CEA Saclay seminar

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Recent results of electron scattering at SCRIT facility

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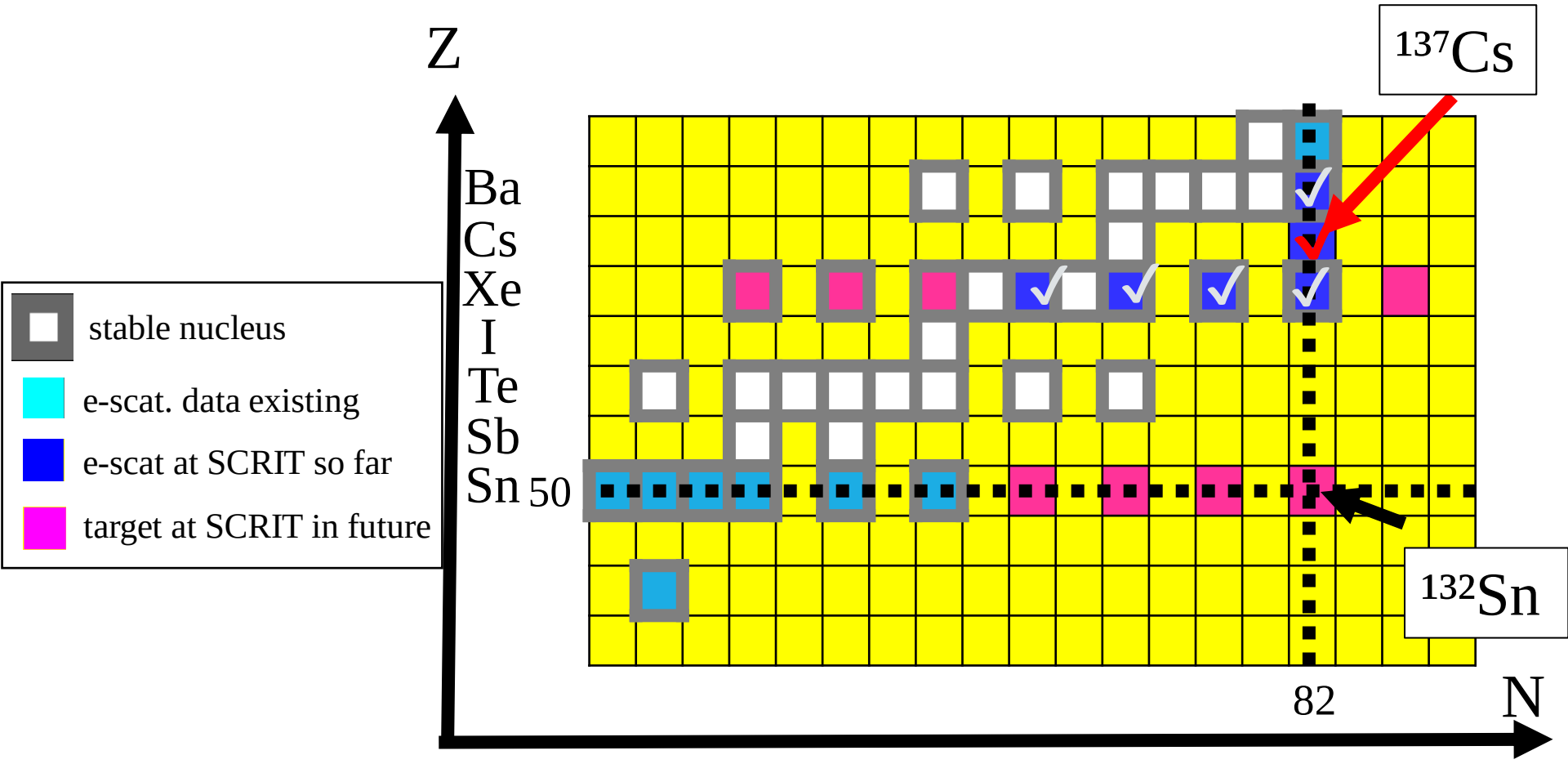
Outline

