

Home task – radionuclide production

Following radionuclides are of interest in PET

^{11}C , ^{18}F , ^{68}Ga and ^{124}I

For these radionuclides

- Give suitable nuclear reaction(s). Aim for high specific radioactivity, high radionuclide purity and technical feasibility.
- Give a suitable energy window for the production.
- Give the energy threshold for the reaction.
- Give threshold energies for eventually disturbing reactions.
- Give suitable irradiation times for optimal yield and purity and purity.

With the irradiation conditions you have chosen, calculate the yield in GBq

You have to your disposal an accelerator that delivers 16 MeV protons and 8 MeV, deuterons with a beam current of 100 μA . To your help you have two internet addresses

<http://www-nds.iaea.org/medical/>

<http://nucleardata.nuclear.lu.se/database/masses/>



Charged-particle cross section database for medical radioisotope production



Diagnostic radioisotopes and monitor reactions

The database contains evaluated cross sections for 48 reactions induced by light charged-particles with incident energies up to several tens of MeV (maximum 100 MeV). Production cross sections for the most important diagnostic radioisotopes are given, with 16 reactions devoted to [gamma emitters](#), and 10 reactions devoted to [positron emitters](#). Cross sections for [beam monitor reactions](#) are given for 22 reactions induced by protons, deuterons, ^3He , and alpha particles.

Data are also available in ENDF-6 format for [protons](#), [deuterons](#), [Helium-3](#), and [alpha](#) particles.
A description of the formatting procedure is given in the report [IAEA-NDS-210](#) (pdf, 68 KB).

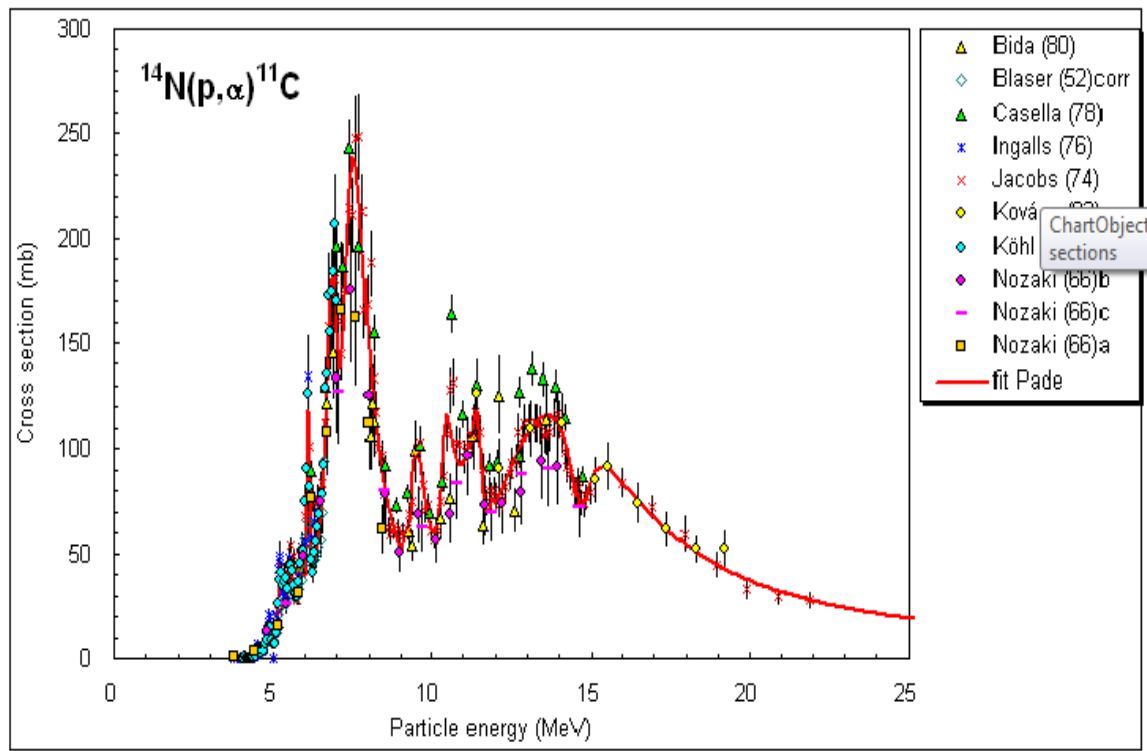
Complete documentation is available, including evaluation methodology, detailed bibliography, graphical and tabulated results. A hardcopy was published as IAEA-TECDOC-1211 (May 2001).

