NS2012, ANL

PRECISION MASS MEASUREMENTS BEYOND NEUTRON-RICH ^{132}Sn AT JYFLTRAP

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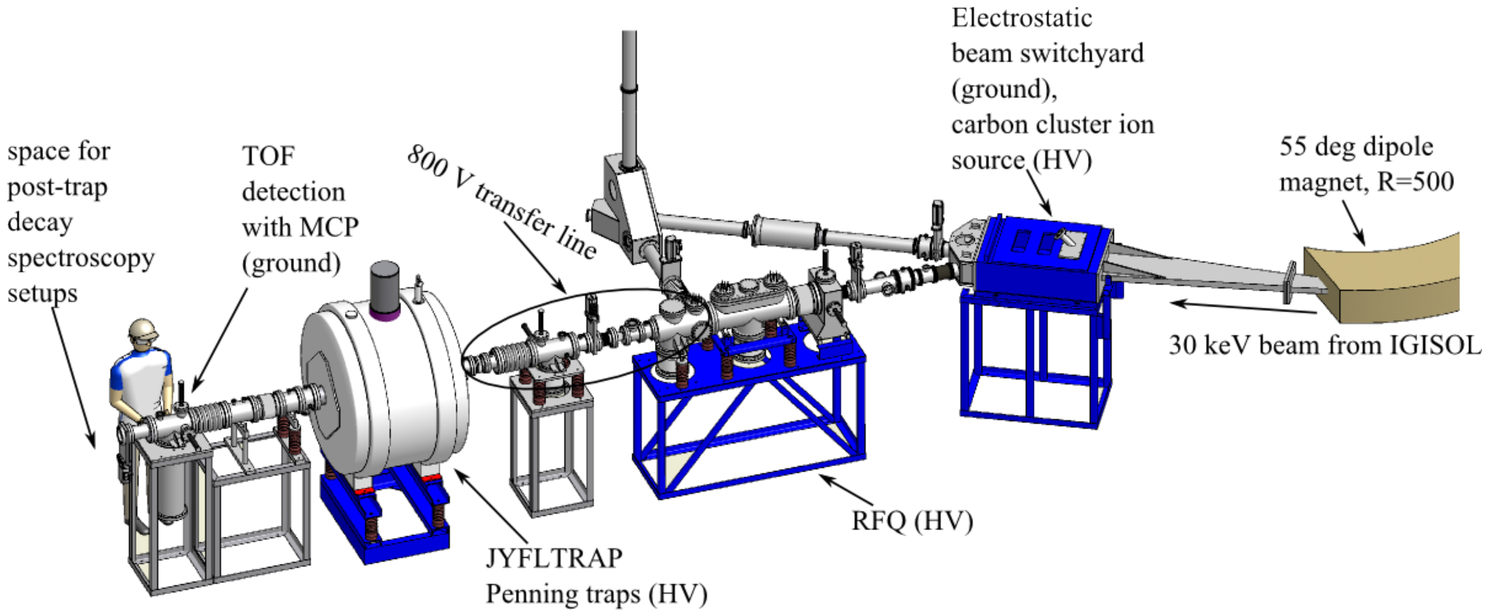
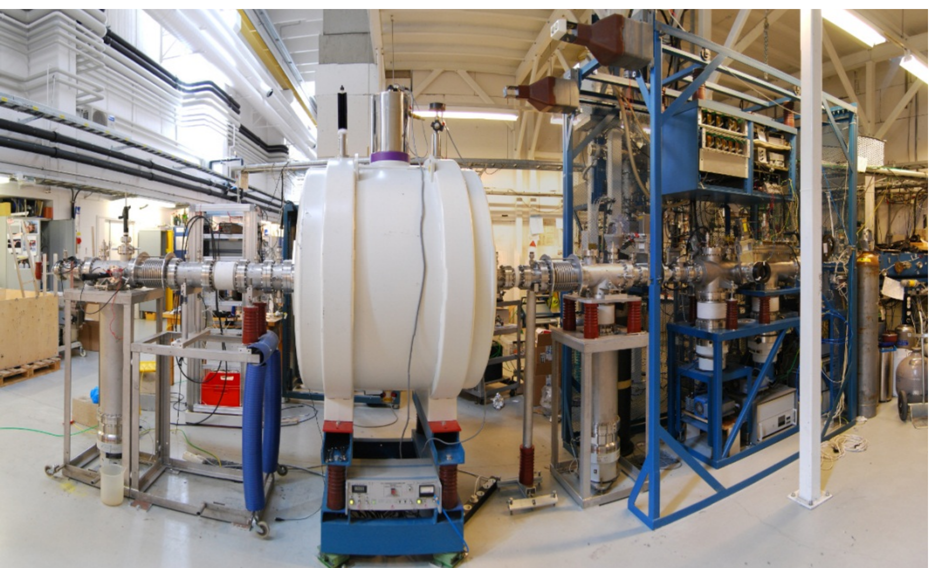
Introduction

- Doubly magic ^{132}Sn (Z=50, N=82)
- Masses measured with JYFLTRAP
  - Produced with IGISOL
    - 20-50 MeV proton-induced fission of ^{238}U
    - Thin target, stopping into gas
  - Isomeric contamination ($T_{1/2}$ > 200 ms)
  - Precision 3-30 keV/c^2
- **Extracted quantities:**
  - Two-neutron and two-proton separation energies
  - Nucleon pairing correlations
  - Isomeric energies