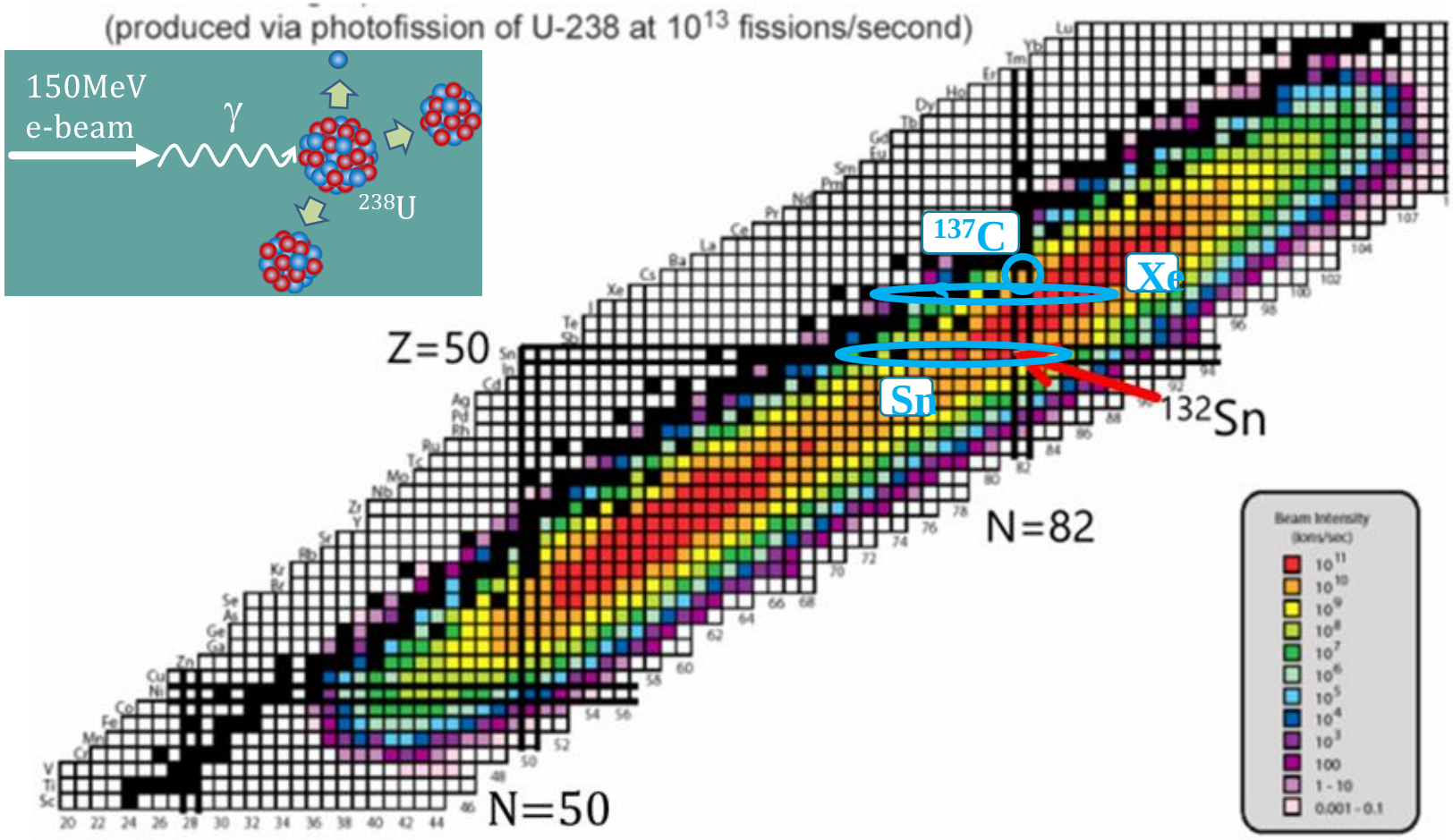
1. Experiments with Cs
2. Toward e-RI at SCRIT facility
3. Xe isotope experiment
4. Summary and outlook

e-scattering at the SCRIT facility



Characteristics of the transportation and the SCRIT system have been also studied and developed at these experiments.

Unstable nuclei produced via photo-fission of ^{238}U

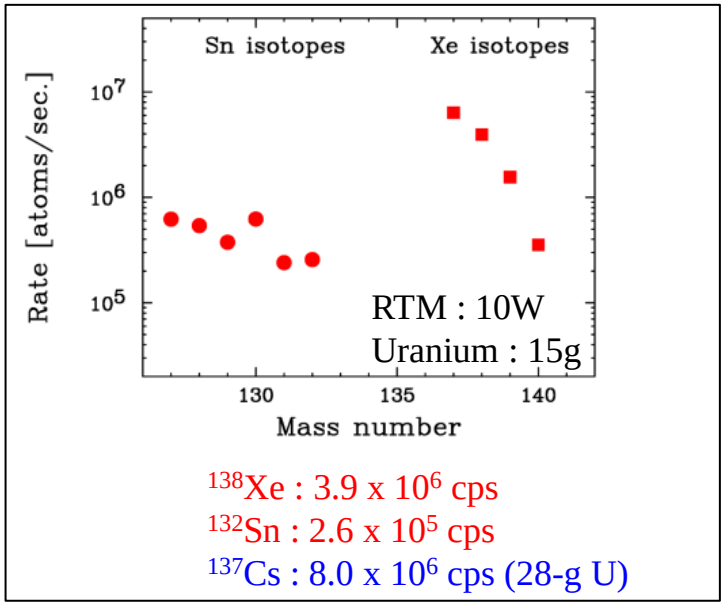


ERIS
(Electron-beam-driven RI separator for SCRIT)

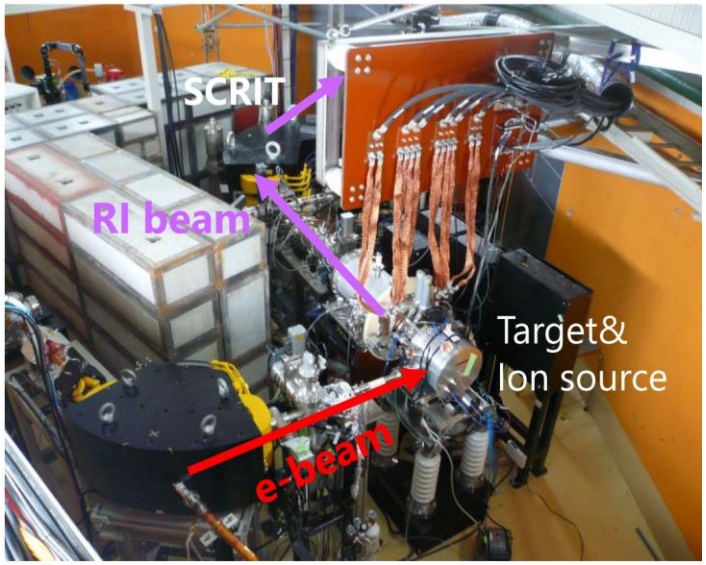
- Production : photo-fission of uranium
- Two ionization methods are available:
  - FEBIAD (Sn, Xe, etc.)
  - Surface ionization (Cs, etc.)
- Extraction : DC or bunched beam

