New β-Decay Studies of Deformed, Neutron-Rich Nuclei in the A~160 Region

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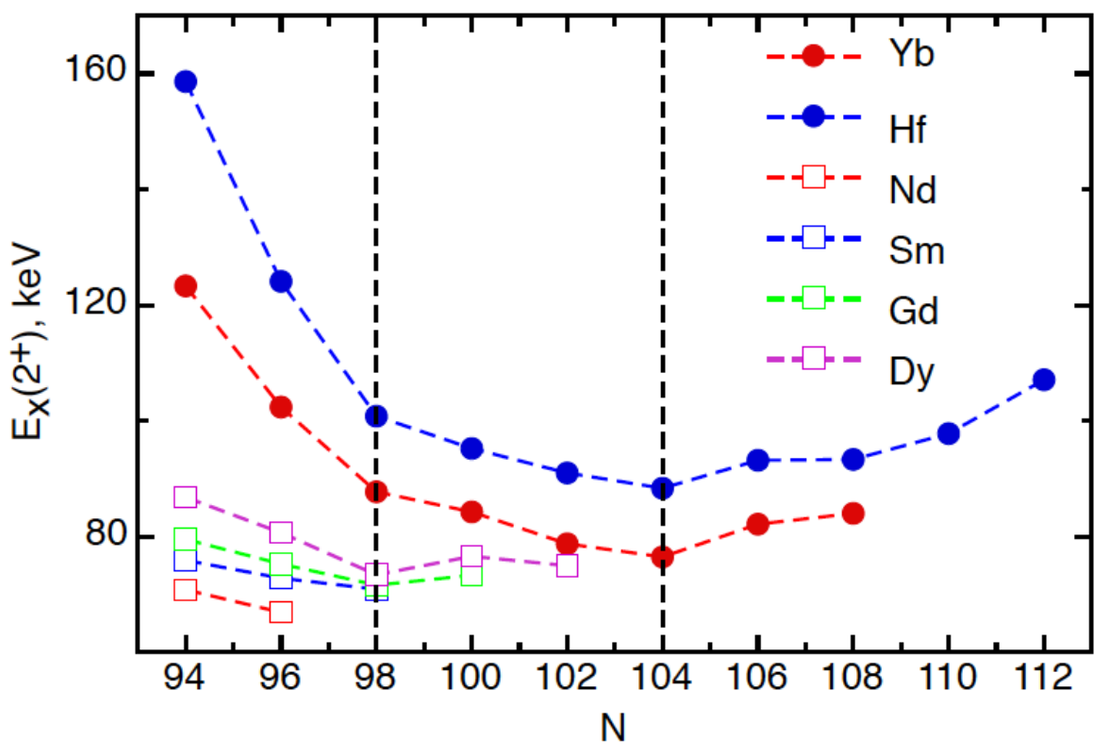
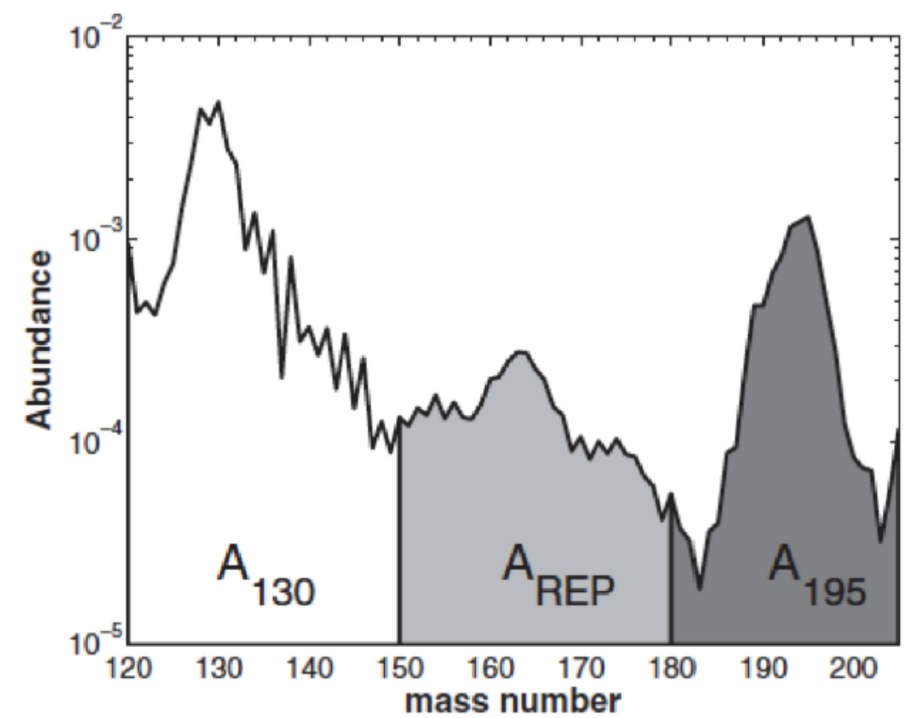
Motivation

