



Nuclear Reaction Studies at MARA focusing on prospects for the new MARA-LEB facility

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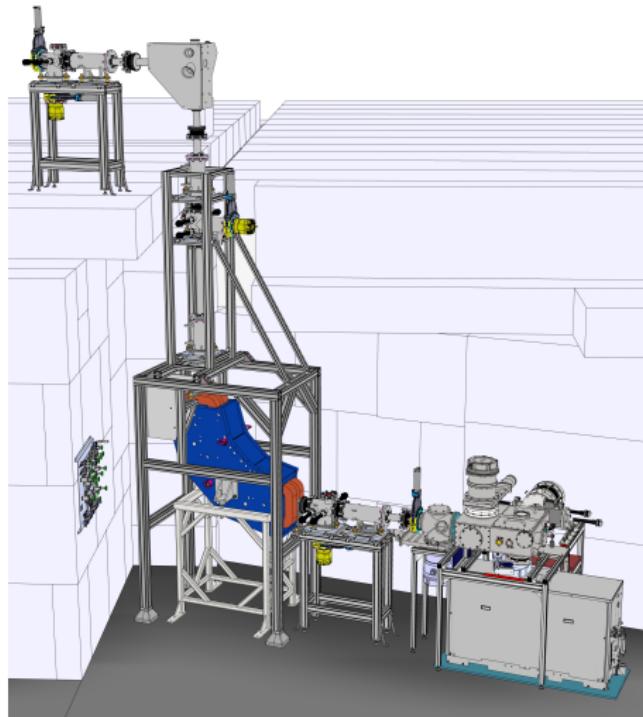
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The Facility

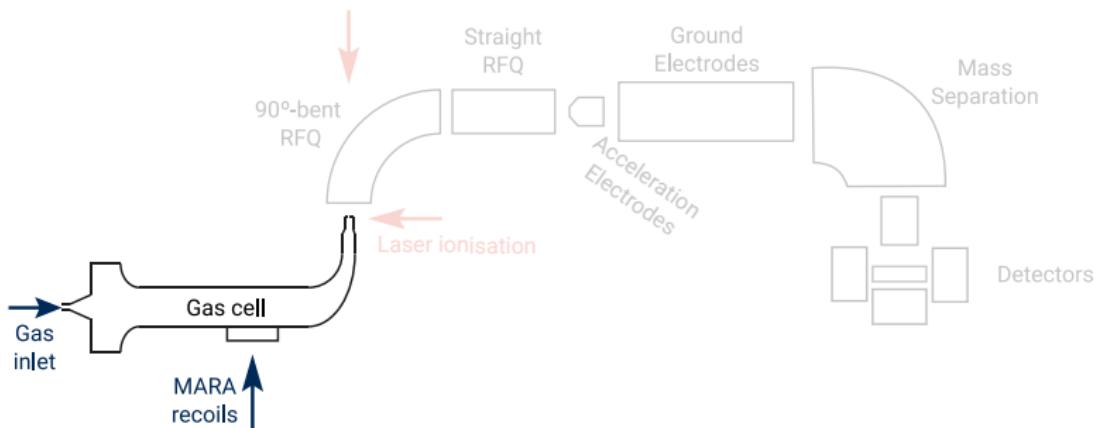
MARA-LEB

The MARA Low Energy Branch (MARA-LEB) will combine several separation techniques to purify beams of exotic ions produced at MARA.

It is currently under initial construction and testing at the Accelerator Laboratory in Jyväskylä, Finland.

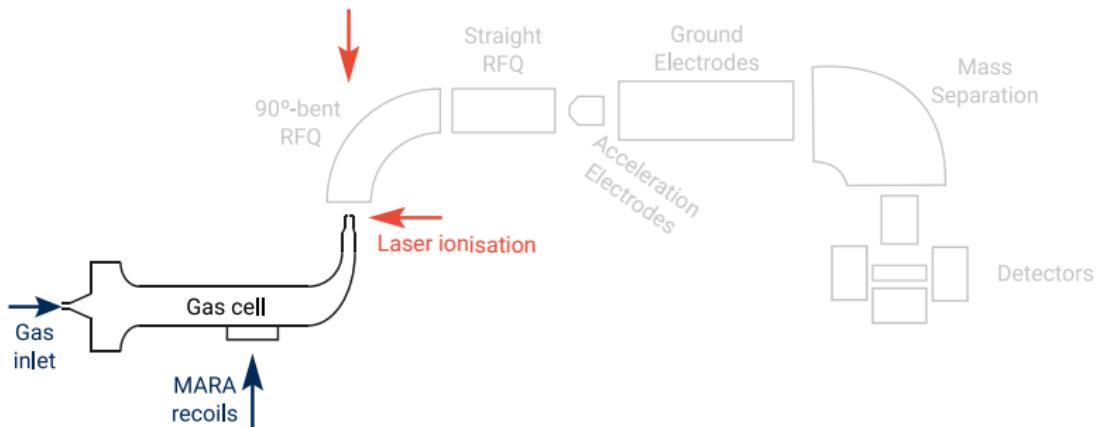


Recoils produced at MARA are stopped and neutralised in a small-volume buffer gas cell. Typical buffer gases are helium and argon.

