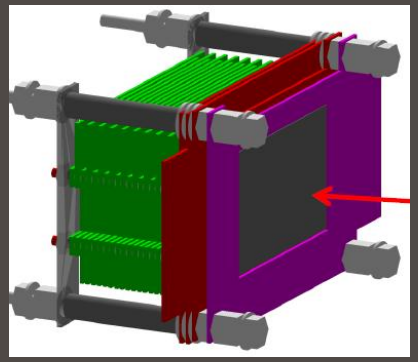
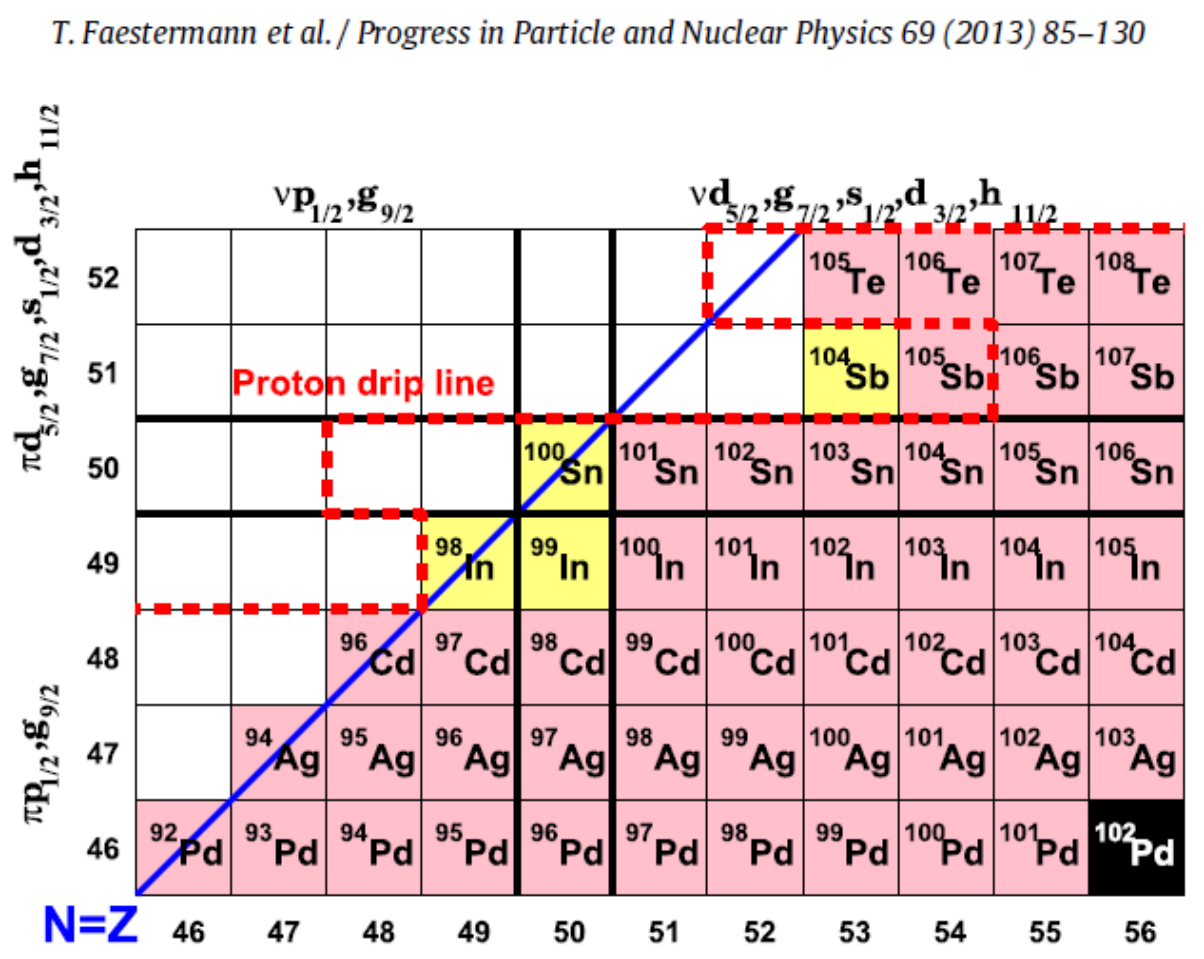
Isomeric decay spectroscopy of ^{96}Cd



Jason Park, UBC/TRIUMF
for the EURICA collaboration

Introduction



Key concepts:

- Isomer
- Proton dripline
- *N* = *Z* nuclei
- g9/2 orbital

Motivation to study ^{96}Cd

What is known:

1. Isomer: ^{96}Cd has a 16^+ spin-gap isomer that decays to ^{96}Ag

   (B. S. Nara Singh et al., PRL 107, 172502, 2011.)

2. Proton dripline: in addition to β^+/EC decay, ^{96}Cd exhibits β-delayed proton emission (G. Lorusso et al., Phys. Rev. C 86, 014313, 2012.)

Questions:

Is the β-delayed proton emission from the $0_{g.s.}^+$, or the 16^+ isomeric state?

Is the 16^+ state due to the interaction of 2p, 2n holes in the g9/2 orbital?

