UNIVERSITÀ DEGLI STUDI DI TRIESTE

The Abdus Salam International Centre for Theoretical Physics

Student and Course Handbook

MASTER OF ADVANCED STUDIES IN MEDICAL PHYSICS

THE PROGRAMME IS ACCREDITED BY THE INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS (*IOMP*)

Contents

Graduation ceremony of the first group of 13 graduated students at the Budinich Hall of the ICTP-the 13th of December 2015 with the presence of F. Quevedo, ICTP Director, M Fermeglia, Rector of the Trieste University, A. Meghzifene, Head of the Dosimetry and Medical Radiation Physics Section at the IAEA, J. Damilakis, President of EFOMP, R. Longo, Director of the Master, L. Bertocchi, Coordinator of the medical physics programme at ICTP and, R. Padovani, ICTP Coordinator of the Master.

Master di Secondo Livello!

Who is who?

General Information

The application of radiation in human health, for both diagnosis and treatment of disease, is an important component of today health systems. The responsibility for the increasing technical aspects is undertaken by the medical physicist as stated in the International Basic Safety Standards of 2014 (IAEA, WHO, ILO, etc.). To ensure good practice in this vital area structured clinical training programmes are required to complement academic learning. An analysis of the availability of medical physicists indicates a large shortfall of qualified and capable professionals and this is particularly evident in developing countries.

The Abdus Salam International Centre for Theoretical Physics (ICTP) and Trieste University announced in 2013 the Master of Advanced Studies in Medical Physics (MMP), a two-year training programme in the field of medical physics, co-sponsored by ICTP and the International Atomic Energy Agency (IAEA), supported by the International Organization for Medical Physics (IOMP) and the European Federation of Organization for Medical Physics (EFOMP) and in collaboration with Trieste Hospitals.

The programme is held from January until December of the second year and leads to an Advanced Studies Master's Degree in Medical Physics. The official denomination of Italian Degree is "Master di Secondo Livello".

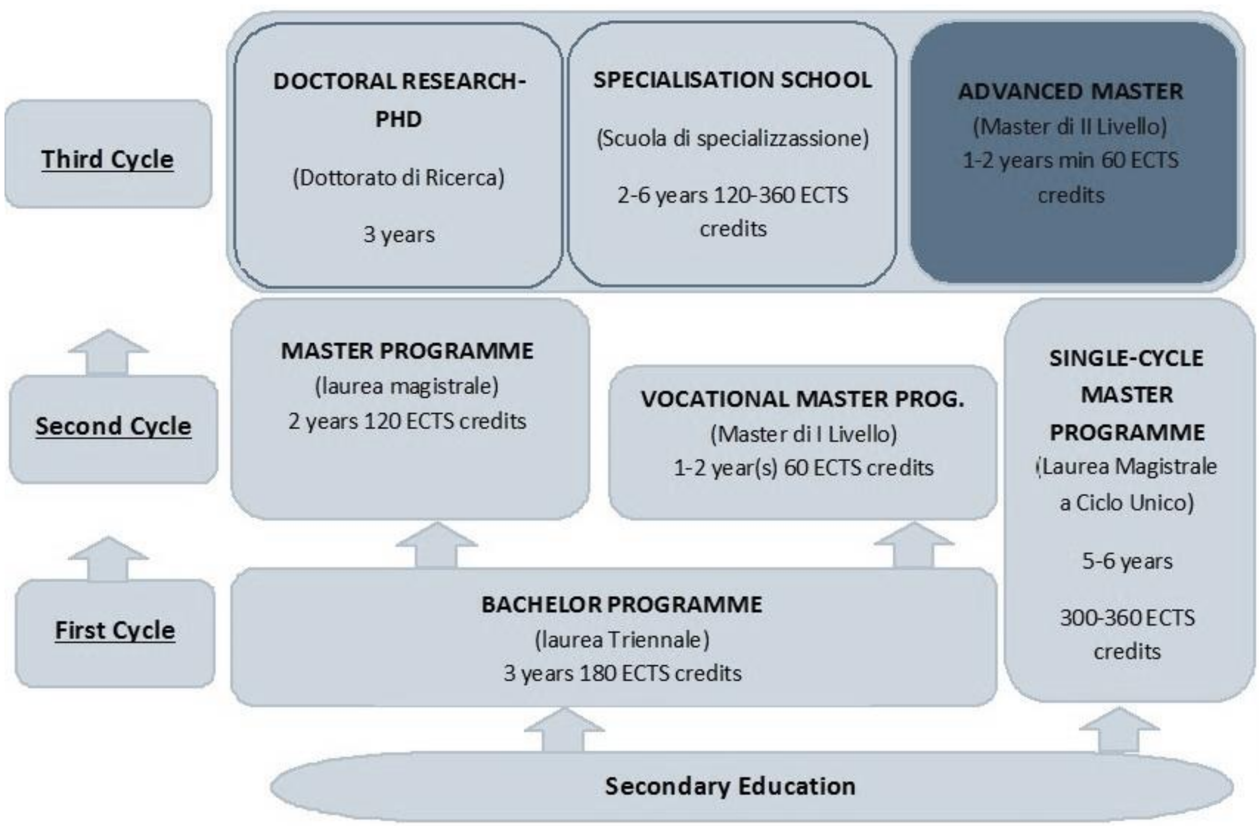


Figure 1:Degree structure at the University of Trieste

The first year is spent at ICTP, Trieste (Italy) while the second is dedicated to clinical professional training in a Medical physics department of a hospital in the programme's training network. Courses are held in English.

The Master's Programme is designed to provide young, promising graduates of physics or related fields (mainly from developing countries) with postgraduate theoretical and clinical training so that candidates may be recognised as Clinical medical physicists in their home countries.

The Master programme has been designed taking into account relevant international recommendations. In particular, the International Organization for Medical Physics (IOMP) in the Policy statement no. 2 is recommending the following to become a Clinical Qualified Medical Physicist:

- The minimum educational qualification is a university degree or equivalent (level corresponding to a master's degree) majoring in medical physics or an appropriate science subject
- MP with clinical responsibilities should have received a clinical competency training, preferably in the form of a formal residency training programme (minimum duration not be less than 2 years full-time equivalent + 1 year for additional sub-fields)
- The training should be carried out under the direct supervision of a Certified Medical Physicist (CMP)

Taking into account the ICTP Mission (an institution of the UNESCO family): "Foster the growth of advanced studies and research in physical and mathematical sciences, especially in support of excellence in developing countries. Develop high-level scientific programmes keeping in mind the needs of developing countries …", the international vocation of the Medical Physics Groups of the Trieste University and the Trieste University Hospital, the setup of this Master programme has been quite mandatory. The other pillar of this programme is the high level of the structured clinical training developed thanks to almost 20 Medical physics dpts. in Italian and Croatian universities or specialised oncology hospitals. The large Italian community of medical physicists represents the great added value to this programme.

This Master programme is not fulfilling all the IOMP recommendations (only a year of supervised clinical training), but it follows the less demanding AFRA Guidelines, devoted to African developing countries, where a single year of clinical training is accepted and recommended in countries where there is a severe lack of medical physicists in the region.

The Master's Programme was then prepared and periodically updated with the assistance of experts from the International Atomic Energy Agency and from the International Organization for Medical Physics (IOMP). It consists of several basic and advanced courses and practical and clinical training by experts in these fields with a final examination at the end of each course. Additionally, participants are required to work on a dissertation to be submitted and defended during the last month of the programme.

The programme has been recently internationally accredited by the International Organisation for Medical Physics (IOMP).

This achievement represents an added value to the Master degree, as it can be easily recognised in most Countries.


International Organization for Medical Physics (IOMP)

CERTIFICATE OF ACCREDITATION

Master of Advanced Studies in Medical Physics (MMP)

International Center for Theoretical Physics (ICTP) &

Università degli studi di Trieste

The IOMP accreditation board certifies that the MMP having met its requirements is granted accreditation

Commencing 1st November 2016 until October 31, 2019

Professor John Damilakis
Chair, Education and Training Committee

Masters Level Program
IOMP
ACCREDITED

Professor Slavik Tabakov
IOMP President

Figure 2: Certificate of Accreditation

The Master's degree is awarded by Trieste University only to those candidates who successfully complete all examinations, clinical training, and other requirements as may be decided by the Master's Committee. Participants will also be required to take part in ongoing activities of ICTP in their related fields.

Board Members

Prof. Luciano Bertocchi (ICTP)
Coordinator of the ICTP Medical Physics Activities and board member
Email:bertocch@ictp.it
Office:ICTP-Leonardo Building- 2nd Floor- Room#227

Prof. Renata Longo (University of Trieste)
Director of the Master in Medical Physics
Email: renata.longo@ts.infn.it
Office: Via Alfonso Valerio, 2,Edificio F, Department of Physics, University of Trieste, 2nd Floor

Prof. Renato Padovani (ICTP)
Coordinator of the Master in Medical Physics
Email: padovani@ictp.it
Office:ICTP-Adriatico bulidng-1st Floor

Prof. Mario De Denaro (University hospital of Trieste)
Board Memeber&Head of the Medical Physics Department (AOU Trieste)
Email: mario.dedenaro@asuits.sanita.fvg.it
Office: Via della Pietà, 4,Ospedale Maggiore, Fisica Sanitaria, 2nd Floor

Prof. Luigi Rigon (University of Trieste)
Board Member
Email:luigi.rigon@ts.infn.it

Prof. Edoardo Milotti (University of Trieste)
Board Member
Email: milotti@ts.infn.it

Prof. Slavik Tabakov (King's College London)
External Adviser
Email:slavik.tabakov@emerald2.co.uk

Prof. Ahmed Meghzifene (IAEA)
External Adviser
Email: a.meghzifene@iaea.org

Ms. Suzie Radosic (ICTP)
Administrative Secretary for the Master's in Medical Physics
Email: mmp@ictp.it **Phone:**
Office: Adriatico Building- Ground floor - Secretariat of medical phyics

Duties of the Board

- To define contents and modalities of development of the programme of the Master
- To assure a regular development of the teaching activities
- To validate the academic level of the Master
- To develop, in agreement with the ICTP and the Physics Department of the Trieste University, the programme of the teaching and training activities defined in the programme of the Master.
- To establish the modalities to reach the defined minimum frequency of the teaching activities in the case of motivated absence.
- To communicate to the Physics Department the teaching programme for the administrative actions to identify and nominate the teachers of the different academic courses of the Master
- To propose a plan of the budget use.

The first days at Adriatico Guesthouse!

Accommodation & Medical Services

How to reach the Hospital And university of Trieste?

Miramare Castle is one of the most popular sights in Trieste. It is a white castle sitting in a bay down by the seaside and surrounded by a flourishing park full of precious botanic species. The castle is reachable from the secondary entrance of Miramare Park in Grignano, about a 15-minute walk from the bus stop Grignano (ICTP Adriatico Building)

Things the MMP students need to know

Things to know about ICTP and Trieste

The Abdus Salam International Centre for Theoretical Physics (ICTP), Founded in 1964 by the late Nobel Laureate Abdus Salam, is an international research institute for physical and mathematical sciences that operates under a tripartite agreement between the Italian Government, United Nations Educational, Scientific and Cultural Organization (UNESCO), and International Atomic Energy Agency (IAEA). (For more information about ICTP, history and mission, directorate, etc. please check the ICTP website)

ICTP Campus

The ICTP Campus consists of five buildings (See the campus map and address)):

- ***Leonardo Da Vinci Building (LB)***
  (former ICTP Main Building)
  - Director's Office
  - Scientific Research groups
  - Diploma Programme
  - Marie Curie Library
  - Information and Communication Technology Section (ICTS)
  - Public Information Office (PIO)
  - Offices for visiting scientists
  - Associates and Federation Schemes
  - Bar & Cafeteria

Note: the Leonardo Building is situated on the very busy and dangerous main road Strada Costiera. Visitors are advised to always use the zebra-crossing, situated by the bus stops at the Grignano end of the two tunnels. No-one should ever try to cross the road while they are under the tunnels.

- **Enrico Fermi Building (EFB)**
  - Administrative offices,
  - Medical Services
  - Passport & Visa Information Office
  - Bank , Insurance, Travel Agency
  - Office of External Activities (OEA)
  - Training and Research in Italian Laboratories (TRIL)
  - The World Academy of Sciences (TWAS)
  - SciFabLab
  - Science Dissemination Unit (SDU)

- **Multidisciplinary Lab (ICTP Mlab)**
  (Five minutes walk north of the Leonardo building (LB))

- **Adriatico Guest House (AGH)**
  - Eklund Lecture room (Master's in Medical Physics Lecture and Study Room)
  - Secretariat of Medical Physics
  - Coordinator of medical physics room (First Floor,)
  - Housing Office- Private Accommodation
  - Reception Desk
  - Denardo Informatics Laboratory
  - Giambiagi Lecture Hall
  - Kastler Lecture Hall
  - Lundqvist Lecture Hall
  - Accommodation and rooms (near the sea)
  - Bar and Cafeteria

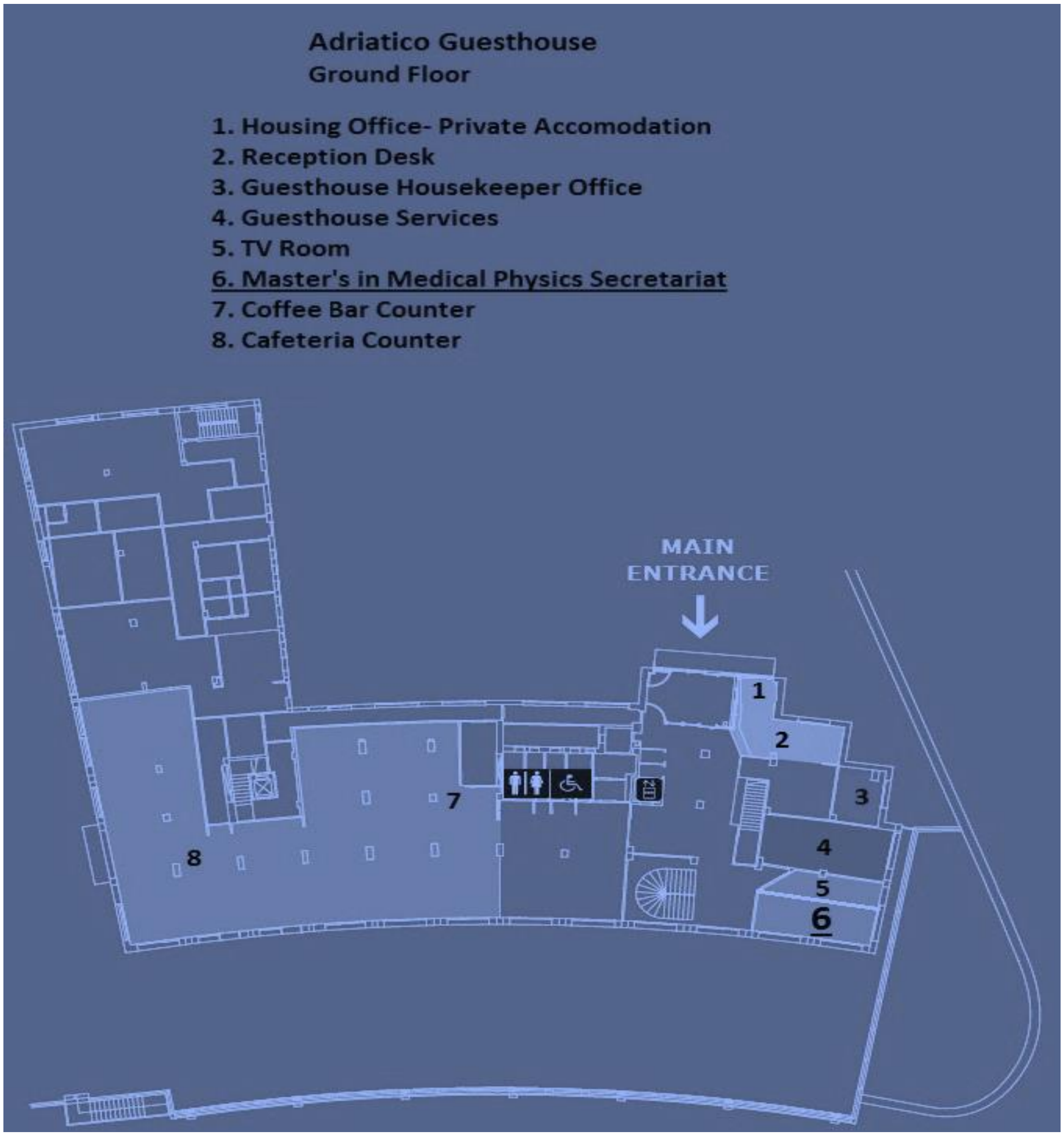


Figure 3: Adriatico Guesthouse (Ground floor)

- **Galileo Guest House (GGH)**
  - Accommodation (on the hill, behind LB)
  - Aeronomy & Radiopropagation Laboratory (ARPL)
  - Bar

ICTP Bars and Cafeteria

Though cooking facilities are not available in the Guesthouses, in private accommodation they generally are. A cafeteria and bar are available at both the Leonardo Building and the Adriatico Guesthouse. A bar is available at the Galileo Building for breakfast. A full meal costs approx. Euro

5. Breakfast and/or snacks are available from the Bars at the ICTP Leonardo Building, Galileo Building and Adriatico Guesthouse.
(Check the opening hours and daily menus)

ICTP Minibus Shuttle Service

There is a minibus shuttle service connecting the ICTP buildings (see the timetable which is also available at the Reception Desks of the Guesthouses and LB lobby)

ICTP Name Badge, Active Badge and E-MAIL Account

An ICTP e-mail account has been created for you. Username and password will be given to you when checking in at the ICTP Guesthouse reception, together with your temporary name and active badges that are inserted in a plastic badge holder. For the sake of privacy the information about your e-mail account is placed in between the two badges. The temporary name badge will be replaced with the regular one bearing picture after the registration with the Secretariat, when going to the Mail Office counter, Leonardo Building for routine operations. In case of loss or damage of the active badge you should immediately request a new one from the Mail Office at the InfoPoint in the Leonardo da Vinci Building, for which you will be charged Euro 10, as cost-reimbursement. Before departure the active badge must be returned to ICTP. For this purpose “Badge collection boxes” are located in the various ICTP buildings. Active badges may also be returned to the Mail Office counters (Leonardo and Fermi Bldgs). You are kindly requested to wear the name badge while on ICTP premises. This badge is also required to borrow books from the Library.

Official Working Hours

The Centre's official working hours are Monday to Friday, 08.30 - 16.48, with a 48' lunch break between noon and 14.00. The Leonardo Building remains open on Saturday from **06.00 - 22.00**, and Sunday from **06.00 to 20.00**. The Reception desks in the Guest Houses are staffed both day and night.

Climate and Clothing

Trieste is located in north-eastern Italy, on the Adriatic Sea. Although it seldom snows, the local climate ranges from cold (as low as –2º C in December-February) and windy (due to a cold wind from the NE called “bora”), to hot (as high as +30º C in July-August). In all seasons, it is advisable to have an umbrella, waterproof shoes and sweater. In winter, a coat, gloves, hat and scarf are necessary. In summer, a bathing costume is useful. Of course, all items are available in Italian shops, but prices may be high in comparison to those in participants’ home countries.

