IAEA Activities in Radiopharmaceutical Therapy

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IAEA
International Atomic Energy Agency

International Atomic Energy Agency (IAEA)

world's central intergovernmental forum for scientific and technical co-operation in the nuclear field.

Organization

Part of the United Nations, an independent organization

2,500+ staff

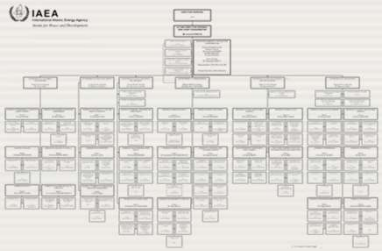
HQ in Vienna

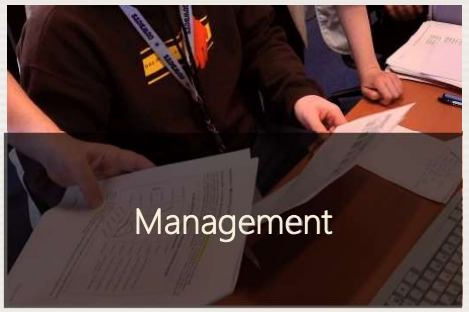
Offices in Toronto, Tokyo, New York, Geneva

Laboratories in Seibersdorf and Monaco

175 Member States

- Director General
- Director General's Office for Coordination
- Secretariat of the Policy-Making Organs
- Offices of Legal Affairs; Public Information and Communication; and Internal Oversight Services, and
- 6 Departments:





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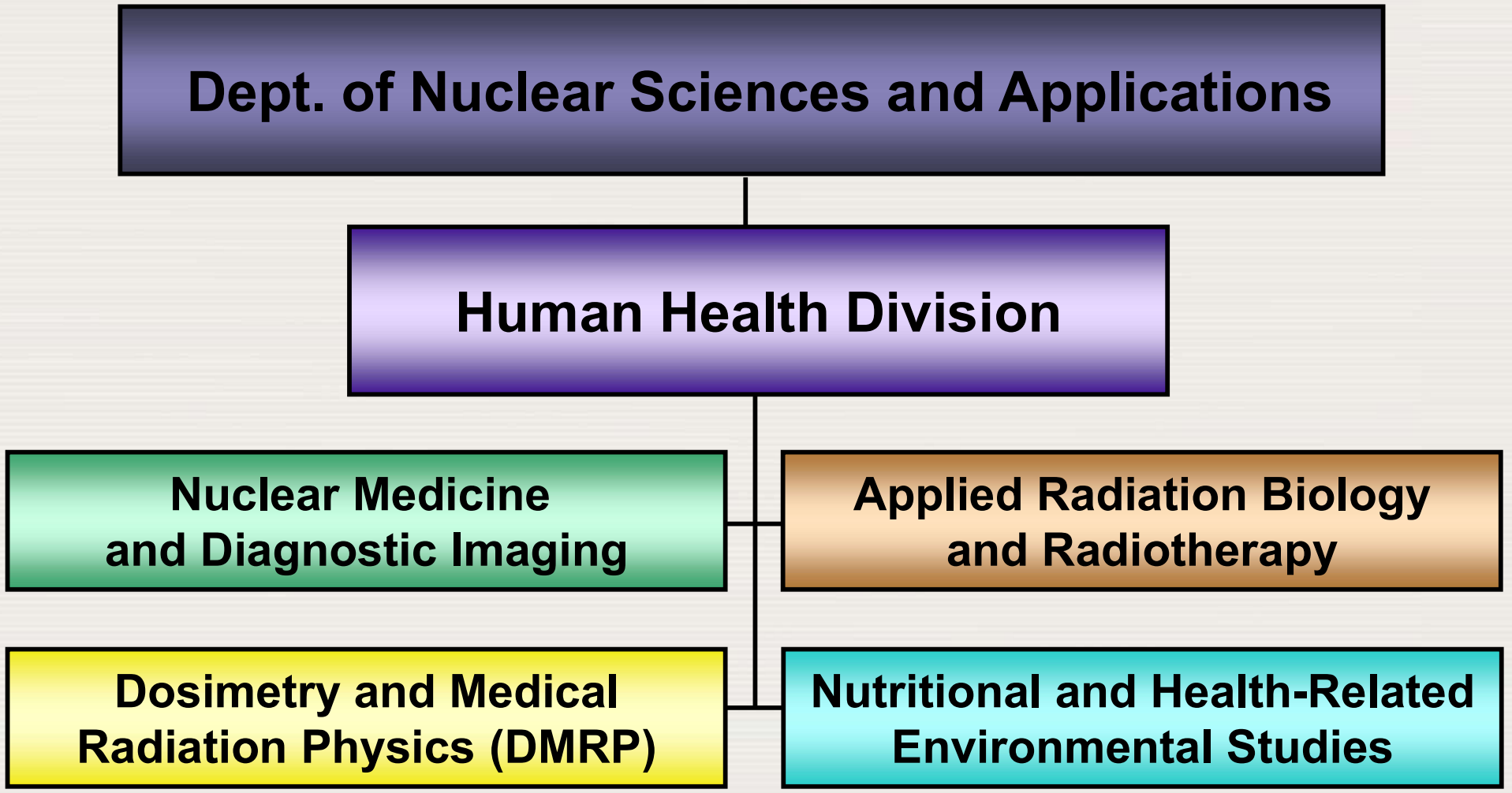
IAEA Human Health Division



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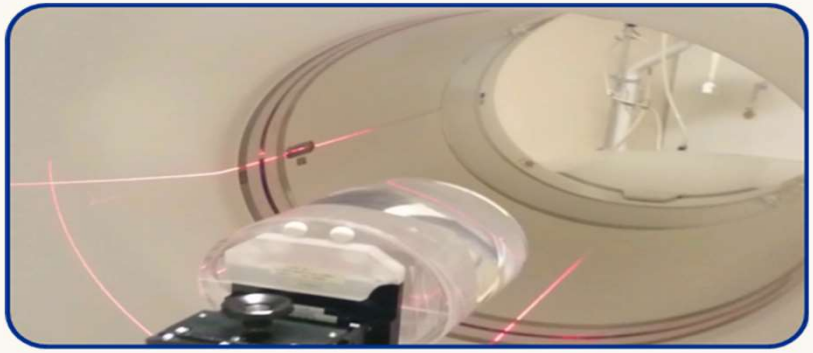
Online information can be found on
YouTube, the Human Health Campus and Twitter

Nuclear Medicine & Diagnostic Imaging

Dosimetry & Medical Physics for Imaging and Therapy



Division of Human Health

Provide comprehensive support to establish or strengthen the practice of radiology and nuclear medicine within a context of appropriate use, safety and quality of clinical practice

Enhance capabilities of Member States to implement radiation imaging and treatment modalities safely and effectively through best medical physics practice

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Roles and Responsibilities of Medical Physicists

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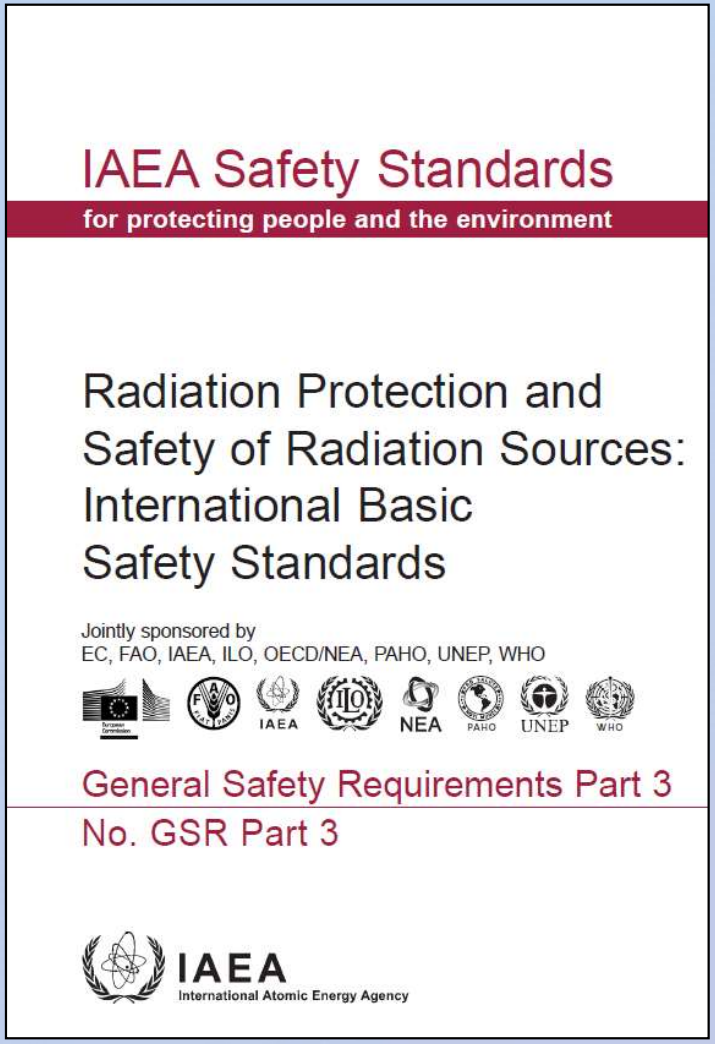
Roles & responsibilities of MPs



Calibration

3.167. In accordance with para. 3.154(d) and (e), the medical physicist shall ensure that:

Dosimetry of patients

3.168. Registrants and licensees shall ensure that dosimetry of patients is performed and documented by or under the supervision of a medical physicist, using calibrated dosimeters and following internationally accepted or nationally accepted protocols, including dosimetry to determine the following:

Quality assurance for medical exposures

3.170. Registrants and licensees, in applying the requirements of these Standards in respect of management systems, shall establish a comprehensive programme of quality assurance for medical exposures with the active participation of medical physicists, radiological medical practitioners, medical radiation technologists and, for complex nuclear medicine facilities, radiopharmacists and radiochemists, and in conjunction with other health professionals as appropriate.

