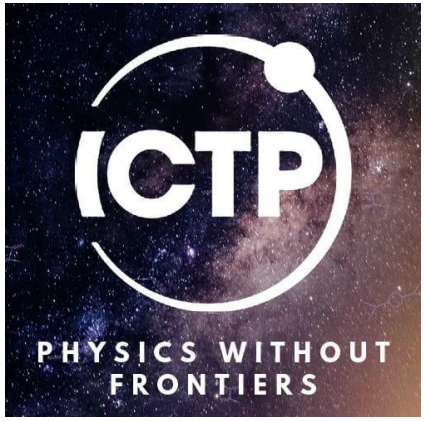


Applications of Radiation Physics in the Medical Industry

Mohammed Abujami

R&D Physicist - Elekta, UK

11th September 2024

Presenter Bio

1. **B.Sc. Physics, Islamic University of Gaza (2011-2015)**
2. **M.Sc. Physics, Islamic University of Gaza (2015-2017)**
3. **Master of Advanced Studies in Medical Physics , ICTP-Italy (2019-2020)**

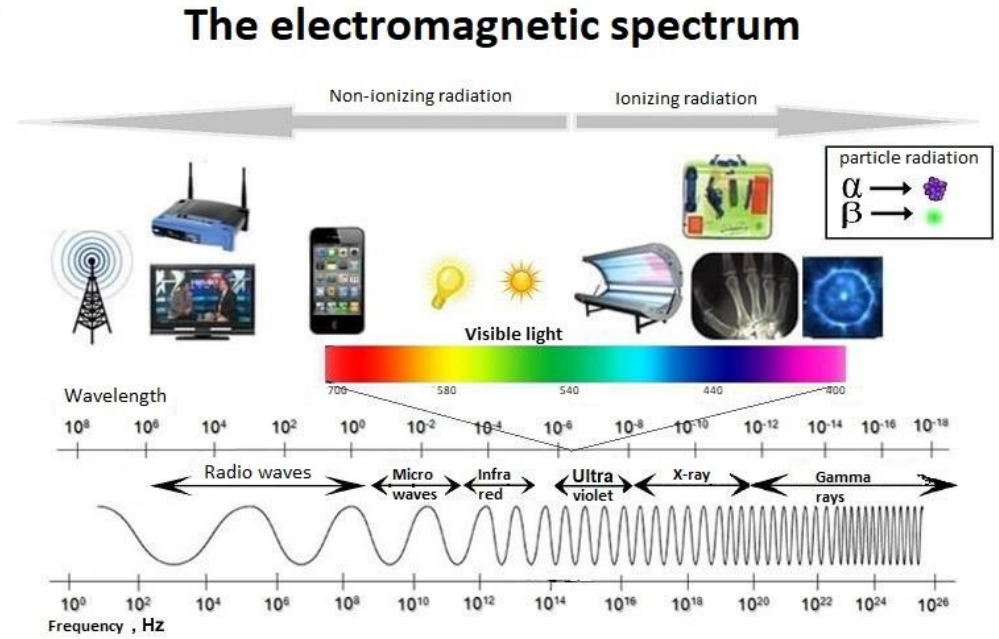
   Master of Advanced Studies in Medical Physics | ICTP
4. **PhD. Medical Physics, University of Turin, Italy (2020- 2023)**

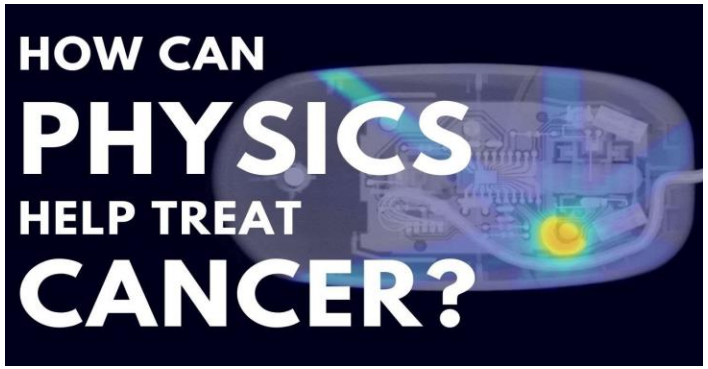
   Medical Physics: development of tools for radiotherapy
5. **R&D Physicist - Elekta, UK (2023- Till now)**

   Elekta | Radiotherapy Treatment Solutions | Cancer Care

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.





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

What is Medical Physics?

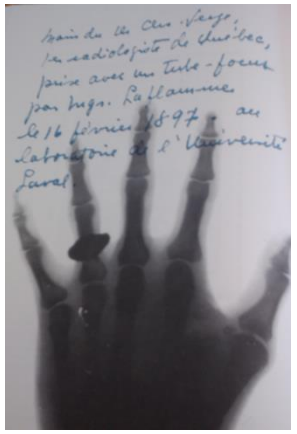
Medical Physics is a branch of applied physics which employs physical concepts for the prevention, diagnosis and treatment of human disease.

