

# Measurement comparisons (part I)

C. Michotte

Principal physicist at the IR  
department of the BIPM



# Outline

---

1. Introduction
2. Planning and initiating a measurement comparison
3. Protocol of the comparison
4. Comparison results and reports
5. Monitoring the comparison
6. Roles and responsibilities in the comparison process

# 1. Introduction

- ◆ International comparisons are organized
  - to demonstrate the equivalence of national standards world wide and test the principal methods in the field *KEY comparison*
  - to cover specific needs *SUPPLEMENTARY comparison*
  - to investigate measurement capabilities, compare new methods, training,... *PILOT STUDIES*
- ◆ Results of international comparisons can be used to support CMCs but this is not the only way !! (see other lectures)

# Outline

---

1. Introduction
- 2. Planning and initiating a measurement comparison**
3. Protocol of the comparison
4. Comparison results and reports
5. Monitoring the comparison
6. Roles and responsibilities in the comparison process

## 2. Planning a measurement comparison (1)

---

- ◆ Long-term plan of **Key Comparisons** defined by Consultative Committee
  - proposal of CC WG (KCWG or strategy WG)
  - interaction with RMOs (mandatory link between CIPM and RMO KCs)
  - choice of pilot lab and comparison scheme (need for pilot study? / at BIPM or NMI ? / transfer instrument?/ circle or star ? : see lecture by R. Davis)
- ◆ Possible change of plan
  - Delay for technical reasons
  - New needs related to emerging technology (e.g. new radiopharmaceutical)
  - ...

## 2. Planning a measurement comparison (2)

---

- ◆ RMOs decide **supplementary** comparisons and inform the CC

NMIs from other regions are sometimes included

## 2. Planning a measurement comparison (3)

- ◆ **Pilot studies** are sometimes organized before the comparison
  - To test/validate a transfer instrument

Example of the SIR transfer instrument: compare the result of a direct KC with the result using the transfer instrument

- To check the feasibility of the comparison in a new field, instrument or method (uncertainty of the results versus CMC claims)
  - ...
- ◆ **Pilot studies** are sometimes organized together with the KC, just for some participant who would like to test his capability

The result of this participant can be included in the Final Report but will not appear in the KCDB, nor be included in the KCRV

