Cumulative cross sections

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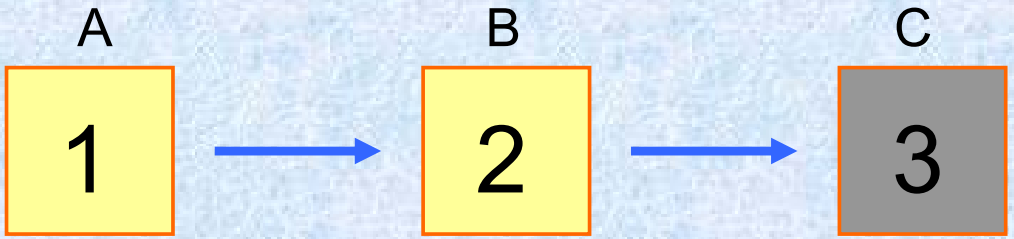
Cumulative cross sections

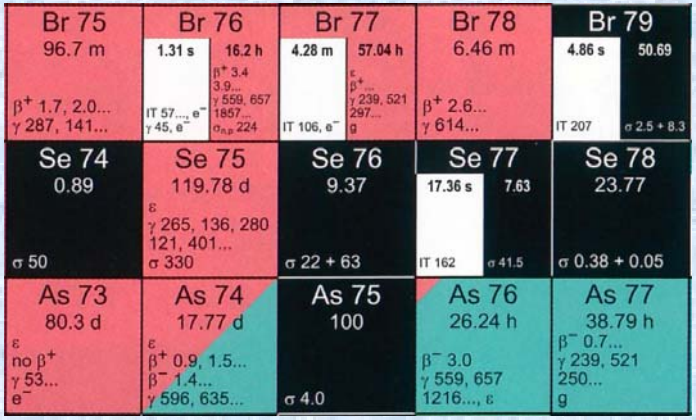
What are the measured data ?

What are the reported data ?

What are the compiled data ?

