29 June 2016

Addendum to the ISOLDE and Neutron Time-of-Flight Committee

IS490 experiment

Seeking the onset of collectivity in neutron-rich krypton isotopes with the mass spectrometer ISOLTRAP

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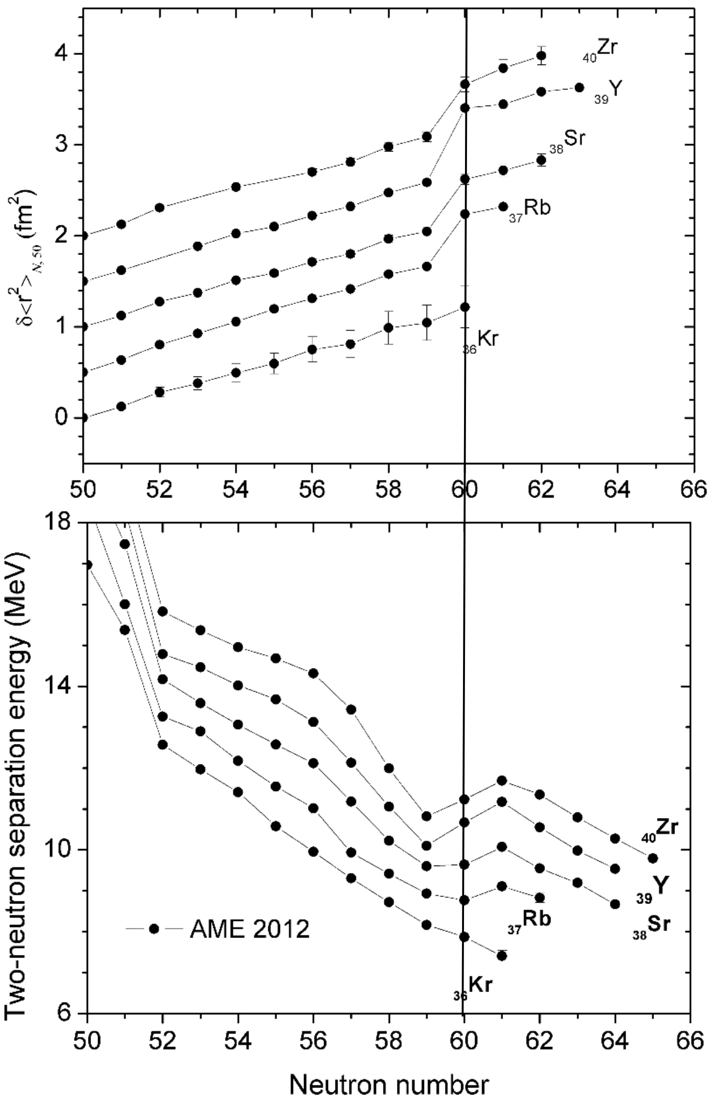
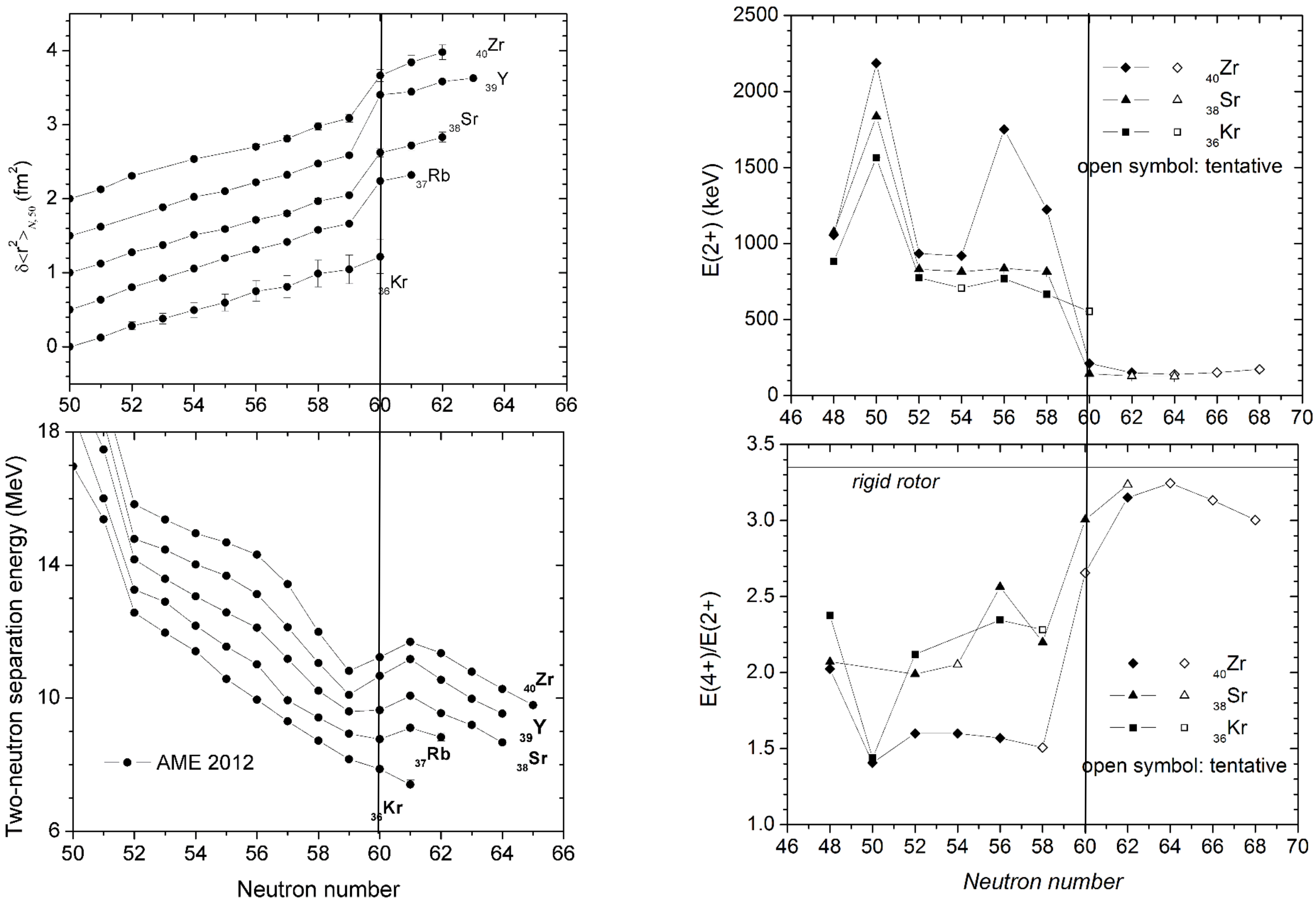
$A \approx 100$ nuclides: onset of collectivity at $N = 60$



Masses: M. Wang *et al.*, Chinese Physics C **36**, 1603 (2012).
Radii: Keim95; Thibault81; Buchinger90; Lievens91; Cheal07; Campbell97; Campbell02; Thayer03.

