

Nucleon-transfer reactions using $^{206,207}\text{Hg}$ beams at ISS

Zsolt Podolyák



π ν

$i_{13/2}$ $i_{11/2}$

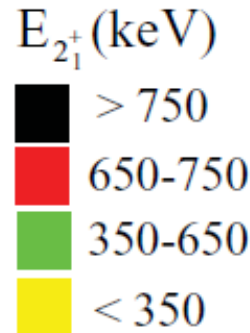
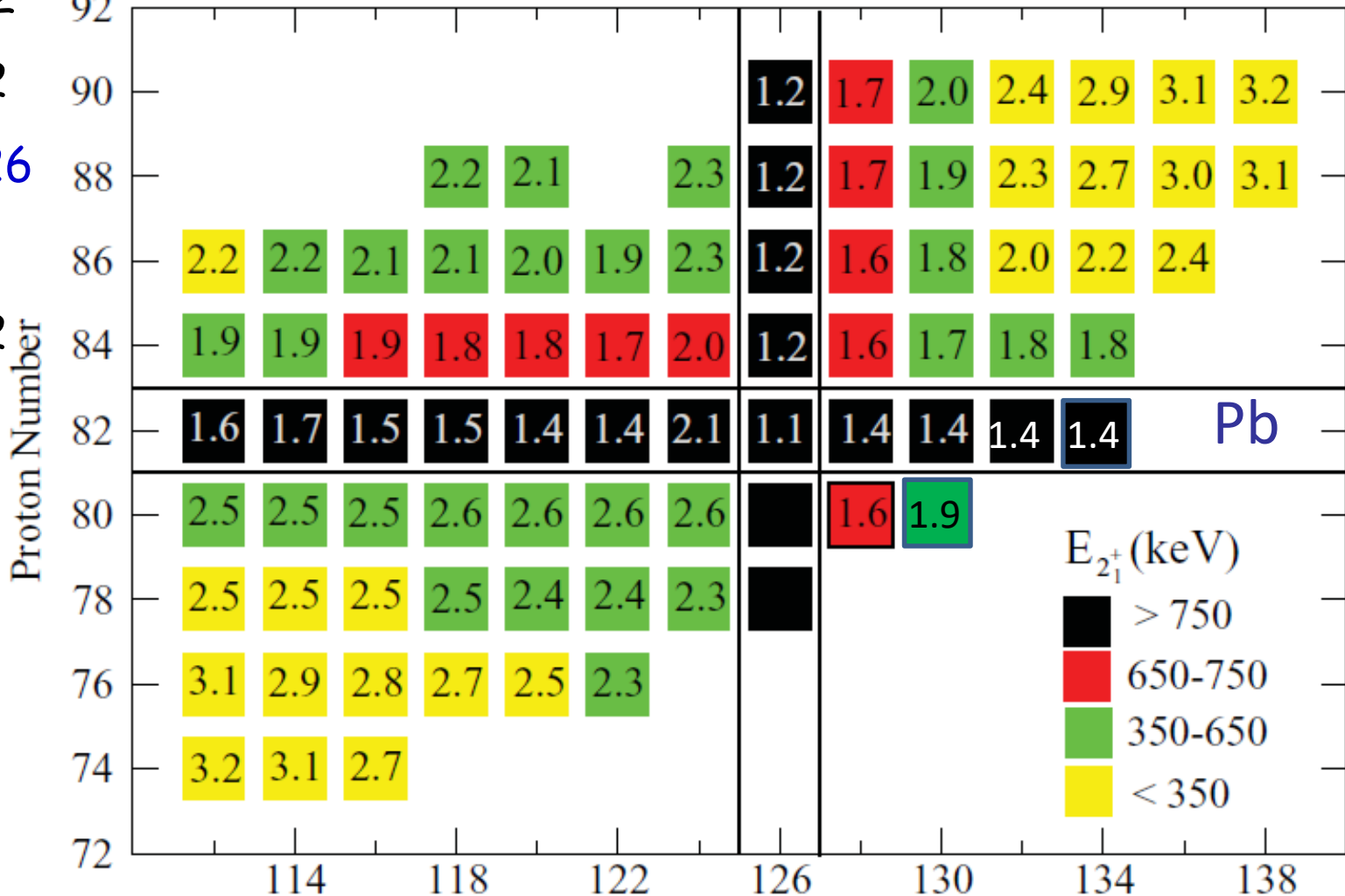
$h_{9/2}$ $g_{9/2}$

