



CYCLHAD
HADRON THERAPY FOR LIFE

CYCLHAD and the C400 accelerator for ion therapy and research

Gabriel Gaubert / CEO / Atelier « Accélérateur, Recherche et Société » – GRENOBLE – 26/03/2026



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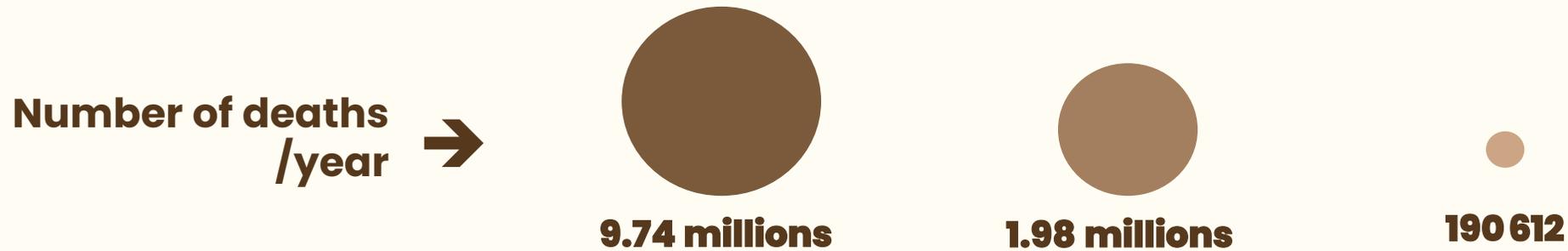
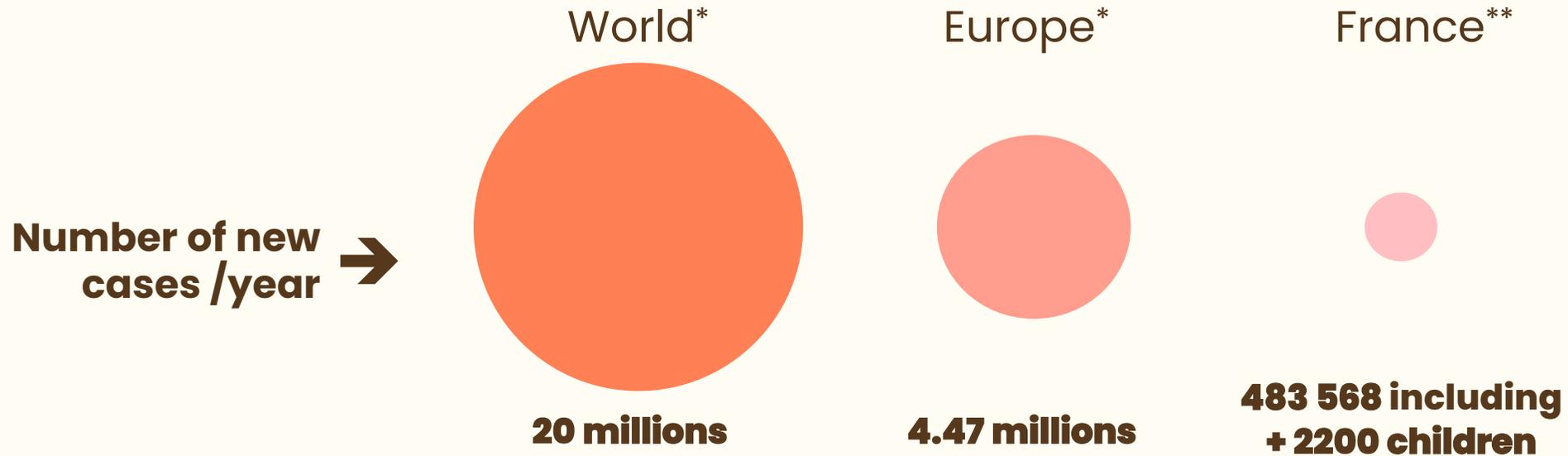




