ECT*, 16-20 Jul. in Torento

Present status of the electron scattering experiments at the SCRIT facility

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for the SCRIT collaboration

- Introduction
- Overview of the facility
- Results from ^{132}Xe and ^{208}Pb target
- Upgrade plans
- Summary

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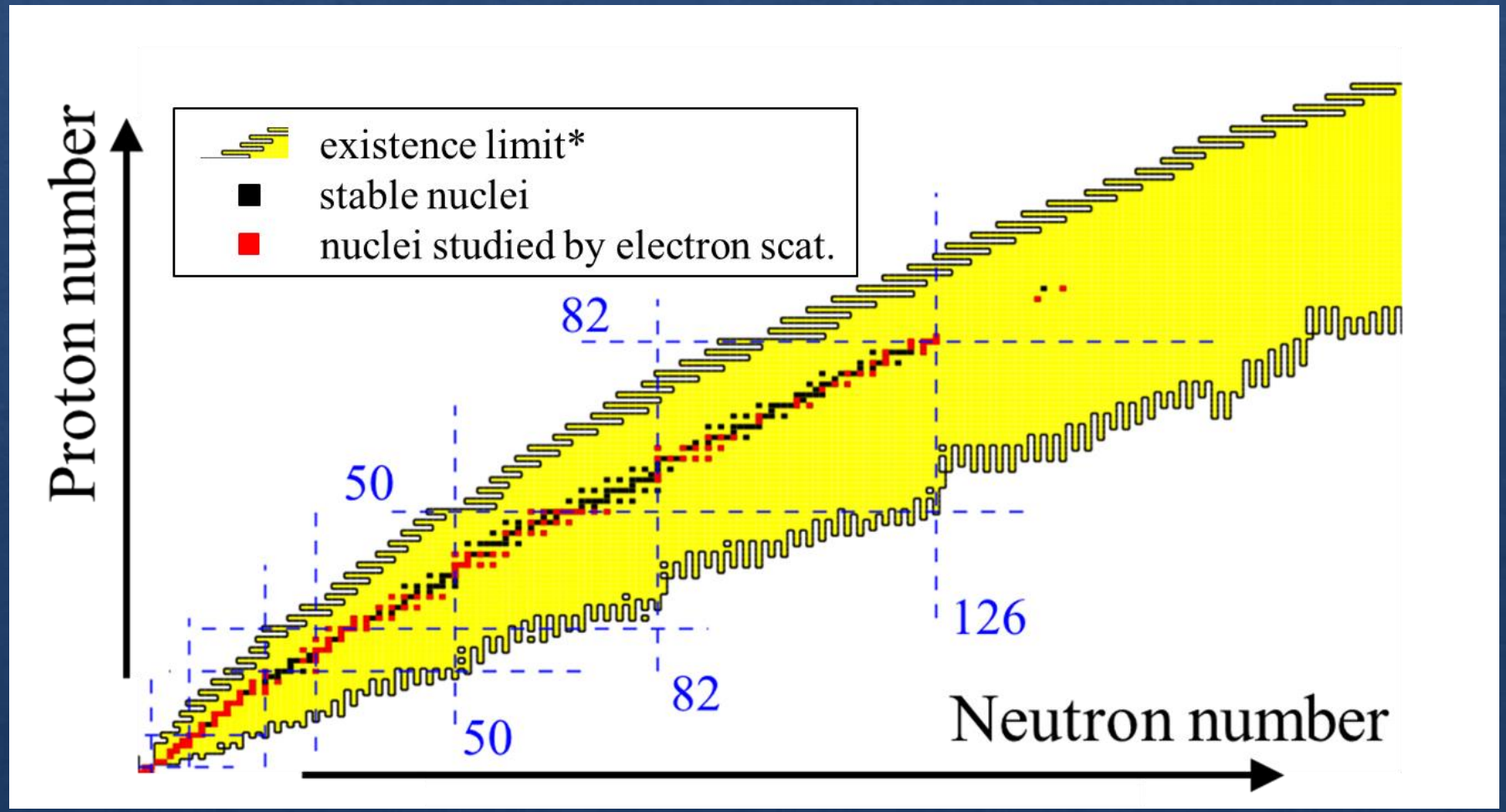
Nuclei studied by electron scattering

- Electron scattering is so powerful to investigate the nuclear structure information.
- It has been performed for almost only stable nuclei. (a few exceptions: ^{3}H, ^{14}C, …)



*KTUY mass formula, Progr.Theoret.Phys. 113(2005) 305

Elastic electron scattering for spin-less nuclei

- Luminosity: ~10^{27} [$cm^{-2}s^{-1}$]
- Relatively large cross section
- Sensitive to charge density distribution

$$\frac{d\sigma}{d\Omega} = \left(\frac{d\sigma}{d\Omega}\right)_{Mott} \cdot |Fc(q)|^2$$

