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Progress in ion source development at the Low Energy Radioactive Ion Beam (LERIB) facility at iThemba LABS

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Abstract:

Isotope Separation On-Line (ISOL) is a well-established technique for the production of radioactive ion beams (RIBs) [1]. It involves the use of a primary light ion beam—such as a 66 MeV proton beam at 1 μ A for LERIB—impinging on a heavier elemental target, typically uranium carbide or silicon carbide. This interaction induces various nuclear reactions, whose products then diffuse out of the target material into an ion source, where they are ionized and extracted as RIBs. To facilitate this process, different types of ion sources must be coupled to the target unit; together, they form what is known as a Target Ion Source (TIS) system.

At the offline LERIB facility [2] at iThemba LABS, two ion sources are currently under development and testing:

1. A hot cavity surface ionization ion source [3], which has successfully produced potassium-40 isotope beams for implantation studies and molecular beams of gadolinium and terbium—potentially relevant to future cancer “theranostic” applications; and
2. A Forced Electron Beam Induced Arc Discharge (FEBIAD) ion source [4], currently being prototyped and tested in-house.

Surface ionization sources primarily ionize Group 1 elements due to their selective nature, while FEBIAD sources are non-selective and can ionize a broader range of neutral atoms. A mass-analyzing bending magnet downstream of the ion source enables separation of the desired isotope for further study or application.

This presentation highlights recent progress in ion source development and operational readiness at the LERIB offline facility.

References:

- 1) M Lindroos 2004 CERN-AB-2004-086, Review of the ISOL Method, CERN, Geneva Switzerland
- 2) J L Conradie et al 2029 JACoW-Cyclotrons2019-MOB02, Progress with a New Radioisotope Production Facility and Construction of Radioactive Beam Facility at iThemba LABS
- 3) S T Segal et al 2023 J. Phys.: Conf. Ser. 2586 012144, Ion Source Development at the off-line LERIB test-facility at iThemba LABS
- 4) M Manzalaro 2011 Study, design and test of the Target – Ion Source system for the INFN SPES facility, Doctoral Dissertation (Padova: University of Padua)

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