
# PRISMAS-MAP
## MEDAUSTRON PROPOSAL

Geneva, 19.09.2019

# HISTORY

1989 – 1994

Predecessor -Project „AUSTRON“: Research Facility for Neutron spallation

1995

New Orientation: MedAustron

1999 – 2004

Financial agreement with Land NÖ, Design study, Agreement for Realisation

2005

Signature of Base Contract

State – Land NÖ – City WN

2007

Founding GmbH, Cooperation with CERN and CNAO

2010 – 2012

Positive EIS-decree, Construction of Building

2013 – 2016

Construction, Commissioning, Certification

2016

Start Treatment

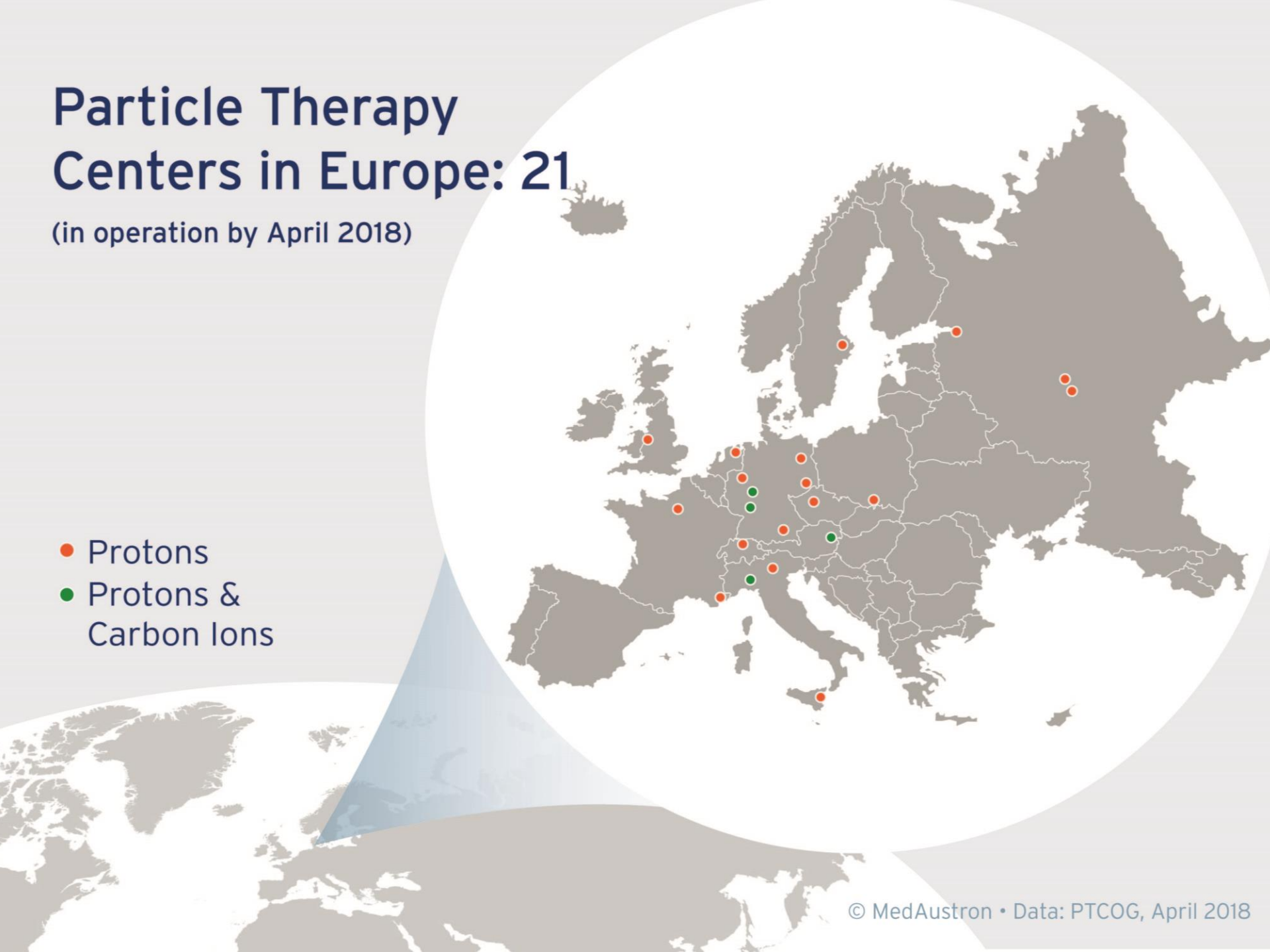
# Kohlenstoffzentren weltweit: 11

(in Betrieb bis August 2017)


© MedAustron • Daten: PTCOG, August 2017

# Particle Therapy Centers in Europe: 21

(in operation by April 2018)



