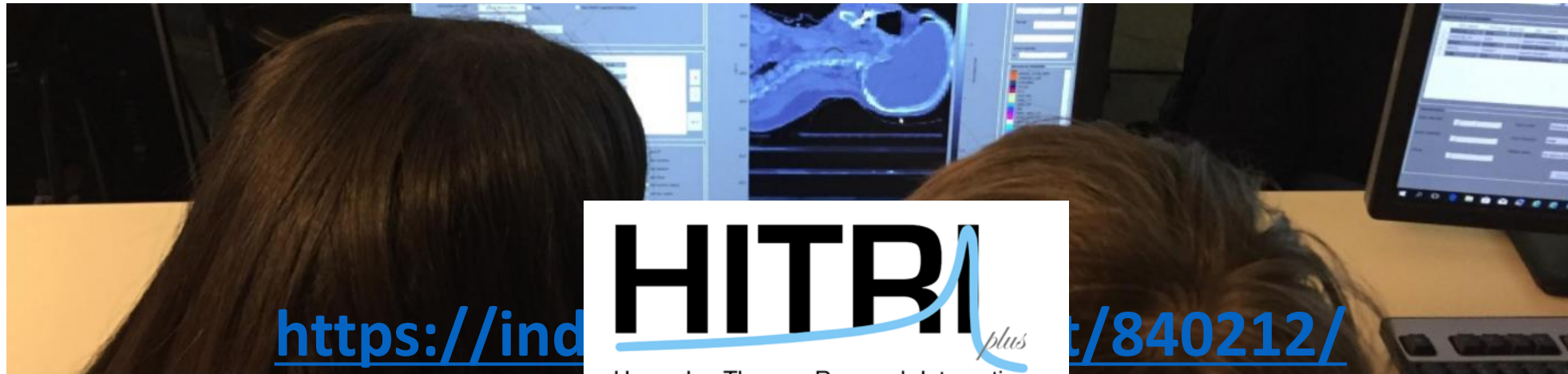


Particle Therapy MasterClass



<https://indico.cern.ch/event/840212/>

HITRI
plus

Heavy Ion Therapy Research Integration

[/840212/](https://indico.cern.ch/event/840212/)

INTERNATIONAL MASTERCLASSES

Yiota Foka (GSI/CERN)

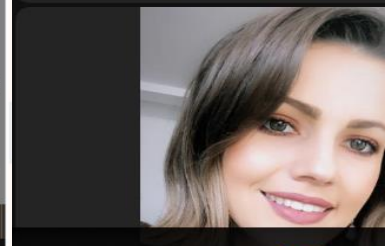
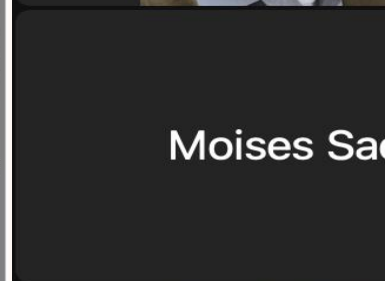
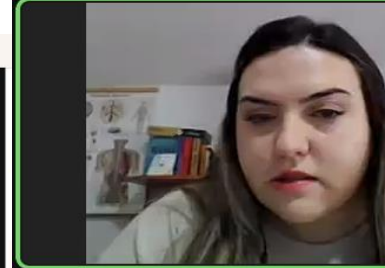
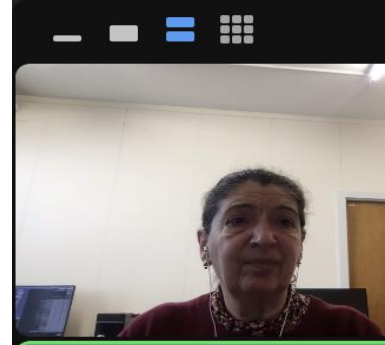
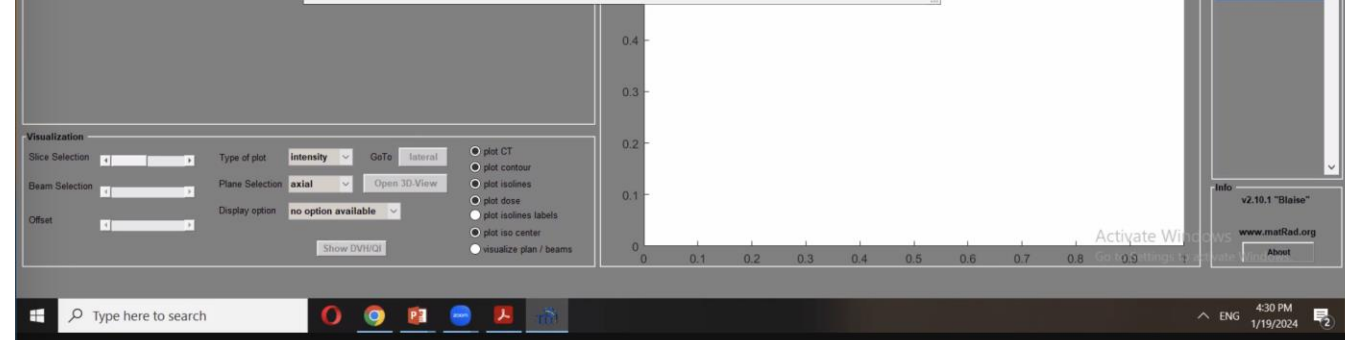
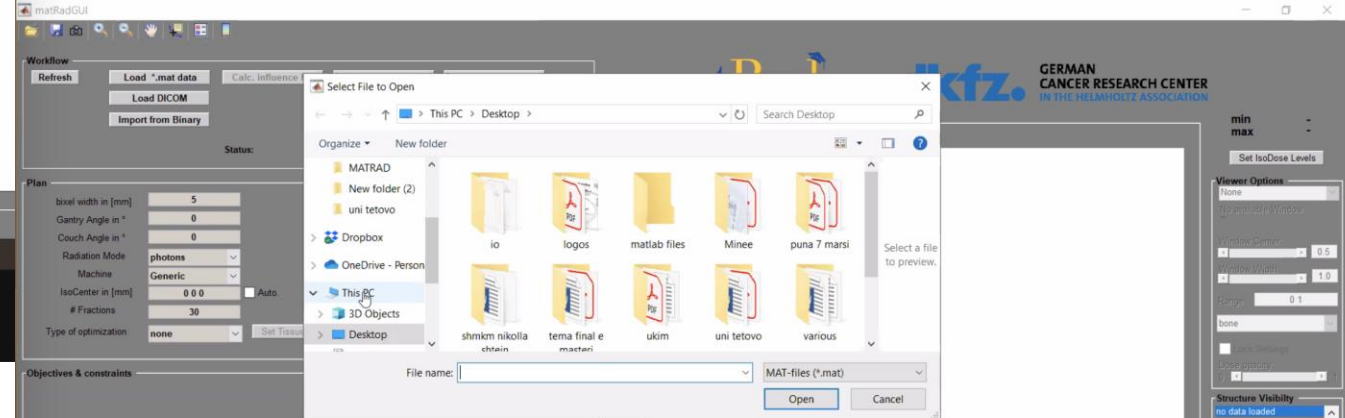
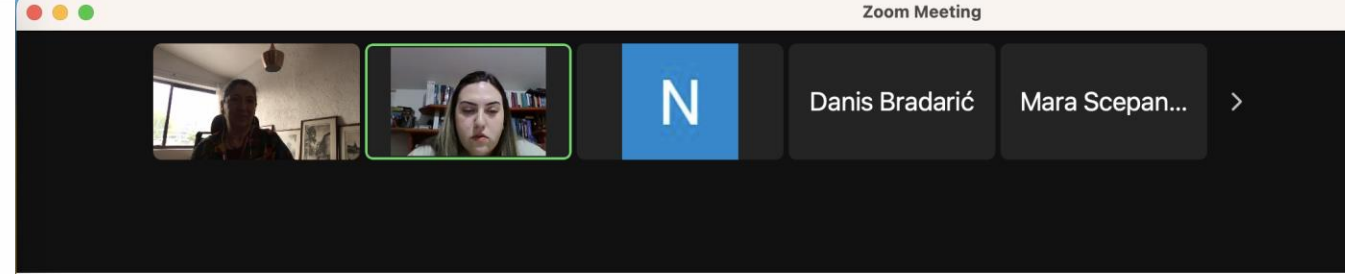
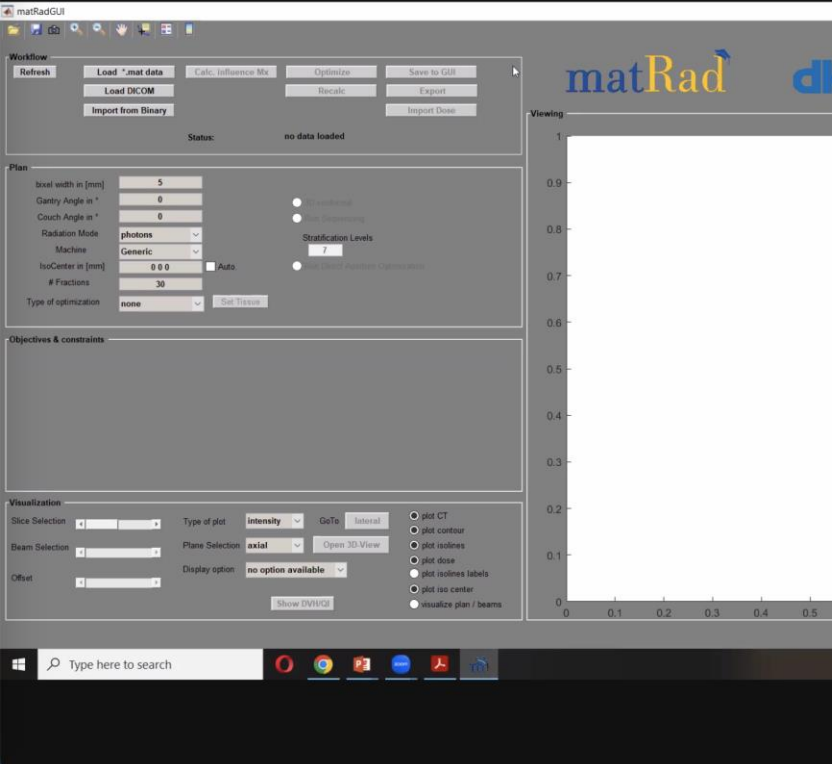
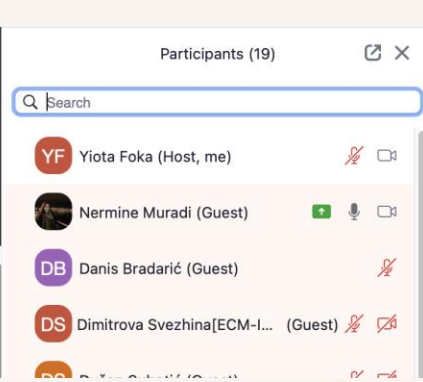
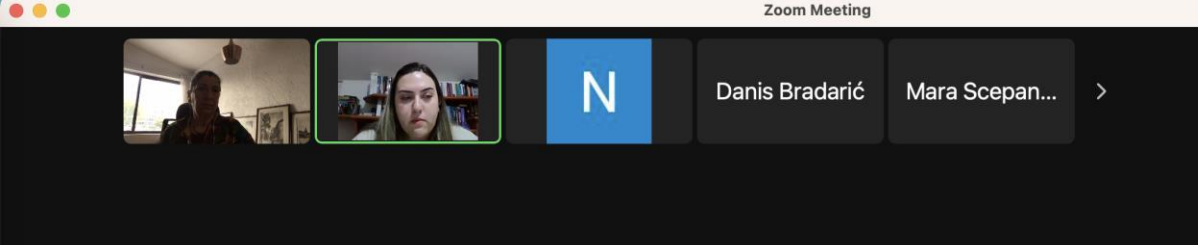
on behalf of