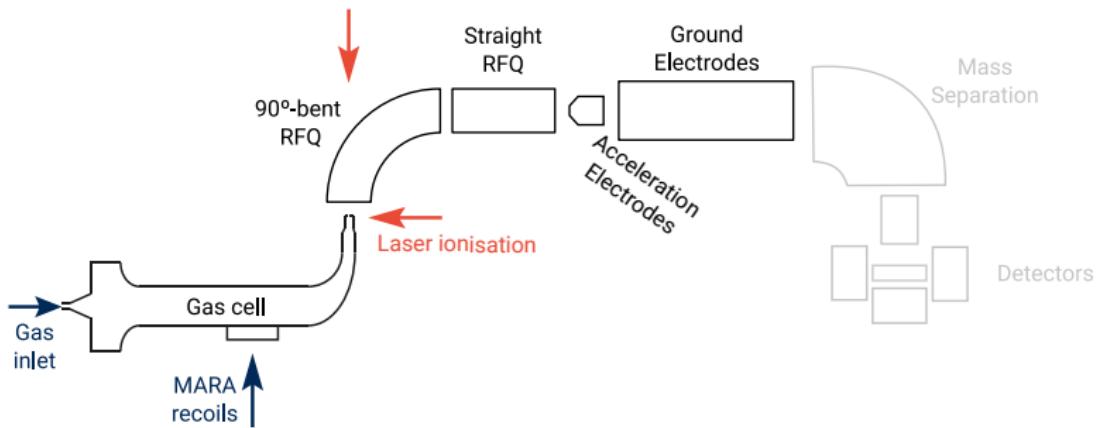


Neutralised recoils can be re-ionised via in-gas-cell or in-gas-jet laser ionisation.

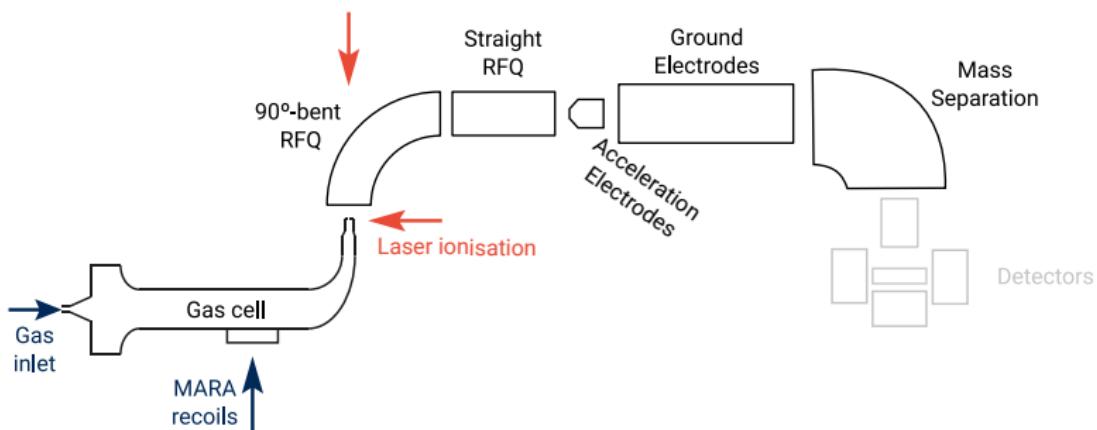
Laser spectroscopy can also be performed.



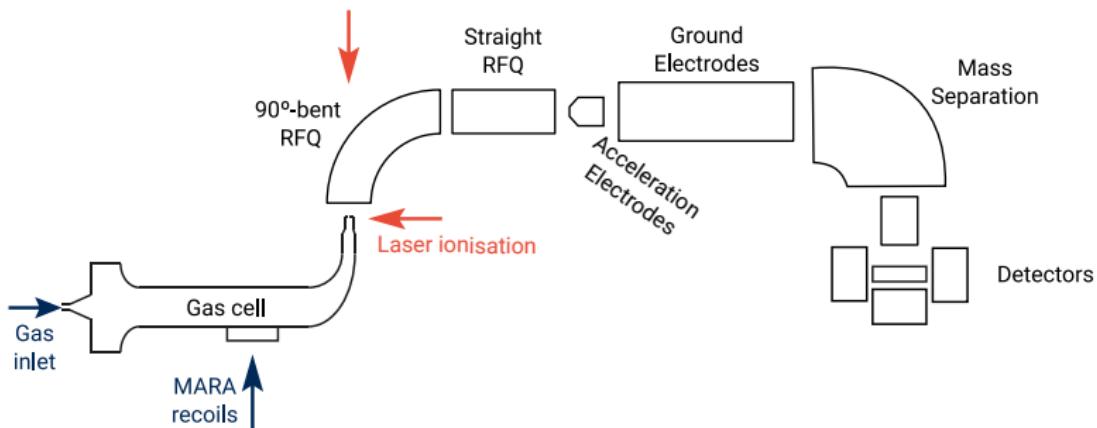
Ions are accelerated to 30 kV via the use of Radio-Frequency Quadrupole ion guides and other forms of ion optics.



