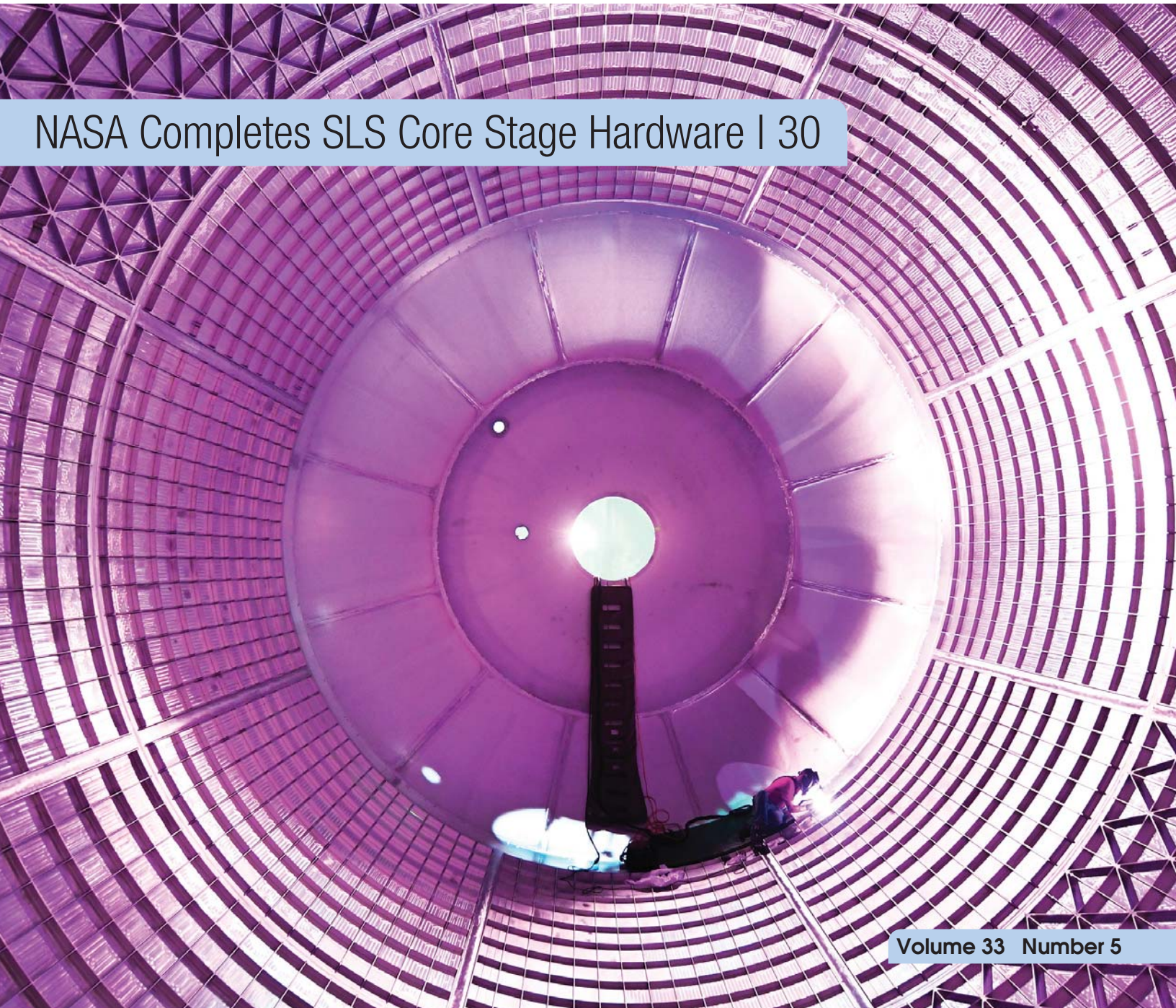
Cold Facts

The Magazine of the Cryogenic Society of America, Inc.

INTERNATIONAL



NASA Completes SLS Core Stage Hardware | 30

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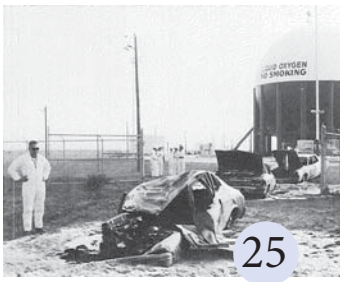

