HITRI plus
Heavy Ion Therapy Research Integration

Hadron Therapy: from pioneering times towards the future

MANJIT DOSANJH, UNIVERSITY OF OXFORD

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manjit.dosanjh@cern.ch

From particle physics to medicine: www.youtube.com/watch?v=WhgDZKr9GQQ

The First Successful Cyclotron (1931)

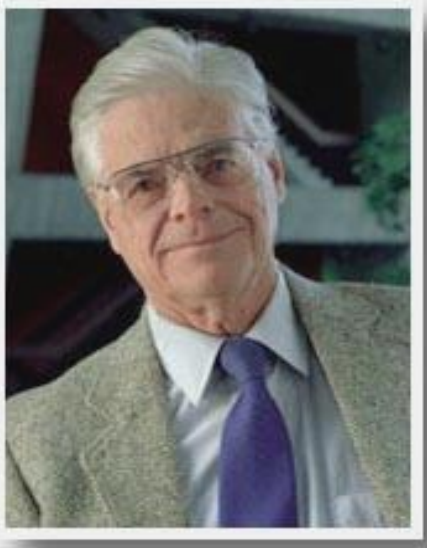
Prof. Ernest Orlando Lawrence and M. Stanley Livingston of University of California Berkeley, constructed a 13-cm diameter cyclotron, which accelerated protons to 80,000 volts using less than 1,000 volts.

EO Lawrence and MS Livingstone, Phys. Rev 37: 1707 (1931); and MS Livingston, The Production of High-Velocity Hydrogen Ions Without the Use of High Voltages, PhD thesis, University of California, Berkeley (1931).

The Radiation Laboratory, 1933

The Rad Lab was established within the UC Berkeley Physics Department with Ernest O. Lawrence as director. Eventually the Rad Lab became the EO Lawrence Berkeley National Laboratory.

The birth of hadrontherapy



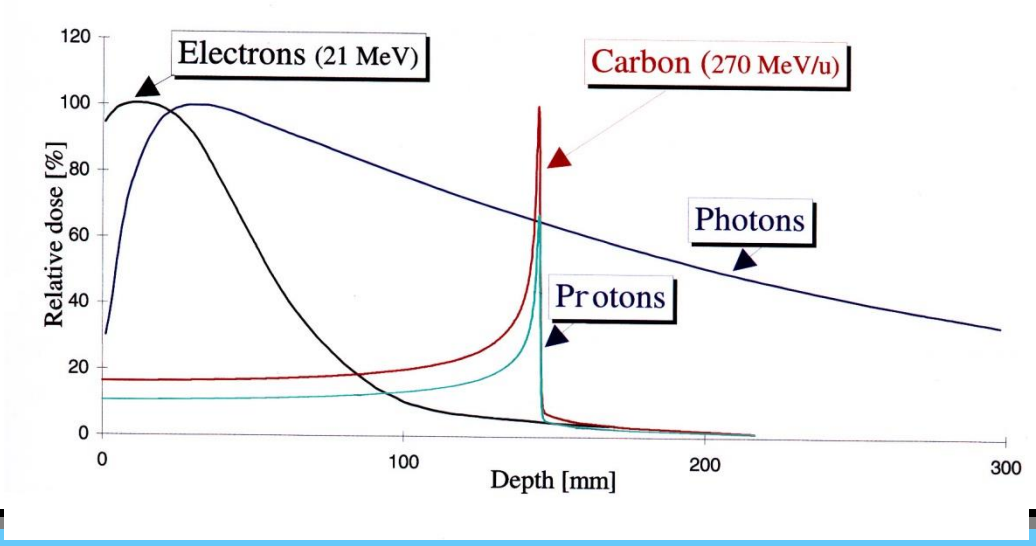
Founder and first director of Fermilab

All started in 1946

In 1946 Robert Wilson:

- Protons can be used clinically
- Accelerators are available
- Maximum radiation dose can be placed into the tumour
- Proton therapy provides sparing of normal tissues

First patient in Berkeley in 1954



The Beginning of Particle Beam Therapy

- 1948: Biology experiments using protons
- 1952: Human exposure to accelerated proton, deuteron and helium ion beams
- First proton patient September 1954
- 1956-1986: Clinical Trials– 1500 patients treated

Clinical Trials at LBNL-UCSF, 1975–1992

Prof. Joseph Castro, UC San Francisco conducted the LBNL clinical trials.

1975-1992	Total treated	NCOG/RTOG
He ions	2054 patients	700 patients
Neon ions	433 patients	300patients

Prof. T. Phillips

Prof. J. Quivey

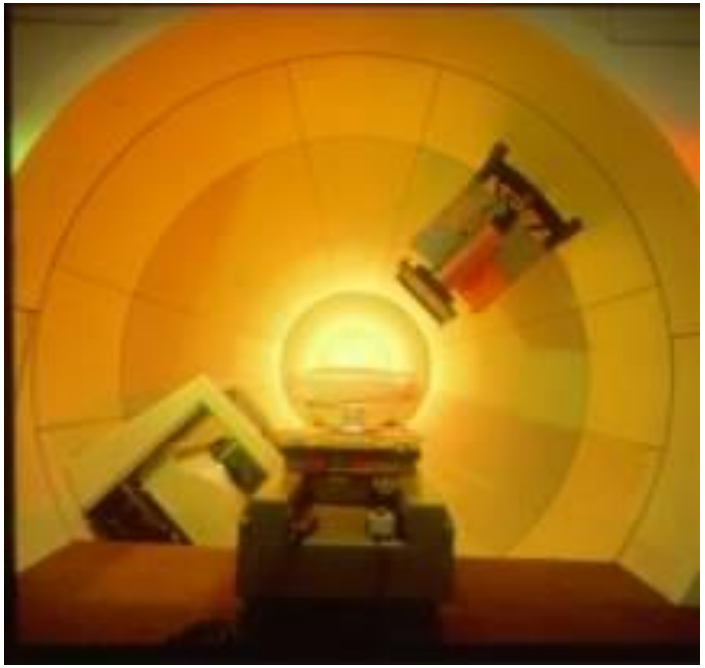
Prof. G. Chen

Dr. E. Blakely

Milestones of Hadron therapy

First hospital based *Proton* facility (1992)
Loma Linda University Medical Center, CA, USA

