

Present status of the KISS project

- Physics motivation of the KISS project
- Recent activities at KISS stage I and mass measurements
 - > Lifetime and hyperfine structure measurements
 - > Mass measurements
- Perspectives of the project
 - > KISS stage II + α
- Summary

Physics goal

— Lifetime and Mass measurements —



Directly

- (n, γ) - (γ, n) equilibrium:
r-process path
- lifetimes of waiting nuclei
duration time to form the third peak
- steady flow approx.:
correlation between T and N_n



Unique circumstance for r-process ?

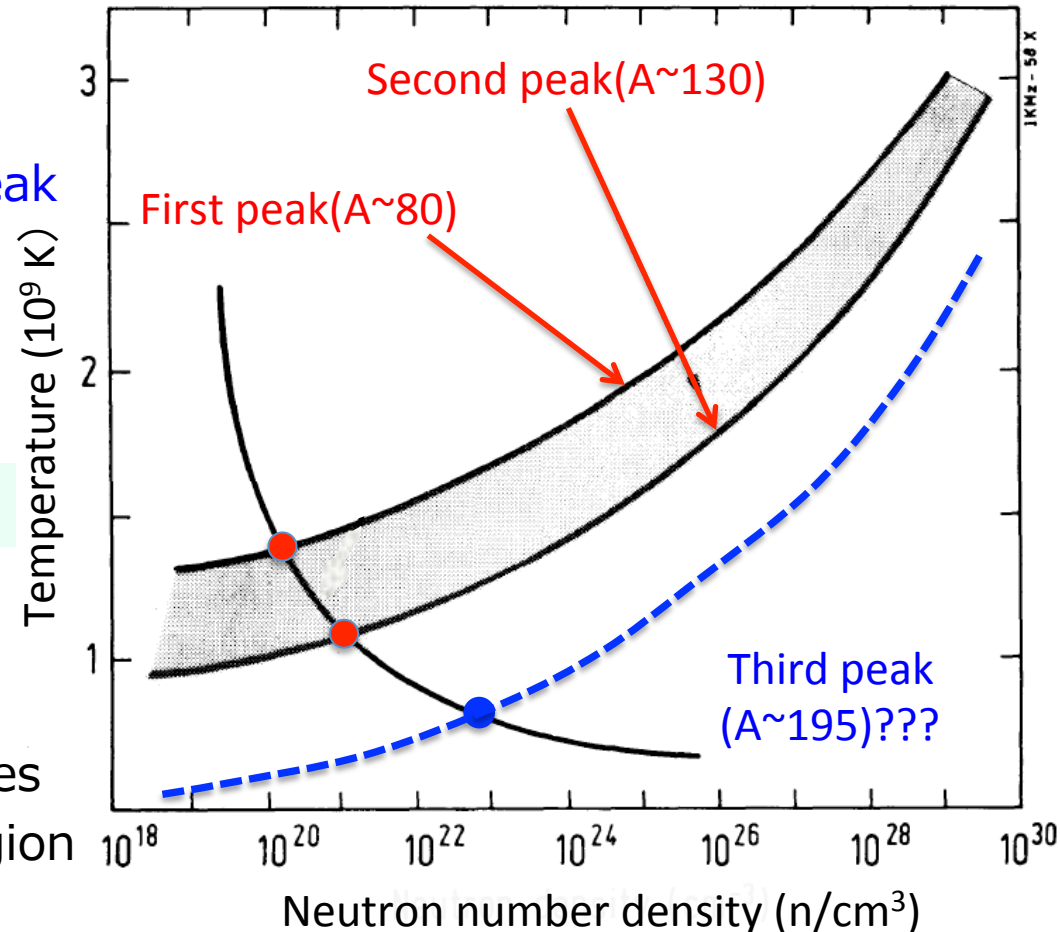
Indirectly

- neutron fraction $(1-Y_e)$
- production rates of fissile isotopes
- nuclear properties in waiting region
-