1. Talking about cancer and treatments



NUMBERS



1st cause of death in France

* IARC – OMS 2022

**INCA 2025



TREATMENTS



Chemotherapy

40-50%



Surgery

50-60%



Radiotherapy

- Photons
- Protons 
- Carbon ions 

60%

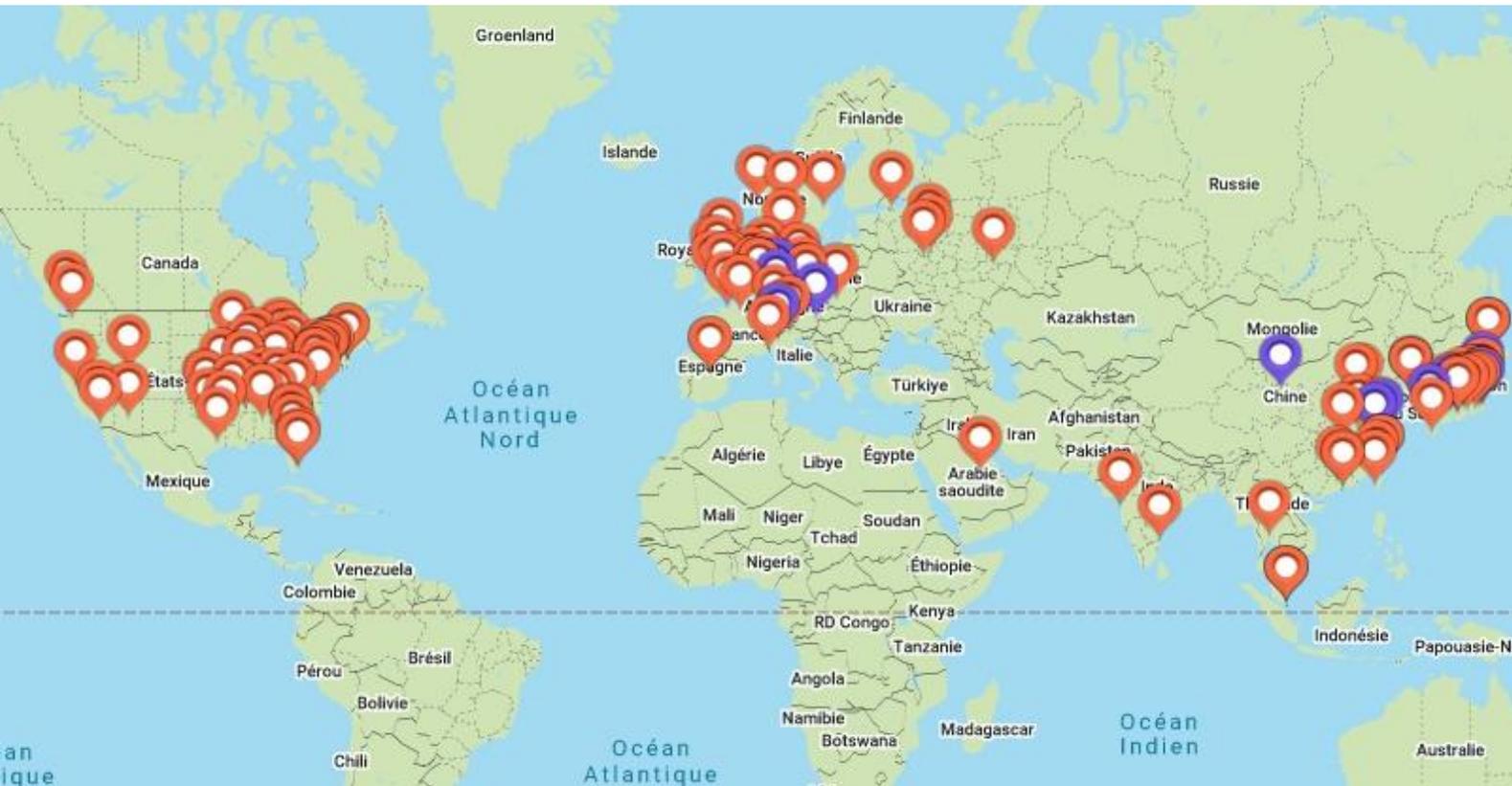


Immunotherapy

<10%



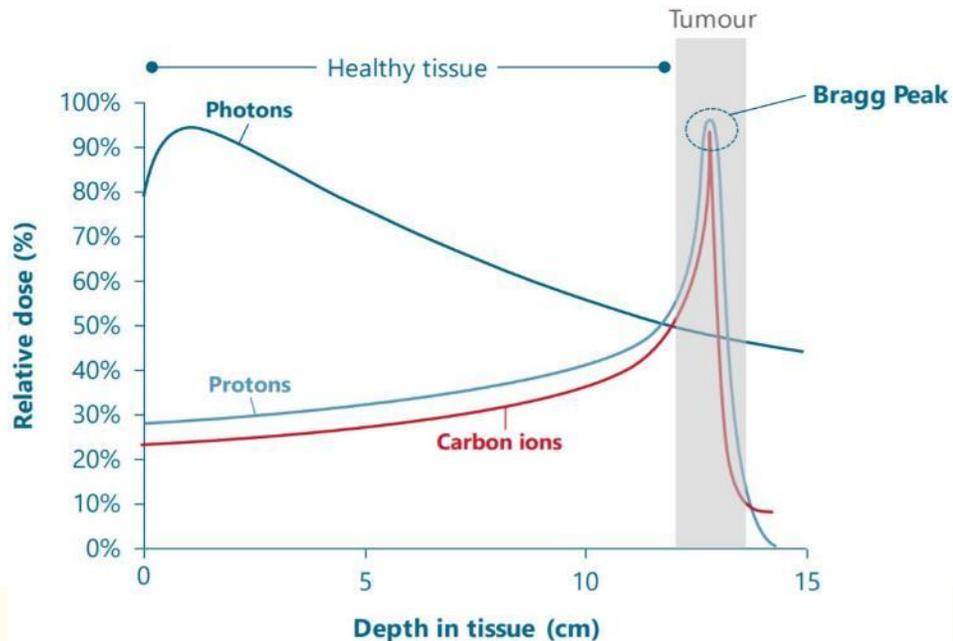
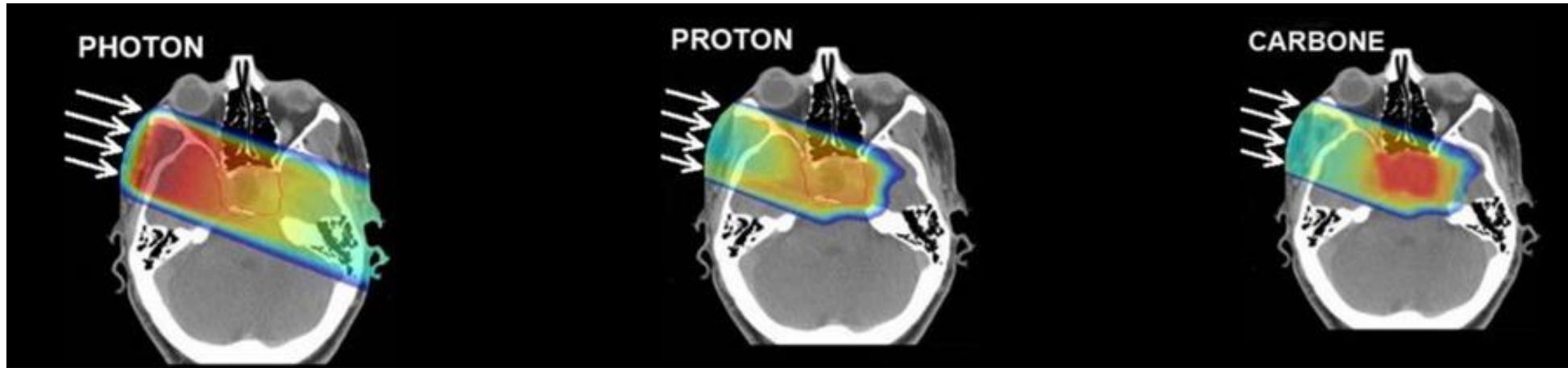
HADRONTHERAPY WORLDWIDE



CONVENTIONAL RADIOTHERAPY CENTERS (Xrays)
~20,000 treatment rooms

PROTON THERAPY CENTERS
182 centres in operation or under installation ~ 400 treatment & research rooms

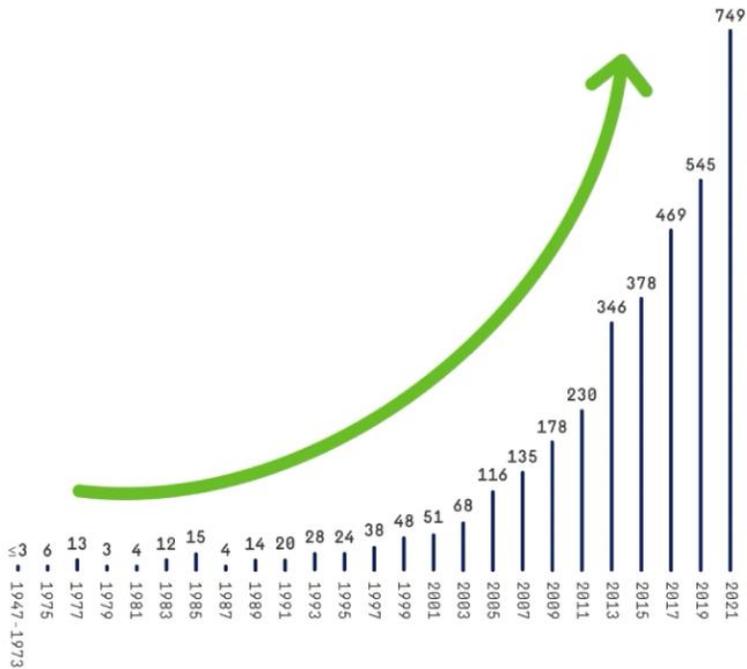
CARBON THERAPY CENTERS
17 multi-ions operational centres with carbon therapy + 6 under installation



- Proton & carbon ions:
 - Dose conformity at tumour location
 - Sparing of the healthy tissues and organs at risk (OAR)
 - Relative Biological efficiency (RBE): x1,1 for proton – RBE x 2 to 3 for carbon
- Carbon ions
 - Less treatment fractions
 - High LET for more complex DNA breaks
 - Effectiveness on radioresistant and hypoxic tumours



CLINICAL EVIDENCE



Number of proton therapy scientific publications worldwide

- 1st phase 3 randomized trial published in the Lancet in 2025 by Steven J Frank, MD Anderson, Houston, Tx.

Proton versus photon radiotherapy for patients with oropharyngeal cancer in the USA: a multicentre, randomised, open-label, non-inferiority phase 3 trial

