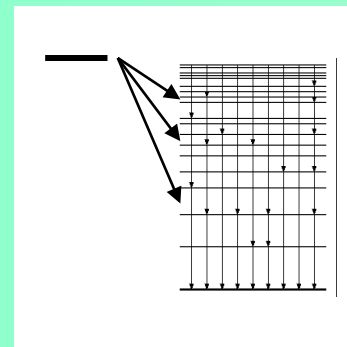
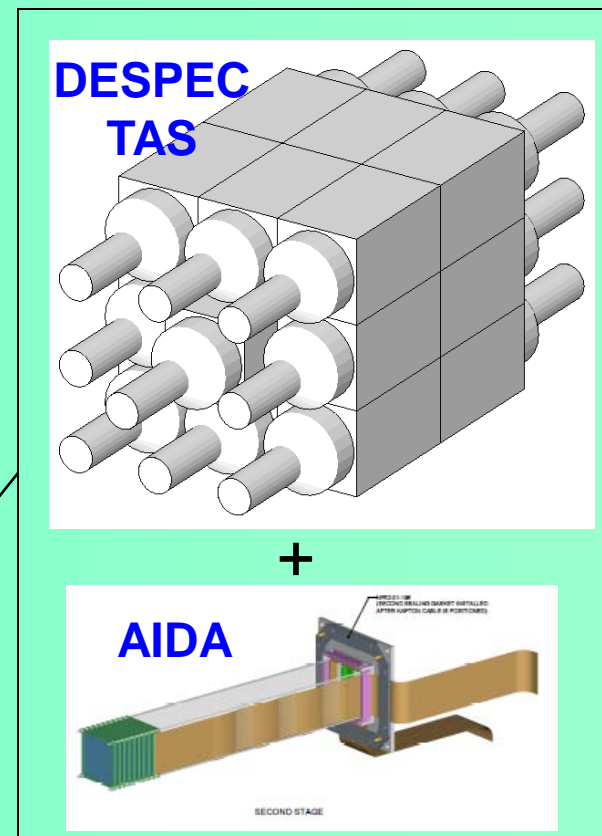
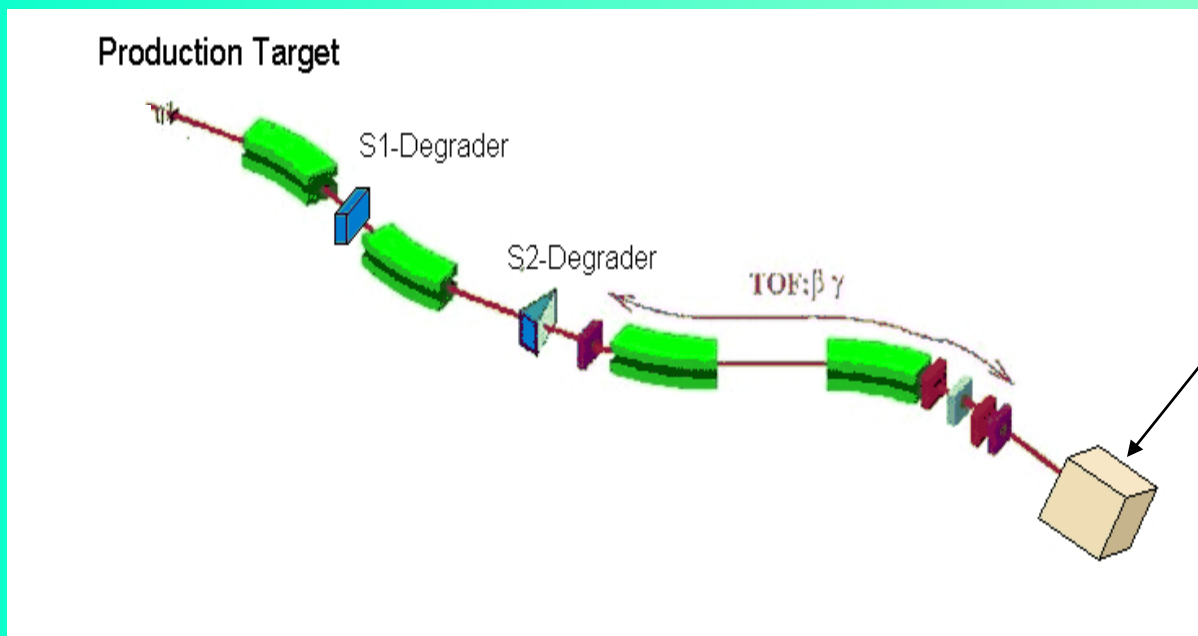


Beta strength measurements near to the 3rd r-process peak

(South-west of ^{208}Pb)



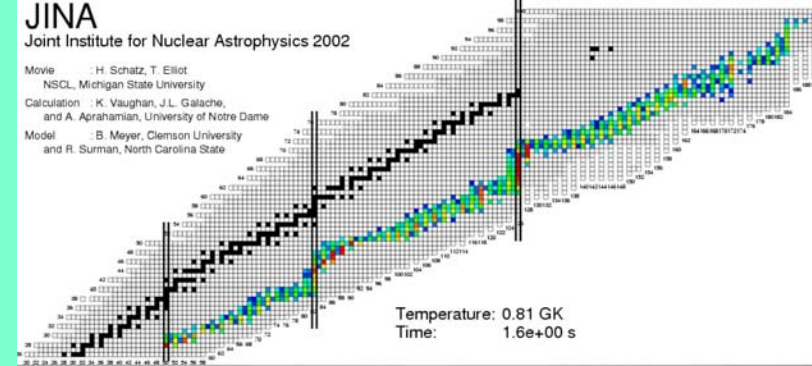
Darmstadt-Gatchina-Madrid-Santiago-Surrey-Valencia...



Jose L. Tain @ IFIC-Valencia

PRESPEC Decay Workshop, Brighton, January 12-13, 2011

- **Beta strength calculations are needed in order to obtain $T_{1/2}$ and P_n values for most of the nuclei involved in r-process calculations**



$$S_{\beta}(E_x) = \frac{1}{D} \frac{4\pi}{g_V^2} B_{i \rightarrow f}$$

$$B_{i \rightarrow f} = \frac{1}{2J_i + 1} \left| \langle f \| M_{\lambda\pi}^{\beta} \| i \rangle \right|^2$$

$\lambda\pi$: 0+ Fermi

$\lambda\pi$: 1+ Gamow-Teller

$\lambda\pi$: 0-, 1- Non-unique first forbidden

$\lambda\pi$: 2- Unique first forbidden

...

$$S_{\beta}(E_x) = \frac{I_{\beta}(E_x)}{f(Q_{\beta} - E_x) \cdot T_{1/2}}$$

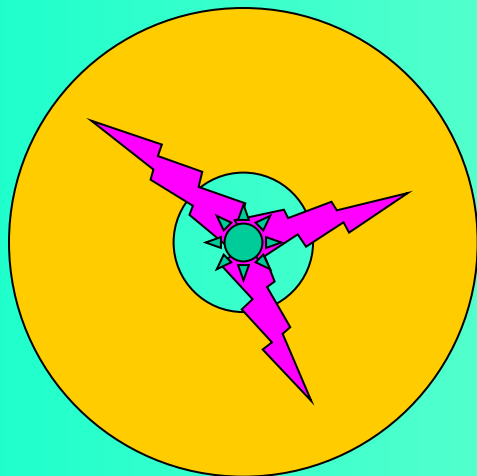
$$\frac{1}{T_{1/2}} = \int_0^{Q_{\beta}} S_{\beta}(E_x) \cdot f(Q_{\beta} - E_x) dE_x$$

$$P_n = T_{1/2} \times \int_{S_n}^{Q_{\beta}} \frac{\Gamma^n}{\Gamma^n + \Gamma^{\gamma}} S_{\beta}(E_x) \cdot f(Q_{\beta} - E_x) dE$$

