Work Programme

of the International Bureau of Weights and Measures

for the four years 2016-2019

Comité international des poids et mesures

Priority activities in the field of Ionizing Radiation

The aim of the Ionizing Radiation Programme for 2016-2019 is to provide Member States with metrological support to provide confidence in the services that the NMIs offer to their users, based on a well-defined and stable set of international reference facilities to compare and establish the equivalence or traceability of the national standards for dosimetry and radionuclide activity in health applications (radiotherapy, nuclear medicine, radiodiagnostics), nuclear industry, environmental survey and related activities.

IR-A1 Dosimetry Programme for international equivalence of measurements in the Health field: radiotherapy, radiodiagnostics and radioprotection.

Project Code	**Project Name**	**Deliverables**	**Resources in:** **a) Person months (pm)** **b) Operating costs** **c) Capital investment**
IR-A1.1	**X-ray standards dosimetry** BIPM.RI(I)-K2,-K3,-K7 ongoing comparisons of air kerma or absorbed dose to water for low-, medium-energy and mammography, using the high-stability BIPM facilities *establishing and maintaining the long-term equivalence or traceability of NMIs for nearly 20 x-ray radiation qualities adopted by the CCRI and widely used in radiotherapy and radiodiagnostics.* Participant NMIs: **25**	1) Maintaining the BIPM primary standards for: - air kerma in low- (5 qualities) and medium-energy (4 qualities) x-rays, - absorbed-dose to water in medium-energy x-rays developed in 2013-2015 (4 qualities), - air kerma for mammography (4 qualities). 2) Providing BIPM Bilateral key comparisons (**BIPM.RI(I)-K2, -K3, -K7**) for 16 NMIs 3) Calibration and characterization of 16 NMIs standards for x-rays, on request. 4) Replacement of the HV generator for low-energy x-rays in 2016	a) 48 pers months b) 22 k€ c) 90 k€
IR-A1.2	**γ-ray standards dosimetry** BIPM.RI(I)-K1,-K4,-K5 and -K6 ongoing comparisons of air kerma and/or absorbed dose to water for ^{60}Co and ^{137}Cs, using the high-stability BIPM facilities *establishing and maintaining the long-term equivalence or traceability of NMIs for ^{60}Co and ^{137}Cs beams, widely used at radiotherapy and/or radioprotection levels, and serving as reference for the calorimetric measurements in high-energy photon beams (medical accelerators).*	1) Maintaining the BIPM primary standards for: - air kerma in ^{60}Co and ^{137}Cs beams for radiotherapy and radioprotection (**BIPM.RI(I)-K1, K5**), - absorbed dose to water in ^{60}Co beams (radiotherapy, **BIPM.RI(I)-K4**), - providing reference to the graphite calorimeter standard for absorbed dose to water in high-energy beams (**BIPM.RI(I)-K6**). 2) Providing **BIPM Bilateral comparisons key comparisons (-K1, -K4, -K5)** for 20 NMIs. 3) Characterization and calibration of **40** national standards (on request). 4) Replacement of the ^{60}Co source in 2017.	a) 60 pers months b) 30 k€ c) 20 k€ + 200 k€ (new ^{60}Co source in 2017)

IR-A1.3	**High-energy dosimetry (accelerator dosimetry)** BIPM.RI(I)-K6 ongoing comparisons of absorbed dose to water for high-energy photon beams, using the transportable BIPM graphite calorimeter on-site at the NMIs *establishing and maintaining the long-term equivalence and traceability of absorbed dose for photons and eventual extension to electrons (see IR-A1.5 in additional projects) in high-energy beams now used in the vast majority of radiotherapy applications.* Participant NMIs: **16**	1) Maintaining the transportable photon calorimeter standard to provide robust traceability for absorbed dose through on-site comparisons and characterizations of national standards. 2) Providing **4 BIPM.RI(I)-K6** comparisons on-site at the NMIs. 3) Continued study of long-term optimal scenario for a sustainable maintenance of **BIPM.RI(I)-K6** comparisons, using the BIPM graphite calorimeter standard.	a) 63 pers months b) 97 k€ c) 15 k€
IR-A1.4	**Brachytherapy** BIPM.RI(I)-K8 ongoing comparisons of reference air kerma using two transportable transfer instruments on-site at the NMIs *establishing and maintaining the long-term equivalence of reference air kerma for HDR ^{192}Ir sources, and eventual extension to LDR ^{125}I sources, used in brachytherapy applications world-wide*. Participant NMIs: **15**	1) Maintaining the BIPM transfer standards (thimble and well-type chambers) for brachytherapy. 2) Providing **4 BIPM.RI(I)-K8** on-site comparisons for NMIs of reference air kerma for HDR ^{192}Ir sources, as adopted by the CCRI. 3) Study of the convenience and feasibility of future development of a primary standard. Proposal at CCRI-2017.	a) 12 pers months b) 17 k€ c) 10 k€

