$, 4 atm

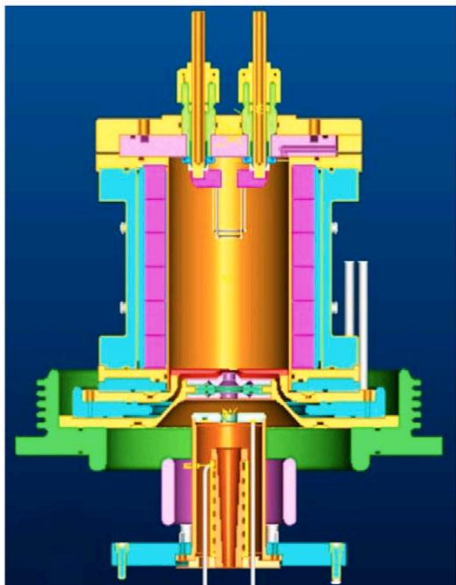


12/12-50万计数

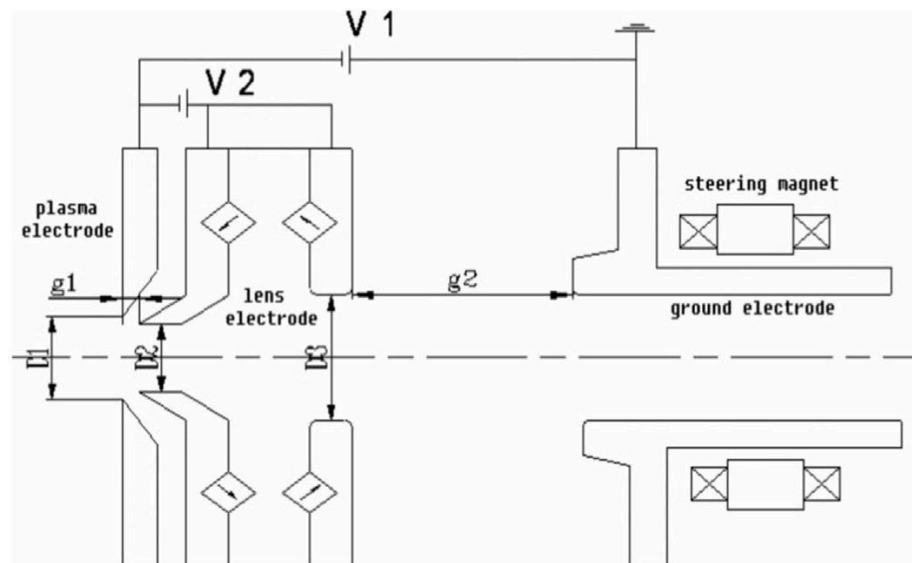
(3)