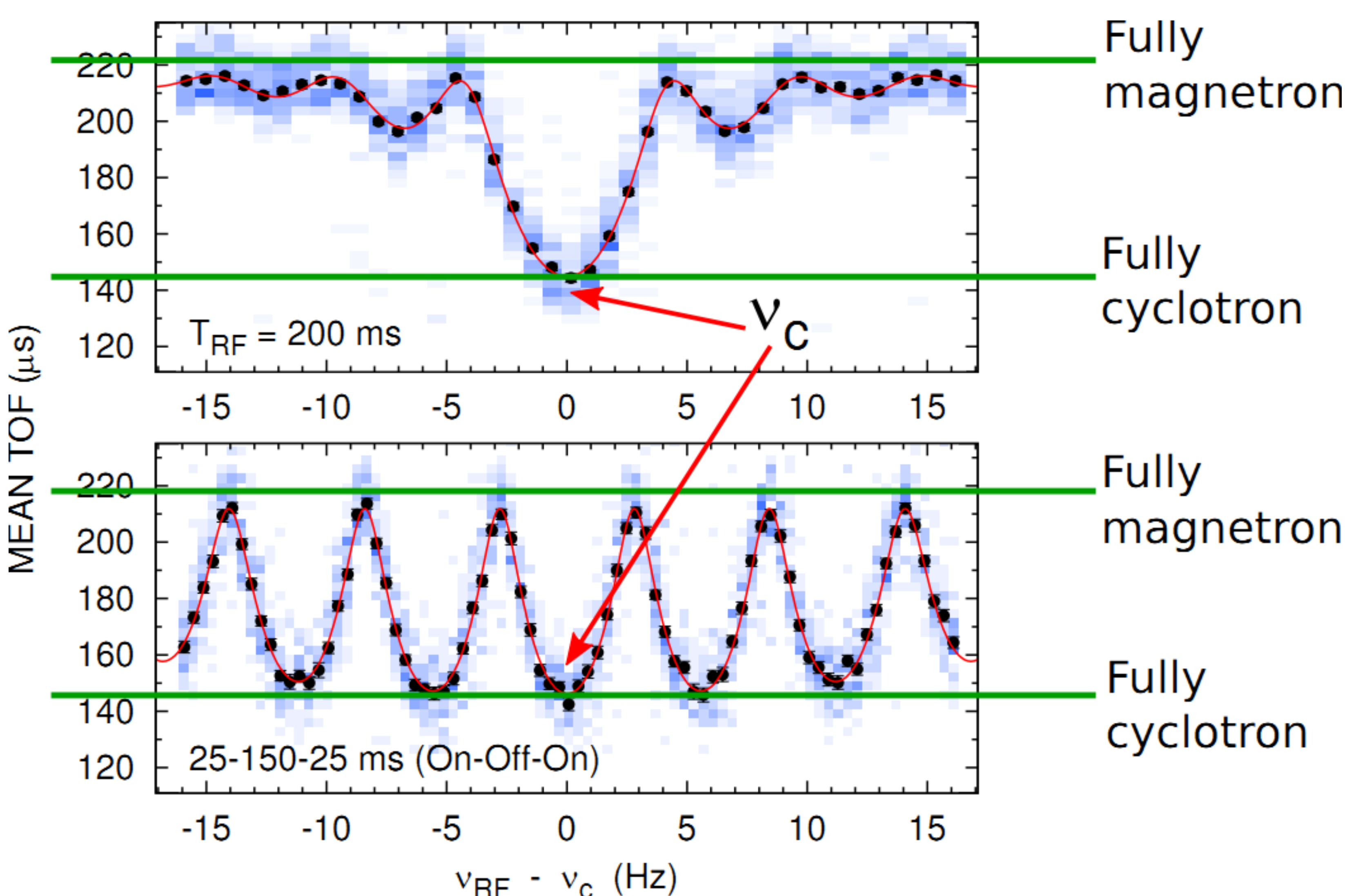
JYFLTRAP until June/2010



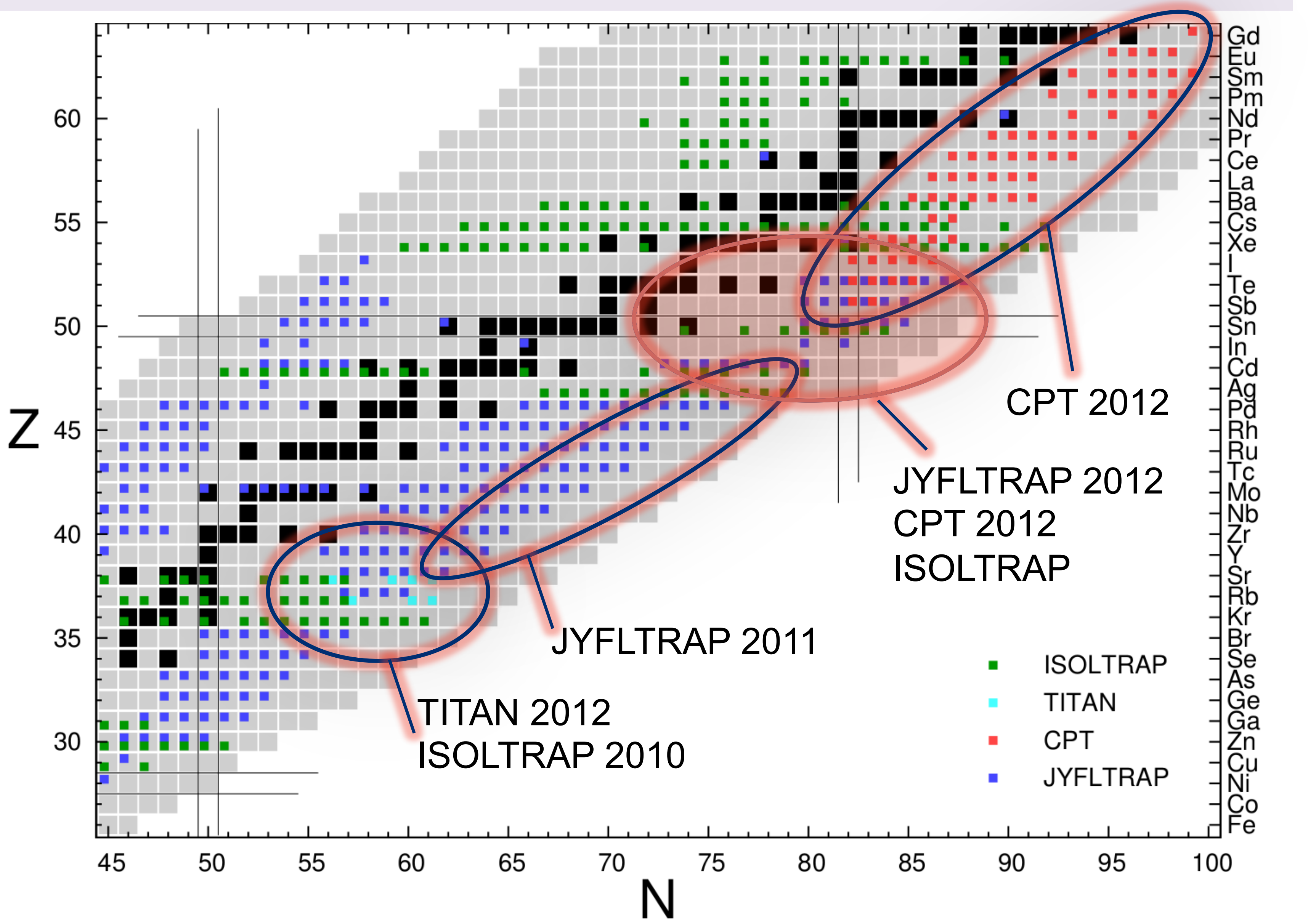


- RFQ + 2 Penning traps
- Isobaric/-meric cleaning
- Mass measurements

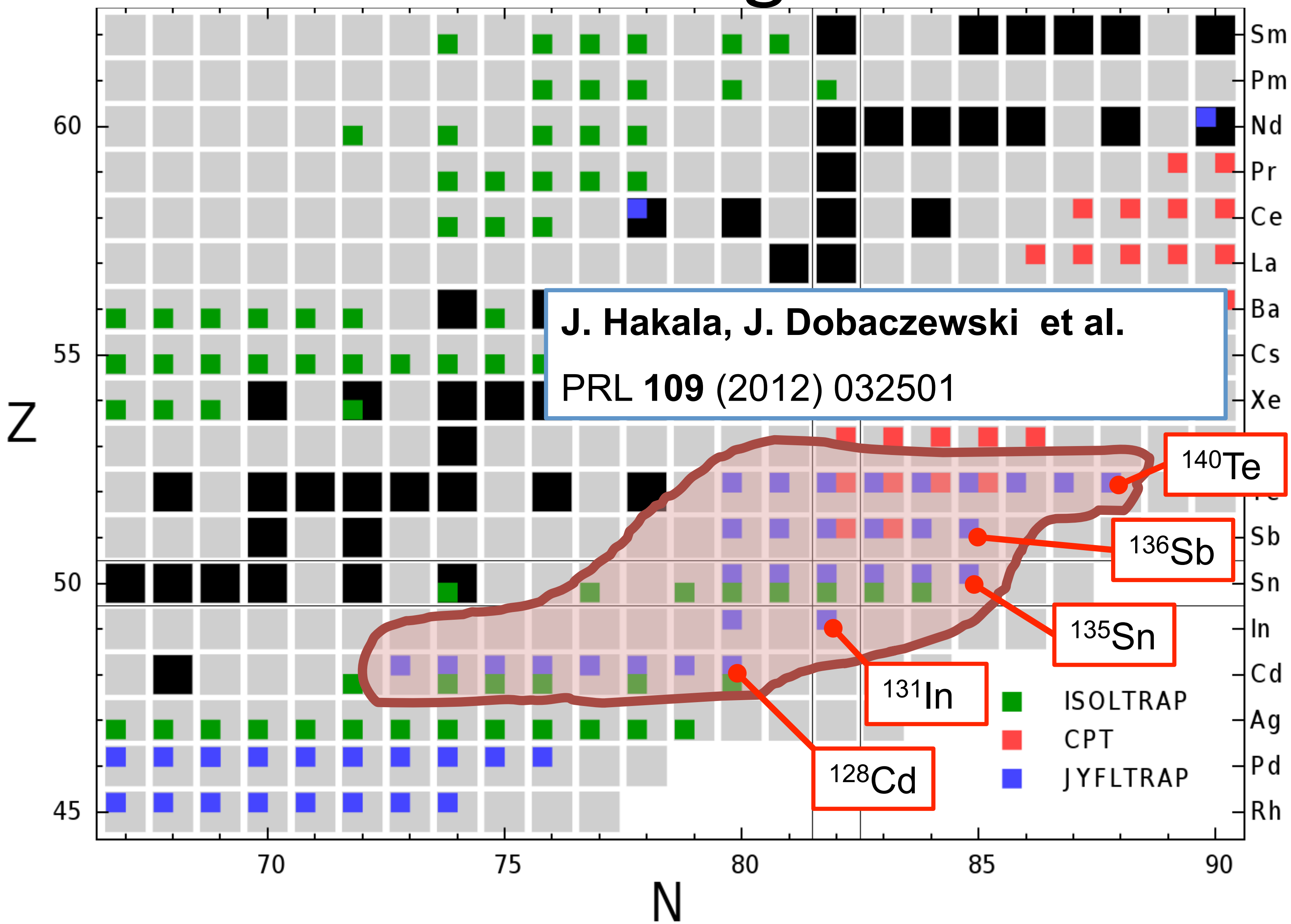
Precision trap – TOF-ICR



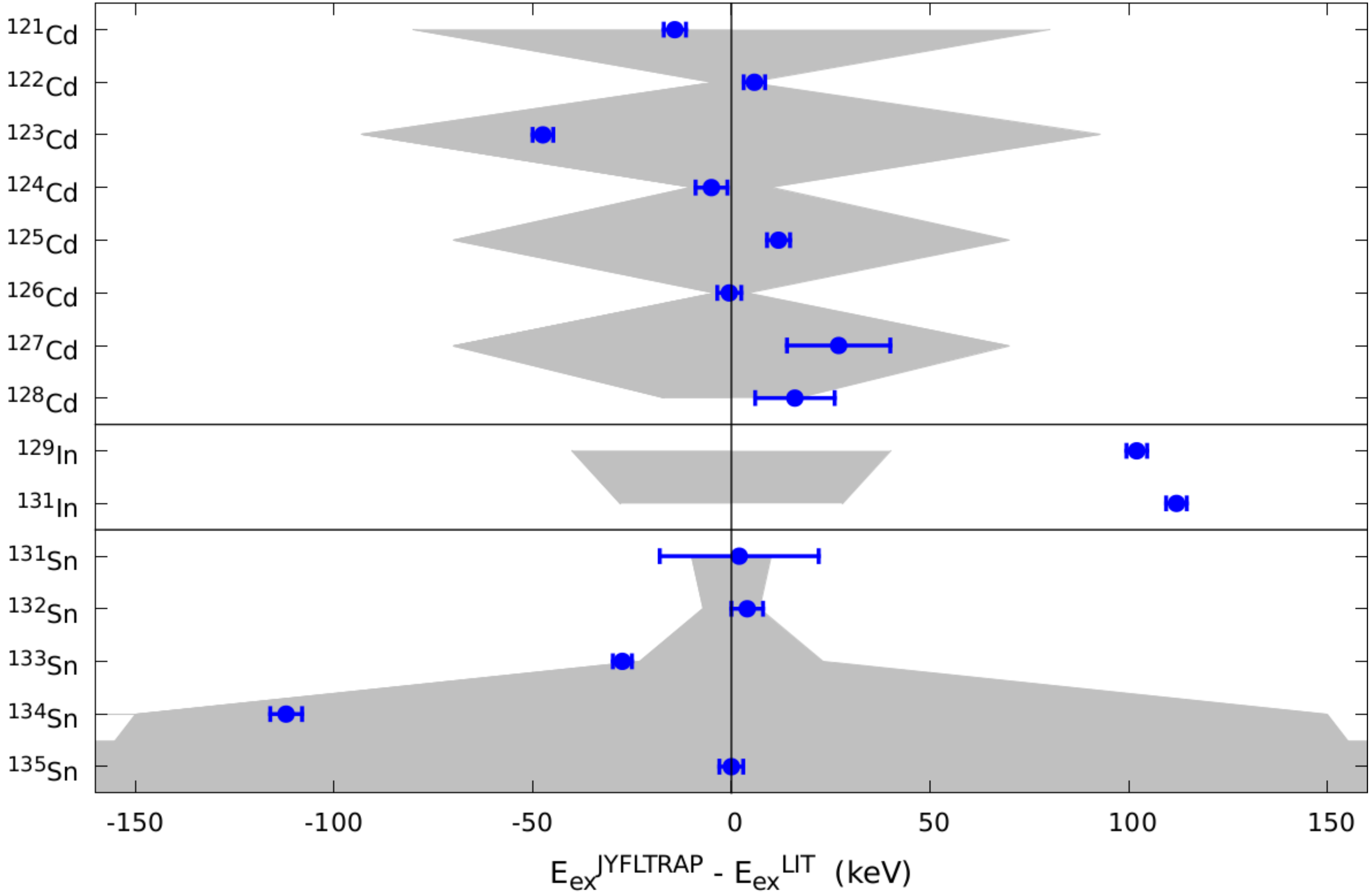
