

Recoil Decay Tagging study of transitional proton emitters

$^{145,146,147}\text{Tm}$

Andrew Robinson

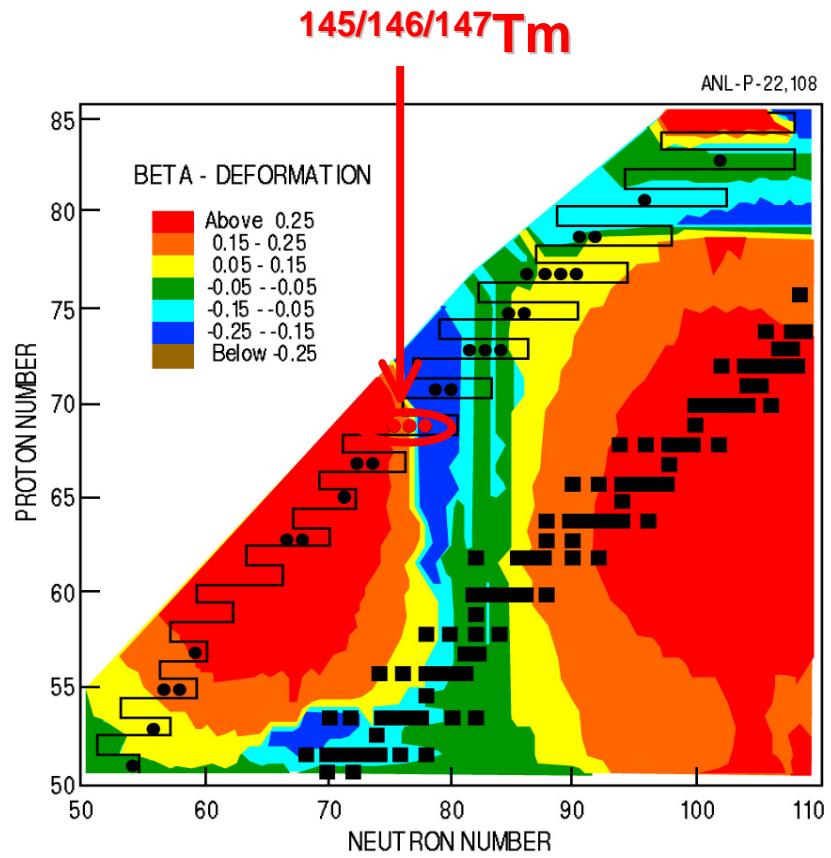
School of Physics



Proton Emission

- Emission of a **proton** from an **odd-Z** nucleus beyond the proton dripline.
- Similar to alpha decay but no **preformation** factor.

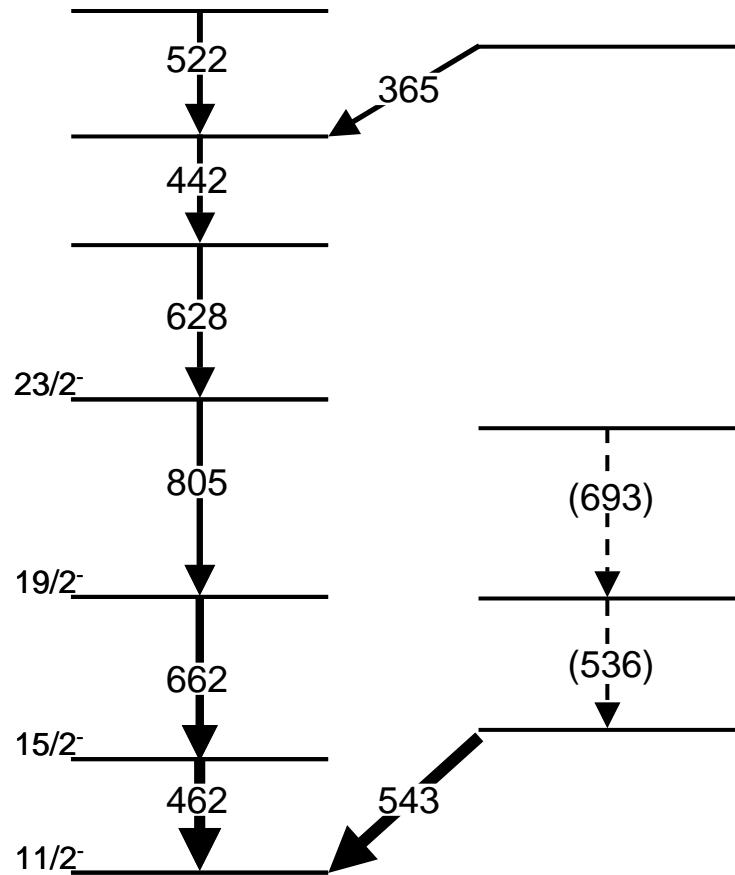
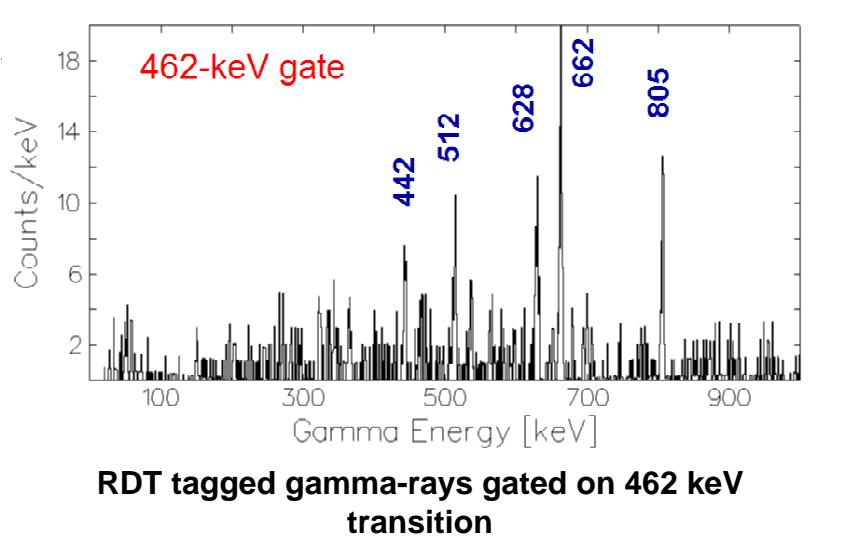
Decay rate is very sensitive to Q_p and l_p



