

in aerospace engineering at Cornell University, uses a CubeSat as a vehicle for even smaller satellites, so-called Sprites. Manchester's goal—at least for now—is not commercial; he wants to see “how small can we make a satellite?” He used Kickstarter to crowdfund his thesis project to send and detect radio signals with postage-stamp-sized satellites—electronics boards that can withstand the harsh conditions of space. One motivation, he says, is to bring down the cost and widen public access to space. His

satellites can be built for “single-digit dollars with parts from Radio Shack,” he says. But the small size also means the Sprites may not be easily trackable by US Air Force radar, which makes them a potential debris problem. For now, Manchester says, he has permission to fly them in orbits below 400 km so that they burn up within a few days.

“One of the nice things about companies like Planet Labs,” says Elwood Agasid, the Ames chief technologist for mission design, “is that they are driving

the industry. Small satellites have become a disruptive factor in the space industry.” NASA and other national space agencies are looking at small satellites to see what they can do to bring down the cost of research. Agasid notes that since 2006, NASA has launched 18 CubeSat missions. They include testing the effects of microgravity on living cells and networking among satellites to create spacecraft-to-spacecraft communications.

Toni Feder

Space, nuclear trade eyed at US-India summit

Meeting a few days after their countries' respective spacecraft entered Mars orbit, President Barack Obama and Indian prime minister Narendra Modi on 30 September pledged cooperation in space, clean energy, climate change mitigation, and other scientific programs. Coinciding with the summit, the heads of the two nations' space agencies signed separate agreements to delineate their respective roles in building and launching an Earth-orbiting satellite and to plan for a future joint Mars mission.

Obama and Modi also agreed to take further steps to implement the US-India civil nuclear cooperation agreement. Under that pact, which took effect in 2008, India agreed to open its civilian nuclear reactors—but not its nuclear weapons facilities—to international inspection. In exchange, the US agreed to export reactors, nuclear fuel, and other nuclear technologies to India. The 47 other countries that export nuclear-



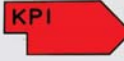
WHITE HOUSE PHOTO BY PETE SOUZA

President Barack Obama and Indian prime minister Narendra Modi agreed to increase cooperation on space, energy, and nuclear commerce at their summit in Washington, DC, on 29–30 September.



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related products, known collectively as the Nuclear Suppliers Group, later followed the US lead.

Nonproliferation activists have criticized the agreement because India has not ratified the Nuclear Non-Proliferation Treaty; they argue that the import of nuclear fuel will free up domestic output of enriched uranium for diversion to weapons.

In a joint statement, the heads of state blamed administrative issues, concerns over liability, and technical issues for continuing to hold up exports of Westinghouse and GE Hitachi reactors to India. "We will partner to ensure that both countries have affordable, clean, reliable, and diverse sources of energy, including through our efforts to bring American-origin nuclear power technologies to India."

According to their communiqué, the two leaders also agreed to strengthen and expand cooperation on clean energy by accelerating the integration of renewable energy into India's power grid and by promoting renewable and energy-efficient technologies.

"Climate change threatens both our countries, and we will join together to mitigate its impact and adapt to our changing environment," said the statement of cooperation endorsed by the leaders. "We will address the consequences of unchecked pollution through cooperation by our governments, science, and academic communities."

Jointly, NASA and the Indian Space Research Organisation (ISRO) are to build and launch an Earth-observing satellite, the *NASA-ISRO Synthetic Aperture Radar (NISAR)*, which is targeted for launch in 2020. NASA will provide one synthetic aperture radar instrument and other hardware, and ISRO will contribute a second SAR operating at a different frequency, the spacecraft bus, and the launch vehicle. The satellite will be capable of measuring changes on Earth's surface that are less than a centimeter across, according to a NASA press release. Ice-sheet collapse, ecosystem disturbances, and natural hazards are potential areas of research for the mission.

On 21 September NASA's *Mars Atmosphere and Volatile Evolution* spacecraft arrived at Mars. MAVEN is the first spacecraft dedicated to exploring the tenuous upper atmosphere of the red planet. ISRO's *Mars Orbiter Mission*, India's first spacecraft launched to Mars, arrived two days later to study the Martian surface and atmosphere and to demonstrate technologies needed for interplanetary missions.

David Kramer

news notes

Fusion experiment crosses ocean.

En route to the University of Illinois at Urbana-Champaign is a small fusion reactor, a gift from the Max Planck Institute for Plasma Physics in Greifswald, Germany. Some 70 tons of dismantled parts were shipped out in late September. The reactor, a tokamak and stellarator rolled into one, will be rechristened the Hybrid Illinois Device for Research and Applications (HIDRA).

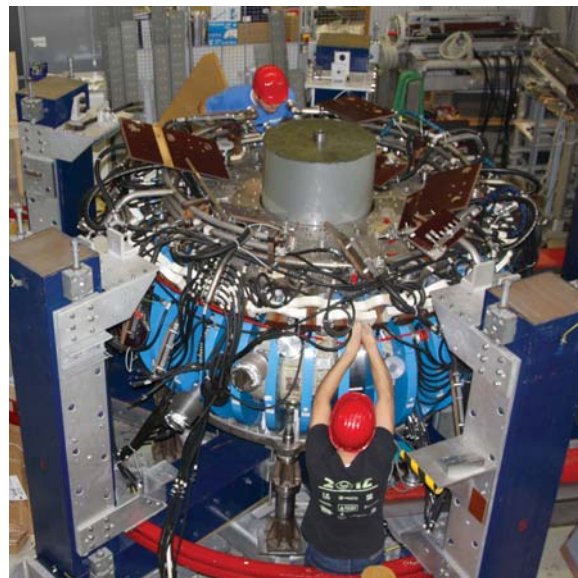
Understanding the interactions between the plasma and the containment walls will be the primary focus at HIDRA, although it will also be used for other studies and for training.

The reactor (shown at right during dismantling) got its start in 1975 in Grenoble, France, and spent time in Stuttgart, Germany, before opening shop in Greifswald in 2001. "The beauty is that it was made very well. That's why it has existed so long and why it will be useful to us," says David Ruzic, director of the Center for Plasma-Material Interactions at Urbana-Champaign. The univer-

sity is ponying up about \$1 million to cover the move, reassembly, 2.2 MW of power, staff, and about two years of operation.

At Greifswald, meanwhile, scientists needed to make room for the larger Wendelstein 7-X, which will start up next year with the purpose of demonstrating that a stellarator can attain the parameters necessary for a fusion power plant. The US is participating in the €370 million (\$460 million) German-led European project.

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