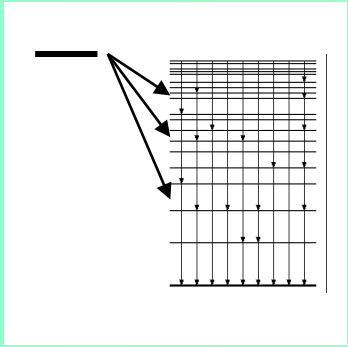
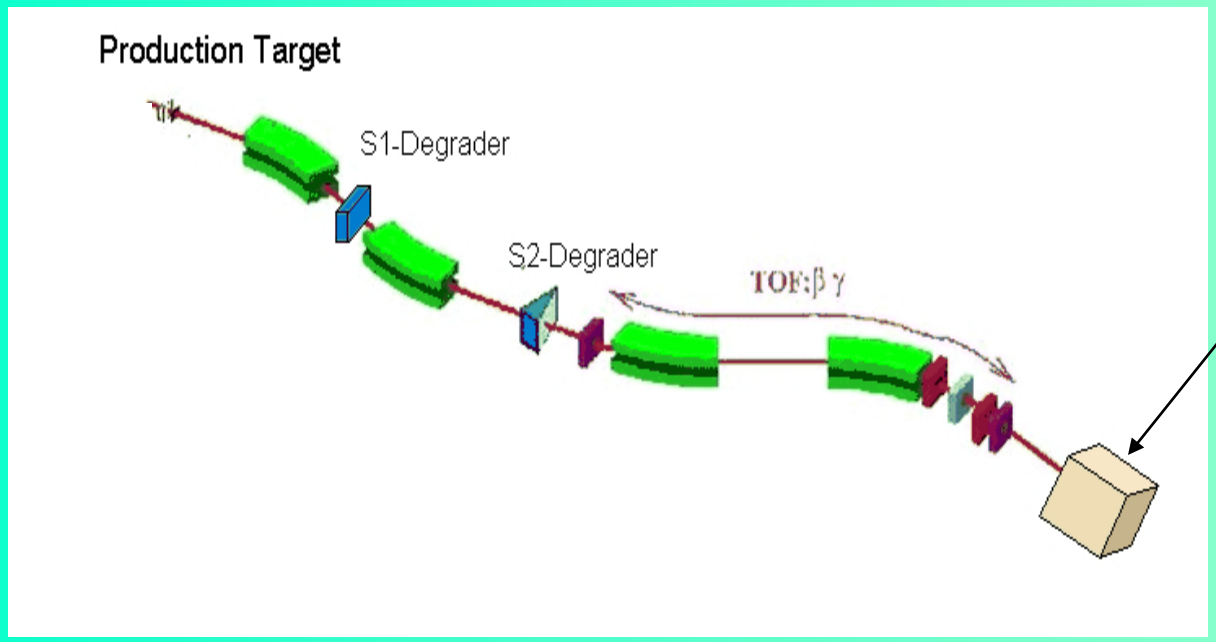
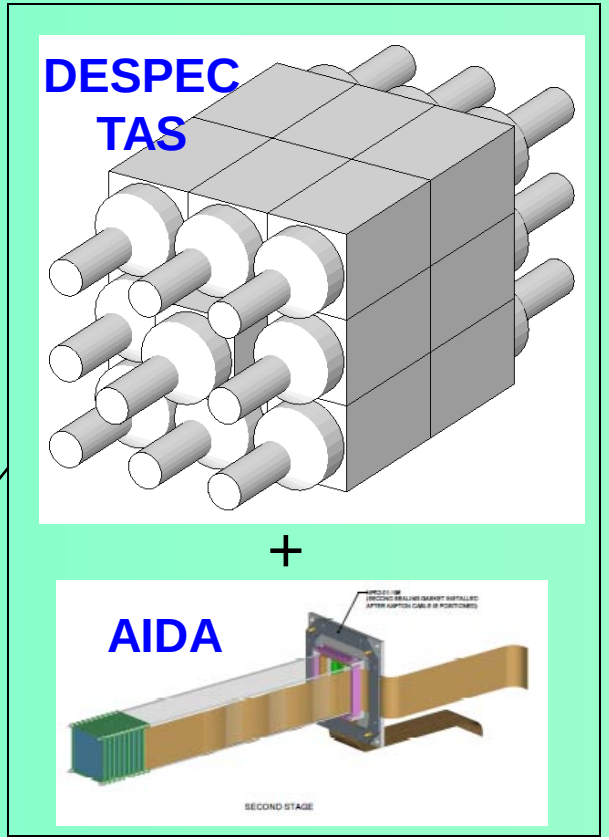
Beta strength measurements near to the 3rd r-process peak

(South-west of ^{208}Pb)



Darmstadt-Gatchina-Madrid-Santiago-Surrey-Valencia…

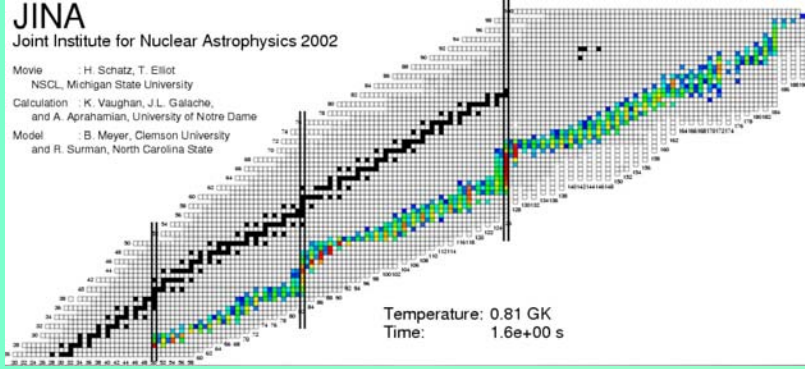




Jose L. Tain @ IFIC-Valencia

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**



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

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

λπ: 0+ Fermi
λπ: 1+ Gamow-Teller
λπ: 0-,1- Non-unique first forbidden
λπ: 2- Unique first forbidden
…

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

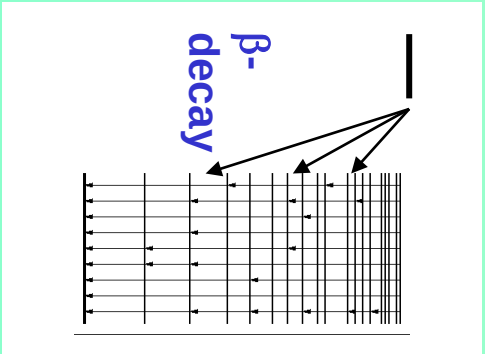
$$\frac{1}{T_{1/2}} = \int_0^{Q_\beta} S_\beta(E_x)\cdot f(Q_\beta - E_x)\,dE_x$$

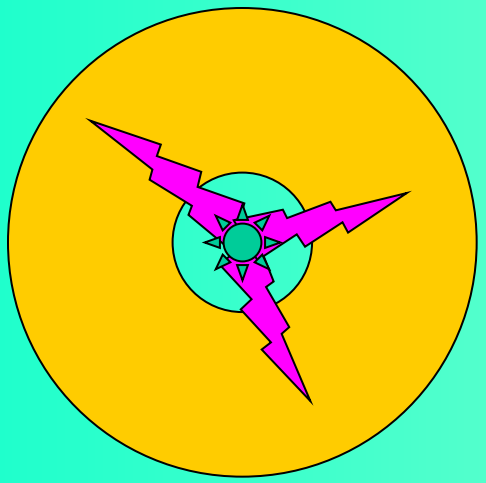
$$P_n = T_{1/2} \times \int_{S_n}^{Q_\beta} \frac{\Gamma^n}{\Gamma^n + \Gamma^\gamma} S_\beta(E_x)\cdot f(Q_\beta - E_x)\,dE$$