^{147}Tm – Recoil Decay Tagging

$^{147}_{\text{69}}\text{Tm}_{\text{78}}$

E_p (keV)	$t_{1/2}$
1051(3)	0.58(3) s
1119(5)	0.36(4) ms

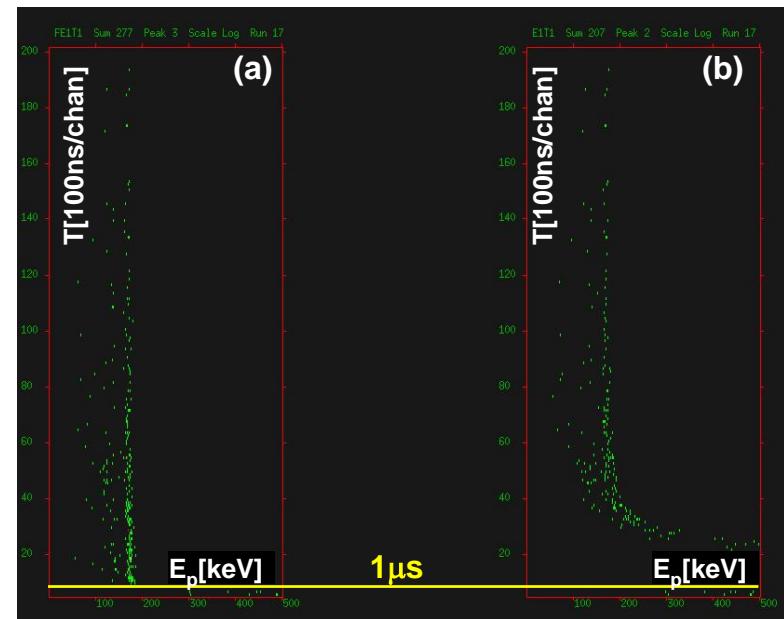


Extended ^{147}Tm Level Scheme

^{145}Tm – Recoil Decay Tagging

$^{145}_{\text{69}}\text{Tm}_{\text{76}}$

E_p (keV)	$t_{1/2}$
1393(10)	2.7(1.0) μs
1728(10)	3.1(3) μs

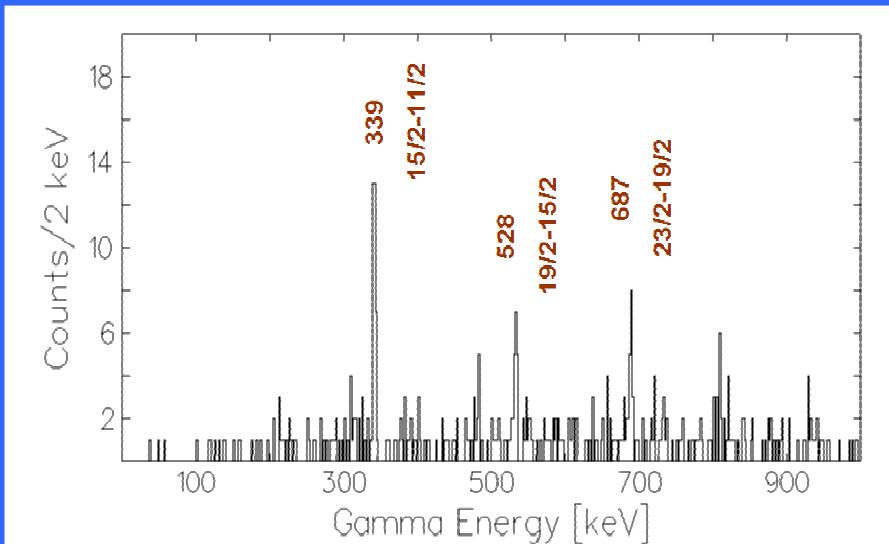
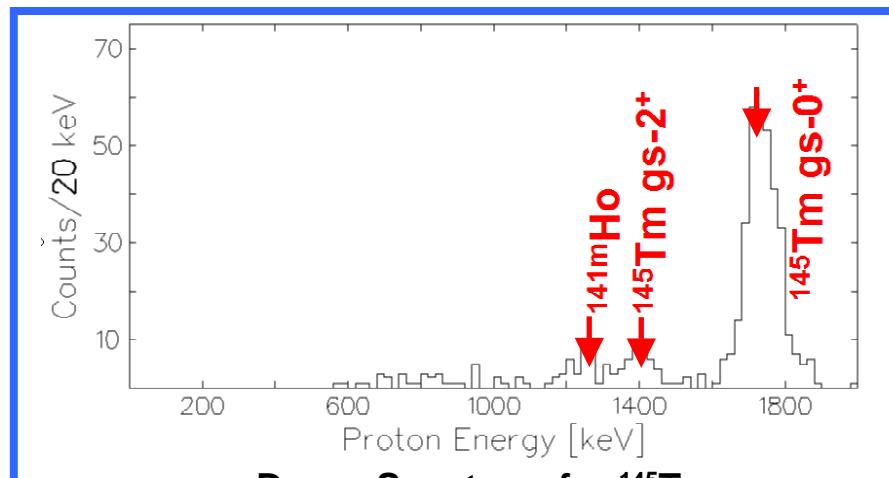


