Development of the MARA-LEB Facility

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Motivation

MARA-LEB (Mass Analysing Recoil Apparatus - Low Energy Branch) [1] is a facility that will be an extension for the MARA deflector at JYFL [2]. MARA is an electromagnetic deflector with a high mass-resolving power, suited to study lighter ions than RITU, the other deflector at JYFL.

It will be used to study proton-rich nuclei close to the drip-line. This area is of interest as a fertile ground to test the predictions of the shell model, p-n interaction and shape-coexistence . Knowledge on these nuclei is of paramount importance for undersanding of the astrophysical rapid proton capture process [3]. The LEB will provide the efficiency and selectivity required for such exotic nuclei.

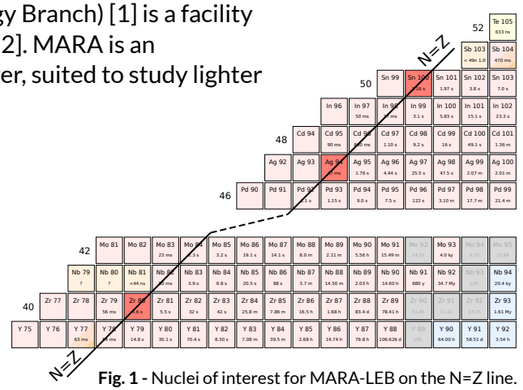


Fig. 1 - Nuclei of interest for MARA-LEB on the N=Z line. Their surrounding region is also of interest.

Setup

The LEB will be used for laser ionisation and spectroscopy experiments. Recoils from MARA will be stopped and neutralised in a buffer noble gas cell. They will then be laser-ionised and transported to an acceleration stage by ion guides, where they will be accelerated to 30 keV. A dipole magnet will provide mass separation before the detectors.

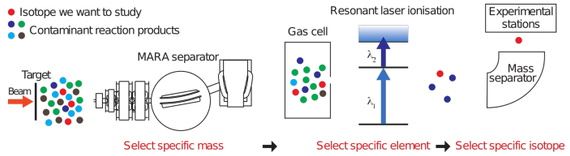


Fig. 2 - Nuclei of interest for MARA-LEB on the N=Z line.

The gas cell is the link between MARA and the LEB.

Its entrance window has to be optimised to maximise recoil acceptance, both in terms of material and size.

MARA experiments using the ions of interest can be used to determine the effect of window size.

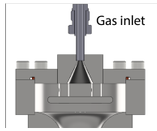
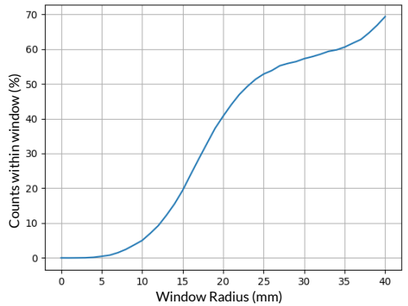


Fig. 3 - MARA-LEB buffer gas cell [1]

Experiment



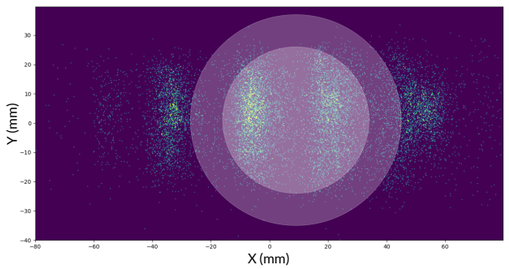
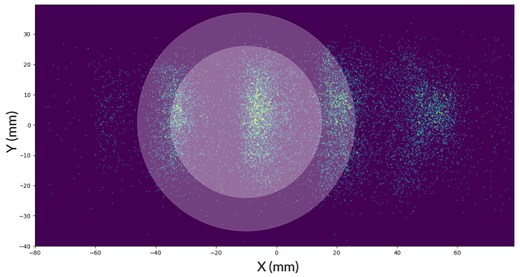


Fig. 4 - ^{96}Pd recoils with 25 mm- and 36 mm-radius windows superimposed (right) and window acceptance as a function of radius (left) centred at charge state 26.5.

An experiment has been carried out using the MARA deflector. An important part of this experiment was to obtain the spatial distributions of ions at MARA's focal plane, where the LEB gas cell will be installed.

With this information, decisions on the window's size can be taken, to optimise for recoil acceptance. This analysis was used to determine that a window larger than previously planned would increase the number of recoils that enter the cell significantly. The current design has a 31.5 mm-diameter window.



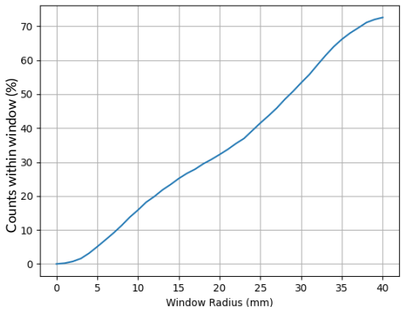


Fig. 5 - ^{96}Pd recoils with 25 mm- and 36 mm-radius windows superimposed (left) and window acceptance as a function of radius (right) centred at charge state 27.

[1] P. Papadakis et al., AIP Conference Proceedings **2011**, 070013 (2018)
[2] J. Sarén et al., Nucl. Instr. and Meth. B **266**, 4196 (2008)
[3] H. Schatz and W.-J. Ong, The Astrophysical Journal **844**, 139 (2017)