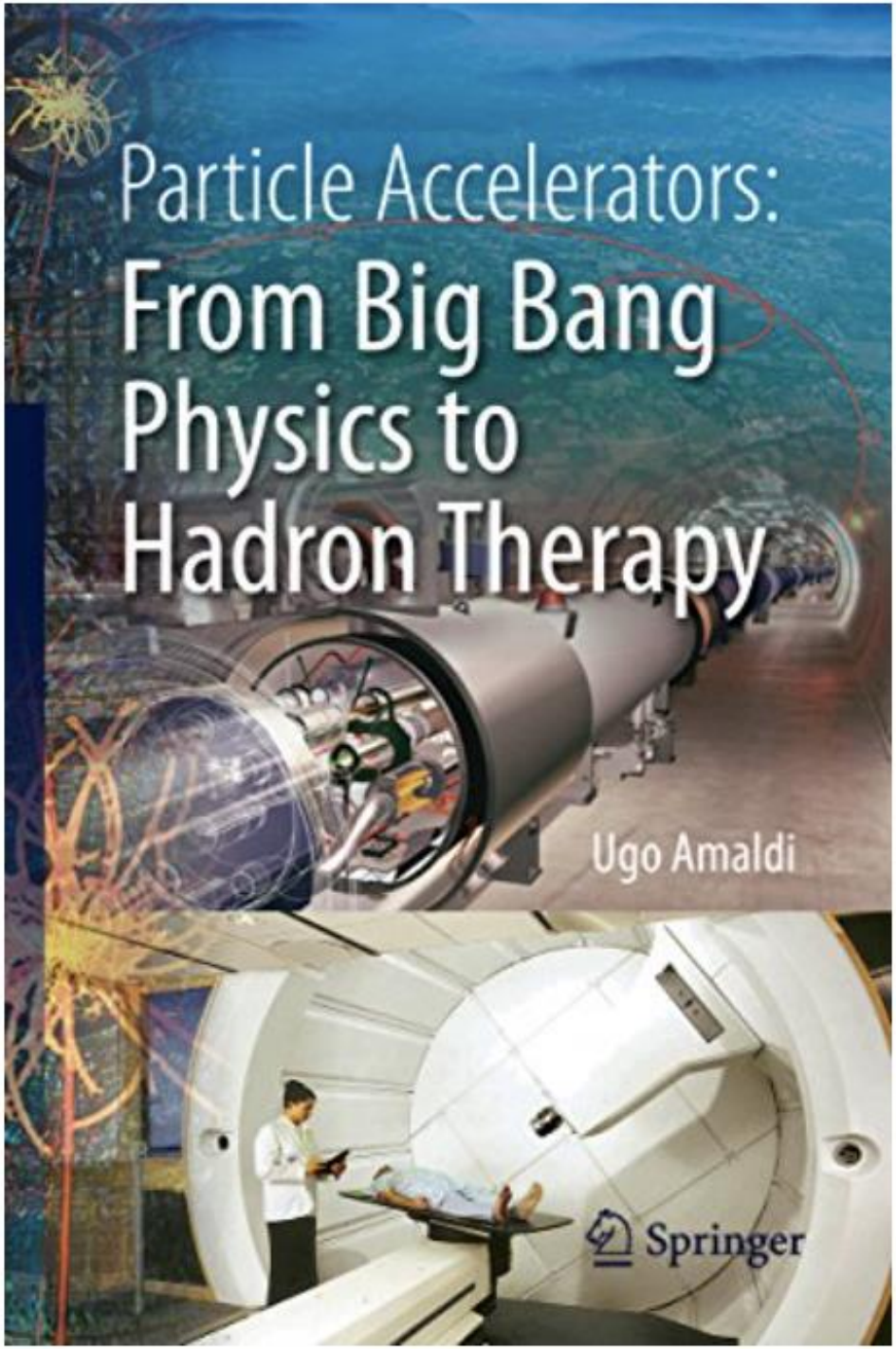
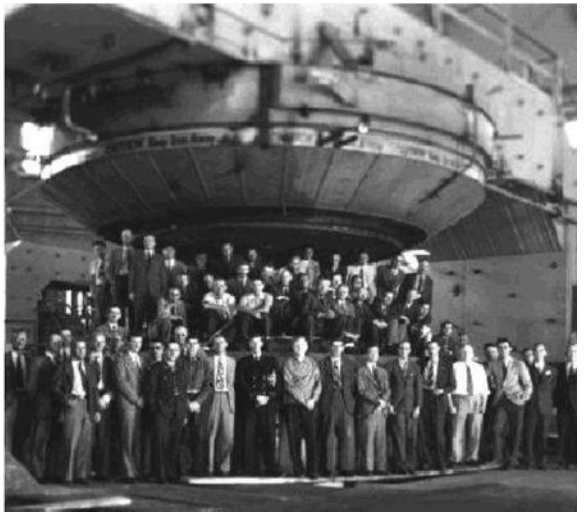
From fundamental research

to medical applications

Accelerators for health





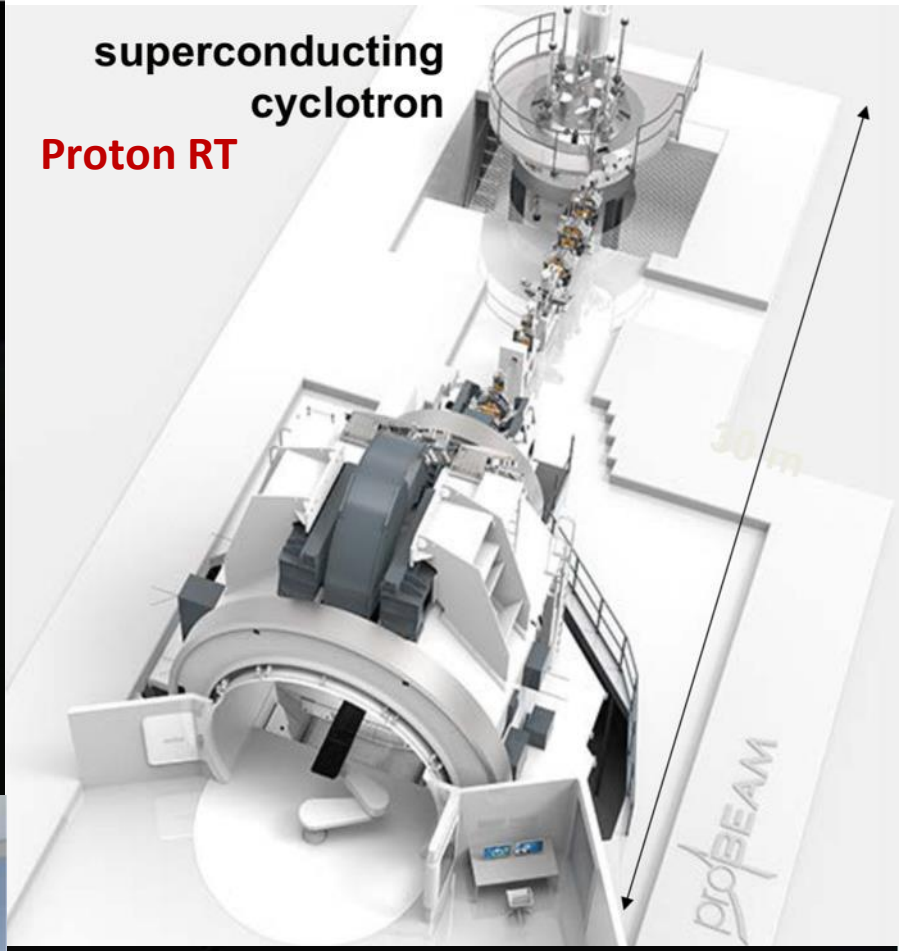
Berkeley cyclotron Nobel Prize 1939

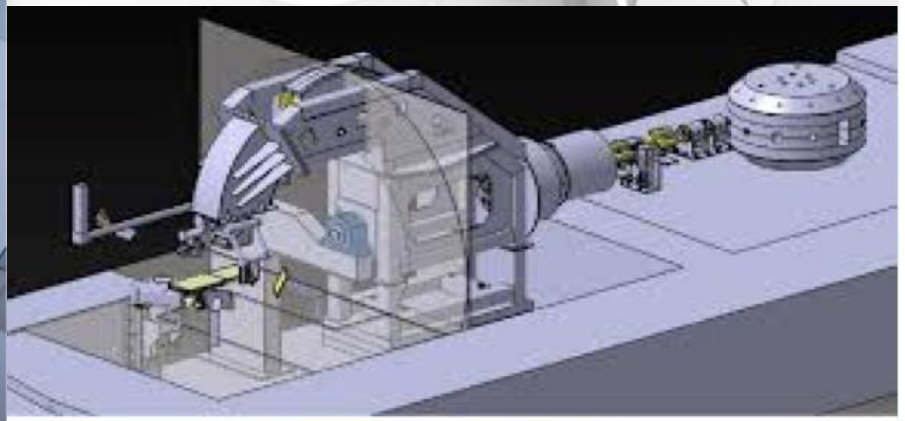
In 1936, the new Berkeley 37-inch cyclotron was producing isotopes for physics. **In 1938** starts direct irradiation of patients with neutrons from the new 60-inch cyclotron **(Lawrence brothers).**

In 1946, Robert Wilson proposed to use protons to treat cancer.

