Symposium

Non-Clinical Ion-Beam Research at MedAustron

October 7, 2026

University of Applied Sciences Wiener Neustadt

Johannes Gutenberg-Straße 3, 2700 Wiener Neustadt

10 Years Research

TU WIEN TECHNISCHE UNIVERSITÄT WIEN

MEDICAL UNIVERSITY OF VIENNA

MARIETTA BLAU INSTITUTE FOR PARTICLE PHYSICS

FACHHOCHSCHULE WIENER NEUSTADT
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About

The symposium on Non-Clinical Ion-Beam Research at MedAustron aims to bring together all users of the non-clinical research infrastructure at MedAustron and colleagues being interested in the ongoing activities of these groups. Besides emphasising ten years of non-clinical research operation and a corresponding outlook to the future, the main topics of the symposium comprise the current developments in the different research fields defined in the present MedAustron Non-Clinical Research Strategy 2025 – 2026 – 2027.

Organising Committee

Hermann Fuchs
Dietmar Georg
Albert Hirtl
Elisabeth Renner
Claus Schmitzer
Thomas Schreiner
Dea Slade
Petra Wurzer
Markus Zeilinger

Timetable

Wednesday, October 7, 2026 – Morning

08:30 – 09:00	Registration	
09:00 – 09:30	Address of Welcome	
09:30 – 09:50	T. Schreiner	Ten Years of Non-Clinical Research at MedAustron – Frame Conditions
09:50 – 10:20	M. Pullia	Non-Clinical Research at CNAO
10:20 – 10:50	***coffee break***	

Session 1: Applied Particle and Medical Physics

Chair: H. Fuchs, A. Hirtl

10:50 – 11:10	F. Ulrich-Pur	Advanced Instrumentation Systems: Cross-Disciplinary Applications in Medical and Particle Physics
11:10 – 11:30	M. Eizinger	Irradiation Studies for Space Applications at MedAustron
11:30 – 11:50	P. Antypas	Towards Online MR-Guided Ion-Beam Therapy
	group photo	
12:00 – 01:00	***lunch break***	

Session 2: Biophysics and Molecular Radiobiology

Chair: S. Kerschbaum-Gruber, M. Zeilinger

01:00 – 01:20	D. Slade	Enhancing Radiotherapy in Pancreatic Cancer and Glioblastoma with PARP7 Inhibitors
01:20 – 01:40	S. Stocchiero	Multimodality Imaging for Non-Invasive Response Assessment in Ion-Beam Research

Wednesday, October 7, 2026 – Afternoon

Session 3: Technological Innovations and Clinical Implementation

Chair: G. Magrin, M. Stock

01:40 – 02:00	M. Knopf	Towards Clinical Implementation of Microdosimetry
02:00 – 02:20	A. Cherit Hernández	Particle Beam Therapy of Ventricular Tachycardia

Session 4: Accelerator Physics

Chair: E. Renner, C. Schmitzer

02:20 – 02:40	K. Holzfeind	Multi-Energy Extraction
02:40 – 03:00	M. Kausel	Accelerating Mixed He/C Ion Beams for Range Monitoring Research
03:00 – 03:20	N. Gambino	Studies for Expanding the Experimental Portfolio at MedAustron
03:20 – 03:50	***coffee break***	

Session 5: Outlook

Chair: R. Pötter, T. Schreiner

03:50 – 04:10	D. Georg	Non-Clinical Research Beyond 2030
04:10 – 04:30	M. Pullia	Research and Development in the Hadrontherapy Community: A Personal View of Where we are Going

List of Abstracts – Talks

Ten Years of Non-Clinical Research at MedAustron – Frame Conditions

T. Schreiner[1]

[1] EBG MedAustron

Based on financial support from Austrian authorities, primarily the Federal Ministry of Women, Science and Research, the first ion beams were provided to non-clinical research users at MedAustron in October 2016. Following a lengthy preparation phase, this milestone marked the beginning of a forward-looking non-clinical research programme that has now reached its tenth year and continues to expand. Three consecutive research periods, each spanning three years, have been successfully completed, while the fourth is currently underway and will conclude at the end of 2027. These activities are embedded within a stable organisational framework comprising interdisciplinary research groups, an Executive Committee, and an Advisory Board appointed by the Federal Ministry of Women, Science and Research.