- **The quality of the model calculations is judged by comparison with experimental $T_{1/2}$ and eventually P_n values in particular for the most neutron rich accessible nuclei, which are however integral quantities**
- **Direct comparison of calculated and measured S_{β} provides a more stringent test of the nuclear structure models**

Total Absorption Gamma-ray Spectroscopy:

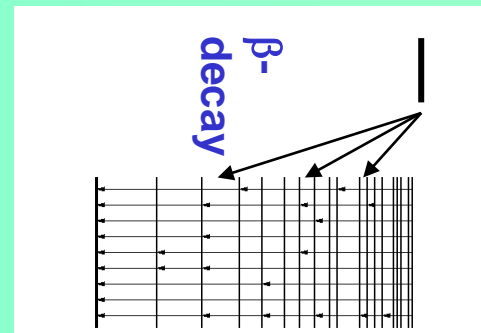
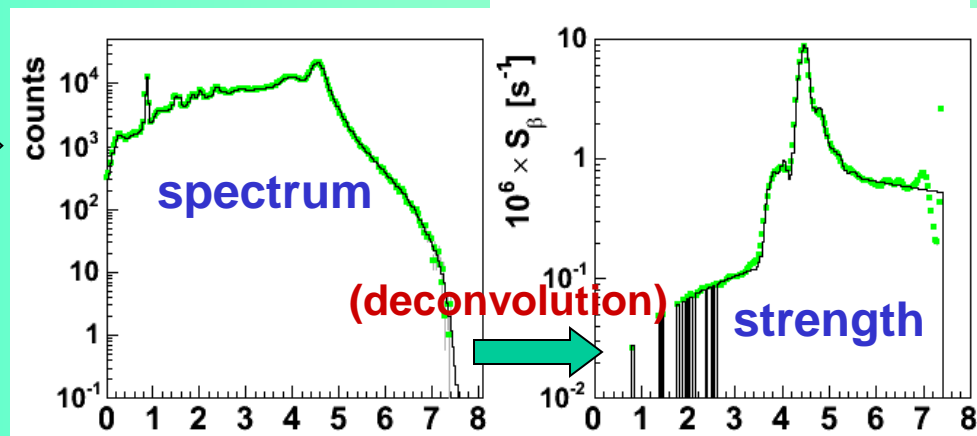
- Uses **large 4π scintillation detectors**, aiming to **detect the full γ -ray cascade** rather than individual γ -rays



ideal TAS
($\epsilon=100\%$)



real TAS



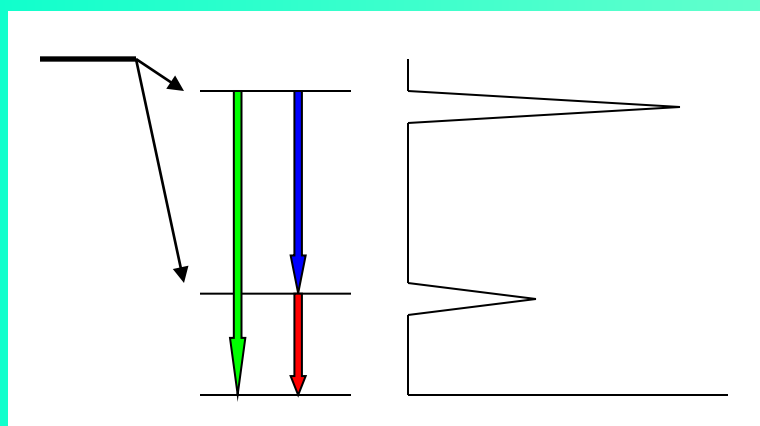
$$d_i = \sum_j R_{ij} f_j$$

Inverse problem

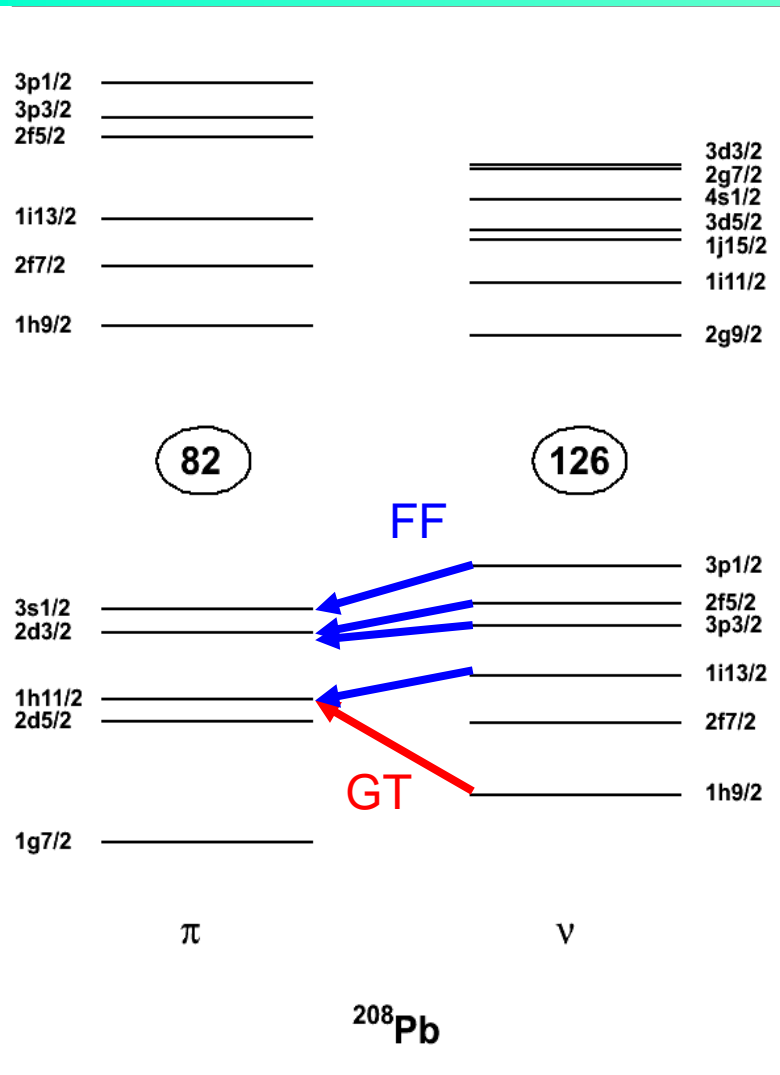
$$\mathbf{r}_j = \sum_{k=0}^{j-1} b_{jk} \mathbf{g}_{jk} \otimes \mathbf{r}_k$$

