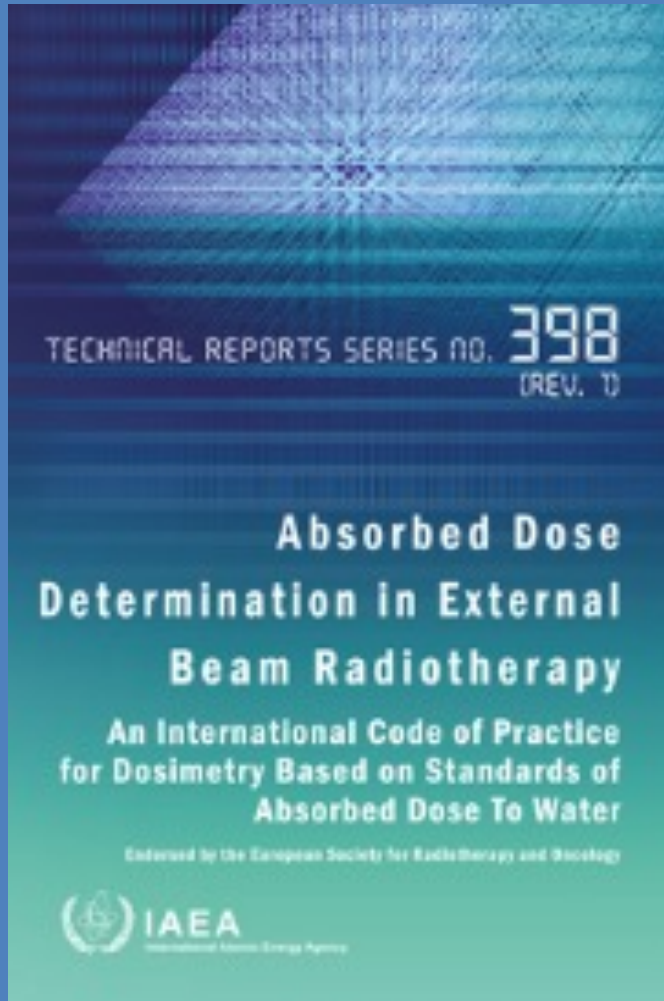


International Measurement System

by
Karen Christaki



Acknowledgement: Zakithi Msimang

Introduction

Aim:

To provide an overview of International Measurement System

Learning objectives:

- Describe the International Measurement System.
- Understand **YOUR** role in the International Measurement System.

Background



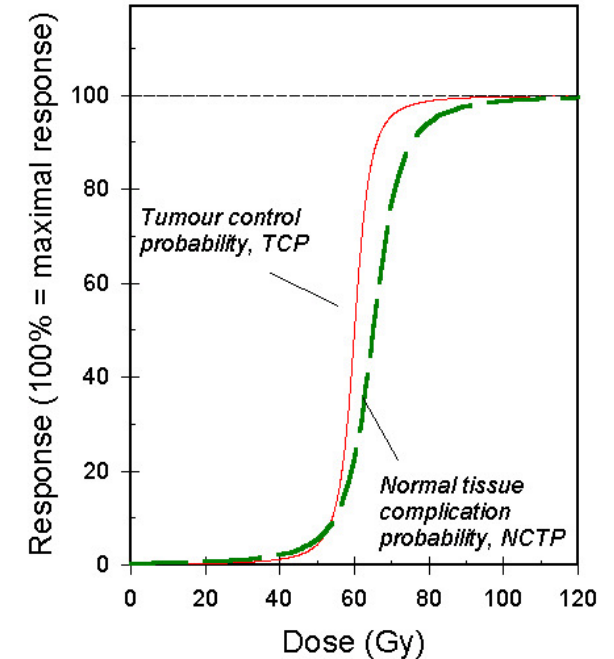
INFORMATION



International measurement system



Measurement of absorbed dose to water relies on the **international measurement system** to ensure measurements can be carried out at an accuracy that is fit for purpose.



History- Metre Convention

A group of academics set out to define new units based on 'universal natural units' that belonged to no particular country.

The logic of this approach was appreciated in other countries, and this eventually led to an international treaty called the Metre Convention in 1875.



Reminder: $D_{w,Q} = \frac{dE}{dm}$

Metre Convention

1. Every 4 years delegates from governments attend a conference (the Conférence Générale des Poids et Mesures (CGPM), to discuss the arrangements for the propagation and improvement of the International System of Units (SI).
2. The treaty also set up a scientific and permanent International Bureau of Weights and Measures (the BIPM) with its headquarters in Paris. Home of the International System of Units (SI).



International Measurement System

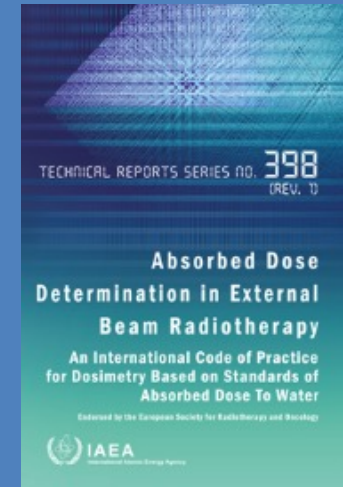
**Bureau International des Poids and Mesures
(BIPM)**

**National Metrology Institutes
(NMI)**

**Secondary Standards
Dosimetry Laboratories (SSDL)**

Users Users Users

Codes of practice





BIPM

1. The Ionizing Radiation Department at the BIPM has a set of primary standards and reproducible radiation beams, for energies from low-energy X rays through to radiotherapy beams from a LINAC.
2. In 1999, it was agreed that the BIPM standards would be accepted as the world standard (setting the so-called 'Key Comparison Reference Value'), against which all primary standards would be compared.
3. A regular programme of comparisons has been established, with NMIs expected to send their standards to the BIPM on a ten-year cycle.

