SECCHI Overview

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STEREO-Solar B Science Planning Workshop

Turtle Bay, Hawaii

November 14-17, 2005

Outline

- SECCHI Science Overview
- Specific Science Goals
- Planned Data Sets
- Analysis Tools
- Observation Plans

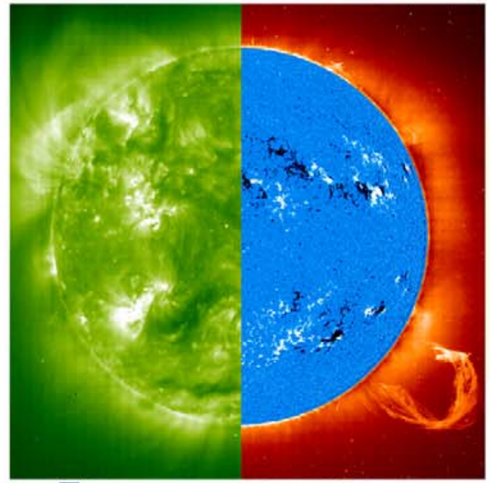
SECCHI Primary Design Driver

Observe CMEs from their launch at the Sun, track them through the corona and inner heliosphere and then their eventual impact at Earth with sufficient resolution and frequency to discern the physics of the launch, their propagation and their morphology.

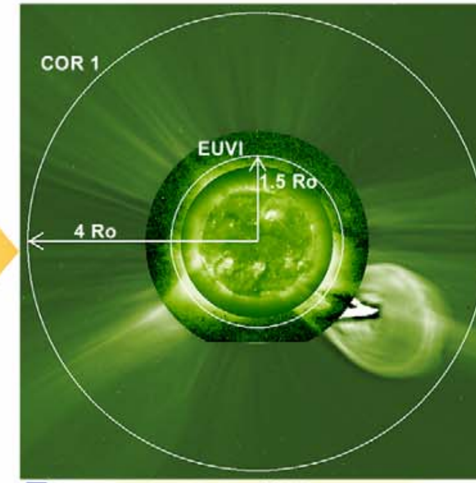
SECCHI Science Overview

SECCHI Exploration of CMEs and the Heliosphere on STEREO

- *What Configurations of the Corona Lead to a CME?*
- *What Initiates a CME?*
- *What Accelerates CMEs?*
- *How Does a CME Interact With the Heliosphere?*
- *How do CMEs Cause Space Weather Disturbances?*

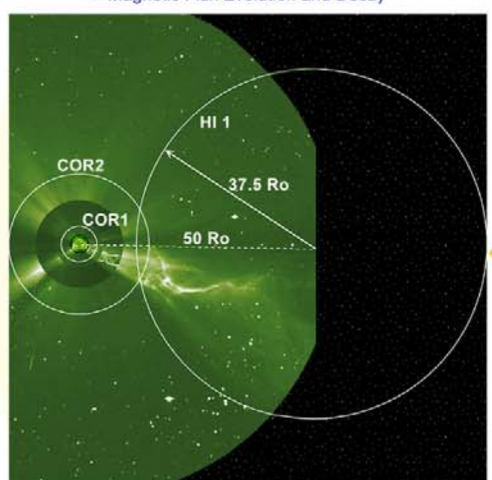


Explore the Magnetic Origins of CMEs
- Photospheric Shearing Motions
- Magnetic Flux Emergence
- Magnetic Flux Evolution and Decay

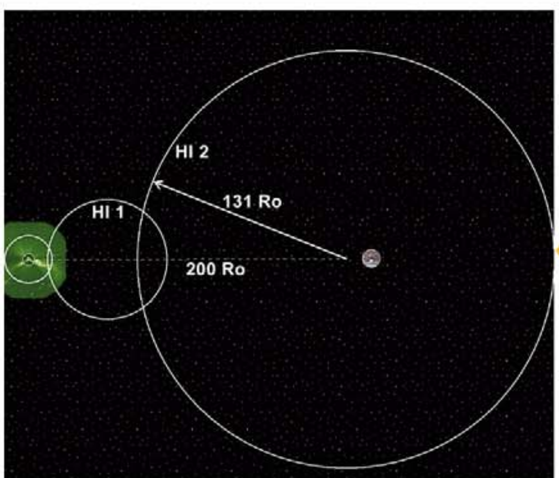


Understand the Initiation of CMEs
- Reconnection
- The Role of Plasma vs. Magnetic Field Effects
- Rapid vs. Slow Drivers

Study the Physical Evolution of CMEs
- Reconnection
- Continued Energy Input and Mass Ejection
- Effect on Helmet Streamers



Investigate the Interaction of CMEs With the Heliosphere
- CME Physical Signatures at 1 AU
- Generation of Shocks
- Acceleration of Charged Particles
- Interaction With Heliospheric Plasma Sheet & Co-Rotating Interaction Regions
- Interaction With Other CMEs

