

The light ion guide project

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In the previous progress report [1], details about and a description of the evolution of the Light Ion Guide (LIG) project were given. Last year, a major piece of equipment was added to the project: the new Charge Breeding ECRIS (CB-ECRIS) built by Scientific Solution, San Diego, California [2]. The CB-ECRIS was turned on and plasma was ignited; details can be found elsewhere in this progress report. The main directions followed last year in the development of the LIG, were: the lengthening of the rf-only hexapole in order to reach the CB-ECRIS's plasma chamber and the development of the ^{228}Th open-source operation.

As explained in the previous progress reports, the device was initially developed with ionized gas created by two high-voltage spark electrodes inside the gas cell. We were able to produce a few mA of current, mainly ionized helium and ionized impurities. The transported current (a few nA) was measured at the end of the rf-only hexapole on a Faraday cup. The discharge voltage and current were 227 V and about 3.5 mA, respectively. The production of the ions via the spark method has drawbacks: the high voltage needed to ignite the spark accelerates the ions, and at the end of the rf hexapole the ions gain about 180 eV in energy. This energy is too high for the injection into the CB-ECRIS.

In order to eliminate the described feature, and reproduce more closely the future on-line operation, we decided to use an open radioactive source (^{228}Th) as the recoil-ion source. An effort to use a heated alkali source was unsatisfactory due to the fact that the continuous flow of helium in the gas cell prevents attaining the temperature where the alkali source will start releasing the products.

Inside the gas cell the daughters from ^{228}Th are released continuously and they are thermalized by the helium gas. In order to have maximum stopping efficiency of the radioactive products, a pressure of 30 mbar of helium was used. The daughters are injected into the rf-only hexapole within helium flow by applying a small (approx. 10 - 50 V) acceleration (guiding) voltage between the cell exit and the hexapole inlet. The same voltage will control the injection energy of the recoil ions into CB-ECRIS plasma chamber. In this preliminary experiment the recoil ions were transported to a collector plate (aluminized mylar), placed at the inlet of the CB-ECRIS plasma chamber. The collector plate is backed by a silicon detector. The alpha particles coming from the products pass through the collector plate and are detected with the Silicon detector. The decay series of ^{228}Th include ^{216}Po with a half life of 145 ms. This is an excellent candidate to test our device: the half-life is short enough to provide a reasonable counting rate and is long enough to be charged boosted in the CB-ECRIS. The first tests, without CB-ECRIS plasma, were successful: we were able to measure about 50 alphas/sec coming from the ^{216}Po . We measured also the energy of the ^{216}Po ions, and found that the energy spread is only around 1 eV (see Figure 1). This extra energy will have to be taken into account for stopping the products in the plasma of the CB-ECRIS. The extraction of radioactive highly-charged ions will be attempted in future experiments after the CB-ECRIS becomes fully operational.

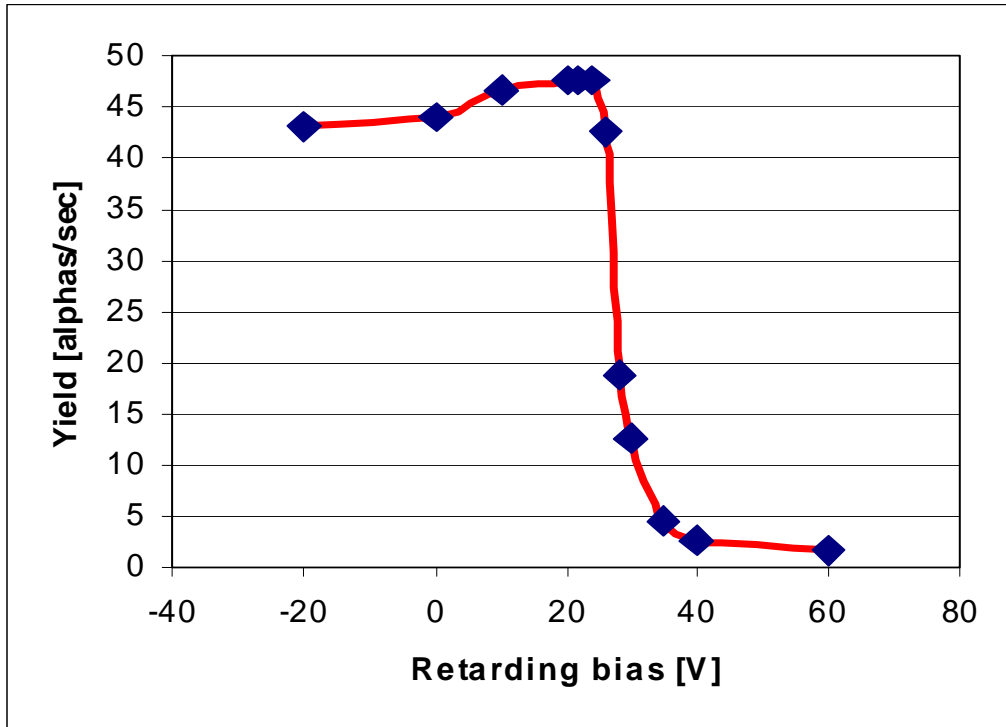


FIG. 1. The retarding bias is a measure of the energy of the ions. The radioactive products exhibit an energy of 20-25 eV approximately. The acceleration voltage was 24 V.

- [1] G. Tabacaru *et al.*, Progress in Research, Cyclotron Institute, Texas A&M University (2007-2008), p V-12; http://cyclotron.tamu.edu/2008_Progress_Report/5_Superconducting_Cyclotron_and_Instrumentation/V_12_progress_on_light_ion_guide.pdf
- [2] W. D. Cornelius, ECRIS 2008, 18th International Workshop on ECR Ion Sources, Chicago, Illinois USA, <http://cern.ch/AccelConf/ecris08/papers/weco-b01.pdf>.