Complementary information concerning the International Reference System (SIR)

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1. Uncertainty of SIR-based activity measurements

The latest efficiency curve is based on about 300 results from SIR measurements on 45 radionuclides and provides calibration of the ionization chamber over a range from 30 to 2 750 keV. The efficiency parameter f, as defined in [1], can be written as

$$f = \frac{10^6/A_e - \sum_{i=1}^{n-1} 60\ E_i\ P_i\ f_i}{60\ E\ P} ,$$

where A_e is the "equivalent activity" (in kBq) of the radionuclide considered, and E_i and P_i are the photon energies and emission probabilities, respectively.

We put $A_e = \frac{10^5}{6 \sum_{i=1}^{n} E_i\ P_i\ f_i}$ and $E\ P\ f = \max(E_i\ P_i\ f_i)$.

By differentiation the uncertainty of f becomes

$$\Delta f = \left[\frac{\left(\frac{10^5}{6}\frac{\Delta A_e}{A_e^2}\right)^2 + \sum_{i=1}^{n-1} E_i^2 (f_i^2\ \Delta P_i^2 + P_i^2\ \Delta f_i^2)}{E^2\ P^2} + \frac{f^2}{P^2}\ \Delta P^2 \right]^{1/2} .$$

For simplicity it may be assumed that the uncertainties ΔP_i, Δf_i and ΔP are negligible. Remembering that $f_i \approx 1$, one obtains for the relative uncertainty of an activity measurement

$$\frac{\Delta A}{A} = \frac{\Delta A_e}{A_e} \approx \frac{\Delta f}{f + \frac{\sum_{i=1}^{n-1} E_i\ P_i}{E\ P}} .$$

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[1] RYTZ, A. The international reference system for activity measurements of γ-ray emitting nuclides, Int. J. Appl. Radiat. Isot. 34 (1983) 1047.

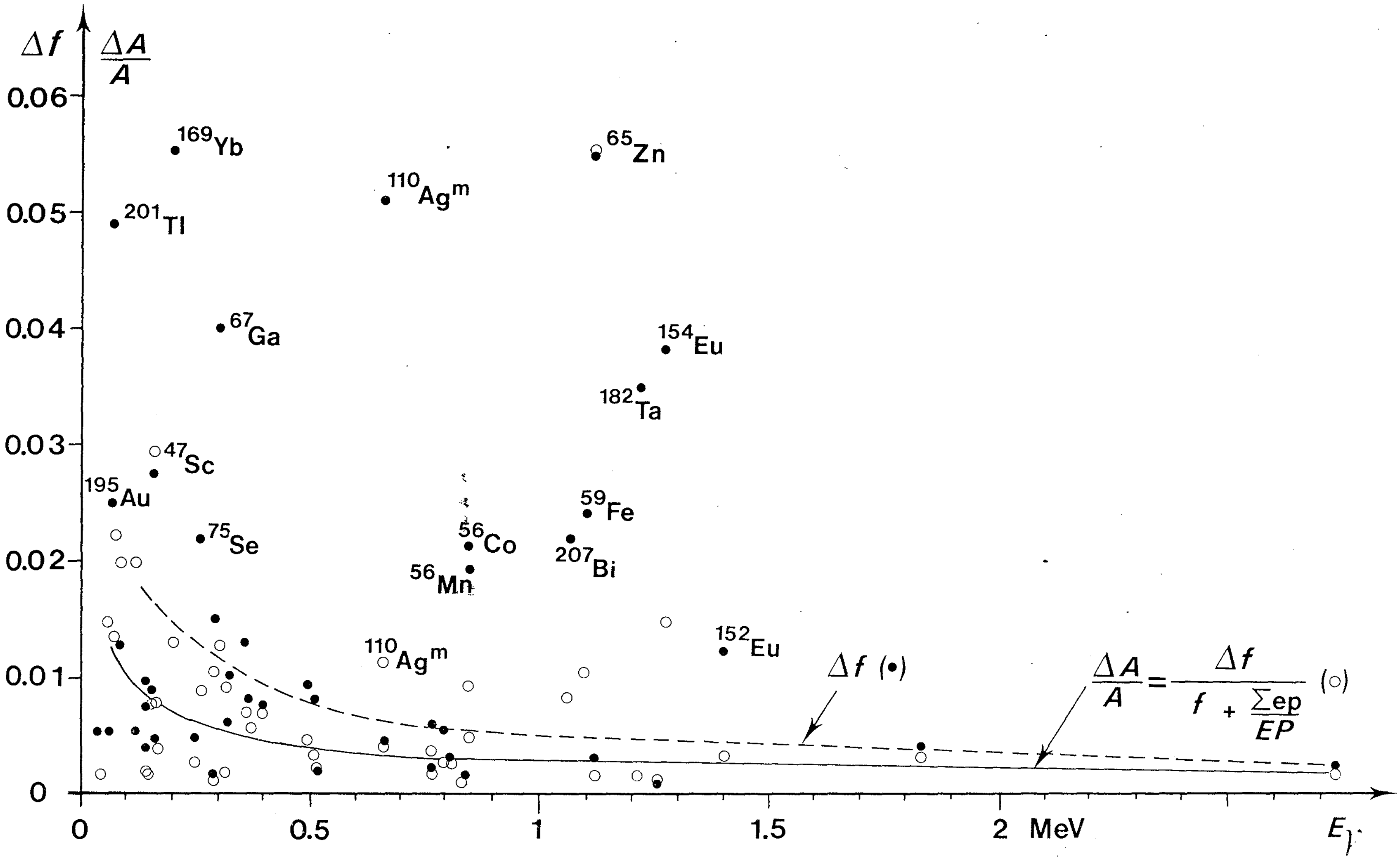

Fig. 1 - Uncertainty of the measurements with the BIPM ionization chamber

In fig. 1 are shown calculated values of Δf and $\Delta A/A$, plotted versus E, for all the radionuclides measured. The curves represent estimated values for the whole energy range. Where the calculated values differ strongly from the estimated ones, the corresponding radionuclides are also indicated. For these deviations one may suspect errors in the activity measurements or incorrect emission probabilities.

2. Wish list of radionuclides for the SIR

a) Important radionuclides that have not yet been measured:

	principal E_γ
^{7}Be	478 keV
^{94}Nb	871
^{124}Sb	1 691
^{124}I	603
^{125}Sb	428
^{155}Eu	86.5
^{170}Tm	84
^{185}W	686
^{210}Pb	46.5

b) Radionuclides with (slightly) doubtful results:

	number of results
^{56}Co	1
^{59}Fe	8
^{65}Zn	8
$^{110}Ag^{m}$	1
^{154}Eu	2
^{195}Au	1
^{207}Bi	1

c) To fill the gap between 850 and 1 050 keV:

	$T_{1/2}$	principal E_γ
^{84}Rb	33 d	882 keV
^{158}Tb	150 a	944
^{160}Tb	72 d	879
^{184}Re	38 d	903

d) The gap between 1 500 and 2 750 keV cannot easily be filled. The only possible candidates would be

^{26}Al	7.5×10^{5} a	1 809 keV
^{188}Pt	10.2 d	2 215
^{206}Bi	15.3 d	1 764 .

(July 1986)

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