IAEA Coordinated Research Activities in 2018

I. General Information

I.1. Statutory Provisions

The International Atomic Energy Agency (IAEA) is authorized under its Statute to encourage and assist research on, and development and practical application of, atomic energy for peaceful uses throughout the world. The IAEA's Programme and Budget for 2018–2019 provides, accordingly, for the placing of research, technical and doctoral contracts and research agreements with universities, colleges, research centres, and laboratories, as well as with other institutions in Member States, with the aim of encouraging and assisting research on subjects directly related to the IAEA's mandate.

I.2. Financial Support

The IAEA's financial support for a project is usually provided in the form of a lump-sum cost-sharing contract. The Contractor engaged by such a contract is usually expected to bear part of the cost of the project and, in any case, to continue to make normal contributions covering overheads and other expenses and the IAEA contributes an appropriate percentage of the total estimated costs. Owing to the limited resources available, the amounts awarded are rarely large — the present average being approximately €7000 per annum per contract. Larger awards may, however, be considered. In addition to the contract award, Contractors participating in IAEA coordinated research projects (CRPs) are invited to attend periodic Research Coordination Meetings (RCMs) at the IAEA's expense.

In addition to the contracts mentioned above, agreements may be awarded to institutes, normally in developed countries, for participation in an IAEA CRP. Under such agreements, no commitment to pay a financial award is made to the agreement holder other than the provision to attend RCMs at the IAEA's expense.

I.3. Selection of Institution

The IAEA selects the institutions to which research contracts and agreements will be awarded. When a specific proposal for research is made by an institution in a Member State, the decision to award a research contract or agreement is made after careful consideration of the technical merits of the proposal, the compatibility of the project with the IAEA's own functions and approved programmes, the availability of appropriate facilities and personnel in the institution and previous research work related to the project.

Additionally, where it is recognized that the award of a particular contract or agreement would materially assist one of the IAEA's programmes, an invitation is sent to those institutions believed to have the necessary facilities and personnel, and the Government of the Member State concerned is kept informed.

In providing research support from the limited funds available for the coordinated research activities programme, priority is normally given to proposals received from institutions in developing Member States and to qualified young and female researchers.

I.4. Formal Submission of Proposals

Based either on a proposal made by the IAEA, or a proposal developed at a research institute, a formal submission of a project proposal should be made by the institute concerned, and **submitted directly to the IAEA's Research Contracts Administration Section**.

If the proposed project is approved, a contract or agreement will be sent to the head of the institution for approval and signature, and the Government of the Member State will be duly notified through the appropriate channels of the conclusion of the contract or agreement. For all research contract proposals, the "Proposal for Research Contract" form N-18/Rev.18 (Apr. 18) must be used. Proposals for research agreements should be made using the "Proposal for Research Agreement" form N-21/Rev.16 (Apr. 18). Both forms are available on the Coordinated Research Activities website, in the following link: https://www.iaea.org/services/coordinated-research-activities/how-to-participate.

II. General Conditions of Contracts and Agreements

II.1. Period of Contract or Agreement

Research contracts and agreements are generally awarded for the entire duration of the CRP. They may, however, be issued for shorter periods and, if need be, extended within the duration of the CRP.

II.2. Reports

Each Contractor must submit a **yearly progress report**, which should also contain the proposed programme of work for the following year, and a **final report** at the end of the contract. The positive evaluation of the progress reports by the appropriate Project Officer constitutes the basis for the continuation of the project and payment of the next instalment of the project award, while the final payment is made only upon positive evaluation of the final report and completion of work. Agreement holders must submit a report at each meeting of the CRP.

II.3. Conditions of Payment under Contracts

The timetable of the IAEA's payments is established when the contract is negotiated. Cash payments are normally made to the Contractor for expenses covered under the contract, except in cases where the IAEA is requested to procure equipment or other project-related supplies on behalf of the Contractor. In such cases, the portion of the total amount designated for equipment and supplies to be procured by the IAEA is not transferred to the Contractor, and shall be held by the IAEA in a trust fund.

Funds are normally obligated when the contract is awarded, and, subsequently, every year upon certification by the Project Officer for the CRP that the progress reports have been received in due time and accepted by the IAEA. The obligation for the final year tranche is split into two instalments, one at the beginning of the final year and one at the end of the final year, upon certification by the Project Officer for the CRP that the final report has been received in due time and accepted by the IAEA. All efforts should be made to submit the required reports in a timely manner.

II.4. Publication of Results and Intellectual Property Rights

Publication, either by the institution or the IAEA, of the results of the work performed under research contracts and agreements is normally the most efficient and effective way of bringing these results to the notice of other scientists. In publishing the results of research, the Contractor must acknowledge the contribution of the IAEA. The reports submitted by the Contractor shall normally be the exclusive property of the IAEA.

II.5. Provision of Equipment

The Contractor may wish to use a portion of the funds provided by the IAEA for the purchase of equipment required for the performance of the research. Only the items relating to the specific project concerned can be purchased from the funds provided by the IAEA. These items can be purchased directly by the Contractor or, upon request, procurement of equipment items can also be arranged by the IAEA, in cases where this expedites their supply. Funds reserved for the purchase of project-related supplies and equipment by the IAEA on behalf of the Contractor are transferred to a trust fund in which they remain until all foreseen purchases are made. No orders for supplies or equipment will be made by the IAEA after the contract is terminated.

II.6. Other Provisions

Each contract/agreement provides that the IAEA shall not be liable for any death, injury or damage arising out of the implementation of the research project; as a rule, a clause is included requiring the Contractor or agreement holder to hold the IAEA harmless from any damage suits. Special provisions are also made with respect to settlement of disputes. Given the immunity from jurisdiction awarded to the IAEA, settlement of disputes must be governed by arbitration or conciliation under the rules of the United Nations Commission on International Trade Law (UNCITRAL). Additional provisions are made with regards to, inter alia, applicable health and safety standards.

