

Investigation of total cross sections of the $^{93}\text{Nb}(p,\gamma)^{94}\text{Mo}$ reaction

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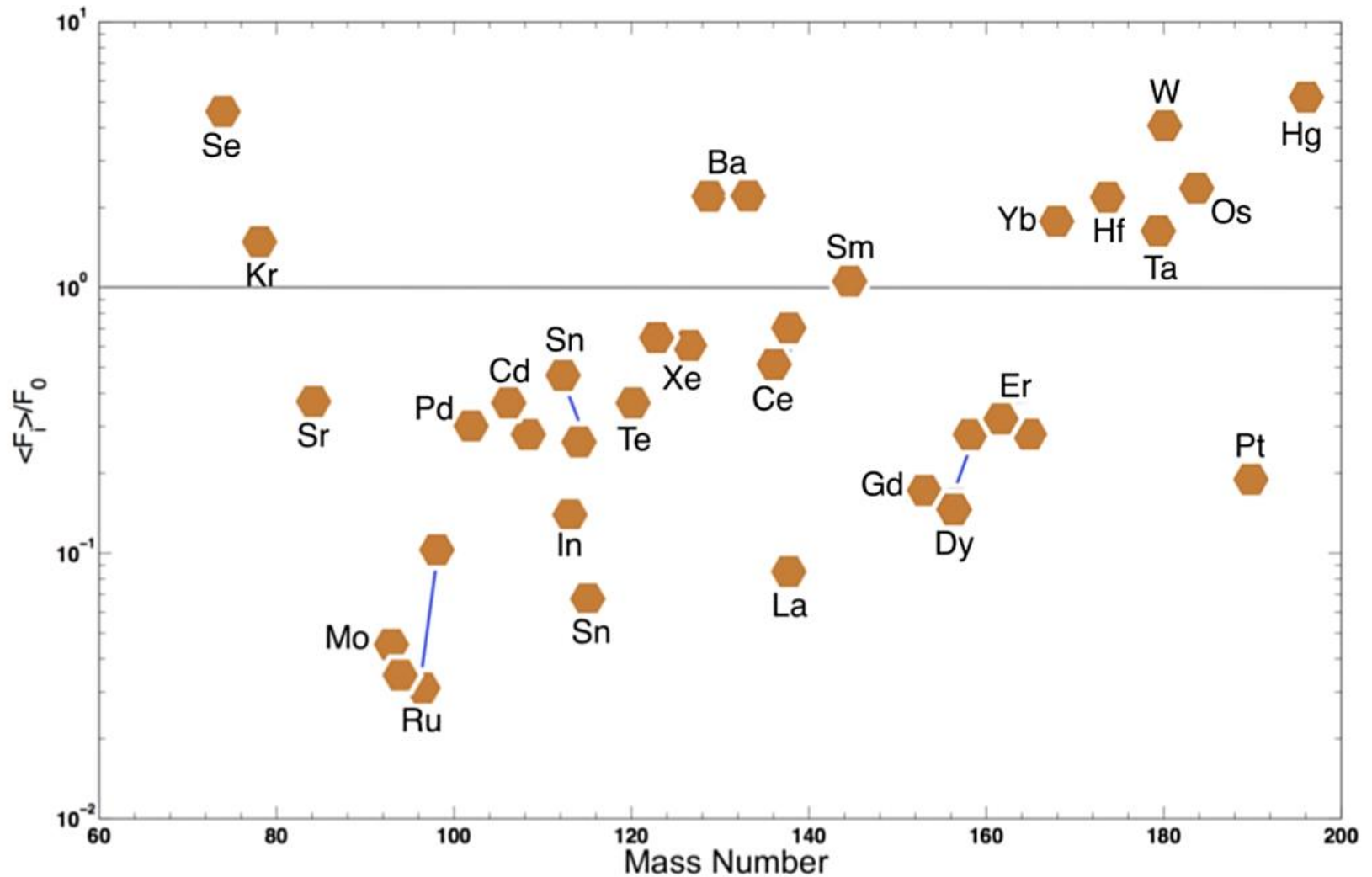
