European Commission

Gamma-ray Spectrometry

Training Workshop on
Applications of Gamma-ray Spectrometry
to Environmental Samples

Sum-peak Method

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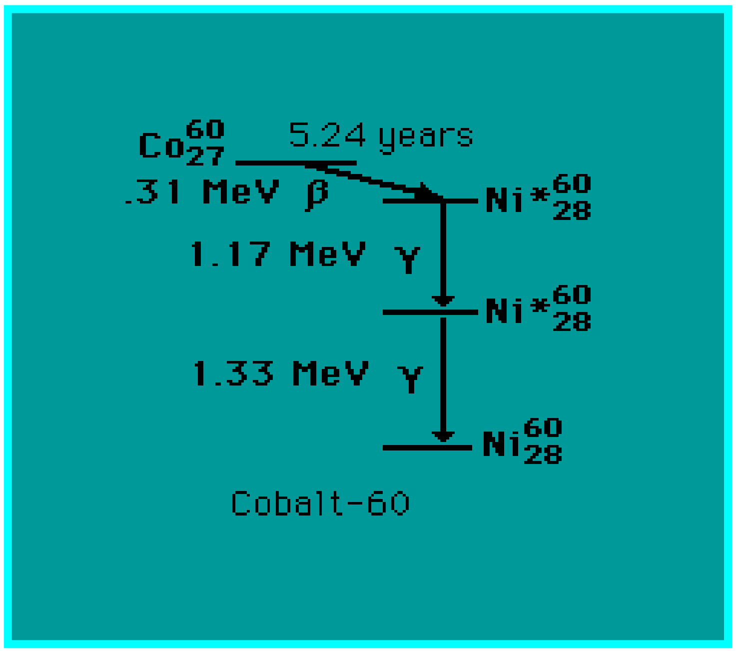
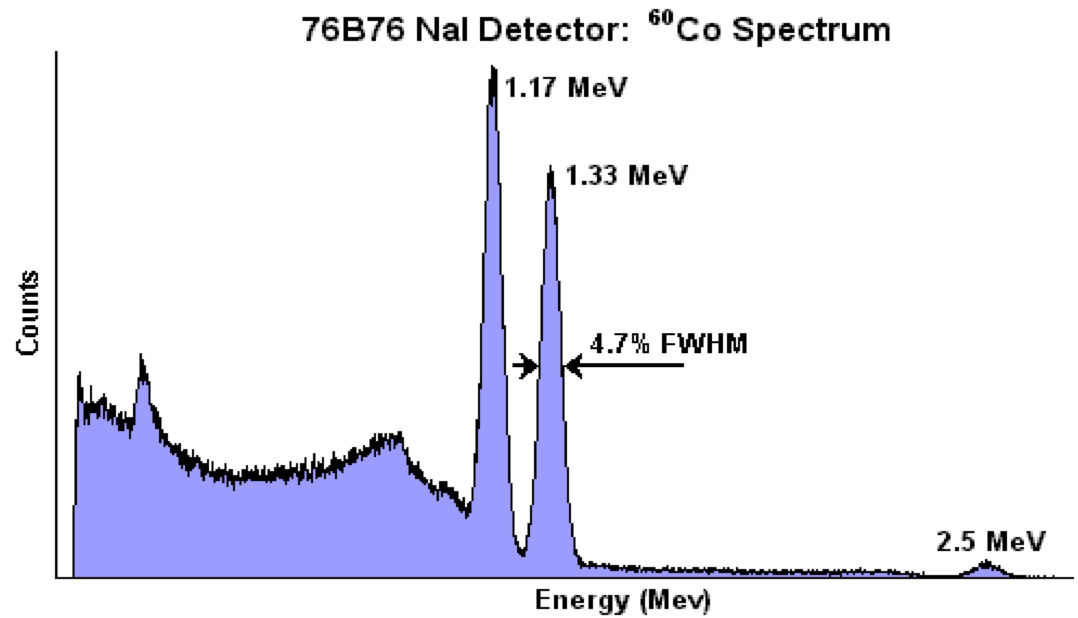
The Sum-peak Method

- “Primary method” of source standardization
- Provides the activity of the radionuclide in the sample
- Requires no efficiency calibration
- Limited to certain suitable decay schemes
- Exploits the coincidence summing effect
- Uses gamma-ray spectrometry
- Point sources only

Coincidence summing with Co-60





Basic equations of coincidence summing

$n_1 = A\varepsilon_1(1-\varepsilon_{t2})$
$n_2 = A\varepsilon_2(1-\varepsilon_{t1})$
$n_{12} = A\varepsilon_1\varepsilon_2$
$n_t = A\left[1-(1-\varepsilon_{t1})(1-\varepsilon_{t2})\right]$

CPS – count per second

FEPE – Full energy peak efficiency

TE – Total efficiency

n_1 – CPS in the first peak

n_2 – CPS in the second peak

n_{12} – CPS in the sum peak

n_t – Total CPS in the spectrum

ε_1 – FEPE of the first gamma ray

ε_2 – FEPE of the second gamma ray

ε_{t2} – TE of the first gamma ray

ε_{t2} – TE of the second gamma ray

A – Activity of the source

t – Live time of the measurement

The sum-peak method

$n_1 = A\varepsilon_1\left(1-\varepsilon_{t2}\right)$	1
$n_2 = A\varepsilon_2\left(1-\varepsilon_{t1}\right)$	2
$n_{12} = A\varepsilon_1\varepsilon_2$	3
$n_t = A\left[1-\left(1-\varepsilon_{t1}\right)\left(1-\varepsilon_{t2}\right)\right]$	4

1 × 2 / 3 ; consider 4 →

$$\rightarrow \quad A = \left(n_1 n_2 / n_{12} + n_t\right)$$

Sum-peak method characteristics

- Actual form of the equations depends on the decay scheme of the radionuclide
- Main source of uncertainty is the area of the sum peak
- Close geometry preferred
  - **Better counting statistics**
  - **Less influence of angular correlations**
- Typically used for two-step and three-step simple cascades
- Co-60, Sc-46, Lu-176

Angular correlations and the sum-peak method

- Sum peak directly affected by angular correlations
- Close geometry preferred for the sum-peak method → W (θ) is averaged out, w close to unity
- For precision work (metrology, source standardization) a correction should still be applied
- Best approach: Monte Carlo simulations with a full decay scheme and angular correlation sampling
- An example: T.Vidmar , K.Kossert , O.J.Nähle, O.Ott, ARI 67 (2009) 160-163