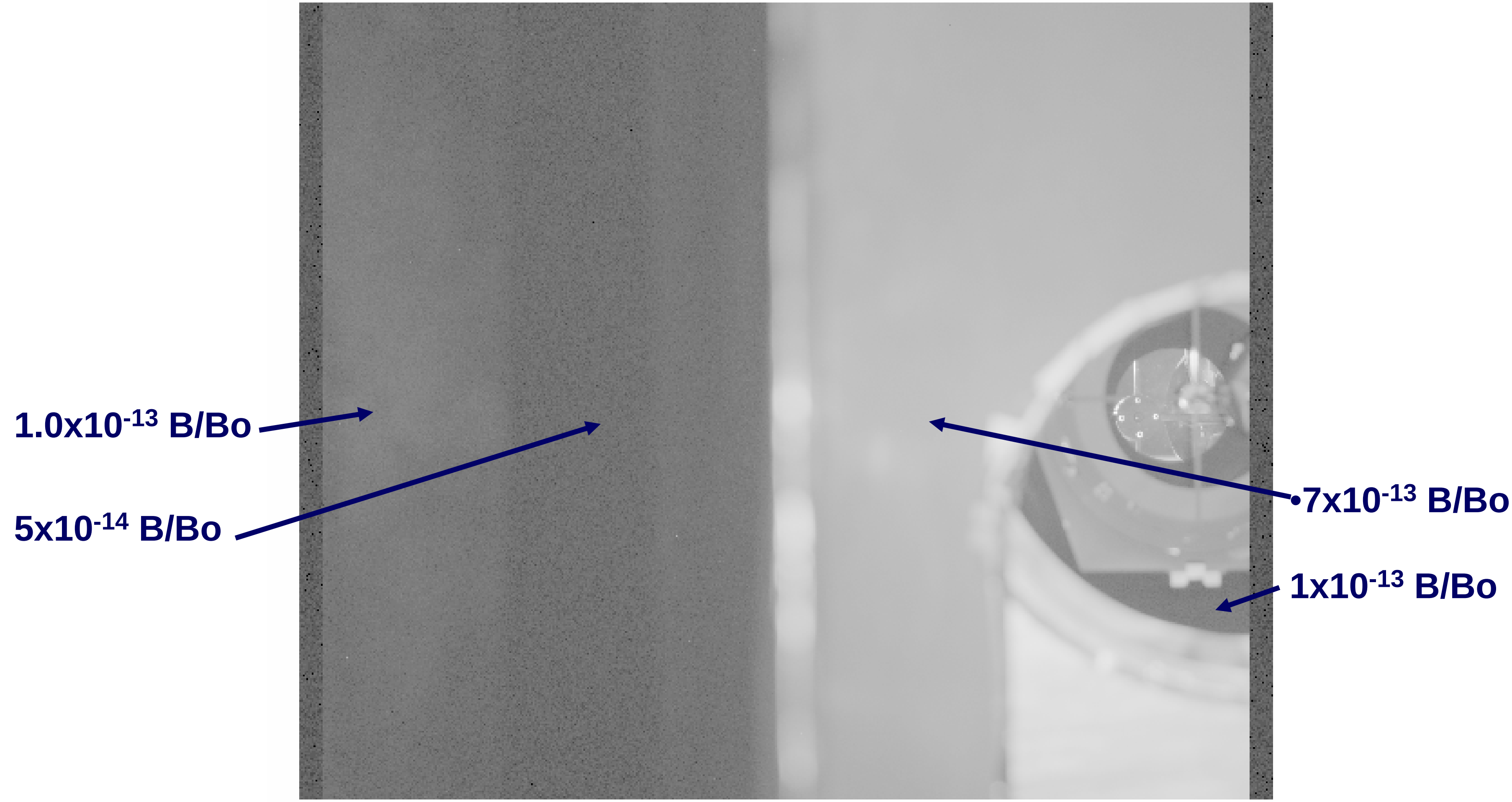


The Sun-Earth Connection: Understand the Role of CMEs in Space Weather
- Observe Trajectory of Earth-Directed CMEs
- Predict Arrival Time and Geo-Effectiveness of CMEs