$Z=82$ $N=126$

$s_{1/2}$ $p_{1/2}$

$d_{3/2}$ $f_{5/2}$

$h_{11/2}$

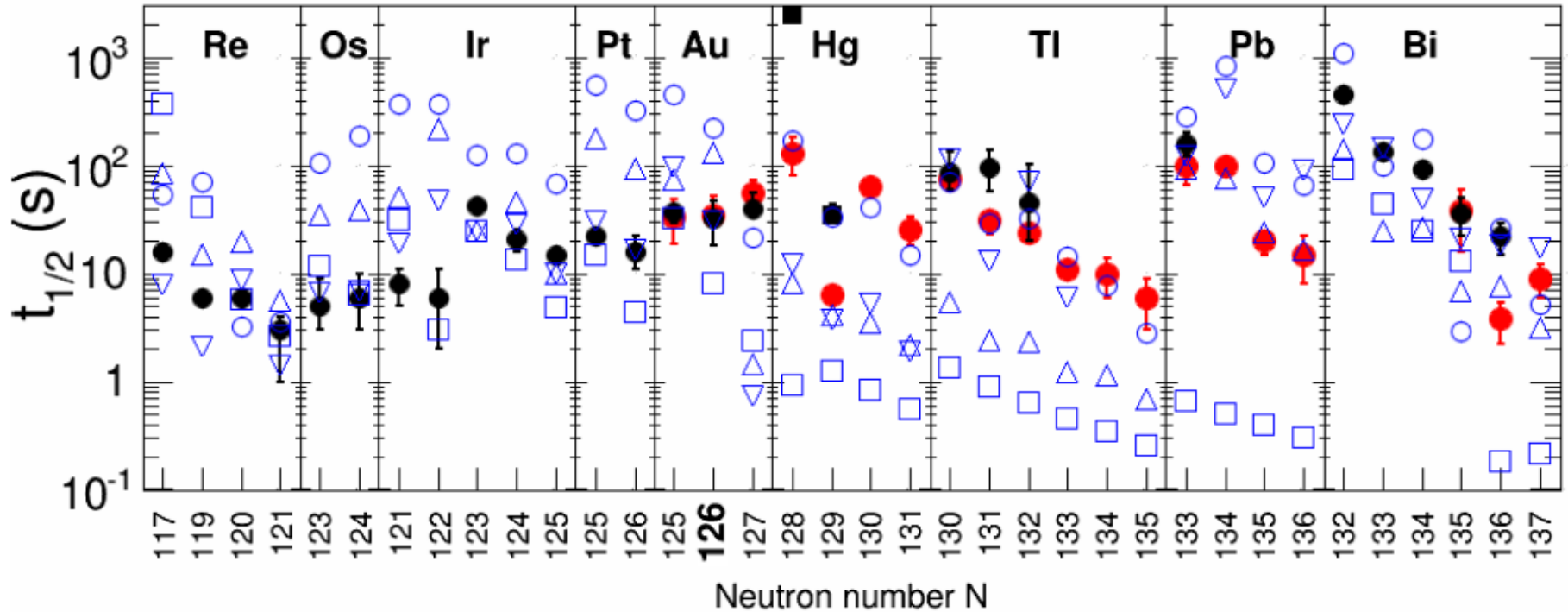


In box: $E(4^+)/E(2^+)$ ratio

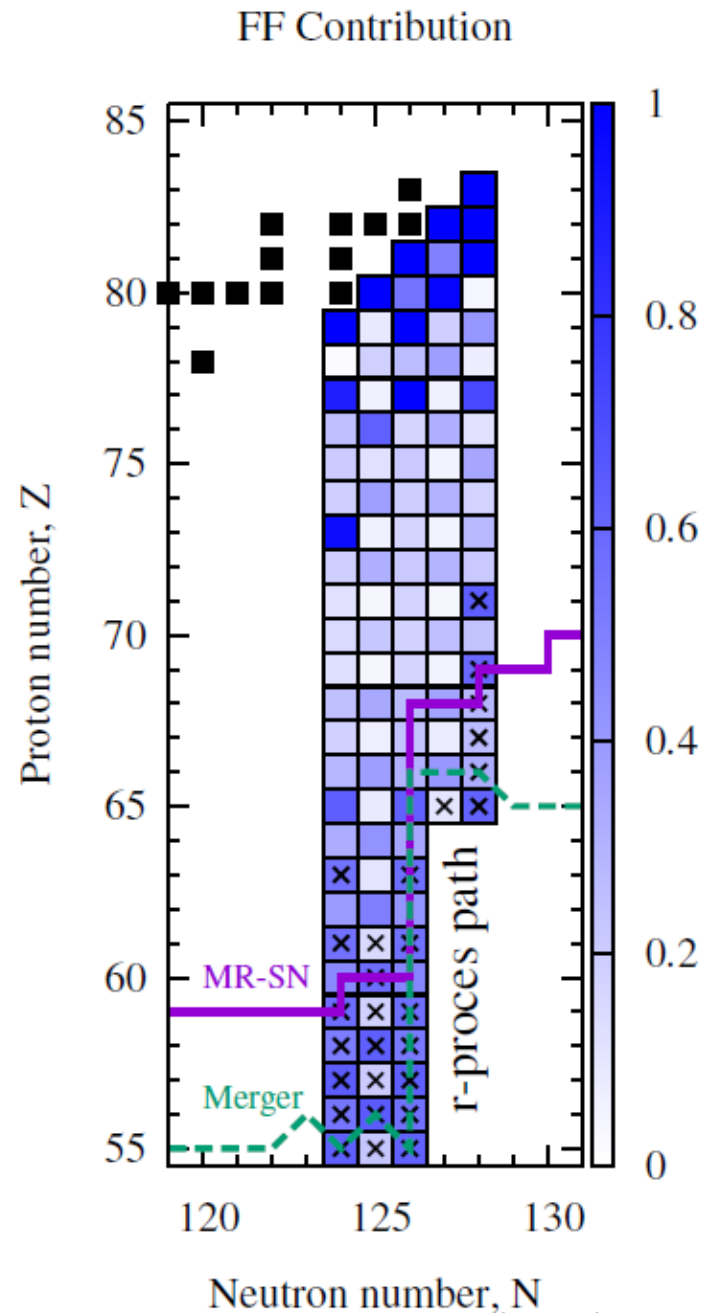
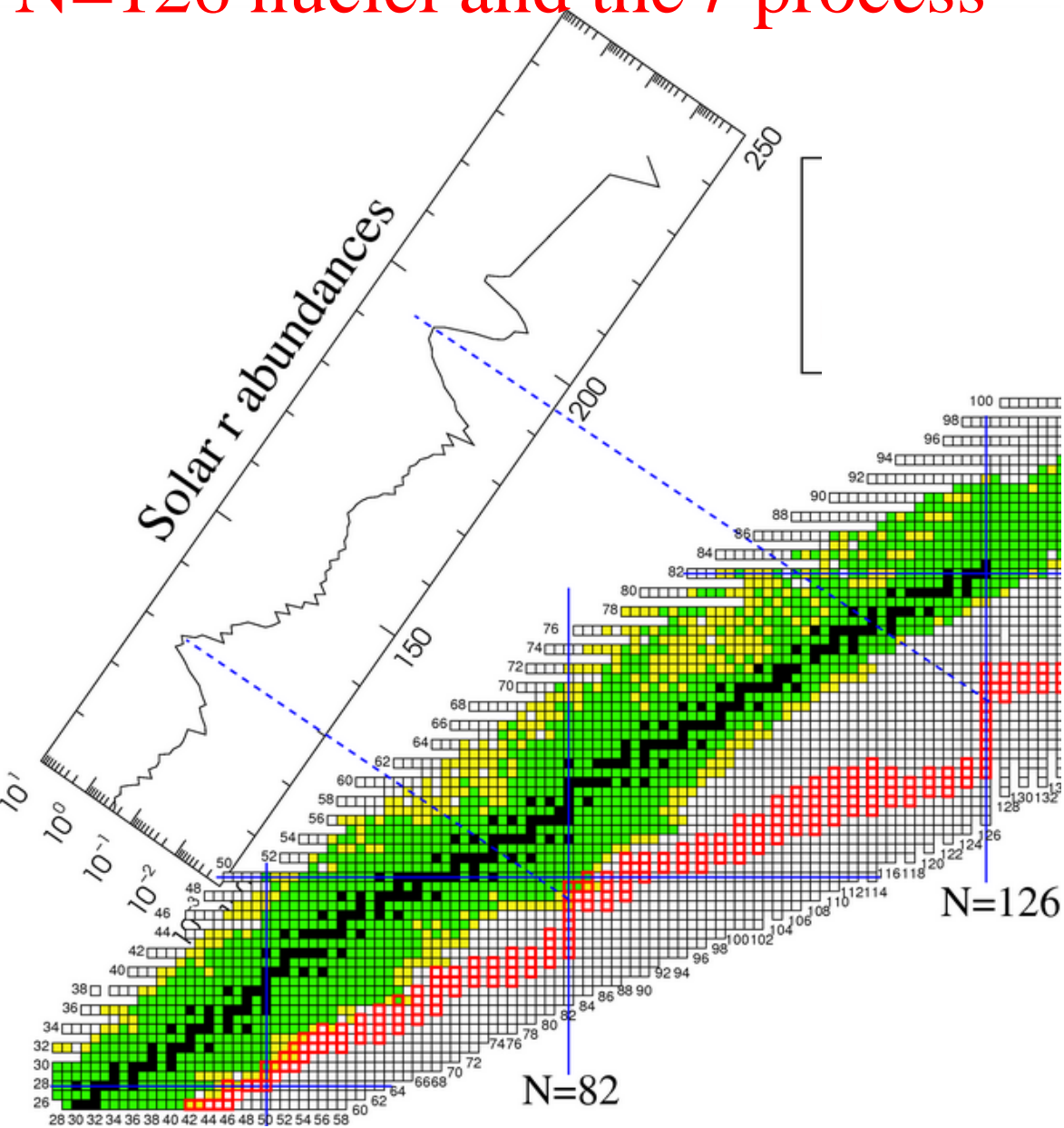
Neutron Number

Lifetime measurements

- This work
- Prev. Experiment A.I. Morales, et al. (2014,2015)
- Prev. Experiment Z. Li, et al. (1998)
- FRDM+QRPA
- △ KTUY
- RHB+RQRPA
- ▽ DF3+cQRPA



