Coulomb excitation of ^{184,186,188}Hg

Nick Bree & Andrew Petts

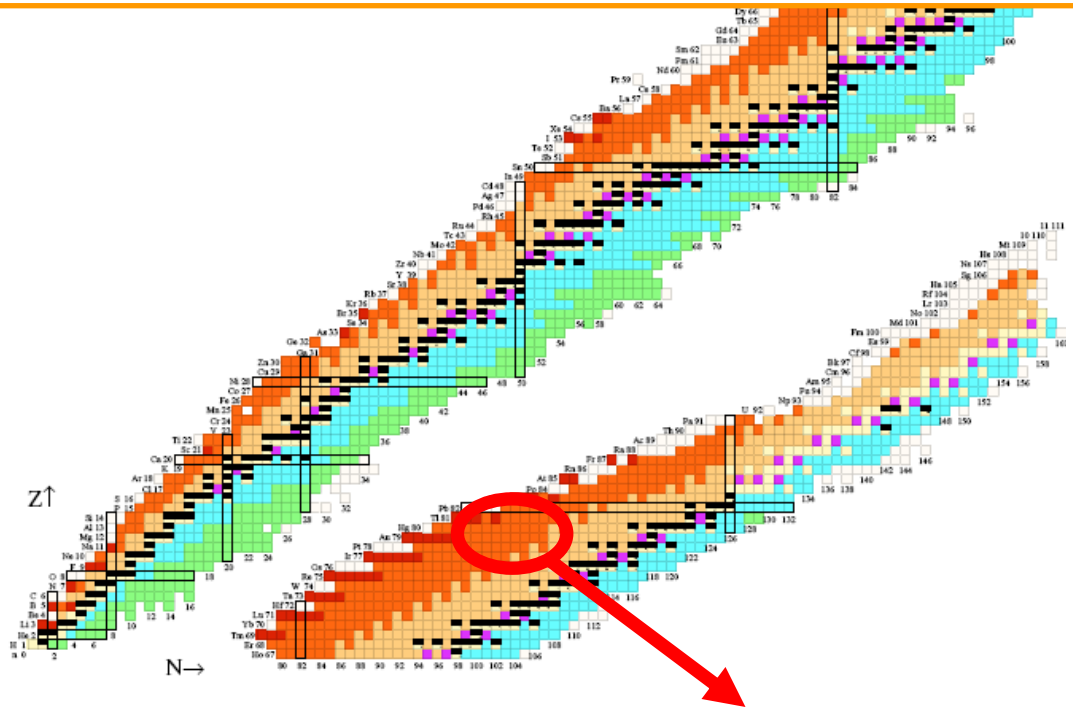
Katholieke Universiteit Leuven & University of Liverpool

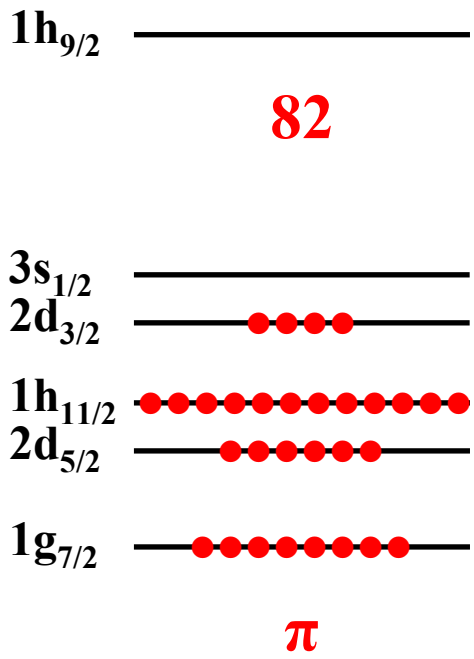
P.A. Butler, J. Cederkäll, E. Clement, T.E. Cocolios, L. Fraile, T. Grahn, M. Guttormsen, K. Hadynska, R.-D. Herzberg, M. Huyse, D.G. Jenkins, R. Julin, S. Knapen, Th. Kroell, R. Krücken, A.C. Larsen, P. Marley, P.J. Napiorkowski, J. Pakarinen, N. Patronis, P.J. Peura, E. Piselli, M. Scheck, S. Siem, I. Stefanescu, J. Van de Walle, P. Van Duppen, D. Voulot, F. Wenander and M. Zielinska

Content

- Motivation: shape coexistence
- Experimental set-up
- Shape measurements by Coulomb excitation
- Preliminary experimental results
- Conclusion and outlook

Coulex of ^{184,186,188}Hg: Motivation

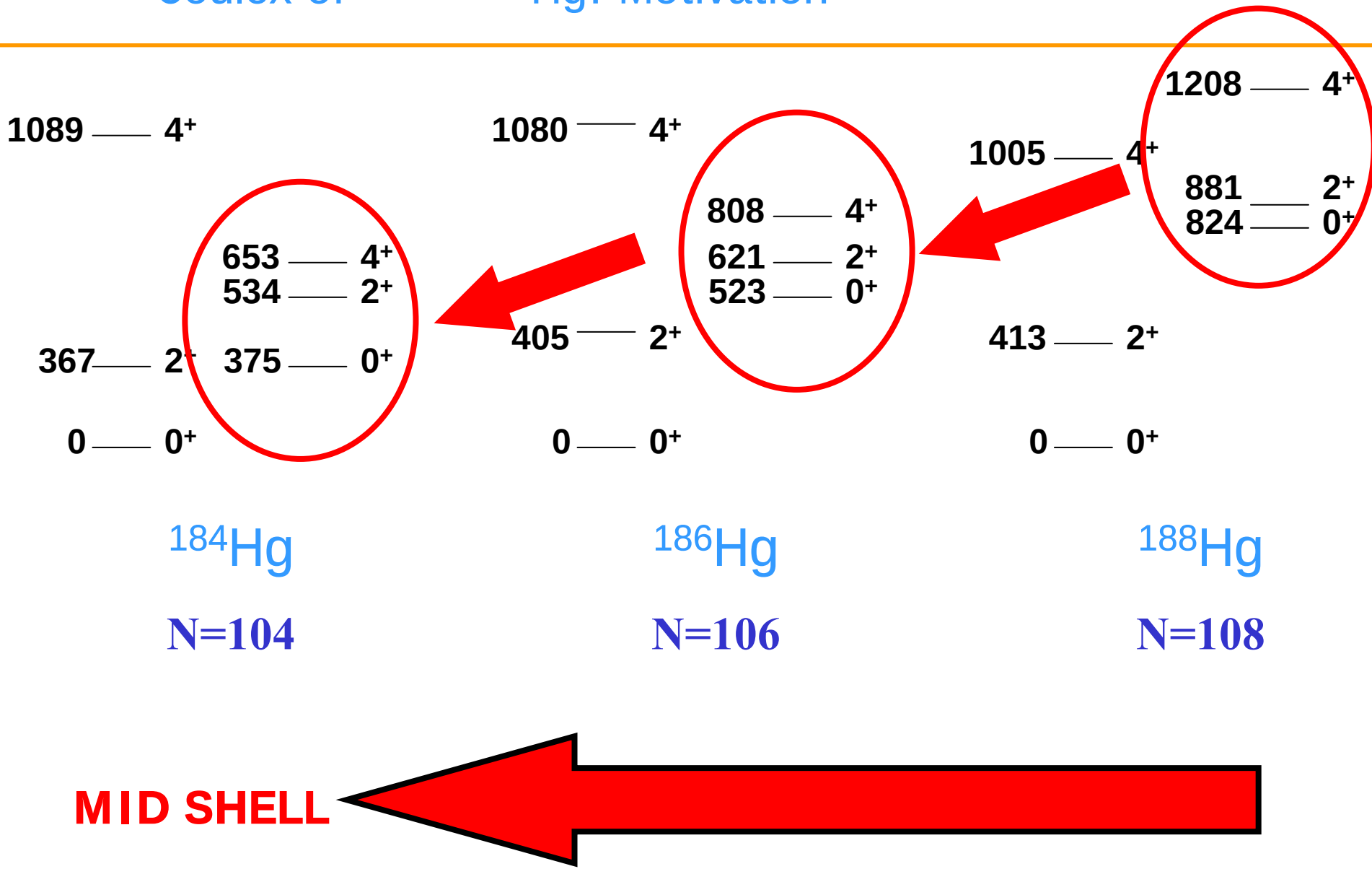




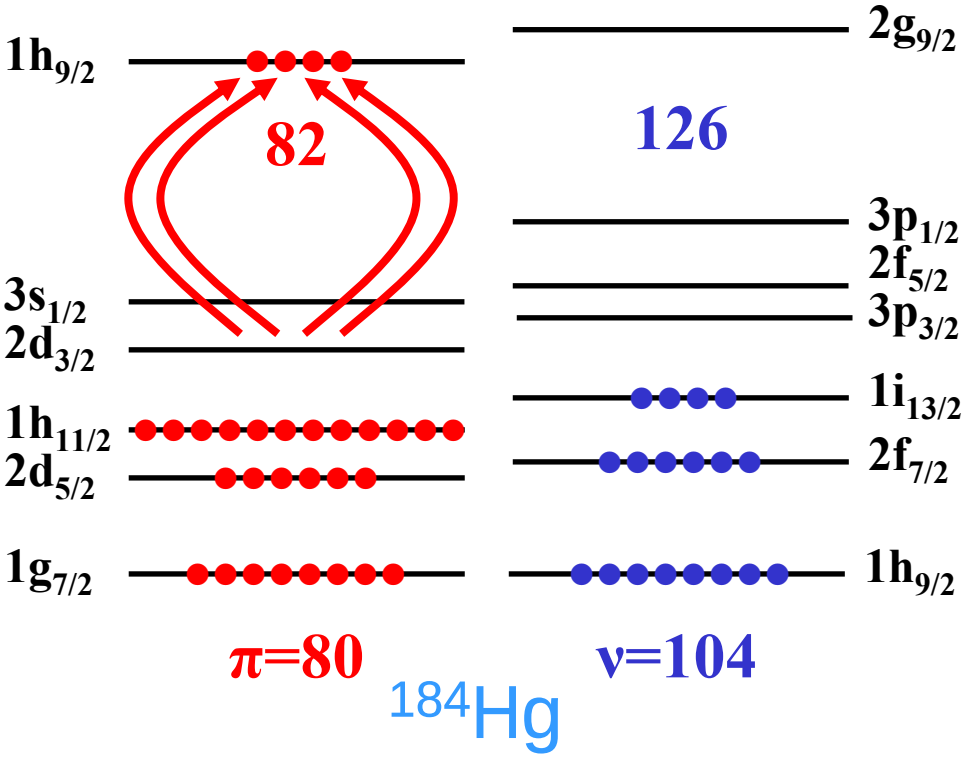
Z = 82

Pb182 55 ms 0+ α	Pb183 300 ms (1/2-) EC,α	Pb184 0.55 s 0+ α	Pb185 4.1 s α	Pb186 4.79 s 0+ α	Pb187 18.3 s (13/2+) EC,α	Pb188 24.2 s 0+ EC,α	Pb189 51 s EC,α	Pb190 1.2 m 0+ EC,α	Pb191 1.33 m EC,α	Pb192 3.5 m 0+ EC,α	Pb193 (3/2-) EC	Pb194 12.0 m 0+ EC,α
Hg181 3.1 s (7+) EC,α	Hg182 (1/2+)	Hg183 11 s EC,α	Hg184 19.5 s (1/2+) EC	Hg185 27.5 s (7+) EC,α	Hg186 51 s (1/2+) EC,α	Hg187 71 s (2-) EC	Hg188 2.3 m (1/2+) EC	Hg189 2.6 m (2)- EC	Hg190 (1/2+)	Hg191 9.6 m (2-) EC	Hg192 21.6 m 1/2(+) EC	
Hg180 2.8 s 0+ EC,α	Hg181 3.6 s 1/2(-) α,ECp,...	Hg182 10.83 s 0+ EC,α	Hg183 9.4 1/2 α,ECp,...	Hg184 30.6 s 0+ EC,α	Hg185 49 s 1/2- EC,α	Hg186 1.38 m 0+ EC,α	Hg187 2.4 13/2 EC,α	Hg188 3.25 m 0+ EC,α	Hg189 7.6 m 3/2- EC,α	Hg190 20.0 m 0+ EC,α	Hg191 49 m (3/2-) EC	Hg192 4.85 h 0+ EC,α
Au179 7.1 s EC,α	Au180 8.1 s EC,α	Au181 11.4 s 5/2- EC,α	Au182 21 s EC,α	Au183 42.0 s (5/2)- EC,α	Au184 53.0 s 3+ EC,α	Au185 4.3 m 5/2- EC,α	Au186 10.7 m 3- EC	Au187 8.4 m 1/2+ EC,α	Au188 8.84 m 1(-) EC	Au189 28.7 m 1/2+ EC,α	Au190 42.8 m 1- EC,α	Au191 3.18 h 3/2+ EC
Pt178 21.1 s 0+ EC,α	Pt179 21.2 s 1/2- EC,α	Pt180 52 s 0+ EC,α	Pt181 51 s 1/2- EC,α	Pt182 2.6 m 0+ EC,α	Pt183 6.5 m 1/2- EC,α	Pt184 17.3 m 0+ EC,α	Pt185 70.9 m 9/2+ EC,α	Pt186 2.0 h 0+ EC,α	Pt187 2.35 h 3/2- EC	Pt188 10.2 d 0+ EC,α	Pt189 10.87 h 3/2- EC	Pt190 6.5E11 y 0+ α 0.01