IPPOG and IMC Steering Group



Skopje 3 March 2023



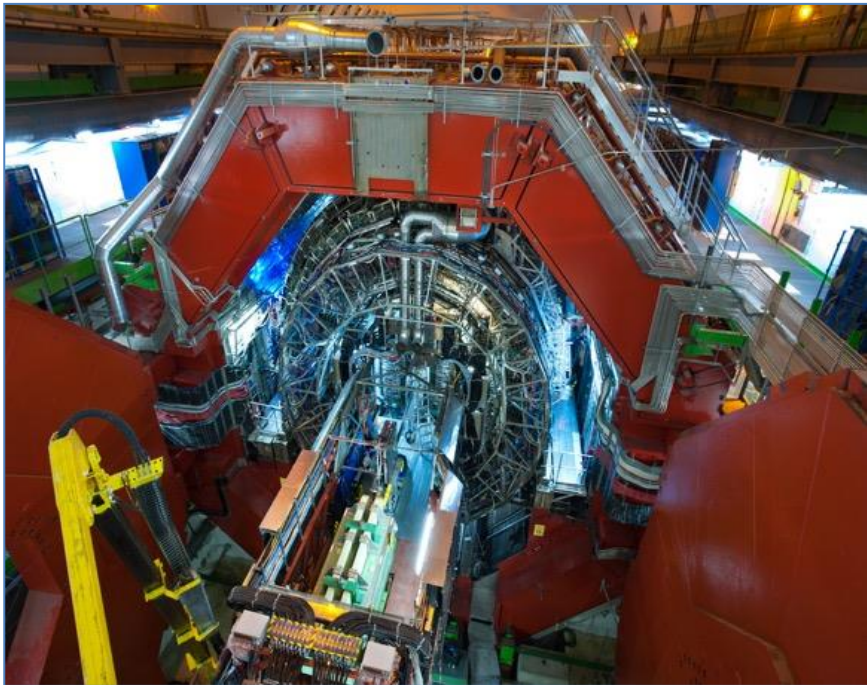


Training session
19 Jan and 1 Feb 2024

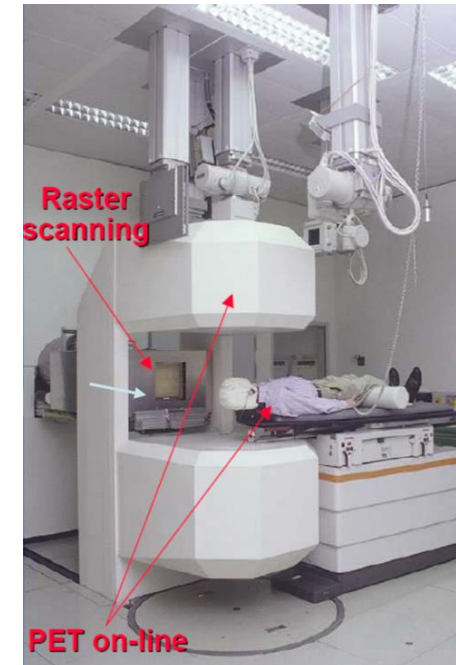
Heavy-ion research and heavy-ion therapy

Heavy-ion Physicist, involved with medical applications of heavy-ions for cancer therapy

ALICE heavy-ion experiment at CERN



GSI, pioneering heavy-ion cancer therapy



**From GSI research laboratory
Implemented in the Heidelberg and Marburg Ion Treatment centers in Germany**

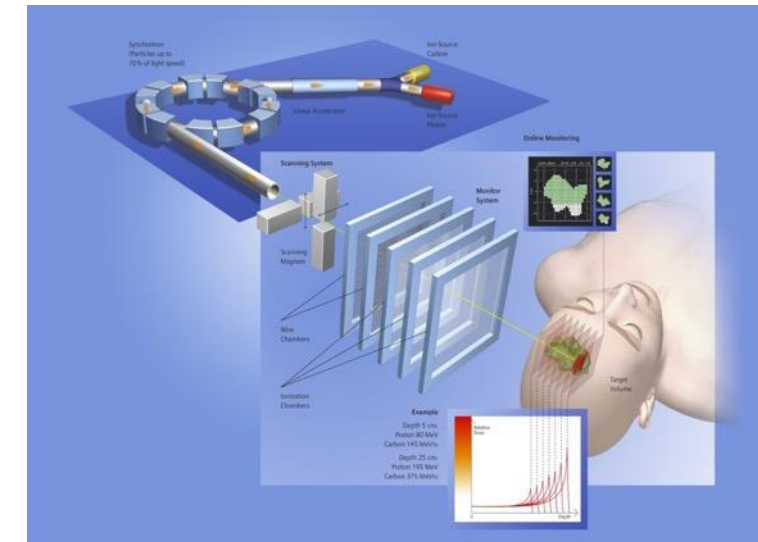
Heavy-ion research and heavy-ion therapy

Heavy-ion Physicist, involved with medical applications of heavy-ions for cancer therapy

