Cold Facts

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First Cryomodule Delivered for LCLS-II | 28

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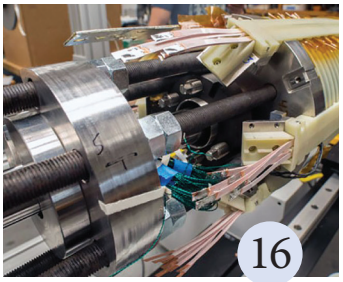

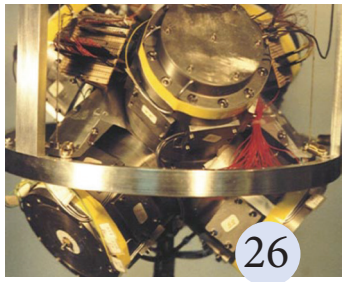

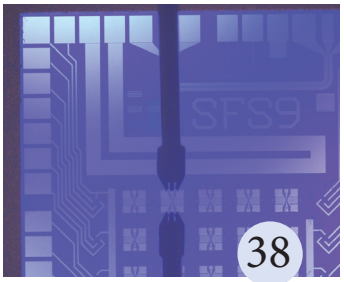

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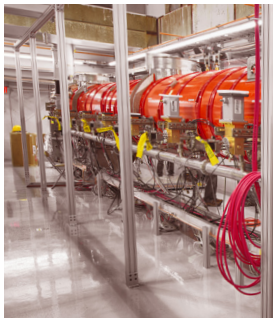

The first of 37 new cryomodules has been delivered to SLAC National Accelerator Laboratory for its planned LCLS-II upgrade. The cover photo shows the unit at the Cryomodule Test Facility at Fermi National Accelerator Laboratory (CSA CSM), where 22 of the modules are under construction. Read more on page 28. ■

In all instances, "CSA CSM" indicates a Corporate Sustaining Member of CSA.

DID YOU KNOW?

Dr. Ray Radebaugh will return to the podium once again for CSA's Foundations of Cryocoolers Short Course, presented June 18 before ICC20. Joining Radebaugh is Dr. Peter Shirron. Register today: **http://2csa.us/shortcourses**.

CSA's Cryogenic Safety webinar series drew 329 registered attendees. Access archived sessions at **http://2csa.us/webinars**.

Dr. J.G. Weisend's new book "He is for Helium" is now available on CSA's website: **http://2csa.us/he**. It's an invaluable resource for anyone wishing to expand their knowledge of the "must know" terms for work in cryogenics. ■

Design and Manufacture of Liquid Helium Vessels

by Shankar Ghosh, Director, shankar.ghosh@shell-n-tube.com

Much of the conversation surrounding helium in global news today focuses either on rumors that the world is running dangerously low on helium or that a helium gas field located in Tanzania's East African Rift valley will eventually safeguard the industry. Irrespective of how rational the fear of global helium shortage is, reliquefaction and storage of liquid helium is of critical importance to projects worldwide.

The properties of liquid helium that make it irreplaceable in certain manufacturing and medical applications are its extremely low boiling point and non-flammability, along with chemical inertness and non-corrosion properties. Helium does not react with any other compounds under ordinary conditions.

Most commercial helium is recovered from natural gas through a cryogenic separation process. The content of helium in natural gas is usually less than one percent by volume. After recovery, helium is purified and liquefied. Shipments of helium usually consist of liquid helium drawn from production sources and delivered in bulk to storage and transfer facilities. Down the supply chain, smaller transportable liquid helium vessels are used to feed end use consumers, including hospitals, welding stations, laboratories and deep-sea diving stations.

Shell-N-Tube was given the challenge of designing, manufacturing and validating a 1,000-liter liquid helium vessel for a bulk customer, the first such attempt by any cryogenic equipment manufacturer in India. The project had a tight time frame of nine months.

Our team considered several options of insulation available to minimize liquid helium product loss, opting for multilayer insulation with multiple thermal shields to minimize the heat in-leak from atmosphere. A major part of that heat in-leak was then absorbed using refrigeration available in the outgoing helium gas vapor, thus achieving minimum net heat leak from ambient into the liquid helium vessel.

ICEFISH-1000 vessel. *Image: Shell-N-Tube*

The project had strict limitations for the outer vessel's dimension, necessitating a very compact and flexible shielding material that could be fixed into position in situ and at the same time offer good heat transfer characteristics along with radiative heat reflectivity.

To meet all the design objectives, our engineers selected copper to fabricate the heat shield. Multiple thermal shields were used to maximize the refrigeration available in the outgoing cold helium vapor, extracting heat at different temperature levels along the exit path. The number of multilayer insulation layers ensured the design temperature of 4 K with an ambient temperature of 300 K. The overall heat in-leak target was equivalent to less than one percent of helium product loss per day under normal operating conditions.

The liquid helium vessel our team manufactured presented a share of challenges, including helium leak testing and vacuum conditioning; welding of dissimilar cross-sections of stainless steel material; in situ silver brazing of ultrathin copper foils to stainless steel neck, etc. All these challenges took some time to solve but the final result was very satisfying.

Our engineers commissioned the liquid helium storage tank with liquid nitrogen as a matter of abundant precaution. As liquid nitrogen is much heavier than liquid helium—and the neck design was optimized to helium density—we were careful to only partially fill the helium vessel with liquid nitrogen. After 30 days, our team was pleasantly surprised to see that only a very marginal quantity of liquid nitrogen had been lost during the extended storage. The result more or less confirmed our design predictions, though the vessel still needed to be tested with liquid helium to finally validate the design, performance and manufacturing procedure.

Shell-N-Tube shipped the ICEFISH 1000, named for its 1,000 net liters, to the customer facility for this extensive, 30-day liquid helium operation trial. At the end of the period, the testing confirmed a net evaporation rate of less than one percent in liquid helium service at near atmospheric pressure. The product line is now in commercial production and we have already started getting repeat orders from the same customer and enquiries from other domestic clients. **www.shell-n-tube.com** ■

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