Fission experiments using ^{254}Es target at the JAEA tandem

K. Hirose[1], K. Nishio[1], M. Asai[1], K. Tsukada[1], A. Toyoshima[1,2],
N. M. Chiera[1], Y. Ito[1], H. Makii[1], M. Matsuda[1], Y. Nagame[1], R. Orlandi[1], K. K. Ratha[1,3],
T. K. Sato[1], H. Suzuki[1,4], K. Tokoi[1,4], T. Tomitsuka[1,5], M. J. Vermeulen[1], R. Yanagihara[1,2],
S. Chiba[3], S. Goto[5], H. Hayashi[6], H. Hirose[5], H. Kamada[7], I. Nishinaka[8], M. Shibata[9], M. Sakama[10],
A.N. Andreyev[XXX, 1] , I. Tsekanovich[12] , K.P. Rykacewski[13], R.A. Boll[13], S. Kubono[14]

[1]JAEA, [2]Osaka Univ., [3]Tokyo Tech., [4]Ibaraki Univ., [5]Niigata Univ.,
[6]Kanazawa Univ., [7]Nagoya Univ., [8]QST, [9]Nagoya Univ. RI, [10]Tokushima Univ.,
[11]Univ. of York, [12]Univ. of Bordeaux, [13]ORNL, [14]RIKEN

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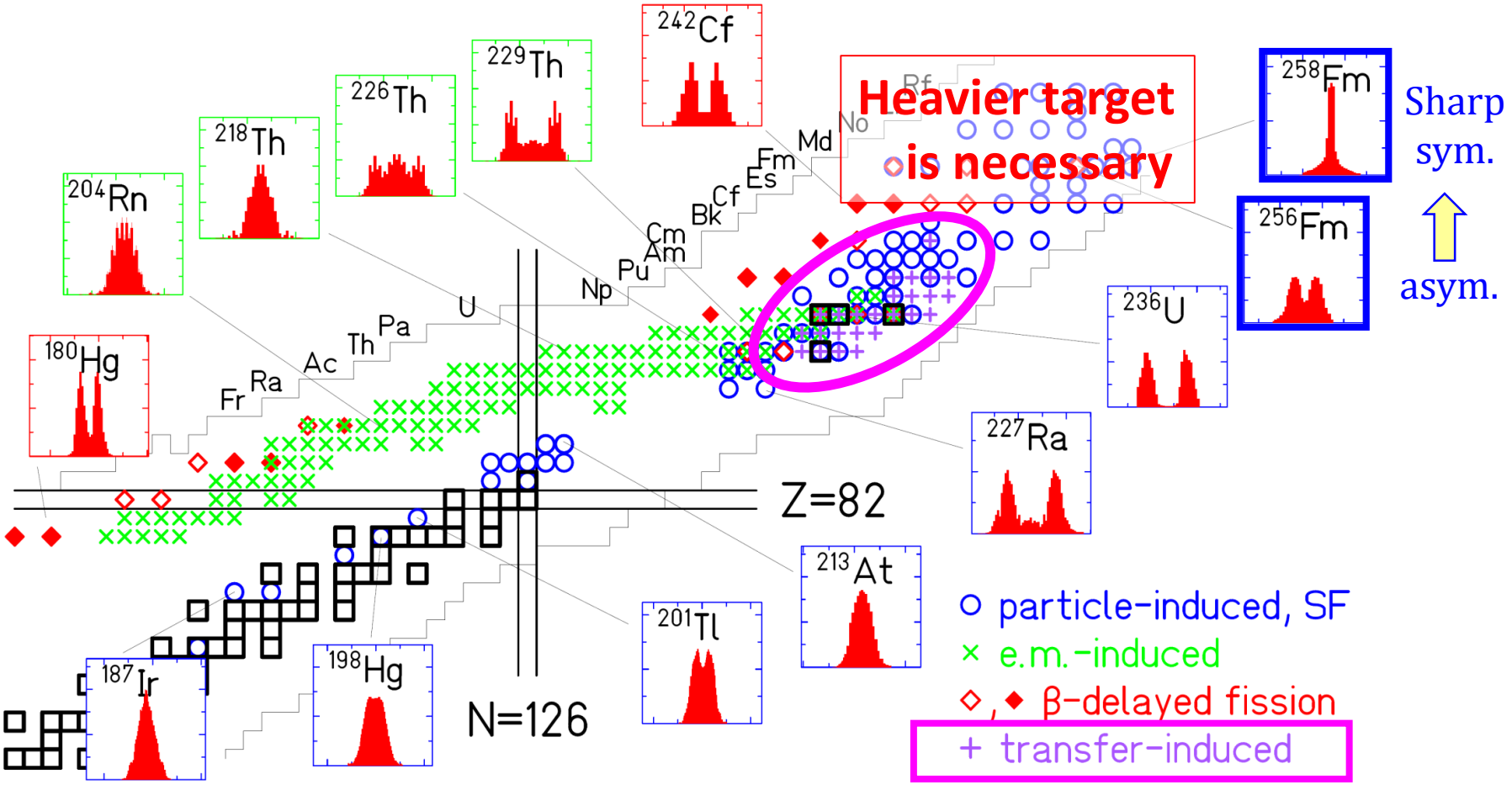
Outlook

