Environmental comparison workshop

NPL February 2006

Primary standardisation

of radionuclides used in the environmental comparison

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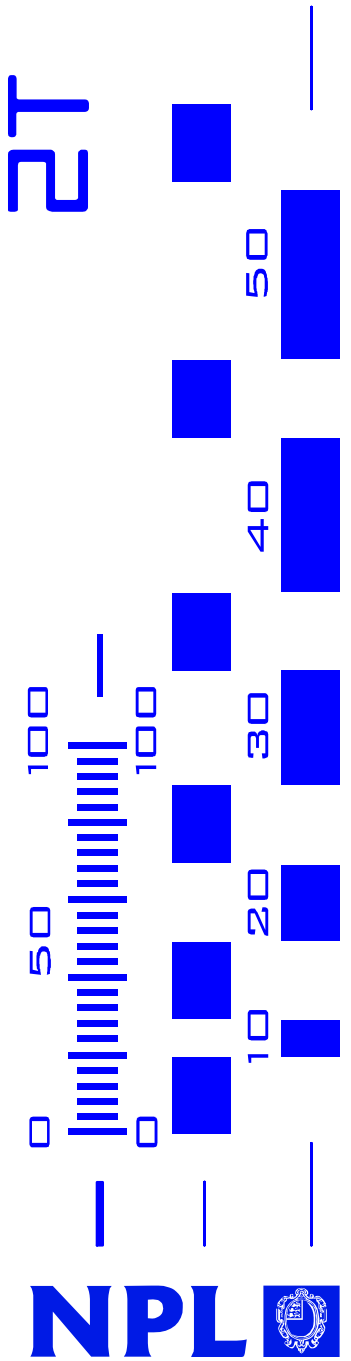

Overview

- The Mutual Recognition Arrangement (MRA)
- BIPM/SIR
- Coincidence counting
- Results – Am-241 and Pu-238

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Background - MRA

The Mutual Recognition Arrangement

October 1999

- to establish the degree of equivalence of national measurement standards maintained by NMIs;
- thereby to provide governments and other parties with a secure technical foundation for wider agreements related to international trade, commerce and regulatory affairs.

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Background - SIR

The International Reference System (SIR) at BIPM, Sevres

is characterized by its high stability and its simplicity.

Since it came into existence, about 830 measurements have been made with some 60 radionuclides – giving a total of about 600 independent results

The results of the measurements are used to construct the efficiency curve of the ionization chamber (IC) as a function of γ-ray energy.

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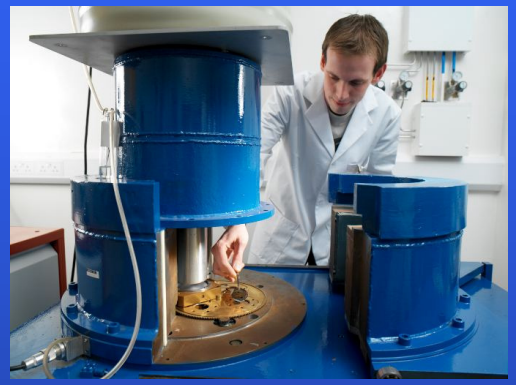
NPL link to SIR for γ-ray emitters