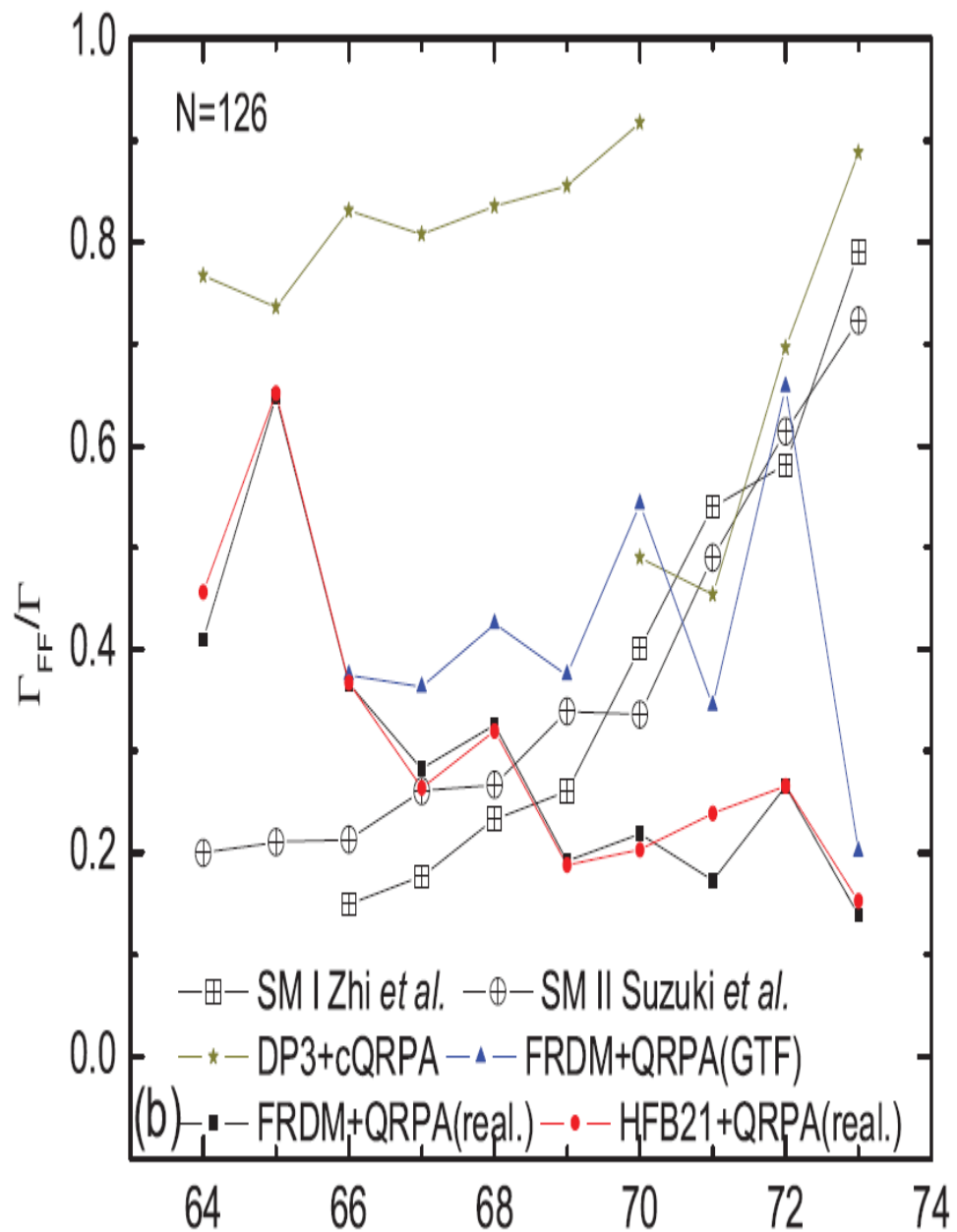
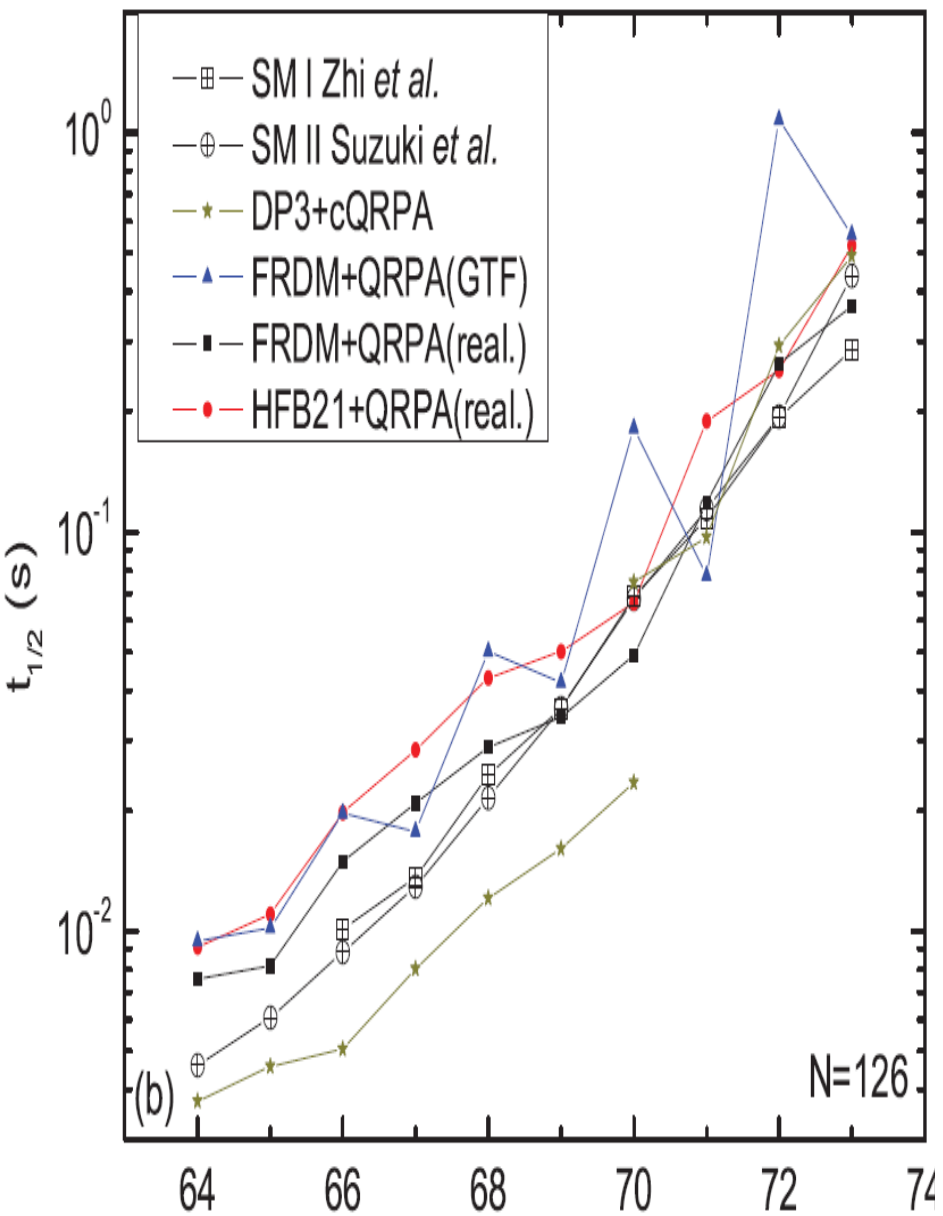
N=126 nuclei and the *r* process



N. Nishimura et al., Phys. Lett. B 756 (2016) 273

D.-L. Fang et al., Phys. Rev. C 88 (2013) 034304

First-forbidden β decay



Building on $d(206\text{Hg},p)207\text{Hg}$

ISS experiment (Ben Kay and the ISS collaboration)

