IAEA activities on diagnostic radiology

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The IAEA is an independent organization within the United Nations serving as the global focal point for nuclear cooperation worldwide

The IAEA works with its 177 Member States and
(2022: Saint Kitts and Nevis; Tonga
2023: Cabo Verde; The Gambia)

multiple partners worldwide

to promote safe, secure and peaceful use of nuclear technologies

IAEA

IAEA

IAEA is an independent organization within the United Nations serving as the global focal point for nuclear cooperation worldwide

SAFEGUARDS

It carries out the IAEA's duties and responsibilities as the world's nuclear inspectorate, supporting global efforts to stop the spread of nuclear weapons.

NUCLEAR APPLICATIONS

It assists Member States to meet their development needs through nuclear science, technology and innovation.

NUCLEAR SECURITY

It aims to protect people, society and the environment from the harmful effects of ionizing radiation

NUCLEAR ENERGY

It provides technical support on the nuclear fuel cycle and the life cycle of nuclear facilities

TECHNICAL COOPERATION

It aims to support the use of nuclear science and technology to address major sustainable development priorities at the national, regional and interregional level.

NUCLEAR SCIENCES AND APPLICATIONS

IAEA

It assists Member States meet their development needs through nuclear science, technology and innovation. It also works with laboratories, universities and research facilities worldwide

HUMAN HEALTH

It supports Member States' fight against cancer, cardiovascular diseases, malnutrition and other diseases using nuclear and nuclear-related techniques.

SEIBERSDORF LABORATORIES

8 laboratories that support and implement activities that respond to the developmental needs of Member and provide technical and analytical services.

ENVIRONMENT LABORATORIES

They use nuclear techniques to study the environmental impacts of radionuclides, trace elements and organic contaminants.

PHYSICAL CHEMICAL SCIENCES

It provides support to Member States in using nuclear methods for a variety of practical industrial applications.

RESEARCH

It manages research, technical and doctoral contracts , research agreements and Coordinated Research Projects

DIVISION OF HUMAN HEALTH

IAEA

support of cancer radiotherapy treatment and diagnostic imaging projects, nutrition centres and human resource development. Development of guidelines; databases; providing a quality assurance framework and review missions; providing technical, advisory and dosimetry laboratory services; as well as educational and research initiatives.

DMRP

The Dosimetry and Medical Radiation Physics Section (DMRP) assists MS to work safely and effectively using radiation medicine.
It promotes and supports:

- **QA programs**
- **quality improvement practices**
- **best practices in cl MP**
- **harmonization of radiation dosimetry.**
- **development of dosimetry protocols**

NMDI

The Nuclear Medicine and Diagnostic Imaging Section (NMDI) focuses on fostering the use of nuclear medicine and diagnostic imaging procedures in Member States for both diagnosis and therapy.

ARBR

The Applied Radiation Biology and Radiotherapy Section (ARBR) objective is to improve the availability and safe use of radiotherapy in IAEA Member States.

NUTRITION

Nutritional and Health-Related Environmental Studies Section This Section enhances the capabilities of Member States to combat malnutrition in all its forms and supports effective, evidence-based nutrition programming using nuclear and related techniques.

IAEA NA Laboratories

- Monaco
- Seibersdorf
- Vienna

"Fit for Purpose" to meet GOALS

Insect Pest Control Laboratory building

Linear Accelerator Facility

Yukiya Amano Laboratories building

IAEA Dosimetry Laboratory

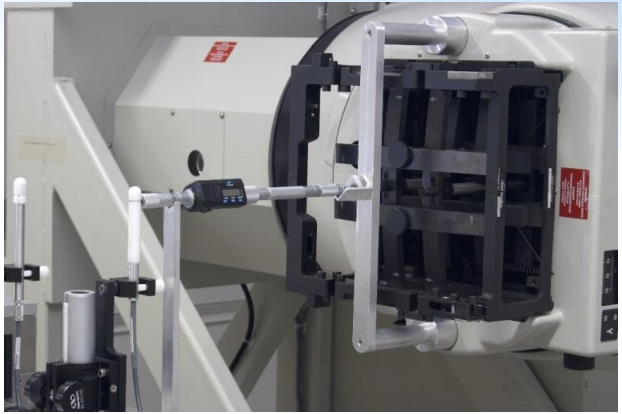
Dosimetry services
R&D in dosimetry and radiation physics
Fellows training (limited)

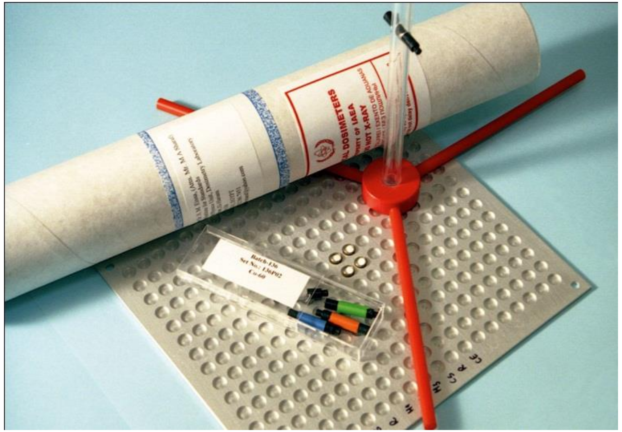
IAEA/WHO SSDL Network

- Dosimetry calibrations
- Comparisons and audits of performance

Dose Assurance Service

- IAEA/WHO TLD network
- Support to national audit networks
- Support to QUATRO





RAYS of HOPE

Leaving no country behind…

> One country in four does not have access to a single radiotherapy machine. This is a sobering statistic. And it is unacceptable.
>
> — Rafael Mariano Grossi, IAEA Director General

IAEA

Rays of Hope

Cancer care for all

"Half of cancer patients who need radiotherapy in low- and middle-income countries do not have access to it. This is a sobering statistic. And it is unacceptable."

— Rafael Mariano Grossi, IAEA Director General

www.iaea.org/rays-of-hope

#CancerCare4All

rays-of-hope-v2.pdf (iaea.org)

Package 1

Estimated value: US$ 7.5 million

Capital costs and operating costs over two years, including participation in ongoing learning and research activities and support from a regional anchor centre of excellence

- Optimal as entry package for countries that lack radiotherapy and have limited financial and human resources.
- It can treat optimally up to 500 cancer patients per year and is scalable with a second treatment unit for a total of 1000 cancer patients per year.

Includes:

1. Two bunkers
2. One conventional simulator
3. One teletherapy cobalt unit
4. One high dose rate (HDR) brachytherapy afterloader

Features:

- Less dependence on water and electricity infrastructure
- Maintenance needs are lower, leading to less expected downtime
- Shorter learning curve required to operate

Package 2

Estimated value: US$ 12.5 million

Capital costs and operating costs over two years, including participation in ongoing learning and research activities and support from a regional anchor centre of excellence

- Optimal as entry or expansion package for countries with trained human resources and enough financial capacity to sustain maintenance costs.
- It can treat optimally up to 1000 cancer patients per year. Equipment configuration can be upgraded to tailor to future needs.
- Requires reliable electricity and water supply.

Includes:

1. Two bunkers
2. One CT-simulator
3. Two single-energy LINACs
4. One HDR brachytherapy afterloader

Features:

- No need for exchange of radioactive cobalt source, therefore logistics of long-term operations is easier; no need for specific nuclear security arrangements
- Requires reliable infrastructure
- Longer learning curve / prior knowledge and training desirable to operate

Package 3

Estimated value: US$ 16 million

Capital costs and operating costs over two years, including participation in ongoing learning and research activities and support from a regional anchor centre of excellence

- Optimal as expansion package for countries with previous experience in radiotherapy service delivery and enough financial resources to sustain it.
- It can treat up to 1000 cancer patients per year with the more advanced techniques but higher maintenance costs. Needs reliable electricity and water supply, as well as resource-intensive quality assurance programme.

Includes:

1. Two bunkers
2. One CT-simulator
3. Two multi-energy LINACs
4. One HDR brachytherapy afterloader

Features:

- Greater versatility in tailoring procedures to individual patients' needs
- Requires reliable infrastructure
- Longer learning curve / prior knowledge and training required to operate
- Higher ongoing maintenance costs the recipient country will eventually need to bear

Complementing the ongoing efforts of the IAEA to assist Member States improve their cancer care capacities, Rays of Hope focuses on countries most in need: those that lack radiotherapy services altogether or have a poor coverage. Rays of Hope will directly contribute to the fulfilment of the 2030 Agenda and the Sustainable Development Goal 3 (Good Health and Well-Being), Indicator 3.4 to reduce premature mortality from non-communicable diseases by one third.

The projects included in Rays of Hope, based on sustainability, will build or strengthen radiation safety legislation and infrastructure and provide quality control, guidance, training and equipment. Rays of Hope combines several elements into a set of interventions that build on and complement each other in order to maximize impact. Through a sharp focus on countries without radiotherapy or with inequitable access, Rays of Hope will initially focus on prioritizing a limited number of high-impact, cost-effective and sustainable interventions in line with national needs and commitment.

INVESTMENT NEEDS

In order to ensure the sustainability and maximize the impact of Rays of Hope, the IAEA is mobilizing additional resources, advocacy and partnership opportunities.

The indicative packages above comprise optimal

facilities. The funding needs listed here are for building the facility, purchasing the equipment and training the personnel. Also included are the operating costs for two years to better support planning of services and sustainability.

The IAEA will also support the development and strengthening of national radiation safety and nuclear security infrastructure, as appropriate. The packages include innovation and support for regional anchor centres, which are established and experienced radiotherapy centres working closely with the IAEA.

Innovative approaches are essential to ensure available resources are used to scale up quality access to radiation medicine. It includes the participation of recipient country experts in online training events and professional discussions, as well as in innovation such as research to increase the cost effectiveness and efficiency of interventions. Regional anchor centres will provide much of the training and quality assurance to countries nearby. However, these anchor centres need to first improve their educational and quality assurance infrastructure and be provided with tools to support continuous improvement in the region.

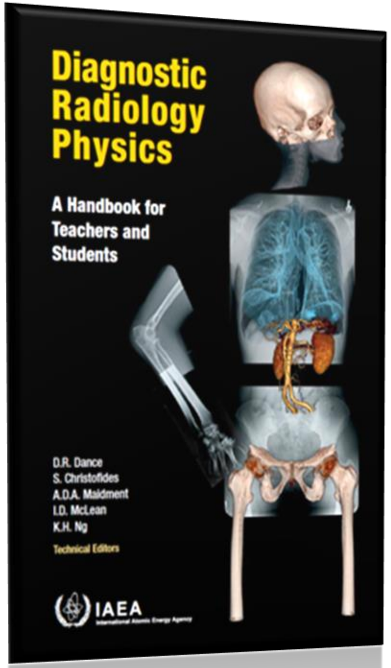
The packages will also contribute to advancing donor development priorities, including gender equality,

IAEA HUMAN HEALTH ACTIVITIES IN RADIOLOGY

- Definition of roles and responsibilities of Professionals
- Development of guidelines to support and standardize harmonization of training
- Development of guidelines to support clinical practice
  - Quality assurance
  - Dosimetry
  - Safety
- Support to comprehensive clinical audits
- Dosimetry and calibration services (through IAEA DOL)
- Education and training activities
- ICTP courses
- Regional courses (through TC courses)
- Individual training (through TC fellowships)
- Education and training material (handbooks, Human Health campus)
- Webinars
- Research
- Coordinated research projects
- Doctoral coordinated research projects
- Technical Cooperation

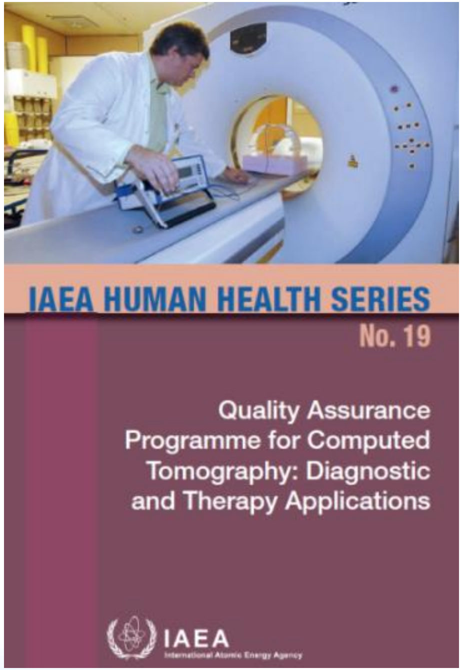
Development of guidelines to support clinical practice

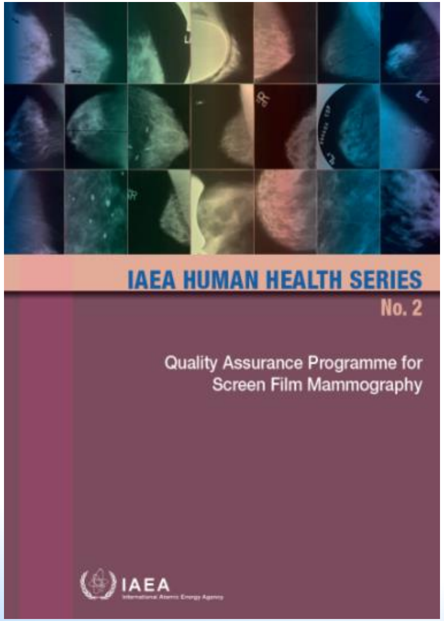
Training – Handbooks and slides

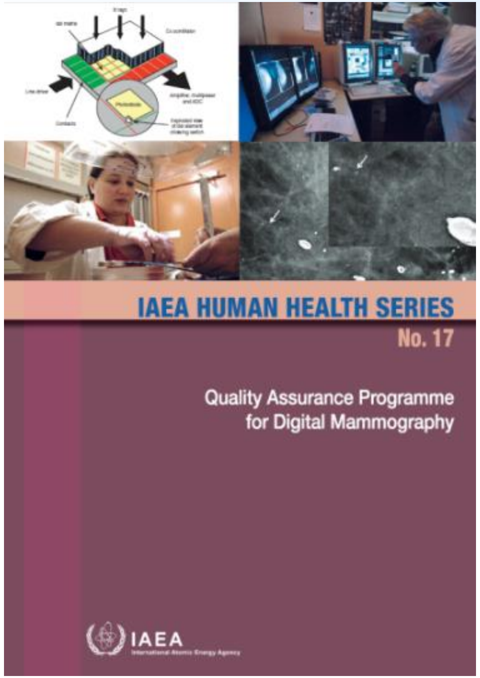


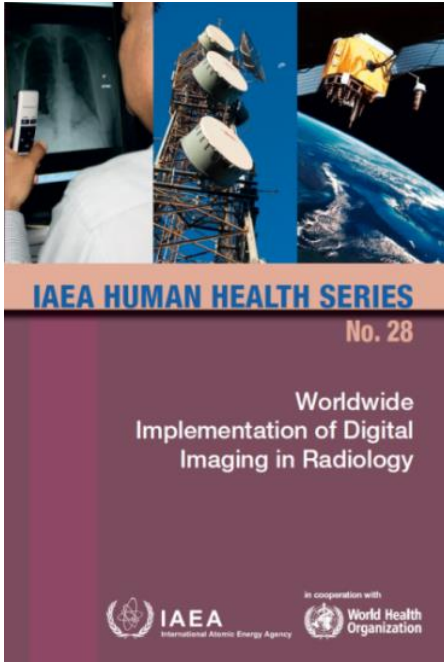
- Fundamentals of Atomic and Nuclear Physics
- Interactions of Radiation with Matter
- Fundamentals of Dosimetry
- Measures of Image Quality
- X ray Production
- Projection Radiography
- Receptors for Projection Radiography
- Fluoroscopic Imaging Systems
- Mammography
- Special Topics in Radiography
- Computed Tomography
- Physics of Ultrasound
- Ultrasound Imaging
- Physics of Magnetic Resonance
- Magnetic Resonance Imaging
- Digital Imaging
- Image Post Processing and Analysis
- Image Perception and Assessment
- Quality Management
- Radiation Biology
- Instrumentation for Dosimetry
- Patient Dosimetry
- Justification and Optimisation in Clinical Practice
- Radiation Protection