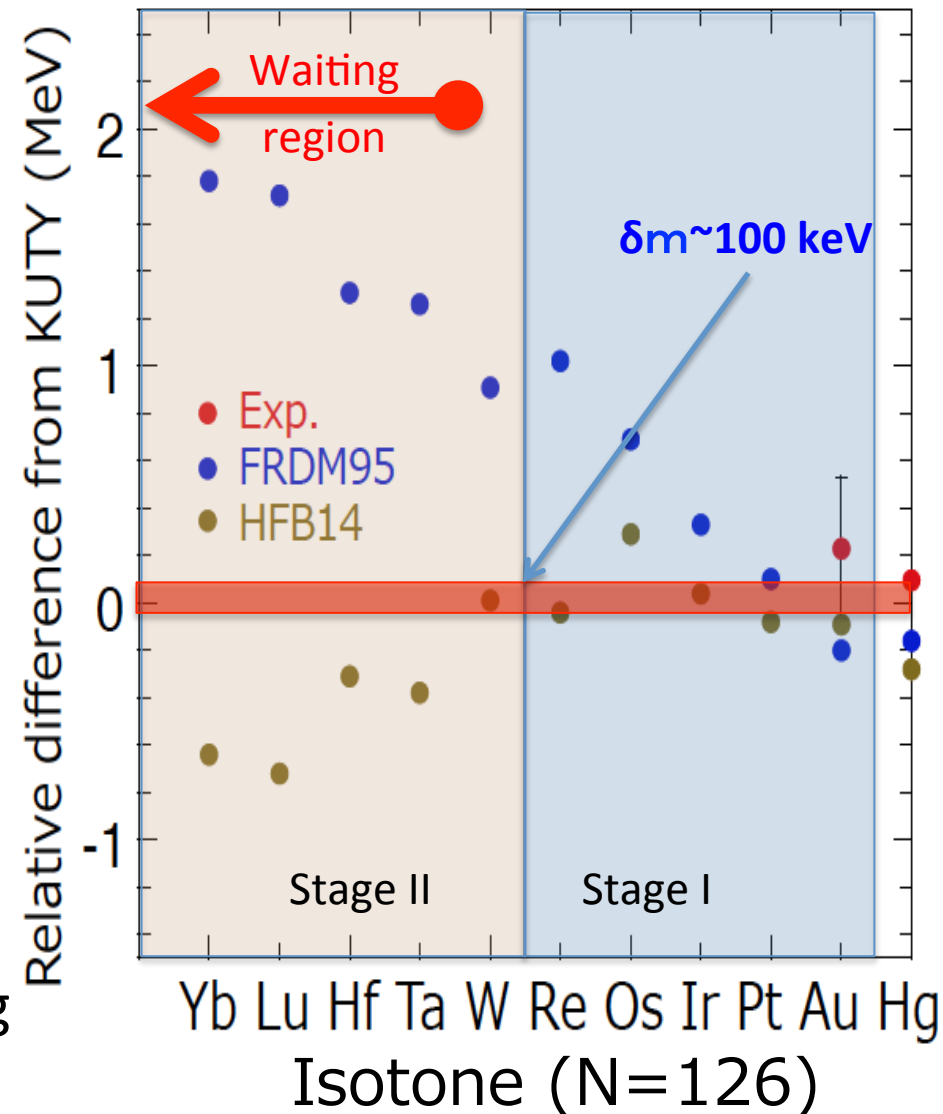
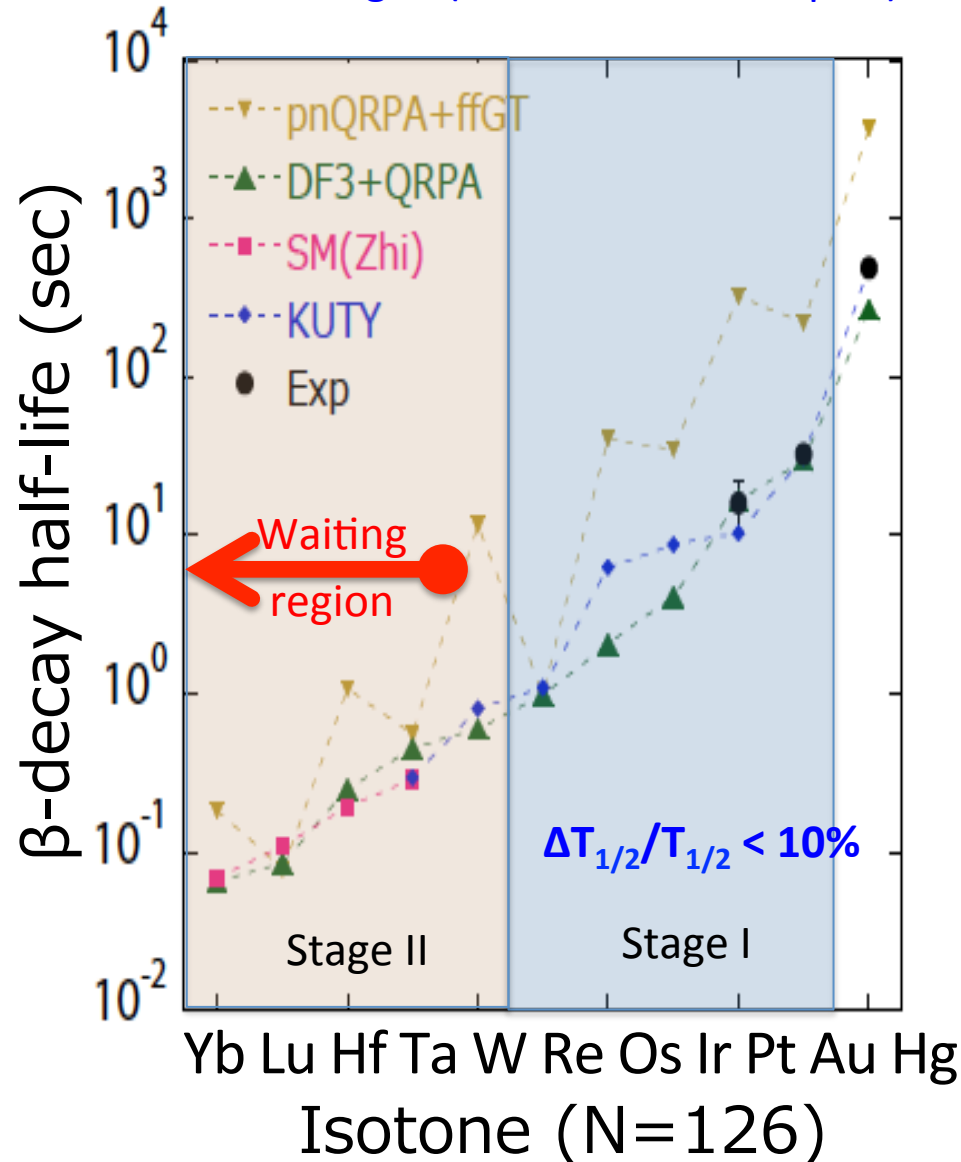
Clarifying the astrophysical origin (CC-SNe, NSM, ..)

from K. -L. Kratz, et al., Ap. J. 403('93)216.



Uncertainty of lifetime & mass predictions in N=126 isotones

Stage I (~2020, ^{136}Xe , 250 pA) to Stage II (2021~, ^{238}U , up to 10 pA)



KISS: KEK Isotope Separation System

- New research method for waiting nuclei of A=195 peak -



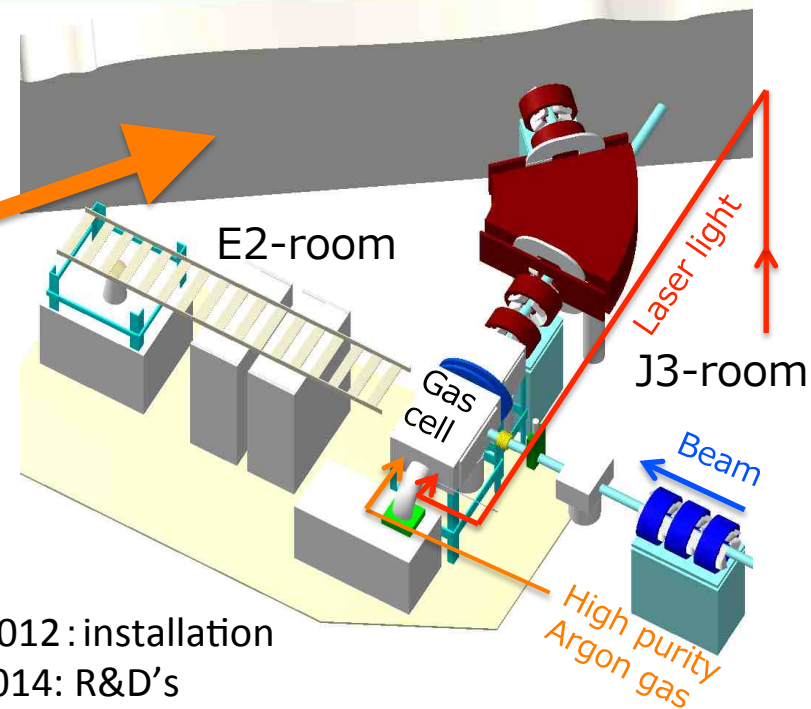
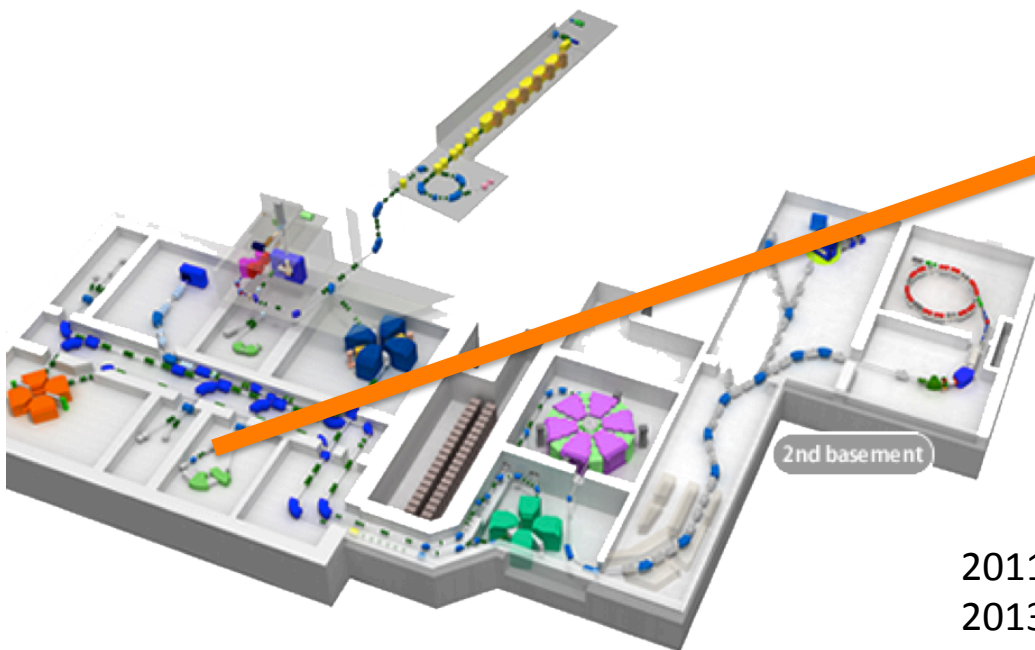
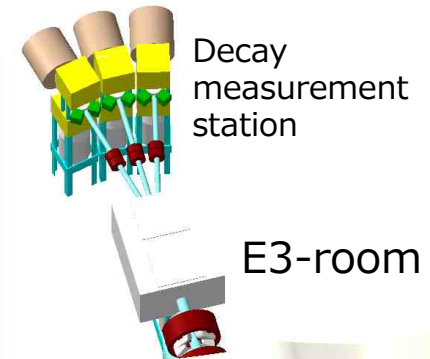
(1) Multi-nucleon transfer reactions

