

Sample Preparation for the NPL Environment PTE



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Introduction to NPL

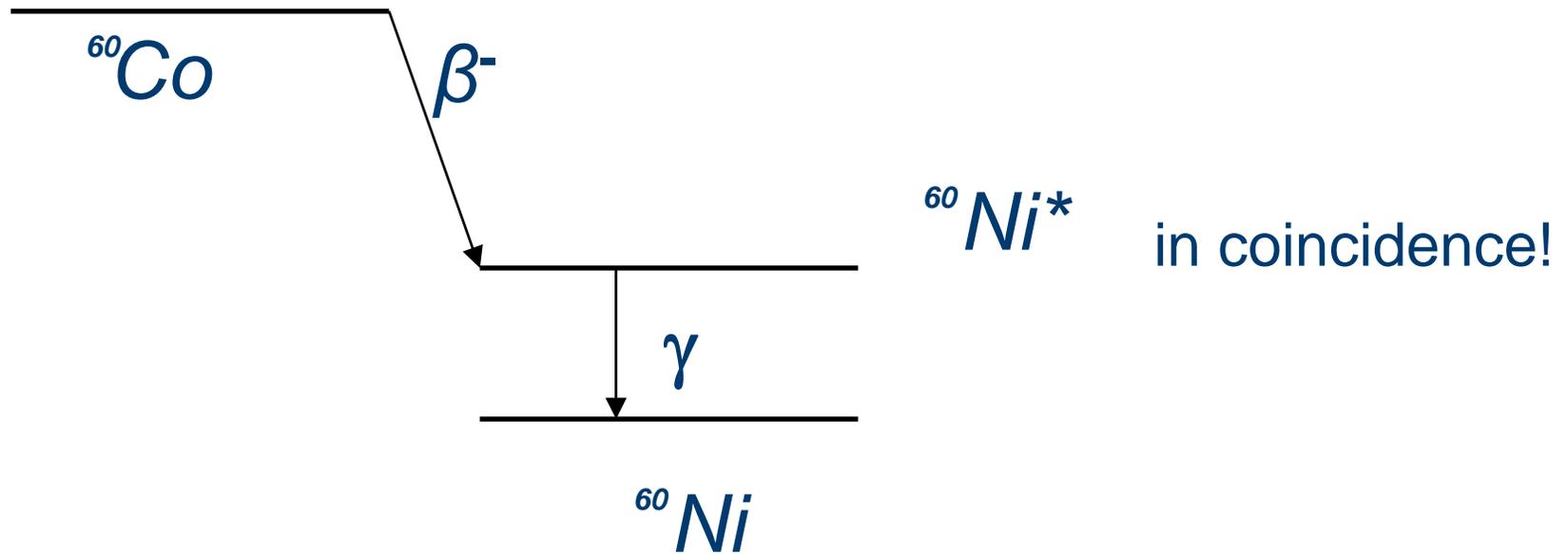
The National Physical Laboratory (NPL) is the UK's National Measurement Institute

NPL was established in 1900 and is a world-leading centre of excellence in developing and applying the most accurate measurement standards.



