Contribution ID: **40** Type: **Poster (In person)**

Challenging production of long-lived Xenon isotopes at ISOLDE: experiment vs theory

Wednesday 30 November 2022 18:14 (2 minutes)

Gamma-MRI is an EU-funded project which aims at the development of a new medical imaging modality, able to combine the high resolution of already established MRI techniques with the high sensitivity provided by SPECT gamma detection method. The nuclear species selected for this new technique are Xenon isomers (129mXe, 131mXe, 133mXe), since they are biologically inert, can be polarised, and their decay offers the maximum gamma-decay asymmetry.
One important element of the project is the efficient production of Xe isotopes, for which ISOLDE represents one of the best suited facilities. The Xe isotopes under study are collected by implanting extracted Xe beam in gold foils, whose activity is evaluated from gamma spectroscopy measurements. Unfortunately, several attempts at efficient production at ISOLDE have been challenging: very high-level of stable contaminants, lower production than expected from test collections, very low efficiency for offline collections.
These unexpected problems have led us to investigate in detail the production on 121-140Xe, and especially 129,131,133Xe during a 2.5-day beamtime. Regular mass scans and test collections, together with one main collection were performed, followed by gamma-spectroscopy of the irradiated foils.
We combined these results with Fluka calculations of in-target yields, and we were able to develop a production model in which a production curve can be obtained for each Xe isotope , considering the contribution of both direct in-target production, side feeding from neighbouring parent nuclei, and total efficiencies. A special case is represented by 133Xe, from which it is possible to estimate experimentally the Isomeric Ratio, as both its isomeric and ground state are unstable.
Consequently, the main outcome of the present work is the possibility to define the optimal conditions that can be exploited to maximize the production efficiency and predict the amount of a given Xe isotope that can be collected.

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Session Classification: Poster Session