THE NEW PARTICLE THERAPY RESEARCH CENTER (PARTREC) AT THE UNIVERSITY MEDICAL CENTER GRONINGEN

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PARTREC facility

The PARticle Therapy REsearch Center (PARTREC) is a newly established research facility at the University Medical Center Groningen (UMCG). Built on the success of the KVI-CART research center, it utilizes the superconducting cyclotron AGOR for experimental research, mainly in radiation physics and biology. Working in close collaboration with the UMCG Groningen Proton Therapy Center (GPTC), PARTREC uniquely combines radiation physics, medical physics, biology and radiotherapy research with an R&D program to continuously improve hadron therapy technology and advance radiation treatment for cancer patients. In addition, it provides opportunities for experiments in the domain of radiation hardness, for both the scientific and commercial communities, and nuclear science, in collaboration with the Faculty of Science and Engineering of the University of Groningen.

Accelerator Capabilities

AGOR delivers ion beams of all stable elements with an energy dependent on the charge-to-mass ratio of the ions. Proton beams with clinically relevant energies (range up to 230 mm) are used for preclinical radiation biology research and proton therapy related physics since twenty-five years.
For radiation hardness tests, the facility provides beams of protons at different primary energies and various ions (from He to Xe) at 30 MeV/amu. Experiments can also be performed with C and O ions at 90 MeV/amu. Extension of the palette of beams towards heavier ions and lower energies is under development.

Image guided preclinical research

Modern image-guidance is an essential element for the realization of the next generation of preclinical experiments to further develop clinical particle therapy. Novel orthotopic tumour models, display anatomical variation that requires not only individually image-guided irradiation planning, but also pencil beam scanning to create highly conformal dose distributions. Image-guided Monte Carlo irradiation planning reduces dose variation between animals reducing the number of animals needed to detect significant differences.

To facilitate this development a new research infrastructure for image guided preclinical research is currently under development and is expected to be available in 2023. With the new infrastructure also helium (range in water up to 60 mm) beam will become available for preclinical research. A wide range of irradiation modalities based on both scattering and pencil beam scanning will be available, including

shoot-through with high energy protons as well as Spread-Out Bragg Peak for protons and helium. Additionally, the adaptation of the facility for the delivery of spatial fractionation (GRID) and high dose rates in excess of 300 Gy/s (FLASH) is maturing.

Research plans with the new infrastructure

PARTREC will provide users a one stop facility to address various research questions such as:

— Studies of radiation sensitivity variations within normal tissue and tumour.
— Mechanistic studies using various tumour and normal tissue *in vitro* and *in vivo* models to investigate interaction between radiation and systemic treatments, such as chemotherapy, immunotherapy and DNA damage response (DDR) modulators.
— LET and RBE studies for biological treatment planning.
— Advanced radiotherapy dose delivery techniques, such as GRID and FLASH.
— Therapeutic window optimization and translation to the clinic.
— Biological and physical radiation effects in space.

Conclusion

The new PARTREC facility will provide the radiation biology, physics and radiotherapy community with a state-of-the-art, open access research infrastructure for cell/tissue culture and small animal research. The upgrades to the infrastructure will become available from 2023.

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