On the feasibility of online terbium extraction at ISOL@MYRRHA.

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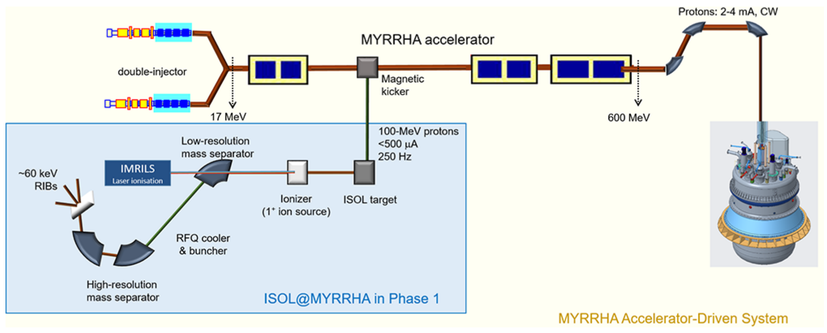
Introduction

$^{149, 152, 155}$Tb production at ISOL@MYRRHA



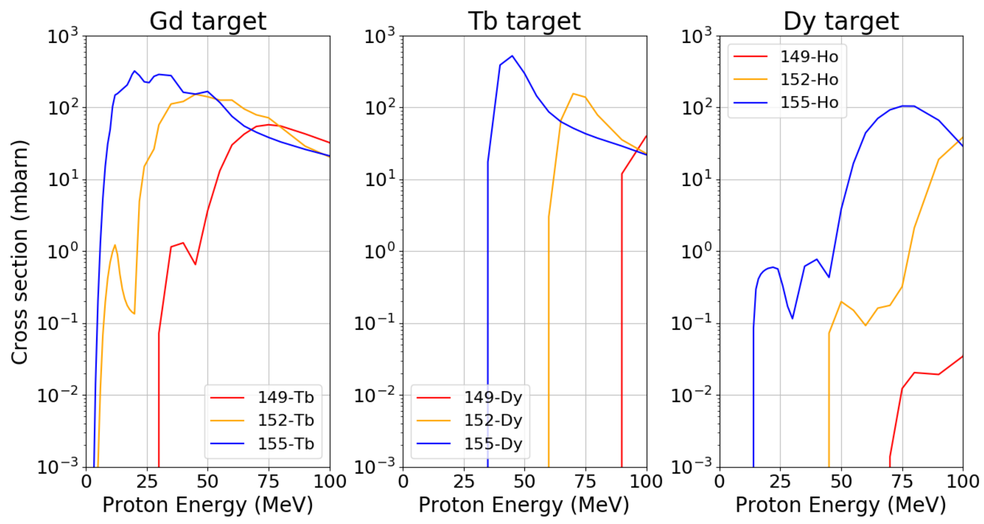
ISOL@MYRRHA is a radioactive ion beam facility under construction at SCK CEN in Mol, Belgium, as part of the MYRRHA ADS in phase 1. The facility will operate with proton beams of 100 MeV and intensities up to 500 μA.

Isotopes

This works looks into the production and on-line extraction of the following Tb isotopes: 149Tb α-decay (therapy), 152Tb PET (diagnostics), 155Tb SPECT (diagnostics).

Production

The first step is to optimise for production of the desired isotopes. This determines the best out of candidate target materials.



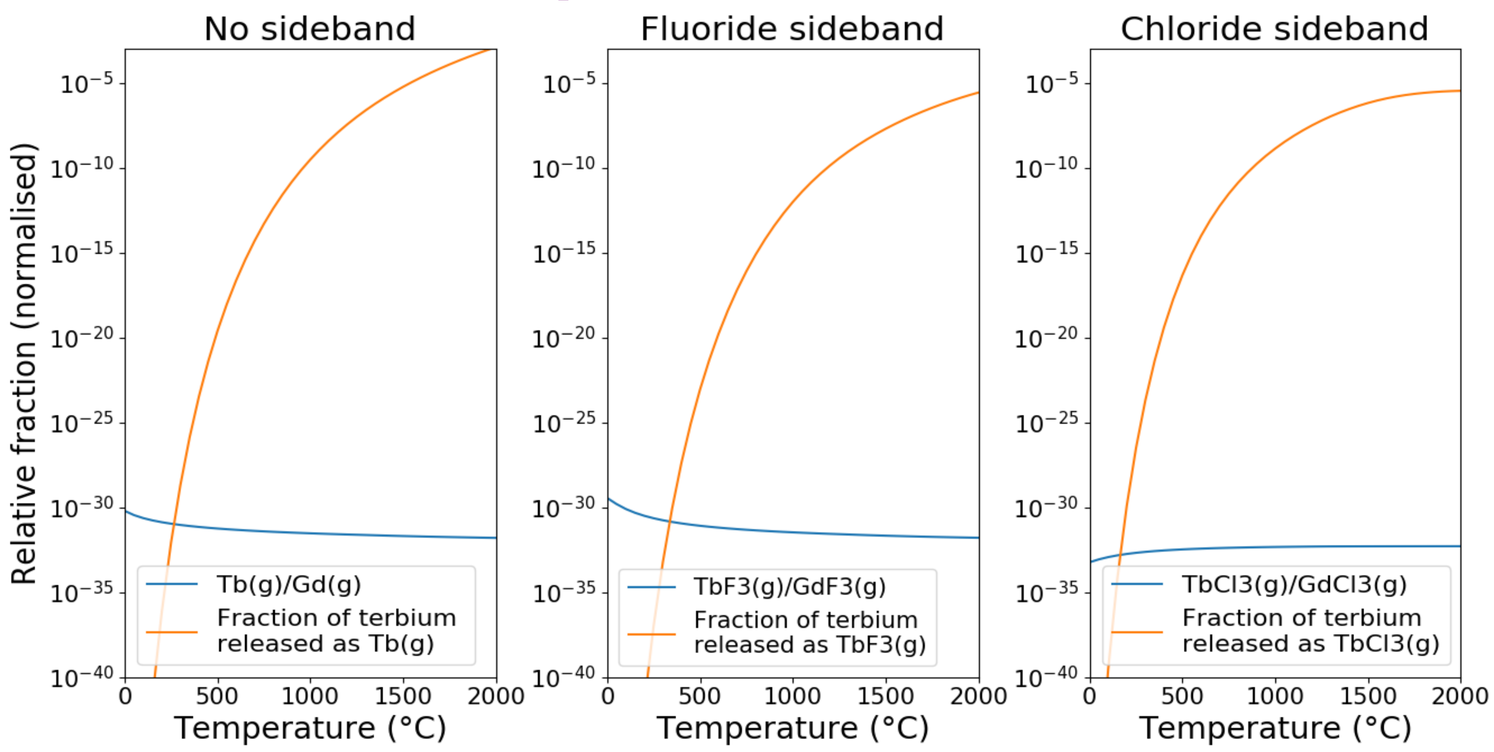
Production cross sections for candidate target materials