CIPM Mutual Recognition Arrangement (CIPM MRA)

- ❑ The CIPM Mutual Recognition Arrangement (CIPM MRA) is the framework through which National Metrology Institutes demonstrate the international equivalence of their measurement standards and the calibration and measurement certificates they issue.
- ❑ The outcomes of the Arrangement are the internationally recognized (peer-reviewed and approved) Calibration and Measurement Capabilities (CMCs) of the participating institutes.
- ❑ Approved CMCs and supporting technical data are publicly available from the CIPM MRA database (the KCDB).

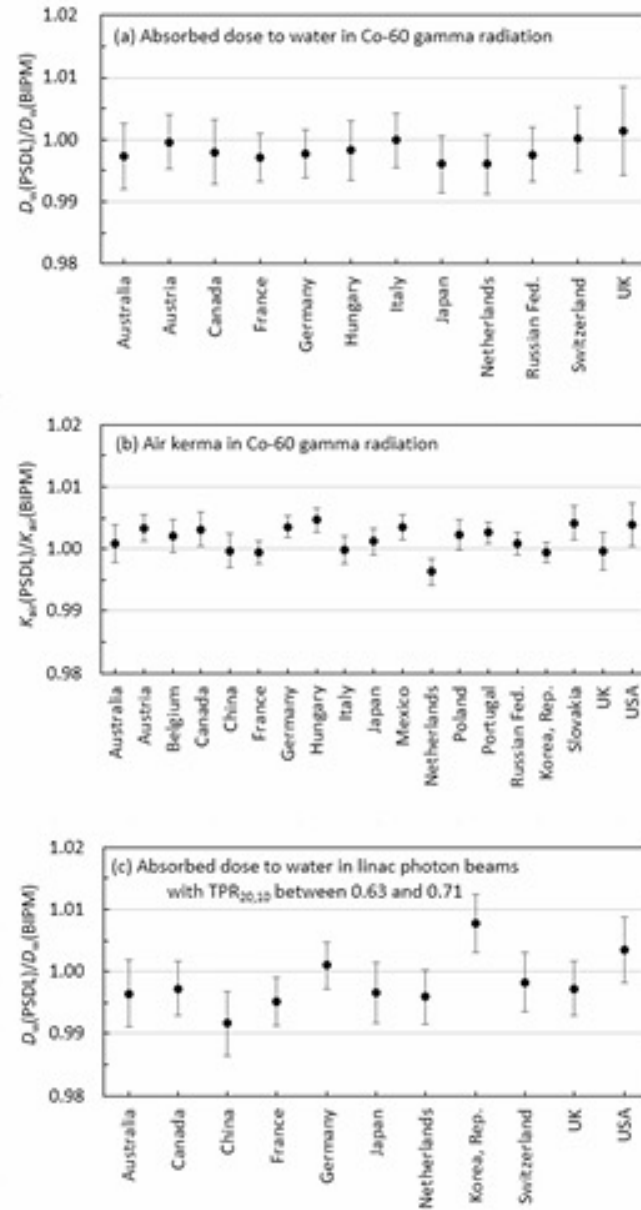
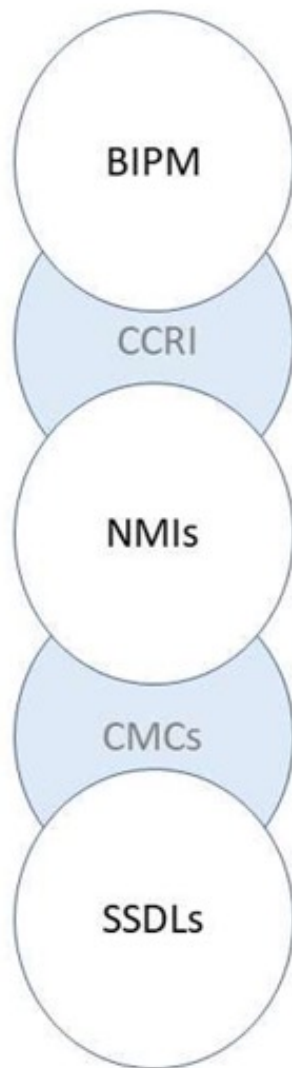


FIG. 4. Results of BIPM comparisons of standards for (a) absorbed dose to water in ^{60}Co gamma radiation, (b) air kerma in ^{60}Co gamma radiation and (c) absorbed dose to water in linac photon beams with $\text{TPR}_{20,10}$ between 0.63 and 0.71. Each result is relative to the corresponding BIPM determination. The uncertainty bars represent the standard uncertainty stated by each PSDL for their standard. All data were taken from BIPM KCDB in July 2020.

Traceability chain



The Bureau International des Poids et Mesures provides the permanent scientific secretariat for the CCRI and offers on-demand comparison and calibration services. The BIPM is also responsible for publishing the results from comparisons and for CMCs.

The Consultative Committee for Ionizing Radiation organizes comparison exercises so that NMIs can demonstrate equivalence. The CCRI is the link between the BIPM, the NMI community and international organizations such as the IAEA, and it advises the CIPM, the governing body for the BIPM.

