Nuclear Structure of Odd-Au Isotopes

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On behalf of

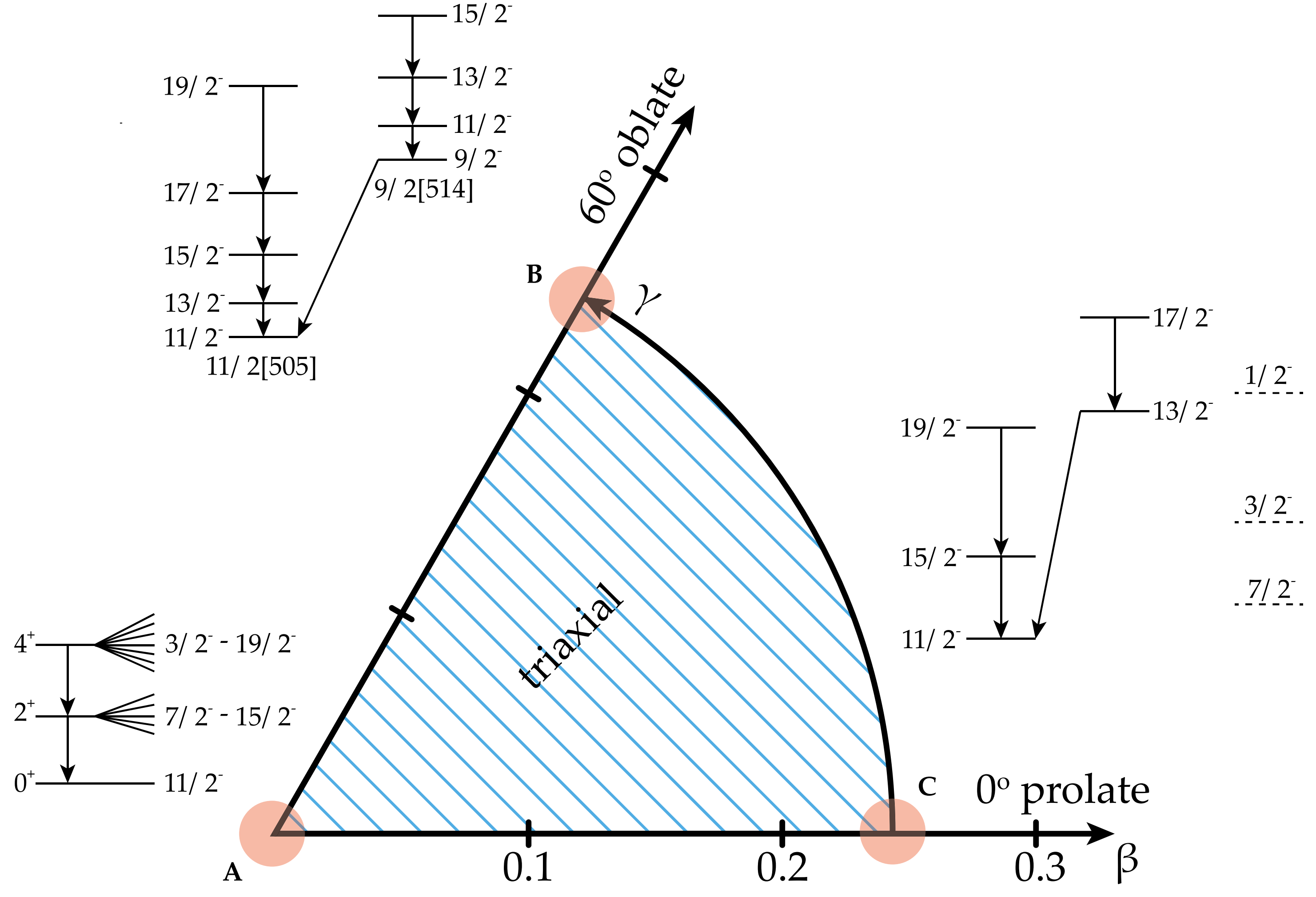
IS521 collaboration

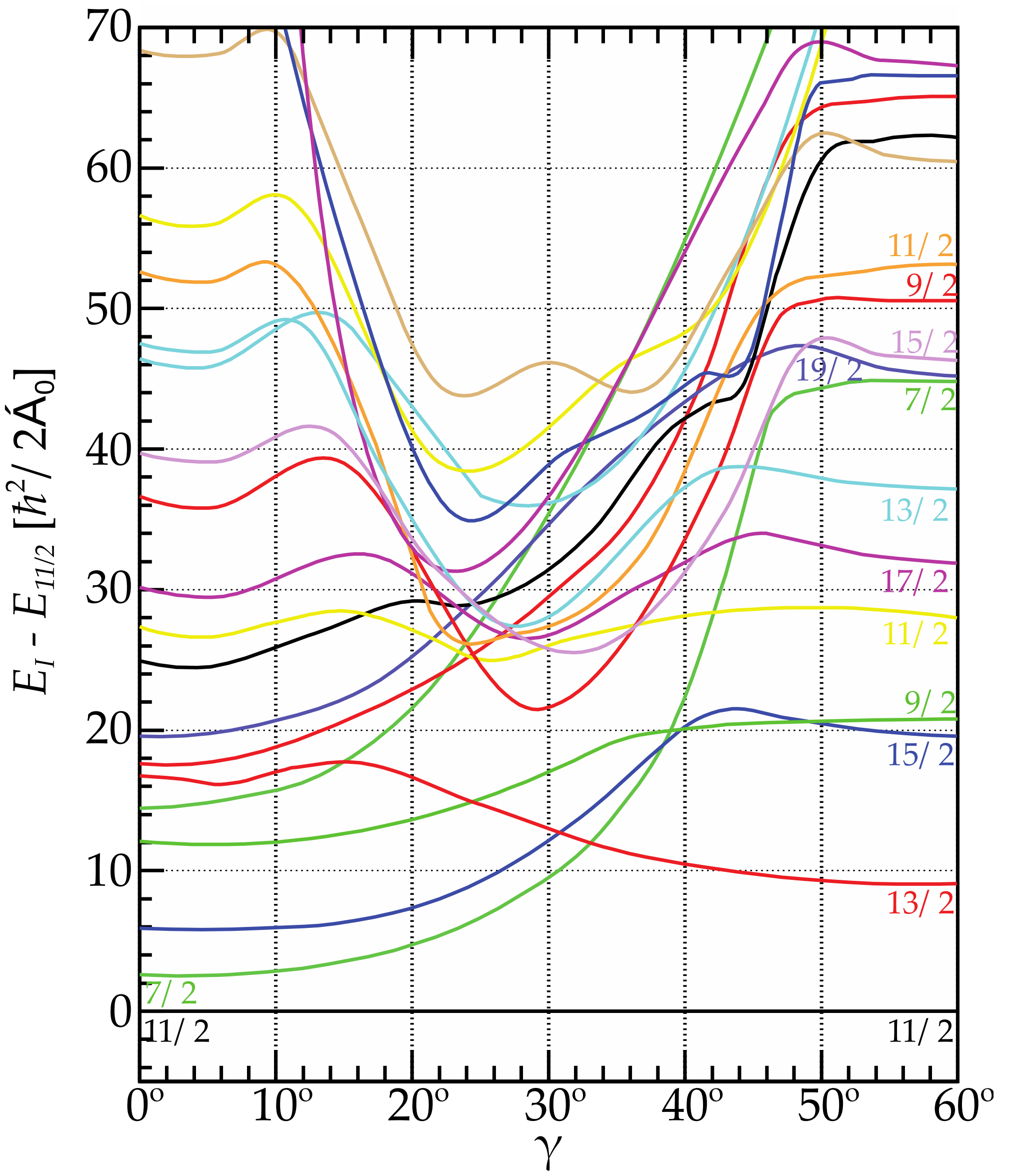
How can we use odd-Au isotopes to understand the structure of Hg and Pt?

- An odd particle acts as a probe of the core
  - Information on independent particle states
  - Information on deformation: axial and triaxial shapes
