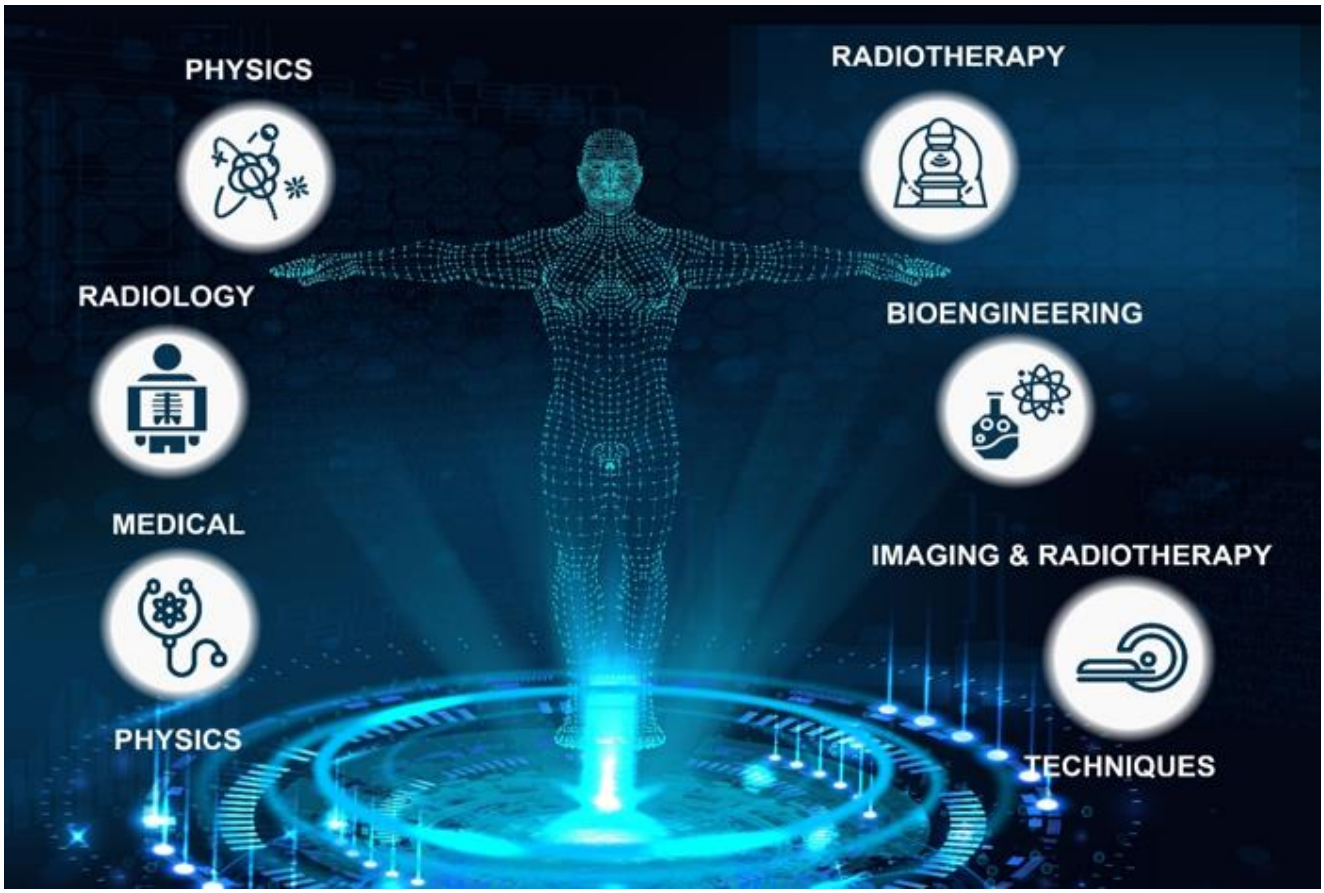
Heavy Ion Therapy - Treatment Planning



Course Overview

Title: Heavy Ion Therapy MasterClass School with a Focus on Treatment Planning

Level: Suitable for undergraduate students, post graduate students and early stage researchers in physics, medicine, biology and engineering with an interest in medical accelerators, oncology and hadron therapy.

Knowledge Requirements: Introductory undergraduate knowledge in physics, medicine, biology or engineering. Intended for students specifically interested in medical physics, radiotherapy, radiobiology, radiology, bioengineering, imaging and medical applications of particle accelerator technologies.

Duration: 34 hours

Mode of Study: Online

Language: English

Course Objectives

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008548

Educate and provide hands-on experience to a new generation of researchers, giving them the required skills and tools to access and engage with Europe's heavy ion therapy research infrastructures.

Provide multidisciplinary researchers from academia and industry with updated knowledge of both heavy ion therapy and the ongoing activities of the four major heavy ion therapy facilities in Europe.