ALICE heavy-ion experiment at CERN



GSI, pioneering heavy-ion cancer therapy in the 90s



Heidelberg Ion Therapy HIT centre

Implemented in Heidelberg, Marburg ion therapy centres

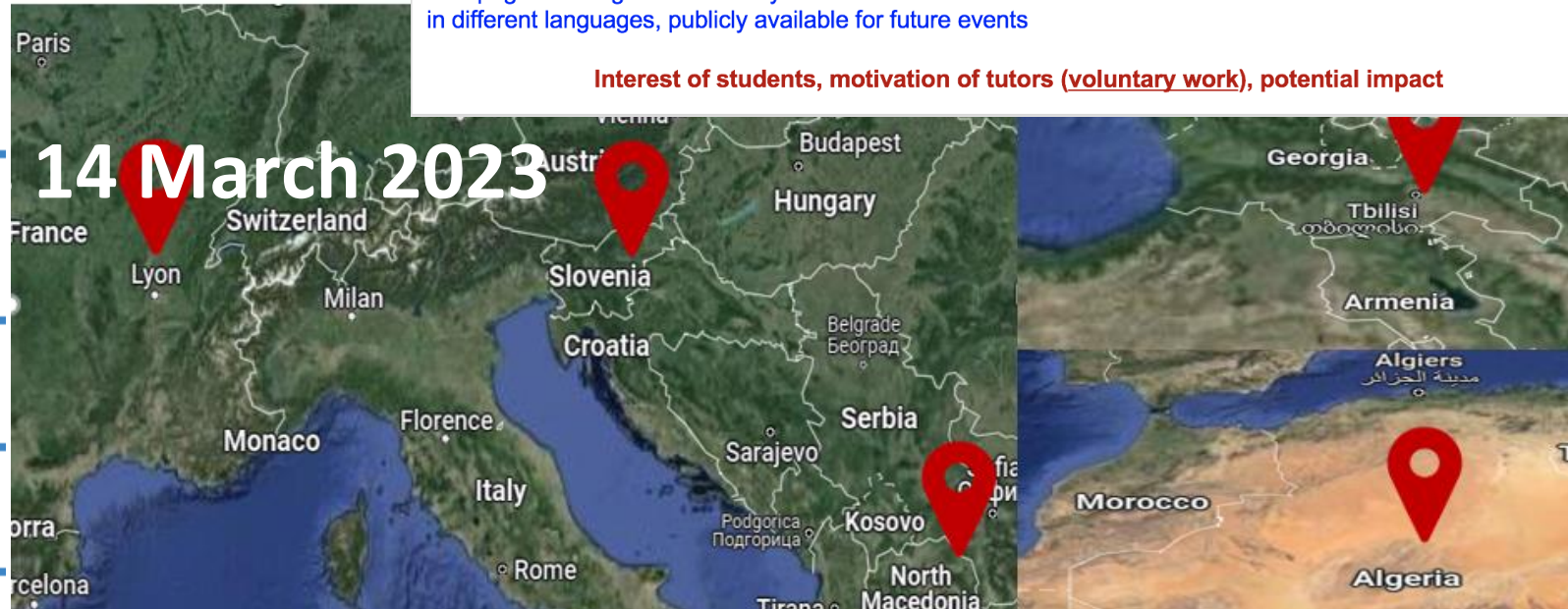
PTMC Participants

International MasterClasses

<https://physicsmasterclasses.org/>

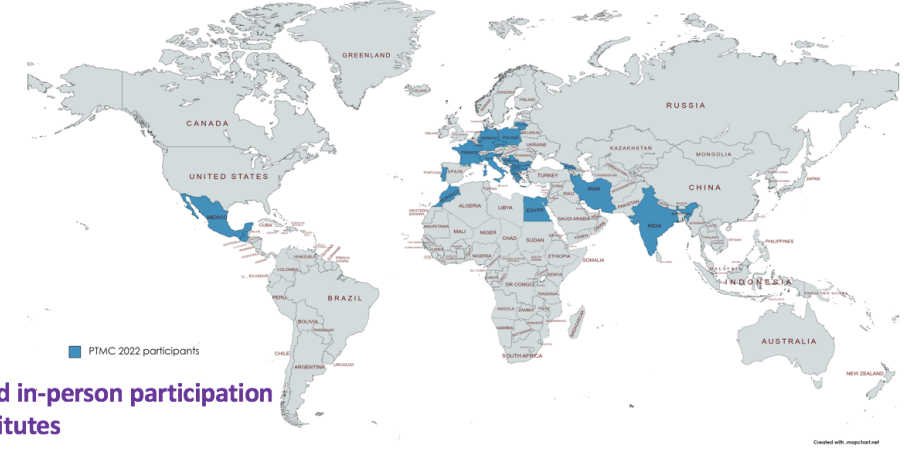
Monday 4 March 2024

| | |
|---|--|
| 1 | NORTH MACEDONIA, UNIVERSITY OF TETOVO 2 , Skopje |
| 2 | SLOVENIA, University of Ljubljana, Faculty of mathematics and physics |
| 3 | FRANCE, Institute of Physics of the 2 Infinities / University of Lyon1 |
| 4 | ALGERIA, Malek ben Nabi High School, Constantine |
| 5 | ALGERIA, Houcine Brahami High School, Constantine |
| 6 | GEORGIA, Kutaisi International University, Tbilisi |



Participants of online PTMC in IMC2022

PTMC: <https://indico.cern.ch/event/840212/>



PTMC2022 online:
ongoing: 6 sessions online and in-person participation from 22 countries and 37 institutes
web pages with agendas of every institute with material in different languages, publicly available for future events

Interest of students, motivation of tutors (voluntary work), potential impact



Home

Information for
High School Students

Information for
Teachers and Educators

Information for
Institutes and Physicists

Schedule

Intl. Day of Women
and Girls in Science

My Country

Physics

In the Media

Published Papers

Archive

Contributors

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<https://physicsmasterclasses.org/>



Hands on Particle Physics Masterclasses SCHEDULE 2021

At the end of each Masterclass day a videoconference between the institutes and with moderators at CERN, at Fermilab, TRIUMF, KEK, or GSI is established. The schedules for 2021 will be created early in 2021.



© CERN



© Fermilab



IMC Statistics 2019

Motivate the next generations of scientists !



54 countries
255 institutes
15 000 students
5 weeks in 2019

IMC 2021 :
11.2.2021 – 27.3.2021



Brings scientific methods and real data to schools!

Coordination QuarkNet / TU Dresden

- 51 institutes (48)
- 54 LHC Masterclasses (50)
 - 22 ATLAS (19)
 - 32 CMS (31)
 (Incl. TRIUMF program)
- 12 MINERvA Masterclasses

- 188 institutes (177)
- 266 LHC Masterclasses (257)
 - 30 ATLAS W (35)
 - 101 ATLAS Z (104)
 - 64 CMS (58)
 - 41 LHCb (39)
 - 27 ALICE SP (18)
 - 3 ALICE R_AA (3)

Flagship project of IPPOG, the International Particle Physics Outreach Group

Concept and programme of a PTMC day

Poster: ARIS MAMARAS on PTMC

Scientists for a day !!

Adapted online/zoom due to covid

Every year, mid-February to mid-April school-children (15-19 year old) are invited at/by an institute of their area.

2-5 institutes per day performing the same programme

LOCAL TIME:

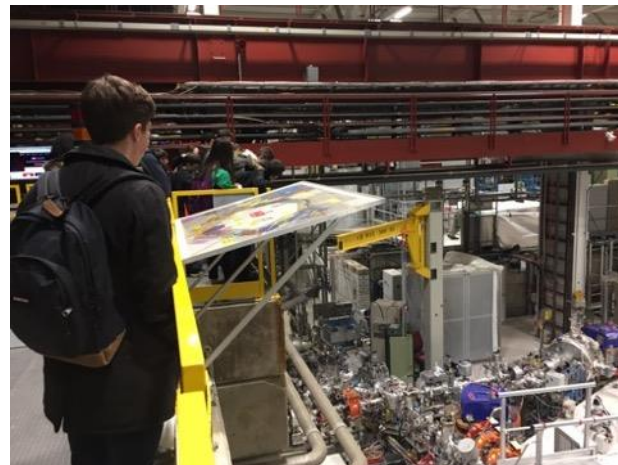
ACTIVITY

| | |
|---------------|------------------------------|
| 8:30 - 9:00 | Registration and Welcome |
| 9:00 - 10:00 | Introductory lectures |
| 10:30 - 11:30 | Visit of a lab or experiment |
| 12:00 - 13:00 | Lunch |
| 13:00 - 15:00 | Hands-on session |
| 15:00 - 16:00 | Discuss results locally |
| 16:00 - 17:00 | Common Video Conference |

