



**Workshop on Understanding and Evaluating Radioanalytical  
Measurement Uncertainty**

*5 - 16 November 2007*

**Uncertainty in Gamma Spectrometry.  
Exercise 3**

P. De FELICE  
*ENEA-INMRI  
Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti  
C.R. Casaccia P.O. Box 2400  
I-00100 Rome  
Italy*

Symbol	Quantity	Value	Unit	Standard Uncertainty	Relative Standard Uncertainty (%)
$n_1$	net count rate lab 1	10.0		0.1000	1.0
$n_2$	net count rate lab 2	12.1		0.1210	1.0
$\varepsilon_1$	full-energy peak efficiency lab 1	1.01		0.0101	1.0
$\varepsilon_2$	full-energy peak efficiency lab 2	0.820		0.0082	1.0
$I_\gamma$	photon emission probability	0.10		0.0500	50.0
$A_1$	sample activity lab 1	9901.0			50.02
$A_2$	sample activity lab 2	14756.1			50.02
R	Ratio $A_1 / A_2$	0.6710		0.0134	2

R: Uncertainty budget		R= $A_1/A_2$		$R = \frac{n_1 \varepsilon_2}{n_2 \varepsilon_1}$		
Source of uncertainty	Expression	Value	Rel. Value	Expression	Value	Rel. Value
$A_1$	$\frac{1}{R} \frac{\partial R}{\partial A_1} u(A_1) = u'(A_1)$		0.50020	$\frac{1}{R} \frac{\partial R}{\partial n_1} u(n_1) = u'(n_1)$		0.010
$A_2$	$\frac{1}{R} \frac{\partial R}{\partial A_2} u(A_2) = u'(A_2)$		0.50020	$\frac{1}{R} \frac{\partial R}{\partial n_2} u(n_2) = u'(n_2)$		0.010
<b>SUB TOTAL</b>	$\sqrt{u'(A_1)^2 + u'(A_2)^2}$		0.70739	$\frac{1}{R} \frac{\partial R}{\partial \varepsilon_1} u(\varepsilon_1) = u'(\varepsilon_1)$		0.010
Correlations between $A_1$ and $A_2$	$\frac{2}{R^2} \frac{\partial R}{\partial A_1} \frac{\partial R}{\partial A_2} \text{cov}(A_1, A_2) = -2u'(I_\gamma)^2$		-0.5000	$\frac{1}{R} \frac{\partial R}{\partial \varepsilon_2} u(\varepsilon_2) = u'(\varepsilon_2)$		0.010
<b>Combined standard uncertainty</b>	$\sqrt{u'(A_1)^2 + u'(A_2)^2 + \frac{2}{R^2} \frac{\partial R}{\partial A_1} \frac{\partial R}{\partial A_2} \text{cov}(A_1, A_2)}$		0.020	$\sqrt{\sum u'(x_i)^2}$		0.020