SECCHI Instrument Performance Requirements

	EUVI	COR1	COR2	HI-1	HI-2
Telescope FOV (deg)	≥ 0.90	≥ 2.13	≥ 8.00	≥ 20.0	≥ 69.2
Occulter Size (deg)	N/A	S/C A: ≤ 0.75 S/C B: ≤ 0.68	S/C A: ≤ 1.34 S/C B: ≤ 1.22	N/A	N/A
Bandpass (nm)	Fe IX: 17.1 Fe XII: 19.5 Fe XV: 28.4 He II: 30.4	[650, 750]	[650, 750]	[650, 750]	[400, 1000]
Spatial Resolution (arcsec)	≤ 3.5	≤ 16.0	≤ 30.0	≤ 140	≤ 486
Intensity / Brightness Range (I/I0, B/B0)	Fe IX: [2.39e-4, 0.477] Fe XII: [3.23e-4, 0.645] Fe XV: [4.11e-3, 0.821] He II: [1.0e-3, 1.000]	[2.0e-9, 1.0e-6]	[2.0e-11, 6.0e-9]	[1.0e-12, 9.0e-11]	[1.0e-13, 6.0e-12]
Intensity / Brightness Resolution (I/I0, B/B0)	Fe IX: 1.2e-4 Fe XII: 1.6e-4 Fe XV: 4.1e-4 He II: 5.0e-4	≤ 2.0e-9, 5.0e-10 at FOV edge	≤ 8.0e-11, 1.0e-12 at FOV edge	≤ 6.0e-14, 5.0e-15 at FOV edge	≤ 2.0e-15, 5.0e-16 at FOV edge
Exposure Time Range (sec)	Fe IX: [0.1, 14.0] Fe XII: [0.1, 20.0] Fe XV: [15.0, 30.0] He II: [7.0, 25.0]	[0.1, 1]	[1, 8]	[10, 30]	[40, 70]
Image Sequence Specification	2 EUV emission line images at 2 different wavelengths	3 white light images at 3 different polarization angles	3 white light images at 3 different polarization angles	70 white light images	50 white light images
Image Sequence Acquisition Time	≤ 60 sec	≤ 12 sec	≤ 45 sec	≤ 38 min	≤ 64 min
Image Sequence Cadence	≥ 1 min	≥ 1 min	≥ 5 min	≥ 47 min	≥ 102 min

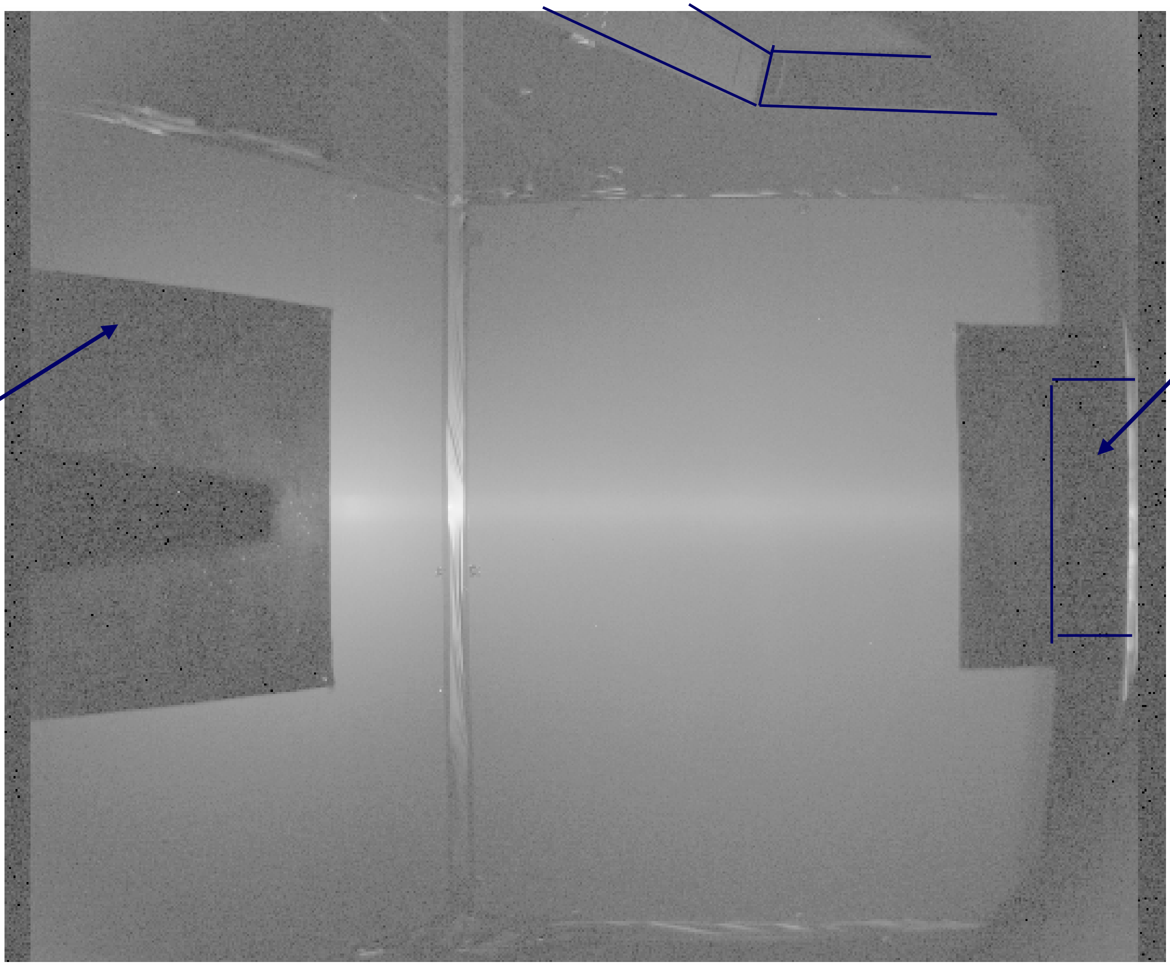
HI-1 FM-B Stray Light Image Equivalent Solar Brightness (B/Bo)