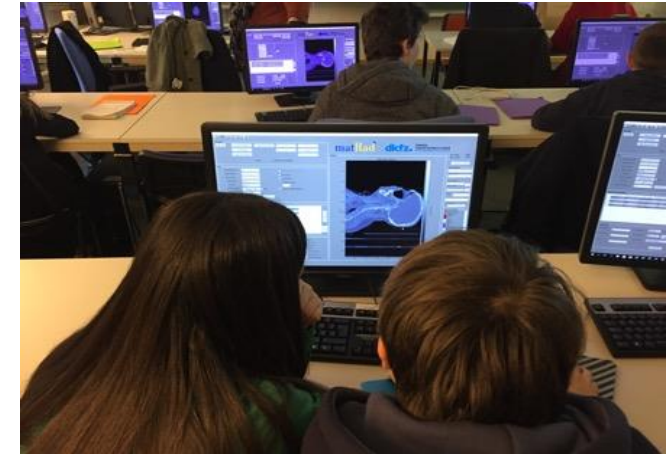
Local: Morning Presentations



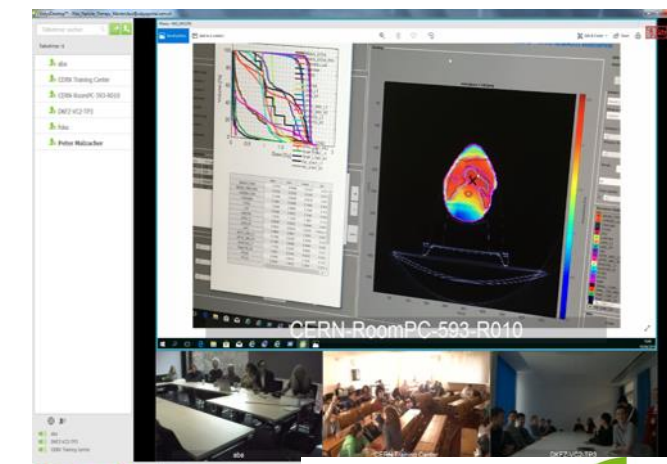
Local: Morning Visits



Local: Afternoon Hands-on

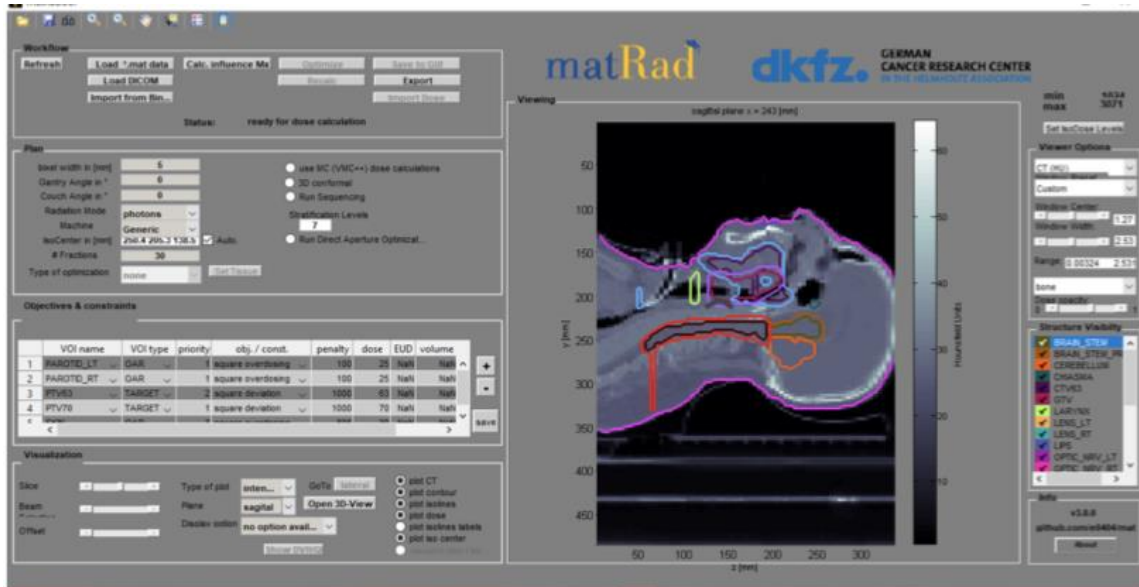


Common: Afternoon at 16:00 Video-Conference



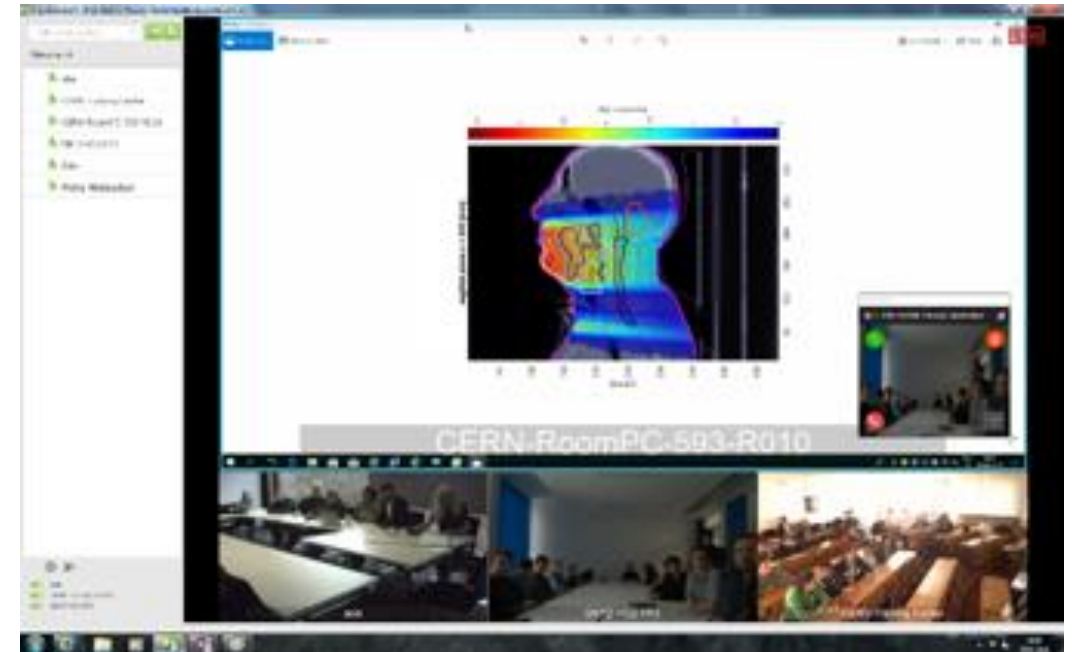
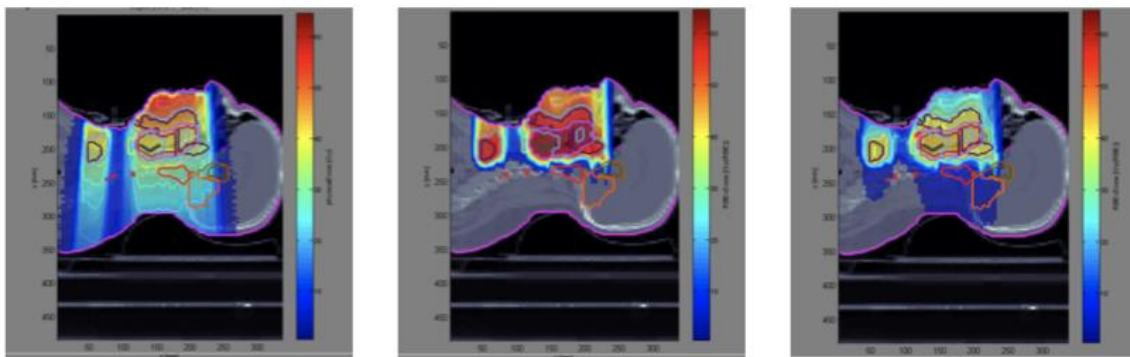
New PTMC and Treatment Planning

Based on professional open source treatment planning: matRad developed by Heidelberg DKFZ www.matrad.org

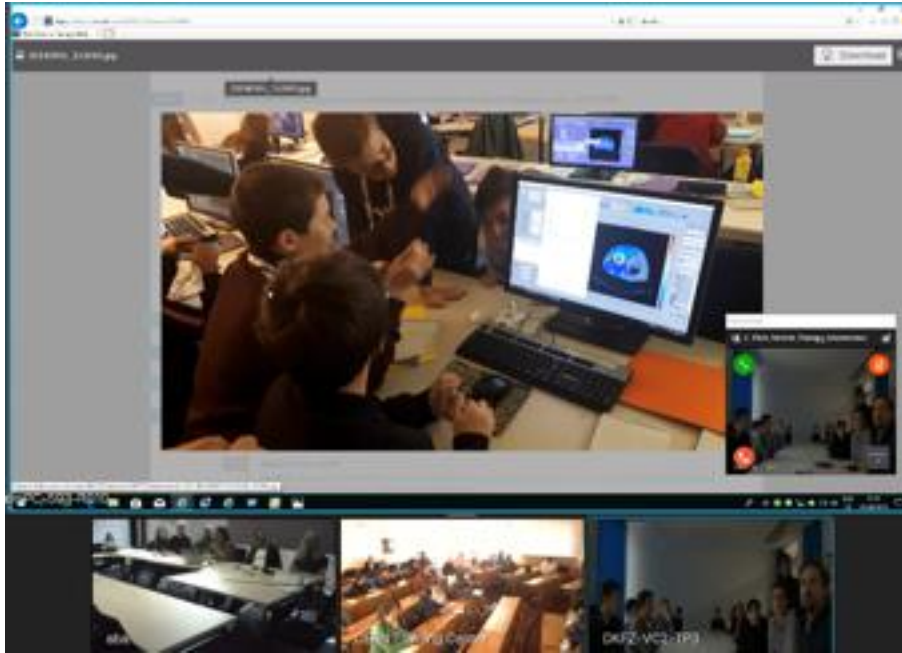


Simplified version for PTMC
Using photons, protons and carbon ions

Demo⁴ of the matRad software kit for Treatment Planning .



PTMC pilots in 2019



- First local test: GSI, 7th February 2019
- First international test: CERN, DKFZ, GSI, 5th April 2019

Participation of CURIEosity Team from Crete, Greece



CERN, DKFZ, GSI

Survey: positive results from students

**Hope and motivation to contribute
to the fight against cancer**

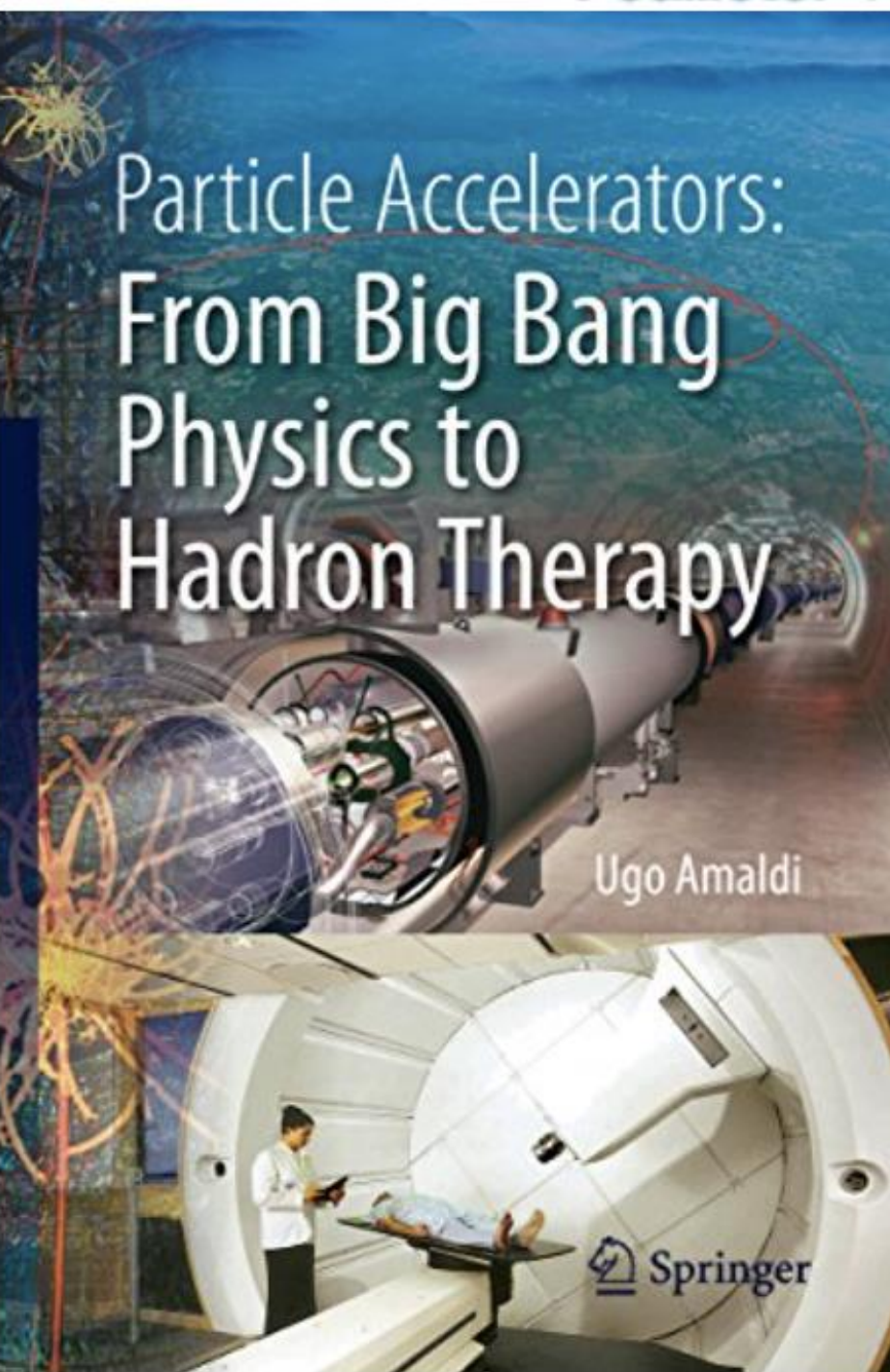
How is physics related to medicine?