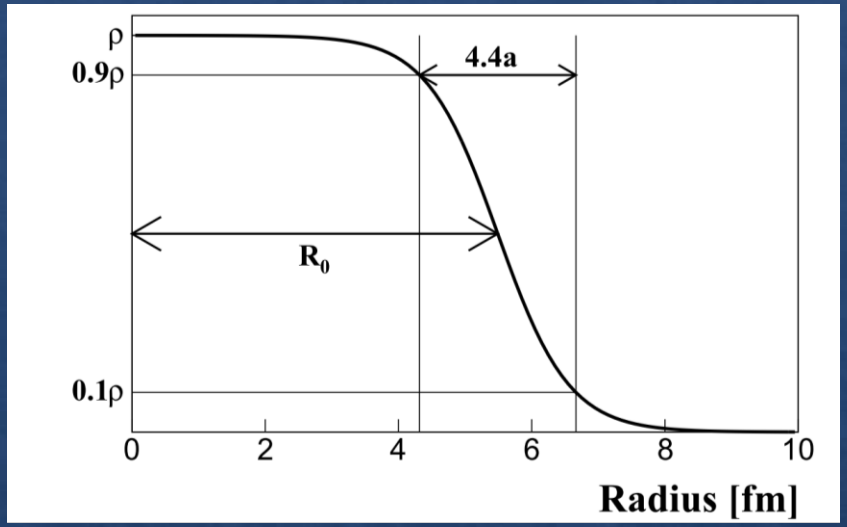
Cross section of Mott scattering

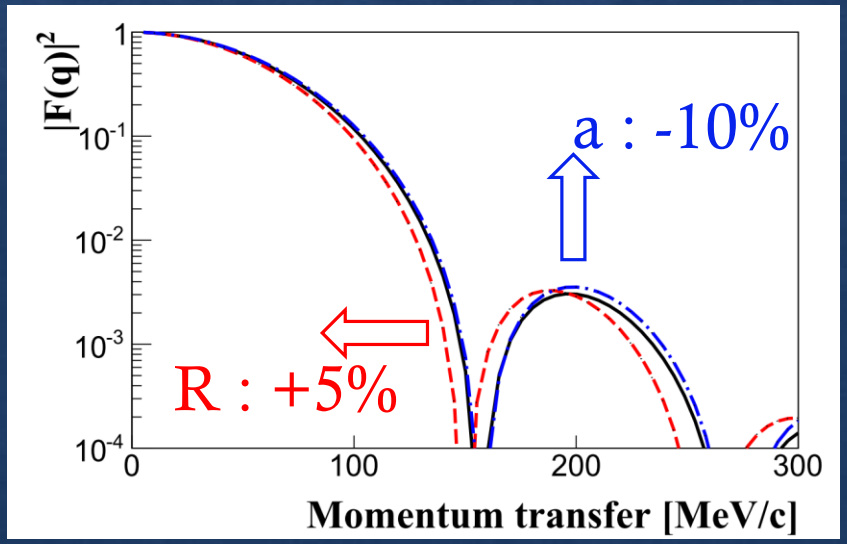
Form factor

$$Fc(q) = \int \rho_C(\vec{r}) e^{i\vec{q}\vec{r}} d\vec{r}$$

Charge density distribution

$$\rho_C = \rho/(1 + e^{(r-R)/a})$$





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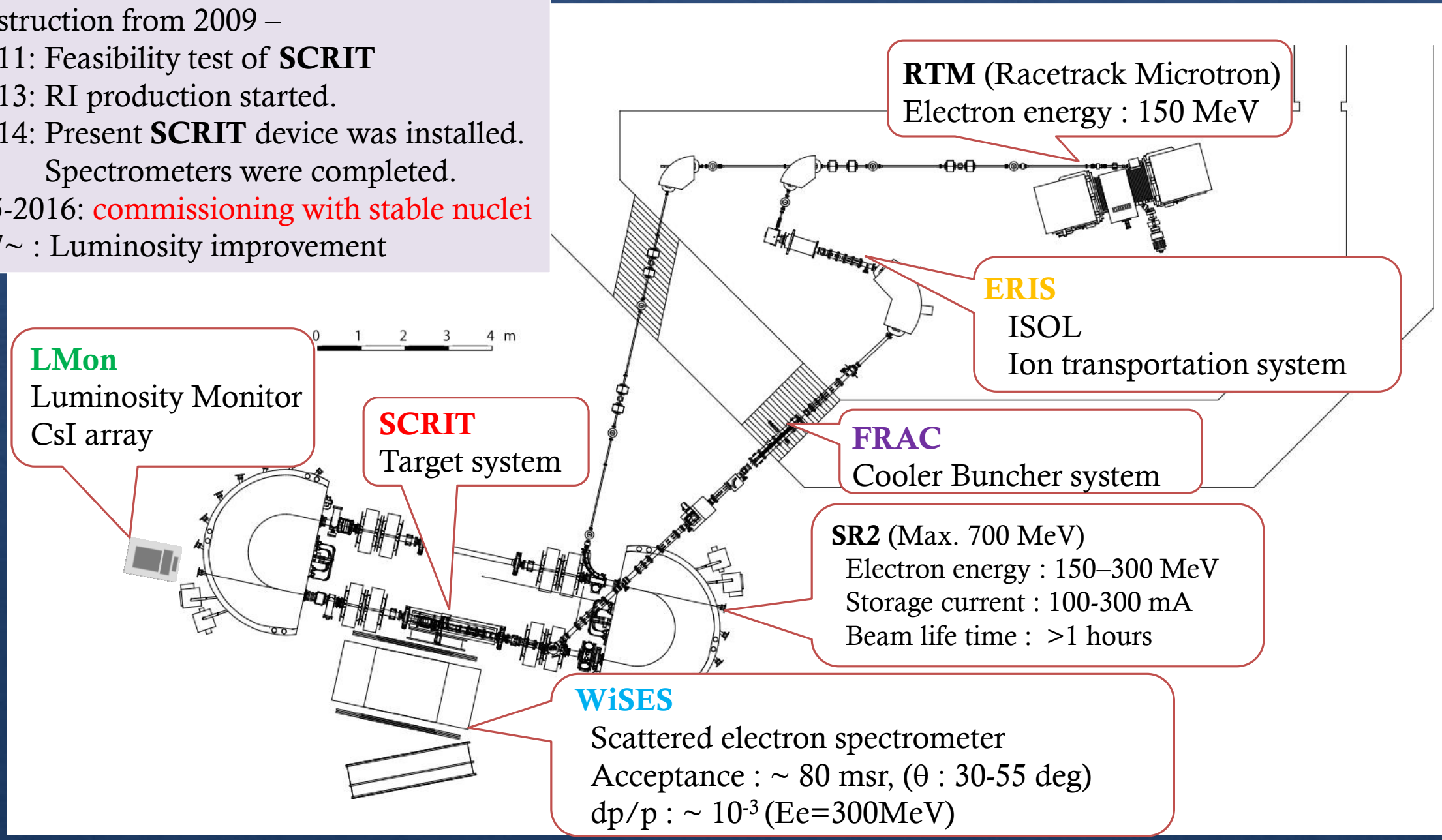
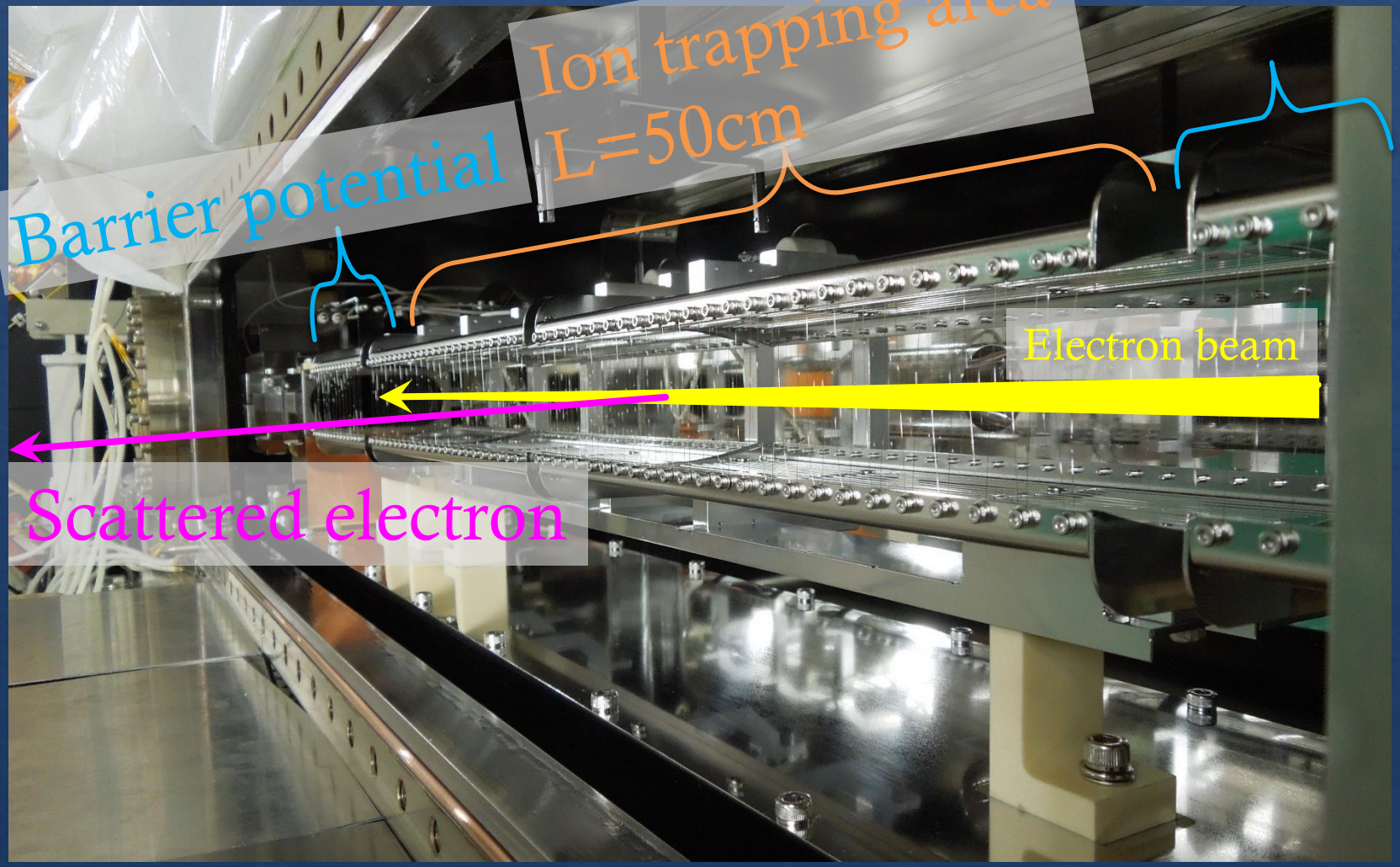
SCRIT electron scattering facility

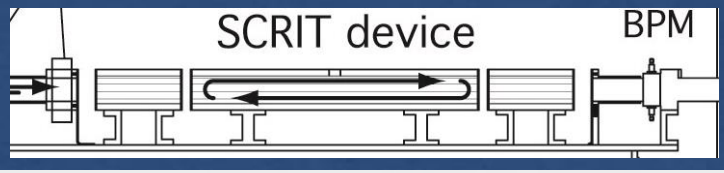
Construction from 2009 –
- 2011: Feasibility test of **SCRIT**
- 2013: RI production started.
- 2014: Present **SCRIT** device was installed. Spectrometers were completed.

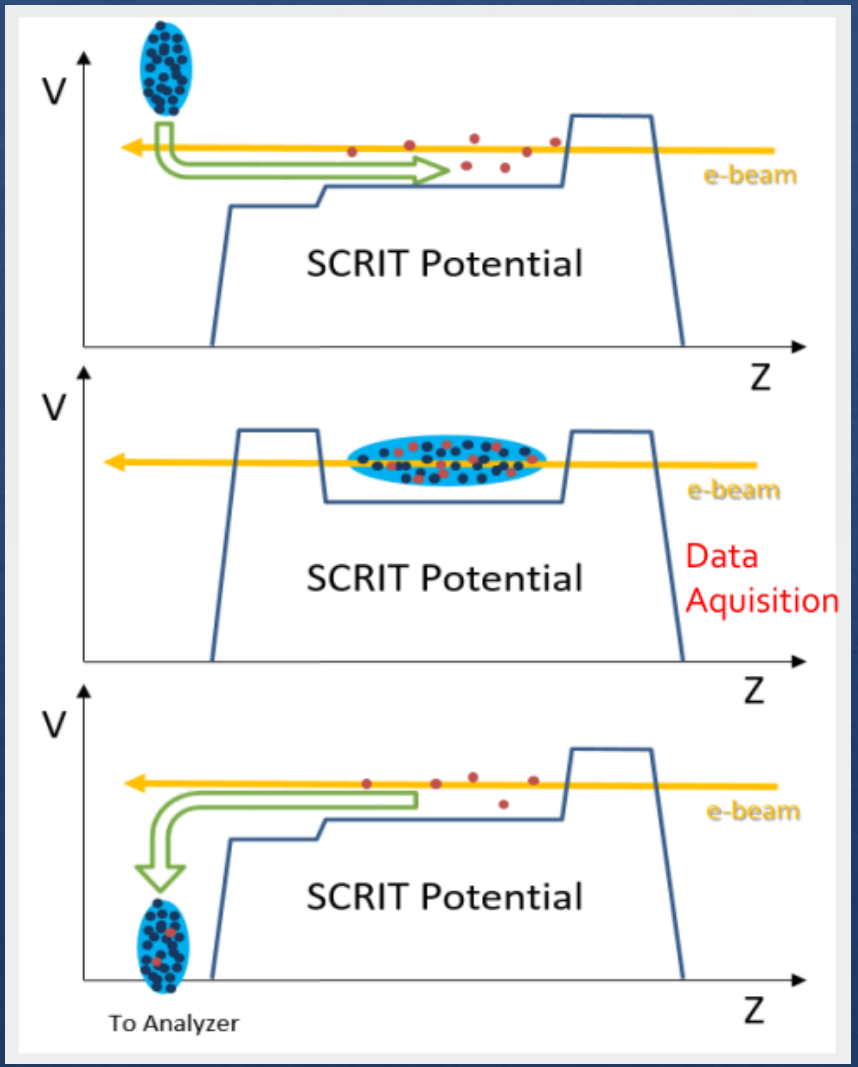
2015-2016: commissioning with stable nuclei
2017~ : Luminosity improvement



SCRIT system



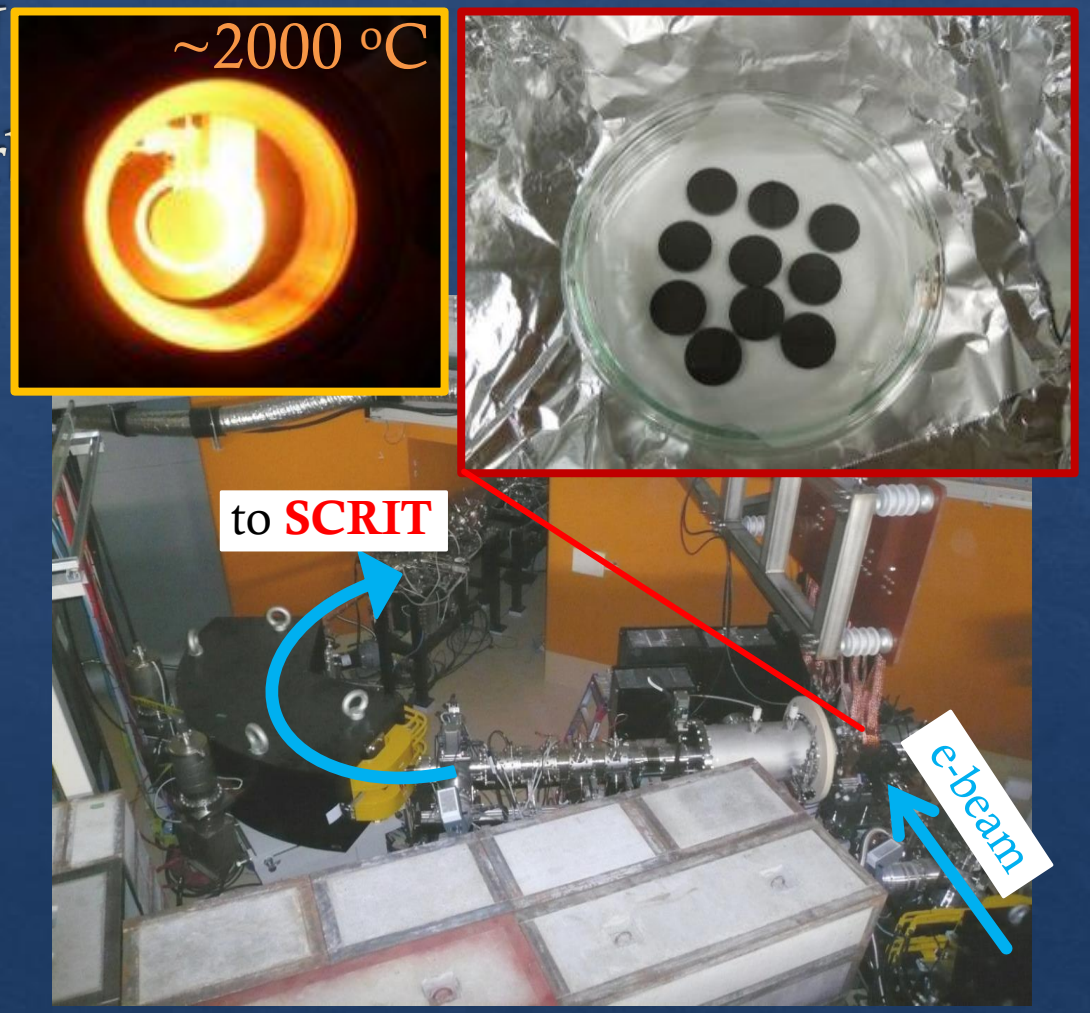




1 cycle ~ 1 Hz (typical)