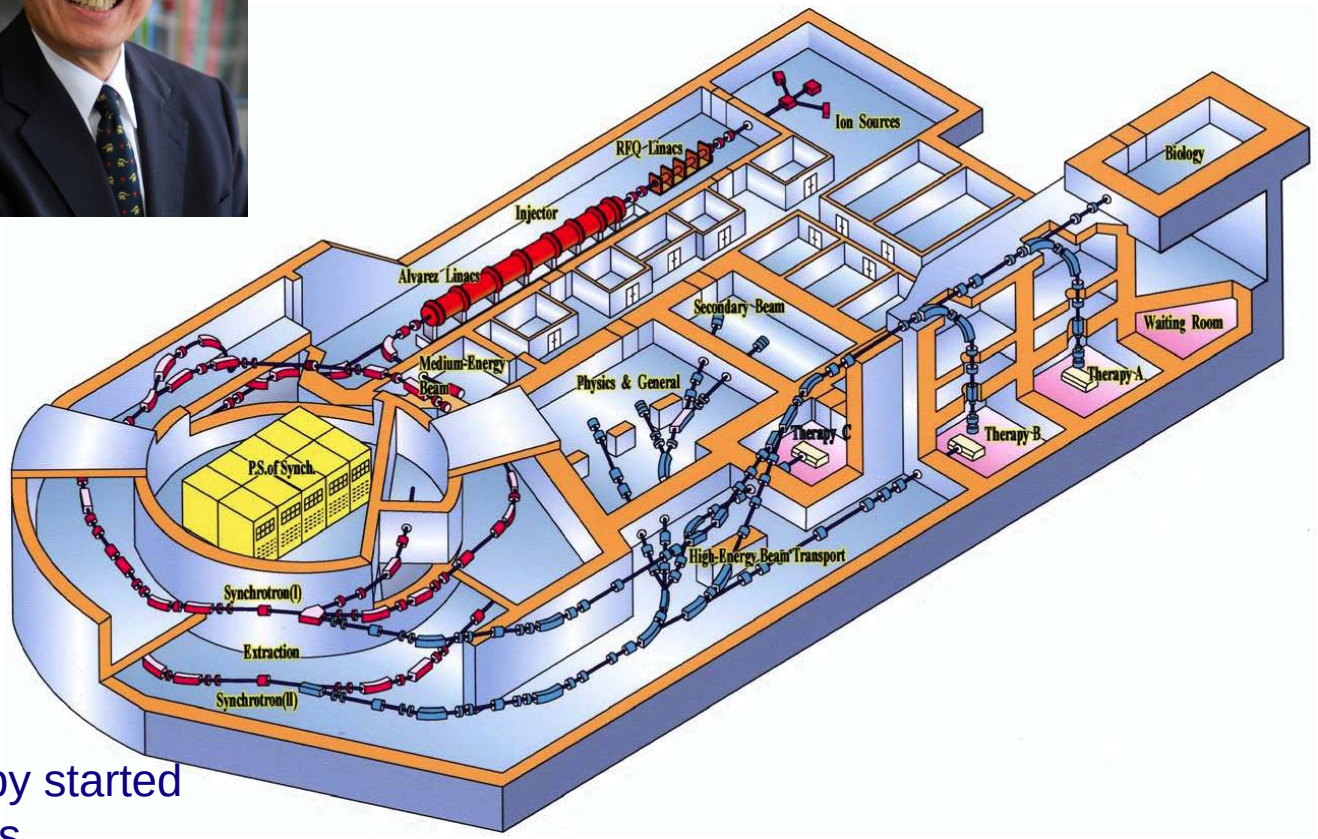
360^0 Gantry



Heavy Ion Medical Accelerator at Chiba (HIMAC) at NIRS, Chiba, Japan (1992)

Prof. Yasuo Hirao

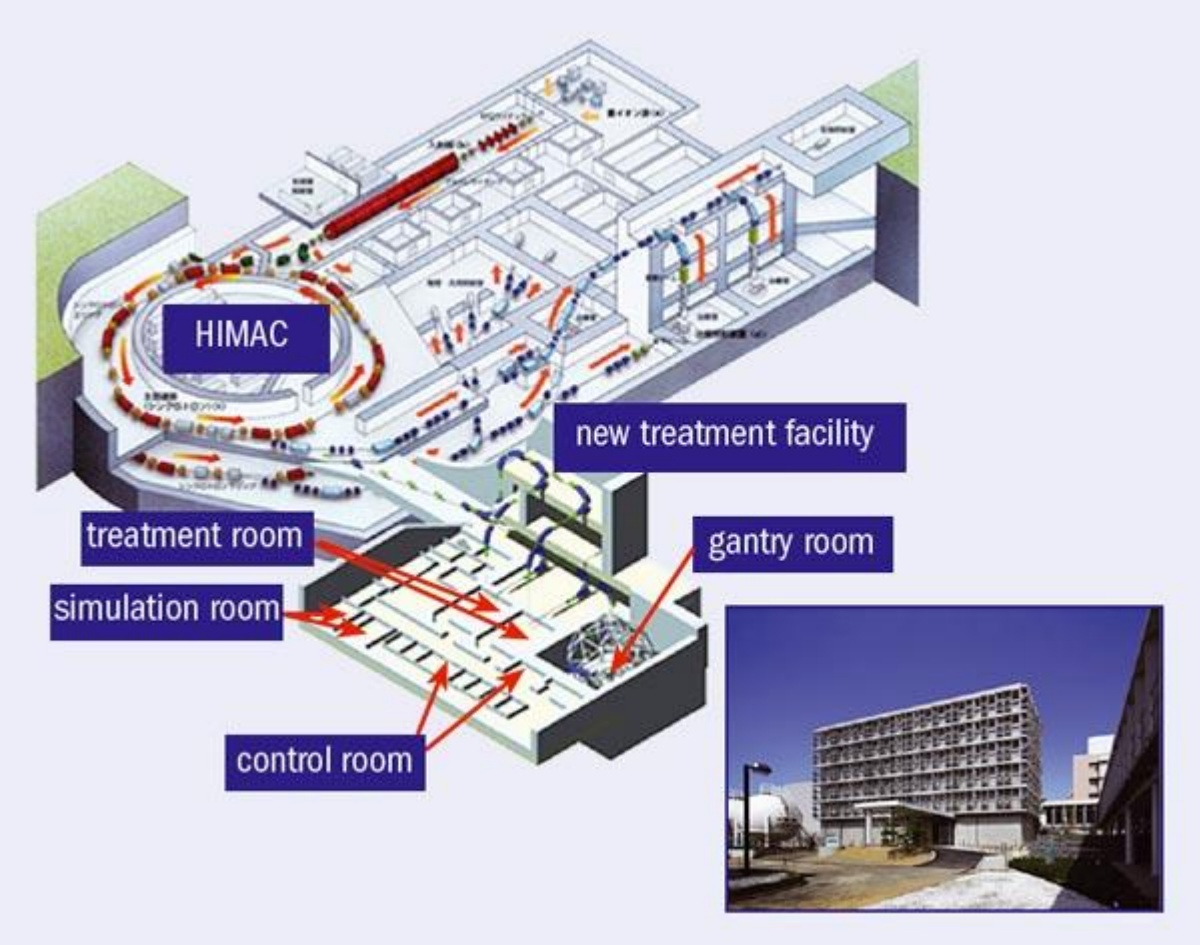
Prof. Hirohiko Tsujii



1994: Carbon-ion radiotherapy started
2010: Treated >5000 patients
2011: New Treatment Facility

Japanese development

- 2010 ~ 6,000 patients treated
- Spot-scanning fully operational
- New therapy facility building with 1V+1H+1G rooms



Carbon Ion Clinical Research at NIRS

Based on “high physical selectivity” & “biological effectiveness”