  - Information on pairing from blocking
  - Identification of intruder states free of mixing
  - Information on rotational collectivity
- Need of beta decay studies - non-yrast states
- Need of in-beam studies - rotational bands

- **One way how to probe even-even cores**

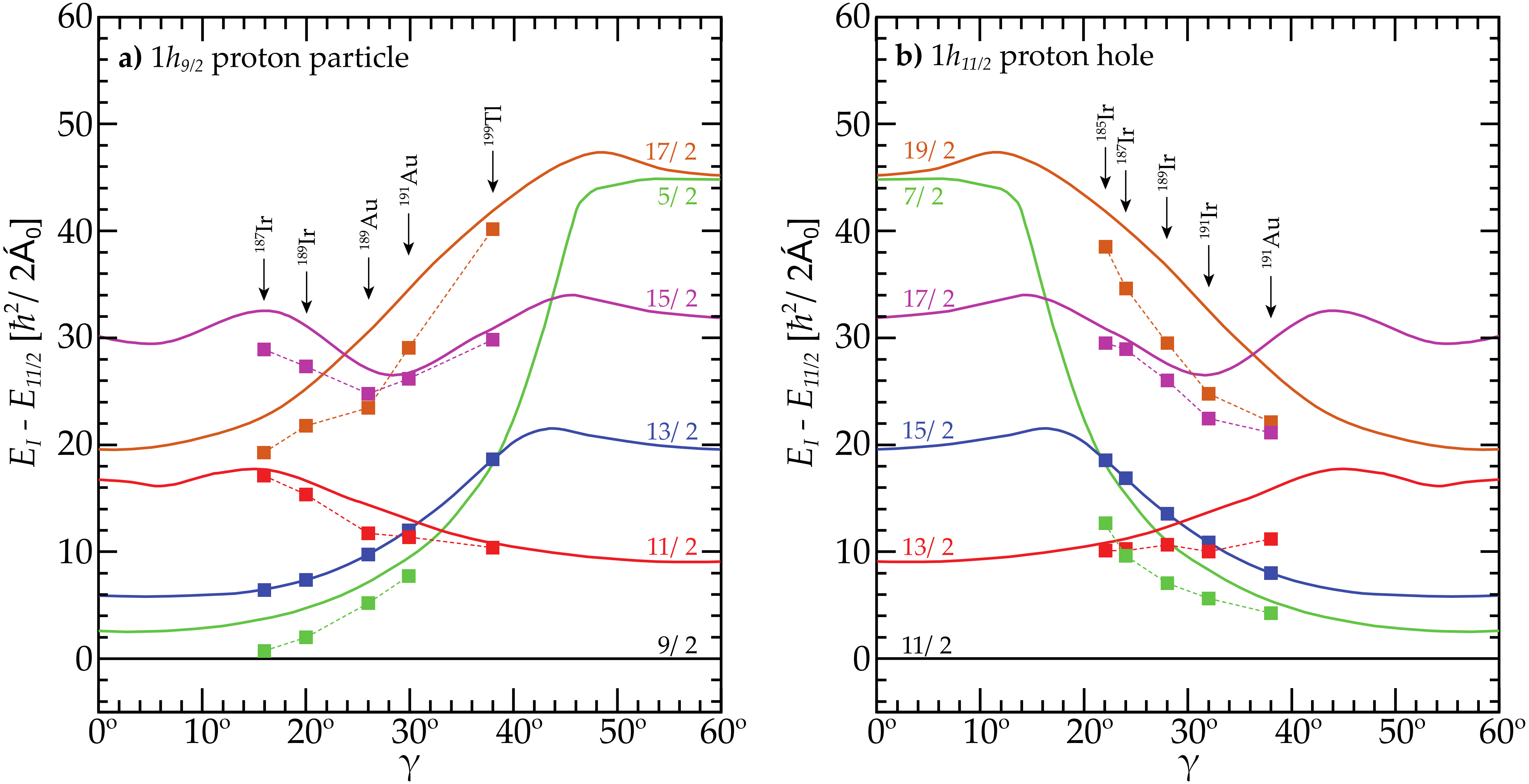
Particle-core coupling: 0th order model to navigate the data





