"*Shape coexistence in the vicinity of Z= 82*"
Re-analyzing the mercury Coulex data

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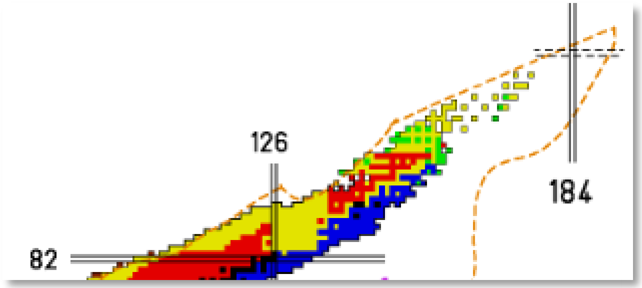
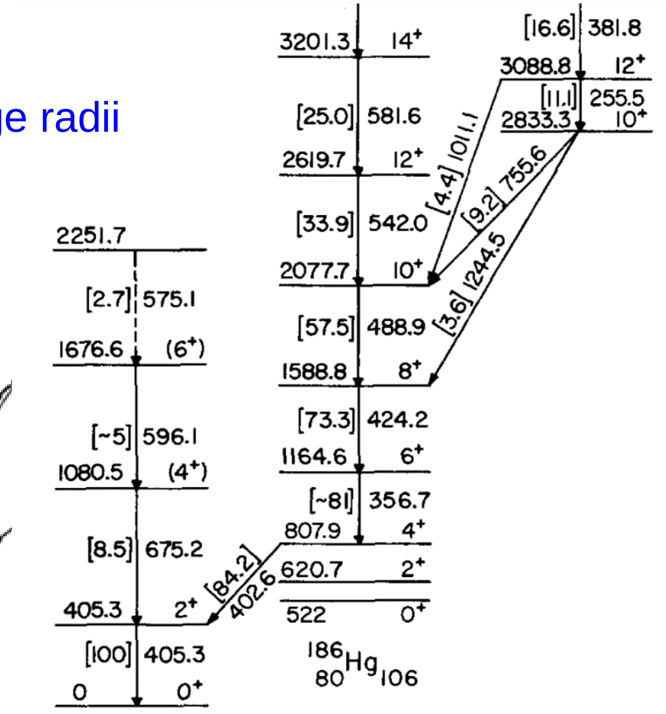
- Shape coexistence in the neutron-deficient mercury isotopes
- New data from beta-decay study of ^{182,184}Tl isotopes – re-analysis of Coulex data
- Two-state mixing, transitional and diagonal matrix elements and (2^+-2^+) monopole transitions
- Laser spectroscopy of neutron-deficient Hg isotopes and Monte Carlo Shell Model calculations (Y. Tsunoda & T. Otsuka)
- Conclusion and outlook with beams from HIE ISOLDE

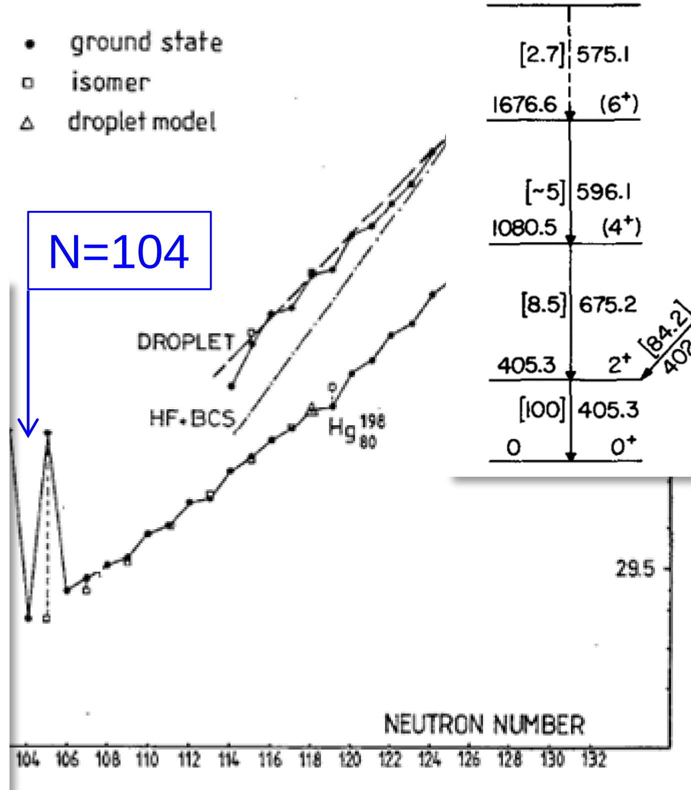
- Shape coexistence in heavy nuclei: initial indications