What is particle therapy?

How one can use particles for cancer treatment?

Accelerators for research and accelerators for cancer treatment

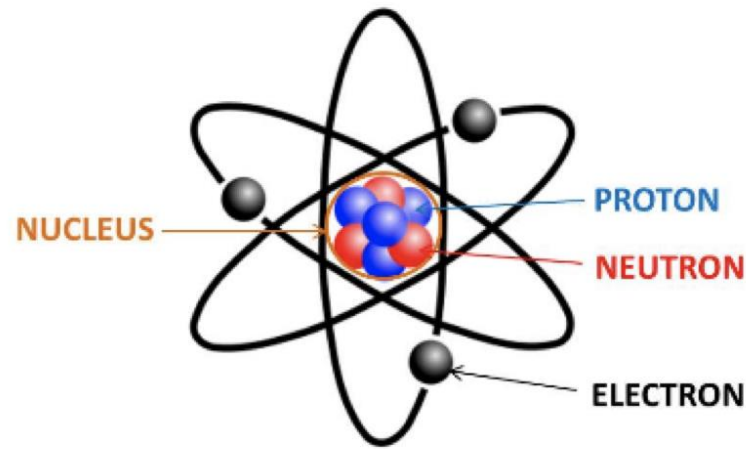
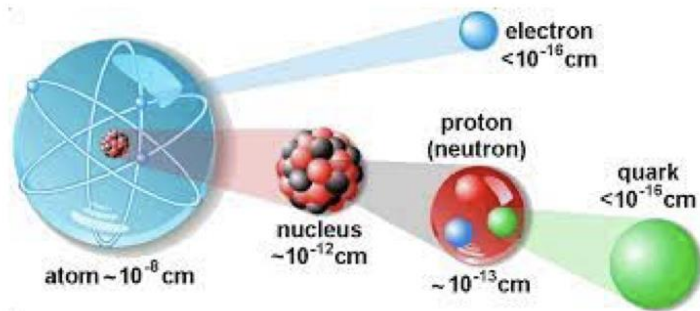
One of the aims of PTMC: address such questions



Accelerators: our key to the subatomic world

Where do we find the particles?

Inside the atoms!

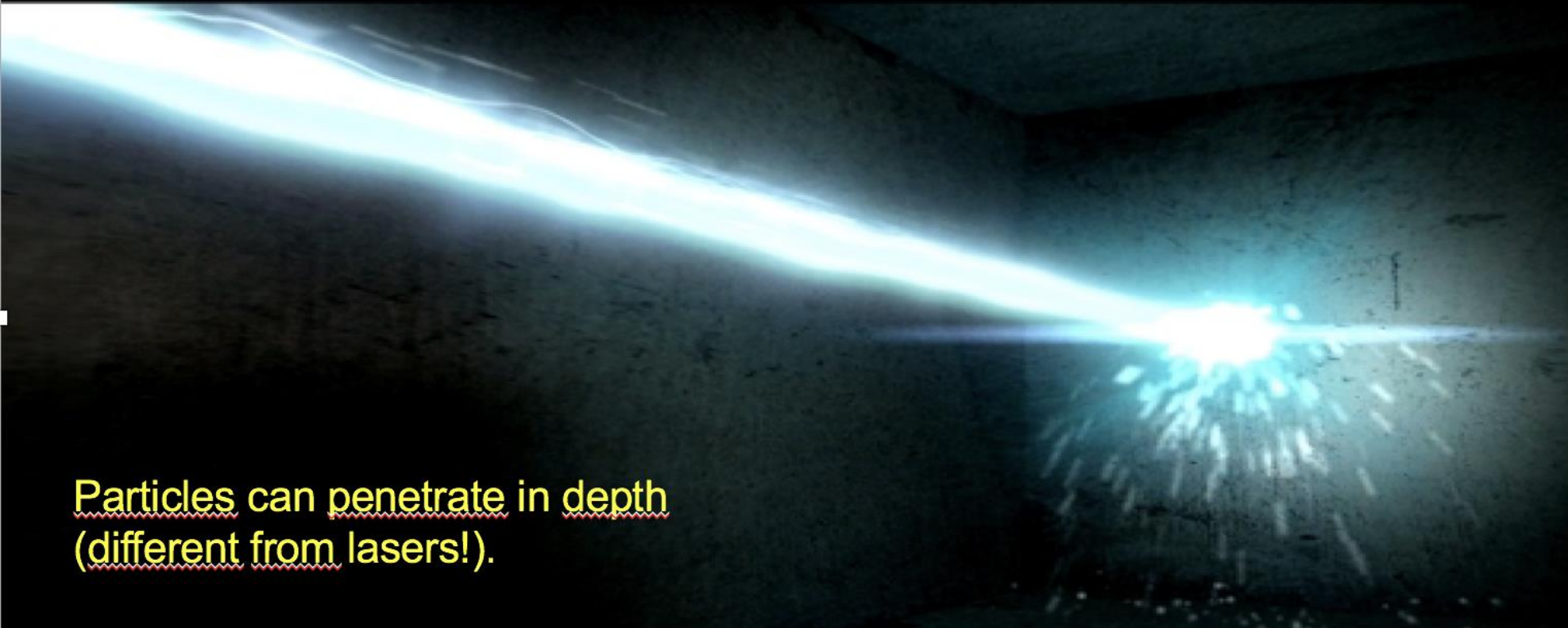


We can use electrons (very light) or protons (1836 times heavier).

Particle accelerators are our door to access the subatomic dimension... and exploit the atom and its components

Accelerators: can precisely deliver energy

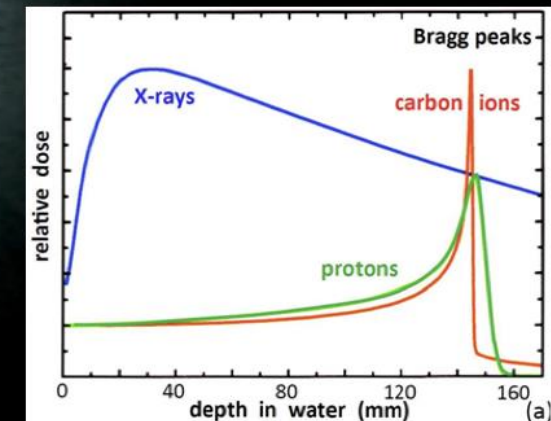
A «beam» of accelerated particles is like a small “knife” penetrating into the matter



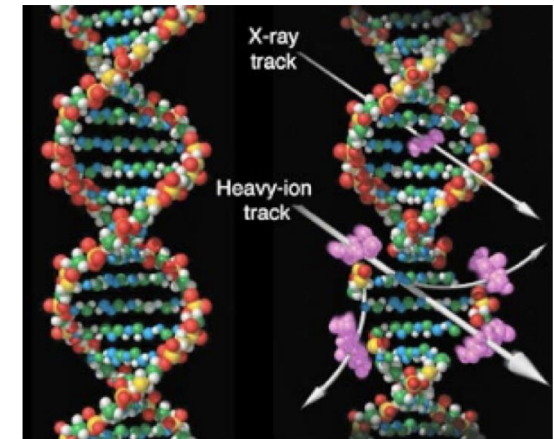
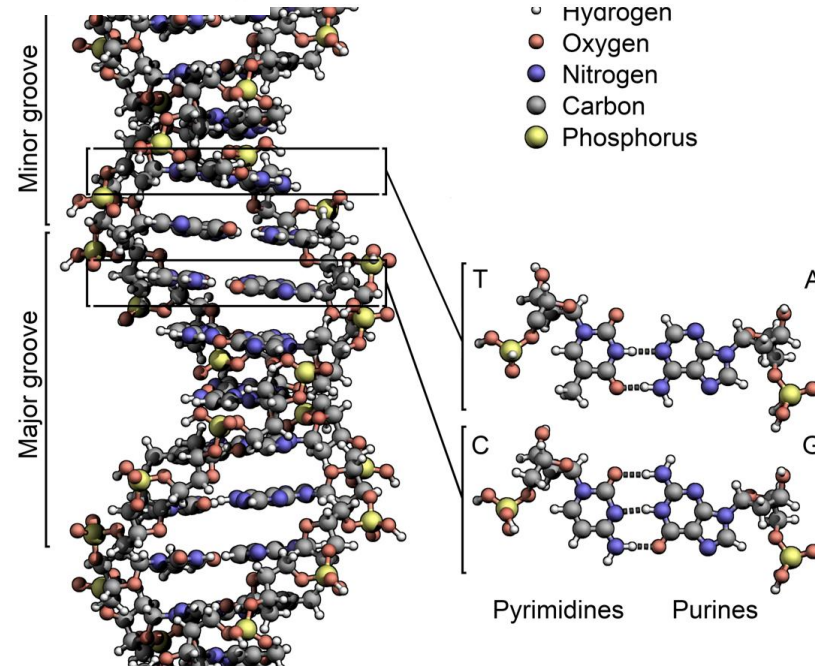
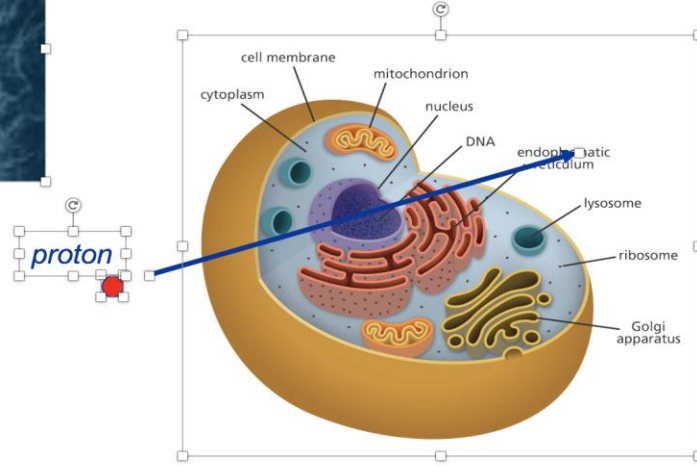
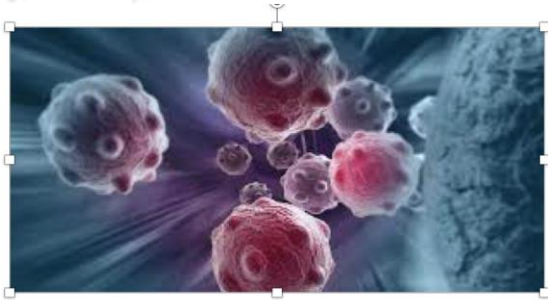
Particles can penetrate in depth
(different from lasers!).

