A Master of Advanced Studies in Medical Physics: a Joint Action of ICTP and Trieste University

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The ICTP

The **Abdus Salam ICTP** is an international organization, belonging to the UN system, through UNESCO and IAEA. Founded in 1964 by the initiative of the Nobel laureate Abdus Salam.

Its mandate it to foster the advancement of physics, better natural sciences, in the developing countries.
The ICTP

In fact its programme covers many areas, both of fundamental and applied physical and mathematical sciences.

The ICTP is at the same time a research institution:

- High energy physics
- Condensed matter
- Earth physics
- Mathematics

And an institution for high level training

Among the subjects covered in high level training, an important role is taken by medical physics
The College on Medical Physics

Since 1982 the College on Medical Physics, a biennial event, has educated over 1000 medical physicists from 90+ countries with low and middle income.
MPs to support development in Digital Medical Imaging

<table>
<thead>
<tr>
<th>Year</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>PET/MR</td>
</tr>
<tr>
<td>2007</td>
<td>Digital tomosynthesis</td>
</tr>
<tr>
<td>2002</td>
<td>3T MRI</td>
</tr>
<tr>
<td>2001</td>
<td>PET/CT</td>
</tr>
<tr>
<td>2000</td>
<td>SPECT/CT</td>
</tr>
<tr>
<td>1999</td>
<td>Digital mammography</td>
</tr>
<tr>
<td>1998</td>
<td>Multislice CT</td>
</tr>
<tr>
<td>1996</td>
<td>VHF Digital Ultrasound</td>
</tr>
<tr>
<td>1995</td>
<td>DR Flat panel system</td>
</tr>
<tr>
<td>1993</td>
<td>Functional MRI</td>
</tr>
<tr>
<td>1990</td>
<td>Spiral CT</td>
</tr>
<tr>
<td>1988</td>
<td>EPID</td>
</tr>
<tr>
<td>1983</td>
<td>CR systems</td>
</tr>
<tr>
<td>1981</td>
<td>PET Scanner</td>
</tr>
<tr>
<td>1980</td>
<td>MR scanner</td>
</tr>
<tr>
<td>1979</td>
<td>DSA</td>
</tr>
<tr>
<td>1978</td>
<td>SPECT</td>
</tr>
<tr>
<td>1972</td>
<td>CT scanner</td>
</tr>
<tr>
<td>1969</td>
<td>Ultrasound Scanner</td>
</tr>
</tbody>
</table>

Main technology drivers:
- Computer systems
- Reconstruction software
- Digital detectors
- Hospital Networks (PACS)

Main healthcare drivers:
- Precise diagnostics
- Increased patient throughput
- Decreased cost

New medical speciality (Imaging)
Rapid Medical Physics development

(approximate years)
2015-2025: A Look in the Near Future
Medical Physics in 2016: 25,000 specialists worldwide

X-ray imaging based on phase contrast (b) & scattered radiation (c):
Dose reduction + new type of information + many times better spatial resolution
(new type of X-ray tube)

Hadron radiotherapy

Modelling and Personalised medicine

Proton Computed Tomography
Global number of medical physicists and their education

Overall University courses in Medical Physics: BSc+MSc

New embedded courses in medicine (BSc in Imaging for medics)

Emphasis on the fast clinical translation of research
### Medical physicists per million population

<table>
<thead>
<tr>
<th>Region</th>
<th>MP/Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA + Canada</td>
<td>26</td>
</tr>
<tr>
<td>Europe (unequal distrib.)</td>
<td>13</td>
</tr>
<tr>
<td>Asia and Oceania</td>
<td>1.7</td>
</tr>
<tr>
<td>Latin America</td>
<td>1.9</td>
</tr>
<tr>
<td>Africa</td>
<td>0.6</td>
</tr>
</tbody>
</table>
.. in developing countries

African Continent
54 sovereign states, one billion of population

- Radiological equipment in all countries
- Radiotherapy equipment (centres) in 25 countries
- Nuclear medicine equipment in ab. 20 countries
- Sophisticated imaging in ab. 10 countries

Very limited number of medical physicists: 450
Access to cancer therapy (radiotherapy)

Shortage of therapy equipment in LMI countries

Megavoltage units per 500 patients requiring radiotherapy per year (IAEA, DIRAC)

In FVG 8 per million
2014: Master on advanced studies on medical physics at ICTP

IAEA (HHS No. 25, 2013) recognizes:

A shortage of clinically qualified medical physicists (CQMPs)

Insufficient education and training (especially properly organized and coordinated clinical training)

Lack of professional recognition
Why a Master after master in Medical Physics at ICTP?

