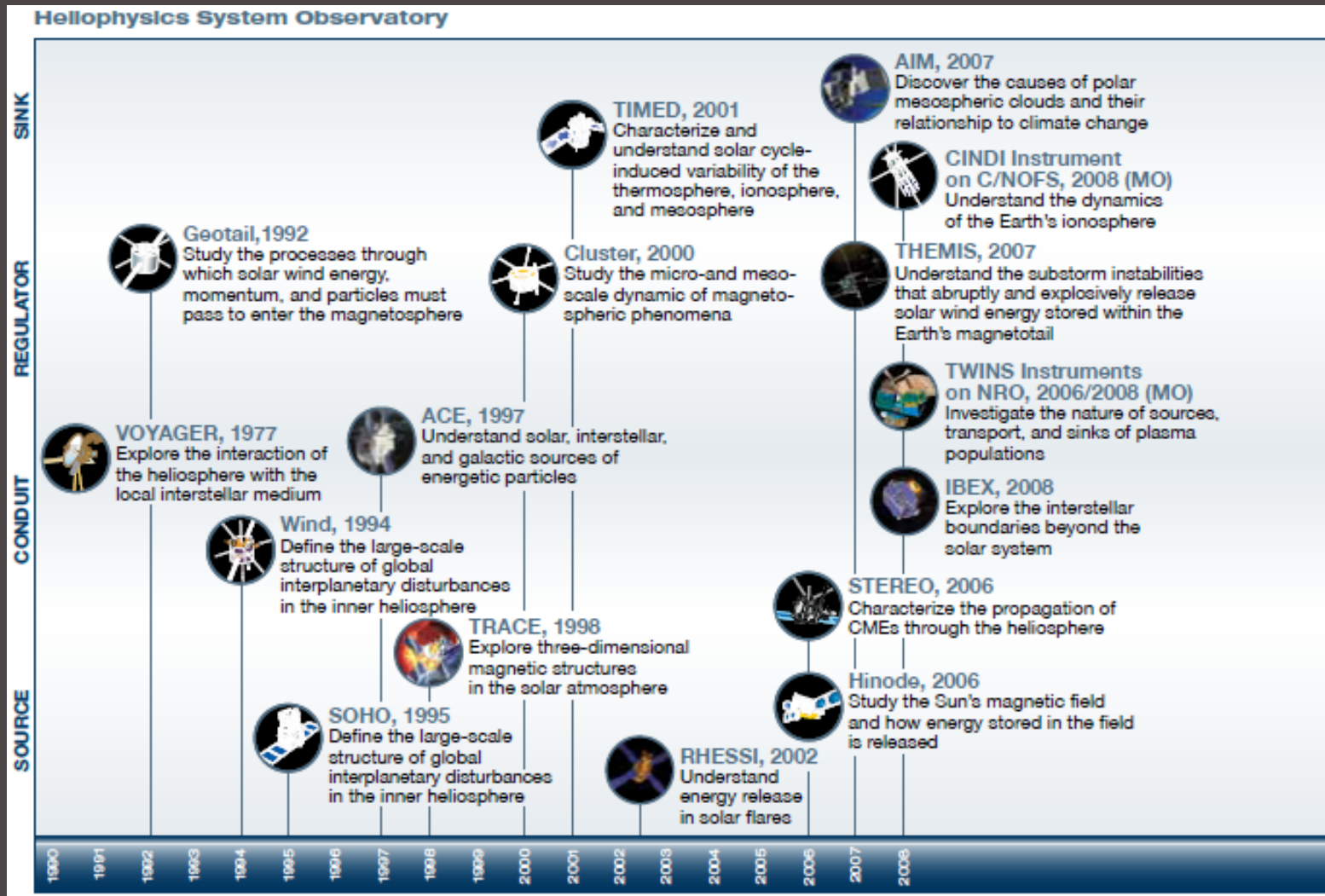


# Data Access and Analysis Tools



# This Talk

So we have all these awesome spacecrafts, but how can we parse it in a meaningful way?