Selected ions are further mass separated by a dipole magnet and an electrostatic deflector.



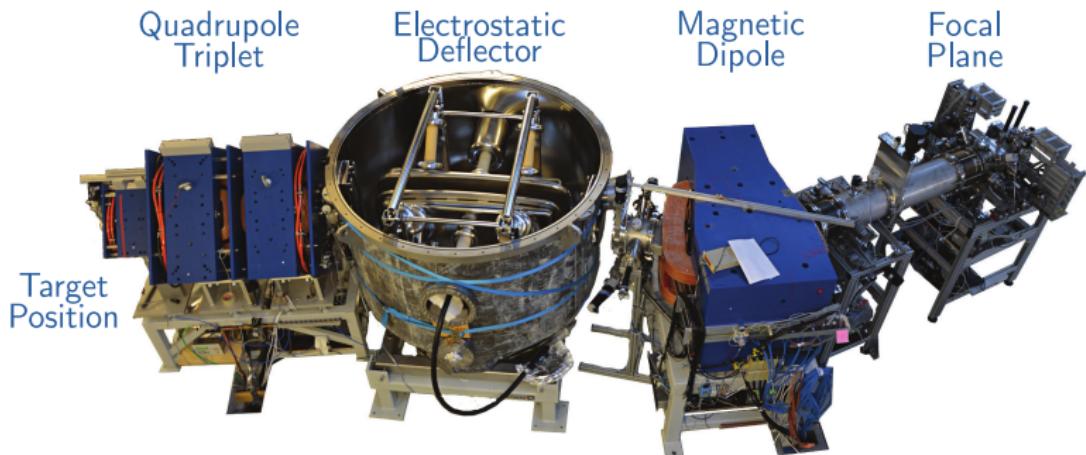
Finally, the purified recoil beam arrives at a detector station that is variable to adapt to individual experiment requirements.