IR-A2 Radionuclides Programme for international equivalence of measurements in the health, environmental and industrial fields: nuclear medicine, radiodiagnostics, PET nuclides, radiotherapy, monitoring contamination of food or environment and safe nuclear activities.

Project Code	Project Name	Deliverables	Resources in: **a) Person months (pm)** **b) Operating costs** **c) Capital investment**
IR-A2.1	**International Reference System (SIR) for γ emitters** BIPM.RI(II)-K1 on-going comparisons of activity of solutions of γ-ray emitting radionuclides, using high-stability well-type ionization chambers and ^{226}Ra sources *establishing and maintaining the equivalence for more than 60 different radionuclides widely used in nuclear medicine or appearing in the nuclear cycle and environmental monitoring.* Participant NMIs: **25**	1) Maintenance and development of SIR facility for γ emitters future core comparisons. 2) **BIPM.RI(II) – K1,** 40 bilateral 'on demand' comparisons covering (at least): C-11 F-18 Na-22 Na-24 Sc-46 Sc-47 Cr-51 Mn-54 Mn-56 Co-56 Co-57 Co-58 Co-60 Fe-59 Cu-64 Zn-65 Ga-67 Se-75 Kr-85 Sr-85 Y-88 Nb-95 Mo-99 Tc-99m Ru-103 Ru-106 Cd-109 Ag-110m Ag-111 In-111 Sn-113 I-123 Sb-124 Sb-125 I-125 I-131 Ba-133 Xe-133 Cs-134 Cs-137 Ce-139 Ba-140 Ce-141 Ce-144 Eu-152 Gd-153 Sm-153 Eu-154 Eu-155 Ho-166m Yb-169 Lu-177 Ta-182 Re-186 Ir-192 Au-195 Tl-201 Hg-203 Pb-203 B i-207 Rn-222 Th-228 Np-237 Am-241 Am-243. 3) **Reduction** of the total number of comparisons through further development of the Measurements Method Matrix (MMM).	a) 45 pers months b) 18 k€ c) 10 k€
IR-A2.2	**International Reference System (SIR) for pure β emitters** BIPM.RI(II)-K1 on-going comparisons of activity of solutions of pure β emitters, using liquid-scintillation counting methods *establishment of equivalence for approximately 15 different radionuclides widely used in nuclear medicine, nuclear cycle and environmental monitoring*. Participant NMIs: **20**	1) Operation, maintenance and development of SIR facility for β emitters, implemented in 2013-2015, for future core comparisons. 2) **20 BIPM.RI(II) – K1** bilateral comparisons covering (on demand): ^{3}H, ^{14}C, ^{32}P, ^{55}Fe, ^{63}Ni, ^{89}Sr, ^{90}Sr/Y, ^{99}Tc, ^{147}Pm, ^{204}Tl and other radionuclides requested by NMIs. 3) Reduction of the current logistics- heavy CCRI (II) - K2 comparisons to a minimum. 4) Reduction of the total number of comparisons through further development of the Measurements Method Matrix (MMM).	a) 40 pers months b) 22 k€ c) 0 k€

