Contribution ID: **72** Type: **Poster Presentation**

Development of a liquid Pb-Bi target for high-power ISOL facilities

Tuesday, 12 May 2015 17:01 (0 minutes)

In the context of the forthcoming next generation of Radioactive Ion Beams (RIBs) facilities based on the Isotope Separation On Line (ISOL) method, the development of production targets capable of dissipating the high power deposited by the primary beam is a major challenge. The concept of a high-power target based on a Lead Bismuth Eutectic (LBE) loop incorporating a heat-exchanger, a pump and a release chamber was proposed during EURISOL DS in 2005-2009. The partners within the ongoing LIEBE project (CEA, CERN, IPUL, PSI, SCK•CEN, SINP) are collaborating since 2012 on the development of this target, with the realization of a prototype and online tests at CERN-ISOLDE in 2016. The prototype could become a production unit for ISOLDE, accommodating a possible primary proton beam upgrade under discussion at CERN, and can easily be adapted for the EURISOL 100-kW beam power.

In this target the irradiated Pb-Bi containing short-lived isotopes is promptly spread into a shower of droplets, thereby reducing by two orders of magnitude the diffusion length of isotopes. Yet, ensuring an efficient release of isotopes is still of crucial importance and several delay-inducing processes have to be optimized. This requires design-optimization of both the irradiation volume and the release chamber. LBE evacuation from the irradiation volume of this target is one such process that needs to be carefully studied. The optimization of the flow of liquid Pb-Bi in the compact and complex geometry of the irradiation volume will be discussed in this presentation. Three-dimensional computer simulation results pertaining to the initial design geometries have revealed issues such as long residence time due to irradiated LBE recirculation, non-uniform distribution of LBE-velocity vectors at outlet apertures and regions with pressure dropping below the vapor pressure of LBE. Thorough analysis of the results led to successively-improved target-design options. Two different optimized target geometries were eventually obtained and will be presented.

Calculations of the thermo-mechanical effects of the impact of a proton pulse will be presented for the optimized geometries. Under the assumptions of a rigid irradiation-volume container and not accounting for potential cavitation effects, temperature and pressure fields inside the irradiation volume have been determined.

The presentation will further include an overview of the activities within LIEBE and the status of the project.

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Session Classification: Poster Session B