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Medical Physics Education and Training in the Asia-Pacific Region: Sustainable Workforce Development Through Long-Term RCA Projects

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Summary

Medical physics is a clinical profession that plays a central role in the safe and effective use of increasingly sophisticated healthcare technologies. Advances in radiation oncology, diagnostic imaging, nuclear medicine and digital technologies - including IMRT, VMAT, IGRT, SBRT, proton therapy and artificial intelligence - are creating new clinical opportunities while increasing the competence required of medical physicists.

Technology alone, however, cannot deliver safe patient care. Sustainable workforce development requires academic education, structured clinical training, supervised practice, competency assessment, professional recognition and continuing professional development.

More than two decades of RCA cooperation demonstrate how regional projects can progressively build this capacity. The experience has evolved from foundational education and clinical training towards competency-based approaches, digital connectivity, remote supervision and professional recognition. The purpose built learning management system (LMS) 'AMPLE' illustrates how digital infrastructure can extend clinical training, supervision and knowledge sharing across geographically diverse countries.

The next phase of regional cooperation should build on these achievements by moving from project-based capacity building towards institutionalised education, certification, professional recognition, CPD and workforce planning, while still advancing regional centres of excellence to underpin training particularly for developing countries.

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1. Introduction

The Asia-Pacific region is currently experiencing rapid growth in its healthcare infrastructure, yet it remains characterized by significant diversity in economic resources and clinical training environments. As participating countries increasingly invest in advanced medical technologies, a critical realization has emerged: medical physics is a clinical profession, not simply a technical support function. The rapid deployment of equipment highlights that technology alone does not improve healthcare; competent professionals, quality systems, and effective governance are required to translate technology into safe patient care.

Historically, many capacity-building efforts focused primarily on foundational learning. However, clinical qualification requires more than academic education: structured clinical training, supervised practice, competency assessment, and professional recognition are essential. Without these components, healthcare systems cannot fully bridge the gap between theoretical knowledge and independent clinical competence, leaving patient safety at risk.

Addressing this structural challenge requires sustained effort. The RCA experience demonstrates that sustainable workforce development is a long-term process rather than a single training project. For more than two decades, the RCA has helped bridge national disparities by developing shared guidelines and fostering regional networks of experienced supervisors. A milestone in this journey is the introduction of digital enabling platforms. AMPLE illustrates how digital infrastructure can extend competency-based clinical training and is a powerful tool in supervision and knowledge sharing across geographically diverse countries.

This article was written to guide the next critical phase of this regional journey. Synthesizing comprehensive lessons from past RCA initiatives, it provides a strategic roadmap for participating Government Parties. Ultimately, the next phase of regional cooperation should move from project-based capacity building towards institutionalised education, certification, professional recognition, CPD, and workforce planning. Through this strategic shift, the region can secure a professionally recognized workforce capable of meeting the complex healthcare demands of the future.

2. Medical physics in modern healthcare: From technology to clinical competence

Medical physics is an essential clinical discipline supporting the safe and effective use of radiation and associated technologies in healthcare.

Over the past several decades, healthcare technology has advanced rapidly. Medical physics has evolved alongside these developments, moving from a predominantly technical support role towards an increasingly integrated clinical profession with direct responsibilities for patient safety, quality assurance and the effective implementation of complex technologies.

The Changing Landscape of Medical Technology

The development of modern healthcare technologies has transformed the diagnosis and treatment of disease. In radiation oncology, the transition from conventional treatment techniques to increasingly sophisticated approaches has substantially expanded the clinical and technical responsibilities of medical physicists.

Three-dimensional conformal radiotherapy (3D-CRT) was followed by increasingly advanced techniques such as intensity-modulated radiotherapy (IMRT), volumetric modulated arc therapy (VMAT), image-guided radiotherapy (IGRT), stereotactic radiosurgery (SRS), stereotactic body radiotherapy (SBRT/SABR), adaptive radiotherapy, proton therapy and other highly conformal and image-guided treatment approaches.

These technologies can improve the precision with which radiation is delivered to the intended target while helping to protect surrounding healthy tissues. However, increasing technological sophistication also increases the complexity of clinical decision-making, treatment planning, commissioning, quality assurance and risk management. The role of the medical physicist has therefore evolved accordingly. A modern medical physicist may be required to evaluate new technologies, participate in commissioning and acceptance testing, develop and implement quality assurance programmes, assess clinical risks, validate treatment systems and support clinicians in the safe adoption of new techniques. The same trend is visible beyond radiation oncology. Advances in diagnostic imaging, nuclear medicine, hybrid imaging, automation, digital technologies and artificial intelligence (AI) are creating new opportunities for healthcare while introducing new requirements for technology evaluation, validation, quality control, data management and clinical governance.

Technology Alone Is Not Enough

The rapid development of healthcare technology can create the important misconception: that access to advanced equipment will automatically lead to better healthcare. In practice, technology delivers its intended clinical benefit only when it is supported by appropriately trained professionals, effective quality systems and sound clinical governance. A sophisticated treatment planning system, for example, does not by itself guarantee safe treatment. Safe implementation requires professionals who understand the underlying science and technology, can evaluate and commission the system appropriately, can establish quality assurance procedures, can identify potential risks and can work effectively within a multidisciplinary clinical team. The same principle applies to advanced imaging, nuclear medicine, AI-enabled systems and other emerging technologies.

Technology alone does not improve healthcare; competent professionals, quality systems and effective governance are required to translate technology into safe patient care.

This relationship can be expressed as:

Technology

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Competence

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Quality and Safety

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Patient Care

The more sophisticated the technology becomes, the greater the need for appropriate professional competence.

Medical Physics as a Clinical Profession

The changing technological environment has consequently changed the nature of medical physics itself. Medical physicists are no longer simply technical specialists who maintain equipment or provide technical advice. They contribute directly to clinical processes that affect patient diagnosis, treatment quality and safety.

Depending on the area of practice, their responsibilities may include radiation dosimetry, treatment planning and verification, equipment acceptance and commissioning, quality assurance, radiation protection, optimisation of imaging procedures, evaluation of new clinical technologies, risk assessment and management, clinical data and software validation, support for multidisciplinary decision-making and implementation of new technologies in accordance with quality and safety requirements.

These responsibilities require a combination of scientific knowledge, technical expertise, clinical understanding and professional judgement. The medical physicist therefore occupies a distinctive position at the interface between science, technology and clinical care.