[Prof Steven J Frank, MD](#) ^a [✉](#) · [Prof Paul M Busse, MD PhD](#) ^h · [Prof J Jack Lee, PhD](#) ^b · [Prof David I Rosenthal, MD](#) ^a · [Mike Hernandez, David M Swanson, PhD](#) ^b · et al. [Show more](#)

DOI: 10.1016/S0140-6736(25)01962-2



- But ...
 - Only 1,2% and 0,6% of all radiotherapy patients received proton therapy in US and EU respectively
 - Less than 15% of paediatric patients receive proton therapy for the ASTRO- recommended indications





2. CYCLHAD Centre



THE HADRON THERAPY ECOSYSTEM IN CAEN

CENTRE FRANÇOIS BACLESSE
CENTRE DE LUTTE CONTRE LE CANCER – UNICANCER

CHU
HÔPITAL UNIVERSITAIRE

ENSICAEN **UNIVERSITÉ**
ÉCOLES DE SCIENCES ET D'INGÉNIERIE

CYCERON **ISTCT**
PLATEFORME D'IMAGERIE BIOMÉDICALE
ET LABORATOIRES DE RADIOBIOLOGIE

CYCLHAD
CENTRE INTERNATIONAL D'HADRONTHÉRAPIE MULTI-IONS
POUR LE TRAITEMENT ET LA RECHERCHE

GANIL **LPC**
CENTRES DE PHYSIQUE DES PARTICULES ET NUCLÉAIRE



FACILITY AND STAFF

EQUIPMENTS

- Protons: ProteusONE
 - 1 treatment room
- Multi-ions: C400 – *under installation*:
 - 1 treatment room
 - 1 mix room for treatment and research
 - 1 research and industrial application room

LABORATORIES & OFFICES

ECOSYSTEM & ENVIRONNEMENT

STAFF

- CYCLHAD employees
- Technical staff
 - ProteuONE: IBA engineers
 - C400: NHa engineers
 - Building : Vinci Facilities technicians
- Clinical staff
 - ProteusONE: Centre François Baclesse
Radiation oncologists, medical physicists and dosimetrist, radiotherapists, medical secretary
 - C400: clinical French national model under definition



SOME FACTS...