Coulex of ^{184,186,188}Hg: Motivation



Coulex of ^{184,186,188}Hg: Motivation



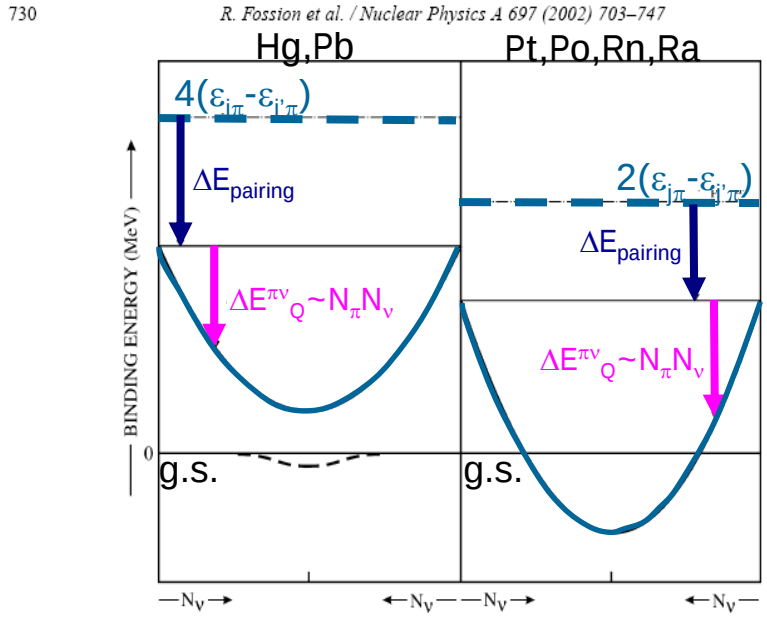


Fig. 13. Schematic representation of the effect of configuration mixing on the binding energy, plotting the different contributions separately. On the left, it is assume that regular and intruder states seat far in energy. On the right, it is assume that the regular and intruder states cross.

$$E^*_{intruder}(4p\text{-}6h) = 4(\varepsilon_{j\pi} - \varepsilon_{j'\pi}) - \Delta E^{\pi\pi}_{pair} + \Delta E^{\pi\nu}_{M} - \Delta E^{\pi\nu}_{Q}$$

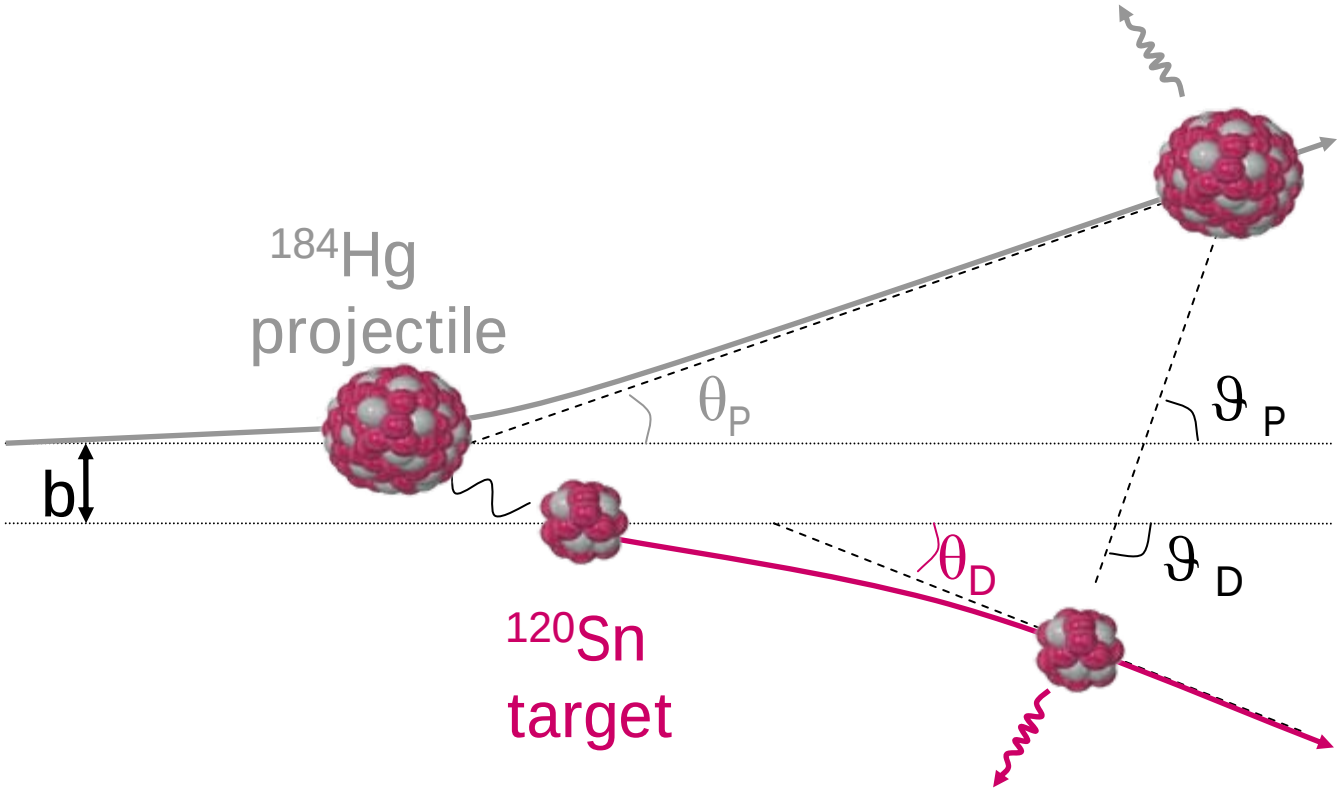
K. Heyde et al, Nucl. Phys. A 466, 189 (1987)

Slightly oblate ground state band

Prolate band

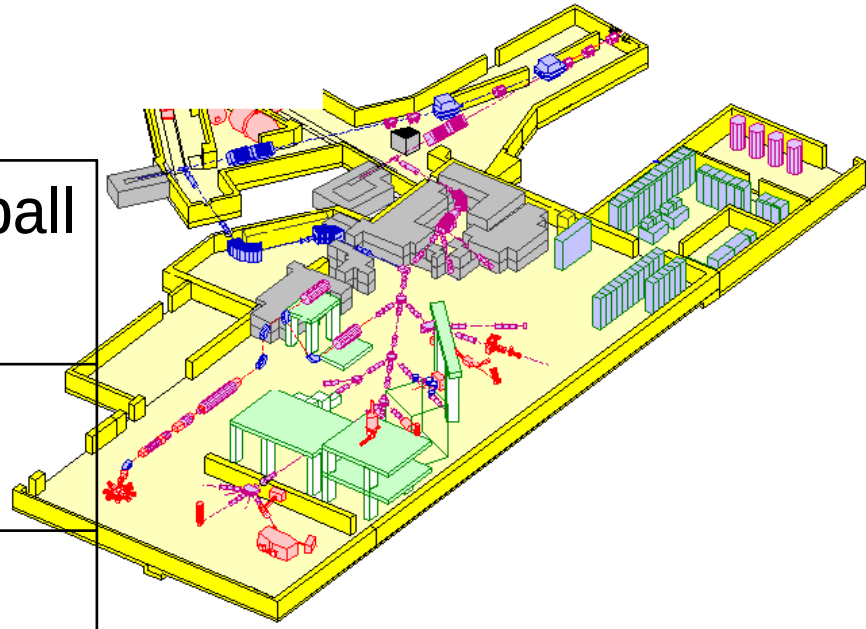
SHAPE COEXISTENCE

Coulex of ^{184,186,188}Hg: Experimental set-up



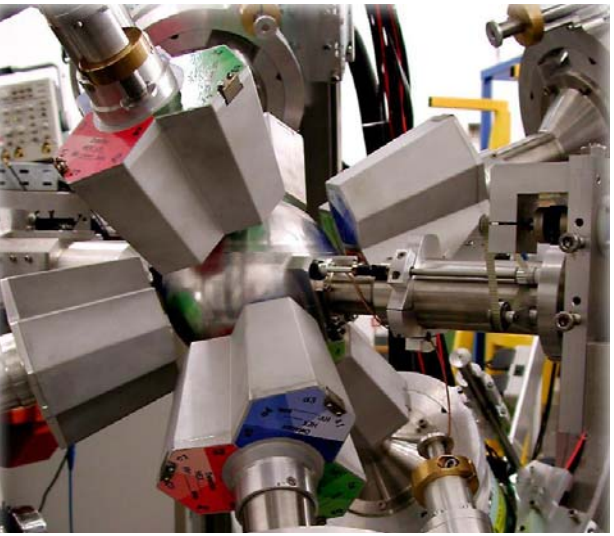
Coulex of ^{184,186,188}Hg: Experimental set-up

Isotope	Charge state	Intensity@Miniball
^{184}Hg	43+	1000 pps
^{186}Hg	43+	2.0 x 10^5 pps
^{188}Hg	44+	2.5 x 10^5 pps

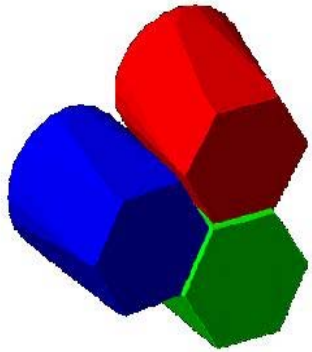


All 3 isotopes were post-accelerated by REX to 2.85 MeV/u.

