



Yiota Foka (GSI/CERN)

HITRI
Heavy Ion Therapy Research Integration
www.hitriplus.eu

SEE IST
South East European
International Institute
for Sustainable Technologies

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

HADRON THERAPY SYMPOSIUM

Commission Europe

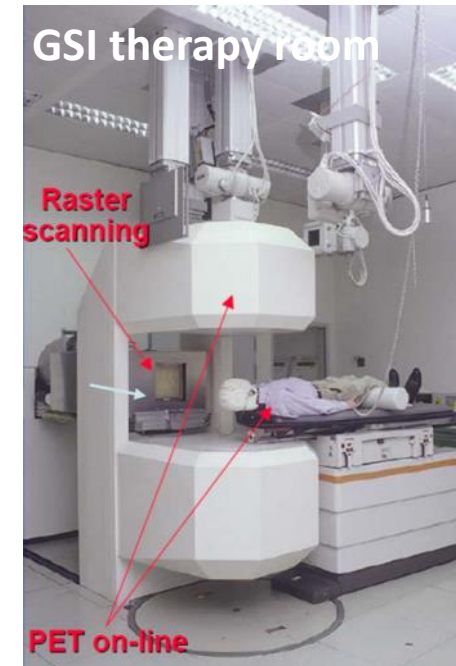
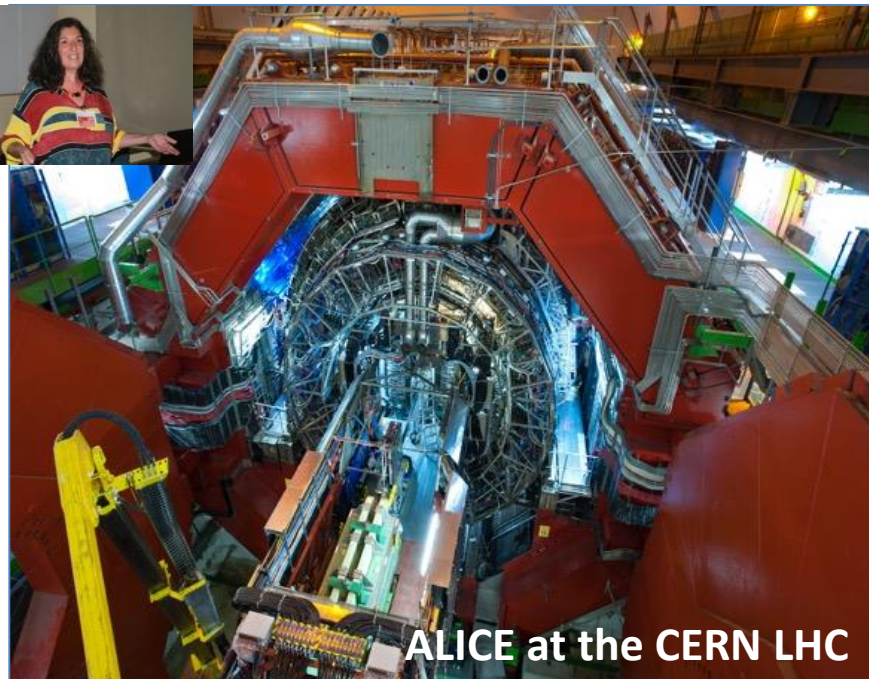


Heavy-ion research and heavy-ion therapy

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



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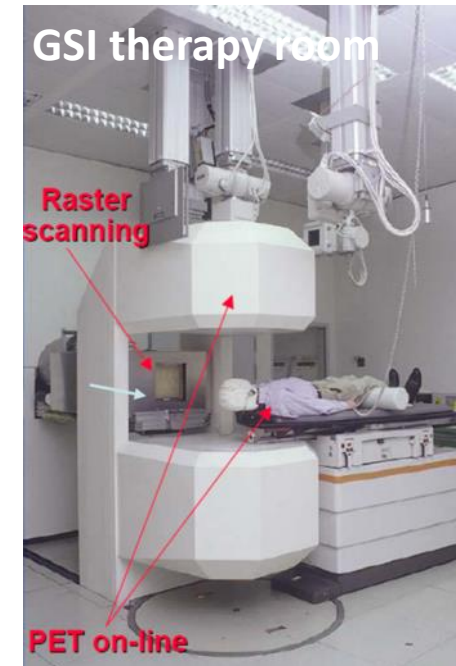


ALICE Control Room

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



GSI and future FAIR



GSI therapy room

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

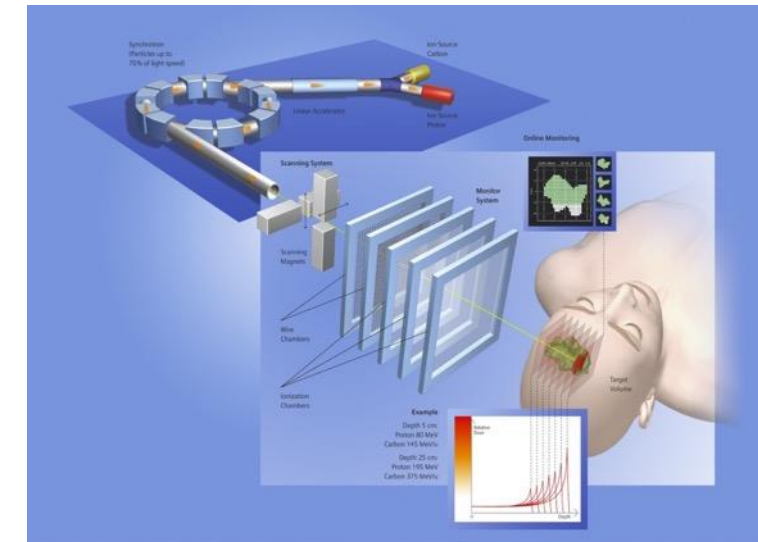


ALICE Control Room

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



Heidelberg Ion Therapy HIT centre

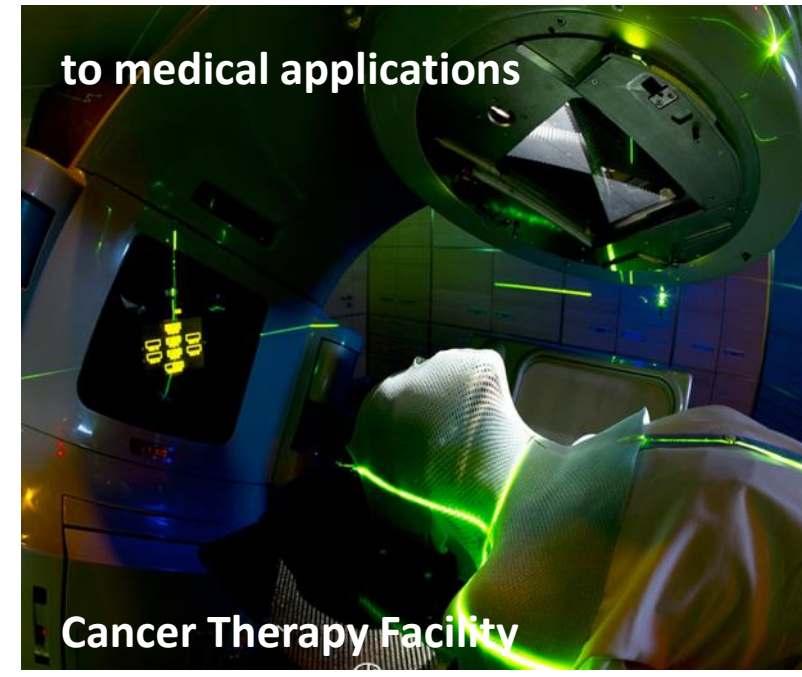


Implemented at HIT, Heidelberg Ion Therapy centre

Heavy-ion research and heavy-ion therapy

Next Steps: Next Ion Medical Machine Study, NIMMS, CERN group

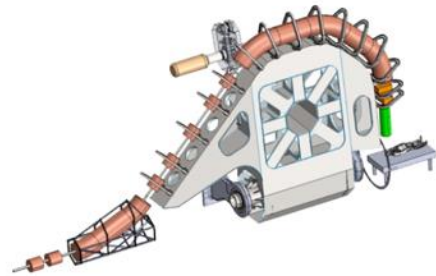
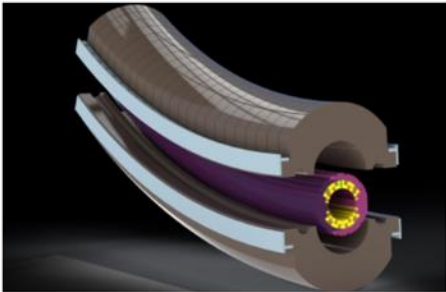
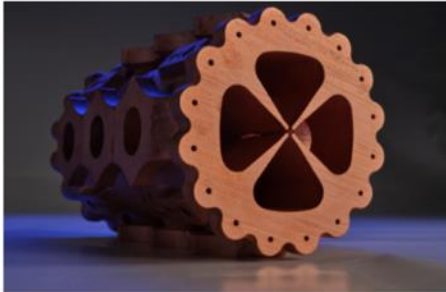
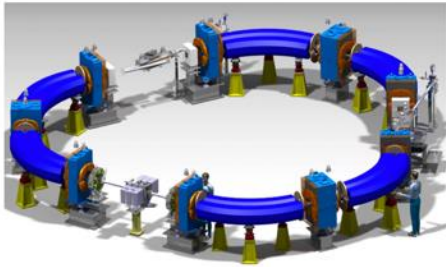
ALICE heavy-ion experiment at CERN Innovative technologies for next generation ion facilities



Next Ion Medical Machine Study Group Developments

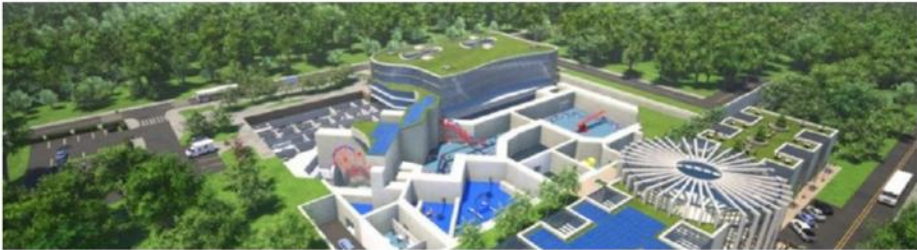


Our Technological R&D



Synchrotron Accelerators	Linear Accelerators	Superconducting Magnets	Superconducting Gantry
HeLICS (Helium Synchrotron), Carbon Synchrotron, and Superconducting Carbon Synchrotron	Innovative LINAC technologies for treatment and radioisotope production	Design and prototyping of novel, compact curved magnets	360° beam delivery with EuroSig & GaToroid