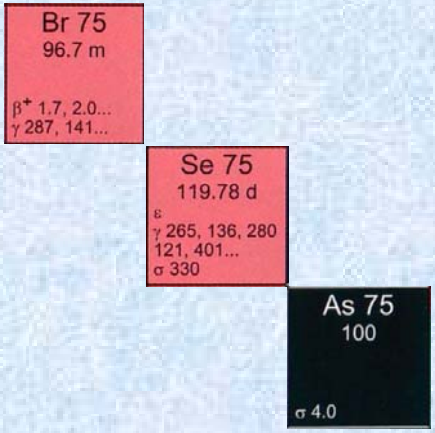
Cumulative cross sections

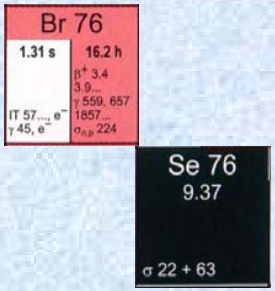




Definition 1

$$\sigma_{2cum} = \sigma_2 + f\sigma_1$$





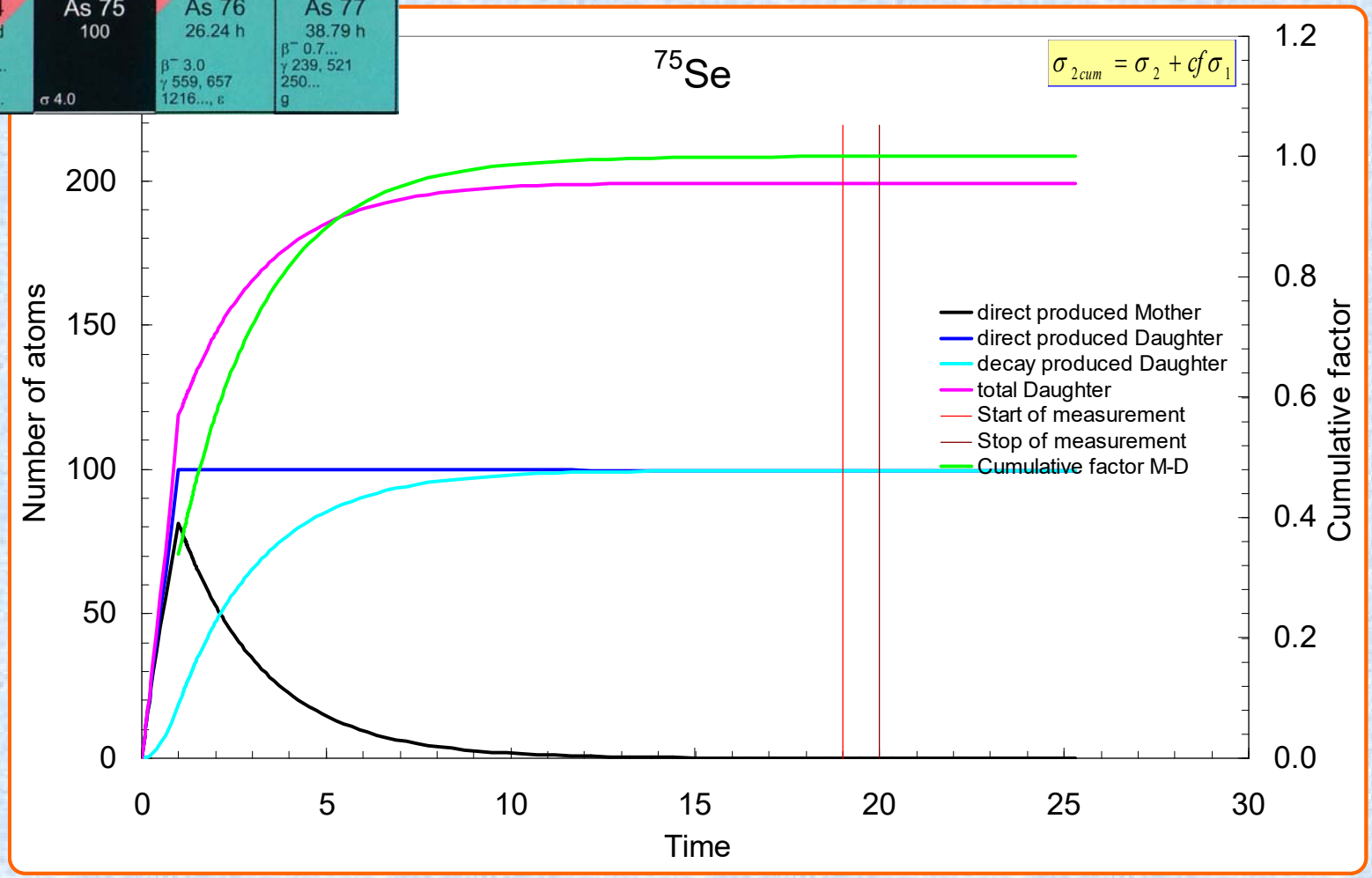
Cumulative cross sections

Activation method

Br 75	Br 76	Br 77	Br 78	Br 79
96.7 m	1.31 s / 16.2 h	4.28 m / 57.04 h	6.46 m	4.86 s / 50.69
β^+ 1.7, 2.0... γ 287, 141...	β^+ 3.4 3.9... γ 559, 657 1857... IT 57..., e^- γ 45, e^- $\sigma_{n,p}$ 224	ε β^+... γ 239, 521 297... IT 106, e^- g	β^+ 2.6... γ 614...	IT 207 σ 2.5 + 8.3
Se 74	**Se 75**	**Se 76**	**Se 77**	**Se 78**