III. IAEA Coordinated Research Projects for which Research may be Supported in 2018

Most of the research supported by the IAEA is related to its CRPs, which are developed in line with the overall goals of the IAEA. Only in exceptional cases will research contract funds be used to finance individual contract proposals that, while not forming part of a CRP, deal with topics in the IAEA's programme. The enclosed document includes an open-ended list of CRPs under which the IAEA may consider providing support for research in 2018. Additionally, the Coordinated Research Activities website lists the most up to date CRPs open for proposals, which can be found at the following link: https://www.iaea.org/services/coordinated-research-activities.

All proposals received by the IAEA will be carefully considered. Enquiries concerning specific CRPs should be addressed directly to the IAEA's Research Contracts Administration Section, at: **research.contracts@iaea.org**.

List of IAEA Coordinated Research Activities That Are Open for Submission of Proposals in 2018

(by Major Programme, Programme and Project)

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[1] AIPS: Agency-wide Information System for Programme Support
[2] SIT: sterile insect technique

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Major Programme 1: Nuclear Power, Fuel Cycle and Nuclear Science	
1.1 Nuclear Power	
Project 1000166	**1.1.5.001 Technology Development for Water Cooled Reactors**
CRP Title:	**Evaluation of Severe Accidents Simulation Codes for Advanced Water Cooled Reactors**
CRP Code:	**I31033**

The objective of this CRP is to advance the understanding and characterization of the effect of various sources of uncertainty and variability in the predictive output of severe accident codes for advanced WCRs. These sources of uncertainty include state of knowledge uncertainty, random sources of boundary condition variability, model form uncertainty and inherent numerical precision variability. Therefore, various widely used severe accident codes (e.g. MELCOR, MAAP, ASTEC, etc) will be used to evaluate model form uncertainty. Monte Carlo sampling methods will be used to assess state of knowledge and stochastic sources of uncertainty, and narrowed parameter distributions will be used to quantify inherent numerical uncertainties. For example, key figures of merit may include in-vessel hydrogen generation or fission product release to containment or environment that will be determined for quantifying uncertainty dispersion. An initial important Phenomena Identification and Ranking Table (PIRT) process will be required to determine key uncertain code inputs and their likelihood distributions most affecting predicted code results based on expert elicitation from participating members. Random sampling methods of determined parameter distributions will generate populations of code inputs for select accident sequences and subsequently distributions of predicted key figures of merit. These resultant distributions will then characterize the uncertainty and precision of severe accident code predictions. This is necessary for defensible applications of code results to various applications such as regulatory margins assessment. A major outcome of this CRP will be to raise the level of expertise and sophistication of severe accident code users and ensure the proper application of code results to safety and regulatory applications. Member States will be provided with an exercise to elevate the ability and sophistication of global severe accident code users and increase the capability of Member States in the methodology for taking a risk-informed decision-making approach to severe accident analysis by focusing on the key phenomena.

1.2 Nuclear Fuel Cycle and Waste Management	
Project 1000033	**1.2.2.001 Nuclear Power Reactor Fuel Engineering and Performance**
CRP Title:	**Fuel Materials for Fast Reactors**
CRP Code:	**2175**

The objectives of this CRP are:

- To bring together experts to enhance international collaboration and combine efforts by optimizing the use of data from a limited number of facilities for joint benefits.
- To promote sharing of data from fast neutron irradiation experiments on fuel pins and associated post-irradiation examination.
- To perform simulations of these datasets, using various fuel performance codes.
- To compare, analyse and share simulation results among participants, including recommendations on the enhancement of fuel performance codes and identification of gaps in irradiation data.

1.4 Nuclear Science	
Project 1000121	**1.4.1.003 Atomic and Molecular Data Developments**
CRP Title:	**Atomic Data for Vapour Shielding in Fusion Devices**
CRP Code:	**F43024**

The objective of Project 1000121 is to provide internationally recommended data for atomic and plasma–material interaction processes that are important in fusion energy research. Disruptions and other pulsed heat loads cause ablation and limit the lifetime of plasma-facing materials. However, under intense power loads the ablating material forms a dense plasma in front of the surface by which much of the impinging energy is converted to radiation and reflected back into the plasma; in some cases, the amount of energy reaching the surface is reduced to just a few percent of the incoming

energy. The process is called vapour shielding. For easily ablating materials, such as lithium, tin and other liquid metals, the process sets in at relatively low heat loads and this has prompted research into the viability of such materials in the plasma-facing components of a fusion reactor. The proposed CRP would provide trusted data for these processes for materials and under conditions most relevant to fusion devices, thereby supporting fusion energy development.	
Project 1000161	**1.4.1.002 Nuclear Data Developments**
CRP Title:	**Fission Yields**
CRP Code:	**NEW**
There is high demand for an updated nuclear data library for fission yields. This will enable, among others, more credible burnup and inventory analyses, while other applications would include non-proliferation, which relies on high quality fission yield data. Related to the fission yields are all associated fission neutron quantities, such as fission neutron spectra and average number of fission neutrons, which can be analysed simultaneously. Since several new measurements and new nuclear model methodologies have been developed in recent years, it is high time to gather together the experts to improve our data libraries for fission yields.	
Project 1000162	**1.4.3.001 Accelerator Applications in Multiple Disciplines**
CRP Title:	**Ion Beam Irradiation for High Level Nuclear Waste Form Development (INWARD)**
CRP Code:	**F11022**
The safe long term disposal of high level nuclear waste form reprocessing has proven problematic worldwide, with few countries possessing a long term strategy. This may be due to a range of reasons, ranging from the technical to the socio-political. Issues remain, including the fabrication and the long term behaviour of high level waste forms during geological storage. This project addresses the nature of such challenges, focusing on the long term behaviour of proposed waste forms and the impacts arising from induced radiation damage through alpha and beta decays. Radiation damage induces change over long timescales, i.e. hundreds to millions of years, making long term effects difficult to examine. However, the accelerated damage produced by ion beams provides a method for developing predictive models that can then be verified and tested; conditions such as temperature, rate of damage, in situ testing can all be controlled during ion beam irradiation. Materials of interest include the international standard glass and pure silica glass; zircon; pyrochlore–fluorite ceramics and a representative glass composite. Where available, the results will be validated using synthetic and natural samples that have undergone differing degrees of damage due to self-irradiation. The knowledge will be used to identify and quantify mechanisms of material transformations, and the long term predictability required for geological repositories. The results will define the source terms for waste forms in evolving repository designs, enhancing the design and reducing uncertainty and costs.	
Project 1000163	**1.4.3.002 Facilitating Experiments with Accelerators**
CRP Title:	**Facilitating Access to Ion Beam Accelerators**
CRP Code:	**G32008**
Accelerator based technologies are associated with a broad range of applications that have a societal and technological impact, and can contribute to the economic development of Member States. The utilization of accelerators enhances innovation in a variety of fields with health, materials, culture, environment, energy and natural resources being typical examples. In this context, accelerator applications are one of the thematic areas where the IAEA supports its Member States in strengthening their capabilities to adopt and benefit from the usage of accelerators. Although IAEA developing Member States recognize accelerator technologies as a key element to serve socioeconomic development, many of them face difficulties in allocating the funds required for the installation and effective operation of accelerator facilities and subsequent running costs. As a result, researchers from these Member States often do not have any support to employ accelerator based techniques, or their access to accelerator facilities is very limited. The overall objective of this CRP is to increase the impact of accelerator-based analytical techniques in IAEA developing Member States by increasing the number of users of accelerator facilities for analytical purposes and education.	