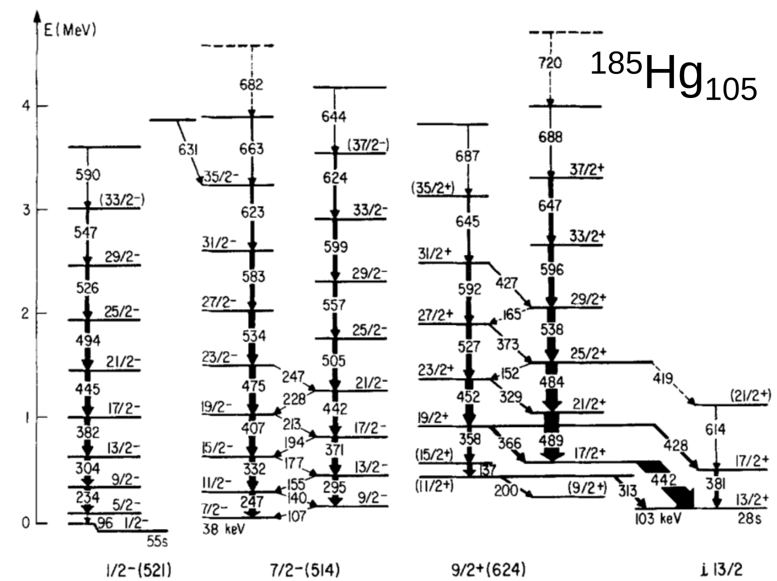


isotope shifts → charge radii



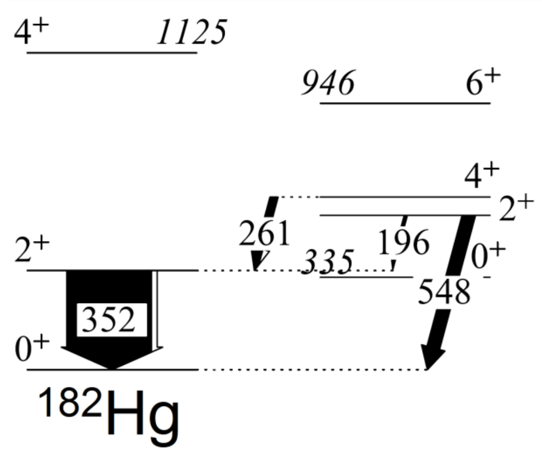
N=104

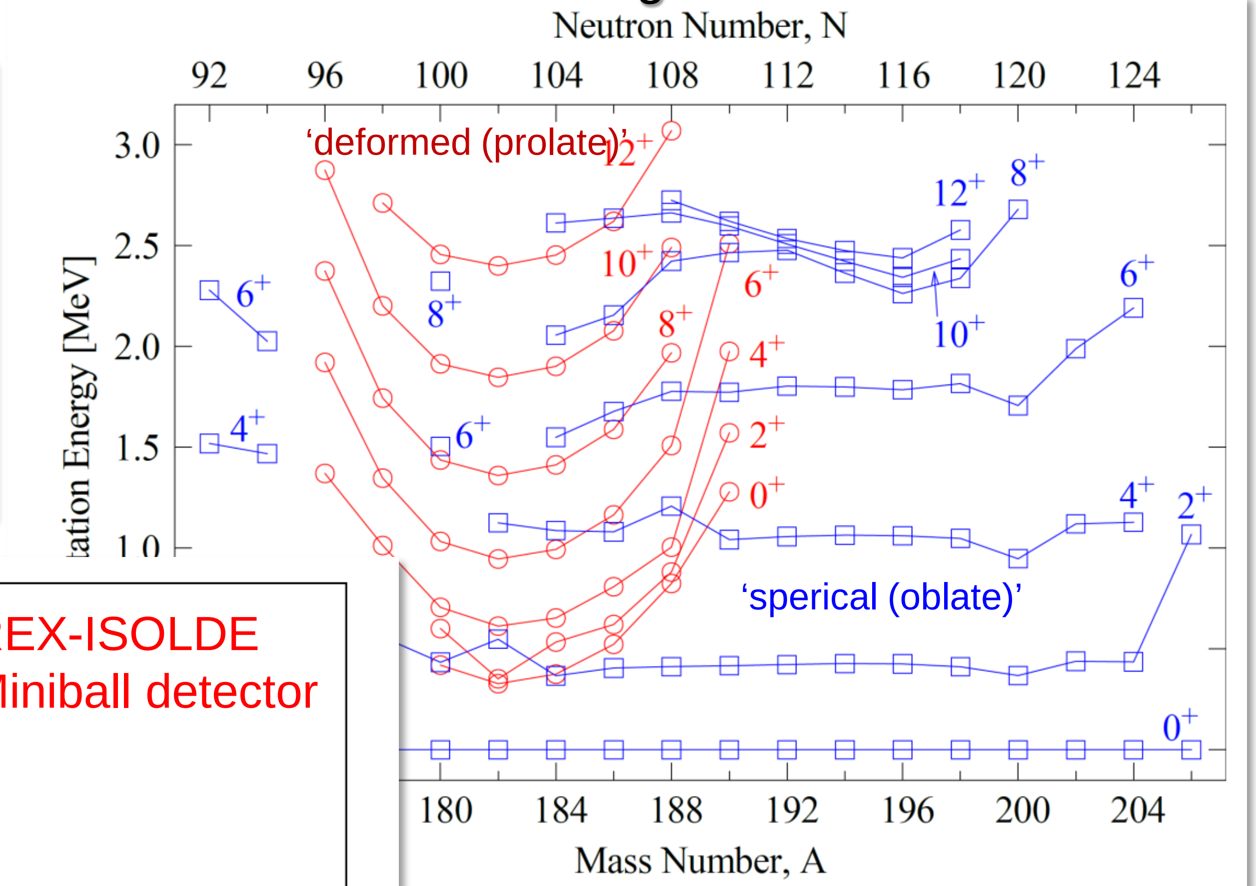


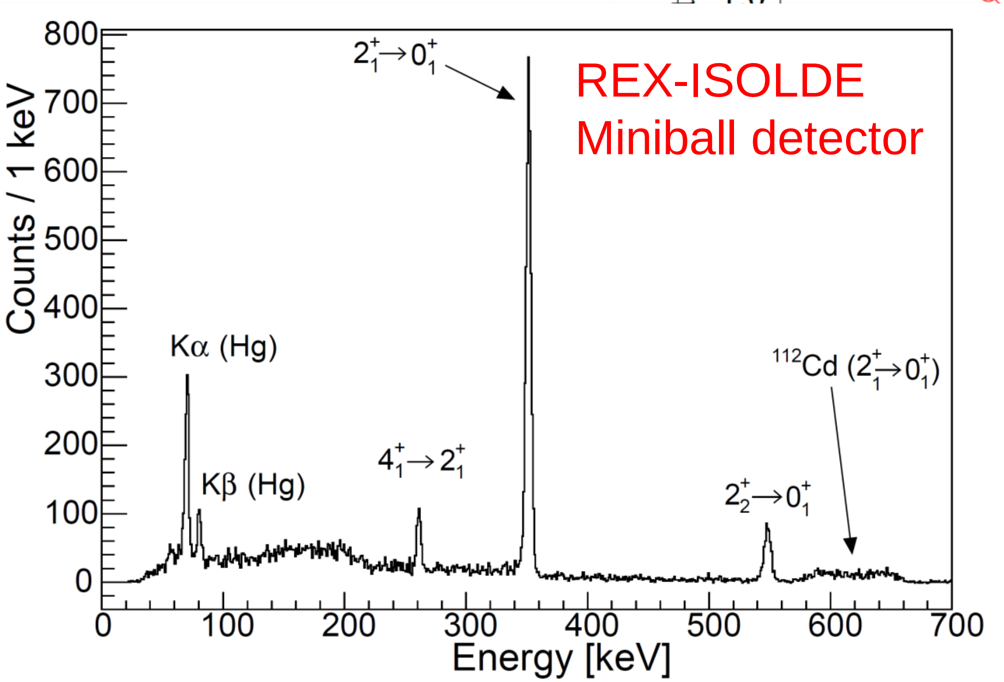


Bonn,- PLB 38 (1972), Hannachi,- ZP A370 (1988), Ma,- PLB167 (1986)
Janssens,- PLB131 (1983), Cole,- PRL37 (1976)

Coulomb excitation of ^{182}Hg

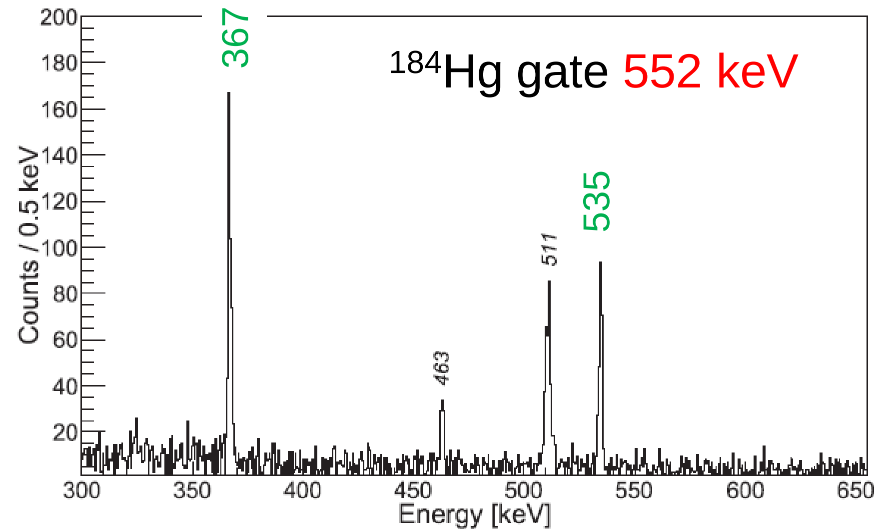


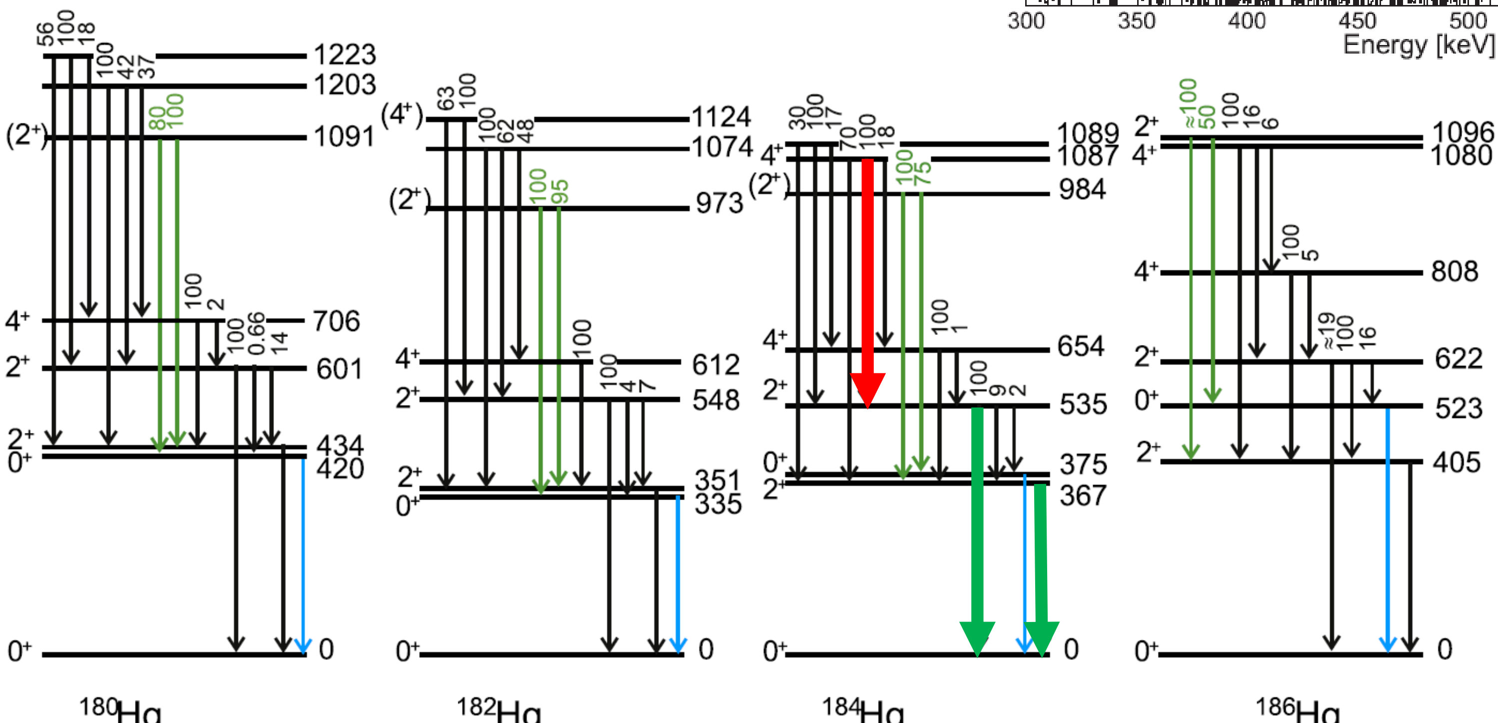




- Energy of 2^+_1 state → ~constant
- Intensity: 3500 atoms/sec
- Energy: 2.85 MeV/u

