



# MEDICINE. RESEARCH. HOPE.

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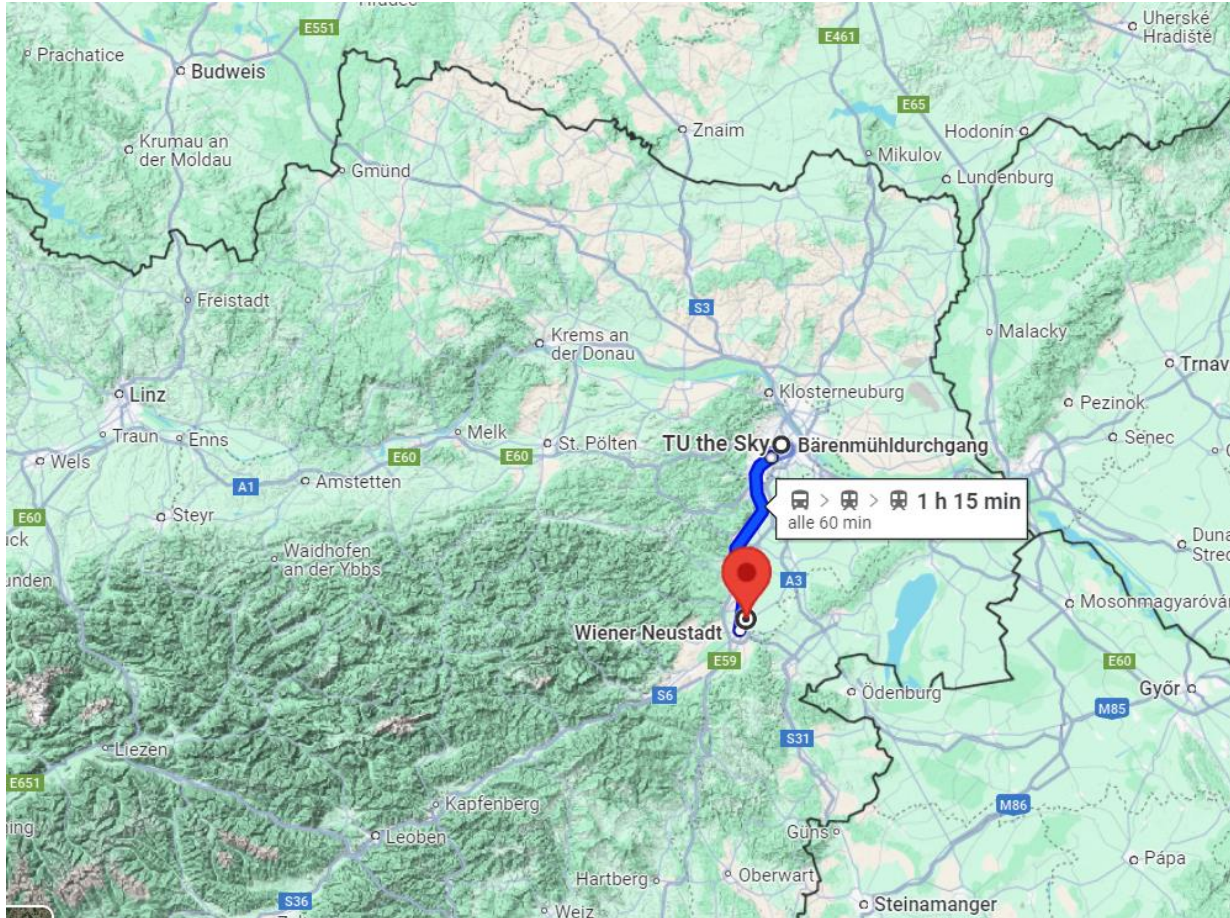
## Particle Therapy and Research at MedAustron

Last Update: 2024-05-17

*Photos / Graphics: MedAustron, Thomas Kästenbauer, Freepik/MedAustron, Kästenbauer/Ettl*

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# ABOUT MEDAUSTRON

Center for **particle therapy for cancer treatment** and for **research**.



**Is one of only six** comparable centers **worldwide**.



**Helps cancer patients** with an advanced and rare treatment method.

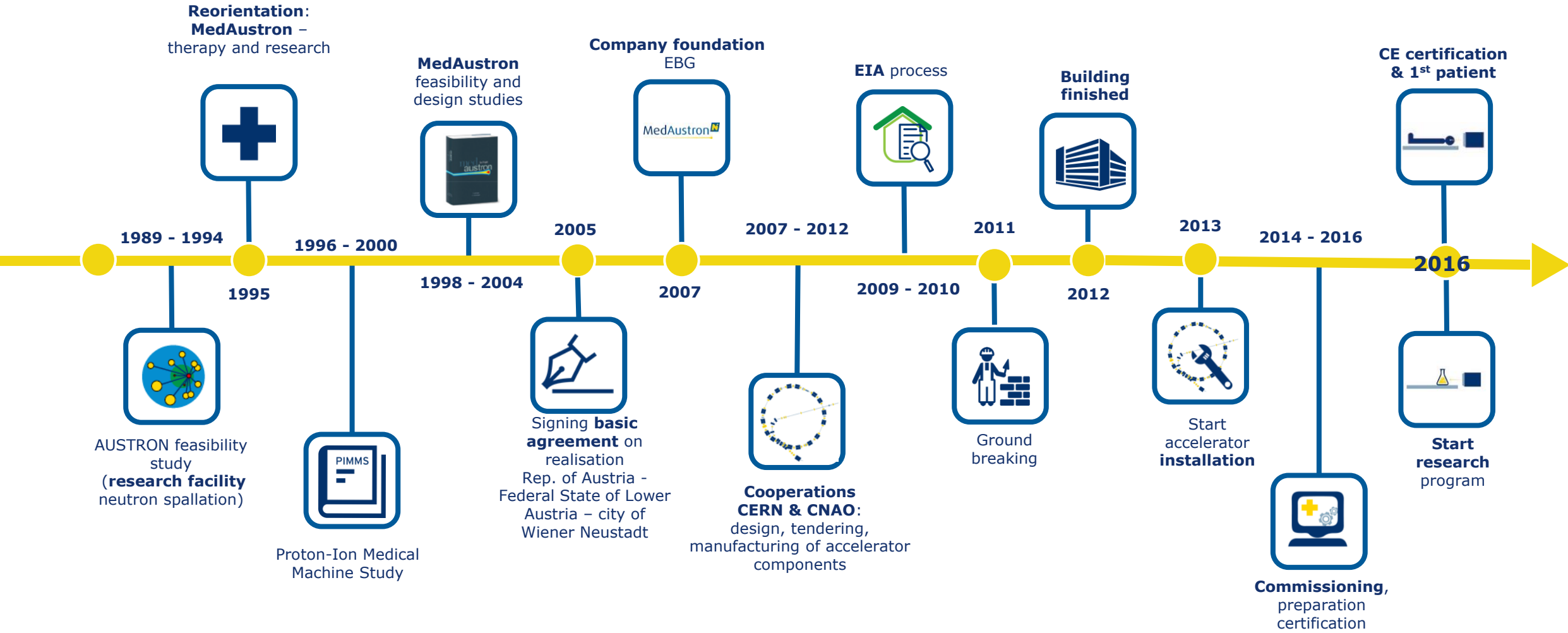


Improves particle therapy and **creates more evidence** through research.

