CCRI strategic plan for the period 2013-2023

With special emphasis on strategic initiatives for the period 2016-2019

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1 Executive Summary

The CCRI strategy plan for the period 2012 to 2023 describes the status of the work in the Consultative Committee for Ionising Radiation (CCRI) of the CIPM. It sets up a vision and discusses strategic actions leading towards the goal. The plan embraces the period 2016-2019, where the BIPM is currently developping its work program. It is based on the strategic approach adopted in 2009 and resides on the fact that CCRI is not a management body with its own resources, but instead it has access to BIPM's and participating NMIs' resources, whenever they find it useful to collaborate under the advice of the CCRI.

CCRI's Deliverables are (see chapter 2.2):

> Establish and run comparisons, published in the *Technical Supplement* of *Metrologia*
> Maintain and develop the SIR[1]
> Coordinate the work from the three sections and its working groups
> Publish monographs on nuclear data and special issues of *Metrologia*
> Contribute to conferences and meetings
> Publish in scientific journals
> Transfer knowledge to NMI-staffs, e.g. through workshops and conferences at BIPM

CCRI has set up the vision for 2019 (see chapter 2.2):

> The vision of the CCRI is to become the undisputed hub for ionizing radiation global metrology. This will be achieved in close collaboration with its institutional stakeholders and in close dialogue with its end-users.

To focus and support its activities, CCRI has set up five strategic initiatives (see chapter 4)

> International traceability for high-energy photon dosimetry
> Focus on stakeholders
> From air kerma to absorbed dose in water
> The International Reference System (SIR)
> MRA operation

Actions have been explicitly defined and subdivided into three new periods: short term (2013-2015, 16 actions), medium term (2016-2019, nine actions), and long term (2020-2023, 6 actions). In total they ensure that CCRI delivers as expected (see chapter 5 to 7).

CCRI works partly though a number of working groups with definite remits, deliverables and lifetimes (see chapter 8). The number of working groups is being reduced to 8 in June 2013, 7 in October 2013, 6 in December 2013 and 5 in December 2014.

The key role of the BIPM in conducting key and supplementary comparisons is acknowledged, and the associated workload is enumerated (see chapter 9).

[1] SIR: "Système International de Référence" for radionuclides

2 Introduction and background

2.1 Facts and figures

Table 1: Essential facts and key figures for the Consultative Committee for Ionizing Radiation, CCRI.

Name:	Comité consultatif des rayonnements ionisants, 28 members. President: Kim Carneiro (COSTA CONSULT), Executive Secretary: José María Los Arcos (BIPM).
Sections:	I: x- and gamma rays, charged particles. 18 members and 9 observers. Chair: Peter Sharpe, NPL. II: Measurement of radionuclides. 20 members and 9 Observers. Chair: Lisa Karam, NIST. III: Neutron measurements. 11 members and 3 observers. Chair:David Thomas NPL
Working Groups	Working groups are currently for the following topics: -regional metrology organisations (RMOWG) -maintenance of the bequerel (BqWG(II) -accelerator dosimetry (ADWG(I)) -extension of the SIR (ESWG(II) -brachytherapy standards (BSWG(I)) - SIR transfer instrument (TIWG(II) - key comparisons (3) (KCWG(I) (II) (III)) -high efficiency counters HEWG(II) The 10 working groups currently existing are further described in Chapter 8. The number of working groups is being progressively reduced to: 8 (June 2013), 7 (October 2013), 6 (December 2013) and 5 (December 2014).
Established:	1958
Last meeting	24 CCRI meeting; 30 participants; 17 May 2013
Periodicity	1-2 years. The periodicity is discussed in Chapter 2.4.
Comparisons, 1999 to 2012	358 (incl. 45 Supplementary comparisons). Key comparisons are discussed in Chapter 9.
Pilot studies	2
KCDB	36 countries participate with 3903 CMCs (10 with NMIs, 26 with DIs) Active comparisons (total in KCDB): Section I: 21 (46), Section II: 26 (131), Section 3: 6 (28) ("Active" includes draft A/B stage)

2.2 Strategic approach

In 2009 CCRI adopted a strategic approach. Accordingly work was initiated to develop a strategy and the "Strategic plan for the CCRI up to 2020" document was issued.[i] Although useful even in its first form, the concept has been continuously evolving and has not yet reached its final form.

The plan is self-contained and includes the following key elements:

Mission and deliverables

The mission follows from the CIPM-mission and is to contribute to the world wide harmonisation of measurements, mainly by overseeing global and regional comparisons within ionizing radiation for the inclusion in KCDB appendix B.

Tasks and Deliverables are:

- *Establish and run comparisons, published in the Technical Supplement series of Metrologia*
- *Maintain and develop the SIR*
- *Coordinate the activities and recommendations from the three sections and some of its working groups*
- *Publish monographs on nuclear data and special issues of Metrologia*
- *Contribute to conferences and meetings*
- *Publish in scientific journals*
- *Transfer knowledge to NMI-staffs, e.g. through workshops and conferences at BIPM*

Vision for 2020:

The vision of the CCRI is to become the undisputed hub for ionizing radiation global metrology. This will be achieved in close collaboration with its institutional stakeholders and in close dialogue with its end-users.

Definitions of stakeholders

Strategic stakeholders were identified and grouped into "institutional-" consisting of organisations contributing to the furtherance of radiation metrology and "end-user" stakeholders, consisting of public and private organisations with a legitimate interest in radiation metrology. A list of stakeholders is provided in Chapter 10.

Strategic actions

Specific time-limited actions that are coherent with the mission and support the vision were initially grouped into short term (2009-2012), medium term (2013-2016), and long term (2017-2020). The periods corresponded to the foreseen budgetary periods of the BIPM at that moment

CCRI working groups

CCRI operates partly through a varying number of working groups, addressing topics that need special attention. They have definite remits and an appointed coordinator, and their progress is reviewed at regular intervals. A significant reduction in number from 10 to 5 is further described in Chapter8.

CCRI comparisons

BIPM as well as CCRI key and supplementary comparisons are organized at regular intervals to provide CMCs support to NMI/DIs. The main facts on workload estimations are presented in Chapter 9.

The back bone of the present strategy plan is the original strategic plan (ref i), where a considerable effort was devoted to analyse and decide about the strategic actions that could and should be undertaken in the short-, mid- and long-term, based on the technical expertise, advice and contributions from the NMIs members of the CCRI, the stakeholders feedback and the end-users needs. This strategic plan was put in place and has effectively guided the CCRI activities since 2009 and has proved its benefits and utility to evaluate and orientate the goals to be achieved by the CCRI.

In this frame, the original short term (2009-2012) is now "past" and summarised in terms of completed actions, which give the starting point for the new short term (previously mid-term). However, facts have been updated, and the periods have been adjusted following the decision of the 24th CGPM (2011) that re-scheduled the next program of work to cover only three years, 2013-2015. Therefore the new short term period is now 2013-2015, the mid-term 2016-2019 and the long term 2020-2023.

2.3 Completed actions up to 2012

The 14 previous short term actions are reproduced in Table 2. Seven of these have been completed and reported at the CCRI meetings, whereas the remaining seven are in progress and will be carried over to the present plan. Table 2so shows the engagement of the three sections and the BIPM in specific actions. Further, it shows the interests of institutional stakeholders, as declared at the 23rd meeting of the CCRI in May 2012.

Given that the short term actions were to be completed within only a little more than a year, the completion rate is satisfactory.

Table 2 demonstrates that the explicit exposition of CCRI's actions improves both the efficiency of the strategic work and the stakeholders spur to take active interest in the work of the CCRI.

*Table 2: Status of the previous short term actions, scheduled for 2009-2012. Actions in **bold (a, c, d, f, h, j, k)** have been completed (C) and will be referred to as "past" (P), whereas actions (b, e, g, i l, n) will be carried over as short term actions in the present plan. The table shows the engagement (X) of sections I-III and BIPM, as well as specific institutional stakeholders.*

ID	Action	Section I	Section II	Section III	BIPM	AFRIMETS	APMP	COOMET	EURAMET	SIM	IAEA	ICRM	ICRU	IOMP	EFOMP
a	**Finish KC and SC reports quicker, focused on CMC-support**	**C**	**C**	**C**	**C**				**X**						
b	Harmonize stringency in uncertainties		P							X					
c	**LINAC photon dosimetry comparisons - establish**	**C**			**C**					**X**					
d	**Activity (SIRTI) comparisons – establish ^{99m}Tc**		**C**		**C**					**X**					
e	Comparison of personal dose equivalent, *H*p - protocol			P							X				
f	**Brachytherapy comparisons - establish**	**C**	**P**		**C**					**X**					
g	New neutron cross-section data - identify			P					X	X	X		X		
h	**Neutron *Metrologia* special issue - publish**			**C**	**C**					**X**					
i	Increase meaningful dialogue between NMIs and DIs	P	P	P			X		X	X	X			X	
j	**SSDL results in the KCDB – establish methodology**	**C**			**C**		**X**			**X**	**X**			**X**	
k	**Mammography comparisons - establish**	**C**			**C**					**X**					
l	Dosimetry for diagnostic imaging - identify metrology needs	P	P						X	X	X				
m	Recommended values for physical constants - publish	P	**C**		**C**								**X**		
n	Standards for fusion - identify			P											

Highlights of completed actions 2009-2012

The achievements during the first strategic period may be summarised as follows:

The removal of the need to calculate pair-wise degrees of equivalence in comparison reports has greatly streamlined the reporting process, and revisions to the 10-year plan for radioactivity comparisons have improved coverage of the Measurement Methods Matrix (MMM) to fully support CMCs. To overcome difficulties associated with circulating transfer devices (or radioactive sources) among different countries, some recent comparisons have been organized whereby all participants come to a single laboratory to make their measurements (e.g. CCRI(III)-K8). There remains the problem of institutes that have to delay their participation because of issues beyond their control, thus delaying the whole exercise. Finally, efforts have been made to not delay the comparison reports because of unresolved basic problems related to the measurements; instead, these have been deferred to new actions or working groups for further investigations.