Coulex of ^{184,186,188}Hg: Experimental set-up

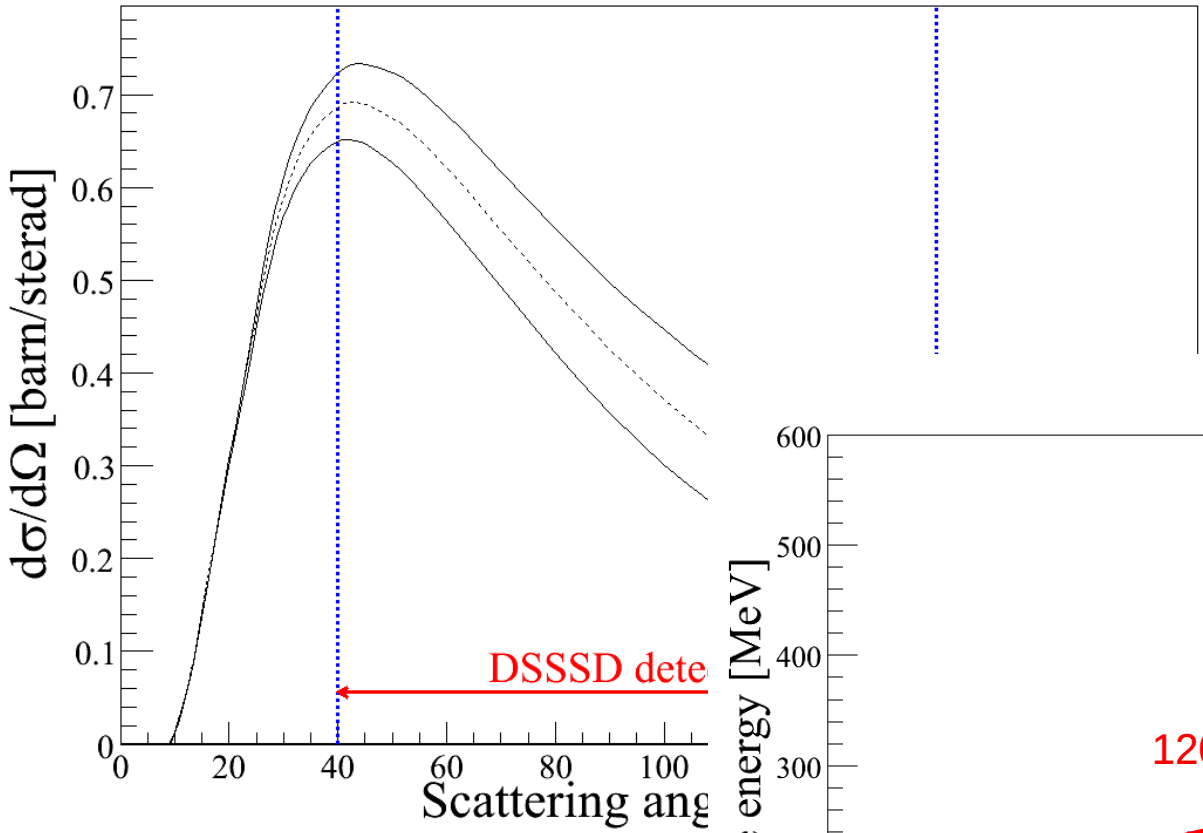


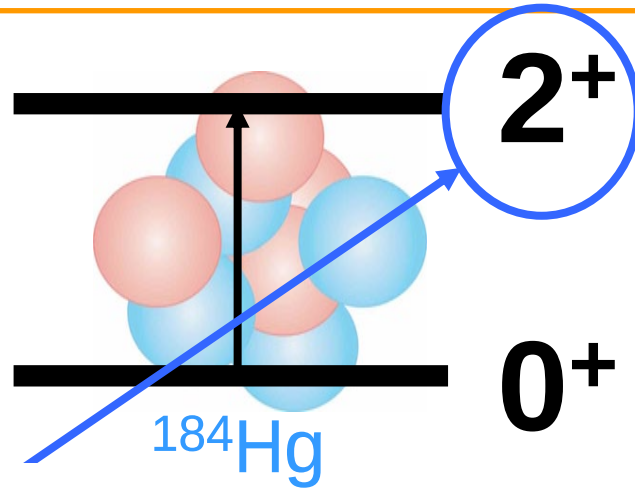
Miniball

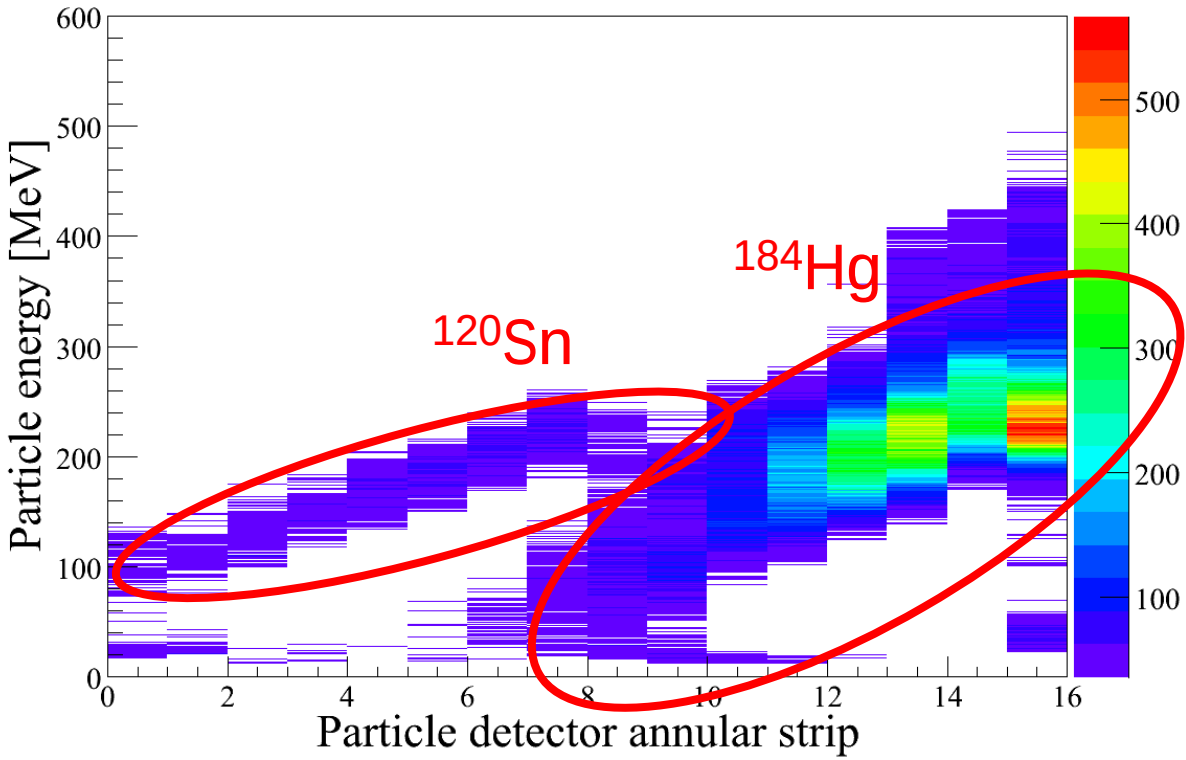


- Doppler shift in the gamma energy!

Coulex of ^{184,186,188}Hg: Shape measurements



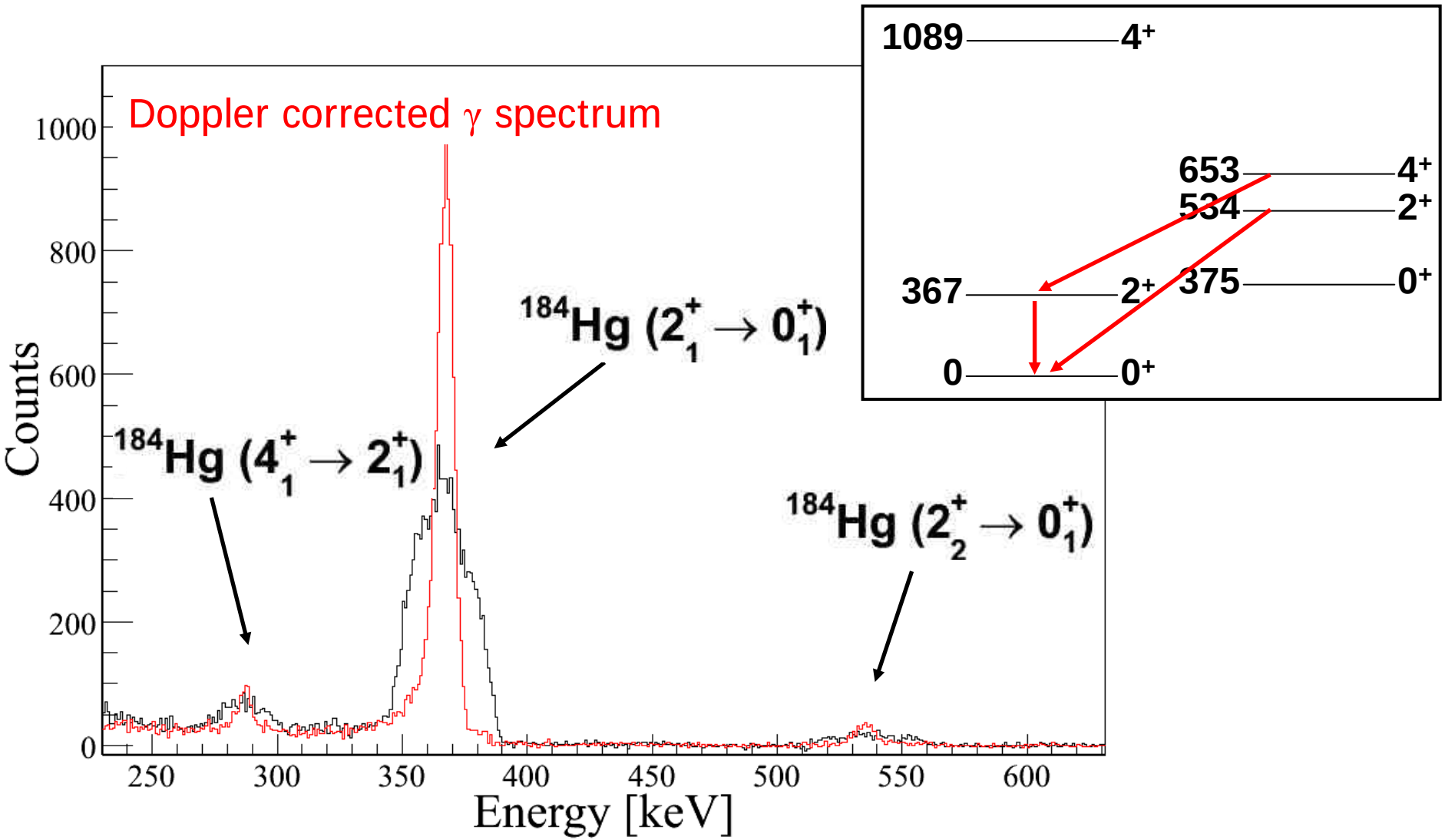




Since the B(E2) value
quadrupole moment c
calculating the excitat
the detected γ photo

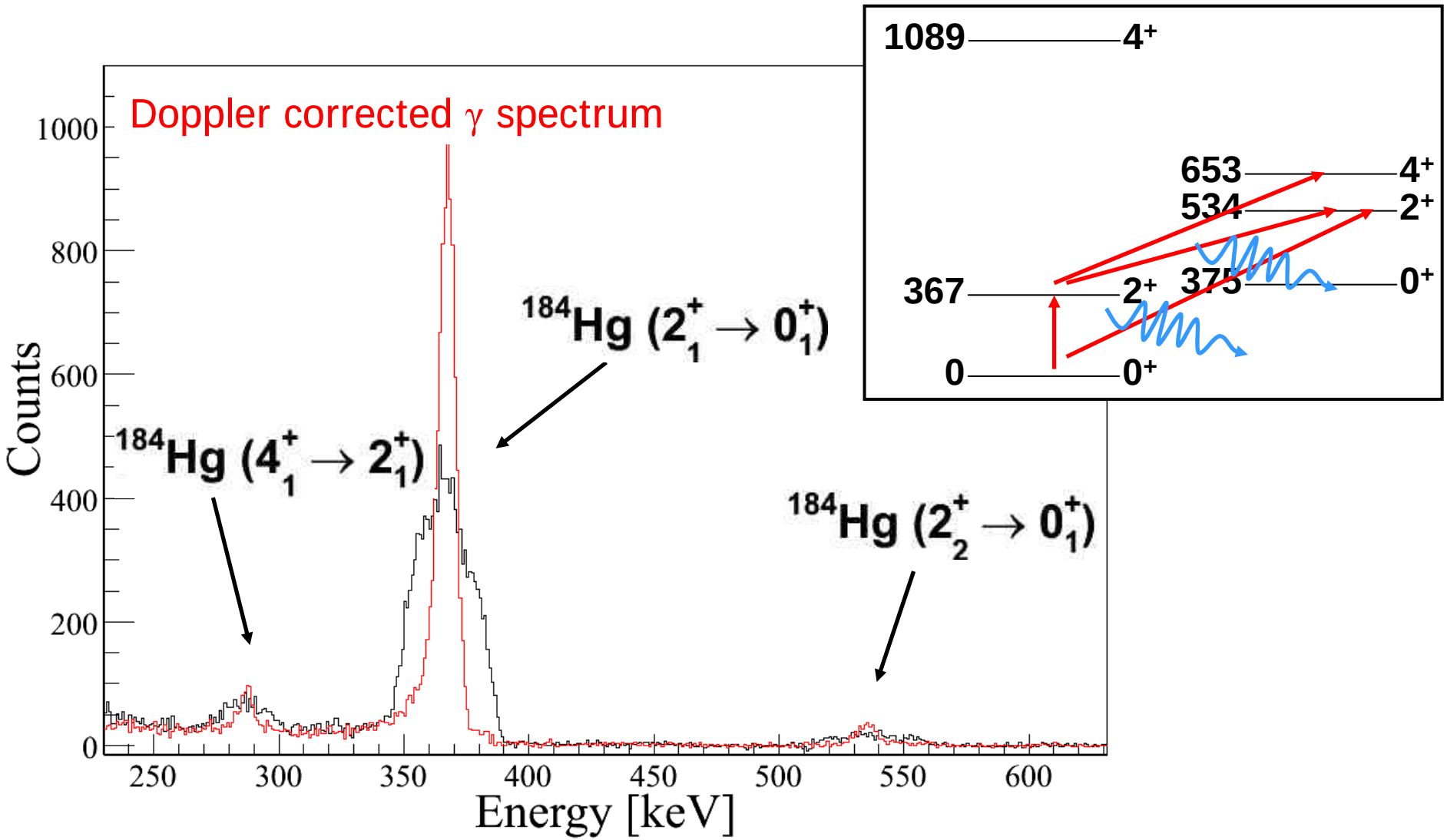
Coulex of ^{184,186,188}Hg: Preliminary experimental results

In August 2007 a Coulomb excitation experiment was performed on the neutron deficient ^{184,186,188}Hg isotopes.



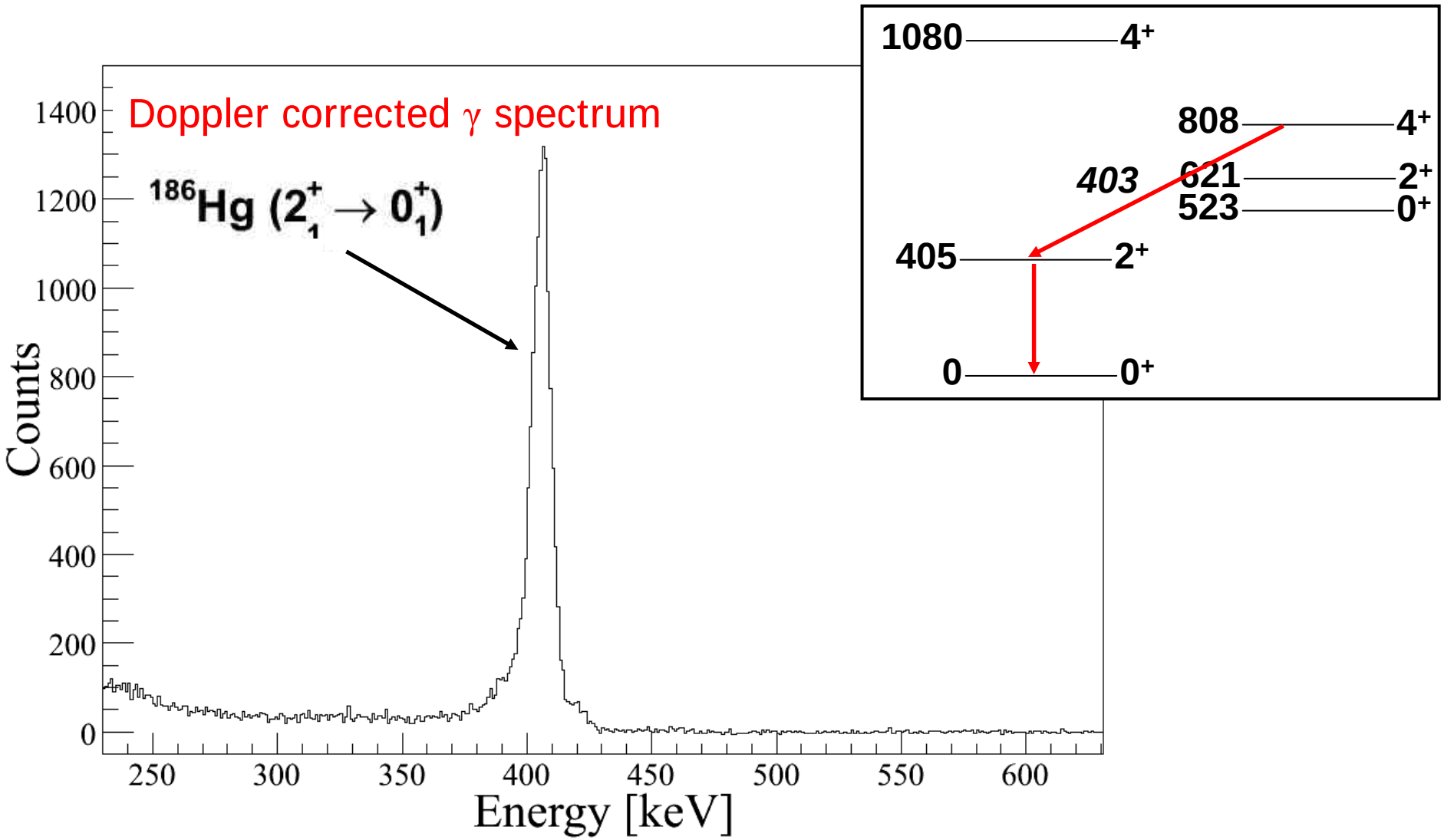
Coulex of ^{184,186,188}Hg: Preliminary experimental results

In August 2007 a Coulomb excitation experiment was performed on the neutron deficient ^{184,186,188}Hg isotopes.



