

Trans-national Access & CNAO: status and perspectives

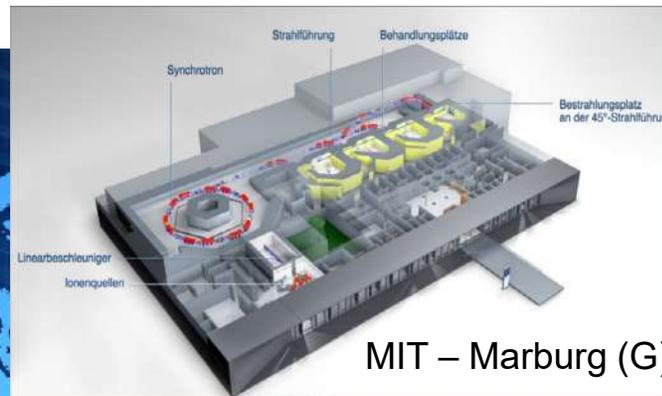
SANDRO ROSSI

CNAO FOUNDATION



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

Only 13 carbon ions centres (6 multi-particle)



CNAO – Pavia (I)



MedAustron – Wien (A)



3 centres in China

6 centres in Japan



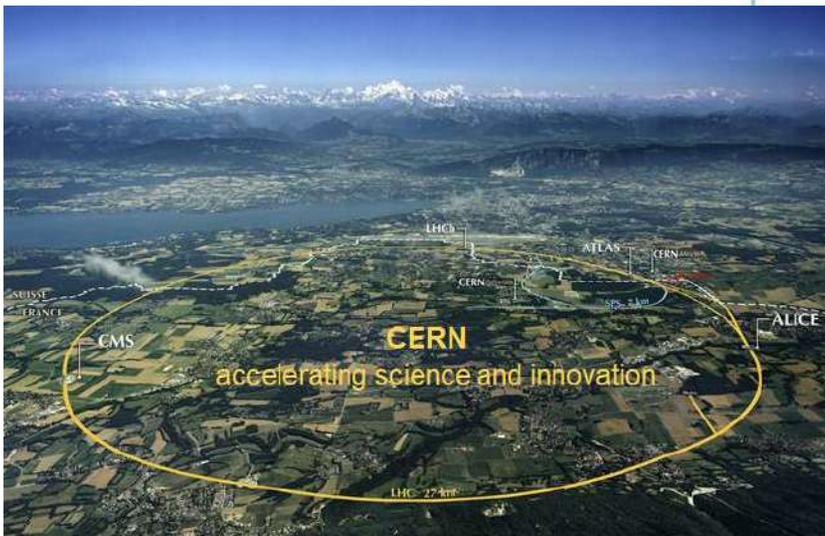
22 Institutes

(4 CIRT centres, 10 research institutions, 5 universities, 3 SMEs)

14 European Countries

Participant No *	Participant organisation name	Country
1 (Coordinator)	Fondazione Centro Nazionale di Adroterapia Oncologica (CNAO)	IT
2	Bevatech GmbH (BEVA)	DE
3	Commissariat à l'énergie atomique et aux énergies alternatives (CEA)	FR
4	European Organisation for Nuclear Research (CERN)	IEIO
5	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT)	ES
6	Cosylab Laboratorij za kontrolne sisteme dd (CSL)	SI
7	GSI Helmholtzzentrum für Schwerionenforschung GmbH (GSI)	DE
8	Universitätsklinikum Heidelberg (UKHD/HIT)	DE
9	Istituto Nazionale di Fisica Nucleare (INFN)	IT
10	EBG MedAustron GmbH (MEDA)	AT
11	Marburger Ionenstrahl-Therapie Betreibergesellschaft mbH (MIT)	DE
12	Paul Scherrer Institut (PSI)	CH
13	South East European International Institute for Sustainable Technologies (SEEIIST)	CH
14	Universita ta Malta (UM)	MT
15	Philipps-University Marburg (UMR)	DE
16	Uppsala University (UU)	SE
17	Wigner Research Centre for Physics (Wigner RCP)	HU
18	Riga Technical University (RTU)	LV

Participant No *	Participant organisation name	Country
19	Ss, Cyril and Methodius University in Skopje, Republic of North Macedonia (UKIM)	MK
20	Clinical Centre of Montenegro (CMSM)	ME
21	Sentronis a.d. (SEN)	RS
22	Jožef Stefan Institute (IJS)	SI



Started April 1st, 2021 – Duration 4 years

HITRIplus

Objectives

Starting from its basic motivations, the HITRIplus Consortium has identified five strategic objectives to be achieved within the Project, aimed at the advancement of ion therapy research with ions heavier than protons.

1. To **integrate, open up and broaden** the leading European Research Infrastructure for the treatment of cancer with **beams of ions**, ranging from helium to carbon and to heavier ions.
2. To **coordinate and strengthen** the research programmes on heavy ion therapy of different European institutions, by promoting synergies, collaborations, innovation, knowledge transfer, new initiatives and sharing of tools and data.
3. To develop in a joint and coordinated way **novel technologies** to improve the accelerators and their ancillary systems that provide particle beams to this scientific community. These technologies will **improve the present generation** of facilities and will be the **foundation for a next generation** European design for ion therapy facilities.
4. To establish a **European multidisciplinary community** for heavy ion therapy research, aiming at improving treatment strategies and modalities by connecting physics and engineering with medicine, biology and biophysics, and to **extend this community** towards emerging European regions, addressing in particular **new initiatives in South East Europe**.
5. To define the main technical features and the scientific programme of a future **pan-European Research Infrastructure** for medical and radiobiological research with heavy ion beams, to be built in South East Europe or in another European region.



WP1: Management



WP2: Networking and Communication, Dissemination and Outreach



WP3: Clinical networking



WP4: Innovation, technology transfer, industry relation



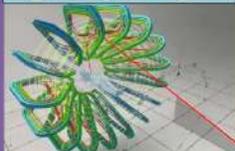
WP5: Education and Training



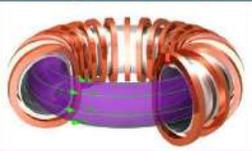
**JRA
Joint Research
Activities**

**TNA
WP6
Transnational Access**

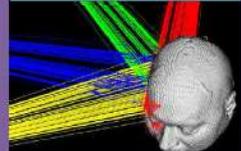
WP7: Advanced accelerator and gantry design



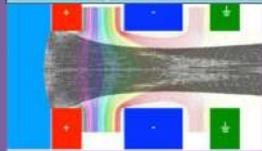
WP8: Superconducting magnets design



WP9: Advanced beam delivery



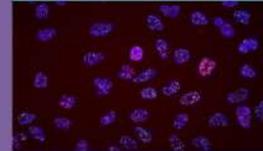
WP10: Multiple energy extraction system



WP11: Controls and safety



WP12: Radiobiology and quality assurance

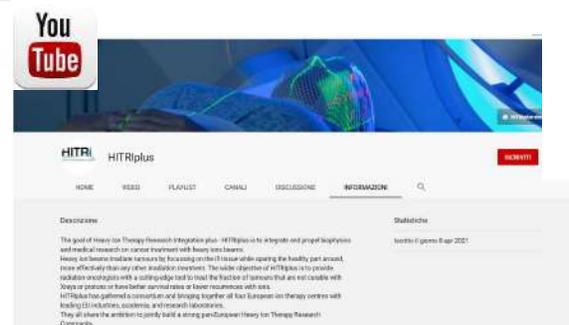
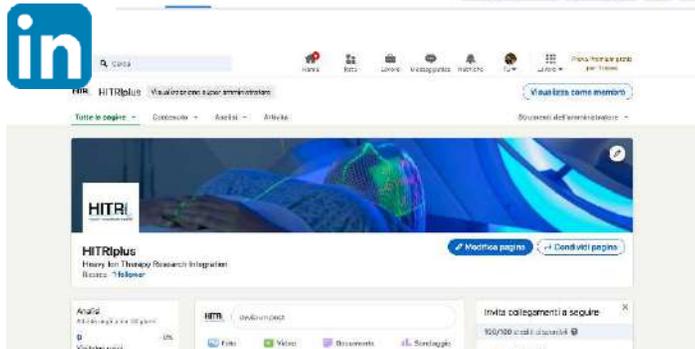




www.hitriplus.eu

HITRIplus SOCIAL NETWORKS

Dedicated social profiles have been created on the showcase website



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

ACCESS BEAM REQUESTS

available on the HITRI*plus* showcase website

Fill in the following form to request beam time for clinical or research projects

Name and Surname

Email *

Institution & Department Affiliation

Country

Title of proposal research

Message: specify the scope of beam request

Attach your abstract

Using the contact form, we will collect the data that you enter in the data fields provided in the contact form. We will require and will process this data in order to answer your enquiry, to provide you with the information you desire or to process and deal with any other specific query you have raised with us.

The data collected via the contact form will be processed solely for the purpose of dealing with your query(-ies); it will be stored and retained for as long as is necessary to deal with your query and deleted within a reasonable period following the last contact. The data will only be retained beyond that if such retention is necessary to satisfy statutory retention periods or you have agreed a longer retention with us. In such cases, the data will be deleted once the statutory or agreed retention period has expired (whichever expires later). In the event of legal disputes, we will retain the data until the corresponding legal dispute(s) has (have) ended if this data will be needed as evidence.

Send

HITRI*plus* - Transnational access
<https://www.hitriplus.eu/transnational-access/>

Request by email to:
info@hitriplus.eu

WP5 - Education and Training (UM)

Task 5.2 – Masterclass School

- Coordinated by N. Sammut (UM) and led by GSI – Yiota Foka
- 1 week school with a focus on Treatment Planning Systems (TPS)
- lectures, therapy tool demonstrations, hands-on exercises, student projects, virtual visits, virtual social events
- 17 – 22 May 2021 – Sarajevo/Online
- <https://indico.cern.ch/event/1019104/overview>



Heavy Ion Therapy MasterClass School | 17 - 22 May 2021
Online Course

The program is intended for the students of the following disciplines Medical Physics, Physics, Radiotherapy, Radiology, Bioengineering and Imaging and Radiotherapy Techniques and early stage researchers.

In collaboration with

Logos of collaborating institutions: CERN, INFN, FAIR, GSI, etc.

Diagram showing a central figure surrounded by icons for: PHYSICS, RADIOLOGY, MEDICAL, PHYSICS, RADIOOTHERAPY, BIOENGINEERING, IMAGING & RADIOOTHERAPY, TECHNIQUES.

Topics

- Particle Therapy
- Treatment Planning
- Accelerator Physics
- Beam Delivery
- Radiation Protection
- Imaging
- Biophysics
- AI/ML for Particle Therapy

Scope

Focus on Heavy Ion Therapy Treatment Planning Systems (TPS) including lectures, treatment planning tool demonstrations, hands-on exercises and student projects.