Our Supported Initiatives



APTCB Advanced Particle Therapy Center for the Baltics	SEEIIST South East European International Institute for Sustainable Technologies
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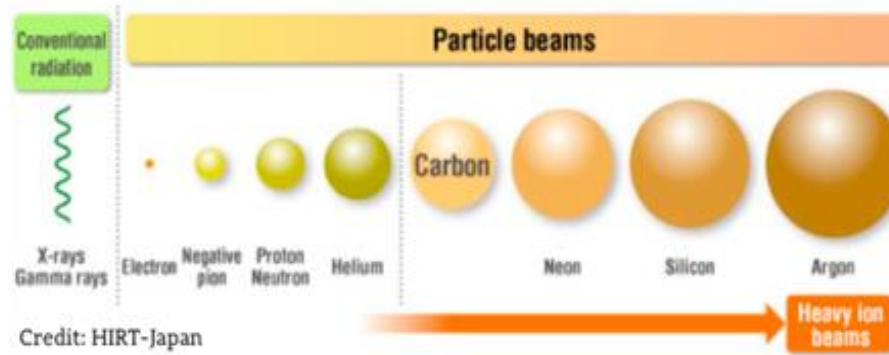
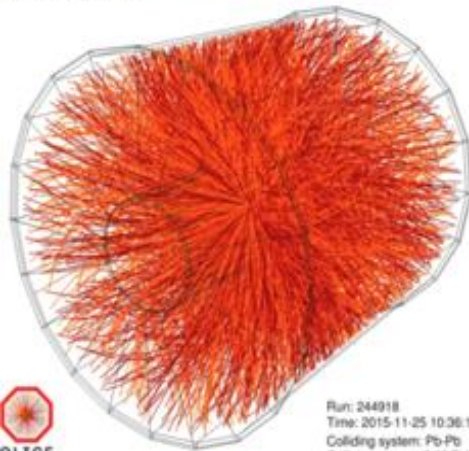
Heavy-ion research and heavy-ion therapy

Pb-Pb at 5.5 TeV
pp at 14 TeV

fundamental science
QGP studies



Credit: CERN



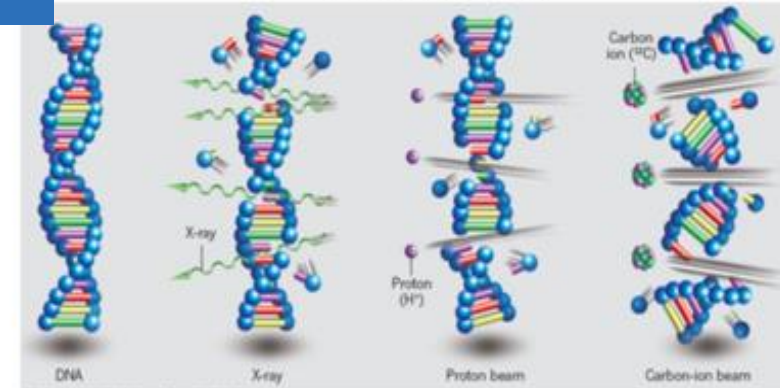
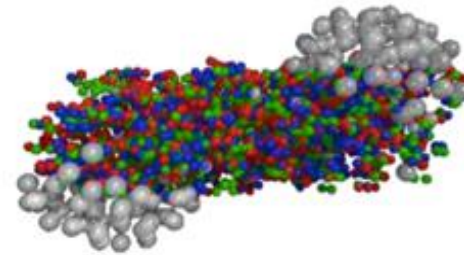
88-430 MeV/u carbon
50-221 MeV/u protons

applied science
medicine



Credit: HIT Heidelberg

What Physics has to do with Medicine?

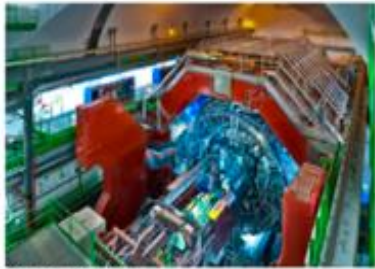


Credit: T. Nomiva, NIRS Japan

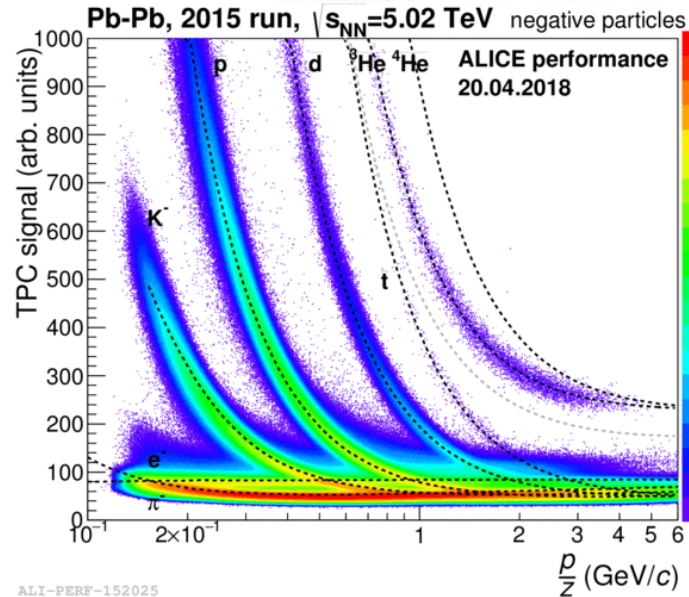
Heavy-ion research and heavy-ion therapy

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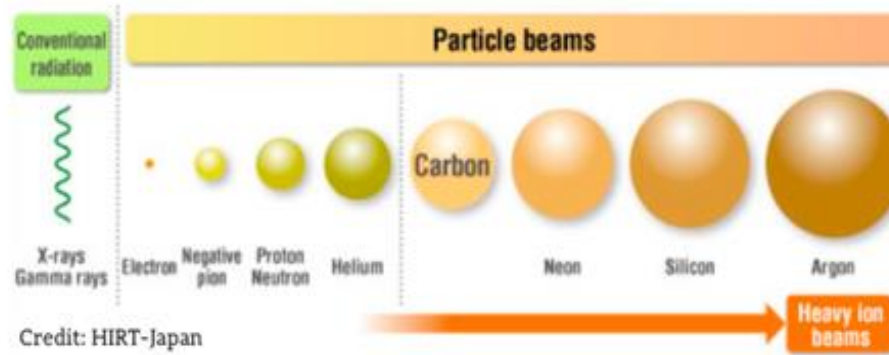


Credit: CERN



ALI-PERF-152025

From Bethe Bloch ionization for PID

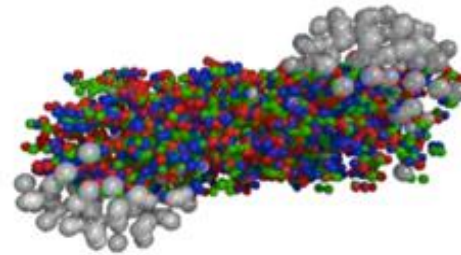


88-430 MeV/u carbon
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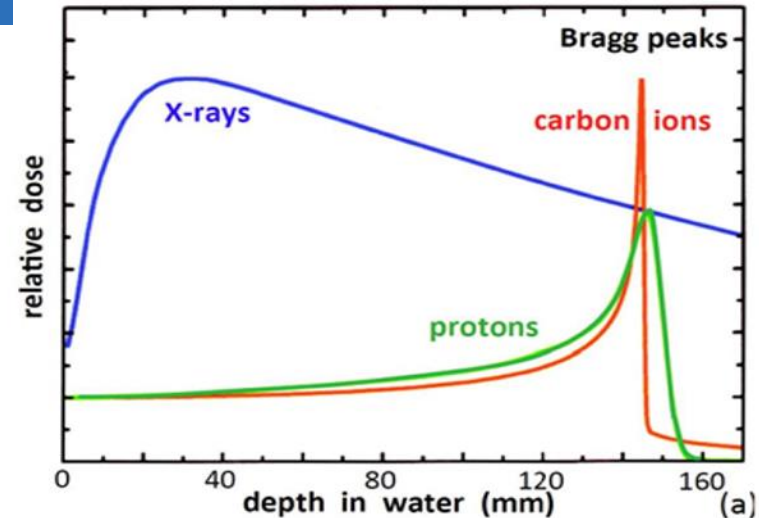
applied science
medicine



What Physics has to do with Medicine?



fundamental properties of particles and their interaction with matter in the service of society



to Bragg peak for cancer therapy

From Fundamental Research....

.....to Medical Applications

What are the benefits for society?

The developed accelerator technology is used for cancer research and therapy

Innovative technologies developed for future CERN projects find already applications in medicine



Accelerators for Health

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%

What are the
International MasterClasses IMC
and
Particle Therapy MasterClasses PTMC



www.hitriplus.eu



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**HADRON THERAPY
SYMPOSIUM**

International MasterClasses

Flagship project of IPPOG Brings scientific methods to schools!



IMC2024: 6.5 weeks

64 countries

311 institutes

15 000 students



Classes by masters, experts



Particle Therapy MasterClass



Become scientist for a day !



