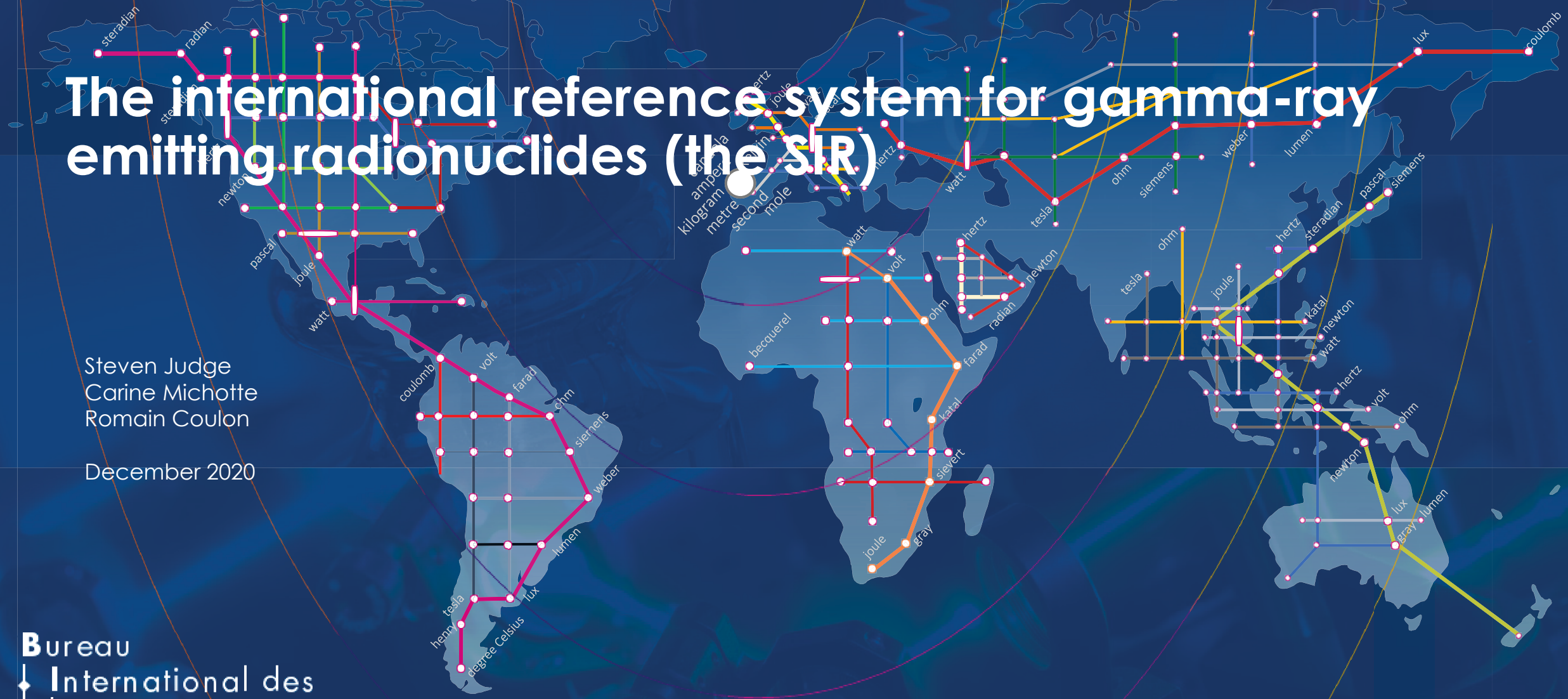
The international reference system for gamma-ray emitting radionuclides (the SIR)



Steven Judge
Carine Michotte
Romain Coulon

December 2020

Bureau International des Poids et Mesures

Applications of the SIR

Comparisons in radionuclide metrology

How do you support a CMC claim?

CIPM-MRA-D-05

…the range and uncertainty of the CMCs submitted must be consistent with information from some or all of the following sources:

1. Results of key and supplementary comparisons
2. Documented results of past CC, RMO or other comparisons (including bilateral)
3. Knowledge of technical activities by other NMIs, including publications
4. On-site peer-assessment reports
5. Active participation in RMO projects
6. Other available knowledge and experience

https://www.bipm.org/utils/common/documents/CIPM-MRA/CIPM-MRA-D-04.pdf

How do you support a CMC claim?

How do you show that the CMC is still valid?

CIPM-MRA-G-02

The comprehensive periodic review of the quality system includes examination of evidence for the continued validity and vitality of published CMCs.

In addition to the 5-year review of the supporting QMS, CMCs published in the KCDB undergo continual monitoring to ensure their validity.

https://www.bipm.org/utils/common/documents/CIPM-MRA/CIPM-MRA-G-02.pdf

How do you support a CMC claim?

How do you show that the CMC is still valid?

How can you comply with ISO17025?

ISO17025:2017

6.2.3 The laboratory shall ensure that the personnel have the competence to perform laboratory activities for which they are responsible and to evaluate the significance of deviations.

7.2.1.5 The laboratory shall verify that it can properly perform methods before introducing them by ensuring that it can achieve the required performance. Records of the verification shall be retained.

7.2.2.1 The laboratory shall validate non-standard methods, laboratory-developed methods and standard methods used outside their intended scope or otherwise modified.

7.2.2.2 When changes are made to a validated method, the influence of such changes shall be determined and where they are found to affect the original validation, a new method validation shall be performed.

7.7.2 The laboratory shall monitor its performance by comparison with results of other laboratories, where available and appropriate. This monitoring shall be planned and reviewed…

How do you support a CMC claim?

How do you show that the CMC is still valid?

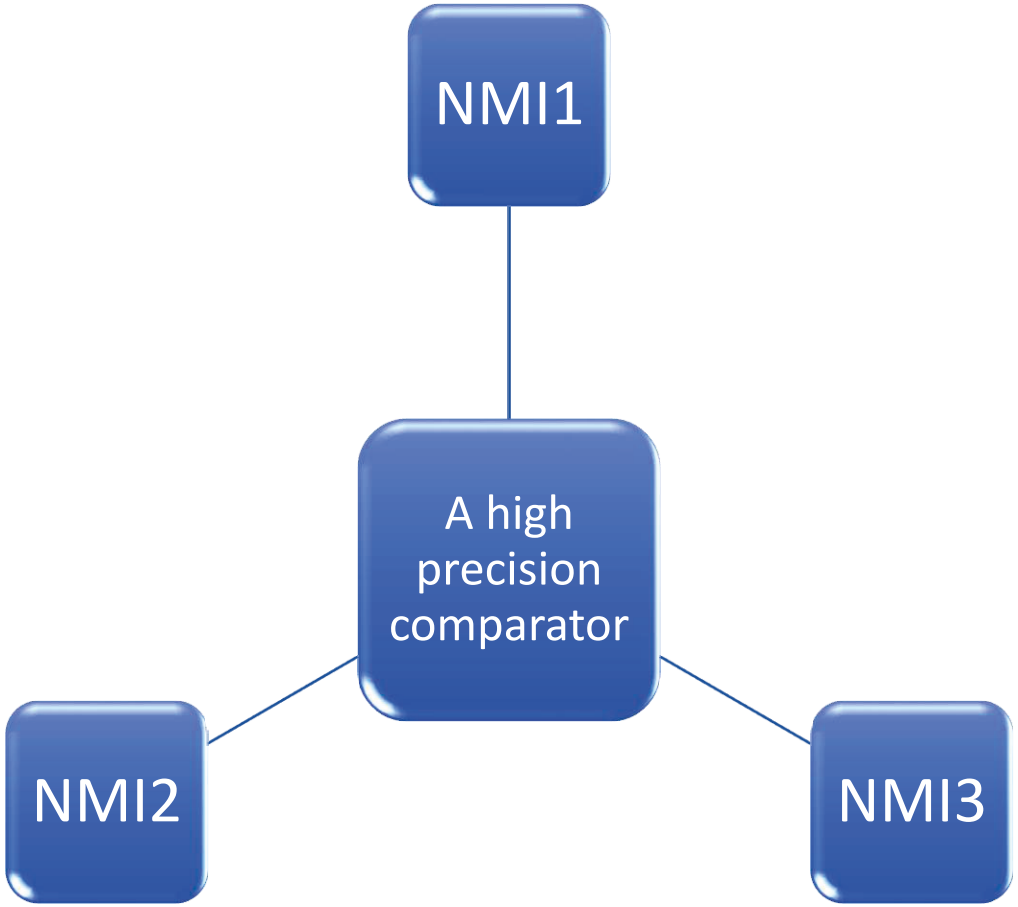
How can you comply with ISO17025?

How can you check a new primary standardization technique?

The science!

