

NNDC Experimental Activities

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U.S. DEPARTMENT OF
ENERGY

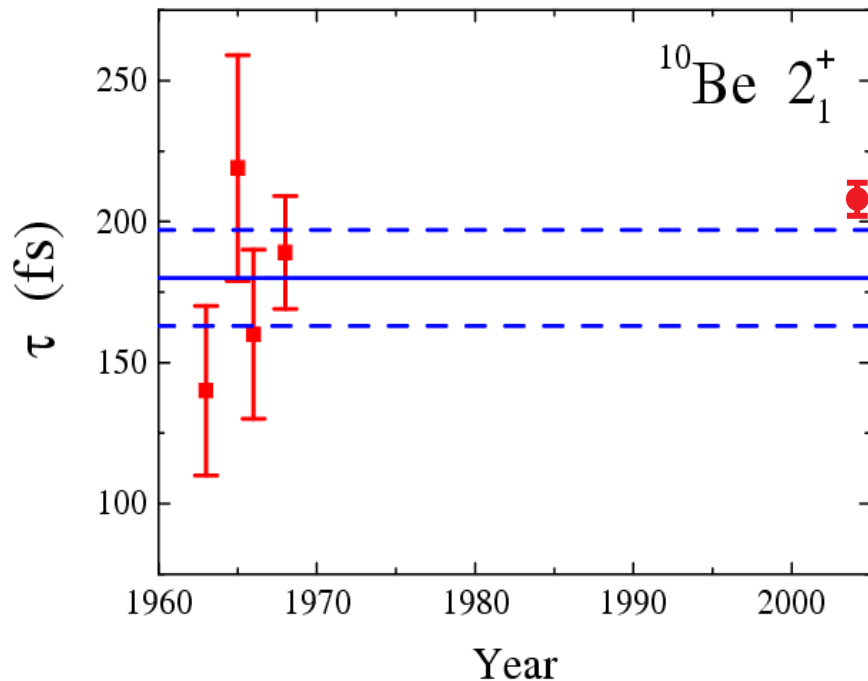
Office of
Science

A Potpourri

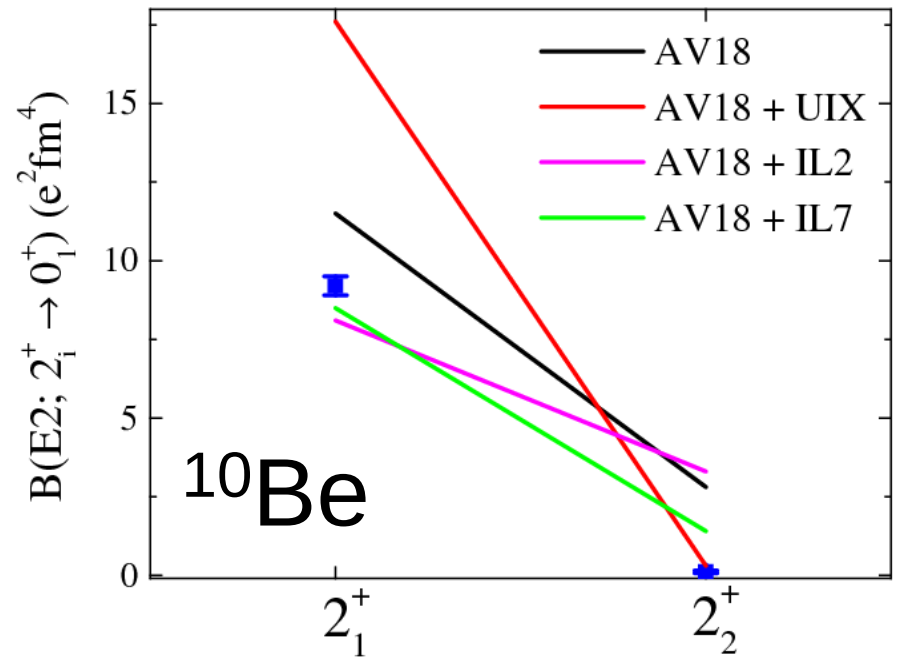
- Data for shaping new theories
- Data history – exotic decay
- Data directly linked to evaluation
- Data for applications

