Update on the He-LIG and LSTAR projects to produce RIB for TAMUTRAP

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As described in last year's report [1], we are developing a ^{3}**He**-based **l**ight-**i**on **g**uide (He-LIG) system, complementing the existing (proton-driven) *p*-LIG system, to increase RIB production at the CI using the high intensity of the K150 cyclotron. The **l**ight-ion guide **s**eparator for **T**exas **A**&M's K150 **r**are isotope beams (LSTAR) will transport and purify the RIBs produced by the He-LIG.

We have been concentrating on the design of LSTAR recently, optimizing the new purely horizontal 2x62.5-degree layout (see Fig. 1). This was again accomplished with COSY [2] calculation

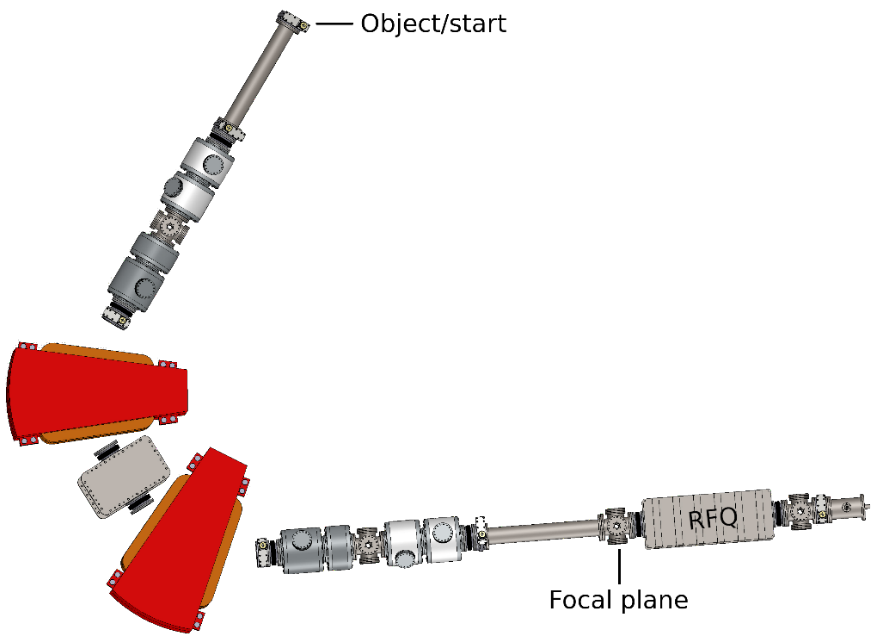

Fig. 1. CAD drawing of the design for LSTAR, including the TAMUTRAP RFQ placed at the focal plane of LSTAR.

using realistic rays from Simion [3] simulations of the He-LIG production. Figure 2 shows some results from these studies. Simion calculations indicate the RIB out of the He-LIG and transported with a SPIG will enter LSTAR with an emittance of 0.65π mm mrad and an energy spread of 3.3 eV; we expect, with precise laser-interferometric alignment techniques, to limit misalignments to ±100 µm. The left plot in Fig. 2 shows the resulting ion distributions at the focal plane of LSTAR. The filled curves are transmitted while unfilled are vetoed. The green curves show the "good" ions, while red are "contaminant" ions with a relative mass difference of 3.3×10^{-4}. In this case, 95% of "good" ions are transmitted with only 0.1% "contaminants" passing through the separator. The middle plot is similar, however in this case the misalignments, energy spread and emittance were all doubled (±200µm, 6.6 eV and 1.30π mm mrad); in this case the transmission of "good" ions is down to 80% and the fraction of contaminant ions rises to 3.3% which is higher than the design specifications. The plot on the right of Fig. 2 shows the trend of the transmission and contaminant fractions as a function of the average misalignment (with nominal energy spread and emittance values). Similar studies were done to find the sensitivity of LSTAR's performance to other parameters.

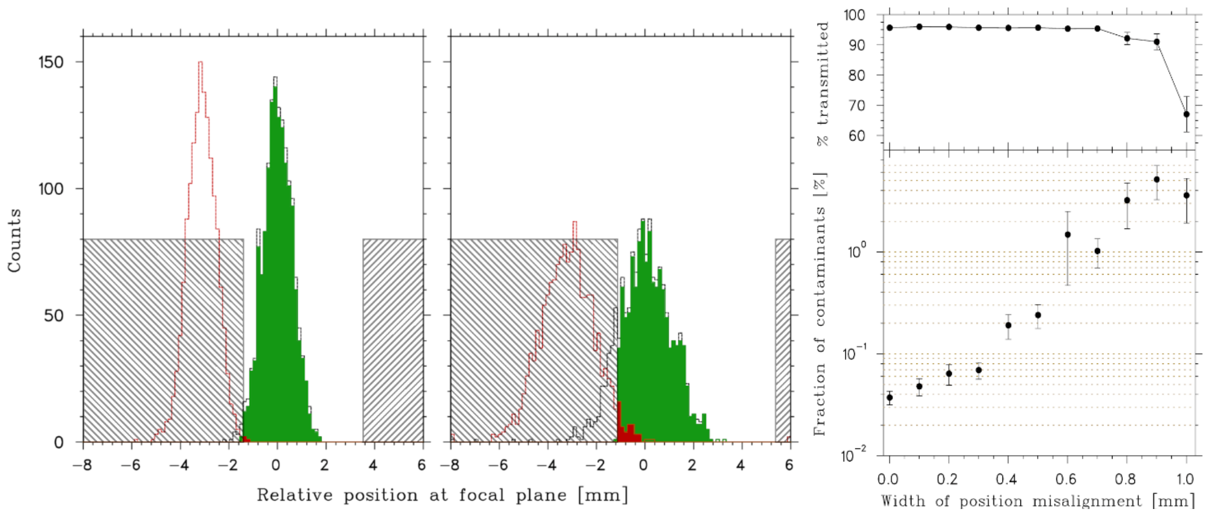

Fig. 2. Sample of the studies done to characterize the performance of LSTAR. Shown are the ion distributions at the focal plane for "good" ions (green) and "contaminant" ions with $M/\Delta M = 3000$ (red) with the expected (left) and 50% larger emittance, energy spread and misalignments (middle). In these plots, the filled histograms are transported through the slits at the focal plane (hatched region), while unfilled are vetoed either in the separator or by the final slits. On the right is a plot of the efficiency for transporting good ions (top) and the fraction of contaminant ions that also passed through LSTAR.

In the spring, we completed a technical specification document and requested bids to construct the separator. As we wait for LSTAR to be constructed, we will now concentrate on installing the *p*/He-LIG chamber, He-LIG gas cell and beam transport to LSTAR. In parallel we will work with the *p*-LIG group to prepare Cave 5 for installation of LSTAR, which will hopefully be ready by summer 2025.

[1] D. Melconian *et al*., Progress in Research 2021-2022, IV-61.

[2] K. Makino and M. Berz, COSY INFINITY Version 9, Nucl. Instrum. Methods Phys. Res. A558, 346 (2006)., Proceedings of the 8th International Computational Accelerator Physics Conference. doi:https://doi.org/10.1016/j.nima.2005.11.109.