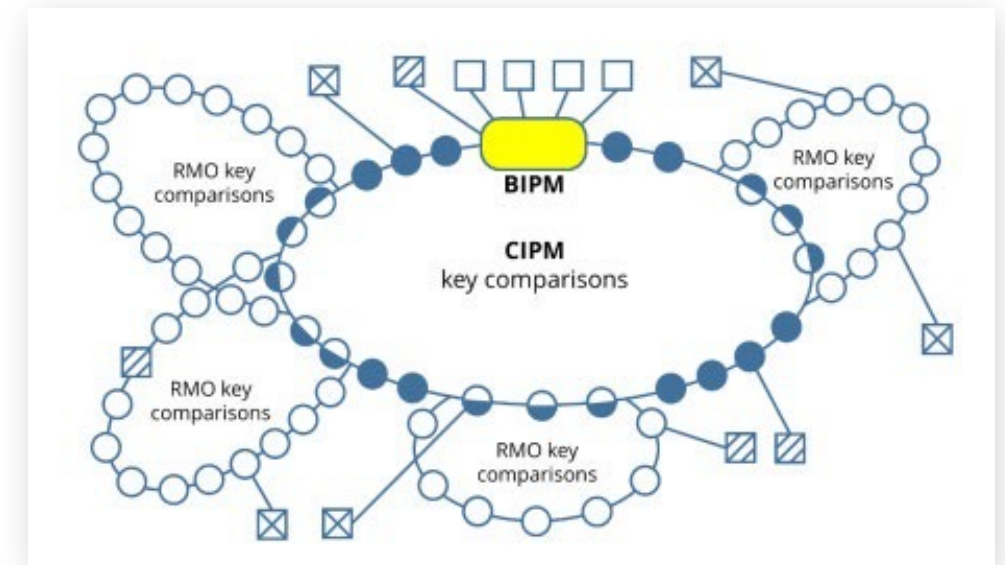
National Metrology Institutes develop primary measurement standards and offer calibration services based on these standards.

Calibration and Measurement Capabilities are published by NMIs to describe their services. CMCs are evidence-based and peer-reviewed, and are the link between NMIs and users.

Secondary Standards laboratories calibrate instruments for use in hospitals, for radiation protection purposes etc and are the link in the chain that directly ensures patient safety and effective treatment.

Regional Metrology Organisations

- Review and approve the Quality Systems of the NMIs.
- CMC 's intra and interregional review
- Organise Key and supplementary comparisons



International Measurement System

Bureau International des Poids and Mesures
(BIPM)

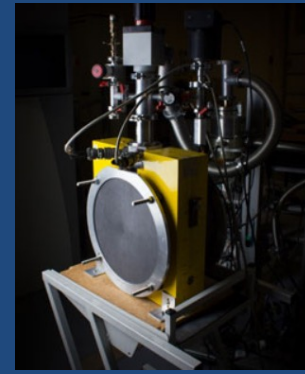
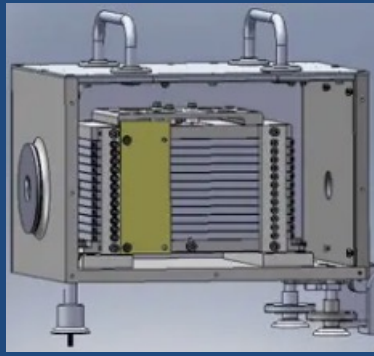
**National Metrology Institutes
(NMI)**

Secondary Standards
Dosimetry Laboratories (SSDL)

Users

Users

Users



National Metrology Institutes

- Develop and maintain primary measurement standards.
- Offer calibration services based on these standards to secondary laboratories and other users.

National Metrology Institute

Actions an NMI should take to demonstrate the equivalence of their primary standards and the associated services to those in other countries.

- ❑ **Participate in international comparison exercises.**
- ❑ **Operating a quality assurance management system (ISO17025).**
- ❑ **Ensuring independent peer-review of services by colleagues from other NMIs.**



International Measurement System

Bureau International des Poids and Mesures
(BIPM)

National Metrology Institutes (NMI)