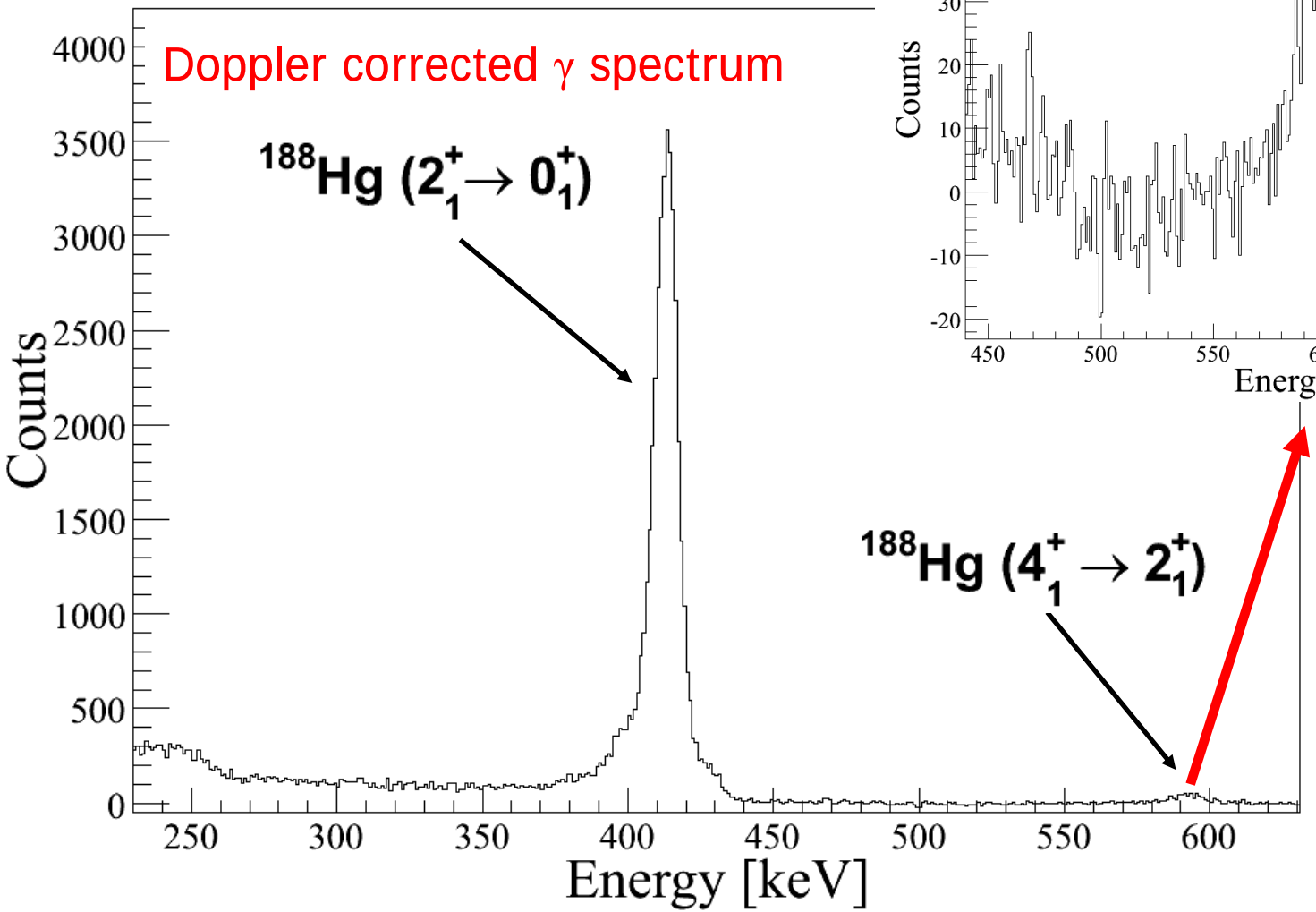
Coulex of ^{184,186,188}Hg: Preliminary experimental results

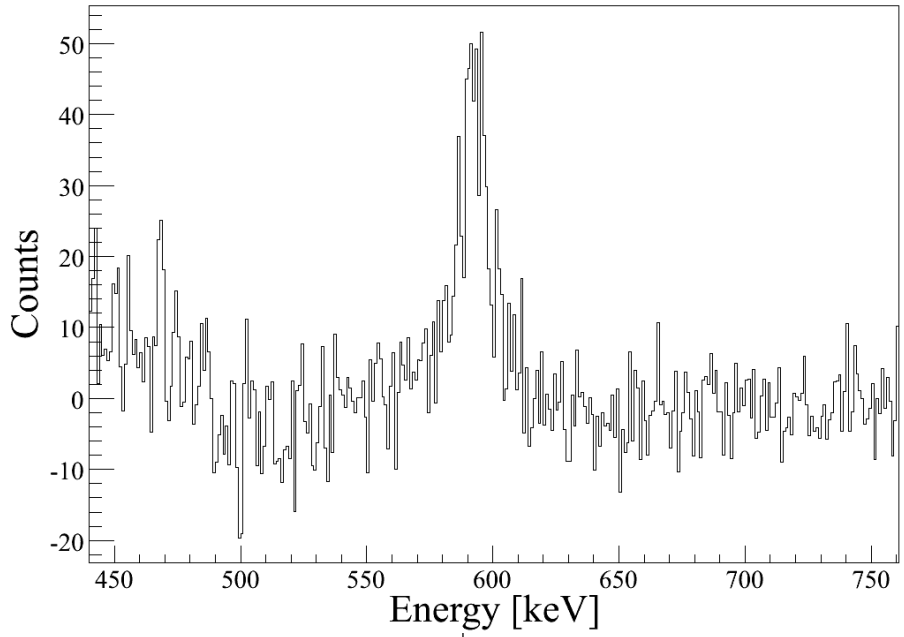
In August 2007 a Coulomb excitation experiment was performed on the neutron deficient ^{184,186,188}Hg isotopes.



Coulex of ^{184,186,188}Hg: Preliminary experimental results

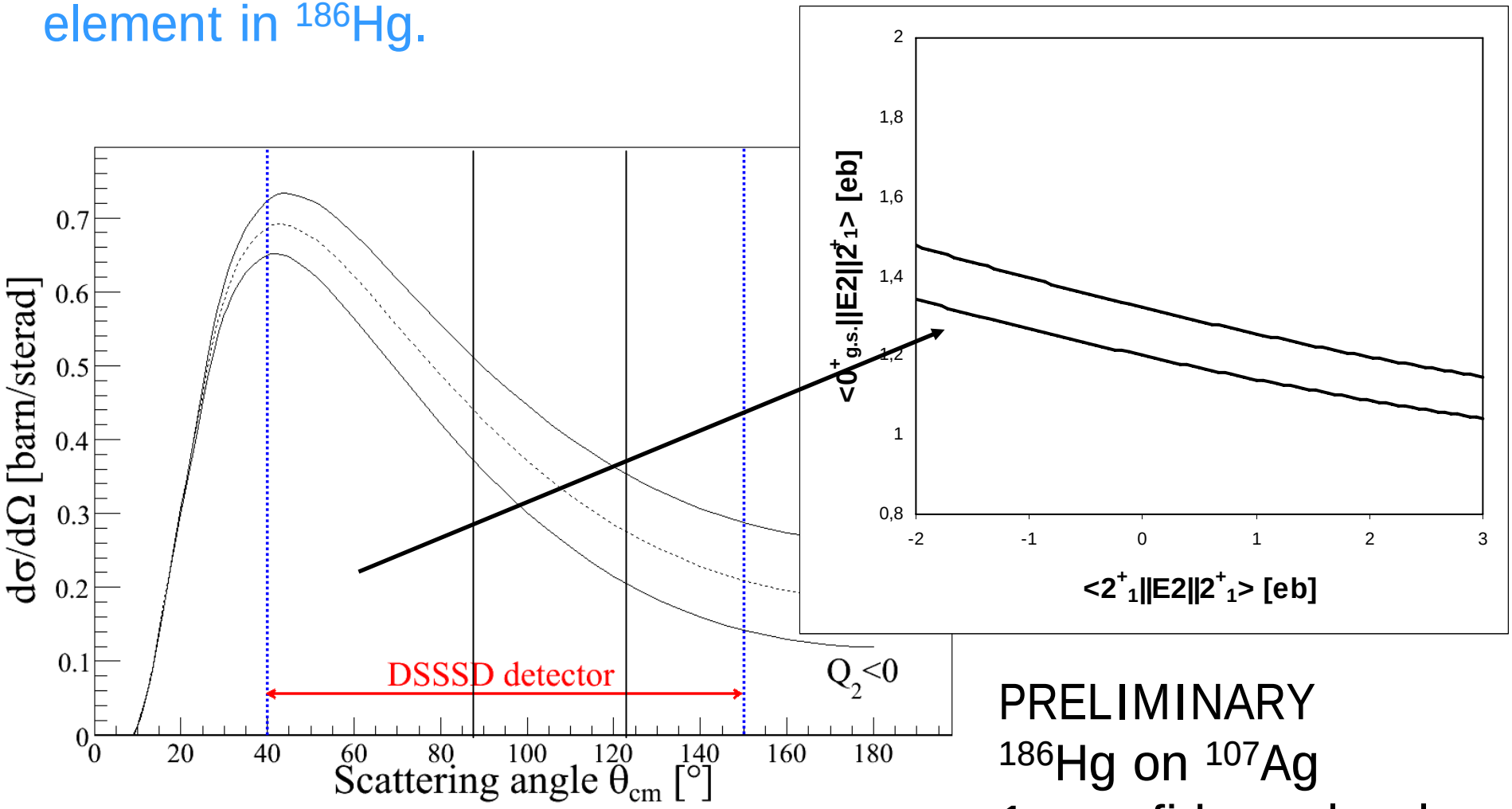
In August 2007 a Coulomb excita
performed on the neutron deficie





Coulex of ^{184,186,188}Hg: Preliminary experimental results

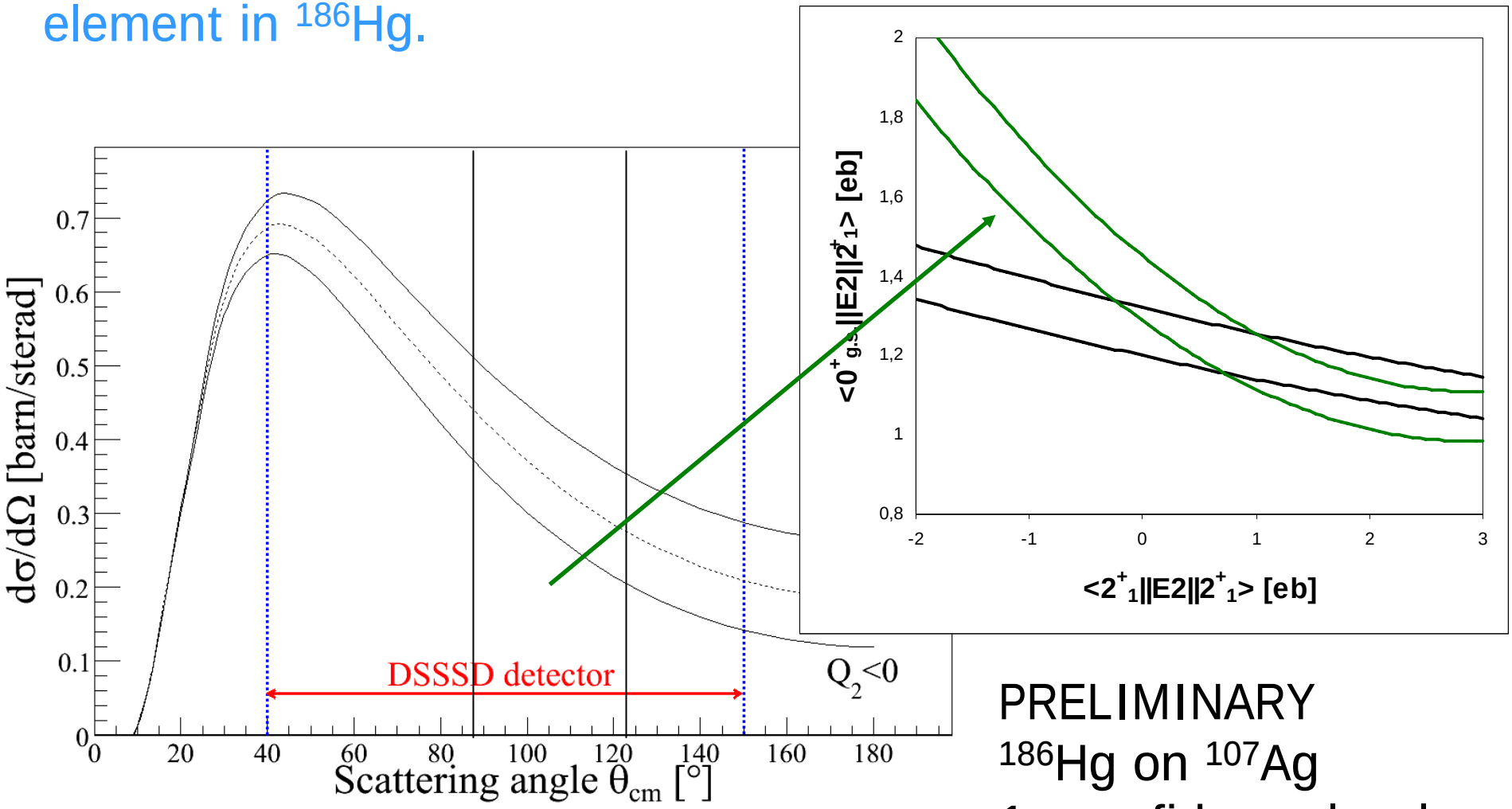
Example: determination of the $<2^+||M(E2)||2^+>$ matrix element in ^{186}Hg.