Language

English is the ICTP official language. Therefore, all Master's in Medical Physics lectures, examinations, etc. are in English. Incoming participants are very strongly advised to develop their reading, writing and speaking skills in English prior to arrival at the Centre. Italian is, of course, the main language of the country; however, there are many dialects in common use. As long-term visitors will interact with shopkeepers, doctors, etc., at least some knowledge of Italian is helpful. Though the ICTP has no academic programmes for languages, it organizes a short Italian course given by an Italian teacher for ICTP Course students. This course usually takes place at the beginning of September. The ICTP bilingual staff does its best to assist newcomers who encounter problems in communicating with Italians.

Insurance and ICTP Medical Service

Italian Law requires all foreigners to have valid health insurance coverage while in Italy. Failure to comply will result in a denial of permission of stay on Italian territory. There are two kind of insuranceS for the MMP students. The students funded by the IAEA are automatically provided with an international student health insurance plan offered by Cigna International Health Services BVBA. For more information about this insurance policy, conditions, rates, etc. please visit Cigna Global Medical Insurance Policy. For the others, ICTP provides free health insurance coverage, through AllianzWorldwideCare, to visitors under the age of 75 who do not have their own valid health insurance coverage and who are NOT nationals of countries listed here, NOR legal residents enrolled in the social security system of these countries. The same terms and conditions apply also to accompanying family member (i.e. spouse and/or children under age 18). The coverage is valid from 00 hrs of the day of arrival in Trieste to midnight of the day of departure from Trieste (according to the dates indicated on the Registration form, or eventual extension of stay).

The purpose of the health insurance coverage provided by ICTP is to grant reimbursement for emergency health problems that may occur during your visit at ICTP. Interventions due to chronic health problems may not be reimbursed.

Visitors covered under the AllianzWorldwideCare insurance policy will receive a welcome pack from the insurers upon enrolment, describing the benefits covered and the procedures for processing claims for reimubursement. For any queries please contact personnel@ictp.it. ICTP Medical Service, is available to all visitors and will assist them as required.

Note on Pregnancy: Before coming to ICTP, pregnant women are kindly requested to notify the ICTP Medical Service (medical@ictp.it) about the status of their pregnancy, to obtain further guidelines.

List of countries:

Andorra, Austria, Belgium, Bulgaria, Channel Islands, Croatia, Czech Rep., Denmark, Estonia, Faeroe Islands, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Isle of Man, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, Bermuda, Canada, Greenland, United States, Australia, New Zealand

Public transportation

- **Airport Shuttle:**
  - Bus 51 runs between the Trieste Bus terminal ("Centro Servizio Auto-corriere" Piazza Liberta della Libertà 9, near the Trieste central Railway Station) and Trieste Airport. The buses stop along Strada Costiera only if you ask the bus driver to stop in advance. Tickets from Trieste Bus Terminal to the Trieste Airport cost around 5 Euro, while tickets from Grignano to Trieste Airport are around 4 Euro. Tickets and timetables are usually available at the Guesthouses and at the Info Point, Leonardo Building. Click here to find bus (51) timetables.

- **Bus No. 6:**
  - From the Trieste (Piazzale Gioberti) to the Grignano (end of the line) and vice versa, you can take bus number 6. Coming from the city, the bus stop for the ICTP leonardo building and Galileo Guest House is close to the road to Galileo Building (via Beirut); for the Adriatico Guesthouse it is at the end of the line at Grignano.

- **Bus C:**
  - Usually from 21.00 hrs. until midnight, Bus C runs between Piazza Goldoni and Barcola. To get the last updated schedule click here to find bus C timetables.

  - **Bus tickets:**
    Bus tickets are usually available at the Info Point at the Leonardo Building and Reception desks of Adriatico and Galileo Guesthouse. In the city you can find bus tickets at news stands, tobacco shop ,the shop sign is always a small blue rectangle with a big **"T"** and the words "Sali e tabacchi" (salt and tobacco) or from automatic machines. Click here to find out the complete list of newsagents, tobacconists, book stores, bars, food shops and gas stations selling TT tickets.
    Note that there are no conductors on the buses, therefore, tickets must be purchased before getting on the bus. There are random controls and anyone without a ticket has to **pay a fine** (**around 70 Euro**).

- **Type of Bus Tickets:**

  - Tickets
    - 10-journey ticket, all routes
    - Single ticket, all routes
    - Single ticket, 2 sections of 1 route
    - Day travel card

  - Monthly Travel Cards
    - 1 Line or route
    - All routes

  - Yearly Travel Cards
    - 1 Line or route
    - All routes

  Click here to get the updated prices and find more options.

  The MMP students who stay in Trieste for a year usually prefer to purchase a monthly or annually ticket. The monthly ticket is valid from the first to the last day of the month on all bus lines in the city. This "monthly card" should be stamped only the first time you use it, but must be carried at all times in case of inspection. You must write the month in the first box named “MESE” and your family name and first name in the second box named “COGNOME e NOME” on the ticket.

- **Taxi:**

  Students usually do not prefer to take a taxi. However, a taxi may be helpful for traveling sometimes. Taxis may be found in "taxi stands" in different area of the city or you can call a taxi service at Radio Taxi Tel: 040 307 730 or check it out this link. When the operator answers, tell him/her where you would like to be picked up. He will find a taxi for you and tell you its number, which is posted on the side of the car.

  Fare from the Rail Station to ICTP will cost around Euro 14-20. Fare from ICTP to the airport will cost approximately Euro 60. Each piece of luggage carries an extra charge. Taxi fares are more expensive at night, holidays and runs that take you outside of town.

- **Train Services**

  There is a good train service between Trieste (Trieste Centrale is Trieste's main train station) and the rest of Italy. Most trains, only stop at Trieste Rail Station. A few trains, however, have daily stops at Miramare Station, located near the ICTP Galileo Guesthouse. Ticket must be purchased at the Rail station in Trieste, or at Carlson Wagnolit Travel (CET), located in the Lobby of Enrico Fermi

Building, where they may be purchased at least 24 hours before departure, or online from train Italia website. You should check the timetable from the website. The MMP Students arriving at Venice airport can take a local bus from outside 'Arrivals' to Venice/Mestre railway station (cost around ~Euro 6-8) or take a taxi which costs over Euro 25. Then, take a second-class train ticket Mestre - Trieste which costs ~Euro 12.

TICKETS must be validated (punched) in the yellow machine on the platform, BEFORE boarding the train.

Things to know about Trieste University

A brief introduction

Founded in 1024, the University of Trieste (Università degli Studi di Trieste), often abbreviated to UNITS, is among the top EU-funded and the best universities in Italy for quality of teaching and excellence of research. The university is dedicated to the discovery, development, communication, and application of knowledge in a wide range of academic and professional fields and it made up of twelve faculties (namely: faculty of Engineering, Humanities and Arts, Mathematics, Physics, Natural Sciences, Pharmacy, Education, Medicine, Political Sciences, Modern Languages for Interpreters and Translators, Psychology and Architecture) and currently has more than 23,000 students and 1,000 professors.

Trieste is home to a number of many research centre and academic institutes; namely, the International Centre for Theoretical Physics (ICTP), the International School for Advanced Studies (SISSA), The World Academy of Sciences (TWAS), the National Institute of Oceanography (OGS), the International Centre for Genetic Engineering and Biotechnology (ICGEB), the Elettra Sincrotrone Trieste Facility, the Trieste sections of the Italian National Institute for Nuclear Physics (INFN) and Italian National Institute for Astrophysics (INAF). Therefore, being the main part of this research network, the so called "Trieste system", is one of the key features of the Trieste University.

Trieste System

- University of Trieste (UNiTs)
- International Centre for Theoretical Physics (ICTP)
- Elettra Sincrotrone Trieste Facility (Elettra)
- The Trieste section of the Italian National Institute for Nuclear Physics (INFN)
- International School for Advanced Studies (SISSA)
- AREA Science Park
- The World Academy of Sciences (TWAS)
- Institute of Marine Science-National Research Council (ISMAR-CNR)
- Italian National Institute for Astrophysics (INAF)
- Marine Biology Lab
- the National Institute of Oceanography (OGS)

Figure 4: Trieste System

Trieste university is one of the most international universities in Italy since one of its missions is welcoming and seeking students of all racial, ethnic, and geographic groups and more significantly serving women and men alike, as it addresses the needs of an increasingly diverse population and a global economy. Accordingly, the majority of the programmes embrace international themes and are taught either entirely or partly in English.

From the academic year 2013/2014, the Department of physics at the University of Trieste and ICTP jointly offer the Master of Advanced Studies in Medical Physics (MMP).

The MMP students in this joint master program are considered students of both the University of Trieste and ICTP and have all the rights and privileges normally accorded to graduate students at ICTP and the University, and they will be issued a University of Trieste student card and ICTP ID badge.

How to reach Trieste University and Department of Physics

The main University campus is centrally located at Piazzale Europa, 1, on the Scoglietto hill.

The department of physics is located just one block from the main campus and the address is building F, Via Valerio 2. The office of Prof. Renata Longo (Director of the Master in Medical Physics) is on the second floor.

You can reach the main campus and department of physics from the rail station by taking bus number 17/ or from Piazza Tommaseo by taking bus 17 (Click here to find bus (17) and (17/) timetables). Get off the bus at the stop close to a petrol station and you can clearly see the university campus on the opposite site.

Student Card

It is used in order to be identified as a student of the University of Trieste. Showing the student card at the restaurants of university campus and at ICTP you will pay a little bit less for your meal.

University libraries and the main library

The University of Trieste has 15 libraries, including the main library, which are associated with its library system offering both hardcopy and digital resources. (Check for opening and closing times and other information about the main library)

The Education Roaming (Eduroam) WiFi network

ICTP and University of Trieste users may connect to (mainly wireless) networks of the other European, American, Asian and Australian Research and Education institutions using the same credentials as logging in the University of Trieste network. (Check this page for more information).

University restaurants

The University of Trieste has two restaurants open to all students. Restaurant service is accessible through a card issued at no cost by ERdiSU (Check this page for more information regarding the restaurant card). The student can apply for discount on food when obtaining the restaurant card from ERdiSU.The main **University C**anteen (Mensa centrale) is open for breakfast, lunch and dinner all days, including holidays. But, Palazzo Vivante Canteen is just open for lunch and dinner, from Monday to Friday. (Check this page for address, Price and opening hours).

University website

The MMP students can check and view their final score, exam booklet and other personal information using the university panel. Login to your data using the provided username and password . Esse3 is the students university career management system and allows you to access to online University Services.

Here is the procedure in case of accident during lecture or training (in Italian only): http://www.units.it/node/283

University Sports Centre

University Sports Centre (Centro Universitario Sportivo) offers organized sport activities to enhance physical activities and improve students' attention and concentration. (Check this page for more information regarding CUS)

Things to know during your first days in Adriatco Guest House

Entering a new place to study can bring about many questions, but you should not worry. All you need to do is following the checklist below and prepare to enjoy your new educational experience at ICTP. Here are the main 6 steps to finalize the administrative procedures.

Finalizing the registeration

Master's in Medical Physics Secretariat

- **Finding your permanent accomodation in Trieste** which can be done with the help of ICTP private accomodation office
- **Obtaining your Italian Fiscal Code**
- **Openning a Bank Account**
- **Take a print-out of your Insurance** from the secretariat; Note that this step is done automatically
- **Collecting all your documents** with the help of VISA office and **applying** for "**Permesso di Soggiorno**" permit of stay

After Arrival Checklist

Checking in at Adriatico Guesthouse Reception Desk

- ☐ Show to the reception your passport and invitation letter and pick up the key to your room for the initial period of stay (usually between 5-10 days) .
- ☐ Take your temporary ICTP Badge including your username and password to access the internet and your ICTP email. Note that:
  - ➢ Your ICTP email account and email address are created for you before your arrival. You will receive all internal communications from Secretariat of Medical Physics and ICTP on your ICTP email account. At any time, you may check to see if your ICTP email address has been updated.
  - ➢ Your email account will be deactivated a few months after you leave ICTP and you will no longer have access to it.

Administrative Procedure: Secretariat of Medical Physics

(Adriatico Guesthouse, ground Floor, just a few steps away from the reception desk)
(Tel: +39-040–2240226; mail: mmp.ictp.it)

- ☐ Bring the required documents and please **do not forget** to bring your ORIGINAL (Dichiarazione di Valore) DV with you!
  - ➢ You need to bring your original DV for registration; otherwise, you cannot officially be enrolled as a student of Trieste University.

- ☐ Check and sign your student contract
- ☐ You will be informed individually as to the next steps you need to take.

ICTP Private Accommodation

(Beside Adriatico Guesthouse Reception Desk)
(mail: prvaccom@ictp.it)

- ☐ Fill in the form, requesting private accommodation and send it to prvaccom@ictp.it
  - ➢ As stated in the invitation letter, MMP Students will be accommodated in 2-person rooms at the Adriatico Guesthouse for the initial period of their stay. During the initial period, ICTP Private Accommodation office will assist the MMP students to find a long-term accommodation. There are actually two types of accommodation open to the MMP students provided by ICTP (A private room typically costs you around €360 per month and the price includes the energy and water consumptions).

- However, some students prefer to have a privately rented accommodation and some other students decide to share the private long-term accommodation since rental rates are quite high. In this case, it is therefore advisable to plan on sharing a flat with others which the ICTP Housing Office/Private Accommodation and/or outgoing participants help them to find.

ICTP Banking Service

(Ground Floor, Enrico Fermi Building)

- Opening a bank account.

  - In ICTP, UniCredit Banca has a branch office next to the Entrance Hall on the Ground Floor of the Enrico Fermi Building.

    Opening times: Open 2 two days--Monday and Friday--from 8:20 to 13:20, and from 14:30 to 16:00. On all other days, the UniCredit branch at Barcola (Viale Miramare, 133) is available from 8:20 to 12:45.

- Obtaining your Italian fiscal code before opening your bank account.

  - MMP students can avoid requesting the "codice fiscal/fiscal code" personally at the local Revenue Agency and ICTP can manage the application procedure before your arrival. But, to obtain the card you should go to the Agenzia delle Entrate by yourself. The Agenzia delle Entrate can be found at Via Lionello Stock, 2/3/4, 34135 Trieste. It is a couple of minutes' walk from the Roiano district and it can be reached using the bus line no. 5, 6 and 8.

  - You need to bring with you:

    EU citizens: Valid Passport or another ID document (for verification). **NON EU citizens:** Passport and Visa (for verification), Copy of passport (with the personal data and copy of the visa)

ICTP VISA Office Information

(Enrico Fermi Building Rooms T-4, T-5)
(Tel: +39-040 - 2240510; mail: VISA@ictp.it)

- Contact the Visa Information Office to apply for Permit of Stay (Permesso di Soggiorno)

  - MMP students need to apply for a Permit of Stay (Permesso di Soggiorno) as soon as they collect all required documents. This shall be applied for through the Postal Service and with the assistance of the ICTP Visa Information Office within 8 working days of the arrival. The Permesso is issued by the Immigration Office of the Italian Police Authorities (Questura) in Trieste.

As soon as possible, and however not later than 72 hours from their arrival at ICTP, MMP students should contact the Visa Information Office who will provide them with the necessary application form and information on how to fill it in. Kindly note however that there are some costs involved: each application will in fact require a 30 Euro handling fee for the Post Office, a payment of Euro 107.50 for the electronic Permit of Stay (compulsory) and an additional Euro 14.62 Tax Revenue Stamp which should be applied on the application form.

IT SHOULD TAKE A COUPLE OF MONTHS TO HAVE THE STANDARD PERMESSO ISSUED. Delays beyond time frames indicated by the Questura are possible.

In the waiting period you will have a receipt, issued by the Post Office which testifies that you complied within the terms of 8 eight days with the Law requirements. PLEASE NOTE THAT WITH THIS RECEIPT, YOU CAN LEAVE ITALY BUT YOU CANNOT RE-ENTER ITALY. SO DO NOT PLAN EARLY TRAVELS TO OTHER COUNTRIES OUTSIDE THE SCHENGEN AREA WHEN PLANNING YOUR STAY AT ICTP.

ONCE YOU ARE GRANTED THE STANDARD PERMESSO, YOU CAN TRAVEL FREELY IN AND OUT OF ITALY AND THE SCHENGEN AREA PROVIDED YOU ALWAYS BRING ALONG THE ORIGINAL PERMESSO TOGETHER WITH YOUR PASSPORT. UNTIL THE STANDARD PERMESSO IS GRANTED, YOU CAN STAY IN ITALY WITH THE RECEIPT AND LEAVE THE COUNTRY, BUT CANNOT RE-ENTER ITALY.

IF A PERSONAL EMERGENCY SITUATION SHOULD MAKE IT NECESSARY FOR YOU TO LEAVE ITALY WHILE STILL WAITING FOR THE PERMESSO, PLEASE CONTACT THE ICTP VISA INFORMATION OFFICE. WHEN APPLYING FOR A PERMESSO DI SOGGIORNO, HAVING ARRIVED IN TRIESTE, you will need:

- The letter your received from the Post Office, fixing your appointment for fingerprints
- Your passport
- 2 photographs in colour, passport size (white background)
- the ICTP SSA Contract and/or the invitation letter (+ 1 copy)
- the Health Insurance Certificate (+ 1 copy)
- the receipts of payment from the Post Office
- regarding your apartment: the contract (registered at the Agenzia delle Entrate-Revenue Agency) or the document called “Cessione di fabbricato” (+ 1 copy)
- Presentation letter from the Visa Office.
- IN CASE OF RENEWAL: your present Permit of Stay

Mail Office and Photographic Services

(Leonardo Building entrance hall, left side)
(Tel: +39-040-2240559; mail)

☐ Request for your long-term ICTP badge

- ➢ To have your official ICTP badge, you will need to take a personal photograph. The Mail Office provides a photo service for MMP students for their ICTP badge.

Lecture Room

All lectures and most of the exams will be held in the Eklund Lecture room in Adriatico Guesthouse, lower level 1 except for clinical and practical sessions. This lecture room is reserved for MMP students where each student will have a computer to work on their assignment and personal use. The room is also equipped with LCD projector, overhead projector and blackboard.

Since some MMP students may stay at the lecture room outside of class time to work and study, some classroom conduct rules are highly recommended.

Printers, Copiers & Scanners

- MMP Students can print their documents at any Digital Photocopier Machine located at the Adriatico Guesthouse, lower level 1 or other buildings. You can also use photocopiers as scanners and photocopier. The name of the closet machine to Eklund lecture room is “apubc2”, and to print your documents you just need to select the printer’s name from printer pop-up menu.

- To use the machine as a photocopier, you should unlock the machine simply by typing the last 4 digits of machine's serial number (For example E175MB1<u>0550</u>). The serial number is printed on the label at the bottom of the machine. Note that photocopying should be kept to a minimum.

- To use the machine as a scanner, you should set the scan setting including the type of scan, scan size, resolution, etc. and also you should specify the destination simply by entering your preferred e-mail address manually.

ICTP Marie Curie Library

The MMP students who would like to access ICTP Marie Curie Library are required to register at the Library's Issue Desks. To apply for membership, applicants must bring their ICTP badge.(Check for opening and closing times).

Italian language Courses

The MMP students are recommended to participate into Italian language course to attain a basic knowledge of the language (based on the discussion at our last meeting between all clinical supervisors and graduate MMP students), even though the MMP students have a busy schedule in the first year of the program.

The Italian language courses take place throughout the academic year, open to ICTP visitors and scientists, staff and family members. They usually take place in ICTP's Leonardo Building, in the L. Stasi Seminar Room. Registration is effected directly in the classroom. For any other questions you may contact the teacher, Professor Ariane de Marchi via e-mail.

ICTP and Joint ICTP-IAEA Course and Workshops

According to the ICTP scientific calendar, there are at least two international workshops and/or joint ICTP-IAEA colleges each year in the field of medical physics. The MMP students are automatically enrolled to these activities as part of their program. The ICTP workshops and colleges give MMP students good opportunities to meet and interact with many other medical physicists and professors from all over the world, share problems and ideas, and finally better grasp a topic from different points of view.