**Secondary Standards
Dosimetry Laboratories
(SSDL)**

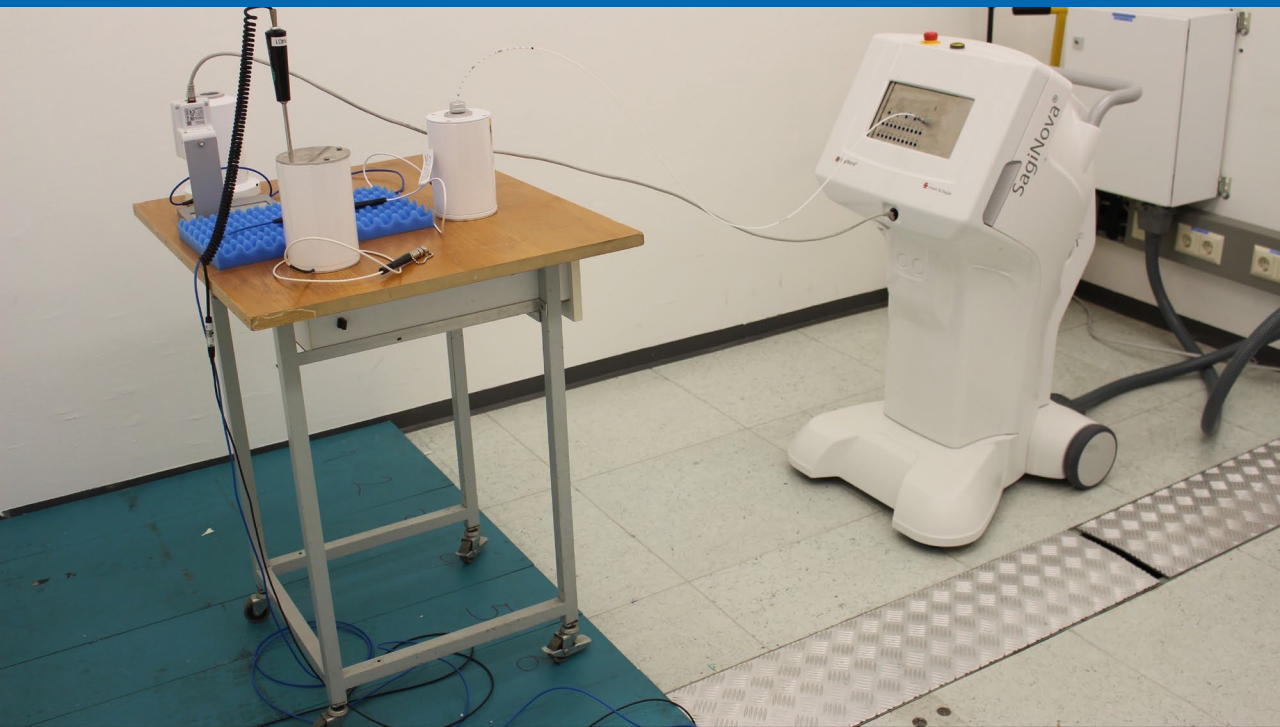
Users

Users

Users

Secondary standards laboratories

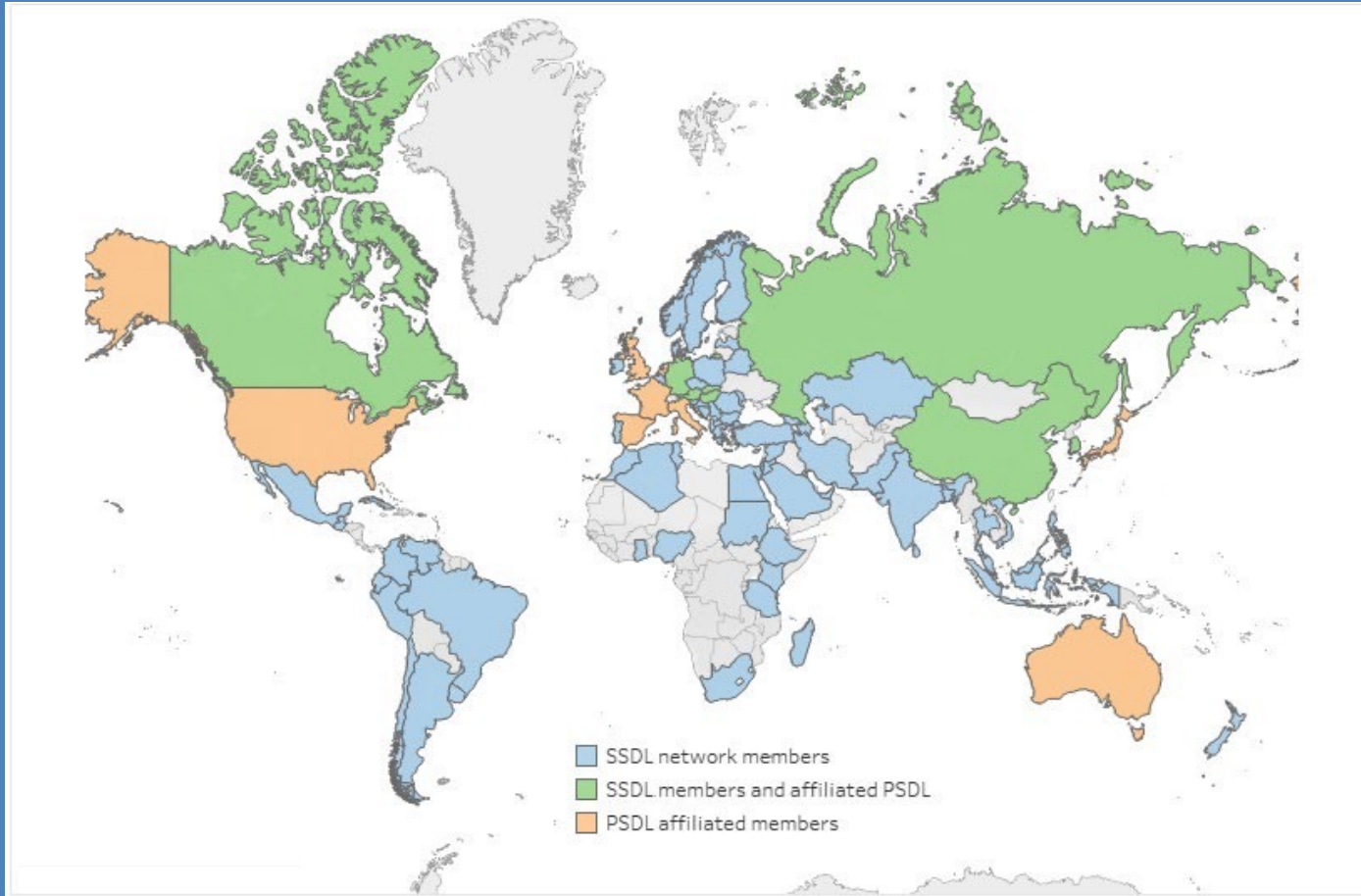
IAEA/WHO SSDL NETWORK



- SSDLs designated by the IAEA Member States, provides a traceability route of national dosimetry standards to the International System of Units (SI)
- The aim of the Network is to disseminate and encourage correct use of the dosimetry quantities and units through the proper calibration of field instruments by the SSDLs
- DOL acts as the central laboratory in the Network