n-rich beams (~ 10 MeV/u)

i.e. $(^{136-144}\text{Xe} + ^{198}\text{Pt})$

(2) In-gas laser ionization

Neutralization of RI by argon gas
+ Laser resonance ionization (Z)
+ mass separation (A)
+ Det. system at low-background



Radioactive Isotope Beam Factory (RIBF)

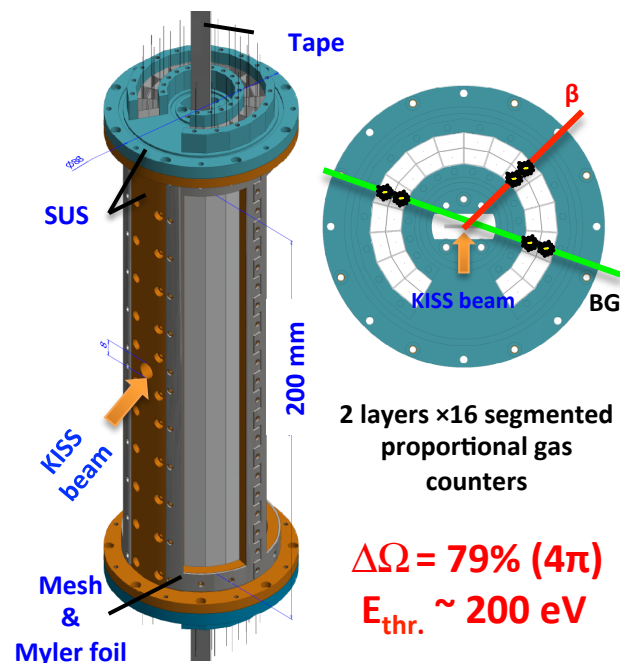
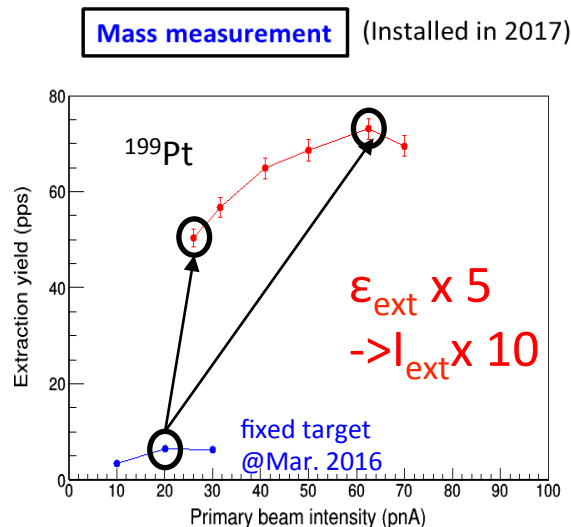
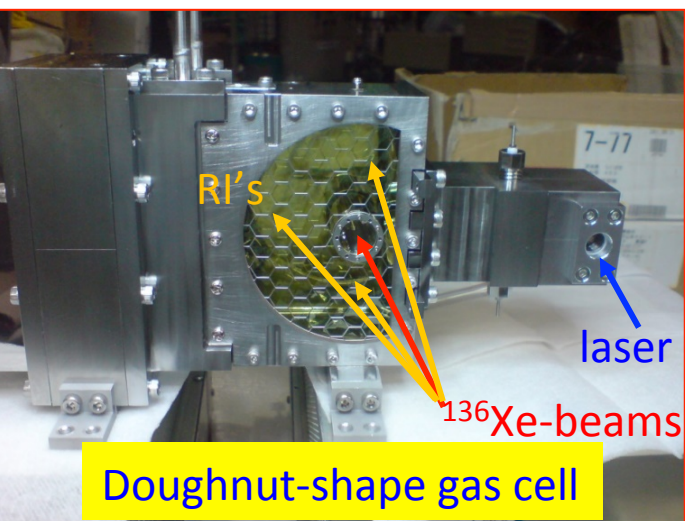
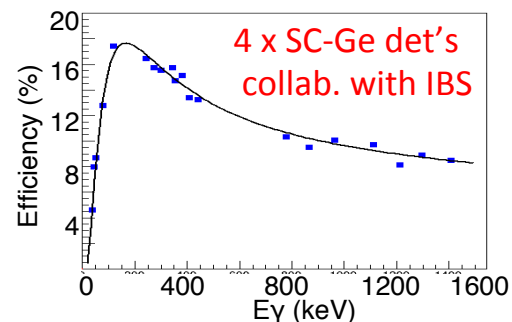
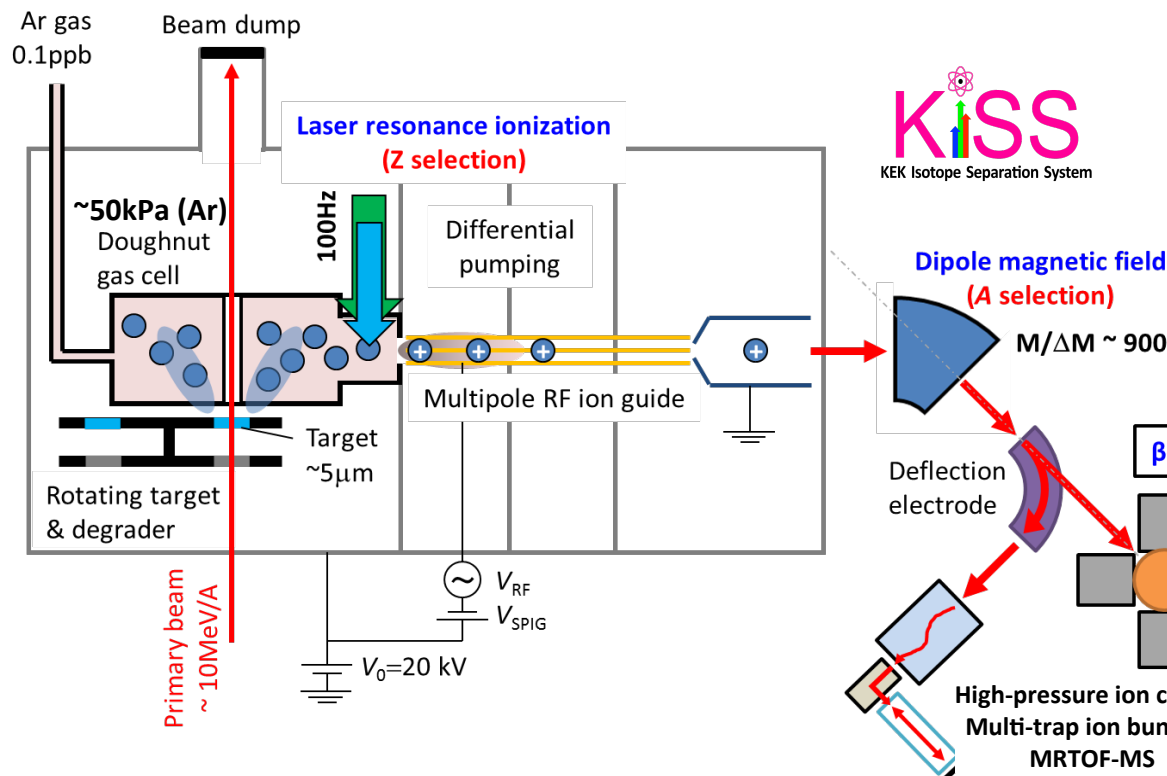
2011~2012: installation