0.89	119.78 d	9.37	17.36 s / 7.63	23.77
σ 50	ε γ 265, 136, 280 121, 401... σ 330	σ 22 + 63	IT 162 σ 41.5	σ 0.38 + 0.05
As 73	**As 74**	**As 75**	**As 76**	**As 77**
80.3 d	17.77 d	100	26.24 h	38.79 h
ε no β^+ γ 53... e^-	ε β^+ 0.9, 1.5... β^- 1.4... γ 596, 635...	σ 4.0	β^- 3.0 γ 559, 657 1216..., ε	β^- 0.7... γ 239, 521 250... g

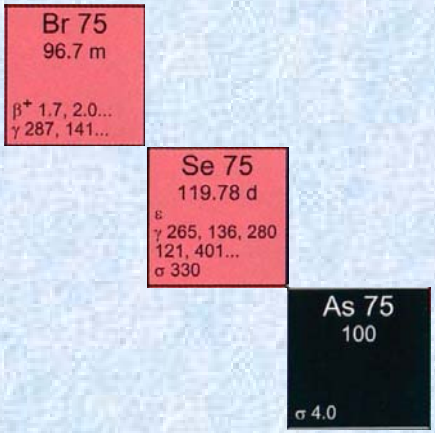
$$T_{1/2}(1) < T_{1/2}(2)$$

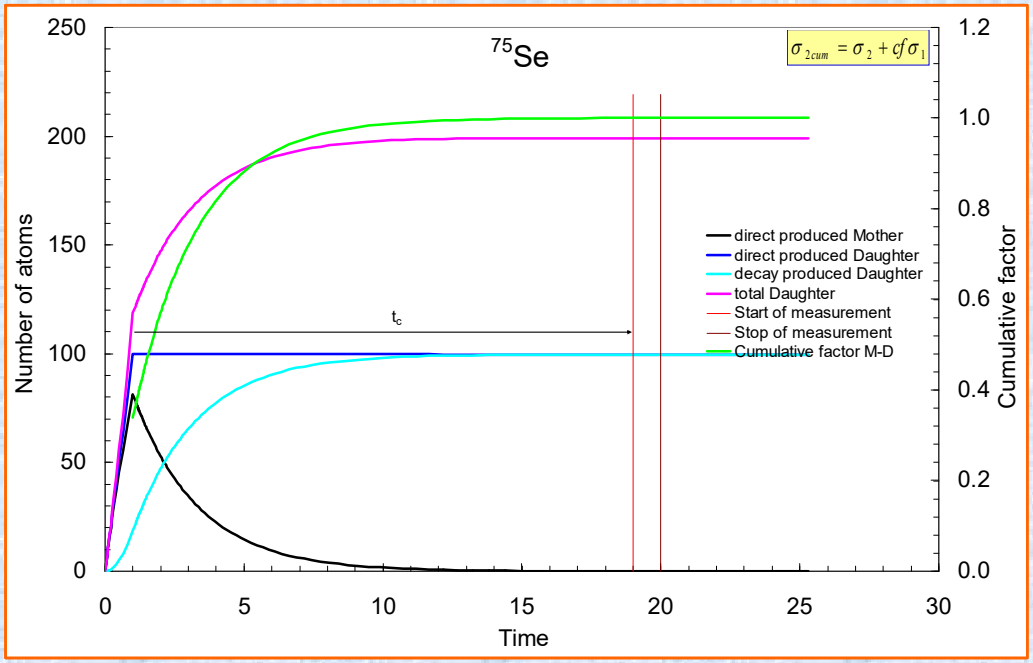
Br 75	Se 75	As 75
96.7 m	119.78 d	100
β^+ 1.7, 2.0... γ 287, 141...	ε γ 265, 136, 280 121, 401... σ 330	σ 4.0