IAEA / WHO SSDL Network

Established in 1976



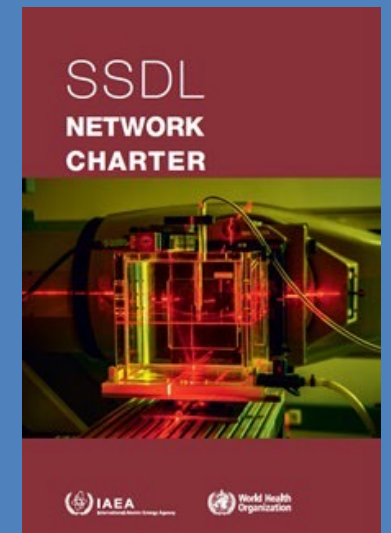
Objectives:
Traceability

Accuracy

Consistency

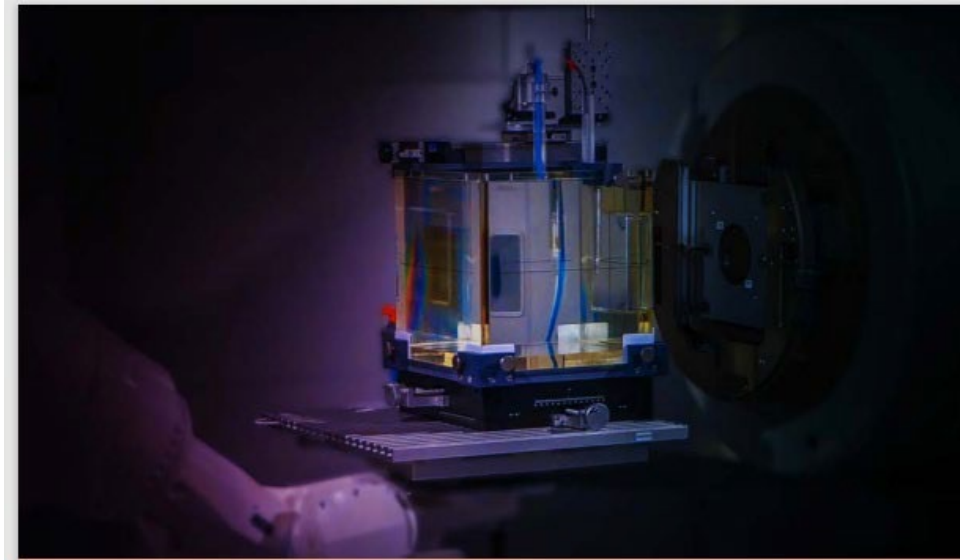
Cooperation

88 SSDLs, 16 PSDLs and 5 International organization in 76 countries



Support to the SSDL Network

- ❑ IAEA provides also guidance for implementing a feasibility study in the initial planning process, and for estimating the cost and timelines of an SSDL establishment project.
- ❑ IAEA supports planning of new calibration facilities or purchasing new equipment.
- ❑ IAEA supports extension of scope of capabilities and what needs to be considered before extension.



IAEA HUMAN HEALTH SERIES

No. 44

Establishing a Secondary
Standards Dosimetry
Laboratory



IAEA

International Atomic Energy Agency

Support to the SSDL Network

- ❑ Provides a framework for the education, practical training and competencies of radiation metrologists responsible for SSDL activities.
- ❑ A model is included to identify potential gaps and define a professional development plan to cover the necessary competencies of the role of radiation metrologists.



IAEA

International Atomic Energy Agency

Education of Radiation Metrologists
for Secondary Standards
Dosimetry Laboratories

International Measurement System

Bureau International des Poids and Mesures
(BIPM)

National Metrology Institutes (NMI)

Secondary Standards Dosimetry Laboratories
(SSDL)

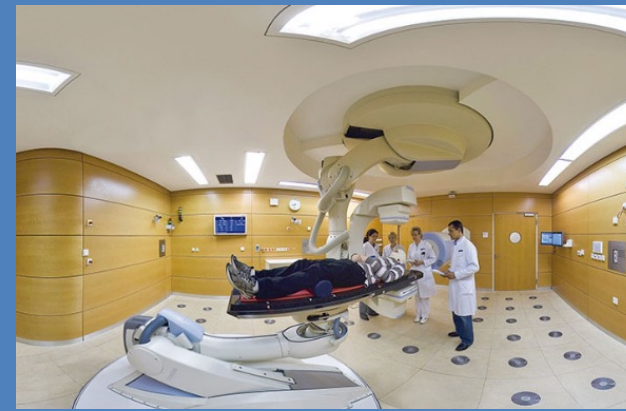
Users

Users

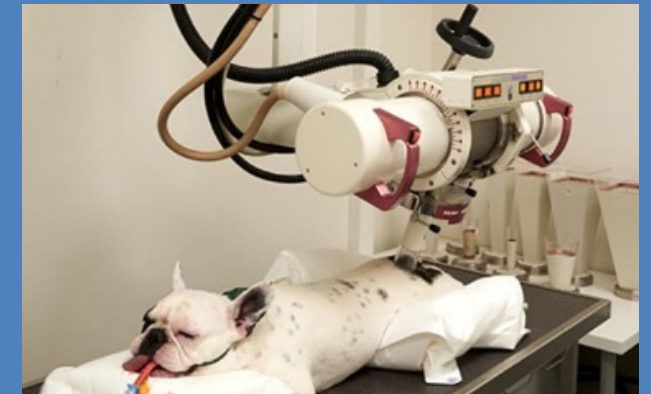
Users



Users



- Calibrate their reference when recommended.
- Measure absorbed dose to water under reference conditions-traceable and consistent.
- Cross-calibrate field instruments
- Measure absorbed dose to water under non-reference conditions.
- Take good care of their reference and field chambers.