Energy-Time response

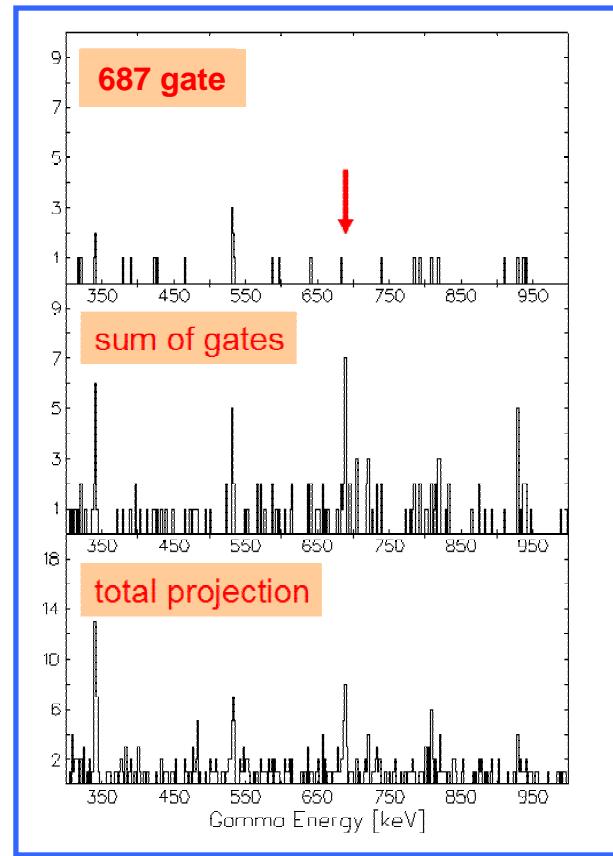
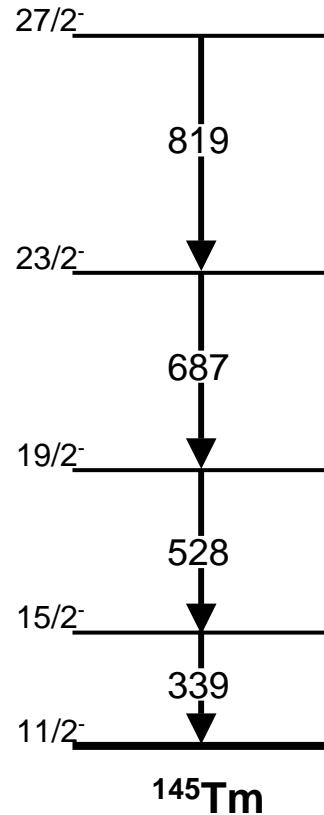
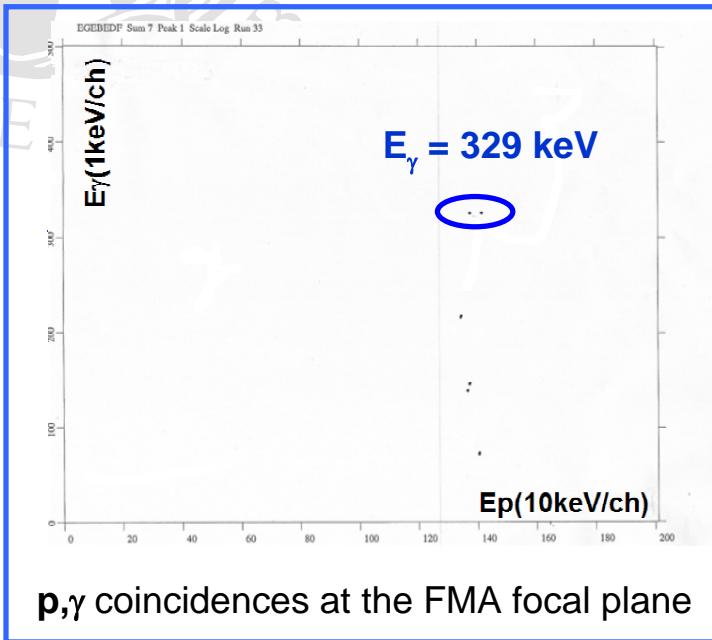
a) delay-line amplifiers

b)