A ≈ 100 nuclides: onset of collectivity at *N* = 60



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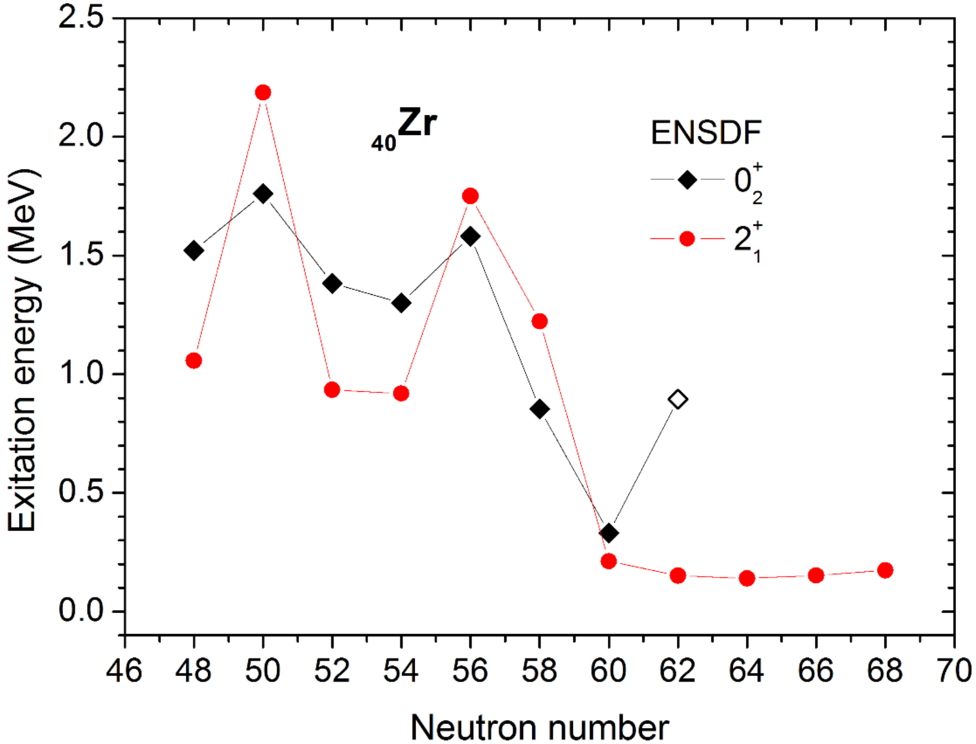
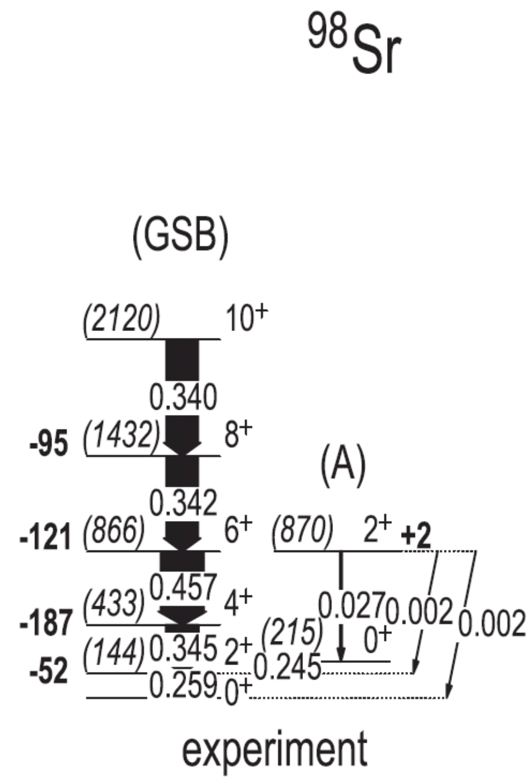
Excitation energies: ENSDF 2016;

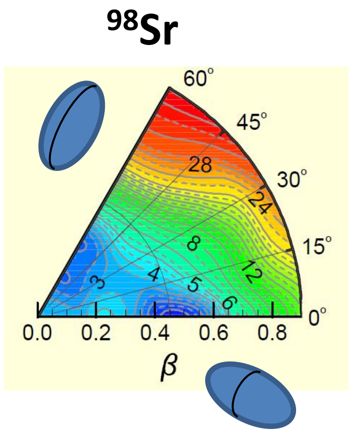
$A \approx 100$ nuclides: a region of shape coexistence