Penning trap mass harvest



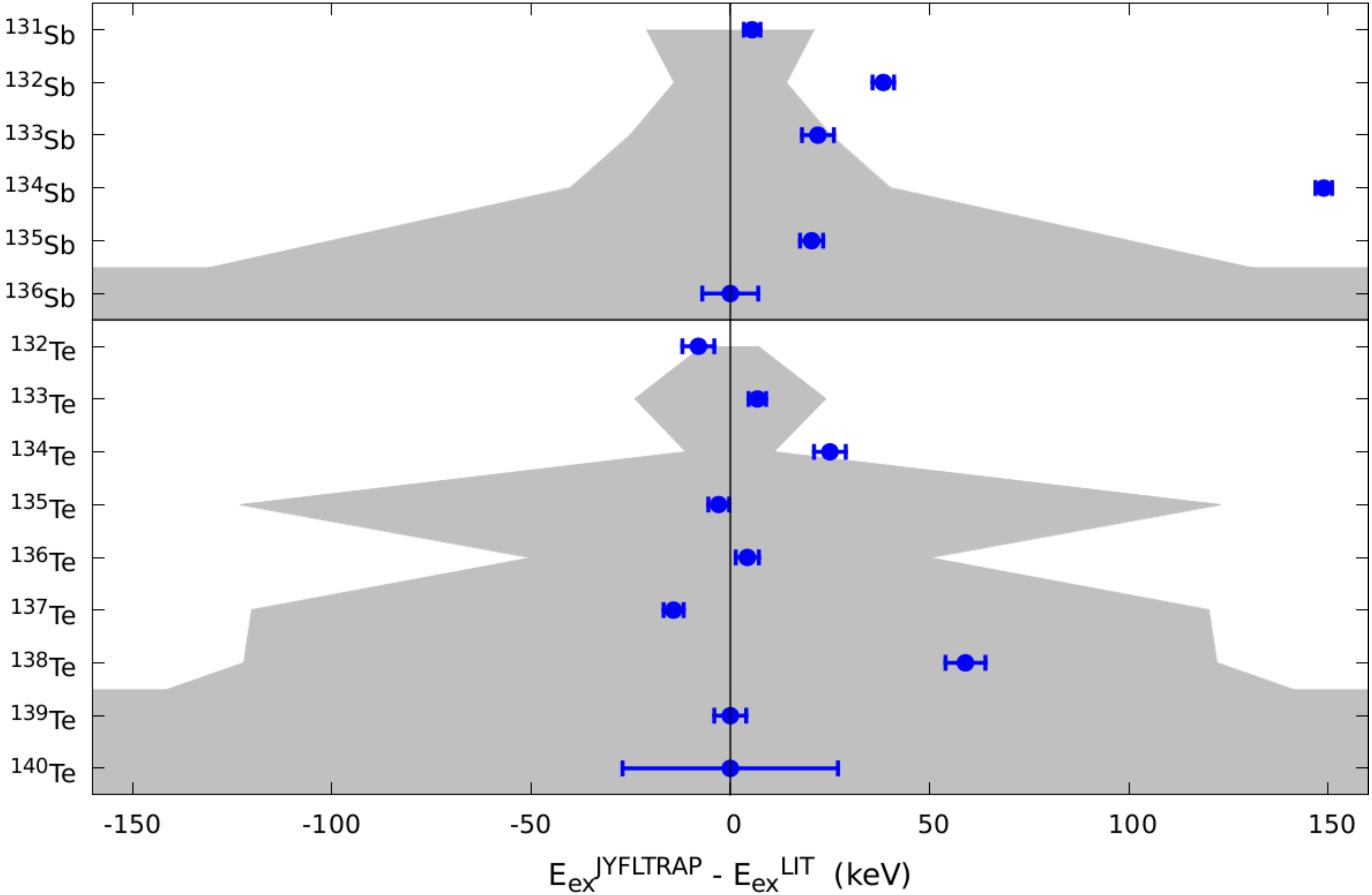
Recent JYFLTRAP measurements at ^{132}Sn region



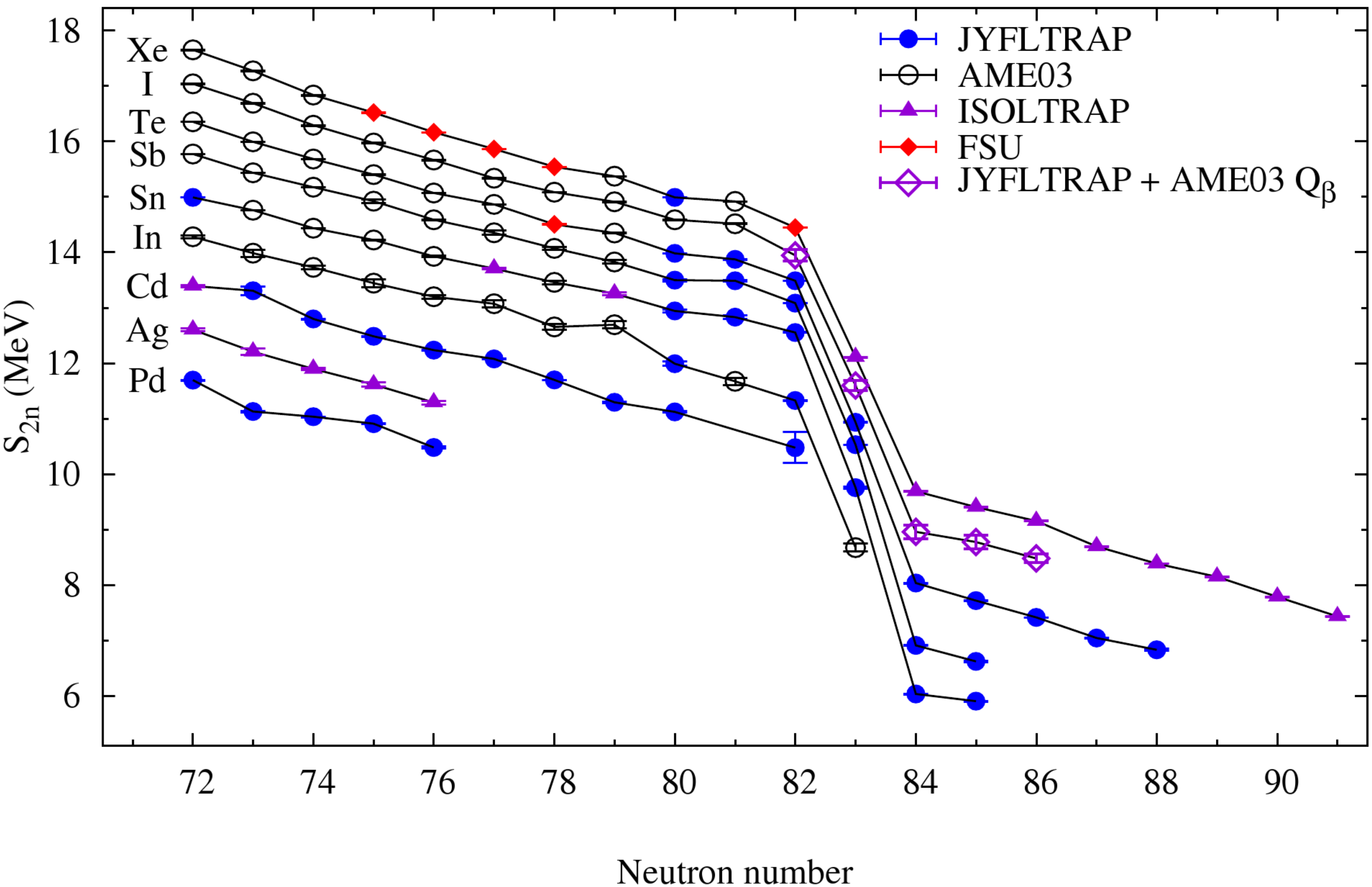
Results Cd – In - Sn



Results Sb - Te

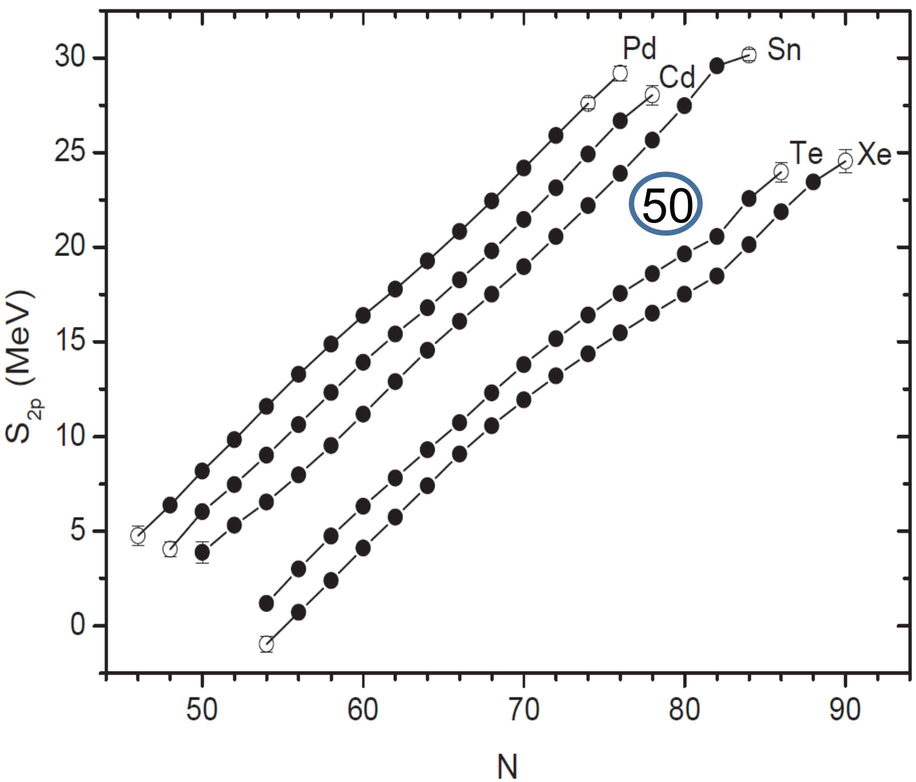


Two-neutron separation energies (S_{2n})