First treatment of pituitary tumours took place **at Berkeley in 1956.**

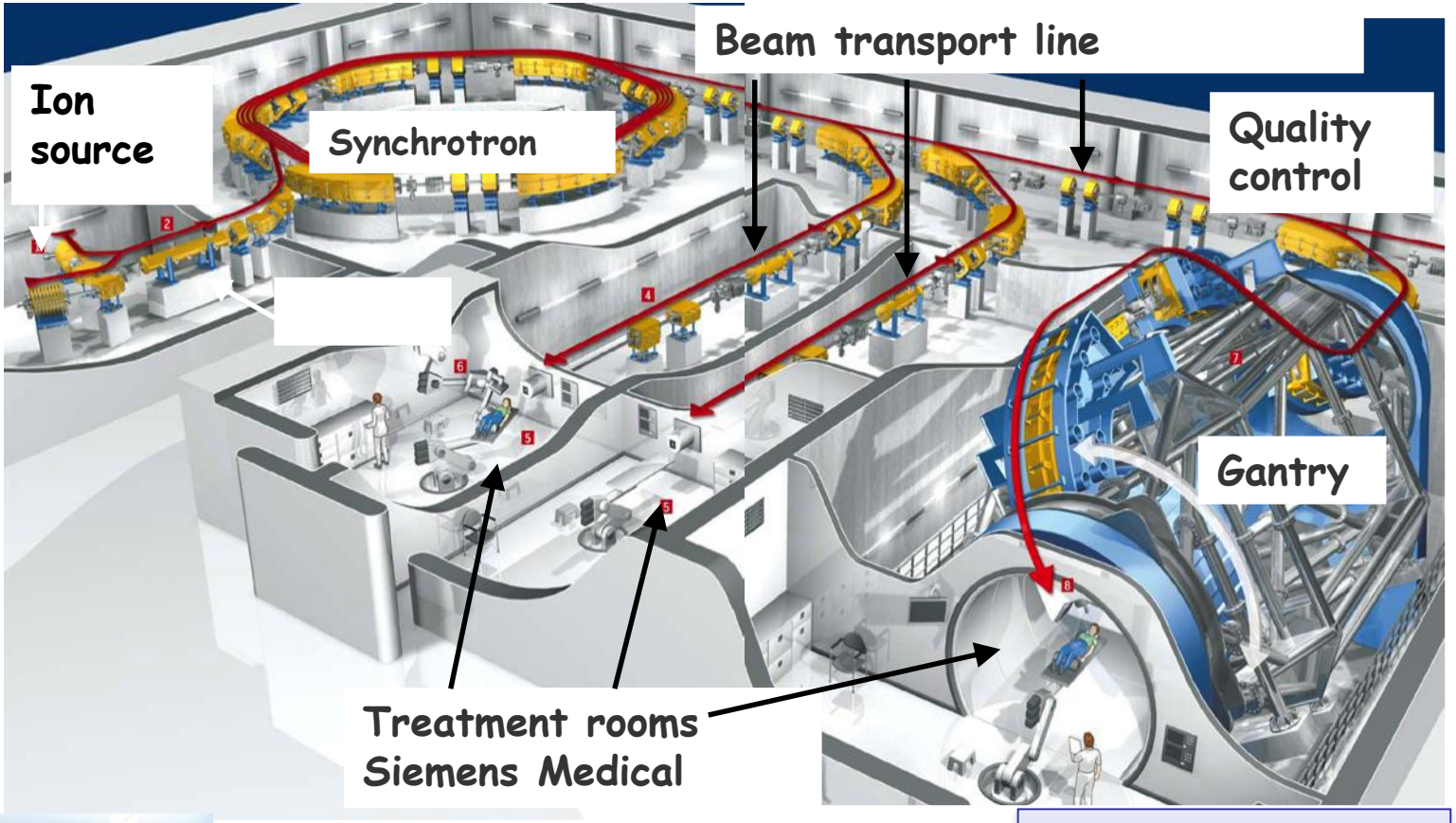
First hospital-based proton treatment center **at Loma Linda (US) in 1990.**





ProteusONE™

HIT carbon-ion facility for cancer therapy



First carbon facility in Europe:
HIT in Heidelberg
started treating patients in 2009.
Followed by MIT in Marburg

The HIT gantry:
600 tons

INTERNATIONAL MASTERCLASSES
hands on particle physics

Workshop on Ions
for Cancer Therapy, Space Research and Material Science

SPACE RESEARCH
WORKSHOP
ON IONS FOR CANCER THERAPY
MATERIAL SCIENCE

Chania, Crete, Greece

26 - 30 August 2017

Workshop Main Topics
28-30 of August at Great Arsenali

Particle therapy status
- Centres worldwide
- Treatment planning and imaging novel methods
- Challenges, new R&D directions

Space research and dosimetry
Nanotechnology, electronics and material research
Modelling and benchmarking of experiments
Novel accelerators and training

Public Events
26 of August - science fair at Neorio Moro
27 of August - public talks at Great Arsenali
30 of August - coffee with scientists at Neorio Moro

https://indico.cern.ch/e/ions2017/

International Advisory Committee

Etiennette Auffray Hillemanns (CERN, Switzerland)
Philip Burrows (University of Oxford, UK)
Marco Durante (TIFPA, INFN, Italy)
Paolo Giubellino (GSI & FAIR, Germany)
Apostolos Karantanas (Medical School, University of Crete, Greece)
Vladimir Kekelidze (JINR, Russia)
Panos Razis (University of Cyprus, Cyprus)
Boris Sharkov (ITEP, Russia)
George Stavrakakis (Technical University of Crete, Greece)
Thomas Stoehlker (GSI & FAIR, Germany)

Organizing Committee

Y. Foka (GSI, Germany) - chair
C. Bates (TUC, Greece)
E. Dimovasili (CERN, Switzerland and UCY, Cyprus)
C. Graeff (GSI, Germany)
N. Kalithrakas (TUC, Greece)
R. Pleskac (GSI, Germany)
E. Tsesmelis (CERN, Switzerland and Oxford, UK)
M. Vretenar (CERN, Switzerland)
M. Zervakis (TUC, Greece)

Web Assistants

E. Andronov (SPbSU, Russia)
K. Foka Sandoval (EPFL, Switzerland)
L. Graczykowski (WUT, Poland)
M. Janik (WUT, Poland)
A. Katanaeva (UB, Spain and SPbSU, Russia)
D. Shukhobodskaia (SPbSU, Russia)

Ions for cancer therapy

ENLIGHT, CERN

BIOMAT and BIOPHYSICS, GSI

IONS2017
https://indico.cern.ch/e/ions2017

Public Event, scenario and material

IONS2017 https://indico.cern.ch/e/ions2017

Sunday 27 august at 20:15

While people come play animations
- of event displays (as we had them in the big laptop)
- videos from CERN and GSI/FAIR
- http://cds.cern.ch/record/2020780
- http://cds.cern.ch/record/1495143
- tp://cds.cern.ch/record/1228924

Last film before starting:
a. *video on CERN: http://cds.cern.ch/record/986165*

Start
2. YF welcome and explaining the basic idea
3. YF thanks to all locals that helped: list of names and titles
4. YF call Kanelos to greet the public