Development of guidelines in Quality Assurance and Quality Control



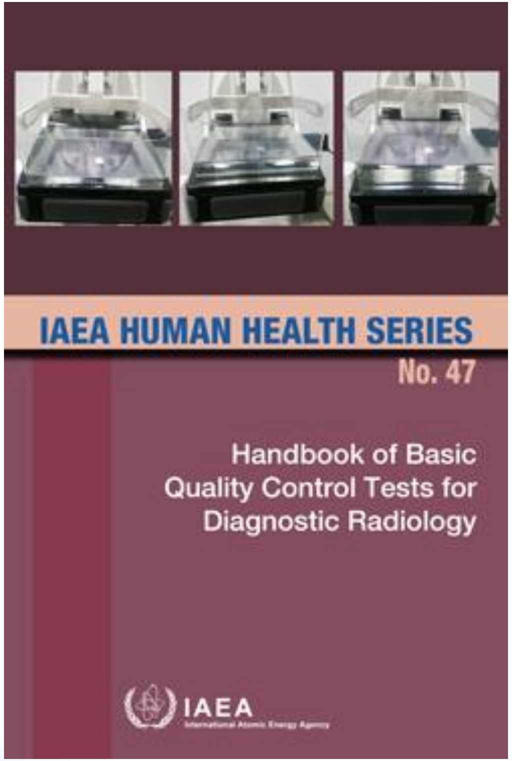






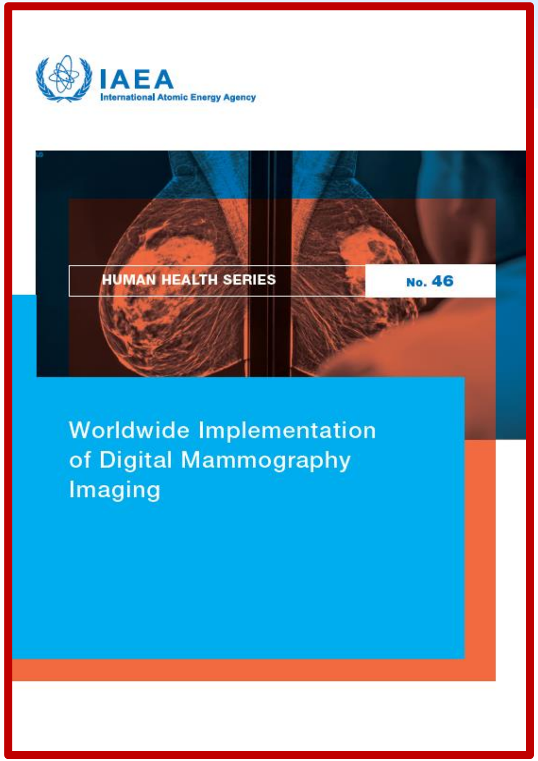
Development of guidelines on automated methods, innovation, etc

2022

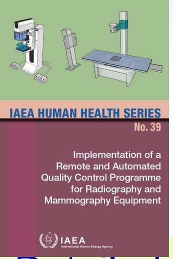


2023

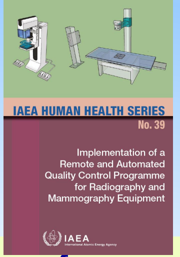
New



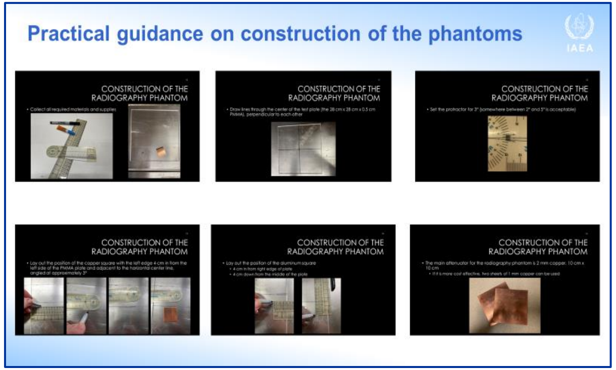
2023

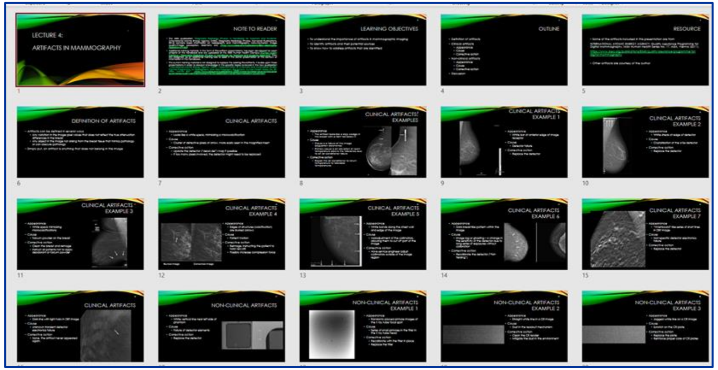


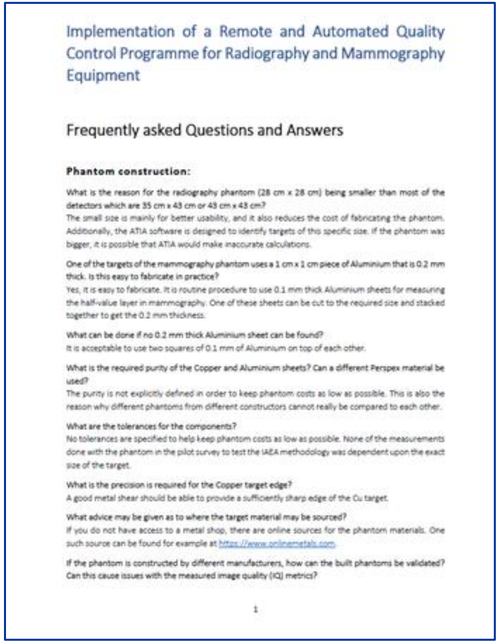
Training/video material developed



Detailed instructions for the phantom manufacturing, the image acquisition and the use of the software have been created and are going to be merged in training material that accompanies the publication including practical guidance on construction of phantoms and Frequently asked Questions with Answers.






Implementation of a Remote and Automated Quality Control Programme for Radiography and Mammography Equipment

Frequently asked Questions and Answers

Phantom construction:

What is the reason for the radiography phantom (28 cm x 28 cm) being smaller than most of the detectors which are 35 cm x 43 cm or 43 cm x 43 cm?
The small size is mainly for better usability, and it also reduces the cost of fabricating the phantom. Additionally, the ATIA software is designed to identify targets of this specific size. If the phantom was bigger, it is possible that ATIA would make inaccurate calculations.

One of the targets of the mammography phantom uses a 1 cm x 1 cm piece of Aluminium that is 0.2 mm thick. Is this easy to fabricate in practice?
Yes, it is easy to fabricate. It is routine procedure to use 0.1 mm thick Aluminium sheets for measuring the half-value layer in mammography. One of these sheets can be cut to the required size and stacked together to get the 0.2 mm thickness.

What can be done if no 0.2 mm thick Aluminium sheet can be found?
It is acceptable to use two squares of 0.1 mm of Aluminium on top of each other.

What is the required purity of the Copper and Aluminium sheets? Can a different Perspex material be used?
The purity is not explicitly defined in order to keep phantom costs as low as possible. This is also the reason why different phantoms from different constructors cannot really be compared to each other.

What are the tolerances for the components?
No tolerances are specified to help keep phantom costs as low as possible. None of the measurements done with the phantom in the pilot survey to test the IAEA methodology was dependent upon the exact size of the target.

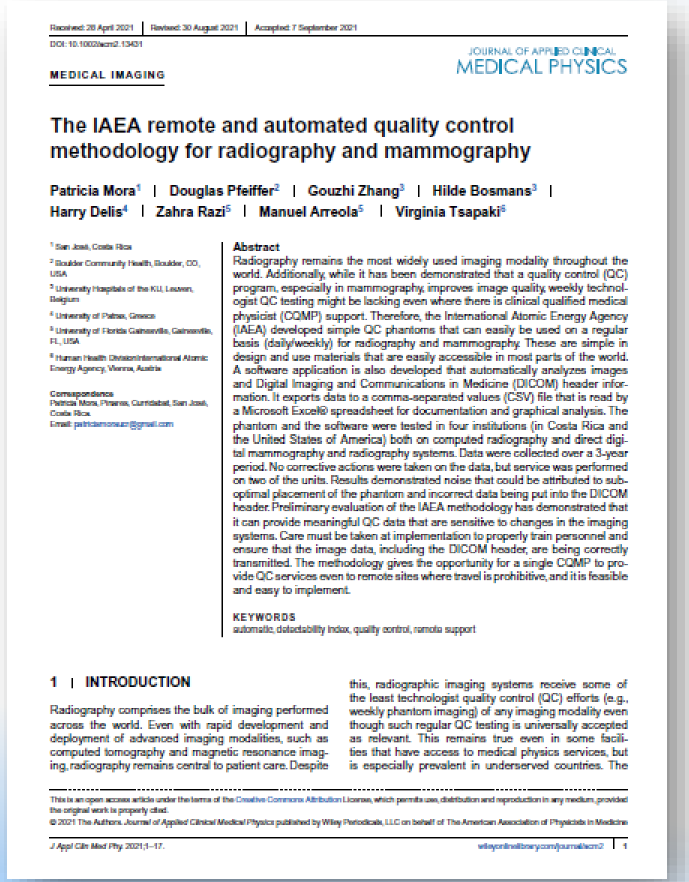
What is the precision is required for the Copper target edge?
A good metal shear should be able to provide a sufficiently sharp edge of the Cu target.

What advice may be given as to where the target material may be sourced?
If you do not have access to a metal shop, there are online sources for the phantom materials. One such source can be found for example at https://www.onlinemetals.com.

If the phantom is constructed by different manufacturers, how can the built phantoms be validated? Can this cause issues with the measured image quality (IQ) metrics?

1

Pilot study results already published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JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS

MEDICAL IMAGING

The IAEA remote and automated quality control methodology for radiography and mammography

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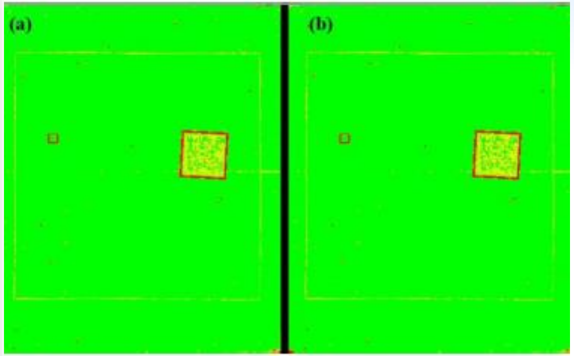
Abstract
Radiography remains the most widely used imaging modality throughout the world. Additionally, while it has been demonstrated that a quality control (QC) program, especially in mammography, improves image quality, weekly technologist QC testing might be lacking even where there is clinical qualified medical physicist (CQMP) support. Therefore, the International Atomic Energy Agency (IAEA) developed simple QC phantoms that can easily be used on a regular basis (daily/weekly) for radiography and mammography. These are simple in design and use materials that are easily accessible in most parts of the world. A software application is also developed that automatically analyzes images and Digital Imaging and Communications in Medicine (DICOM) header information. It exports data to a comma-separated values (CSV) file that is read by a Microsoft Excel® spreadsheet for documentation and graphical analysis. The phantom and the software were tested in four institutions (in Costa Rica and the United States of America) both on computed radiography and direct digital mammography and radiography systems. Data were collected over a 3-year period. No corrective actions were taken on the data, but service was performed on two of the units. Results demonstrated noise that could be attributed to sub-optimal placement of the phantom and incorrect data being put into the DICOM header. Preliminary evaluation of the IAEA methodology has demonstrated that it can provide meaningful QC data that are sensitive to changes in the imaging systems. Care must be taken at implementation to properly train personnel and ensure that the image data, including the DICOM header, are being correctly transmitted. The methodology gives the opportunity for a single CQMP to provide QC services even to remote sites where travel is prohibitive, and it is feasible and easy to implement.

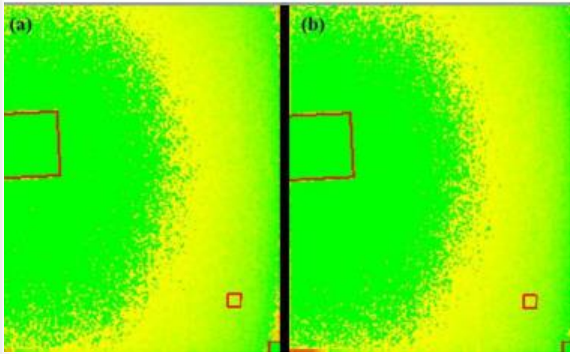
KEYWORDS
automatic, detectability index, quality control, remote support

1 | INTRODUCTION

Radiography comprises the bulk of imaging performed across the world. Even with rapid development and deployment of advanced imaging modalities, such as computed tomography and magnetic resonance imaging, radiography remains central to patient care. Despite this, radiographic imaging systems receive some of the least technologist quality control (QC) efforts (e.g., weekly phantom imaging) of any imaging modality even though such regular QC testing is universally accepted as relevant. This remains true even in some facilities that have access to medical physics services, but is especially prevalent in underserved countries. The

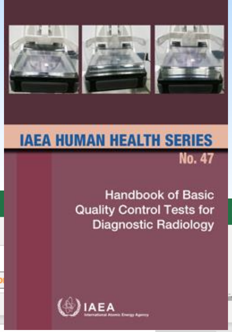


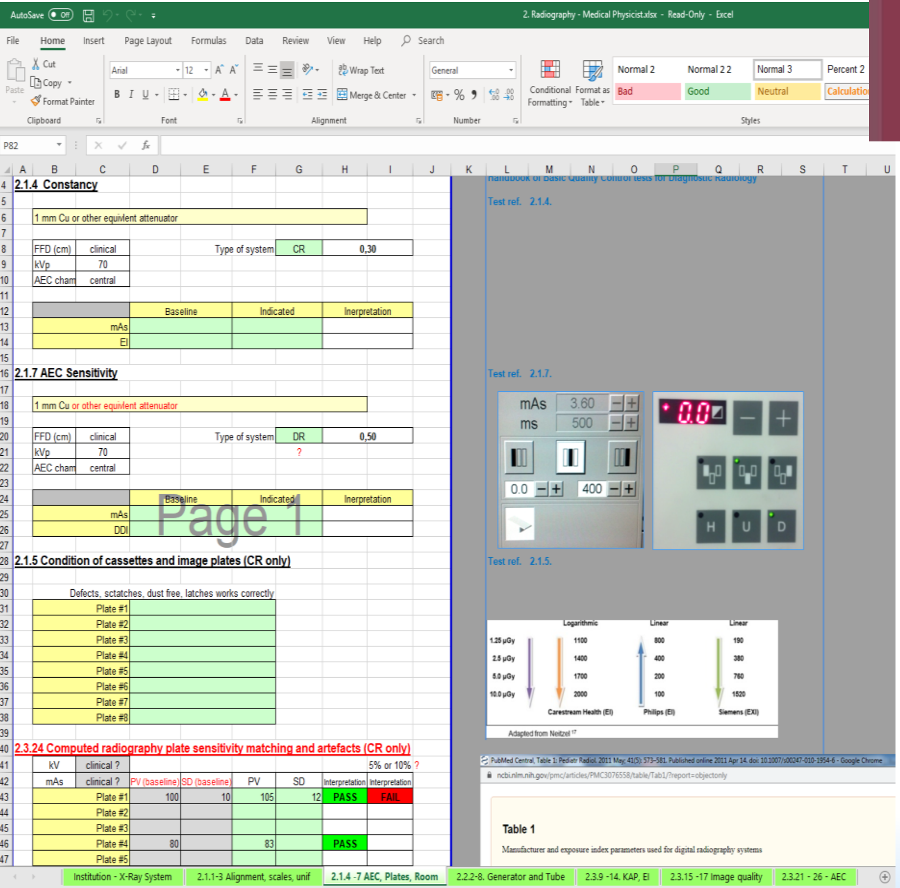
IGURE 11 Variance maps of AGFA CR-30 (a) before, and (b) after 23 months showing the same IP flaws in the same location (red dots)

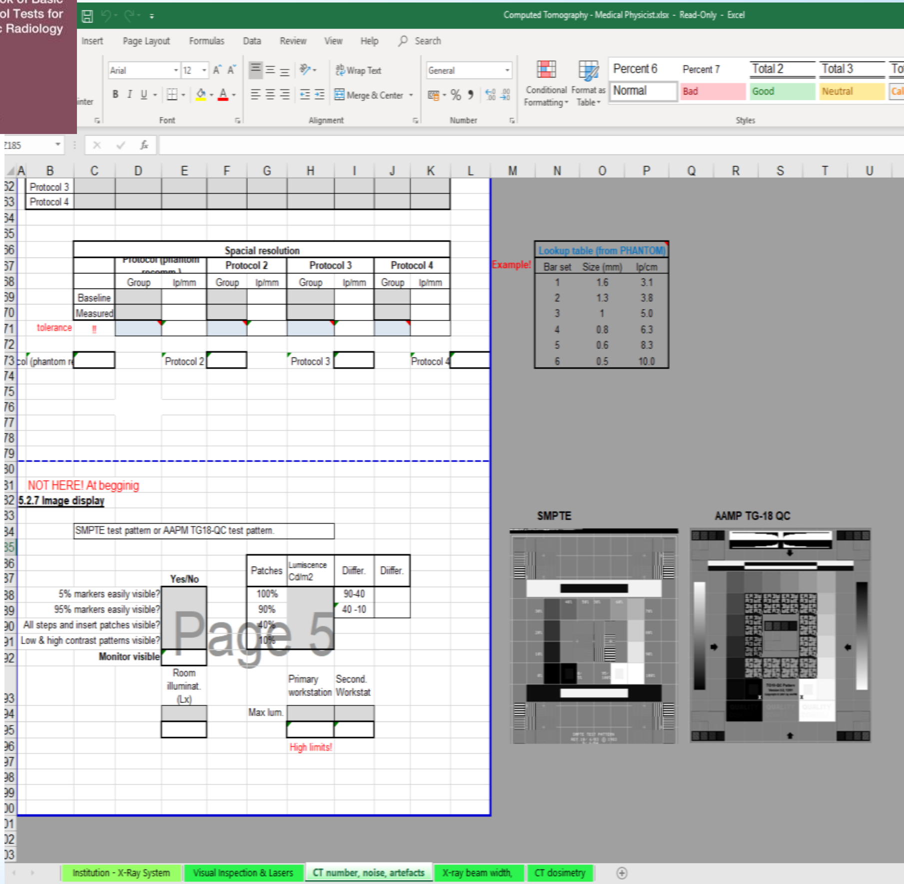


- 4 institutions (in Costa Rica and USA)
- Computed radiography and direct digital mammography and radiography systems.
- Data were collected over a 3-year period