- To test new techniques

The international reference system for gamma-ray emitters (SIR)



Advantages

- You can compare your standards to those at other institutes and also to your results from the past
- Available when you need it
- Free of charge to NMIs and DIs
- Easy to use
- Results can be used to support CMCs for other radionuclides (for discussion at another webinar)

How the SIR works

The SIR
The International Reference System for gamma-emitting radionuclides

S. Judge, C. Michotte,
R. Coulon

CCRI webinar

Dec. 2020

Bureau International des Poids et Mesures

The SIR in a nutshell

BIPM.RI(II)-K1

- Highly stable comparator of activity measurements since 1976
- Total of ~ 800 SIR results for 72 different radionuclides

- Measurements carried out relatively to ^{226}Ra source
- SIR Result = Equivalent activity / kBq

$$A_{e,i} = \frac{A_i(t_m) C_{imp}}{I_i(t_m) / I_{Ra\ N°5}(t_0)}$$

~ inverse of a calibration factor pA/MBq

IG 11 – N_2 – 2 MPa

The SIR impurity correction: how is it estimated?

$$C_{imp} = 1 + \sum_k \frac{A_k(t_m)}{A(t_m)} \frac{A_e}{A_{e,k}}$$

→ from SIR measurement

γ-spectrometry at NMI

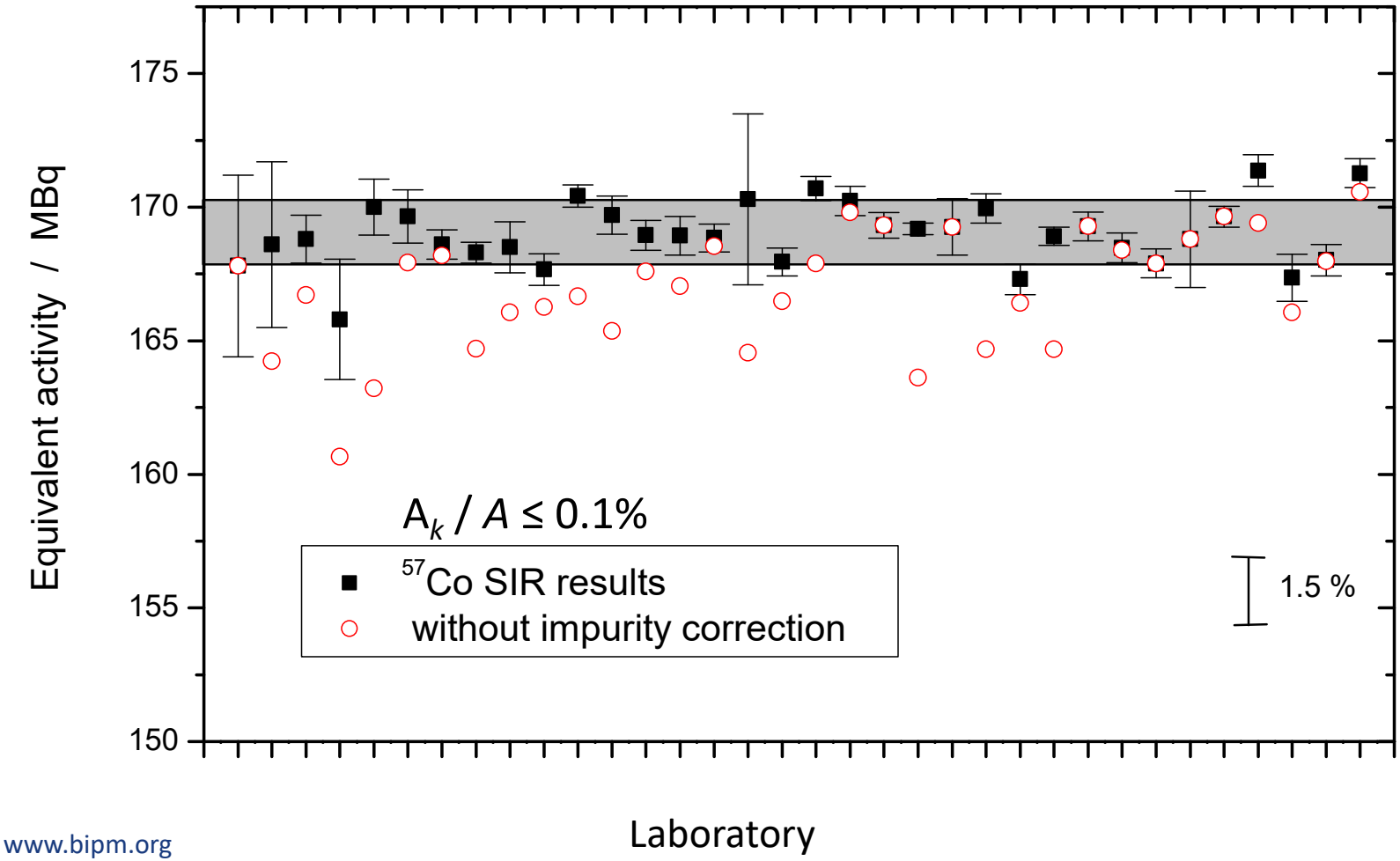
$A_{e,k}$: Equivalent activity for impurity *k*

obtained

- from SIR measurement
- or calculated (SIR efficiency curve + nuclear data)

The SIR impurity correction: how is it estimated?

For low-energy γ-emitter: C_{imp} reaches several (tens of) percents
precise γ-spectrometry is needed



The SIR range

- Bg current: 30 fA — Factor 50 — *u*(Bg) is supposed negligible
- SIR measurement range: from 1.5 pA to 500 pA, which corresponds to a different activity range for each RN

$$A_{e,i} = \frac{A_i(t_m) C_{imp}}{I_i(t_m) / I_{Ra\ N°5}(t_0)}$$

- Five ^{226}Ra sealed sources to cover the whole range
- Current ratios F_j between the 5 sources is well-known

$F_j = I_{RaN°5} / I_{RaN°j}$

New version on the BIPM website

See SIR-T-20 pro

Radionuclide	Minimu /kBq	/MBq
Cr-51	2 600	50
Mn-54	100	29
Co-57	900	150
Co-60	40	11
Ge-68	90	20
Y-88	40	10
Cd-109	43 000	500
Cs-137	150	41
Ce-139	700	200
Eu-152	80	22
Am-241	11 000	50

The SIR long-term stability

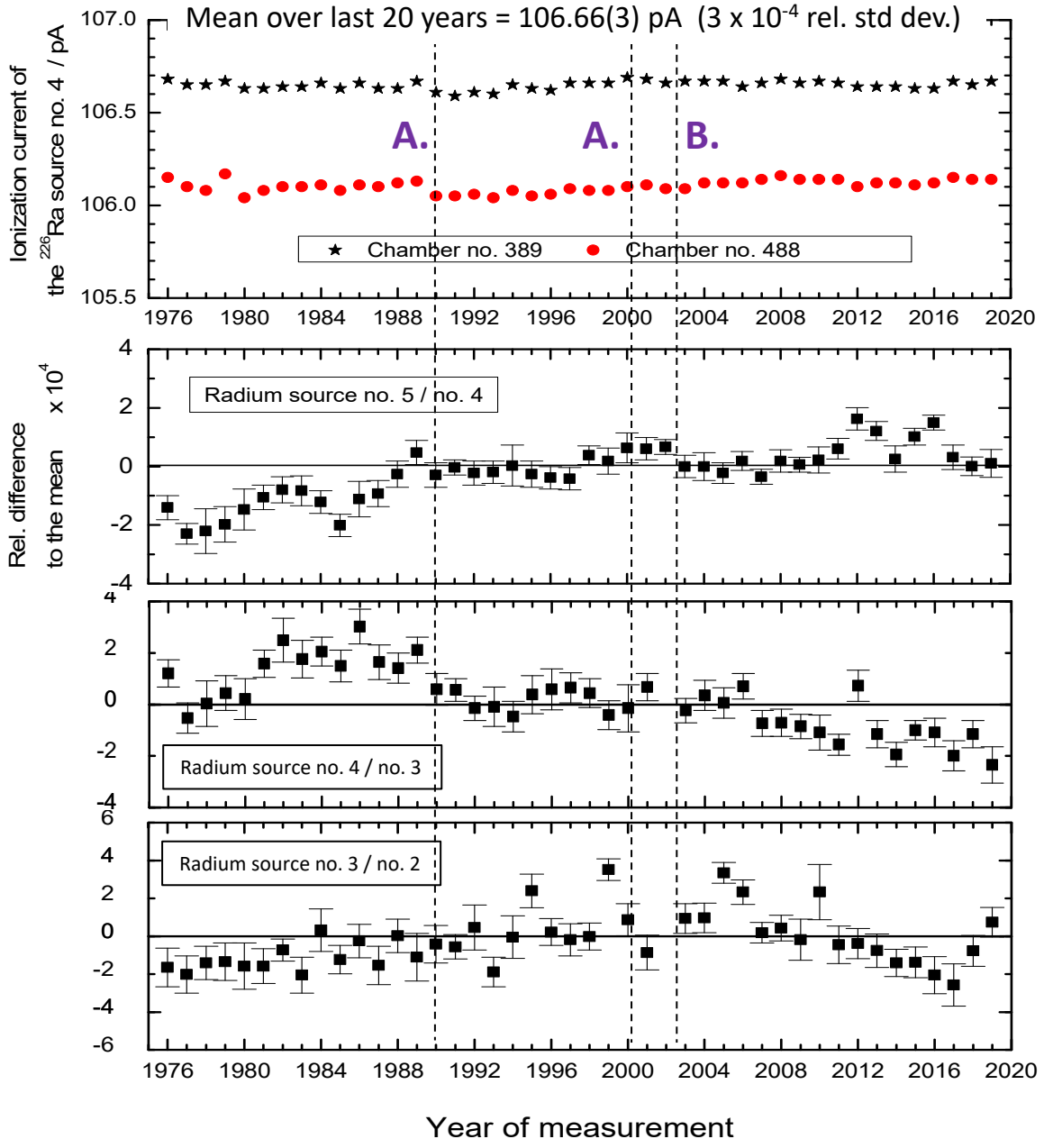
- ^{226}Ra current is monitored : global stability check of SIR IC, electronics and ^{226}Ra sources
- Current ratios between the ^{226}Ra sources are monitored and used in calculation of A_e

