COORDINATION
AT THE NATIONAL LEVEL

LNE-LNHB PRESENTATION

INTRODUCTION

At least two different national organizations for the metrology can be decribed:

- One big institute (NMI) gathering labs to deal with all technical domains in one organization with a very few external labs (DIs) to deal with specific domains

- A rather small institute (NMI) with a lot of labs (DIs) belonging to different organizations

The French organization is in between for scientific and historical reasons

HISTORY / ORGANISATION

Past (since 1969 until 2005)

Bureau National de Metrologie gathered four National Metrological Laboratories

- LNE (Mass, Electricity, Electromagnetism)
- CNAM (Electricity, Electromagnetism)
- SYRTE (Time, Frequency)
- LNHB (Ionizing Radiations)

+ six associated labs (associated labs / DIs)

HISTORY / ORGANISATION

How research programs are chosen:

Strategic Research Agenda sent to consultative metrology committee ~every five years

Research Projects proposed/reveiwed (Scientific Council for Ionizing Radiation)

- The Scientific Council gathers representative of nuclear industry, medical physicists, academic research bodies, international bodies. Projects review twice a year
- Scientific Audit of CEA
- Scientific Audit of French Science Academy…

Budget: ~50 permanent workers

EU research Calls (Framework program)
National reseach Calls
IMERA/EMRP/EMPIR calls
Metrology (CEA) } French state
Metrology (LNE) } French state
Calibration services
Industrial contrats

SUMMARY

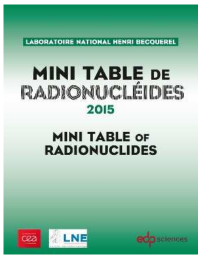
- LNE-LNHB is a DI for Ionising Radiation, it is one of the four DIs federated by LNE to cover the entire field of metrology
- LNHB belongs to the CEA (French atomic energy commission) ~50 permanent workers / 15000 at CEA
- LNE-LNHB provides primary standards for absorbed doses, kerma, dose equivalents, activity and neutron flux
- LNE-LNHB provide proficiency test and calibration services to users for radioactivity and dosimetry

All in all 290 CMCs lines

FEW EXAMPLES

R&D ; TRANSFER ACTIVITIES AND MEANS AT LNE-LNHB

- **Decay Data Evaluation Project DDEP (coordinated by LNE LNHB)**
- **Collaboration with BIPM to publish the monographie**
- **Free access to library for gamma and alpha emissions** http://laraweb.free.fr/
- **Publication of the pocket table of radionuclides**



- Volume 7 of the Table of Radionuclides (Monographie BIPM - 5) published in 2013, including the IAEA CRP Actinide evaluations:

^{14}C, ^{35}S, ^{36}Cl, ^{37}Ar, ^{45}Ca, ^{67}Ga, ^{68}Ga, ^{68}Ge, ^{127}Sb, ^{127}Te, ^{127m}Te, ^{134}Cs, ^{141}Ce, ^{147}Nd, ^{147}Pm, ^{195}Au, ^{206}Hg, ^{207}Tl, ^{208}Tl, ^{209}Tl, ^{211}Pb, ^{211}At, ^{213}Bi, ^{238}Th, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm

- See also: www.nucleide.org/NucData.htm
- 24 new evaluations
- 5 re-evaluations ^{67}Ga, ^{208}Tl, ^{238}Th, ^{242}Cm, ^{244}Cm

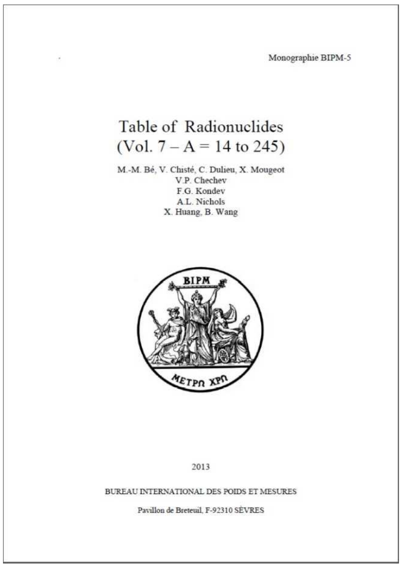

Monographie BIPM-5

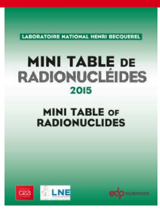
Table of Radionuclides
(Vol. 7 – A = 14 to 245)