Programme Committee

- Y. Foka (GSI/EMMI, Chair)
- A. Gazibegović-Busuladžić (UNSA)
- N. Sammut (Uni. Malta)
- M. Sapinaki (SEGI/IST)
- J. Seco (DKFZ)
- M. Wretenar (CERN)
- N. Wahl (DKFZ)
- H.P. Wieser (LMU)

Scientific Assistants

- A. Mamaras (AUTH/CERN)
- A. Kaplic (EPFL/CERN)
- D. Skutjeli (UNSA/DKFZ)
- R. Taylor (ICU/CERN)

SIGN UP NOW TO THE FIRST HEAVY ION THERAPY COURSE!

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

Registration deadline: 15 May 2021

HITRI Heavy Ion Therapy Research Integration

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008540

- **1050** Registrants
- 992 actually attended at some point – average 600 per day
- 190 Number of hands-on exercises delivered
- 158 certificates of attendance awarded (must satisfy 80% attendance and submission of hands-on exercises)
- 343 questions received during lectures + several more chat questions during hands-on sessions + more than 100 questions during social events
- 316+ evaluation forms
- 36 lecturers (15 female)
- 33 hours - (15h lectures, 7.5h Hands-on, 5h Student sessions, 5h Social Events)
- recordings and presentations available for people in different time zones

European countries:

➤ 495 participants

Non-European countries:

➤ 470 participants

CENTRO NAZIONALE ADROTERAPIA ONCOLOGICA (CNAO)

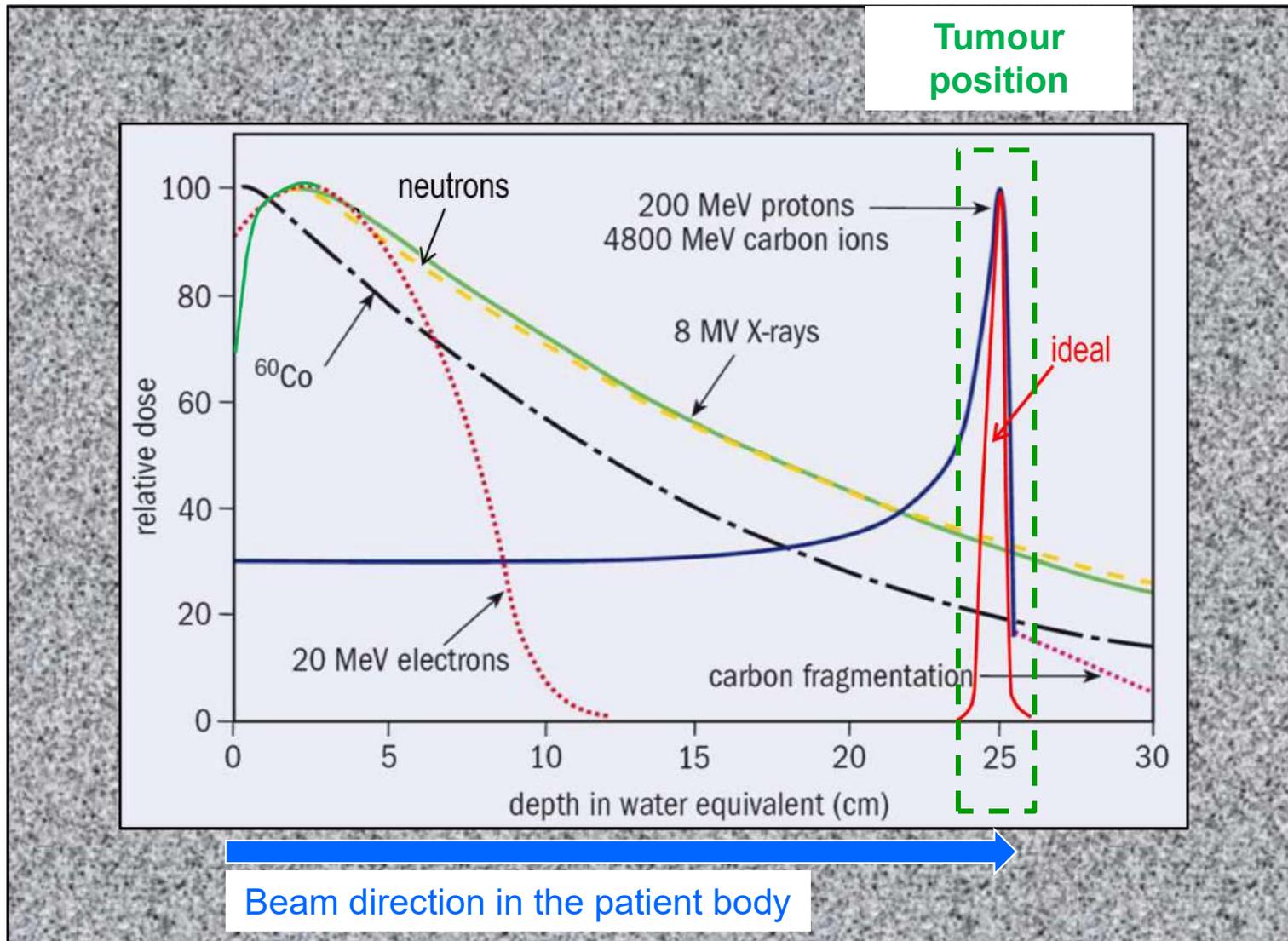
Not-for-profit private Foundation

Created by the Italian Ministry of Health in 2001

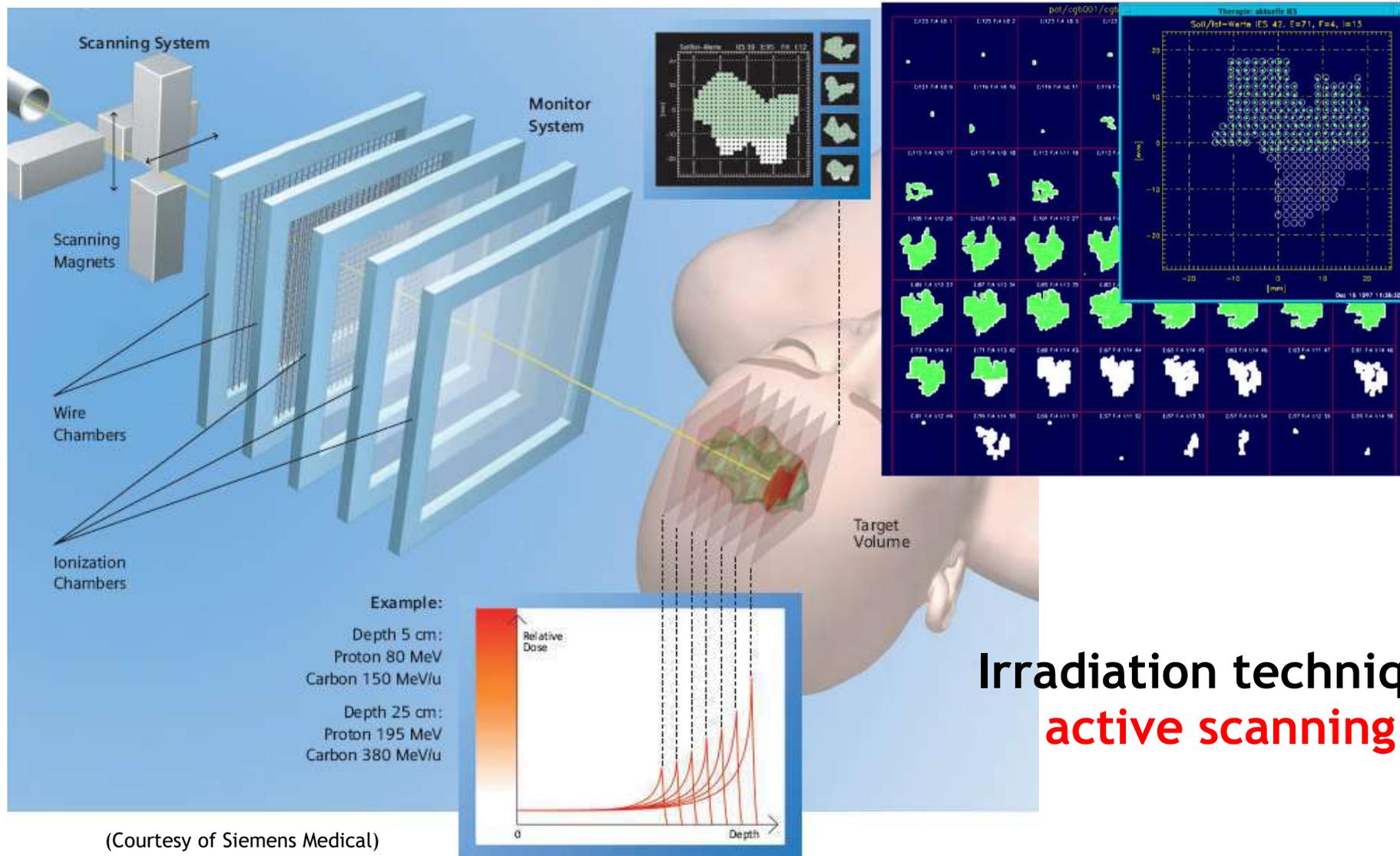
with the purpose to build and run a hadrontherapy Centre



Hadrontherapy to treat 'difficult' cases: **PRECISION**



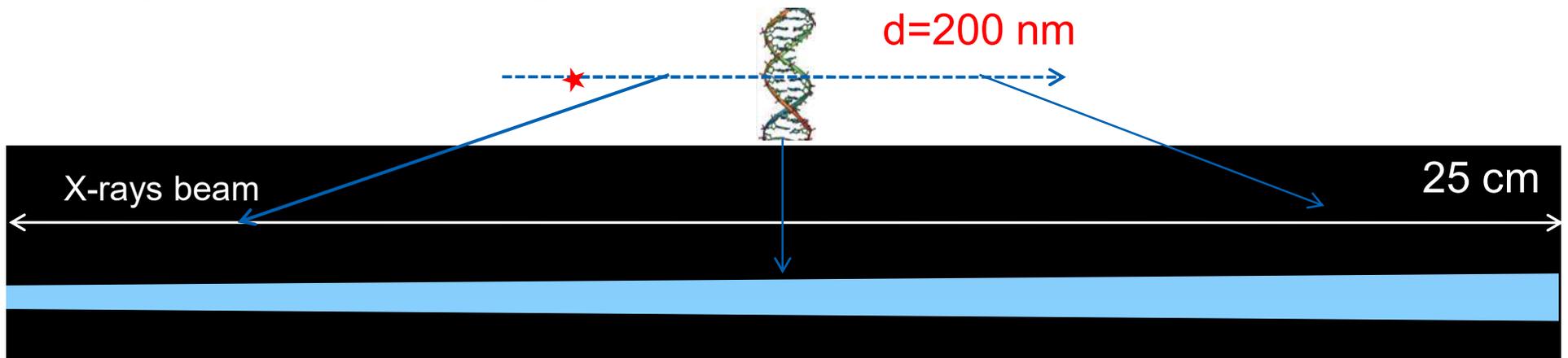
Hadrontherapy to treat 'difficult' cases: **PRECISION**