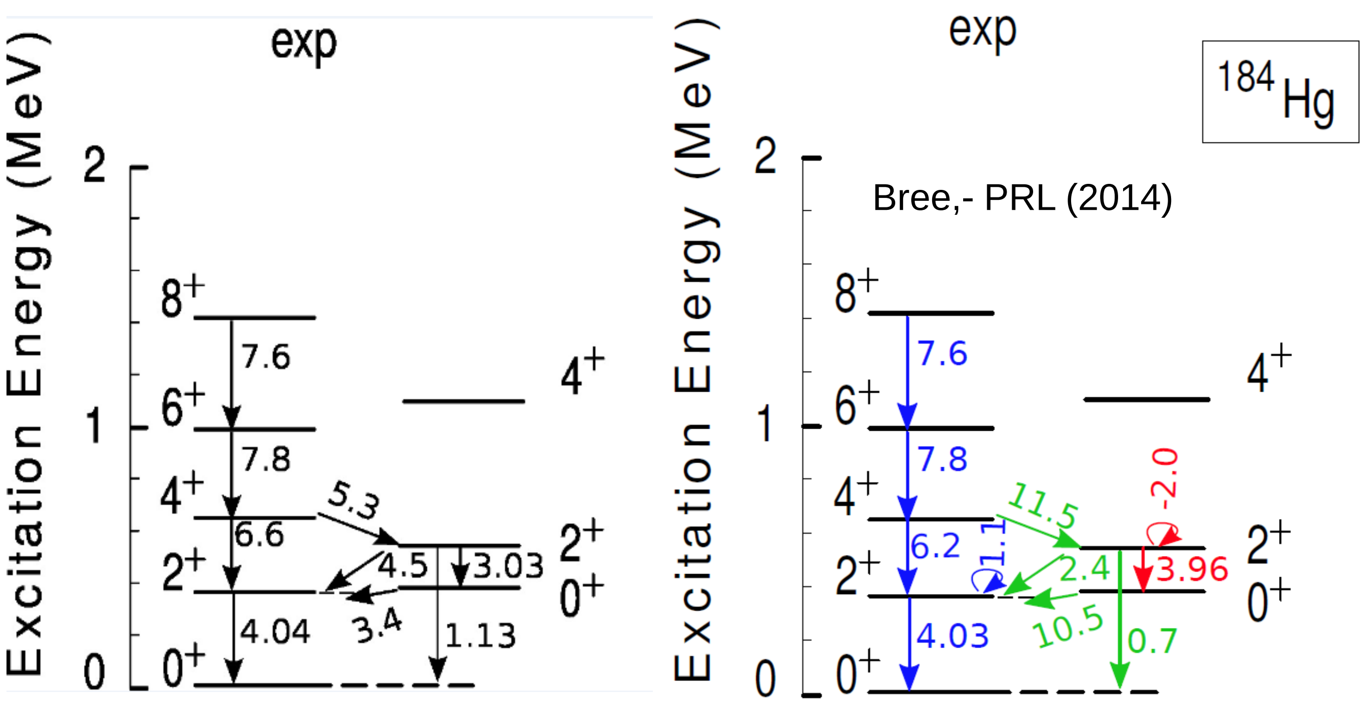
- Re-analysis of Coulex data on Hg isotopes – data from ^{182,184}Tl β-decay
  - ✓ new gamma-ray branching ratios
  - ✓ new 2^+-2^+ conversion coefficients
  - ✓ sensitivity to δ(E2/M1)
  - ✓ approved ^{182,184,186}Tl decay study at ISOLDE – IDS (K. Rezynkina - IS641)





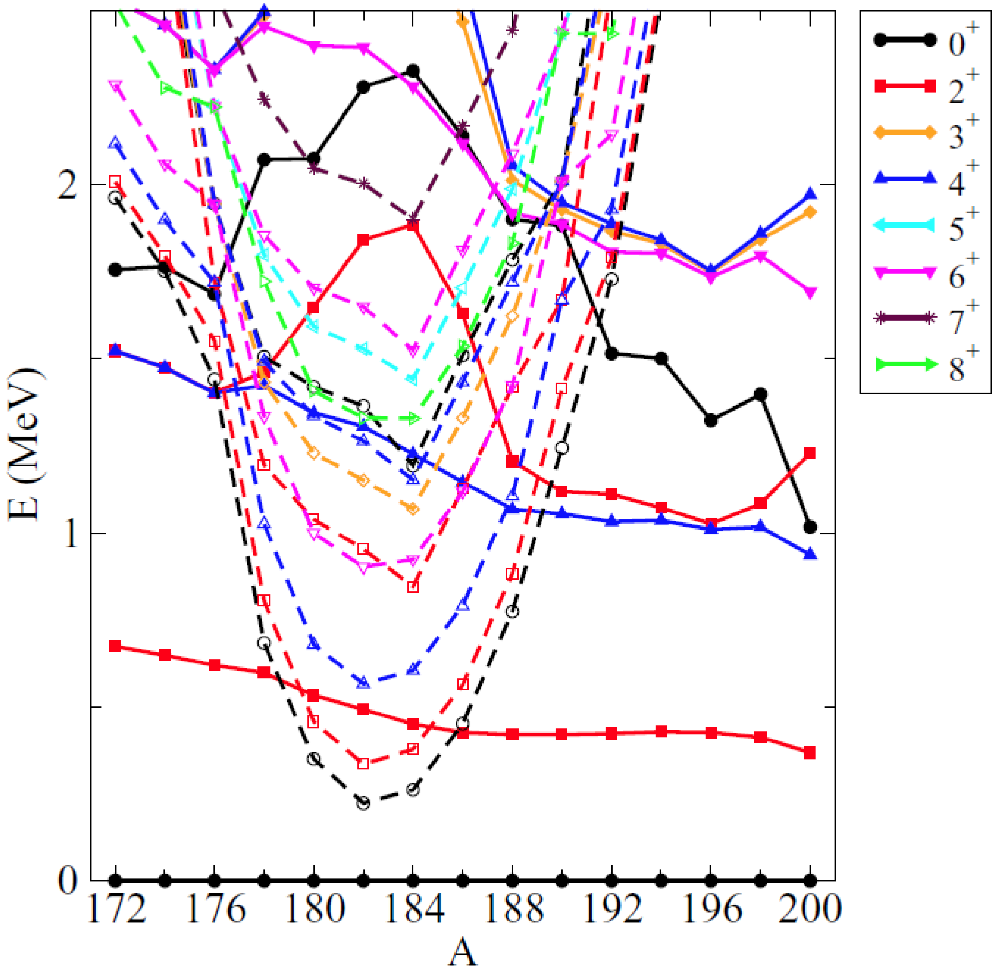
α_{tot} $(2^+_2$-$2^+_1)$= 7,2(13) 14,2(36)