J. Meyer-ter-Vehn *et al.*, Phys. Rev. Lett. **32**, 1383 (1974).

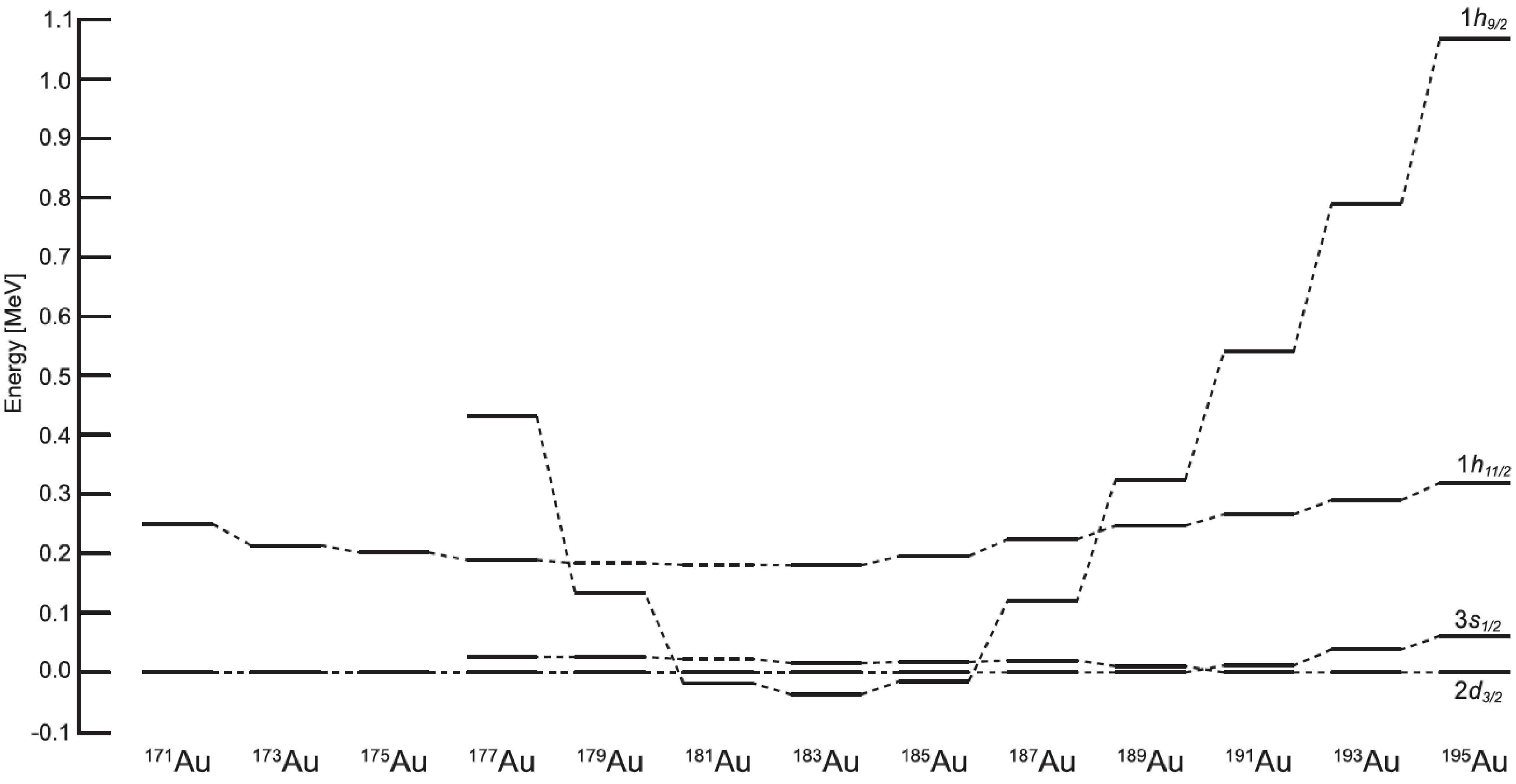
Particle-core coupling: 0th order model to navigate the data