Calibration of LHENA with $^{51}\text{V}(p, n)^{51}\text{Cr}$

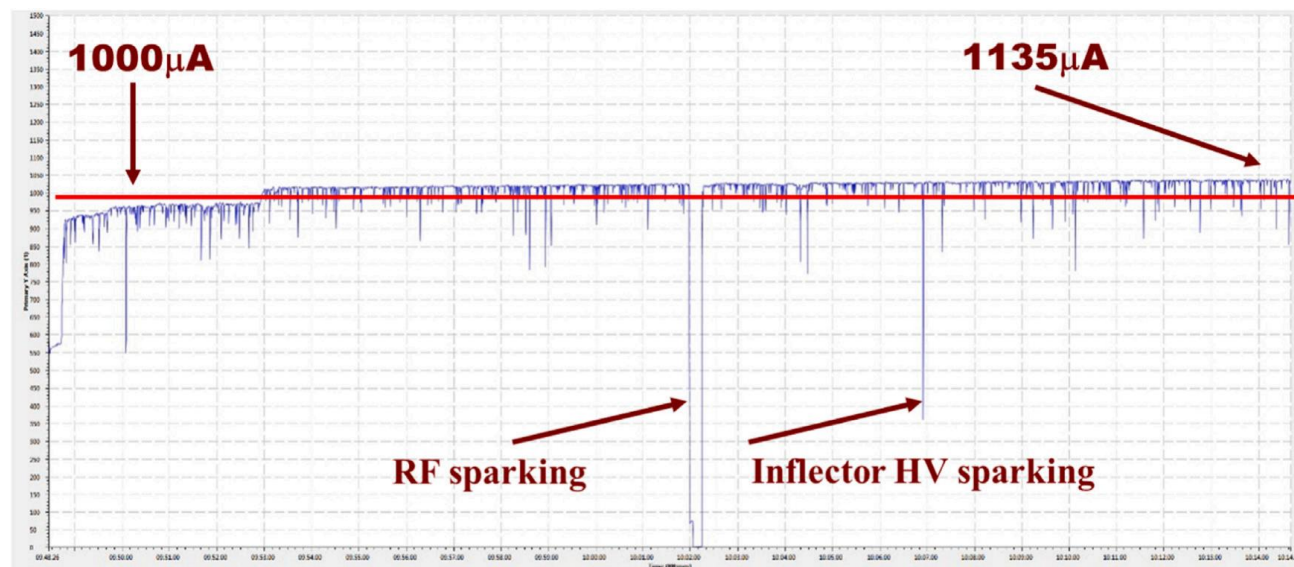




Structure of CYCIAE-100 ion source and extraction system

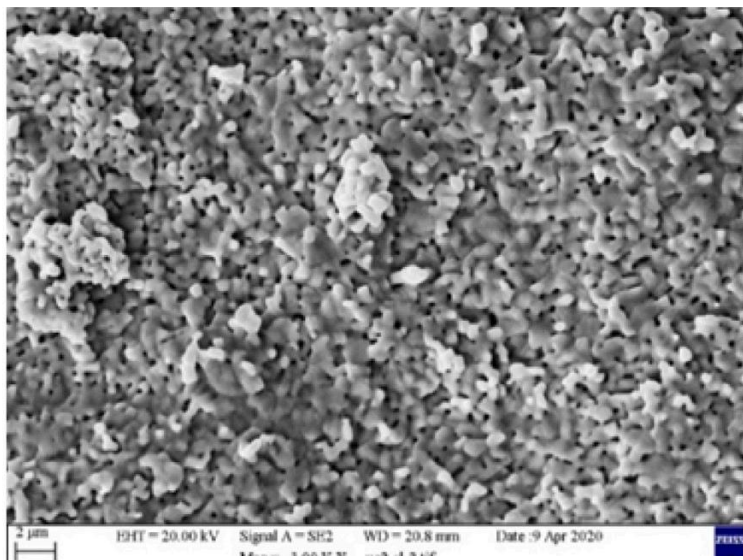
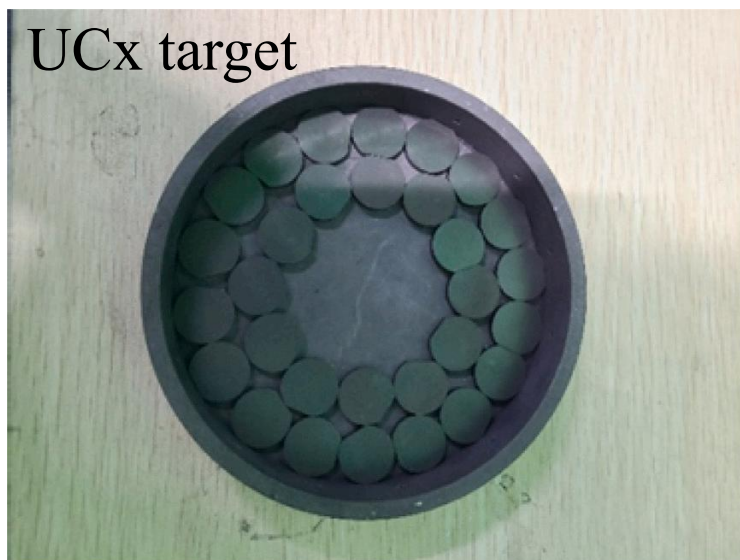