Major Programme 2: Nuclear Techniques for Development and Environmental Protection	
2.1 Food and Agriculture	
Project 2000006	**2.1.1.002 Water Management for Resource-Saving Agriculture**
CRP Title:	**Multiple Isotope Fingerprints to Identify Sources and Transport of Agro-Contaminants**
CRP Code:	**D15018**
Agriculture is the main source of pollution in rivers and streams and this has a direct negative impact on human health. A major knowledge gap regarding pollution in agro-ecosystems is source identification and apportionment, which requires more data, research and integration of approaches. This CRP aims to: (i) identify and apportion macronutrient and micro-contaminant inputs in agro-ecosystems using an integrated isotope approach; (ii) develop, evaluate and standardize an integrative isotope approach for identifying and apportioning sources of contaminants in agro-ecosystems; (iii) provide guidelines and decision trees for adapting and applying the toolbox; (iv) support adaptive land and water management and conservation practices to reduce pollutants from agriculture into soil and water bodies. The nuclear techniques to be applied include (i) compound specific isotope analysis (CSIA) to determine the fate of micro-contaminants in soils and water; (ii) Stable isotopes analyses of other solutes: $\delta^{15}N-NO_3$, $\delta^{18}O-NO_3$ $\delta^{15}N-SO_4$, $\delta^{18}O-SO_4$ and water $\delta^{2}H-H_2O$, $\delta^{18}O-H_2O$; and (iii) the oxygen isotope ratio of dissolved inorganic phosphate ($\delta^{18}Op$)	
Project 2000017	**2.1.3.002 Traceability for Food Safety and Quality and to Enhance International Trade**
CRP Title:	**Implementation of Nuclear and Related Techniques to Confirm the Authenticity of Foods with High Value Production Chains and High Value Food Property Labelling Claims**
CRP Code:	**2189**
Numerous foods are sold at premium prices because of high value labelling claims related to specific production methods, unique characteristics and origins. These claims include agricultural, geographic, religious, ethical and nutraceutical labelling specifications that add value to the products. In order to protect consumers from fraud, and potential unintended food safety issues, standardized analytical methods are required to confirm such claims. Several nuclear, isotopic and related techniques have proven suitable for confirming a wide range of high value labelling claims such as free range, organic, natural/synthetic etc. The overall objective of this CRP is to enable developing countries to protect and promote food products with high-value labelling claims through the development and application of nuclear and related techniques. The project thereby aims to safeguard consumers and reputable producers, ensure regulatory, religious and ethical compliance, stimulate domestic markets and reduce barriers to international trade.	
Project 2000021	**2.1.4.001 SIT and Related Technologies to Manage Major Insect Plant Pests**
CRP Title:	**Simultaneous Application of SIT and MAT to Enhance Pest Bactrocera Management**
CRP Code:	**D41027**
The sterile insect technique (SIT), which is an environment-friendly technique that involves the mass-rearing of male insects, sterilizing them by ionizing radiation and releasing them in the target area in numbers large enough to out-compete their wild counterparts. Sterile male insects mating with wild female insects does not result in offspring, and the release of sterile males in adequate sterile-to-wild male overflooding ratios suppresses the wild population in the targeted area. In certain cases, this population suppression can lead to eventual eradication of the target population. Furthermore, as SIT acts in an inverse density dependent manner, it becomes more effective when the wild population is reduced. The male annihilation technique (MAT) has been used to suppress Bactrocera pest species as part of integrated pest management approaches, and even successfully applied to eradicate populations in isolated situations such as on islands or during outbreaks. Integration of MAT with SIT has so far been sequential, rather than simultaneous, with SIT applied after a significant reduction of	