☑ 1 of 3 French
protontherapie centres 

☑ 1 of 20 multi-ion centers
worldwide 

☑ Patient workflow: TOP 1 Europe &
TOP 3 World with a ProteusONE
single room

☑ Patient feedback from Google:
4.9/5 which reflect an excellent
patient care at the CFB/Cyclhad
partnership

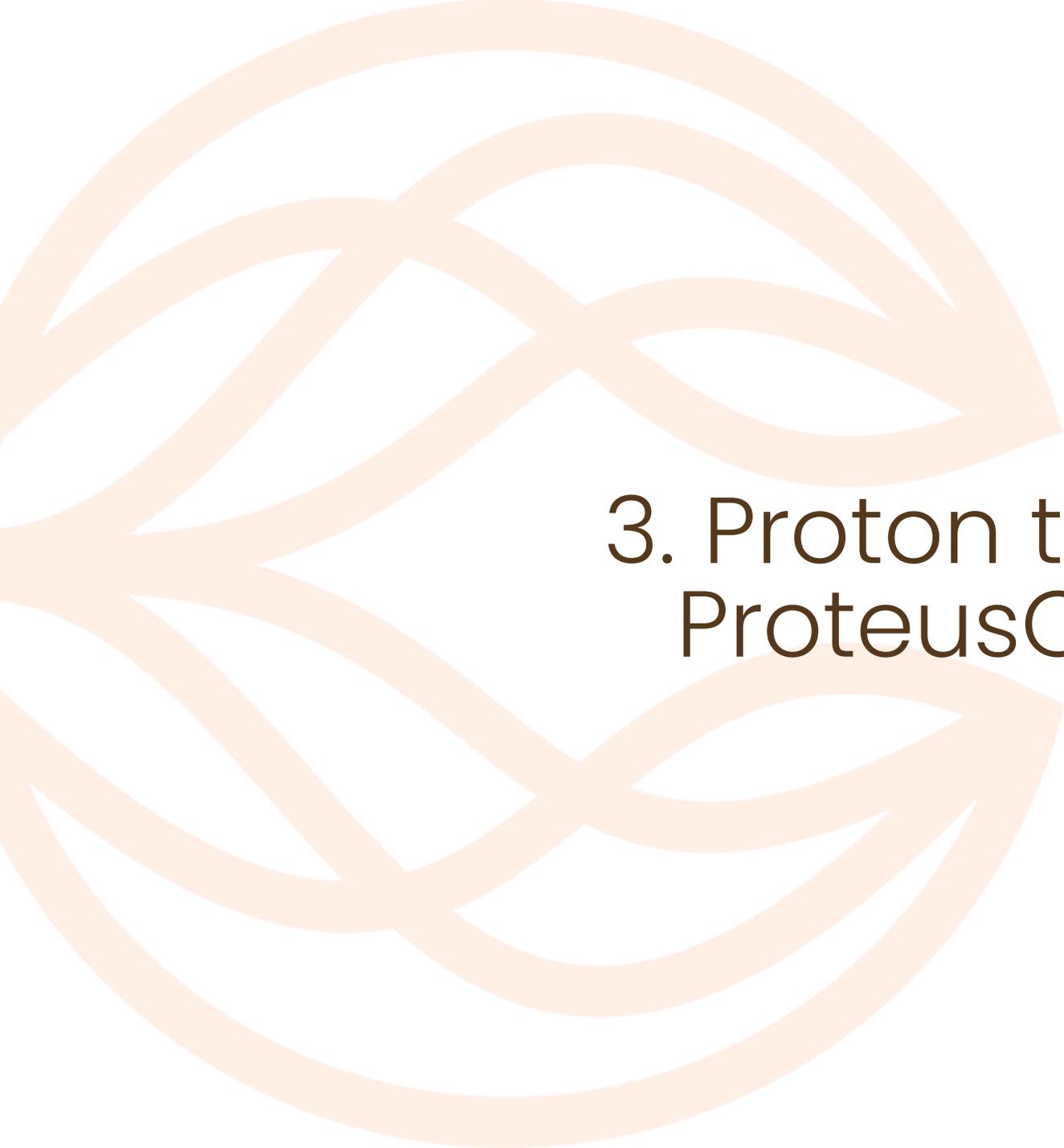


☑ The unique French multi-ion
hadrontherapy center

☑ First multi-ion hadron therapy
center equipped with a **cyclotron**

☑ Expertise in distraction techniques for
pediatric patients and skin cancers



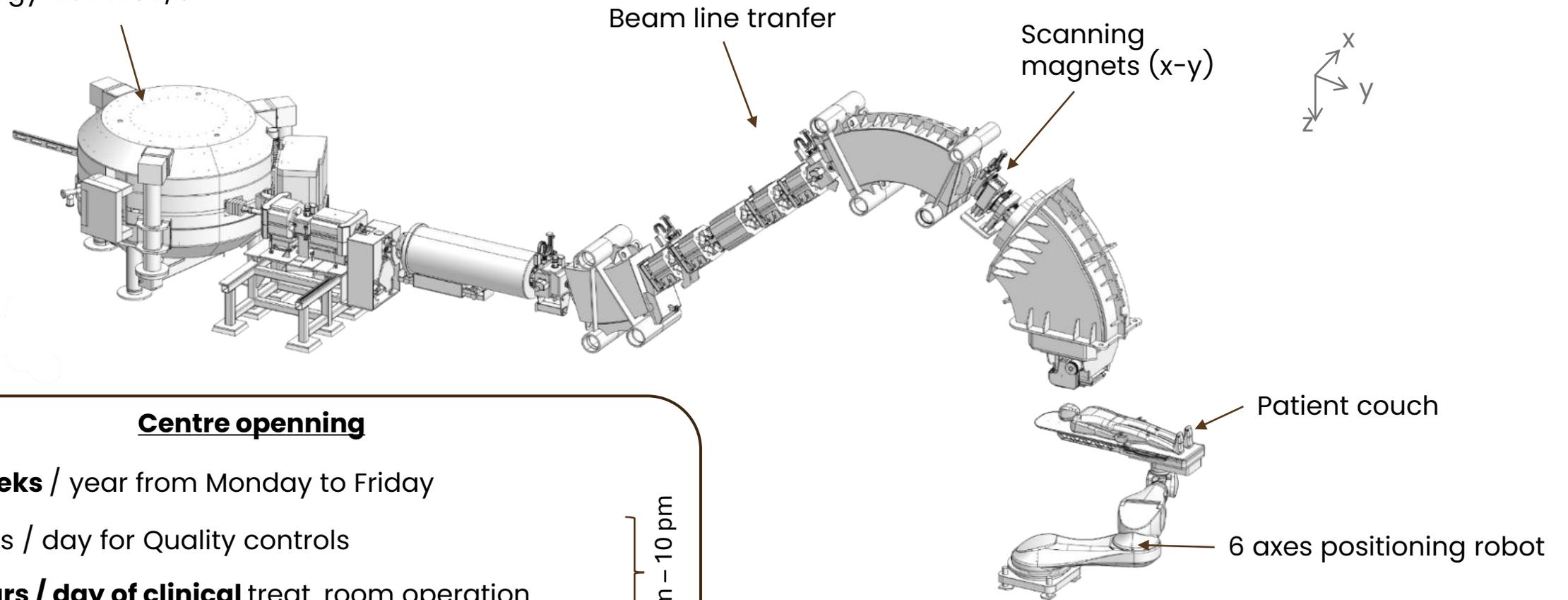


3. Proton therapy with the ProteusOne



ProteusONE DESIGN

S2C2 accelerator:
Super conducting Synchro-cyclotron
Energy: **230 MeV/u**



Centre opening

52 weeks / year from Monday to Friday

2 hours / day for Quality controls

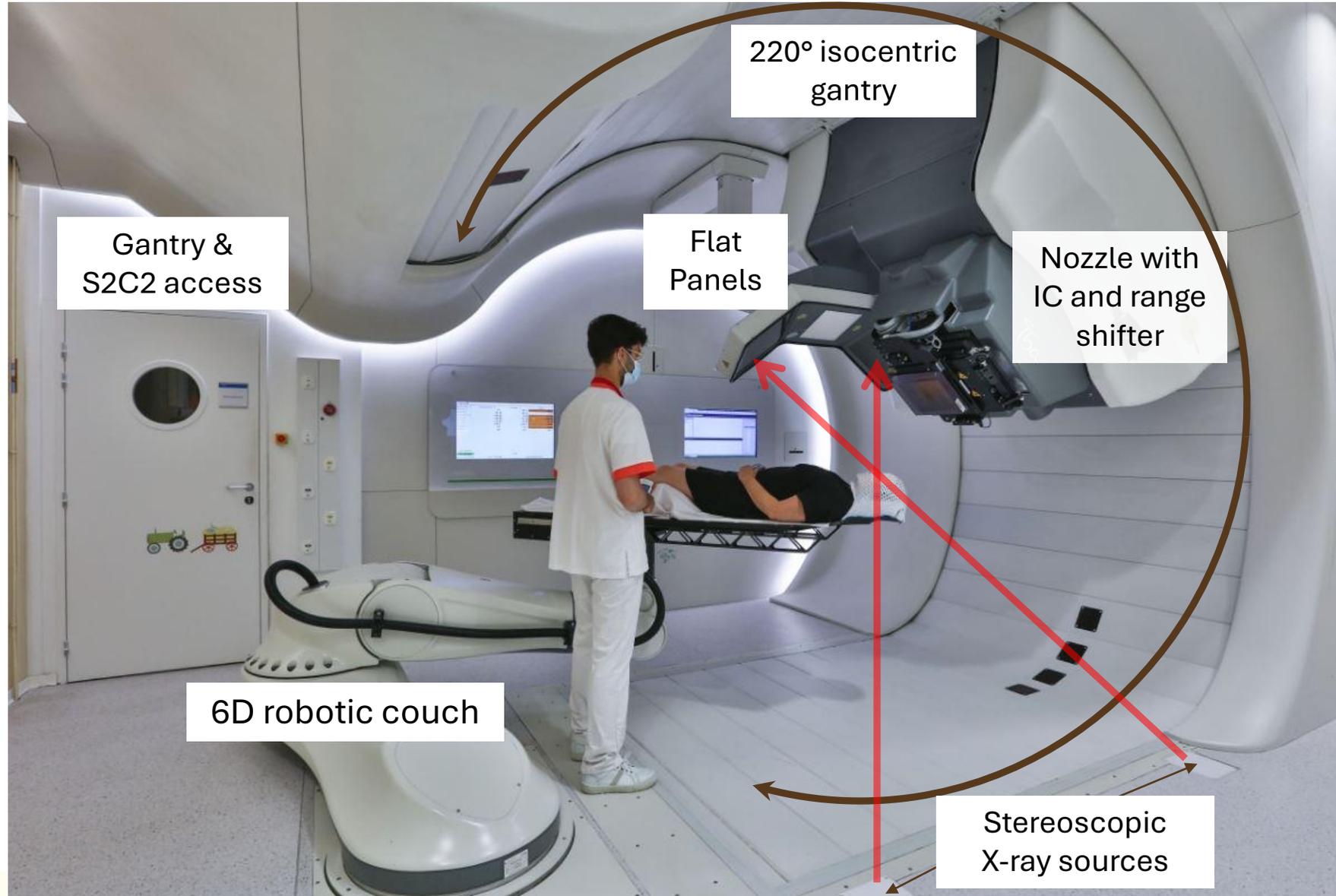
14 hours / day of clinical treat. room operation

Evening & Week-end for maintenance

}
6 am – 10 pm



ProteusONE DESIGN



PATIENT WORKFLOW & INDICATIONS

The patient's journey and treatment indications: from the François Baclesse Center to Cyclhad