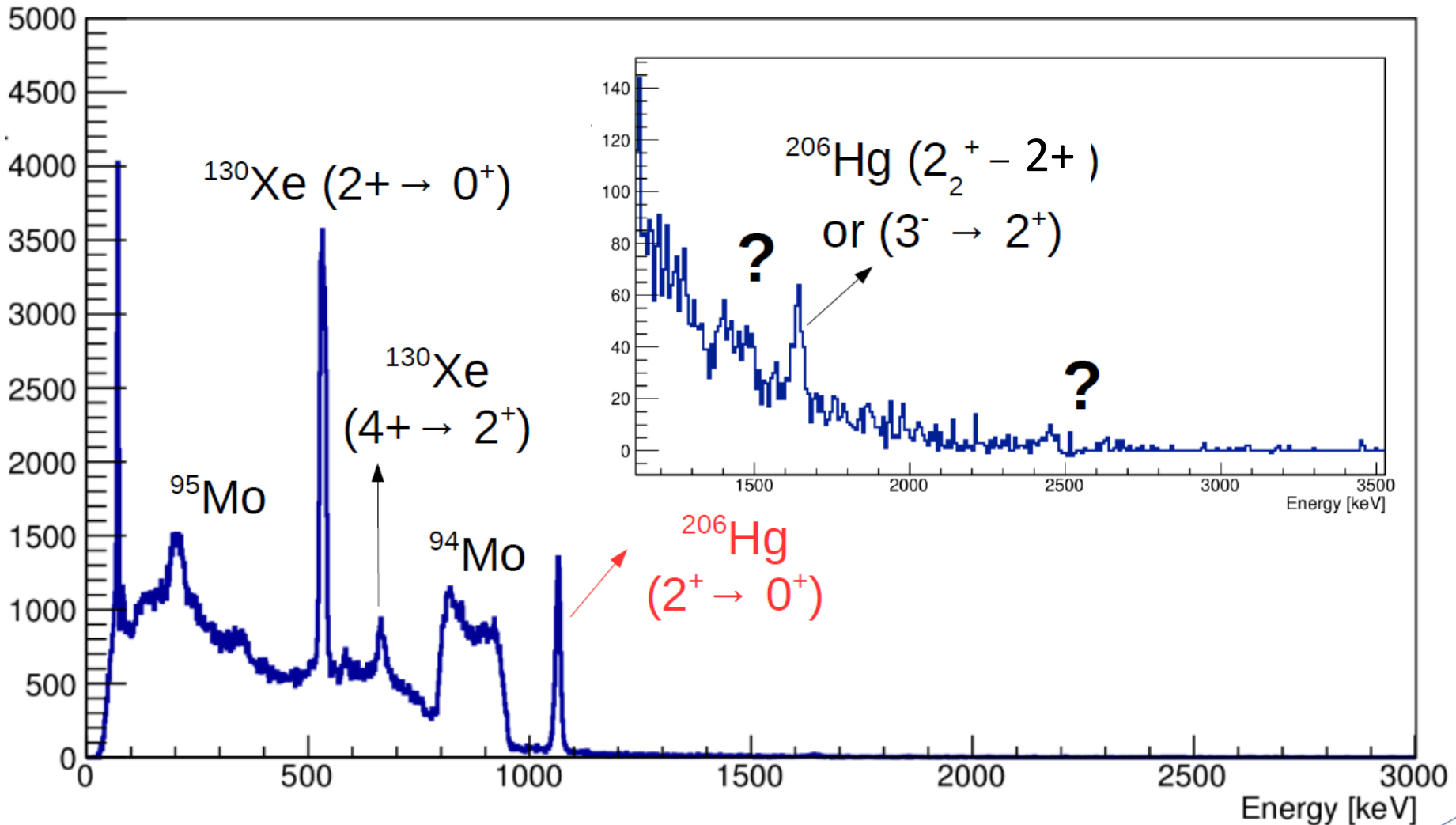
Talk by Ryan Tang

Very successful

Established single neutron particle energies beyond $N=126$

Further opportunities?

Coulomb excitation spectrum of ^{206}Hg (exp. in November 2107)



Possibilities with 206Hg (and 207Hg) beams

$^{206}\text{Hg}(d,3\text{He})^{205}\text{Au}$

$^{206}\text{Hg}(t,p)^{208}\text{Hg}$

$^{206}\text{Hg}(t,3\text{He})^{206}\text{Au}$

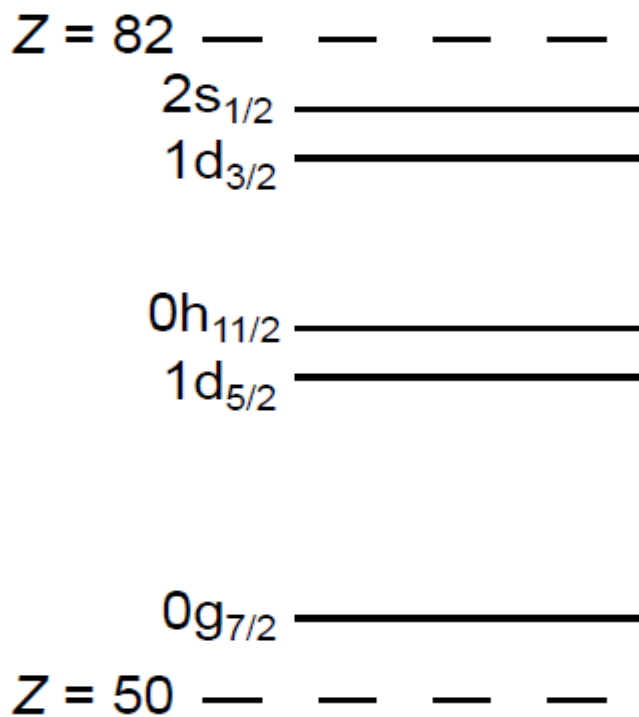
$^{207}\text{Hg}(t,p)^{209}\text{Hg}$

$^{207}\text{Hg}(t,3\text{He})^{207}\text{Au}$

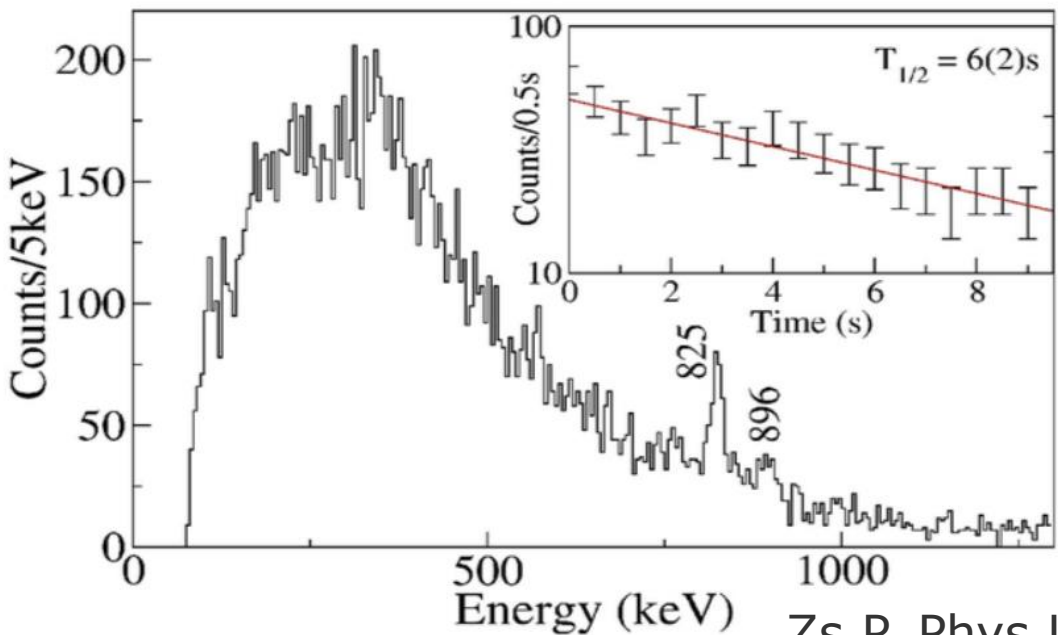
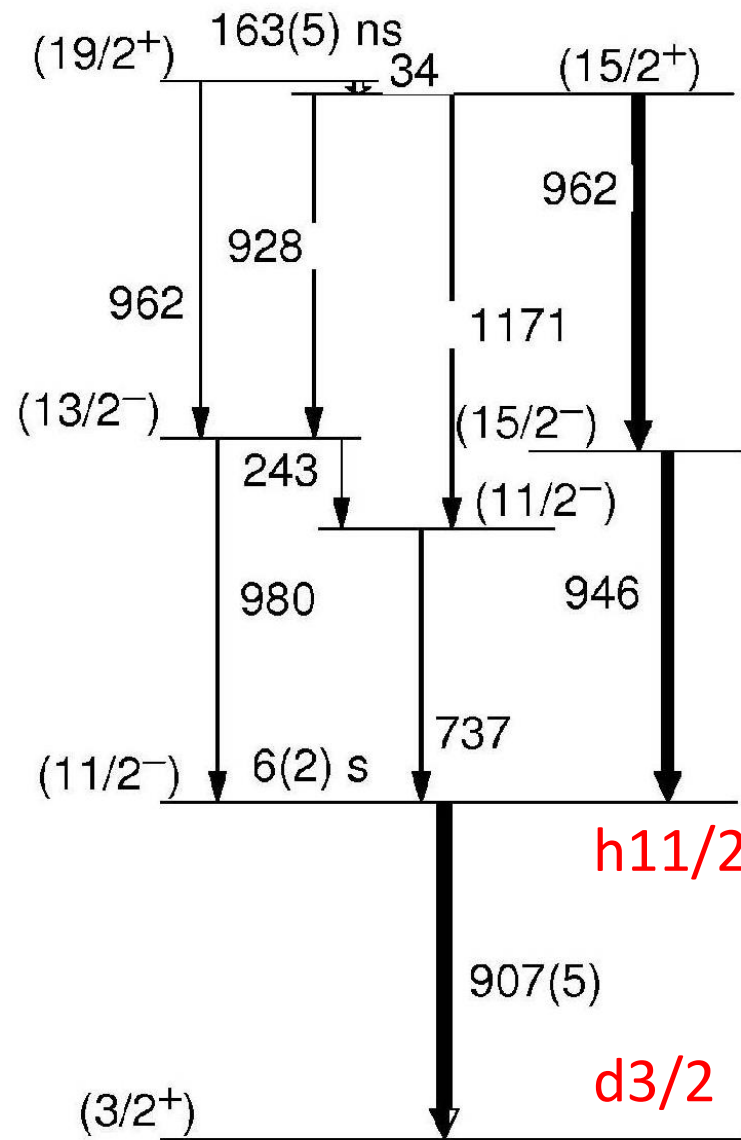
All in inverse kinematics

ISS or MINIBALL?