DSP: M. Karny *et al.*, PRL 90,
012502 (2003)

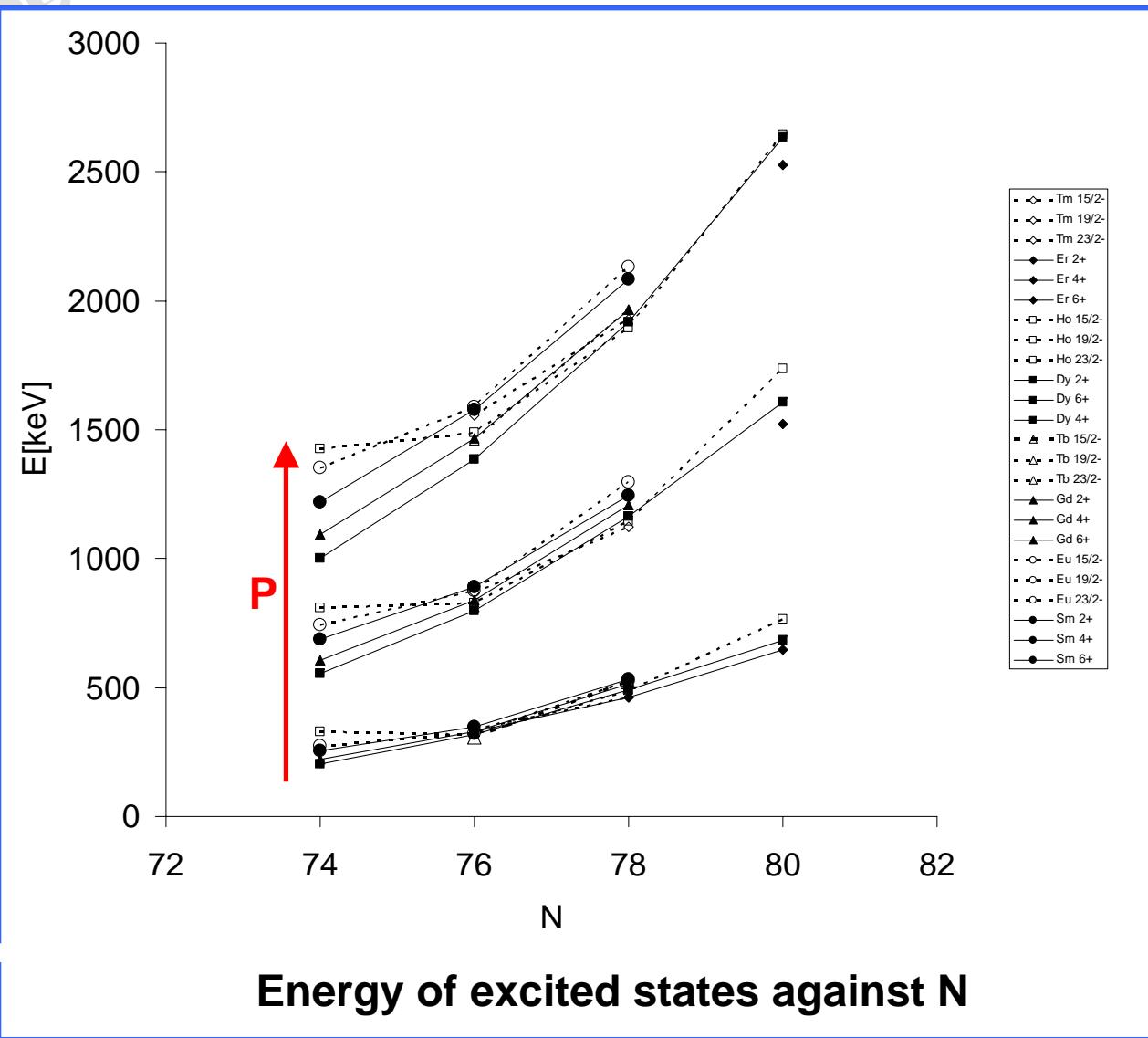


^{145}Tm – Recoil Decay Tagging



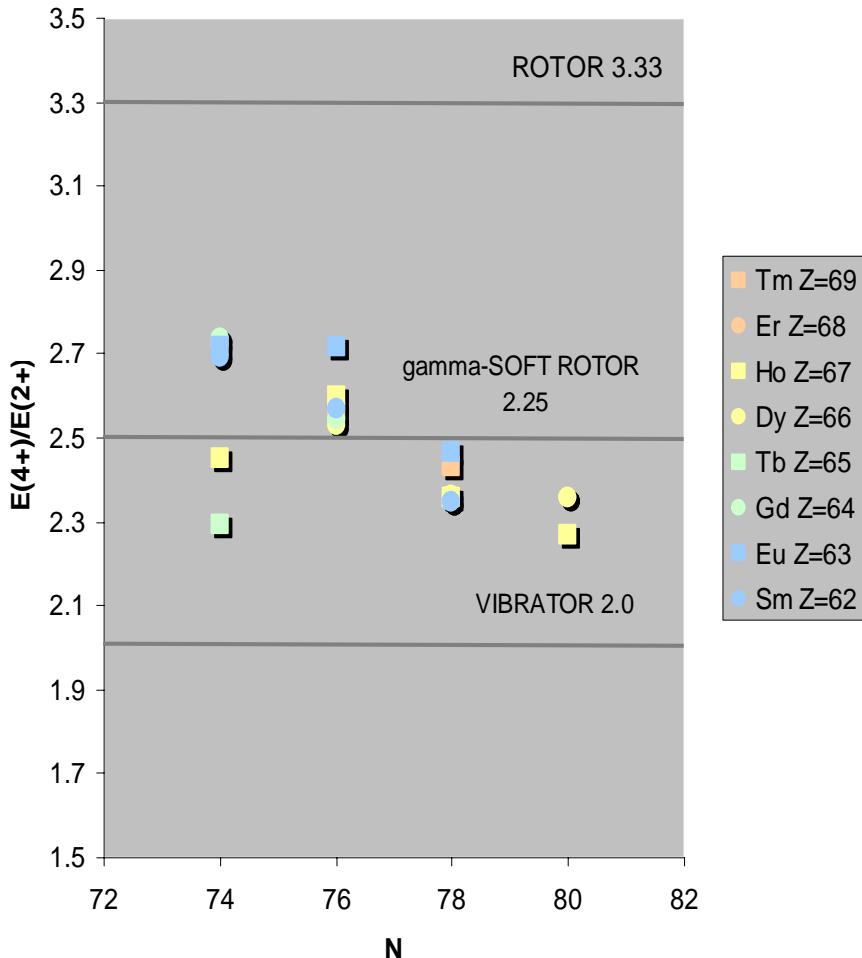
Grodzins formula $\beta_2 \sim 0.18$
Moller, Nix calculated $\beta_2 \sim 0.25$