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

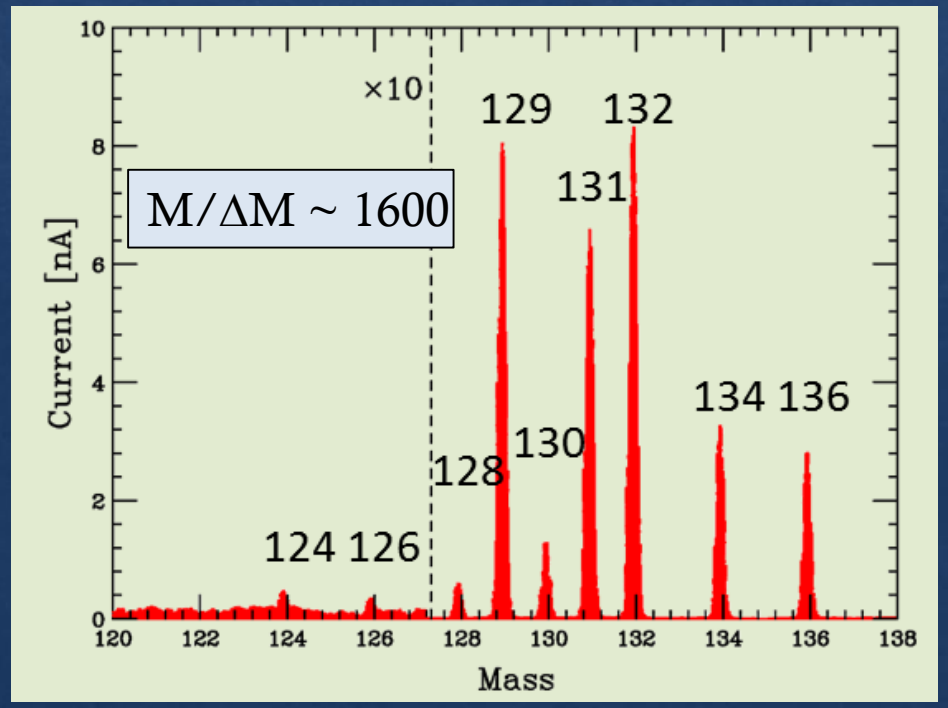
- Production : photo-fission of ^{238}U
- Target : house-made Uranium car
- Driver : electron from RTM
- FEBIAD or Surface ionization

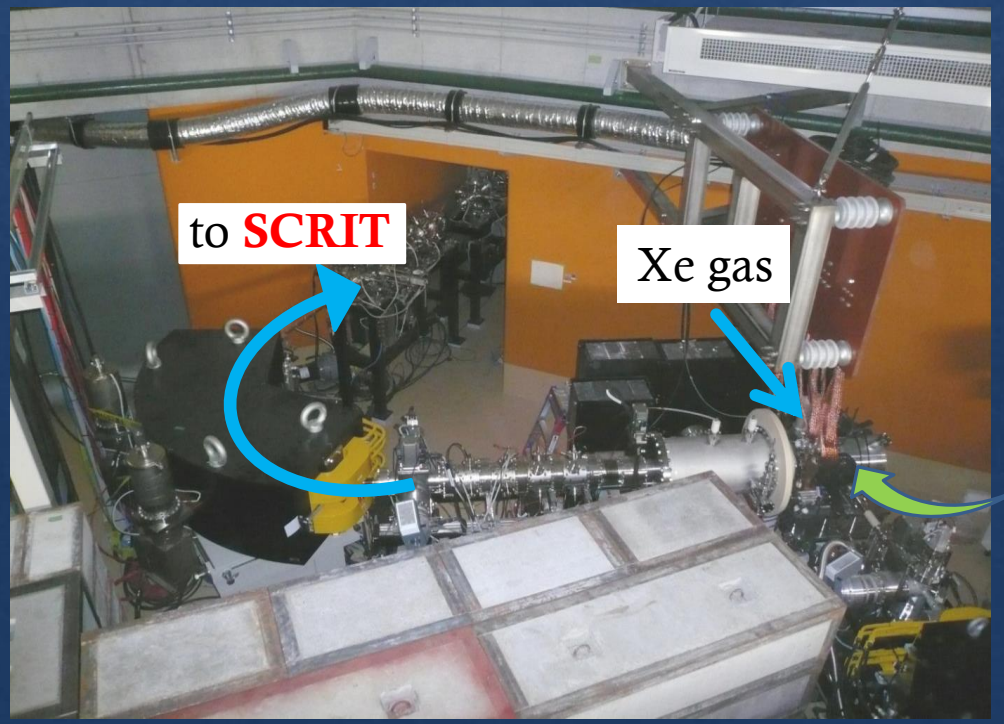


ERIS (Electron-beam-driven RI separator for SCRIT)

For the experiment with ^{132}Xe and ^{208}Pb,

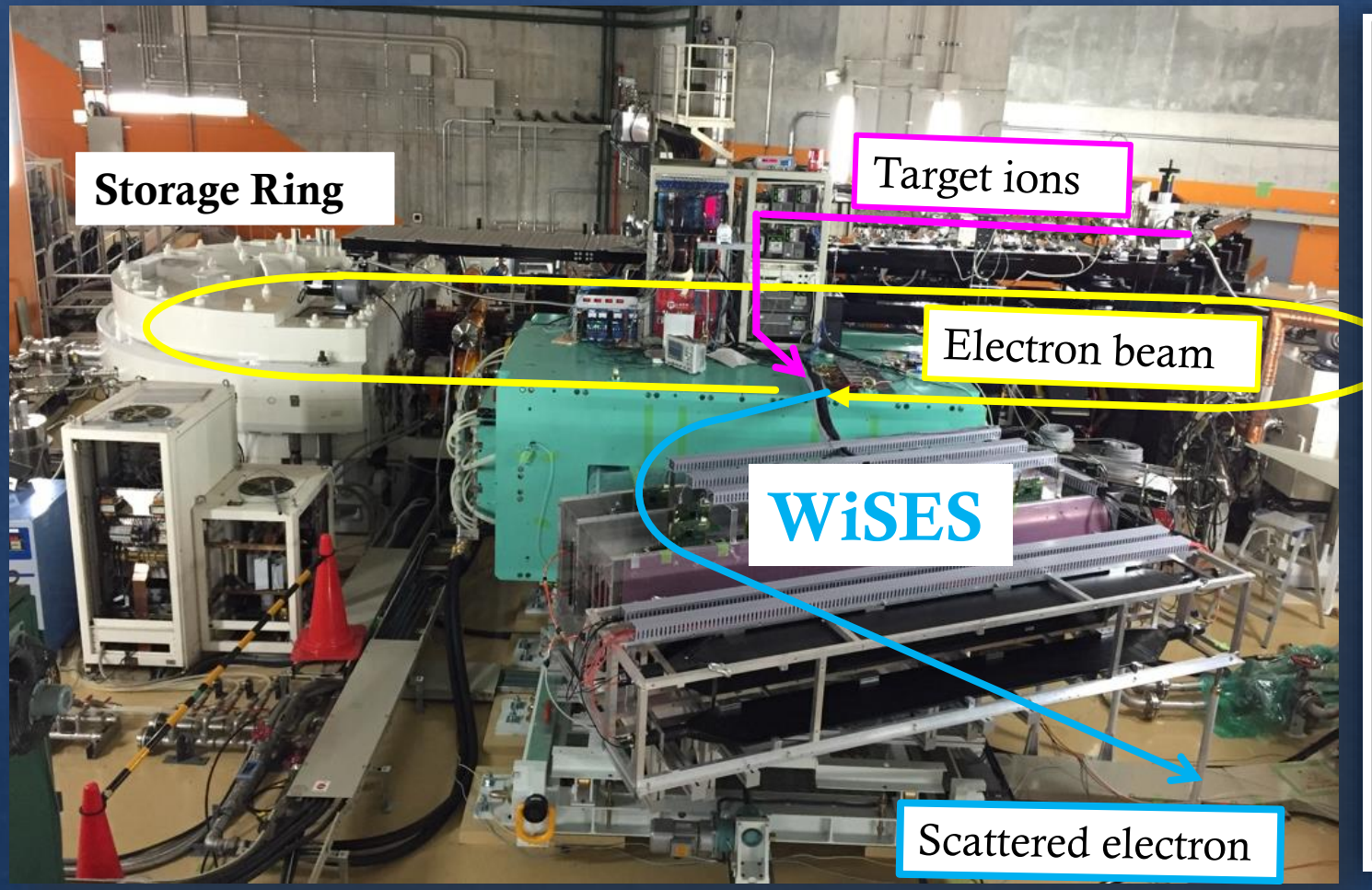
- ^{132}Xe : Natural xenon gas was introduced from a gas bottle.
- ^{208}Pb : Vapor of the lead from a crucible was used.
- Mass resolution is good enough.