Thank you



Regulations are at a core of the society livelihood whether it is in sports, business, health etc



Measurements are crucial for enforcing most regulations



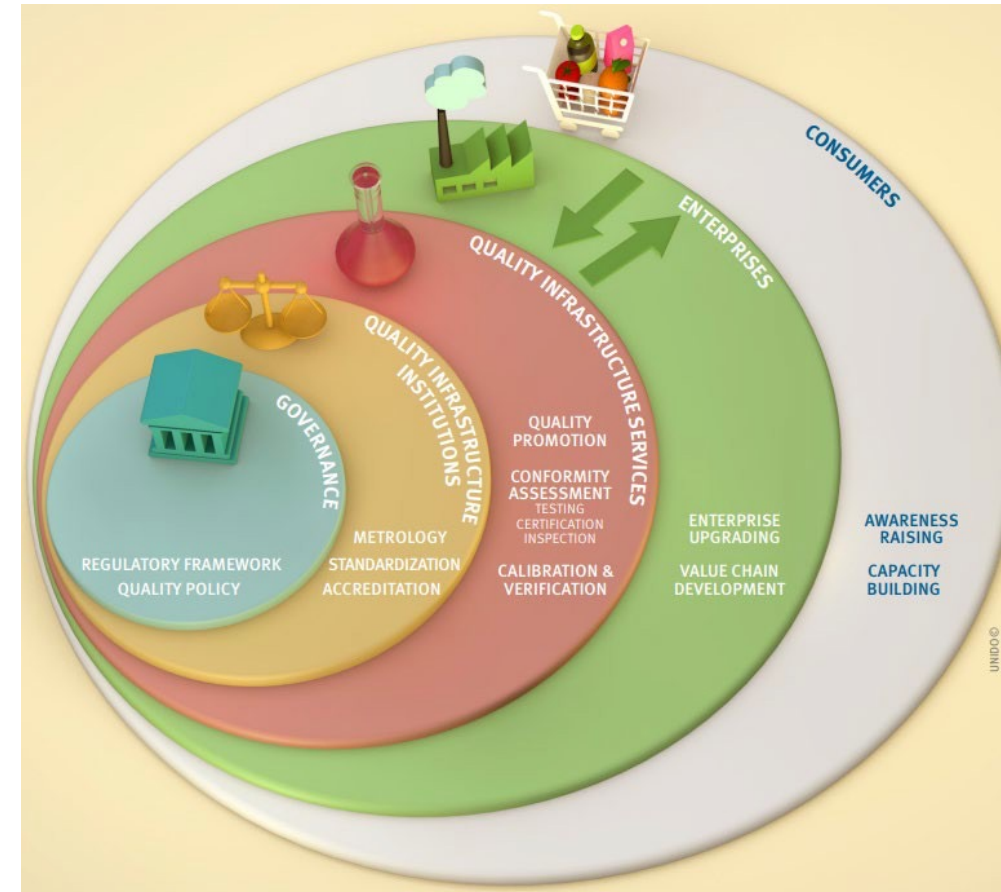
You cannot regulate what you cannot measure



Quality infrastructure is crucial for supporting a healthy regulatory system

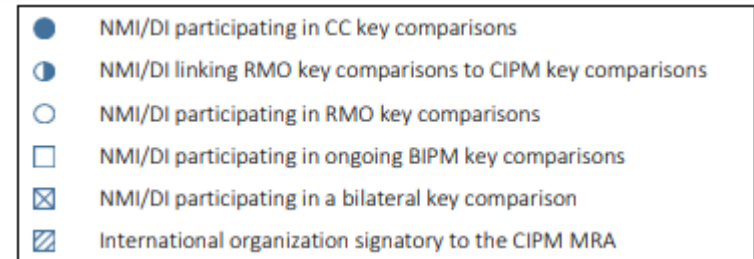
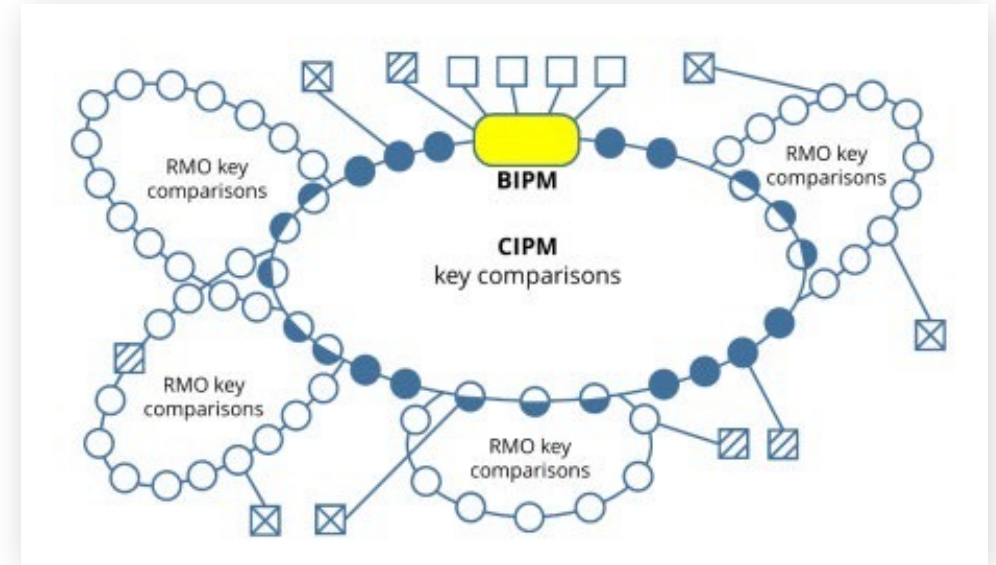
Quality Infrastructure

- Tool for defining, developing and verifying quality requirements for products and services.
- It verifies and demonstrates that products and services meet the set requirements.
- It ensures that the quality requirements and the products and services they generate meet the requirements and best practice essential for participating in international trade.
- QI is important as it provides technical support to the country for industry needs, to improve production processes and ensuring compliance to regulations or international requirements.
- Metrology (legal, scientific), standards, accreditation