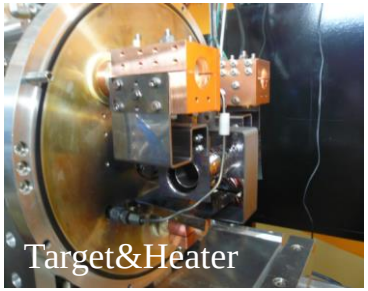
Target : house-made Uranium carbide (UCx)

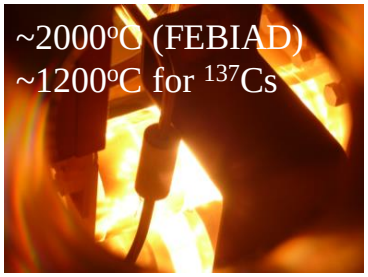
φ 18 mm, t 0.8 mm disks



^{138}Xe : 3.9 x 10^6 cps
^{132}Sn : 2.6 x 10^5 cps
^{137}Cs : 8.0 x 10^6 cps (28-g U)





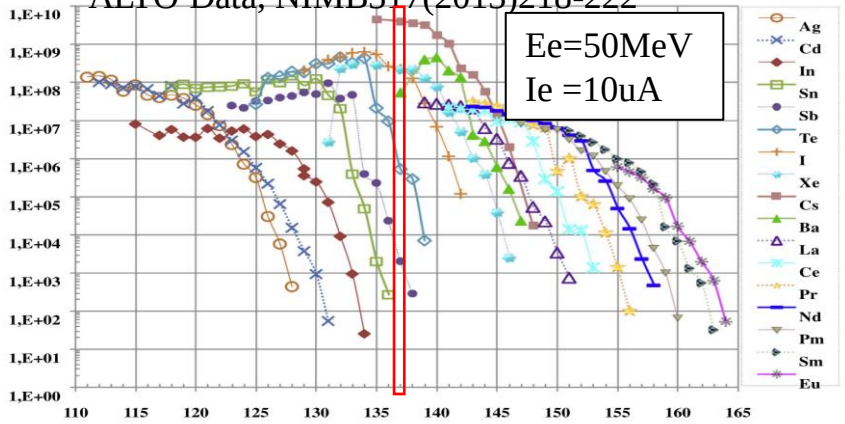


^{137}Cs beam

Features of ^{137}Cs beam with SI

- Relatively high production rate
  Cs, Ba, La … at 1200^{o} at SCRIT
- Good beam emittance

ALTO Data, NIMB317(2013)218-222



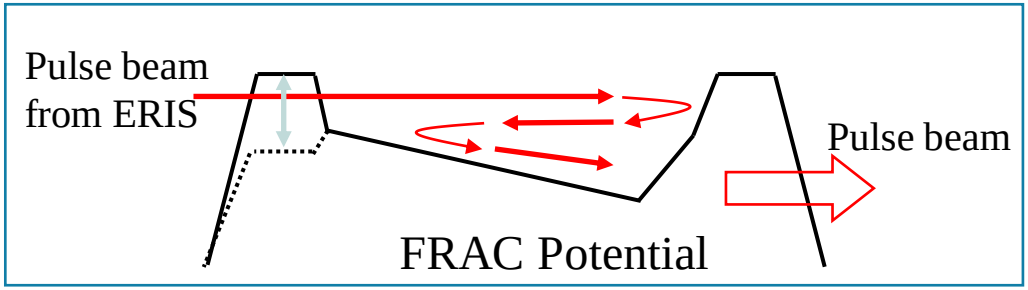
#ions extracted from ERIS

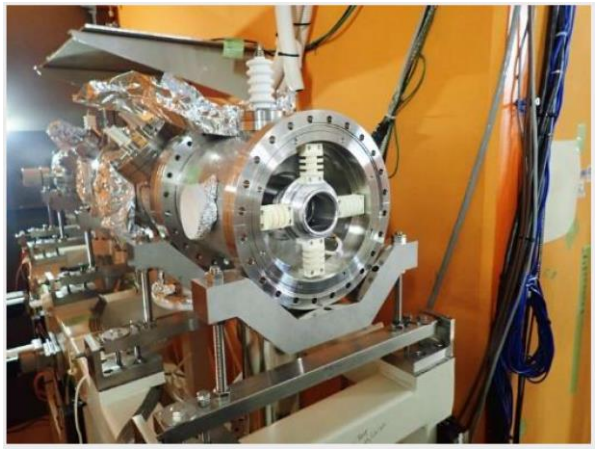
- measured with Ge detector and FC
- BG of ^{137}Ba was negligible.
- Purity of ^{137}Cs was >99.5%.

FRAC
(Fringing-RF-field-Activated dc-to-pulse Converter)

Ion beams are stacked in the FRAC for:

- ✓ Cooling by collision with Ne buffer gas
- ✓ Increasing #RI-ions in single pulses





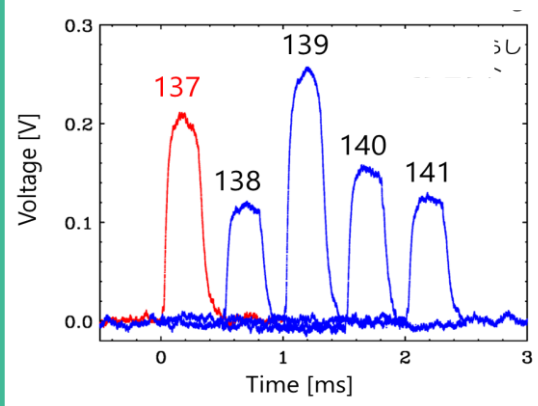
M. Wakasugi, Rev. Sci. Instrum. 89 (2018) 095107