• **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**

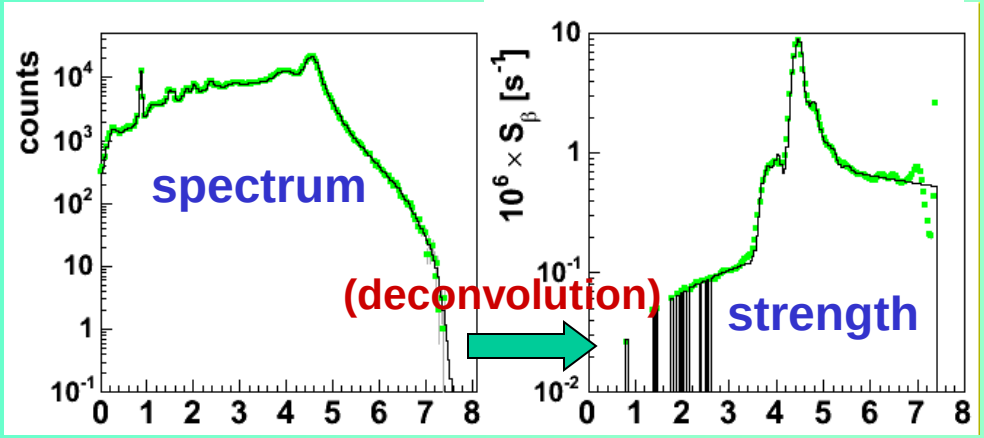
Total Absorption Gamma-ray Spectroscopy:

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

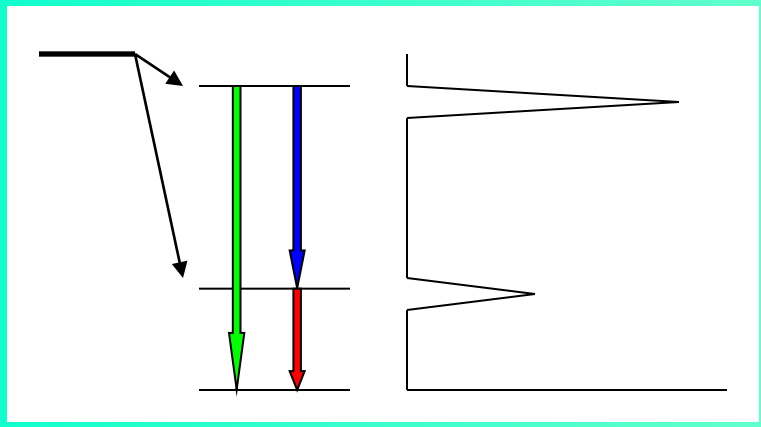




real TAS



ideal TAS (ε=100%)



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

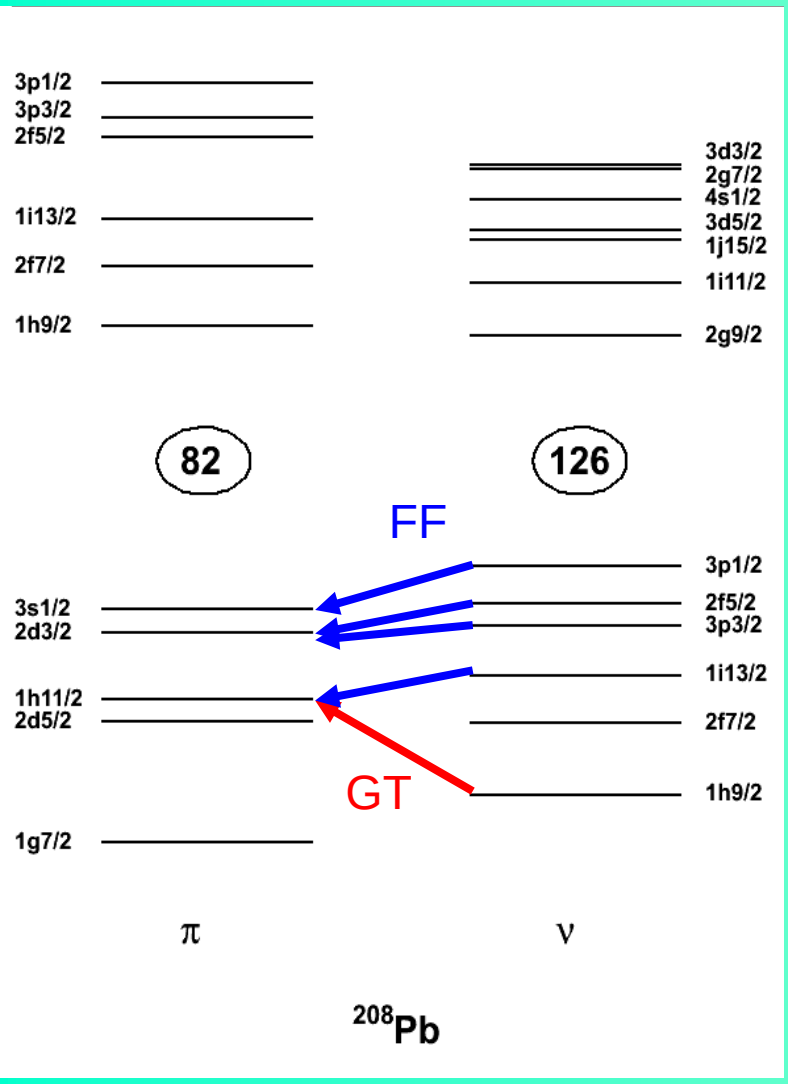
Inverse problem

$$\mathbf{r_j} = \sum_{k=0}^{j-1} b_{jk} \mathbf{g_{jk}} \otimes \mathbf{r_k}$$

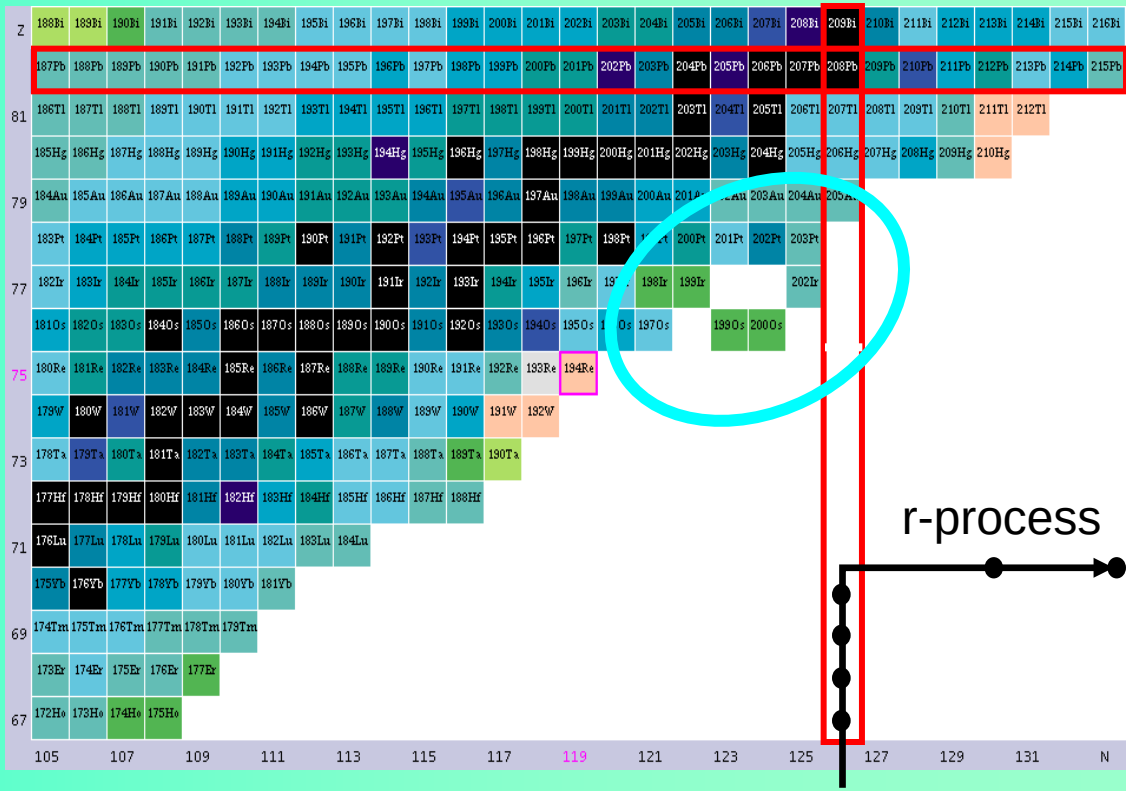
$$\mathbf{R_j} = \boldsymbol{\beta_j} \otimes \mathbf{r_j}$$