Precision Measurements to Test Ab Initio Theories

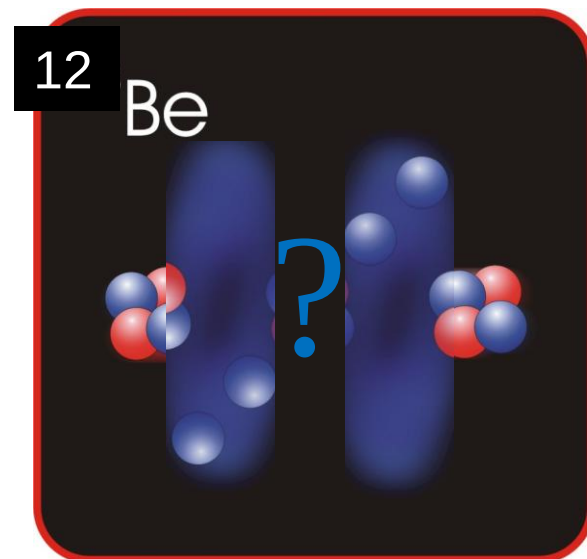
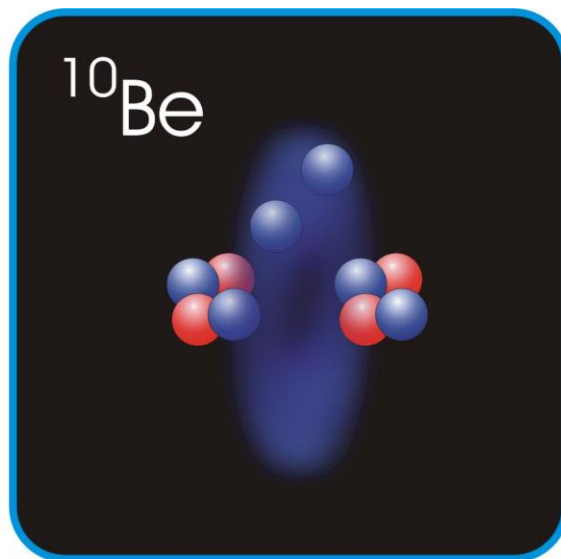
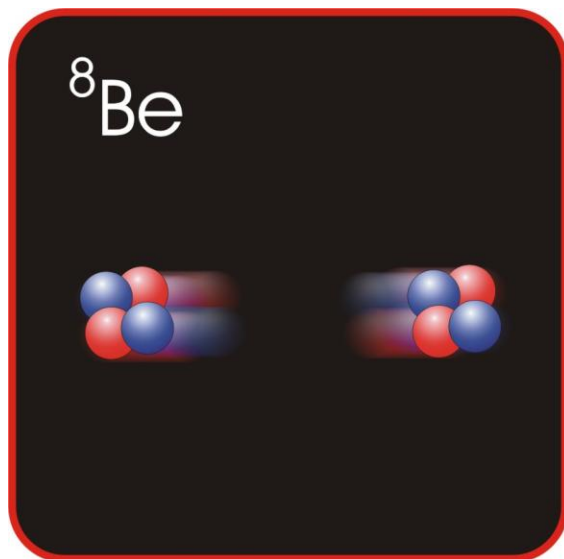
History of 2^+ lifetime measurements in ^{10}Be



Green's function Monte Carlo NN + 3 body forces



What do the extra neutrons do?



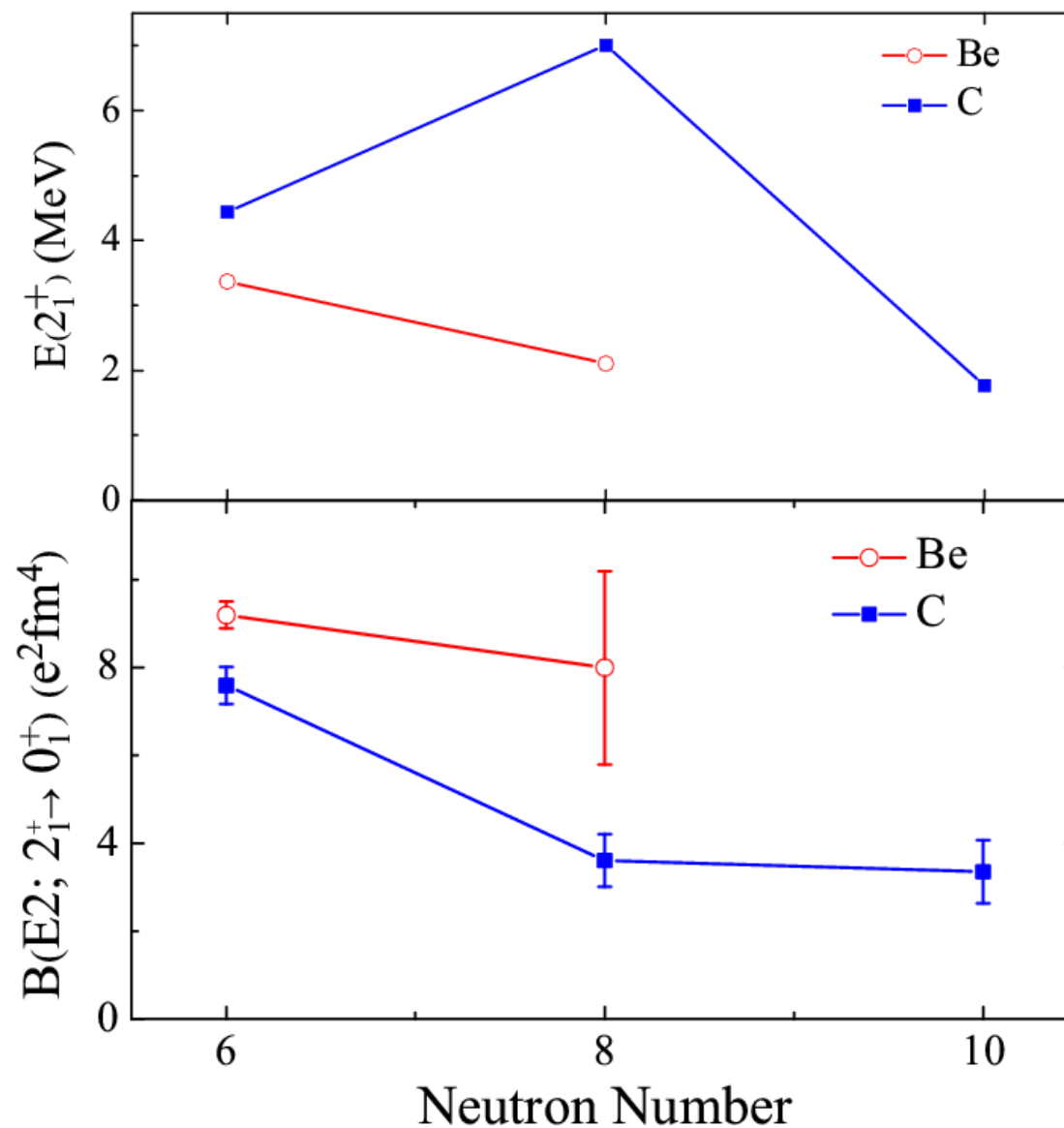
Make a “Nuclear Molecule”?