IR-A2.3	**Extension of SIR to α emitters** Implementation of methods for extending to α emitters the BIPM.RI(II)-K1 on-going comparisons of activity of solutions of radionuclides ,*establishment of equivalence for about 10 radionuclides of interest in the nuclear cycle, nuclear medicine, radiotherapy and environmental survey*. Participant NMIs: **10**	1) Development and Implementation of liquid scintillation methods or α-particle counting using defined solid angle detectors. 2) **10 BIPM.RI(II) – K1** bilateral comparisons**,** covering (on demand): ^{241}Am, ^{223}Ra, ^{211}At, ^{238}Pu, ^{210}Po and other radionuclides demanded by NMIs. 3) This will allow to complete (with IR-A2.1 and IR-A2.2) the frame for the most common α- , β- and γ-emitters. 4) Reduction of the total number of comparisons through further development of the MMM.	a) 22 pers months b) 12 k€ c) 15 k€
IR-A2.4	**International reference facility for comparison of short-lived γ-emitting radionuclides** BIPM.RI(II)-K4 on-site (at NMIs) on-going comparisons of short-lived radionuclides, using the transportable transfer instrument (SIRTI), *establishment of equivalence for about 10 short-lived γ-emitting radionuclides of interest in nuclear medicine, PET, molecular imaging.* Participant NMIs: **15**	1) Maintenance and development of the SIR Transfer Instrument for on-site comparisons and extension to new radionuclides. 2) **8 BIPM.RI(II) – K4** bilateral comparisons covering (on demand): ^{99m}Tc, ^{18}F, ^{64}Cu, ^{11}C, ^{68}Ga, ^{211}At, ^{56}Mn and other radionuclides demanded by NMIs. 3) Reduction of the total number of comparisons through further development of the MMM.	a) 22 pers months b) 28 k€ c) 30 k€
IR-A2.5	**Reference instruments for primary measurements** Provision of new SIR entries for improvement of KCRVs not well established, applying and developing technical skills of staff for efficient coordination of comparisons. *KCRV improvements for about 15 radionuclides in support of traceability/equivalence of radionuclide comparisons.* <u>Participant NMIs:</u> **15**	1) Maintenance and further development of 4πβ-γ (anti)coincidence counting and TDCR LSC systems. 2) Organization of **one CCRI comparison for ^{109}Cd** and participation in two CCRI comparisons according to the Rolling Plan and the MMM table. 3) Establish missing KCRVs for: ^{47}Sc, ^{68}Ge, ^{111}Ag, ^{140}Ba, ^{155}Eu, ^{195}Au and improve KCRVs for: ^{24}Na, ^{56}Co, ^{123}I, ^{124}Sb, ^{125}Sb, ^{153}Sm, ^{154}Eu, ^{166m}Ho, ^{177}Lu as priorities.	a) 12 pers months b) 12 k€ c) 20 k€

IR-A2.6	**Establishment of operational capability for low-level activity measurements of γ and β emitters** Completion of capability of low-level activity measurements for β and γ emitter, *support to CCRI comparisons on environmental and reference materials programmes for international cooperation.* Participant NMIs: **12**	1) Acquisition, Monte Carlo simulation and setup of a 4π-γ NaI(Tl) well-type detector for γ emitters. 2) Operational use of the existing Quantulus 1220-LSC spectrometer for β emitters. 3) **Participation/organization of one CCRI comparison** on low-level measurements of contaminated materials.	a) 24 pers months b) 10 k€ c) 20 k€ + 70 k€ (γ counter)
IR-A2.7	**Development of physical backup to SIR ^{226}Ra sources** Prevention of long-term obsolescence of ^{226}Ra sources (IR-A2.1) by implementing as replacement an electronic absolute current source, *enhancing robustness of SIR in the long-term, as additional safeguard to the equivalence of more than 60 γ emitters widely used in nuclear medicine or appearing in the nuclear cycle and environmental monitoring.* Participant (related) NMIs: **25**	1) Feasibility and eventual construction and operation of an electronic current source of high stability and reproducibility. 2) Parallel operation of the electrical source and comparison of performance with the ^{226}Ra sources. 3) In case of positive answer to point 1) gradual replacement and elimination of ^{226}Ra sources used in the SIR.	a) 19 pers months b) 9 k€ c) 25 k€

IR-A3. Thermometry Service to BIPM Departments

Project Code	**Project Name**	**Deliverables**	**Resources in:** **a) Person months (pm)** **b) Operating costs** **c) Capital investment**
IR-A3.1	**BIPM internal service of thermometry calibrations**	- Internal calibration service of SPRTs and laboratory thermometers.	a) 12 pers months b) 2 k€ c) 5 k€ + 65 k€ (precision bridge replacement)