Give some centralized locations for Heliospheric and Solar Data

Talk about the king of Solar data analysis:  
SolarSoft (SSW)



# Virtual Observatories

- But what if you want more context?
- Virtual Observatories / Data centers!
- NASA language:
  - “Information from a single spacecraft vantage point is being replaced by multispacecraft distributed observatory methods”
  - “The VO program is designed to develop an integrated approach to scientific research and analysis”
  - i.e. Data Assimilation

## Heliophysics Virtual Observatories currently supported:

Virtual Cosmic Ray Observatory (ViCRO)

Virtual Heliospheric Observatory (VHO)

Virtual Ionosphere, Thermosphere, Mesosphere Observatory (ViTMO)

Virtual Magnetospheric Observatory (VMO)

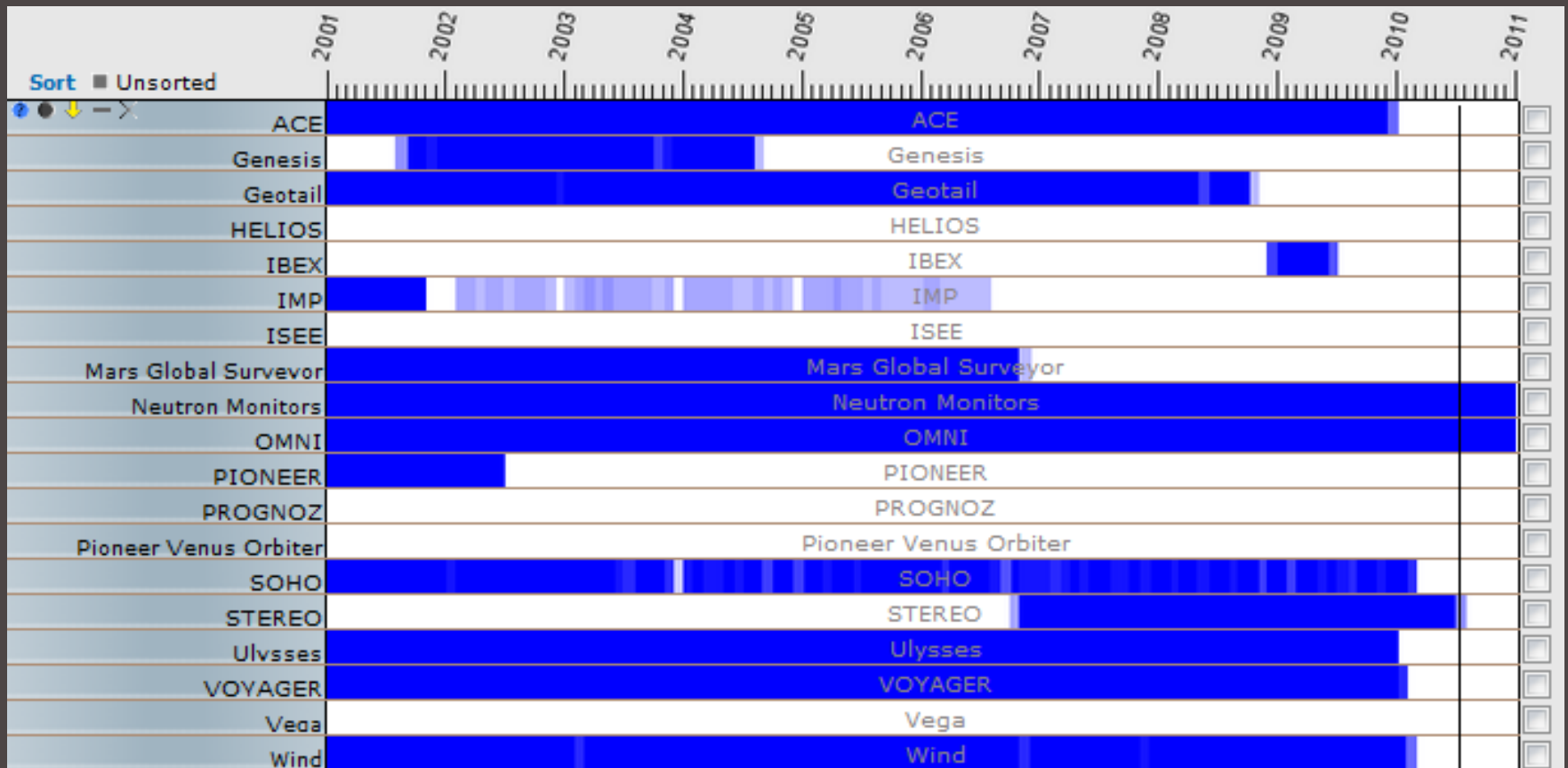
Virtual Radiation Belt Observatory (ViRBO)

Virtual Solar Observatory (VSO)

# Virtual Heliospheric Observatory

- Centralized data distribution center for in-situ data

[vho.nasa.gov](http://vho.nasa.gov)



# Virtual Heliospheric Observatory

- Many diff types of queries, can span many instruments

The image shows a screenshot of the Virtual Heliospheric Observatory (VHO) Query Builder interface, divided into two main panels: 'Query Builder' and 'Current Query'.