A new ongoing comparison BIPM.RI(I)-K6 on accelerator high-energy photon dosimetry was established using the BIPM graphite calorimeter on-site at the NMI/DIs facilities. Five comparisons

were completed with NRC(2009), PTB(2010), NIST(2011), LNE(2011), ARPANSA(2012). Four more are already agreed or planned for 2013-2015.

The short-lived radionuclides activity comparison BIPM.RI(II)-K4 was established as an on-going comparison for Tc-99m, performed on-site at the NMIs facilities with the SIR Transfer Instrument (SIRTI), which is directly linked to the SIR. Measurements have been done at five NMIs/DIs, NIST (2009), KRISS(2010), NMIJ(2011), NIM(2012), CNEA (2012). Seven more are already agreed or planned for 2013-2015.

The new ongoing comparison BIPM.RI(I)-K8 comparison for brachytherapy with ^{192}Ir HDR sources was established with the help of RISO, NMISA, VSL and ININ. Since that, four comparisons were carried out using transfer chambers on-site at VSL(2009), LNE-LNHB(2010), NPL(2010), and PTB(2011). Three more at NRC, LNMRI-IRD and ENEA are already agreed or planned for 2013-2015.

The *Metrologia* special issue on Neutron Metrology was published in December 2011 completing the three-issue collection on ionising radiation metrology. It provides an excellent up-to-date picture of present-day neutron metrology at NMIs. This action completes the marking of the 50th anniversary of the CCRI by a special issue of *Metrologia* for each section.

In addition to a planned campaign by the CCRI to improve awareness, several laboratories have begun the process of increasing dialogue and relations between the DI, the parent NMI, and larger organizations.

Mammography on-going comparisons have been fully established and six have been completed NRC(2007), NMIJ(2009), NIST(2010), PTB(2010), VSL(2012), VNIIM(2012) as well as a bilateral comparison carried out to support the IAEA calibration and measurement capabilities (CMCs).

Updated physical constants and nuclear data are published on a permanent basis. The Monographie BIPM-5, *Table of radionuclides*, published the Volume 5 (2010) and Volume 6 (2012), and the Volume 7 was also published early 2013. A paper was published by the BIPM in *Metrologia49 (2012)* which provided the basis for changes to the CCRI recommended values for the W_a value for air, I_c for graphite and for the electron stopping-power ratios. The work described in the paper will be included in a forthcoming ICRU report and when this has been published, the CCRI will consider changing the values it recommends NMIs to use.. The work incorporated an analysis of all existing data on these constants to provide recommendations to be taken up by ICRU. However, it is not the role of NMIs to measure large numbers of neutron cross sections for the nuclear industry. NMIs do, however, have a role in measuring standard cross sections and in transferring fluence measuring capabilities to other laboratories. This has been recognised and a EURAMET EMRP project is presently underway with this objective. Measurements have been performed by the PTB and NPL on an ion chamber containing both plutonium and uranium samples. The chamber belongs to the IRMM and, in addition to providing fluence measuring information, the measurements should help resolve a problem with the determination of the ^{242}Pu cross section in the MeV region.

2.4 Timeline

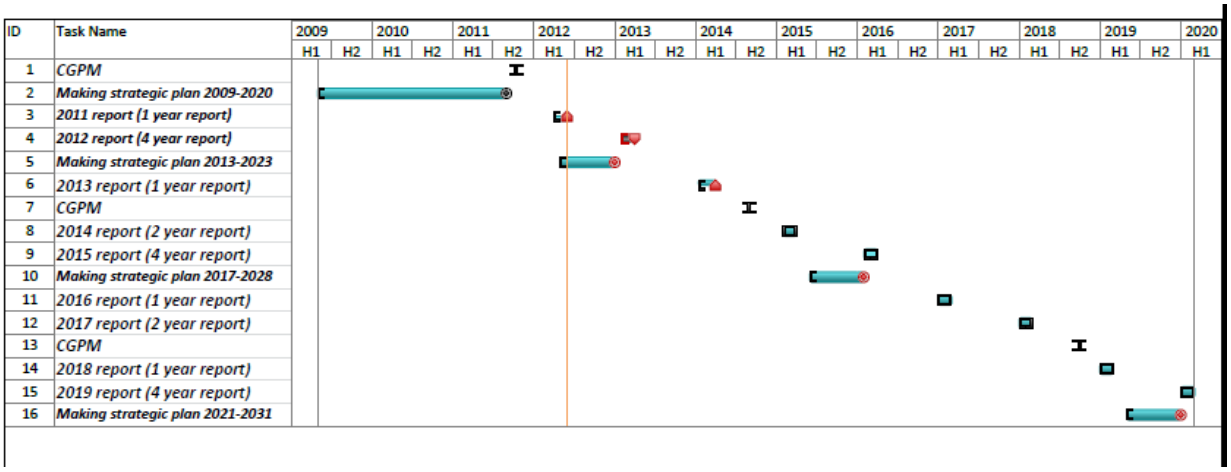

Figure 1: Gantt chart showing the strategic planning and reporting of the CCRI, covering the period 2009 to 2020, prepared in 2011. The present plan is represented by task ID5; it is preceded by the original plan (ID2) and annual reports for 2011 and 2012 (ID3 and ID4. The period's CGPMs are also shown (ID1, ID7, ID13). Directors' and state representatives' meetings are not shown. The annual reports are labelled in accordance with the instructions that were circulated by the BIPM during 2012; this is only indicative.

Timing is important in CCRI's strategic planning. Plans must be prepared in time for the approval process of the CIPM, reporting with reference to the plans should be regular to monitor progress correctly, and at the end of a strategic period an evaluation must be possible to assess "How well did we do?" in achieving the goals.

Figure 1 shows the critical steps in the CCRI strategic planning. According to it, the major strategic work will be done in the latter halves of 2012 (on-going), 2015, and 2019. During its recent meetings in the spring 2013, the CCRI and its sections revisited the meeting schedule with the aim of returning to a 2-year period for meetings, harvesting from the strategic approach and the much improved overview that it has given. More work will be done by correspondence and in connection with other meetings, and this will lead to substantial savings in time and money.

3 Vision and overall strategy up to 2019

Although the stated vision may seem evident and already evident to the insider, it must be recognised that to many of the stakeholders and the public at large, the structures of metre convention, including the CCRI, appear somewhat distant from normal life. By exposing itself to external bodies and questioning to itself how to become universally accepted as “the hub of radiation metrology”, the CCRI expects to achieve its goal.

The type of strategic approach results from the form of the strategy plan. Its cornerstones are explicit formulations and transparency, paired with a humble approach, which reflects that the CCRI strategy can only succeed when the BIPM, all involved NMIs and relevant stakeholders find that the strategy is in full compliance with their own.

4 Initiatives to support the strategy

The CCRI has selected five strategic initiatives to focus its work and to support its strategy in coordination with the CIPM as well as the members of CCRI. These initiatives are reflected in specific actions that permeate the short- and mid-term time scales. The initiatives are the following:

International traceability for high-energy photon dosimetry

In its original strategy plan, the CCRI recommended that a medical accelerator be installed at the BIPM to serve as a global reference for high energy photon dosimetry. However, this has not been accepted in the form of general consensus, and as a consequence is not part of the BIPM future work plans. As an alternative, the CCRI has produced a preliminary document,[ii] which summarises the considerations on how the BIPM can best fulfil its role in ensuring worldwide equivalence of calibrations for clinical applications using accelerators in medical therapy. The key activity in this initiative is described in the reference ii and in chapter 5.

Focus on stakeholders

Stakeholders have been registered and subdivided into two groups “institutional stakeholders” and “end-user stakeholders”. The former group is invited to take part in meetings and in the strategy process. The latter group has so far been addressed indirectly, but the strategy plan proposes to arrange seminars and workshops to engage them more directly.

From air kerma to absorbed dose to water

The quantity of interest in many ionizing radiation applications, mostly in the medical field, is absorbed dose to water. Historically, this was usually derived from air kerma calibrations, via the application of agreed protocols and codes of practice. The trend over the past two decades has been the development of absorbed dose primary standards, often based on either graphite or water calorimetry. Calibrations of customer instruments in many fields are now based on these direct absorbed dose standards and the use of protocols to convert from air kerma measurements is rapidly decreasing. This has many potential advantages in terms of accuracy and a reduction in the possibility of mistakes, but can also bring problems during the transition from one approach to the other. There is now a need to review the status of this evolution from air kerma to absorbed dose standards and to make decisions about the degree of effort by the NMIs and the BIPM on the range of air kerma standards now maintained, not forgetting other fields (e.g., radiation protection calibrations according to ISO 4037) where air kerma should still continue in use during the strategy periods in this plan. A CCRI(I) Working Group could be established when needed to review these issues and make recommendations on future requirements.

