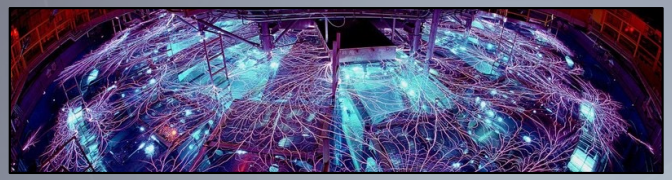
Z-Machine Cryogenic Target Performance Advances and Innovations*

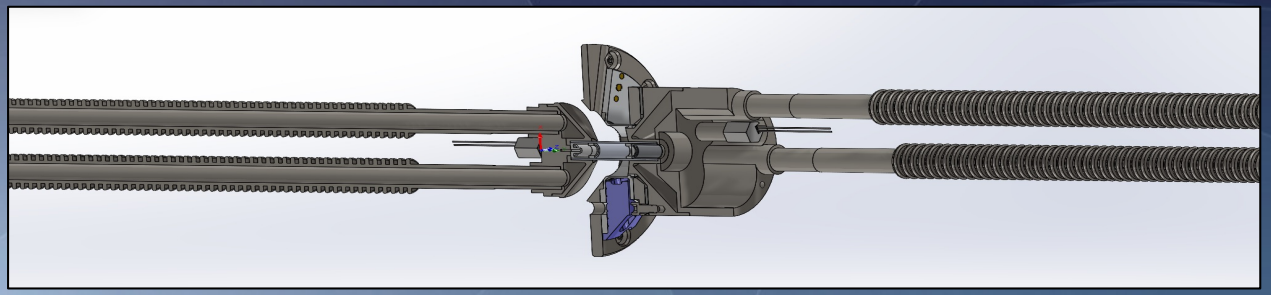
J.L. Taylor, G.E. Smith, R.R. Paguio, J.A. Crabtree[1]
General Atomics, San Diego, CA 92186, [1]Sandia National Labs, Albuquerque, NM 87185

GENERAL ATOMICS

OVERVIEW

Several improvements were made to Z-machine cryogenic MagLIF targets within the recent time frame to enhance performance in the areas of cryogenic cycling robustness and increased success rate for cryogenic targets fielded on Z.



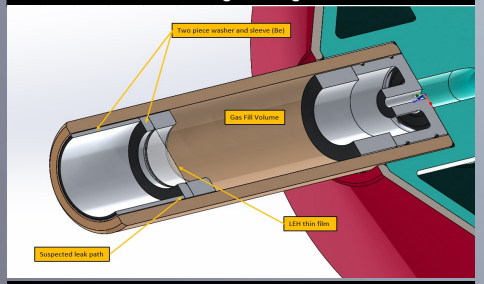


DESIGN IMPROVEMENTS

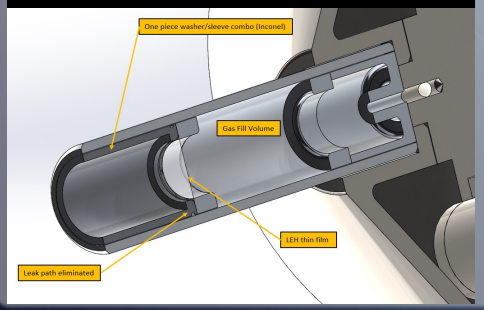
In addition to mechanical bonding improvements, several design changes were made from acquired data on target performance and target failures.

- Direct correlation between failures, Laser Entrance Hole (LEH) aperture size, and gas fill pressure (based on 500 nm LEH thickness). Efforts to further understand these correlations resulted in near zero LEH window failures.

Old MagLIF Design



New MagLIF Design



- Materials were chosen so that the epoxy bonds were not in tension at cryo temps based on CTE. Effort was made for compression situations.
- Be sleeve and washer (12.0 x 10^{-6}/°C CTE) changed to one piece Inconel (11.5 x 10^{-6}/°C CTE). This results in the sleeve/washer combo being in compression at cryo temps in addition to eliminating a potential leak path.

EPOXY SELECTION

Due to lower desired temperatures (~15K), the existing epoxy used (Stycast 2850/23LV catalyst) for cryo target builds was showing decreased performance.

After some research, an epoxy change was made to MasterBond EP29-Black due to technical data sheet information on usable temperature range. The robustness of cycled targets was improved by this change.

MasterBond EP-29 Black Temp Range	
Service temperature range	4K to +250°F [4K to +121°C]

Stycast 2850/23LV Catalyst Temp Range	
Operating Temperature	-65 to 105°C

PLASMA CLEANING

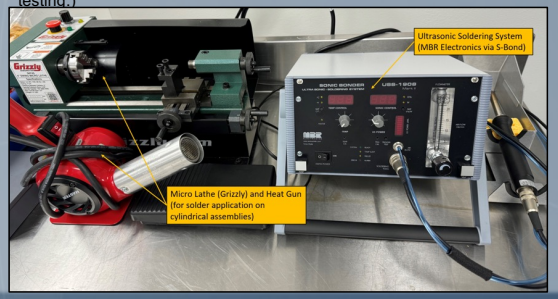
In addition to improved mechanical bonding techniques, SNL Target Fab has also adopted plasma cleaning as part of the process for cryo targets in areas that have a pressure differential.

- Plasma cleaning removes organics contamination through chemical reaction of hydrocarbons on treated surfaces. This insures that the mating surfaces are as clean as possible for the bonding materials.
- The Harrick Plasma PDC-001 was chosen for its lower wattage (assures that no Be ablation occurs) and its proven track record by LLNL target fab.

BERYLLIUM SOLDERING

During a period of time when robustness of cryo targets was low, another avenue of bonding of targets was explored. This method is **a low temp ultrasonic soldering that bonds the Be target liner to the cryostat** (S-Bond Corporation). While it proved to be robust, several hurdles made it less desirable than an improved performance epoxy.

- Long lead time of shipping parts to vendor for soldering. (Solution: Implemented system within the GA Energy Group.)
- Less than desirable clean up of soldering material in areas of scientific interest. (Solution: Improve with the addition of our own equipment and testing.)



RESULTS

With the effort to better understand the design and materials (based on CTE), coupled with the emphasis on extremely clean mating surfaces and better performing epoxy, the success rate of viable cryogenic Z-Machine targets has improved greatly.

Prior to these changes, success was in the 60% range. Typical failures occurred from cryogenic cycling (testing prior to shot day) and could vary from complete failure of LEH window to slow leak due to epoxy failure in tension.

After implementation of these changes, there have been no LEH failures and leak rate at cryogenic temperatures, even after cycling, are nearly undetectable.

*This work performed under the auspices of the U.S. Department of Energy by General Atomics under Contract 89233119CNA000063