Isomeric decays of $N \sim Z$ nuclei in the vicinity of ^{100}Sn

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ISOLDE WORKSHOP AND USERS MEEING 2017, DEC. 4

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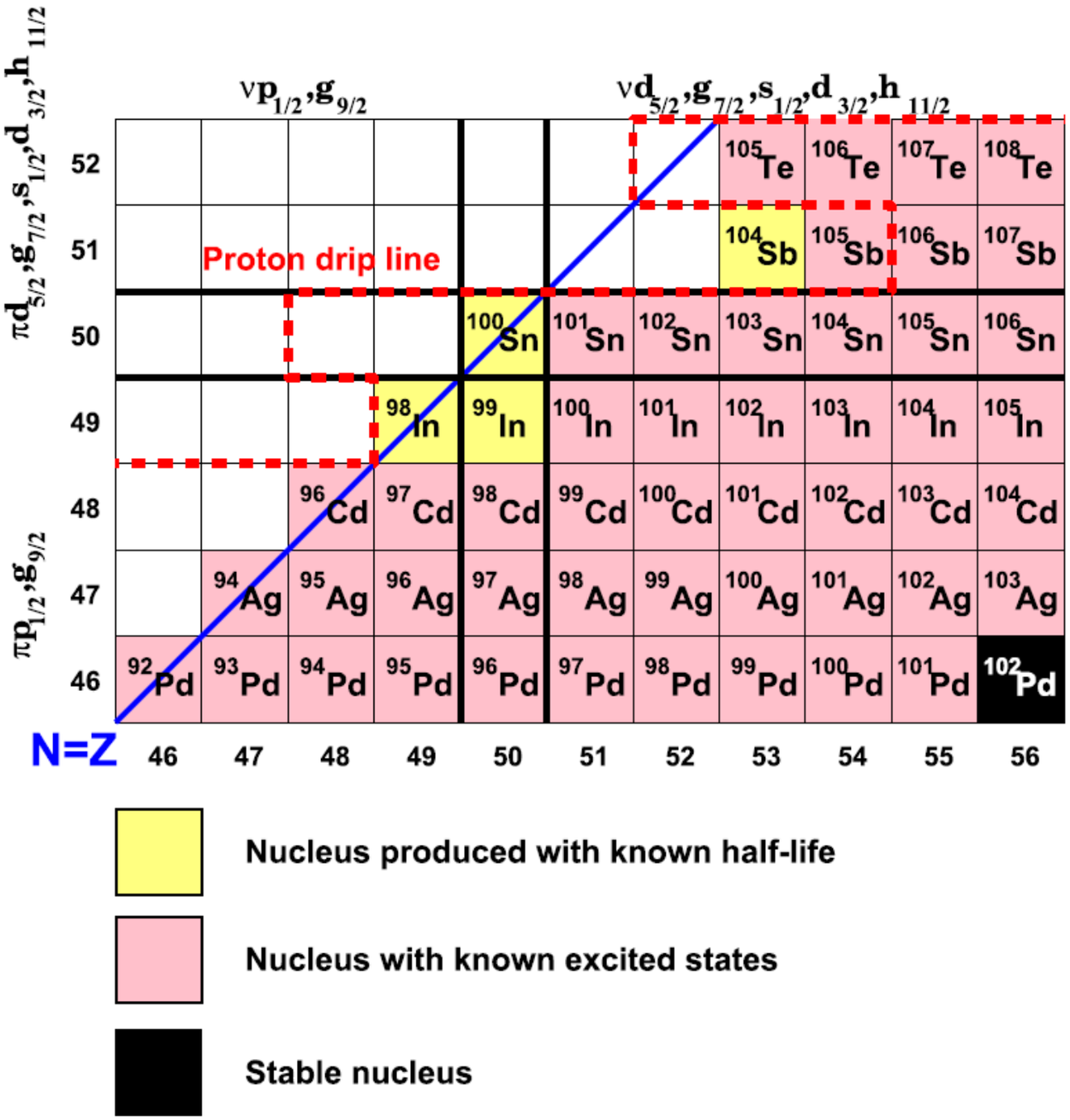
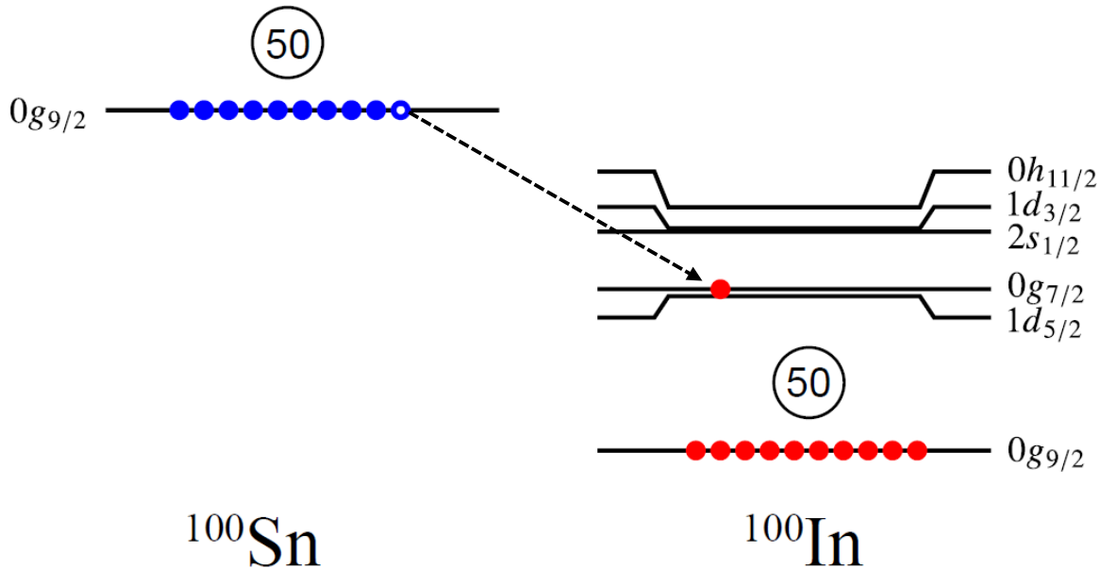
Doubly magic ^{100}Sn

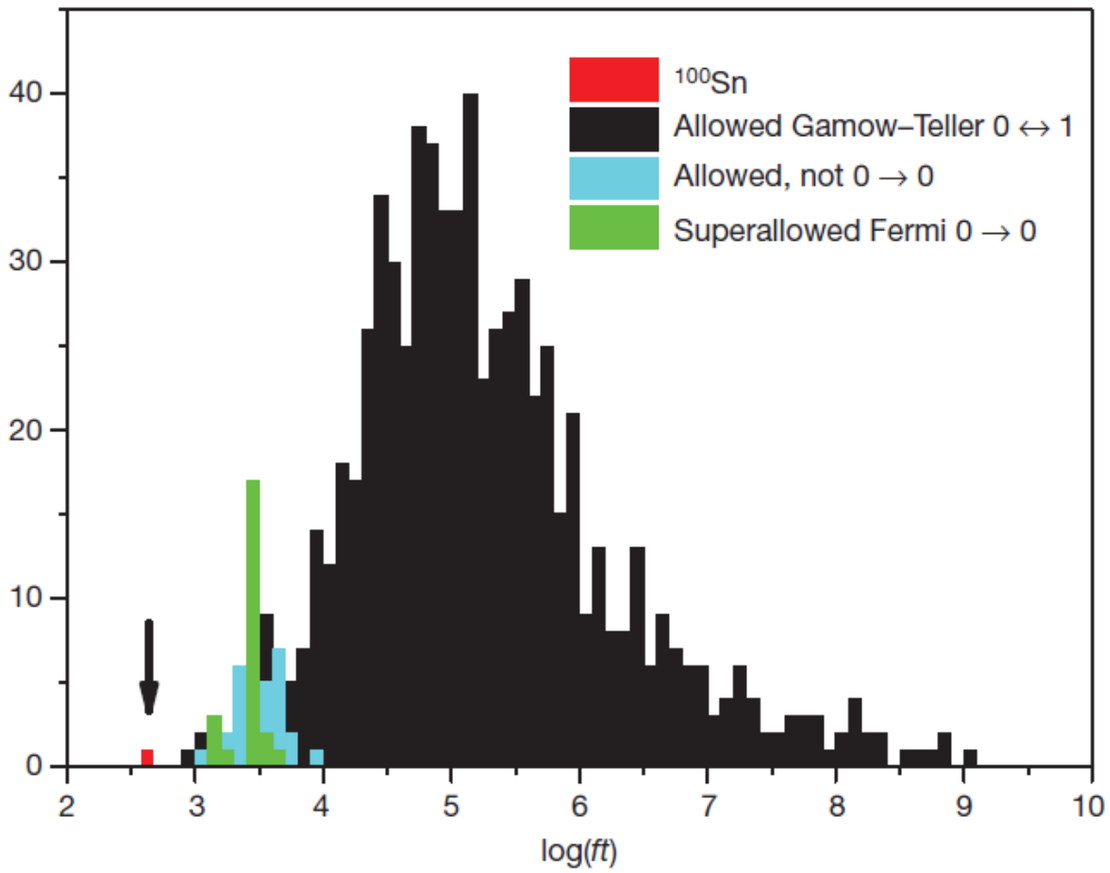
T. Faestermann et al. / Progress in Particle and Nuclear Physics 69 (2013) 85–130



