Uncertainties of Normalized Particle Emission Probabilities

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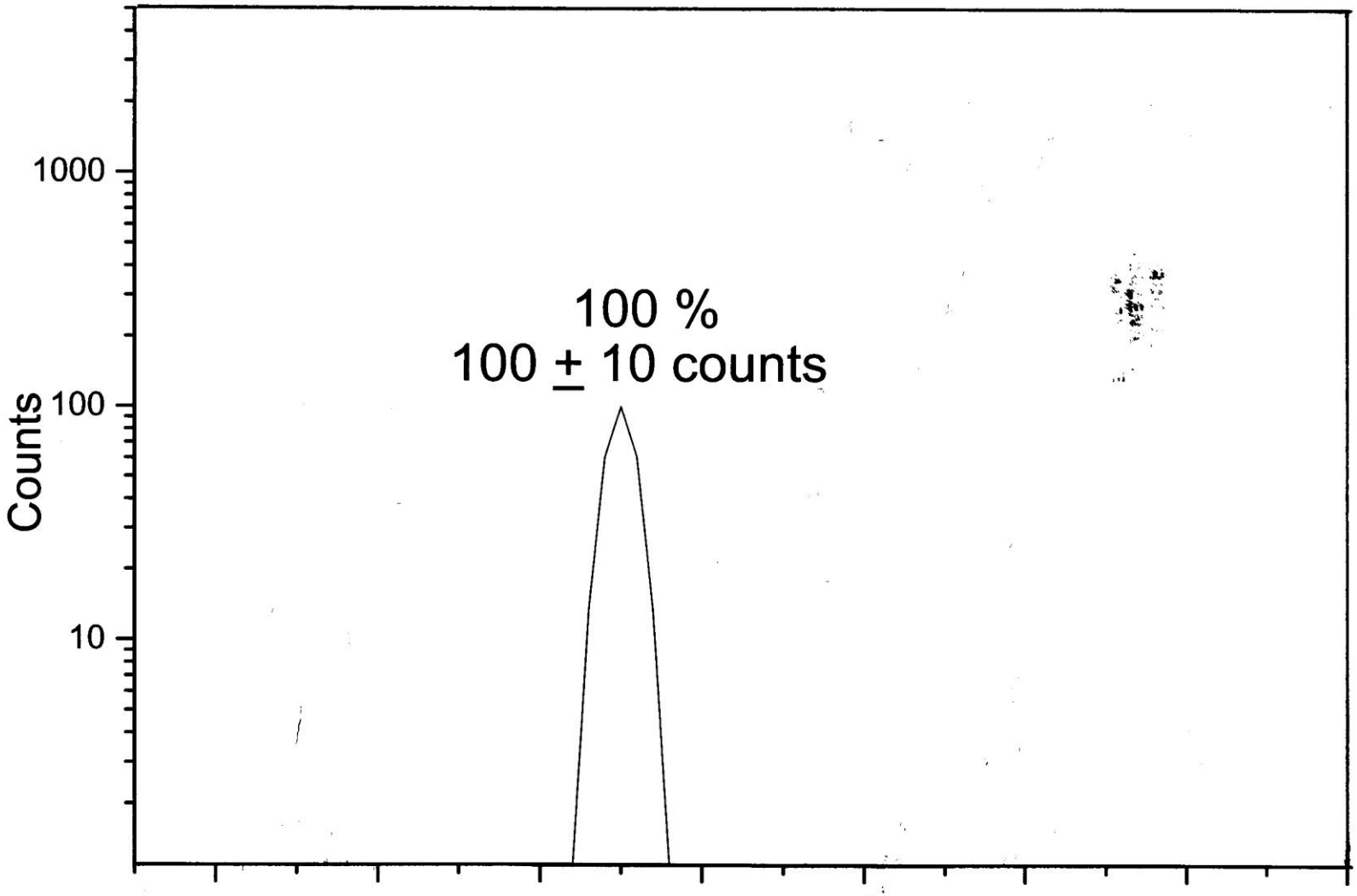
November 2009


