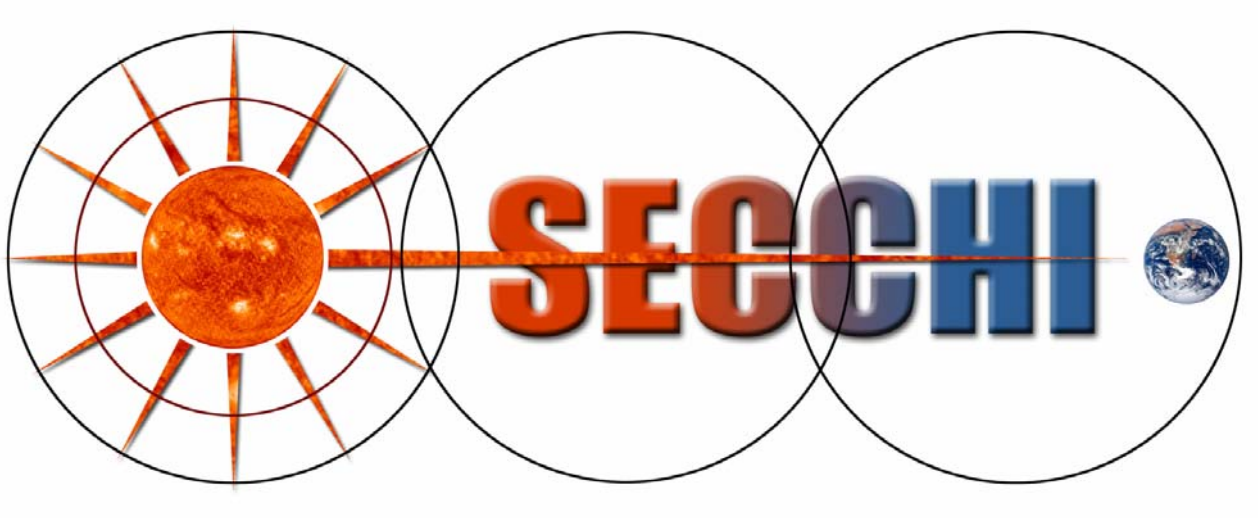

SECCHI Data Processing, Analysis and Access

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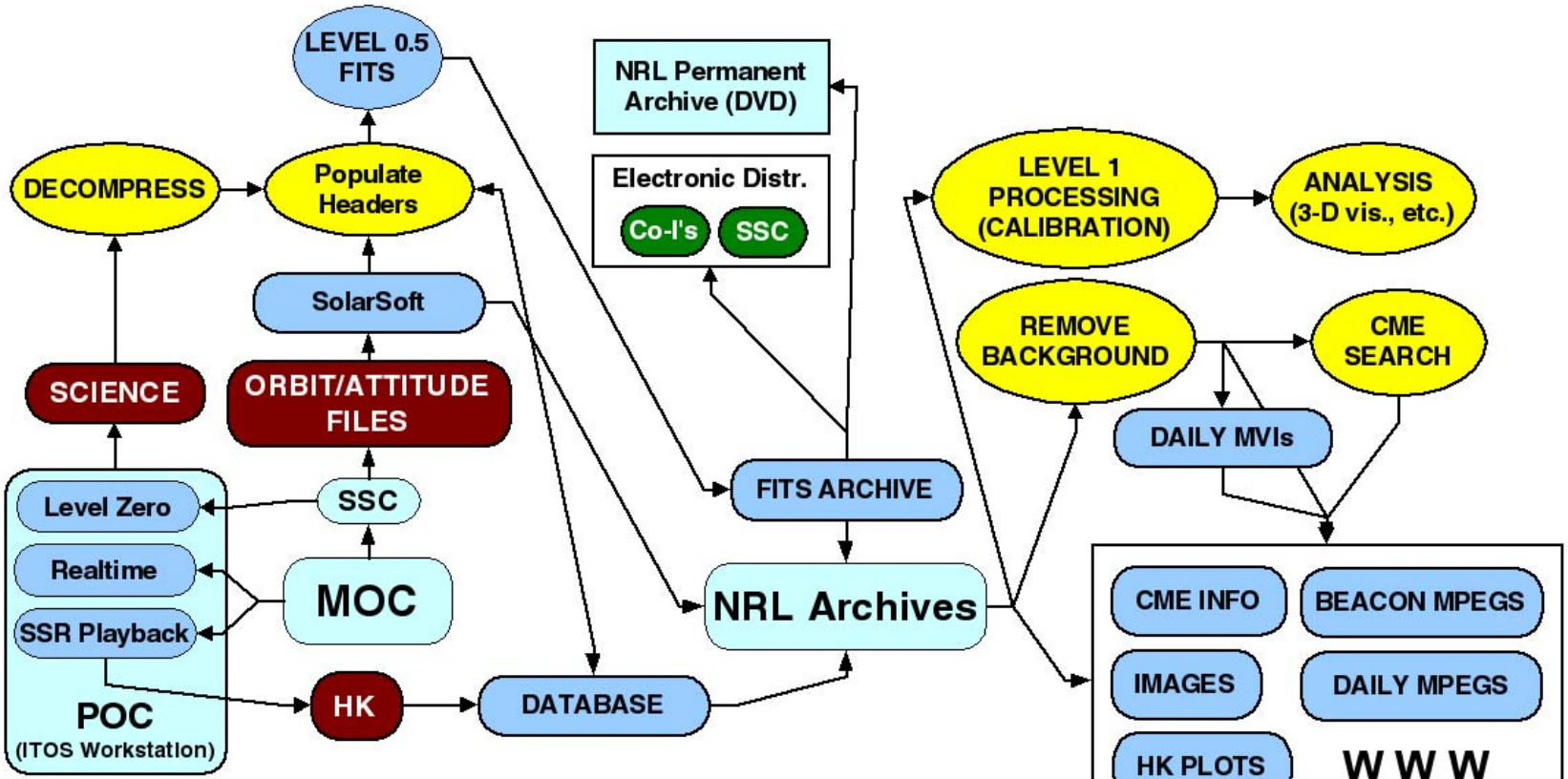
SECCHI Data Processing System



SECCHI Data Processing Flow

4/13/06

Data Processing Level Definition

Level	Source	Description
Packets	MOC	CCSDS packets as transmitted by the spacecraft to the DSMS
Level-0	MOC/SSC	CCSDS packet files sorted and duplicates removed; final after 30 days
Level-0.5	DPS	FITS files containing uncompressed images oriented with ecliptic north “up”. Values are raw counts (DN)
Level-1	User workstation using Solarsoft	FITS files with calibration applied by the user. Values are physical units (CORs, HI) or calibrated DN (EUVI)
Level-2	User workstation using Solarsoft	Data products which are the result of combining two or more images (movies, polarized brightness images, Carrington maps etc). May or may not be calibrated in physical units
Level-3	User workstation using Solarsoft	Derived quantities (electron density, emission measure etc)

Data Products

- Science data will be processed to Level-0.5 at the SECCHI Data Processing Facility (DPF) at NRL
  - Uncalibrated FITS files: a binary data array preceded by a header
  - FITS files generated from real-time data are “Quick-Look”
  - FITS files generated from socket playback or Level-0 packet files are “Preliminary”