PRELIMINARY
^{186}Hg on ^{107}Ag
1σ confidence level
no multiple Coulex

Coulex of ^{184,186,188}Hg: Preliminary experimental results

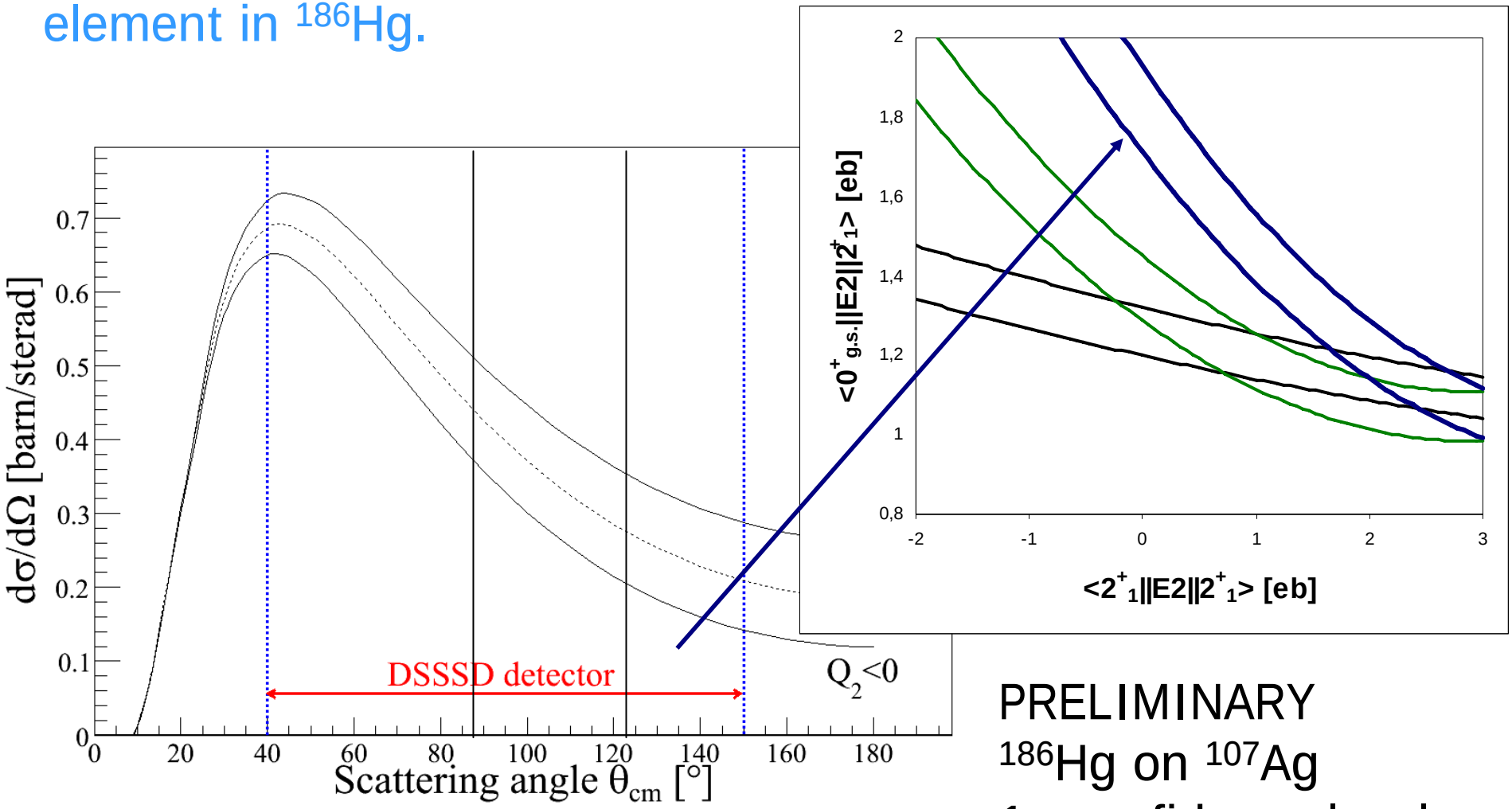
Example: determination of the $<2^+||M(E2)||2^+>$ matrix element in ^{186}Hg.



PRELIMINARY
^{186}Hg on ^{107}Ag
1σ confidence level
no multiple Coulex

Coulex of ^{184,186,188}Hg: Preliminary experimental results

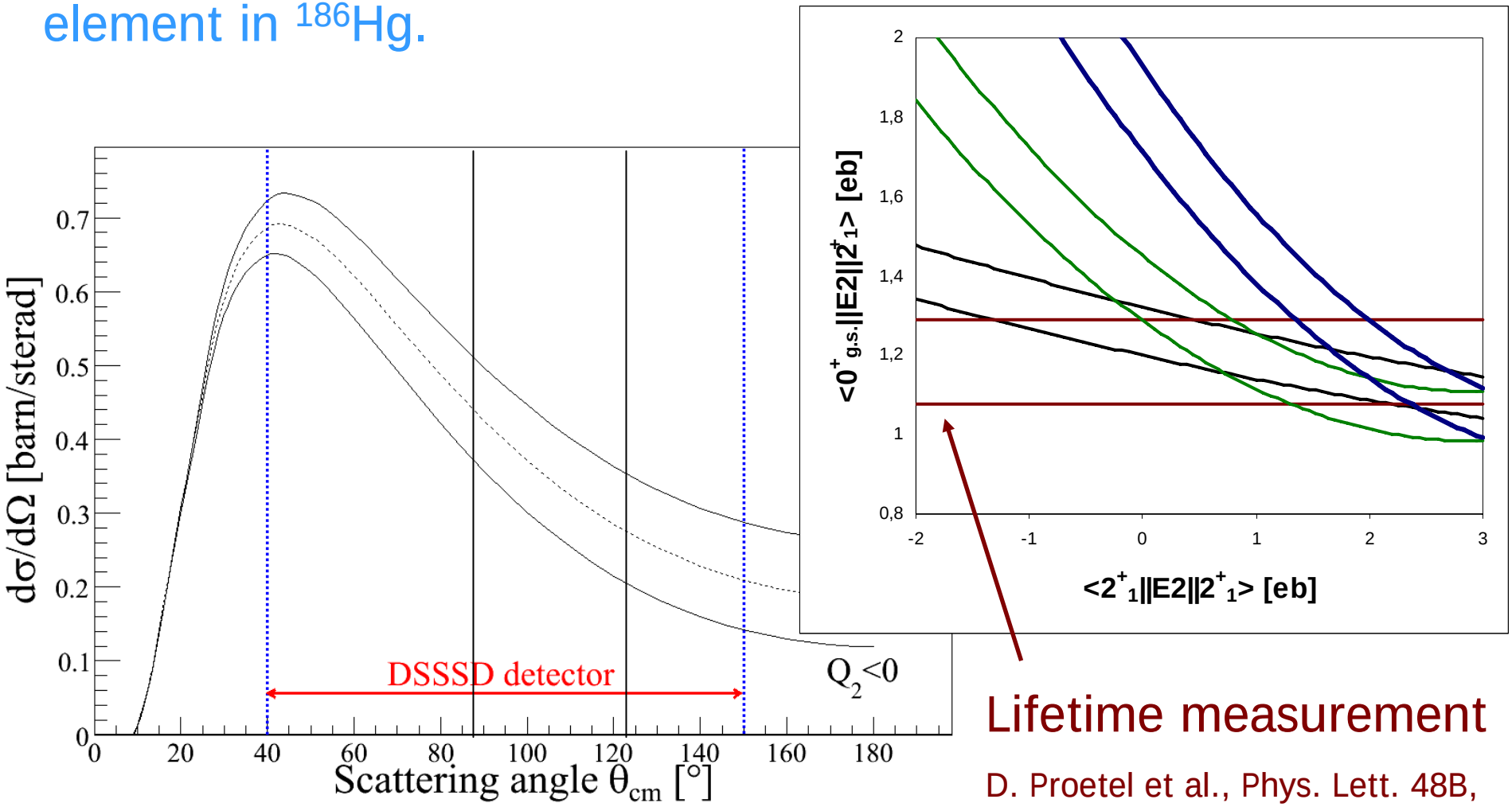
Example: determination of the $<2^+||M(E2)||2^+>$ matrix element in ^{186}Hg.



PRELIMINARY
^{186}Hg on ^{107}Ag
1σ confidence level
no multiple Coulex

Coulex of ^{184,186,188}Hg: Preliminary experimental results

Example: determination of the $<2^+||M(E2)||2^+>$ matrix element in ^{186}Hg.



Lifetime measurement

D. Proetel et al., Phys. Lett. 48B, 102 (1974)

Coulex of ^{184,186,188}Hg: Conclusion and outlook

Conclusions:

The heavy ^{184,186,188}Hg were successfully produced and post-accelerated by REX-ISOLDE.

Apart from the first 2^+ state, also other states have been populated.

The detected γ yields of the photo peaks can be used to extract:

- transitional matrix elements (B(E2) values)
- diagonal matrix elements (quadrupole moments)

This is done by the program GOSIA by fitting the matrix elements to produce the obtained γ yields by a χ^2 minimization. (T. Czosnyka et al, *GOSIA2*)

Coulex of ^{184,186,188}Hg: Conclusion and outlook

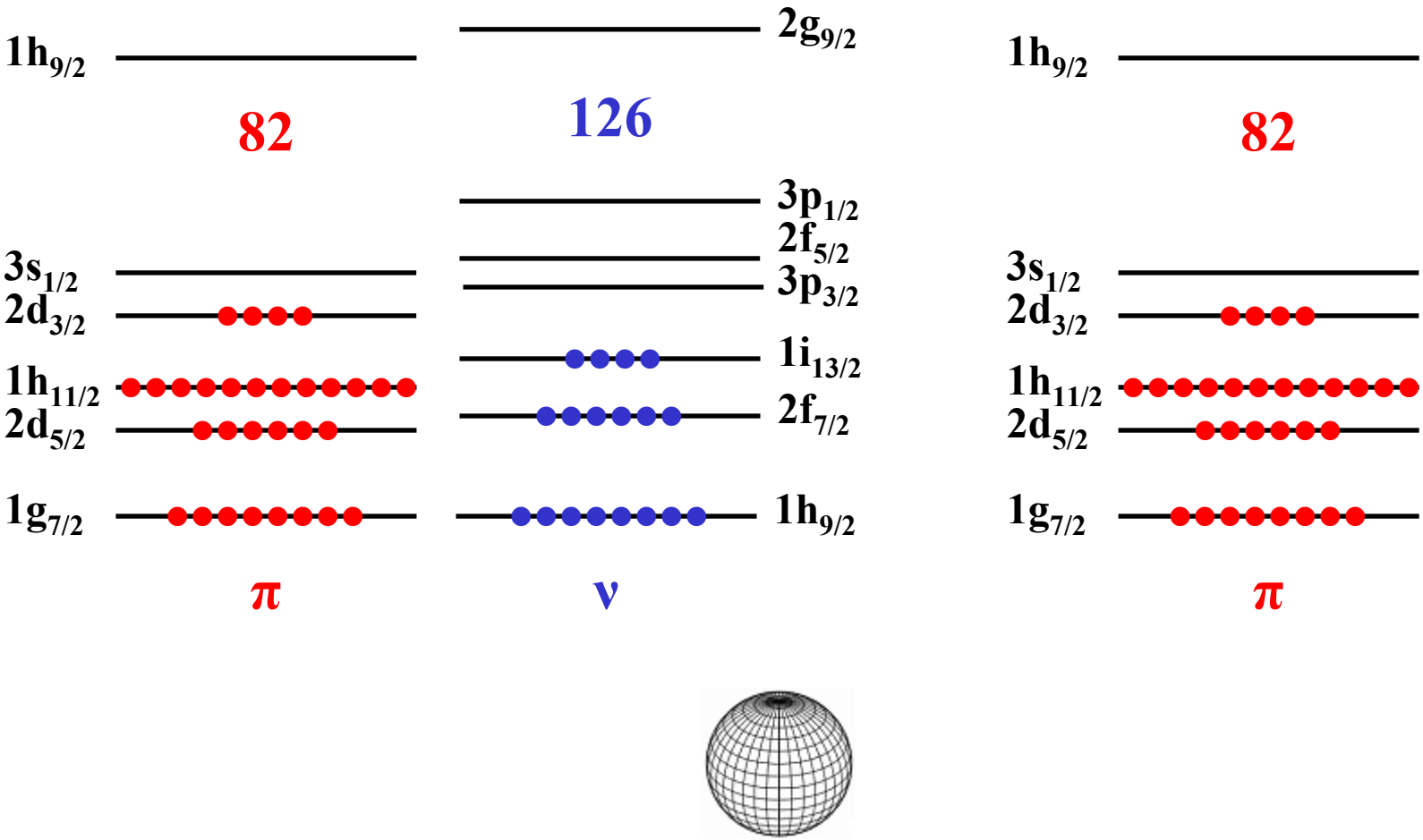
Outlook:

A proposal for a Coulomb excitation experiment on ^{180,182}Hg at REX-ISOLDE has been accepted.

