

High-Resolution Laser Spectroscopy for Nuclear-Structure Studies

D. T. Yordanov¹, D. L. Balabanski², M. L. Bissell³, K. Blaum¹, I. Budinčević³, B. Cheal⁴, M. De Rydt³, K. T. Flanagan⁴, N. Frömmgen⁵, R. F. Garcia Ruiz³, G. Georgiev⁶, Ch. Geppert^{5,7}, M. Hammen⁵, H. Heylen³, M. Kowalska⁸, K. Kreim¹, A. Krieger⁵, R. Neugart⁵, G. Neyens³, W. Nörtershäuser^{5,9}, J. Papuga³, M. M. Rajabali³, R. Sánchez¹⁰, S. Schmidt⁹

¹Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany

²INRNE, Bulgarian Academy of Science, BG-1784 Sofia, Bulgaria

³Instituut voor Kern- en Stralingsfysica, KU Leuven, B-3001 Leuven, Belgium

⁴School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL, UK

⁵Institut für Kernchemie, Universität Mainz, D-55099 Mainz, Germany

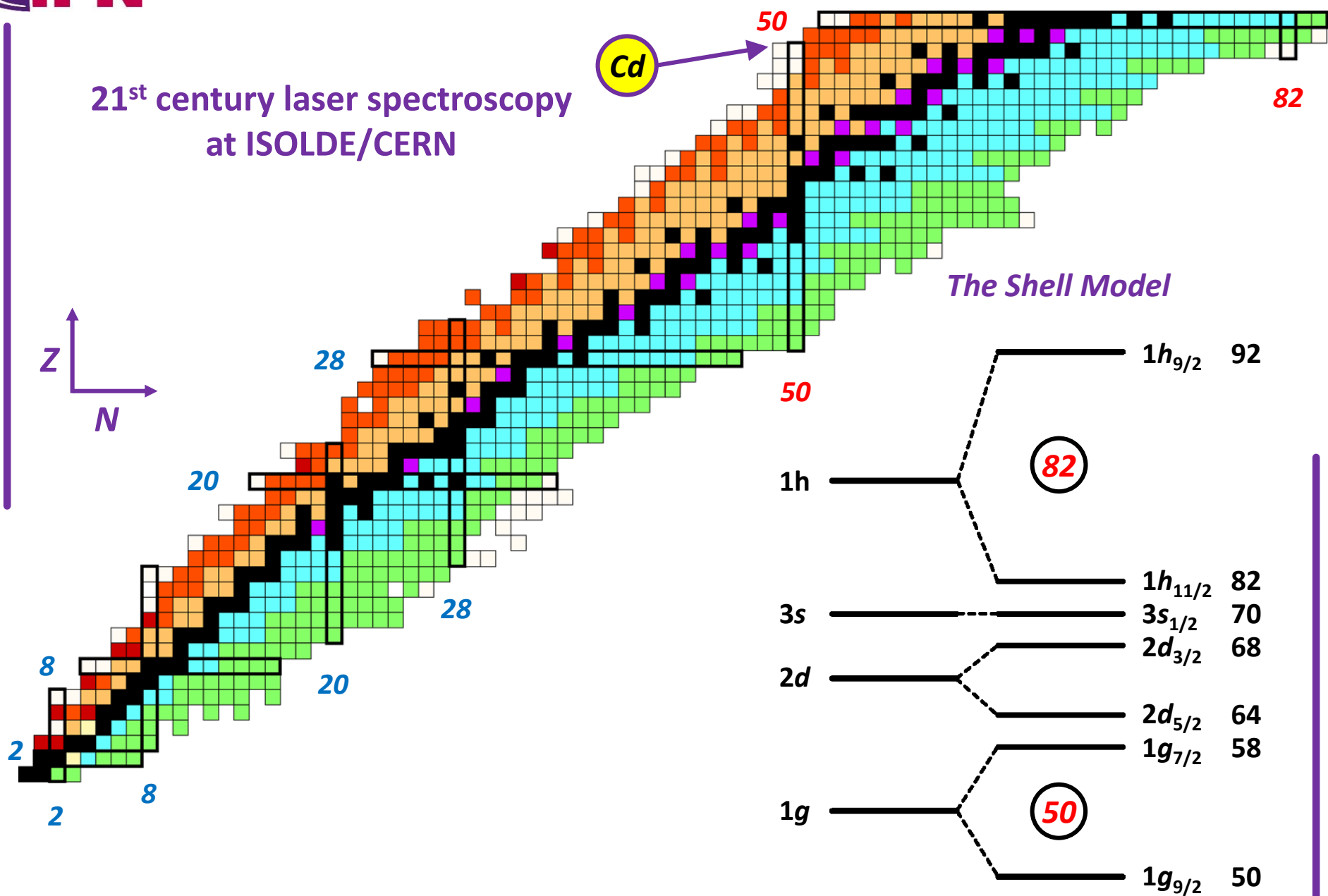
⁶CSNSM-IN2P3-CNRS, Université de Paris Sud, F-91405 Orsay, France

⁷Helmholtz Institute Mainz, D-55099 Mainz, Germany

⁸Organisation Européenne pour la Recherche Nucléaire, CH-1211 Geneva 23, Switzerland

⁹GSI Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt, Germany

21st century laser spectroscopy
at ISOLDE/CERN



21st century laser spectroscopy at ISOLDE/CERN

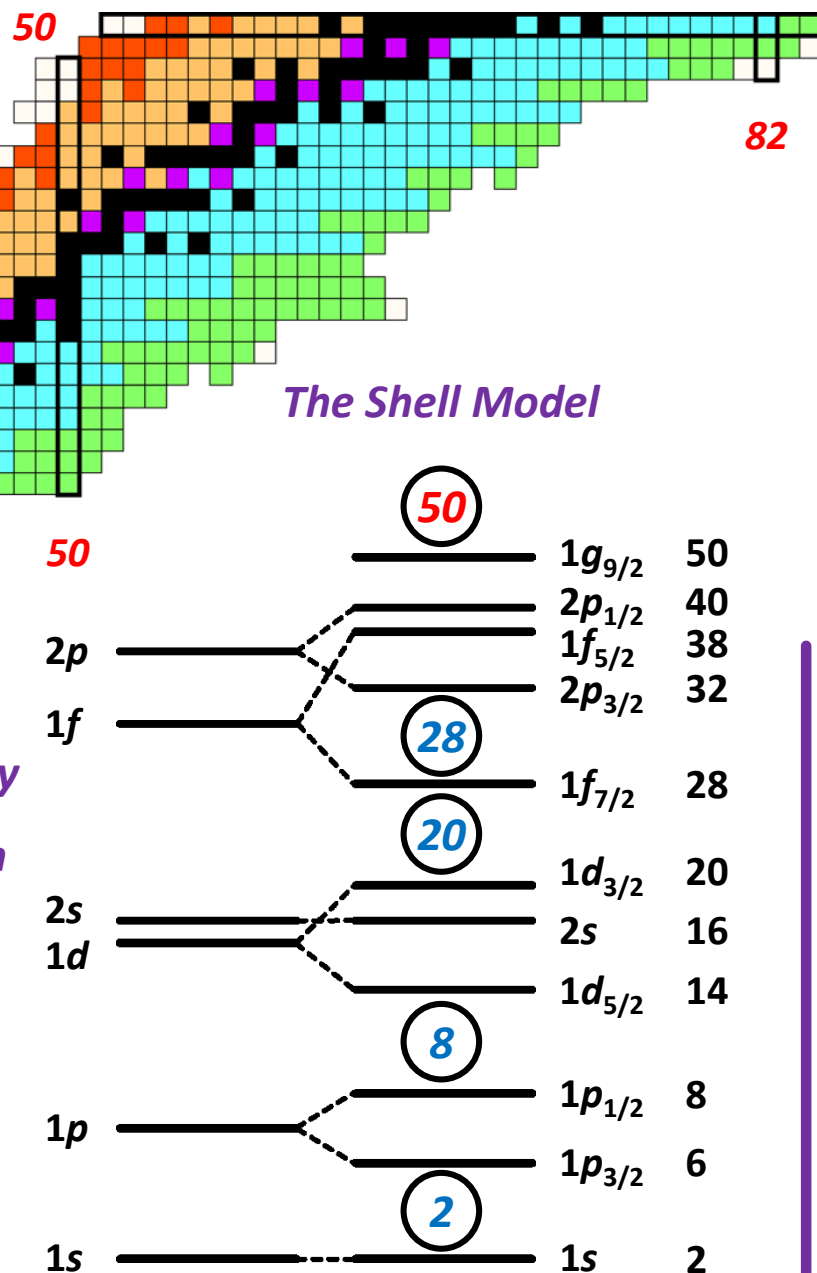
Monopole migration

The Shell Model

Magicity

Island of inversion

Halo nuclei



Outline

Cadmium:

- *Physics interest*
- *Laser spectroscopy with bunched beams*
- *Frequency quadrupling*
- *Shell structure from μ and Q moments*
- *Preliminary results*

Potassium:

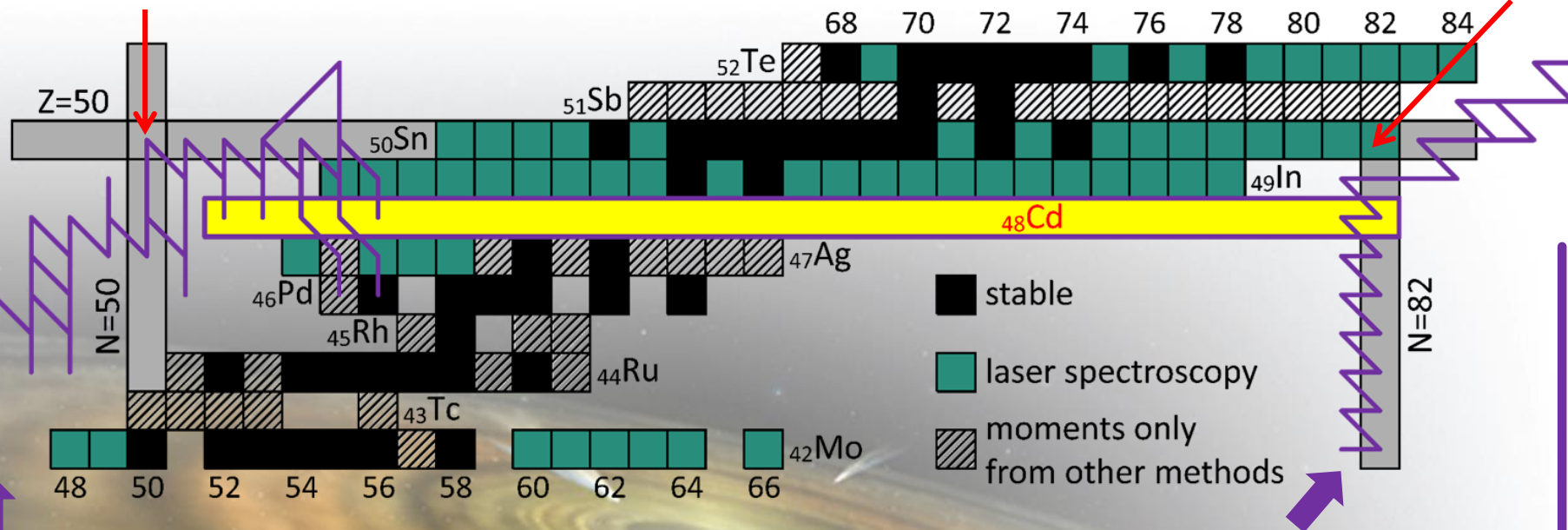
- *Inversion and reinversion of states*
- *Charge radii*
- *Isomer vs. g.s. in ^{38}K*

Survey of ground-state properties in the Sn region

ground and isomeric state properties of $^{100-130}\text{Cd}$

^{100}Sn

^{132}Sn

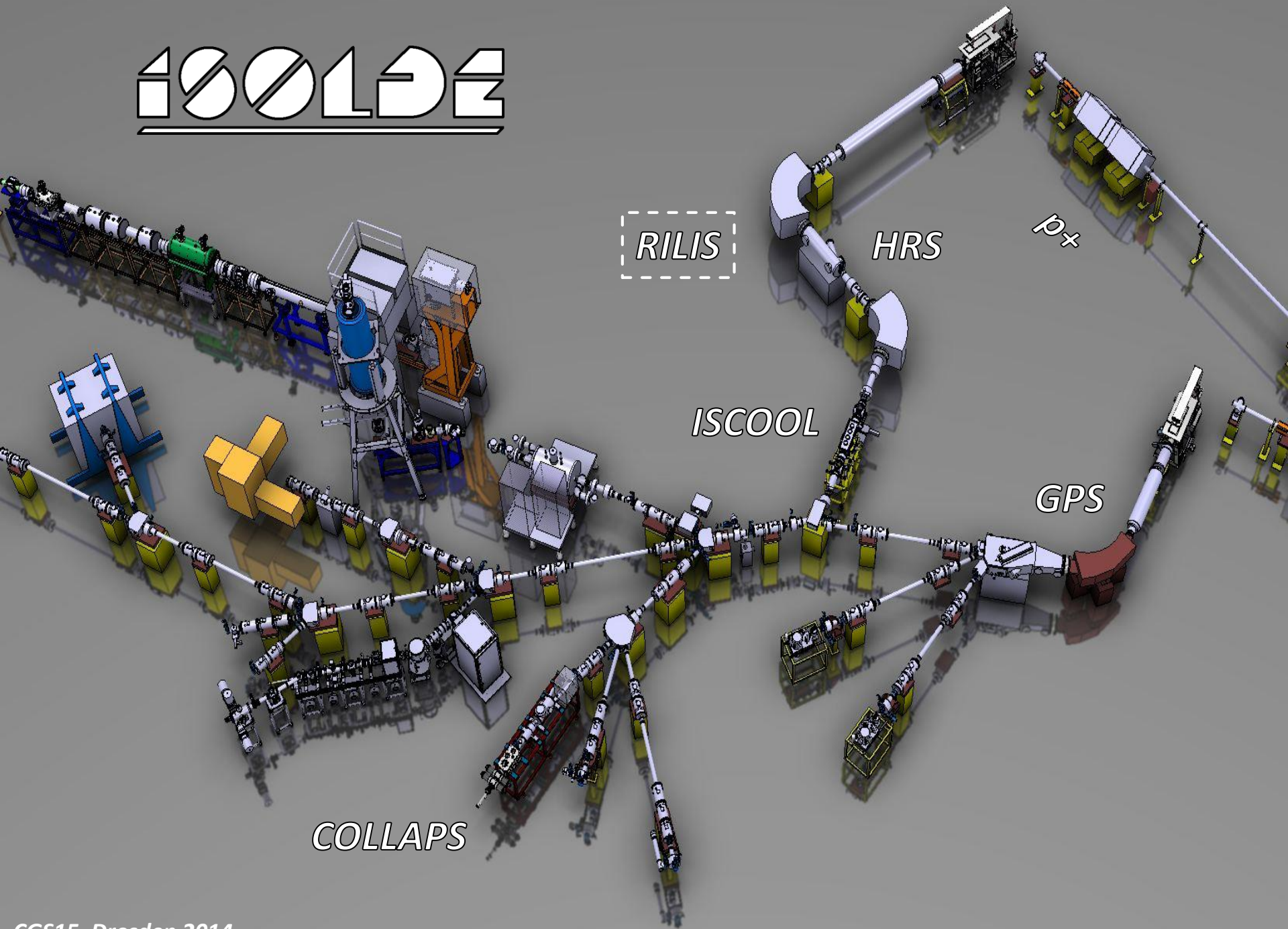


rp process

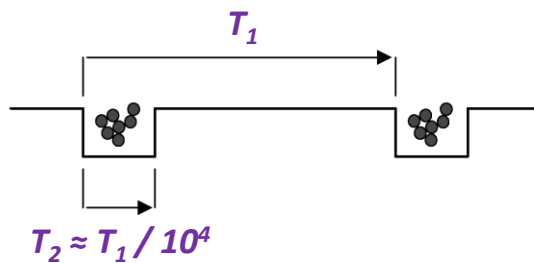
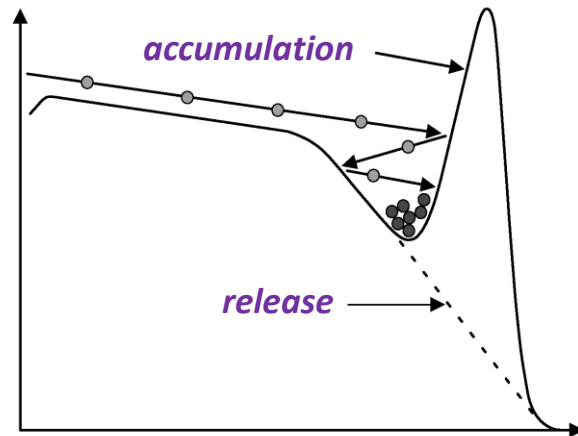
r process