A. Move of SIR to another room

B. Complete renew of electrometer, electronics, DAQ

C. 2020 update of DAQ

Fluctuations observed within +/- 3 x 10^{-4}



The SIR uncertainty budget

Combined relative uncertainty
Typ. 0.03 – 0.15 %

Uncertainty component	Relative uncertainty / 10^{-4}	Type A/B evaluation method	Comment
Current measurement	2 - 10	A	Standard deviation of the mean
Ratio of ^{226}Ra sources F_j	0 - 7	B	Depends on ^{226}Ra source used for the measurement
Decay (RN)	Typ. < 5	B	Can reach several 10^{-3}
Decay (^{226}Ra)	0.8	B	Today
Decay (impurity)	Typ. < 1	B	
Impurity correction	Typ. < 5	A/B	Propagation of uncertainty provided by NMI Can reach several 10^{-3}
Ampoule wall thickness (liquids)	2 - 10	B	Interpolation/extrapolation of Rytz's study using ^{241}Am and ^{60}Co
Background current	-		Negligible (within the activity range of the SIR)
Solution volume	-		Height of ampoule holder adjusted to compensate

The SIR:
case of complex decay-scheme not at equilibrium

- A_e is always calculated using the activity of the parent nuclide
- Equilibrium with daughter nuclides is assumed

- In some case, equilibrium is never reached ($A_{daughter}/A_{parent}$ is not constant), so A_e depends on time

- Specific procedure is being developed to enable comparison (J. Keightley, NPL)

- Examples: Th-227, Pa-231, Zr-95

The SIR is a reliable tool for

- Long-term comparison of primary/secondary activity standards
- To test/validate a new method, new nuclide…
  « Pilot comparison »: no degrees of equivalence calculated

+ extension to short-lived radionuclides (SIRTI)
+ extension to beta emitters (ESIR)

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The SIR and the MRA

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The SIR and the MRA

- Degrees of Equivalence for lab *i* $D_i = x_i - x_{ref}$; U_i (k = 2)
- The CCRI(II) decided that D_i remains valid for 20 years
- The CCRI(II) decided that

  x_{ref} = KCRV = power moderated weighted mean

  (S. Pommé *et al, Metrologia 2015*)

$$x_{\mathrm{ref}} = \sum_{i=1}^{N} w_i x_i \qquad \frac{1}{u^2(x_{\mathrm{ref}})} = \sum_{i=1}^{N} \left[\left(\sqrt{u_i^2 + s^2} \right)^{\alpha} S^{2-\alpha} \right]^{-1},$$

$$w_i = u^2(x_{\mathrm{ref}}) \left[\left(\sqrt{u_i^2 + s^2} \right)^{\alpha} S^{2-\alpha} \right]^{-1}$$

S = 'characteristic uncertainty per datum'

- s = 'dark uncertainty' such that $\chi^2 = 1$
- Power α : between 0 (arithmetic mean) and 2 (weighted mean)
- CCRI(II) decided that $\alpha = 2 - 3/N$

Which data for the KCRV?

SIR data only

- No data from linked comparisons (except if ampoules also measured in the SIR)

No limit in time

- old good results remain valid
  (because the SIR demonstrates long-term stability to a few 10^{-4})

=> more entries in KCRV => more robust

Most recent primary result for each participant

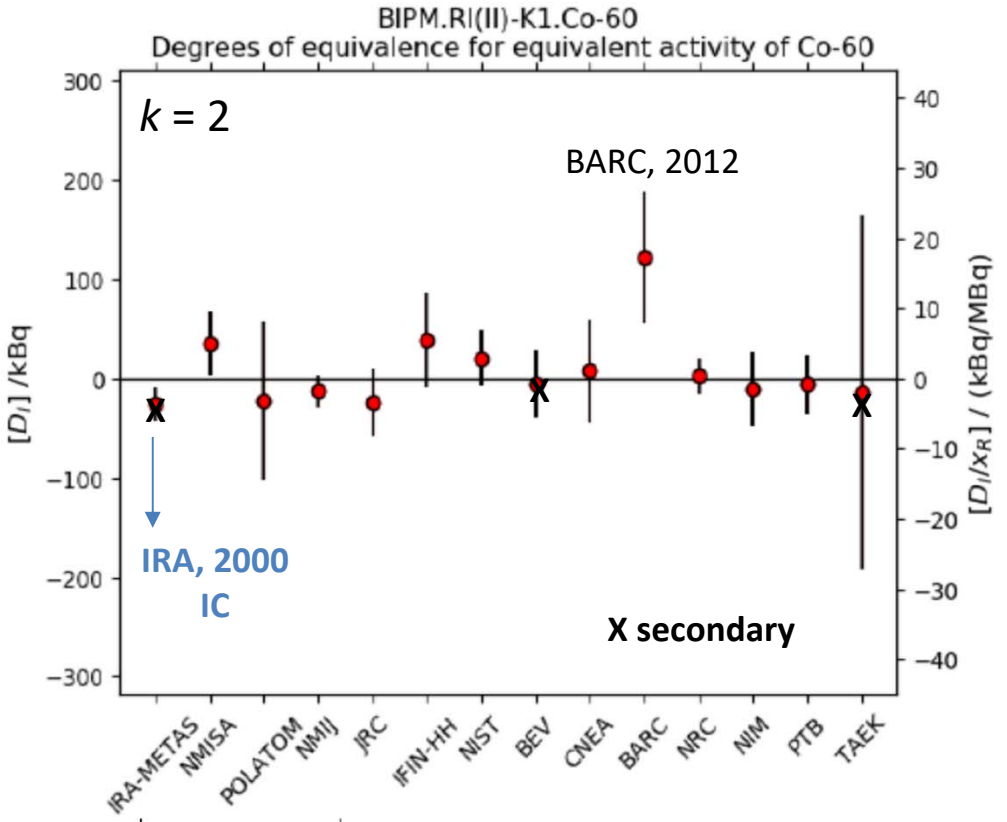
- Exception of old IC results for historical reason

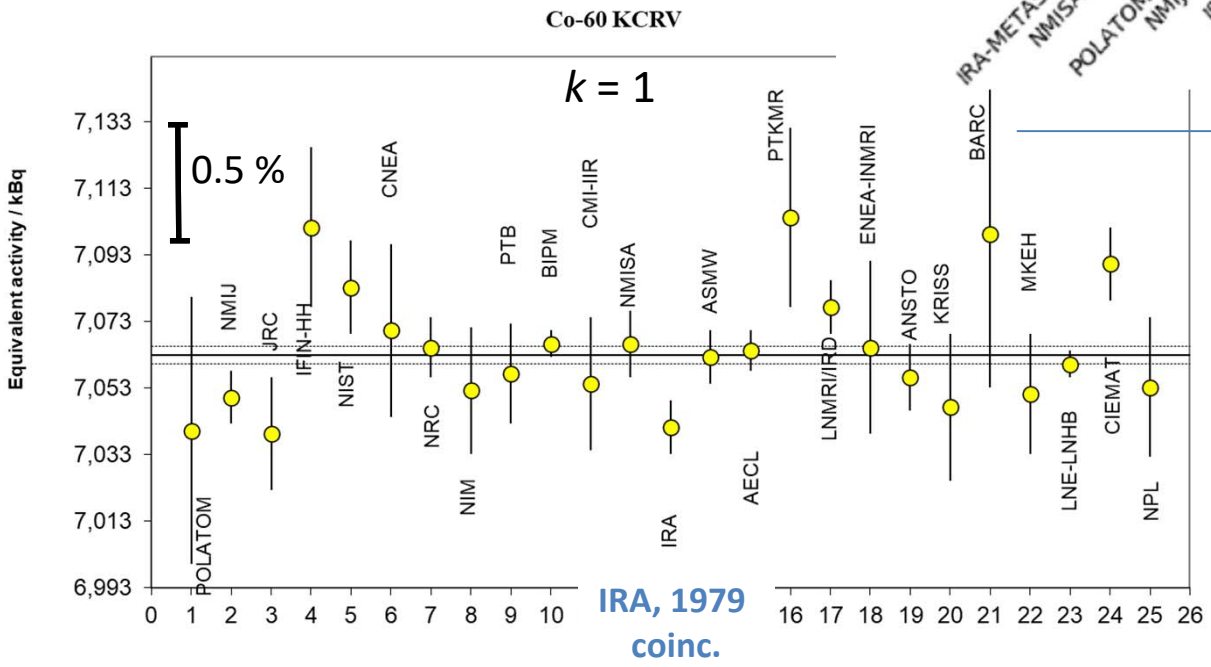
Exclusion

- KCWG(II) to recommend excluding some results on technical ground
- Outlier rejection if $D_i / u(D_i) > +/- 2.5$ to be agreed by CCRI(II)