^{137}Cs transportation for e-RI commissioning

Features of ^{137}Cs

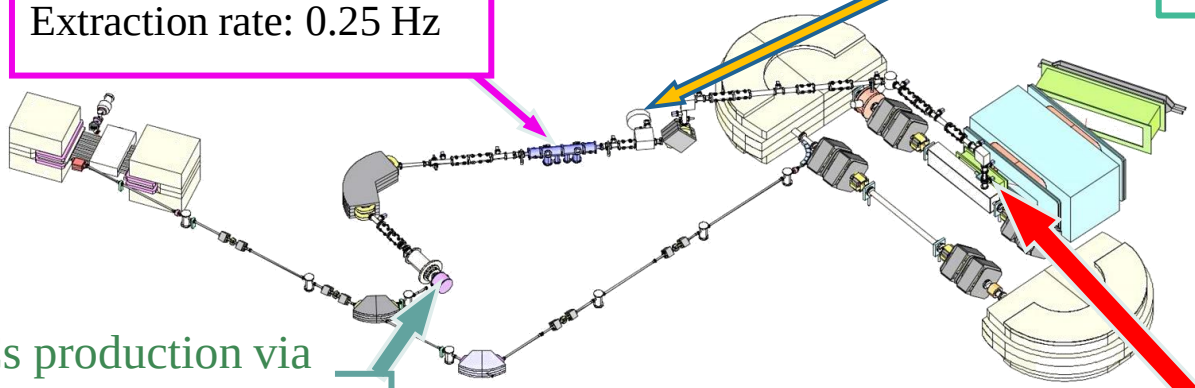
- Relatively high production rate
- Good beam emittance by Surface ionization
- Long lifetime of nucleus ~ 30 years

Faraday cup signal of Cs isotopes

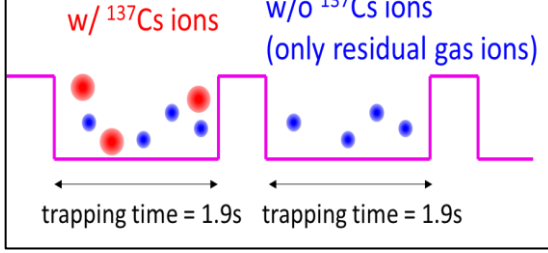


Storing & Cooling & Bunching by FRAC

Buffer gas : Ne
Extraction rate: 0.25 Hz



Time sequence of trapping



^{137}Cs production via photo-fission of U

28g Uranium
RTM power of 15 W
Extraction rate of 40 Hz

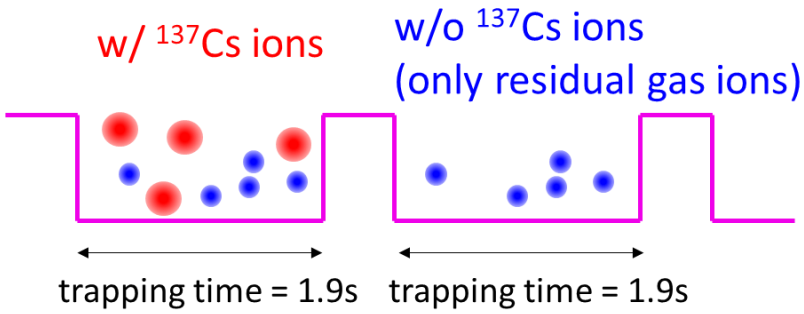
~2 x 10^7 ^{137}Cs/pulse @SCRIT

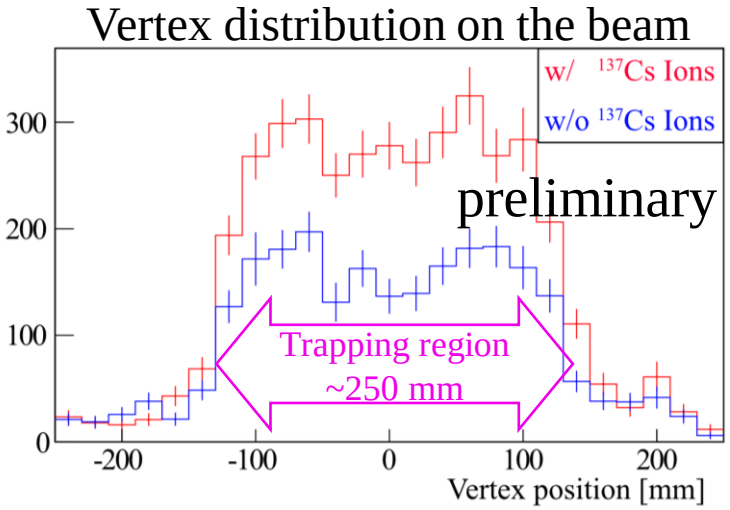
⇩

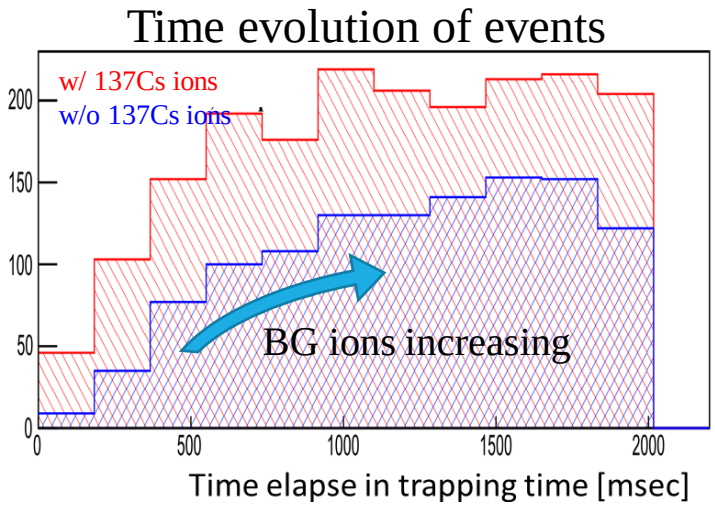
~1 x 10^{26} $cm^{-2}s^{-1}$ was achieved.