NPL coincidence counting



NPL Radionuclide calibrator

SIR, Paris

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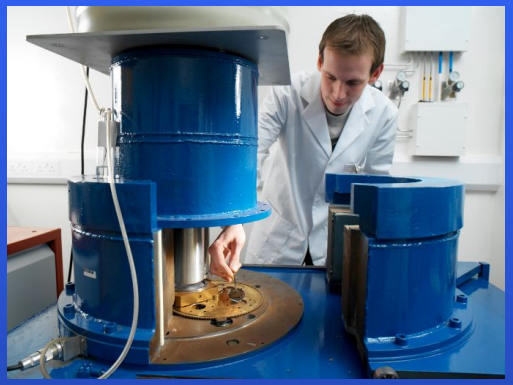
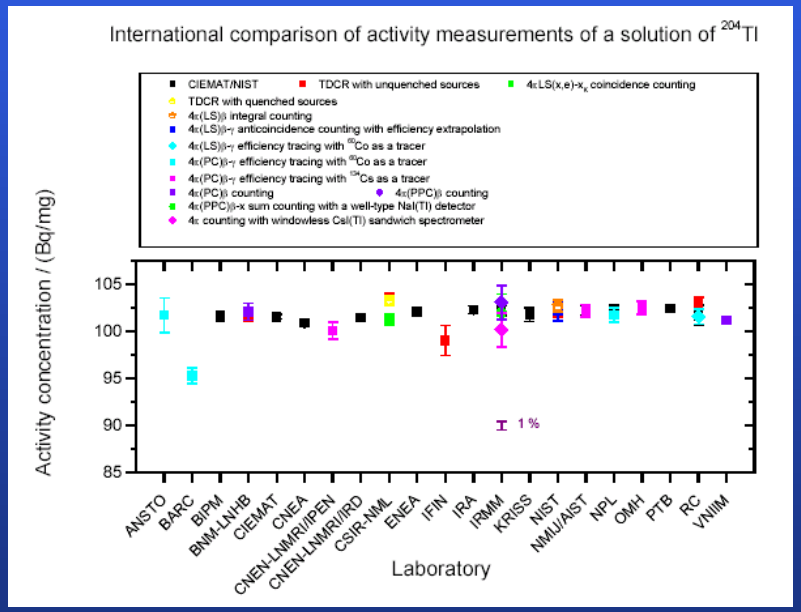
NPL link to SIR for *non* γ-ray emitters

NPL coincidence counting

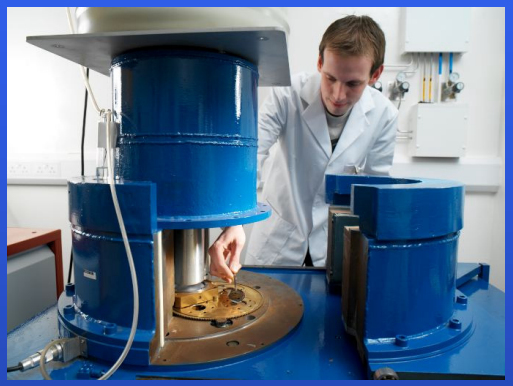


BIPM Key comparison, Paris



Primary standardisation

NPL coincidence counting



BIPM Key comparison, Paris

Approximately 1-2 per year

- ^{241}Am 2003
- ^{238}Pu 2001
- ^{60}Co 2001 (^{204}Tl)