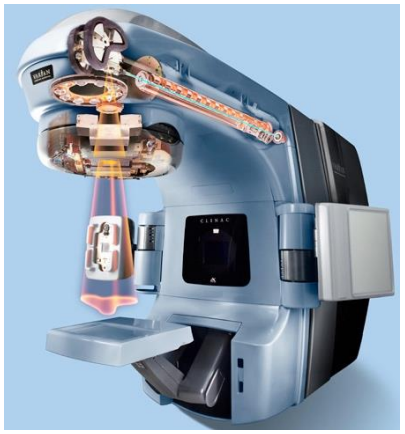
Medical physics is easy to define

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)

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....

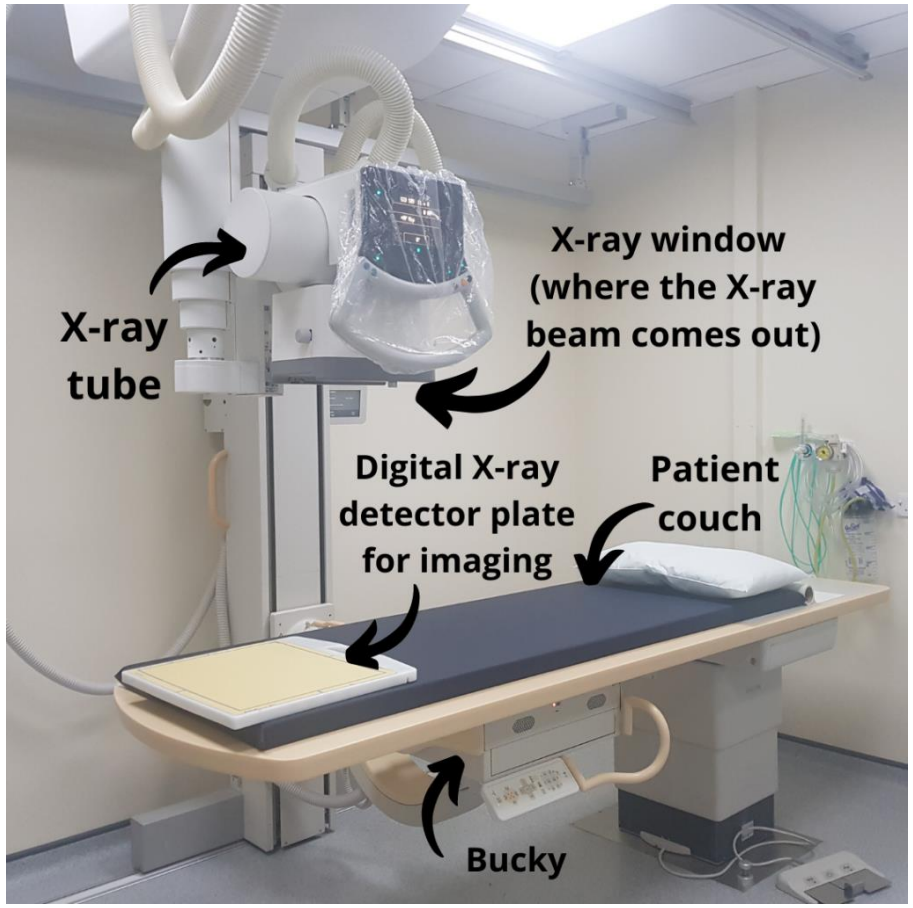
X-Rays

- **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.

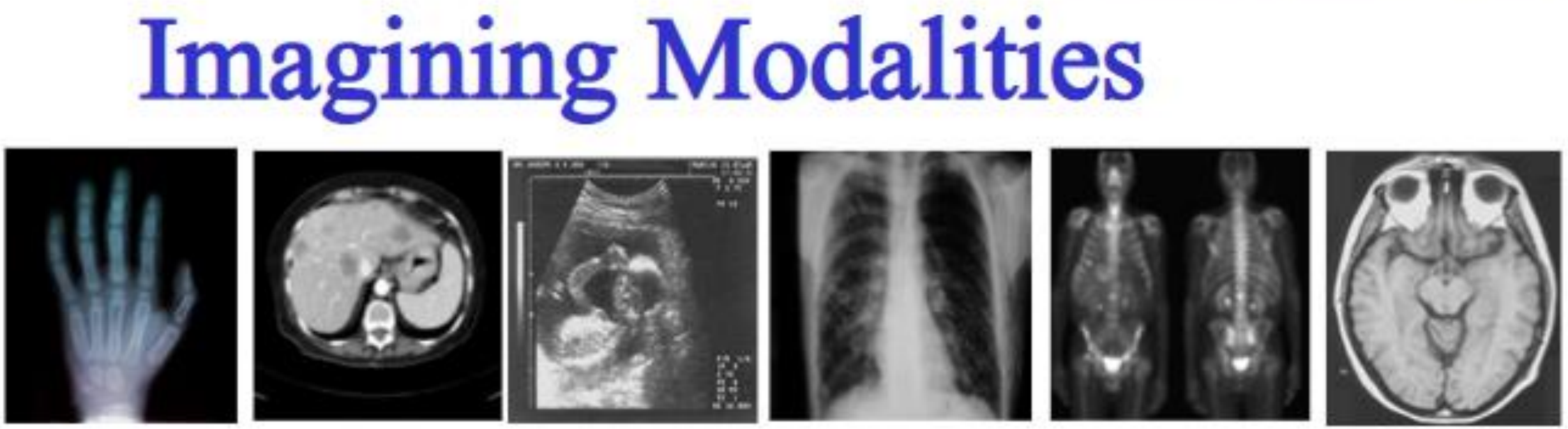
The 1st X-Ray photograph taken was of **Röntgen's** wife's left hand.