$B(E2)$ increases

Make a “N=8” spherical cloud?

$B(E2)$ decreases

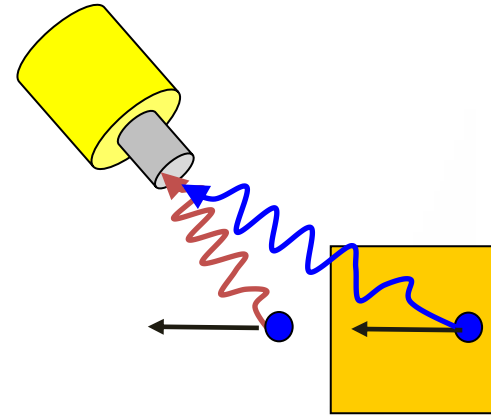
Systematics



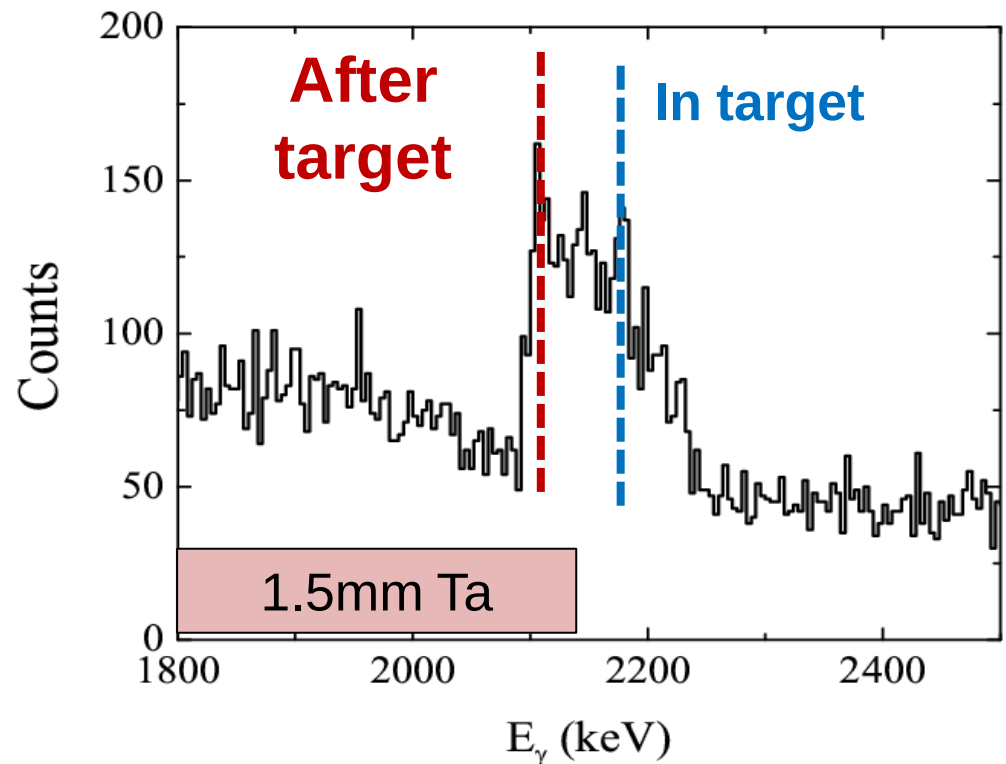
A precise measurement of the $B(E2; 2^+ \rightarrow 0^+)$ in ^{12}Be

Fast, thick target DSAM

- 55 MeV/A ^{12}Be beam
- 3 different targets
- GRETINA + S800



Gretina at MSU/NSCL



2-photon decay

One of a family of second order electromagnetic processes. They are sensitive to the initial and final state wave functions.

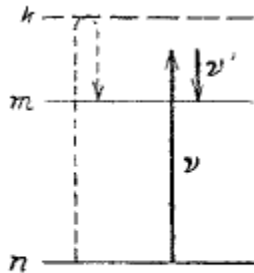


Fig. 1.
STOKESScher Fall
des RAMAN-Effekts.

