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Studies of shape coexistence using Coulomb excitation of light Hg isotopes

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for the IS452 & IS563 collaborations

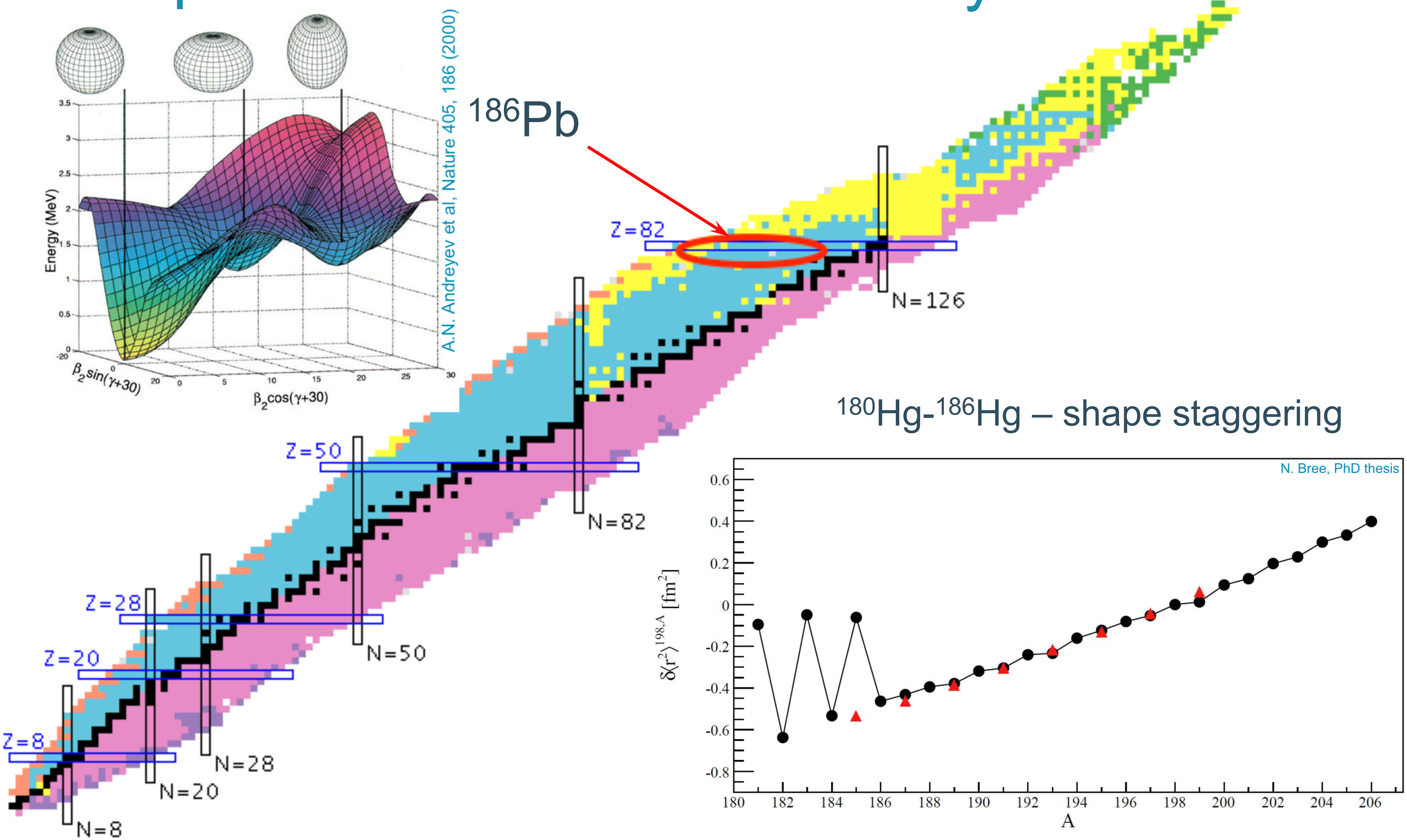
SSNET 2017 Conference,

Gif-sur-Yvette

6-10 November 2017

Shape coexistence

Shape coexistence in the vicinity of Z=82



^{186}Pb

^{180}Hg-^{186}Hg – shape staggering

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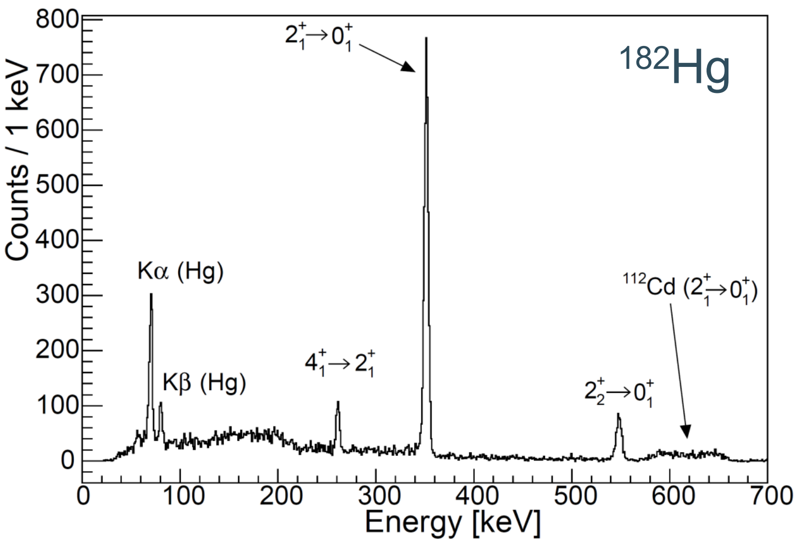
Shape coexistence in $^{180-186}$Hg