  - After 30 days, Level-0.5 FITS files are “Final”
- SECCHI images will be available as soon as the routine processing steps have been completed (within 30 minutes of receipt of all data necessary to form an image)
- Final Level-0.5 FITS files will be retrieved electronically by SSC and Co-I institutions from NRL as they are available
- Routine processing will generate additional products including movies (browse and high-resolution), Carrington maps, ancillary data (housekeeping tables and plots), and lists of events (CMEs, comets etc)
- Plots of long-term tracking of key parameters such as pointing, temperatures, voltages, currents, CCD offset bias and numbers of hot and dark pixels will be regularly updated

Data and Analysis Tools

- Data and Analysis Tools – Will Be Distributed Freely in SOLARSOFT Library Available to Community
- Images, Movies, Synoptic Maps
- Movie Generation Tools
- Space Weather Information (e.g., Beacon Data)
- CME Lists (Automatic CME Recognition)
- Comet/Asteroid Lists
- Calibration Procedure (Photometric, Geometric)
- Removal of Energetic Particle Tracks
- Structure Measurements
- Potential B Field Calculation Tool
- Emission Measure Map Tool
- Image Visualization Tools (Single/Multiple Instrument)
- Three-Dimensional Image Reconstruction
- CME Propagation Modeling Tool
- Database/Web Interfaces (e.g. Virtual Solar Observatory Interface)