Provide students and early stage researchers with opportunities to network with leading researchers in the field.

How to Apply

Course is readily available online on YouTube. Interested students are free to access the course at a click of a button from the HITRI*plus*.eu webpage (Select Tab – Training and Events)

Content

- Introduction to Heavy Ion Therapy
- Treatment Planning
- Medical accelerators and accelerator physics including:
    - Ion sources
    - Beam optics
    - Beam delivery systems
    - Controls
- Linear accelerators for isotope production
- Radiation protection and safety
- Imaging for particle therapy and diagnostics
- Biophysics
- Machine learning applications for particle therapy
- European heavy ion therapy centres:
    - Current activities
    - Future upgrades

Learning Outcomes

This course consists of a number of introductory lectures that provide a good foundation of the field. It also consists of a number of hands treatment planning exercises that may be done through freely available simulation software.

The skills and learning outcomes include:

- scientific knowledge of the underpinning theory, techniques and methods that should form the arsenal of specialists in heavy ion therapy, allowing you to attain the necessary valid insight into real-world phenomena
- design and planning skills of heavy ion therapy treatment programmes
- technical expertise in the fundamental building blocks of heavy ion therapy facilities
- practical appreciation and real mapping of theoretical knowledge to practical treatment planning scenarios

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- analytical, critical and evaluation skills including the ability to learn and analyse an existing scenario and propose heavy ion therapy treatment plans

Fees

This is a free online course

Career Prospects

Opportunities to work, study or conduct research in Heavy Ion Therapy facilities as part of the scientific, engineering or medical teams.

Suggested Reference Books

Protontherapy versus Carbon Therapy: Advantages, Disadvantages and Similarities, by Marcos d'Ávila Nunes, Springer (2015), ISBN-13: 978-3-319-18982-6

Particle Accelerators: From Big Bang Physics to Hadron Therapy, by Ugo Amaldi, Springer (10 Jan. 2015), ISBN-13: 978-3319088716

Ion Beam Therapy; Fundamentals, Technology, Clinical Applications; by Ute Linz, Springer (2012), ISBN-13: 978-3-642-21413-4

Organisers and Sponsors

EU – European Union Horizon 2020 Research and Innovation Programme
HITRIplus – Heavy Ion Therapy Research Integration Plus
CERN – The European Organisation for Nuclear Research
CNAO – Centro Nazionale di Adroterapia Oncologica
DKFZ – Deutsches Krebsforschungszentrum
EMMI – Extreme Matter Institute
ENLIGHT – European Network for Light Ion Hadron Therapy
FAIR – Facility for Antiproton and Ion Research in Europe
GSI - Helmholtzzentrum fur Schwerionenforschung
HIT – Heidelberger Ionenstrahl-Therapiezentrum
INFN - Instituto Nazionale di Fisica Nucleare
MedAustron - EBG GmbH MedAustron
MIT - Marburger Ionenstrahl-Therapiezentrum
Ruđer Bošković Institute
SEEIIST - South-East European International Institute for Sustainable Technologies
TARLA - Turkish Accelerator and Radiation Laboratory
AU - Ankara University
AUTh - Aristotle University of Thessaloniki
ICL - Imperial College London
LMU - Ludwig Maximilian University of Munich
UKIM - Ss Cyril and Methodius University in Skopje
UM - University of Malta
University of Montenegro

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UNSA - University of Sarajevo
Cosylab JSC
“Three Physicists” Trust of the US National Philanthropic Trust

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Technical Instructions – MatRad

Participants who wish to fully exploit matRad and take full advantage of the hands-on sessions are expected to have MATLAB licenses obtained via their academic institutions.

matRad is an open source software for radiation treatment planning of intensity-modulated photon, proton, and carbon ion therapy. matRad is developed for educational and research purposes. It is entirely written in MATLAB.

Software Installation

Minimum requirements

There are no hard minimum requirements to do dose calculation and optimization with matRad. Treatment planning tutorials can be done with systems with 2GB RAM but then cases you are looking at are somewhat small (low spatial resolution, few beams, rather no particles). If you want to do treatment planning at realistic resolutions, we recommend 8GB RAM or more. More information can be found on https://github.com/e0404/matRad/wiki/Minimum-System-Requirements.

matRad Installation step by step

There are two ways to install matRad. The first (and suggested) one is to use the Matlab source code from within the MATLAB programming environment. It requires a local MATLAB installation. The second way is to use a standalone that installs a runtime that allows usage of matRad without a valid MATLAB license. However, the functionality is limited to the user interface and thus one would not be able to take part in coding exercises.