the wild population due to MAT. The reason for this is to avoid the mass-trapping of released sterile males in the lured traps using semiochemical methyl eugenol, which would significantly reduce the efficacy of the SIT. The development of cost-effective semiochemical treatments and delivering systems that improve sterile male sexual performance and reduce their response to MAT formulations is highly desirable so that MAT and SIT could be integrated. Even though the incorporation of semiochemical supplements for Bactrocera species appears feasible, practical and standard procedures to implement them at an operational scale still need to be developed and validated. Thus, exploring the potential of such an approach is essential since the simultaneous application of MAT and SIT has considerable potential to drastically increase sterile-to-wild male overflooding ratios and therefore SIT cost-effectiveness. The combination of male replacement plus male enhanced performance increases what can be achieved with the same number of sterile flies; treating a wider area or enabling more rapid suppression or eradication. Furthermore, due to the increased cost-effectiveness, decisions to invest in SIT may be facilitated in situations where this would not otherwise be feasible. The CRP objective is to explore the potentially synergistic relationship between MAT and SIT when applied simultaneously to dramatically improve the efficacy of Bactrocera fruit fly management. The assessment of semiochemicals to enhance Bactrocera spp. SIT application against these pest fruit flies will include: assessment of the effect of exposure of major Bactrocera pest species to semiochemicals on earlier sexual maturation and improved male sexual performance, as well as reduced response of exposed sterile males to MAT traps; evaluation of key parameters in large field cages such as wild fly sex ratio, degree of lure response of sterile flies, sterile-to-wild overflooding ratio and bisexual release to determine their influence on the effectiveness of simultaneous MAT and SIT; field evaluation of simultaneous MAT and SIT within a pilot or operational setting that includes compatible management practices.	
Project 2000031	**2.1.5.001 Mutation Induction for Better Adaptation to Climate Change**
CRP Title:	**Disease Resistance in Rice and Wheat for Better Adaptation to Climate Change**
CRP Code:	**D23032**
The world population is predicted to reach more than nine billion by 2050, requiring an increase of about 50% in food production relative to current levels. It is a major challenge to ensure sustainable food production without further expanding the area of cultivated crops. Plant breeding is important to improving yield and tolerance to existing and emerging biotic and abiotic stresses. Cereals are the key staple crops for the food security of the world's population, They supply around 42.5% of the global food calorie supply. Rice and wheat make up almost half of the cereals consumed; the predictions for 2017/18 being 703 and 503 million tonnes respectively (FAO, 2017 - http://www.fao.org/3/a-i8278e.pdf). Rice is grown all over the world and is the main staple for about 50% of the world population (IRRI, 2015; AfricaRice, 2015). The world today still has huge concentrations of poverty, most of them where rice is grown. While wheat production is mostly confined to temperate climates, wheat is the staple food for hundreds of millions of poor people in developing countries. Wheat provides around one-fifth of all calories and protein for people globally. In developing countries, wheat feeds around 1.2 billion people who live on less than US$ 2 a day. Diseases are among the major obstacles hindering yield improvements both in rice and wheat. Changing climatic conditions help the spread of diseases to new destinations and exacerbate their impact. In addition to the already widespread diseases of rice such as blast, sheath blight, false and bacterial leaf blight, threats of emerging diseases are becoming more serious, such as in the case of false smut of rice and blast of wheat. To minimize the impact of these diseases, environmentally friendly and cost-effective technologies are needed for their prevention and management. The development and utilization of disease resistant varieties is the most effective, affordable and environmentally friendly approach for the management of these threats. of the mutation breeding technique appears to be a viable tool in the development of such germplasms and varieties. Breeding for disease resistance is aimed at incorporating durable resistance into improved rice and wheat varieties. However, varieties released as resistant have become susceptible after years or decades of cultivation due to pathogen evolution and adaptation to cultivated varieties. Thus, breeding for disease resistance is a continuous challenge to rice/wheat breeders and pathologists.	

Rice diseases (bacterial, fungal, or viral) threaten food productivity. For example, one of the largest impediments to increased rice production is the presence of rice blast (Magnaporthe oryzae, fungus), which directly decreases rice yields and indirectly increases production costs. Rice blast is one of the most frequent and costly rice diseases in temperate rice-growing regions worldwide. Host resistance is the most efficient, environmentally friendly method to cope with such diverse pathogens. Wheat blast was initially identified in Brazil in 1985. It gradually expanded in South America to around 3 million ha in the early 1990s. The disease appeared in Bangladesh in 2016 and rapidly became a serious threat to wheat production in the country. There is fear that the disease might spread in the country and also to neighbouring countries, putting wheat production in the region at great risk.

This CRP proposes the use of physical mutagenesis and associated screening technologies to broaden the genetic base of resistance in rice and wheat. The project seeks to link rice and wheat improvement programmes in Member States and IAEA staff. This would combine expertise in the field, screen house and laboratory screening to enhance mutation breeding for the timely development or adaptation of screening packages to generate novel sources of disease resistance in rice and wheat. Up to ten research contracts are expected to be awarded and up to five no-cost agreement holders from selected advanced laboratories. Research institutes with recognized expertise in the targeted technologies will be invited to share their experience with the contract holders and contribute to the development and validation of the planned technical packages. In addition, it is foreseen that two technical contracts will be awarded for services in advanced areas such as marker development and mutant characterization. Coordination and technical management will be handled by the scientific secretary in the Plant Breeding and Genetics Section with involvement of Plant Breeding and Genetics Laboratory.

2.2 Human Health

Project 2000004	**2.2.4.002 Developments in Radiation Dosimetry**
CRP Title:	**Development of Methodology for Dosimetry Audits in Brachytherapy**
CRP Code:	**2201**

This CRP will focus on the development and testing of dosimetry audit methodologies for high dose rate brachytherapy services. The audit will commence with the determination of the reference air kerma rate for ^{192}Ir and/or ^{60}Co high dose rate brachytherapy micro-sources using agreed methodologies, including derivation of an uncertainty budget. An off-site dosimetry audit methodology will then be developed to investigate the accuracy of the brachytherapy system for in phantom dose distributions using solid state dosimeters and film dosimetry, for instance. Advanced on-site end-to-end audit techniques will then be developed and tested to support dosimetry in clinical brachytherapy.

Project 2000010	**2.2.1.001 Health Effects of Nutrition and the Environment**
CRP Title:	**Nutritional Care During Diagnosed Cancer and Monitoring of Nutritional Status in Low and Middle Income Countries**
CRP Code:	**2196**

Malnutrition is a common problem among patients with cancer, affecting up to 85% of patients with high risk cancers. Nutrition support can play an important role in improving survival and outcomes for cancer patients. This CRP will investigate the use of stable isotopes to assess body composition and energy expenditure during cancer treatment, contribute new evidence on the impact of body composition on cancer outcomes, and explore the effectiveness of physical activity, diet or nutritional interventions during cancer treatment on improving body composition and outcome measures in LMIC. This CRP will provide evidence for the nutritional management of cancer and improve the nutritional support toolbox available for LMICs to improve outcomes for cancer patients.

