Efficiency curve of the SIR ionization chamber

$$(A_e)_{i,l}^{meas} = A_{i,l}\, M_{i,l}\, C_{i,l}$$

NMI *l* — SIR — correction for impurities

The beta and gamma efficiency curves of the ionization chamber are needed
- to evaluate the response for radioactive impurities
- to give a comparison point for radionuclides measured for the first time

$$C_{i,l} = 1 + \sum_k R_{i,l,k} H_{i,l,k} (A_e)_i \,/\, (A_e)_k$$

The iterative method (1976 to 2002)

New $\varepsilon^m(E)$ curve ← Least-squares fit to polynomial of $(E_n, \varepsilon_n{}^m)$ values using commercial software

Calculation of $\varepsilon_n{}^{m+1}$ using BIPM program

$$\varepsilon_n{}^{m+1} = \frac{1/A_e^{meas} - \sum_{i=1}^{n-1} \varepsilon^m(E_i)\cdot P_i - \sum_j \varepsilon_\beta(\beta E_j)\cdot \beta P_j}{P_n}$$

Non-linear least-squares minimization

$$\frac{1}{(A_e)_i^{model}(\boldsymbol{B})} = \sum_j P_{i,j} F(\boldsymbol{B}^{(1)}, E_{i,j}) + \sum_{j'} \beta P_{i,j'} \int_0^{W_{i,j'}} S_{i,j'}(W) G(\boldsymbol{B}^{(2)}, W)\, dW$$

β spectrum shape

$$F(\boldsymbol{B}^{(1)}, E_{i,j}) = E_{i,j} \exp\left(\sum_h B_h^{(1)} \phi_h(\ln E_{i,j})\right) \qquad G(\boldsymbol{B}^{(2)}, W) = W \exp\left(\sum_h B_h^{(2)} \phi_h(W)\right)$$

ϕ_h : Chebyshev polyn.

$$\min_{\boldsymbol{B}} \sum_i \sum_l \left(A_{i,l} M_{i,l} - \frac{(A_e)_i^{model}(\boldsymbol{B})}{C_{i,l}(\boldsymbol{B})} \right)^2 \Big/ u(A_{i,l} M_{i,l})^2$$

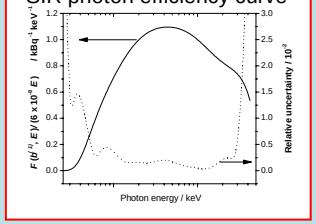
SIRIC (in collaboration with NPL/DTI)

Example of input meas. results

NMI / date, Radionuclide, $(A_e)^{meas}$, $u((A_e)^{meas})$, No. of impur.
Impurity, Relative activity at SIR measurement date, std uncert.
...
'NPL / 1980', ' 51Cr', 488300.0, 2000.0, 0
'NMIJ / 1993', ' 51Cr', 484700.0, 1700.0, 0
'NIST / 1981', ' 51Cr', 487818.0, 1839.0, 2
' 75Se', 8.25e-05, 7.98e-06
' 65Zn', 4.17e-06, 4.17e-07
'OMH / 1994', ' 51Cr', 487236.0, 1294.0, 1
' 60Co', 1.73e-06, 8.63e-07
'BIPM / 1976', ' 54Mn', 19258.0, 46.0, 0
...

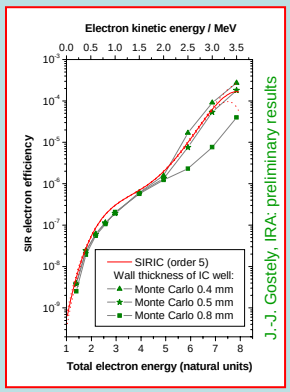
Initial estimates of efficiencies + KCRVs (for impur. Corr.) + Nucl.data

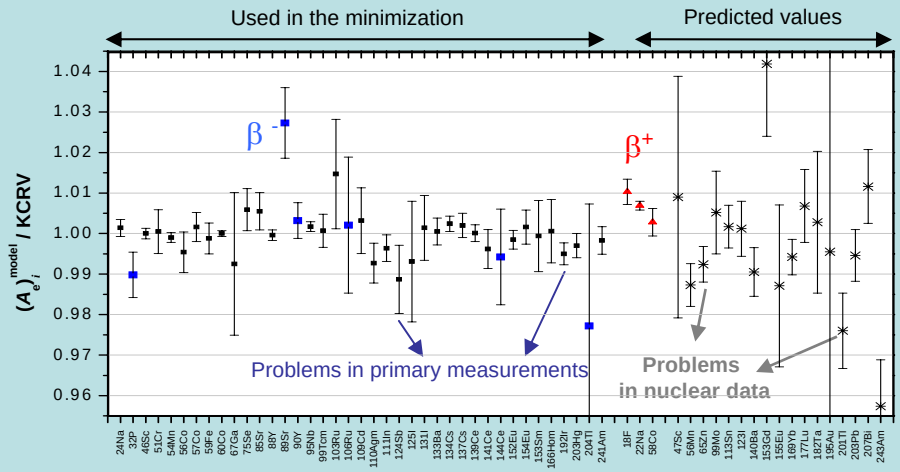
SIR photon efficiency curve



OUTPUTS

$(A_e)^{model}$ values and cov. matrix; $C_{i,l}$ values; outliers; β spectra





Motivation for new research on activity measurement methods and nuclear data determinations