# MedAustron in Austria

MedAustron Center


Wiener Neustadt


# MedAustron in Austria

## OWNERSHIP STRUCTURE

**Federal State of Lower Austria**

**100 %**

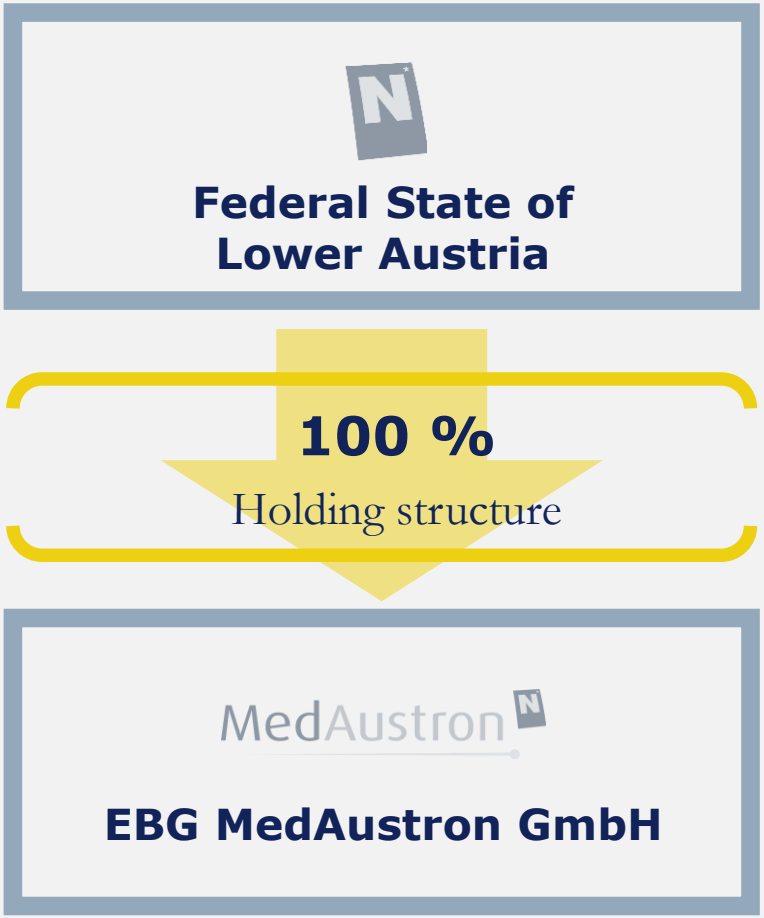
Holding structure

**EBG MedAustron GmbH**

MedAustron Center


# MedAustron in Austria

## OWNERSHIP STRUCTURE




Our main task is the operation of the facility as an outpatient clinic (OPS).

Treatment of up to 1000 patients/year in full operation from Austria and foreign countries.

We focus on the further **development** of this treatment method and the **technology** behind (**M**anufacturer **T**herapy **A**ccelerator).

Our facility is used for basic and translational research and provides non-clinical research area.

»EBG« stands for construction and operating company.

