Solar Orbiter: Exploring the Sun-Heliosphere Connection

Mission Summary

Launch Date: Feb 2019

Cruise Phase: ~2.5 years

Nominal Mission: 3.5 years

Extended Mission: 2.5 years

Orbit: 0.28 – 0.91 AU

Out-of-Ecliptic View:
Multiple gravity assists with Venus to increase inclination out of the ecliptic to >24° (nominal mission),
>33° (extended mission)

Reduced relative rotation:
Observations of evolving structures on solar surface & in heliosphere for almost a complete solar rotation

Joint ESA-NASA mission

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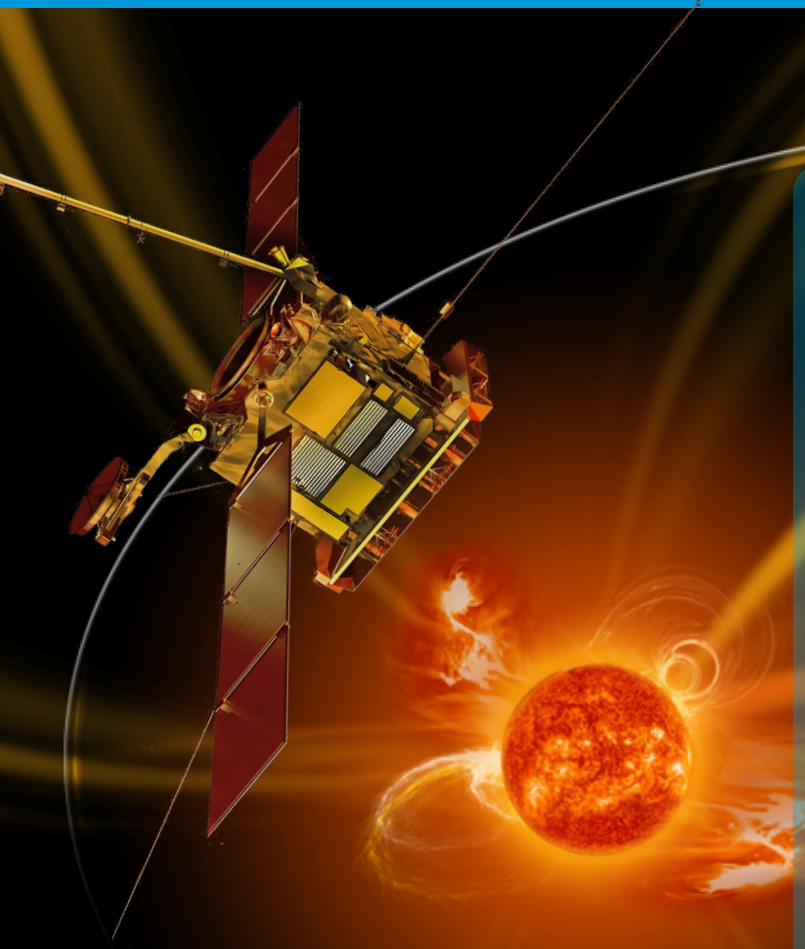


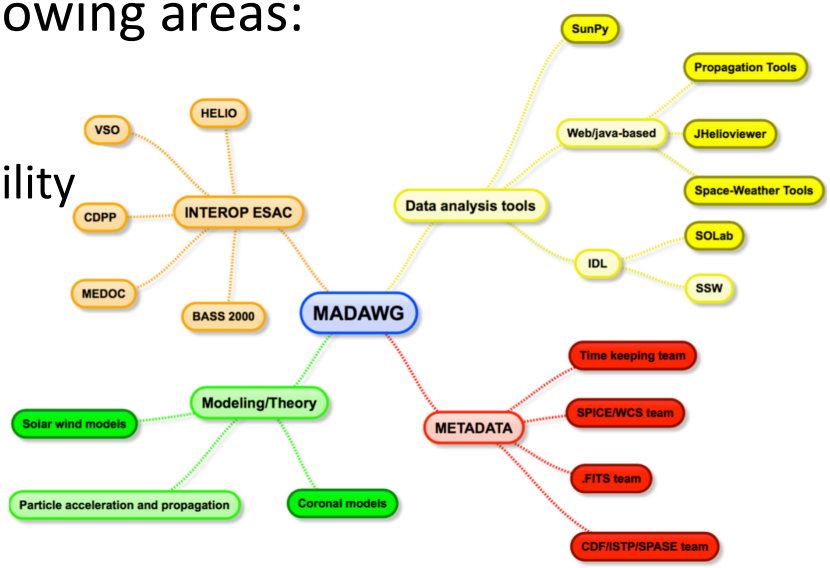
Science Focus

How does the Sun create and control the Heliosphere – and why does solar activity change with time ?