Project 2000015	**2.2.2.001 Nuclear Medicine and Radiology Techniques in Health Conditions**
CRP Title:	**Lutetium-Labelled Peptides for Therapy of Neuroendocrine Tumours — The LUPNET Trial**
CRP Code:	**2054**

Cancer is among the leading causes of mortality worldwide. In patients with advanced and metastatic neuroendocrine tumours (NETs), the use of surgery, external beam radiotherapy and chemotherapy is limited. However, there is a new and promising therapy that includes the use of peptide receptors agonists or antagonists coupled with lutetium-177. The use of ^{177}Lu-labelled somatostatin agonists has proven to provide symptomatic improvement in the management of patients with advanced NETs. More recently, the use of somatostatin antagonists is showing very encouraging results in terms of tumour regression and progression-free survival of more than 40 months. This CRP is aimed at: 1. allowing Member States to gain a first-hand understanding and experience of the use of this new radionuclide therapy, including clinical indications, patient selection, clinical protocol, follow-up and limitations; and 2. assisting the Member States to tackle the burden of NETs by introducing novel radionuclide therapies that will allow the personalized management of patients with NETs.	
CRP Title:	**Comparison of Planar Multiple Gated Acquisition (MUGA) Scanning, Single Photon Emission Computed Tomography (SPECT–MUGA) and Echocardiography in the Evaluation of Chemotherapy Related Cardiotoxicity**
CRP Code:	**2158**
This CRP will focus on the comparison of planar multiple gated acquisition (MUGA) scanning versus single photon emission computed tomography (SPECT–MUGA) versus echocardiography in the evaluation of patients undergoing treatment with chemotherapeutic agents that have potentially cardiotoxic effects, such as anthracyclines and monoclonal antibodies (trastuzumab). Anthracyclines, such as doxorubicin and idarubicin, remain an important class of chemotherapeutic agents. Unfortunately, their efficacy in treating cancer is limited by a cumulative dose dependent cardiotoxicity, which can cause irreversible heart failure. The same collateral effects can be observed with monoclonal antibody-based chemotherapy such as trastuzumab. Ventriculography is the method of choice to evaluate cardiac functional parameters. There are nuclear based techniques, such as planar MUGA and SPECT–MUGA, that have been used for many years to assess the left ventricular ejection fraction (LVEF) among other parameters that can indicate the cardiotoxicity associated with the therapy and lead to withdrawal of the ongoing treatment. In recent years, non-nuclear techniques, such as echocardiography, have been used increasingly instead of MUGA studies. However, a comparison of the two modalities in terms of their accuracy in evaluating the LVEF has not been undertaken. The focus of this CRP will be on comparing head to head the accuracy, reproducibility and reliability of these techniques for the early detection of cardiotoxicity in patients with breast cancer.	
CRP Title:	**Prognostic Value of Arterial Fluorodeoxyglucose Positron Emission Tomography (8F-FDG-PET Imaging) – the PIAF Trial**
CRP Code:	**2198**
Cardiovascular diseases (CVD) are among the leading causes of mortality worldwide. It is known that atherosclerosis increases the risk of coronary artery disease (CAD) and stroke. From a clinical perspective, inflammatory atherosclerosis leading to arterial plaque rupture is one of the most significant causes of death that still lacks a personalized, reliable and quantitative assessment of risk. Personalized support for treatment decisions and monitoring of treatment efficacy needs to be provided on an individual basis. The CRP is aimed at: 1. evaluating the prognostic value of arterial ^{18}F-fluorodeoxyglucose (FDG) positron emission tomography (PET) imaging in patients with inflammatory atherosclerosis; and 2. defining widely applicable imaging thresholds for the identification of patients with inflammatory atherosclerosis at risk of CAD or stroke.	
Project 2000024	**2.2.3.001 Clinical Radiation Oncology**
CRP Title:	**Development of Clinical Quality Management Systems for High Dose Rate Brachytherapy (HDRBT)**
CRP Code:	**2199**

Brachytherapy is essential for the radical treatment of cervical cancer. This CRP will produce an economic model for high dose rate (HDR) brachytherapy as used to treat cervical cancer, including resources needed and costs based on the activity costing model. It will also validate the model in centres migrating from two-dimensional (2-D) film based HDR brachytherapy to three-dimensional (3-D) HDR brachytherapy based on computed tomography or magnetic resonance imaging. The CRP will begin with a large-scale survey of brachytherapy practice at centres of all income levels, followed by a detailed study of the resources, costs and times needed to implement 2-D and 3-D brachytherapy in different settings. The economic model will be produced using these data, and the third phase will consist of the validation of the model in a number of centres adopting 3-D brachytherapy following certain criteria proposed by the economic model. Once validated, the model will allow new users to precisely calculate the resources needed for, and the costs of, 3-D brachytherapy, and to predict the efficacy of this technique.

CRP Title:	**E-Learning for Teaching and Assessing Competency in Radiotherapy Contouring for Multidisciplinary Teams in Low and Middle Income Countries**
CRP Code:	**E33041**

Variability in anatomical contouring is a major source of uncertainty in 3-D radiotherapy planning. As access to conformal treatment increases, so does the need to train practitioners in radiotherapy contouring to ensure homogeneity across institutions and countries, and as survival after radiotherapy increases, the importance of accurate delineation of healthy organs to reduce late toxicity rises. Delineation of organs at risk (OARs) is often delegated to radiotherapy technologists (RTTs) or dosimetrists who consequently require training as part of the team. In a previous study (E33040) undertaken by the IAEA in collaboration with the European Society for Radiotherapy and Oncology (ESTRO) using the ESTRO blended learning package, FALCON, we demonstrated the benefit gained by FALCON training for radiation oncologists from LMICs in terms of increased accuracy and homogeneity of target volume and OAR delineation. In this second study, we propose to:

- Determine whether the same benefit from training can be achieved using cases imported from LMICs which more specifically represent the local challenges in terms of disease stage and imaging quality.
- Recruit radiation oncologists and radiation oncology trainees, plus RTTs and dosimetrists who will undertake contouring of organs at risk.
- Deliver FALCON workshops with the submission of contours at baseline and two subsequent time points.
- Use software currently under development to convert the submitted contours into radiotherapy plans in order to demonstrate the improvement in dosimetry and hence the clinical impact that can be predicted following the training.