The International Reference System (SIR)

The International Reference System (SIR) for radionuclides is, after the time service of the BIPM, the most popular service provided under the Metre Convention. The SIR is characterized by its high stability and its simplicity. Since it came into existence, more than 900 measurements have been made with

over 60 different γ-emitting radionuclides – giving a total of about 650 independent results – and interest in the method remains high. The results of the measurements are published in the KCDB and are used to construct the efficiency curve of the reference ionization chamber (IC) as a function of γ-ray energy.

CCRI's strategic initiative will maintain and extend the SIR to additional short-lived radionuclides through the already ongoing SIRTI comparisons and through the extensions of SIR to β- and α-emitters, to support the worldwide traceability of PET and other nuclear medicine radiodiagnostic or radiotherapy techniques commonly used. . SIR could also support in the future the development of the reference materials program of the International Energy Agency (IAEA). In addition, efforts to establish additional SIR systems, all traceable to the original SIR, and possibly eventually located at multiple NMIs, could lead to a more world-wide distributed metrological infrastructure for radioactive measurements.

MRA operation

To optimize procedures, adjust inappropriate practices, and simplify the operation of the MRA, efforts are being done to reduce meetings and working groups, to increase the communication by electronic means and to implement appropriate comparison schemes and matrices to optimize the coverage of CMCs.

The five strategic initiatives and the main related actions are summarized in Table 3.

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Table 3 CCRI KEY STRATEGIC INITIATIVES 2013-2019

No.	Name	Description	Main related short- and mid-term CCRI Actions
1	**International traceability for high-energy photon dosimetry**	To ensure sustainable, worldwide equivalence of calibrations for high-energy photon beams, with direct impact in radiotherapy applications using medical accelerators.	- Established BIPM.RI(I)-K6 on-site comparison with graphite calorimeter travelling to each NMI. - Under consideration: alternative options for the BIPM to best fulfil the role (RMO-distributed or BIPM-based facility): CCRI has compiled a document and BIPM shall complete it. - Development of standards/comparisons for related techniques (for example, small field IMRT, FFF) needs regular access to high-energy photon beams.
2	**Focus on stakeholders**	To increase the feedback and involvement from stakeholders.	- Extensive list has been completed and updated. - "Institutional stakeholders" are invited to take part in meetings and in the strategy process and "end-user stakeholders" have been so far addressed indirectly. - CCRI Strategy plan proposes to arrange seminar/workshops to engage them more actively - IOMP interested in signing a Memorandum of Understanding similar to that signed with IAEA.
3	**From air kerma to absorbed dose to water**	To respond to the current trend of development of direct and more accurate standards for absorbed dose to water, that is usually derived from air kerma calibrations via agreed protocols. A plan will be developed so that the transition will be efficient and lead to minimum work overlap.	- New dosimetry instrumentation: for example the BIPM project for a primary standard for absorbed dose to water in medium-energy X-rays to allow direct comparisons, or the EMRP project on brachytherapy standards. - New challenges for operational quantities in radiation protection dosimetry. - Promoting absorbed dose to water standards in radiotherapy. - New biologically-related quantities, that could effectively be linked to absorbed dose. - Revision of status of NMIs effort, and consideration of ISO4037, radioprotection and brachytherapy recommendation, still in use in terms of air kerma references.
4	**The International Reference System (SIR)**	To continue the operation of SIR (restricted to γ-emitting radionuclides) and SIRTI (with ^{99m}Tc); to enlarge its scope to provide equivalence for additional short-lived and β- and α-emitters while keeping its high stability, simplicity and operation on NMIs' demand, to support the worldwide traceability of PET and other nuclear medicine, radiodiagnostics or radiotherapy nuclides. SIR could also serve as support to cooperate in reference materials characterization for environment, health or industry.	- Activity comparisons with the SIRTI (SIR transfer instrument), for short lived ^{99m}Tc. - SIRTI extension to include other short-lived radionuclides: ^{18}F, ^{64}Cu, ^{11}C. - Extension of SIR to pure β emitters: implementation exercise in 2014, with ^{3}H, ^{14}C, ^{55}Fe and ^{63}Ni, and participation of more than 15 NMIs. - Further extension to α emitters in 2016-2019. - Standards for contaminated environment or foodstuffs (post Fukushima) - Standards for nuclear forensics. - Anthropogenic and natural radionuclides standards for the environment and the industry (e.g. NORM, wastes). - Standardization methods for new radionuclides.
5	**MRA operation**	To optimize procedures and adjust inappropriate practices.	- Return to biennial periodicity of CCRI meetings. - Increased work by electronic means. - Reduction of Working Groups: from 10 in May 2013 to 6 in 2014 and 5 in 2015. - Further development and application of the Measurement Methods Matrix (MMM) adopted by Section II to systematize "how far the light shines" from radionuclide key comparisons: it allows the NMIs an appropriate selection of radionuclides and techniques to optimize the coverage of CMCs.

5 Action plan for 2013-2015 (short term)

Table 4: Strategic actions proposed for the period 2013-2015:

ID	Action	Section I	Section II	Section III	BIPM	AFRIMETS	APMP	COOMET	EURAMET	SIM	IAEA	ICRM	ICRU	IOMP	EFOMP
a	Harmonize stringency in uncertainties		X		X	X	X	X	X	X	X	X		X	X
b	Comparison of personal dose equivalent, *H*p - protocol			X						X	X			X	X
c	Increase meaningful dialogue between NMIs and DIs	X	X	X		X	X	X	X	X	X	X		X	X
d	Dosimetry for diagnostic imaging - identify metrology needs	X	X		X		X	X	X	X	X	X		X	X
e	Standards for fusion – identify			X					X		X	X			
f	Evaluation and improvements of the MRA	X	X	X	X		X	X	X	X	X	X		X	X
g	Stakeholder workshop (both institutional and end-user)	X	X	X	X		X	X	X	X		X		X	X
h	Exploring options for international traceability fin high-energy photon beams	X			X		X		X					X	X
i	New challenges for radiation protection dosimetry (operational quantities)	X	X	X	X	X	X		X	X	X		X	X	X
j	High-energy (>20 MeV) neutron standards			X					X		X				
k	Activity (SIRTI) comparisons		X		X	X	X	X	X	X		X		X	X
l	Recommended values for physical constants (ICRU publication)	X			X		X	X	X	X	X		X	X	X
m	Consistent radionuclide decay schemes		X		X		X	X	X	X	X	X		X	X
n	New needs in public security, health, and industry	X	X	X	X	X	X	X	X	X	X	X		X	X
o	Radiobiological data for neutrons			X						X				X	X
p	Extend SIR to pure α and pure β emitters		X		X	X	X	X	X	X		X		X	X
q	SIRTI for more short-lived radionuclides		X		X	X	X	X	X	X		X		X	X
r	Develop primary standards and comparisons / calibrations for absorbed dose in medium energy x-rays	X			X				X	X	X				
s	Small field and flattening filter free (FFF) dosimetry	X							X	X	X				
t	Standards for contaminated environment or foodstuffs (e.g., post Fukushima)		X		X				X	X	X	X			
u	Standards for nuclear forensics		X						X	X		X			
v	Shorten the publication of comparisons reports		X		X				X			X			

Table 4 shows previous short term actions that were not completed, a selection of previous medium term actions, as well as new actions. A few actions, considered redundant or obsolete, have been removed or merged with others. The selection was based on experience gained from previous plans and took into account that the period is only three years. It should be noted that several actions have close relations to research projects going on “elsewhere”. This has been realised as result of the more explicit attitude of the CCRI. This knowledge will be used to ensure appropriate flow of information between the CCRI and the respective project owners, and to reduce redundancy.

The plan was discussed during spring 2013, at the CCRI sections meetings, and all institutional stakeholders were asked to contribute.

Summary of planned actions 2013-2015

Selected highlights from the actions in Table 4 are given below:

Based on the previous action, a compilation of best practices to evaluate the uncertainties in radionuclide measurements are being developed, with the aim of publishing in 2015 a *Metrologia* special issue on this topic. In addition, the recent decision by the Section II to add explanations in the uncertainty budgets of comparison reports of how the uncertainty is evaluated will certainly contribute to harmonize the uncertainty estimations among all the NMIs and other laboratories involved

Despite interest in 2011 in a proposed comparison of NMI capabilities in delivering personal dose equivalent standards, there has since been no progress. A comparison of personal dose meters has been arranged by EURADOS. This highlights the need for a comparison of the standard fields used in these types of irradiations. CCRI will follow this activity of importance for the harmonisation of neutron personal dosimetry and take appropriate actions.

Standards for fusion present problems because fluence measurements applicable at fusion facilities need to be made at very high intensities and NMIs cannot produce these intensities to develop the required standards. An EMRP bid in 2010 by several European NMIs was not successful. Meetings of interested parties were held in 2012 to discuss an EMRP funding proposal in the call for project topics in the 'Energy' call in 2013. However, after serious discussion it was felt that, with the small number of NMIs capable of contributing and the fact that the fusion community have not yet worked out in full what they require, any EMRP proposal was unlikely to be successful. The danger is that the required standards will not be available when required by the fusion community and discussions are still underway, for example, with staff at ITER.