- What drives the solar wind and where does the coronal magnetic field originate?
- How do solar transients drive heliospheric variability?
- How do solar eruptions produce energetic particle radiation that fills the heliosphere?
- How does the solar dynamo work and drive connections between the Sun and the heliosphere?

Solar Orbiter Modeling and Data Analysis WG (MADAWG)

- Originally known as as the Data Analysis Working Group (DAWG), the importance of modeling was quickly realized and added to the group's purpose.
- Holds periodic meetings, both separately and in conjunction with Science Operations Working Group meetings.
  - Last MADAWG meeting in July 2017
  - Next meeting: 22-24 January 2017 in Toulouse: focused on preliminary activities to integrate PHI magnetograms in the modeling framework.
- The working group addresses the following areas:
  - Solar Orbiter metadata
  - Modeling support
  - Solar Orbiter archive, and interoperability with other data centers
  - Data analysis tools



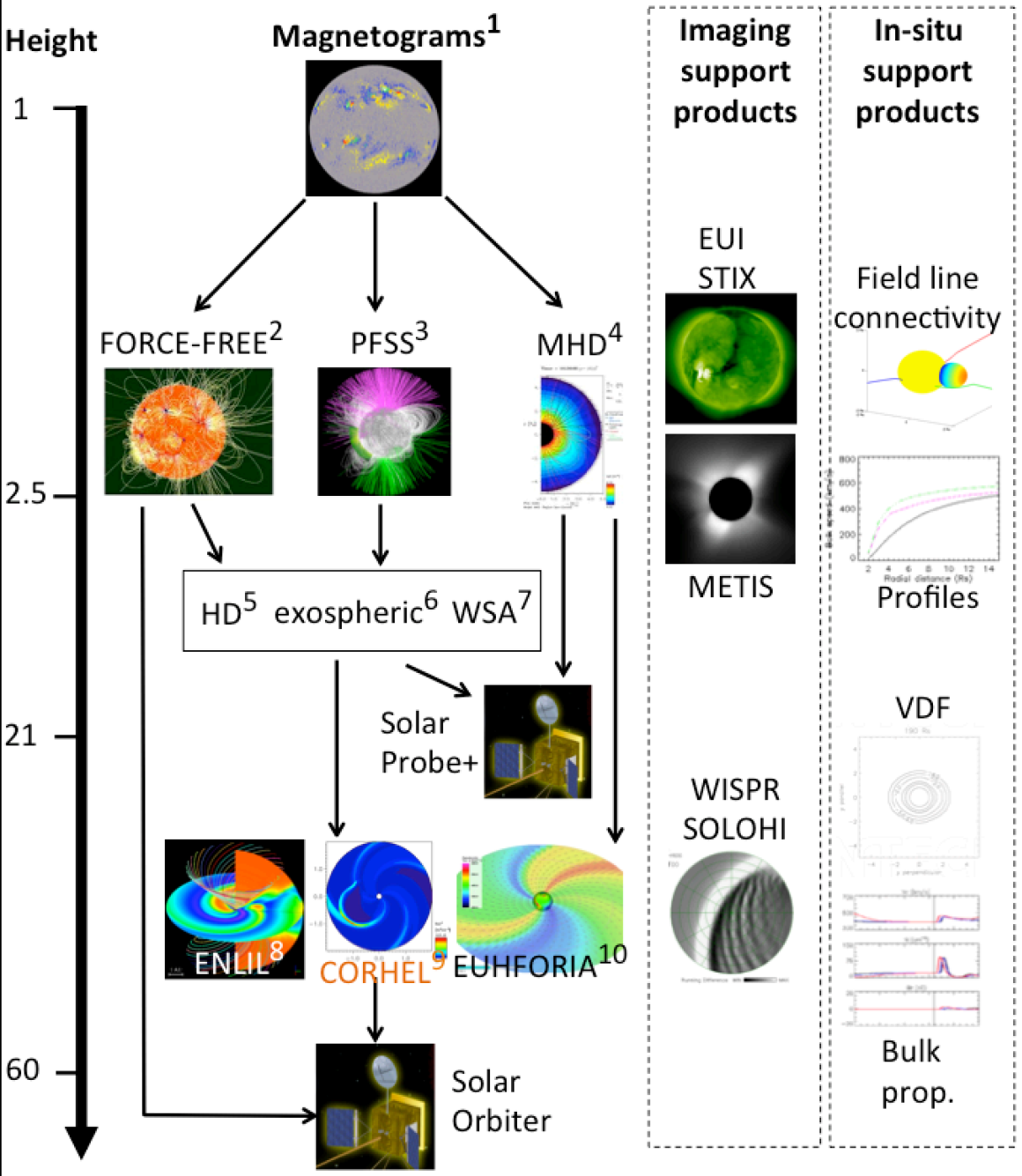
Modeling support for Solar Orbiter

Role of modeling for Solar Orbiter falls into the following categories:

- Support for mission planning and data acquisition
  - On what target do we point Remote-Sensing instruments?
  - Which data do we downlink from the spacecraft? (Do we put priority on periods when Remote-Sensing instruments look at source of plasma measured in situ?)
- Support for research (once data has been downlinked)
- Solar Orbiter role in space-weather forecasting

This involves the development of new models and techniques to test the output of these models