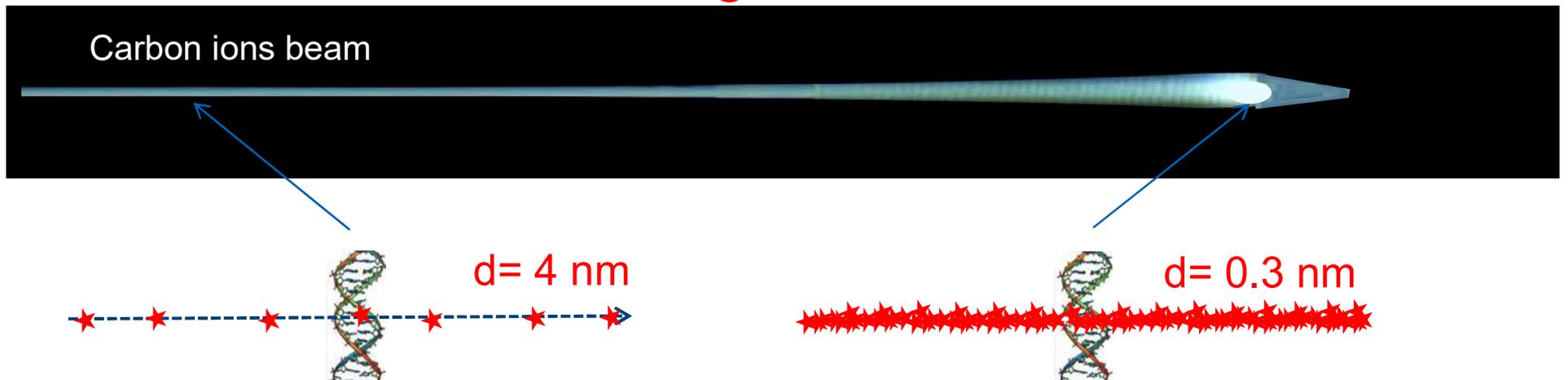
(Courtesy of Siemens Medical)

