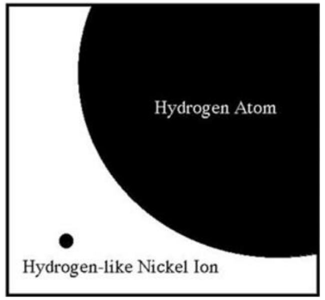
New avenue: Highly Charged Ion based Nuclear Radius Measurements



J.D. Gillaspy J. Phys. B. 34, R93 (2001)

$$S \equiv \frac{\partial E}{\partial R} \qquad S \propto Z^4$$

$$\delta E_{AB} \equiv E^{\mathrm{exp}}_{A-B} - E^{\mathrm{th}}_{A-B}$$

theoretical difference has reduced uncertainty (factor of 10!)

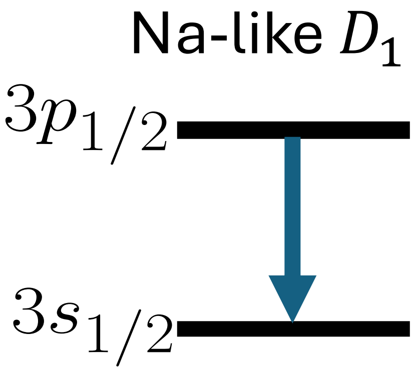
$$\delta E_{AB} = S_B \delta R_B$$

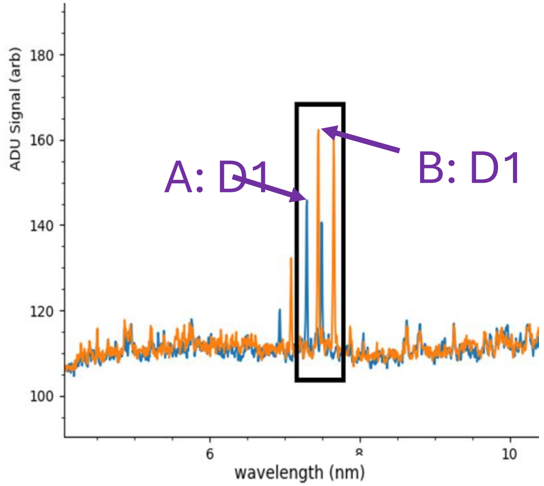
nuclear sensitivity coefficient

$$\delta R_B \equiv R_B - R_{B_0}$$

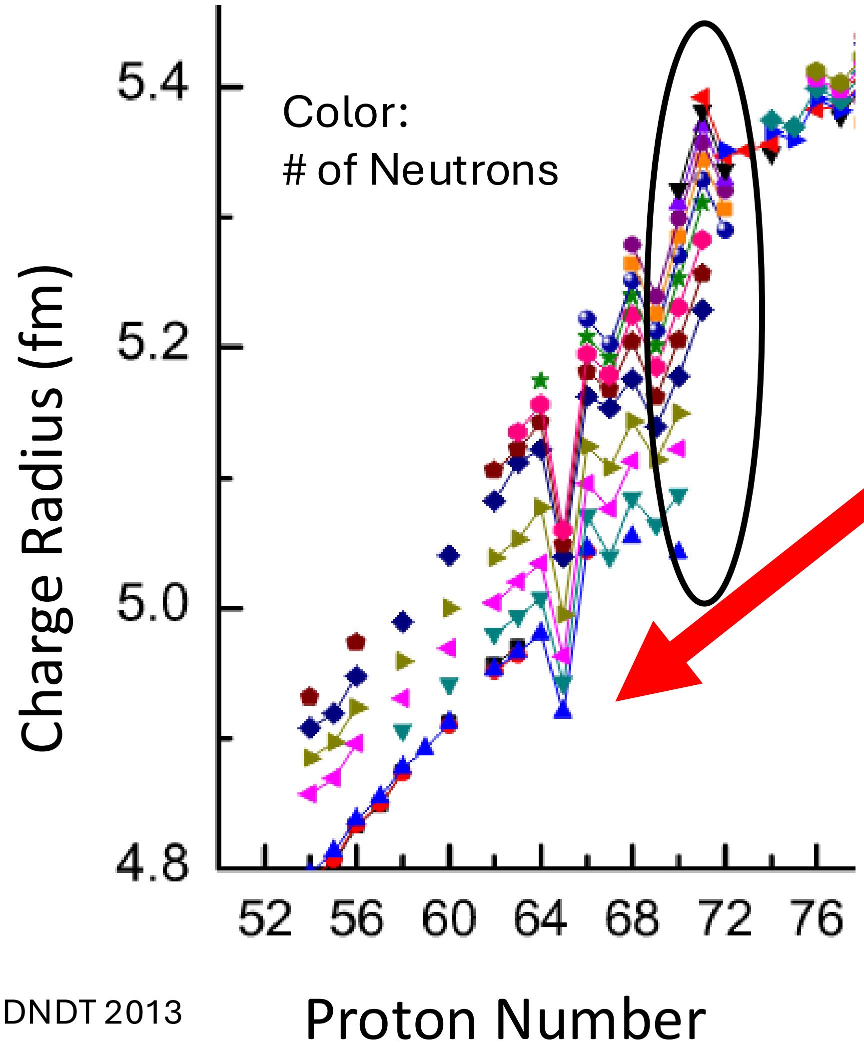
- APNC measurements using heavy radioactive isotopes are limited by the precise knowledge of the charge radius of these nuclei.

- *Na-like highly charged ions ideal for determining nuclear charge radii:*
  - *require fewer atoms than conventional techniques.*
  - Simple charge states (Na-like, Li-like) to reduce theoretical uncertainties
  - D1/D2 transitions are strongly sensitive to nuclear radius



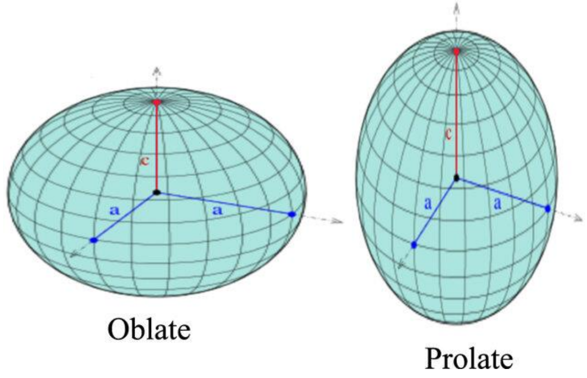


The Puzzle



Angeli ADNDT 2013

- Rare earth nuclei are **highly deformed**, causing an odd/even stagger in charge radii