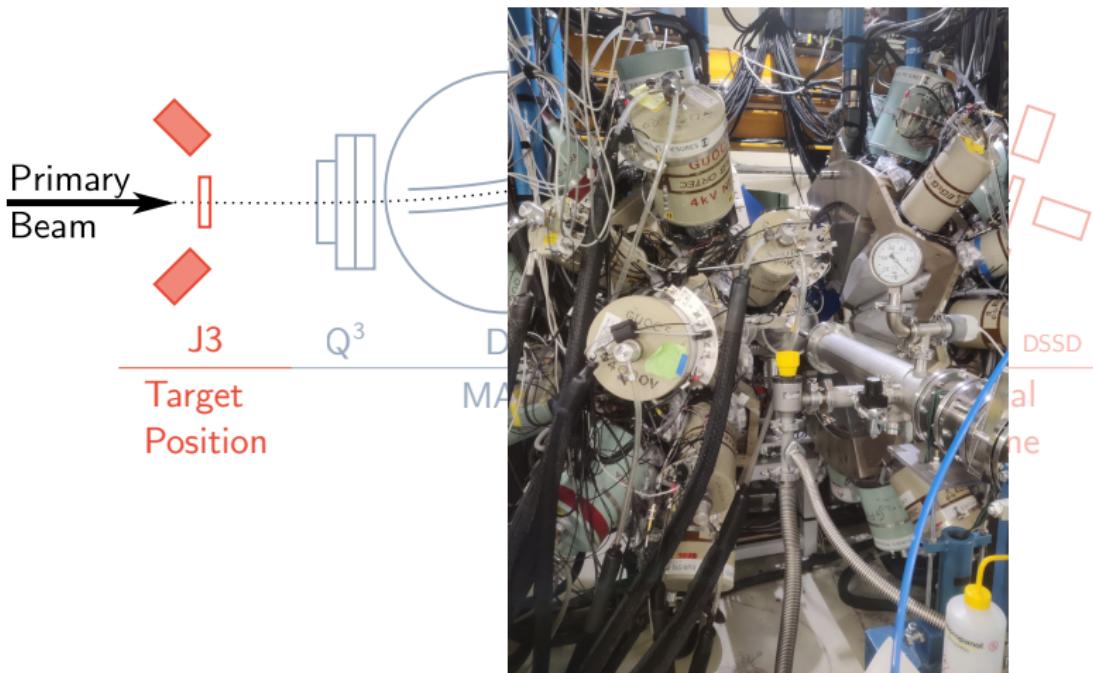


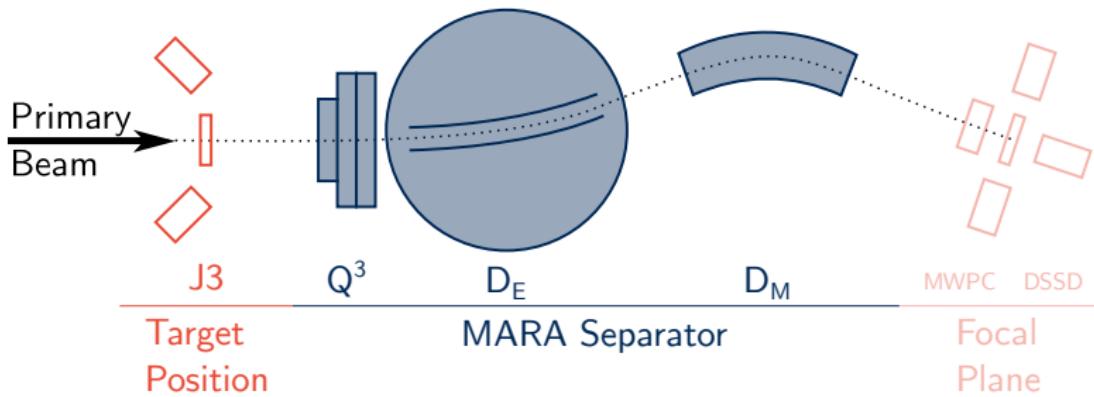
Current Status - Assembly and testing phase

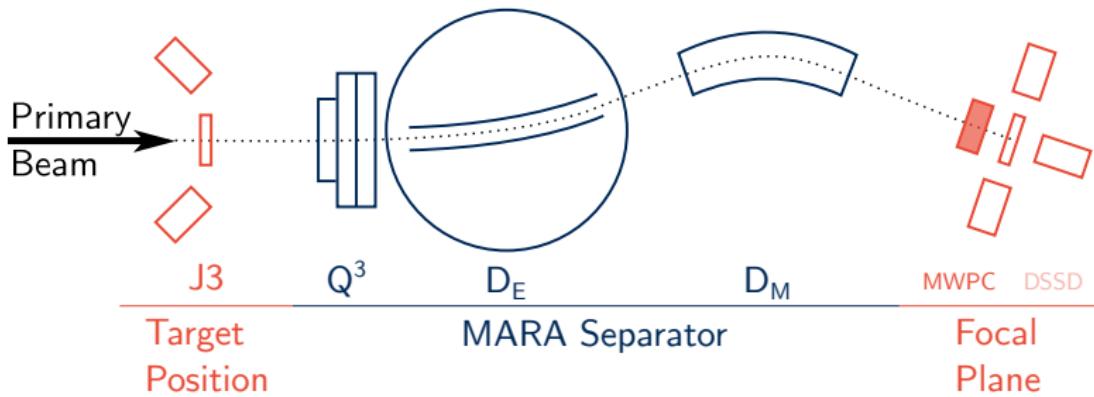


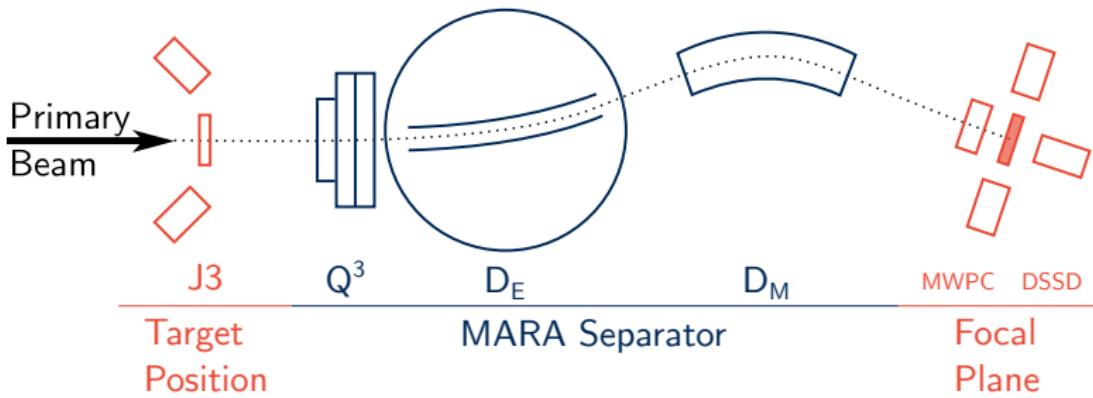
The Mass Analysing Recoil Apparatus (MARA) is a Q^3DED_M separator with a mass resolution of 250, mainly used for symmetric fusion-evaporation reactions.



