Press Release

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Interviews are available with Dr. Bernard Bigot, Director-General of ITER (France) and John Smith, Director of Engineering and Projects at General Atomics (San Diego, California)

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Note: for security clearance to access the ITER worksite, please contact Sabina Griffith, above.

General Atomics video on Central Solenoid, B-roll, high resolution pictures at:
https://drive.google.com/drive/folders/14fYsJaD1efFtcmlXa4uy9-PUDKz3QeHC?usp=sharing

World's Most Powerful Magnet arrives at ITER
ITER is now 75 percent completed

Saint Paul lez Durance, France, September 9, 2021 –Arriving today at the ITER worksite in southern France is the first module of the world's largest and powerful magnet, the Central Solenoid. It will become the central component of ITER, a machine that replicates the Sun's fusion power.

ITER is being built in southern France by 35 partner countries: The European Union (plus the United Kingdom and Switzerland), China, India, Japan, Korea, Russia and the United States.

The Central Solenoid, a first-of-kind magnet, is being built by General Atomics, San Diego, California and is part of the U.S. support for ITER, which is delivered mainly in the form of advanced components. This arrangement drives companies like General Atomics (GA) and others to expand their expertise for fusion technologies.

The Central Solenoid will play a critical role in ITER's mission to establish fusion energy as a carbon-free, safe, economic and inexhaustible source of electricity.

"ITER is the most complex scientific collaboration in history," explains Dr. Bernard Bigot, Director-General of the ITER Organization. "Very special first-of-a-kind components are being manufactured in Europe, Asia and North America over a nearly 10-year period by leading companies such as General Atomics."

Despite the challenges of Covid-19, ITER is now 75 percent completed. The Central Solenoid and many other first-of-a-kind components have been arriving in France from three continents.

After arriving recently at the Marseille harbor, the 166-ton magnet module, one of six that will comprise the Central Solenoid, was placed on a special remote-controlled transport vehicle, to be driven 104 kilometers (65 miles) to ITER on a reinforced roadway that can accommodate heavy loads. The transport lorry travels slowly and at night and is expected to arrive at the plant on September 9.

Fully assembled, the Central Solenoid, the largest of ITER's magnets, will be 18 meters (59 feet) tall and 4.25 meters (14 feet) wide, and will weigh a thousand tons.

It will induce a powerful current in the ITER cloud-like plasma, helping to shape and control the fusion reaction during long pulses. It is sometimes called the "beating heart" of the ITER machine.

How powerful is the Central Solenoid? Its magnetic force is strong enough to lift an aircraft carrier 2 meters (6 feet) into the air. At its core, it will reach a magnetic field strength of 13 Tesla, about 280,000 times stronger than the earth's magnetic field. The support structures for the Central Solenoid will have to withstand forces equal to twice the thrust of a space shuttle lift-off.

"The Central Solenoid project ranks among the largest, most complex and demanding magnet programs ever undertaken," says John Smith, GA's Director of Engineering and Projects. "I speak for the entire team when I say this is the most important and significant project of our careers. We have all felt the responsibility of working on a job that has the potential to change the world. This is a significant achievement for the GA team and US ITER."

The Central Solenoid modules are being manufactured at GA's Magnet Technologies Center in Poway, California, near San Diego, under the direction of the US ITER project, managed by Oak Ridge National Laboratory (ORNL). Five additional Central Solenoid modules, plus one spare, are at various stages of fabrication. The second module is currently in transit to France.

PHOTO CAPTION: *Module 1 of the Central Solenoid in the final stages of testing. Courtesy General Atomics.*

How does fusion work?

- *A small amount of deuterium and tritium (hydrogen) gas is injected into a large, donut-shaped vacuum chamber, called a tokamak.*
- *The hydrogen is heated until it becomes an ionized plasma, which looks like a cloud.*
- *Giant superconducting magnets, integrated with the tokamak, confine and shape the ionized plasma, keeping it away from the metal walls.*
- *When the hydrogen plasma reaches 150 million degrees Celsius—ten times hotter than the core of the Sun—fusion occurs.*
- *In the fusion reaction, a tiny amount of mass is converted to a huge amount of energy ($E=mc^2$).*
- *Ultra-high-energy neutrons, produced by fusion, escape the magnetic field and hit the metal tokamak chamber walls, transmitting their energy to the walls as heat.*
- *Some neutrons react with lithium in the metal walls, creating more tritium fuel for fusion.*
- *Water circulating in the tokamak walls receives the heat and is converted to steam. In a commercial reactor, this steam will drive turbines to produce electricity.*
- *Hundreds of tokamaks have been built, but ITER will be the first to achieve continuous "burning" or largely self-heating plasma.*

The Promise of Fusion

Hydrogen fusion is an ideal method of generating energy. A container of deuterium-tritium (DT) fuel about the size of a single pineapple will create as much energy as 10,000 tons of coal. Deuterium is readily available in seawater, and the lithium used to breed tritium is abundant in the earth's core. When heated to the point that fusion occurs, the only by-product is harmless helium.