The Emergence of the Clinically Qualified Medical Physicist

As medical physics has become increasingly integrated into clinical practice, the concept of the Clinically Qualified Medical Physicist (CQMP) has become increasingly important. Academic education provides the scientific and theoretical foundation of the profession. However, academic education alone does not establish readiness for independent clinical practice. Clinical qualification requires a structured pathway that combines:

Academic Education

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Structured Clinical Training

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Supervised Practice

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Competency Assessment

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Professional Recognition

The development of clinical competence therefore requires more than obtaining an academic degree. It requires opportunities to apply knowledge in real clinical environments, work under appropriate supervision, demonstrate defined competencies and receive formal assessment. This distinction is fundamental to sustainable medical physics workforce development.

The Growing Competency Requirement

The increasing complexity of technology means that the competency requirements of medical physicists are also evolving. A professional working with IMRT, VMAT, IGRT, SBRT, proton therapy or adaptive radiotherapy requires not only knowledge of the underlying physics but also the ability to evaluate clinical implementation, understand uncertainties, establish appropriate quality assurance and manage risks associated with increasingly complex treatment pathways.

Similarly, the introduction of AI and advanced digital technologies requires medical physicists to develop competencies in areas such as technology evaluation, algorithm validation, data quality, performance monitoring, clinical implementation, quality assurance, risk management and understanding the limitations of automated systems.

The workforce must therefore evolve alongside technology. Education and training systems that were adequate for earlier generations of technology may not automatically provide the competencies required for modern clinical practice.

Education, Training and Professional Development

A sustainable medical physics workforce requires a continuum of professional development. The pathway begins with academic education but must continue through clinical training, supervised practice and competency assessment. After clinical qualification, professionals require continuing professional development (CPD) to maintain and extend their competence as technologies, clinical practices and professional standards evolve.

The resulting professional pathway can be viewed as:

Education

Clinical Training

Competence

Professional Recognition

CPD

Workforce Sustainability

This pathway also demonstrates why workforce development cannot be achieved through education alone.

It requires cooperation among universities and academic institutions, hospitals and clinical training centres, experienced medical physicists and clinical supervisors, professional organisations, national authorities and regional and international partners.

The Asia-Pacific Context

The need for a sustainable medical physics workforce is particularly important in the Asia-Pacific region. Countries within the region differ substantially in their healthcare infrastructure, access to advanced technologies, tertiary educational capacity, clinical training opportunities, professional recognition and workforce size. Some countries have well-established university programmes, clinical residency structures, professional organisations and certification systems. Others continue to face challenges in establishing sufficient academic and clinical training capacity, developing supervisors and creating appropriate professional recognition mechanisms. These differences mean that the region requires approaches that can be adapted to national circumstances while benefiting from regional cooperation. The central challenge is therefore not simply to increase the number of trained medical physicists. It is to establish sustainable systems capable of producing competent medical physicists appropriate to national healthcare needs and technological development.

Why Regional Cooperation Matters

The diversity of the Asia-Pacific region creates both a challenge and an opportunity. Countries can benefit from sharing educational resources, clinical expertise, training approaches and professional experience. Regional cooperation can also help countries with smaller workforces gain access to specialised expertise that may not be available nationally. Over time, such cooperation can create a cumulative process of capacity building in which knowledge, trained professionals, training resources, networks and institutional experience are carried forward from one project to the next. The long-term RCA experience provides an important example of this approach. Since the early 2000s, successive RCA projects have contributed to the development of medical physics education and clinical training across the region. The evolution of this cooperation - from foundational capacity building to structured clinical training, competency development, digital connectivity and professional recognition - provides the central experience examined in this Issue Brief.

From Technology to Sustainable Workforce Development

(Fig .1) RAS6038 Project Management Officer, Prinath Dias and Lead Country Coordinator, John Drew. (Photo: IAEA)

The central argument of this Issue Brief can therefore be summarised as follows:

Advanced technology increases clinical opportunities. Clinical opportunities increase the need for professional competence. Professional competence requires education, clinical training, supervision and assessment. Sustainable competence requires professional recognition, CPD and workforce planning. Sustainable workforce development requires institutional capacity and long-term cooperation.

The experience of RCA projects over more than two decades provides valuable evidence of how regional cooperation can contribute to this process. The following sections examine this experience, beginning with the development of medical physics education and clinical qualification, followed by the evolution of RCA projects, the emergence of AMPLE and competency-based training, and the strategic requirements for sustainable workforce development.

3. From Academic Education to Clinical Qualification

The development of modern radiation medical practice requires more than access to advanced technologies. It requires professionals who possess the scientific knowledge, clinical skills and professional judgement necessary to use those technologies safely and effectively. Thus an important distinction is made between academic education and clinical qualification. Academic education provides the foundation. Clinical training transforms that foundation into professional competence. Competency assessment demonstrates readiness for clinical responsibility. Professional recognition provides the framework within which that competence can be exercised.

Academic Education: The Foundation

Appropriate medical physics education should be at the Masters level and grounded in physics, mathematics and related scientific disciplines, complemented by knowledge relevant to healthcare and clinical practice. A strong academic programme should provide an understanding of radiation physics, imaging physics, instrumentation and measurement, radiation dosimetry, treatment planning, quality assurance, radiation interactions, radiation protection, computing and data analysis and relevant aspects of anatomy, physiology and clinical practice.

Academic education must also evolve as medical technologies change. The increasing use of IMRT, VMAT, IGRT, SBRT, proton therapy, adaptive radiotherapy, advanced imaging and AI means that graduates increasingly need to understand not only the underlying physics but also the principles of technology evaluation, validation, uncertainty, quality assurance and clinical implementation. However, the purpose of academic education is to provide a scientific and professional foundation. It does not, by itself, provide sufficient experience for independent clinical practice.

The Gap Between Education and Clinical Practice

The transition from university education to clinical practice represents one of the most important stages in the development of a medical physicist. Clinical environments introduce complexities that cannot be fully reproduced in academic settings. A trainee must learn to apply scientific knowledge to real patients and clinical situations, work within multidisciplinary teams, understand clinical workflows, recognise uncertainties and limitations, manage competing clinical priorities, communicate effectively with clinicians and other healthcare professionals, participate in quality and safety systems and take appropriate professional responsibility.

These capabilities develop through structured clinical experience and supervised practice [3-5]. The transition should therefore not be viewed simply as moving from the classroom into the workplace. It is a process through which theoretical knowledge becomes demonstrated clinical competence.

Structured Clinical Training

Structured clinical training provides the bridge between academic education and independent professional practice. A structured programme should define the competencies to be achieved, the expected progression of trainees, the clinical experiences required, the methods of assessment, the requirements for completion and the supervision arrangements.