Over the past decade, the range of beam modalities available in the non-clinical irradiation room IR 1, equipped with a fixed horizontal beam line, has been substantially expanded. Initially, only protons within the clinically used energy range of 62.4 MeV to 252.7 MeV were available. Since 2019, proton beams with energies of up to 800 MeV and carbon-ion beams ranging from 120 MeV/A to 402.8 MeV/A have also been provided. For nominal proton and carbon-ion beam intensities, four extraction settings are available: 100 % nominal intensity with extraction times of 1 s, 5 s, or 10 s and 10 % nominal intensity with an extraction time of 10 s. To support detector development and the testing of novel radiation-sensitive materials and associated readout electronics, several dedicated low-flux settings have been commissioned, covering a range from 2 kHz to 4700 kHz. Furthermore, very short extraction times can be achieved, enabling FLASH-compatible dose rates. Following several years of intensive commissioning work, helium-ion acceptance measurements were successfully completed in 2025, fulfilling a long-standing request from the non-clinical user community. Helium ions can now be provided for research projects in IR 1 over an energy range extending from 40 MeV/A to 402.8 MeV/A, exceeding the range anticipated for potential clinical applications. The same extraction settings available for proton and carbon-ion beams can also be applied to helium ions.

To date, more than 1000 beam-time shifts, each lasting eight hours, have been allocated and utilised by research groups from Austria and abroad. The continuous efforts of the past decade have resulted in a remarkable scientific output, reflected in more than 200 publications accepted in peer-reviewed journals and more than 180 completed academic theses, i.e. 24 PhD projects, 93 Master's theses, and 64 Bachelor's theses.

Non-Clinical Research at CNAO

M. Pullia[1]

[1] Director of the Research and Development Board, CNAO

CNAO, like MedAustron, is one of the only six facilities worldwide where hadrontherapy is administered with more than one particle, and in particular protons and carbon ions. Besides patient treatment, CNAO has research as an institutional objective. CNAO features an “experimental room” (XPR) dedicated to research activities where experiments can be installed and conducted, out of treatment time, without hindering the clinical activities. Besides the experimental room, a radiobiology lab is also available equipped with the needed instrumentation. A wide range of experiments and developments is carried out at CNAO ranging from rabiobiology to basic physics, from accelerator development to range verification, from innovative dose delivery to detector development and many other research subjects. An overview of the CNAO research and development activities will be given in this talk.

Applied Particle and Medical Physics

Advanced Instrumentation Systems: Cross-Disciplinary Applications in Medical and Particle Physics

F. Ulrich-Pur[1]

[1] Marietta Blau Institute for Particle Physics of the Austrian Academy of Sciences

Instrumentation for applications in particle therapy, space research, and ion imaging is a joint effort of the Marietta Blau Institute for Particle Physics (MBI) and the Atominstitut of the TU Wien. Our work is currently mainly driven by the maturation of silicon carbide (SiC) as a detector material and the growing international efforts toward ion-computed tomography (iCT) as a direct imaging modality for improved treatment planning.

Ion tomography has advanced from early proton radiography demonstrators toward integrated iCT system concepts. A key enabling technology in this field are low-gain avalanche detectors (LGADs), whose internal signal amplification enables precise time-of-flight measurements for particle identification, energy determination via time-of-flight methods, and fast timing-based tracking at the high particle rates required for clinical image acquisition. We give an overview on our LGAD-based iCT system concepts and show first preliminary results.

Silicon carbide has evolved from being a material primarily studied for extreme environments to becoming a serious candidate for use in several applications, ranging from high-energy physics to dosimetry in harsh radiation environments, and microdosimetry. We summarise recent developments in SiC detector technology, including thin epitaxial pad and strip sensors, monolithic structures, and detector characterisation under beam conditions, with emphasis on their radiation hardness, low leakage currents, and rate capability compared to conventional silicon solutions.

This contribution outlines, how advances in semiconductor instrumentation may shape the next generation of ion imaging and instrumentation at MBI and TU Wien.