2013-2014: R&D's

Y. Hirayama, EPJ 66('14)11017.

Y.X. Watanabe, P.R.L. 115('15)172503.

KISS (KEK Isotope Separation System)

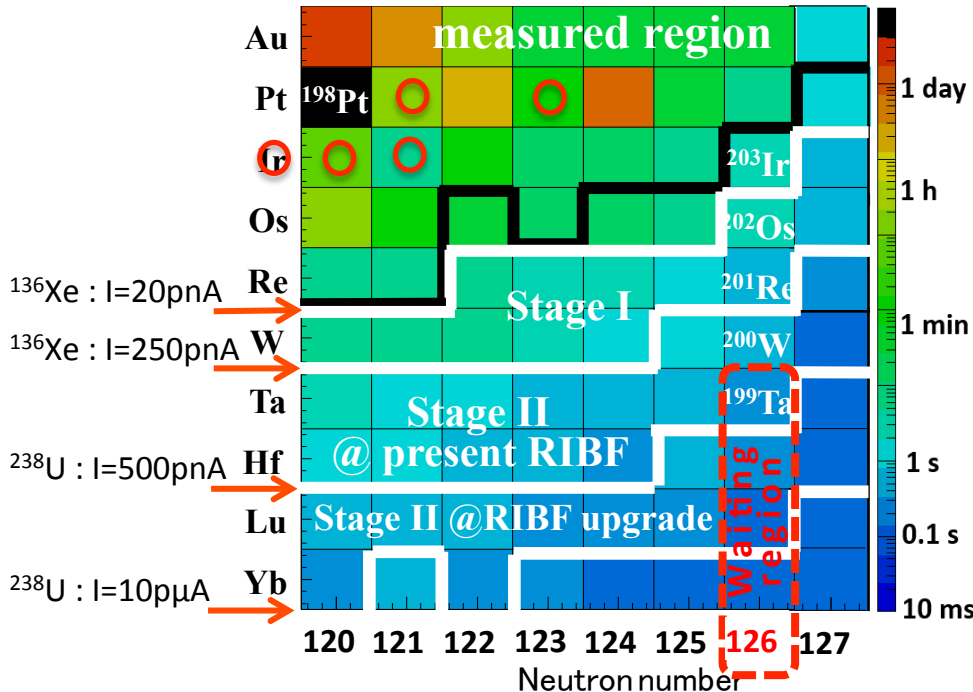


Lifetime confirmation in decay spectroscopy

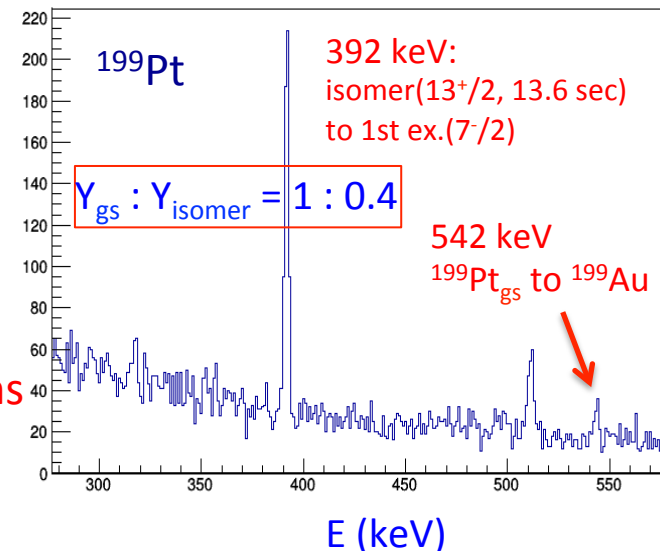
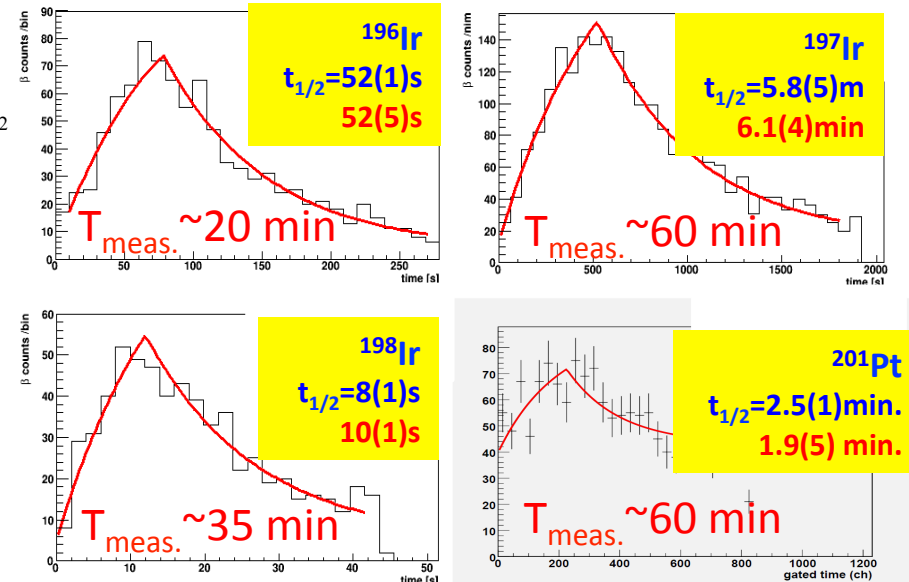
- Y. Hirayama, NP1512-RRC41: "Lifetime measurement of nuclei around N=126 using KISS" (2016~)

