



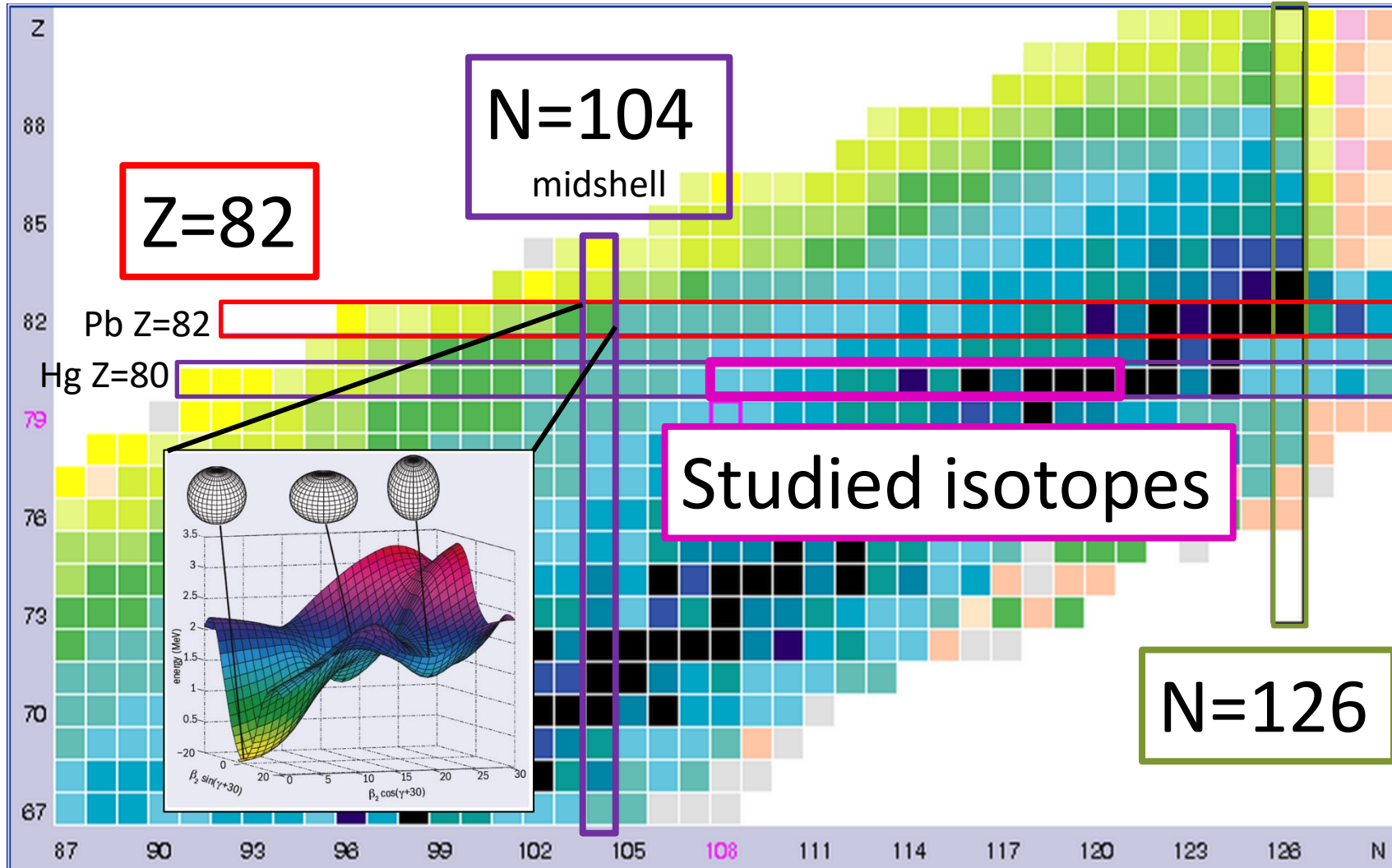
Shape coexistence and shape mixing in the n-deficient Hg isotopes

Bruno Olaizola

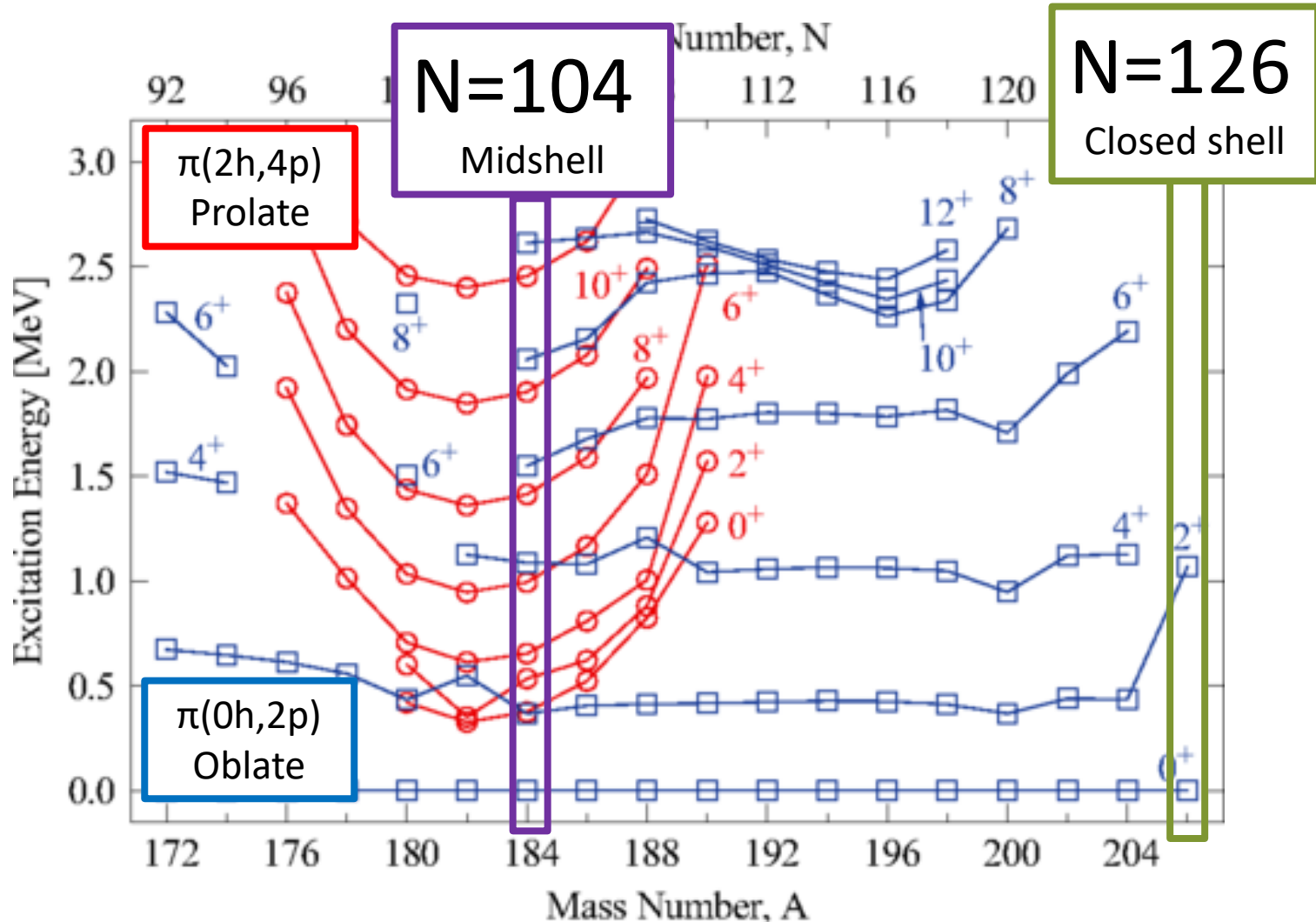
10th International workshop on Quantum Phase
Transitions in Nuclei and Many-Body Systems
Dubrovnik, Croatia, July 11-15, 2022



Region of interest



Even Hg systematics



Systematic study of mixing

- As the intruder configuration decreases in energy, mixing is expected to increase
- Systematic study of even Hg
- ϵ decay from high-spin Tl isomer
- Benchmark unperturbed normal configuration
- Mixing from:

➤ B(E2)