Hadrontherapy to treat 'difficult' cases: **EFFICACY**

X-rays: sparse damage and indirect effects

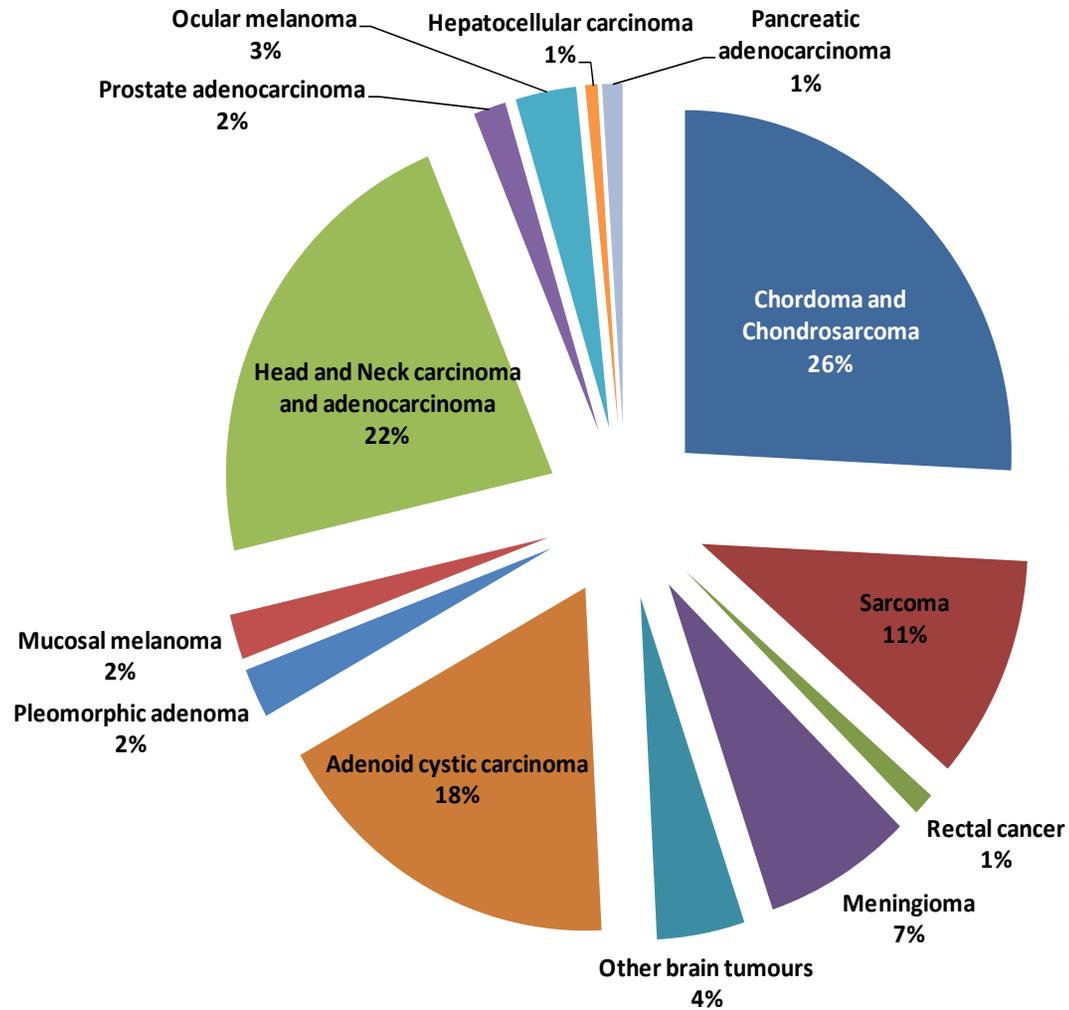


Carbon ions: clustered damage on tumour and direct effect

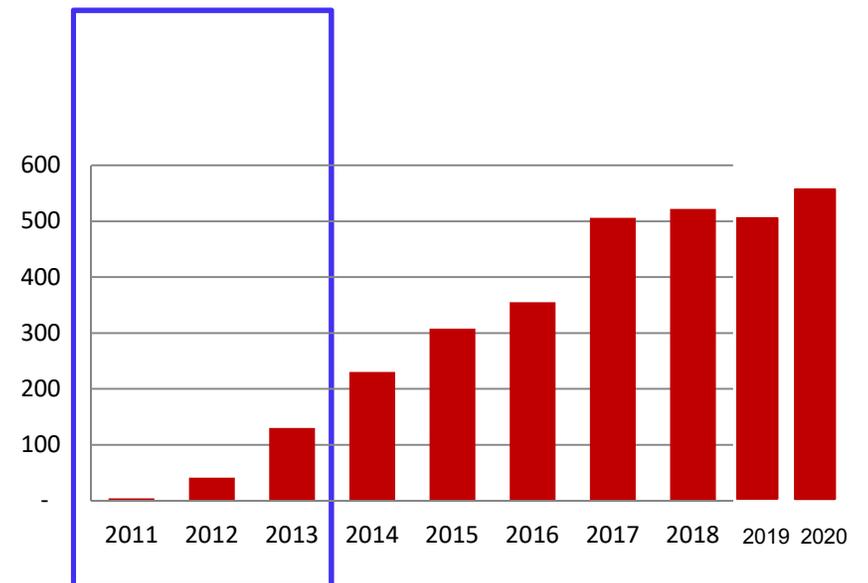


CNAO: 3300 patients treated

55% carbons - 45% protons



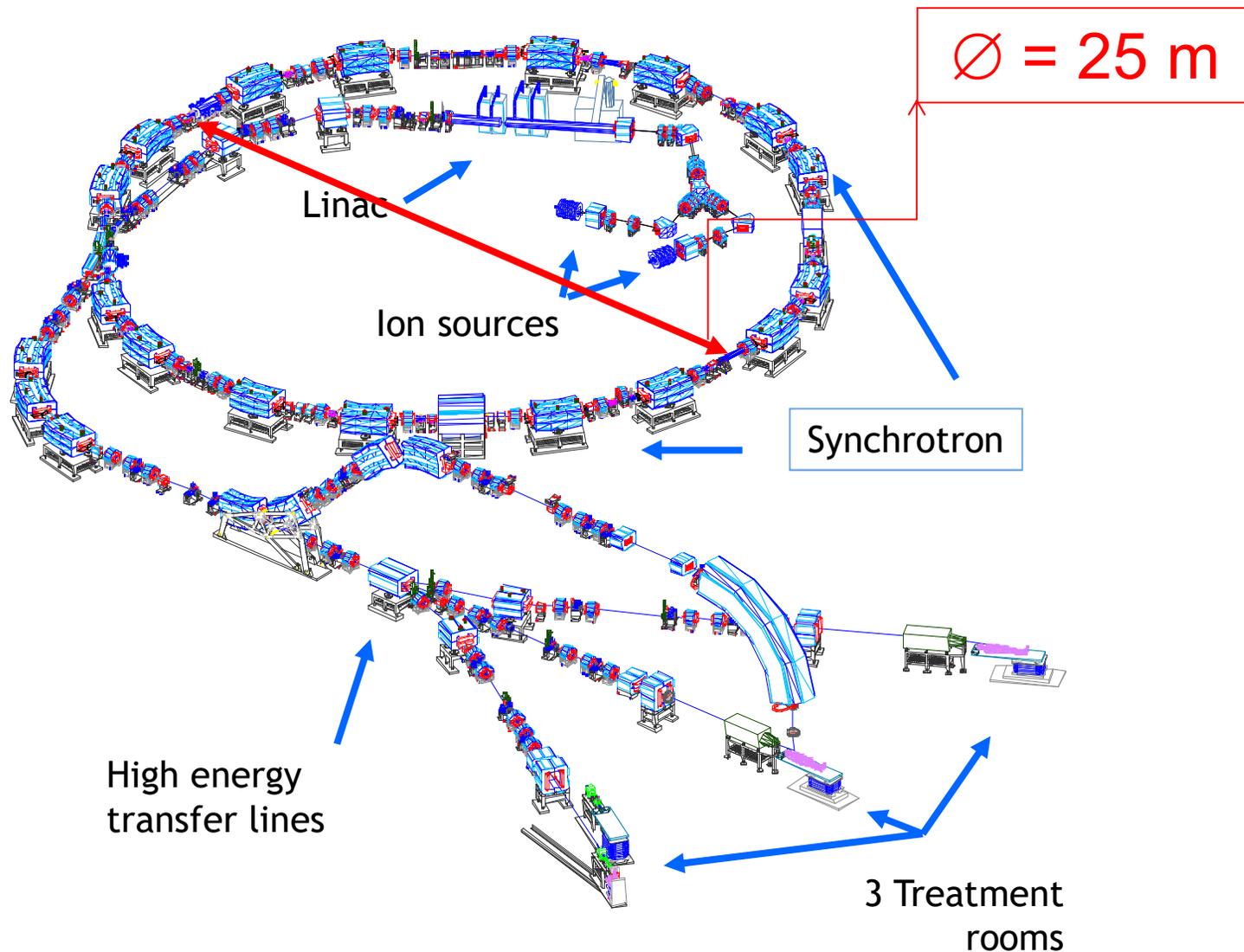
CE clinical trials

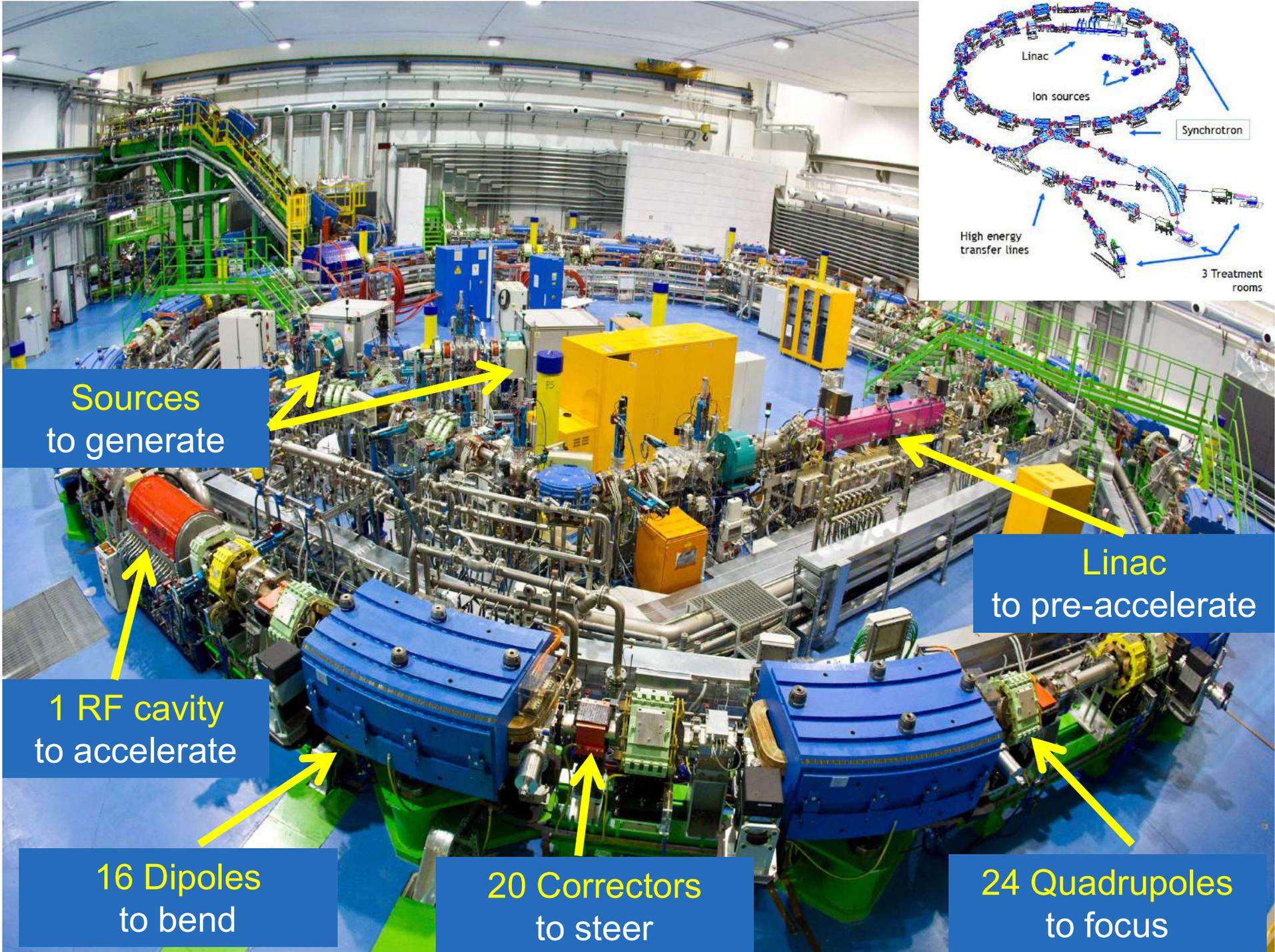


Patients per year

Accelerator at CNAO: compact design

Intellectual property shared by CNAO - INFN - CERN



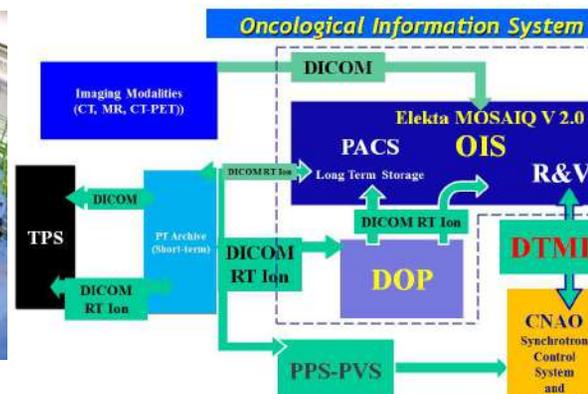


High precision devices for patient positioning

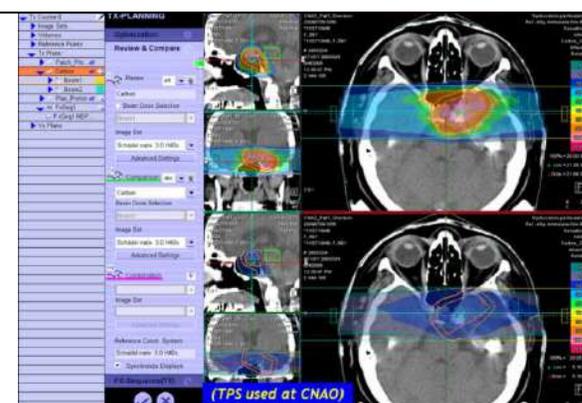
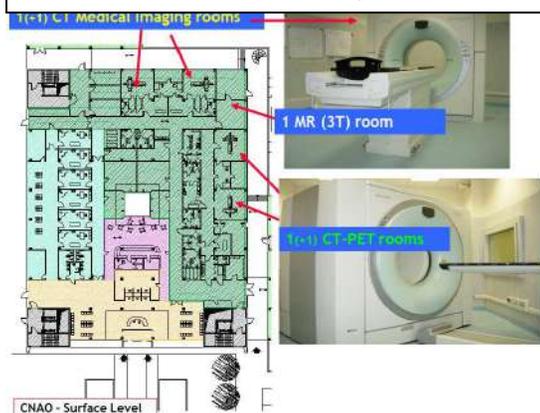


Collaboration CNAO-PoliMi

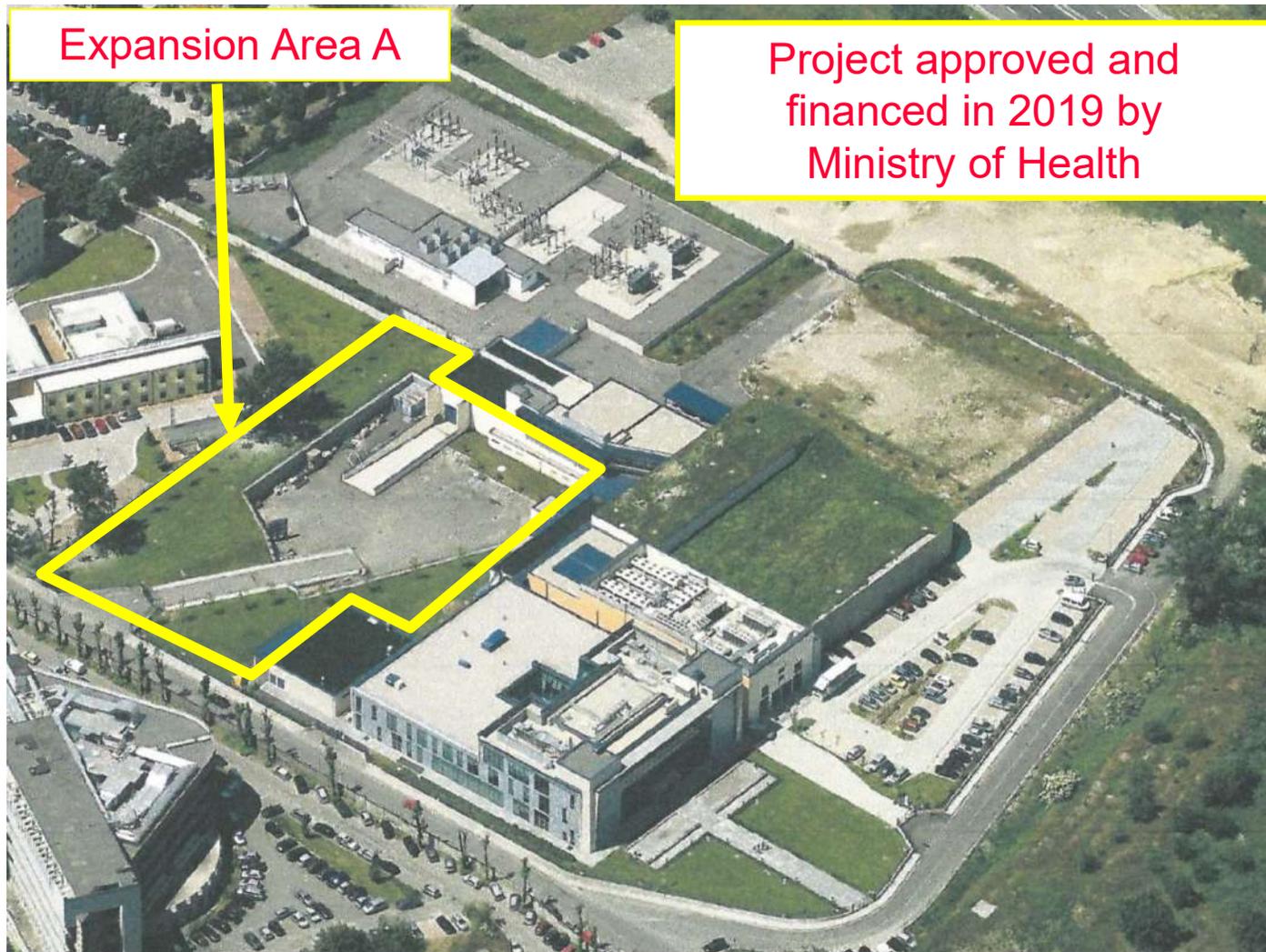
“LEGO Model”: integrated technical and medical solutions