5. **YF call Kalliopi for singing**

6. YF call Tasos Liolios (15'')
   a. Tasos: Fundamental research, CERN, basics of accelerators, LHC program, discoveries: Higgs, Matter-AntiMatter, Quark-gluon-plasma….
   Stress greek contributions

7. YF fill in: CERN is best known for Higgs boson discovery and Nobel price but as Tasos Liolios said ALICE is using collisions of lead ions to create and study quark gluon plasma, a primordial type of matter that existed at the early universe after the big bang

8. **YF call Kalliopi for singing** (to have time to call Despina)

9. YF call Despina Chatzifotiadou, virtual visit at CERN, ALICE control room
   - *Despina: see video on ALICE*
   - *http://cds.cern.ch/record/1018975?ln=en*
   - Despina: about QGP and ALICE via vidyo (< 15'')

11. YF call Christina Kourkoumeli (15'')
    a. Christina: research at CERN and education
    b. CERN beam for schools; you will have the opportunity of a presentation by Curiosity science team (application for beam, listed 10th)
    c. IPPOG and MasterClasses
    d. Creations
    e. Activities in Greece

12. YF call Astrinos Tsoutsoudakis
    - Astrinos: presentation of the activities of the team

13. YF fill in: while the primary aim is to develop the tools (accelerators and detectors) for fundamental research purposes, we always try to identify cases of use in everyday life. Some notable examples are: the web….
    Most importantly: the use os such tools in medicine and in particular diagnosis and therapy of cancer that is the todays theme

12. YF call Manjit (15''):
    a. see video as an intro: http://cds.cern.ch/record/1611721?ln=en
    b. Manjit: developments for research and their applications for cancer therapy
    c. *Manjit: see video as summary:* http://cds.cern.ch/record/2002120

    An interactive virtual visit to a hadrotherapy centre:
    http://www.cern.nymus3d.nl/maps# (not used)

14. YF call Kalliopi: singing

15. YF call Giorgos Dedes (30'')
    a. Giorgos presentation on details on cancer therapy

16. YF call Kalliopi: singing

17. YF call speakers for questions

18. YF call Kalliopi: last song, flowers !!

Workshop on Ions

for Cancer Therapy, Space Research and Material Science

SPACE RESEARCH WORKSHOP ON IONS FOR CANCER THERAPY MATERIAL SCIENCE

Chania, Crete, Greece

26 - 30 August 2017

Workshop Main Topics

28-30 of August at Great Arsenali

Particle therapy status
- Centres worldwide
- Treatment planning and imaging novel methods
- Challenges, new R&D directions

Space research and dosimetry
Nanotechnology, electronics and material research
Modelling and benchmarking of experiments
Novel accelerators and training

Public Events

26 of August - science fair at Neorio Moro
27 of August - public talks at Great Arsenali
30 of August - coffee with scientists at Neorio Moro

https://indico.cern.ch/e/ions2(

International Advisory Committee

Etiennette Auffray Hillemanns (CERN, Switzerland)
Philip Burrows (University of Oxford, UK)
Marco Durante (TIFPA, INFN, Italy)
Paolo Giubellino (GSI & FAIR, Germany)
Apostolos Karantanas (Medical School, University of Crete, Greece)
Vladimir Kekelidze (JINR, Russia)
Panos Razis (University of Cyprus, Cyprus)
Boris Sharkov (ITEP, Russia)
George Stavrakakis (Technical University of Crete, Greece)
Thomas Stoehlker (GSI & FAIR, Germany)

Organizing Committee

Y. Foka (GSI, Germany) - chair
C. Balas (TUC, Greece)
E. Dimovasili (CERN, Switzerland and UCY, Cyprus)
C. Graeff (GSI, Germany)
N. Kallithrakas (TUC, Greece)
R. Pleskac (GSI, Germany)
E. Tsesmelis (CERN, Switzerland and Oxford, UK)
M. Vretenar (CERN, Switzerland)
M. Zervakis (TUC, Greece)

Web Assistants

E. Andronov (SPbSU, Russia)
K. Foka Sandoval (EPFL, Switzerland)
L. Graczykowski (WUT, Poland)
M. Janik (WUT, Poland)
A. Katanaeva (UB, Spain and SPbSU, Russia)
D. Shukhobodskaia (SPbSU, Russia)

PIMMS2 @CERN

Workshop
Location Archamps, France
Venue: European Scientific institute (ESI)
Dates: 19-21 June 2018

Ideas and technologies for a next-generation facility for medical research and therapy with ions

Proposal submitted 12 nov 2019

https://indico.cern.ch/e/ions2018

MAIN TOPICS:
- EXISTING FACILITIES
- CURRENT INITIATIVES
- NEW TECHNOLOGIES
- DESIGN PARAMETERS
- TECHNICAL OPTIONS

ORGANIZATION

International Advisory Committee

U. Amaldi (TERA, Italy)
F. Bordry (CERN, Switzerland)
J. Debus (HIT, Germany)
M. Durante (TIFPA, INFN, Italy)
P. Giubellino (GSI & FAIR, Germany)
K. Hrabetl (HUG, Switzerland)
S. Rossi (CNAO, Italy)
H. Specht (Univ. of Heidelberg, Germany)
E. Tsesmelis (CERN, Switzerland)
U. Weinrich (GSI & FAIR, Germany)
A. Zens (MedAustron, Austria)

Programme Committee

M. Citilli (CERN, Switzerland)
M. Dosanjh (CERN/ENLIGHT, Switzerland)
Y. Foka (GSI & FAIR, Germany)
C. Graeff (GSI & FAIR, Germany)
M. Pullia (CNAO, Italy)
L. Rinolfi (ESI, France)
M. Vretenar (CERN, Switzerland)

Organizing Committee

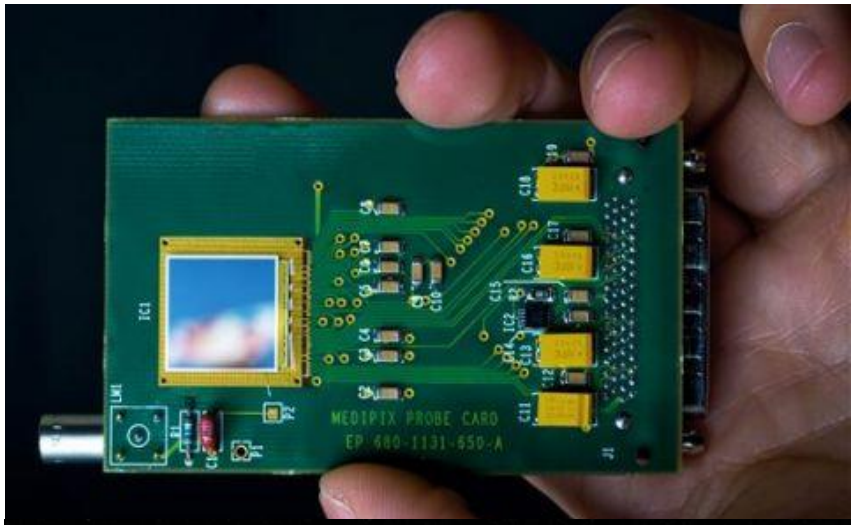
V. Brunner (CERN, Switzerland)
Y. Foka (GSI & FAIR, Germany)
B. Holland (ESI, France)
M. Janik (WUT, Poland)
A. Katanaeva (UB, Spain & SPbSU, Russia)
L. Rinolfi (ESI, France)
M. Vretenar (CERN, Switzerland)