- Comparison with theory

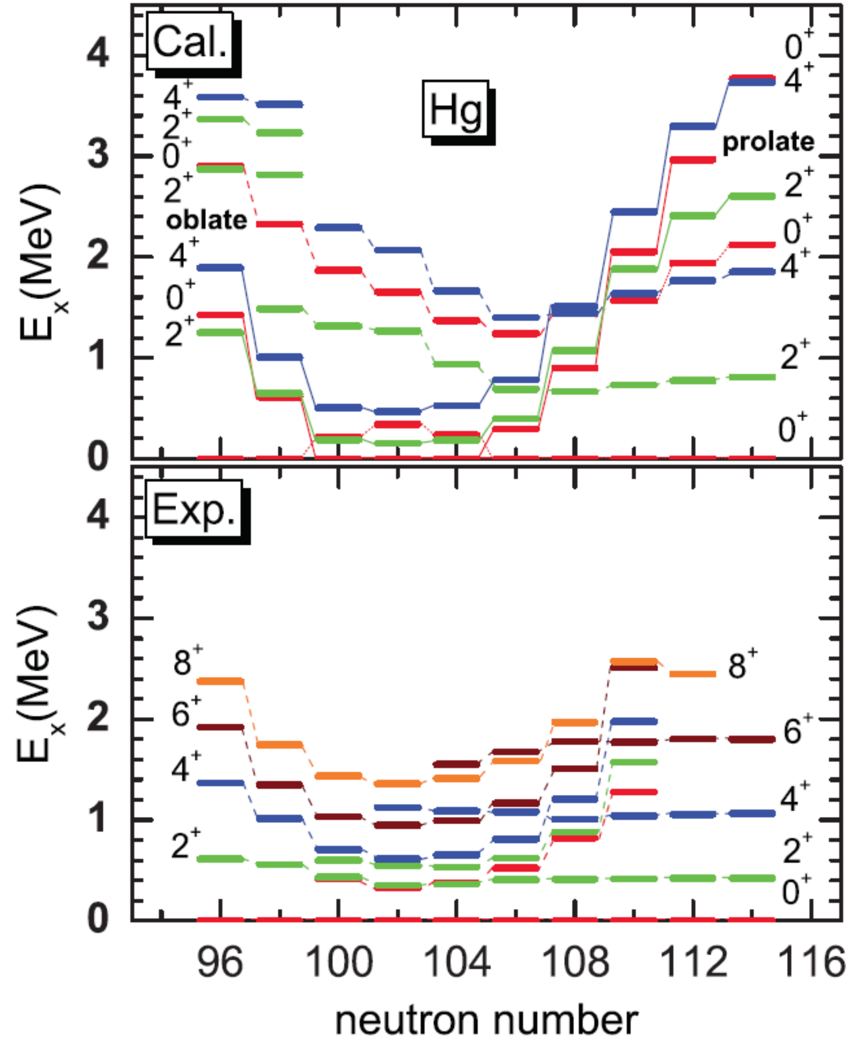


- Transitional (arrows) and spectroscopic (loops) quadrupole moments given in eb units (K. Wrzosek-Lipska,- to be published)

IBM - CM



BMF



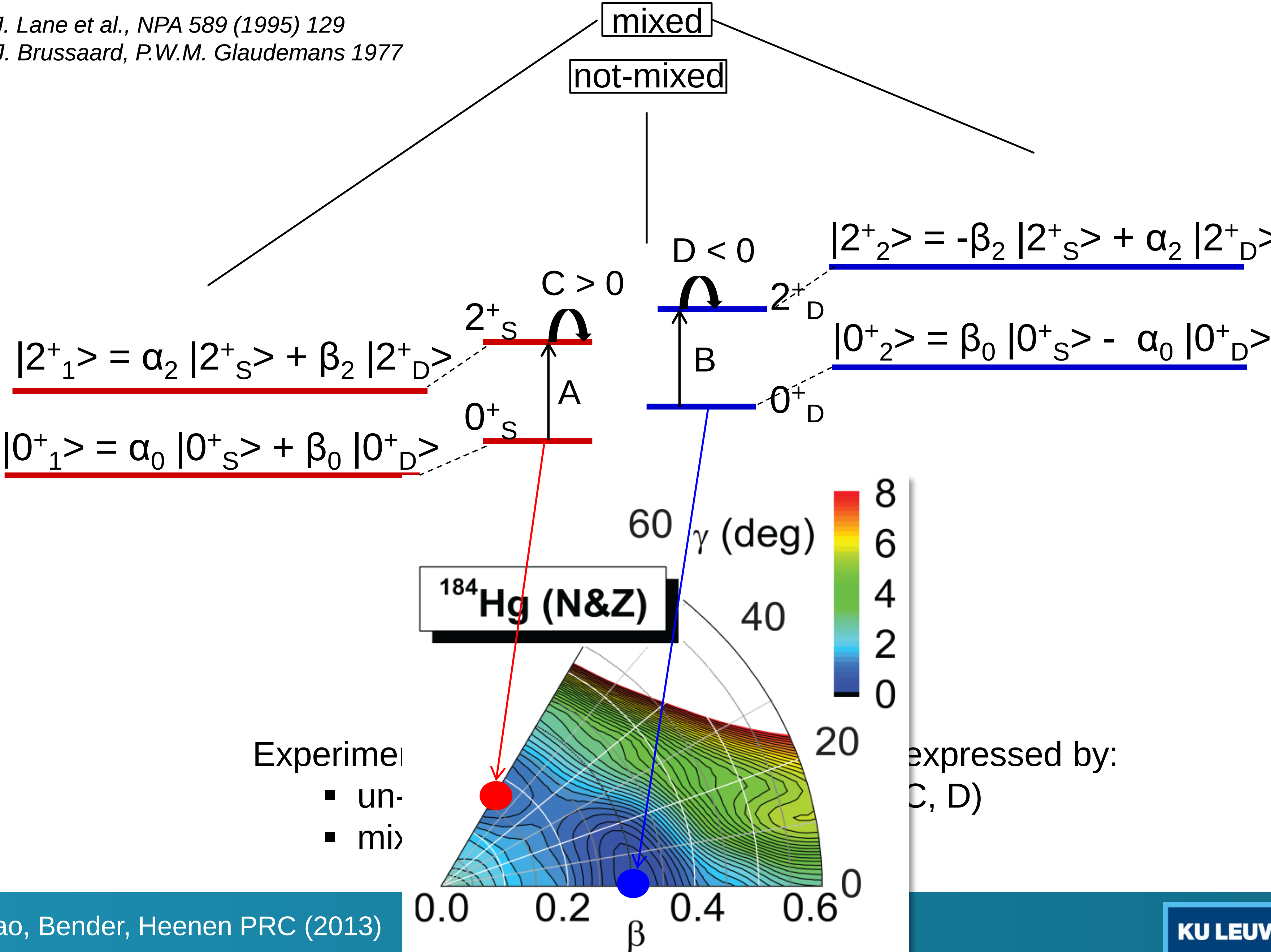
- no mixing

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

IBM-CM: Garcıa-Ramos PRC 89 (2014)
BMF: Yao PRC 87 (2013).

- Two level mixing calculations

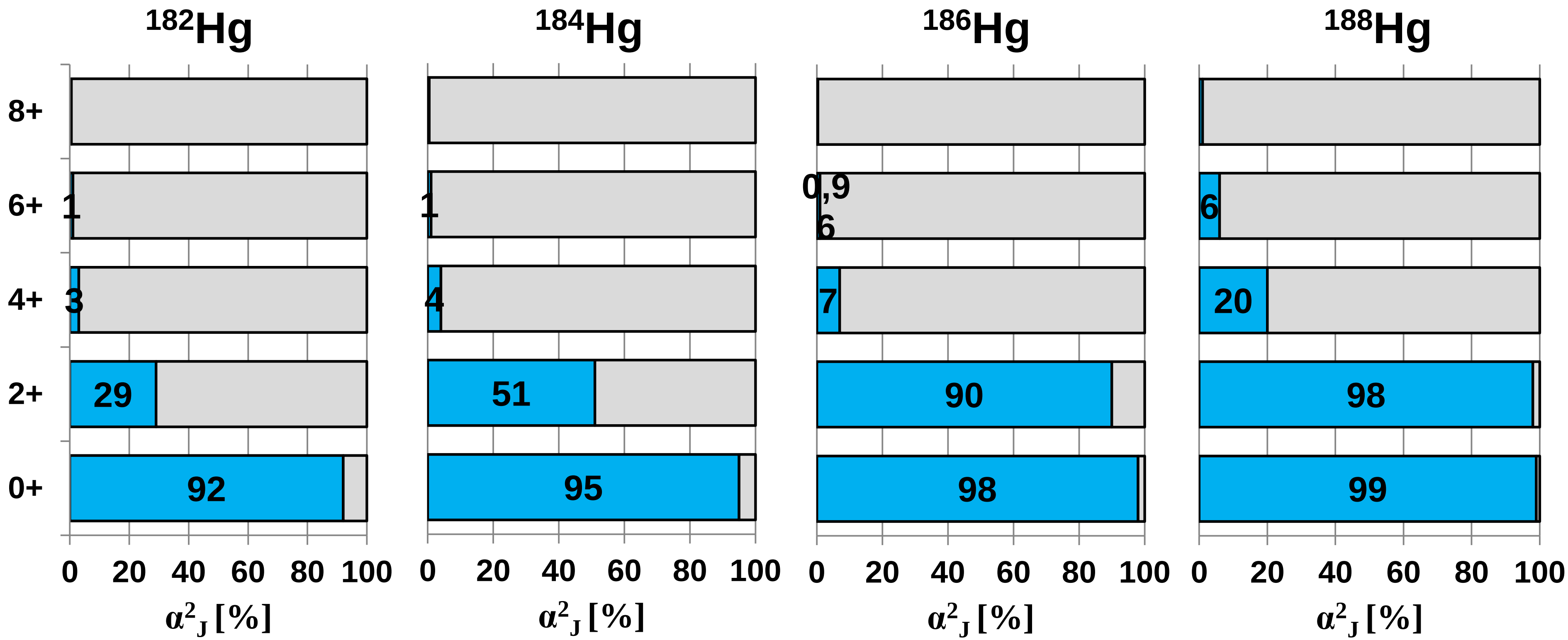
G.J. Lane et al., NPA 589 (1995) 129
P. J. Brussaard, P.W.M. Glaudemans 1977