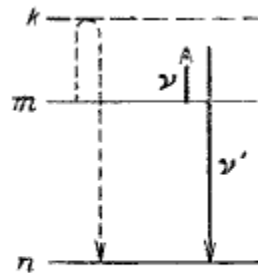


Fig. 2.
Antistokesscher Fall
des RAMAN-Effekts.

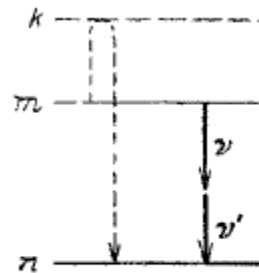


Fig. 3.
Doppelemmission.

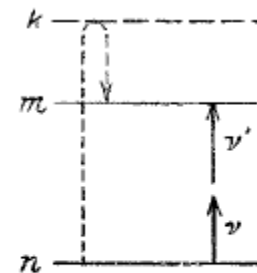


Fig. 4.
Doppelabsorption.



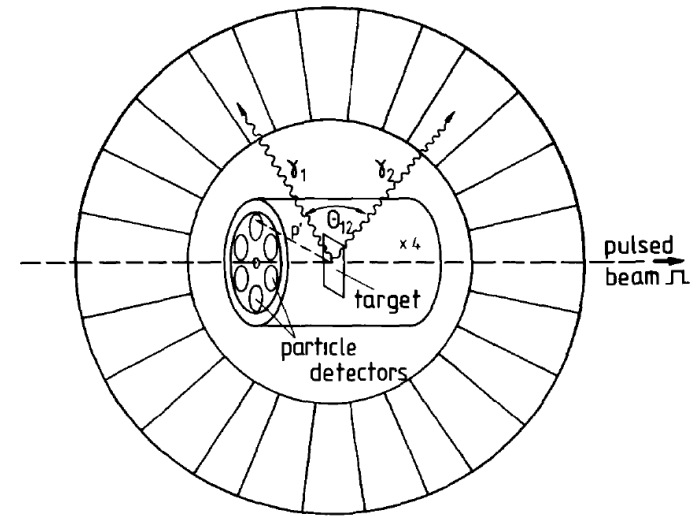
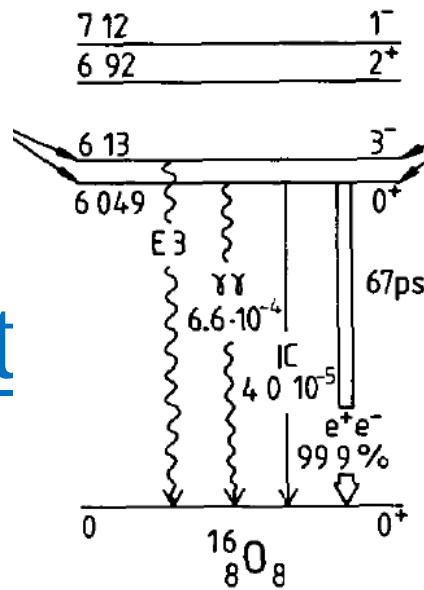
Über die Wahrscheinlichkeit
des Zusammenwirkens zweier Lichtquanten in
einem Elementarakt.

On the probability of a collaboration of two light quanta in an elementary process

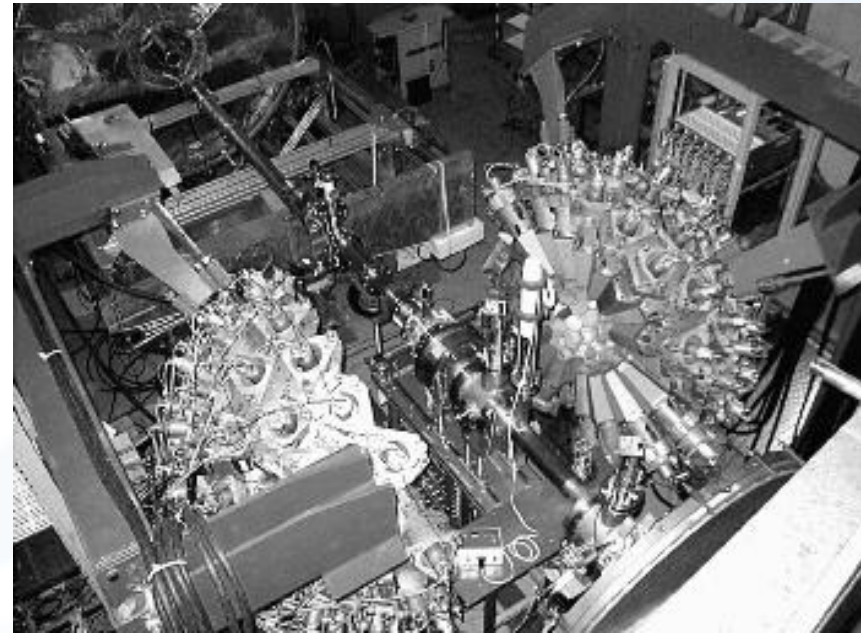
M. Goppert. Natureweiss 17 932 (1929)