University Hospital of Trieste (Azienda Sanitaria Universitaria Integrata di Trieste)

During the first year, the Clinical exercises and hospital sessions take place both in Maggiore hospital and Cattinara hospital in Trieste. Getting to the hospitals from ICTP is easy. You should take the bus number 6 (check the bus schedule) starting from ICTP Adriatico building (Grignano). You should take this bus and then get off at "Via C.Battisti 3" first station and it takes around 10 minutes' walk to get there without changing buses. Click the icon to view maps and get walking directions in Google Maps.

However, if you are in the town you can reach the Maggiore Hospital using the following bus lines: no. 5 (P.zza Perugino - Roiano); no.11 (Ferdinandeo - P.zza della Borsa); no. 22 (Cattinara - Stazione Centrale); no. 23 (Grandi Motori-Stazione centrale); no. 26 (Chiadino -Largo Osoppo); no.37 (Raute - Largo Barriera); no. 40 (San Dorligo - Stazione Centrale).

Since Cattinara is far from ICTP and Downtown, you need to get the bus. The easiest way to reach there from ICTP is taking bus 22 (check the bus schedule) from rail station (Stazione Centrale). It can be also reached using the following bus lines from the town: no. 25 (Piazza Borsa - Cattinara); no. 26/ (Largo Osoppo - Cattinara on Sundays only); no.39/ (Aurisina - Cattinara); no. A (only after 9 p.m.); no. 48 (Largo Barriera); no. 49/ (Muggia - Cattinara)

Scientific Excursions

Each year, three educational excursions are usually organized for the MMP students in their first year to visit Elettra Synchrotron in Trieste and the Secondary Standard Dosimetry Laboratory at the Ruder Bosković Institute (SSDL) in Zagreb. The MMP students also visit "Centro di Riferimento Oncologico-CRO" at Aviano as part of their practical exercises. These excursions provide an opportunity for the MMP students to deepen their learning and participate in activities relevant to their studies.

Out-of-class Activities

When you are in a new place for the first time, it seems difficult to interact and make friendship with people who are not similar to you. However, ICTP has a warm welcoming environment and building friendship is easy. Correspondingly, the MMP students create a group of international friends quickly and easily. Then, they start planning to do out-of-class activities such as throwing birthday parties, sport activities like jogging and biking near Grignano and Miramare, swimming during summer, ICTP tennis table tournament, participating in Trieste summer activities, ICTP Christmas party, Trieste Mini Maker Fair, Bavisela running Festival, Barcolana and so on.

Holidays and Academic Breaks

There are some holiday periods during the academic year such as Christmas, Easter and Italian national holidays. However, the main vacation times for MMP is the summer holiday; usually the first in August till the first week of September. Some of the MMP students would like to return home and some others prefer to travel around Italy or within Europe during this period by their own source.

ICTP Club

ICTP has a fitness center located in the Adriatico building and memberships are available to students and ICTP staff. For more information about monthly cost of gym membership and registration, you should contact Mr. DE POL Leonardo (ICTP Club) in Enrico Fermi Building room T17. There is also a tennis (ping-pong) table area in Leonardo Building and a piano in Adriatico building-cafeteria.

Things to know during your second year in your training hospital

Renewal of your Permit of Stay

You will need to renew your permit of stay before the beginning of the second year and prior to its expiration date. This shall be applied for through local post office at the city of your training program and with the assistance of the ICTP Visa Information Office before starting of second year. They will assist you individually to collect all required documents and facilitate the application procedure.
Do not hesitate to contact ICTP VISA office and the MMP coordinator for any possible problem.

Final Version of your Portfolio

A couple of weeks before you start the training, please download the template portfolio and read it carefully before filling out the portfolio. Then, in the first weeks of the clinical training, finalize your portfolio with your clinical supervisor including required signatures.

Take weekly notes of your activities in the hospital. Send a mid-term (end of July) report on the training activities to Dr. Renato Padovani (Coordinator of the Master in Medical Physics). By the end of November, send the filled portfolio with all the signatures to the MMP Coordinator.

Accommodation for the Second Year

Finding accommodation is a top priority for the MMP students in the second year of the program. Some students prefer to have a short trip before packing their stuff and moving to the city of their training to look for an accommodation and some others prefer to rent a short-term accommodation and then find a long-term one. In some centers, the clinical supervisors can help the MMP students in this regards as well as former students. Another possible way to look for accommodation is using online websites for finding rental apartments or homes (see" useful links" section).

Italian Safety Regulation in work place

In the first year, after summer, you will be asked to follow an on-line course on the safety requirements in the work places. It introduces you to the Italian regulation to be applied for you, your colleagues and patient safety in the working places and, in particular, in the hospitals. The acquired knowledge will be assessed with a final written exam and a certificate released.

The certificate is required by the hospital. The hospitals can require a more specific training on the safety regulation. Safety regulations and rules are mandatory and must be followed in all the working places, school, hospitals, etc.

Frequently Asked Questions (FAQ)

What is Dichiarazione di Valore DV (Statement of value) and how to obtain it?

- ✓ *The Dichiarazione di Valore (DV) is an official document issued by Italian Embassy in the country where you have studied. Students who would like to study in Italy should apply for DV.*

How much should I pay for DV?

- ✓ *Obtaining DV is free of charge if the DV requested is to be used for study purposes.*

After completing this program, is it possible to work in Italy?

- ✓ *The present Master Course does not prepare Medical Physicists for the Italian hospitals, because in Italy a 4-year course in "Fisica Sanitaria" is required.*

Can I bring my family to Italy if I get the scholarship?

- ✓ *It is highly recommended to come unaccompanied since the grant will allow for living of only one person and the authorities will not accept family members with the grant provided for one person. However, if you wish to bring your family as dependants on your visa, you need to meet some criteria including budget implications.*

What is Permesso di Soggiorno (Permit of Stay)?

- ✓ *Foreign students - those are non-EU citizens - may enter Italy provided that they hold a valid visa issued in their country of origin. Then, they also need to apply for a "permesso di soggiorno" if they are a non-EU citizen and are going to be in Italy for more than 90 days. It is not an entry visa and is not an identity card. Permesso di soggiorno is a document that the Italian state demands of all foreign citizens, that is citizens of countries that are not part of the European Union (EU). The Italian permesso di soggiorno GIVES*

THOSE WHO HOLD IT THE RIGHT TO LIVE IN ITALY UNTIL THE EXPIRY DATE OF THE PERMIT, which then needs to be renewed. It will allow you to travel through the Schengen area for as long as it's valid.

What is Italian Codice Fiscale (Fiscal Code)?

- ✓ *The "codice fiscale" is an alphanumeric code of 16 characters issued for free by the Revenue Agency to identify Italian citizens and foreign residents. You need to have your own "codice fiscale" to: open a bank account, sign any type of contract (rental, phone line…) and register at the National Healthcare Service (SSN).*

How much does it cost to live and study as an MMP student in Trieste?

- ✓ *The cost of living can vary greatly depending on your lifestyle, type of accommodation you choose and spending habits. You need to find accommodation, buy bus and Train tickets and think about food and entertainment. The following table shows some major expenses as an estimation to assist you to estimate your monthly costs of living in Trieste.*
  Note that the estimates do not include the cost of some other items such as traveling, clothes, entertainment etc. It is also important to keep in mind that you are also likely to have some initial costs. (e.g. a deposit for accommodation which might be the equivalent of 1 month rent).

Table 1::a rough estimate of living costs in Trieste

Item	Estimated Monthly Costs
Accommodation	Monthly rent for a room/month: €250-€360 Monthly rent for an apartment/month: € 400-€700
Food and grocery shopping	€200-400 per month
Monthly Ticket for bus	€34.35 per month
Mobile Internet Package	€10 for 3-5GB/month

ICTP Bulding (Adriatico Guest House) where at the -1 floor Eklund lecture hall and informatics lab is devoted to the Master activities of the first year of the programme.In the first year a number of exercises are conducted in the radiological, nuclear medicine and radiation therapy facilities of the Trieste University Hospital under the supervision of the Medical Physicists of the Medical Physics Dpatrtment.

Course description

Aims

&

Learning outcomes of the module

Medical physics residency

&

The second year portfolio

Program Overview

Medical physicists make a major contribution to the safe and effective diagnosis and treatment of patients. Their knowledge of physics, particularly radiation physics, the physics of the complex technology involved in modern diagnosis and treatment and how radiation interacts with human tissue are essential to the successful application of ionising and non-ionising radiation in medicine.

The radiation oncology medical physicist's responsibilities cover five major areas: dosimetry, treatment planning, quality control, equipment selection and radiation safety.
The diagnosis medical physicist's responsibilities cover areas of dosimetry, imaging detectors, image processing, radionuclide and radiopharmaceutical production and use, quality assurance and quality control, equipment selection and radiation safety.
A large part of the duties involves commissioning, calibration, and quality assurance (QA) of the ever increasingly complex equipment used in medicine.

First year programme

The first year programme is taking into account the clinical responsibilities of the medical physicists providing the necessary knowledge in all area of medical physics (diagnostic and interventional radiology, nuclear medicine and radiation oncology and radiation protection) from theoretical topics (atom and nuclear physics, radiation interaction and radiation dosimetry, physics of imaging and physics of detectors, statistics) to applied areas (technology of radiological, MRI, US equipment, radionuclide production, QA in diagnostic, nuclear medicine and radiation oncology equipment, radiation oncology techniques including treatment planning, Monte Carlo methods, radiation protection on medical sector, etc)

Table 3: Curriculum at a Glanceshows how different topics are developed in the first year and distribute in 3 distinct periods. At the end of each period, about 4 weeks are devoted to the examinations of the courses in the period.
Typically the first year begins the 15 of January and ends the 20 of December, with a free month in August.

The calendar of the activities, usually distributed form Monday to Friday, can be suspended to give the opportunity to the students to follow other relevant medical physics ICTP activities (e.g. Joint IAEA/ICTP Advanced short courses, College of medical physics, School of radiation oncology, etc).

Second year programme

The objective of the clinical training programme for medical physicists specialising in radiation oncology or diagnostic and nuclear medicine is to produce an independent practitioner who is a life long learner and who can work unsupervised at a safe and highly professional standard.

While there are an increasing number of Master level courses in medical physics offered by universities in many countries of the world, the clinical training component for the total process has, in many cases, been missing. This has resulted in incomplete preparation of the medical physicist to practice independently as important aspects of training cannot be completed in the university setting. A structured in-service clinical training programme provides a better preparation for medical physicists to ensure that they are capable of independent, safe and effective practice.

The programme of the full time year of clinical training of this Master has been developed following IAEA (TSC 37, 47 and 50) and AFRA recommendations.

The student has to select the area of interest for the clinical training:

- Medical physics for radiation oncology
- Medical physics for diagnostic and nuclear medicine

The Network of hospitals for the clinical training has agreed the content and duration of the different modules of the training and has developed a Portfolio that guides the Clinical Supervisor (CS) and the Resident (the student) in developing the training. The Portfolio will collect the formal assessment by the CS of the competences and skills reached for each module and sub-module. The filled and signed Portfolio will accompany the Graduated medical physicit after the Master programme and it will allow her/him to demonstrate the skills and competences acquired.

During the year of residency, the Resident will be asked to develop a short applied research work on matters of the training (a month of total duration time devoted) that will be presented and defended at the final graduation exam.

The final graduation exam includes also a discussion with the Graduation board and her/his Clinical supervisor on the clinical training activities. Finally, to become familiar with the Italian academic grading, a section of this chapter is describing and comparing this system with the European and USA ones.

Academic Grading

First year

For ordinary exams, universities in Italy use a 30-point scale simply divided in two: non-passing (0 to 17), and passing grades (18 to 30 and 30 cum laude). The table compares the Italian system with others.

Table 2: Italian grades with corresponding ECTS & US grading

Italian Grades	ECTS Grade	ECTS Definition	% of successful students	US Grade	US definition
27-30 con Lode	A	Excellent	10%	A-,A,A+	Excellent
24-26	B	Very Good	25%	B-,B,B+	Good
21-23	C	Good	30%	C-,C,C+	Satisfactory
19-20	D	Satisfactory	25%	D-,D,D+	Barely Passing
18	E	Sufficient	10%		
14-17	Fx	Fail	10%	E or F	Fail
0-13	F	Fail	25%		

Second year

The assessment of the competences acquired in the clinical training are attributed by the clinical supervisor/s, topic by topic, following the modules and sub-modules of the Portfolio and only for the activities performed (it is well understood that not all the task detailed in the Portfolio can be developed in the short time of a year).

Final rating

For the final rating a 110-point scale is used, with 66 being the minimum for passing. The 110-point scale incorporates scores on both exams of the first year, the clinical training of the second year and the final thesis discussion.

Approximately, 65-points are coming from exams of the first year, 35-points from the clinical training, and 10-points from the final thesis.

For outstanding results, the Lode "praise" is added to the maximum grade.

Curriculum at a Glance

Table 3: Curriculum at a Glance

First year (Lectures & Exercies)			
Term1	L01	Anatomy and Physiology as Applied to Medical Physics	
	L02	Radiobiology	
	L03	Radiation Physics	
	L04	Radiation Dosimetry	
	L05	Medical Imaging Fundamentals	
	L06	Physics of Imaging Detectors	
	P5.2	Statistics for medicine	
	P01	At Hospital in Radiology, Nuclear Medicine, Radiotherapy and Medical Physics depts. (1/3)	
Term2	L09	Physics of Diagnostic and Interventional Radiology with X-ray 1,2	
	L10	Physics of Diagnostic Radiology with US and MR	
	L11	Physics of Radiation Oncology 1 :	
			L11(1)Fundamentals of Radiation Oncology
			L11(2)Equipment and technology for RT
			L11(3)Imaging for Radiation Oncology
	L13	Radiation Protection 1	
	L14	Radiation Protection 2	
	P02	Guided exercises: Radiology	
	P04	Guided exercises: Radiation oncology 1	
			P04(1)Basic Quality Control
			P04(2)Treatment planning and dose calculation
			P04(3.1)Treatment Planning 1
			P04(4)Imaging for Radiation Oncology
	P01	At hospital in radiology, nuclear medicine, radiotherapy and medical physics depts. (2/3)	
Term3	L07	Physics of Nuclear Medicine 1,2	
	L12	Physics of Radiation Oncology 2 :	
			L12(1)Treatment planning systems and dose calculation algorithms
			L12(2)Intensity Modulated Techniques
			L12(3)Special Techniques
			L12(4)Brachytherapy
	L15	Information Technology for Medical Physics	
	L16	Medical Equipment Management	
	P05.1	Information technology and software tools: exercises with ImageJ	
	P04	Guided exercises: Radiation oncology 2	
			P04(5)Intensity Modulated Techniques

		P04(3.2)Treatment planning 2 P04(6)Brachytherapy
	P03	Guided exercises: Nuclear medicine
	P06	Monte-Carlo simulation methods
	P01	At hospital in radiology, nuclear medicine, radiotherapy and medical physics depts. (3/3)

Second year (Clinical Medical Physic Residency)

9-10 months Portfolio	1-2 months Thesis work	Defence & Final oral examination

Table 4

Full module description (First year)	
L01: **Anatomy and Physiology as Applied to Medical Physics**	**Aims:** To educate foundation-level knowledge of human anatomy, physiology, biology and pathology (with focus on cancer) relevant to medical physics.
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Be able to interpret common medical terminology from knowledge of Greek and Latin root words. ✓ Be able to describe the functions of the most important organs. ✓ Be able to identify gross anatomical structures (especially on CT images used in treatment planning). ✓ Know the anatomy and physiology of the main organs of the body. ✓ Familiar with cell biology and physiology, basic tumor pathology, cell proliferation and carcinogenesis. ✓ Familiar with anatomical landmarks from medical imaging cross-sections. ✓ Familiar with basic human genetic.
➢ Module Syllabus	• Anatomical Nomenclature ○ Origin of anatomical names ○ Prefixes and suffixes

	○ Anatomical position and body plane terminology • Structure, Physiology, Pathology, and Radiographic appearance (x-ray, CT, MRI and nuclear medicine imaging) of: ○ Bones and Bone Marrow ○ Brain and CNS ○ Thorax ○ Abdomen ○ Pelvis ○ Respiratory, Digestive, Urinary, Reproductive, Circulatory, Lymphatic, Endocrine Systems
➢ Number of hours	**32** (face to face on lecture room)
➢ ETCS[*1] Credits	**4**
➢ Module Organizer	**Dr. Manuel Belgrano (University of Trieste)** Email:
➢ Assessment Items	**Examination**: ▪ Oral: **100 %**

[*1] **European Credit Transfer and Accumulation System** (**ECTS**) is a standard for comparing the study attainment and performance of students of higher education across the European Union and other collaborating European countries. For successfully completed studies, ECTS credits are awarded. One academic year corresponds to 60 **ECTS-credits** that are equivalent to 1500–1800 hours of study in all countries irrespective of standard or qualification type and is used to facilitate transfer and progression throughout the Union. Typically, a ECTS is equivalent to 25-30 hours of study.

***L02:* Radiobiology**	**Aims:** to provide the basic biological and physiological background for understanding the effects of radiation on human tissues and resulting safety policies and therapy regimes
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Understand the fundamental concepts including linear quadratic model, cell survival curve, tissue radio-sensitivity (LET, RBE, tissue weighting factor), presence of radio-sensitizers, oxygen and radio-protectors, age, dose-effect relationships. ✓ Be able to explain the radiobiological rational underpinning the various treatment strategies (fractionation, dose rate, radio-sensitization and re-oxygenation) in radiation therapy. ✓ Be able to explain quantitatively the fundamental radiobiological models (TCP, NTCP, EUD,...) and know their application ✓ Familiar with radiobiological dose-effect relationship relevant to radiation oncology ✓ Familiar with deterministic/stochastic, early/late and teratogenic/genetic effects ✓ Familiar with the radiobiological advantages of proton and heavier ions for radiation oncology.
➢ Module Syllabus	• Classification of Radiation in radiobiology • Radiation injury to DNA and Repair of DNA damage • Radiation-induced chromosome damage and repair • Radiation injury to tissues

	• Cell death, cell cycle and cell kinetics
	• Survival curve theory
	• Cellular recovery processes
	  ○ Type of radiation damage, potential lethal and sub-lethal damage, fractionation effort and dose rate effects
	• Modifier of radiation responses- Sensitizers and protectors
	  ○ Oxygen effect and other radio-sensitizers, radioprotection
	• LET (Linear Energy Transfer), RBE (Relative Biological Effectiveness) and OER(oxygen Enhancement Ratio)
	• Radiation pathology- Acute and Late effects
	• Time, dose and fractionation
	  ○ The 4 R's of radiobiology, volume effects, the basis of fractionation, dose response relationships for early and late responding normal tissues
	  ○ Hyper-fractionation and accelerated treatments, hypo-fractionation and high dose per fraction, α/β model
	• Tumor Control Probability (TCP), Normal Tissue Complication Probability (NTCP), Equivalent Uniform Dose (EUD)

➢ Number of hours	**12** (face to face on lecture room)
➢ ETCS Credits	**1**
➢ Module Organizer	**Prof. Edoardo Milotti (University of Trieste)** Email: milotti@ts.infn.it
➢ Assessment Items	**Examination:** ▪ written (closed book) **80%** ▪ Oral: **20%**

***L03:* Radiation Physics**	**Aims:** to give the students an understanding of the principles of radiation physics and more specifically a detailed knowledge of the physics of the ionizing radiations used for medical diagnostic purposes. This course is intended to give students a solid background for the other related courses.
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Understand atomic and nuclear structure, radioactivity decay mechanism, radioactive decay law (Half-life, activity, secular equilibrium) ✓ Be able to explain interaction of radiation with matter photon interactions including photon beam attenuation, photoelectric absorption, Rayleigh and Compton scatter, pair production. and the variation of cross-section/angular distribution of scattered photons/secondary electrons with photon energy, atomic number and density of the attenuating materials, attenuation coefficients. ✓ Familiar with charged particle interaction (Elastic and Inelastic scattering) ✓ Know the structure and functioning of the main components of the imaging device (e.g., x-ray tubes and its characteristics, filters and shaped filters, beam limiting devices, detector, anti-scatter grids,…). ✓ Familiar with physics and technologies in common x-ray imaging modalities (general projection (DDR, CR and film-

	screen where this is still valid), chest systems, mammography, dental systems (intra-oral, OPG, cephalometric systems), mobile, flat panel / image intensifier fluoroscopes including C-arms, interventional systems, tomosynthesis, paediatric systems, radiostereometric (RSA) systems, stereotactic systems, dual energy X-ray absorptiometry (DXA)). ✓ Familiar with the main features of fluoroscopes: flat-panel /image intensifier detectors, continuous and pulsed acquisition.

