

Applications of Radiation Physics in the Medical Industry

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Presenter Bio

1. **B.Sc. Physics, Islamic University of Gaza (2011-2015)**
2. **M.Sc. Physics, Islamic University of Gaza (2015-2017)**
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[Master of Advanced Studies in Medical Physics | ICTP](#)

4. **PhD. Medical Physics, University of Turin, Italy (2020- 2023)**

[Medical Physics: development of tools for radiotherapy](#)

5. **R&D Physicist - Elekta, UK (2023- Till now)**

[Elekta | Radiotherapy Treatment Solutions | Cancer Care](#)



Master of Advanced Studies in Medical Physics
January 2025 - December 2026

The Abdus Salam International Centre for Theoretical Physics (ICTP) and the University of Trieste, Italy, announce the twelfth edition of the Master of Advanced Studies in Medical Physics (MMP), a two-year training programme, under the patronage of the Trieste University Hospital.

The programme will be held from 1 January 2025 until 31 December 2026 leading to an Advanced Studies Master's Degree in Medical Physics. The first year is spent in Trieste while the second year is dedicated to clinical training in a hospital of the training network. Courses are held in English.

The programme is designed to provide young promising M.Sc. graduates in physics or equivalent (mostly from low and medium income countries that are members of the UN, UNESCO or IAEA) with postgraduate training suitable to be recognised as Clinical Medical Physicists in their countries.

The selection of maximum 30 candidates is based on university performance, research and professional activities in the field. A limited number of scholarships will be awarded to successful candidates thanks to the support of the IAEA and ICTP.

The Master's Programme is under re-accreditation by the International Organisation for Medical Physics (IOMP).

Topics:

FIRST YEAR PROGRAMME:
Anatomy, physiology and radiation oncology as applied to medical physics - Radiobiology - Radiation physics - Radiation dosimetry - Physics of nuclear medicine - Medical physics imaging fundamentals - Physics of diagnostic and interventional radiology (X rays, US, MRI, hybrid systems) - Physics of radiation oncology - Radiation protection - Information Technology in medical physics - Monte Carlo simulation - Statistics
IN TOTAL 330 HOURS OF LESSONS AND 230 HOURS OF GUIDED EXERCISES

SECOND YEAR PROGRAMME:
Clinical training in radiotherapy, diagnostic and interventional radiology, nuclear medicine and radiation protection in a Medical Physics department of a hospital of the clinical network.
IN TOTAL 1400 HOURS

How to apply:
Online application
<http://www.ictp.it/programmes/mmp/apply>
Female scientists are encouraged to apply.

Grants:
A limited number of full or partial scholarships will be awarded to successful candidates from developing countries, thanks to the support of the IAEA and ICTP.

Deadline:
15 April 2024

More information can be found at:
<https://d4.unifi.it/en/graduate-schools/advancedstudies/mmp>
Activity e-mail:
mmp@ictp.it

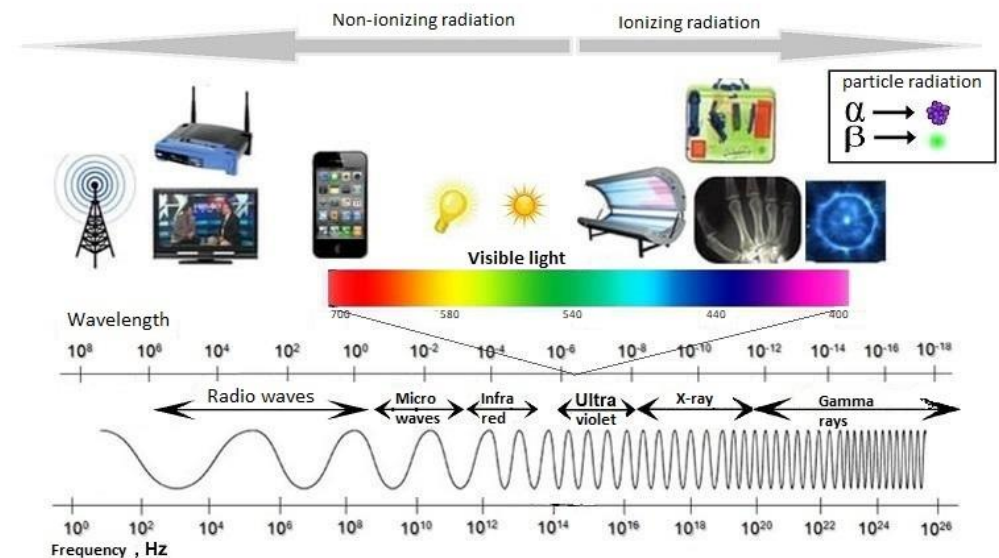


Introduction

- Cancer is uncontrolled cell growth.
- Cancer can start almost anywhere in the human body which is made up of trillions of cells.
- Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020.
- The most common cancers are breast, lung, colon and rectum and prostate cancers.



The electromagnetic spectrum



Many cancers can be cured if detected early and treated effectively.