Data Archive and Distribution

- 2 year mission at 46.2, 50.7, or 54.9 kbps ⇒ 5 TB:
  - Stored on-line using Network Storage
- NRL Website provides interface to SECCHI data
  - Browser Interface (see following slide)
  - Subsets available through online query and/or DVD
  - Data Analysis tools and descriptions
  - Advanced Data Products – e.g. 3D reconstructions, Emission measure maps, CME lists, etc.
- Level 0.5 Final data product (FITS) routinely transferred electronically to SSC and other institutions (e.g. European Co-I institutes)
- Designed compatibility with Goddard VSO
- Beacon and display images/movies
  - Through website or FTP using query or by special collections
- Housekeeping plots
  - Through website or FTP

Web Data Archive Access - Ideas

- **Traditional – large lists**
  - **SOHO Data Archive**
  - **LASCO/EIT**
  - **Comments: Good for small number of images and/or well defined studies of particular time ranges or campaigns**
- **NRL SECCHI Data interface – Event or time/cadence driven, incorporate components of below options**
  - **SSW Latest Events (Freeland) - Solarsoft**
  - **HESSI – HESSI Data Center**
  - **Comments: More of a near-real time tool, less prior knowledge of "event" necessary, more user "friendly."**
- **SSC, VSO**

CME Reconstructions

- **Currently pursuing two broad approaches for 3D reconstructions of CMEs and coronal structures (plumes, streamers, etc).**
  - **Parametric modeling (RayTrace)**

    Thernisien, Howard, Vourlidas
  - **Tomographic modeling (Pixon)**

    Cook, Newmark, Antunes

RayTrace

- **Models the brightness (total and polarized) produced by Thomson electron scattering from an arbitrary electron density distribution.**
- **The input electron density distribution can be either a 3D data cube or an analytic description.**
- **The output is a 2D image that simulates the observation in a white light coronagraph (user-defined).**
- **The observer location, image spatial resolution, the orientation of the density model and the instrumental vignetting function are arbitrary.**