Irradiation Studies for Space Applications at MedAustron

M. Eizinger[1,2]

[1] FOTEC Forschungs- und Technologietransfer GmbH, [2] Technische Universität Wien

The Space Research work package at MedAustron is dedicated to the study and characterisation of radiation effects expected in the space environment. A major concern of recent space missions are single event effects. With the ongoing miniaturisation of electronics on the nanometre scale, the amount of deposited charge carriers required to produce undesired effects such as bit-flips or upsets has been decreasing significantly. At modern technologies, the ionisation due to protons or light ions is sufficient to cause upsets in static random-access memory (SRAM). For this reason, several methods have been developed, to study single event effects on SRAM devices. This includes a variable depth Bragg peak (VDBP) approach, where thin absorbers are inserted into the beam upstream of the device to shift the Bragg peak through the sensitive volume and vary the linear energy transfer (LET). For this purpose, a set-up for carbon ions at the MedAustron IR 1 facility,

operating in steps of 25 µm LDPE, as well as an SRAM readout system have been constructed and a data processing framework for computing the single event upset probability as a function of LET has been developed. The experimental data are correlated to OpenGate simulations of the deposited dose. To verify the simulations and provide monitoring data, a custom LET spectrometer, based on discrete electronic circuits is under development. The talk will be focused on single event studies at MedAustron before giving a brief overview on further projects within the space research activities.

Towards Online MR-Guided Ion-Beam Therapy

P. Antypas[1]

[1] Department of Radiation Oncology, Medical University of Vienna

Ion-beam therapy offers superior physical properties compared to photon beams enabling highly conformal dose distributions and enhanced biological effectiveness. Nevertheless, the sensitivity to inter- and intra-fractional anatomical changes and motion prevents the exploitation of the treatment modality's full advantages. Online magnetic resonance image (MRI) guidance allows motion management and adaptive strategies, which can further improve treatment outcomes and reduce toxicity. The combination of MRI and ion beam line systems, however, is accompanied by a number of challenges with the most important one the interaction between the charged particles and the external magnetic field. This effect alters the resulted dose distributions and impacts dosimetry in magnetic field environments.

The Medical University of Vienna (MUW) is one of the first institutions contributing to the field of online MR-guided ion therapy and laying the foundation for clinical implementation. Currently, and after almost ten years of experience, MUW participates in the DosiMagic project, a collaboration between institutions from Austria and Germany. The ultimate goal of the project is the establishment of a protocol for accurate dosimetry in magnetic fields.

To date, various commercially available radiation detectors that being used in the clinic routinely for different dosimetry tasks have been characterised for the ion beams available in the MedAustron facility. Efforts have also been devoted to understanding the underlying effects and the resulting influence factors. Furthermore, thanks to a collaboration with researchers from Graz University of Technology, a novel hardware solution, ultra-low-field MR scanner, was investigated showing that combination of ion beams and MR imaging can be achieved with minimal modifications of the treatment room and without compromising image.

In this talk, the key results from our experimental investigations, so far, at the MedAustron therapy and research centre towards clinical implementation of MR-guided ion therapy and the future steps for the developing clinical dosimetry guidelines are presented.

Biophysics and Molecular Radiobiology

Enhancing Radiotherapy in Pancreatic Cancer and Glioblastoma with PARP7 Inhibitors

N. Bragato[1,2,3], ***L. Lippert***[1,2,3,4], ***AB. Dias***[1,2,3], ***A. Ohradanova-Repic***[5], ***A. Dupanović***[1,2,3], ***A. Kleinwächter***[1,2,4], ***F. Horvat***[1,2,4], ***L-M. Appel***[1,2,4], ***L. Walch***[1,2,4], ***A. Röhrer***[1,2,3], ***S. Barna***[1], ***P. Fossati***[3,6], ***K. Podar***[6,7], ***J. Widder***[1,2], ***D. Georg***[1,2,3], ***S. Kerschbaum-Gruber***[1,2,3], ***M. Cohen***[8], ***D. Slade***[1,2,3,4]

[1] Department of Radiation Oncology, Medical University of Vienna, [2] Comprehensive Cancer Centre, Medical University of Vienna, [3] MedAustron Ion Therapy Centre,[4] Max Perutz Labs, Vienna Biocenter Campus (VBC), [5] Centre for Pathophysiology, Infectiology and Immunology, Institute for Hygiene and Applied Immunology, Medical University of Vienna, [6] Karl Landsteiner University of Health Sciences, [7] Division of Internal Medicine 2, University Hospital Krems, [8] Department of Chemical Physiology and Biochemistry, Oregon Health and Science University, Portland, OR, USA

Glioblastoma (GBM) and pancreatic ductal adenocarcinoma (PDAC) are among the most lethal solid tumours, both characterised by immunosuppressive tumour microenvironments and resistance to conventional radio- and chemotherapy. Radiation can remodel the tumour microenvironment and promote anti-tumour immunity via the STING and type I interferon (IFN-I) pathways, which can be potentiated by targeting negative regulators of this signalling axis, including the ADP-ribosyltransferase PARP7. We investigated whether PARP7 inhibitors (PARP7i) enhance the immunogenic effects of photon and particle radiation across these two tumour types. Particle radiation with carbon ions (C-ions) is of particular interest because of dose deposition with extremely high precision, which spares surrounding healthy tissue and reduces radiation-induced lymphopenia.