## 2. Planning a measurement comparison (3)

- ◆ **Pilot studies** are sometimes organized before the comparison

- To test/

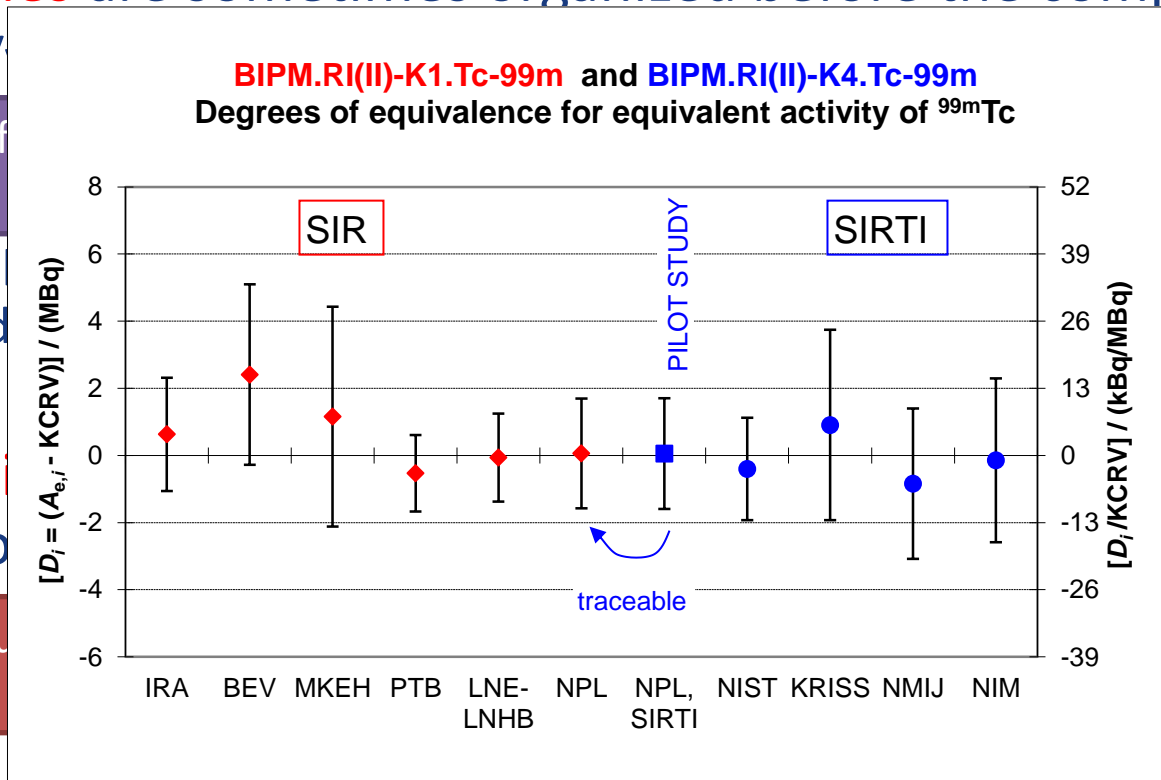
Example of

- To check method

- ...