Measured once, accepted everywhere

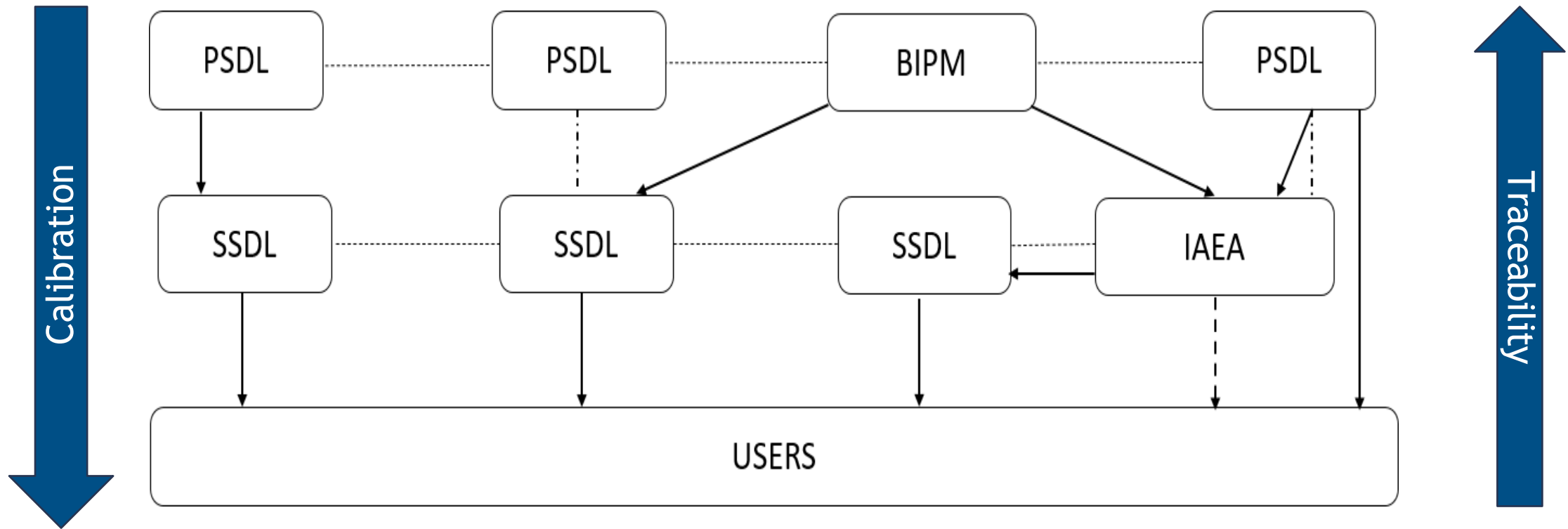
- This concept addresses the availability of calibration capabilities in countries and regions.
- With the requirements of the CIPM MRA met, one country can confidently accept calibration certificates from another country.
- What are the requirements?
 - Laboratories having a quality management system that aligns with the ISO/IEC 17025:2017 and peer reviewed by peers participating in the MRA;
 - Validated measurement system e.g. using comparisons.



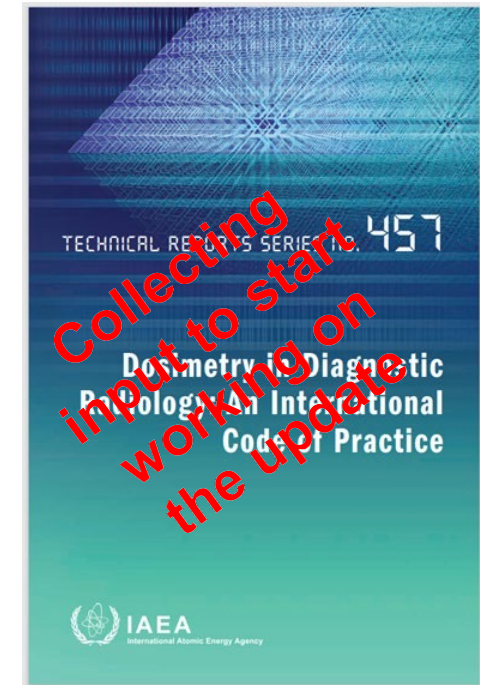
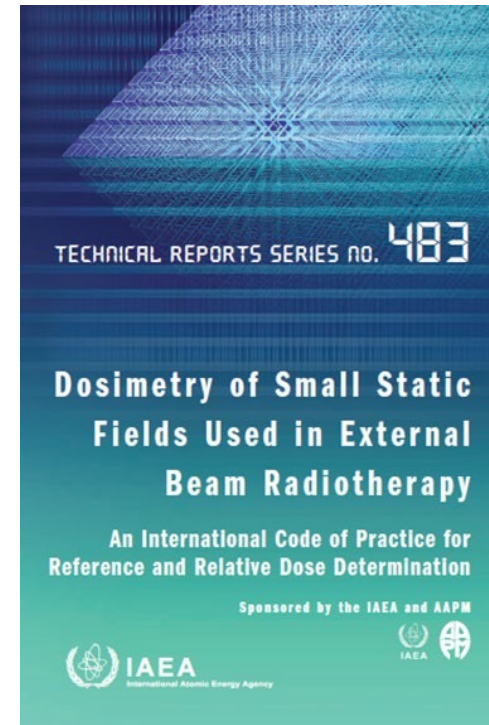
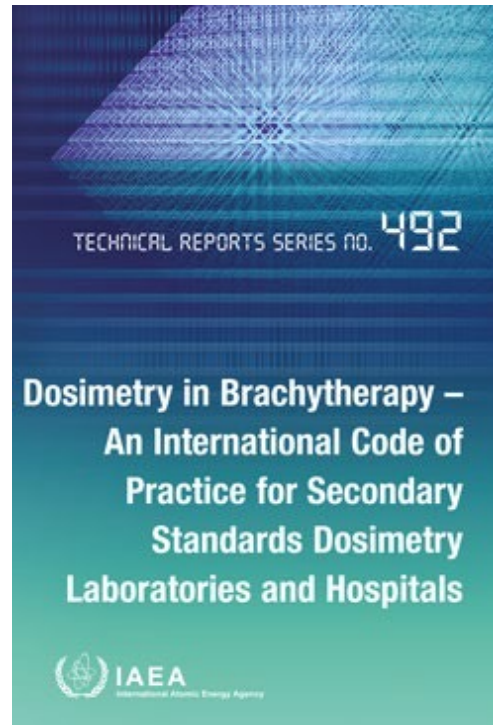
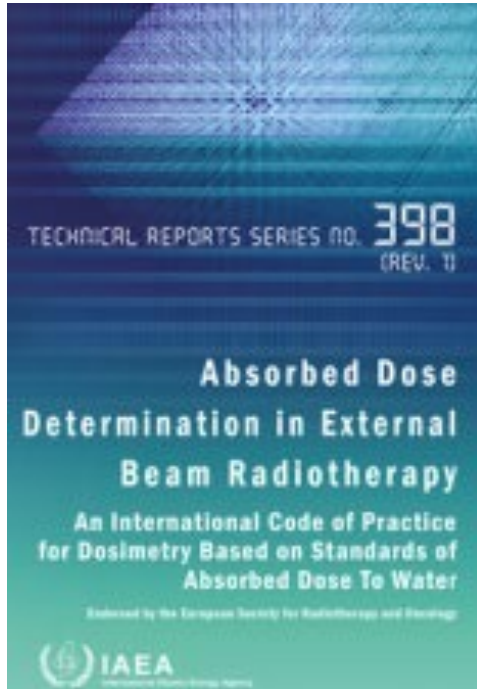
<https://www.bipm.org/documents/20126/43742162/CIPM-MRA-G-11.pdf/>