- Introduction
- ^{254}Es target
- ^{4}He + ^{254}Es experiment (^{258}Md*)
- Spontaneous fission (^{256}Fm, ^{258}Fm, ^{259}Lr)
- Summary

Measured Fragment Mass/Charge Yield

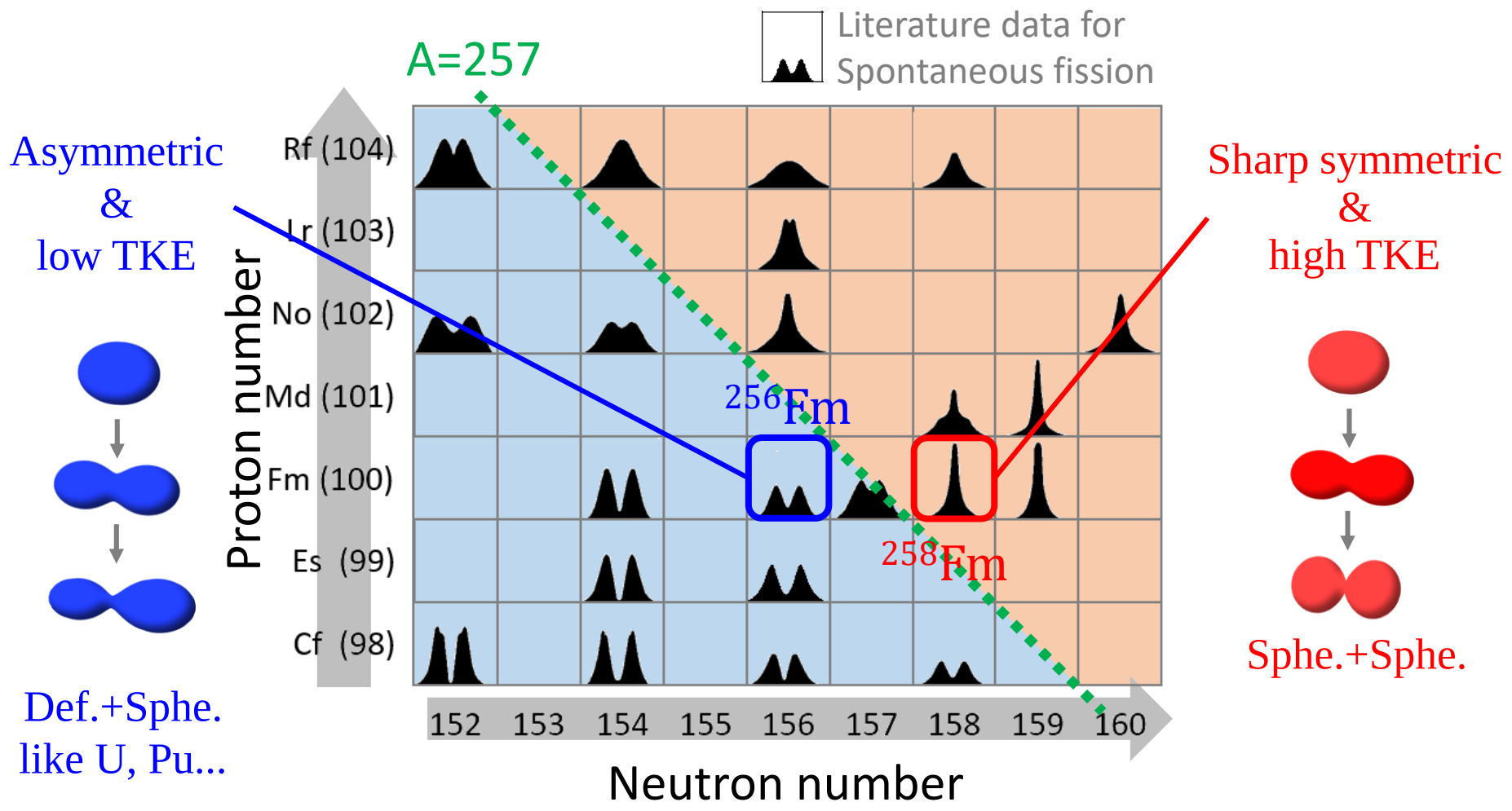
A.N. Andreyev, K. Nishio, K.-H. Schmidt, Reports on Progress in Physics, 81,016301(*2018*)



