

The New PArticle Therapy REsearch Center (PARTREC) at the University Medical Center Groningen

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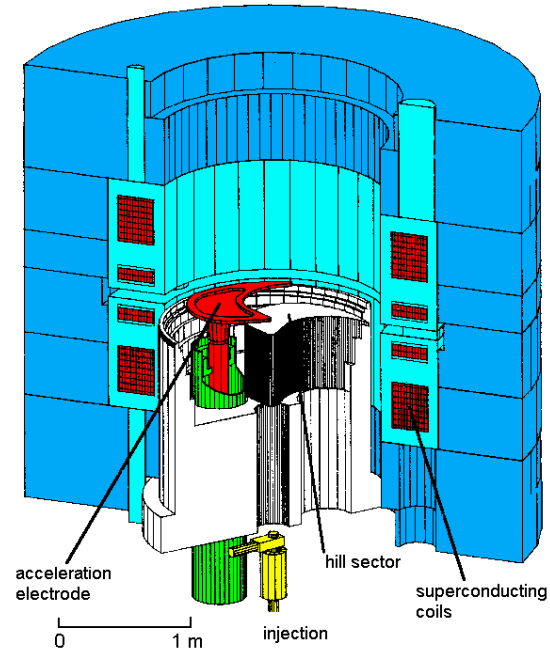


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Content

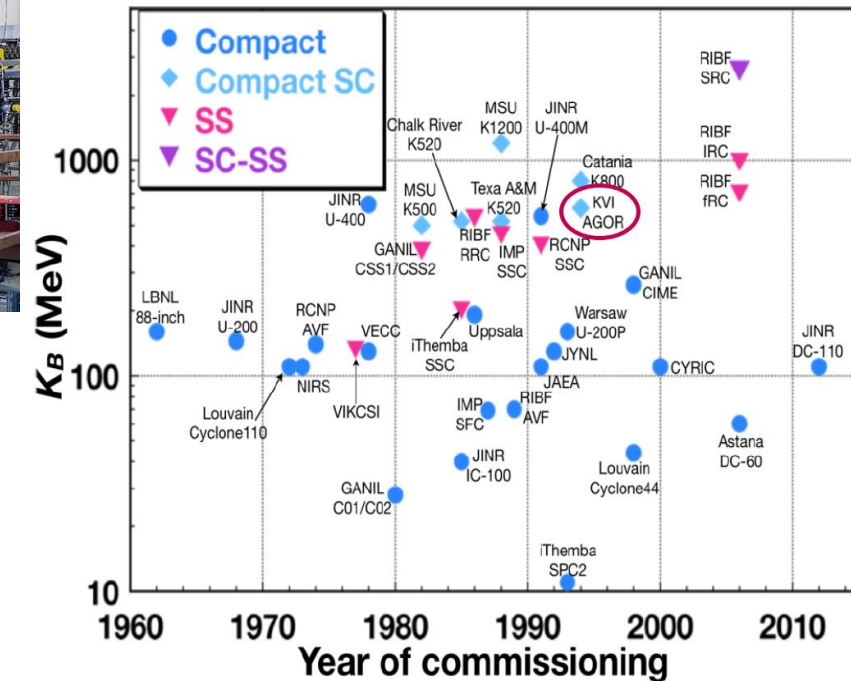
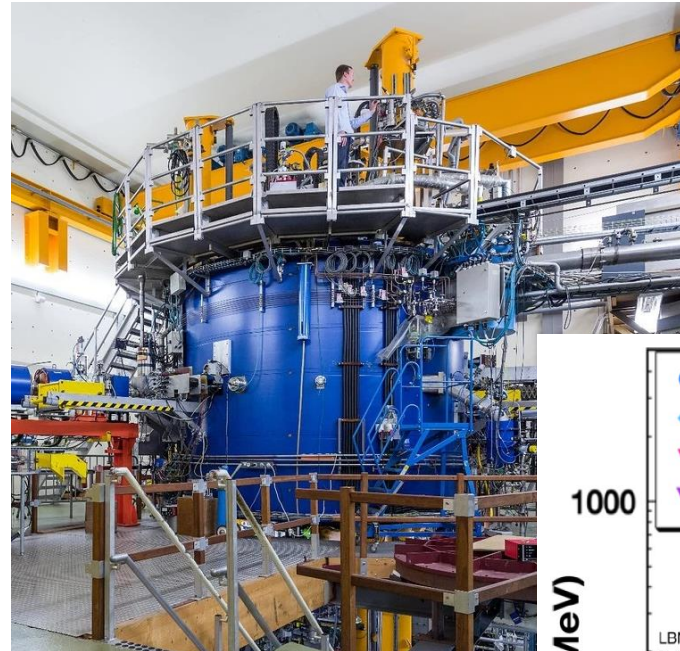
- Facility
- Team and Operation
- Users
- Ongoing Upgrades
 - Heavy ion beams
 - Infrastructure for biomedical research
 - FLASH capabilities