Elastically scattered events from ^{137}Cs and BG

Experimental conditions
- Ee : 150 MeV
- Ie : 150-250 mA
- Luminosities on average :
  - **0.9×10^{26} cm^{-2}s^{-1} for ^{137}Cs**
  - **1.5×10^{27} cm^{-2}s^{-1} for BG (^{16}O,^{12}C,…)**
- Exp. time : 3 days







Momentum and angular distributions

Momentum distribution after BG subtraction

Angular distribution

Success of world's first e-RI experiment with online-produced RI!!

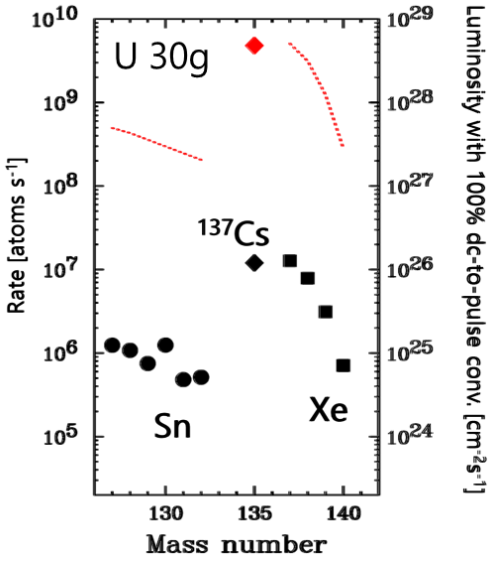
Towards short-lived unstable nuclei

Upgrade of e-beam driver

- High frequency (2Hz → 100Hz)
- High peak current

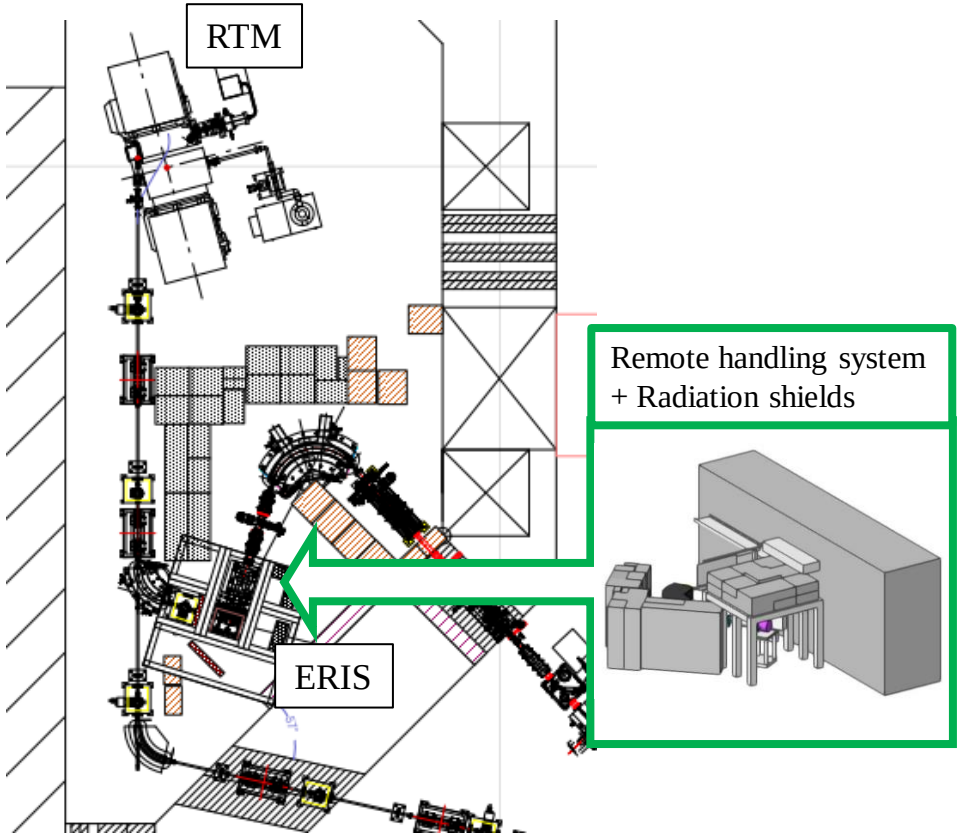
  → High Power up to 1 kW
- Related works are ongoing.
  - radiation control
  - remote handling
  - BG suppression for spectrometers

Preparation of ^{132}Sn beam extraction after RTM upgrade.