➢ Module Syllabus	• Brief review of quantum mechanics and modern physics
	• X-rays radiology - introduction
	• Passage of the radiation though matter; microscopic treatment
	  o coherent and incoherent scattering on atoms
	  o photoelectric effect
	  o characteristic x-rays
	• Passage of x-rays through matter: macroscopic treatment
	  o Filtering
	  o X-rays instrumentation
	  o Contrast and scattered radiation
	• X-rays detectors
	  o Image intensifiers
	  o Image screens
	  o Digital detectors: computed radiography; the f-centers, direct radiography, indirect conversion methods, direct conversion methods
	  o Other digital detectors

➢ Number of hours	**32** (face to face on lecture room)
➢ ETCS Credits	**4**
➢ Module Organizer	**Prof. Luciano Bertocchi (ICTP)** Email: bertocch@ictp.it
➢ Assessment Items	**Examination:** ▪ Written (closed book) **80%** ▪ Oral: **20%**
***L04:* Radiation Dosimetry**	**Aims:** to describe in detail the principles of dosimetry, definitions of dosimetric quantities, the relationship between the various dosimetric quantities, the structure and operation of various types of dosimeters, the content of relevant code of practices for dosimetry measurements in diagnostic and interventional radiology and in radiation oncology.
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Be able to define charge particles and photon interaction with matters. ✓ Know quantities and units according to ICRU including particle and energy fluence, kerma, Cema, exposure, absorbed dose, relationship between various quantites, ✓ Know particle and charge particle equilibrium and transient CPE concepts,

	✓ Know the principles of cavity theory including Brag-Gray theory, Spencer-Attix theory, Burlin theory ✓ Familiar with different types of dosimeters including Gas based dosimeter, Solid state dosimeter (Thermoluminescence, Scintillation, Diode, Mosfet) and chemical dosimeter and their specific criteria such as accuracy, precision, linearity, dose rate/energy dependence and spatial resolution. ✓ Know uncertainties calculation in dosimetry measurements ✓ Familiar with radiation beam quality standards ✓ Know international radiation dose calibration chain (PSDLs, SSDLs, user cross-calibration) ✓ Know IAEA TRS 457 (dosimetry in diagnostic radiology) and IAEA TRS 398 (absorbed dose determination in external beam radiotherapy). ✓ Know existence of other relevant national code of practices for dosimetry (e.g. AAPM)

➢ Module Syllabus	• Interaction of charged particles (electrons) with matter
	• Stopping Power
	    ○ Restricted, Unrestricted
	    ○ Linear Energy Transfer (LET)
	• Interaction of uncharged particle with matter: photons and neutrons
	• Quantities and Units
	• Stochastic, non-stochastic quantities
	• Fluence, Exposure, KERMA, CEMA, Absorbed dose, exposure
	• Radiation and charged particle equilibrium
	• Multiple scattering theories

	• Transport Equation
	  ○ Charged Particle slowing down
	  ○ Continuous Slowing Down Approximation (CSDA)
	• Fano theorem
	• Cavity Theory
	  ○ Large, intermediate and small cavity theories
	• Radiation Dosimeters and instrumentation
	• Radiation Standards
	• Calibration Chain
	• Absolute dosimetry protocols and IAEA codes of practice for diagnostic and international radiology and for radiation oncology

➢ Number of hours	**32** (face to face on lecture room)
➢ ETCS Credits	**4**
➢ Module Organizer	**Dr. Renato Padovani (ICTP)** Email: padovani@ictp.it
➢ Assessment Items	**Assignment:** ▪ Short lecture on a assigned topic **10%** **Examination:** ▪ Written (closed or open book) **70%** ▪ Oral: **20%**

L05:
Medical Imaging Fundamentals

Aims: to introduce students to the major medical imaging technique employed in hospitals and enable students to develop a basic familiarity with imaging subspecialty to the general concepts of imaging science, including signal processing, system performance, linear system theory, digital image processing, image formation, reconstruction, quantification and decision theory.

➢ Learning Outcomes

After completion the module, the student is expected to :

- ✓ Understand the physics and mathematics of image formation with ionizing radiation
- ✓ Be able to Explain the principles of image quality measurement: linear systems theory, types of contrast (subject, image and display), unsharpness (LSR, PSF, LSF, MTF), lag, noise (including sources, noise power spectra, effect of lag on noise, noise propagation in image subtraction), SNR (including Rose model, Wagner's taxonomy, CNR, relation to dose, NEQ, DQE, NPS etc).
- ✓ Know fundamental concepts of image science including digital signal distortion due to inadequate sampling (e.g. aliasing), image reconstruction techniques based on Fourier Transform and inverse problem mathematical techniques used in image reconstruction (including both convolution and iterative methods and the advantages and disadvantages of each),
- ✓ Familiar with the principles and methods of Medical image processing including knowledge based image analysis, pattern theory, image segmentation, image registration and co-registration / fusion

➢ Module Syllabus	• Mathematical Methods • Tomographic Reconstruction Techniques • Linear Systems • Acquisition, formation, processing and display of medical images • Perception • Evaluation of Image Quality
➢ Number of hours	**24** (face to face on lecture room)
➢ ETCS Credits	**3**
➢ Module Organizer	**Dr. Luigi Rigon (University of Trieste and INFN)** Email:luigi.rigon@ts.infn.it
➢ Assessment Items	**Assignment:** ▪ written assignment **10%** **Examination:** ▪ written (closed book) **70%** ▪ Oral: **20%**

L06: Physics of Imaging Detectors

Aims: to provide an understanding of the physics of detectors commonly used in X-ray and gamma ray imaging. This module is intended to complement the other related courses.

➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Know the functioning of the radiation detectors for X-ray imaging and nuclear medicine. ✓ Be able to explain the concepts of fundamental detector properties like energy resolution, sensitivity, spatial resolution and temporal resolution. ✓ Be able to explain quantitatively the fundamental characteristics of ionizing radiation sensors / detectors including pulse height spectrum and energy resolution, counting curves and plateau, detection efficiency and energy response, dead time, detection threshold and temporal resolution. ✓ Familiar with detector dose requirements: speed class (film-screen), speed index (CR), DQE (DR).

➢ Module Syllabus	• Basics: Introduction to Poisson statistics
	• Physics of generic photon detectors
	  ○ Quantum efficiency
	• Direct conversion detectors
	  ○ Charge generation and charge collection
	• Indirect conversion detectors
	  ○ Scintillators
	  ○ Integrating detectors
	  ○ Counting detectors
	  ○ Spectroscopic detectors
	• Sampling
	  ○ Space
	  ○ Time

	• Noise considerations
	  ○ Signal to noise ratio
	• Photon transfer curve
	• Concept of spatial frequency depending detective Quantum efficiency
	  ○ Integrating detectors
	  ○ Counting detectors

➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**
➢ Module Organizer	**Dr. Ralf Menk (ELETTRA)** Email: ralf.menk@elettra.eu
➢ Assessment Items	**Examination:** ▪ Written (open book) **90%** ▪ Oral: **10%**

L07:
Physics of Nuclear Medicine 1,2

Aims: to provide an introduction to physical principles and technical aspects of the most important nuclear medicine modalities and equipment as well as the essential elements of quality management in nuclear medicine. The module is designed to ensure that students have the underpinning knowledge of the production and use of radionuclides in diagnostic and therapy, nuclear medicine image formation and internal dosimetry.
***The module is split into two parts.

➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Be able to explain the physics, specification and fundamental component of medical devices used in diagnostic nuclear medicine including gamma camera, PET, SPECT and multi-modality imaging. ✓ Know the processes for the production of medical radionuclides using cyclotrons, reactors and generators, including quantities of generated activities in thin and thick targets ✓ Be able to explain the procedures for correction and quantitation, and fundamental limits in Nuclear Medicine. ✓ Know the measurement of physical quantities relevant to Nuclear Medicine. ✓ Know the physical properties of radionuclide compounds selected to implement Quality Control (QC) and their radioprotection implications. ✓ Familiar with institutional framework for Quality Assurance (QA) activity and regulation in a Nuclear Medicine department. ✓ Familiar with in vitro techniques including radioimmunoassay (RIA), reagent, well counters.

➢ Module Syllabus	• Short elements of nuclear decays
	• Radioisotope imaging generalities
	• Images from radioisotopes
	• Radioisotopes production
	  ○ Bateman equations
	• Radionuclides administration
	• The most frequenty used radioisotopes
	• Imaging Instrumentation
	  ○ Planar, Whole-body
	  ○ SPECT

	○ PET ○ Hybrid Imaging • Medical applications of spect and pet • Image Quality and noise • Non-imaging Instrumentation ○ Dose calibrators, Well counters ○ Probes • Internal Dosimetry • Quantitative Imaging • Radionuclide Therapy • Acceptance testing and commissioning • Quality management of Nuclear Medicine	
	Physics of Nuclear Medicine 1	**Physics of Nuclear Medicine 2**
➢ Number of hours	**24 hours,** (face to face on lecture room)	**16 hours** (face to face on lecture room)
➢ ETCS Credits	**3**	**2**
➢ Module Organizer	**Prof.Luciano Bertocchi (ICTP)** Email: bertocch@ictp.it	**Dr. Faustino Bonutti (AOU Udine)** Email
➢ Assessment Items	**Examination:** ▪ written (closed book) **80%** ▪ Oral **20%**	**Assignment:** ▪ presentation **10%** **(the subject will be confirmed)** **Examination:** ▪ written (closed book) **90%**

L08-L09:

Physics of Diagnostic and Interventional Radiology with X-ray 1,2

Aims: provide knowledge that underpins the principles and technical aspects of modalities used in diagnostic and interventional radiology such as Mammography, Fluoroscopic, CT, DECT, Tomosynthesis and Dual energy imaging systems. The module is designed to describe the principles from the production of X-ray to the formation of a medical image, as well as the essential elements of QC procedures in radiology.

***The module is split into two parts.

➢ Learning Outcomes

After completion the module, the student is expected to :

- ✓ Be able to explain in detail x-ray production for general projection x-ray imaging modalities
- ✓ Be able to define image quality evaluation and optimization in radiology including contrast, resolution, noise and artefacts
- ✓ Know the physical principles, functioning and structure for diagnostic and interventional image modalities including (chest systems, mammography, mobile, flat panel / image intensifier fluoroscopes including C-arms, interventional systems, tomosynthesis, dual energy X-ray absorptiometry (DXA), axial an.d sequential/axial and helical mode CT, multidetector CT, dual source/energy CT, volumetric CT scanners, CT scanners for radiotherapy planning.
- ✓ Know dosimetry related indicators/quantities including (mammography): glandular dose in mammography; (fluoroscopy): cumulative fluoroscopy time, cumulative

	fluoroscopy KAP, cumulative fluorography KAP, total cumulative KAP, cumulative air kerma at the international reference point, peak skin dose, organ absorbed dose, effective dose; (CT): CTDIair (Ca,100), CTDIW (CW), CTDIvol (CVOL), KLP (PKL,CT), organ absorbed dose, effective dose … ✓ Familiar with the fundamental features of fluoroscopes: flat-panel / image intensifier detectors, continuous and pulsed acquisition including frame rate, automatic brightness control, high dose rate fluoroscopy, digital spot imaging, cine runs, last image hold, roadmapping. ✓ Familiar with acquisition parameters for all forms of CT imaging including kV, bowtie filter, mA, rotation time, tube current modulation, noise index, pitch, collimation, scanned field of view, slice thickness, beam collimation, over beaming, over scanning), ✓ Familiar with the factors for optimizing acquisition/processing procedures to decrease CT dose. ✓ Familiar with the principles of quality control of for diagnostic and interventional image modalities.
➢ Module Syllabus	• Overview of Imaging Modalities (ionizing and non-ionizing) • X ray Imaging ○ Generation of x-rays , x-ray spectra ○ Detectors ○ Image Parameters ○ Image quality, Noise, contrast, resolution ○ Radiographic, Mammography, Fluoroscopic, ○ CT, DECT, Tomosynthesis ○ Interventional Radiology ○ Dual energy imaging and absorptiometry

	○ Patient dose and system optimization • Dual and Multi-modality Imaging • Quality Management of Diagnostic and Interventional Radiology	
	Physics of Diagnostic and Interventional Radiology with X-ray 1	**Physics of Diagnostic and Interventional Radiology with X-ray 2**
➢ Number of hours	**16** (face to face on lecture room)	**16** (face to face on lecture room)
➢ ETCS Credits	**2**	**2**
➢ Module Organizer	**Dr. Fulvia Arfelli (University of Trieste-INFN)** Email: fulvia.arfelli@ts.infn.it	**Dr. Paola Bregant (AOU Trieste)** Email: paola.bregant@asuits.sanita.fvg.it
➢ Assessment Items	**Examination:** ▪ written (closed book) **100%**	**Examination:** ▪ written (closed book) **100%** ***Note that in some cases examinations might be required in some cases

L10:

Physics of Diagnostic Radiology with US and MR

Aims: to introduce students to the physics of medical imaging with non-ionizing radiation (MRI and ultrasound) and provide them with the necessary theoretical background of these image modalities.

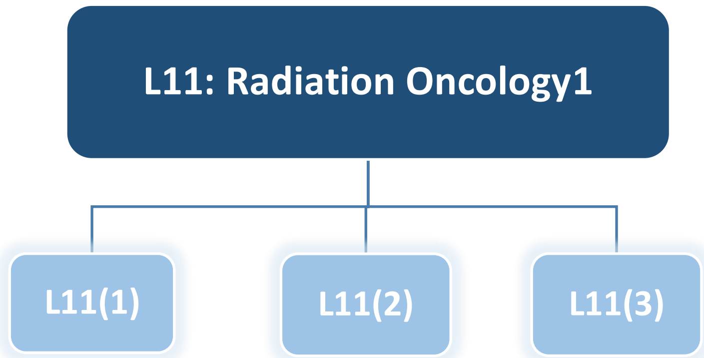
- Learning Outcomes

After completion the module, the student is expected to :

- ✓ Be able to explain the fundamental MRI concepts/principles: MR nuclei in a static magnetic field (B0), Larmor frequency, radiofrequency field (B1), relaxation mechanisms and times (T1, T2, T2*), Bloch equation (without and with relaxation terms), rotating frame, intrinsic and extrinsic MRI contrast parameters, pulse-sequence selection, TE, TR, flip angle, FOV, matrix size.
- ✓ Know the following pulse sequences: spin echo, gradient echo, fast spin echo, inversion recovery (STIR, FLAIR).
- ✓ Know the MRI spatial encoding using linear magnetic field gradients including the k-space formalism.
- ✓ Know the user determined MRI parameters influencing image contrast, SNR, CNR, spatial resolution and acquisition time.
- ✓ Familiar with MRI main component including static magnetic field subsystem, radiofrequency field subsystem, gradient field subsystem (amplitudes, rise times, slew rate and eddy current effects), computer and control sub-system, the various types of RF coils and RF shielding.
- ✓ Familiar with the physics principles underpinning MR angiography (MRA) and flow, perfusion and diffusion imaging, functional MR imaging (fMRI) and BOLD contrast, MR spectroscopy (MRS), parallel imaging, DCE-MRI.
- ✓ Familiar with the formation of common artefacts e.g., motion artefact, aliasing (‘wrap-around’ artefact), metal and

	susceptibility artefact, chemical shift artefact, truncation artefact, B0 / B1 inhomogeneity, RF distortions and coil problems, ghosting (non-motion). ✓ Familiar with the bioeffects of MRI with regard to patient safety including static field effects (projectile, effects on implants, physiological effects), RF field (Tissue heating, SAR, burn injuries) and gradient field considerations (peripheral nerve stimulation, sound pressure levels). ✓ Be able to explain the various interactions of ultrasound with tissue (including gas in tissues: absorption (including frequency dependence), Rayleigh scatter (including frequency dependence), reflection, behaviour at interfaces (including angular dependence), and refraction. ✓ Know the following ultrasound modes: 2D/3D/4D B-Mode scanning, A-Mode , M-Mode , Colour Flow Pulsed Doppler, Duplex/triplex scanners, Pulsed Doppler, Continuous Wave (CW) Doppler, Spectral Doppler, Power Doppler ✓ Familiar with performance indicators for ultrasound imaging devices e.g., spatial resolution (axial , lateral, slice thickness), contrast resolution (including dynamic range), SNR, range, dead zone.
➢ Module Syllabus	• Ultrasound Imaging ○ Acoustic properties of biological tissues ○ Wave, motion and propagation, acoustic power ○ Modes of Scanning ○ Transducers ○ Doppler ○ Safety • Magnetic Resonance Imaging (MRI)

	○ Physics of Magnetic Resonance ○ MR Image formation ○ MR Instrumentation ○ MRI methods ○ MR contrast and image quality ○ Clinical applications and artefacts ○ Safety
➢ Number of hours	**32** (face to face on lecture room)
➢ ETCS Credits	**4**
➢ Module Organizer	**Dr. Renata Longo (University of Trieste)** Email: renata.longo@ts.infn.it
➢ Assessment Items	**Assignment:** ▪ presentation **20% (the subject will be confirmed)** **Examination:** ▪ Written (closed book) **70%** ▪ Oral: **10%**



Aims: to provide students with essential skills in physics of radiation oncology. The module aims to build students' essential elements and understanding of physics and radiobiology applied in radiotherapy, different equipment used in radiotherapy, and the role of imaging in the radiotherapy process.