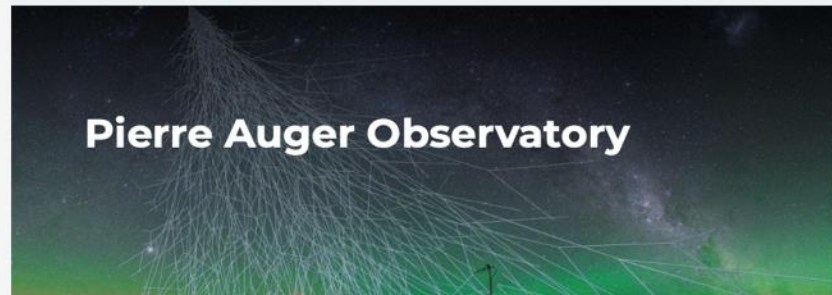
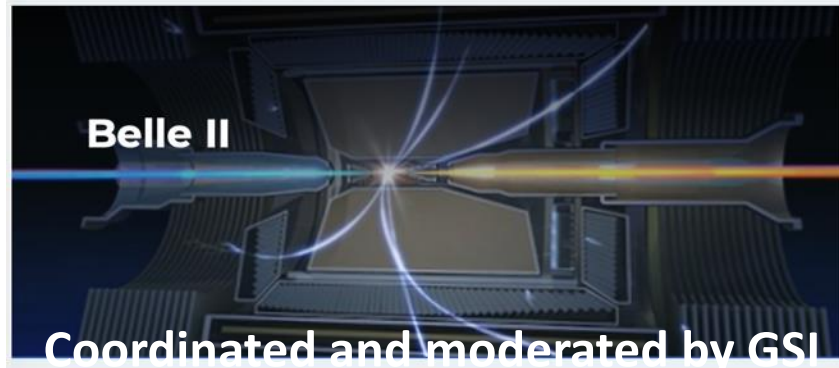
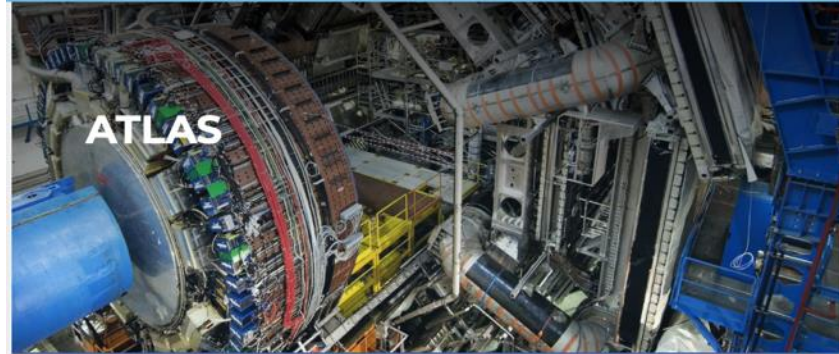
Students are given the opportunity to analyze real data the same way that scientists do.

New PTMC:

- what physics has to do with medicine
- how we go from Particle Physics to Particle Therapy: impact of physics research on medicine advancements
- *different new career opportunities*, various possibilities that physics and STEM studies may open up for interesting jobs



International Masterclasses



PTMC: Typical MasterClass Day Agenda

Adapted: online/hybrid modes

Every day 3-5 institutes participate, during the months of February-April. School-children (15-19 year old) are invited **at/by** an institute of their area.

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

Importance of collaboration for common projects

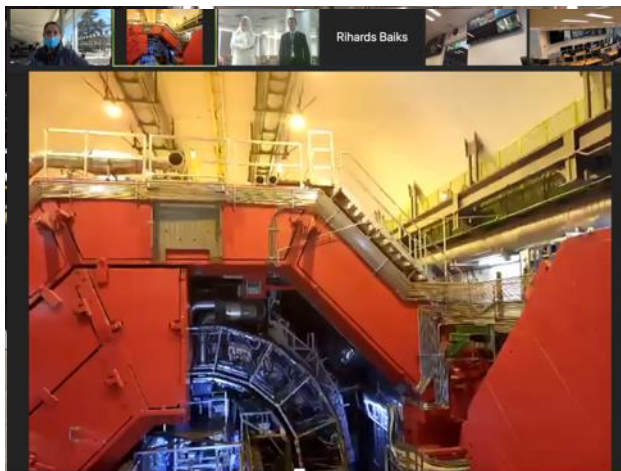
Local: Morning Presentations



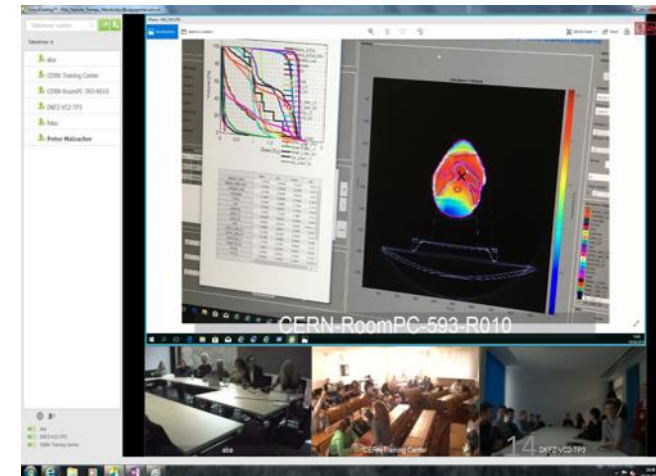
Local: Afternoon Hands-on



Local: Morning Visits real-time online ALICE visit



Common: Afternoon at 16:00 Video-Conference



PTMC: Typical MasterClass Day Agenda

Start with videos on hadron therapy procedures in a virtual hadron therapy center while participants arrive (or join the zoom session)