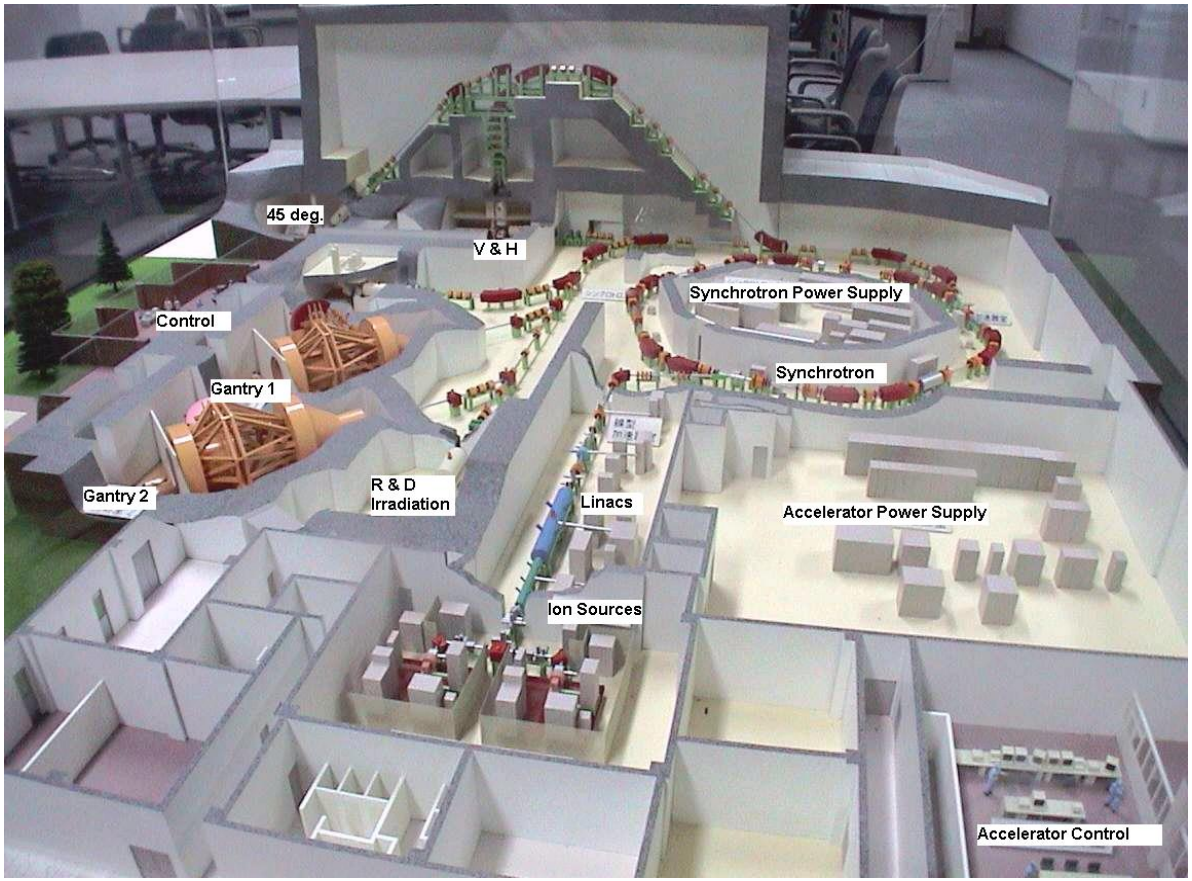
a) Establish safe and precise C- ion RT technique

b) Conduct phase I study ⇒ phase II study

1. Achieve local control in radio-resistant tumor
2. Demonstrate hypo-fractionation in common cancer
   (and conduct comparative study, if necessary)

To prove efficacy and safety of C-ion RT

HIBMC, Hyogo (2001)



Synchrotron

- 70–230-MeV protons with 2 gantries
- 70–320 MeV/nucleon ^{12}C beam with one each horizontal, vertical and 45˚ oblique fixed beams

GSI 'pilot project' (1997-2008)