Additional activities in the field of Ionizing Radiation - not covered by the adopted budget

IR-A1.3.1	**High-energy electron dosimetry (accelerator dosimetry) – calorimeter for high energy electrons** *See IR-A1.3 in the prioritized projects for details*	1) Development of a calorimeter standard for high-energy electrons, with the aim of providing equivalence and traceability for absorbed dose in electron beams through comparisons and characterizations of national standards. Requires one additional staff member and frequent access to an accelerator.	a) **48 pers months (1 new staff member)** b) 10 k€ c) 35 k€
IR-A1.4.1	**Brachytherapy** *See IR-A1.4 in the prioritized projects for details*	1) Extension to LDR ^{125}I sources, to be decided by the CCRI(I) in 2015: Four comparisons.	a) 6 pers months b) 12 k€ c) 35 k€

IR-A2.8	**Development of the Becquerel ionization chamber** Prevention of eventual future obsolescence (long term) of the SIR ionization chambers (IR-A2.1), by using an optimized backup chamber, *enhanced robustness of SIR in the long term, as an additional safeguard to the current equivalence of more than 60 γ emitters used in nuclear medicine or appearing in the nuclear cycle and environmental monitoring.* Participant (related) NMIs: **25**	1) Analysis of conclusions of the BqWG(II) *"Realization of the Becquerel"* project (design a robust, highly stable and reproducible chamber), and decision making about its suitability for the BIPM SIR. 2) If relevant to the BIPM, **construction of the first BIPM prototype**, operation in parallel with the conventional SIR chambers and comparison of performance. 3) If not relevant, prevision of backup for the existing chambers using commercial equipment.	a) 6 pers months (+ workshop workload) b) 4 k€ c) 110 k€

IR-A2.9	**Development of a sandwich-type coincidence counter for β-γ emitters** New reference instrument to complete the primary measurement methods (IR-A2.5) available at the BIPM and the technical skills of staff for provision of new SIR entries and efficient coordination of comparisons, *comparisons of radionuclides used in nuclear medicine or appearing in the nuclear cycle and environmental monitoring.* Participant (related) NMIs: **25**	1) Design, construction and experimental setup. 2) **Operational tests with β-γ emitters**. 3) Support to CCRI (^{109}Cd) and BIPM comparisons.	a) 18 pers months b) 12 k€ c) 50 k€

CIR-A1.1	**Coordination and Support to the CCRI** (Ionizing Radiation)	Provision of the CCRI Executive Secretary, general support to CC and WGs plus specifically support for: 1) Biennial CCRI and sections I, II and III meetings 2) Regular meetings of five working groups 3) Review of CC and RMO comparison reports before publication 4) Development of strategic plans 5) Publication of BIPM *Monographies* 6) Review of CC and RMO comparison reports before publication 7) Related liaisons with RMOs.	a) 20 pers months b) 0 k€ c) 0 k€
CIR-A1.2	**Coordination and Support to the CCAUV** (Acoustics, ultrasound and vibration)	Provision of the CCAUV Executive Secretary: support and advice to CC and WGs including:- 1) Biennial CCAUV and three WG meetings 2) Pro-active interaction on strategy and communication 3) Coordinate review of CC and RMO comparison reports before publication 4) Related liaisons with RMOs.	a) 6 pers months b) 0 k€ c) 0 k€
CIR-A1.3	**Coordination and Support to the CCT** (Thermometry)	Provision of the CCT Executive Secretary: support and advice to CC and WGs including:- 1) Biennial CCT and ten WG meetings 2) Pro-active interaction on strategy and communication 3) Coordinate review of CC and RMO comparison reports before publication 4) Related liaisons with RMOs.	a) 6 pers months b) 0 k€ c) 0 k€
CIR-A1.4	**Support to JCGM/WG1**	- Two annual meetings, Executive Secretary and *Rapporteur*.	a) 5 pers months b) 0 k€ c) 0 k€
CIR-A1.5	**International scientific collaboration**	- International Commission on Radiation Units (ICRU) (Commissioner and sponsor of Report Committees), - International Atomic Energy Agency (IAEA) (SSDL Scientific Committee), - International Committee for Radionuclide Metrology (ICRM) (Scientific Committee and technical refereeing).	a) 12 pers months b) 0 k€ c) 0 k€