**Query Builder Panel:**

- Search Criteria:** Expand | Reset
- Time:** (Empty field)
- Observatories:**
  - All
  - Inner heliosphere
  - Near Earth heliosphere
  - Earth surface
  - Remote 1 AU
  - Outer heliosphere
- Data Products:**
  - All
  - Inner heliosphere
  - Near Earth heliosphere
  - Remote 1 AU
  - Outer heliosphere
  - Heliosheath
- Measurement type:**
  - Activity index
  - Energetic particles
  - Ephemeris
  - Instrument status
  - Ion composition
  - Magnetic field
  - Neutral atom images
  - Thermal plasma
- Parameter values:**
  - Magnetic field

**Current Query Panel:**

- Buttons:** Submit, Save, Clear
- Load:** Load, Time intervals (dropdown), From, Choose File, No file chosen
- Limit:**
- Query Name:**
- Query Component:**
  - Time
  - Start Date: 2008-03-25 18:00:00 Stop Date: 2008-03-25 19:00:00
- EXPRESSION:**
  - Near Earth heliospheric observatory:
    - ACE

# Virtual Heliospheric Observatory

- Can download data or even plot directly

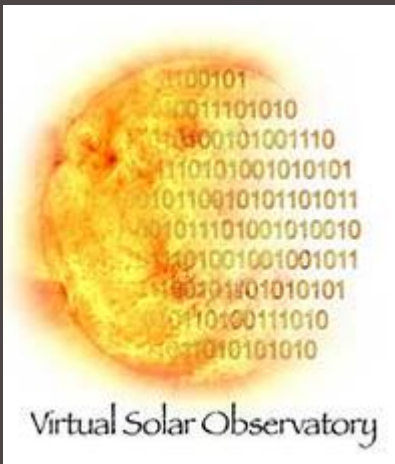
Totals: 6 Instrument(s), 6 Product(s), 7 Time Interval(s)

- ▼ ACE Cosmic Ray Isotope Spectrometer XML
  - ▼ ACE Cosmic Ray Isotope Spectrometer XML
    - ▼ Granules (1)
      - ac\_h2\_cris\_20080325\_v04.cdf XML
      - 2008-03-25 18:00:00 — 2008-03-25 19:00:00
    - ▼ Alternative Access Methods and Services (1)
      - ACE Science Center, CRIS Data, plots/listings/subse

- ▼ ACE Magnetometer XML
  - ▼ ACE Magnetic Field 16-Second Data XML
    - ▼ Granules (1)
      - ac\_h0\_mfi\_20080325\_v05.cdf XML Plot
      - 2008-03-25 18:00:00 — 2008-03-25 19:00:00

# Virtual Solar Observatory

- Centralized data distribution center Solar data  
[sdac.virtualsolar.org](http://sdac.virtualsolar.org)



## **Time**

Search by time interval.

[Derive time intervals from event catalogs](#)

## **Observable**

Search based on physical observables ⓘ

## **Instrument / Source / Provider**

Search based on instruments ⓘ or data archives ⓘ

Compact listing

Instrument / Source (not provider dependent)

Instrument Only (not source or provider dependent)

## **Spectral Range**

Search based on a spectral range

## **Nicknames**

Search based on common terms used to describe data products



# Virtual Solar Observatory

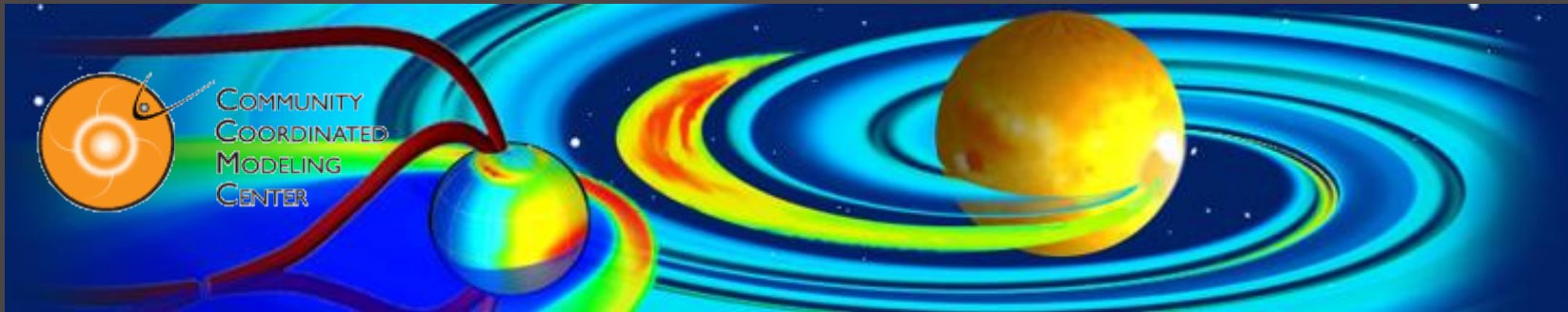
- Centralized data distribution center Solar data

sdac.virtualsolar.org

- Huge number of instruments (too many to list)
- Includes ground based obs as well
- Interface is a bit clunky, but can help finding multiple datasets