The training should provide sufficient exposure to the clinical environment to allow trainees to progressively develop professional independence. For different areas of medical physics, this may include structured clinical training in:

Radiation Oncology : including treatment planning, dosimetry, treatment verification, commissioning, quality assurance and emerging treatment techniques.

Diagnostic Radiology : including imaging physics, optimisation, quality assurance, equipment performance and radiation protection.

Nuclear Medicine : including instrumentation, dosimetry, imaging, quality assurance, radiation protection and the clinical application of radionuclides.

The IAEA has developed dedicated clinical training resources for these three major areas, providing an important international reference for competency-based clinical development [3-5].

Supervised Practice

Supervision is a central component of clinical training. Trainees need experienced medical physicists who can demonstrate clinical procedures, provide constructive feedback, explain professional decision-making, identify areas requiring further development, observe trainees in practice, assess progression and determine when a trainee is ready to undertake defined responsibilities with increasing independence.

The supervisor therefore has a role that extends beyond teaching. The supervisor contributes directly to the assessment and development of professional competence. This creates an important workforce relationship:

Sustainable Training	▸	Requires Supervisors
Sustainable Supervisors	▸	Require an Experienced Workforce
Sustainable Workforce	▸	Requires Long-term Professional Development

This is one reason why workforce development must address not only the number of trainees, but also the availability and capability of clinical supervisors.

Competency-based Clinical Education

A competency-based approach focuses on what a medical physicist is able to demonstrate in clinical practice, rather than simply what the individual has studied. Competencies may include technical, clinical, professional and communication skills. For example, a medical physicist may need to demonstrate competence in equipment acceptance and commissioning, dosimetry, treatment planning and verification, quality assurance, radiation protection, clinical risk assessment, technology evaluation, data analysis, documentation, multidisciplinary communication and professional responsibility.

The exact competencies will vary according to the specialty and national context. However, the fundamental principle is universal: Clinical qualification should be based on demonstrated competence, not academic achievement alone.

Competency Assessment

Competency must be assessed in a structured and transparent manner. Assessment can include direct observation of clinical practice, workplace-based assessment, case-based discussion, clinical portfolios, practical examinations, written examinations, structured interviews, supervisor reports and demonstration of defined clinical tasks.

The purpose is not simply to test knowledge. Assessment should provide evidence that the trainee can apply knowledge safely and effectively in the clinical environment. It should also identify areas requiring additional training and provide a basis for progressive professional development.

The Role of Clinical Training Guides

The development of structured clinical training resources has been an important contribution to medical physics workforce development. The IAEA Training Course Series publications addressing radiation oncology, diagnostic radiology and nuclear medicine provide structured guidance for clinical training in these major specialties. Such resources can help countries establish or strengthen national training systems by providing defined areas of clinical learning, structured training content, reference competencies, examples of clinical practice, guidance for supervisors and a basis for assessment.

They can also facilitate regional cooperation by providing a common reference framework while allowing individual countries to adapt implementation to their own healthcare systems.

From Clinical Qualification to Professional Recognition

Clinical competence should be supported by appropriate professional recognition. Professional recognition provides a formal framework through which the healthcare system, employers, colleagues and patients can understand the responsibilities and expected standards of medical physicists. Depending on national circumstances, professional recognition may involve certification, registration, professional licensing, specialist recognition, defined career structures or other nationally appropriate mechanisms.

The specific mechanism will differ between countries. The underlying principle, however, remains the same:

Clinical responsibility should be linked to appropriate education, structured clinical training and demonstrated competence.

Continuing Professional Development

Clinical qualification is not the end of professional development. Medical physics is a rapidly evolving profession. New treatment techniques, imaging technologies, software, automation, AI and quality standards continually change the knowledge and competencies required of medical physicists. Professionals therefore need opportunities to maintain and extend their competence throughout their careers. CPD can include specialist courses, workshops, conferences, online learning, case discussions, peer learning, clinical audits, research and innovation, professional mentoring and training associated with new technologies. A sustainable workforce system should therefore connect initial education with lifelong professional development.

Regional Cooperation as a Bridge

Countries in the Asia-Pacific region have different capacities to provide this complete pathway. Some countries have mature academic programmes and established clinical training systems. Others may have academic education but limited clinical training opportunities, a shortage of supervisors or incomplete professional recognition mechanisms. Regional cooperation can help bridge these differences. Potential mechanisms include regional training centres, clinical attachments, expert exchanges, train-the-trainer programmes, shared clinical training resources, mentoring, professional networks, digital learning and remote supervision.

Such mechanisms do not replace national education and clinical training. Instead, they can extend national capacity and accelerate the development of sustainable national systems.

The RCA Contribution

(Fig. 2) RAS6077 Final Review Meeting, October, 2017, Indonesia. (Photo: IAEA)

The long-term RCA experience provides an important example of how regional cooperation can progressively strengthen this continuum. Beginning with the development of medical physics education and clinical training capacity, successive regional projects have supported the development of training resources, clinical supervisors, competency-based approaches, professional networks and, increasingly, digital connectivity.

The evolution of these activities provides the foundation for the next section of this Issue Brief, which examines the long-term RCA Medical Physics Roadmap and how successive projects have contributed to the development of a regional workforce system.

4. The RCA Medical Physics Roadmap: More Than Two Decades of Regional Capacity Building

The development of a sustainable medical physics workforce in the Asia-Pacific region has not occurred through a single project or a single training intervention. It has evolved through a sequence of regional initiatives supported by the IAEA and the RCA, with successive projects building on the experience, infrastructure, professional networks and human resources developed through earlier phases. This long-term experience provides an important lesson for workforce development: Sustainable capacity building is a process, not a project.

From Training Activities to a Regional Development Pathway

The early RCA medical physics projects focused primarily on strengthening the foundations required for education and clinical training. These foundations included academic and professional education, clinical training, access to international expertise, development of clinical supervisors, exchange of experience among participating countries and establishment of regional professional networks. As regional capacity increased, the focus progressively expanded. The emphasis moved from individual training activities towards:

Structured Clinical Training

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Competency Development

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Professional Networks

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Digital Connectivity

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Professional Recognition

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Sustainable Workforce Development

This evolution reflects an important change in thinking. The objective was no longer simply to train more individuals. It was increasingly to strengthen the systems through which medical physicists are educated, trained, assessed, recognised and supported throughout their professional careers.

Project RAS6038: Establishing the Foundations

Project RAS6038 represented an important stage in the development of structured medical physics education and clinical training within the RCA region. The project supported the development of clinical training capacity and strengthened regional cooperation among medical physics professionals. An important contribution was the development and dissemination of structured clinical training approaches in major areas of medical physics practice. This included the use of clinical training resources associated with radiation oncology, diagnostic radiology and nuclear medicine. The associated IAEA clinical training guides - TCS 37, TCS 47 and TCS 50 - provided important reference resources for clinical training in these areas. The significance of this stage was not simply the delivery of training courses. It was the recognition that medical physics education needed to extend beyond academic knowledge into structured clinical experience, supervision and competency development.