SCIENCE SUPPORT

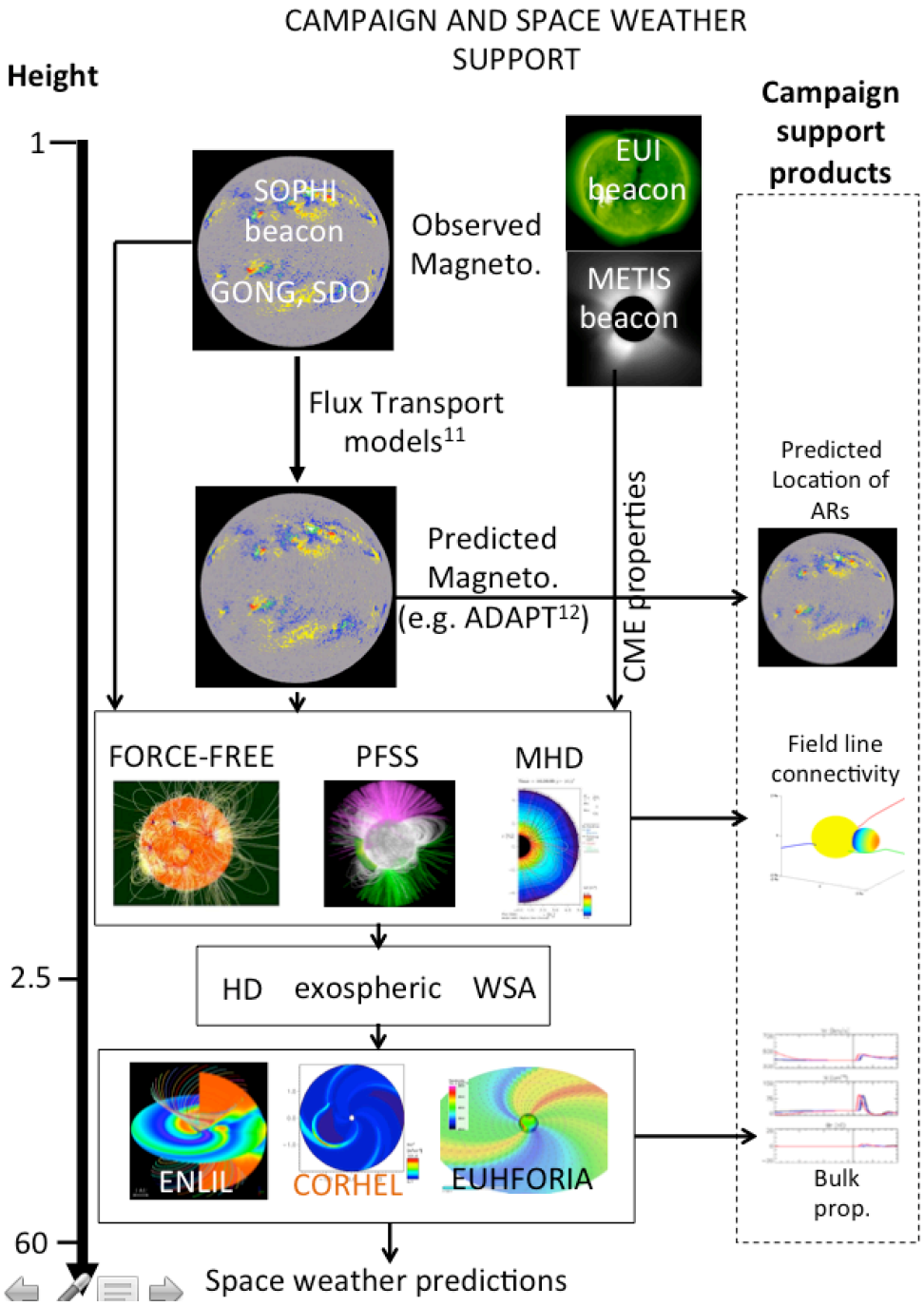


Recipe follows the usual coupling of surface-coronal-heliospheric models

Different magnetograms lead to different results

We need techniques to test and validate model realisations with observations: synthetic imagery and in-situ data

A lot of effort at developing advanced data products from remote-sensing instruments to capture the 3-D inverted parameters of the corona (N,V,T) at an instant in time (multi-spacecraft techniques).



Models for planning and SWx

For campaign support we need to forecast the state of the photosphere and corona so that operators can point towards a feature of interest (AR, CH,…).

Critical for science questions that require multi-instrumental (coordinated RS and IS), multi-spacecraft studies.

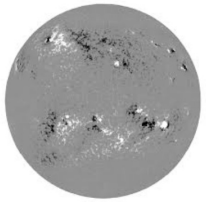
State of the photosphere is forecasted using flux transport models (e.g. ADAPT maps) on many different magnetograms