(a) Measurements of the physical parameters of medical radiological equipment made by, or under the supervision of, a medical physicist:

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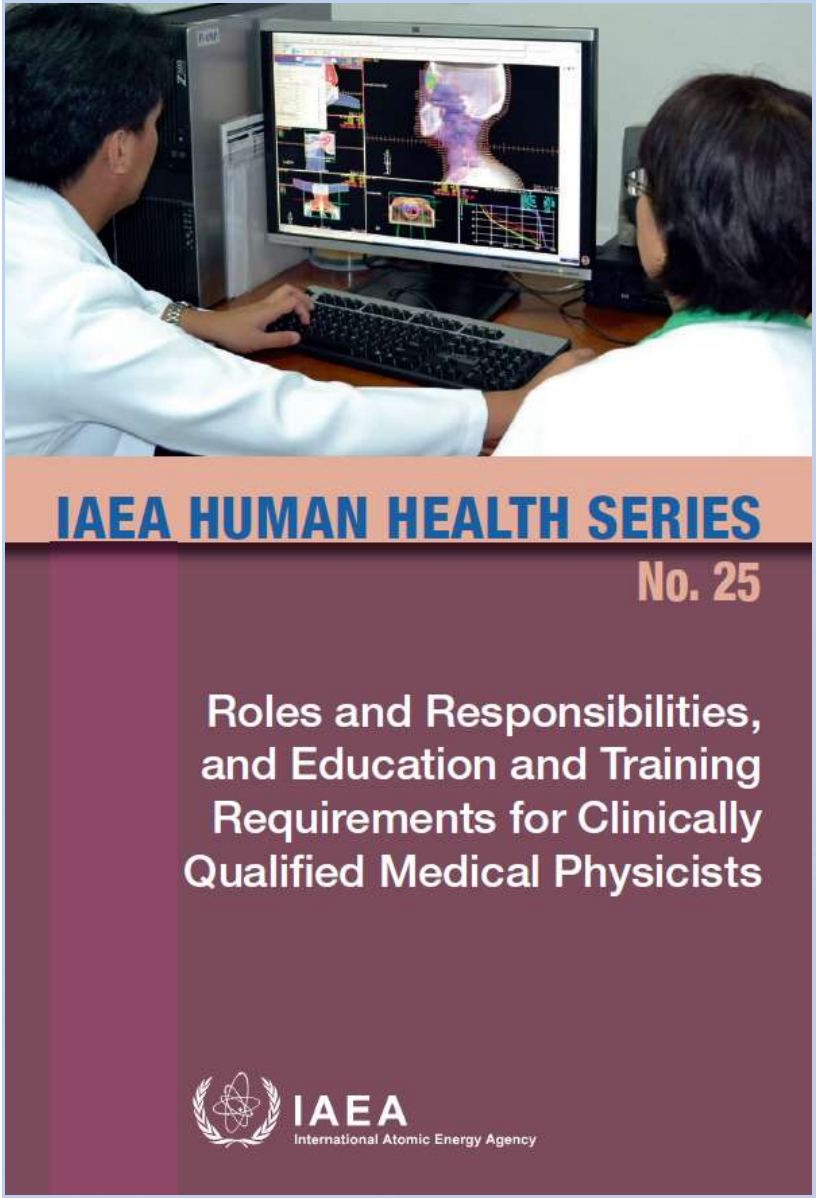
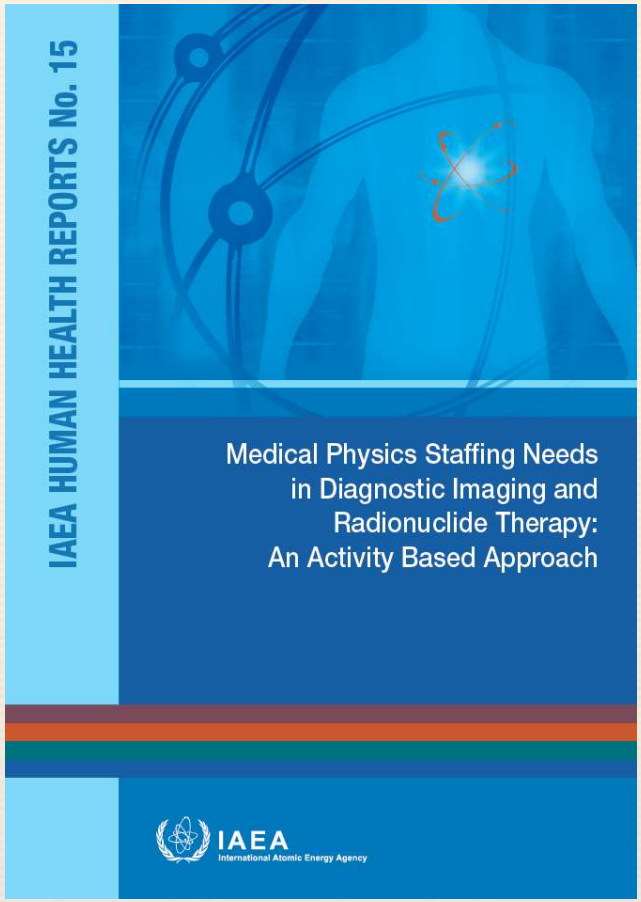


Roles & responsibilities of MPs

- Defines appropriately and unequivocally the **roles and responsibilities of a Clinically Qualified Medical Physicist in specialties of medical physics** related to the use of ionizing radiation
- Establish criteria to support harmonization of education and clinical training worldwide,
- Promote the recognition of medical physics as a profession internationally



Recommended MP staffing levels for medical imaging, based on the roles and responsibilities of the MP

D. McLean (Australia)

S. Holm (Denmark)

M. Brambilla (Italy)

M.C. Martin (USA)

H. Delis and GL Poli (IAEA)

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International Atomic Energy Agency

Spreadsheet

	without efficiency of scale	with efficiency of scale	
		Reduction Factor (RF)	0.7
TOTAL NUMBER OF CQMP REQUIRED	2.0	2.0	
REAL NUMBER OF CQMP	0.0	0.0	
DEVIATION FROM THE ALGORITHM			
Total suggested supportive staff	2.0	2.0	
Number of residents	0.0	0.0	
Suggested supportive staff (excluding residents)	2.0	2.0	
REAL NUMBER OF SUPPORTIVE MP STAFF	0.0	0.0	

EQUIPMENT DEPENDENT FACTORS	0.708
Nuclear Medicine	0.3
Diagnostic/Interventional	0.408
PATIENT DEPENDENT FACTORS	0.5
Nuclear Medicine	0.32
Diagnostic/Interventional	0.18
RADIATION PROTECTION RELATED FACTORS	0.325
Department RP	0.31
Occupational protection	0.015
SERVICE RELATED FACTORS	0.43
TRAINING RELATED FACTORS	0.04
Interdepartmental training	0.04

Staffing of imaging MP

Medical physics services in radiology and nuclear medicine in Africa: challenges and opportunities identified through workforce and infrastructure surveys

Christoph Trauernicht[1] · Francis Hasford[2] · Nadia Khelassi-Toutaoui[3] · Imen Bentouhami[4] · Peter Knoll[4] · Virginia Tsapaki[4]

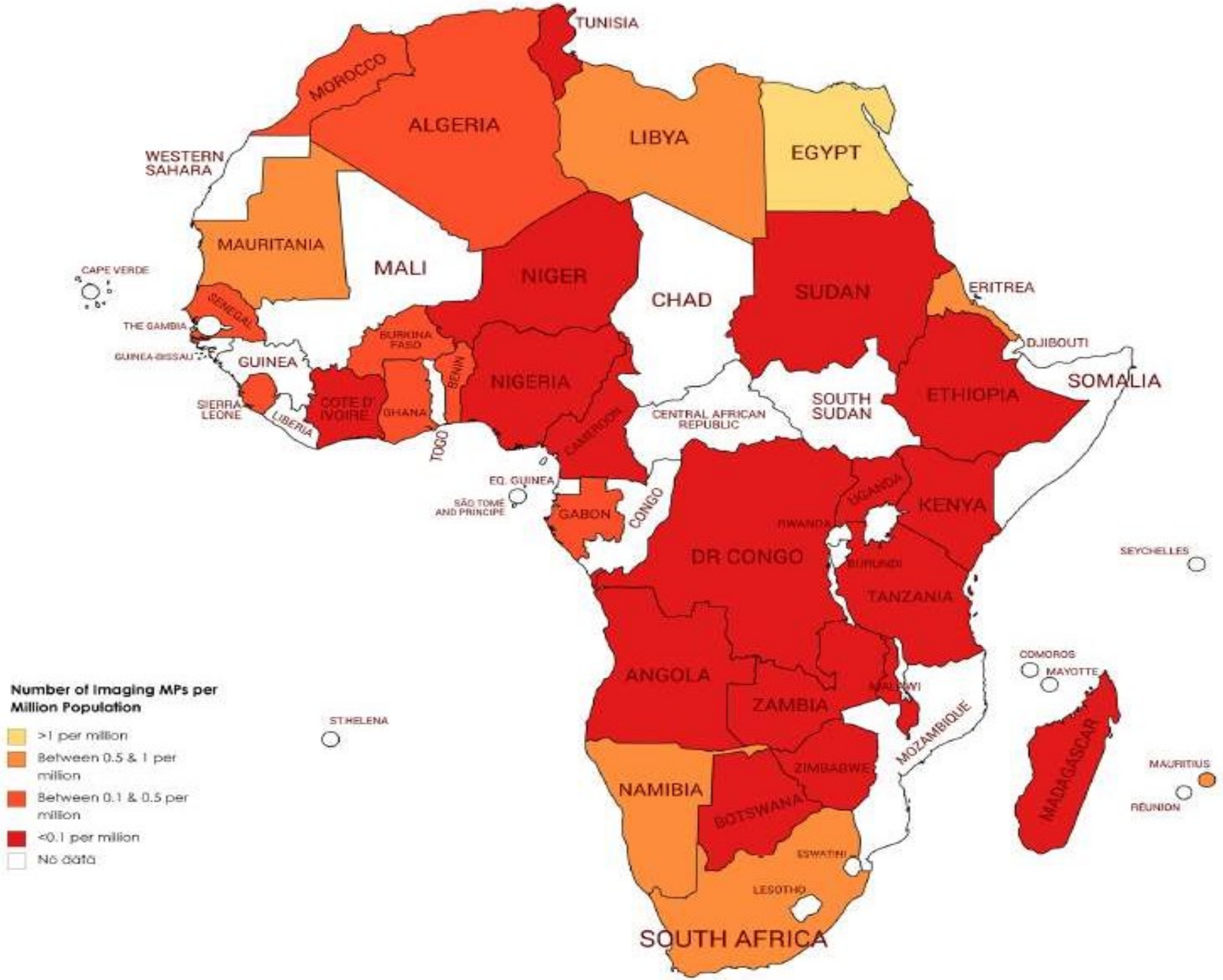
Health Technol. **12,** 729–737 (2022)

Received: 4 March 2022 / Accepted: 24 March 2022

Abstract

The International Atomic Energy Agency (IAEA) developed a staffing model to estimate the number of clinically qualified medical physicists (CQMP) that are required in an imaging facility, including diagnostic radiology and nuclear medicine. For the first time this staffing model was applied on a large scale across Africa. Within the framework of the IAEA African Regional Agreement (AFRA) Technical Cooperation (TC) project RAF6/053 entitled "Enhancing Capacity Building of Medical Physics to Improve Safety and Effectiveness of Medical Imaging (AFRA)", a survey based on the IAEA staffing model was used to investigate the current CQMP workforce needs in imaging and radionuclide therapy in Africa in order to establish a baseline, identify gaps and suggest steps for improvement. The survey was open for five months, after which data verification was performed. 82 responses were received from 21 countries, including data from 97 diagnostic radiology and 40 nuclear medicine departments, as well as 75 interventional radiology departments and/or catheterization laboratories. Only 26·8% of centres employed an adequate number of CQMPs. The staffing model indicated that 134·3 CQMPs were required for these centres, but only 63 are currently employed in medical imaging and/or nuclear medicine at these centres. At least 11 countries do not have a single institution with an adequate number of CQMPs. Data analysis indicated that the number of radiology and nuclear medicine CQMPs is largely inadequate, at least by a factor of 20 in almost all countries in the region.

