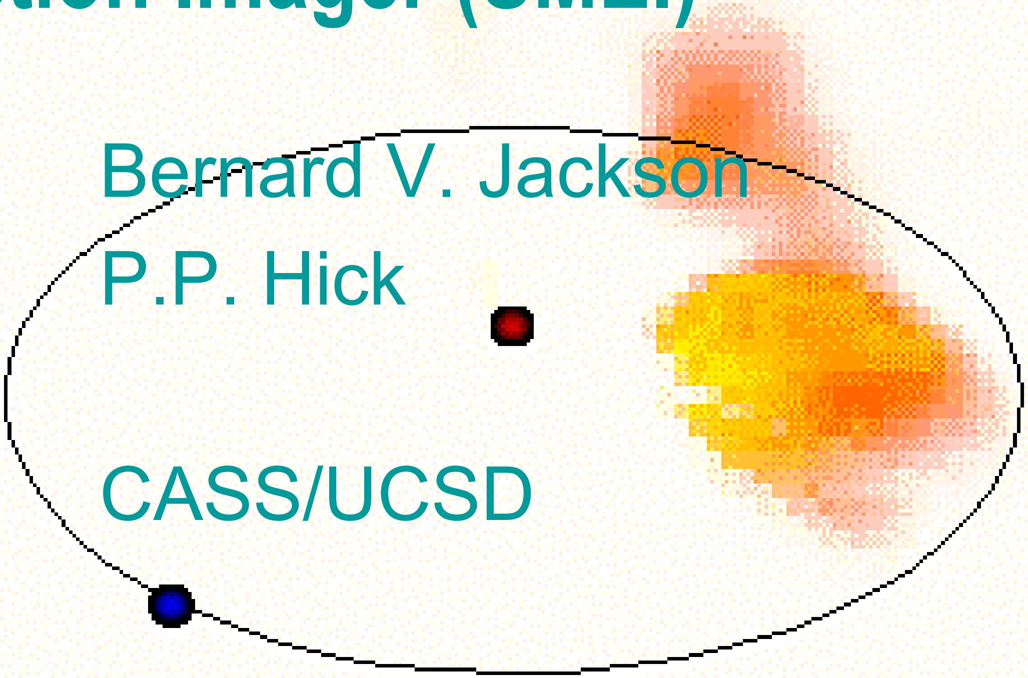
A Study of Plasma Phenomena Using the Tomographic 3-Dimensional Reconstruction Techniques Developed for the Solar Mass Ejection Imager (SMEI)



Bernard V. Jackson

P.P. Hick

CASS/UCSD

A Study of Plasma Phenomena Using Reconstruction Techniques

Introduction

- Motivation: The Solar Mass Ejection Imager - SMEI
- The Helios Spacraft Example and Tomographic Techniques
- Specific Events

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Motivation: The Solar Mass Ejection Imager - SMEI

SMEI has been delivered to the Coriolis spacecraft for integration. Launch, within one year.

A Joint AFRL - NASA project

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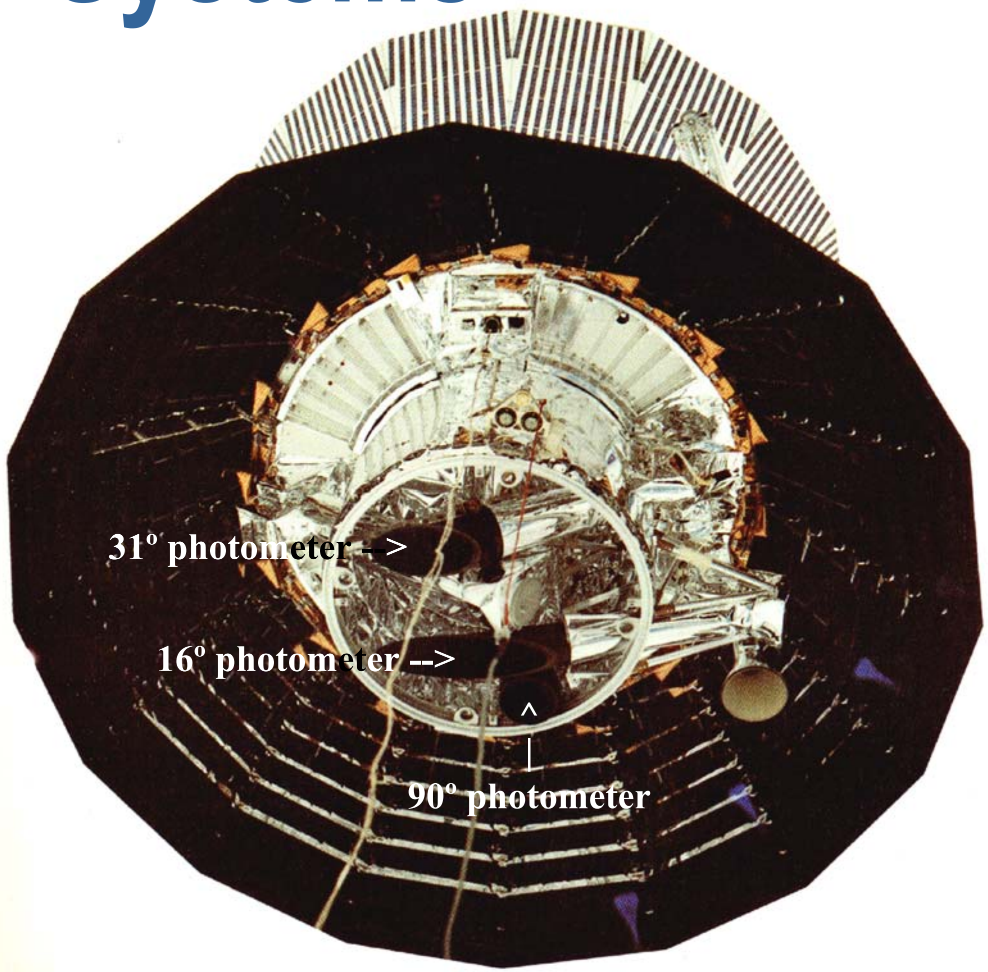
The Helios Spacecraft Photometer Systems

HELIOS spacecraft: the three photometers are shown as tubes with blackened ends.



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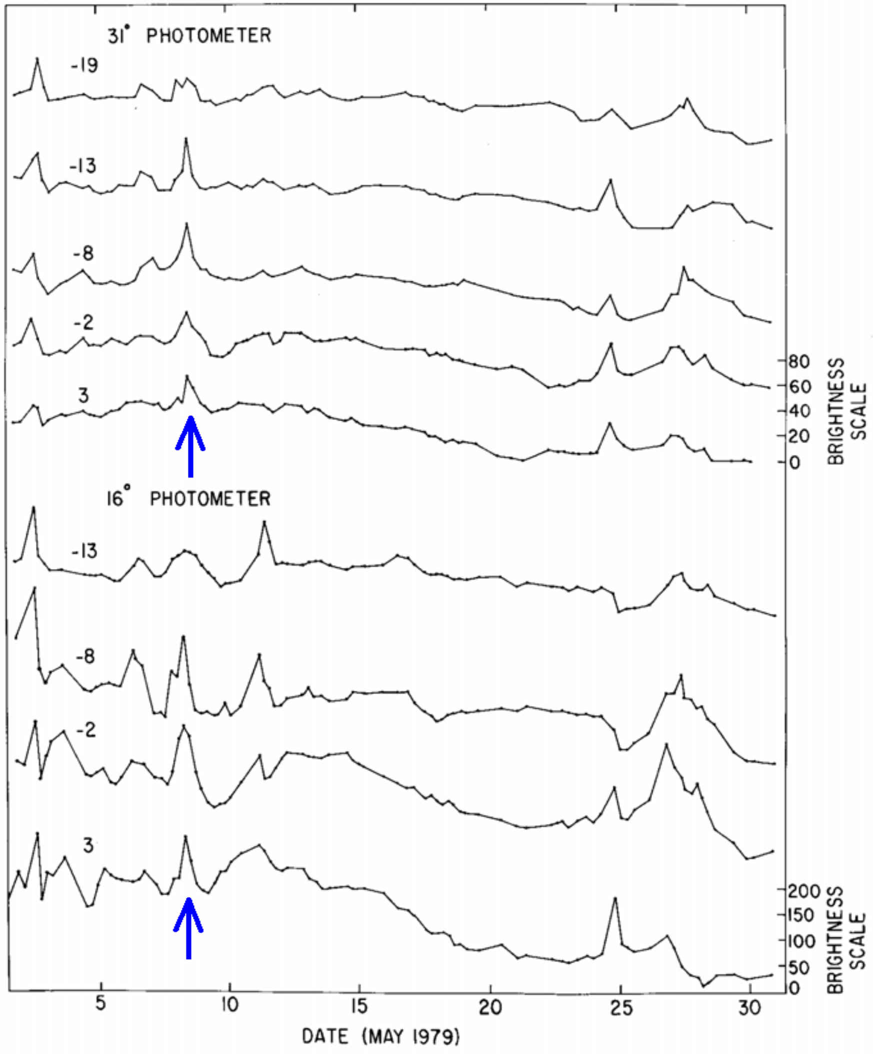
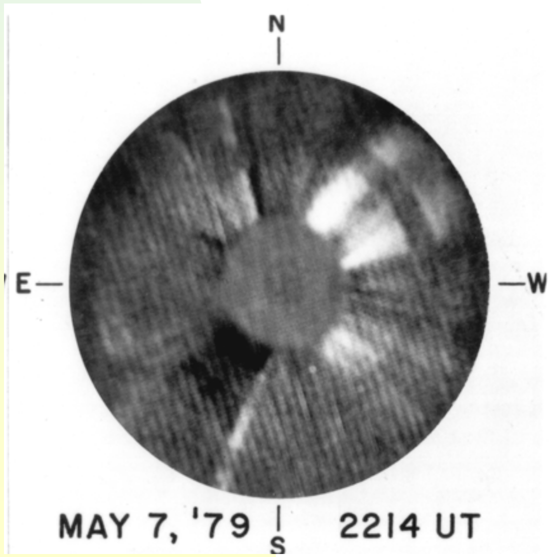
Helios 2 photometer Time Series

HELIOS 2 16º and 31º photometer time series. The May 7 1979 CME is present on May 8-9



SOLWIND coronagraph difference image



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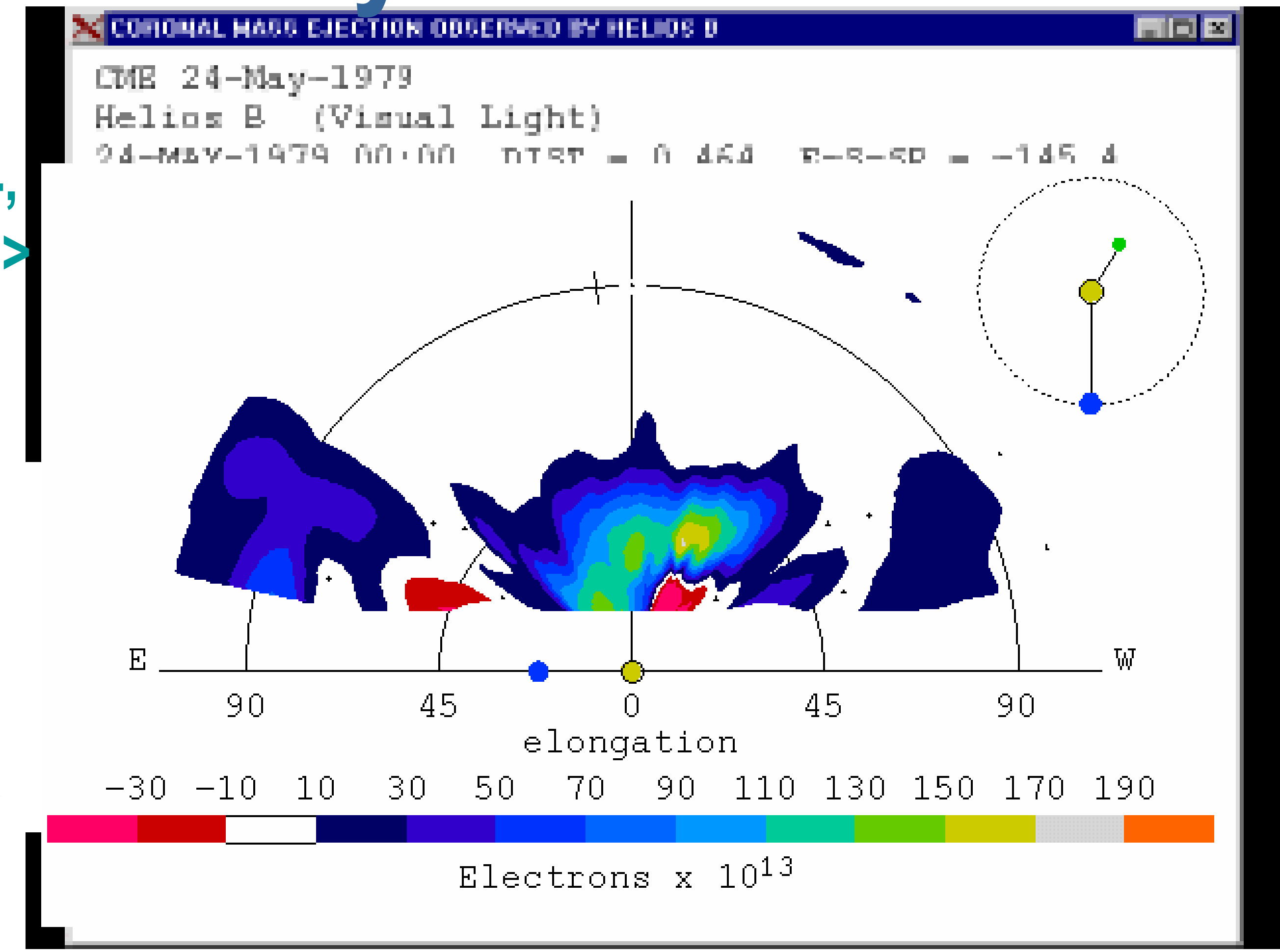
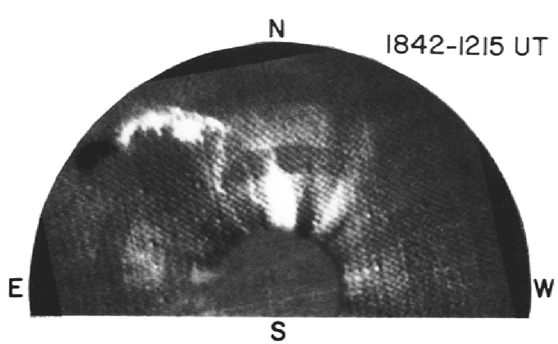
Helios 2 Spacecraft Contour Image of the May 24 CME

HELIOS 2 spacecraft contour image. May 24, 1979 CME and Video -->





Solwind coronagraph difference image on May 24, 1979.