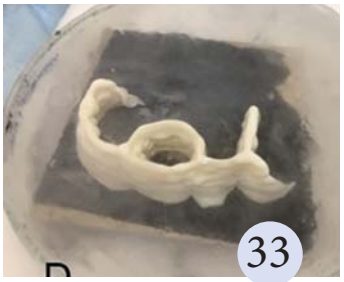

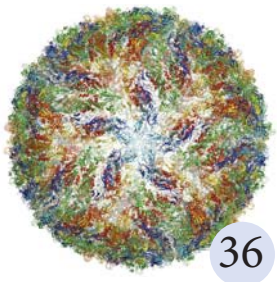

FEATURES

ON OUR COVER

A technician inside the SLS liquid oxygen tank completes welds to plug holes left by a robotic welder. NASA engineers are now conducting hydrostatic testing on the tank. Read more about this and other core stage hardware on page 30. ■

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

COLUMNS

SPOTLIGHTS

Advanced Cryogenic Machining Technology Lowers Cost, Improves Quality

by Will Gruber, manager of marketing and channel sales, will.gruber@5ME.com

Manufacturers today are under increased pressure from agile competitors, capacity constraints, material cost increases and skilled labor shortages. Cryogenic machining can help many remain competitive, reducing carbon footprints, increasing production per machine, lowering piece cost and improving part quality. It also allows for new projects to take off or exciting ones to continue, many of which may have been hindered in the past due to high cost or complex machining.

Consider the F-35 Lightning II, a single-seat, single-engine stealth fighter plane. The aircraft is a marvel of aeronautic engineering, design and construction, but its development and cost have generated significant controversy. So much so, in fact, that the US Department of Defense compelled Lockheed Martin Corp., the program's primary contractor, to commit to a program of cost-cutting goals that began in 2014.

The United States Air Force, on behalf of the DOD, investigated these cost-cutting procedures, supporting industry initiatives with Small Business Innovation Research (SBIR) and Small Business Technology Transfer (SBTT) funds. Machining costs were a prime target for reduction as Lockheed and its partners were machining more titanium for the F-35 project than for any prior program.

The USAF awarded Creare LLC, an engineering consulting firm based in Hanover NH and a CSA CSM, SBTT and SBIR funding to continue research the company had begun in 2002 under a SBIR grant from the US Environmental Protection Agency. The EPA had asked Creare to develop a machining methodology to remove metal working fluids from manufacturing operations, in turn reducing environmental health and safety hazards as well as overhead costs. Creare's solution was to utilize liquid nitrogen at -321°F (-200°C) to

Lockheed Martin Ti6Al4V structure component. Utilizing 5ME cryogenics, cycle time was reduced by 52percent and piece cost reduced by 30 percent.
Image: 5ME

cool the cutting tool internally within a green, dry machining environment. The byproduct of this process was nitrogen gas—an inert, non-greenhouse gas that accounts for 78 percent of breathable air.

To implement this new machining process, Creare designed a through-the-spindle lance that allowed LN_2 to flow through a machine tool spindle and drawbar and then safely and efficiently through the cutting tool. Tests of the concept showed that the process significantly outperformed standard flood coolant, and led to new avenues of development with proven benefits in both sustainability (green manufacturing) and performance, including increased cutting speeds, metal removal rates and tool life.

Creare continued development of the technology with the USAF funding, designing a robust, repeatable system that could be implemented into a production environment. Creare chose 5ME LLC, a technology company based in Cincinnati with a Cryogenic Technology Center in Detroit, as the commercialization agent for the project, and together the companies installed and demonstrated the technology for Lockheed Martin. The demonstration put cryogenic machining technology head-to-head with conventional coolant machining and convinced Lockheed that using cryogenics would result in increases in production and reductions in cost per piece. Lockheed estimated the savings amount as over $260 million for its F-35 program.

Following the successful demonstration, 5ME purchased the original Creare patents and has since expanded them, furthering the development of the cryogenic system it now markets as 5ME® Cryogenic Machining Technology. The new research extended the system's use beyond titanium manufacturing and 5ME now offers solutions to optimize the performance, sustainability and part quality of steels, stainless steels, irons, compacted graphite iron, carbon and glass fiber composites, nickel alloys, aluminums and ceramic matrix composites. The system is offered both as a retrofit to existing machine tools or as a new machine tool option.

The company has also expanded beyond aerospace and defense to work with a variety of global market leaders in the renewable energy, power generation, oil and gas, construction, agriculture, die and mold, automotive and medical industries.

Part of this expansion involved further development of the cutting tool technology used with the cryogenic system. 5ME's cutting tool design allows LN_2 to plumb internal to the solid carbide round or indexable cutting tool, cooling the cutting edge while keeping the LN_2 from escaping onto the workpiece. This patented tool design is now being licensed to a number of global cutting tool manufacturers under the BlueZone™ brand. **To view the full newsletter, please click here.**