What is NEXT?
A setup for the production and separation of neutron-rich nuclei

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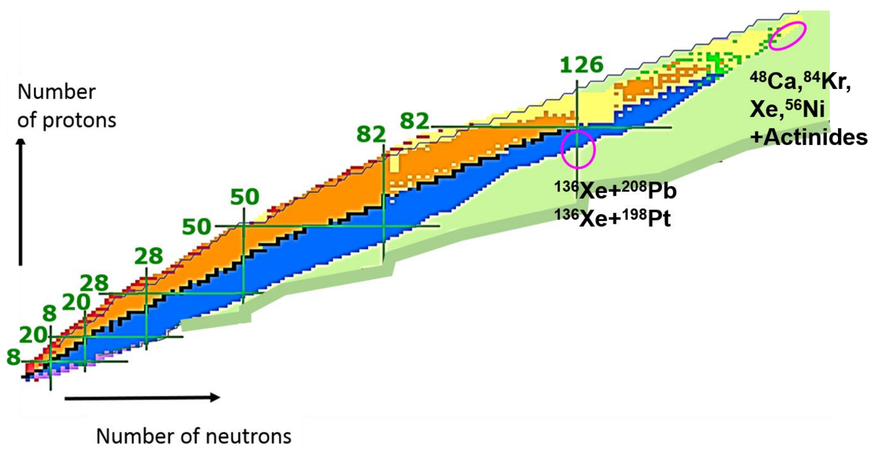
1 What is *NEXT* ?

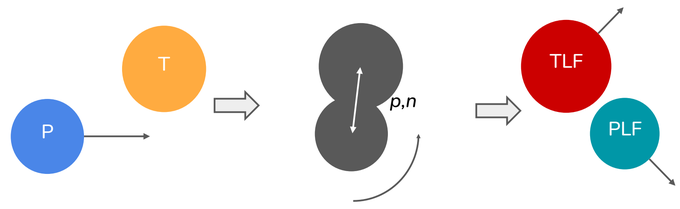
The aim of *NEXT* are studies of *N*eutron-rich, *EX*otic, heavy nuclei produced in multinucleon *T*ransfer reactions. Multi-nucleon transfer reactions using actinide targets provide access to neutron-rich transfermium nuclei and hold the potential for the discovery of new isotopes in this region. Xe-136 induced reactions open the door to study nuclei along, the 3rd waiting point of the astrophysical r-process around N=126.

Our aim is to measure masses in these regions of interest and study the fission half-lives of neutron-rich transfermium nuclei.



2 Experimental Challenges

- Wide angular distribution of the transfer products
- Brought range of half-lives of the nuclides of interest
- Isotope separation and identification

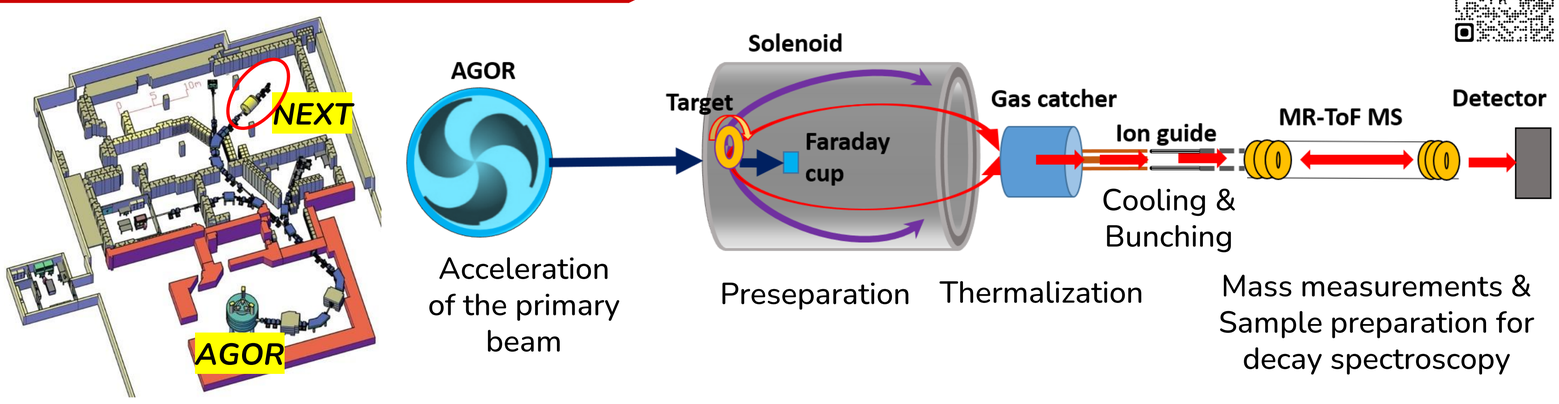


P	Projectile	PLF	Projectile-Like Fragments
T	Target	TLF	Target-Like Fragments

Need:
Spectrometer with a large angular acceptance, and good back-ground separation independent from the chemical and atomic properties

3 Our strategy – *NEXT @ AGOR*

J. Even *et al.*, Atoms **10** (2022) 59

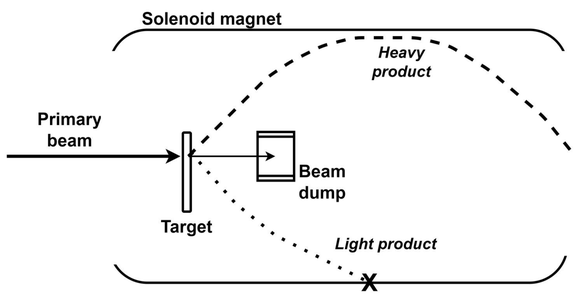


4 AGOR

- superconducting cyclotron with a cyclotron K value of 600 MeV
- ECR ions source capable to provide a broad range of beams
- Energy range of AGOR: 5 MeV/amu for heavy ions up to 190 MeV for protons