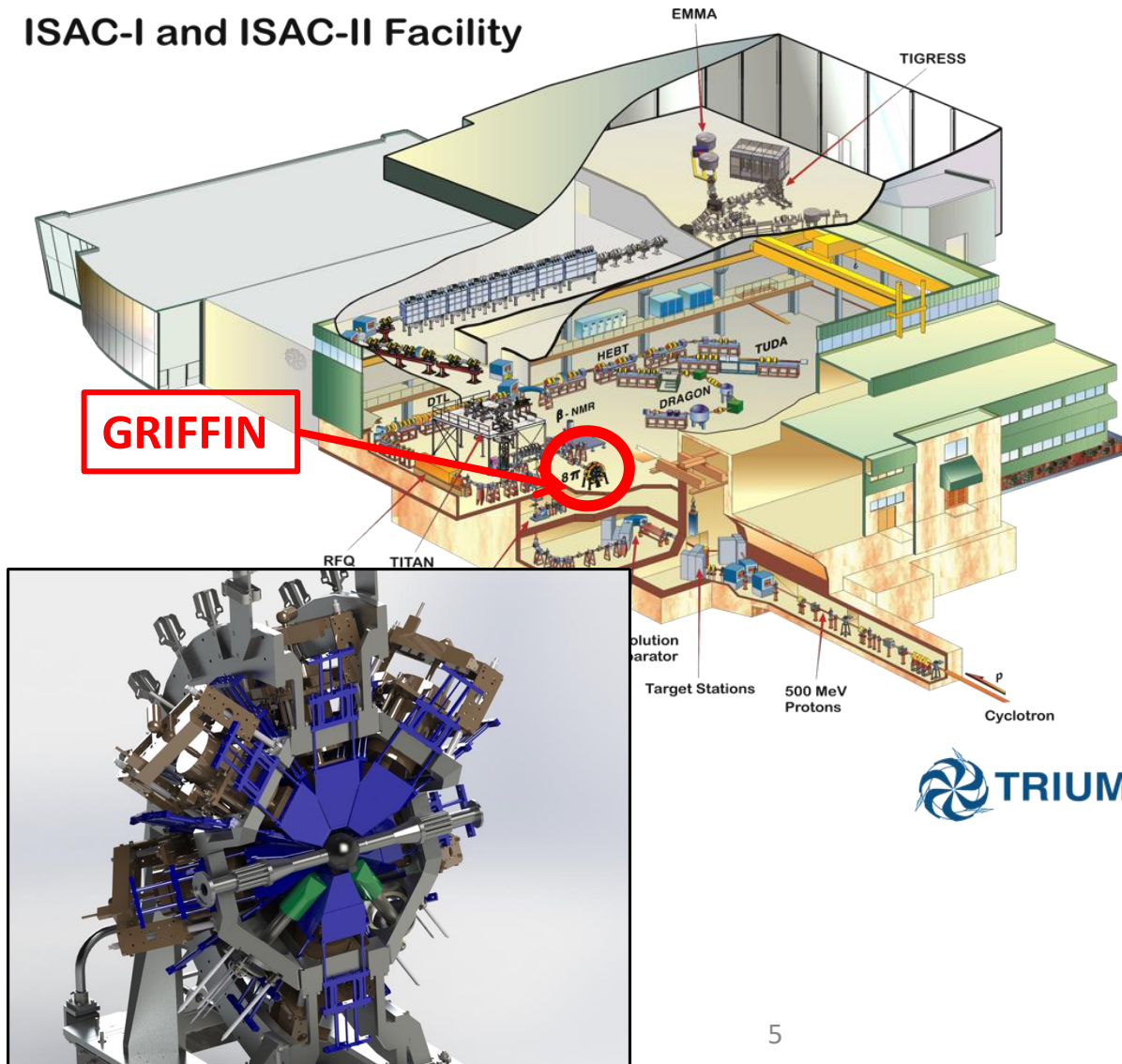
$$B(E2; \gamma_i J_i \rightarrow \gamma_f J_f) \equiv \frac{2J_f + 1}{2J_f - 1} \langle \gamma_f J_f || Q_2 || \gamma_i J_i \rangle^2.$$

➤ $\rho^2(E0)$

$$\rho_{if}^2 \cdot 10^3 = \alpha^2 \beta^2 (\Delta \langle r^2 \rangle)^2 \cdot 10^3 \frac{Z^2}{R^4},$$

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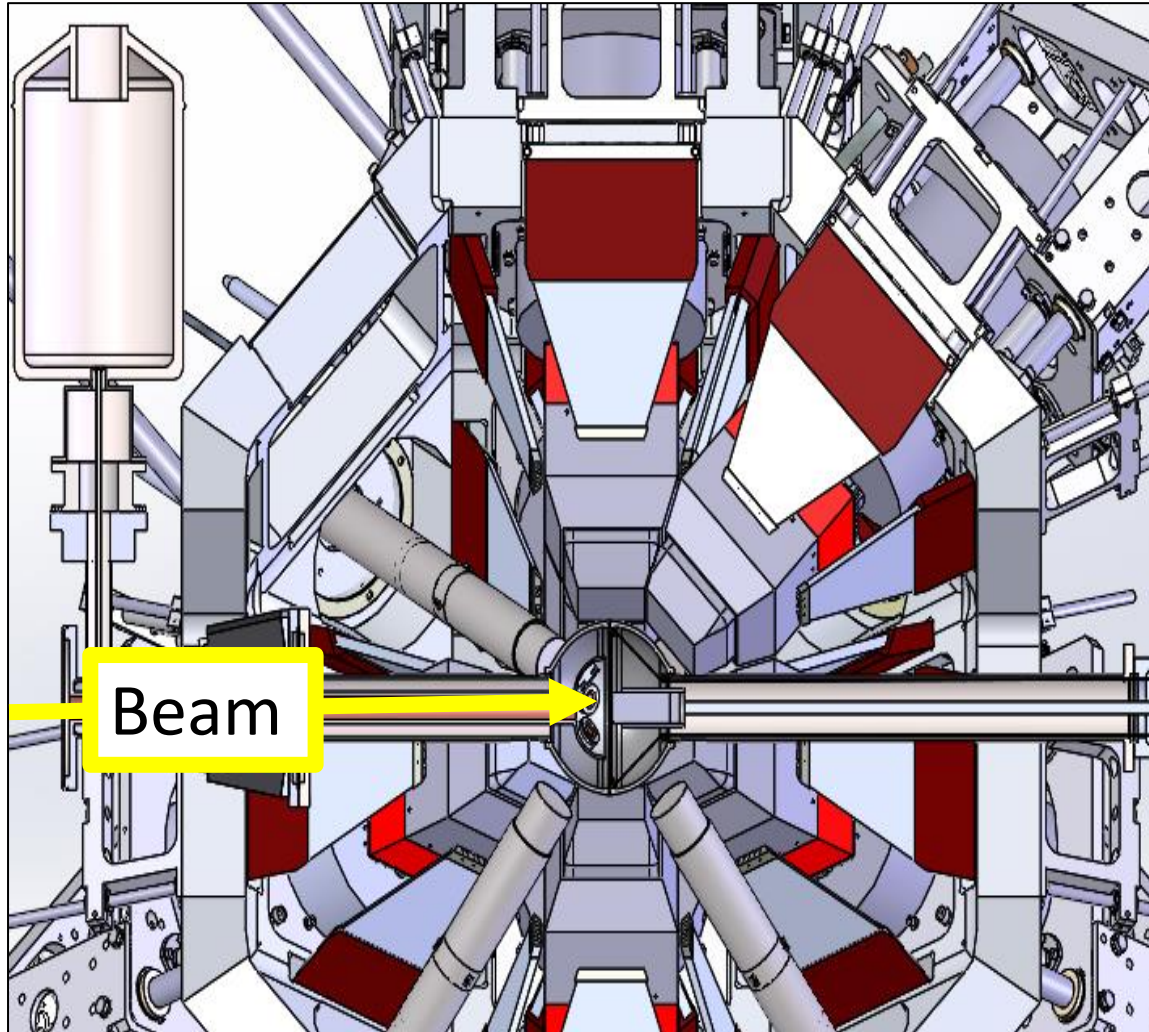
ISAC-I and ISAC-II Facility



- 500 MeV protons on an UC_x target
- 7^+ Tl isomer ionized with TRILIS
- Mass separated
- No significant contamination

