3D morphological reconstruction of CMEs and CME-driven shocks fromSECCHI/COR and HI1 observations and their link to in-situ measurements

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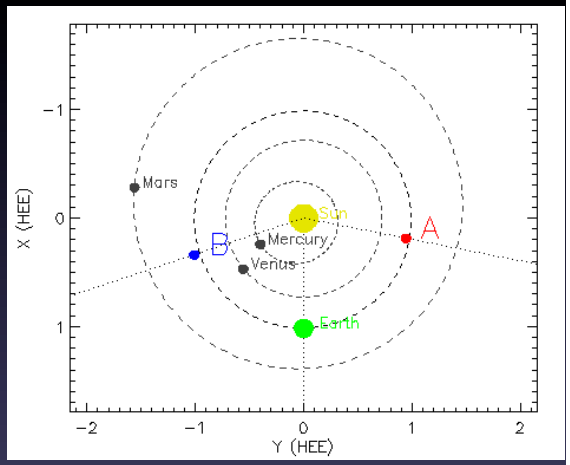
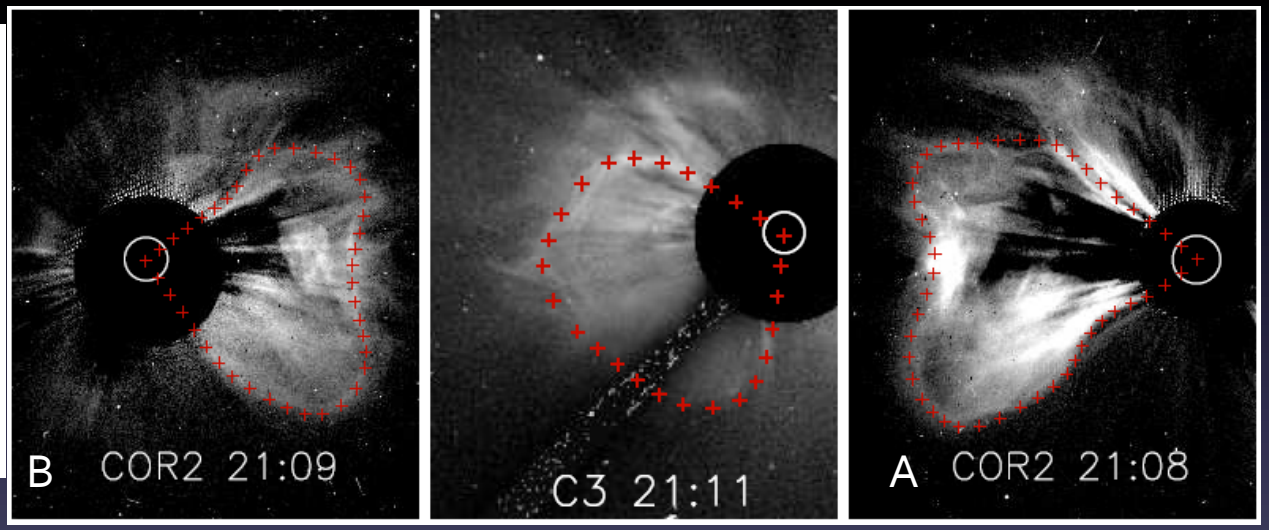
Outline

- Introduction to mask fitting method
- Comparison to other methods
- Application to the 3D shock reconstruction
- Extension from COR to HI1 observations
- In-situ observations

Mask Fitting Method: input data

Input data: 2D coordinates of the CME periphery in coronagraph images from three viewpoints: COR 1 & 2 /STEREO A, B and LASCO C2 & 3 /SOHO