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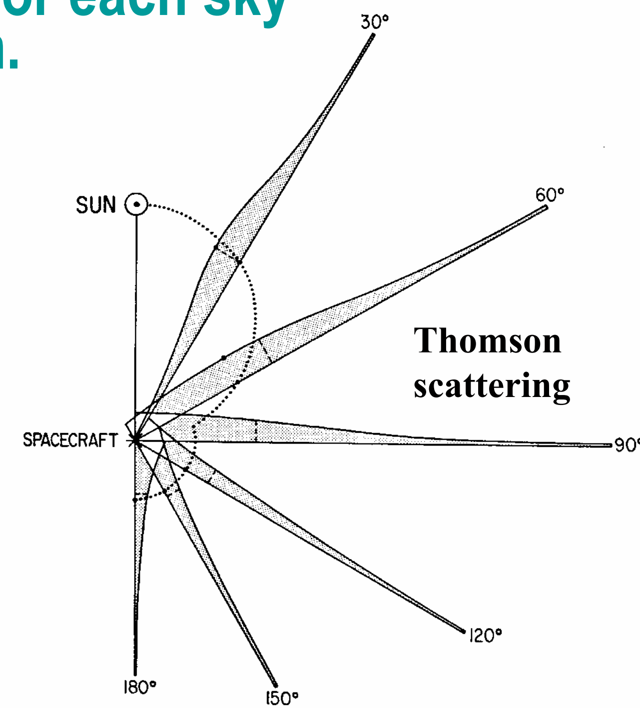
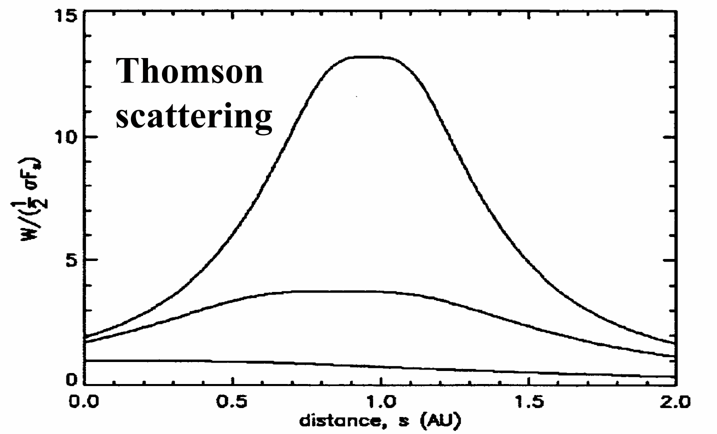
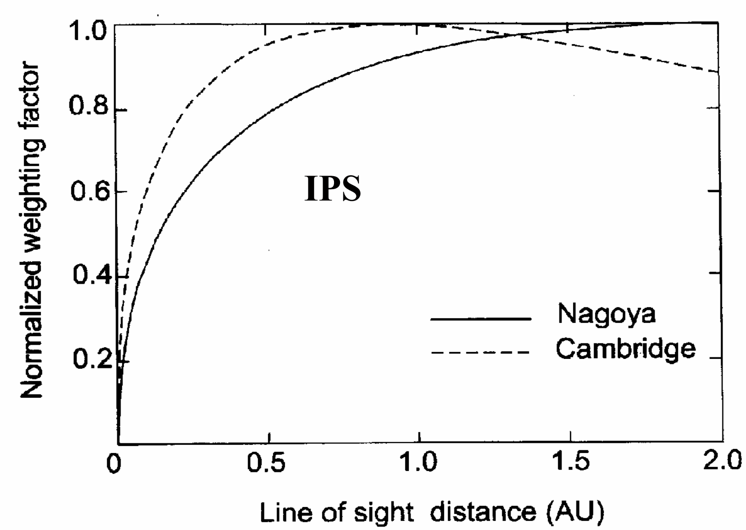
Heliospheric C.A.T. Analyses

Line of sight weighting values for each sky location.







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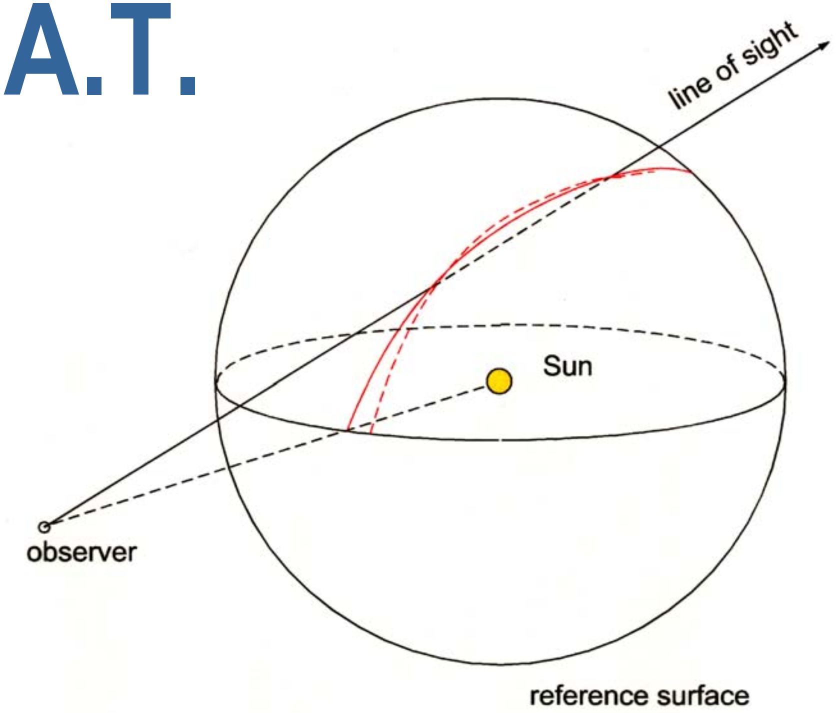
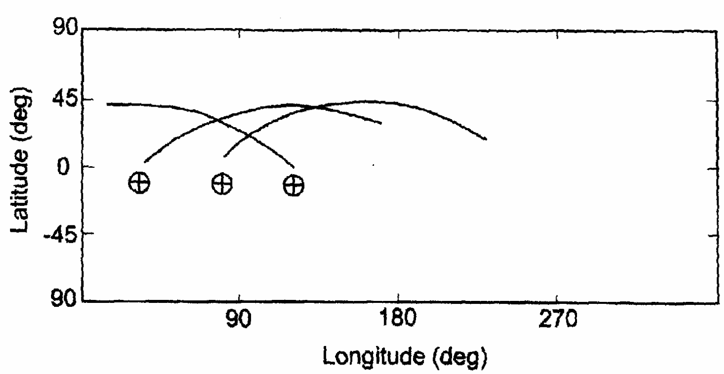
Heliospheric C.A.T. Analyses

Line of sight "crossed" components on a reference surface. Corotational projections on the reference surface are shown.





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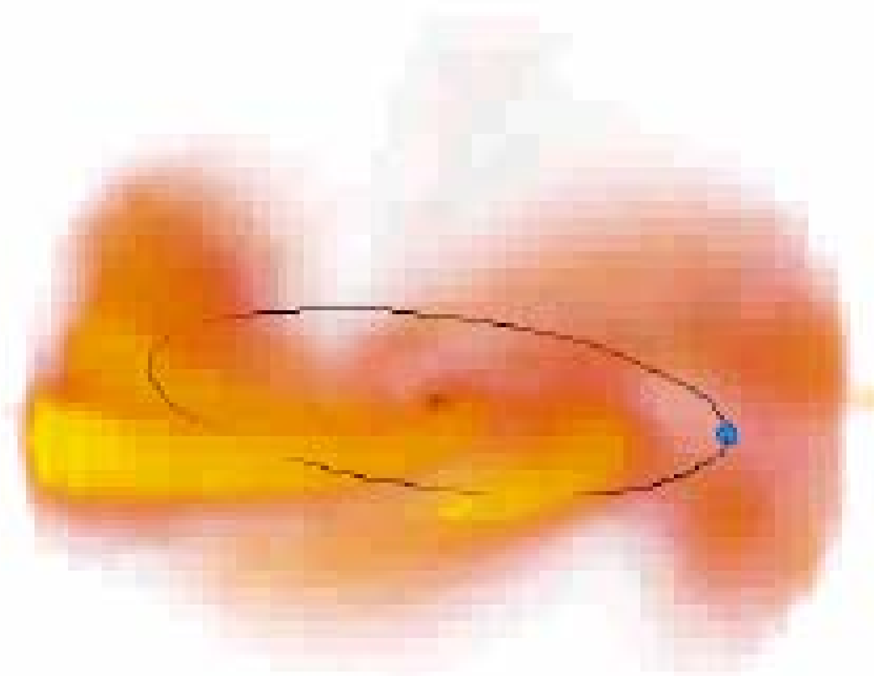
Corotational Heliospheric C.A.T. Analysis

Helios 1 and 2 Carrington Rotation 1653 (March-April,1977) corotational reconstruction.



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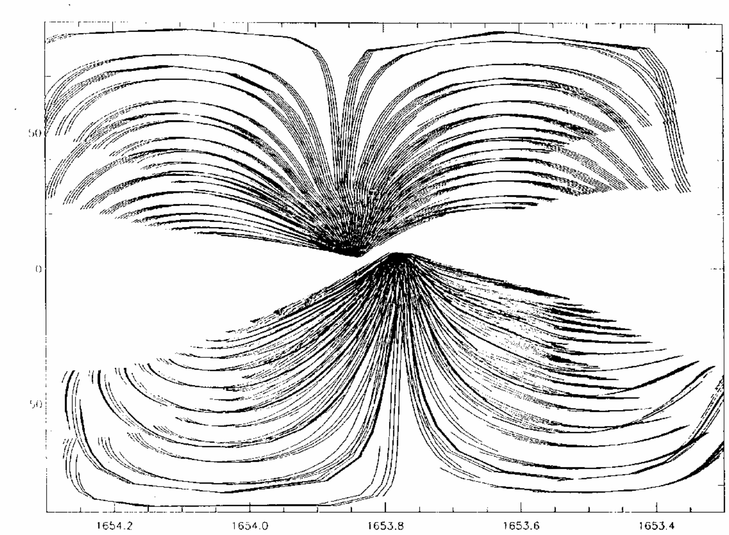
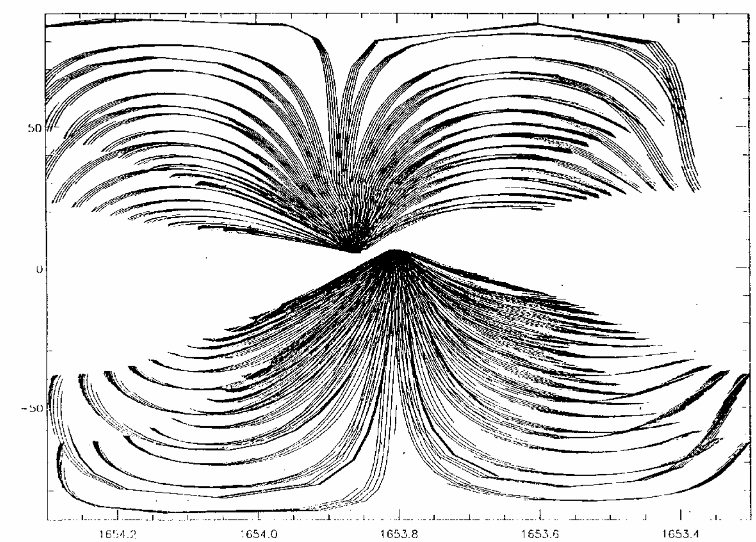
Heliospheric Time-Dependent C.A.T. Analyses



Line of sight "crossed" components traced to a reference surface. Maps from Helios 1 (south) and Helios 2 (north) separated by one-day time intervals.