Isotope production & identification

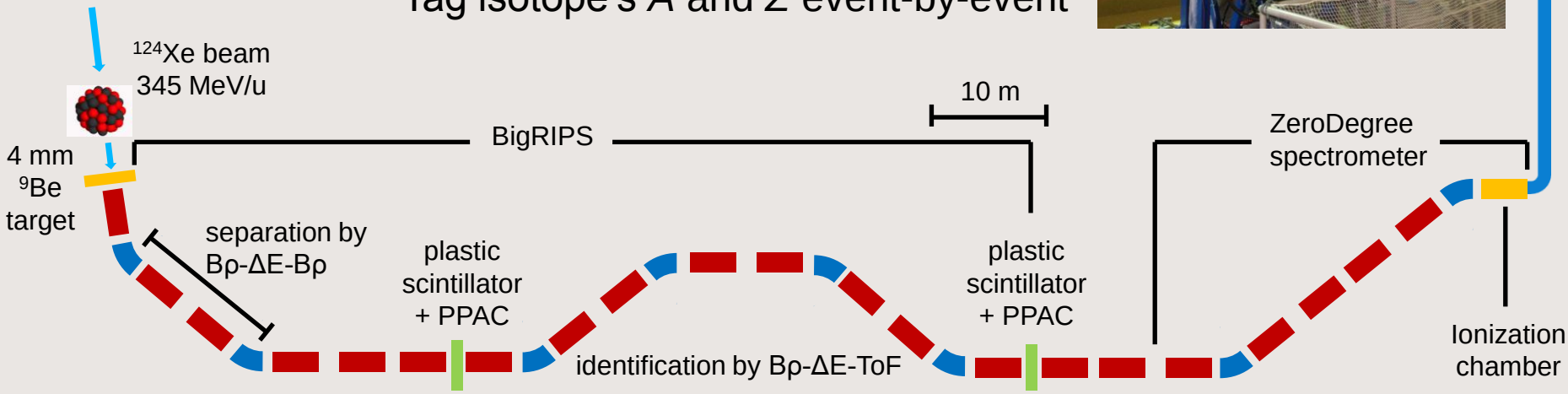
RIKEN SRC

Fragmentation reaction

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

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

EURICA + WAS3ABI



Position-sensitive PPAC: *Bρ*

$$B\rho = \frac{p}{q} = \beta\gamma m_u c \frac{A}{q}$$

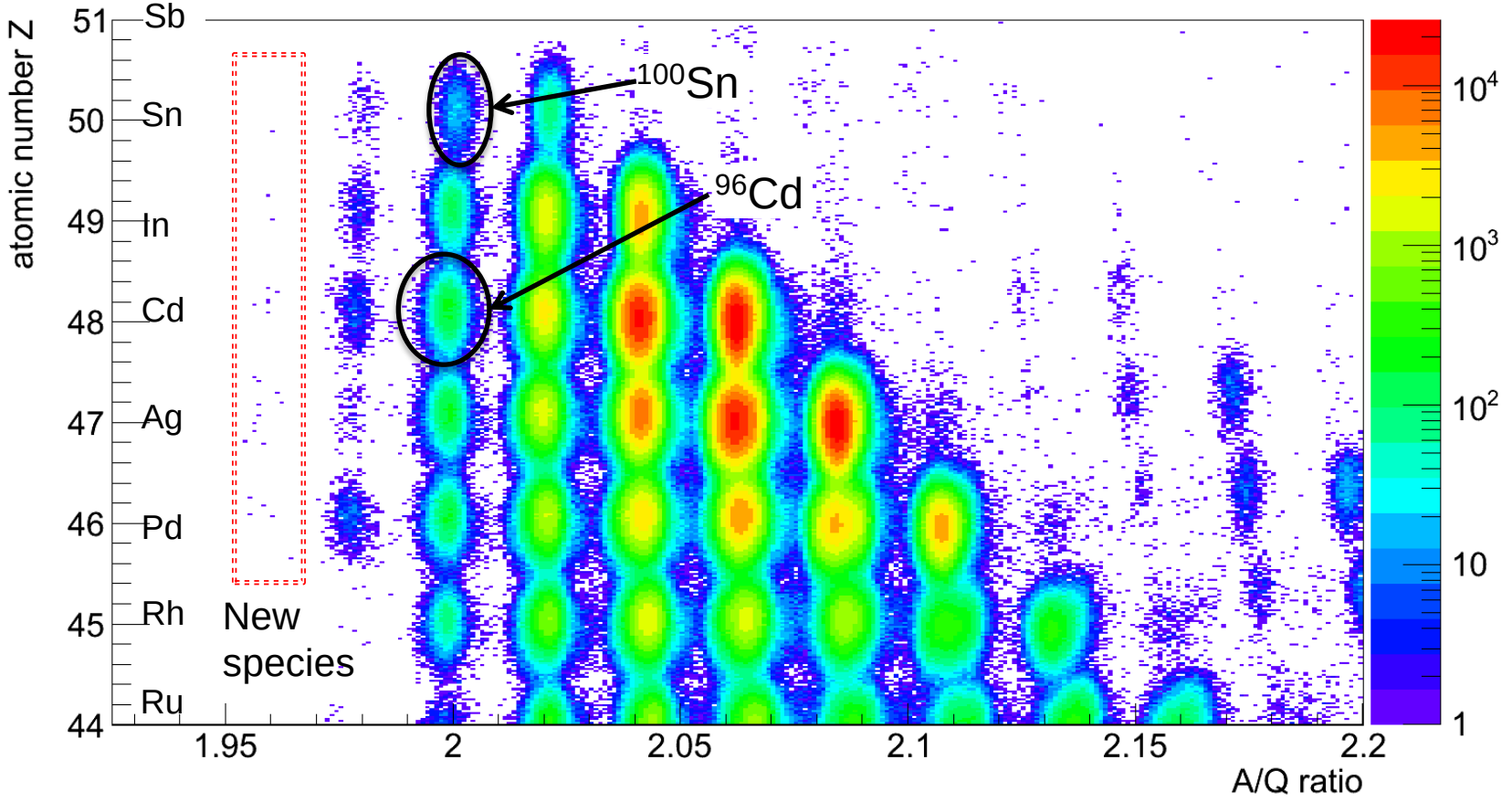
Plastic scintillator: ToF

$$\beta = \frac{1}{c}\frac{L}{\mathrm{ToF}}$$