KUTY : H. Koura, et al., <http://www.ndc.jaea.go.jp/CN14/index.html>

Expected : $T_{1/2}$

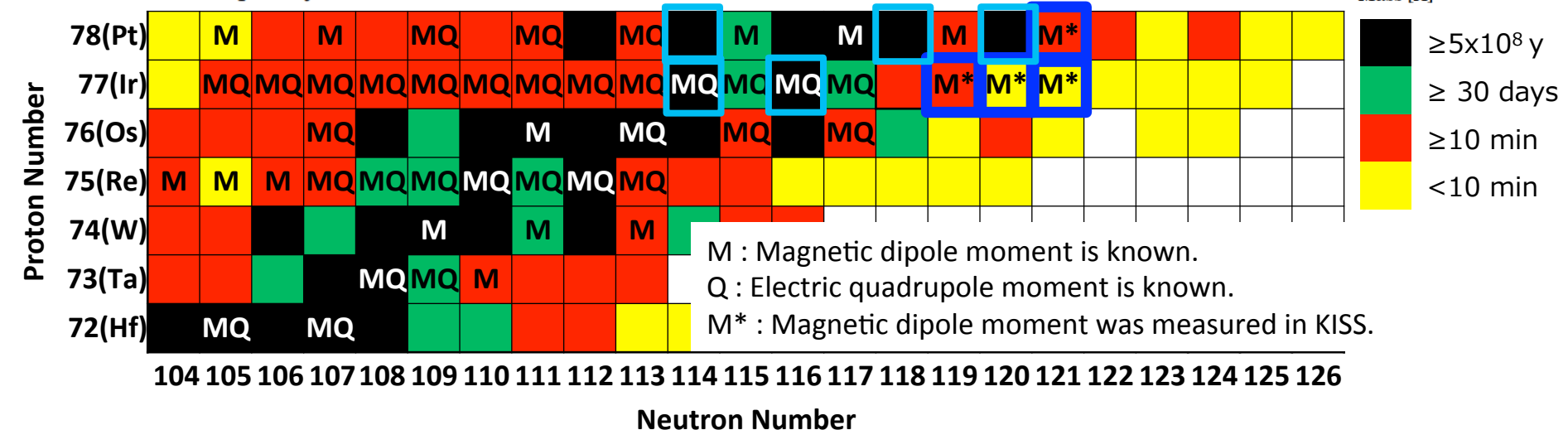
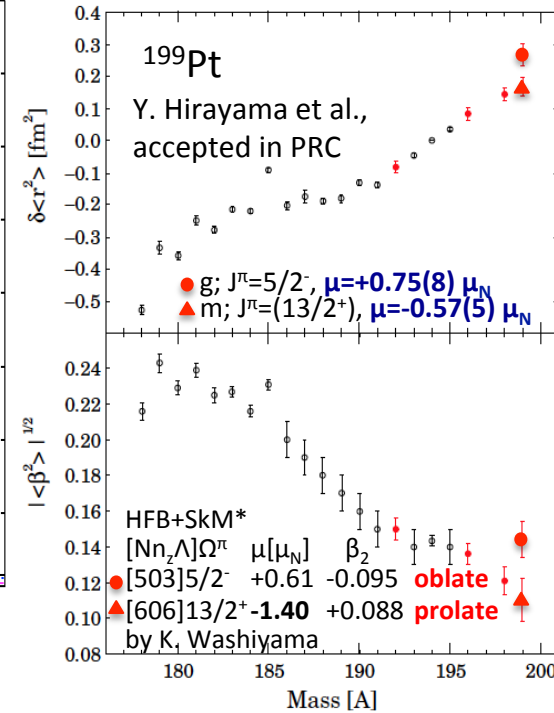
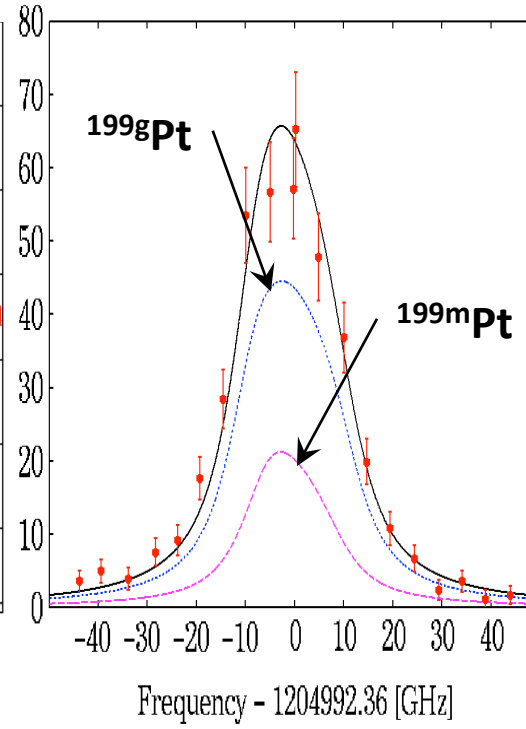
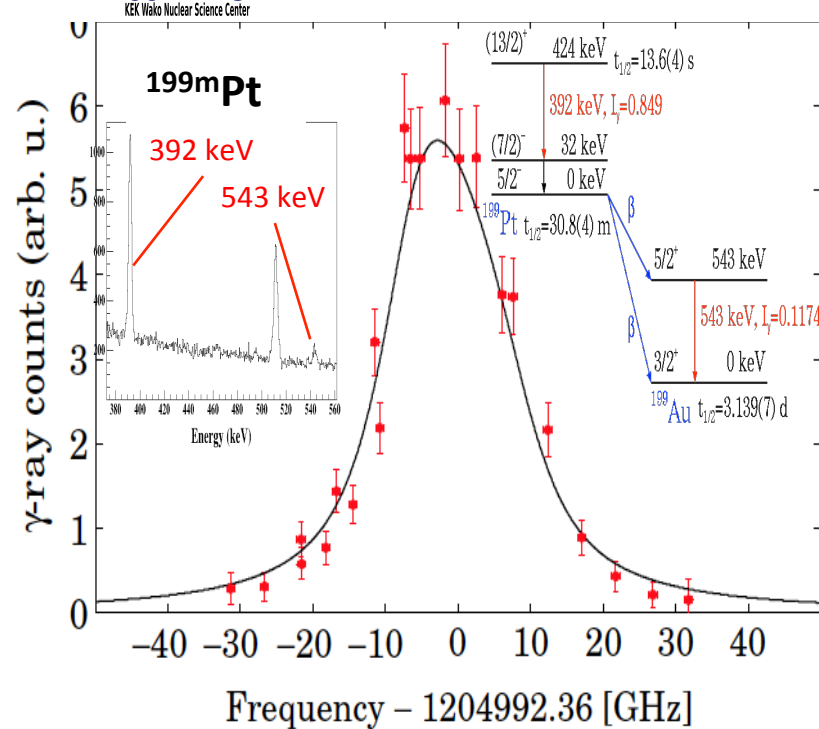


Confirmation of the reported lifetimes



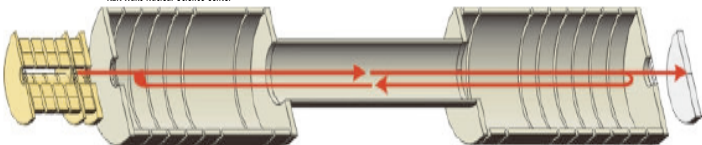
- Lifetimes of 5 n-rich isotopes around ^{198}Pt have been confirmed within measuring time of several tenth minutes
- The population probability of isomeric state in MNT reactions suggest the feasibility of isomer spectroscopy
- Further lifetime measurements are soon (Sept., 2017)