1000
100
10
Counts
100 %
100 ± 10 counts

Normalization Factor *N*

(10 ± 3) x *N* = 100% → ***N* = 100% / (10 ± 3)**

(100 ± 10) x *N* = 100% → ***N* = 100% / (100 ± 10)**

(1000 ± 30) x *N* = 100% → ***N* = 100% / (1000 ± 30)**

Absolute Emission Probabilities

$p(\%) = (10 \pm 3) \times 100\% / (10 \pm 3) = 100\%$

$p(\%) = (100 \pm 10) \times 100\% / (100 \pm 10) = 100\%$

$p(\%) = (1000 \pm 30) \times 100\% / (1000 \pm 30) = 100\%$

Normalizing Two Peaks

Relative emission probabilities

$I_{\alpha 0} = 42{,}000 \pm 205$, $I_{\alpha 1} = 16{,}000 \pm 126$

or

$I_{\alpha 0} = 72.41 \pm 0.35$ $I_{\alpha 1} = 27.59 \pm 0.22$

$(I_{\alpha 0} + I_{\alpha 1}) \times N = 100\%$ **Normalization Procedure**

$\longrightarrow$

$(58{,}000 \pm 241) \times N = 100\%$ $N = 0.001724 \pm 0.000007$

If we assume that $I_{\alpha 0}$, $I_{\alpha 1}$, and N are *independent quantities*, then the absolute emission probabilities become:

$P_{\alpha 0}(\%) = (42{,}000 \pm 205) \times (0.001724 \pm 0.000007) = 72.41 \pm 0.46$ %

$P_{\alpha 1}(\%) = (16{,}000 \pm 126) \times (0.001724 \pm 0.000007) = 27.59 \pm 0.25$ %

BUT THEY ARE NOT, BECAUSE

$(I_{\alpha 0} + I_{\alpha 1}) \times N = P_{\alpha 0}(\%) + P_{\alpha 1}(\%) = 100\%,$

Then

$$P_{\alpha 0}(\%) = \frac{(42{,}000 \pm 205) \times 100}{(42{,}000 \pm 205) + (16{,}000 \pm 126)} = \frac{100}{1 + \dfrac{(16{,}000 \pm 126)}{(42{,}000 \pm 205)}} = 72.41 \pm 0.19\ \%$$

$$P_{\alpha 1}(\%) = \frac{(16{,}000 \pm 126)}{(42{,}000 \pm 205) + (16{,}000 \pm 126)} = \frac{100}{1 + \dfrac{(42{,}000 \pm 205)}{(16{,}000 \pm 126)}} = 27.59 \pm 0.19\ \%$$

The alpha-particle emission probabilities and their uncertainties become:

$P_{\alpha 0}(\%) = 72.41 \pm 0.19\ \%$

$P_{\alpha 1}(\%) = 27.59 \pm 0.19\ \%$

General Formulas

$$\mathbf{P_i(\%)} = I_i \times 100 / \Sigma_k I_k$$

Where:

I_i is the relative spectral intensity for the i-th group.

Its uncertainty is given by [#]

$$\mathbf{dP_i(\%)/P_i(\%)} = [(dI_i/I_i)^2 (1 - 2I_i/ \Sigma_k I_k) + \Sigma_k dI_k^2/(\Sigma_k I_k)^2]^{1/2}$$

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[#] Nucl. Instrum. and Methods in Phys. Res. **A265,** 541 (1988).

A more complete analysis, which includes the use of the error matrix, is given by Sanchez et al.[&]

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[&] Nucl. Instrum. and Methods in Phys. Res. **A340**, 509 (1993).

PABS: **A Computer Program to Normalize Emission Probabilities and Calculate Realistic Uncertainties**

