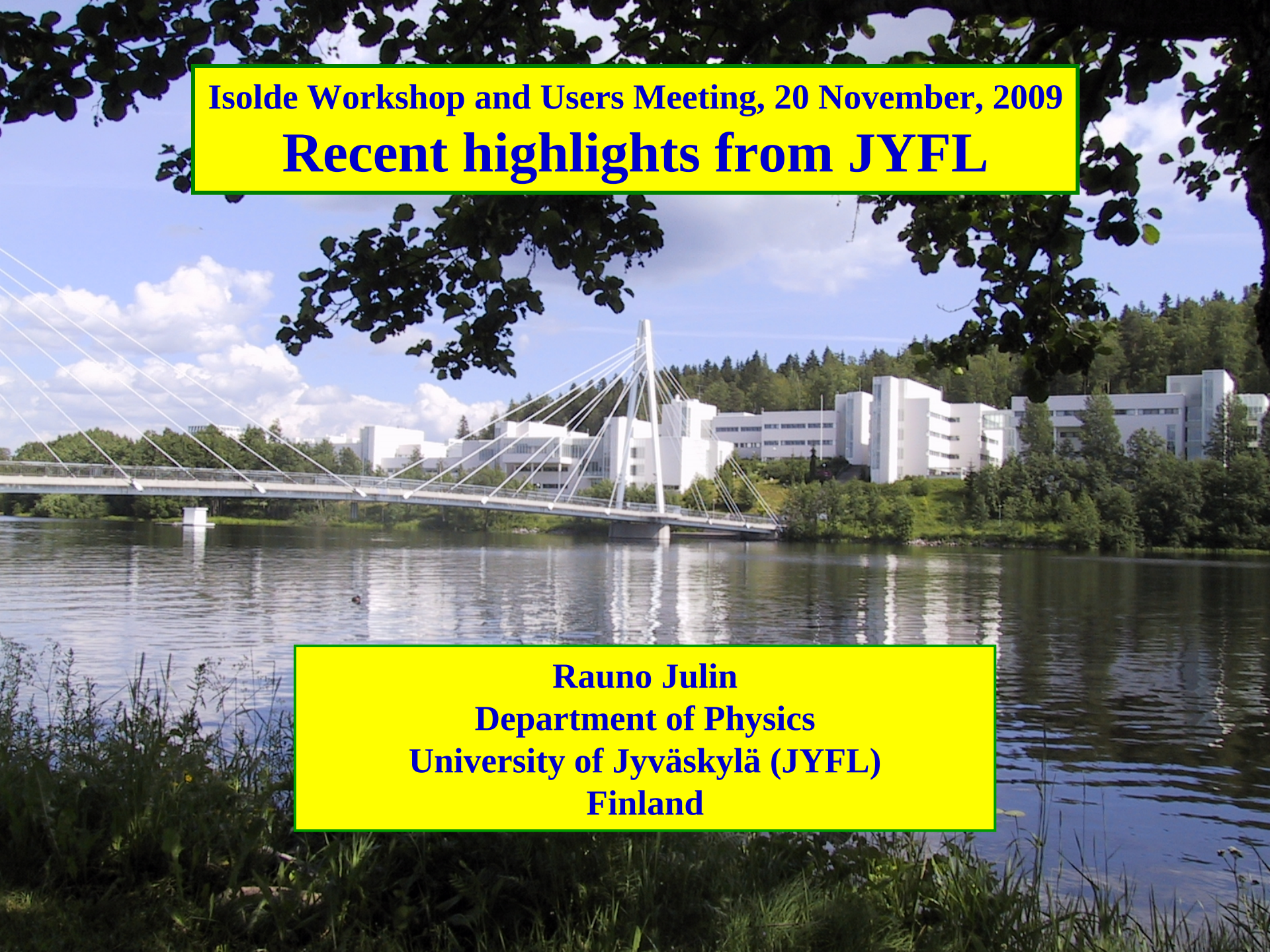


Isolde Workshop and Users Meeting, 20 November, 2009

Recent highlights from JYFL

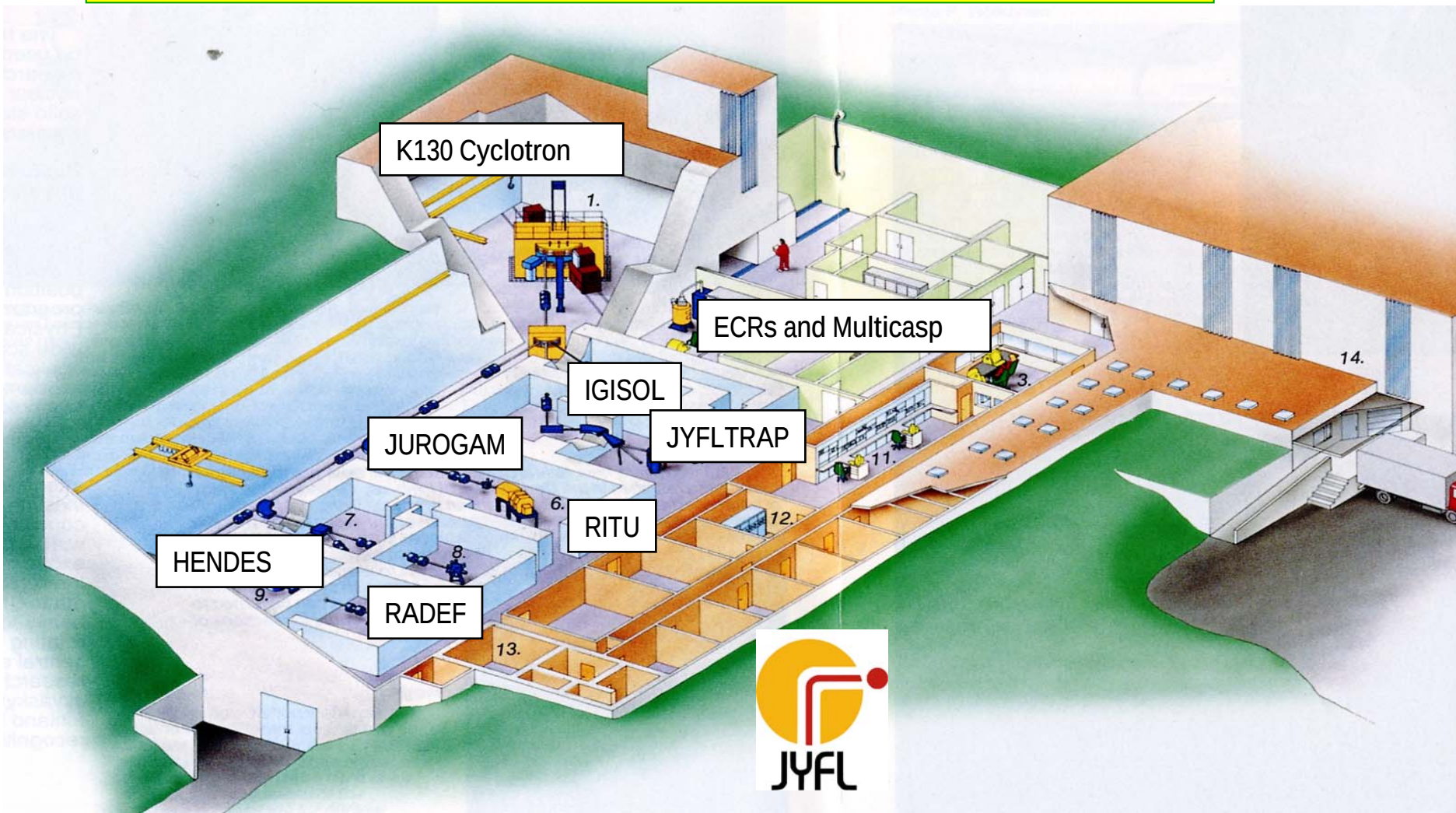
Rauno Julin
Department of Physics
University of Jyväskylä (JYFL)
Finland

Content

- JYLF Accelerator Laboratory
- In-beam tagging experiments
  (JUROGAM + RITU)
- IGISOL experiments
  (JYFLTRAP, Lasers)

JYFL Accelerator Laboratory

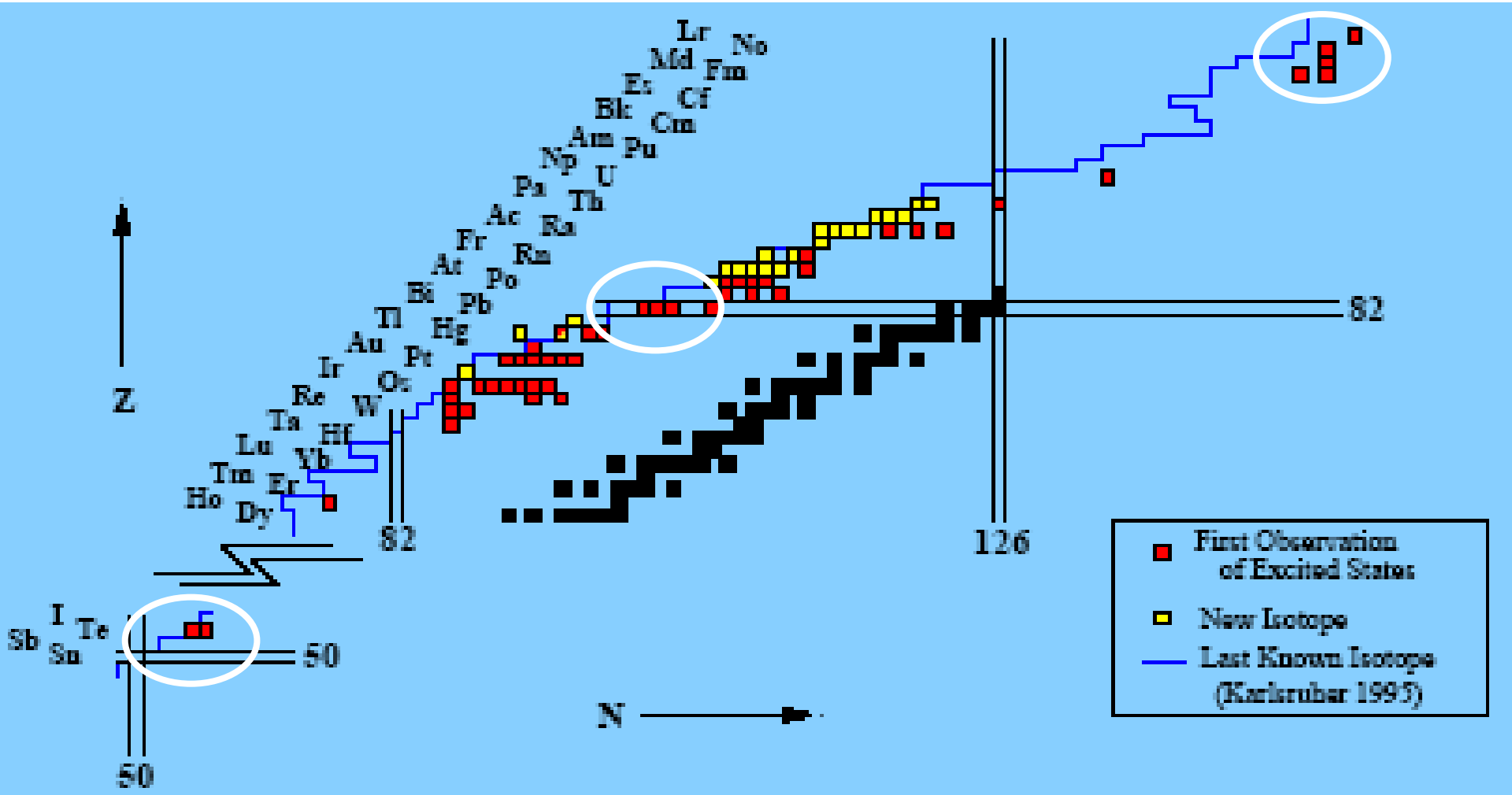
Light- and heavy ions for nuclear physics and applications
7000 beam time hours a year
EU Access Laboratory in FP4-6
European Space Agency's test facility