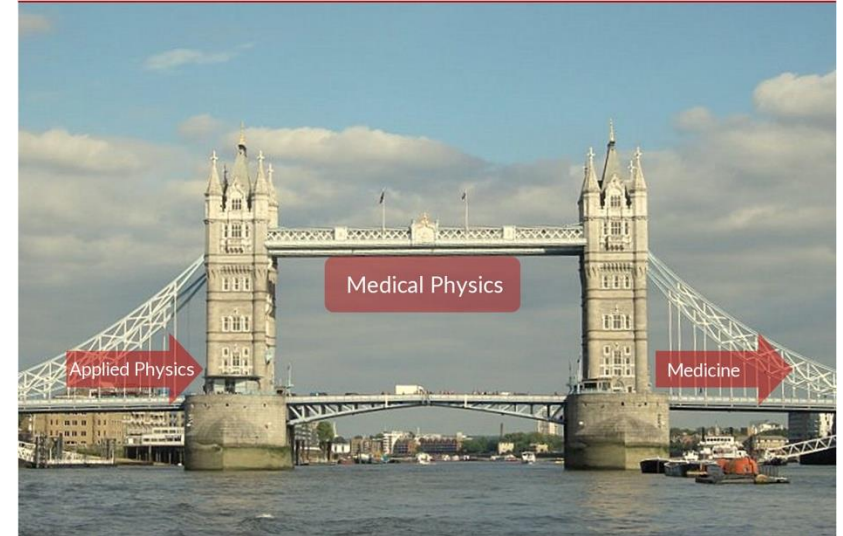
What is Medical Physics?

Medical Physics is a branch of applied physics which employs physical concepts for the prevention, diagnosis and treatment of human disease.

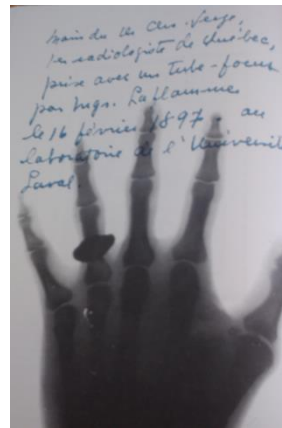
Medical physics is easy to define

Application of radiation physics to medicine

To treat patients in medical field, the technologies are getting complex, therefore someone who can interpret this complexity is needed.



From the early radiographs to the modern medical linear accelerator



What are the types of medical physics?

Medical physicists commonly practice in one of these areas:

- Diagnostic medical physics (Medical Imaging).
- Therapeutic medical physics (Radiotherapy).
- Nuclear medical physics (Nuclear Medicine).
- Medical health physics.



Diagnostic medical physics (Medical Imaging)

Diagnostic Medical Physics



Doctors often need to look inside our bodies without cutting them open....

"Medical Physicists"

are essential in the development of many scanning technologies

Some you may have heard of...

X-rays.....CT scans.....MRI scans,
PET scans.....

And new ones you may not have heard of yet....

X-Rays

- **X-Rays** were discovered in 1895 by **German physicist Wilhelm Conrad Röntgen**. They were called X-Rays because their nature was unknown at the time. He was awarded the Physics Nobel Prize in 1901.

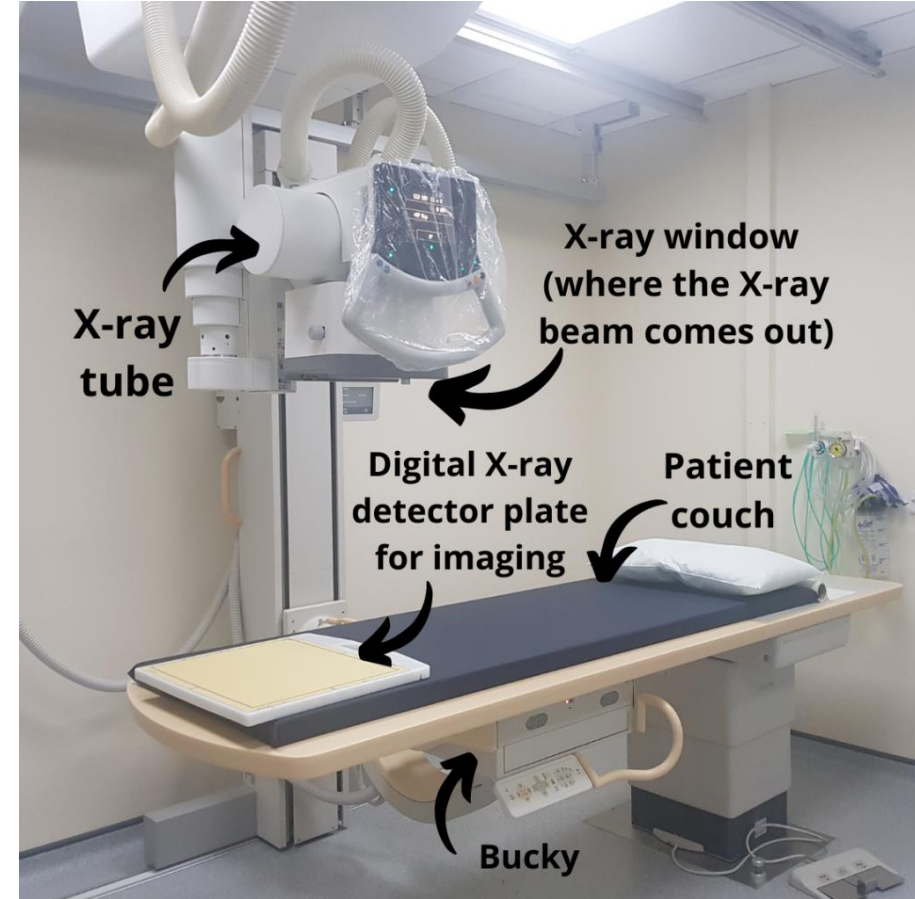


The 1st X-Ray photograph taken was of **Röntgen's** wife's left hand.