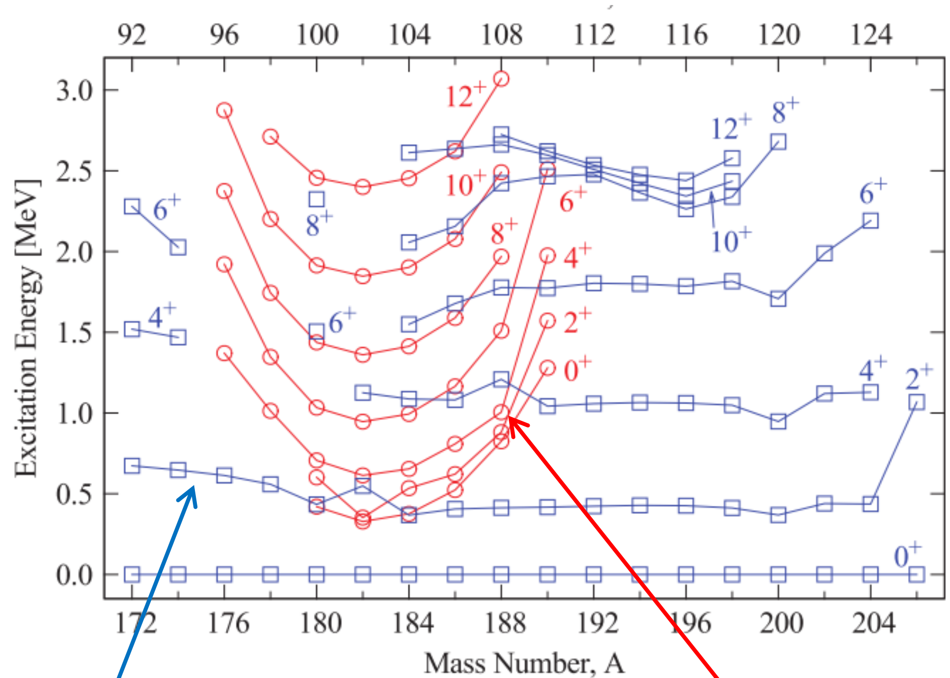
"Fingerprints" of shape coexistence:

- ✓ Low-lying 0_2^+
- ✓ Collective band built on top of the 0_2^+
- ✓ Large ρ(E0)

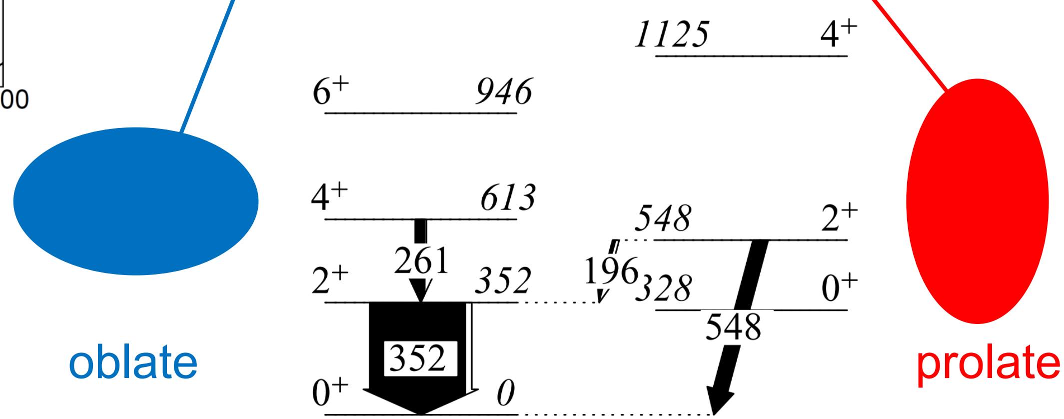


N. Bree et al., Phys. Rev. Lett. 112, 16 (2014), 162701

REX-ISOLDE + Miniball
First 2-step coulex experiment



L.P. Gaffney et al., Phys. Rev. C 89, (2014) 024307



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Re-analysis of Coulex data on Hg isotopes: data from ^{182,184}Tl β-decay

- ✓ new values for the **ɣ-ray BR**
- ✓ new $2_2^+ \rightarrow 2_1^+$ **ICC** *e.g. in ^{182}Hg ~~4.1(7)~~ 7.2(13)*
- ✓ sensitivity to δ(E2/M1) *^{184}Hg ~~14.2(36)~~ 23(5)*

E. Rapisarda et al., J. Phys. G 44 (2017) 074001

What?

