Gasp/Clara Workshop

Proposal for the construction of a Mini Orange Spectrometer to use with the GASP array

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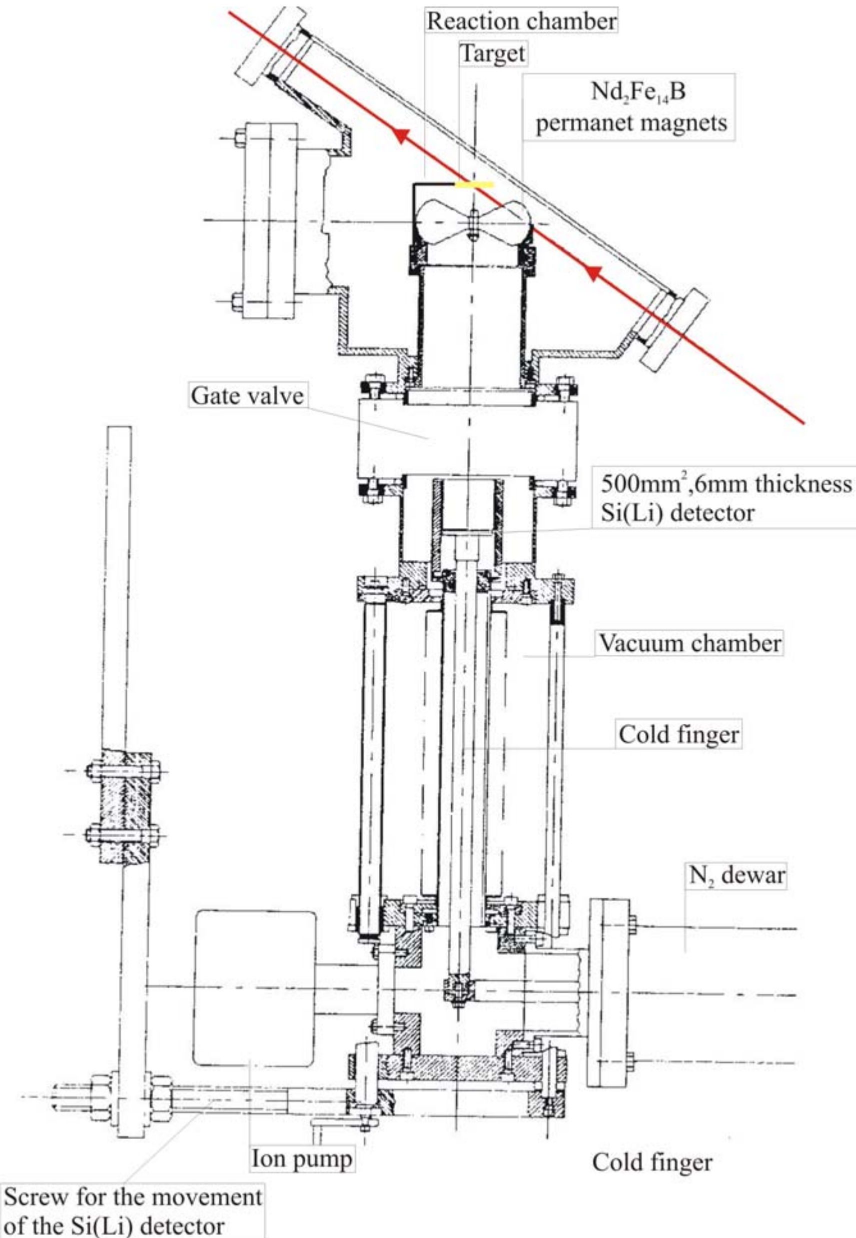
Mini Orange Spectrometer@LNS



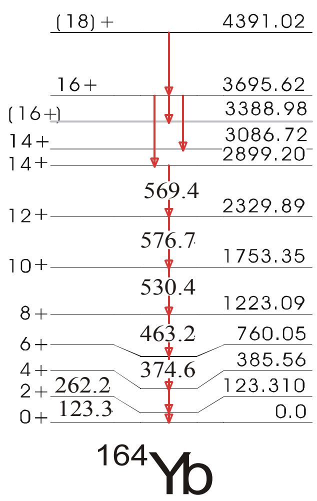
How we get the transmission curves for the magnets?