$$\mathbf{R}_j = \beta_j \otimes \mathbf{r}_j$$

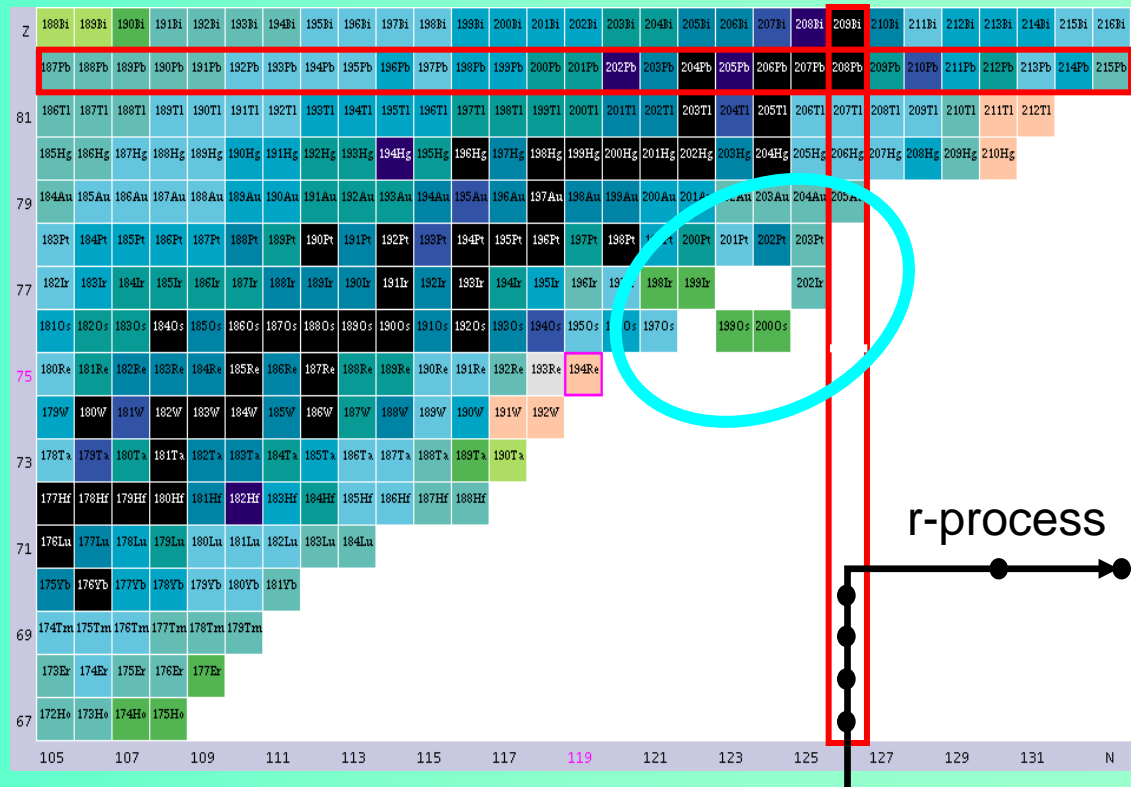
MC simulations
+ know level sch.
+ statistical model

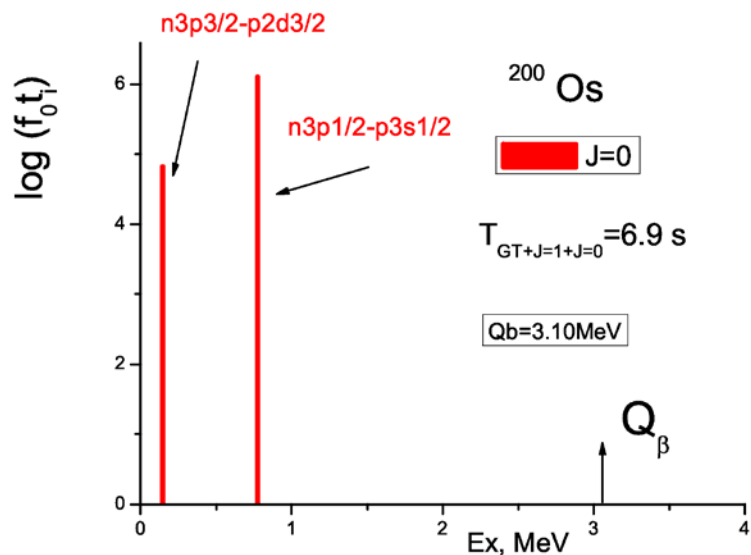
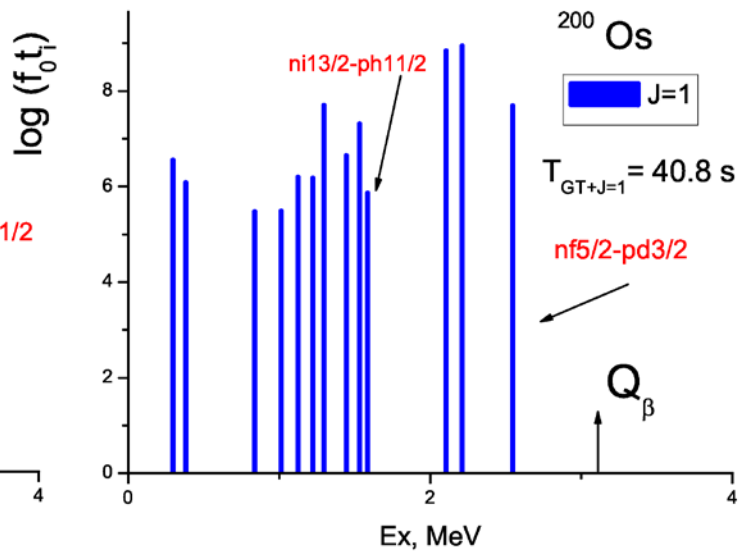
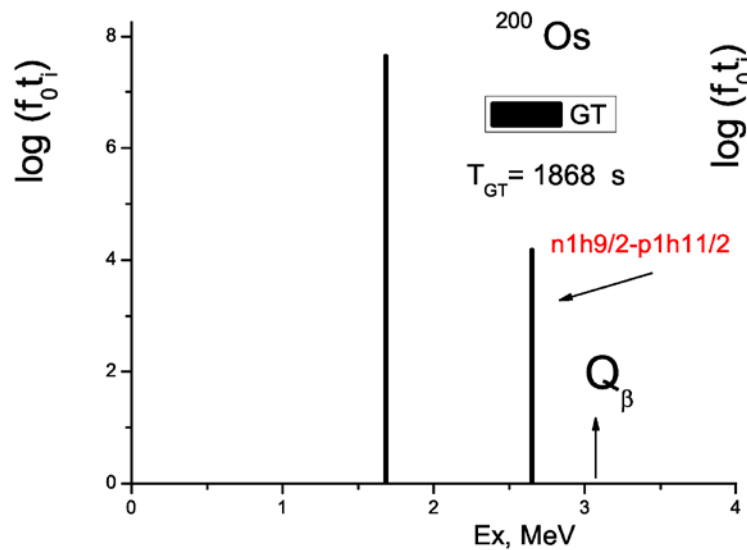


“South-west” of ^{208}Pb



- “Close” to r-process 3rd abundance peak
- Decay dominated by FF transitions
- Largely unexplored but accessible at GSI





b	204Pb	205Pb	206Pb	207Pb	208Pb	209Pb	210Pb
l	203Tl	204Tl	205Tl	206Tl	207Tl	208Tl	209Tl
g	202Hg	203Hg	204Hg	205Hg	206Hg	207Hg	208Hg
u	201Au	202Au	203Au	204Au	205Au		
t	200Pt	201Pt	202Pt	203Pt			
r	199Ir			202Ir			
s		199Os	200Os				

Borzov, Phys.At.Nucl. (2011)