The CCRI will review its operations related to the CIPM MRA, will adjust inappropriate practices and streamline its procedures. This includes the review of the work load of the strategic approach, with the aim of cutting down resources devoted to this effort while maintaining the benefits. One result is that the CCRI will go back to a biennial meeting schedule. Continuity will be maintained by utilising the systematic approach of the strategy, and increasing work by electronic correspondence and remote meetings. A particular tool is represented by the Measurement Methods Matrix (MMM) adopted by Section II to systematize "how far the light shines" from key comparisons. A particular useful action was the participation in the BIPM workshop on Best Practices in CMC Reviews held at the BIPM on March 18-19, 2013, where the MMM approach was presented as another "best practice" in optimizing resources for the planning of comparisons.

Whereas CCRI's strategic approach has greatly facilitated its interactions with institutional stakeholders, relations with end-users have remained scarce. In line with what is being adopted by some NMIs, stakeholder conferences or workshops should be arranged at the BIPM as an encounter of institutions, manufacturers and end-users to enrich the strategic relations between CCRI and all of its stakeholders.

The BIPM Program of Work 2013-2015 recommends exploring funding sources for a high-energy photon facility at the BIPM. Steps have already been done which provide technical solutions at a

substantially reduced cost, of 1.7 M€ against the previous quotation of 3.6 M€ received in 2011. Additional funding from external foundations will be explored to compensate or reduce the effective cost to the Member States to a minimum. Alternative options based on a RMO-distributed approach will also be explored in order to keep the highest level of performance of the BIPM staff in this emerging area, by making them available a similar tool to the accelerators existing at other NMIS, to maintain their contributions at the highest metrological level. (See reference ii). Meanwhile, the BIPM.RI(II)-K6 comparison for high-energy photon dosimetry is already agreed/planned on-site at the facilities of four more NMIs: NPL(2013), VSL-NPL (2014), NMIJ(2015), NIM(2015/2016). A workshop oriented to participants (current and potential) in this comparison is planned in 2014.

Challenges will also have to be addressed in the field of radiation protection, with the introduction of new operational quantities and eventual needs for comparisons. CCRI(III) has already agreed a comparison on electronic personal dosimeters measurements of Hp. The CCRI will follow further developments covered by the other sections.

Work to develop a primary standard for absorbed dose to water in medium energy x-ray beams has been started at the BIPM. This is intended to lead to new comparisons and calibrations at the end of the 2013-2015 period.

Advances in the SIRTI's instrumentation aims at expanding the applicability of the system for use in comparisons of other, very short lived radionuclides. While the comparisons for ^{99m}Tc agreed in this period are IRD-LNMRI(2013), IFIN-HH(2013), VNIIM(2014) ENEA(2014), NMISA (2015), the BIPM will also extend the SIRTI to ^{18}F (1.8 h half-life, instead of 6 h for ^{99m}Tc) in 2013 and to ^{11}C (20.4 min half-life) in 2014-2015. First comparisons for ^{18}F will be carried out at ENEA (2014), NIST (2015) and NIM (2016) and studies will continue to consider its extension since 2016 to other short-lived radionuclides as ^{64}Cu or low-energy emitters as ^{129}I. The BIPM will also complete a backup system with a second detector in 2014.The design of the ionisation chamber for maintaining the becquerel continues to evolve through collaborations among the partners, e.g. IRMM, LNHB and NIST for simulations, the NPL for electronics and the IRMM for coordination and testing.

A bilateral collaboration between the LNHB and the IFIN was established for the evaluation of decay data for a variety of nuclides, and a EURAMET exercise to improve the decay scheme data for ^{64}Cu is underway. Several labs actively contribute decay data evaluations to the DDEP for improvements in the schemes of the most common radionuclides; plans have expanded to others and evaluations are regularly published as part of the Monographie BIPM-5, Table de Radionucléides, whose volume 7 has been published in 2013[2]. The values for the physical constants W_a and $s_{c,a}$ published as part of the BIPM 2009–2012 programme will be incorporated into the recommendations of the ICRU, who currently have a Report Committee studying this matter. This committee will produce an ICRU Report on Key Data for Dosimetry in late 2013 or early 2014.The CCRI will follow these activities and take appropriate actions.

[2] Which includes evaluations of half-lives, decay modes,x-ray, γ-ray and electron emissions, as well as α- and β-particle transitions and emissions of:^{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, ^{215}Bi, ^{228}Th, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm.

The needs for good neutron metrology to underpin radiation protection and reactor design and monitoring will be promoted at conferences similar to NEUDOS12 which will be held during the first week of June 2013 at Aix-en-Provence

An EMRP project looking at improved quantities for therapy level photon dosimetry is underway. Some of this work will be relevant to radiation protection as well. NMI input will be crucial to ensure any new quantities are realisable experimentally. The CCRI will follow these activities and take appropriate actions.

Standards at neutron energies above 20 MeV are needed for protection at high energy accelerators and for cosmic ray doses at aircraft flight altitudes. Proton therapy will also require higher energy neutron standards than are presently available to calibrate the instruments that will need to be used to measure the unwanted neutron contaminant doses to patients, doses which could induce secondary cancers in future years. The small number of laboratories where such fields are available is diminishing and at present there is no international impetus to providing such standards. The available facilities tend to be supported by one individual NMI, e.g. iThemba laboratories in South Africa supported by the PTB. The CCRI will follow these activities and take appropriate actions. In Japan, where much of the work on high energy standards is being undertaken, it has been hit by the aftermath of the 2010 earthquake.

It is important for the CCRI to be aware of the emerging needs in public security, health, and industry. However, information about these issues mostly comes from end users, with whom CCRI has relations only indirectly through its members. Action g and a possible working group should be the tools to improve the situation. CCRI's engagement in proton dosimetry will also be clearer after discussion with end-users.

According to the 2013-2015 Program of Work, the BIPM plans an intensive action during 2013-2014 to test at the BIPM the implementation of the extension of SIR to beta emitters, using both the Apparent Activity and the Universal LS Cross-efficiency methods for ^{63}Ni, ^{3}H, ^{55}Fe and ^{14}C(and possibly ^{99}Tc) which was discussed during the 2013 spring meetings of the ESWG(II) and the CCRI(II), with 20 NMI/Dis having declared their interest to contribute. The practical procedures and the definitive method to be adopted will be discussed and eventually maintained. The SIR extension to α-emitters has been postponed to the medium term action.

New actions

Finally, four new actions (s, t, u, v) have for this period are shown in Table 5.

Table 5: New short term actions

s	Small field and flattening filter free (FFF) dosimetry
t	Standards for contaminated environment or foodstuffs (e.g., post Fukushima)
u	Standards for nuclear forensics
v	Shorten the publication of comparisons reports

These actions are established in response to the needs and advice expressed during the CCRI meetings in spring 2013. These new actions will orientate the NMI/DIs activities and studies in these fields and will contribute to harmonize and optimize the efforts of the CCRI community. In particular, action t is already being addressed by a new CCRI(II) supplementary comparison on measurements of ^{134}Cs and ^{137}Cs in wheat flour, that was approved at the spring 2013 meeting. Some RMOs are also proposing supplementary comparisons of this type. Actions s and u have already initiated at some NMIs and action v was proposed during the CCRI(II) meeting and also in the evaluation forms received (see Chapter 11).

6 Action plan for 2016-2019 (medium term)

Table 6: Strategic actions proposed for the period 2016-2019 include actions from previous medium term actions that are not considered possible at short term and some new actions. A few actions are considered redundant or obsolete. The selection is based on experience gained from previous plans and takes into account that the period is again four years. It should be noted that several actions have close relations to research projects going on "elsewhere", which was realised as result of the greater exposure of the CCRI. This knowledge will be used to ensure appropriate flow of information between CCRI and the respective project owners, and at the same time avoid undue double work.

The plan was discussed during spring 2013, at the CCRI sections meetings, and all institutional stakeholders were asked to contribute.

Table 6: Strategic actions proposed for the period 2016-2019

ID	Action	Section I	Section II	Section III	BIPM	AFRIMETS	APMP	COOMET	EURAMET	SIM	IAEA	ICRM	ICRU	IOMP	EFOMP
a	Implementation of optimal option for international traceability in high-energy photon beams				**X**									X	X
b	High-energy photon dosimetry comparisons - establish	**X**			**X**		X		X	X				X	X
c	Small field dosimetry e.g. for IMRT	**X**			**X**		X	X	X	X	X			X	
d	Promoting neutron metrology			**X**			X	X		X	X			X	
e	Promoting absorbed dose standards for radiotherapy	**X**			**X**		X	X	X	X	X			X	
f	Radiobiological data for neutrons			**X**					X	X				X	
g	Extension of the SIR to α-emitters		**X**		**X**		X	X	X	X		X		X	
h	Molecular imaging measurement needs		**X**				X		X	X	X	X		X	X
i	Hadron therapy (proton and carbon ion)	**X**		**X**			X		X		X			X	
j	Brachytherapy – LDR comparisons	**X**	**X**		**X**					X	X*				
k	Climate change needs for low-level measurements standards and tracers	**X**			**X**				X	X					
l	Anthropogenic and natural radionuclides standards for the environment and the industry (NORM, wastes,…)	**X**			**X**				X	X					
m	Single atom counting techniques for activity-mass connection	**X**			**X**				X	X					
n	Nano-dosimetry (sub-cellular structures) needs for new radiation qualities and biological quantities	**X**		**X**	**X**		x		X	X			X	X	X

*Only for ^{137}Cs

Summary of planned actions 2016-2019

Selected highlights from the actions in Table 4 are given below:

The first three actions depend on the final approach adopted for the BIPM.RI(I)-K6 comparison. They are further described in reference ii. They mark the implementation of the appropriated procedures and regular development of comparisons.