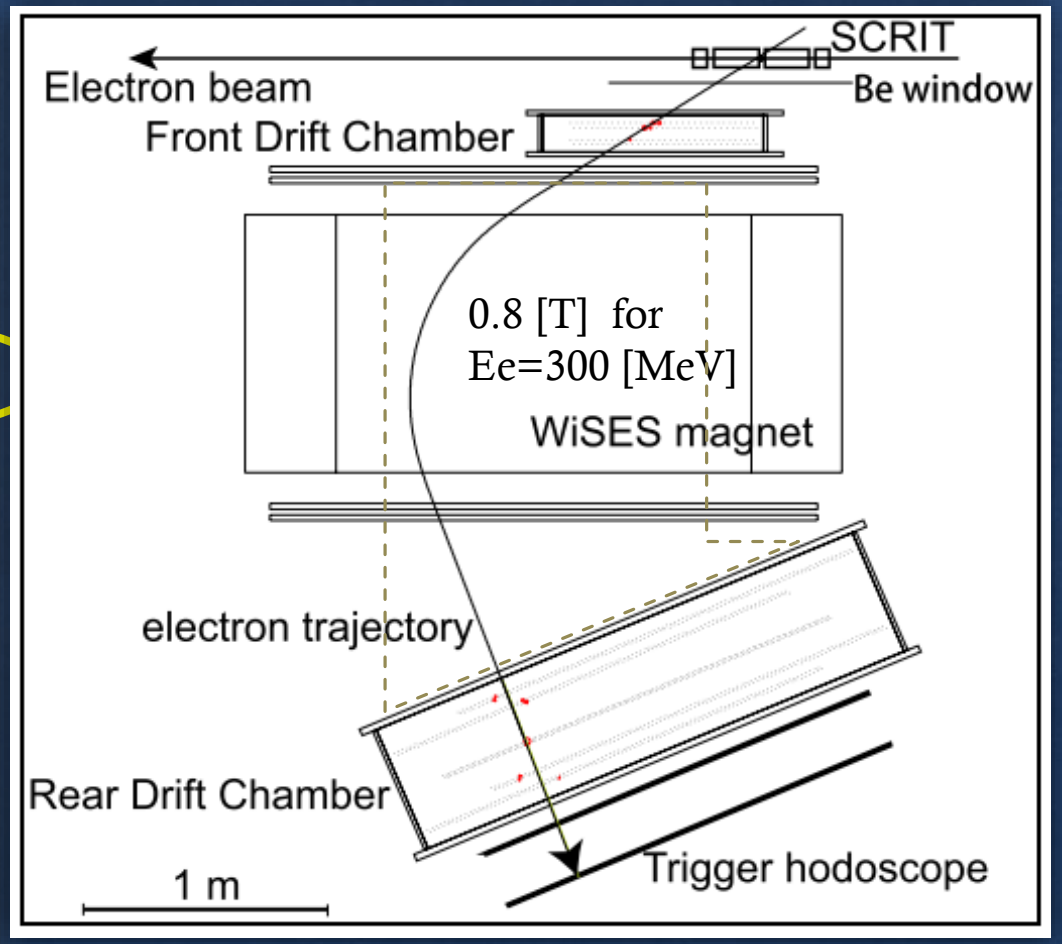




Heated up to ~600°C

WiSES (Window-frame Spectrometer for Electron Scattering)





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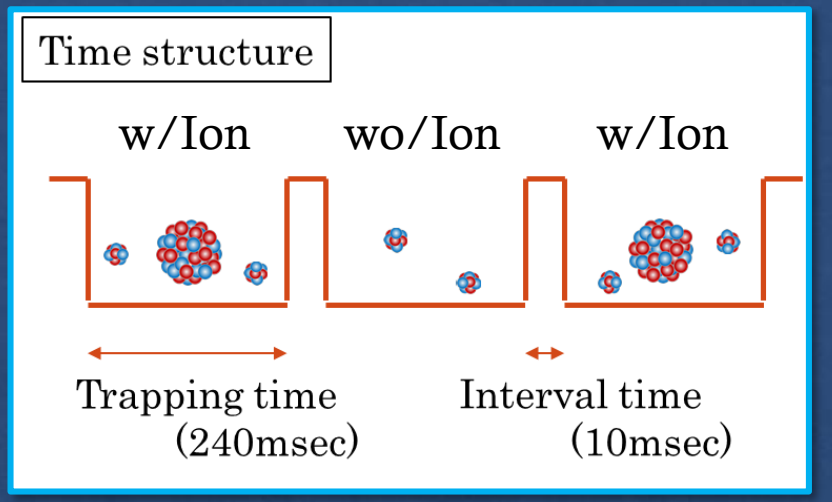
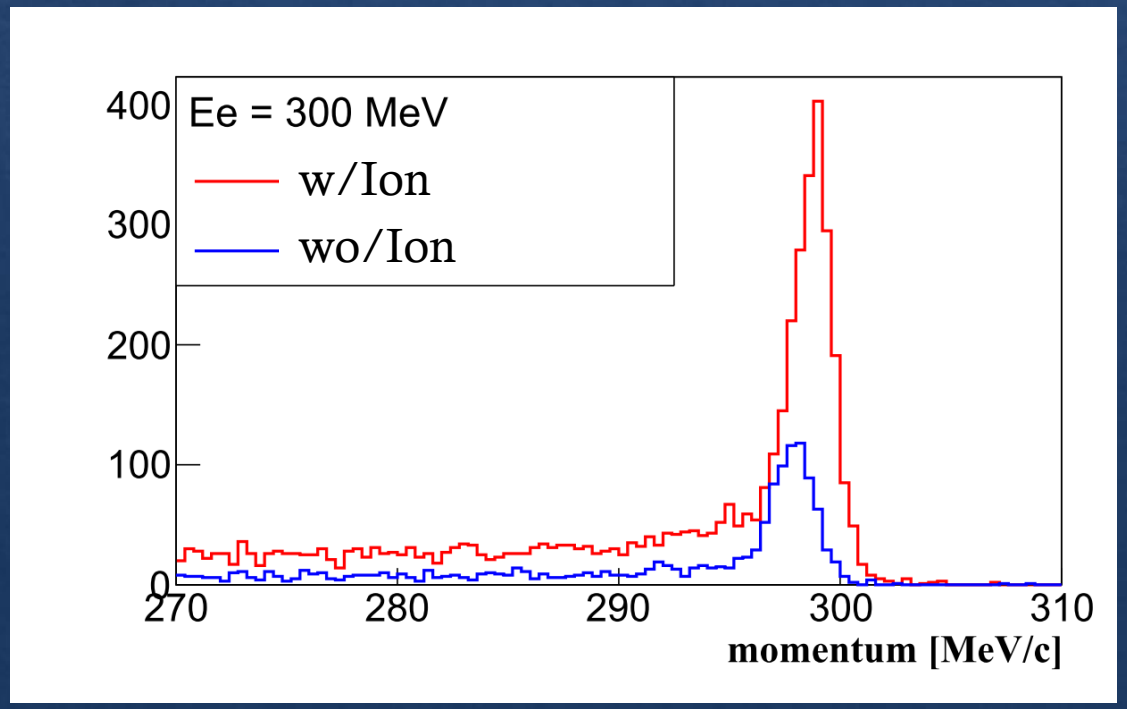
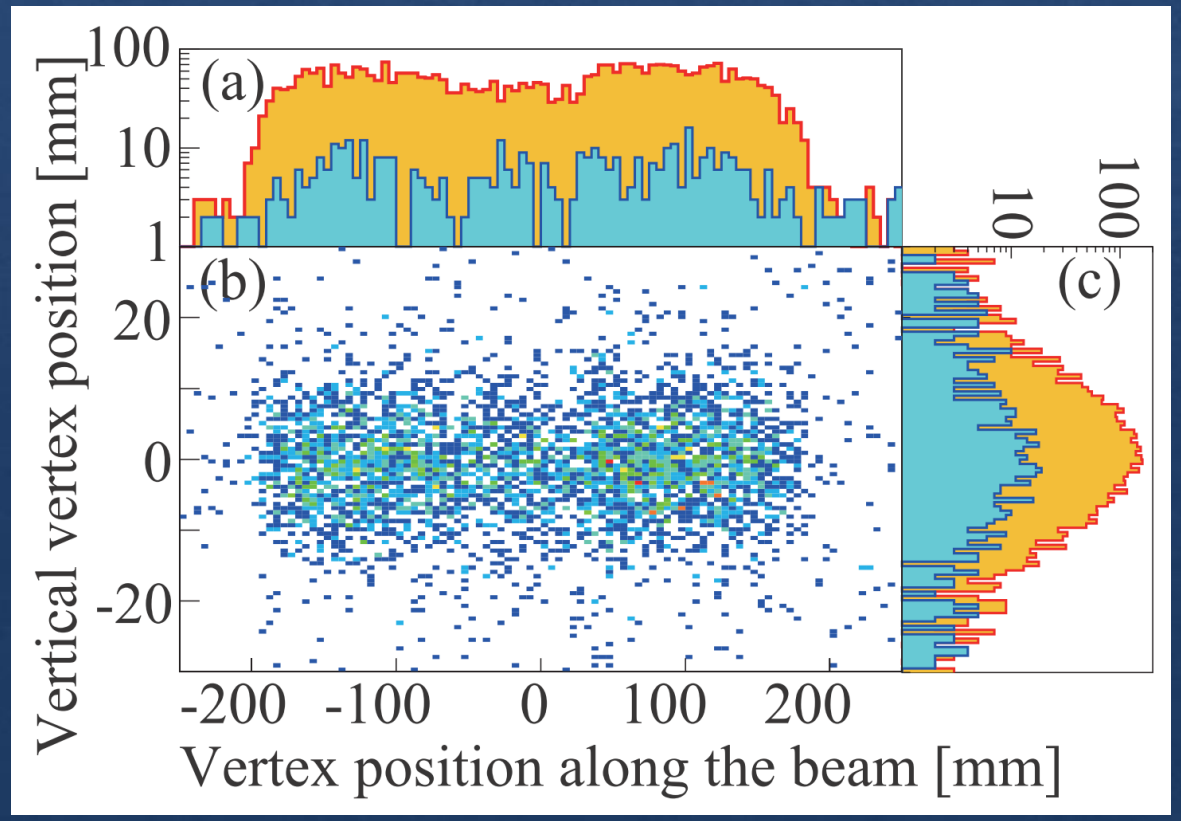
Data analysis

- Momentum distribution
  - Clear elastic peak from

    ^{132}Xe targets (wIon) and residual gas (woIon)
- Vertex point distribution
  - Events come from SCRIT trapping region