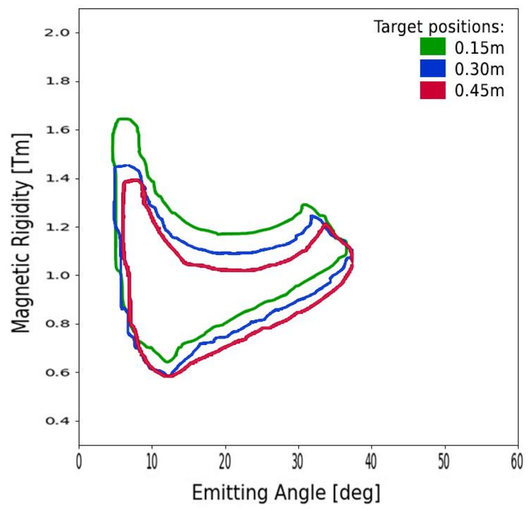
5 Solenoid Separator

- 3 T superconducting solenoid magnet (old MRI scanner)
- Length: 157 cm length;
- Diameter of the : 87 cm



- Ion focusing and transmission can be tuned by adjusting the target position
- Primary beam is suppressed by the Faraday cup
- Lighter transfer products are outside the acceptance region

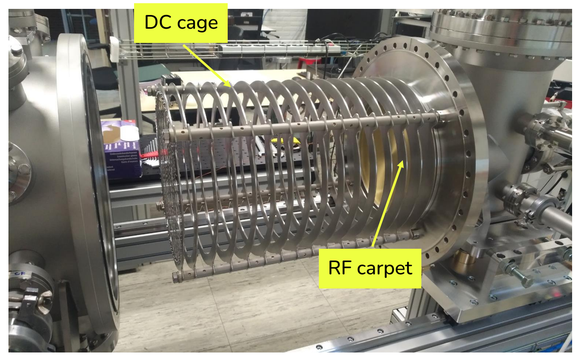
For details, see the poster : "Ion optical simulations for the NEXT solenoid separator at AGOR", A. Soylu et al.



Acceptance region of the solenoid separator for various target positions. Transfer products that are within the acceptance region will be transmitted from the target to the gas-catcher

6 Gas Catcher

A. Mollaebrahimi *et al.*, B. Nucl. Instrum. Meth. B **463** (2020) 508

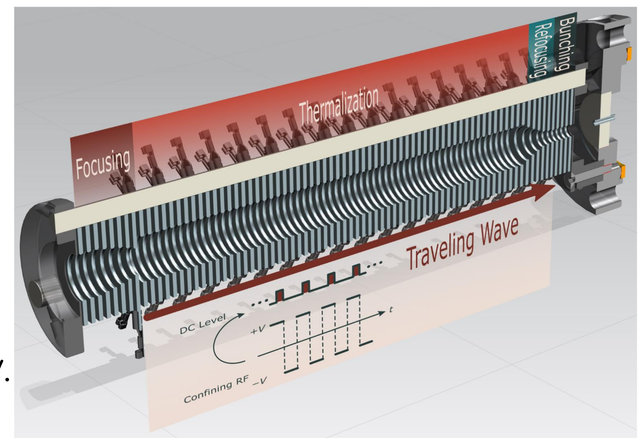


- DC cage: axially guiding field, 6 V/cm.
- RF carpet: sine wave, 100 V_{pp} @ 5 MHz; radial gradient, 1.5 V/cm; central pinhole for ions' exit, 0.45 mm diameter.
- 50 mbar helium

7 Ion Guide

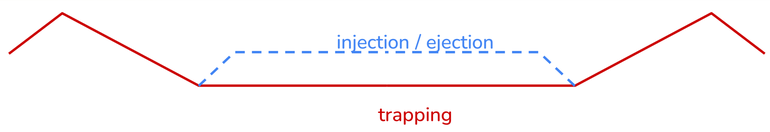
X. Chen *et al.*, Int. J. Mass Spectrom. **477** (2022) 116856

- In total 78 ring electrodes of varying apertures, thicknesses, and in-between gaps.
- Rectangular-wave RF for radial confinement, 164 V_{pp} @ 3.82 MHz.
- DC bias voltage induced by duty cycle modulation, 2.5 V.
- Traveling wave of bias voltages for axial ion transport.
- Transverse emittance, 21 π mm mrad @ 0.1 keV.
- Ion bunch width, 0.2 μs.
- Transmission efficiency, 80%.



8 MR-ToF Mass Spectrometer

M. Schlaich, Master Thesis, Technical University of Darmstadt, (2021)



- The in-trap lift potential is varied for different purposes of ion trapping and ion injection or ejection.
- Transverse acceptance, 244 π mm mrad @ 3 keV.
- Longitudinal acceptance, 5.8 μs.
- Mass resolving power, 1.5 × 10^5 after 2000 revolutions.

8 Status and Outlook

- The solenoid magnet will arrive in October in Groningen. Optimizations of the solenoid separator has been finalized.
- The assembling of the ion guide and MR-ToF mass spectrometer is in progress.
- Our aim: First beam on target by the end of 2023

- ***NEXT* will open the door to precision mass measurements and background-free decay spectroscopy of neutron-rich nuclides in the regions of *N* = 126 and *Z* > 100.**

We thank the accelerator support staff, the mechanical workshop and the electronic workshop at UMCG-PARTREC for their help.
This work is funded by the European Research Council through an ERC Starting Grant (No. 803740) and by the Dutch Research Council though a NWO Natuurkunde Projectruimte grant (No. 68091103).