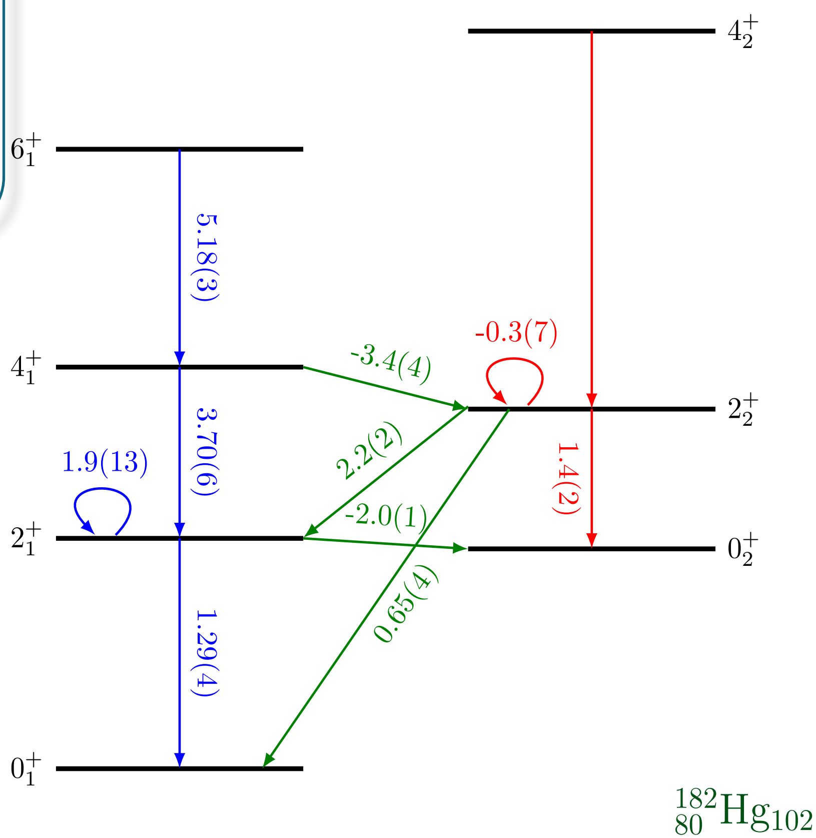
GOSIA calculations: a multi-dimentional fit of the matrix elements

How?

Combining coulex **yields**

+

Spectroscopic data (**BR, ICC, δ(E2/M1), τ**)



K. Wrzocek-Lipska et al., Phys. Rev. C, to be published

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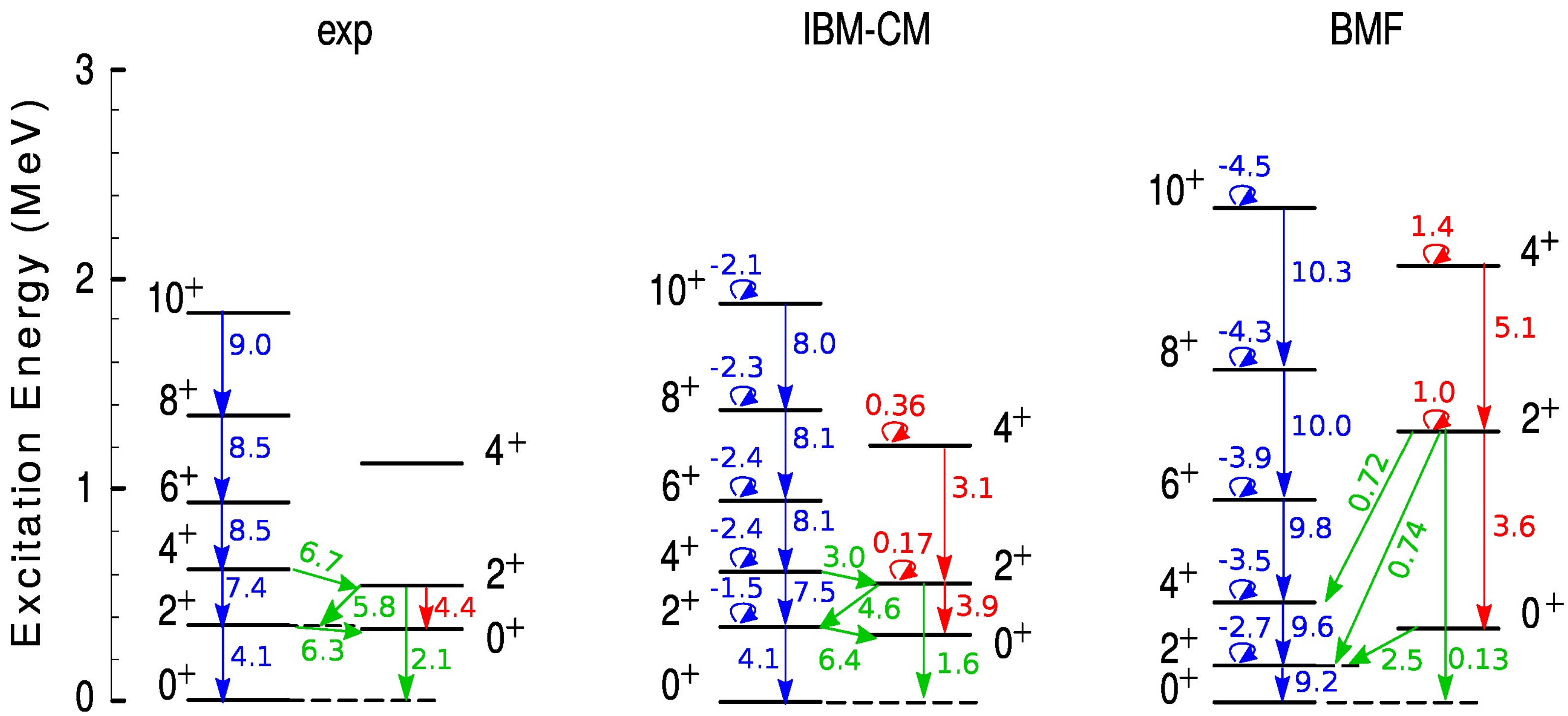
Comparison with the theoretical calculations

