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Charge State Breeding Experiences and Plans at TRIUMF

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At the ISAC facility at TRIUMF radioactive isotopes are produced by bombarding solid targets with high energy (480MeV) protons. The products diffuse out of the target into an ion source. Ions are extracted at several tens keV and selected in a mass separator. After separation they are either sent directly to experiments or post-accelerated. Due to the proximity of the target at high temperature and in high radiation fields, the ion sources have to be robust and with low maintenance requirements. As a result, mainly singly charged ions can be extracted. For post-acceleration, charge state breeding with an electron cyclotron resonance ion source (ECRIS) has been chosen. Shortly after the installation and first tests of this source it became clear, that the background from stable contaminants in the source plasma can be orders of magnitude higher than the intensity of the rare radioactive ions. Several measures, including changing materials for the plasma chamber and the surrounding components, have been implemented to reduce this background. Further reduction has been achieved by using the post-accelerator chain as a mass filter. This made a first physics experiment on accelerated Sr isotopes possible in 2013. Several more experiments have since followed.

With the planned expansion of the isotope production capabilities at TRIUMF within the ARIEL project, two new target stations, one using photo-fission induced by a high-power electron beam at 50 MeV and the other one using 480 MeV protons as at ISAC, will be put into operation within the next 5 years. Additionally, a new electron beam ion source (EBIS) based charge state breeding system will be installed. Background from such a source is expected to be much lower as no plasma wall interaction is involved. The drawback is that for the efficient operation of such a system pulsed beam operation is required. Bunching of the incoming beam after mass separation will be done with a gas-filled radio frequency quadrupole cooler/buncher. In order to minimize decay losses from short-lived isotopes the repetition frequency will be at 100 Hz.

Results from the existing system and design parameters for the planned facility will be presented.