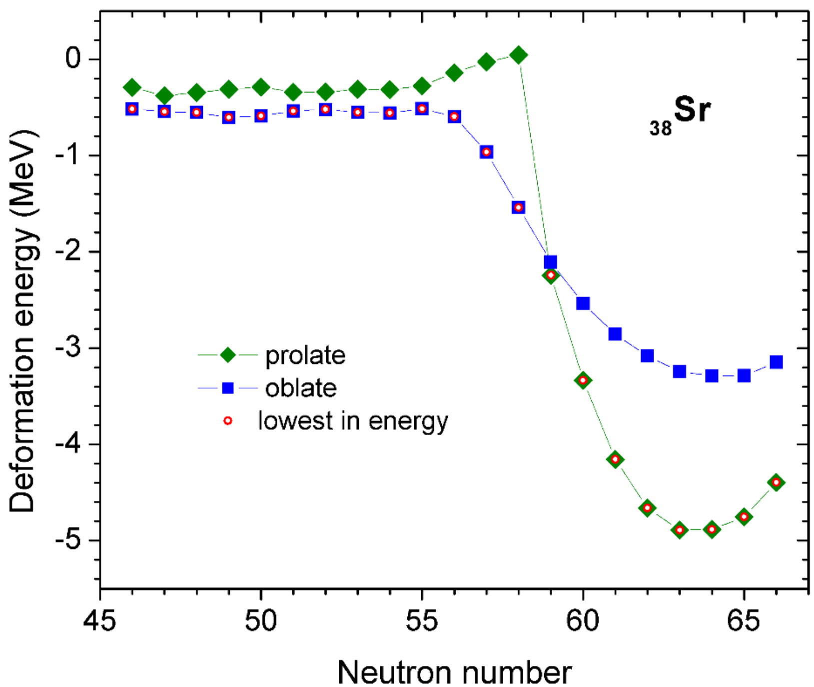


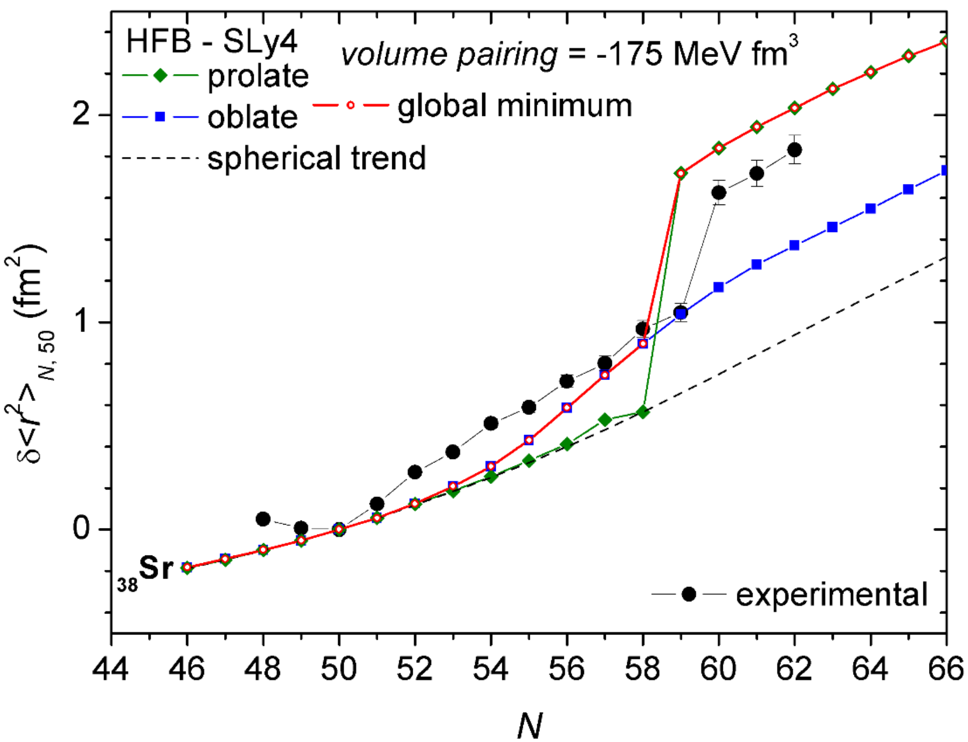


Excitation energies: ENSDF 2016;
^{98}Sr scheme: E. Clément *et al.*, Phys. Rev. Lett. **116**, 022701 (2016).

Intrinsic shapes of *A* ≈ 100 nuclei







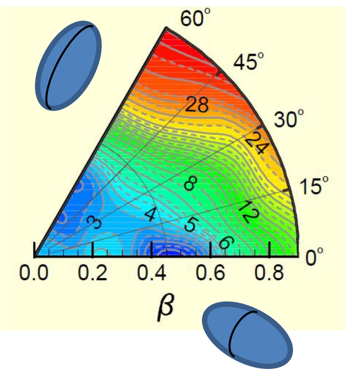
➢ Prolate and oblate configurations in competition.

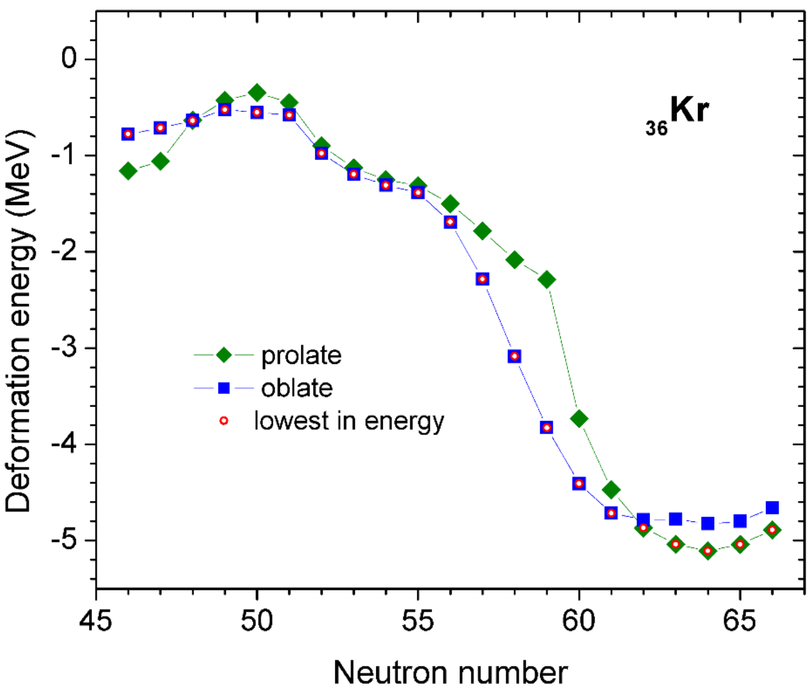
Radii: Buchinger90; Lievens91;

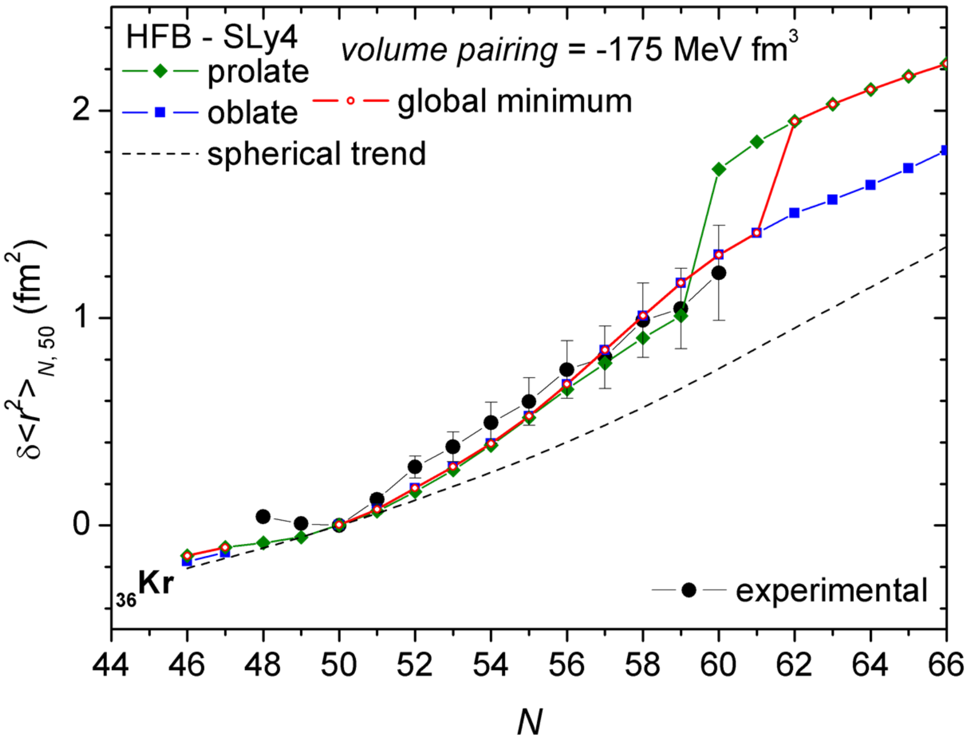
PES: J. P. Delaroche *et al.*, Phys. Rev. C **81**, 014303 (2010).