Different coronal models must run in parallel to evaluate uncertainties in estimated positions of AR, CH, and on how Solar Orbiter is magnetically connected to the photosphere.

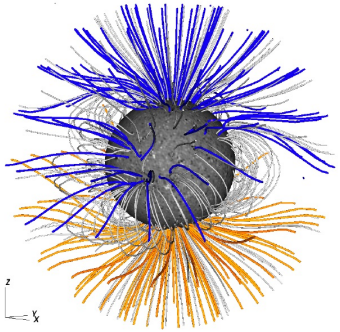
Solar Orbiter / Parker Solar Probe Connectivity Tool

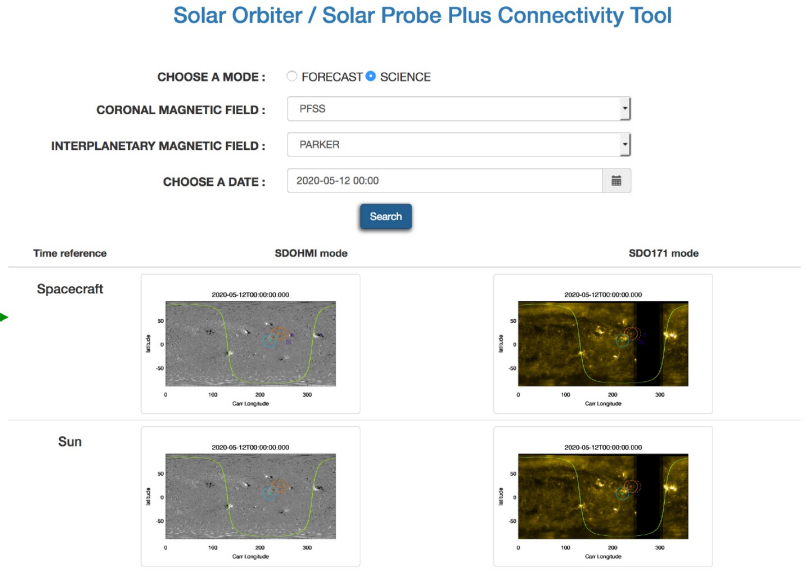
- Aim is to deploy the SolO/PSP magnetic connectivity tool: will provide estimates of where the two spacecraft connect to on the solar surface either using past data (for science purposes) or else using forecasts of the solar magnetic field (for operational purposes).
- In its forecasting mode the tool would estimate where SolO connects to the solar surface in order to decide where the remote-sensing instruments should point. Forecasted magnetograms can be ADAPT maps, and the Toulouse group is developing a flux-transport model running on SDO magnetograms.