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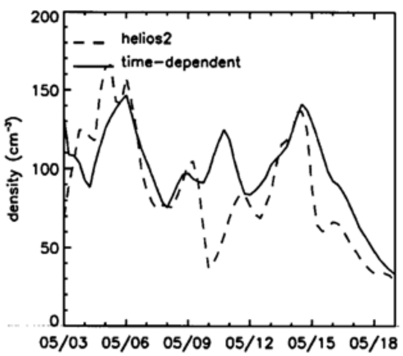
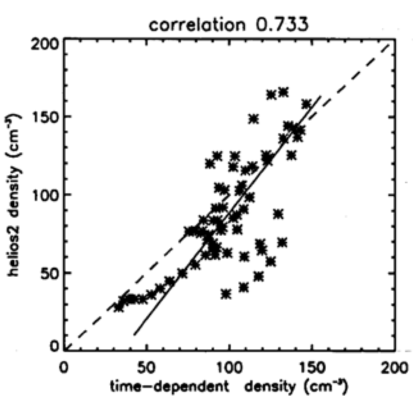
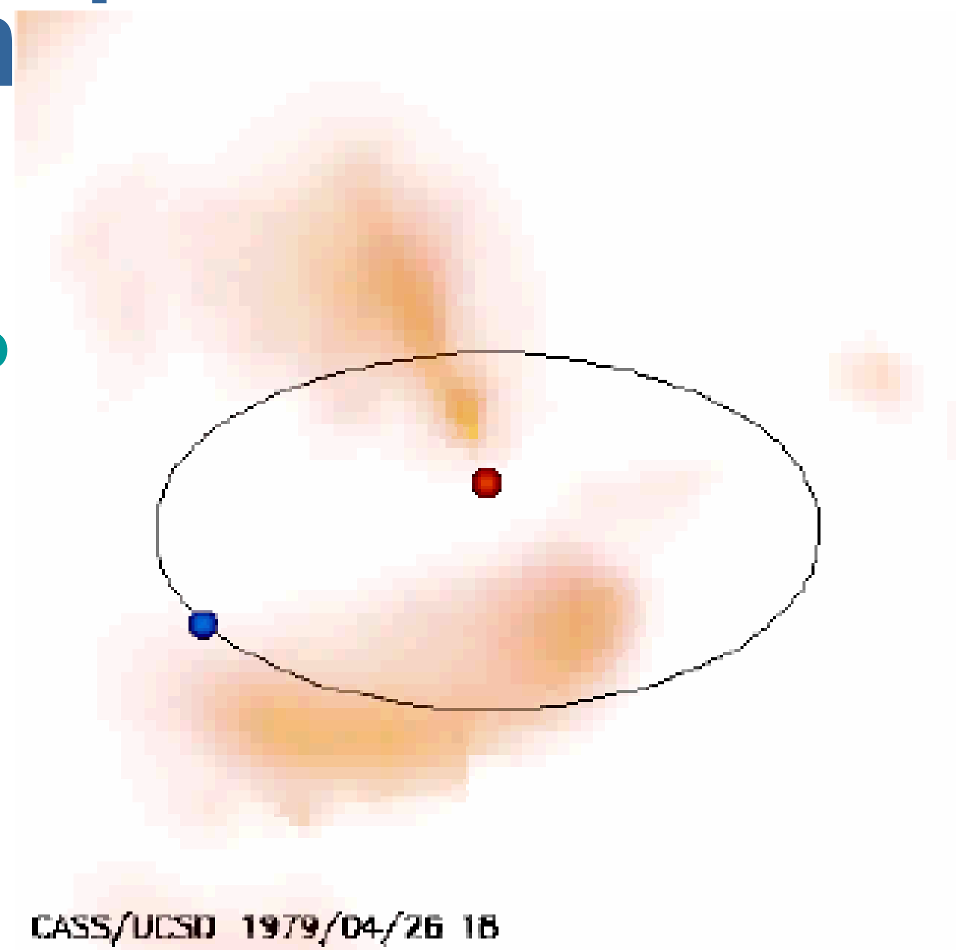
Time-Dependent Tomographic Analysis Technique Reconstruction





Carrington rotation 1681 April 26 - June 6, 1979 Helios 2 reconstruction video and density time series comparison of time-dependent model with Helios 2 spacecraft *in situ* observations. Only the northern hemisphere is reconstructed.



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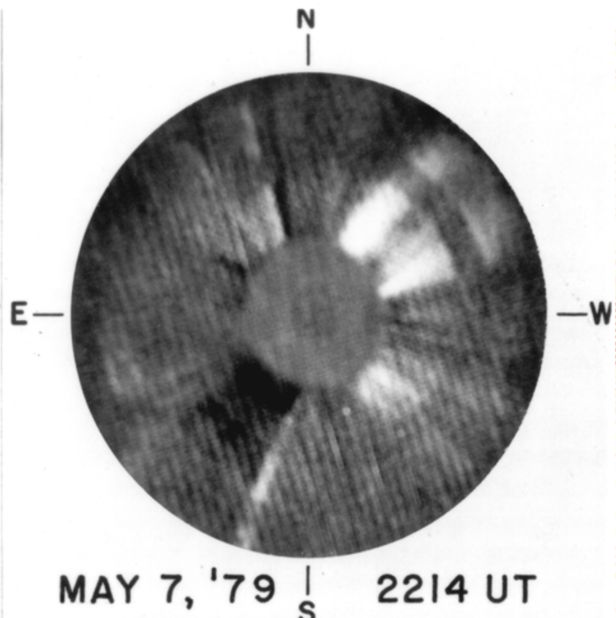
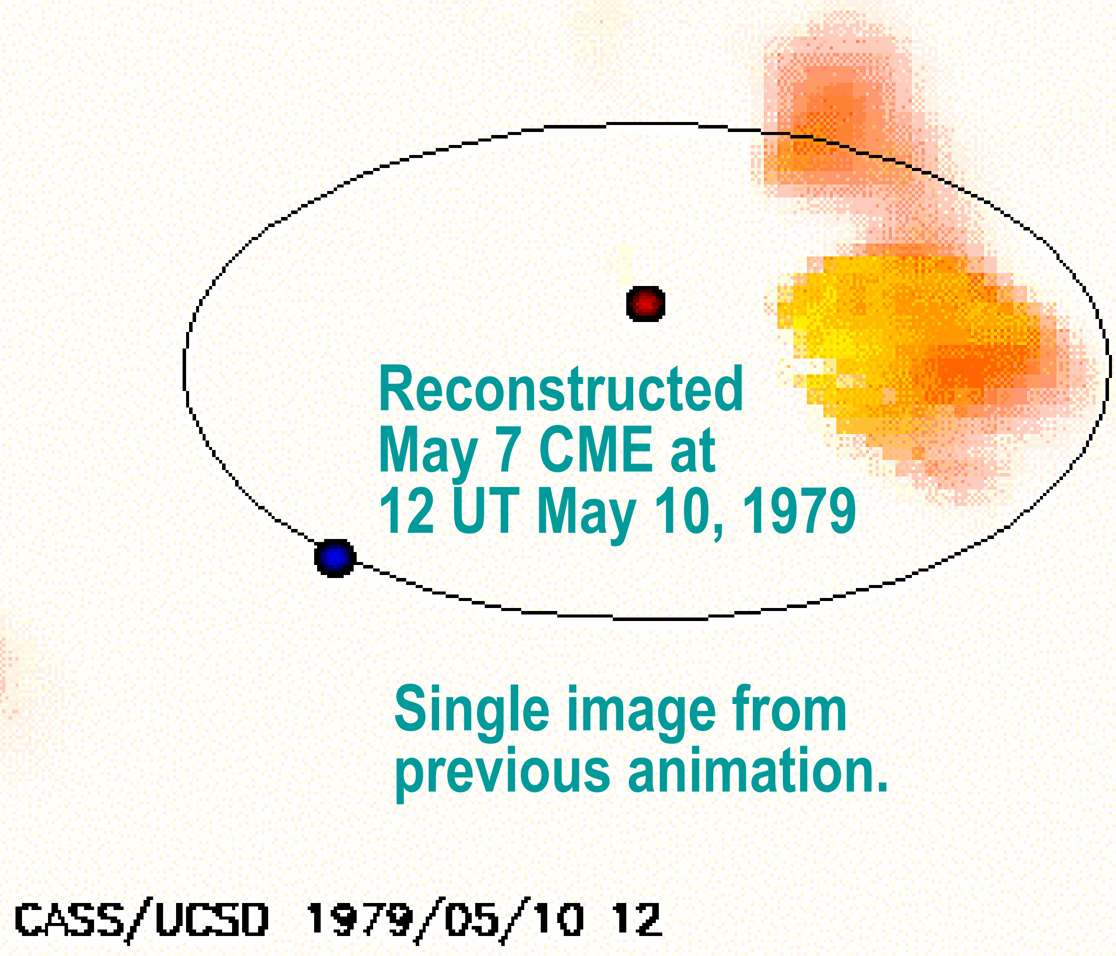
Time-Dependent Tomographic Analysis Technique Reconstruction

SOLWIND
Coronagraph
Image - May 7 CME



Reconstructed
May 7 CME at
12 UT May 10, 1979

Single image from
previous animation.



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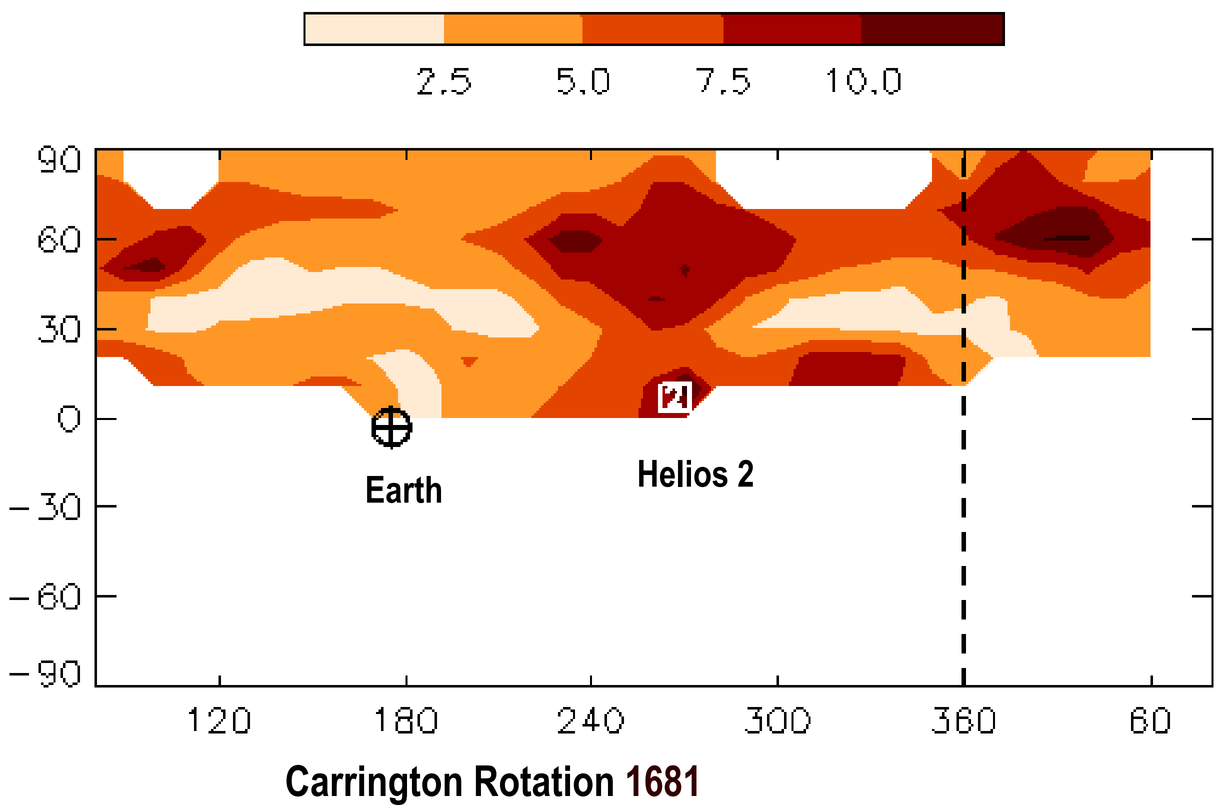
Time-Dependent Tomographic Analysis Technique Reconstruction

12 UT May 10,1979 Carrington Rotation 1 AU Map showing the front part of the 7 May, 1979 CME Helios 2 (at .3 AU) and Earth location indicated.



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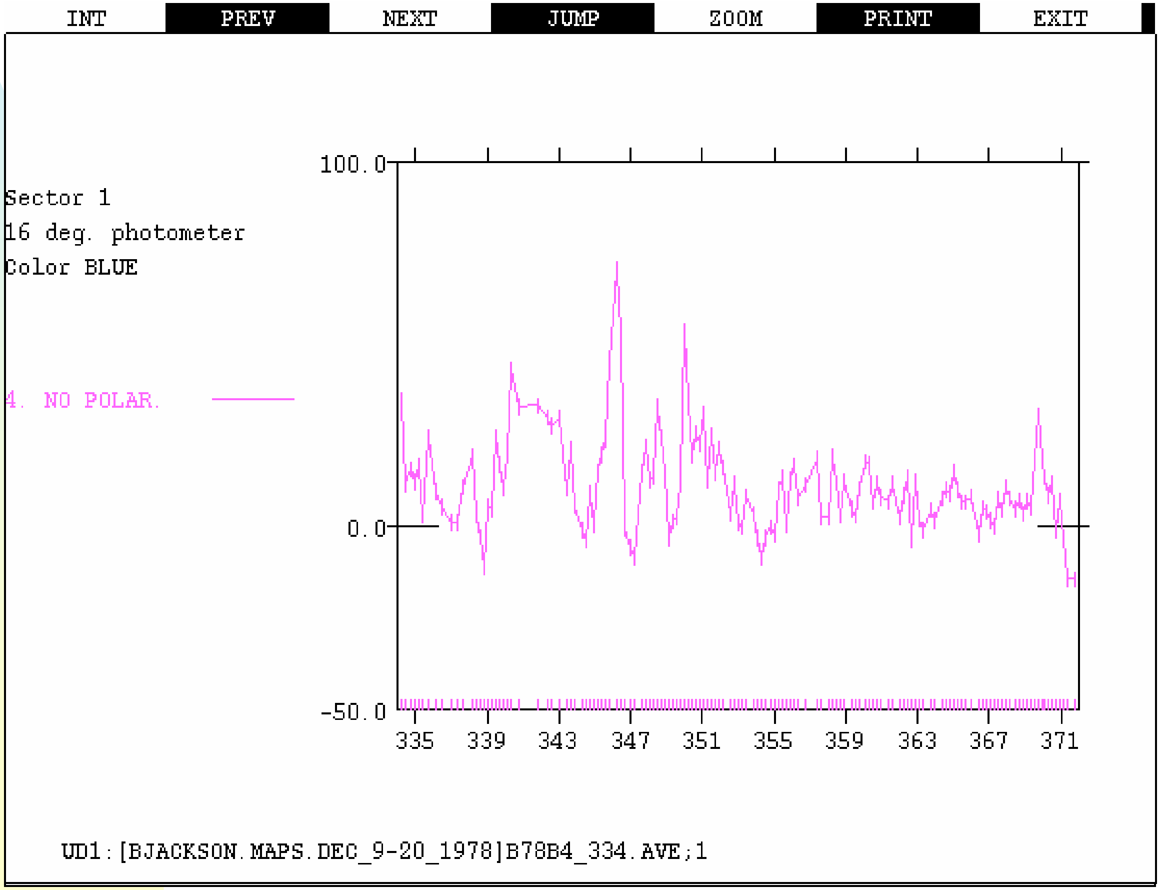
Data Editing for Reconstruction Analysis