***The module is split into three parts

L11(1): Fundamental of Radition Oncology

- Learning Outcomes

After completion the module, the student is expected to :

- ✓ Understand the rational basis for using external beam radiotherapy
- ✓ Understand the workflow of a Radiotherapy Department
- ✓ Understand the principles of Quality Management in a Radiotherapy Department
- ✓ Comprehend and apply the principles of professional ethics for medical physicists in the clinical environment
- ✓ Understand the biological basis of the accuracy requirements in radiotherapy
- ✓ Have knowledge of the sources of dose uncertainty in treatment planning and delivery
- ✓ Be familiar with the principal models of dose effects, influence of time, dose fractionation and treatment interruption

➢ Module Syllabus	• Overview of clinical radiation oncology and medical physicist activity
	  ○ Historical introduction
	  ○ Overview of cancer treatment modalities (surgery, chemotherapy and radiotherapy)
	  ○ Professionals and Workflow of a Radiotherapy Department
	  ○ Role of a clinical medical physicist
	  ○ IAEA Code of Ethics for Medical Physicists in the clinical environment
	• Quality Assurance Systems in Radiotherapy
	  ○ International Guidelines for implementation
	• Radiobiological basis and dose accuracy in radiation therapy
	  ○ Radiation dose-response curves and the therapeutic ratio.
	  ○ Steepness of the dose-effect curves and accuracy requirement of dose delivery
	  ○ Sources of uncertainty from prescription to delivery of the treatment
	• Treatment Planning Optimisation
	  ○ Tumour Control/Normal Tissue Complication Models for non-uniform irradiation
	  ○ Dose-volume constrained planning
	  ○ Histogram reduction methods
	  ○ Biological optimization

➢ Number of hours	**16** (face to face on lecture room)
➢ ETCS Credits	**2**

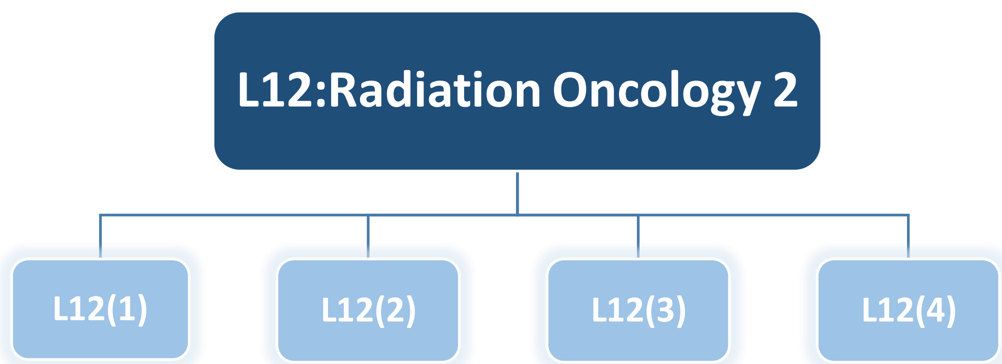
➢ Module Organizer	**Dr. Maria Rosa Malisan (Udine)** **Email:** mr.malisan@gmail.com
➢ Assessment Items	**Examination:** ▪ Written (closed book) **50%** ▪ Oral: **50%**
L11(2): **Equipment and Technology for Radiation Oncology**	
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Be able to explain the functioning, characteristics, strengths and limitations of the various types of available treatment devices: kV therapy devices, cobalt units and medical linacs. ✓ Familiar with general aspects of other systems for MV X-ray / gamma-ray /electron beams including tomotherapy devices, robotic linacs, mobile linacs, intra-operative radiation oncology devices, gamma knife, cyberknife, cyclotrons and synchrotrons (protons and heavier ion beams).
➢ Module Syllabus	• Functional principles and fundamental component of external beam radiation therapy equipment ○ ^{60}Co unit ○ Linear accelerator (photons and electrons)

	○ Mobile linac ○ cyberknife and gamma knife ○ Cyclotrons and synchrotrons • Basic parameters of clinical photon beams: ○ Basic parameters: field size, SSD, SAD, source collimator distance. ○ Filed size options: circular, square, rectangular, irregular. ○ Filed collimators: primary, secondary, and tertiary placement of collimators; rectangular (upper and lower jaws);circular; multileaf collimator
➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**
➢ Module Organizer	**Dr. Mara Severgnini (AOU Trieste)** Email: mara.severgnini@asuits.sanita.fvg.it
➢ Assessment Items	**Examination:** ▪ written (closed book) **100%** ***Note that this exam and the Basic Quality control examination (E(1)-Dr.Vidimari) will be scheduled for the same time.
L11(3): **Imaging in Radiation Technology**	

➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Be able to explain the methods for management of patient organ motion in radiation oncology. ✓ Know the clinical application of a CT based treatment-planning system. ✓ Know techniques for minimizing errors due to target motion resulting from respiration including respiratory gating, breath hold and tumor tracking. ✓ Familiar with the use of 4DCT and 4D treatment planning systems. ✓ Familiar with application of image fusion, registration and deformation in radiation therapy.

➢ Module Syllabus	• Motion and motion management
	    ○ Musculoskeletal, cardiac, breathing and gastrointestinal motion
	    ○ Treatment margins, systematic and random errors
	    ○ Margin reduction strategies: on-line, offline and adaptive
	• CT and 4D CT
	    ○ Hounsfield units for treatment planning (CT number and electron density relation)
	    ○ Artifact rejection
	    ○ Principle of 4D CT
	    ○ Quantification of intra-fraction motion
	    ○ Phase storing
	• Fusion, registration, deformation
	    ○ Algorithms, multimodality imaging treatment planning, treatment planning and motion
	• Motion management through gating and coaching

	○ Measuring technique, gating technique active breating control (ABC)
➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**
➢ Module Organizer	**Dr. Carlo Cavedon (AOU Verona)** **Email:** carlo.cavedon@ospedaleuniverona.it
➢ Assessment Items	**Assignment:** ▪ written assignment **X%** **Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**



Aims: to provide students with essential skills in physics of radiation oncology. The module also aims to build students' essential elements and understanding of more complex and advanced patient treatment planning, dose calculation and optimization algorithms, the role of IGRT and ART in radiotherapy process, special radiotherapy techniques in radiotherapy and brachytherapy.

***The module is split into six parts

L12(1): **Treatment planning and dose calculation**	
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Understand the principles of photon and electron dose calculation algorithms ✓ Know the limitations of dose calculation algorithms for heterogeneity corrections in low-density tissue, in presence of tissue interfaces or metallic implants. ✓ Gain familiarity with the different categories of dose calculation algorithms (correction-based, model-based, Monte Carlo, Boltzmann equation solvers) ✓ Familiarize with the process of commissioning a TPS
➢ Module Syllabus	• Effects of patient and beam geometry ○ Air gap, beam obliquity, irregular patient surface, internal heterogeneities: bone, fat, lung, air • Dose algorithms ○ Analytical algorithms including Pencil Beam, Collapsed Cone, Boltzmann Equation Solvers, etc. ○ Monte Carlo algorithms (AAPM 105) ○ Clinical commissioning ○ Management of metallic implants (AAPM 81)
➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**

➢ Module Organizer	**Dr. Michele Avanzo (Onc. Hosp Aviano)** **Email:** mavanzo@cro.it
➢ Assessment Items	**Assignment:** ▪ written assignment **X%** **Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**
L12(2): **Intensity Modulated Techniques**	
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Understand how IMRT techniques are used for creating optimized dose distributions: fixed-gantry IMRT (static or dynamic MLC), rotating-gantry IMRT (serial and helical tomotherapy) and intensity-modulated arc therapy (IMAT or VMAT).
➢ Module Syllabus	• Delivery, treatment planning, and clinical implementation of IMRT based on (AAPM RPT 82) • Optimization algorithms based on (AAPM TG 166)
➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**

➢ Module Organizer	**Dr. Giovanna Sartor** **(Onc. Hosp Aviano)** **Email:** gsartor@cro.it
➢ Assessment Items	**Assignment:** ▪ written assignment **X%** **Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**
L12(3): **Special Techniques**	
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Know the principles of sophisticated and special radiation oncology techniques including stereotactic radiotherapy (SRT)/radiosurgery (SRS) and intraoperative radiation therapy (IORT. ✓ Familiar with delivery and dosimetry in SRT and IORT.
➢ Module Syllabus	• International dosimetry protocols (IAEA TRS 398, AAPM TG 51) • Special external beam radiotherapy techniques: o Stereotactic radiosurgery, stereotactic radiotherapy; intraoperative electron therapy (IOERT) • Principles of QA and dosimetric considerations (based on AAPM TG135 and AAPM TG 72).
➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**

➢ Module Organizer	**Dr. Paolo Scalchi (AO Vicenza)** **Email:** paolo.scalchi@ulssvicenza.it
➢ Assessment Items	**Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**
L12(4): **Brachytherapy**	
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Know the most common radionuclides and types of sealed sources used in brachytherapy and their clinical use. ✓ Demonstrate understanding of the dosimetry properties of brachytherapy sources ✓ Demonstrate knowledge about the principles of operation of remote afterloading units, their safety features and essential quality control tests ✓ Familiar with recommended methods for reference air kerma rate (RAKR) determination for LDR/HDR/PDR brachytherapy sources. ✓ Know the principles and structure of brachytherapy treatment planning systems, dose calculation algorithms (TG 43, model-

	based algorithms) and dose optimization algorithms for HDR, LDR and PDR. ✓ Familiar with principles of imaging in brachytherapy, applicator and source dwell point position reconstruction techniques (e.g. radiographic films, CT, MRI). ✓ Familiar with the AAPM TG-43 dose calculation algorithm and acquainted with modern model based calculation algorithms. ✓ Grasp the importance of the establishment and maintenance of brachytherapy quality assurance (QA) programme ✓ Be able to explain the principles of special brachytherapy techniques including permanent prostate seeds, stereotactic brain implants, eye plaques, partial breast irradiation. .
➢ Module Syllabus	• Basic physical characteristics ○ Radionuclides and source types used in brachytherapy ○ Sealed-source dosimetry protocols: source strength specification ○ Clinical source calibration: techniques, equipment and related quality assurance • Clinical aspects ○ Brachytherapy techniques: interstitial, intracavitary, intraluminal, surface applicators ○ Brachytherapy delivery systems: direct loading vs. after-loading; manual vs. remote afterloading ○ Dose calculation formalism and dose optimisation techniques ○ Gynecological intracavity therapy ○ Interstitial therapy: Paris dosimetry systems ○ Clinical dose prescriptions, recording and reporting-example for gynecological treatments

	○ Selected clinical treatment planning cases: imaging, dose optimisation procedures, dose-volume histograms, implant quality evaluation ○ Seed implants ○ Ultrasound-guided prostate seed implants
➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**
➢ Module Organizer	**Dr. Tomislav Bokulic** (IAEA, DMRP, Dosimetry Laboratory) **Email:** t.bokulic@iaea.org
➢ Assessment Items	**Examination:** ▪ written (closed book) **100%**

L13-L14:

Radiation Protection (1,2)

Aims: to provide the students with underpinning radiation protection knowledge including biological effects of ionizing radiations, principles of radiation protection and the international framework, regulatory control, assessment of external and internal exposures, shielding calculation for medical applications, protection against occupational exposure in diagnostic radiography, radiotherapy and nuclear medicine
***The module is split into two parts

➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Know radiation biology and radiation effects on human body and know stochastic and tissue reaction effects, dose

	thresholds and risk factors for the purposes of radiation protection of workers, population and patients ✓ Know radiation protection dose quantities (equivalent dose, and effective dose), radiation weighting and tissue weighting factor, operational quantities (ambient and personal dose equivalents), committed dose. ✓ Know the principles of justification, optimization (including ALARA), and dose limitation and know how are used for occupational and public protection. ✓ Know dose limits to limit stochastic risk and to prevent tissue reactions for workers and members of the public ✓ Familiar with Legal framework for radiation protection (BSS) ✓ To be able to design radiation protection program, implementation and management in medical sector. ✓ To be able to apply the radiation protection principles to medical exposure. ✓ To be able to perform shielding calculation for radiotherapy, radiology and nuclear medicine installations ✓ Familiar with personal and environmental dosimetry methods and detectors ✓ Familiar with methods for internal dosimetry and effective dose assessment from internal contamination ✓ Familiar with Radiation protection instrumentation (Ionization chambers, Geiger-Mueller, Proportional counters, Scintillators, Thermoluninescent Dosimeters (TLDs), neutron detectors) ✓ Familiar with Radioactive transport and waste management ✓ Familiar with emergency procedures (risk assessment and calculation of potential exposure) ✓ To be able to plan a radiation protection programme for radiotherapy, radiology and nuclear medicine practices

➢ Module Syllabus	• Biological Effects of Radiation • Radiation Quality factor, Equivalent dose, Effective dose • Operational dose quantities • Radiation protection principles, As low as reasonably achievable (ALARA) concept • Legal framework for radiation protection (BSS) • Occupational, public exposure and annual limits • Radiation protection detectors (Ionization chambers, Geiger-Mueller, Proportional counters, Scintillators, Thermoluninescent Dosimeters (TLDs), neutron detectors) • Personal (external and internal) and environmental dosimetry • Shielding calculation • Radioactive transport and waste management • Emergency procedures • Radiation protection programme design, implementation and management in the medical sector (radiotherapy, radiology and nuclear medicine practices)	
➢ Module Organizer	**Radiation Protection 1**	**Radiation Protection 2**
➢ Number of hours	**16** (face to face on lecture room)	**8** (face to face on lecture room)
➢ ETCS Credits	**2**	**1**
➢ Module Organizer	Dr. Renato Padovani (ICTP) **Email:** padovani@ictp.it	Dr. Elisa Quai (IAEA) **Email:**

➢ Assessment Items	**Assignment:** ▪ written assignment 10% **Examination:** ▪ written (open book) 70% ▪ Oral: 20%	**Assignment:** **Examination:** ▪ written (closed book) **100%**

L15: Information Technology in Medicine

Aims: to enable students to understand and apply some basic concepts in information technology with an emphasis on networking. This module is intended to build medical physics student's knowledge of integrated information technology (IT) systems applied to health care and to describe its impacts on hospital productivity.

➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Be able to explain the structure and the application of Information and Communication Technologies (ICT) for healthcare including Diagnostic and Interventional Radiology, nuclear medicine especially file format, and secure file transfer. ✓ Be able to describe the use of information/ communication standards in medicine such as HL7, SNOMED, IHE, integrated picture archive and communication systems (PACSs) and Hospital information systems (HISs). ✓ Know the DICOM standard for all modalities including the meaning of the terminology used in the DICOM header of images from the various modalities, and know its application to own area of medical physics practice.

	✓ Familiar with the function of ICT hardware and software associated with devices including digital communications networks (LAN, WAN, network typologies, protected subnets for 'mission critical' devices including firewalls) and systems (e.g., PACS) and data exchange standards used in medicine (e.g., DICOM, DICOM-RT).
➤ Module Syllabus	• International standards (IEC, DICOM, IHE) • General concepts and architecture of HIS/RIS/PACS • Radiotherapy record and verify (R&V) systems • DICOM objects for patient dosimetry
➤ Number of hours	**16** (face to face on lecture room)
➤ ETCS Credits	**2**
➤ Module Organizer	Dr. Annalisa Trianni (AOU Udine) Email: Trianni.annalisa@aoud.sanita.fvg.it
➤ Assessment Items	**Assignment:** ▪ written assignment **X%** **Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**

L16: Medical Equipment Management

Aims: to introduce students to the fundamental principles of medical equipment management including Device Risk Management, Governance in Healthcare system.

➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Be able to describe principle of medical equipment management, including standards and guidance. ✓ Know the key principles of medical equipment management, including standards and guidance. ✓ Know the process of specifying, designing, implementing, validating and verifying a novel clinical measurement, software or electronic design solution. ✓ Know how to evaluate the risk management and governance framework for medical devices in healthcare. ✓ Familiar with project management methodologies
➢ Module Syllabus	• Healthcare organization and the role of clinical engineering: Organization and role; Business planning; Risk and governance; Management options; • Principles of Engineering design; Prototyping and testing, outcome evaluation. • Equipment specification; Technology assessment; Clinical evaluation, calibration and standardization; Weighing up costs, risks and benefits; sources of advice; Procurement processes; Methods of acquisition, upgrades and disposals • Quality systems and assurance in equipment management: Quality standards; Auditing; Handling adverse incidents; External standards; Benchmarking services; Equipment calibration and traceability to national standards. • Safety in the clinical environment: General safety issues: electrical safety, other factors; The Medical Device

	Directives and CE marking; Support for clinical trials: R&D and Ethics submissions; Developing new and novel devices: risk assessment and design; Manufacturer indemnity. • Infection risks and control procedures, sterilisation, decontamination, protective equipment. • Principles of Project management; Project Scheduling and Cost Estimation; Systems of management; Risk assessment and cost-benefit analysis applied to equipment management; Computer-based systems for inventory control and maintenance; Managing service contracts; Equipment replacement programmes; Providing staff and facilities; Training users. • Business development: Students will develop a business case covering aspects of the operation of an equipment management service.
➢ Number of hours	**16** (face to face on lecture room)
➢ ETCS Credits	**2**
➢ Module Organizer	Dr. Email:

Practical Sessions and Exercises

P01: Guided Exercises at University Hospital of Trieste

- P01 (S1)
- P01 S(2)
- P01 S(3)
- P01 S(4)
- P01 S(5)
- P01 S(6)
- P01 S(7)
- P01 S(8)
- P01 S(9)
- P01 S(10)
- P01 S(11)
- P01 S(12)

Aims: The aim of this module is to enhance students' understanding of a variety of clinical concepts applied in medical physics. Further emphasis is put on the development of skills required for the next year of residency.

***The module is split into twelve parts.

Module Syllabus

- **Interventional and Diagnostic Radiology**

Session1:
Conventional radiography

Session2:
Mammography

Session3:
Interventional Radiology

Session4:
Computed Tomography

- **Nuclear Medicine**

Session5:
Non-imaging Instrumentation QC

Session6:
Imaging Instrumentation (SPECT) QC

- **Radiation Dosimetry**

Session7:
Radiochromic Film Dosimetry

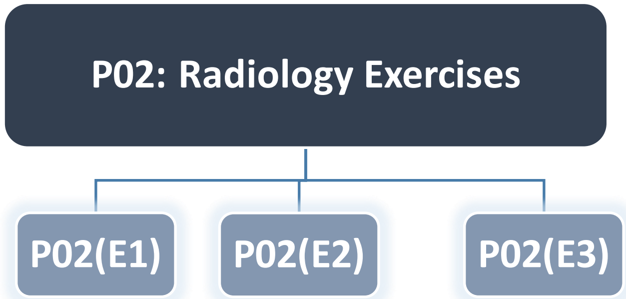
- **Radiation Protection**

Session8:
Radiation Survey of a clinical installation

- **Radiation Oncology**

Session9: **Water Tank Scanning of Photons clinical beams**	***Session10:*** **Water Tank Scanning of Electrons clinical beams**	***Session11:*** **QC on Linac**	***Session12:*** **Radiation Survey of a clinical installation**

➢ Number of hours	12 sessions× 3 hours **= 36 hours**
➢ ETCS Credits	**3**
➢ Module Organizer	**Dr. De Denaro et al. (AOU Trieste)** Email: mario.dedenaro@aots.sanita.fvg.it
➢ Assessment Items	**Evaluation:** ▪ Write 12 reports **100%** ❖ You are required to write a report on each 12 practical session you attend at the Hospital. So that the evaluation is based primarily upon the quality of your report ❖ The deadline for submission of reports should be respected and is usually on September 30 for the first parts and XXXX for the second part of the practical sessions.



Aims: The aim of this practical module is to develop competence in radiology. The module is spilt into three parts and in each part students work individually on tasks involving general and interventional radiology as well as computer image analysis.