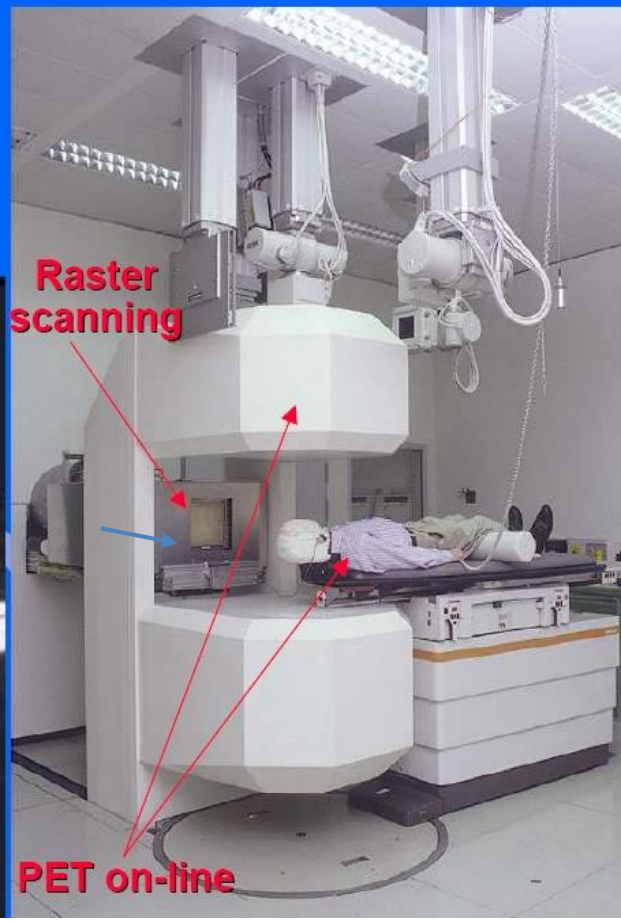
G. Kraft

J. Debus

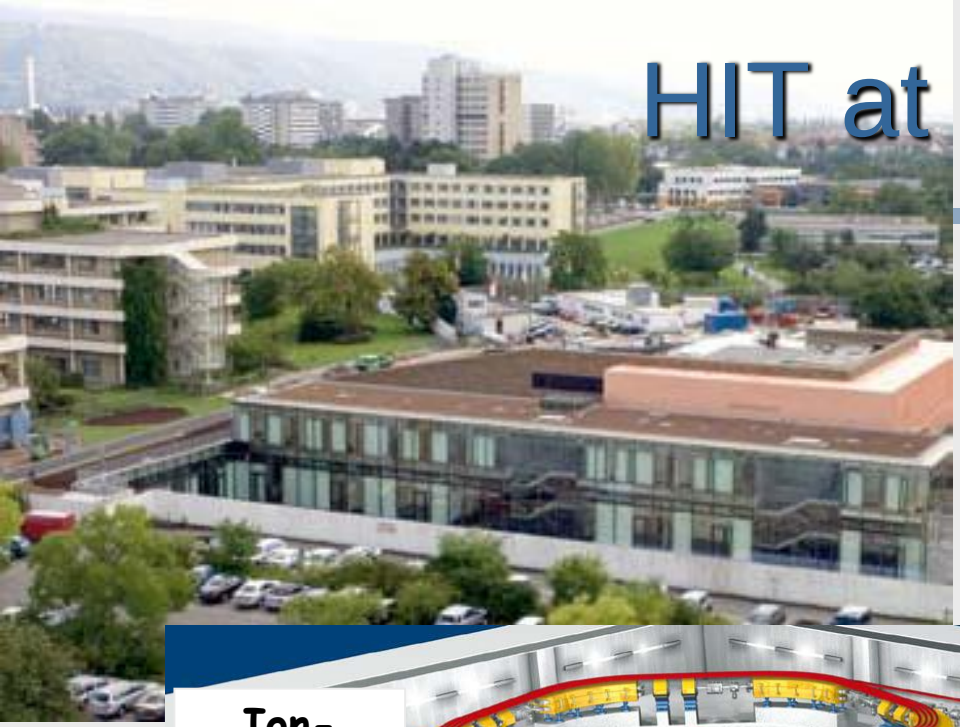
G. Kraft

450 patients treated with carbon ions

J. Debus (Heidelberg Univ.)

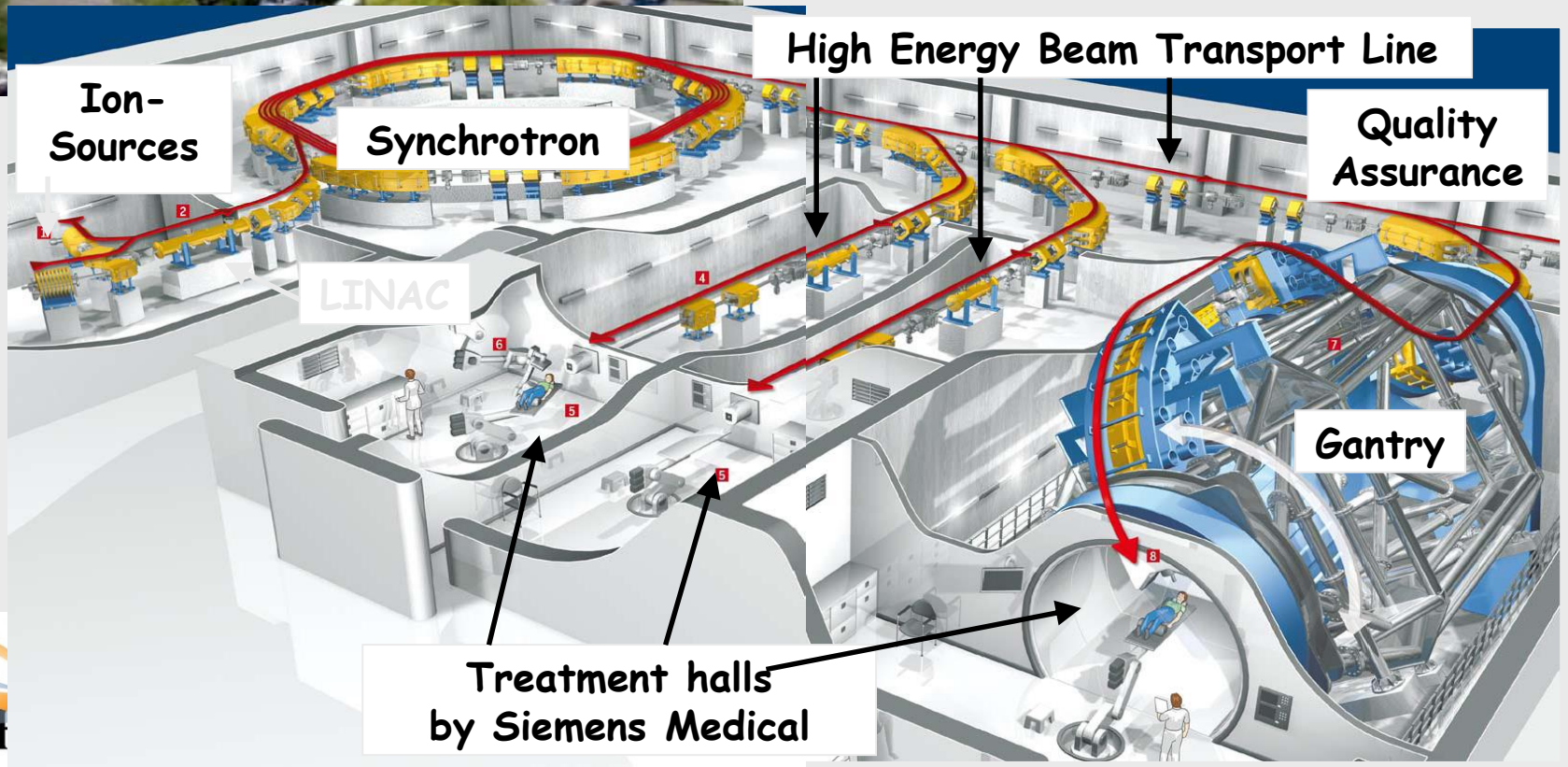


HIT at Heidelberg



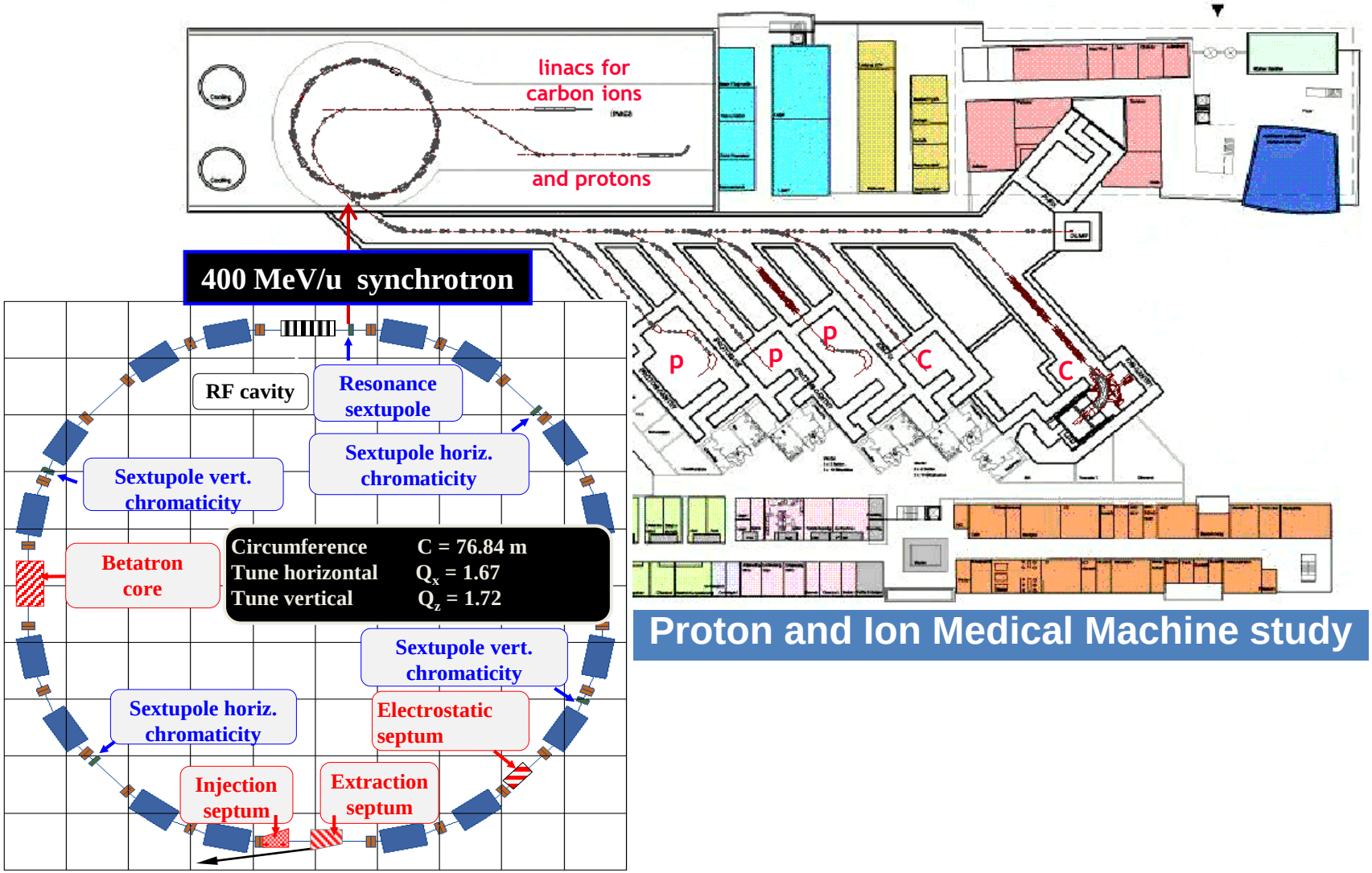
First beam extracted in 2007

First patient: in 2009



PIMMS at CERN in 1996 – 2000 (trigger for ENLIGHT)

CERN–TERA–MedAustron-Oncologie 2000 Collaboration



Proton and Ion Medical Machine study

2001

The beginnings of ENLIGHT

The idea germinated in 2001 during a ESTRO- Med-AUSTRON meeting where PIMMS was presented

The ESTRO HT group was proposed for creating a joint platform covering the different aspects of hadron therapy and projects in Europe which should lead to a closer European collaboration

