AFRL Solar Mass Ejection Imager
New Tool for Space Weather!

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Coronal Mass Ejections (CMEs) are the source of all severe space weather. Until now we could only see these giant plasma clouds for a short distance after leaving the Sun, and then when they are at our doorstep. Travel speeds vary; so predicting "Earth fall" was imprecise. Now, with the successful launch January 2003 of the Space Test Program Coriolis satellite, which carries SMEI, CMEs can be tracked from the Sun to Earth orbit and beyond!

Built as a proof-of-concept imaging experiment and designed specifically to detect, track and forecast the arrival at Earth of coronal mass ejections (CMEs), since launch, SMEI has seen over 200 CMEs; 30 of which were Earth-directed (halo) CMEs. With this major step of its mission achieved, SMEI is helping scientists better understand, and predict with longer lead-times, the harmful solar effects on spacecraft and ground systems. SMEI orbits 840 km above the Earth along the day-night terminator. It uses three CCD baffled cameras that reject unwanted light.

To image CMEs from 90 solar radii to beyond Earth orbit, the system must see objects as dim as 0.1% of the starlight and zodiacal background. The cameras "sweep out" nearly the entire sky during each orbit (Figure 1 shows a very bright and fast limb CME observed by SMEI).

Archived to the latest SMEI all-sky images and running difference movies of interesting events are available at www.NSO.Edu. This website will be continually updated. SMEI observed its first halo event on 29 May (Figure 2) as much as16 hours before Earth fall.

SMEI was designed and constructed by a team of scientists and engineers from the U.S. Air Force Research Laboratory, the University of California at San Diego, Boston College, Boston University, and the University of Birmingham in England. Financial support provided by the Air Force, the University of Birmingham and NASA. The Sun put on quite a show for Solar-imagers in Oct-Nov 2003 despite the approach of Solar minimum.

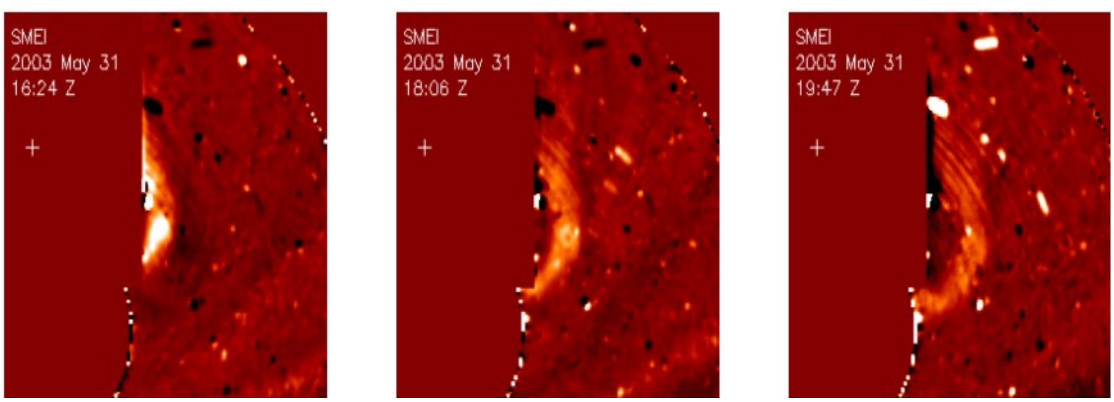

Figure 1. A very bright, fast (~2000 km/s) mass ejection observed by SMEI on May 31. The ejection is observed within the field of the sunward camera out to half the Sun – Earth distance.

Current as of November 2006

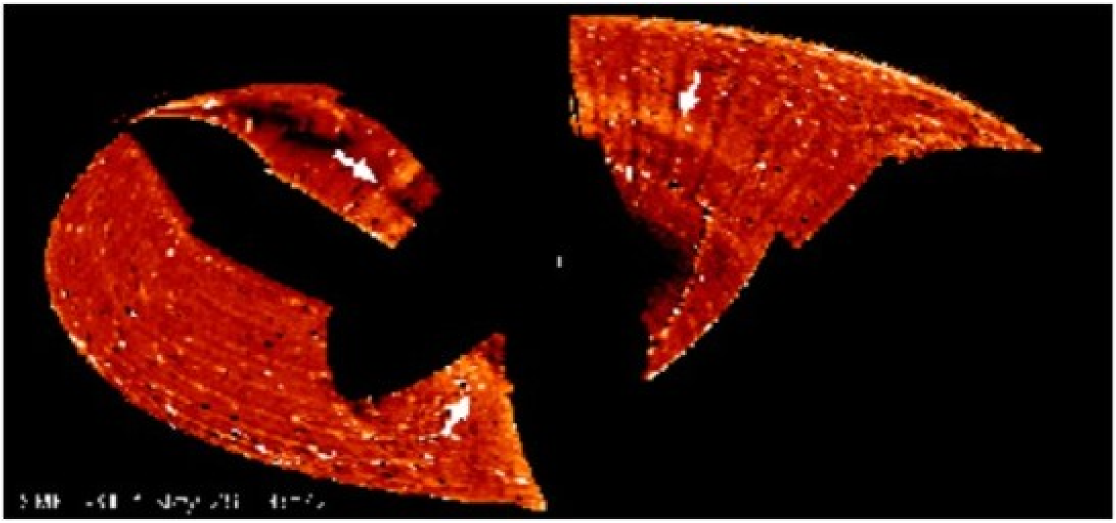

Figure 2. SMEI all-sky difference image of May 29 halo CME. Halo appears as a broad, bright ring centered on the sun (white cross). The halo is brightest in the north (top), but can be traced over a 150-degree arc. Blacked out areas include masked bright sunlight and the experiment's 20 degree radius exclusion zone.

Three huge solar flares—among recorded history's worst 20— were part of a series of major events centered around two immense sunspot groups. Three significant CMEs blasted the Earth's protective magnetosphere, leaving in their wake the potential for fried satellites and scrambled circuits on the ground. Not good news for electronically-dependant military and civilian telecommunication operations. Warning time is of the essence; given that one solar eruption took only took 19 hours to completely reach the Earth. SMEI cameras detected two of them; at 21hr and 10 hr before the shocks hit earth. An image of the first event in this series appears in Figure 3.

Seeing CMEs in this distance range (20-180 degrees from the sun) is a new capability that along with other space environment sensors promises to greatly enhance the space weather "big picture". SMEI also observes asteroids, comets and comet tail disconnections, stellar time series, zodiacal light and high altitude auroras.

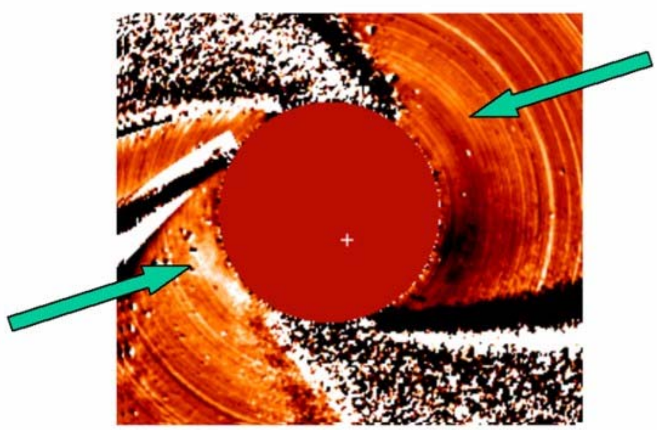

Figure 3. SMEI partial field view of halo CME on Oct. 29 at 02:10 UT.