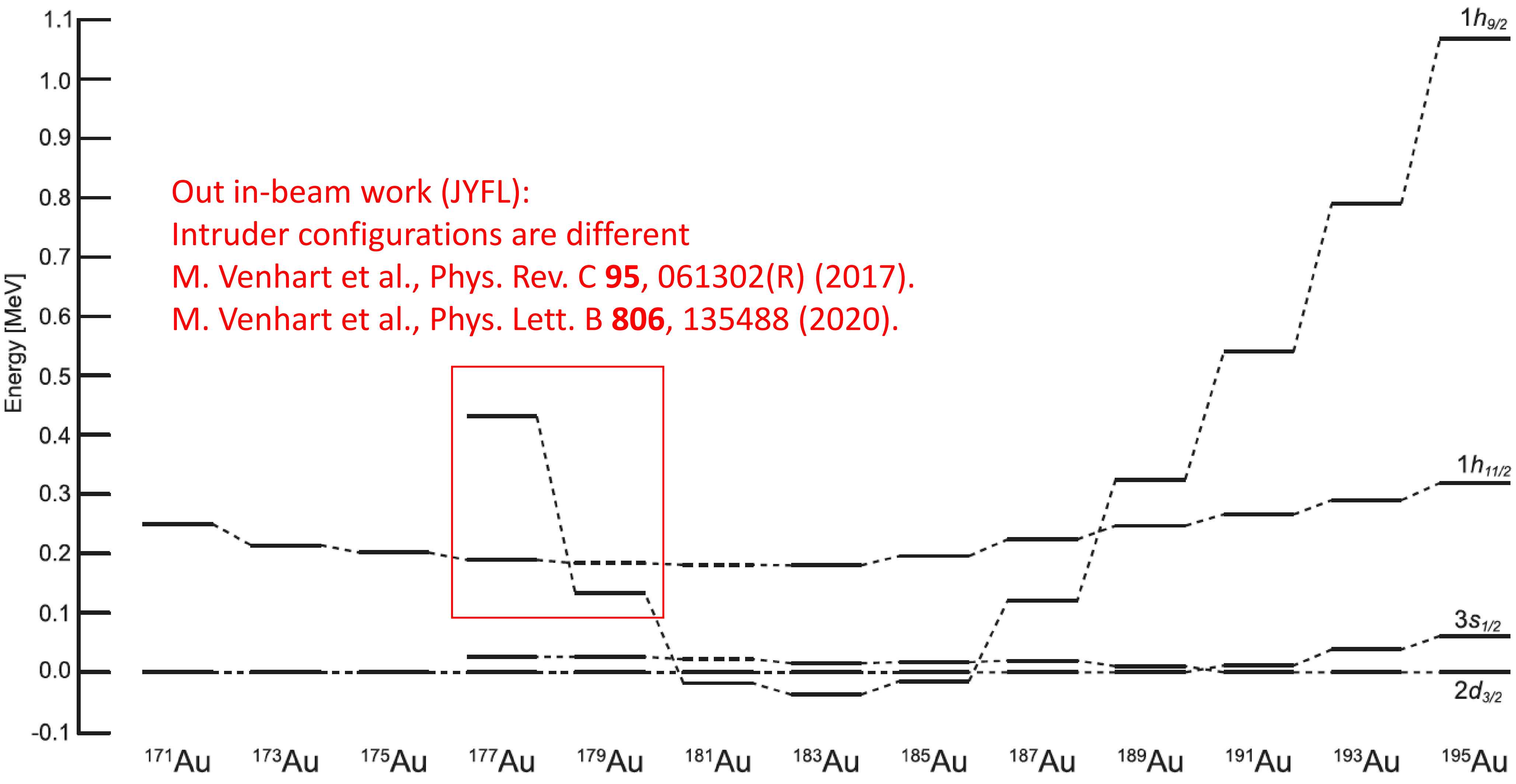
Broader picture of studies of odd-Au isotopes

- Done at ISOLDE so-far: structure of ^{181,183}Au (4 publications, 1 PhD., 2 master and 3 bachelor theses)
- In-beam gamma-ray studies performed at the University of Jyvaskyla and at iThemba Labs
- Newly discovered K isomerism in light Au isotopes (unpublished) – new research program is starting
- Lifetimes measurements are foreseen
- These studies complement decay studies at ISOLDE
- Our work has implications on understanding of even-even Hg isotopes
- We closely follow the work of laser spectroscopy specialists