Intrinsic shapes of $A \approx 100$ nuclei

^{98}Sr





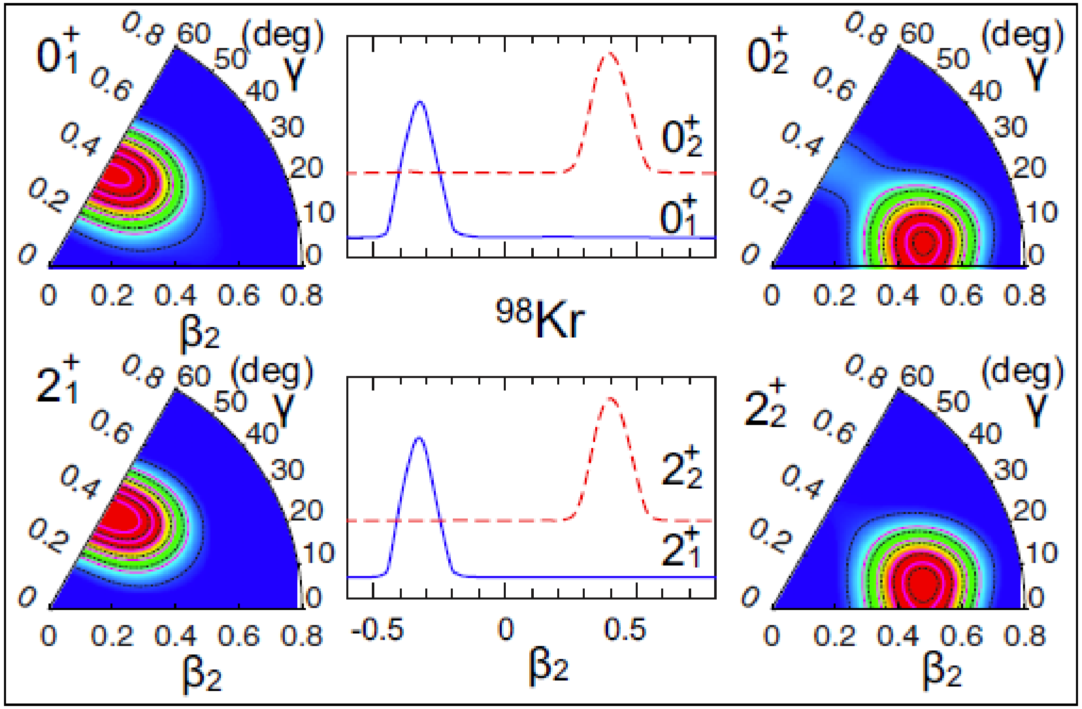


- Prolate and oblate configurations in competition.
- Less obvious ordering in the krypton isotopic chain.

Radii: Keim95;

PES: J. P. Delaroche *et al.*, Phys. Rev. C **81**, 014303 (2010).

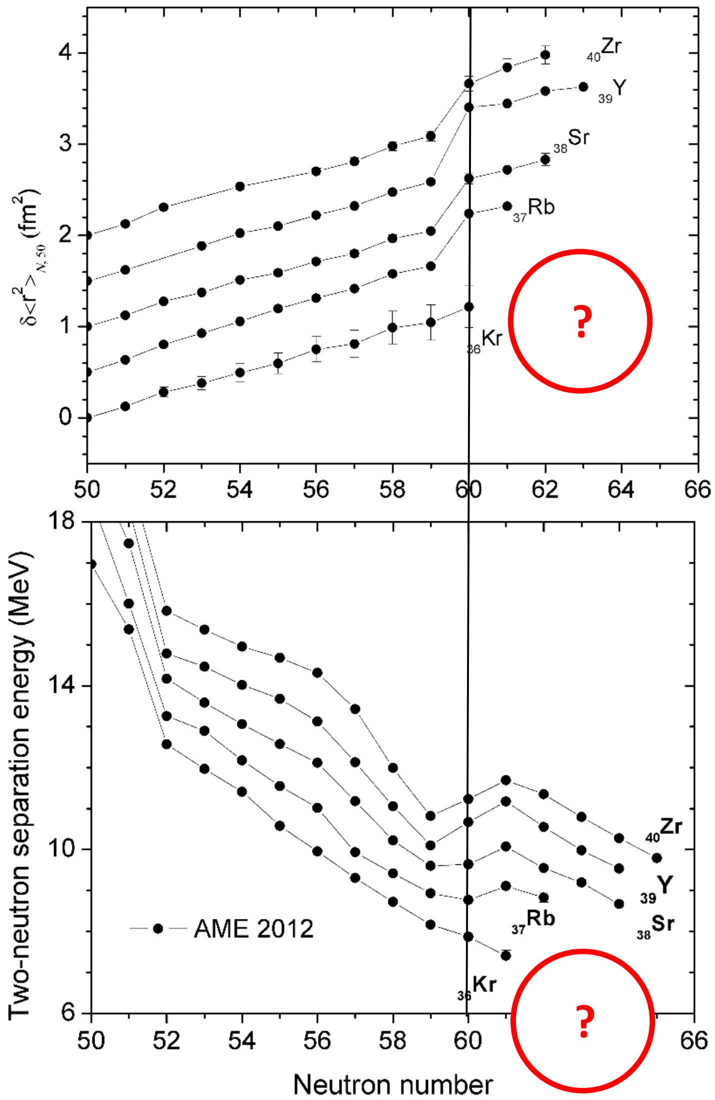
How much of the intrinsic picture survives unaltered in the laboratory frame?



➢ Beyond-mean-field calculations show that the configurations don't mix strongly in the ground state.

