

Introduction to Medical Physics: Subfields, Applications, and Career Opportunities in Afghanistan and Internationally

Presented by:
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For:
Afghan Students of PWF, ICTP

Introduce

Greetings and respect to all professors, organizers, and students. I am very happy to be here with you today to talk about a field that has shaped both my academic and professional life — a field that I believe builds a **bridge between science and humanity: Medical Physics**.

My name is **Dr. Mohammad Yasin Mohammadi**. I am a **medical physicist in radiation therapy**, originally from Afghanistan and currently living in Iran. I completed my **PhD in Medical Physics (Radiotherapy)** at Mashhad University of Medical Sciences. In this talk, I hope to give you a **clear and inspiring picture** of this field — its **subfields, applications, challenges, and future**, especially in the context of **Afghanistan**.

I would also like to thank **PWF** for organizing this program and for giving me the **opportunity to speak** today. It is truly an honor. Since the participants in this event are **Afghan students**, and to make the content easier to understand, I will present my talk in **Dari**.

What is Medical Physics?



Medical Physics according to the AAPM definition

- ❑ Medical physics is a branch of applied physics that utilizes physical principles, methods, and techniques for the prevention, diagnosis, and treatment of diseases, with the ultimate goal of enhancing human health and well-being.
- ❑ Today, if cancer is more treatable than in the past, if devices such as MRI, CT, PET-CT, and linear accelerators (LINACs) play a vital role in medicine, and if highly precise targeted therapies are possible, a significant part of these advancements is owed to medical physics.

A Brief History of Medical Physics

- ❑ The story of medical physics began with the discovery of **X-rays** by **Röntgen** in 1895.
- ❑ Since then, each decade has witnessed remarkable advances:
 - ❖ from radiotherapy with **cobalt-60** to today's sophisticated techniques such as **IMRT** and **IGRT**;
 - ❖ from two-dimensional radiographic imaging to **CT, MRI, SPECT, PET**, and molecular imaging.
- ❑ Prominent scientists, such as **Marie Curie**, have played pivotal roles in shaping this field.
- ❑ Today's medical physics is the result of a century of interaction among **physics, medicine, biology, and technology**.

Major Subfields of Medical Physics

- 1) Radiation Therapy:** The use of ionizing radiation for cancer treatment.
- 2) Medical Imaging:** Processing and enhancement of medical images (CT, MRI) for disease diagnosis.
- 3) Nuclear Medicine:** The use of radiopharmaceuticals for diagnosis (gamma cameras, SPECT) and therapy.
- 4) Radiobiology and Radiation Protection:** Studying the effects of ionizing radiation on tissues, cells, and DNA.
- 5) Non-ionizing Radiation in Medical Diagnosis and Treatment:** Applications of lasers, microwaves, and light-based therapies in medicine, including photodynamic therapy and nanoparticle-based diagnostics.

The Role of a Medical Physicist

IOMP Policy Statement No. 1

Safety

Clinical

Teaching

Research and Development

Management and Planning

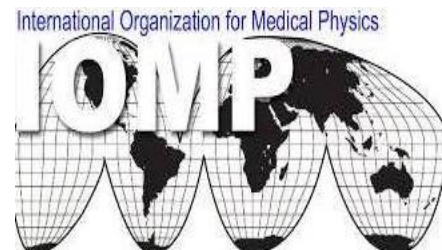
The Role of a Medical Physicist in Clinical Centers

IOMP Policy Statement No. 1

- 1) Treatment Planning**
- 2) Quality Assurance of Treatment**
- 3) Dosimetry**
- 4) Periodic Quality Control and Equipment Calibration**
- 5) Radiation Protection, Shielding, and Safety Assurance for Patients and Staff**



Medical Physics Organizations and Federations



فدراسیون خاورمیانه سازمان های
فیزیک پزشکی



فدراسیون آسیای جنوب شرقی سازمان های
فیزیک پزشکی



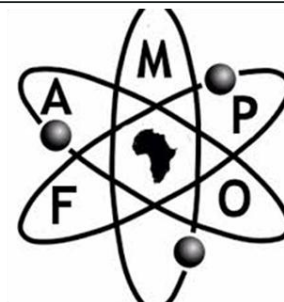
فدراسیون آسیا-اقیانوسیه سازمان های
فیزیک پزشکی



فدراسیون اروپایی سازمان های
فیزیک پزشکی



انجمن آمریکای مرکزی سازمان های
فیزیک پزشکی



فدراسیون آفریقایی سازمان های
فیزیک پزشکی



AMERICAN SOCIETY FOR RADIATION ONCOLOGY

Leading Medical Physics Departments



1. Harvard University

- ☐ Image-guided Radiation Therapy (IGRT)
- ☐ Biophysics
- ☐ Nanotechnology



2. Stanford University

- ☐ Molecular Imaging
- ☐ Photodynamic Diagnosis
- ☐ Microfluidics
- ☐ Radiobiology



3. University of Toronto

- ☐ Image-Guided Therapy
- ☐ Cancer Diagnosis and Therapy

Medical Physics in Afghanistan

- ❑ Medical physics is still in its **early stages**.
- ❑ There is a limited number of specialists and a **shortage** of formal educational programs.
- However, this challenge presents a **historic opportunity**:
 - ❑ A real **need** for specialists within the healthcare system.
 - ❑ The **possibility** to develop **cancer** treatment centers.
 - ❑ The high **potential** of Afghan students to take a leading role.
 - ❑ Opportunities for **collaboration** with international organizations such as **ICTP and IAEA** (Afghanistan being a **member**).
- ✓ The young generation of Afghanistan, **through education and research**, can build a bright future for this field.