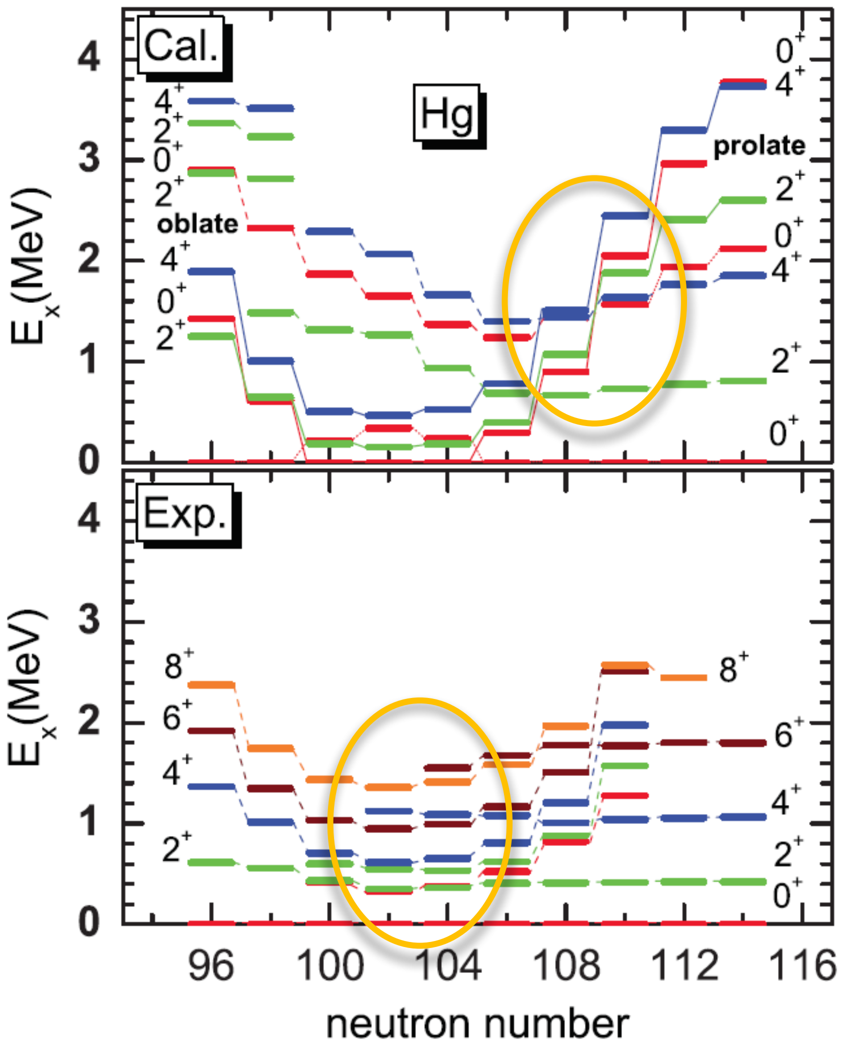


Transitional (arrows) and spectroscopic (loops) quadrupole moments are given in eb units.

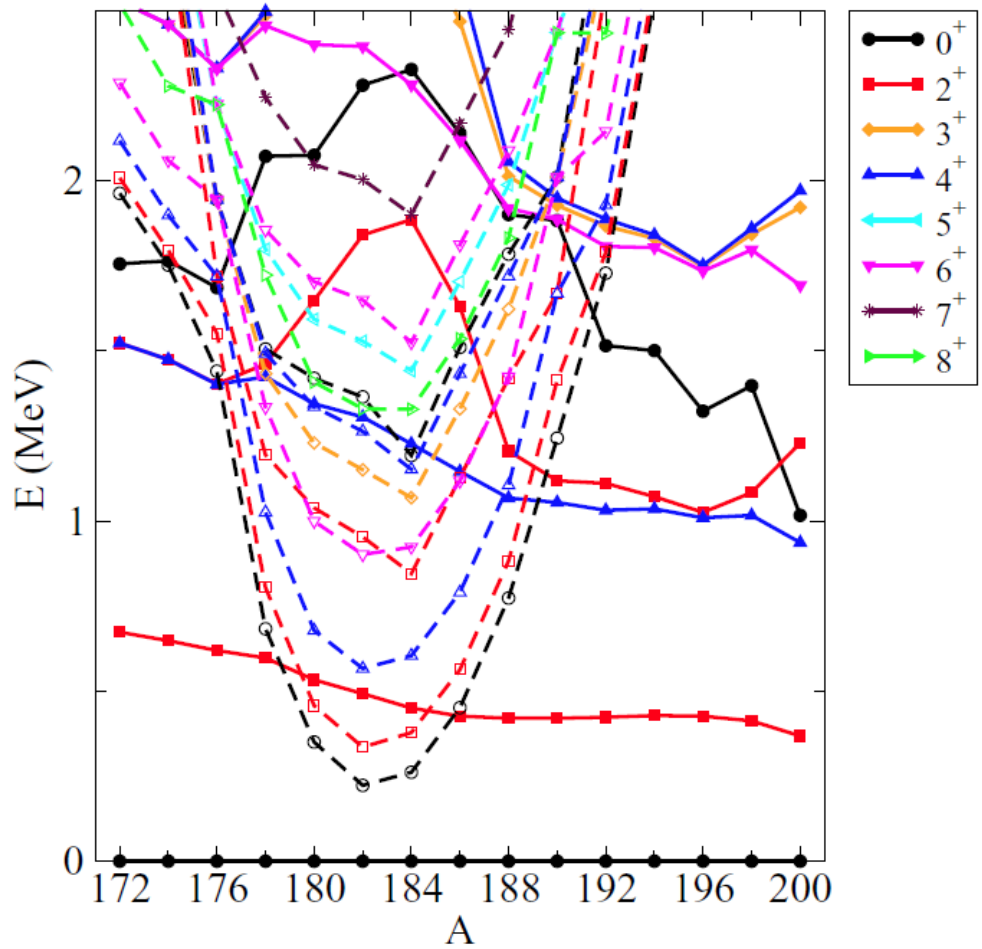
K. Wrzocek-Lipska et al., Phys. Rev. C, to be published