In GBM cells, we found that hypofractionated radiation elicited a ferroptosis-dependent IFN-I response, and PARP7i enhanced radiation-induced immune activation to an extent comparable to the STING agonist. Notably, in patient-derived GBM cancer stem cells with low STING expression, PARP7i was more effective than the STING agonist at inducing immunogenic signalling, highlighting its potential in tumours where STING is downregulated, which is often the case in GBM. In PDAC cells, PARP7i similarly enhanced radiation-induced cell death and promoted STING- and NF-χB-dependent immunogenic signalling, driving inflammatory gene expression, cytokine release, and activation of monocytes and NK cells. Importantly, C-ion irradiation showed a stronger induction of the IFN-I response and proinflammatory cytokines.

Together, these findings across GBM and PDAC demonstrate that PARP7 inhibition is a promising strategy to boost radiation-induced anti-tumour immunity, particularly in tumours with low STING expression or immunosuppressive features, and support further evaluation of PARP7i combined with radiotherapy as a therapeutic approach in both cancers.

Multimodality Imaging for Non-Invasive Response Assessment in Ion-Beam Research

S. Stocchiero[1,2], ***I. Abdarahmane***[1,2], ***L. Wolf***[1], ***S. Kerschbaum-Gruber***[1], ***A. Dupanovic***[1], ***N. Bragato***[1], ***A.B. Dias***[1], ***S. Höglerd***[3], ***P. Kodajovad***[3], ***E. Poblador Rodríguez***[2], ***K. Hill***[2], ***L.M. Techt***[2], ***P. Gröger***[2], ***V. Fröhlich***[2], ***B. Knäusl***[1,4], ***D. Slade***[1,4], ***M. Zeilinger***[2,4], ***D. Georg***[1,4]

[1] Department of Radiation Oncology, Medical University of Vienna, [2] University of Applied Sciences Wiener Neustadt, [3] Department for Biological Sciences and Pathobiology, University of Veterinary Medicine Vienna, [4] EBG MedAustron

Ion-beam therapy, employing protons and carbon ions, represents a promising treatment option for highly aggressive and radioresistant tumours, such as pancreatic ductal adenocarcinoma (PDAC). However, robust clinical evidence on ion-beam therapy response remains limited by short follow-up periods, heterogeneous study designs, and the scarcity of effective early non-invasive detection methods, which are essential to understanding the biological mechanisms underlying ion-beam therapy. Preclinical research with small-animal models offers a controlled platform to address these open questions, enabling longitudinal, multimodal investigation of tumour biology and treatment response under reproducible conditions.

In this context, the interdisciplinary FWF-funded PAIR (PreclinicAl Ion beam Research) project, part of the non-clinical research activities at the MedAustron facility, leverages for the first time a unique combination of particle therapy and preclinical imaging, integrating µCT, µPET, and ultra-high-field MRI at 15.2 T to assess ion-beam therapy response. Building on this framework, an initial multimodal imaging workflow was established and validated in a healthy murine brain model irradiated with protons, laying the methodological groundwork for preclinical irradiation. Recently, an MRI-only preclinical irradiation workflow was tested, converting anatomical 15.2 T MR images into synthetic CTs using an in-house neural network and validating it for ion-beam treatment planning.

This foundational healthy brain experimental workflow – including developments on irradiation set-up, beam collimation, dose and LET determination – was subsequently extended to a particle-therapy oncological setting using a heterotopic PDAC mouse model, enabling longitudinal multi-parametric MRI (mp-MRI) characterisation of tumour response across control, proton- and carbon ion-irradiated cohorts.