Classic Nuclear Experiment

J Kramp et al. Nucl. Phys.
A474 (1987) 412

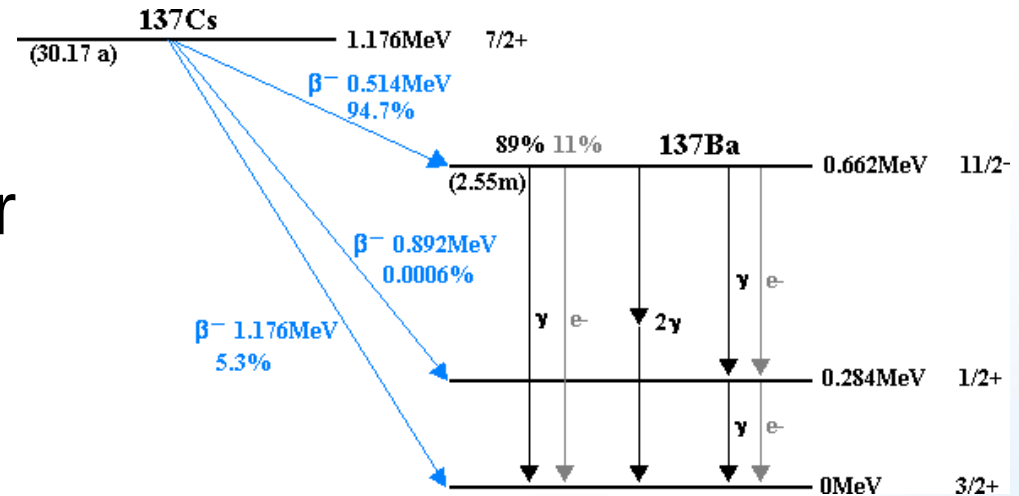


- Studied $0^+ \rightarrow 0^+$ transition in ^{16}O , ^{40}Ca , and ^{90}Zr
 - Used Heidelberg-Darmstadt Crystal Ball
 - 4π gamma detector
 - 162 NaI(Tl) crystals arranged in sphere with radius of 25cm