Measure beta decay of products?

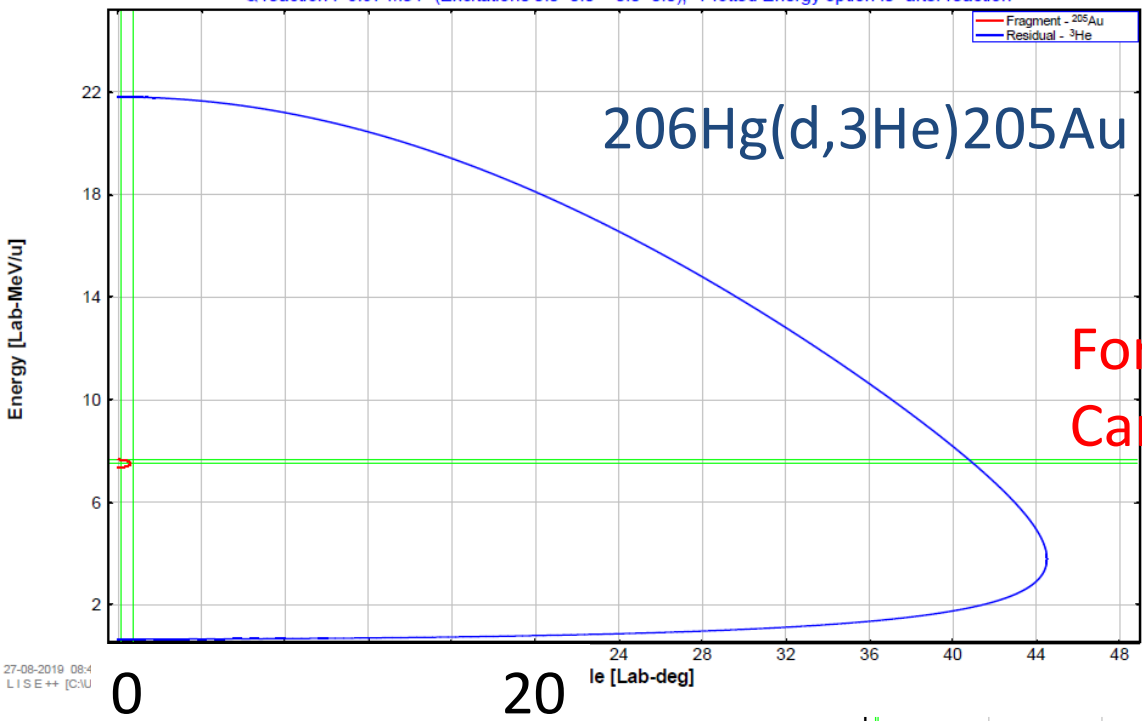


206Hg(d,3He)205Au



Reaction's Kinematics: A_lab & E_lab

$^{206}\text{Hg} + ^2\text{H} \Rightarrow ^{205}\text{Au} + ^3\text{He}$ $^2\text{H}(^{206}\text{Hg}, ^{205}\text{Au})^3\text{He}$; Reaction at the "middle" of the target
 Projectile Energy at the reaction place: 7.66 MeV/u Grazing angle: CMS = 63.93 deg; Lab = 0.53 deg
 Q reaction : -3.97 MeV (Excitations 0.0+0.0=>0.0+0.0); Plotted Energy option is "after reaction"

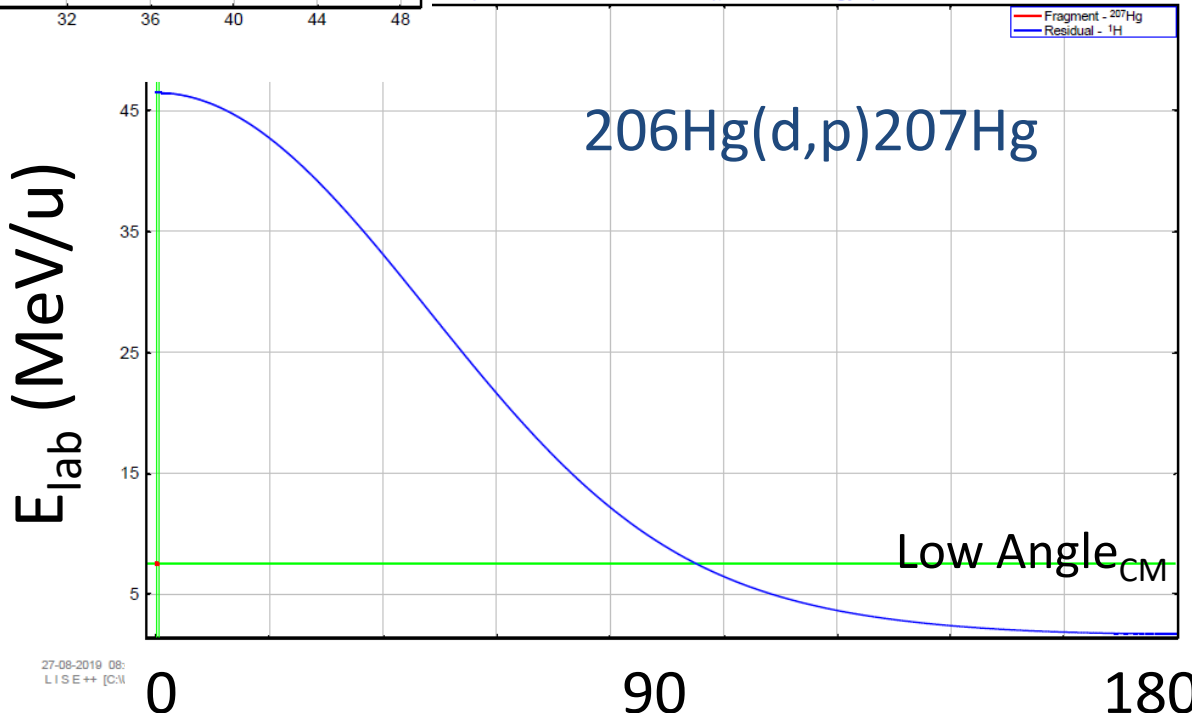


3He forward
1H backward

Forward it needs ID from TOF.
Can we use two Si arrays at ISS?