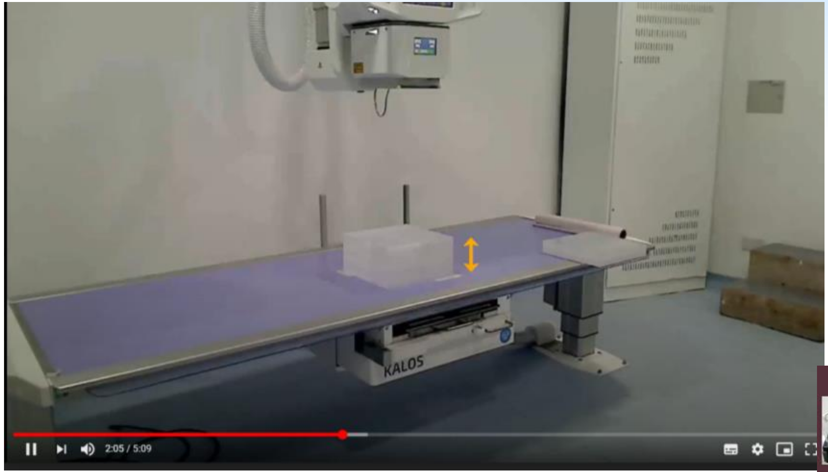
- The IAEA methodology is feasible and easy to implement.
- The phantoms are easily fabricated and consist of materials that are readily available.
- The ATIA software is robust and reproducible
- 259 issues have been detected in the daily QC. The majority of the problems had to do with localized “pixel” artifacts (128/259) and either dead lines or columns (28/259),all of these analyzed from the variance map.

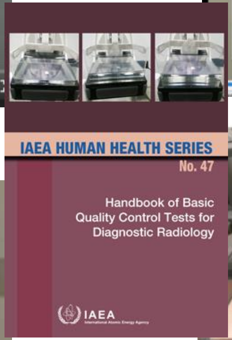

IAEA HUMAN HEALTH SERIES
No. 47
Handbook of Basic Quality Control Tests for Diagnostic Radiology
IAEA


2. Radiography - Medical Physicist.xlsx - Read-Only - Excel
2.1.4 Constancy
1 mm Cu or other equivlent attenuator
Type of system
CR
0,30
Baseline
Indicated
Inerpretation
2.1.7 AEC Sensitivity
DR
0,50
Page 1
2.1.5 Condition of cassettes and image plates (CR only)
Defects, sctatches, dust free, latches works correctly
2.3.24 Computed radiography plate sensitivity matching and artefacts (CR only)
PASS
FAIL
Test ref. 2.1.4.
Test ref. 2.1.7.
Test ref. 2.1.5.
Adapted from Neitzel
Table 1
Manufacturer and exposure index parameters used for digital radiography systems
Institution - X-Ray System
2.1.1-3 Alignment, scales, unif
2.1.4 -7 AEC, Plates, Room
2.2.2-8. Generator and Tube
2.3.9 -14. KAP, EI
2.3.15 -17 Image quality
2.3.21 - 26 - AEC


Computed Tomography - Medical Physicist.xlsx - Read-Only - Excel
Spacial resolution
Protocol 2
Protocol 3
Protocol 4
Baseline
Measured
tolerance
Example!
Lookup table (from PHANTOM)
NOT HERE! At begginig
5.2.7 Image display
SMPTE test pattern or AAPM TG18-QC test pattern.
Page 5
Monitor visible
High limits!
SMPTE
AAPM TG-18 QC
Institution - X-Ray System
Visual Inspection & Lasers
CT number, noise, artefacts
X-ray beam width,
CT dosimetry

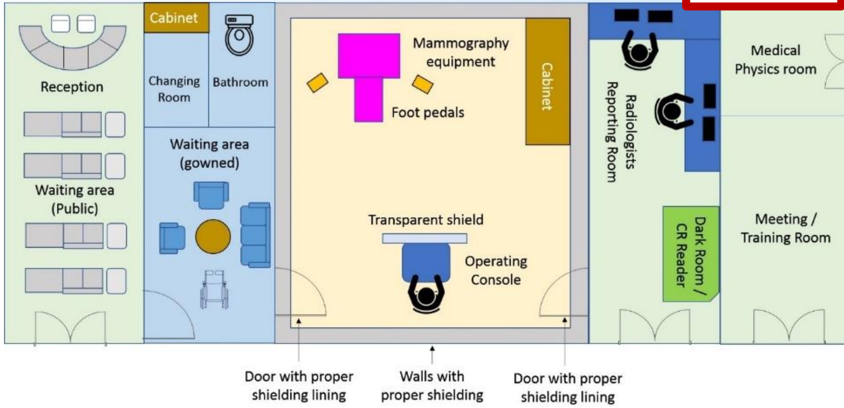
QC Handbook video tutorials

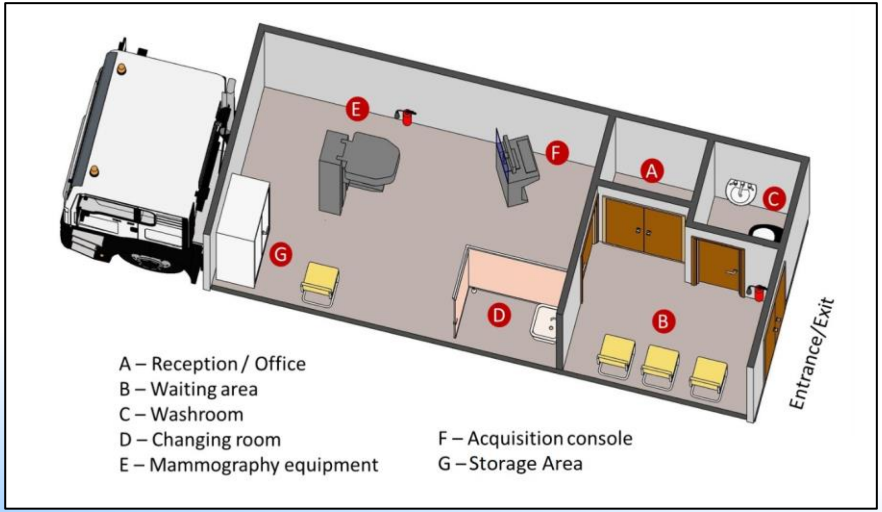


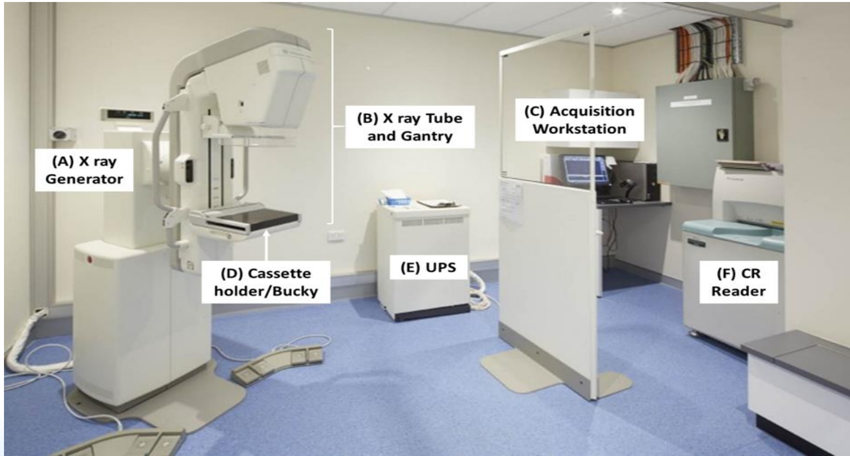


WORLDWIDE IMPLEMENTATION OF DIGITAL MAMMOGRAPHY IMAGING

The purpose of this publication is to provide guidance on the establishment of digital mammography facilities or upgrade of existing facilities when selecting and implementing new technology for mammography imaging in different resource settings.

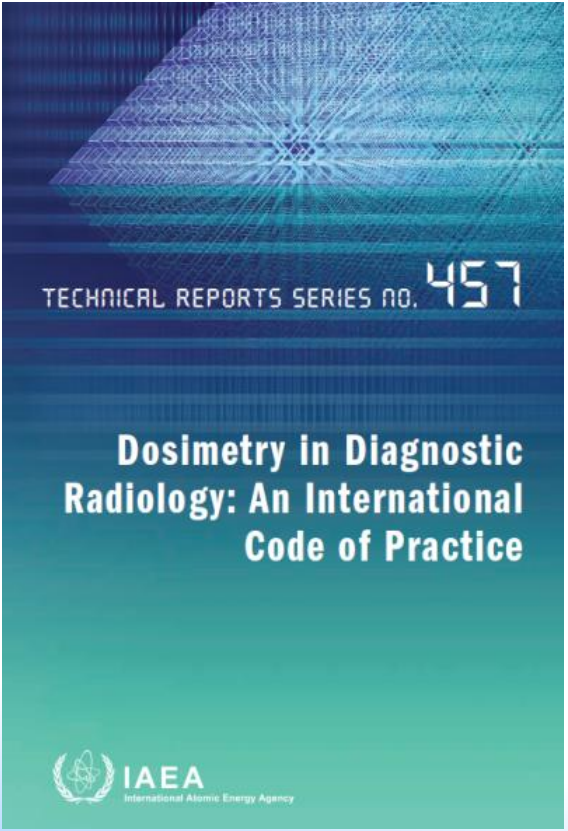


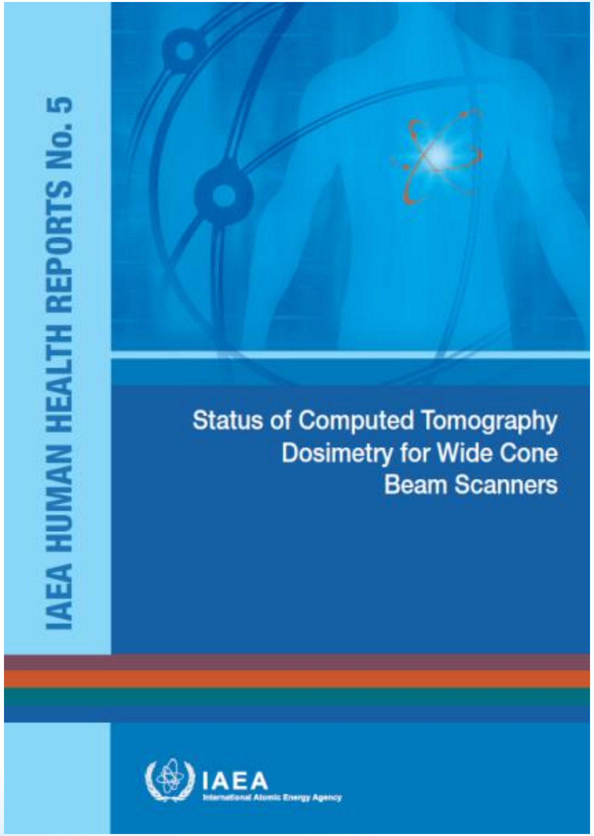


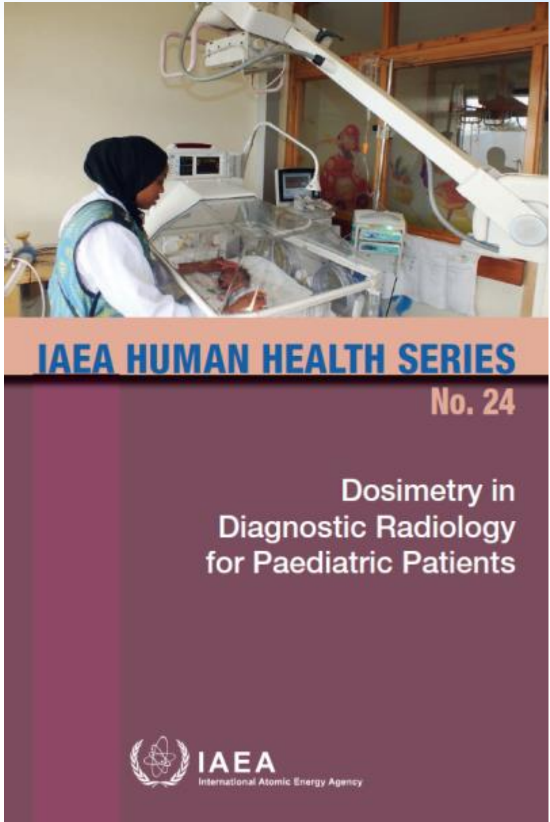


Development of guidelines (dosimetry)

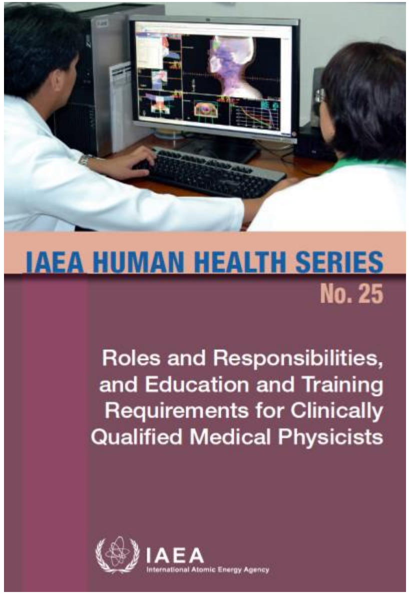
IAEA

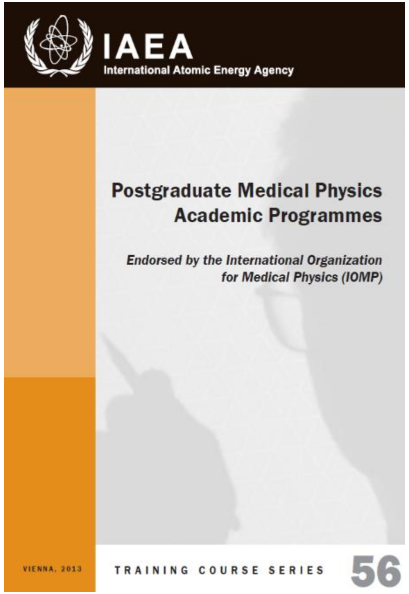


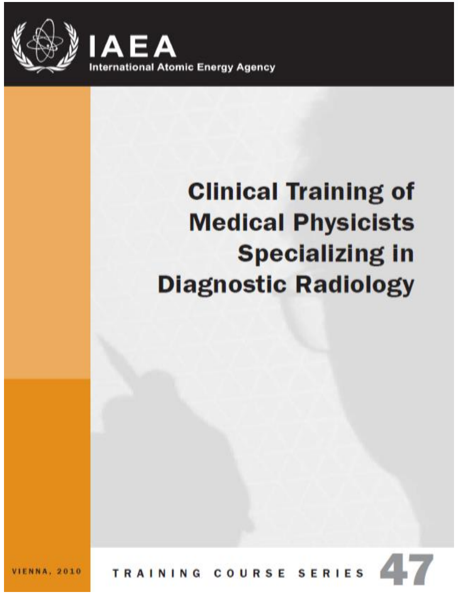


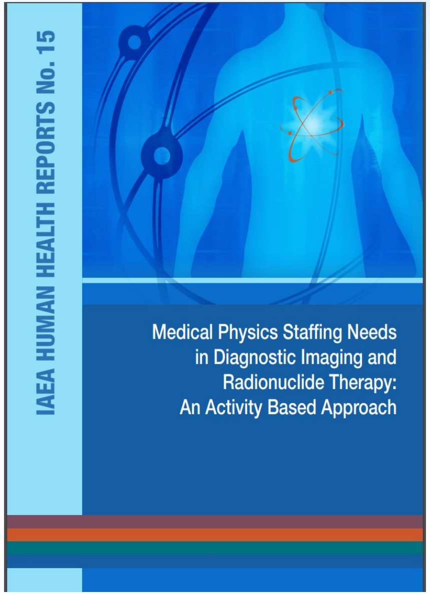


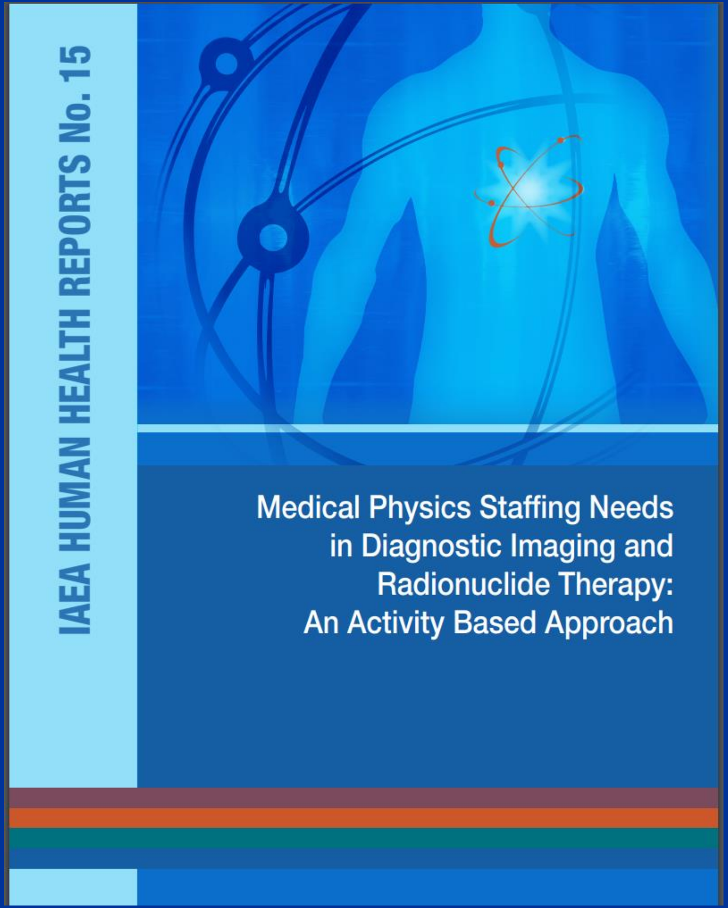
Development of guidelines (education, clinical training and staffing requirements)