Definitions of the quantities given - production yields and cross sections - can be found [here](#) (PDF, 15 kB).

The database was developed under the IAEA Coordinated Research Project (1995-1999).

The participants and contributors to the project were:

S.M.Qaim	FZ, Julich, Germany	Chairman
F.T.Tarkanyi	ATOMKI, Debrecen, Hungary	Co-chairman
P.Oblozinsky	IAEA, Vienna, Austria	Scientific secretary
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B.Scholten	FZ, Julich, Germany	
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Recommended cross sections for $^{14}\text{N}(p,\alpha)^{11}\text{C}$ reaction

Last updated: March 2003.

Reaction calculator ▾

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About

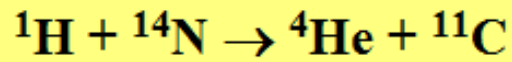
Calculation of reaction Q-values

	A	Symb.	Z
Projectile	<input type="text" value="1"/>	<input type="text" value="H"/>	<input type="text" value="1"/>
Target	<input type="text" value="14"/>	<input type="text" value="N"/>	<input type="text" value="7"/>
Ejectile	<input type="text" value="4"/>	<input type="text" value="He"/>	<input type="text" value="2"/>
(Product	<input type="text" value="11"/>	<input type="text" value="C"/>	<input type="text" value="6"/>)