- Unusual structure effects in N-rich, rare-earth nuclei
  - Especially near N = 98



- Understanding the pygmy rare-earth peak depends on nuclear structure input



M.R. Mumpower, G.C. McLaughlin, R. Surman, PRC **86**, 035803 (2012)

^{156}Pm, ^{160}Eu, & ^{162}Eu Decay Studied: Focus on ^{160}Eu

CARIBU at Argonne National Laboratory provided the beams

Mass Measurement

Canadian Penning Trap

β Decay Spectroscopy

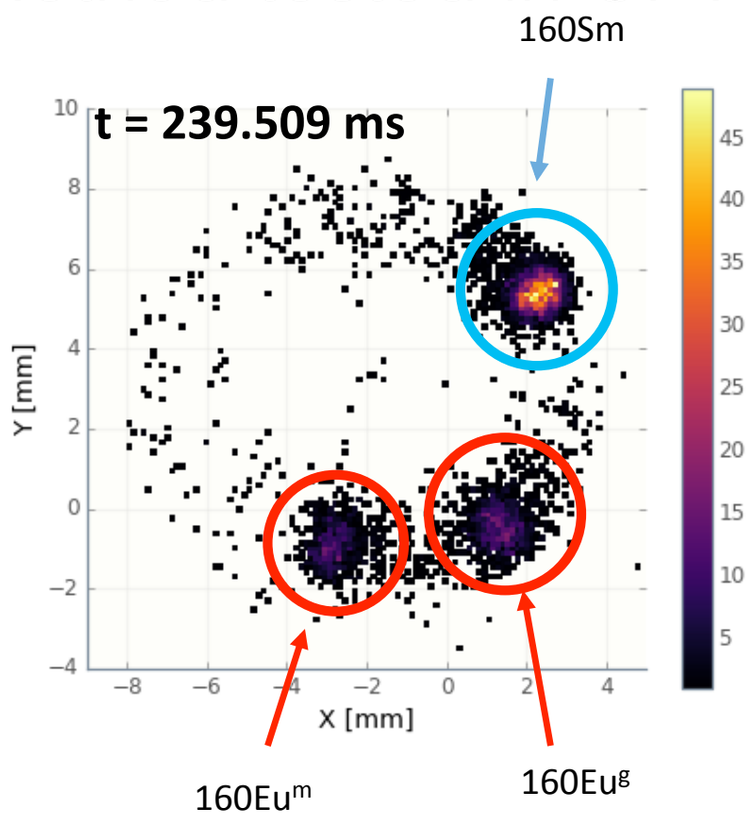
SATURN Tape Station

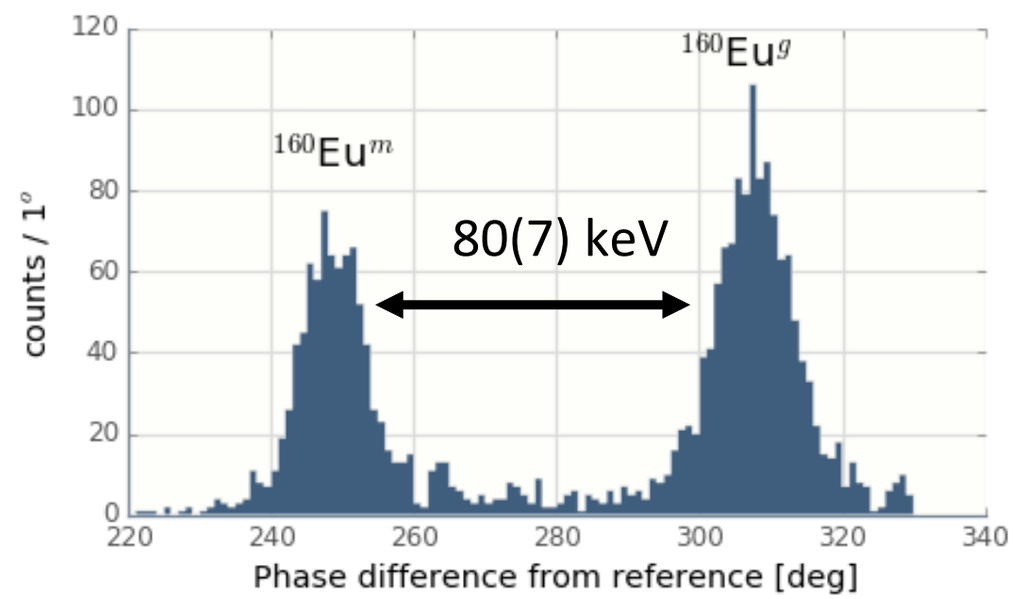
X-Array

- Previously for ^{160}Eu: Only a (1^-) isomer with $t_{1/2}$ = 38(4) s
- Tape/Beam Cycle: 180 s beam on, 180 s beam off
- β-gated γ vs. time matrix: Measure lifetimes
- β-gated γ-γ coincidence matrix in beam off condition