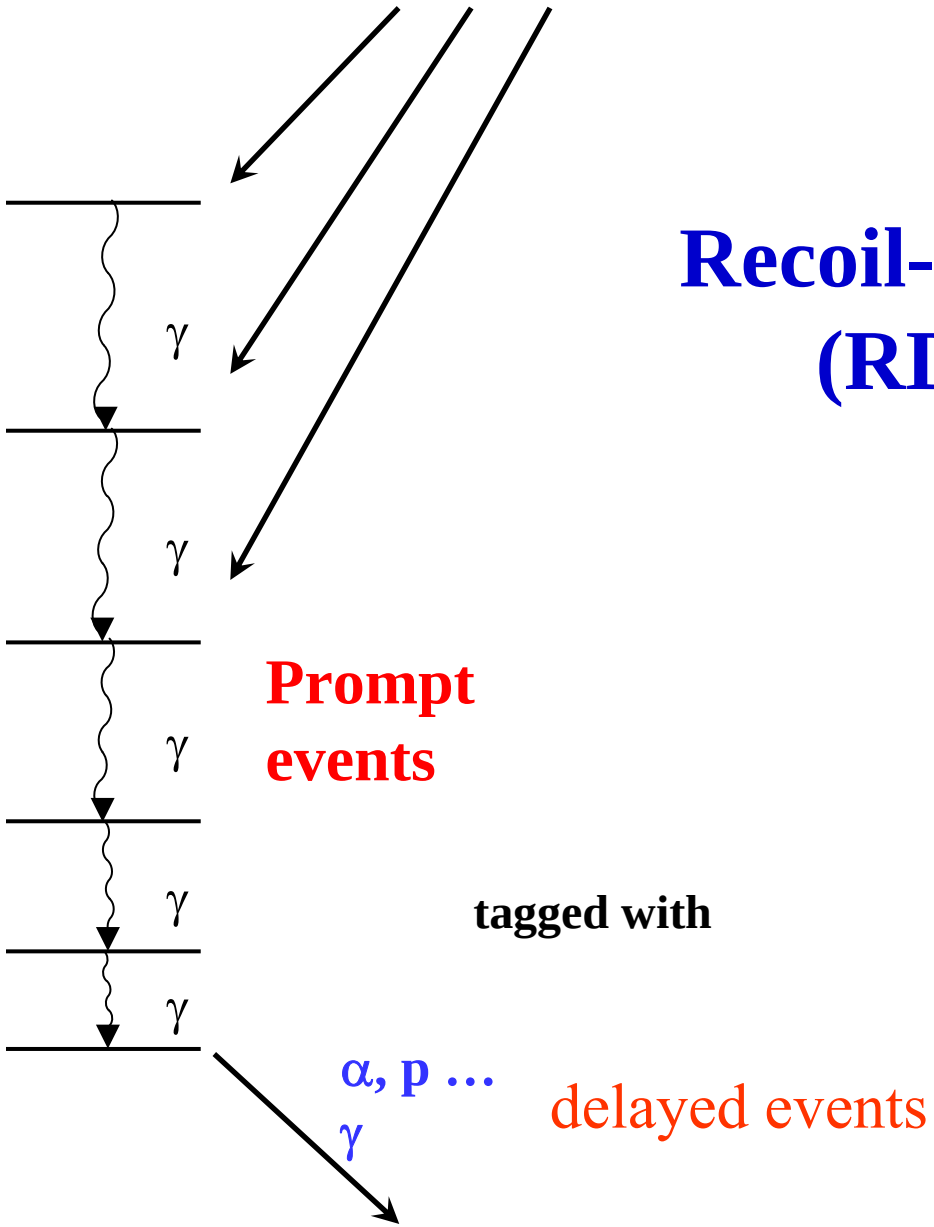
In-beam tagging experiments

Very neutron deficient heavy and SHE nuclei

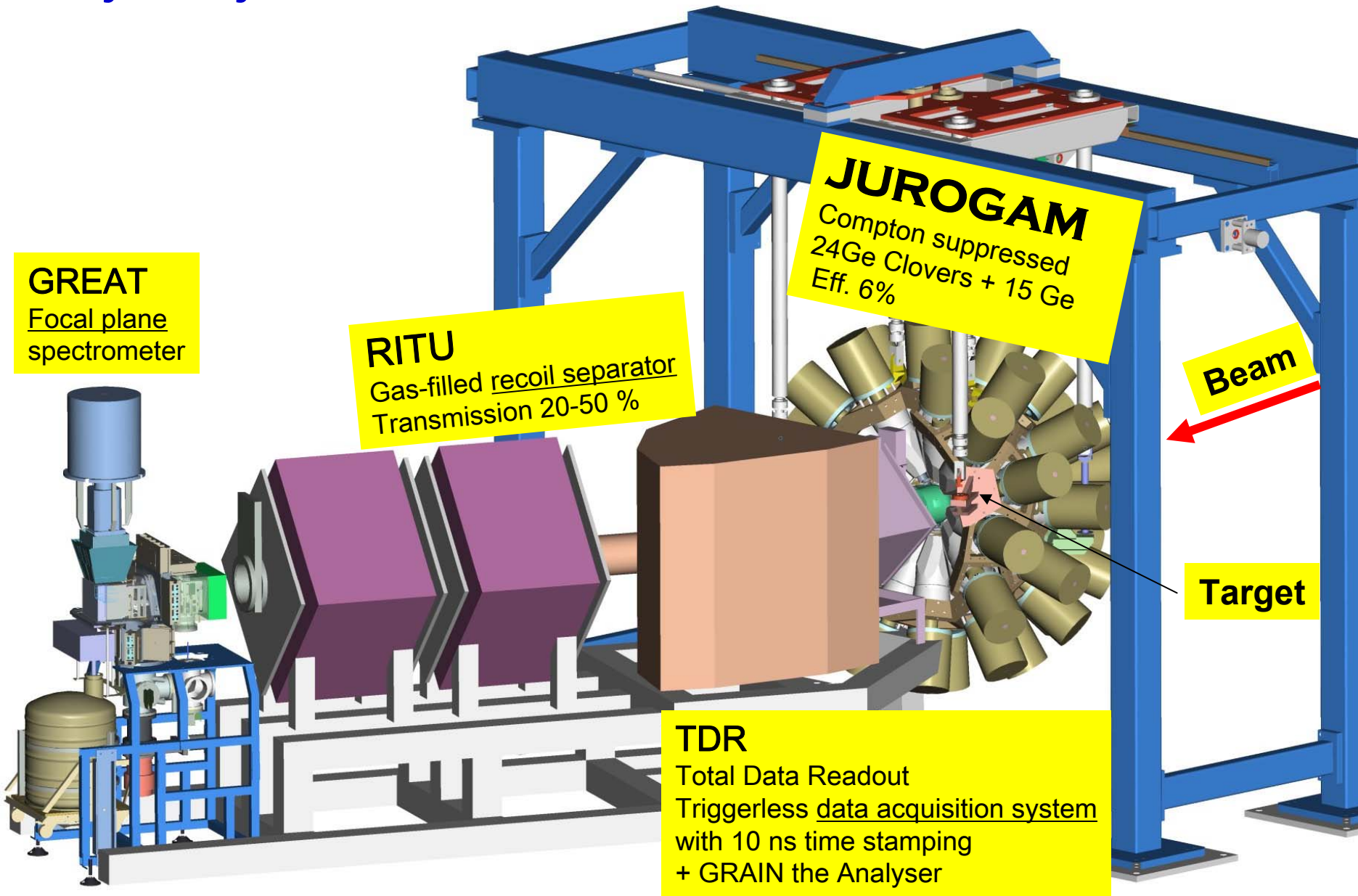
- ☺ Can be produced via fusion evaporation with stable-ion beams and stable targets
- ☹ Cross-sections down to 1 nb
- ☺ Short-living alpha or proton emitters → tagging methods