- Improve the extraction system for mA proton beam

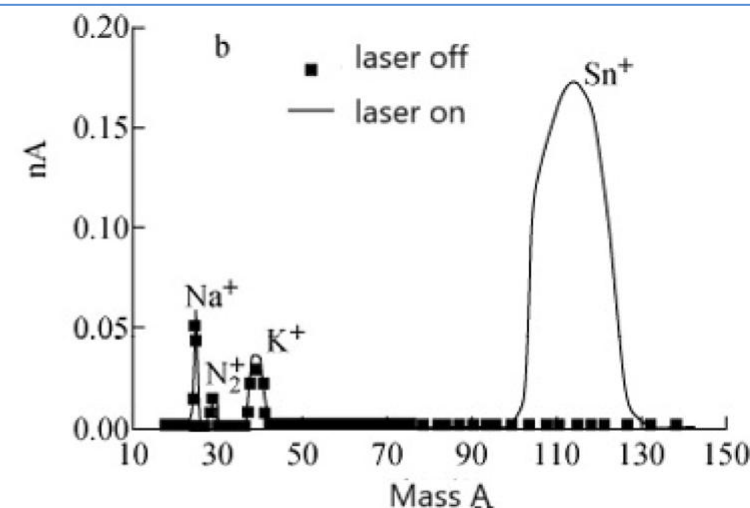
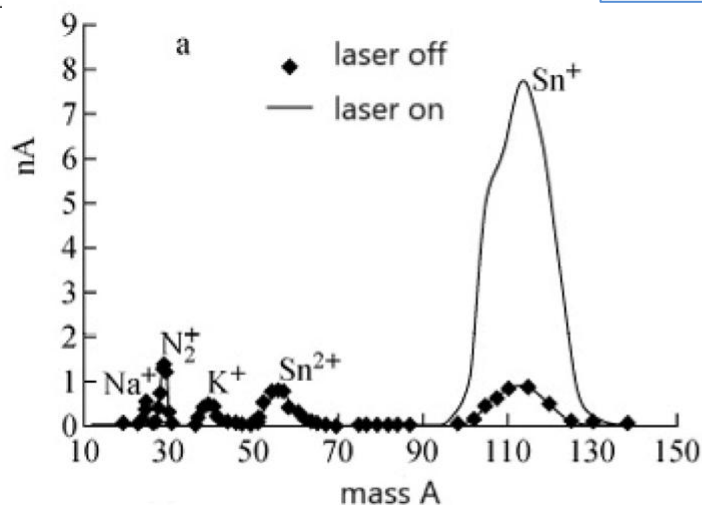
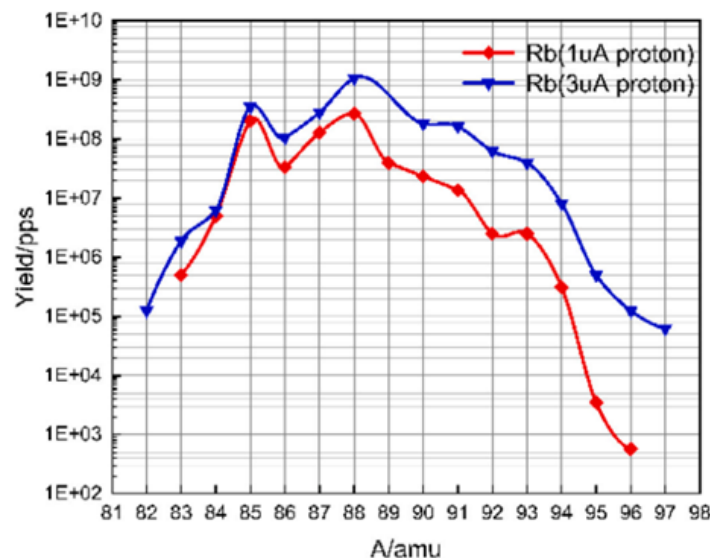