Mass Measurement of ^{160}Eu

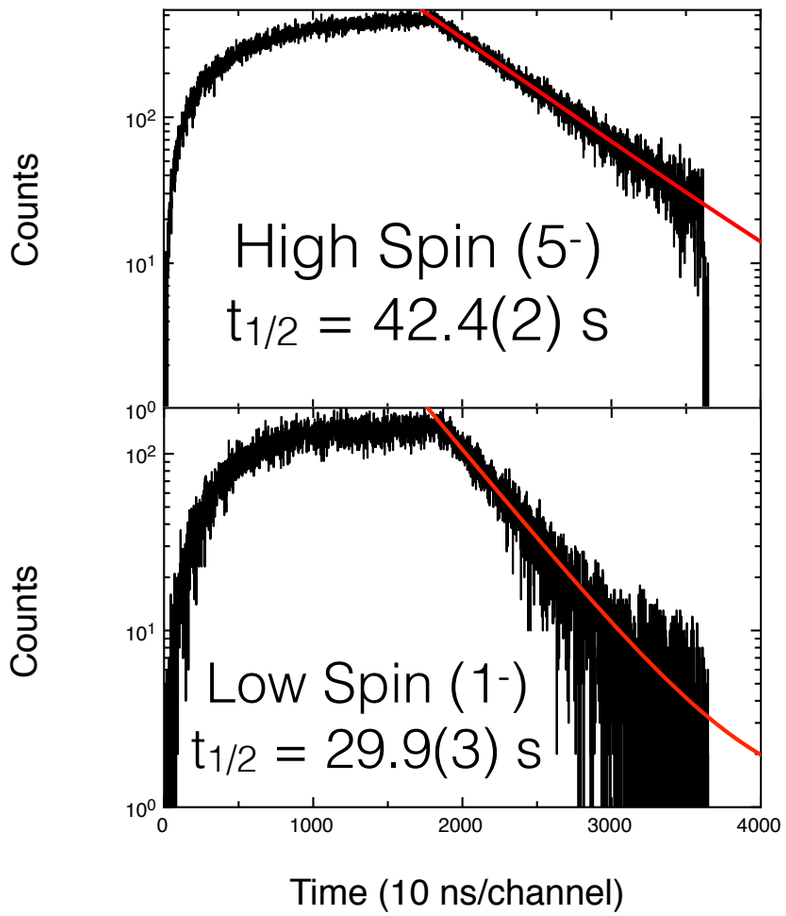
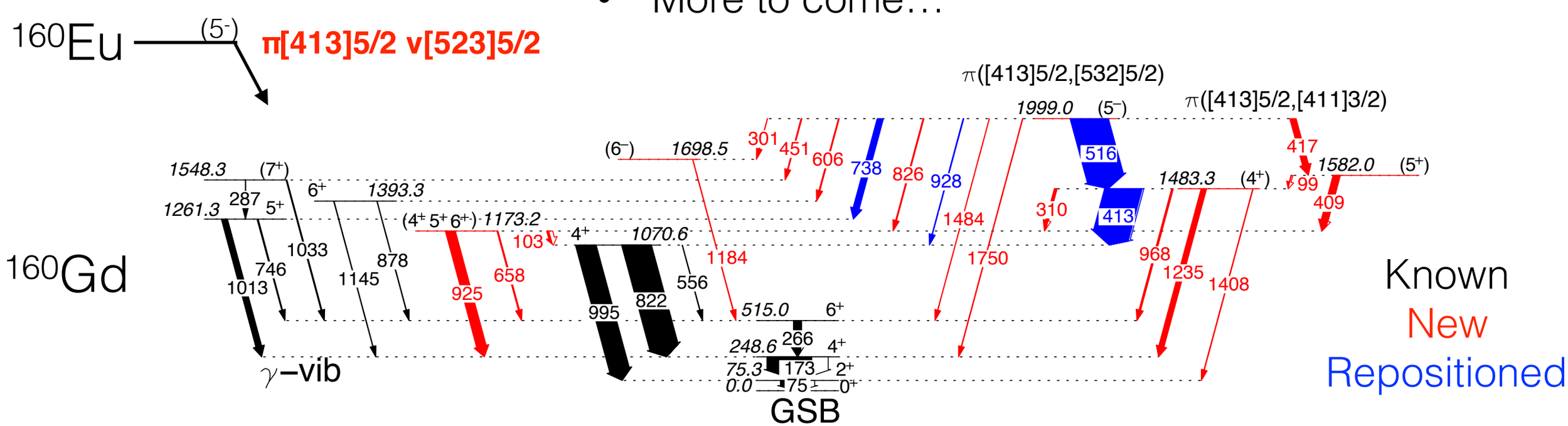
- The new phase-imaging ion-cyclotron-resonance (PI-ICR) technique was used
  - S. Eliseev *et al.*, Phys. Rev. Lett. **110**, 082501 (2013)
- Method tested in CPT with well-known energy of ^{156}Pm^{m}





- Cyclotron frequency determined by measuring the accumulated phase during a period of free motion (t)
- Measured phase difference between the states gives the excitation energy
- AME12 value for ^{160}Eu is an unknown mixture of these two states

β-Decaying States in ^{160}Eu



- Previous $t_{1/2}$: 31(4) s, 41(4) s, 50(10)s, 53(10)s
  - Assumed single low-spin, β-decaying state
- Lifetimes of γ's fell into 2 values (2 isomers)
- γ's with $t_{1/2}$=42 s from, or fed, high-spin states
- π[413]5/2 ν[523]5/2 -> $K^{\pi} = 5^-$ & 0^-
- Nuclear structure of ^{160}Gd states assist in configuration assignment
- Two different level schemes proposed for ^{160}Gd
  - Ours differs from both!
- 1999-keV state most strongly fed by $K^{\pi} = 5^-$ $t_{1/2}$=42 s isomer; log*ft* ≈ 5.0 -> related configs
- More to come…