- more accurate theoretical lifetimes of the N=82 isotones below ^{129}Ag
- shell quenching vs. deformation
- shell effect in the radii

ISOLDE

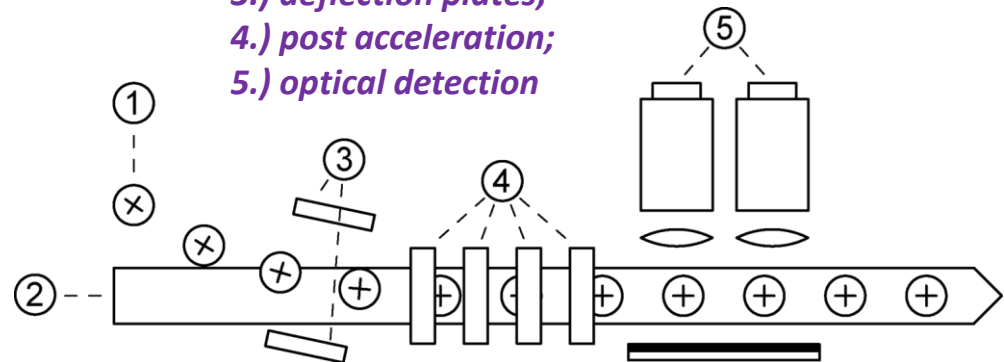


Bunched-beam fluorescence

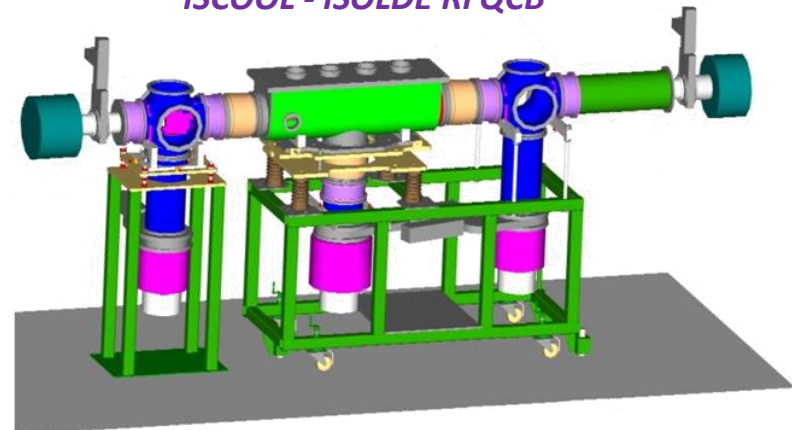


COLLAPS

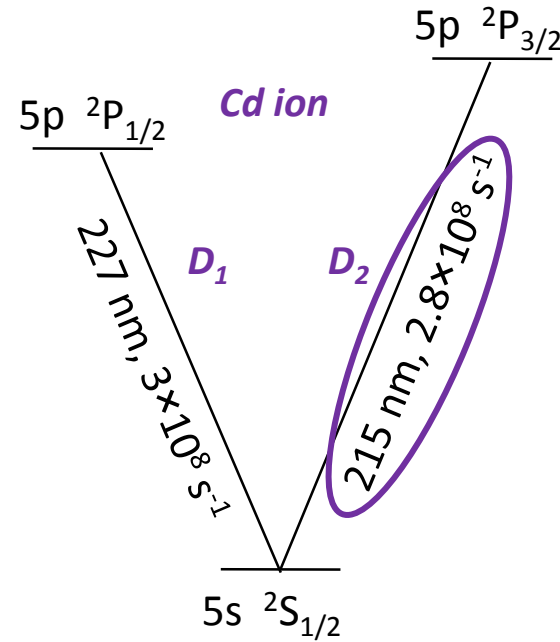
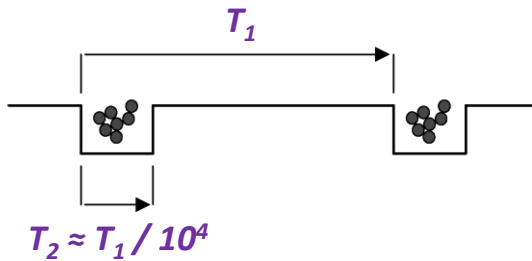
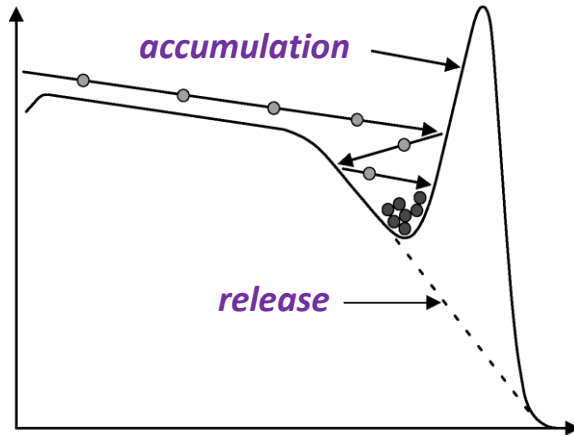
- 1.) ion beam;
- 2.) laser;
- 3.) deflection plates;
- 4.) post acceleration;
- 5.) optical detection