Particle beams are used in medical and industrial applications,
e.g. to cure cancer, delivering their energy at a well-defined depth inside the body (Bragg peak)

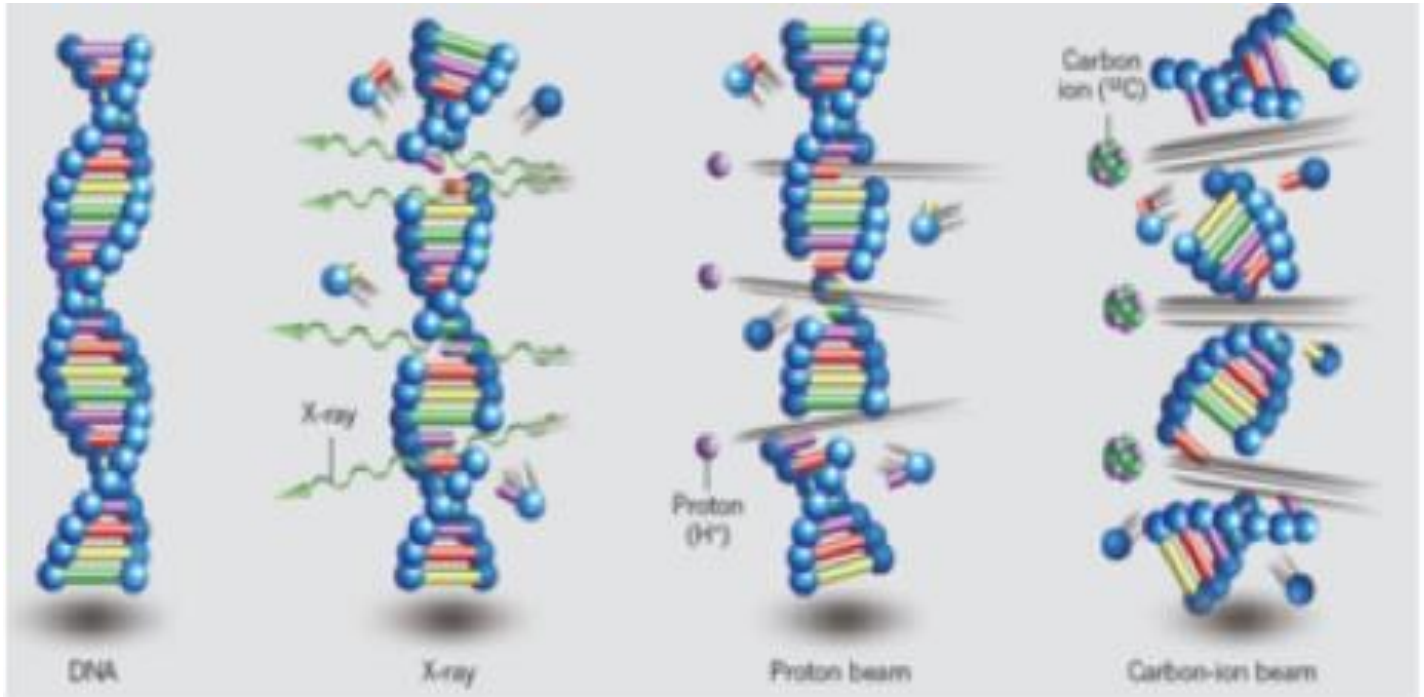
A particle beam can deliver energy to a very precisely defined area, interacting with the electrons and with the nucleus.



A particle beam can break the DNA and kill a cell

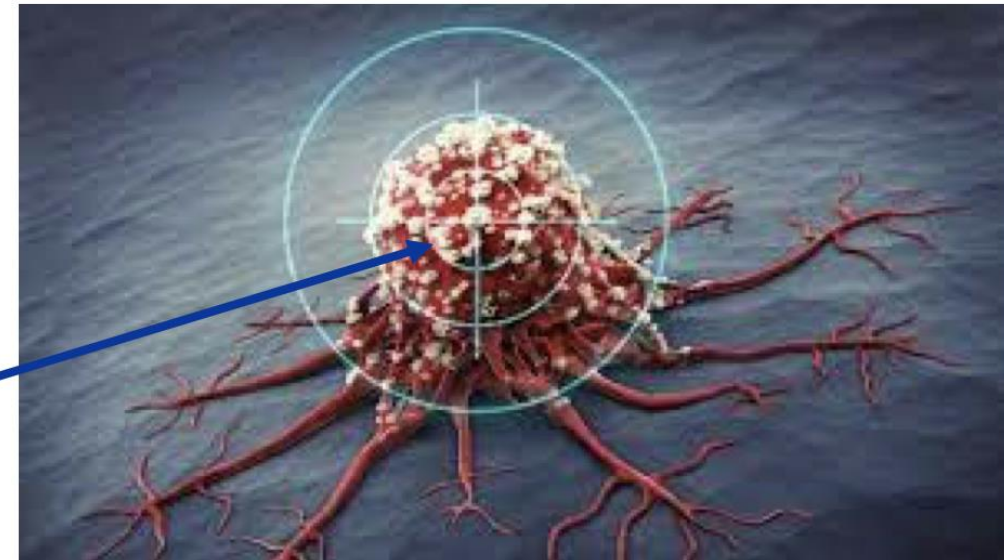


A particle beam can break the DNA and kill a cell



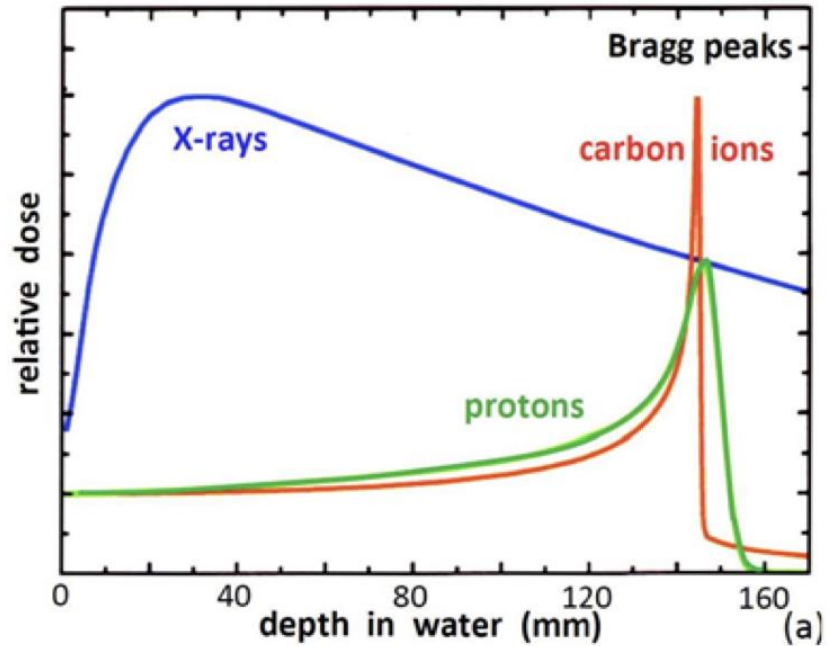
And if the cells has the cancer?
Killed !

proton



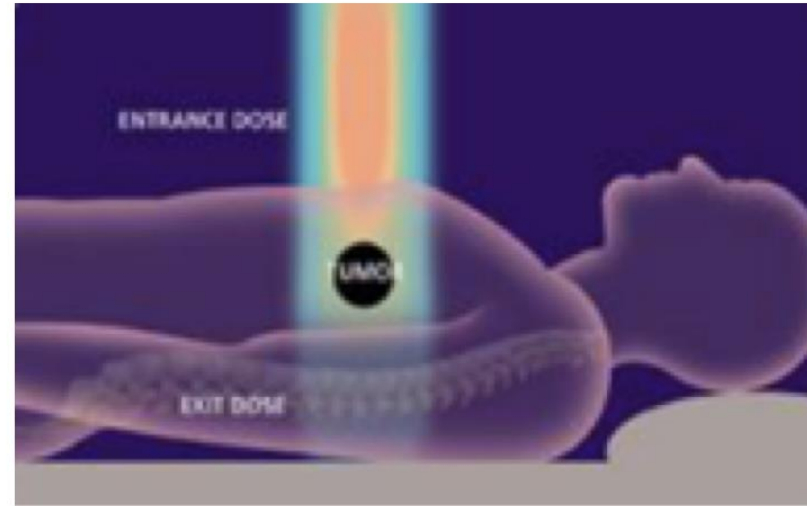
Hadron therapy with protons or ions

The Bragg peak



Different from X-rays or electrons, protons (and ions) deposit their energy at a given depth inside the tissues, **minimising dose to the organs close to the tumour, sparing nearby organs.**

Required energy for full-body penetration: 230 MeV protons, 450 MeV/u C-ions.