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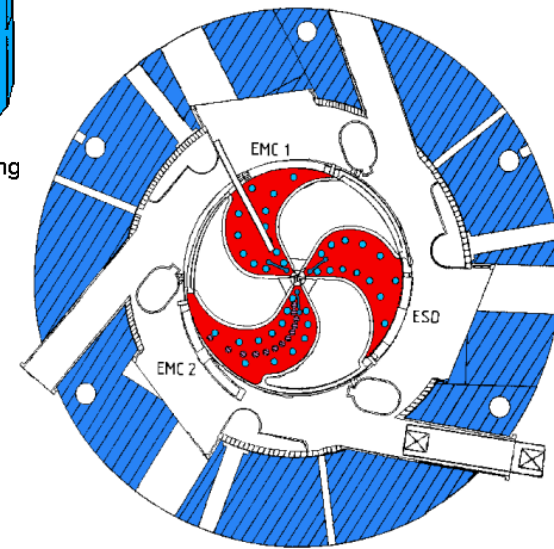
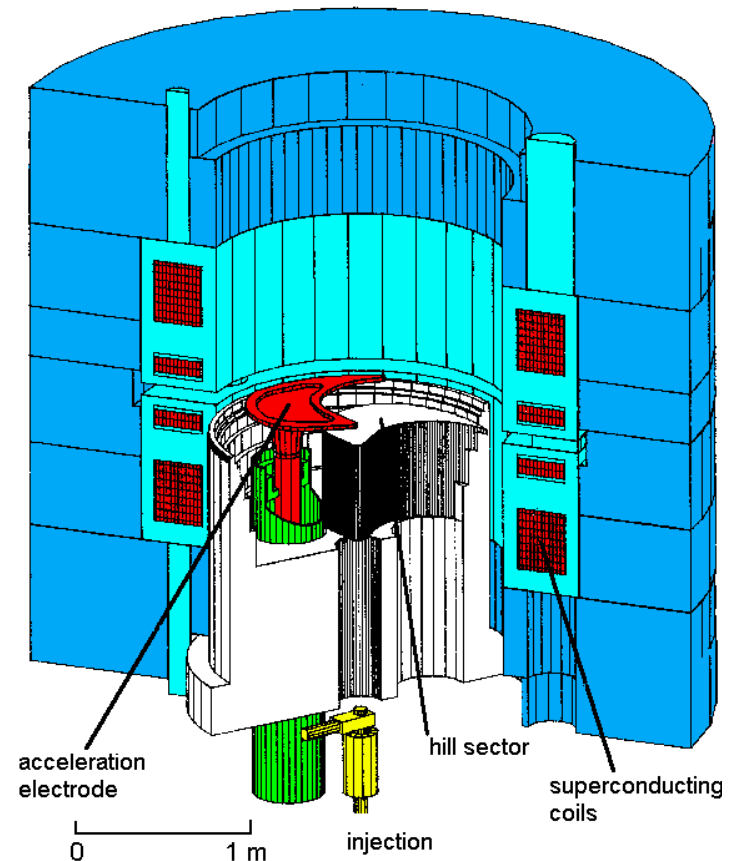
Our Facility

- Formerly known as KVI-CART
- We operate a superconducting cyclotron for experimental research
- From 1996 – 2013 beams mainly used for research in nuclear physics (light ions) and on fundamental symmetries (heavy ions)
- Emphasis has shifted towards detector development and radiation hardness testing (since 2005, mainly commercial with some funded experimental research) and biomedical research (since 2014)
- Reorganization:
 - KVI's accelerator facility, staff and medical physics group was integrated into UMCG and became PARTREC