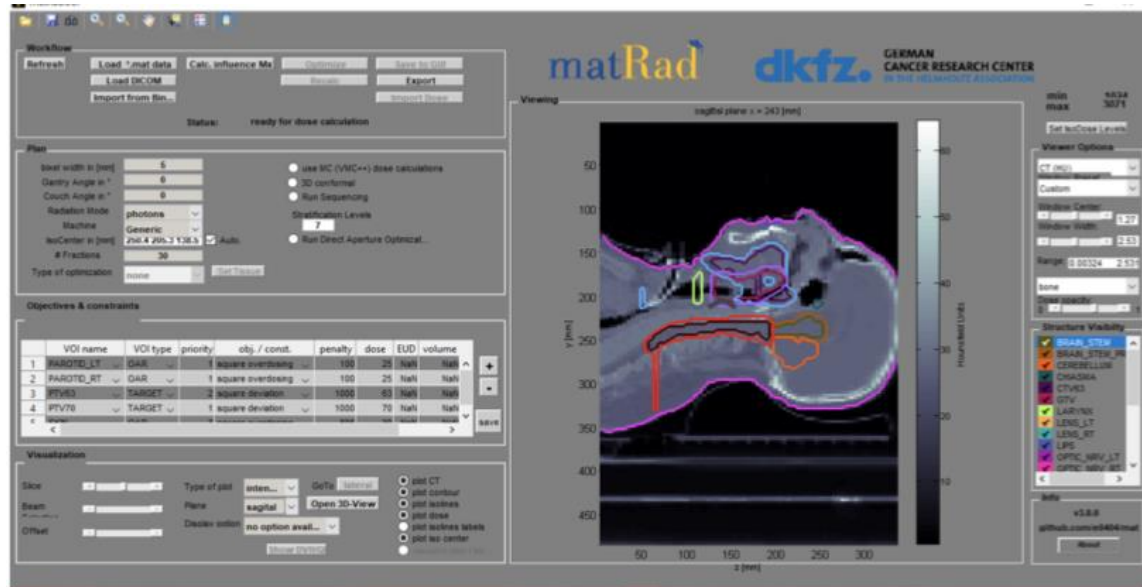
<https://indico.cern.ch/event/840212/>

Lectures adapted to the
expertise of institutes

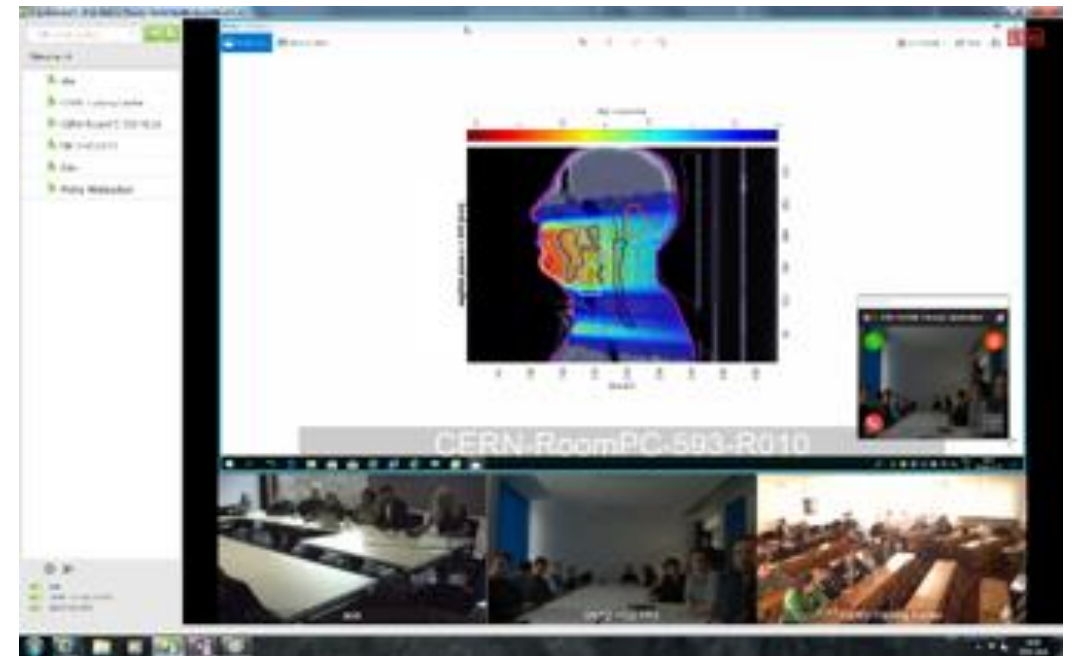
PTMC hands-on Treatment Planning

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

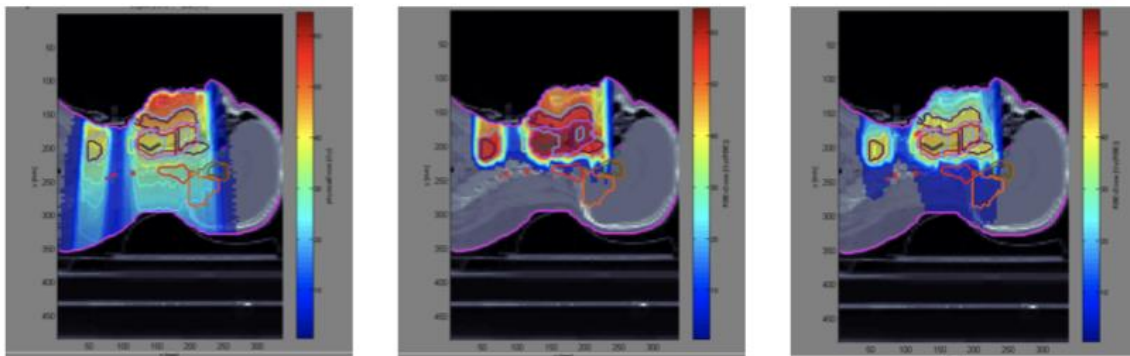
Simplified version for PTMC



Dose prescription
using photons, protons and carbon ions



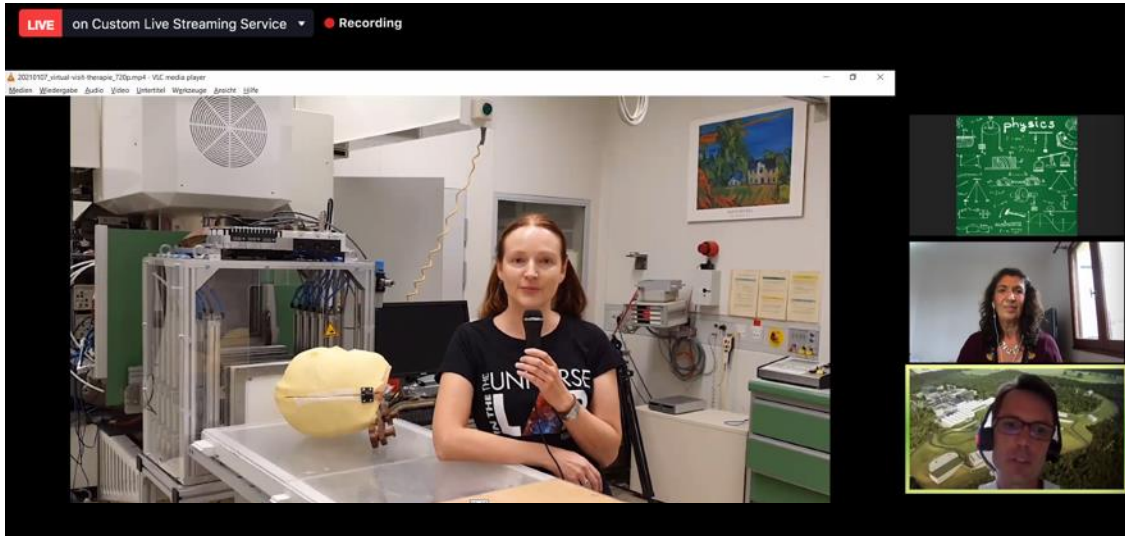
Demo⁴ of the matRad software kit for Treatment Planning .



Easily visible the difference of photons and hadrons

Virtual visits and video-conferences

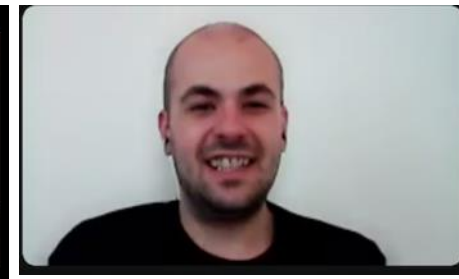
Virtual visits during video-conference: GSI research institute, CNAO, MedAustron therapy centers



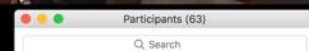
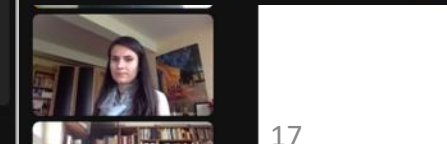
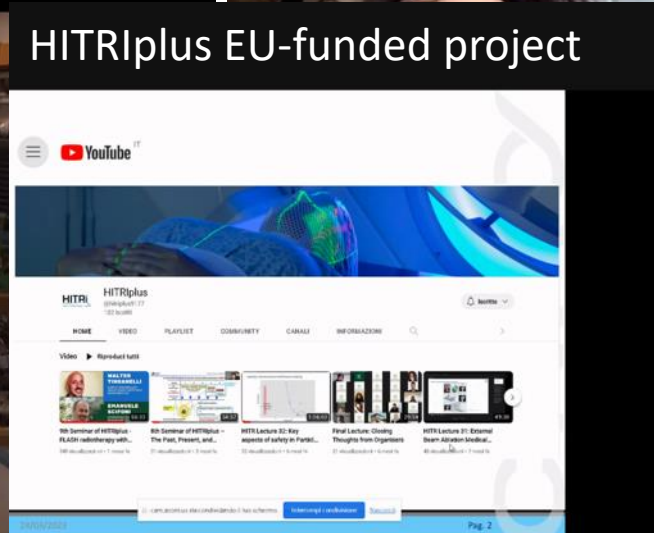
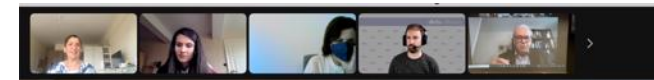
GSI moderators

CNAO moderator

medAustron moder.



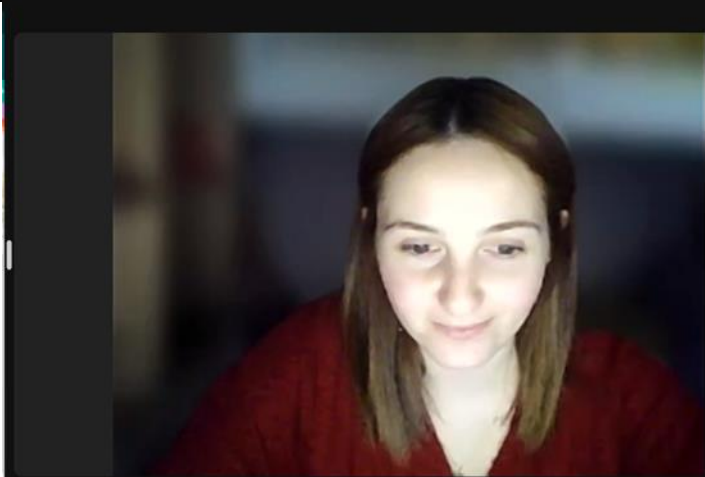
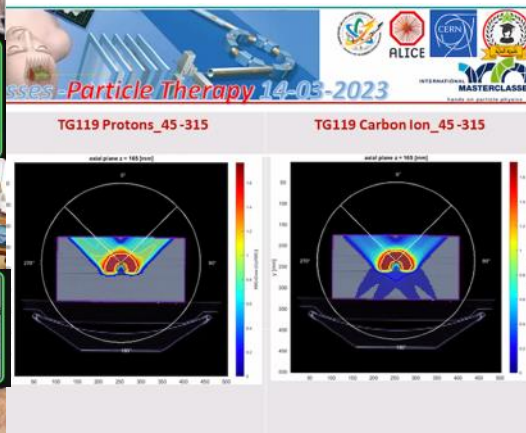
U. Amaldi: HI therapy pioneer



Levan Kankadze

PTMC supporting females in STEM

11 Feb and 8 March sessions encouraging female participation and providing role models




What have we learnt?








Particle Therapy MasterClass


<https://indico.cern.ch/e/PTMC>


-  Instruction in Albanian


-  Instructions in Bosnian

-  Instructions in French

-  Instructions in Greek

-  Instructions in Lithuanian

-  Instructions in N.Macedonian

-  Instructions in Spanish

Material in different languages including animations and demos

“PTMC in a kit”

in different languages
with introduction by DKFZ
including recordings

https://drive.google.com/drive/folders/1L94yhos6L7k3FQIMzD9QI7kpk_c_ABD7

Training sessions: 4-5 per year

Importance of training teachers:
Sofia, Madrid, and Sarajevo

Example of UNSA/Sarajevo:

- in-person at university
- in-person at schools
- common lectures online

PTMC and matRad Treatment Planning

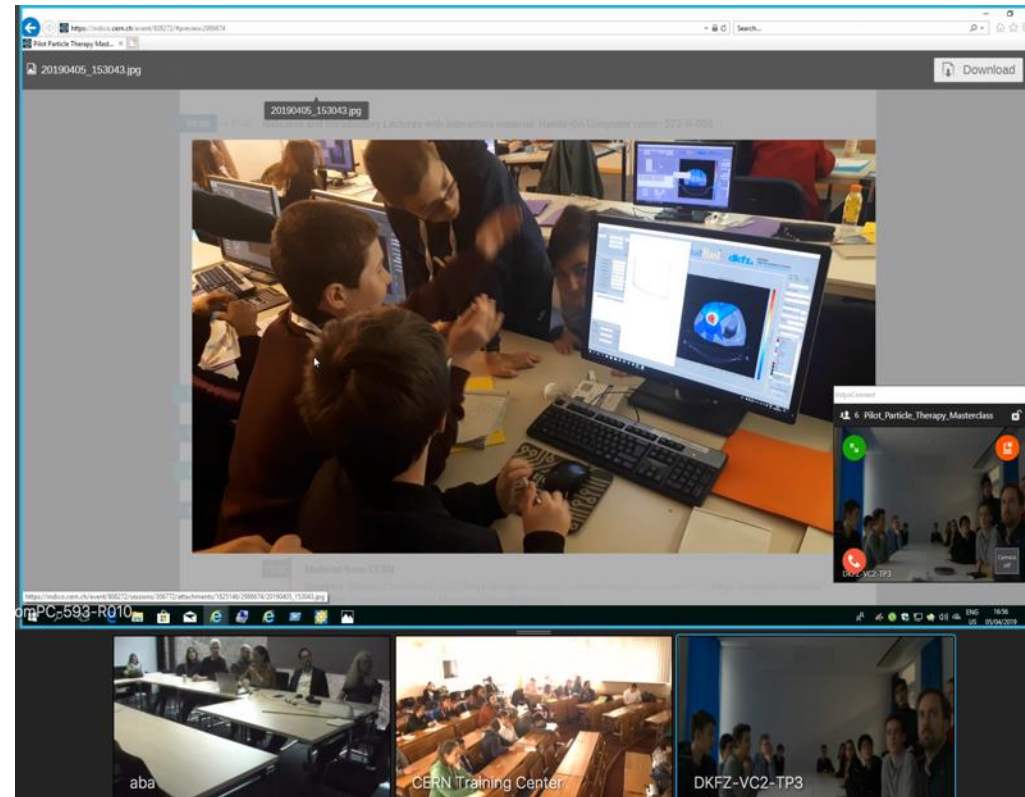
First Local Test: GSI Feb 2019



Web page: UNSA students
CERN Open Days, Aug 2019



International Pilot: CERN, GSI, DKFZ April 2019



IMC Steering Group Approval: GSI May 2019

We could not imagine
what physics has to do with medicine,
that research institutes such as CERN
can contribute to medical applications