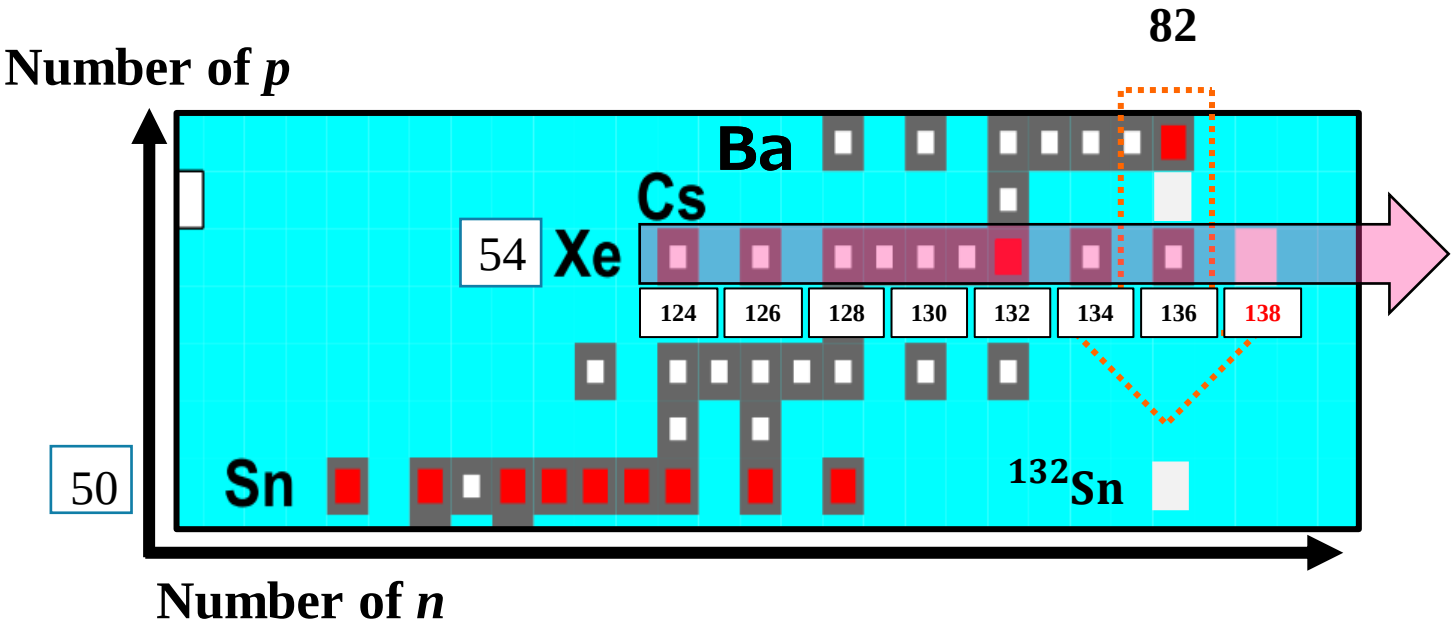
1 kW beam
Eff. × 4

10W beam
Eff. 5.5%(^{138}Xe),
2.0%(^{132}Sn)
5.5% (^{137}Cs)



We will perform e-RI experiment for various RI, such as ^{132}Sn, in a few years.

Xe isotopes experiment

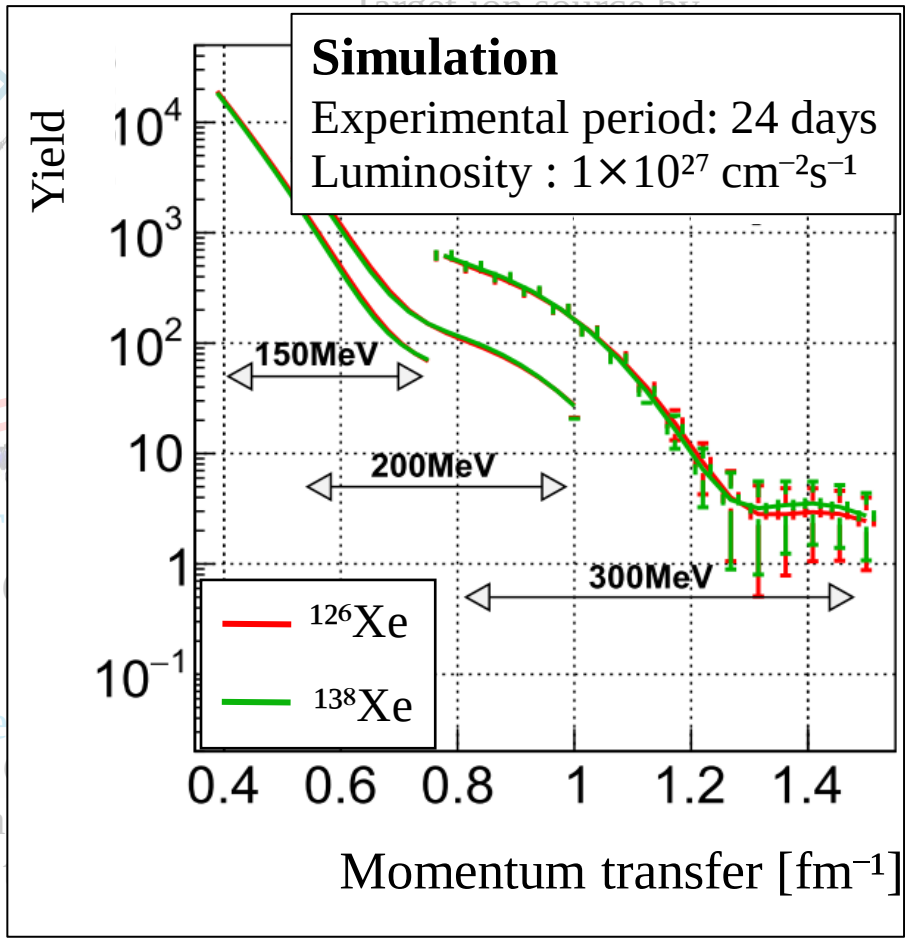


- **Xe isotopes**
  (stable : $^{124-136}$Xe, unstable : ^{138}Xe)

  - No data on charge density distribution by electron scattering.
  - Isotope dependence across neutron magic (N=82).