Laser spectroscopy probing nuclear structure around N=126 isotones



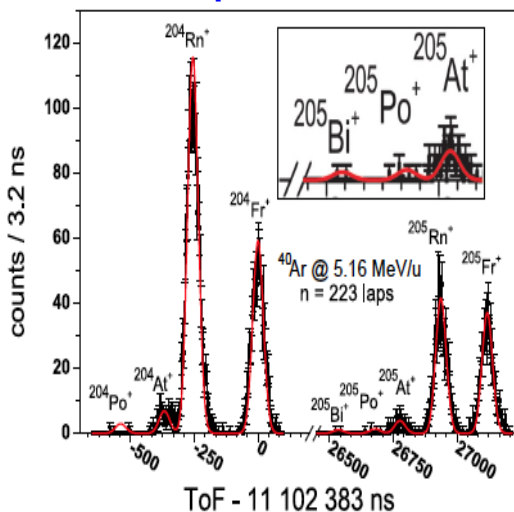
Direct mass measurement

with Multi-Reflection Time-Of-Flight Mass Spectrograph (MRTOF-MS)



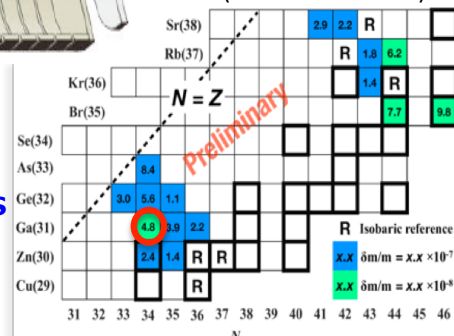
- suitable for the heavy nuclides
→ $\delta m < 100 \text{ keV}$ at 100 ions
- fast measuring time $\leq 20 \text{ ms}$
→ available for short-lived nuclides
- compact ($\sim 1 \text{ m}$) + simple principle
→ many applications

- high sensitivity
← identification with 2 ^{205}Bi ions
- high efficiency
← simultaneous measurements for 9 isotopes

