



# Haystack Upgrade Program

Massachusetts Institute of Technology (MIT) has recently initiated a major upgrade of the Haystack Radar in Tyngsborough, Massachusetts. The upgrade program is jointly sponsored by the United States Air Force and the Defense Advanced Research Projects Agency and is being executed by Lincoln Laboratory, a federally funded research and development center of MIT.

MIT Lincoln Laboratory developed the Haystack facility in the 1960s as a step in the technological evolution of high-performance microwave systems. Haystack is now used for two purposes. Part of the year it is used by the MIT Haystack Observatory as a radio-telescope to conduct research and for education activities. As a radio-telescope, the Haystack antenna is used to conduct single-dish radio astronomy in the 22-25 GHz, 35-50 GHz and 85-115 GHz frequency bands, and for Very Long Baseline Interferometry experiments. The Haystack research facilities are also used in various education programs for graduate, undergraduate, and pre-college students. The pre-college outreach programs for the local middle and high school students enhance their interest in science, engineering, and mathematics, and contribute to the neighboring towns, the Commonwealth, and the Nation.

Haystack is also used by MIT Lincoln Laboratory as a radar which acts as a contributing sensor to the United States Space Surveillance Network and as a radar technology testbed. The Haystack Radar utilizes the 37 m Haystack antenna to generate radar images of satellites orbiting the Earth. These images are used by the United States Strategic Command to assess satellite structure, mission, and status. The radar is also used to collect data on orbiting space debris. Orbiting debris could be a threat to the International Space Station, the Space Shuttle, and other satellites. The Haystack Radar has been the major contributor to understanding the space debris environment in the 1-10 cm size regime.

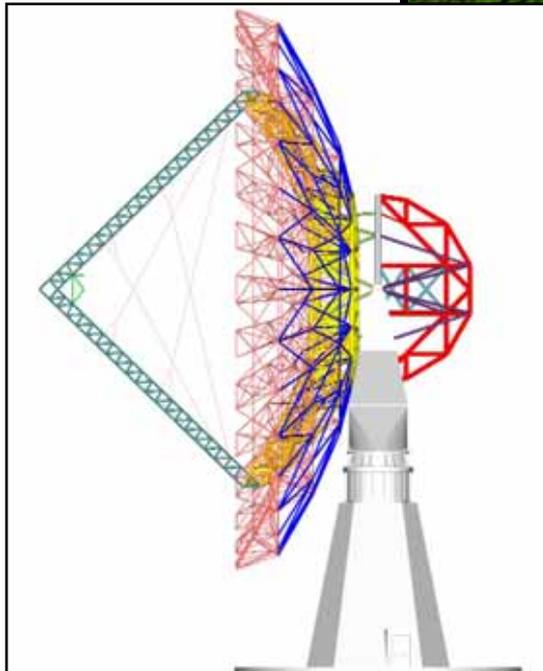
The Haystack Radar currently operates in the 9.5 GHz to 10.5 GHz frequency band. As part of the upgrade, a millimeter-wave radar that operates in the 92 GHz to 100 GHz frequency band will be added to the system. The new radar will use an innovative transmitter design and signal processing to achieve image resolution that is about 10 times better than what is currently available. The existing 37 meter (120 foot) antenna will be replaced by a new dish, accurate to 0.1 millimeter (0.004 inch) over its entire surface, which is a factor of 3 better than at present. The new antenna will permit the Haystack radio-telescope to operate in the 150 GHz range or higher, making it a premier radio-astronomy facility. L-3 ESSCO of Concord, MA, has been selected to design, fabricate, and install the new antenna.

The upgrade program is currently in the design stage and will be completed in 2009. In 2006, the 150 foot diameter Haystack radome will be temporarily lifted and set aside to permit the removal of the existing antenna and the installation of the new antenna. The new radar transmitter and processing system will be integrated and tested in 2007-2009. The final testing of the new radar will be completed in 2009. These modifications and upgrades will dramatically advance the state of the art in space surveillance technology and will allow Haystack to remain at the forefront of radio astronomy research facilities.