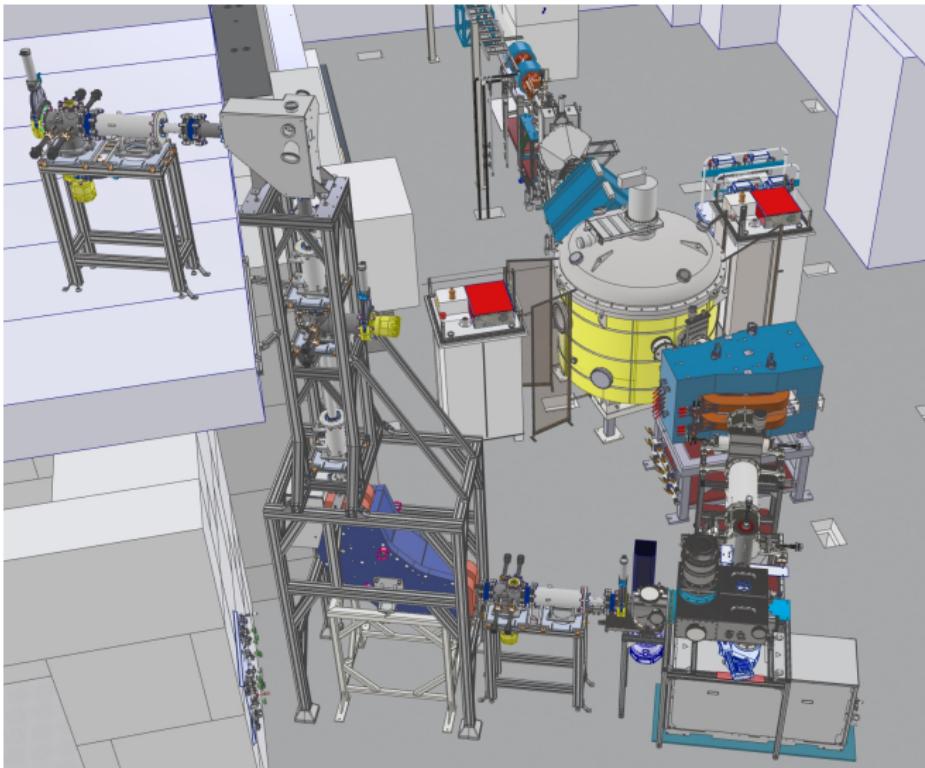








Full Facility



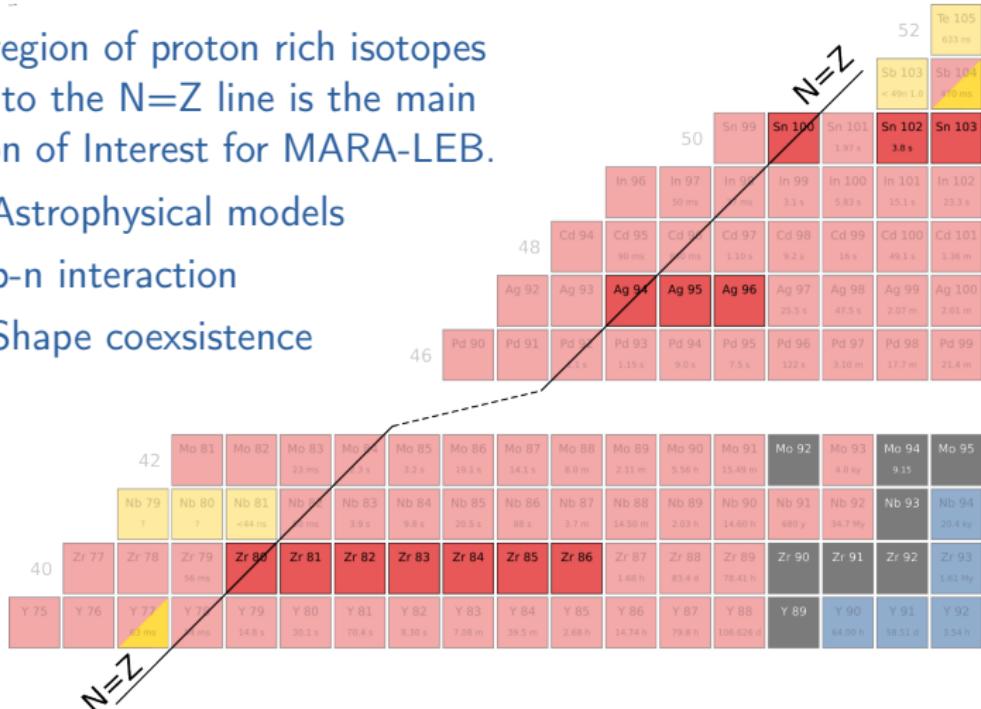
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Experiments at MARA

N=Z Region

The region of proton rich isotopes close to the N=Z line is the main Region of Interest for MARA-LEB.