Report LBNL-2623E, August 2009

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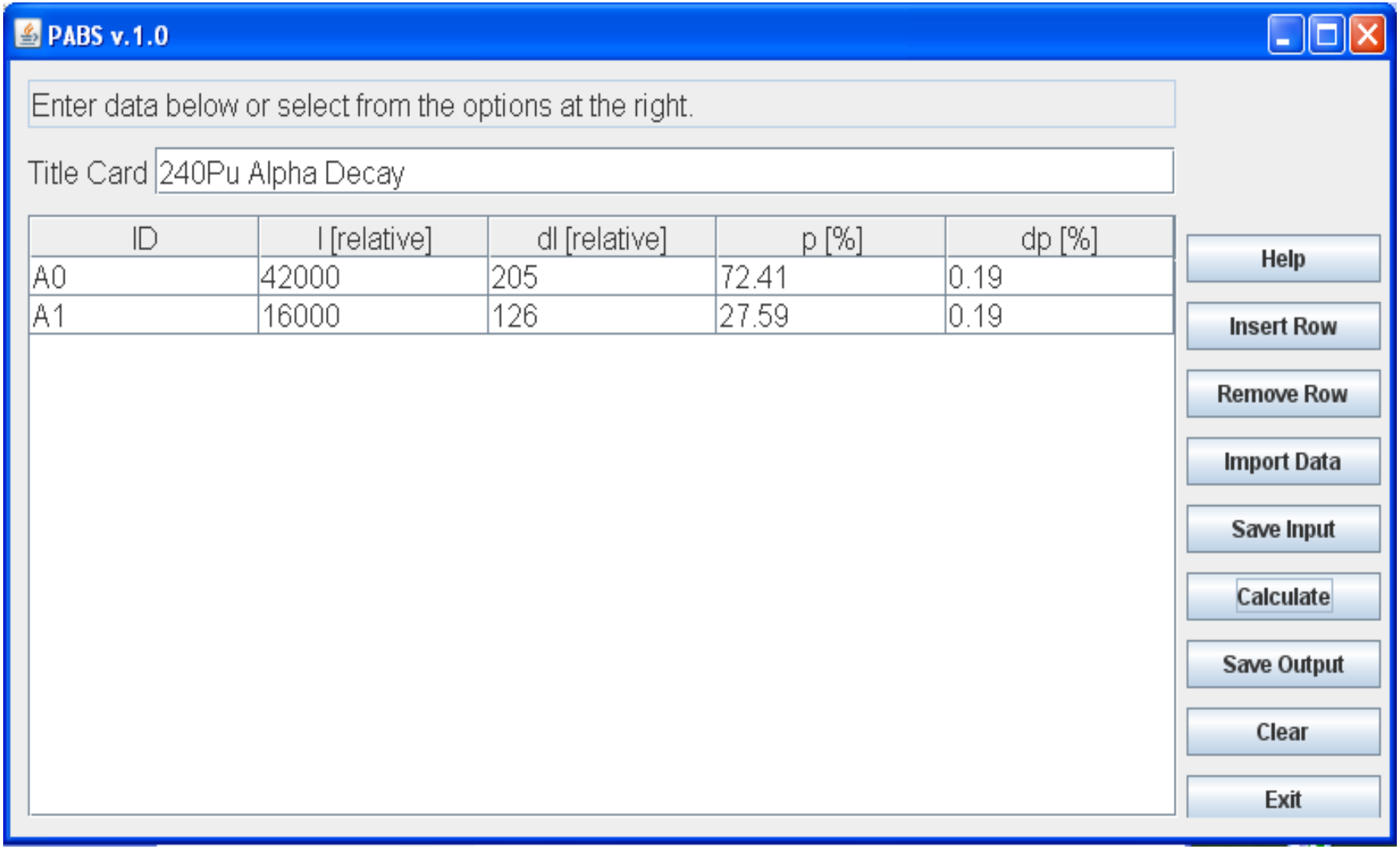
1 Abstract

The program PABS normalizes relative particle emission probabilities to an absolute scale and calculates the relevant uncertainties on this scale. The program is written in Java using the JDK 1.6 library. For additional information about system requirements, the code itself, and compiling from source, see the README file distributed with this program. The mathematical procedures used are given below.


PABS v.1.0
Enter data below or select from the options at the right.
Title Card
240Pu Alpha Decay
ID
I [relative]
dI [relative]
p [%]
dp [%]
A0
42000
205
72.41
0.19
A1
16000
126
27.59
0.19
Help
Insert Row
Remove Row
Import Data
Save Input
Calculate
Save Output
Clear
Exit