Project 2000029	**2.2.4.003 Clinical Medical Radiation Physics**
CRP Title:	**Doctoral CRP on Advances in Radiotherapy Techniques**
CRP Code:	**2203**

The training of specialized medical physicists, through this specific PhD programme, will allow Member States to implement and enhance modern radiotherapy techniques. PhD candidates, under the guidance of a local supervisor and a remote mentor, will be involved in modern research associated with the assessment, enhancement, development and implementation of advanced radiotherapy external beam modalities including motion management, automation, audit methodologies, quality and safety. For the purpose of ensuring that the research projects are of interest to the local clinical institution and the host nations, these projects should be selected on the basis of their potential to generate achievable short term outputs and long term outcomes.

2.3 Water Resources

Project 2000056	**2.3.1.001 IAEA Isotope Data Networks for Precipitation, Rivers, and Groundwater**
CRP Title:	**Isotope Variability of Rain for Assessing Climate Change Impacts**
CRP Code:	**2204**

This CRP aims to investigate the relationship between the isotopic composition of precipitation and modern atmospheric circulation patterns to explore the use of isotope data in atmospheric waters to better assess and model climate change impact on water resources. A better understanding of the main factors controlling the isotopic content of precipitation is required for the more effective use of isotope tools in hydrology and atmospheric sciences. Relating isotope records to dynamic climate models and synoptic features of the atmospheric circulation is a powerful approach to understand present climatic conditions and to reconstruct past climates. The IAEA will support ongoing efforts by facilitating and collaborating in systematic collection and interpretation of the isotope contents of precipitation across various temporal and spatial scales. As it is directly linked toh precipitation, relevant investigations concerning the isotopic content of atmospheric moisture are also within this scope.

Project 2000059	**2.3.2.001 Comprehensive Assessment of Resources**
CRP Title:	**Use of Isotope Techniques for the Evaluation of Water Sources for Domestic Supply in Urban Areas**
CRP Code:	**F33024**

In many urban centres of the world, rapid population growth and water demand for various uses have placed a serious constraint on both the quantity and quality of available local water resources. In many cases, urbanization results in profound changes in the local water balance and groundwater recharge conditions, perturbation of the hydraulic conditions (aggravating, for example, the impact and magnitude of floods) as well as in significant pollution and degradation of water quality. Assessing the sources, pathways and interactions of groundwater bodies in urban areas to determine their suitability for domestic uses and developing sustainable management strategies requires the use of various tools. This CRP will focus on the use of isotope tracers in combination with other conventional hydrological tools to obtain key information that can help assess the sustainability of water resources in urban areas.

CRP Title:	**Isotope Techniques for the Evaluation of Water Sources in Irrigation Systems**
CRP Code:	**F33025**

Globally, irrigated agriculture consumes 70% of freshwater resources and provides 40% of global food requirements. Increasing agricultural production and productivity depends, to a large extent, on the availability of water; which is drawn either from river diversions (canal irrigation) or from aquifers (groundwater irrigation). Groundwater resources are the only source of reliable clean water in many parts of the world. In most cases, good quality aquifers are exploited for irrigation at rates higher than natural replenishment rates, leading to a decline in groundwater levels. Therefore, a more precise knowledge of sources of water and estimates of recharge rates, and groundwater dating to know how fast the aquifer is replenished are important aspects to assess the future availability and sustainability of these resources. This CRP aims to improve the capability and expertise of Member States in the use of environmental isotope techniques for better assessment and mapping of water sources to improve irrigation practices and sustainable water management in irrigated areas.

Project 2000064	**2.3.3.002 Noble Gas Isotopes for Groundwater Recharge and Pollution Studies**
CRP Title:	**Global Monitoring of Nitrogen Isotopes in Atmospheric Waters**
CRP Code:	**F32008**

The increasing production of food and energy worldwide has multiplied today's anthropogenic emissions of nitrogen compounds in the atmosphere, which are transported and deposited through precipitation on the terrestrial and aquatic systems. Disruption of N-balance, eutrophication in rivers and lakes, and stream acidification are a few of the negative consequences of N-deposition exceeding the remediation capacity or critical load of the aquatic system. Environmental isotopes have been widely used, not only to assess hydrological processes, but also to address water quality issues, such as nitrogen pollution. This CRP aims to determine the spatio-temporal distribution of nitrogen isotopes in precipitation as a potential source of nitrogen pollution of water resources, especially of aquatic systems sensitive to eutrophication stressors. This CRP aims to combine N-isotopes with

atmospheric chemistry and hydrometeorological techniques to better understand wet deposition processes and to characterize the origin of inorganic nitrogen loadings. Overall, the CRP will be aimed at improving the capability and expertise of participating Member States in the use of environmental isotopes to assess impacts of nitrogen wet deposition on water quality and ecosystems.	
Project 2000123	**2.3.2.002 Management Strategies for Groundwater and Surface Water Resources**
CRP Title:	**Isotope-enabled Models for Improved Estimates of Water Balance in Catchments**
CRP Code:	**F31005**
The use of stable isotope tools to identify the main flow paths and residence times of both surface water and groundwater has been expanded to improve the simulated components of the water balance model at several scales: from small catchment areas to larger hydrological basins. The IAEA's Isotope Hydrology Section has developed, in cooperation with various partners, the IAEA Water Balance Model with Isotopes (IWBMIso), which aims to promote and expand the use of common isotope tracers to obtain more precise estimates of the various water balance components and water fluxes in a range of climatic and hydrological settings. Once the model has been fully tested in different selected catchments and scenarios, which is the main objective of this CRP, it can be routinely incorporated into future technical cooperation projects dealing with isotope hydrology and water resources management.	
2.4 Environment	
Project 2000132	**2.4.2.002 Assessing Carbon Cycle and Impacts of Ocean Acidification**
CRP Title:	**Evaluating the Impact of Ocean Acidification on Seafood — a Global Approach**
CRP Code:	**K41018**
Concern about the impacts of ocean acidification on economically and socially important seafood is increasing worldwide, and ocean acidification is now an integral part of the United Nations 2030 Agenda for Sustainable Development. Sustainable Development Goal 14.3 seeks to "minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels". This CRP will apply a novel collaborative approach to assess the impacts of ocean acidification on key seafood species (e.g., oysters, mussels, shrimps, lobsters and/or fish) in 10 to 15 geographical locations (Member States). The CRP will build on capacity building activities and methodology developed under the framework of the IAEA Ocean Acidification International Coordination Centre and the interregional Technical Cooperation project INT7019. Each CRP participant will carry out a long term study using a common experimental approach and similar methodology to evaluate both quantitative and qualitative impacts of ocean acidification on a locally important seafood species in their country. Impacts will be assessed using both conventional and nuclear and isotopic techniques. The data collected will provide an overview of ocean acidification impacts on key seafood species around the world, and lay the basis for the development and implementation of adaptive solutions. This will be the first time that such an approach to studying ocean acidification is conceived and put into practice. Successful implementation of this CRP will provide Member States with new perspectives and strategies for building resilience to the impacts of ocean acidification in their respective coastal/marine waters.	
CRP Title:	**Applied Radioecological Tracers to Assess Coastal and Marine Ecosystem Health**
CRP Code:	**K41019**
Sustainable management of coastal and marine resources requires an extensive comprehension of the current health of these ecosystems, as well as capacity for anticipating and predicting future impacts due to changing climate conditions and anthropogenic stressors. Radioecological tracers are invaluable for assessing many aspects of the marine environment, particularly with regards to external perturbations. However, to maintain relevancy and efficiency it is necessary to develop new and	