Experime… …expressed by:
- un-… …C, D)
- mi…

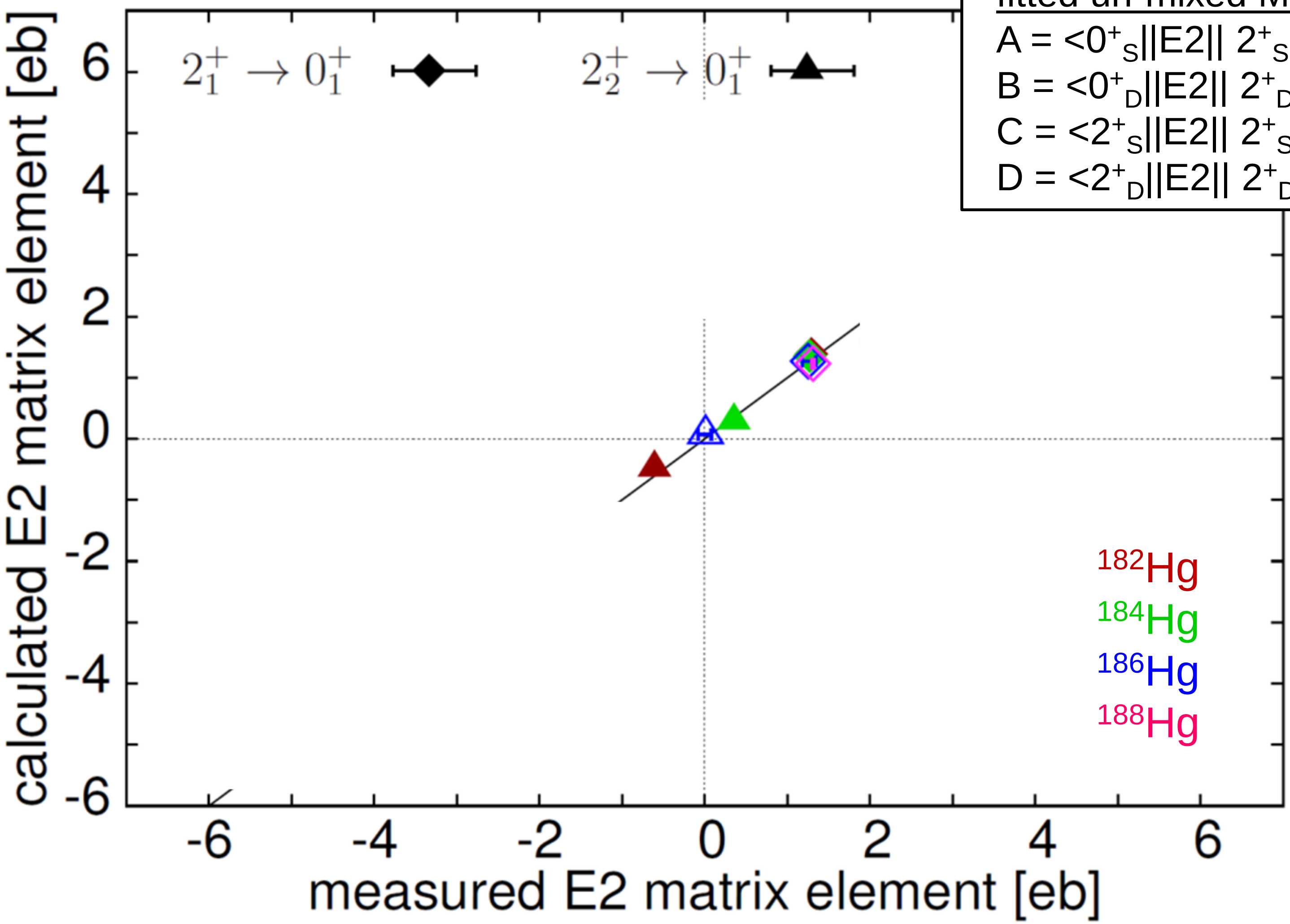
- Two level mixing calculations

Deduced from fitting the higher-lying levels using the variabel moment of inertia model



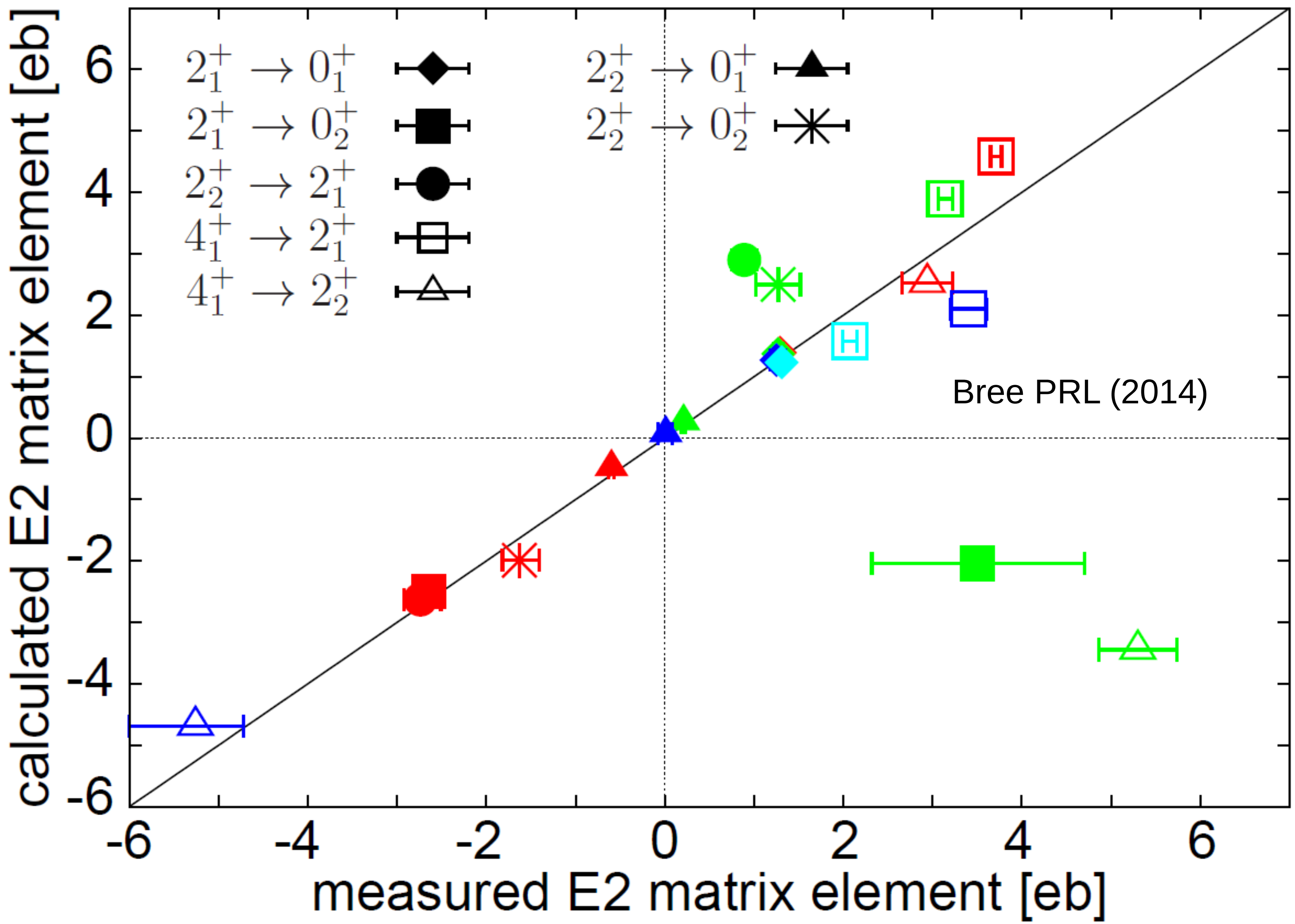
- 0^+ states: only weakly mixed for all $^{182-188}Hg$
- 2^+ states: mixing is changing from 29% up to 98%
- 4^+ states: dominant deformed configuration for all $^{182-188}Hg$