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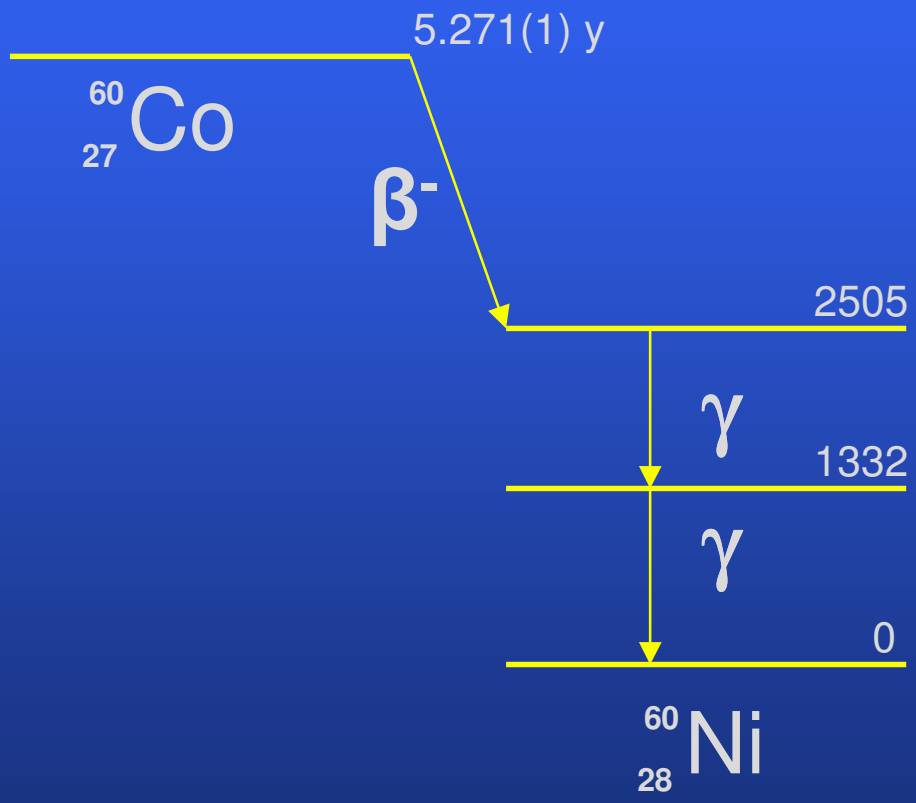
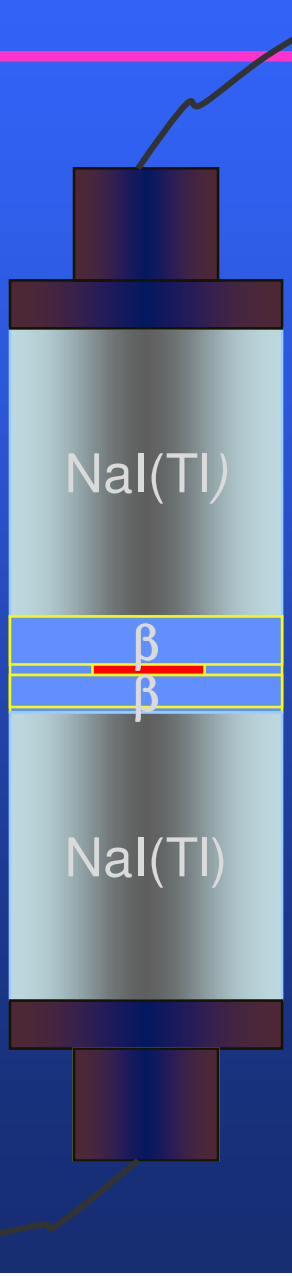
The method – coincidence counting



β
in coincidence with
γ

Coincidence counting



$$\begin{cases} N_\beta = A\,\varepsilon_\beta \\ N_\gamma = A\,\varepsilon_\gamma \\ N_c = A\,\varepsilon_\beta\,\varepsilon_\gamma \end{cases}$$

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

Activity!