Ionization chamber:Δ*E*

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

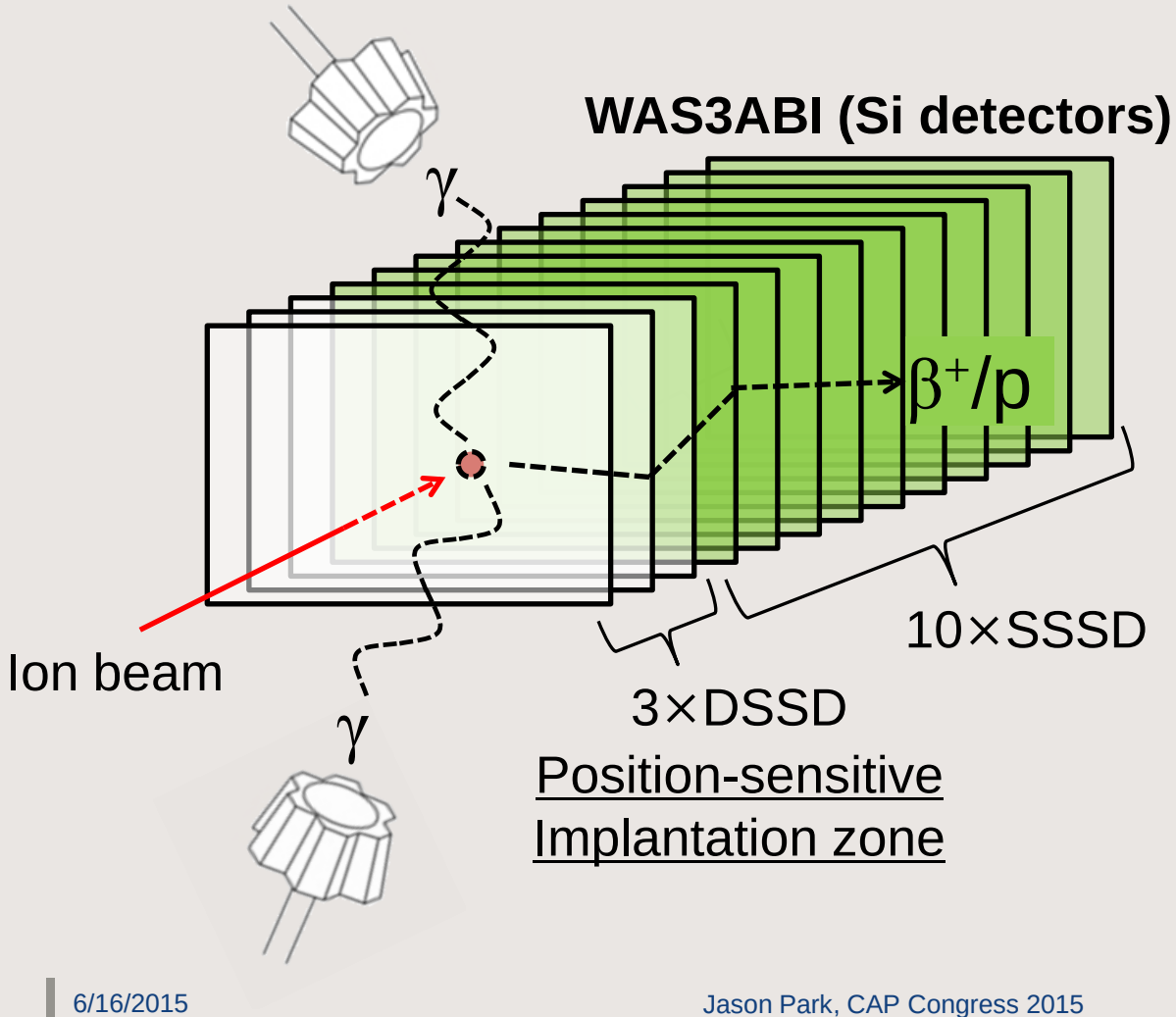
Isotope production (8.5 days of beam)



2317 ^{100}Sn ions, ~18000 ^{96}Cd ions produced and identified
>10 improvement in statistics compared to previous records

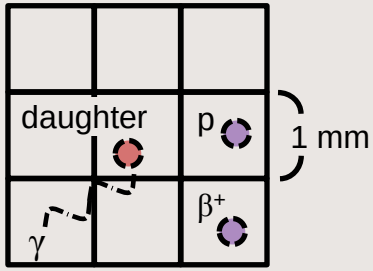
Detector systems: WAS3ABI + EURICA

EURICA (HPGe detectors)



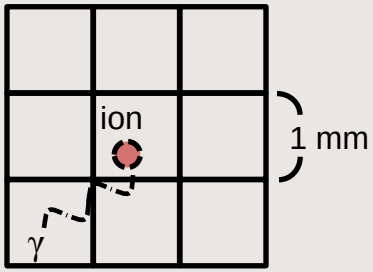
Two spectroscopy modes:

1. Decay spectroscopy



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

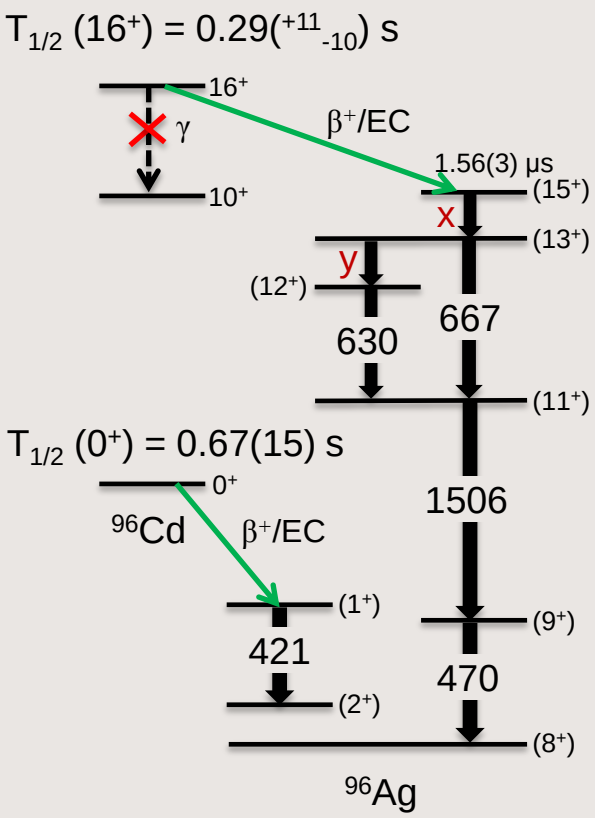
2. Isomer spectroscopy



Measure γ-rays of isomer after implantation

Previously reported 16^+ isomer in ^{96}Cd

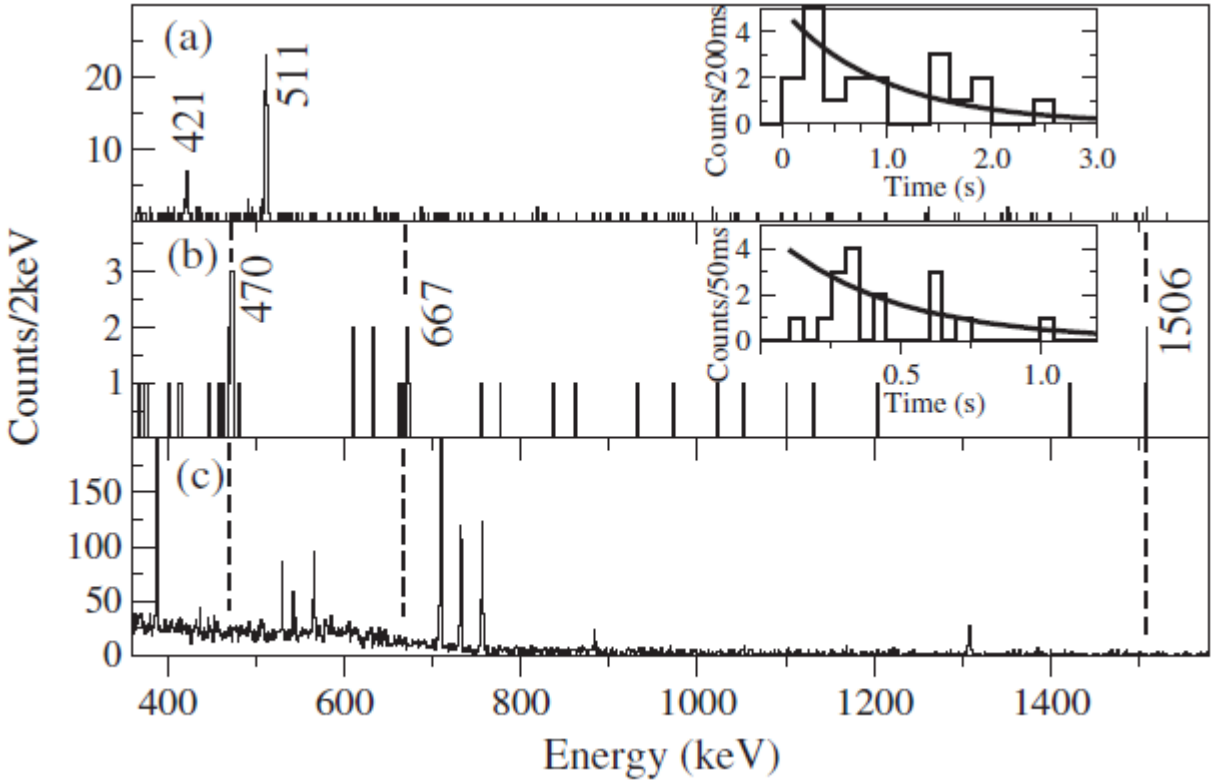
Literature



(a) Prompt: $0 < T_\gamma < 200$ ns

(b) Delayed: $200\ \text{ns} < T_\gamma < 4\ \mu\text{s}$

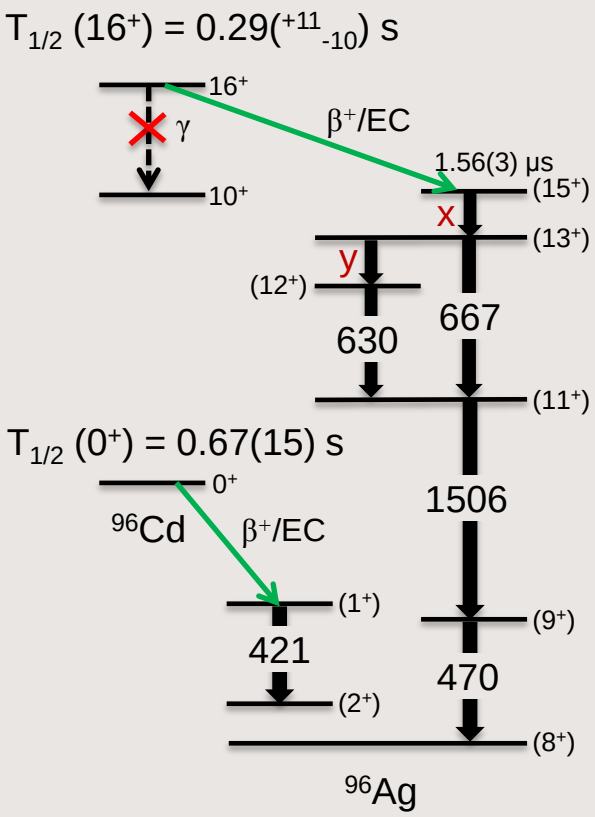
(c) All other nuclei, $200\ \text{ns} < T_\gamma < 4\ \mu\text{s}$