- ▶ Astrophysical models
- ▶ p-n interaction
- ▶ Shape coexistence



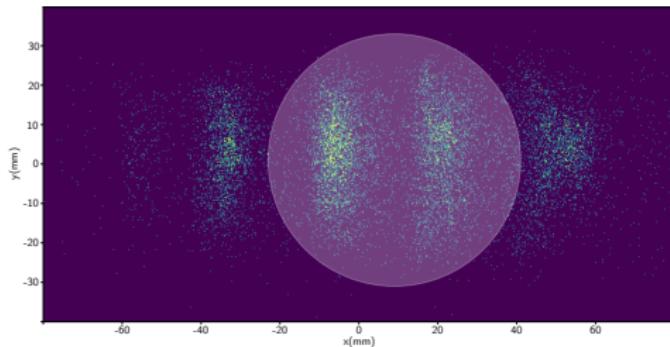


Gas Cell Window Study



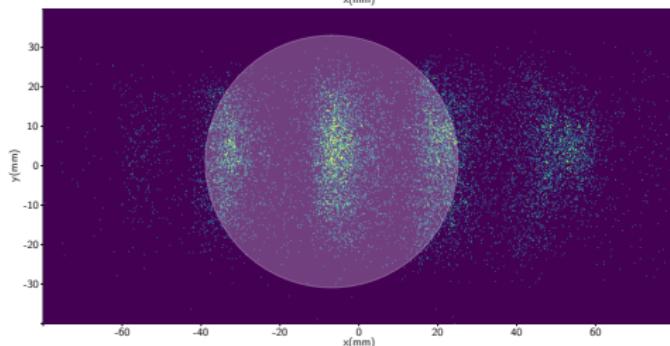
2 charge states
entering the cell

58% acceptance



3 charge states
entering the cell

63% acceptance





Actinide Region

Experiment JM20 was carried out in the Accelerator Laboratory of the University of Jyväskylä in November 2021.

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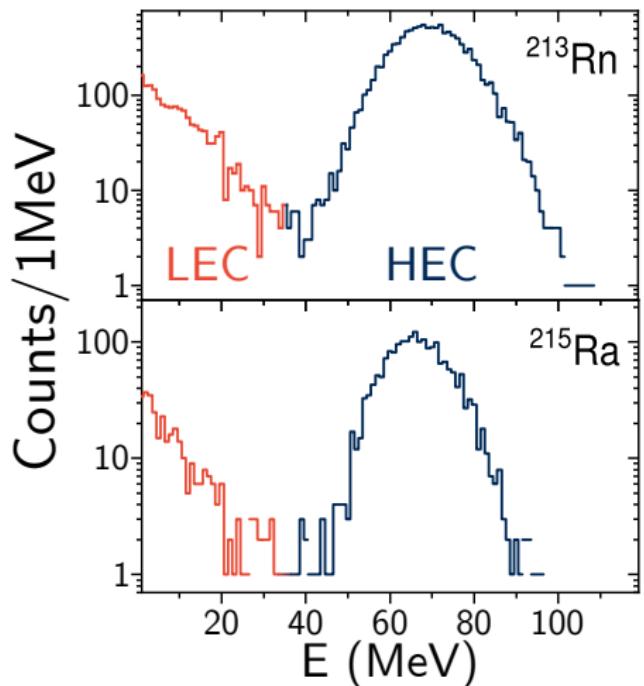


Fig 1: Energy distribution of the non-fusion products of $^{50}\text{Ti} + ^{249}\text{Cf}$ at TASCA.

Actinide Region

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QF may be an alternate production method for actinides, which can be used to perform laser spectroscopy experiments in MARA-LEB.