Cumulative cross sections

Activation method





$$\sigma_{2,cum} = \frac{\lambda_2 T_{\gamma,cum}}{\varepsilon_d \varepsilon_\gamma N_t N_b \left(1-e^{-\lambda_2 t_b}\right) e^{-\lambda_2 t_c} \left(1-e^{-\lambda_2 t_m}\right)} = \sigma_2 + cf\sigma_1$$

$$c = \frac{\lambda_1}{\lambda_1 - \lambda_2}\left(1 - \frac{\lambda_2}{\lambda_1}\frac{\lambda_2}{\lambda_1}\frac{\left(1-e^{-\lambda_1 t_b}\right)e^{-\lambda_1 t_c}\left(1-e^{-\lambda_1 t_m}\right)}{\left(1-e^{-\lambda_2 t_b}\right)e^{-\lambda_2 t_c}\left(1-e^{-\lambda_2 t_m}\right)}\right)$$

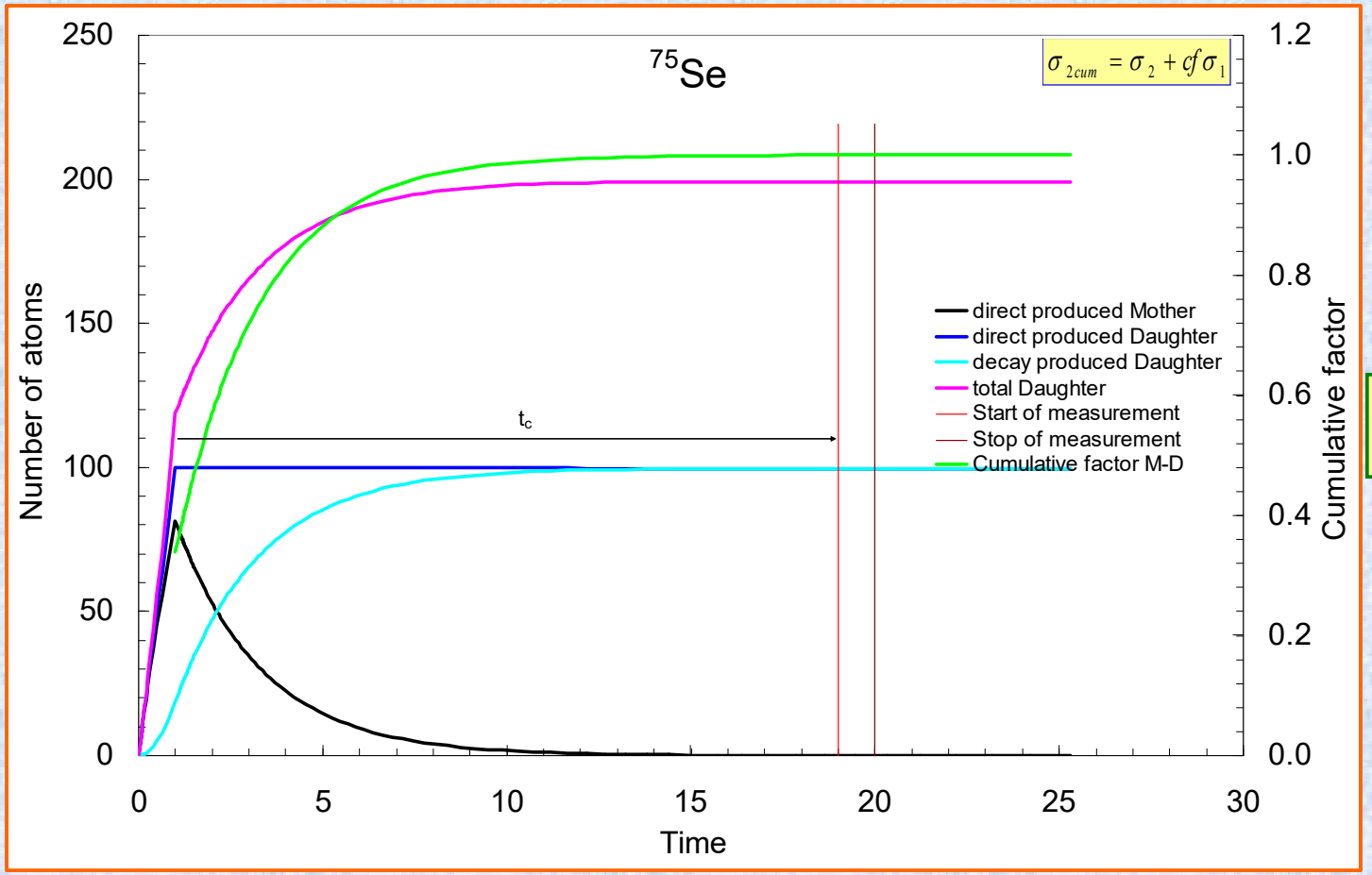
Cumulative cross sections

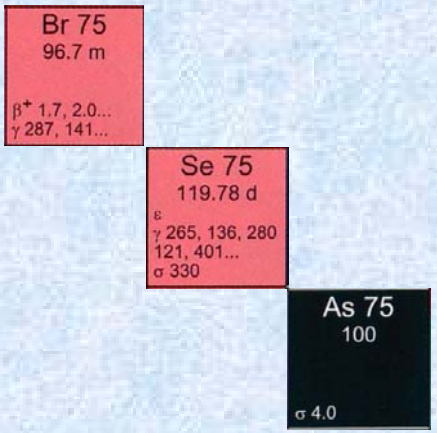
Activation method

c is time dependent

$$c = \frac{\lambda_1}{\lambda_1 - \lambda_2}\left(1 - \frac{\lambda_2}{\lambda_1}\frac{\lambda_2}{\lambda_1}\frac{\left(1-e^{-\lambda_1 t_b}\right)e^{-\lambda_1 t_c}\left(1-e^{-\lambda_1 t_m}\right)}{\left(1-e^{-\lambda_2 t_b}\right)e^{-\lambda_2 t_c}\left(1-e^{-\lambda_2 t_m}\right)}\right)$$

$T_{1/2}(1) < T_{1/2}(2)$





$$\sigma_{2cum} = \sigma_2 + cf\sigma_1$$

$$c = \frac{\lambda_1}{\lambda_1 - \lambda_2} > 1$$

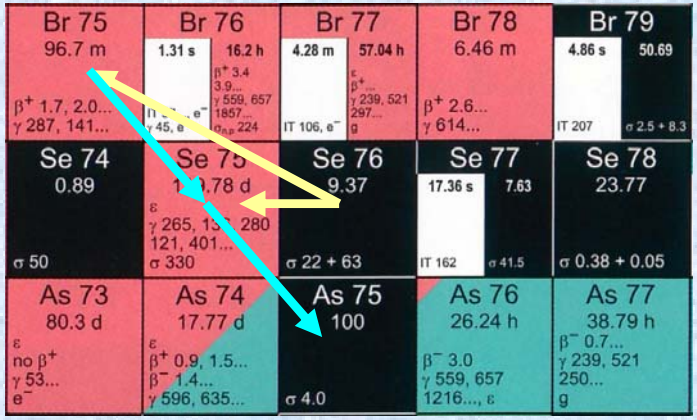
C=1.00056

Cumulative cross sections

Activation method

Definition 1

$$\sigma_{2cum} = \sigma_2 + f\sigma_1$$



Definition 2

$$\sigma_{2cum} = \sigma_2 + cf\sigma_1$$

C=1.00056

conditional

supracumulative

Yu.E. Titarenko et al.,
Phys. Rev. C65(2002)064610

REACTION (34-SE-76(P,X)34-SE-75,CUM,SIG)

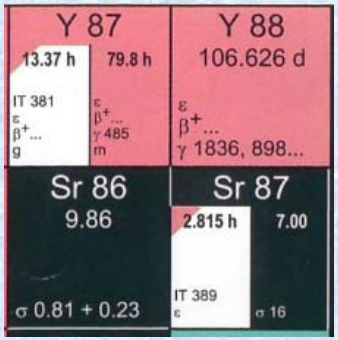
REACTION (34-SE-76(P,X)34-SE-75,SCUM,SIG)