In recent years, a dedicated MR set-up and mp-MRI protocol were established and optimised to identify imaging biomarkers for ion-beam therapy response in PDAC. Combining tumour volumetry, T2 relaxation time, apparent diffusion coefficient (ADC) and magnetisation transfer ratio (MTR) biomarkers with histopathological validation, day 10 post-irradiation was identified as the time point of maximum PT-induced biological effect. T2 and ADC emerged as promising early indicators, capturing an initial inflammatory phase followed by cumulative cytotoxicity, confirmed histologically by necrosis and a sustained antiproliferative effect supported by reduced Ki67. Immunohistochemistry further suggested modality-specific immunomodulatory profiles between protons and carbon ions. These preliminary findings demonstrated the potential of non-invasive mp-MRI for longitudinal ion-beam therapy response monitoring in a PDAC mouse model, providing a basis for larger, confirmatory and comparative studies. Future work will focus on cross-correlation of mp-MRI and PET data.

Technological Innovations and Clinical Implementation

Towards Clinical Implementation of Microdosimetry

M. Knopf[1]

[1] Atominstitut, Technische Universität Wien

Microdosimetry is increasingly recognised as a valuable tool for incorporating radiation quality descriptors, such as linear energy transfer, into particle therapy treatment planning and quality assurance. By providing experimentally measured lineal-energy spectra, microdosimetry offers a practical experimental means of characterising the biological effectiveness of therapeutic ion beams. Over the past decade of non-clinical research at MedAustron, a strong foundation has been established, with significant contributions to both the theoretical and experimental aspects of the field. This includes the development of theoretical frameworks as well as advances in gas-based tissue-equivalent proportional counters and solid-state detector technologies. However, the routine clinical implementation of microdosimetric measurements remains challenging due to the demanding requirements for energy resolution and high dose-rate performance of the readout electronics. Recent advances in instrumentation now enable rapid and reliable acquisition of microdosimetric spectra at full clinical dose rates, creating new opportunities for integration into routine clinical practice. This talk will present the current status and ongoing developments of the microdosimetry collaboration at MedAustron.

Proton Beam Therapy of Ventricular Tachycardia

A. Cherit Hernández[1,2], ***M.C. Fuss***[3], ***T. Madar***[3], ***M. Grehn***[4], ***C. Schmitzer***[3], ***N.E. Salinas Bustillo***[3], ***C. Ramsl***[5], ***L. Fiedler***[6], ***P. Fossati***[1,3], ***M. Izzo***[7], ***A. Garonna***[7], ***D. Georg***[2], ***O. Blanck***[4], ***M. Stock***[1,3]

[1] Karl Landsteiner University of Health Sciences, [2] Department of Radiation Oncology, Medical University of Vienna, [3] EBG MedAustron, [4] Department of Radiation Oncology, University Medical Centre Schleswig-Holstein, [5] Department of Physics, TU Wien, [6] Danube Private University GmbH, [7] EBAMed SA, Geneva

Ventricular tachycardia is a leading cause of sudden cardiac death. In refractory cases, standard therapies, including anti-arrhythmic drugs, implantable cardioverter-defibrillators, and catheter ablation, may require repeated interventions. Stereotactic arrhythmia radioablation (STAR) with photons has shown promising efficacy, while proton therapy may offer improved healthy-tissue sparing and access to deep ventricular and septal substrates beyond the reach of catheter ablation.

In collaboration with the STOPSTORM consortium, an ion-beam STAR workflow was developed at MedAustron from treatment planning to experimental validation. Cross-modality imaging compatibility was evaluated, electro-anatomical mapping targets were transferred to the planning computed tomography using CARDIO-RT, and proton treatment plans were generated for three STOPSTORM benchmark cases.

Experimental validation was performed in two irradiation rooms using a dynamic anthropomorphic phantom simulating cardiac and respiratory motion, adapted for ionisation chamber and

radiochromic film measurements. Proton and carbon-ion delivery under motion was assessed using gamma analysis, together with cardiac and respiratory gating. Optical trigger signals corresponding to predefined ECG phases were transmitted to the accelerator control system. Gating was tested using an in-house system and subsequently EBAMed's CardioKit, representing its first use at a synchrotron facility. Accelerator response and latency were characterised using standard ECG signals and simulated premature atrial and ventricular contractions. Interference and simulated patient-positioning tests were additionally performed with the surface scanner.

The technical feasibility of a synchrotron-based ion-beam STAR workflow was demonstrated. Clinical translation will require patient-specific motion characterisation, positioning and verification, end-to-end validation, in-room cardiac monitoring, and regulatory clearance.

