HITRI*plus*
Heavy Ion Therapy Research Integration

HITRI*plus* overview and CNAO experience and opportunities

Sandro Rossi
Director General - CNAO Foundation
HITRI*plus* Coordinator

SC SEEIIST – Thessaloniki 4 April 2022

CNAO
Centro Nazionale di Adroterapia Oncologica

HITRI – Hadron Ion Therapy Research Infrastructure
Design Study Proposal – EU H2020 INFRADEV-01-2019-2020 call

TIARA prepared to give advice

HITRI Consortium

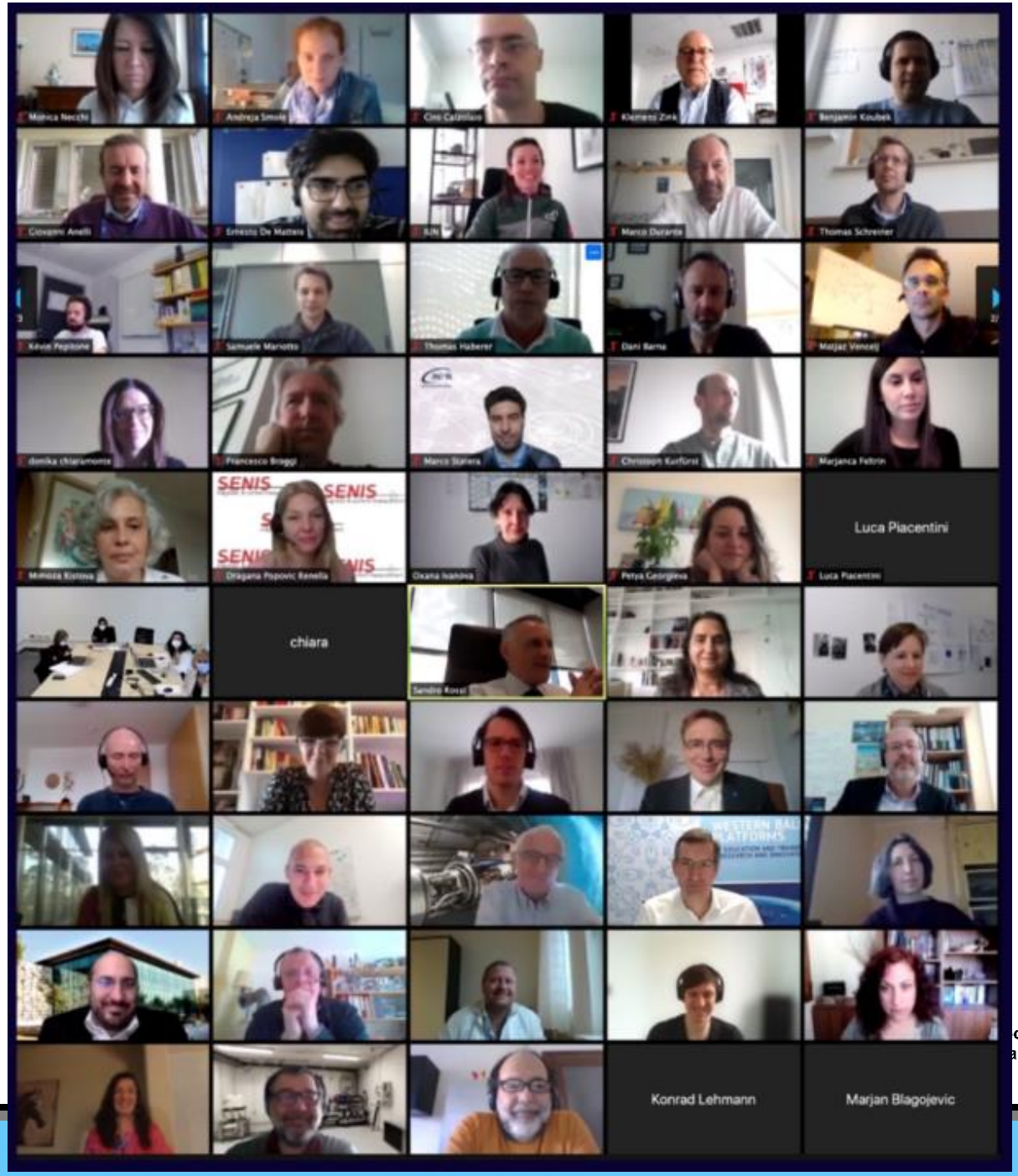
Several beneficiaries from SEE Region through SEEIIST

HITRIplus PARTNERS

CNAO
BEVATECH
cea
CERN European Organisation for Nuclear Research
Laboratorio Nacional de Fusión Ciemat
COSYLAB
GSI Helmholtzzentrum für Schwerionenforschung
INFN Istituto Nazionale di Fisica Nucleare
MedAustron
PAUL SCHERRER INSTITUT PSI
1862 RIGA TECHNICAL UNIVERSITY
SEE ST South East European International Institute for Sustainable Technologies
UKGM UNIVERSITÄTSKLINIKUM GIESSEN UND MARBURG
UNIVERSITÄTSKLINIKUM HEIDELBERG
L-Università ta' Malta
Philipps Universität Marburg
UPPSALA UNIVERSITET UPPSALA UNIVERSITY SWEDEN
wigner
KLINIČKI CENTAR Crne Gore
Jožef Stefan Institute
SENTRONIS a SENIS company magnetic & current measurement
Cyril and Methodius University in Skopje

HITRIplus
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 101008548



April 13, 2021
Kick off Meeting

Duration: 4 years
Funded 5 mEuro

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

HITRI*plus* Objectives

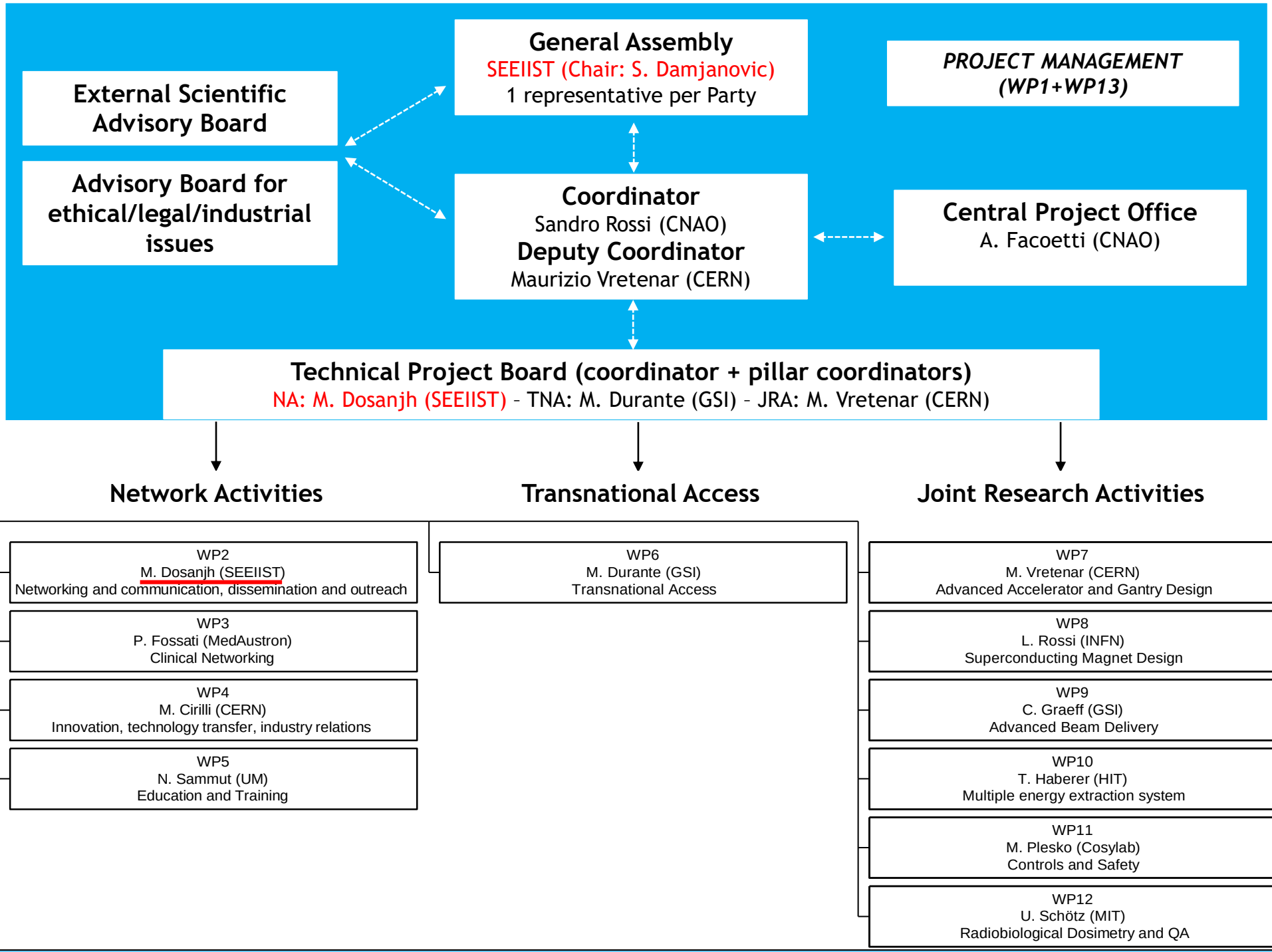
1. To **integrate, open up** and **broaden** the leading European Research Infrastructure for the treatment of cancer with **beams of ions,** ranging from helium to carbon and to heavier ions.

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.