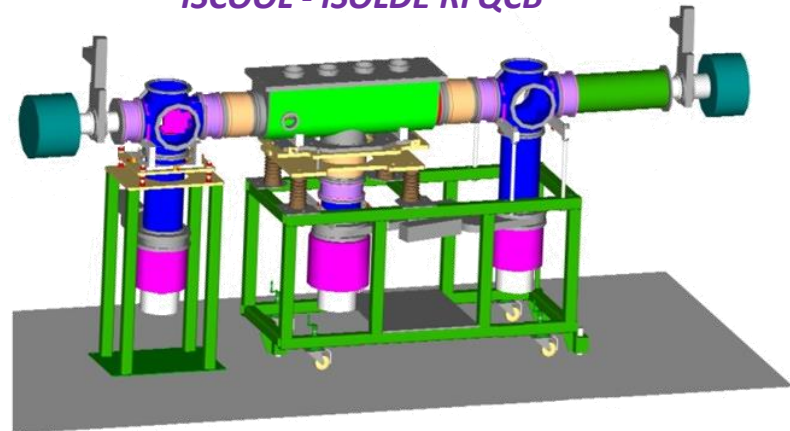
ISCOOL - ISOLDE RFQCB



Bunched-beam fluorescence



ISCOOL - ISOLDE RFQCB

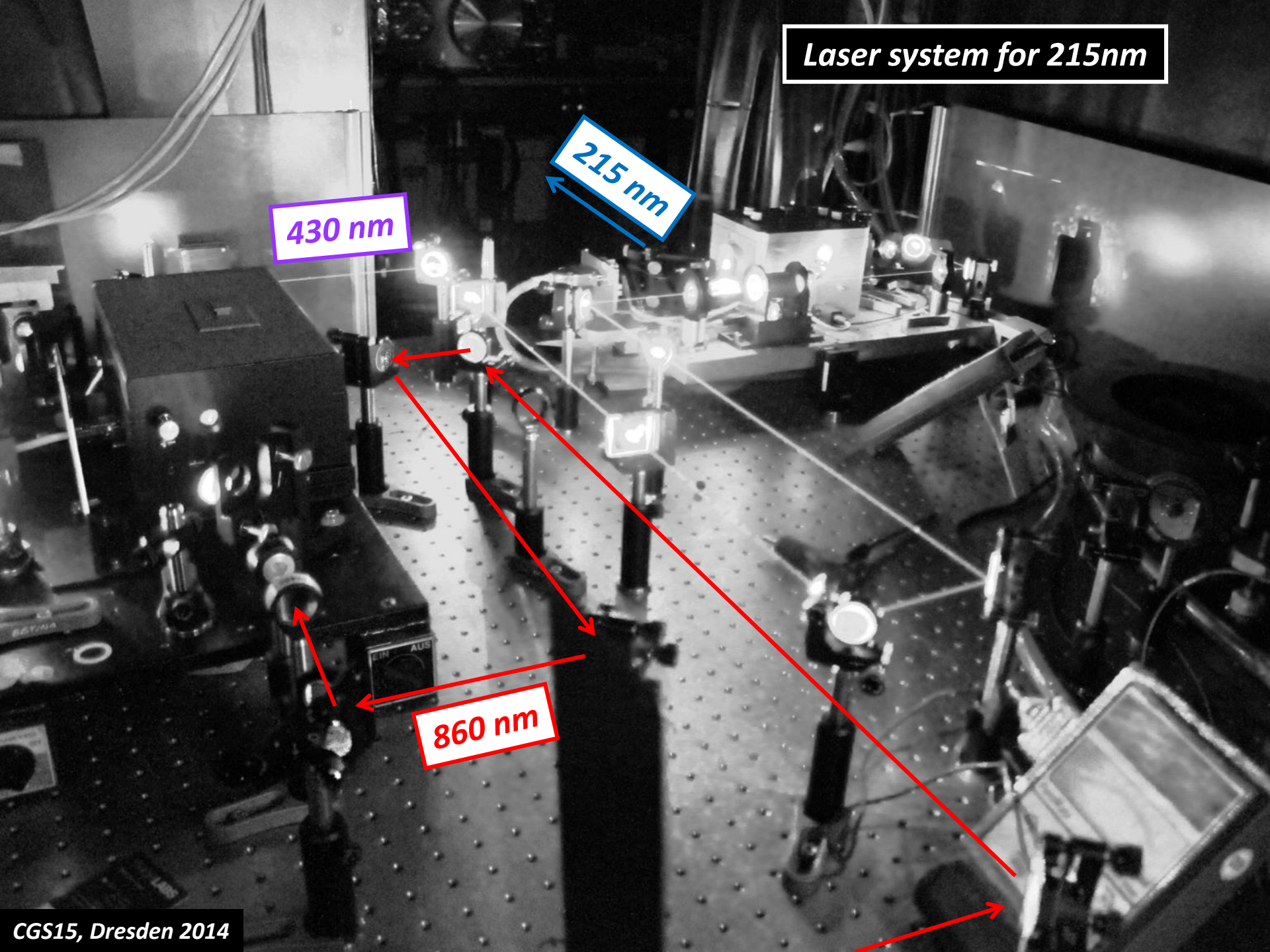


Laser system for 215nm

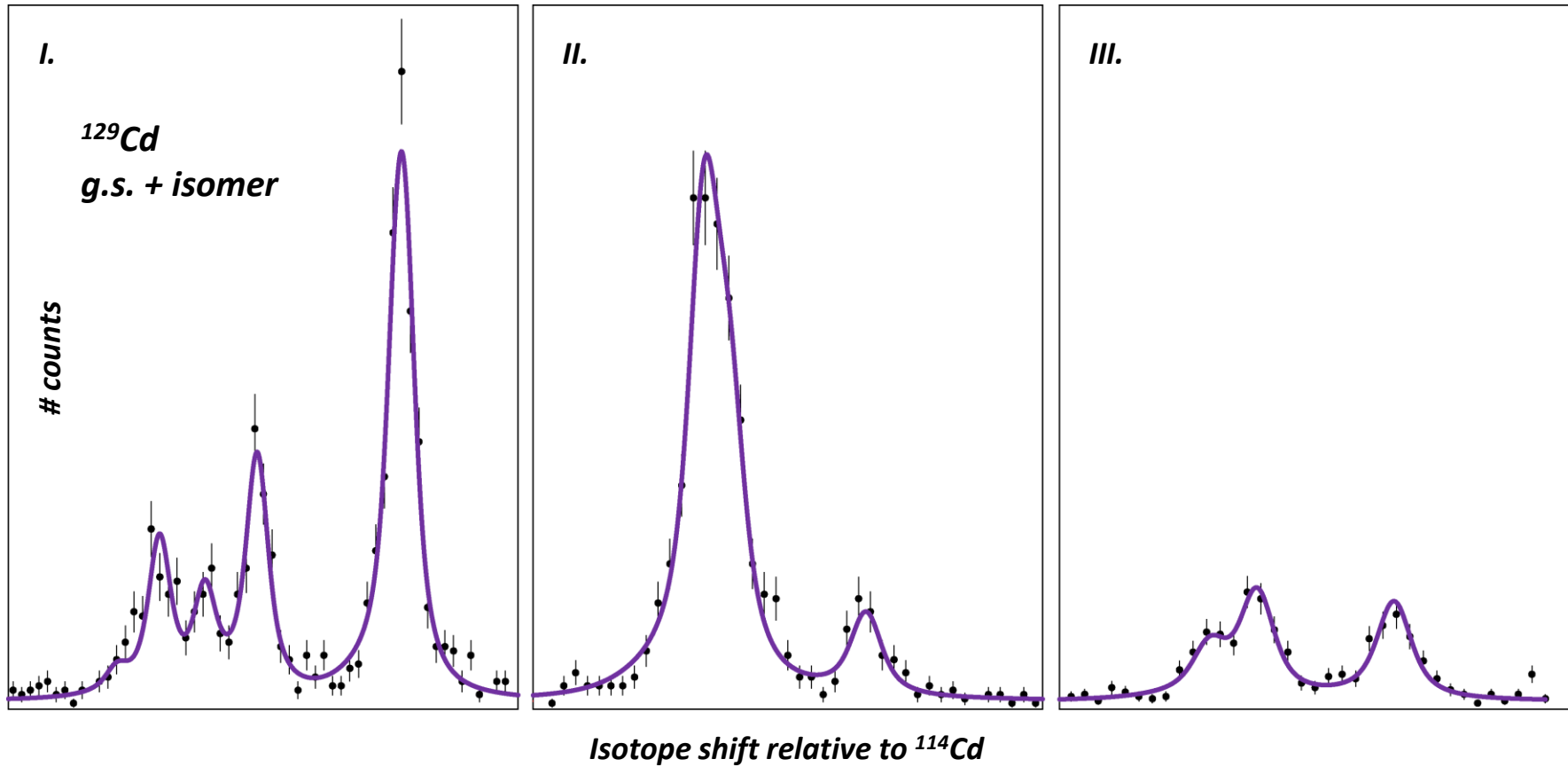
430 nm

215 nm