Multi-nucleon transfer fission + actinide targets

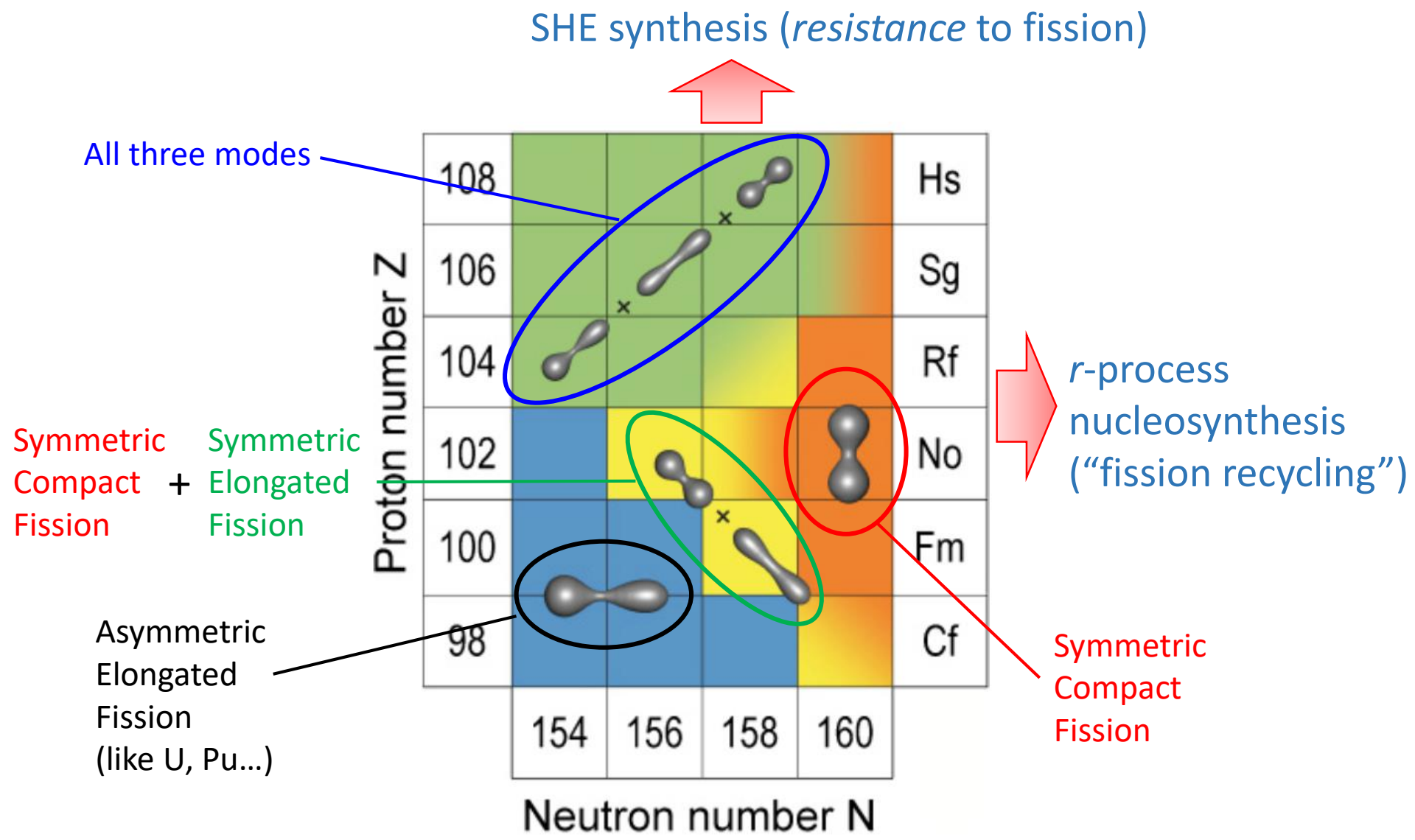
- R. Léguillon *et al.*, Phys. Lett. B 761, 125 (2016)
- K. Hirose et al. Phys. Rev. Letters, 119, 222501 (2017)