From Individual Training to Structured Clinical Capacity

The experience of the early projects highlighted a fundamental challenge. Training individual medical physicists is valuable, but its impact is limited if the trained professionals return to environments where there is no or insufficient clinical support. In these cases where supervisors are insufficient, structured residency or clinical training programmes are unavailable, competency assessment systems are weak, professional recognition is unclear or opportunities for continuing professional development are limited, sustainable results will be poor. The focus therefore progressively shifted towards strengthening the training environment itself. This included support for clinical supervisors, residency programmes, structured clinical training, competency assessment, professional networks, regional collaboration and institutional capacity.

This was an important transition from training people towards building systems that can train people.

Emergence of Competency-based Training

The problem of how to create a training environment within a clinical setting called for a new approach to medical physics education and a competency based modular learning framework was developed based around the essential competencies that were agreed to be fundamental to the work of a medical physicist for each of the specialties of radiotherapy, diagnostic radiology and nuclear medicine. Modules such as clinical awareness, radiation protection and safety, professionalism and communication accompanied more technical topics like performance testing of imaging equipment, dosimetry, instrumentation and calibration, patient dose audit and optimization as examples for diagnostic radiology clinical training. Such training required structured learning that could be achieved by an individual, or more communally when larger groups could be formed. The RAS6038 experience also used graded continuous assessment which was to underpin the importance of competency-based clinical education. Competency-based training shifts the emphasis from: "What has the trainee studied?" to: "What can the trainee demonstrate safely and effectively in clinical practice?"

This distinction continues to be particularly important in medical physics because technological complexity continues to increase. A trainee working with IMRT, VMAT, IGRT, SBRT, proton therapy, advanced imaging or AI-enabled technologies needs more than theoretical knowledge. The trainee must be able to apply knowledge in the clinical environment, understand uncertainties, participate in quality assurance, identify risks and work effectively with the multidisciplinary team.

Project RAS6077: Innovation - Expanding Competency-based Clinical Training

Project RAS6077 represented a significant development in this pathway. The project built on the earlier foundation and placed greater emphasis on the effectiveness and reach of medical physics education and clinical training. A major development was the introduction of a purpose built Learning Management System (LMS) called Advanced Medical Physics Learning Environment (AMPLE). AMPLE provided a digital platform through which clinical training, competency tracking, communication and remote interaction could be supported across participating countries. This was particularly important for countries where access to experienced clinical supervisors and specialised expertise was limited. The development of AMPLE demonstrated that digital infrastructure could complement rather than replace face-to-face clinical training.

Project RAS6087: Extending Regional Connectivity

The next phase of regional cooperation further expanded the emphasis on connectivity, collaboration and access to expertise. Project RAS6087 supported the strengthening of regional cooperation and mechanisms such as expert exchange, training, networking and remote interaction with an added component of resource sharing in areas for example of tertiary education and subsequent provision of remote clinical supervisors. This was particularly valuable for countries with smaller medical physics communities. Regional connectivity can help address an important structural limitation: A country may have only a small number of experienced medical physicists, but its trainees can potentially access a much larger regional pool of expertise. This does not eliminate the need for national capacity. Rather, it allows countries to extend national capacity through regional cooperation. An outstanding example in this project was the help extended by Thailand through King Chulalongkorn Memorial Hospital act as a regional training centre where medical physicists from Laos and Myanmar where able to fulfil conditions for MSc training under specific arrangements which then lead to remote clinical supervision during clinical training in the medical physicists' home institute.

Project RAS6101: Harmonization - From Training Towards Competency, Quality and Recognition

Project RAS6101 represented a further evolution in the regional approach. The focus increasingly included postgraduate education, clinical training, competency development, quality assurance, continuing professional development, certification, professional recognition and institutional capacity. The regional objective was increasingly becoming a complete professional development pathway rather than a collection of independent training activities. The underlying model can be expressed as:

Education

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Clinical Training

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Competency

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Assessment

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Certification / Professional Recognition

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CPD

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Sustainable Professional Practice

This evolution is consistent with the broader IAEA concept of the Clinically Qualified Medical Physicist (CQMP).

Project RAS6109: Improving the Quality and Safety of Diagnostic and Interventional Radiology Services to Benefit Health Care

RAS6109 represents a further step towards strengthening the clinical role, professional status, knowledge and skills of medical physicists in support of safe and effective healthcare. The project builds on the experience of previous RCA initiatives, including RAS6038, RAS6077, RAS6087, RAS6088 and RAS6101. This continuity is significant. It demonstrates that regional workforce development is not being restarted from zero with each project. Instead, successive projects can build upon trained professionals, clinical supervisors, training materials, institutional relationships, professional networks, digital infrastructure, competency frameworks and lessons learned from previous implementation.

The Human Dimension of the RCA Experience

The evolution described above is ultimately an evolution of people and professional relationships. Projects create opportunities for medical physicists from different countries to learn from one another, develop professional networks, establish mentoring relationships and share practical experience. These relationships often continue beyond the formal duration of individual projects. They create a regional professional community capable of transferring knowledge across national and institutional boundaries.

From Physical Networks to Digital Connectivity

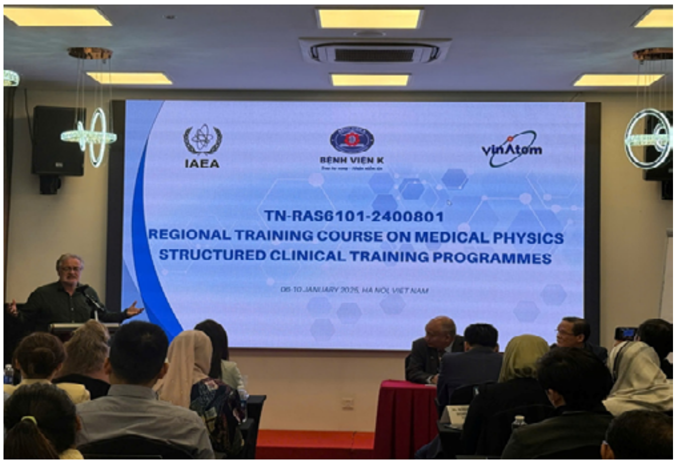
(Fig. 3) RAS6077 Meeting in Vietnam, December 2016, established the roles and responsibilities of the AMPLE Editorial Board

The evolution of RCA cooperation also illustrates a broader transformation in the way regional capacity can be developed. Earlier projects depended heavily on face-to-face courses, expert missions, fellowships, clinical attachments and regional meetings. These mechanisms remain important. However, digital platforms now provide an additional layer of connectivity. Resources can be shared more widely. Communication can occur more frequently. Clinical cases can be discussed across borders. Supervisors can provide support remotely. Trainees can maintain connections with regional experts between physical training activities. The development of AMPLE therefore represents not a replacement for traditional regional cooperation, but an extension of its reach.