Bertha Röntgen's Hand 8 Nov, 1895

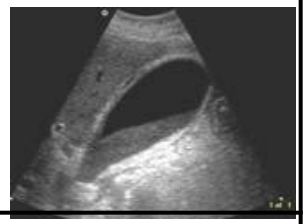
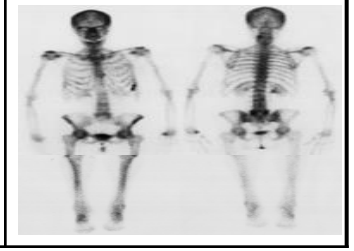
Wilhelm Conrad Röntgen (1845-1923)



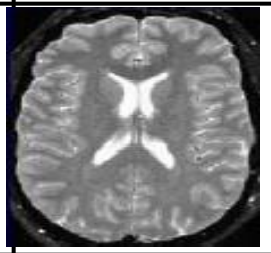
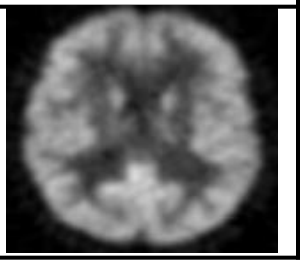
Imaging Modalities



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**	

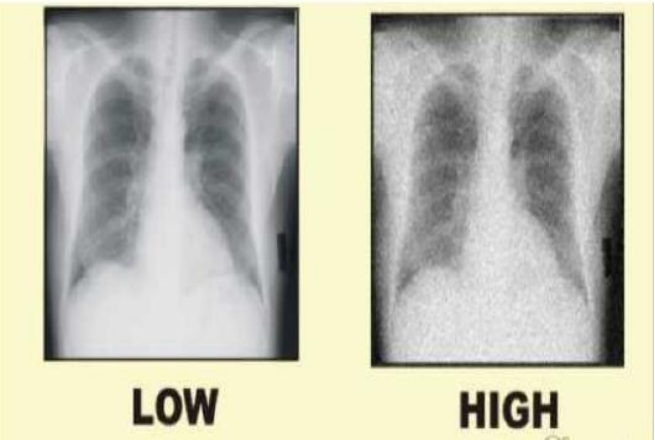
Advanced Medical Imaging Techniques

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**	

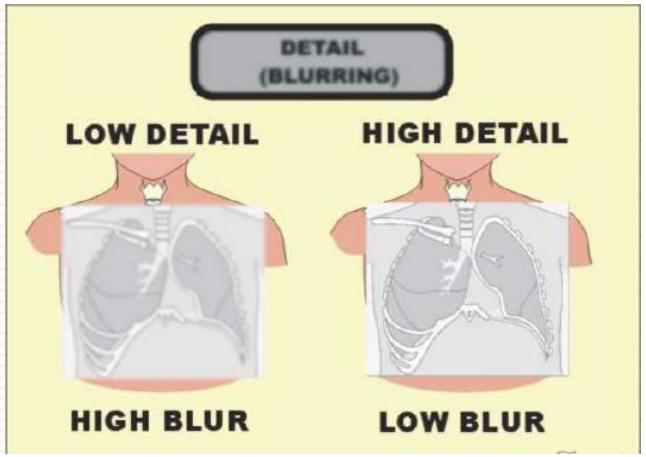
Essential Role of a Medical Physicist

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

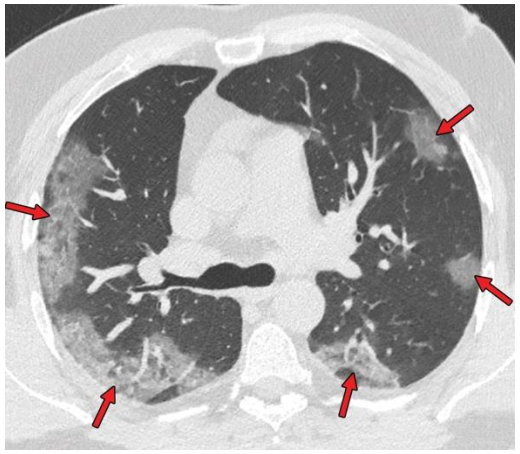
- **Perform acceptance testing of imaging equipment**
- **Conduct periodic evaluations of imaging modalities for regulatory and accreditation compliance**
- **Provide patient dose estimations**