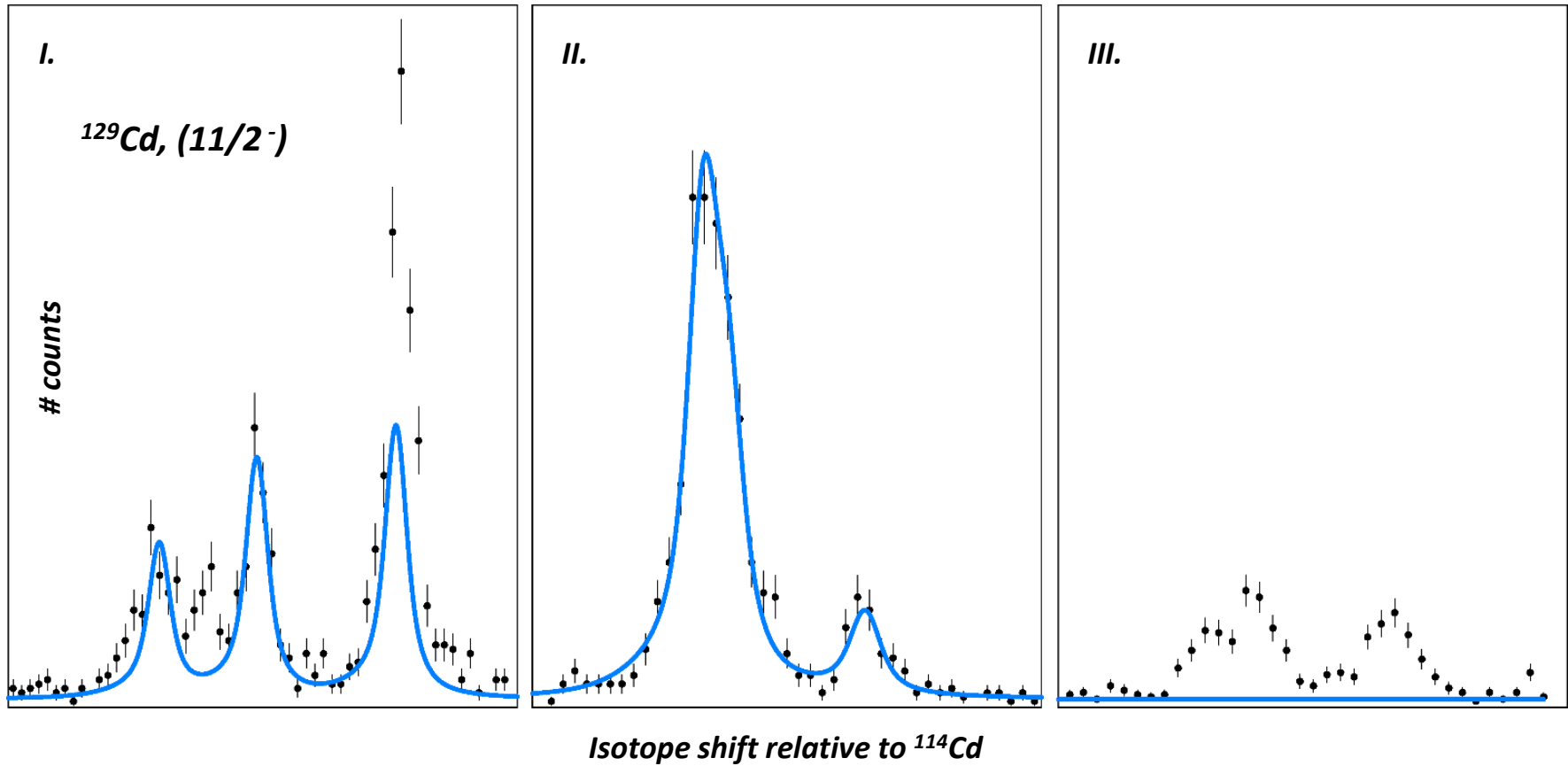
860 nm



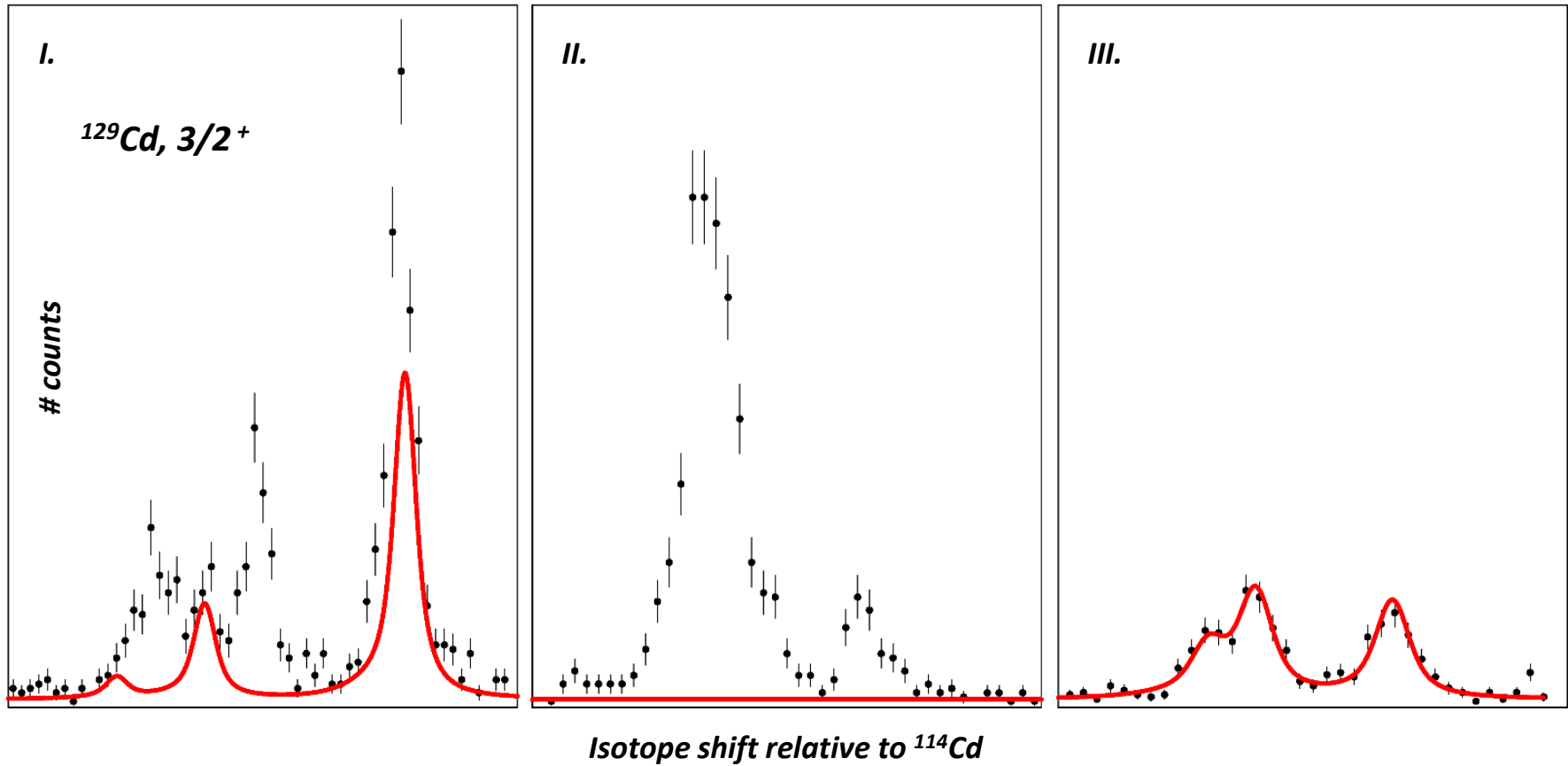
Discovery of a long-lived isomeric state in ^{129}Cd



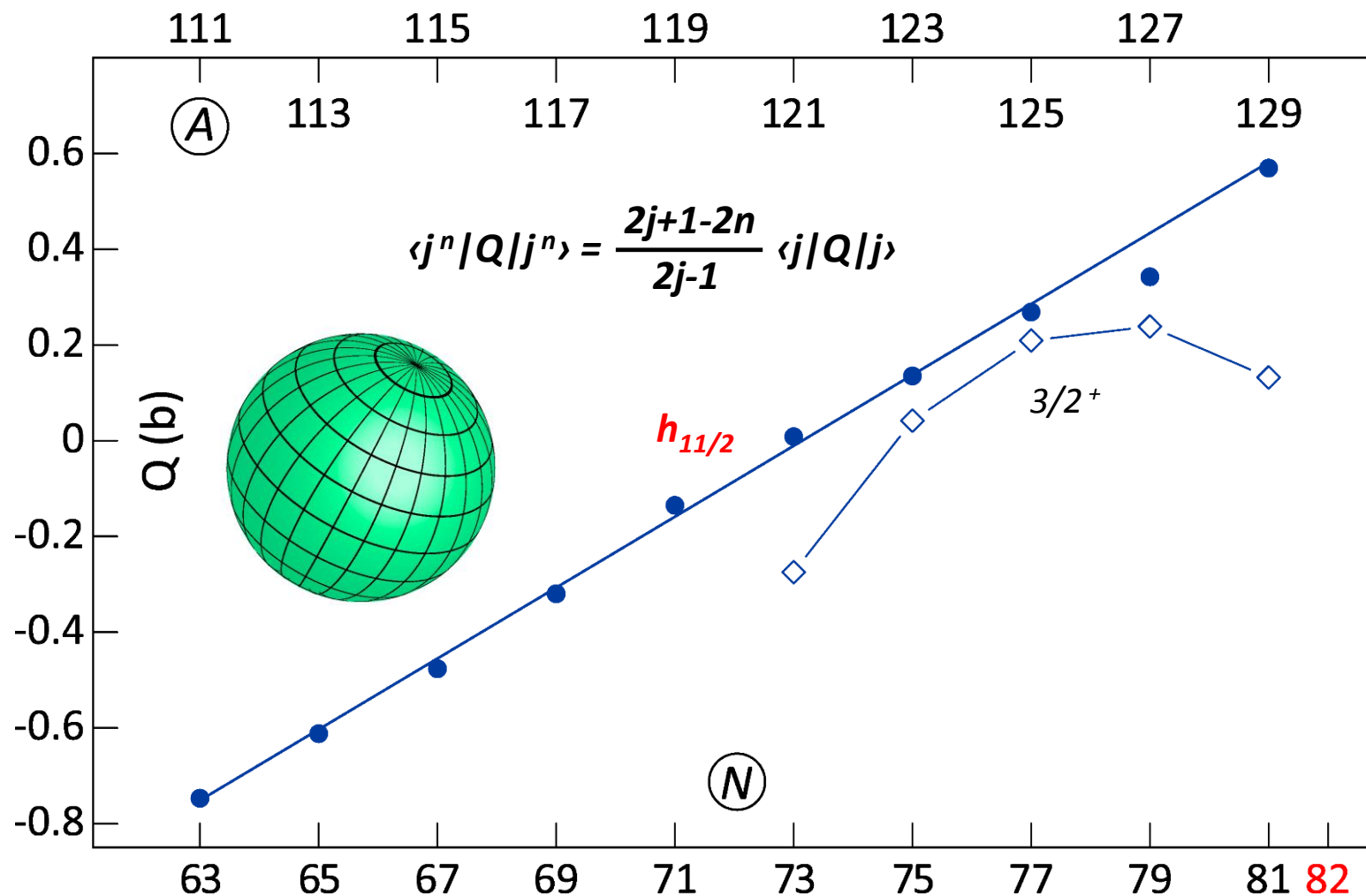
Discovery of a long-lived isomeric state in ^{129}Cd