- ◆ **Pilot studies** just for so

The resu



<C with the

ument or

e KC,  
ability

will not

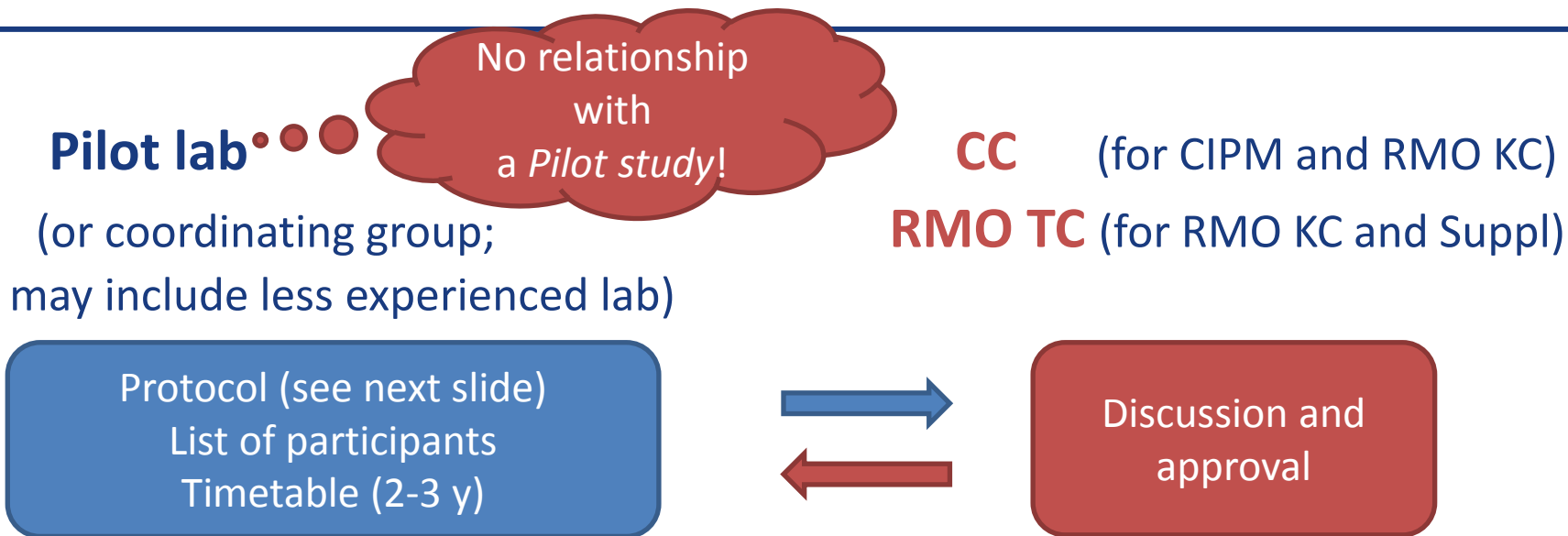


## 2. Some words about BIPM KC

---

- ◆ Pilot lab (= coordinator of the comparison) = BIPM
- ◆ BIPM KC comparison = series of bilateral comparisons with the BIPM
- ◆ Direct comparison with **BIPM reference standard**, at the BIPM or at the NMI
- ◆ Indirect comparison at the NMI using **transfer standard** of the BIPM
- ◆ « On-going comparison » = continuous; on demand
- ◆ KCRV is often equal to the BIPM value but not mandatory

## 2. Initiating a measurement comparison (1)



- ◆ After agreement, the pilot lab registers the comparison (registration form on BIPM web site: CIPM MRA docs/Guidance on comparisons) => New comparison and protocol in the KCDB

## 2. Initiating a measurement comparison (2)

Example of  
registration form

### Key and supplementary comparisons (and pilot studies) - registration and progress form

Comparison conducted by <b>AFRIMETS</b> in <b>AUV</b>		Date: <b>30/03/2017</b>
1. Subfield: <b>Sound pressure in air</b>	RMO internal identifier	
2. KCDB identifier: <b>AFRIMETS.AUV.A-K5</b> <small>(for KCs and SCs) (to be attributed by the BIPM)</small>	<b>AFRIMETS.AUV.A-K5</b>	
3. Type of comparison:  Key <input checked="" type="checkbox"/> Supplementary <input type="checkbox"/> Pilot study <input type="checkbox"/>	4. Short description: Comparison of primary calibration of laboratory standard microphones (modulus and phase)	
5. Measurand and nominal value(s): Pressure sensitivity level of laboratory standard microphone type LS1P (modulus and phase)		Special characters for copying <small>(if required)</small> α β γ δ ε ζ η θ ι κ λ μ
6. Parameter(s): Frequency range 2 Hz to 10 kHz		
7. Transfer device(s)/sample(s):  Brüel & Kjær type 4160 (LS1P) with serial numbers 811014 and 2036126.		
8. Pilot/Coordinating laboratory(ies) <u>(acronyms and countries)</u> :  NMISA (pilot), NPL (co-pilot)		
9. Participating institutes <u>(acronyms and countries)</u> :  CMI (Czech Republic), MIKES (Finland), NMISA (South Africa), NPL (United Kingdom)		

## 2. Initiating a measurement comparison (3)

Example of  
registration form

10. Progress: (please note date and tick appropriate box to indicate current status)				
Date	Status	Pilot	Supplementary	Key
	Planned	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19/08/2015	Protocol complete/approved	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	In progress	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24/02/2016	Measurement completed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
09/12/2016	Report in progress	<input type="checkbox"/>	Draft A <input type="checkbox"/>	<input type="checkbox"/>
			Draft B <input type="checkbox"/>	<input type="checkbox"/>
30/03/2017	Report submitted to <b>CCAUV</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Results approved	<input type="checkbox"/>	<input type="checkbox"/>	
	Approved for equivalence			<input type="checkbox"/>
	Abandoned	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comments: Draft B approved by CCAUV KCWG.		Publication reference:		
11. Measurement start date: <b>09/2015</b>		12. (Expected) measurement completion date: <b>02/2016</b>		
13. Contact person's name: <b>Riaan Nel</b>				
Address: NMISA, Building 5, CSIR Campus, Meiring Naude Road, Brummeria, Pretoria, 0183, South Africa		Tel.: <b>+27128412534</b>		
		Fax: _____		
		e-mail: <b>RNel@nmlsa.org</b>		
		Web: <b>www.nmlsa.org</b>		

Completed copy to be forwarded to a) CCXX Executive Secretary;

b) relevant CC Key Comparison WG Chairman;

c) Regional coordinator as appropriate;

d) KCDB Coordinator (except Pilot studies): [BIPM.KCDB@bipm.org](mailto:BIPM.KCDB@bipm.org)