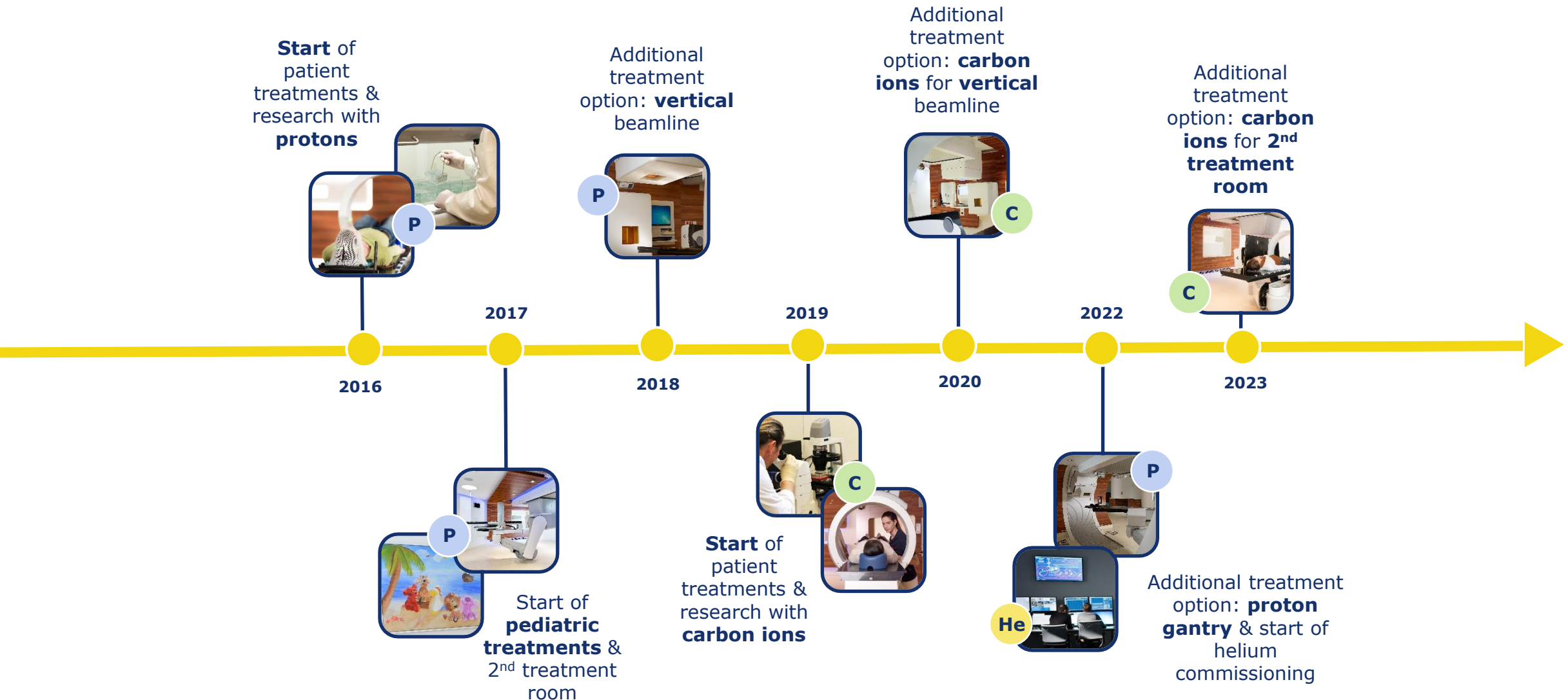


Has expertise in designing, building, commissioning, certifying & operating an accelerator.

# COMPANY HISTORY



# MILESTONES

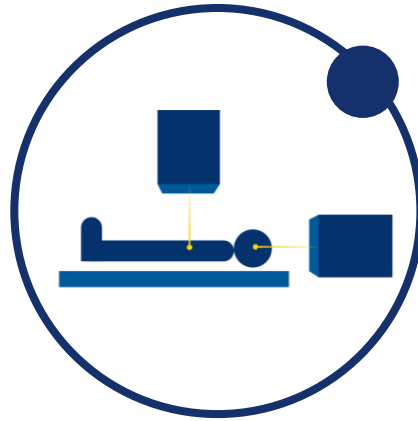


# INTERNATIONALITY



## TEAM

~300 employees from  
20 different countries



## CLINIC

Patients from all over  
Austria and abroad



## COOPERATIONS

With institutes,  
companies,  
professional societies  
worldwide

# THE THERAPY METHOD



Ion Beam or Particle Therapy



# TUMOR THERAPY



SURGERY



RADIOTHERAPY

- IMRT
- VMAT
- Gamma Knife
- Brachytherapy
- ...
- **PARTICLE THERAPY**

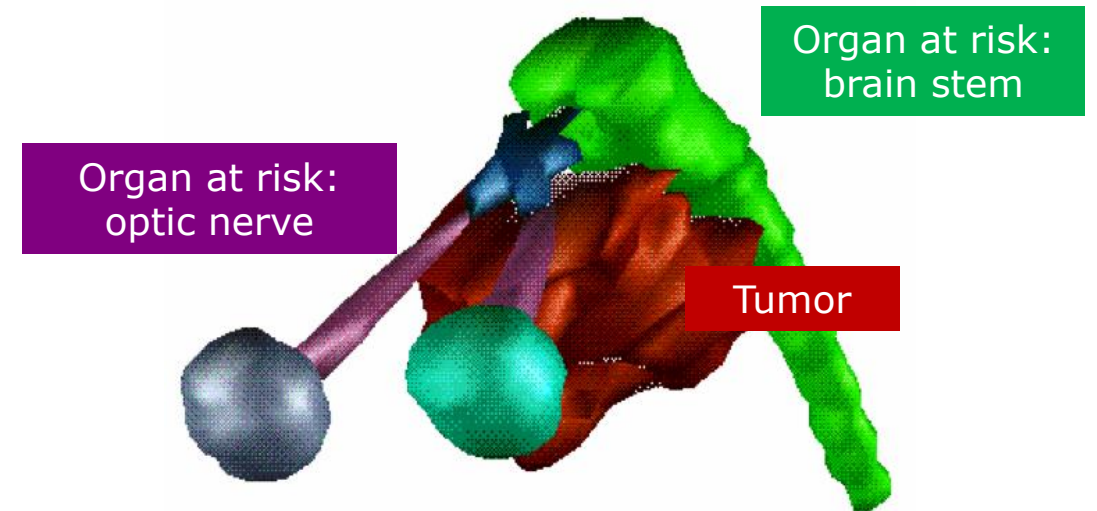
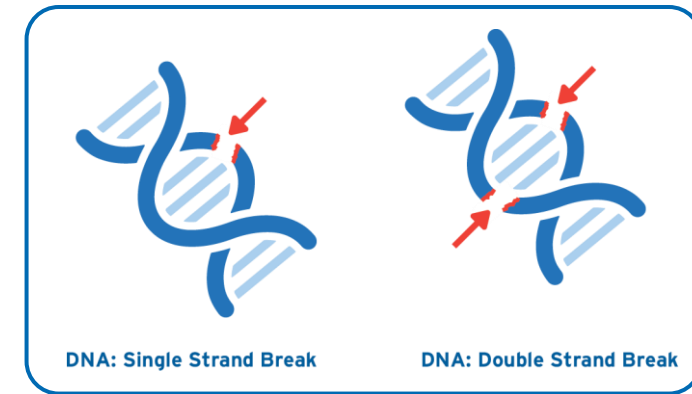