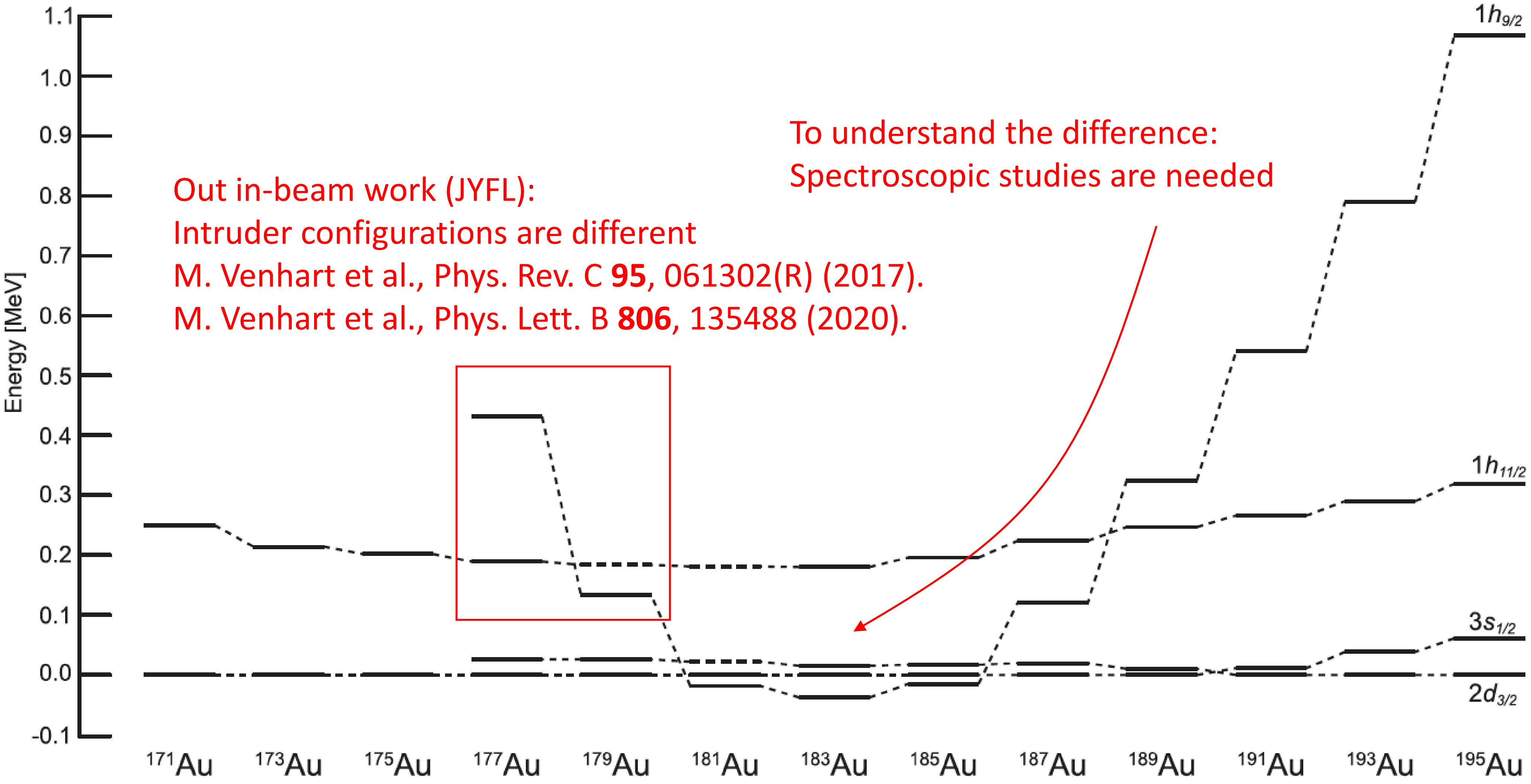
Choice of the isotope



Choice of the isotope



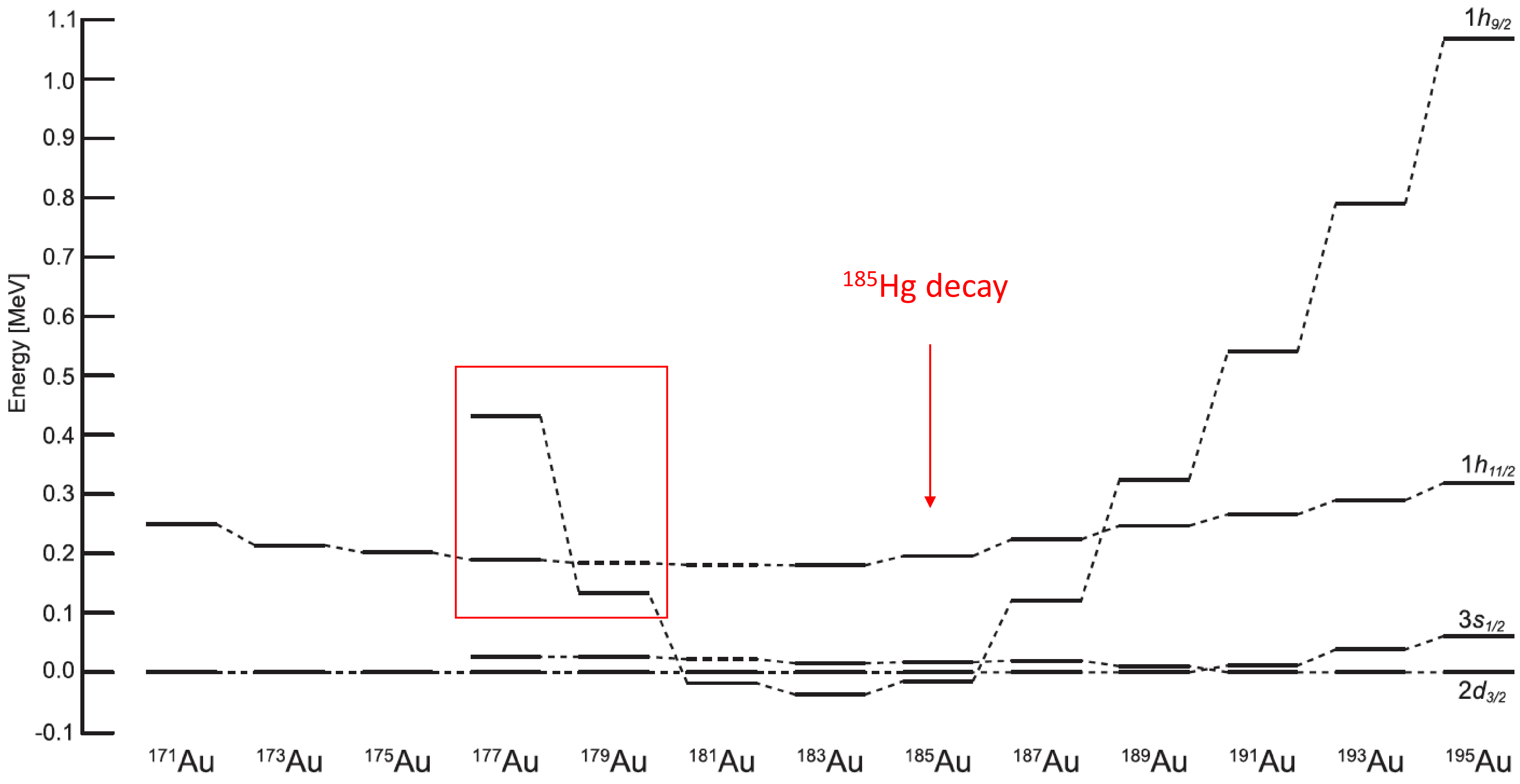
Choice of the isotope



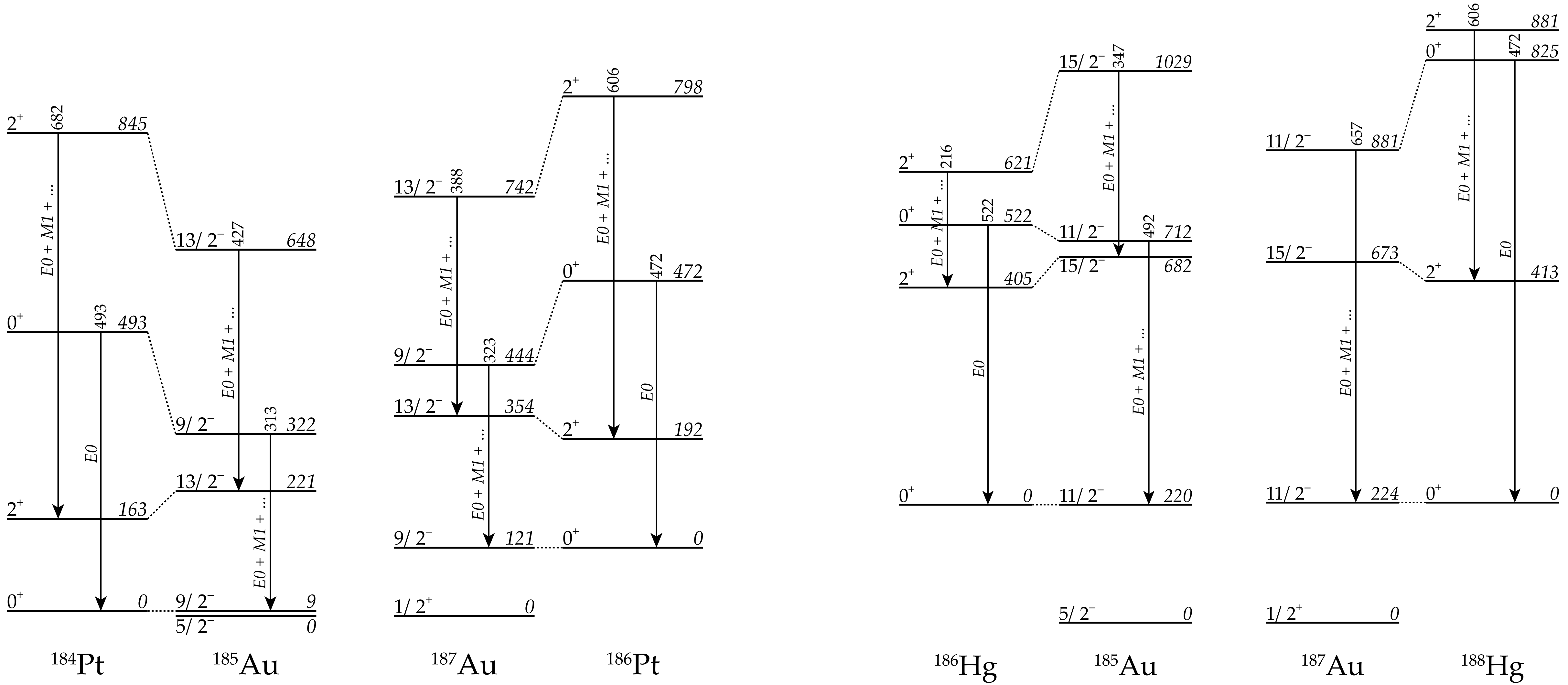