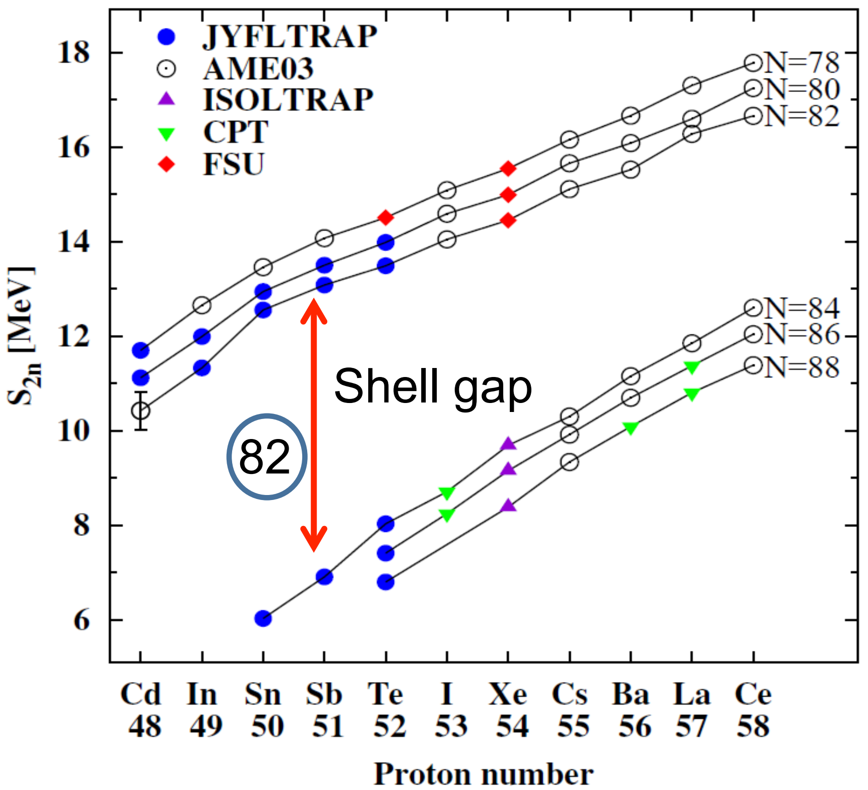


Evolution of shell structure at Z=50 and N=82

Two-proton shell gap for Z=50



Two-neutron shell gap for N=82



Odd-even staggering (OES);

a measure of empirical pairing gap

3-point formula

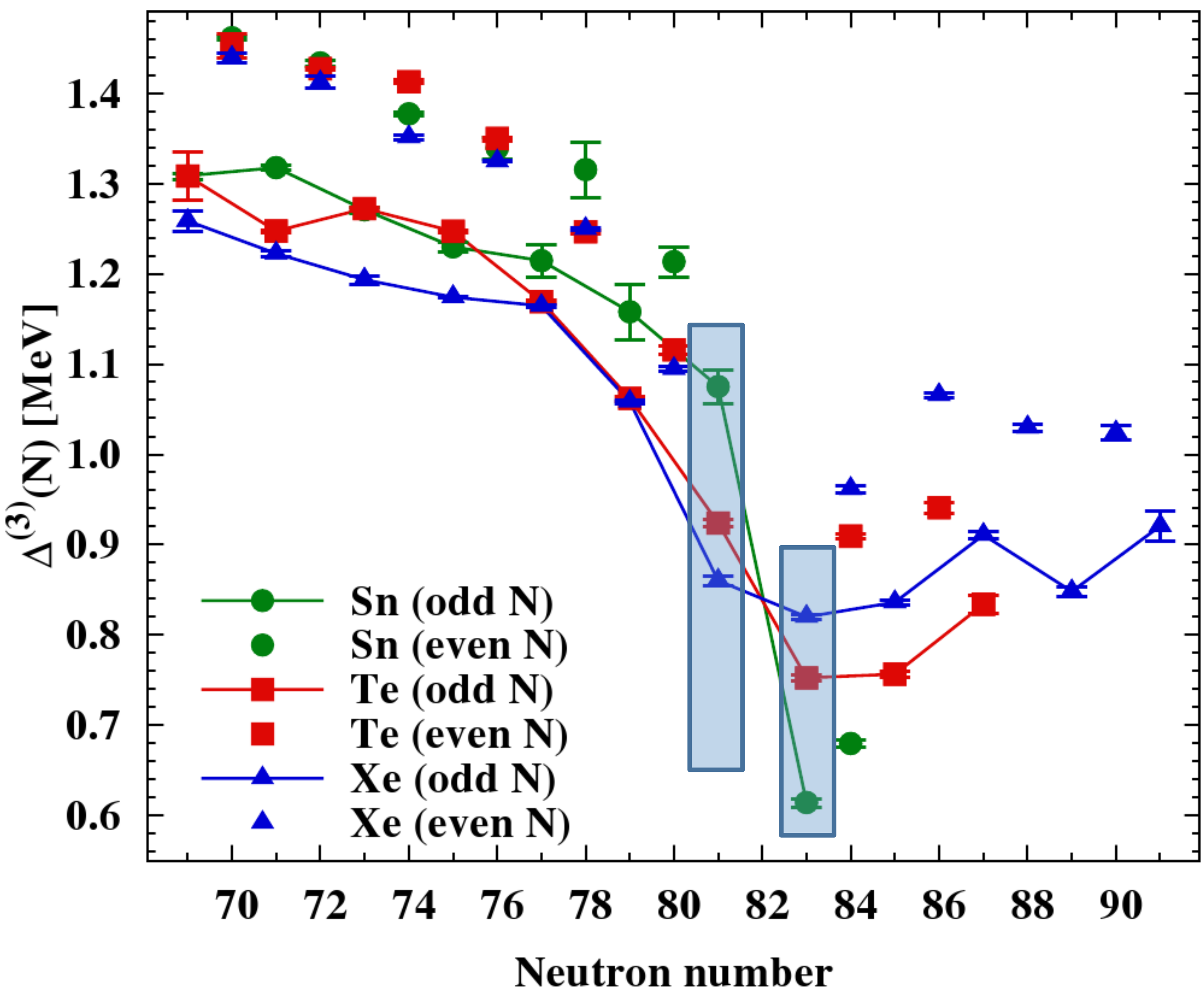
$$\Delta^{(3)}(N) = (-1)^N [E(N+1) - 2E(N) + E(N-1)]/2$$

OES mostly depends on the intensity of nucleonic pairing correlations in nuclei but is also affected by the polarisation effects!

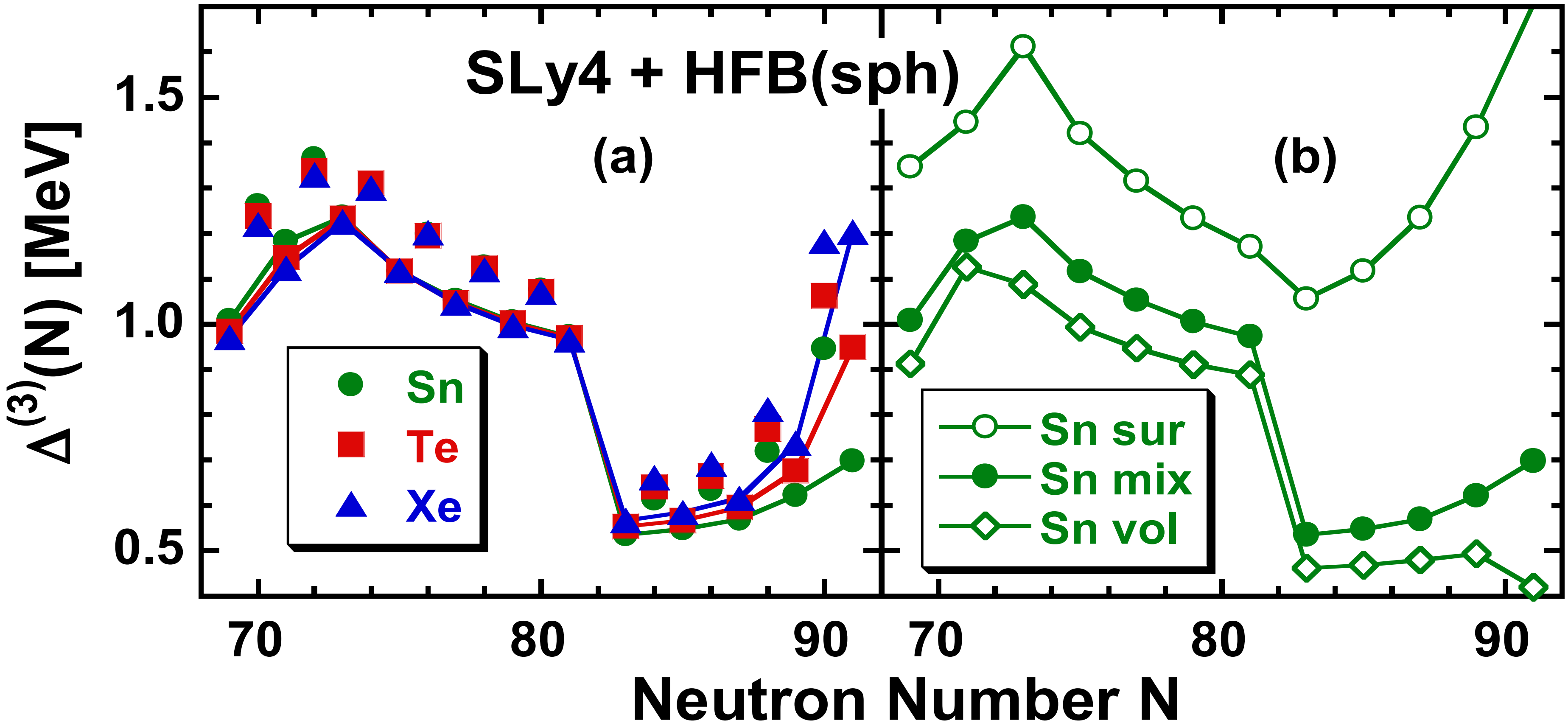
OES(N_{odd}) ~ measure of pairing effects