Noise

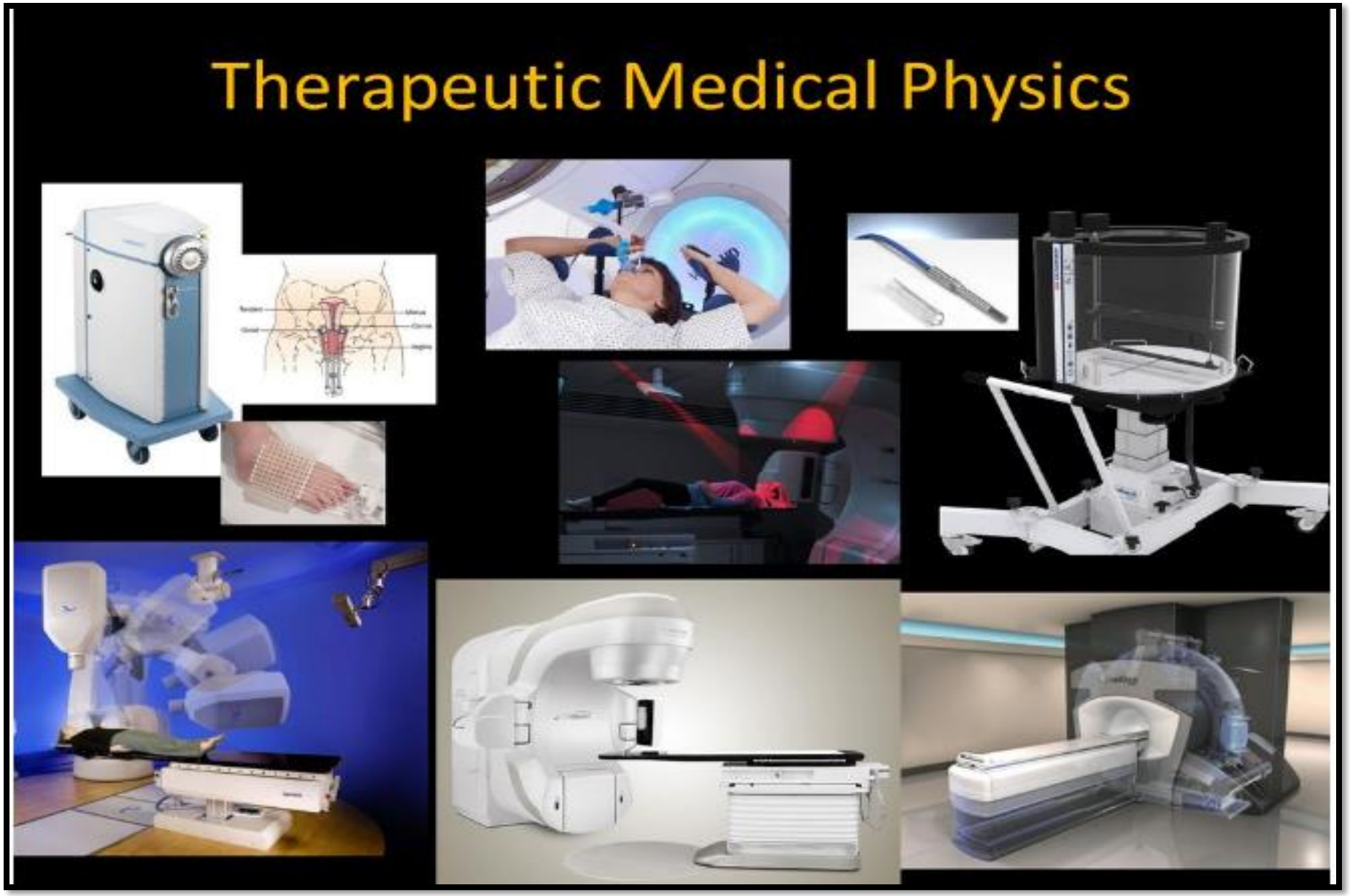


Spatial Resolution



Lung CT-Covid

Therapeutic medical physics (Radiotherapy).