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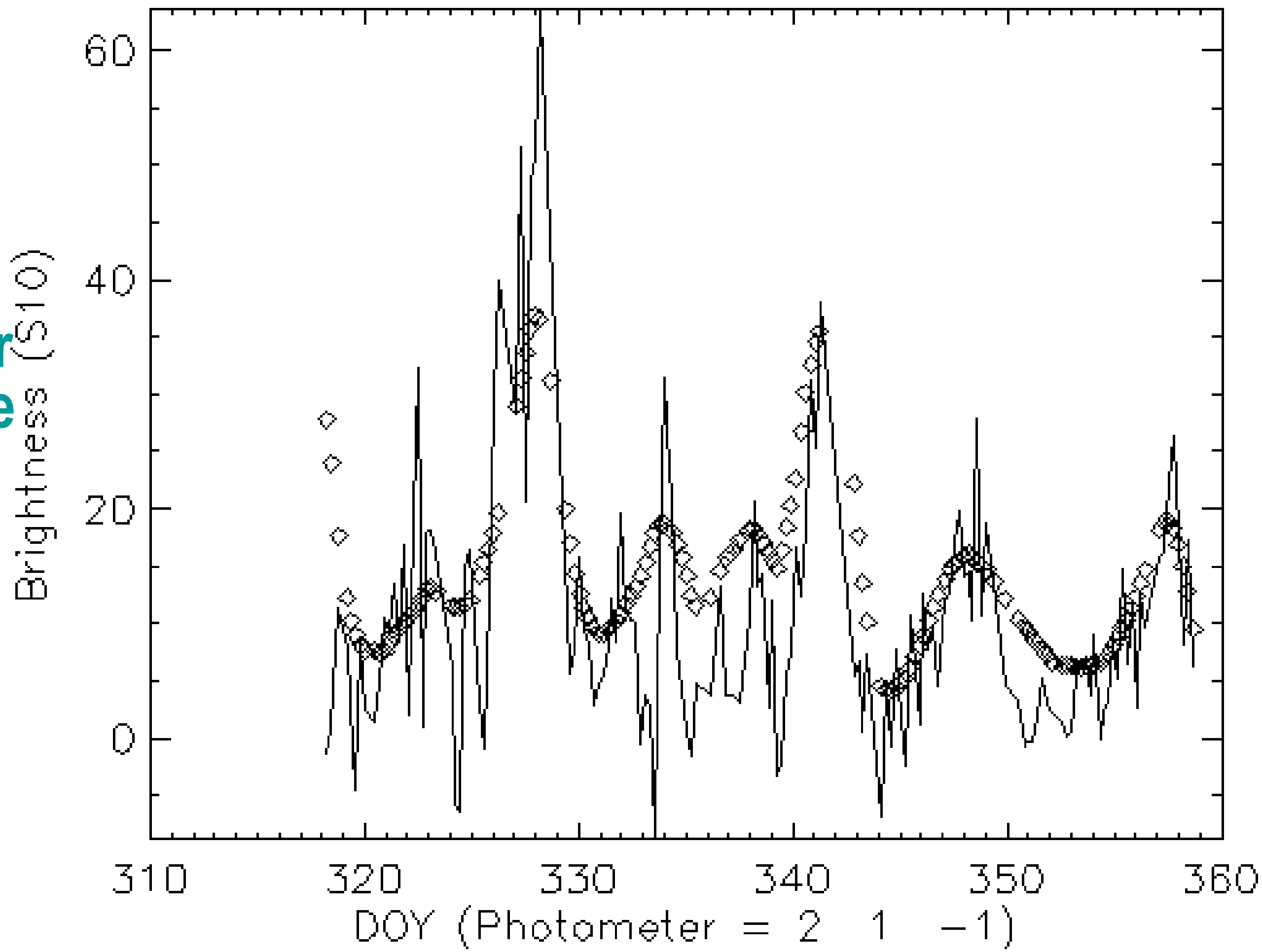
November 24 Reconstruction Analysis

November 14,1977 - December 25, 1977 time series showing a sample photometer sector blue-light time series matched by the time-dependent model (diamonds).



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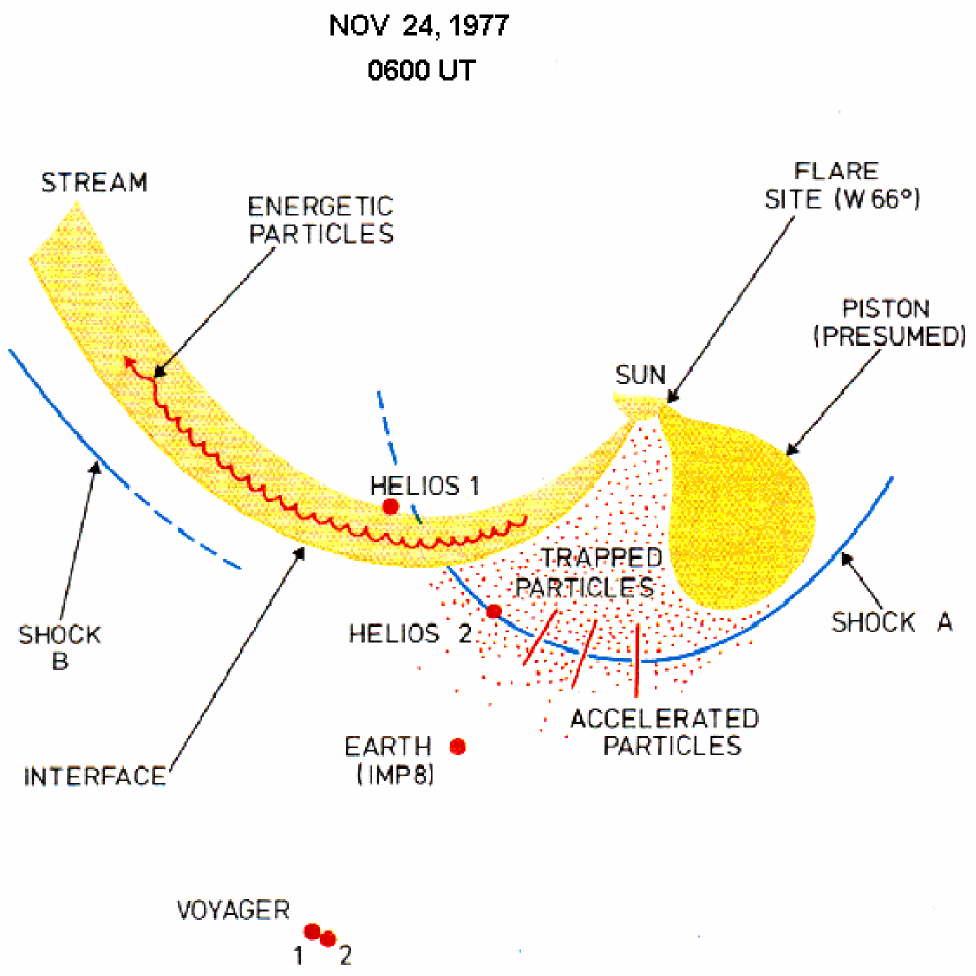
November 24 1977 Event

Burlaga *et al*., JGR, 85, 2227, 1980

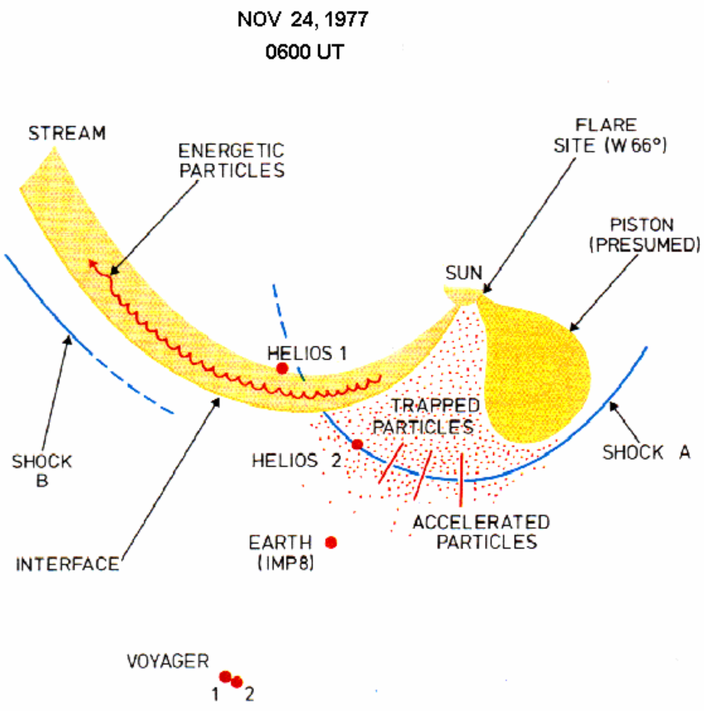
Analysis using multi-spacecraft observations.

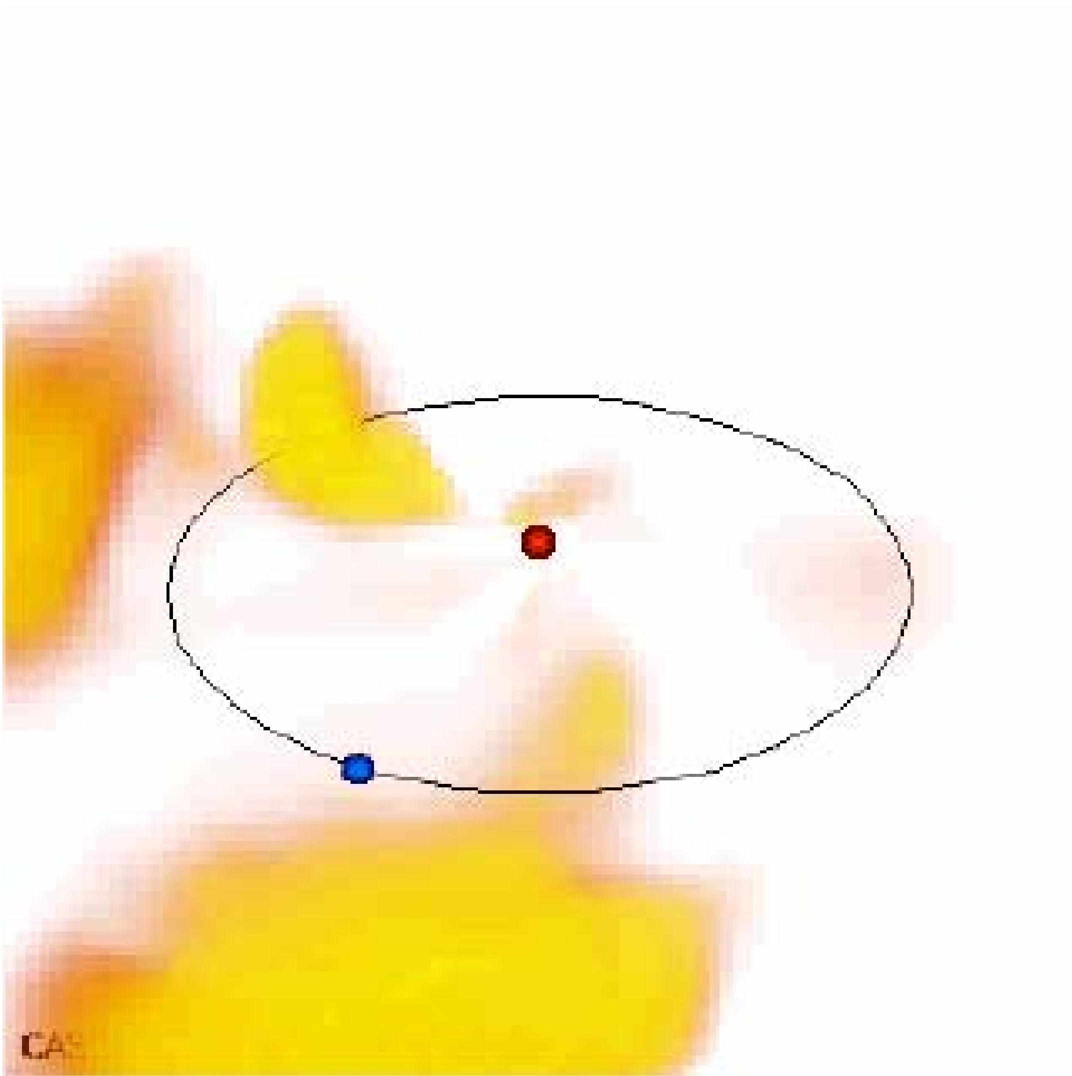


A Study of Plasma Phenomena Using Reconstruction Techniques

November 24 1977 Reconstruction

November 20 -27, 1977 time-dependent recon-struction using Helios 1 and 2 photometer data.

