U.S. NAVAL RESEARCH LABORATORY

The EIS Spectrometer on *Hinode*

Imaging the extreme-ultraviolet atmosphere of the Sun

AT A GLANCE

What is it?

EIS is an extreme-ultraviolet imaging spectrometer (EUV) that measures the physical properties of the solar atmosphere, such as temperature, density, element abundances, turbulent motions, and bulk flow. It measures the origin of space weather at the Sun.

How does it work?

Atomic collisions in the Sun's atmosphere generate remote-sensing fingerprints that reveal physical conditions in the Sun's atmosphere. Spectral lines are detected with an imaging mirror, grating and CCDs that are optimized to detect EUV radiation. The chemical elements in the solar atmosphere produce unique signatures of their presence and the state of the gas in which they reside.

What is it accomplishing?

EIS is providing detailed descriptions of solar flares and solar active regions that produce coronal mass ejections, leading towards a predictive capability of solar activity and space weather effects at the Earth. EIS is highly relevant to Navy/DoD operational systems, including over-the-horizon radar (OTHR), communications, and orbital debris tracking.

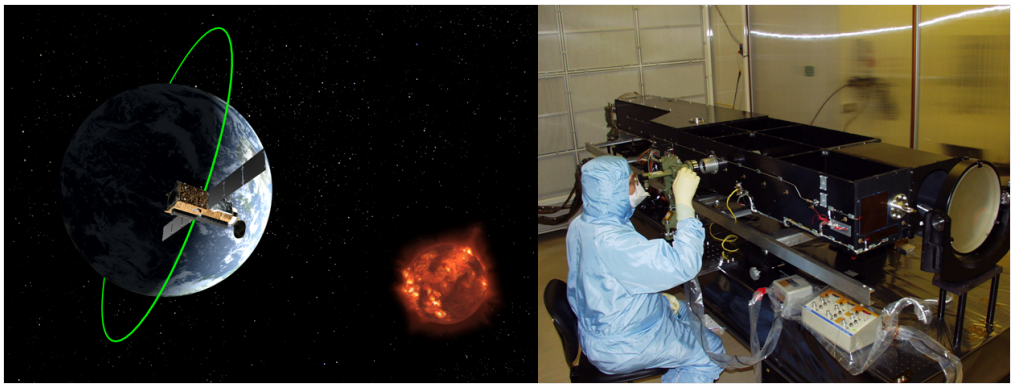
R&D Sponsors

NASA

Point of Contact

Dr. Harry Warren, PI

Naval Research Laboratory
Space Science Division, Code 7681
harry.warren@nrl.navy.mil



(Left panel) EIS is on the Japanese Hinode spacecraft and was built by an international consortium including laboratories in the UK, Japan, Norway, and the US. The US Principal Investigator institution is the Naval Research Laboratory (NRL), with funding from NASA. The international lead laboratory for the instrument is the University College London- Mullard Space Science Laboratory (UK). (Right panel) An NRL scientist working on the instrument in the UK.

Objectives

- The primary objective of EIS is to observe and understand the fundamental physical properties that form the solar upper atmosphere. This includes coronal heating, the initiation of solar flares and coronal mass ejections, and the formation of the solar wind.
- EIS measurements include the electron temperature, density, and dynamical properties of solar magnetic flux tubes in flares, active regions, coronal holes, and the quiet Sun. EIS determines the morphology of active regions and flares over temperatures ranging from about 100,000 K to 10,000,000 K.

Approach

- The EIS articulated mirror images the EUV Sun between about 170-290 Å onto a slit. Light passing through the slit is diffracted by a grating and spectra are imaged onto two CCDs. The instrument can remotely and passively sense the solar atmosphere at any location on the solar disk or slightly above the solar limb.
- Solar images are made by moving the mirror in small steps in the east-west direction. Combining all the spectra produces an EUV image that covers a field of view determined by the scientific program being implemented.

Payoffs

- Understanding the basic physics of the solar atmosphere and how it interacts with the near-earth environment is the fundamental problem in predicting Space Weather. Spectroscopy is a key tool in remotely sensing astrophysical sources. Understanding the basic physics in the Sun-Earth interaction can provide precision predictive capability for the occurrence of solar flares and the coronal mass ejections that can contain high energy particles disruptive to DoD communications. Right image: A solar flare imaged in spectral lines of different temperatures. Blue is Fe X (1,000,000 K), yellow is Fe XV (2,000,000 K), and orange is Ca XVII (5,000,000 K).