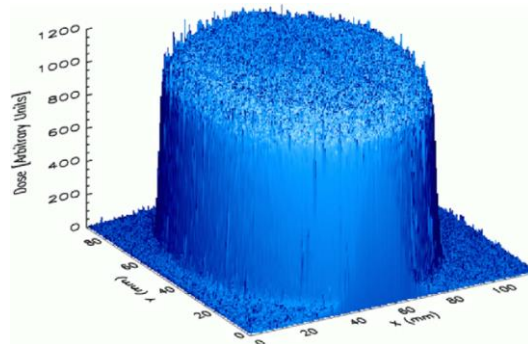
AGOR Cyclotron

- Superconducting AGOR cyclotron is a multi-particle, variable energy AVF-cyclotron
- French-Dutch collaboration built 1987 – 1994
- Operational since 1996
- Magnetic field (1.7 to 4.1 T) produced by
 - Two pairs of superconducting main coils
 - fifteen trim coils
 - three iron hill sectors for focussing
- 3 halfwave RF cavities, 24 - 62 MHz; $h = 2, 3$ or 4
- Three external ion sources (two ECR sources for heavy ions, multi-cusp source for light ions) are axially injected
- Extraction
 - 300 - 500 turns depending on harmonic mode
 - extraction radius 870 - 890 mm depending on E/A
 - turn separation at extraction 2 - 3 mm \sim beamwidth