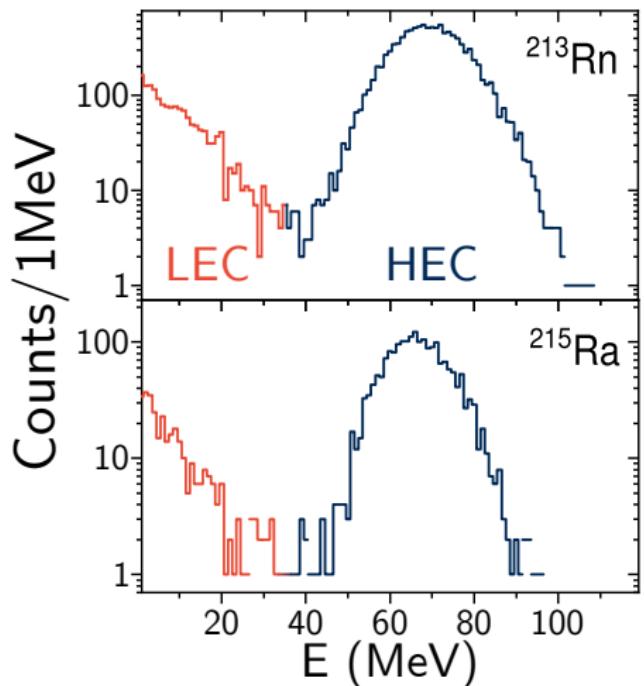
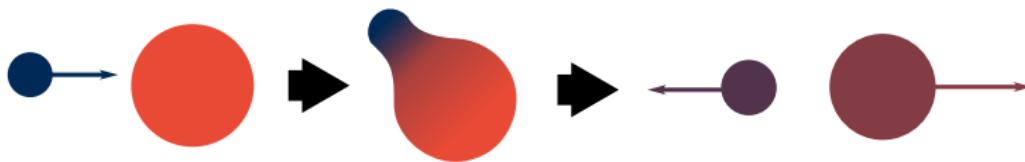


Fig 1: Energy distribution of the non-fusion products of $^{50}\text{Ti} + ^{249}\text{Cf}$ at TASCA.

Quasi-Fission

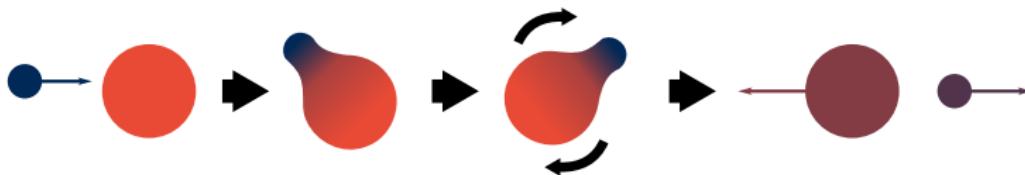


The high energy component is analogous to a usual fusion-fission reaction, where an inelastic collision occurs.

Quasi-Fission



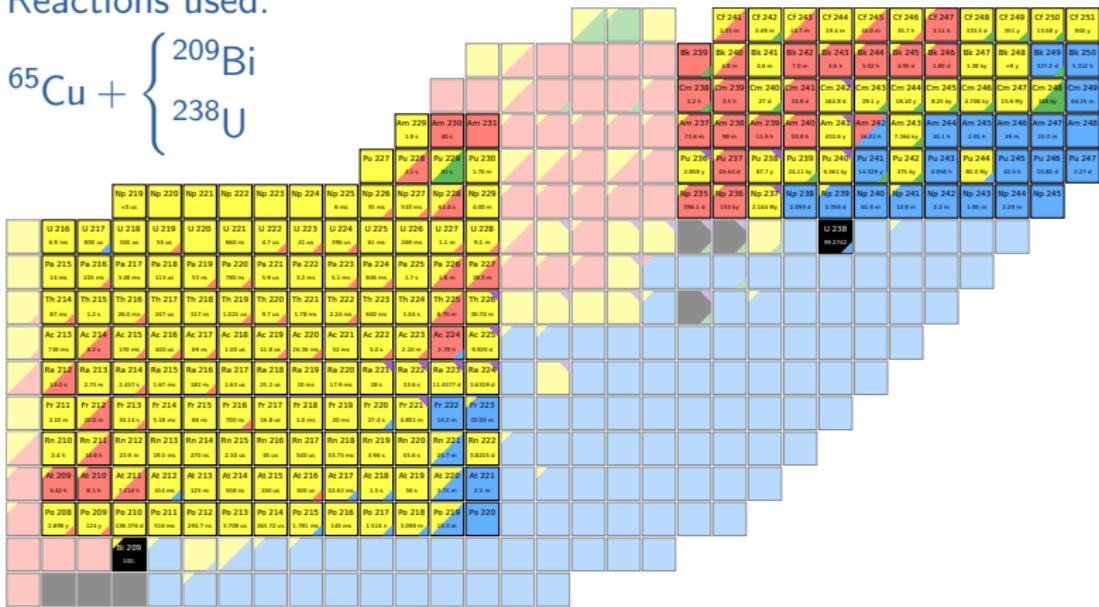
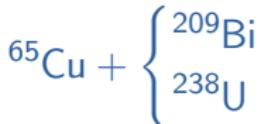
The low energy component can be interpreted as the rotation of the compound in the **centre-of-mass frame** before fission.