Recoil-Decay-Tagging (RDT) method

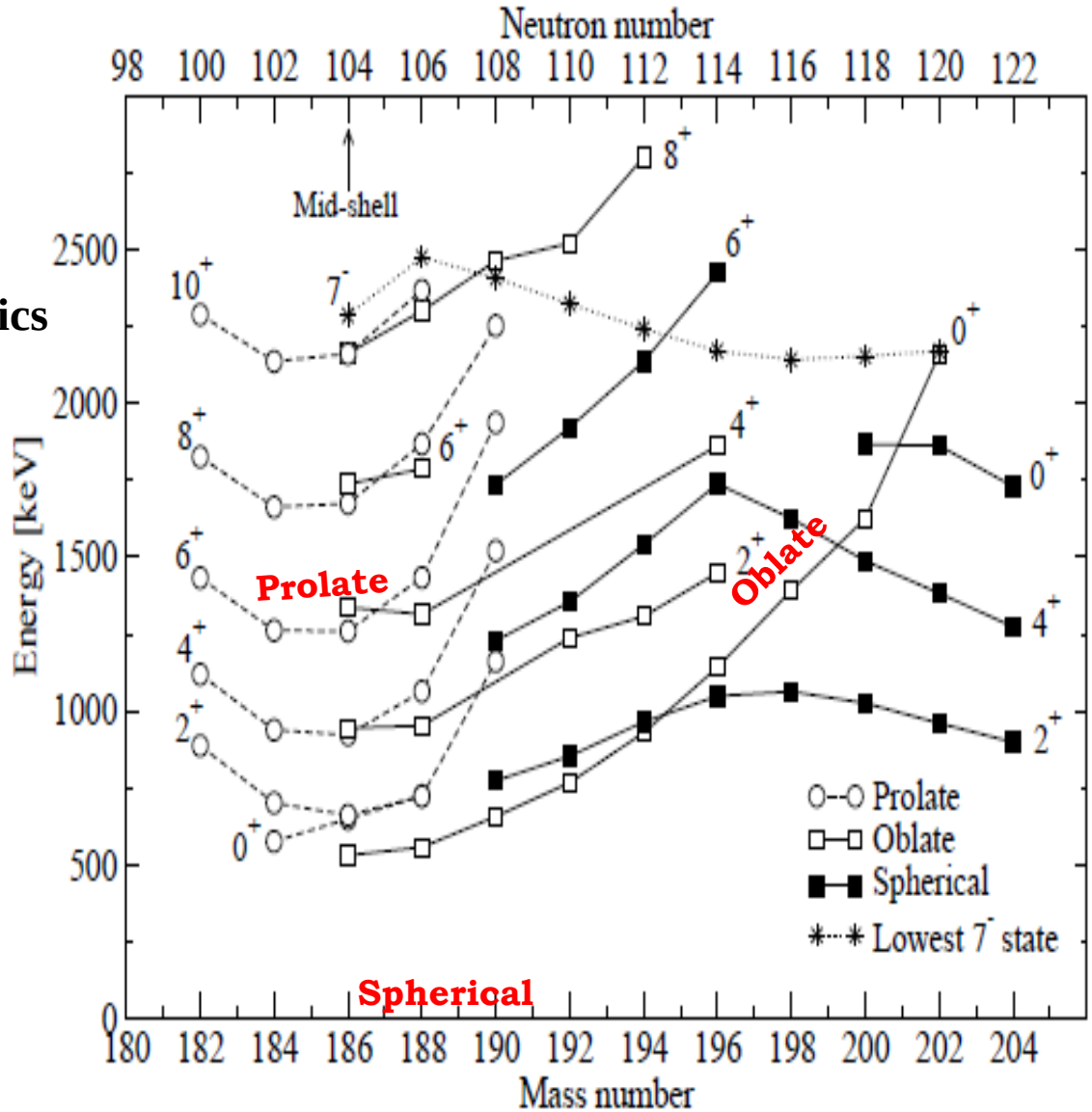


RDT Instrumentation at JYFL in Jyväskylä, Finland



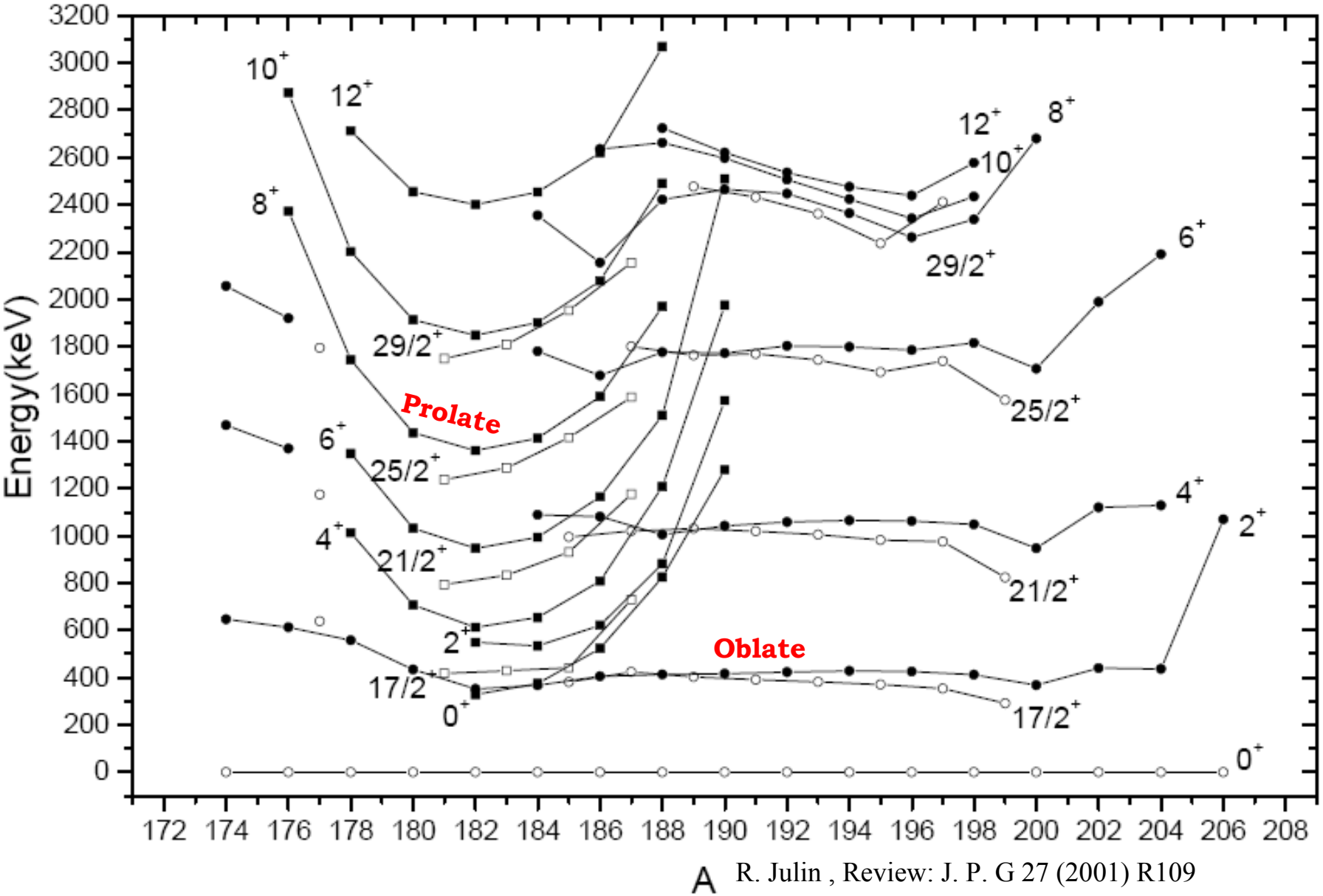
RDT- experiments 188Pb → 180Pb

Pb level systematics



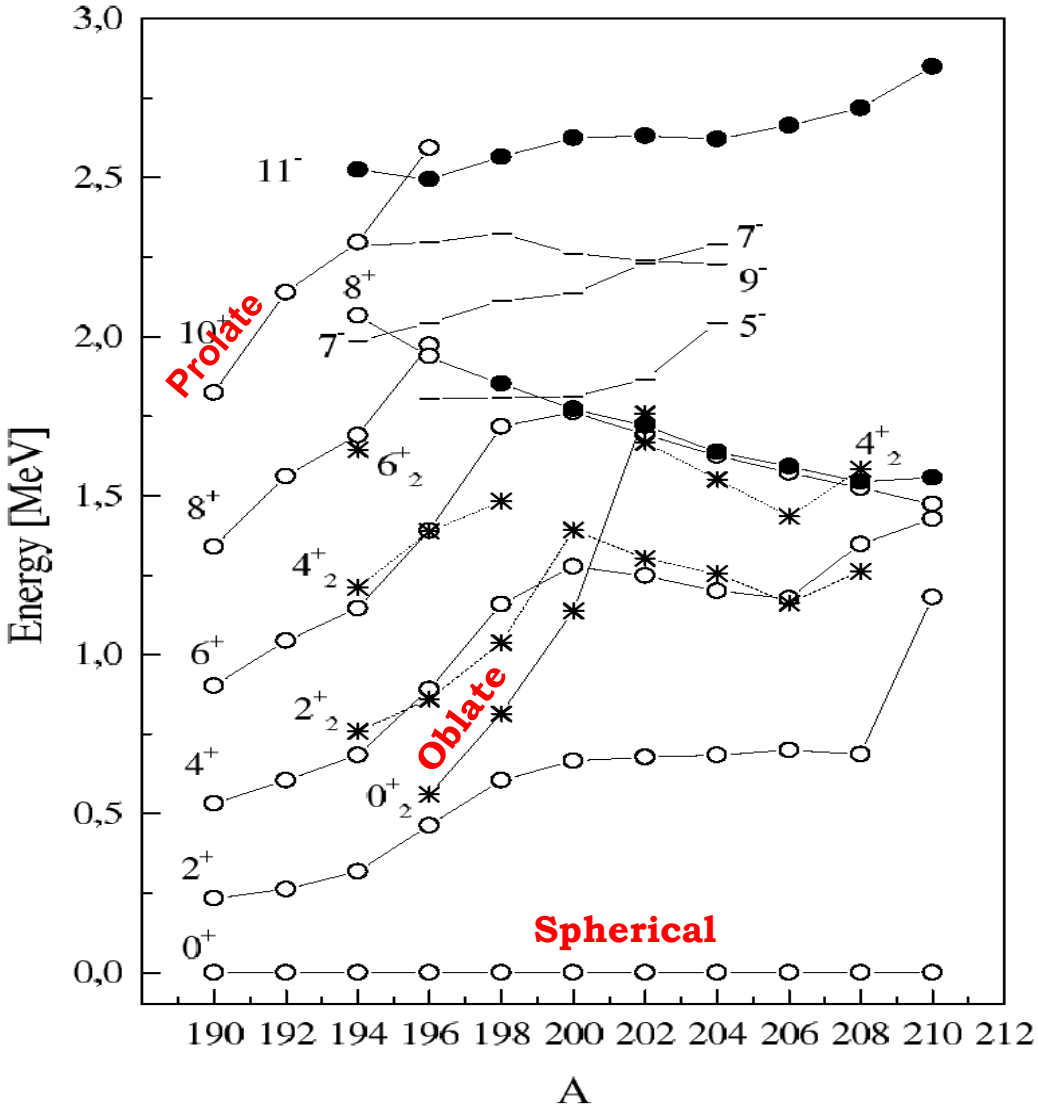
J. Pakarinen et al. Phys.Rev. C 75, 014302 (2007)