To understand the difference:
Spectroscopic studies are needed

Out in-beam work (JYFL):
Intruder configurations are different
M. Venhart et al., Phys. Rev. C **95**, 061302(R) (2017).
M. Venhart et al., Phys. Lett. B **806**, 135488 (2020).

Choice of the isotope



Multiple shapes in odd-Au isotopes



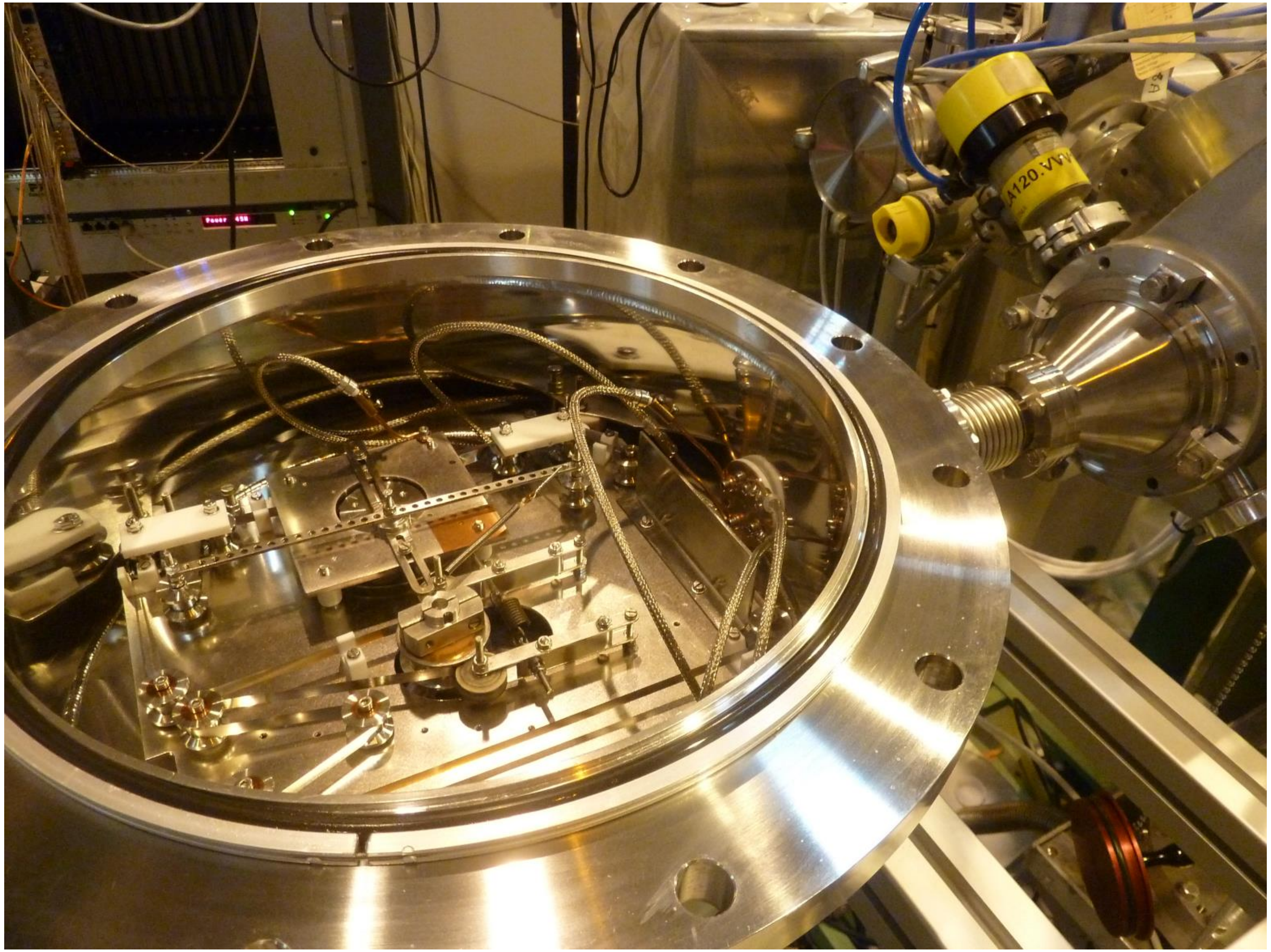
C. D. Papanicolopoulos *et al.*, Z. Phys. A **330**, 371 (1988).