Nuclear Reaction:

$$^{18}O + ^{150}Sm \xrightarrow{4\nu} {}^{164}Yb$$

Beam Energy: 79 MeV

Gs band*

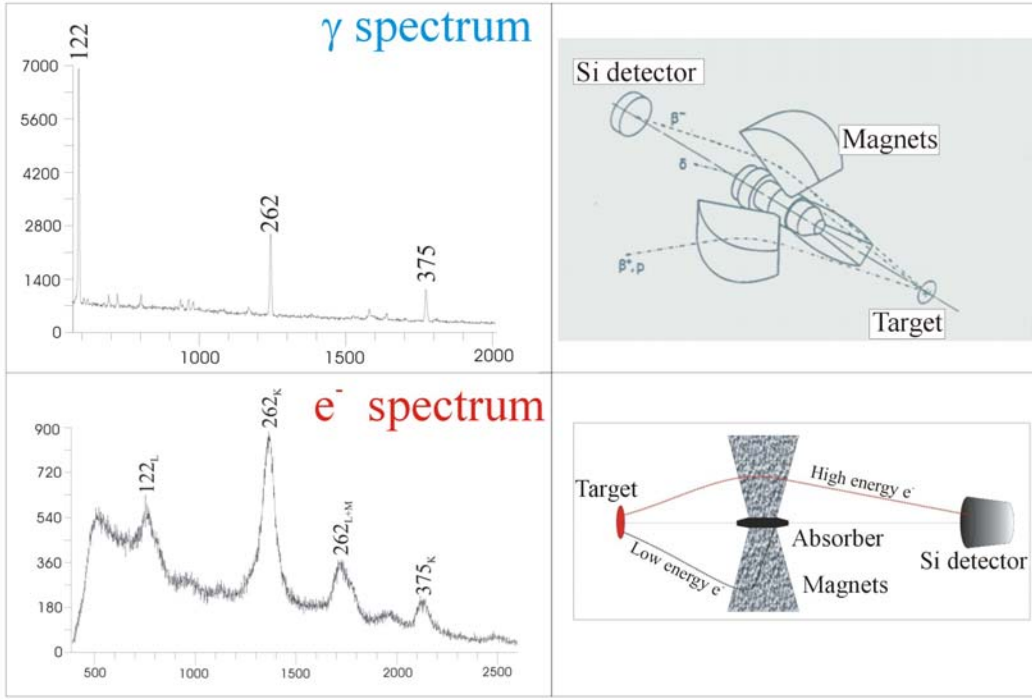


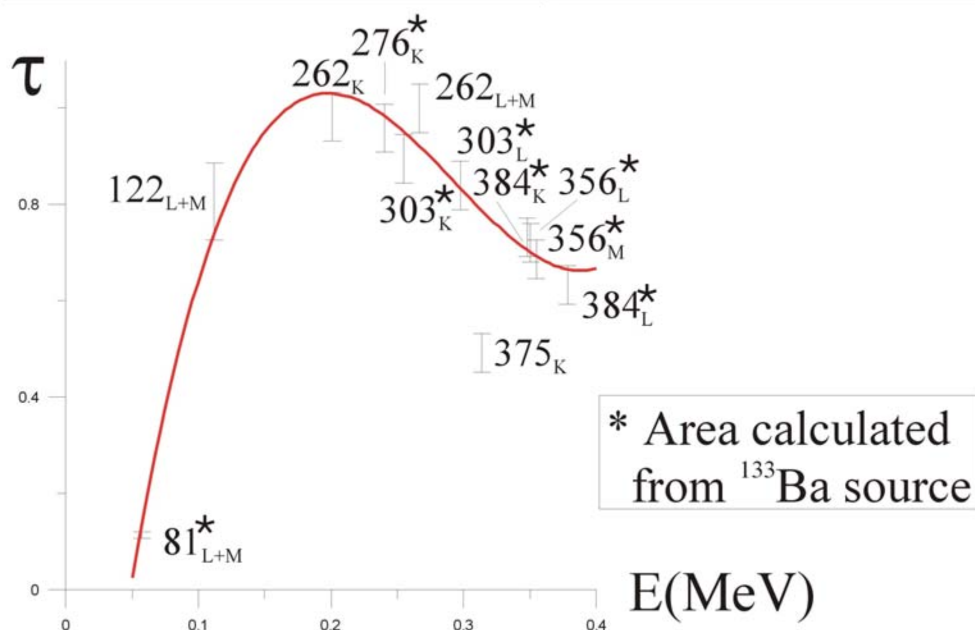
Gammas for ^{164}Yb: Gs Band *

Eγ	Jp_i	Jp_f	Mult	Iγ	$T_{1/2}$	α
123.27 3	2+	0+	E2	100	881 ps 35	1.48
262.22 4	4+	2+	E2	100	29.7 ps 10	0.113
306.6 1	16+	(16+)		12 4		
374.6 1	6+	4+	E2	100	5.02 ps 17	0.0391
463.2 1	8+	6+	E2	100	1.5 ps 5	0.0218
530.4 1	10+	8+	E2	100	0.82 ps 30	0.0156
569.4 1	14+	12+	E2	100	0.73 ps 20	0.0131
576.7 1	12+	10+	E2	100	0.55 ps 20	0.0127
608.8 1	16+	14+	(E2)	98 6		0.0111
695.4 1	(18)+	16+	E2	100		
796.6 1	16+	14+	E2	100 6		