FFMDs around A=257 by SF



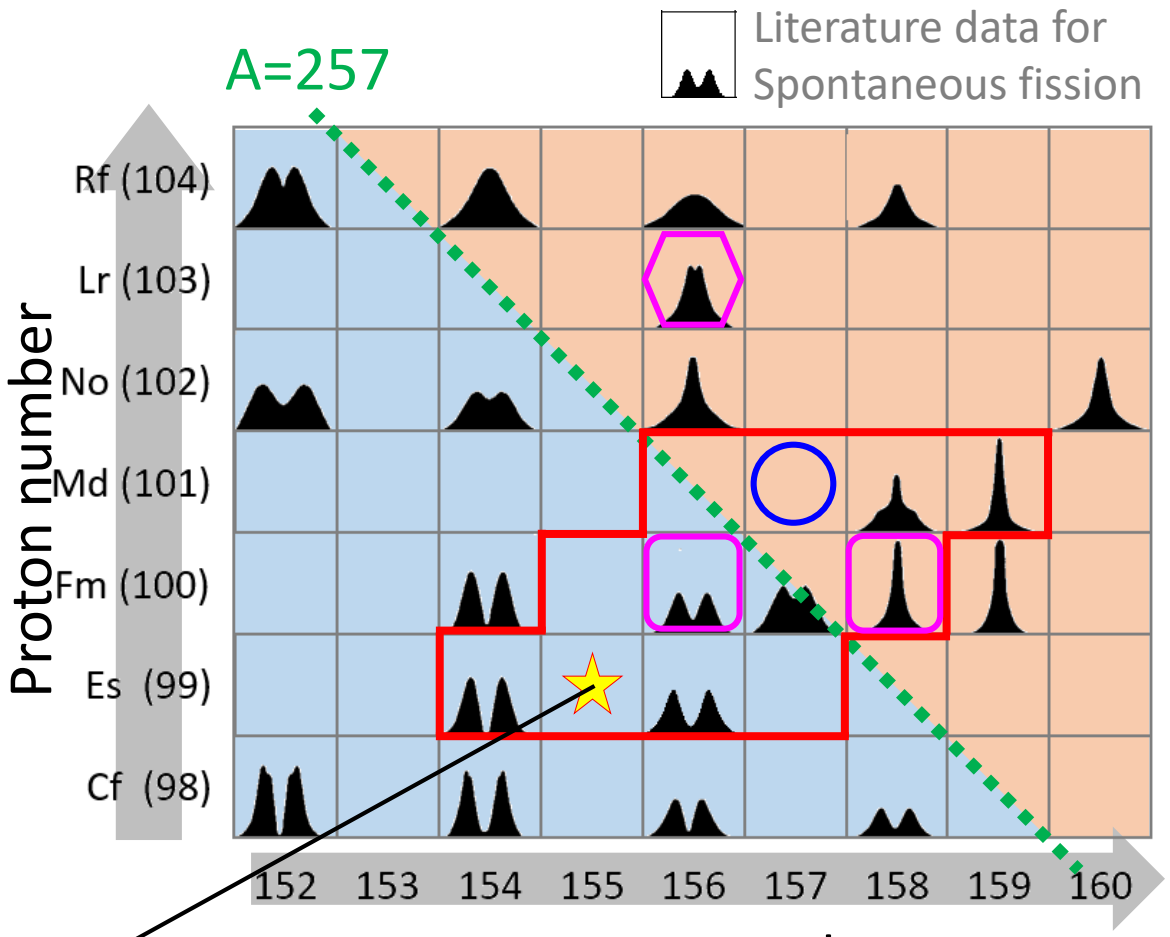
M.R. Lane *et al.*, Phys. Rev. C **53**, 1893 (1996)