OES(N_{even}) ~ impacted by single particle states around Fermi level

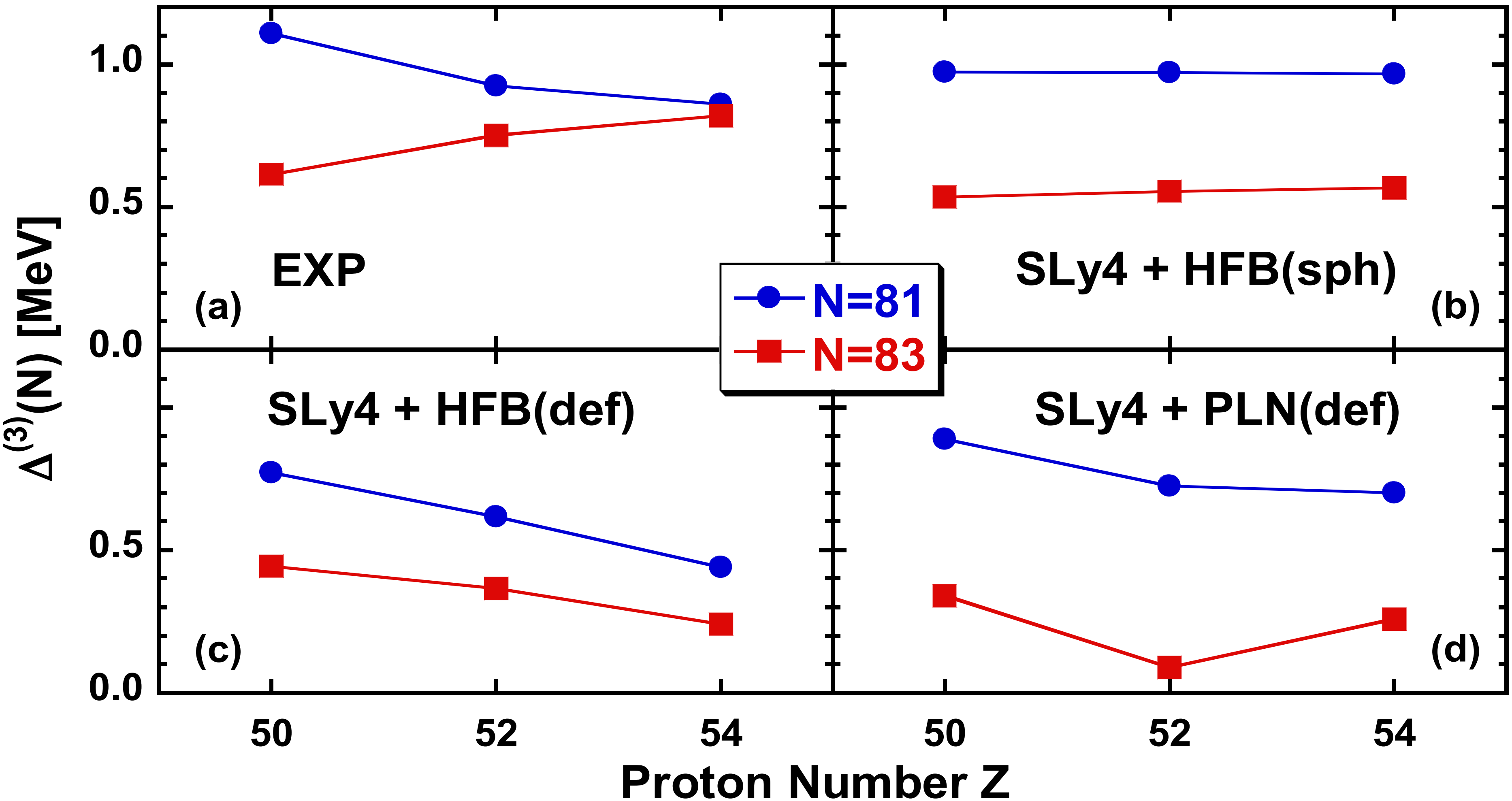
Odd-even mass staggering



Spherical EDF calculations around ^{132}Sn

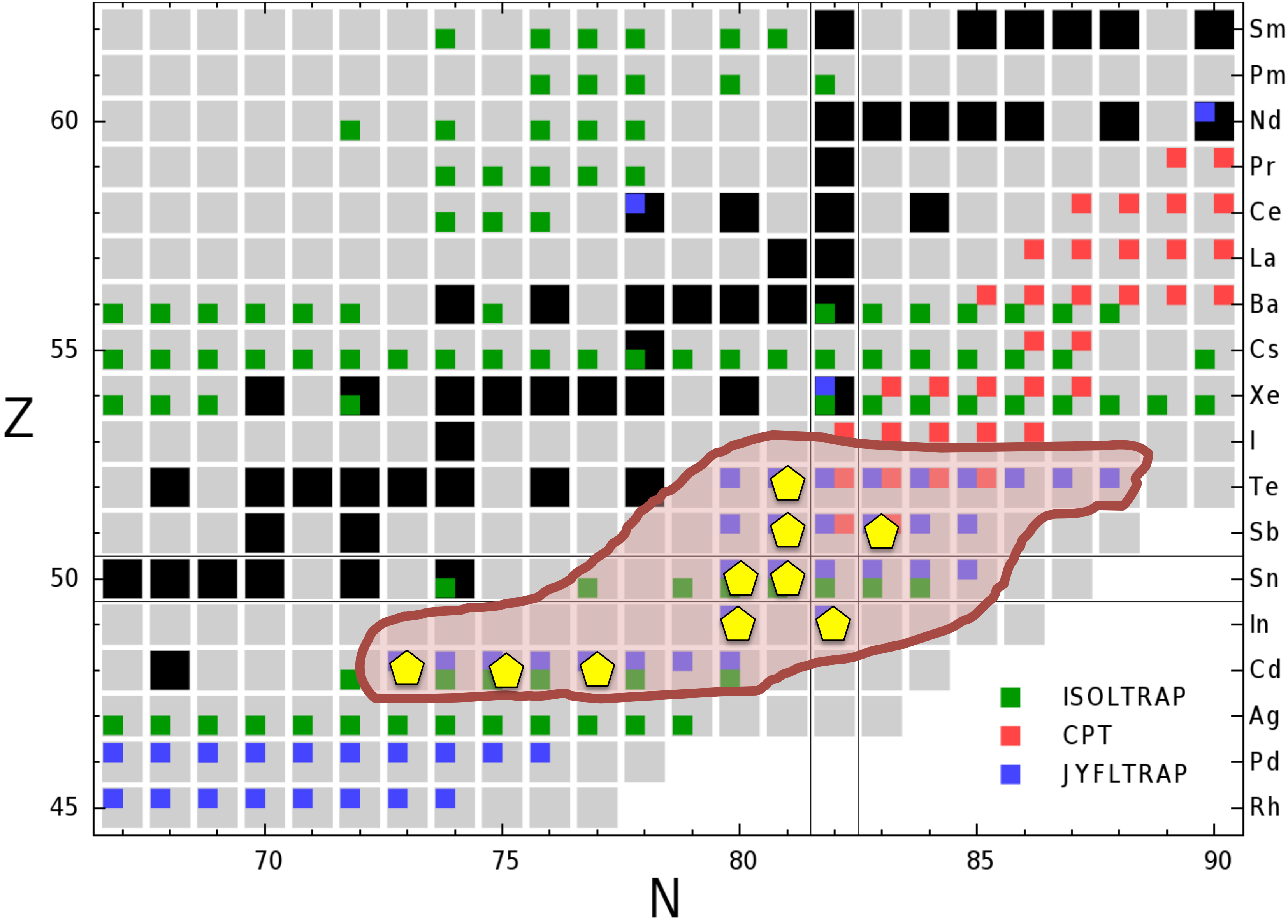


Odd-even mass staggering in N=81 & 83