In October 2001 the proposal for a Thematic Network was submitted to EC and Funded: 1 million Euros in 2002

ENLIGHT was launched In February 2002 at CERN

Driving Force:

Jean Pierre Gerard

Germane Heeren

Organization:

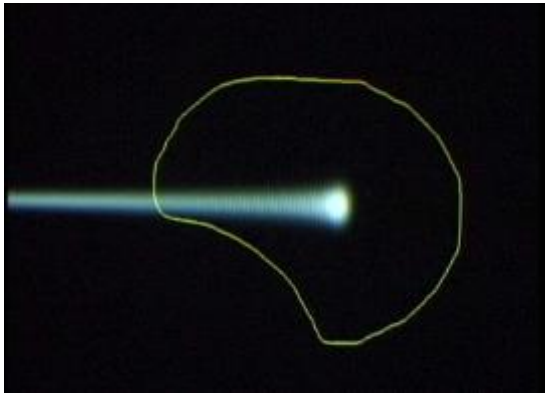
Ugo Amaldi

Hans Hoffmann

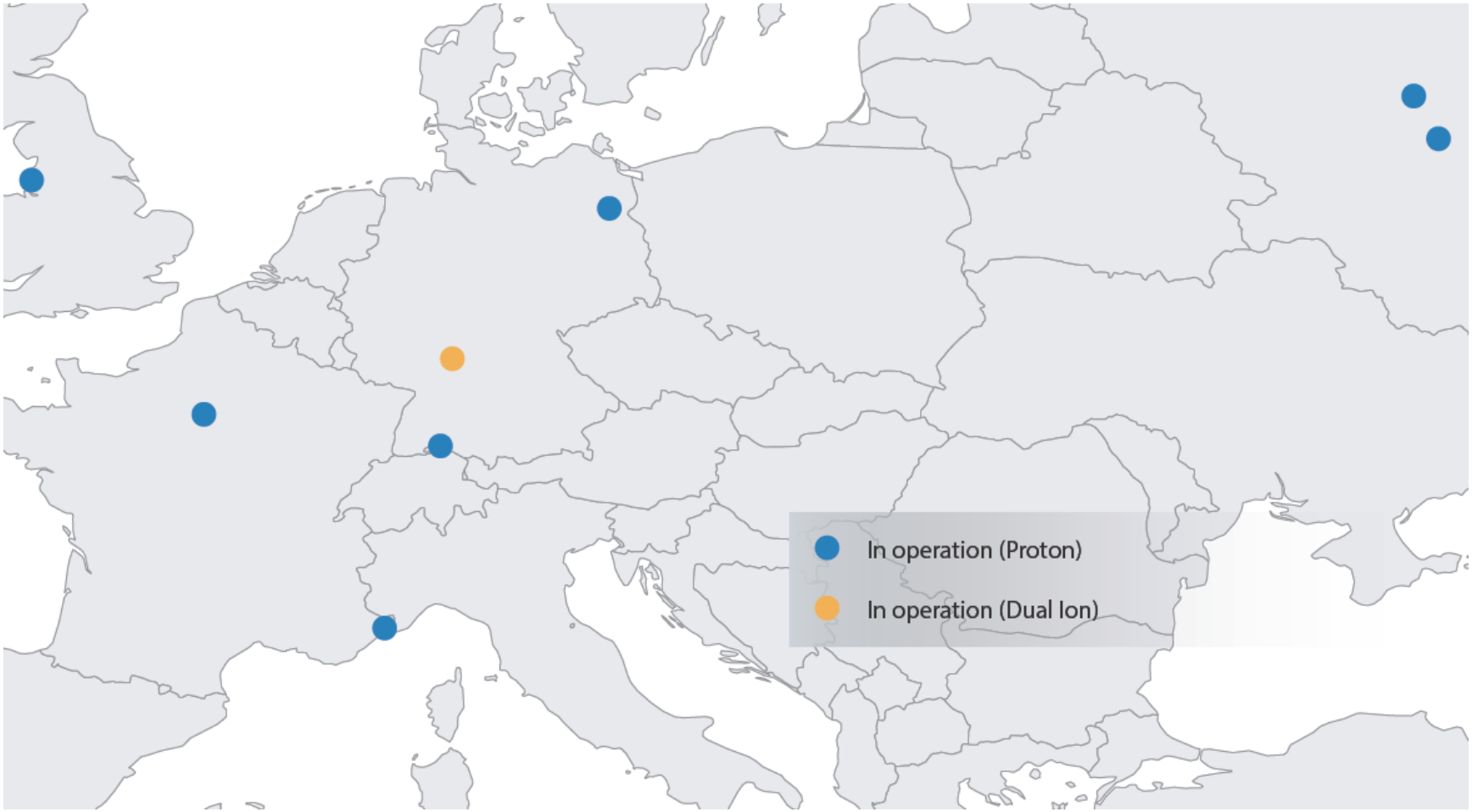
Manjit Dosanjh

ENLIGHT: Importing Physics collaboration philosophy into a medical environment

- Create common multidisciplinary platform
- Cancer treatment
- Identify challenges
- Share knowledge
- Share best practices
- Harmonise data
- Provide training, education
- Innovate to improve
- Lobbying for funding