The needs for good neutron metrology to underpin radiation protection and reactor design and monitoring will be promoted at conferences similar to NEUDOS12.

The brachytherapy activities will be discussed at CCRI 2015 to be extended from the current high dose rate ^{192}Ir- sources comparisons, by developing the logistics and the planning of future comparisons with low dose rate ^{125}I- seeds. Potential new sources will be characterised by activity comparisons.

Radiobiological data for neutrons have not been extensively studied. Measurements are, however, expensive and have not to date been seen as being of sufficient importance for widespread funding. Awareness of this issue will be raised during stakeholder meetings. There is some evidence of increased activity in this area, for example, a microbeam will be installed at the IRSN AMANDE facility specifically for radiobiology experiments.Molecular imaging measurement needs have been expressed by an expanding interest among clinical providers in using metrology in medical applications, particularly in nuclear- medicine based quantitative imaging (PET, SPECT), leading to expanding capabilities and increasing collaborations among various laboratories in this field. Building on current capabilities (such as providing measurement assurance of radionuclide calibrators, standardization of relevant nuclides, and development of relevant and calibrated phantoms) provides a firm technical foundation for these efforts. CCRI will discuss this with stakeholders and take appropriate actions.

Although a few NMIs are actively involved in proton and carbon ion dosimetry, no clear picture has emerged for the needs for comparisons. CCRI will discuss this with stakeholders and take appropriate actions.

Regarding neutron therapy dosimetry support for BNCT, this is a therapy technique which has been developed at a small number of institutes over a number of years but has never been widely adopted because of difficulties with the facilities and the technique itself. Needs are not clear and will have to be clarified. The BNCT facility at Birmingham University is still not treating patients although work on the project has been underway for more than 10 years.

New actions

Finally, 4 new actions (k, l, m, n) have been introduced in response to the feedback from CCRI members and stakeholders in spring 2013, in particular from some RMOs approaches being currently addressed. The actions are summarised in Table 7:

Table 7. New medium term actions

k	Climate change needs for low-level measurements standards and tracers
l	Anthropogenic and natural radionuclides standards for the environment and the industry (NORM, radioactive waste,…)
m	Single atom counting techniques for activity-mass connection
n	Nano-dosimetry (sub-cellular structures) needs for new radiation qualities and biological quantities

These new actions will orientate the NMI/DIs activities and studies in these fields and will contribute to harmonize and optimize the efforts of the CCRI community as well as to orientate the future program of work of the BIPM.

In particular, for action n, the Metrology applied to sub-cellular structures will change radiation dosimetry concepts radically and even if the prerequisites have not yet emerged, relevant research is already going on at a few NMIs. Therefore, it is considered as a matter of analysis in the mid-term, to follow the trend and the eventual results reached.

Actions k and l arise directly from the world-wide concern about the need to control and manage the changing climate and the sustainable use of our environment and industrial applications. Significant effort will be devoted in 2013-2015 as joint or individual projects at several NMIs and therefore this strategic action aims at preparing the metrological coordination that will eventually be needed in 2016.

Finally, action m aims at keeping a permanent thought on the fundamentals of ionizing radiation quantities and its eventual connection to other SI units.

7 Action plan for 2020-2023 (long term)

Table 8 includes actions from previous long term as well as previous medium term actions that are not considered possible at the current medium term. The time span until "long term" starts has the consequence that the selection does not represent detailed planning. It indicates actions on the horizon, which should be kept in mind and may possibly pop up before it is currently expected. It may also be considered a foresight attempt.

The plan was discussed during the spring 2013, at the CCRI sections meetings, and all institutional stakeholders were asked to contribute.

Table 8: Strategic actions proposed for the period 2020-2023

ID	Action	Section I	Section II	Section III	BIPM	AFRIMETS	APMP	COOMET	EURAMET	SIM	IAEA	ICRM	ICRU	IOMP	EFOMP
a	Standardization methods for new radionuclides	X	X		X	X	X	X	X	X				X	X
b	Introduction of new biologically related quantities	X	X	X			X		X	X		X	X	X	X
c	New dosimetry instrumentation	X		X	X		X	X	X	X	X			X	X
d	Evaluate non-reactor based methods of radionuclide production		X	X			X			X	X	X		X	X
e	Evaluate radiation resistance of materials	X		X			X	X	X	X	X				X

Summary of planned actions 2020-2023

Selected remarks regarding the actions in Table 8 are given below:

Absolute counting techniques by selective sampling and anti-coincidence methods, as well as new high-efficiency detectors systems shall be updated or implemented to contribute to the eventual standardization needs for environmental/food contamination controls, nuclear forensics, or for characterization of reference materials arising from the mid-term strategy actions. The IAEA stakeholder has already declared their interest for the BIPM to support this activity and establish eventual joint programmes of cooperation.

Evolutions and modifications of current methods (e.g., TDCR) are used to standardize either rarely-before standardized nuclides (e.g., ^{68}Ge) or extremely short-lived species (e.g., ^{11}C). Collaboration is crucial for establishing an infrastructure which can address nuclides not-yet under consideration.

Changes in NMI/DI organizational structures present new opportunities for investigating synergisms between radionuclide metrology and biologically-related models, establishing a basis for assessing the most relevant quantities to be investigated or defined. However, this is very much dependent on the progresses in nano-dosimetry techniques eventually reached in 2016-2019 (action n).

While the BIPM keeps as strength its capability for designing and constructing new chambers and calorimeters, this may turn out into a weakness if the accelerator dosimetry cannot be implemented at the BIPM, due to the lack of high-energy reference beams to test and develop new instruments.

The need for better protection-level devices for neutrons is clear. However, the role of NMIs in providing improvements, over and above providing standards for testing new devices, is not clear. NMIs with plans for improved devices pursue these ideas, often in collaboration with universities or manufacturers, but there is still little concerted research involving only NMIs and this activity should be fostered.

In the interest of avoiding or minimizing the need for using nuclear reactors for source production, accelerator-based production of ^{99}Mo is being investigated at one NMI. To address difficulties in clinical access to short-lived isotopes, cyclotron-production of therapeutic radionuclides is being evaluated at a number of places.

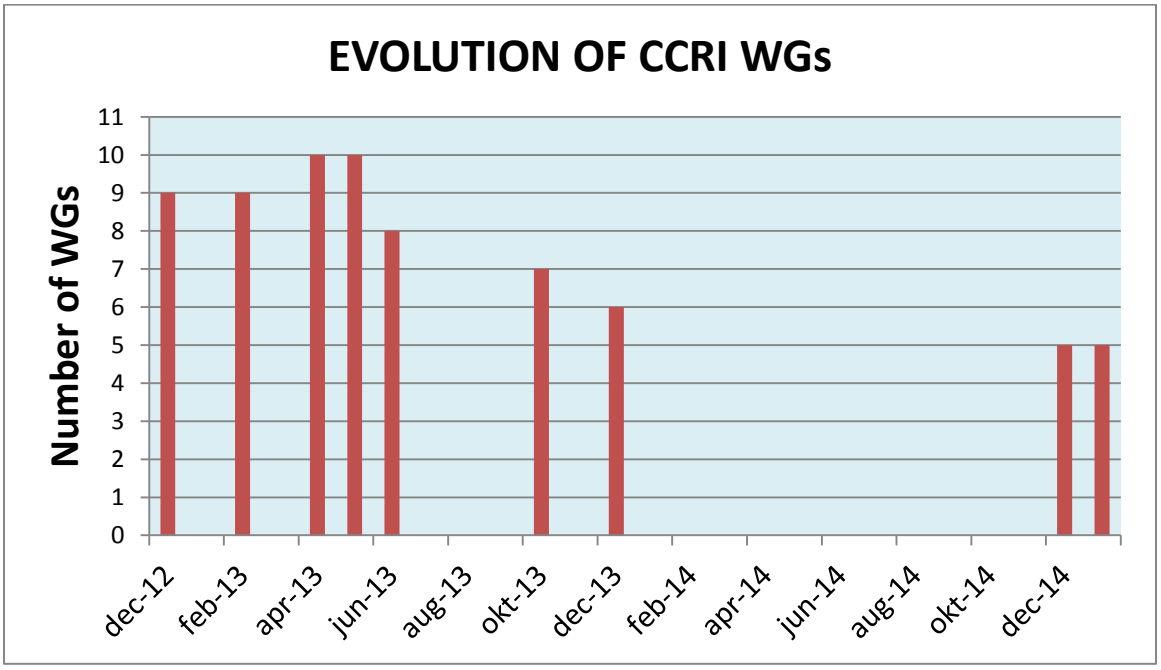
The present and possible future involvement of NMIs in the area of materials is not clear and the needs, if any, should be identified. The CCRI will consult representatives of the VAMAS and other organisations for materials' metrology to identify possible areas of actions.

8 CCRI Working groups

The CCRI has operated 10 working groups until May 2013. However, following the CCRI meetings in spring 2013, a number of them are being closed in the short term, and the total number will be reduced to 5 according to the following time table:

Working Group	Achronym	Planned closing
-regional metrology organisations	(RMOWG)	Ongoing
- key comparisons (3)	(KCWG(I) (II) (III))	Ongoing
-brachytherapy standards	(BSWG(I))	2015
-accelerator dosimetry	(ADWG(I))	June 2013
-high efficiency counters	HEWG(II)	June 2013
- SIR transfer instrument	(TIWG(II)	October 2013
-maintenance of the bequerel	(BqWG(II))	October 2013
-extension of the SIR	(ESWG(II)	December 2014

Therefore, the evolution of the CCRI working groups can be depicted as follows:



Two possible new working groups have been mentioned above in this plan that could be established, only if necessary, on the following topics:

- Suggestions for the transition from air kerma to absorbed dose to water
- Identifying new needs in public safety, health, and industry

The ten currently existing working groups are described in the next pages. The annual reports for 2011 and 2012 are not shown although they were discussed at the respective section meeting.