Example: Co-60

- 72 ampoules measured since 1976
- 14 in the last 20 years
- KCRV: one data for each NMI (if primary, not outlier,…): 25 entries





PMM	
mean	7062.7
std dev	2.7
chi	1.17
dark unc	6.4
power α	1.88

The SIR: link of RMO KC

Ampoule(s) (mass M_L) from the RMO KC measured in the SIR

For Lab *j* from RMO KC:

$A_{e\,j} = (A/m)_j$ x Link to SIR

Linking laboratory L

Link = $A_{e\,L} / (A/m)_L$

$= (\cancel{A/m})_L \; M_L / (I_L / I_{Ra\text{-}5}) / (\cancel{A/m})_L$

independant on linking lab K2 result

Example : recent Ge-68 SIR Final report

$A_{e\,j} = (A/m)_j \; M_L / (I_L / I_{Ra\text{-}5})$

The SIR: improved service

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The SIR : improved service

Quicker	• New NMI reporting form (Excel) + LabView • Automation to calculate the comparison result • start of use in January
Quicker	• Automation to produce reports • see R. Coulon's presentation
Safer	• ^{226}Ra: almost 50 years old; α-emitter • To be replaced by ^{166m}Ho next year
More robust	• Transfer of KCRVs to 2nd SIR IC • Project starting in January with NPL
More robust	• Buy new IC (2020-2023 work program)

The SIR : improved service

http://www.magnicon.com

ULCA = Ultra-stable Low-noise Current Amplifier

More robust

- ULCA to replace the old Keithley electrometer
- Absolute current traceable to SI
- Calibration each 20 years?
- Highly linear

- Workshop at NIST to review options
- Support of the new CCEM-CCRI Task Group on low current measurement
- First tests at BIPM on-going

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I thank you for your attention,
and invite my colleague
Romain Coulon to continue.

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www.bipm.org

Digitalization of the SIR comparison reporting

_ *A faster and more secure process for producing CCRI(II) comparison reports*

BIPM Ionizing Radiation Department

CCRI webinar 15th December 2020

Bureau International des Poids et Mesures

How to build an efficient reporting of SIR comparison data?

Objectives

Optimize the workforce and the velocity of SIR comparisons

Limit risk factors and their frequency of occurrence

Give opportunities toward more digital data exchange between BIPM and NMIs

Strategies

Maximize the automatization
- Software must support the maximum of work

Build a scheme as simple as possible
- One database
- One software
- One repository

Secure the data and the software
- A robust Life Cycle process
- A robust version control system

Comply with FAIR principles
- Machin readable format of the database
- Availability on the KCDB API

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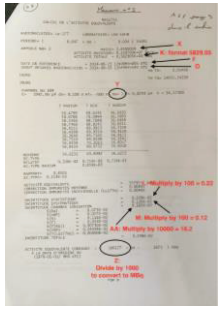
Which database format for the SIR?

Dispersed information

from past reports, excel spread sheets, forms, measurement results reports…

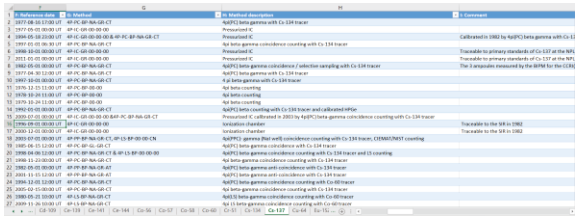
❌ Easy handling of data
❌ Robust format of data
❌ Complying with FAIR



A unique Excel file

gathering all past information
Matrix representation
(1 sheet / rad.)

✅ Easy handling of data
❌ Robust format of data
❌ Complying with FAIR



36 columns = properties
Lines = SIR submissions

CSV files

UTF-8 text files
Matrix representation

(One file / rad.)

✅ Easy handling of data
✅ Robust format of data
✅ Complying with FAIR

```
A:KCRV;B: DoE;C: NMI;D: BIPM authors;E: NMI authors;F: Reference date;G: Metho
1;0;BIPM;;;1975-04-21 13:00 UT;4P-PC-MX-NA-GR-CO;4piPC-gamma coincidence;;1;46
0;0;BKFH;;;1980-04-15 12:00 UT;4P-PP-MX-NA-GR-CO;4pi(x,ex)-gamma coincidence;;
0;0;BKFH;;;1990-09-15 12:00 UT;4P-PP-MX-NA-GR-AC;4pi(x,ex)-gamma anti-coincide
0;0;BKFH;;;1991-11-01 12:00 UT;4P-PP-MX-NA-GR-CO;4pi(x,ex)-gamma coincidence;;
1;0;BKFH;;;1994-05-15 00:00 UT;4P-PP-MX-NA-GR-AC;4piPPC-gamma coincidence;;1;7
0;0;CMI-IIR;;;1978-10-13 11:00 UT;4P-PC-MX-NA-GR-CO;4pi(x,eA)-gamma coincidenc
1;0;CMI-IIR;;;1982-11-15 00:00 UT;4P-PC-MX-NA-GR-CO;4piPC-gamma coincidence;;1
0;0;LNE-LNHB;;;1983-11-28 12:00 UT;4P-PP-XR-NA-GR-AC;4piPPC-gamma anti-coincid
1;0;LNE-LNHB;;;1995-02-16 12:00 UT;4P-PP-XR-NA-GR-AC;4pi beta-gamma anti-coinc
0;0;NIRH;;;1996-10-15 08:00 UT;4P-IC-GR-00-00-00;ionization chamber;;1;5800;0.
0;0;NIST;;;1977-04-20 17:00 UT;4P-IC-GR-00-00-00 calibrated by 4P-PP-MX-NA-GR-
1;0;NIST;;;1983-06-13 17:00 UT;4P-IC-GR-00-00-00 calibrated by 4P-PP-MX-NA-GR-
0;1;NIST;;;2001-11-15 12:00 UT;4P-IC-GR-00-00-00 calibrated by 4P-PP-MX-NA-GR-
0;0;NMIJ;;;1976-11-01 12:00 UT;4P-PC-MX-NA-GR-CO;4pi x-gamma coincidence;;1;97
1;0;NMIJ;;;1994-12-01 12:00 UT;4P-PC-MX-NA-GR-CO;4pie(x)-gamma coincidence;;1;
0;1;NMIJ;;;2004-02-01 00:00 UT;4P-IC-GR-00-00-00;ionization chamber traceable
1;0;NPL;;;1981-10-05 00:00 UT;4P-IC-GR-00-00-00 calibrated by 4P-PP-MX-NA-GR-C
1;1;POLATOM;;;2009-01-01 11:00 UT;4P-LS-MX-NA-GR-CO & 4P-LS-MX-NA-GR-AC;4pi(LS
0;0;PTB;;;1976-10-01 00:00 UT;4P-PP-MX-NA-GR-CO;4piPPC-gamma coincidence;;6;27
```

A unique JSON or XML file

UTF-8 text files
Tree representation

(1 file)