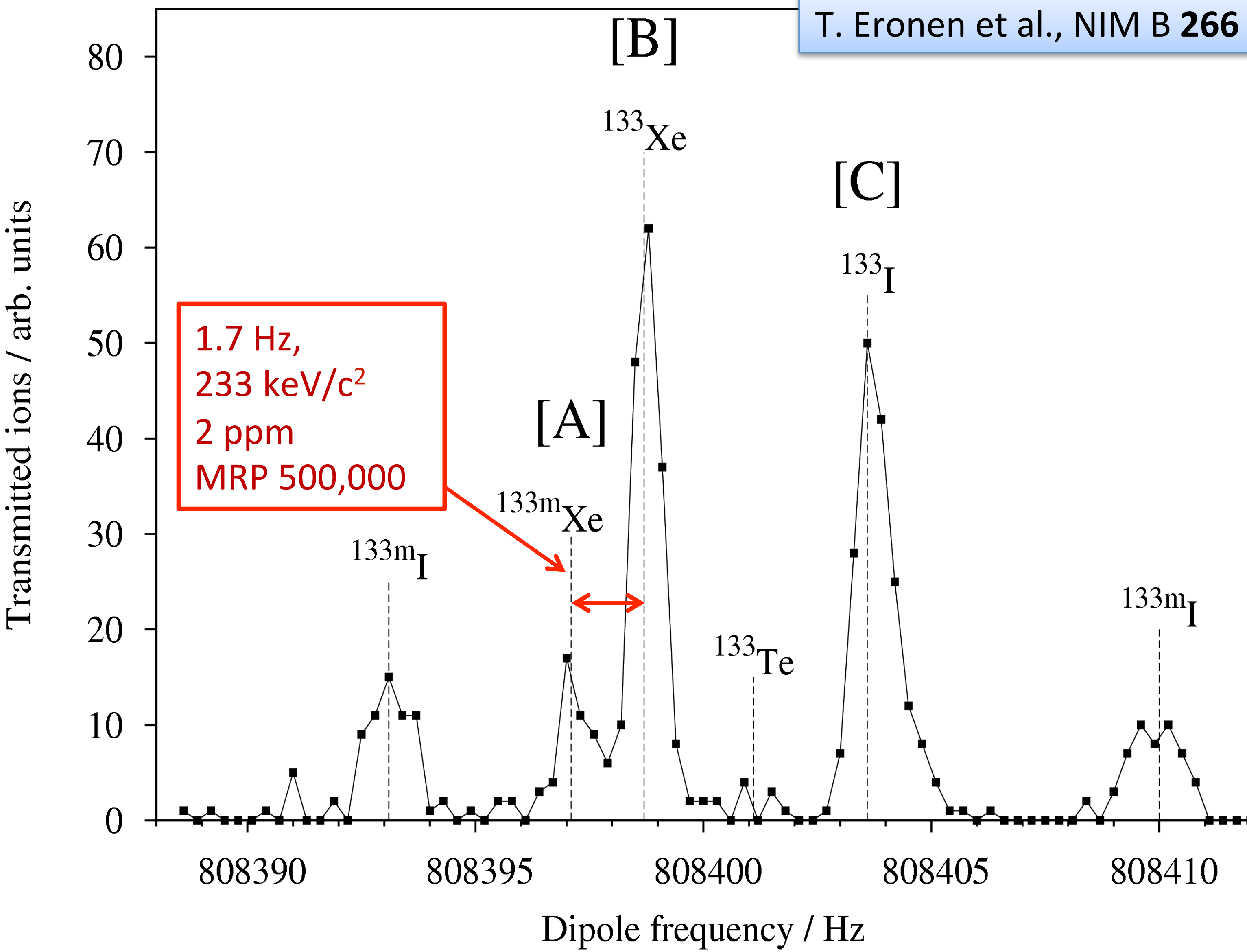
Isomeric states

$T_{1/2}$ > 100 ms

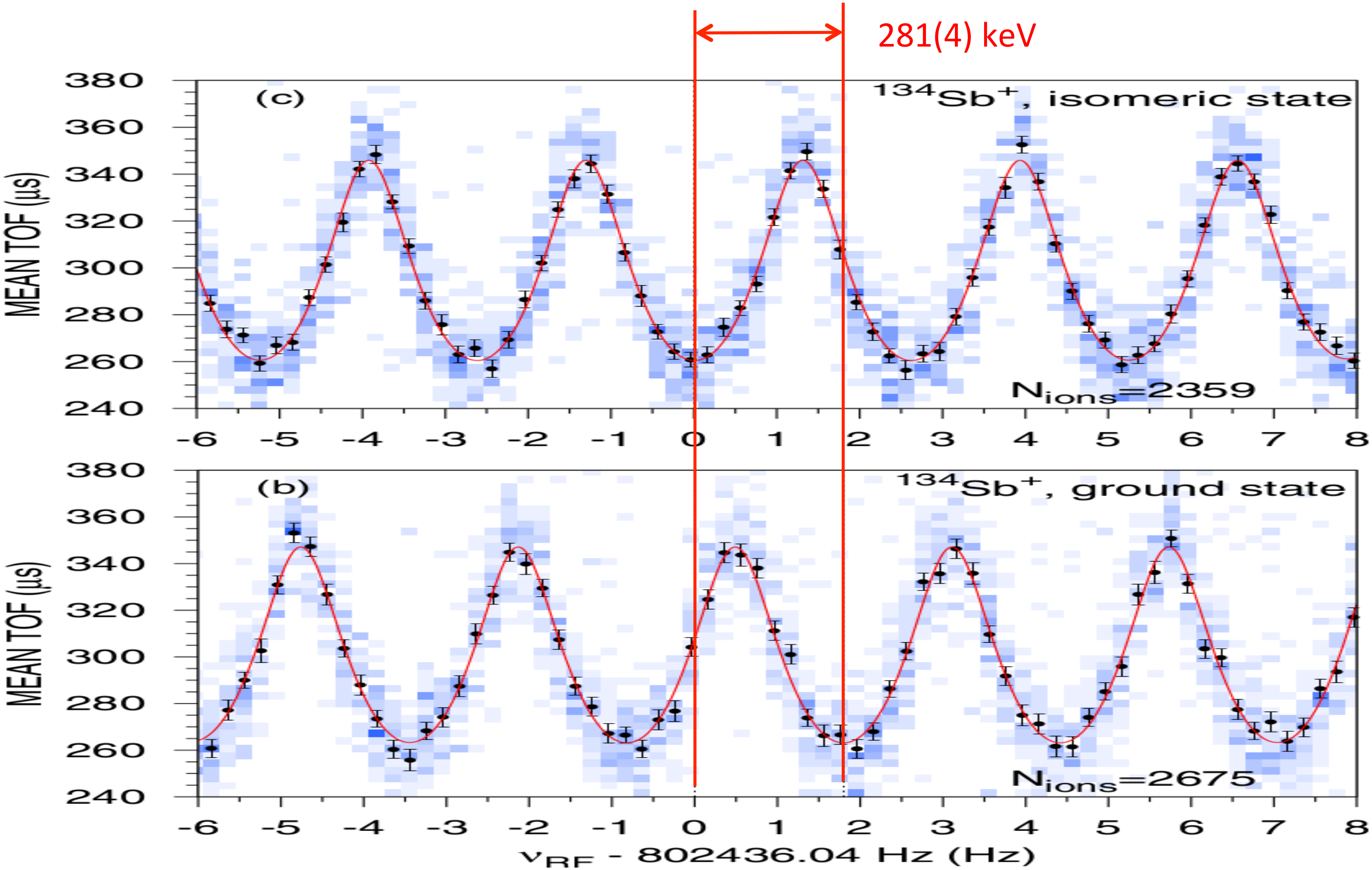


Isomers can be separated in 250 ms

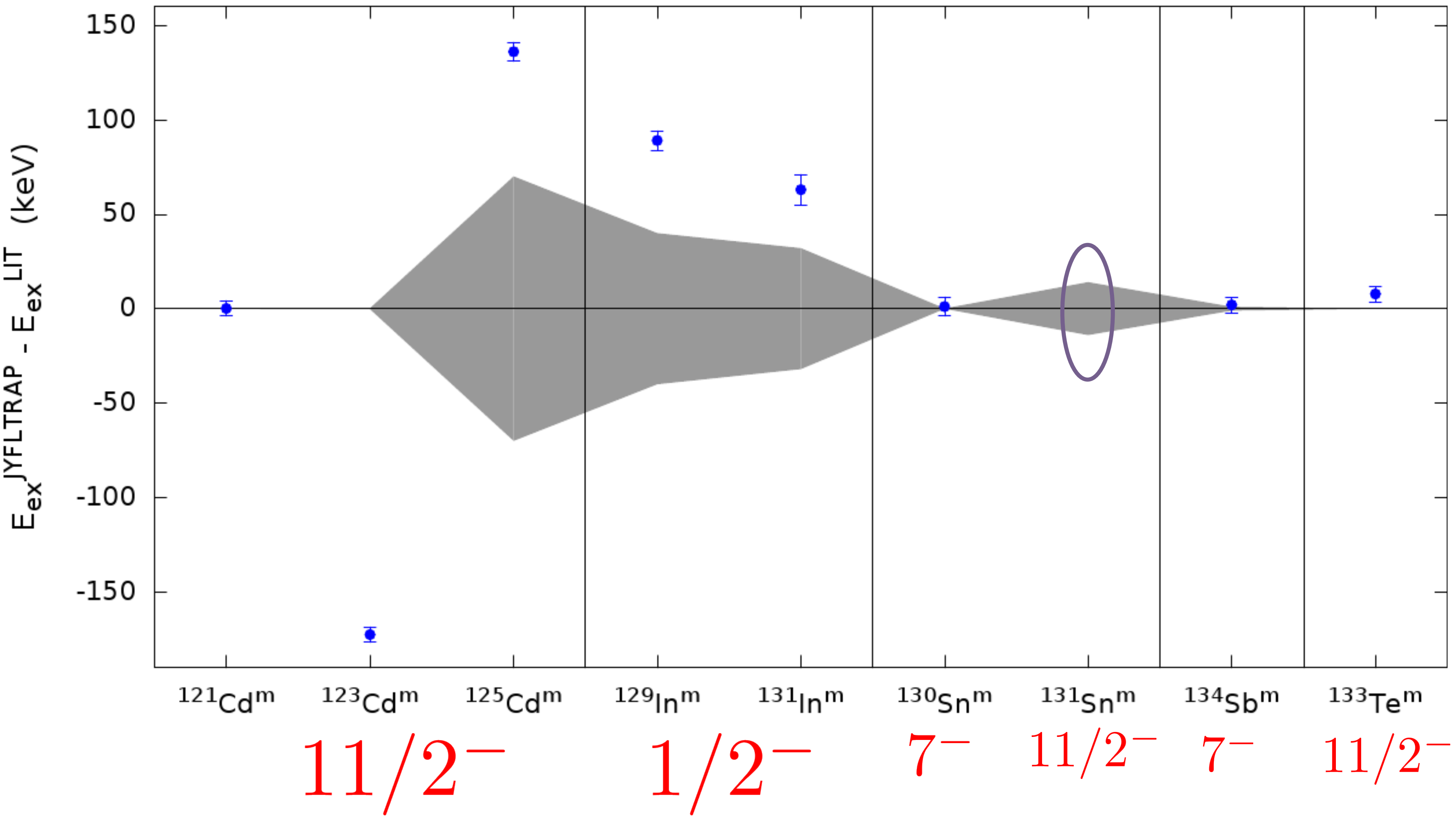
T. Eronen et al., NIM B **266** (2008) 4527