With the ISOL@MYRRHA beam and accounting for metastable states a terbium target is preferred, for the production of Dy precursors that decay post-exctraction into Tb.

Extraction methods explored

Molecular sidebands

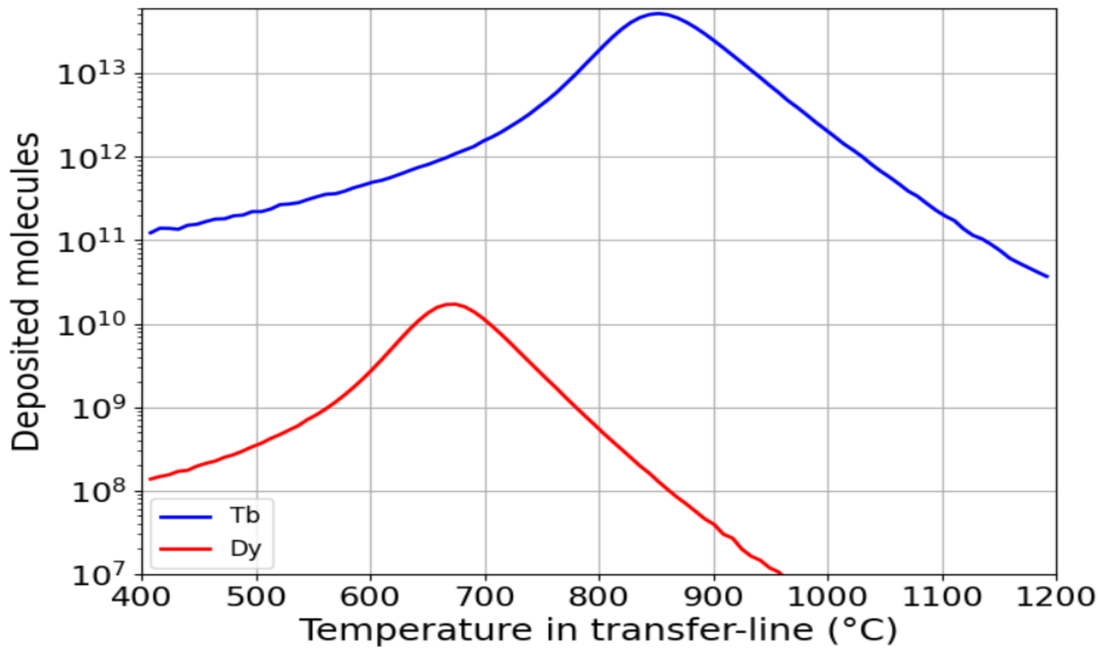
Owing to similar volatility of lanthanides, a selective release is not granted. Improving release selectivity through molecular side bands has then been studied. Fluoride and chloride proved not to improve the release selectivity. A broader, more systematic search resulted in most sidebands being unselective. The few sidebands initially identified (Gd_2O_3*WO_3, Gd_2O_3*$2WO_3$) are complex compounds and the change in volatility difference was not significant.



Tb evaporation from Gd with fluoride and chloride sidebands

Temperature controlled of the transfer-line

A temperature controlled transfer-line has also been considered, to improve selectivity, based on adsorption enthalpies. Results indicate that the deposition peak of Tb is ~850°C while that of Dy is ~670°C. Yet, because there are ~104 times more target atoms of Tb than Dy, the tail of the Tb peak overwhelms the Dy peak.



Surface deposition of Tb & Dy on Ta

Conclusion

Online separation of lanthanides at low energy proton beam facilities is highly unlikely. As an alternative, an off-line is considered at ISOL@MYRRHA.

Acknowledgement

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