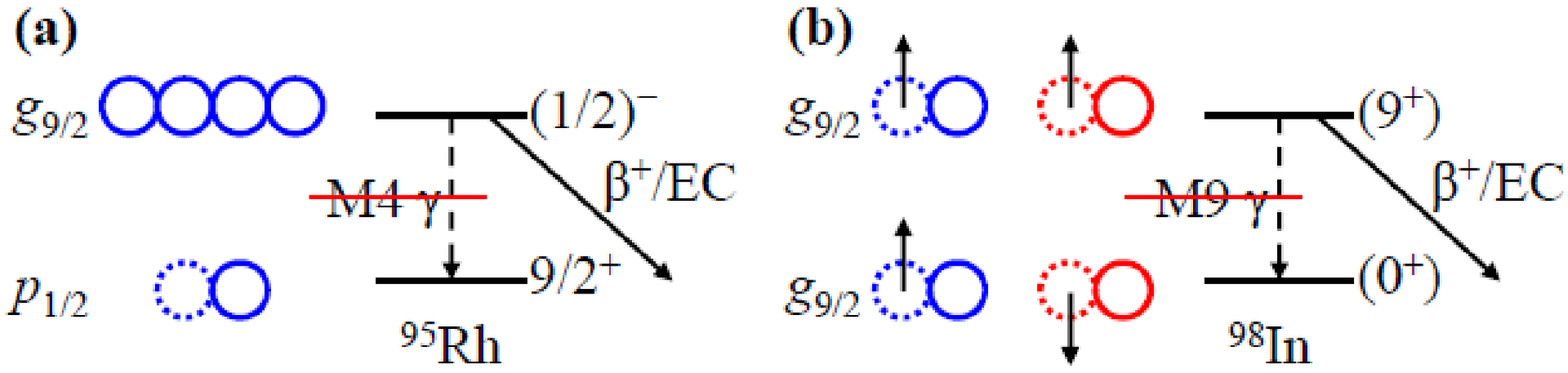
- Heaviest bound $N = Z$ nuclei
- Proton dripline
- End of rp-process

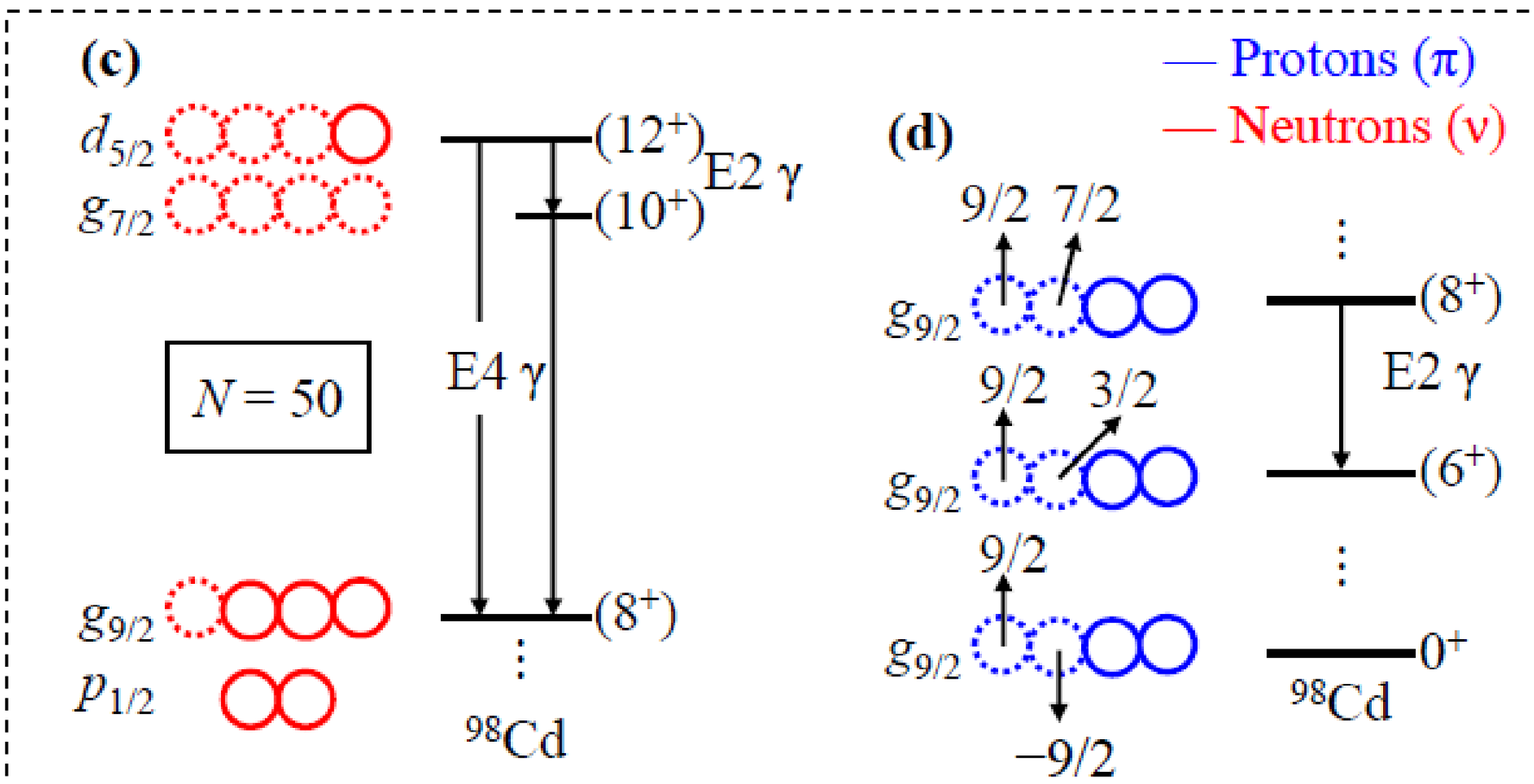


C. B. Hinke et al., Nature 486, 341 (2012)



Isomers in the ^{100}Sn region





Only γ-decaying isomers in this talk; others in preparation

Rare isotope production

RIKEN SRC

Heavy-ion fragmentation

$$^{124}\mathrm{Xe} + {}^{9}\mathrm{Be} \rightarrow \begin{cases} {}^{100}\mathrm{Sn} + \ldots \\ {}^{96}\mathrm{Cd} + \ldots \\ \ldots \end{cases}$$

Tag isotope's *A* and *Z* event-by-event

EURICA + WAS3ABi

^{124}Xe beam
345 MeV/u,
~30 pnA (3.5×10^{9}/s)

10 m

BigRIPS

ZeroDegree spectrometer

^{9}Be target
740-mg/cm^2

Bρ-ΔE-Bρ separation

plastic scintillator + PPAC

plastic scintillator + PPAC

Ionization chamber

Identification by Bρ-ΔE-ToF

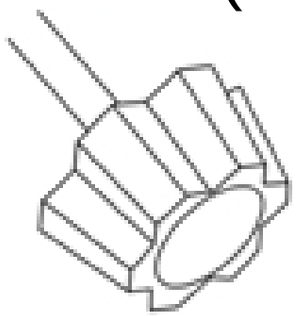
$$B\rho \propto \beta\gamma \frac{A}{Q}$$

$$\mathrm{ToF} \propto \frac{1}{\beta}$$

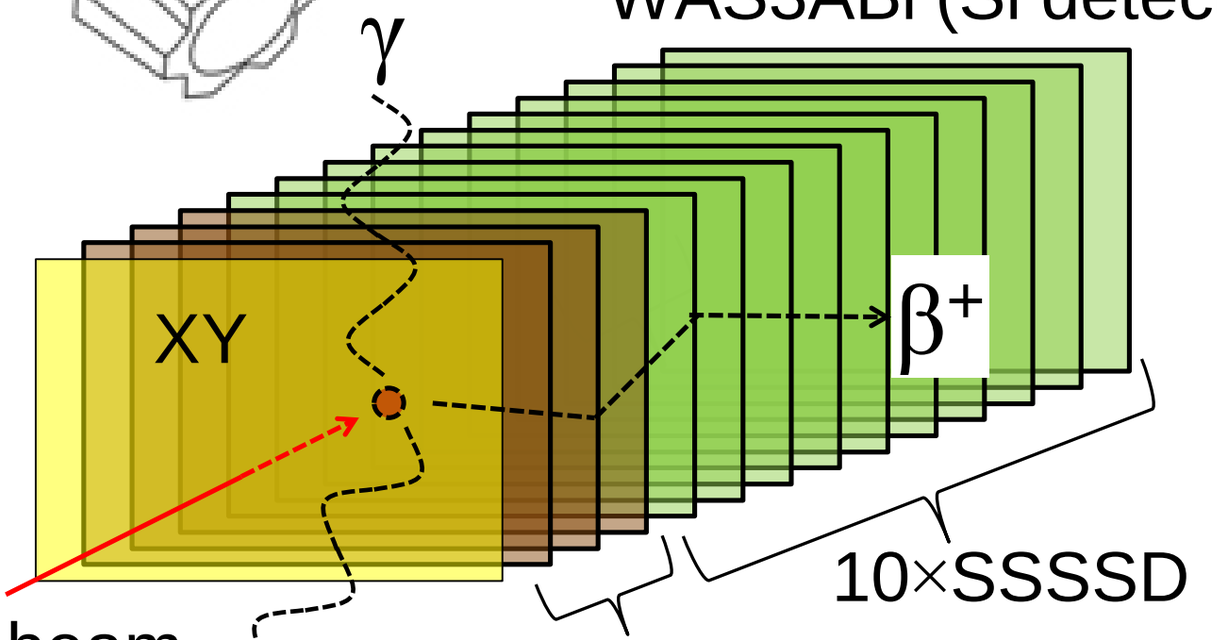
$$\Delta E \propto \frac{Z^2}{\beta^2}$$