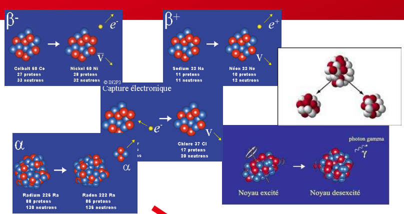
M.-M. Bé, V. Chisté, C. Dulieu, X. Mougeot
V.P. Chechev
F.G. Kondev
A.L. Nichols
X. Huang, B. Wang

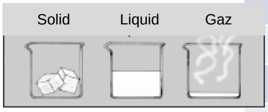
2013

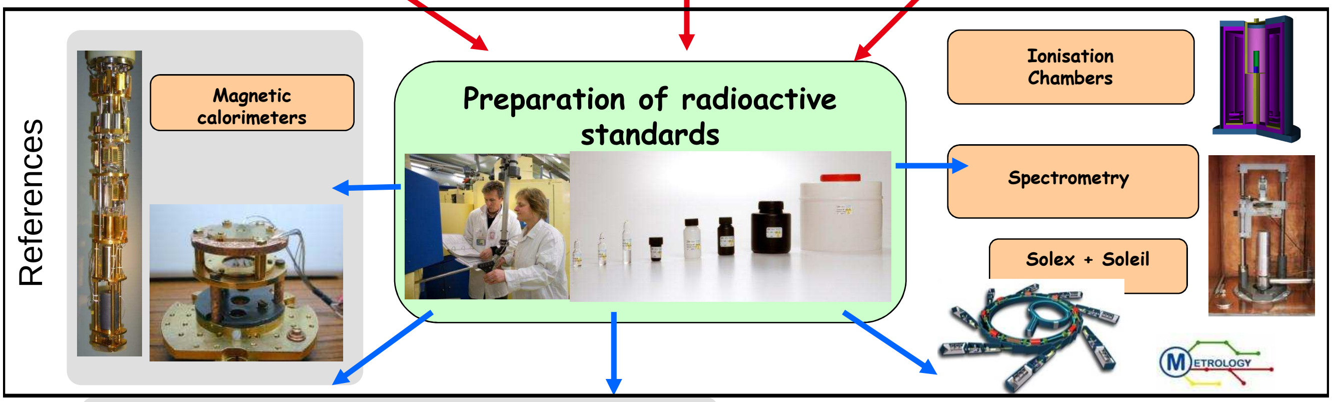
BUREAU INTERNATIONAL DES POIDS ET MESURES
Pavillon de Breteuil, F-92310 SÈVRES

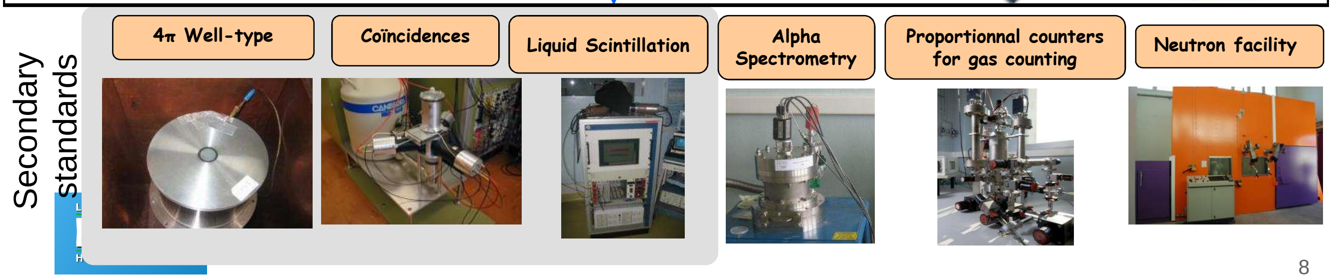
Radionucléide	Half-life
Fluor 18	1,83 h
Radon 222	3,82 d
Iode 131	8,05 d
Carbone 14	5 730 y
Plutonium 239	24 100 y
Uranium 238	4,47 billions y