Keywords Medical physics · Nuclear medicine · Radiology · Imaging · Workforce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MOROCCO
ALGERIA
LIBYA
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MALI
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GUINEA-BISSAU
GUINEA
BURKINA FASO
BENIN
NIGERIA
DJIBOUTI
SOMALIA
ETHIOPIA
SIERRA LEONE
LIBERIA
COTE D' IVOIRE
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TOGO
CAMEROON
CENTRAL AFRICAN REPUBLIC
SOUTH SUDAN
EQ. GUINEA
SÃO TOMÉ AND PRINCIPE
GABON
CONGO
UGANDA
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ZAMBIA
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MOZAMBIQUE
MADAGASCAR
MAURITIUS
REUNION
ZIMBABWE
NAMIBIA
BOTSWANA
ESWATINI
LESOTHO
SOUTH AFRICA
ST HELENA
Number of Imaging MPs per Million Population
>1 per million
Between 0.5 & 1 per million
Between 0.1 & 0.5 per million
<0.1 per million
No data

Academic Education and Clinical Training

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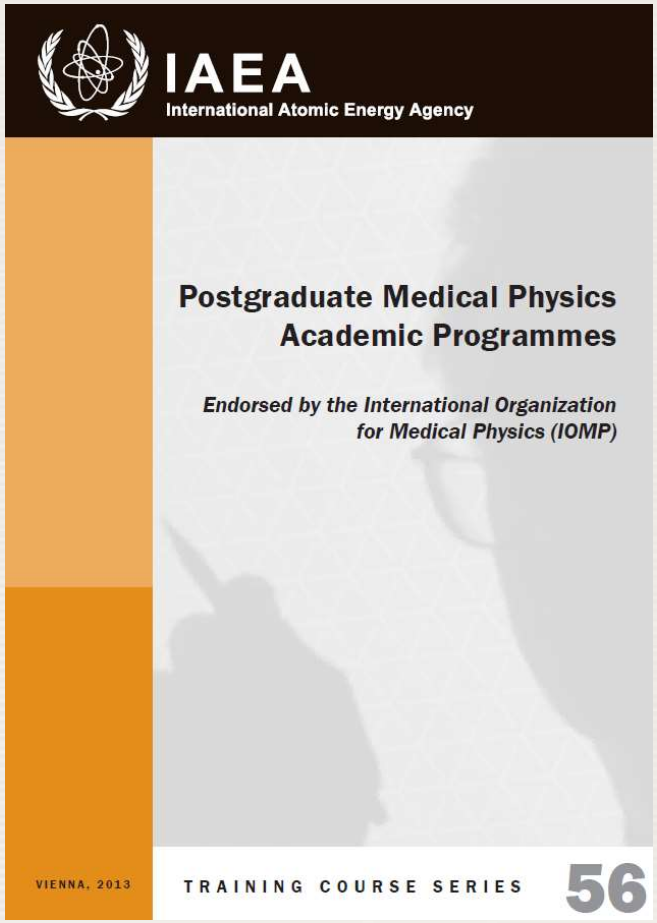
Academic education

This publication, seeks to provide guidelines for the establishment of a postgraduate academic education programme in medical physics, which could also be used to achieve harmonized standards of competence worldwide.



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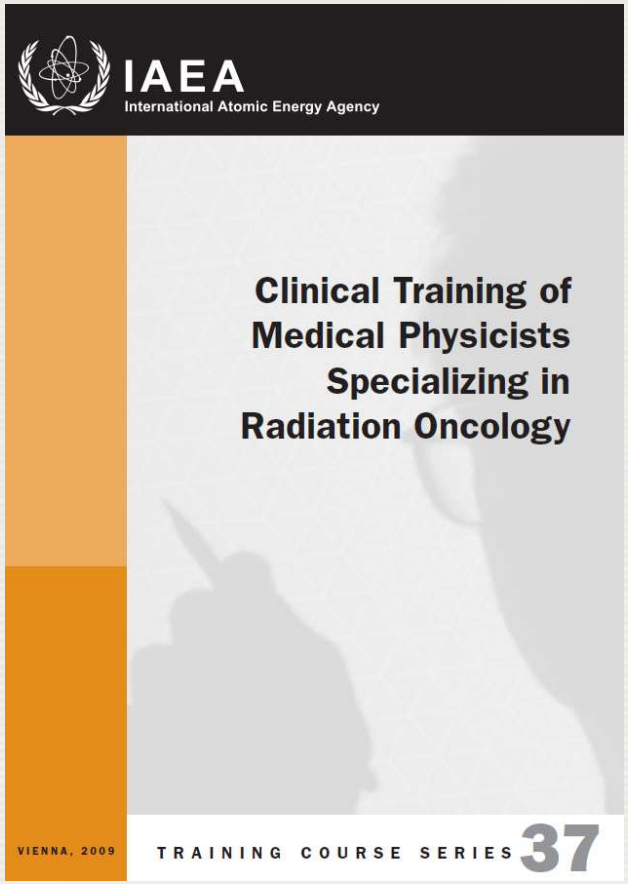
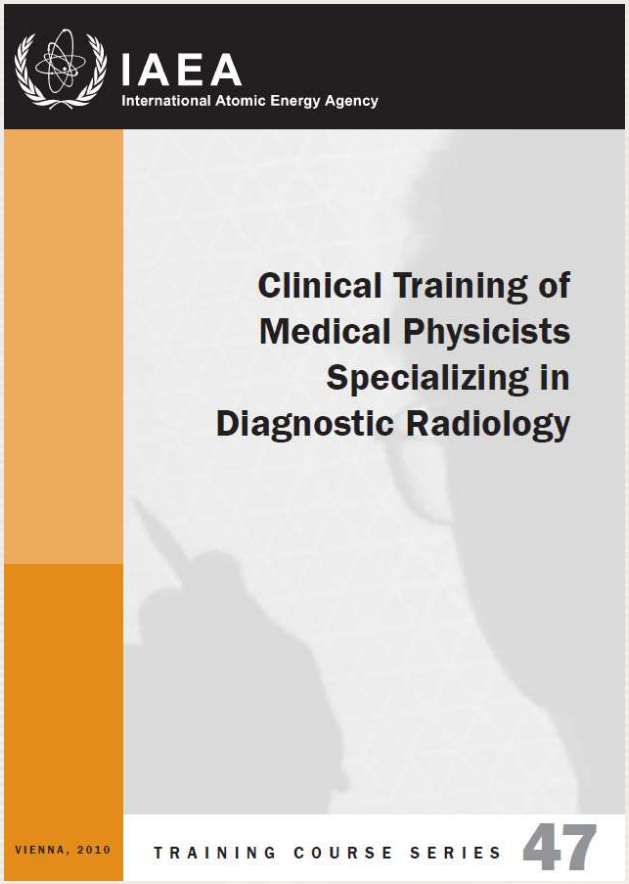
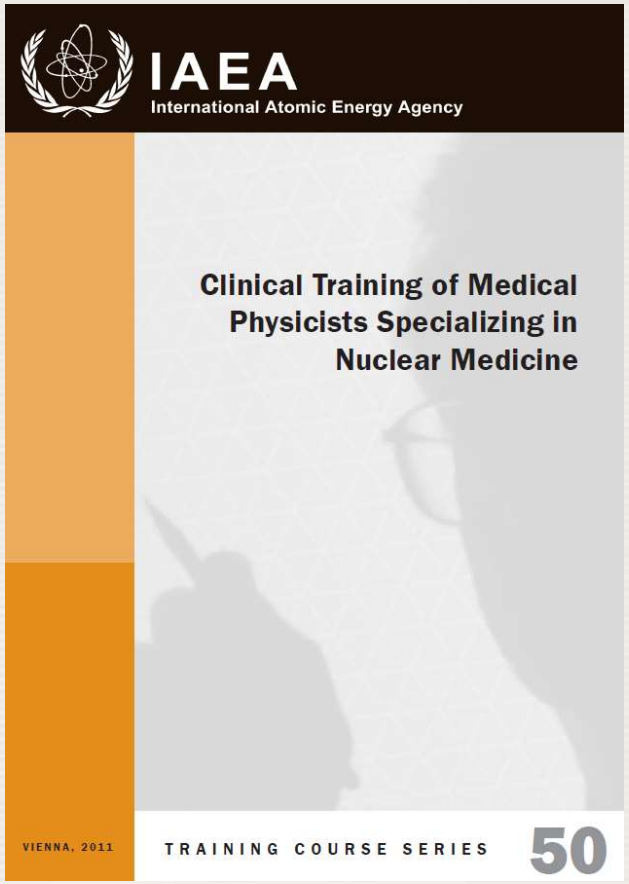
Clinical training







Development of clinical training guides for medical physicists specialising in Radiation Oncology, Diagnostic Radiology and Nuclear Medicine