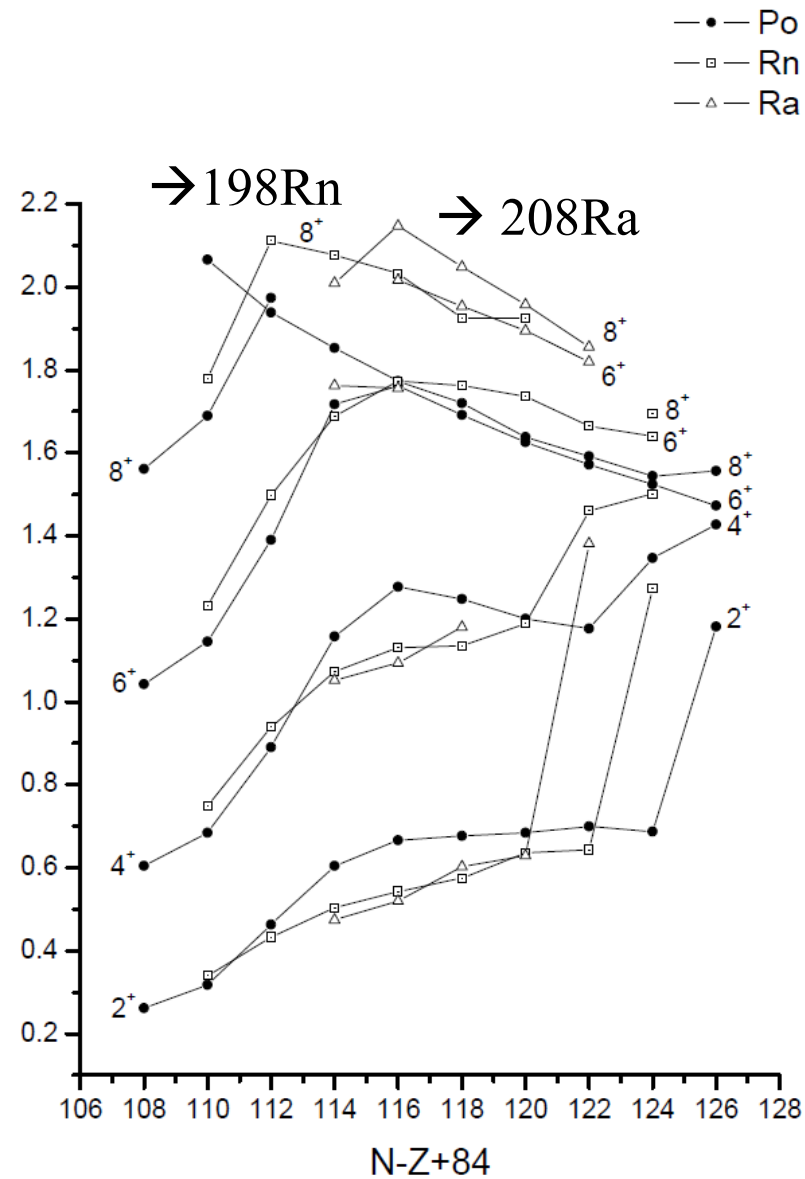
RDT- experiments 182Hg → 172Hg



R. Julin , Review: J. P. G 27 (2001) R109

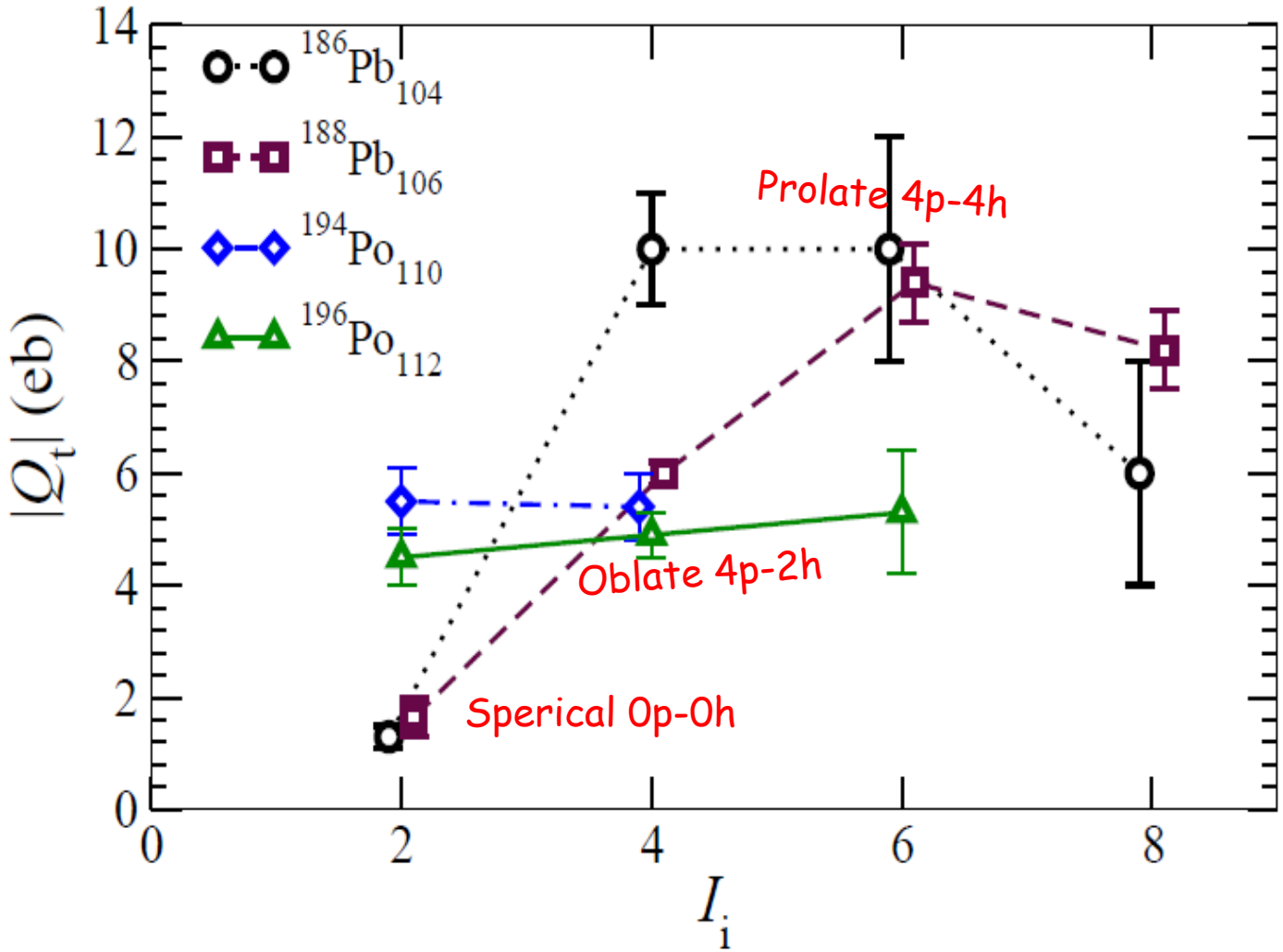
RDT- experiments 196Po → 190Po





RDT Plunger data:

Level lifetimes
→ Quadrupole moments
→ Deformation
→ Mixing



T. Grahn et al. PRL 97, 062501 (2006), NP A801, 83 (2008)

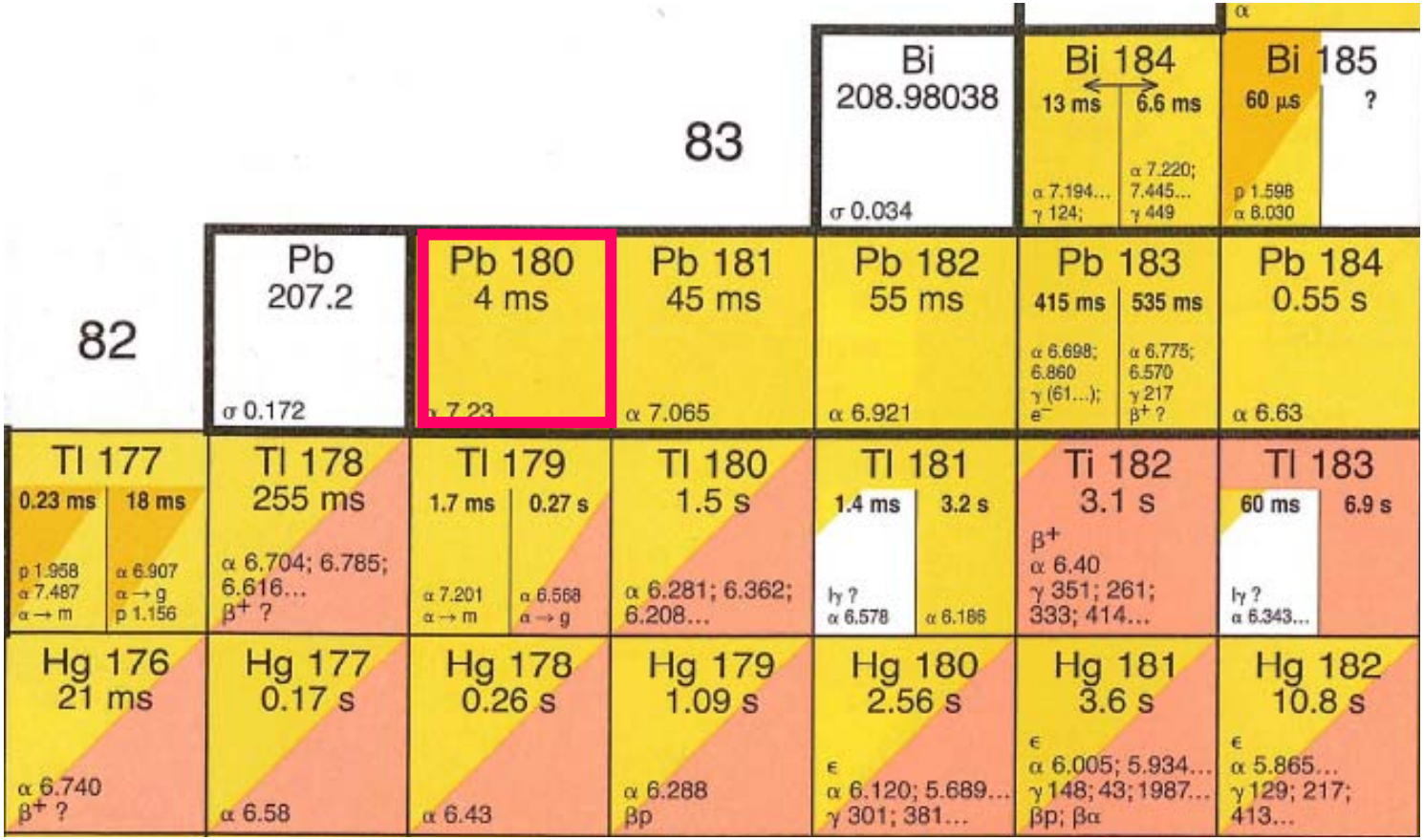
HIGHLIGHT 2009

First observation of excited states in ^{180}Pb

Shape coexistence at the drip line

^{90}Zr + ^{92}Mo → ^{180}Pb + 2n (10 nanobarn)

June 2009: JYFL-York-Liverpool collaboration



Reminder:

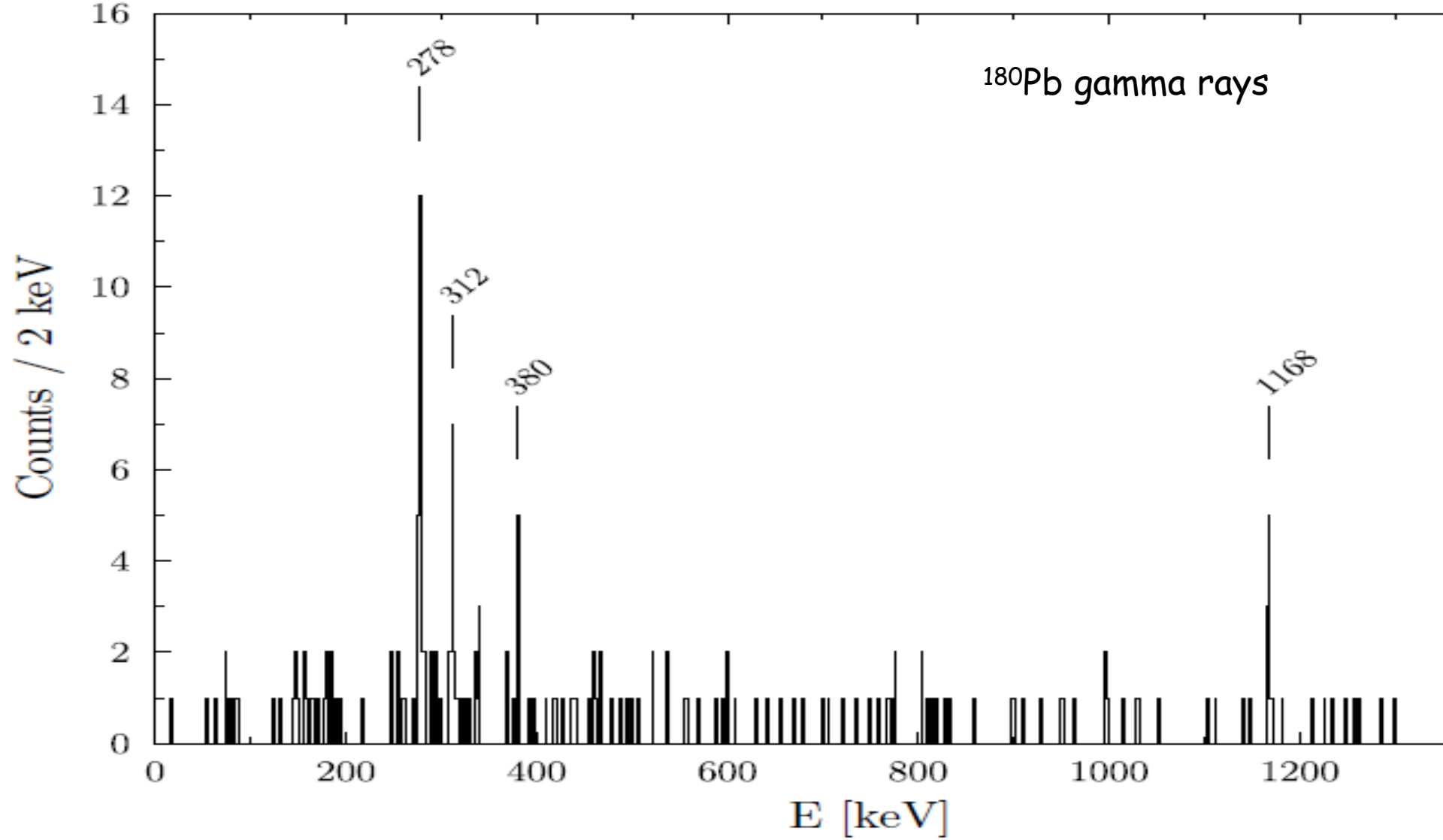
In-beam gamma-ray experiment
$\longrightarrow$ 10 pnA on a 0,5 mg/cm^2 target

10 nanobarn
$\longrightarrow$ 2 reactions per hour !!