Measurement comparisons in the CIPM MRA

International Measurement System for IR



Dosimetry codes of practice



Clinical Medical Radiation Physics

Project objective: To achieve international harmonization in QA in radiation medicine enhancing the quality in the practice of diagnosis and treatment in Member States.

- Guidelines and methodologies
- Education and Clinical Training
- Support Medical Physics profession
- Databases



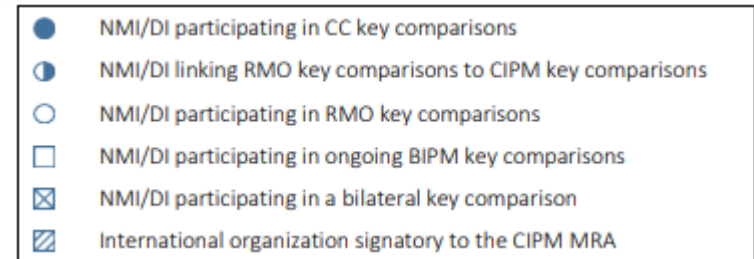
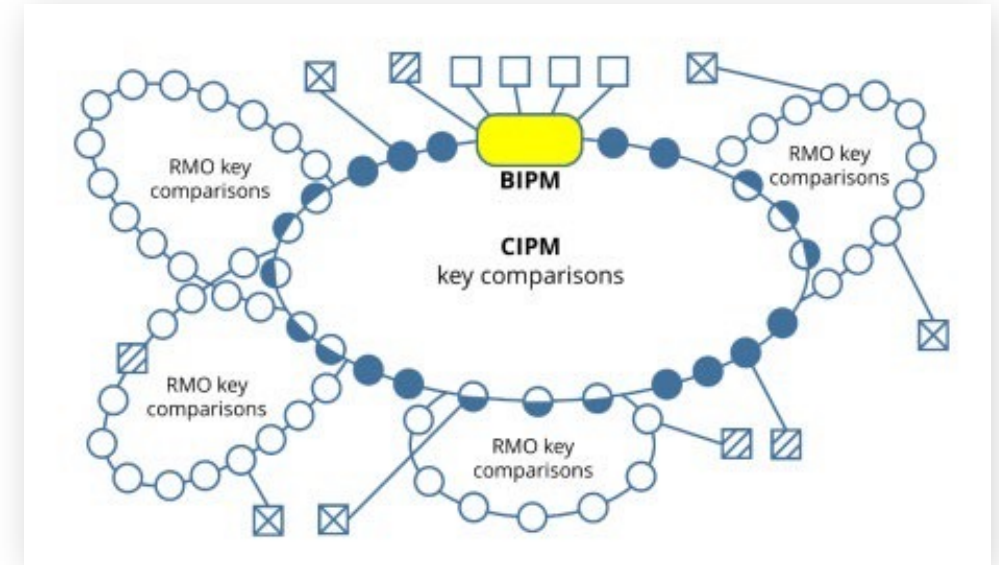
Regional Metrology Organisations

- Review and approve the Quality Systems of the NMIs/DIs
- CMC 's intra and interregional review
- Organise Key and supplementary comparisons



Measured once, accepted everywhere

- This concept addresses the availability of calibration capabilities in countries and regions.
- With the requirements of the CIPM MRA met, one country can confidently accept calibration certificates from another country.



<https://www.bipm.org/documents/20126/43742162/CIPM-MRA-G-11.pdf/>

Measurement comparisons in the CIPM MRA