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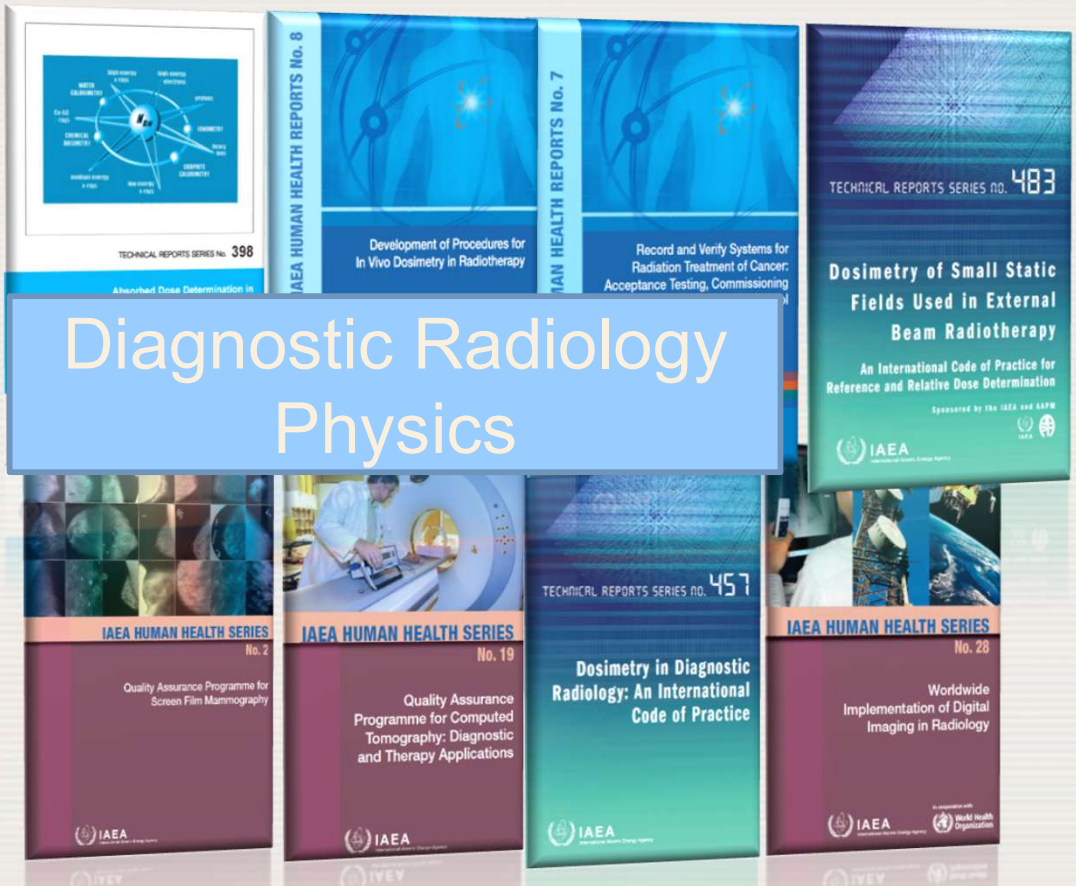
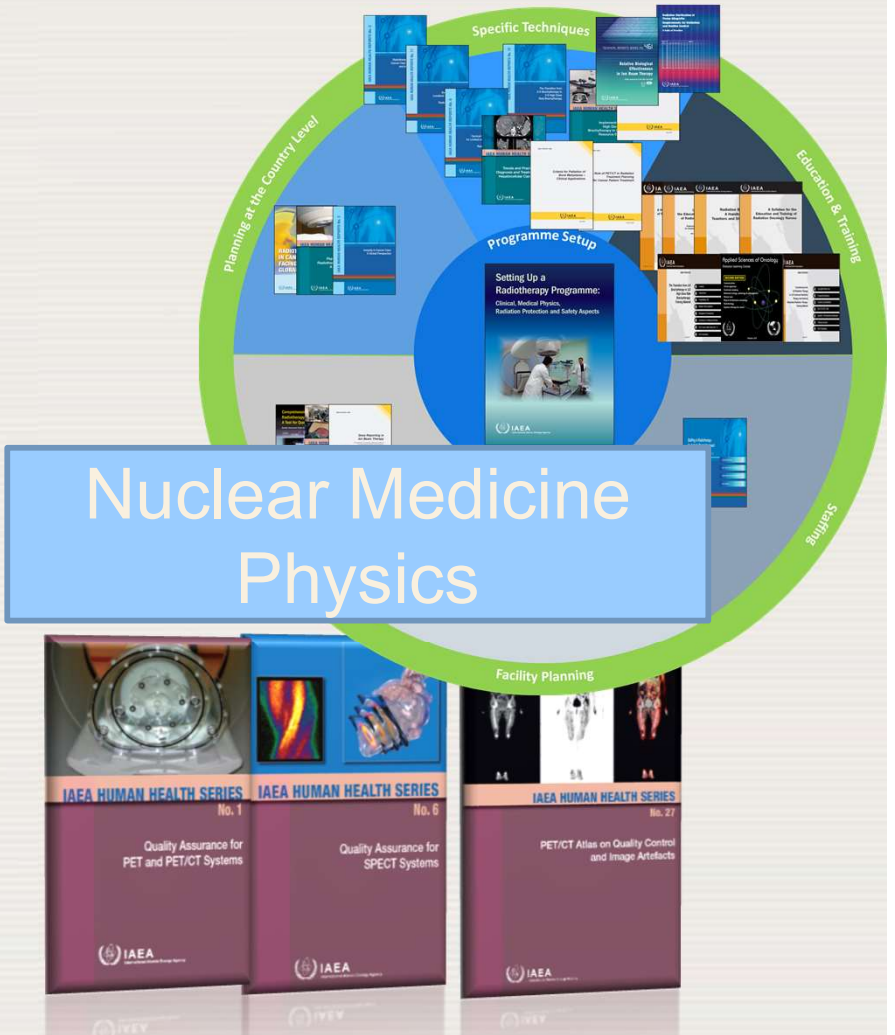
IAEA Publications

Radiation Oncology Physics



Diagnostic Radiology Physics

Nuclear Medicine Physics



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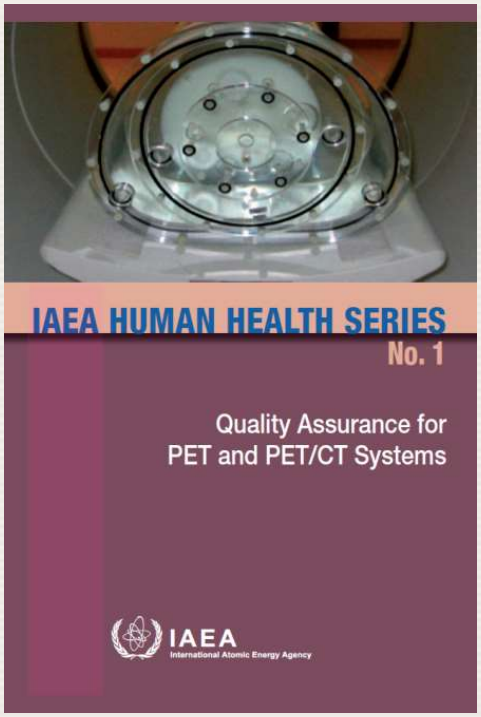
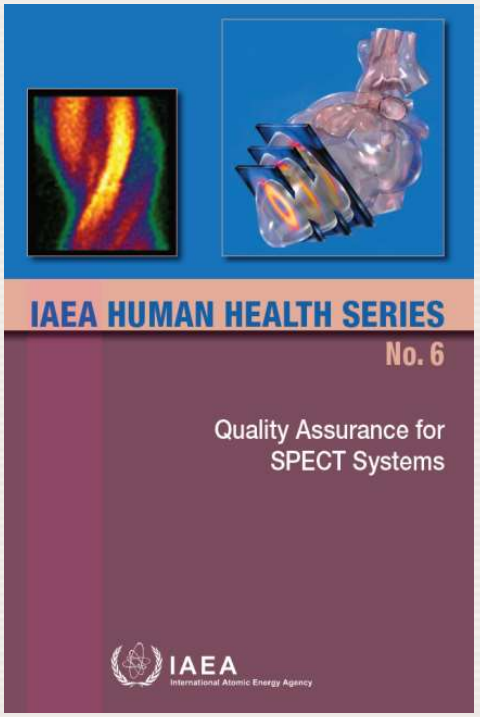
More than 9000 scientific and technical publications were produced:

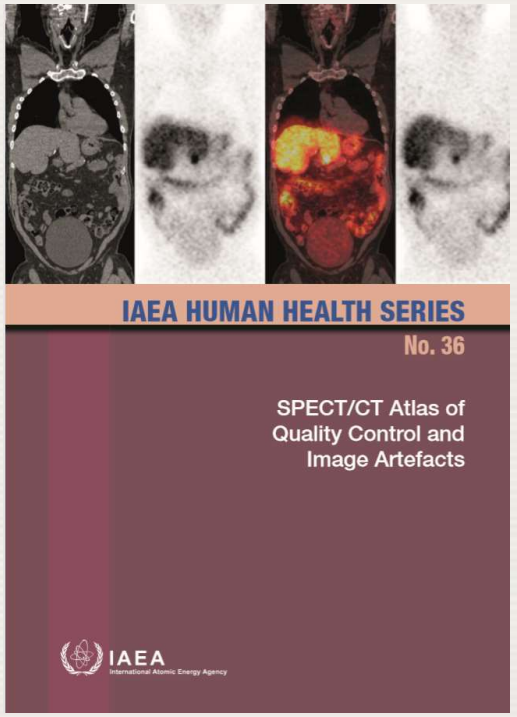
For a complete list, visit https://www.iaea.org/publications

Nuclear Medicine Physics Publications

Quality Assurance







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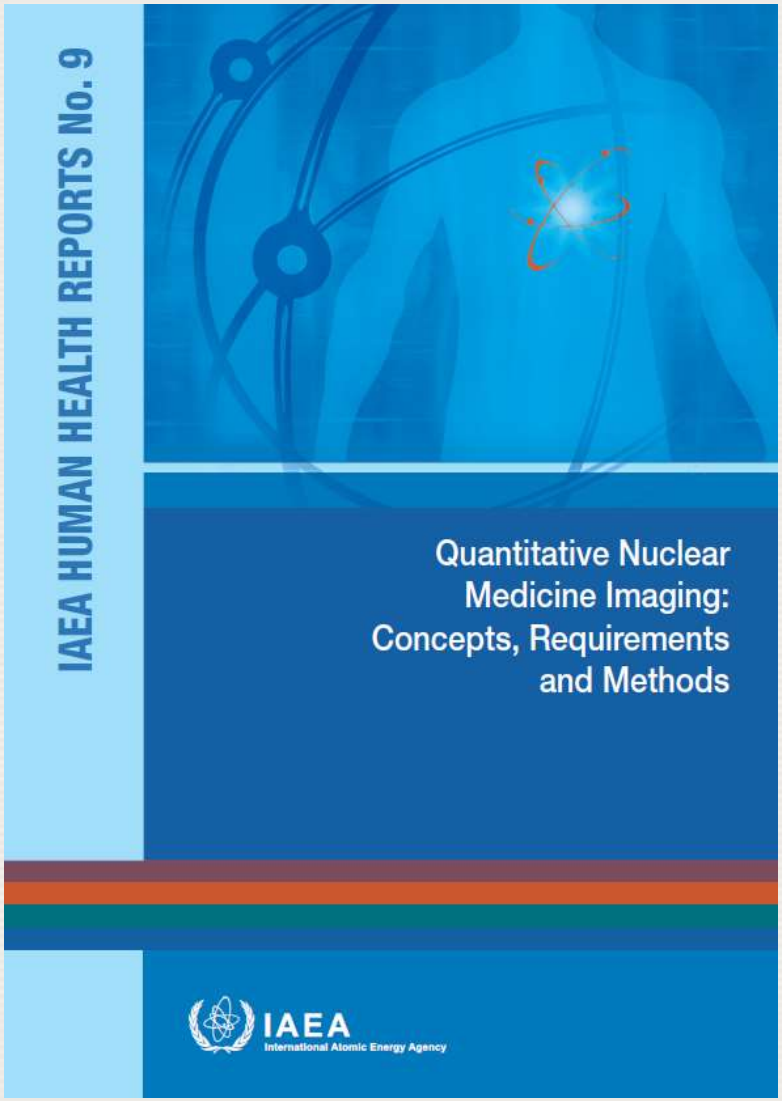
Quantitative Nuclear Medicine Imaging



- Published in February 2014
- Addressed to Medical Physicists working in a clinical environment in establishing proper procedures for quantification of nuclear medicine images and for internal dosimetry

Irene Buvat (France)
Eric C Frey (USA)
Alan J Green (UK)
Michael Ljungberg (Sweden)
S. Palm, GL Poli (IAEA)

