Gas Cherenkov Detector 3 (GCD-3): In collaboration with LLE, LANL scientists and engineers have designed, constructed, and implemented a new gas Cherenkov detector (GCD-3) on OMEGA, opening a new window to inertial confinement fusion (ICF) gamma-ray spectroscopy. GCD-3 (Figs. 1 and 2) was funded by the National Nuclear Security Administration ICF program (LANL C-10). GCD's operate by converting MeV gammas to UV/visible Cherenkov photons for easy detection. They provide variable energy thresholding based on the pressure and temperature of the Cherenkov-conversion gas. Previously, there were two ten-inch manipulator–based GCD's fielded on OMEGA, both limited to ≤100 psia CO_2 maximum operating pressure, providing a >6.3-MeV energy threshold. These GCD's were primarily designed to measure DT fusion gammas at 16.75 MeV in order to provide a fusion reaction history. An additional GCD-type detector, known as gamma reaction history (GRH), operates outside the OMEGA target chamber, restricting sensitivity, and is limited to operation with <215 psia of SF_6, lowering the Cherenkov conversion threshold to ≥2.9 MeV. In addition to reaction history, the improved lower threshold of GRH makes it possible to measure ablator areal density based on the $^{12}C(n,n')$ gamma at 4.44 MeV. The OMEGA GRH acted as the prototype for the four-gas cell GRH-6m, which has been in operation on the National Ignition Facility (NIF) since 2010. The new GCD-3 fulfills the need for greater sensitivity and lower threshold than afforded by the exiting detectors. This was achieved by designing GCD-3 to operate inside the target chamber with high-pressure fluorinated gases. It can be safely pressurized up to 400 psia and uses all metal seals to nearly eliminate leakage into the target chamber. With this instrument, the energy threshold can be as low as 1.8 MeV, opening a new portion of the gamma-ray spectrum to investigation. Its first use was in collaboration with MIT on an NLUF experiment to measure the cross section for H–D fusion [$H + D \rightarrow {}^3He + \gamma(5.5\ MeV)$], an important step in big-bang nucleosynthesis, brown dwarfs, protostars, and the solar pp fusion chain. It performed as expected with CO_2 at 400 psia, successfully measuring HD gammas for the first time in an ICF experiment. It will also be used at the end of August to compare gamma emission of samples of ^{12}C and ^{13}C under 14-MeV neutron exposure as part of a feasibility study for time-dependent "dark-mix" studies on the NIF.

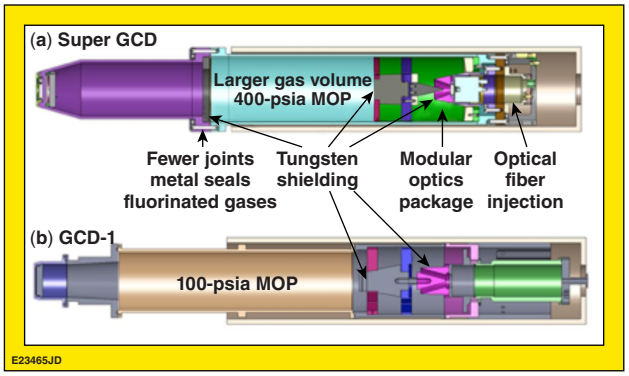

Figure 1. CAD model depicting differences between the super gas Cherenkov detector (GCD-3) and GCD-1. Each gas cell is ~1 m long. MOP: maximum operating pressure.

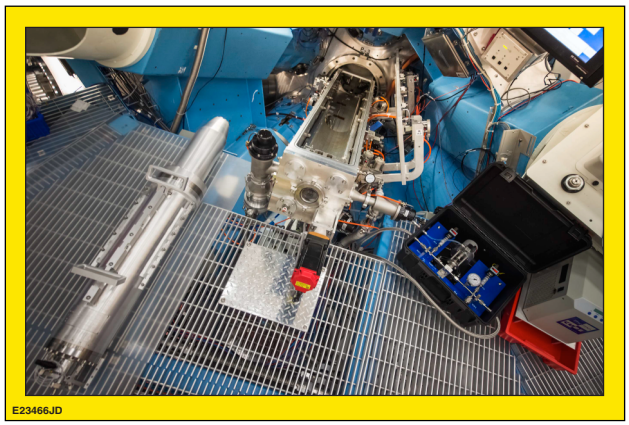

Figure 2. GCD-3 pressure vessel prior to insertion in an OMEGA ten-inch manipulator. GCD-3 is capable of being pressurized to 400 psia, providing Cherenkov thresholds as low as 1.8 MeV.

Omega Facility Operations Summary: The Omega Facility conducted 217 target shots in July, 2014 with an average experimental effectiveness of 93.3% (137 on OMEGA and 80 on OMEGA EP with an effectiveness of 92.3% and 95.0%, respectively. The ICF program accounted for 100 target shots for experiments led by LLNL, LLE, and SNL scientists; LANL, LLNL, and LLE scientists carried out 60 shots for the HED program. The NLUF and LBS programs accounted for 28 and 19 target shots, respectively, for experiments led by MIT, the University of Michigan, and LLNL; ten shots were taken for CEA programs.