PABS v.1.0

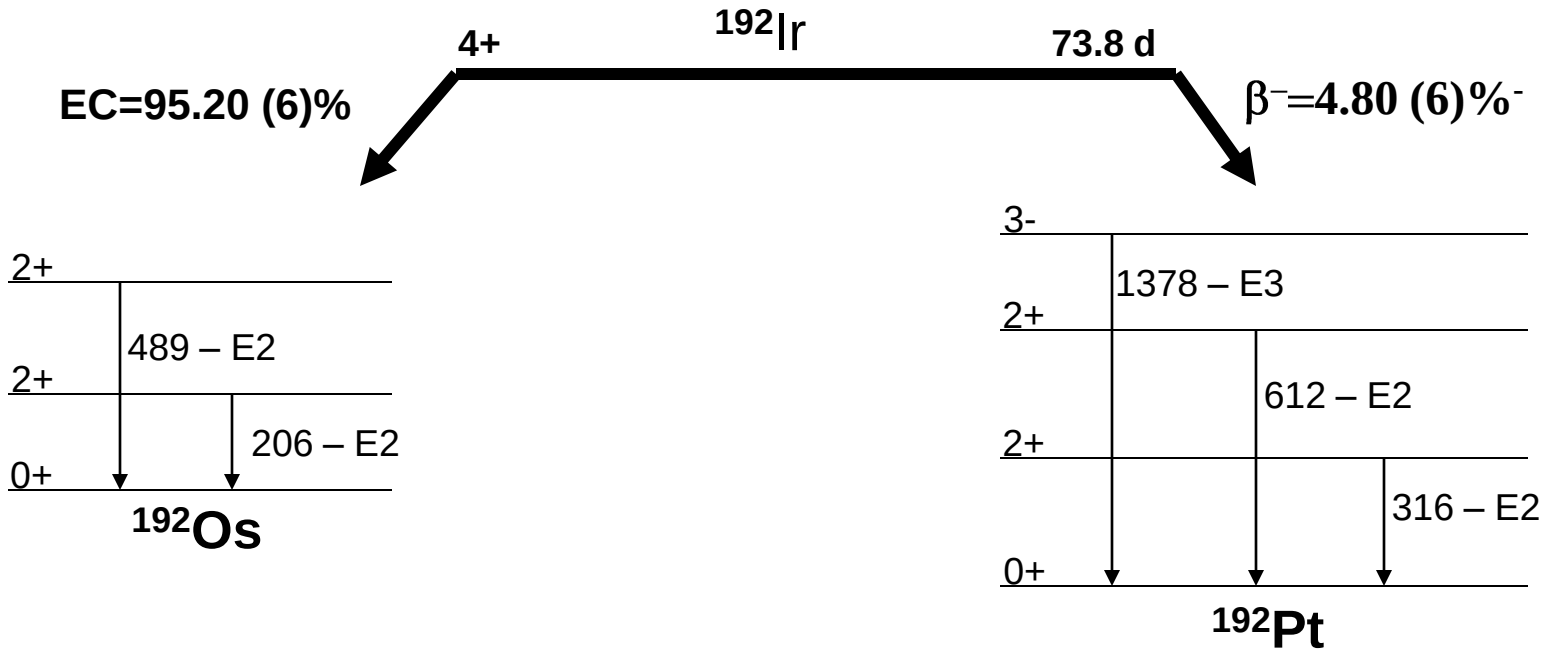
Enter data below or select from the options at the right.