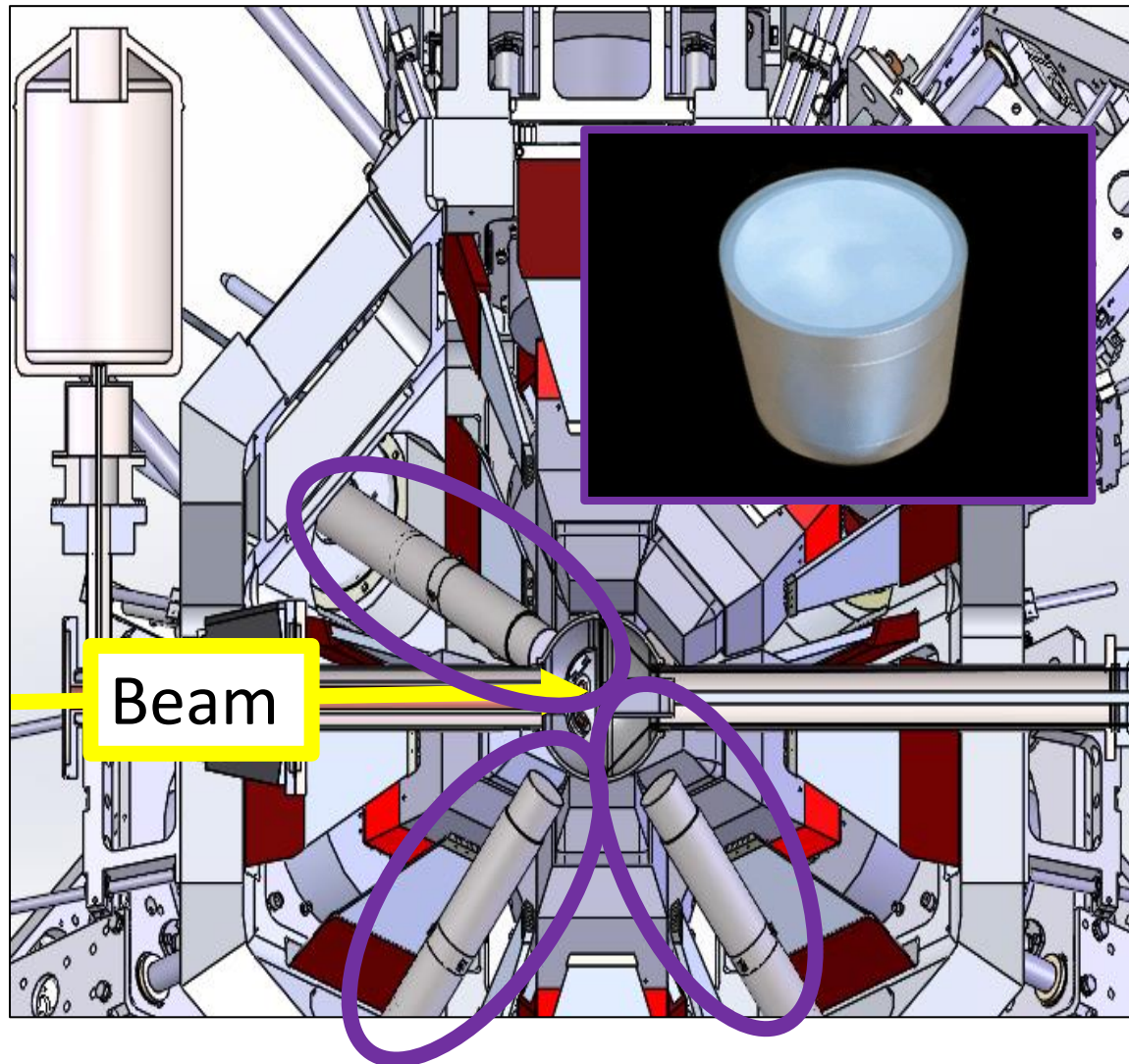


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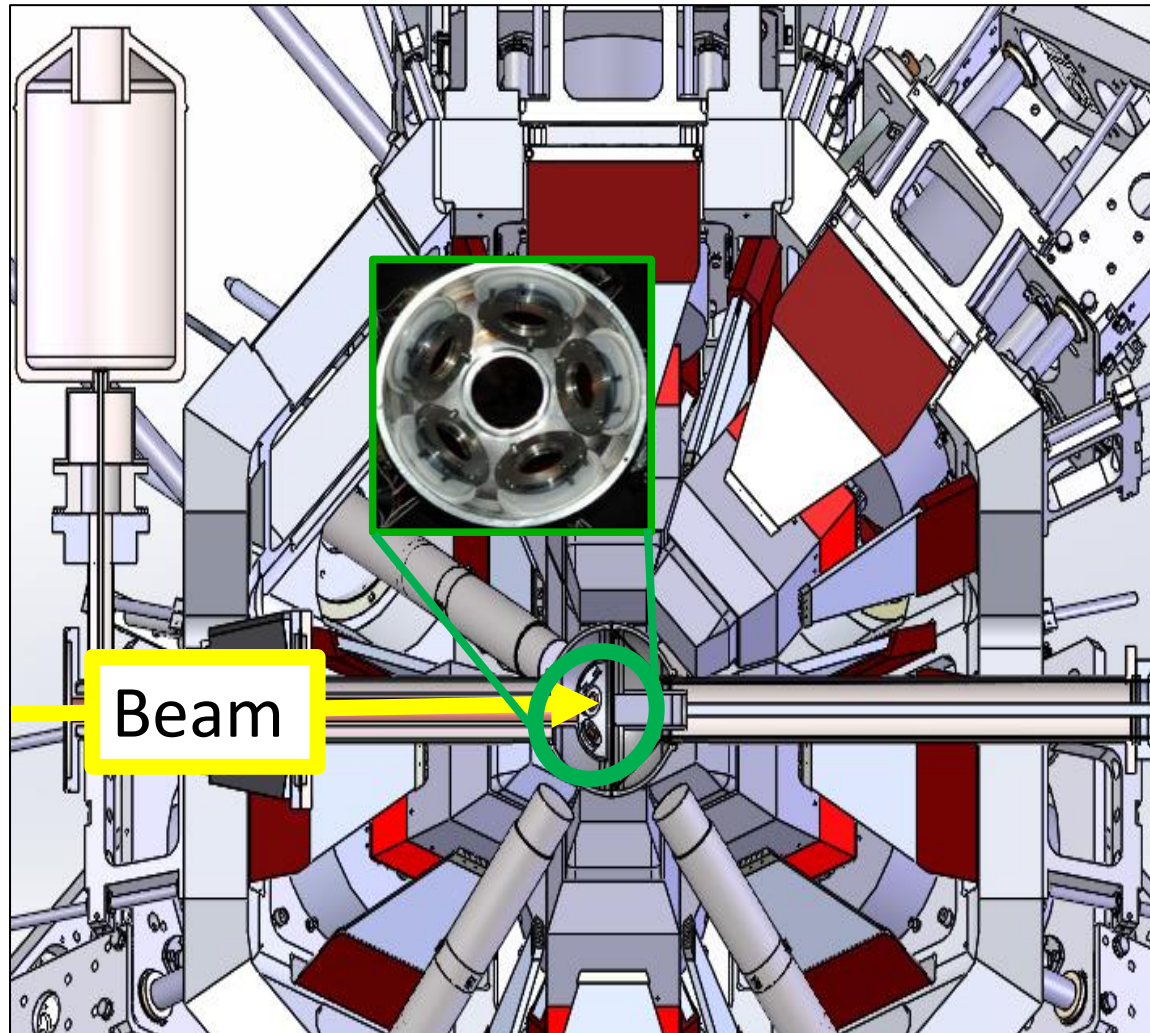
- 16 HPGe clovers
 - Gammas
- 8 LaBr
 - Timing
- PACES -5 Si(Li)
 - Conversion electrons
- ZDS
 - Betas+timing
- BGO shields
 - Not this experiment
- Tape system

GRIFFIN



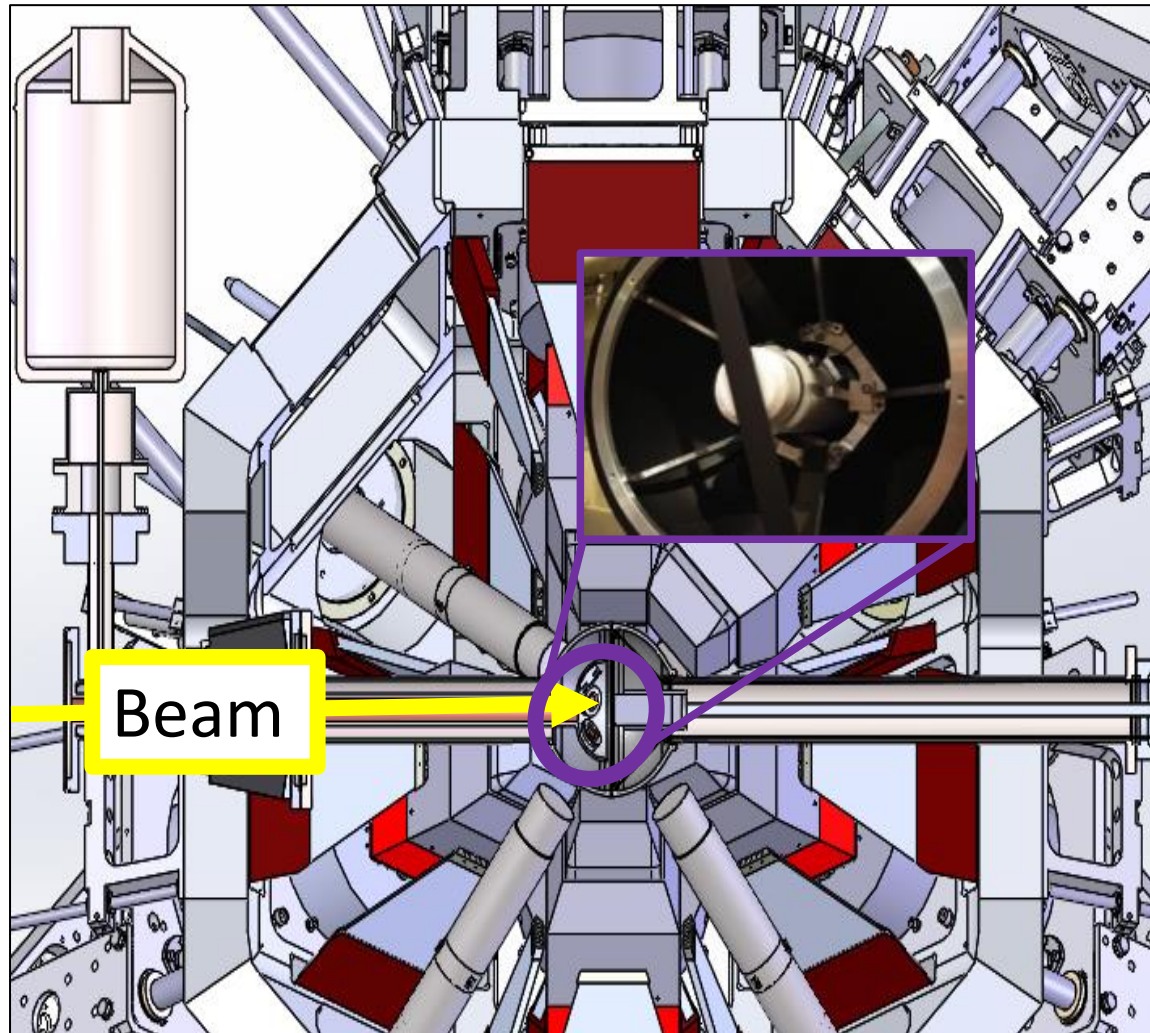
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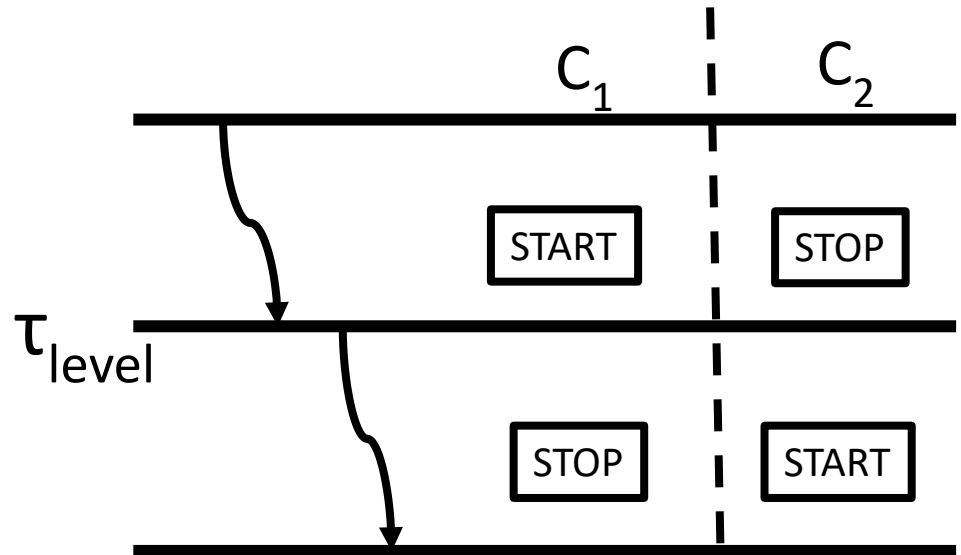
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Centroid shift method