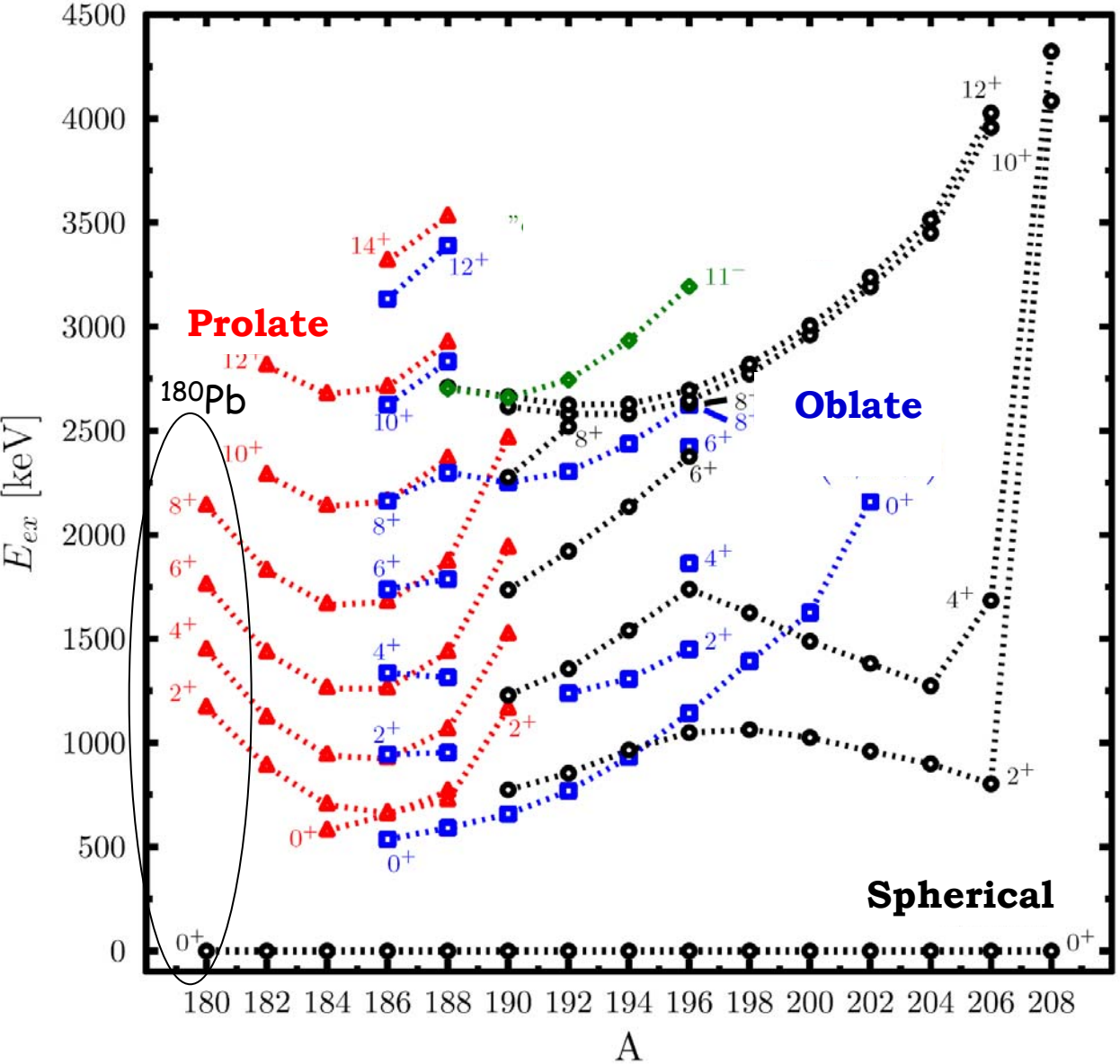
Gamma-rays from $^{90}Zr + ^{92}Mo \rightarrow ^{180}Pb + 2n$

Recoil Decay Tagging with ^{180}Pb and ^{176}Hg alpha decays

10 nanobarn – world record



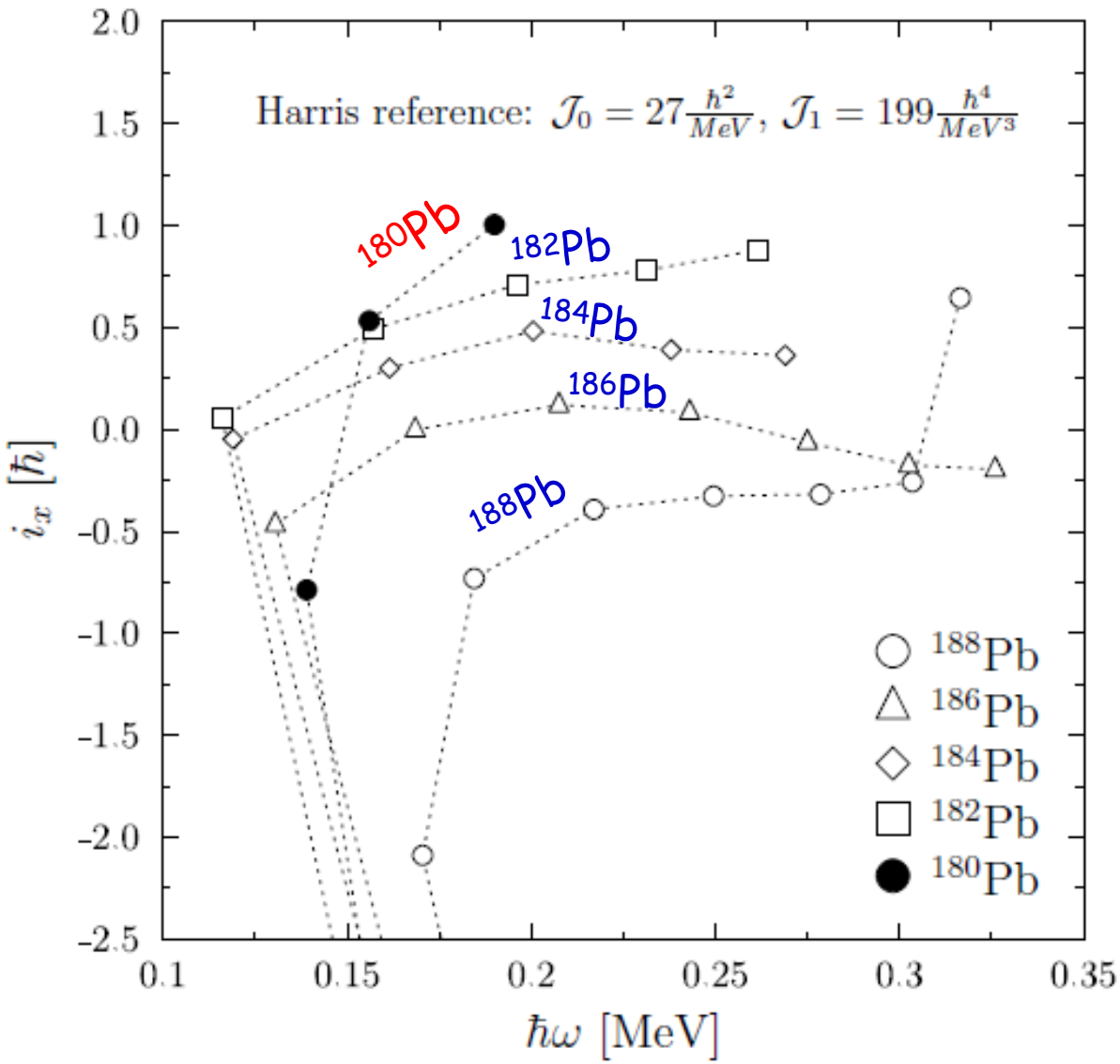
Level systematics of even-A Pb nuclei



In ^{180}Pb still
a prolate minimum
at about 1 MeV above
the spherical one

Obs !
S(p) = 930 (50) keV,
S(2p) = 200 (25) keV

R. Julin , Review: J. P. G 27 (2001) R109

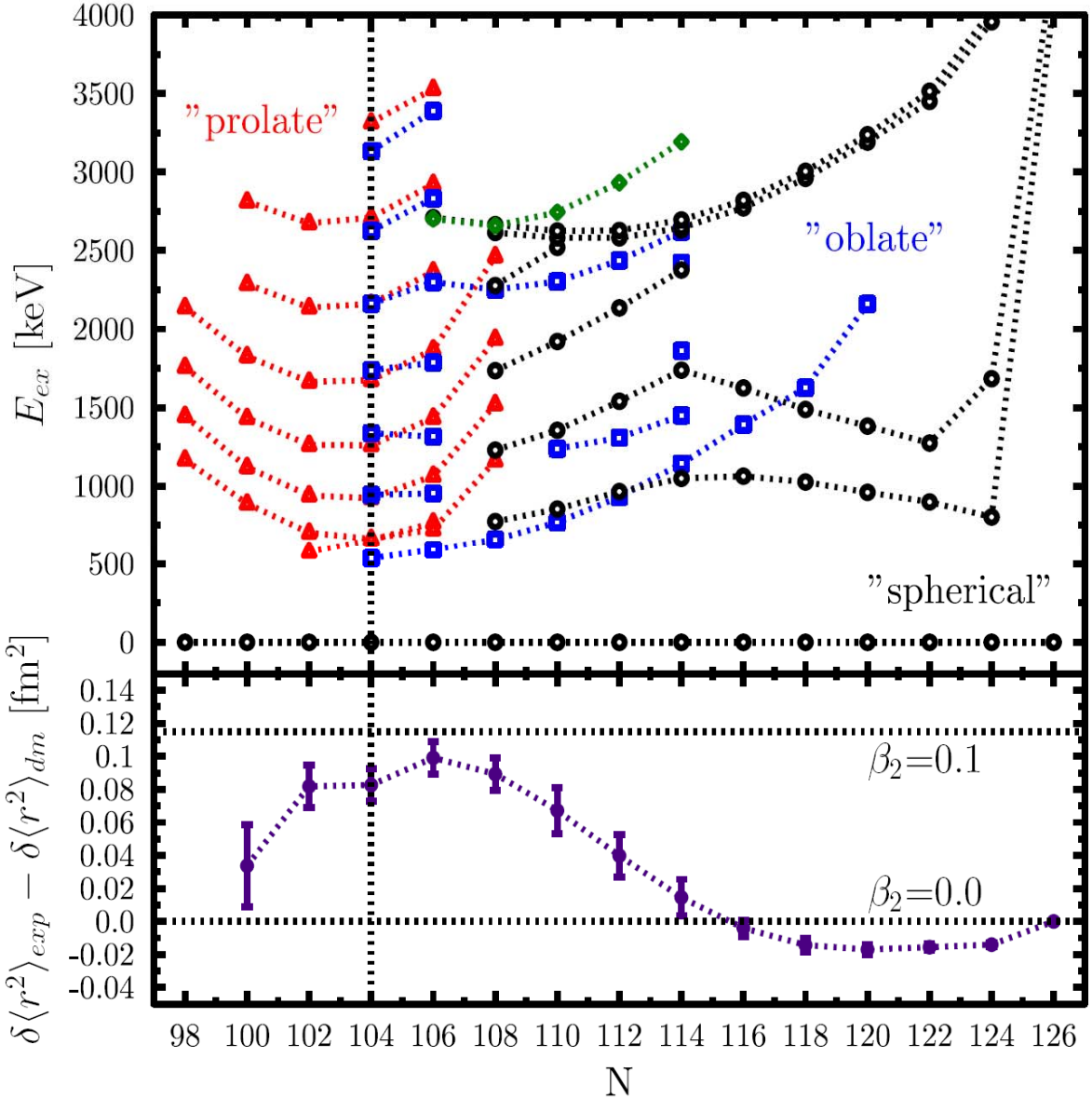


Alignments:

^{180}Pb behaves like ^{188}Pb

→

???