Decay spectroscopy setup

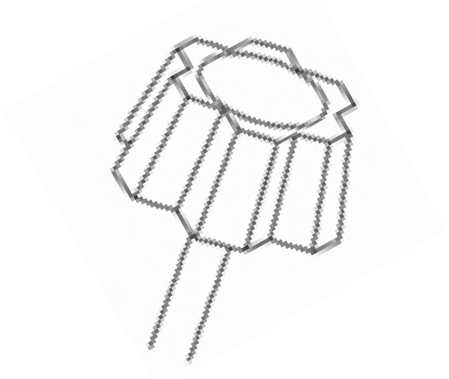
EURICA (HPGe detectors)



WAS3ABi (Si detectors)

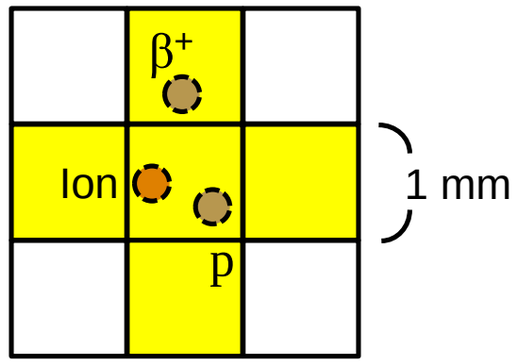


3×DSSSD (1mm thick)
Position-sensitive
Implantation zone



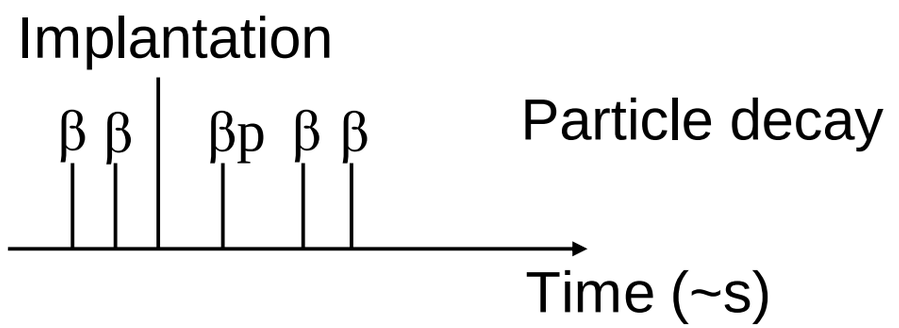
18×$LaBr_3$ also
installed but not used
(low efficiency)

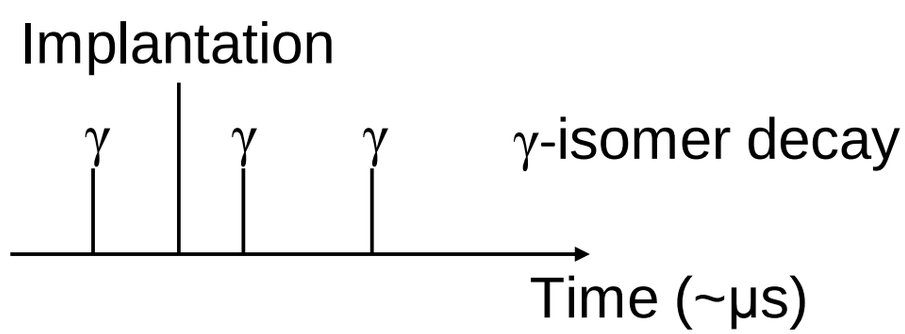
Spatial correlation



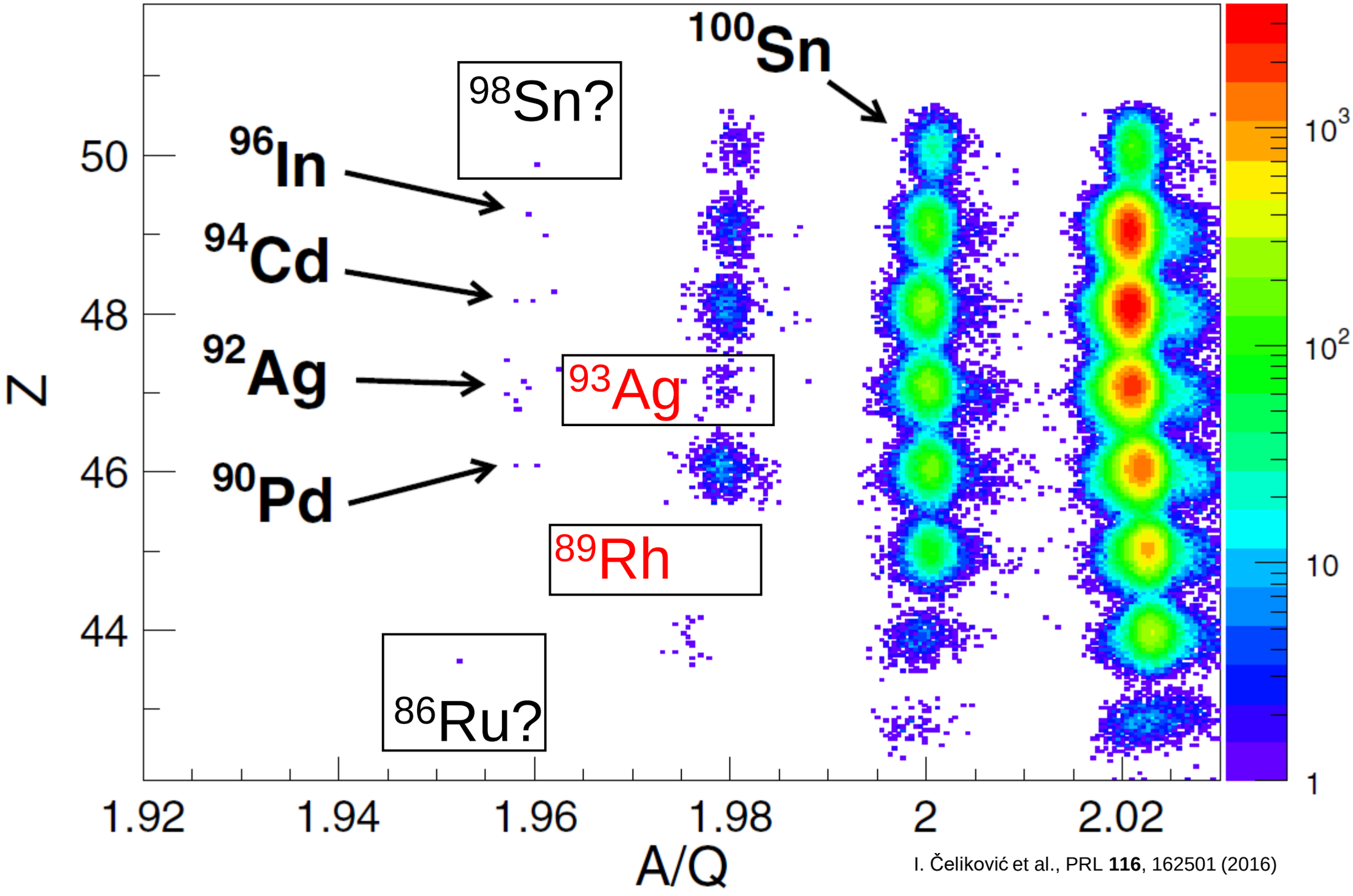
Correlate β^+/p to ion events in spatial/time window, measure γ-rays of daughter