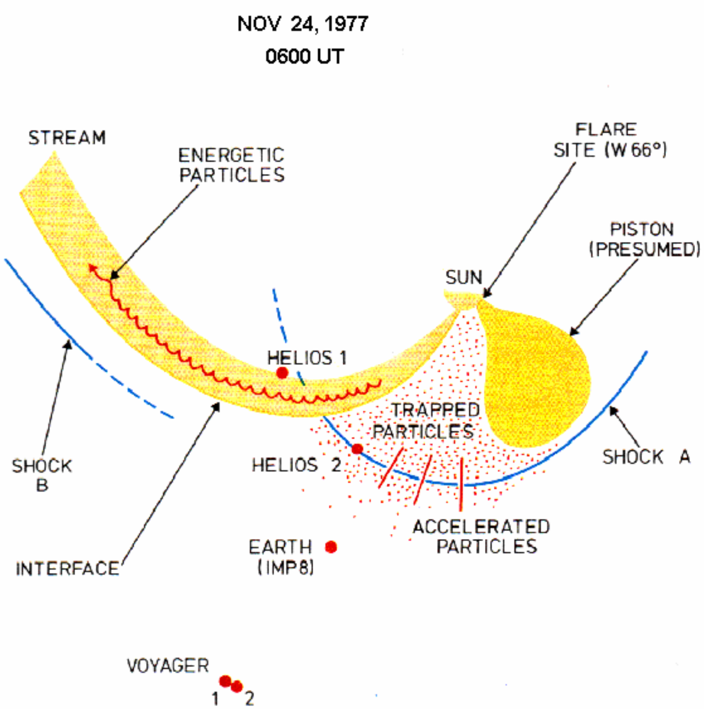


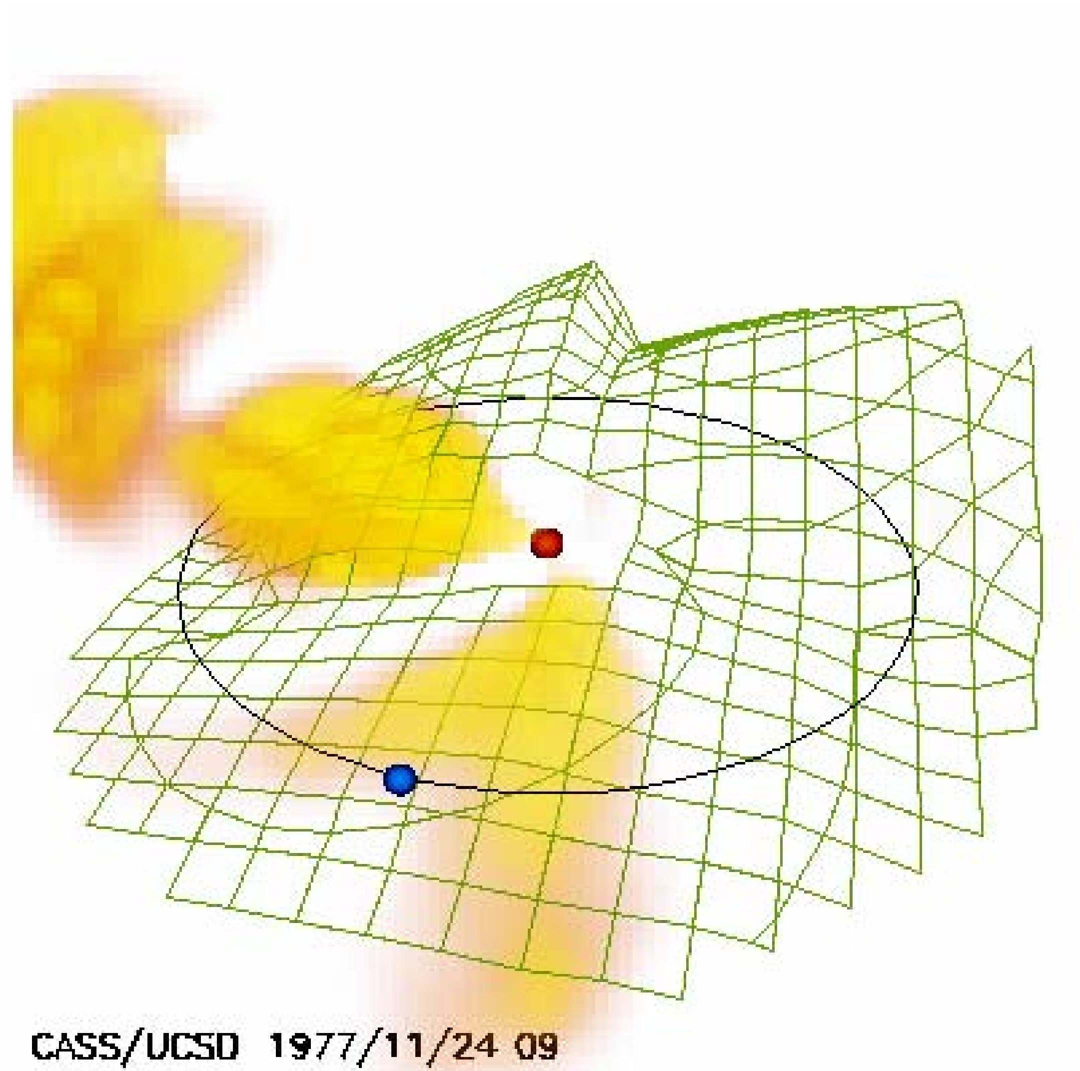


A Study of Plasma Phenomena Using Reconstruction Techniques

November 24 1977 Reconstruction

November 20 -27, 1977 time-dependent reconstruction using Helios 1 and 2 photometer data.





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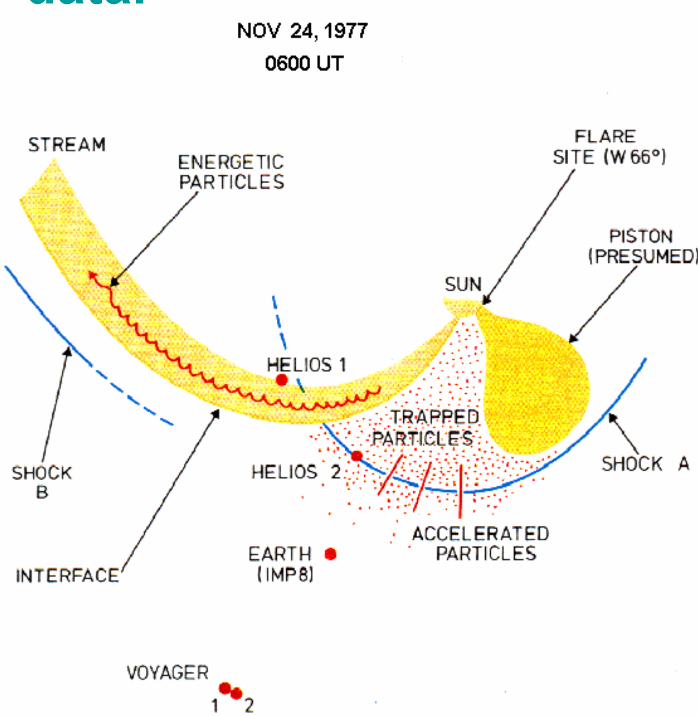
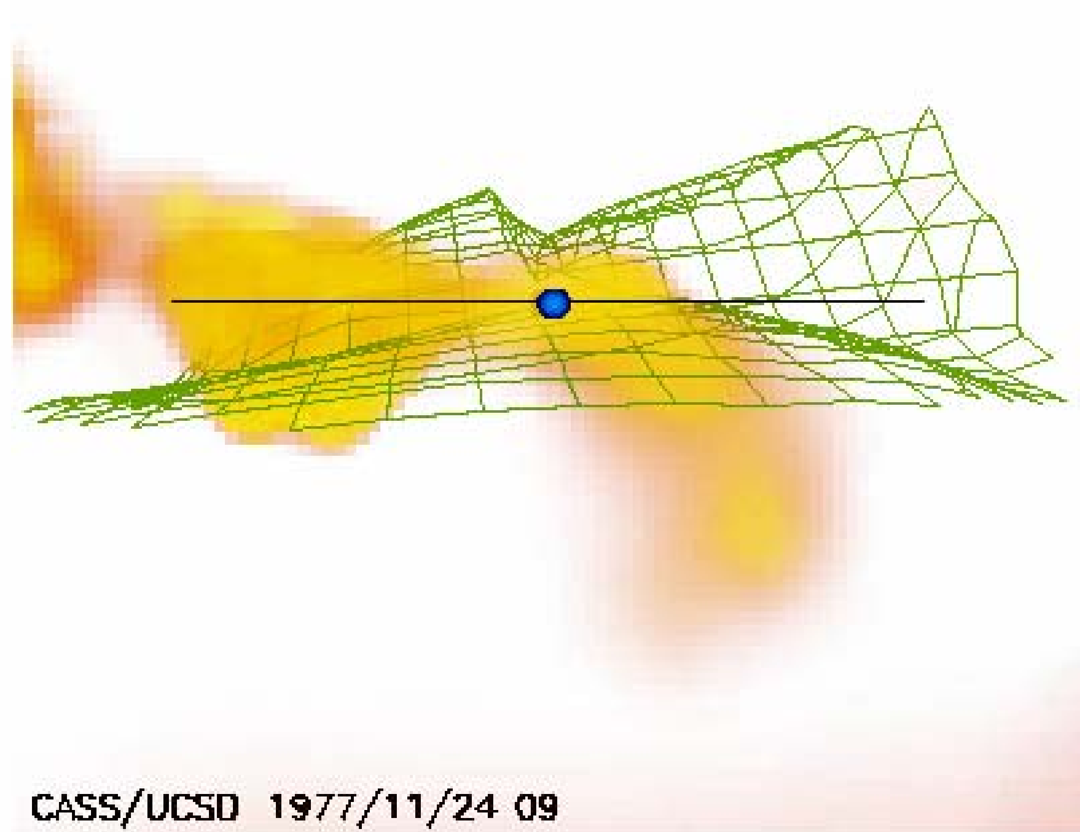
November 24 1977 Reconstruction

November 20 -27, 1977 time-dependent recon-struction using Helios 1 and 2 photometer data.





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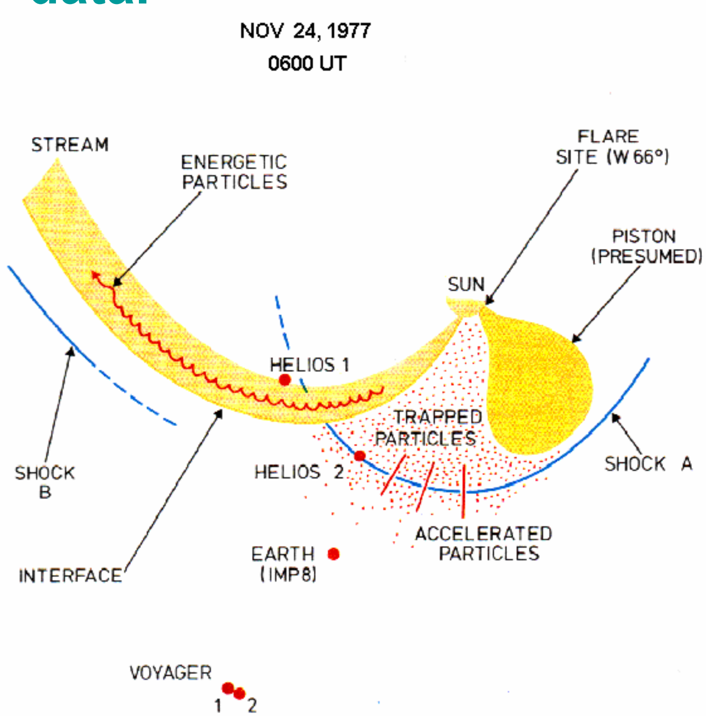
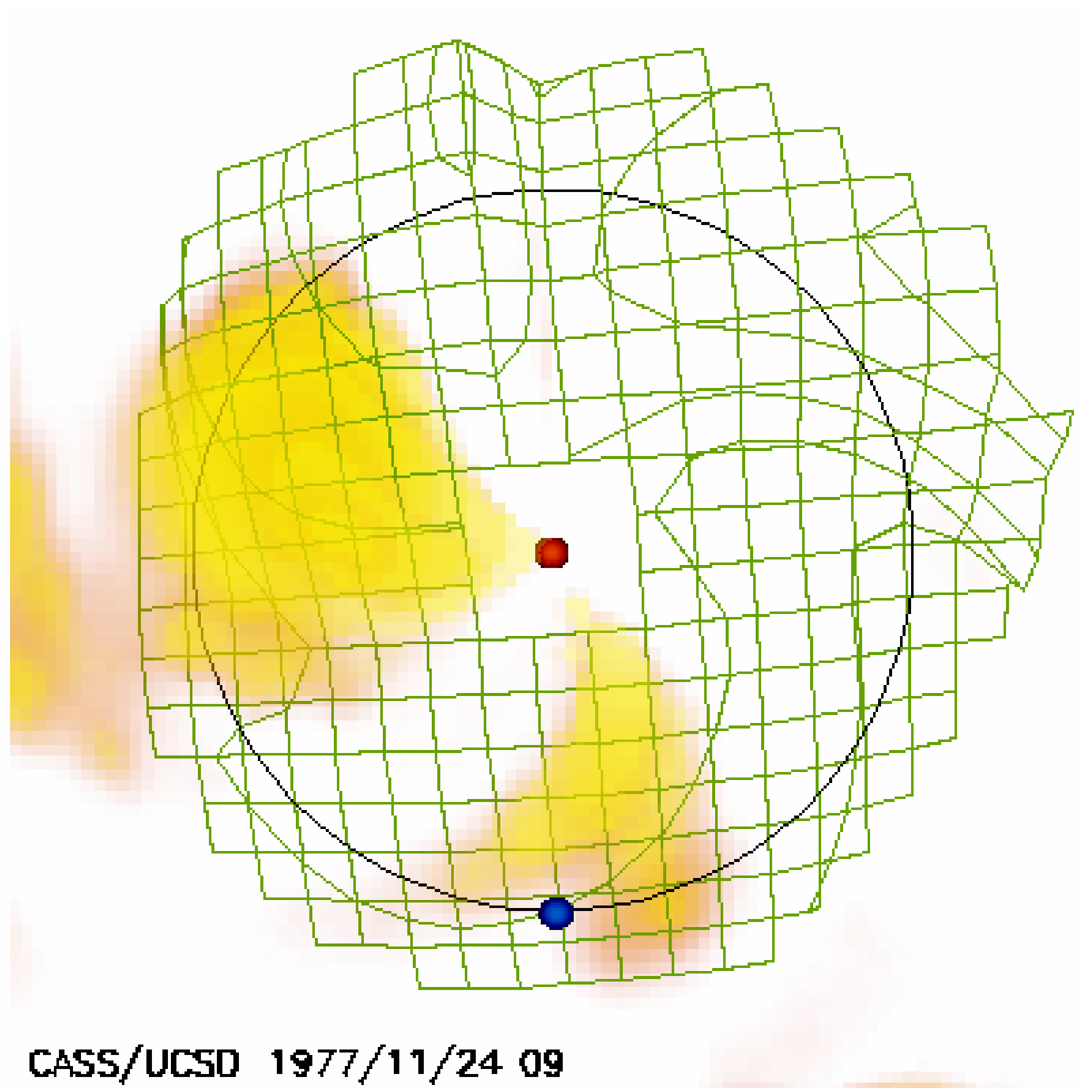
November 24 1977 Reconstruction

November 20 -27, 1977 time-dependent recon-struction using Helios 1 and 2 photometer data.