***The module is split into three parts.

Learning Outcomes

After completion **Exercise 1**, the student is expected to :

- ✓ be able to apply basic principles of Quality assurance for CT scan including CT# Linearity, Spatial Resolution, Low contrast Resolution, Mean CT#, Noise, Uniformity using Osiris and Imagej software packages

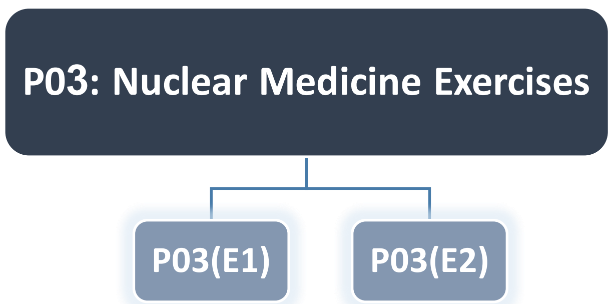
After completion **Exercise 2**, the student is expected to :

- ✓ Familiar with Radiation output, assessment and KAP calibration, entrance air Kerma rates measurements and DRL assessment
- ✓ Be able to analyze patient dose data using Microsoft Excel and perform skin dose map from gafchromic image and gafchromic calibration using ImageJ software package

After completion **Exercise 3**, the student is expected to :

- ✓ Familiar with the effect different parameters have on image quality including Contrast, signal-to-noise ratio and dose, Spatial resolution

	✓ Familiar with Receiver Operating Characteristic (ROC) Curve analysis in medical imaging ✓ Familiar with the effect of beam hardening, the geometry, the statistics, the reconstruction filter and any image artifacts in CT images.		
➢ Module Syllabus	**Radiology Exercise 1** • General radiology (CT): QA, patient dosimetry (software tools) **Radiology Exercise 2** • Interventional radiology: ○ Procedure optimization: DRLs, equipment set-up, protocol optimization ○ Prevention of skin burns: skin dosimetry, trigger level, protocol optimization, clinical follow-up of high dose patients ○ To setup a patient dosimetry survey and data analysis **Radiology Exercise 3** • Introduction and use of IDL tools for image analysis		
	Radiology Exercise 1	**Radiology Exercise 2**	**Radiology Exercise 3**
➢ Number of hours	**12**	**12**	**12**
➢ ETCS Credits	**1**	**1**	**1**
➢ Module Organizer	**Dr. Mario De Denaro (AOU Trieste)**	**Dr. Renato Padovani (ICTP)**	**Dr. Silvia Pani (University of Surrey)**

	Email: mario.dedenaro@aots.sanita.fvg.it	Email: padovani@ictp.it	Email: s.pani@surrey.ac.uk
➢ Assessment Items	**Examination:** ▪ Written (Open book) **100%**	**Examination:** ▪ Written (closed book) **X%** ▪ Oral: **X%**	**Examination:** ▪ Written (closed book) **X%** Oral: **X%**
		**Aims:** the aim of this practical module is to develop practical experience in nuclear medicine.	
➢ Learning Outcomes	A After completion **Exercise 1,** the student is expected to be : ✓ Familiar with the most important QC tests for SPECT systems, including, for each parameter, test equipment, acquisition set-up and factors affecting the results. ✓ Be able to use simple software (Osiris, ImageJ) to process the resulting test images and evaluate quality parameters.		

	✓ Familiar with the procedure for the evaluation of the personalized activity to be administered for the radiomethabolic treatment of hyperthyroidism. ✓ Be able to use simple software (Osiris, ImageJ) to process the images and evaluate some patient-specific parameters. After completion **Exercise 2,** the student is expected to : ✓ Familiar with the principle of radiopharmaceutical preparation and associated quality control. ✓ Familiar with the MIRD scheme, understanding its development and the fundamental characteristics and limitations of the formalism, and how this governs its usage . ✓ Familiar with compartmental / bio-kinetic models and the fundamental characteristics and limitations of the MIRD model and algorithms for internal radionuclide patient dosimetry.	
➢ Module Syllabus	**Nuclear Medicine Exercise 1** • Image quality assessment • Quality Controls (SPECT) • Radionuclide Therapy for hyperthayroidism **Nuclear Medicine Exercise 2** • Patient internal dosimetry (use of software tools)	
	Nuclear Medicine Exercise 1	**Nuclear Medicine Exercise 2**
➢ Number of hours	**12**	**12**
➢ ETCS Credits	**1**	**1**
➢ Module Organizer	**Dr. Maria Rosa Fornasier (AOU Trieste)**	**Dr. Faustino Bonutti (AOU Udine)**

	Email: mariarosa.fornasier@asuits.sanita.fvg.it	Email:
➢ Assessment Items	**Examination:** ▪ Written (closed book) **100%**	**Examination:** ▪ Written (closed book) **X%** ▪ Oral: **X%**
P04: Radiation Oncology Exercises P04(E1) P04(E2) P04(E3) P04(E4) P04(E5) P04(E6)		**Aims**: This module will provide practical experiences in radiation oncology including basic principles of quality control in radiotherapy, manual MU calculation, treatment planning techniques (3DCRT, IMRT,VMAT), Brachytherapy planning and QA, registration and motion managements. ***The module is split into six parts
E(1): Basic Quality Control		
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Know the principles of quality control in Radiation Therapy. ✓ Familiar with acceptance testing and commissioning.	
➢ Module Syllabus	• Principles of quality assurance in radiotherapy based on (AAPM TG 106, 43 and 142) ○ Quality assurance concept (standards, tolerance, etc.) ○ QA of radiotherapy equipment	

	○ Mechanical quality control (QC) ○ Dosimetric and beam characteristics ○ TPS QA • Principles of quality assurance in computed tomography based on (AAPM RPT 83)
➢ Number of hours	**8** (face to face on lecture room) *Note that part of guided exercises at TS hospital (P01:session9-12) form part of the syllabus of this module
➢ ETCS Credits	**1**
➢ Module Organizer	**Dr. Rossella Vidimari** **(AOU Trieste)** **Email:** rossella.vidimari@aots.sanita.fvg.it
➢ Assessment Items	**Examination:** ▪ written (closed book) **100%** ***Note that this exam and the Equipment and Technology for Radiation Oncology examination (L11(2) -Dr.Severgnini) will be scheduled for the same time.
E(2):Treatment Planning and dose calculation	
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Be able to perform MU calculation or time calculation for photon and electron beams based on (AAPM TG114,258) ✓ Familiar with the terminology used in photon, electron and proton Radiation oncology dosimetry including PDD, PSF, TAR, TMR, TPR, scatter function, SAR,SMR collimator factor, relative dose factor, output factor, off-axis ratio .

	✓ Familiar with various meanings of the term ‘normalization’.
➢ Module Syllabus	• Photon beams ○ PDD, profile, Isodose curves (concepts) ○ Dose ratios (e.g. PDD,TMR,etc.) ○ Output-factors (e.g. head scatter factors, total scatter correction factor, etc.) ○ Factors influencing dose distribution (e.g. filed size, energy, etc.) ○ Treatment time and monitor unit calculations and dose tables (equivalent square, PDD tables,..) • Electron beams ○ PDD, profile, Isodose curves (concepts) ○ Range and energy concepts ○ Monitor unit calculation
➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**
➢ Module Organizer	**Dr. Maria Rosa Malisan (AOU Udine)** **Email:** malisan.mariarosa@aoud.sanita.fvg.it
➢ Assessment Items	**Examination:** ▪ An integral part of the examination of "Fundamentals and Radiation Oncology”
E(3): **Treatment Planning 1,2**	
	After completion the module, the student is expected to :

➢ Learning Outcomes	✓ Understand the function of treatment planning system (TPS) software as a virtual treatment system with dose distribution calculator including associated features including BEV, DRR, and DVH. ✓ Understand how CT patient simulators provide a virtual (immobilized) patient for treatment plan generation and optimization purposes. ✓ know the principles of simulation, virtual simulation, DRR's, image registration, Patient setup, including positioning and immobilization ✓ Familiar with the effect of various beam arrangements, beam modification devices (hard and virtual wedges, compensators, blocks, MLCs, bolus) and beam weights on dose distribution.

➢ Module Syllabus	• Principles of photon planning based on(ICRU 50 & 62) and Electron planning(ICRU71)
	• Target Volume definition, and dose prescription criteria prescribing
	   ○ GTV,CTV,PTV, dose prescription point, isodose line
	• Patient data acquisition
	   ○ Contours, images: plain film, EPID,CR.
	• Conventional simulator techniques:
	   ○ positioning, immobilization, markers
	• Accessory device and techniques:
	   ○ Block cutting, compensators, and bolus.
	• CT-simulators techniques
	   ○ Scout view images, virtual simulation, DRRs
	• Special consideration
	   ○ Skin dose, field matching, integral doses, DVHs(differential and integral)

➢ Number of hours	**16** (face to face on lecture room)

➢ ETCS Credits	**2**
➢ Module Organizer	**Dr. Giovanna Sartor <u>(Onc. Hosp Aviano)</u>** **Email:** gsartor@cro.it
➢ Assessment Items	**Assignment:** ▪ written assignment **X%** **Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**
E(4): **Imaging in Radiation Oncology**	
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Familiar with the use of 4DCT and 4D treatment planning systems. ✓ Familiar with application of image fusion, registration and deformation in radiation therapy.
➢ Module Syllabus	• Fusion, registration, deformation ○ Algorithms, multimodality imaging treatment planning, treatment planning and motion • Motion management through gating and coaching ○ Measuring technique, gating technique active breating control (ABC)
➢ Number of hours	**8** (face to face on lecture room)

➢ ETCS Credits	**1**
➢ Module Organizer	**Dr. Carlo Cavedon (AOU Verona)** **Email:** carlo.cavedon@ospedaleuniverona.it
➢ Assessment Items	**Assignment:** ▪ written assignment **X%** **Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**
E(5): Intensity Modulated Techniques	
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Know the principles of forward and inverse planning. ✓ Familiar with IMRT and VMAT treatment planning, optimization and evaluation. ✓ Familiar with pre-treatment dosimetric verification of treatment plans for standard and sophisticated Radiation Oncology techniques including IMRT and VMAT in a phantom.
➢ Module Syllabus	• Forward Vs inverse treatment planning; • Inverse planning objectives and techniques: optimization methods (considering ICRU 83, AAPM TG 142);

	◦ Dose delivery systems: single-slice collimator, multileaf collimators, tomotherapy, volumetric arc therapy (VMAT) ◦ Dose delivery techniques: step and shoot, sliding windows • IMRT and VMAT pre-treatment verification	
	IMRT	**IMAT (VMAT)**
➢ Number of hours	**8** (face to face on lecture room)	**8** (face to face on lecture room)
➢ ETCS Credits	**1**	**1**
➢ Module Organizer	**Dr. Andrea Dassie(Onc. Hosp Aviano)** **Email:** adassie@cro.it	**Dr. Michele Avanzo (Onc. Hosp Aviano)** **Email:** mavanzo@cro.it
➢ Assessment Items	**Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**	**Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**
E(6): Brachytherapy exercise		
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Know the principles and structure of brachytherapy treatment planning systems, dose calculation algorithms (TG 43, model-based algorithms) and optimization algorithms for HDR, LDR and PDR.	

	✓ Familiar with source and points position reconstruction algorithms for brachytherapy (radiographic films, CT and other image based algorithms). ✓ Familiar with the AAPM TG-43 dose calculation algorithm and modern model based algorithms for brachytherapy. ✓ Familiar with acceptance testing, commissioning and QC of after-loading equipment (LDR, HDR, PDR), treatment planning systems, sources and applicators, imaging systems in brachytherapy,. ✓ Familiar with Manage brachytherapy sources including source specification, source security, procedures in case of source loss and source disposal. ✓ Familiar with imaging systems used in brachytherapy.
➢ Module Syllabus	• Clinical aspects ○ Brachytherapy techniques: interstitial, intracavitary; surface applicators ○ Brachytherapy systems: direct loading vs. after-loading; manual vs. remote afterloading ○ Interstitial therapy: Manchester and Paris systems ○ Seed implants ○ Ultrasound-guided prostate seed implants ○ Gynecological intracavity therapy ○ Clinical prescriptions and dose-volume histograms ○ Remote after-loading machines
➢ Number of hours	**8** (face to face on lecture room)
➢ ETCS Credits	**1**
➢ Module Organizer	**Dr. Francesco Ziglio (AO Trento)** **Email:** francesco.ziglio@apss.tn.it

➢ Assessment Items	**Examination:** ▪ written (closed book) **100%**

P05: Exercises on Information Technology in medicine

- **P05(E1)**
- **P05(E2)**

Aims: The aim of this module is to enhance student learning by improving students' ability and knowledge of computer programming, probability and statistics applied in medical physics.

➢ Learning Outcomes

After completion, **Exercise 1**, the student is expected to :

- ✓ Understand the principle of digital image manipulation and processing
- ✓ Be able to apply basic principles of program design using imageJ
- ✓ Familiar with imageJ interface and tools
- ✓ Be able to write Macros to accomplish specific medical physics tasks

After completion, **Exercise 2**, the student is expected to :

- ✓ Select and apply appropriate statistical methods for analysing data typically encountered in medical applications, including Binary, categorical, count, quantitative data.
- ✓ Know how quantitative statistical techniques are used to interpret and handle biomedical data, including the calculation of confidence intervals, combined uncertainties, correlation, regression and hypothesis testing, the influence of sample size and interpretation of p-value. Include specific techniques of

	relevance to the particular specialty of medical physics (e.g., sensitivity, specificity, ROC, VGA, model observers in diagnostic studies). ✓ Critically evaluate the use of statistics in the medical literature ✓ Familiar with the use “R“statistical software for the analysis of clinical and biomedical data: organize and manage datasets, ✓ carry out statistical analysis, and construct tables and figures

➢ Module Syllabus	**Exercise 1: Information technology and software tools for medical physics**
	• Introduction to digital image processing in the medical field
	• Brief review of Fourier analysis in image processing
	• Introduction to ImageJ: basic features, Fourier analysis
	• Programming with ImageJ: quantitative image quality assessment
	• Automated processing with ImageJ: macro and batch processing
	Exercise 2: Statistics for Medicine: Statistics is a useful and necessary tool for the health professions
	• **Descriptive statistics**:
	    ○ Charts /tables, box-plot, measures of central tendency, measures of dispersion and their 'critical' use.
	    ○ Elements of probability theory: definitions and problems, the conditional probability.
	    ○ Diagnostic tests and ROC curve
	    ○ Populations of Gaussian data and their properties.
	• **Elements of statistical inference:**

	○ Point estimates, estimates of intervals, the 'confidence intervals'. Estimation of the mean of a population of Gaussian data; ○ Statistical tests: the chi-square test, Fisher's exact test, the t test Student, Mann-Whitney test and the Wilcoxon test. ○ Risk measures: relative risk (RR) and odds ratio (OR) ○ Linear regression and logistic regression • **Critical reading of a scientific article** • The course focuses on real examples from the medical literature; the open-source software R and the package R Commander (easy-to-use) will be used in order to analyze data. The programme is delivered through a combination of lectures, some of which are dedicated to practical work. The teacher will leave optional homeworks to students about statistical lessons.	
	Exercises on IT in medicine (1)	**Exercises on IT in medicine (2)**
➢ Number of hours	**12**	**12**
➢ ETCS Credits	**1**	**1**
➢ Module Organizer	**Dr. Nico Lanconelli (University of Bologna)** Email: nico.lanconelli@unibo.it	**Dr. Fabiola Giudici (University of Trieste)** Email: fgiudici@units.it
➢ Assessment Items	**Examination:** ▪ Practical **80%** ▪ written **20%**	**Examination:** ▪ written (closed book) **100%**

P06: Monte-carlo simulation methods	**Aims:** This module introduces Monte Carlo methods in medical physics and the application of Monte Carlo simulation using the GEANT4 simulation toolkit in introductory level.
➢ Learning Outcomes	After completion the module, the student is expected to : ✓ Know the principles of modelling and simulation based on Monte-Carlo techniques ✓ Understand the structure of Monte Carlo radiation transfer codes based on Geant4 ✓ Know how to simulate basic codes based on Geant4 ✓ Be able to discuss about Geant4 example relevant to Medical Physics including requirements, methods and "Basic" analysis of results
➢ Module Syllabus	• General Introduction to Monte Carlo methods • Use of Monte Carlo methods in Medical Physics • Basic of Monte Carlo simulation within the Geant4 framework • Practical session of Geant4 simulation • Basic information about other MC tools
➢ Number of hours	**12**
➢ ETCS Credits	**1**
➢ Module Organizer	**Prof. Francesco Longo** **(University of Trieste)**

	Email: francesco.longo@ts.infn.it
➢ Assessment Items	**Examination:** ▪ written (closed book) **X%** ▪ Oral: **X%**

Medical Physics Residency (Second Year)

The clinical training is possible thanks to the collaboration of the Hospitals and the Medical Physics Departments of the clinical training network.

The objective of clinical training program is to provide the MMP students with clinical training in medical physics based on the IAEA clinical training guides in medical physics (TCS-37 for radiation oncology physics, TCS-47 for radiology physics and TCS-50 for nuclear medicine physics).

Four months before the start of the training year, the MMP students need to decide one of the two specific fields of the clinical training to pursue, namely: Radiation Oncology and Diagnostic and Interventional Radiology/Nuclear Medicine.

Medical Physics Residency Training is a full year program and the MMP residents will participate in the clinical physics duties under the supervision of a certified medical physicist of a Medical Physics Department of the clinical training network. During the residency, the Resident will be involved in the routine work of the department according to the workplan of the department.

At the conclusion of the program, the resident is expected to demonstrate competencies in one of the specific training areas.

It should be noted that the clinical training is required in order to complement the education of Residents who have completed the first year academic programme at ICTP.

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Portfolio

Before starting the second year of the programme as a medical physic resident, the student should read the portfolio template. The Portfolio is developed to assure a harmonized and guided clinical training of the Residents of the Master's in Medical Physics Programme of the ICTP and Trieste University.

This document is adapted from the IAEA Technical Course Series No. 47 and 50 and the AFRA guidelines (Recommendations for medical physics education in AFRA member states, 2014). The document was developed and agreed at the ICTP Workshop of 27-28 October 2014, and updated in the next years meetings, where the Head of Medical Physics Departments and Clinical Medical Physicists (CMPs) from the network of the hospitals for the clinical training participated.

The Portfolio tasks to be developed in the year of clinical training are identified by the the Clinical Supervisor **(CS)** in agreement with the Resident taking into account the existing competences and skills of the Resident, the activities and equipment present in the Hospital, and the specific training needs of the Resident.

The CS can assign specific modules or sub-modules to other MP of the Department. The development of the Portfolio and the time devoted to the different modules will have to take into account the following agreed contents and times:

Table 5: Modules for Radiation Oncology Medical Physics Track

Module	Duration (weeks)	Range (weeks)
Clinical environment in radiotherapy	Entire programme 46 weeks	
External beam radiotherapy (EBRT) reference dosimetry	4	2-6
EBRT relative dosimetry	7	4-10
Imaging equipment	3	2-4
EBRT	17	14-20
Brachytherapy	2.5	1-4
Radiation protection and safety	3	2-4
Equipment specification and acquisition	1.5	1-2
Quality management	8	6-10

Professional ethics	Entire programme 46 weeks	
Total weeks	46	

Table 6: Modules for Diagnostic and Interventional Radiology and Nuclear Medicine Track

Module	Duration (weeks)	Priorities
Clinical awareness	Entire programme 23 wks	
Radiation protection and safety	3	
Dosimetry instrumentation and calibration	1	
Performance testing of imaging equipment	13	1
Patient dose audit	2	4
Technology management of imaging equipment	1	2
Optimisation of clinical procedure	3	3
Professional ethics	Entire programme 23 wks	
Total weeks	23	
(The training can be expanded up to 36 wks including angiography units and MRI imaging and safety. The remaining 10 weeks will be devoted to performance testing modules of nuclear medicine equipment) – Priorities: 1 basic – 4 highest competences		

Module	Duration (weeks)	Priorities
Clinical awareness	Entire programme 23 wks	
Radiation protection and safety	4	4: design of the NM Dpt
Technology management in NM	2	
Radioactivity measurement and internal dosimetry	3	
Performance testing of NNM equipment	7	1

Preparation and quality control of radiopharmaceuticals	1	
Radionuclide therapy using unsealed sources	2	3
Optimisation in clinical application	4	2
Professional ethics	Entire programme 23 wks	
Total weeks	23	
(The training can be expanded up to 36 wks including also PET/CT. The remaining 10 weeks will be devoted to performance testing modules of diagnostic radiology equipment) – Priorities: 1 basic – 4 highest competences		

Note: For diagnostic and interventional radiology & nuclear medicine track, it is stated that the 2 sub-programmes can share equally the time or, in the case of specific resident training needs, a sub-programme can be enlarged maintaining some modules of the second programme that has to be included following the indicated priorities (priority 1 indicate the mandatory module)

The content of the clinical training has to be signed by the Resident and the Clinical Supervisor after the first week of the training.