CHEMOTHERAPY



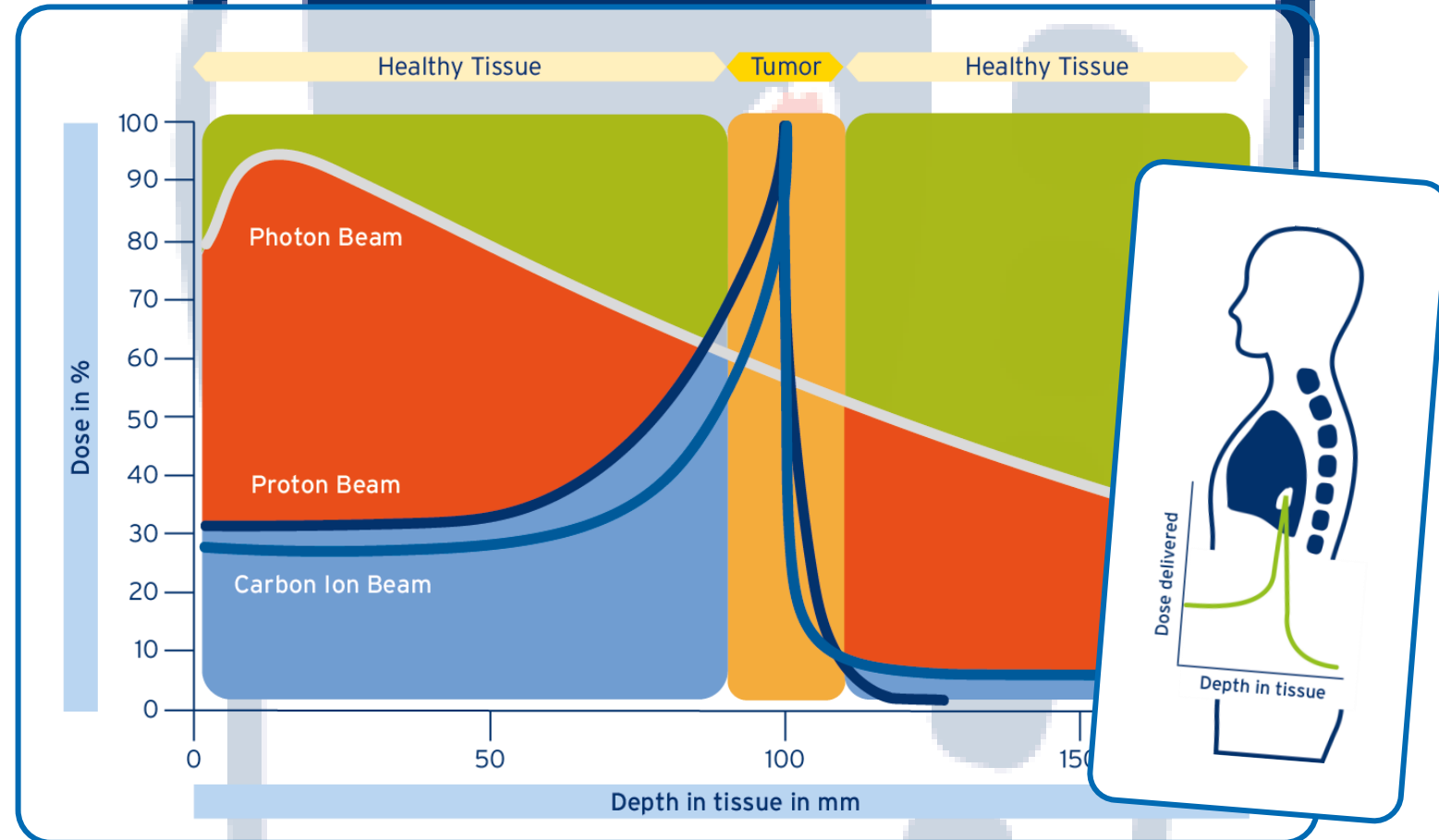
# RADIOTHERAPY IN GENERAL

- The aim is to **prevent further proliferation** of the cancer cells
- **Cancer cells** divide more often than normal cells → they **are more vulnerable to radiation**
- A **high radiation dose** in the tumor cells leads to DNA damage (ideally: double strand breaks) → the more damage, the less likely the cell can recover from it
- **Organs at risk** - healthy tissues/organs near the tumor - tolerate only a low radiation dose, e.g. brain stem, optic nerve, spinal cord, etc.



# THE PRINCIPLE OF PARTICLE THERAPY

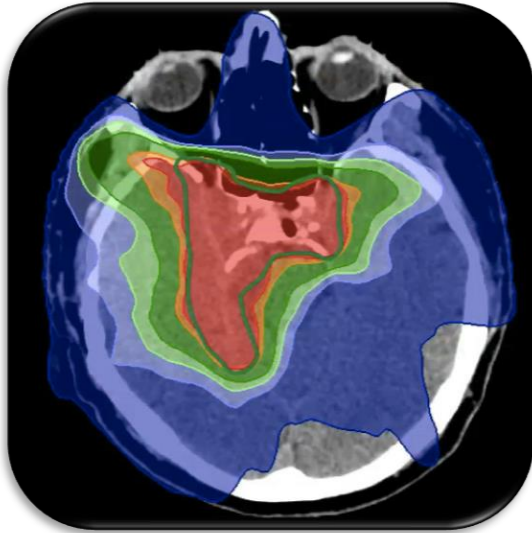
- »Bragg Peak« is the name of the **physical principle** underlying particle therapy.
- It entails **lower exposure** to radiation dose **in healthy tissue** (compared to conventional radiotherapy).
- This can **reduce side effects and late effects** of the therapy.



# TREATMENT PLANNING - COMPARISON

## PHOTONS

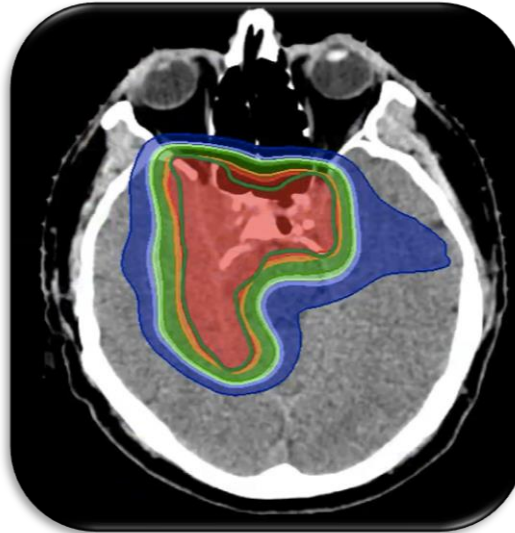
IMRT, VMAT, SBRT



Several fields, entry and exit dose

## PROTONS

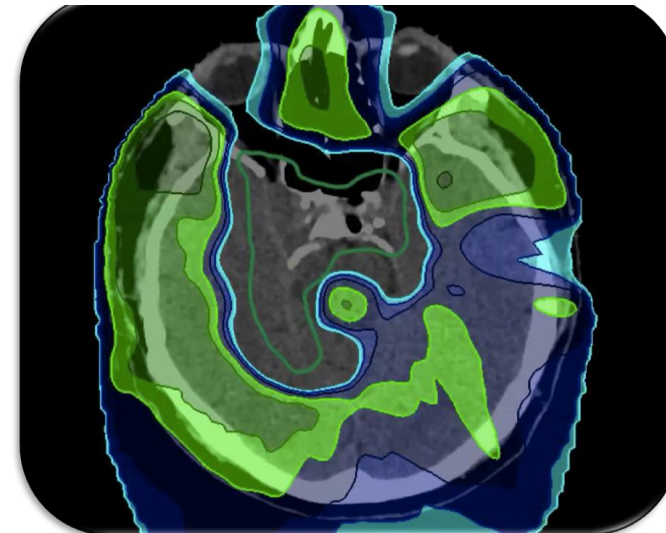
IMPT



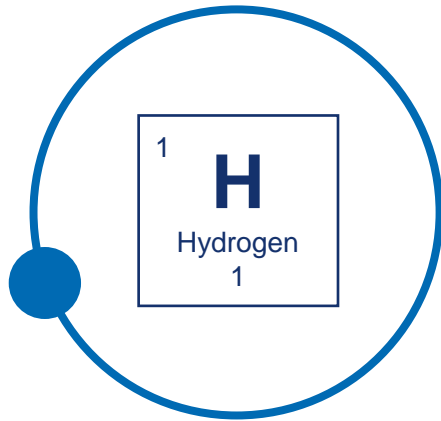
Fewer fields, reduced entry dose, no exit dose