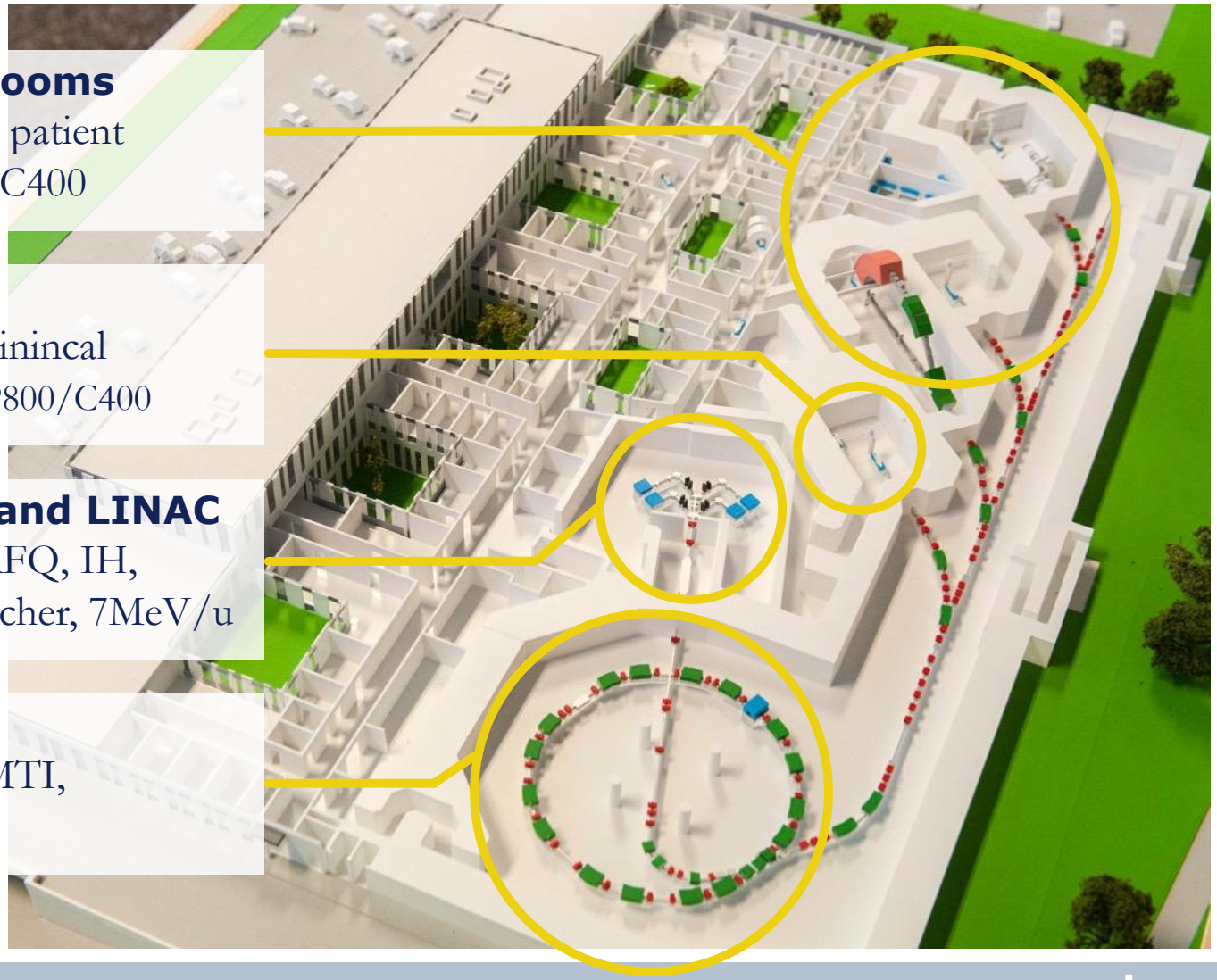
# MEDAUSTRON FACILITY

**Irradiation Rooms**
Three rooms for patient treatment P252/C400

**Research**
dedicated non-clinincal research room P800/C400

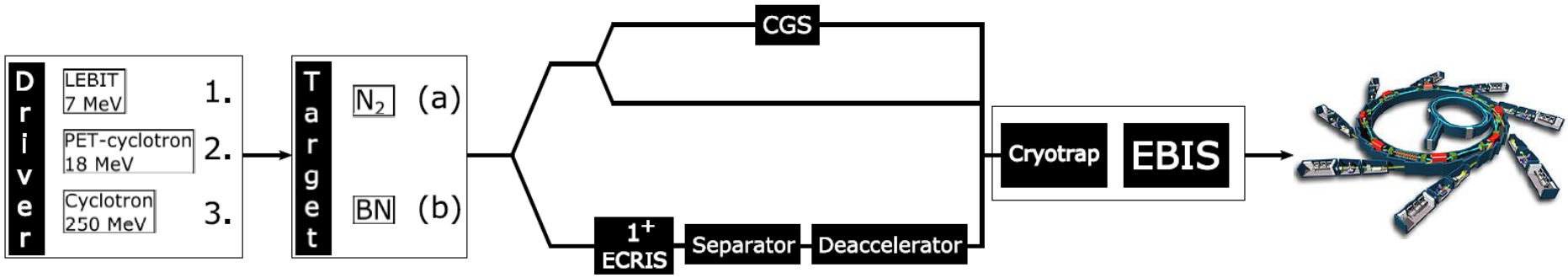
**Ion Sources and LINAC**
Three sources, RFQ, IH, Buncher, Debuncher, 7MeV/u

**Synchrotron**
$B\rho < 6.34$ Tm, MTI, slow extraction



# MEDAUSTRON – MEDICIS PROMED

- MedAustron was part of the Medicis Promed Network
- Contributed to TDR for implemention of C-11 use in european medical treatment facilities (MedAustron/CNAO)
- Studied options of integration in existing facilties



# MEDAUSTRON AS A NETWORK PARTNER

**MedAustron is aiming to:**

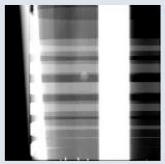
- **become a center of excellence in the field of particle therapy**
- **broaden the range of indications and treatment methods**
- **increase performance and number of patients treated**
- **improve treatment quality**
- **follow up development of online radioisotope beam production**
- **provide access to a functioning treatment facility for testing of technology in clinical environment**

# MEDAUSTRON NON-CLINICAL RESEARCH

## Intrafraction Adaptive Radiation Therapy

- Intrafraction Surveillance Optimisation
- Markerless Real-Time Tumour Motion Imaging

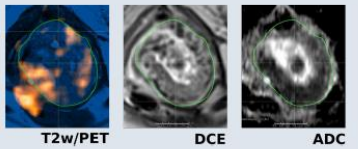
- 4D Dose Calculation and Beam Delivery Optimisation