General Assembly
SEEIIST (Chair: S. Damjanovic)
1 representative per Party
PROJECT MANAGEMENT
(WP1+WP13)
External Scientific Advisory Board
Advisory Board for ethical/legal/industrial issues
Coordinator
Sandro Rossi (CNAO)
Deputy Coordinator
Maurizio Vretenar (CERN)
Central Project Office
A. Facoetti (CNAO)
Technical Project Board (coordinator + pillar coordinators)
NA: M. Dosanjh (SEEIIST) – TNA: M. Durante (GSI) – JRA: M. Vretenar (CERN)
Network Activities
Transnational Access
Joint Research Activities
WP2
M. Dosanjh (SEEIIST)
Networking and communication, dissemination and outreach
WP3
P. Fossati (MedAustron)
Clinical Networking
WP4
M. Cirilli (CERN)
Innovation, technology transfer, industry relations
WP5
N. Sammut (UM)
Education and Training
WP6
M. Durante (GSI)
Transnational Access
WP7
M. Vretenar (CERN)
Advanced Accelerator and Gantry Design
WP8
L. Rossi (INFN)
Superconducting Magnet Design
WP9
C. Graeff (GSI)
Advanced Beam Delivery
WP10
T. Haberer (HIT)
Multiple energy extraction system
WP11
M. Plesko (Cosylab)
Controls and Safety
WP12
U. Schötz (MIT)
Radiobiological Dosimetry and QA

SEEIIST's role in HITRI*plus*

WP1 - Project Management *(Manjit Dosanjh , Petya Georgieva)*
Task 1.2: Scientific and Technical Management
Task 1.3: Coordination of Participants, Communication and Meeting Organisation
WP2 - NA1 - Networking and communication, dissemination and outreach (leader) *(Manjit Dosanjh, Petya Georgieva)*
Task 2.1: Coordination of Communication tools
Task 2.2: Building the user community

SEEIIST beneficiary and responsible of 17% of the HITRI*plus* budget (845 kEuro)

Task 7.2: Synchrotron and Advanced Components Design
Task 7.3: Operational modes, beam transport and instrumentation
Task 7.4: Injector Linac Design
Task 7.5: Integration of an innovative superconducting gantry: optics, mechanics, beam delivery
WP8 - JRA2 - Superconducting magnet design *(Sentronis as collaborating Institute)*
Task 8.4: Construction of a small size magnet demonstrator for accelerator and gantry
WP11 - JRA5 - Controls and Safety (*Jožef Stefan Institute as collaborating Institute)*
Task 11.2: Machine controls

WP1: Management
WP13: Ethics Requirement

WP2: Networking and Communication, Dissemination and Outreach

WP3: Clinical networking

WP4: Innovation, technology transfer, industry relation

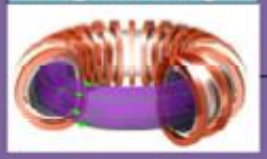
WP5: Education and Training

JRA
Joint Research Activities

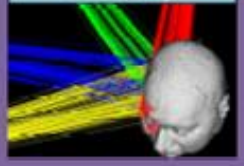
TNA
WP6
Transnational Access

WP7: Advanced accelerator and gantry design

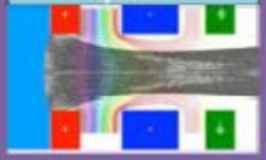
WP8: Superconducting magnets design



WP9: Advanced beam delivery

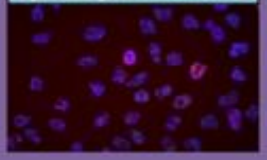


WP10: Multiple energy extraction system



WP11: Controls and safety

WP12: Radiobiology and quality assurance

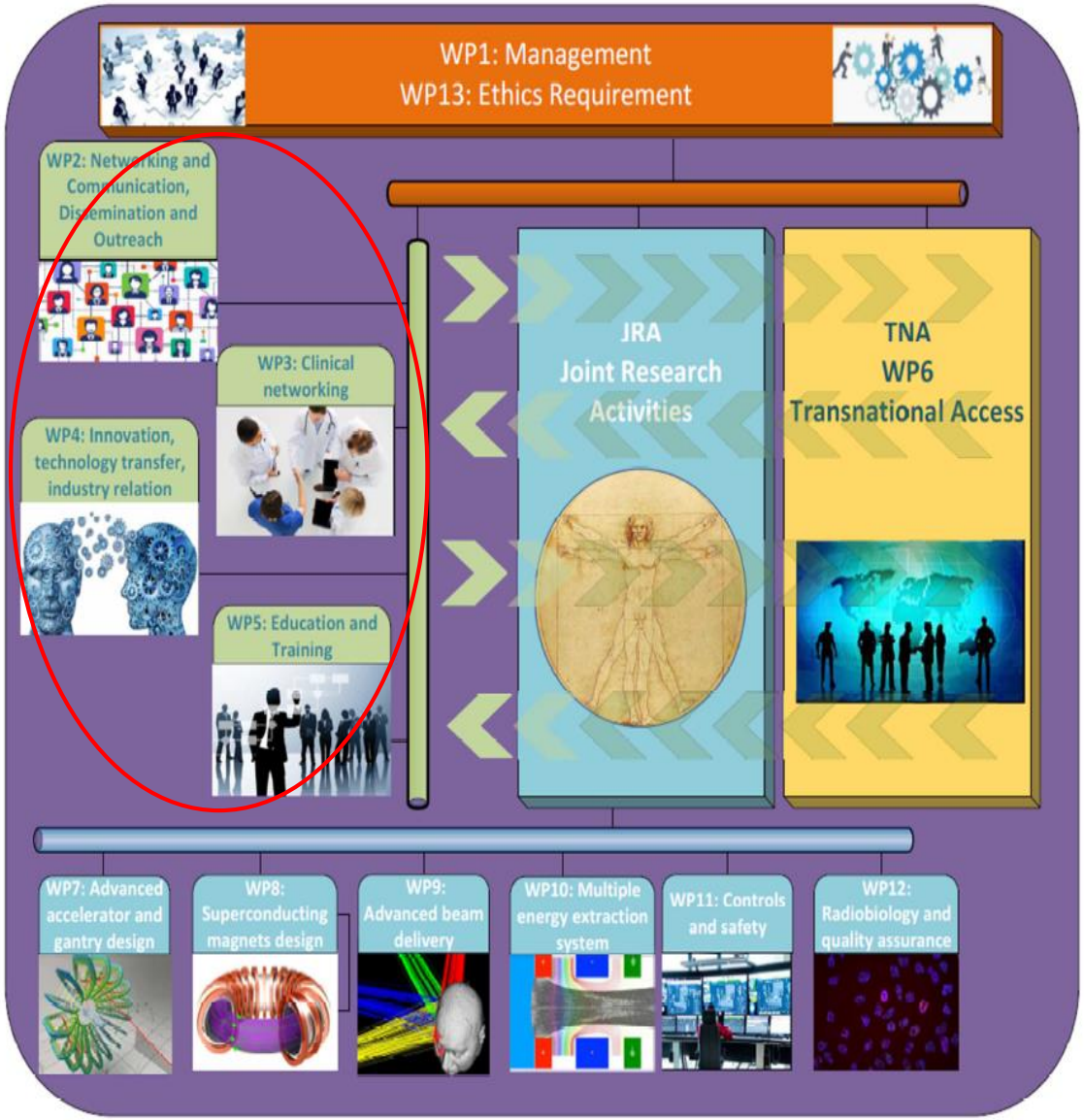


WP6: Transnational Access

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

www.hitriplus.eu

Big opportunity for SEEIIST Members!!!



Networking Activities: communication, dissemination and outreach, clinical networking, innovation technology transfer and industry relations, education and training;

Transnational Access: to promote the access to the existing facilities of the research and clinical communities;

Joint Research Activities: improved accelerator and gantry design, superconducting magnet design, advanced beam delivery, multiple energy extraction system, controls and safety, radiobiological dosimetry and Quality Assurance.

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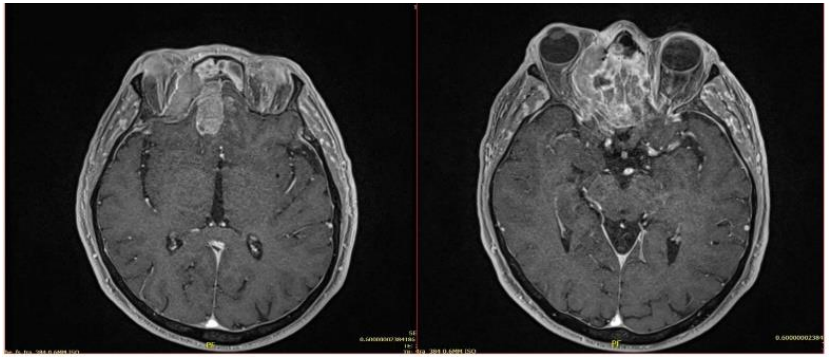
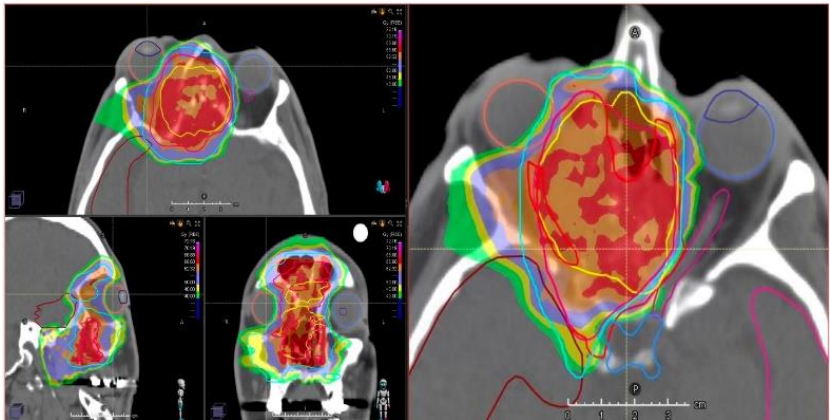
WP2: Network and Communication Dissemination and Outreach