22,000 patients/year (2018) treated with particle beams,
25,000,000 patients/year with X-rays.

Accelerator and Society

Over 30'000 particle accelerators are in operation world-wide.

Only ~1% are used for fundamental research.

Medicine is the largest application with more than 1/3 of all accelerators.

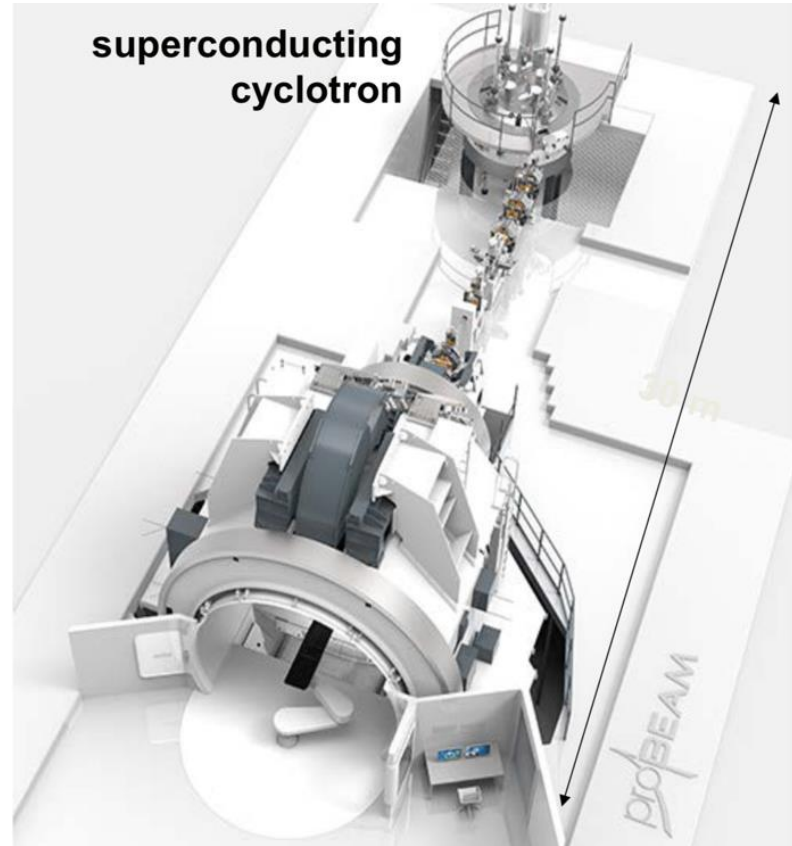
| | | |
|--------------------------------|--|----------------|
| Research | | 6% |
| | <u>Particle Physics</u> | 0,5% |
| | <u>Nuclear Physics, solid state, materials</u> | 0,2 - 0,9% |
| | <u>Biology</u> | 5% |
| Medical Applications | | 35% |
| | <u>Diagnostics/treatment with X-ray or electrons</u> | 33% |
| | Radio-isotope production | 2% |
| | <u>Proton or ion treatment</u> | 0,1% |
| Industrial Applications | | <60% |
| | Ion implantation | 34% |
| | <u>Cutting and welding with electron beams</u> | 16% |
| | <u>Polymerization</u> | 7% |
| | <u>Neutron testing</u> | 3.5% |
| | <u>Non destructive testing</u> | 2,3% |

Accelerators for health

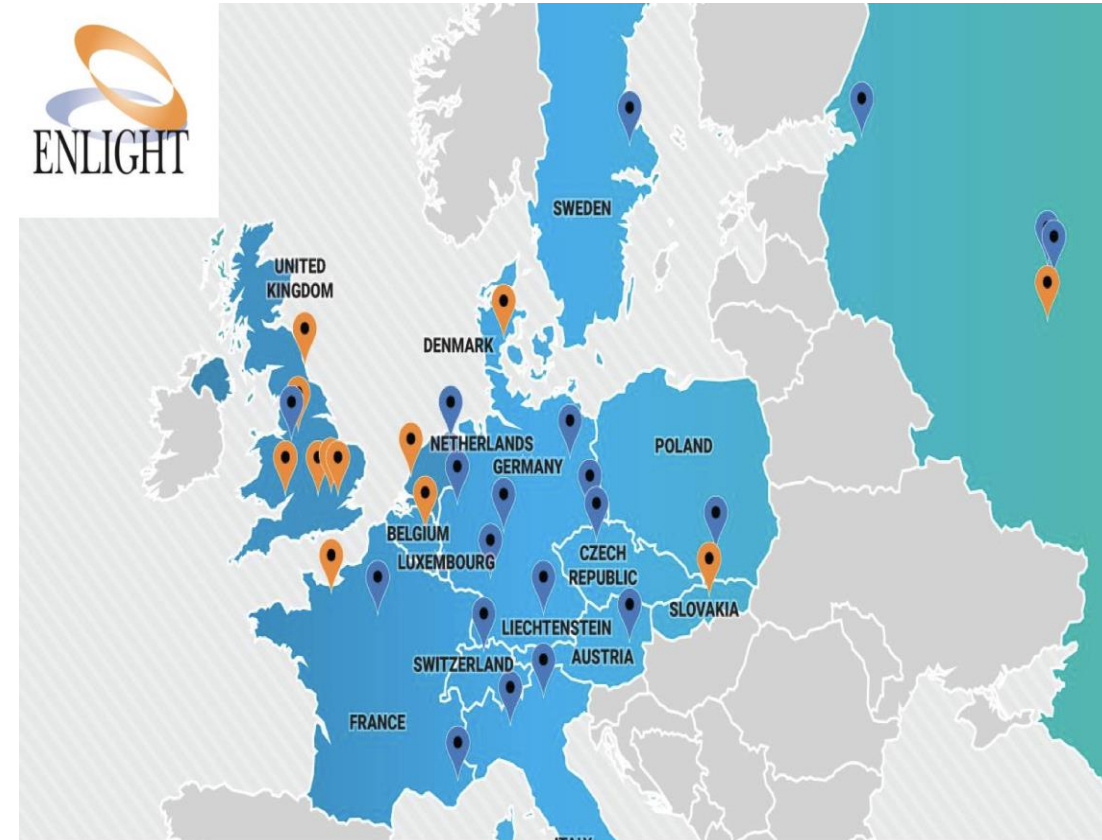
Conventional x-ray Radiotherapy



Particle/Hadron Therapy with protons



Hadron Therapy centers in Europe (2018)



Four carbon-ion cancer therapy centers in Europe

MedAustron, Austria



CNAO, Italy



HIT, Germany



MIT, Germany



Virtual Hadron Therapy Center





SEEIIST

South East European International Institute
for
Sustainable Technologies

Proposal for a facility in South East Europe: SEEIIST
50% research and 50% therapy
with multiple ions



Particle Therapy MasterClass

- Home
 - Posters
 - Aim
 - Materials
 - Agenda
 - Instructions
 - Invitation
 - Survey
 - Articles
 - Photos
 - Contacts and Teams
 - Events
 - Sponsors
- Contact
- ✉ pt.mc@cern.ch

Presentations

<https://indico.cern.ch/event/840212/>

Presentation of MatRad



Particle Therapy Masterclass

Overview and Pilot Report



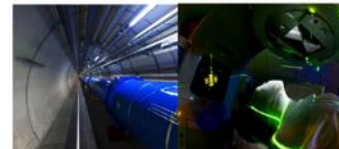
For ppt click [here](#).

Material in different languages

Animations

Presentation of Particle physics to medical applications

Particle physics to medical applications



Manjit Dosanjh, CERN

Introductory presentation in Greek



Workflow Instructions

Workflow Instrukcije



From discovery through science

CERN is the world's largest laboratory for particle physics. At CERN, physicists and engineers of more than 100 nationalities study the building blocks of matter and the forces that hold them together. They use the world's largest and most complex scientific instruments: accelerators, particle detectors and high-performance computing.

When CERN was founded, in 1954, the structure of matter was a mystery. Today, we know that all visible matter in the Universe is composed of a remarkably small number of particles, whose behaviour is governed by four distinct forces. CERN has played a vital role in reaching this understanding.

Hadron Collider (LHC), 27 kilometres below ground. It is there that the Higgs boson was discovered, a long sought mechanism that gives mass to particles. Beyond CERN's Large Hadron Collider, the LHC, there are many other diverse scientific instruments. Some of the many remarkable discoveries about the universe.