- End to End Testing
- Eye Treatment Solution for MedAustron

## Interfraction Adaptive Radiation Therapy

- Quantitate Evaluation of mpMRI for Clinical Pilot Studies

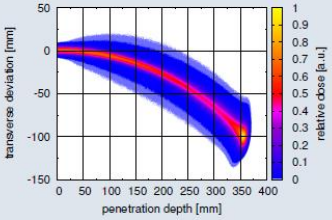


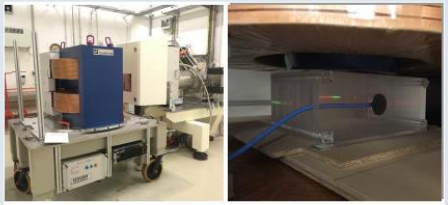

- ART via In-Room CBCT

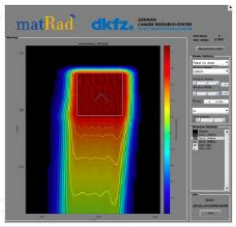
- Particle Therapy PET
- Monte Carlo Patient Specific QA

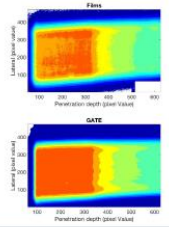
## Magnetic Resonance Guided Particle Therapy

- Magnetic Resonance Workflow Development
- Dose Calculation
- Dosimetry



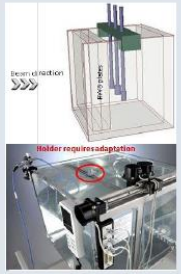



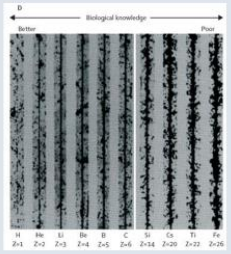


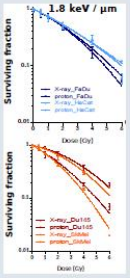



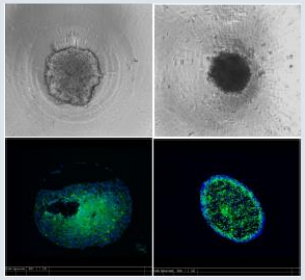
## Energy Transfer Mechanisms and Applications in Biology and Physics

- Method Establishment
- Model Development for Microdosimetry
- Immunologically Hot Tumours
- Immunologically Cold Tumours



# MEDAUSTRON IN A JOINT RESEARCH ACTIVITY

- **Proposal of a workpackage on Radioisotope application in particle therapy**
- **Potential aspects of the Workpackage:**
  - Study and improve PET imaging supported by radioisotope beams
  - Study and propose technologies for integration of radioisotope beams in european treatment facilities
  - Develop required components for radioisotope beams for particle therapy -> eg high efficiency Ion Source
- **JRA - Ion Source Development**
  - Design (EB)IS suitable to fulfill the requirements for integration into existing treatment facilities
  - Prototyping and execution of preliminary tests
  - Integration of EBIS into existing facility and perform efficiency tests
  - Provide test facility for other ISOL developing institutions within PRISMA-MAP

# REQUIREMENTS ON ION SOURCE

| | | |
|---|---|---|
| Intensity per pulse | $>10^{10}$ | $^{11}C^{+4}$ Ions |
| Pulse repetition rate | < 0.2 | Hz |
| Pulse length | 2-30 | µs |
| Emittance | < 180 | pi mm mrad |
| Molecular break up | CO -> C | |
| Preferred charge state | $C^{+4}$ | |
| Optional charge states | $C^{+5}$, $C^{+6}$ | |
| Extraction Energy | 8 | keV/amu |
| Gas refilling | CO – continous | |
| Gas release | pulsed heating | |

- The source must provide $10^{10}$ particles during a synchrotron multiturn injection pulse which lasts 2-30 us.
- A pulse is expected every 5-10 seconds
- In between pulses the source may remain on or off. Any outgoing beam will be blocked by a fast deflector.