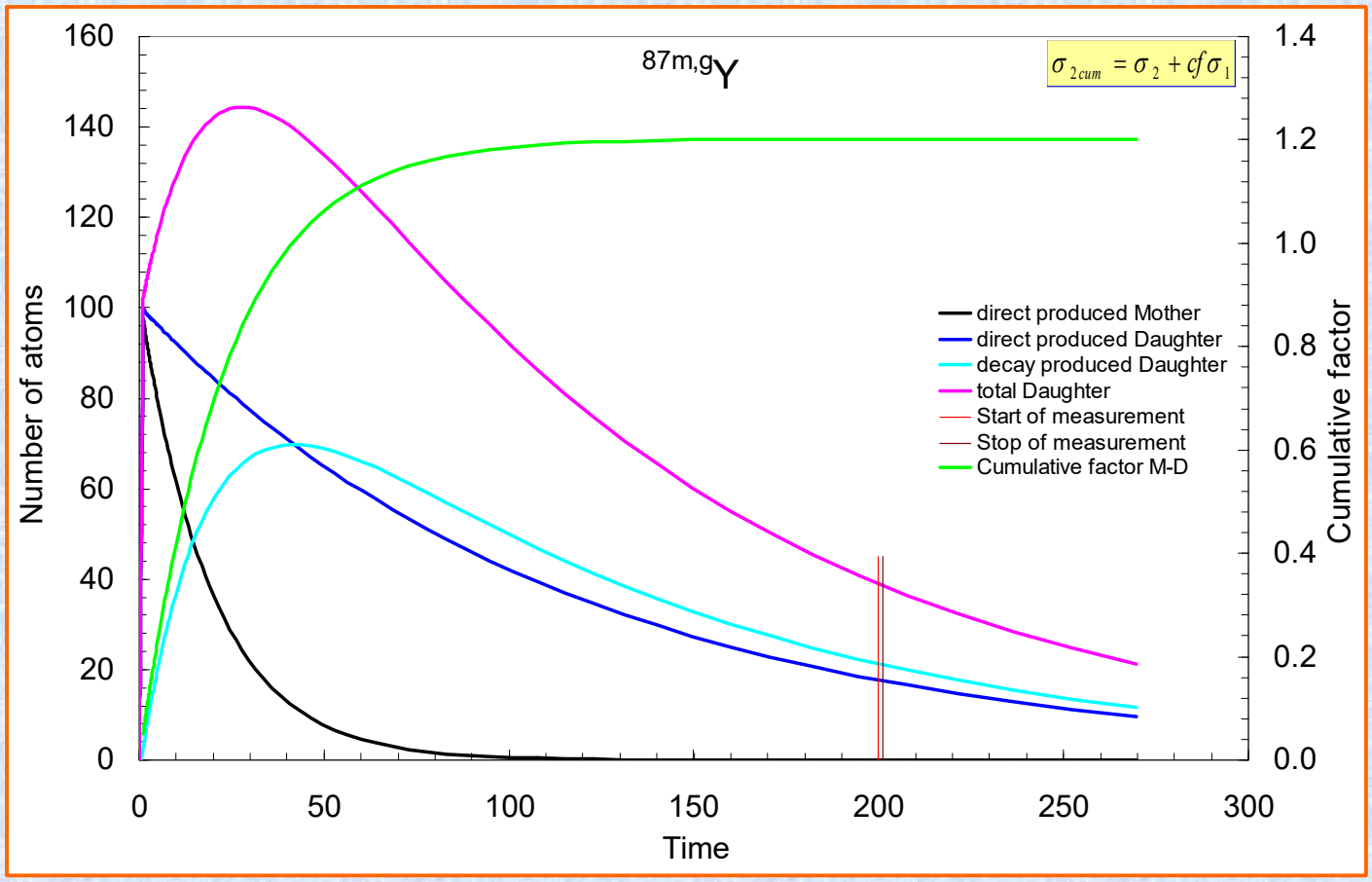
LEXFOR

CUM Data given includes the feeding via radioactive decay of another nuclide (and via isomeric transition when it exists). To be used only with process codes X or F.

Cumulative cross sections

Activation method





REACTION (38-SR-87(P,X)39-Y-87-G,M+,SIG)

REACTION (38-SR-87(P,X)39-Y-87-G,SCUM,SIG)