- Two level mixing calculations

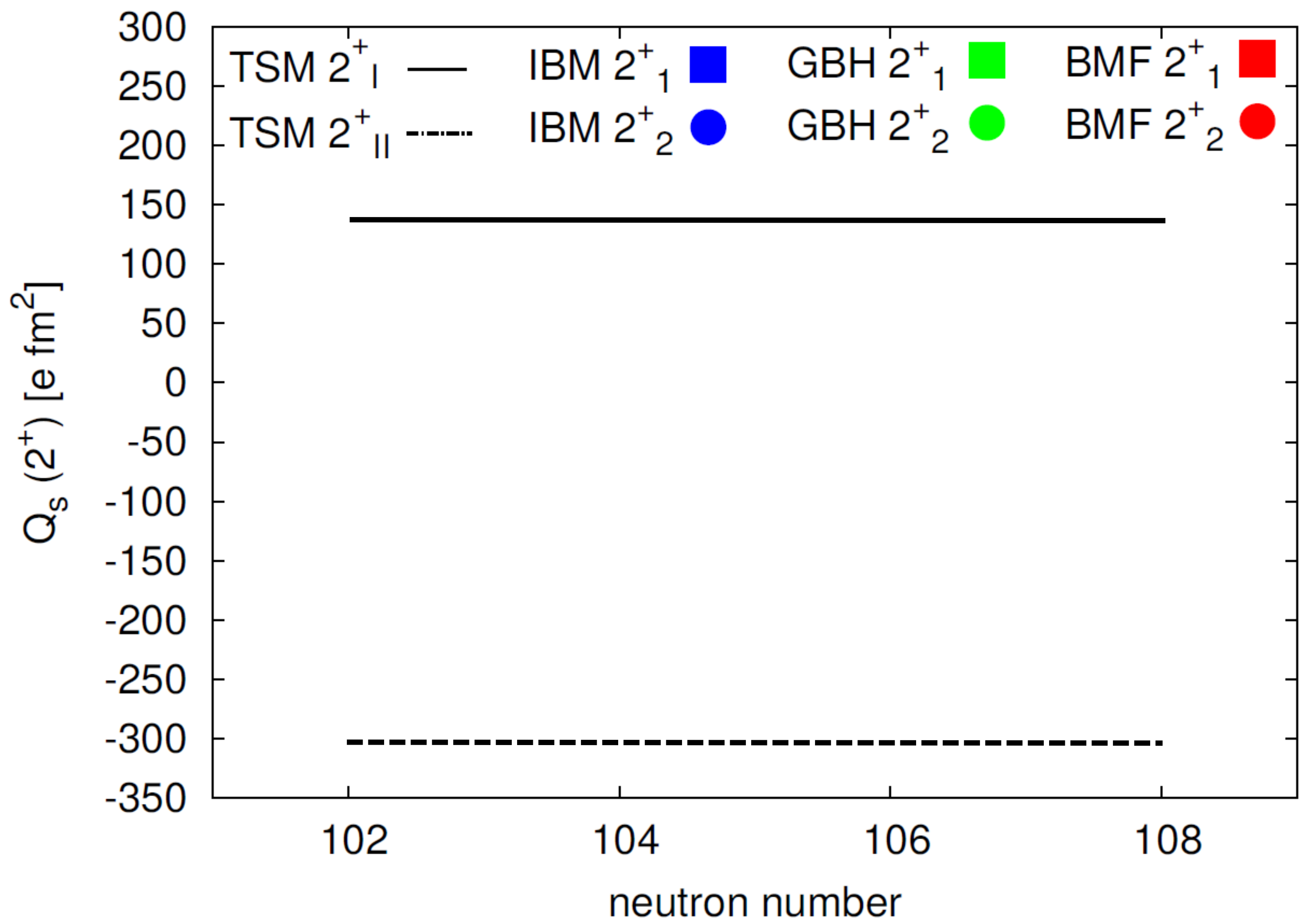


fitted un-mixed ME2's:
A = $<0^+_S||E2|| 2^+_S>$ = 1.2 eb
B = $<0^+_D||E2|| 2^+_D>$ = 3.3 eb
C = $<2^+_S||E2|| 2^+_S>$ = 1.8 eb
D = $<2^+_D||E2|| 2^+_D>$ = -4.0 eb