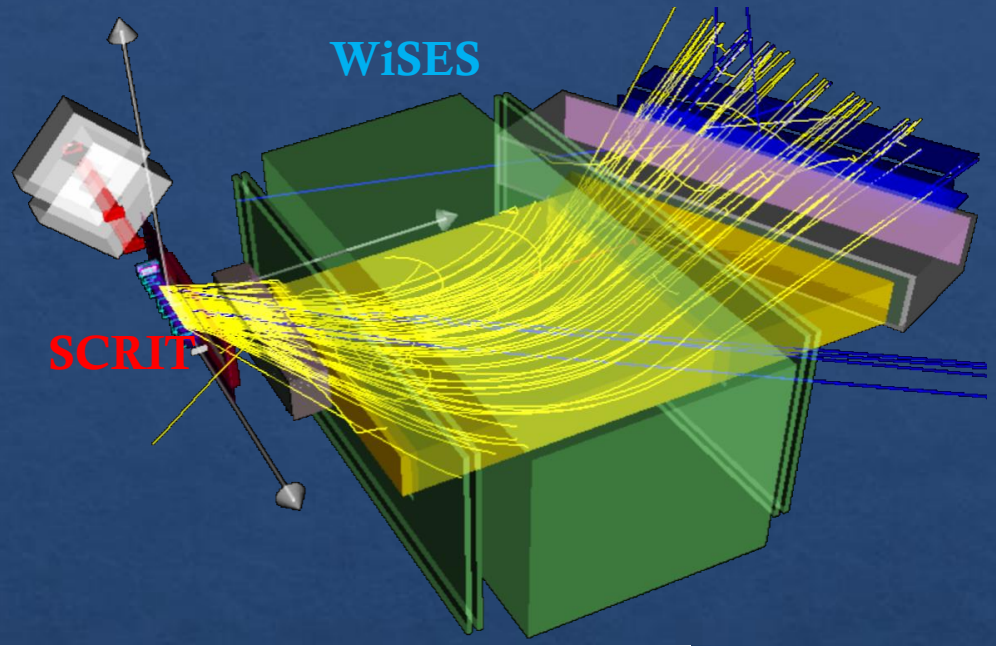


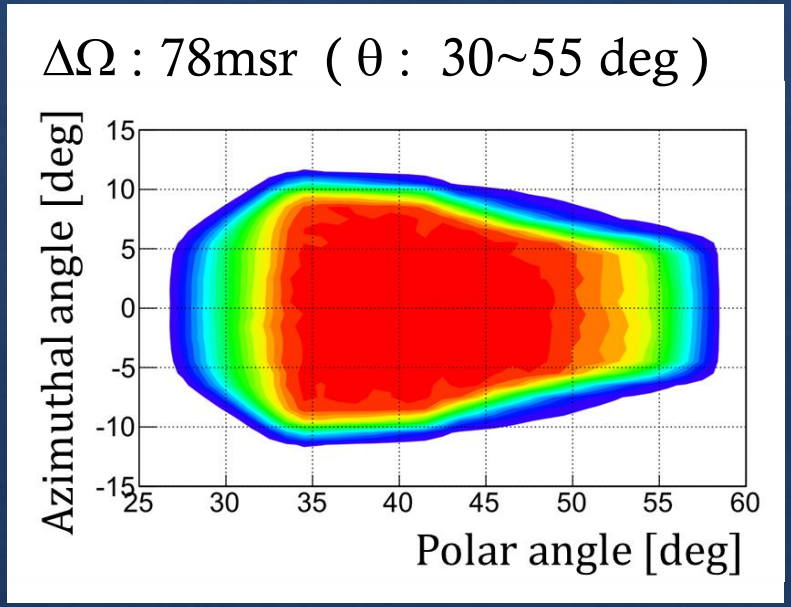


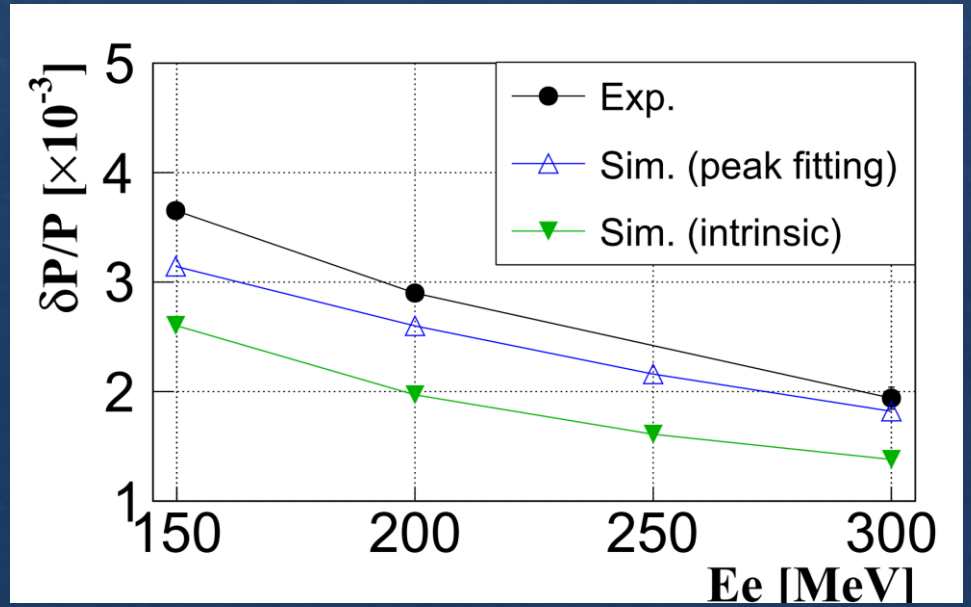
Performances of WiSES

- Geant4 simulation including
  - All materials
  - Detector resolutions & efficiencies
  - Radiative tail

J. Friedrich, Nucl.Instr.Meth.129 (1975) 505

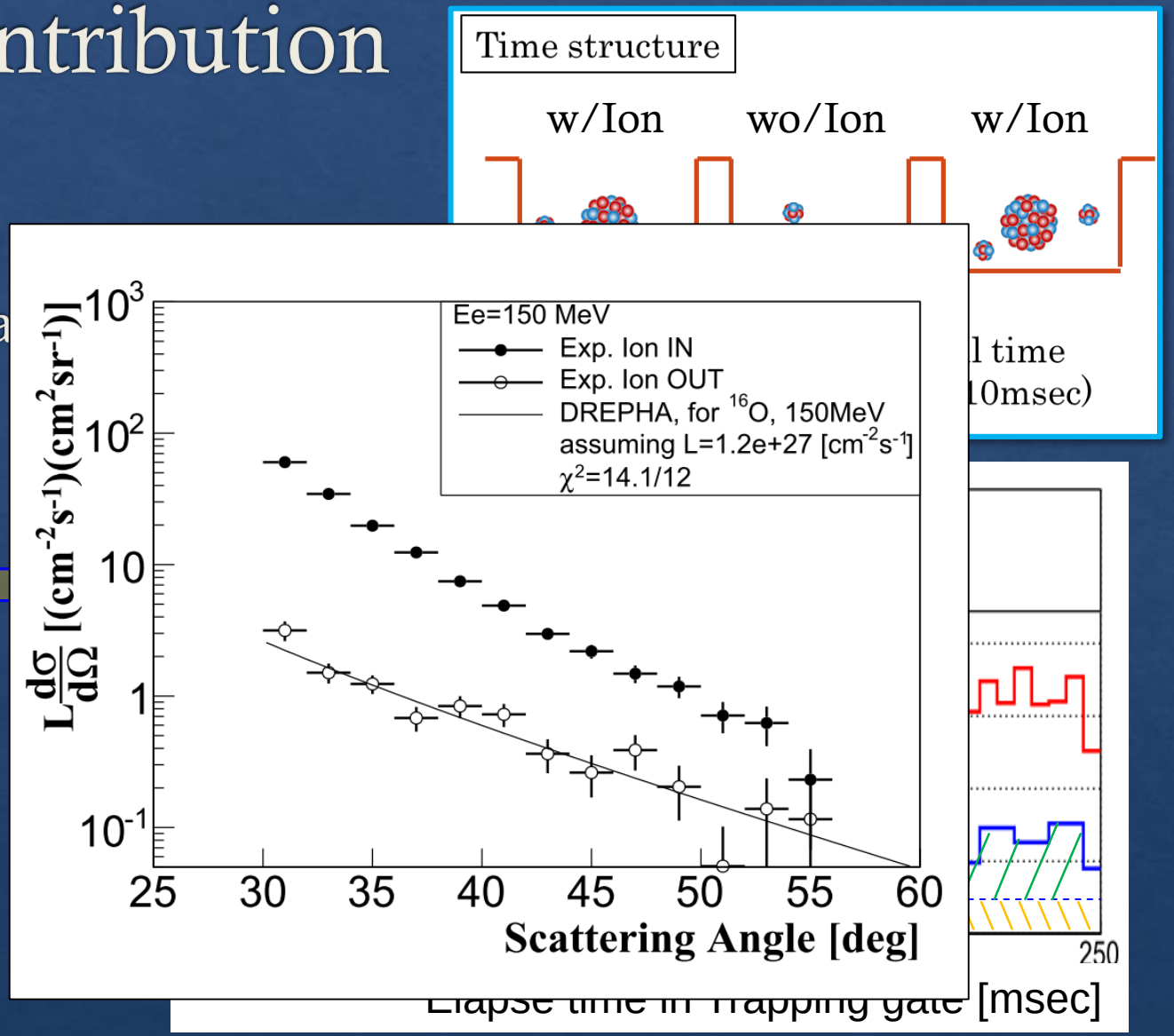






Background contribution

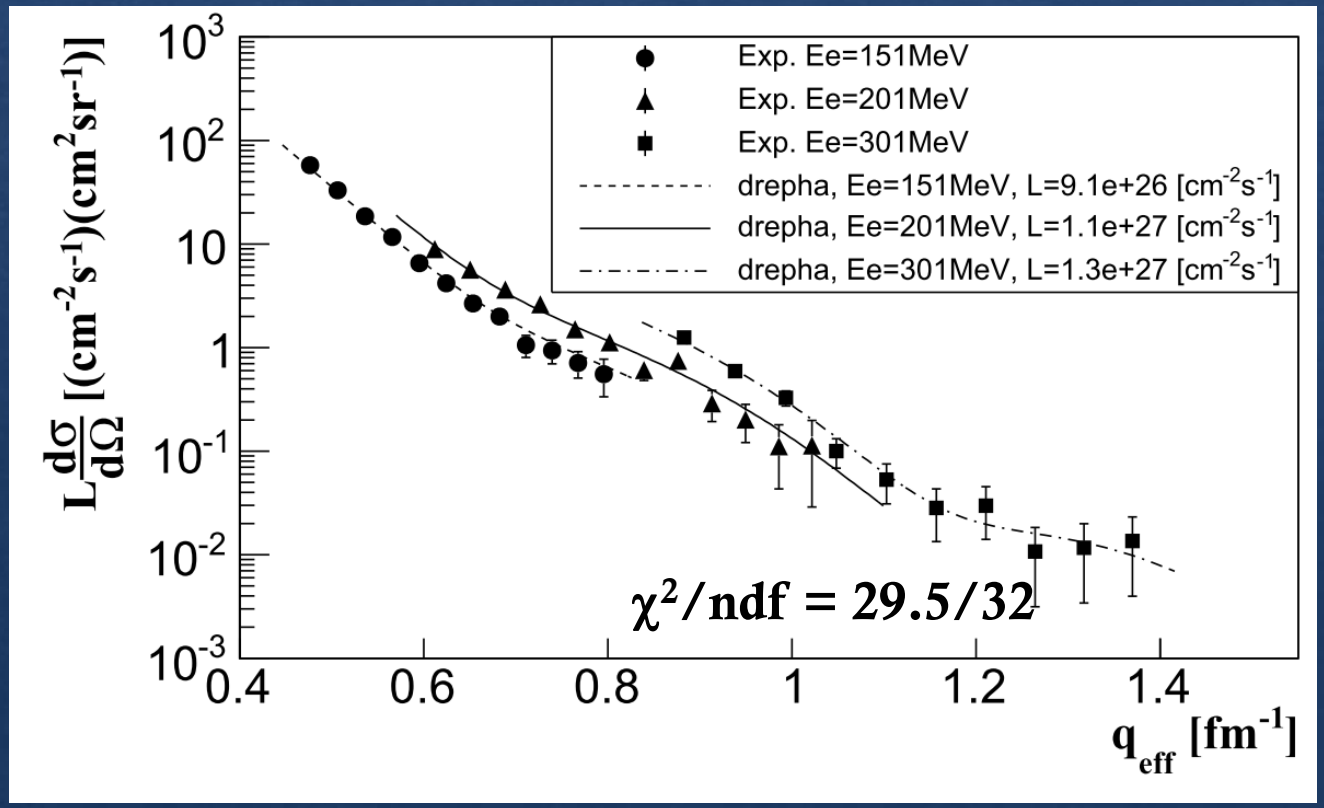
- Beam current : ~200 mA → 10^{18} [e^-/s]
- Residual gases in the SCRIT : ~5×10^{-8} Pa
  → 6×10^{8} [particles/cm^2]
  → L ~ 0.6×10^{27} [/cm^2/s]
  for neutral gas
- Residual gases are ionized and trapped by the beam.
  - Amount is similar to the neutral ones.
- Luminosity of residual gas : > 1×10^{27} [/cm^2/s].
  - It is not small, and should be subtracted.