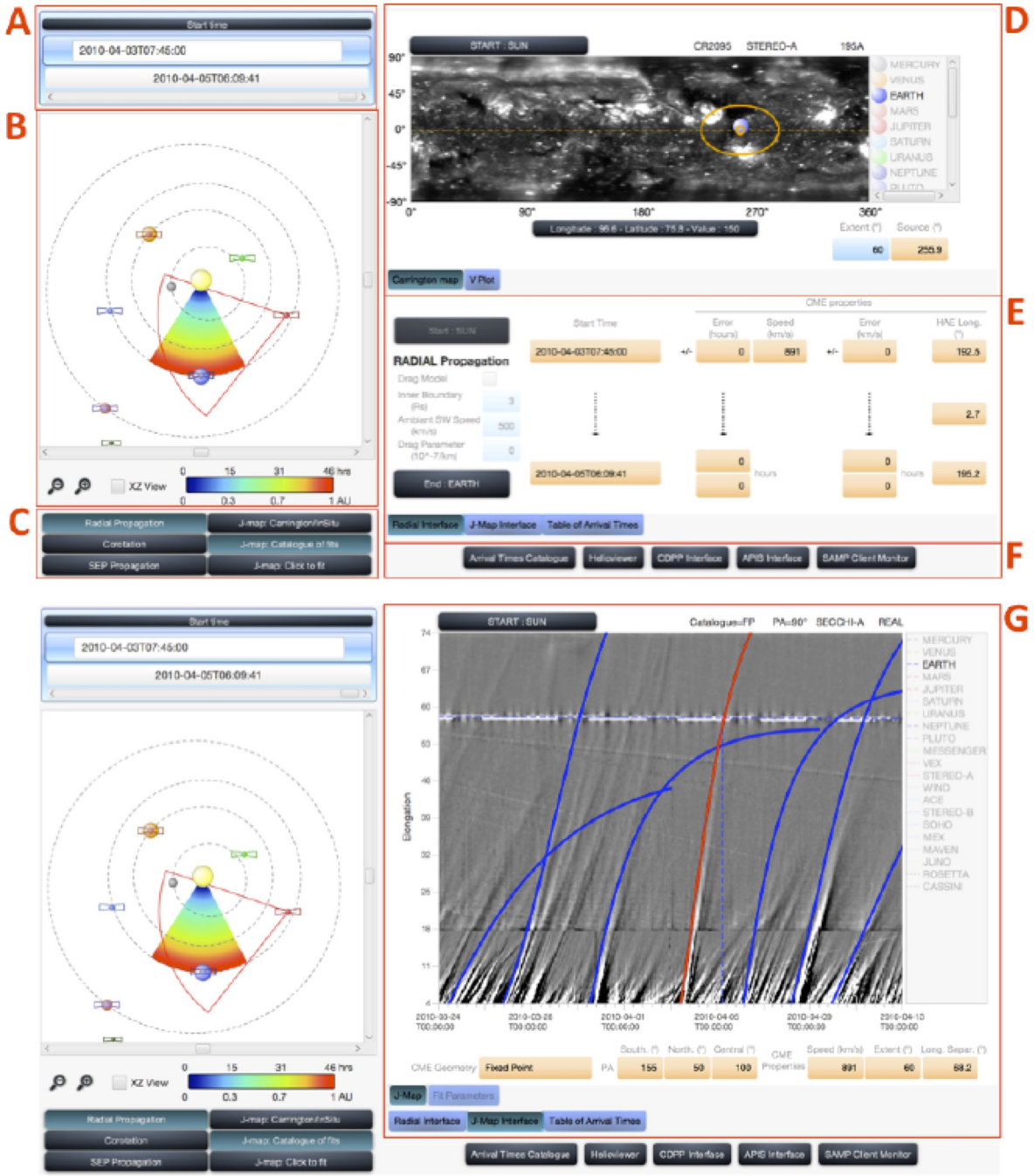
FLUX TRANSPORT



PFSS, NLFF, MHD







propagationtool.cdpp.eu

Rouillard et al. (2017)

- Propagation Tool going 3-D!