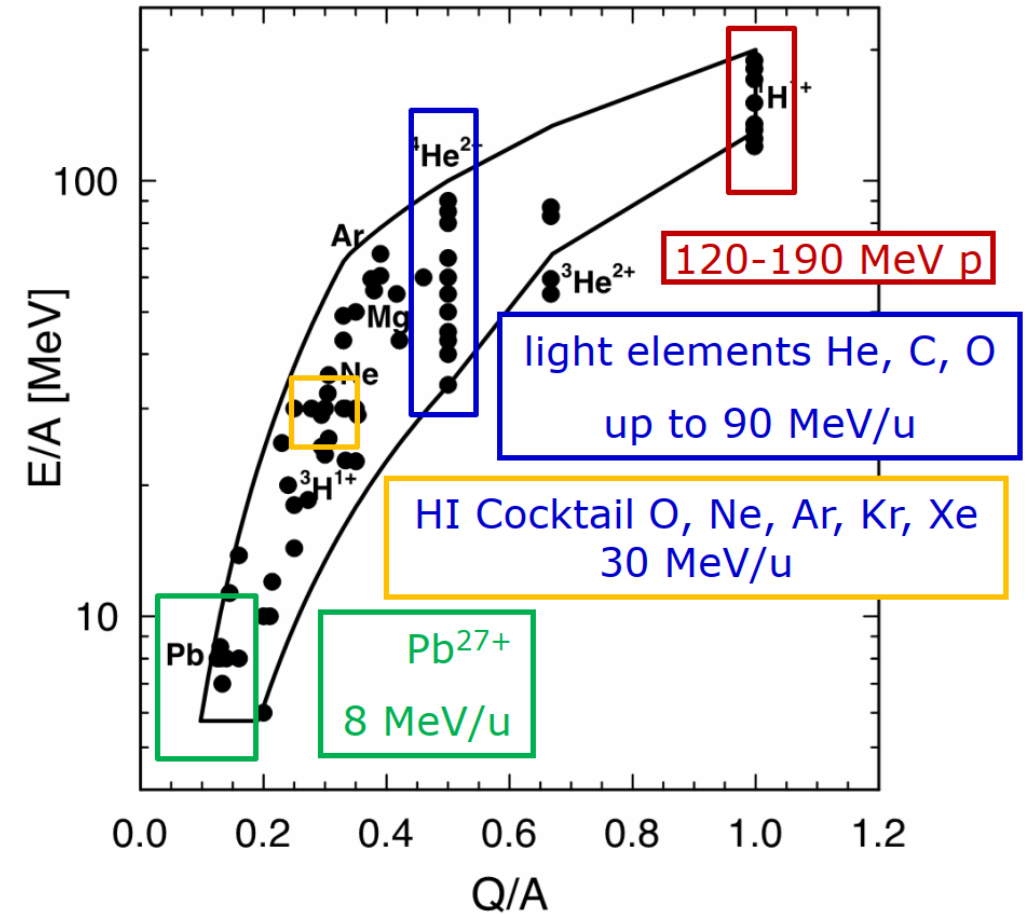


Beam Parameters

	Protons	Ions
Kinetic energy (MeV/amu)	≤ 190	≤ 90 for C and O ≤ 30 for all up to Xe
Attainable flux (particles per s)	$> 10^{13}$	$\leq 10^{13}$ for Ne $\leq 10^{11}$ for heavier ions
Field size (cm ²)	$\leq 10 \times 10$ (scanned beam) $\leq 8 \times 8$ (scattered beam)	$\leq 7 \times 7$ for light ions (scanned beam) $\leq 3 \times 3$ for heavy ions (scanned beam)
Field homogeneity	$\pm 2\%$ (scattered beam) $\pm 1\%$ (scanned beam)	$\pm 2\%$ (scattered beam) $\pm 1\%$ (scanned beam)



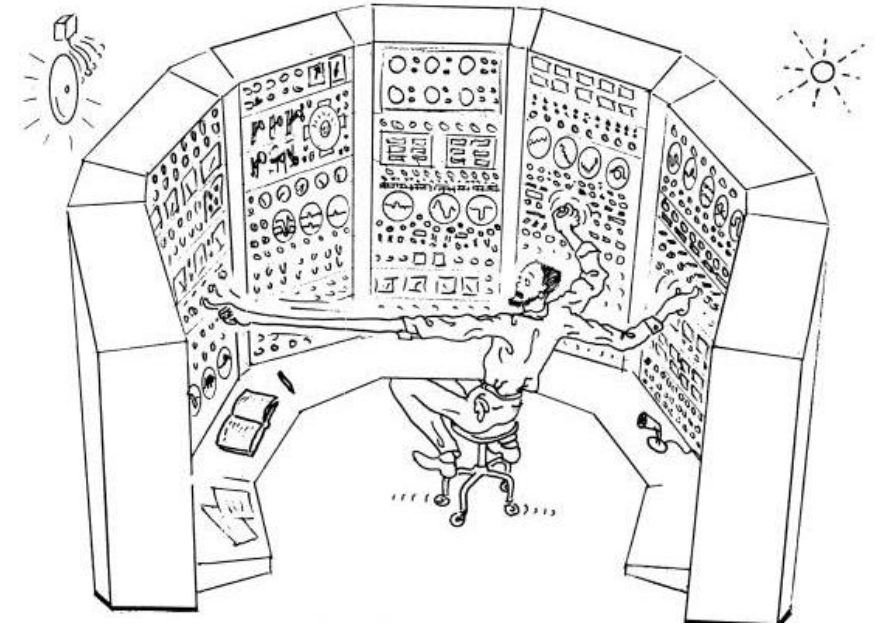
AGOR can deliver beams of all elements up to Xe