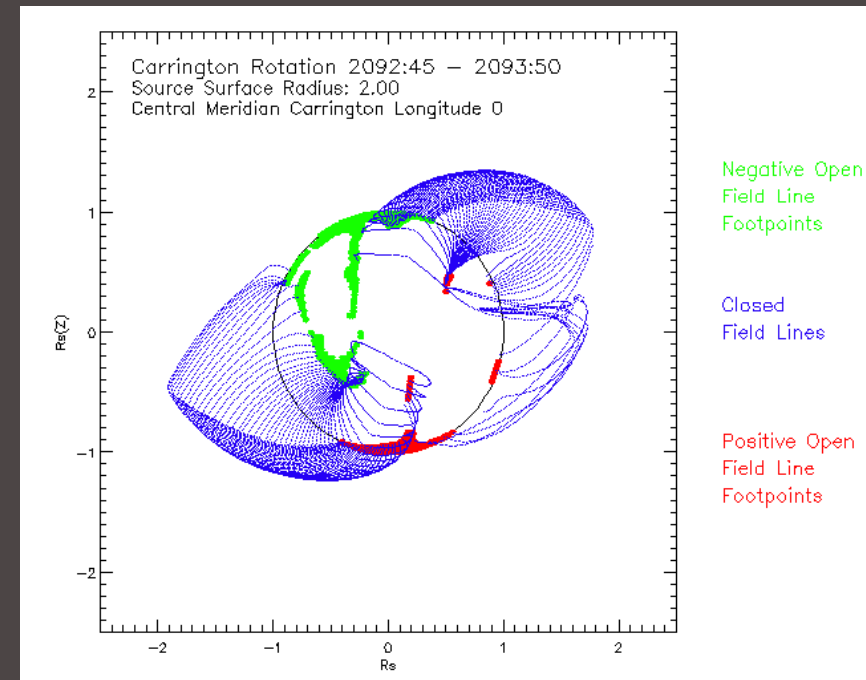
<input type="checkbox"/> AIA ⓘ	2010.05.23 →
<input type="checkbox"/> BBSO ⓘ	2000.07.05 →
<input type="checkbox"/> BCS ⓘ	1991.09.01 – 2001.12.14
<input type="checkbox"/> Big Bear ⓘ	1996.06.01 →
<input type="checkbox"/> CDS ⓘ	1996.01.19 →
<input type="checkbox"/> CELIAS ⓘ	1995.12.02 →
<input type="checkbox"/> Cerro Tololo ⓘ	2001.04.20 →
<input type="checkbox"/> CFDT1 ⓘ	1986.05.26 →
<input type="checkbox"/> CFDT2 ⓘ	1992.01.11 →
<input type="checkbox"/> chp ⓘ	1996.04.20 →
<input type="checkbox"/> Coronagraph ⓘ	1995.10.20 →
<input type="checkbox"/> COSTEP ⓘ	1995.12.07 – 2003.05.01
<input type="checkbox"/> Decametric Array ⓘ	2003.03.10 →
<input type="checkbox"/> dpm ⓘ	1994.02.20 →
<input type="checkbox"/> EIS ⓘ	2006.10.23 →
<input type="checkbox"/> EIT ⓘ	1996.01.01 →
<input type="checkbox"/> El Teide ⓘ	2001.07.30 →
<input type="checkbox"/> ERNE ⓘ	1996.05.08 – 2001.06.01

# More Context: Models at the CCMC



<http://ccmc.gsfc.nasa.gov/>

- Community repository for validated heliospheric models
- MHD models, B extrapolations
- Runs on Request
- Lets you ask what 3D magnetic, velocity, thermodynamic structures might look like for any time in the past 2 decades



# Data Analysis

# SolarSoft (SSW)

- Huge Repository of general IDL tools and mission specific data analysis routines and calibration files.
- Primary Goal: **“Provide a large reuse software library”**  
→ **save everyone time and effort!**
- Website: <http://www.lmsal.com/solarsoft>
- (or just google ‘solarsoft lmsal’)