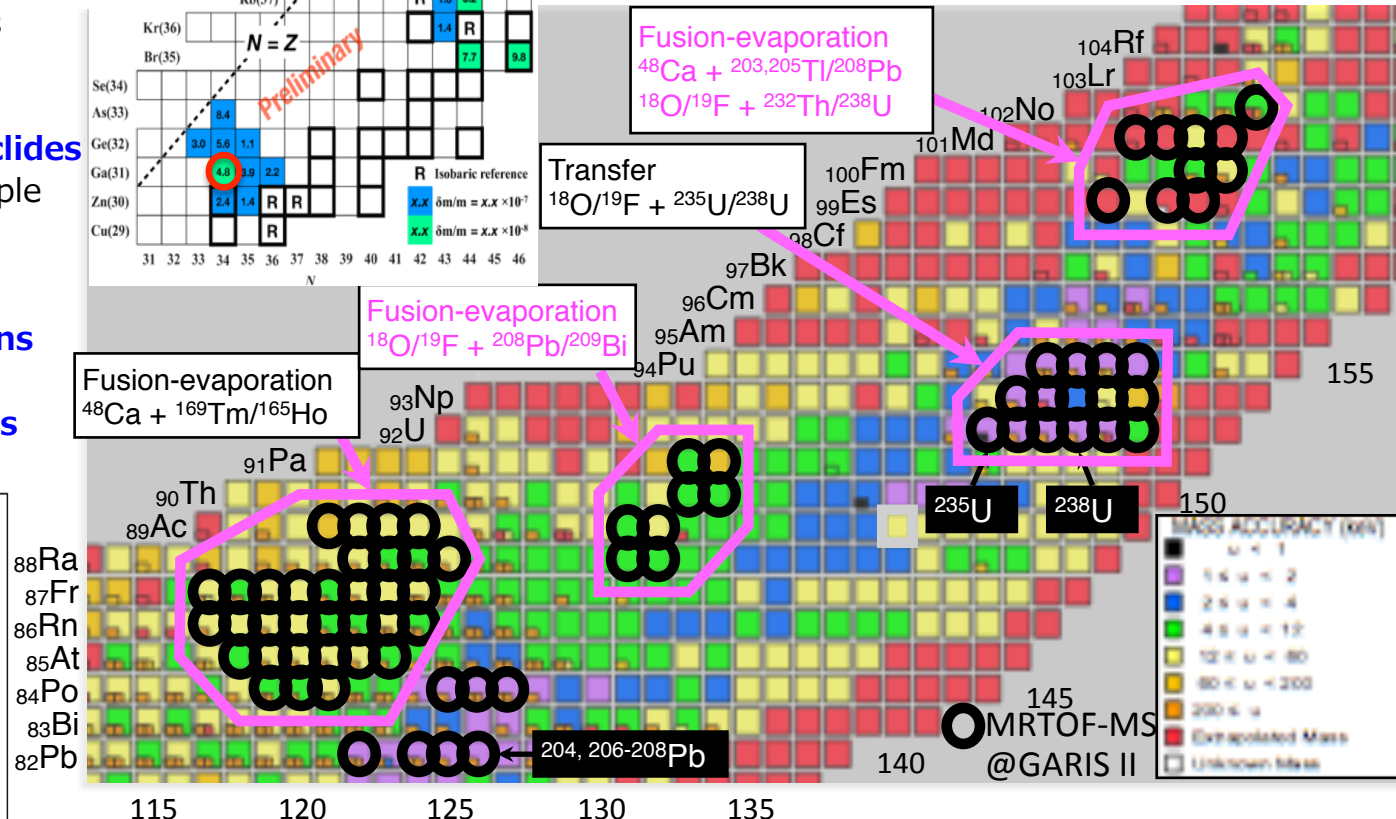


P. Schury et al, PRC95('17)011305(R)
and to be published in NIMB

S. Kimura et al, arXiv.1706.00186
(submitted to PRC)



Firstly installed at GARIS II

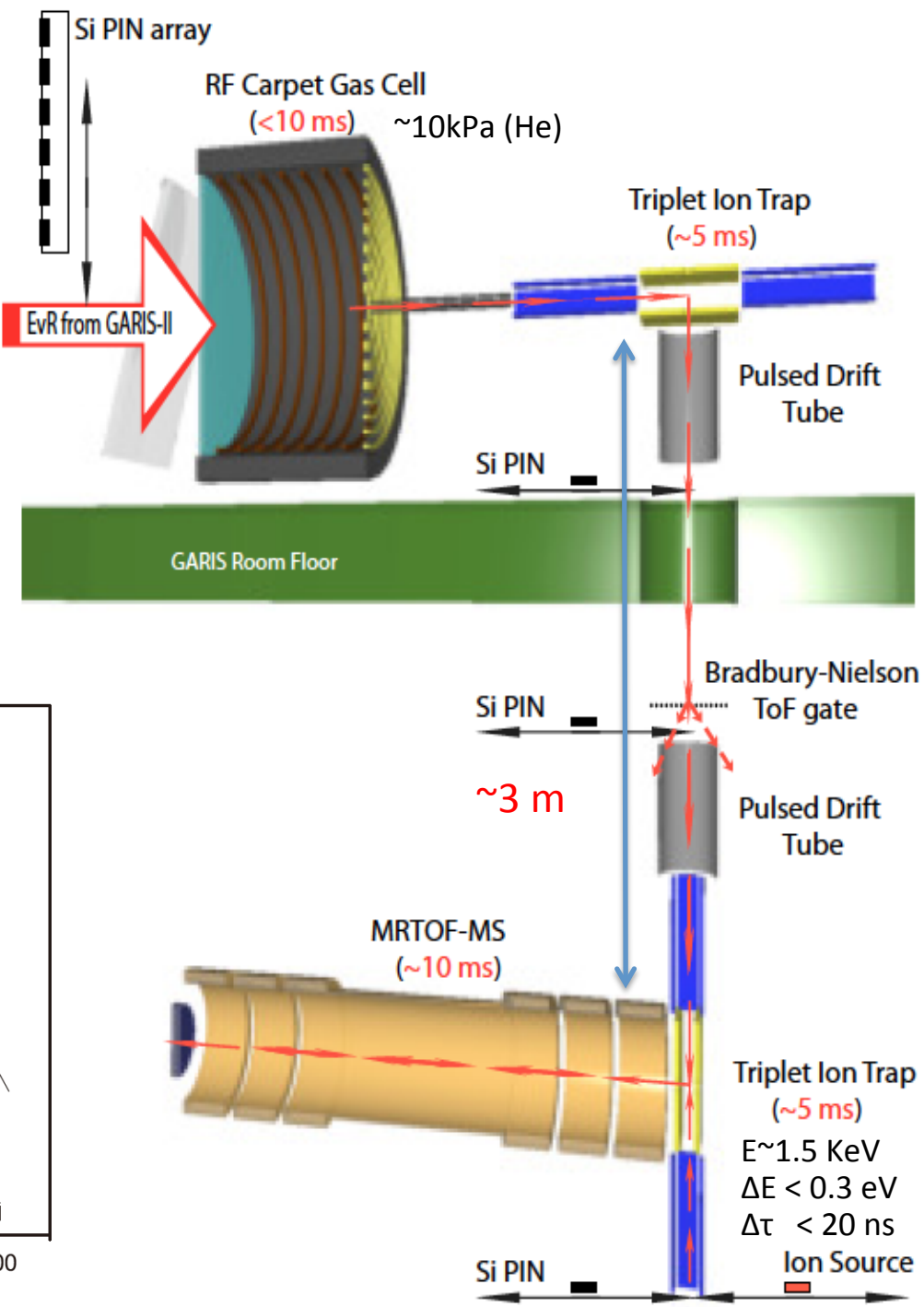
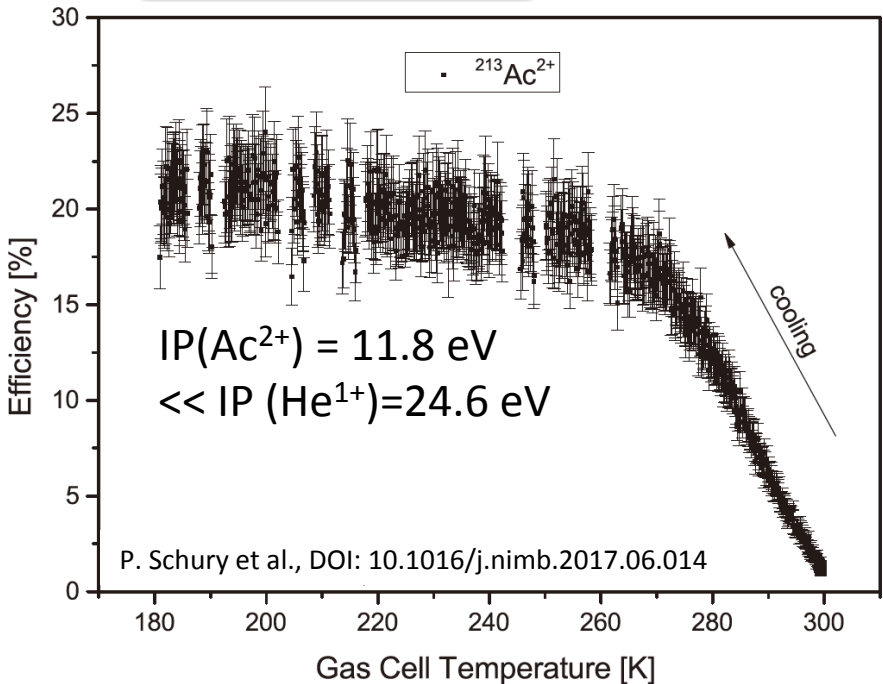
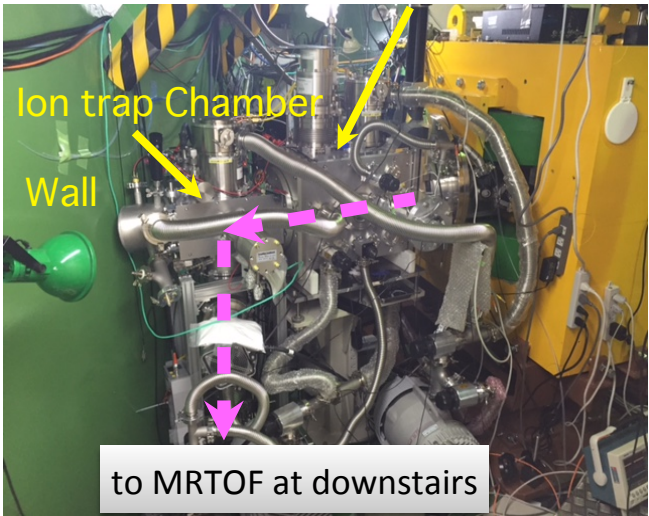


- Masses of **more than 80 isotopes were measured** in 2016-2017
- More than 30 masses of them were directly measured for the first time
- 6 of them ($^{246}, ^{247}, ^{248}\text{Es}, ^{249}, ^{250}, ^{252}\text{Md}$) were newly determined
- Highest precision of 3.5×10^{-8} (2.8 keV!!) using 10^4 ions was achieved for $^{65}\text{Ga}^+$
→ Feasible for accurate mass measurements in $A=60 \sim 80$ proton-rich mass region relevant to the rp-process