- Integration SolO Connectivity Tool

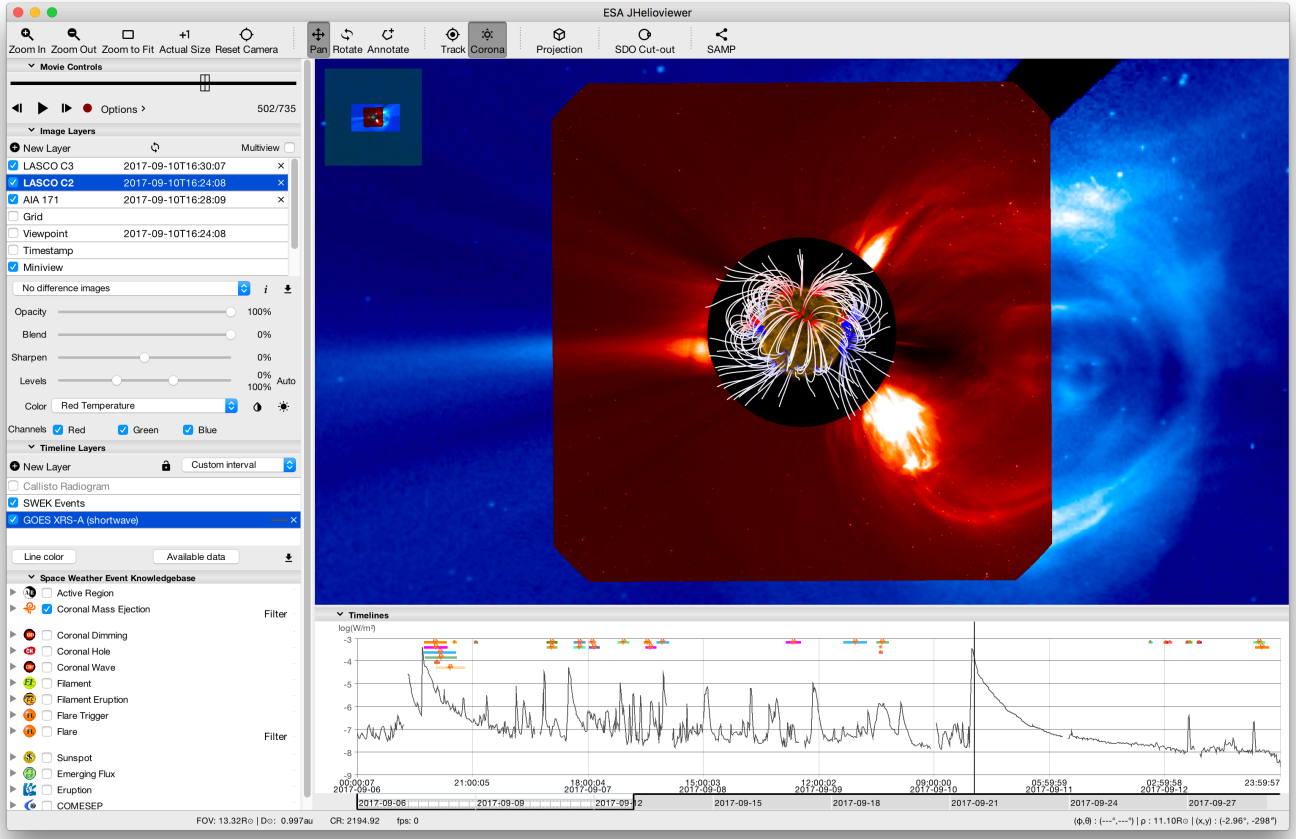
JHelioviewer: Interactively visualize multi-viewpoint data

Today:

- Project solar and heliospheric data in 3D using ephemeris data
- Display 1D and 2D time series
- Overlay PFSS field lines, events from Events databases (HEK, SWEK)
- Difference movies

To be added for SO + PSP:

- In-situ data (time correlation to images requires model)
- Functionality to support SO science planning
- Interface to SO archive + VSO
- Augmented visualization



➔ **Download from www.jhelioviewer.org**

Müller et al. (2017)
A&A **606**, A10

Want to get involved?

➔ contact MADAWG chair: Alexis Rouillard (arouillard@irap.omp.eu)

➔ next meeting: IRAP, Toulouse 22-24 January 2017 will address:

- current developments
- integration of Solar Orbiter PHI magnetograms in numerical models