8.1 WG reporting directly to the CCRI:

Name	Interregional CMC review working group
Abbreviation	RMOWG
Coordinator	A. Aalbers, VSL
Membership	RMO TC Chairs and their representatives; CCRI President; CCRI Executive Secretary; JCRB Executive Secretary; KCDB Coordinator
Foreseen Lifetime	Ongoing
Remit	To discuss all issues related to the CIPM MRA CMCs for ionizing radiation, including reviews when necessary
Deliverables w/ deadlines	Feed back to the CCRI, BIPM, and JCRB in time for their meeting. Deadlines set by meeting schedules

8.2 WGs in Section I:

Name	Key Comparisons
Abbreviation	KCWG(I)
Coordinator	P. Sharpe, NPL
Membership	P. Sharpe,(NPL), J.M. Los Arcos (BIPM), D. Burns (BIPM), L. Büermann (PTB), I. Csete (IAEA), C. Ross (NRC), D. Webb (ARPANSA), A. Aalbers (*ex officio;* RMO WG), K. Carneiro (*ex officio*; CIPM), C. Kuanbayev (*ex officio*; JCRB Executive Secretary)
Foreseen Lifetime	Ongoing
Remit	The purpose of the KCWG(I) is to support and aid the CCRI(I) and BIPM in meeting obligations arising from the CIPM Mutual Recognition Arrangement, and to identify areas of radiation dosimetry that require further attention in the pursuit of improved standards, key comparisons and degrees of equivalence. Work Schedule: The KCWG(I) meets as necessary but at least once before each CCRI(I) meeting, with individual members, either singly or in collaboration, taking forward the various items of the working group agenda. Correspondence by e-mail supplements these meetings.
Deliverables with deadlines	On-going support to the CCRI(I) and the BIPM in evaluating approaches for comparisons in radiation dosimetry, guidance in types of comparisons that may support laboratories' claims on measurement capabilities, and providing advice to both the BIPM and the CCRI(I) on the many reports and results arising from the CIPM and RMO comparisons. The KCWG(I) reports to the CCRI(I) on a periodic basis, including after each convened meeting of the working group and in advance of the CCRI(I) meetings.

Name	Brachytherapy Standards
Abbreviation	BSWG(I)
Coordinator	P.J. Allisy-Roberts BIPM (until 2012). Cecilia Kessler (BIPM) appointed as new coordinator in CCRI(I) 2013.
Membership	All NMIs that have primary standards for brachytherapy dosimetry, K. Carneiro (CIPM), J.M. Los Arcos (BIPM)
Foreseen Lifetime	One complete comparison cycle (2014-2015). To be revised at CCRI(I) in 2015.
Remit	to produce the protocols for the comparisons as agreed; interpret the results and identify the KCRV
Deliverables with deadlines	First protocol completed July 2010; First analysis and KCRV: Foreseen 2012 Second protocol, 2012 with the comparison in 2012/13 Note: There has been some delay to the planned schedule due to staff constraints. The KCRV will be established based on comparisons that have already taken place. Remaining comparisons will be completed in 2013/14.

Name	Accelerator Dosimetry .
Abbreviation	ADWG(I)
Coordinator	P. Sharpe, NPL
Membership	L. Karam/M. Mitch (NIST), M.McEwen (NRC), A.Meghzifene/I. Csete (IAEA), T. Aalbers (VSL), H. Bjerke (NRPA), C. Andersen (Risö), D. Twerenbold (METAS), K. Carneiro (CIPM), J.M. Los Arcos (BIPM), The ADWG(I) met in March 2013 to prepare documents required by the BIPM by May 2013. Once this action is complete the ADWG(I) will be closed. Responsibility for the K6 high energy x-ray comparison will be transferred to the KCWG(I).
Foreseen Lifetime	2013
Remit	1. To identify the logistics of running high-energy dosimetry comparisons in the interim programme period 2009 to 2012. 2. To respond to the invitation of the 23rd CGPM and produce a strategy by February 2009 to submit to the CCRI for approval on options for addressing needs for dosimetry comparisons and calibrations using a BIPM or another linear accelerator. 3 To define the programme of work of the BIPM for the 2013 to 2016 period: - on the basis of a linear accelerator installed at the BIPM - on the basis of linear accelerators not at the BIPM.
Deliverables with deadlines	Reports to the CCRI, and CIPM on the issues 1-3 – completed. The preliminary document listed in reference ii is the last of a series of documents submitted to the BIPM director.

8.3 WGs in Section II:

Name	Key Comparisons Working Group
Abbreviation	KCWG(II)
Coordinator	J. Keightley, NPL
Membership	J.M. Los Arcos (BIPM), D. Arnold (PTB), C. Bobin (LNE-LNHB), F. Bochud (IRA), L. Johansson (NPL), J. Keightley (NPL),), C. Michotte (BIPM), S. Pommé (IRMM), G. Ratel (BIPM), M. Unterweger (NIST), F. Van Wyngaardt (NMISA), A. Yunoki (AIST/NMIJ), L.R. Karam (*ex officio*, CCRI(II) Chair; NIST)
Foreseen Lifetime	On going
Remit	Continuing support to the CCRI(II), the BIPM, and the RMOs in proposing and evaluating comparisons (including uncertainties) in radionuclide metrology, including those involving the SIR, guidance in types of comparisons that may support laboratories' claims on measurement capabilities, and providing advice to both the BIPM and the CCRI(II) on reports and results arising from the SIR and various other key and supplementary comparisons. The purpose of the KCWG(II) is to support and aid the CCRI(II) and BIPM in meeting obligations arising from the CIPM Mutual Recognition Arrangement, and to identify areas of radionuclide metrology that require further attention in the pursuit of improved standards, key comparison reference values and degrees of equivalence. As of October 2013, this WG takes over actions from the BqWG(II) and the TIWG(II).
Deliverables with timelines	The KCWG(II) meets at least annually, with individual members, either singly or in collaboration, taking forward the various items of the working group agenda. Correspondence by e-mail supplements these meetings. The KCWG(II) reports to the CCRI(II) on a periodic basis, including after each convened meeting of the working group and in advance of CCRI(II) meetings. The KCWG(II) maintains the master copy of the radionuclide Measurement Methods Matrix (MMM) and updates it (taking into account comparison results) with input from the WG, CCRI(II), and technical experts (on-going). Production of a *Monographie* on uncertainty budgets for radionuclide metrology (2015).

Name	High-efficiency photon detection systems
Abbreviation	HEWG(II)
Coordinator	G. Winkler, IIK
Membership	G. Winkler (IIK), F.J. Maringer (BEV), S. Pommé (IRMM)
Foreseen Lifetime	Closed June 2013.
Remit	To produce a BIPM Monographie on high-efficiency photon detection systems
Deliverables with deadlines	A MONOGRAPH on high-efficiency photon detection systems foreseen 2014, which will be developed as an ACTION with assistance from ENEA (P. De Felice), IRMM(S. Pommé), LNHB (C. bobon) and BEV (F.J. Maringer).

Name	EXTENSION OF SIR WORKING GROUP
Abbreviation	ESWG(II)
Coordinator	J. M. Los Arcos (BIPM)
Membership	J. M. Los Arcos (BIPM), T. Altzitzoglou (IRMM), R. Broda (RC), P. Cassette (LNE-LNHB), P. De Felice (ENEA), A. Harms (NPL), K. Kossert (PTB), G. Ratel (BIPM), F. van Wyngaardt (NMISA), B. Zimmerman (NIST)
Foreseen Lifetime	The ESWG will conclude once the technical tasks for ongoing comparisons of beta and alpha emitters will be fulfilled and conveniently documented in the *BIPM Monograph* and after a joint BIPM-ESWG verification of routine operation for 6 to 12 months. This is foreseen to happen in 2015.
Remit	The objective of the *"Extension of SIR Working Group"* (ESWG) of the CCRI(II) is to develop and implement a self-consistent scheme for including the alpha and beta emitters within the Système International de Référence (SIR), currently restricted to gamma emitters. Support and guidance to the BIPM in defining the most adequate technical procedures for ongoing comparison of beta and alpha emitters, Advise on the best experimental setup for implementing the extension of the SIR at the BIPM, Documentation of the specific metrological principles as well as the practical aspects of the operation of the extended SIR at the BIPM. The ESWG meets periodically, approximately once a year, to analyse jointly the contributions of individual members and of invited experts and to assume the new actions. Supplementary information is also exchanged by e-mail. Occasional visits to, or secondments at, the BIPM are also organized in view of specific problems that require more intensive joint work.
Deliverables with deadlines	Technical documents stored at the ESWG restricted web site. o Distribution of Minutes of each group meeting or action – ongoing. o Reports at the CCRI(II) meetings – 2011; 2013 o Confirmation of reference scintillator production at the BIPM – 2011 o Trial exercise of simulation of extended SIR operation -2011 o Analysis of trial exercise -2012 o Technical implementation of extended SIR – 2013-2014 o *BIPM Monograph* on the Extension of the SIR -2014 o Verification of extended SIR operation -2014 The above mentioned deliverables will be provided in time for the BIPM to implement its proposed work programme for the period 2016 to 2019