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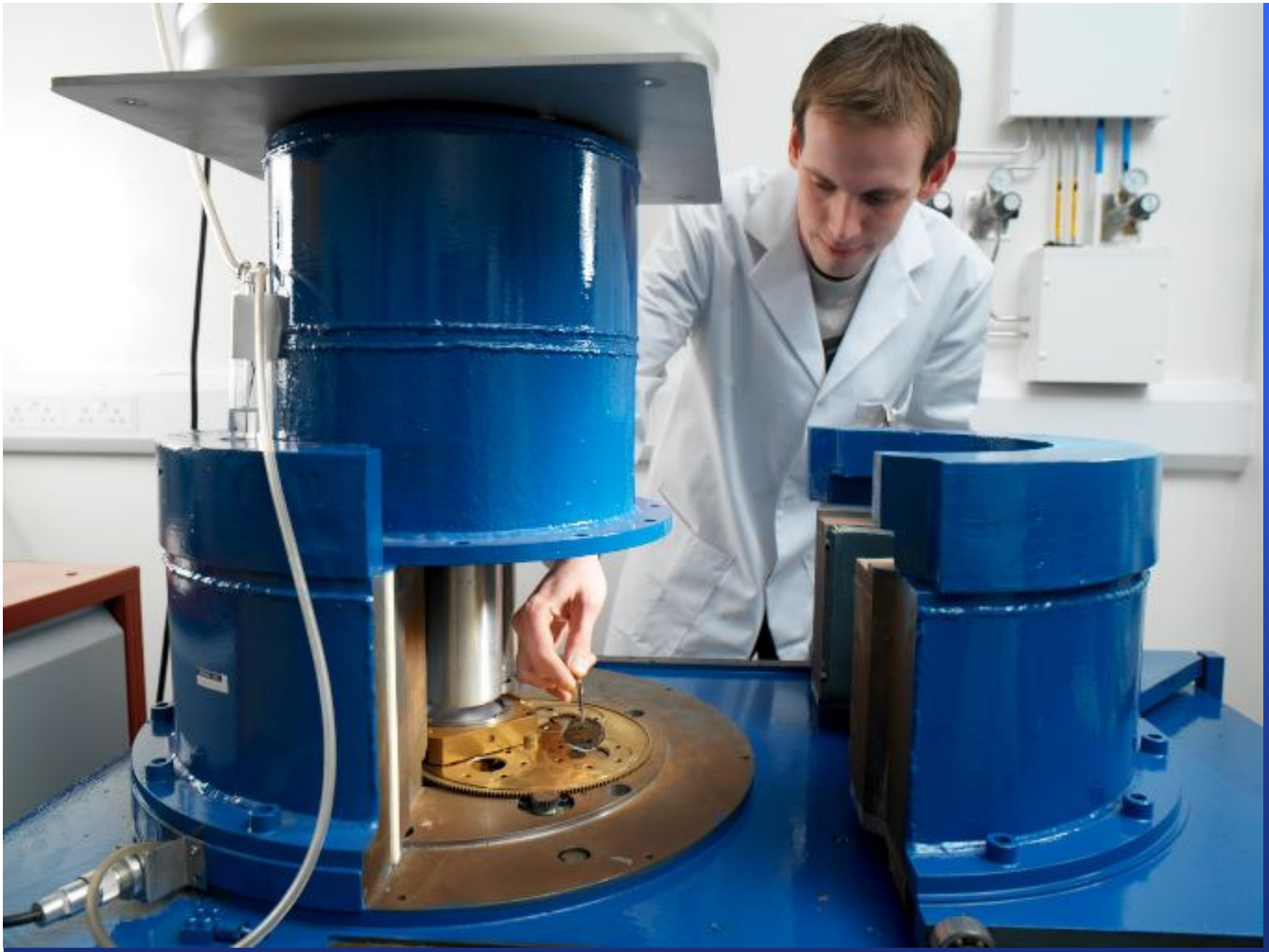

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$4\pi\beta$–γ coincidence counting extended

$$N_\beta = N_o \sum a_i \left[\varepsilon_{\beta i} + (1-\varepsilon_{\beta i}) \frac{\alpha_i \varepsilon_{\beta\gamma}}{1+\alpha_i} \right]$$

$$N_\gamma = N_o \sum a_i \frac{\varepsilon_{\gamma i}}{1+\alpha_i}$$

$$N_c = N_o \sum a_i \left[\frac{\varepsilon_{\beta i}\ \varepsilon_{\gamma i}}{1+\alpha_i} + (1-\varepsilon_\beta)\varepsilon_{c i} \right]$$