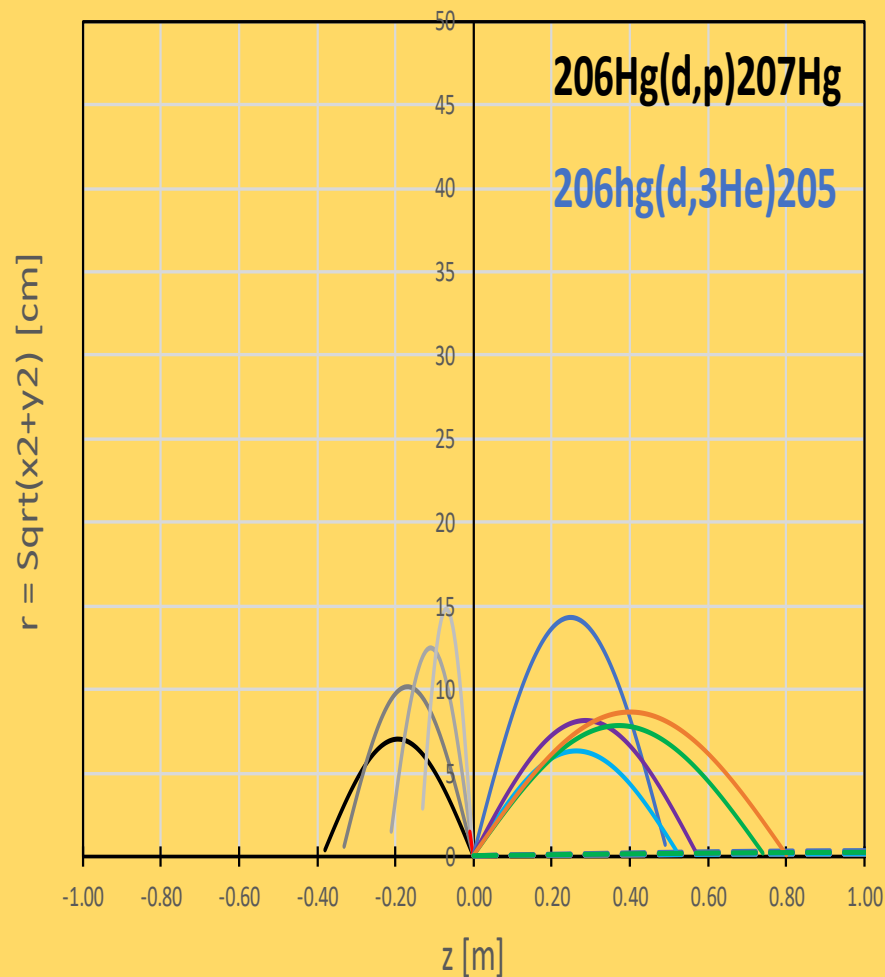
Reaction's Kinematics: A_lab & E_lab

$^{206}\text{Hg} + ^1\text{H} \Rightarrow ^{207}\text{Hg} + ^1\text{H}$ $^1\text{H}(^{206}\text{Hg}, ^{207}\text{Hg})^1\text{H}$; Reaction at the "middle" of the target
 reaction place: 7.66 MeV/u Grazing angle: CMS = 63.93 deg; Lab = 0.37 deg
 Q reaction : -0.0 MeV (Excitations 0.0+0.0=>0.0+0.0); Plotted Energy option is "after reaction"



Compare | $^{206}\text{Hg}(d,p)^{207}\text{Hg}$ -- $^{206}\text{Hg}(d,^3\text{He})^{205}\text{Au}$

(heliosmatic)



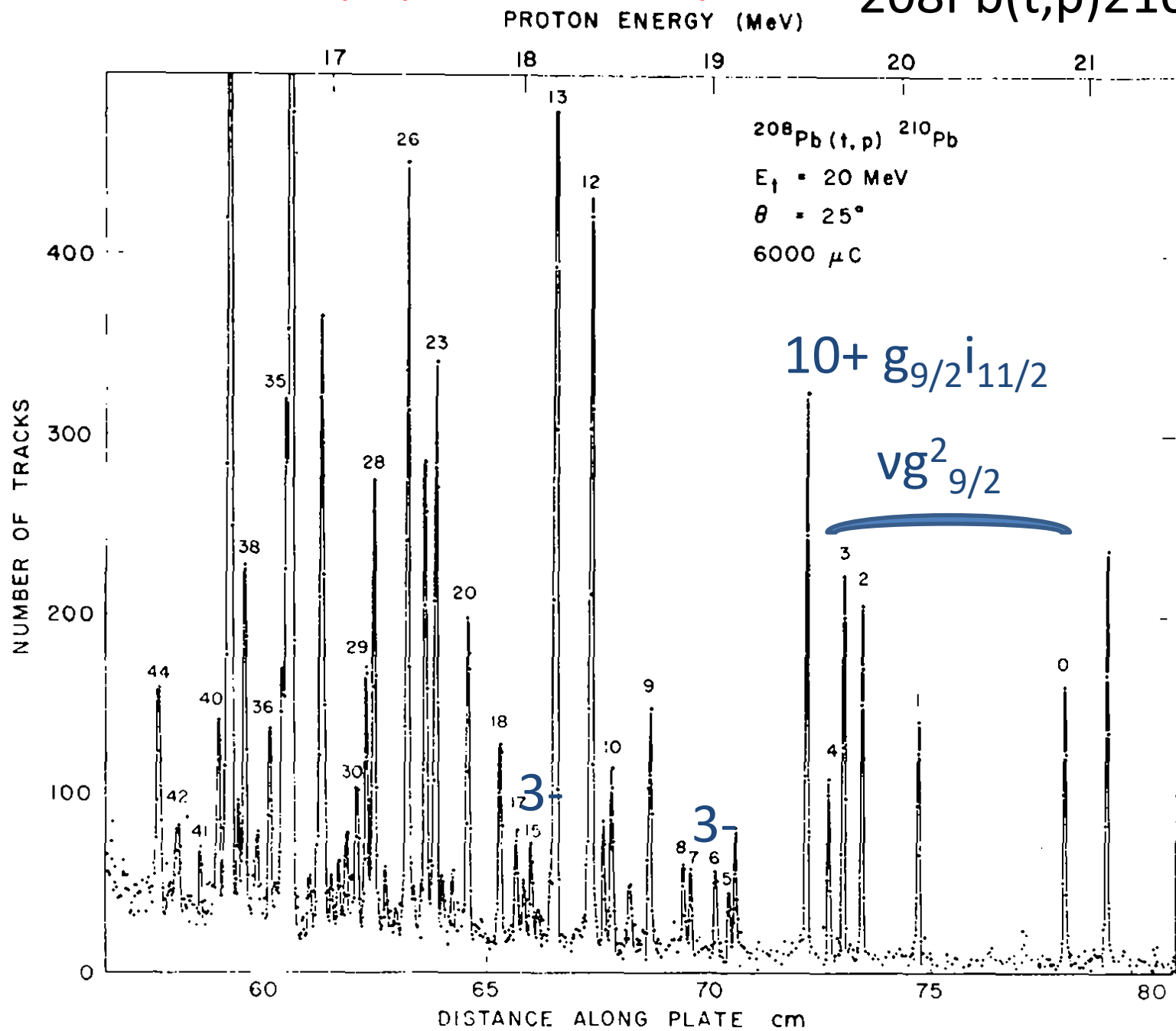
3He forward
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Forward it needs ID from TOF.
Can we use two Si arrays at ISS?

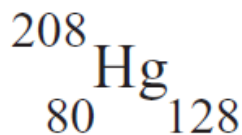
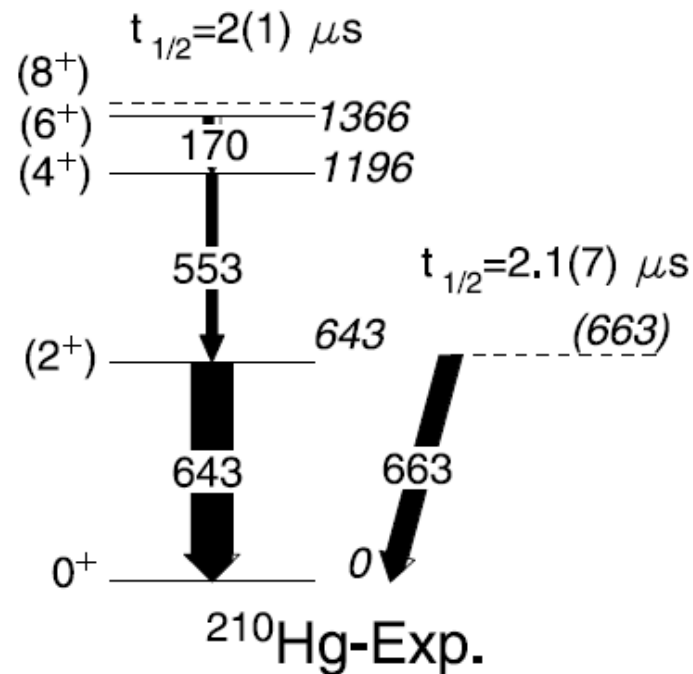
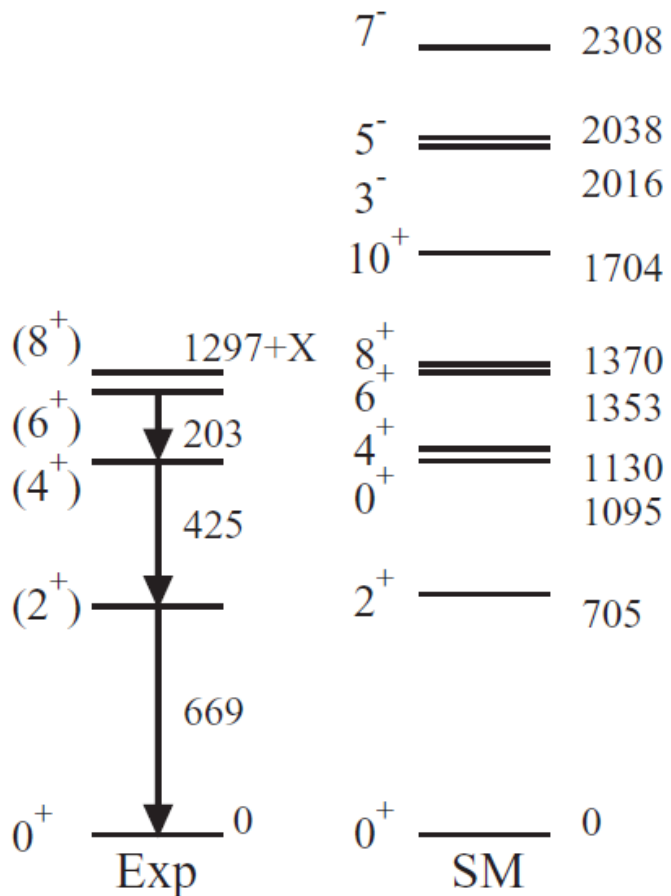
What can be populated in (t,p)?