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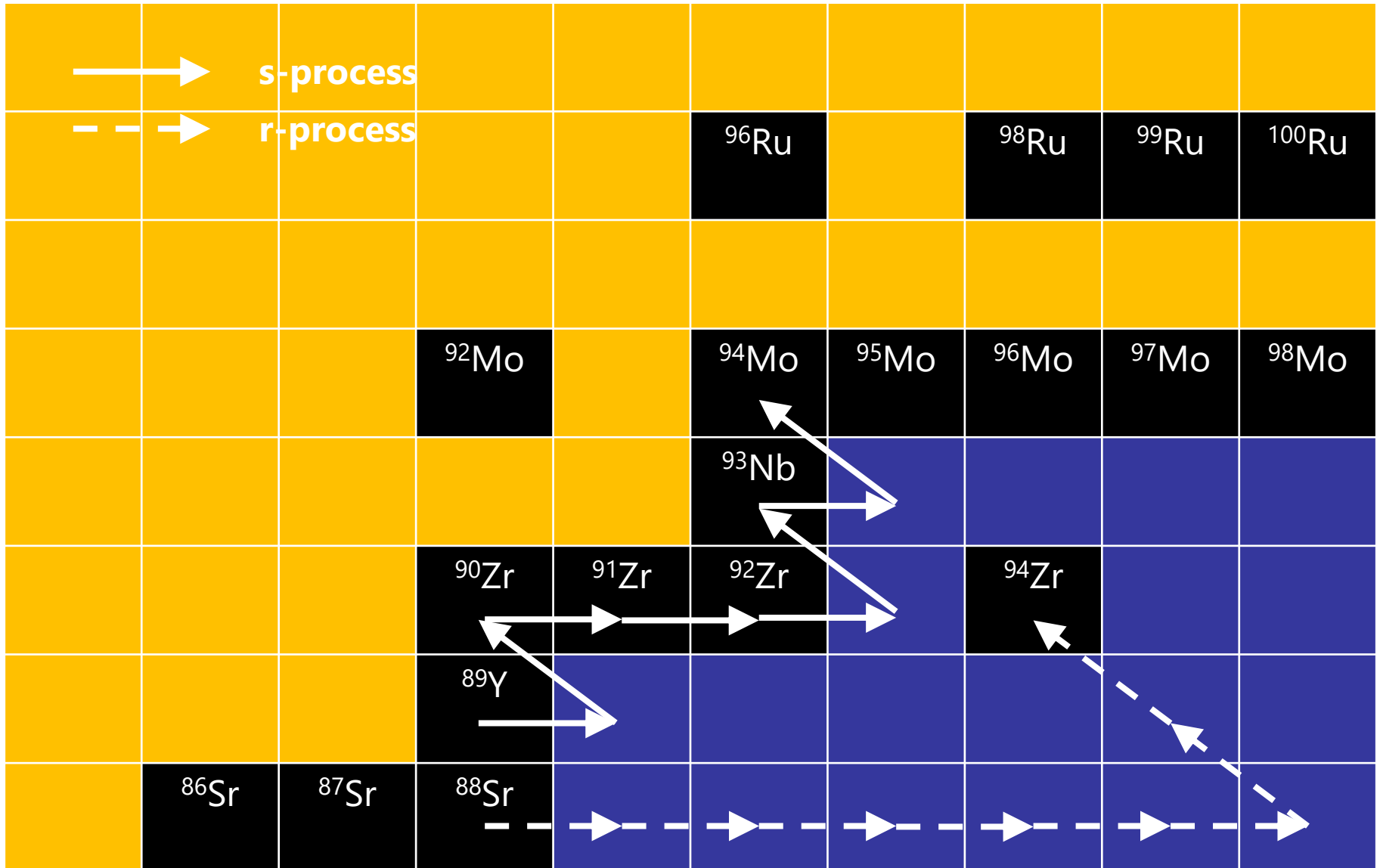
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Motivation