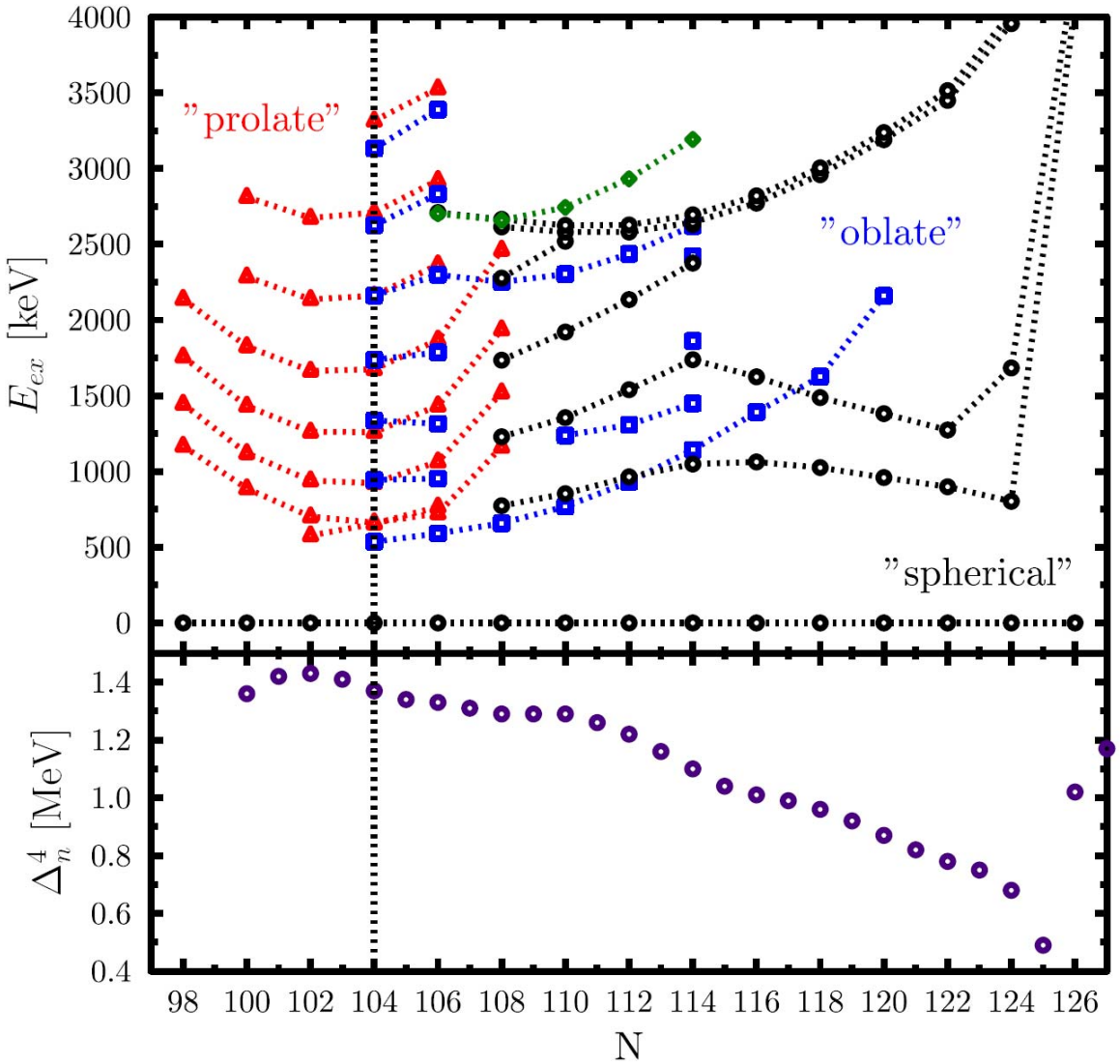


Pb level systematics

and

Ground-state radia

ISOLDE data



Pb level systematics

and

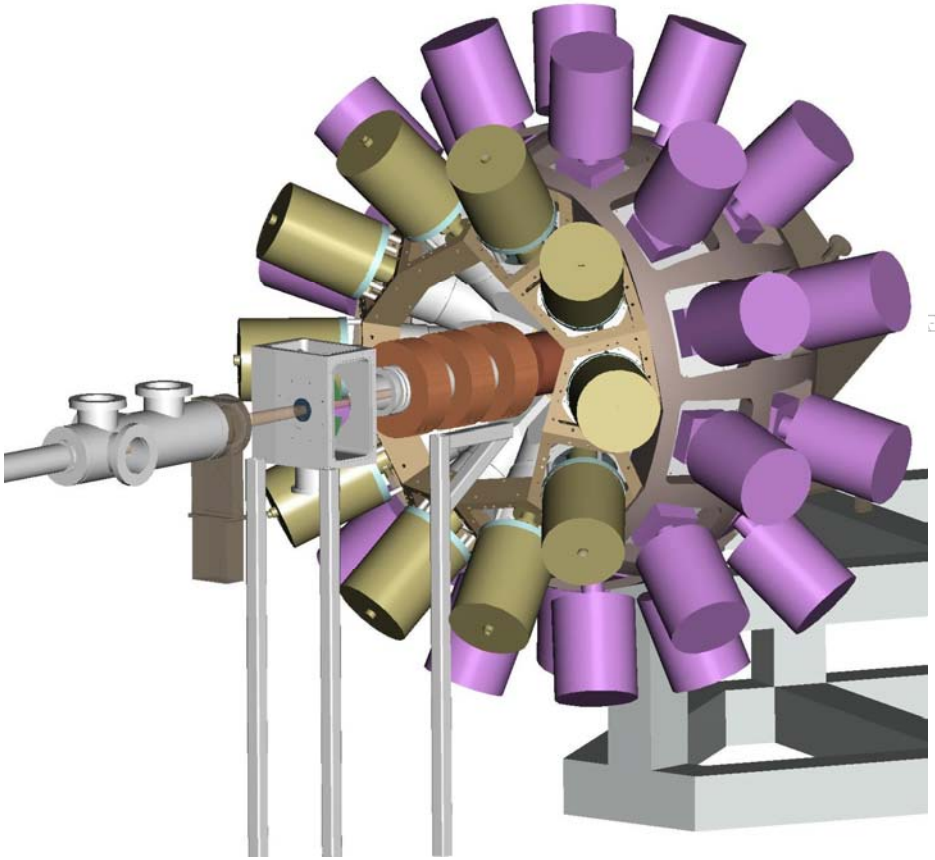
Ground-state masses

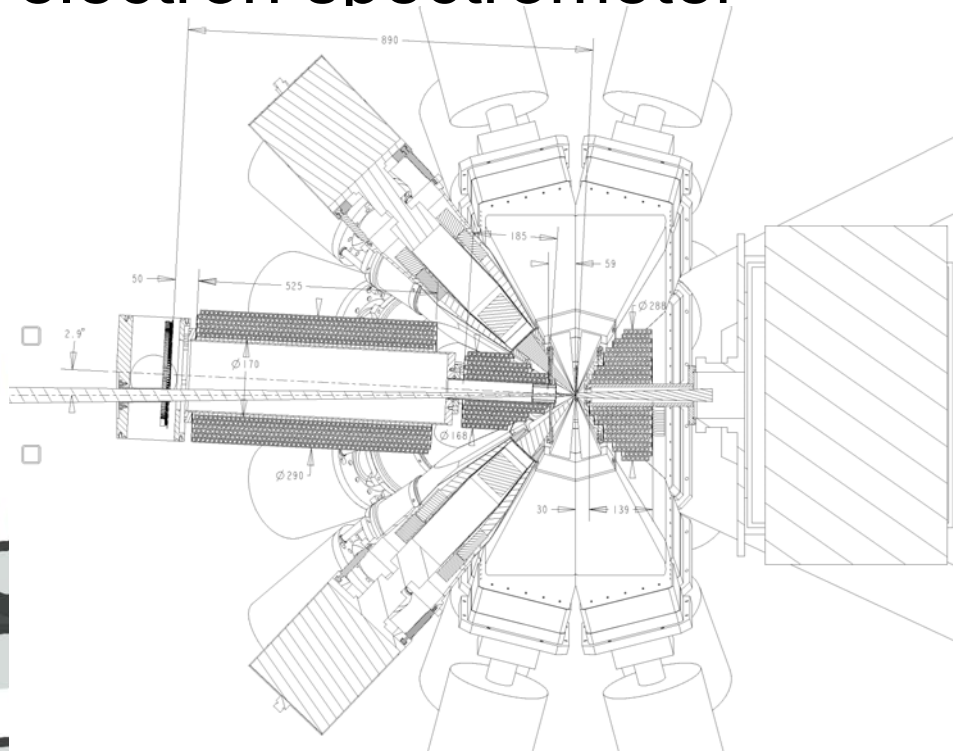
Δ^4 = "pairing gap"

Future of RDT experiments:

SAGE

JUROGAM2+Solenoid electron spectrometer





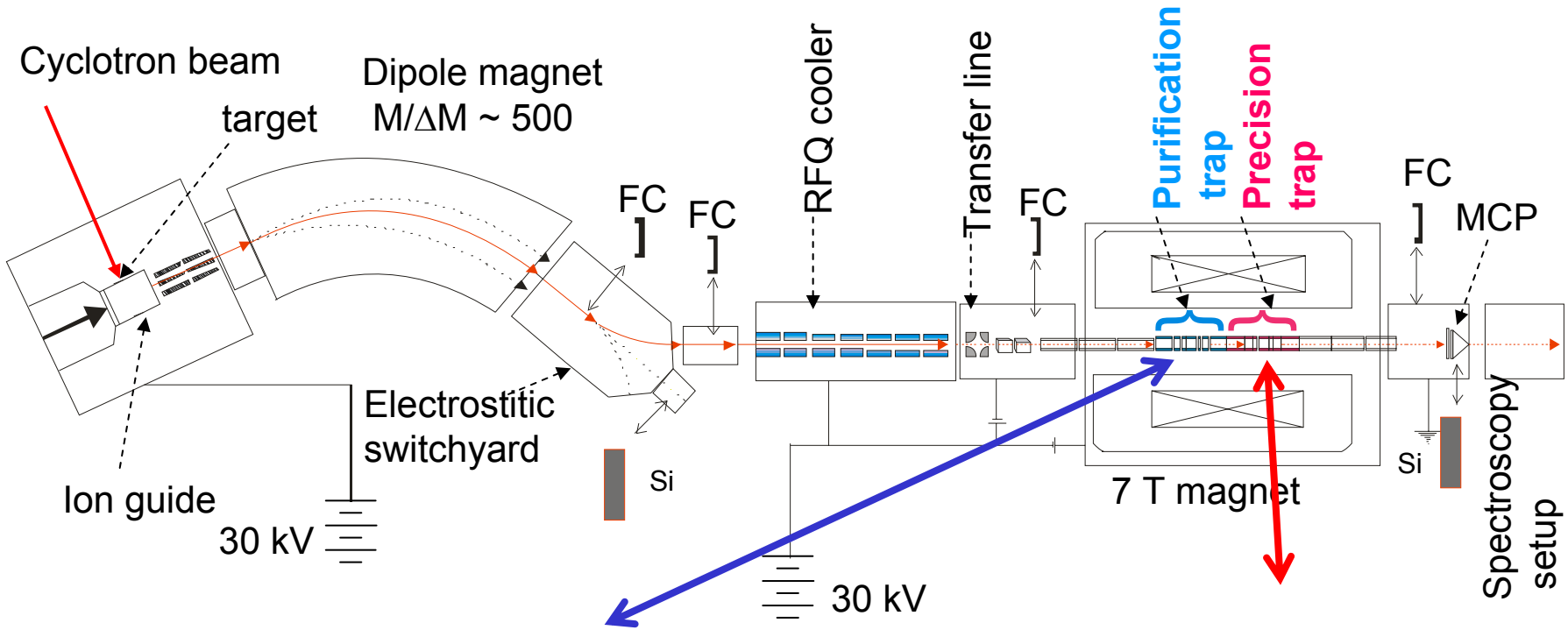
24 EUROBALL clovers
+ 15 Phase1 detectors