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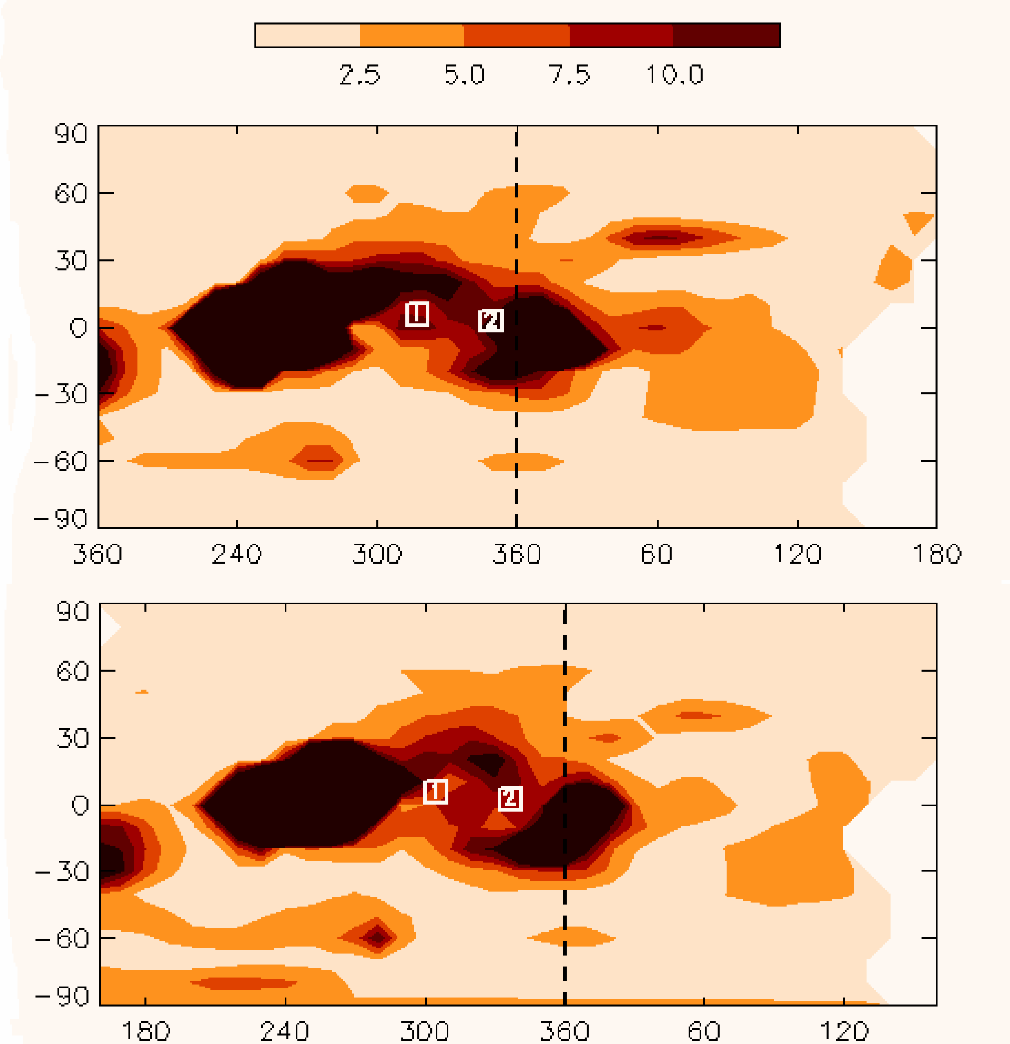
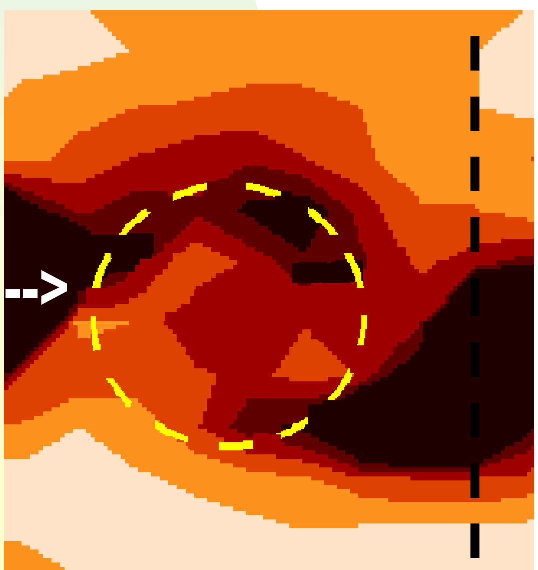
November 24 1977 Reconstruction

9 UT 24 and 25 November 1977 time-dependent reconstruction using Helios 1 and 2 photo-meter data. Cut through data at 0.6 AU. Helios 1 and 2 position marked.



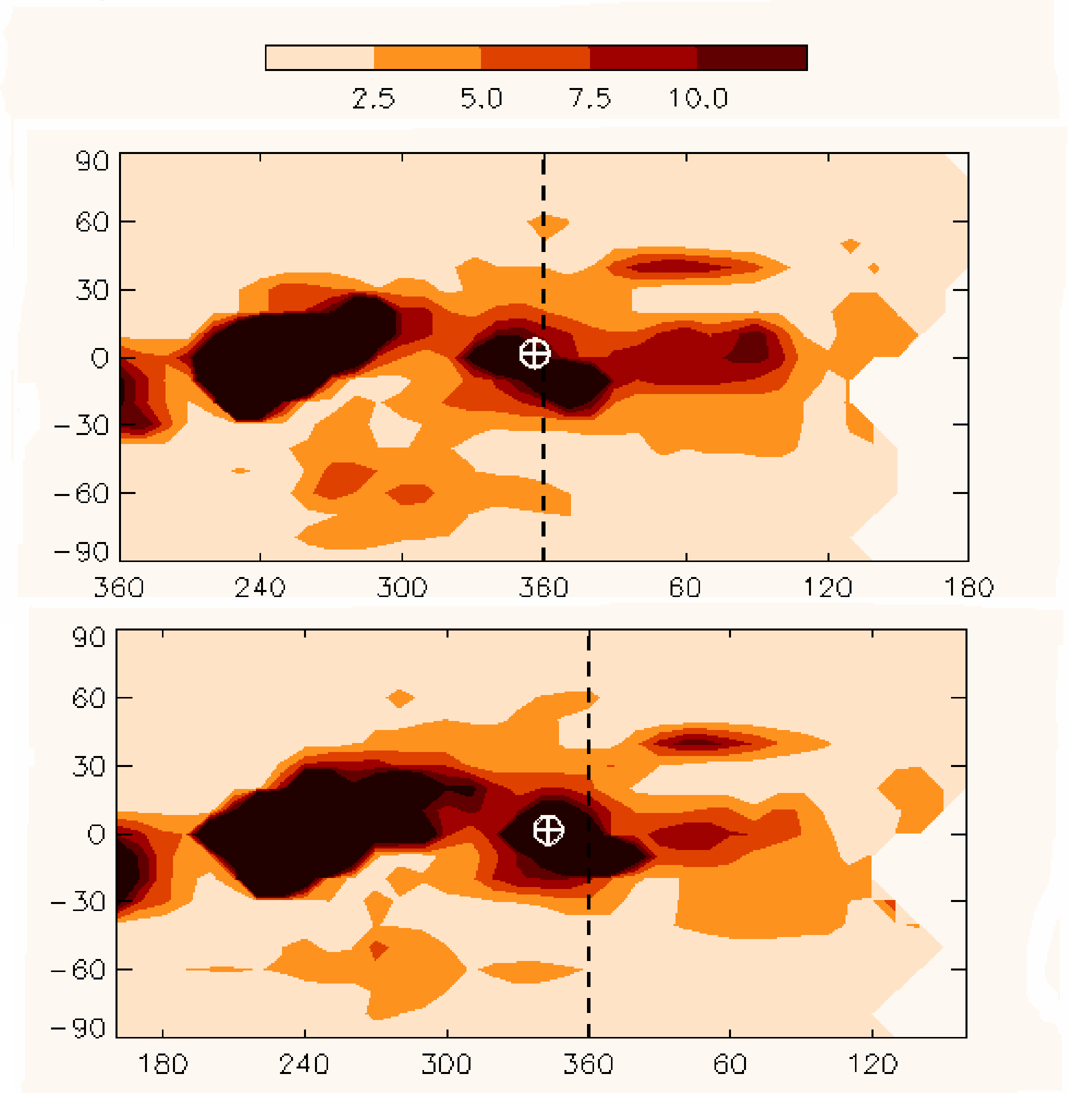
Shock -->



A Study of Plasma Phenomena Using Reconstruction Techniques

November 24 1977 Reconstruction

9 UT 24 and 25 November 1977 time-dependent reconstruction using Helios 1 and 2 photometer data. Cut through data at 1.0 AU. Earth position marked.



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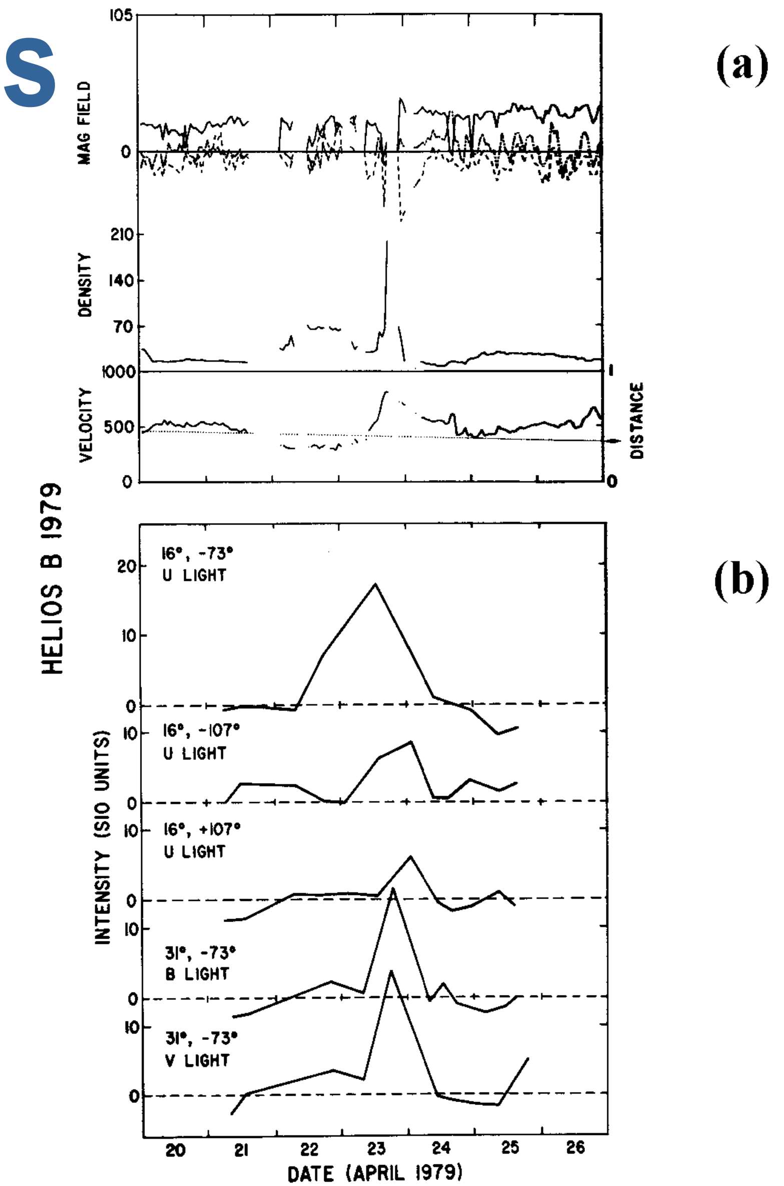
Shock Observations from Helios



a) Helios 2 *in situ* observations of an April 23 1979 shock.

b) Helios 2 photometer observations.

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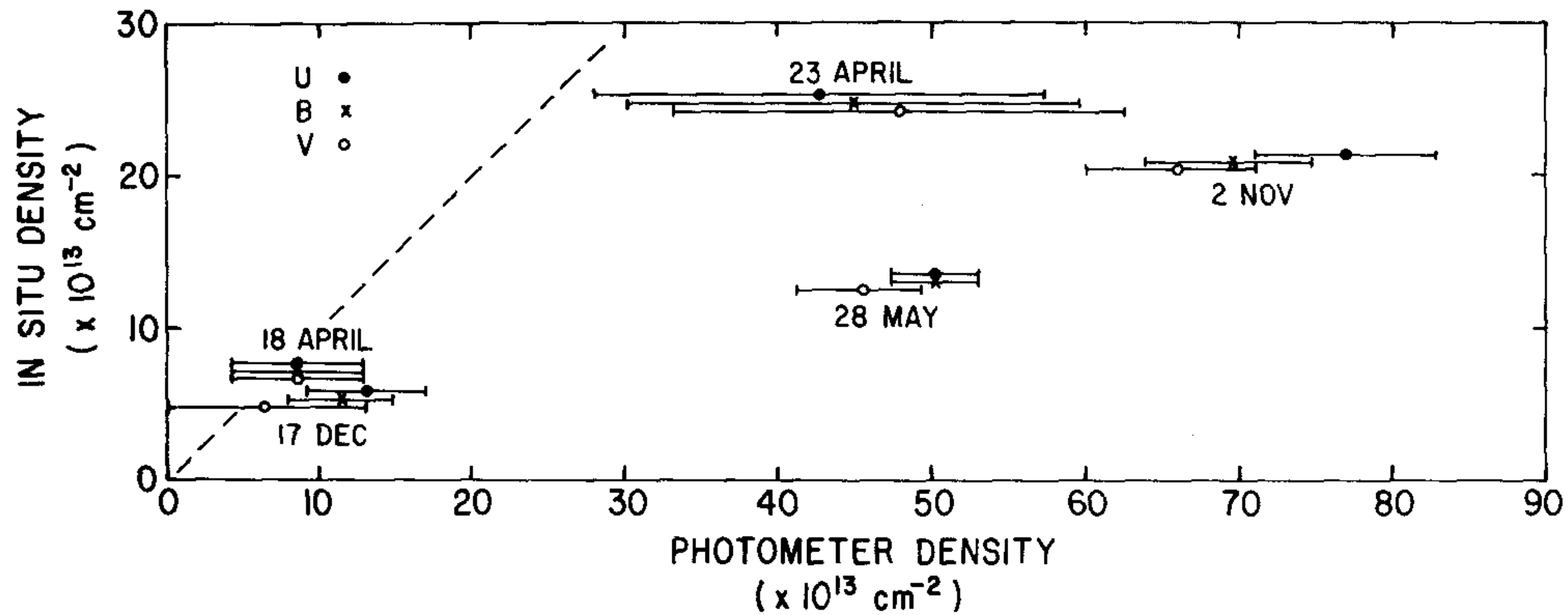
Shock Observations from Helios

Helios 2 *in situ* and photometer comparison observations.