First PTMC in IMC2020

Mexico 2nd March 2020, then online due to covid



Participants of online PTMC in IMC2021

<https://indico.cern.ch/e/PTMC>

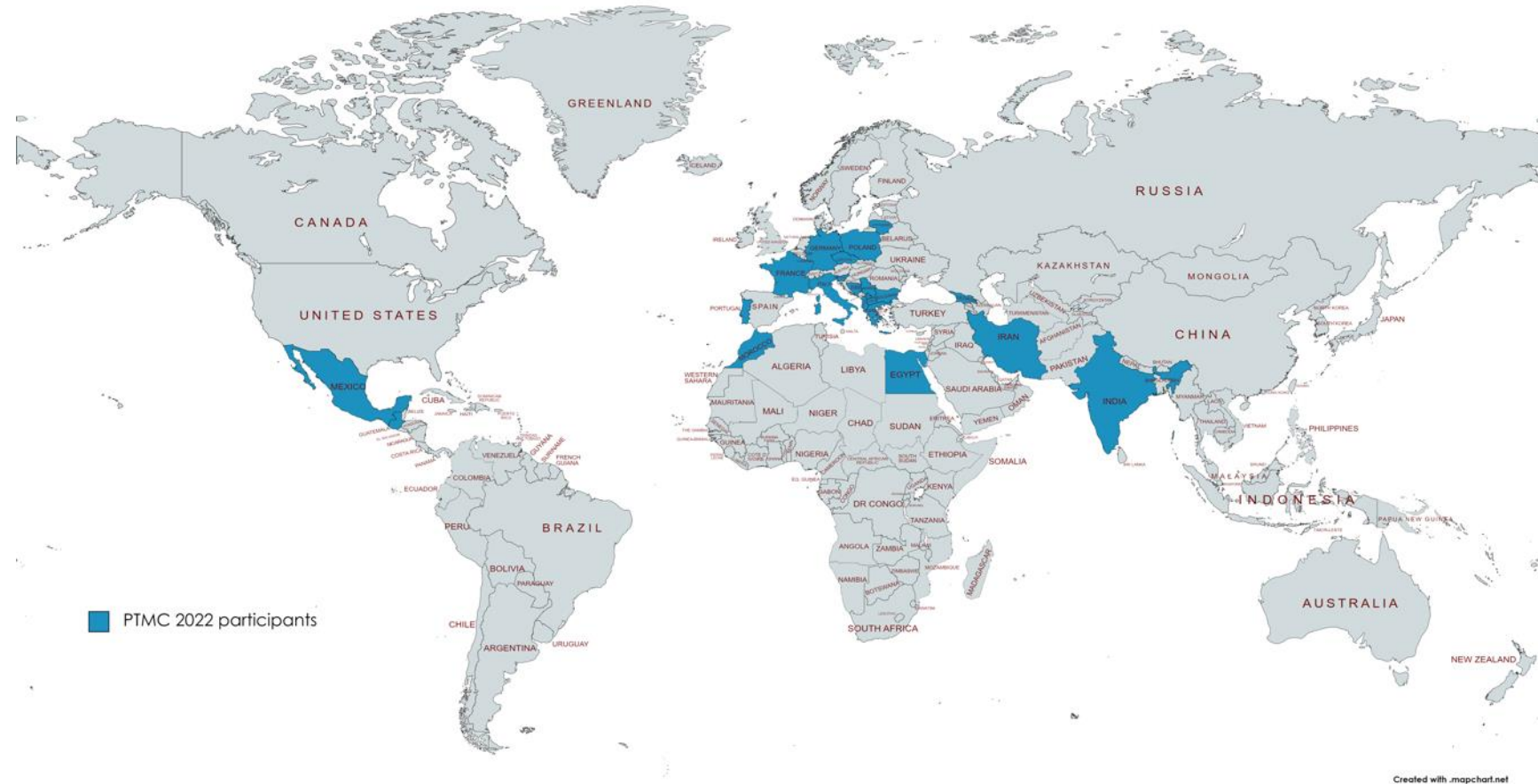


PTMC2021 online:
6 sessions, 1500 students
from 20 countries and 37 institutes



Participants of online PTMC in IMC2022

<https://indico.cern.ch/e/PTMC>



Created with mapchart.net

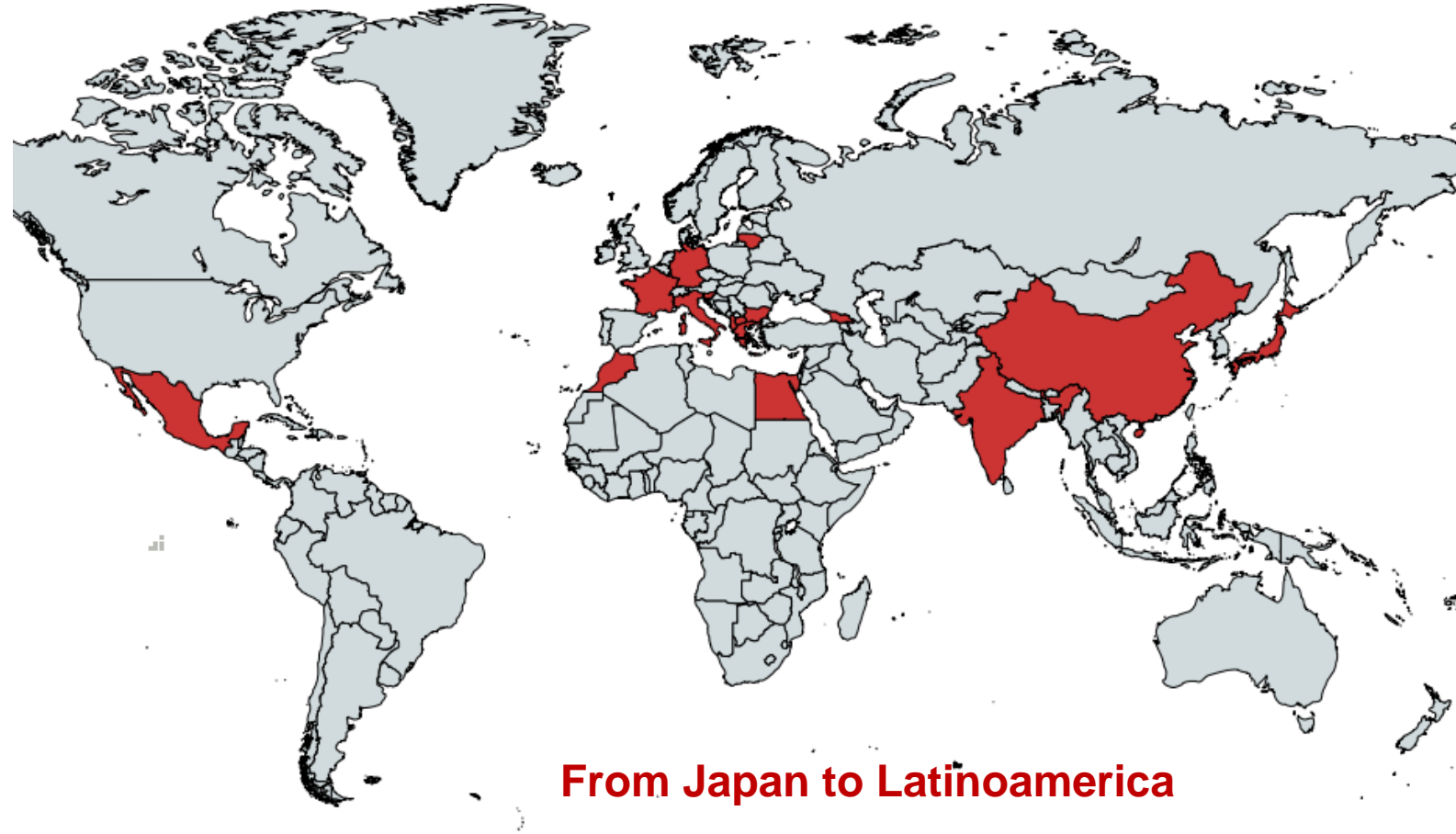
**PTMC2022 online/hybrid:
6 sessions, 1500 students
from 22 countries and 37 institutes**

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

Participants of hybrid PTMC in IMC2023

<https://indico.cern.ch/e/PTMC>



PTMC2023 in person/online/hybrid:
9 sessions
from 22 countries and 38 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

Participants of hybrid PTMC in IMC2024

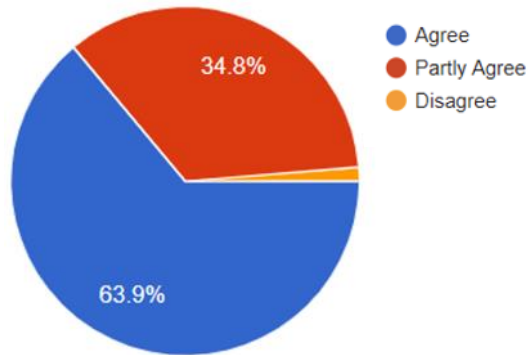
<https://indico.cern.ch/e/PTMC>

Statistics of 22 out of 47 institutes:

Total: 1567

428 female, 430 male

17 in person, 5 hybrid



Some institutes had 2 sessions
in-person and online

PTMC2023 in person/online/hybrid:
8 sessions, more than 1500 students
from 22 countries and 47 institutes

web pages with agendas of every institute with material
in different languages, publicly available for future events