✅ Easy handling of data
✅ Robust format of data
✅ Complying with FAIR

```
    ],
    "PTB" : {
      "D_1" : -7,
      "U_1" : 35
    }
  },
  "Data from BKFH-2000": {
    "Eligible for the Key Comparison Reference Value (KCRV)": true,
    "Eligible Degree of Equivalence (DoE)": false,
    "Laboratory": {
      "Acronym": "BKFH",
      "Full name": "Government Office of the Capital City Budapest",
      "Address": "Németvölgyi út 37-39 H-1124 Budapest",
      "Country": "Hungary",
      "Regional Metrology Organization (RMO)": "EURAMET",
      "Old acronyms": "OMH, MKEH"
    },
    "Contributor(s) from the BIPM": null,
    "Contributor(s) from the laboratory": null,
    "Date of reference specified by the laboratory": "2000-06-01 00:00 UT",
    "Acronym(s) of the measurement method(s)": "4P-PC-BP-77-GR-CO, 4P-PC-BP-77-GR-AC",
    "Description of the measurement method(s)": "4pi-beta(PC)-gamma coincidence and anticoincidence",
    "Comment(s) on the measurement method(s)": null,
    "Particularities of the submission to the SIR": "1 sample and 1 measurement method",
    "Activity measured by the laboratory / kBq": "6308",
    "Type A evaluation of the relative standard uncertainty of the activity measured by the laboratory": "0.09",
    "Type B evaluation of the relative standard uncertainty of the activity measured by the laboratory": "0.27",
    "Combined relative standard uncertainty of the activity measured by the laboratory": null,
    "Date of the measurement by the BIPM international reference system (SIR)": "11/07/2000",
    "Half-life used by the laboratory / d": "249.8(3)",
    "Reference for the decay data used by the laboratory": null
```

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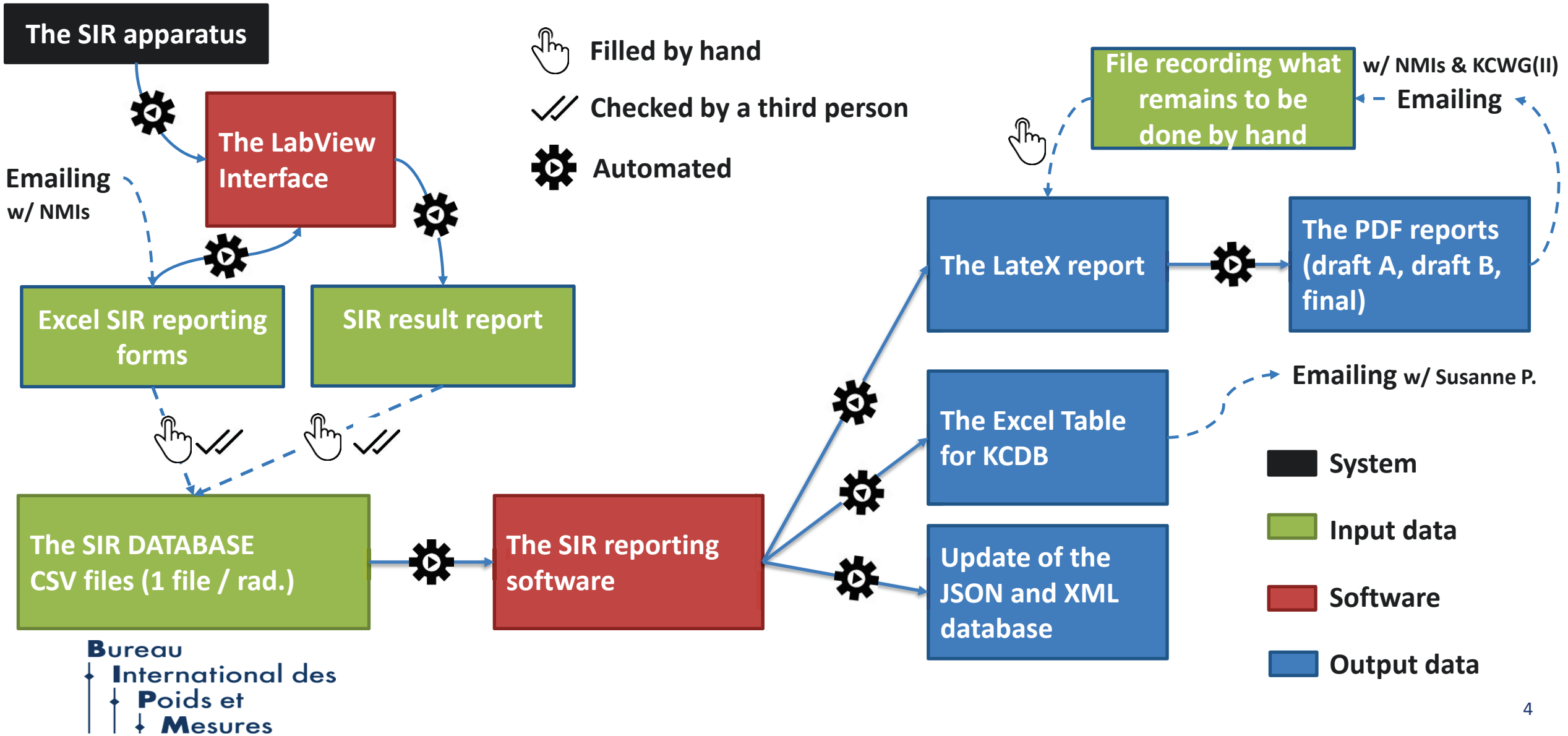
The new SIR reporting flowchart



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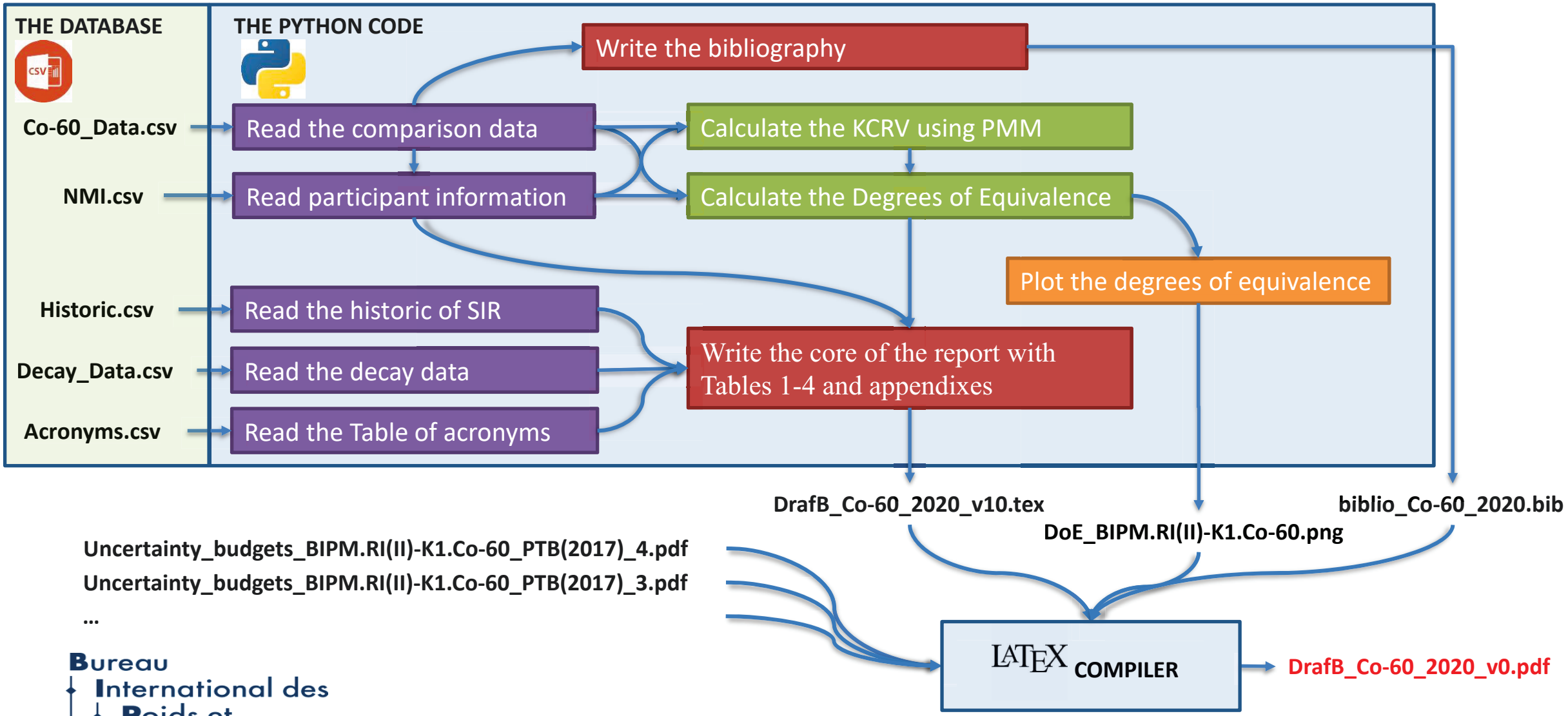
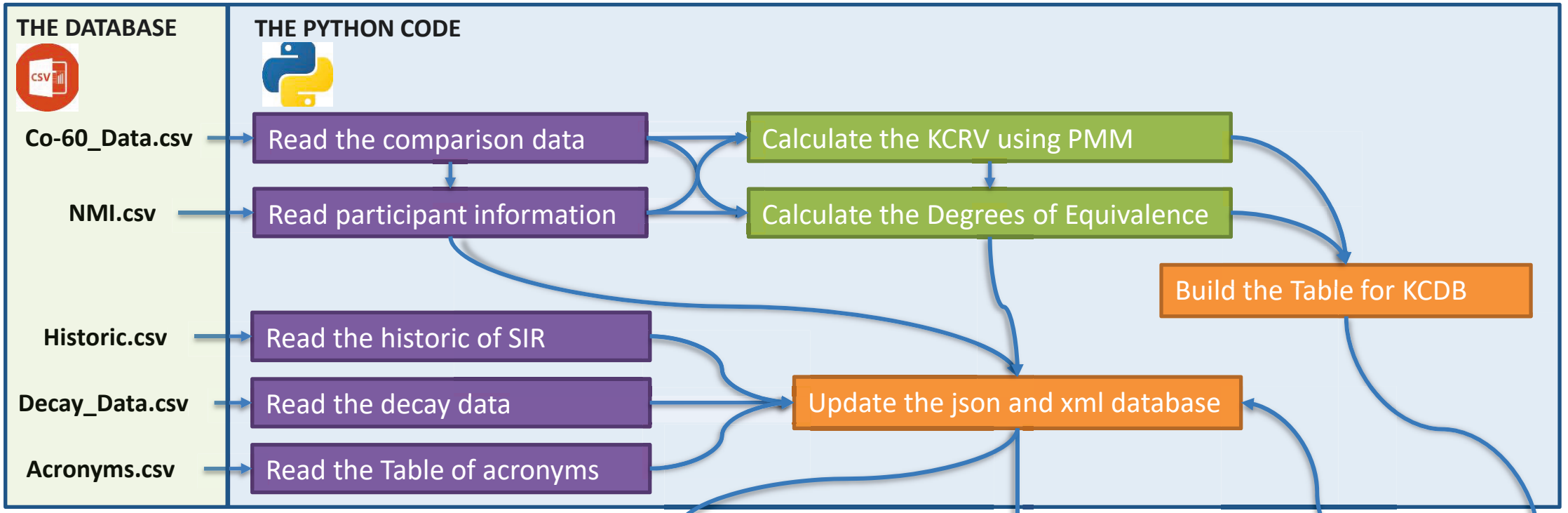
The SIR reporting software - Production of comparison reports