B. S. Nara Singh et al., PRL 107, 172502 (2011).

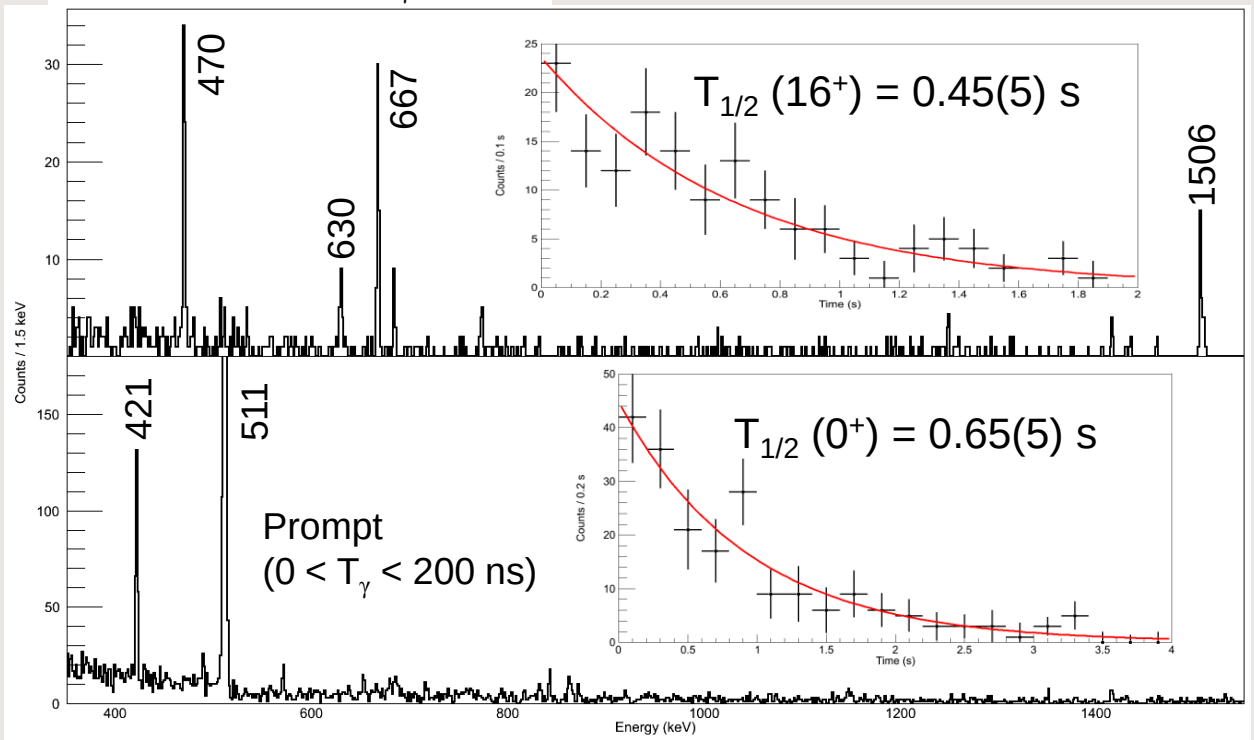
Verification of the 16^+ isomer in ^{96}Cd