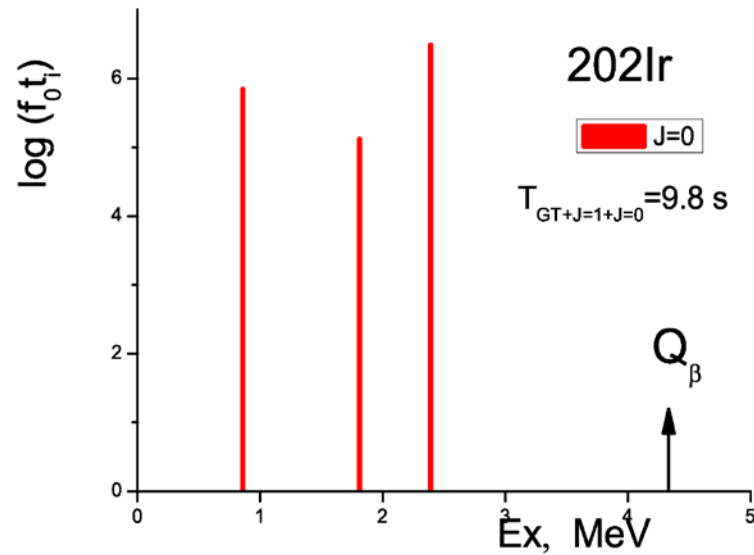
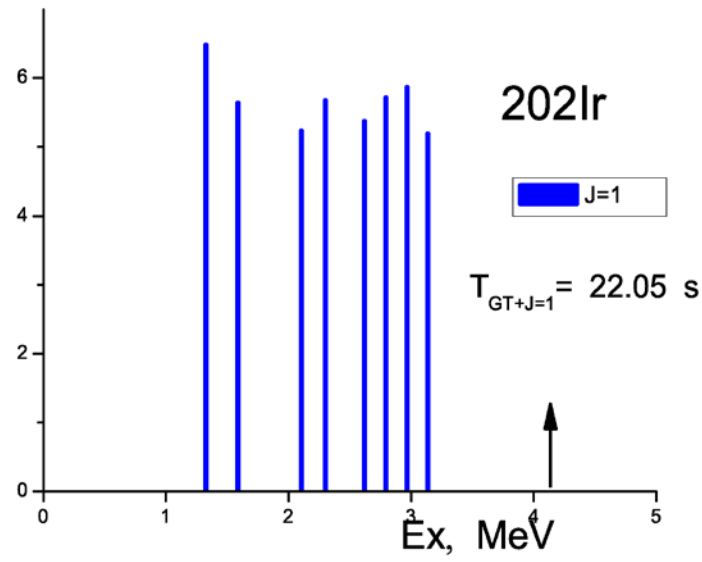
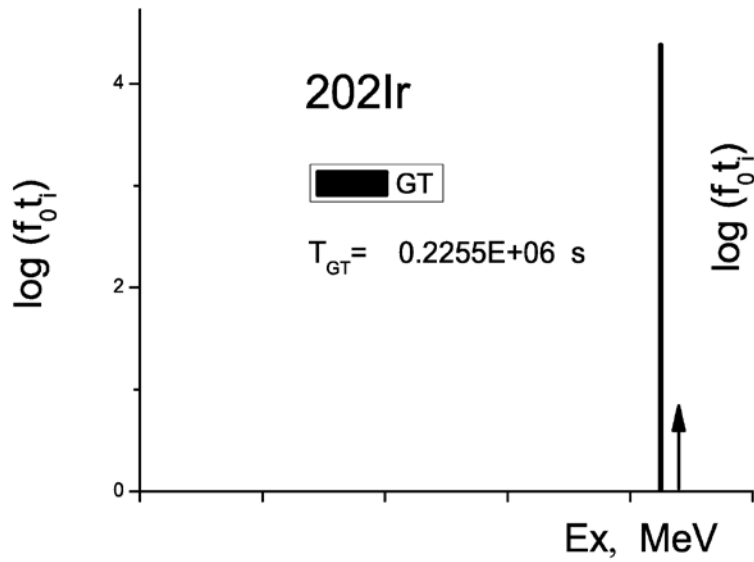
- DF+QRPA
- both GT and FF microscopic
- no deformation

$Q_{\beta} = 2.6\text{ MeV (SY)}$

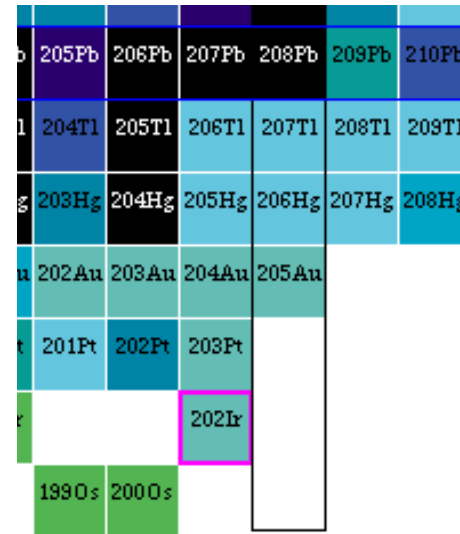
Expected number of levels: $N^{\text{lev}}=800$
 Goriely et al. PRC78(08) 064307

^{200}Os

($Z=76, N=124$)



$Q_b = 4.37$ MeV

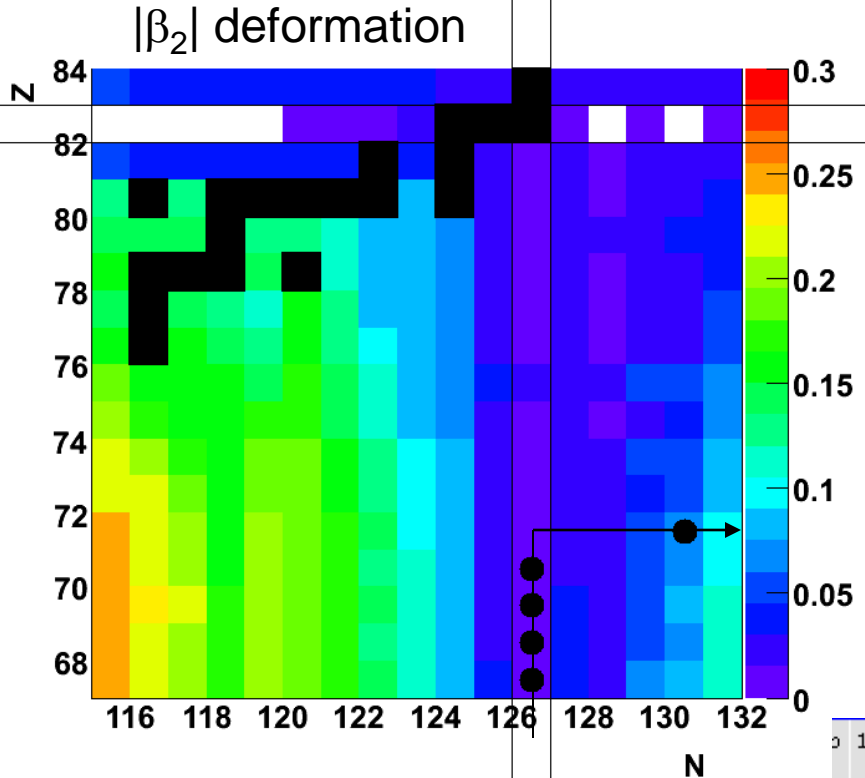


202Ir

(Z=77, N=125)

$Q_\beta = 5.4$ MeV (SY)