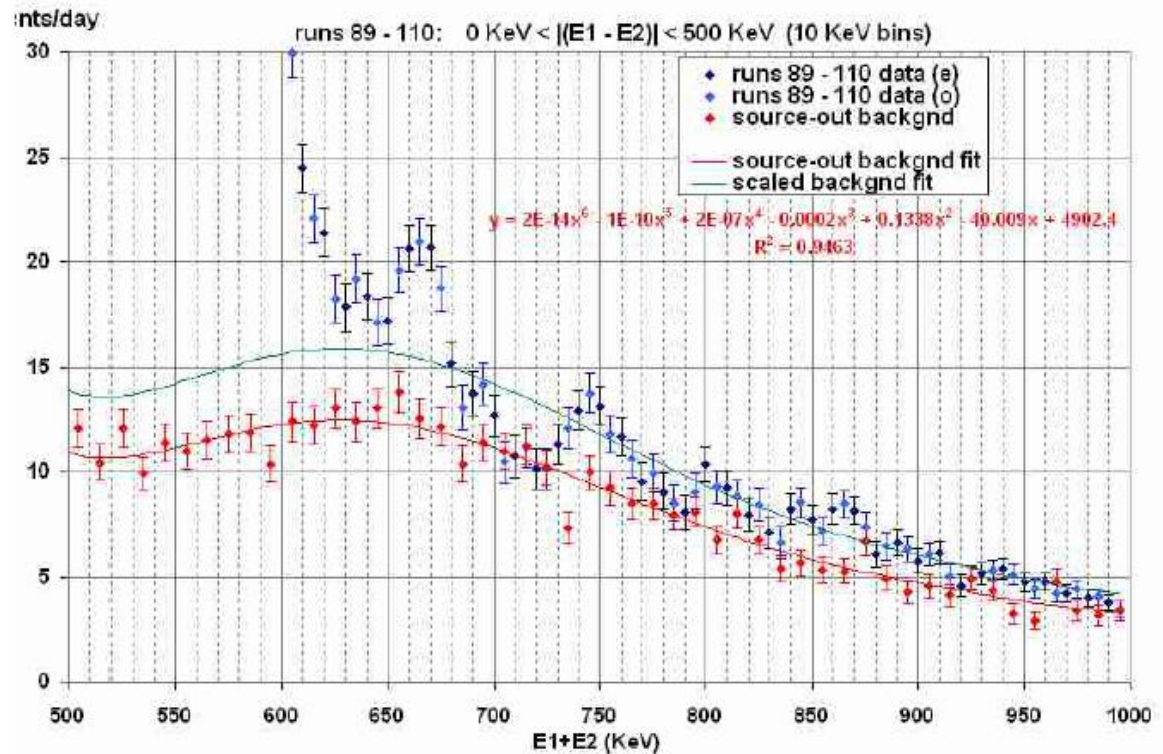


BNL experiment on ^{137}Cs

Alburger, Sutter, Millener



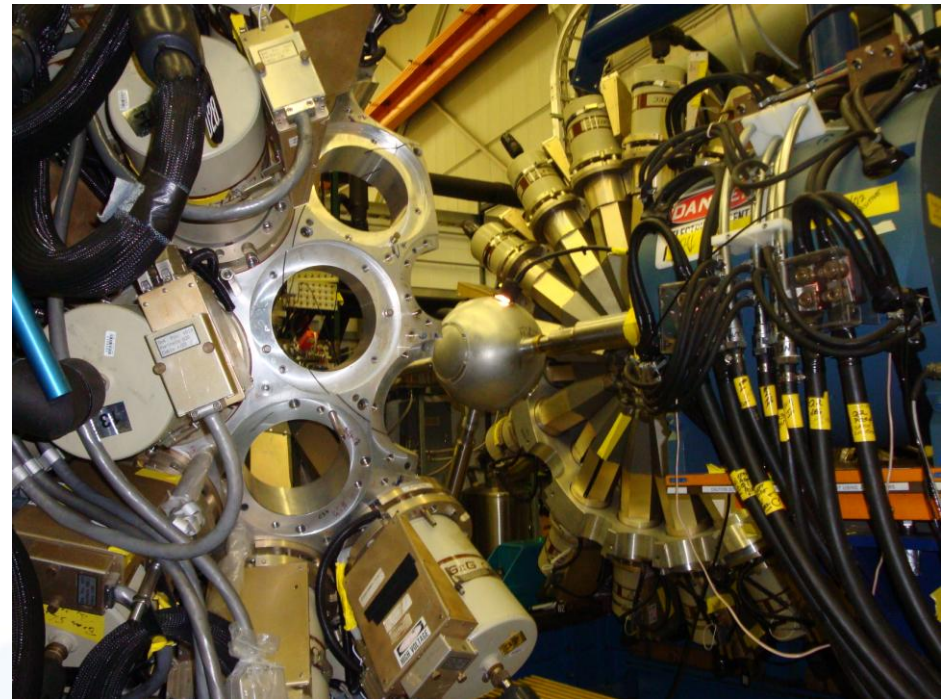
2 NaI detectors
and lots of Pb
shielding



Source Experiment at ANL



- Gammasphere Detector Array used for ^{137}Cs source experiment
- ~100 spherically arranged, Compton suppressed Ge detectors

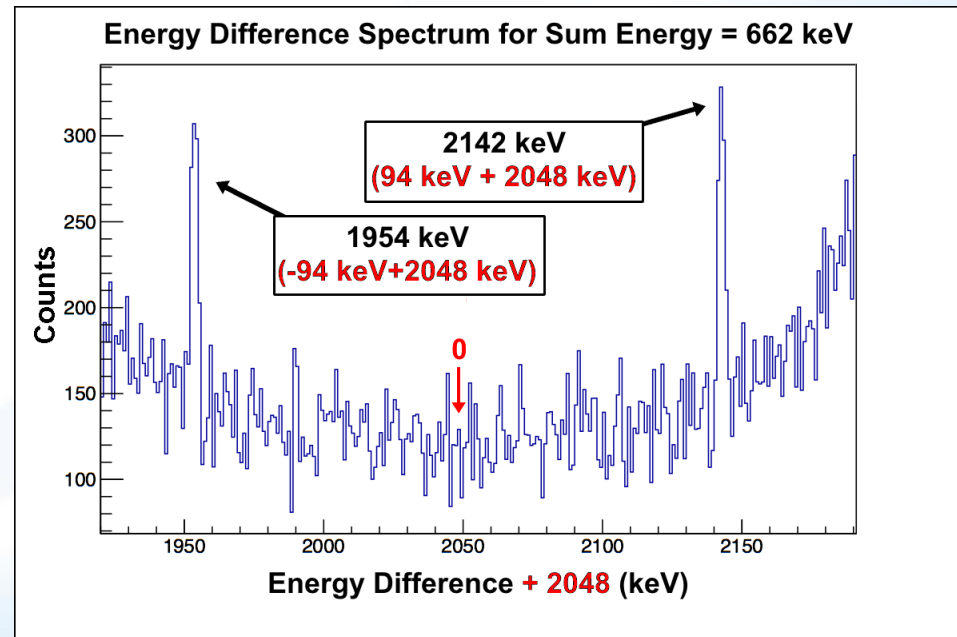
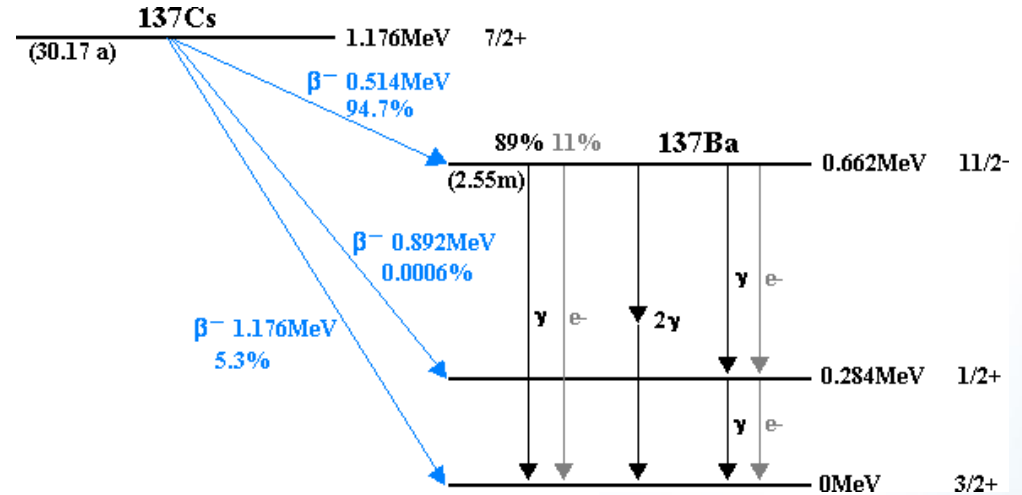