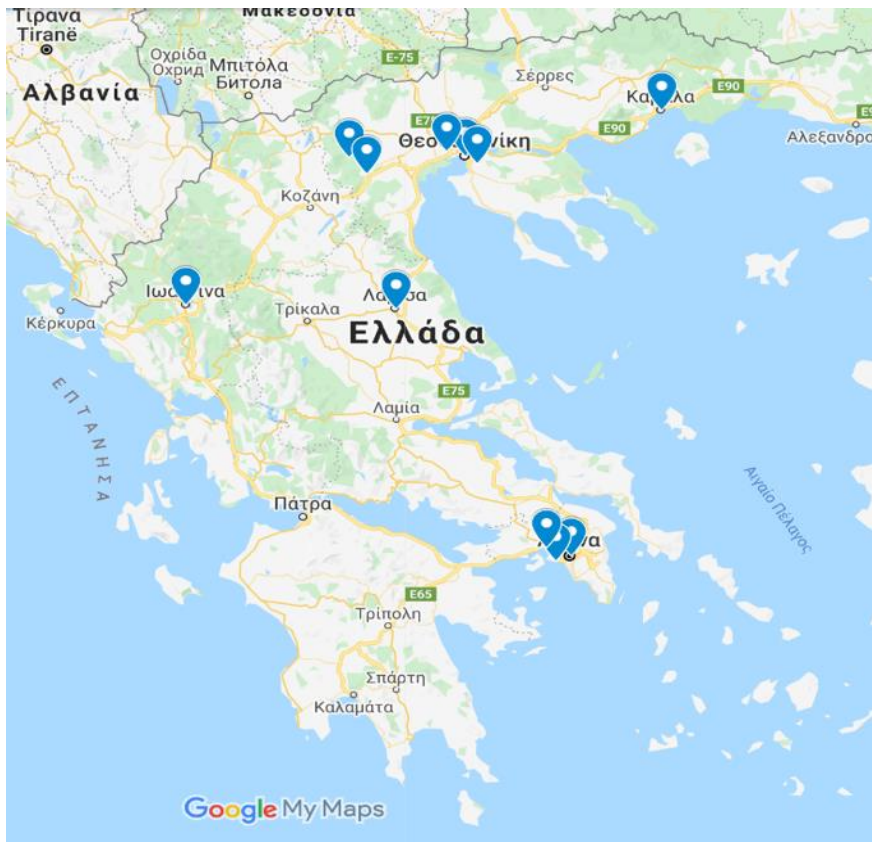
Interest of students, motivation of tutors (voluntary work), potential impact

PTMC in Greece

PTMC2021 online: through Library of Veroia

Total of 366 live views

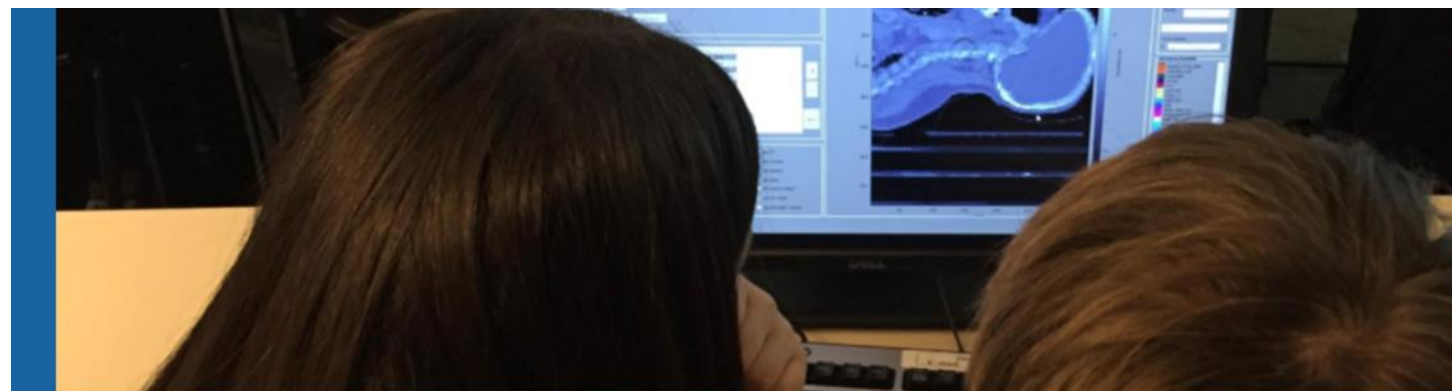
from at least 20 major regions of Greece



PTMC2022 online: more than 150 participants, PTMC2024: 275 participants

AUTH uni, Dimokritos research centre, Papageorgiou Hospital, Technopolis.

Publicity: Library of Veroia extended networks and national press



International Particle Therapy MasterClass

9 April 2022
AUTH
Europe/Zurich timezone

Enter your search term

Overview

PTMC 2022

Registration

Participant List

PTMC main page

Contact

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✉ p.foka@gsi.de

✉ amamaras@physics.aut...

«Επιστήμονες για μία ημέρα»

διαδικτυακό Masterclass για μαθητές λυκείου από τους ερευνητές του CERN και GSI

για τη χρήση της Φυσικής επιστήμης πάνω στην Ιατρική Θεραπεία

9 Απριλίου 2022

Τα ερευνητικά κέντρα CERN και GSI, το Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης, το ερευνητικό κέντρο ΔΗΜΟΚΡΙΤΟΣ και το Γενικό Νοσοκομείο Παπαγεωργίου Θεσσαλονίκης με την υποστήριξη του Veria TechLab της Δημόσιας Κεντρικής Βιβλιοθήκης της Βέροιας, και της Περιφέρειας Κεντρικής Μακεδονίας παρουσιάζουν το **Σάββατο 9 Απριλίου 2022**, ένα μοναδικό Masterclass για

- Press Release published in **nation-wide media**
- Post on Facebook resonated with **3,600** people
- Announcement viewed **941** times on website

Took it a step further !

A full week MasterClass school
inspired by the PTMC format
within the HITRIplus EU funded project

**Advanced material
for uni students and up to professionals**

<https://indico.cern.ch/e/HeavyIonTherapyMasterClass>



HITRI
Heavy Ion Therapy Research Integration
www.hitriplus.eu

SEEIST
South East European
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Commissione Europea

HADRON THERAPY SYMPOSIUM

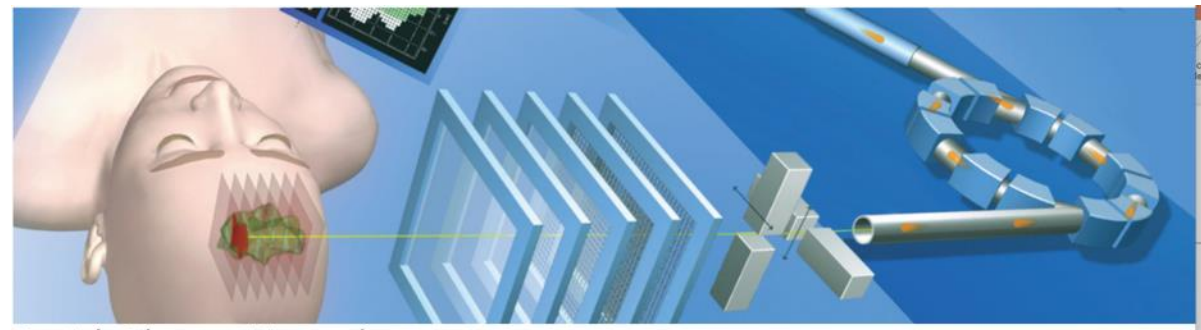


Heavy Ion Therapy Masterclass School

<https://indico.cern.ch/e/HeavyIonTherapyMasterClass>

Full week course

The HITM school is aimed at university students, and up to early stage researchers.



Particle Therapy Masterclass

<https://indico.cern.ch/e/PTMC>

One day activity

The Particle Therapy MasterClass, is aimed at high-school students (16-18)



Different options studying physics, for example accelerator physics, medical physics, bio-physics... that can provide interesting career paths in upcoming fields where there is lack of specialised personnel

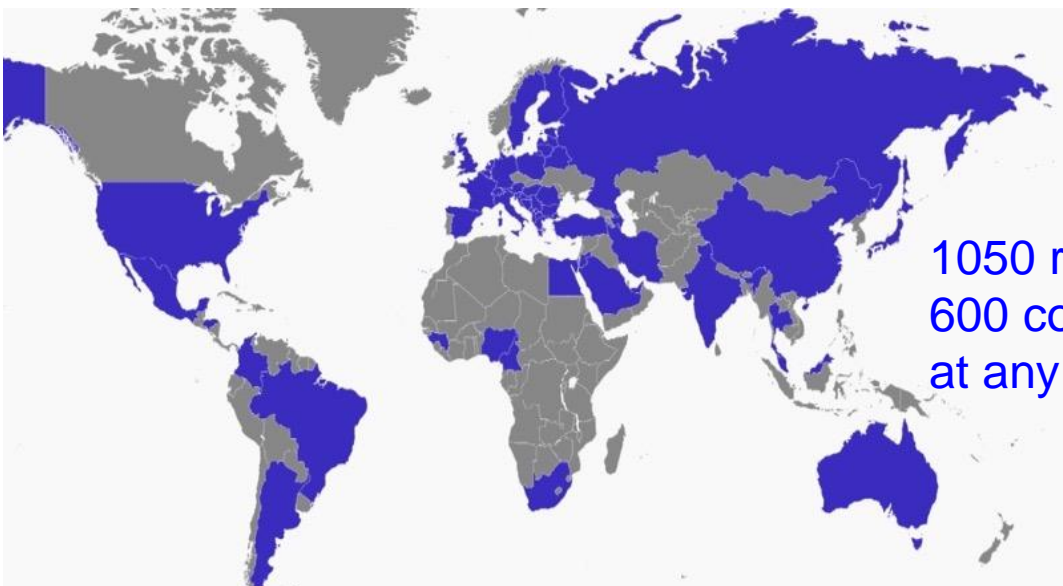
Information about upcoming modern techniques for cancer tumour therapy and new research avenues, where clearly the development of technology and the expertise of research laboratories is crucial