Discovery of a long-lived isomeric state in ^{129}Cd

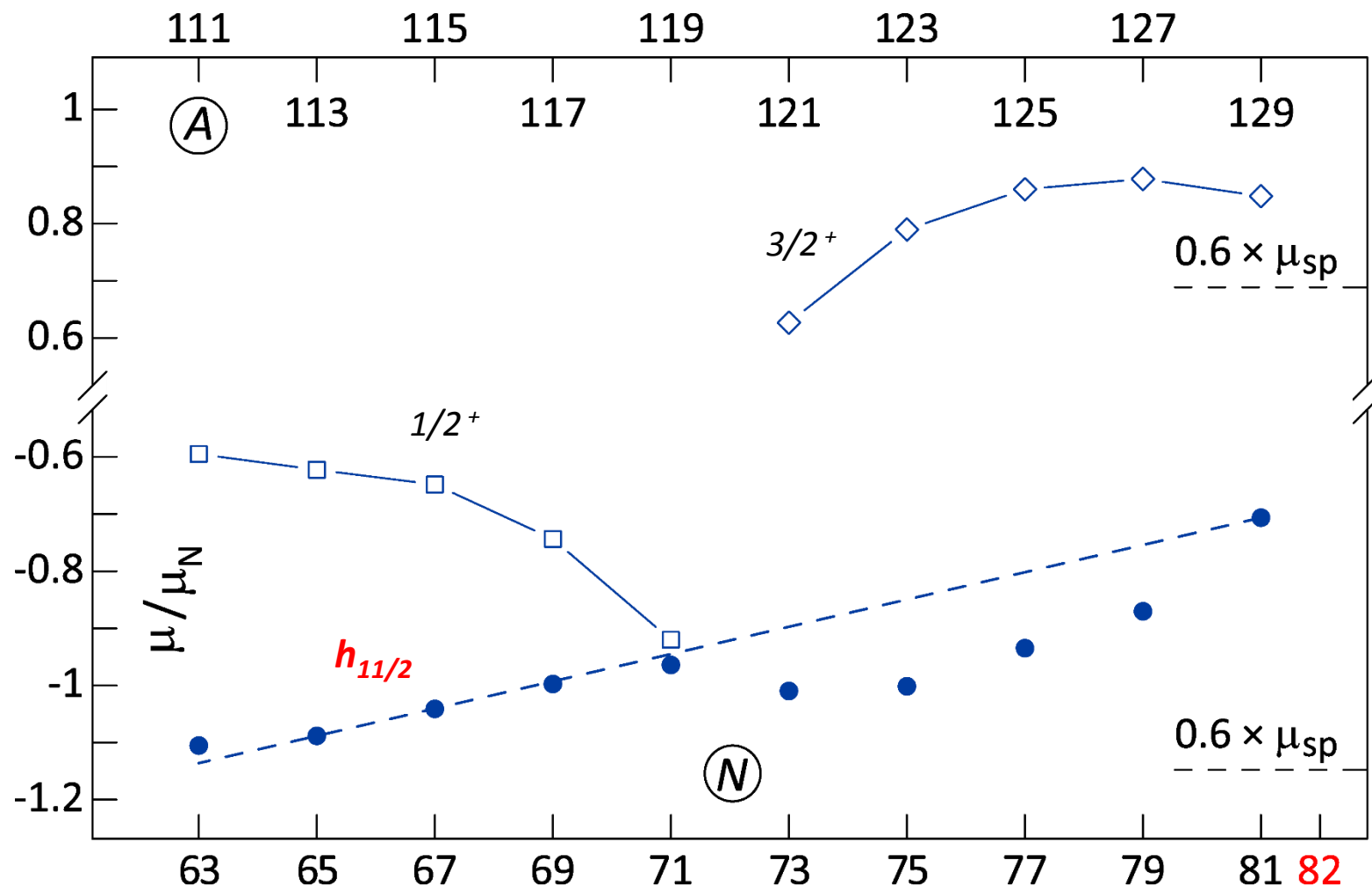


11/2⁻ states: extreme shell-model view



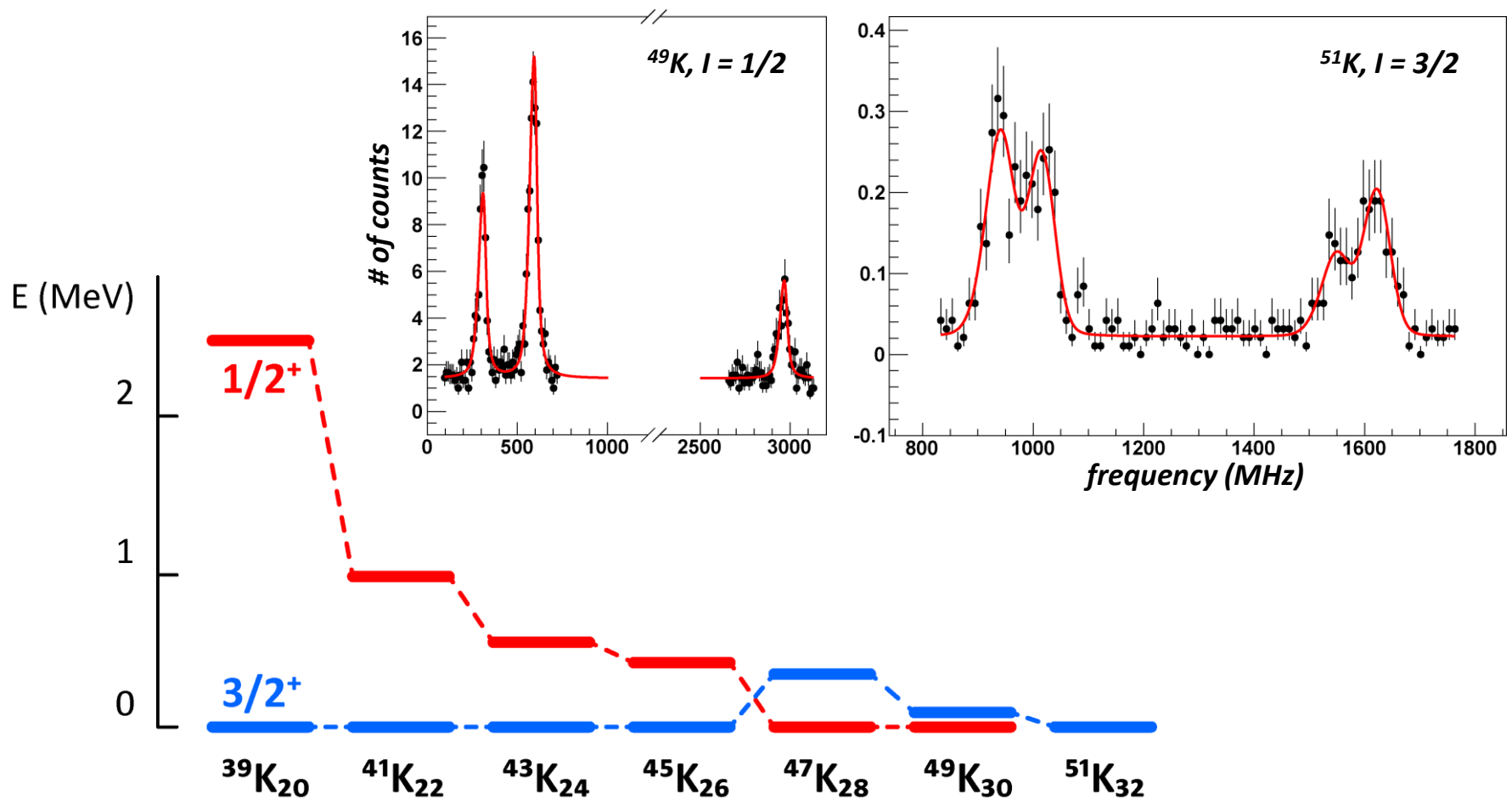
Phys. Rev. Lett., 110, 192501 (2013)

