Isotope Production R&D at LERF, Jefferson Lab’s High Power Electron Linear Accelerator

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Abstract:

High power (~100 kW) electron accelerators are well suited for the production of some important isotopes for medical and industrial applications. The very high power densities they provide to the target can result in significant yields of desired isotopes. The Low-energy Electron Recirculator Facility (LERF) at Jefferson Lab is a Superconducting Radio Frequency (SRF) electron accelerator where electron energy and current are highly tunable, from 10 MeV to 170 MeV and a few µA to many mA. At LERF, beam powers in excess of 100 kW are easily achievable.

Yields of isotopes depend on the electron beam power. Increasing beam power requires targets that can handle the power. Higher beam energies can create undesired isotopes which have to be removed from the final desired isotope. Additionally, target handling post-irradiation and radiation shielding require attention.

In this proposal, we focus on creating Cu-67 using photo-production method. The reason for focusing on Cu-67 is that it is a very promising isotope for imaging as well as cancer therapy. The potential market for this isotope is large (numbers, SDSMT?) and there exists no reliable supply. The three major objectives of this proposal are demonstration of i) a target system that can handle 50kW of beam power, ii) separation of Cu-67 from the irradiated target and iii) a technique for effective delivery of the isotope to a targeted area, such as a tumor. (VCU may want to make this more precise). Three additional objectives are to experimentally establish optimal beam parameters for production, quantify yields and train a graduate student in this field. We propose to introduce a new target nucleus which has not been explored before, namely Gallium, in addition to the more common Zinc target. We will outline the path to take past this R&D program to secure a steady supply of Cu-67 isotope at LERF.

In executing this endeavor, we will refine our preliminary simulations of target design and photo-nuclear simulations and verify them against experiments. In order to alleviate radiological concerns (shielding and local activity), we will use LERF’s capability of generating low energy electron beam at high current (10 MeV and 5 mA) to test our 50 kW target design. We will then vary the beam energy at lower current to produce isotopes in the targets and carry out the objectives listed above. We fully expect that as a result of this work, there will be a path for reliable production of Cu-67 which will expand medical research in this field and treatments of many types of cancer. We also expect that the new high power density target irradiation technology and design developed for Cu-67 production at LERF will find use in other important isotope production processes in the future.