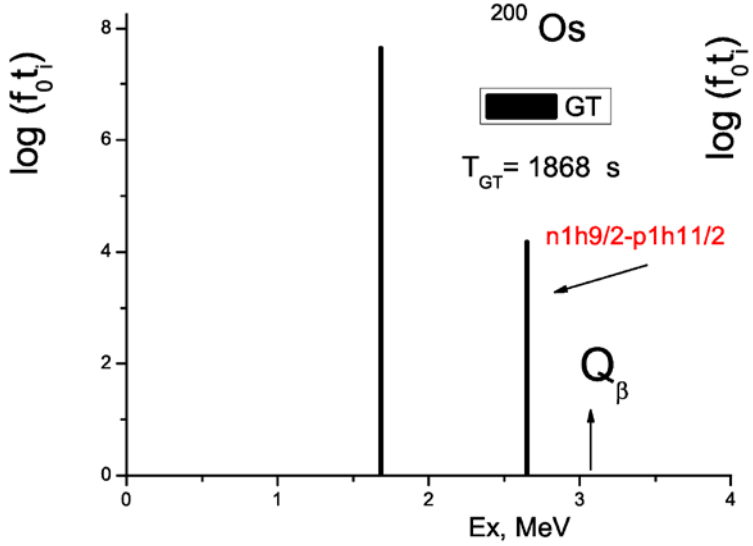
MC simulations
+ know level sch.
+ statistical model

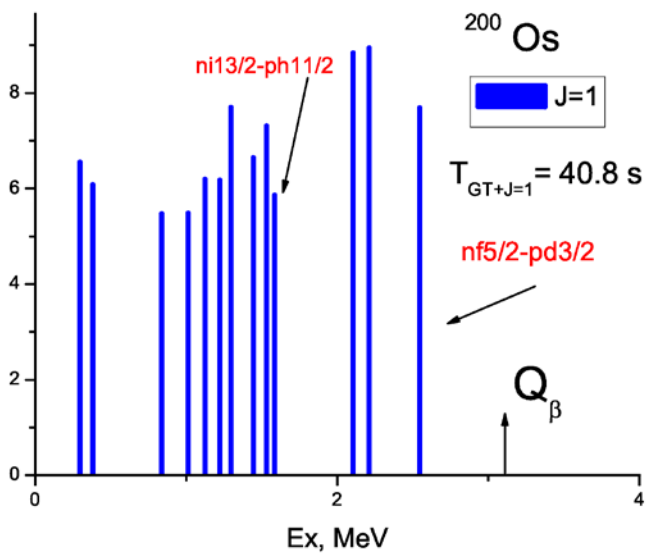
“South-west” of ^{208}Pb

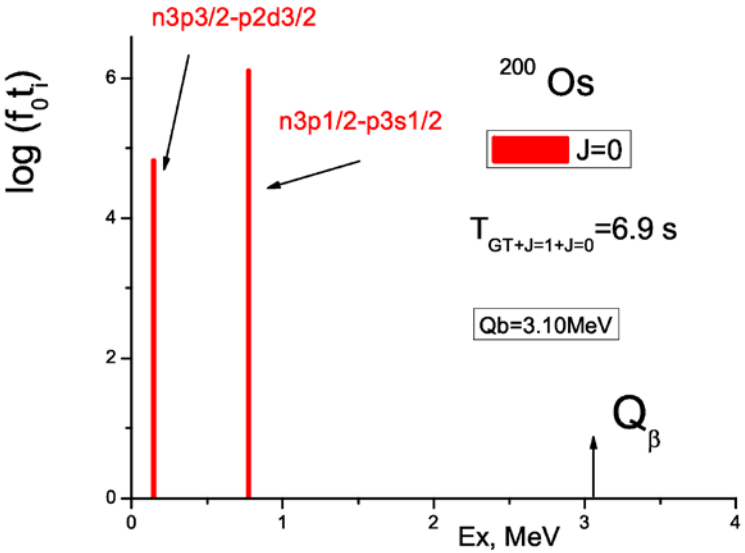


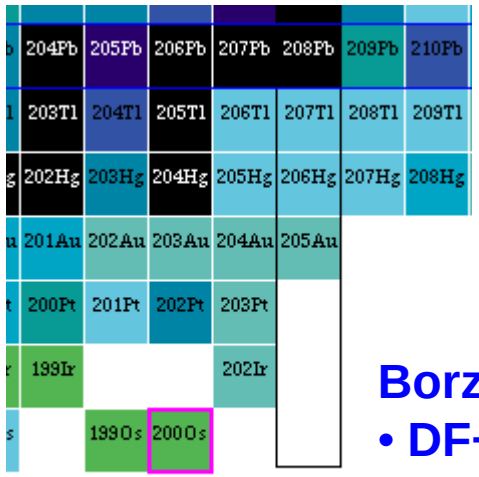
- “Close” to r-process 3rd abundance peak
- Decay dominated by FF transitions
- Largely unexplored but accessible at GSI











^{200}Os

(Z=76, N=124)

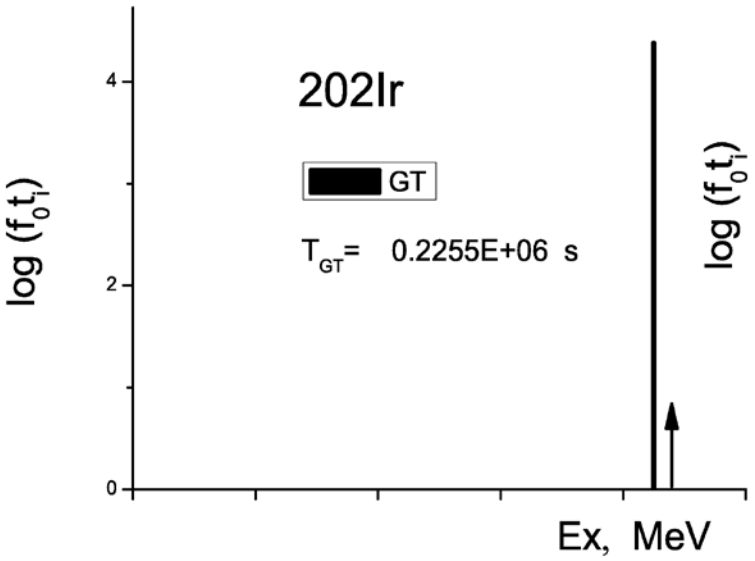
Borzov, Phys.At.Nucl. (2011)

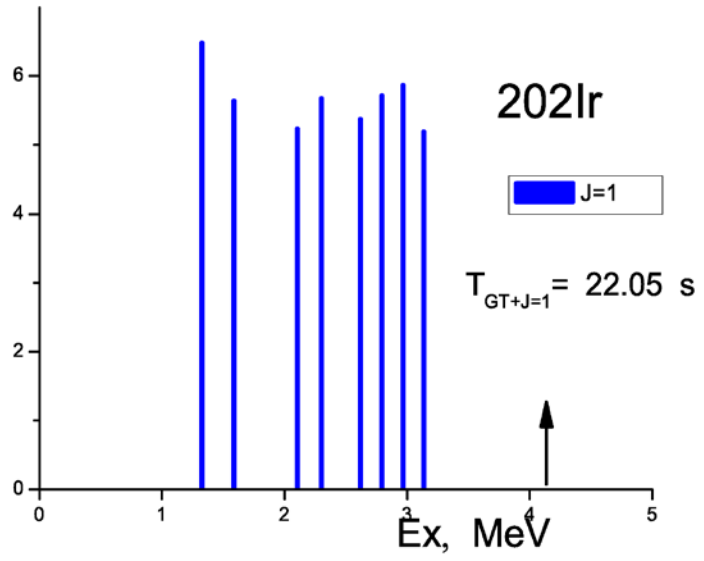
- **DF+QRPA**
- **both GT and FF microscopic**
- **no deformation**