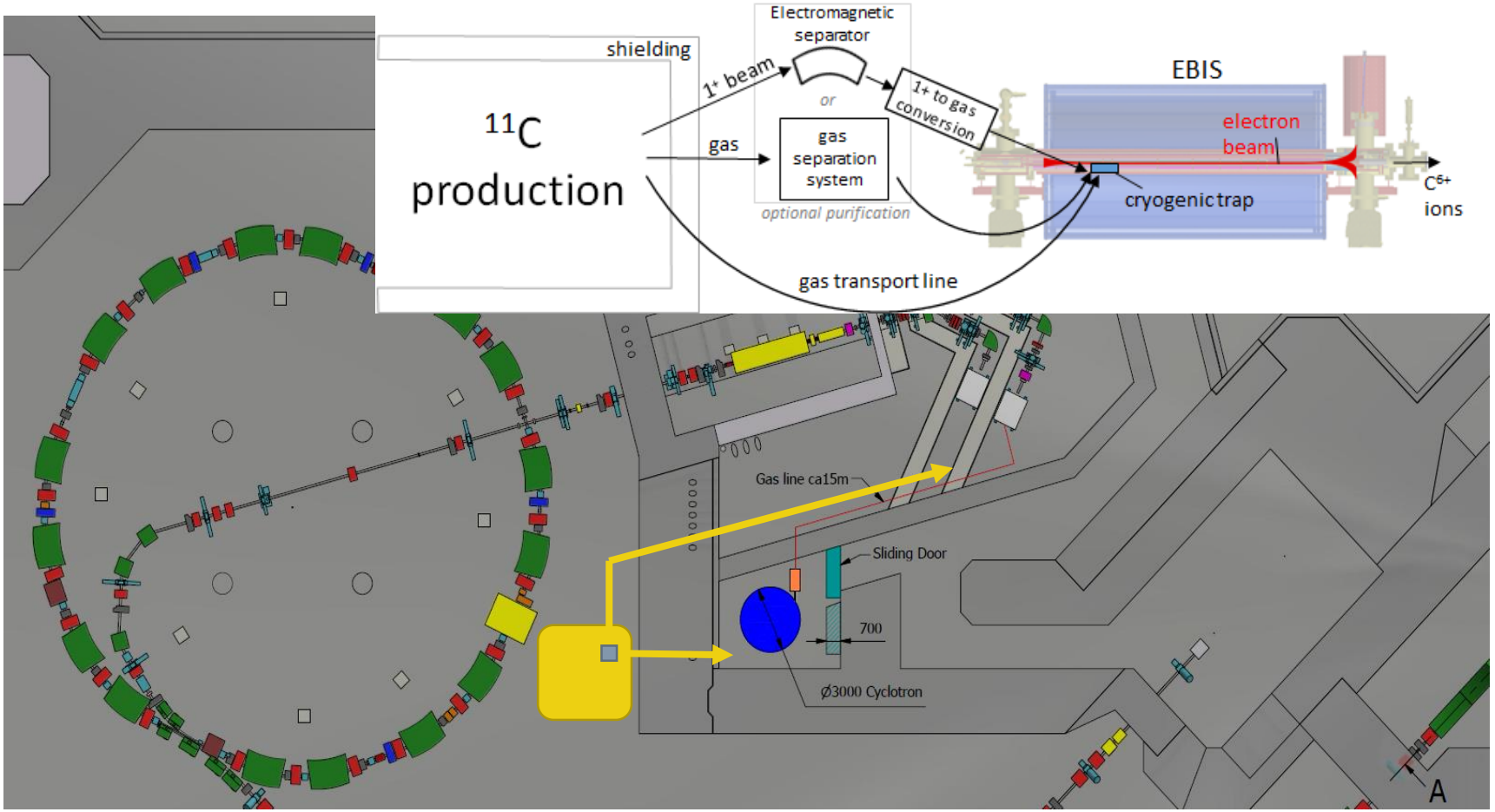
# TYPICAL CYCLE DEG100

- **Carbon cycle duration 9.5s**

| Sector | Time Structure | Current [µA] | #Parts | Efficiencies |
|---|---|---|---|---|
| S2 | DC | 100 | n.a. | n.a. |
| LEBT | 25µs | 75 | 2.90E+09 | n.a. |
| LI | 25µs | 47 | 1.80E+09 | 62.1% |
| MEBT | 25µs | 68 | 1.70E+09 | 94.4% |
| MR-CTS | debunched | n.a. | 4.20E+08 | 24.7% |
| IR2 | 5s | 1.22E-04 | 3.17E+08 | 75.5% |

- **Total efficiency 10.9%**
- **Clinically DEG20 will be used!**
- **Typical treatment 1e9 carbons (varies a lot!!)**

# TDR – C11 STUDY IN TREATMENT CENTER (MEDAUSTRON)



# POTENTIAL IS - EBIS

## High efficiency Ion Source (EBIS)

- Accumulate $^{11}CO$ in a cryo trap which shall be integrated into the EBIS or in the close vicinity.
- Shock heat the cryo trap for pulsed release of $^{11}CO$ (see Dubna source)
- Inject $^{11}C^{+4}$ pulse ($10^{10}$, <30us) into the existing accelerator structure (RFQ,IH-Tank, Synchrotron)
- Accelerator chain transport efficiency for Carbon-12 beams is ≈10%

# MEDAUSTRON JRA – ISOPROT:

- **High efficiency Ion Source (see JRA - OptION)**
  - Required for radioactive beam line
    (see Medicis Promed TDR for C-11 treatment facility)
  - Post-Doc + Student
  - MedAustron, CERN, DREEBIT, INFN-LNS, CNAO,
    update existing Ion Source design including cryotraps
  - Construction and first test (B-field, charge density, e-gun...)
  - Prepare MedAustron (S4/S5) beam line for Ion Source installation
    (beam optics, instrumentation, vacuum system)
  - Provide installation space at MedAustron (S4/S5) and integrate Ion Source in existing facility
  - Execute proof of principle test with non radioactive beams under authentic conditions

  - Make new Ion Source commercially available for other treatment facilities (via industrial partners)
  - Provide test facility for other ISOL developing institutions to enable radioisotope treatment in europe (gas purification, EM-separation,..)