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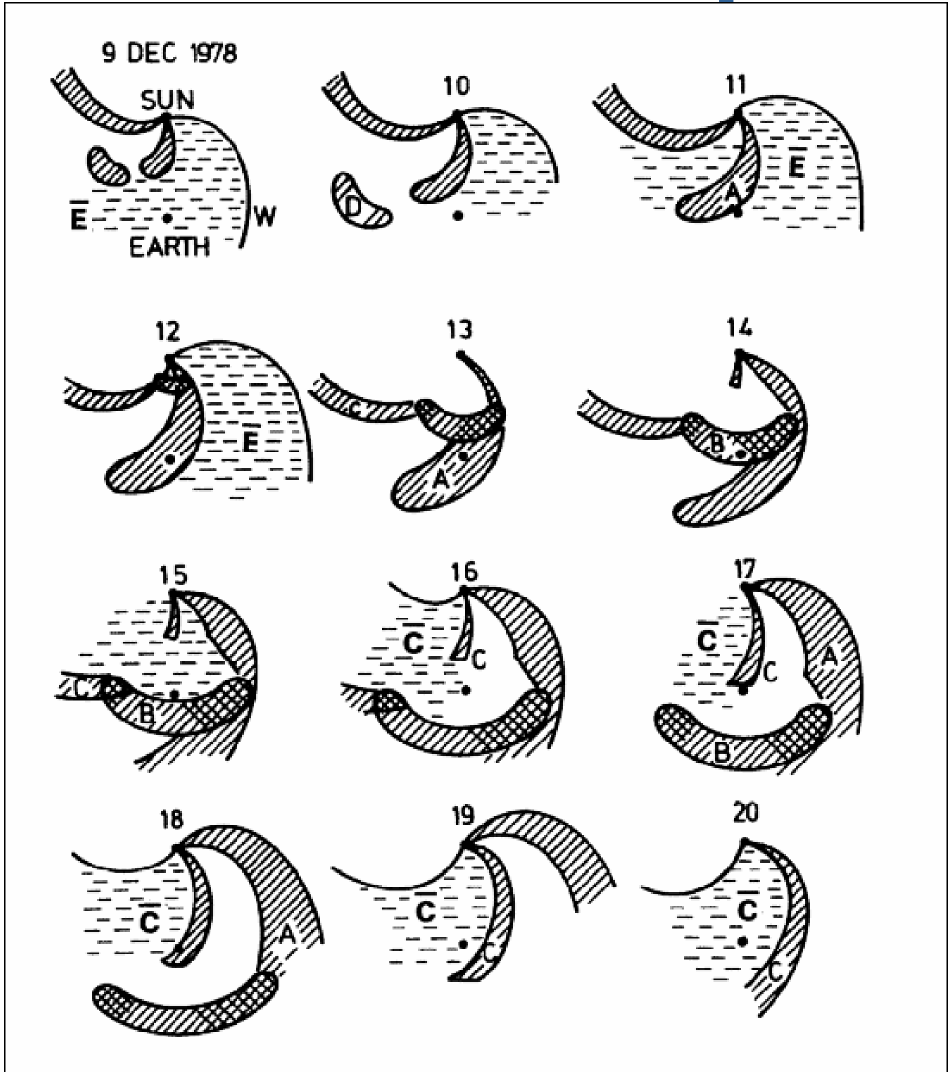
Dec. 9-20 1978 Event Sequence

Behannon *et al*., JGR, 96, 21213, 1991



Analysis using multi-spacecraft and IPS observations.

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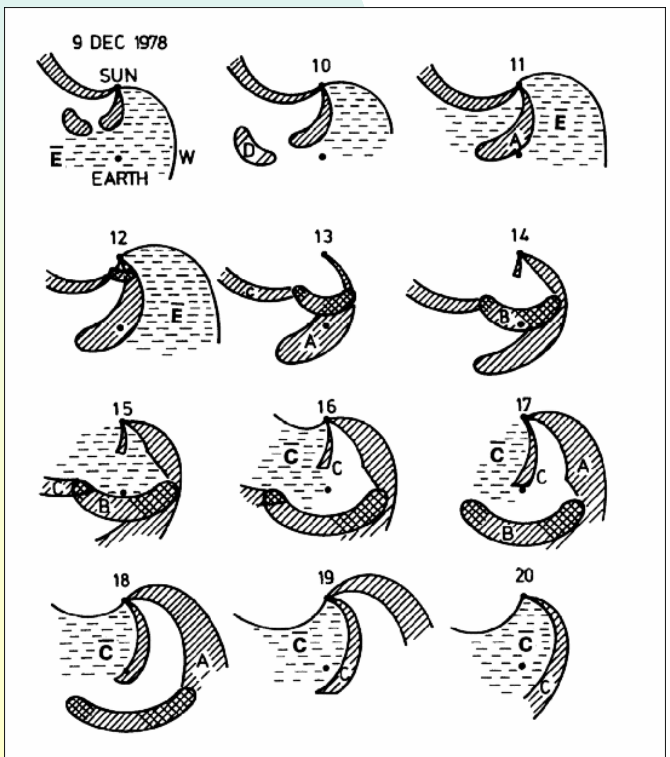
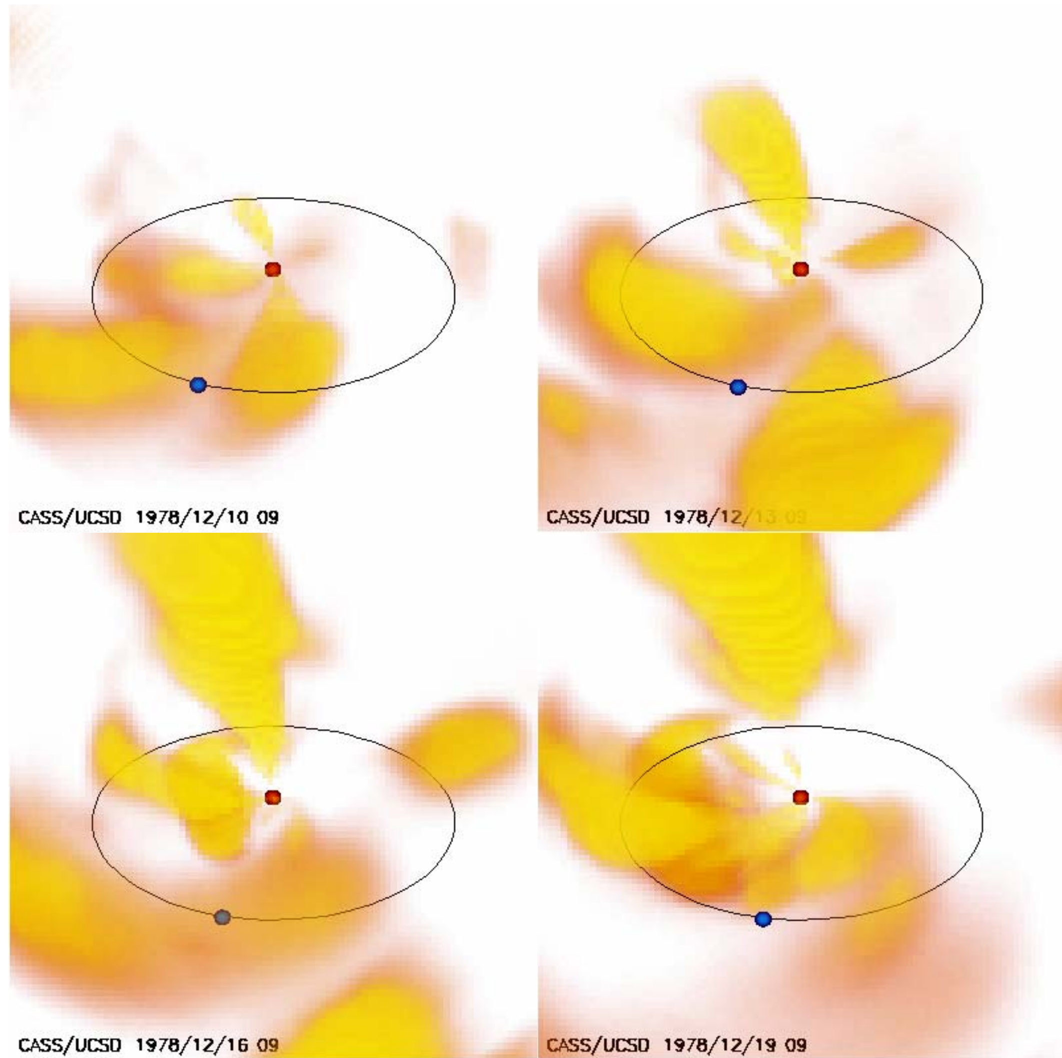
Dec. 9-20 1978 Reconstruction

Time-dependent reconstruction using Helios 1 and 2 photometer data.





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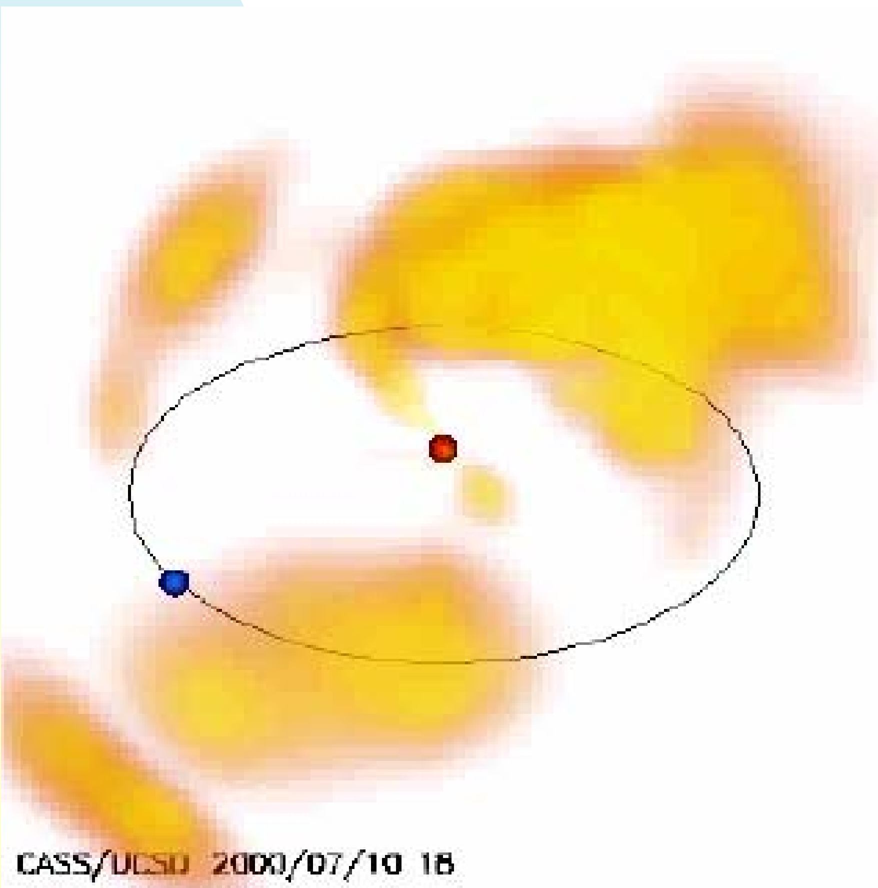
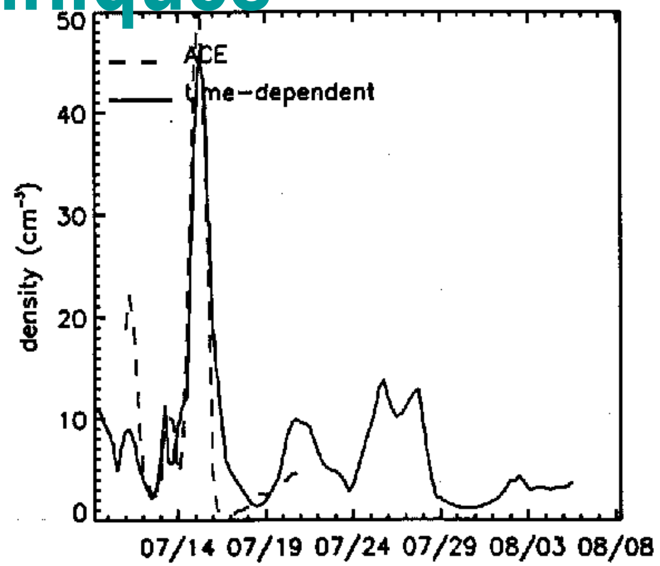
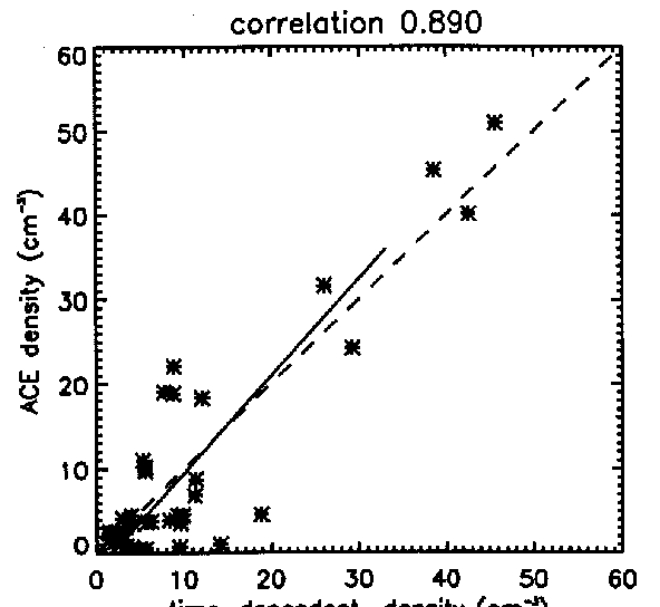
Time-Dependent IPS C.A.T. Analysis