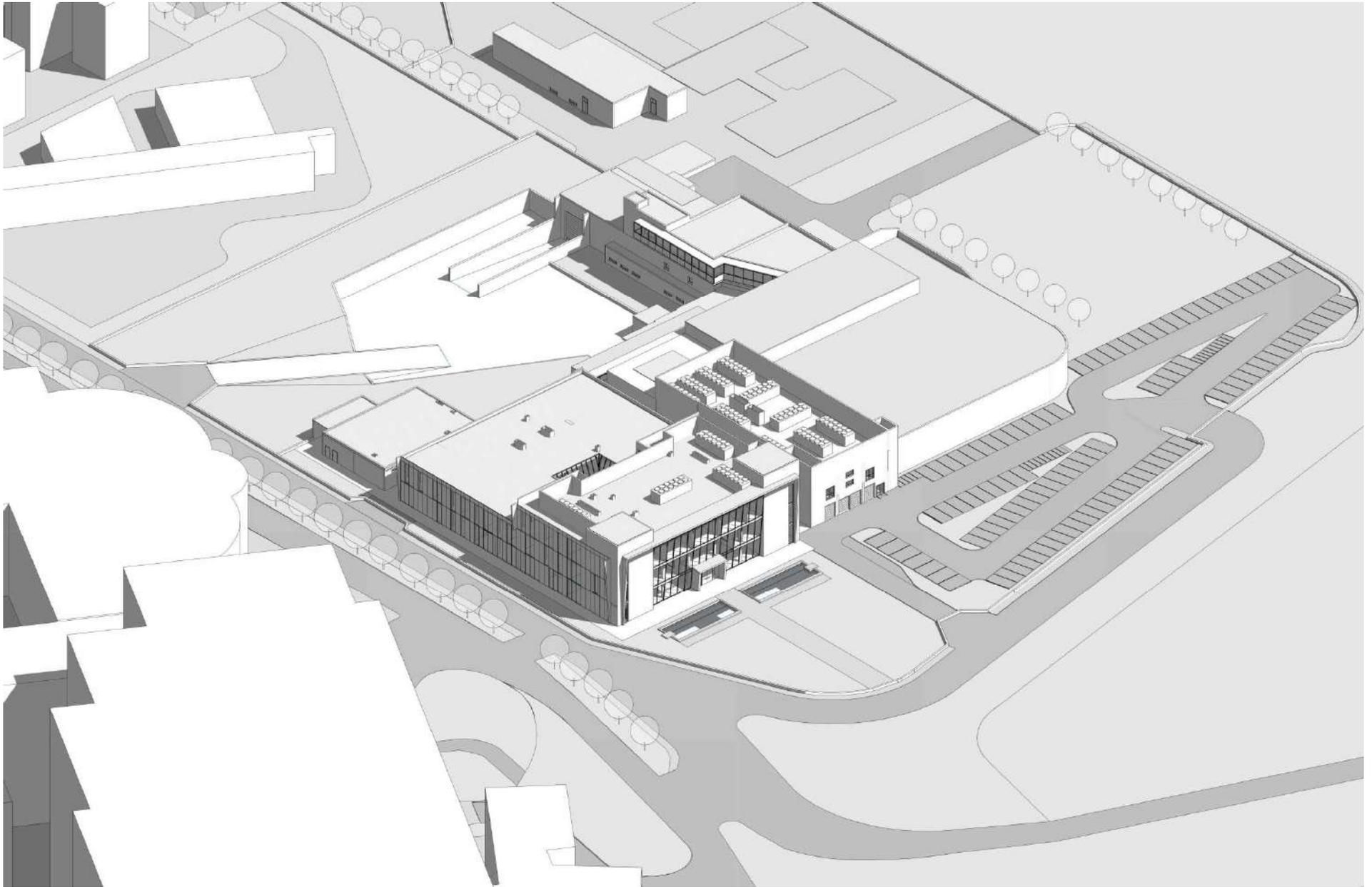
The real challenge:
make ALL systems running together
safely, efficiently, reliably and easily maintainable.



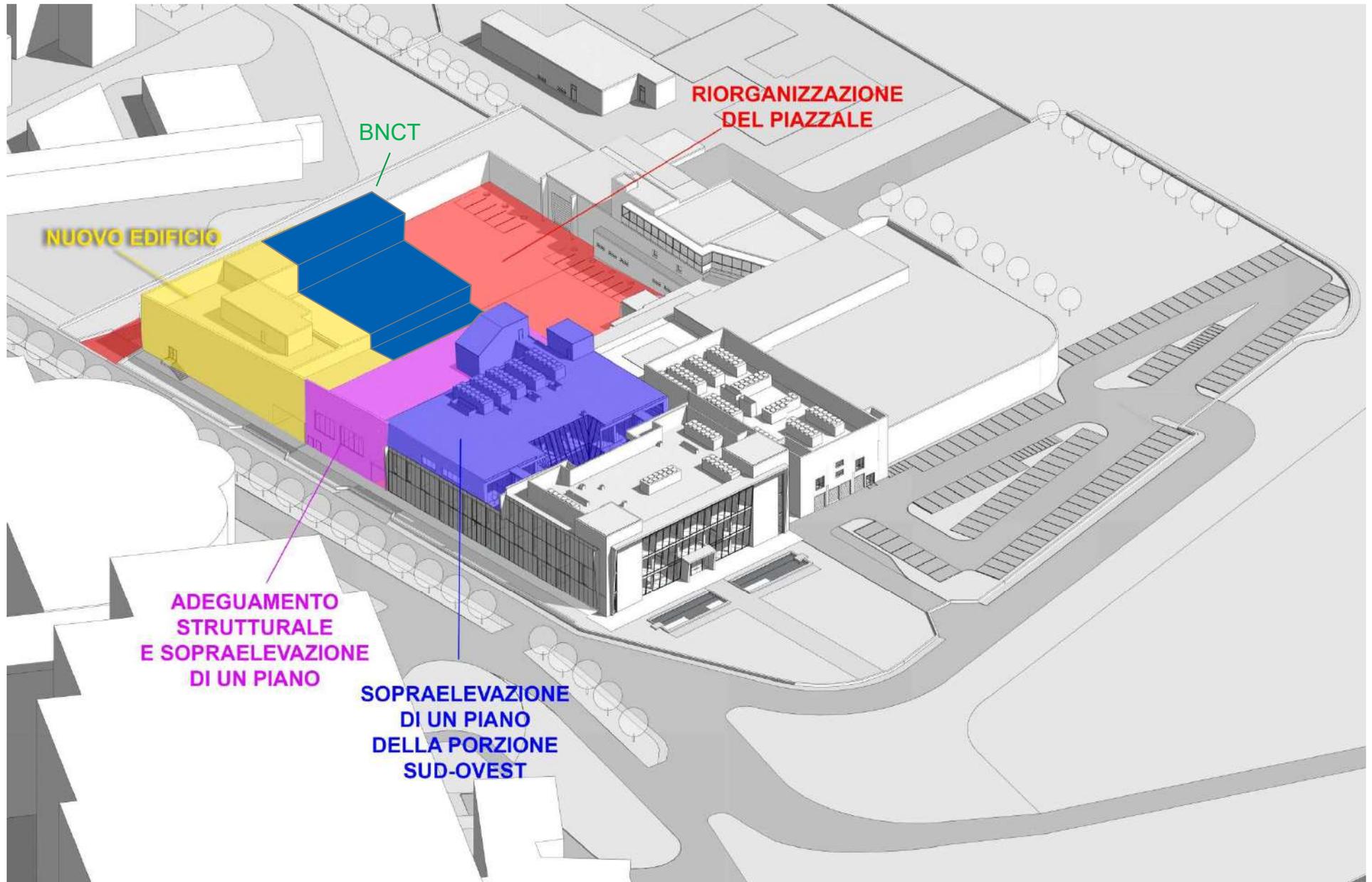
Expansion project: to keep CNAO at cutting edge of the technology



Present

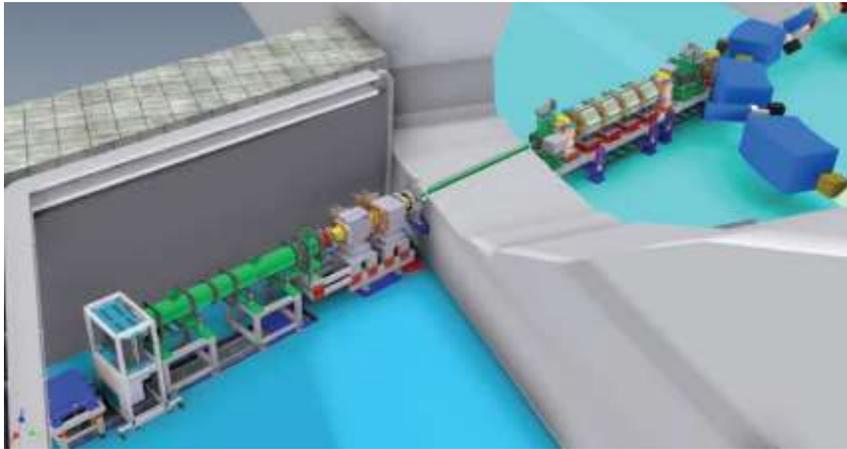


Fully operational end 2023

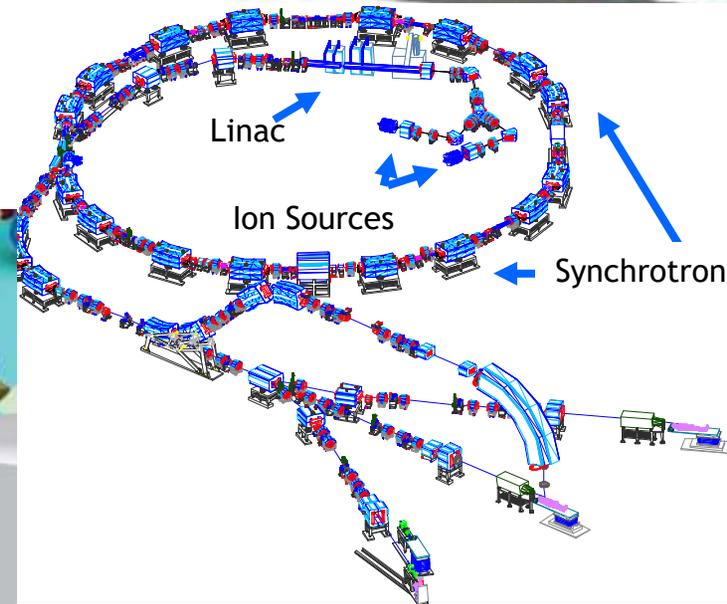


New Research Room

Realized in collaboration with INFN



Ready for external groups (Covid free)



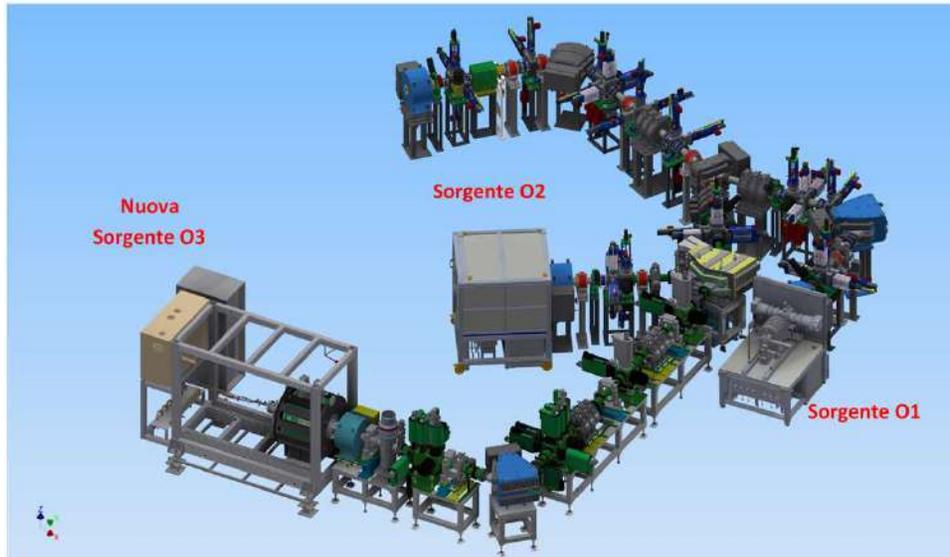
Animal house and other facilities
at Univ. of Pavia (500 m away)