2018

Staffing algorithm

- **Guidelines for Medical Physics staffing requirements in diagnostic imaging**
- In-line with:
  - International Basic Safety Standards
  - Human Health Series No.25,
  - the SSC-16 comment (C13)
- Guidelines are being developed for the necessary medical physics staffing levels in medical imaging (Diagnostic Radiology and Nuclear Medicine).
- The output of this activity is a comprehensive method for the estimation of the staffing requirements for medical imaging departments.

Spreadsheet

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

Data	*Number*	
EQUIPMENT DATA		
Nuclear Medicine		
Planar Gamma Cameras	1	
SPECT systems	1	
SPECT/CT systems	1	
PET/CT systems	1	
PET/MR systems	0	
Cyclotrons	0	
Thyroid probes	1	
Activity calibrators	1	
Sentinel lympth node probes	0	
Isotope generators (number of different types)	1	
Gamma counters	1	
Diagnostic/Interventional Radiology		
CT Scanners	2	Both fixed and mobile scanners used for radiology, radiotherapy and the CT component of hybrid modalities. It does not include cone beam CT units for dental and
Fixed Radiographic units	10	Panoramic dental and CBCT units should be included here. Note digital detectors are counted separately as applicable.
Mammography units	2	Including both screen film and digital units, also including biopsy and tomosynthesis
Specimen Cabinet units	0	For Biopsy analysis
Fluoroscopy units	1	Includes both fixed and mobile C arm units used for basic fluoroscopy
Interventional Fluoroscopy units	2	Both fixed and mobile units used for this purpose
Portable radiographic units	5	Note digital detectors are counted separately as applicable.
Intra-oral dental x-ray units	0	
DEXA equipments	0	
CR Detectors	0	Number of plates
DR Detectors	17	Number of detectors (including detectors in fixed units)
Image display devices (primary/reporting per pair)	10	This applies only to primary interpretation stations.
MR scanners	1	
Ultrasound units	0	
Reading and Printing devices	0	CR readers and laser printers
Dark rooms - wet processors	0	

Quality assurance dosimetry and optimization in fluoroscopically guided procedures (publication)

The IAEA has published guidance on quality assurance and dosimetry in various modalities but no guidance on similar topic or optimization specifically in fluoroscopically-guided interventional procedures.

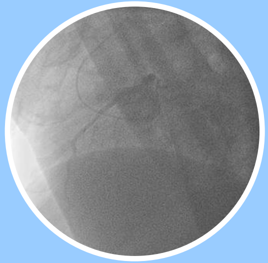
Draft table of contents

Clinical applications

Equipment technology

Quality assurance

Optimization of image quality and dose

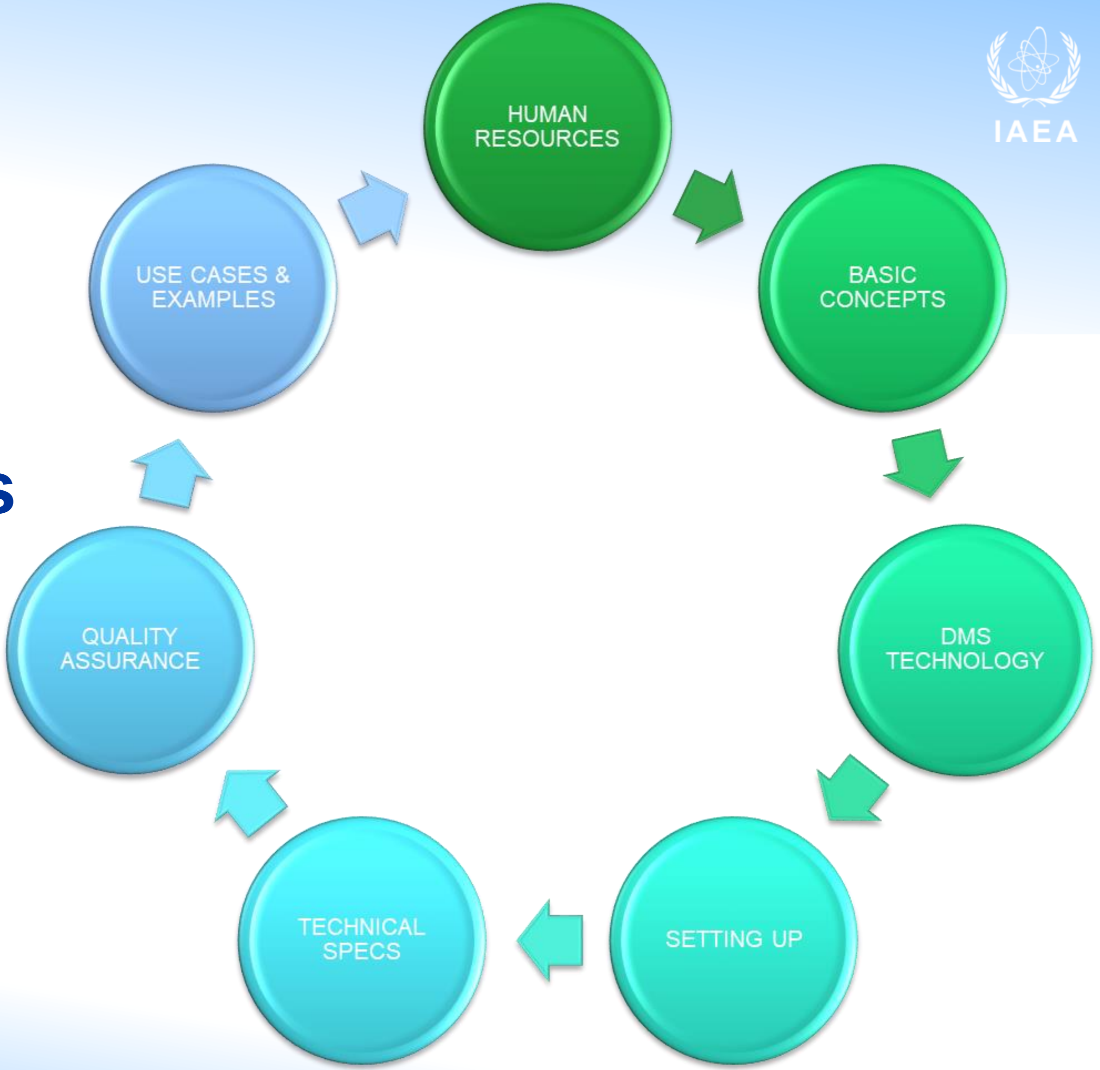


Clinical examples

Dose Management Systems (publication)

There is little guidance on how to set up and assess the accuracy of a DMS, including a lack of standardization of procedures related to acceptance testing and periodic quality control tests.

Draft table of contents



Technical DMS vendor survey

IAEA IRIS collection platform

- IRIS is an IAEA digital platform, launched in 2020, for streamlining data collection process and enhancing quality of scientific research.
- IRIS provides access to trustworthy and validated data, enabling IAEA researchers to conduct high-quality scientific projects. The platform facilitates the collection and collation of research data, the distribution of surveys, and the management of datasets, positioning IRIS as an IAEA crucial tool in advancing IAEA scientific work.
- It provides basic data analysis and the ability to export data, to use additional tools to optimize advanced data analysis.
- It supports the collection of numerical and text data, images, as well as DICOM images with subsequent tag extraction.
- It is hosted on the secure IAEA cloud infrastructure, ensuring top-level security at all stages of the data collection and management process.

A questionnaire with more than 400 questions was developed:

- 267 yes/no answers
- 7 questions with selection from a list of pre-set answers.
- The remaining questions required answers in the form of free text.
- An invitation was sent to all known commercial and open source DMS manufacturers to fill-in the questionnaire.
- Data collection finalised in March 2023

Information Collected

1. Certifications

FDA, CE, Joint Commission
other Certification

2. Data Transfer Methods, Patient/Facility Information

Data connection & Collection
Examination/Patient/Facility Records
Unit Conversion & Calibration Factors

3. Modalities, Metrics & Methods Supported

Acquisition & Reconstruction
Parameters Collected
Dose Metrics & Parameters Calculated
Image Quality Evaluation Tools
Occupational Dose Tracking

4. Statistical Analysis Capabilities

Information Dashboard
Export Capabilities
Analysis of data collected & calculated

5. Customization

Setting Alerts
Master Protocols
DRL Libraries
User Rights

6. Implementation Process

IT installation requirements
Support & Functionalities
Implementations

Courtesy Mrs Laurentcia Arlany, member of the IAEA DMS expert group

Preliminary results

	1	2	3	4	5	6	7	8	9	10	11
DATA TRANSFER	100%	96%	93%	100%	93%	86%	75%	71%	86%	75%	39%
DATA COLLECTION	95%	88%	92%	99%	91%	74%	70%	77%	71%	77%	6%
STATISTICAL ANALYSIS	100%	97%	86%	100%	91%	77%	97%	89%	77%	69%	0%
CUSTOMIZATION	88%	75%	72%	96%	49%	49%	55%	75%	12%	31%	0%
IMPLEMENTATION	57%	59%	54%	62%	59%	62%	30%	70%	49%	14%	0%
	88%	**83%**	**79%**	**91%**	**77%**	**69%**	**65%**	**76%**	**59%**	**53%**	**9%**

- Bayer
- GE HealthCare - GE Medical Systems
- Hospital Clinico San Carlos
- INFINITT Europe GmbH
- Medsquare
- OpenREM (Copyright The Royal Marsden)

- PACSHealth, LLC
- PixelMed Publishing, LLC
- Qaelum NV
- Region Västerbotten
- Siemens Healthineers

IAEA

38%

FDA Cleared

50%

CE Approved

63%

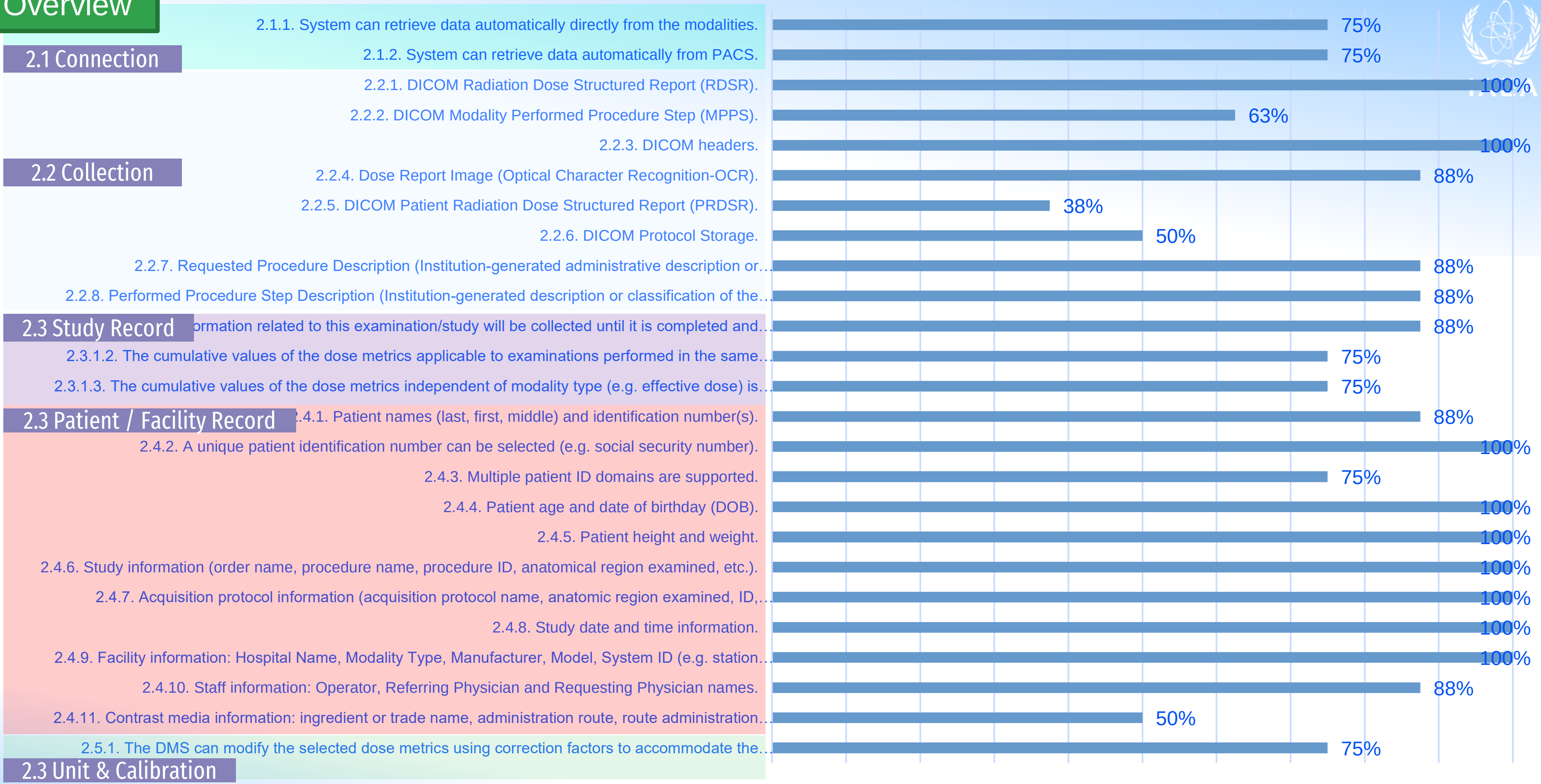
Comply with Joint Commission Requirements