$E(2^+)$ vs N

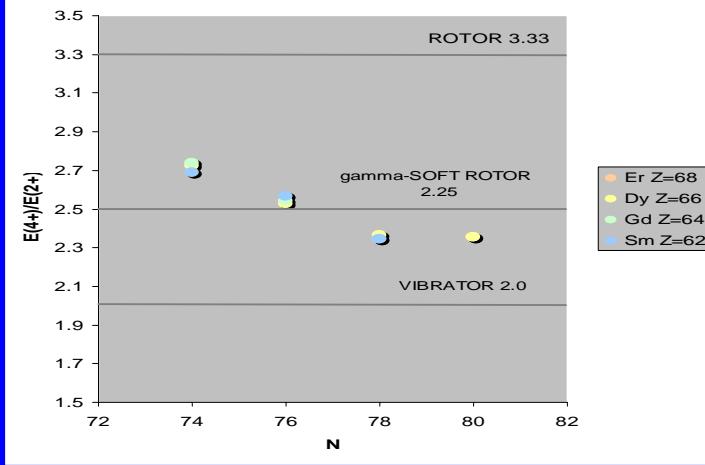


$E(2^+)/E(4^+)$

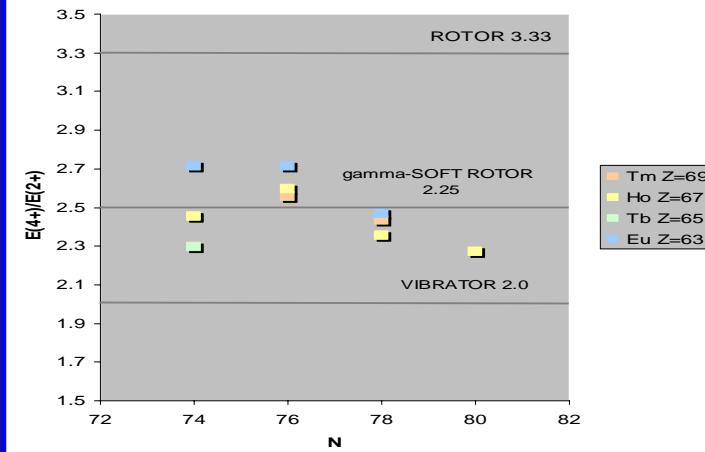
Even-Even and odd-Z nuclei



Even-Even nuclei

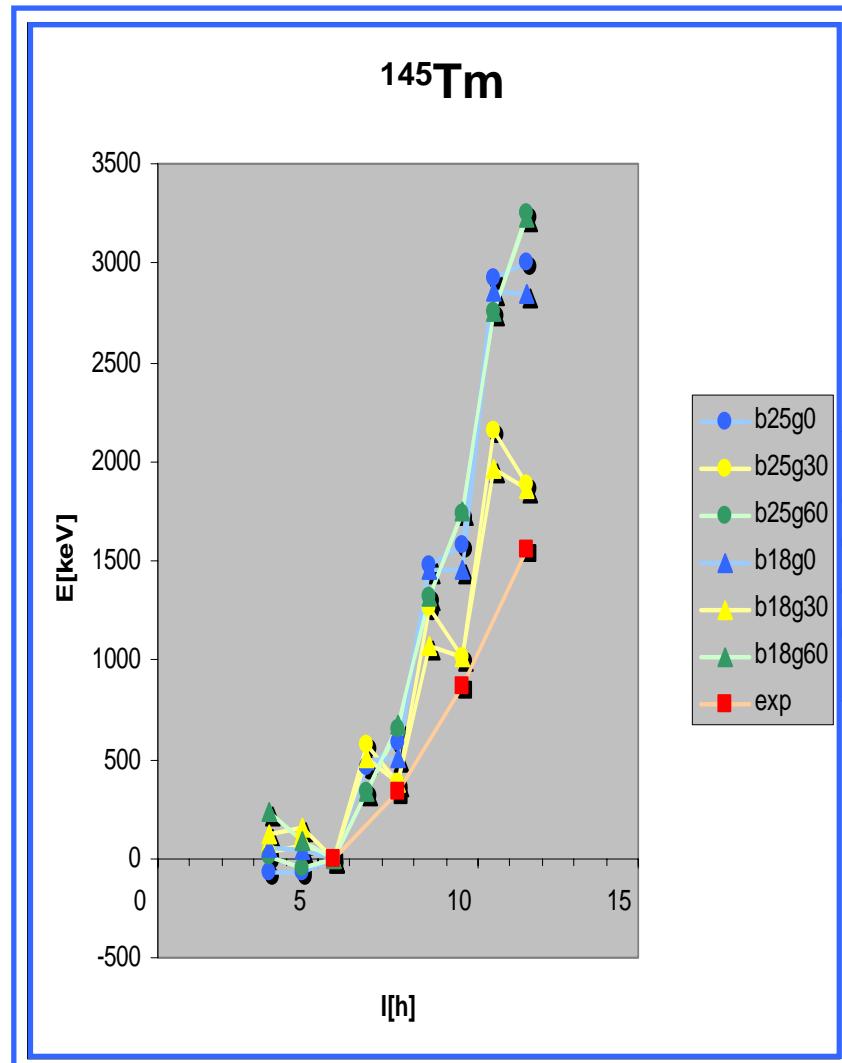


Odd-Z nuclei



Particle-Rotor Model

- Triaxial Rotor
- Woods-Saxon potential with the universal set of parameters