# Outline

---

1. Introduction
2. Planning and initiating a measurement comparison
- 3. Protocol of the comparison**
4. Comparison results and reports
5. Monitoring the comparison
6. Roles and responsibilities in the comparison process

### 3. The protocol of the comparison : content

---

SEE DOCUMENT CIPM MRA-D-05

Also see CC and RMO guidelines

### 3. The protocol of the comparison : tips for the content (1)

---

- ◆ **Measurement method** is NMI choice ! But:
  - parameters can be fixed  
e.g. half-life to be used, frequency for AC voltage measurement,...
  - some recommendations can be made  
e.g. « *Measurement should be made as soon after reception of the sample* »  
(because of instability issues, of growing radioactive daughter or impurity,...)  
or « *A given method is not recommended because of ...* »
- ◆ **Reporting form** including template for uncertainty budget (GUM) and for measurement details as relevant :  $T$ ,  $RH$ ,  $P$ , count rate, measurement date, method/model, equipment/standard used and traceability (especially if traceable to another NMI because correlations should be identified for the KCDB), ...

### 3. The protocol of the comparison : tips for the content (1)

- ◆ **Measurement method** is NMI choice ! But:
  - parameters can be fixed  
e.g. half-life to be used, frequency for AC voltage measurement,...
  - some recommendations can be made  
e.g. « *Measurement should be made as soon after reception of the sample* »  
(because of instability issues, of growing radioactive daughter or impurity,...)  
or « *A given method is not recommended because of ...* »
- ◆ **Reporting form** including template for uncertainty budget (GUM) and for measurement details as relevant :  $T$   $RH$   $P$  count rate measurement, used and traceability, correlation...



### 3. The protocol of the comparison : tips for the content (2)

---

- ♦ **KCRV for CIPM KC** – See lecture by R. Davis:

The protocol includes the **proposed** method of calculation, but may change depending on results

Scatter larger than expected, groups of results,  
case of new measurement method,...

### 3. The protocol of the comparison : tips for the content (2)

- ◆ **Linking for RMO KC:** the protocol includes the **proposed** method of calculation (but may change depending on results). Examples of linking:

- Use of DoE from same NMIs in the CIPM and RMO KCs

The linking NMIs should use the same method in both comparisons  
and show good reproducibility

- In case of link to BIPM KC: by sending the transfer equipment/distributed sample of the RMO KC to the BIPM

- CCQM-K27 (ethanol in aqueous matrix)