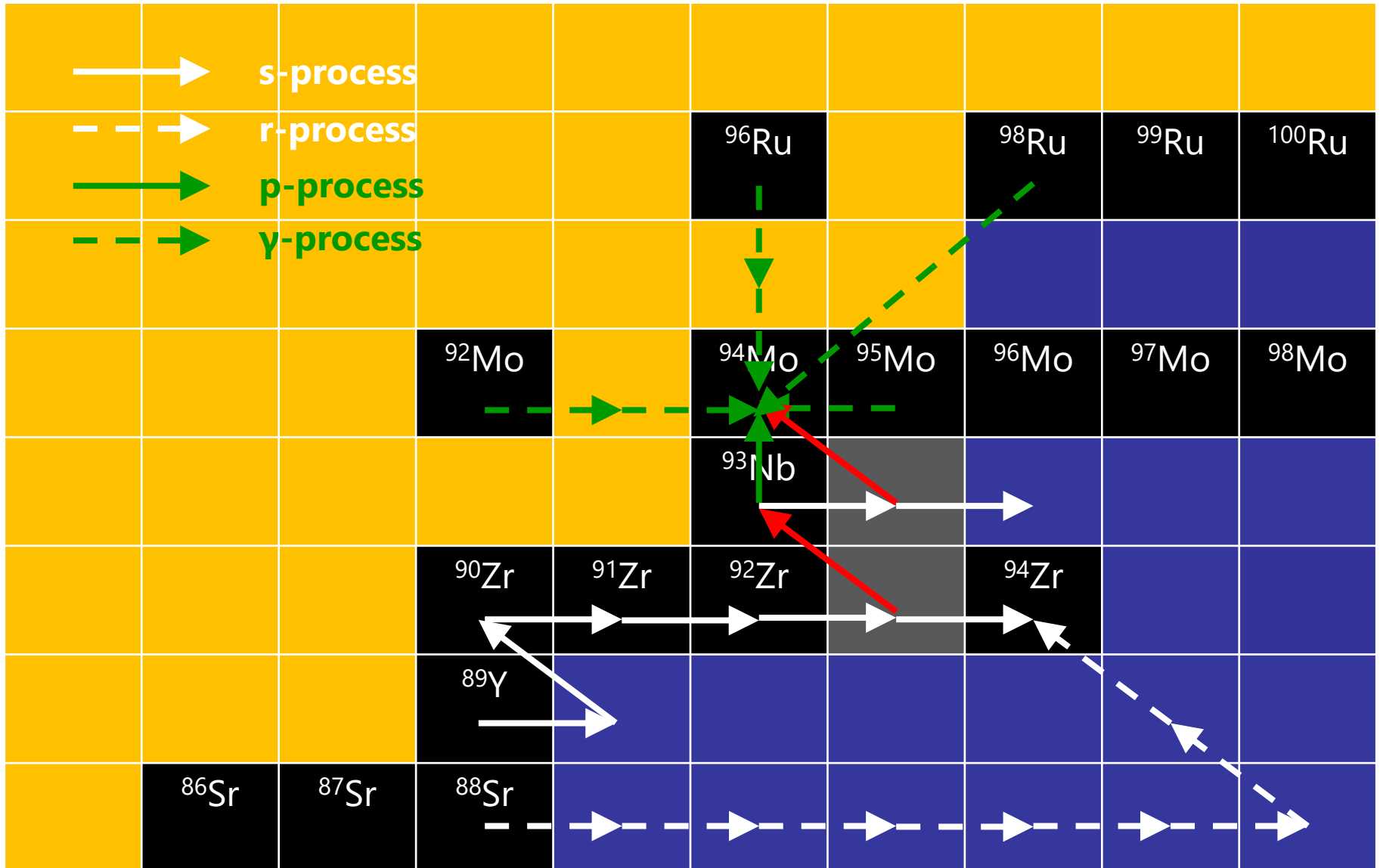


V. Liccardo *et al.* Eur. Phys. J. A **54**: 221 (2018)

p-process