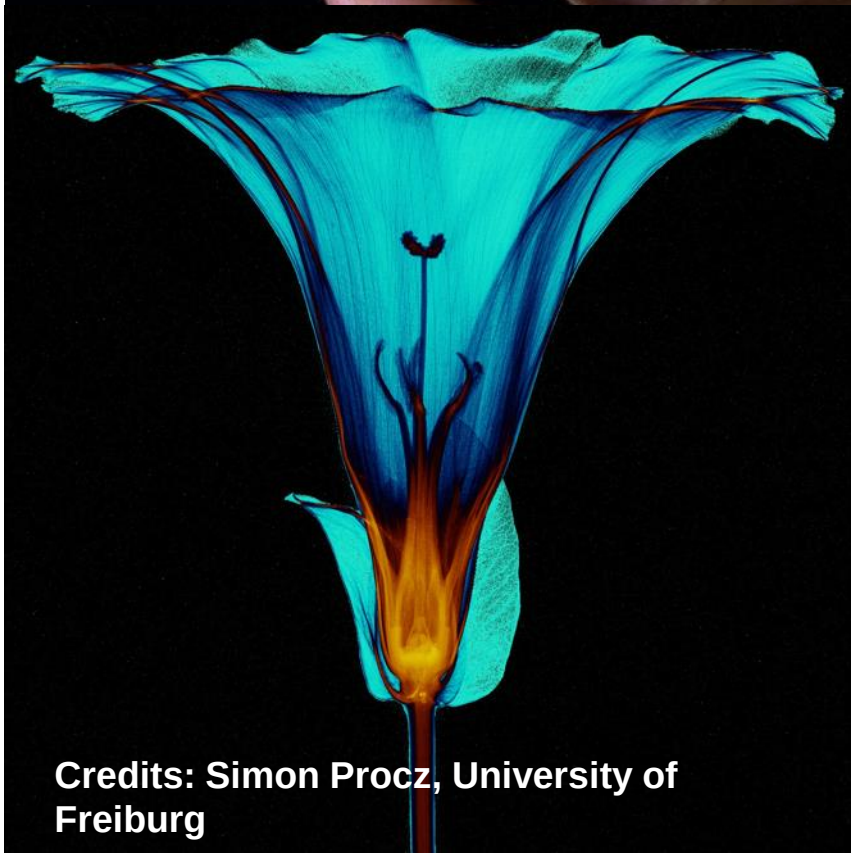
CERN ARIES esi FAIR EMMI GSI ENLIGHT

From particle tracking to Medipix

- **High Energy Physics original development:**
  - **Particle tracking detectors**
  - **Allows counting of single photons in contrast to traditional charge integrating devices like film or CCD**
- **Main properties:**
  - **Fully digital device**
  - **Very high space resolution**
  - **Very fast photon counting**
  - **Good conversion efficiency of low energy X-rays**

Seminar:
https://indico.cern.ch/event/820083/attachments/1861456/3061478/KTSeminarMC.pdf

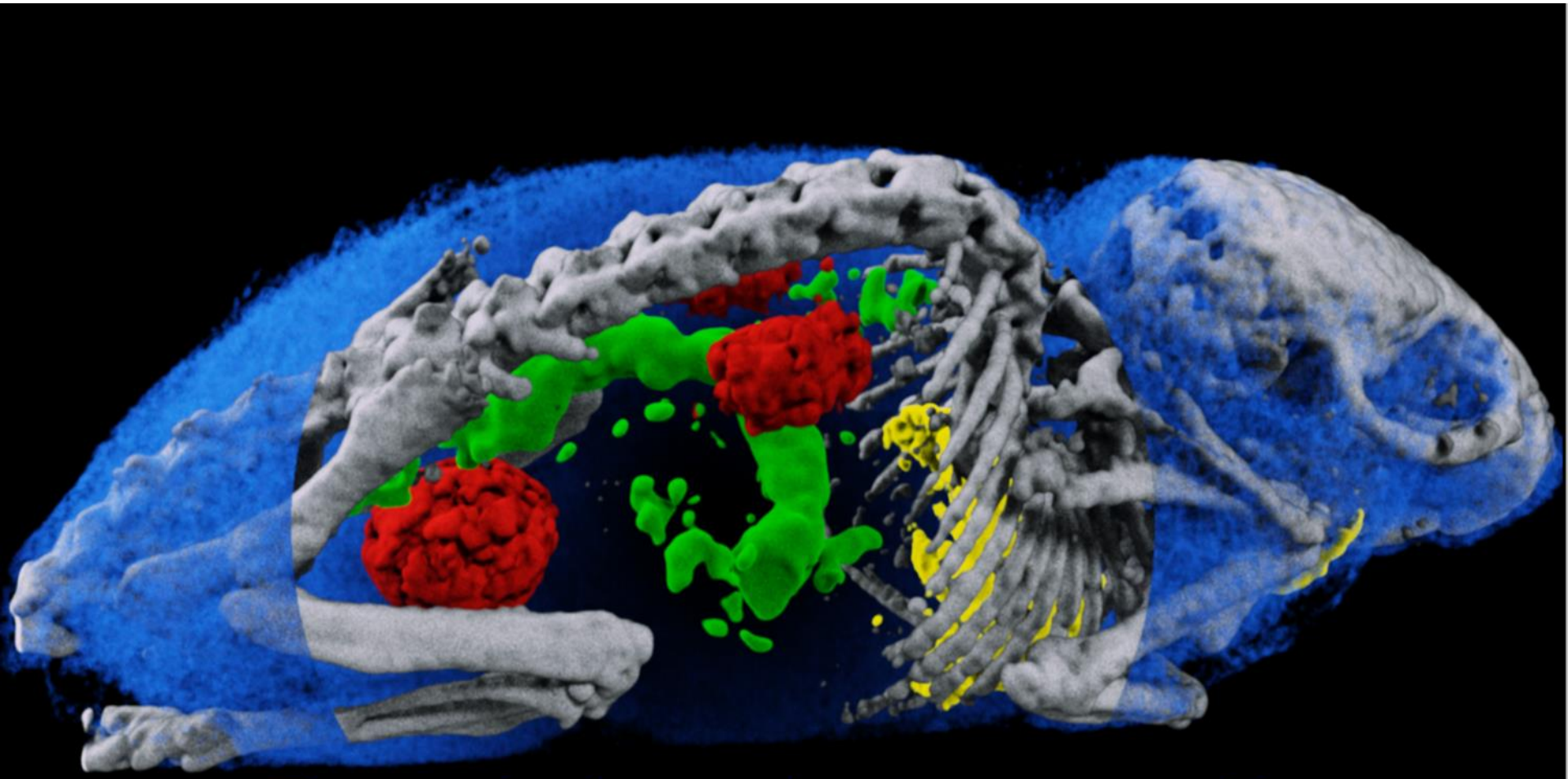




Credits: Simon Procz, University of Freiburg

From particle tracking to Medipix

Spectroscopic information permits material separation



The water has been partly cut away to reveal the bone, gold, gadolinium and iodine

Images presented and the European Congress of Radiology, Vienna, March 2017. MARS BioImaging Ltd

Taking it to humans

CT image of Phil Butler's wrist, *Uni. Of Canterbu*

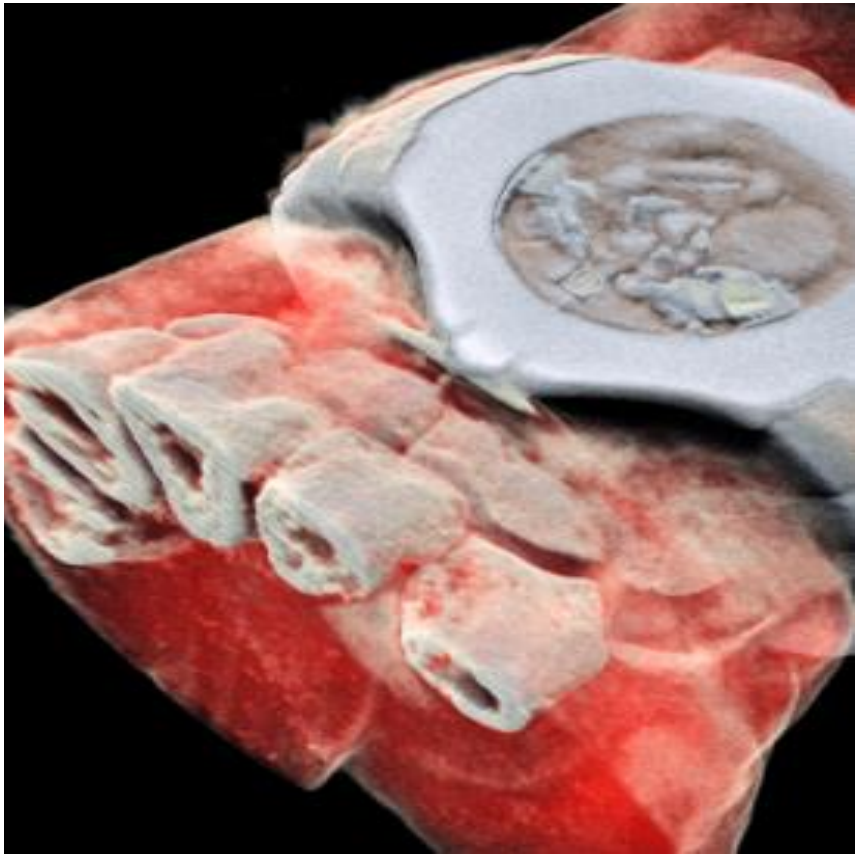
The world is watching !!