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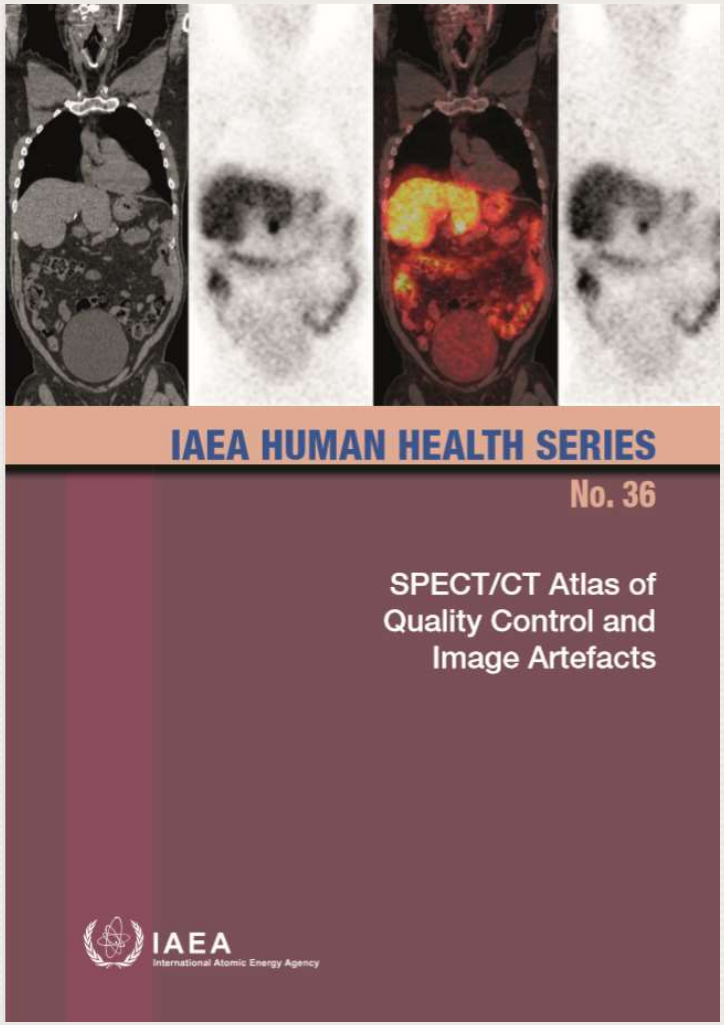
SPECT/CT Atlas of Quality Control and Image Artefacts



- Published in December 2019
- This publication presents an overview of quality control procedures in SPECT and SPECT/CT and describes pitfalls and artefacts that can occur in these imaging modalities

J. C. Dickson (UK)
S. Holm (Denmark)
O. Malawi (USA)
C.C. Robilotta (Brazil)
G.L. Poli (IAEA)

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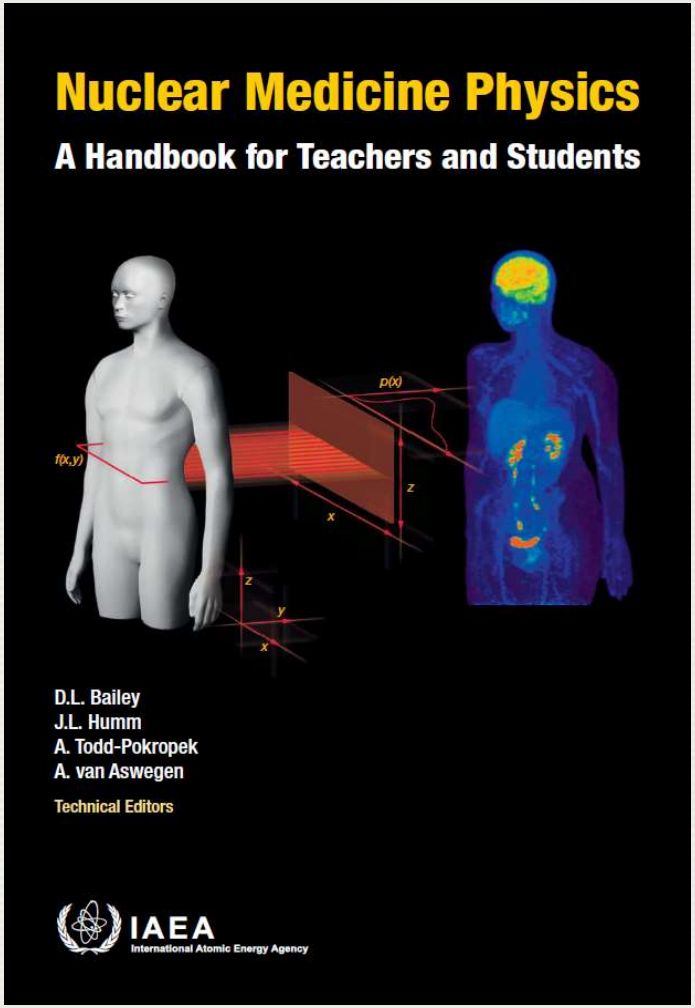
https://www.iaea.org/publications/13407/spect/ct-atlas-of-quality-control-and-image-artefacts

Nuclear Medicine Physics Handbook

1. Basic Physics for Nuclear Medicine
2. Basic Radiobiology
3. Radiation Protection
4. Radionuclide Production
5. Statistics for Radiation Measurements
6. Basic Radiation Detectors
7. Electronics Related to Nuclear Medicine Imaging Devices
8. Generic Performance Measures
9. Physics in the Radiopharmacy
10. Non-Imaging Detectors and Counters
11. Nuclear Medicine Imaging Devices
12. Computers in Nuclear Medicine
13. Image Reconstruction
14. Nuclear Medicine Image Display
15. Devices for Evaluating Imaging Systems
16. Functional Measurements in Nuclear Medicine
17. Quantitative Nuclear Medicine
18. Internal Dosimetry
19. Radionuclide Therapy
20. Management of Therapy Patients

A1. Artefacts and Trouble-Shooting



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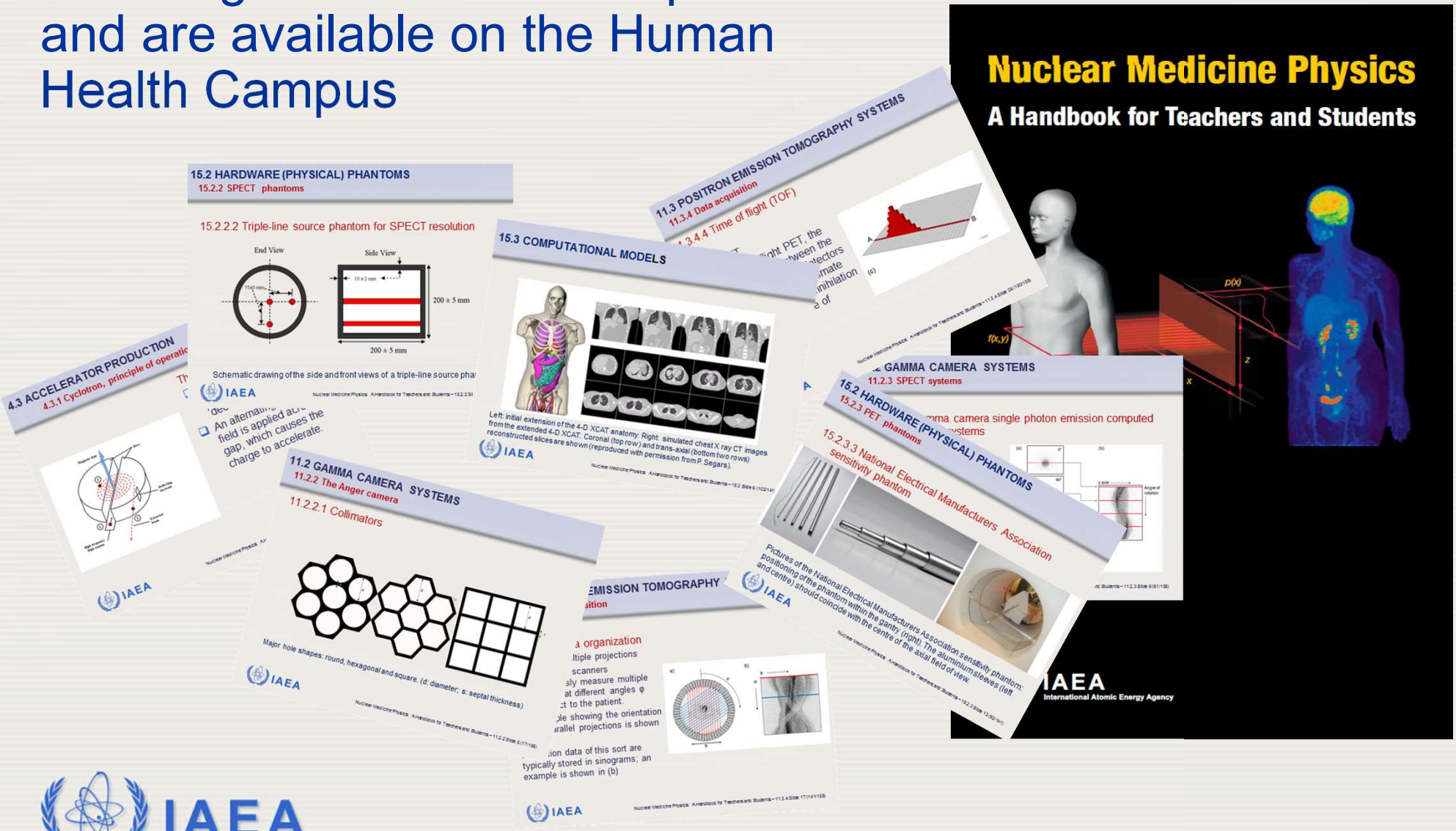
Nuclear Medicine Physics Handbook

Teaching slides have been produced and are available on the Human Health Campus



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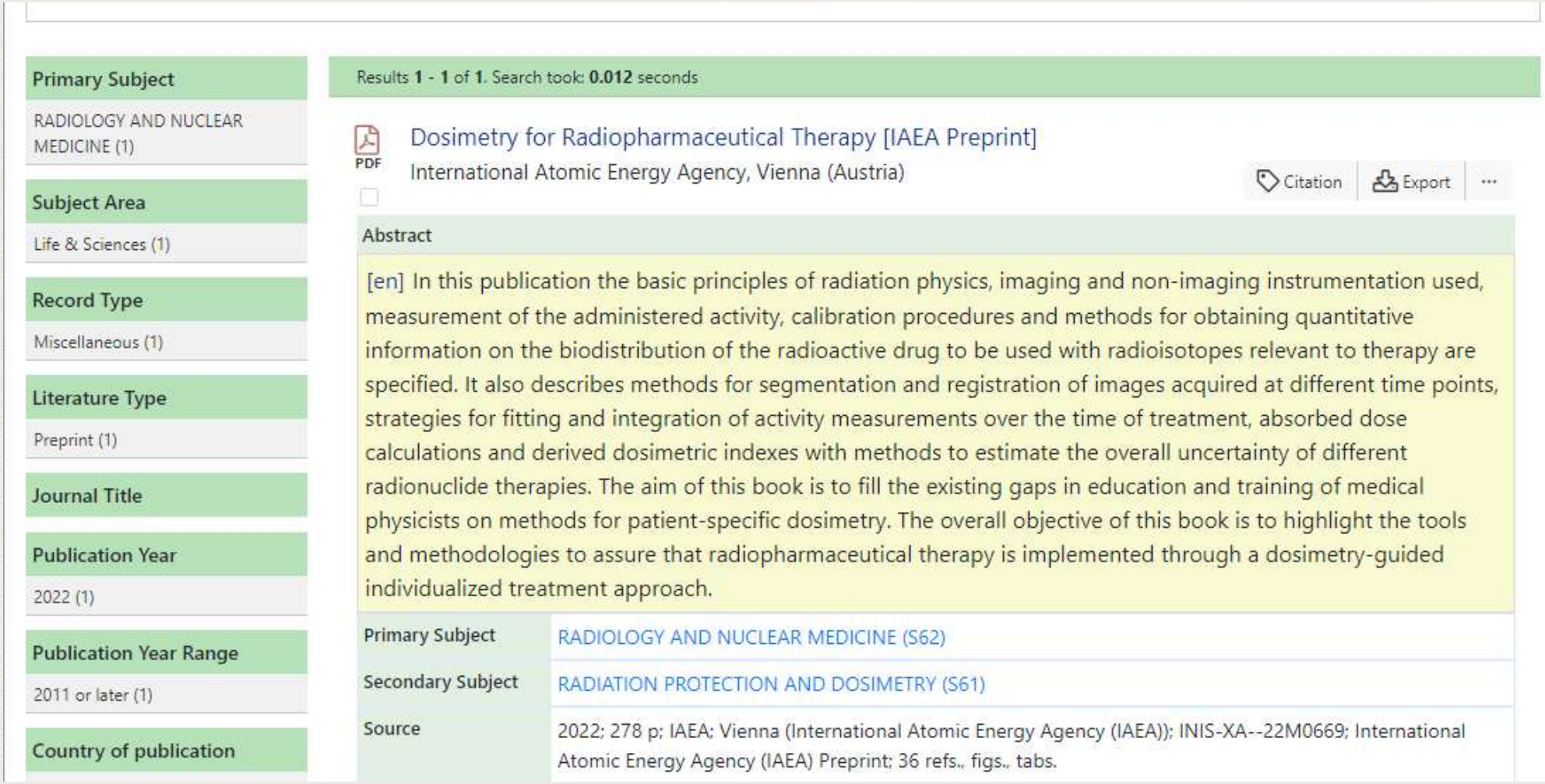
Dosimetry for Radiopharmaceutical Therapy [IAEA Preprint]