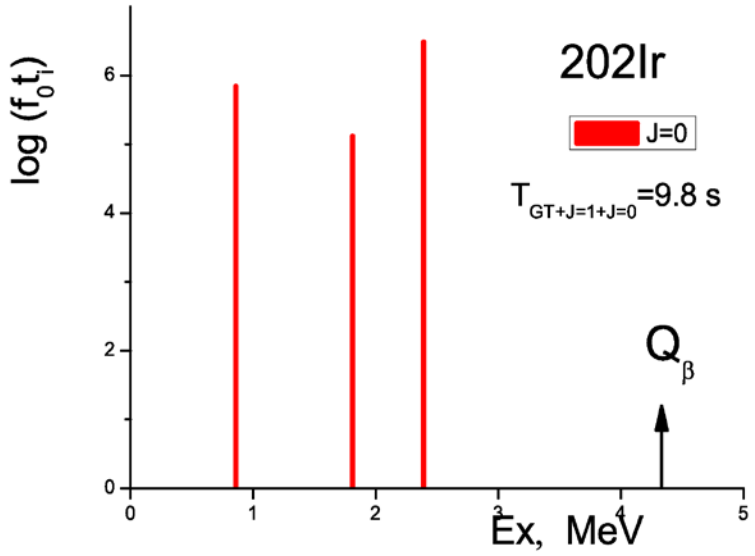
Q_β = 2.6 MeV (SY)

Expected number of levels: N^{lev}=800

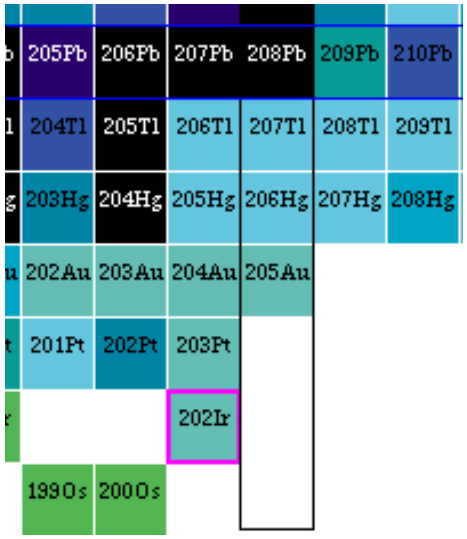
Goriely et al. PRC78(08) 064307







Qb=4.37MeV

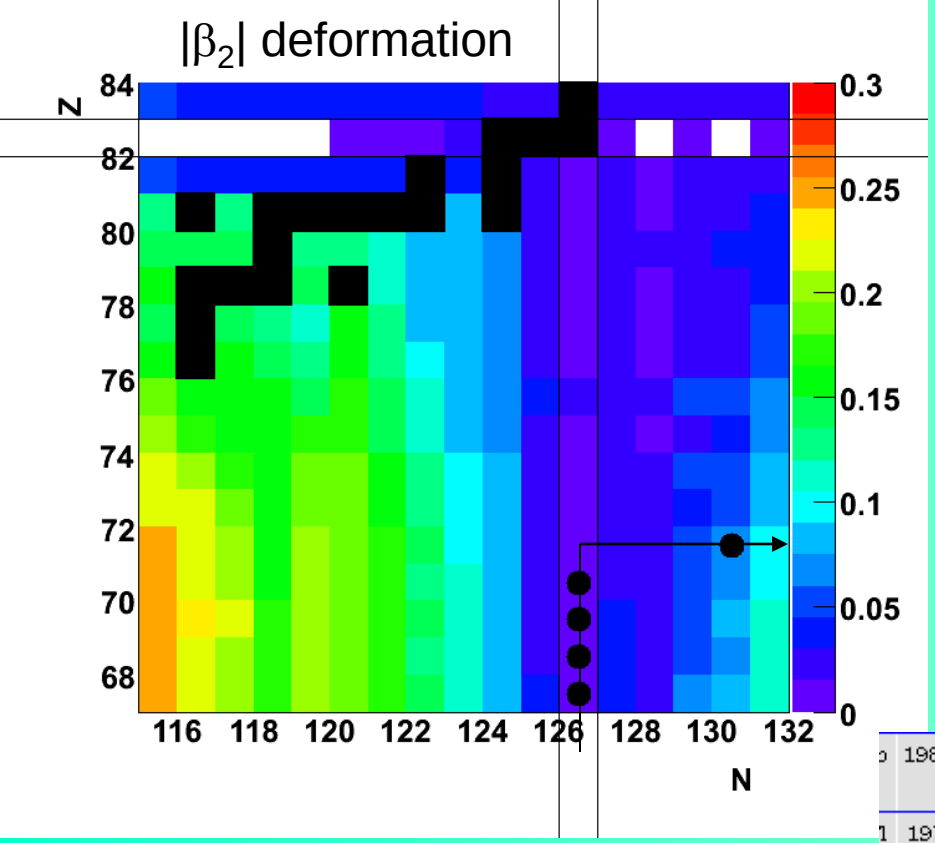


^{202}Ir

(Z=77, N=125)

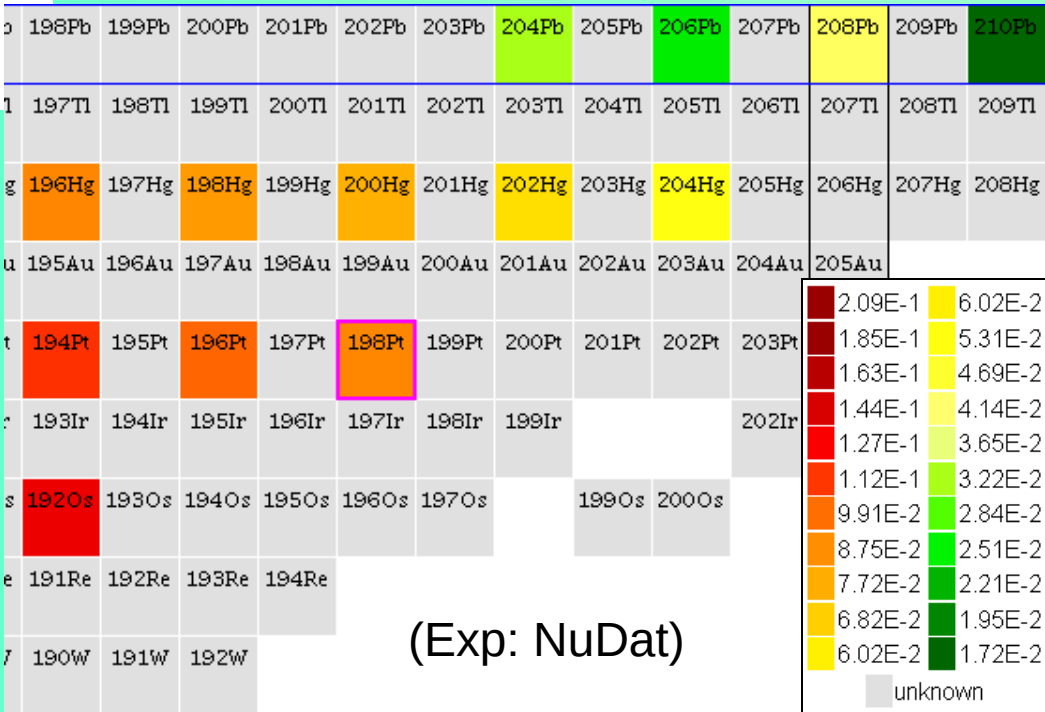
Q_β = 5.4 MeV (SY)

Expected number of levels: $N^{lev}=4.1\times10^4$



Moeller et al., ADNDT59(95)185

- Further into the play: deformation



(Exp: NuDat)

Moeller et al.