Time correlation





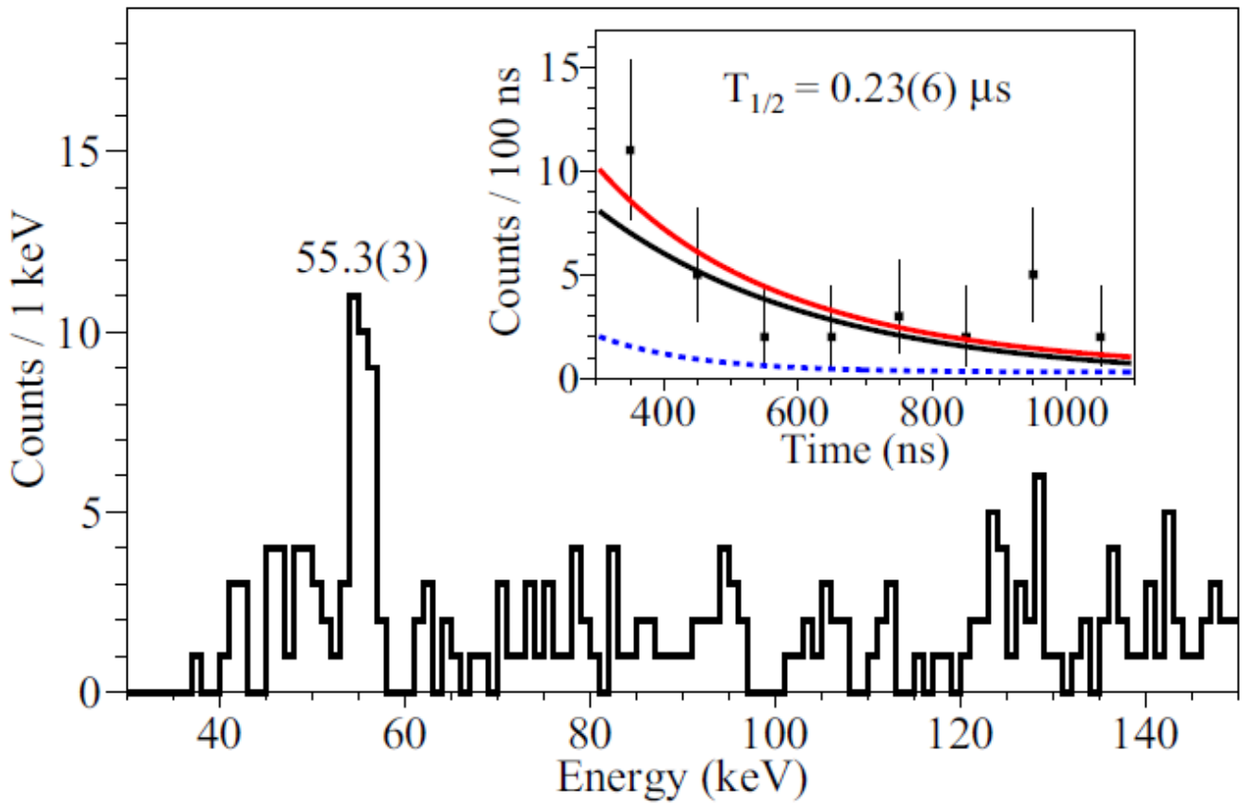
New isotopes, ^{89}Rh and ^{93}Ag



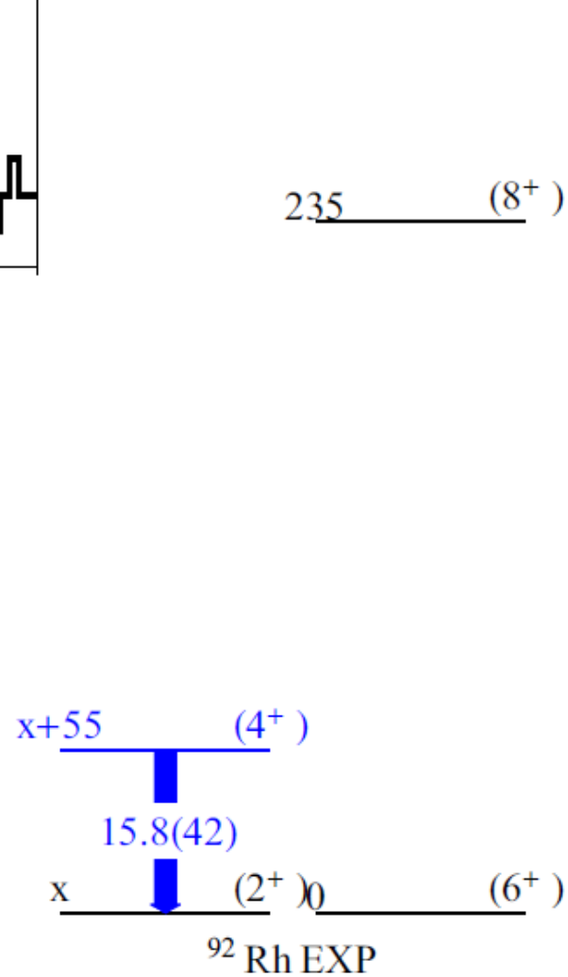
I. Čeliković et al., PRL **116**, 162501 (2016)

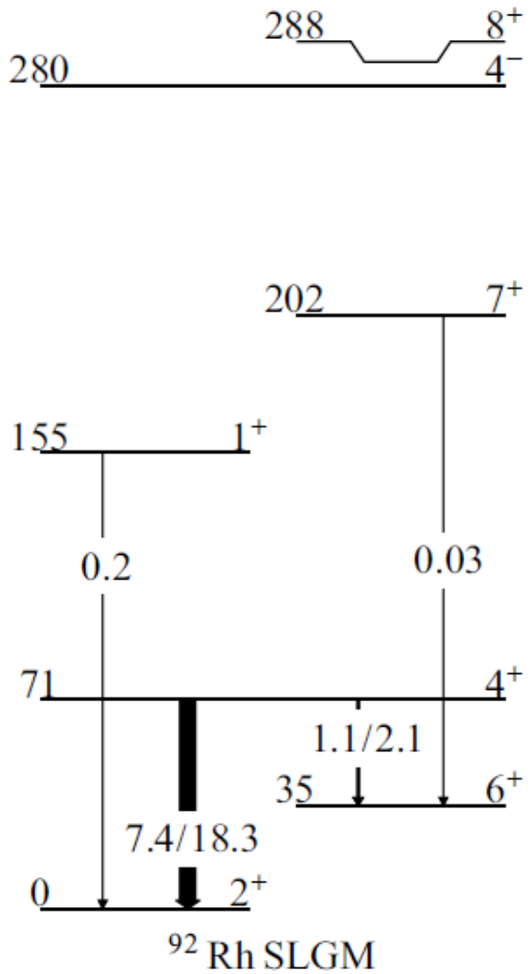
- New record for ^{100}Sn production (~2000 counts)
- First identification of ^{90}Pd, ^{92}Ag, ^{94}Cd, ^{96}In
- ^{89}Rh ($T_{1/2}$ < 120 ns) and ^{93}Ag ($T_{1/2}$ = 228(16) ns) proton unbound

New (4^+) isomer in ^{92}Rh

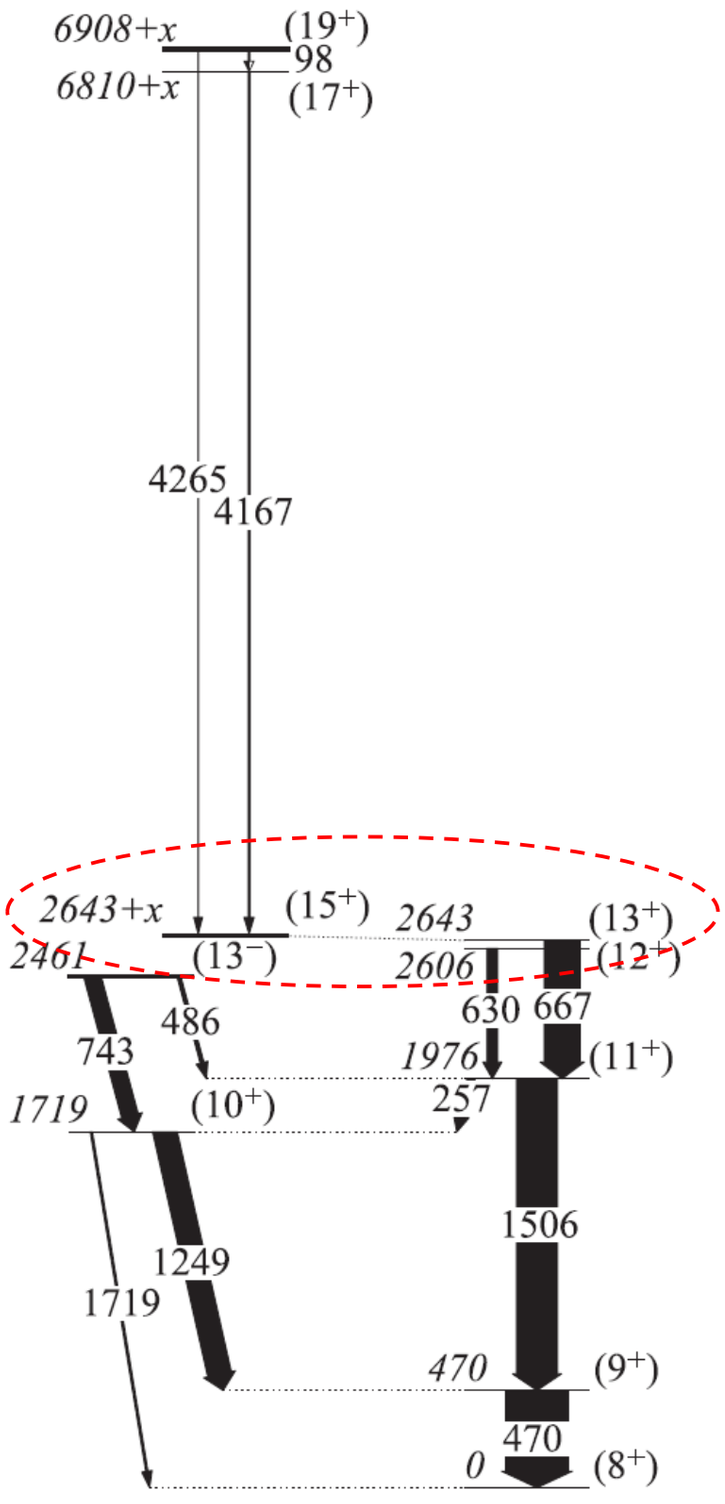


- New and only 1 delayed γ-ray transition
- E_γ, $T_{1/2}$ similar to $(2^+) \rightarrow (4^+)$ decay in ^{94}Rh (55 keV, 0.48(4) µs)
- (4^+) isomer proposed from SM, B(E2) favors $(4^+) \rightarrow (2^+)$ transition rather than to (6^+)