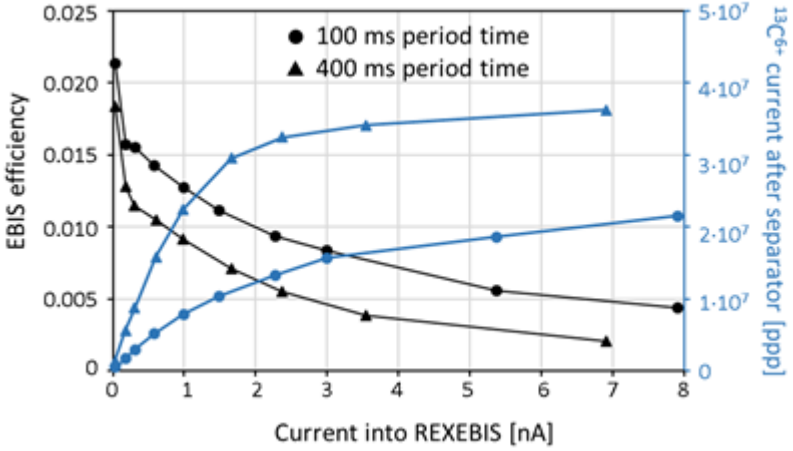
# GOAL - IMPACT

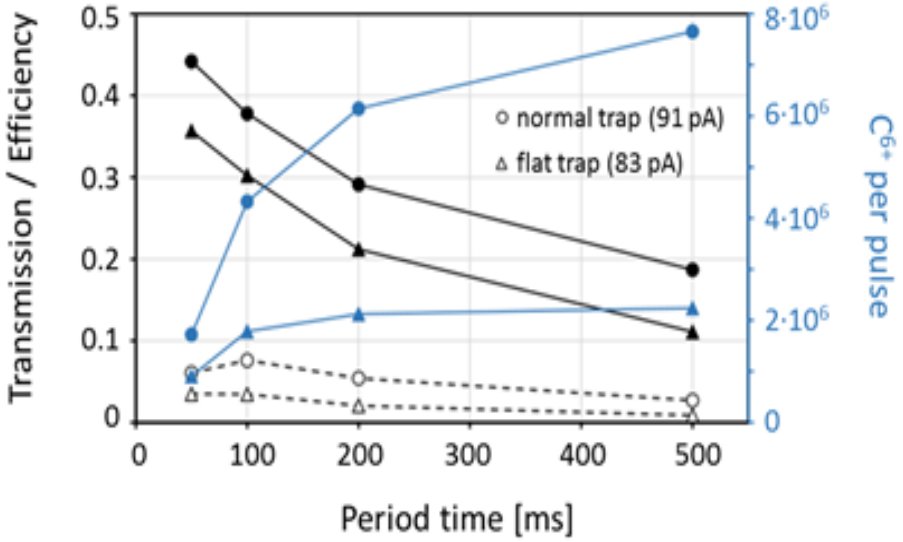
- **Start working towards full integration of C-11 beams in hadron therapy**
- **Provide test facility in clinical environment for developments towards this goal**
- **Demonstrate feasibility of ISOL integration in a treatment faciltiy – Ion Source development/integration**
- **Develop and provide technology together with commercial partners to enable C-11 application in other european centers**


# THANK YOU

## For your attention!

# REXEBIS TESTS

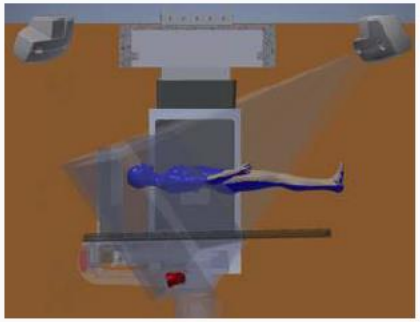


# NON-CLINICAL RESEARCH

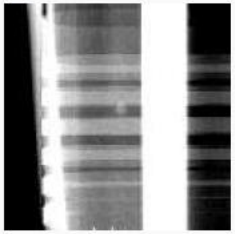
## P 1 – Intrafraction Adaptive Radiation Therapy

WP 1: Intrafraction Surveillance Optimisation



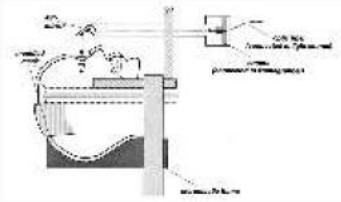
WP 2: Markerless Real-Time Tumour Motion Imaging