## DOSE DIFFERENTIAL

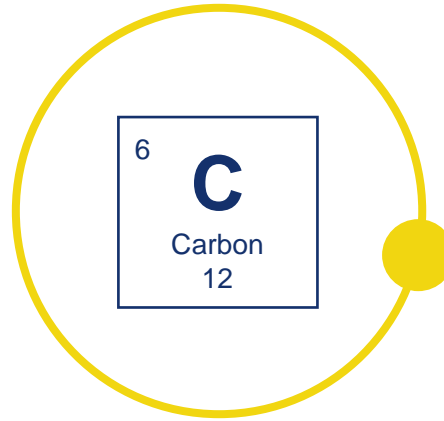
Photons minus Protons



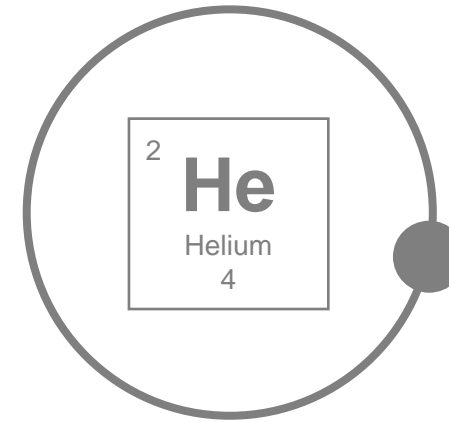
# PARTICLES IN PARTICLE THERAPY



PROTONS



CARBON IONS



HELIUM IONS

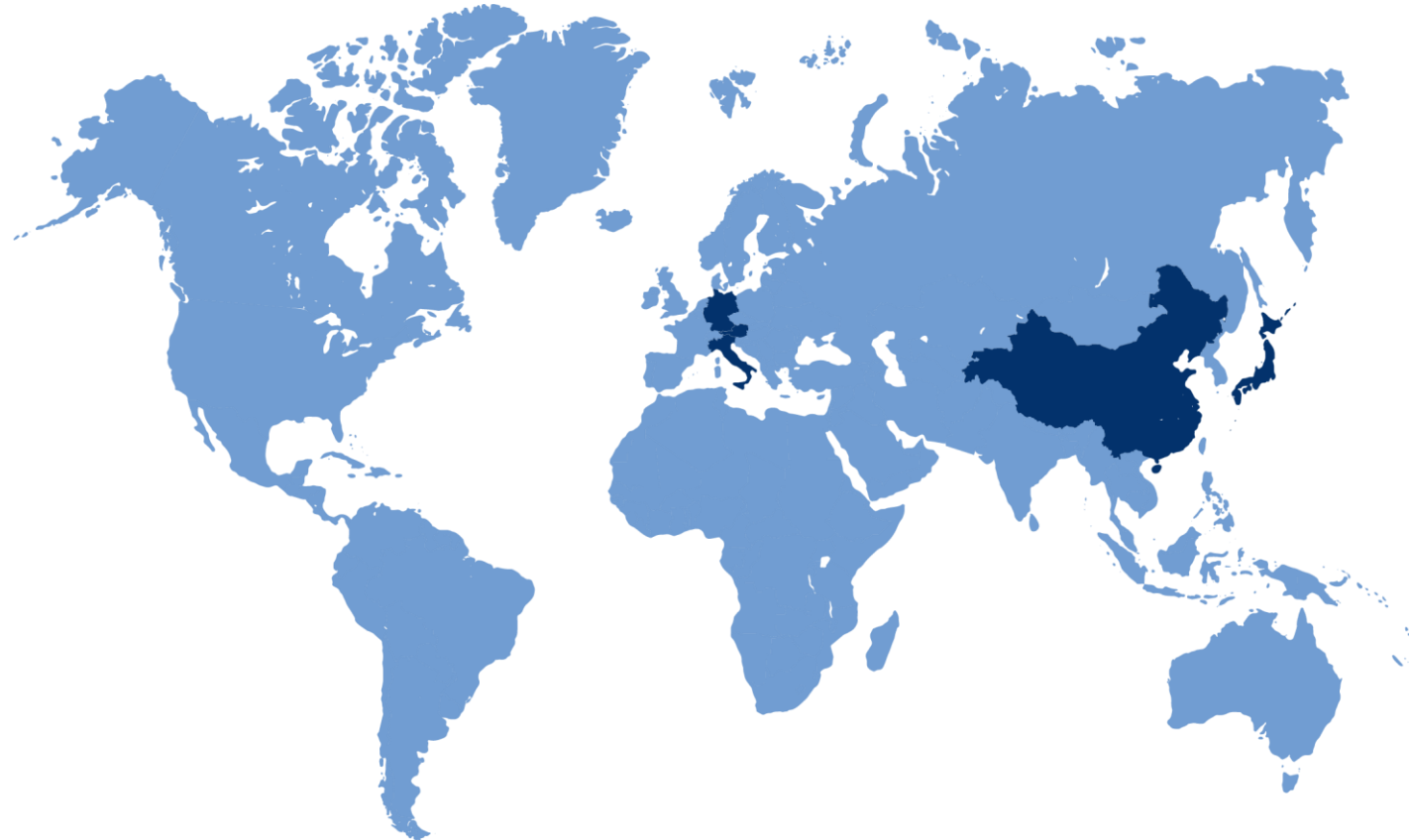
**Sparing** of organs at risk and healthy tissue

Higher dose in the tumor /  
application in  
**radioresistant tumors**

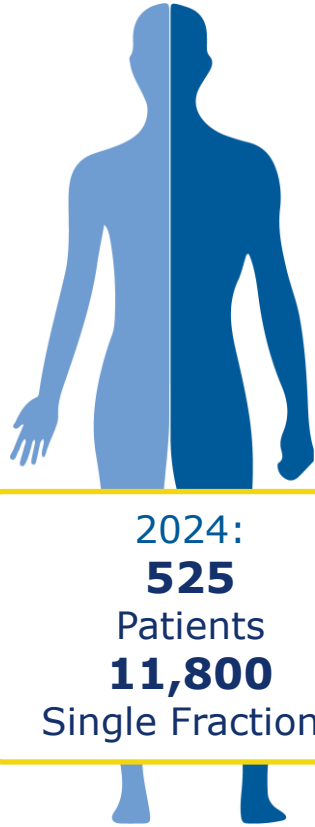
Possible future candidate  
– currently **subject of  
research**

# AVAILABILITY OF CARBON IONS

- Carbon ion therapy is available in only five countries worldwide:
  - **Austria – MedAustron**
  - Germany
  - Italy
  - China
  - Japan



# INDICATIONS TREATED AT MEDAUSTRON



2024:  
**525**  
Patients  
**11,800**  
Single Fractions

<b>CNS</b>	<b>25%</b>
<b>Head &amp; Neck</b>	<b>20%</b>
<b>Re-Irradiation</b>	<b>16%</b>
<b>Pediatrics</b>	<b>16%</b>
<b>Sarcoma</b>	<b>12%</b>
<b>Skull Base</b>	<b>5%</b>
<b>Prostate</b>	<b>3%</b>
<b>Gastrointestinal (upper)</b>	<b>2%</b>
<b>Thorax</b>	<b>1%</b>
<b>Gastrointestinal (lower)</b>	<b>&lt;1%</b>
<b>Urogenital Tumors</b>	<b>&lt;1%</b>
<b>Breast/Mamma-Ca</b>	<b>&lt;1%</b>
<b>Gynecological Tumors</b>	<b>&lt;1%</b>

Values (rounded) as of April 2024

# THE TECHNOLOGY BEHIND IT



Particle Accelerator and Medical Technology

# „SANDWICH“ TECHNOLOGY

- Excavated material used to build the walls instead of concrete
- Savings:
  - 25000m<sup>3</sup> concrete
  - 2500 t construction steel
  - € 7 Mio. costs
  - 6 months construction time
  - 10000 truck loads