11/2⁻ states: extreme shell-model view

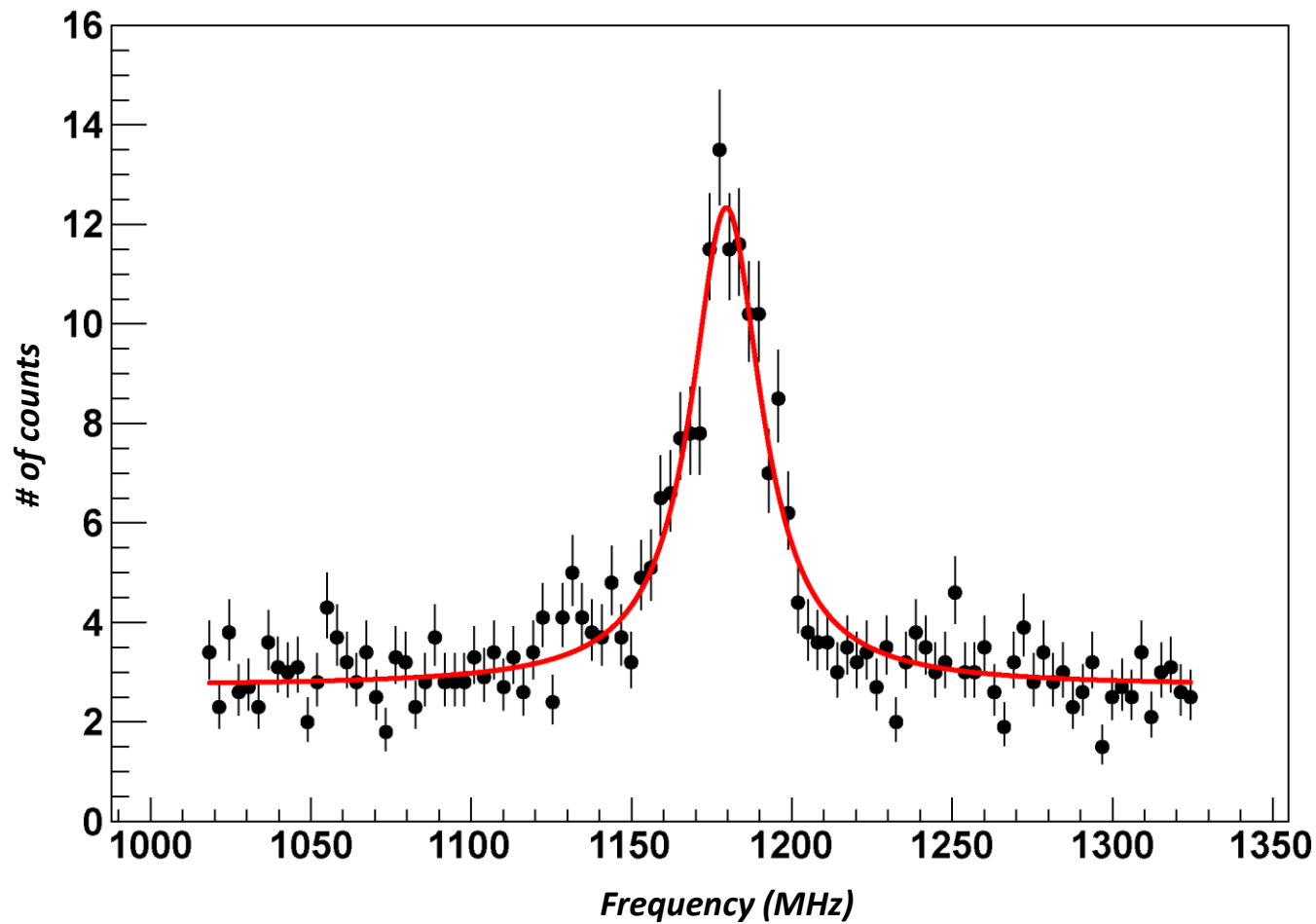


Phys. Rev. Lett., 110, 192501 (2013)

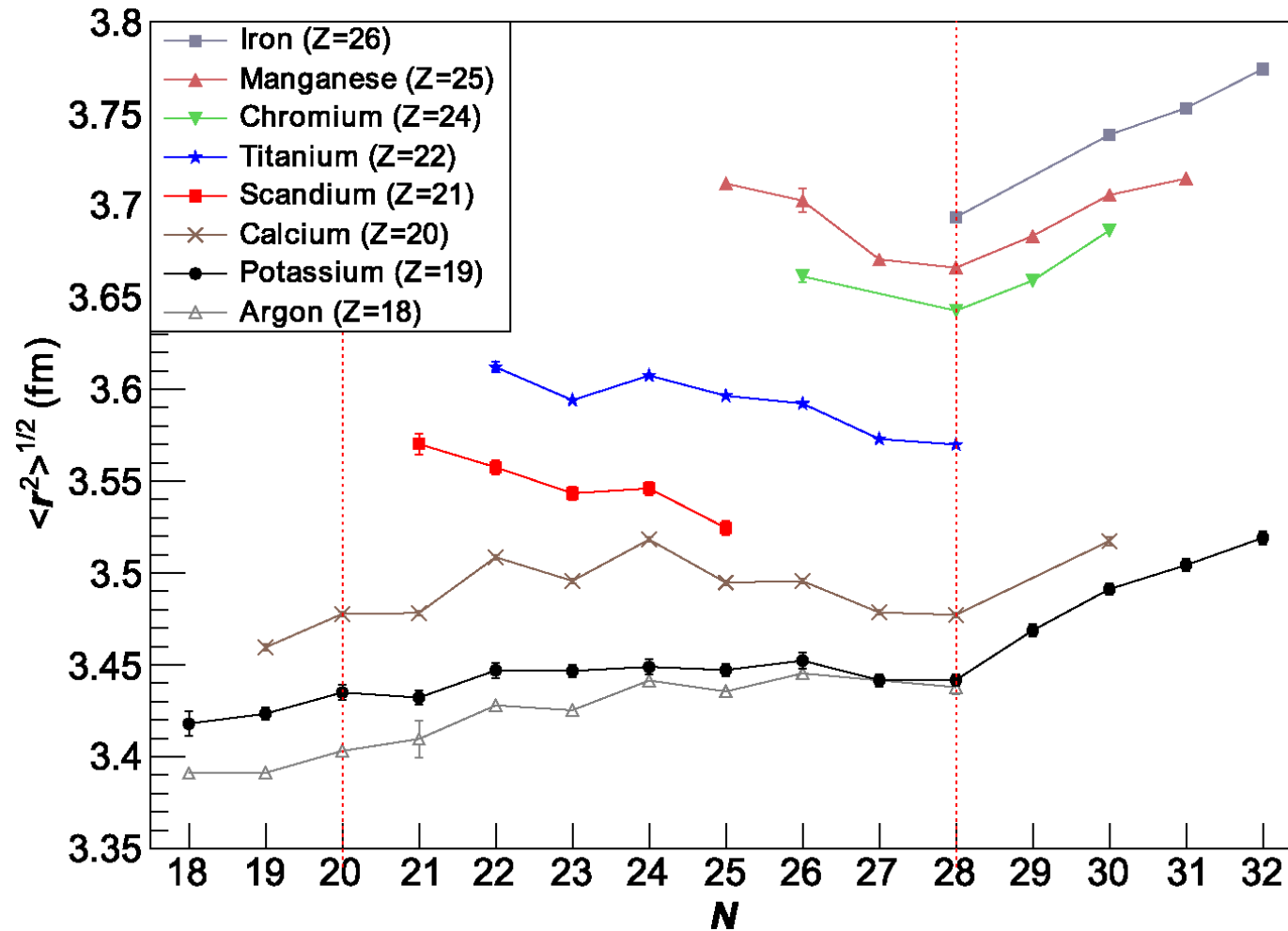
Reinversion from $1/2^+$ to $3/2^+$ between ^{49}K and ^{51}K