Name	Realization of the becquerel
Abbreviation	BqWG(II)
Coordinator	U. Wätjen, IRMM
Membership	J.M. Los Arcos (BIPM), M.-N. Amiot (LNE-LNHB), G. Ratel (BIPM), J. Sephton (NPL), M. Unterweger (NIST), U. Wätjen (IRMM), A. Yunoki (AIST/NMIJ)
Foreseen Lifetime	The work of the BqWG will conclude when an action plan is developed with the goal of producing a prototype ionization chamber which mimics the SIR for the energy range 30 keV to 2000 keV. This is foreseen in December 2013.
Remit	Design and construct an ionization chamber which can be reproduced at any time and any place based on precise definitions traceable to SI units – mechanical drawings, material compositions, operating specifications. Having identical ionization chambers will enable the maintenance of the becquerel at NMIs and facilitate bilateral comparisons. The working group on the realization of the becquerel (BqWG) meets at least in advance of CCRI(II) meetings or more frequently to report and discuss work progress. Correspondence by e-mail supplements these meetings.
Deliverables with timelines	1 Testing of design options using the existing Reher-Woods-Dennecke RWD prototype chamber – 2013 2 Action plan for construction and testing of of the improved prototype chamber – December 2013 Technical documents are stored in the BqWG restricted website. The BqWG reports to the CCRI(II) after each convened meeting of the working group and at the CCRI(II) meetings.

Name	SIR Transfer Instrument. Closed October 2013. Actions transferred to KCWG(II).
Abbreviation	TIWG(II)
Coordinator	C. Michotte (BIPM)
Membership	C. Michotte (BIPM), J.M. Los Arcos (BIPM), C. Bobin (LNE-LNHB), A. Yunoki (AIST/NMIJ), G. Ratel (BIPM), L. Johansson (NPL), M. Unterweger (NIST), S. Pommé (IRMM), M. Capogni (ENEA)
Foreseen Lifetime	The work of the TIWG(II) will conclude when the transfer instrument has run successfully for ^{99m}Tc and ^{18}F, foreseen December 2013 Issues related to the degrees of equivalence will be discussed by the KCWG(II) as for any other comparison
Remit	Support to the BIPM in developing the SIR transfer instrument for short-lived radionuclides. Guidance in evaluating the best experimental setup and the most appropriate method of data analysis. Providing advice in defining comparison protocols.
Deliverables with timelines	^{99m}Tc: completed. Extension to ^{18}F: by December 2013.

8.4 WGs in Section III:

Name	Key Comparisons
Abbreviation	KCWG(III)
Coordinator	D.J. Thomas, NPL
Membership	D.J. Thomas (NPL), J.M. Los Arcos (BIPM), NMIs piloting comparisons
Foreseen Lifetime	Ongoing
Remit	On-going support to the CCRI(III) and the BIPM in evaluating approaches for comparisons in neutron metrology, guidance in types of comparisons that may support laboratories' claims on measurement capabilities, and providing advice to both the BIPM and the CCRI(III) on the reports and results arising from CCRI and RMO comparisons. The purpose of the KCWG is to support and aid the CCRI(III) and BIPM in meeting obligations arising from the CIPM Mutual Recognition Arrangement, and to identify areas of neutron metrology that require further attention in the pursuit of improved standards, key comparison reference values and degrees of equivalence. The Key Comparison Working Group (KCWG) meets as required to resolve problems with key comparisons. Most of this work is, however, undertaken by e-mail and at the full CCRI Section (III) level.
Deliverables with deadlines	On-going support to the CCRI(III) and the BIPM in evaluating approaches for comparisons in neutron metrology, guidance in types of comparisons that may support laboratories' claims on measurement capabilities, and providing advice to both the BIPM and the CCRI(III) on the reports and results arising from CCRI and RMO comparisons. In particular: Comparison analyses and KCRV's

9 BIPM and NMI work load in comparisons and calibrations

Out of the 39 CCRI/BIPM comparisons in KCDB appendix B, BIPM coordinates and pilots 11, 8 for Section I, and 3 for Section II. They are listed in Table 9 and Table 10. Note that the engagement per comparison and annual work load includes only the direct service for the comparison. Standards maintenance, quality assurance and related developments are not included.

The average annual work load for BIPM's comparisons is estimated to be 2.42 FTE.

BIPM also spends a noticeable time on supporting NMIs with secondary standards in x-ray and γ dosimetry. They are listed in Table 10.

The average annual work load from BIPM's calibrations is estimated to be 0.42 FTE.

Table 9: BIPM-piloted comparisons for CCRI Section I, and their workload. It only includes the direct service for the comparison. Standards maintenance, quality assurance and related developments are not included.

Section I	**Title**	**BIPM engagement Person-month/ participant**	**BIPM annual load (FTE)**	**NMI engagement /comparison** Person-month / **(FTE)** (BIPM estimation)		
				Direct comparison	Indirect comparison	Dir.&Ind. comparison
BIPM.RI(I)-K1	Measurement of air kerma for ^{60}Co 1975 -	1	**(0.11)**	0.25 **(0.023)**	0.30 **(0.027)**	0.38 **(0.035)**
BIPM.RI(I)-K2	Measurement of air kerma for low energy x-rays 1966 -	1	**(0.10)**	0.25 **(0.023)**	0.60 **(0.055)**	0.68 **(0.062)**
BIPM.RI(I)-K3	Measurement of air kerma for medium energy x-rays 1975	1	**(0.10)**	--	0.60 **(0.055)**	--
BIPM.RI(I)-K4	Measurement of absorbed dose to water for ^{60}Co 1993 -	1	**(0.09)**	--	0.35 **(0.032)**	--
BIPM.RI(I)-K5	Measurement of air kerma ^{137}Cs 1994 -	1	**(0.08)**	0.25 **(0.023)**	0.30 **(0.027)**	0.38 **(0.035)**
BIPM.RI(I)-K6	Measurement of absorbed dose to water; accelerator based radiation 2009 -	4.25 without BIPM linac [1.5 with BIPM linac]	**(0.39)** **(0.14)**	2.0 **(0.18)**	--	--
BIPM.RI(I)-K7	Measurement of air kerma in mammography beams 2007	1	**(0.07)**	0.25 **(0.023)**	0.30 **(0.027)**	0.38 **(0.035)**
BIPM.RI(I)-K8	Measurement of air kerma rate for HDR Ir-192 brachytherapy sources 2009 -	1	**(0.07)**	--	0.15 **(0.014)**	--

Table 10: BIPM-piloted comparisons for CCRI Section II, and their workload. It only includes the direct service for the comparison. Standards maintenance, quality assurance and related developments are not included. Note that K1 and K2 each involve some 60 individual radionuclides

Section ii	**Title**	**BIPM engagement Person-month/ participant**	**Number of comparisons per year**	**BIPM annual load (FTE)**	**NMI engagement /comparison** Person-month / **(FTE)** (BIPM estimation)		
					Ioniz. Chamb.	Primary measur.	Verific. method
BIPM.RI(II)-K1	General radionuclide out of 60 (SIR comparison since 1976)	0.5	15	**(0.68)**	0.20 **(0.018)**	0.75 **(0.068)**	0.38 **(0.035)**
BIPM.RI(II)-K4	^{99m}Tc (SIRTI comparison since 2009)	2.5	1	**(0.23)**	1.0 **(0.09)**		0.38 **(0.035)**
BIPM.RI(II)-K2 CCRI(II)-K2	Activity concentration (general isotope, several participants)	7.0 (TOTAL)	1	**(0.50)**	0.1 **(0.01)**	0.50 **(0.045)**	0.38 **(0.035)**

Table 11: BIPM calibrations for NMIs with secondary standards in dosimetry (x- and γ-rays). It only includes the direct service for the calibration. Standards maintenance, quality assurance and related developments are not included.

Year	**Number of calibrations**	**Average/year**	**BIPM engagement Person-month/ calibration**	**BIPM annual load (FTE)**	**NMI engagement /comparison** Person-month / **(FTE)** (BIPM estimation)
2009	17	26.3	0.17	**(0.42)**	0.1 **(0.01)**
2010	30				
2011	26				
2012	32				

10 Stakeholders

The CCRI considers three types of stakeholders, either “RMO”, “institutional-”, which may or may not directly profit from the work that the CCRI coordinates, or “end-user”, which are direct beneficiaries of CCRI’s work, and may be public institutions, private companies or individuals.

The stakeholders for CCRI(I) include institutions, regulatory agencies and end-users with requirements for traceable absorbed dose and air-kerma measurements, covering the range from low level environmental and protection measurements through diagnostic and therapeutic medicine to the very high doses employed in industrial applications. All sectors are subject to regulatory control.

The stakeholders for CCRI(II), include users in health care, environmental monitoring, security, industrial, and analytical/research laboratory applications where the quantitative assessment of radioactivity is required for technical and also regulatory reasons, covering from extremely low levels in environmental sampling to the very high levels in nuclear medicine, as well as those for which distinction between and among specific radioactive isotopes is critical for security applications.