RayTrace Frontend

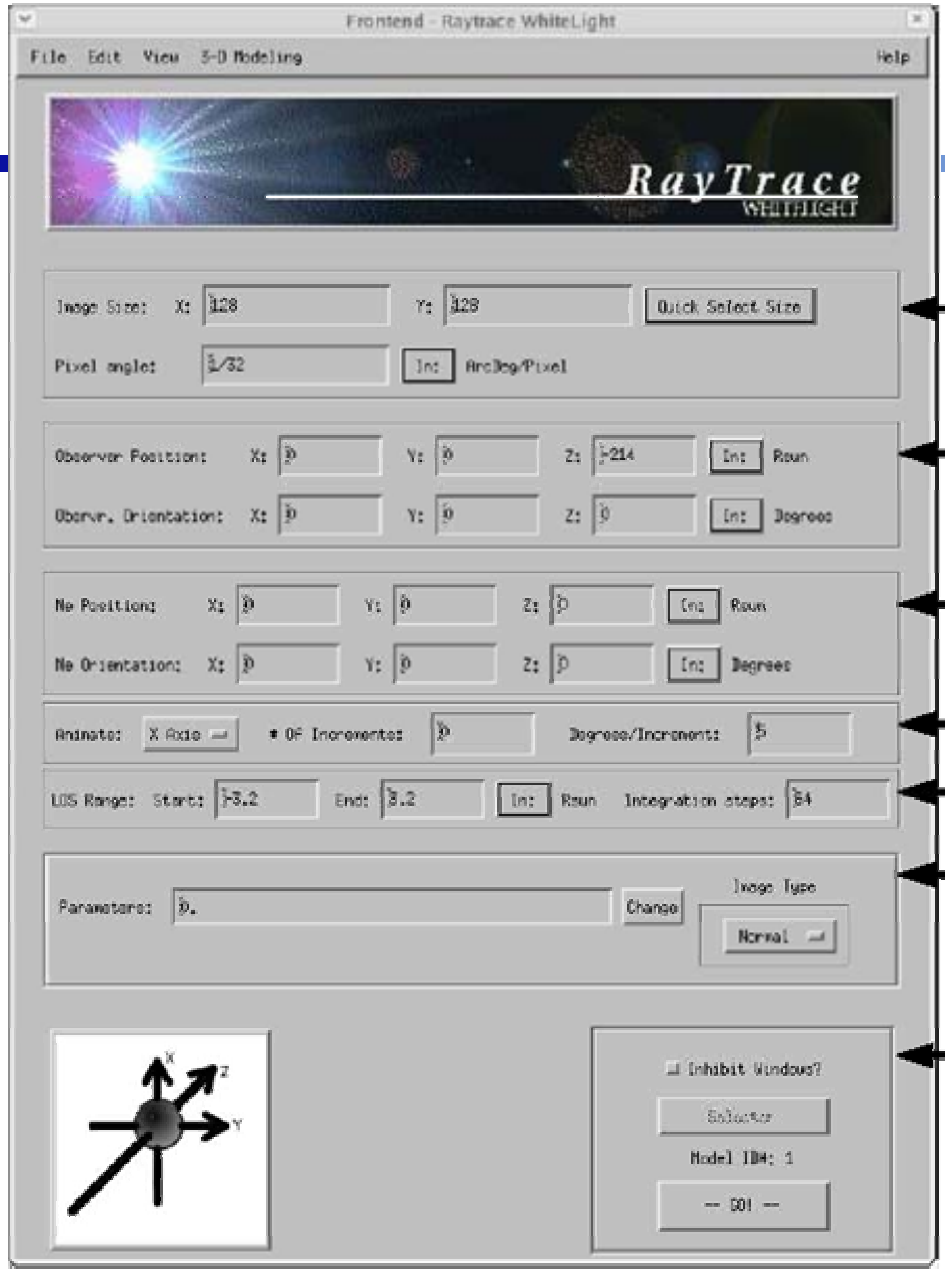


Image Resolution

Observer Position

Electron Density Position

Movie Making

LOS Integration Step

Model Parameters

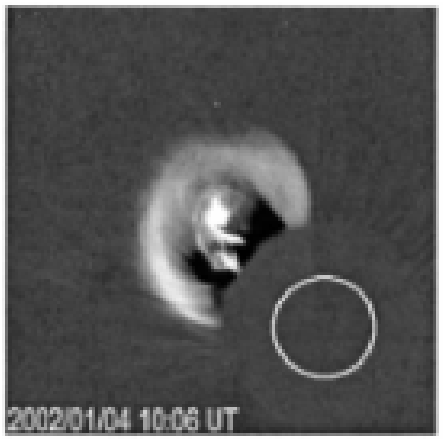
Start Raytracing and Display

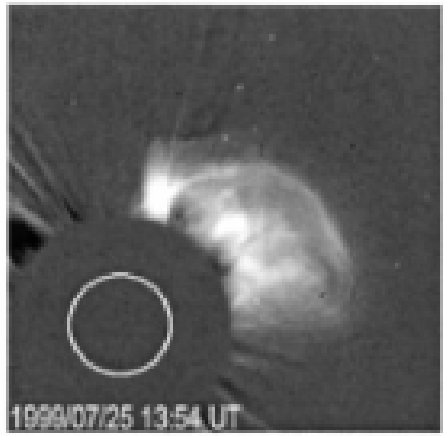
From Thernisien et al. 2004

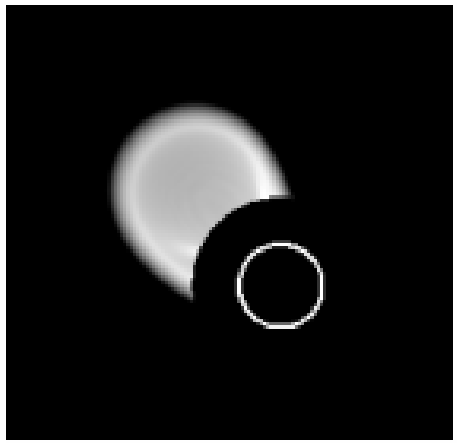
3D CMEs Reconstruction

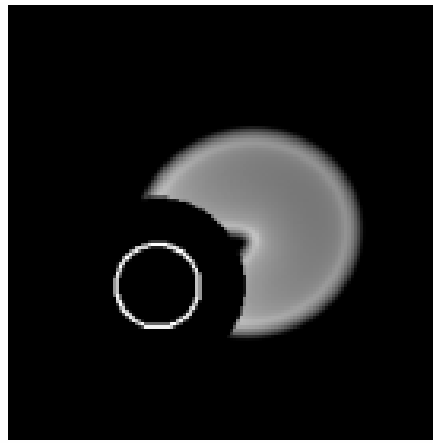
Observations

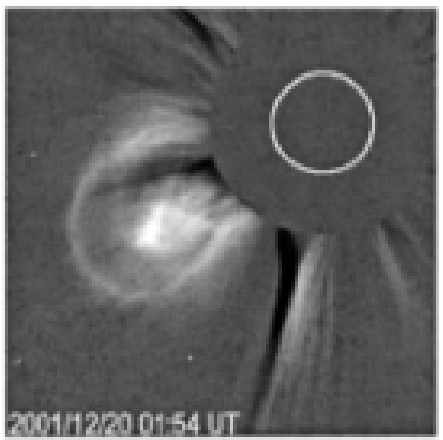
Modeling Output

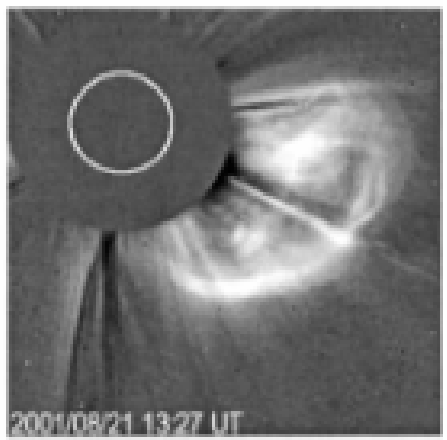


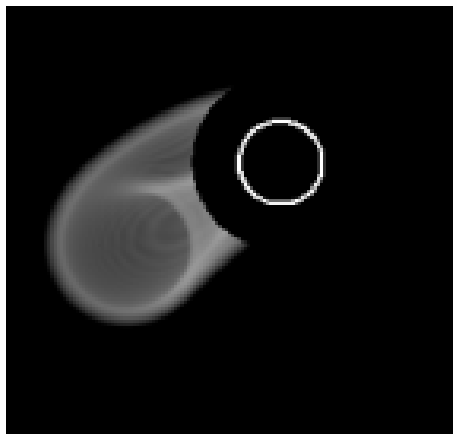