# SolarSoft (SSW)

- Time series analysis, time conversions
- Spectral fitting
- Image and Image cube (movies) display, wavelets
- IDL data manipulation (structure, string, array, math)
- File I/O
- Solar utilities: limb fitting, grid overlay, coordinate transformations...
- Provide access to supporting ancillary data bases
- Provide integrated access to other IDL packages

# SolarSoft (SSW)

- Caveat, SSW website / main documentation is pretty 'dated'



- But SSW is constantly being contributed to/updated

- Individual package documentation (+file headers) is usually good

- Once you manage to install it, very easy to keep up to date

- If it is at all relevant to what you do, It is well worth the initial effort!

# SSW: Packages

- Software suites for a number of observatories (SDO, SOHO, HINODE, STEREO, GOES, YOHKOH, TRACE, + other optical and radio observatories

- Also has virtual observatory packages

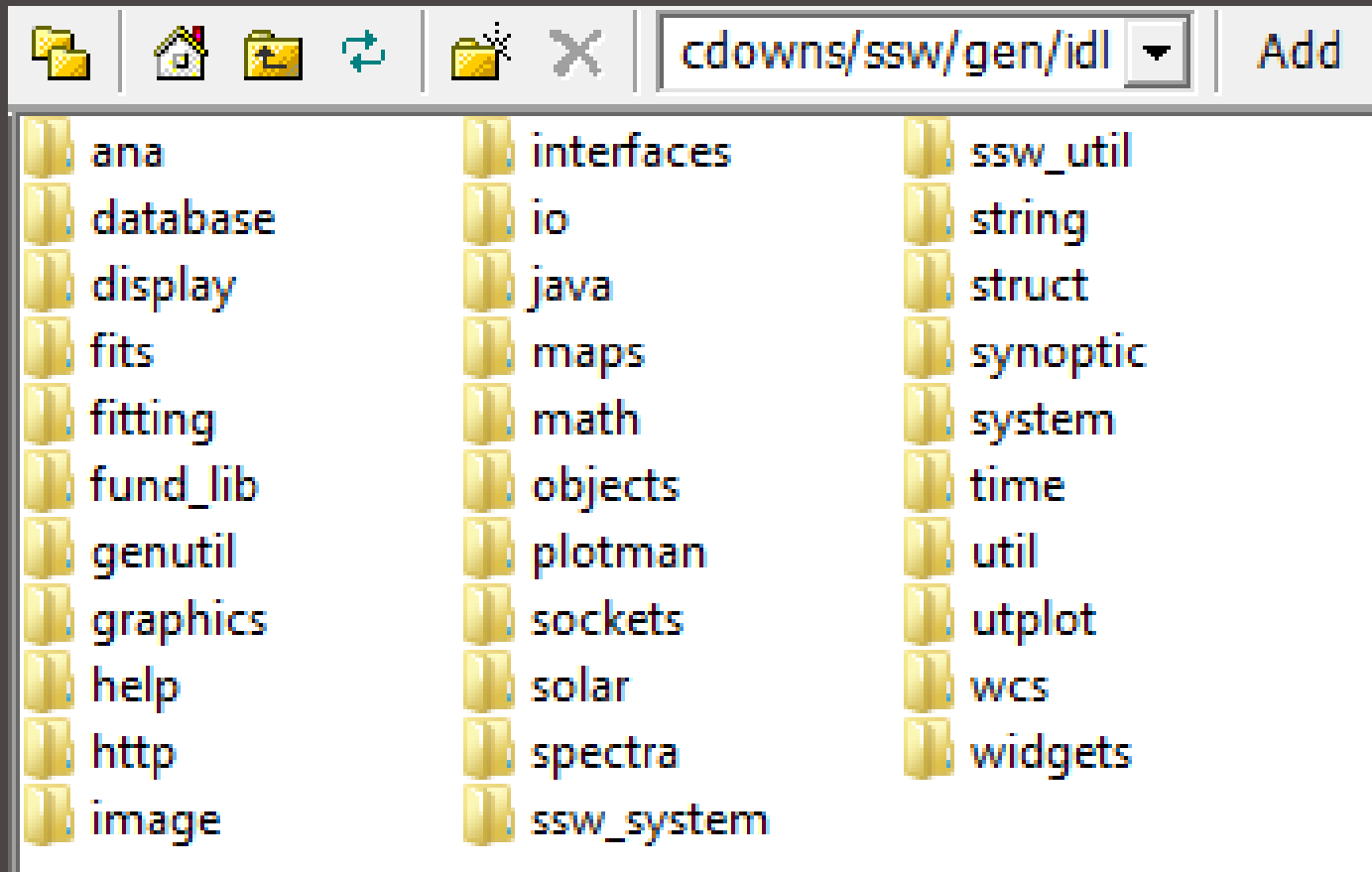
- This includes a VSO interface → can script data acquisition in IDL!