Literature



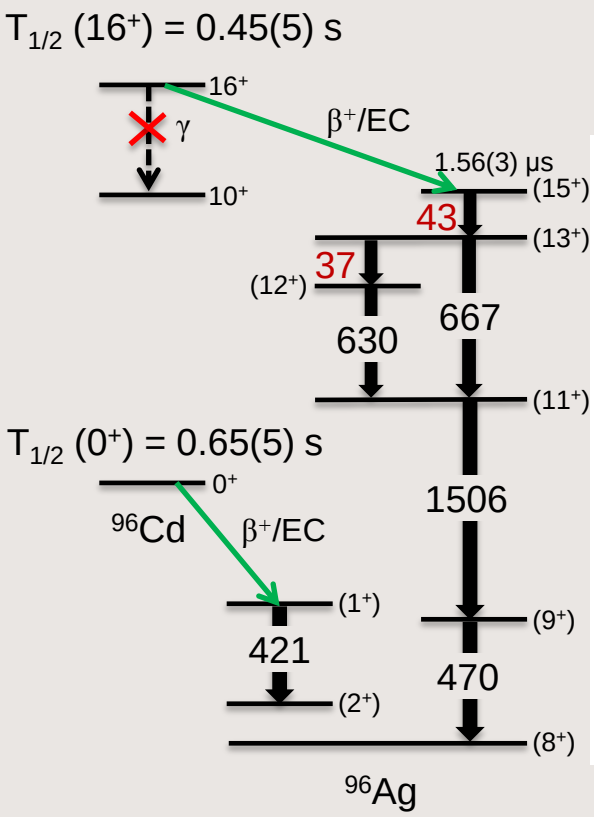
This work

Delayed: 200 ns < T_γ < 8 μs

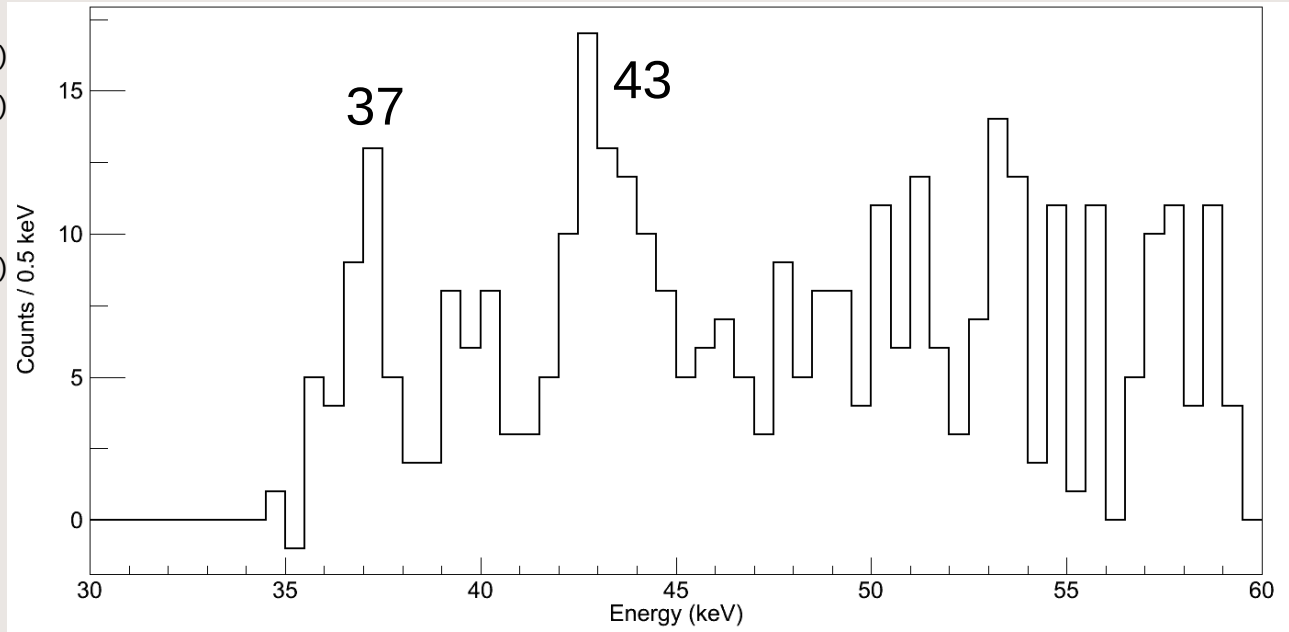


Improvement in statistics, $T_{1/2}$ precision

Low-energy γ-rays in ^{96}Ag

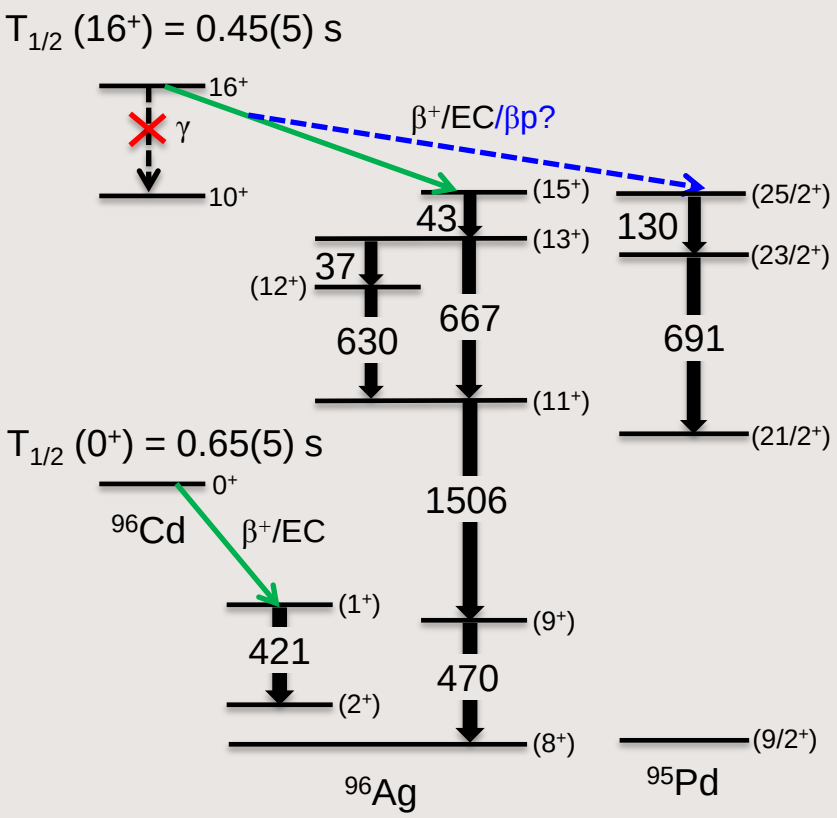


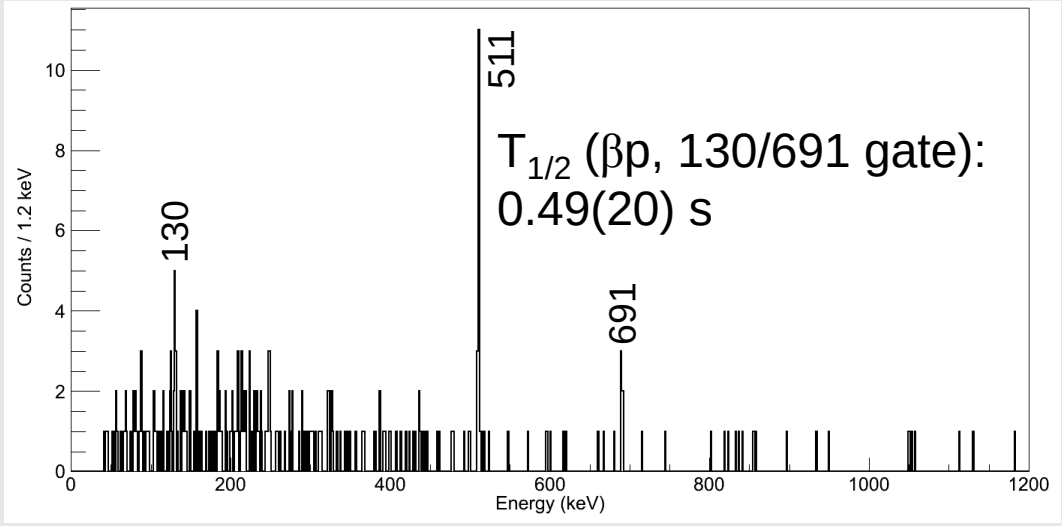
Coincident gamma-ray spectrum with summed gates of 630, 667, and 1506 keV