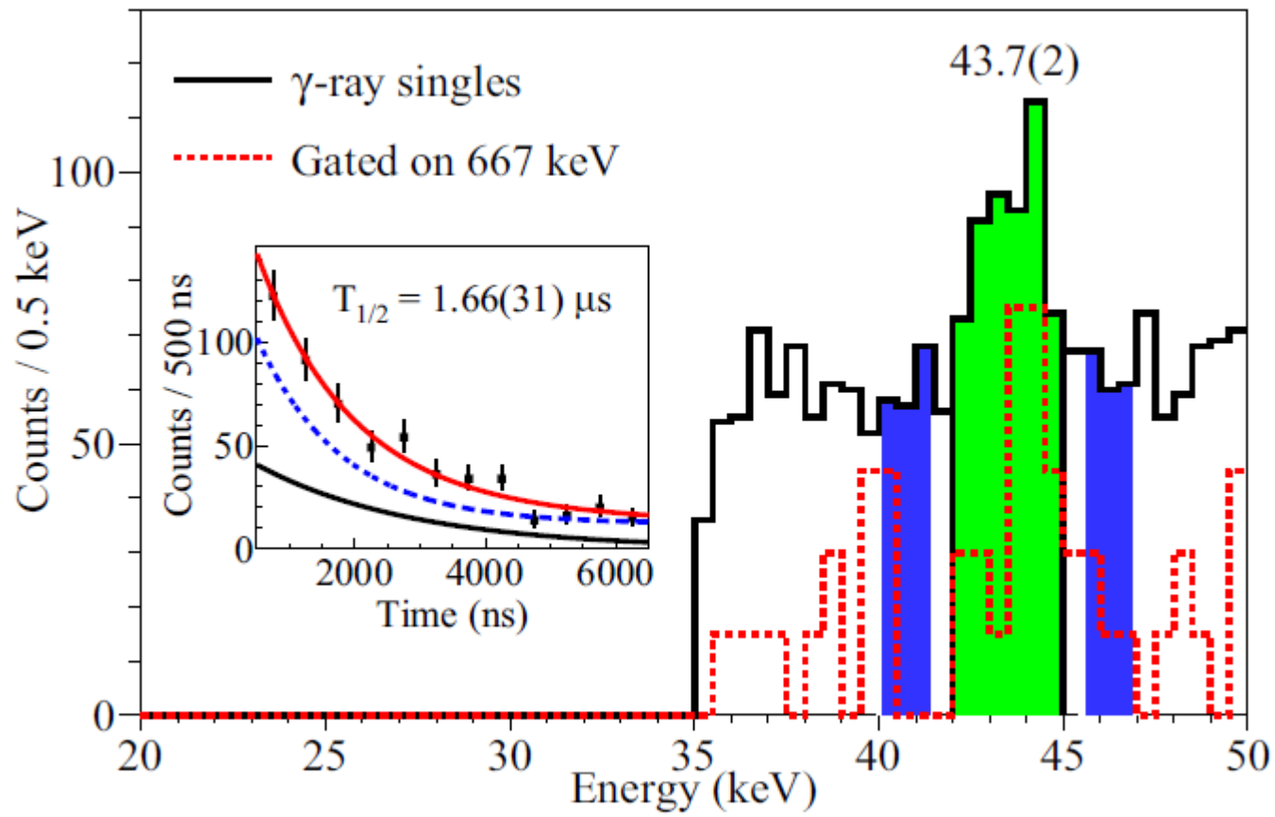




Energy of the (15+) isomer in ^{96}Ag

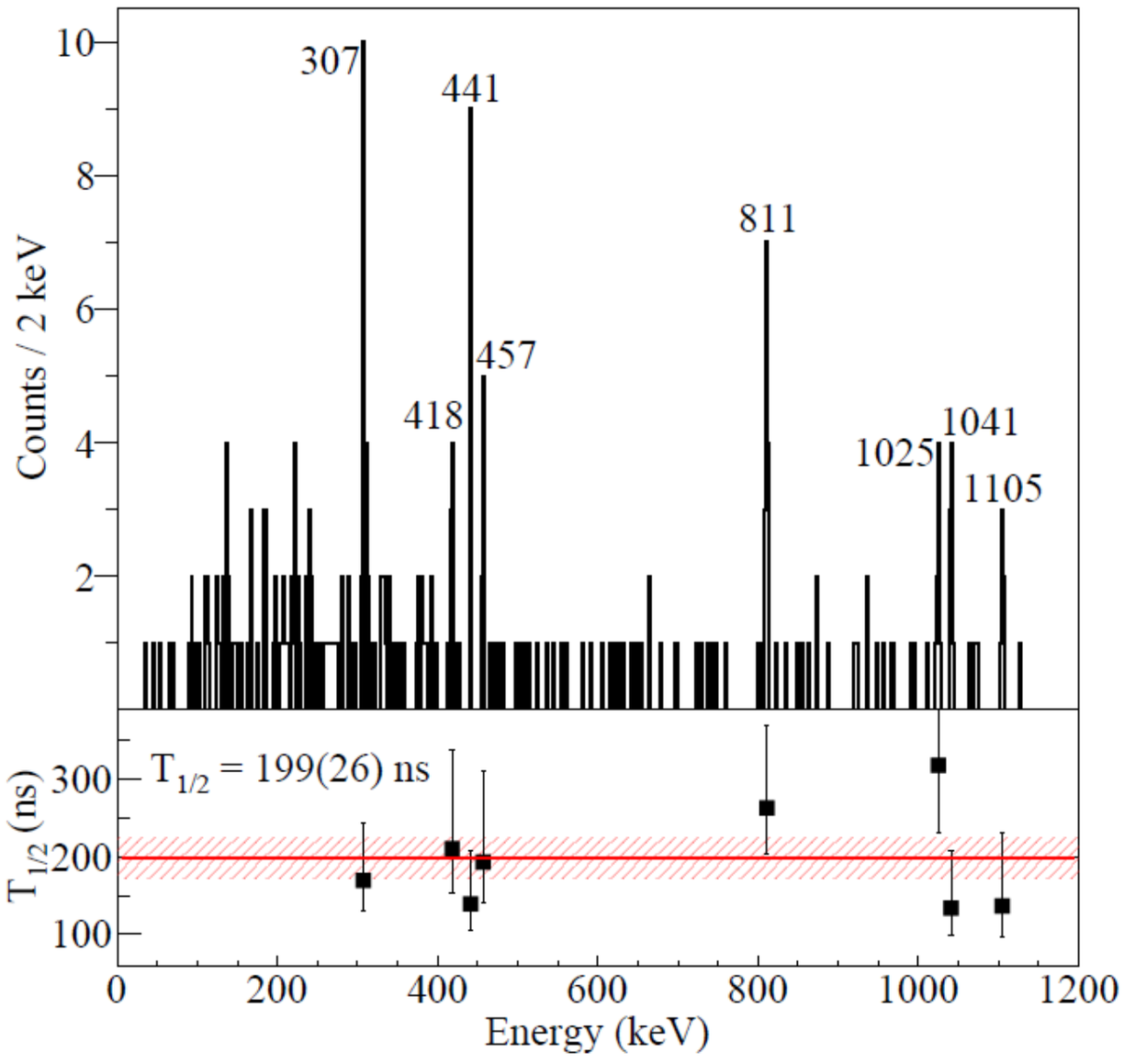


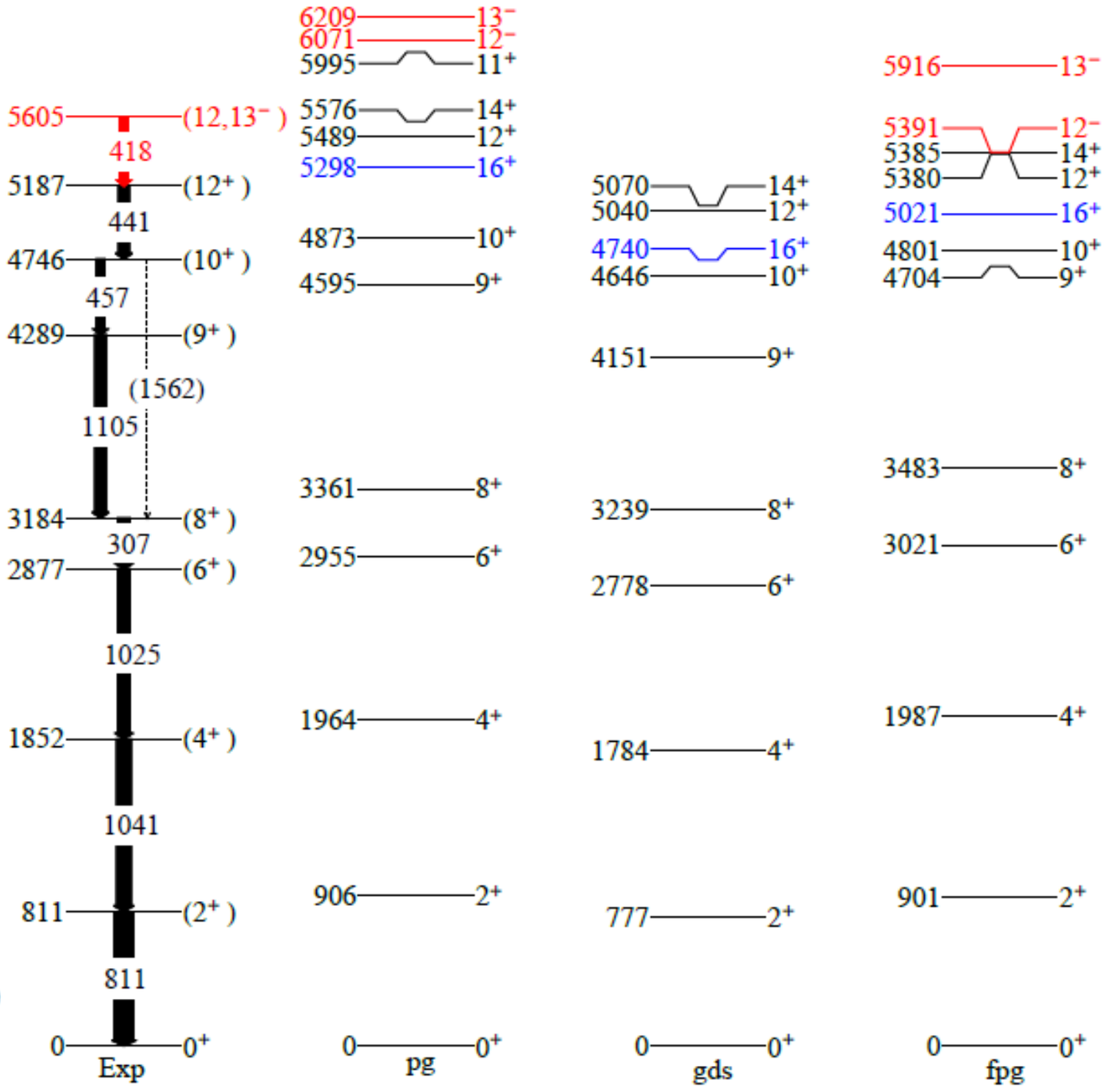
P. Boutachkov et al., PRC **84**, 044311 (2011)



- Maximum spin isomer in $g_{9/2}$ with unknown excitation energy;
  25 keV < E_γ < 50 keV suggested from B(E2) calculation, experimental $T_{1/2}$
- Peak at 44 keV with consistent $T_{1/2}$, coincidence with 667 keV, α(E2)