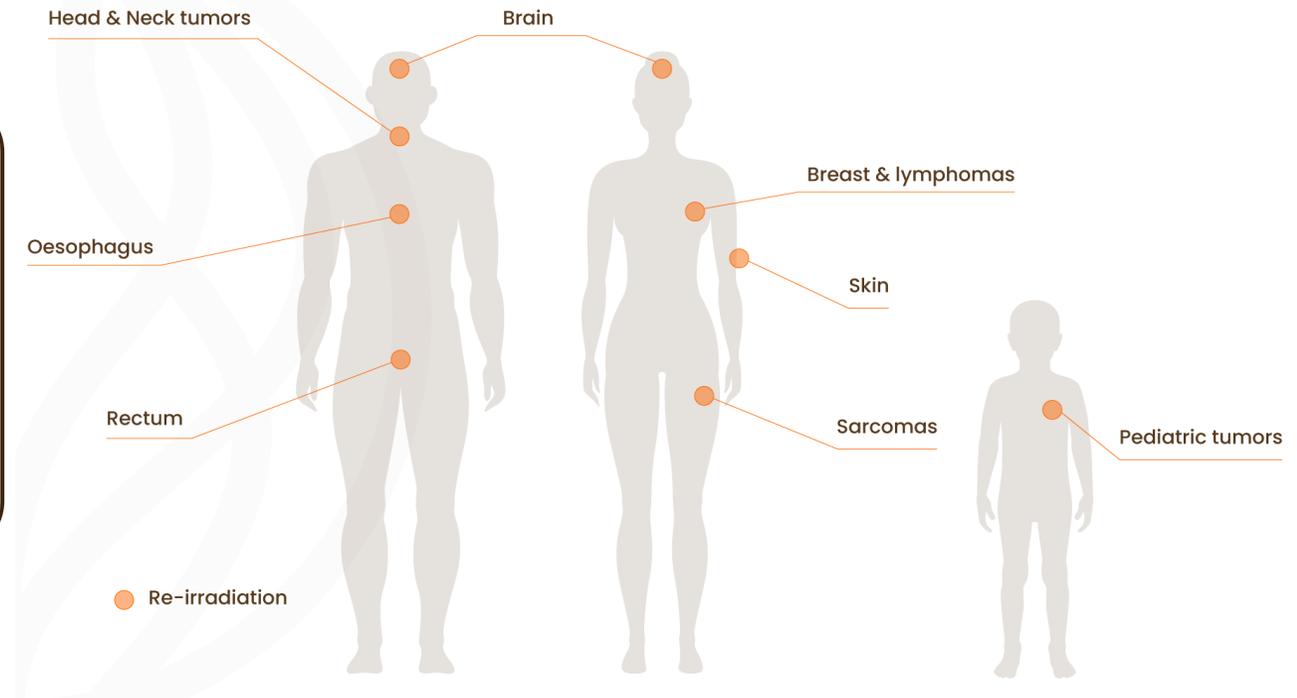


Average proton therapy treatment

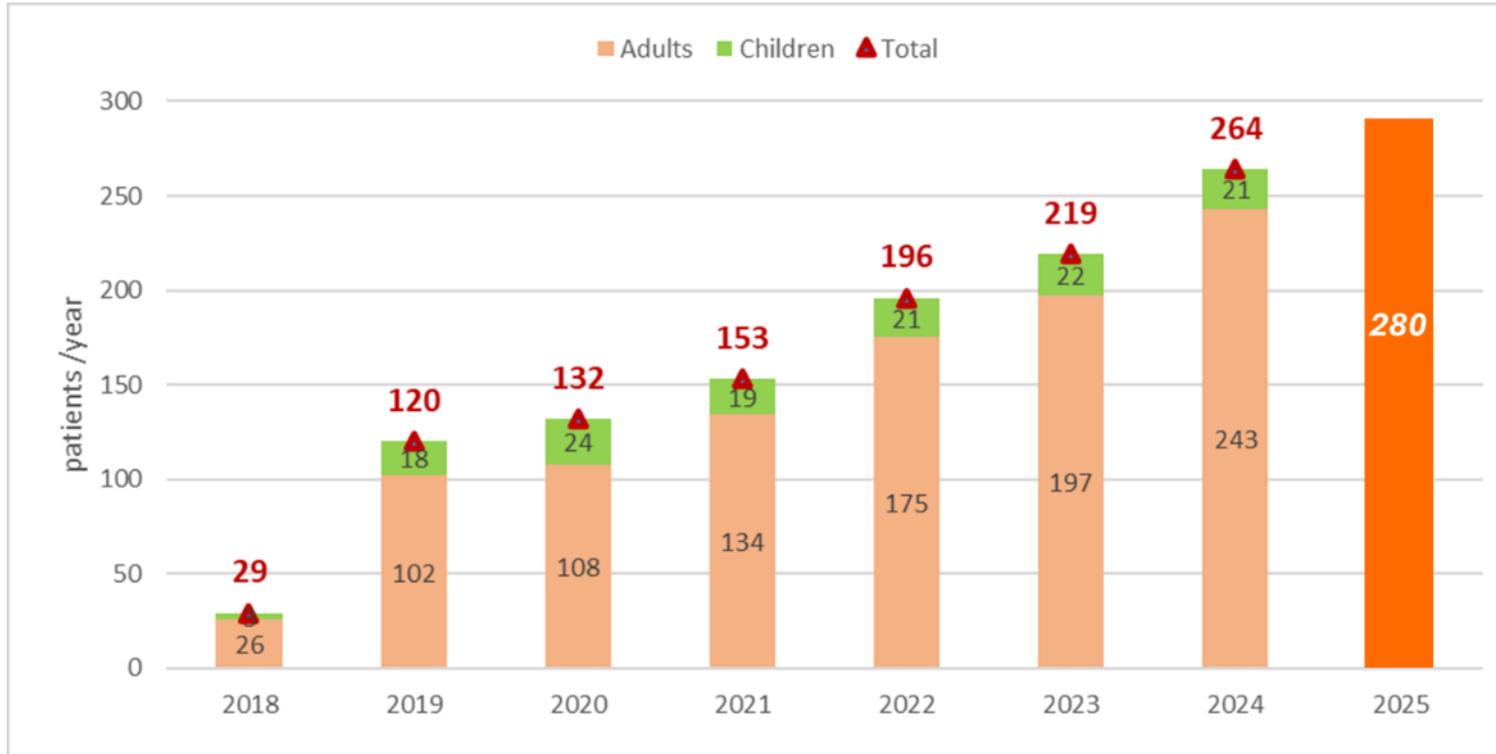
30 beam delivery **fractions at 2 Gy** within 5 weeks