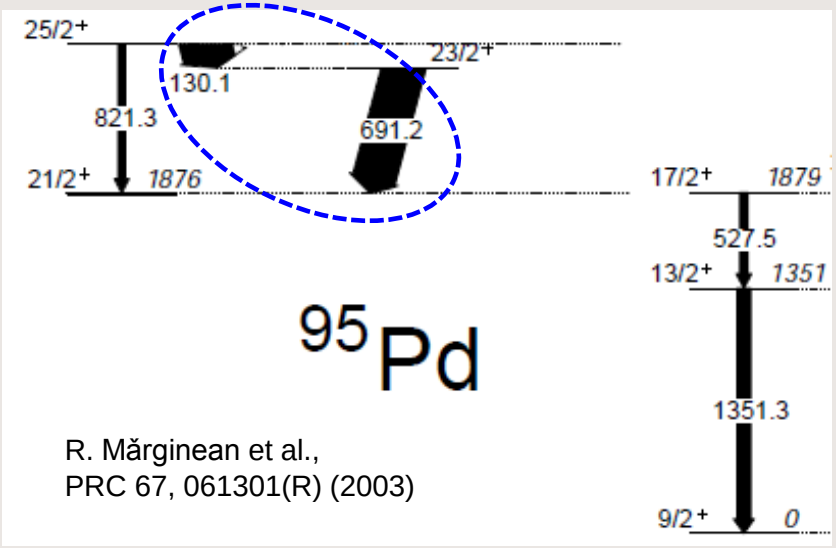


β-delayed proton emission in ^{96}Cd

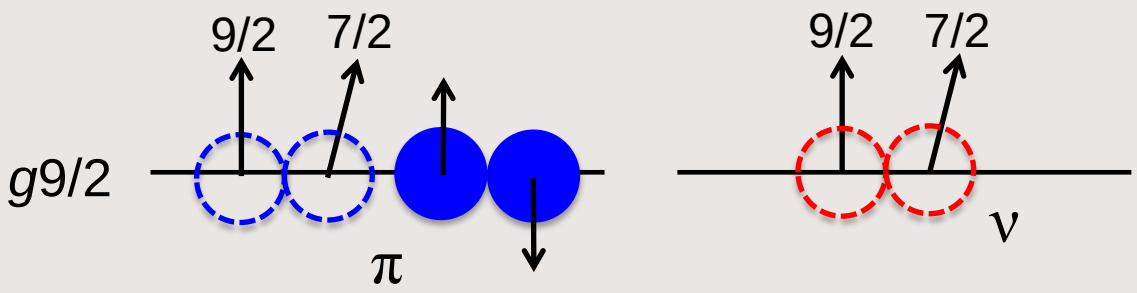
Selection cut: events with ΔE > 1 MeV in a single pixel



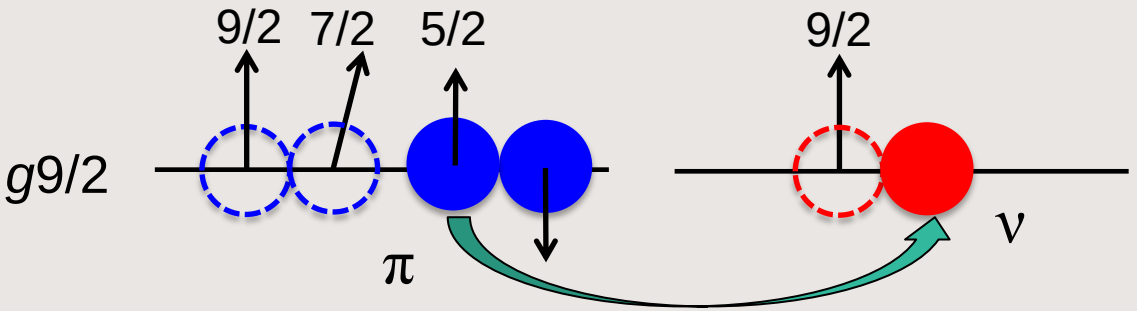




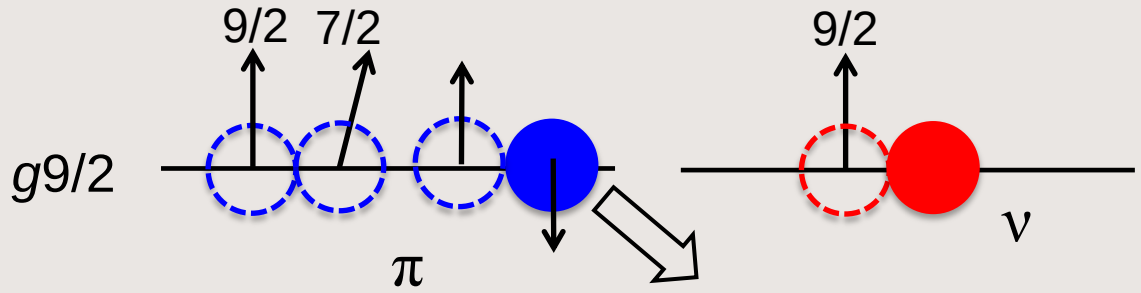
^{96}Cd 16^{+} isomeric decay hypotheses