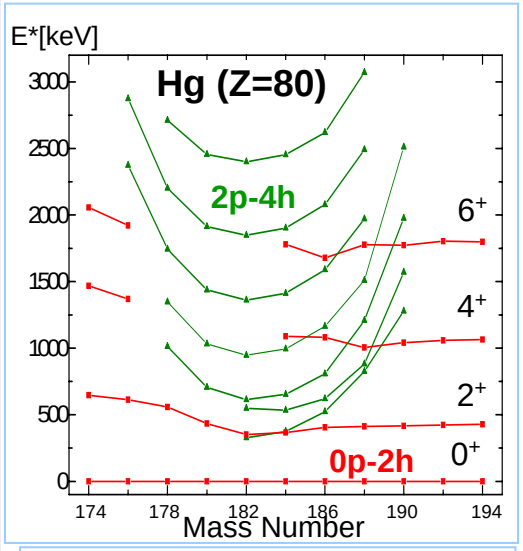
A proposal for lifetime measurements in ^{184,186,188}Hg at Argonne National Laboratory has been submitted.

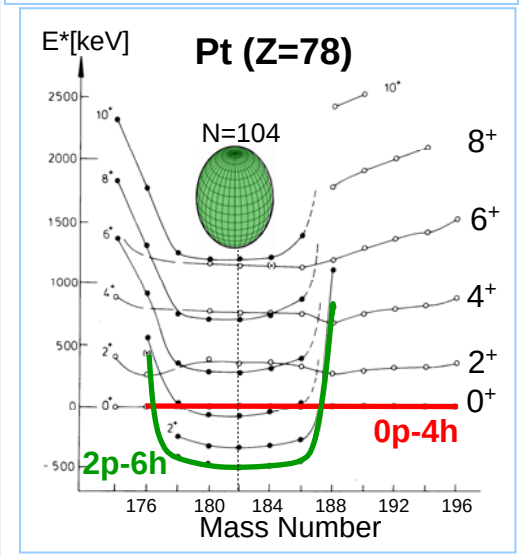
Other experiments aiming at studying this heavy mass region have been proposed (Ra and Rn).

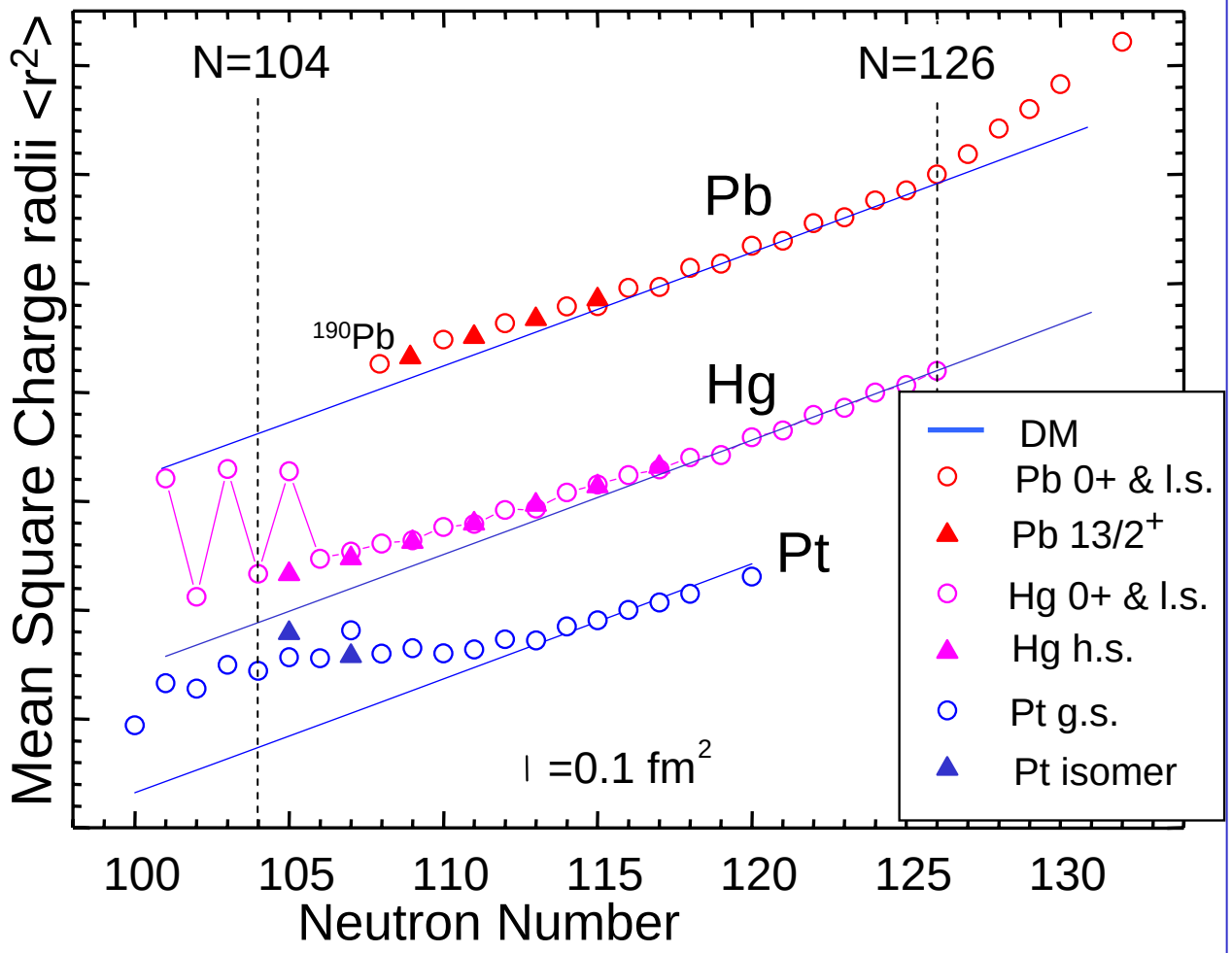
Coulex of ^{68}Ni: Challenges and analysis improvements



existence and $\langle r^2 \rangle$ in the Le

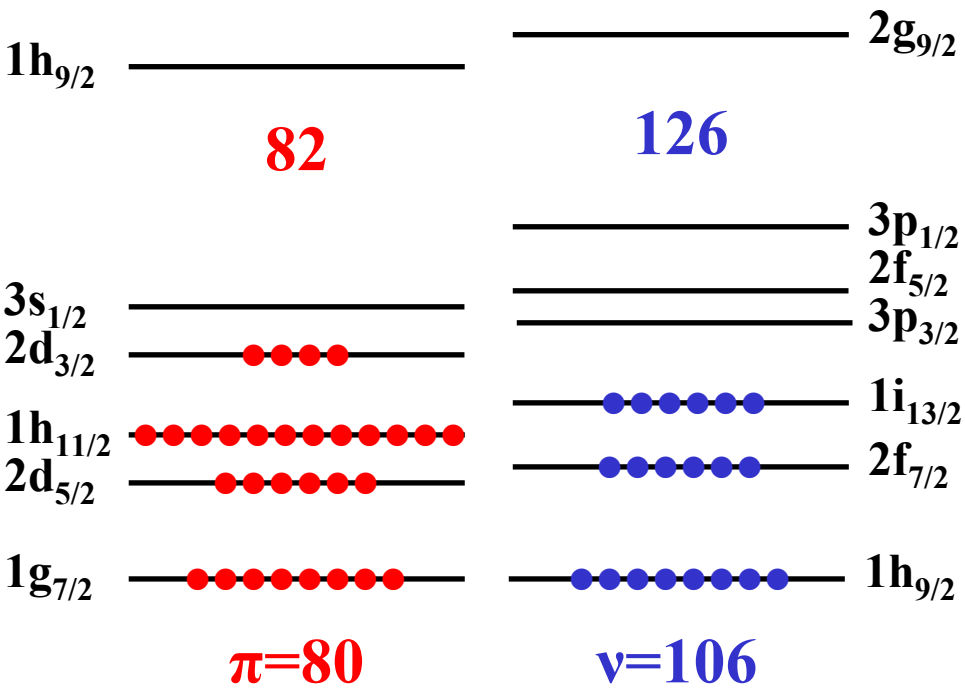




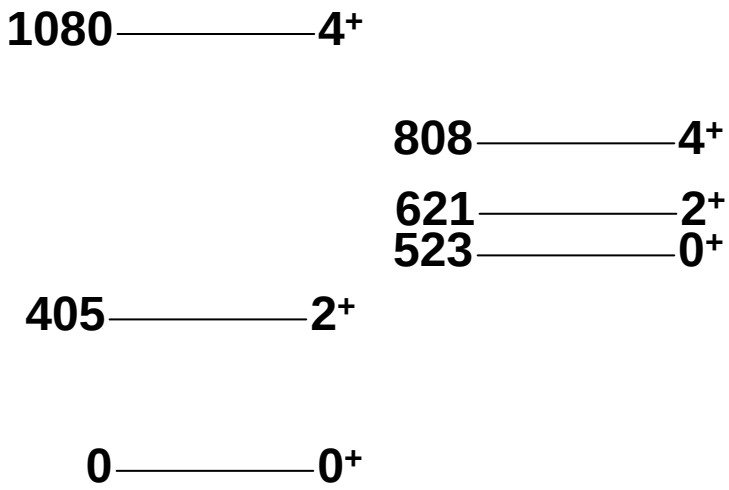


- Influence of intruder states on the $\langle r^2 \rangle$ values in Pt and Hg isotopes
- Evidence for a deviation of the $\langle r^2 \rangle$ values from the DM in Pb's around $^{190\text{-}194}$Pb