T. R. Rodriguez, Phys. Rev. C **90**, 034306 (2014)

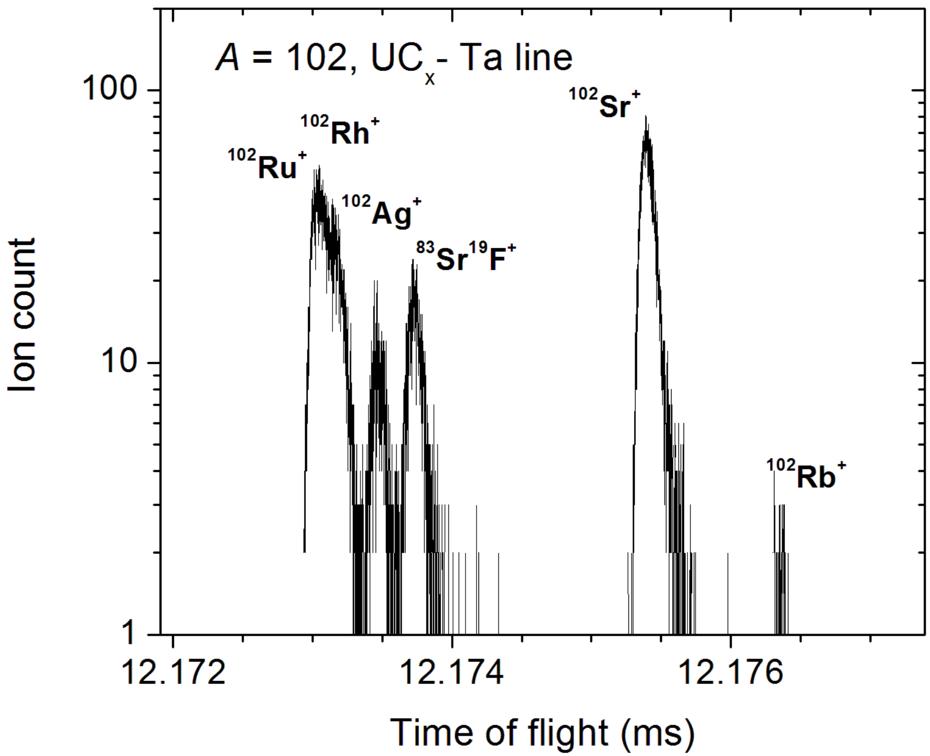
$A \approx 100$ nuclides: onset of collectivity at $N = 60$



- Chains with Z >36 studied in much more detail (and up to larger N).
- Structure along the krypton isotopic chain (Z = 36) still not clear.

Masses: M. Wang *et al.*, Chinese Physics C **36**, 1603 (2012).
Radii: Keim95; Thibault81; Buchinger90; Lievens91; Cheal07; Campbell97; Campbell02; Thayer03.

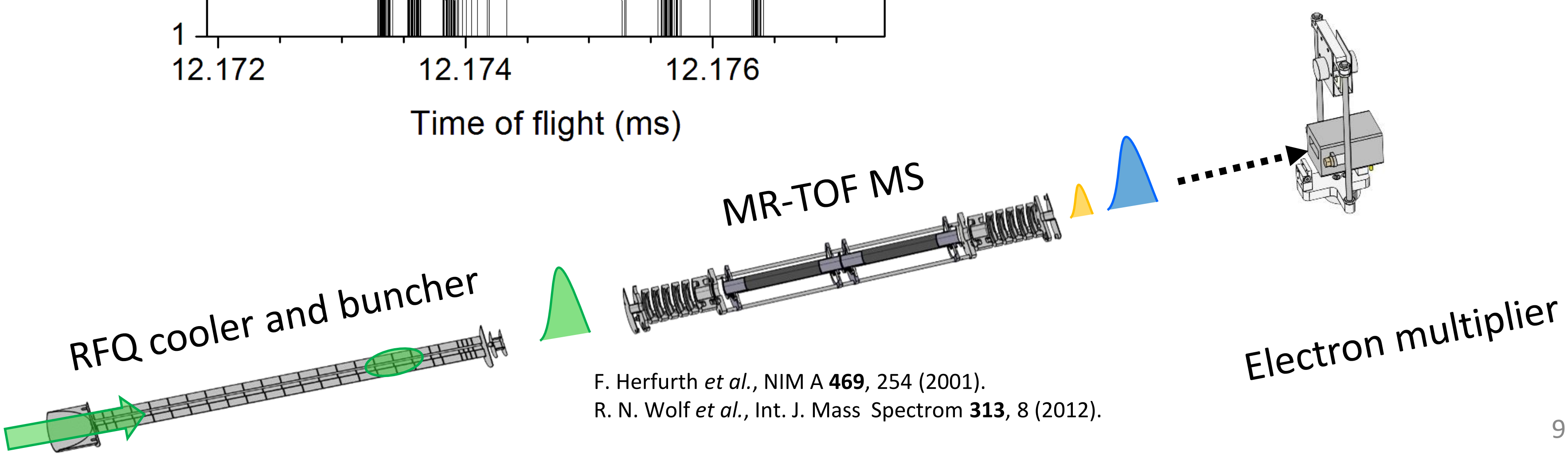
ISOLTRAP spectrometer



Multi-reflection time-of-flight mass spectrometer

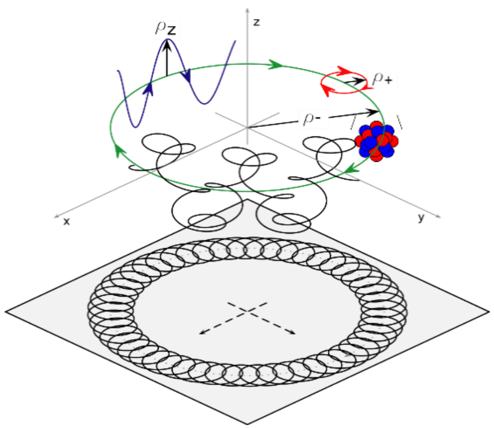
Typical performance:

- resolving power above 10^5
- trapping time 10-50 ms
- operation rate 10-20 Hz.