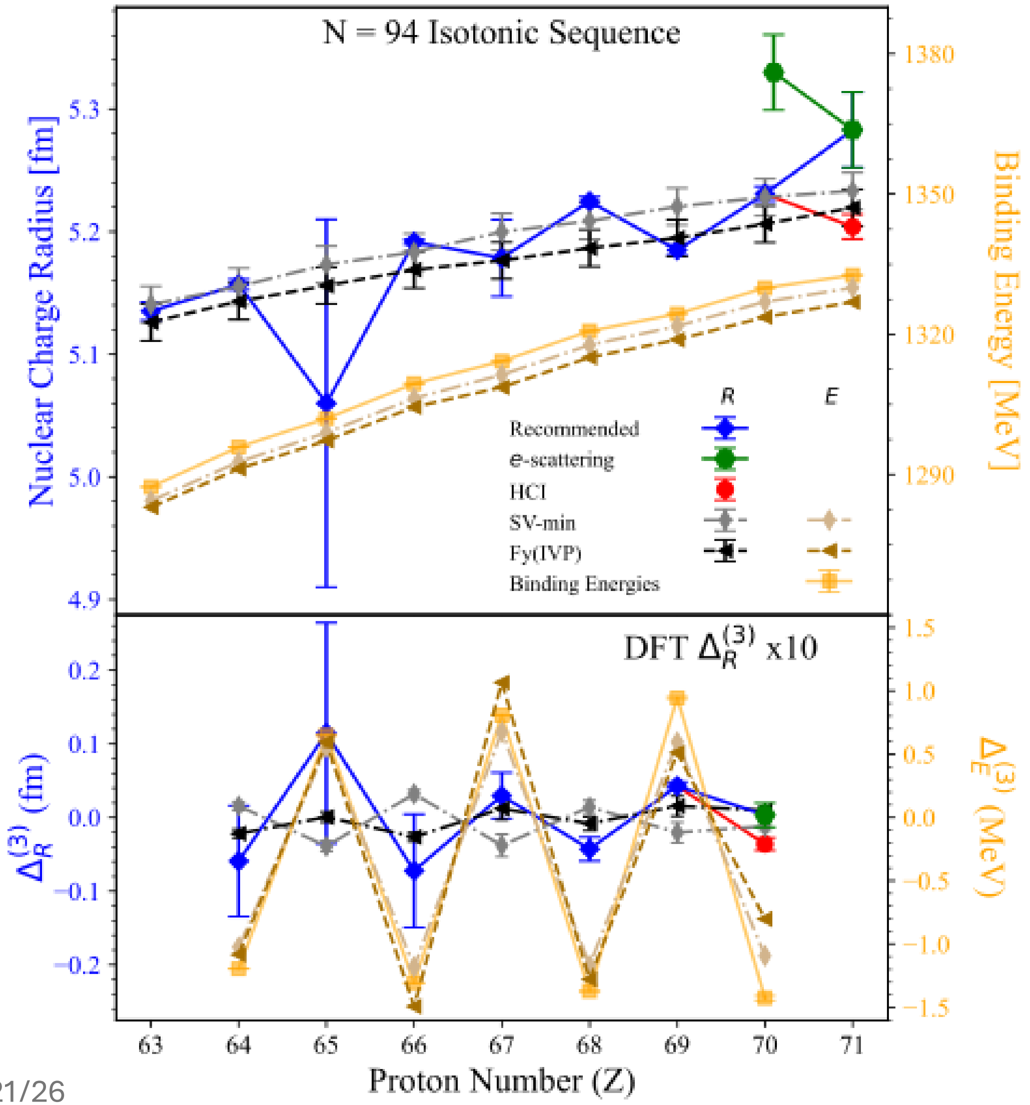


- Exception: Lu (Z=71)?

Image Credit: E. Yazdankish Phys. Scr. 98, 115309 (2023)