Bureau International des Poids et Mesures

The SIR reporting software – Production of KCDB Table and machine-readable databases



CIPM Task Group on the Digital SI

database.json

<xml /> database.xml

DegreesOfEquivalence_Co-60_2020.xlsx

Available for future developments meeting FAIR principles:

Findable Accessible Interoperable Reusable

Bureau International des Poids et Mesures

KCDB

The SIR reporting software – The Life Cycle

CCRI(II) requirements

Requirement specifications

Functional specifications

Design specifications

Coding

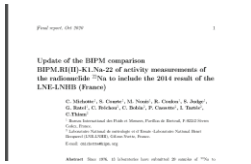
Unit testing

Functional testing

User acceptance testing

PEER REVIEW

Draft A – Draft B approvals



Reproduce published reports & compare

Using the unit testing framework of python

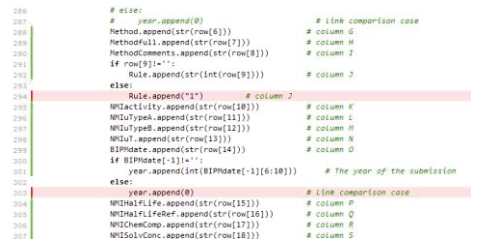
unittest

Creation of the transversal group at BIPM to discuss quality issues from software validation.

ISO 17025

ISO 12207

Bureau International des Poids et Mesures



Coverage report: 75%

Module ↓	statements	missing	excluded	coverage
DataProcessing.py	376	47	0	88%
DisplayData.py	1635	417	0	74%
TDCRcalculation.py	255	207	0	19%
test_Modules.py	1087	165	0	85%
Total	**3353**	**836**	**0**	**75%**

How to control the SIR data (database + source codes)?

Key data to control and secure

The Python source codes
SIRreport.py
Dataprocessing.py
Display_Data.py
Test_Modules.py

The input database
NMI.csv
Historic.csv
Decay_Data.csv
Acronyms.csv
Co-60_Data.csv
Na-22_Data.csv
…
Changes to do by hand for Co-60.txt
Changes to do by hand for Na-22.txt
…

Other under control files

The LaTeX sources
DrafB_Co-60_2020_v1.tex
DrafB_Co-60_2020_v2.tex
…

The full database
database.json
database.xml

The key data are stored in a unique local repository

git is used as version control system

- Track all the changes in text files
- Each versions / a unique ID
- A unique master repository

GitHub is used to store and analyse the versions in a remote repository

Visualization of change between two versions in GitHub

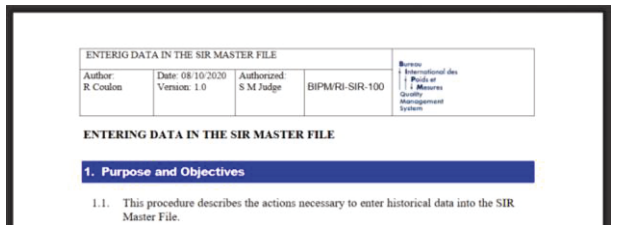
18 Co-60_Data.csv

```
: ur_A;M: ur_B;N: ur_T;O: Date of SIR measurement;P: NMI Half-
77, 0.94642;3, 3;7050, 7051;5, 5;mass of solution before dilut
ass of solution before dilution;6;;;;;SJ (27/04/2020);SC (06/0
/2020);SC (06/05/2020);1;2003;7064.6(3.8) kBq;Ratel G., Michot
 3.6052;4, 4;7063, 7061;4, 4;;8, 8;;;;;SJ (27/04/2020);SC (06/
/04/2020);SC (06/05/2020);1;2010;7063.3(4.0)  kBq ;"Michotte (
;SJ (27/04/2020);SC (06/05/2020);1;2017;7062.7(2.7)  kBq;Micho
27/04/2020);SC (06/05/2020);1;2020;7062.6(2.7) kBq;under verit
77, 0.94642;3, 3;7050, 7051;5, 5;mass of solution before dilut
ass of solution before dilution;6;;;;;SJ (27/04/2020);SC (06/0
/2020);SC (06/05/2020);1;2003;7064.6(38) kBq;Ratel G., Michott
 3.6052;4, 4;7063, 7061;4, 4;;8, 8;;;;;SJ (27/04/2020);SC (06/
/04/2020);SC (06/05/2020);1;2010;7063.3(40)  kBq ;"Michotte C.
;SJ (27/04/2020);SC (06/05/2020);1;2017;7062.7(27)  kBq;Michot
27/04/2020);SC (06/05/2020);1;2020;7062.6(27) kBq;under verifi
;;;SJ (27/04/2020);SC (06/05/2020);1;;;;;
;4;;42;;;;;SJ (27/04/2020);SC (06/05/2020);1;;;;;
ieu {C}., {B}rowne {E}., {C}hechev {V}., {K}uzmenko {N}., {H}e
```

Bureau International des Poids et Mesures

Documentation of the digitalized SIR reporting

5 BIPM procedures



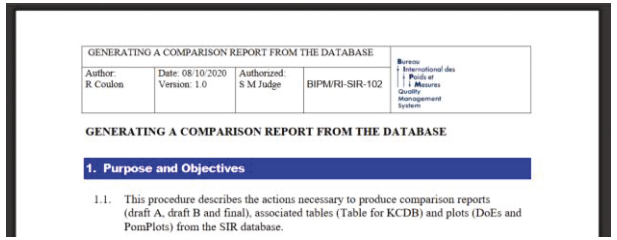
ENTERIG DATA IN THE SIR MASTER FILE

Author:	Date: 08/10/2020	Authorized:	BIPM/RI-SIR-100
R Coulon	Version: 1.0	S M Judge	

ENTERING DATA IN THE SIR MASTER FILE

1. Purpose and Objectives

1.1. This procedure describes the actions necessary to enter historical data into the SIR Master File.



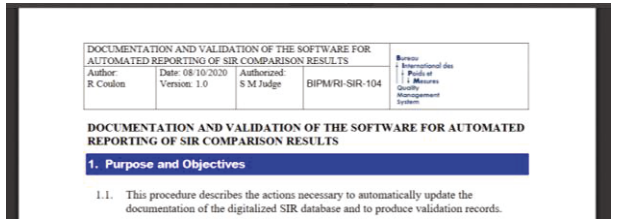
GENERATING A COMPARISON REPORT FROM THE DATABASE

Author:	Date: 08/10/2020	Authorized:	BIPM/RI-SIR-102
R Coulon	Version: 1.0	S M Judge	

GENERATING A COMPARISON REPORT FROM THE DATABASE

1. Purpose and Objectives

1.1. This procedure describes the actions necessary to produce comparison reports (draft A, draft B and final), associated tables (Table for KCDB) and plots (DoEs and PomPlots) from the SIR database.