- Used Calibrated 19.67 μCi ^{137}Cs source
- Doubles trigger
- Collected data for ~10 days
- 6.42×10^{11} total decays

New E5 Transition

- Initially, no discernable features
- Choose detector pairs to suppress scattering
- Cascade is isotropic (no angular correlation)
- Cascade features become clear
- Values correspond to $\pm(378 \text{ keV} - 284 \text{ keV})$, or $\pm 94 \text{ keV}$

$$B(E5)_{^{137}\text{Ba}} = 0.35(4) \text{ W.u.}$$



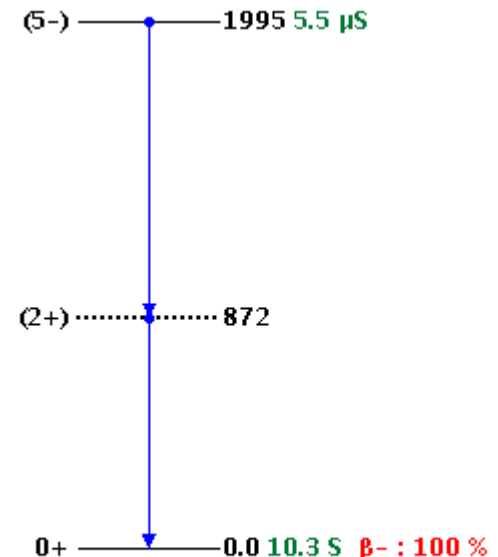
Connecting Evaluation to Measurements

Z	200Hg STABLE 23.10%	201Hg STABLE 13.18%	202Hg STABLE 29.86%	203Hg 46.594 D β^- : 100.00%	204Hg STABLE 6.87%	205Hg 59.4 M β^- : 100.00%	206Hg 8.32 M β^- : 100.00%	207Hg 2.9 M β^- : 100.00%	208Hg 41 M β^- : 100.00%
79	199Au 3.139 D β^- : 100.00%	200Au 48.4 M β^- : 100.00%	201Au 26.0 M β^- : 100.00%	202Au 28.4 S β^- : 100.00%	203Au 6 S β^- : 100.00%	204Au 39.8 S β^- : 100.00%	205Au 32.5 S β^- : 100.00%	206Au >300 NS β^- : 100.00%	207Au >300 NS β^- : 100.00%
78	198Pt STABLE 7.36%	199Pt 30.80 M β^- : 100.00%	200Pt 12.6 H β^- : 100.00%	201Pt 2.5 M β^- : 100.00%	202Pt 4 S β^- : 100.00%	203Pt 10 S β^- : 100.00%	204Pt 10 S β^- : 100.00%	205Pt >300 NS β^- : 100.00%	206Pt >300 NS β^- : 100.00%
77	197Ir 5.8 M β^- : 100.00%	198Ir 8 S β^- : 100.00%	199Ir 6 S β^- : 100.00%	200Ir >300 NS β^- : 100.00%	201Ir >300 NS β^- : 100.00%	202Ir 11 S β^- : 100.00%	203Ir >300 NS β^- : 100.00%	204Ir >300 NS β^- : 100.00%	205Ir >300 NS β^- : 100.00%
76	196Os 34.9 M β^- : 100.00%	197Os 2.8 M β^- : 100.00%	198Os 2.8 M β^- : 100.00%	199Os 5 S β^- : 100.00%	200Os 6 S β^- : 100.00%	201Os >300 NS β^- : 100.00%	202Os >300 NS β^- : 100.00%	203Os >300 NS β^- : 100.00%	204Os >300 NS β^- : 100.00%
	120	121	122	123	124	125	126	127	N

Deep inelastic reaction
with ^{204}Hg beam

^{207}Hg :
No excited
states known !!

^{204}Pt :
First 2^+ state
not definite



$^{204}\text{Pt}_{126}$

Data for Applications

PRL 105, 202501 (2010)