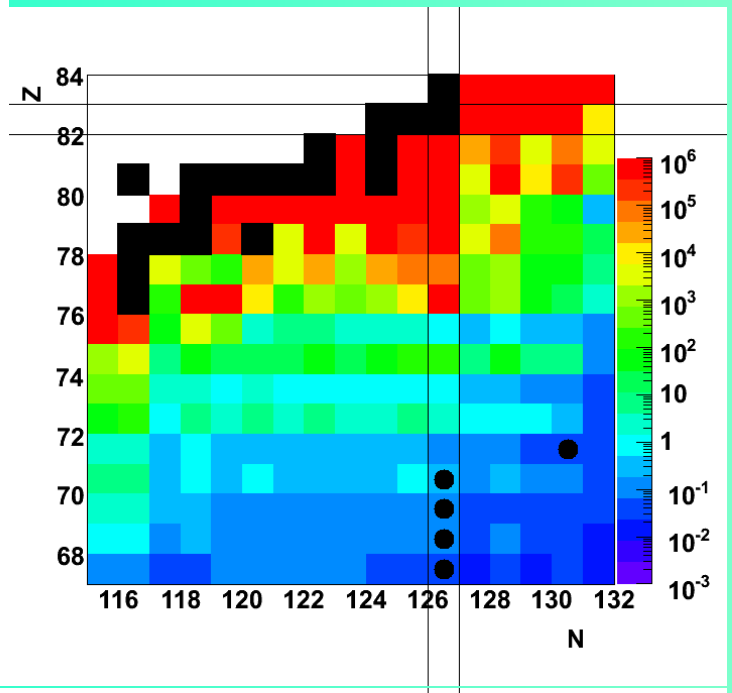
- **FRDM+QRPA**
- **FF from Gr.Th.**
- **deformation**
- **exper. Q_β, S_n**