HITRI*plus* monthly seminars

WP3: Clinical networking

- ✓ Design **one trial** as a template for bringing innovative heavy ion therapy approaches in the clinics
- ✓ Set up a **European registry** to collect data on rare cancers treated with heavy ion therapy
- ✓ Review existing data on **OARs dose costraints** in use in the clinical facilities



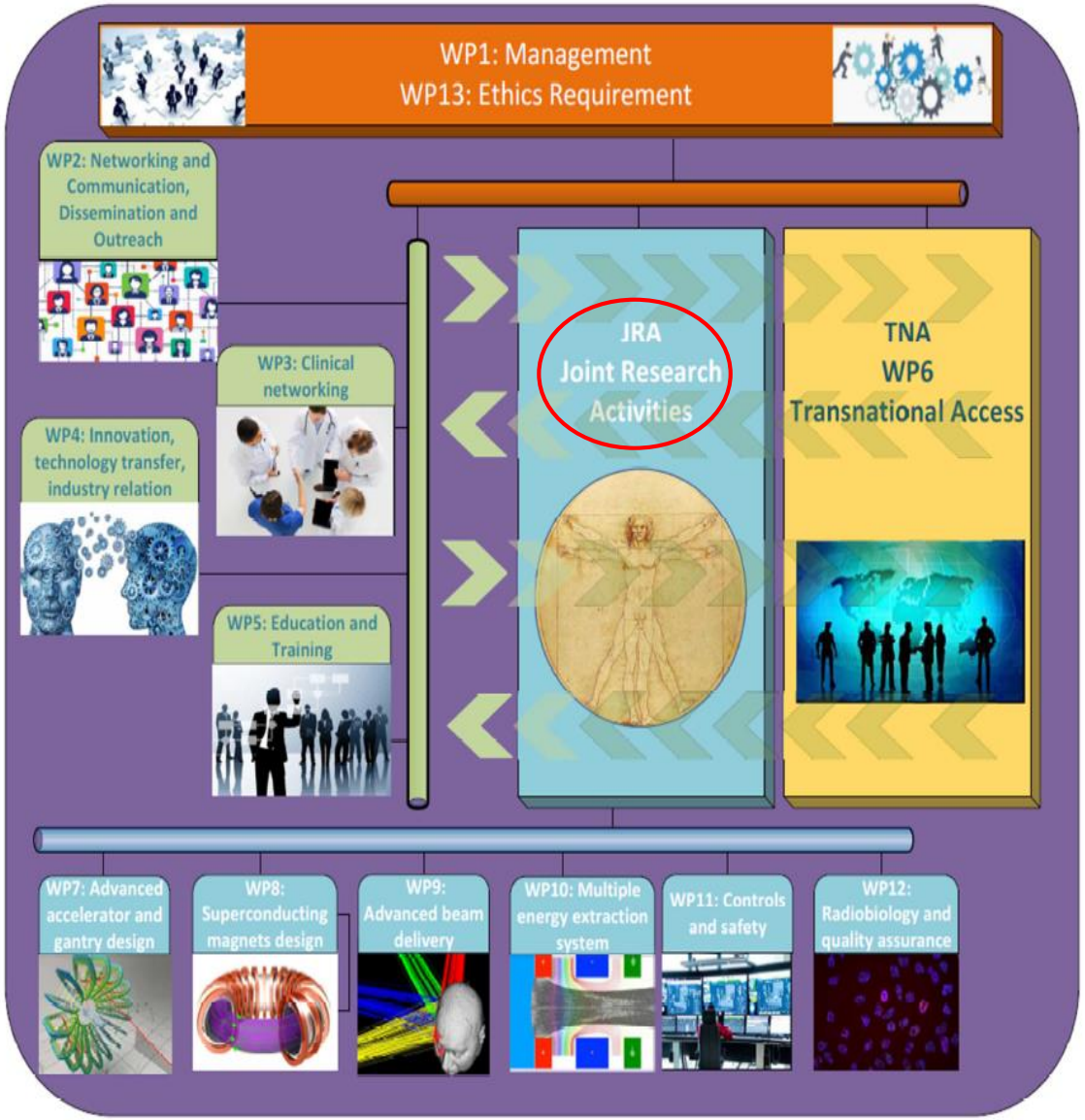


WP4: Innovation, technology transfer, industry relation

WP5: Education and training

Secondments & Internships

- ✓ Postgraduate students, postdocs, academic researchers, industrial researchers, oncology practitioners
- ✓ Provide first-class unique scientific opportunity to join day-to-day work of research teams and participate in experiments to learn best practices
- ✓ Enable participants to become facility users
- ✓ 45 weeks of grants
- ✓ 3+2 positions starting soon



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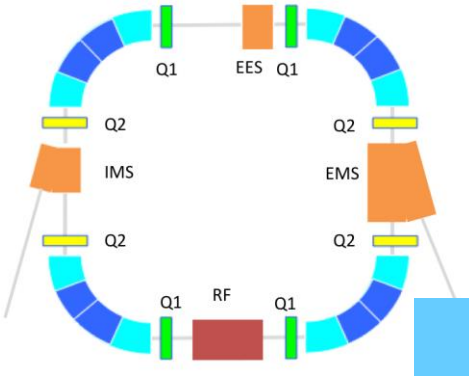
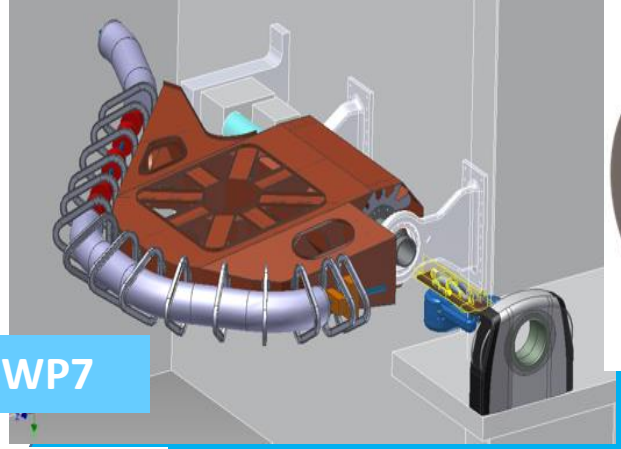
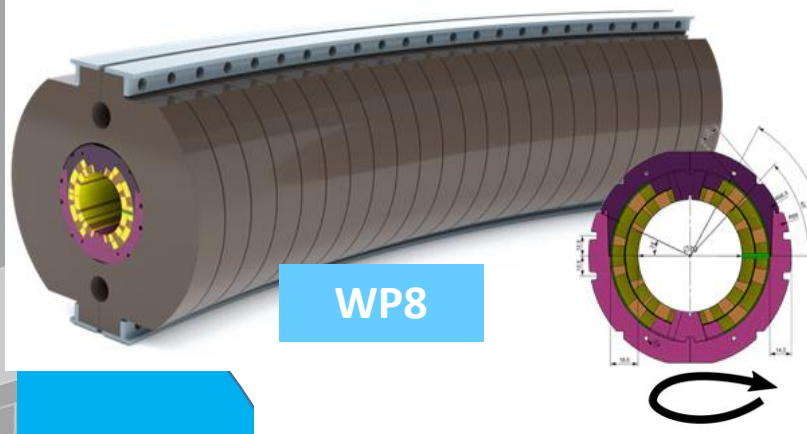


