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)

- HIT – Heidelberg (G)
- CNAO – Pavia (I)
- MedAustron – Wien (A)
- MIT – Marburg (G)
- 3 centres in China
- 6 centres in Japan
22 Institutes
(4 CIRT centres, 10 research institutions, 5 universities, 3 SMEs)

14 European Countries

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.
Heavy Ion Therapy Research Integration

www.hitriplus.eu
HITRIplus SOCIAL NETWORKS

Dedicated social profiles have been created on the showcase website

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ACCESS BEAM REQUESTS
available on the HITRIplus 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

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. 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 has been resolved. This data will be needed as evidence.

Attach your abstract

Send

HITRIplus - Transnational access
https://www.hitriplus.eu/transnational-access/

Request by email to:
info@hitriplus.eu

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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

- 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

Irradiation technique active scanning

(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

- Head and Neck carcinoma and adenocarcinoma: 22%
- Adenoid cystic carcinoma: 18%
- Prostate adenocarcinoma: 2%
- Mucosal melanoma: 2%
- Pleomorphic adenoma: 2%
- Ocular melanoma: 3%
- Hepatocellular carcinoma: 1%
- Pancreatic adenocarcinoma: 1%
- Chordoma and Chondrosarcoma: 26%
- Sarcoma: 11%
- Rectal cancer: 1%
- Meningioma: 7%
- Other brain tumours: 4%

CE clinical trials

Patients per year
Accelerator at CNAO: compact design

Intellectual property shared by CNAO - INFN - CERN
16 Dipoles to bend
24 Quadrupoles to focus
20 Correctors to steer
1 RF cavity to accelerate
Linac to pre-accelerate
Sources to generate
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

Expansion Area A

Project approved and financed in 2019 by Ministry of Health
Fully operational end 2023
New Research Room
Realized in collaboration with INFN

Ready for external groups (Covid free)

Radiation hardness studies

Radio-biology studies

Animal house and other facilities at Univ. of Pavia (500 m away)
Third source: new ion species

Collaboration
CNAO-INFN-HiFuture

A facility INnovativa di irraggiamento con Sorgente per Ioni per Ricerca e studi di radiation hardness con applicazioni IndusTriali e cliniche INSpIRIT - ID 1161908
Call HUB ricerca e Innovazione - EU/Regional funds

Operational end 2022

Beam currents

<table>
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<th>Ion</th>
<th>Supernanogan (14 GHz) euA</th>
<th>AISHa (18 GHz + TFH) euA</th>
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<tr>
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<td>//</td>
<td>800</td>
</tr>
<tr>
<td>¹⁰B³⁺ - ¹¹B³⁺</td>
<td>//</td>
<td>600</td>
</tr>
<tr>
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<tr>
<td>²¹Ne⁷⁺</td>
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<tr>
<td>³⁶Ar¹²⁺</td>
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</table>
New single-room for protons

Synchrotron room

Contract signed with Hitachi: December 5th, 2019

Operational end 2023

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

Selective absorption

$^{10}\text{B}$

Local energy deposition

Boron neutron capture

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

Sparing healthy tissues
BNCT: tandem accelerator

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

Collaboration agreement signed
September 2020

Operational end 2023

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

**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
HITRIplus 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 !