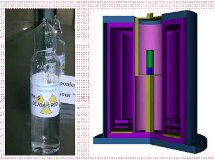




PROFICIENCY TESTS AND TRANSFER TO USERS

Establishment of traceability chains

Ionisation chamber



Activimeter : device used in hospitals for activity measurements

Transfer to end users

Alpha spectrometry

X and gamma spectrometry

Liquid scintillation

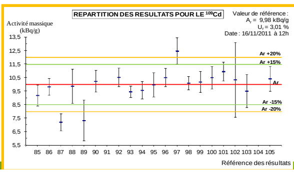
Proportionnal counters

AREVA
LEA

40 years expertise for organizing proficiency tests for laboratories in charge of radioactivity measurements in France

Radioactive standards

Measurements for reference value of activity



Samples

- 5-6 proficiency tests per year
- about 80 laboratories
- Liquid & solid matrices
- Measurements of gamma & beta emitters

LNE-LNHB WORLD UNIQUE BETA SPECTROMETER

BETA SPECTROMETRY

Aim :

Better knowledge of the form of the beta spectra for :

- Metrology of activity
- Internal dosimetry for radiotherapy
- Waste storage, calculation of residual power of powerplants

Results

Use of cryogenic detectors

Conception of a prototype with a semi-conductor detector (for an energy range between 500 keV and 3 MeV)

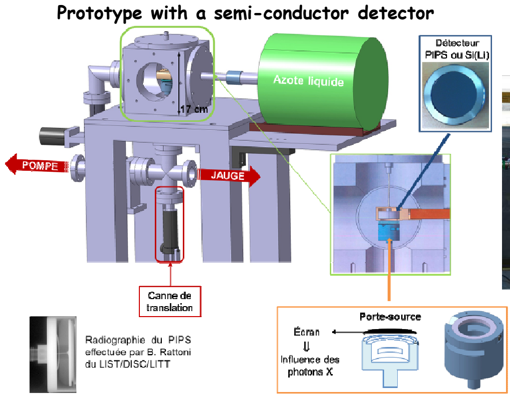
Measurements of beta spectra

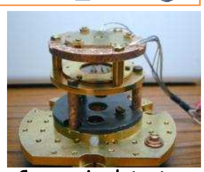
Conception of codes to calculate the spectra

Comparison measured spectra with calculated spectra

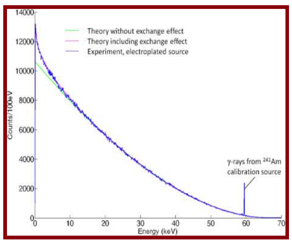
Metrobeta JRP begining in June 2016

Prototype with a semi-conductor detector





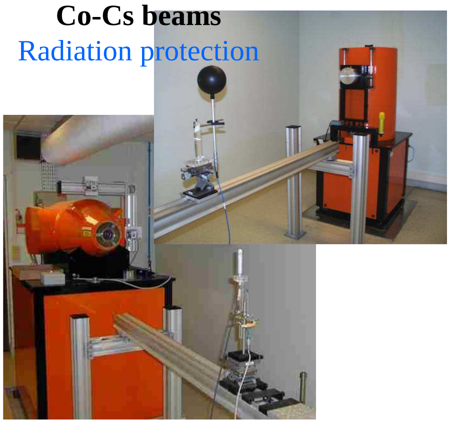
Cryogenic detectors



Beta spectra of Pu-241

DOSIMETRY FACILITIES & DOSEO PLATE FORM

Co-Cs beams
Radiation protection

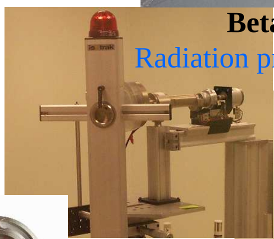


LINACs
Radiotherapy
DOSEO

Continuous X rays beams
Radiation protection

X rays beams, Iridium, Iodine
Brachytherapy

Beta
Radiation protection



Irradiation for industry

Pulsed X rays beams
Radiodiagnostic,
Mammography
interv. Radiol./cardiol.