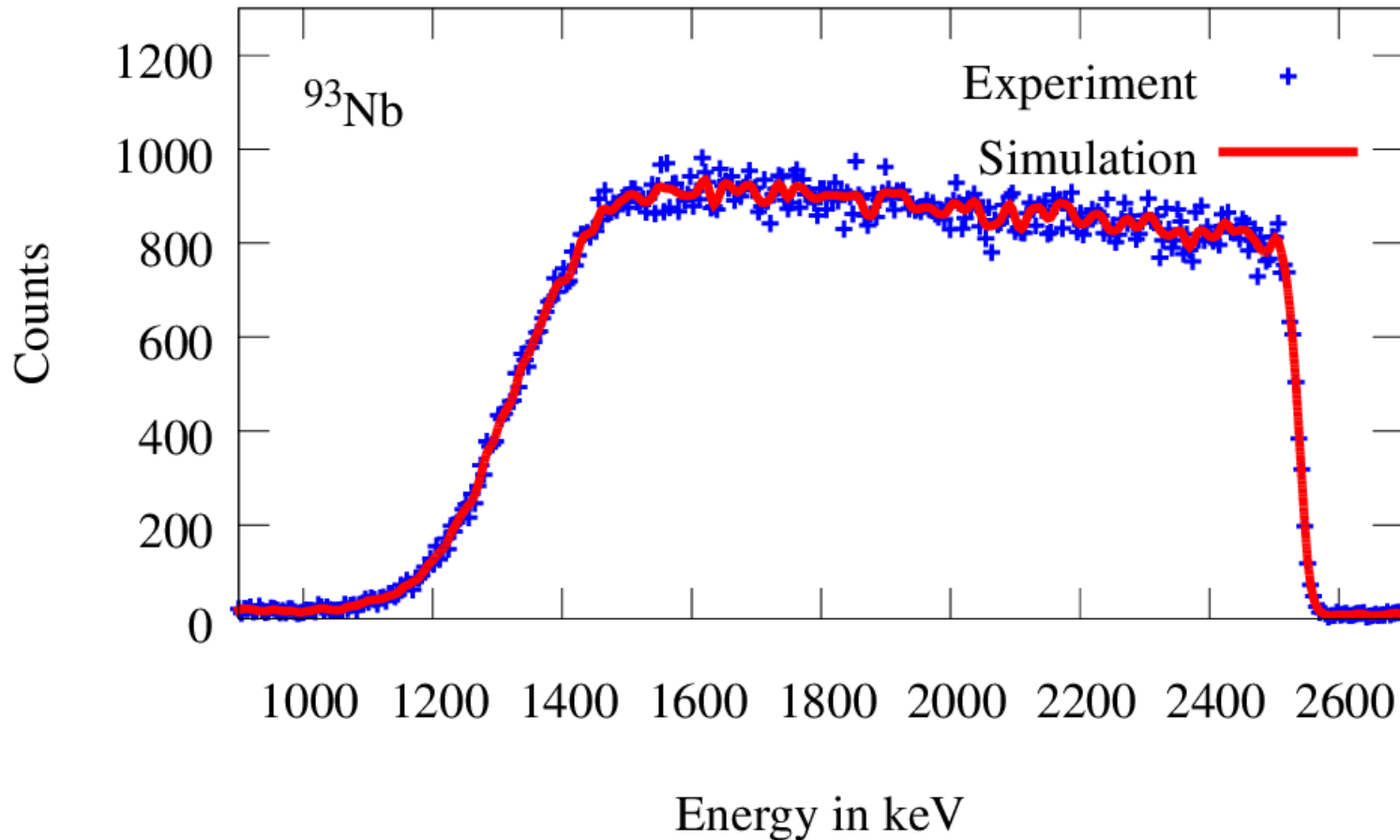


p-process



Target properties

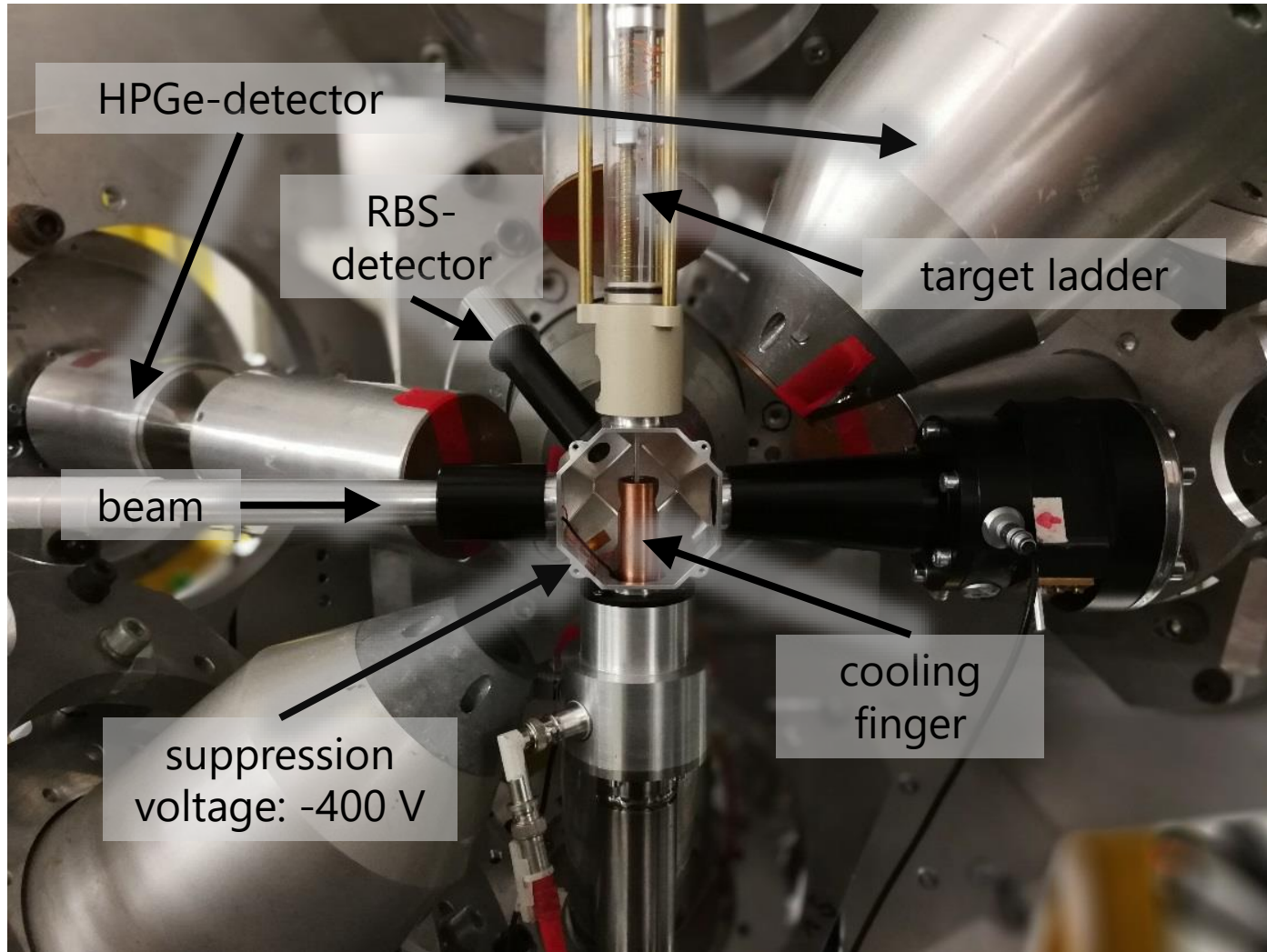
- Q-value of the $^{93}\text{Nb}(p,\gamma)^{94}\text{Mo}$ reaction: $Q = 8490.2$ keV
- RBS-measurement at the RUBION facility (RU Bochum)



