Progress on the light ion guide project

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The Light Ion Guide project [1] continues to be developed with the main focus on reliability, reproducibility and the finding of a set of functioning parameters for each ion studied, stable or radioactive. The Light Ion Guide was also retrofitted to serve and provide radioactive ions to the TAMUTRAP facility [2].

A search for the best conditions for the Light Ion Guide was made using a stable element heated ion source, as explained in the previous reports (see [1] and the references therein). We have very good results using a short section of the sextupole ion guide (SPIG) directly injecting ions into the plasma chamber of the Charge Breeding ECR (CBECR). Extending the SPIG to the full length (5 sections of approximately 2.4 meter) was the next test and this was also successfully proved to be a very good solution. One of the issues related to the long SPIG is the difficulty of mounting, connecting and aligning the five sections. The actual design of the vacuum chambers makes it difficult to service the SPIG sections, and a new design has been envisioned. The new design presented in figure 1 consists in two aluminum boxes with ample room inside to accommodate four SPIG sections. A platform will support the sections making it possible to align properly all the SPIG sections on a different table and then to place them into the boxes. After this baffles that manage the helium flow can be installed. This design will allow us to remove the SPIG and clean it when its performance degrades due to carbon deposition from the pumping system and from the CBECR extracted current.

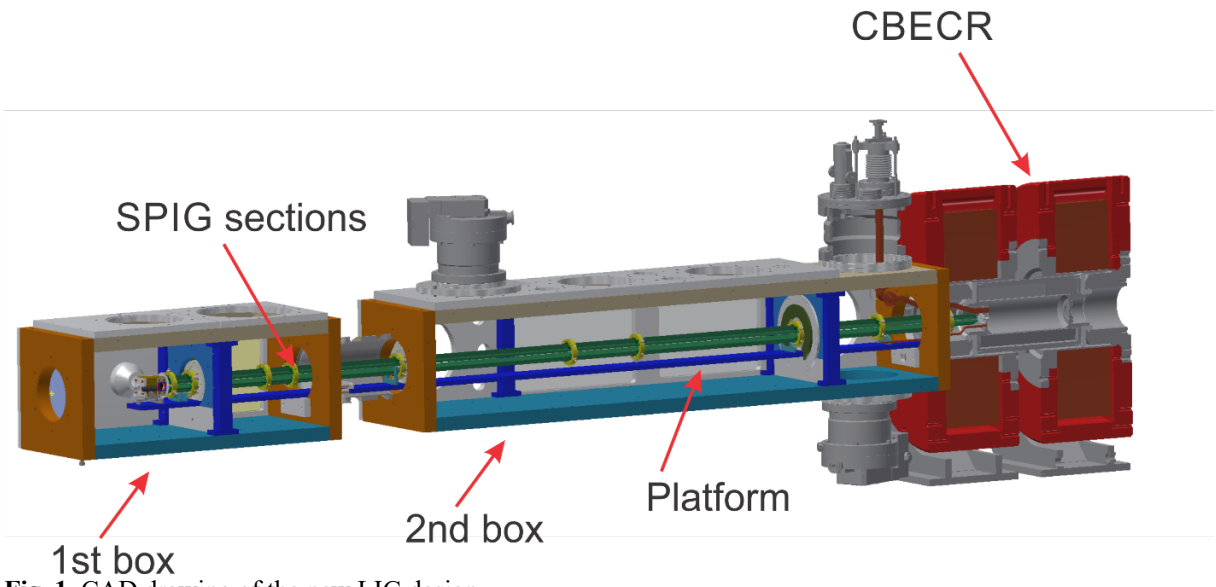

Fig. 1. CAD drawing of the new LIG design.

The new boxes were built by an outside vacuum parts supplier, and panels, covers and SPIG sections are going to be built in house.

In parallel with the new design work, we tested separately how sensitive the SPIG transport efficiency is dependent on the RF frequency. A new type of RF phase splitter was developed that allows the SPIG rods and the flat bars to be driven with a load of 50-ohm. Usually an RF amplifier needs a 50-ohm load, but the SPIG is mostly a capacitive load, and it is an open circuit. The new RF circuit splits the phase 180 degree and keeps a 50-ohm load such that the amplifier sees the correct load, and there is no reflected power with the ability to change the frequency to where the SPIG is resonating. With this new circuit we tested potassium and rubidium samples of the heated ion sources. We found out that there is no ion transport through the SPIG when the frequency is below 1 MHz. The transport efficiency is close to 90% between 1 MHz and 3.5 MHz for the same amplitude of the RF signal measured directly to the rods or flat bars. Multiple tests were performed showing that there is no dependence on the RF frequency and the ion species (atomic mass). Another result was that there is no difference in the transport efficiency when the SPIG was constructed out of rods or flat bars. The same result of no dependence in frequency was found when one SPIG section made out of rods was coupled to one section made out of flat bars. The main conclusions from these studies were that the SPIG transports the ions from the source with great efficiency, keeping the ions in a tight envelope.

As we mentioned in the beginning of this report, a few months of the LIG operation were dedicated to the TAMUTRAP facility. The TAMUTRAP group needed to test the ability of the LIG to produce ^{25}Si radioactive ions. ^{25}Si is a proton emitter with half-life of 220 ms and by detecting protons it is relatively easy to detect the production the ions. The reaction chosen for production was ^{3}He as beam and ^{24}Mg as target. Since the recoil ion ^{25}Si has a much higher energy than the recoil ions produced in (p,n) reactions, a new larger gas cell was designed. The Roots chamber stayed in the same position, the new gas cell was mounted, and a new SPIG was mounted in reverse direction compared with the normal LIG operation. An additional beam line equipped with electrostatic focusing elements was installed in order to transport the ^{25}Si into a more shielded location with very low background. The tests were successfully performed and now the TAMUTRAP can start developing the new phase comprising separation, beam cleaning and transport to the Penning trap.

[1] G. Tabacaru *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2018-2019), p. IV-13.

[2] P.D. Shidling *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2018-2019), p. IV-47.