WP7

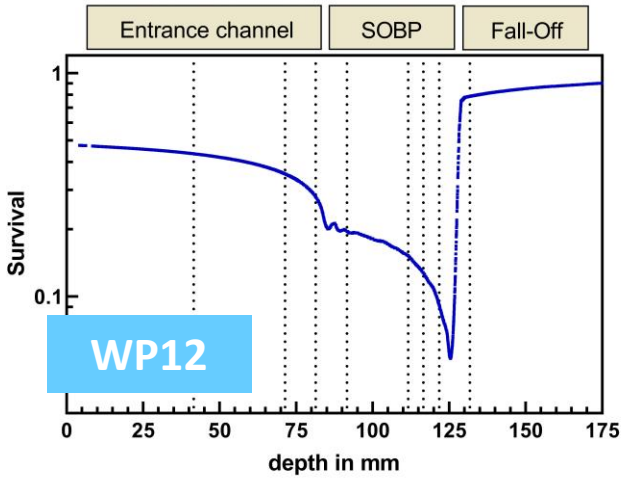




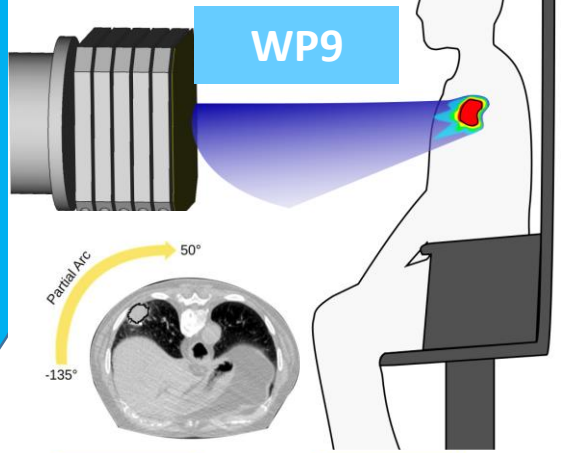
WP8

HITRI*plus*

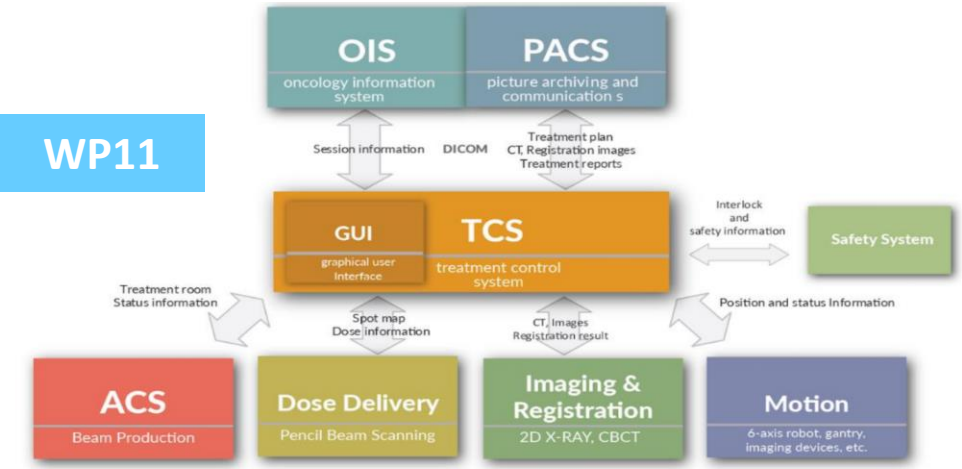
JRA



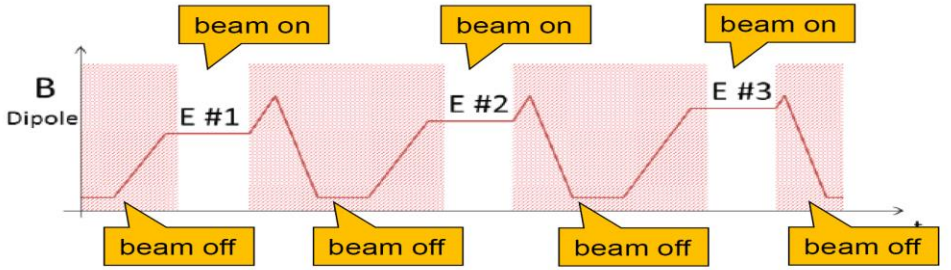
WP12

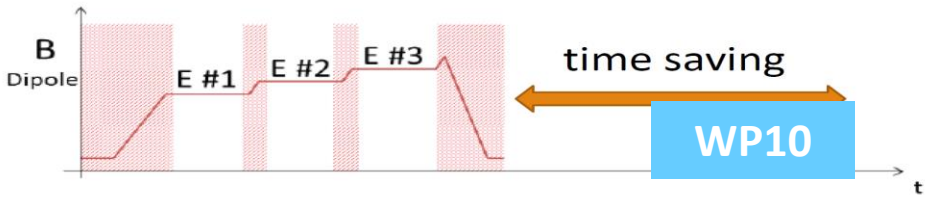


WP9



WP11





WP10

Not-for-profit private Foundation

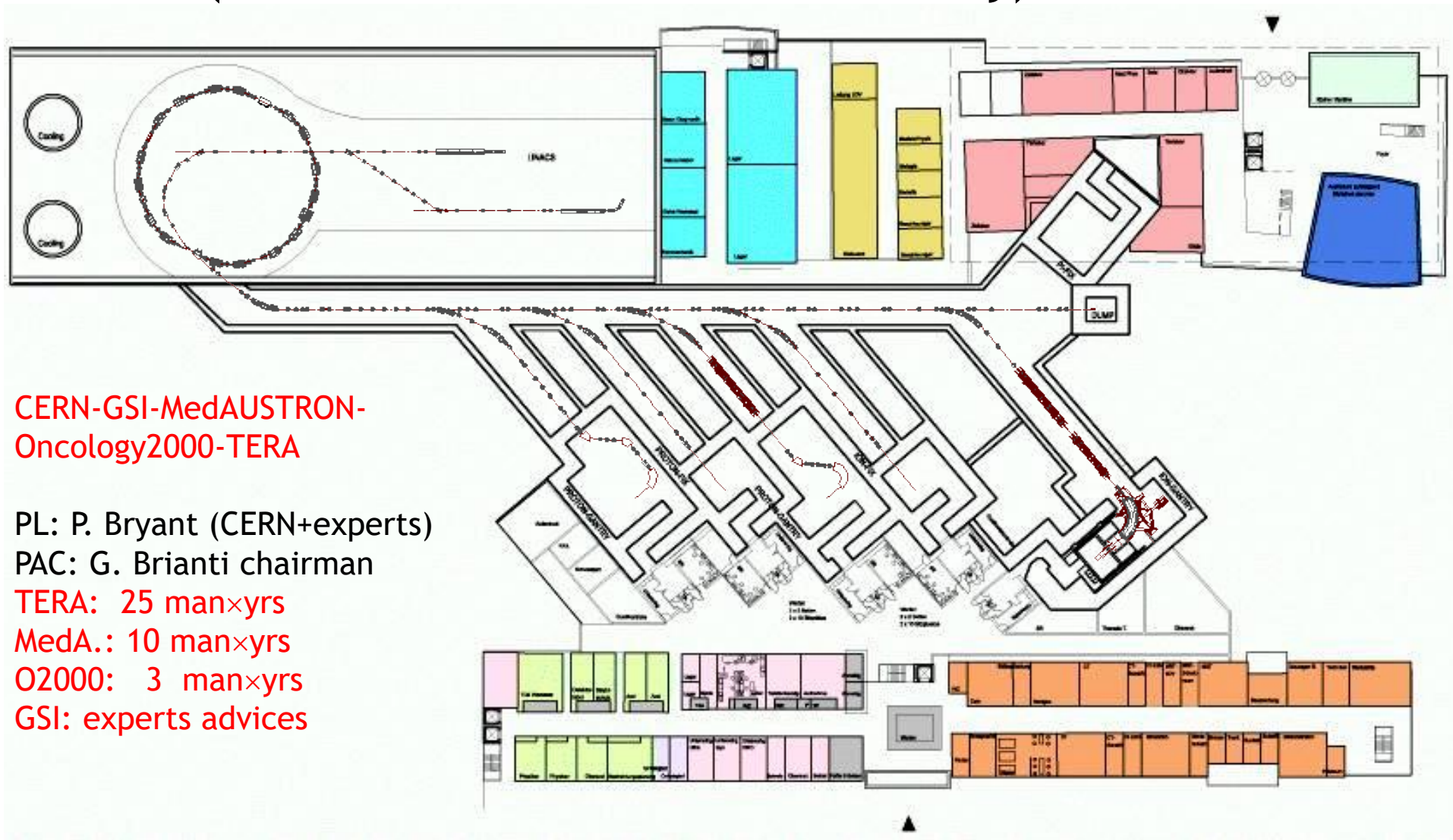
Created by the Italian Ministry of Health in 2001

with the purpose to build and run a hadrontherapy Centre

Organization Accredited
by Joint Commission International

From 1996 to 1999 at CERN

PIMMS (Proton-Ions Medical Machine Study)



CERN-GSI-MedAUSTRON-
Oncology2000-TERA

PL: P. Bryant (CERN+experts)
PAC: G. Brianti chairman
TERA: 25 man×yrs
MedA.: 10 man×yrs
O2000: 3 man×yrs
GSI: experts advices

Objective: define the optimal hadrontherapy centre without constraints

Collaboration agreements: fundamental contracts for construction and presently for technology R&D