Expected number of levels: $N^{lev} = 4.1 \times 10^4$



• Further into the play: deformation

Moeller et al., ADNDT59(95)185

Pb	198Pb	199Pb	200Pb	201Pb	202Pb	203Pb	204Pb	205Pb	206Pb	207Pb	208Pb	209Pb	210Pb
Tl	197Tl	198Tl	199Tl	200Tl	201Tl	202Tl	203Tl	204Tl	205Tl	206Tl	207Tl	208Tl	209Tl
Hg	196Hg	197Hg	198Hg	199Hg	200Hg	201Hg	202Hg	203Hg	204Hg	205Hg	206Hg	207Hg	208Hg
Au	195Au	196Au	197Au	198Au	199Au	200Au	201Au	202Au	203Au	204Au	205Au		
Pt	194Pt	195Pt	196Pt	197Pt	198Pt	199Pt	200Pt	201Pt	202Pt	203Pt			
Ir	193Ir	194Ir	195Ir	196Ir	197Ir	198Ir	199Ir				202Ir		
Os	192Os	193Os	194Os	195Os	196Os	197Os		199Os	200Os				
Re	191Re	192Re	193Re	194Re									
W	190W	191W	192W										

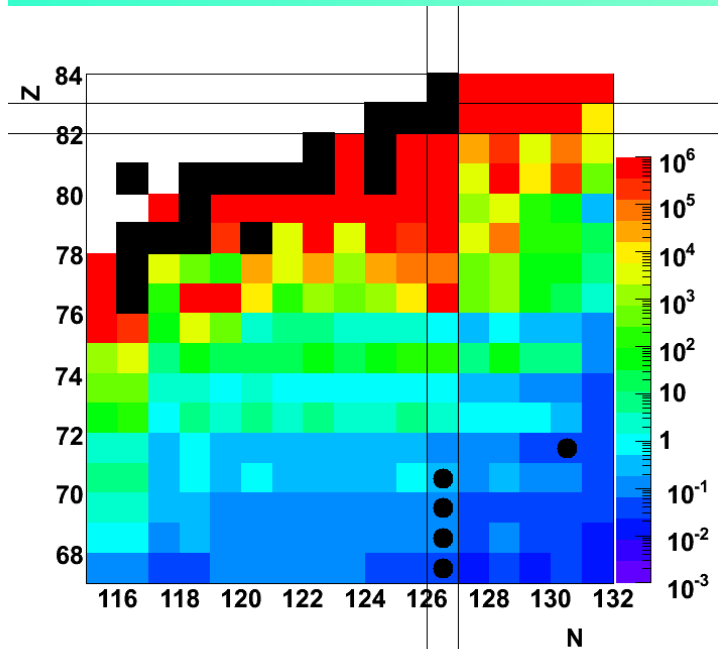
2.09E-1	6.02E-2
1.85E-1	5.31E-2
1.63E-1	4.69E-2
1.44E-1	4.14E-2
1.27E-1	3.65E-2
1.12E-1	3.22E-2
9.91E-2	2.84E-2
8.75E-2	2.51E-2
7.72E-2	2.21E-2
6.82E-2	1.95E-2
6.02E-2	1.72E-2
unknown	

(Exp: NuDat)

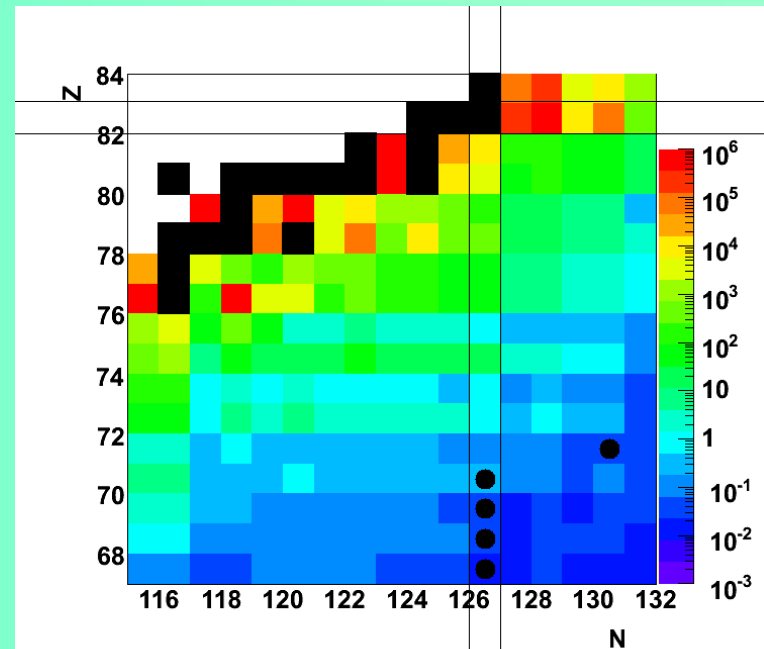
- Moeller et al.
- FRDM+QRPA
 - FF from Gr.Th.
 - deformation
 - exper. Q_β , S_n

$T_{1/2}$

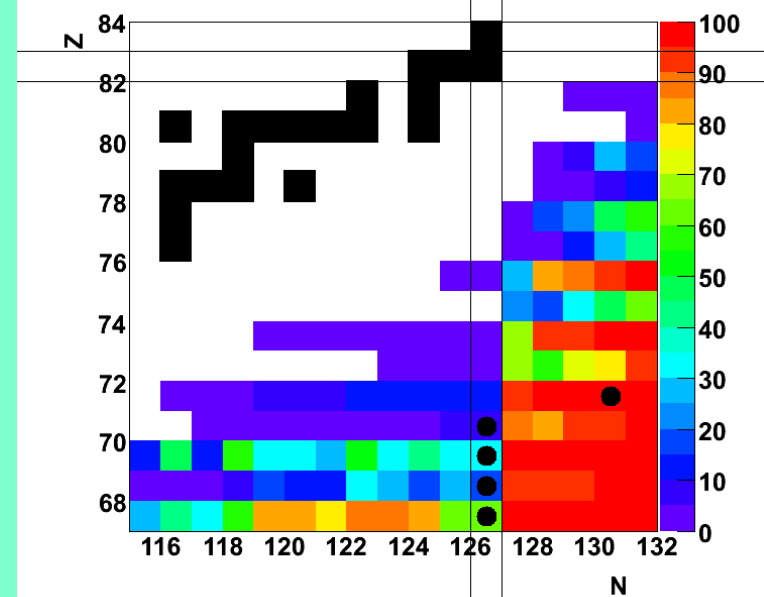
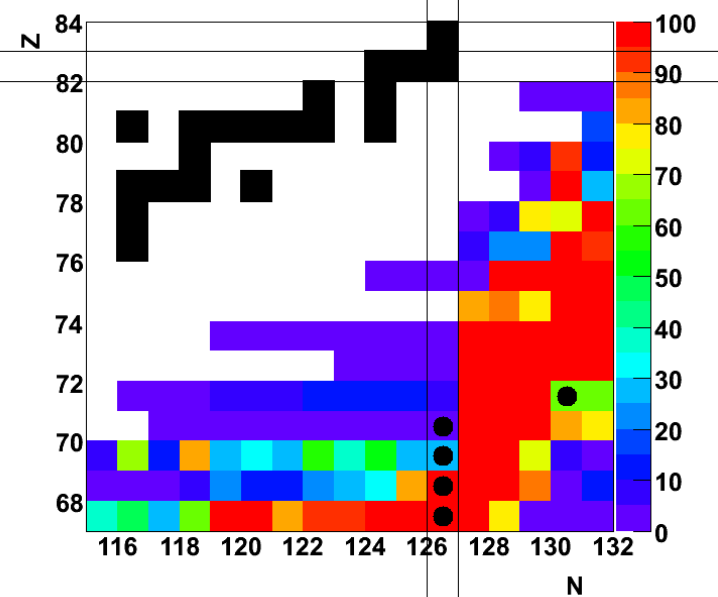
ADNDT66(97)131 : GT