Stray Light Requirement Met
Performance Exceeds Requirement

HI-2 FM-B Stray Light Image Equivalent Solar Brightness (B/Bo)

5×10^{-14} B/Bo

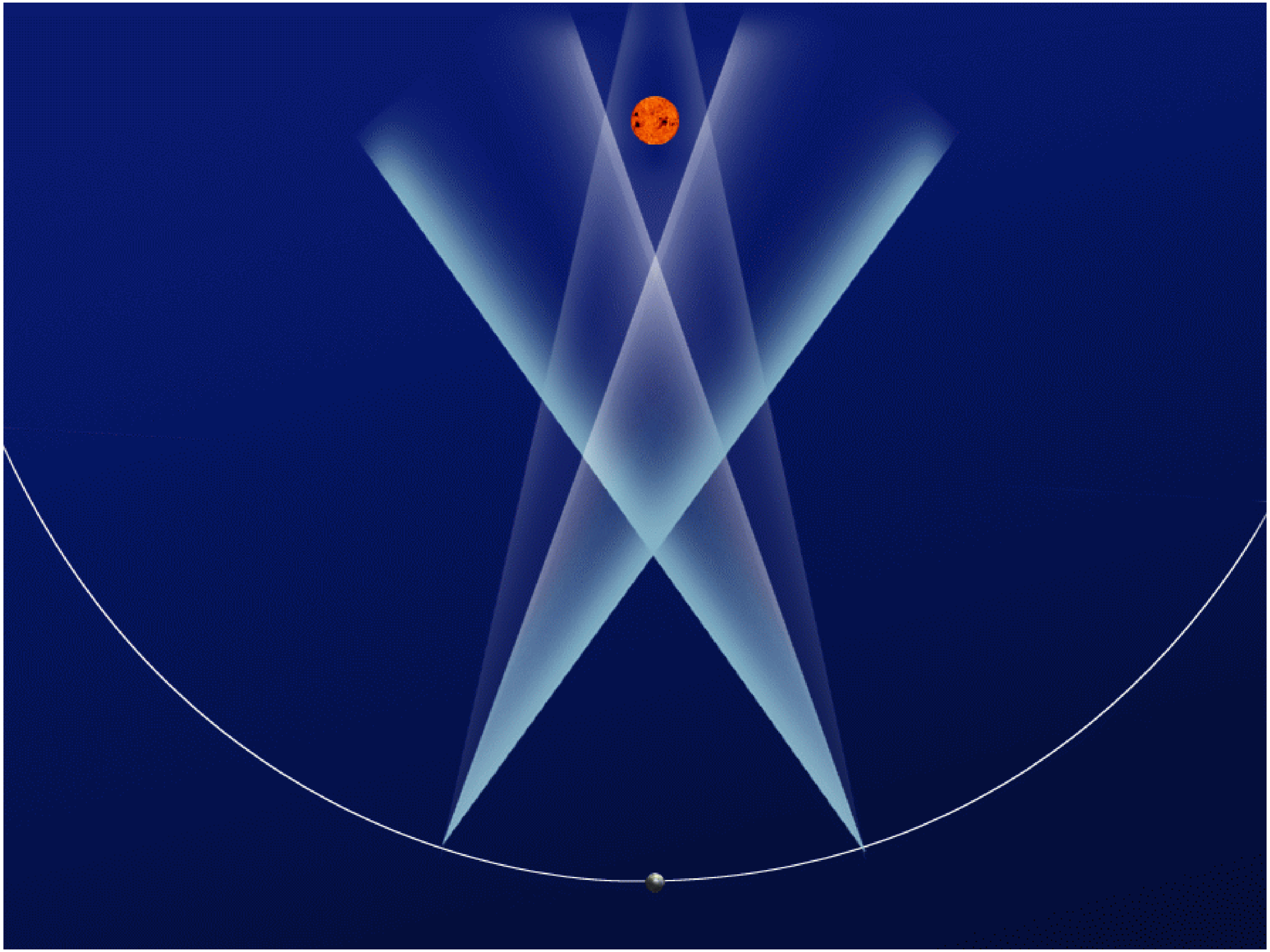


5×10^{-14} B/Bo

Note that in the HI 1&2 overlap region, both instruments observe The same radiance. Since HI 1&2 have different diffraction characteristics, the observed levels must that of the be due to the chamber, not the Instrument.