25%

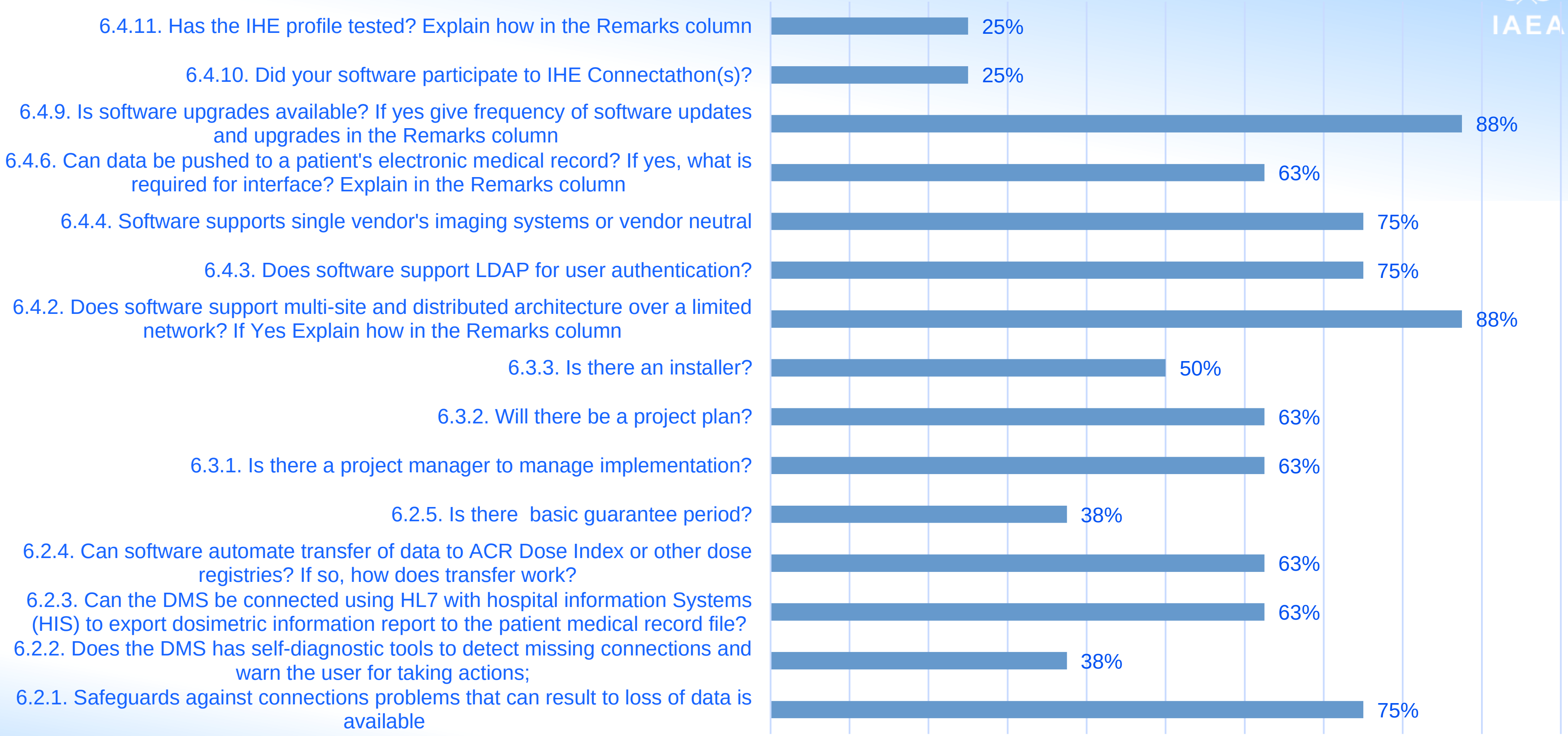
Other Certifications

1. General Certifications

Overview

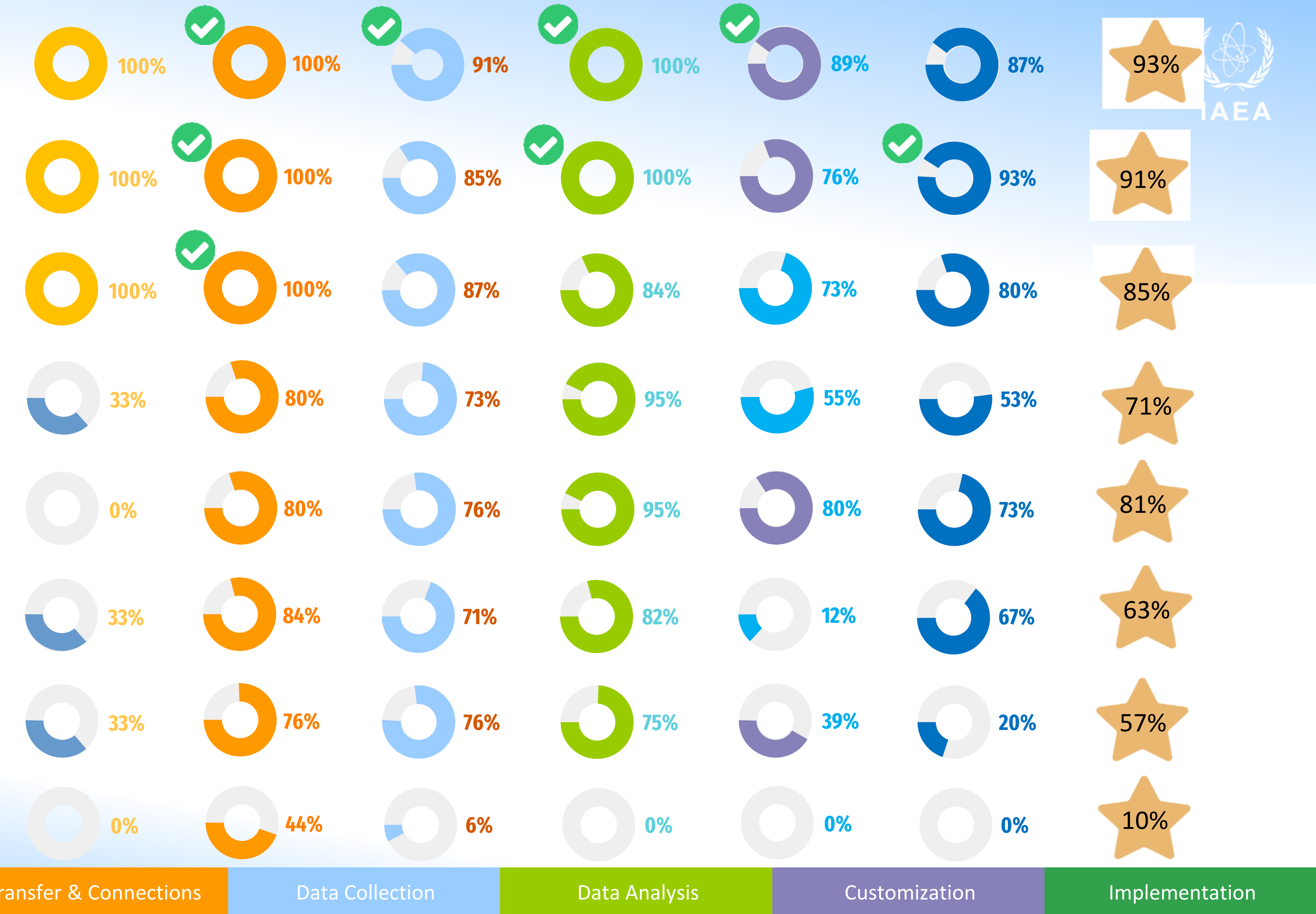

2.1 Connection
2.1.1. System can retrieve data automatically directly from the modalities. 75%
2.1.2. System can retrieve data automatically from PACS. 75%
2.2 Collection
2.2.1. DICOM Radiation Dose Structured Report (RDSR). 100%
2.2.2. DICOM Modality Performed Procedure Step (MPPS). 63%
2.2.3. DICOM headers. 100%
2.2.4. Dose Report Image (Optical Character Recognition-OCR). 88%
2.2.5. DICOM Patient Radiation Dose Structured Report (PRDSR). 38%
2.2.6. DICOM Protocol Storage. 50%
2.2.7. Requested Procedure Description (Institution-generated administrative description or… 88%
2.2.8. Performed Procedure Step Description (Institution-generated description or classification of the… 88%
2.3 Study Record
…ormation related to this examination/study will be collected until it is completed and… 88%
2.3.1.2. The cumulative values of the dose metrics applicable to examinations performed in the same… 75%
2.3.1.3. The cumulative values of the dose metrics independent of modality type (e.g. effective dose) is… 75%
2.3 Patient / Facility Record
….4.1. Patient names (last, first, middle) and identification number(s). 88%
2.4.2. A unique patient identification number can be selected (e.g. social security number). 100%
2.4.3. Multiple patient ID domains are supported. 75%
2.4.4. Patient age and date of birthday (DOB). 100%
2.4.5. Patient height and weight. 100%
2.4.6. Study information (order name, procedure name, procedure ID, anatomical region examined, etc.). 100%
2.4.7. Acquisition protocol information (acquisition protocol name, anatomic region examined, ID,… 100%
2.4.8. Study date and time information. 100%
2.4.9. Facility information: Hospital Name, Modality Type, Manufacturer, Model, System ID (e.g. station… 100%
2.4.10. Staff information: Operator, Referring Physician and Requesting Physician names. 88%
2.4.11. Contrast media information: ingredient or trade name, administration route, route administration… 50%
2.3 Unit & Calibration
2.5.1. The DMS can modify the selected dose metrics using correction factors to accommodate the… 75%

Section 6. Implementation Process



Overall Capabilities

The percentages refer to the positive responses (YES questions) related to the functionality options so that the user is aware of what the system can offer



Steps for successful optimization practice

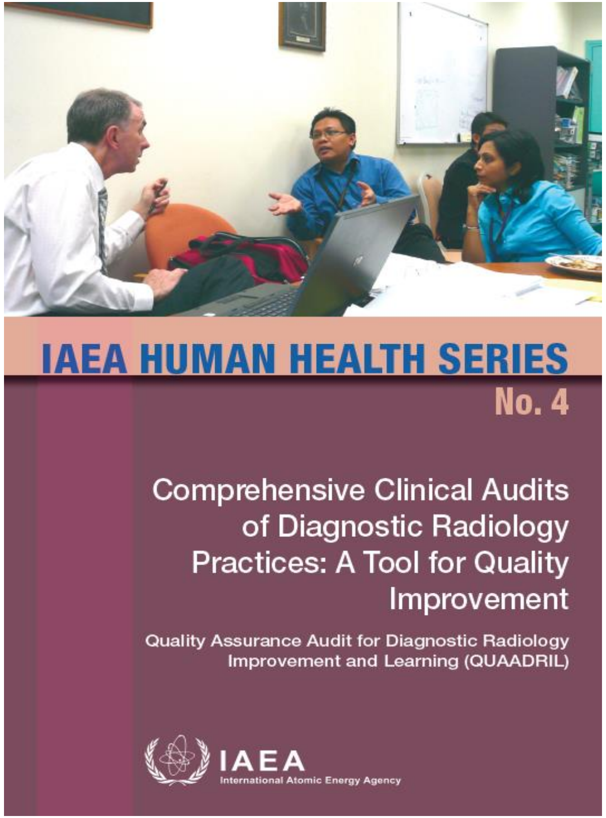
Radiation dose optimization in diagnostic and interventional radiology: Current issues and future perspectives. Phys Med. 2020 Nov;79:16-21. doi: 10.1016/j.ejmp.2020.09.015.

1. Establishment of a Quality Assurance Program
2. Establishment of an optimization team
3. Baseline dose and image quality levels. Comparison with benchmarks (DRLs) to decide which exam protocols should be optimized
4. Modification of protocols
5. Evaluation of optimization process and its effect on patient dose and image quality

The goal is: to keep the exposure of patients to the minimum necessary to achieve the required clinical task

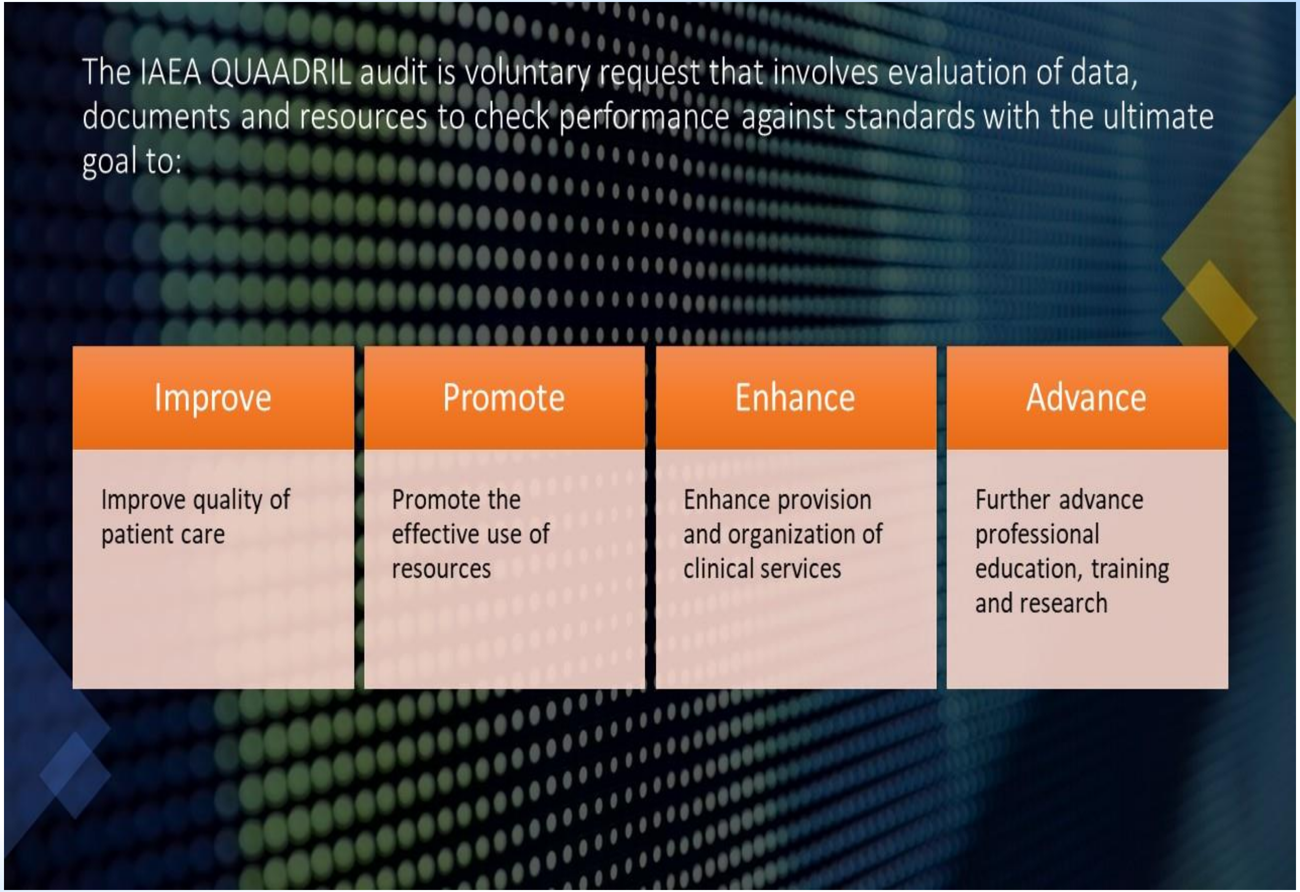
Support comprehensive clinical audits

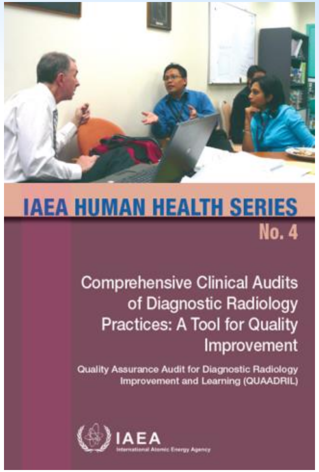
Comprehensive clinical audits



Clinical audit is one of the key elements within the framework of quality assurance through the comprehensive and critical review of the practice in a medical radiation facility.

- Development of guidance
- Training of auditors
- Development of training material
- Function as the independent auditing body.