Image viewed over 40 M times on Twitter

Highest number of hits on CERN website since the Higgs announcement

Spectral CT : true colour x-ray imaging

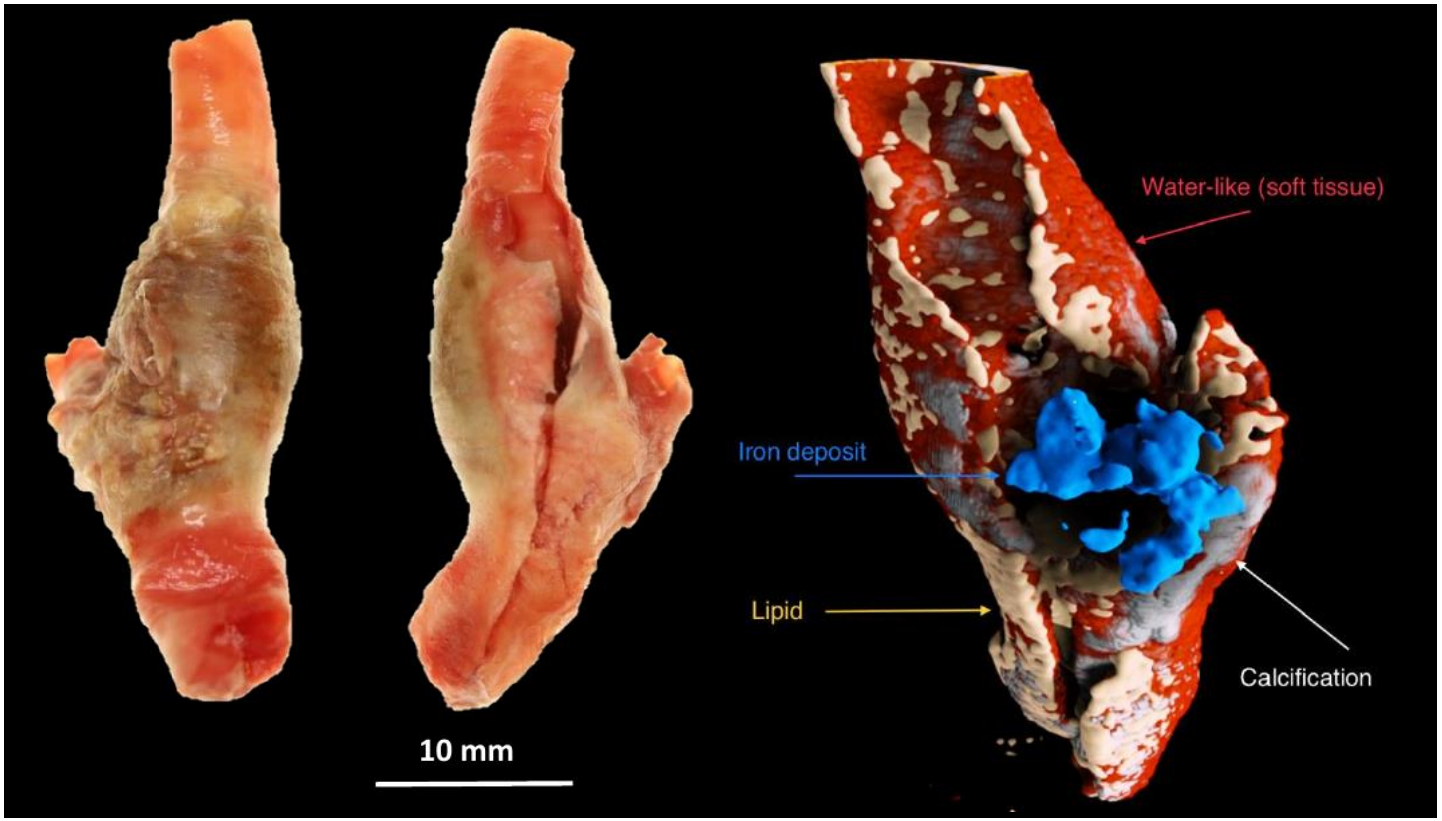
Computed Tomography is 3D X-rays



Rontgen 1895,

to CERN technology 2018

Molecular imaging

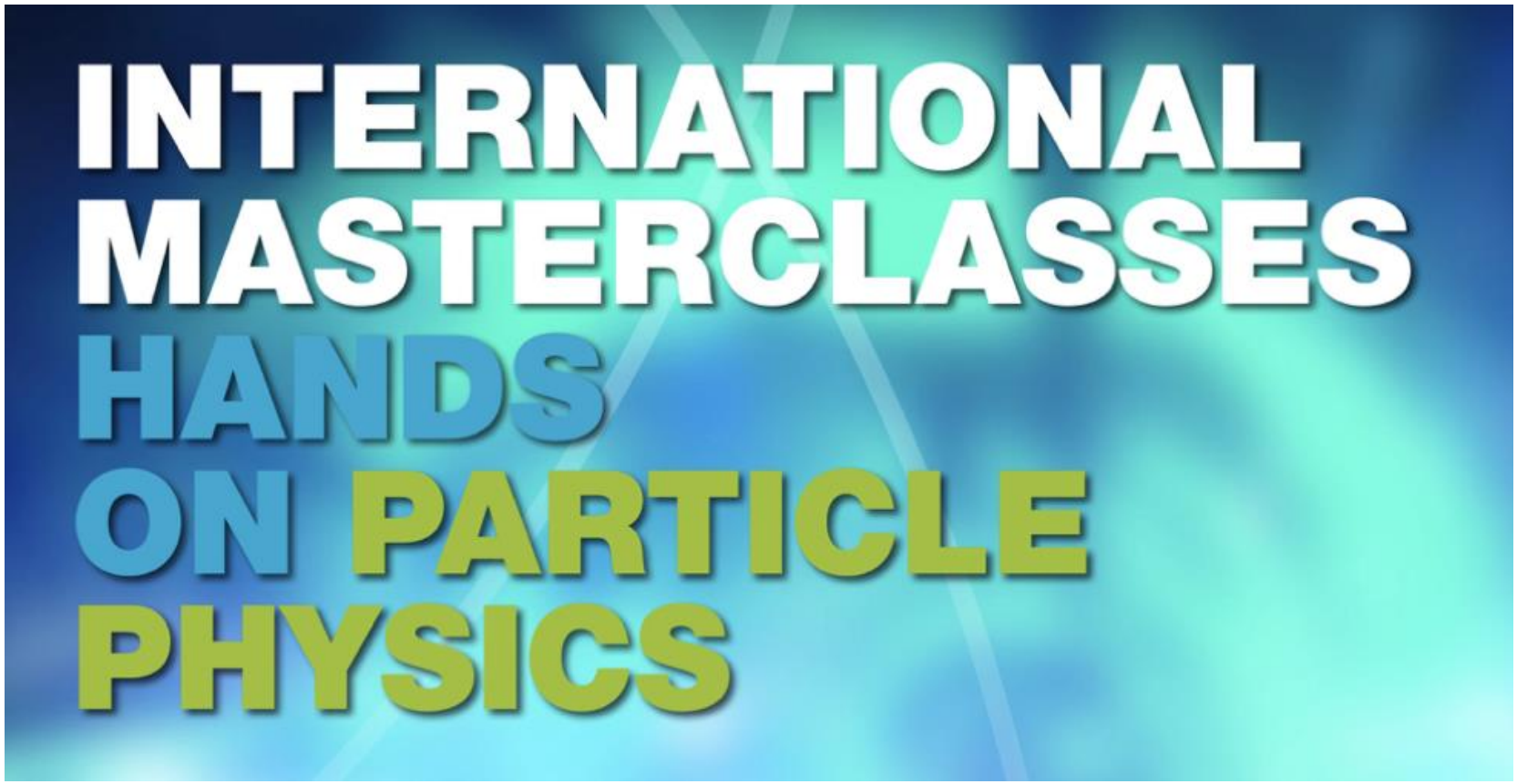


Cardiovascular disease causes 37% of EU deaths

Steven Gieseg, Uni. Canterbury

International Particle Physics Outreach Group

Bringing it to the schools !!