Coexistence of several fission modes



A. Staszczak *et al*., Phys. Rev. C **80**, 014309 (2009)

FFMDs around A=257 by SF



Fission of
^{258}Md
^{256}Fm
^{258}Fm
^{259}Lr
will be shown

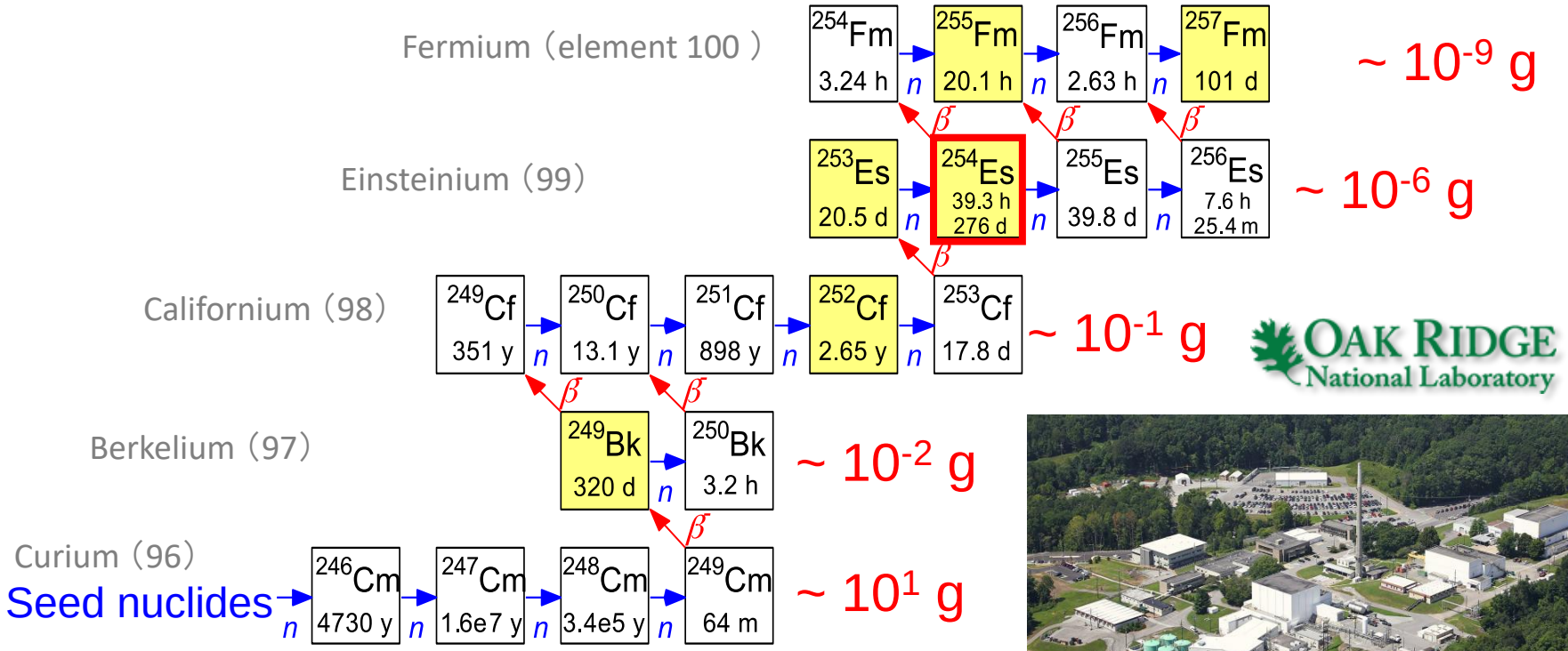
Using ^{254}Es,

Induced fission by ^{4}He+^{254}Es
Spontaneous Fission using ^{254}Es(^{18}O,X), ^{248}Cm(^{15}N,4n)
Multi-nucleon transfer reaction ^{18}O+ ^{254}Es

^{254}Es ($T_{1/2}$ = 276 days) from ORNL

High Flux Isotope Reactor(HFIR) at ORNL

- production of ^{252}Cf
- also ^{254}Es as a by-product



OAK RIDGE National Laboratory

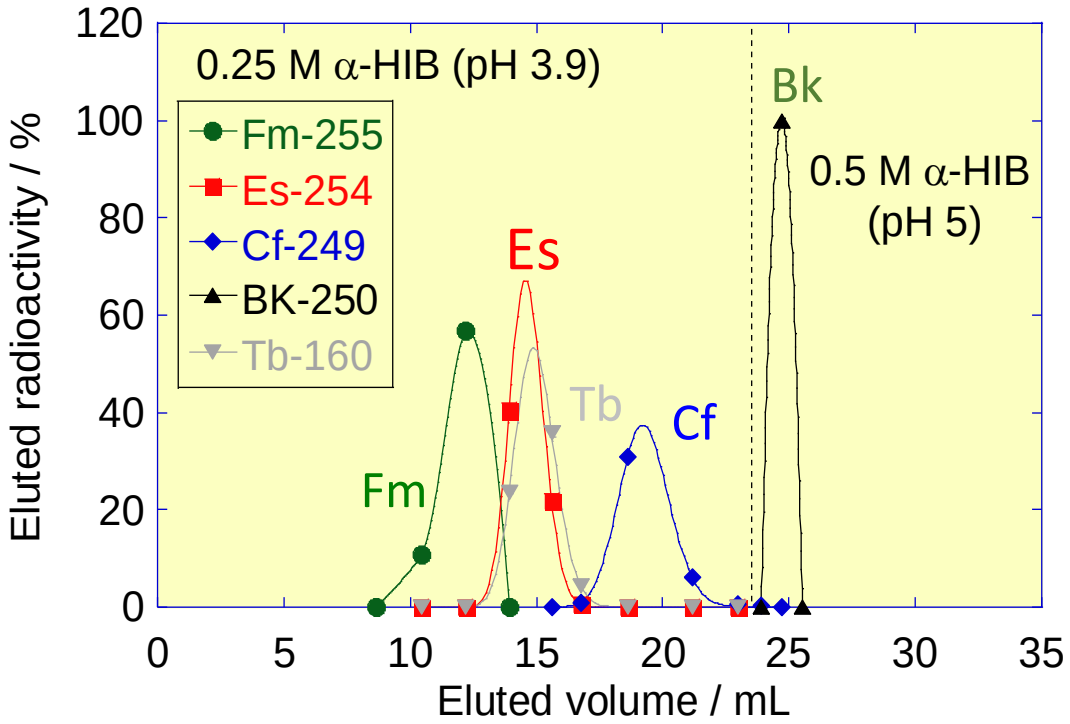
https://neutrons.ornl.gov/hfir

0.5 μg of ^{254}Es was transported to JAEA (2017.Oct.)