1. The ICTP Mission (UNESCO family): “Foster the growth of advanced studies and research in physical and mathematical sciences, especially in support of excellence in developing countries…”

2. The Medical physics group of the Trieste University (Head R. Longo)

3. The strong support of the high level Italian medical physics community and the value of the Italian health system

→ Ideal base for an international action to support the MP development in the LMI countries
The Master of Advanced Studies in Medical Physics

In 2013 an agreement between Trieste University and ICTP has been signed.

The action has the support of the Trieste University Hospital.

Scientific advisors from IAEA (A.Meghzifene, D. van der Merwe) and IOMP (S.Tabakov, King’s College, London)

Main financial support from ICTP and IAEA but also TWAS, KFAS (Kuwait), Am.CancerSociety, Ecuador, EFOMP and IOMP.
Education & Training of the MP: recommendations from IAEA, IOMP, EFOMP

1. Medical physicists must have a undergraduate education in physical or engineering sciences

2. Additional 1–3 years of academic education in medical physics at the postgraduate level

3. At least two additional years of supervised clinical training to become a Clinically qualified medical physicist (CQMP)
The ICTP – Trieste University Master of Advanced Studies in Medical Physics

Prerequisite

Master of science in physics, medical physics or equivalent

MMP

1 year of academic courses in medical physics

MMP

1 year of full-time supervised clinical training

Shorter clinical training according to an international recommendation for the needs of developing countries (AFRA)
The ICTP – Trieste University
The Master of Advanced Studies in Medical Physics

A year at ICTP:

60 ECTS: 400 lessons, 200 h exercises, 12 exercises at Trieste hospital

27 teachers from Trieste and Bologna University, Elettra, Trieste hospital, ICTP and MPs from the Network of hospitals

<table>
<thead>
<tr>
<th>Courses</th>
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<tbody>
<tr>
<td>Anatomy and physiology as applied to MP</td>
</tr>
<tr>
<td>Radiobiology</td>
</tr>
<tr>
<td>Radiation Physics</td>
</tr>
<tr>
<td>Radiation Dosimetry</td>
</tr>
<tr>
<td>Medical Imaging Fundamentals</td>
</tr>
<tr>
<td>Physics of Imaging Detectors</td>
</tr>
<tr>
<td>Physics of Nuclear Medicine</td>
</tr>
<tr>
<td>Physics of Diagnostic and Int. Radiology</td>
</tr>
<tr>
<td>Physics of Diagnostic with US and MR</td>
</tr>
<tr>
<td>Physics of Radiation Oncology</td>
</tr>
<tr>
<td>Statistics</td>
</tr>
<tr>
<td>Guided exercises at Trieste Hospital</td>
</tr>
<tr>
<td>Guided exercises at ICTP (TPS, Monte carlo)</td>
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</tbody>
</table>
The ICTP – Trieste University
The Master of Advanced Studies in Medical Physics

A second year of full-time clinical training in a Medical Physics Dpt. of the Network of accredited hospitals in Italy and Croatia.
The students

The numbers:

- 1st cycle (2014-15): 13 students
- 2nd cycle (2015-16): 13 students
- 3rd cycle (2016-17): 20 students
- 4th cycle (2017-18): 18 students
- 5th cycle (2018-19): 20 students

in total >1600 applications

<table>
<thead>
<tr>
<th>Region</th>
<th>Countries</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>22</td>
<td>8</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Asia</td>
<td>13</td>
<td>4</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>Europe</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Latin America</td>
<td>8</td>
<td>7</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td><strong>23</strong></td>
<td><strong>64</strong></td>
<td><strong>87</strong></td>
</tr>
</tbody>
</table>
International accreditation of the programme by the IOMP

The accreditation gives higher value to the Master degree released by the Trieste University, mainly in countries where MP profession is not recognised.
Certification of the medical physicist

The International Medical Physics Certification Board (IMPCB) has offered to Master’s graduates the opportunity to undertake the international certification exams at the ICTP:

- Session 7-8 April 2017
- Session 7-9 December 2017
- Session 13-14 December 2018

www.impcbdb.org
Success stories

- A graduate in 2017 has setup a new radiotherapy center with two linacs, the first in Senegal and she is the Coordinator of a IAEA programme for Africa for the development of medical physics
- 5 graduates entered in PhD programmes in USA, Japan, Italy
- A student from Kazakhstan is supporting the setup of an advanced radiotherapy center (with two Tomotherapy), under a Princeton University project
- An international action is supporting the setup of 5 oncology hospitals in Ethiopia: the MMP is training 6 MPs
- Our model of clinical training will be spread in Africa and South America under IAEA projects
- Several other graduates have improved their career and are taking responsibilities in their countries
Summary

The programme represents a unique international action to support the development of medical physics in low and medium income countries.

The programme is possible thanks to:

- the large community of teachers, network of hospitals and clinical medical physicist supervisors
- the financial contributions of IAEA, TWAS, IOMP, ACS, EFOMP