The Strategic Lesson from More Than Two Decades

The RCA experience demonstrates that sustainable workforce development requires continuity. A project can establish a training programme. A subsequent project can strengthen supervision. Another can develop competency assessment. A later project can extend digital connectivity. Further cooperation can support professional recognition, CPD and workforce planning. The value emerges when these activities are connected over time. This leads to a central conclusion for the Issue Brief (Fig. 4):

The RCA experience demonstrates that sustainable workforce development is a long-term process rather than a single training project.



(Fig. 4) Regional Training Course on MPSCTP

5. AMPLE and Competency-based Residency

The evolution of RCA medical physics cooperation demonstrates that sustainable workforce development requires more than face-to-face training. As the number and complexity of technologies increase, countries need mechanisms that can extend access to clinical expertise, support supervisors, facilitate competency assessment and maintain professional connections across geographical boundaries.

The Advanced Medical Physics Learning Environment (AMPLE) represents an important development in this direction.

AMPLE as a Regional Digital Enabling Platform

AMPLE was developed to strengthen the effectiveness and reach of medical physics education and clinical training through digital connectivity. Its significance lies not simply in providing online learning materials.

AMPLE can support a broader clinical training ecosystem involving trainees, clinical supervisors, training institutions, academic institutions, professional networks, clinical resources and regional expertise. This allows digital infrastructure to complement physical clinical training.

Extending Access to Clinical Expertise

A major challenge in medical physics education is the uneven distribution of experienced clinical supervisors. Some countries have established medical physics departments with several experienced professionals. Others have smaller teams and may have limited access to specialised expertise. Digital connectivity can help bridge this gap. A trainee can remain within a national clinical environment while accessing regional expertise through remote discussion, mentoring, case review, shared resources, competency documentation, professional communication and remote supervision.

AMPLE therefore provides a mechanism for extending the reach of clinical expertise without requiring every country to reproduce the same level of specialised resources independently.

Competency-based Clinical Training

The value of AMPLE is closely linked to the development of competency-based clinical training. The central question is not simply whether a trainee has completed a course. It is whether the trainee has demonstrated the competencies required for safe clinical practice. A competency-based approach can provide a structured connection between:

Training Activities

▾

Clinical Experience

▾

Supervision

▾

Competency Assessment

▾

Clinical Qualification

AMPLE can support this process by providing a digital environment in which training resources, communication, supervision and competency-related information can be connected.

Remote Supervision

Remote supervision is particularly valuable in a region characterised by geographical diversity. A clinical supervisor may be located in a different city or country from the trainee. Digital communication can allow the supervisor to discuss clinical cases, review training progress, provide feedback, support problem-solving, discuss quality assurance issues and maintain professional contact between face-to-face activities.

Remote supervision should not be regarded as a substitute for local clinical supervision. Rather, it should be understood as a complementary regional resource that can strengthen national training capacity.

AMPLE and the Role of Clinical Supervisors

Digital infrastructure is only as effective as the professional system in which it operates. AMPLE cannot replace experienced clinical supervisors. Instead, it can help supervisors extend their reach and maintain contact with trainees. This creates an important principle: Digital infrastructure enables connectivity; professional competence provides the substance. The combination of the two can create a more flexible regional training environment.

AMPLE and Knowledge Sharing

Medical physics is a rapidly changing profession. Clinical experience accumulated in one institution or country can be highly valuable to colleagues elsewhere. Digital platforms can facilitate the sharing of training resources, clinical cases, practical experience, quality assurance approaches, educational materials, lessons learned, professional guidance and emerging technology information. Such sharing can help reduce duplication and allow countries to benefit from regional experience.

AMPLE in a Geographically Diverse Region

The Asia-Pacific region includes countries with very different geographical, economic and healthcare environments. Physical access to regional training activities may be difficult for some professionals because of distance, travel costs, limited staffing, competing clinical responsibilities and availability of specialised training.

Digital connectivity can reduce some of these barriers. It cannot eliminate the need for face-to-face clinical experience, but it can increase the frequency and continuity of interaction between training activities.

AMPLE and Professional Recognition

Competency-based training becomes more valuable when it is connected to formal professional recognition. Training records, competency evidence and assessment processes can contribute to a transparent pathway towards certification or other nationally appropriate forms of recognition. This creates a stronger link between:

Education

▾

Training

▾

Competency

▾

Assessment

▾

Clinical Qualification

The ultimate objective is not simply to create a sophisticated digital platform. It is to help create competent professionals who are recognised and trusted to perform clinical responsibilities safely.

AMPLE and the Future of Regional Cooperation

The next phase of regional cooperation could include digital clinical education, remote supervision, competency-based assessment, regional mentoring, shared educational resources, professional networking, CPD and workforce information and planning.

The objective should be to integrate digital connectivity into the wider medical physics workforce system. AMPLE illustrates how digital infrastructure can extend competency-based clinical training, supervision and knowledge sharing across geographically diverse countries. The challenge for the future is therefore not whether digital technology should replace conventional training. It is how digital connectivity can strengthen the continuity, reach and sustainability of clinical training systems.

6. The Asia-Pacific Medical Physics Workforce: Current Challenges and Gaps

The Asia-Pacific region has made substantial progress in medical physics education and training. However, significant differences remain among countries in workforce size, academic education, clinical training capacity, supervision, professional recognition, access to technology and opportunities for continuing professional development. These differences create an important regional challenge. The objective is not simply to produce more medical physicists. The objective is to develop a workforce that is appropriately educated, clinically competent, professionally recognised and capable of evolving with healthcare technology.

Uneven Workforce Capacity

The availability of medical physicists varies considerably across the region. Some countries have established medical physics departments, academic programmes, clinical training pathways and professional organisations. Others have much smaller workforces and limited access to specialised clinical expertise. This creates differences not only in the number of professionals available but also in the breadth of competencies that can be developed nationally.

Limited Clinical Training Capacity

Academic programmes may exist without corresponding clinical training capacity. A country may be able to educate students in medical physics but have insufficient numbers of clinical supervisors, training positions or appropriately equipped clinical centres to provide structured practical training. This creates a critical bottleneck between: Academic Education and Clinical Qualification. Strengthening this transition should therefore remain a priority for regional cooperation.