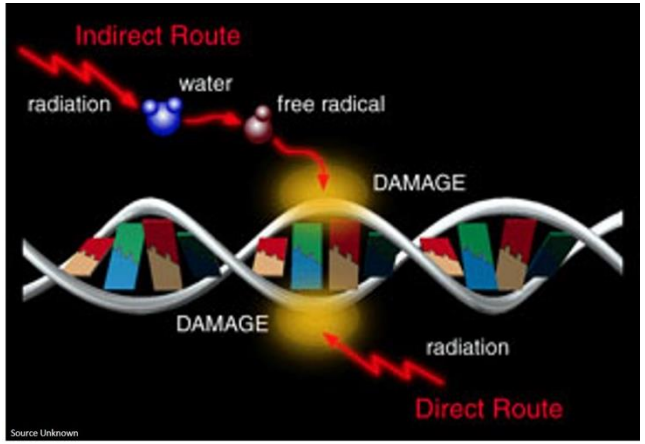
Radiation therapy

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

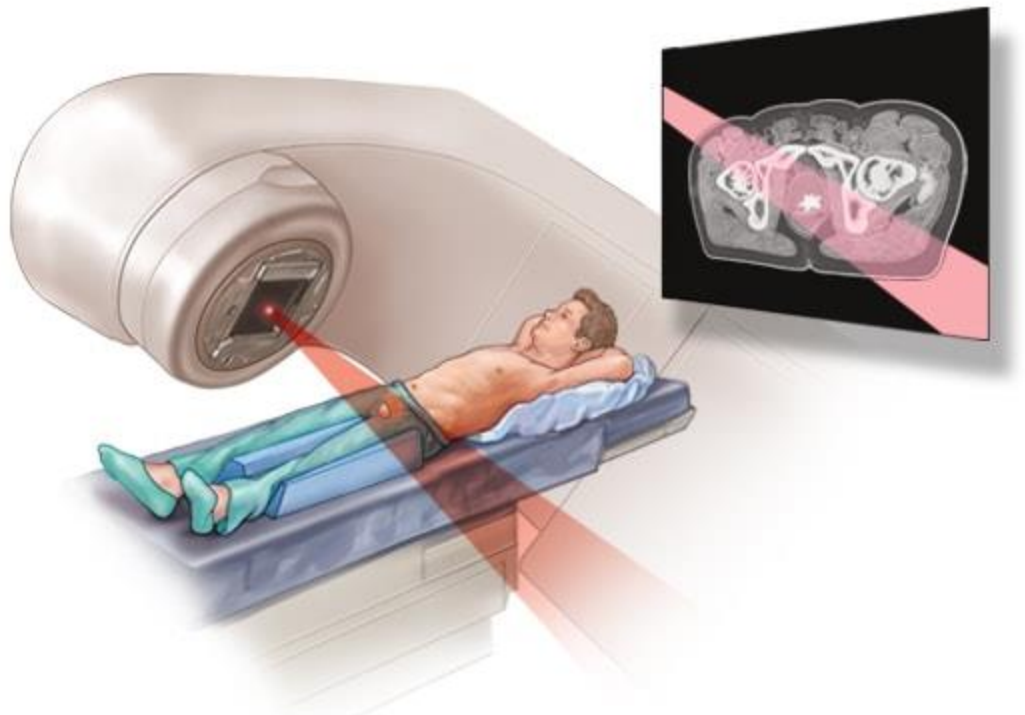


- Net effect:
  - Prevent tumor from dividing
  - Normal cells can be affected by radiation, but they can repair themselves in a way cancer cells cannot.

Brief Types of beams used in radiation therapy

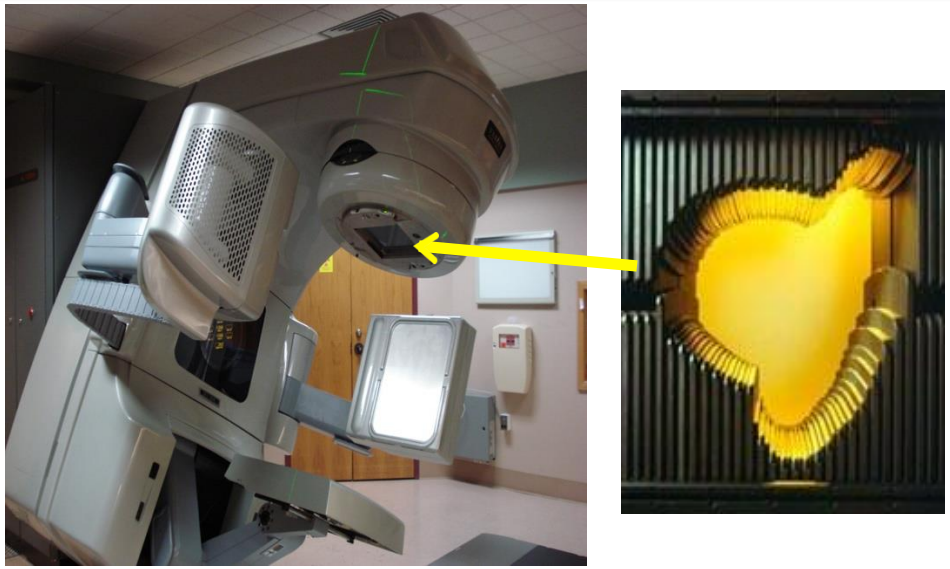
Most common forms of radiation used:

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.