End-to-end Stray Light Performance Requirement Met, Measurement is Still Limited by Chamber Background

Overlap of Views From HI1 and CORs



SECCHI

"30 Day" Science Questions

- CME Morphology
  - What are the 3D pre-and post-CME configurations?
  - What is the 3D Structure of CMEs?
- CME Initiation
  - How is the pre-CME energy partitioned and how does it repartition?
  - How does the pre-CME configuration evolve to initiate a CME?
  - What is the relative timing of the structures associated with the liftoff of CMEs?
  - What is the acceleration profile? What are the forces involved?
  - Can we rule out/confirm any mechanisms?
- Propagation/Interaction with the Heliosphere
  - Where does the mass originate?
  - Where does the shock form? Type II? SEP?
  - What is the 3D nature of the shock?
  - How does the 3D nature of the CME evolve as it propagates?
  - What is the 3D acceleration/deceleration profile?
  - How does the CME interact with streamers in 3D?

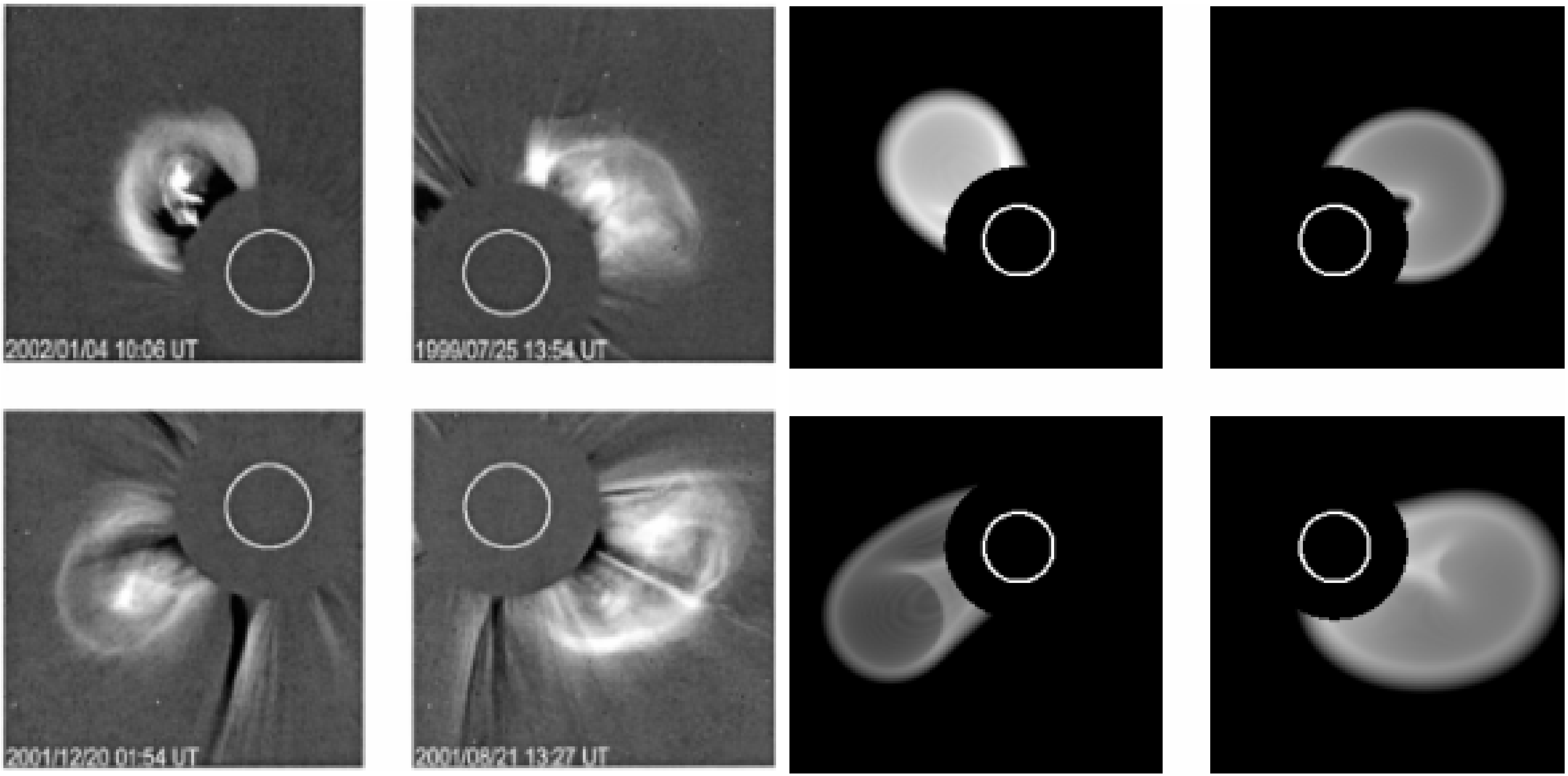
SECCHI Data Sets

- Images