Radiation hardness studies

Radio-biology studies

Third source: **new ion species**

Operational end 2022



Collaboration CNAO-INFN-HiFuture

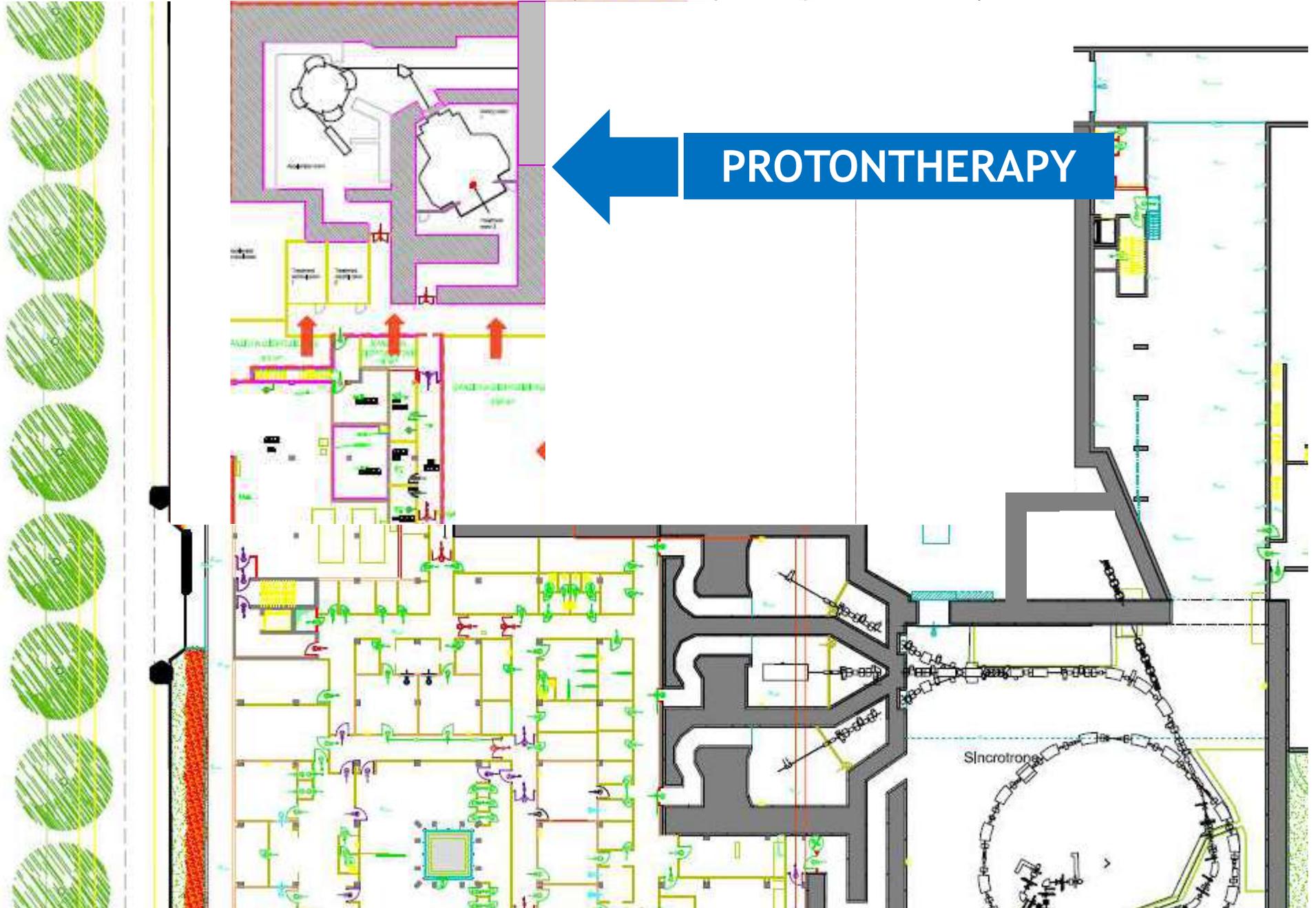
A facility **I**nnovativa di irraggiamento con **S**orgente per **I**oni per **R**icerca e studi di radiation hardness con applicazioni **I**ndus**T**riali e cliniche **I**NS**P**IRIT - ID 1161908

Call HUB ricerca e Innovazione - EU/Regional funds

Beam currents

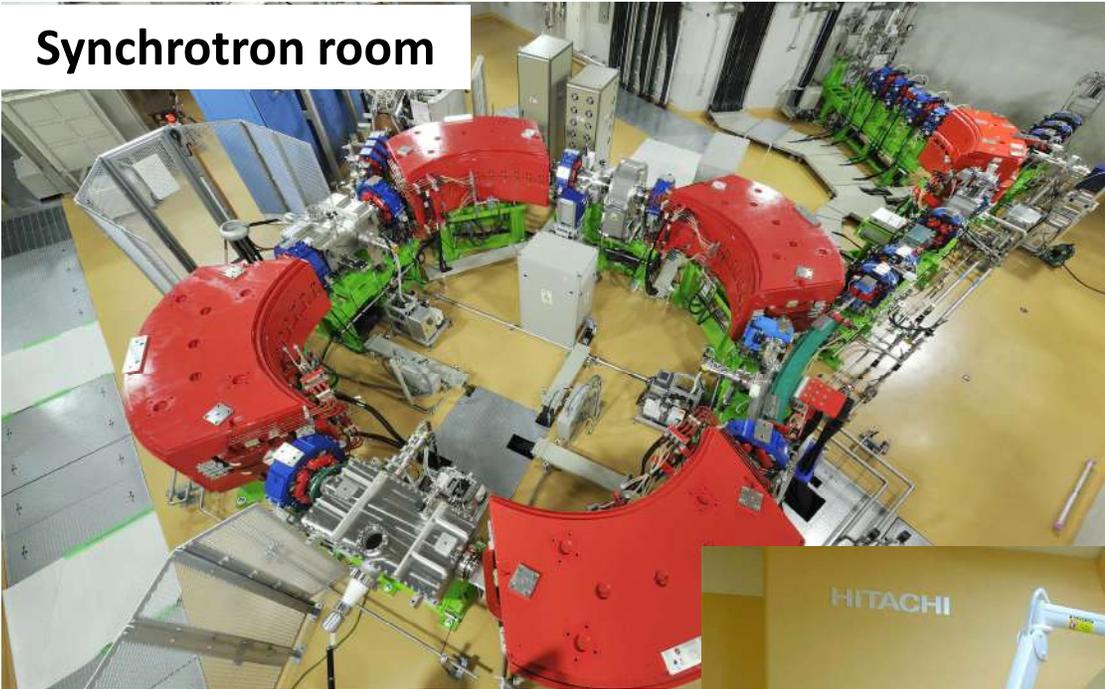
Ion	Supernanogan (14 GHz) euA	AISHa (18 GHz + TFH) euA
H ⁺	2000	4000
H ₂ ⁺	1200	2000
H ₃ ⁺	1000	1500
³ He ⁺	800	2000
¹² C ⁴⁺	250	800
⁶ Li ²⁺ - ⁷ Li ²⁺	//	800
¹⁰ B ³⁺ - ¹¹ B ³⁺	//	600
¹⁸ O ⁶⁺	400	1000
²¹ Ne ⁷⁺	120	500
³⁶ Ar ¹²⁺	20	150