- Coriolis attenuation factor **0.85**
- Proton pairing strength 0.136 MeV
- Moments of inertia adjusted to the 2+ energy in the daughter nucleus
- Coriolis matrix elements are attenuated by the pairing factor:
 $u_1 u_2 + v_1 v_2$



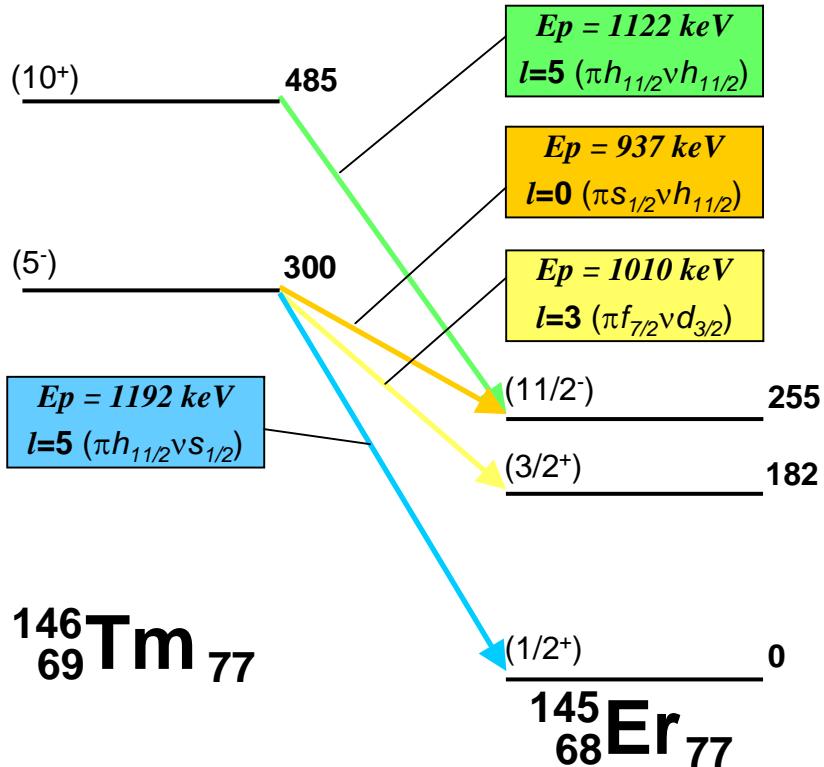
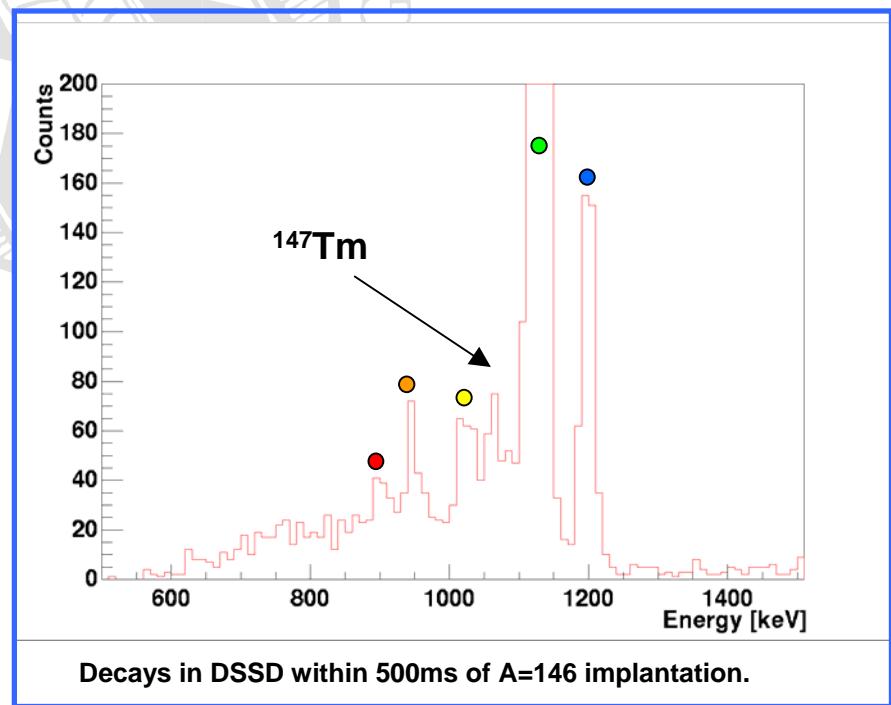
¹⁴⁶Tm – Previous Results