- Many other special use packages:

**Packages:** [BINARIES

# SSW: GEN

- Standard tools with SSW (sww/gen/idl)
- Great resource for IDL code to use



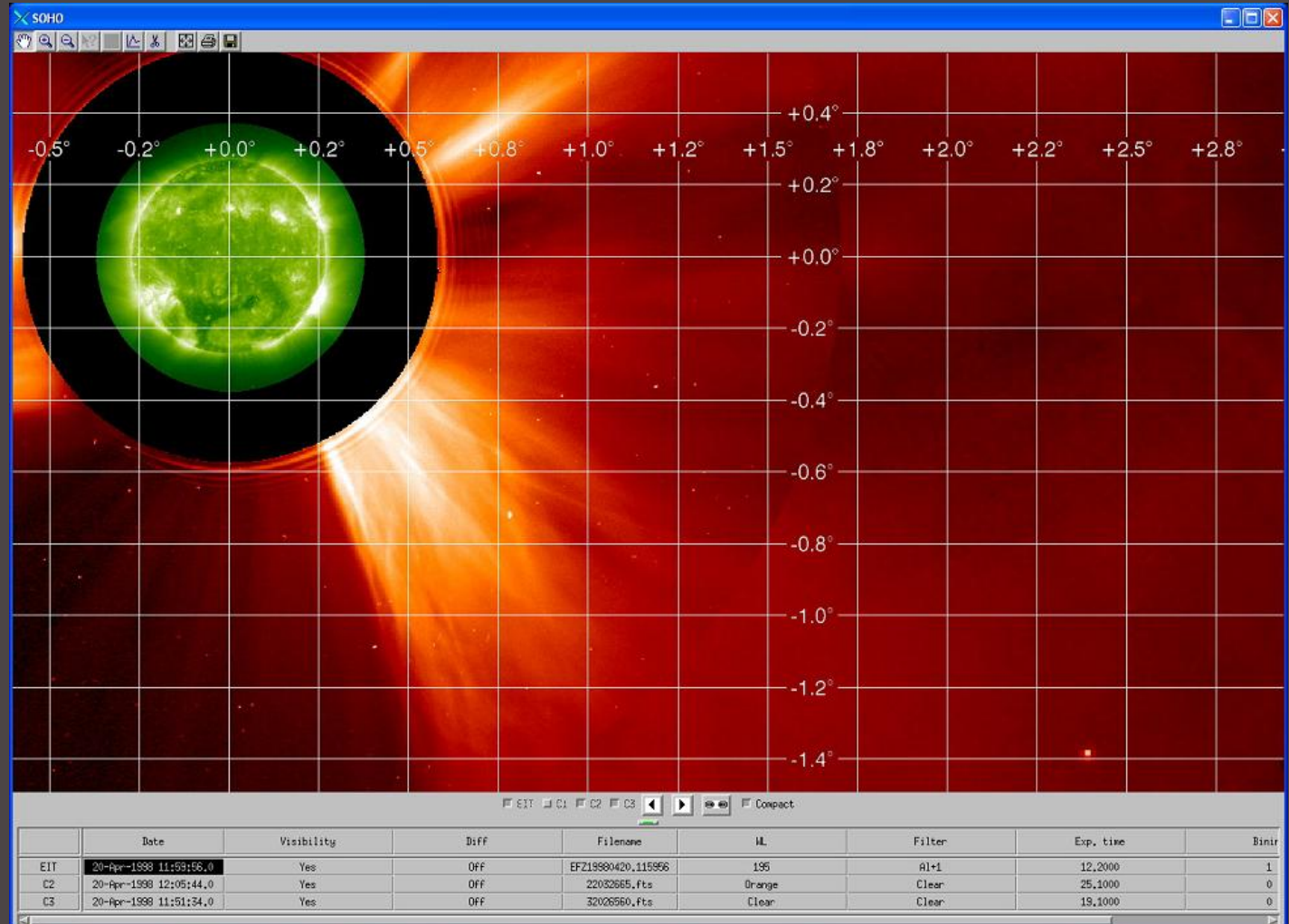


# SSW: FESTIVAL

- SSW package for studying multiple imaging datasets in unison with a variety of analysis tools