Need for specialized personnel !!

INTERNATIONAL MASTERCLASSES
hands on particle physics

Particle Therapy MasterClass

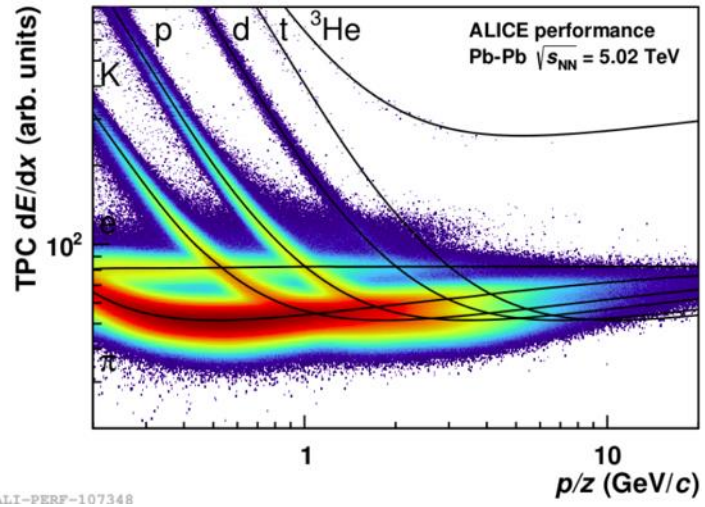
https://indico.cern.ch/event/840212/

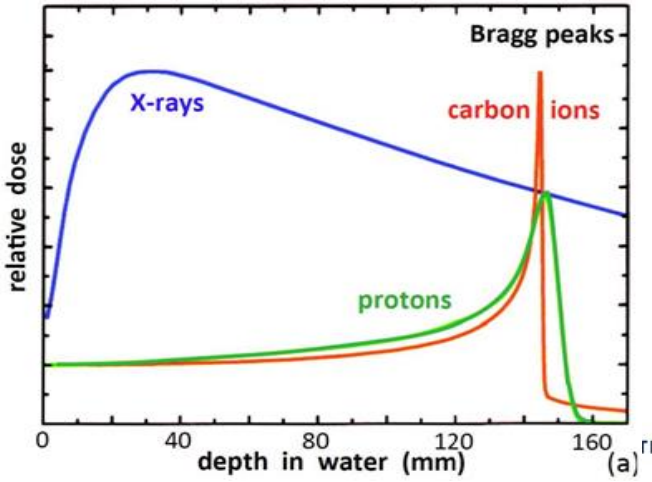
Aim: benefits for society from fundamental research

Direct applications for health of instrumentation and methods developed for fundamental research: accelerators, detectors, software....

Aim: enhance awareness on HT cancer therapy possibilities

From Bethe Bloch ionization for PID to Bragg peak for cancer therapy





INTERNATIONAL MASTERCLASSES
hands on particle physics

Particle Therapy MasterClass

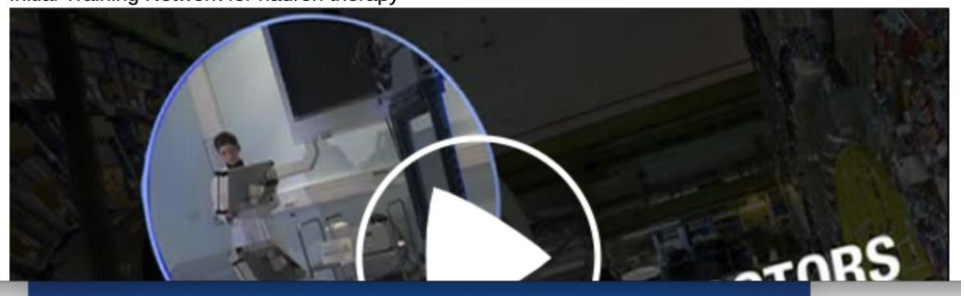
https://indico.cern.ch/event/840212/

Contact
pt.mc@cern.ch

ENLIGHT Animations

Short video presetation of the ENTERVISION project

Initial Training Network for hadron therapy



INTERNATIONAL MASTERCLASSES
hands on particle physics

Home
Posters
Aim
Materials
Agenda
Instructions
Invitation
Survey
Articles
Photos
Contacts and Teams
Events
Sponsors

Contact
pt.mc@cern.ch

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

Events

15.09.2019 CERN Open Days

01.10.2019 Open Science Days at Montenegro

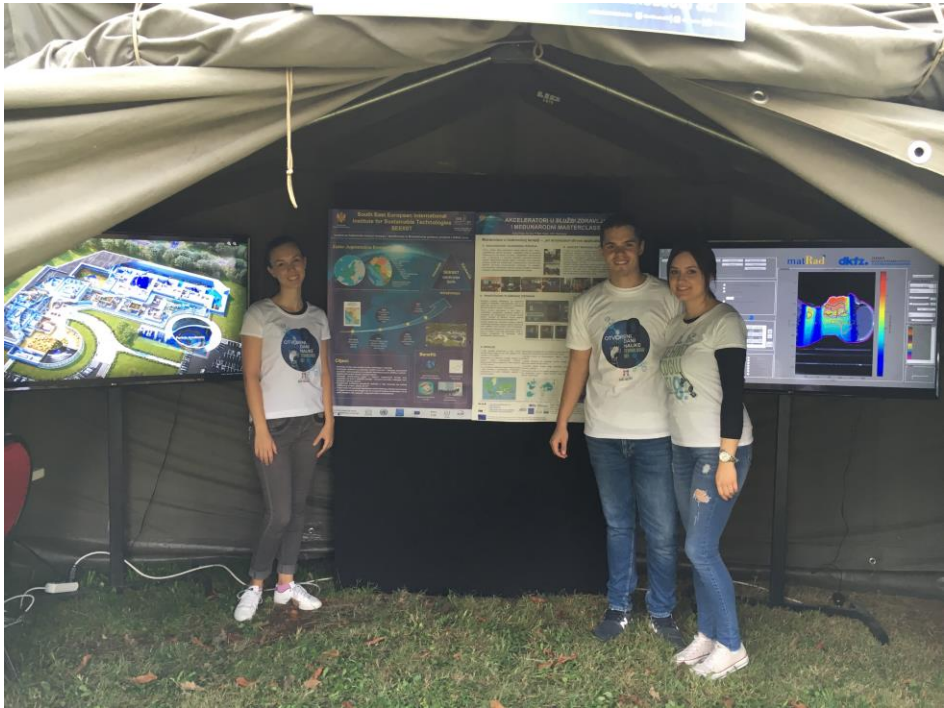
3.04.2020 Public event at Sarajevo

CERN Open Days stand

The CERN Open Days took place on 14th and 15th of September 2019. The ENLIGHT stand presented animations and the Particle Therapy Masterclass. There were in total four screens. Two of them were showing ENLIGHT animations, one about the Carbon ions facility and procedure of treatment, and the other about a future project that is going to use real time imaging while treating patients. There was also a thouch screen with an interactive virtual visit to a Carbon ions facility. The demo of the Particle Therapy Masterclass was shown on a fourth screen at the end of the stand. Two posters were complementing the stand, one about the Particle Therapy Masterclass and one about collaborative strategies for meeting the global need for cancer radiation therapy treatment.


South East European International Institute for Sustainable Technologies
FROM PHYSICS TO HEALTH


FROM PHYSICS TO HEALTH
02-04. oktobar
10:00-15:00 | 17:00-19:00
OTVORENI DANI NAUKE
TEHNOLOGIJU SE!