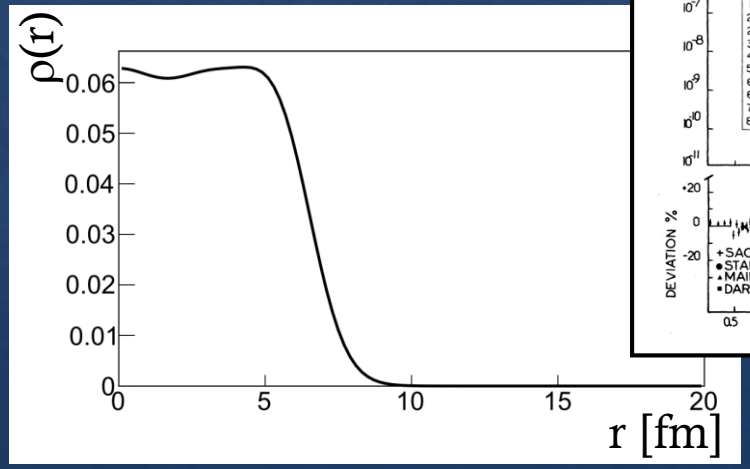


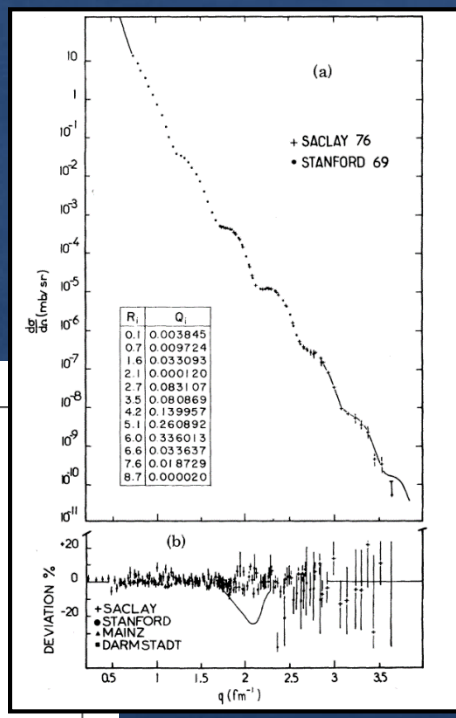
Momentum transfer distribution of ^{208}Pb

- The cross sections are calculated by a Phase shift calculation code (DREPHA).
  Private communication with J. Friedrich
- The charge density distribution is expressed by the Sum Of Gaussian.
- The luminosity is considered as free parameter.

#injected ions ~ 2x10^8 [/pulse]







$$\rho(r) = \frac{Ze}{2\pi^{\frac{3}{2}}\gamma^3}\sum_{i=1}^{N}\frac{Q_i}{1+2R_i^2/\gamma^2}\left(e^{-(r-R_i)^2/\gamma^2}+e^{-(r+R_i)^2/\gamma^2}\right).$$

B. Frois *et. al.*,
Phys.Rev.Lett.38,152 (1977)

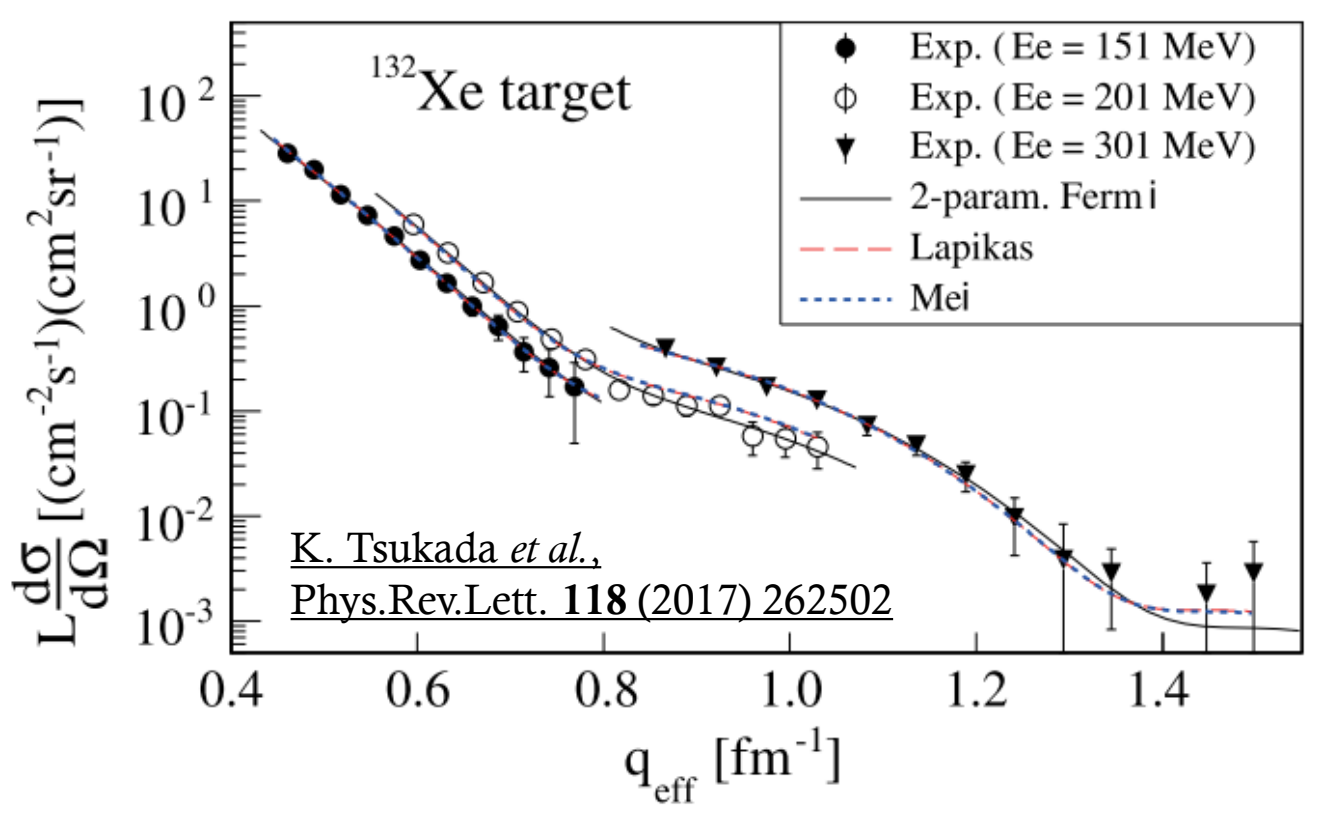
Momentum transfer distribution of ^{132}Xe

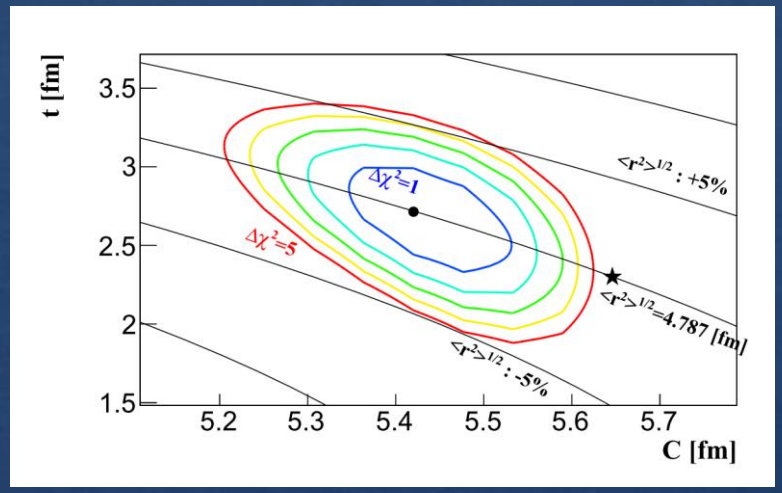
- The cross sections are calculated by a Phase shift calculation code (DREPHA).

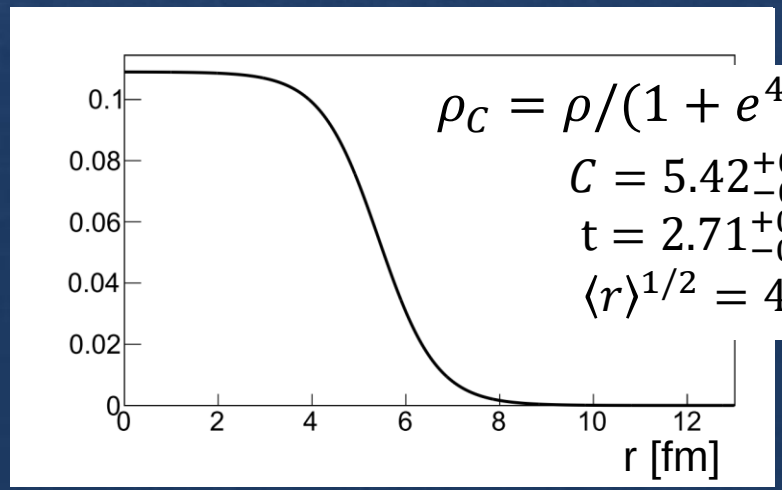
Private communication with J. Friedrich

- The charge density distribution is expressed by the 2-parameter Fermi.
- The luminosity and C, t are considered as free parameters.

#injected ions ~ 2x10^8 [/pulse]







Contribution of inelastic scattering for ^{132}Xe

- Transition density of the first 2^+ state is calculated by a relativistic mean field theory.

  Private communication with K. Hagino and H. Mei

- Cross section of the inela. scatt. is calculated by a DWBA code (FOUBES).

  Private communication with H. Blok and L. Lapikas

- The contribution is **negligible** in our kinematical region.