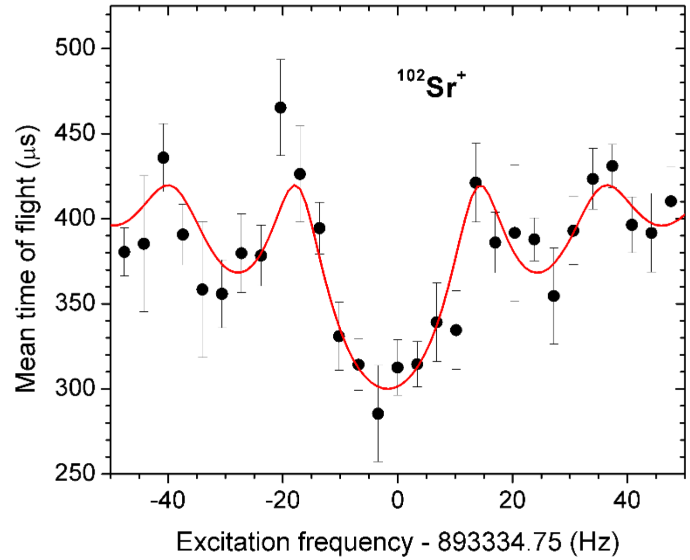


F. Herfurth *et al.*, NIM A **469**, 254 (2001).
R. N. Wolf *et al.*, Int. J. Mass Spectrom **313**, 8 (2012).

ISOLTRAP spectrometer

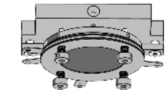


$$\omega_+ + \omega_- = \omega_c$$

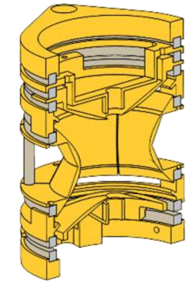


$$\omega_c = \frac{qB}{m_{ion}}$$

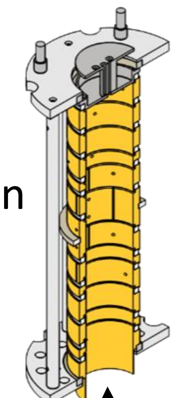
MCP



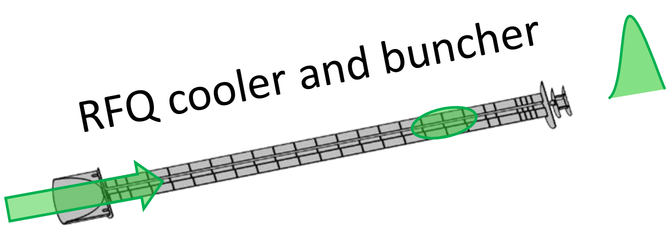
Precision trap



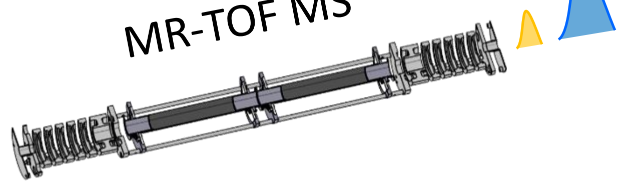
Preparation trap

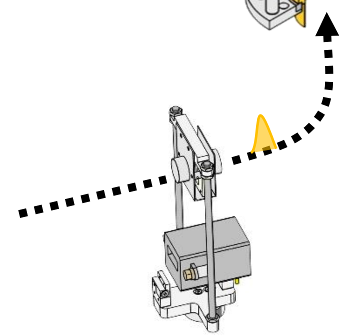


RFQ cooler and buncher



MR-TOF MS



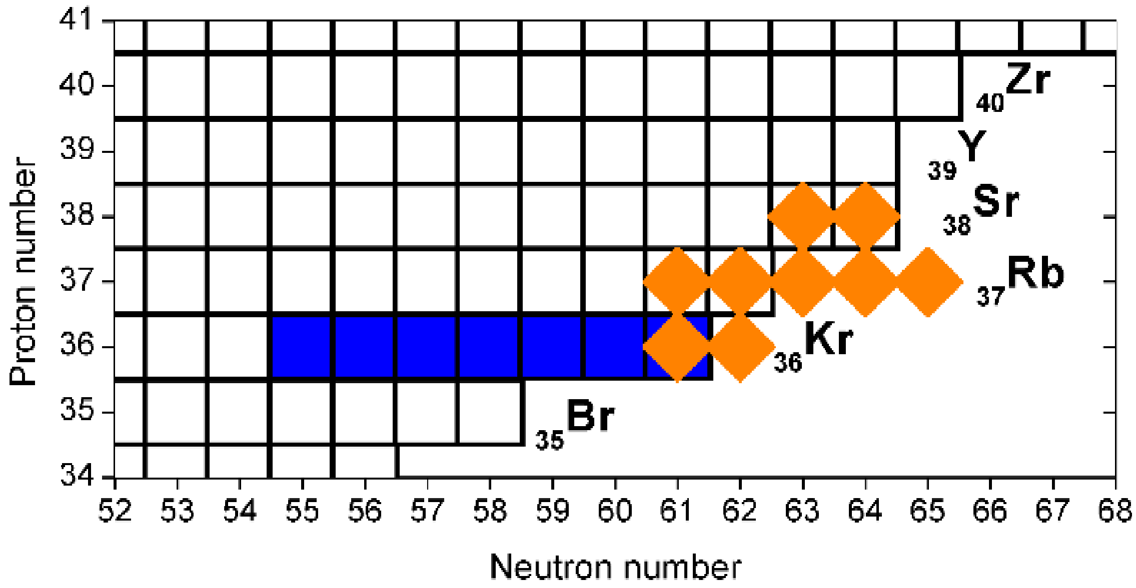


Bradbury-Nielsen beam gate

F. Herfurth *et al.*, NIM A **469**, 254 (2001).
R. N. Wolf *et al.*, Int. J. Mass Spectrom **313**, 8 (2012).
G. Savard *et al.*, Phys. Lett. A **158**, 247 (1991).
M. König *et al.*, Int. J. Mass Spectrom. **142**, 95 (1995).