The stakeholders for CCRI(III), are bodies who need to measure neutron fluence, or dose equivalent, in absolute terms, and include establishments measuring cross sections, developers of radiation protection devices, reactor instrument manufacturers, security system developers, and people in the safeguards area. The current list includes the following entities, listed in alphabetic order:

- Regional metrology organizations (RMOs)
  AFRIMET, APMP, COOMET, EURAMET, SIM
- Institutional stakeholders:
  Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) (Section II)
  Food and Agriculture Organization (FAO) of the United Nations (UN) [Section II]
  Individual NMIs and DIs [Sections I, II and III]
  Institute for Reference Materials and Measurements (IRMM) [Sections II and III]
  International Atomic Energy Agency (IAEA)
  International Commission on Radiation Units and Measurements (ICRU)
  International Commission on Radiological Protection (ICRP) [Sections I, II and III]
  International Committee for Radionuclide Metrology (ICRM) [Section II]
  International Electrotechnical Commission (IEC) [Sections I, II and III]
  International Laboratory Accreditation Cooperation (ILAC)
  International Organization for Medical Physics (IOMP) and associated regional organizations
  International Organization for Standardization (ISO)
  International Organization of Legal Metrology (OIML)
  International Radiation Protection Association (IRPA) [Sections I, II and III]
  Nuclear Energy Agency (NEA)-OECD
  World Health Organization (WHO)

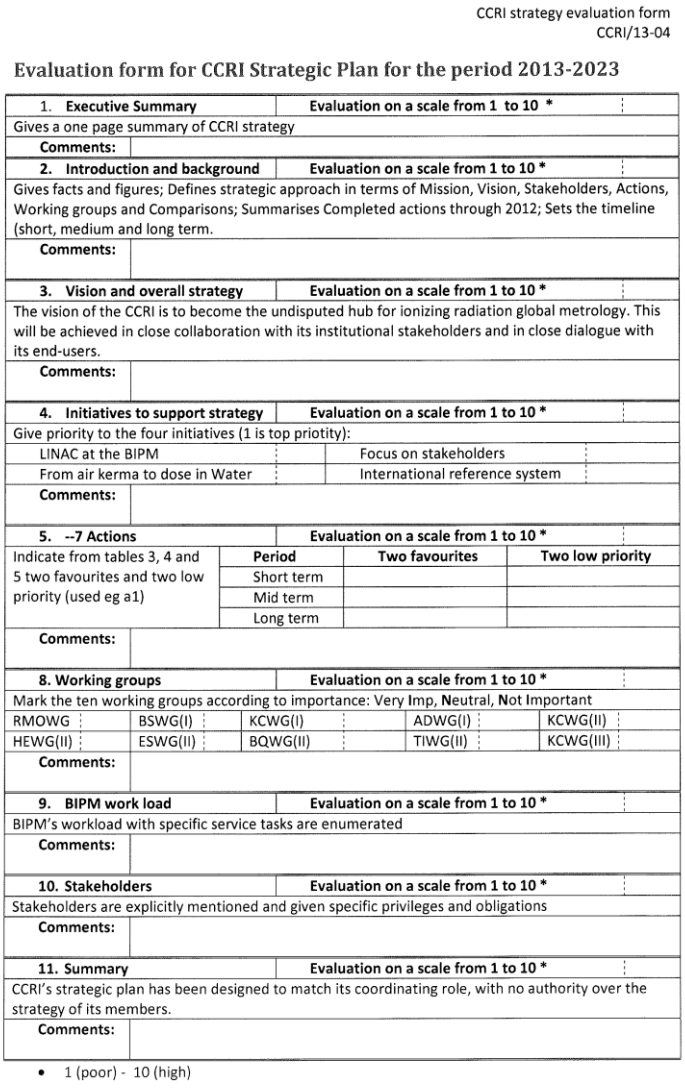
- End-user stakeholders:
  - Accelerator manufacturers
  - Calibration laboratories
  - Defence and security bodies
  - Dosimetry services
  - Environmental radiation surveillance measurement laboratories
  - Fission reactor constructors
  - Fusion reactor constructors
  - Health care laboratories
  - Hospitals and other medical facilities
  - Instrument manufacturers
  - Nuclear industry
  - Radiation processing industry
  - Radiation protection laboratories
  - Radioactive source producers
  - Regulatory agencies, national and international
  - Veterinary facilities

11 Evaluation

The chapters in the original of this Strategy Plan were subject to evaluation by the attendees at the CCRI(I), CCRI(II), CCR(III) and CCRI meetings, in spring 2013.

For this purpose, both the draft document and an "Evaluation Form for the CCRI Strategic Plan for the period 2013-2023" were made available as working documents at each meeting and the attendees filled in the form and returned their comments after their respective meeting. The form is reproduced in Figure 2. A total of 31 forms were received as response, around 34 % of the attendees. The Table 11 shows the analysis of the responses.

The conclusions from this analysis have been taken into account in the present version of the Strategy Plan.



CCRI strategy evaluation form
CCRI/13-04

Evaluation form for CCRI Strategic Plan for the period 2013-2023

1. **Executive Summary**	**Evaluation on a scale from 1 to 10 ***			
Gives a one page summary of CCRI strategy				
Comments:				
2. Introduction and background	**Evaluation on a scale from 1 to 10 ***			
Gives facts and figures; Defines strategic approach in terms of Mission, Vision, Stakeholders, Actions, Working groups and Comparisons; Summarises Completed actions through 2012; Sets the timeline (short, medium and long term.				
Comments:				
3. Vision and overall strategy	**Evaluation on a scale from 1 to 10 ***			
The vision of the CCRI is to become the undisputed hub for ionizing radiation global metrology. This will be achieved in close collaboration with its institutional stakeholders and in close dialogue with its end-users.				
Comments:				
4. Initiatives to support strategy	**Evaluation on a scale from 1 to 10 ***			
Give priority to the four initiatives (1 is top priotity):				
LINAC at the BIPM		Focus on stakeholders		
From air kerma to dose in Water		International reference system		
Comments:				
5. --7 Actions	**Evaluation on a scale from 1 to 10 ***			
Indicate from tables 3, 4 and 5 two favourites and two low priority (used eg a1)	**Period**	**Two favourites**	**Two low priority**	
	Short term			
	Mid term			
	Long term			
Comments:				
8. Working groups	**Evaluation on a scale from 1 to 10 ***			
Mark the ten working groups according to importance: Very **I**mp, **N**eutral, **N**ot Important				
RMOWG	BSWG(I)	KCWG(I)	ADWG(I)	KCWG(II)
HEWG(II)	ESWG(II)	BQWG(II)	TIWG(II)	KCWG(III)
Comments:				
9. BIPM work load	**Evaluation on a scale from 1 to 10 ***			
BIPM's workload with specific service tasks are enumerated				
Comments:				
10. Stakeholders	**Evaluation on a scale from 1 to 10 ***			
Stakeholders are explicitly mentioned and given specific privileges and obligations				
Comments:				
11. Summary	**Evaluation on a scale from 1 to 10 ***			
CCRI's strategic plan has been designed to match its coordinating role, with no authority over the strategy of its members.				
Comments:				

- 1 (poor) - 10 (high)

Figure 2. Evaluation form, distributed to all CCRI-meeting participants in 2013

Table 11. Analysis of the responses of CCRI(I), CCRI(II), CCRI(III) and CCRI attendees (spring 2013) to the Evaluation Form. Marks were given from 1 (poor) to 10 (high value). Average marks are given with standard deviations in parenthesis

Item	Average score	Feedback/Selected Comments /
1. Executive Summary	**8.0** (0.3)	Format comments
2. Introduction and Background	**7.9** (0.3)	Format comments
3. Vision and overall strategy	**8.4** (0.3)	- Workshop essential to improve stakeholders connections in next period
4. Initiatives to support the strategy	**8.1** (0.2)	- Ranking of the four strategic initiatives gives: 1) LINAC at the BIPM, 2) SIR, 3) $K_{air} \rightarrow D_w$, 4) Stakeholders focus
5. – 7. Actions	**8.1** (0.2)	• **Short-term:** **Favourite actions:** - g: LINAC at the BIPM - o: Extension of SIR to pure α- and β-emitters - c: Identify metrology needs for diagnostic imaging **Low-priority actions:** - i: Increase dialogue NMIs – DIs - e: Evaluation and improvements of the MRA • **Mid-term:** **Favourite actions:** - g: Extension of SIR to α-emitters - c: Small field dosimetry - e: Promoting absorbed dose standards for radiotherapy **Low-priority actions:** - i: Hadron therapy needs - f: Radiobiological data for neutrons • **Long-term:** **Favourite actions:** - d: New dosimetry instrumentation - c: Introduction of new biologically related quantities - b: Standardization methods for new radionuclides **Low-priority actions:** - f: Evaluate radiation resistance of materials - a: Nano-dosimetry • **Some CCRI low priorities can be high for NMIs and vice-versa**
8. Working groups	**8.1** (0.2)	• **Importance of WGs (from higher to lower):** KCWG(I), KCWG(II), ADWG(I), KCWG(III), RMOWG, BSWG(I), ESWG(II), TIWG(II), BqWG(II), HEWG(II)
9. BIPM workload	**8.4** (0.3)	- Clear overview - Too many tasks with too few people - Too long delays for producing Section II comparison reports
10. Stakeholders	**8.3** (0.3)	- Exhaustive list - No explicit duties for stakeholders
11. Summary	**8.2** (0.3)	- Strategy is good, but not robust without authority/finance

[i] Strategic plan for the CCRI up to 2020, submitted to the CIPM (September 2011)

[ii] Provision of international traceability for high-energy photon dosimetry, ADWG(I), CCRI-2013.