Bertha Röntgen's Hand 8 Nov, 1895



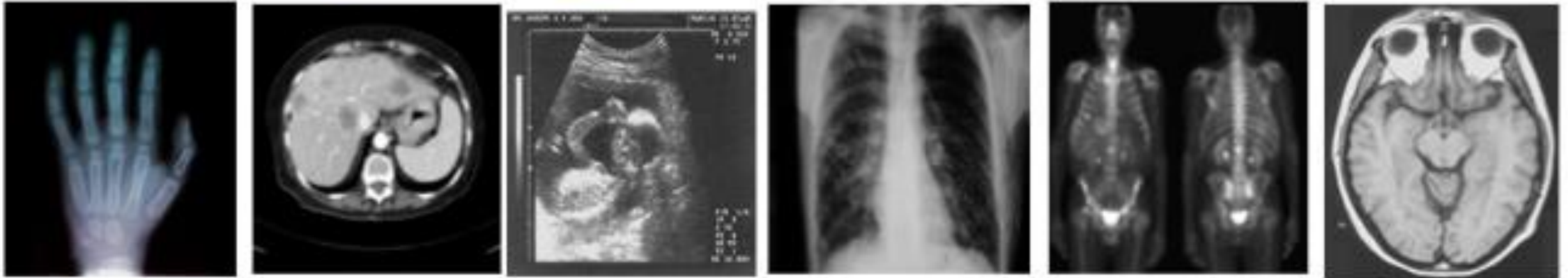
Wilhelm Conrad Röntgen (1845-1923)



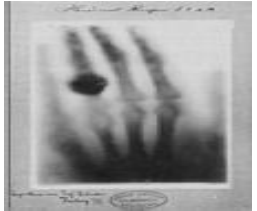
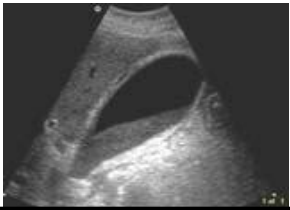

Imaging Modalities



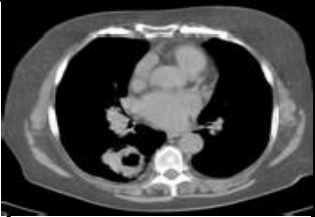

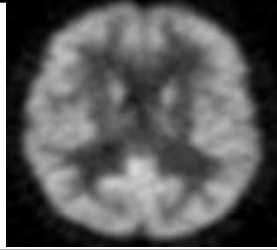
Imaging Modalities



Medical Imaging Techniques

TECHNIQUE		YEAR	ENERGY	PHYSICAL PROPERTY	IMAGING
RADIOLOGY	X RAYS IMAGING	1895	X RAYS	ABSORPTION	
ECHOGRAPHY	ULTRASOUND IMAGING	1950	US	REFLECTION TRANSMISSION	
NUCLEAR MEDICINE	RADIOISOTOPE IMAGING	1950	γ RAYS	RADIATION EMISSION	

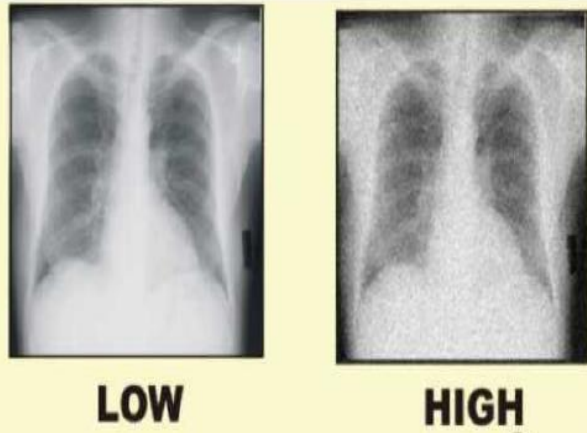
Advanced Medical Imaging Techniques

TECHNIQUE		YEAR	ENERGY	PHYSICAL PROPERTY	IMAGING
X RAYS COMPUTERIZED TOMOGRAPHY	CT	1971	X RAYS	ABSORPTION	
MAGNETIC RESONANCE IMAGING	MRI	1980	RADIO WAVES	MAGNETIC RESONANCE	
POSITRON EMISSION TOMOGRAPHY	PET	1973	γ RAYS	RADIATION EMISSION	

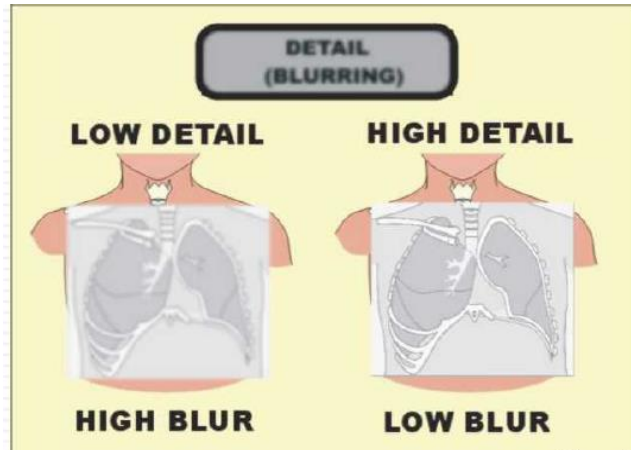
Essential Role of a Medical Physicist

The role of a medical physicist involves quality and safety activities, which include.