Panel 2: From discovery through science...To benefits for society

or Ion Therapy or Particle Therapy

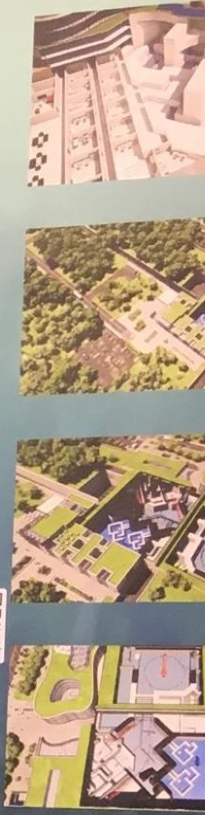
των ή Σωματιδιακή Ραδιοθεραπεία για καρκινικούς όγκους



SEEIST: South East European International Institute for Sustainable Technologies
SEEIST: Διεθνές Ινστιτούτο Βιώσιμων Τεχνολογιών Νοτιοανατολικής Ευρώπης
Μία σύγχρονη προηγμένη ερευνητική υποδομή για καινοτόμο θεραπεία καρκινικών όγκων



Το Διεθνές Ινστιτούτο Βιώσιμων Τεχνολογιών Νοτιοανατολικής Ευρώπης (South East European International Institute for Sustainable Technologies - SEEIST) στοχεύει στην ανάπτυξη και υλοποίηση προηγμένων ερευνητικών υποδομών για καινοτόμοις εφαρμογές στην αντιμετώπιση καρκινικών όγκων, με τη βοήθεια των δέσμων ιόντων και...



ALICE
CERN Alice
Κέντρα
Access
ary Centi...
...τοκομείο
...μπορείτε να βρείτε εδώ:
...Ραδιοθεραπεία Ηλεκτρονίων



Consortium

The consortium consists of 2 major European heavy ion physics laboratories, 4 European ion therapy centres, 8 world-class research institutions, 5 leading universities, 3 innovative SME's (two of which from SEE region). Their combined knowledge and background, grounded in experience of running four state-of-the-art treatment facilities and committed user communities, constitutes the core of this proposal.

Discover



HITRIplus Aims

Main aims:

- (a) transnational access,
- (b) new developments for the future SEEIST facility and upgrades of the existing ones
- (a) networking, training and education (capacity building)



HITRIplus EU-funded project

Large consortium of research infrastructures including CERN and GSI, plus universities, industry, all four existing European heavy-ion therapy centres, and the future research infrastructure SEEIST (South-East Europe International Institute for Sustainable Technologies)

HITRIplus Open Access: Transnational Access TNA

The **Clinical Access** gives the opportunity to clinicians/medical physicists/technicians referring patients to the hadrontherapy facilities to personally follow patient's treatment and follow up.

The **Research Access** will attract universities, research centres, and hospitals, which will connect all the groups to perform research activities with carbon ion beams. Industrial partners are also encouraged to take part in the research programme, to be involved in the development of new clinical procedures and new medical devices.

CLINICAL RESEARCH ACCESS

REFER PATIENTS TO THESE FACILITIES AND PERSONALLY PARTICIPATE TO CLINICAL RESEARCH.
IMPROVE YOUR KNOWLEDGE ON HEAVY ION THERAPY

CNAO, HIT, Marburg, MedAustron will be glad to welcome physicians, oncologists, radiotherapists and medical physicists willing to perform clinical research:

- discussing the eligibilities
- comparing treatment plans
- taking part in research clinical trials

THE BEST OF CLINICAL RESEARCH ON:

- Chordoma & chondrosarcoma base/spine
- Meningiomas
- Brain tumors (trunk)
- ACC Salivary Glands
- Orbit tumors including eye melanoma
- Sinonasal carcinoma
- Soft Tissue & bone Sarcoma (every sites)
- Recurrent tumors (retreatment)
- Immunological disorders

CLINICAL RESEARCH IN HADRONTHERAPY AT NO COST FOR SCIENTIFIC PROGRESS AGAINST CANCER:

- Choose the treatment facility
- Stay at the centre with a group of 2-3 clinical researchers for up to one week
- Reimbursement for travel and accommodation

SCAN AND APPLY

RESEARCH ACCESS

SHARE RESEARCHERS HIGH LEVEL KNOWLEDGE AND BE INVOLVED IN PRECLINICAL RESEARCH AND NEW CHALLENGES

CNAO, GSI, HIT will be glad to welcome members of universities, research centres, and hospitals for carrying out research activities with heavy ion beams.

SUBMIT YOUR PROPOSAL FOR A NEXT LEVEL RESEARCH PROJECT ON:

- radiation biology for heavy ions radiotherapy
- medical physics of heavy ions
- nuclear physics applied to particle therapy
- new model systems for pre-clinical experiments with heavy ions

ION BEAMS AT NO COST:

- Choose the research facility and plan your experiments with the experts
- Reimbursement for travel and accommodation

SCAN AND APPLY

Available and effective
Capacity Building
in SEE Countries
for Clinicians and Researchers

www.hitriplus.eu

Big opportunity for SEEIIST Members!!!

FORMS for TNA Access

CLINICAL: <https://www.hitriplus.eu/transnational-access-ca/>
RESEARCH: <https://www.hitriplus.eu/transnational-access-ra/>

HITRIplus Educational Material in YouTube Channel

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@hitriplus9177
102 iscritti

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349 visualizzazioni • 1 mese fa
- 8th Seminar of HITRIplus – The Past, Present, and...**
31 visualizzazioni • 3 mesi fa
- HITR Lecture 32: Key aspects of safety in Partic...**
33 visualizzazioni • 6 mesi fa
- Final Lecture: Closing Thoughts from Organisers**
21 visualizzazioni • 6 mesi fa
- HITR Lecture 31: External Beam Ablation Medical...**
40 visualizzazioni • 7 mesi fa

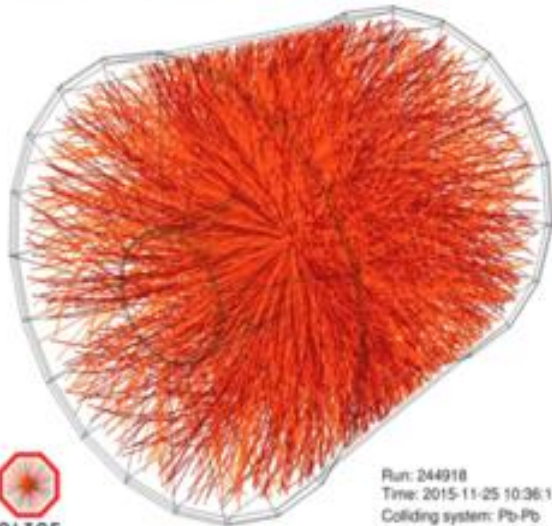
Heavy-ion research and heavy-ion therapy

Pb-Pb at 5.5 TeV
pp at 14 TeV

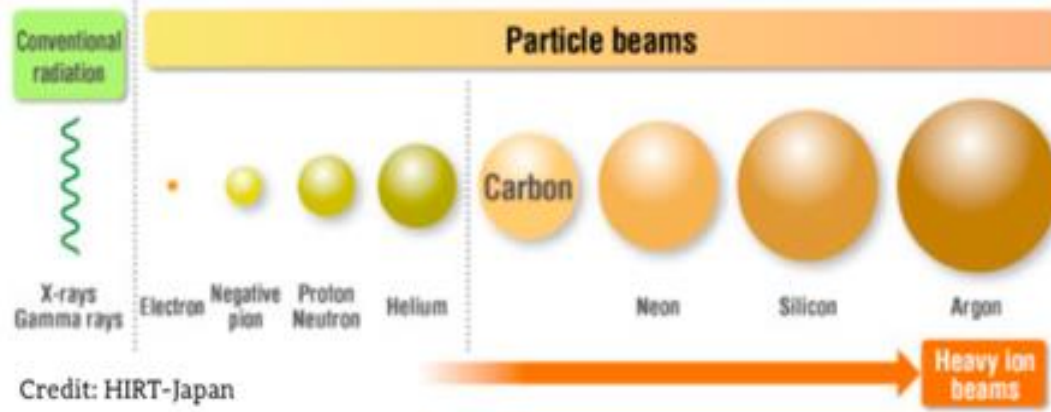
fundamental science
QGP studies



Credit: CERN



Run: 244918
Time: 2015-11-25 10:36:18
Colliding system: Pb-Pb
Collision energy: 5.02 TeV



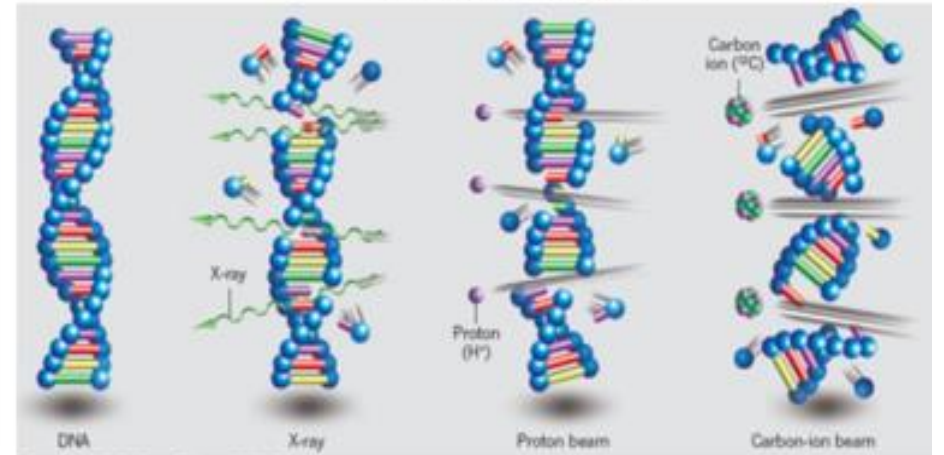
Credit: HIRT-Japan

88-430 MeV/u carbon
50-221 MeV/u protons

applied science
medicine



Credit: HIT Heidelberg



Credit: T. Nomiya, NIRS Japan



<https://indico.cern.ch/event/840212/>