Accelerator Physics

Multi-Energy Extraction

K. Holzfeind[1]**, *F. Plassard*[2]**, *E. Renner*[1]**, *on behalf of the project team***

[1] Atominstitut, Technische Universität Wien, [2] EBG MedAustron

Some of the main challenges to the further establishment of ion-beam therapy are its higher cost and longer treatment times compared to conventional radiation therapy with X-ray beams. One option to significantly increase the efficiency of ion-beam therapy with synchrotrons is multi-energy extraction (MEE). In MEE, the prescribed dose for several iso-energy layers of the tumour can be delivered with one synchrotron filling. Currently, only one iso-energy layer is irradiated from one synchrotron filling, thus necessitating a full cycle for each layer. Compared to this single energy extraction, MEE requires less cycles for delivering the same dose. Therefore, energy consumption can be significantly reduced, and irradiation time can be shortened by up to 40 %, in first estimations. MEE requires an extraction mechanism, which is compatible with bunched beam operation. It is hence commonly based on radio frequency knock-out slow extraction (RFKO), in which the amplitude of the particles' horizontal oscillations is increased by applying an AC voltage.

During the MEE project, our group developed a first prototype for RFKO-based MEE at MedAustron. Today, this set-up is used for exploring novel methods for minimising the time required for safe and well-controlled energy changes and mitigating losses during energy changes. It is further used to investigate combinations of RF voltage and RFKO excitation signals that enable reliable and smooth slow-extraction spills despite the beam-dynamics challenges associated with multi-energy operation.

This talk provides a summary of MEE and developments in RFKO-based slow extraction. Furthermore, a brief overview of other slow extraction developments, including delivery methods for ultra-high dose rate beams for FLASH irradiation, will be presented.

Accelerating Mixed He/C Ion Beams for Range Monitoring Research

M. Kausel[1,2]**, *C. Schmitzer*[2]**, *E. Renner*[1]**, *on behalf of the project team***

[1] Atominstitut, Technische Universität Wien, [2] EBG MedAustron

Mixed helium and carbon ion beams are proposed as an innovative approach for online range monitoring during carbon ion radiotherapy. In this proposed treatment modality, the helium and carbon ions are co-accelerated in the synchrotron and delivered together to the patient. The carbon ions are used for treating the malignant tissue, whereas the helium ions – with approximately three times the range compared to the carbon ions – fully penetrate the patient and can be used for diagnostic purposes.

During the last three years, a joint project between TU Wien and MedAustron, in collaboration with the Marietta-Blau Institute of the Austrian Academy of Sciences, the Medical University Vienna, GSI, and CNAO, has investigated the generation and application of mixed ion beams at the MedAustron accelerator facility. Up until now, the conducted research mainly focused on the accelerator physics

R&D required to enable the generation, acceleration, and delivery of such mixed ion beams. Using a novel sequential injection scheme, the first successful delivery of a mixed ion beam was achieved in mid-2024, marking the first time this beam modality was generated via sequential injection into a synchrotron, and the first time such a beam was delivered in a medical synchrotron facility. Further developments and improvements, which mainly concerned the dynamics and beam control during the slow extraction of the ion mix, allowed for first mixed beam treatment monitoring experiments in late 2025. Since then, the mixed beams have been regularly used for medical physics experiments conducted within the project consortium. Present and future investigations aim to thoroughly investigate the beam dynamics of mixed ion beams during the generation, acceleration, slow extraction, and delivery, as well as to study the applicability of the mixed beam range probing method in theory and experiment for different treatment scenarios.

Within this talk, the research developments and achievements of the mixed-beam project at the MedAustron facility are presented, also highlighting the broader impact of the conducted research on the international research field of mixed ion beams.

Studies for Expanding the Experimental Portfolio at MedAustron

N. Gambino[1], ***L. Fuxreiter***[1], ***P. Galeazzo***[1], ***L. Heißenberger***[4], ***K. Holzfeind***[2], ***M. Kausel***[1,2], ***E. Renner***[2], ***V. Rizzoglio***[1], ***C. Schmitzer***[1], ***R.A. Wilhelm***[3]

[1] EBG MedAustron, [2] Atominstitut, Technische Universität Wien, [3] Institute of Applied Physics, Technische Universiät Wien, [4] University of Applied Sciences Wiener Neustadt