Interaction between pairs of pn hole pairs lowers the 16^{+} state below the 12^{+}



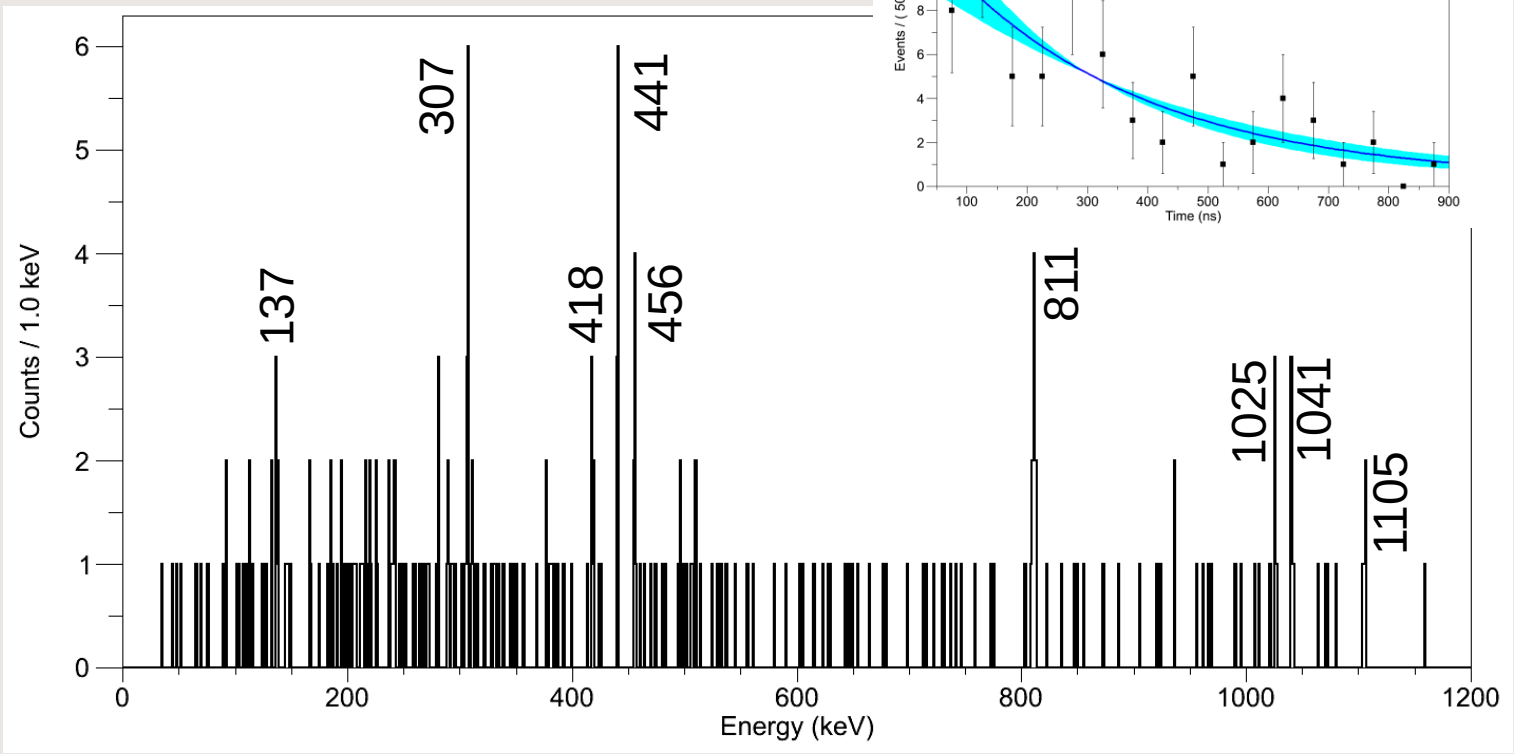
β^{+}/EC decay to 15^{+} in ^{96}Ag: holes coupled to maximum spin

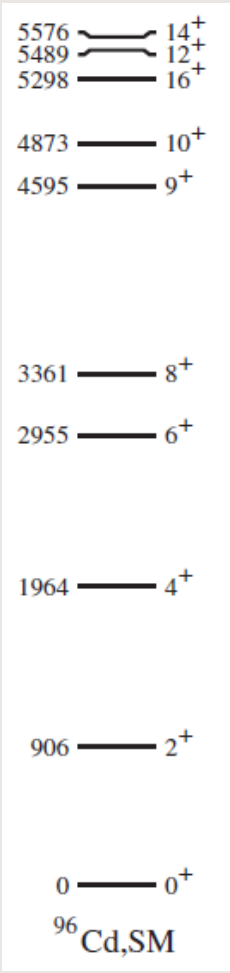


βp emission to 25/2^{+} in ^{95}Pd: Emission of unpaired proton with I = 5/2

Isomeric γ-ray transitions of ^{96}Cd

Gamma-rays with
50 ns < T_γ < 900 ns
after ^{96}Cd implantation





9 new candidate gamma-rays, energies similar to level gaps in SM calculations

B. S. Nara Singh et al., PRL 107, 172502 (2011).

EURICA collaboration

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

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