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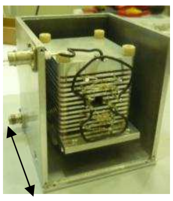
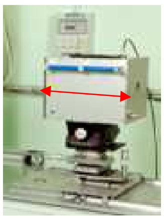
PRIMARY STANDARDS

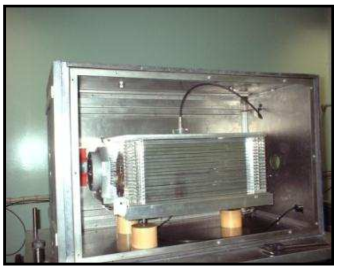
Free air ChamberS, air kerma standard for low and medium energy Xrays



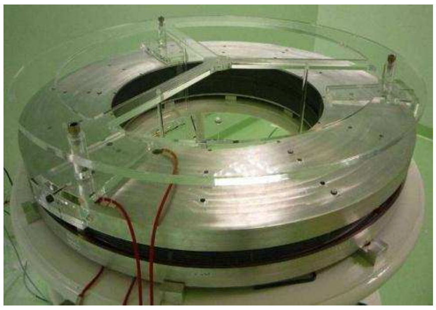
15 cm , 1 kg
0.33 cm^3
Mammography



40 cm, 50 kg
3.8 cm^3
Diagnosis



80 cm , 300 kg , 4.8 cm^3
Continuous soft X rays



1150 cm^3, brachytherapy

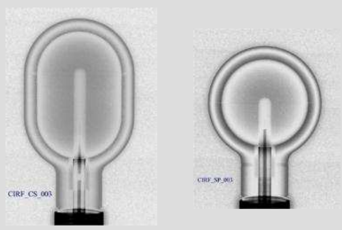
Cavity chamberS, air kerma for high energy photons

Spherical chambers from 4 to 7 cm^3

Cylindro-sphérical chambers from 7 to 12 cm^3

Leakage current ~ 10^{-16} A

Collaboration: IST – Portugal ; IFIN HH – Romania ; CIEMAT - Spain
to diseminate primary standard
EMPIR JRP Absorb



Radiography chambers

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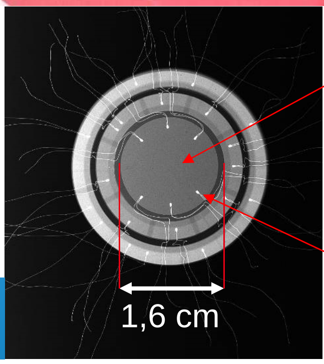
CalorimeterS : absorbed dose standard

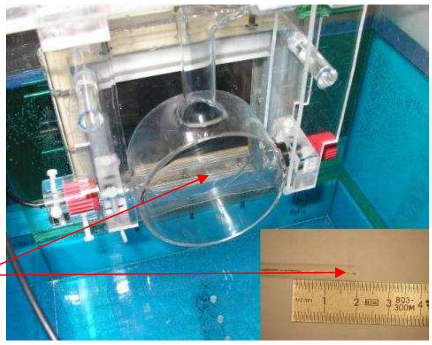
Graphite Calorimeter

Water Calorimeter



Core + thermistors

Temperature probe



iMeraPlus-EMRP-EMPIR 20/26 ; FP7 1/1

iMera+
- **JRP7** External Beam Cancer Therapy (2010) **(Health)**
- **JRP6** 3D Brachytherapy (2010) **(Health)**

FP7 → **ORAMED** optimisation of radiation protection of medical staff (2011)

EMRP
- **ENG08** MetroFission - Metrology for new generation nuclear power plants (2014)
- **ENV09** MetroRWM - Metrology for Radioactive waste management (2014)
- **IND04** MetroMetal - Ionising Radiation for Metallurgical Industry (2014)
- **IND07** Thin Films - Metrology for manufacturing thin films (2014)
- **HLT09** MetrExtRT - Metrology for radiotherapy using complex radiation fields (2015) **(Coordination LNHB)**
- **HLT11** MetroMRT – Metrology for Molecular Radiotherapy (2015)
- **NEW01** TReND - Traceable Characterization of Nano-Structured Device (2015)