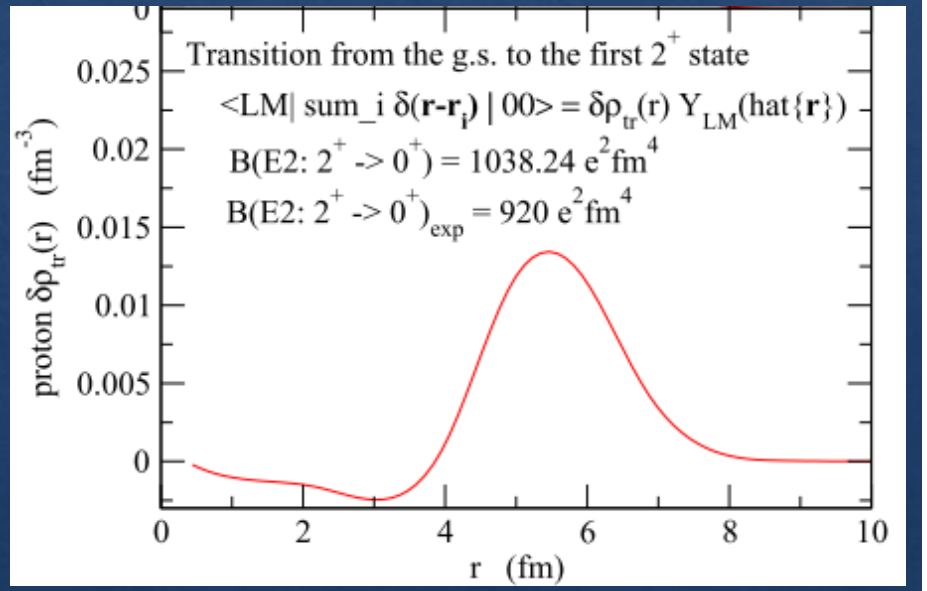
3^+ 1803.7

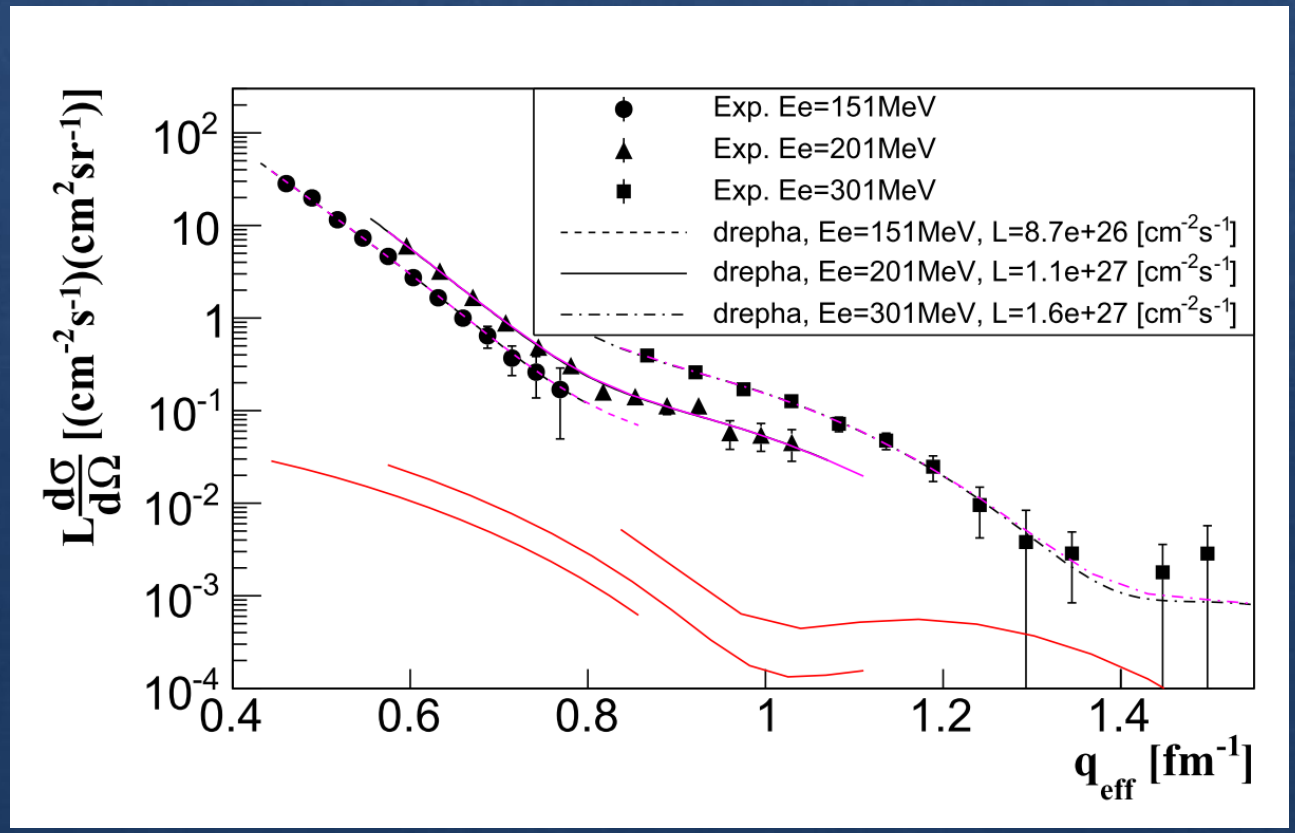
2^+ 1297.9

2^+ 667.7

0^+ 0.0

^{132}Xe



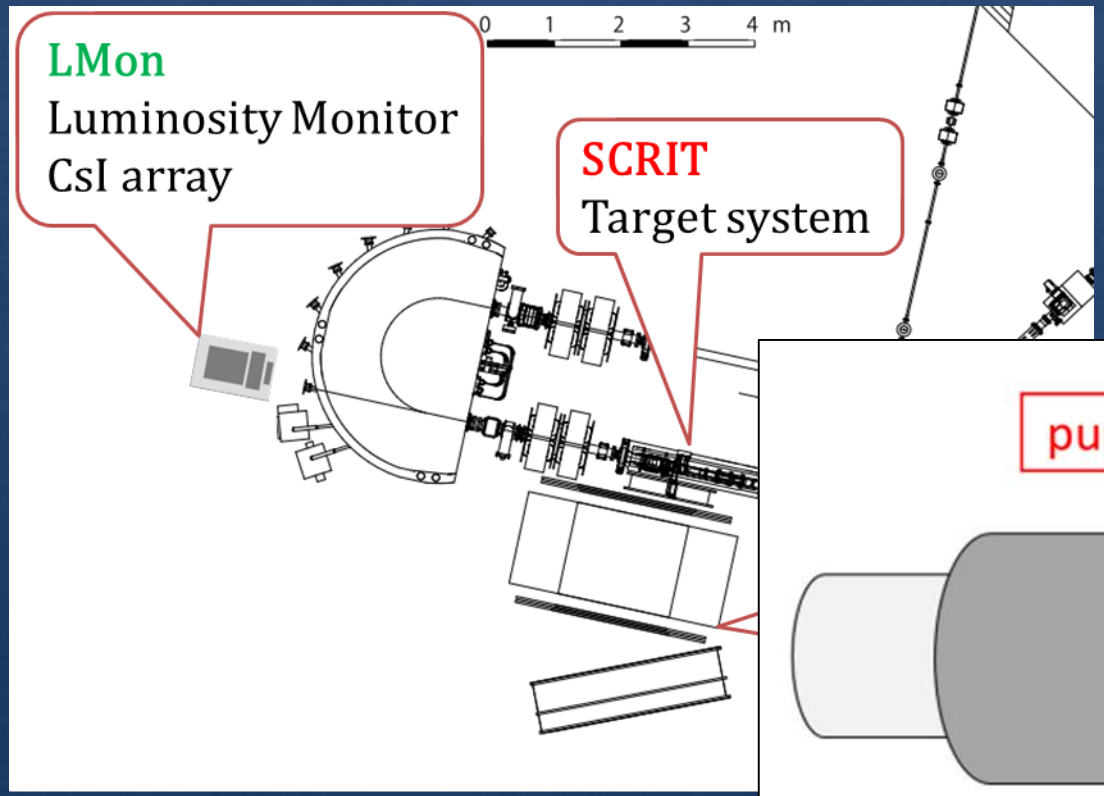


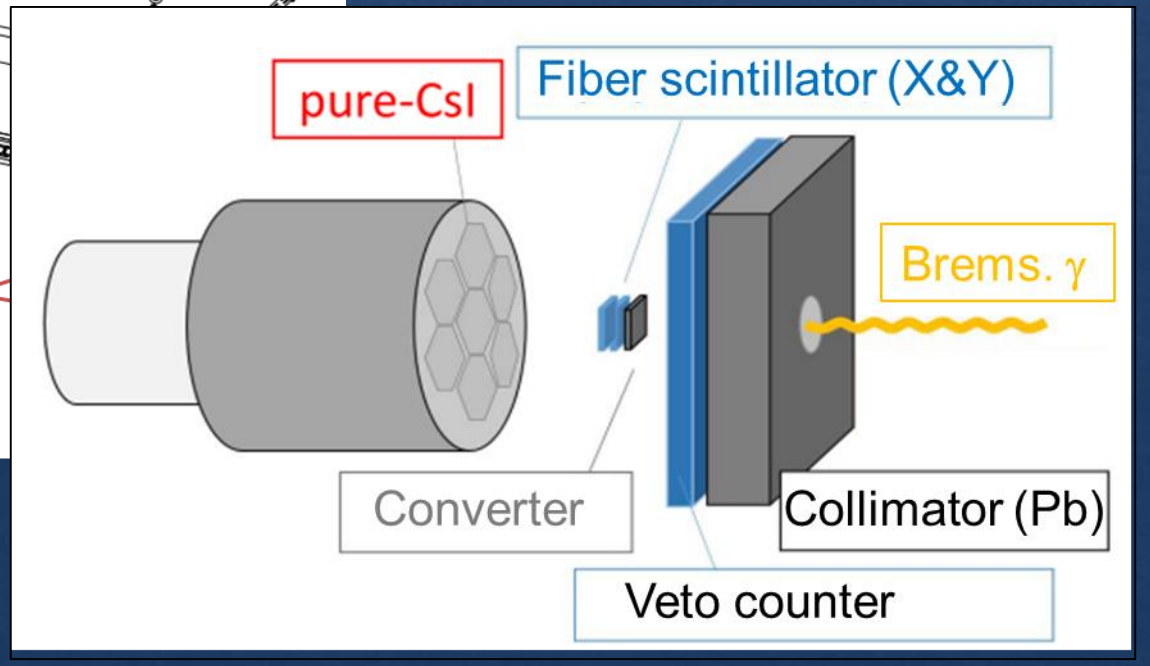
Luminosity Monitor

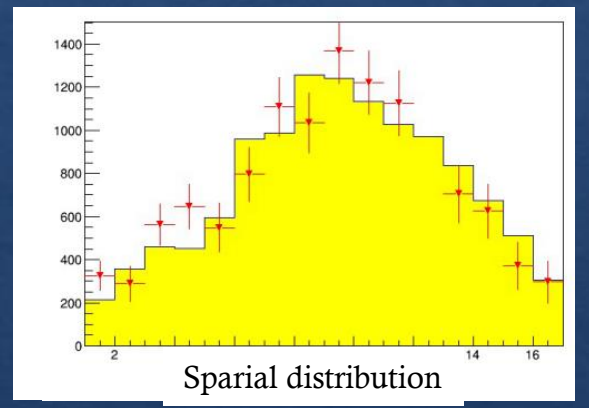
Cross Section of electron scattering $\frac{d\sigma}{d\Omega} = \frac{1}{L}\frac{dN}{d\Omega}$