The CS will monitor the development of the residency, can adjust the programme and, at the end of the training will assess the competences and skills achieved by the Resident assigning a mark, from 1 (maximum level of competences – the resident is able to perform the task independently and without supervision) to 5 (minimum – the resident has only a limited knowledge of the task and can perform it only together with an experienced MP), to each task.

The signed Portofolio is then transmitted (by the end of November) to the Coordinator of the master (Dr. Padovani).

The following modules or sub-modules (Table 5: Modules for Radiation Oncology Medical Physics Table 6: Modules for Diagnostic and Interventional Radiology and Nuclear Medicine Track) should be assigned by the Clinical Supervisor to a Medical Physics resident according to the following Table 7: Modules and Sub-Modules Sample form

Table 7: Modules and Sub-Modules Sample form

Module No.	Sub-Module	Assigned to the Clinical Medical Physicists:	Signature

The Clinical Supervisor   The MP Resident

_______________   _______________

Date: _______________

The portfolio provides you with an opportunity to demonstrate the breadth and depth of your knowledge on certain topics. It should incorporate the following documents:

- *Curriculum vitae (CV)*
- *Progress reports*
- *"Summary of Competency Achievement" demonstrating the level of competency achieved in each sub-module.*
- *Samples of work prepared by the Resident from at least 5 of the modules of the Clinical Training Guide*. The samples of work could be:
  - ✓ *Departmental reports, e.g. commissioning and clinical implementation of new equipment or treatment technique.*
  - ✓ *Assignments on key competencies.*
  - ✓ *A research paper published in a peer-reviewed journal*
  - ✓ *A presentation delivered covering key aspects of the module*

The clinical supervisor will examine the portfolio at regular (at least 3 monthly) intervals and provide feedback to the Resident. The ICTP Coordinator will review periodically the portfolio.

Roles and Responsibilities

Your responsibilities include:

- Meeting regularly with your clinical supervisor to discuss progress and to review deadlines.
- Accepting the supportive and corrective feedback provided by your clinical supervisor and other experienced medical physicists in your department. You need to accept this feedback in the spirit that it is provided, i.e. to assist in improving your performance in the programme.
- Maintaining necessary documentation. An important example is to ensure that your clinical supervisor "signs off" after completing a competency assessment. A second important example is keeping your portfolio up-to-date
- Preparing in a thorough manner for all assessments required as part of the programme.
- Taking every opportunity to develop your knowledge and skills and, once acquired, maintaining the knowledge and skills

Assessment of Competences and Progress Report

- The Resident should meet frequently with the Supervisor (a short weekly meeting is recommended).
- The Resident maintains a weekly note of the activity performed
- A mid-term report will be asked to the Resident by the ICTP Coordinator.

The final assessment is performed before the end of November and a copy of the signed Portfolio is sent to the ICTP Coordinator.

The MMP Coordinator may discuss with the Clinical Supervisor the assessments and the progress report and may provide to the Resident feedback. The Resident should discuss the feedback received with the Clinical Supervisor.

The assessment of each task will be graded on a 5 to 1 scale as given in the Table 8: Assessment Scale.

Table 8: Assessment Scale

Grade	Definition
1	Excellent
2	Good
3	Just Satisfactory
4	Unsatisfactory
5	Unsatisfactory

When a grade of 4 or 5 is awarded you will be required to modify the assignment, taking into consideration the feedback provided, and to resubmit the assignment.

Clinical Training Portfolio for Radiation Therapy

For the components in which skills and competencies are directly measurable, the modules, sub-modules and activities from the programme are listed in the following tables, the details of the competencies particular to each activity have been included as a separate column.

Individual training programmes need have been adapted to the routine clinical activities, departmental workflow, access to equipment and to the existing competences and specific needs of the Resident.

A column for comments and signoff of the Supervisor or Medical Physicist in charge is also linked to each competency.

The modules are ordered according to the programme of clinical training but do not necessarily reflect a logical or practical schedule of training.

Notes:

- It has been agreed that if the training on kilo Voltage and Co-60 machines are required and it is not possible to provide in the hospital, a specific workshop will be organised by the ICTP at the end of the period.
- An advanced training on brachytherapy, if required by the Resident, can also be organised in the Trento Hospital (workshop for more Residents or individual training to be defined according to the needs). Please specify in the Portfolio.

Portfolio for Radiation Therapy

M1 M2 M3 M4 M5 M6 M7 M8 M9 M10

Module(1):

Clinical environment in radiotherapy

SUB-MODULE	ACTIVITY
• Workflow of a radiotherapy department	○ Orientation at each major duty station
• Skills to communicate in radiotherapy with other professionals	○ Developing the « language » : Attendance at all clinical rounds, peer review meetings, film review sessions, new patient planning conferences, quality assurance (QA) committee meetings, protocol review meetings, CPD activities

Module (2):

EBRT. Reference dosimetry including instrumentation and calibration

SUB-MODULE	ACTIVITY
• Kilo-voltage therapy	○ Instrument quality control (QC), calibration and cross calibration of field dosimetry systems ○ Beam quality ○ Output calibration
• 60Co teletherapy	○ Instrument QC, calibration and cross calibration of field dosimetry systems ○ Reference field mechanical QC

	○ Reference dose calibration ○ Other calibration methods ○ Constancy – source position, timer, transit time
• MV photons (LINAC)	○ Instrument QC, calibration and cross calibration of field dosimetry systems ○ Reference field mechanical QC ○ Beam quality ○ Reference dose calibration ○ Constancy measurements
• MeV electrons (LINAC)	○ Instrument QC, calibration and cross calibration ○ Beam quality ○ Reference dose calibration ○ Constancy measurements

Module (3):

EBRT Relative dosimetry (ATP, commissioning and ongoing QC)

SUB-MODULE	ACTIVITY
• Kilo-voltage therapy	○ Measurement of field size factors, BSF, PDD, ISL ○ Mechanical, dosimetry and safety checks
• 60Co teletherapy	○ Safety, emergency procedures and ○ Mechanical ○ Relative Dosimetry measurements: TAR, BSF ○ PDD ○ Open and wedge field data ○ Penumbra ○ Equivalent square
• MV photons (LINAC)	○ Safety ○ Mechanical ○ Relative dosimetry measurements:

	○ Scatter correction factors ○ TMR ○ PDD ○ Penumbra ○ Uniformity and symmetry ○ Open field and wedge data ○ Asymmetric collimation
• MeV electrons (LINAC)	○ Safety ○ Relative dosimetry measurements: - Applicator factors - PDD - Irregular fields - Uniformity and symmetry - Virtual source position

Module (4): Imaging equipment)

SUB-MODULE	ACTIVITY
• Fluoroscopic simulator	○ QC and dose (mechanical, safety, radiography, fluoroscopy)
• C-arm	○ QC and dose (mechanical, safety, radiography, fluoroscopy)
• Ultrasound	○ QC
• Computed Tomography (CT)	○ Safety ○ Relative dosimetry measurements: - Applicator factors - PDD - Irregular fields - Uniformity and symmetry

	- Virtual source position
• Film processor, CR or laser printer/imager	○ QC

Module (5): EBRT

SUB-MODULE	ACTIVITY
• Positioning and Immobilization	○ Observe methods of patient positioning and immobilization in order to facilitate optimal field arrangement and minimize setup uncertainty
• Beam modification and shaping devices	○ Manufacture ○ QC and verification ○ Safety aspects
• Contours (manual or single slice) and hand planning	○ Clinical examples
• Techniques relying on a clinical markup, a direct setup and 2D simulation	○ Develop technique, setup instruction and calculation of times ○ Clinical examples
• Establishing margins for PTV definition	○ Clinical examples for different sites and techniques
• 3D Computerized Treatment Planning (TP) equipment	○ Acceptance ○ Acquisition of beam data ○ Commissioning – geometric, dosimetry and networking ○ CT validation ○ End to end testing ○ Algorithms
• 3D TP cases	○ Volume definition ○ Dose plan modelling process ○ DP evaluation and approval (DVH and prescription) ○ DP verification

	○ Setup instruction

Module (6): Brachytherapy

SUB-MODULE	ACTIVITY
• Imaging techniques	○ Planar (stereo shift, orthogonal, semiorthogonal, jigbox) techniques
• Low dose rate and/or high dose rate (HDR) brachytherapy	○ ATP ○ Commissioning ○ QC ○ Source calibration and exchange ○ Image, applicator and source data for TP ○ Prescriptions ○ TP ○ Source preparation
• Safety of sources	○ Stock, acquire, transport, waste management ○ Emergency procedures
• HDR	○ Optimization methods ○ Intraluminal techniques
• Brachytherapy cases	○
• Treatment delivery	○ IVD ○ Recording and reporting
• Ophthalmic applicators	○ QC

Module (7): Radiation protection and safety

SUB-MODULE	ACTIVITY
• International and national regulatory frameworks	○ Review institutional compliance
• Occupational and public exposure in radiotherapy	○ Controlled areas, pregnant staff, monitoring, signage, safe practices
• Design of a facility	○ Hypothetical exercise : Integration of siting, surrounding structures, infrastructure assessment, expansion needs, workflow and efficiency
• Shielding calculations for all radiation bunkers	○ Use layouts to calculate the effective dose rates to the public and the staff around and in the facility ○ Verifying shielding calculations using survey instruments
• Special procedures	○ Fetal dose calculations ○ Pacemakers, etc. ○ 131I therapy or other therapeutic procedures using unsealed sources (if applicable).

Module (8): Equipment specification and acquisition

SUB-MODULE	ACTIVITY
• Department needs assessment	○ Workload ○ Functionality ○ Compatability ○ Siting
• Technology assessment	○ Technical specifications : ○ Dosimetry ○ Imaging ○ Treatment units

	○ Treatment Planning ○ Information Technology and networking ○ National tender and procurement process

Module (9): Quality management

SUB-MODULE	ACTIVITY
• Institutional policies and procedures	○ Personnel monitoring (pregnant workers), reporting incidents and near accidents, notifications (equipment failure), optimizing workflow, personnel orientation
• Performing and documenting QC	○ Dosimetry instrumentation, equipment, calibration of sources, abiding by well-established good practices (e.g. international CoPs), developing internal redundancy systems, clinical aspects
• Auditing	○ Internal (peer review) ○ External
• Risk management culture	○ Risk assessments ○ Investigating incidents and near accidents

Module (10): Professional ethics

SUB-MODULE	ACTIVITY
• Medical ethics	○ Research ethics : Familiarity with the World Medical Association (WMA) Helsinki agreement j and responsibilities in clinical trials. Good clinical practice (GCP).

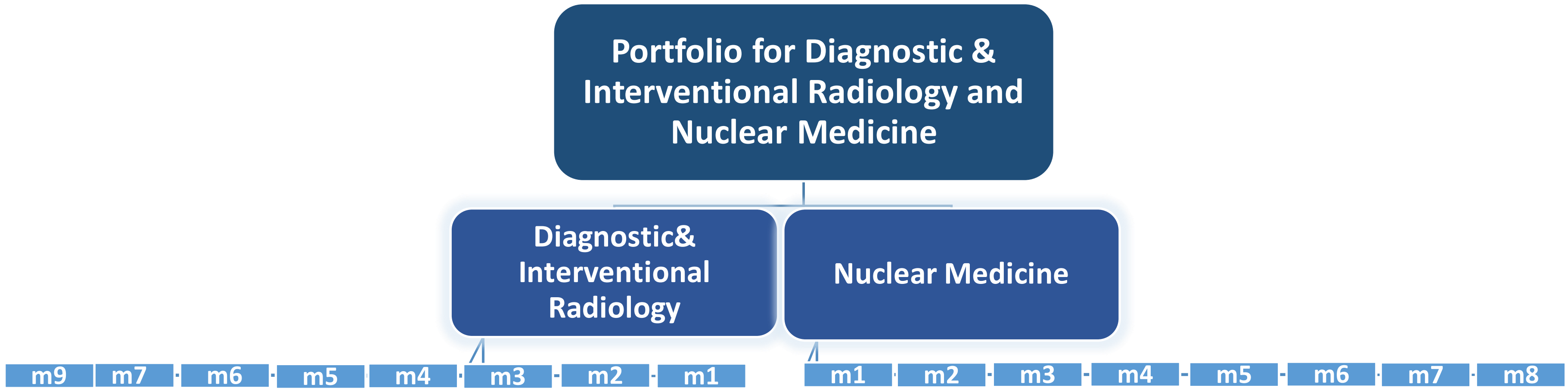
	○ Informed consent
• Knowledge management	○ Medical Physics Organizations : Understanding national, regional and global medical physics bodies ○ Maintenance of knowledge, skills and competence (CPD)
• Code of conduct	○ Patient confidentiality ○ Appropriate conduct in the clinical environment ○ Malpractice

For the components in which skills and competencies are directly measurable, the modules, sub-modules and activities from the programme are listed in the following tables, the details of the competencies particular to each activity have been included as a separate column.

Individual training programmes need have been adapted to the routine clinical activities, departmental workflow, access to equipment and to the existing competences and specific needs of the Resident.

A column for comments and signoff of the Supervisor or Medical Physicist in charge is also linked to each competency.

The modules are ordered according to the programme of clinical training but do not necessarily reflect a logical or practical schedule of training.



Diagnostic& Interventional Radiology

Module (1): Clinical awareness

SUB-MODULE	ACTIVITY
• Patient related experience	○ Understanding patient workflow in a diagnostic radiology department and the role of multidisciplinary professionals involved in diagnostic radiology.

Module (2): Performance testing of imaging equipment

SUB-MODULE	ACTIVITY
• Screen-film systems	○ Measurement and assessment of system performance, periodic QC of screen film systems
• Film processing and darkroom	○ Measurement and assessment of system performance, periodic QC of processor and dark room
• General radiography	○ Measurement and assessment of system performance, periodic QC of general radiography installations and equipment
• Conventional and digital fluoroscopy	○ Measurement and assessment of system performance, periodic QC of simple fluoroscopic systems ○ Measurement and assessment of system performance, periodic QC of complex fluoroscopic / angiographic systems ○
• Computed radiography and digital radiography	○ Measurement and assessment of system performance, periodic QC for computed and digital radiography systems
• Mammography	○ Measurement and assessment of system performance, periodic QC of conventional (screen film) systems ○ Measurement and assessment of system performance, periodic QC of digital systems
• Computed tomography	○ Measurement and assessment of system performance, periodic QC of axial systems ○ Measurement and assessment of system performance, periodic QC of helical systems and MDCT ○
• Ultrasound	○ Measurement and assessment of system performance, periodic QC of ultrasound systems
• Dental radiography	○ Measurement and assessment of system performance, periodic QC
• Display and printing devices and viewing conditions	○ Measurement and assessment of system performance, periodic QC of display and printing devices. Evaluation of viewing conditions.

Module (3): Radiation protection and safety

SUB-MODULE	ACTIVITY
• Design of a facility	○ International and local standards, safety review, surrounding structures, dose and risk assessment, expansion needs, workflow and efficiency ○ Use layouts to calculate shielding requirements ○ Calculation of shielding barriers ○ Verifying shielding calculations using survey instruments
• Radiation hazard assessment	○ Hazard assessment of facilities and radiological procedures ○
• Personnel dosimetry	○ Methods for measuring personal dose ○ Operational use of personal dosimeters
• Unintended and accidental exposure • in diagnostic radiology	○ Respond to an unintended or accidental exposure ○ Occurring in a radiology department affecting staff, patients or members of the public.

Module (4): Dosimetry, instrumentation and calibration

SUB-MODULE	ACTIVITY

• Ionising radiation dosimetry and principles of measurement	○ Dose measurements and uncertainties in clinical practice

Module 5: Patient dose audit

SUB-MODULE	ACTIVITY
• Dose Assessment	○ Dosimetric principles ○ Concept of diagnostic reference levels. ○ Patient dose surveys
• Patient Dose Audit	○ Dosimetry of adult and ○ paediatric patients,
• Foetal dose estimation	○ Foetal dosimetry

Module (6): Image quality assessment

SUB-MODULE	ACTIVITY
• Assessment of image quality with phantoms	○ Image quality phantoms and methodologies useful ○ to assess image quality in various diagnostic radiology modalities
• Assessment of image quality of clinical patient images	○ Subjective methods for image quality evaluation from clinical images. ○

Module (7): Technology management in diagnostic radiology

SUB-MODULE	ACTIVITY
• Tender and procurement process	○ The ability to prepare the specifications and acquire suitable equipment through a tendering process ○
• Quality management of systems in radiology	○ To develop an understanding of the principal requirements and elements for a ○ quality management system in diagnostic radiology.
• Acceptance Testing / Commissioning	○ Understanding of the concept and principles of acceptance and commissioning of equipment.
• Routine testing / Quality control	○ Understanding of the methods for the clinical implementation and ○ supervision of a quality control programme
• Imaging informatics	○ Skills to practice basic imaging informatics in digital imaging environments.

Module (8): Optimization of clinical procedures

SUB-MODULE	ACTIVITY
• Optimization of Procedures	○ Understanding of the main factors that affect image quality and patient radiation dose.

• Clinical audits	○ Use of clinical audits as a tool to optimize the overall quality of processes and services

Module (9): Quality management

SUB-MODULE	ACTIVITY
• Institutional policies and procedures	○ Personnel monitoring (pregnant workers), reporting incidents and near accidents, notifications (equipment failure), optimizing workflow, personnel orientation
• Performing and documenting QC	○ Dosimetry instrumentation, equipment, calibration of sources, abiding by well-established good practices (e.g. international CoPs), developing internal redundancy systems, clinical aspects
• Auditing	○ Internal (peer review) ○ External
• Risk management culture	○ Risk assessments ○ Investigating incidents and near accidents

Nuclear Medicine

Module (1): Clinical awareness

SUB-MODULE	ACTIVITY
• Clinical awareness	○ Understanding of the role of multidisciplinary professionals involved in or requesting nuclear medicine services.

Module (2): Radiation protection and safety

SUB-MODULE	ACTIVITY
• Design of a facility	○ International and local standards, safety review, surrounding structures, dose and risk assessment, expansion needs, workflow and efficiency ○ The designation of areas associated with protection from unsealed radioactive material ○ Calculation of shielding barriers ○ Verifying shielding calculations using survey instruments
• Exposure from unsealed Sources and the Risk of Contamination	○ Handle unsealed radioactive sources, designation of areas of the workplace
• Radiation hazard assessment	Hazard assessment of facilities and radiological procedures
• Personnel dosimetry	○ Methods for measuring personal dose ○ Operational use of personal dosimeters
• Unintended and accidental exposure in nuclear medicine	○ Respond to an unintended or accidental exposure occurring in a nuclear medicine affecting staff, patients or members of the public

Module (3): Technology management in Nuclear Medicine

SUB-MODULE	ACTIVITY
• Tender and procurement process	○ The ability to prepare the specifications and acquire suitable equipment through a tendering process
• Quality management of systems in nuclear medicine	○ To develop an understanding of the principal requirements and elements for a quality management system in nuclear medicine.
• Acceptance Testing / Commissioning	○ Understanding of the concept and principles of acceptance and commissioning of equipment.
• Routine testing / Quality control	○ Understanding of the methods for the clinical implementation and supervision of a quality control programme
• Imaging informatics	○ Skills to practice basic imaging informatics in digital imaging environments.