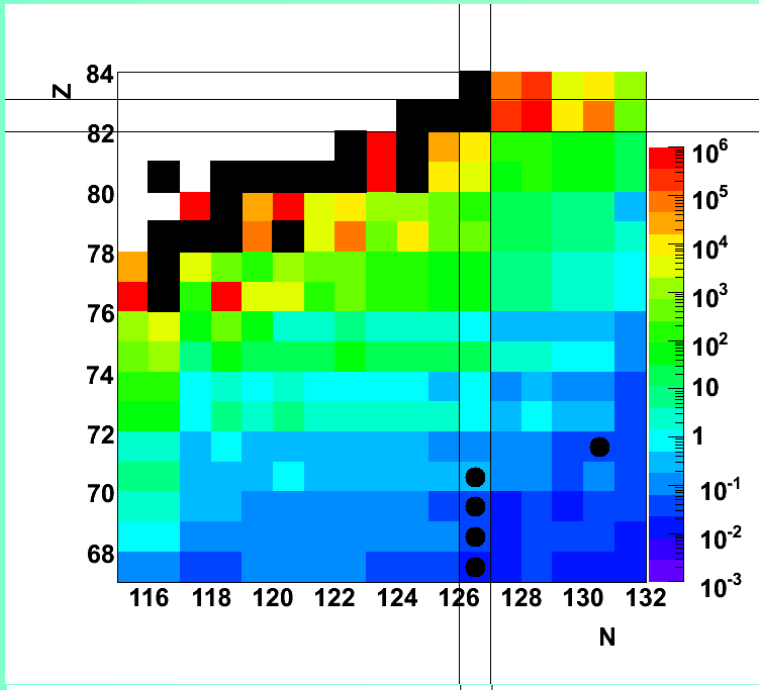
$T_{1/2}$

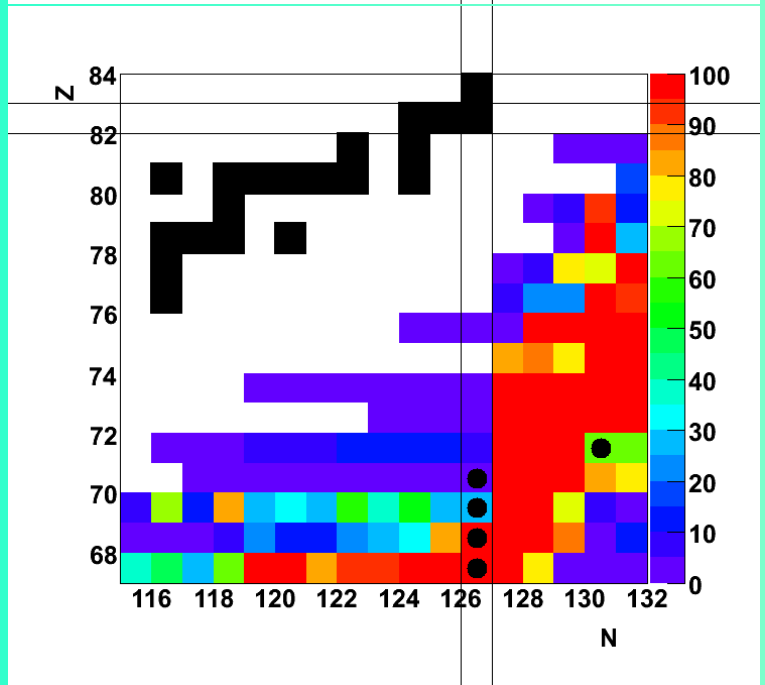
P_n

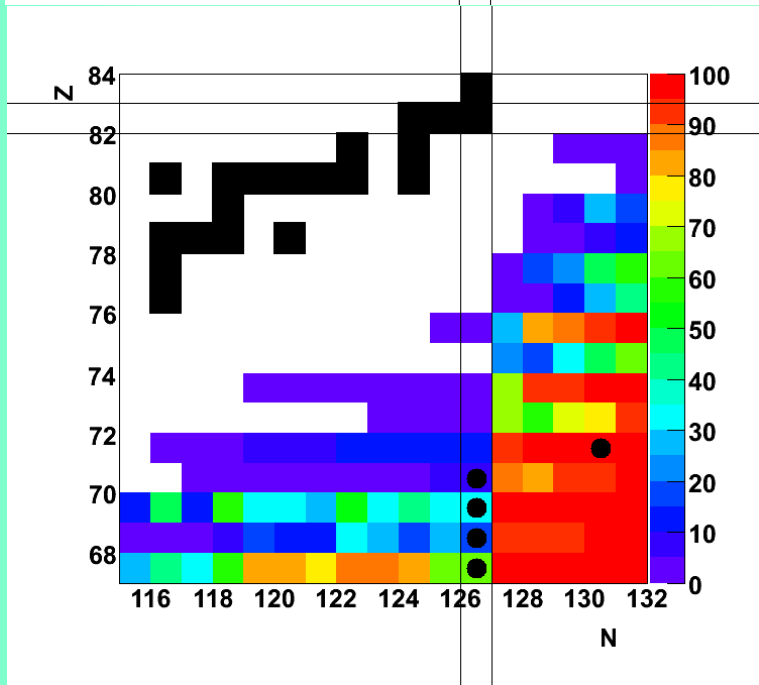
ADNDT66(97)131 : GT

PRC67(03)055802 : GT+FF

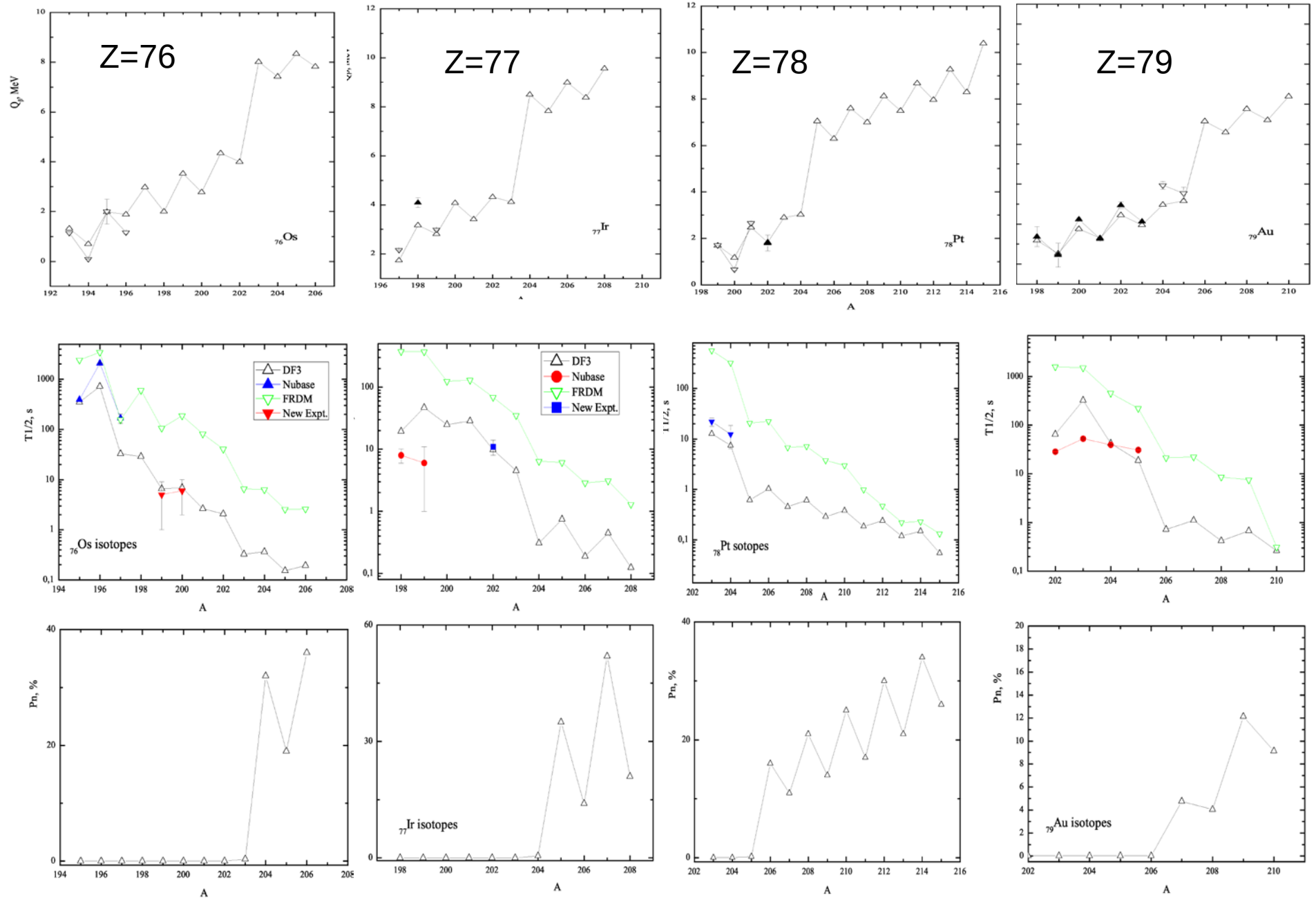








DF3: Borzov, Phys.At.Nucl. (2011), FRDM: Moeller et al., PRC67(03)055802

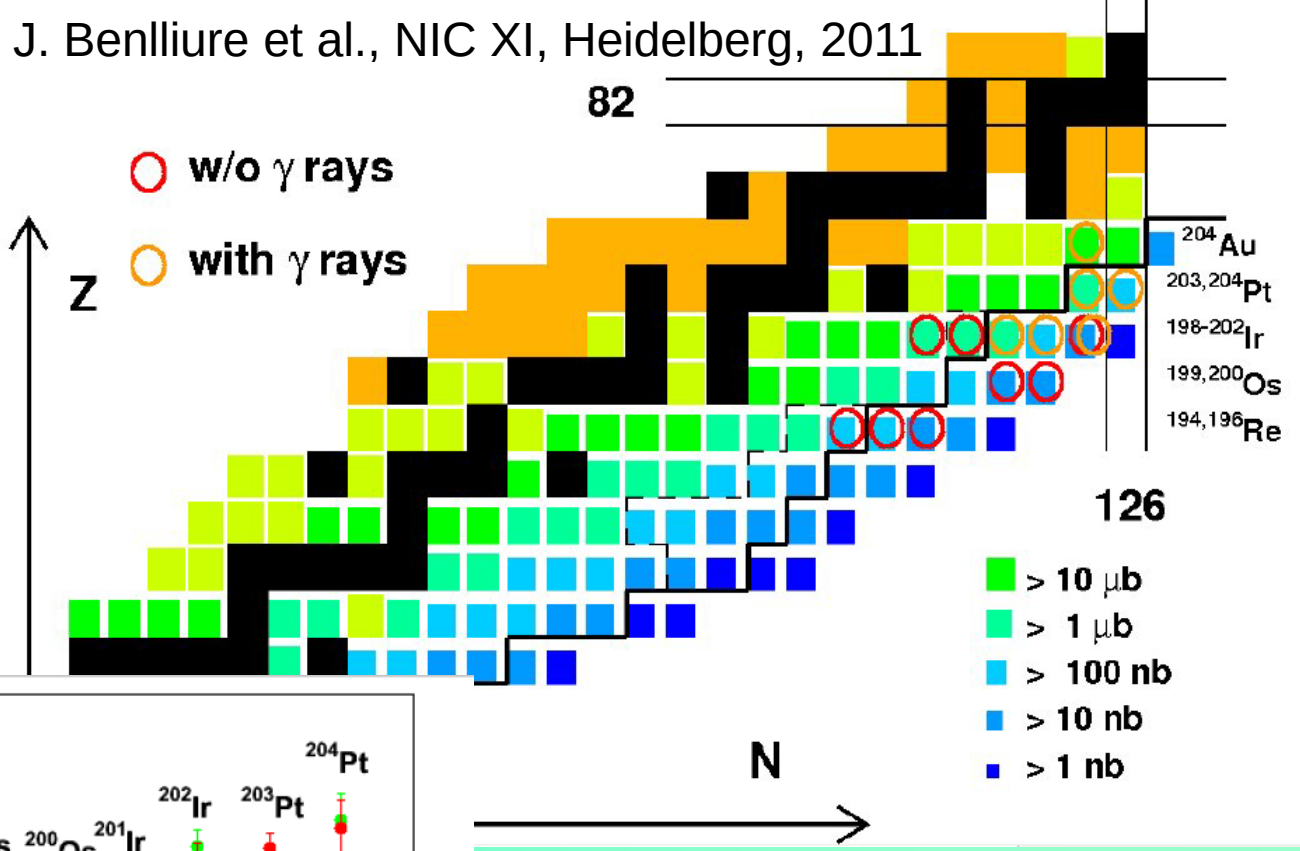