Particle Therapy Centres in Europe 2002- start of ENLIGHT



From PIMMS study coordinated by CERN

TERA

fondazione CNAO

ebg MedAustron

First patient with carbon ions Nov 2012

Will start treatments in 2016

Facilities in Europe

→ Austria

Synchrotron

ebg MedAustron

1 research room – horizontal fixed beam

3 treatment rooms

- **Horizontal and vertical fixed beam**
  - Protons and carbon ions
- **Horizontal fixed beam**
  - Protons and carbon ions
- **Gantry (-30/+180)**
  - Protons

ENLIGHT++

From **2006** it became

+ More than a network….research
+ More countries, more institutions

- The community decided to continue **without funding** but
  - Develop strategies for securing the funding for specific projects under the umbrella of ENLIGHT, along two major axes
    - Research in areas needed for highly effective hadron therapy
    - Networking, to establish and implement common standards and protocols for treating patients

ENLIGHT and the European projects

European Network for LIGht-ion Hadron Therapy (2002-2005)

- GSI project for the University of Heidelberg Clinics
- CNAO in Pavia

} in construction

- Med-Austron for Wiener Neustadt (approved in Novembre 2004)
  partner of PIMMS since 1996
- ETOILE in Lyon (approved in June 2005)
  preliminary design by IN2P3 and CEA based on PIMMS/TERA

[ASCLEPIOS in Caen postponed]

- Baltic Centre in Stockholm
  preliminary design by TERA: NIM B184 (2001) 569

EC funding: building the community

ENLIGHT

Total funding of 24,6 M Euros

PARTNER
Particle Training Network for European Radiotherapy

- Marie Curie Initial Training Network
- 12 institutions
- 29 trainees

2008-2012

ULICE

- Infrastructures for hadron therapy
- 20 institutions

2009-2014

ENVISION

- R&D on medical imaging for hadron therapy
- 16 institutions

2010-2014

Prompt ɣ camera, prototyped, now commercial

ENTERVISION

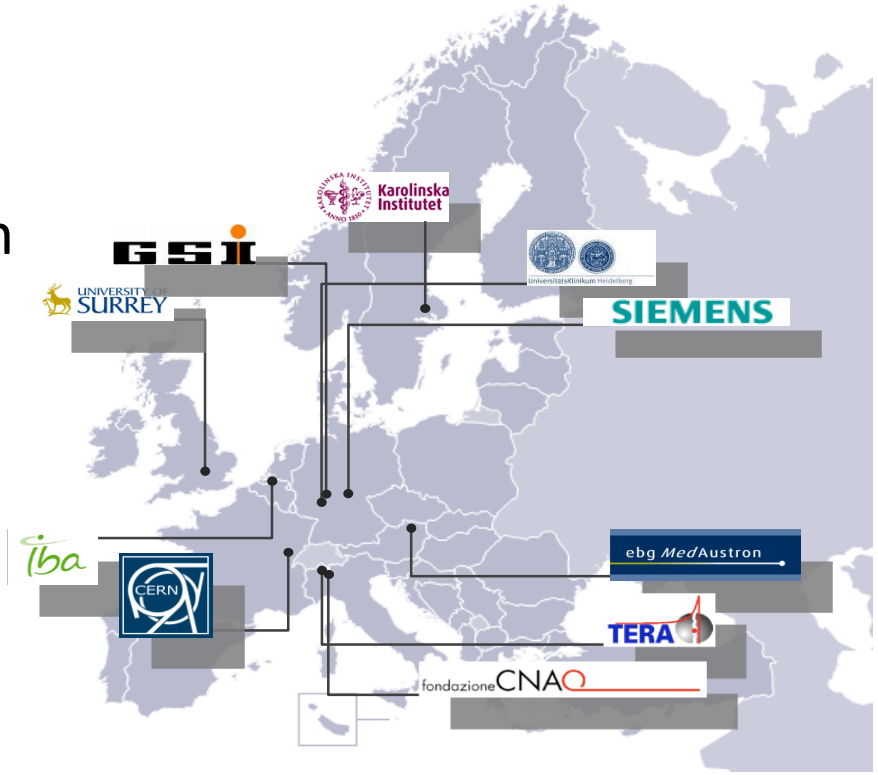
- Marie Curie ITN
- 12 institutions
- 16 trainees

2011-2015

Chosen as Gold project

PARTNER – a success story

- Particle Training Network for European Particle therapy
- 10 academic institutes, research centres, 2 leading companies
- 29 young researchers

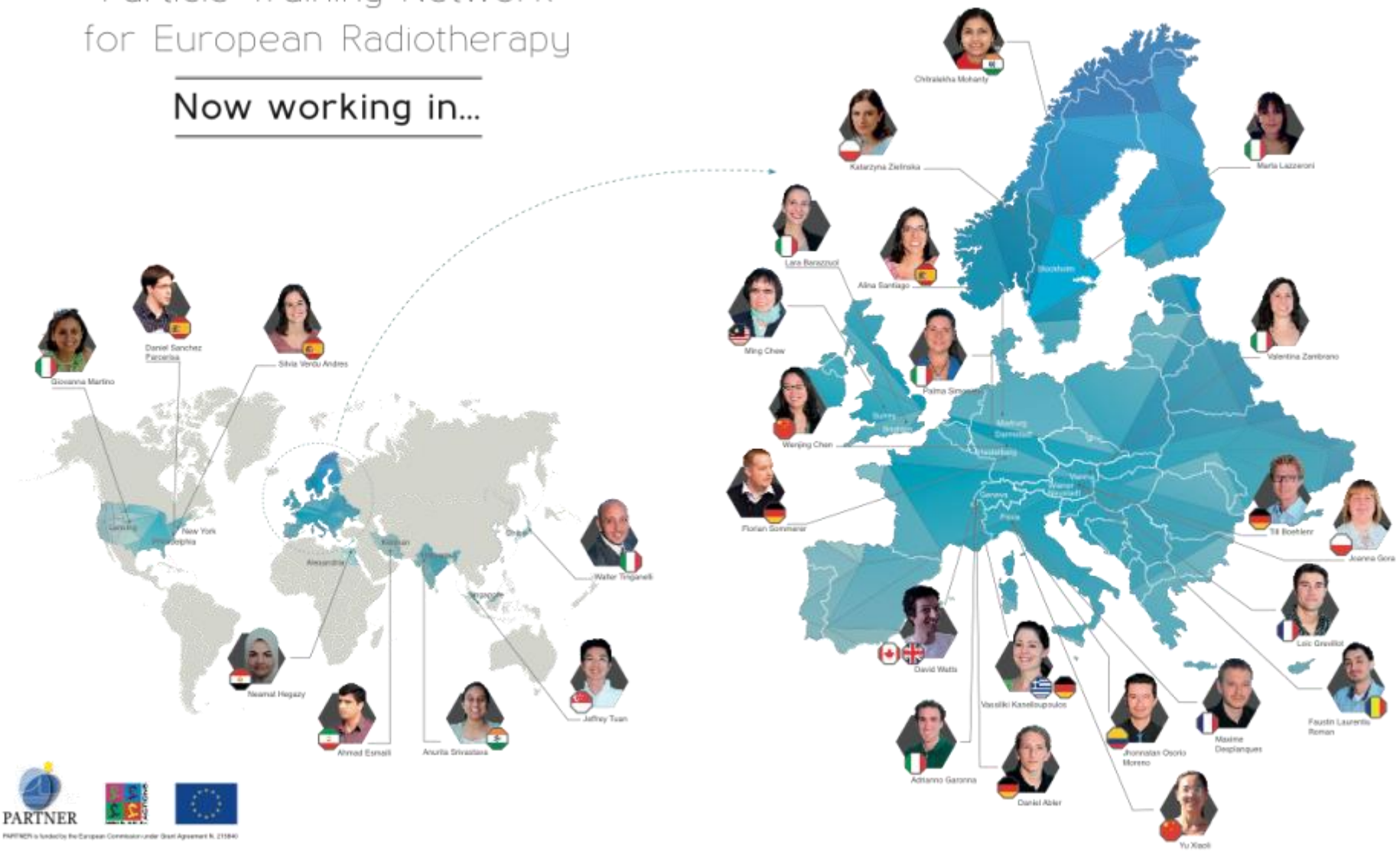


Outcome :

- Now working around the World
- Open access PARTNER-JRR

Particle Training Network for European Radiotherapy

Now working in...