BMF: J. M. Yao et al., Phys. Rev. C 87 (2013) 034322
IBM-CM: J. E. García-Ramos et al., Phys. Rev. C 89 (2014) 034313

BMF



IBM - CM



2_1^+ energy: **cross** between N=106 and N=108

no mixing

BMF: J. M. Yao et al., Phys. Rev. C 87 (2013) 034322
IBM-CM: J. E. García-Ramos et al., Phys. Rev. C 89 (2014) 034313

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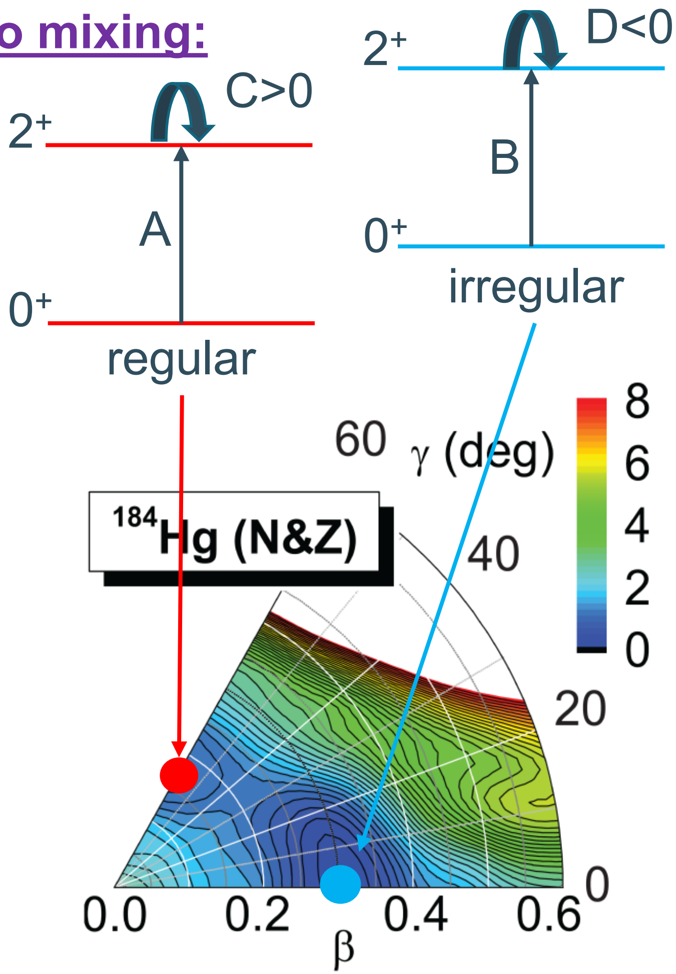
Two-state mixing model

Experimental E2 matrix elements can be expressed by:

- ✓ un-mixed E2 matrix elements (A,B,C,D)
- ✓ mixing amplitudes ($\alpha_0, \alpha_2, \beta_0, \beta_2$)

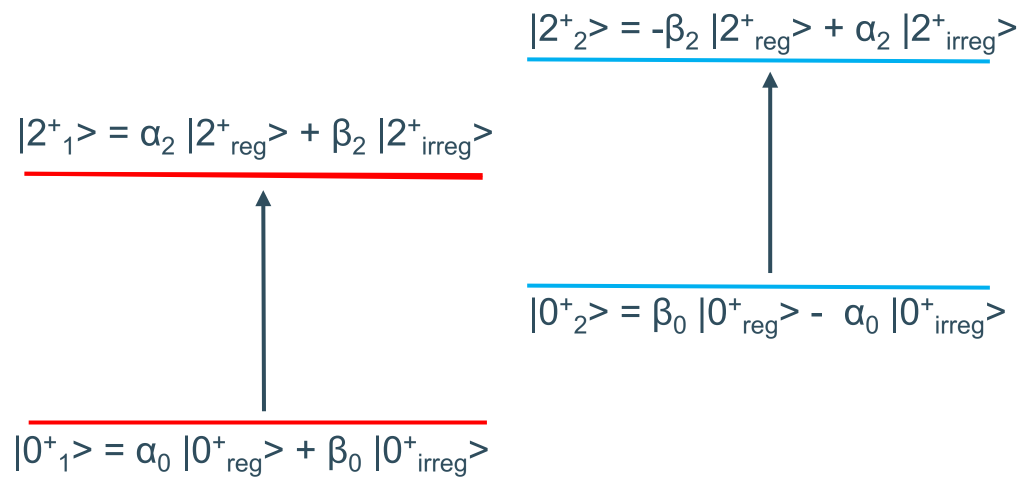
$$<J^\pi_{reg}||E2||\, J^\pi_{irreg}> = 0$$
$$\alpha_J^2 + \beta_J^2 = 1$$

no mixing:



J. M. Yao et al., Phys. Rev. C 87 (2013) 034322

mixed configuration:

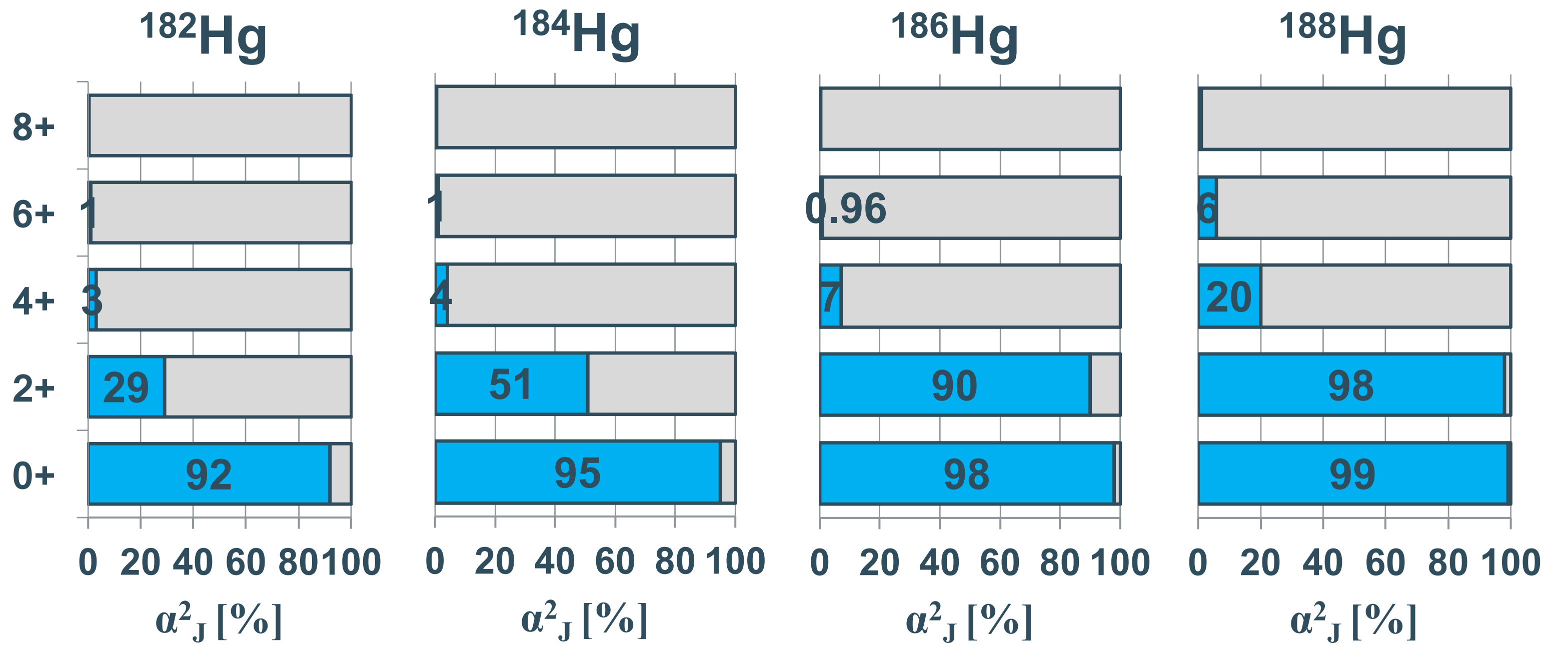


P. Van Duppen , M. Huyse, J. Wood, J. Phys. G: Nucl. Part. 16, 441 (1990)
P. J. Brussaard, P.W.M. Glaudemans 1977

Two-state mixing calculations

From fitting the higher-lying levels using the VMI (variable moment of inertia) model:

L.P. Gaffney et al, Phys. Rev. C 89 (2014) 024307



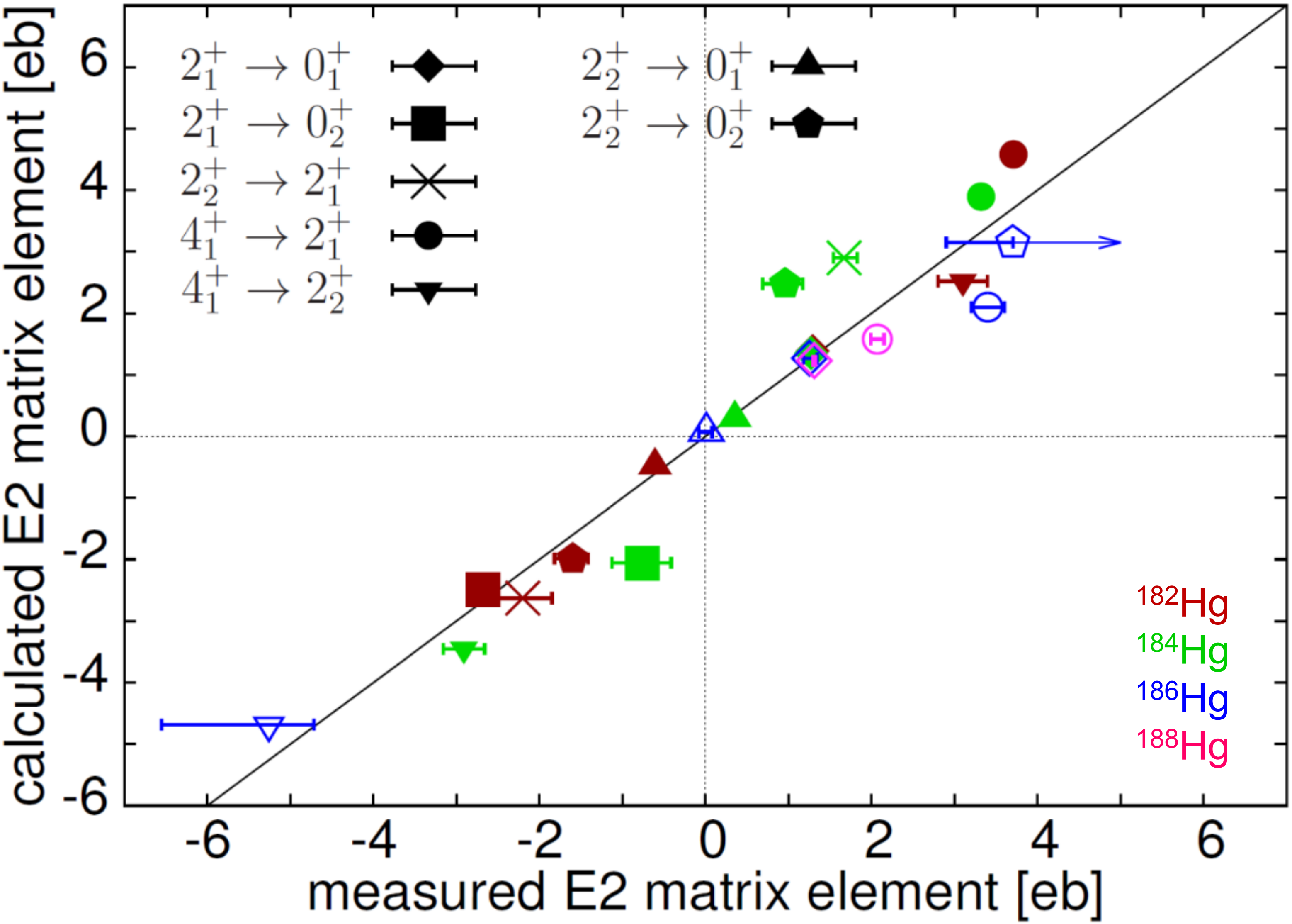
- 0^+ states: only weakly mixed for all $^{182\text{-}188}$Hg
- 2^+ states: mixing is changing from 29% up to 98%
- 4^+ states: dominant deformed configuration for all $^{182\text{-}188}$Hg