World-wide reach motivating next generation of scientists

HITRIplus full week heavy-ion therapy masterclass school



Heavy Ion Therapy Masterclass School



1050 registrants,
600 connections
at any given time

International MasterClasses one day activity



Home
Information for
High School Students
Information for

Hands on Particle Physics Masterclasses
SCHEDULE 2021

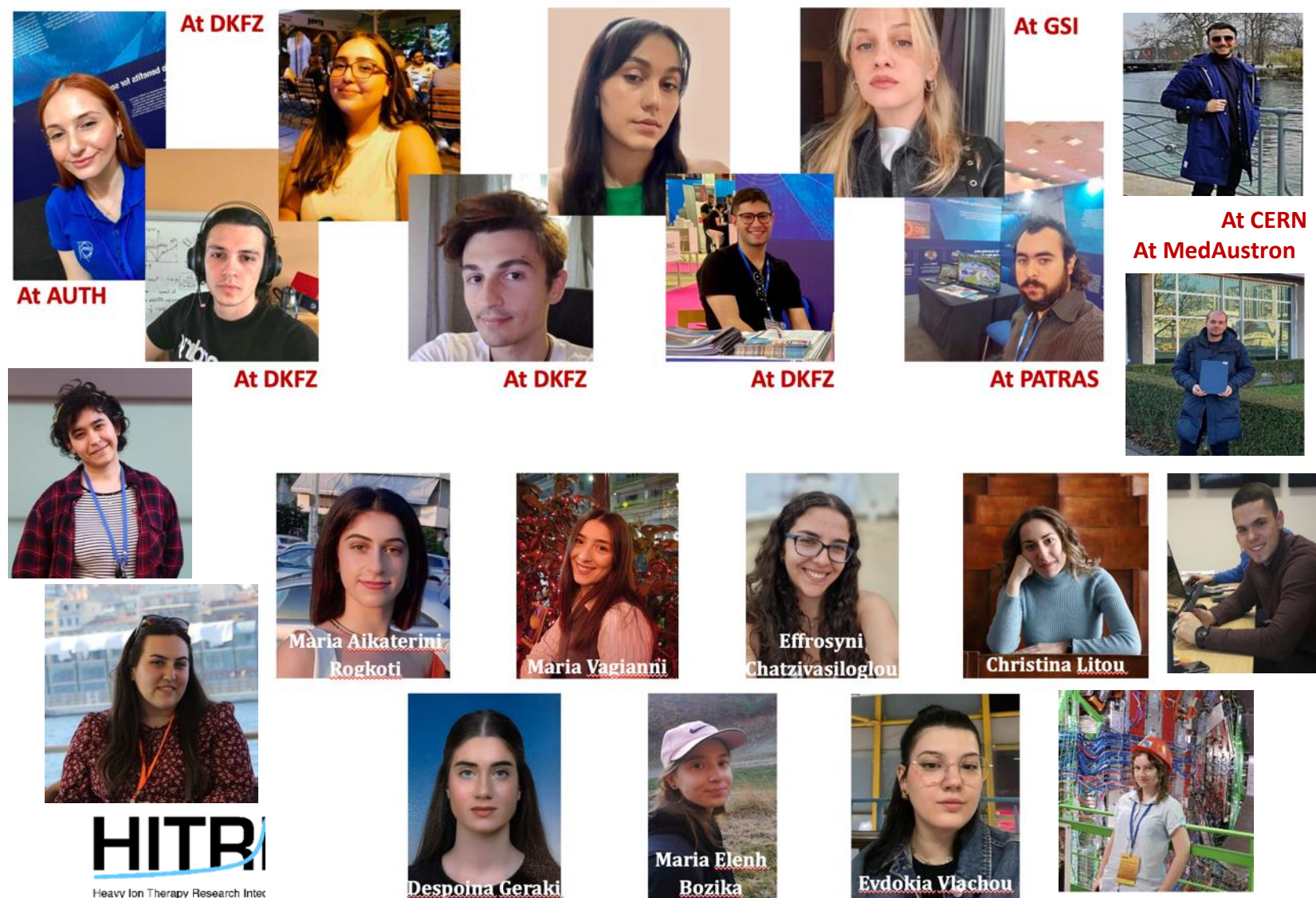


Power of Networks !



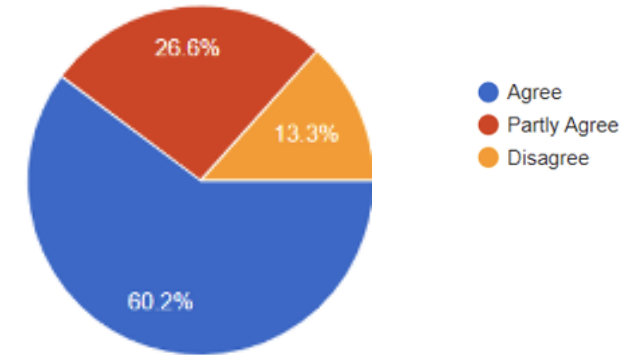
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PTMC and HITRIplus school assistants