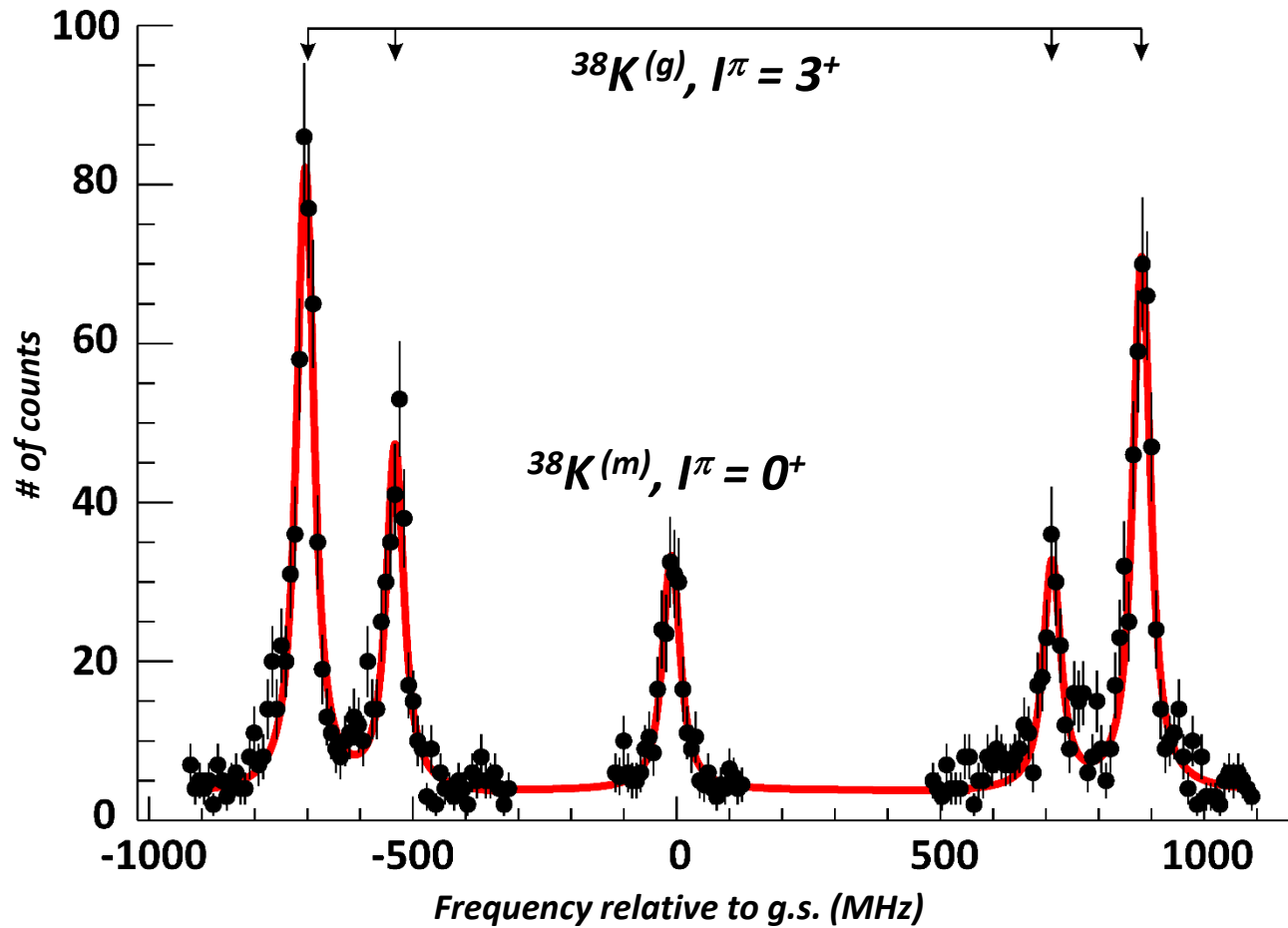
J. Papuga et al., Phys. Rev. Lett., 110, 172503 (2013)

Zero spin for the odd - odd ^{50}K 

Z dependence of the N=28 kink

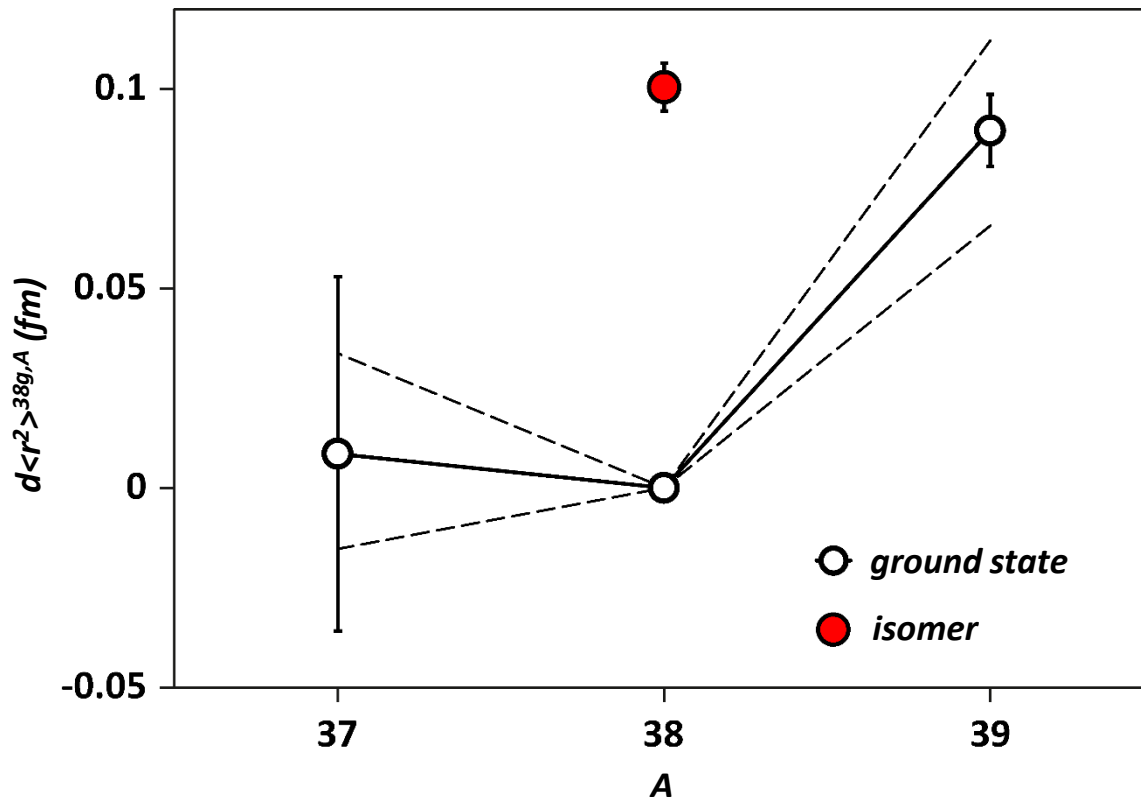


Isomer vs. g.s. in the self conjugate ^{38}K



M. L. Bissell et al., Phys. Rev. Lett., 113, 052502 (2014)

Isomer vs. g.s. in the self conjugate ^{38}K



Summary

Cadmium:

- Measured model independent I , μ , Q and $\langle r^2 \rangle$ of $^{100-130}\text{Cd}$
- First direct observation of long-lived isomers in $^{127, 129}\text{Cd}$
- Linear behavior of the $h_{11/2}$ Q moments in $^{111-129}\text{Cd}$
- Core polarization from magnetic moments

Potassium:

- Reinversion from $1/2^+$ to $3/2^+$ between ^{49}K and ^{51}K
- Strong Z dependence of the $N=28$ kink
- 0^+ isomer larger than the 3^+ g.s. in the self conjugate ^{38}K



MAX-PLANCK-GESELLSCHAFT



Federal Ministry
of Education
and Research