Primary Subject
RADIOLOGY AND NUCLEAR MEDICINE (1)

Subject Area
Life & Sciences (1)

Record Type
Miscellaneous (1)

Literature Type
Preprint (1)

Journal Title

Publication Year
2022 (1)

Publication Year Range
2011 or later (1)

Country of publication

Results **1** - **1** of **1**. Search took: **0.012** seconds

PDF

Dosimetry for Radiopharmaceutical Therapy [IAEA Preprint]

International Atomic Energy Agency, Vienna (Austria)

Citation | Export | ...

Abstract

[en] In this publication the basic principles of radiation physics, imaging and non-imaging instrumentation used, measurement of the administered activity, calibration procedures and methods for obtaining quantitative information on the biodistribution of the radioactive drug to be used with radioisotopes relevant to therapy are specified. It also describes methods for segmentation and registration of images acquired at different time points, strategies for fitting and integration of activity measurements over the time of treatment, absorbed dose calculations and derived dosimetric indexes with methods to estimate the overall uncertainty of different radionuclide therapies. The aim of this book is to fill the existing gaps in education and training of medical physicists on methods for patient-specific dosimetry. The overall objective of this book is to highlight the tools and methodologies to assure that radiopharmaceutical therapy is implemented through a dosimetry-guided individualized treatment approach.

Primary Subject	RADIOLOGY AND NUCLEAR MEDICINE (S62)
Secondary Subject	RADIATION PROTECTION AND DOSIMETRY (S61)
Source	2022; 278 p; IAEA; Vienna (International Atomic Energy Agency (IAEA)); INIS-XA--22M0669; International Atomic Energy Agency (IAEA) Preprint; 36 refs., figs., tabs.

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can be freely downloaded from the IAEA preprint server

Training Courses and webinars

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Training Courses

ICTP-IAEA Workshop on Internal Dosimetry for Medical Physicists Specializing in Nuclear Medicine

Joint ICTP-IAEA Workshop on Dosimetry in Radionuclide Therapy and Diagnostic Nuclear Medicine

20 September - 1 October 2021
An ICTP - IAEA Virtual Meeting
Trieste, Italy

Further information:
http://indico.ictp.it/event/9593/
smr3570@ictp.it

In recent years, there has been an increase of therapeutic applications using radiopharmaceuticals. This workshop, which is intended for clinically qualified medical physicists with experience in radionuclide therapy, will provide the participants with a comprehensive review of the developments in the field of nuclear medicine image quantification and practical internal dosimetry.

Description:

The purpose of this workshop is to contribute to the knowledge of clinically qualified medical physicists in nuclear medicine by providing theoretical and practical tools for internal dosimetry. Molecular radiotherapy has demonstrated unique therapeutic advantages in the treatment of an increasing number of cancer types. Such treatments can deliver high absorbed doses to specific targets (tumour lesions) and healthy organs (organs at risk) and, thus, require a patient specific dose assessment. These calculations would help to optimize the amount of radioactivity to be administered and to reduce the risk of under- or over-dosing patients, otherwise observed when using empirical approaches to activity determination. As part of the selection, candidates will be requested to undertake a written test.

The workshop is under the umbrella of ICTP and IAEA and is expected to strengthen the knowledge of clinically qualified medical physicists working in nuclear medicine. The expected audience are clinically qualified medical physicists working in a hospital, with at least 5 years' experience in the field of nuclear medicine medical physics including radionuclide therapy.

The workshop will be conducted in English.

Topics:

- Introduction to radiopharmaceutical dosimetry and MIRD formalism
- Time integrated activity coefficient calculation
- Radiation transport and energy deposition
- ICRP internal dose coefficient for radiological protection
- Y-90 microspheres dosimetry
- Bone seeking radiopharmaceuticals (including Ra223 therapy)
- Peptide receptor radionuclide therapy
- I131 therapy
- Radiation safety for staff and the public in therapeutic nuclear medicine

How to apply:

Online application:
http://indico.ictp.it/event/9593/

Female scientists are encouraged to apply.

Registration:

There is no registration fee.

Director:

R KNOLL, IAEA, Austria

Local Organiser:

R. PADOVANI, ICTP, Italy

Lecturers:

M. BARDIES (France)
W. BOLCH (USA)
C. CHIESA (Italy)
M. CREMONESI (Italy)
L. FERRER (France)
G. GLATTING (Germany)
R. HOBBS (USA)
M. LASSMANN (Germany)
L. STRIGARI (Italy)
A. VERGARA-GIL (France)

Deadline:

30 June 2021

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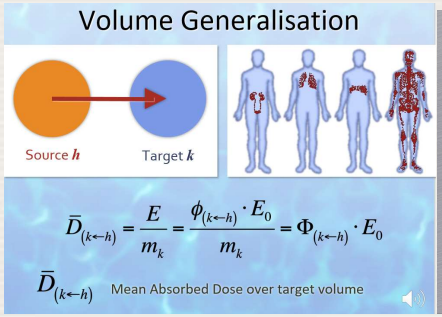
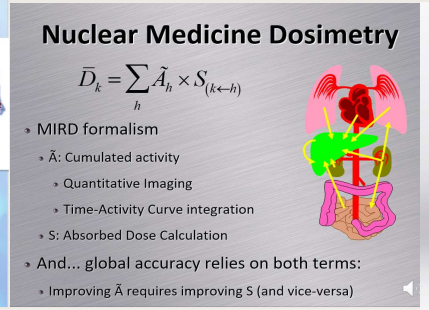
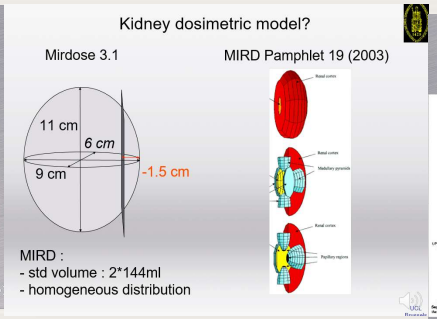
International Centre for Theoretical Physics