NATIONAL

TERA Foundation: final design and high tech specifications

INFN: technical issues, radiobiology, research, formation

University of Milan: medical coordination and formation

University of Pavia: technical issues, radiobiology, formation

Polytechnic of Milan: patient positioning, radioprotection, authorisations

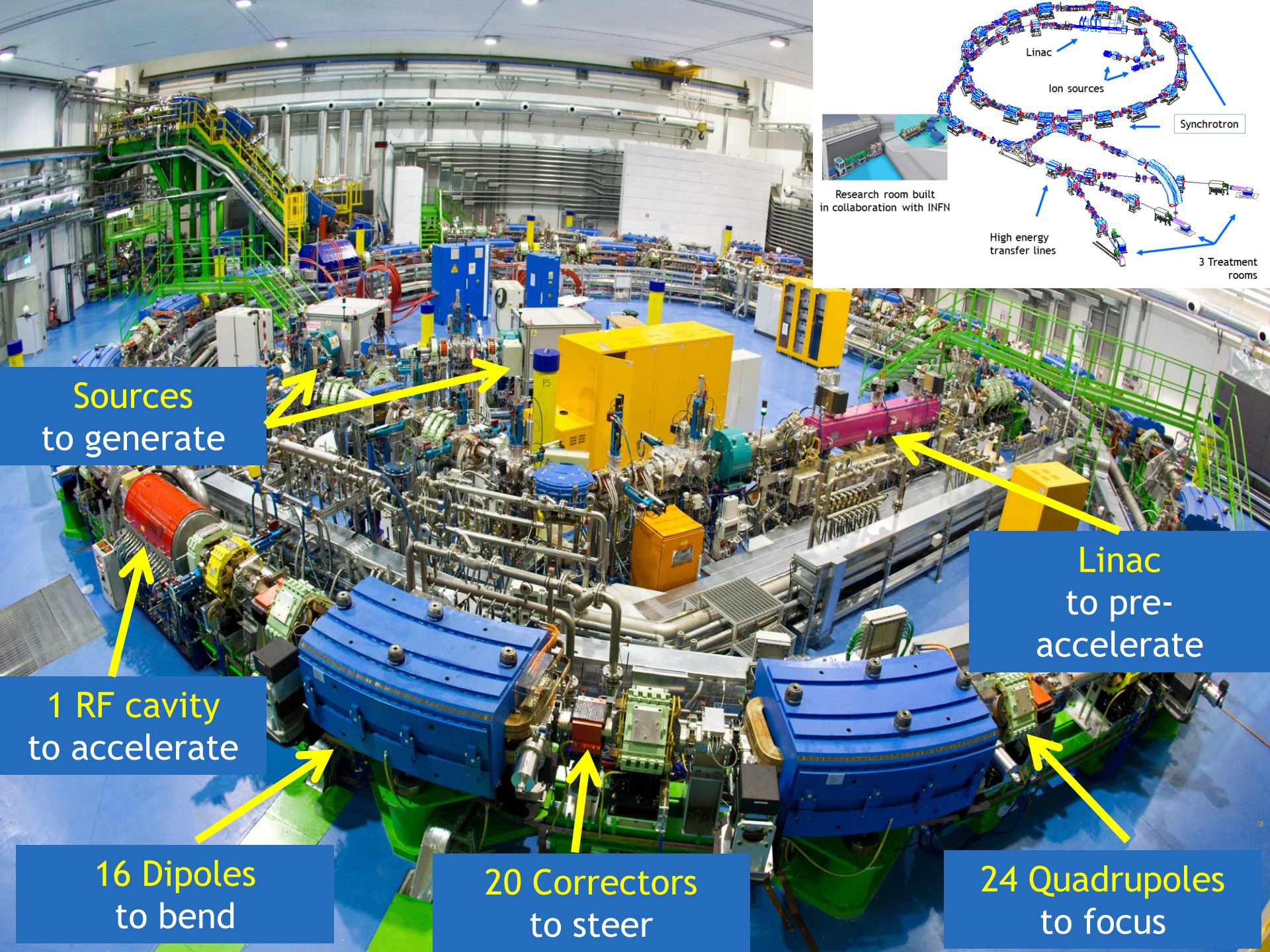
INTERNATIONAL

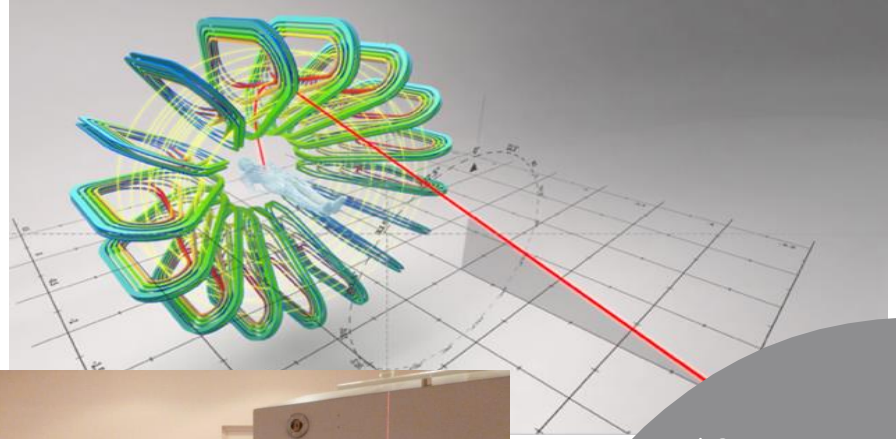
CERN (Geneva): technical tasks, PIMMS

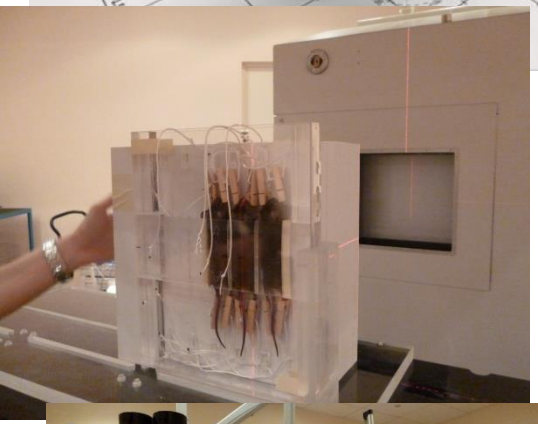
GSI (Darmstadt): linac and special components

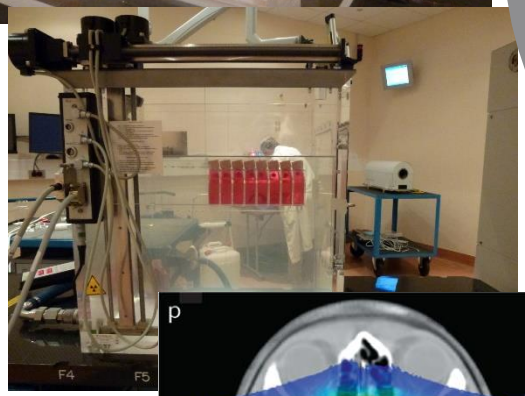
LPSC (Grenoble): technical tasks

NIRS (Chiba): medical activities, radiobiology, formation


Linac
Ion sources
Synchrotron
Research room built
in collaboration with INFN
High energy
transfer lines
3 Treatment
rooms
Sources
to generate
Linac
to pre-
accelerate
1 RF cavity
to accelerate
16 Dipoles
to bend
20 Correctors
to steer
24 Quadrupoles
to focus







The *Hadron School*

(PhD Courses IUSS-CNAO)