$$\sigma_{2cum} = \sigma_2 + cf\sigma_1$$

C=1.2018

f=0.9843

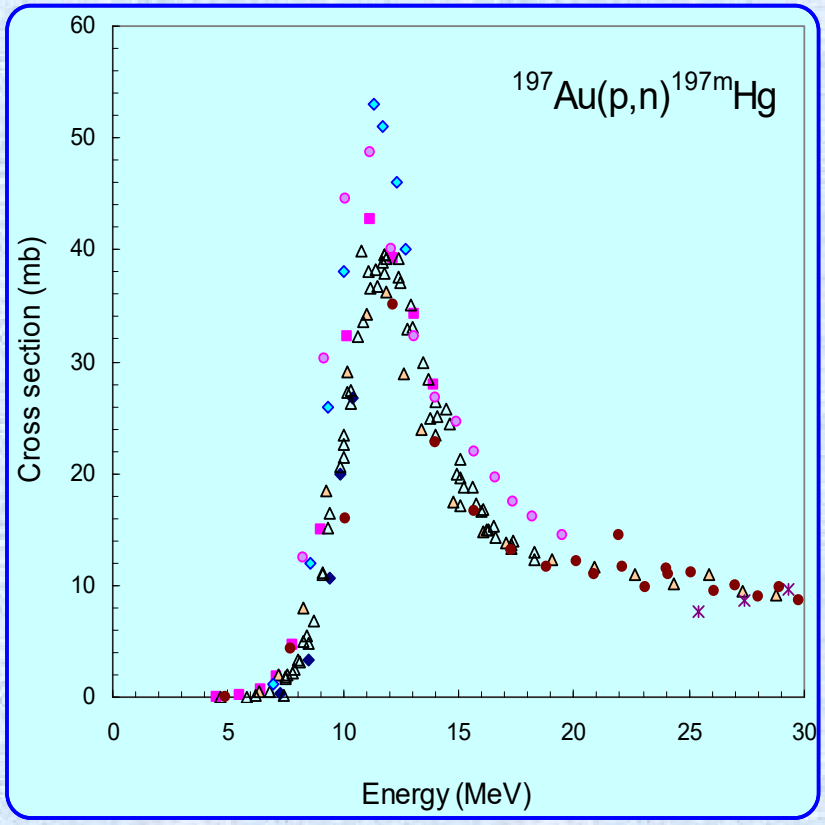
Cumulative cross sections

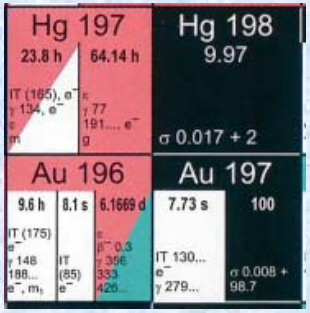
Activation method

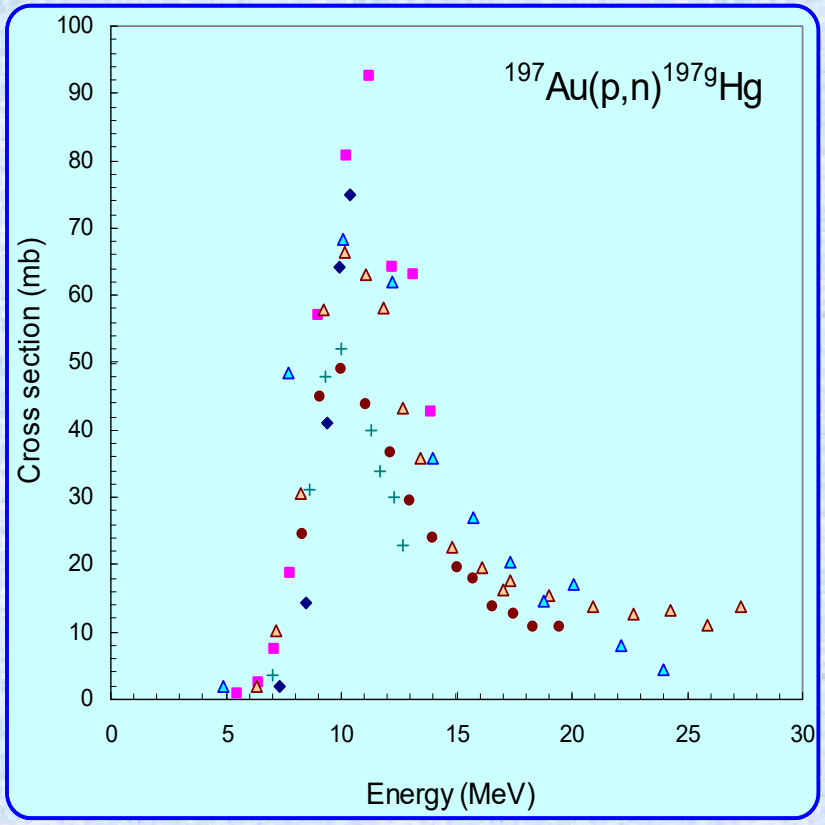
isotopes	$T_{1/2}$ (h) perent	$T_{1/2}$ (h) daughter	N_{max} tc (h)	decay 100% tc (h)	ratio $T_{1/2}$ g/m	**c factor**	N_{100}/N_{max}
^{195m,g}Au	0.008	4464	0.099	0.2	526927	**1.000002**	0.995
^{52m,g}Mn	0.4	134.2	2.3	3.5	381.6	**1.003**	0.990
^{58m,g}Co	9.1	1700.6	59.4	100.0	186.9	**1.005**	0.975
^{57}Ni-^{57}Co	36.0	6523.2	235.0	400.0	181.2	**1.006**	0.973
^{191m,g}Os	13.1	369.6	51.7	148.0	28.2	**1.037**	0.785
^{123}Cs-^{123}Xe	0.1	2.1	0.1	0.6	21.2	**1.049**	0.825
^{90m,g}Y	3.2	64.0	10.8	35.9	20.1	**1.052**	0.700
^{86m,g}Y	0.8	14.7	2.3	8.3	18.7	**1.057**	0.694
^{196m_2,g}Au	9.6	148	30.2	112.0	15.4	**1.069**	0.607
^{56}Ni-^{56}Co	145.8	1853.7	430.9	1740.0	12.7	**1.085**	0.530
^{197m,g}Pt	1.6	19.9	4.2	18.0	12.5	**1.087**	0.539
^{199m,g}Pb	0.2	1.5	0.1	1.9	7.4	**1.157**	0.373
^{123}Xe-^{123}I	2.1	13.2	3.9	27.0	6.4	**1.186**	0.216
^{87m,g}Y	13.4	79.8	26.9	176.0	6.0	**1.201**	0.193
^{93m,g}Tc	0.7	2.8	0.7	9.9	3.8	**1.358**	0.055
^{198m,g}Tl	1.9	5.3	1.8	31.0	2.8	**1.545**	0.0082
^{197m,g}Hg	23.8	64.1	27.0	420.0	2.7	**1.590**	0.0046
^{198m,g}Au	54.5	64.7	12.0	3820.0	1.2	**6.374**	7.19489E-24
^{76}Kr-^{76}Br	14.6	16.2	1.6	1630.0	1.1	**10.125**	1.39669E-40

Cumulative cross sections

Activation method







$$\sigma_{2cum} = \sigma_2 + cf\sigma_1$$

REACTION (79-AU-197(P,N)80-HG-197-M,,SIG)

REACTION (79-AU-197(P,N)80-HG-197-G,,SIG)