WP 3: 4D Dose Calculation and Beam Delivery Optimisation




WP 4: End to End Testing

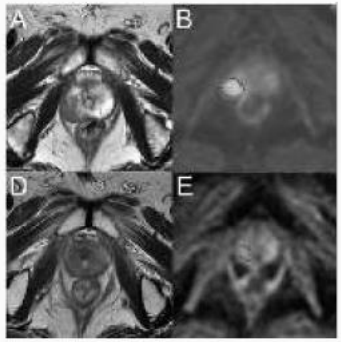
WP 5: Eye Treatment Solution for MedAustron



# NON-CLINICAL RESEARCH

## P 2 – Interfraction Adaptive Radiation Therapy

WP 1: Quantitate Evaluation of mpMRI for Clinical Pilot Studies

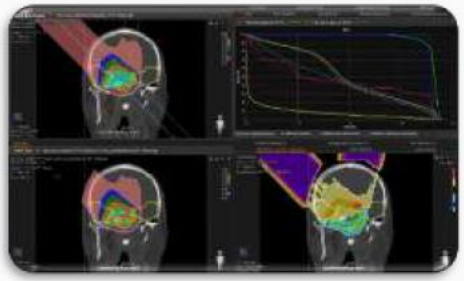



Before RT

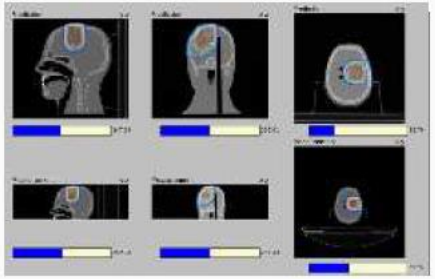
4 months post RT

WP 2: ART via In-Room CBCT

WP 3: Monte Carlo Patient Specific QA



WP 4: Particle Therapy PET



# NON-CLINICAL RESEARCH

## P 3 – Imaging with Ion Beams

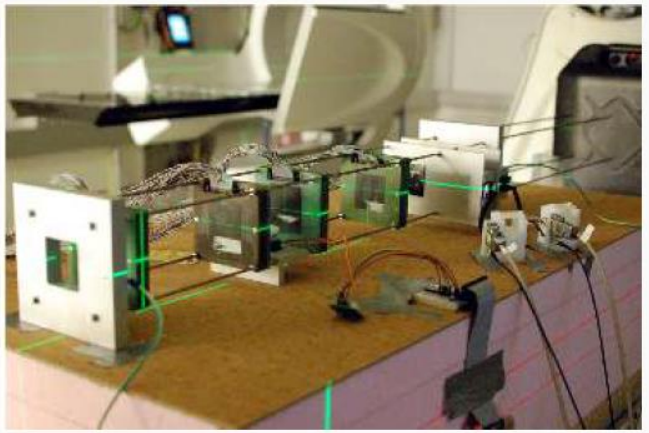
*continuation from the last research period*

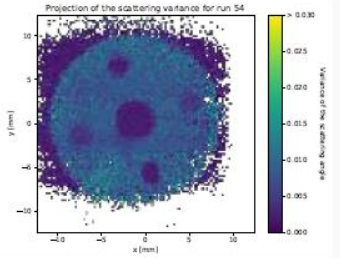
WP 1: Monte Carlo Simulation & Dose Estimation

WP 2: Proton Computed Tomography Set-Up & Data Taking

WP 3: Stopping Power Reconstruction

WP 4: Beam Delivery System Development





# NON-CLINICAL RESEARCH

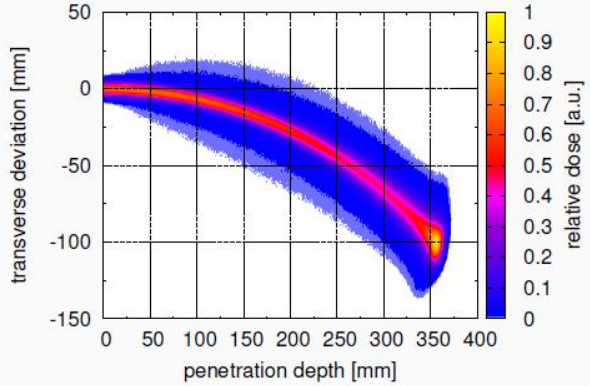
## P 4 – Magnetic Resonance Guided Particle Therapy

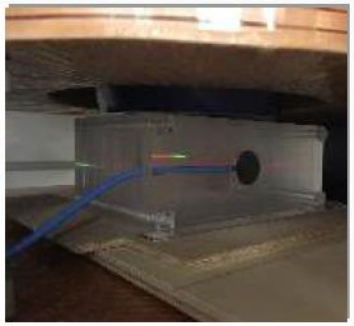
*continuation of the FWF Grant "MAGIG-PRO"*