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Our Team

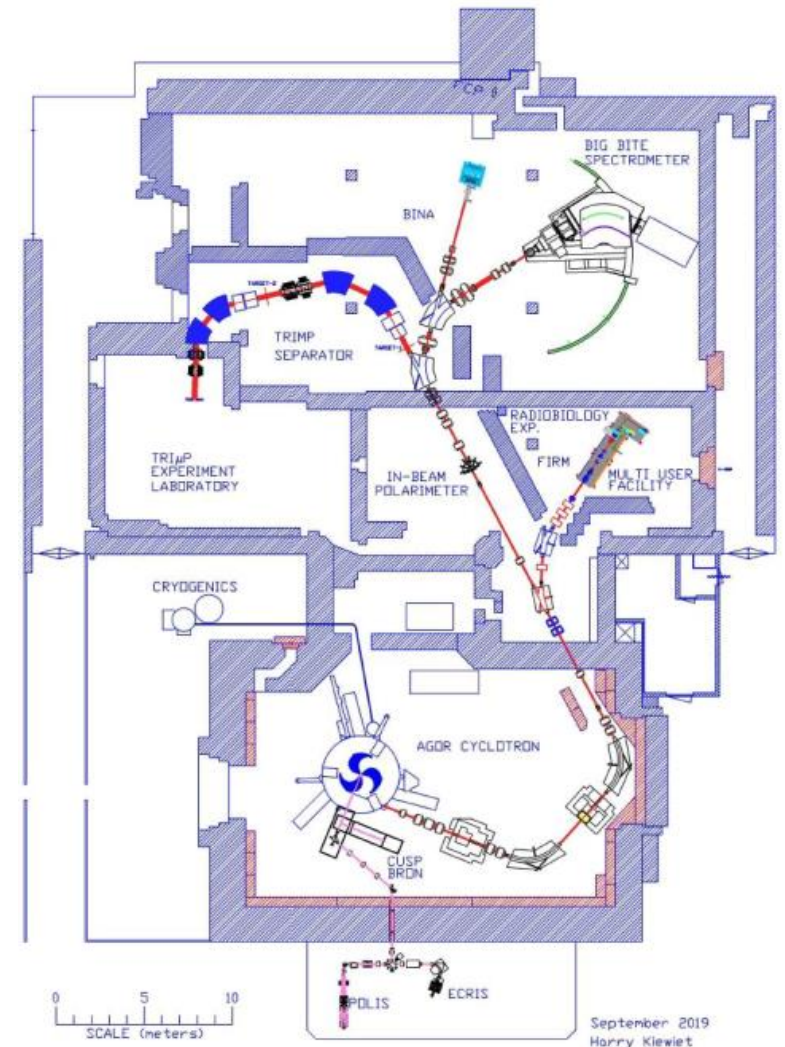
- Faculty (4)
- Post-docs (2)
- PhD-students (5)
- Technical staff (24)
 - Operators to operate and maintain the accelerator (5)
 - Cryogenics, cooling, compressed air and vacuum (2)
 - Design/Mechanical: mechanical repairs, design and construct mechanical components that have become obsolete and contribute to scientific and infrastructure projects (5)
 - Electronics: maintenance of the magnet power supplies, RF-amplifiers, low level RF-electronics, PLC-systems and interfaces of all these systems to the central control system of the accelerator (5)
 - IT Support needed for operation, maintenance and upgrading of the accelerator control system as well as the irradiation control system (3)
 - Experimental and project support provided to internal/external scientists as well as companies, ECR sources (4)



PARTEC Operation

- We strive to provide a reliable and reproducible ion beam to satisfy the needs of the user
- We also provide support
- Operational 120 hours/week, 26 weeks/year
- Beam requests: irradiations.partrec@umcg.nl
- With shift from fundamental physics to radiation biology and physics and technology of particle therapy the number of individual experiments increased while their duration has decreased
- Over the past few years proton beams provided for over 80% of beam time