Academic Pathways and International Opportunities

- ❑ Graduates of **physics and radiology** can continue their path in a **Master's program in Medical Physics** in countries such as Iran, India, Turkey, and others.
- ❑ Strengthening **English** language proficiency and **computer** skills is essential.
- ❑ Learning software such as **MATLAB**, programming languages like **Python**, and **artificial intelligence** is highly recommended.
- ❑ **Participation** in international courses and **workshops**, such as those offered by **ICTP**, is also encouraged.

Closing Message

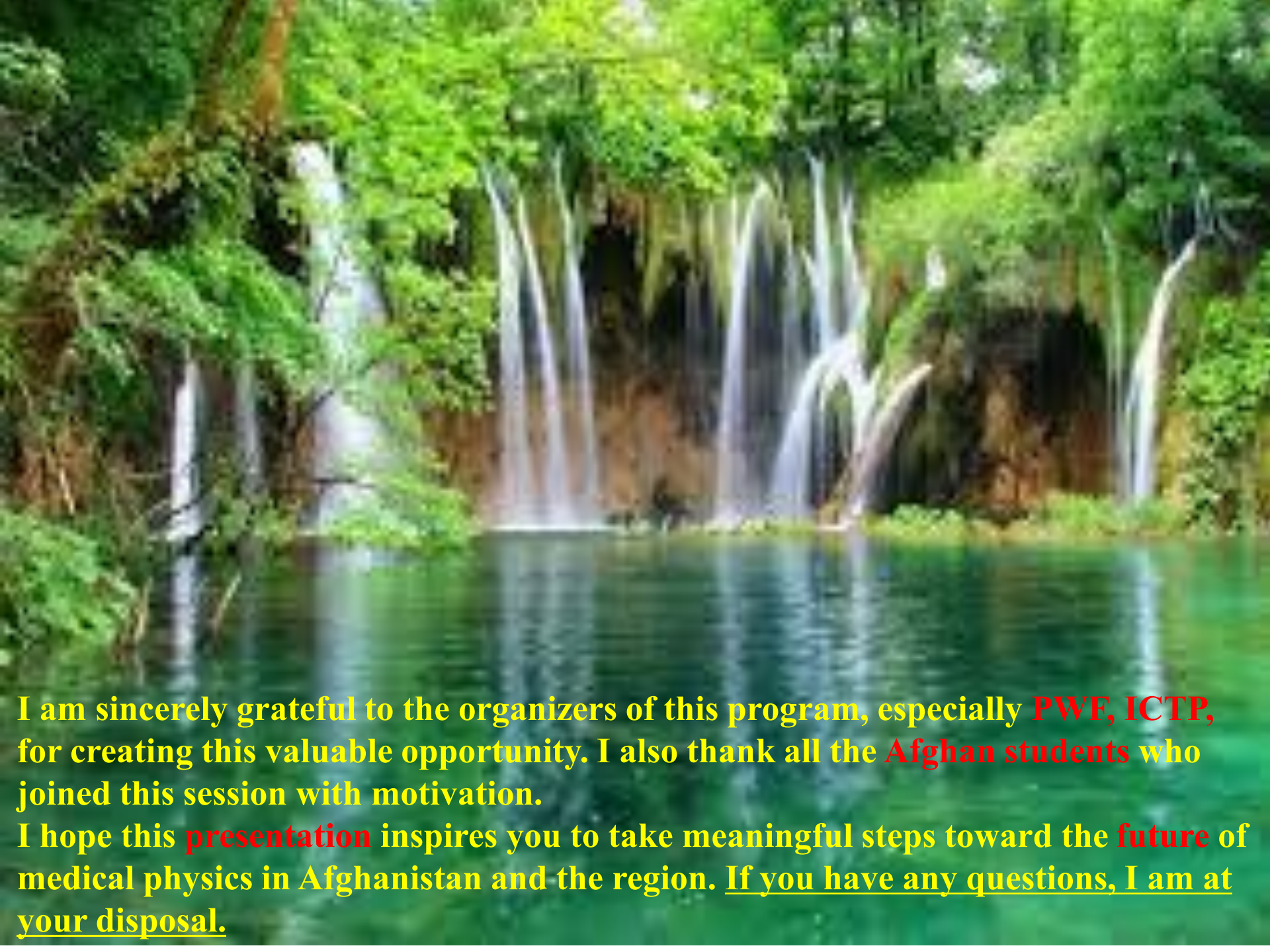
❑ For me, medical physics is not merely an **academic discipline**; it is a **human responsibility**.

Science is truly **valuable** when it can **improve human lives**.

Medical physics serves as a **bridge** between knowledge, technology, and saving lives.

❑ I tell Afghan students: resources may be **limited**, but your determination and big **dreams** will shape the future of this field. I have walked this **path** with both challenges and hope, and I firmly believe that the future of medical physics in Afghanistan will flourish through **your hands**.

❑ The future of this field in Afghanistan depends on nurturing specialized **professionals**, establishing **proper** healthcare infrastructure, and expanding **international** scientific collaborations.



I am sincerely grateful to the organizers of this program, especially PWF, ICTP, for creating this valuable opportunity. I also thank all the Afghan students who joined this session with motivation.

I hope this presentation inspires you to take meaningful steps toward the future of medical physics in Afghanistan and the region. If you have any questions, I am at your disposal.