PARTNER

PARTNER is funded by the European Commission under Grant Agreement N. 215840

ENTERVISION

- Training Network for medical imaging
- 10 academic institutes, research centres, IBA leader PT
- 12 Early Stage Researchers
- 3 Experienced Researchers

Outcome :

- 11 PhDs
- Over 30 posters, 50 oral presentations and 35 publications
- Patent for prompt gamma camera
- Frontiers in Oncology: Special Issue with 11 articles written by Entervision researchers in an open-access journal

http://journal.frontiersin.org/researchtopic/3520/charged-particles-in-oncology

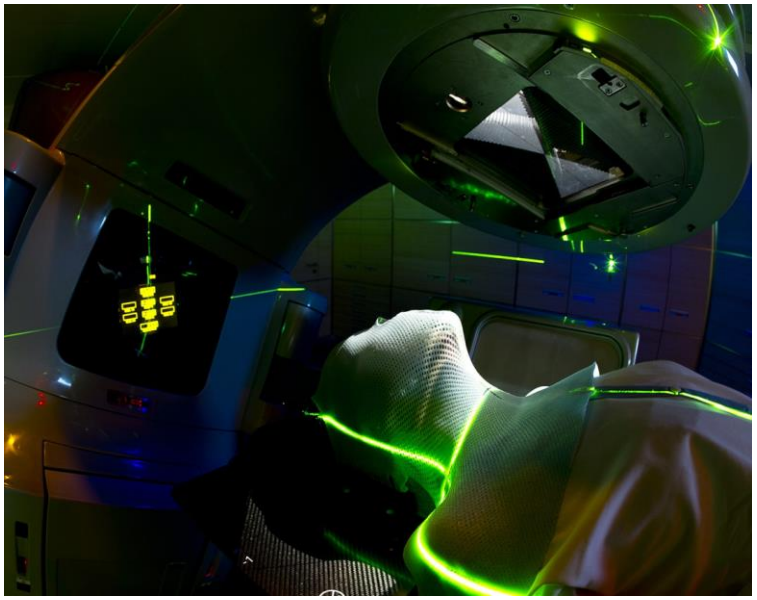
ENVISION

European Novel Imaging Systems for Ion Therapy

Accurate positioning is a crucial challenge for targeting moving organs during particle treatment

- 4-year EU funded project: Budget 6M euros
- launched in February 2010
- 16 leading European research centres and industrial partners, coordinated by CERN

- R&D in real-time medical imaging for more precise and effective particle therapy
  - 2 demonstrators for real time imaging have been constructed and are being tested
  - > 40 scientific publications and 80 conference talks/posters



Union of Light Ion Centre in Euro

ULICE

- Transnational access to beam time at HIT and CNAO successfully implemented
- Joint research activities: New gantry design being finalized
- Training courses at HIT and CNAO
  - For physicians and physicists already working in hadron therapy
  - For physicians, physicists, biologists who want beam time for their experiments

2010

An outcome of ENLIGHT: Physics for Health in Europe

PHE + ICTR

ICTR-2010
Jacques Bernier

ICTR-PHE 2012

Uniting physics, biology and medicine for better healthcare

A conference that brings together the International Conference on Translational Research in Radio-Oncology and Physics for Health in Europe