A fusion plant will provide highly concentrated energy around the clock. Fusion produces no greenhouse gas emissions or long-lived radioactive waste. The risk of accidents with a fusion plant are extremely limited. If containment is lost, the fusion reaction simply stops.

Fusion energy is closer to reality than the general public realize. It could provide a source of carbon-free electricity for electric grids globally and play a key role as industrialized nations decarbonize their power-producing infrastructure.

Two recent reports by the fusion community focus on ways the U.S. can get there.

In December, the U.S. Department of Energy Fusion Energy Sciences Advisory Committee released a report that lays out a strategic plan for fusion energy and plasma science research over the next decade. It calls for the development and construction of a fusion pilot plant by 2040.

In February of this year, the National Academies of Sciences, Engineering, and Medicine released a complementary report calling for aggressive action to build a pilot power plant. The report proposes a design by 2028 and a fusion pilot plant in the 2035–2040 timeline.

“The point of working from this timeline was to outline what it would take to have an impact on the transition to reduced carbon emissions by the mid-century,” says Kathy McCarthy, Director of the US ITER Project Office at Oak Ridge National Laboratory.

“Many investments and essential activities would need to begin now in order to meet that timeline. The experience we’re gaining from ITER in integrated, reactor-scale engineering is invaluable for realizing a viable, practical path to fusion energy.”

Leveraging global resources for fusion research

ITER (“The Way” in Latin) is the most ambitious energy project ever attempted. The experimental campaign to be carried out at ITER is crucial to preparing the way for the fusion power plants of tomorrow.

Under the 2006 ITER Agreement, all 35 members will share equally in the technology developed while funding only a portion of the total cost. The 27 countries of the European Union (plus the United Kingdom and Switzerland) are contributing 45 percent of the construction costs. China, India, Japan, Korea, Russia and the United States contribute nine percent each to ITER’s costs.

“Without this global participation with the leveraging of funding, scientific rigor, and technological expertise, the ITER fusion program and plant are not possible,” explains Dr. Bernard Bigot, Director-General of the ITER Organization.

Both the engineering insights and the scientific data generated by ITER will be critical for all other fusion programs. The in-kind contribution approach allows member countries to support domestic manufacturing, create high-tech jobs, and develop new capabilities in spin-off industries.

ITER will be the first fusion device to produce more thermal energy than the energy required to heat the molecules to make a self-heating or “burning” plasma.

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About General Atomics: *Since the dawn of the atomic age, General Atomics innovations have advanced the state of the art across the full spectrum of science and technology – from nuclear energy and defense to medicine and high-performance computing. Behind a talented global team of scientists, engineers, and professionals, GA's unique experience and capabilities continue to deliver safe, sustainable, economical, and innovative solutions to meet growing global demands.*

GA is supplying microwave waveguides, diagnostics and the world's most powerful pulsed superconducting electromagnet for ITER. GA operates the DIII-D National Fusion Facility for the U.S. Department of Energy (DOE) Office of Science, where researchers from GA and more than 100 institutions worldwide work to develop the physics basis for practical fusion-generated power. GA also supports the DOE National Nuclear Security Administration's research in Inertial Confinement Fusion and high-energy-density physics, which is aimed at achieving a safer, more secure, and effective nuclear deterrent without underground testing by producing thermonuclear burn conditions in the laboratory.

About US ITER: *Dr. Kathy McCarthy is the Director of the US ITER Project Office and the Associate Laboratory Director for Fusion and Fission Energy and Science at Oak Ridge National Laboratory. US ITER is funded by the DOE Office of Science's Fusion Energy Sciences program. UT-Battelle manages ORNL for the Department of Energy's Office of Science, the single largest supporter of basic research in the physical sciences in the United States. The Office of Science is working to address some of the most pressing challenges of our time. For more information, please visit https://energy.gov/science.*

About ITER: *ITER—designed to demonstrate the scientific and technological feasibility of fusion power—will be the world's largest experimental fusion facility. Fusion is the process that powers the Sun and the stars: when light atomic nuclei fuse together to form heavier ones, a large amount of energy is released. Fusion research is aimed at developing a safe, abundant and environmentally responsible energy source. For more information on the ITER Project, visit: http://www.iter.org/*