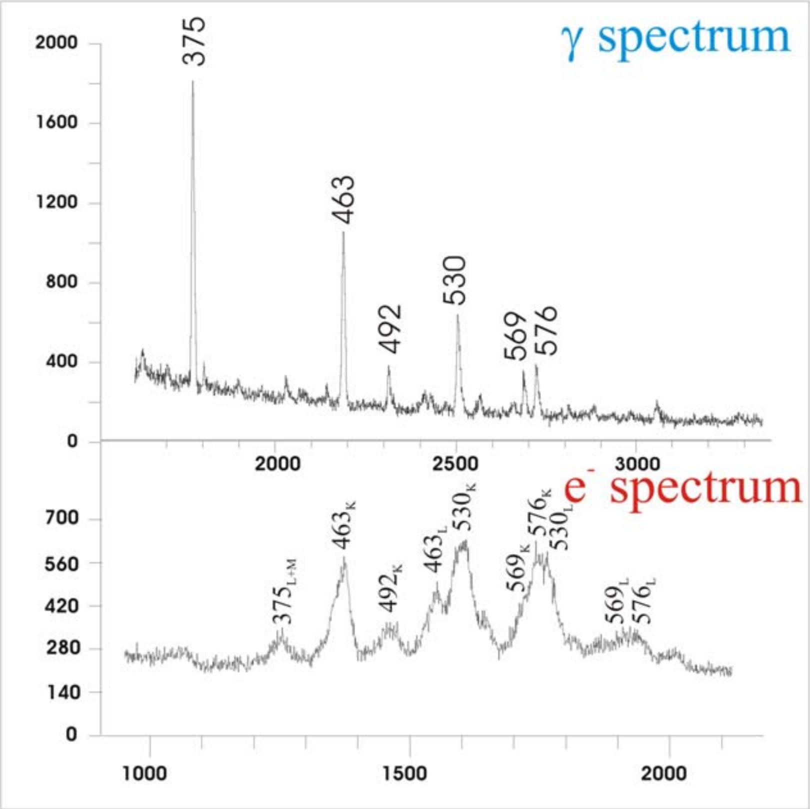
* From Nuclear Data Sheets

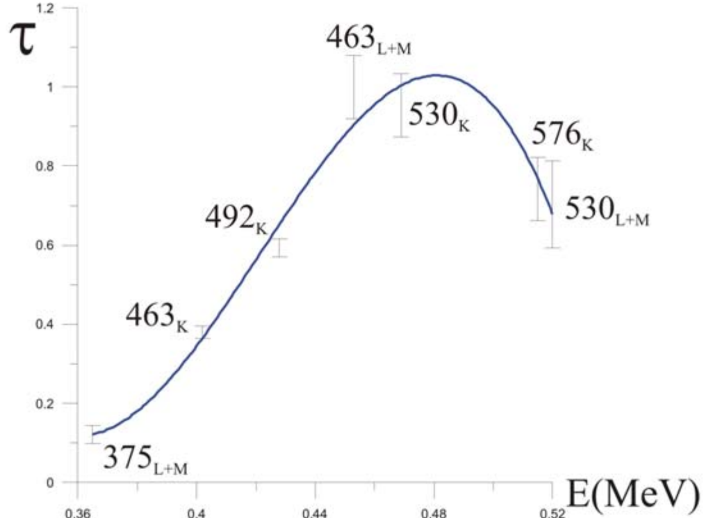
Transmission curve for low energies





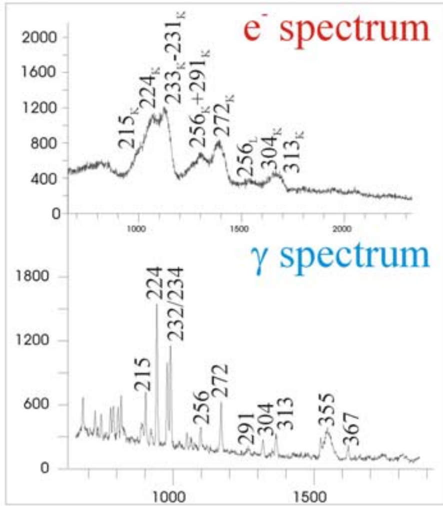