Check

Calculate

Reset



B.E.(1)= 0.0 ± 0.0 keV

B.E.(2)= 104658.628 ± 0.016 keV

B.E.(3)= 28295.673 ± 0.005 keV

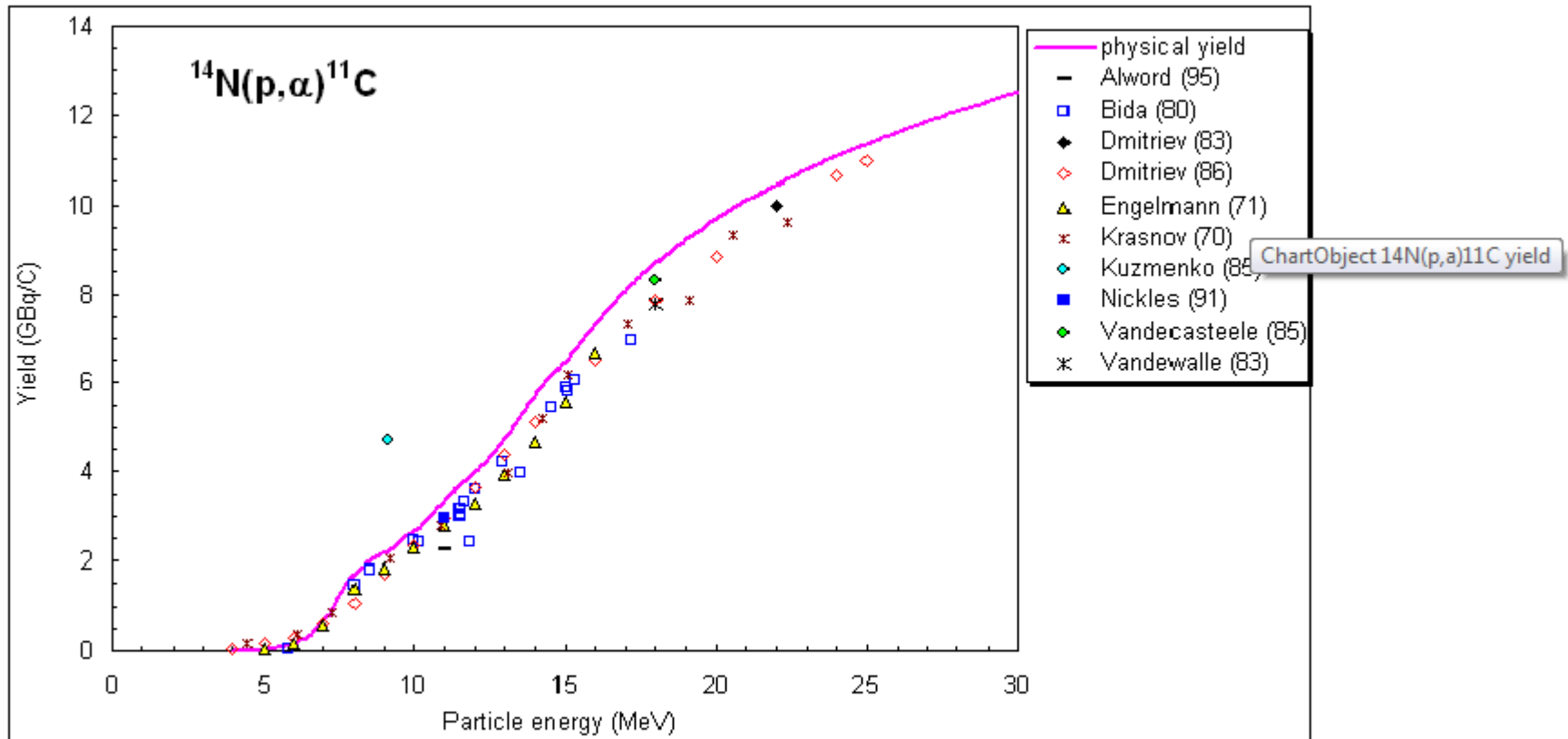
B.E.(4)= 73439.899 ± 0.952 keV

Q-value: -2923.056 keV

Uncertainty: 0.952 keV (ignoring correlations)

Threshold: 3133.433 keV

Yield calculated from the recommended cross sections for $^{14}\text{N}(p,\alpha)^{11}\text{C}$ reaction

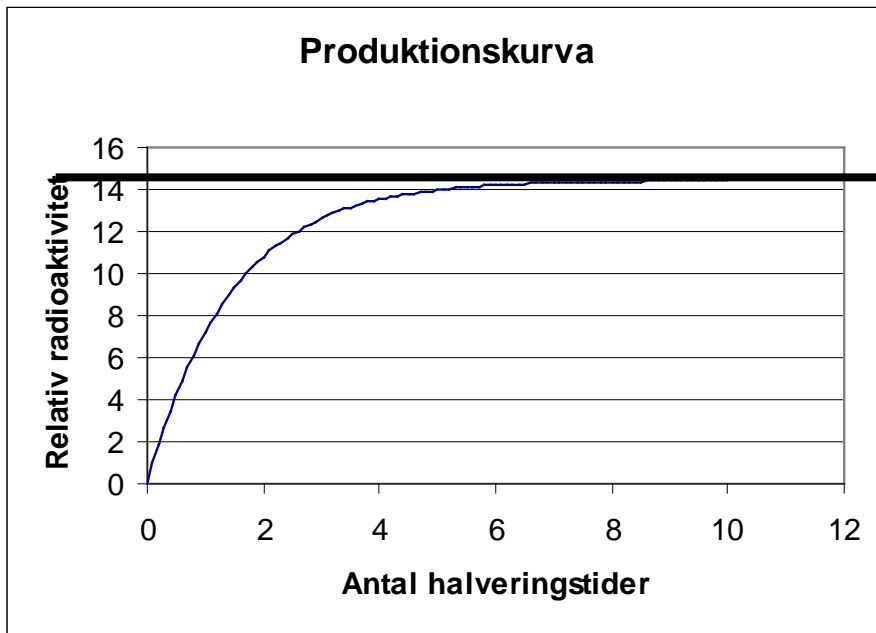
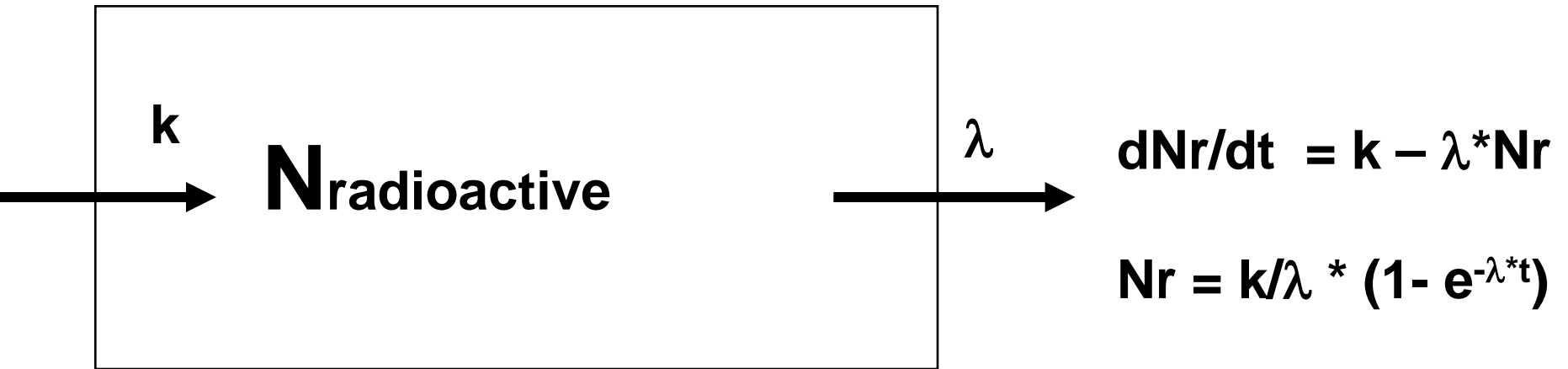