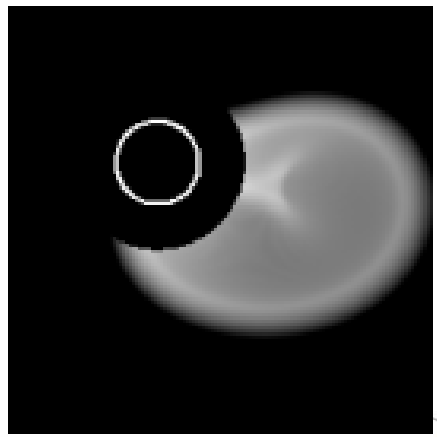










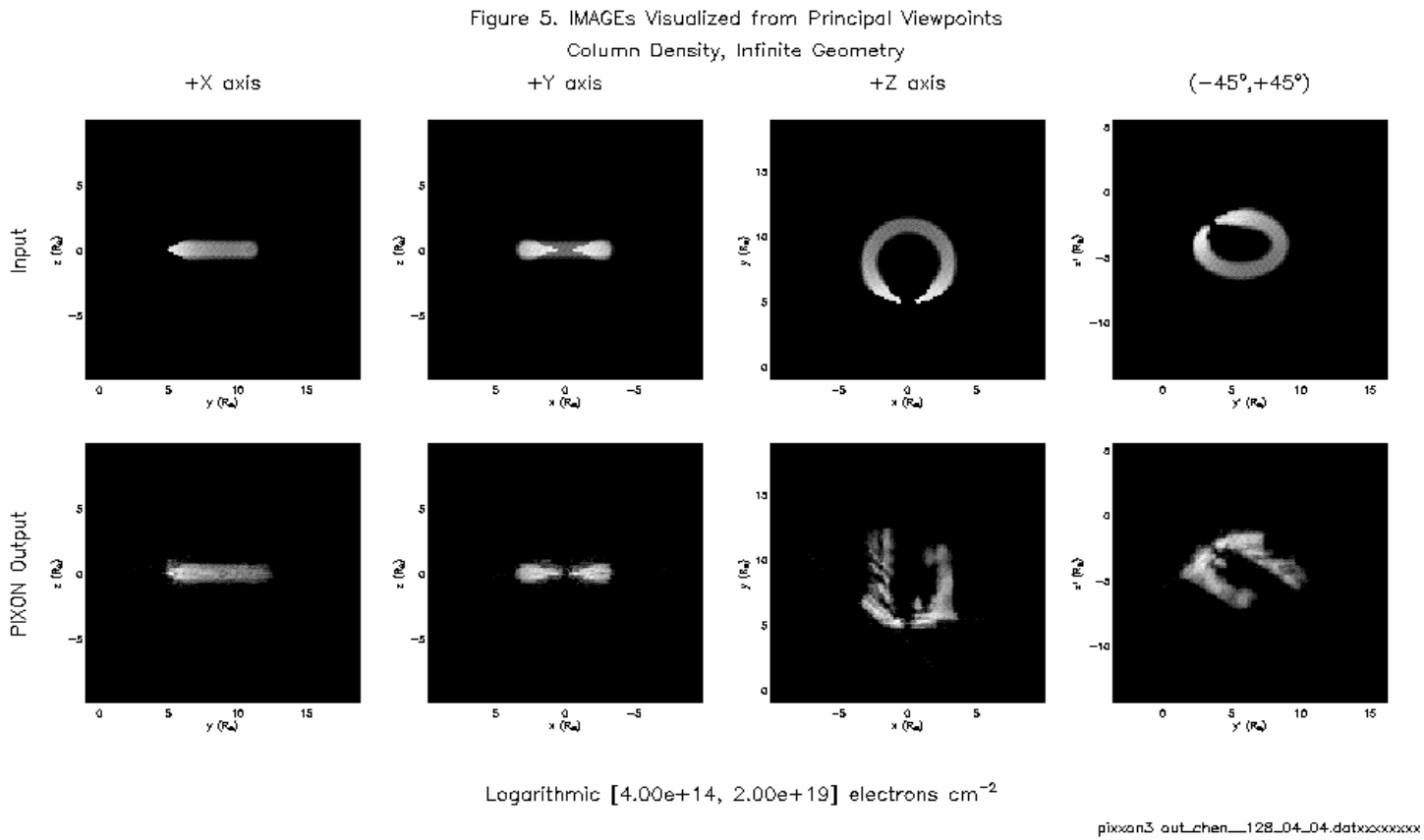


SECCHI

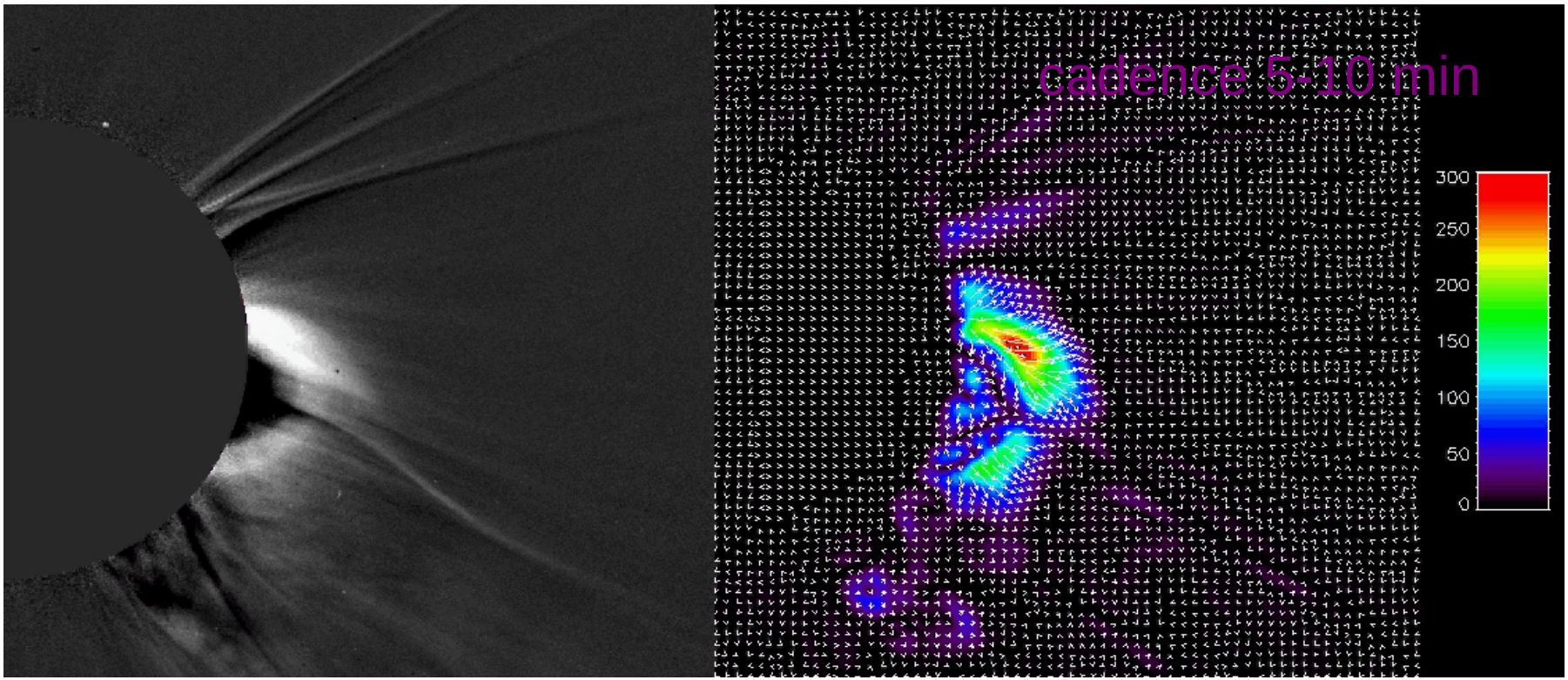
Tomographic Modeling

- **Strategy:**
  - **Apply 3D tomographic electron density reconstruction techniques to solar features (mainly CMEs).**
  - **Utilize B, pB, temporal evolution from 2/3 vantage points.**
  - **Construct (time dependent) 3D electron density distribution.**
- **Focus:**
  - **Use theoretical CME models and existing LASCO observations to identify the range of conditions and features where reconstruction techniques will be applicable.**
- **Goal:**