- B(E2) in excellent agreement with SM

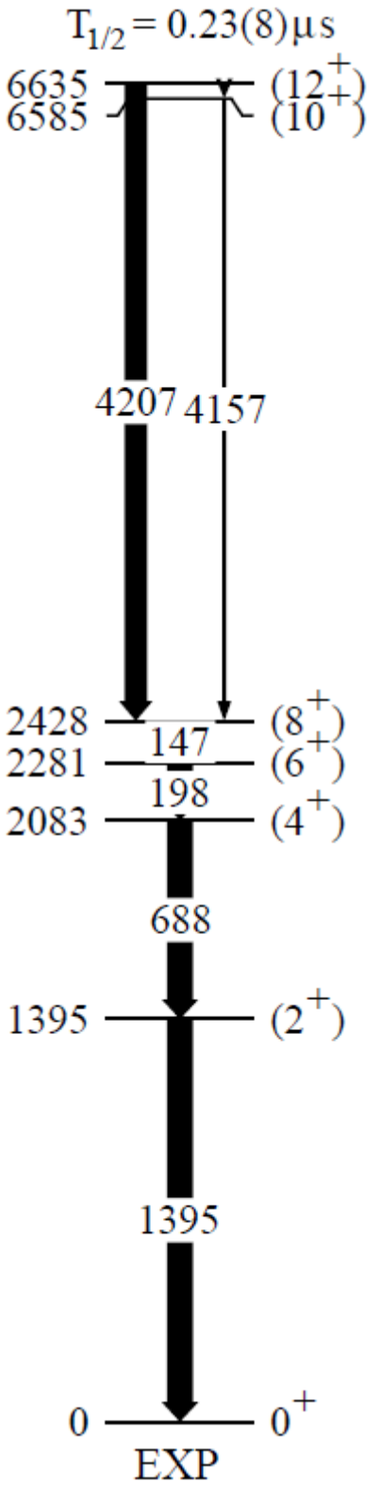
New isomer and excited states in ^{96}Cd

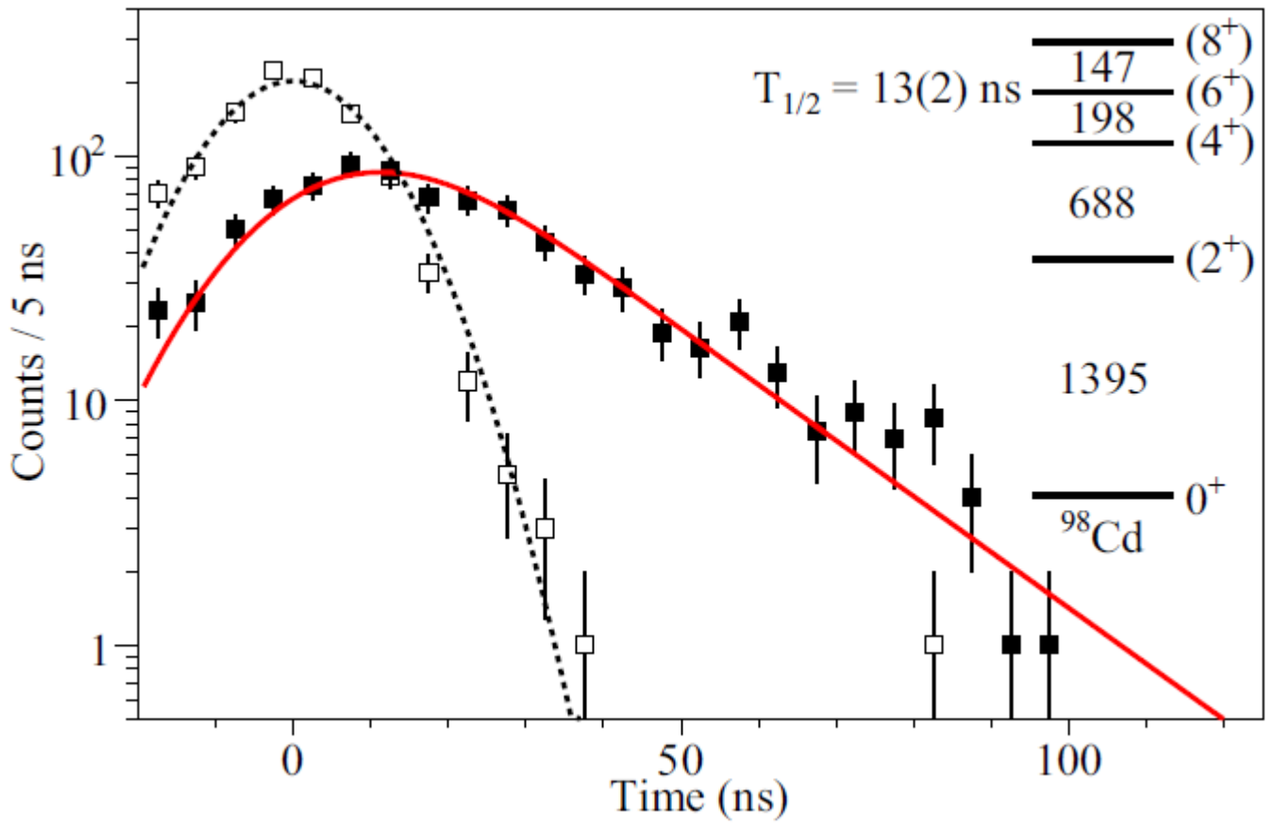




- First observation of low-spin states of the heaviest $N = Z$ nucleus below ^{100}Sn
- Two independent experiments, joint publication in progress
- Level scheme, γ-ray ordering based on intensities, SM calculations