¹⁴⁶₆₉Tm₇₇

E _p (keV)	t _{1/2} (ms)
1119(5)	235(27)
1189(5)	72(23)

K. Livingston *et al.*, Phys. Lett. B **312**, 46 (1993)

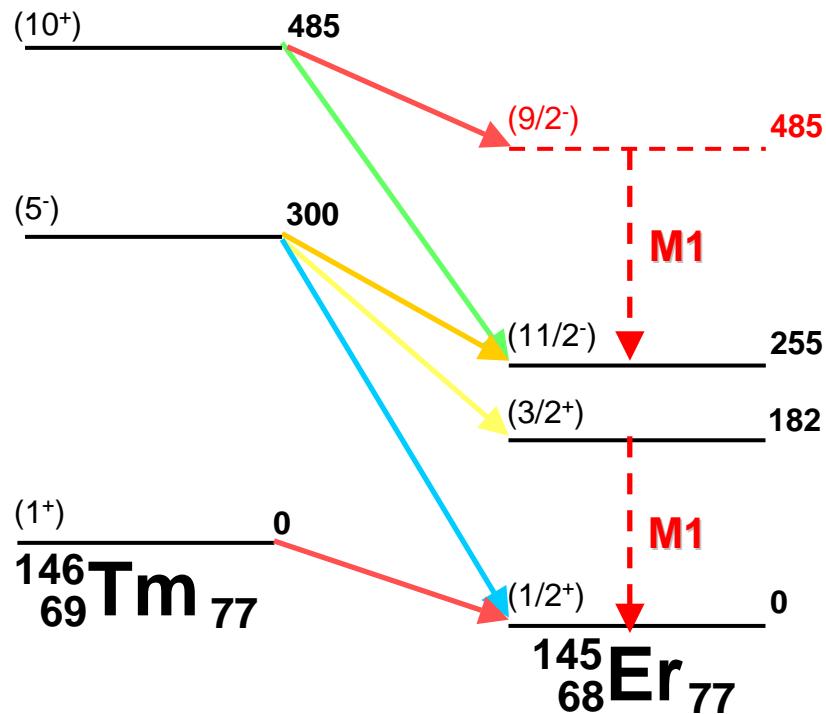
^{146}Tm – Particle Decay



E_p (keV)	$Q_{p,n}$ (keV)	$t_{1/2}^{\exp t}$	Proton branch	Proton partial half-life		
					j_p	$t_{1/2,p}^{calc}$
892(4)	912(4)	155(20) ms	0.30(16)	517(284) ms	$s_{1/2}$	4.04 ms
937(4)	957(4)	88(8) ms	0.12(4)	754(256) ms	$s_{1/2}$	3.19 ms
1010(4)	1030(4)	88(11) ms	0.14(4)	649(213) ms	$f_{7/2}$	22.5 ms
1122(4)	1143(4)	213(9) ms	1	213(9) ms	$h_{11/2}$	342 ms
1192(4)	1214(4)	78(5) ms	0.38(11)	208(27) ms	$h_{11/2}$	52.7 ms