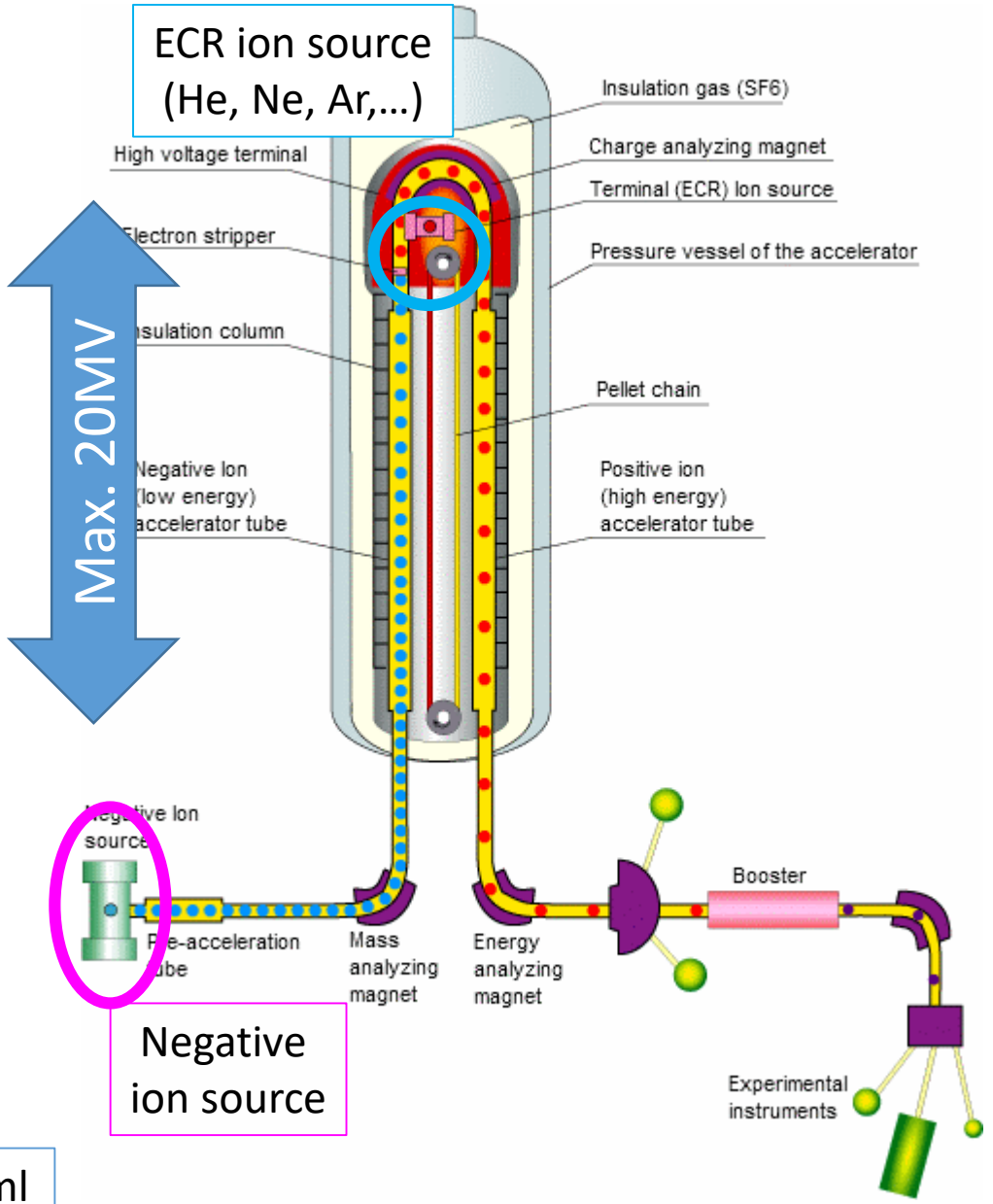
Purification of ^{254}Es

Chemical separation
@ JAEA tandem

^{254}Es decays with $T_{1/2}$=276 d.
→ 7.3% decays per month



JAEA tandem

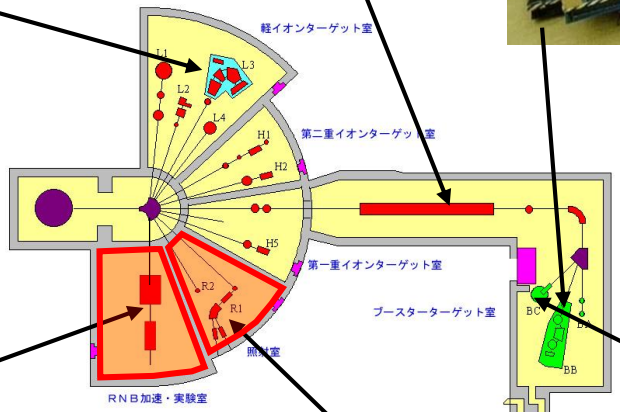


https://ttandem.jaea.go.jp/index-eng.html

Magnetic Spectrograph

Booster Linac

Recoil Mass Separator

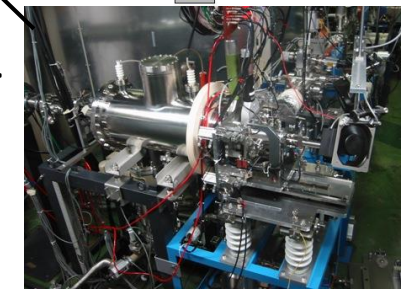


In-beam fission/ γ-ray spectroscopy

^{258}Md*

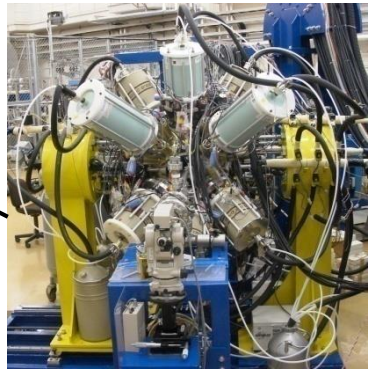
RI materials can be used (Th, U, Np, Pu, Am, Cm, Bk, Cf, Es)