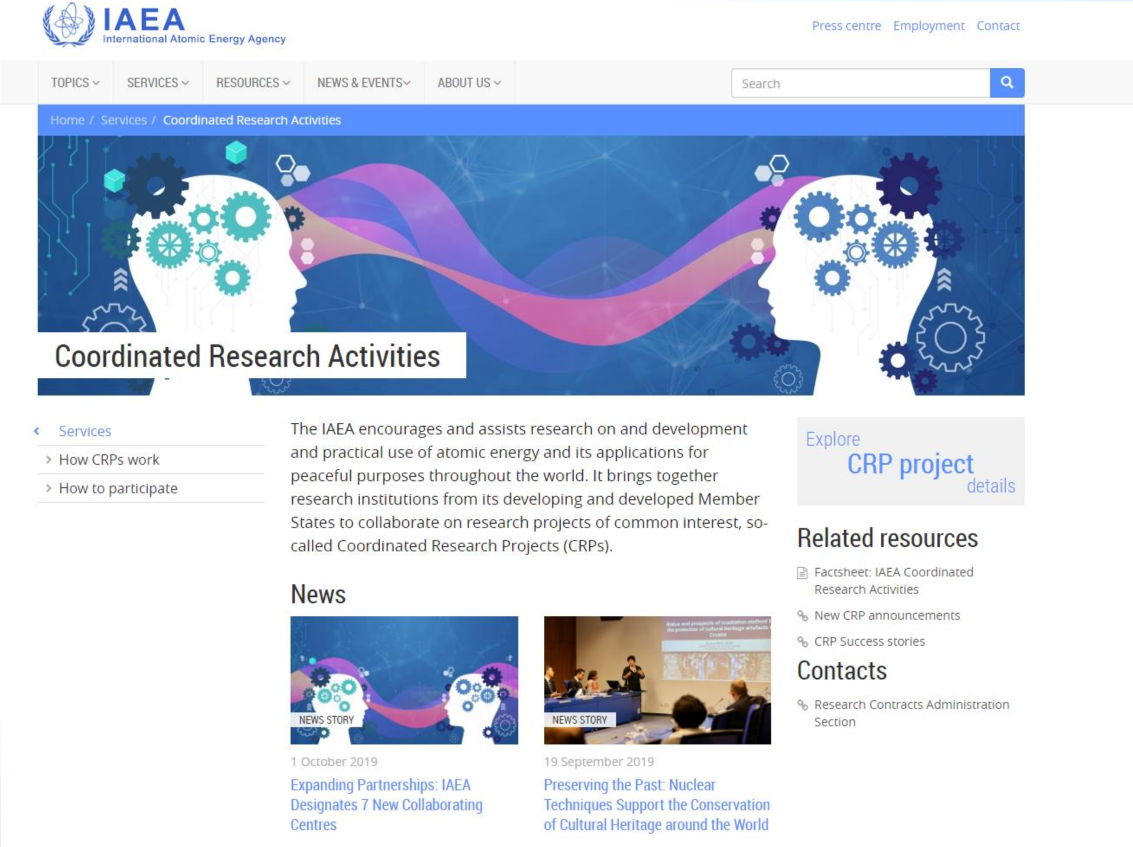


The IAEA QUAADRIL audits can expand in Africa, as well as more countries in Asia, Europe, and Latin America in the immediate future.

Coordinated research projects

Coordinated research projects

Coordinated Research Projects (CRPs) are designed to encourage the acquisition and dissemination of new knowledge from the use of nuclear technologies and isotopic techniques.



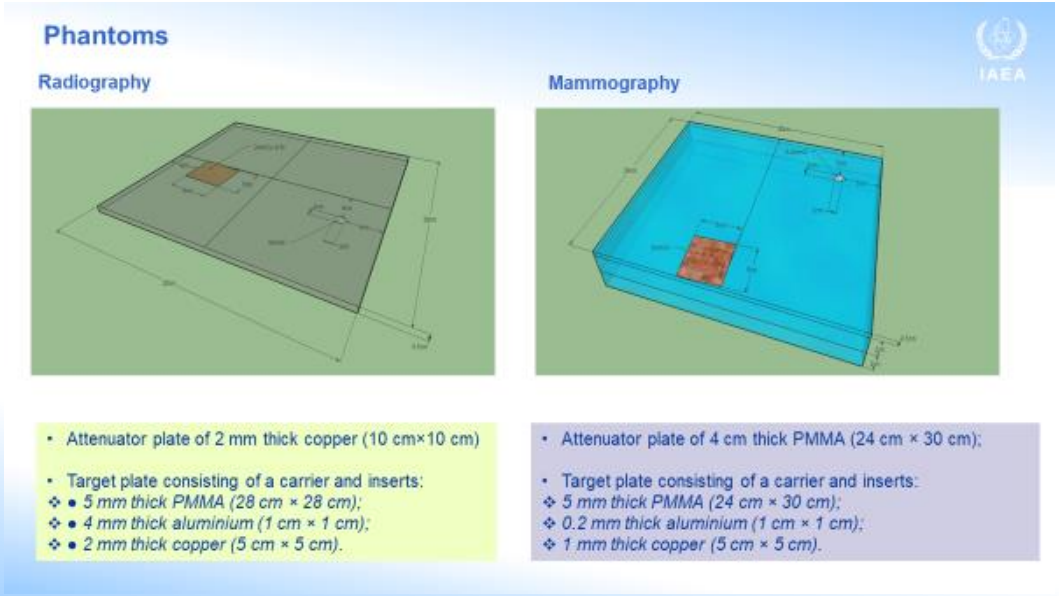
Coordinated Research Project

Wide implementation and evaluation of the method

New CRP: Advanced Tools for Quality and Dosimetry of Digital Imaging in Radiology (E24025). Primary Officer: V.Tsapaki, Alternative Officer: O. Ciraj Bjelac, 2021-2025

https://www.iaea.org/newscenter/news/new-crp-advanced-tools-for-quality-and-dosimetry-of-digital-imaging-in-radiology-e24025

Different institutions from around the world will independently create the phantoms to test the **accuracy and reproducibly of the method. I**ts ability to produce results identical to similar commercial phantoms will be also investigated.



- Argentina
- Brazil
- France
- Greece
- Hungary
- Ireland
- Mexico
- Malaysia
- Qatar
- Slovenia
- Sudan

Results of the 1rst year (pilot survey)

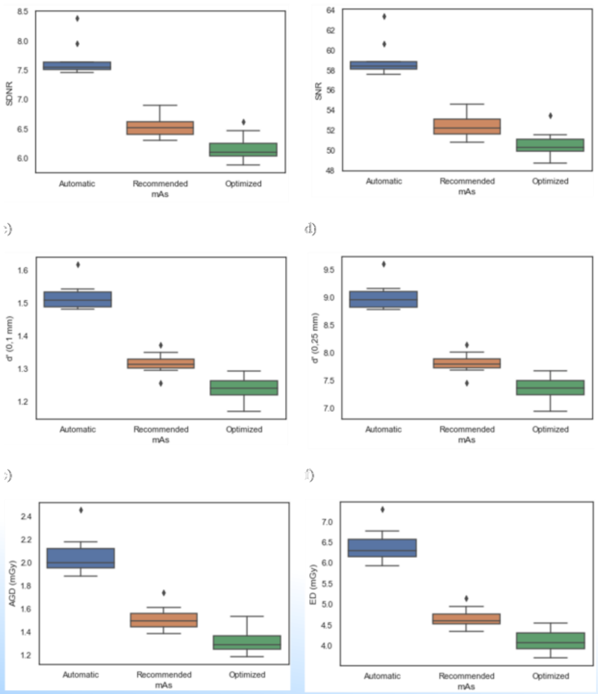
N	Country	Cost/per phantom	N of Rad phantoms	N of mammo phantoms	N of Rad machines	N of mammo machines
1	Argentina	49	3	3	11	5
2	Brazil	45	1	1	4	1
3	France	60	1	1	1	1
4	Greece	65	1	1	2	1
5	Hungary	50	4	4	2	2
6	Ireland	50	1	1	1	1
7	Mexico	25	3	3	1	2
8	Malaysia	16-133, 32-34	2	2	2	1
9	Qatar	25 (Mammo)*$15 (Rad)	25	6	9	2
10	Slovenia	50	10	10	0	6
11	Sudan	78 (Rad), 123 (Mammo)	3	3	2	1
	Sum		54	35	35	23

Individual research activity;
Hôpital Européen Georges Pompidou, Department of Radiology, Paris, France

Image quality and radiation dose optimization in women with breast implants in 2D mammography

Research group:

Isabelle FITTON, Jonathan ZERBIB, Antoine DECOUX Aude STEMBERT, Claire VAN NGOC TY, Françoise MALCHAIR, Armelle ARNOUX, Laure FOURNIER



A challenging process due to:

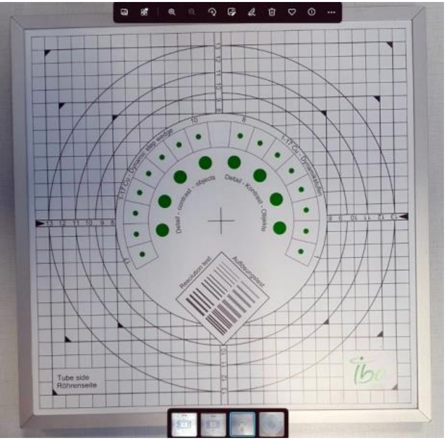
- ✓ radiopaque characteristics of the breast implants,
- ✓ limitations in breast compression that negatively affects mammographic image quality,
- ✓ silicone prostheses can decrease the breast tissue areas imaged.

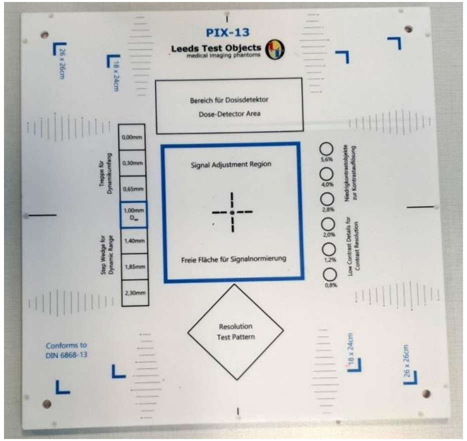
Objectives of the individual study:

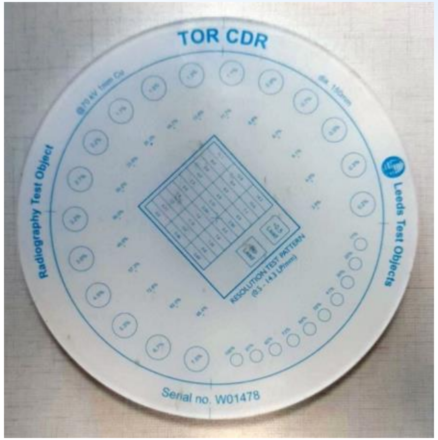
- ✓ investigate if and how the IAEA methodology can facilitate the assessment of image quality and radiation dose evaluation for breast implant imaging
- ✓ evaluate how breast implants impact imaging quality and radiation dose in clinical cases

Individual research activity: Hamad Medical Corporation, Qatar

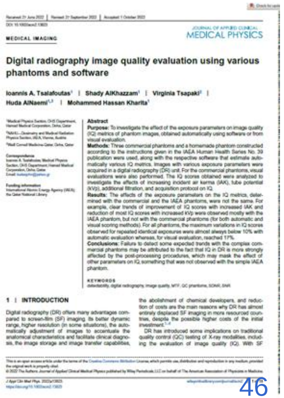
Comparison of 3 commercial phantoms and software



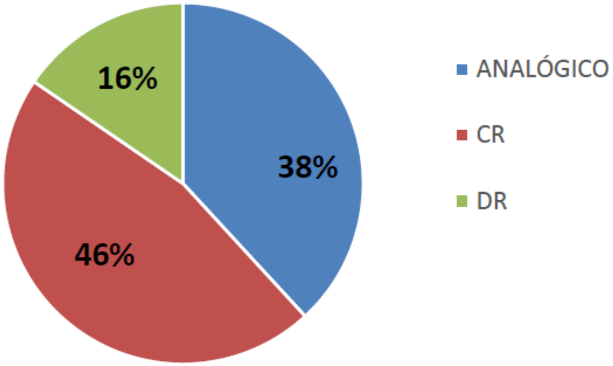




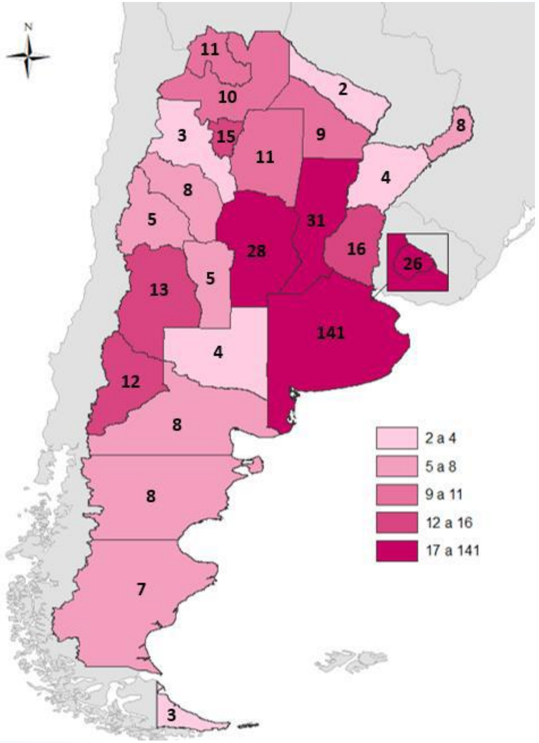
- Three commercial phantoms and the IAEA proposed phantom were used by one participating institution from Qatar (Hamad Medical Corporation) along with their respective software that estimate automatically various IQ metrics.
- The comparison showed that improvement of image quality scores with increased incident air kerma and reduction of most IQ scores with increased kVp were observed mostly with the IAEA phantom, but not with the commercial phantoms (for both automatic and visual scoring methods).



Salud, Argentina
National mammography accreditation programme



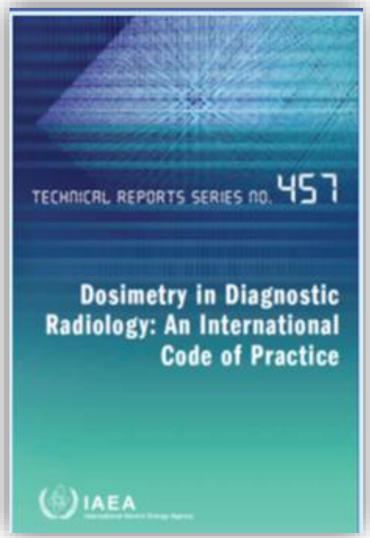
Approximately 900 mammography candidates



388 In public institutions And 970 in private institutions for a total of nearly 1500

"Evaluation of the Dosimetry Needs and Practices for the Update of the Code of Practice for Dosimetry in Diagnostic Radiology (TRS-457)" (E2.40.24)

IAEA



Mammography	Phantom	Incident air kerma	Mean glandular dose is the primary quantity of interest. It is calculated from measured incident air kerma.
		Entrance surface air kerma	When this is measured (using TLDs) the backscatter factors are used to calculate the incident air kerma.
	Patient	Incident air kerma	Mean glandular dose is the primary quantity of interest. It is calculated from the incident air kerma estimated from measurements of tube output by using the exposure parameters for the examination.

13 April 2021

New CRP: Evaluation of the Dosimetry Needs and Practices for the Update of the Code of Practice for Dosimetry in Diagnostic Radiology (TRS-457) (E24024)

CRP Overall Objective:

Standardization of radiology medical physics dosimetry instrumentation, equipment and procedures in laboratories and hospitals to support the update of the IAEA TRS 457.

Education and training activities

Training

Individual

(FE,SV, training material)