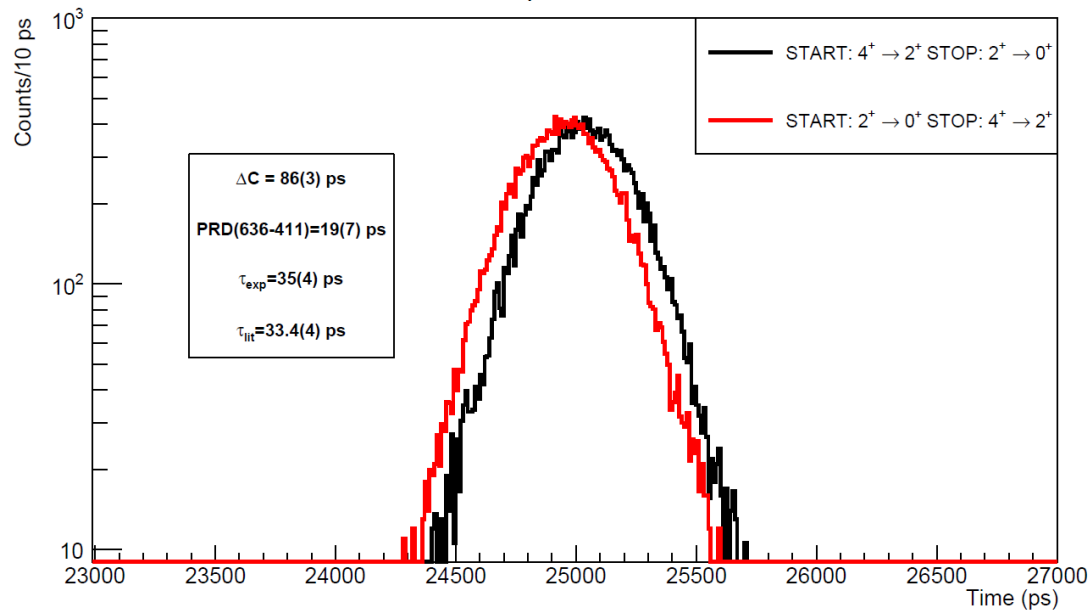
$$C_1 = \tau_{\text{level}} + \tau_0$$

$$C_2 = -\tau_{\text{level}} + \tau_0$$

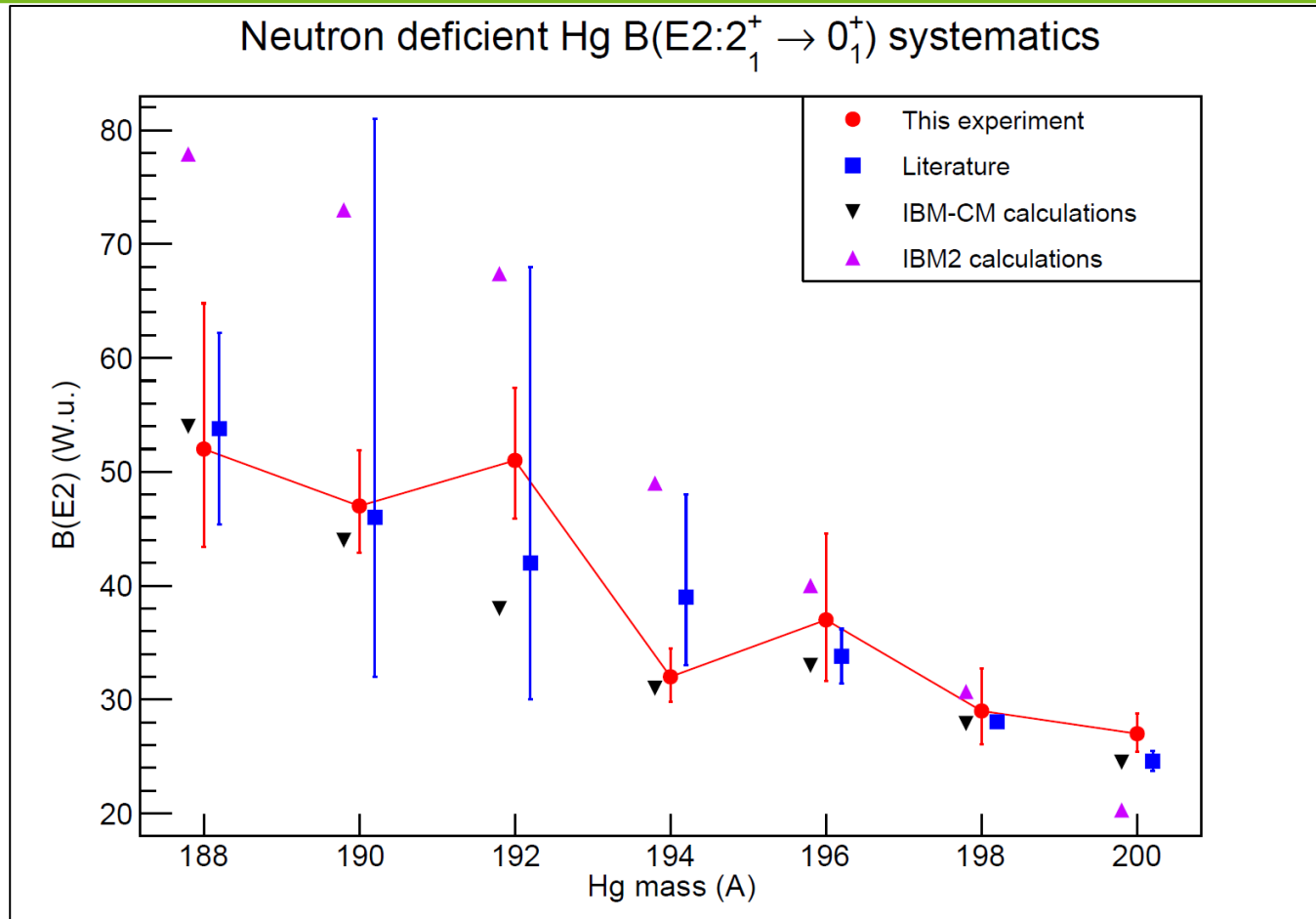
$$\Delta C = C_1 - C_2 = 2\tau_{\text{level}}$$