- Two level mixing calculations

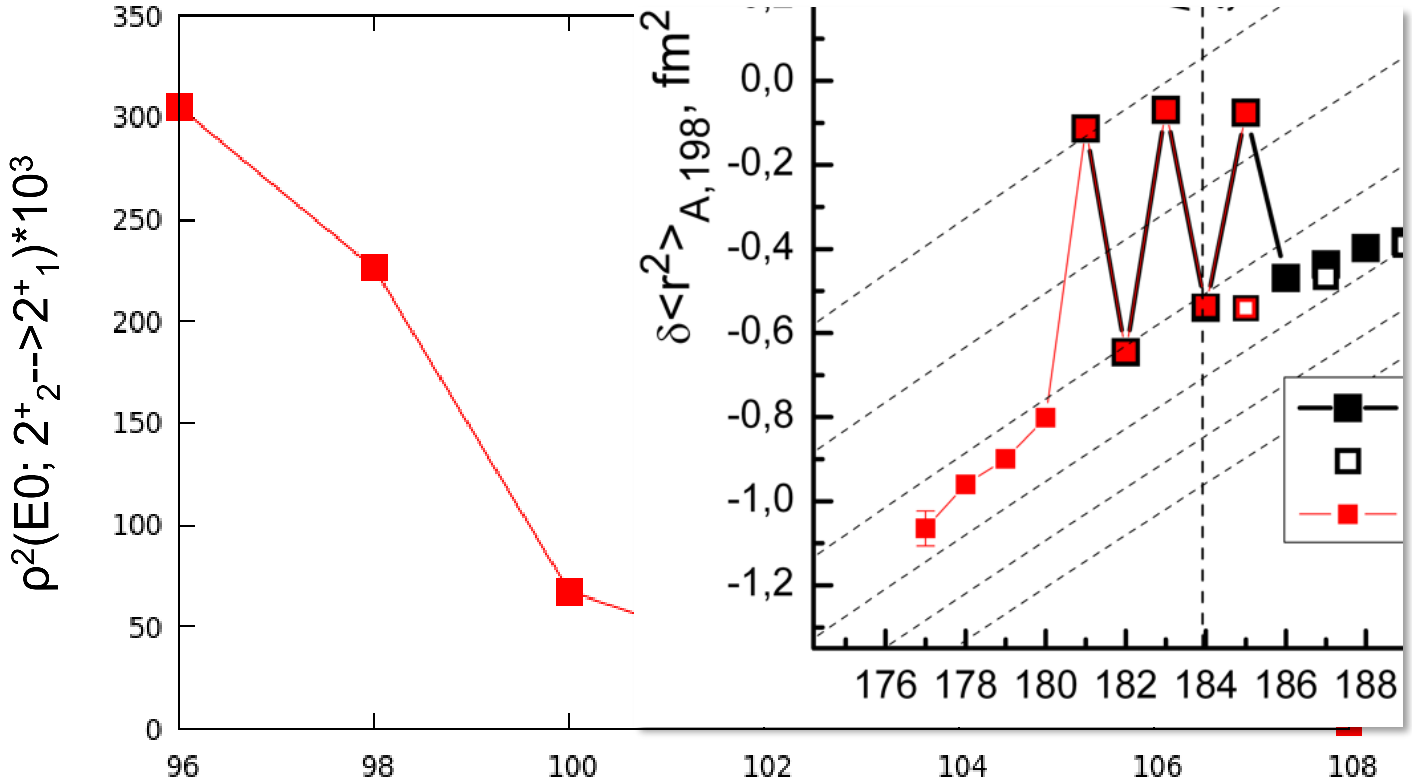


- Comparison of $Q_s(2^+)$



TSM: Two-State Mixing

- E0 (2^+_2-2^+_1) transition from B(E2) and α_{tot}

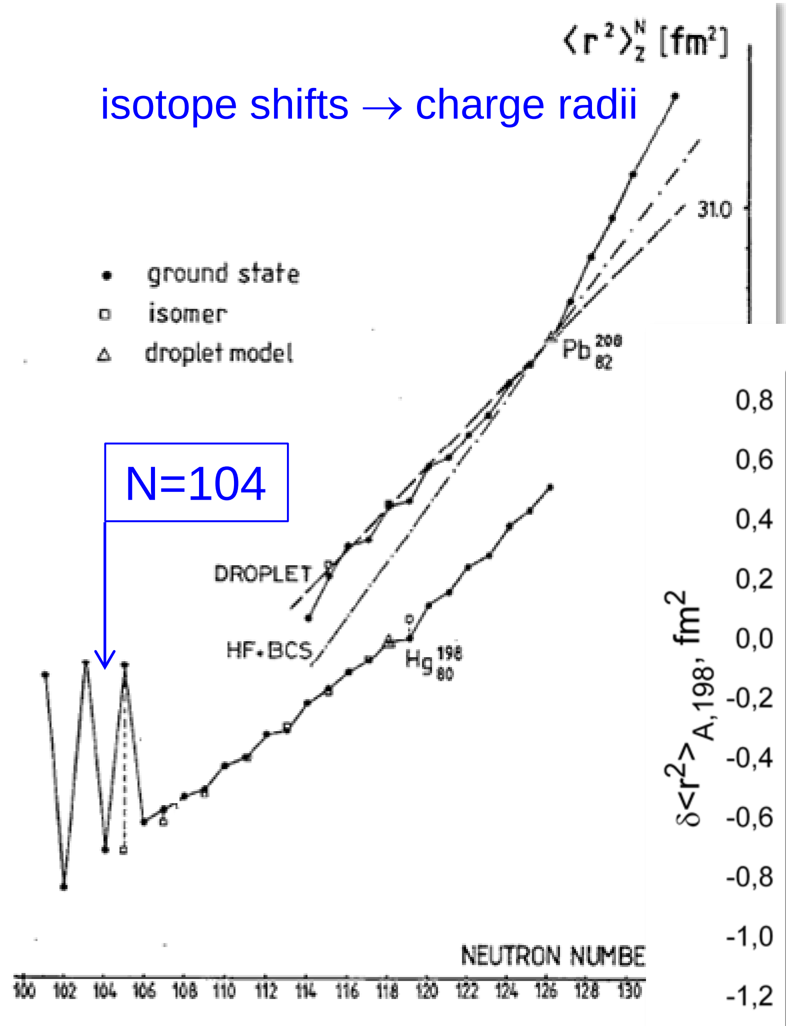


$$\rho^2(\mathrm{E0}) = \frac{Z^2}{R_0^4} a^2(1-a^2)\left[\Delta\langle r^2\rangle\right]^2. \quad R_0 = r_0 A^{1/3},\ r_0 = 1.2\ \mathrm{fm}$$

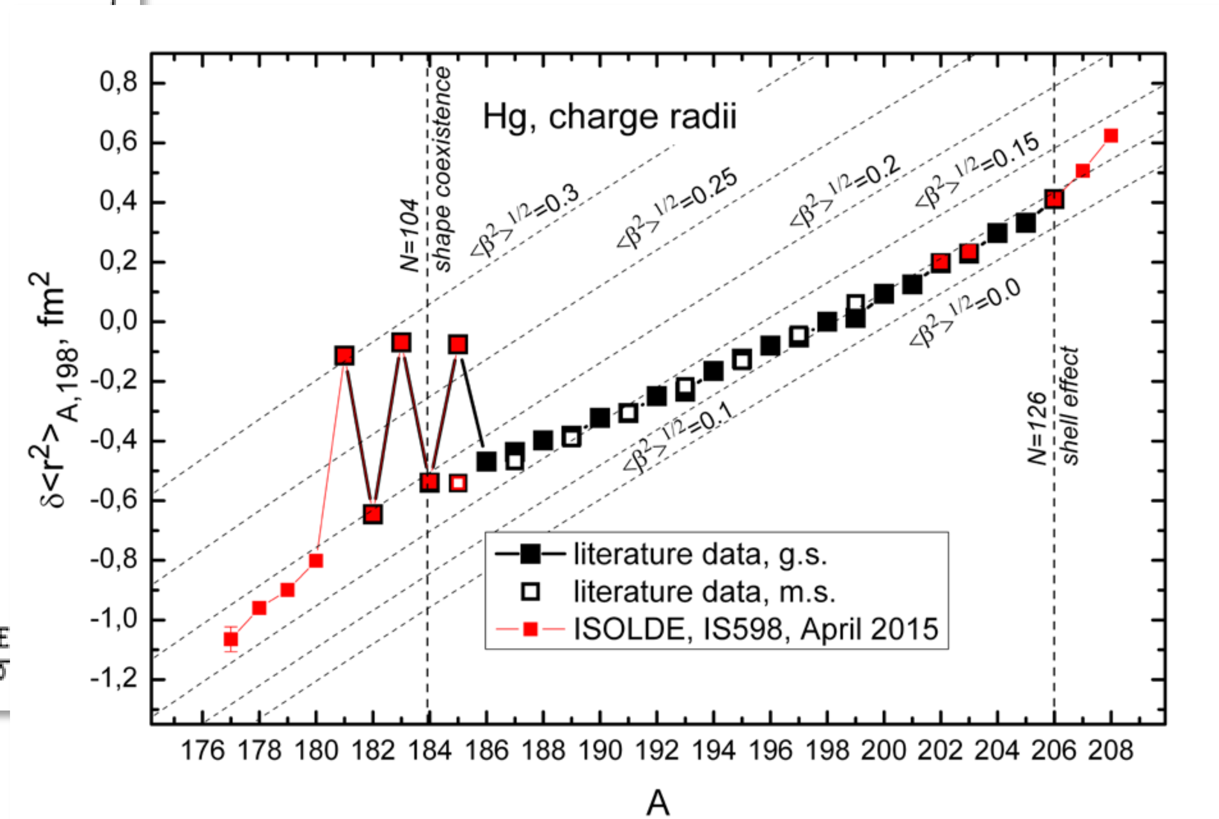
- Mixing amplitudes from two-level mixing calculation (Gaffney PRC (2014))
- $\Delta\langle r^2\rangle$ = 0.55 fm^2 for ^{182}Hg and 0.48 fm^2 for ^{184}Hg from laser spectroscopy

- Laser ionization spectroscopy of neutron-deficient mercury isotopes using VADLIS and MR-TOF

isotope shifts → charge radii



- see talk Th. Cocolios

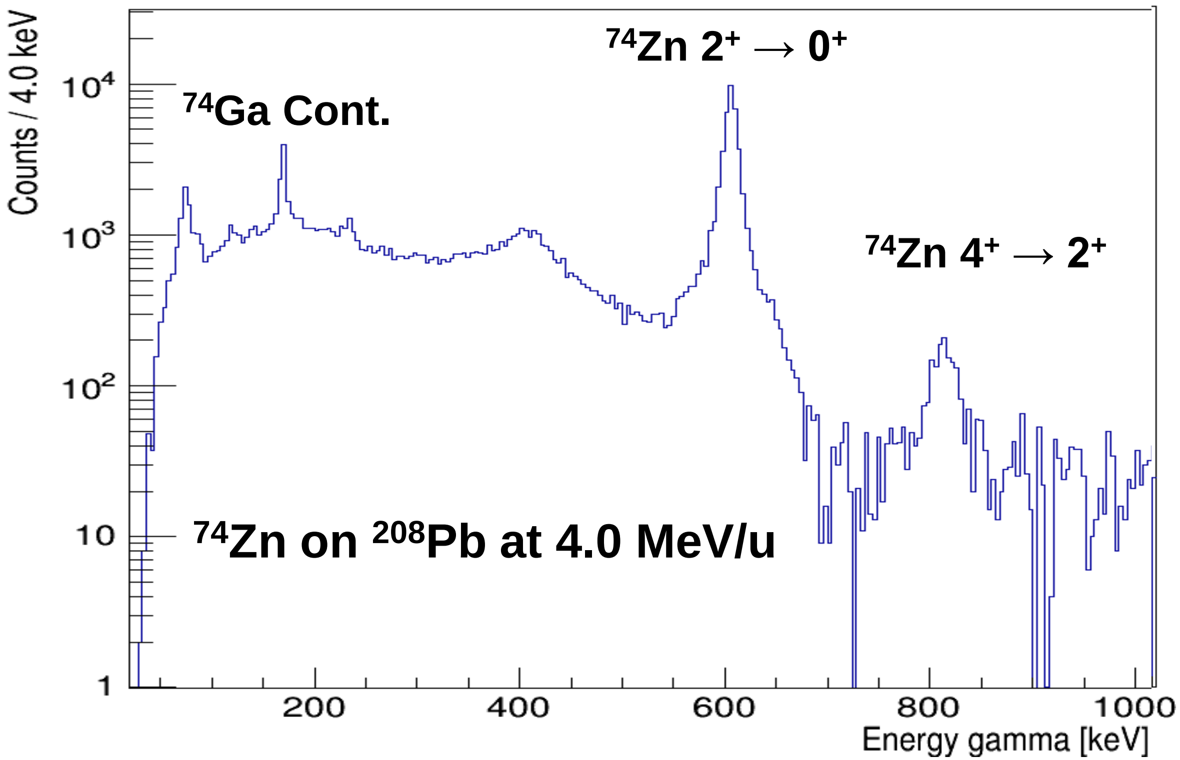


 Bonn,- PLB 38 (1972)