Transmission curve for medium energies

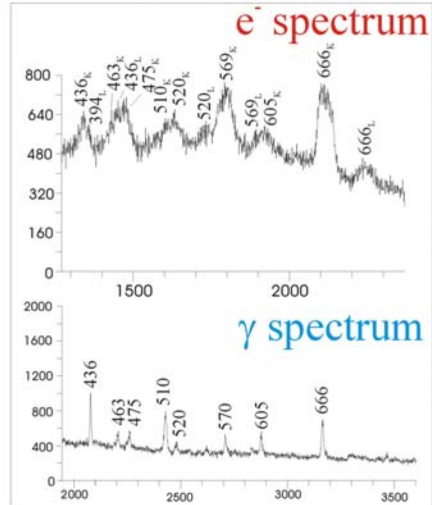




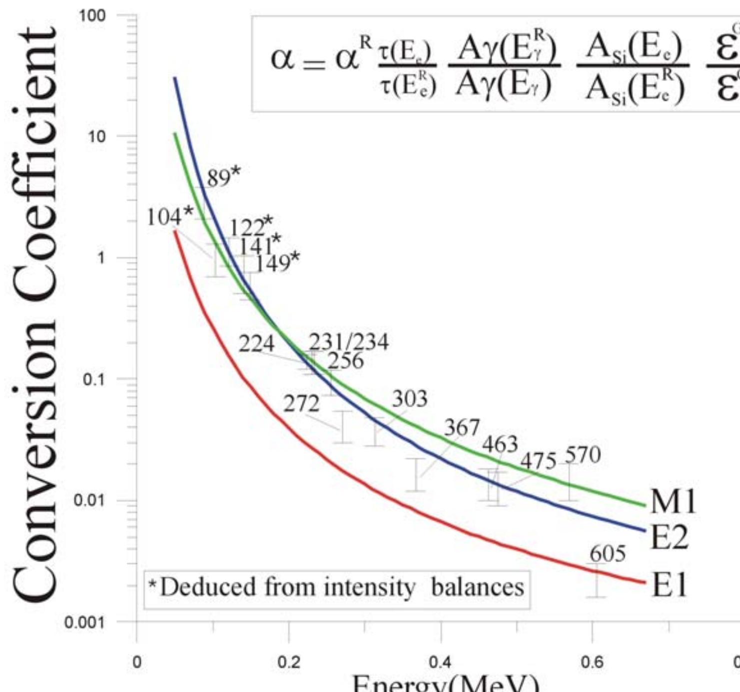
An example of application:

^{139}Nd-Conversion Coefficients





$$\alpha = \alpha^{R} \frac{\tau(E_e)}{\tau(E_e^R)} \frac{A\gamma(E_\gamma^R)}{A\gamma(E_\gamma)} \frac{A_{Si}(E_e)}{A_{Si}(E_e^R)} \frac{\varepsilon^{Ge}(E_\gamma)}{\varepsilon^{Ge}(E_\gamma^R)}$$



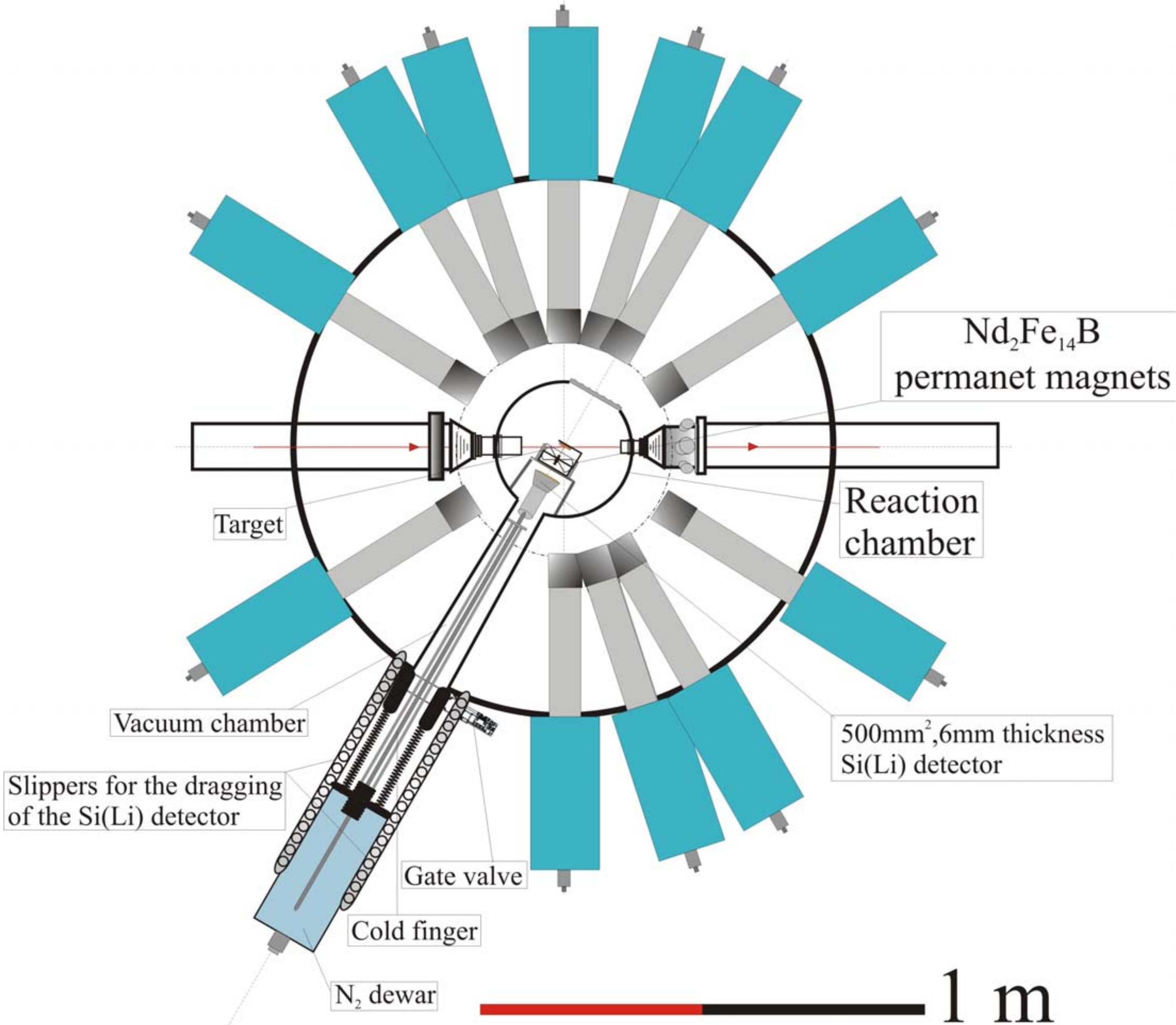
What can be improved in the MOS?