Using trapped ions to look into odd-even staggering

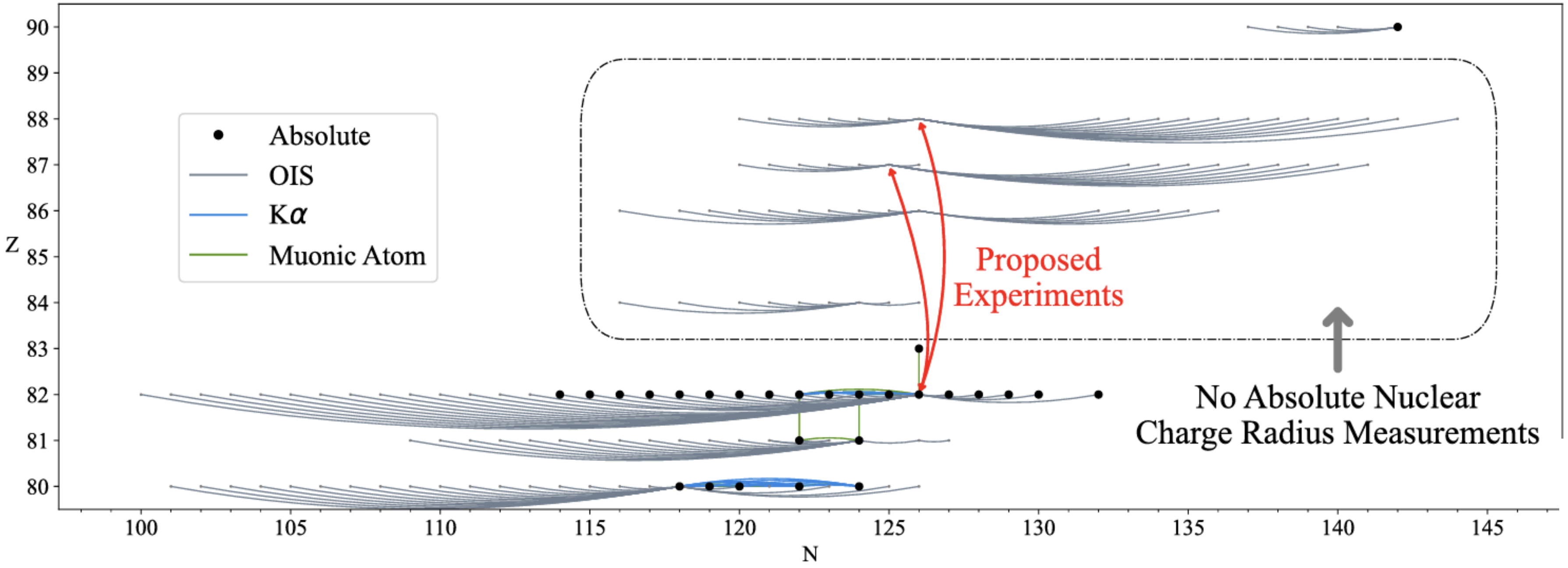
E. Takacs et al., arXiv:2511.19395



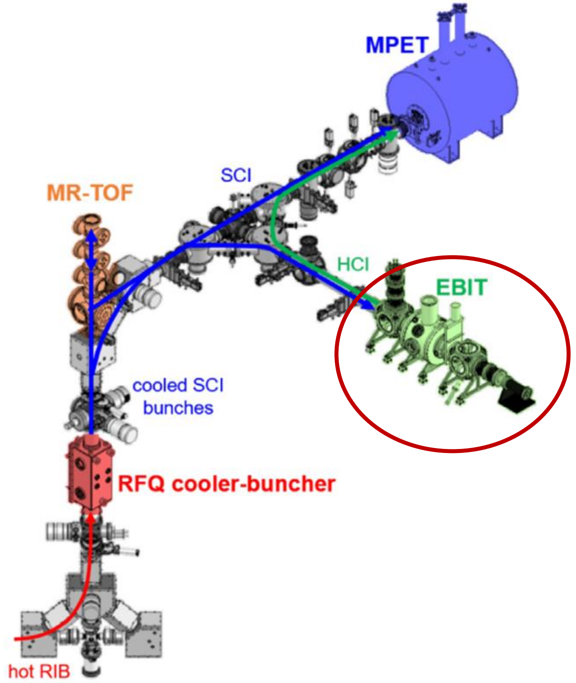
New result from the Lu-Yb Tokyo EBIT measurement resolves the longstanding Lu inversion anomaly and reestablishes a pronounced **odd-even staggering** along the N = 94 isotonic chain

The isotonic sequence Tb-Dy-Ho was measured recently at the Tokyo EBIT. Analysis underway

What Next: Towards Radioactive Isotopes



We project determining the nuclear charge radii of Fr Rn, and Ra with uncertainties between 0.005 fm and 0.010 fm, improving the current recommended value by a factor of 2 to 4.



A snapshot of the nuclear radius landscape in the high Z region. Notably for $84 \leq Z \leq 89$, no absolute charge radius measurements nor difference measurements to an element with an absolute charge radius measurement exist [Silwal et al., NIM A 1082 (2026) 170947].