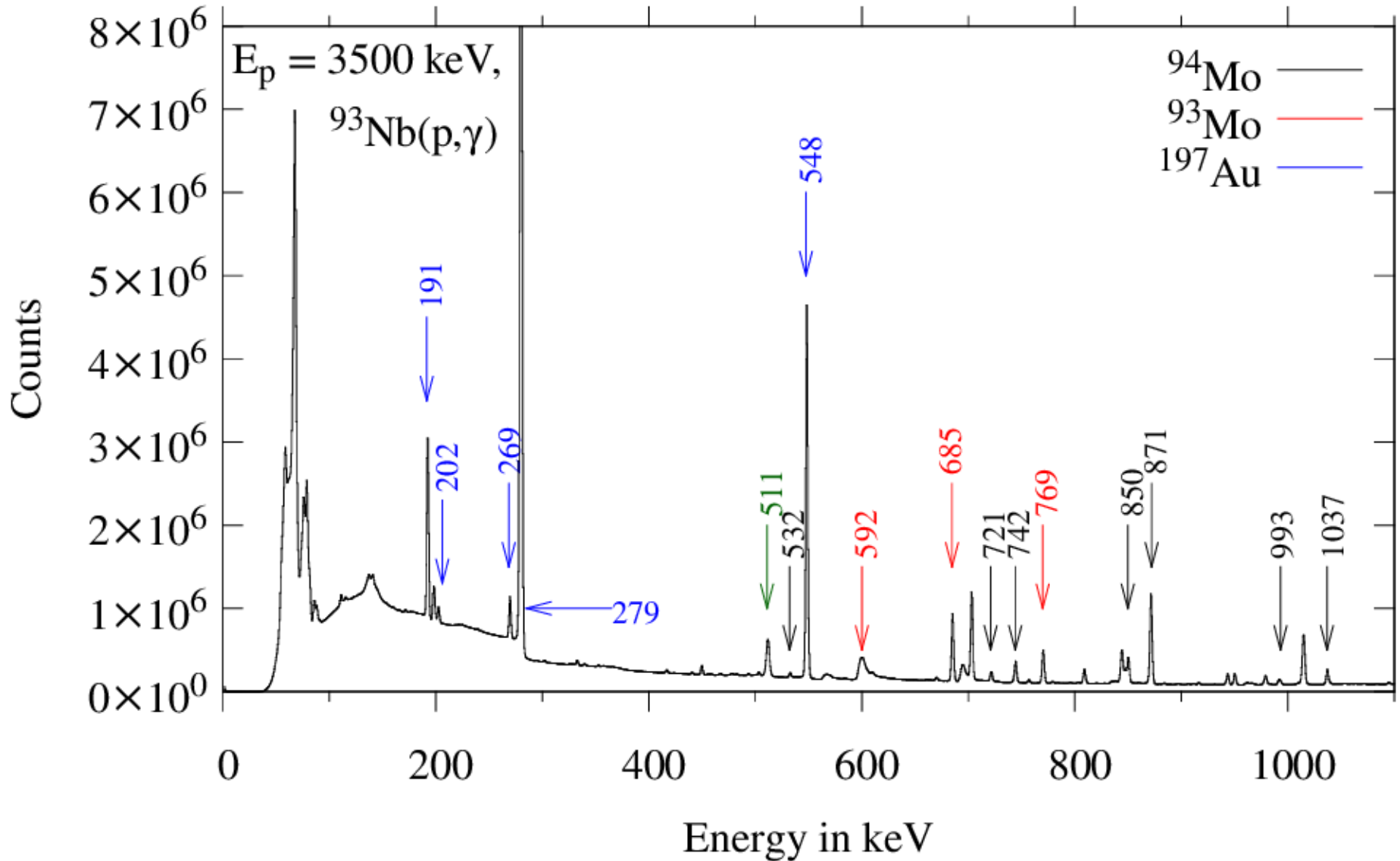
- Thickness 1.1 (1) mg/cm²

Detector properties

- HORUS γ -spectrometer: up to 14 HPGe-detectors at 5 different angles



γ -spectrum

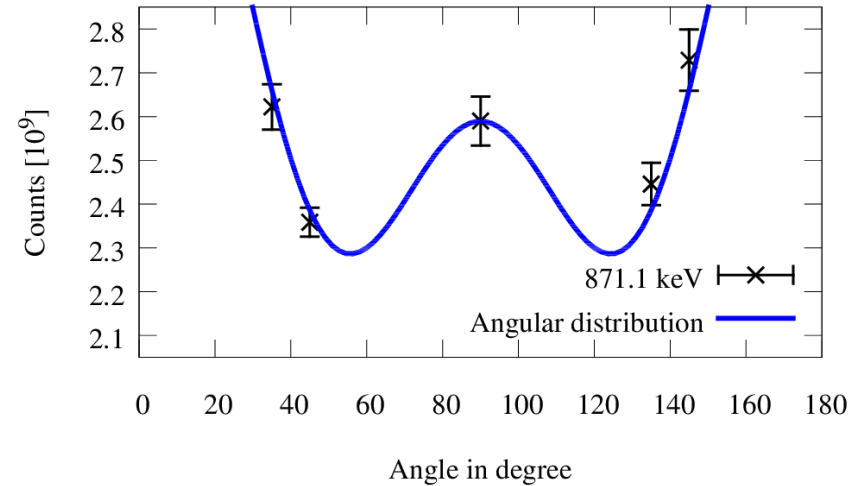


Ground state transitions

Angular correction:

$$W(\theta) = N_\gamma(1 + A_2P_2(\cos \theta) + A_4P_4(\cos \theta))$$

Branching ratios: $\varepsilon = \frac{I_{G.S.}}{I_{observed}}$



E_γ in keV		branching ratios	beam energy in keV		
ground state transition	observed		3000	3500	4500
871.1	871.1	1	X	X	X
1864.3	993.2	0.089 (11)	X	X	X
2067.4	1196.2	0.151 (7)	X	X	-
2393	1521.8	0.111 (3)	X	X	X
3447.6	2576.5	0.051 (3)	-	X	-
γ_0	γ_0	1	X	X	-