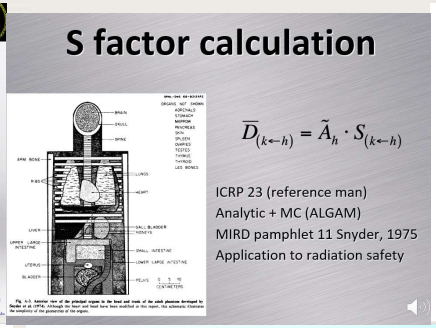
http://indico.ictp.it/event/9593

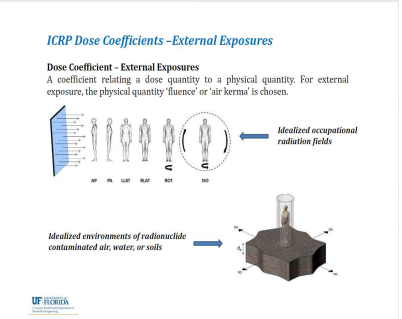
Pre-recorded video material

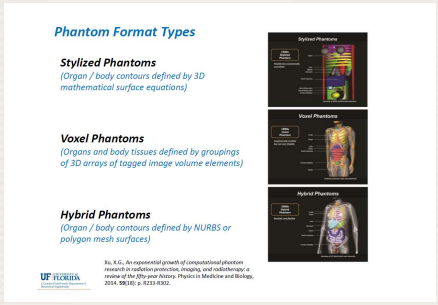


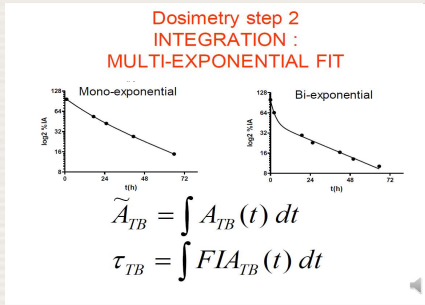


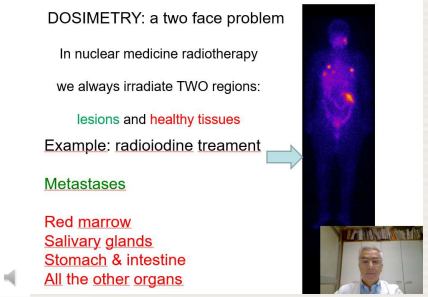


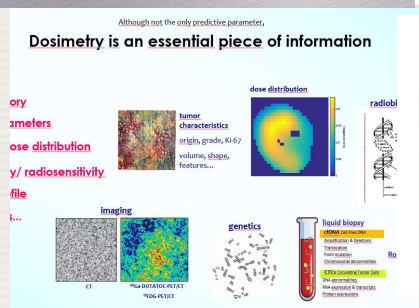


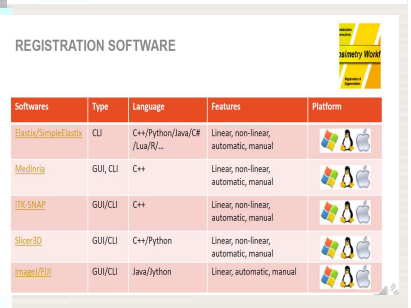


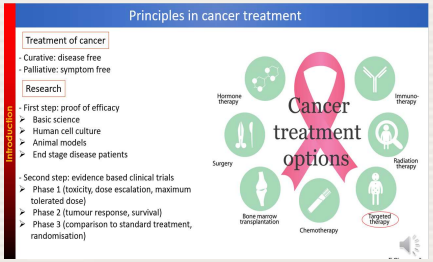


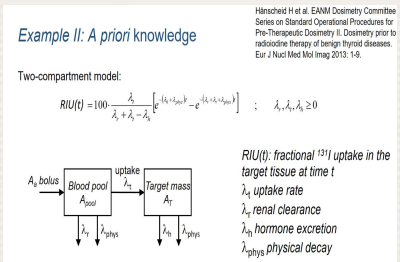


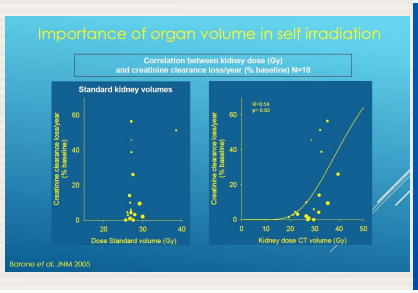


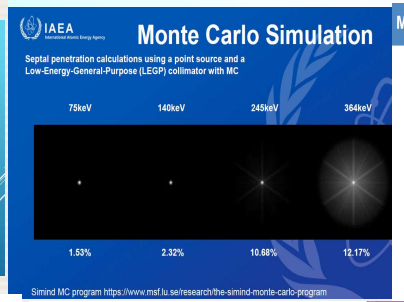


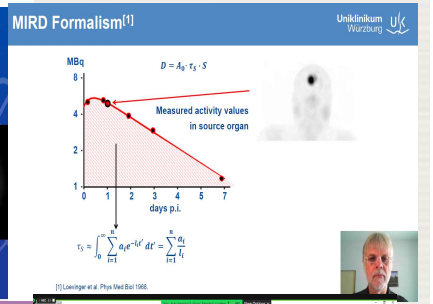


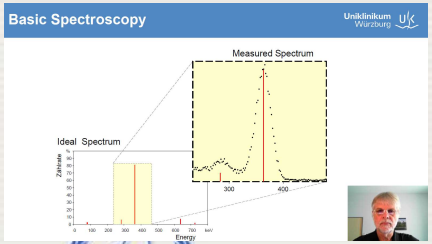


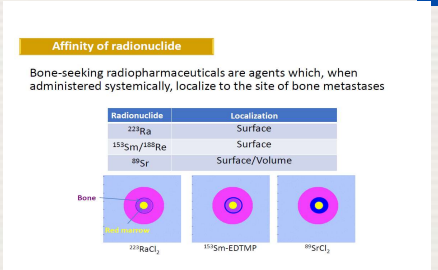


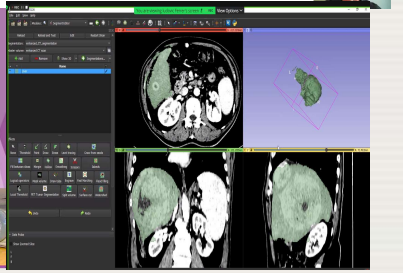












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Webinars organized by NSRW

RPOP Radiation Protection of Patients

Radiation Protection in Nuclear Medicine

- Free webinars (since 2016, recordings available from https://www.iaea.org/resources/rpop/resources/webinars)
  - Radiation Protection in Nuclear Medicine: Best Practice
  - Clinical Hybrid Imaging: Radiation Issues
  - Radiation exposure of the pregnant and breastfeeding patients in nuclear medicine
  - Paediatric Nuclear Medicine
  - Radionuclide therapy events: What we can learn and what to do?
  - Radiation Protection of Patients: Diagnostic Reference Levels and Accuracy of Activity Meters
  - More others…..

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Human Health Campus

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Medical Physics

- Radiotherapy
- Diagnostic Radiology
- Nuclear Medicine
- The Medical Physicist

Shortcuts

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- Events
- Links

Medical Radiation Physics

Radiotherapy

Diagnostic Radiology

Nuclear Medicine

The Medical Physicist

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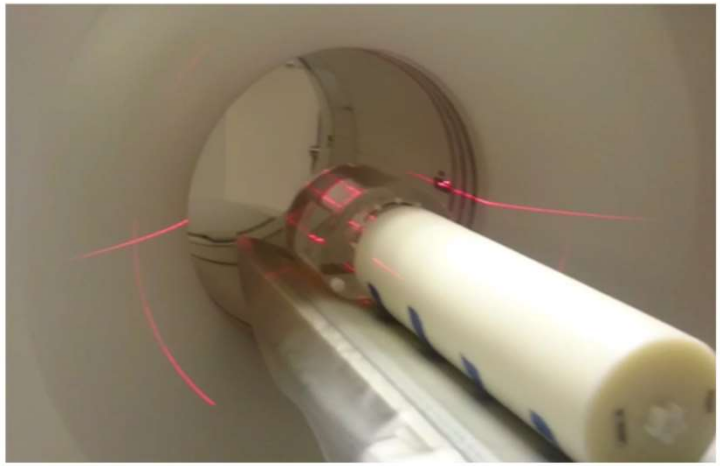
PET/CT QC videos

Tutorial videos for Quality Control tests on PET/CT scanners

The IAEA published in 2009 a technical reference book that provides guidance on acceptance testing of PET and PET/CT scanners, including guidelines for routine quality control of the equipment. The PET/CT Quality Control tests described in this publication adhere closely to the NEMA standard. As a supplementary training tool, 8 tutorial videos were produced, demonstrating, in practice, the procedures to perform the tests described in the IAEA Human Health Series No. 1 on Quality Assurance for PET and PET/CT Systems.

1. Daily PET/CT QC tests
2. Radioactivity concentration calibration
3. Spatial resolution
4. Sensitivity
5. Scatter fraction, count losses and randoms measurements
6. Image quality
7. Accuracy of corrections for count losses and randoms
8. Accuracy of PET/CT image registration



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E-learning module for QC on SPECT

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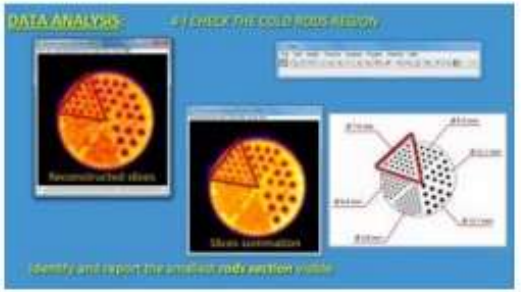
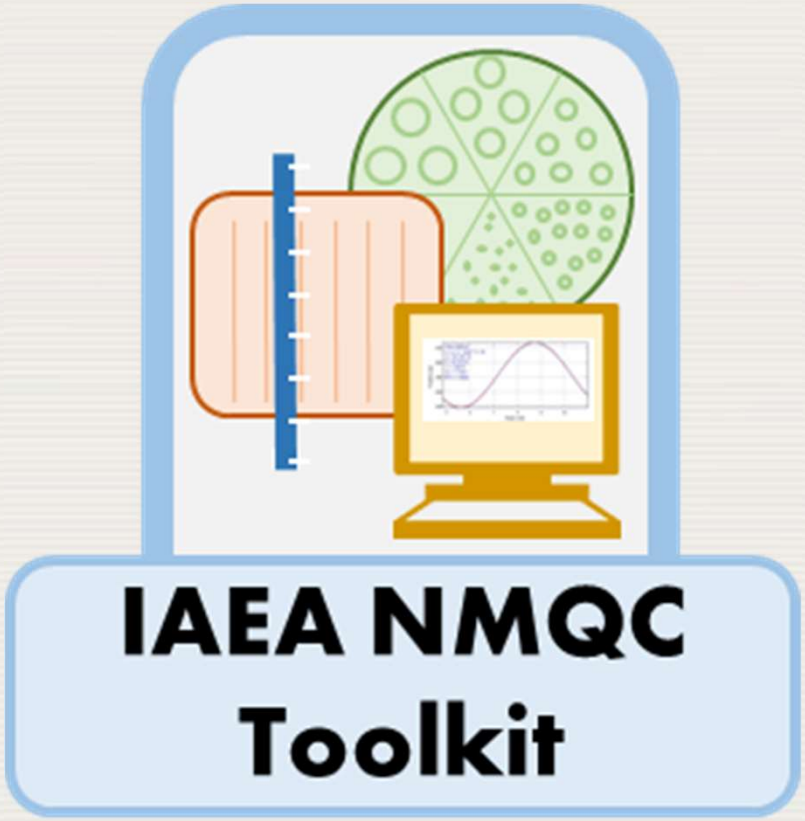
Tutorial videos on Quality Control tests for SPECT systems

The following tutorial videos demonstrate in practice the procedures to perform the tests described in the IAEA Human Health Series no. 6 on "Quality Assurance for SPECT Systems". The videos can be downloaded by simply right clicking and choosing "save as" on a download link. Users are welcome to use the videos for any non-commercial use.

1. Intrinsic Flood Field Uniformity (download link)
2. System Flood Field Uniformity (download link)
3. System Planar Sensitivity (download link)
4. Maximum Count Rate (download link)
5. Intrinsic Spatial Resolution - Visual method (download link)
6. Intrinsic Spatial Resolution and Linearity (download link)
7. System Spatial Resolution (download link)
8. Energy Resolution (download link)
9. Multiple Window Spatial Registration (download link)
10. Physical Inspection (download link)
11. Tomographic Uniformity (download link)
12. Center of Rotation (download link)
13. Absolute Size of a Pixel (download link)
14. Tomographic Resolution in Air (download link)
15. Tomographic Resolution with Scatter (download link)
16. Total Performance (download link)



QC plugins



Planar uniformity
Maximum count rate
Sensitivity
Intrinsic spatial resolution
Intrinsic spatial linearity
System spatial resolution
Pixel size
4 quadrant bar phantom
Centre of rotation
Tomographic contrast
Tomographic resolution
Tomographic uniformity

IAEA

https://humanhealth.iaea.org/HHW/MedicalPhysics/NuclearMedicine/QualityAssurance/NMQC-Plugins/index.html