  - **Provide a practical tool that will achieve ~daily CME 3D electron density models during the STEREO mission.**

3D Reconstruction: CME model (J. Chen) Three Ecliptic Viewpoints: Image Visualization



Optical Flow



Mass

Optical Flow

MHD Modeling

- Essential to Interpret SECCHI Observations and to Connect Them to the *in-Situ* and Radio Wave Observations
- 3 Broad MHD Objectives:
  - Model the Quasi-Static Plasma Parameters
  - Investigate the Physics of the Initiation of CMEs
  - Propagate a Transient Structure Into the Heliosphere
- NRL
  - MHD CME initiation and propagation, Coronal loop structure, Coronal heating, Loop plasma evolution (incl. Prominences), Coronal hole evolution, Flux emergence, Active region structure
  - 3D Visualization - Heliospace package, Developed with ARL (Tim Hall), Based on FAST (NASA/Ames)
- SAIC – Mikic, Linker, Riley, Lionello – coronal and Heliospheric time dependent MHD model = MAS
- Univ. Alabama – Wu – MHD models
- GSFC CCMC – Hesse - hosts models
- University of Michigan + JPL – 3D models of CMEs as seen from STEREO
- These Model Outputs Will Be Available As Boundary Values to New Codes for Predicting Solar Wind Properties, Energetic Particles, and Radio Emission