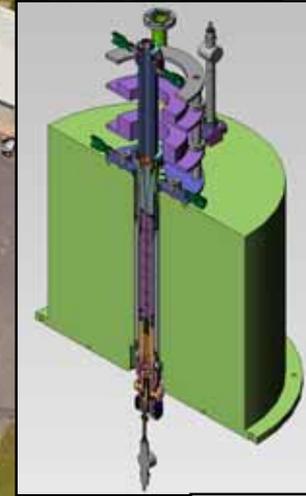
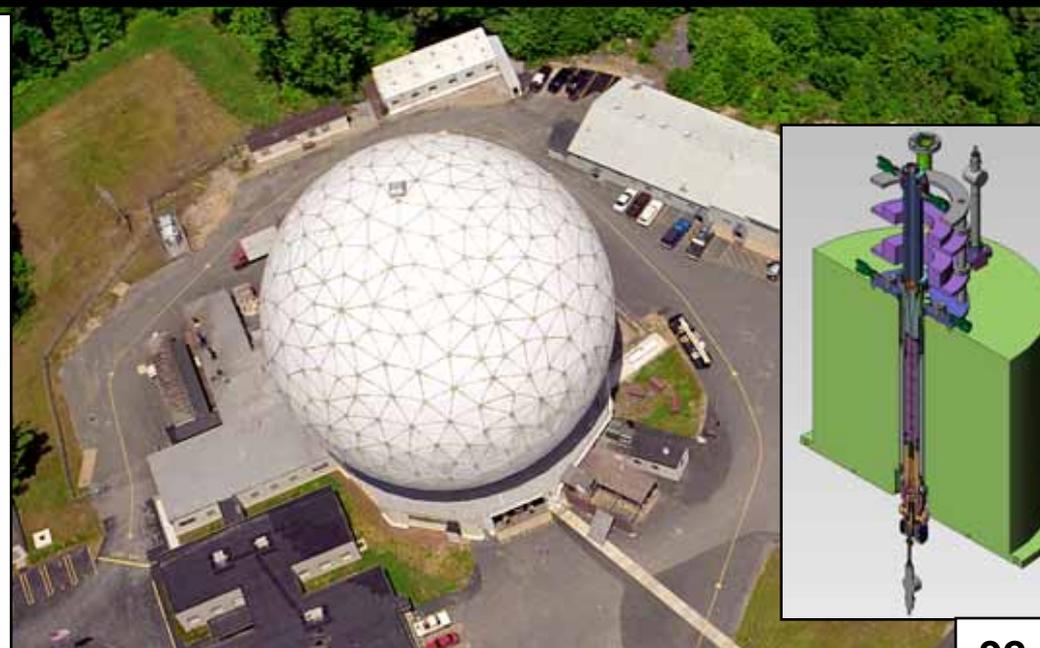
# HUSIR

## Haystack Ultra-wideband Satellite Imaging Radar



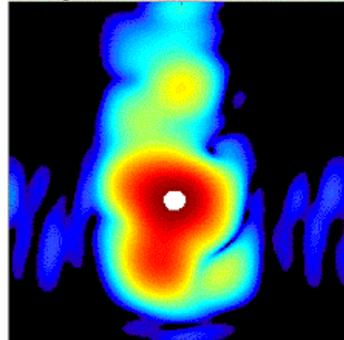
100 micron rms surface  
120' diameter

Order of magnitude  
improvement in Haystack  
imaging resolution



92-100 GHz  
High Power  
Transmitter

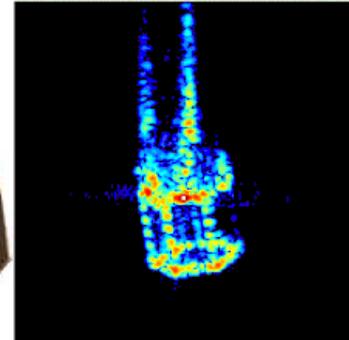
Haystack X-Band\*



9.5-10.5 GHz



HUSIR W-Band\*



92-100 GHz