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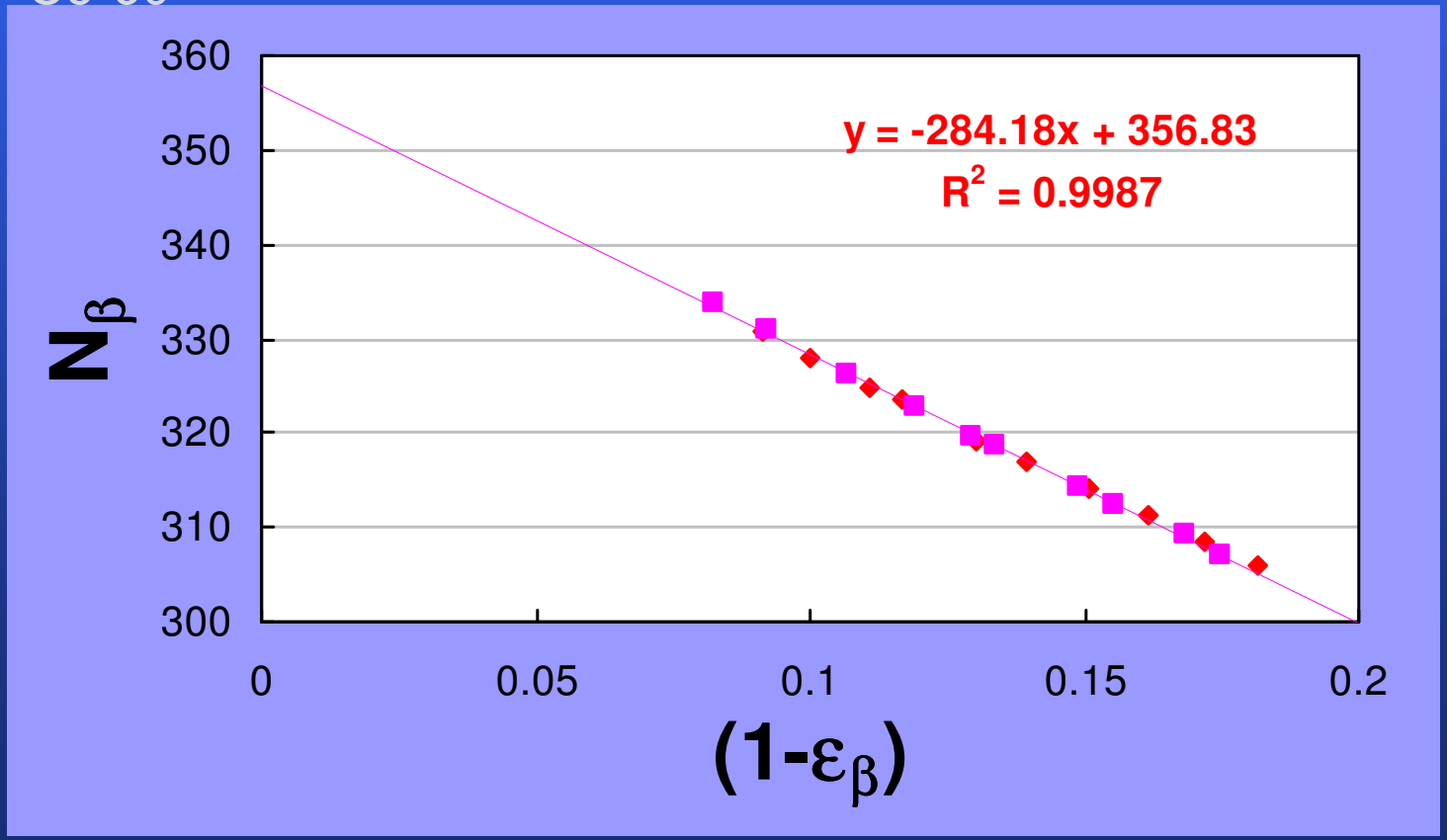
Solution: Extrapolation

The β-efficiency is varied experimentally and the activity is determined by extrapolation to $\varepsilon_\beta=1$.