Module (4): Radioactivity measurements and internal dosimetry

SUB-MODULE	ACTIVITY
• Use of Traceable Standards for	○ Skills to be able to perform and understand quality assurance principles for radioactivity measurement in nuclear medicine.
• Radioactivity Measurements	○ Biokinetics analysis ○ MIRD formalism ○ Absorbed dose and effective dose estimation

• Formalism and Application of Internal Dosimetry	○ Activity quantification calibration and evaluation ○ The effect of acquisition parameters

Module 5: Performance testing of Nuclear Medicine equipment

SUB-MODULE	ACTIVITY
• dose calibrator	○ Measurement and assessment of system performance, periodic QC of dose calibrators
• gamma probe and well counter	○ Measurement and assessment of system performance, periodic QC of gamma probes and well counters
• planar gamma camera	○ Measurement and assessment of system performance, periodic QC of planar gamma cameras
• SPECT gamma camera	○ Measurement and assessment of system performance, periodic QC of SPECT gamma cameras
• Display and printing devices	○ Measurement and assessment of system performance, periodic QC of display and printing devices. Evaluation of viewing conditions.

Module (6): Preparation and quality control of radiopharmaceuticals

SUB-MODULE	ACTIVITY
• The preparation of radiopharmaceuticals	○ Radiopharmaceutical preparations protocol
• Quality control of the radiopharmaceuticals	○ Quality Control tests ○ Physical characteristics , Radionuclide purity, Radiochemical purity, Chemical purity

Module (7): Radionuclide therapy using unsealed sources

SUB-MODULE	ACTIVITY
• Treatment Procedure	○ The purpose, principles and operational procedures of ○ the radionuclide therapy
• Radiation safety precautions for therapy using unsealed radionuclide sources	

Module (8): Clinical application

SUB-MODULE	ACTIVITY
• Protocols for Routine Clinical Procedures	○ The effect of technical factors and acquisition protocol
• Common Artefacts in Clinical Images	○ Image artefacts, their causes, and how to deal with them.

Module (9): Optimization

SUB-MODULE	ACTIVITY
• Optimization of Procedures	○ Understanding of the main factors that affect image quality and patient radiation dose.
• Clinical audits	○ Use of clinical audits as a tool to optimize the overall quality of processes and services

Hospitals in the Programme’s Training Network

Hospitals in the Programme’s Training Network

1. **Ancona,** Az. Ospedaliero Universitaria Ospedali Riuniti
2. **Aviano**, Centro di Riferimento Oncologico
3. **Bergamo,** Az. Ospedaliera Papa Giovanni XXIII
4. **Brescia,** Az. Ospedaliera Spedali Civili
5. **Ferarra,** Az. Ospedaliero-Universitaria S. Anna
6. **Firenze,** Az. Ospedaliera Careggi
7. **Milan,** Ospedale Niguarda Ca' Granda
8. **Modena,** Az.Ospedaliero-Universitaria di Modena
9. **Monza,** Az. Ospedaliera S. Gerardo
10. **Novara,** Az. Ospedaliero-Universitaria Maggiore della Carità
11. **Padova,** Istituto Oncologico Veneto
12. **Pisa,** Az. Ospedaliero Universitaria Pisana
13. **Rome,** Ist. Nazionale Tumori Regina Elena
14. **Turin,** Az. Ospedaliero-Universitaria, Citta della Salute
15. **Trento,** Ospedale S. Chiara
16. **Trieste,** Az. Ospedaliero-Universitaria, Ospedali Riuniti
17. **Udine,** Az. Ospedaliero-Universitaria S. Maria della Misericordia
18. **Verona,** Az. Ospedaliera Universitaria Integrata Verona
19. **Vicenza,** ULSS 6 Vicenza, Ospedale San Bortolo
20. **Zagreb,** University Hospital Centre Zagreb

Table 9: Hospitals in the Programme's Training Network

Name of Hospital: *Az. Ospedaliero Universitaria Ospedali Riuniti*

Website

Full Address *Via Conca, 71 - Torrette (AN) ,Ancona, Italy*

Head of Medical Physics Department: *Dr. Stefania Maggi*

Email: s.maggi@ospedaliriuniti.marche.it

Name of Hospital: *Centro di Riferimento Oncologico*

Website

Full Address: *Via Franco Gallini, 2, Aviano, Italy*

Head of Medical Physics Department: *Dr. Elvira Capra*

Email: *ecapra@cro.it*

Name of Hospital: *Az. Ospedaliera Papa Giovanni XXIII*

Website

Full Address*: Piazza OMS, 1, 24127 Bergamo*

Head of Medical Physics Department: *Dr. Andreoli Stefano*

Email: sandreoli@hpg23.it

Name of Hospital: *Azienda Ospedaliera Universitria Senese*

Website

Full Address: *Viale Mario Bracci, 16, 53100 Siena SI, Italy*

Head of Medical Physics Department: *Dr. Fabrizio Banci Buonamici*

Email: *f.banci@ao-siena.toscana.it*

Name of Hospital: *Az. Ospedaliera Careggi*

Website

Full Address: *Padiglione 25,Azienda Ospedaliero-Universitaria Careggi,Largo Piero Palagi, 1,50139 Firenze, Italy*

Head of Medical Physics Department: *Dr. Busoni Simone*

Email: *simonebusoni@gmail.com*

Name of Hospital: *Az. Ospedaliero-Universitaria S. Anna*

Website

Full Address: *via aldo moro 8, 44124 cona-Ferrara, Italy*

Head of Medical Physics Department: *Dr. Renzo Moretti*

Email:*renzo.moretti@spedalicivili.brescia.it*

Azienda Ospedaliera
Ospedale Niguarda Ca' Granda

Name of Hospital: *Ospedale Niguarda Ca' Granda*

Website

Full Address*: Piazza dell'Ospedale Maggiore, 3,20162 Milano, Italy*

Head of Medical Physics Department: *Dr. Alberto Torresin*

Email:

Name of Hospital: *Az.Ospedaliero-Universitaria di Modena*

Website

Full Address*: Viale del Pozzo, 71,41124 Modena, Italy*

Head of Medical Physics Department: *Dr. Gabriele Guidi*

Email: *guidi.gabriele@policlinico.mo.it*

Azienda Ospedaliera San Gerardo

Name of Hospital: *Az. Ospedaliera S. Gerardo*

Website

Full Address*: Via G. B. Pergolesi, 33,20052 Monza, Italy*

Head of Medical Physics Department: *Dr. Andrea Crespi*

Email: : *a.crespi@hsgerardo.org*

Name of Hospital: *Az. Ospedaliero-Universitaria Maggiore della Carità*

Website

Full Address*: Corso Mazzini, 18,28100 Novara, Italy*

Head of Medical Physics Department: *Dr. Marco Brambilla*

Email:

Name of Hospital: *Istituto Oncologico Veneto*

Website

Full Address*: Via Gattamelata, 64,35128 Padova, Italy*

Head of Medical Physics Department: *Dr. Marta Paiusco*

Email:

Name of Hospital: *Az. Ospedaliero Universitaria Pisana*

Website

Full Address*: Via Roma, 67,56126 Pisa, Italy*

Head of Medical Physics Department: *Dr. Antonio Traino*

Email: *c.traino@ao-pisa.toscana.it*

Name of Hospital: *Ist. Nazionale Tumori Regina Elena*

Website

Full Address*: Via Elio Chianesi, 53,00144 Roma, Italy*

Head of Medical Physics Department: *Dr. Lidia Strigari*

Email: *strigari@ifo.it*

Name of Hospital: *Az. Ospedaliero-Universitaria, Citta della Salute*

Website

Full Address*: Corso Bramante, 88,Torino, Italy*

Head of Medical Physics Department: *Dr. Roberto Ropolo*

Email:

OSPEDALE
S.CHIARA

Name of Hospital: *Ospedale S. Chiara*

Website

Full Address*: Largo Medaglie D'oro, 9,38122 Trento, Italy*

Head of Medical Physics Department: *Dr. Aldo Valentini*

Email:

Name of Hospital: *Azienda Sanitaria Universitaria Integrata di Trieste asuits*

Website

Full Address: *Via della Pietà, 19,34129 Trieste, Italy*

Head of Medical Physics Department: *Dr. Mario De Denaro*

Email: mario.dedenaro@asuits.sanita.fvg.it

Name of Hospital: *Az. Ospedaliero-Universitaria S. Maria della Misericordia*

Website

Full Address: *Piazzale Santa Maria della Misericordia, 15,33010 Udine , Italy*

Head of Medical Physics Department: *Dr. Maria Rosa Malisan*

Email:

Name of Hospital: *Az. Ospedaliera Universitaria Integrata Verona*

Website

Full Address: *Piazzale Aristide Stefani, 1,37122 Verona, Italy*

Head of Medical Physics Department: *Dr. Carlo Cavedon*

Email:

Name of Hospital: *ULSS 6 Vicenza, Ospedale San Bortolo*

Website

Full Address*: Viale Ferdinando Rodolfi, 37,36100 Vicenza, Italy*

Head of Medical Physics Department: *Dr. Paolo Francescon*

Email:

Name of Hospital: *University Hospital Centre Zagreb*

Website

Full Address*: Kišpatićeva ul. 12,10000 Zagreb, Croatia*

Head of Medical Physics Department: *Dr. Nenad Kovacevic*

Email:

Master’s thesis work

The MMP students need to work on a specific clinical subject as their final thesis that demonstrates their knowledge acquired through their clinical residency and the program. The MMP students typically focus on their portfolio and become familiar with their training hospital during the first five months of training program. Afterwards, it would be a good time to find a thesis topic. Usually, the master’s thesis work is more closely related to a topic area that you would have completed during your clinical experience and training.

Sometimes your supervisors and/ or the department of medical physics of your training hospital may have some relevant topics and sometimes you may propose a topic based on your clinical training. However, approval of the topic by your supervisor is mandatory and it needs to be confirmed by the MMP coordinator at the final step.

A master’s thesis is usually 30-50 pages. To determine the length of your thesis or dissertation, you should first consult your supervisor.

To write up your thesis, you should download the Thesis Template for Microsoft Word and follow the structure. Then you should also discuss the content of your thesis with your supervisor to get your supervisor’s approval. The last step is sending your final version of thesis to the MMP coordinator as a PDF file and keep in mind that the deadline to submit your thesis work is the 30th of November.

The time and place of all thesis defences and final oral exams will be announced and mail to the MMP students and their supervisors.

In the days leading up to your thesis defence, you will be expected to present and defend your thesis in front of supervisors, tutors, Master's Thesis committees, the MMP students and other audience. You can expect to be asked a number of questions after your presentation. Typically, you will be asked to talk for almost 20 minutes, and will be given 10-15 minutes to answer the questions.

The whole medical phsyics residency program compromises 55 ECTS and final oral exam is the last step leading to your graduate degree and has 5 ECTS credits.

Table 10: Title of thesis for the 1st cycle 2014-15

Student Name	Thesis title	Supervisor(s) & Hospital
	Effective of CT Hounsfield units (HU) on dose calculation for radiotherapy treatment planning	Dr. Timor Grego University Hospital Centre Zagreb, Zagreb, Croatia
	Quality Controls in Digital Mammography. Comparison of different protocols	Dr. Annalisa Trianni University Hospital S. Maria della Misericordia, Udine, Italy
	Evaluation of MONACO treatment planning system for VMAT plans and plan verification using Octavius 4D system: from simple to more complex cases	Dr. Mara Severgnini, Dr. Fabrizio Cupardo, Dr. Rossella Vidimari University Hospital of Trieste, Trieste, Italy
	Comparison of Volumetric Modulated Arc Therapy (VMAT) and fixed-field Intensity Modulated Radiation Therapy (IMRT) for threedose level irradiation of head and neck cancer	Dr. Maria Rosa Malisan University Hospital S. Maria della Misericordia, Udine, Italy
	Commissioning of the Analytical Anisotropic Algorithm (AAA) calculation algorithm for 2100CD linac 18MV photon energy beam	Dr. Paola Chiovati, Dr. Giovanna Sartor Centro di Riferimento Oncologico (CRO), Aviano, Italy
	Patient specific QA for Head and Neck ConPas technique	Dr. Juraj Bibić University Hospital Centre Zagreb, Zagreb, Croatia
	Pretreatment evaluation: from the 2 D metrics to 3D patientspecific metrics	Dr. Franca Simonato Istituto Oncologico Veneto, Padova, Italy
	Commissioning of the Analytical Anisotropic Algorithm (AAA) calculation algorithm for 2100CD linac 6MV photon energy beam	Dr. Paola Chiovati, Dr. Giovanna Sartor Centro di Riferimento Oncologico (CRO), Aviano, Italy

Previsional dosimetric study of patients undergoing radiometabolic treatment with iodine I-131 for hyperthyroidism	Dr. Roberta Matheoud University Hospital "Maggiore della Carità", Novara, Italy
Influence of ct acquisition parameters on treatment planning in external beam radiation therapy	Dr. Stefania Cora, Dr. Paolo Francescon S. Bortolo Hospital, ULSS 6, Vicenza, Italy
Commissioning of a photon dose calculation algorithm by comparison with experimental measurements	Dr. Carlo Cavedon University Hospital, Verona, Italy
Comparison between 3D-CRT, IMRT and VMAT techniques for cancer radiation treatment	Dr. Angelo Monti Hospital Niguarda Ca' Granda, Milano, Italy
Implementation of machine data on TPS Pinnacle and comparison of treatment planning between clinical planning and Auto-Planning Pinnacle	Dr. Francesca Romana Giglioli AOU Cittá della Salute e della Scienza, Torino, Italy

Table 11:Title of thesis for the 2ed cycle 2015-16

Student Name	Thesis title	Supervisor(s) & Hospital
Ejugu Kebede ABDISSA, Ethiopia		
	Analysis of the dose deposition iscrepancy on lung-like lesions: An extended PTV definition for a more robust optimization.	Dr. Angelo Monti, Dr. Paola Enrica Colombo Hospital Niguarda Ca' Granda, Milano, Italy
	DR systems: A comparison of three "twins" systems and optimisation of protocols for chest imaging	Dr. Annalisa Trianni University Hospital S. Maria della Misericordia, Udine, Italy

Marcos Calixto CATU, Guatemala	Dr. Francesco Ziglio S. Anna Hospital, Trento, Italy
Introduction into the clinical practice of a new treatment planning system	Dr. S. Anna Hospital, Trento, Italy
Atifa FARAH, Sudan	
Pretreatment dose verification using transmission detector: implementation and measurements	Dr. Francesca Romana Giglioli AOU Cittá della Salute e della Scienza, Torino, Italy
Commissioning of Flattening Filter Free Beams and its clinicalApplication for SBRT Treatment Planning	Dr. Sara Fabbri, University Hospital Ferrara
Sensitivity of a diode based dosimetric system for the verification of radiation therapy treatment plans	Dr. Carlo Cavedon University Hospital, Verona, Italy
Evaluation of radio-biological modules and assessment of the match between what these modules expect as TCP and NTCP compared to actual clinical results	Dr. Stefania Cora, Dr. Paolo Francescon S. Bortolo Hospital, ULSS 6, Vicenza, Italy
Evaluation Of Automatic Planing And Multi-Criteria Omptimization Of Head And Neck Treatment Plans	Dr. Stefania Cora S. Bortolo Hospital, ULSS 6, Vicenza, Italy
Comparison between methods and tools used for analysis of gamma camera quality control images	Dr. Maria Rosa Fornasier AOU "Ospedali Riuniti", Trieste, Italy
A Comparison between Delta4 and Portal Dosimetry for Quality Control checks, and DQA	Dr. Giovanna Sartor, Dr. Paola Chiovati Centro di Riferimento Oncologico (CRO), Aviano, Italy

Distribution of MMP students by continent and country 2014

Latin America | Africa | Asia | Europe

MMP Student

First cycle

2013-2014

Distribution of MMP students by continent and country 2015

Latin America **Africa** **Asia** **Europe**

MMP Student

Second cycle

2014-2015

Distribution of MMP students by continent and country 2016

Latin America | Africa | Asia | Europe

MMP Student

Third cycle

2016-2017

MMP Student at the University Hospital of Trieste

Useful Links

University of Trieste-Login to your university panel to check exam booklet and other information

https://esse3.units.it/Guide/PaginaCorso.do?corso_id=10254&cod_lingua=eng&ANNO_ACCADEMICO=

University of Trieste-MMP page and MMP Graduate page

http://df.units.it/en/graduate-schools/node/6678

http://df.units.it/en/graduate-schools/advanced-master-programmes

Triste Transportation-all bust stops, Schedule

http://www.triestetrasporti.it/index.php?linee-e-orari

Some suggested websites by former students to look for rental accommodation

www.ilmercatino.it	www.easystanza.it	www.affitto.it
www.subito.it/	www.casa.it/	www.trovacasa.net/
www.bakeca.it/	www.kijiji.it/	www.trieste.bakeca.it
www.trieste.kijiji.it	www.affittistudenti.studenti.it	www.it.quickasa.com
www.mioaffitto.it	www.facebook.com/groups/affittacameretrieste/	

Welcome Office FVG- lots of useful information for international researchers and students coming to Friuli Venezia Giulia from all over the world to study or carry out research activities.

http://www.welcomeoffice.fvg.it/

Sightseeing in Trieste

https://www.ictp.it/visit-ictp/about-trieste/whattovisit.aspx

MMP Official Fan Page-Facebook to communicate and find current and former MMP

https://www.facebook.com/ictp.mmp

Reference

[1] **European Commission EC**, *European Guidelines on Medical Physics Experts.* Radiation Protection No 174 (*Annex 2)*; 2014.

[2] **International Atomic Energy Agency IAEA**, *Clinical Training of Medical Physicists Specializing in Radiation Oncology,* Training Course Series 37, IAEA, Vienna; 2010 http://www-pub.iaea.org/books/IAEABooks/8222/Clinical-Training-of-Medical-PhysicistsSpecializing-in-Radiation-Oncology

[3] **International Atomic Energy Agency IAEA**, *Clinical Training of Medical Physicists Specializing in Diagnostic Radiology*, Training Course Series 47, IAEA, Vienna; 2010 http://www-pub.iaea.org/books/IAEABooks/8574/Clinical-Training-of-Medical-PhysicistsSpecializing-in-Diagnostic-Radiology

[4] **International Atomic Energy Agency IAEA**, *Clinical Training of Medical Physicists Specializing in Nuclear Medicine*, Training Course Series 50, IAEA, Vienna; 2011 http://wwwpub.iaea.org/books/IAEABooks/8656/Clinical-Training-of-Medical-Physicists-Specializing-in-Nuclear-Medicine

[5] **International Atomic Energy Agency IAEA**, *Roles and Responsibilities, and Education and Training Requirements for Clinically Qualified Medical Physicists,* Human Health Series No. 25, IAEA, Vienna; 2013 http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1610_web.pdf

[6] **International Atomic Energy Agency IAEA**, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards - Interim Edition, General Safety Requirements Part 3, IAEA, Vienna; 2011 http://www-pub.iaea.org/MTCD/publications/PDF/p1531interim_web.pdf

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ICTP- Strada Costiera, 11 I-34151 Trieste Italy

mmp@ictp.it