Shortage and Distribution of Clinical Supervisors

Clinical supervisors are essential to structured clinical training. However, experienced medical physicists are not distributed evenly across the region. Smaller or developing programmes may have limited numbers of professionals with sufficient clinical experience to supervise trainees across all relevant specialties. This is one area where regional cooperation and digital connectivity can provide valuable support. Regional experts can contribute through mentoring, train-the-trainer activities, expert exchange, remote supervision, shared resources and professional networks.

Professional Recognition

Professional recognition remains an important element of workforce development. Where certification, registration or other formal recognition mechanisms are weak or absent, medical physics may not be adequately positioned within the healthcare system. This can affect career progression, recruitment and retention, professional responsibilities, access to training, recognition of clinical competence and long-term workforce planning.

Professional recognition is therefore not simply a matter of professional status. It is an important component of patient safety and healthcare quality.

The Technology–Workforce Gap

Healthcare technology continues to advance rapidly. IMRT, VMAT, IGRT, SBRT, proton therapy, adaptive radiotherapy, advanced imaging, nuclear medicine, automation and AI are increasing the complexity of clinical practice. However, workforce development may not always progress at the same rate. The introduction of advanced technology without sufficient professional competence can create risks. The issue is therefore not whether countries should acquire advanced technologies. It is whether they can develop the human and institutional capacity required to implement those technologies safely and effectively.

Continuing Professional Development

The rapid pace of technological change means that competence cannot be considered permanent. A medical physicist who qualified several years ago may now be required to work with technologies, software and clinical procedures that were not part of their original training. CPD is therefore essential. Professional development should include opportunities to update technical knowledge, clinical competencies, quality assurance practice, safety and risk management, digital skills, AI-related knowledge and leadership and communication.

Institutional Capacity

Workforce development depends on institutions as much as individuals. Sustainable systems require academic programmes, clinical training centres, supervisors, competency frameworks, assessment mechanisms, professional organisations, certification or recognition systems, CPD opportunities and national workforce planning.

Where these elements are disconnected, individual training activities may have limited long-term impact.

Regional Cooperation as a Strategic Response

The challenges facing the region are interconnected. Regional cooperation can help address them by enabling countries to share expertise, educational resources, clinical training approaches, supervisors, digital platforms, professional experience and lessons learned.The RCA experience demonstrates that this approach can create cumulative value over time.

From Individual Capacity to System Capacity

The key lesson is that individual training and institutional development must proceed together. Training an individual medical physicist is valuable. But the long-term impact is much greater when that professional returns to an institution capable of providing clinical supervision, supporting continuing education, maintaining quality systems, recognising professional competence, adopting new technologies safely and developing the next generation of professionals. This is the transition from individual capacity building to system capacity building.

The Strategic Challenge

The region therefore faces a strategic choice. It can continue to address workforce gaps mainly through individual projects and training activities. Or it can use the experience accumulated through more than two decades of RCA cooperation to strengthen institutionalised national and regional workforce systems. The second approach provides a stronger foundation for long-term sustainability. The next section examines how such institutionalisation can be achieved.

7. Sustainable Workforce Development: From Project-based Capacity Building to Institutionalisation

The RCA experience demonstrates that regional projects can create substantial and lasting value. However, the ultimate measure of success is not the number of courses delivered or participants trained. It is whether project achievements become embedded in national institutions and professional systems. This is the transition from project-based capacity building to institutionalised workforce develoment.

From Projects to Systems

A project has a defined duration, objectives and resources. A workforce system must operate continuously. The challenge is therefore to ensure that project achievements are transferred into universities, hospitals, clinical training centres, professional organisations, national authorities and long-term professional development structures. This requires institutional ownership.

Institutionalised Education

Medical physics education should be embedded within sustainable academic programmes capable of adapting to technological and clinical developments. Academic curricula should evolve alongside advances in radiation therapy, diagnostic imaging, nuclear medicine, digital technologies, automation, AI and patient safety and quality systems. Academic education should also maintain a clear connection with clinical practice.

Institutionalised Clinical Training

Clinical training should increasingly become a recognised component of national workforce development. This requires defined clinical

Key Challenge	Workforce Impact	Potential Regional Response
Uneven workforce distribution	Limited access to specialised expertise	Regional networking, expert exchange and mentoring
Limited clinical training capacity	Gap between academic education and clinical qualification	Clinical attachments, training centres and train-the-trainer programmes
Shortage of clinical supervisors	Reduced capacity for supervised practice	Regional supervisors, mentoring and remote support
Weak professional recognition	Limited career progression and retention	Certification, registration and professional recognition
Rapid technological change	Competency–technology mismatch	CPD, technology-focused training and competency development
Uneven digital access	Limited continuity of training	Digital learning and regional connectivity
Weak workforce planning	Unsustainable workforce development	National and regional workforce planning

(Table 1) Key Workforce Challenges and Potential Regional Responses.

training pathways, accredited or appropriately recognised training centres, trained clinical supervisors, structured competencies, transparent assessment, appropriate documentation and sustainable funding and institutional support.

Certification and Professional Recognition

Professional recognition should provide a formal link between demonstrated competence and clinical responsibility. National systems may differ, but they should aim to ensure that professionals undertaking defined clinical responsibilities have appropriate:

Education
+
Training
+
Competence
+
Recognition

This is particularly important as technologies become increasingly sophisticated.

Continuing Professional Development

Institutionalised workforce development must continue beyond initial qualification. CPD should become an integral part of professional practice rather than an optional activity. It should support professionals as they adopt new technologies and develop new competencies. This is especially relevant to areas such as advanced radiotherapy, proton therapy, adaptive radiotherapy, advanced imaging, AI, automation and digital health.

Workforce Planning

A sustainable workforce cannot be developed without understanding future needs. Workforce planning should consider population and healthcare needs, existing workforce size, retirement and attrition, geographic distribution, emerging technologies, expected clinical workload, tertiary and clinical training capacity, supervisor availability and future competency requirements.

Workforce planning should therefore be connected to national healthcare planning and technology strategies. A good example of this in the region is that of Indonesia, where the health care services for their large population have seen improved availability of the medical physics services through an increased number of radiation treatment, diagnostic and nuclear medicine facilities, the founding of more medical physics programs and the combination of two previously independent professional societies. On closer inspection this is linked to recent policy of the medical physics professional society, working along side universities and the regulatory authority, to develop appropriate professional training schemes for medical physics services.