Example: ^{134}Sb and $^{134}Sb^m$

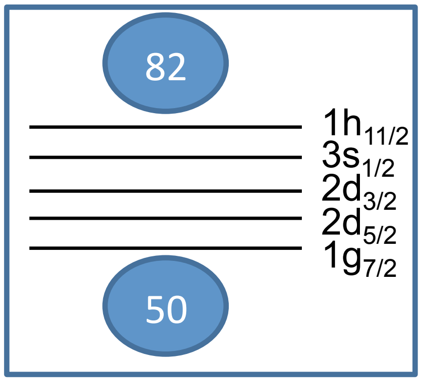


Isomer energies measured

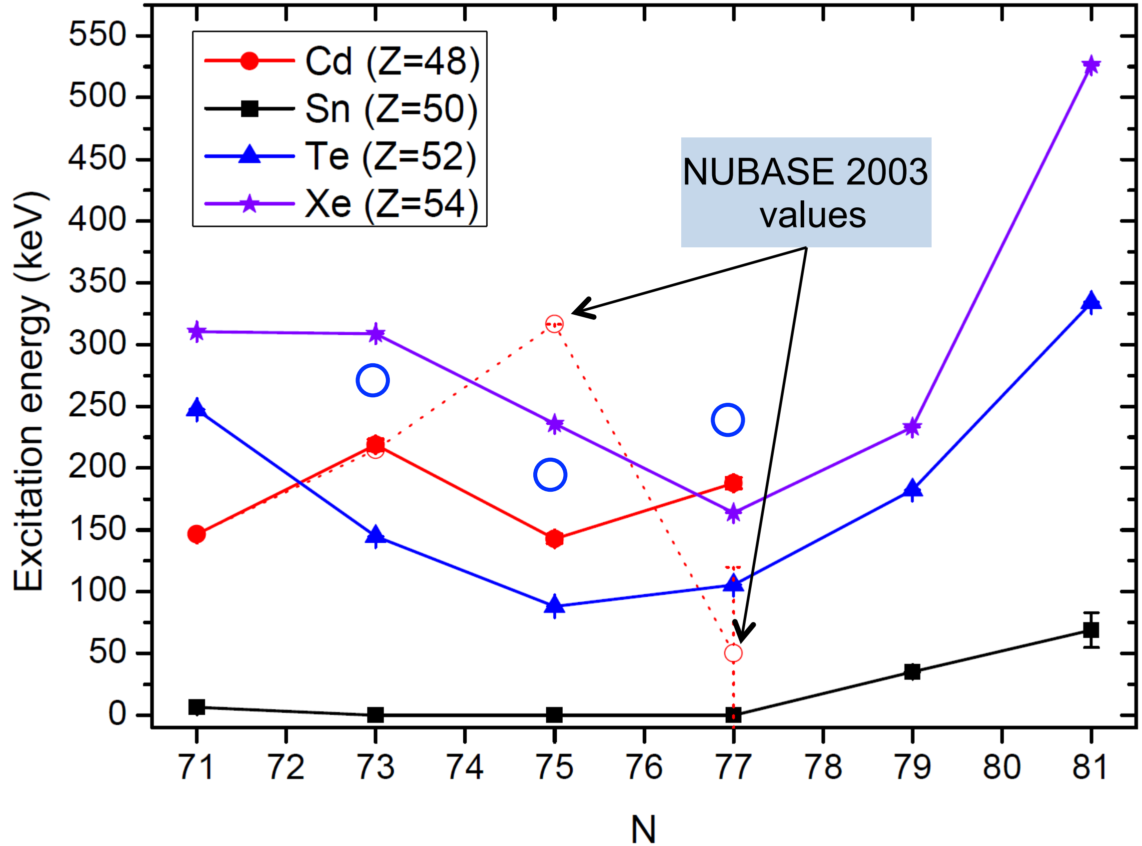


$11/2^-$ isomers in odd-N isotopes

Odd neutron in the $1h_{11/2}$ shell



SYSTEMATICS of the $11/2^-$ state

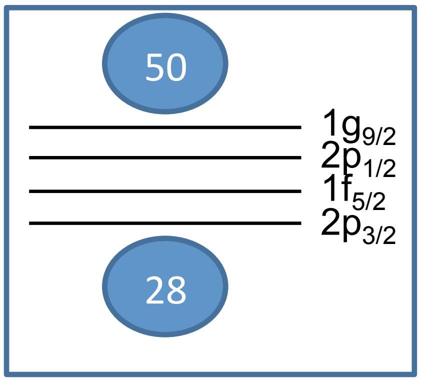


JYFLTRAP values→ similar trend as for Te isotopes

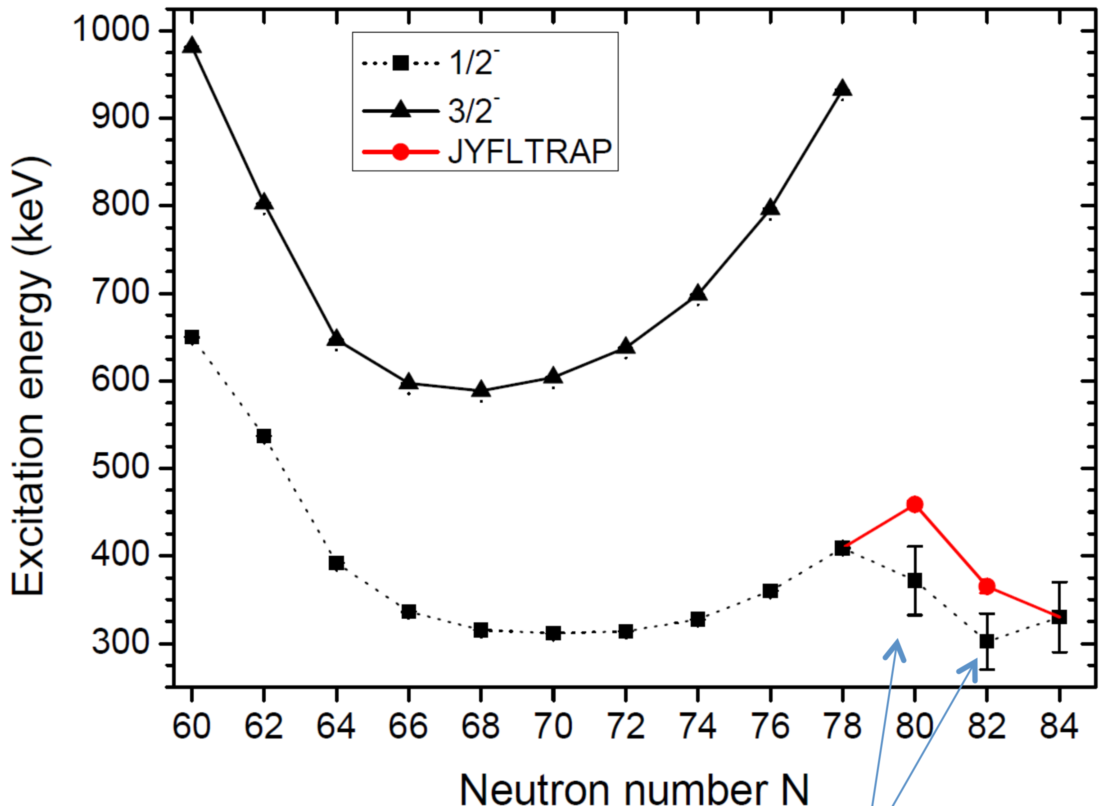
A. Kankainen, J. Hakala et al., PRC submitted (2012) arXiv:1206.6236v1

$1/2^-$ isomers in In

In (Z=49)
proton-hole in the
$2p_{1/2}$ or in $1g_{9/2}$ shell



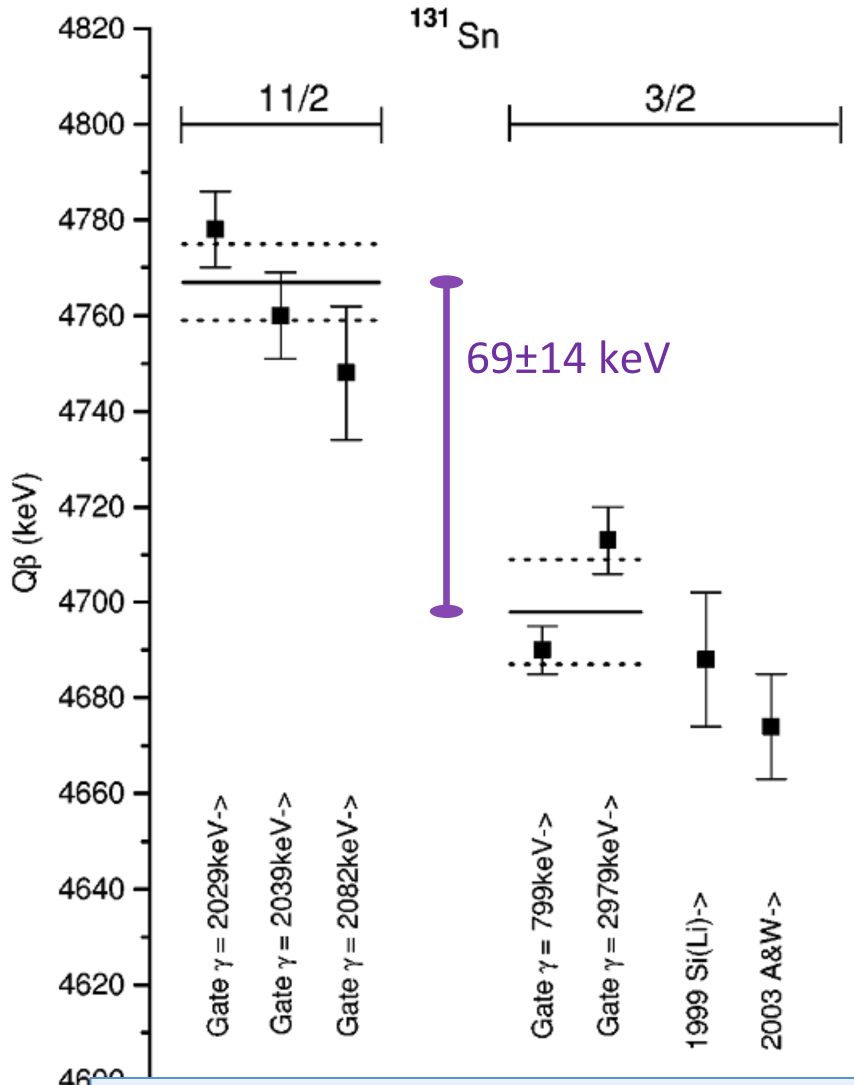
Excitation energy increases from N=78 to N=80



Old values based on beta-decay energy differences

^{131}Sn

- $\nu h_{11/2}$ hole
  - Presently from β endpoint
  - 69 keV
  - 0.5 ppm
  - MRP 2,000,000
  - 0.6 Hz at 7 T, 1^+



B. Fogelberg et al., PRC **70** (2004) 034312

Summary

- Masses beyond ^{132}Sn measured
- Down to ≈100 ms half-life, 10 keV accuracy
- Isomers resolved & removed
- Shell gaps
- Pairing gaps

- Also astrophysically important!