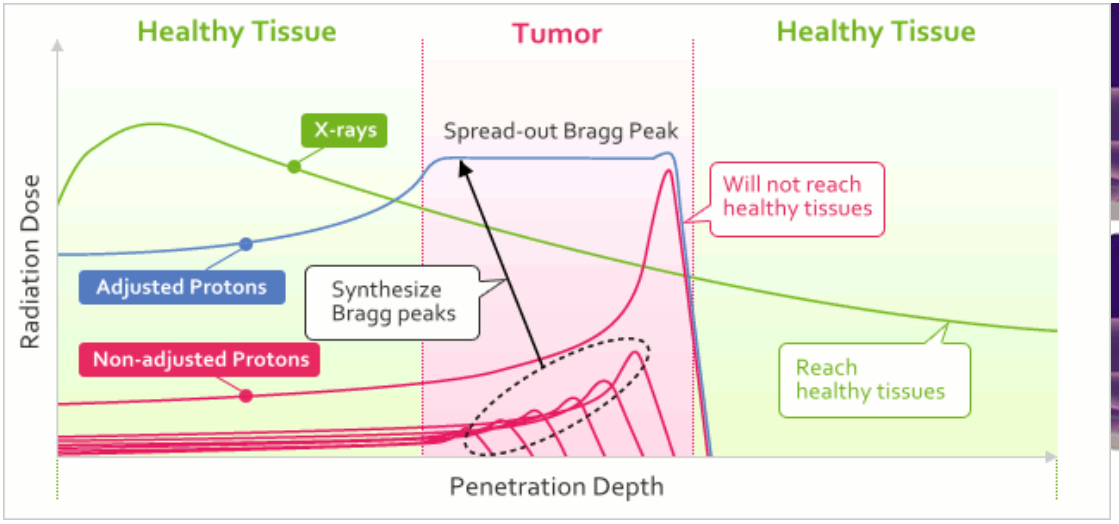


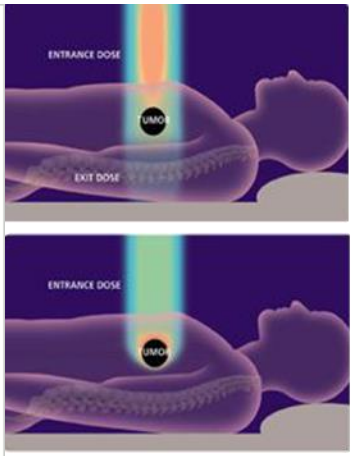
Physics for Health

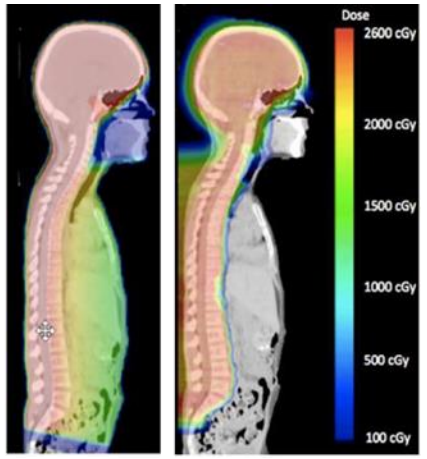
Hadron (proton, ion) Radiation Therapy, HT, is a precise and effective way to destroy cancer cells sparing healthy tissues.

preferred for children, pregnant women, deep-seated, radio-resistant tumours

Direct application of different particle properties and ionization loss in matter

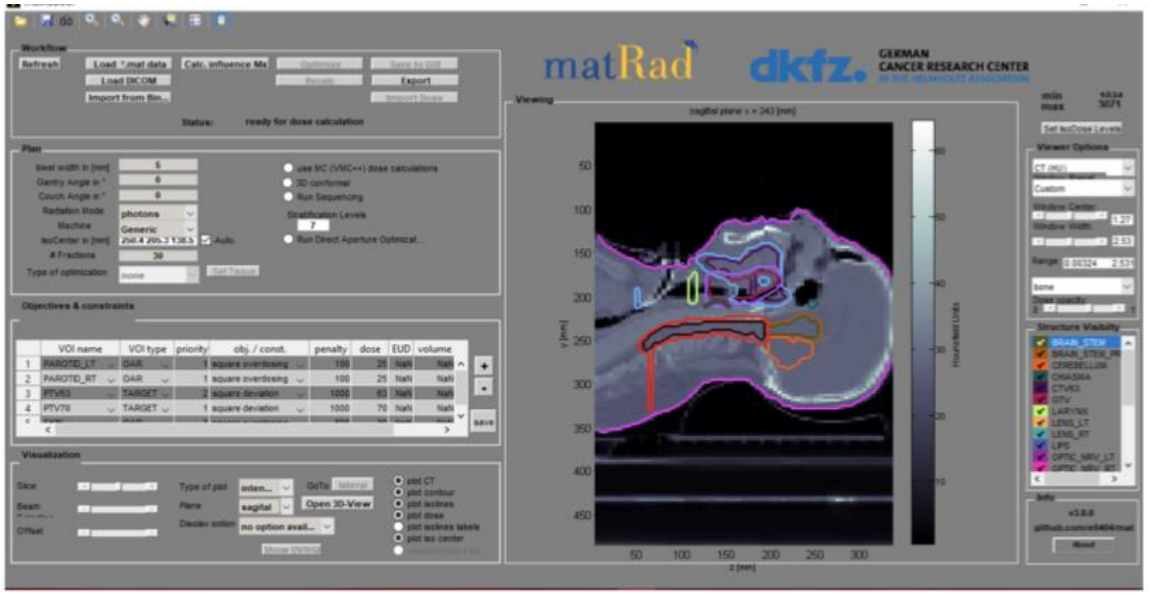




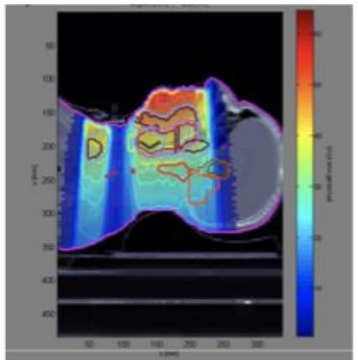


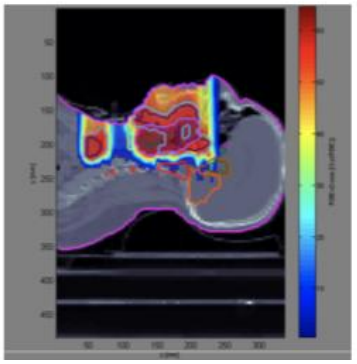
New Particle Therapy MasterClass

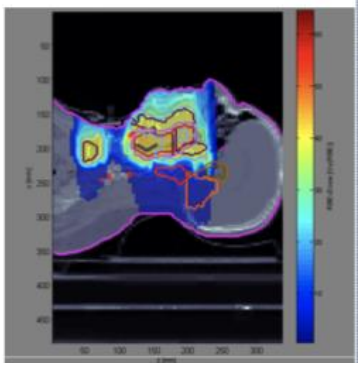
Based on professional open source research and training toolkit for calculation of dose delivery (treatment planning) : matRad developed by Heidelberg DKFZ



Demo[4] of the matRad software kit for Treatment Planning .







[matRad: www.matrad.org](www.matrad.org)