$^{198}\text{Hg } 2^+_1$ mean lifetime



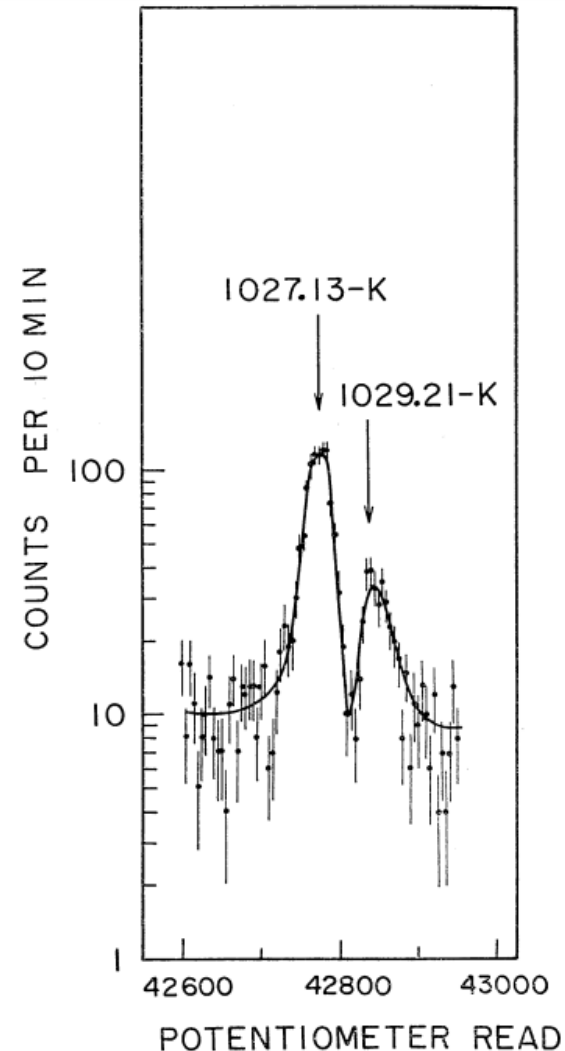
B(E2;2⁺→0⁺)



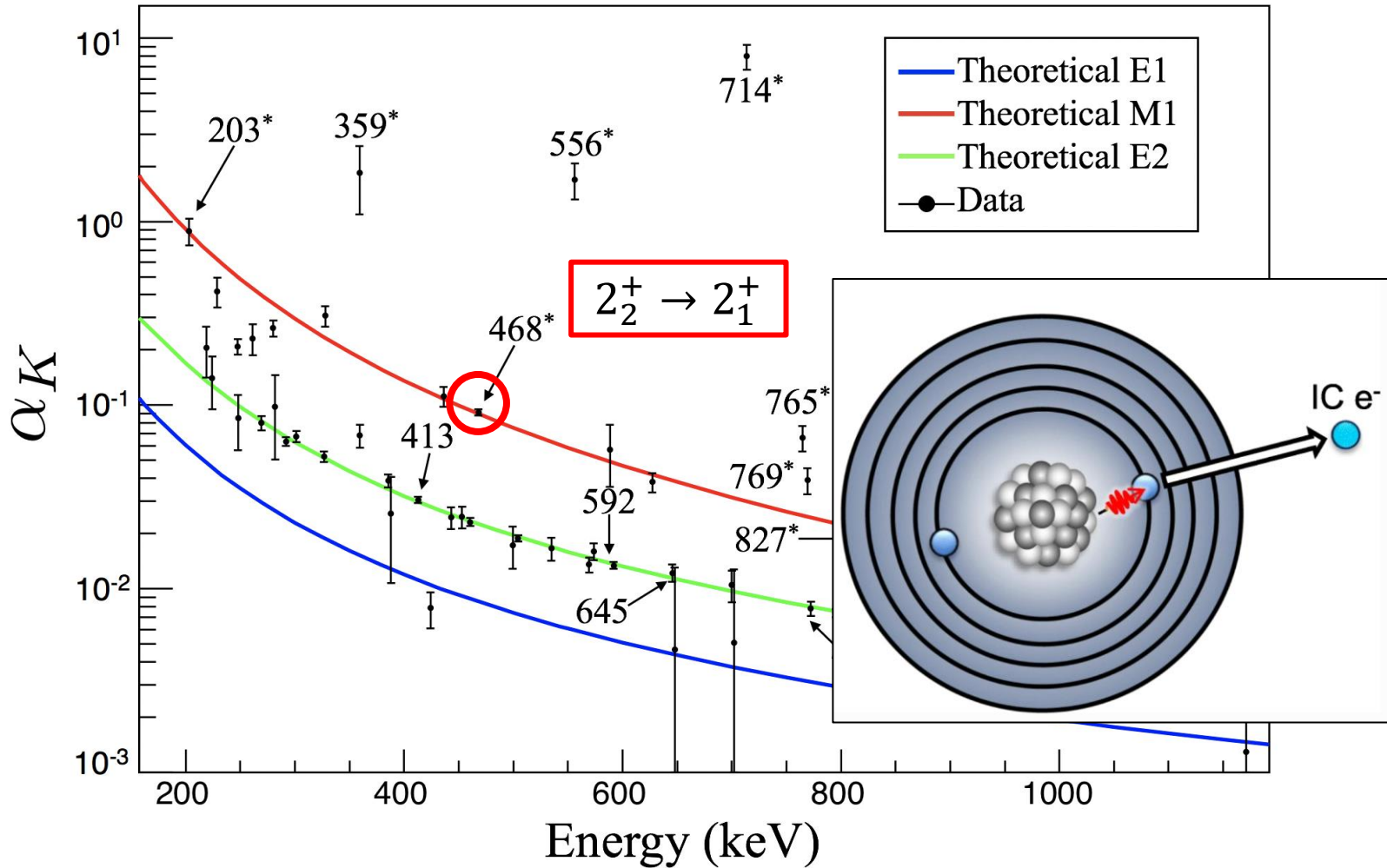
- **Literature(190-194):** Esmaylzadeh *et al* 10.1103/PhysRevC.98.014313 (2018)
- **Literature:** NNDC
- **IBM-CM:** J. E. García-Ramos and K. Heyde Phys. Rev. C 89, 014306 (2014)
- **IBM2:** K. Nomura, R. Rodríguez-Guzmán, and L. M. Robledo Phys. Rev. C 87, 064313 (2013)

Mixing in ^{200}Hg from $\rho^2(E0)$

- Extract mixing from $0_2^+ \rightarrow 0_1^+$
- $q_k^2(E0/E2)$ previously measured
- From decay of $^{200}\text{Tl}(2^-)$
- $\tau(0_2^+) = 8(4)$ ps in ^{200}Hg
- $\rho^2(E0) = 0.02(1)$ milliunits
- Benchmark of no mixing

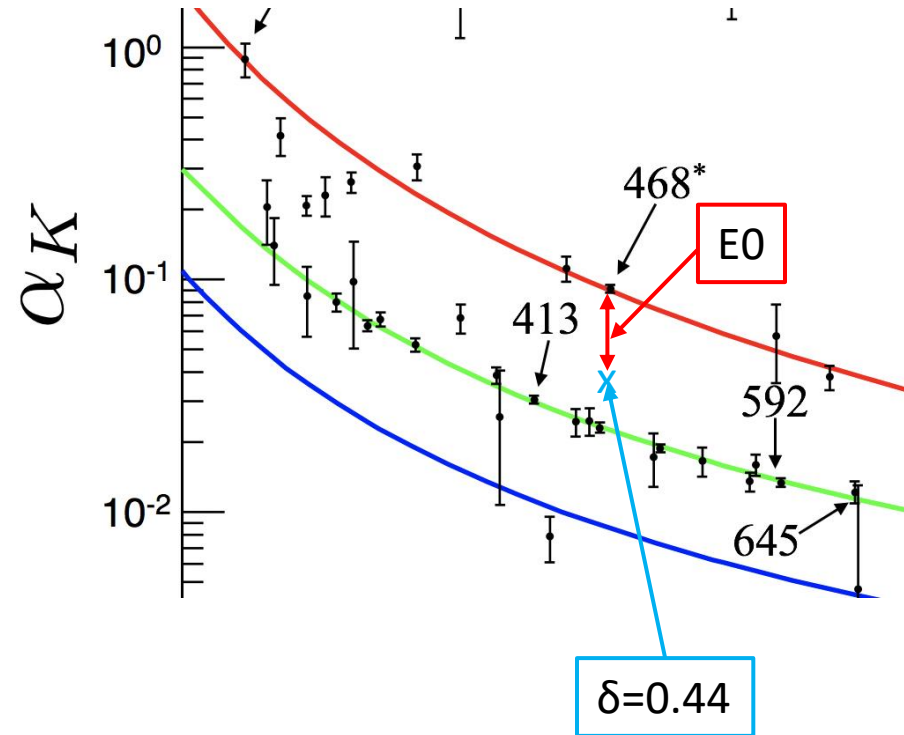
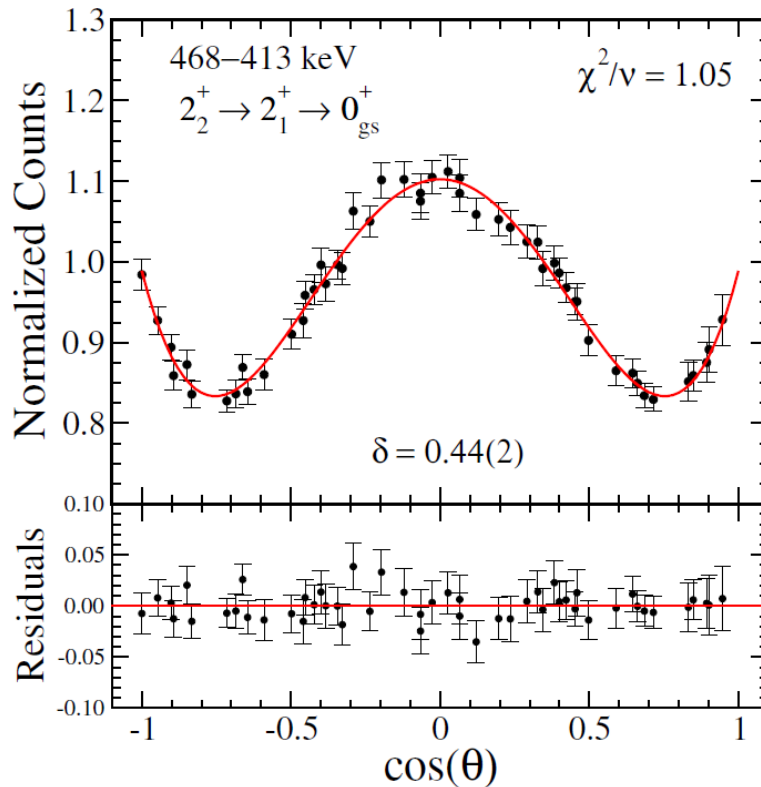