Medicine and Biology

Physics and Engineering

Risk and complexity in high-tech medical innovation

Management and Innovation

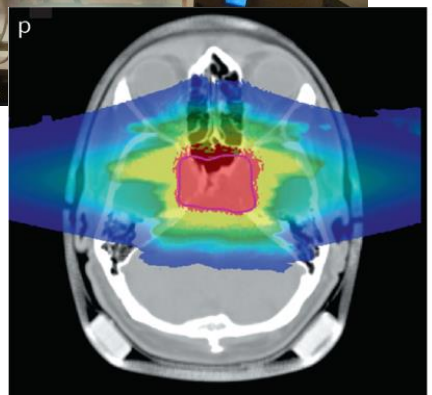
Research

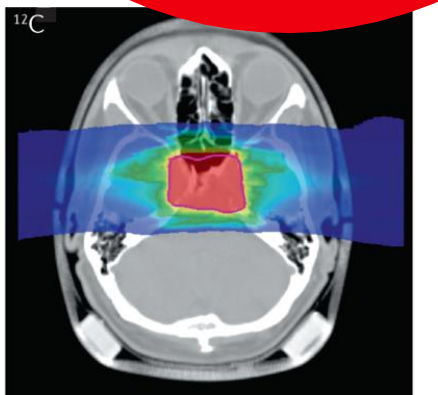
Post-graduate Education

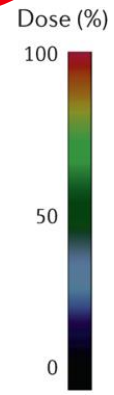
Clinical Activities

CNAO

Centro Nazionale di Adroterapia Oncologica

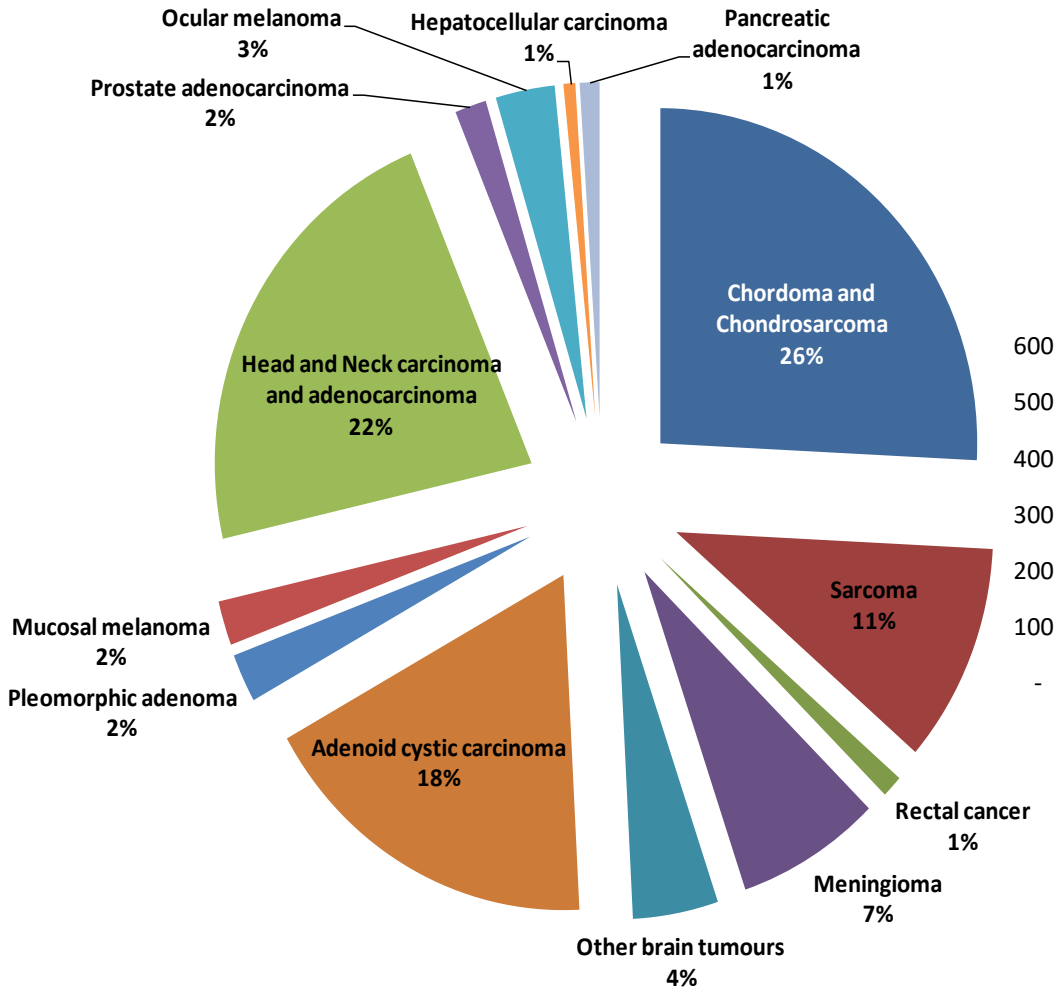


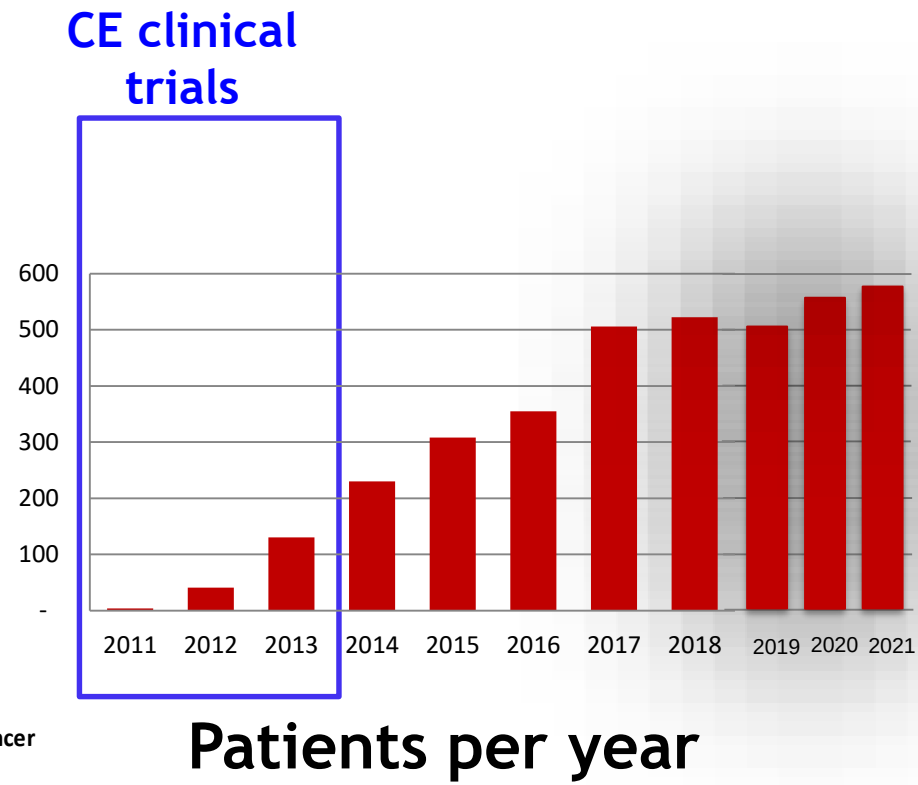




Patients treated at CNAO: 3900

55% carbons - 45% protons





Experimental programmes (besides clinical trials)

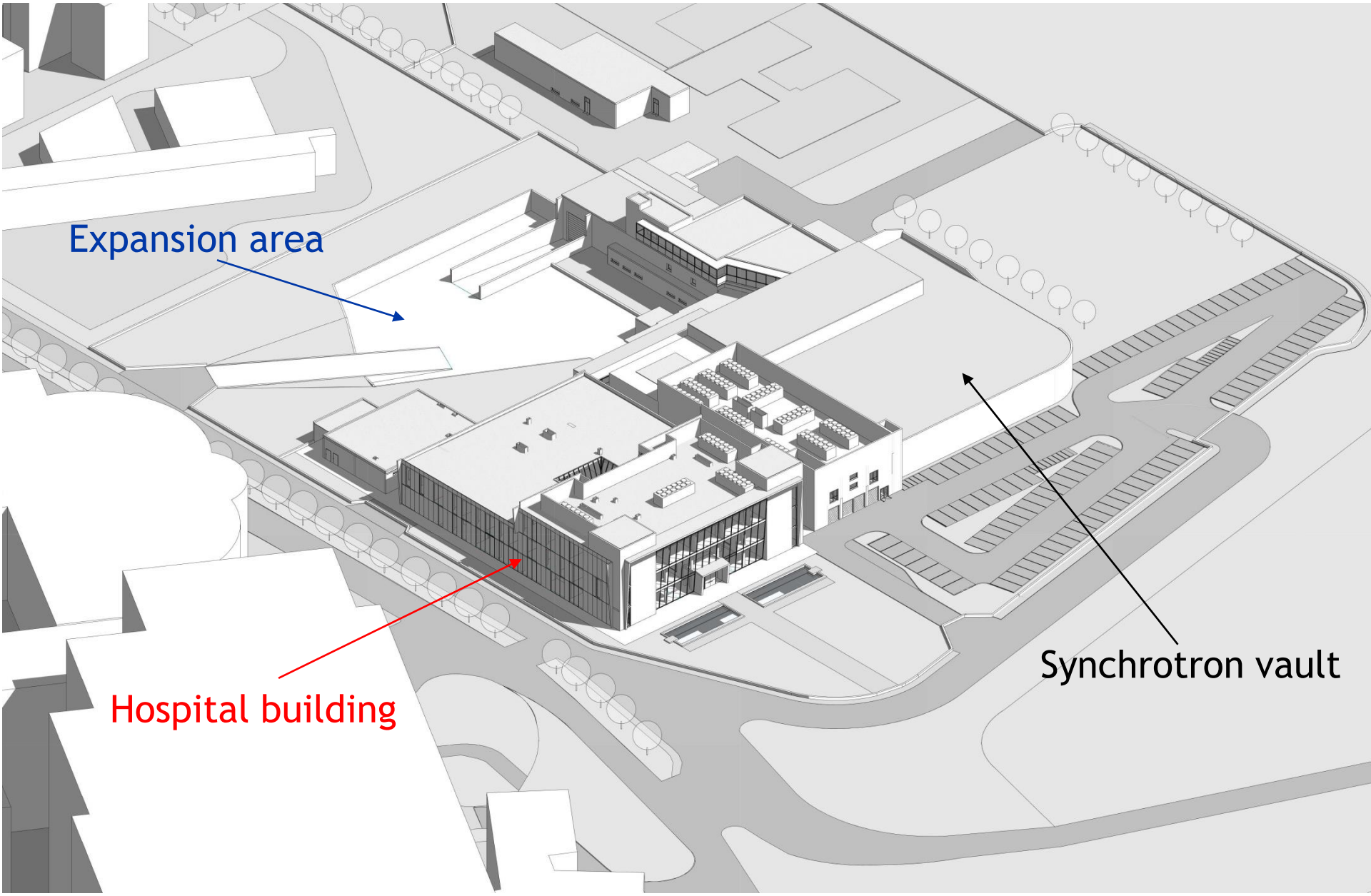
Radiobiology: pre-clinical radiobiology is an essential tool to support new therapy solutions, such as the novel combined use of particle therapy with immunotherapy and radio-genomics for patient selection and personalized medicine. Basic radiobiology studies are also important for space radiation protection.

Animal Studies: the majority of the radiobiology studies need animal models, generally rodents, including genetically modified animals. In collaboration with UniPv, CNAO will provide on-site state-of-the-art animal facilities and tools to enable modern radiobiological research.

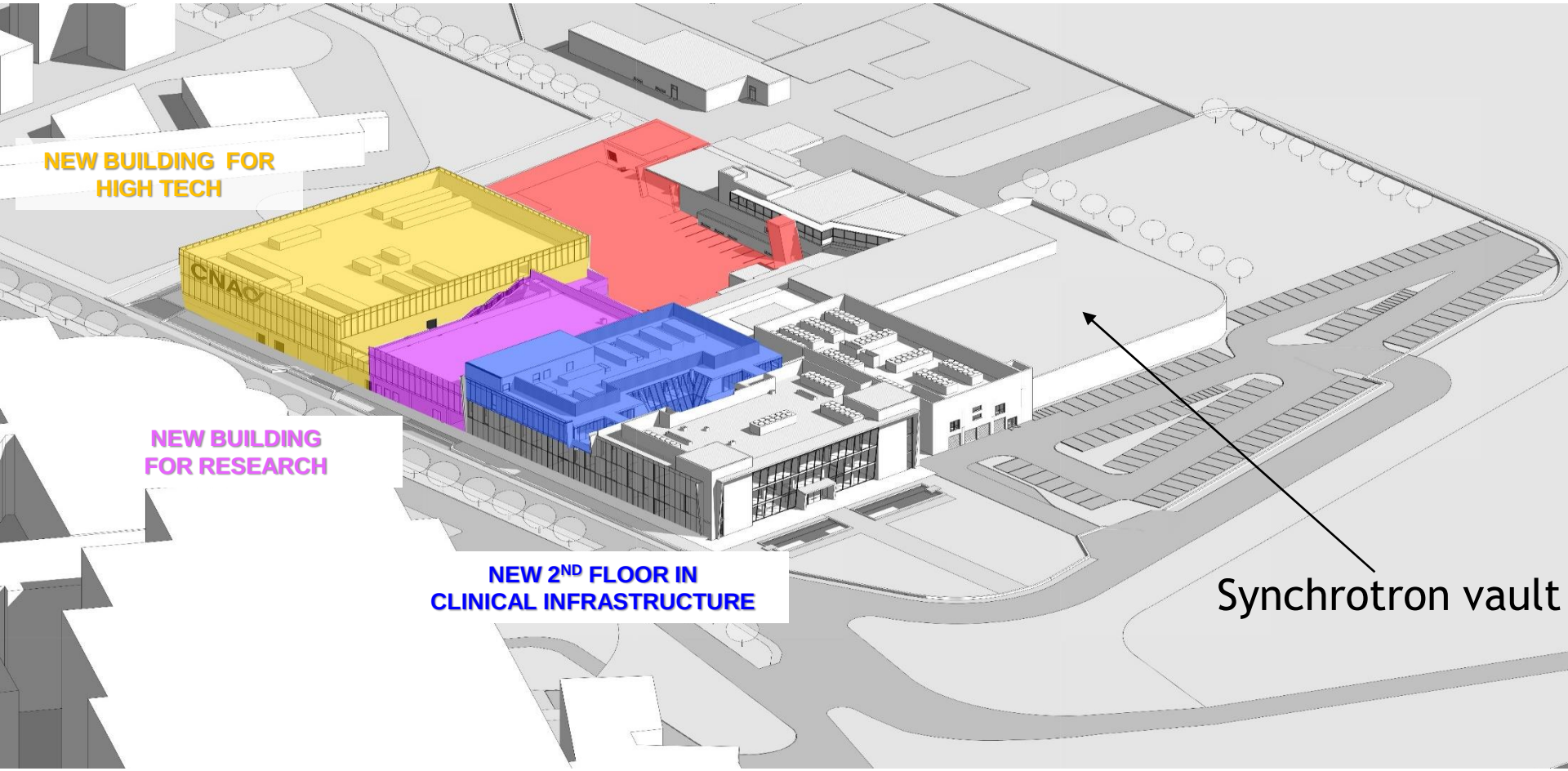
Medical Physics: ultra-fast dose delivery methods will extend ion therapy to the very promising group of moving organs, while new synchrotron extractions and delivery systems will allow FLASH irradiations. Tomography with helium ions - possibly extracted together with C-ions - together with ion-acoustic imaging promise to reduce range uncertainties. Moreover, real-time techniques generate information and pave the way to adaptive treatments.