DoE are defined as  $(\text{KC result} - \text{KCRV})/\text{KCRV}$

$(\text{RMO result} - \text{CRV})/\text{RMO CRV}$



Plotted on same graph

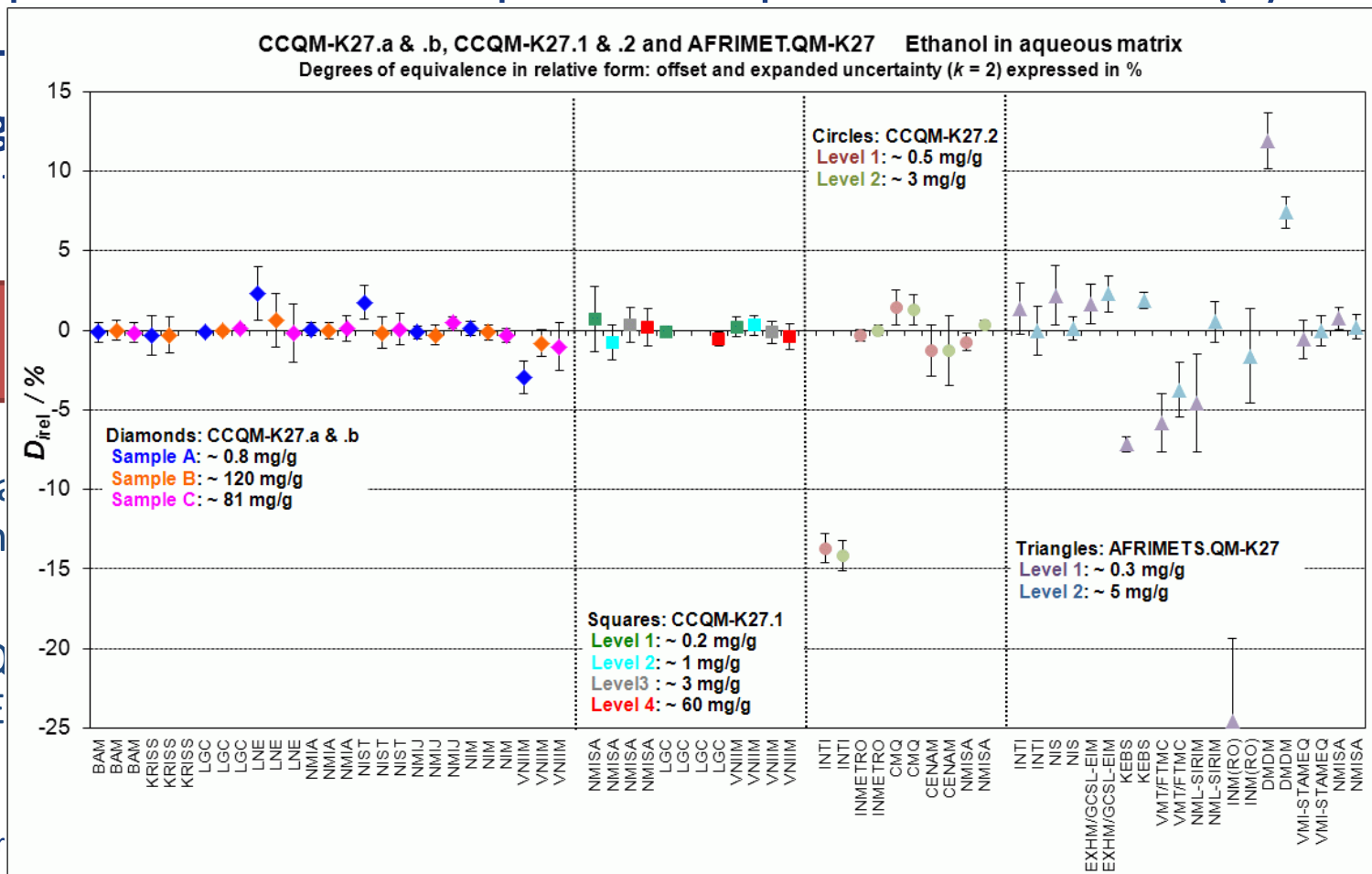
### 3. The protocol of the comparison : tips for the content (2)

#### ◆ Linking calcula

– Use

– In ca  
sam

– CCQ  
DoE



### 3. The protocol of the comparison : tips for the content (3)

---

- ◆ State who writes the reports, calculates the KCRV, the links, the DoE ? (usually the pilot lab but not always, e.g. when link to BIPM KC)
- ◆ Describe comparison scheme and time table
- ◆ State that the participant needs to inform the pilot lab in case of delay, at reception/re-sending of travelling equipment, unexpected behaviour or damage (examples of BIPM.RI(II)-K4 and CCEM.K12)
- ◆ State who pays what?

Cost of transport of travelling equipment should be shared (not only BIPM or pilot lab!)

### 3. The protocol of the comparison : tips for the content (4)

---

- ◆ State whether dangerous good is included in the package (e.g. pressurized gas, flammable substance, toxic, infectious or radioactive substance,...)  
=> see IATA regulations (International Air Transport Association)

Trained staff is useful or even sometimes legally required to prepare package

- ◆ Give instructions to import/export using ATA (Admission Temporaire/Temporary Admission ) carnet when possible
- ◆ Fragile or precious transfer instruments are hand carried

An explaining letter should be prepared by each participant  
for going through security check

# Outline

---

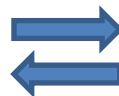
1. Introduction
2. Planning and initiating a measurement comparison
3. Protocol of the comparison
4. **Comparison results and reports**
5. Monitoring the comparison
6. Roles and responsibilities in the comparison process

## 5. Comparison results and reports (1)

Result = Value & Uncertainty  
(VIM3)

Pilot lab sends its own result to non participating lab / BIPM

Pilot lab looks for anomalous result and keep  
the bias value confidential



NMI to correct for typo,  
arithmetic error,...