$^{188}\text{Hg } 2_2^+ \rho^2 (EO)$



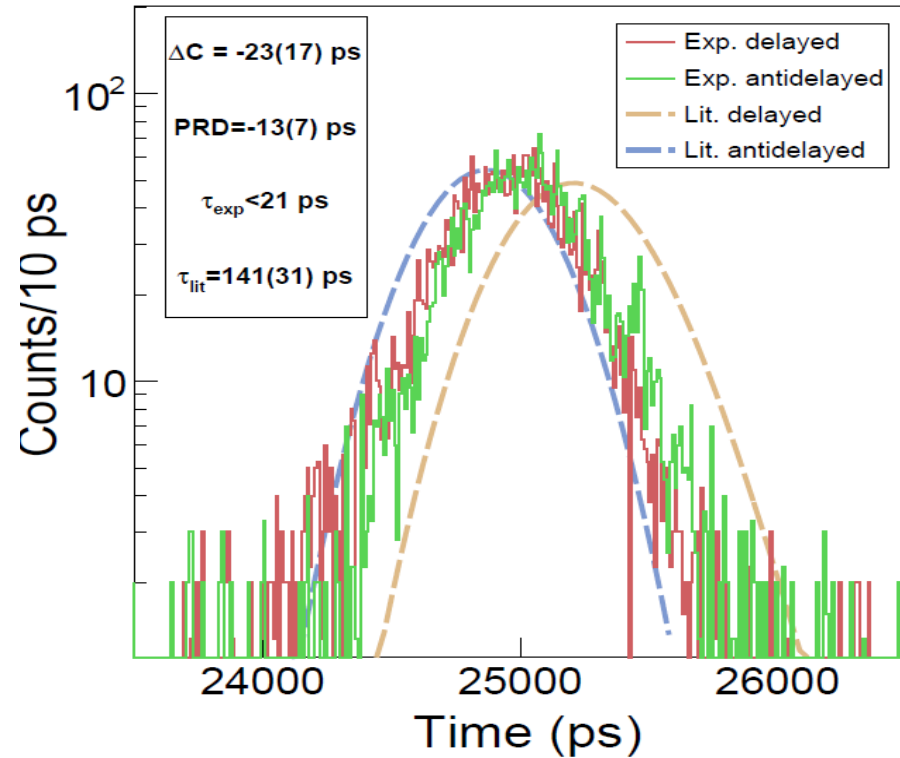
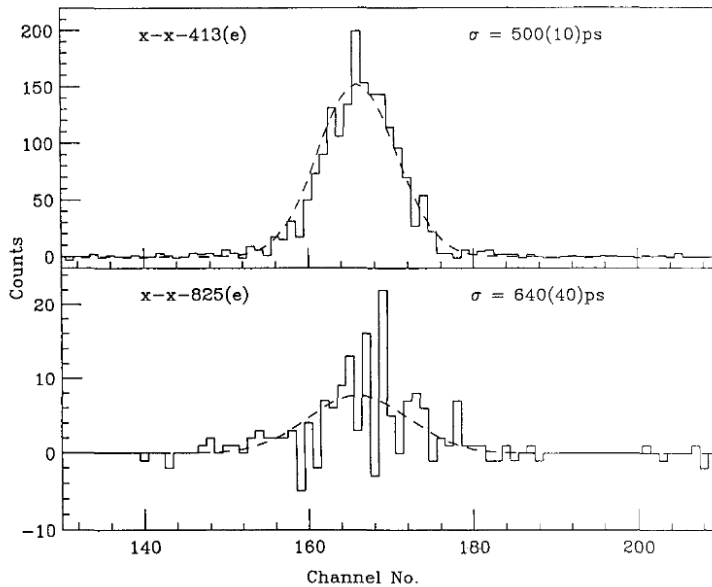
● Electron spectroscopy seems to suggest pure M1

$^{188}\text{Hg } 2_2^+ \rho^2(E0)$



- Angular firmly establish a significant M1/E2 mixing
- $\alpha(M1/E2) < \alpha(M1)$
- Excess electrons must be E0 component

$^{188}\text{Hg } 2_2^+ \rho^2(E0)$



- Previous $\tau(2_2^+) = 141(31)$ ps
- New $\tau(2_2^+) < 21$ ps
- $\rho^2(E0) > 0.98$ milliunits for $2_2^+ \rightarrow 2_1^+$
- $\rho^2(E0) = 8.1(65)$ milliunits for $4_2^+ \rightarrow 4_1^+$
- Strong mixing between normal and intruder configurations

Joshi et al Int. J. Mod. Phys. E 03, 757 (1994).

M. Siciliano et al. PRC 102, 014318 (2020)

Summary

- Systematic study of lifetimes for even neutron-deficient Hg
- Increased precision for B(E2)
- Great agreement with IBM-CM
- Negligible mixing for $^{192-200}\text{Hg}$
- Confirmed by low $\rho^2(E0)$ in ^{200}Hg
- Large $\rho^2(E0)$ in 2_2^+ and 4_2^+ ^{188}Hg
 - Strong mixing
- Other large E0 in $2_4^+ \rightarrow 2_1^+$ and $4_3^+ \rightarrow 4_1^+$
 - Mixing with higher energy structures *may* be relevant



G.C. Ball, N. Bernier, M. Bowry, R. Caballero-Folch, I. Dillmann, A.B. Garnsworthy, S. Georges, G. Hackman, J. Smallcombe, J. K. Smith, D. Southall, E. Timakova, R. Umashankar

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University of Guelph, Canada;