MedAustron's scientific programme is continuously expanding through a broad range of research and development projects aimed at enhancing the facility's capabilities and strengthening the collaboration with the non-clinical research user groups. In recent years, several parallel activities have been carried out along the accelerator chain. These studies range from ion source developments and novel extraction mechanisms at the synchrotron level, to the expansion of the infrastructure aimed at supporting multi-user experimental areas for non-clinical research. In particular, recent progresses at the ion source level have included fundamental studies of plasma dynamics via optical emission spectroscopy and double frequency heating. These investigations provide unique opportunities to expand the experimental portfolio towards plasma physics and, in parallel, to improve the performance of the ion source in terms of extracted current stability and beam quality. Substantial efforts have also been devoted to the production of new ion beam species. These include oxygen beam generation at the ion source level and an upcoming feasibility study to assess the commissioning of oxygen beams up to the non-clinical irradiation room (IR 1) and the already successful commissioning of helium ion beams in IR 1 completed last year. The expansion of the facility's research infrastructure capabilities is also under assessment, including the potential installation of an additional ion source branch for low-energy beam-line experiments and the possible development of a new experimental station through the repurposing of an unused beam dump currently installed along the high energy beam transfer line.

The talk presents an overview of these activities, highlighting the main results obtained so far and the future outlook for strengthening the facility's versatility and expanding opportunities across a broad spectrum of scientific applications.

Outlook

Non-Clinical Research Beyond 2030

D. Georg[1]

[1] Department of Radiation Oncology, Medical University of Vienna

When non-clinical research activities at MedAustron were launched in 2016, the national use of the research facilities were mainly driven by the involvement of the Medical University of Vienna (MedUni Wien) and the Vienna University of Technology (TU Wien). Today, non-clinical research activities are now fully integrated into the Austrian research landscape. Besides the MedUni Wien and the TU Wien, other Austrian research institutions are active in non-clinical research: Marietta Blau Institute for Particle Physics of the Austrian Academy of Sciences (MBI), University of Applied Sciences Wiener Neustadt (FHWN) and its research company FOTEC, Karl Landsteiner Private University of Health Sciences (KL), University of Veterinary Medicine Vienna (VetMed), Medical University of Graz (MedUni Graz), Graz University of Technology (TU Graz). Several of these institutions did not only establish professorships, group leaders and dedicated research personnel, moreover they contribute to enlarge the research opportunities with infrastructure from their own budget. In this context, the continuous investments of EBG MedAustron to steadily expand and improve research opportunities in the dedicated research room (IR 1) (e.g. low or very high dose rates, novel ion species) are greatly acknowledged. The expertise developed during the last decade, together with demonstrated research outcomes, dedicated Austrian researchers, and the outstanding research infrastructure, have resulted in numerous international co-operations, particularly within Europe but also beyond. The scientific achievements of the last decade provide a solid foundation for the research ambitions of the Austrian institutions beyond 2030 and strengthen Austria's position on the international landscape of ion-beam research, with following key research areas:

- Applied particle and medical physics builds on existing expertise in detector development and dosimetry, but aims to expand in space research, particle physics, and the translation of patient-specific methods in medical physics.

- Molecular biology coupled with high-resolution preclinical imaging systems to drive interdisciplinary, medically motivated ion-beam research. This ensures precise beam application, including the study of radiation effects in vivo, both at the cellular and molecular levels.

- The integration of technology and methodological development from the non-clinical field with clinical research will be further promoted. The existing infrastructure in the experimental research room enables to develop new methods and technologies, including new particle types, and to test and validate them thoroughly in the non-clinical research environment before they become available to patients in clinical trials.

- In accelerator physics, the development of innovative beam modalities (e.g. particle types, time structures, dose rates), forms the basis for new therapy methods and research applications. One promising area, where internationally leading expertise and experimental infrastructure have already been built, is the acceleration of mixed helium and carbon ion beams for real-time treatment monitoring.

In summary, there is a clear commitment from Austrian research institutions to continue their outstanding scientific activities in non-clinical research at MedAustron. This requires extending the national financial support from authorities for necessary investments and reinvestments, and most importantly for beam time beyond 2030. This way, interdisciplinary, excellent, and forward-looking ion-beam research for the future in Austria can be secured, based on the unique features of the infrastructure at the research site in Wiener Neustadt.

Research and Development in the Hadrontherapy Community: A Personal View of Where we are Going

M. Pullia[1]

[1] Director of the Research and Development Board, CNAO

An overview of the more popular and more interesting research and development lines reported in conferences and scientific reviews (author's point of view) will be discussed. The many subjects and the many groups working on them are a clear indication of the importance of research to improve hadrontherapy. The many subjects and many groups working on them are also a clear indication of the fundamental importance and need of beam lines and irradiation facilities. Experimental facilities like the ones in CNAO and MedAustron are particularly important because at these facilities the available beams and beam delivery systems and the experimental environment are those finally used "in real life".