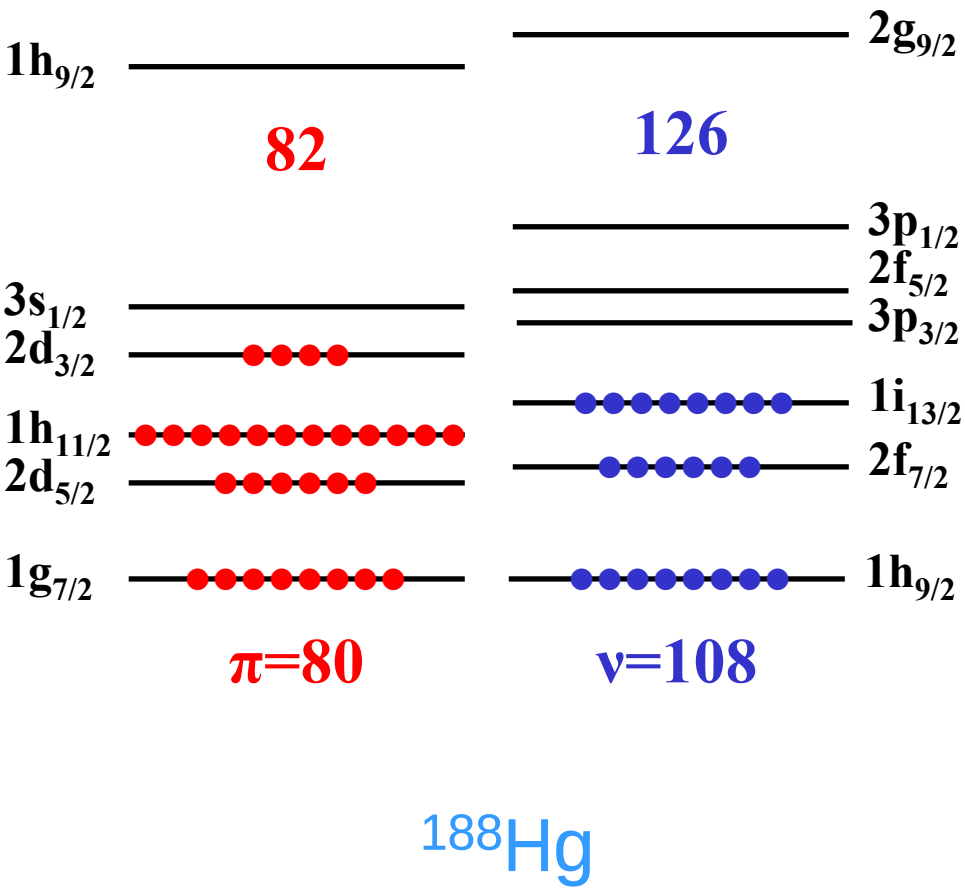
Coulex of ^{184,186,188}Hg: Motivation



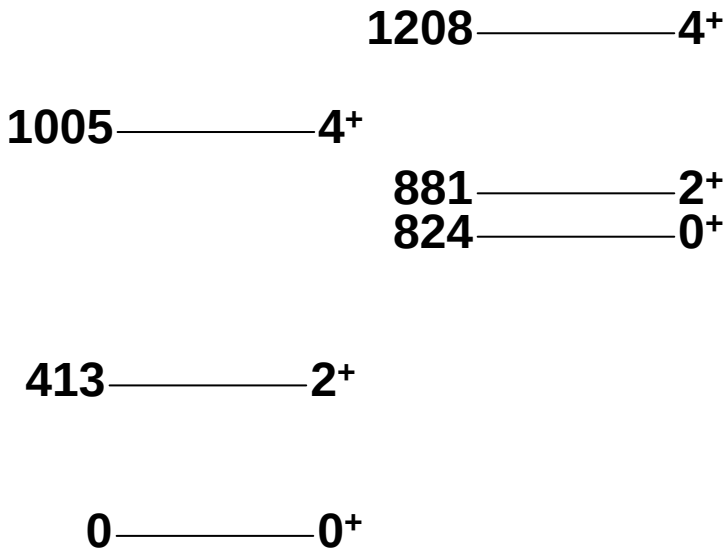
^{186}Hg



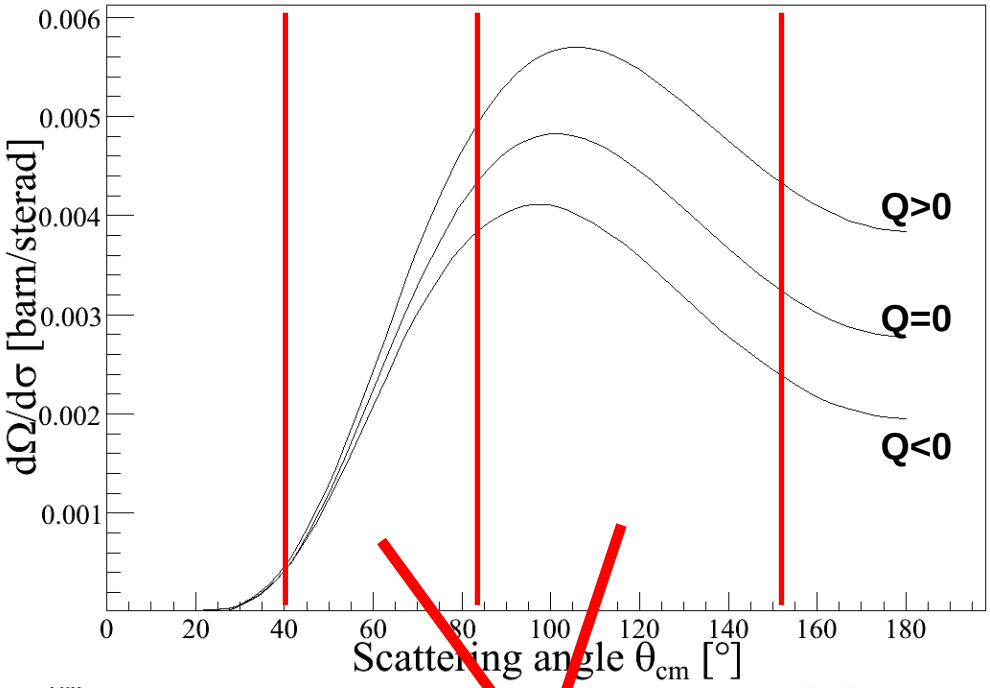
Coulex of ^{184,186,188}Hg: Motivation

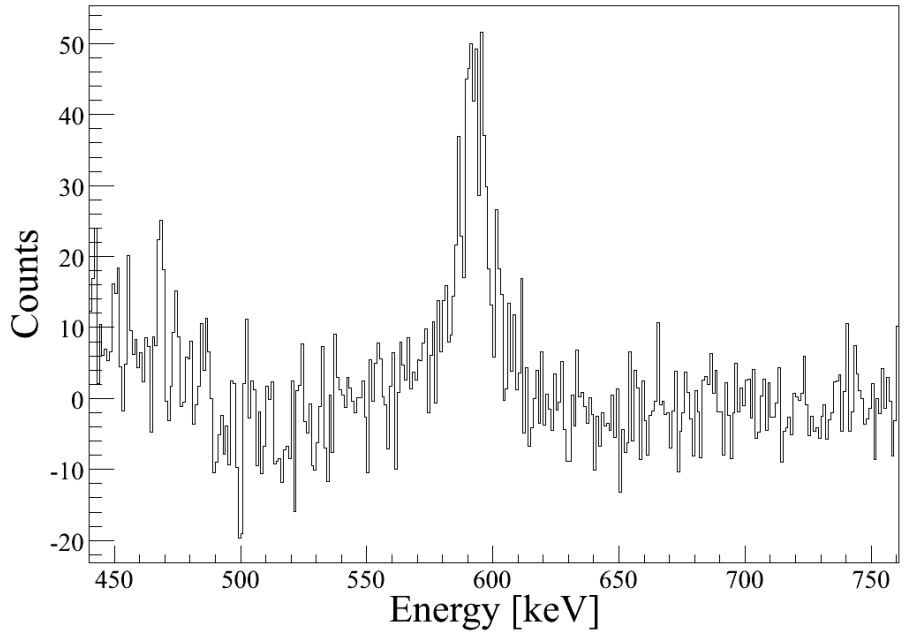


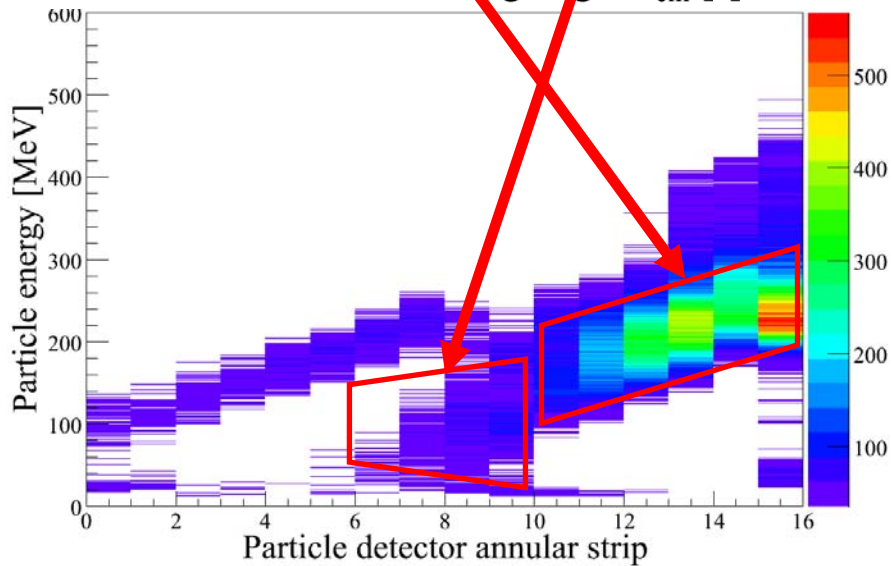
^{188}Hg

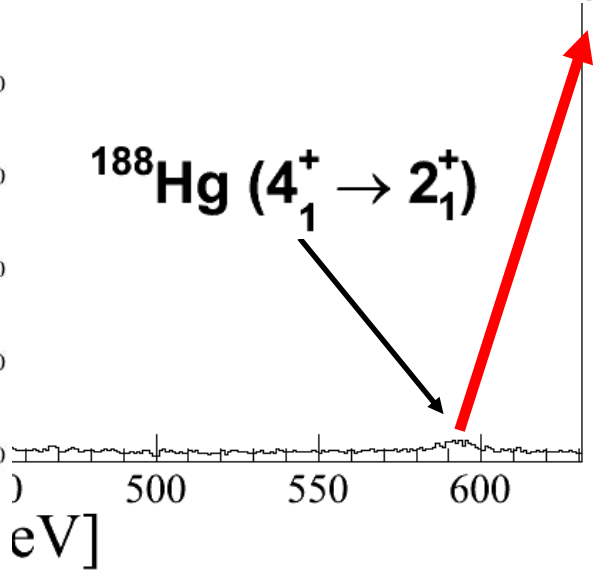


Coulex of ^{184,186,188}Hg: Preliminary experimental results

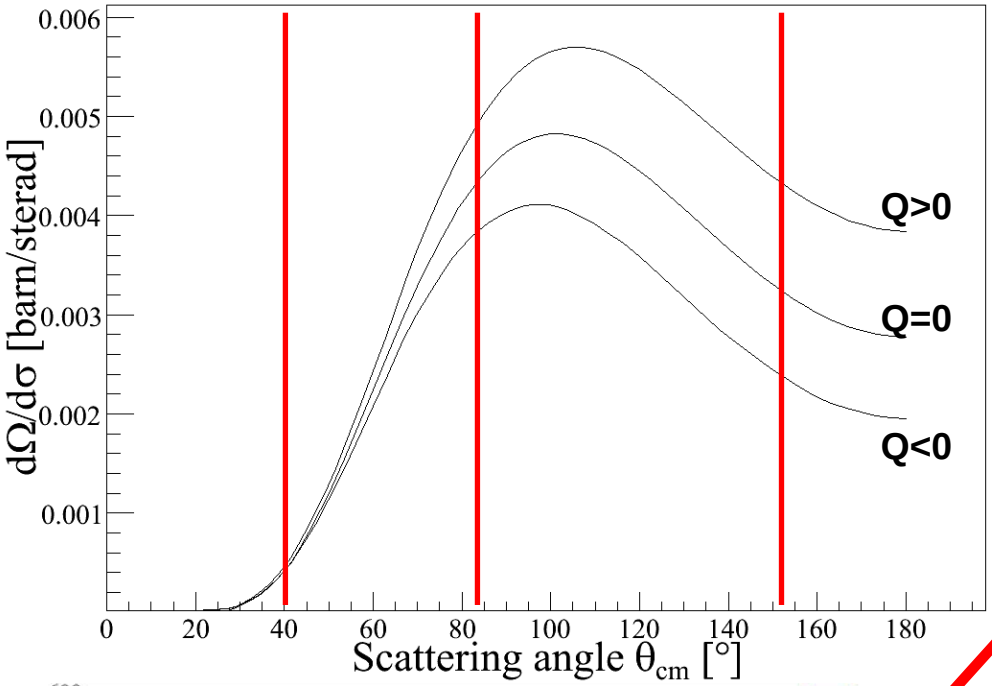


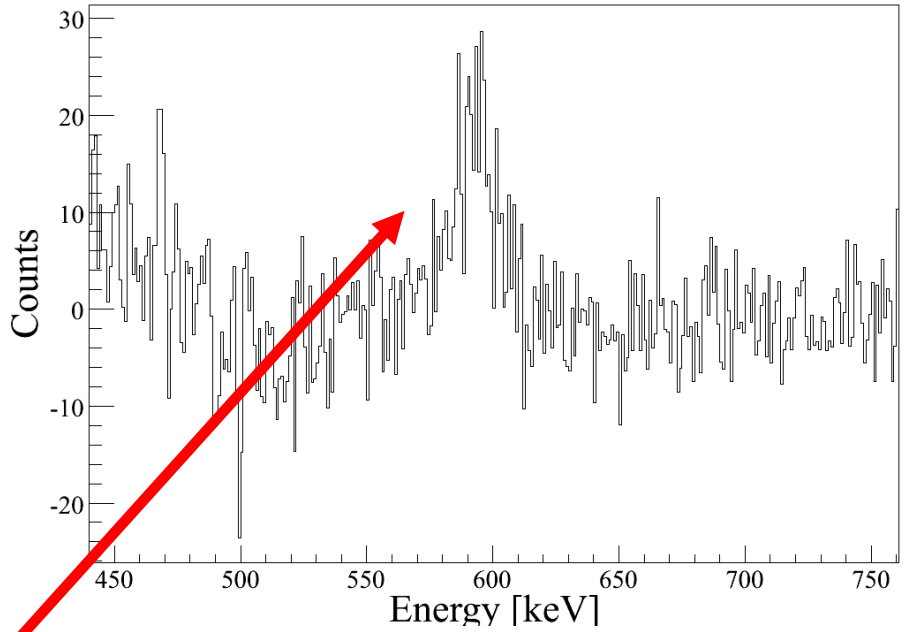


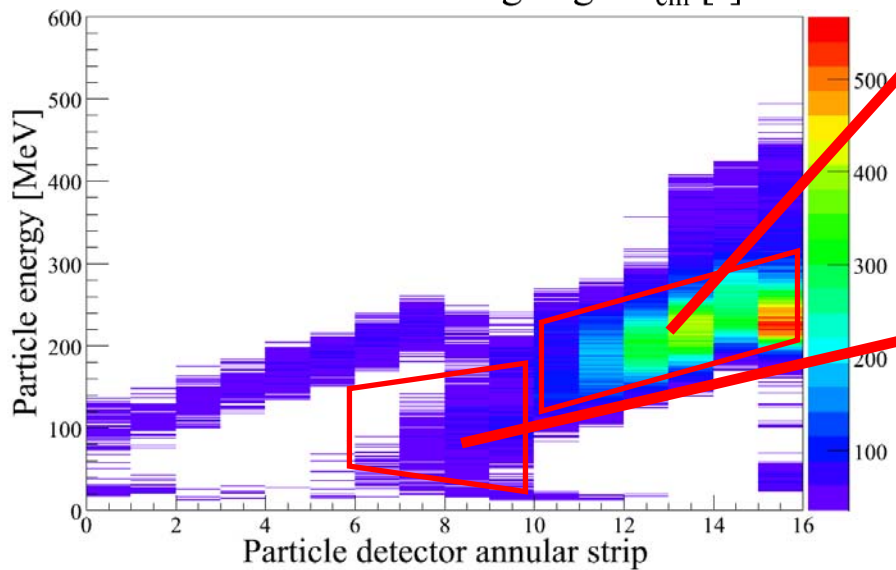


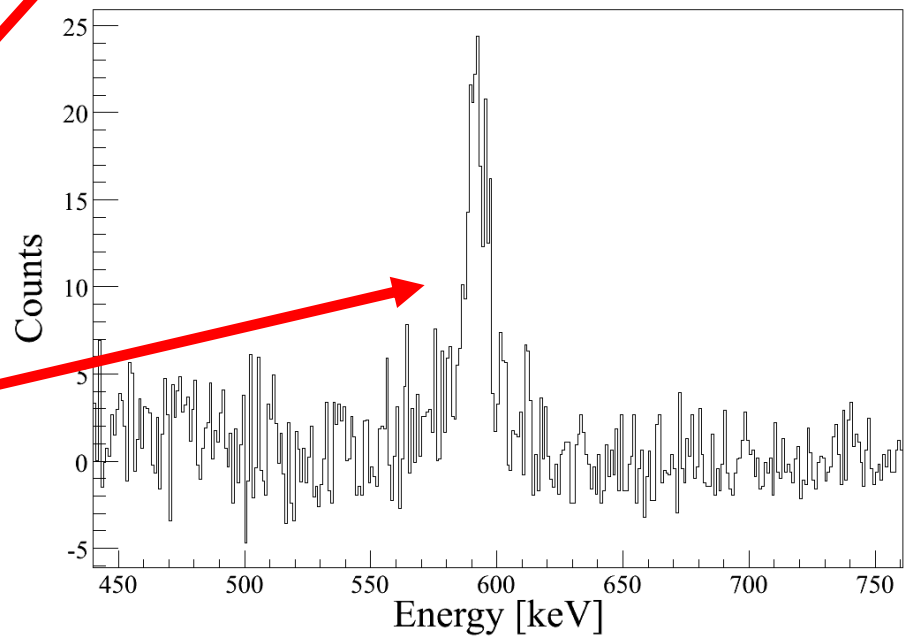


Coulex of ^{184,186,188}Hg: Preliminary experimental results