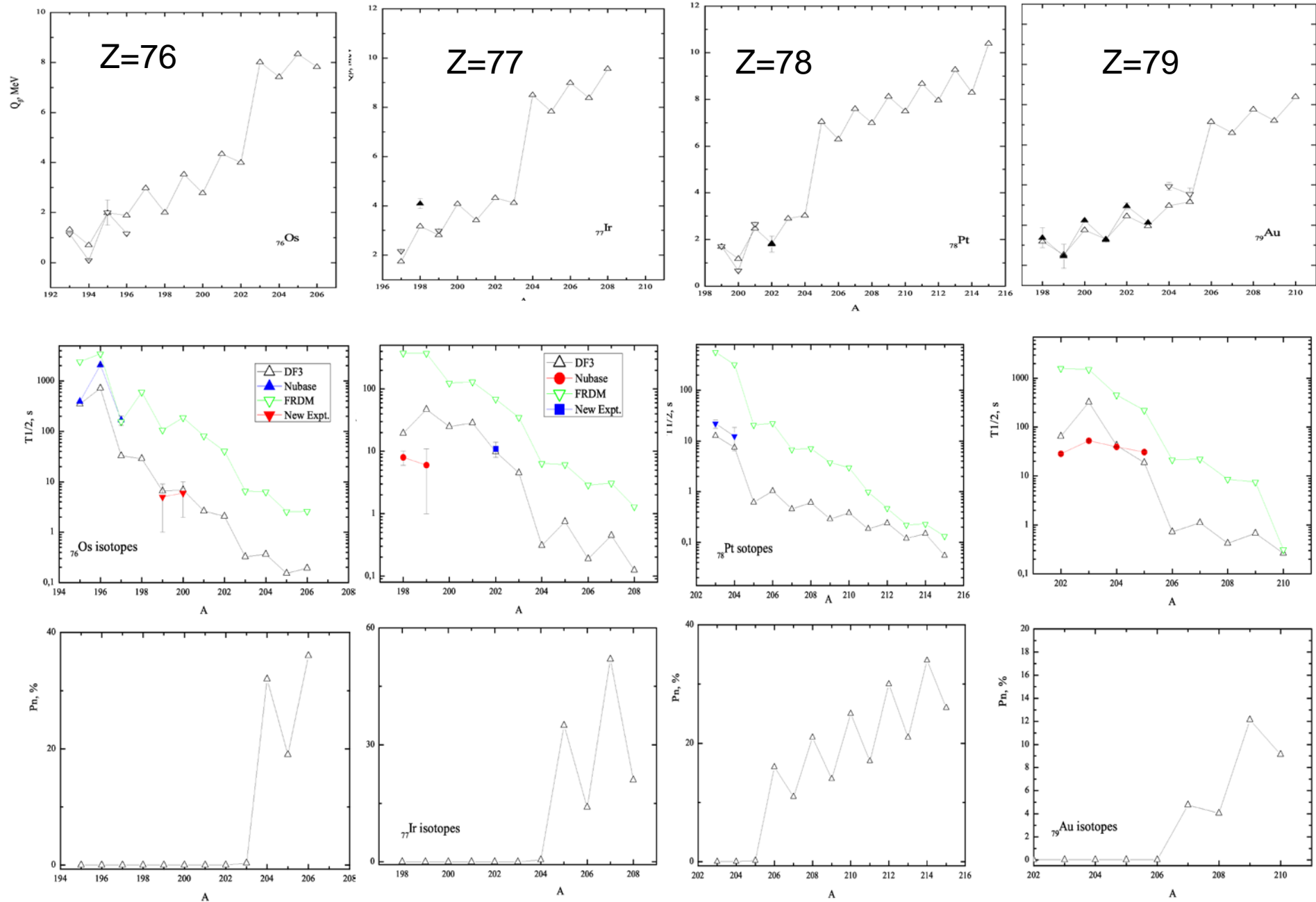


PRC67(03)055802 : GT+FF



P_n





- Region accessible with enough statistics

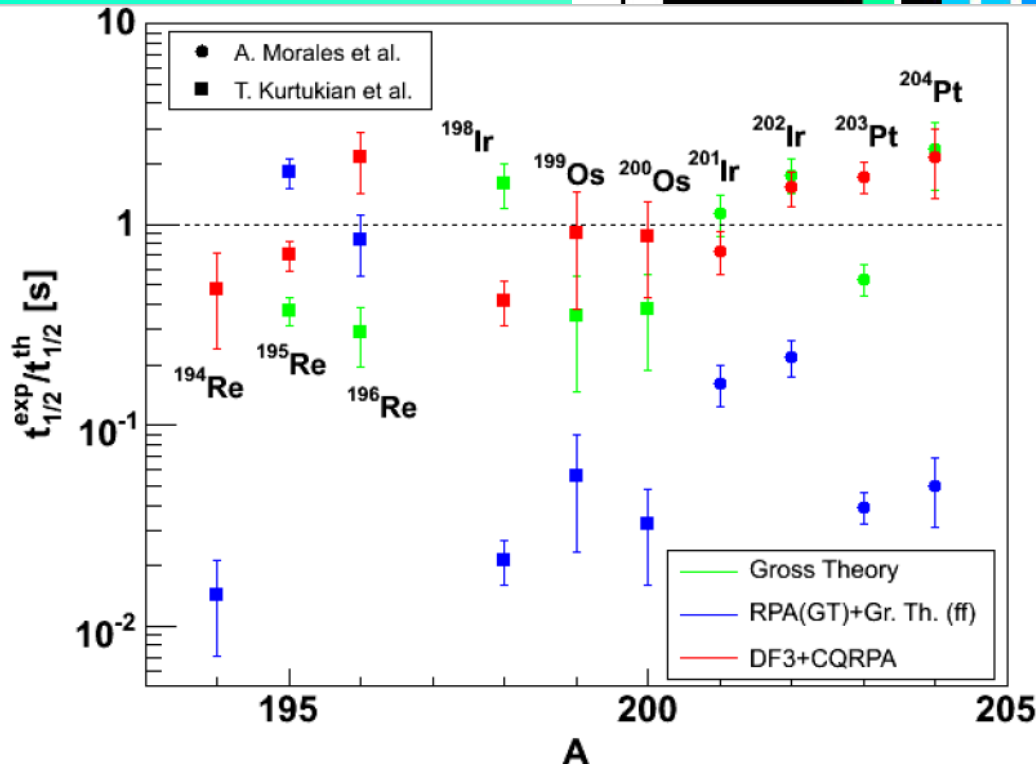
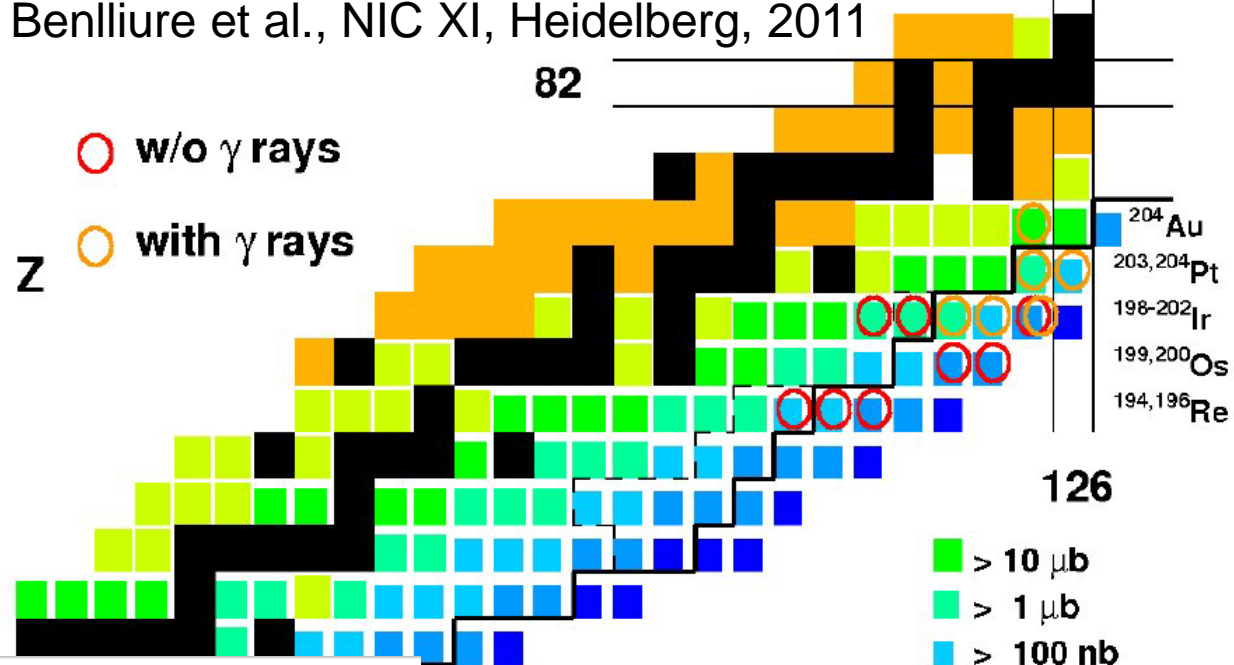
(²⁰⁴Au, ^{204,203}Pt, ²⁰¹Ir, ...)