  - FITS Format
  - Level 0.5
    - Corrections That Do Not Involve Interpolations
    - Images Rotated to Put Ecliptic North at Image Top
  - Total Brightness and Percentage Polarization Images (QL)
  - IDL Routines to Convert the Level 0.5 Images to Level 1
- Catalogues
  - Image Meta Data in an SQL Data Base
  - Lists of CME Events
    - Separate Lists for STEREO A/B and SOHO/LASCO
    - Automatically Generated with Automatic Measurements
    - Similar to LASCO CME Web Page
- Movies and Synoptic Maps
- All Data Will Be Available Via an IDL Query Tool, a Web-based Query Tool, As Well As Through Vxo Queries.

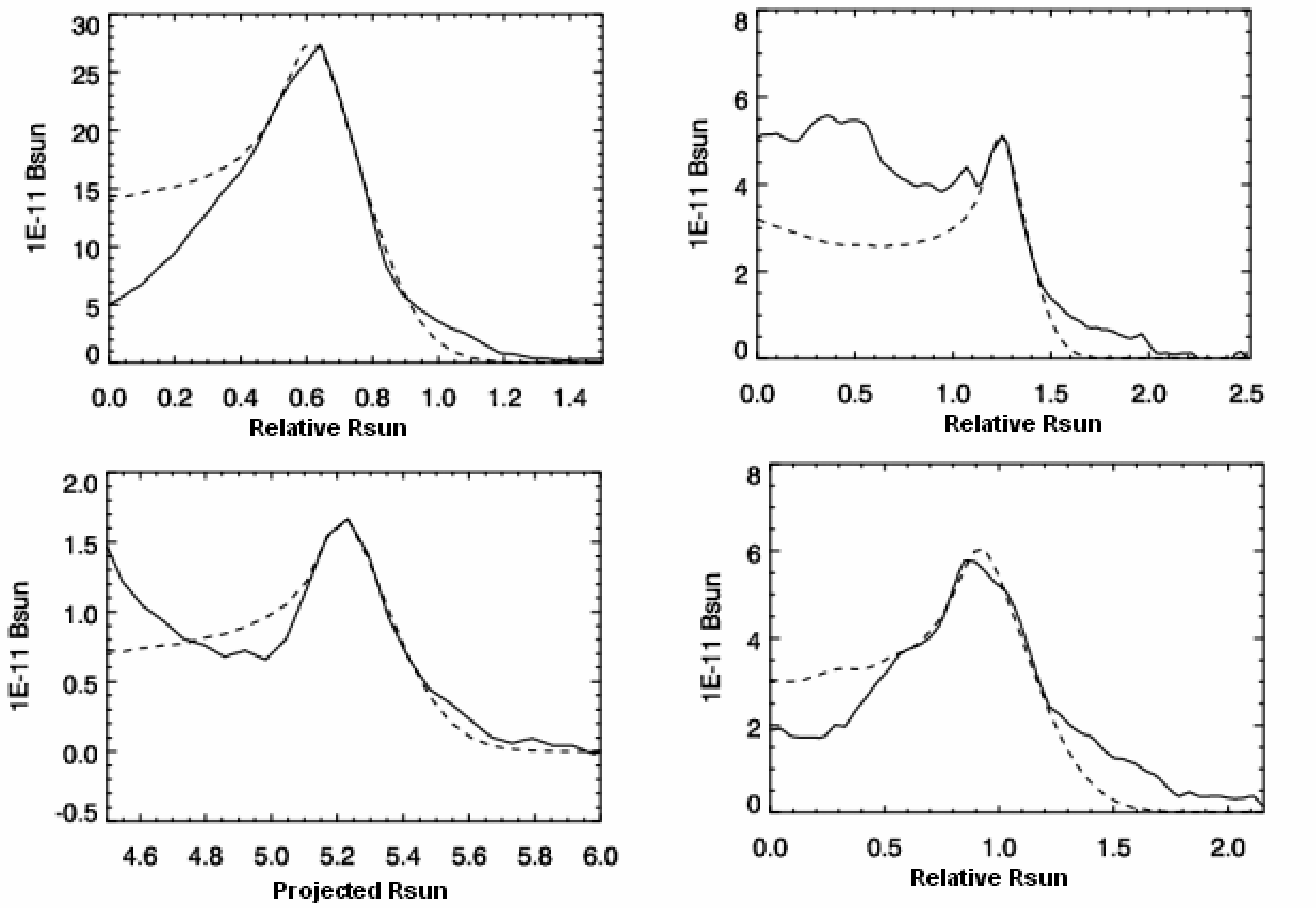
SECCHI Analysis Tools

- CME Measurements
  - Width, Location, Height Time positions
  - Acceleration/Deceleration
  - CME Mass, Center of Mass
- 3D Reconstruction
  - Tie Point Analysis
  - Loop Reconstruction
  - 3D Inversion
  - Forward Modeling (White Light and UV)
  - Thomson Scattering Parametric Curves
- Miscellaneous
  - Differential Emission Measure
  - Synoptic Maps
  - MHD Modeling