ISOL

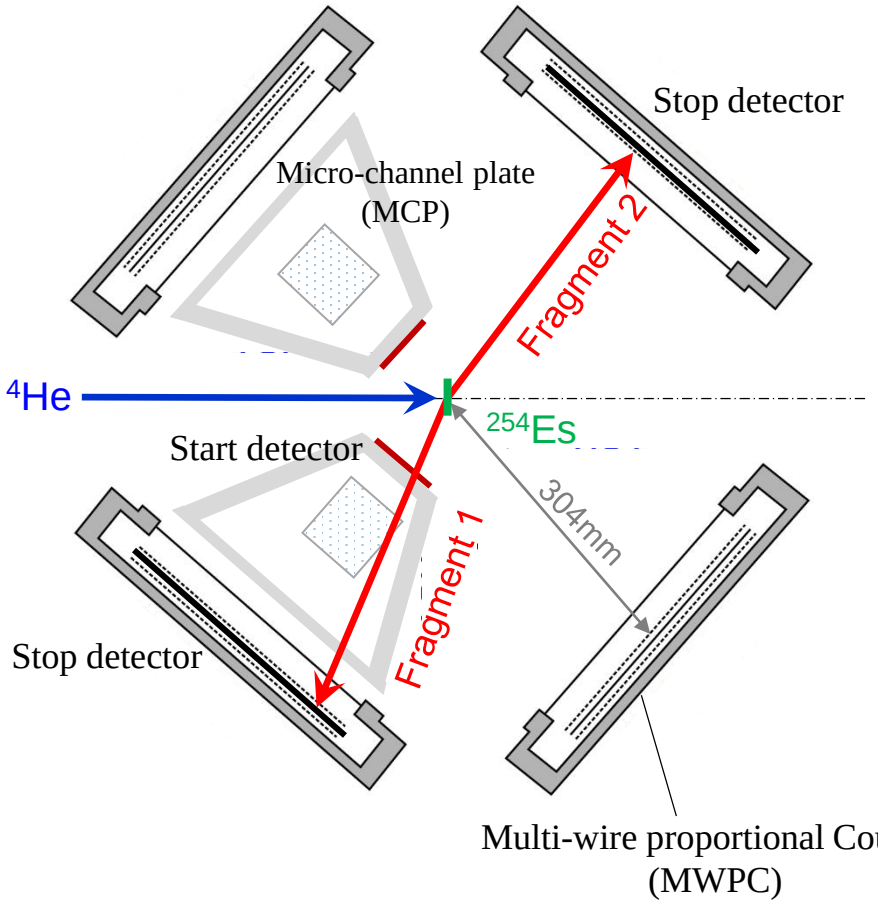


^{256,258}Fm, ^{259}Lr

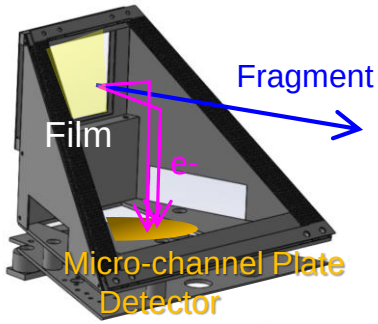
Ge-detector array

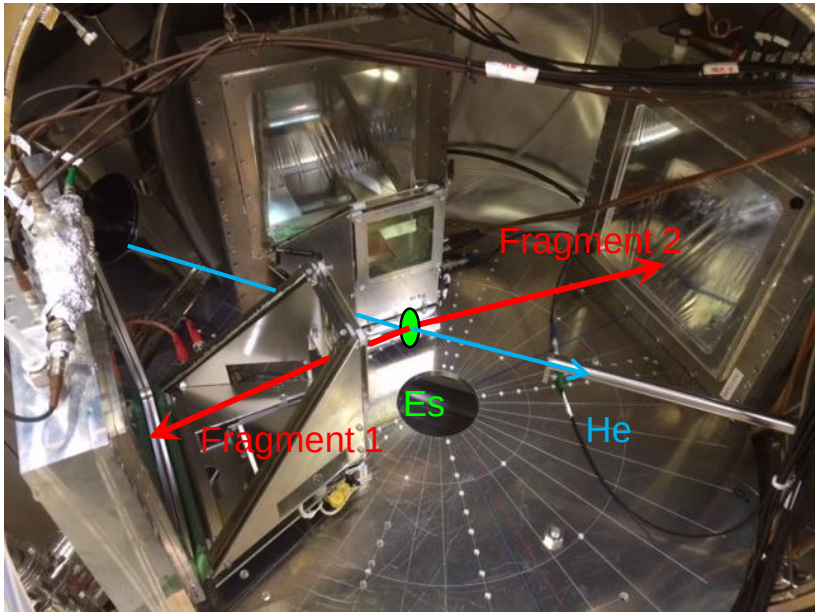


Setup for $^{4}He+^{254}Es$



^{254}Es 0.011μg, 1.2mmϕ
(0.88μg/cm^2, 750kBq)
on Ni backing (270ug/cm^2)

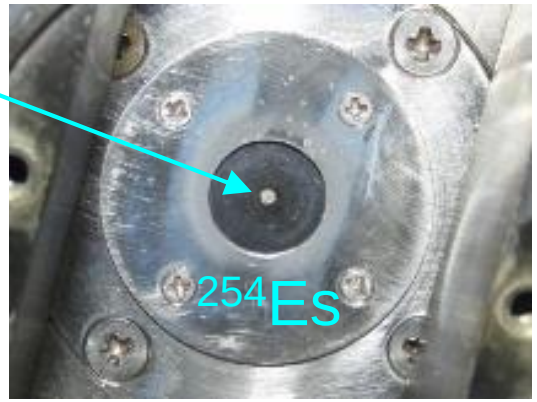


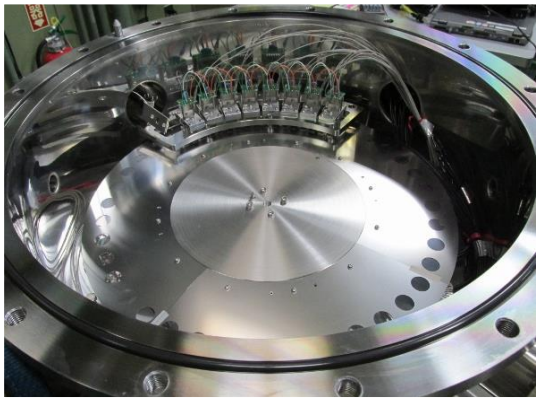


- E(^{4}He)=22.6 & 25.7MeV
  → E*(^{258}Md)=15 & 18MeV
- 4MWPCs & 2MCPs (2ν-method)

Spontaneous fission measurements using ^{254}Es target

^{254}Es target
0.8 mmϕ (30 ng)





He/CdI_2 gas

Target ^{254}Es

^{197}Au

Beam ^{18}O

120 MeV

Md

Reaction products

^{254}Es(^{18}O,X)^{258m}Md $\xrightarrow{EC}$ ^{258}Fm

Rotating wheel system

^{258m}Md

Si detectors

JAEA Tandem Accelerator

257

259

Surface ion source

Magnet

Gas-jet transport

M^+

Differential pumping

Extractor

On-line isotope separator (JAEA-ISOL)

Summary

- ^{254}Es target was obtained in 2017 (for the first time in Japan)
- Fission experiments for ^{258}Md* and SF of ^{256,258}Fm, ^{259}Lr
- TKE and fragment mass distributions were measured

- aEF and sCF are dominant for ^{256,258}Fm
- sEF are found in ^{259}Lr and ^{258}Md*

Future plans

- We will get a new Es material this year (2019.10)
- SF of ^{258}Fm will be remeasured with very high statistics
- SF of ^{259}Md and ^{261}Lr will be measured
- In-beam fission studies with multinucleon transfer reactions
- In-beam γ-ray spectroscopy using an ^{254}Es target