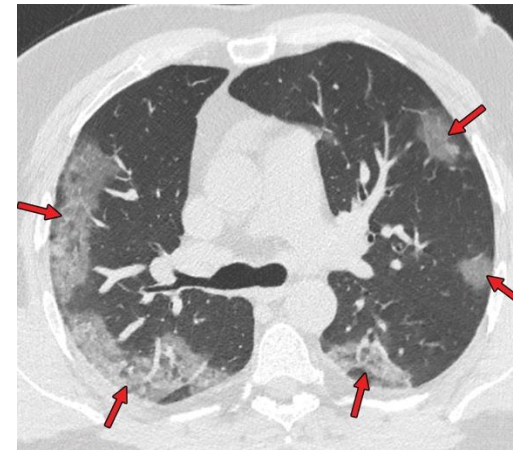
- Perform acceptance testing of imaging equipment
- Conduct periodic evaluations of imaging modalities for regulatory and accreditation compliance
- Provide patient dose estimations



Noise



Spatial Resolution

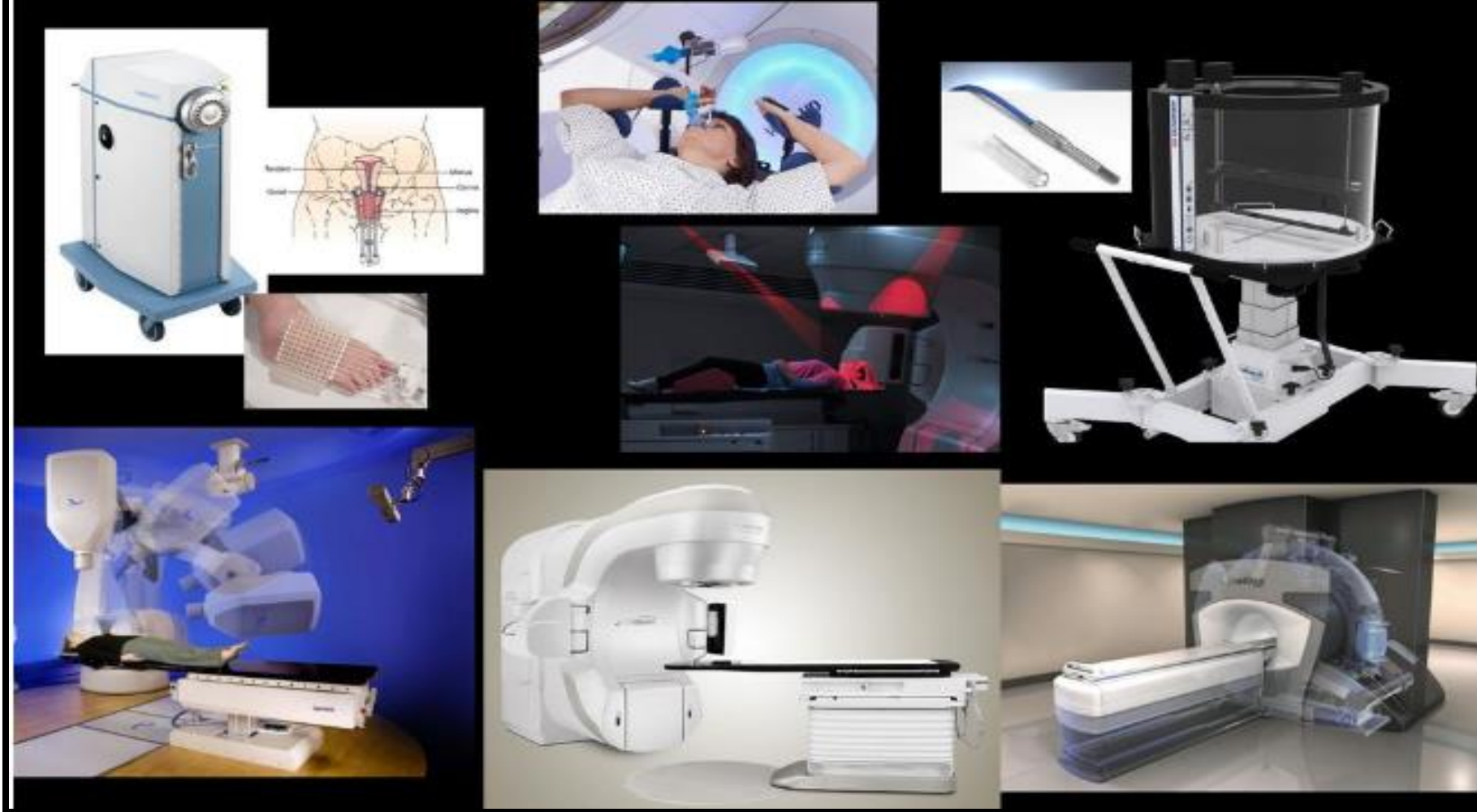


Lung CT-Covid



Therapeutic medical physics (Radiotherapy).

Therapeutic Medical Physics



Radiation therapy

Radiation therapy (also called radiotherapy) is a cancer treatment that uses high doses of radiation to kill cancer cells and shrink tumors with minimum dose to surrounding normal tissues.

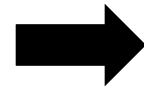


• How Does Radiation Therapy Work?