further refine existing radiotracers so that these techniques continue to best serve Member States in evaluating coastal and marine ecosystems. Through this CRP, the IAEA will support the development, refinement, and application of radioecological tracers to assist Member States in appraising their coastal and marine resources under both current and future environmental regimes.	
2.5 Radioisotope Production and Radiation Technology	
Project 2000090	**2.5.1.001 Development and Production of Medical Radioisotopes**
CRP Title:	**New Ways of Producing Technetium-99m (Tc-99m) and Tc-99m Generators (Beyond Fission and Cyclotron Methods)**
CRP Code:	**F22068**
The objective of the CRP is to formulate guidelines to enhance and strengthen the expertise and capability of Member States in developing the new production method of Mo-99 (based on photodynamic reaction) and optimizing existing low to medium specific activity generators using high capacity absorbents for Mo to meet national needs. The CRP is expected to produce a document containing the production and quality control of Mo-99 using linear accelerators through the Mo-100(gamma,n)Mo-99 reaction, developing a new generation of low to medium specific activity Mo-99/Tc-99m generators, including the application of new organic/inorganic absorbent materials to develop high performance separation columns, liquid extraction techniques and utilization of auxiliary instruments for the concentration of final generator eluate.	
Project 2000091	**2.5.1.002 Development of Diagnostic and Therapeutic Radiopharmaceuticals**
CRP Title:	**Production of Zirconium-89 and the Development of Zr-89 Radiopharmaceuticals**
CRP Code:	**2223**
The overall objective of this CRP is to formulate guidelines to enhance and strengthen the expertise and capability of Member States in production and quality control of Zr-89 radioisotope as well as Zr-89 radiopharmaceuticals covering all preclinical stages. The specific objectives are: (1) To produce guidelines for the production of Zr-89 radioisotope using medical cyclotrons through the 89Y(p,n)89Zr reaction and the optimization of the available targetry methods (solid and liquid targets), the purification methods and quality control protocols of final radioisotope; and (2) To produce guidelines for the production and quality control of Zr-89 radiopharmaceuticals with a focus on developing Zr-89 radioimmunomolecules.	
Project 2000094	**2.5.2.001 Applications of Radiotracers and Radiation Techniques**
CRP Title:	**Imaging Technologies for Process Investigation and Components Testing**
CRP Code:	**F22069**
The overall objective of the CRP is to facilitate further advancement and implementation of imaging nuclear technologies in industries and to develop a synergetic approach to imaging technologies coming from different fields. Different topics should be addressed, such as the production of radiotracer based on neutrons generator, neutron imaging, new detectors and imaging systems, software, multimodal approach using different radiations simultaneously. Specifically, targets to be addressed will include safety, cost, and the availability of nuclear technologies, as well as knowledge transfer with a particular focus on developing Member States.	
CRP Title:	**Development of Radiometric Methods and Modelling for the Measurement of Sediment Transport and Dispersion of Particles and Pollutants from Outfalls**
CRP Code:	**NEW**
Radiation techniques are increasingly applied and continuously evolving for an improved understanding sediment transport mechanisms to better protect coastal environments and water resources. The increasing need for such techniques is due to both climate changes and the increasing impact of human activities on coastal areas. Compared to conventional techniques, nuclear techniques have the unique advantage of providing a quick response (months instead of decades). Key issues the technologies face nowadays are public concern and associated regulatory restrictions.	