Regional Cooperation as an Enabling Mechanism

Institutionalisation does not mean that regional cooperation becomes unnecessary. On the contrary, regional cooperation can become more strategic. The focus can move from delivering isolated activities towards supporting national systems through regional standards and guidance, including in assessment processes, regional training centres with appropriate mechanisms to assist neighboring countries, expert networks, shared training resources, specialist centres, train-the-trainer programmes, digital connectivity, professional exchange, peer review and collaborative workforce planning.

The Role of AMPLE in an Institutionalised System

AMPLE provides an example of how a regional digital mechanism can contribute to this transition. Rather than being treated as a separate educational activity, AMPLE can be integrated into national clinical training systems as a supporting layer for clinical learning, supervision, competency tracking, communication, knowledge sharing and CPD.

Its long-term value will depend on how effectively it becomes integrated into institutional training systems.

From Project Outputs to Institutional Assets

A central principle should be that project outputs are transformed into institutional assets. For example:

Training course	▸	National training programme
Expert mission	▸	Sustainable supervision capacity
Training material	▸	Institutional learning resource
Project network	▸	Professional network
Digital platform	▸	Continuing training infrastructure
Competency framework	▸	National assessment system
Project experience	▸	National policy and workforce planning

This transformation is essential for sustainability.

A Sustainable Capacity-building Framework

The complete workforce development pathway can therefore be represented as:

Education

↓

Clinical Training

↓

Competence

↓

Assessment

↓

Certification / Professional Recognition

↓

CPD

↓

Workforce Planning

↓

Sustainable Workforce

The Strategic Direction

The next phase of regional cooperation should therefore focus increasingly on helping countries institutionalise what has already been developed through RCA projects. The objective should not be to replace project-based cooperation overnight. Instead, projects should increasingly be designed to leave behind sustainable institutional capacity. This means that every new regional initiative should consider from the outset:

- Who will own the outcome after the project ends?
- How will the training continue?
- Who will supervise future trainees?
- How will competence be assessed?
- How will professional recognition be maintained?
- How will CPD be supported?
- How will workforce needs be monitored?

These questions should become integral to project design.

The Long-term Goal

The long-term goal is a regional medical physics workforce system in which education is sustainable, clinical training is structured, competencies are defined and assessed, professionals are appropriately recognised, CPD is continuous, digital connectivity supports learning and supervision and workforce planning anticipates future healthcare and technology needs.

This represents the transition from capacity building to capacity sustainability.

8. Recommendations and the Way Forward

The experience of more than two decades of RCA cooperation provides a strong foundation for the next stage of regional medical physics workforce development. The priority should now be to consolidate achievements, strengthen national ownership and build sustainable systems capable of supporting the profession as healthcare technologies continue to evolve.

Recommendation 1. Recognise Medical Physics as a Clinical Profession

Medical physics has been recognised as a distinct clinical profession by the International Labour Organization (ILO) as well as by IAEA and WHO and should be recognised and positioned as a clinical profession with direct responsibilities for patient safety, quality of care and the safe implementation of medical radiation technologies involving dosimetry and calibration. The role of medical physicists should be appropriately reflected in national healthcare structures, career pathways and professional frameworks.

Recommendation 2. Strengthen the Education-to-Clinical Qualification Pathway

Countries should strengthen the continuum from academic education to clinical qualification. This should include appropriate academic education, structured clinical training, supervised practice, competency assessment and professional recognition. The pathway should be adapted to national circumstances while benefiting from regional experience.

Recommendation 3. Expand Competency-based Clinical Training

Competency-based clinical training should become a central element of medical physics workforce development. Regional cooperation should support countries in establishing competency frameworks, clinical training programmes, trained supervisors, assessment mechanisms and quality assurance of training.

Recommendation 4. Strengthen the Regional Network of Clinical Supervisors

A sustainable clinical training system requires sufficient numbers of experienced supervisors. Regional cooperation should therefore support train-the-trainer programmes, mentoring, regional training centres with appropriate mechanisms to assist neighboring countries, unified assessment procedures, expert exchange, peer networks, remote supervision and development of national supervisory capacity.

Recommendation 5. Institutionalise Professional Recognition

Countries should strengthen appropriate mechanisms for certification, registration, professional recognition and career development. Regional cooperation can support the sharing of experience and the development of approaches that are appropriate to national healthcare systems.

Recommendation 6. Integrate AMPLE and Digital Connectivity into the Regional Training Ecosystem

AMPLE should be developed and maintained as a digital layer supporting the wider medical physics training ecosystem. Its future development should focus on competency-based clinical training, remote supervision, knowledge sharing, mentoring, CPD, professional networking and access to regional expertise. Digital connectivity should complement, rather than replace, face-to-face clinical training.

Recommendation 7. Make CPD an Integral Part of Professional Practice

CPD should be integrated into professional development throughout the career of a medical physicist. This is particularly important as new technologies such as advanced radiotherapy, proton therapy, adaptive treatment, AI and automation become increasingly integrated into clinical practice.

Recommendation 8. Strengthen National Workforce Planning

Countries should progressively develop workforce planning mechanisms that link medical physics staffing to population needs, healthcare service development, tertiary education development, technological change, clinical workload, retirement and attrition, training capacity and future competency requirements.

Recommendation 9. Design RCA Projects for Sustainability from the Beginning

Future regional projects should include explicit sustainability mechanisms from the project design stage.

Each project should identify how its outputs will be institutionalised, maintained, funded, transferred, monitored and integrated into national systems.

Recommendation 10. Strengthen Regional Knowledge Sharing

Regional cooperation should continue to facilitate the sharing of clinical experience, educational resources, competency frameworks, quality assurance approaches, technology assessment methods, professional development opportunities and lessons learned.

Recommendation 11. Develop a Regional Vision for Medical Physics Workforce Sustainability

The RCA and its participating countries should consider developing a longer-term regional vision linking:

Education
↓
Clinical Training
↓
Competence
↓
Recognition
↓
CPD
↓
Workforce Planning

Such a vision would help ensure that future projects contribute to a coherent regional pathway rather than operating as isolated interventions.

The Strategic Shift

The recommendations above point towards one fundamental strategic shift:

From project-based capacity building to institutionalised workforce development.

This does not mean abandoning regional projects. It means ensuring that each project contributes to a system that becomes progressively more capable of sustaining itself.

The Next Phase of Regional Cooperation

The next phase should therefore build on the accumulated experience of RCA medical physics projects and focus increasingly on national institutional ownership, clinical qualification pathways, competency-based training, professional recognition, CPD, digital connectivity, workforce planning and long-term sustainability.

This would allow the region to move from training individuals towards strengthening the institutions and systems that sustain the profession.