Physics



Chemistry



Biology

Ionization



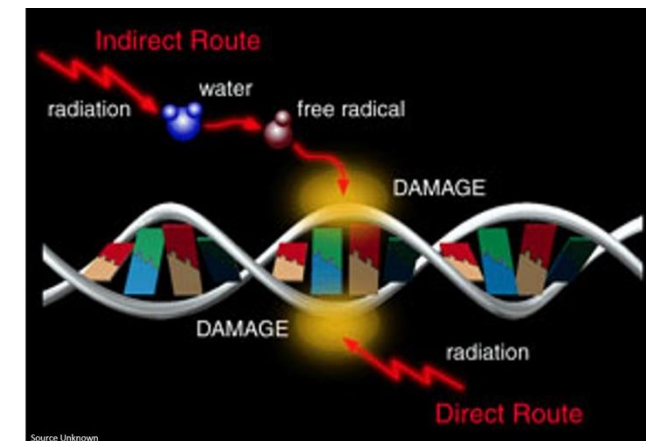
Creation of free radicals
 $H + OH$



Damage to DNA
Simple/double breaks

• Net effect:

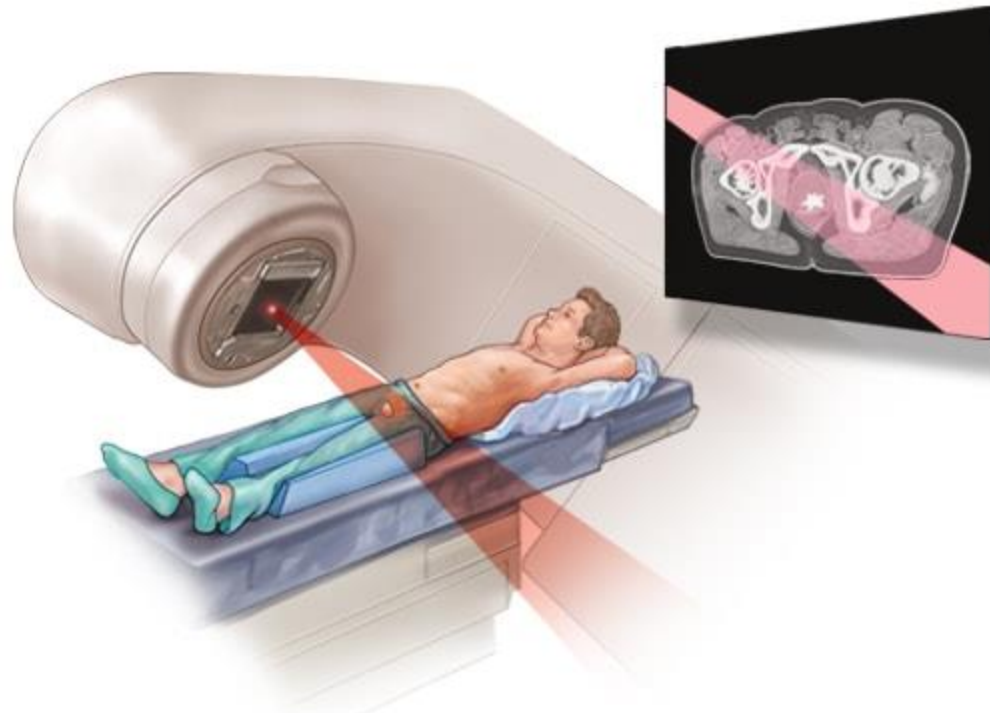
- Prevent tumor from dividing
- Normal cells can be affected by radiation, but they can repair themselves in a way cancer cells cannot.



Brief Types of beams used in radiation therapy

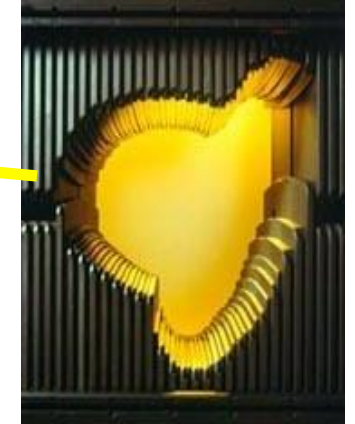
Most common forms of radiation used:

Particle	Energy range	Production
Photons	200 keV – 20 MeV	Linear accelerator
Electrons	6 MeV – 20 MeV	Linear accelerator
Proton	70 MeV – 250 MeV	Cyclotron / Synchrotron



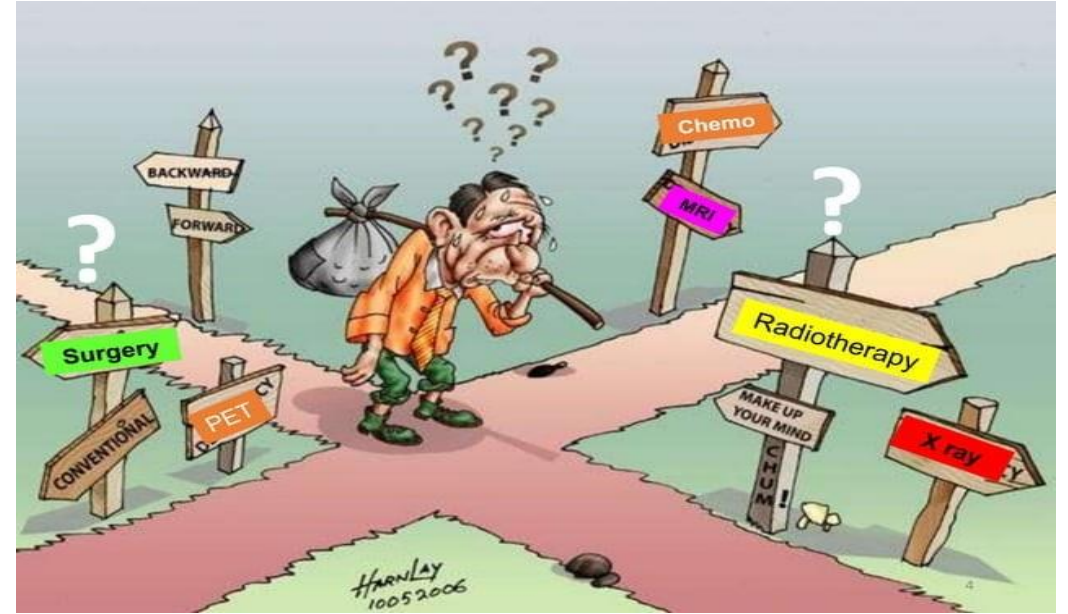
Brief History of Radiation Therapy

- The first patient was treated with radiation therapy in 1896, just two months after the discovery of the X-ray.
- Since the first uses of radiation to treat cancer, important changes have been made in the field and numerous developments have been accomplished.
- Rapid technology advances began in the early 1950s, with the invention of the linear accelerator.
- Planning and treatment delivery advances have enabled radiation therapy to be more effective and precise, while decreasing the severity of side effects.