RIB development with laser ion source

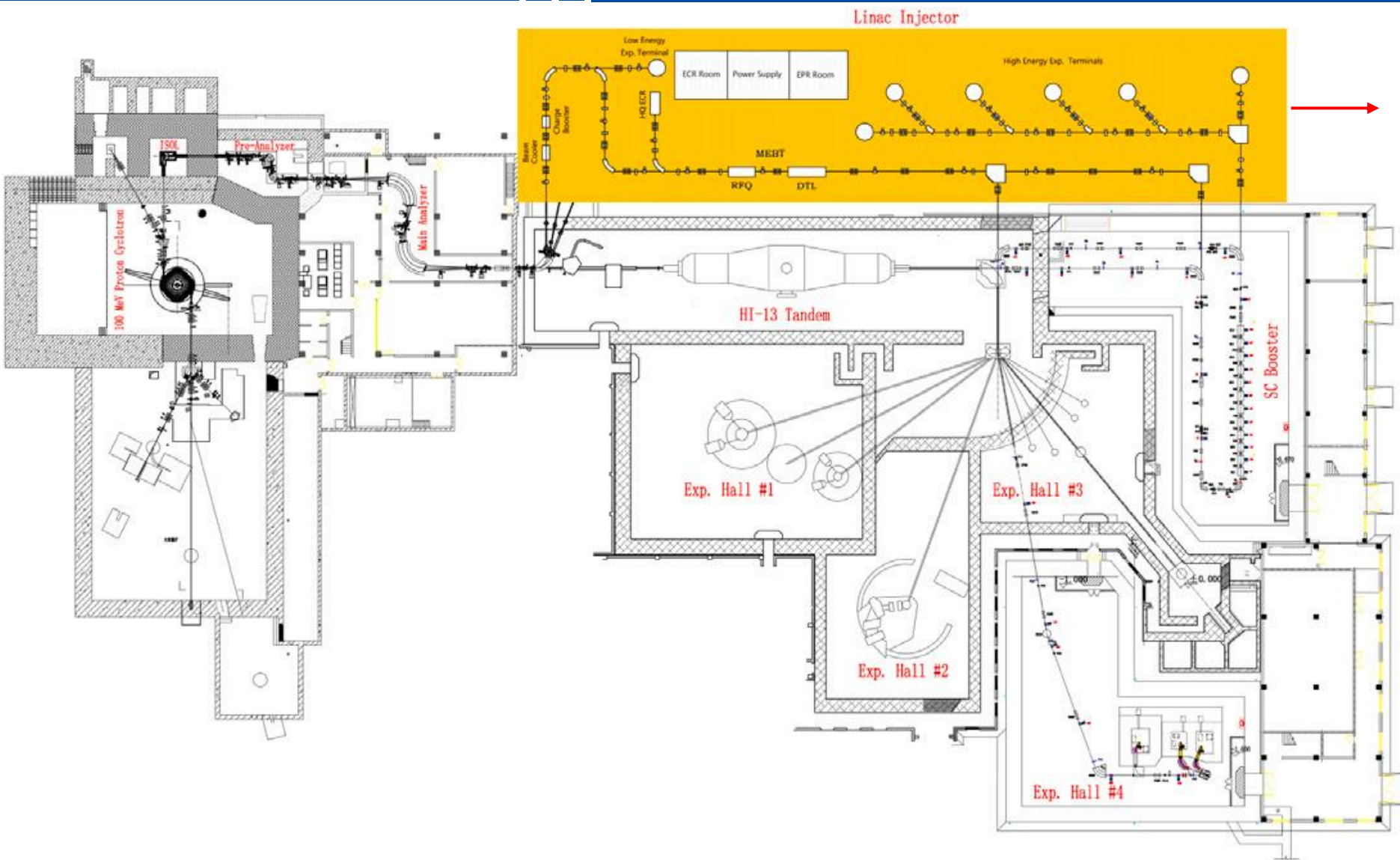
UCx target



- Many tests have been made with UCx target for n-rich isotopes.
- **Laser ion source has been developed and tested off-line.**
- Three-step resonance ionization scheme of 286.415, 811.63 and 823.704 nm for Sn^+ ions



a — 9.6 kW; b — 6 kW



- 30 keV charge booster
- A RFQ acceleration section
- A medium energy beam transport section
- A drift tube linac (DTL) acceleration section

- BRIF has been in duty as the first ISOL based Radioactive Ion-beam facility in China.
- Experiments have been carried out with Radioactive Ion Beams from BRIF, successfully.
- Intense efforts are being put in for more beams and experiments to realize at BRIF.

Thank you for your attention! Please refer to this review for more details.