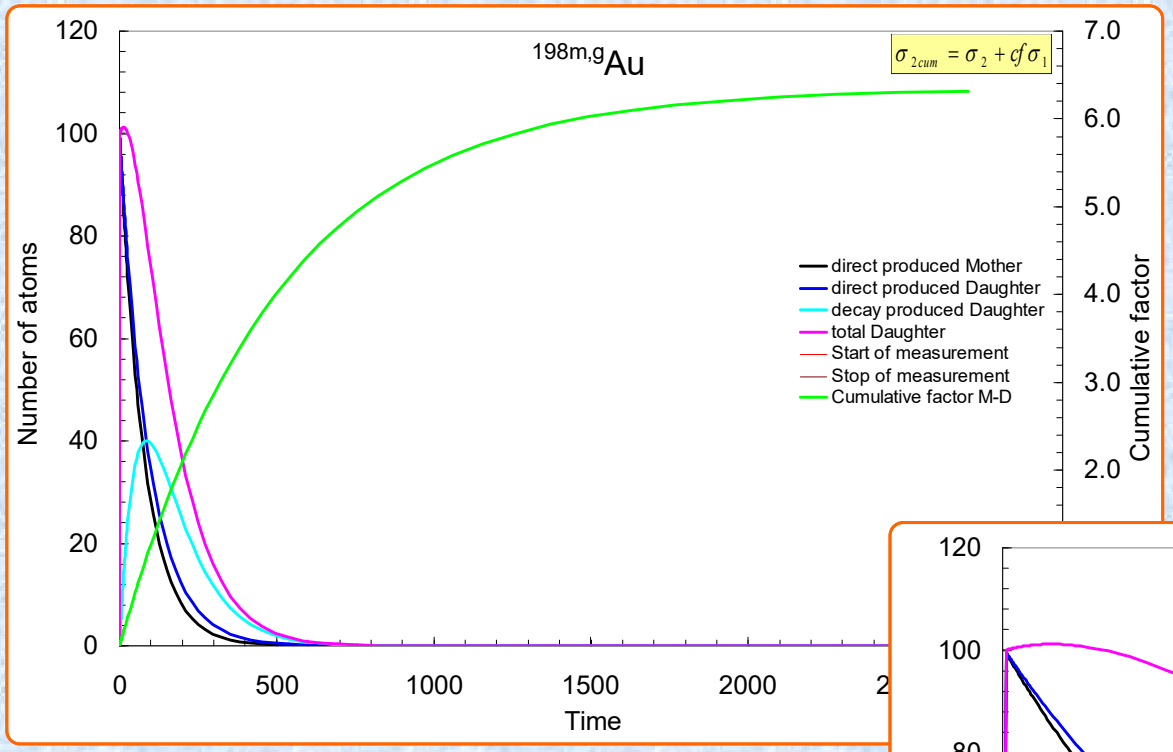
$T_{1/2}$(m)=23.8 h

$T_{1/2}$(g)=64.1 h

C=1.590

Cumulative cross sections

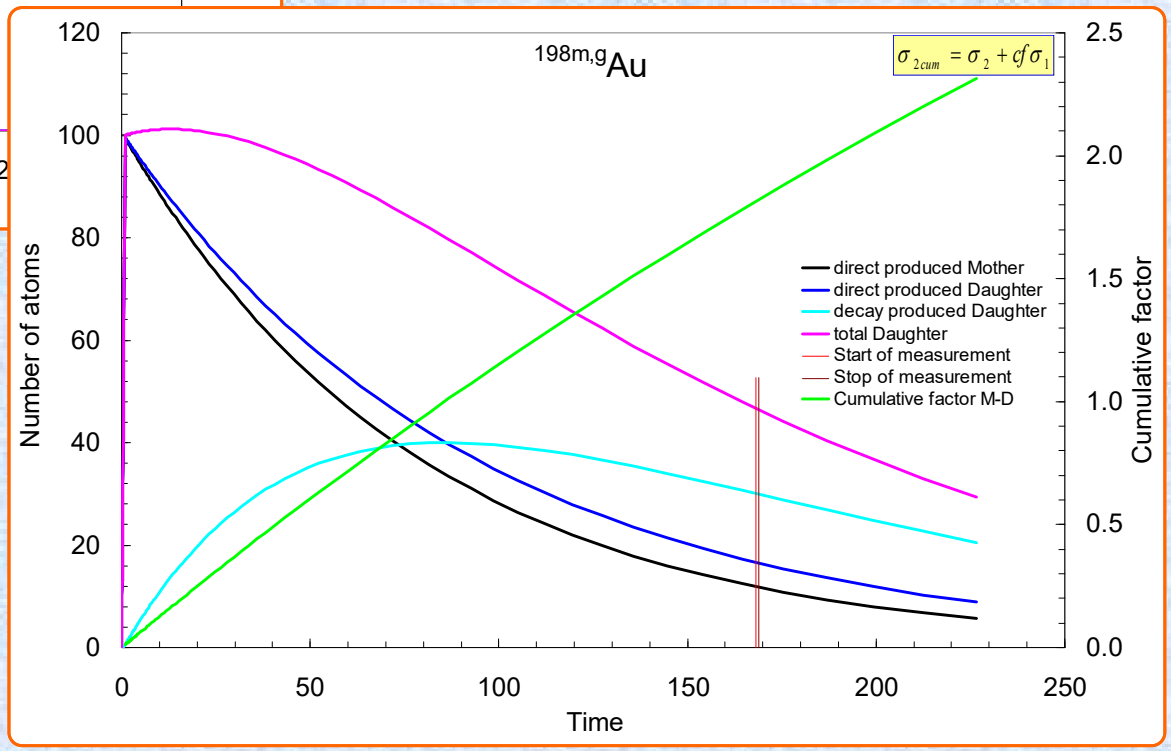
Activation method



$T_{1/2}(m)=2.272$ d

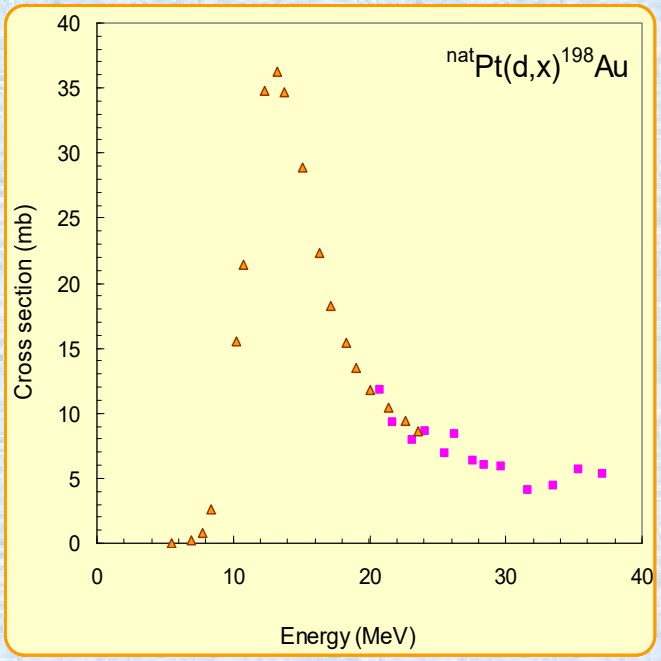
$T_{1/2}(g)=2.6948$ d

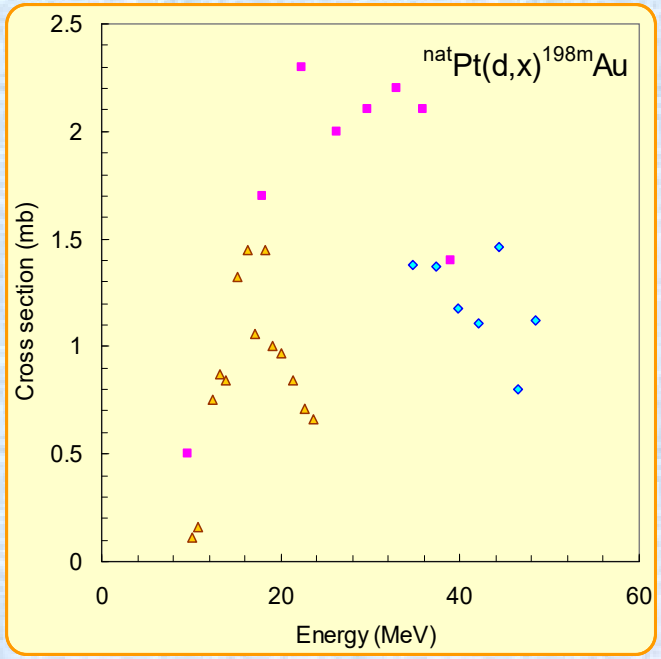
C=6.374

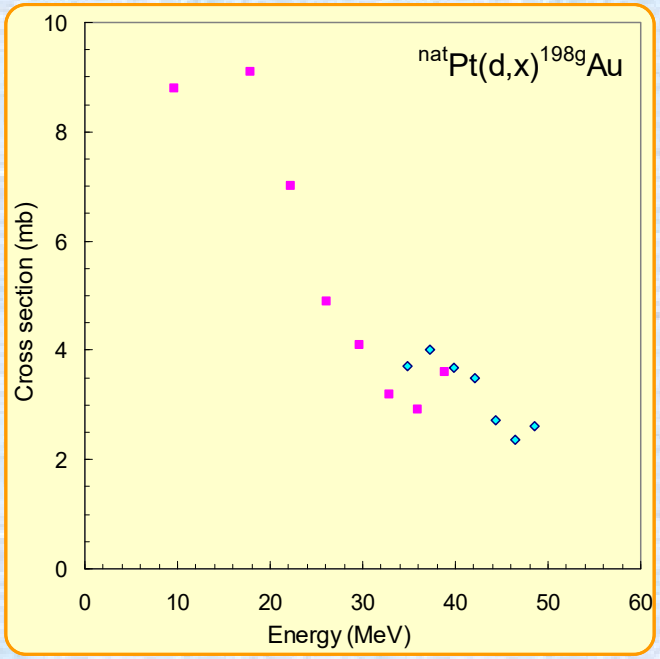


Cumulative cross sections

Activation method







REACTION (98-PT-0(D,X)97-AU-198,,SIG)

REACTION (98-PT-0(D,X)97-AU-198-M,,SIG)

REACTION (98-PT-0(D,X)97-AU-198-G,,SIG)

$$\sigma_{2cum} = \sigma_2 + f\sigma_1$$

$$\sigma_{2cum} = \sigma_2 + cf\sigma_1$$

$T_{1/2}(m)=2.272$ d

$T_{1/2}(g)=2.6948$ d

C=6.374

Cumulative cross sections

Activation method

Some Conclusions

- The cumulative cross section measured (properly) by activation method is always higher than the sum of the corresponding cross sections
- The “c” cumulative factor is time dependent
- Cumulative cross section for a pair of isotopes with c>1.4 cannot be measured properly, since it requires long cooling time, and remaining activity is <1%
- The m/g or m/(m+g) isomer ratios depend on the measurement of the cumulative cross section
- Using activation method deducing the cross section for the ground state or for the daughter isotope requires consideration of the cumulative factor
- Only an early measurement can be performed for a pair of isotopes with similar half-lives, that provides lower cumulative cross section, therefore correction is needed
- For a decay chain the linear combination of the individual cross section is applied

$$\sigma_{3cum} = \sigma_3 + c_2 f \sigma_2 + c_1 g \sigma_1$$

Cumulative cross sections

Activation method

What data are measured ?

What data are reported ?

What data are compiled ?