Finished

- **IND57** MetroNORM - Metrology for processing materials with high natural radioactivity (2016)
- **ENG53** ThinErgy-Traceable characterisation of thin-film materials for energy applications (2017)
- **ENV54** MetroDecom-Metrology for decommissioning nuclear facilities (2017)
- **ENV57** MetroERM - Metrology for Radiological Early Warning Network in Europe (2017)

EMPIR
- **SIP07** DIGITAL STD – Standard for Digital Data Format for Nuclear Instrumentation (2018)
- **IND01** 3DMetChemIT – Advanced 3D chemical metrology for innovative technologies (2018)
- **RPT04** ABSORB - Absorbed dose in water and air (2017) **(Coordination LNHB)**
- **HLT18** MRTDosimetry: Metrology for clinical implementation of dosimetry in molecular radiotherapy (2019)
- **SI07** MetroBeta: Radionuclide beta spectra metrology (2019) **(Coordination LNHB)**
- **HLT15** MetMRgRT: Metrology for MR guided RadioTherapy; (2019)
- **N11** UHV Techniques for ultra-high voltage and very fast transients (2019)

So we are altogether (MNIs AND DIs) EURAMET

For the French organization, it works well

This does not mean that one cannot find improvements

Here after three ideas which are for both NMIs and DIs

EMPR / EMPIR

Technical Commitee discussions ☺, EURAMET task groups ☺, Partnering meeting ☺, → **Improve internal communication**

Review conference ☺, MSU-website ☺. → **Improve communication with reviewers and administration**

3-4 calls every years targeting more of less the same teams is « difficult » to manage ☹

So why not:

Two years JRPs starting every three years to be more efficient ?

SPECIFICITIES OF I.R.

Due to the **relatively high uncertainties** of primary standards (~0,2%;~1%) compared to those needed by end users (2,5% RT), the traceability chain must be short. And National Metrology Laboratories have often a direct link to end users (nuclear medicine, radiotherapy, radio diagnosis).

In case of accident, the national authorities are accountable to the public.

So, ionizing radiation requires a high-quality "local" or "distributed" metrology.

Capacity building JRPs are one of the tools to deal with potential errors, (i) helping laboratories to develop the expertise required to **answer the specific needs of their countries** and therefore (ii) allowing more researchers to **develop innovative solutions**.

For the same reasons, a **"redundancy"** of primary standards should not be considered as a problem, but an **opportunity and a strength for Europe**, to prevent potential biases and their propagation, especially in the medical field.

National Metrology Laboratories should have the capability to adapt their references to **specific regulations or specific medical practice of their countries**.

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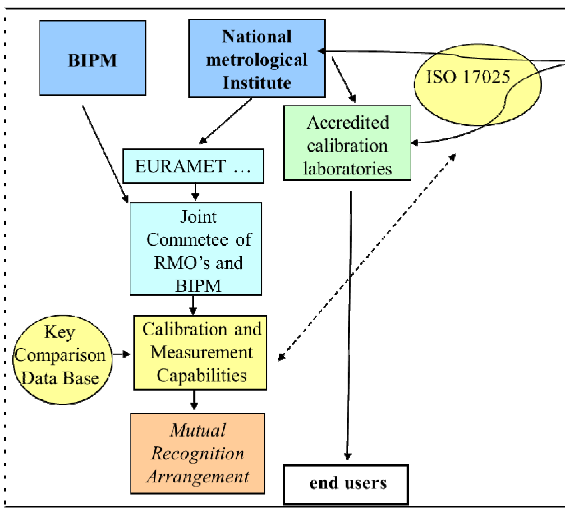
QUALITY SYSTEM (ISO 17025)

TC Q offers two possibilities ☺

- self declaration
- external accreditation

TC Q checks the quality system

- self declaration ☺
- external accreditation ☹



External accreditations are already agreed
at the international level through the *Multilateral Agreement*
therefore TC Q could rely on the decisions of the **external** accreditation bodies.

Laboratoire National LNHB Henri Becquerel

DE LA RECHERCHE À L'INDUSTRIE

cea

Laboratoire National
LNHB
Henri Becquerel

LNE
Le progrès, une passion à partager

I thank you for your attention

EURAMET