EXTRACTION OF RADIONUCLIDES FROM ACCELERATOR WASTE AT PSI

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PSI operates the most powerful proton accelerator world-wide. With 590 MeV and a beam current of 2.5 mA it serves as the proton feeder for the Swiss neutron spallation source SINQ. Components in the surrounding of this instrument are highly activated by high energetic protons and secondary particles. Since spallation reactions induce the production of isotopes with masses up to one mass unit higher then the target mass, the spectrum of elements produced cover nearly the entire periodic table. Therefore, some of these activated components represent valuable archives for exotic and rare isotopes, which are urgently needed for experiments in several scientific fields. One of these research areas is nuclear physics, and especially nuclear astrophysics.

1. Separation of ^{44}Ti

Core collapse supernovae are remarkable astrophysical sites, representing one of the most extreme physics laboratories in Nature. Without them, the diversity and abundances of the chemical elements around us would be radically different, and yet the details of the core collapse phenomenon are still poorly known. One of the important diagnostic tools to help understand these processes is the isotope ^{44}Ti.

Moreover, due to its nuclear properties (β^+ radiation, convenient half-life) the short-lived daughter nuclide ^{44}Sc ($T_{1/2}$=3.92h) is believed to be a potential PET (Positron Emission Tomography) nuclide. For model studies, about 4 MBq ^{44}Ti were separated from a copper beam dump irradiated with 590 MeV protons at PSI by use of ion exchange from HF containing aqueous solution [1].

2. Preparation of ^{60}Fe samples for the determination of the neutron capture cross section at stellar energies and the re-measurement of the half-life

The long-lived radionuclide ^{60}Fe plays a key role in tracing the history of the Early Solar System (ESS). Attempts at reconstructing the inventory of radioactivity between Fe and Pb require, among others, the exact knowledge of the half-life and experiments aimed to determine the neutron capture cross section. Two ^{60}Fe samples were prepared from the copper beam dump mentioned above using liquid-liquid extraction, precipitation and ion exchange. The two experiments were successfully performed in 2007 and 2008 [2,3].

3. ^{7}Be separation from the SINQ cooling water

^{7}Be is a key radionuclide for investigations of astrophysical processes and phenomena like the study of the solar neutrino flux, in particular the reaction ^{7}Be(p,γ)^{8}B [4]. Highly-active ^{7}Be targets in the range of several 100 GBq are required for such studies.

^{7}Be is produced in considerable amounts in the cooling water (D_2O) of the SINQ facility at PSI by spallation reactions on ^{16}O with the generated fast neutrons. By use of a mixed-bed ion exchanger the separation of ^{7}Be samples with an activity in the TBq-range is possible.

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