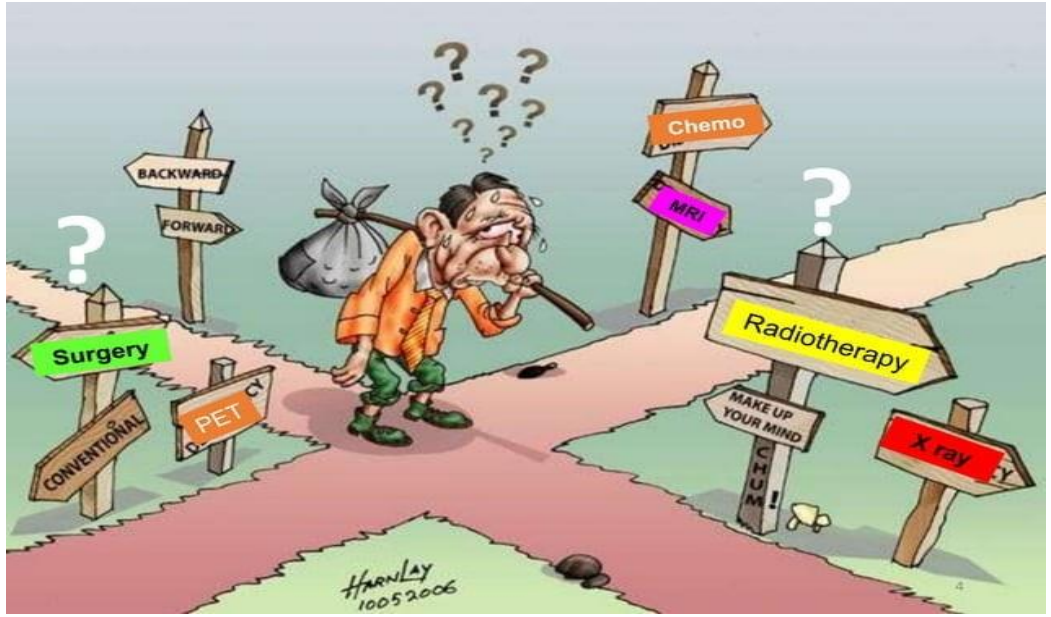


When is radiation used?

- 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.

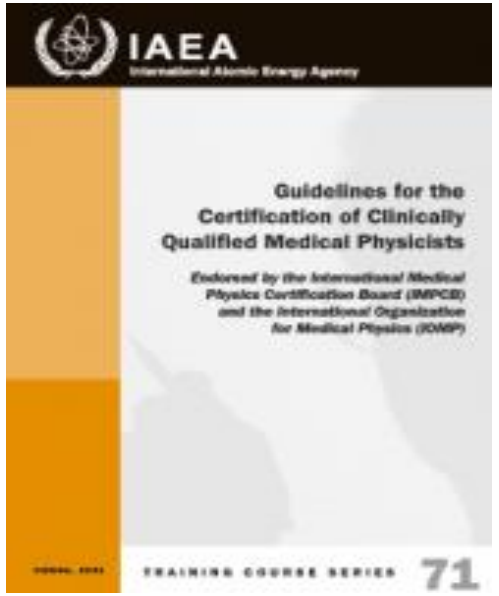
- Other times, it is combined with other treatments, such as surgery and chemotherapy.

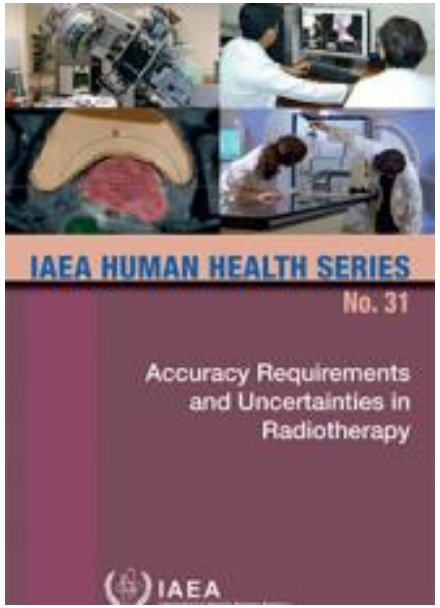


Tumor boards meet to discuss comprehensive patient treatment plans

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.





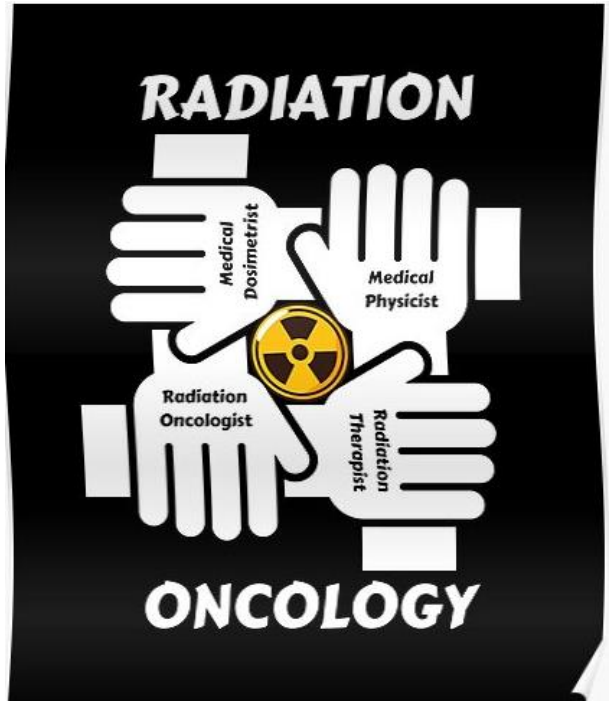
Radiotherapy Workflow

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

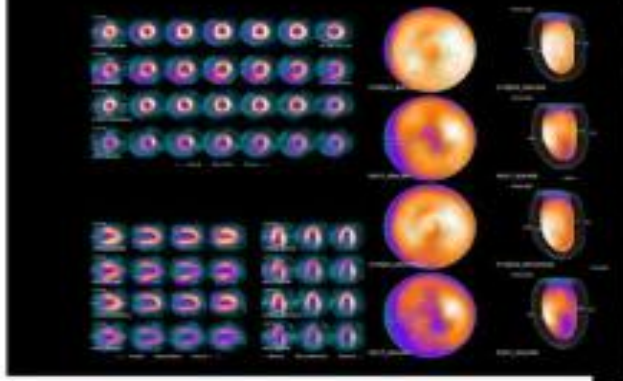
What do a medical physicist do?