208Pb (1 GeV/u)
+
Be (2.5 g/cm²)

Z ↑

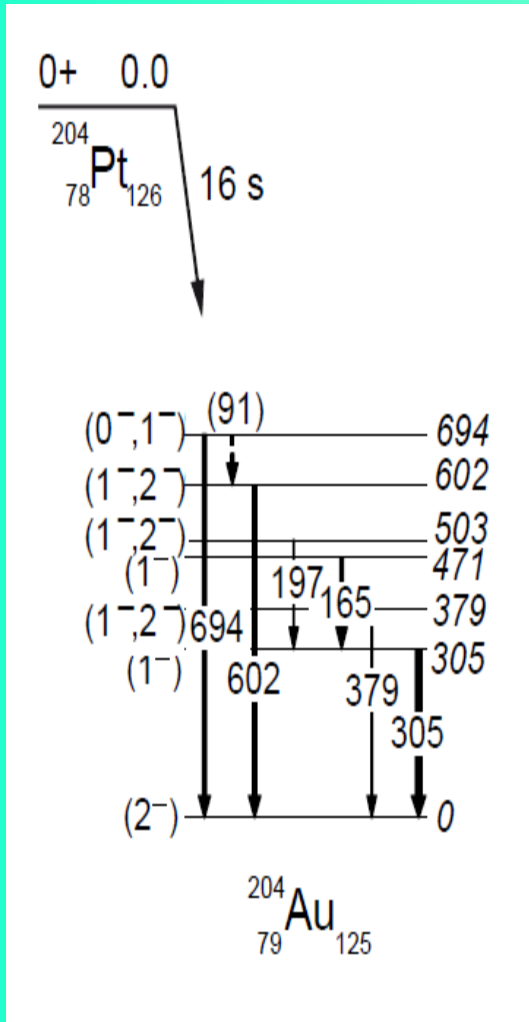
○ w/o γ rays

○ with γ rays



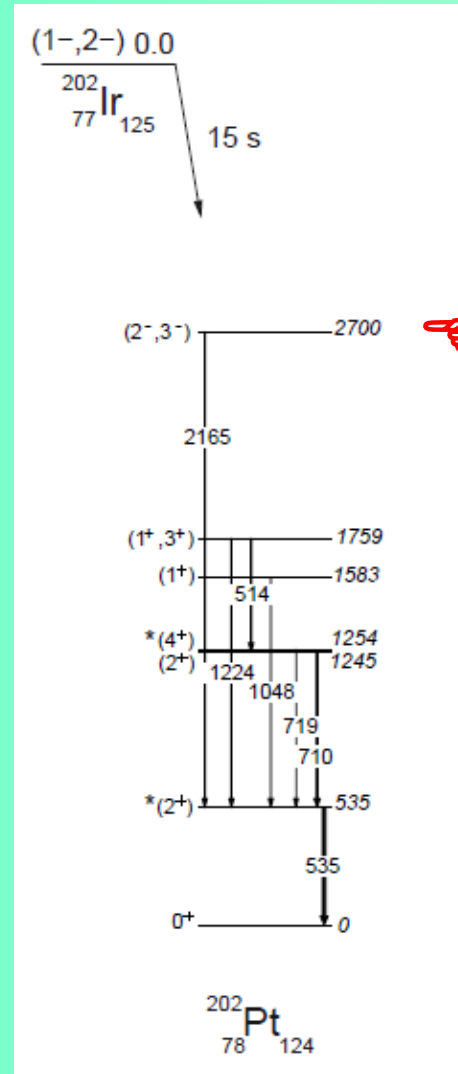
N →

- T. Kurtukian et al., NPA827 (2009) 687c
- A.I. Morales, PhD Thesis, U. Santiago, 2011