$^{208}\text{Pb}(t,p)^{210}\text{Pb}$

A.R. Flynn et al., Nuclear Physics A195 (1972) 97



What can we get from $206\text{Hg}(t,p)208\text{Hg}$?



$vg^2_{9/2}$ states known only!

- A. Gottardo et al.,
- B. Phys. Lett. B 725, 292 (2013)

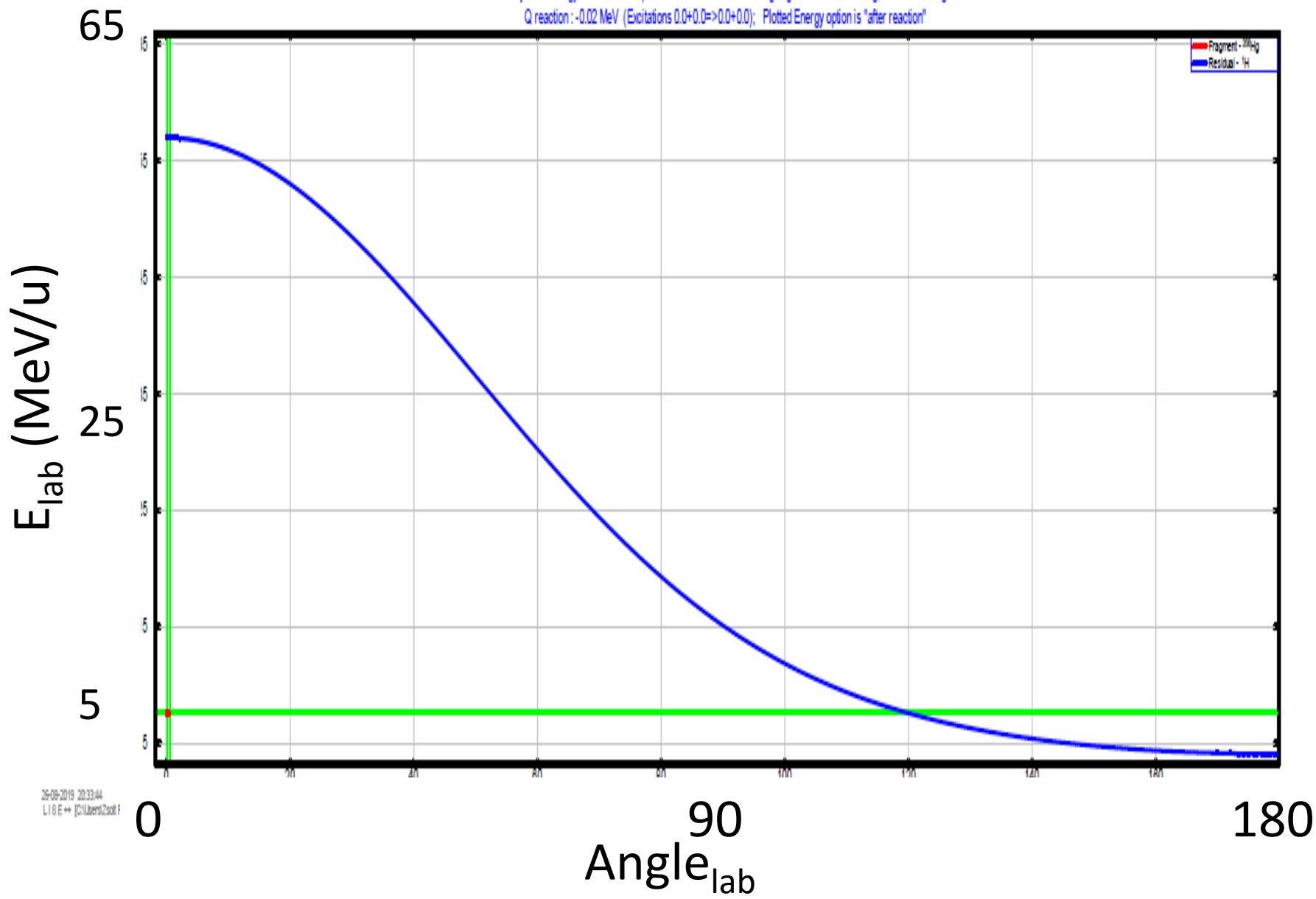
206Hg(t,p)208Hg

Reaction's Kinematics: A_{lab} & E_{lab}

$^{206}\text{Hg} + {}^3\text{H} \Rightarrow {}^{208}\text{Hg} + {}^1\text{H}$ ${}^3\text{H}(^{206}\text{Hg}, ^{208}\text{Hg}) {}^1\text{H}$; Reaction at the "middle" of the target

Projectile Energy at the reaction place: 7.77 MeV/u Grazing angle: CMS = 33.77 deg; Lab = 0.27 deg