When is radiation used?

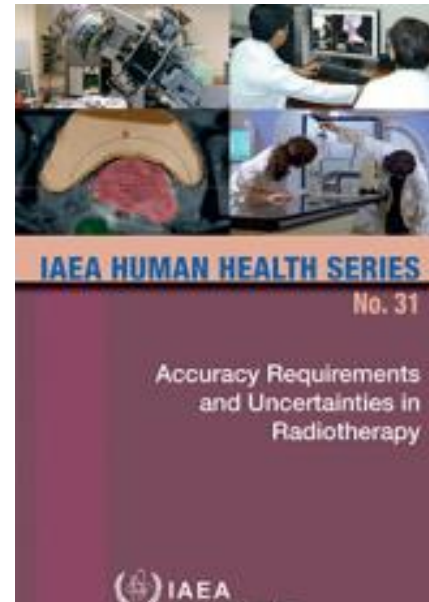
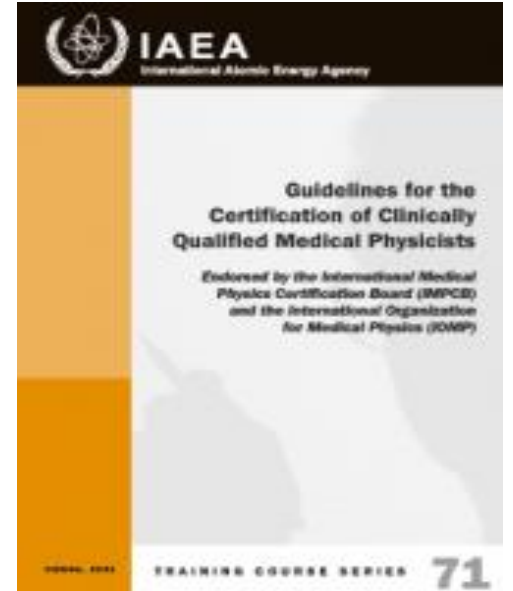
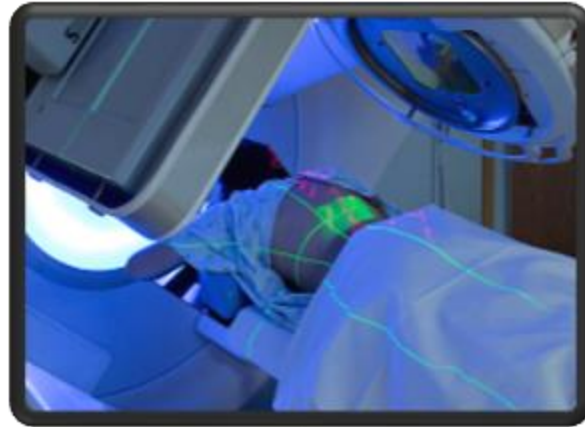
- The best treatment plan for each patient is frequently determined by a team of doctors, including Medical Physicists, a medical oncologist and a surgeon.
- Sometimes radiation therapy is the only treatment a patient needs.
- Other times, it is combined with other treatments, such as surgery and chemotherapy.



Tumor boards meet to discuss comprehensive patient treatment plans

Is Radiation Therapy Safe?

- New advances in technology and treatment delivery continue to make radiation safe and effective.
- A team of medical professionals develop and review the treatment plan for each patient to minimize side effects and assure that the area where the cancer is located is receiving the dose of radiation needed.
- The treatment plan and equipment are constantly reviewed to ensure the proper treatment is being given.



Radiotherapy Workflow



Simulation

Registration

Contouring

Dose planning

Treatment

Follow-up

MR /CT
imaging in
the treatment
position

Registration
of MR and CT
datasets

Contouring
target and
organs at risk

Dose calculation
aiming high dose
on target, while
sparing critical
structures

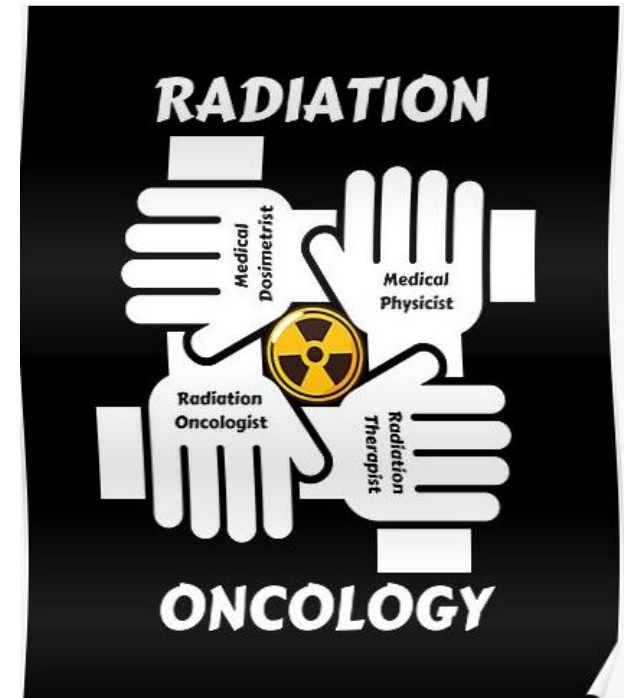
Radiation
therapy delivery
in multiple
fractions