25 minutes mean time per fraction

3 fractions per week for skin cancer: hypofractionation @6Gy



CLINICAL ACTIVITY SINCE 2018



Number of patients treated per year with proton therapy at Cyclhad

New achievements

30,000 proton fractions delivered

1,300 patient treated including

150 paediatric patients

Capacity to treat up to 300+ patients per year



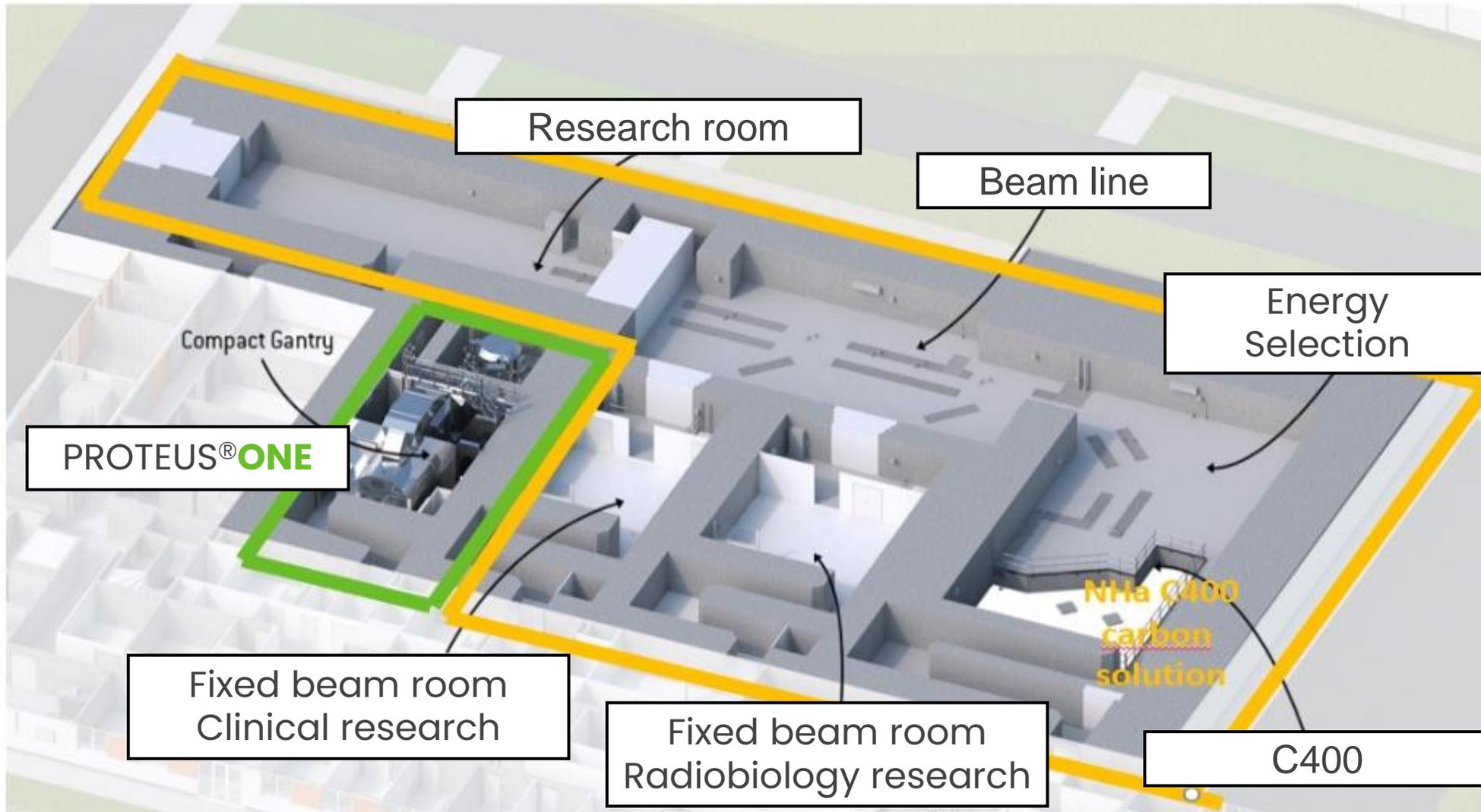


4. Multi-ion hadrontherapy with the C400 system

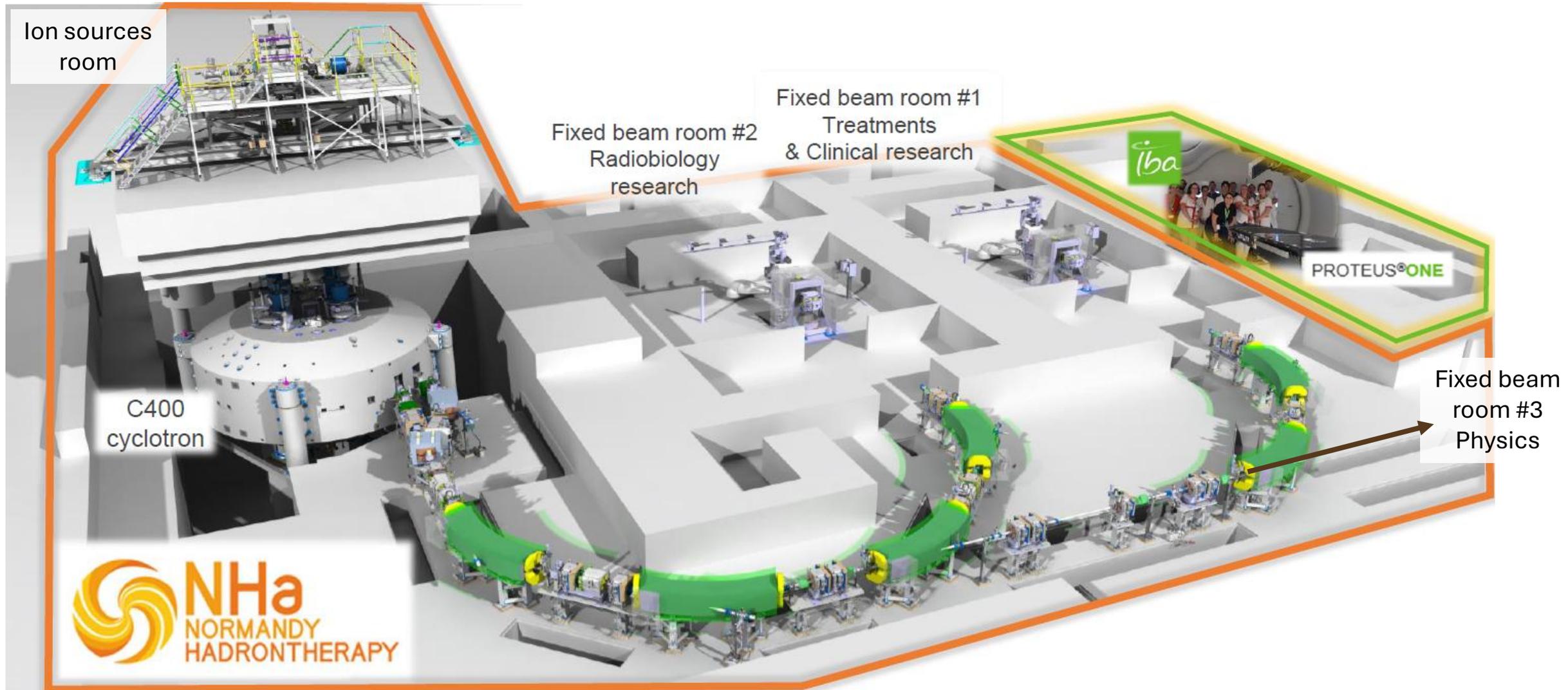


GENERAL OVERVIEW

SRTH: Système de Recherche et de Traitement en Hadronthérapie



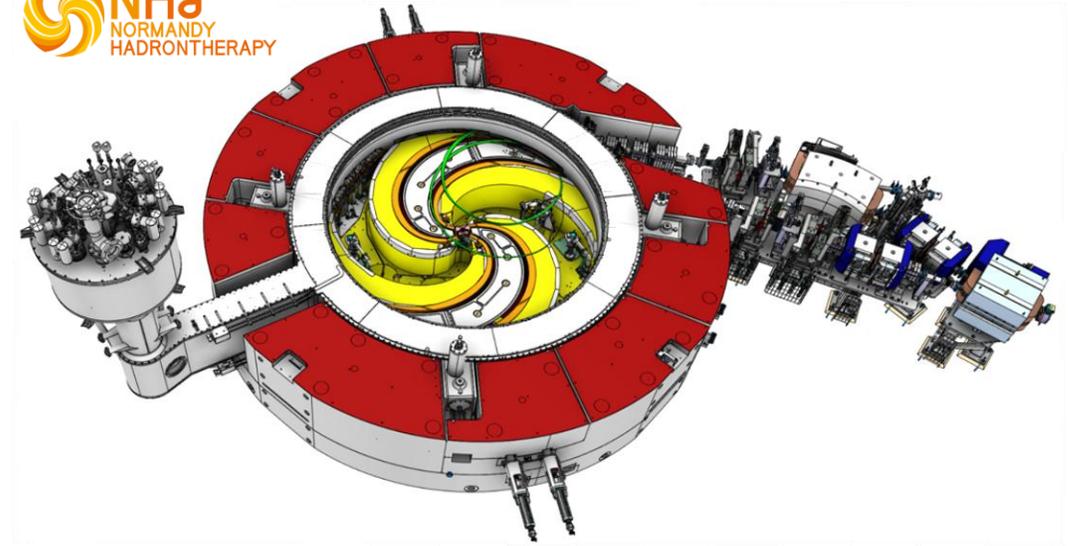
GENERAL OVERVIEW



MAIN FEATURES OF THE C400 CYCLOTRON

Superconducting cyclotron

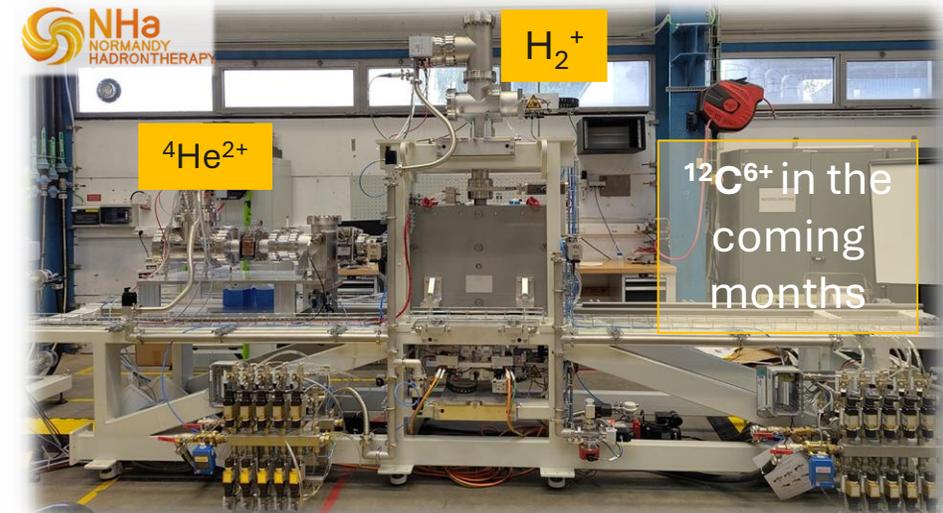
- “Compact” magnet
 - 7m diameter yoke
 - Accelerate $q/m = \frac{1}{2}$ particles
- RF: 75MHz for $^{12}\text{C}^{6+}$, 75.6MHz for H_2^+ , Harmonic #4
- Cryogenic coils
 - max field 4.5T
 - 2 coils in liquid Helium bath
- Injection line
 - 3 sources: H_2^+ , $^4\text{He}^{2+}$ & $^{12}\text{C}^{6+}$
 - Beam optics controls, buncher & diagnostics
- Dual extraction:
 - H_2^+ @ ~265 MeV/u: protons extracted via stripping
 - $^4\text{He}^{2+}$ & $^{12}\text{C}^{6+}$ @ 400 MeV/u: via electrostatic deflector
- Vacuum requirements @ $2 \cdot 10^{-7}$ mbar
- Fundamental resonance crossing $3Vr=4$