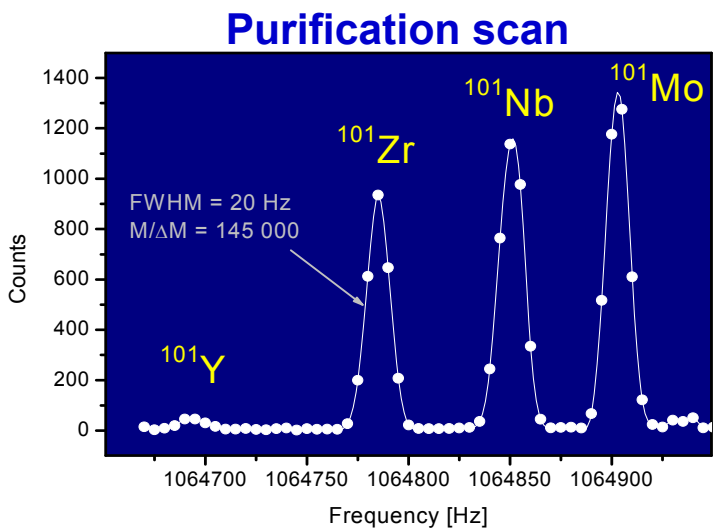
- Simultaneous Gamma and CE studies

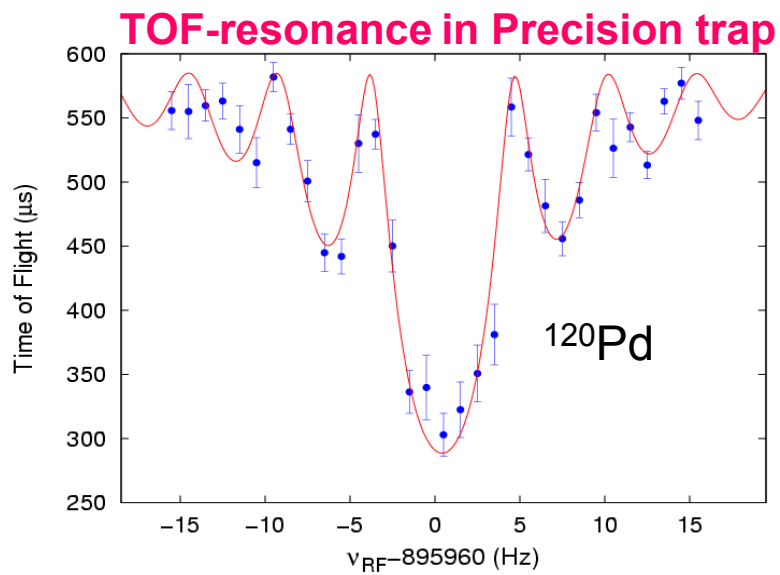
Digital electronics

IGISOL experiments

JYFLTRAP setup @ IGISOL



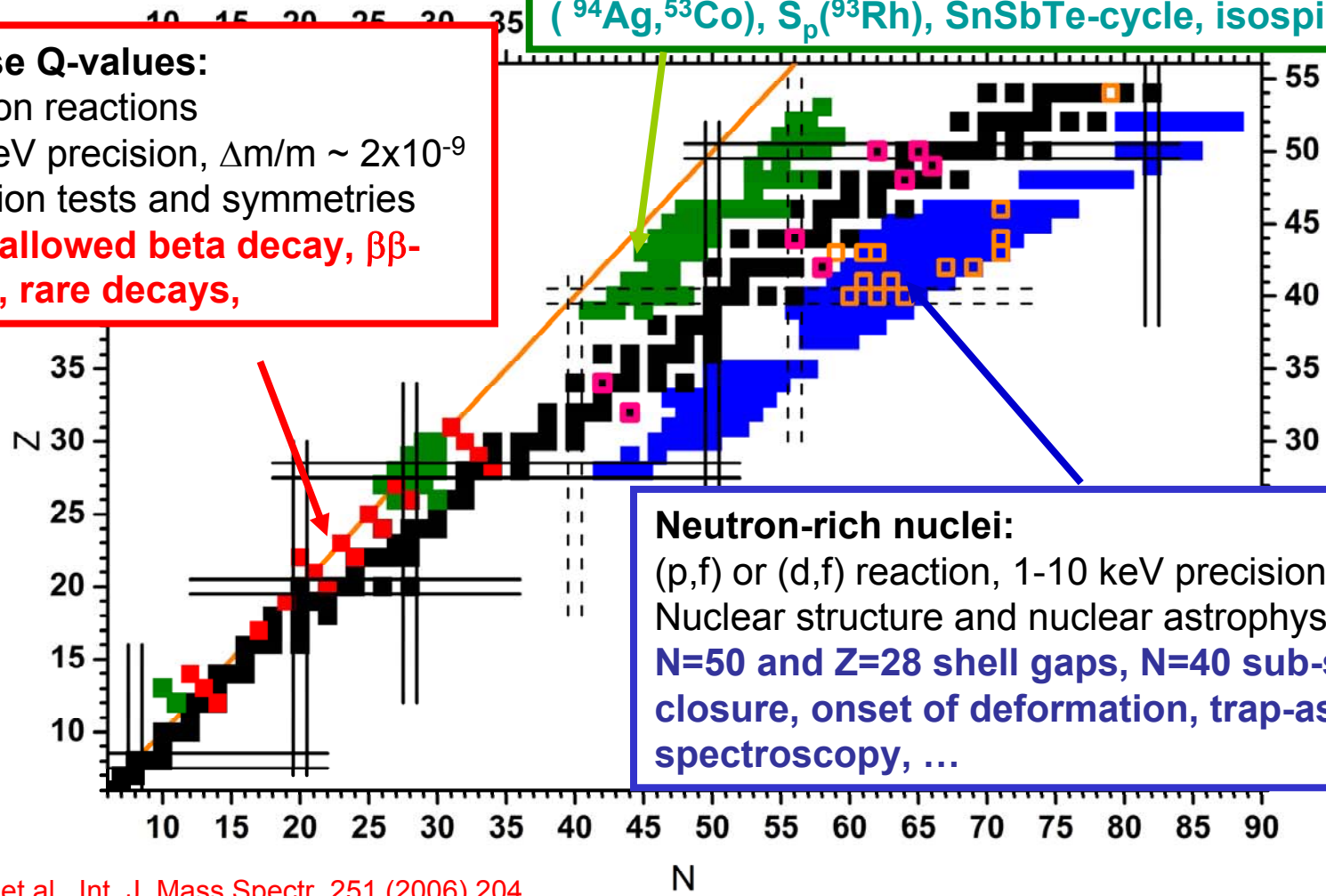




JYFLTRAP program

Neutron-deficient nuclei:
Heavy and light-ion fusion, 1-10 keV precision
Nuclear structure and nuclear astrophysics
Rp and νp-processes, particle decaying isomers (^{94}Ag,^{53}Co), S_p(^{93}Rh), SnSbTe-cycle, isospin symm.,

Precise Q-values:
Light ion reactions
Sub-keV precision, $\Delta m/m \sim 2\times10^{-9}$
Precision tests and symmetries
Superallowed beta decay, ββ-decay, rare decays,



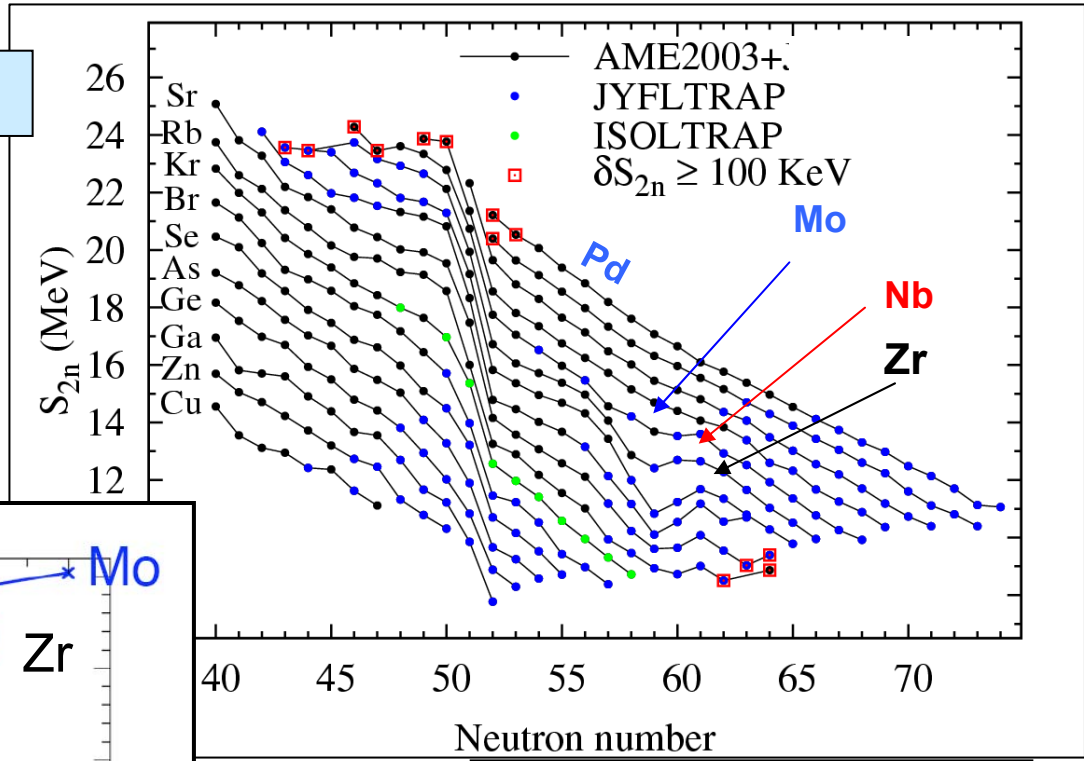
Neutron-rich nuclei:
(p,f) or (d,f) reaction, 1-10 keV precision
Nuclear structure and nuclear astrophysics
N=50 and Z=28 shell gaps, N=40 sub-shell closure, onset of deformation, trap-assisted spectroscopy, …

A. Jokinen et al., Int. J. Mass Spectr. 251 (2006) 204

http://research.jyu.fi/igisol/JYFLTRAP_masses/

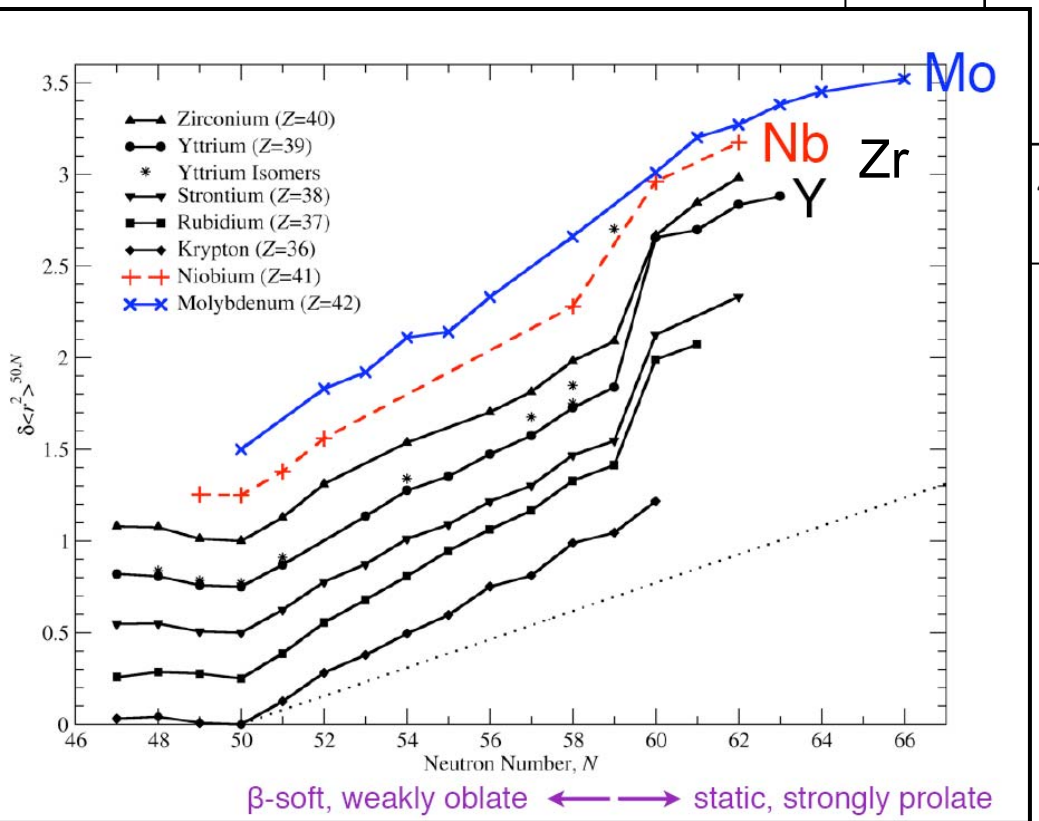
Ground-state properties, S_{2n} vs. $\delta\langle r^2\rangle$

$$S_{2n}(N,Z) = B(N,Z) - B(N-2,Z)$$



Collinear laser spectroscopy at JYFL:

Mo:	F.C. Charlwood et al., PLB 674 (2009) 23
Nb:	B. Cheal et al., PRL 102 (2009) 222501
Y:	B. Cheal et al., PLB 645 (2007) 133
Zr:	P. Campbell et al., PRL 89 (2002) 082501



JYFLTRAP:

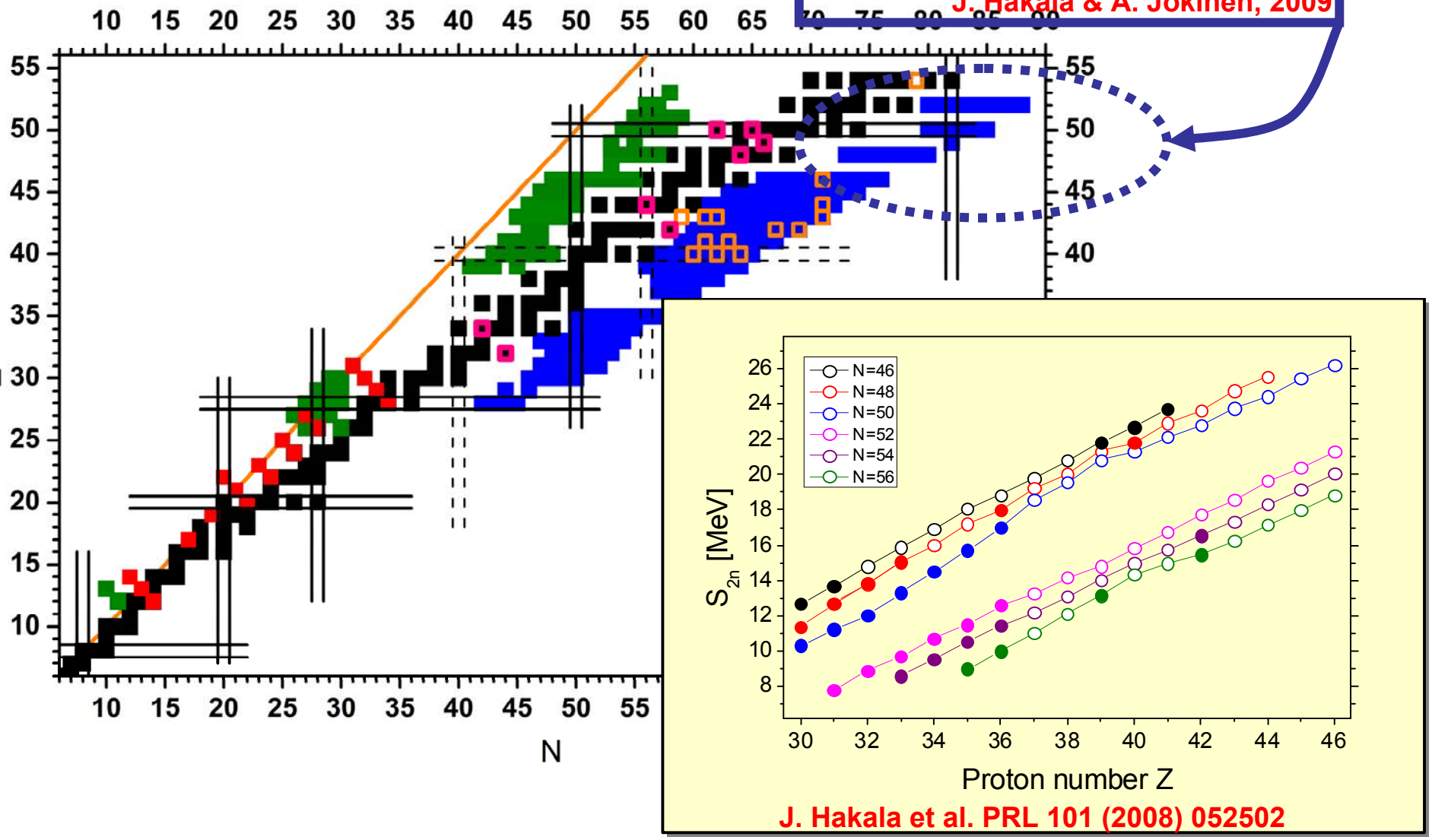
J. Hakala et al., PRL 101 (2008) 052502
U. Hager et al. PRL 96 (2006) 042504
U. Hager et al., NPA 793 (2007) 20
S. Rahaman et al., EPJA 32 (2007) 87

Evolution of shell gaps

Z=50 and N=82 shell gaps

New data → ^{128}Cd,^{135}Sn,^{140}Te

J. Hakala & A. Jokinen, 2009

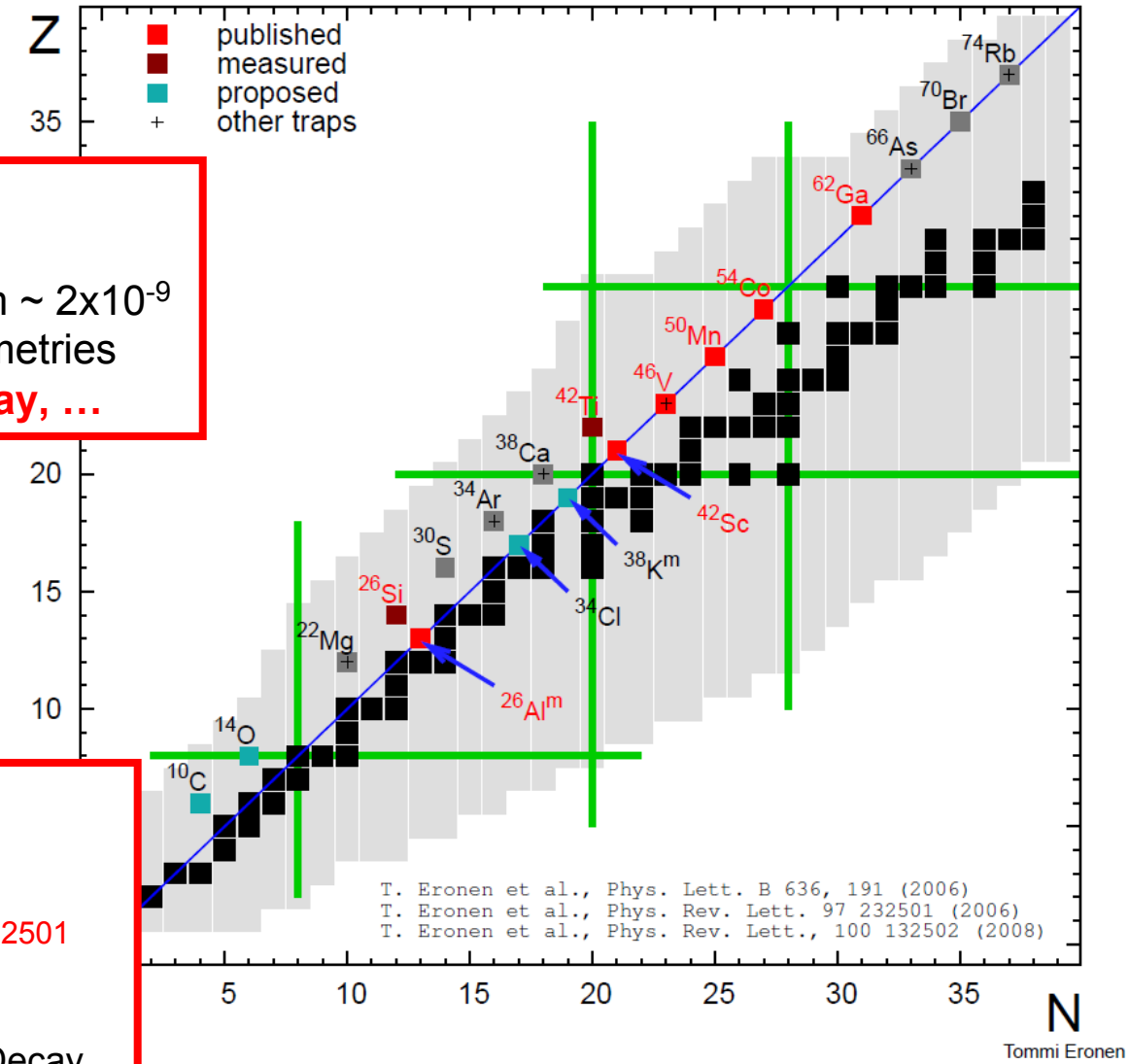


J. Hakala et al. PRL 101 (2008) 052502

Precise Q-values (Q_{EC}, Q_{bb}, …)

Mass-doublet measurements !

Precise Q-values:
Light ion reactions
Sub-keV precision, $\Delta m/m \sim 2\times10^{-9}$
Precision tests and symmetries
Superallowed beta decay, …



Tommi Eronen

Rare weak decays:

Double beta decay studies:

S. Rahaman et al., Phys. Lett. B 662 (2008) 111
S. Rahaman et al., Phys. Rev. Lett.103 (2009) 042501

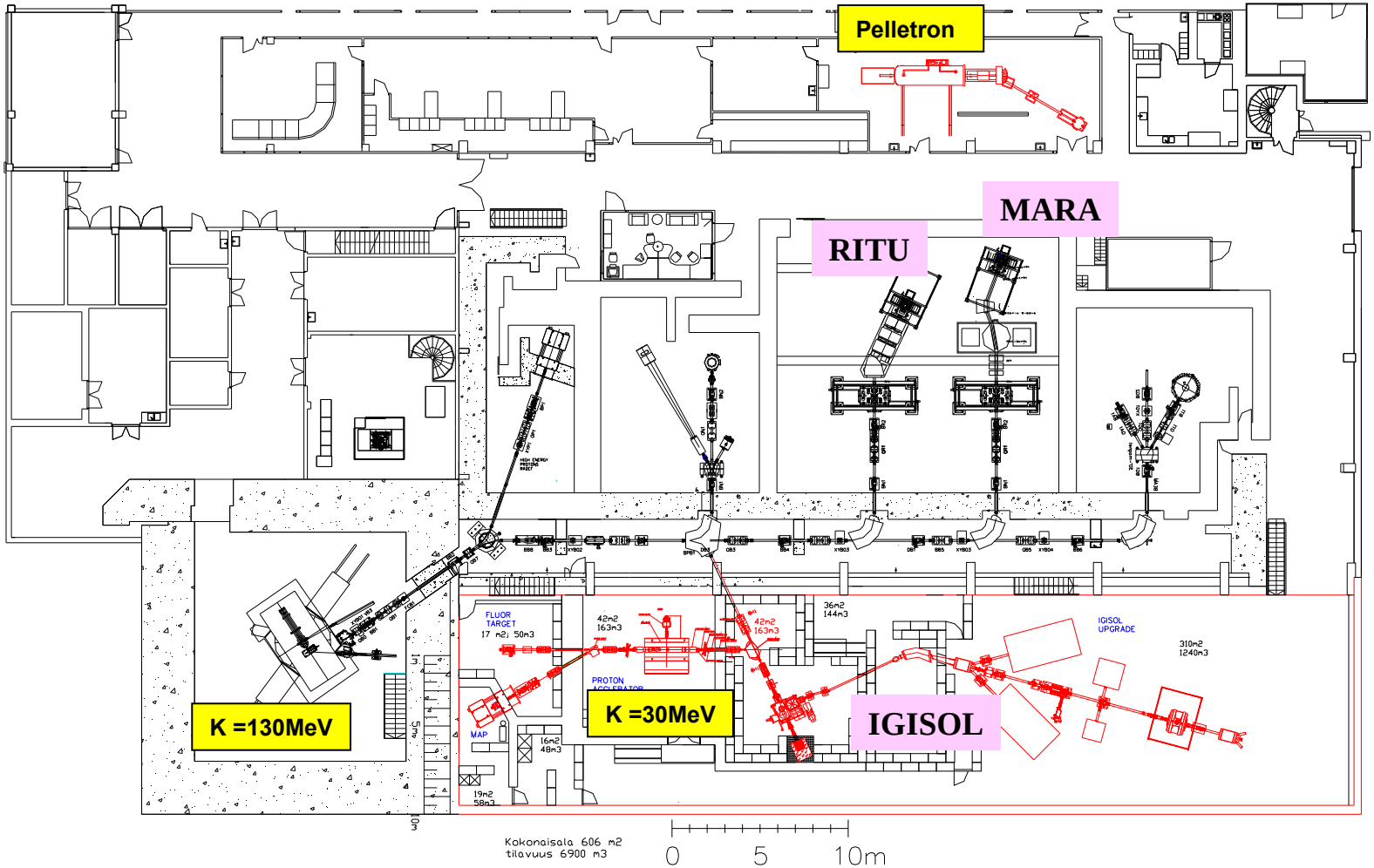
β- decay of ^{115}In($9/2^+$)→^{115}Sn($3/2^+$)

Smallest Known Q Value of Any Nuclear Decay, 350(170) eV:

E. Wieslander et al., Phys. Rev. Lett. 103 (2009) 122501

New 30 MeV cyclotron in 2009:

- More beam time




Thank you for your attentions