Masses of neutron-rich nuclides in the A ≈ 100 region

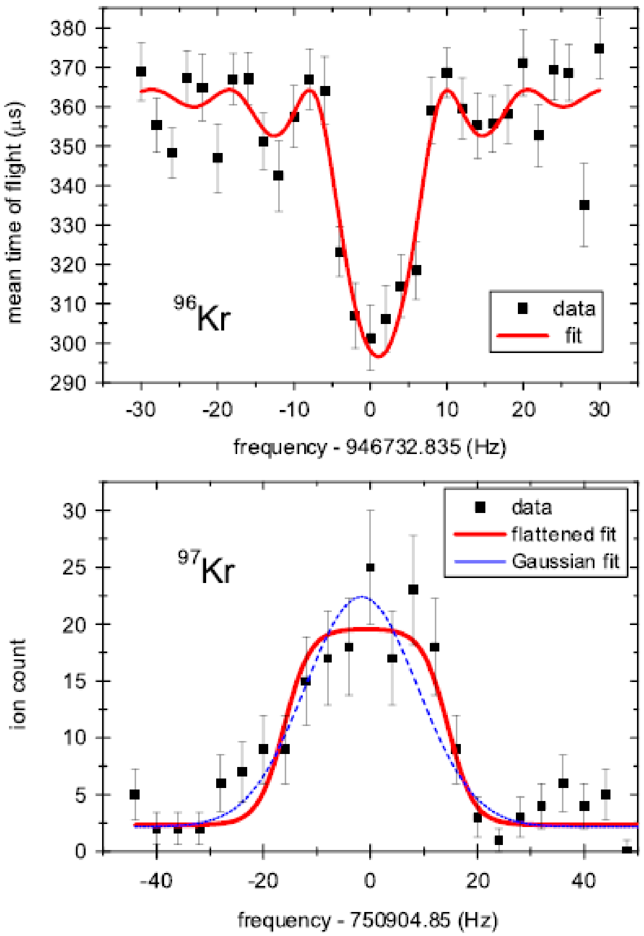
- Three campaigns in the $A \approx 100$ region during the last four years.
- ^{101,102}Sr, $^{98\text{-}100}$Rb, ^{97}Kr measured with Penning trap, $^{100\text{-}102}$Rb, ^{98}Kr with MR-TOF MS.



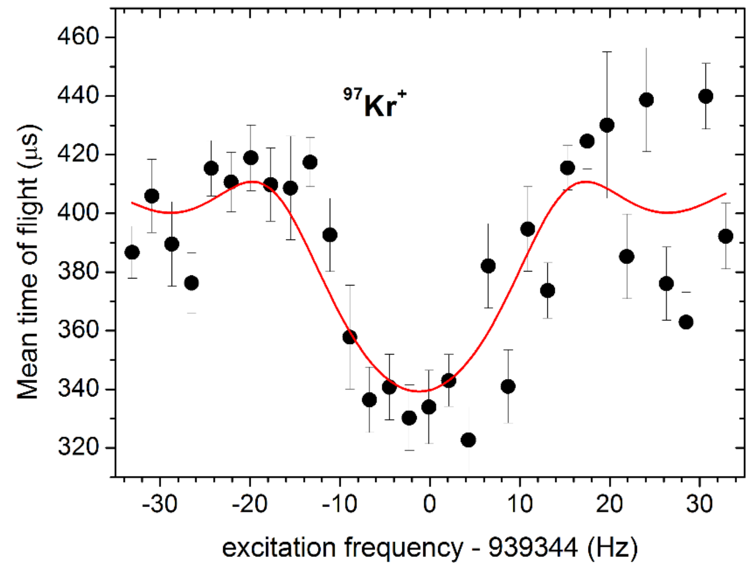
S. Naimi *et al.*, Phys. Rev. Lett. **105**, 032502 (2010).
P. Delahaye *et al.*,Phys. Rev. C **74**, 034331 (2006).
V. Manea *et al.*, Phys. Rev. C **88**, 054322 (2013).
A. de Roubin, article and thesis in preparation.

Measurements of krypton isotopes in 2015

S. Naimi *et al.*, Phys. Rev. Lett. **105**, 032502 (2010).



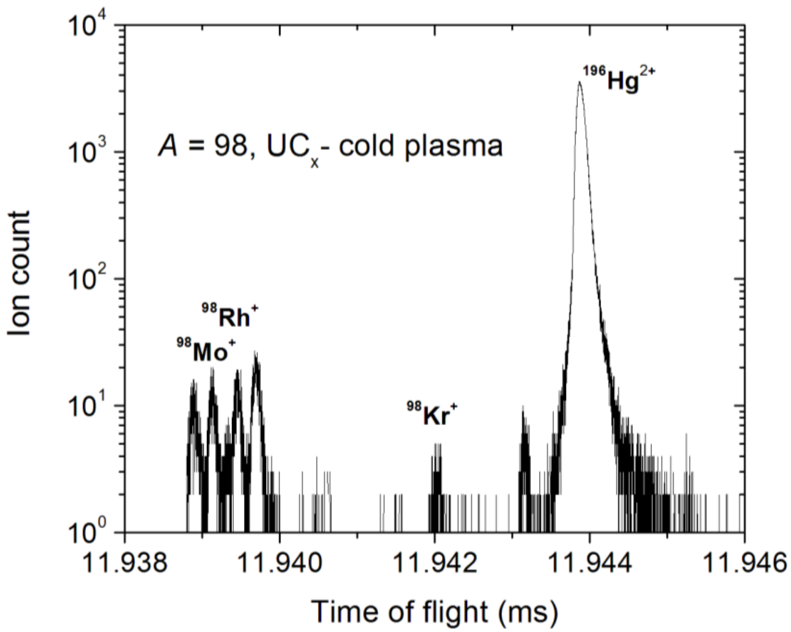
ISOLTRAP 2015

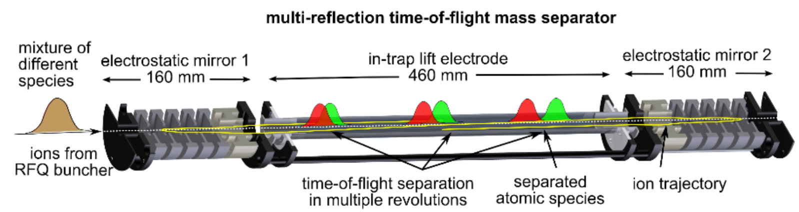


- ISOLTRAP succeeded measuring in 2015 further than previously possible.

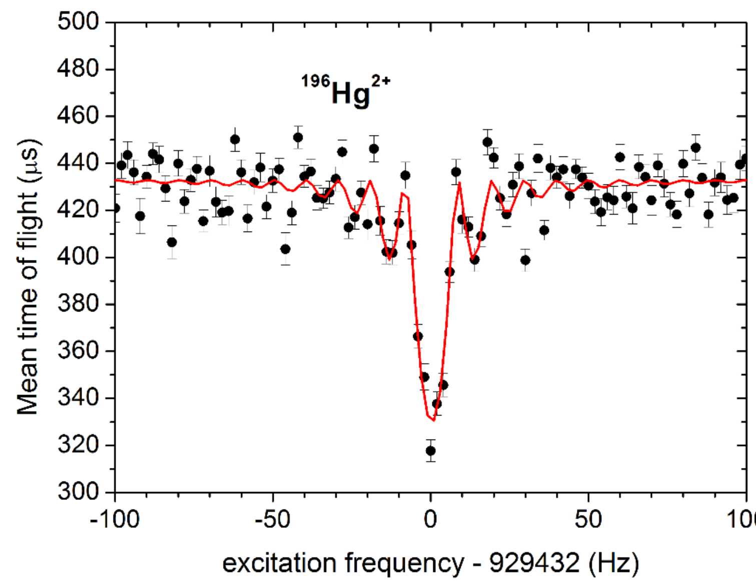
Measurements of krypton isotopes in 2015

- ^{98}Kr was studied with the MR-TOF MS.

