User project report

Accurate determination of the activity and nuclear decay data of ^{175}Yb

Karsten Kossert

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2. Context of the project

Taking advantage of the radionuclide portfolio of the PRISMAP consortium, two deliveries of ^{175}Yb were requested by PTB. The aim of the project is to carry out primary activity standardisation of this emerging radionuclide and to study its decay properties in detail. Regarding the underlying nuclear decay data, the focus of the project is to provide new, robust measurements for gamma-ray emission probabilities and the half-life of ^{175}Yb. Furthermore, the results of activity standardisation are to be submitted to the BIPM in Paris to facilitate an international intercomparison.

3. Results and discussion

Various methods for activity standardization were applied to ^{175}Yb. Each method achieved an uncertainty of less than 0.4%, with all individual results showing good agreement. These results were then used to calibrate ionization chambers, which are crucial for secondary calibration processes. An ampoule was sent to the BIPM, where it was measured within the framework of the International Reference System (SIR). This allows other National Metrology Institutes to compare their results with those of PTB, provided they also send an ampoule containing this isotope. Additionally, PTB determined the half-life of ^{175}Yb, finding it to be in excellent agreement with the most recent determination from 2021. However, the uncertainty in the measurement was reduced by more than a factor of two. The analyses of the gamma-ray emission intensities and the associated decay scheme data have yet to be completed. A corresponding publication is planned after the second ^{175}Yb delivery (mid-September 2025).

4. Conclusions

The main goals of the proposed research project were (or will soon be) achieved. This comprises:

- Development of primary activity standardization techniques for ^{175}Yb with highest accuracy (see, Figure 1) and calibration of ionization chambers as secondary standardization instruments (completed)
- Submission of an ampoule to the SIR@BIPM to form the basis for an international comparison of ^{175}Yb activity measurements (completed)
- Determination of the ^{175}Yb half-life with outstanding high precision (completed for first delivery and in progress for the second delivery). Determination of gamma-emission intensities and related decay scheme parameters (in progress)

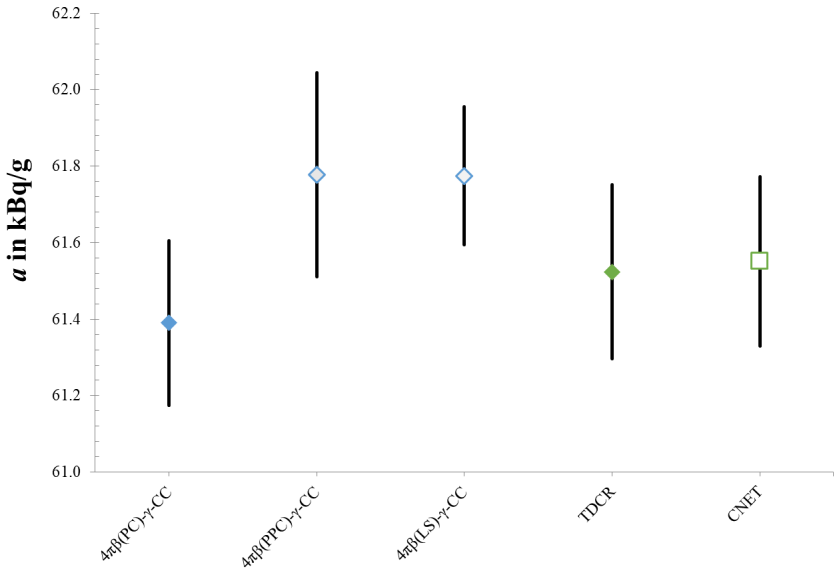

Figure 1. Activity concentration of an ^{175}Yb solution determined with various coincidence counting (CC) systems using a proportional counter (PC), a pressurized proportional counter (PPC) or a liquid scintillation (LS) counter as the beta channel detector. In addition, two liquid scintillation counting methods (TDCR and CNET) were applied. The uncertainty bars represent overall standard uncertainties, which were found to be below 0.4% for each method.

5. Involvement of the PRISMAP services

A key prerequisite for the research conducted at PTB was the availability of suitable ^{175}Yb material, provided by the PRISMAP consortium. The activity measurement was greatly enhanced by the high radionuclidic purity achieved through purification processes—first at PSI for the initial delivery, and later at CERN-MEDICIS for the second delivery. Accurate half-life measurements not only require high purity but also significant activity, which was ensured by the production at ILL.

6. Feedback to PRISMAP

The technical processes involved in radionuclide production, subsequent purification, and the necessary logistics are highly complex. Thanks to the excellent communication and flexibility demonstrated by all involved partners, minor issues were effectively addressed. The purity and chemical composition of the solutions met the specified requirements. In one instance, the activity was lower than initially anticipated, but this had no significant impact on the research conducted at PTB. The materials provided were of excellent quality, which underlines the uniqueness of the PRISMAP initiative.

7. Publications and other dissemination activities

A publication with a description of the newly developed methodologies for the activity standardization and the determined nuclear decay data are in preparation.
A presentation at the 12th International Conference on Isotopes (12ICI) in Florence in February 2026 is planned.

Appendix 1. Dissemination guidelines for user projects as agreed in the signed User Agreement

Dissemination rules

Only user groups that are allowed to disseminate the results which they have generated under the project may benefit from the access, unless they are working for SMEs.

For each user group project, a publishable project summary and a publishable summary of the results will be published on the European Union Horizon 2020 PRISMAP project website www.prismap.eu. The publication of results in journals or at conferences is strongly encouraged.

To ensure the long-term sustainability of the PRISMAP initiative, proper recognition of the contributing facilities, their services and the involved persons is necessary. All participating PRISMAP facilities shall be acknowledged in the publication. Acknowledgement and co-authorship of PRISMAP staff members who participated in the experiment shall be considered according to the research field best practices and verified with the PRISMAP Technical Manager before any publication.

The user group shall contact the PRISMAP Technical Manager 30 days prior to submission of publications or other communications of results that were obtained by making use of services provided by PRISMAP (radionuclides delivered or medical services provided). The Technical Manager will communicate to the user group the list of PRISMAP facilities and persons that have contributed to each specific project and the way this contribution must be acknowledged in the publication/communication or where co-authorship is required to reflect specific scientific contributions.

Users must comply with Horizon 2020 dissemination rules (i.e. acknowledge that their work was financially supported by the European Union's Horizon 2020 Research and Innovation Programme by including the following acknowledgement: "This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008571 (PRISMAP)"), and grant open access to resulting publications and related data.

Dissemination shall take place only once legitimate interests regarding intellectual property have been safeguarded. A maximum publication delay of 90 days may be granted for this purpose.

Acknowledgements

The list of name(s) to be mentioned in the acknowledgment section is sent to the technical manager by the main contact of the involved facilities.

A general sentence will be added by the corresponding author of the article (user side):

"The authors would like to thank the members of the PRISMAP consortium and of the PRISMAP user selection panel, coordination and management team for their advice and support."

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