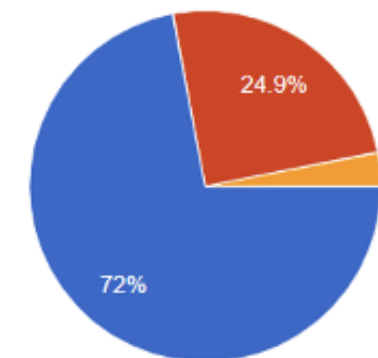


PTMC surveys cumulative

Changed your perspective regarding the job of scientists/physicists

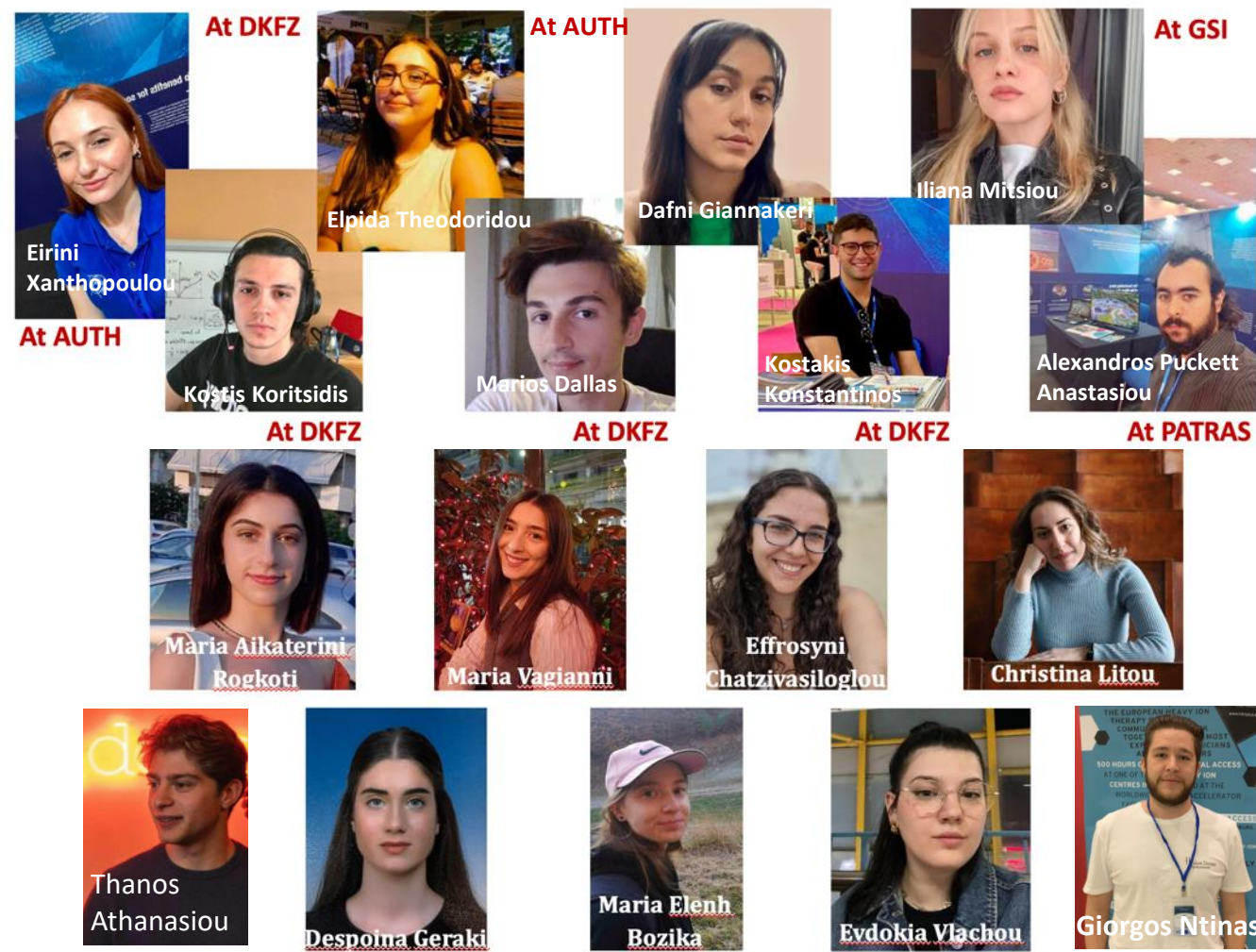


Encouraged you to look for more information on related subjects

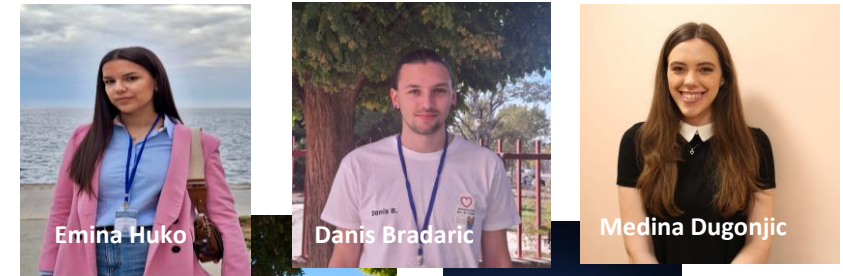


PTMC and HITRIplus school assistants

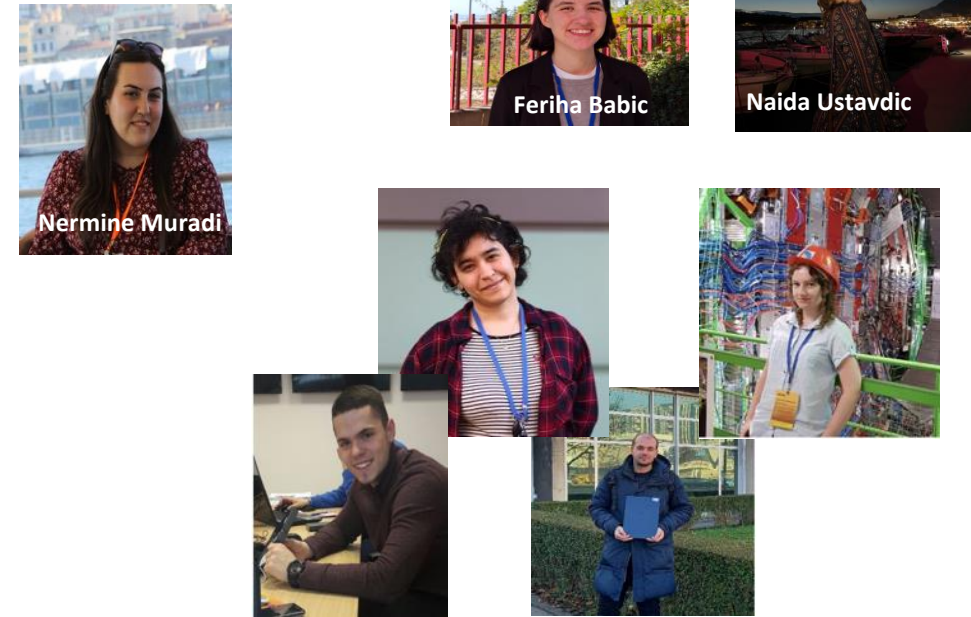
Greece



Sarajevo



Tetova

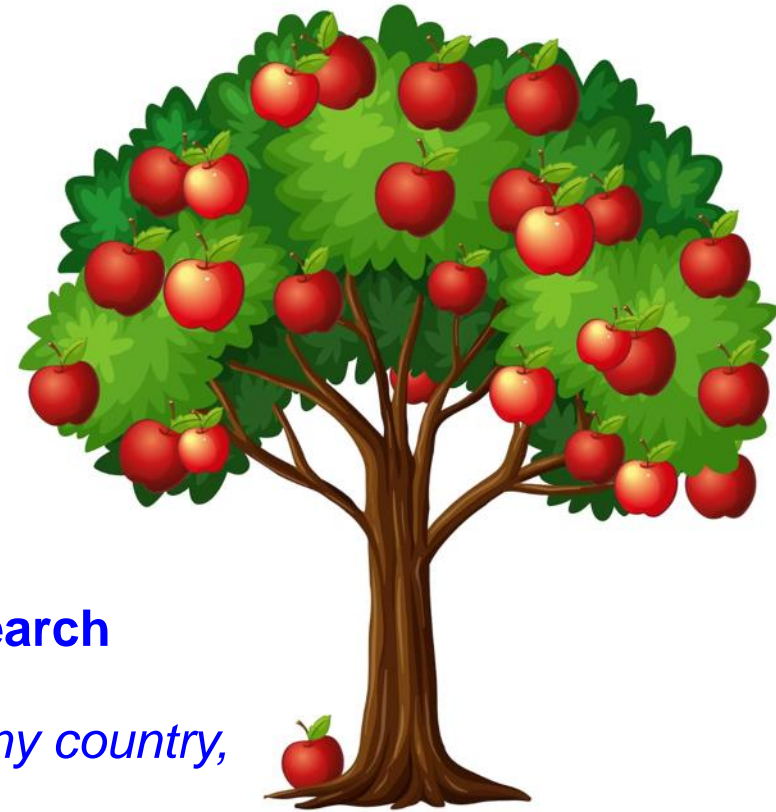


Main Message: need for fundamental research

To get the fruit you need the tree with its roots, trunk, branches....

- **Attract high-school students to STEM**
- **Cultivate confidence through the hands-on**
- **Support female participation**
- **Create groups of Uni assistants that learn better in order to teach**
- **Enhance public awareness on benefits from fundamental research**
- **Prepare future generations aware of importance of fundamental research**

a science educated future generation is crucial for shaping the future of any country, based on rational scientific thinking and decision-making processes

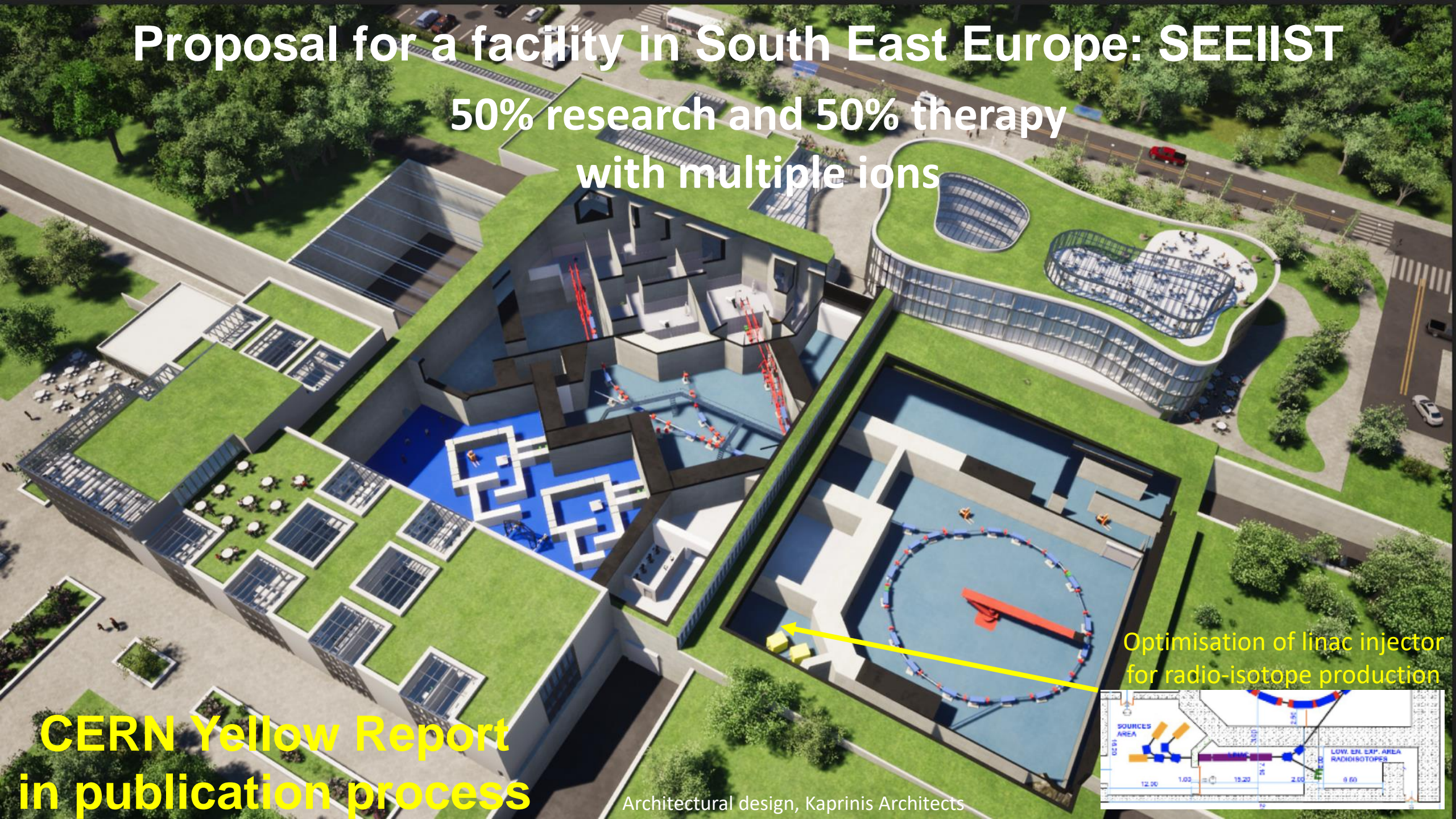


Demonstrate a return to society from investment in fundamental research

Our reward: the enthusiasm and appreciation of the students

Proposal for a facility in South East Europe: SEEIST

50% research and 50% therapy
with multiple ions



Optimisation of linac injector
for radio-isotope production



CERN Yellow Report
in publication process

Publications as CERN Yellow Reports

- (1) Proposal for a multi-ion accelerator based facility
 - (2) Conceptual (pre-TRD) design report
- CERN Yellow Reports by Ugo Amaldi and international collaborators

<https://e-publishing.cern.ch/index.php/CYRM/issue/view/88>

CERN Yellow Reports:
Monographs

CERN-2019-002

A Facility for Tumour Therapy
and Biomedical Research
in South-Eastern Europe

U. Amaldi
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S. Rossi
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B. Singers Sørensen



<https://cernbox.cern.ch/s/AqytzIPSL2kZoA3>,

CERN Yellow Reports:
Monographs

CERN-2024-XXX

DRAFT

An Accelerator-based
Research Infrastructure for
Cancer Therapy and Biomedical
Sciences with Ion Beams

Editor:

U. Amaldi
E. Benedetto
P. Foka
S. Rossi
M. Vretenar



SCIENTIFIC CASE

A project of the
South-East European International Institute for Sustainable Technologies—SEEIIST

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Thank you for your attention !

Looking forward to future collaborations
on common projects
in the fight against cancer
and contributing to capacity building
at the same time!

Architectural design, Kaprinis Architects

BACKUP

PTMC Important Links

<https://indico.cern.ch/e/PTMC>

- Information about the PTMC, in a different languages, can be found through the PTMC web page and the “PTMC in a kit” Google Drive links:

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

Google Drive: https://drive.google.com/drive/folders/1jRnLf49N_yRoOGg8V8vwq3DIpnetWdF0?usp=sharing

- Material for the matRad installation can be found through the word document in the link below, together with a video describing the procedure:

Installation: <https://drive.google.com/file/d/1vT9tQ9ft1C7AwUSbU18pftC9H-ep4BPC/view>

Video: https://drive.google.com/file/d/1BdkjN63StX-1kFEqR_FgTgj_pgZ2-PhL/view?usp=sharing

- Additional instructions for the use of matRad are provided through the workflow, which is available in many languages through the PTMC web page
A video describing the workflow of different cases is provided via the google drive:

Workflow: <https://indico.cern.ch/event/840212/page/17991-workflow>

Video: https://drive.google.com/file/d/1jyCzJFfS7I_-0e45ZEcyb4fnXTaRJmpK/view?usp=sharing

- Units and terminology of matRad can be found here:

Link: <https://indico.cern.ch/event/840212/page/18006-definitions>

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Participants of hybrid PTMC in IMC2024

More than 1500 students participated from 22 countries and 47 institutes during 8 sessions

Including 11 Feb and 8 March women days

Czech republic, Prague, Proton Therapy centre AND Charles UNI

Mexico Puebla

Mexico Hermosillo Uni of Sonora

Mexico, Mexico city, UNAM

Algeria

Poland

Greece

India

Montenegro

Ukraine

Italy Uni Piemonte Orientale

Italy Bologna

Italy Pavia Uni AND INFN

Italy Torino

Italy Cosenza. Uni AND INFN

Italy Milano UNIMI AND INFN

CERN

Slovenia

Lithuania Vilnius, Uni AND Cancer institute

Lithuania Kaunas Health uni AND Uni of Technology

Germany DKFZ

Georgia

France

Slovenia Uni Ljubljana

N. Macedonia Uni Tetovo

Morocco

Bulgaria Varna Astronomical observatory AND Uni

Bulgaria Sofia Uni

Spain Uni AND Hospital

Portugal Uni Lisbon

BiH Sarajevo AND Tuzla

From participants to collaborators

Attendees of IMC were attracted by Science, Technology, Engineering and Math careers.

It was definitely our case



It is inspiring to young students.

This could mean more professionals in STEM topics

Noteworthy fact:

now we collaborate in UNAM with our IMC tutors