<u>fitted un-mixed ME2's:</u>

A = $\langle 0^+_S || E2 || 2^+_S \rangle$ = 1.2 eb; B = $\langle 0^+_D || E2 || 2^+_D \rangle$ = 3.3 eb;

C = $\langle 2^+_S || E2 || 2^+_S \rangle$ = 1.8 eb; D = $\langle 2^+_D || E2 || 2^+_D \rangle$ = -4.0 eb

Two-state mixing compared to experiment



N. Bree et al., Phys. Rev. Lett. 112, 16 (2014), 162701
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K. Wrzosek-Lipska et al., to be published

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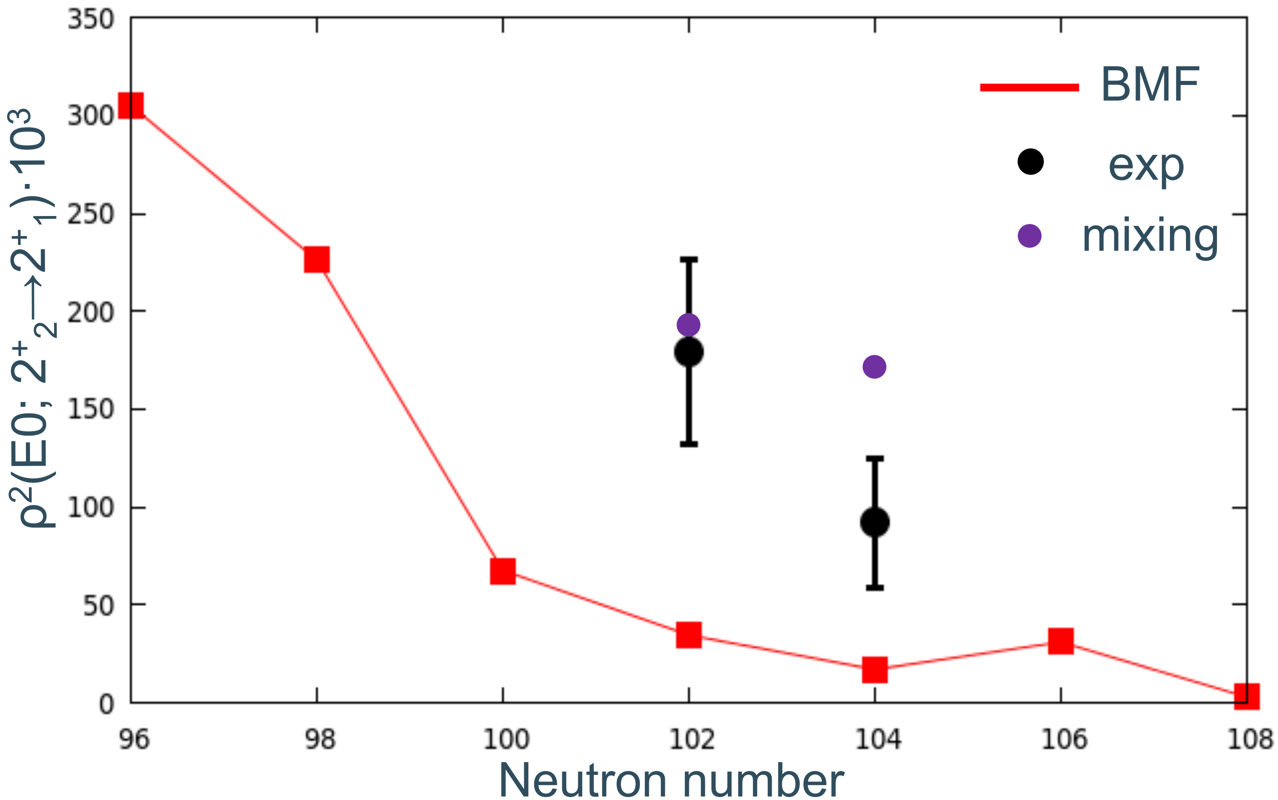
Monopole transition strength

$$\rho^2(\mathrm{E0}) = \frac{Z^2}{R_0^4} a^2(1-a^2) \left[\Delta\langle r^2\rangle\right]^2 \qquad R_0 = r_0 A^{1/3},\ r_0 = 1.2\ \mathrm{fm}$$