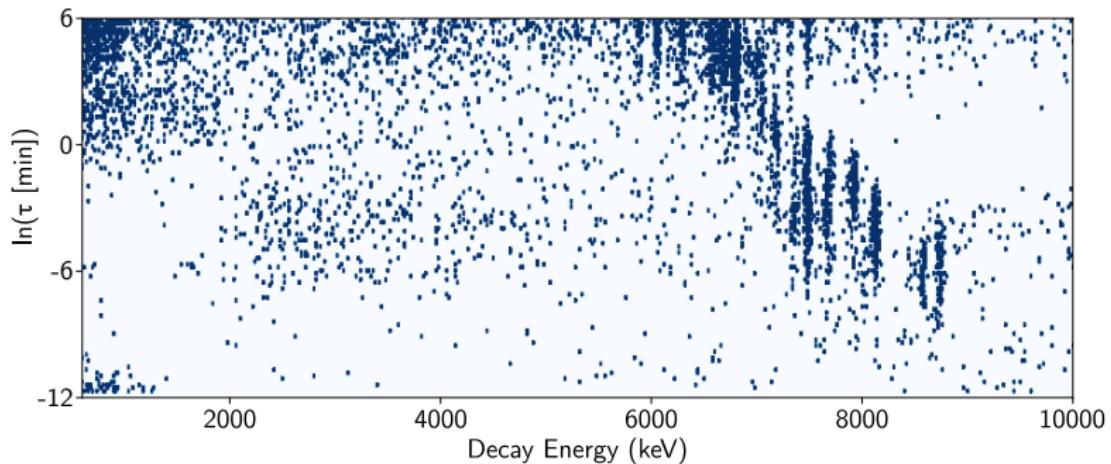


Experiment JM20

Reactions used:

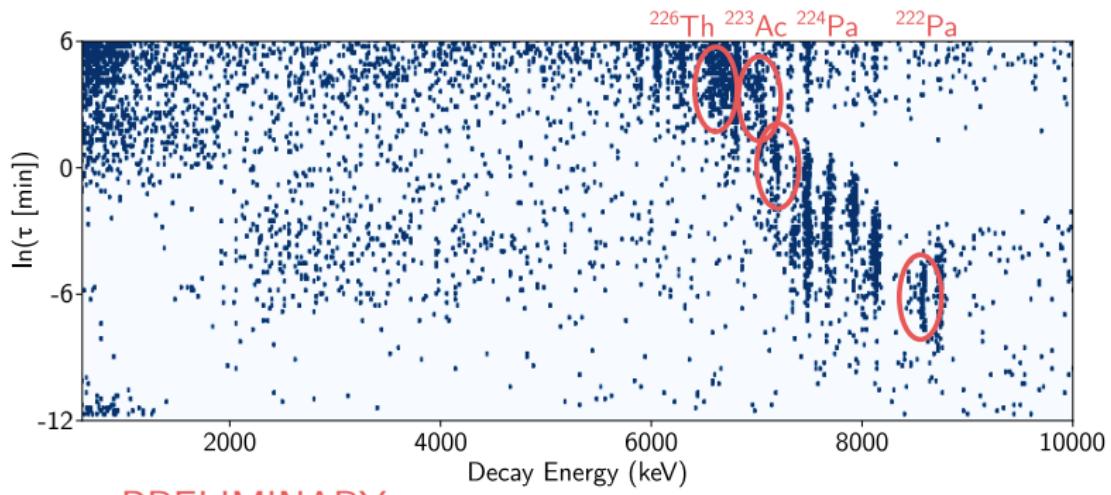


Alpha decays are identified by their energy and timing.



PRELIMINARY

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PRELIMINARY

3

Outlook



Outlook

Experimental Prospects

- ▶ $N=Z$, $A \sim 100$ recoils produced and high transmission is expected.
- ▶ Actinides produced, opening up a new region of interest for MARA-LEB.



Outlook

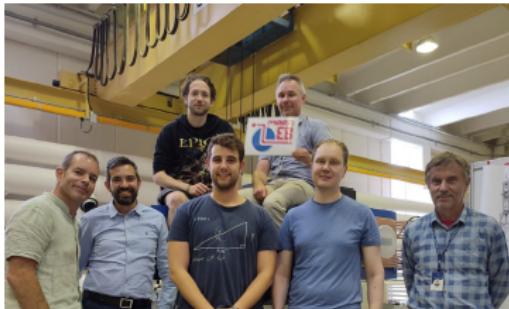
Experimental Prospects

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Long-Term Prospects

- ▶ New regions of interest have been proposed by collaborators.
- ▶ RITU-LEB for the study of Super-Heavies.

Dziękuję! Kiitos! Thank you!



Thanks to the MARA-LEB group in particular and to the Nuclear Spectroscopy group as a whole!



Backup