C. Andreoiu, F. Garcia, J.L. Pore, U. Rizwan, K. Starosta, P. Voss, J. Williams,

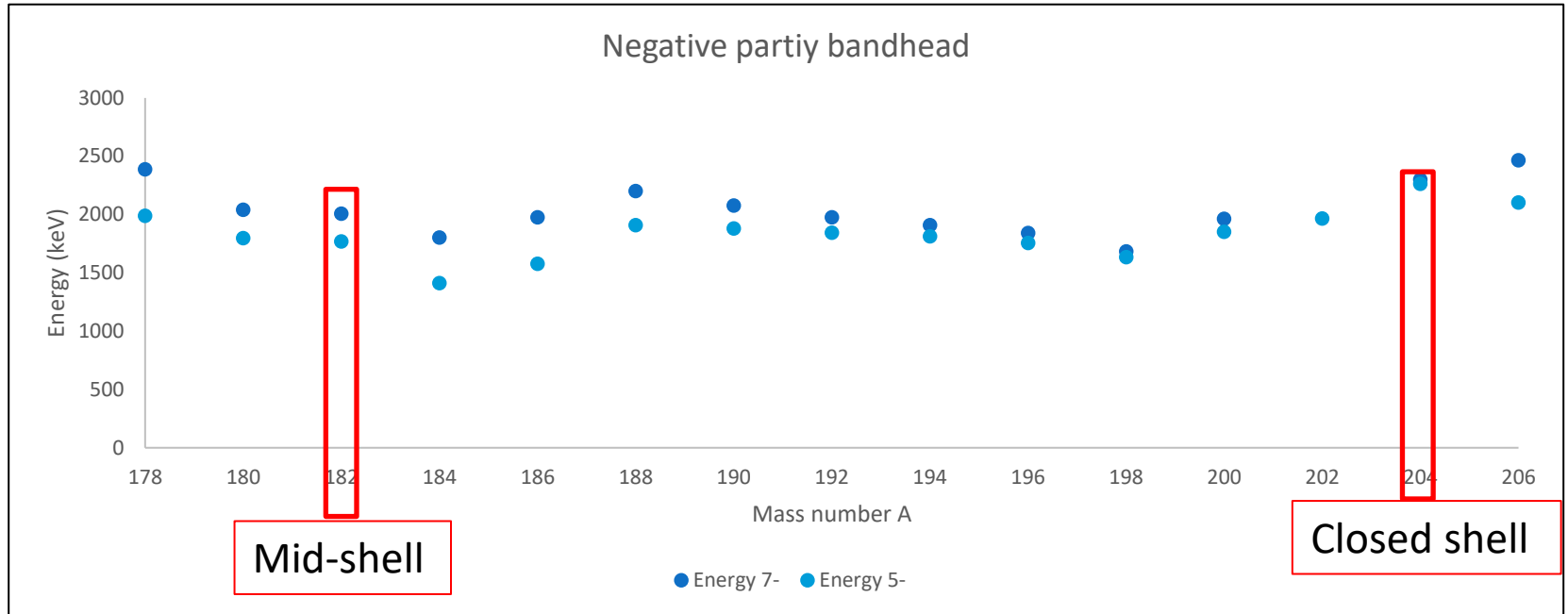
Simon Fraser University, Canada



and the other members of the GRIFFIN collaboration

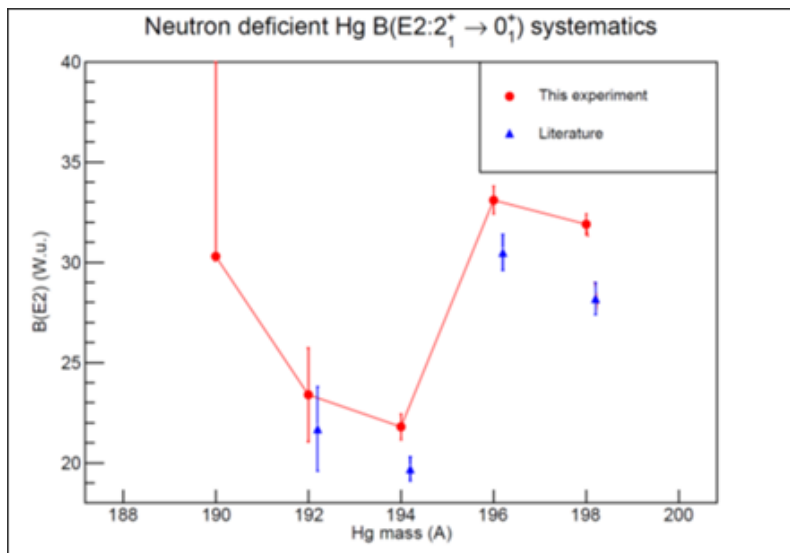
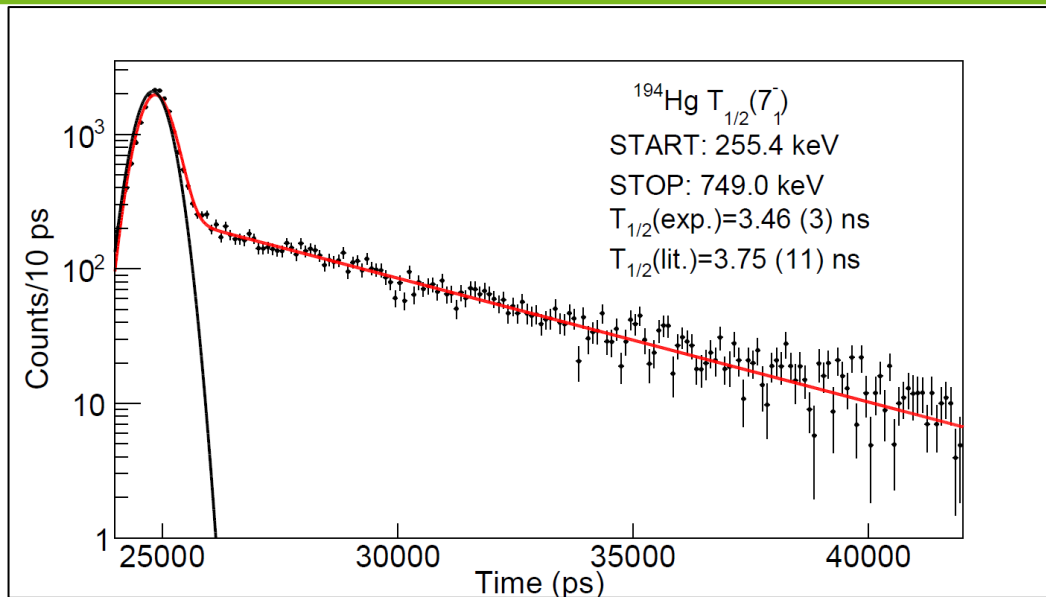


Negative parity band



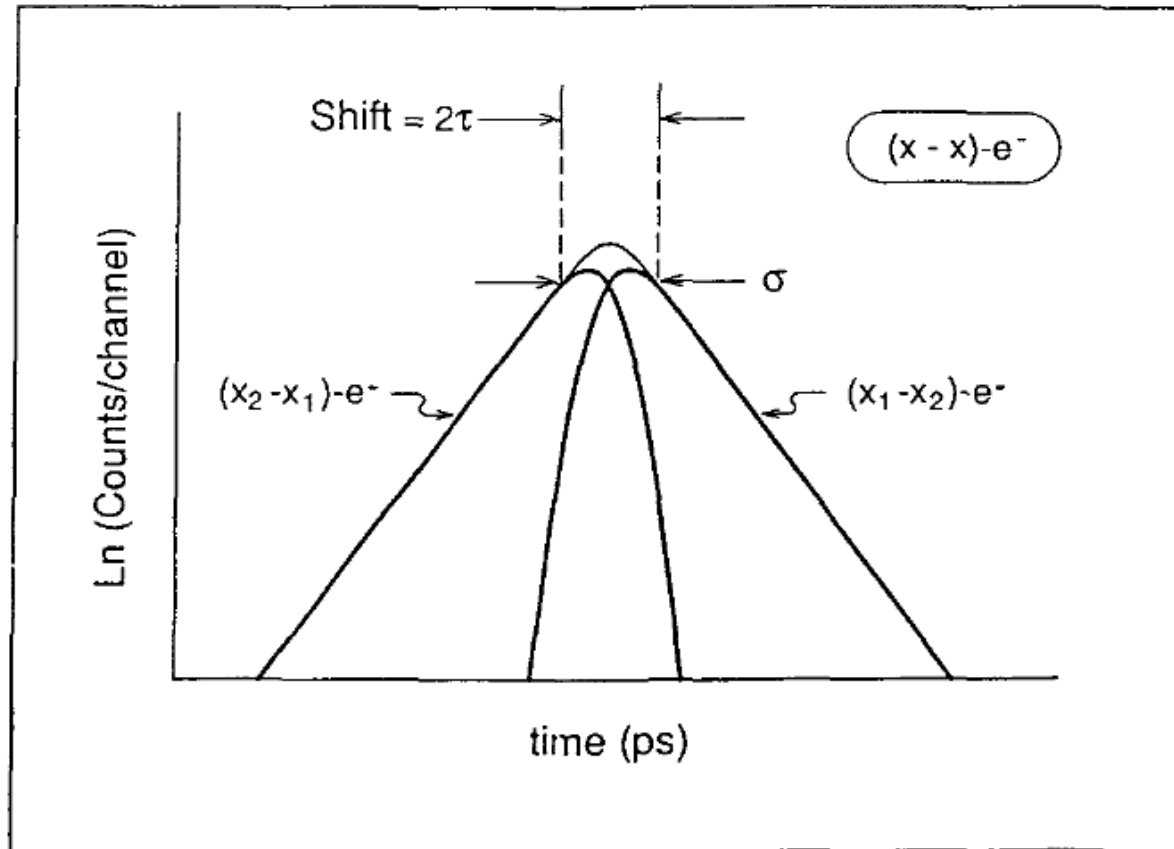
- Negative parity band interpreted as an oblate rotor + 2 quasiparticles
- One particle is occupying the $\pi h_{11/2}$ or $\nu i_{13/2}$ orbitals
- The other particle has low spin from the pf shell

B(E2;7- → 5-)



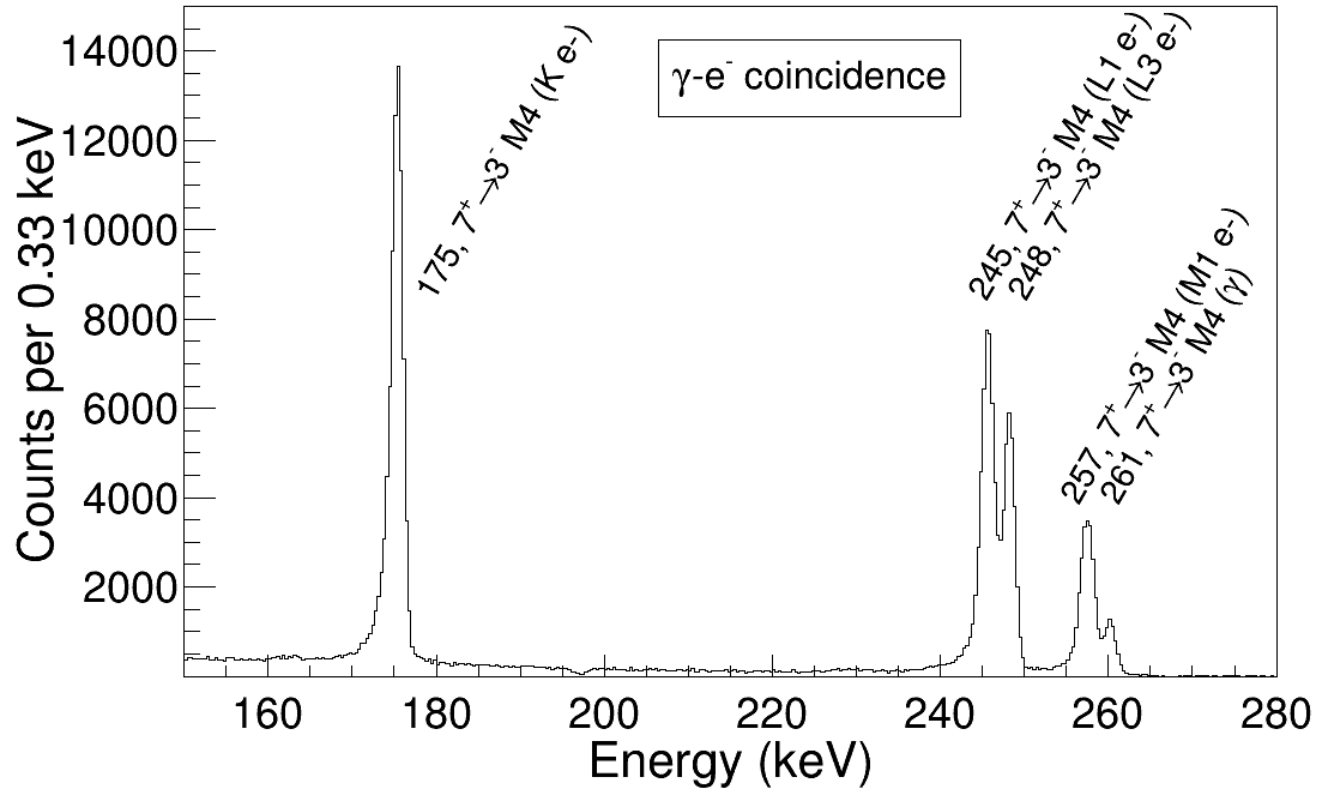
- Negative parity band
- Poor agreement with literature
- No easy physical interpretation