MRTOF-MS @GARIS II



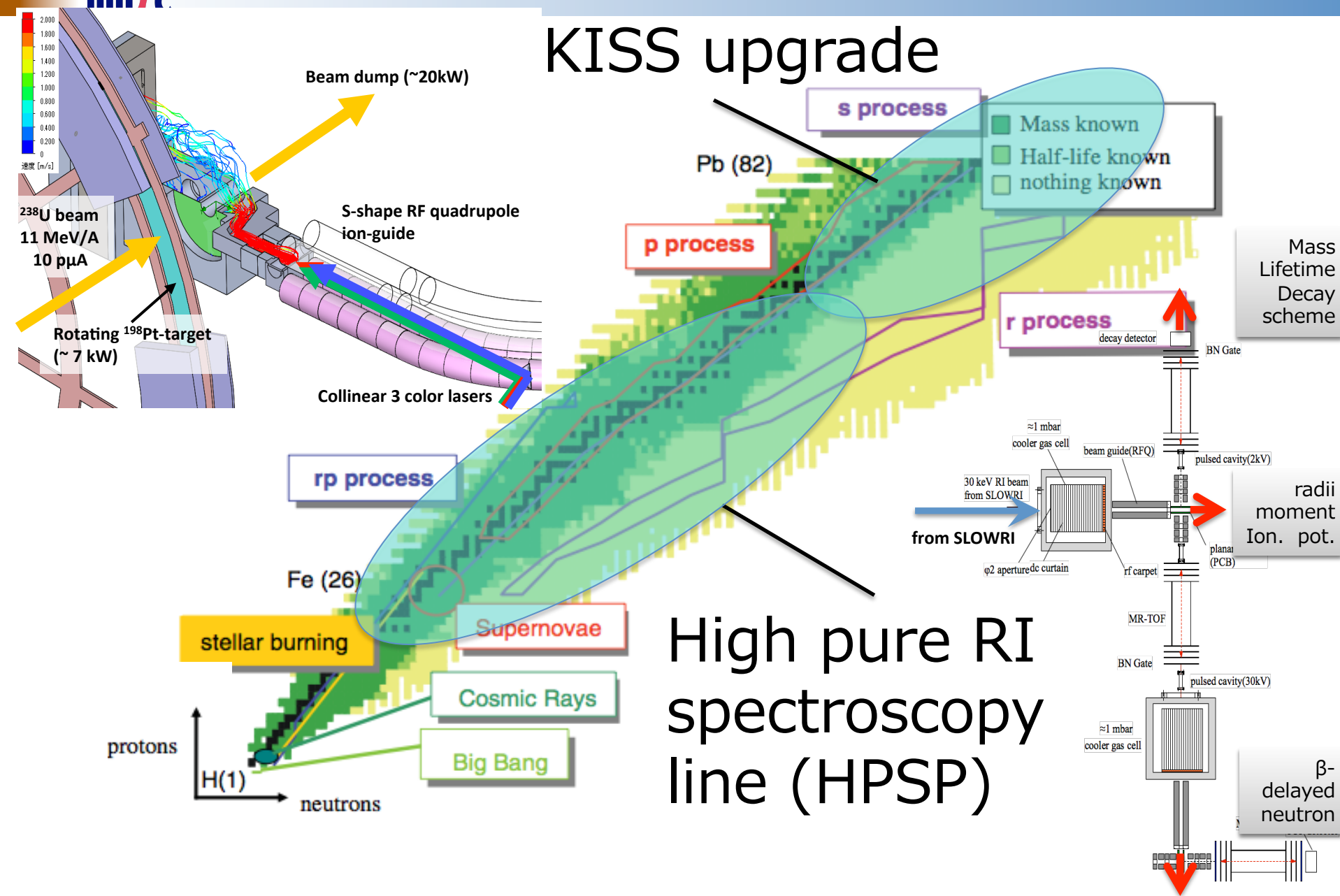
Cryogenic Gas Cell



Future's plan: KISS Stage II

-Comprehensive study of element synthesis with precise spectroscopy-

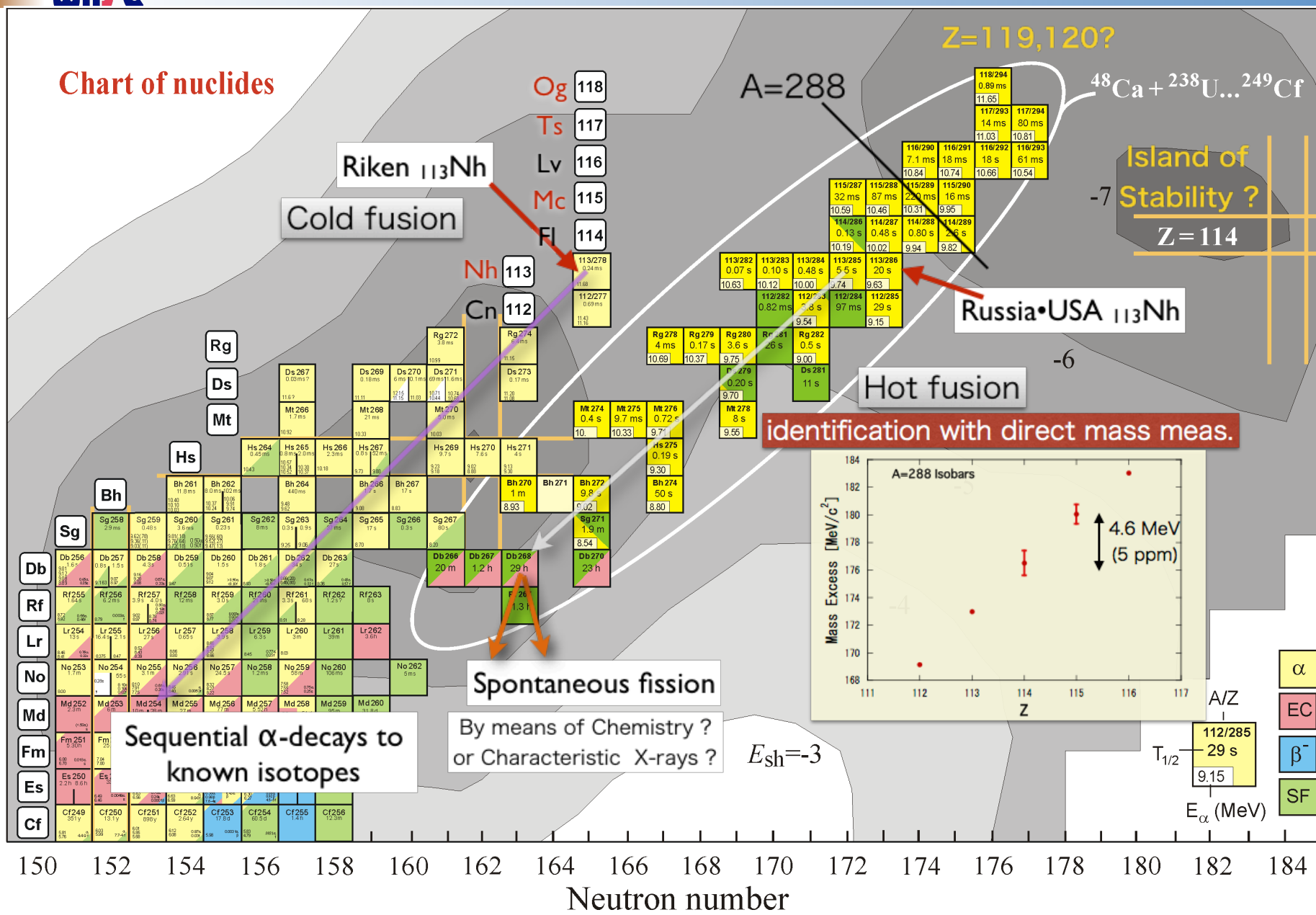
KISS upgrade



Challenge!!:: Mass and identification of super-heavy nuclides



Chart of nuclides



Summary



- Charge-radii shifts and magnetic moments of $^{199g, m}\text{Pt}$, $^{196, 197, 198}\text{Ir}$ were measured for the first time by means of In-gas-cell laser spectroscopy.
- Shape coexistence in ^{199}Pt is suggested.
- Lifetime measurements in the vicinity of N=126 isotones will be performed soon at the KISS decay measurement station.
- MRTOF has revealed its high performance for mass measurements both in medium- and very-heavy element regions.
- Mass measurements at KISS will be ready within this year.
- R&Ds of KISS Stage II, has been launched since this year for comprehensive study of element synthesis with precise spectroscopy.
- MRTOF will challenge to measure masses of super heavy isotopes.

User collaboration group: SSRI-pns

<http://research.kek.jp/group/wnsc/ssri-pns/>

Calling Letters of Intent concerning to KISS, SLOWRI, MRTOF experimental subjects: submit SSRI-PNS_contact@kek.jp, dead line is 15th, July

end