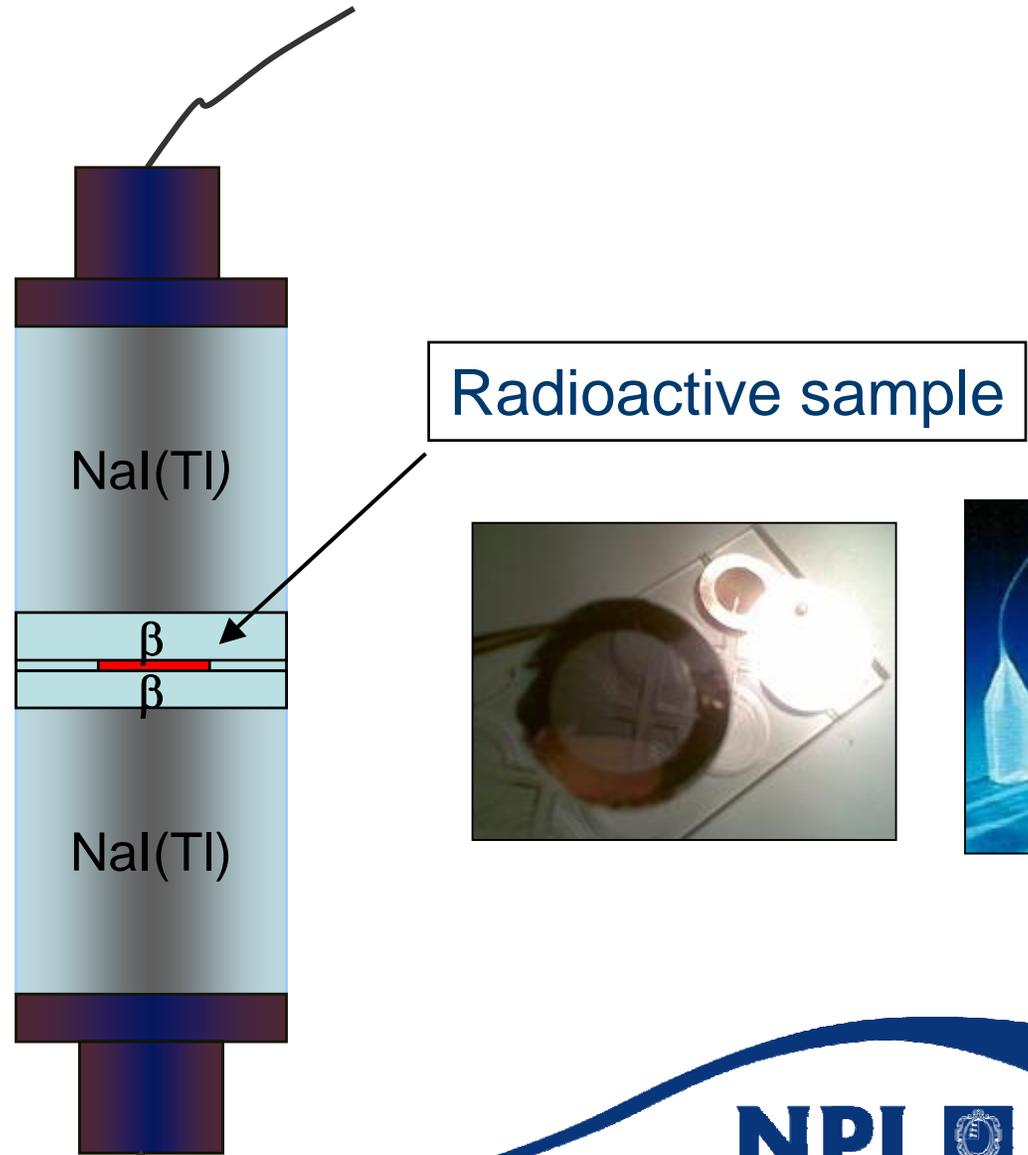
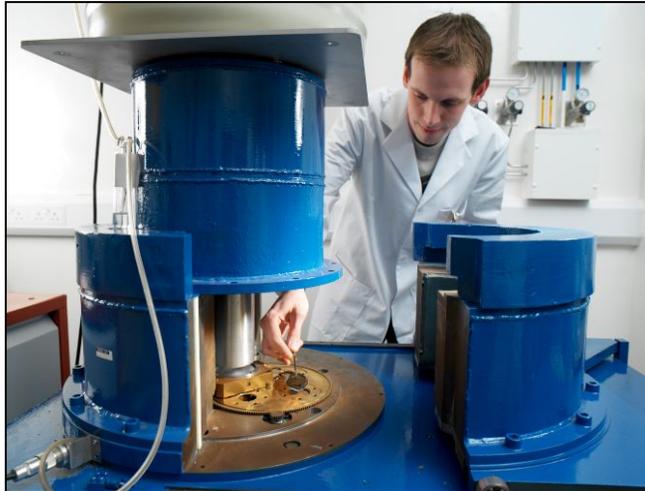
Standardisation of Radionuclides

An Example of Nuclear Decay by Beta Emission



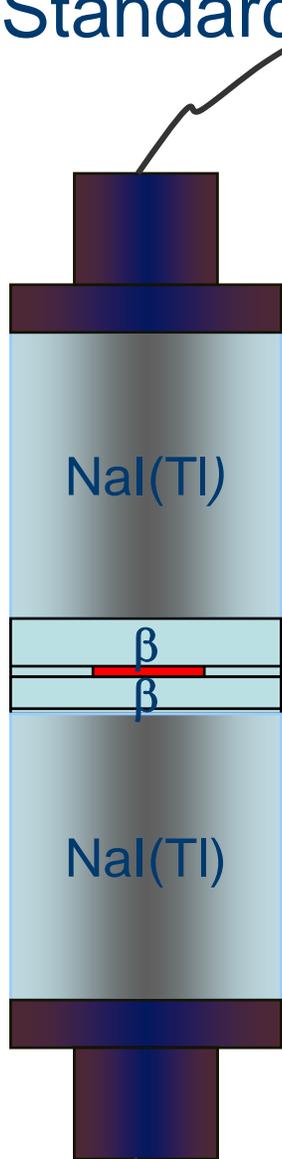
Measuring β Particles and γ Emissions

$4\pi\beta/\gamma$ coincidence counter



How do we Measure the Activity?