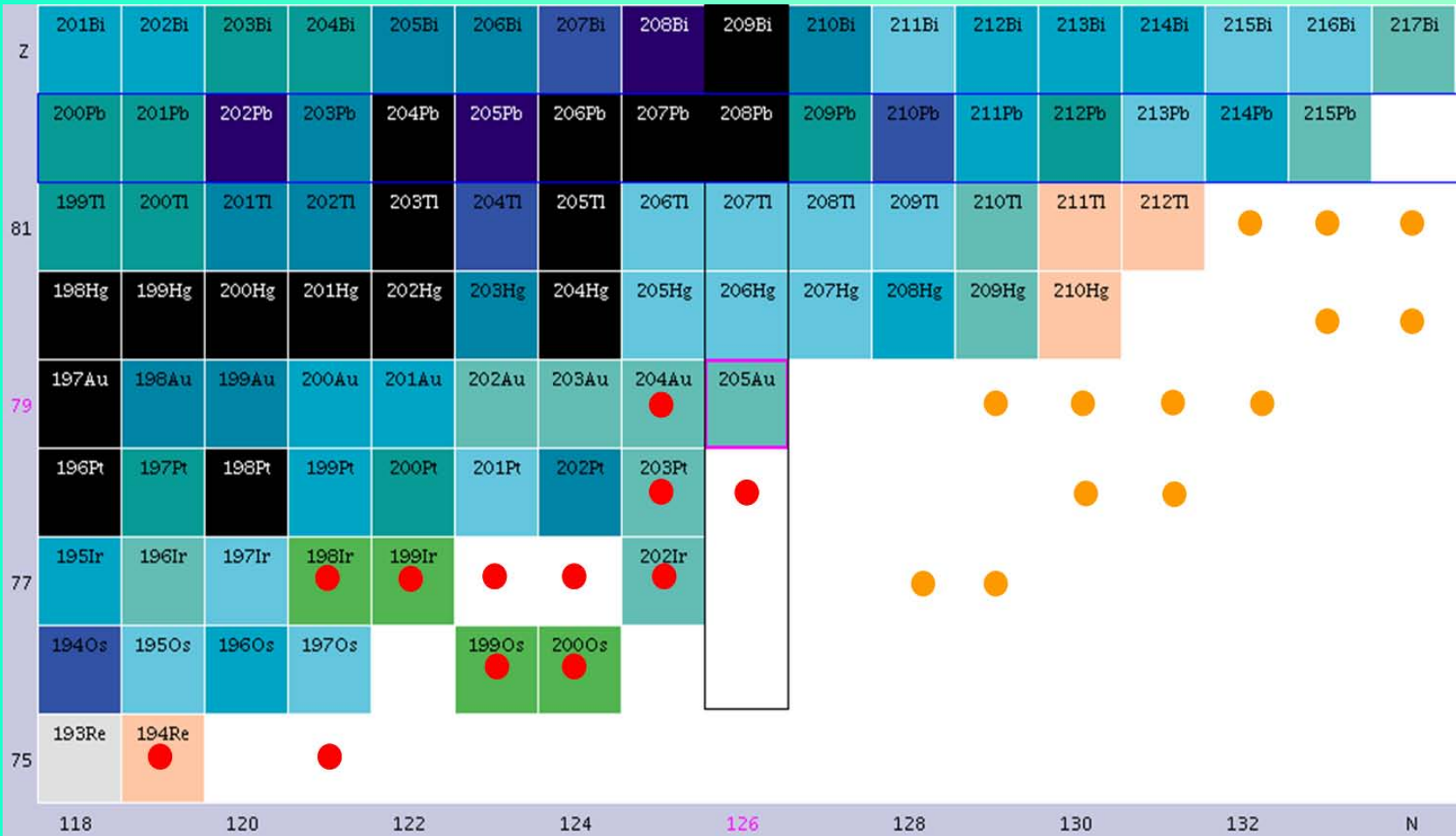
$$Q_{\beta} = 2.3 \text{ MeV (SY)}$$

$$N^{\text{lev}} = 2.7 \times 10^3$$



$$Q_{\beta} = 5.4 \text{ MeV (SY)}$$

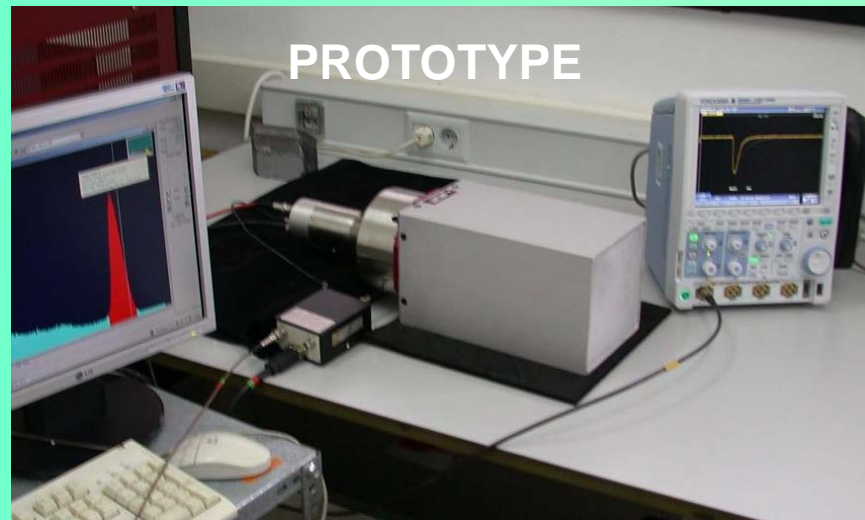
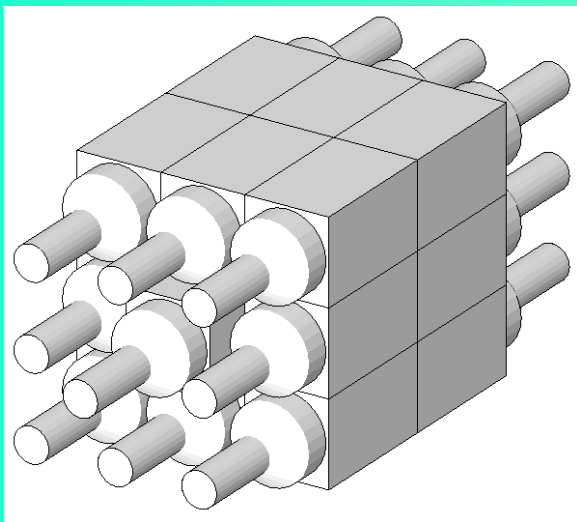
$$N^{\text{lev}} = 4.1 \times 10^4$$



- J. Benlliure et al., NIC XI, Heidelberg, 2011
- C. Domingo-Pardo et al., Experiment S410

16 + 1 modules:

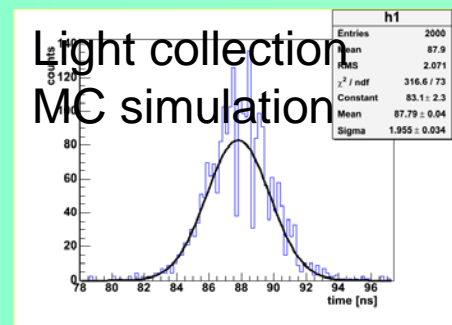
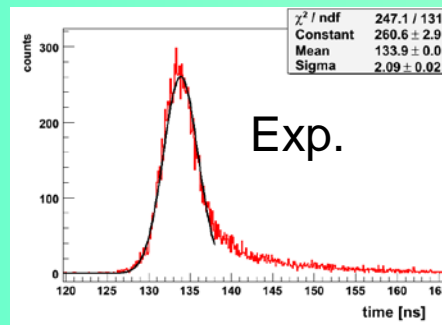
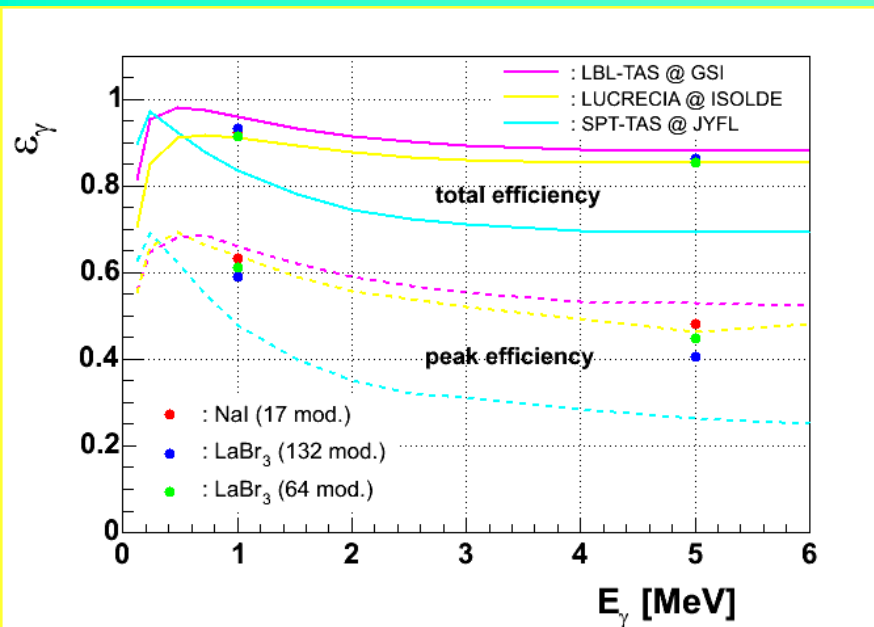
15×15×25 cm³ NaI(Tl)
+ 5" PMT (50% light col.)
V= 95 L, M= 351 kg



PROTOTYPE

$R_E = 6.8\%$ @662keV

$\Delta t(\text{FWHM}) = 4.5 \text{ ns}$



- Half detector will be ordered this year
- The rest in 2012