Follow-up
and response
assessment

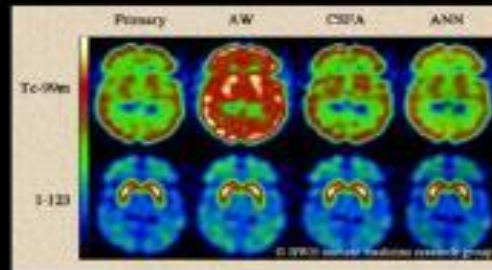
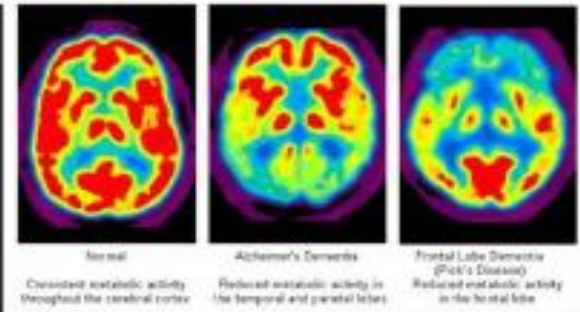
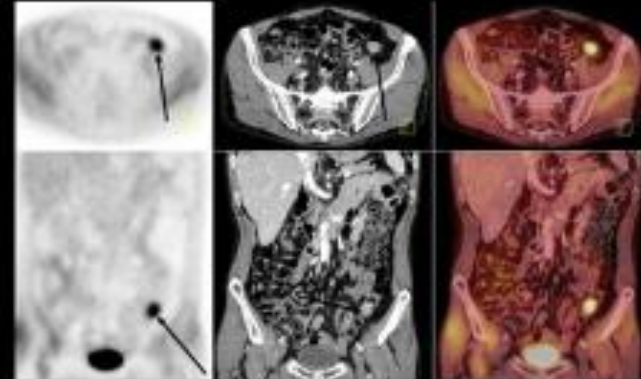
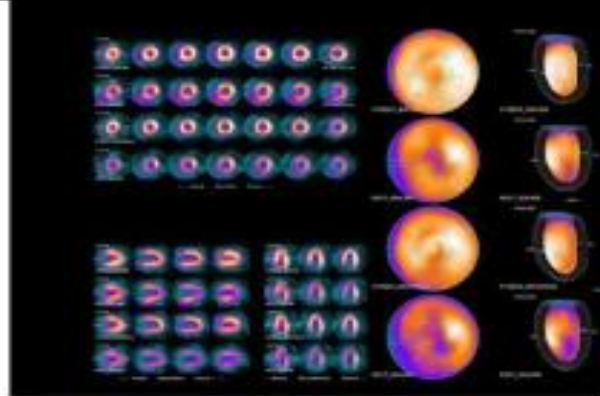
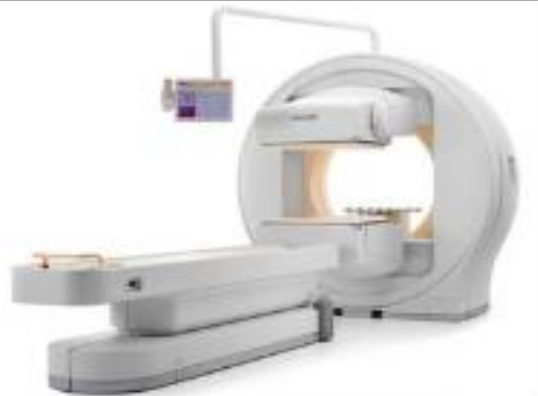
What do a medical physicist do?

Medical physicist responsible for the precision and accuracy of treatments by using advanced computer calculations to develop individual patient treatment plans.

- Radiation beam calibration and characterization
- Image quality assessment.
- Consultation and treatment planning with practitioners to determine dose to be delivered.
- Validate the radiation delivery plans of (nearly) every patient Acceptance testing and commissioning.
- Radiation shielding design.
- ... and much more.