Choice of the isotope: Complexity of the level scheme

- Many configurations are expected to coexists in ^{185}Au
- Only small fraction of the data that were measured at UNISOR was published
- Large density of excited states (example: ^{181}Au has first-excited state at 1.76 keV)
- Resolution of the system is crucial

- In ^{187}Au: 9 *E*0 transitions is known (connecting both positive and negative parity states)
- In ^{185}Au: E0 transitions connecting positive-parity states are not known
- Strongest gamma-ray is not placed into the level scheme

TATRA system: high-vacuum tape tranportation

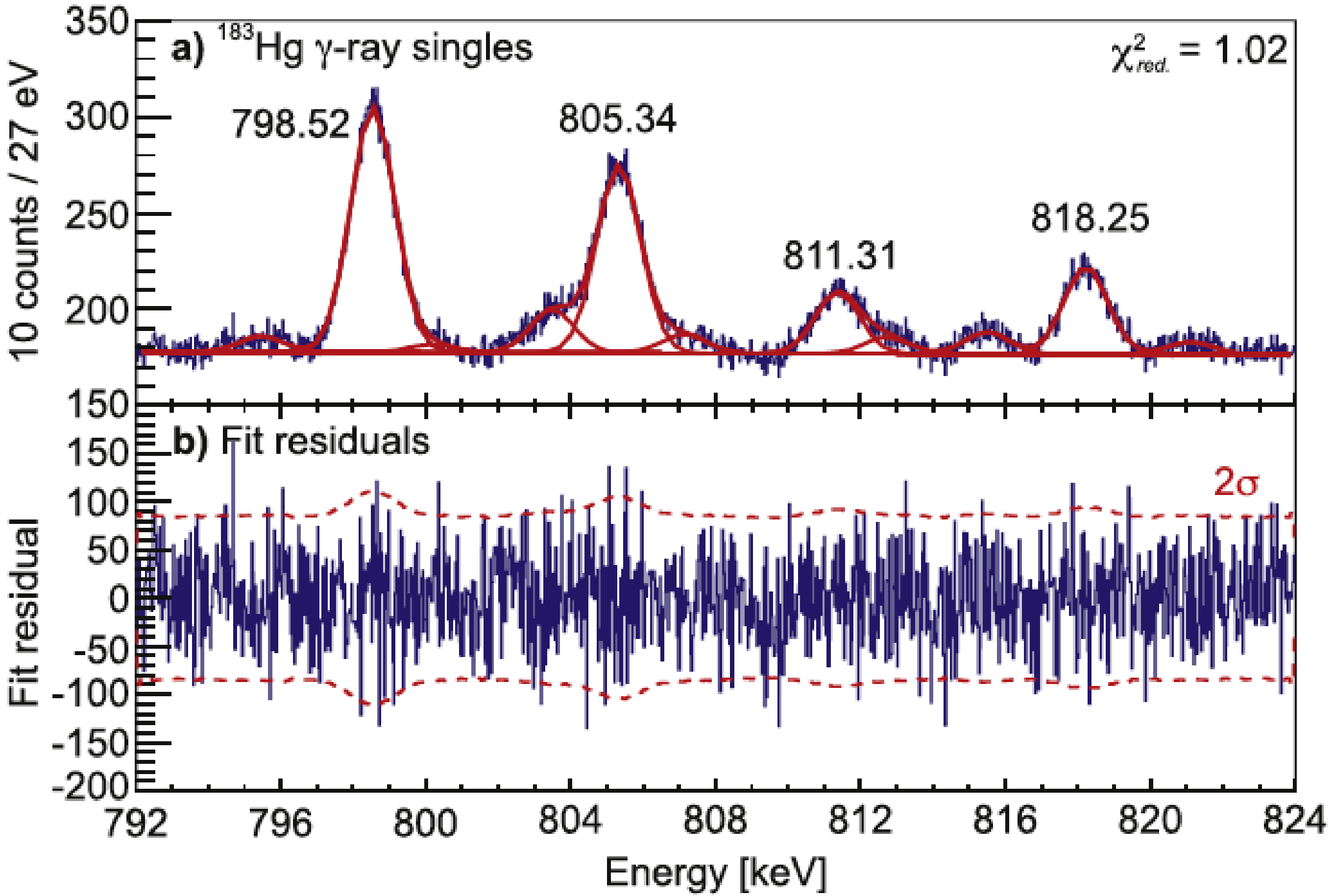


V. Matoušek *et al.*, Nucl. Instrum. And Meth A **812**, 118 (2016).

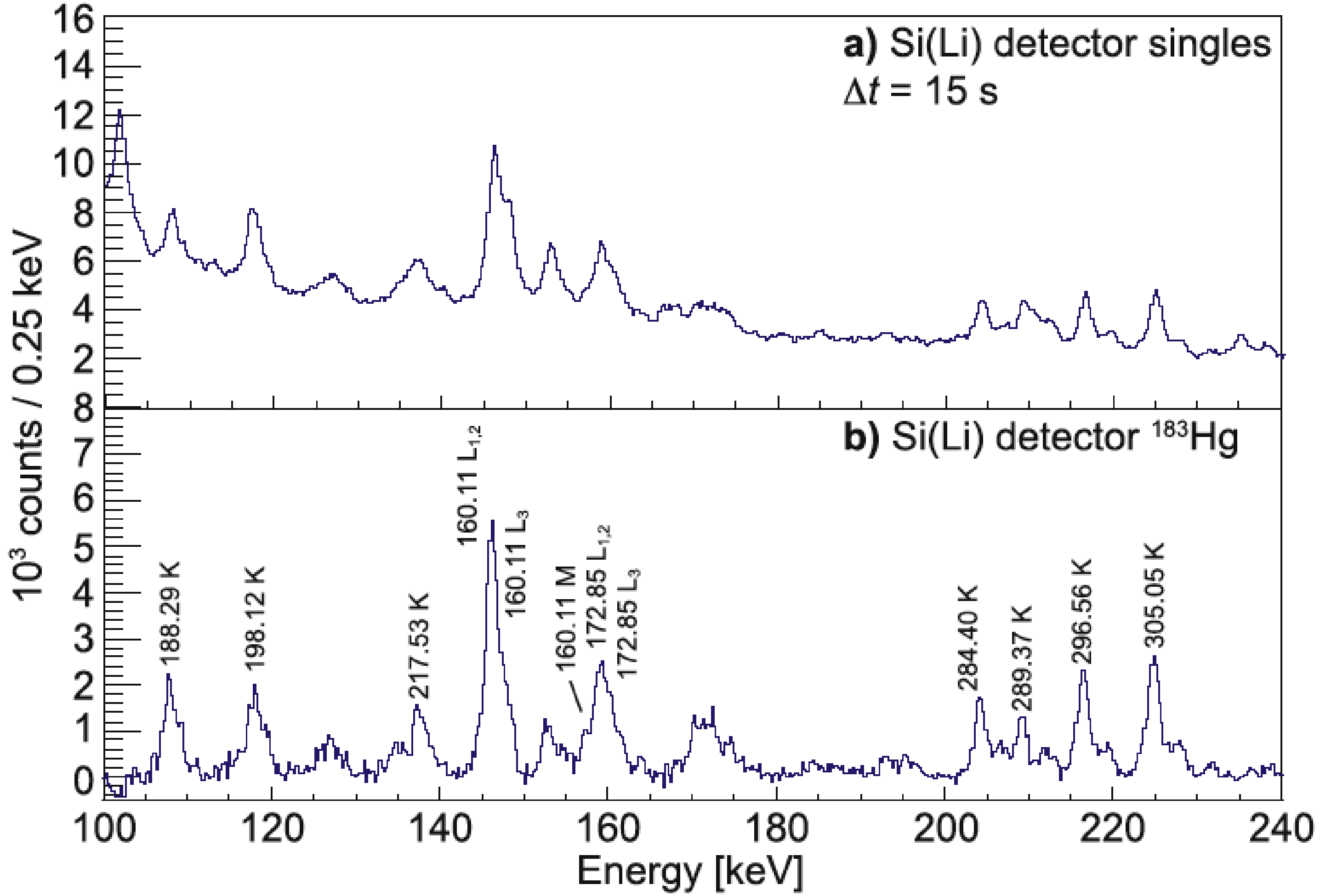
- **TA**pe **TRA**nsportation system inspired by 8-track tapes
- Rapidly quenched material: metallic glass is used to transport radioactive samples (deposition of ISOLDE beam)
- Operated at 3 x 10^{-8} mbar
- Windowless LN_2 cooled detector was used
- Very good resolution for conversion electrons

Broad Energy Germanium detotors

- Apporximately 1 MeV range for the BEGe, i.e. 27 eV per channel
- (Almost) ideal gaussian peak shape
- (Almost) linear background
- Rydberg-Ritz combination principle to 30 eV precision (in most cases down to 10 eV)
- System is combined with “standard“ germanium detectors for coincidences
- Sucessfully used to construct decay schemes of ^{181,183}Hg



Conversion electrons



- Resolution 1.6 keV for electrons above 100 keV
- **Worse resolution is not acceptable for these studies**

Beam time length justification

- Goal of the experiment: Spectroscopy on the level of 1 % of strongest gamma ray

- E0 transitions are expected to have 1 – 6 %

- The yield is not a limitation, beam time estimation is based on our study of 183Hg decay (10 % of strongest gamma ray)

- Increased gamma-gamma efficiency => factor of 3 increase

- Optimised DAQ electronics => factor of 2 increase

- Longer beam time compared with study of ^{183}Hg => factor of 2 increase

- Within 4 days of beamtime we will reach the goal.

- **Therefore we request to add 7 shifts to remaining 5**