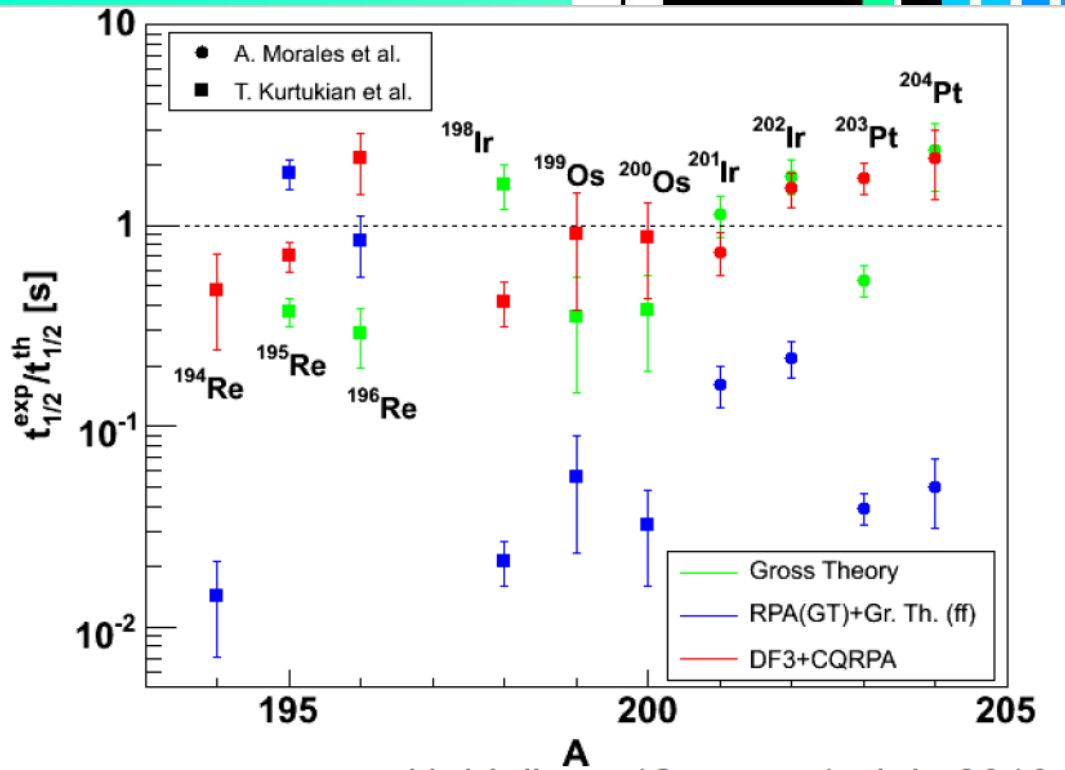
J. Benlliure et al., NIC XI, Heidelberg, 2011

• Region accessible with enough statistics

(^{204}Au,^{204,203}Pt, ^{201}Ir,…)

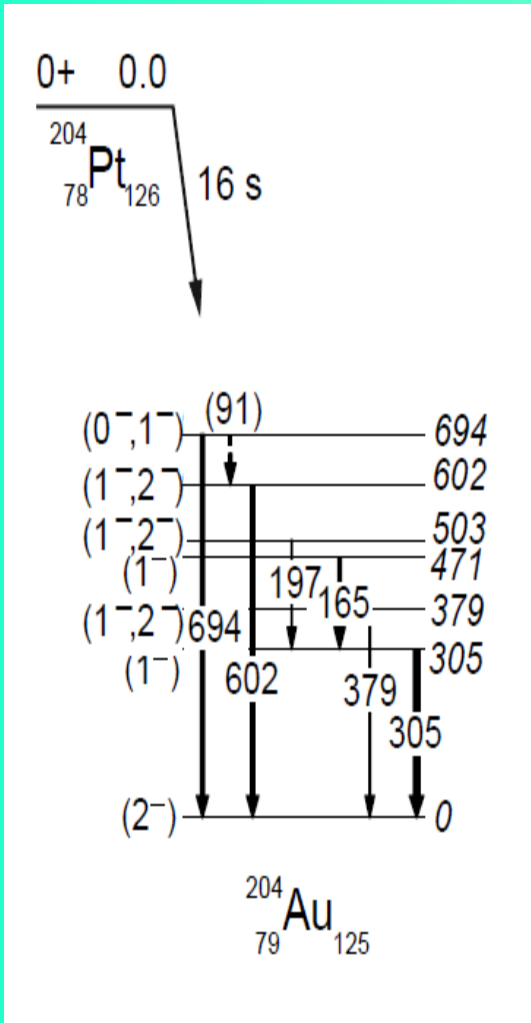
208Pb (1GeV/u)
+
Be (2.5g/cm2)

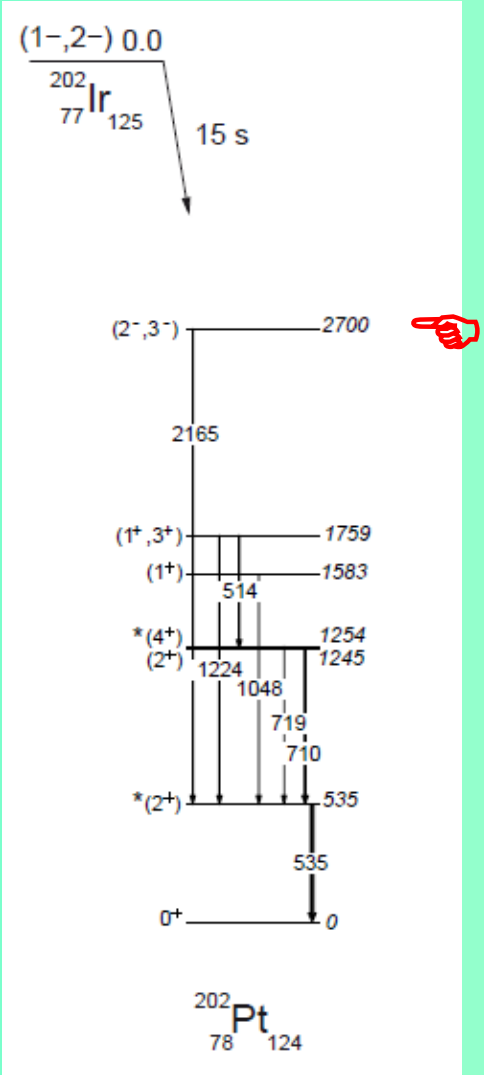




• **T. Kurtukian et al., NPA827 (2009) 687c**
• **A.I. Morales, PhD Thesis, U. Santiago, 2011**