measured by **WiSES**

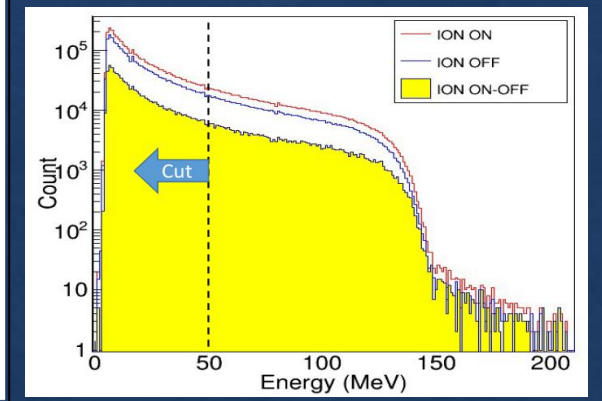
measured by **LMon**







Sparial distribution



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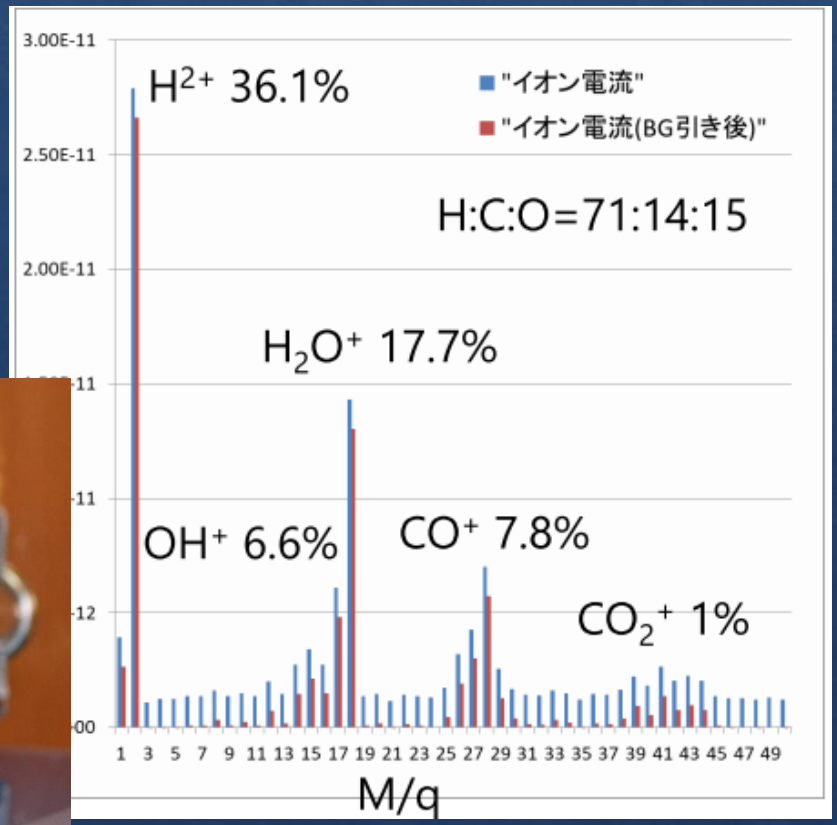
Background suppression

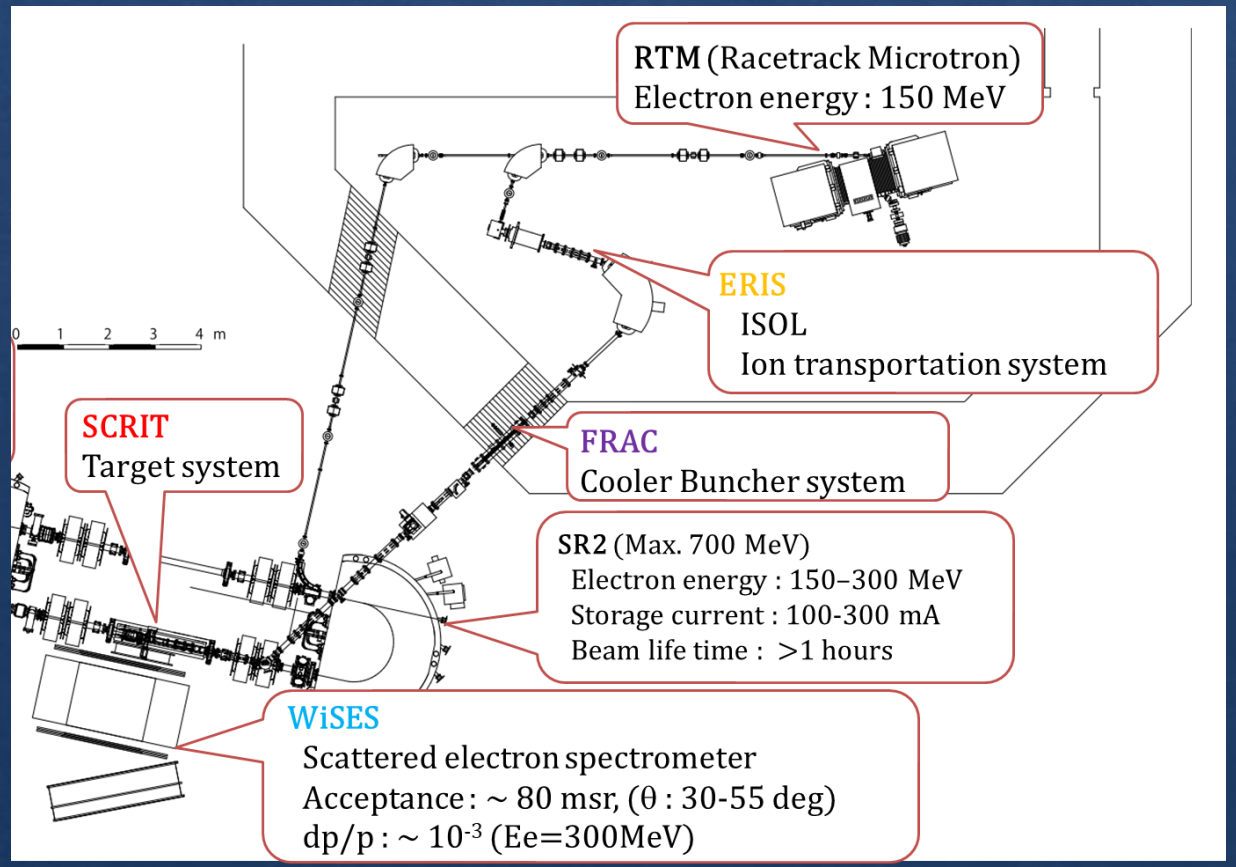
- Followings are planed this summer:
  - Vacuum pump (NEG) will be reinforced
  - Cold trap (liq.N_2) will be installed to remove H_2O component
  - New SCRIT device
    - Fewer material
    - E-field Modulation by RF to remove residual gas ions

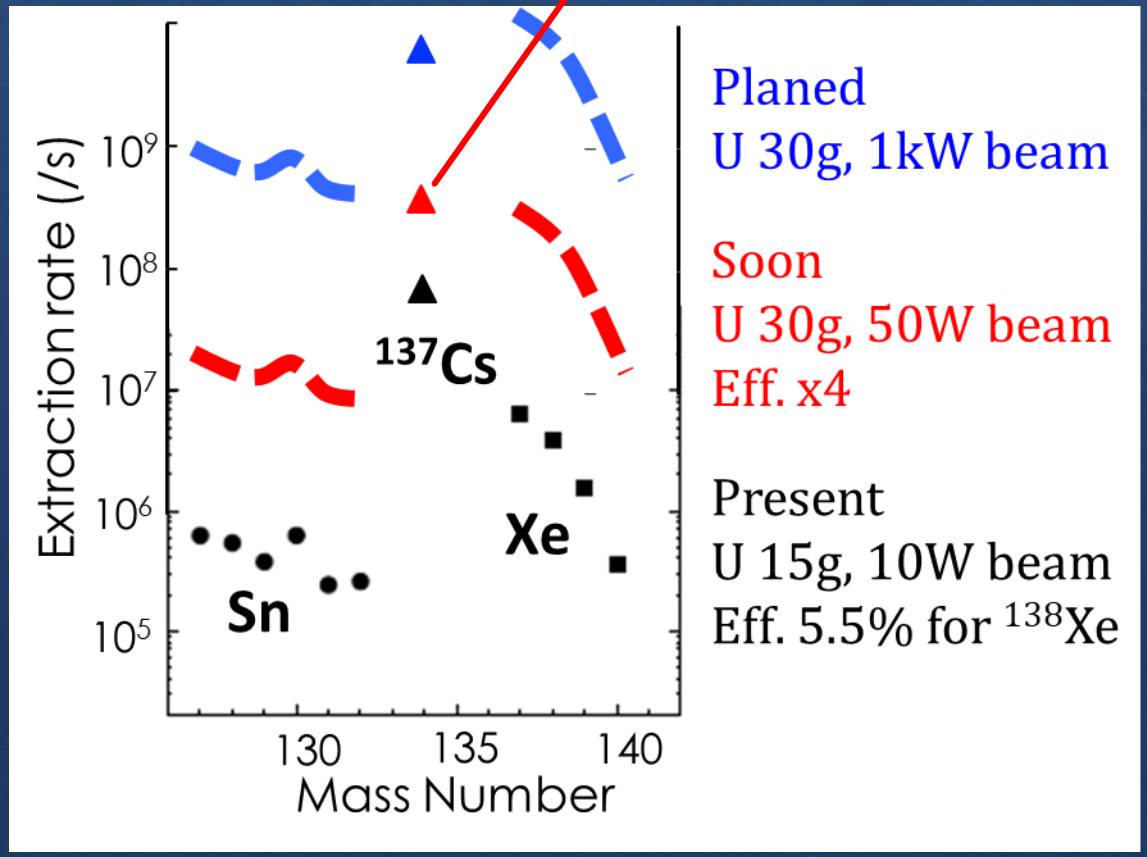


easured by Q-mass spectrometer

Luminosity Upgrade

- RI generation & transportation systems are continuously developed and improved.
- Higher power driver (>1kW) for ISOL (future)





Summary

- SCRIT electron scattering facility was constructed.
  - Successful commissioning experiments with stable nuclei were performed
  - Development & improvement for unstable nuclei are ongoing.
  - The first experiment with unstable nucleus, ^{137}Cs, will be carried out soon.

- The advices and/or hints for physics to be studied by electron scattering are very welcome.