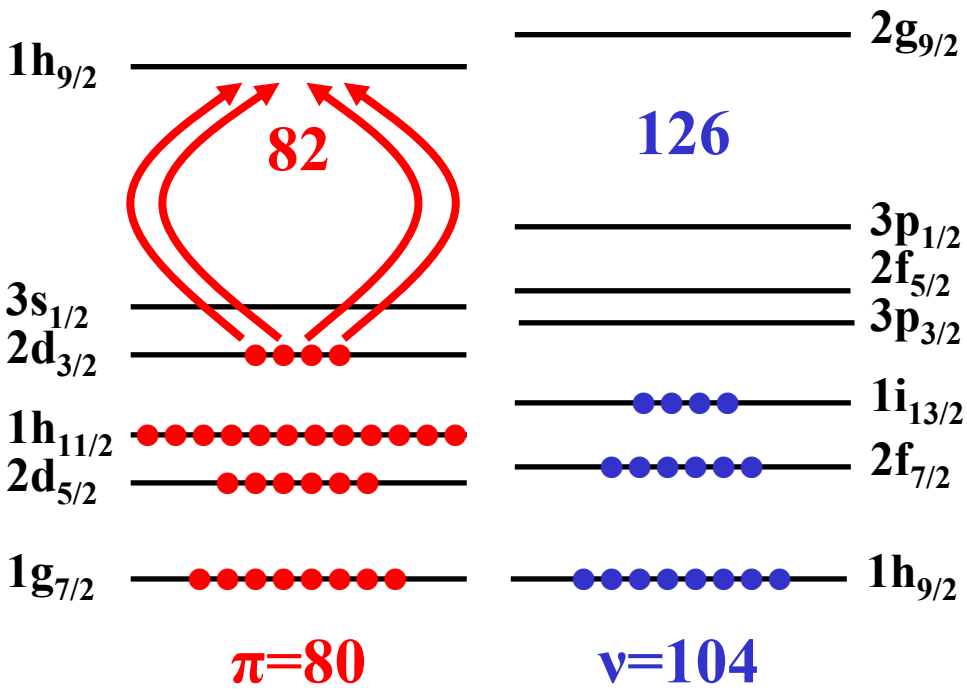


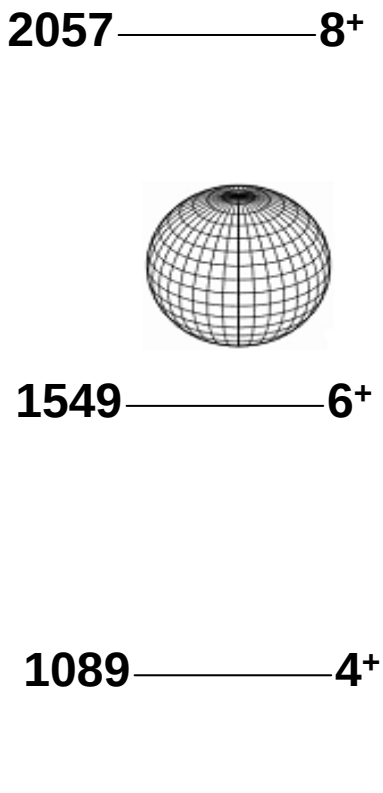






Coulex of ^{184,186,188}Hg: Motivation





^{184}Hg

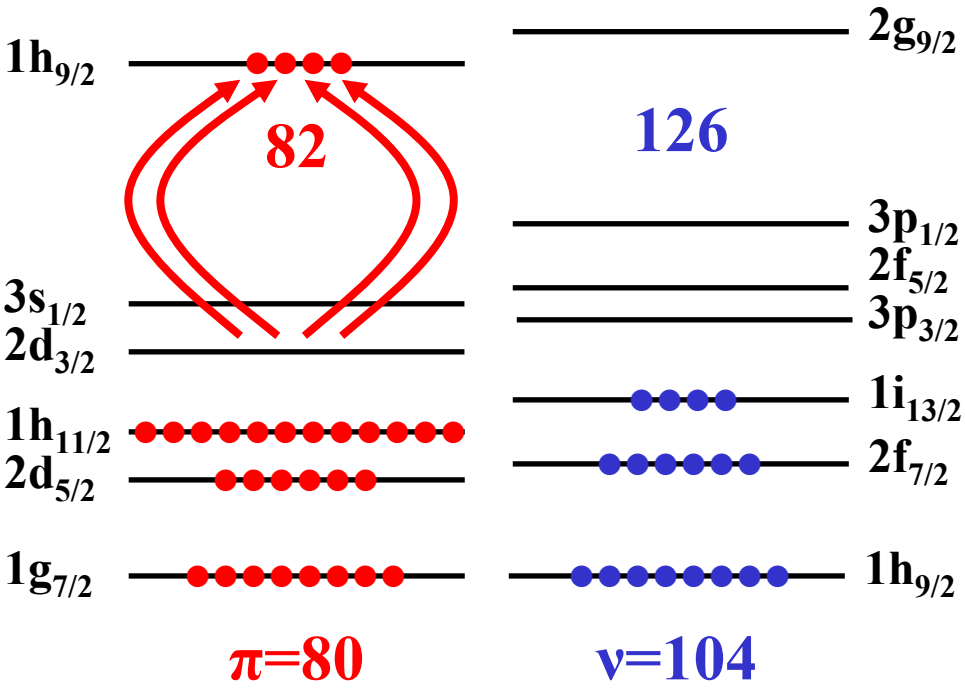
shell model: π0p2h states

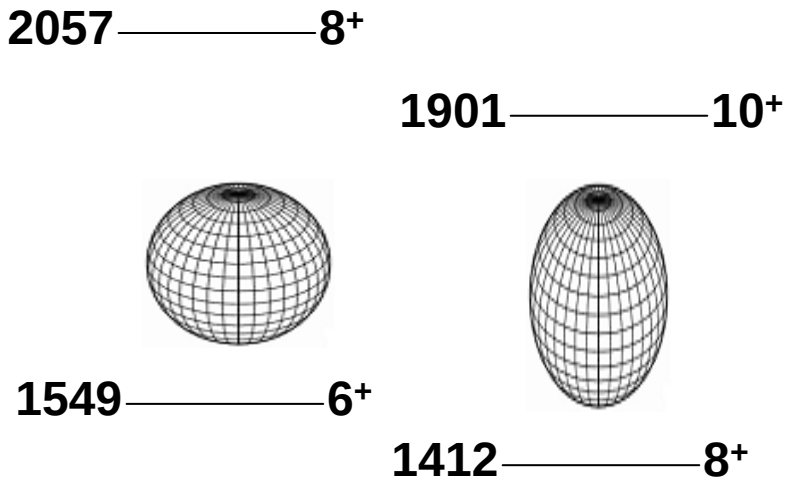
mean-field approximation:

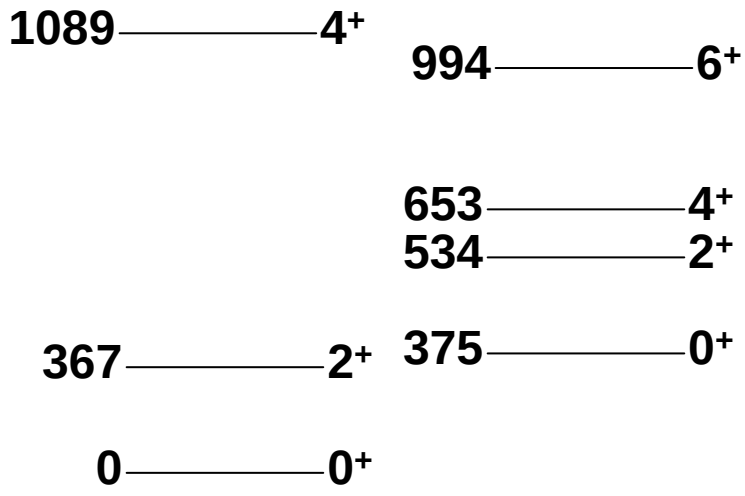
slightly oblate

J.L.Wood et al, Phys, Rep., 215, 3&4 (1992)

Coulex of ^{184,186,188}Hg: Motivation







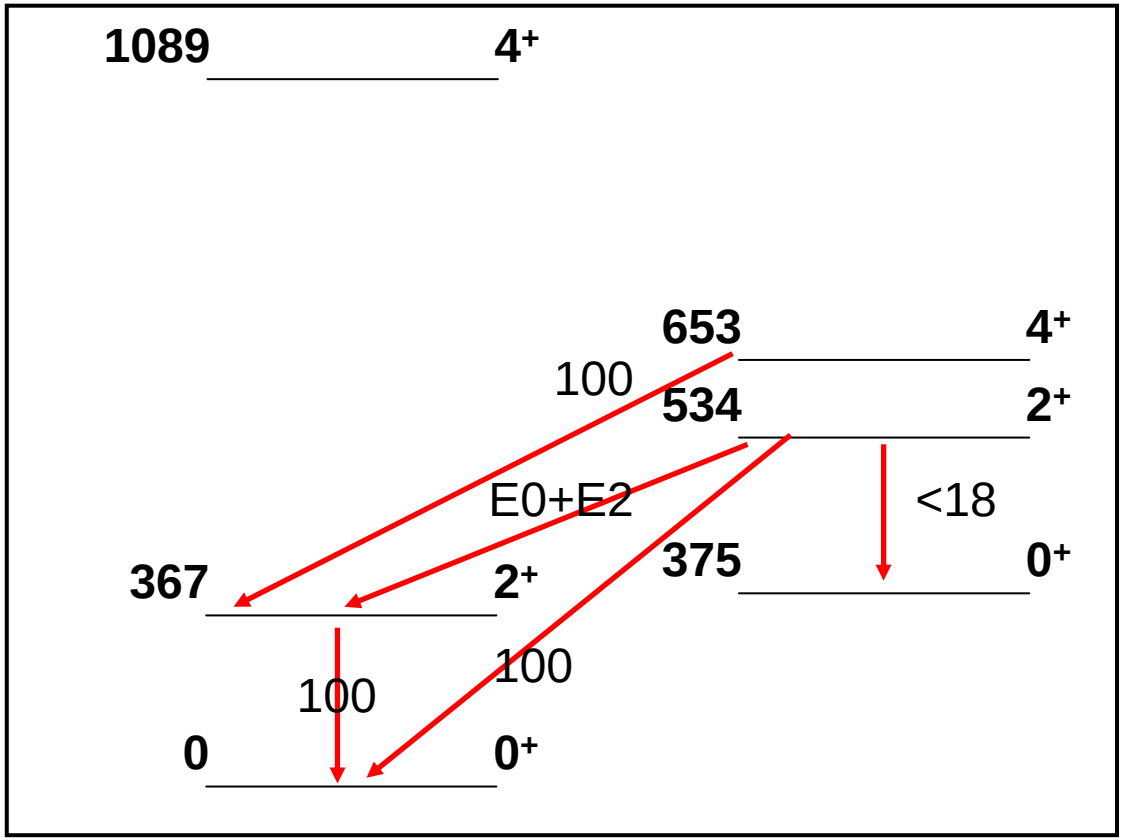
^{184}Hg

shell model: π4p6h states

mean-field approximation:

stronger prolate deformation

J.L.Wood et al, Phys, Rep., 215, 3&4 (1992)


1089
4+
653
4+
100
534
2+
E0+E2
<18
375
0+
367
2+
100
100
0
0+