Joshi et al timing



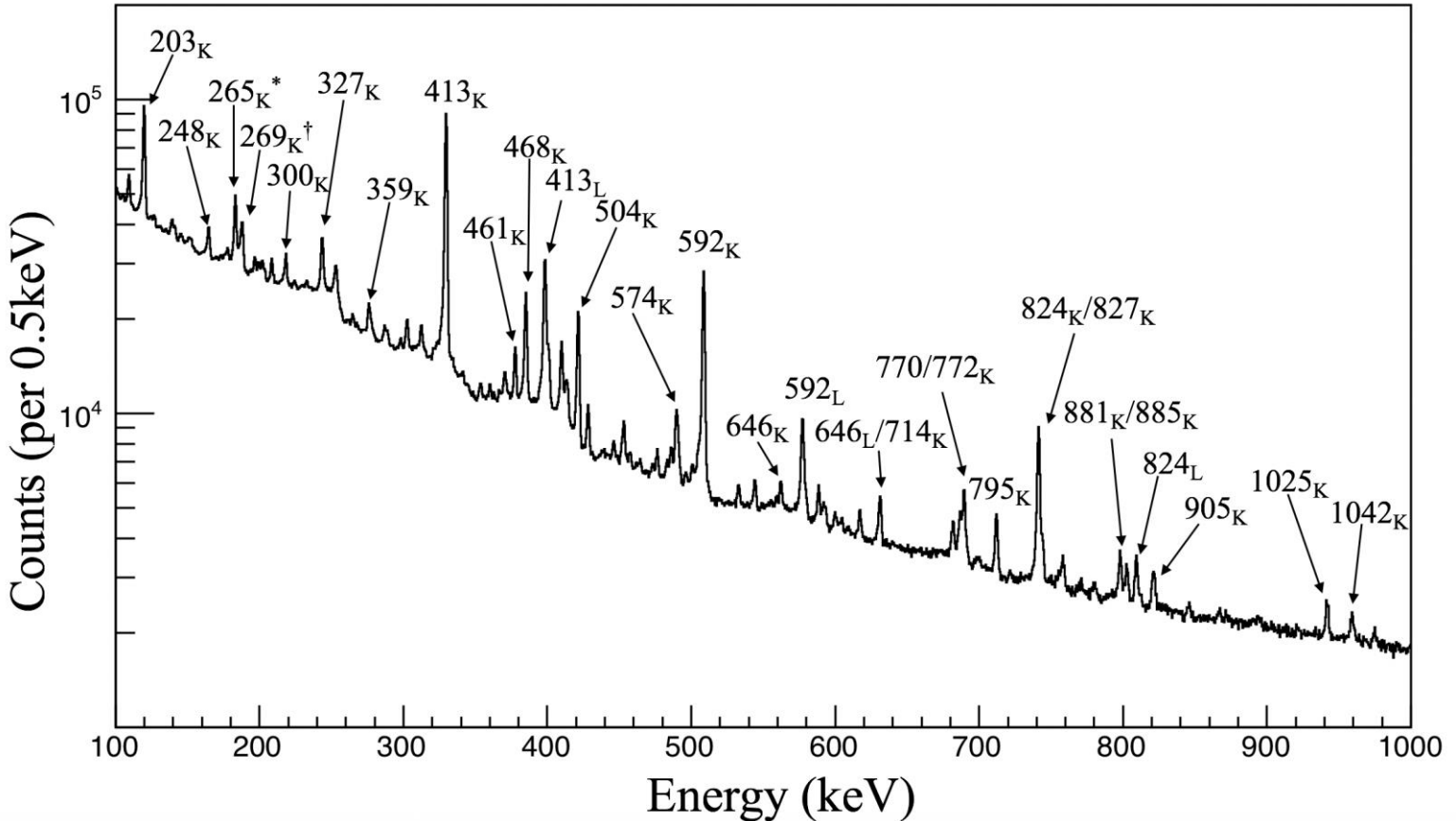
- Gate on x-rays
- Lifetime from widening of time distribution

Electron spectroscopy



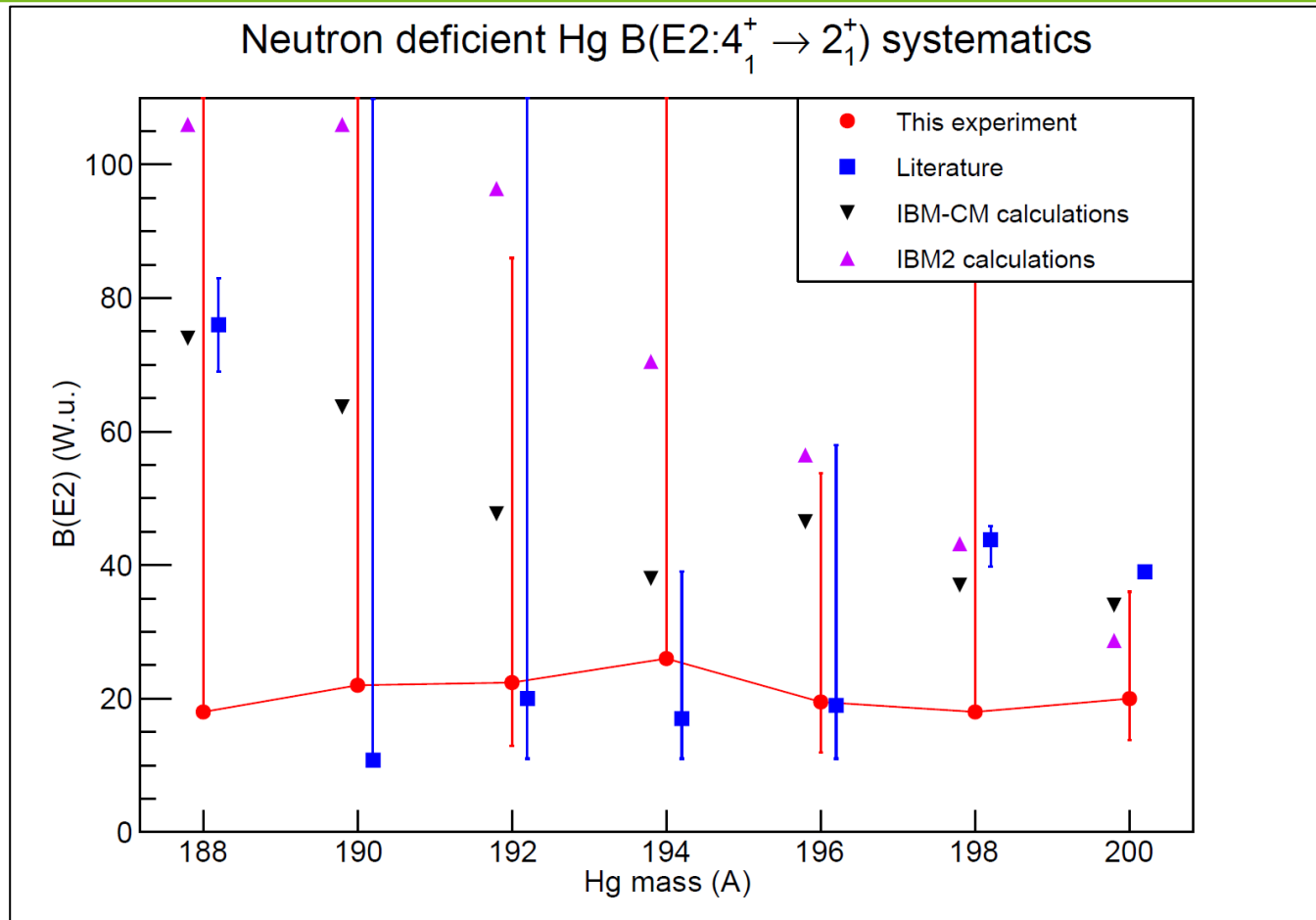
^{198}Tl ($7^+ \rightarrow 3^-$) internal decay

PACES spectrum



● Electron spectroscopy ^{188}Hg

B(E2;4+ \rightarrow 2+)



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