Acknowledgements

IGISOL and JYFLTRAP:
J. Hakala
D. Gorelov
A. Jokinen
V.S. Kolhinen
I.D. Moore
H. Penttilä
S. Rinta-Antila
V. Sonnenschein

T. Eronen (MPI-K)
J. Rissanen (LBNL)
A. Saastamoinen (TAMU)
J. Äystö (Helsinki Institute of Physics)

This work has been supported by the Academy of Finland under the Finnish Centre of Excellence Programme 2006–2011 (Nuclear and Accelerator Based Physics Programme at JYFL).

Thank you for your attention!

Unterstützt von / Supported by

Alexander von Humboldt
Stiftung/Foundation

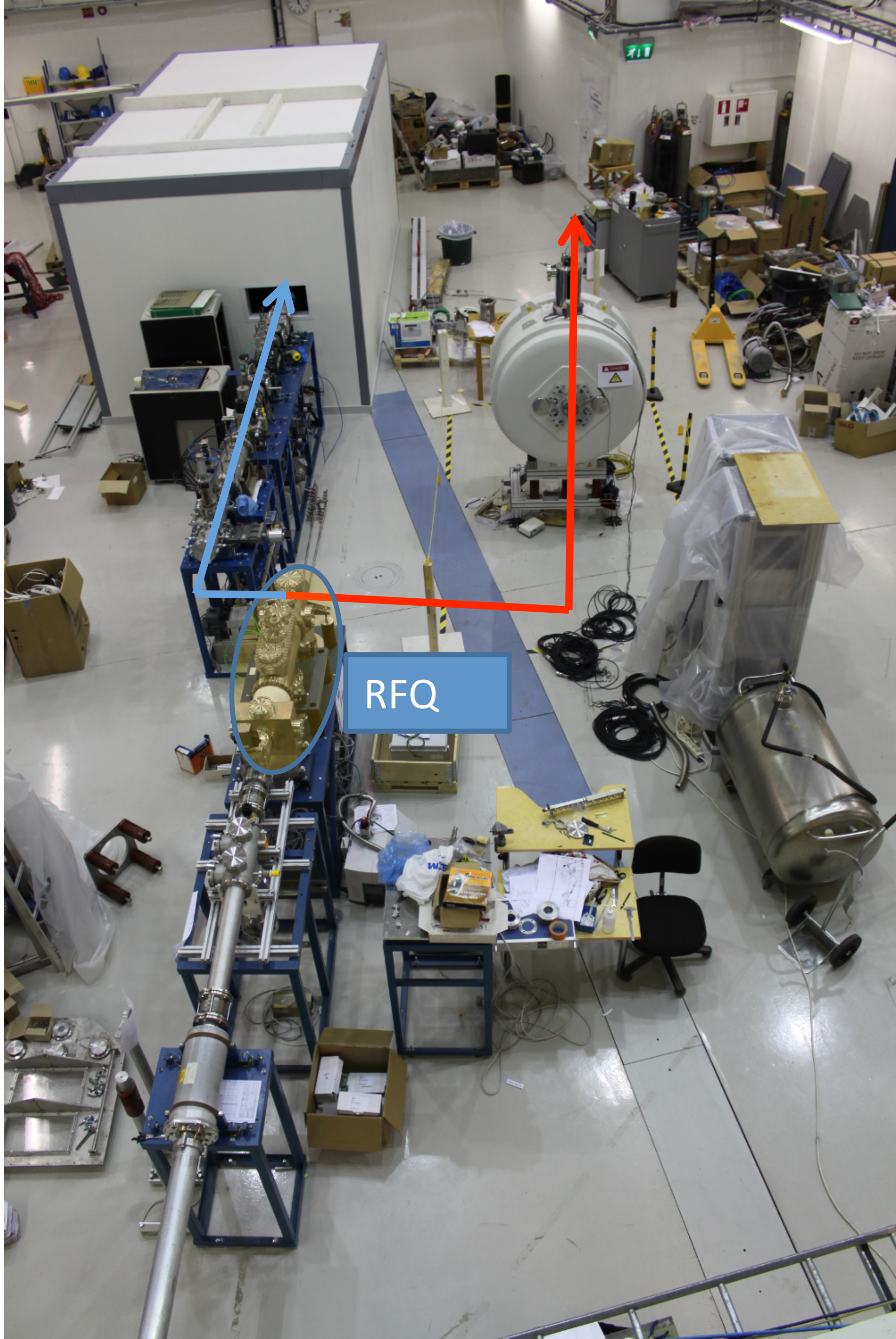
MAX-PLANCK-INSTITUT
FÜR KERNPHYSIK

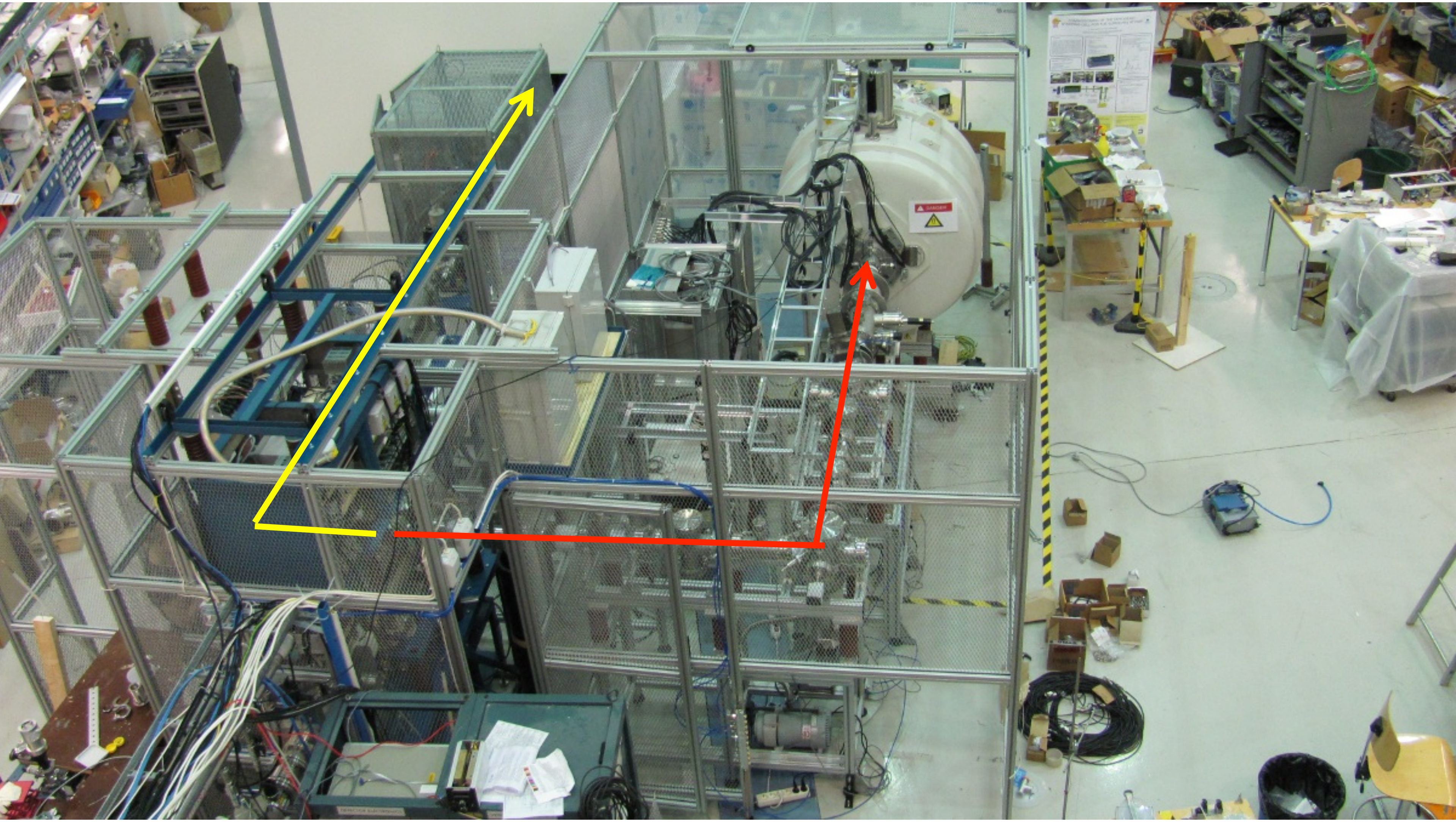
JYVÄSKYLÄN YLIOPISTO

IGISOL4

February 2012

- RFQ cooler+buncher (existing)
- Penning trap line
- Collinear laser spectroscopy line (Birmingham+Manchester)





Example: ^{131}In and $^{131}In^m$