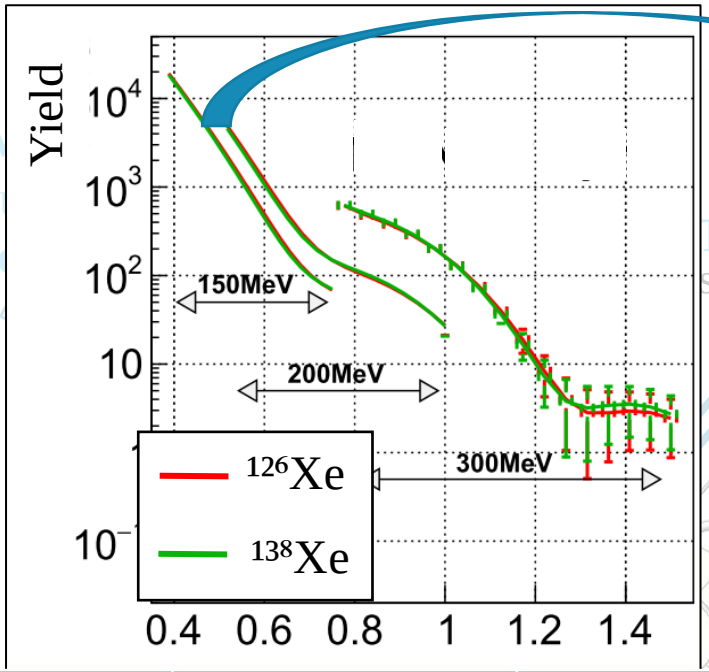
Xe isotopes experiment

	Experimental design		
Spectrometer	WiSES		
Scattered angle	30 − 60°		
Momentum transfer [fm^{-1}]	0.35 − 1.5 fm^{-1}		
Electron beam [MeV]	150	200	300
Experimental period [days]	3	7	14
	24		

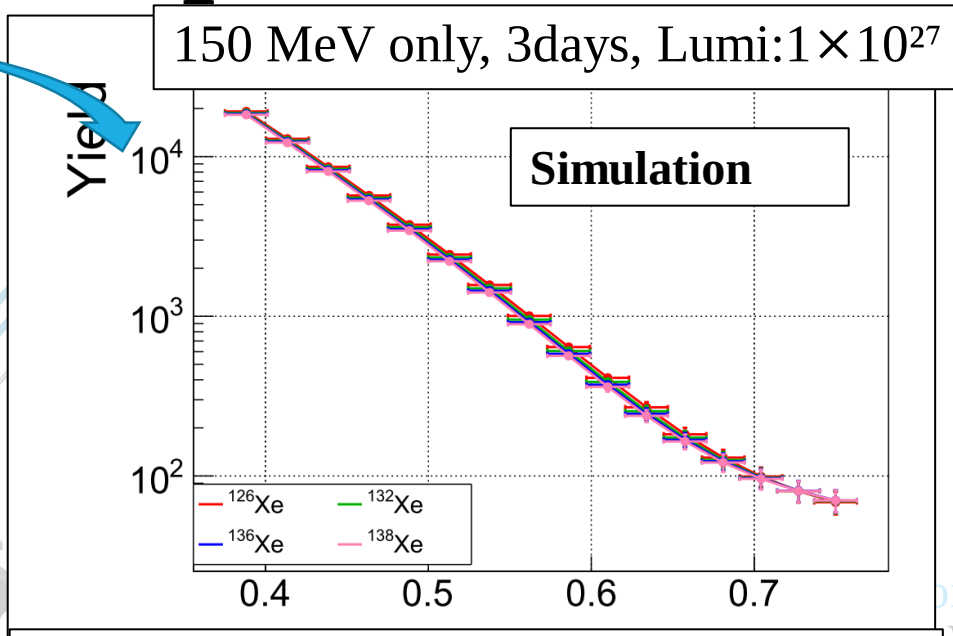


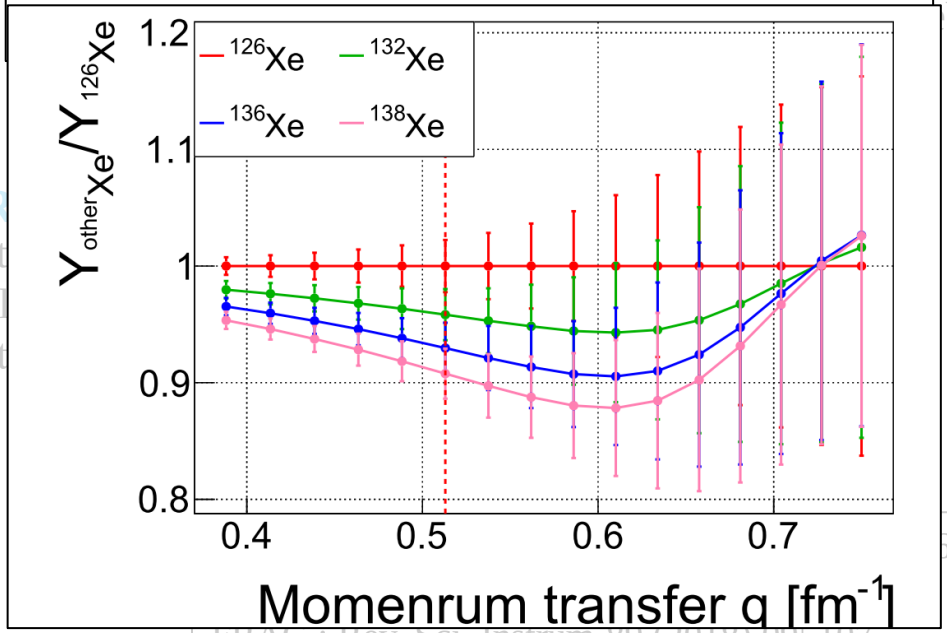
Tongqi Liang *et al*, Phys. Rev. Let. C, 98, 044310, (2018)

