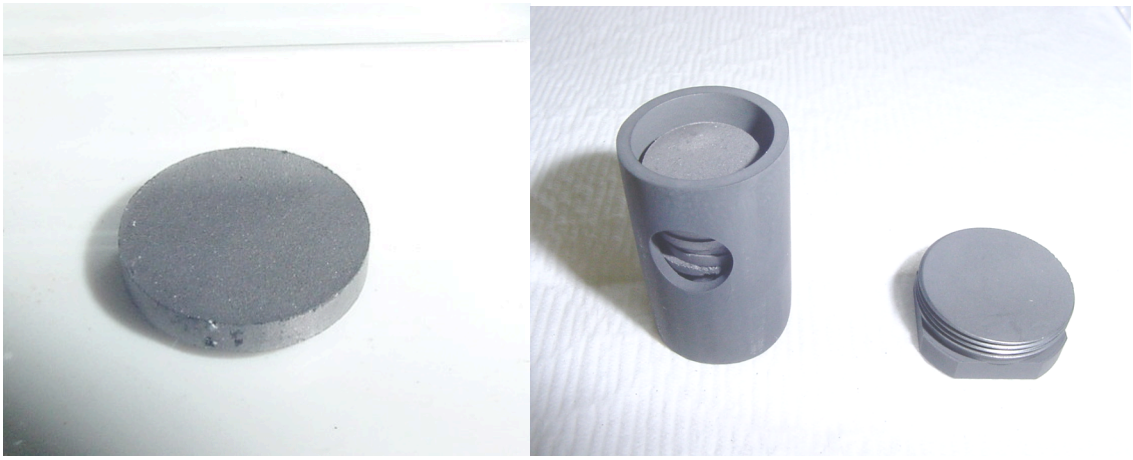
Improved uranium carbide targets for RIB production at the HRIBF

At the Holifield Radioactive Ion Beam Facility (HRIBF), radioactive nuclei on the neutron-rich side of the valley of stability are produced via proton-induced fission in a uranium carbide (UC) target. These targets are operated at temperatures in excess of 2300 K to facilitate transport of the radioactive atoms to an ion source where an ion beam is produced. Ions with the mass of interest are selected and transported to a particle accelerator to be boosted up to energies useful for nuclear physics research.

In the past, these production targets have been made by applying a thin coating of UC onto the fibers of a robust and highly-porous carbon matrix. This target geometry seems ideal given the thin layers of UC material, the open structure of the matrix and the ability to withstand high temperatures for an extended period (up to 50 days of irradiation). However, the fabrication process is complex resulting in high costs and inconsistent quality. The intensities of the delivered radioactive beams were often significantly lower than expected with serious negative impact on the quality of experiments.

In collaboration with the Materials Processing group at ORNL, a new type of UC target was recently developed to address these problems. The new production targets consist of a mixture of UC powders and graphite powders that are pressed together into a relatively low density disk. The process is fast, inexpensive, and results in disks with consistent physical properties and on-line performance. The delivered radioactive ion beam intensities have been consistently high and are as good as or better than those achieved with the previous UC targets, resulting in the recent completion of several nuclear physics experiments. Further development activities will help to determine the optimum disk density and the ideal mixture of graphite powder to ensure fast release of short-lived nuclei. On-line studies will be performed at the High Power Target Laboratory (HPTL).



A disk of uranium carbide (UC) used for the production of short-lived radioactive nuclei is shown. The picture on the right shows a graphite target holder containing some of the UC disks. The proton beam irradiates the UC target from one end and the radioactive atoms are extracted through the hole on the side and transported to an ion source.