Expansion Area A



New single-room for protons

Synchrotron room



Contract signed with Hitachi:
December 5th, 2019

Operational end 2023

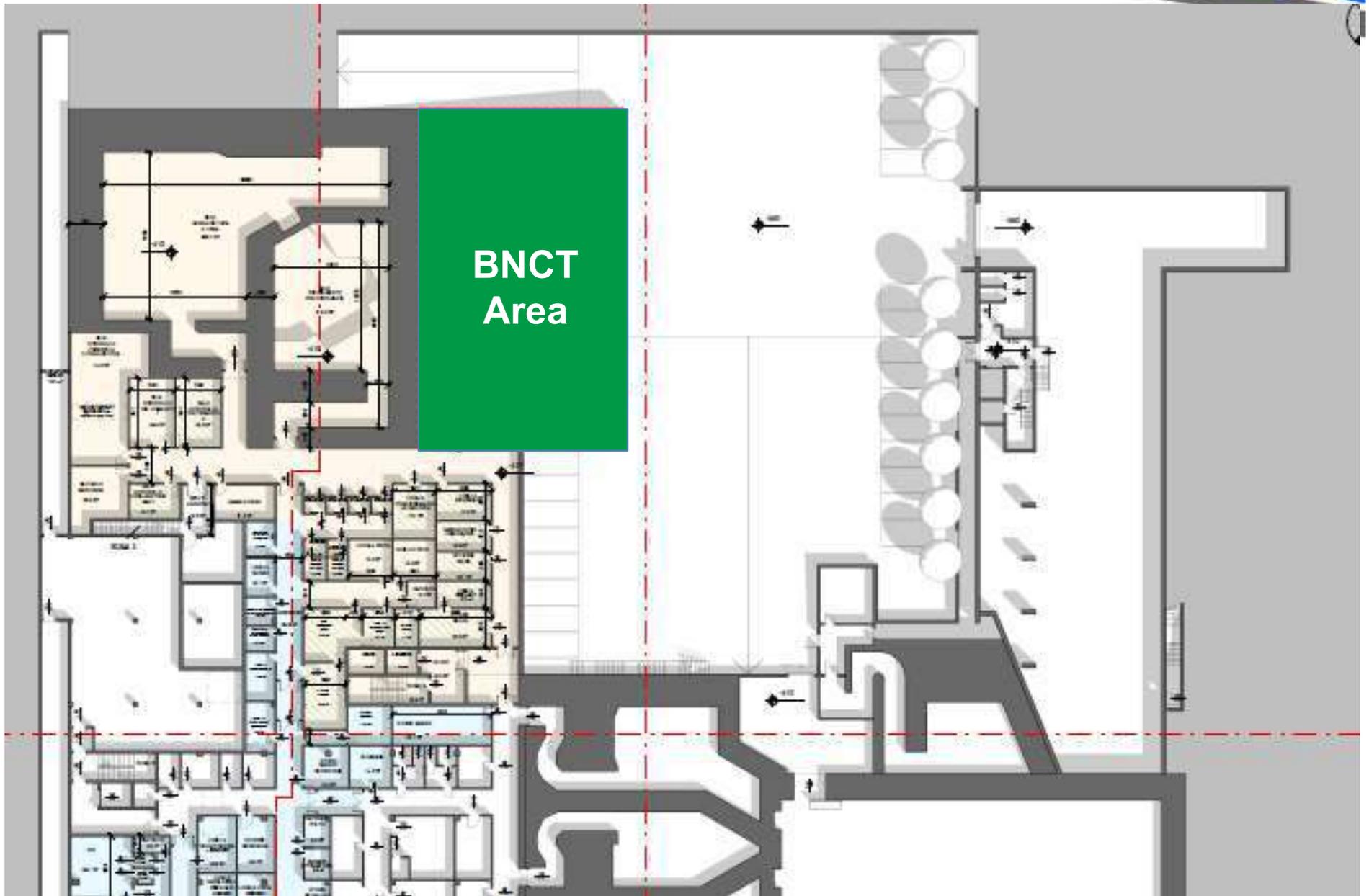


**360° isocentric gantry
(Field size: 30x40 cm²)**

Treatment room



Expansion Area A: integrating BNCT

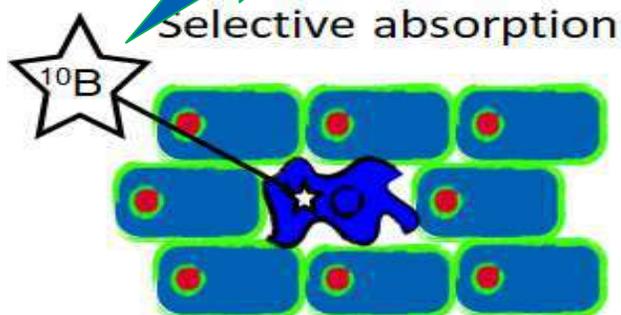


BNCT: Boron Neutron Capture Therapy

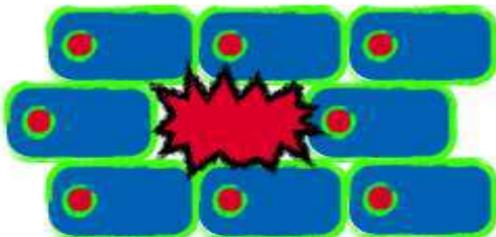
2-steps research approach for metastasized tumours

Boronated drug that selectively reaches the tumour cells and avoids the healthy tissues

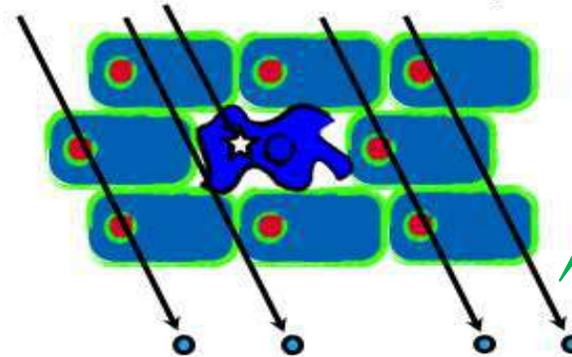
Accelerator driven neutron production



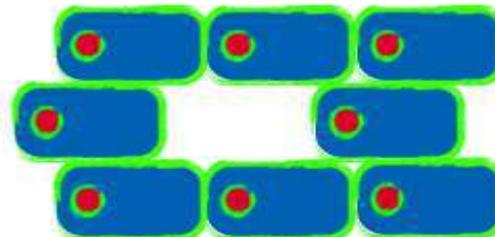
Local energy deposition



$^{10}\text{B}(n,\alpha)^7\text{Li}$
Boron neutron capture



Sparing healthy tissues



BNCT: tandem accelerator

Collaboration agreement signed
September 2020

Operational end 2023



Proton energy 2.5 MeV
Intensity 10-15 mA
p-Li reaction

alpha α beam™

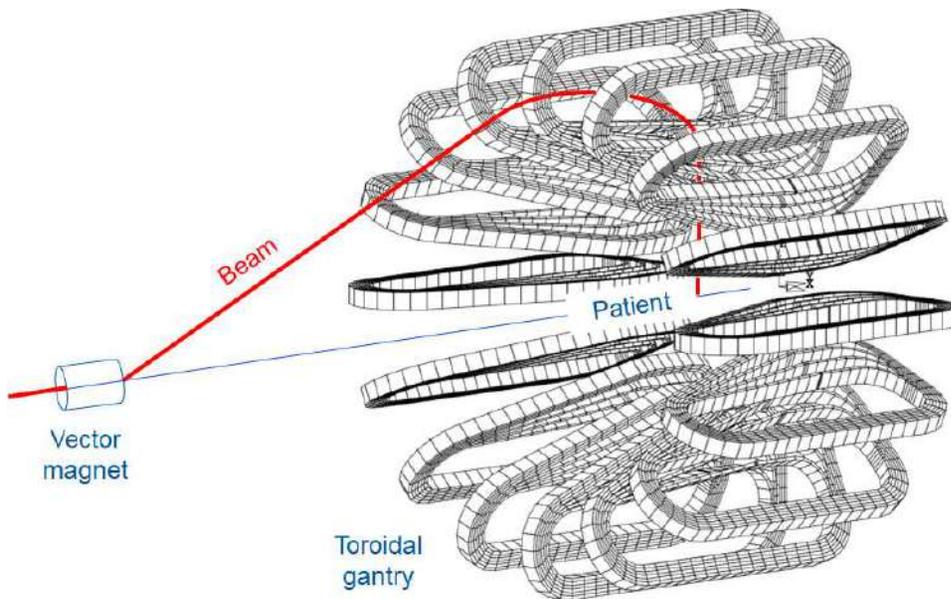
tae LIFE SCIENCES

Research issues: **main topics**

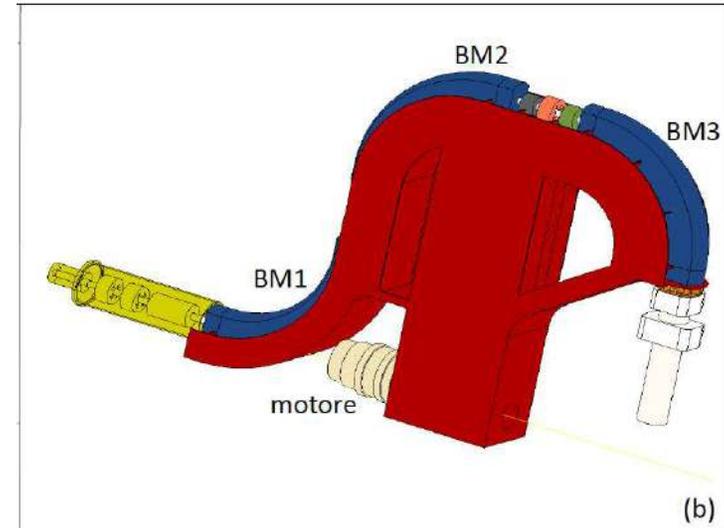
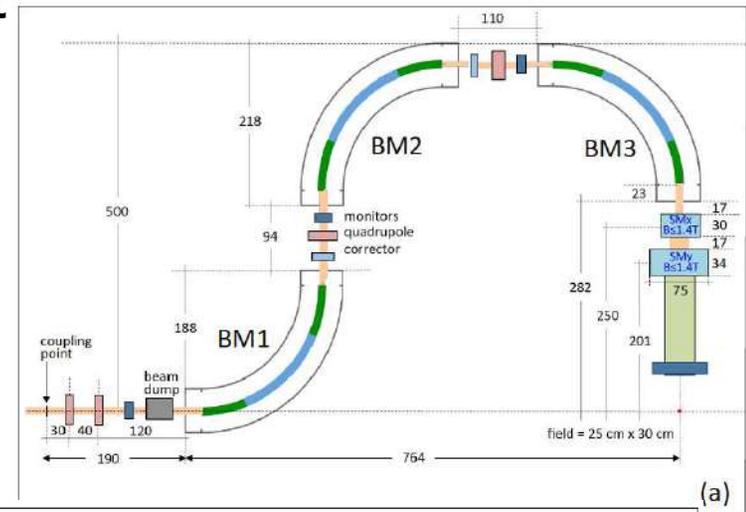


R&D: carbon ions gantry

Collaboration CNAO-INFN-CERN-MedAustron
under discussion: start 2021, 4 years project



Toroidal magnet SC design (L. Bottura/CERN)



TERA-CERN-LBNL (SC canted cosine theta)

Imaging and positioning

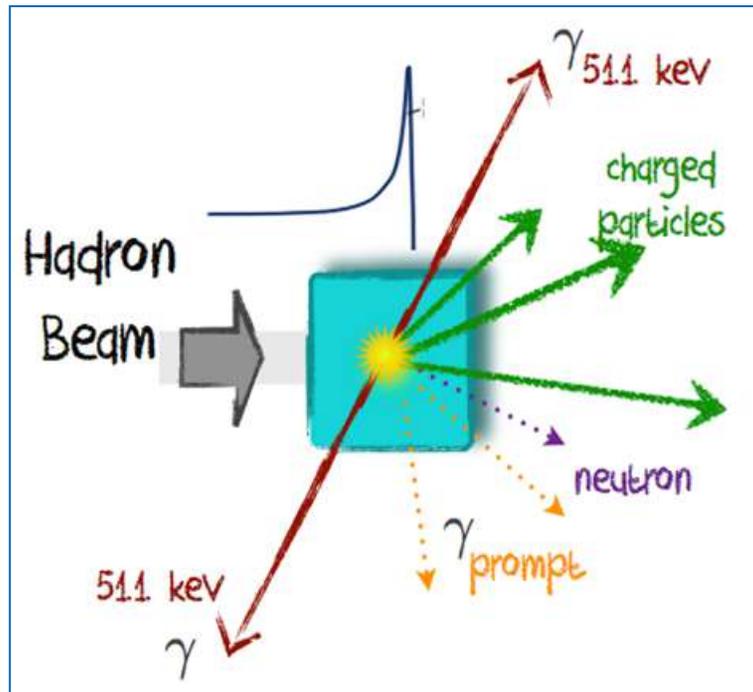
A world of science/technology to master the treatment

- ✓ Off-line imaging to “define target and OARs”
- ✓ Automated patient positioning systems
- ✓ In-room imaging devices for inter/intra-fractional uncertainties detection and compensation
- ✓ Management of moving organs (breathing synch./rescanning)