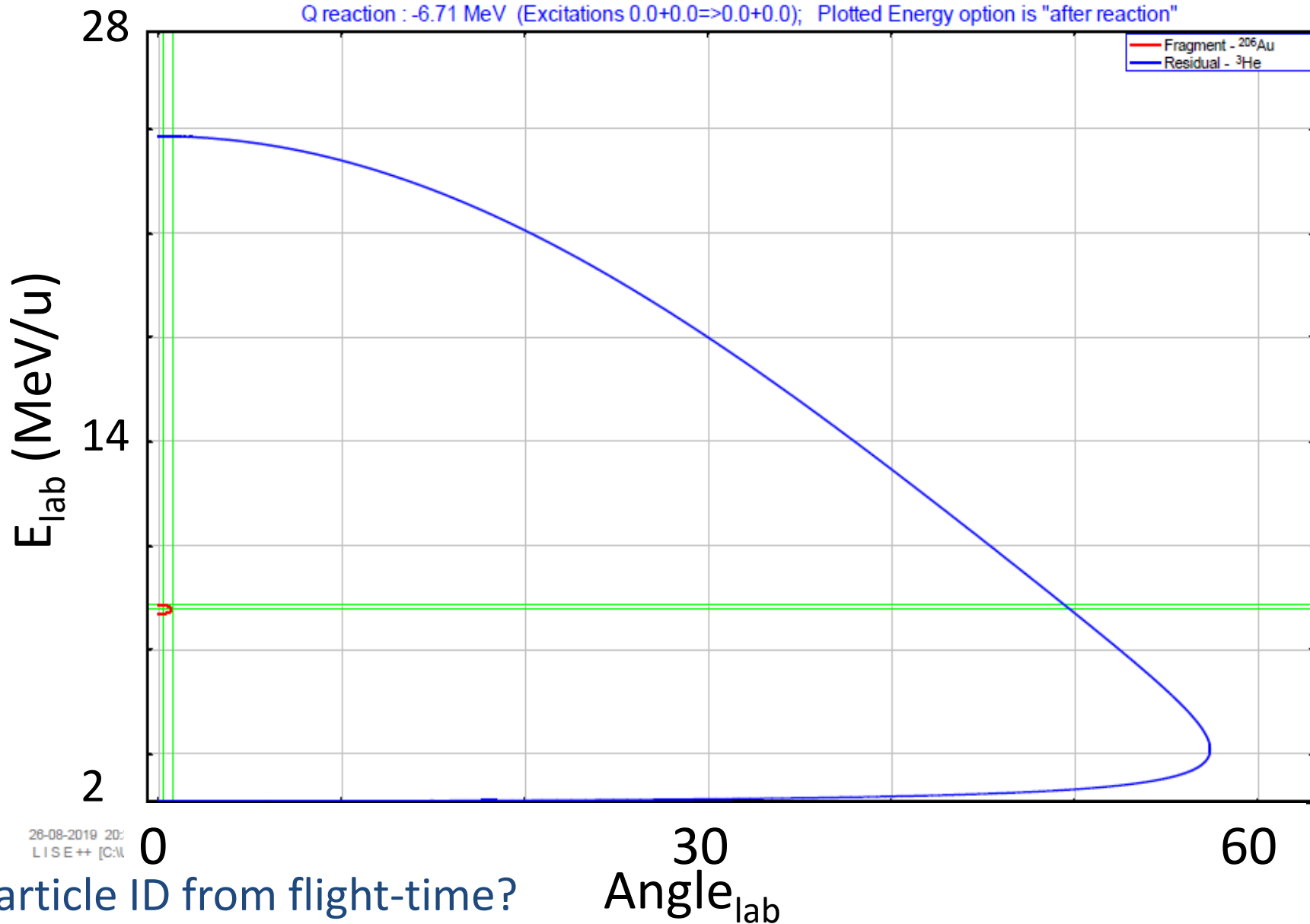
Q reaction: -0.02 MeV (Excitations 0.0+0.0=>0.0+0.0); Plotted Energy option is "after reaction"



206Hg(t,3He)206Au

Reaction's Kinematics: A_lab & E_lab

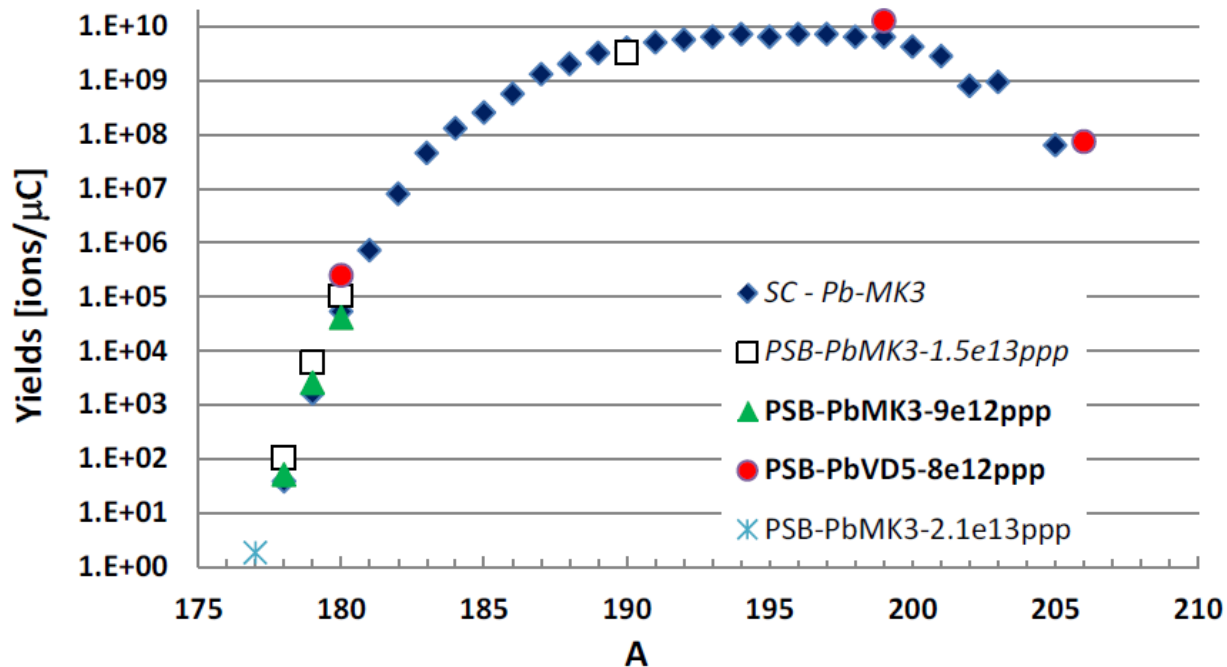
$^{206}\text{Hg} + ^3\text{H} \Rightarrow ^{206}\text{Au} + ^3\text{He}$ $^3\text{H}(^{206}\text{Hg}, ^{206}\text{Au})^3\text{He}$; Reaction at the "middle" of the target
Projectile Energy at the reaction place: 7.77 MeV/u Grazing angle: CMS = 33.77 deg; Lab = 0.39 deg
Q reaction : -6.71 MeV (Excitations 0.0+0.0=>0.0+0.0); Plotted Energy option is "after reaction"



26-08-2019 20:
LISE++ [C:\]

$^{206,207}\text{Hg}$ beams at ISOLDE

Hg yields from molten Pb targets at ISOLDE



T. Stora, EURISOL town meeting, Oct. 2012

^{207}Hg at IDS:
 4×10^4 pps in 2014
 2×10^5 pps in 2016

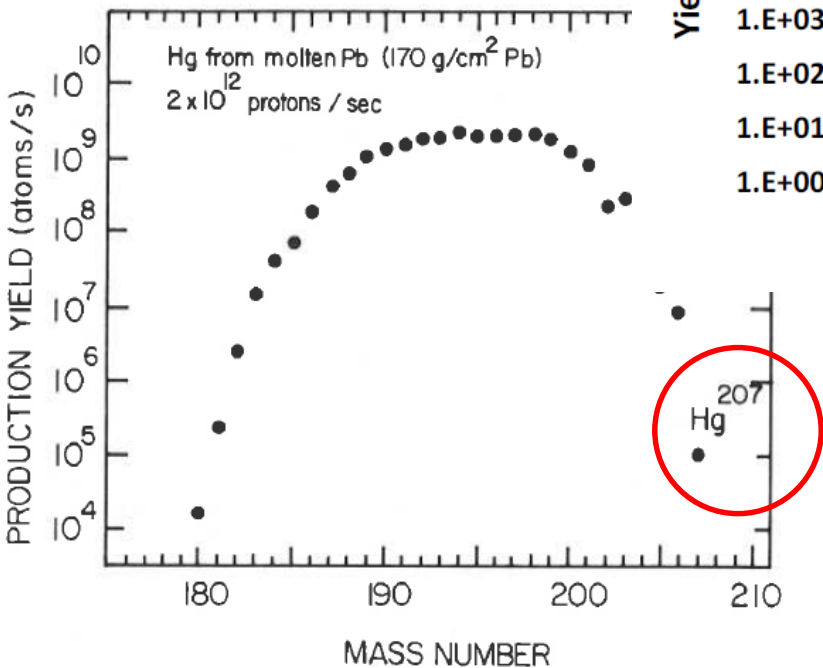


Fig. 1 Production yield in the ISOLDE facility of the mercury isotopes, including ^{206}Hg and ^{207}Hg .

B. Jonson, O.B. Nielsen, J. Zylicz, CERN-81-09 (1981)

(Proc. Int. Conf. Nuclei far from stability, Helsingor, Denmark. Vol.2 p.640 (1981))

Summary

Transfer reactions with $^{206,207}\text{Hg}$ beams

Study of neutron-rich nuclei

$^{206}\text{Hg}(d,3\text{He})^{205}\text{Au}$ single proton states

Using triton targets

^{206}Hg beams available

^{207}Hg after upgrade?