Modeling of LASCO CMEs as Fluxrope



Radial Profiles of the CME Fronts

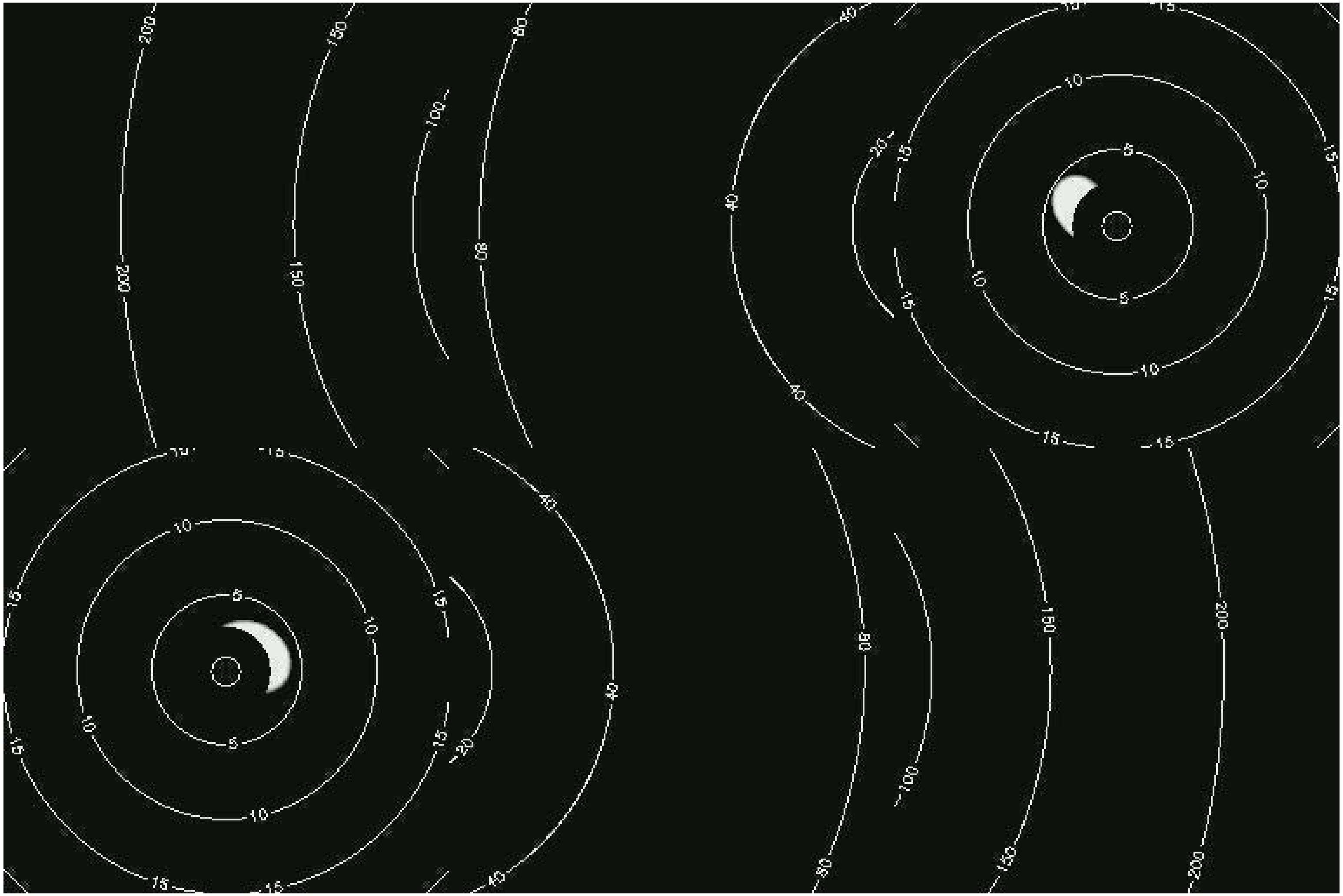


Simulated CME from Sun to 1 AU (Ecliptic View)