A.I. Morales, PhD Thesis, U. Santiago, 2011



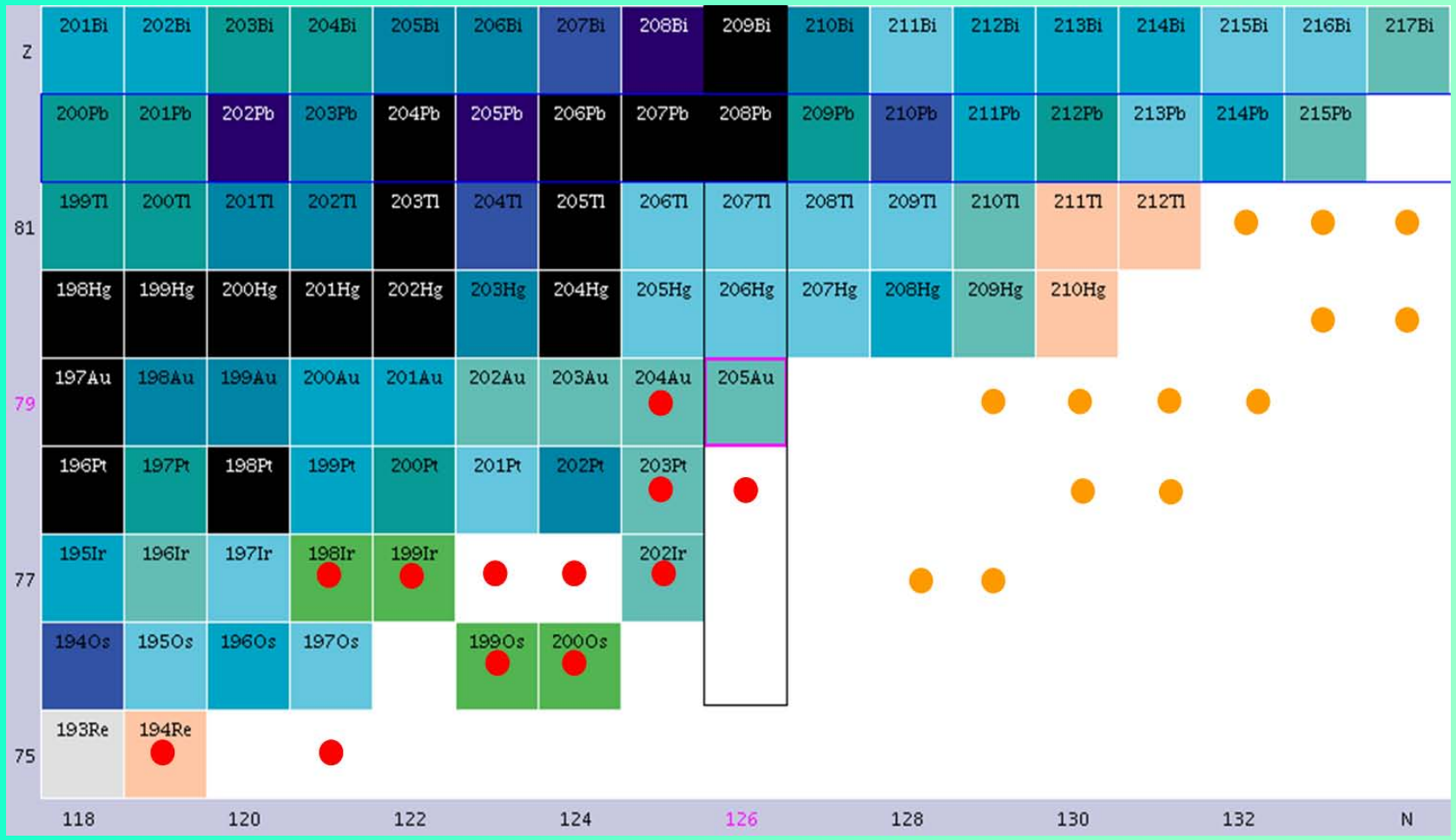


Q_β = 2.3 MeV (SY)

$N^{lev}=2.7\times10^3$

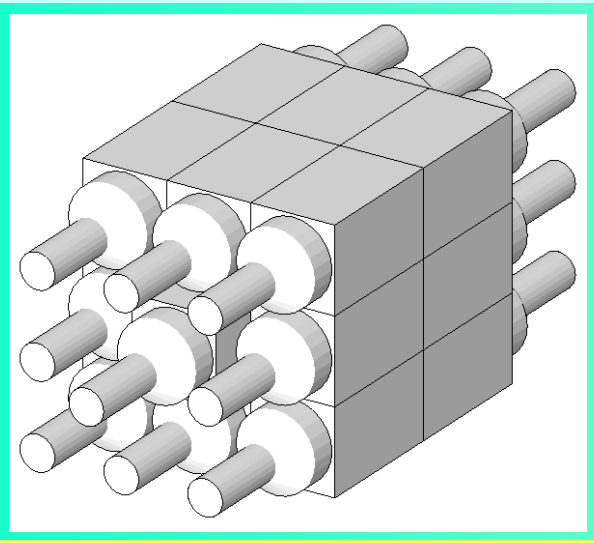
Q_β = 5.4 MeV (SY)

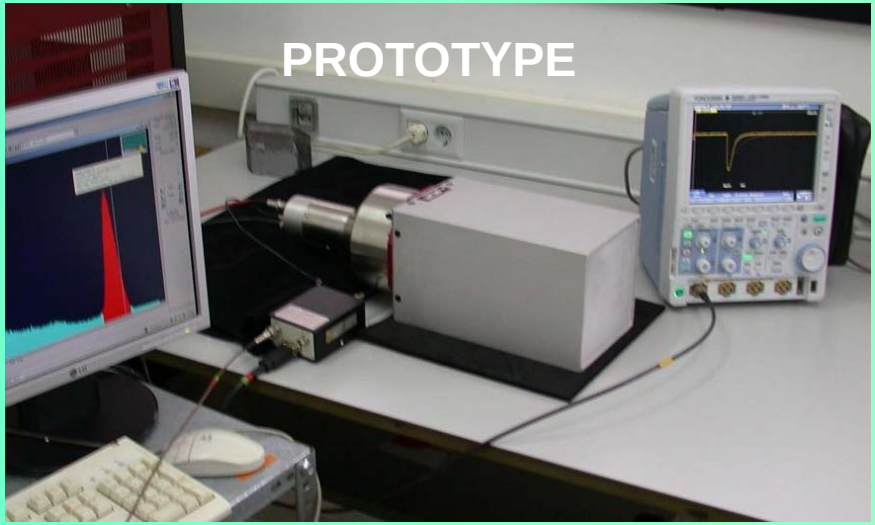
$N^{lev}=4.1\times10^4$



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

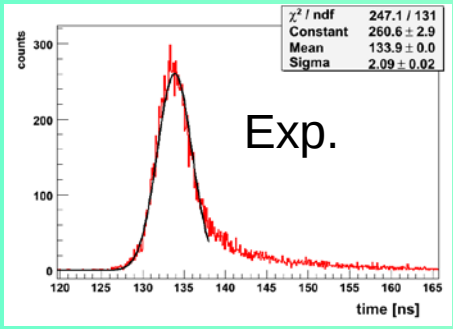
16 + 1 modules:
15×15×25 cm^3 **NaI(Tl)**
+ 5” PMT (50% light col.)
V= 95 L, M= 351 kg



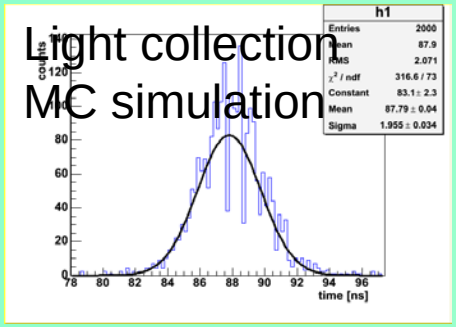


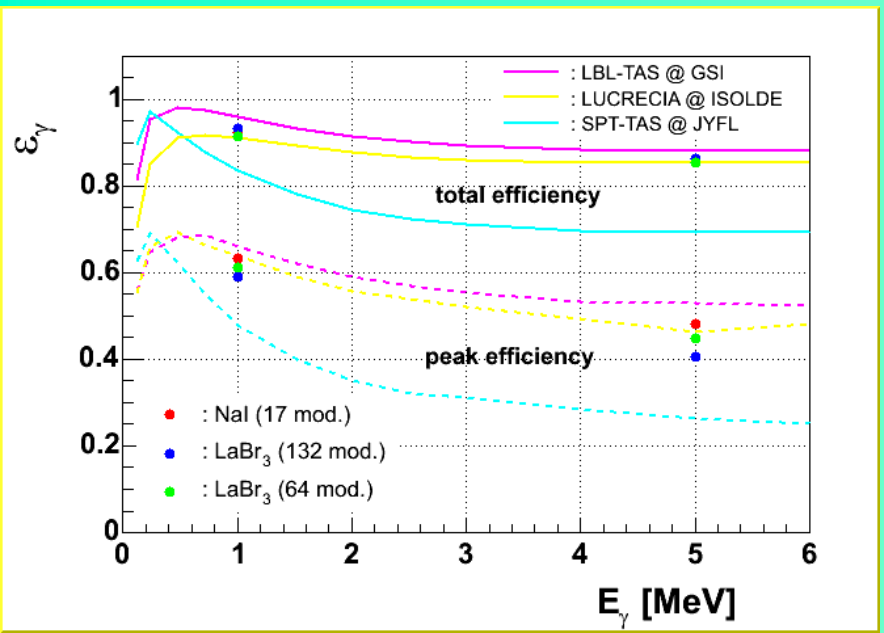
R_E= 6.8% @662keV

Δt(FWHM) = 4.5 ns



Light collection
MC simulation





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