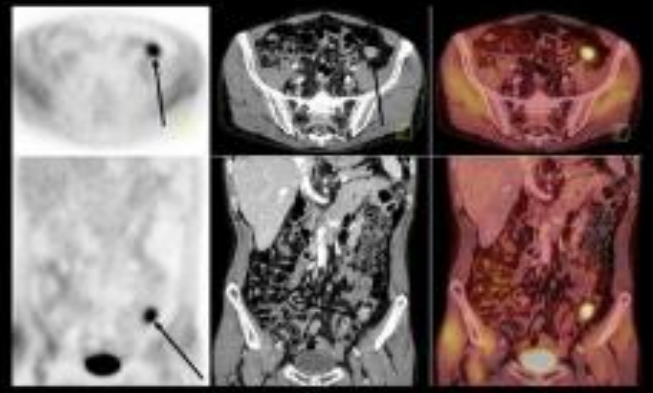
Medical physicist responsible for **the precision and accuracy of treatments by using advanced computer calculations to develop individual patient treatment plans.**

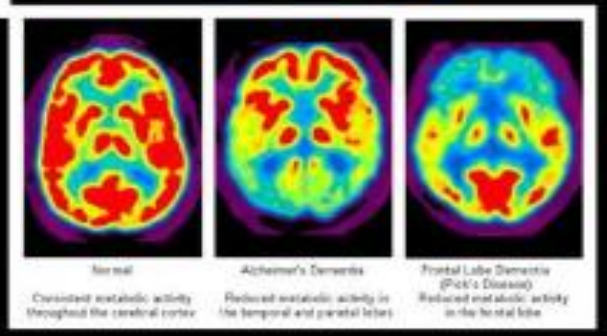
- Radiation beam calibration and characterization
- Image quality assessment.
- Consultation and treatment planning with practitioners to determine dose to be delivered.
- Validate the radiation delivery plans of (nearly) every patient Acceptance testing and commissioning.
- Radiation shielding design.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