KU LEUVEN

First Coulex experiment at HIE ISOLDE 10/2015

- HIE ISOLDE Coulex in Hg and Pb using SPEDE
  - Multiple Coulex
  - Study of yrast and non-yrast states
  - Better sensitivity to diagonal E2 matrix element
  - Combined analysis with new data from beta decay (branching ratios, electron conversion coefficients

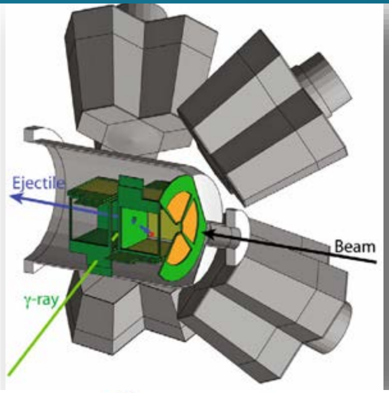


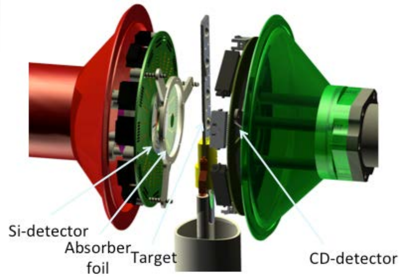
HIE ISOLDE - Opportunities

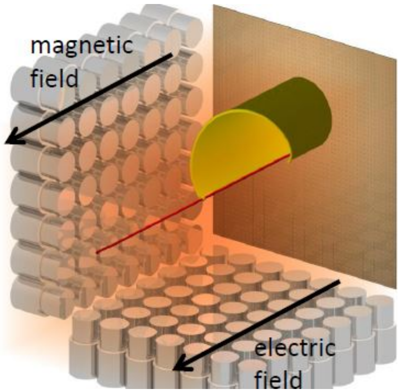
Reaction	Physics	Optimum energy
(d,p), (^{3}He,α), (^{3}He,d), (d,n),… transfer	Single-particle configurations, r- and rp-process for nucleosynthesis	10 MeV/u
(^{3}He,p), (d,α), (p,t), (t,p)	pairing	5-10 MeV/u
Few-nucleon transfer	Structure of neutron-rich and proton-rich nuclei	8 MeV/u
Unsafe Coulomb excitation	High-lying collective states	6-8 MeV/u
Compound nucleus reactions	Exotic structure at drip line	5 MeV/u
Coulomb excitation, g-factor measurements	Nuclear collectivity and single-particle aspects	3-5 MeV/u
(p,p'γ), (p,α), …	nucleosynthesis	2-5 MeV/u

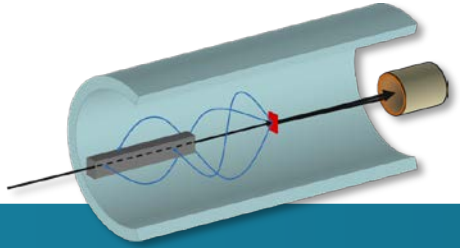
Instrumentation

- Miniball + T-REX (upgrade planned) :
  COULEX + Transfer
- SPEDE: added to Miniball+T-REX
  (Hg and Pb Coulex – J. Pakarinen)
- Multipurpose reaction chamber
- CORSET chamber for fusion-fission reactions
- MAYA/ACTAR/SpecMAT: resonant scattering + transfer
- ISOL Solenoidal Spectrometer: ISS (Hall →@ TSR)
- Zero degree type spectrometer: HIE ISOLDE Fragment Identifier (HIFI)

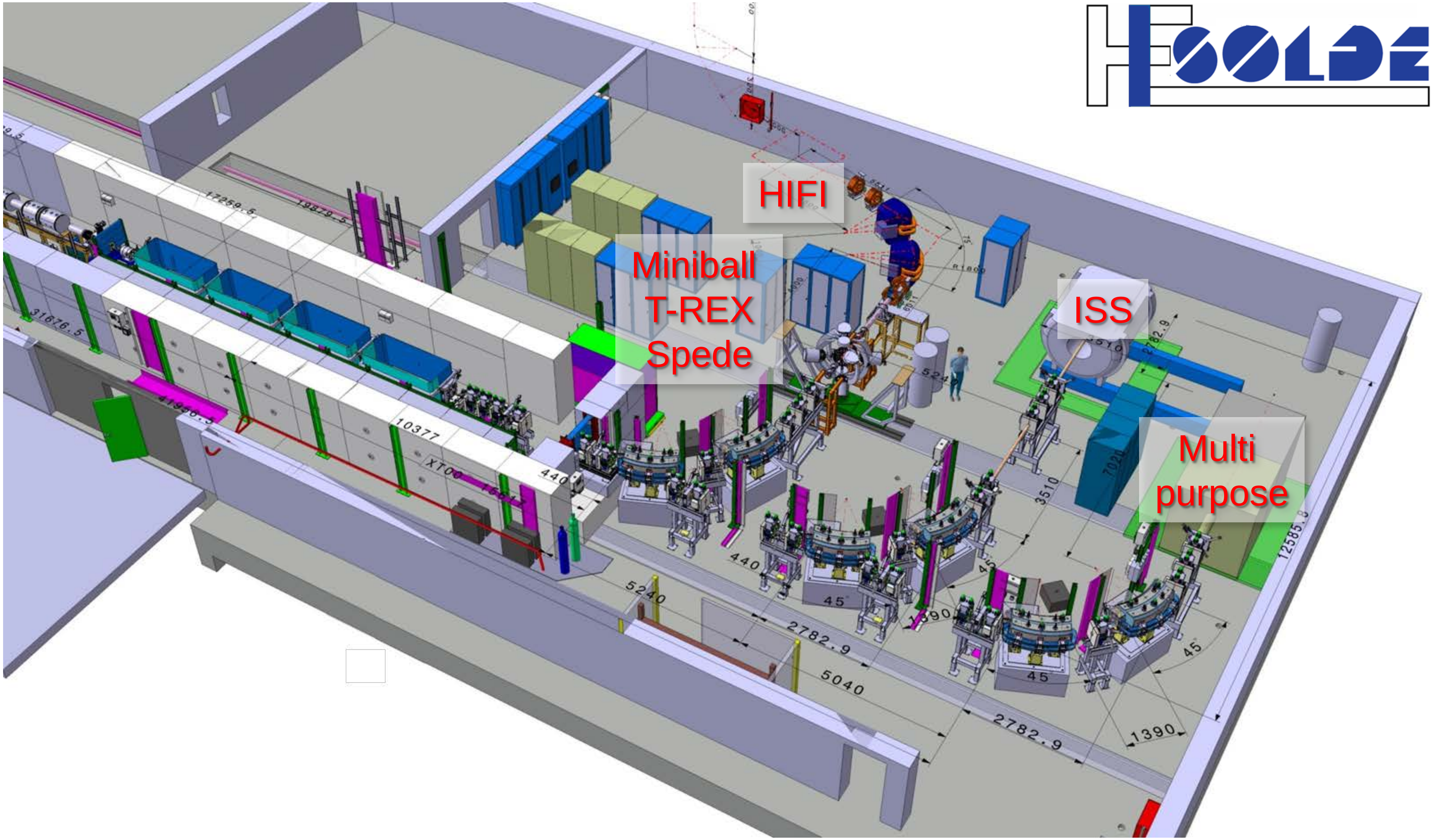








The High Energy Beam Transport Lines and experimental set-ups



• Open questions:

- what after the next set of high-statistics Coulex measurements (^{182,184}Hg, ^{A}Pb)?
- transfer reaction probes (^{185m,g}Hg(d,p)^{186}Hg) populating different band members in ^{186}Hg (see Riccardo Raabe)
- nucleon occupancy numbers: which experimental tool can be used to probe them – proton transfer?
- what makes beyond mean-field calculations predict the ‘prolate’ deformed states become the ground state in mercury?