Xe isotopes experiment



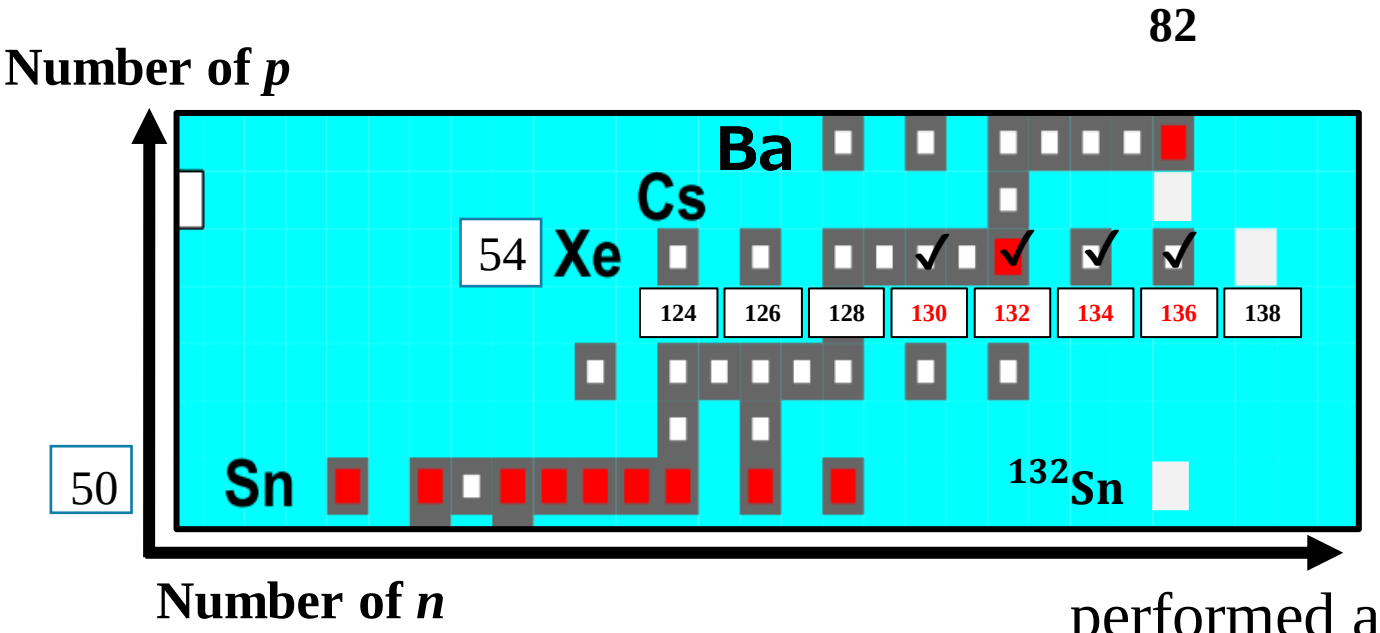
150 MeV only, 3days, Lumi:1×10²⁷





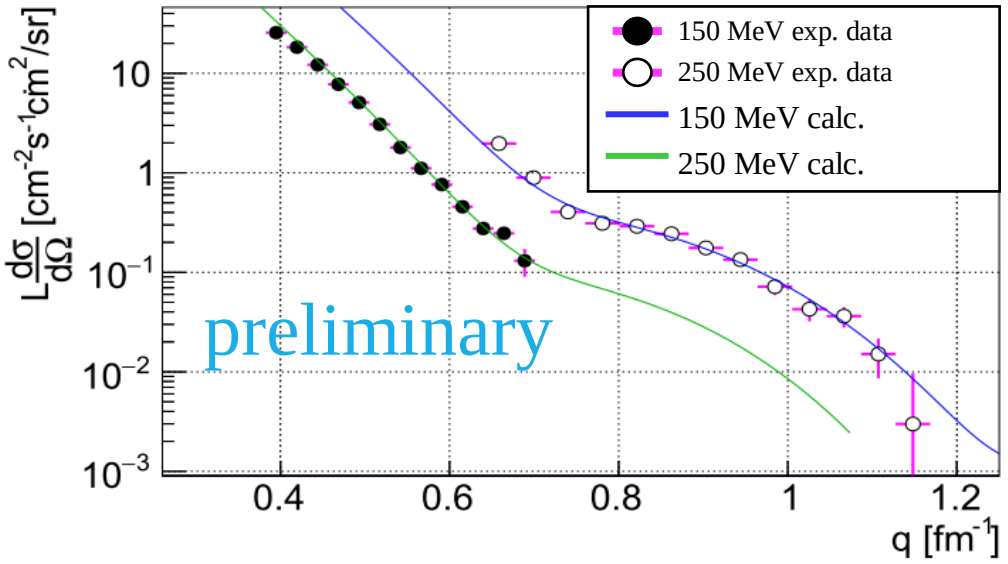
nuclei	Charge radius	ratio %
126Xe	4.7722	0.0
132Xe	4.7859	0.20
136Xe	4.7964	0.51
138Xe	4.8279	1.12

The result of Xe isotopes exp.



performed at Jul. 2022

- **^{136}Xe**
  - Isotone of ^{132}Sn
  - The first electron scattering data!
  - Experiments with other Xe isotopes($^{130\sim134}$Xe) have already been carried out using 150 MeV and analysis is ongoing.



Summary

- The SCRIT facility was built to realize electron scattering from unstable nuclei.
- The experiments with unstable nucleus ^{137}Cs finally has been carried out and obtain angular distribution!

Outlook

- The first electron scattering with short-lived unstable nuclei, such as ^{132}Sn, and other Xe isotope will be performed soon.