Primary Standards



$$N_{\beta} = A \epsilon_{\beta}$$

$$N_{\gamma} = A \epsilon_{\gamma}$$

$$N_c = A \epsilon_{\beta} \epsilon_{\gamma}$$

$$\frac{N_{\beta} N_{\gamma}}{N_c} = \frac{\cancel{A} \cancel{\epsilon_{\beta}} \cancel{A} \cancel{\epsilon_{\gamma}}}{\cancel{A} \cancel{\epsilon_{\beta}} \cancel{\epsilon_{\gamma}}}$$

$$\frac{N_{\beta} N_{\gamma}}{N_c} = A$$

Activity!

NPL Secondary Standards



Ampoules of solution
measured using
primary techniques



used to calibrate
Secondary standards.
Ion chambers &
 γ -spectrometers



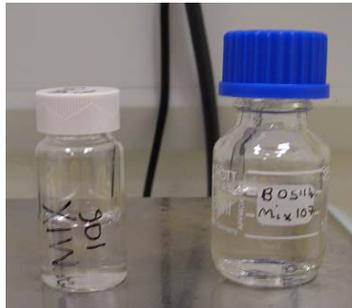
How were the samples made?

Dilution $>10^6$ Required

1. Standardised single nuclide solutions
2. Dispense solutions into a small bottle to make a mixed nuclide source
3. Dispense 'mix' into a larger bottle, dilute with carrier.



D.F.
→



D.F.
→



D.F.
→



G.D.F. = Total Mass/Active Mass (Gravimetric Dilution Factor)

Is the GDF correct?



Calibrated Weights (traceable to UK kilogram)
Calibrated Balances

Uncertainty derived from
difference between the two
weights.

Typically <0.1 %



Active Mass 1.112968 g

Total Mass 57.167578 g

GDF 51.361(6)

-0.0004 g active

-0.004 g total

Active Mass 1.112339 g

Total Mass 57.16320 g

Validation Measurements GDF₁



GDF compared with
RDF for each nuclide
 γ -spectrometer



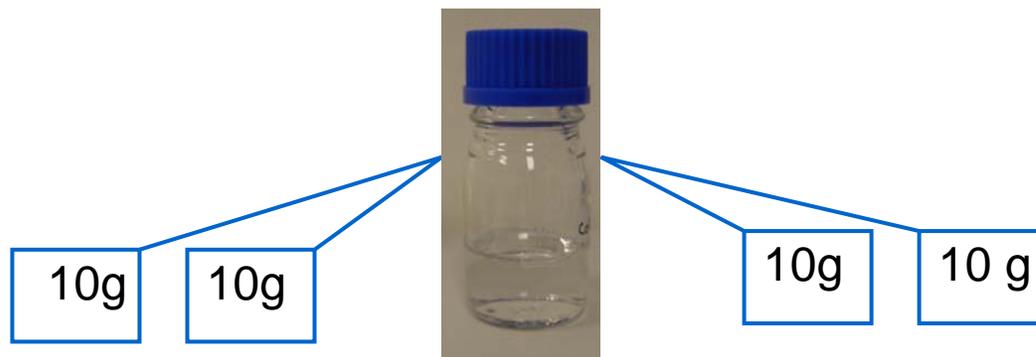
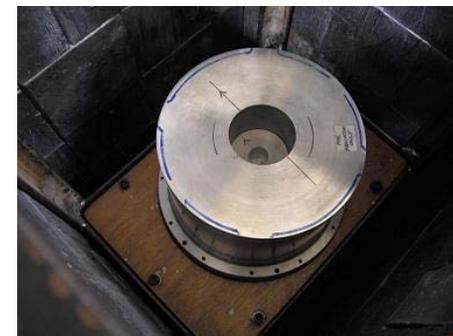
Validation Measurements GDF_2

GDF_2 51.361(6) compared with

RDF_2 51.48(12)

Using a 'well' type NaI(Tl) detector
(LSC, Cerenkov, Ge)

'zeta' test 0.96



Summary

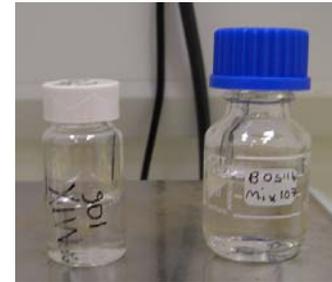
1. Standardise radionuclides



2. Mixed Nuclide Source



3. Dilution



Thank you

Questions?