New $T_{1/2}$ measurements in ^{98}Cd





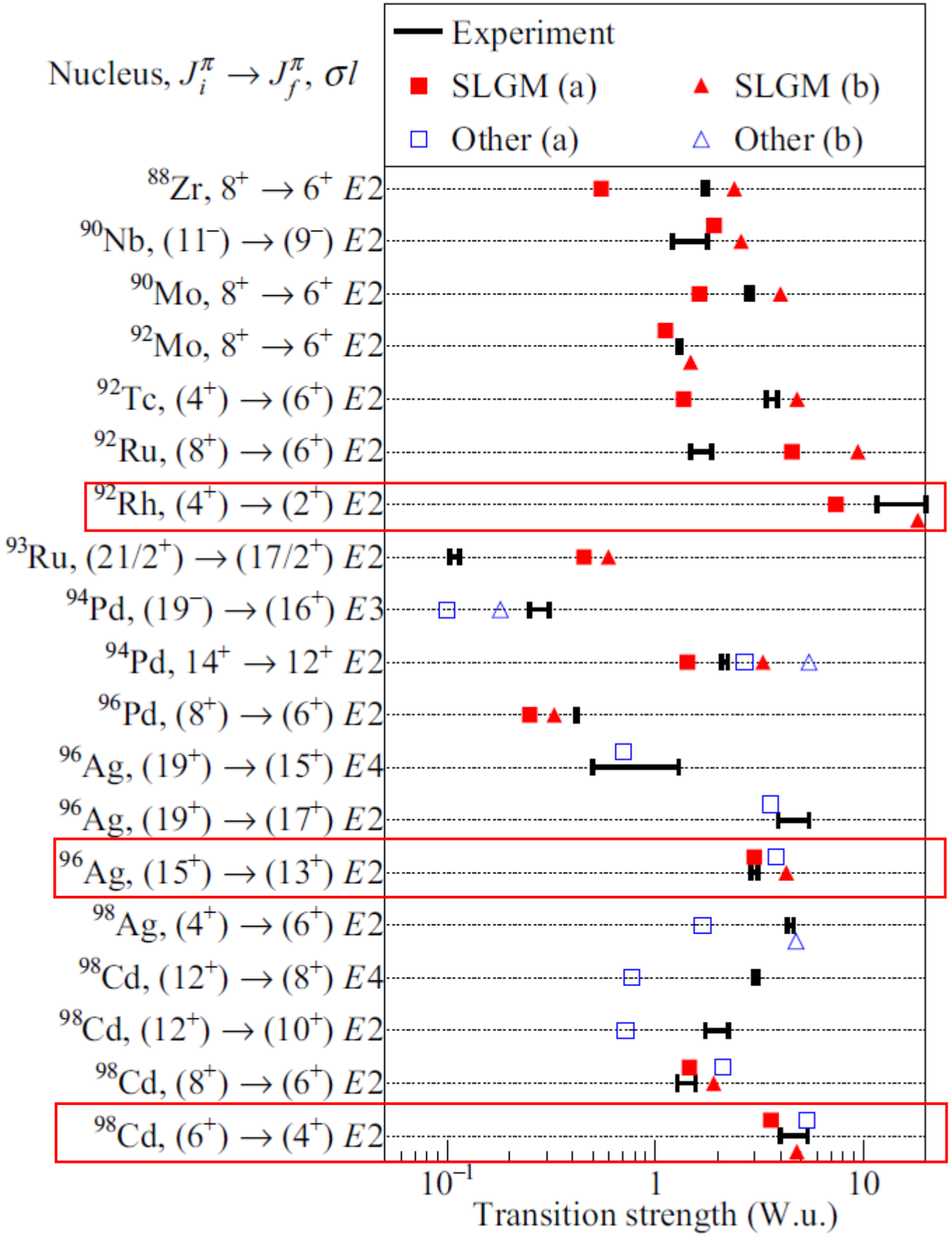
- $T_{1/2}$ of (12^+), (8^+), upper limit (< 20 ns) for (6^+) isomers previously reported

- $T_{1/2}$ measured from 147(start) – 198/688/1395(stop) coincidence time difference

- B(E2) in good agreement with SM

A. Blazhev et al., J. Phys. Conf. Ser. **205**, 012035 (2010)

Transition strength comparisons with SM

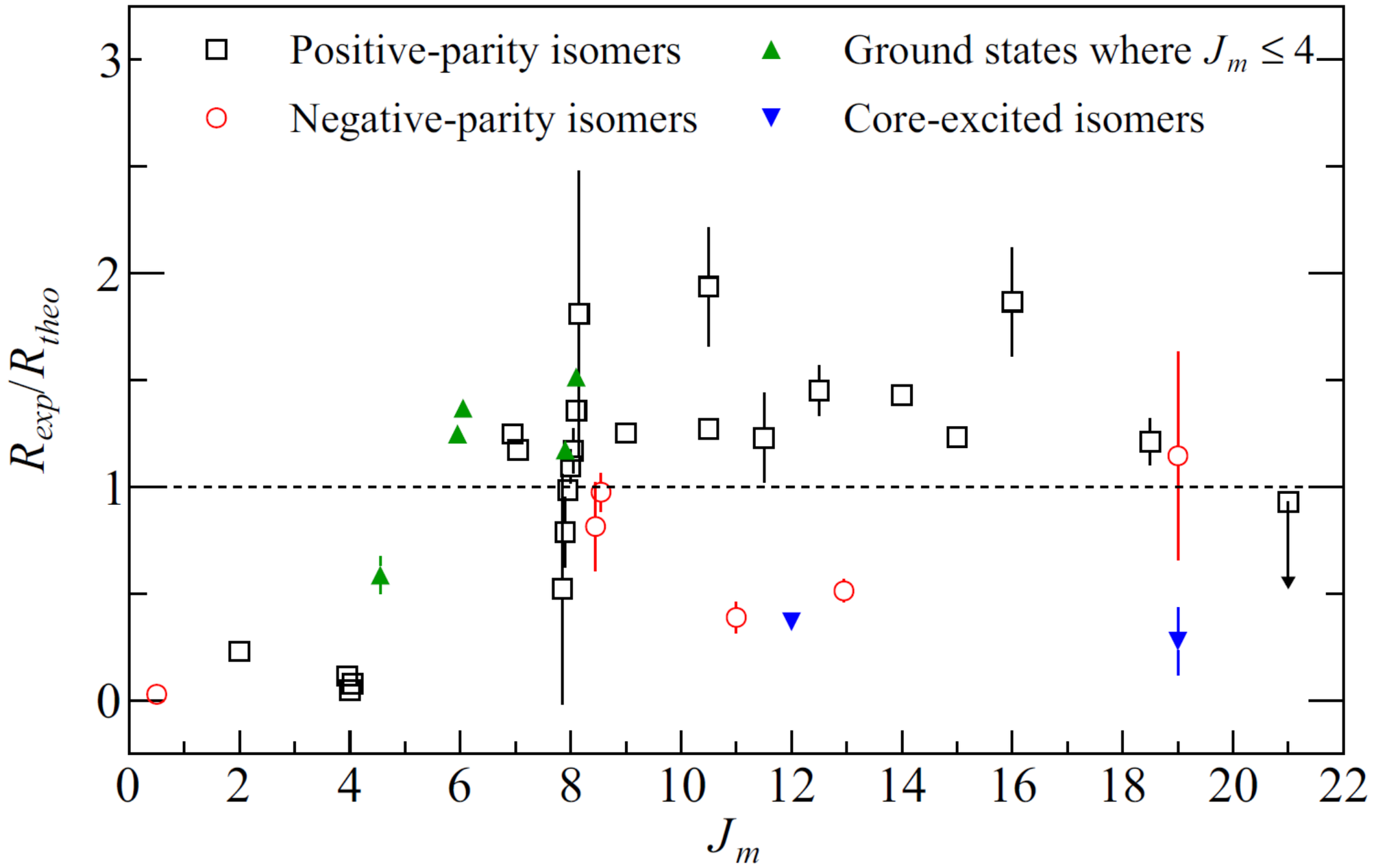


- B(σL) from $T_{1/2}/E_\gamma$ measurements, some with better precision

- Good agreement with SM in ($p_{1/2}$, $g_{9/2}$) model space for new results
  (a): e_p = 1.5e, e_n = 0.5e
  (b): e_p = 1.72e, e_n = 1.44e