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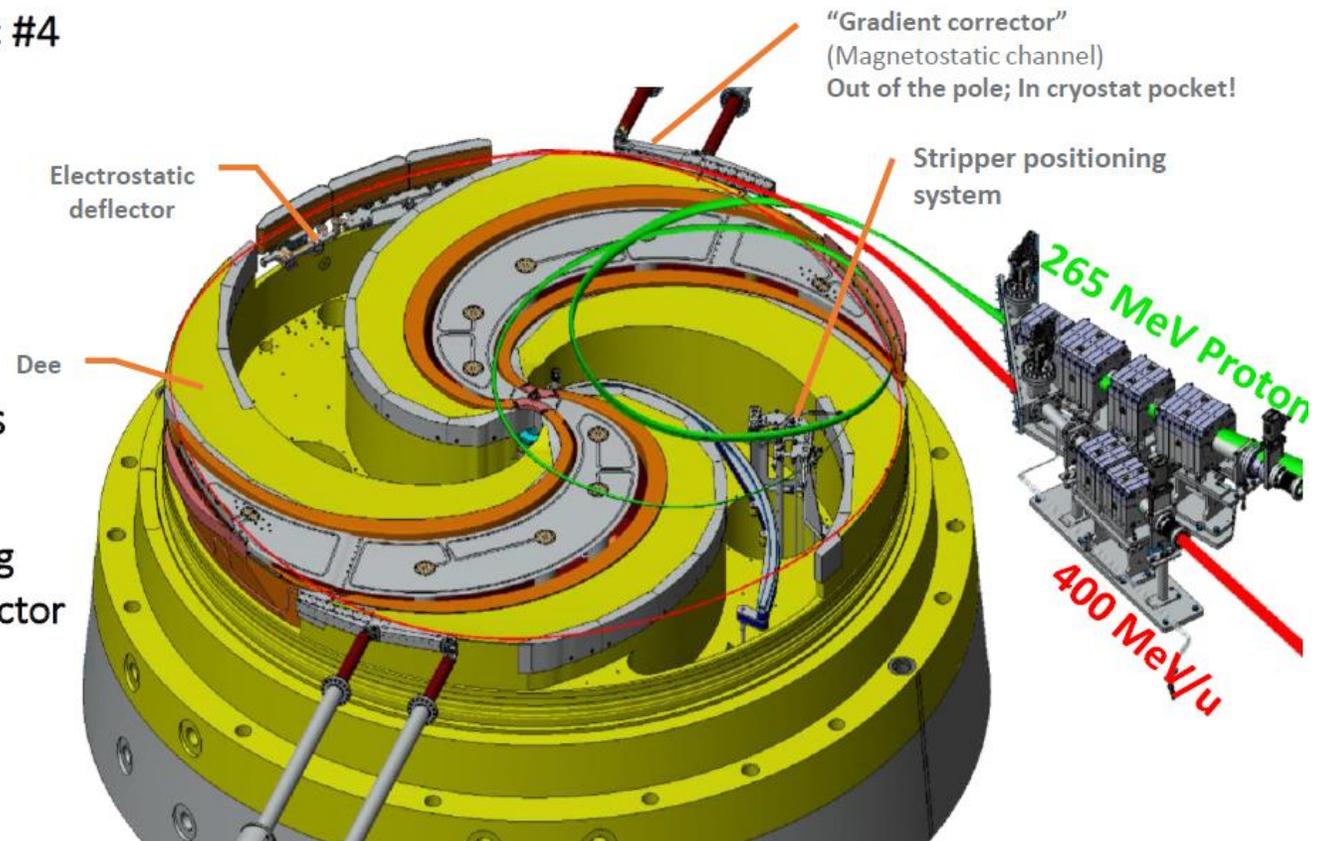
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MAIN FEATURES OF THE C400 CYCLOTRON

Accelerator Specifications		Protons	He Ions	C Ions
Nominal Energy	MeV/u	260	400	400
Maximum achievable beam intensity	enA	≥ 300	≥ 150	≥ 15
Minimum achievable beam intensity	enA	≤ 1	≤ 1	≤ 0.2
Cyclotron emergency beam-off time	μsec	≤ 200		
Time to switch between different particle types	min	≤ ~15 (faster between C and He)		

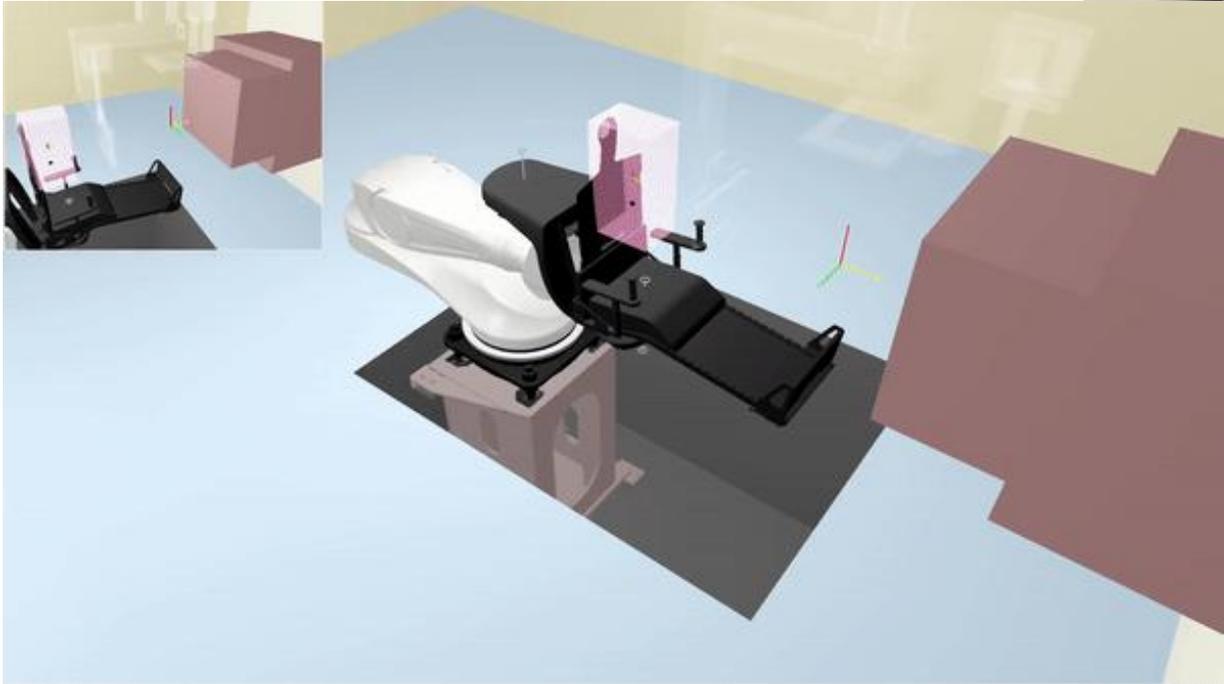


Clinical Beam Performance Specifications		Protons	He Ions	C Ions
Maximum achievable range in water	g/cm ²	≥ 32	≥ 32	≥ 27
Minimum achievable range in water without range shifter	g/cm ²	≤ 4	≤ 4	≤ 4
Range-in-water accuracy (1σ)	g/cm ²	≤ 0.25	≤ 0.25	≤ 0.25
Distal fall-off (80%-20%): Excess of physical limit	g/cm ²	≤ 0.25	≤ 0.25	≤ 0.25
Maximum field size at isocenter (for all ranges)	cm ²	≥ 30 × 30	≥ 25 × 25	≥ 20 × 20
Lateral dose uniformity	%	≤ ±2.5	≤ ±2.5	≤ ±2.5
Beam position accuracy at isocenter (planar radial deviation as 1σ value, after automatic tuning)	mm	≤ 0.5		
Minimum achievable beam spot size (1 sigma of beam profile) at isocenter at max. range	mm	≤ 3.6	≤ 3.6	≤ 3.0
Minimum achievable beam spot size (1 sigma of beam profile) at isocenter at min. range	mm	≤ 8.0	≤ 6.0	≤ 4.0
Beam spot size symmetry at isocenter ($\epsilon = (\sigma_x - \sigma_y) / (\sigma_x + \sigma_y) $)	%	≤ 10	≤ 10	≤ 10
Average dose rate (for homogeneous irradiation of a 10 cm × 10 cm × 10 cm cube)	Gy/min	≥ 2	Under evaluation	≥ 2
Room switching time	sec	≤ 60		
SAD X/Y		3297 mm / 2961 mm		



FIXED BEAM TREATMENT ROOM

Mix patient positioning system: a unique design



FIXED BEAM TREATMENT ROOM

Therapeutic indications with carbon ions

TREATMENT INDICATIONS (CONSIDERED)

Advanced Head & Neck cancers (non-SCC)