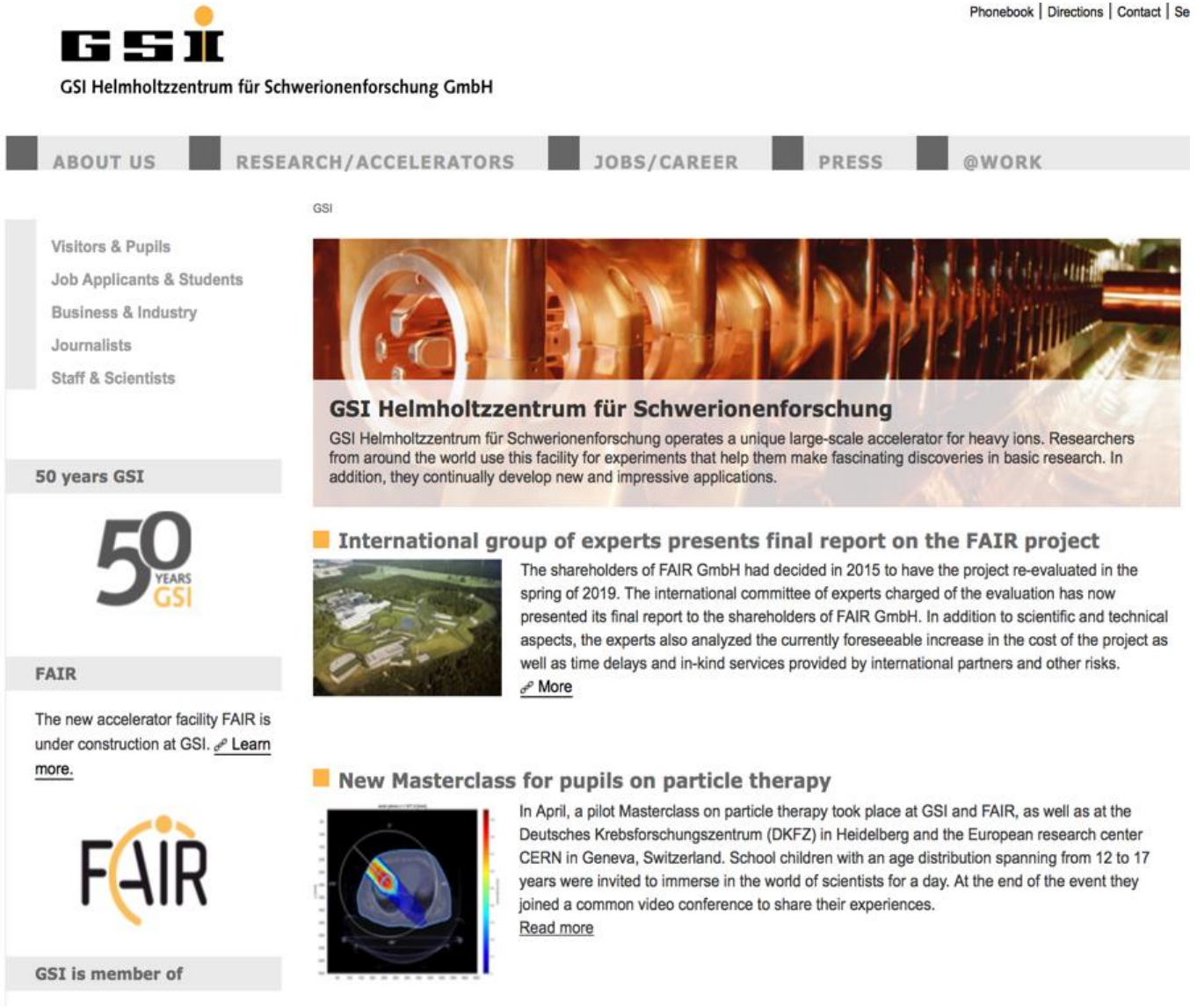
with photons, protons, ions

Head and Liver Data

INTERNATIONAL MASTERCLASSES
hands on particle physics

PTMC publicity, articles

Articles in web page: ARIES, ENLIGHT, GSI…



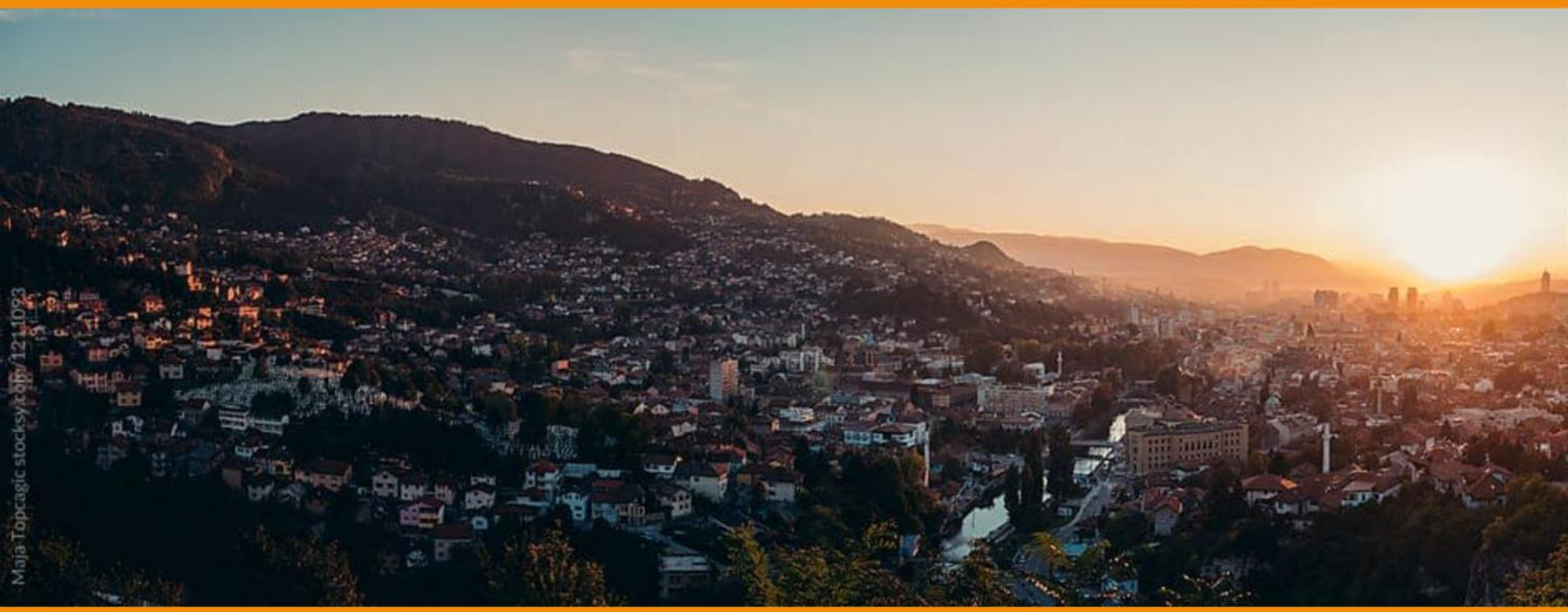
PTMC Conferences, Open Days

Invitation to CONF14, Norway, 27 July 2019

ENLIGHT, Caen, 2019

Open Days: CERN and Montenegro 2019

INTERNATIONAL MASTERCLASSES
hands on particle physics



Under development: SEEIIST meets Industry (draft)

1-3 April 2020
Sarajevo City Hall
Europe/Sarajevo timezone

The workshop **SEEIIST meets Industry** will take place 1-3 April 2020 in the **Sarajevo City Hall** , Bosnia and Herzegovina. It will be followed by an event for general public **SEEIIST meets Sarajevo** in the evening of 3rd of April 2020, also in the **Sarajevo City Hall.**

Workshop Outline

Aim of the workshop

- Industry
- Inform the public
- Students, motivate, next generation of scientists for the facility

Outline of Workshop Agenda Proposal

https://indico.cern.ch/event/839930/page/17879-agenda

Wed 1 April 14:00 Industry Worskhop
Thu. 2 April 9:00 Industry Worskhop
Fri 3 April 9:00 Academia

Fri 3 April 18:00 Public Event

Educational Outreach

Mon 30 March Particle Therapy MasterClass in Sarajevo UNSA
Tue 31 March Particle Therapy MasterClass in Tuzla, oncology

Acknowledgements PTMC

matRad Developers
Wahl, Niklas
Bangert, Mark
Hans-Peter Wieser

DKFZ Heidelberg

LoC: Wahl, Niklas
Katrin Platzer, Malte Ellerbrock
Noa Homolka Amit Ben Antony Bennan

GSI

LoC: Yiota Foka
GSI Biophysics:
Christian Graeff, Radek Pleskac
GSI ALICE, EMMI :
Ralf Averbeck, Malzacher, Peter
GSI IT :
Thorsten Kollegger, Behnert, Katharina
Osdoba, Sascha

CERN (staff and users)

CERN: tutors
Loc Org: Nikolaos Charitonidis
Alexander Gerbershagen
Evangelia Dimovasili
Elena Benedetto

CERN/ARIES: Maurizio Vretenar, Valerie Brunner
CERN/ENLIGHT: Manjit Dosanjh Petya Georgieva
CERN/KT: Manuela Cirilli Anais Rassat Rita Ferreira
Giovanni Porcellana
CERN: Visits Service Erwan Harrouch Francois Butin
CERN: Training Centre: Eric Bonnefoy M-L LECOQ

Uni Sarajevo: web pages
Amila Avdic
Amra Ibrahimovic
Mirsad Tunja

General Coordination : Yiota Foka

Sponsors : Edmond Offermann