Co-60



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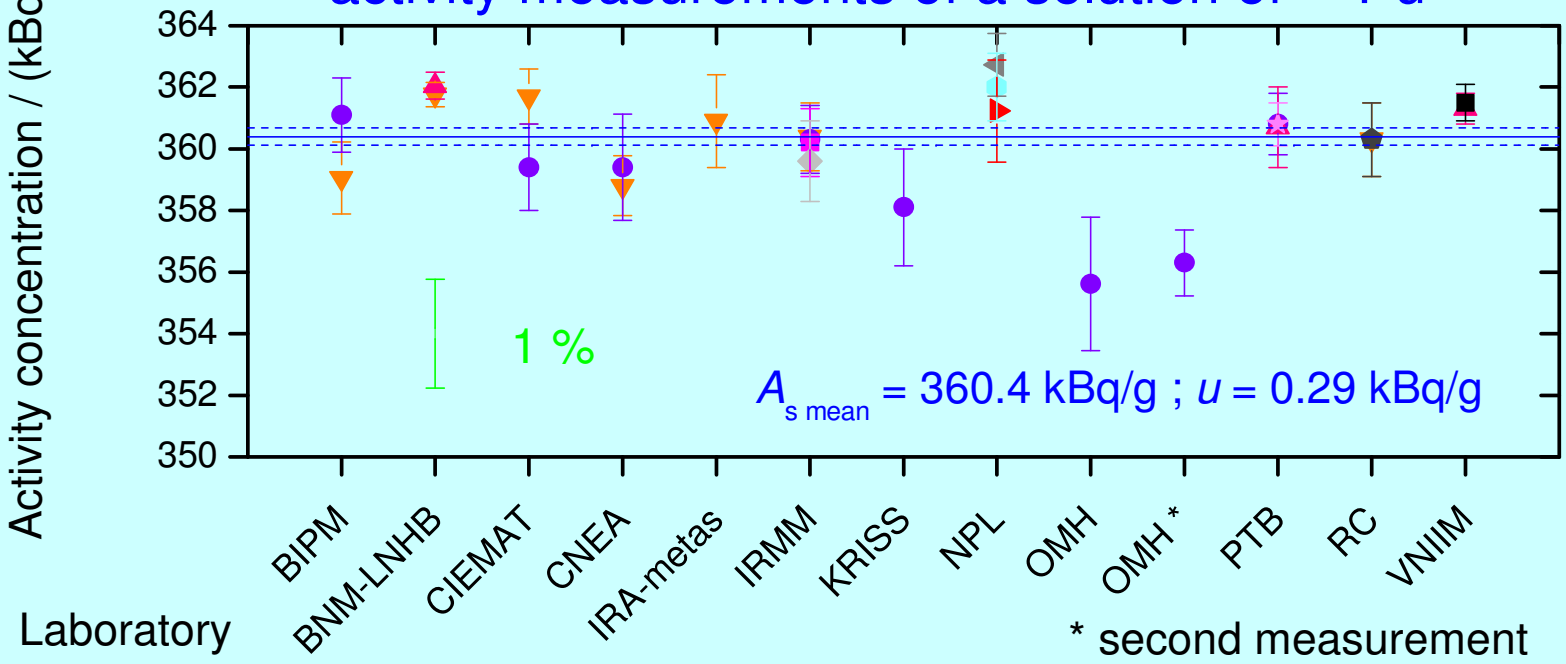
Results of the international comparison of activity measurements of a solution of ^{238}Pu



- Liquid scintillation
- CIEMAT/NIST method
- TDCR method
- 4π(LS)α-γ efficiency tracing with ^{241}Am as tracer
- 4π(PPC)α
- 4π(PC)α
- 4π(PC)α-Lx coincidence
- 4π(PC)α-γ efficiency tracing with ^{241}Am as tracer
- 4π(PPC)α-γ efficiency tracing with ^{241}Am as tracer
- α counting with defined solid angle
- 4πCsI(Tl) sandwich spectrometer

Results of the international comparison of activity measurements of ^{241}Am January 2004