A1  
A2  
A3  
...

**Draft A report in progress:**  
Description of the comparison, results,  
contact details, measurement details,  
**proposed** KCRV or link, and DoE



Confidential to participants



Agreement by participants « asap »

**Draft B report in progress**



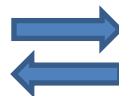
No more confidential.  
Results can be published but  
not yet the KCRV and DoE.  
Can support CMCs.

## 5. Comparison results and reports (1)

Result = Value & Uncertainty  
(VIM3)

Pilot lab sends its own result to non participating lab / BIPM

Pilot lab looks for anomalous result and keep  
the bias value confidential



NMI to correct for typo,  
arithmetic error,...

A1 Draft A report  
A2 Description of the  
A3 contact details, me  
... **proposed** KCRV



Agreement by part

Draft B report

In case of disagreement on  
the proposed KCRV or link:  
proposal to postpone the  
discussions with the KCWG to  
the draft B stage,  
in order not to delay the  
publication of the results

confidential to participants

No more confidential.  
Results can be published but  
yet the KCRV and DoE.  
Can support CMCs.



## 5. Comparison results and reports (2)

B1  
B2  
B3  
...

### Draft B report in progress

- The report may include comments from participants on their result (specially in case of discrepant result)
- Possible discussion of KCRV and link made at the level of KCWG