National

National training courses

Regional

Regional Training Courses

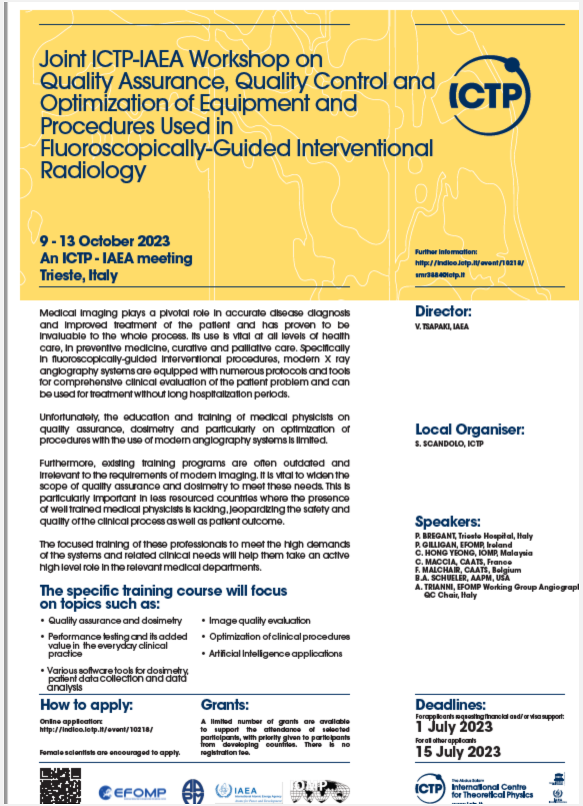
Interregional

ICTP courses

TRAINING - ICTP COURSES

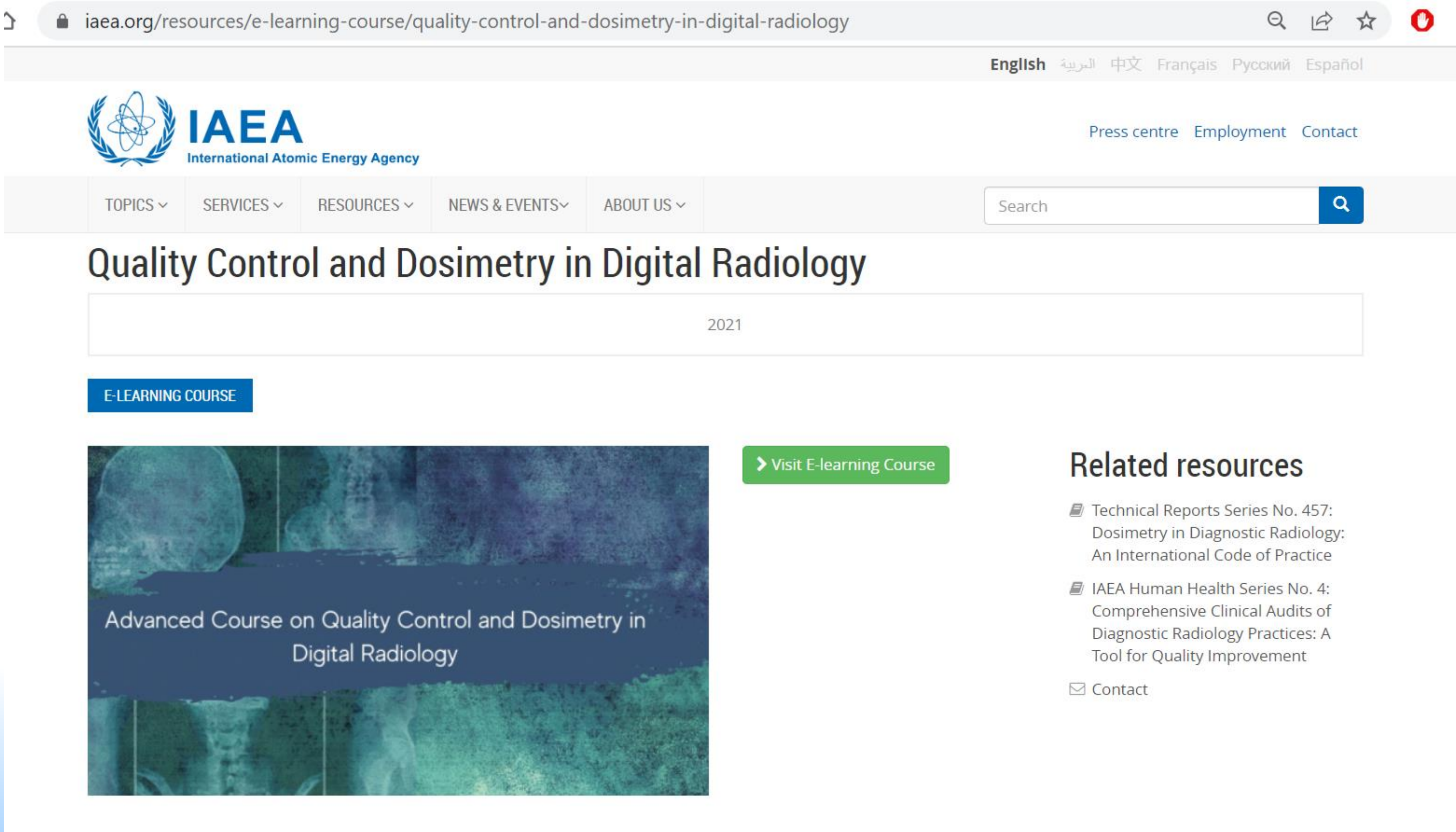
- For more than 50 years, the Abdus Salam International Centre for Theoretical Physics (ICTP) has been a driving force behind global efforts to advance scientific expertise in the developing world.

- The IAEA/ICTP joint courses are an effective method of organizing training events within the area of medical imaging (especially in medical physics) open to professionals from around the globe!



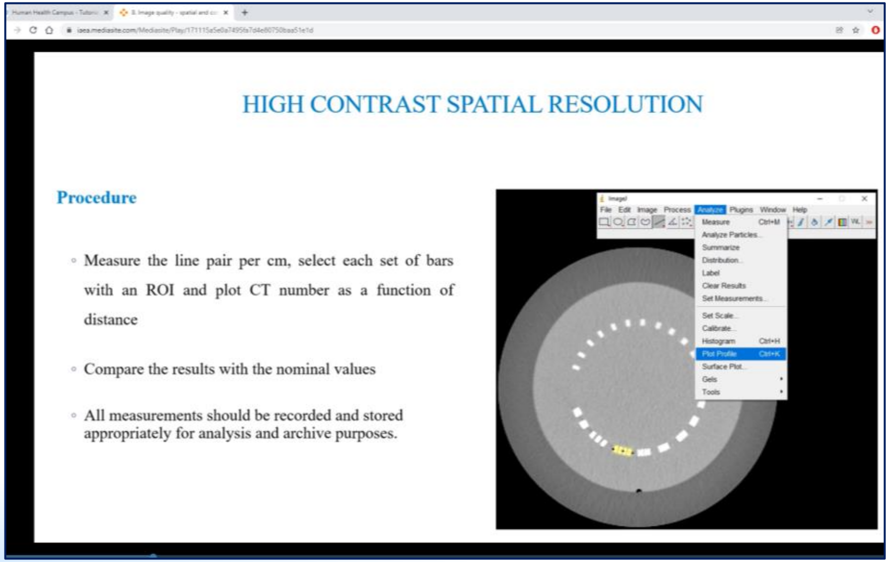
https://indico.ictp.it/event/10218/

e learning courses



Tutorial Videos on Quality Control for CT

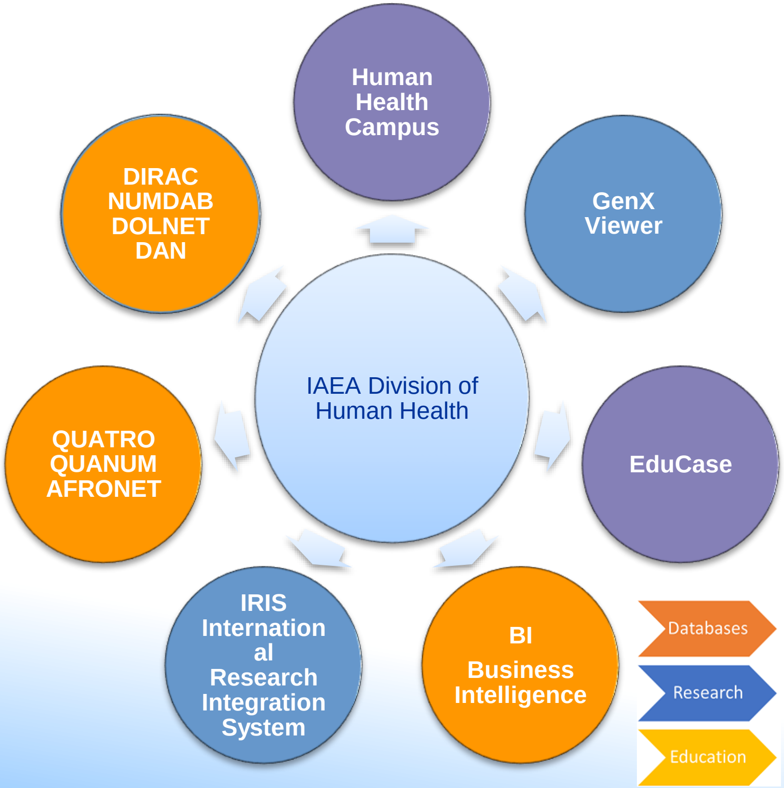
The video-tutorials are intended to be used by clinically qualified medical physicists (CQMPs) and presupposes underlying knowledge in the field of diagnostic radiology medical physics.

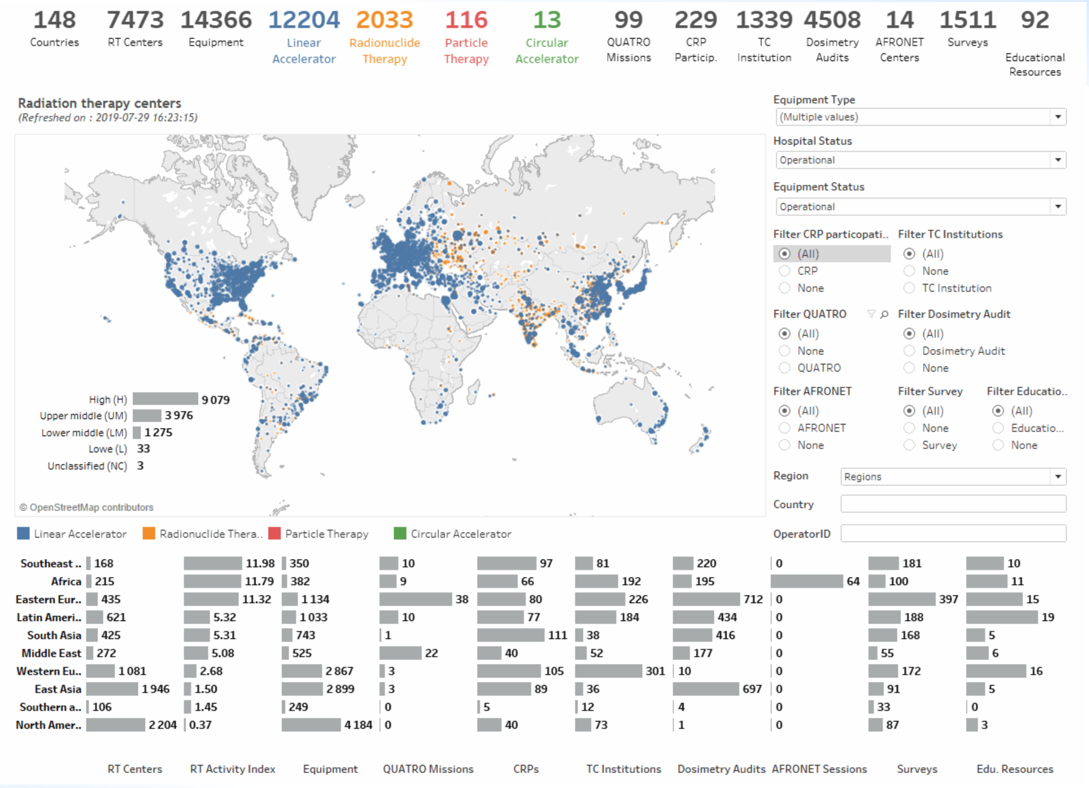


https://humanhealth.iaea.org/HHW/MedicalPhysics/e-learning/ctqualitycontrol/index.html

Databases and Data Management activities

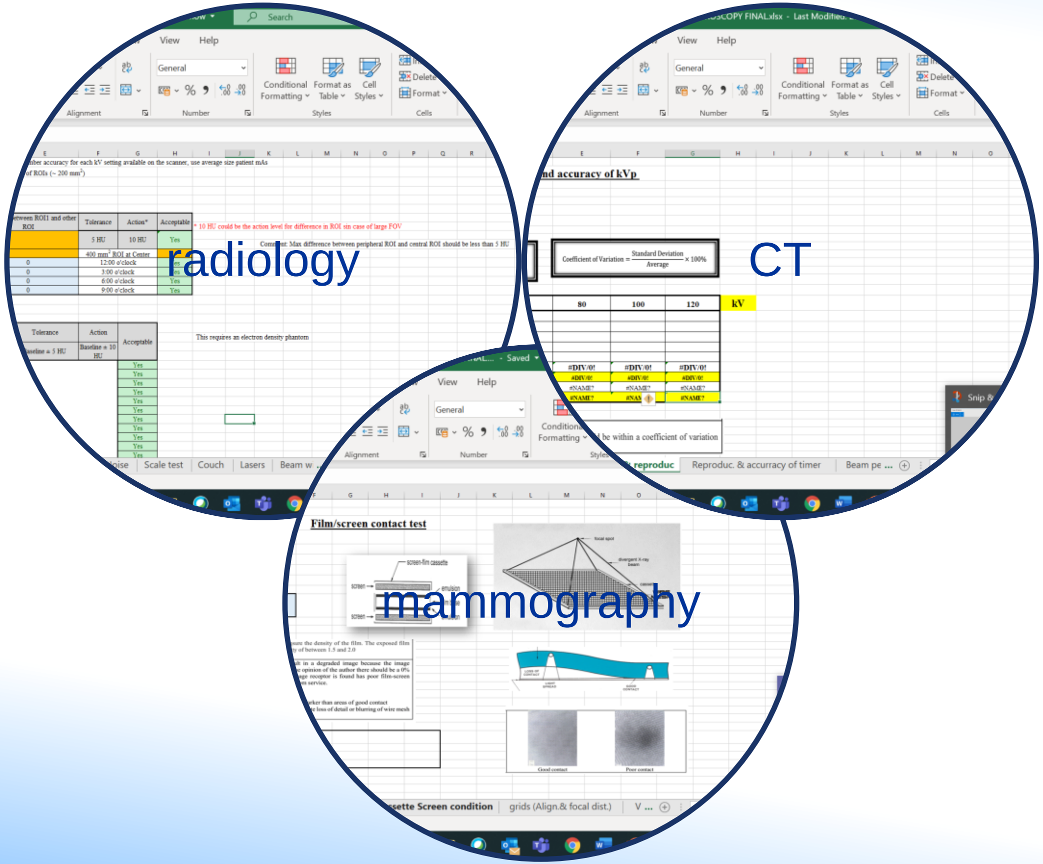
Databases and Data Management activities in the Division of Human Health past, current and future

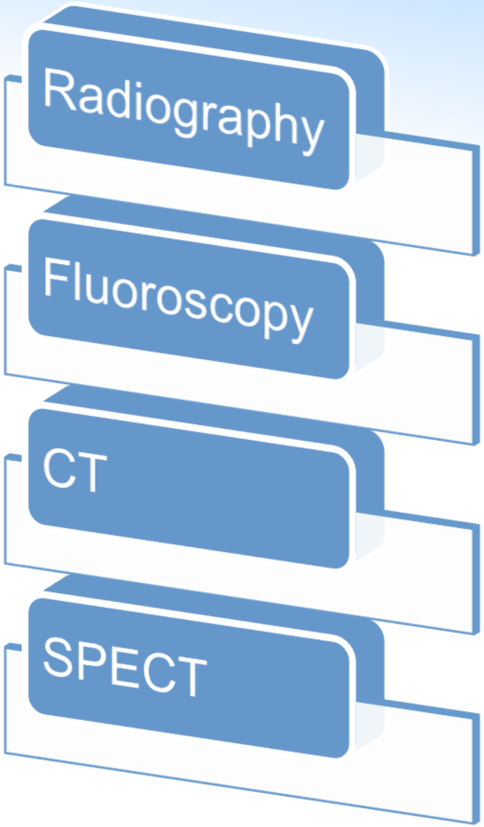




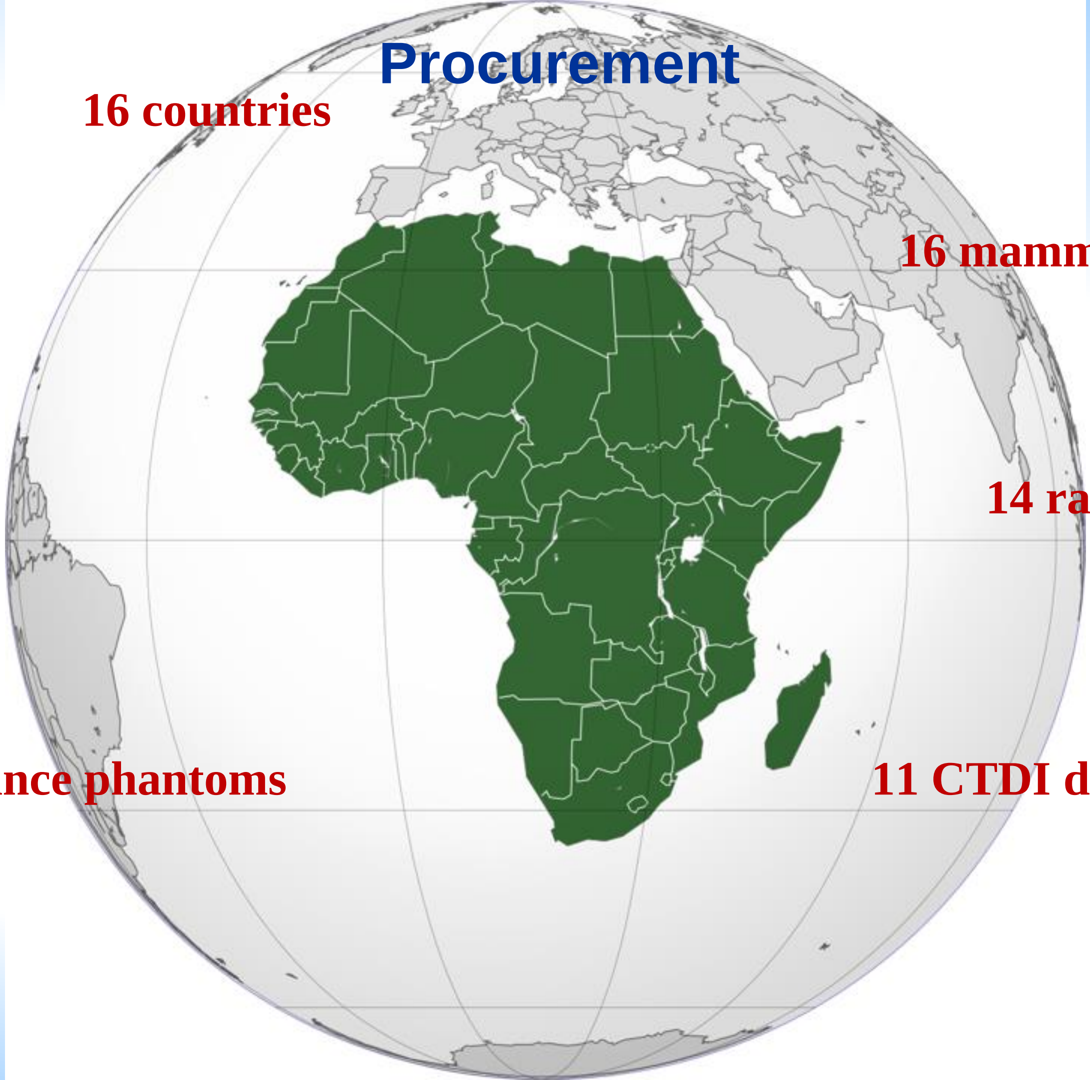
Technical cooperation

Harmonized quality control program in Africa for countries with no national program