# FACILITY OVERVIEW

## Irradiation Rooms

Three rooms for patient treatments

## Research

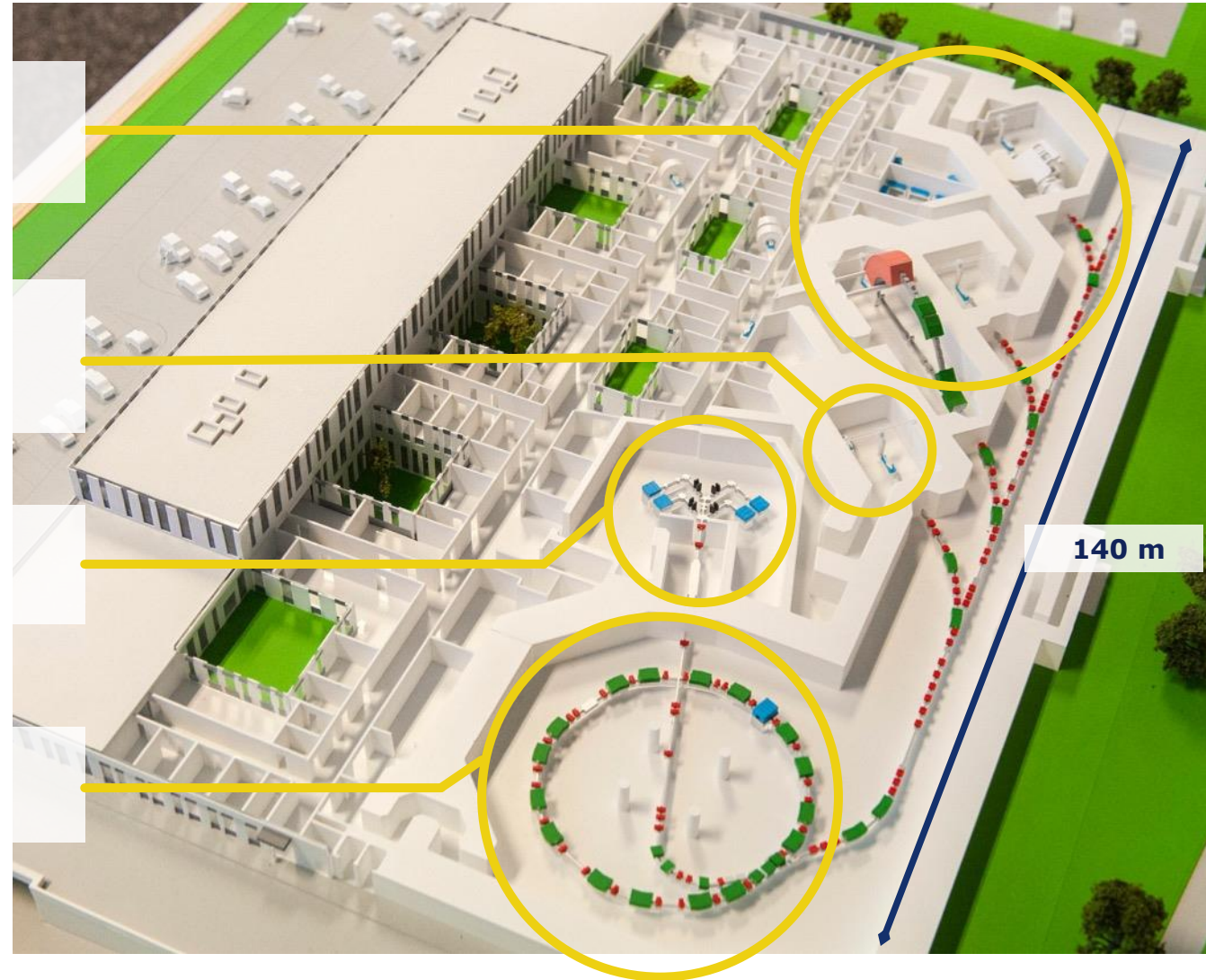
Irradiation room for non-clinical use

## Ion Sources

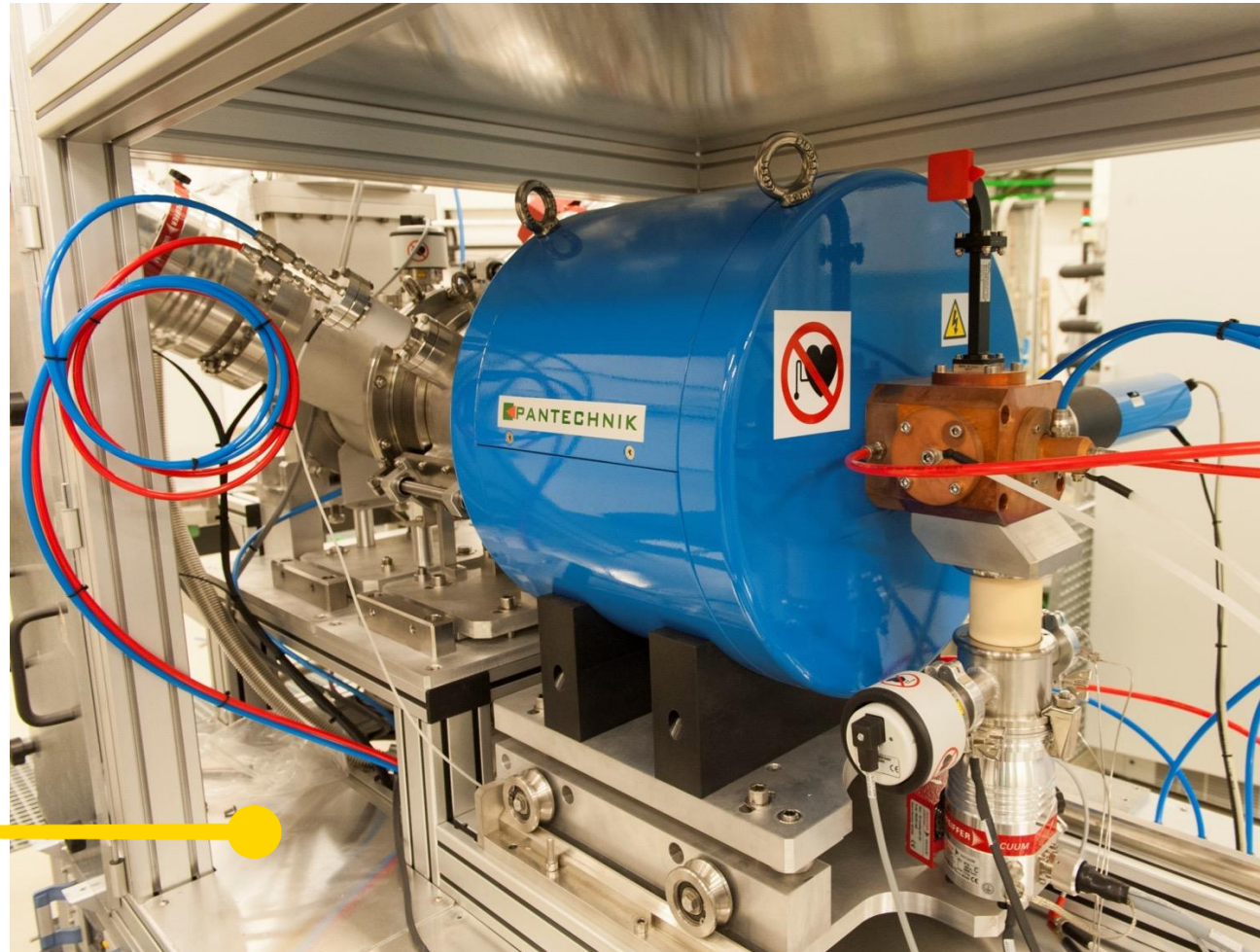
and linear accelerator

## Synchrotron

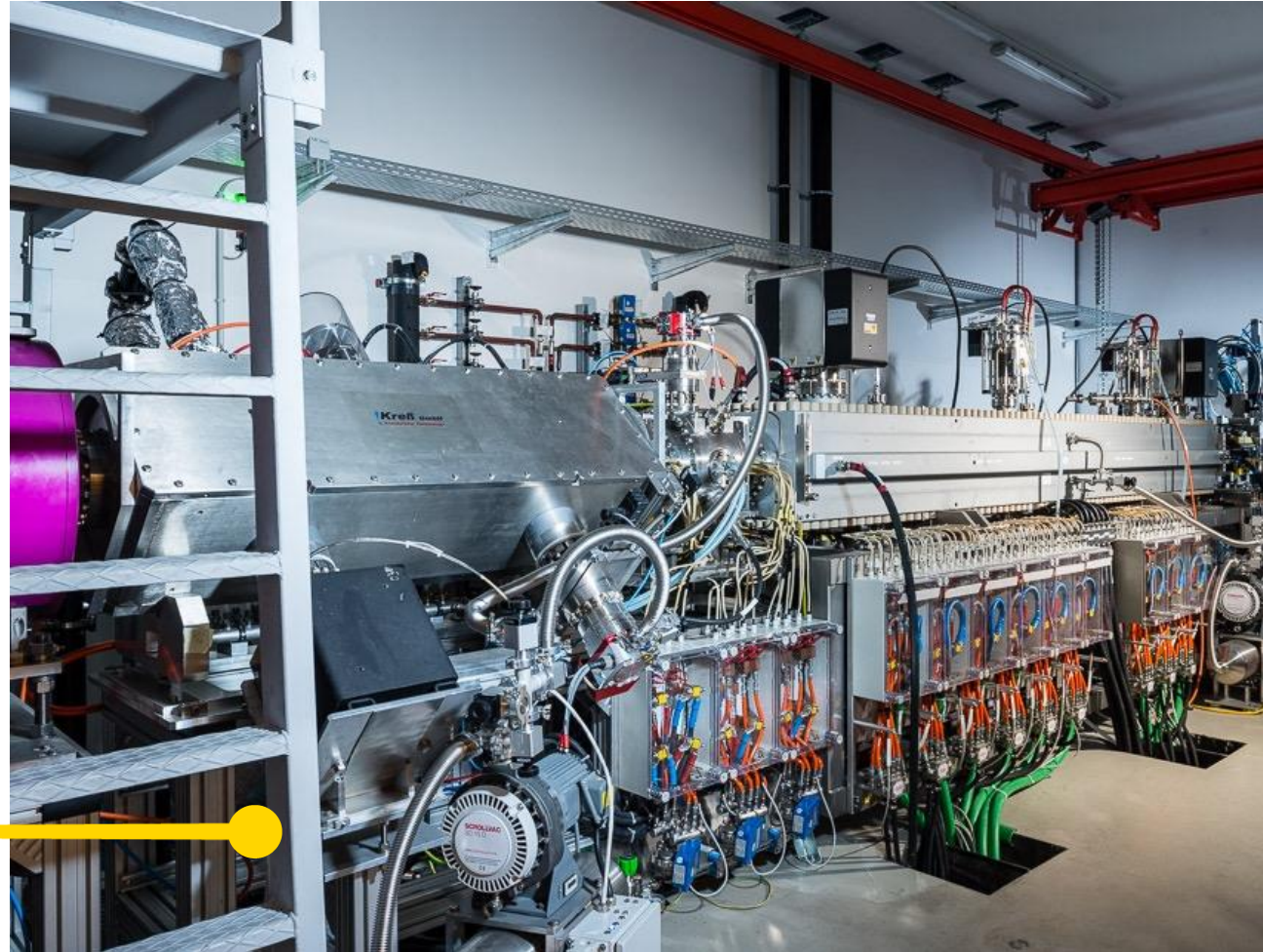
= circular accelerator



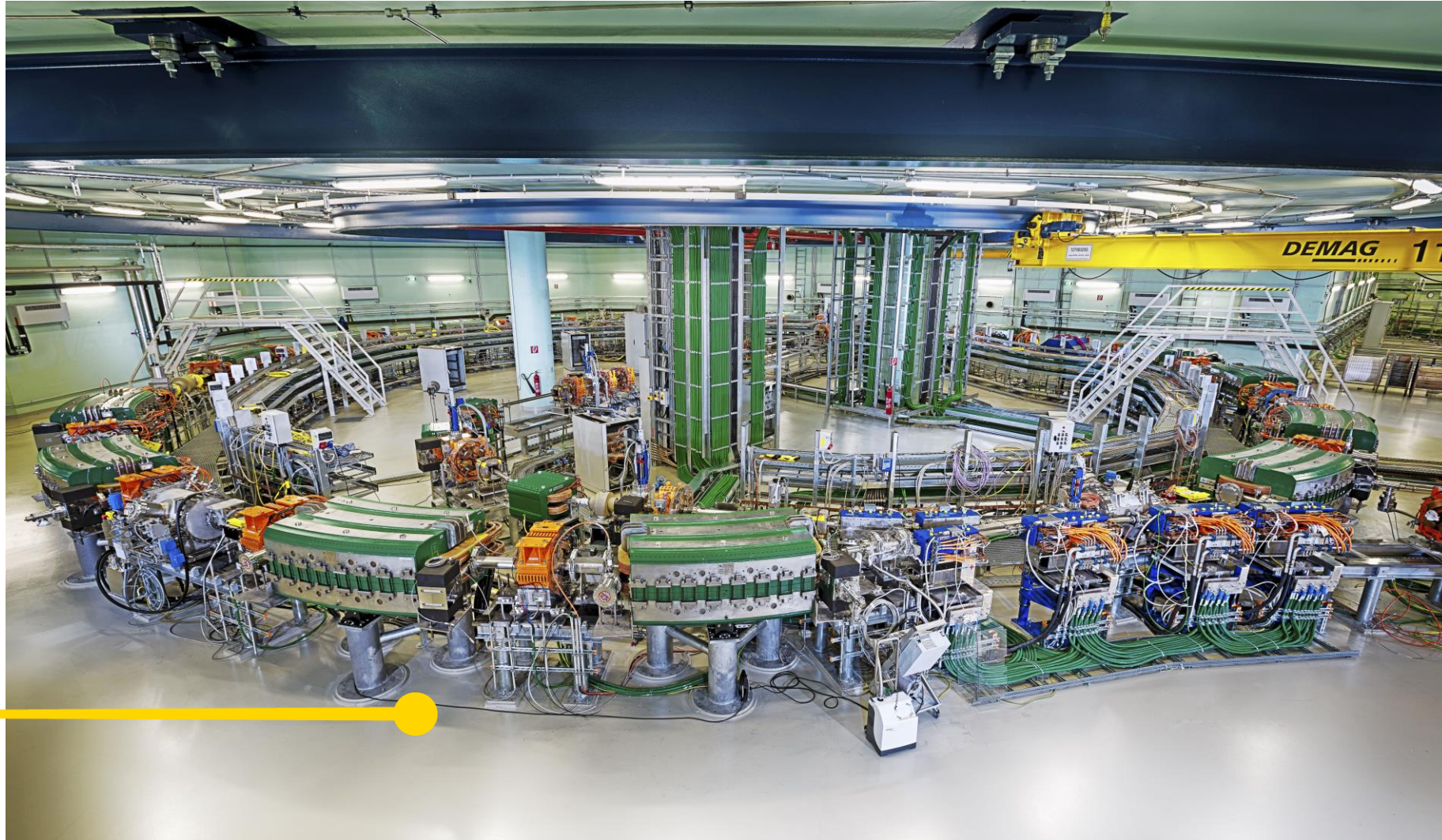
# STARTING POINT OF THE PARTICLE BEAM: ION SOURCES



# ACCELERATION (1): LINEAR ACCELERATOR



# ACCELERATION (2): SYNCHROTRON



# PATIENT POSITIONING ROBOT



# IMMOBILIZATION OF PATIENTS



# IRRADIATION ROOM FOR RESEARCH



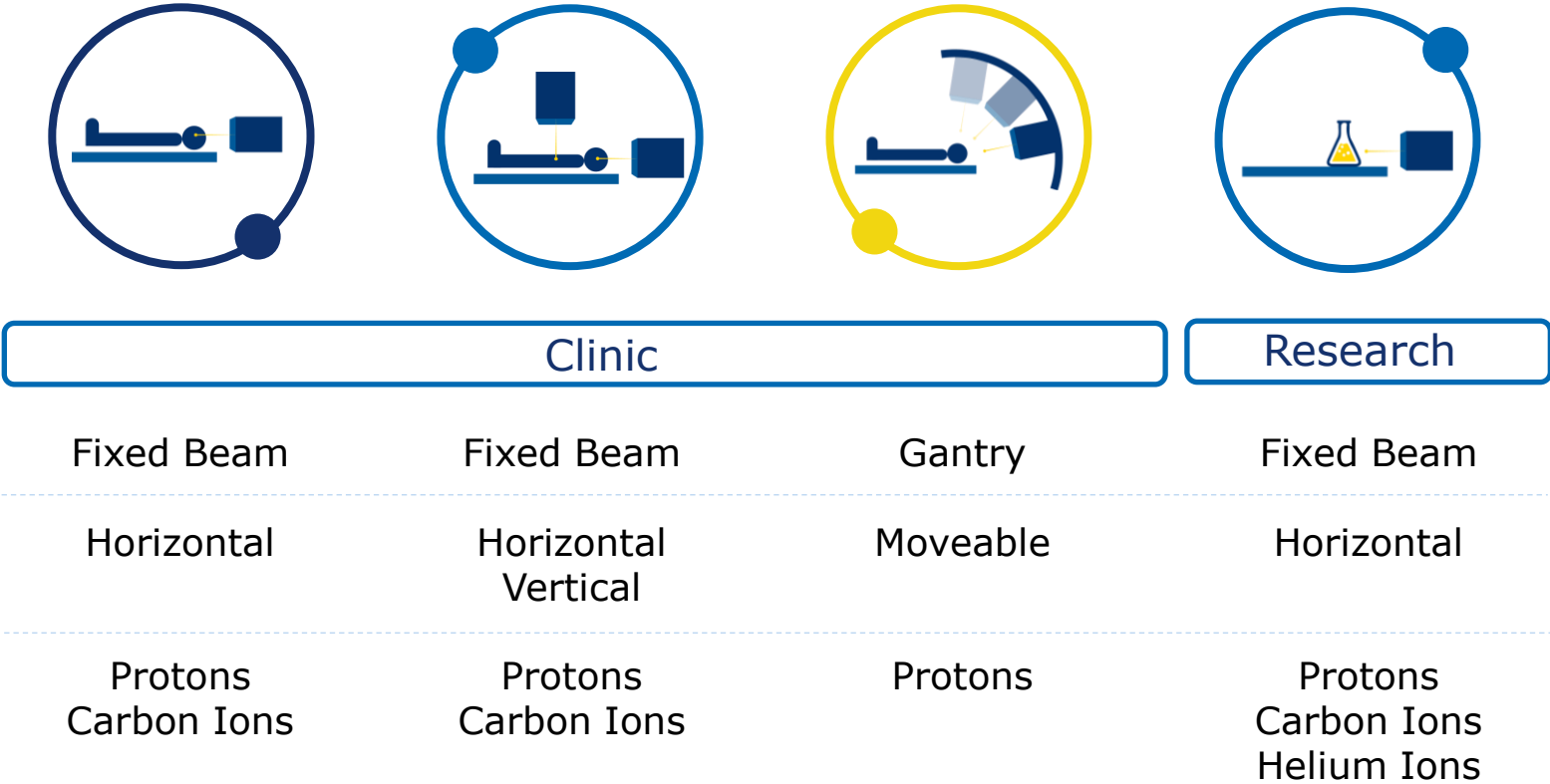
# PROTON GANTRY





# IRRADIATION ROOMS

**Which particles can be applied from which directions?**



# AREAS OF RESEARCH

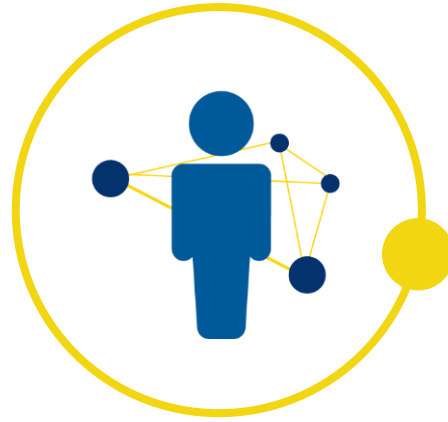


Clinical • translational • scientific

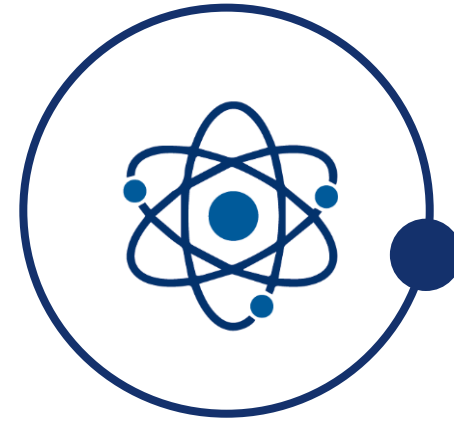
# RESEARCH AT MEDAUSTRON



CLINICAL  
RESEARCH



INTERDISCIPLINARY  
ONCOLOGY  
RESEARCH



TRANSLATIONAL &  
SCIENTIFIC  