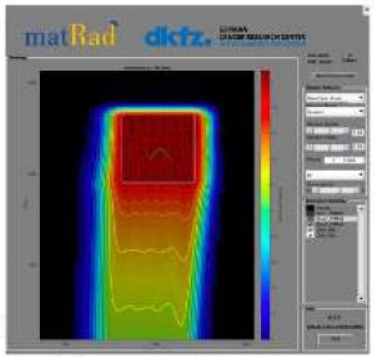
WP 1: MR Workflow Development

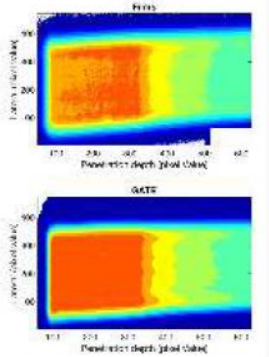
WP 2: Dose Calculation

WP 3: Dosimetry





# NON-CLINICAL RESEARCH

## P 5 – Energy Transfer Mechanisms and Applications in Biology and Physics

### Physics Part

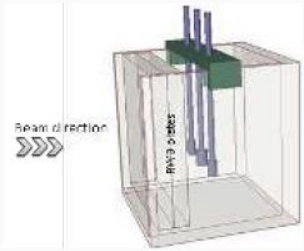
WP 1: Method Establishment

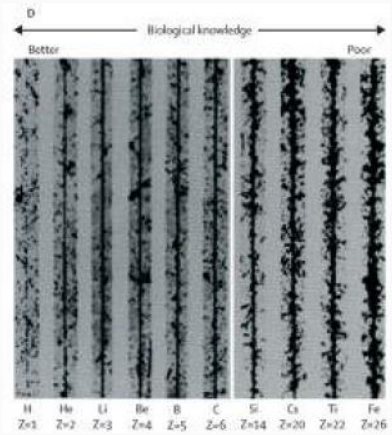
WP 2: Model Development for Microdosimetry

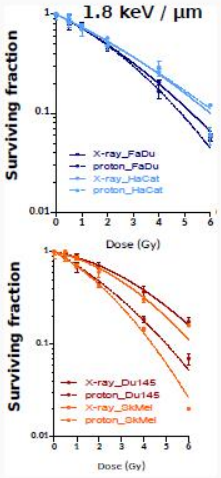
### Biology Part

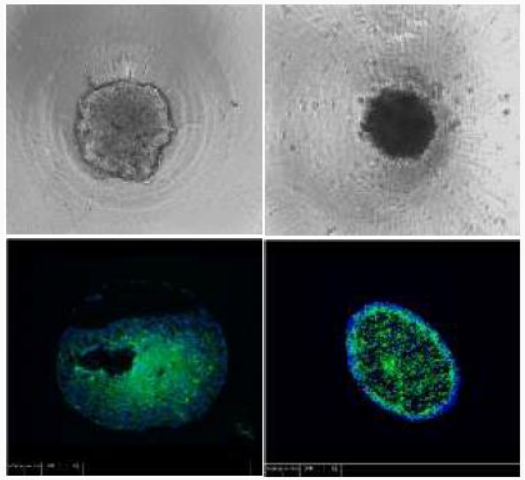
WP 3: Immunologically Hot Tumours

WP 4: Immunologically Cold Tumours



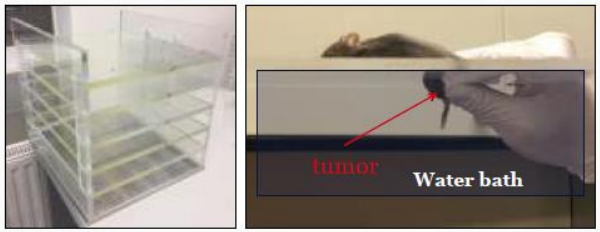
# NON-CLINICAL RESEARCH

## P 6 – Pre-Clinical Animal Research

WP 1: Commissioning of Animal Facility at MedAustron

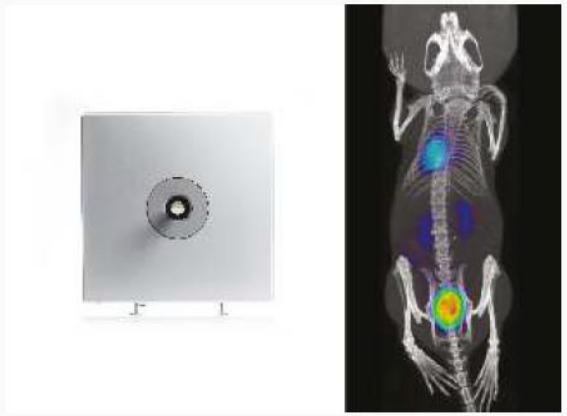
WP 2: Evaluation and Characterisation of "In Vitro Tumour" Transplantation Techniques

WP 3: Construction and Dosimetry of Animal Irradiation Set-Ups




WP 4: Effects of Tumour Micro-Environment Composition on Tumour Control

WP 5: PET/CT Imaging to Monitor (Alterations in) Tumour Biology



Non-Clinical Research at MedAustron · Projects for 2019–2021 ◇ Dietmar Georg and Thomas Schreiner ◇ March 13, 2019 10