Production and Separation of Long-lived Radionuclides for Nuclear Physics Experiments

Dorothea Schumann[1] and Jörg Neuhausen[1]
[1]Paul Scherrer Institute Villigen, 5232 Villigen PSI, Switzerland

Long-lived exotic radionuclides such as ^{60}Fe, ^{26}Al, ^{44}Ti or ^{10}Be are of great interest in several fields of research like radiopharmacy, basic nuclear physics, astrophysics and/or radioactive ion beam techniques. Some examples for the use of such rare isotopes in the research area of nuclear astrophysics are the application of ^{44}Ti for investigations of core collapse supernovae or studies of several neutron capture reactions on radioactive isotopes like the $^{60}Fe(n,\gamma)^{61}Fe$ reaction at stellar energies. The direct production of these nuclides in sufficient amounts is, in some cases, nearly impossible, in others very time consuming and extremely expensive.

Until very recently, no concerted effort had been made to reclaim such radionuclides for future use from activated components of particle accelerators. This is due, in large part, to the small amounts of suitably irradiated material. Nowadays, this situation changed drastically with the construction of new large accelerator facilities, spallation neutron sources and radioactive-beam-facilities. An example is the EURISOL project [1].

The Paul Scherrer Institute operates the most powerful spallation neutron source (SINQ) in Europe, driven by a high power proton accelerator, the 590-MeV ring cyclotron with a proton beam current up to 1.8 mA. Previous radiochemical analyses [2,3] showed that beam dumps, shielding and target materials from these facilities contain long-lived radionuclides in such high amounts, that chemical separation for several applications seems to be attractive. It was found that the isotopes ^{60}Fe, ^{26}Al, ^{10}Be, ^{44}Ti and probably many others can be separated already now in amounts of 10^{16} - 10^{18} atoms [4].

At the moment, PSI can provide about 500g of proton-irradiated copper stemming from a former beam dump, as well as irradiated graphite targets with a high content of ^{7}Be and ^{10}Be. Additionally, the first lead targets, already irradiated at the spallation neutron source, SINQ, will be ready for use in the near future. With these materials, provision of several interesting long-lived radionuclides (^{7}Be, ^{10}Be, ^{26}Al, ^{44}Ti, ^{53}Mn, ^{60}Fe and many others) will be possible after chemical separation in quantities sufficient for scientific studies to be conducted in several different research fields. A first exploratory workshop on this topic (ERAWAST - Exotic Radionuclides from Accelerator Waste for Science and Technology) was held in 2006 at PSI.

In the present contribution, an overview on the possibilities for "mining exotic radionuclides" from accelerator waste at PSI is given. Some selected chemical separation procedures are presented.

Ref.

[1] http://www.ganil.fr/eurisol/
[2] D. Schumann et.al. NIM B 2007, submitted
[3] D. Schumann,et.al. Radiochim. Acta 2007, submitted
[4] D. Schumann, et.al. Journal of Physics G 2007, submitted