Procurement



16 countries

22 hospitals

16 mammography phantoms

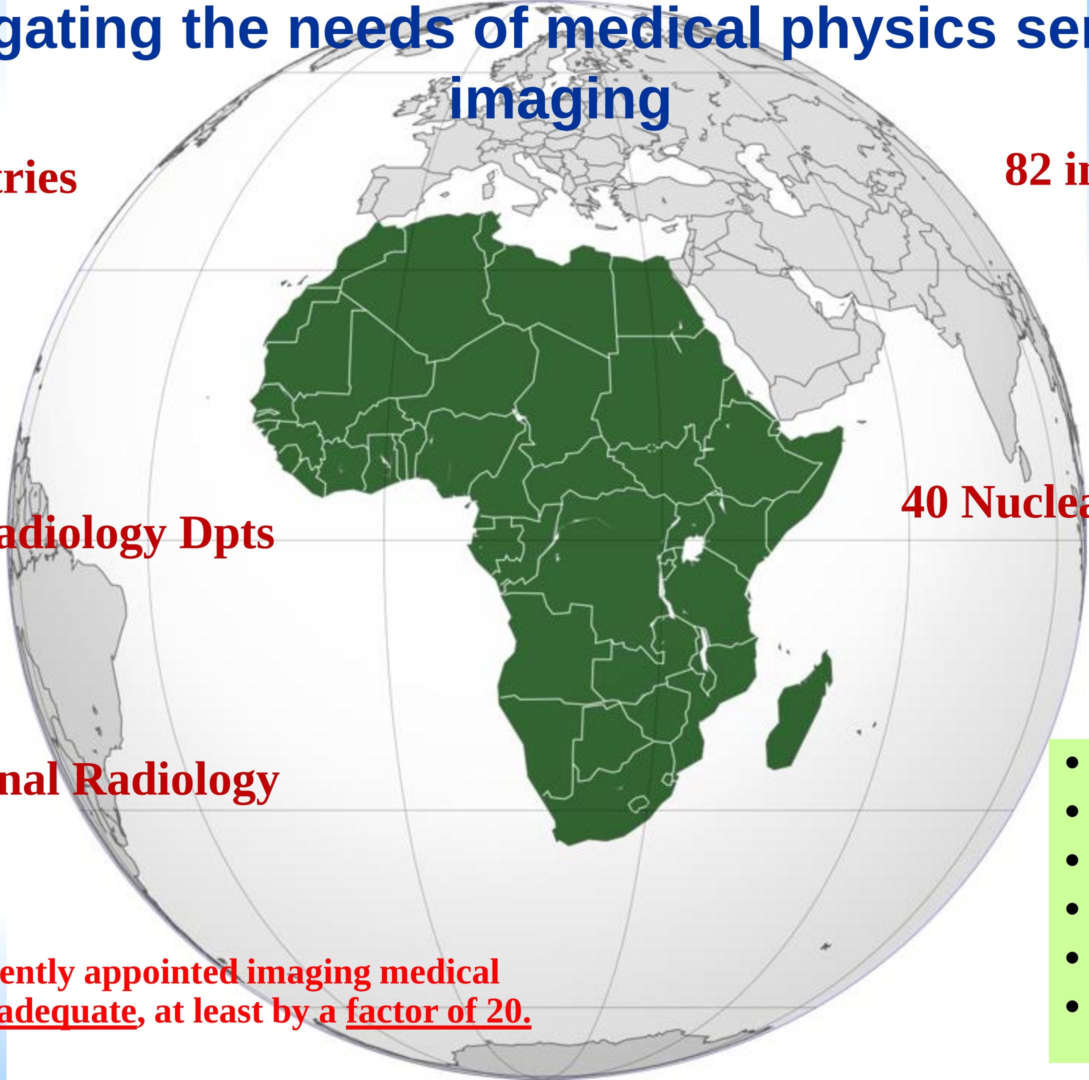
20 multimeters

14 radiography phantoms

10 CT performance phantoms

11 CTDI dosimetry phantoms

Investigating the needs of medical physics services in imaging



21 countries

82 institutions

97 Diagnostic Radiology Dpts

40 Nuclear MedicineDpts

75 Interventional Radiology

- 1.414.752 planar X-rays
- 604.597 CTs
- 70.366 IR, ICs
- 268.240 NM
- 19.481 non-imaging
- 9351 radionuclide therapy

The number of currently appointed imaging medical physicists is largely <u>inadequate</u>, at least by a <u>factor of 20.</u>

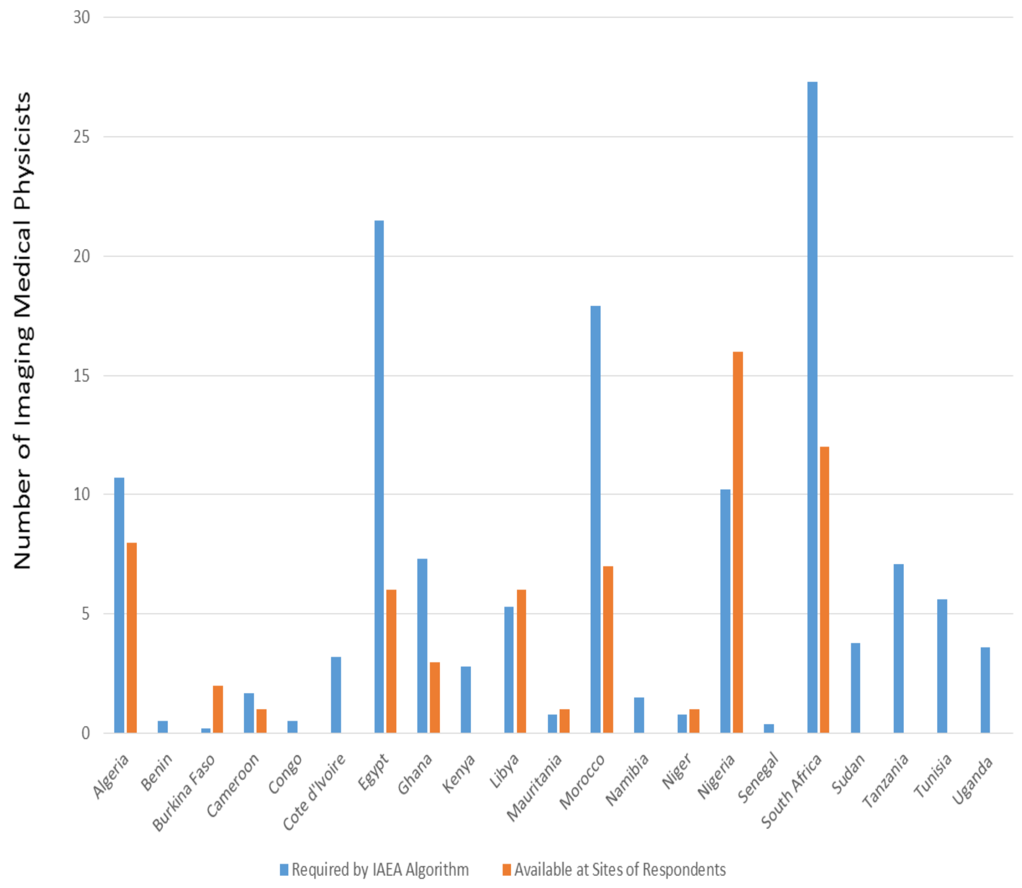
Investigating the needs of medical physics services in imaging

- 133 CTs
- 311 fixed radiographic units,
- 80 mammography
- 214 fluoroscopy units
- 126 interventional units
- 180 portable units
- 61 intra-oral X-ray units
- 24 DEXA units
- 417 image display devices
- 68 MRI scanners
- 326 ultrasound units
- 420 reading and printing devices
- 69 processors

- 32 SPECTs
- 19 SPECT-CTs
- 16 PET-CT systems
- 4 cyclotrons
- 11 thyroid uptake probes
- 64 activity meters
- 22 sentinel lymph node probes
- 61 isotope generators
- 26 gamma counters.

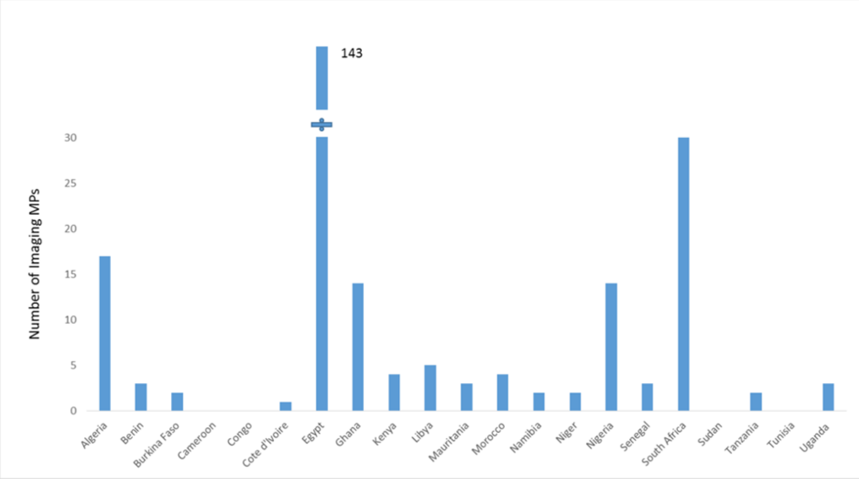
The number of currently appointed imaging medical physicists is largely inadequate, at least by a factor of 20.

Imaging Medical Physicists needs at Surveyed Centres



IAEA

Total number of imaging MPs (FAMPO data)



Health and Technology
https://doi.org/10.1007/s12553-022-00663-w

ORIGINAL PAPER

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]

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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

1 Strengths and limitations of the study

– The study applied a well-established imaging medical physics staffing model on a large scale across Africa.
– This is the first study to broadly investigate the staffing model across a whole region.
– The severe shortage of medical physicists in Africa was partially quantified.
– Results of the study will be biased towards centres that actually employ medical physicists, as these were the main respondents of the staffing survey.

2 Introduction

Medical imaging is technologically advanced, and the wide availability of services has resulted in a significant increase in applications and in global utilization [1, 2]. Medical physics deals with the application of physics principles to medicine and plays an important role in the prevention, diagnosis, and treatment of disease [3]. According to the International Labour Organisation, medical physicists are considered an integral part of the health workforce, with one of the listed tasks being "ensuring the

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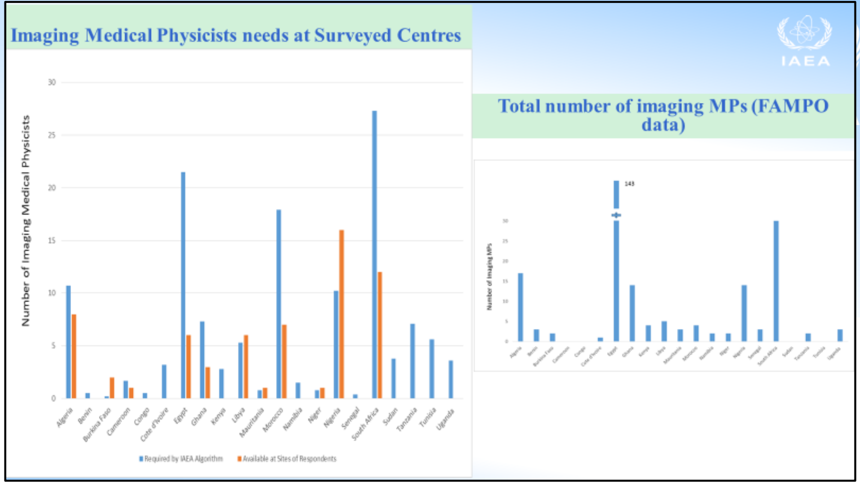
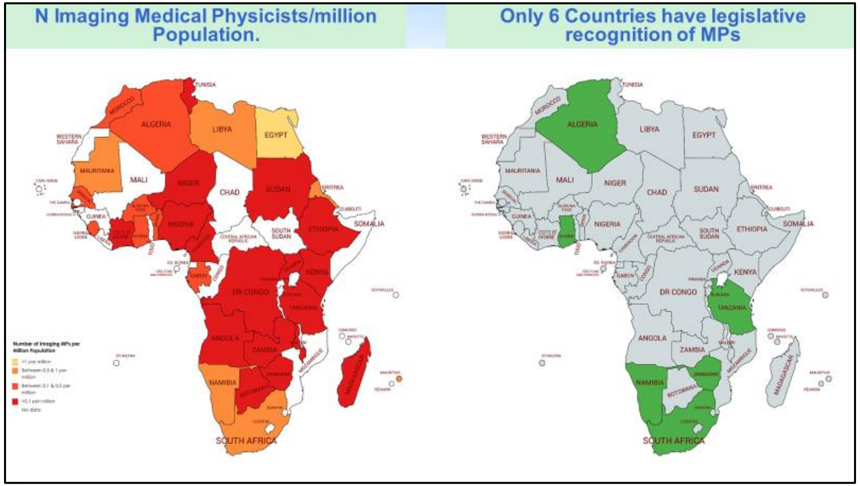
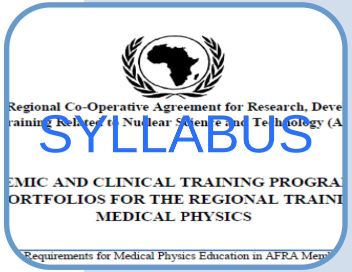




Harmonized Clinical training program in imaging in Africa



Radiology program

Nuclear Medicine Program

Medical physicists clinical training in imaging in 2021

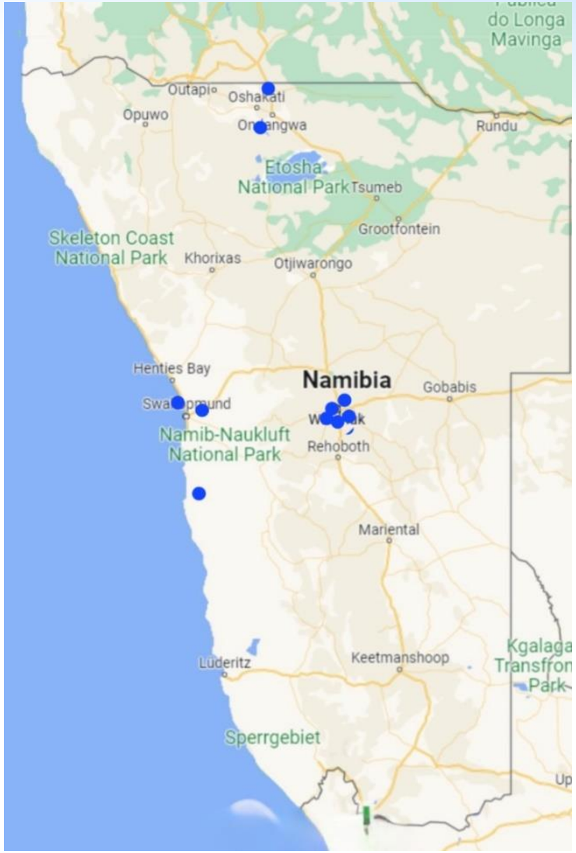
(more countries to be involved in the near future)

19 long term groups fellowship for clinical training on quality assurance, dosimetry, safety, quality management systems, etc

Implementation of the staffing algorithm at a national level in the country of Namibia

Distribution of Hospitals part of the study

	Private	Public	Total
Number of hospitals	10	4	14
Number of CQMP required	4.3	3	7.3



Conclusions

IAEA NAHU activities are focused on all aspects of radiation in medicine to ensure quality and best practices in all radiation medicine applications.

A lot of effort and financial resources are given to Member States to improve their capacities, as well as professionals' knowledge, skills and competences in quality and safety.

The development and improvement of quality and safety in radiological era in various less resourced countries encourages us to strengthen our efforts in the future.

THANK YOU FOR YOUR ATTENTION