Title Card: 251Fm Alpha Decay

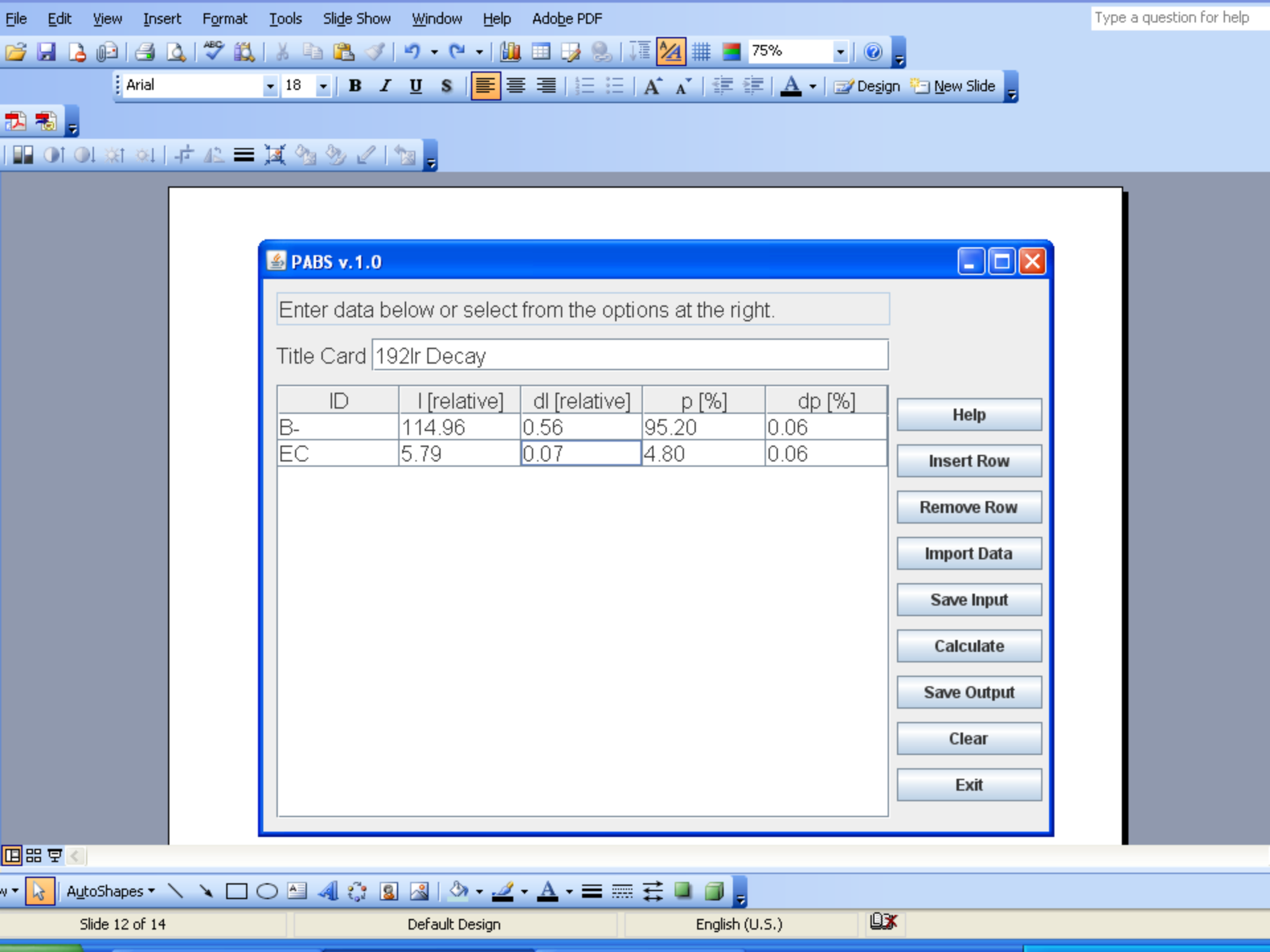
ID	I [relative]	dI [relative]	p [%]	dp [%]
A1	1.5	0.1	1.50	0.1
A2	0.93	0.08	0.93	0.08
A3	0.29	0.03	0.29	0.03
A4	1.8	0.1	1.80	0.1
A5	1.7	0.1	1.70	0.1
A6	87.0	0.9	87.2	0.3
A7	4.8	0.2	4.81	0.20
A8	0.38	0.06	0.38	0.06
A9	0.44	0.04	0.44	0.04
A10	0.07	0.03	0.07	0.03
A11	0.56	0.06	0.56	0.06
A12	0.26	0.04	0.26	0.04

Help
Insert Row
Remove Row
Import Data
Save Input
Calculate
Save Output
Clear
Exit

^{192}Ir β^- and EC Decay



Eγ(keV)	Iγ(rel)	α(theor)	I_T=Iγ(1 + α(theor))
316	100.0 (5)	0.0841 (12)	108.41 (55)
612	6.45 (9)	0.01536 (22)	6.55 (9)
1378	0.0014 (4)	0.00613 (9)	0.0014 (4)
			Σ = 114.96 (56)
206	4.03 (5)	0.302 (5)	5.25 (7)
489	0.529 (17)	0.0241 (4)	0.542 (17)
			Σ = 5.79 (7)


File Edit View Insert Format Tools Slide Show Window Help Adobe PDF
Type a question for help
75%
Arial 18
Design New Slide
PABS v.1.0
Enter data below or select from the options at the right.
Title Card 192Ir Decay
ID | I [relative] | dI [relative] | p [%] | dp [%]
B- | 114.96 | 0.56 | 95.20 | 0.06
EC | 5.79 | 0.07 | 4.80 | 0.06
Help
Insert Row
Remove Row
Import Data
Save Input
Calculate
Save Output
Clear
Exit
AutoShapes
Slide 12 of 14
Default Design
English (U.S.)

Program GABS

REPORT

Current date: 09/29/2009

192IR B- DECAY (73.827 D)

NR= 1.052 BR= 0.9520 6

192IR EC DECAY (73.827 D)

NR= 20.85 BR= 0.0480 6

Thank you for your attention