Large skull base cancers

Stage I lung cancer

Early stage esophageal cancer

Pancreatic cancer

Liver cancer

Prostate cancer

Post-op recurrent rectal cancer

● Intractable radio-resistant cancers <14 fractions

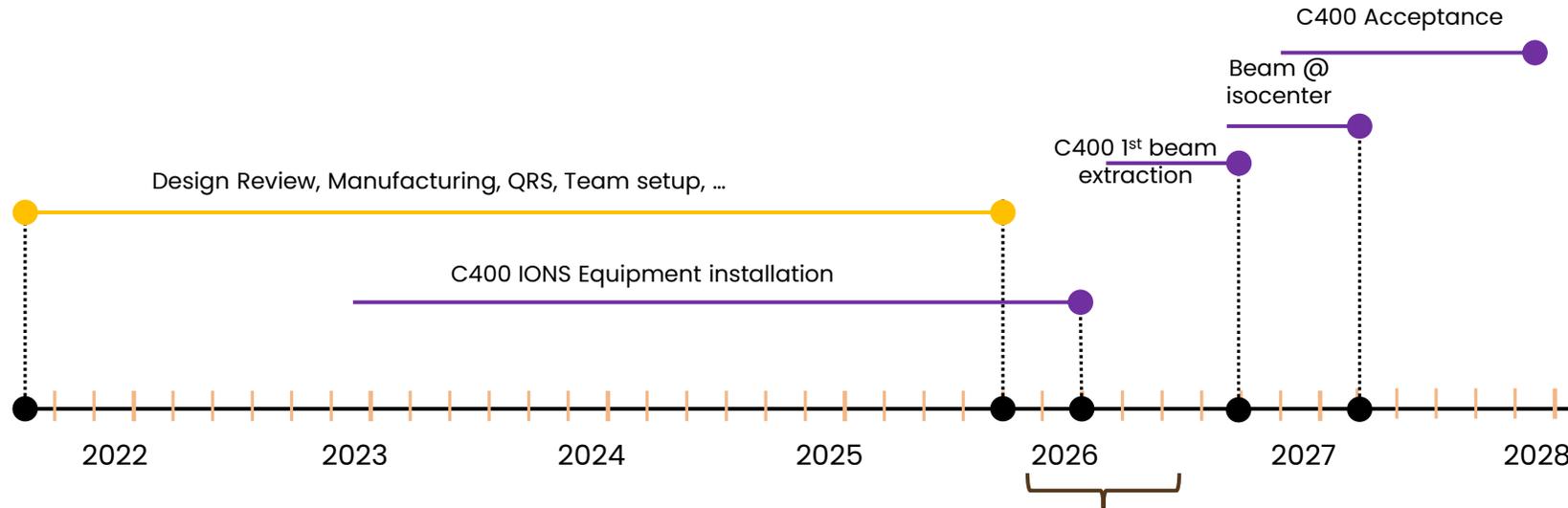
● Common cancers <12 fractions

● Re-irradiation

● Inoperable sarcoma



INSTALLATION AND TIMELINE



Coming soon:

- Cryocooling system & superconductive coil testing
- Magnetic mapping
- RF system commissioning

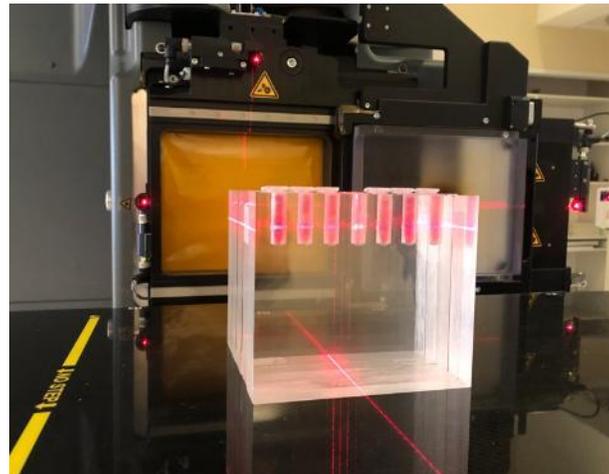


R&D FACILITIES

500 m² dedicated for radiobiology laboratories

- ⇒ Direct access to the irradiation rooms delivering different ion species
- ⇒ Access to a cells & small animals Xray on site irradiator
- ⇒ Bio molecular and cellular labs connected to a temporary small animal room facility

Major strength: combine multi-irradiation modalities in the same centre facility avoiding external bias



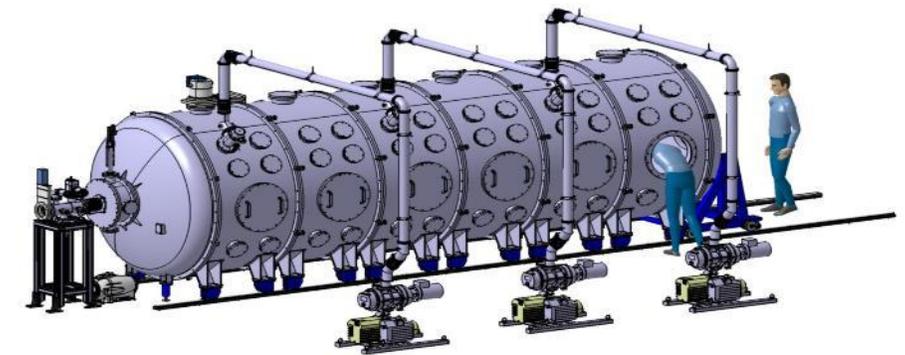
R&D FACILITIES

300 m² experimental hall for physics and industrial applications

⇒ A FIXED BEAM LINE ROOM OPERATED BY A DEDICATED ENGINEERS & PHYSICISTS TEAM



- Physics experiments, measurements and studies with heavy ions
- Instrumentation and detectors developments
- Material development and characterization
- Radio pharma experiments
- Radioprotection testing
- Microelectronic radiation hardness testing and qualification



Major strenght: Modular research room with easy switching ion species and irradiation experimental stands



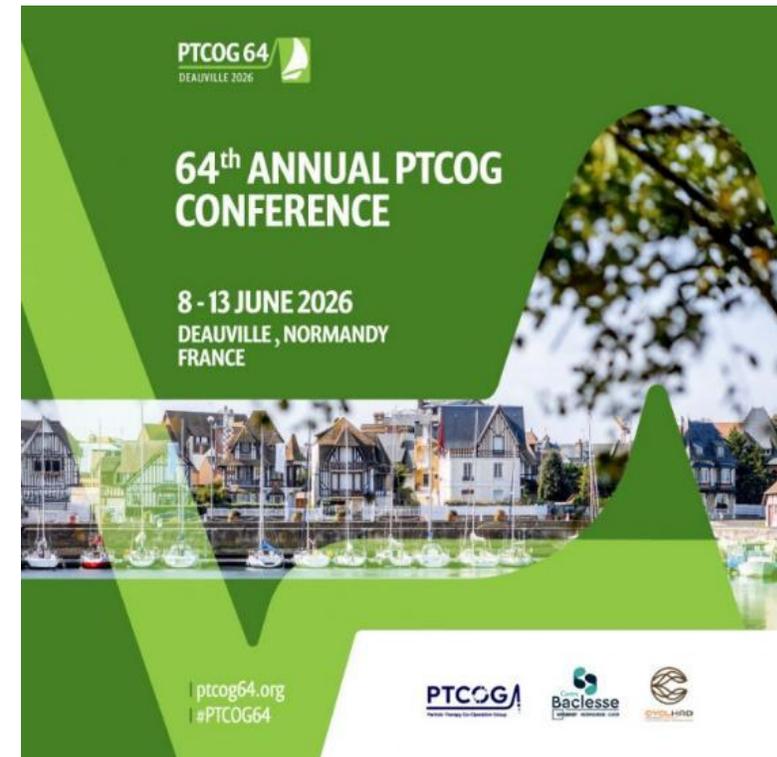
TAKE HOME MESSAGE

- CYCLHAD is a multi-ion facility running since 2018 for research & treatments
- The new compact C400 IONS system will be fully commissioned early 2028
- Great perspectives for Clinical & Physics research

SCIENTIFIC COMMITTEE



Particle Therapy International Congress





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THANK YOU

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