KVI facility layout before PARTEC upgrades

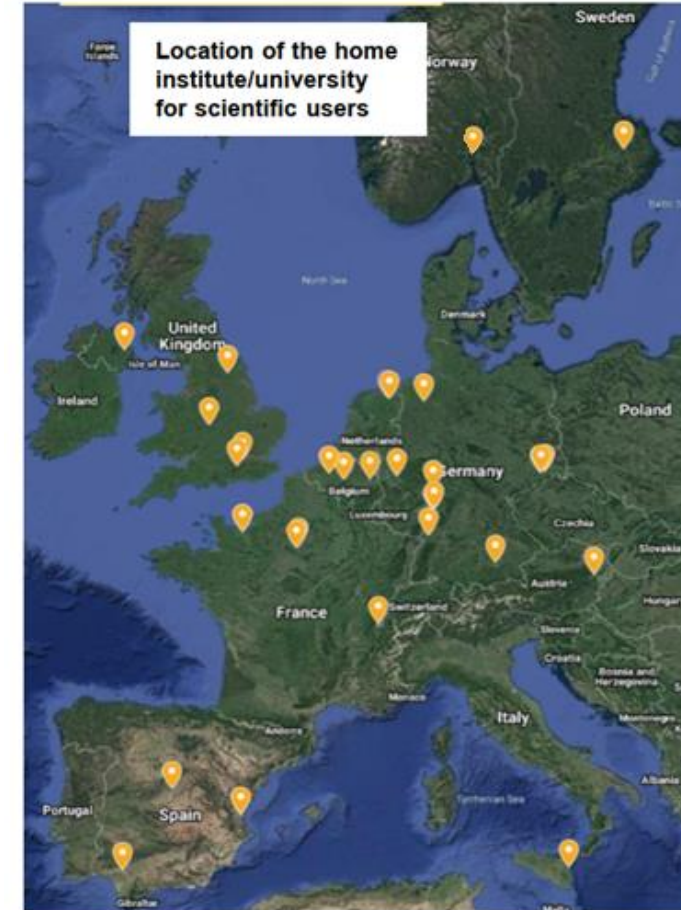


Our Users and Funding

- Recognized by ESA as Ground-Based Facility
(CORA-IBER, Investigating biological effects of space radiation)
- Supported by EU as Large-Scale Facility
(IAs RADNEXT, INSPIRE)
- Commercial Funding:
 - Mainly proton in-air irradiations
 - Expanding heavy ions
 - Mostly non-domestic aerospace
- Local and national funding (RUG, UMCG, KWF, NWO)



European Space Agency



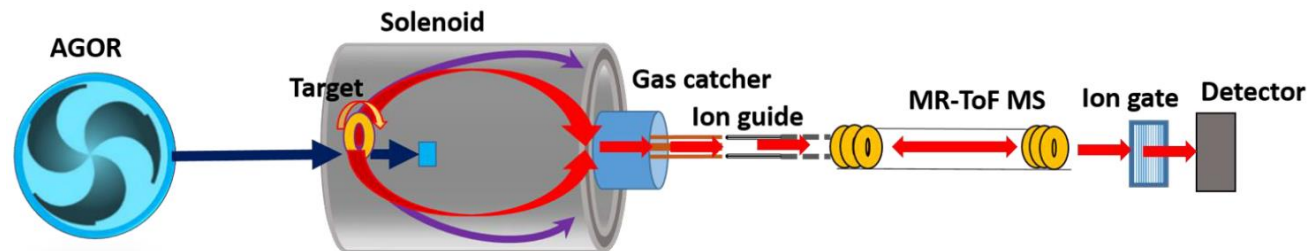
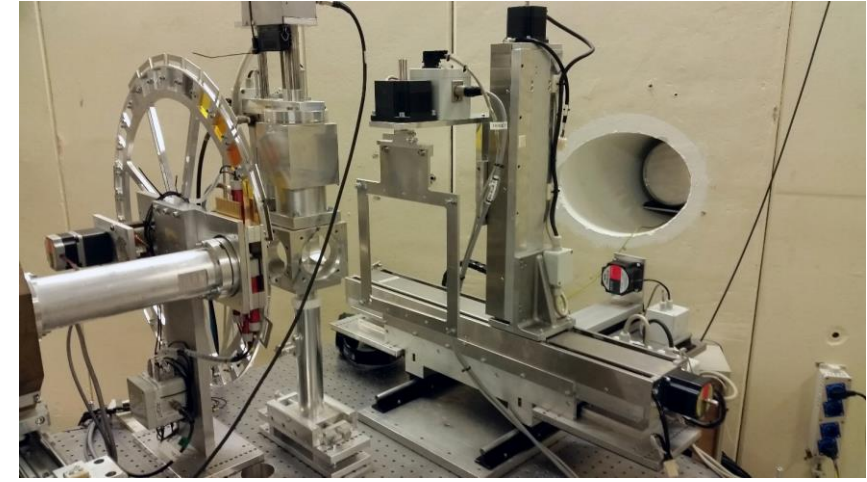
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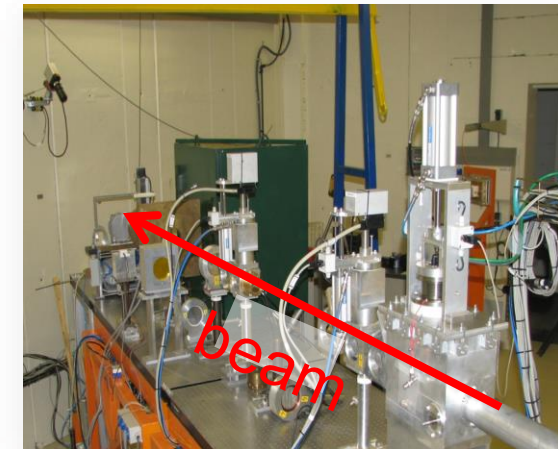
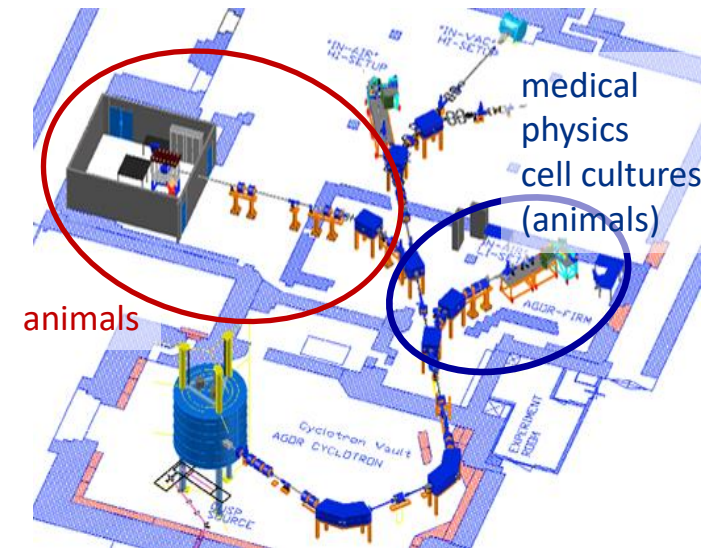
Heavy Ion Beams