Material science: the beams available at CNAO give the opportunity for testing radiation hardness of shielding materials, space microelectronics, and production of nanotubes.

Present layout



Layout end 2023

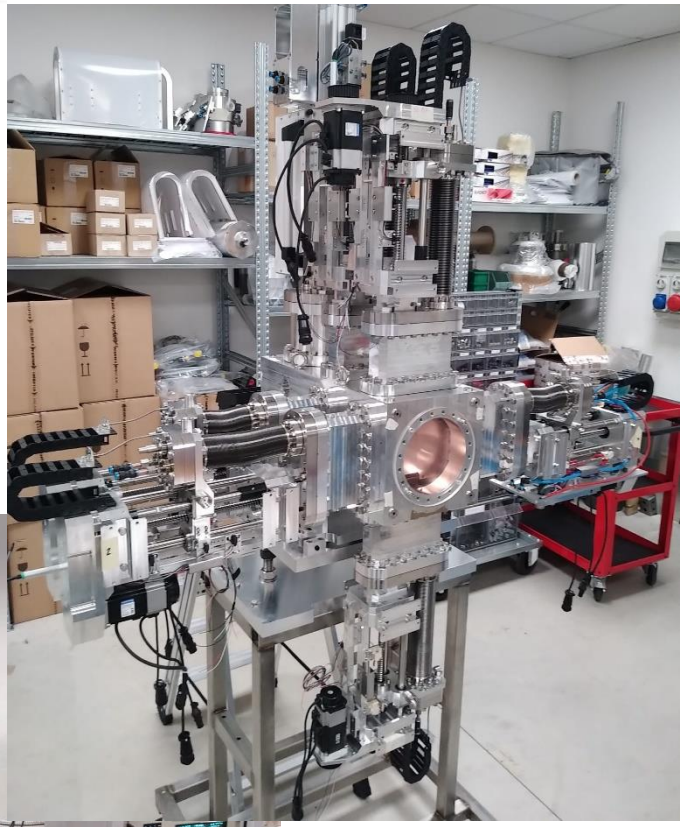


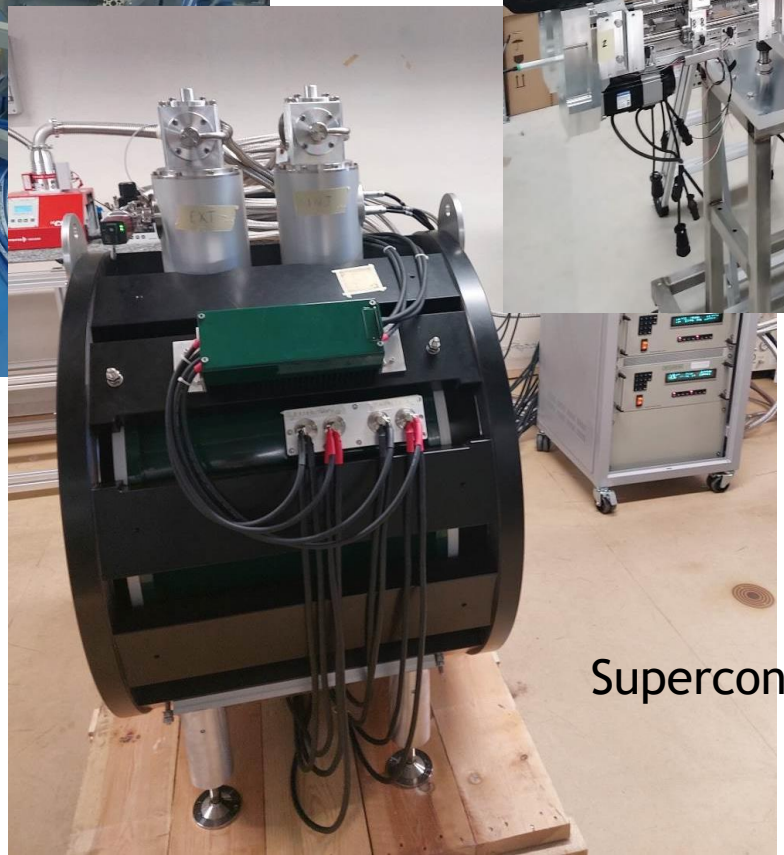
INSpIRIT: new Ion Species

Collaboration CNAO-INFN-HiFuture

Mechanics in synchrotron room

Beam diagnostics

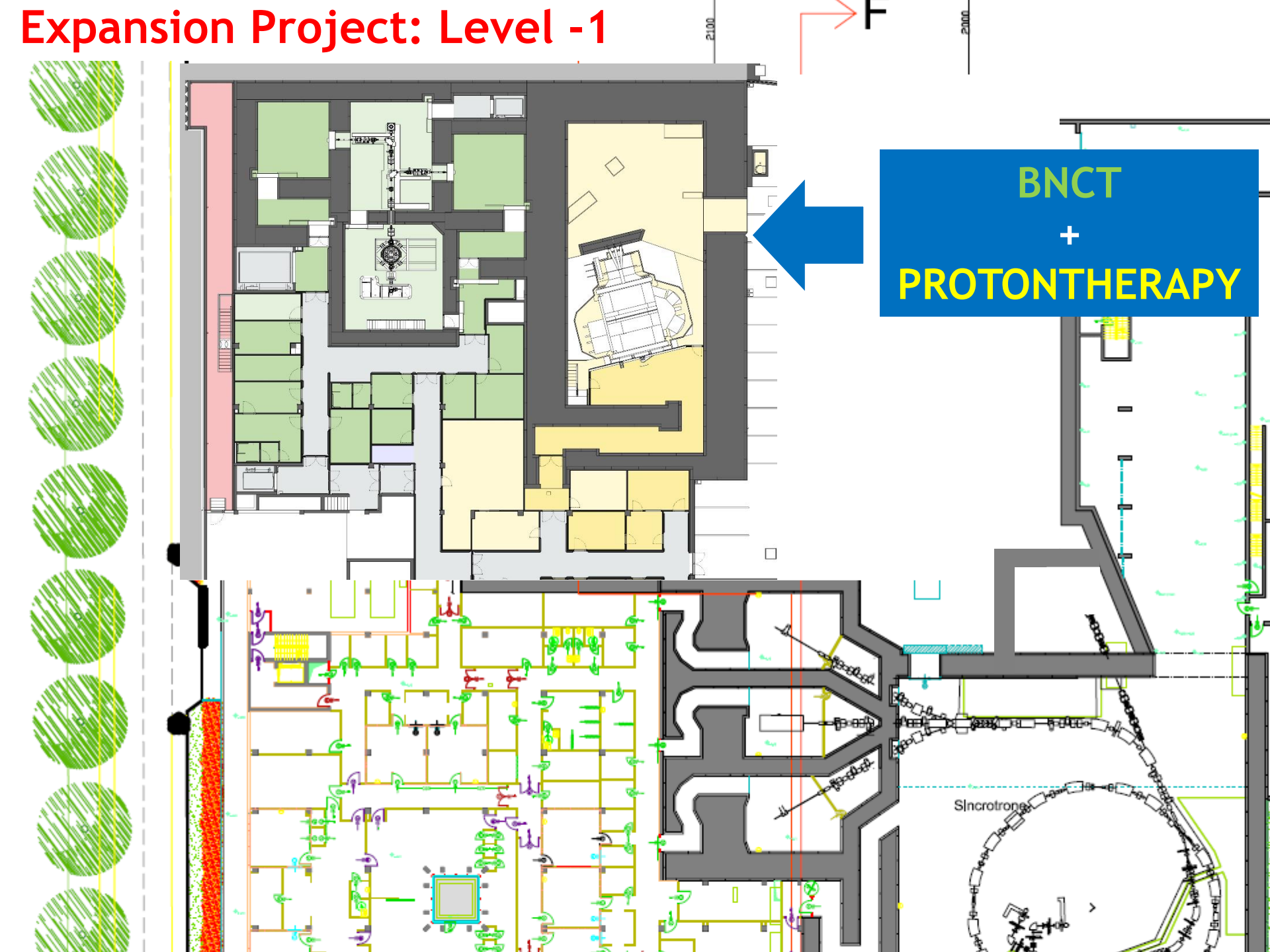




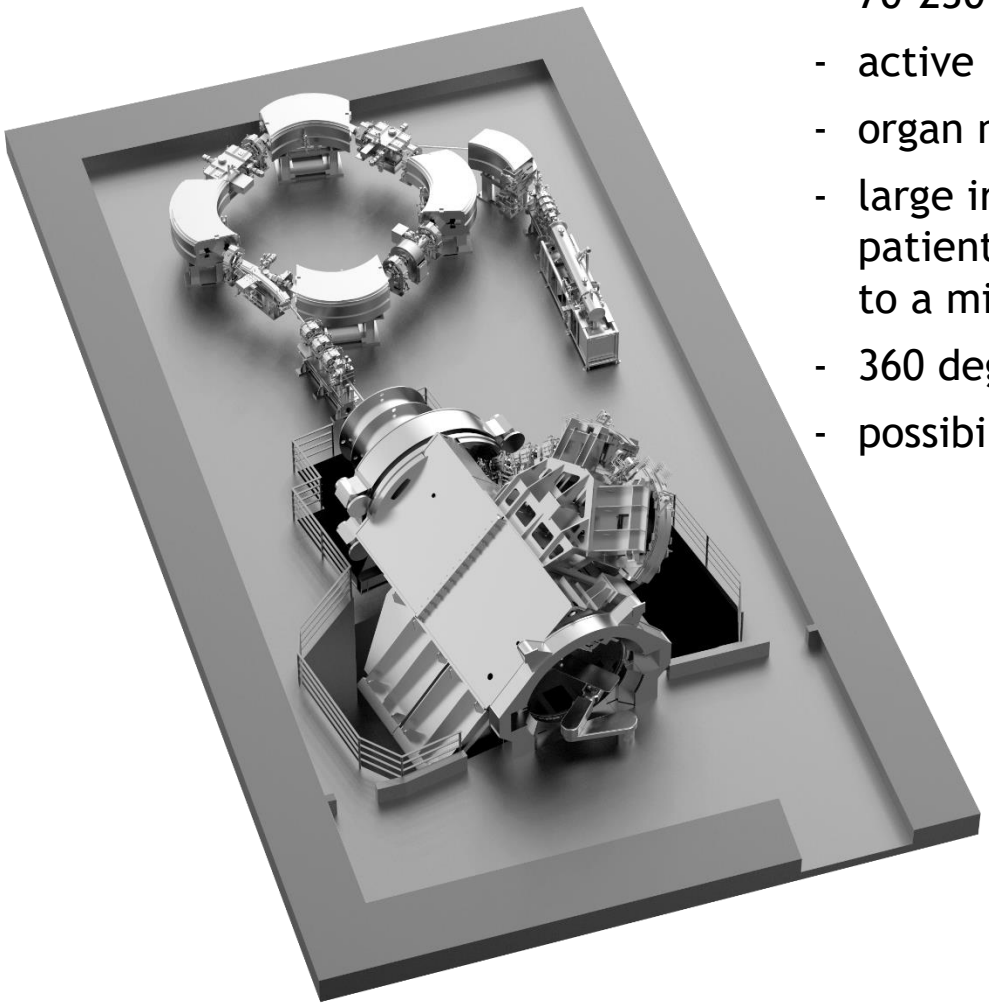
Superconducting magnet

Status: on-time
Deadline: end 2022

Expansion Project: Level -1



New Protontherapy @ CNAO



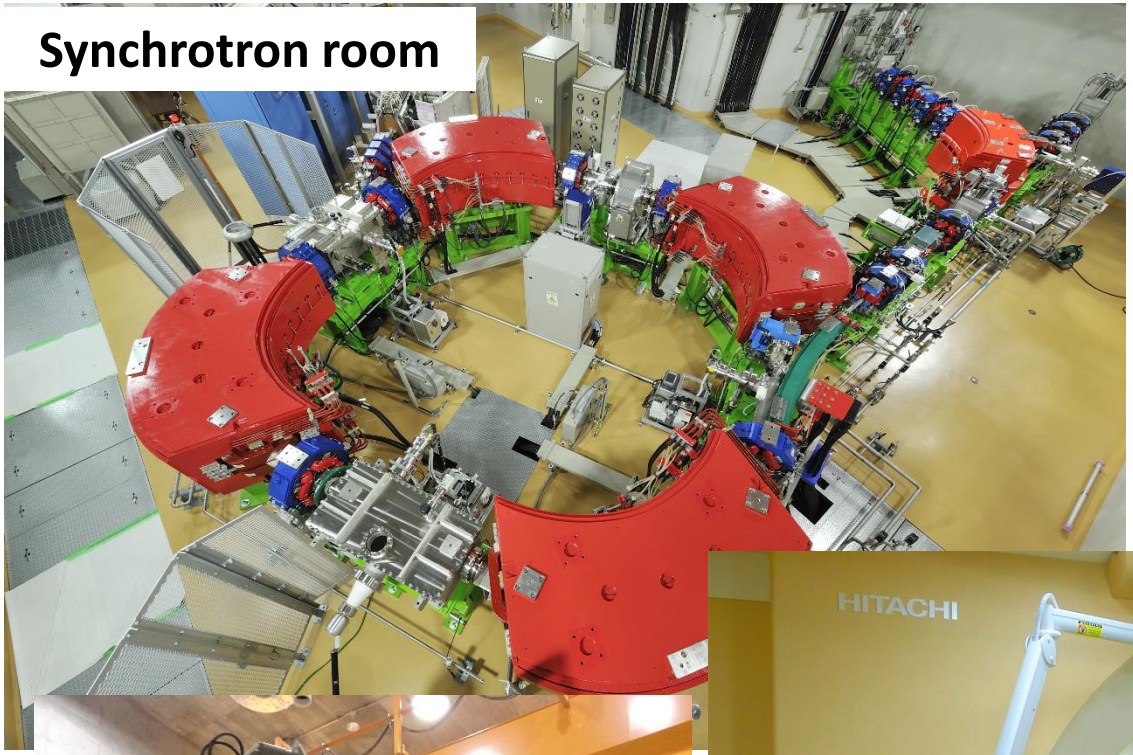
Main features:

- synchrotron, 5.7 m diameter;
- 70-230 MeV energy range;
- active pencil beam scanning;
- organ motion management functionality;
- large irradiation field (30 x 40) cm^2; for paediatric patients, to ease cranio-spinal irradiations reducing to a minimum the required field patching;