ICTR-PHE 2014

ICTR-PHE 2016

INTERNATIONAL CONFERENCE ON TRANSLATIONAL RESEARCH
IN RADIATION ONCOLOGY | PHYSICS FOR HEALTH IN EUROPE

February 15 – 19, 2016 CICG, Geneva, Switzerland

ICTR-PHE 2012

Uniting physics, biology and medicine for better healthcare

International Conference on Translational Research in Radio-Oncology

&

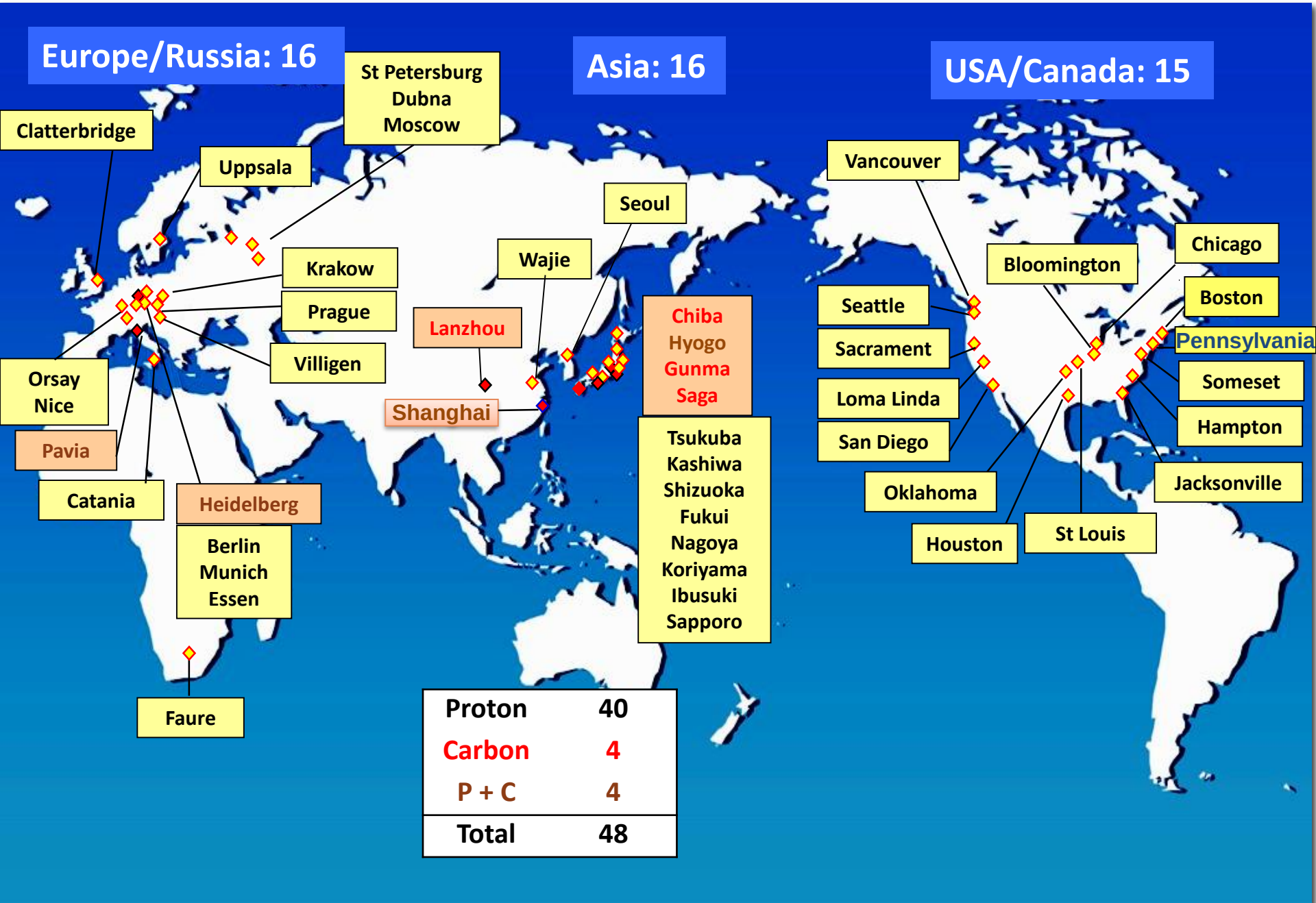
Physics for Health in Europe

- February 27 – March 2, 2012 at CICG, Geneva
  - –2 days devoted to physics, 2 days to medicine, 1 day of overlapping topics

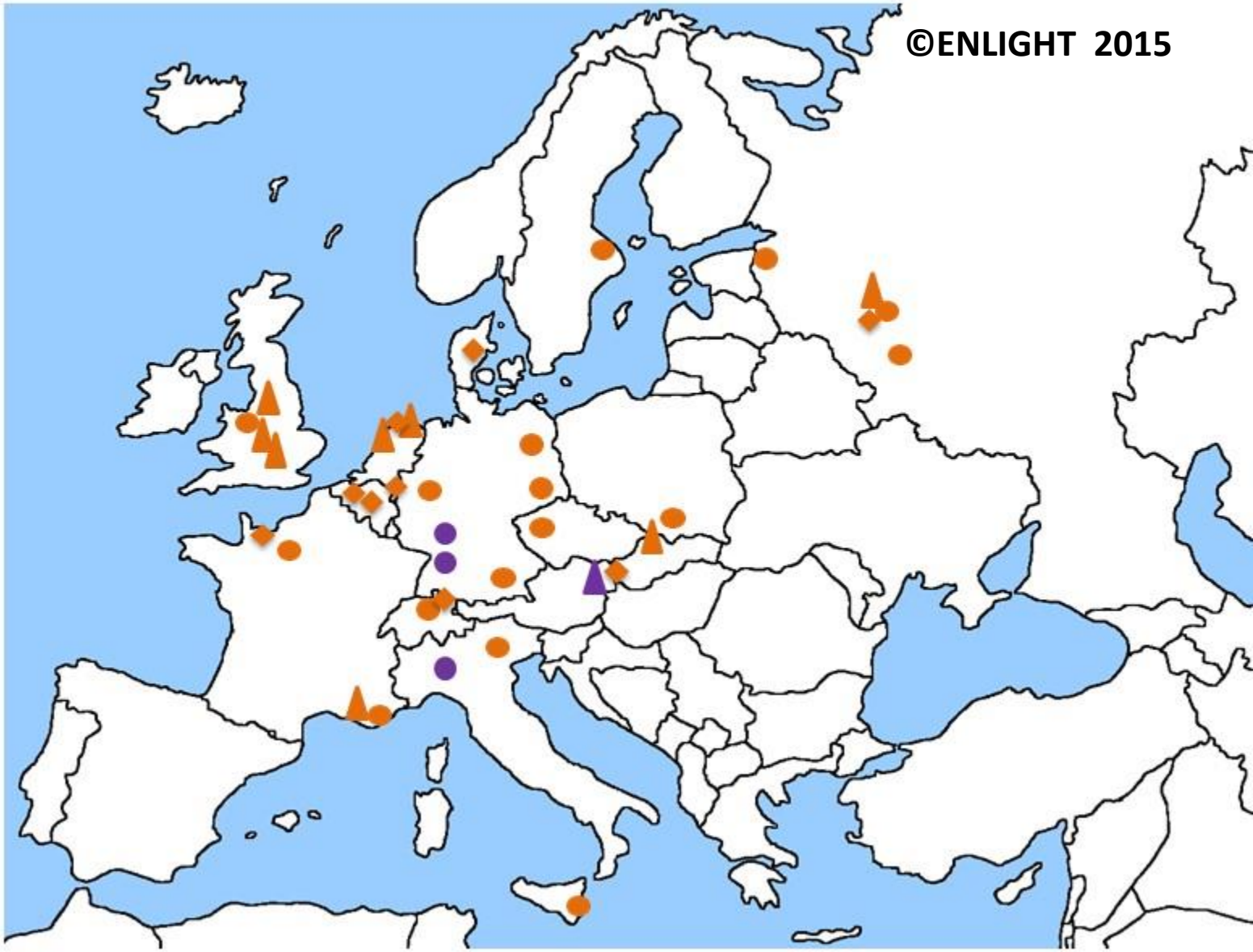
- Registration now open
- Abstract submission & Early registration deadline: October 15

- http://cern.ch/ICTR-PHE12

Particle therapy facilities in operation (Tsujii, 2014)



Particle therapy centres in Europe - 2015



Source: PTCOG, October 2015 and ENLIGHT

Krakow Meeting 2015: was time for reflection

Much had changed since 2002: many centres, community was established, more than 1000 members for over 30 countries, much had been done…

- Did we still need **ENLIGHT**?
- If yes, what sort of **ENLIGHT** did we need?

ENLIGHT

ENLIGHT Training (2016)

Training young people and preparing skilled experts in particle therapy

Why?

Society's need for qualified, competent experts in hadron therapy - Cancer patients' need to readily access this treatment - Practitioners' need for high-level training in hadron therapy

Who?

Research students on particle physics globally - Cancer patients worldwide

How?

1-week Introductory Training at CERN, 2-day Advanced Training at ENLIGHT Annual Meeting, 3-4 weeks hands-on Internship

Impact

30 students attending the Introductory Training
80 participants taking part to the Advanced Training
3 researchers completing a hands-on Internship

Last in person ENLIGHT meeting

ENLIGHT at Caen, 2019

ENLIGHT

New Facilities in Europe: Balkans and Baltics project

Goals and Benefits for SEE Region

- more than 40 millions people could benefit from this project
- possibility for education, training and innovation
- more effective cancer treatment using the cutting-edge technologies and innovative treatment options
- participate in clinical trials Europe-wide
- a unique facility in Europe which will have 50% time for fundamental, translational, clinical innovative research
- attractive for external research community: also cheaper research and living costs
- possibility to boost the regional development and create a new generation of young scientists, industry
- mitigate brain-drain - reverse brain in some cases

A joint, dedicated workshop
“Particle therapy - future for the Baltic States? State-of-play, synergies and challenges”