Cross sections

Cross section formula:

$$\sigma = \frac{N(p, \gamma)}{N_p N_T}$$

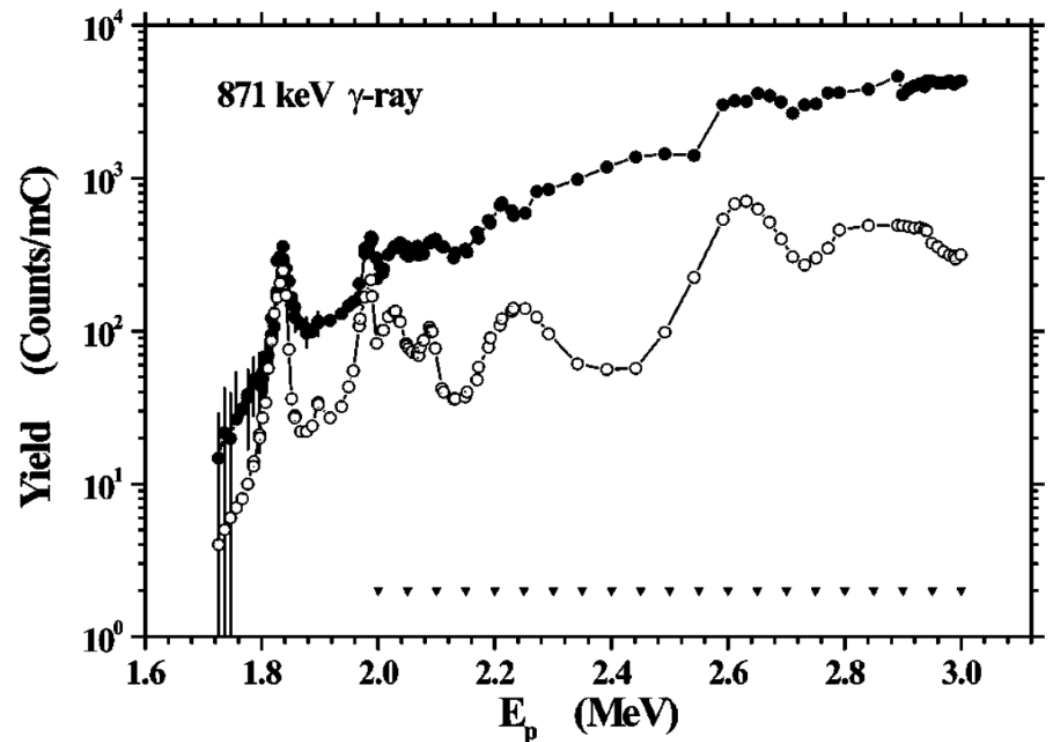
Corrected beam energy in keV	Cross section in μb	
	This work	Harissopulos <i>et al.</i>
2988 (10)	116 (13)	81 (6)
3491 (10)	227 (26)	157 (12)
4495 (10)	118 (13)	98 (8)

Major discrepancies between the results of Harissopulos *et al.* and this work can be observed

S. Harissopulos *et al.* Phys. Rev. C **64**, 055804 (2001)

Comparison with the results of S. Harissopoulos *et al.*

- Observation of the 2_1^+ -state only
- Minimal contribution of the 871.1 keV transition $\approx 85\%$
- Average contribution = 95.5 (15) %
- No suppression voltage mentioned in Harissopoulos *et al.* Publication
- Angular distribution measurement at Stuttgart using niobiumoxide
- Later measurement on metallic niobium in Athens **but** only one HPGe-detector



$$\sigma_{kor} = \frac{\sigma}{0,955} \times \frac{1}{0,9} \times \frac{1 + A_{2|H} P_2(\cos \theta) + A_{4|H} P_4(\cos \theta)}{1 + A_2 P_2(\cos \theta) + A_4 P_4(\cos \theta)}$$