The CRP objectives will be the development of the use of natural radioactivity and naturally radioactive sediment for tracing (black sand tracing) and associated methodologies on the followings topics: (1) development of new technologies and methodologies to assess sediment transport in an efficient manner from natural radioactivity spectrometric measurement to complement existing techniques associated with appropriate modelling; and (2) development of black sand tracing to tackle the licensing issue of the use of artificial radioactive tracer and the poor availability of such tracers due to the lack of research reactors in many countries as well as transportation problems.	
Project 2000095	**2.5.2.002 Radiation Processing: Technologies and Applications**
CRP Title:	**Enhancing the Beneficial Effects of Radiation Processing in Nanotechnology**
CRP Code:	**F22070**
The aim of this CRP is to exploit the innovative methodologies and technologies to fabricate high performance and high value-added nano-products for applications in electronics, energy, environment, and advanced materials. The objectives are: 1) to develop processes, techniques, protocols for radiation-driven nanofabrication for value-added products; 2) to investigate key factors behind scientific challenges in radiation processing, such as structural and functional parameters, methodological and technological aspects; 3) to endeavour to transfer research results to end-users; and 4) to establish and develop the network of collaboration in the field of radiation-driven nanofabrication.	
CRP Title:	**Radiation Based Technologies for Treatment of Emerging Organic Pollutants**
CRP Code:	**2216**
The objective of this CRP is to conduct a comprehensive techno-economic assessment of the radiation technology to remove EOPs under various real-world conditions through a multidisciplinary approach, covering areas including radiation chemistry, toxicology, biochemistry, radiation treatment and environmental engineering. The following expected outputs are being considered and will be defined during the pre-CRP Technical Meeting planned to be held in 2018: harmonized analytical methods for the characterization of the effects of ionizing radiation on water, wastewater, sludge, soil and solid wastes; developed remediation methods for the reuse of wastewater and sewage sludge by means of ionizing radiation; proposed appropriate treatment methodologies in combination with radiation techniques for the abatement of pollutants.	
CRP Title:	**Radiation Inactivation of Bio-hazards Using High Powered Electron Beam Accelerators.**
CRP Code:	**F23033**
The objective is to formulate guidelines to enhance and strengthen the use of electron beam accelerators for the treatment of biohazards of concern under changing conditions, such as at high dose rates, different ambient conditions, and varying substrates in applications such as radiation sterilization, hygienization of biosolids, sanitizing infectious hospital waste or toxic effluents and eliminating deliberate biohazards. The specific objectives are: to provide reliable data about radiation inactivation of pathogenic microorganisms and other bio contaminants under varying physical conditions; to establish dose setting procedures appropriate to specific bio contaminants; to develop appropriate methodologies for treatment of biohazards using electron beam accelerators; to develop validation procedures for the processes of treating biohazards at high dose rates; to develop guidelines for treatment of biohazards using electron beam accelerators; and to demonstrate treatment of biohazards using electron accelerators.	

Major Programme 3: Nuclear Safety and Security	
3.5 Nuclear Security	
Project 3000153	**3.5.2.002 Enhancing Nuclear Materials Security Using Accounting and Control**
CRP Title:	**Preventive and Protective Measures Against Insider Threats at Nuclear Facilities**
CRP Code:	**J02010**
The objective of this CRP is to enhance existing preventive and protective measures against insider adversaries to reduce the risk of theft of nuclear material and sabotage at nuclear facilities. The aim is to develop: (1) a predictive model for trustworthiness programmes; (2) a predictive model for identifying colluding insider adversaries; (3) tools and methods to be used in the application of process monitoring for nuclear security to improve detection capability, including analysis of technological barriers in process designs that may prevent or limit the achievement of detection goals; (4) technical measures to enhance the control of nuclear material and control of access to personnel; and (5) a database for selecting nuclear material accounting and control measures for specific facility types.	
Project 3000157	**3.5.3.002 Nuclear Security Detection and Response Architecture**
CRP Title:	**Improved Assessment of Initial Alarms from Radiation Detection Instruments**
CRP Code:	**J02005**
This CRP is intended to investigate improvements in the initial assessment of radiation alarms from radiation detection equipment. The goal is to develop guidance and a software tool to provide consistency and confidence in the interpretation of complex nuclear data from radiation detection equipment used to combat illicit trafficking in nuclear and other radioactive materials. The tool is necessary to deal with the facts that: (1) measurements at borders are sensitive to the physics of radiation detection and operational/environmental conditions; (2) decisions are made by front line officers (FLO) with non-technical backgrounds; and (3) the expectation that a high confidence and rapid alarm assessment will be made. One of the primary instruments used to monitor border traffic is a radiation portal monitor (RPM). The RPM will alarm when the occupant (person, vehicle, etc.) of the RPM contains materials emitting radiation over the natural background radiation level. Based on the RPM alarm and associated data, a FLO must decide if the alarm was the result of some innocent naturally occurring radioative material (NORM) or whether a secondary inspection or other action is needed. Making this decision is a complicated process. RPM profiles are not easily interpreted, especially when concerned with the possible presence of nuclear material, as issues with background suppression effects, traffic/pedestrian management, speed, changes in background radiation, weather, cross-talk from other lanes, possible masking or shielding, etc., all present challenges that FLOs and expert authorities should consider when making their initial assessments. Since the vast majority of alarms are simply the result of NORM moving through commerce, separating alarms possibly caused by nuclear and other radioactive materials from the alarm pool of mostly NORM can be quite difficult. Additionally, operator fatigue and de facto training that the alarm is likely NORM because that is usually the case (over 99% of cases) creates a situation where material out of regulatory control could pass through a border crossing without being acted upon. This CRP has already produced a library of alarming commodities that is available as a smart phone application (search for IAEA TRACE) — the Tool for Radiation Alarm and Commodity Evaluation (TRACE). Additional development of algorithms and enhancements to the tool and guidance is still underway and the CRP is still open to participants.	

CRP Title:	Advancing Detection Equipment Maintenance and Calibration
CRP Code:	2101
At the Second Technical Meeting on Radiation Detection Instruments for Nuclear Security, held from 16 to 20 April 2018 in Vienna, Austria, representatives from 73 Member States unanimously endorsed a proposal that the IAEA pursue with priority the implementation of a CRP on Advancing Detection Equipment Maintenance and Calibration. The goal is to produce tools and guidance that will enable States to maintain, repair, and calibrate radiation detection instruments more effectively and sustainably. The advances will be supported by research and development in areas including: enhancements to current detector design to reduce maintenance and repair costs, diagnostics to indicate detector performance and component failure, improved kits and aids for maintenance and calibration, and use of sustainable radiation sources. This proposed CRP is anticipated to be approved and open for proposals in late 2018.	

CRP Title:	Advancing Radiation Detection Equipment for Detecting Nuclear and Other Radioactive Material Out of Regulatory Control
CRP Code:	J02012
The current state of radiation detection instruments and systems used to detect illicit trafficking in nuclear or other radioactive material is inadequate to meet the nuclear security needs of the Member States. Research under this CRP will assist in advancing design attributes, communication means, operational conditions and sustainability elements related to radiation detection instruments and methods. The advances will be supported by research and development in areas including: enhancements of current detector materials, new algorithms for faster and more reliable decision-making, indications of state of performance and health of detectors, designs for networking and information communication, improved user interface and human factor engineering, improvements in detector functional and technical specifications, enhancements to reduce training requirements, and software tools for use and diagnostics on instruments. The CRP scope includes radiation detection systems used at both designated and undesignated points of entry.	