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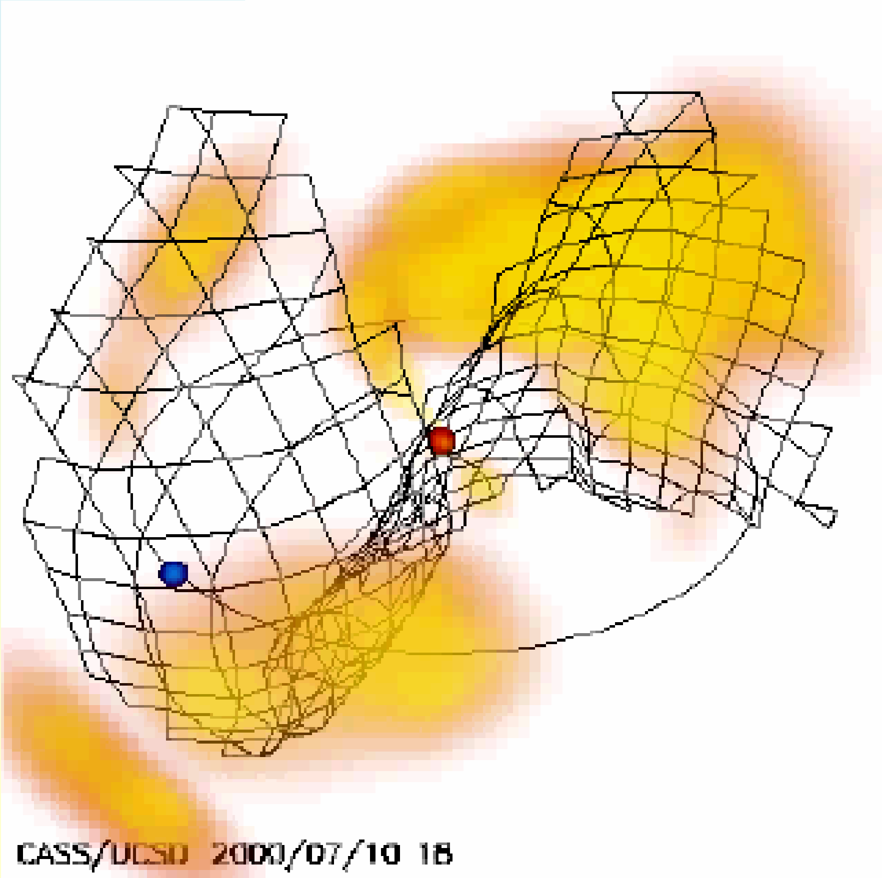
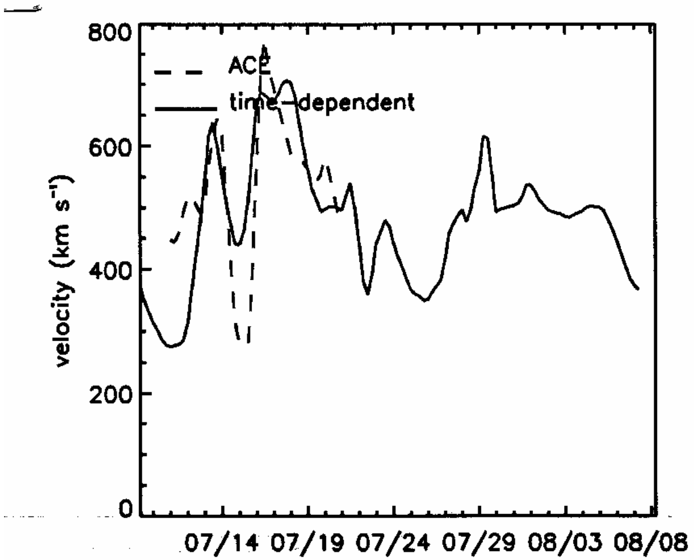
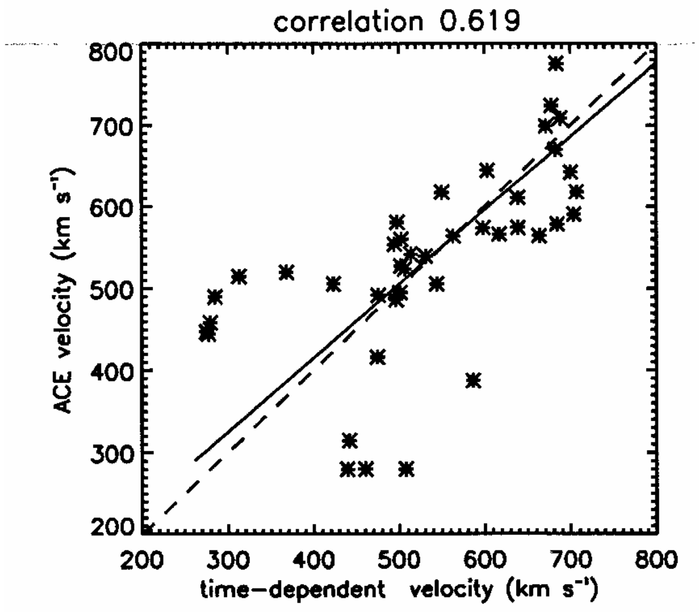
Time-Dependent IPS C.A.T. Analysis







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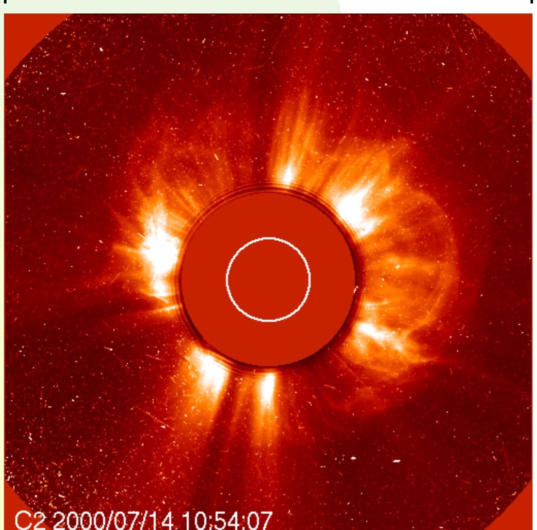
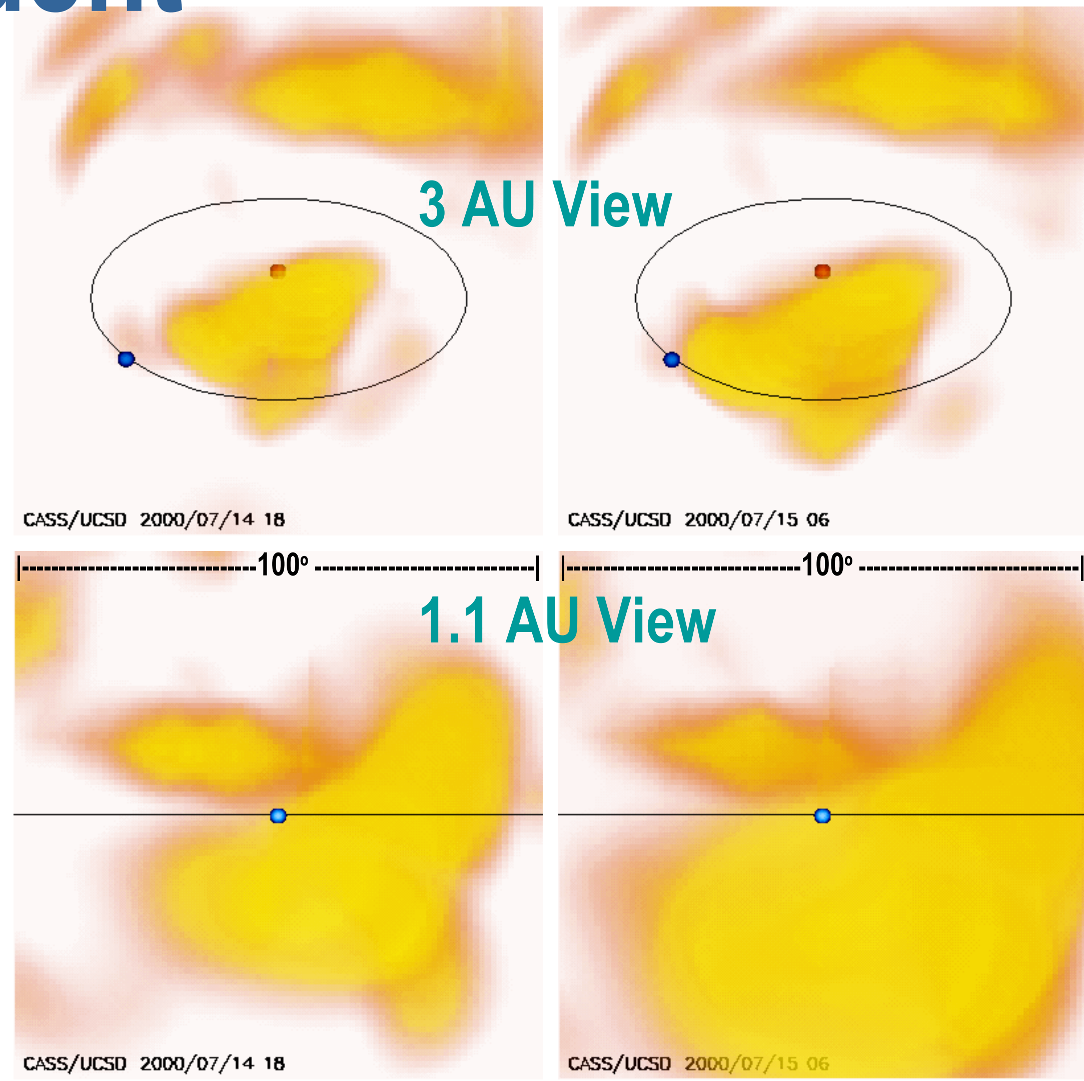
Time-Dependent Heliospheric C.A.T. Analysis

|------------------------------------3 ° ---------------------------------|

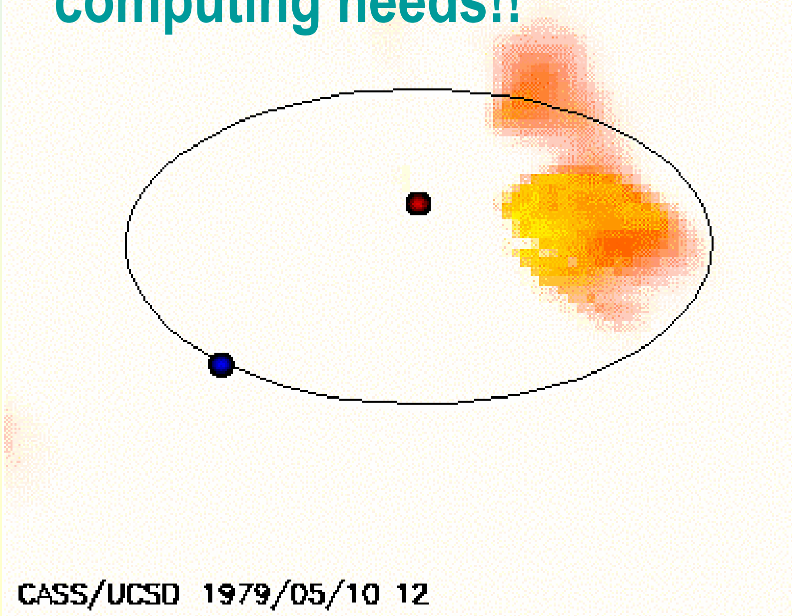


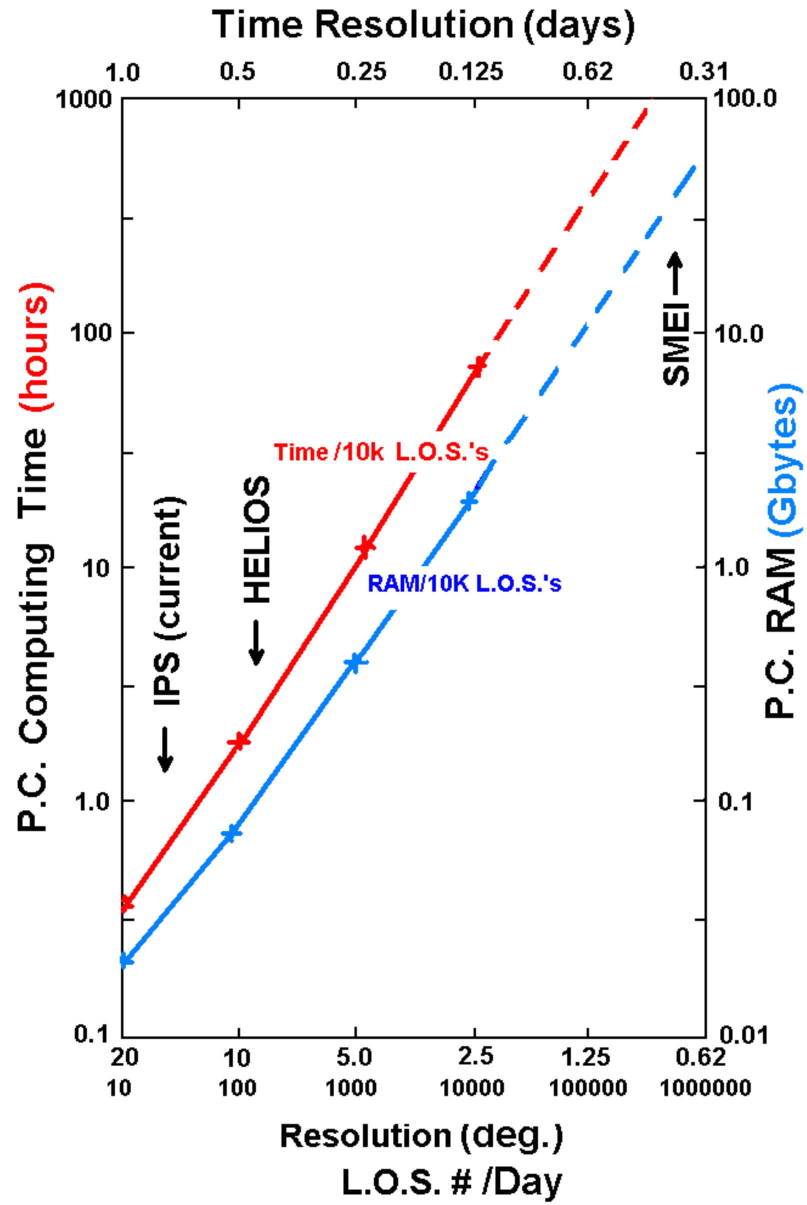


A Study of Plasma Phenomena Using Reconstruction Techniques

Future

- SMEI will give 1000 times more data than Helios!
- 10 times the resolution in all coordinates
- at least 10^4 times the computing needs!!





A Study of Plasma Phenomena Using Reconstruction Techniques

Summary

- We are currently able to do a pretty accurate job using our time-dependent tomography technique and Helios photometer observations.
- The Solar Mass Ejection Imager (SMEI) will provide nearly 1000 times more data than Helios. This will provide density reconstruction of over half the heliosphere with an ~1-hour time cadence and 1º by 1º latitude - longitude resolution.