D. Abriola und A. S. Samsogul, Nuclear Data Sheets **610753424** (2006)

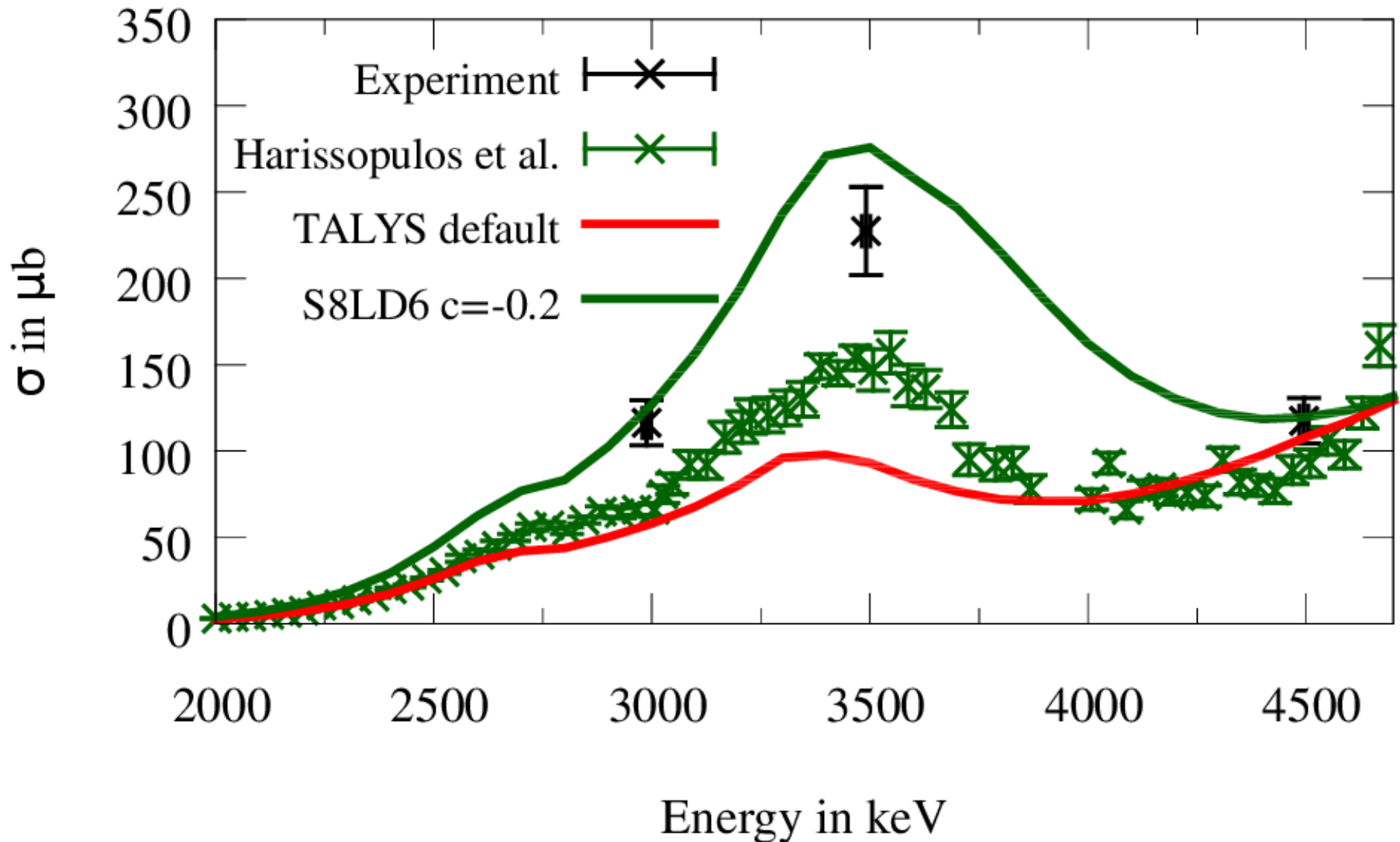
Comparison with the results of S. Harissopoulos *et al.*

$$\sigma_{kor} = \frac{\sigma}{0,95} \times \frac{1}{0,9} \times \frac{1 + A_{2|H} P_2(\cos \theta) + A_{4|H} P_4(\cos \theta)}{1 + A_2 P_2(\cos \theta) + A_4 P_4(\cos \theta)}$$

Corrected beam energy in keV	Angular correction factor	Cross section in μb	
		This work	Harrisopoulos <i>et al.</i> corrected
2988 (10)	1.25 (2)	116 (13)	118 (20)
3491 (10)	1.12 (3)	227 (26)	205 (35)
4495 (10)	1.155 (16)	118 (13)	132 (23)

The corrected results are in very good agreement

Comparison with TALYS model calculations



Summary and Outlook

- Total cross sections of the $^{93}\text{Nb}(p,\gamma)^{94}\text{Mo}$ reaction determined at 3 beam energies
- Correction factor for scan-like measurements obtained
- Comparison to TALYS model calculations \rightarrow viable set of parameters
- Measurement, using only the 2_1^+ -state, performed at HORUS (to be analysed)
- Partial cross section \rightarrow γ -strength-function (to be analysed)