RESEARCH

# CLINICAL RESEARCH

- **Registry study:** 1,641 patients included\*
  - Documentation of clinical results (therapy response) and side effects (toxicity)
- **12 clinical studies\*** (monocentric, multicentric or participation as a treatment center)
  - Disease-specific; e.g. for pancreatic tumors, chordoma, sarcoma, inoperable tumors, etc.)
- **Goal:** Creating more evidence in particle therapy



*Registry study:  
neurocognitive test*



\* as of April 2024

# INTERDISCIPLINARY ONCOLOGY RESEARCH

- MedAustron is a teaching and research site of the Karl Landsteiner University of Health Sciences
- Two professorships at KL:
  - **Radiation Oncology**
  - **Medical Physics**



**Markus Stock,**  
Professor of Medical Physics



**Piero Fossati,**  
Professor of Radiation Oncology



# NON-CLINICAL RESEARCH AT MEDAUSTRON – ACHIEVEMENTS AND OUTLOOK

ON BEHALF OF **THOMAS SCHREINER**

## Non-Clinical Irradiation Room – IR 1

- dedicated irradiation room with 8 m × 12 m, i. e. 96 m<sup>2</sup>
- same positioning and verification system as used in the medical irradiation rooms
- optional passive beam modifier system for small field sizes
- research magnet with a magnetic field from 0 T to 1 T
- adjacent cooling-down room for storage of activated material
- additional beam parameters:
  - ▶ up to 800 MeV protons
  - ▶ dedicated low flux settings for protons, i.e. 4.7 MHz, 350 kHz, 3 kHz
  - ▶ helium ions in 2024



Commissioning of low particle flux for proton beams at MedAustron  
Felix Ulrich-Pur<sup>a,\*</sup>, Laurids Adler<sup>c</sup>, Thomas Bergauer<sup>a</sup>, Alexander Burker<sup>b</sup>, Andrea De Franco<sup>c</sup>,  
Greta Guidoboni<sup>c</sup>, Albert Hirtl<sup>b</sup>, Christian Imler<sup>b</sup>, Stefanie Kaser<sup>a</sup>, Sebastian Nowak<sup>c</sup>,  
Florian Pitters<sup>a</sup>, Mauro Pivi<sup>c</sup>, Dale Prokopovich<sup>c</sup>, Claus Schmitzer<sup>c</sup>, Alexander Wastl<sup>c</sup>

Non-Clinical Research at MedAustron – Achievements and Outlook ◊ Thomas Schreiner ◊ September 19, 2023