Agreement by the participants, the KCWG and the CC

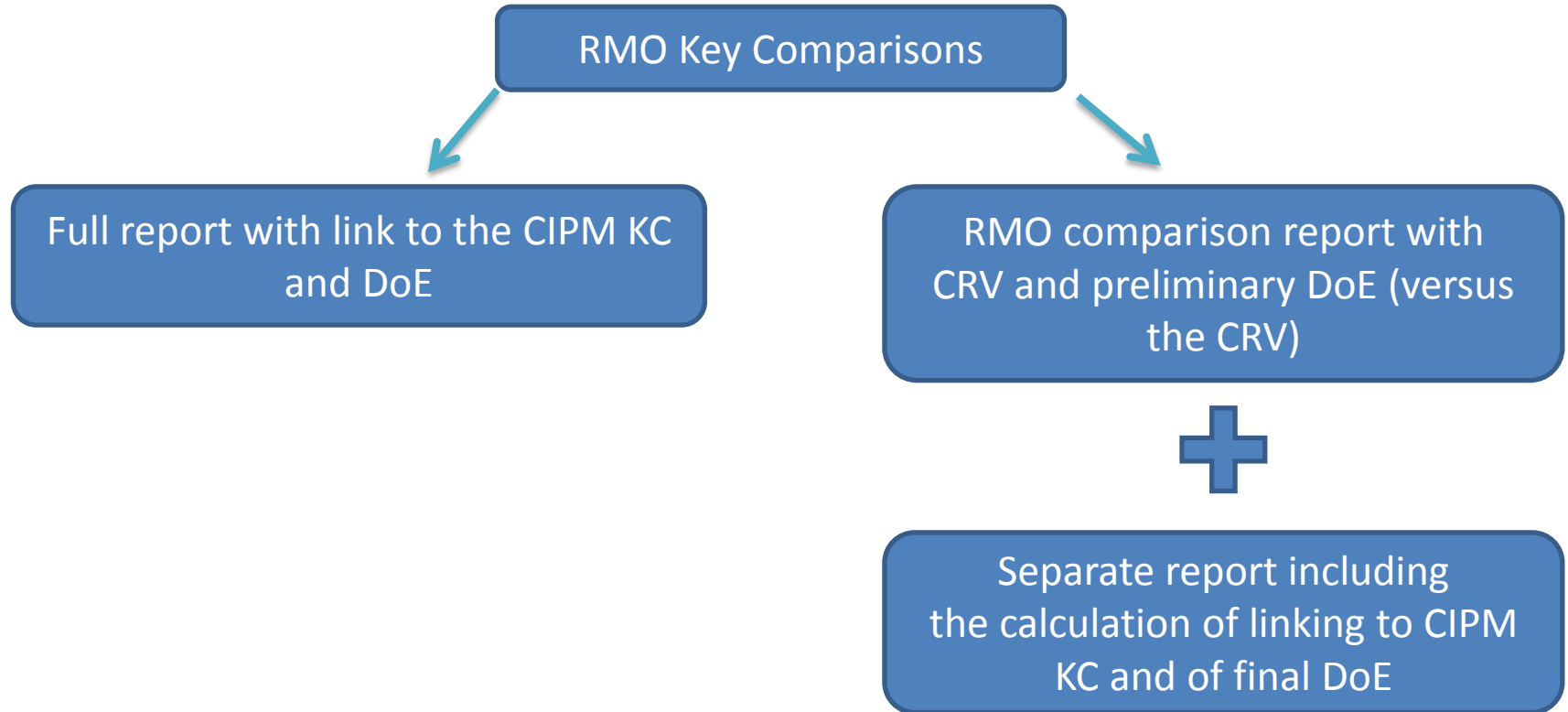
### Final report

(usually published in *Metrologia Tech. Supp.*)

Are the results compatible with the CMCs?  
How far the light shines?

See other lectures

## 5. Comparison results and reports (3)



# Outline

---

1. Introduction
2. Planning and initiating a measurement comparison
3. Protocol of the comparison
4. Comparison results and reports
5. **Monitoring the comparison**
6. Roles and responsibilities in the comparison process

## 4. Monitoring the comparison by the pilot lab.

- ◆ First register!
- ◆ Pilot lab to report the status of the comparison so that the KCDB contains up-to-date information

Specially important  
when passing to Draft B stage

A comparison should not last more than 5 years

### Status

Registration & progress form

Planned

Protocol complete

In progress

Measurement completed

Report in progress Draft A  
Draft B

Report submitted to **KCWG**

Results approved

Approved for equivalence

Abandoned

to be forwarded to a) CCXX Executive Secretary;  
b) relevant CC Key Comparison WG Chairman;  
c) Regional coordinator as appropriate;  
d) KCDB Coordinator ([BIPM.KCDB@bipm.org](mailto:BIPM.KCDB@bipm.org))

# Outline

---

1. Introduction
2. Planning and initiating a measurement comparison
3. Protocol of the comparison
4. Monitoring the comparison
5. Comparison results and reports
6. **Roles and responsibilities in the comparison process**

## 6. Role of the CC and/or KCWG

---

- ◆ Define the long-term plan of the KC
- ◆ Approve the protocol and list of participants
- ◆ Discuss the results, link, KCRV and DoE if necessary
- ◆ Review the Draft B before publication
- ◆ Decide actions in case of excessive delay or technical issue compromising the success of the comparison

## 6. Role of pilot lab (or coordinating group)

---

- ◆ Prepare the protocol, the list of participants, the time table in collaboration with CC (WG) and/or RMO TC
- ◆ Register the comparison and fill-in the progress form at each stage of the comparison
- ◆ Manage the delays, technical issues and make sure that the timetable is respected as far as possible
- ◆ To prepare the draft A, B and final reports including the calculation of the KCRV or the link to the CIPM KC and of the DoE
- ◆ Can get support/discussion from KCWG or strategy WG

## 6. Role of participants

---

- ◆ Have the technical competence, resources and time for making the measurements and organizing the transport of the equipment
- ◆ Read and follow the protocol and the time table of the comparison
- ◆ Keep informed the pilot lab of delays and other problems
- ◆ Review the comparison reports within the dead-line
- ◆ Do not exchange information with other participants



# Final remarks

---

- ◆ Guidelines => Be flexible as long as all participants and CC (WG) or RMO agree
- ◆ Rules may change in future
- ◆ Document CIPM-MRA-D-05
- ◆ Regional guidelines (e.g. EURAMET Guide No. 4)
- ◆ Many CCs developed guidelines specific to their field

Thank you for your  
attention

BIPM, 16 Nov. 2017