Mixing amplitudes from two-level mixing calculations

$\Delta\langle r^2\rangle$ = 0.55 fm^2 for ^{182}Hg
$\Delta\langle r^2\rangle$ = 0.48 fm^2 for ^{184}Hg
from laser spectroscopy



Yao PRC 87 (2013) and P.H. Heenen private comm., J. L. Wood,- NPA 651 (1999) 323

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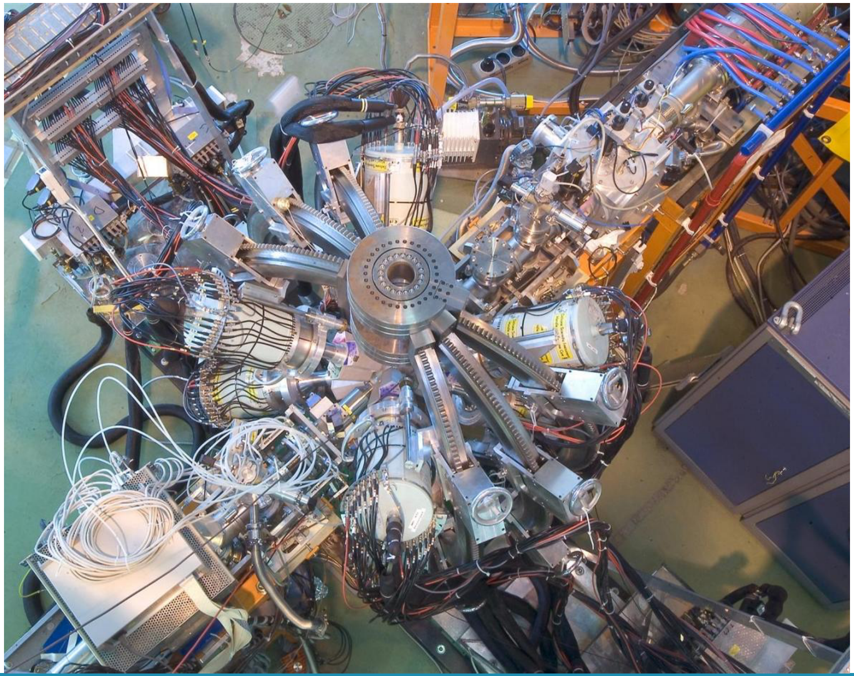
Future experiments

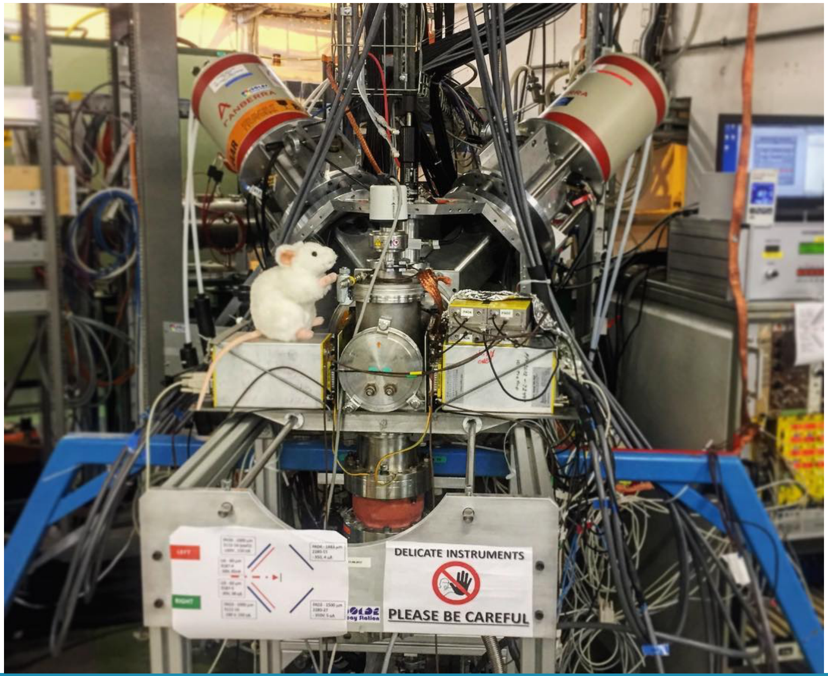
IS563:
Couloumb excitation of ^{182}Hg and ^{184}Hg with HIE-ISOLDE, Miniball and SPEDE

- ✓ Higher excitation energy
- ✓ Access to the higher-lying no-yrast states
- ✓ ICE information
- ✓ Q_s for the 2^+_1 & 2^+_2 (and other if possible)



IS641:
Decay spectroscopy of ^{182,184,186}Hg studied in β-decay of Tl with IDS (Isolde Decay Station)

- ✓ Precise BR & ICC values (current uncertainties ~30%)
- ✓ ICE spectroscopy
- ✓ Info on higher-lying states



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Thank you!

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