Selected for a Viewpoint in *Physics*
PHYSICAL REVIEW LETTERS

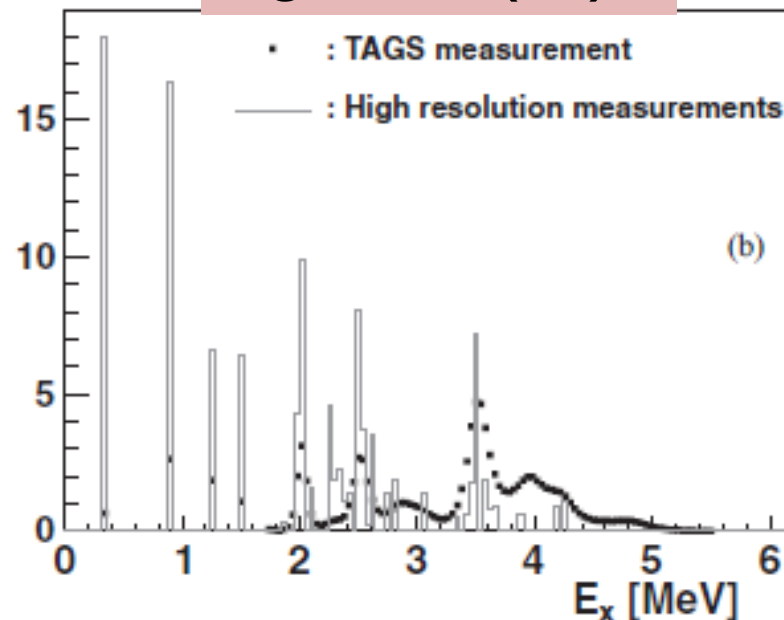


Reactor Decay Heat in ^{239}Pu : Solving the γ Discrepancy

A. Algora,^{1,2,*} D. Jordan,¹ J. L. Taín,¹ B. Rubio,¹ J. Agramunt,¹ A. B. Pérez,¹ E. Nácher,¹ A. Krasznahorkay,² M. D. Hunyadi,² J. Gulyás,² A. Vitéz,² M. C. I. D. Moore,³ T. Eronen,³ A. Jokinen,³ A. Nieminen,³ J. Hakala,³ P. Karvo,³ J. Rissanen,³ T. Kessler,³ C. Weber,³ J. Ronkainen,³ S. Rahaman,³ V. Elomaa,³ K. Burkard,⁴ W. Hüller,⁴ L. Batist,⁵ W. Gelletly,⁶ A. L. Nichols,⁶ T. Yoshi

^{104}Tc
g.s. $J^\pi = (3^+)$

Feeding



					106Rh				E _x [MeV]																																			
					E(level)	J _π	T _{1/2}	Decay																																				
					0.0	1+	30.07 s 35%	β ⁻ : 100.00%	0.0	1+	30.07 s 35%	β ⁻ : 100.00%	0.1370	(6)+	131 m 2	β ⁻ : 100.00%	0.0	1+	30.07 s 35%	β ⁻ : 100.00%	0.1370	(6)+	131 m 2	β ⁻ : 100.00%																				
					106Rh	207.3 D	100%	β ⁻ : 99.55% α : 0.45%	106Rh	35.36 H	100%	β ⁻ : 100.00%	106Rh	30.07 s	100%	β ⁻ : 100.00%	106Rh	39.247 D	100%	β ⁻ : 100.00%	104Ru	STABLE	18.1%	β ⁻ : 100.00%	105Ru	4.44 H	100%	β ⁻ : 100.00%	106Ru	371.8 D	100%	β ⁻ : 100.00%	107Ru	3.75 M	100%	β ⁻ : 100.00%	108Ru	4.55 M	100%	β ⁻ : 100.00%	109Ru	34.5 s	100%	β ⁻ : 100.00%
					101Rh	STABLE	17.0%	β ⁻ : 100.00%	102Rh	STABLE	31.55%	β ⁻ : 100.00%	103Rh	39.247 D	100%	β ⁻ : 100.00%	104Rh	STABLE	18.62%	β ⁻ : 100.00%	105Rh	4.44 H	100%	β ⁻ : 100.00%	106Rh	30.07 s	100%	β ⁻ : 100.00%	107Rh	3.75 M	100%	β ⁻ : 100.00%	108Rh	4.55 M	100%	β ⁻ : 100.00%	109Rh	34.5 s	100%	β ⁻ : 100.00%				
					100Tc	15.46 s	100%	β ⁻ : 100.00% α : 2.6E-3%	101Tc	14.02 M	100%	β ⁻ : 100.00%	102Tc	5.28 s	100%	β ⁻ : 100.00%	103Tc	54.2 s	100%	β ⁻ : 100.00%	104Tc	18.3 M	100%	β ⁻ : 100.00%	105Tc	7.6 M	100%	β ⁻ : 100.00%	106Tc	35.6 s	100%	β ⁻ : 100.00%	107Tc	21.2 s	100%	β ⁻ : 100.00%	108Tc	5.17 s	100%	β ⁻ : 100.00%				
					101Mo	14.61 M	100%	β ⁻ : 100.00%	102Mo	11.3 M	100%	β ⁻ : 100.00%	103Mo	67.5 s	100%	β ⁻ : 100.00%	104Mo	60 s	100%	β ⁻ : 100.00%	105Mo	35.6 s	100%	β ⁻ : 100.00%	106Mo	8.73 s	100%	β ⁻ : 100.00%	107Mo	3.5 s	100%	β ⁻ : 100.00%	108Mo	5.17 s	100%	β ⁻ : 100.00%	109Mo	3.3 M	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
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					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s	100%	β ⁻ : 100.00%	108Nb	5.17 s	100%	β ⁻ : 100.00%				
					100Nb	1.5 s	100%	β ⁻ : 100.00%	101Nb	7.1 s	100%	β ⁻ : 100.00%	102Nb	4.3 s	100%	β ⁻ : 100.00%	103Nb	6.0 s	100%	β ⁻ : 100.00%	104Nb	35.6 s	100%	β ⁻ : 100.00%	105Nb	8.73 s	100%	β ⁻ : 100.00%	106Nb	8.73 s	100%	β ⁻ : 100.00%	107Nb	3.5 s</										