- 360 deg rotating gantry, 6 dof robotic couch;
- possibilities of treatments in anaesthesia.

Hitachi PT systems have been used by 32 centres worldwide to treat more than 80,000 cancer patients

New single-room for protons

Synchrotron room



Contract signed with Hitachi:
December 5th, 2019

Start installation end 2023

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

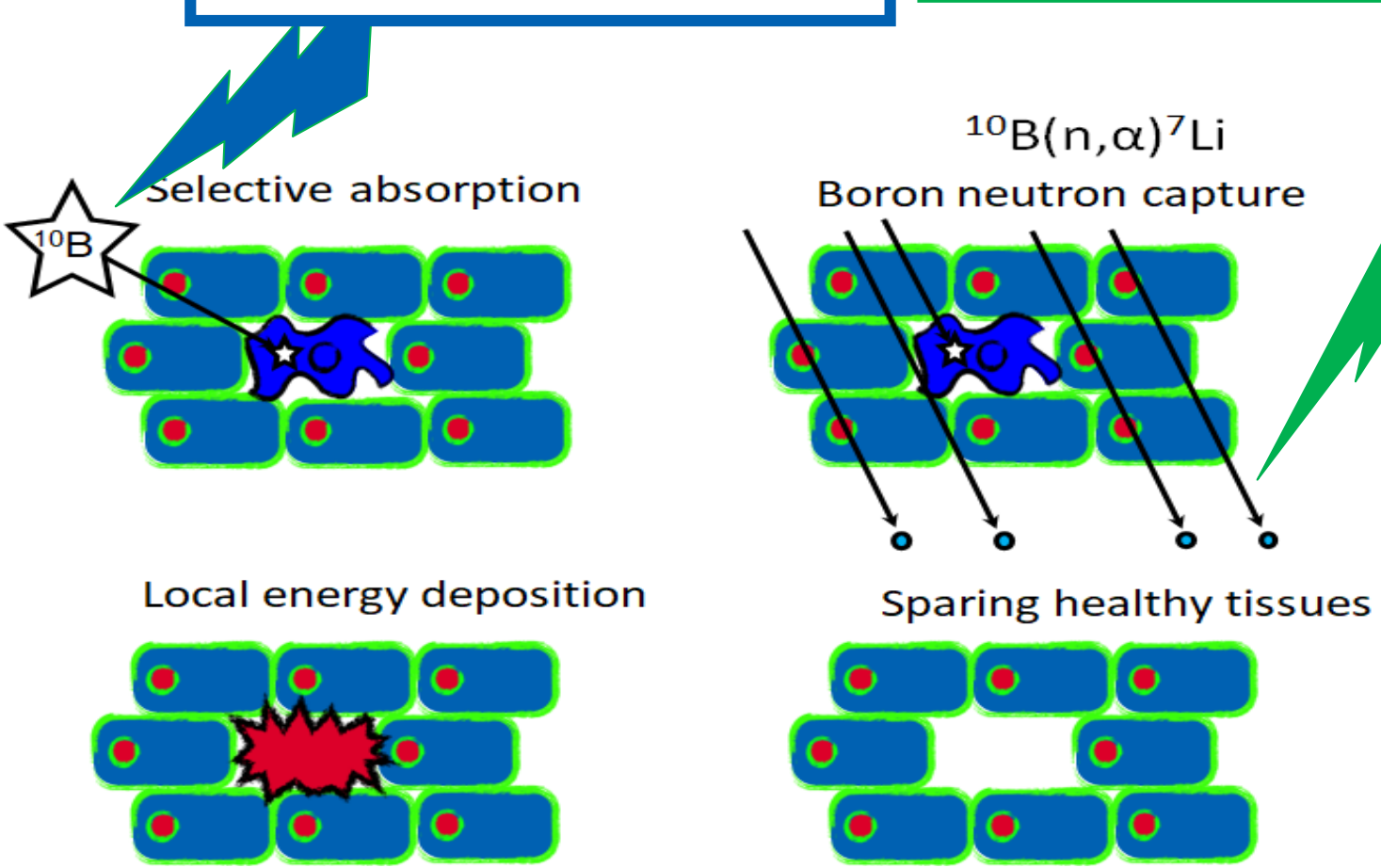
Treatment room

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



BNCT: proton tandem accelerator

Collaboration agreement with TLS signed November 2020

Start installation end 2023

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

alpha beam™

tae LIFE SCIENCES

CNAO
Centro Nazionale di Adroterapia Oncologica

CNAO is ready and willing to continue sharing and collaborating with SEEIIST

THANK YOU!

https://www.hitriplus.eu/

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