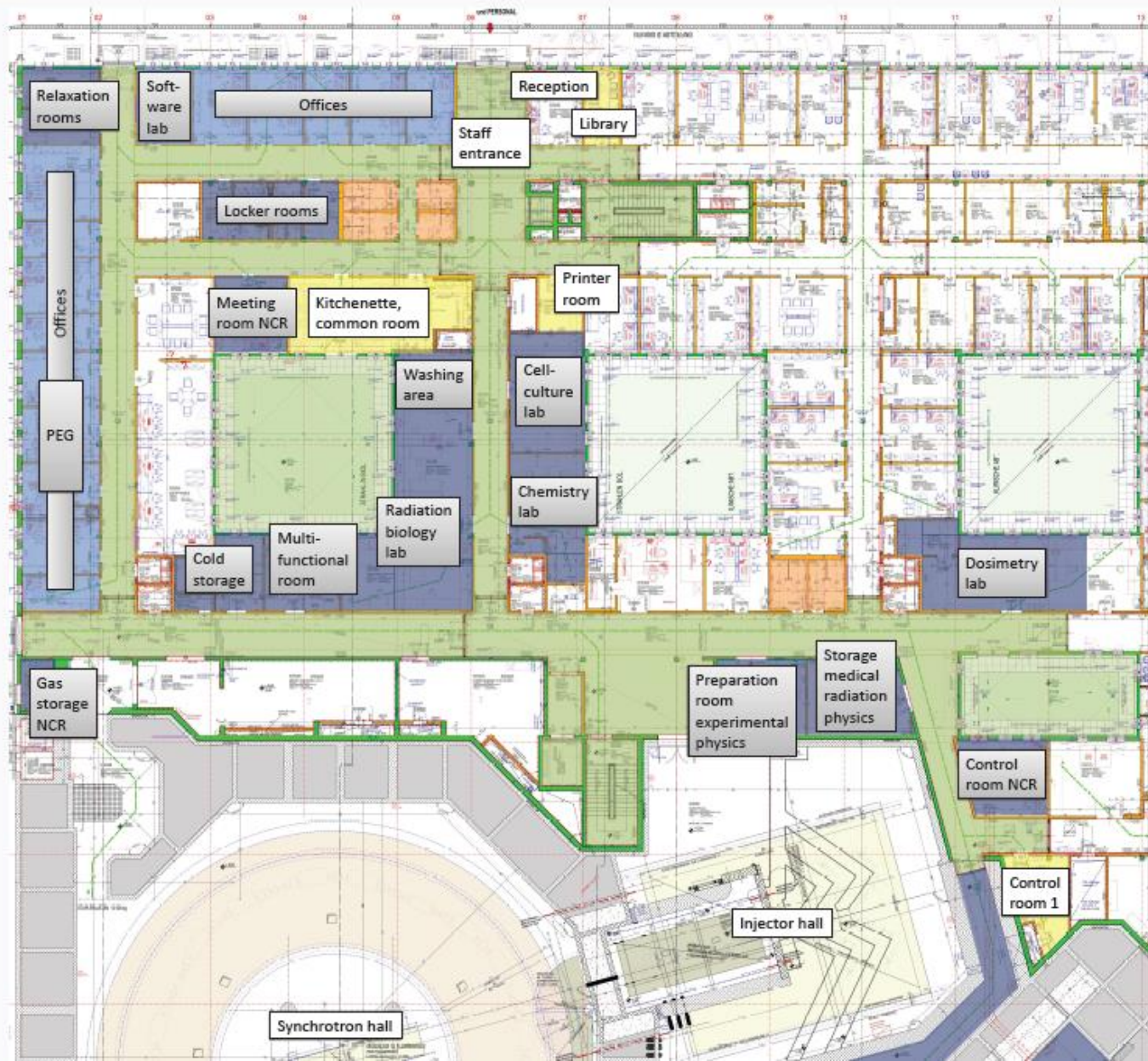
# Rooms for Non-Clinical Research

## ground floor:

- 11 offices with  
25 workplaces
- 6 labs
- 3 storage rooms
- 1 irradiation room

## basement:

- 5 offices with  
10 workplaces
- 3 labs



# Main Collaborations



MEDICAL UNIVERSITY  
OF VIENNA

Medical University of Vienna



HEPHY  
INSTITUT FÜR HOCHENERGIEPHYSIK Institute of High Energy Physics



TECHNISCHE  
UNIVERSITÄT  
WIEN

Vienna University of Technology



TU  
Graz Graz University of Technology



FACHHOCHSCHULE  
WIENER NEUSTADT  
Austrian Network for Higher Education  
University of Applied Sciences

University of Applied Sciences  
Wiener Neustadt



FOTEC  
Forschungsinstitut  
der FH Wiener Neustadt

Research Subsidiary of the  
FH Wiener Neustadt



Medical University of Graz

Medical University of Graz



SEIBERSDORF  
LABORATORIES

Seibersdorf Laboratories,  
Aerospace Engineering



KARL  
LANDSTEINER KL  
PRIVATUNIVERSITÄT FÜR  
GESUNDHEITSWISSENSCHAFTEN

Karl Landsteiner University of Health Sciences

two professorships for radio-oncology and medical  
physics, both related to particle therapy



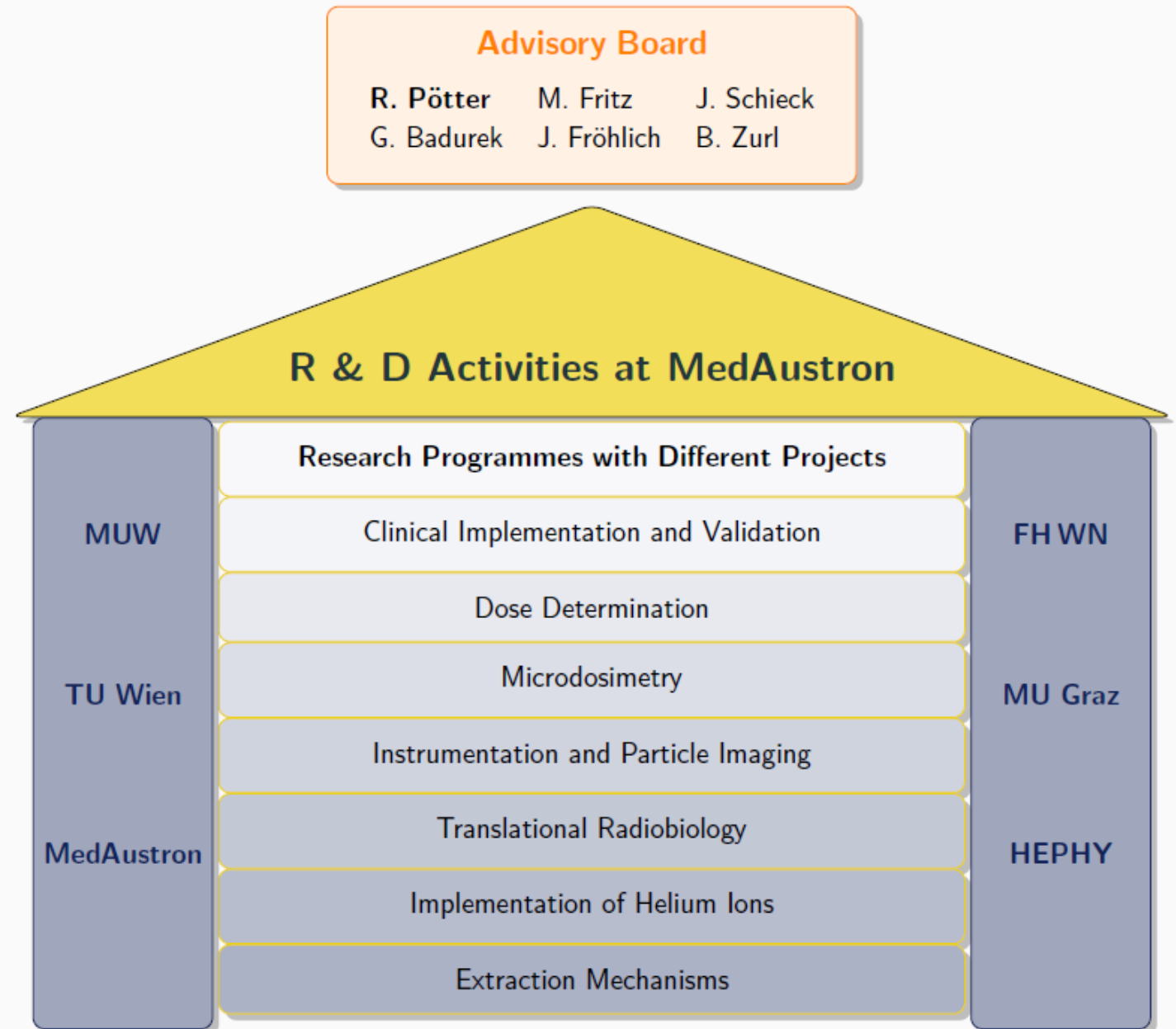
# Research Programmes: Achievements and Outlook

- three research programmes:  
2016–2018 | 2019–2021 | 2022–2024
- almost 750 beam time shifts used
- 121 accepted publications
- 110 successfully finalised academic theses  
20 PhD | 50 MSc | 40 BSc
- preparation of beam time shifts for 2025 (132 shifts)
- preparation of upcoming research period 2025–2027
- strategy for non-clinical research after 2031



# Research Organisation

- 1 Advisory Board meeting per year
  - recommendations on beam time distribution
  - report to the ministry
- 11–12 Executive Committee meetings per year
  - progress reports of the projects
  - organisational issues
- biweekly seminar on research projects



# Structure of the Research Programme – Research Fields and Work Packages

- Instrumentation for High-Energy Physics and Medical Applications
- Space Research
- Dose Determination

- Pre-Clinical Animal Research
- Translational Radiobiology

Applied Particle and Medical Physics

Technological Innovations and Clinical Implementation

Research Strategy 2025 – 2027

Biophysics and Molecular Radiobiology

Accelerator Physics

- Microdosimetry
- Clinical Implementation

- Optics and Dynamics
- Experimental Beam Modalities

- Teaching, Quality Assurance, Exploratory Studies and Emerging Topics