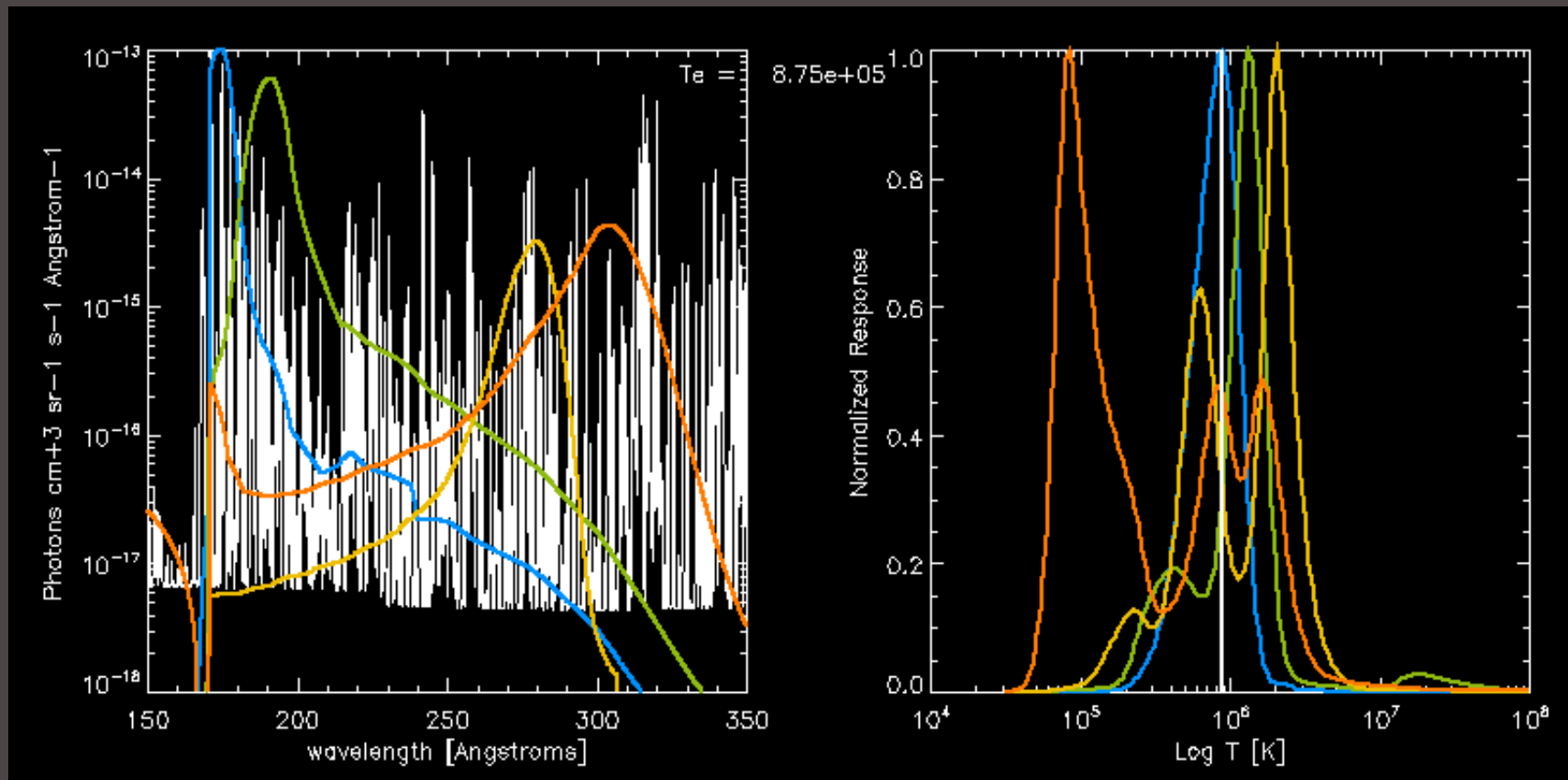
SOHO EIT +  
LASCO

STEREO EUVI +  
COR1&2 + HI1&2



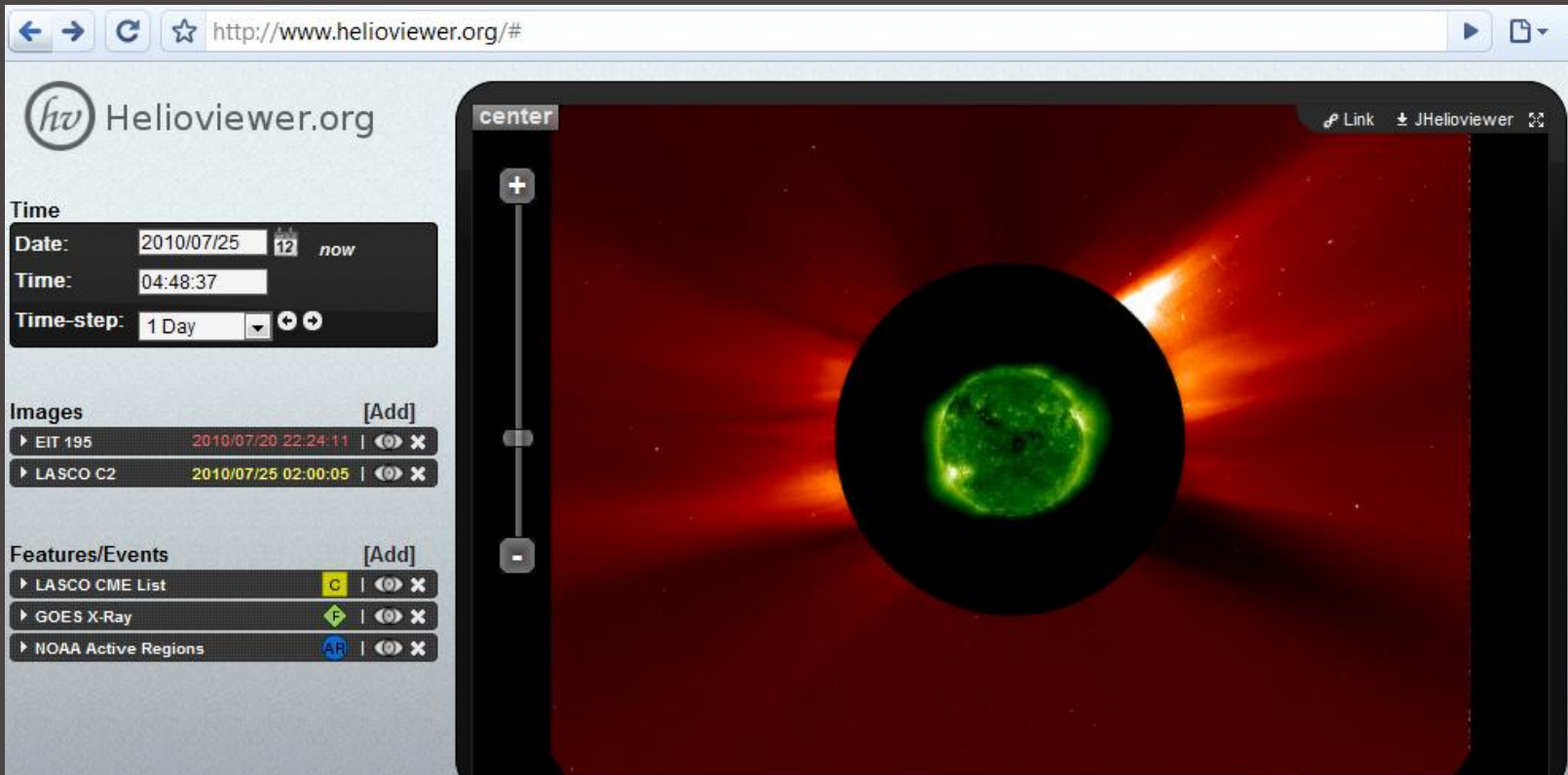
# SSW: CHIANTI

- Comprehensive spectral analysis suite (next talk)



# Other: Helioviewer.org

- NASA/ESA project that uses VSO API and makes nice web and java interface for viewing data.
- ▣ Will load calibrated images in real time!
- ▣ Intended eventually for SDO scale data, so check back!



The screenshot shows the Helioviewer.org website interface. The browser address bar displays <http://www.helioviewer.org/#>. The page features the Helioviewer.org logo and a main viewing area labeled "center" showing a solar image with a green sun and red solar wind. The interface includes several control panels:

- Time:** Date: 2010/07/25 12:00:00 now, Time: 04:48:37, Time-step: 1 Day.
- Images:** [Add] EIT 195 2010/07/20 22:24:11 | [Eye] [X], LASCO C2 2010/07/25 02:00:05 | [Eye] [X].
- Features/Events:** [Add] LASCO CME List [C] | [Eye] [X], GOES X-Ray [G] | [Eye] [X], NOAA Active Regions [AR] | [Eye] [X].