- 1st way (recommended): Source Code to use with valid MATLAB installation

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You can also work with the current source code when you have matlab installed (even with Octave, but only without a GUI), which you can get from GitHub here:

https://github.com/e0404/matRad/releases/tag/v2.10.1

There, just download the provided *.zip or *.tar.gz file and extract it to a folder on your hard drive that can be accessed from Matlab.

For completeness and for the ones interested to go deeper, there's also a detailed documentation, targeted at people who work with the software (Matlab source code). It can be found in https://github.com/e0404/matRad/wiki explaining a lot about the workflow and the underlying principles.

- 2nd way: matRad Installation as standalone

VIDEO: MatRad Installation Video (Installation_MatRad file)

1. To download matRad, download the installer for your system from https://github.com/e0404/matRad/releases/tag/v2.10.1

2. Run the respective installer for your system

- Windows: Run the downloaded executable installer
- Linux: Run the executable install script. Make sure that the *.install file has executable permissions.
- Mac: Here we provide a dmg containint the installer (Since the installer is not apple-certified, you might explicitly launch it from the terminal or by right-click).

After that, you should be guided through the installation process:

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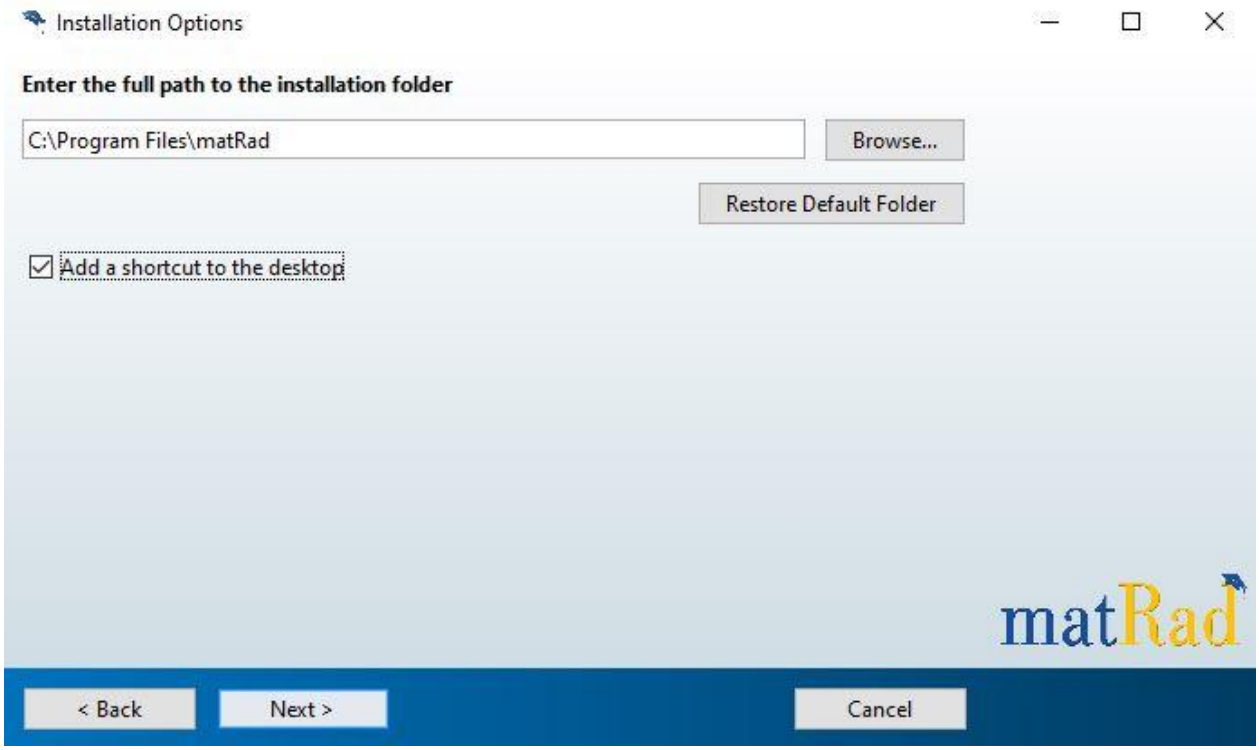

Note that the installers will want to download the "Matlab Runtime" from Mathworks in the process. The runtime is quite large (~2GB) and is required to run compiled deployed applications written in Matlab.

3. Run matRad:

- Windows: Just like with every other progam, you should have a desktop icon.
- Linux & Mac: To start matRad, you can use the provided run_matRad.sh script from the terminal. It requries one argument which gives the path to the installed Matlab-Runtime. Refer to the readme_linux.txt and readme_mac.txt in your installation directory for more information.

Patient/Phantom files

The patient files should be included with the installer and will be installed into the desired location. For windows, for example, they can be found within the "application" folder ofr the chosen installation directory.

We also provide an extra link for the patient files: Download here!

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