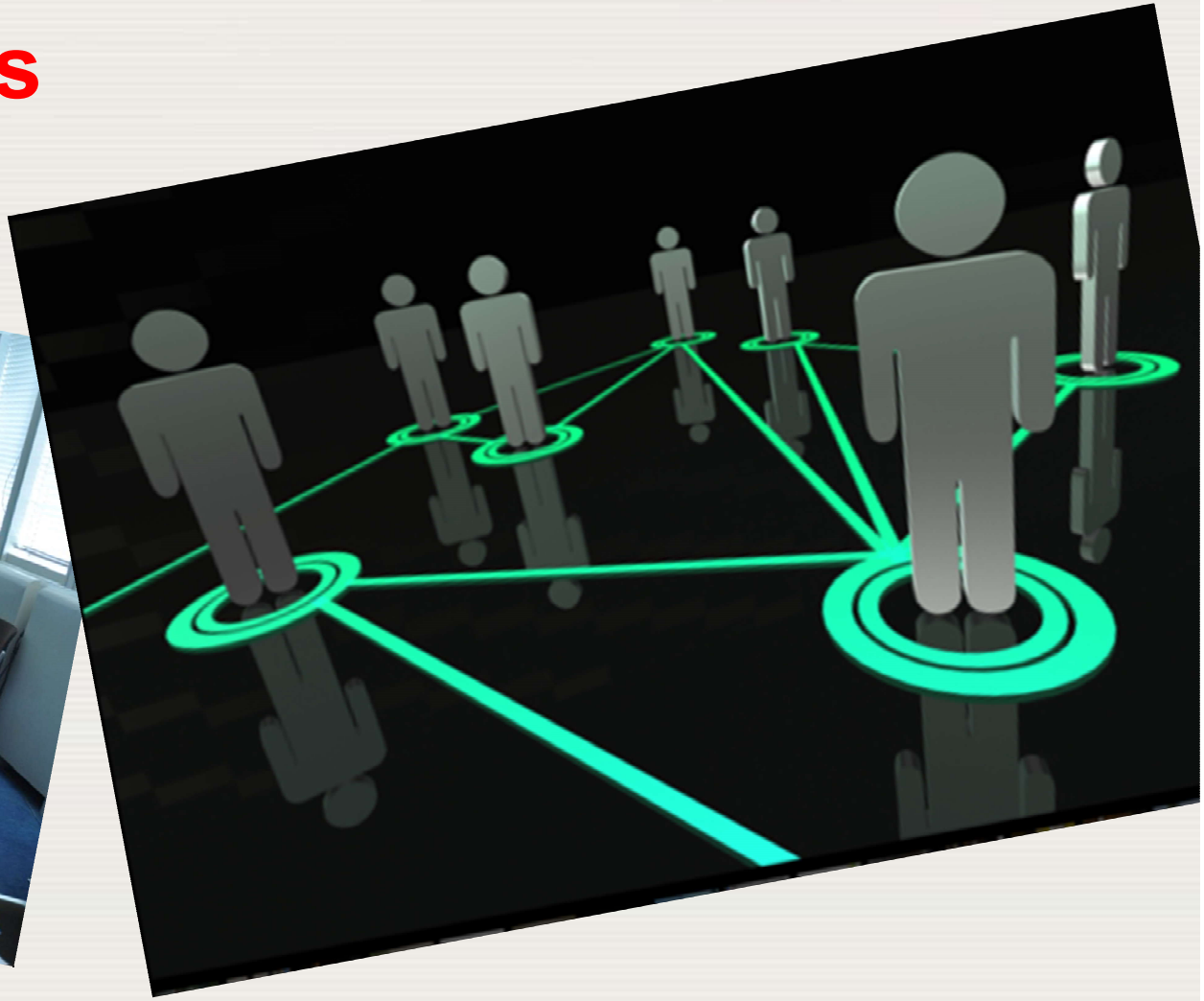
Research activities

IAEA

International Atomic Energy Agency

Coordinated Research Projects (CRPs)

Involve participants from different countries into state of the art **scientific research** and create **scientific networks**



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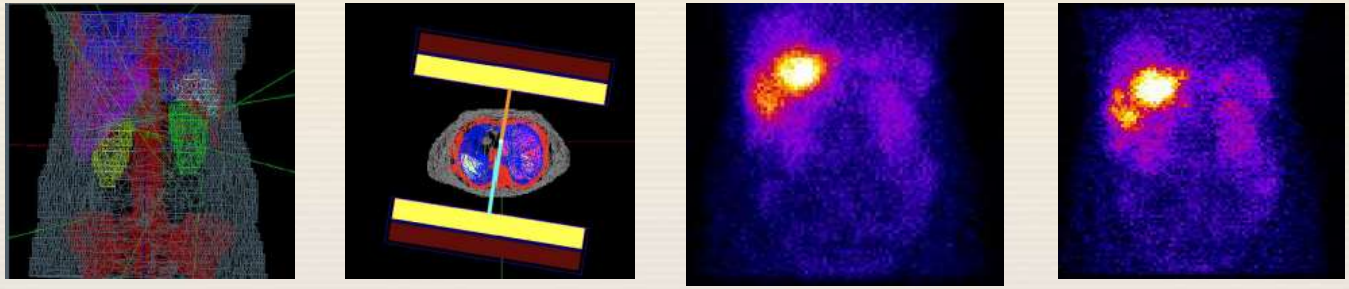
CRP E2.30.05:
Dosimetry in Molecular Radiotherapy for Personalized Patient Treatments

The main objective of CRP E2.30.05 was to contribute in the standardization of dosimetric methods.

Specific objectives are to assist the Member States in testing and adopting harmonized dosimetric protocols and to assess the typical accuracy with which dosimetry can be reached in nuclear medicine practice



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International Atomic Energy Agency

Technical Cooperation

IAEA
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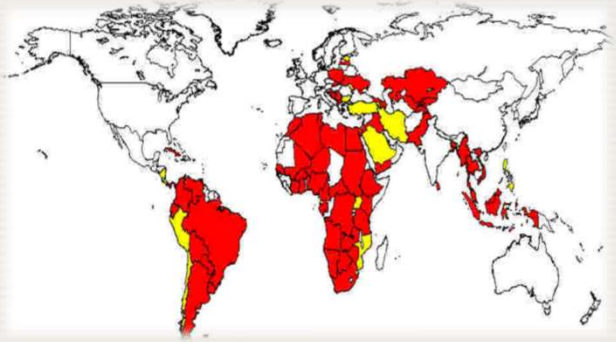
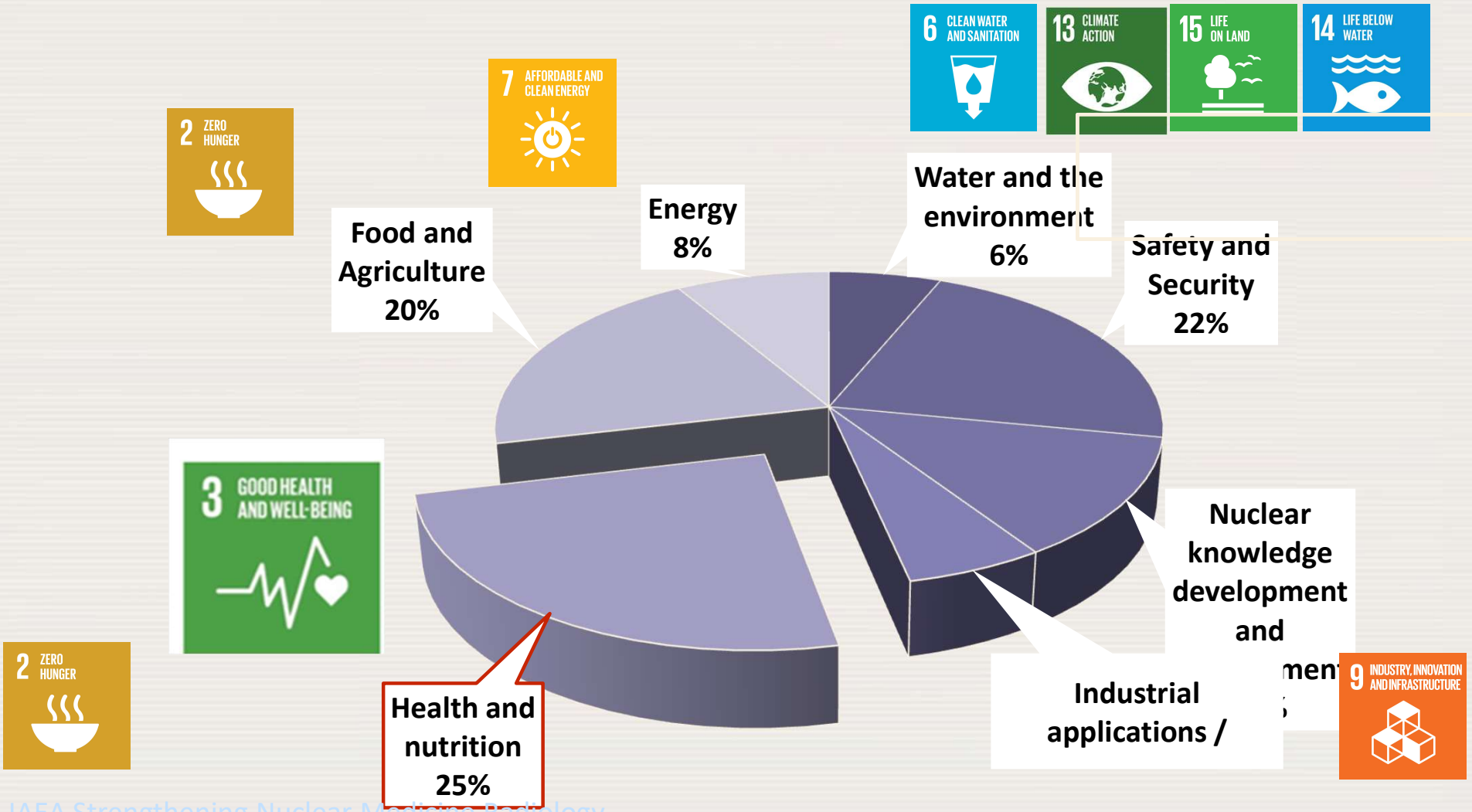
Technical Cooperation Programmes



IAEA's primary mechanism for transferring nuclear technology to the member states:

- Fellowships
- Expert missions
- Training Courses
- Procurement

Response to Member States request



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242 Projects | **143** Countries | **24** Staff | **2021** Since

5 Interregional | **31** Regional | **206** National

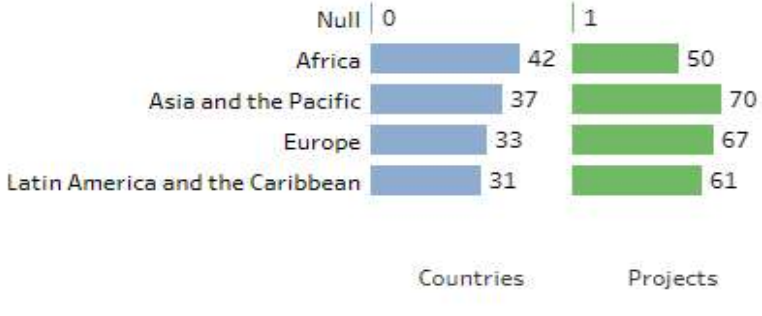
TC Projects

Last Update: 01/02/2022 10:15:22

TC projects by section

TO is a part of the project team

TC projects by region



Project Type: (All)

Sections
- (All)
- Division of Human H...
- Dosimetry
- Nuclear Medicine
- Nutrition
- Radiation Oncology

TO Name: (All)

Closure Status
- (All)
- Cancelled
- Closed
- On-hold
- Open
- Pending Closure

TC Project Year: (Multiple values)

Project Number

Country

Regions: (All)

ProjectType
- Interregional
- Regional
- National

CountProjectNumber: 1 — 14

Summary

DMRP activities are focused on all aspects of radiation in medicine to ensure safety and quality.

The role of the medical physicist in radiopharmaceutical therapy is crucial.

The clinical qualified medical physicist is a key professional in delivering safe and accurate diagnosis and treatment.

IAEA

Thank you for your attention!

p.knoll@iaea.org