

## **Improved High Current Liquid and Gas Targets for Cyclotron Produced Radioisotopes**

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Radiopharmaceuticals utilizing cyclotron produced radionuclides have already been shown to be extremely valuable in basic medical research, disease diagnosis and radiotherapy. IAEA Member States world-wide have acquired more than 600 cyclotrons employed for nuclear medicine applications and the number is growing every year. In the past, cyclotrons and the related targetry systems were mainly operated by dedicated professionals situated either within academic physics research institutions, large university hospitals or industrial scale radionuclide manufacturers. However, because of the rapidly spreading use of PET and PET/CT, the number of cyclotron installations is rapidly growing and target technology needs to be appreciated by a much larger group of professionals. Although many of the new cyclotrons are primarily erected for the production of a single isotope (F-18) in the form of a single, well defined radiopharmaceutical (FDG) a sizeable fraction of these new installations have declared and started active research programs in C-11 and other non-traditional positron emitting radiotracers. As part of International Atomic Energy Agency (IAEA) activities to disseminate knowledge for member states, a three year Coordinated Research Project (CRP) was organized. The overall goal of this CRP was the development of new and reliable cyclotron targetry technology for the production of high specific radioactivity for the most widely used radionuclides.

Significant advances have been made under this CRP in the development and standardization of high power gas and liquid targets. The primary focus of this CRP was to develop targets and methods to increase specific activity, radionuclidic purity and production reliability for several radionuclides including F-18, C-11, I-123, and Rb-81/Kr-81m. These advances applied in several facilities have minimized the unnecessarily operator exposure to radiation. A particular area of interest for this group was the recovery and characterization of enriched  $\text{H}_2^{18}\text{O}$  focusing on the reuse of the water and several important conclusions were reached. It was determined that the tritium introduced by the inevitable nuclear reactions does not pose any health physics problems either during the tracer manufacturer or during potential water reclamation. It was further determined that radionuclides produced in the metal foil during irradiation are found in the target water at very low concentrations. These impurities can be essentially eliminated by using noble metal plated foils and by the separation used for fluorine extraction from the O-18 water. In no case were the radionuclides produced in the foil found in the final product. Moreover, a survey of target maintenance procedures has been carried out and the results of this survey are reported in this CRP. In spite of these findings, the knowledge that has been gained needs to be transferred to the countries and facilities where it will help to optimize the production of radionuclides used for PET and SPECT. In this regard, a book will be published focusing on two of the most widely used target systems (F-18 and C-11) and including both fundamental knowledge and practical advice on the operation of these target systems. In addition to this book, lectures have been planned to convey both the knowledge gained in this CRP and the problems identified by the expert panel to the wider radionuclide production community with the idea that further research on these problems will benefit all the member states and the community in general.