Project-based approach	Institutionalised approach
Individual training activities	Continuous national training pathways
Short-term expert missions	Sustainable supervisory capacity
Project-specific resources	Institutional learning resources
Temporary networks	Permanent professional networks
Training outputs	Competency and assessment systems
Digital platform as project tool	Digital infrastructure for continuous learning
Project completion as endpoint	Long-term monitoring and workforce planning

(Table 2) From Project-based Capacity Building to an Institutionalised Workforce System.

9. Conclusion

Medical physics is increasingly central to the safe and effective delivery of modern healthcare. As technologies become more sophisticated, the clinical responsibilities of medical physicists also become more demanding. IMRT, VMAT, IGRT, SBRT, proton therapy, adaptive radiotherapy, advanced imaging, nuclear medicine and AI offer significant opportunities to improve healthcare, but they also require professionals with appropriate knowledge, clinical competence and professional judgement. The central lesson is therefore clear: Technology alone is not enough. Technology must be supported by competent professionals, effective quality systems and appropriate clinical governance.

From Education to Clinical Competence

Academic education provides the foundation of medical physics. But clinical qualification requires more. Structured clinical training, supervised practice, competency assessment and professional recognition are essential to prepare medical physicists for clinical responsibility. Continuing professional development must then maintain and extend that competence throughout the professional career.

The RCA Experience

The RCA experience demonstrates the value of long-term regional cooperation. Over more than two decades, successive projects have contributed to education and clinical training, structured clinical development, competency-based approaches, clinical supervision, professional networks, digital connectivity, professional recognition and workforce development.

The value of this experience lies not only in the outputs of individual projects. It lies in the continuity between projects. Each phase has provided a foundation on which subsequent initiatives could build.

The Contribution of AMPLE

AMPLE illustrates how digital infrastructure can extend the reach of regional cooperation. By supporting clinical training, supervision, competency-related activities and knowledge sharing, digital connectivity can help connect professionals and institutions across geographically diverse countries. However, digital platforms are most effective when integrated into a broader professional system. Technology enables connectivity. People, competence and institutions create sustainable clinical capacity.

From Projects to Institutions

The next phase of regional cooperation should therefore focus increasingly on institutionalisation. The objective should be to ensure that the knowledge, competencies, networks, resources and systems developed through regional projects become embedded in national education, clinical training, professional recognition, CPD and workforce planning. The ultimate goal is not simply to train more medical physicists. It is to establish a sustainable medical physics workforce capable of evolving with healthcare technology and supporting safe, high-quality patient care.

Final Strategic Message

The experience of the RCA demonstrates that sustainable workforce development is a long-term process rather than a single training project. The next stage is therefore to build on this experience and move from project-based capacity building towards institutionalised education, certification, professional recognition, CPD and workforce planning. This is the strategic direction required to ensure that the Asia-Pacific region has the competent, recognised and sustainable medical physics workforce needed to translate technological progress into safe and effective patient care.

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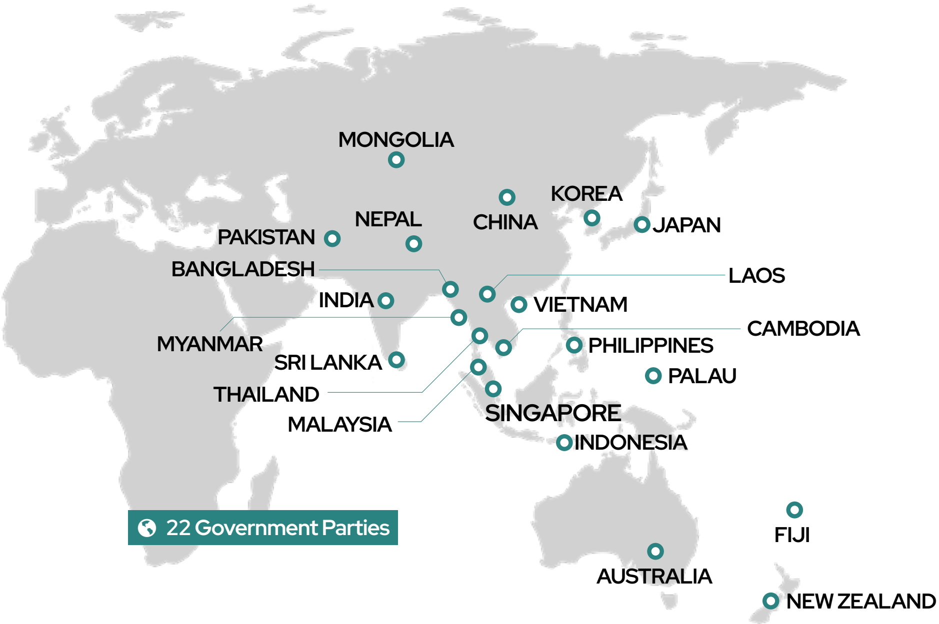
RCA at a Glance

The RCA (Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific) **is an intergovernmental agreement among the IAEA Member States that are located in South Asia, South East Asia and the Pacific, and the Far East.**



Establishment

1972

Membership

Member States of the International Atomic Energy Agency (IAEA) in the Asia and the Pacific Region. Current membership 22 states.

Objective

To cooperate with each other and the IAEA in the use of nuclear techniques to contribute to the socio-economic development of the members (Government Parties) of the RCA (Regional Cooperative Agreement for Asia and the Pacific).

Thematic Areas

Agriculture, Environmental Protection, Human Health, Industry, Radiation Protection, Energy Planning and others

No. of RCA Projects Implemented

186 (up to 2024)

Number of persons trained in regional training courses

Approximately 14,000.

Financial Resources

Technical Cooperation Fund of the IAEA and the Extra Budgetary contributions of the RCA Government Parties for regional activities, RCA Government Parties for national activities and partner organizations.

Role of the IAEA

To provide financial, administrative, and technical support to the programs and projects of the RCA.

Governance

By National RCA Representatives appointed by the Government Parties at two annual meetings.

Project Implementation

By national project teams functioning under National Project Coordinators, led by a Lead Country Coordinator

RCA website

www.rcaro.org

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RCA Newsletter also publishes the Issue Brief, dedicated to disseminating informative and analytical materials that provide in-depth insights into the peaceful uses of nuclear science and technology within the RCA region. We cordially invite contributions from experts, researchers, and RCA-related stakeholders to submit Issue Briefs that explore these topics. A standard format of an article is about 3,000-4000 words (10-12 pages of WORD document in English) accompanying several pictures/images related to the article. Relevant guidelines and article templates can be found here. Please send us the article to djlee@rcaro.org.

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