Goal: tumour tracking in real time

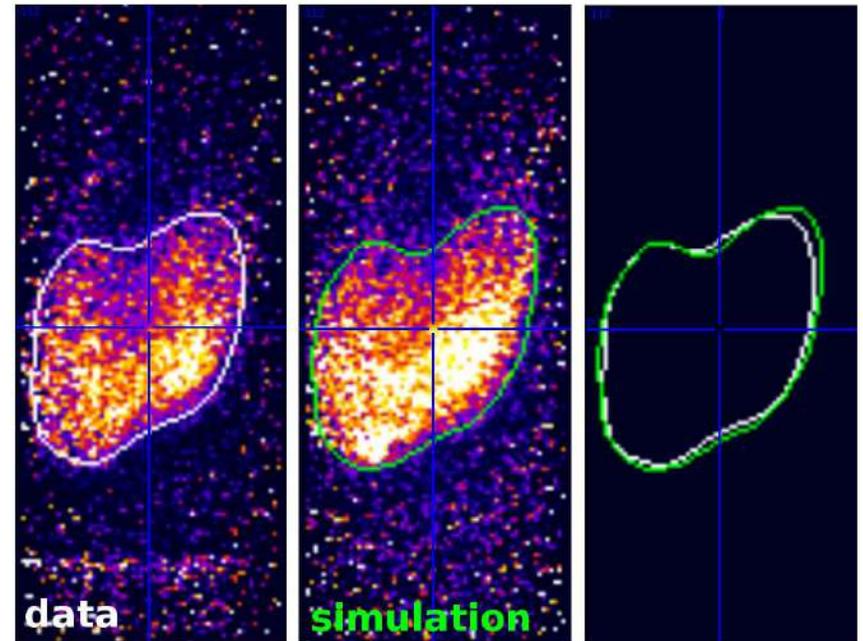


Dose and Beam range monitoring



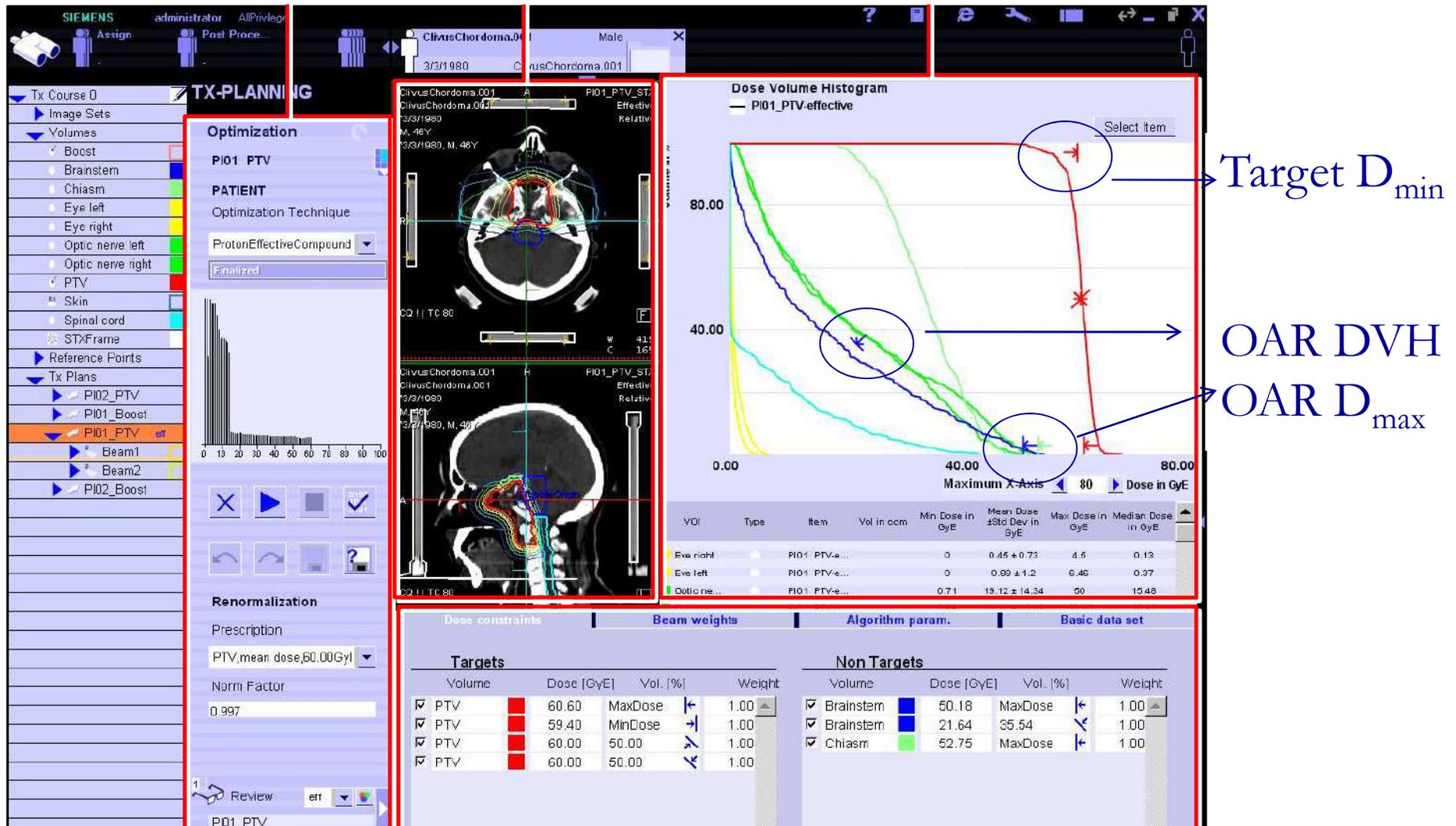
Patient - 01/12/2016
Proton beam
4 min treatment + 1min after

InSide



Goal: dose monitoring and pre-treatment range assessment

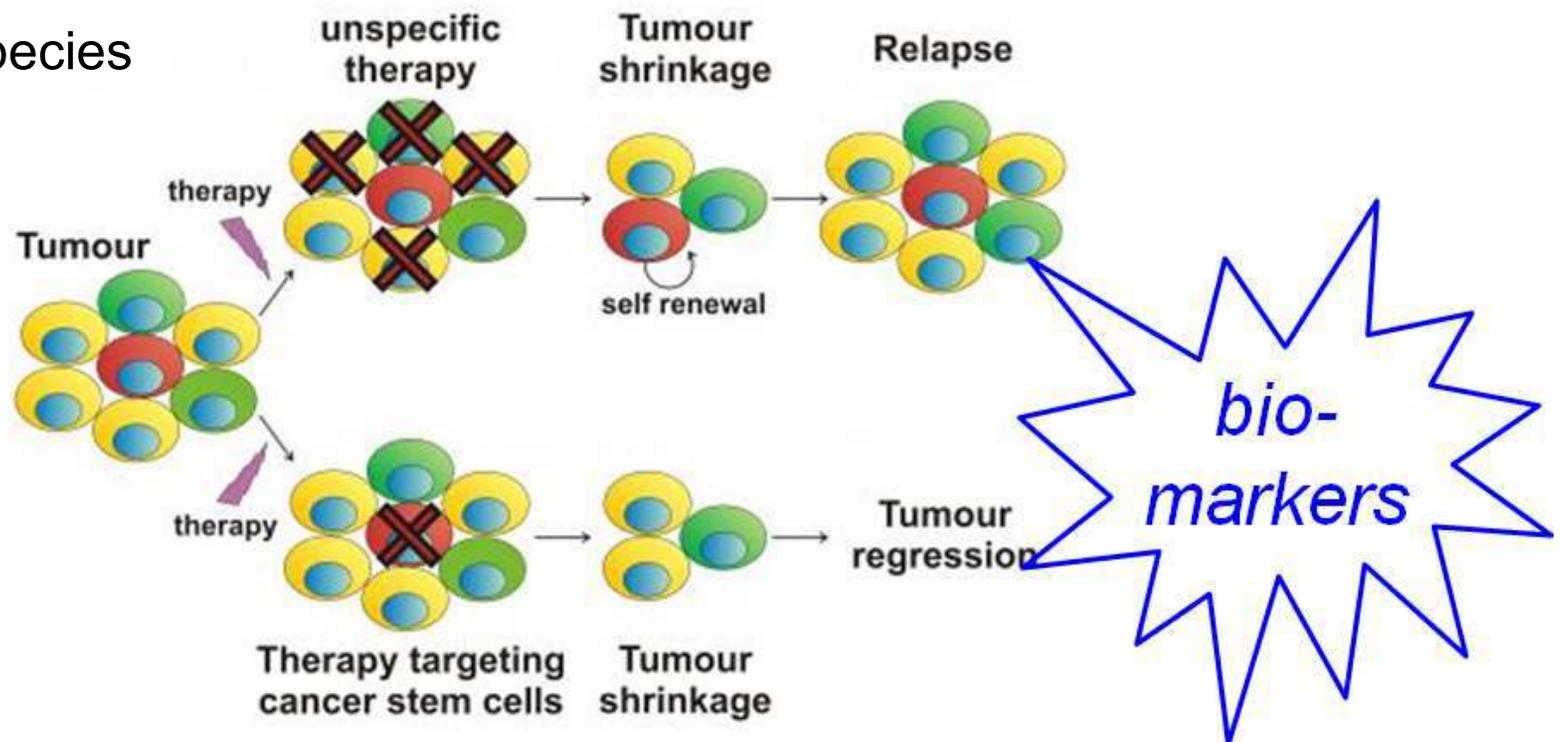
Dose optimization algorithm (+ Monte Carlo)



Need to include management of moving organs and integration of in-room imaging
Goal: robust and adaptive planning on a daily basis

Radiobiology pre-clinical Research

- Mechanisms of radioresistance
- Healthy tissues and microenvironment response
- Effects of high let radiation in combination with other therapeutic modalities
- Low doses effects
- Other ion species
- Late effects
- ...



Clinical Research

New clinical protocols

New particles

Particles + immunotherapy = ???

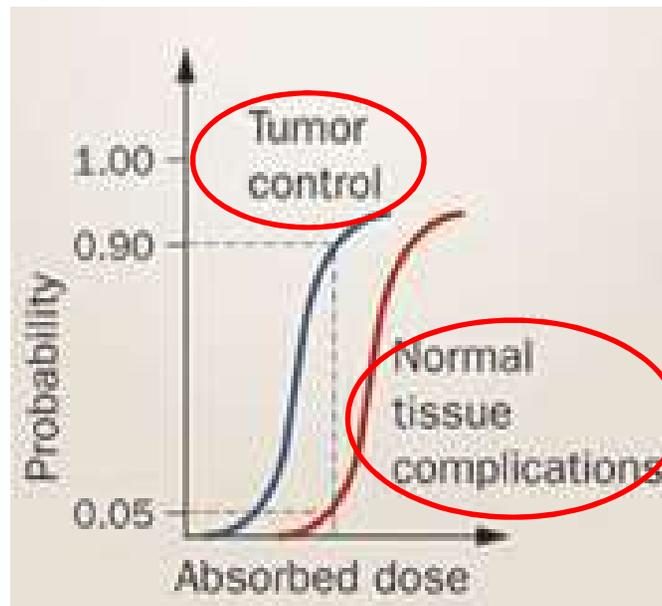
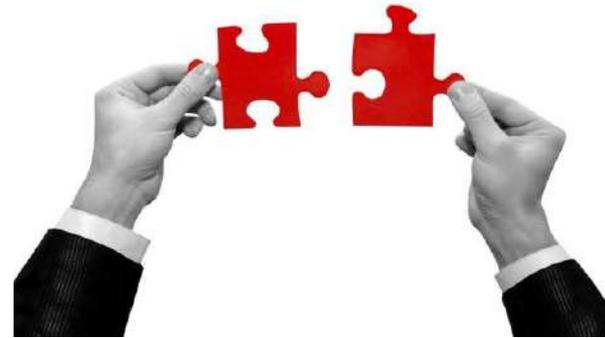
Particles + radiosensitizers = ???

Particles + chemotherapics = ???

Particles + photons = ???

Particles + = ???

Flash effects



HITRI*plus* aims to integrate and propel biophysics and medical research on cancer treatment with heavy ions beams while jointly developing its sophisticated instruments.

Share our vision and collaborate with us !!!

Thank you !