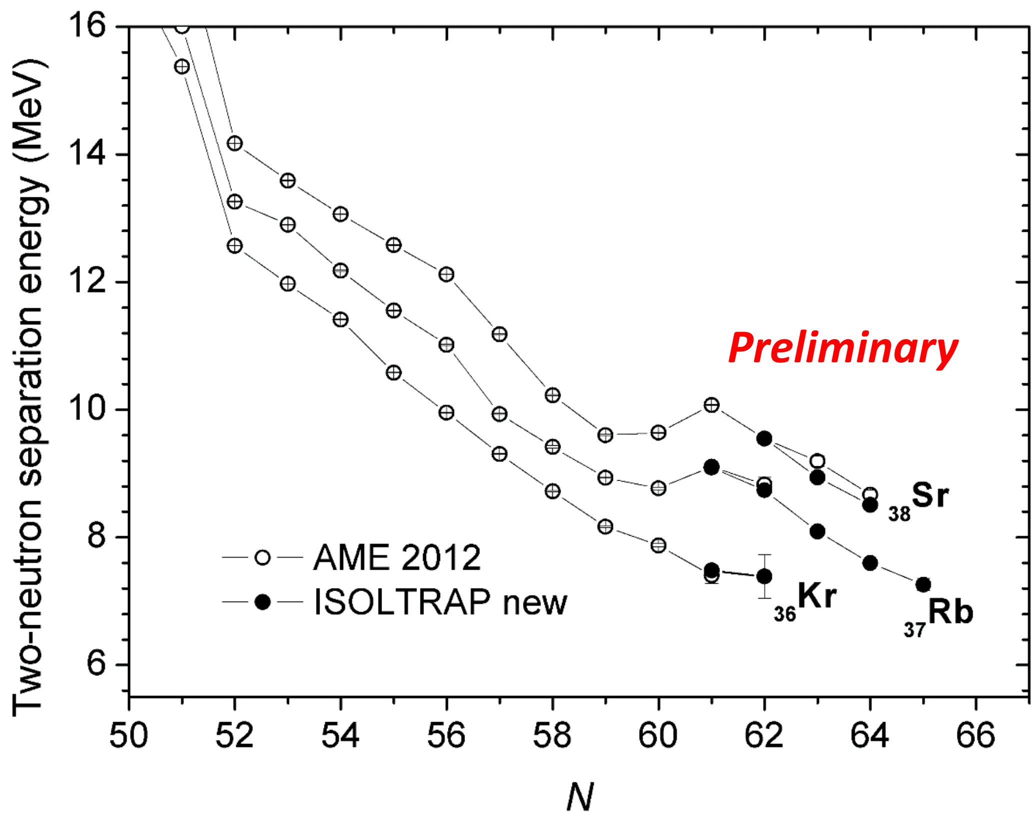




- The ^{196}Hg^{2+} beam was identified using the precision trap.



Two-neutron separation energies around A ≈ 100



- New ISOLTRAP data in Sr and Rb isotopic chains continue the previous trends. More precise measurements in the Kr chain are needed.

M. Wang *et al.*, Chinese Physics C **36**, 1603 (2012).
V. Manea *et al.*, Phys. Rev. C **88**, 054322 (2013).
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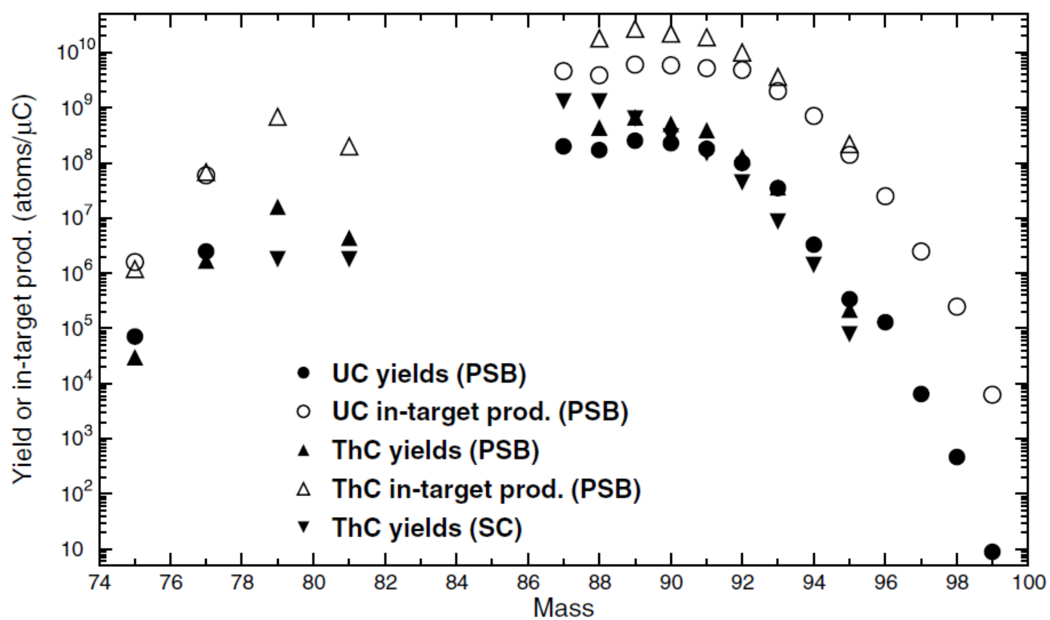
Masses of neutron-rich nuclides in the A ≈ 100 region

Isotope	Half-life (ms)	Target	Yield† (ions/μC)	Method	Ion source	Shifts
^{98}Kr	42.8(3.6)	UC_x	470	Penning trap and MR-TOF MS	VADIS (cold line)	**3**
^{99}Kr	40(11)		10	MR-TOF MS		**4**
^{100}Kr	12(8)		<1	MR-TOF MS		**6**
					Target/ion-source optimization	**2**
					Total shifts	**15**



TAC questions concerning feasibility:

- ^{98}Kr already observed at ISOLTRAP,
- ^{99}Kr is in a yield/half-life range where were ISOLTRAP has measured before,
- ^{100}Kr is very challenging (nano-structured target to potentially improve release, tests considered for later this year, MR-TOF MS desirable) .

Yields: U. C. Bergmann et al., NIMB **204**, 220 (2003).