- Research areas
 - Radiobiology (RuG, UMCG, PSI)
 - Detector tests & development (ESA)
 - Experiment development (ESA)
 - Radiation hardness (ESA, companies)
- AGOR can deliver beams of all elements up to Pb
- New experimental research on the production of neutron-rich heavy nuclei using multi-nucleon transfer reactions between heavy nuclei (e.g. ^{136}Xe on ^{208}Pb) has recently been started
- ECR ion source development, improvement of transmission from source to extraction
- A new experimental station consisting of a 3 T superconducting solenoid fragment separator and MR-ToF mass spectrometer is developed with RUG and will be installed



Biomedical Research

- Currently performed :
 - Animal (rats) experiments: protons, helium
 - Cell cultures and organoids: protons to neon
 - Physics: mainly protons, helium, carbon
- University of Groningen and the University Medical Center Groningen (UMCG) have recently established a clinical proton therapy center (first patient at the start of 2018)
- A new beam line with 3D X-ray and bioluminescence imaging at the irradiation position (individually optimized small animal irradiations) will be built in the coming years
- Several new dose delivery modalities will be available, including pencil beam scanning, spatial fractionation and very high dose rate (>1000 Gy/s)
- Operated as an open access facility
- Individual imaging
 - Anatomical variations between animals
 - Individually optimized irradiation plan



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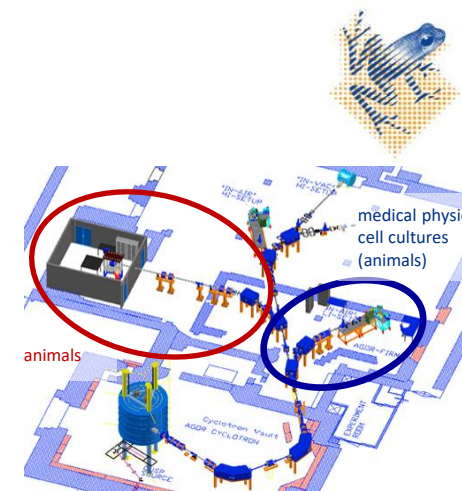
Summary

- UMCG has unique combination of treatment facility (GPTC) and research center accelerator facility (PARTREC)
- PARTREC delivers protons (<190 MeV) and ions up to Xe for
 - Commercial and institutional irradiation tests
 - Radiobiology and medicine
 - Nuclear physics research
- Ongoing upgrades include
 - Very heavy ions acceleration (up to ^{209}Bi)
 - Very high beam intensities (microAmps)
 - New infrastructure for animal, organoid and cell irradiation

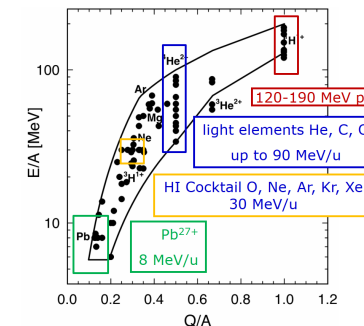
- Acknowledgement
 - Research funding
 - Access funding
 - Host institutions and all colleagues for contributing



Netherlands Organisation
for Scientific Research



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Thank you for your attention!
Questions?

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