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The SPES Target - Ion Source system

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SPES (Selective Production of Exotic Species) is a project approved and financed by INFN (Istituto Nazionale di Fisica Nucleare), aimed to produce neutron-rich Radioactive Ion Beams (RIBs) according to the ISOL (Isotope Separation On Line) technique [1]. The core of the SPES facility is constituted by the TIS (Target - Ion Source) system, that converts a stable proton beam into a RIB (Radioactive Ion Beam). The SPES production target is an innovative multi-foil direct target, composed of 7 UCx co-axial disks [1,2]. It is impinged by a 40 MeV, 0.2 mA proton beam, that generates approximately 10 to the 13 fissions per second. The nuclear reaction products get into the ion source thanks to diffusion-effusion processes [3], passing through a tubular transfer line made of Ta. In the framework of the SPES project, two different kinds of ion source will be adopted: a hot-cavity surface ion source (used for both surface and laser ionization), and a FEBIAD (Forced Electron Beam Induced Arc Discharge) ion source [4,5]. The SPES TIS system is installed inside a water-cooled vacuum chamber, and works at temperature levels approximately equal to 2000°C. High temperatures are fundamental to enhance the aforementioned diffusion-effusion processes, and to dissipate efficiently by thermal radiation the important amount of power deposited by the primary proton beam.

In this work, all the specific issues related to the SPES TIS system (including the target production, the primary beam power deposition, the steady state and the transient thermal behavior, the diffusion-effusion and ionization processes) are appropriately commented, showing the results obtained making use of both the theoretical and the experimental approaches. The characterization of the SPES ion sources in terms of efficiency and emittance is presented in detail, with an accurate description of the related experimental apparatus. A particular attention is dedicated also to safety issues, that are of primary importance in the context of ISOL facilities.

References:

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Primary author: Dr MANZOLARO, Mattia (INFN-LNL)

Co-authors: Dr ANDRIGHETTO, Alberto (INFN); Mr MONETTI, Alberto (INFN); Mr MOZZI, Aldo (INFN); Mr GOBBI, Christian (INFN); Dr SCARPA, Daniele (INFN); Dr PRETE, Gianfranco (INFN); Prof. MENEGHETTI, Giovanni (University of Padova); Mr VASQUEZ, Jesus (INFN); Mr ROSSIGNOLI, Massimo (INFN); Mr CALDEROLLA, Michele (INFN); Mr SILINGARDI, Roberto (INFN); Dr CORRADETTI, Stefano (INFN)

Presenter: Dr BISOFFI, Giovanni (Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Legnaro)

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