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On the comprehensive characterization of the thermally optimized SPES Laser Ion Source

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The SPES (Selective Production of Exotic Species), located in INFN-LNL, Italy, is an ISOL (Isotope Separator On-Line) facility dedicated to the production of radioactive ion beams (RIBs). One of the main ion sources SPES employs is the Hot Cavity Resonant Ionization Laser Ion Source (HC-RILIS).
The RILIS method employs stepwise photo-ionization schemes that are element-specific, thereby offering high elemental selectivity. When combined with mass separation, it enables the production of high-purity isotopic beams with minimal isobaric contamination.
The geometry of the SPES-Laser Ion Source (SPES-LIS) has been realized as a result of the thermal optimization of the ISOLDE MK1 ion source. The SPES-LIS is made of tantalum, and is composed of a hot cavity, a transfer line, and an alignment system.
Laser enhancement ratio of the ion yield and time structure of the ion beam has been measured in relation to the production of Sm and Ga ions. The time structure of the laser ion beams from the SPES-LIS reveals that roughly 50% of the total ions are produced in the transfer line which was not observed for the ISOLDE MK1 source. This effect is attributed to the actively heated transfer line system in the SPES-LIS which provides an ion guide along the whole length of the ion source.
The measurements were performed under various ion source temperatures and ion load conditions, primarily influenced by surface ion contaminants. Through this study, it was also observed that the radial ion confinement in the transfer line could be further optimized for high ion load conditions, which is particularly critical for the production of medical radionuclides with inherently low in-target yields.
Furthermore, laser resonance ionization efficiency measurements for the production of Ga were performed, with a reported value of 27.2%. This measurement sets a crucial reference as it was the first completed set of laser ionization efficiency in ISOLDE Offline 2, performed using the SPES-LIS.

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