List of Posters

Applied Particle and Medical Physics

Influence of Detector Sensitive Volume on Ionisation Chamber Response for MR-Guided Particle Therapy
Panagiotis Antypas, *Department of Radiation Oncology, Medical University of Vienna*

A Versatile Phantom-Based Framework for End-To-End Testing of (Online) Adaptive Particle Therapy
Jacob Brunner, *Department of Radiation Oncology, Medical University of Vienna*

Feasibility of Ultra-Low-Field Magnetic Resonance Imaging for Online MR-Guided Particle Therapy
Hermann Fuchs, *Department of Radiation Oncology, Medical University of Vienna*

New Time-of-Flight Ion Imaging System Based on LGADs
Harald Handerkas, *Atominstitut, Technische Universität Wien*

Versatile Readout System for Beam Monitors
Simon Waid, *Marietta Blau Institute for Particle Physics of the Austrian Academy of Sciences*

Biophysics and Molecular Radiobiology

MRI-Only Workflow for Preclinical Ion Beam Therapy Deep-Learning Based Synthetic CT Generation from Ultra-High-Field Small Animal MRI

Isselmou Abdarahmane, *University of Applied Sciences Wiener Neustadt*

Harnessing Particle Radiation and Cell Cycle Checkpoint Inhibitors to Induce an Immunogenic Response in Pancreatic Cancer

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PARP7 Inhibition and a STING Agonist Potentiate Radiation-Induced Immunogenicity in Glioblastoma

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Longitudinal Multiparametric MRI for Early Detection of Proton and Carbon Ion Therapy Effects in a PDAC Mouse Model

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Adaptation of a Beamline and Analytical Dose Engine to Superficial, Collimated Carbon Ion Beams

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Technological Innovations and Clinical Implementation

First Mixed-Beam Approach to Real-Time Beam Monitoring in Cardiac Ion-Beam Therapy
Ariadna Cherit Hernández, *EBG MedAustron/Karl Landsteiner Privatuniversität*

SPECTACULAR: Development of a Modular DAQ System for Microdosimetry
Matthias Knopf, *Atominstitut*, *Technische Universität Wien*

Commissioning and Validation of a Scanned Helium Pencil Beam Line
Lukas Martin, *Karl Landsteiner Privatuniversität*

A Readout ASIC for Microdosimeters
Simon Waid, *Marietta Blau Institute for Particle Physics of the Austrian Academy of Sciences*

Accelerator Physics

First Oxygen Ion Beam Tests with the MedAustron Ion Sources
Lukas Fuxreiter, *Atominstitut*, *Technische Universität Wien/EBG MedAustron*

Optical Emission Spectroscopy for Beam Stability Monitoring and Plasma Characterisation at MedAustron
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Implementation of Multi-Energy Extraction Configurations at MedAustron
Katrin Holzfeind, *Atominstitut*, *Technische Universität Wien*

Update on Slow Extraction Studies at MedAustron
Katrin Holzfeind, *Atominstitut*, *Technische Universität Wien*

Measured Properties of the Mixed Helium and Carbon Ion Beam at MedAustron
Matthias Kausel, *Atominstitut*, *Technische Universität Wien/EBG MedAustron*

Progress on Mixed He/C Beam Slow Extraction at MedAustron
Elisabeth Renner, *Atominstitut*, *Technische Universität Wien*

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Useful Information

Talks will be held at the **Lecture Hall** of the University of Applied Sciences Wiener Neustadt. It is situated on the ground floor and can be reached via the main entrance of the University of Applied Sciences Wiener Neustadt at the Johannes Gutenberg-Straße 3 in 2700 Wiener Neustadt.

Coffee breaks and lunches will be offered in the floors in front of the main entrance of the lecture hall. In addition, the **posters** can be found in this area.

Wi-Fi will be available during the conference. The University of Applied Sciences Wiener Neustadt also provides access to an **eduroam** network.

How to get to the University of Applied Sciences Wiener Neustadt?

The location can be reached via bus or taxi from the main train station in Wiener Neustadt. Wiener Neustadt's transport company is part of the Verkehrsverbund Ost-Region (VOR). The use of the inner city bus lines is therefore included in a VOR ticket to Wiener Neustadt.

- Timetable information and prices: vor.at & preisauskunft.vor.at
- Wiener-Neustadt route network: wiener-neustadt.at/de/service/line network