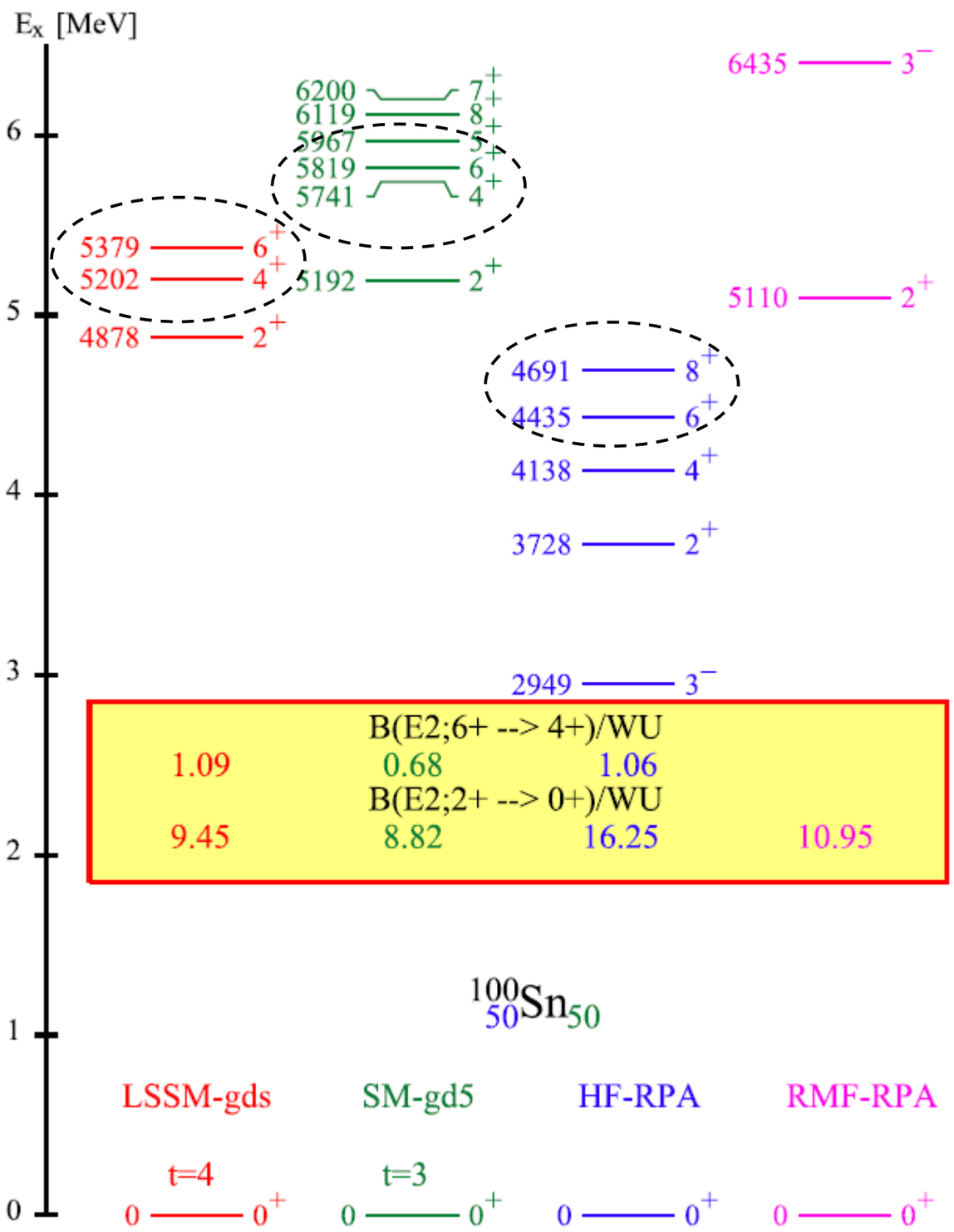
- Notable disagreements in ^{92,93}Ru, core-excited (12^+) isomer in ^{98}Cd

Isomeric ratio comparisons

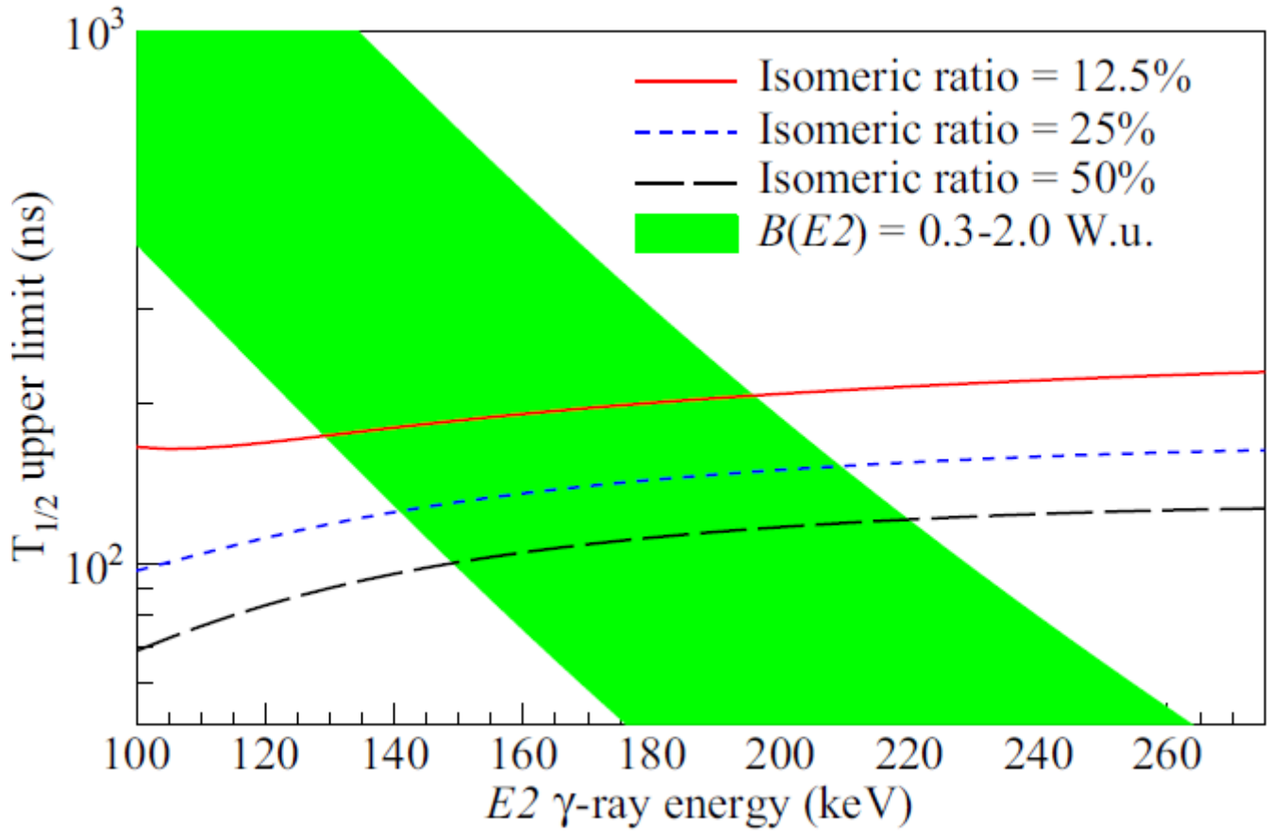


- Theoretical isomeric ratios calculated from ablation-abrasion + sharp cutoff model
- Good agreement for positive-parity isomers ($g_{9/2}$)
- Experimental ratios less than expected for core-excited/negative-parity isomers

Search results for an isomer in ^{100}Sn



T. Faestermann, M. Górska, H. Grawe, PPNP **69**, 85 (2013)



- Predictions of 6^+ or 8^+ E2 isomer from SM
- No time-delayed γ rays observed in ^{100}Sn
- $T_{1/2}/E_\gamma$ limits determined with B(E2) range, different isomeric ratios:

  $T_{1/2} < 200$ ns, $E_\gamma > 130$ keV

- Isomer could be proton unbound, but no signature of ^{99}In decay observed

PHYSICAL REVIEW C **96**, 044311 (2017)

Properties of γ-decaying isomers and isomeric ratios in the ^{100}Sn region

J. Park,[1,2,*] R. Krücken,[1,2] D. Lubos,[3,4,5] R. Gernhäuser,[3] M. Lewitowicz,[6] S. Nishimura,[4] D. S. Ahn,[4] H. Baba,[4] B. Blank,[7] A. Blazhev,[8] P. Boutachkov,[9] F. Browne,[4,10] I. Čeliković,[6,11] G. de France,[6] P. Doornenbal,[4] T. Faestermann,[3,5] Y. Fang,[12] N. Fukuda,[4] J. Giovinazzo,[7] N. Goel,[9] M. Górska,[9] H. Grawe,[9] S. Ilieva,[13] N. Inabe,[4] T. Isobe,[4] A. Jungclaus,[14] D. Kameda,[4] G. D. Kim,[15] Y.-K. Kim,[15,16] I. Kojouharov,[9] T. Kubo,[4] N. Kurz,[9] G. Lorusso,[4] K. Moschner,[8] D. Murai,[4] I. Nishizuka,[17] Z. Patel,[4,18] M. M. Rajabali,[1] S. Rice,[4,18] H. Sakurai,[19] H. Schaffner,[9] Y. Shimizu,[4] L. Sinclair,[4,20] P.-A. Söderström,[4] K. Steiger,[3] T. Sumikama,[17] H. Suzuki,[4] H. Takeda,[4] Z. Wang,[1] H. Watanabe,[21] J. Wu,[4,22] and Z. Y. Xu[19]

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