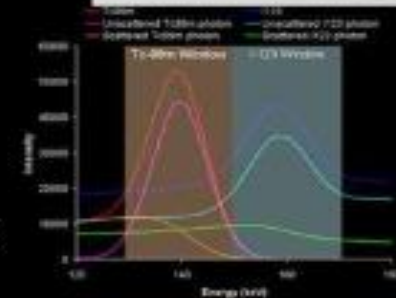


Nuclear Medical Physics



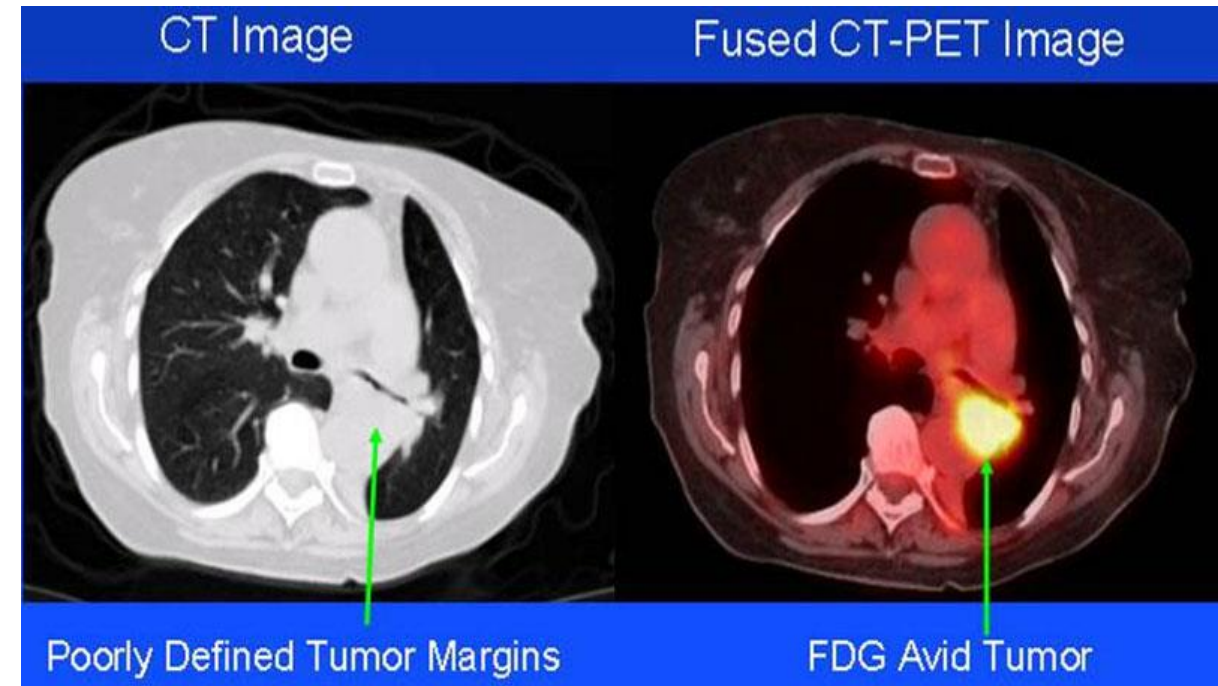
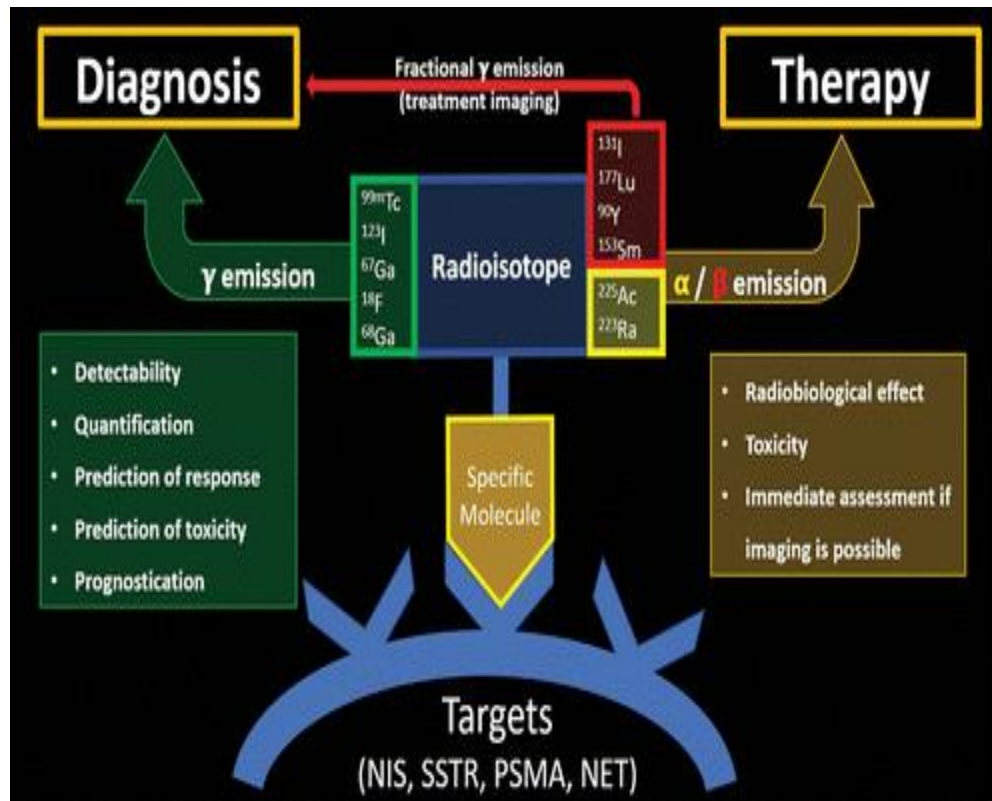
Brain perfusion

neurotransmission



Nuclear medicine

Nuclear medicine uses radioactive materials and their emitted radiation from the body to diagnose and treat disease.



Functions in Medical Physics

❑ Clinical Medical Physics

- ✓ Dosimetry, radiation safety, quality assurance, etc.

❑ Research and Development

- ✓ Develop new therapeutic equipment or procedures, Software, AI, etc.

❑ Education

- ✓ University and Academic Teaching
- ✓ Training of medical physicists, physicians, technologists, radiation therapists, etc.



Some Opportunities

1. [American Association of Physicists in Medicine – AAPM](#)
2. [CAMPEP Accredited Residency Programs in Medical Physics](#)
3. [Jobs and Career - German Cancer Research Center \(dkfz.de\)](#)
4. [Master of Advanced Studies in Medical Physics | ICTP](#)
5. [Dipartimento di Fisica - Università degli Studi di Torino \(unito.it\)](#)
6. [Home - impcb \(International Medical Physics Certification Board\)](#)
7. [EFOMP: European Federation of Organisations for Medical Physics](#)