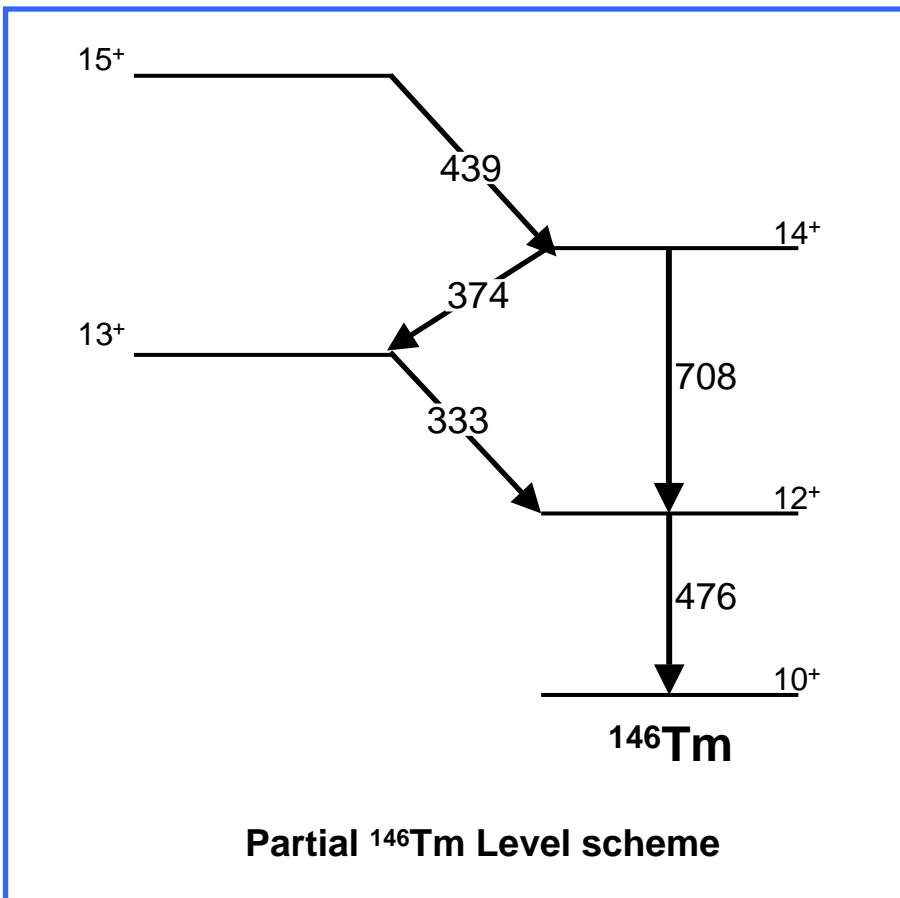
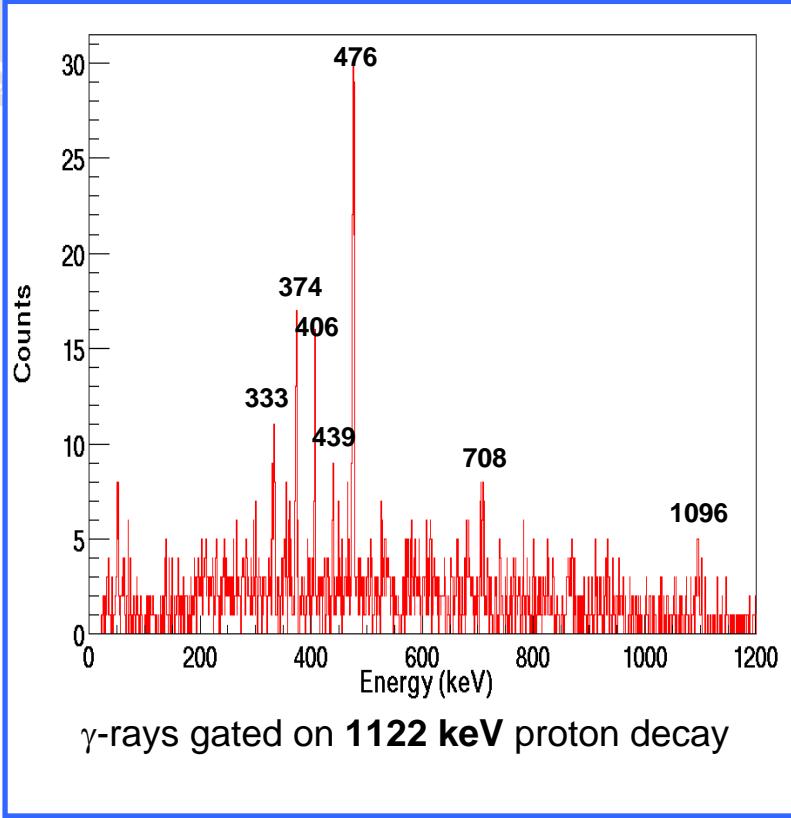
^{146}Tm – Particle Decay

Confirmation of the **892 keV** and **1010 keV** transitions assignment's could be provided by p,γ coincidences at **FMA focal plane**.



Analysis is being undertaken.

^{146}Tm – Recoil Decay Tagging



Conclusions

- G.S band in ^{147}Tm confirmed and extended, unfavored signature sequence found.
- gs rotational band in ^{145}Tm observed with properties of a decoupled proton $h_{11/2}$ band.
- Coincidences between fine-structure ^{145}Tm protons and 2^+-0^+ γ rays measured.
- Particle-Rotor model indicates $\gamma \sim 30^\circ$ or γ -soft shapes in the Tm proton emitters.
- First example of decay to 3 states in daughter nucleus from ^{146}Tm .
- Band similar to ^{147}Tm was observed in ^{146}Tm .

Collaborators



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