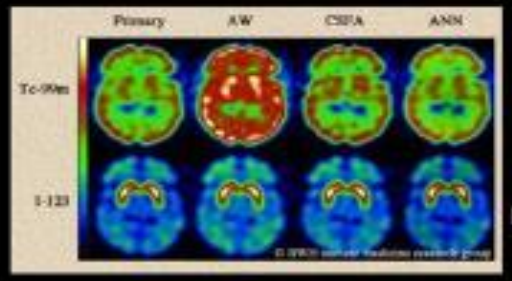


Nuclear Medical Physics



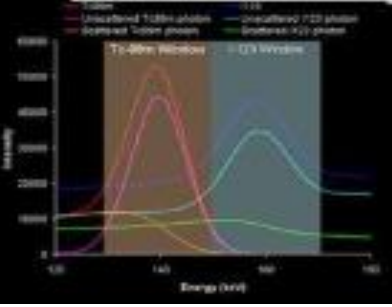






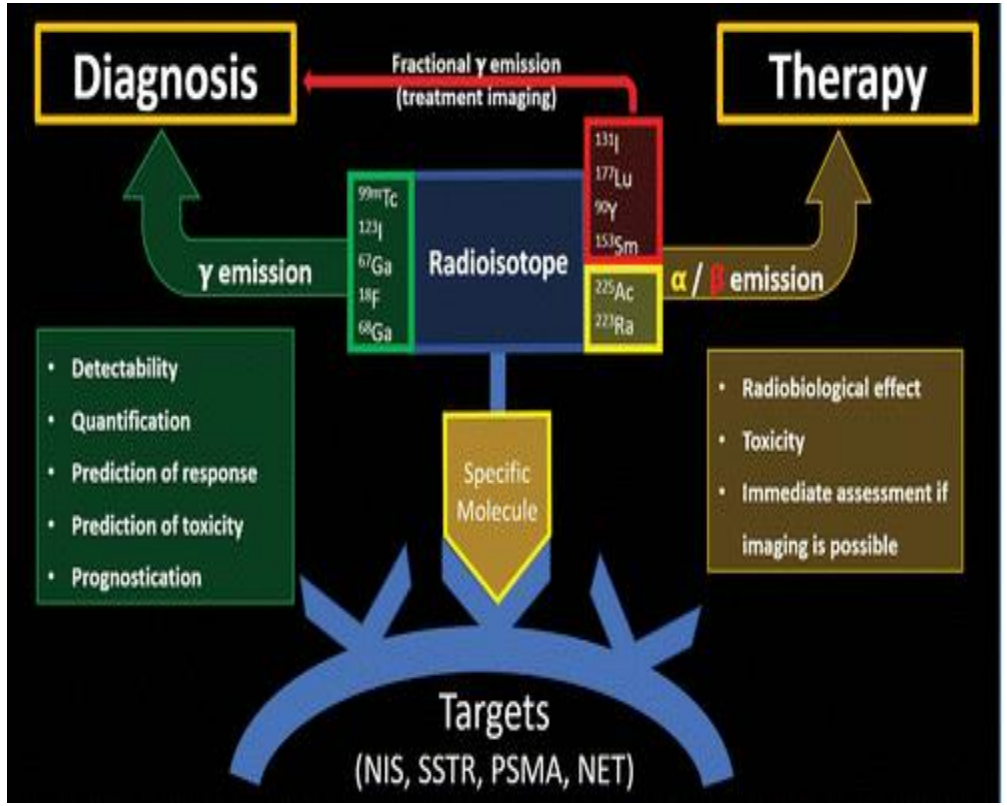
Brain perfusion

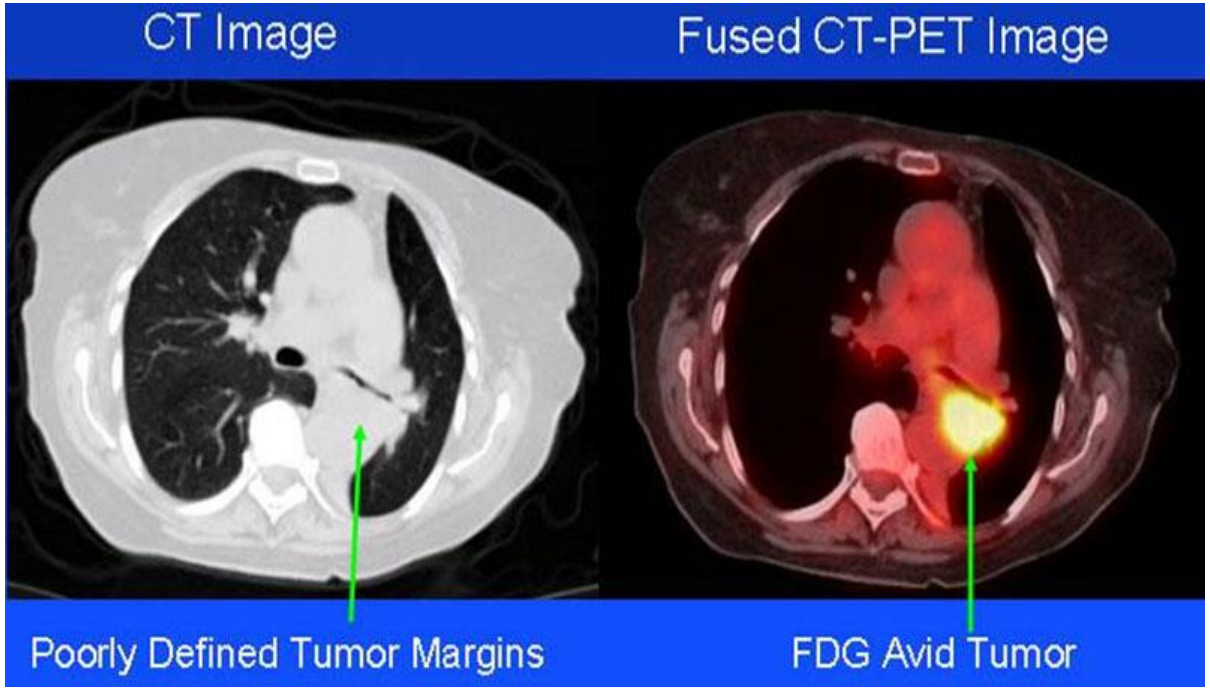
neurotransmission



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.

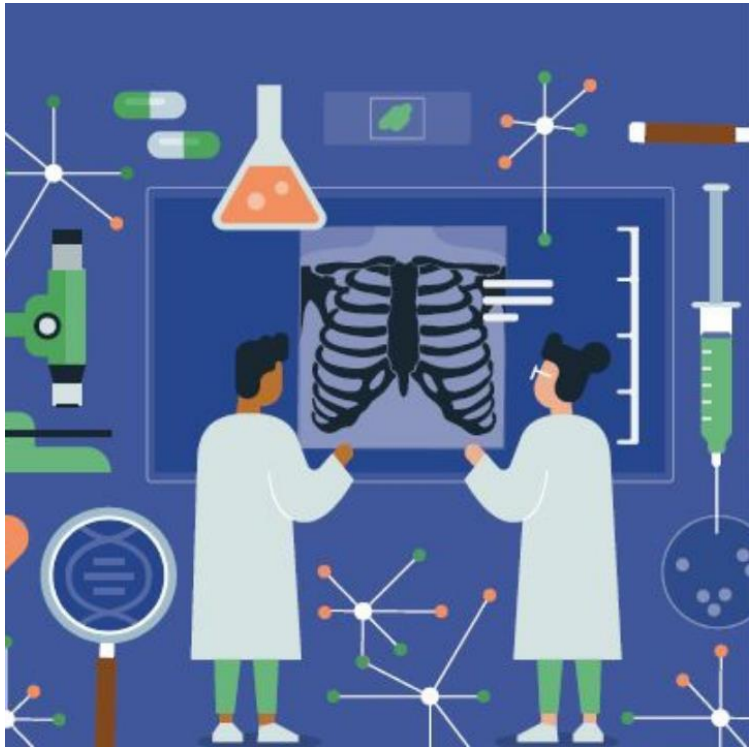
❑ Research and Development

✓ 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


THANK
YOU!


Any
Questions