Last updated: March 2003.

Y_1 : physical yield, A_1 : activity of fixed 1 hour and 1 μ A irradiation, A_2 : saturation activity for 1 μ A

Energy (MeV)	Y_1 (GBq/C)	A_1 (GBq)	A_2 (GBq)	Energy (MeV)	Y_1 (GBq/C)	A_1 (GBq)	A_2 (GBq)
4.0	0.02	0.00003	0.00004	15.0	3674.8	5.64	6.49
4.5	0.63	0.001	0.001	15.5	3915.7	6.01	6.91
5.0	10.0	0.02	0.02	16.0	4152.8	6.38	7.33
5.5	46.9	0.07	0.08	16.5	4373.5	6.72	7.72
6.0	94.1	0.14	0.17	17.0	4575.8	7.03	8.08
6.5	183.2	0.28	0.32	17.5	4761.0	7.31	8.40
7.0	390.6	0.60	0.69	18.0	4930.7	7.57	8.70
7.5	669.5	1.03	1.18	18.5	5086.9	7.81	8.98
8.0	966.0	1.48	1.71	19.0	5231.4	8.03	9.23
8.5	1132.0	1.74	2.00	19.5	5365.8	8.24	9.47
9.0	1235.8	1.90	2.18	20.0	5491.3	8.43	9.69
9.5	1370.9	2.10	2.42	20.5	5608.9	8.61	9.90
10.0	1517.3	2.33	2.68	21.0	5719.7	8.78	10.10
10.5	1682.5	2.58	2.97	21.5	5824.4	8.94	10.28
11.0	1879.7	2.89	3.32	22.0	5923.7	9.10	10.46
11.5	2101.6	3.23	3.71	22.5	6018.2	9.24	10.62
12.0	2262.0	3.47	3.99	23.0	6108.5	9.38	10.78
12.5	2450.8	3.76	4.33	23.5	6194.9	9.51	10.93
13.0	2684.5	4.12	4.74	24.0	6277.8	9.64	11.08
13.5	2953.3	4.53	5.21	24.5	6357.6	9.76	11.22
14.0	3233.1	4.96	5.71	25.0	6434.4	9.88	11.36
14.5	3472.5	5.33	6.13				

Energy (MeV)	Y_1 (GBq/C)	A_1 (GBq)	A_2 (GBq)
15.0	3674.8	5.64	6.49
15.5	3915.7	6.01	6.91
16.0	4152.8	6.38	7.33
16.5	4373.5	6.72	7.72
17.0	4575.8	7.03	8.08



Saturation value (infinity) = k/λ

In our example you get 7.33 GBq for 1 uA and 16 MeV protons

$$\lambda = 2.04 \text{ 1/h}$$

$$k = 7.33 * 2.04 = 15 \text{ GBq/h}$$

A usual way to express yield is as MBq per charge (C). 1 C = 1 Ampersecond (As).

$$1 \text{ uAh} = 0,0036 \text{ C}$$

Each proton has the charge $1,60 * 10^{-19} \text{ C}$

1 uAs corresponds to $6,25 * 10^{12}$ protons

1 uAh corresponds to $2,25 * 10^{16}$ protons