Earth ← HI-2 HI-1 COR

Ahead

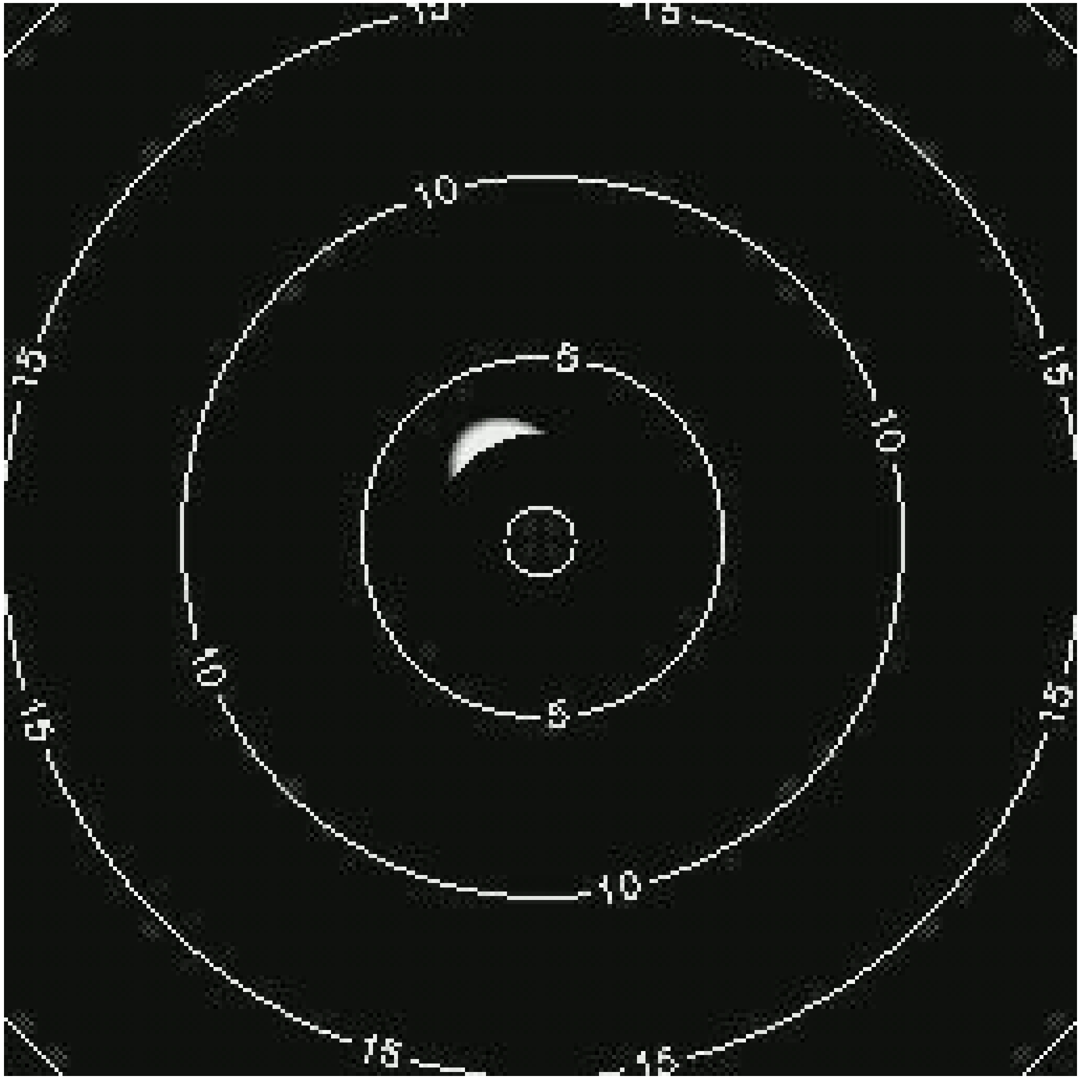
Behind



COR (Reversed) HI-1 HI-2 → Earth

SECCHI

Simulated CME from Sun to 15 R (Earth View)



SECCHI Observation Plans

- The observations are intended to be synoptic in nature and go into a S/C buffer that has been set to not overwrite
- But 20% of the telemetry has been allocated to special observations. These observations go into another S/C buffer that has been set to recirculate, thus providing about 1-2 hours
  - To fill those special observations, we will have a series of planning meetings (web based) at quarterly, monthly and weekly intervals.
  - Anyone may submit a request for special observations – a web page will explain the procedure, but it is based on the SOHO JOP.
- The synoptic observations will be carried out from both platforms, but the special observations may or may not.
  - An example of such "special observations" might be a high cadence sequence trying to get higher cadence on the initial phases of the CME process. The sequence might end by the on-board detection of a CME, which would freeze the circulating buffer. The two spacecraft might not trigger on the detection of the CME at the same time, so those observations would be from one spacecraft alone.

Summary

- The unique and varying perspective observations from STEREO, combined with the observations from Solar-B and other space- and ground- based assets and the well developed modeling provide an exciting opportunity for the community to address the specific STEREO mission objectives but also many others.
- We welcome participation by anyone to use the SECCHI data in their analyses as well as to develop the special observing programs.