- Resolution of Si(Li) can be improved, buying a new 4-sector silicon detector (very expensive: at least 50.000€!).

  At the moment we have **7 Kev** for ^{18}O projectile and **5 KeV** for ^{11}B projectile, cause the Doppler effect on the recoiling nuclea.

- By using the GASP array coupled with a MOS, we can do γ-e^- coincidences and get clean spectra.

MOS coupled with the GASP array



Main features of the new MOS:

- High e^- efficency: 10%
- Low loss of γ efficency: >30%
- δ rays reduction by a potential grid.
- Easy access to the reaction chamber (***retractile Si(Li) detector***).
- Few metal components close to the target and γ-detectors (***the gate valve is placed outside***).

Estimates & Costs

- Dewar for Si(Li) detector: $1.5\ 10^3$ €
- Engineering support & planning: $1.5\ 10^3$ €
- Si(Li) detector & electronics: $7.5\ 10^3$ €
- Gate valve: $1.5\ 10^3$ €
- Ion pump: $5\ 10^3$ €
- Mechanical & electrical componenents: $6\ 10^3$ €
- Permanents magnets: $2\ 10^3$ €
- Reaction chamber: $10\ 10^3$ €

TOTAL: $35\ 10^3$ €

An outlook for the future measurements…

Monopole strenghts and coexisting shapes.

$$\rho_{fi} = \left| \frac{\langle f | \Sigma_k \, e_k r_k^2 | i \rangle}{eR^2} \right|^2$$

Monopole operator

- Internal Conversion
- Internal Pairing (only for Eγ>1.022 MeV)
- Two Photon Emission (2° order process)

Typical probabilities are: $P_{IC}:P_{IP}:P_{2\gamma}=0.7:0.3:10^{-4}$

for 1.761 MeV $|0^+\rangle \longrightarrow |0^+\rangle$ transition of ^{90}Zr

What we learn measuring the electron conversion coefficient of an E_0 transition?

$$\alpha_T^{exp} = \alpha_T^{th}(E_2) + \Gamma^{e}(E_0)/\Gamma^{\gamma}(E_2)$$

Shape mixing effects on E0 transitions:

$$\begin{cases} |0^+_i\rangle = a\,|0^+_1\rangle + b\,|0^+_2\rangle \\ |0^+_f\rangle = -b\,|0^+_1\rangle + a\,|0^+_2\rangle \end{cases}$$

$$\rho_{fi}(E_0) = (1/eR^2)[ab(\langle 0^+_1|\hat{T}(E0)|0^+_1\rangle - \langle 0^+_2|\hat{T}(E0)|0^+_2\rangle) + (a^2-b^2)\langle 0^+_2|\hat{T}(E0)|0^+_1\rangle]$$

Weak mixing:

$$\rho_{fi}(E_0) \sim 0$$

Strong mixing:

$$\rho_{fi}(E_0) = (3/8\pi)^2 Z^2 (\beta_1^2 - \beta_2^2)$$

References:

- G.D.Dracoulis *et al.*,PRC 67,051301 (2003)
- J.L. Wood *et al.*, Nuclear Physics A651 (1999),323-368