DOCUMENTATION AND VALIDATION OF THE SOFTWARE FOR AUTOMATED REPORTING OF SIR COMPARISON RESULTS

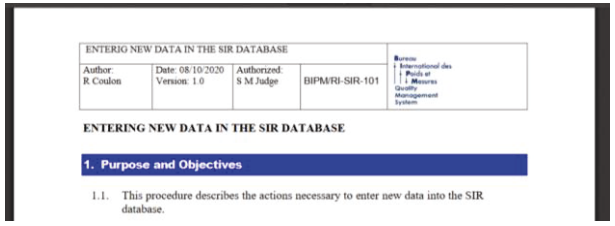
Author:	Date: 08/10/2020	Authorized:	BIPM/RI-SIR-104
R Coulon	Version: 1.0	S M Judge	

DOCUMENTATION AND VALIDATION OF THE SOFTWARE FOR AUTOMATED REPORTING OF SIR COMPARISON RESULTS

1. Purpose and Objectives

1.1. This procedure describes the actions necessary to automatically update the documentation of the digitalized SIR database and to produce validation records.

Bureau International des Poids et Mesures



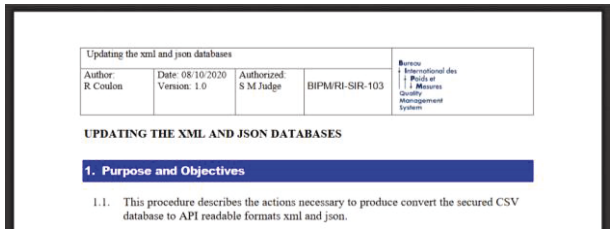
ENTERIG NEW DATA IN THE SIR DATABASE

Author:	Date: 08/10/2020	Authorized:	BIPM/RI-SIR-101
R Coulon	Version: 1.0	S M Judge	

ENTERING NEW DATA IN THE SIR DATABASE

1. Purpose and Objectives

1.1. This procedure describes the actions necessary to enter new data into the SIR database.



Updating the xml and json databases

Author:	Date: 08/10/2020	Authorized:	BIPM/RI-SIR-103
R Coulon	Version: 1.0	S M Judge	

UPDATING THE XML AND JSON DATABASES

1. Purpose and Objectives

1.1. This procedure describes the actions necessary to produce convert the secured CSV database to API readable formats xml and json.

ISO 17025

SPHINX PYTHON DOCUMENTATION GENERATOR

Python Docstrings - embedded into the script

_build/html/DocStrings.html#structure-of-the-code-sirreport-py

From module DataProcessing.py

This module contains a set of functions used for the processing of measurement data and time series.

Created on Wed May 20 15:31:18 2020

Updated on Wed May 20 15:36:29 2020

@author: romain.coulon@bipm.org

`DataProcessing.PMM`(*x*, *u*, *, *autoRej=False*, *k=2.5*, *conv=0.0001*)

This function calculates the Power-Modered Mean (PMM) on a data sample.

References:

[Accred Qual Assur (2008)13:83-89, Metrologia 52(2015)S200]
https://link.springer.com/article/10.1007/s00769-007-0330-1
https://iopscience.iop.org/article/10.1088/0026-1394/52/3/S200/pdf

This method is applied to calculate de Key Comparison Reference Value (KCRV) related to international inter-laboratory comparisons of the CIPM/CCRI(II). It was validated from PMM v1.xlsm provided by S. Pommé [email of the 14 Jan 2020]

Parameters:

- **x** (*array of floats*) – Sample of values
- **u** (*array of floats*) – Sample of standard uncertainties related to the values
- **r** – (Optional) Set if the auto-rejection capability is activated or not (False by default)
- **k** (*float*) – (Optional) Threshold (see as quantiles of a Normal density) of the frequentist test (default value = 2.5)
- **conv** (*float*) – (Optional) Convergence paramater (set ny default equal to 1e-4)

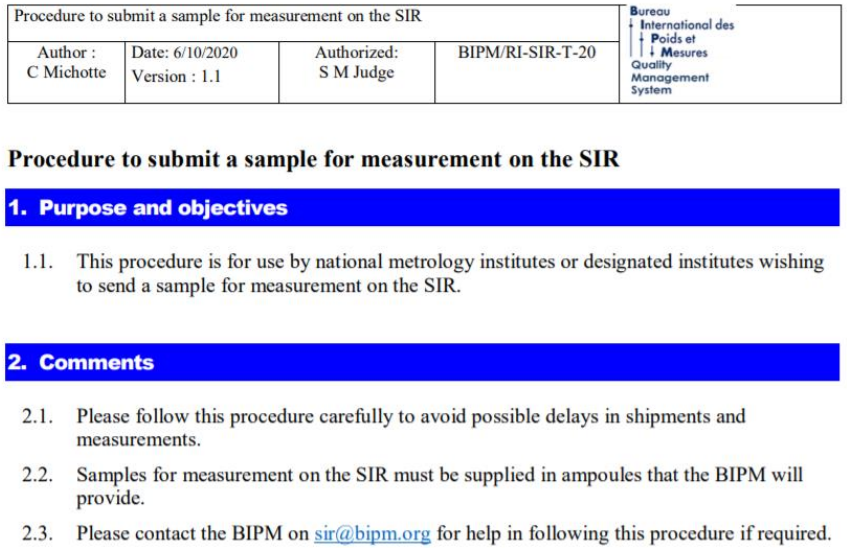
Conclusion

- Summary
  - A clear specification from the needs
  - A process as simple as possible (1 database – 1 software – 1 repository)
  - Defining a dedicated life cycle process
  - Using only text encoded files (.csv, .json, .xml, .tex, .bib, .py)
  - Using only licence-free and largely supported software
    - Python, Git, GitHub, Sphinx…
- Achievement
  - Draft reports produced for 10 radionuclides
  - Draft B in circulation for approval: Ga-67, Sr-85, Tl-201, Ra-223, Cd-109, Cs-137, Ba-133
  - Final reports: Na-22, Co-60, Ag-110m

How to use the SIR

Step 1: Check that the radionuclide is covered

- Download https://www.bipm.org/utils/en/pdf/RI-SIR-T-20.pdf
- Check that the radionuclide is listed in the table in the document



Procedure to submit a sample for measurement on the SIR				Bureau International des Poids et Mesures Quality Management System
Author : C Michotte	Date: 6/10/2020 Version : 1.1	Authorized: S M Judge	BIPM/RI-SIR-T-20	

Procedure to submit a sample for measurement on the SIR

1. Purpose and objectives

1.1. This procedure is for use by national metrology institutes or designated institutes wishing to send a sample for measurement on the SIR.

2. Comments

2.1. Please follow this procedure carefully to avoid possible delays in shipments and measurements.

2.2. Samples for measurement on the SIR must be supplied in ampoules that the BIPM will provide.

2.3. Please contact the BIPM on sir@bipm.org for help in following this procedure if required.

Step 2: Prepare the ampoule

- Contact SIR@bipm.org to arrange a date for the measurement
- You will receive an empty ampoule by post
- You **must** use this ampoule for the sample
- Dispense 3.6 g of standardized solution into the ampoule
- Don’t forget to determine any radioactive impurities, estimate the measurement uncertainties and note the chemical form
- Seal the ampoule and check it is not leaking

Step 3: Dispatch your ampoule

- Complete the BIPM shipping form
- Package the ampoule following the IATA regulations
- Complete all the IATA documents and dispatch the ampoule to the BIPM

Administration procedure/Shipping instructions for comparisons

Authors :	Date : 2019/11/28	Authorized :	ADM-DOU-F-02
L. Dell'Oro E. Van	Version : 4.0	M. Milton	

Bureau International des Poids et Mesures — Admin

(to be filled by the NMI and emailed to : customsbipm@bipm.org and technical contact for comparison)

1. SHIPPING INSTRUCTION FOR COMPARISONS :

- Name of the NMI:
- Contact:
- Address:
- Tel :
- e-mai

2. TYPE OF SHIPMENT: CARGO TRANSPORT

ATA carnet:
Temporary Importat
Diplomatic bag:

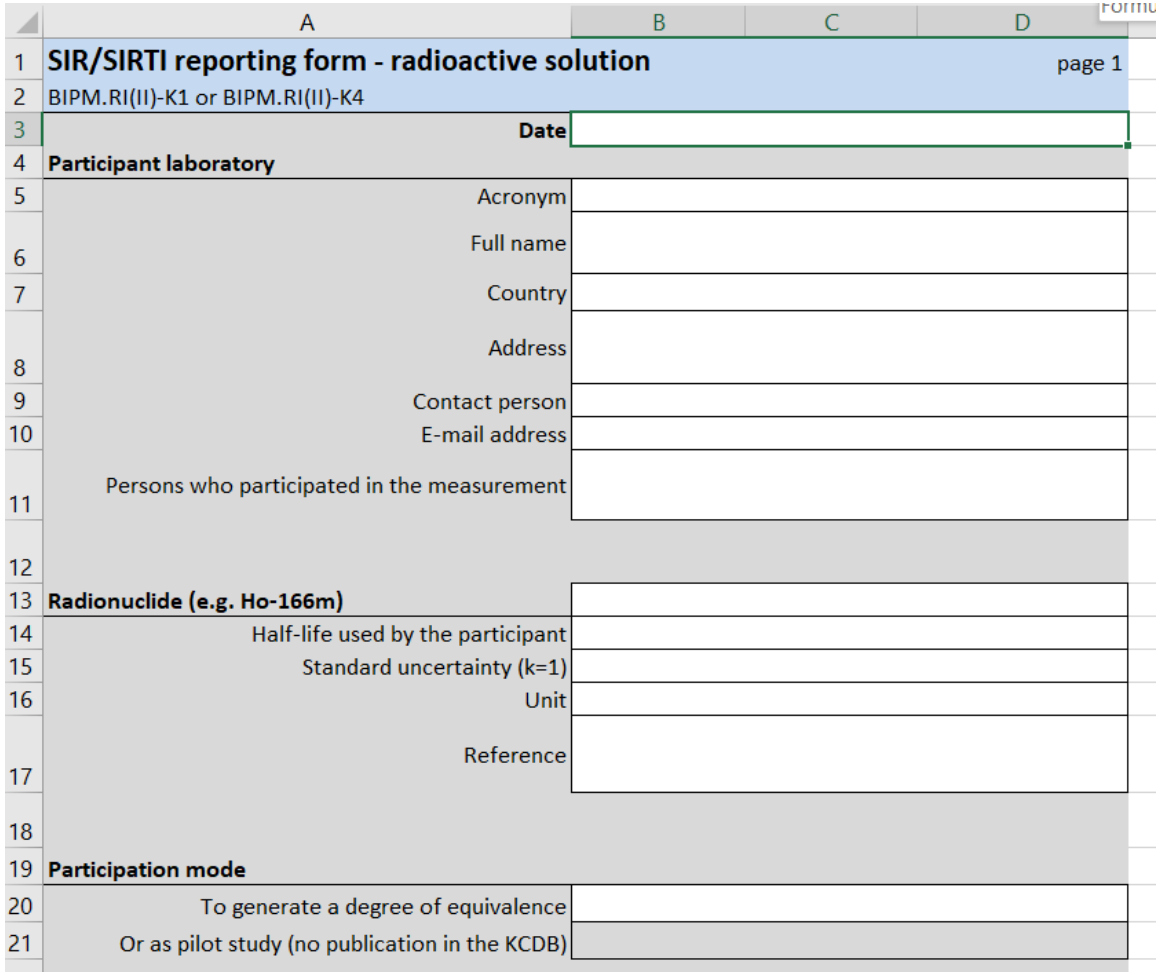
3. SHIPPING INFORMATION: TO

- Description of the equipment: (including UN

https://www.bipm.org/en/bipm/ionizing/radionuclides/sir/participation.html

Step 4: Send the details of the source

- Download and complete the Excel form
- The form asks for information on the radionuclide, uncertainties, measurement technique used, chemical form and impurities
- Email the form to SIR@bipm.org



	A	B	C	D
1	**SIR/SIRTI reporting form - radioactive solution**			page 1
2	BIPM.RI(II)-K1 or BIPM.RI(II)-K4			
3	**Date**			
4	**Participant laboratory**			
5	Acronym			
6	Full name			
7	Country			
8	Address			
9	Contact person			
10	E-mail address			
11	Persons who participated in the measurement			
12				
13	**Radionuclide (e.g. Ho-166m)**			
14	Half-life used by the participant			
15	Standard uncertainty (k=1)			
16	Unit			
17	Reference			
18				
19	**Participation mode**			
20	To generate a degree of equivalence			
21	Or as pilot study (no publication in the KCDB)			

https://www.bipm.org/en/bipm/ionizing/radionuclides/sir/participation.html

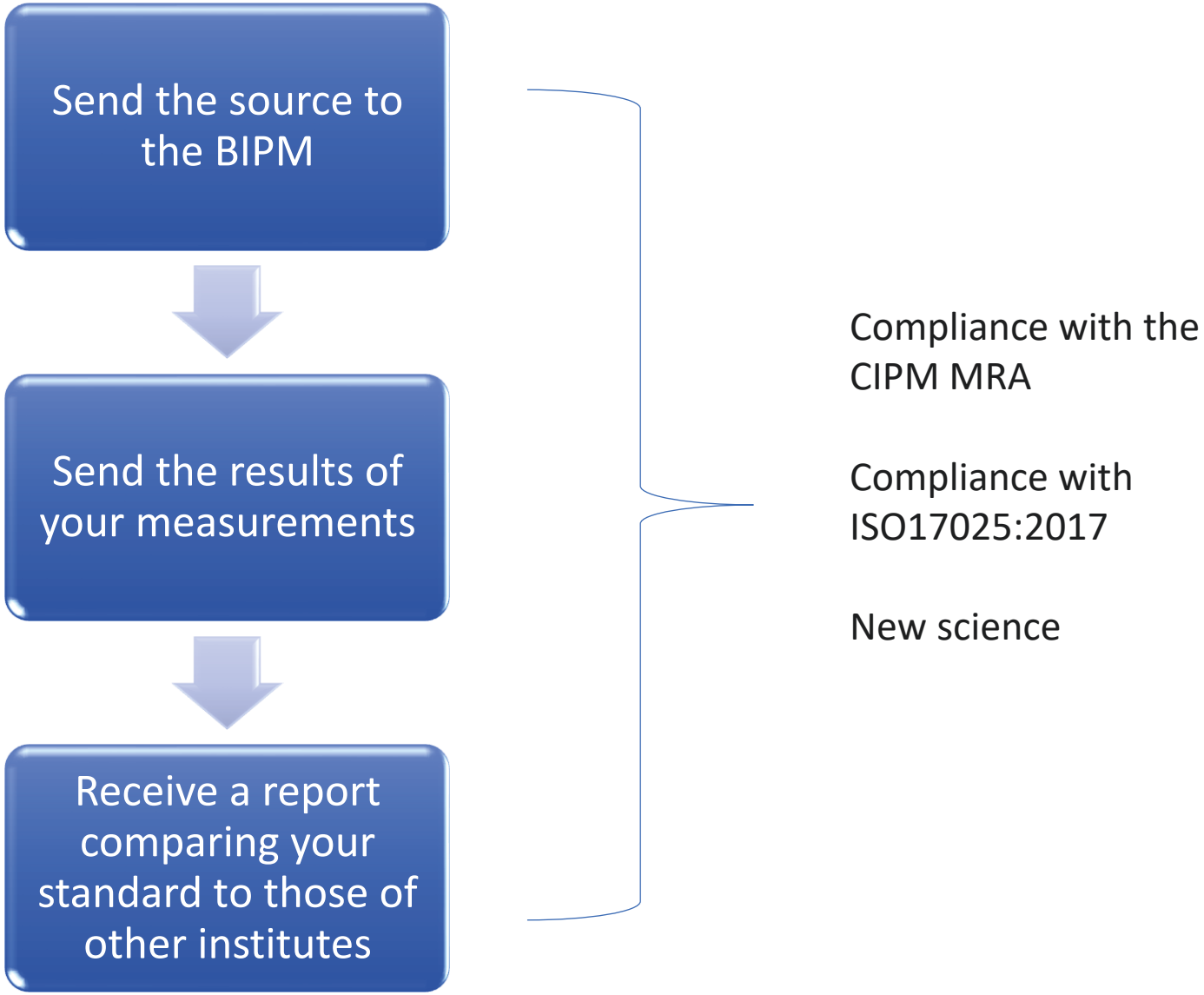
Step 5: Results

- BIPM staff carry out the measurements and generate a Draft A report.
- The Draft A report is sent to you for checking.
- Any typographical errors can be corrected.
- For key comparisons, BIPM staff circulate the Draft B report to CCRI(II) for review and then arrange publication on the KCDB.
- The comparison is then finished - you will have an entry in the database and a publication in the Metrologia Technical Supplement

New software

Draft A of the update of the BIPM comparison BIPM.RI(II)-K1.Cs-137 of activity measurements of the radionuclide ^{137}Cs to include and the 2016 result of the TAEK (Turkey).

Summary


Send the source to the BIPM
Send the results of your measurements
Receive a report comparing your standard to those of other institutes
Compliance with the CIPM MRA
Compliance with ISO17025:2017
New science


Thank you
steradian
radian
hertz
newton
pascal
joule
watt
coulomb
volt
farad
ohm
siemens
weber
lumen
tesla
henry
degree Celsius
lux
candela
ampere
kilogram
metre
second
kelvin
mole
becquerel
gray
sievert
katal
radian
coulomb
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