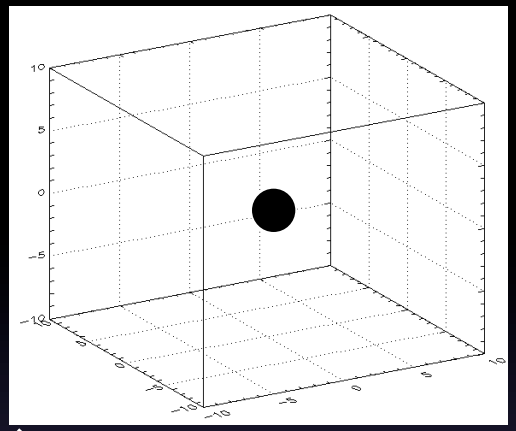




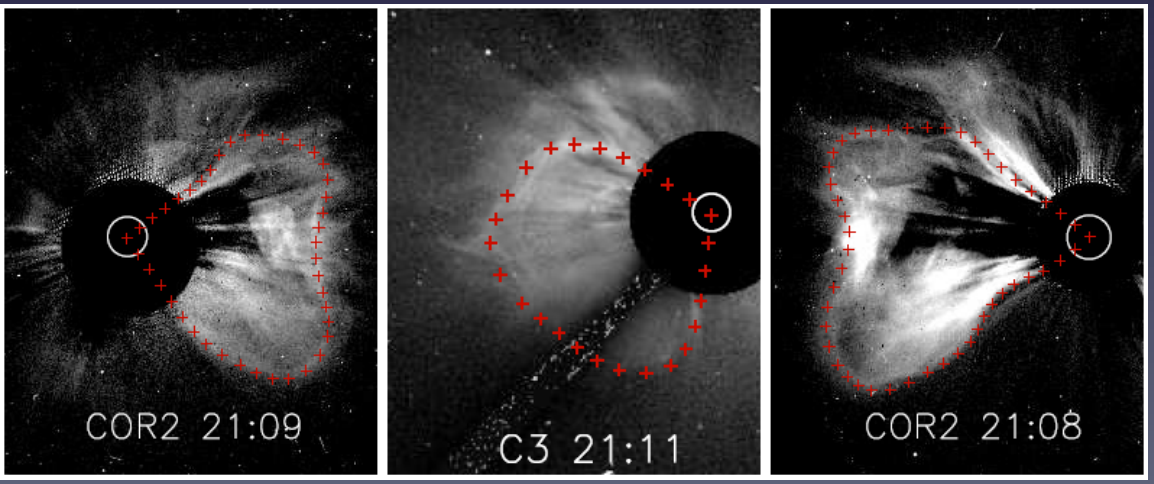
In cases that three images are not taken simultaneously, linear interpolation of the CME periphery positions is used for a desired time.

Feng et al. 2012, ApJ

Mask Fitting Method: method description



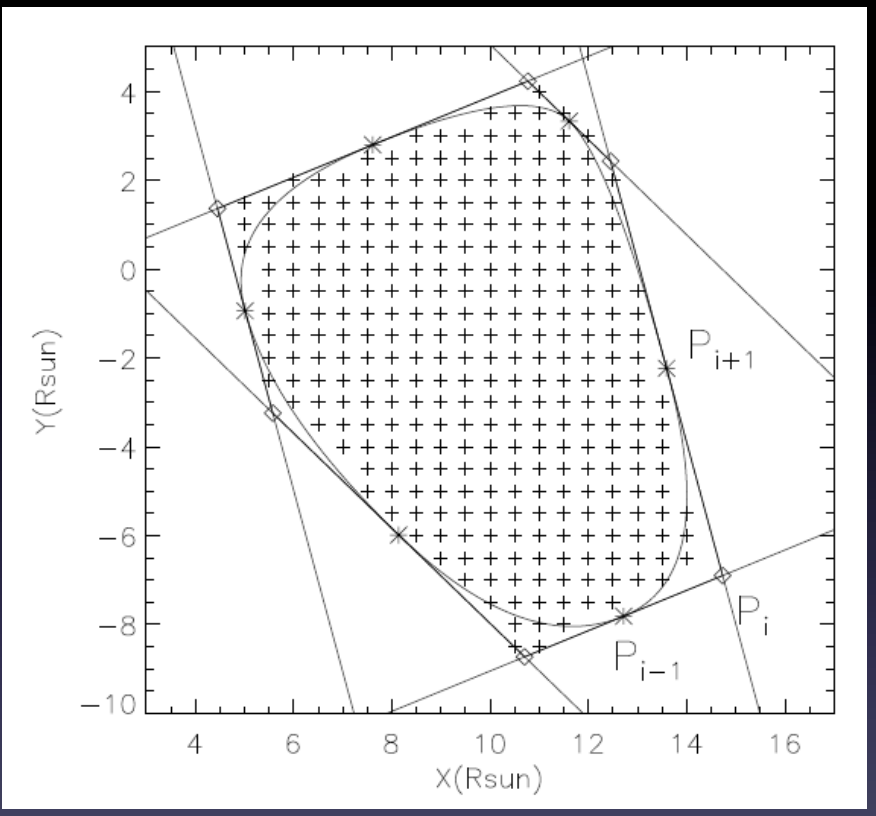
project each 3D grid point

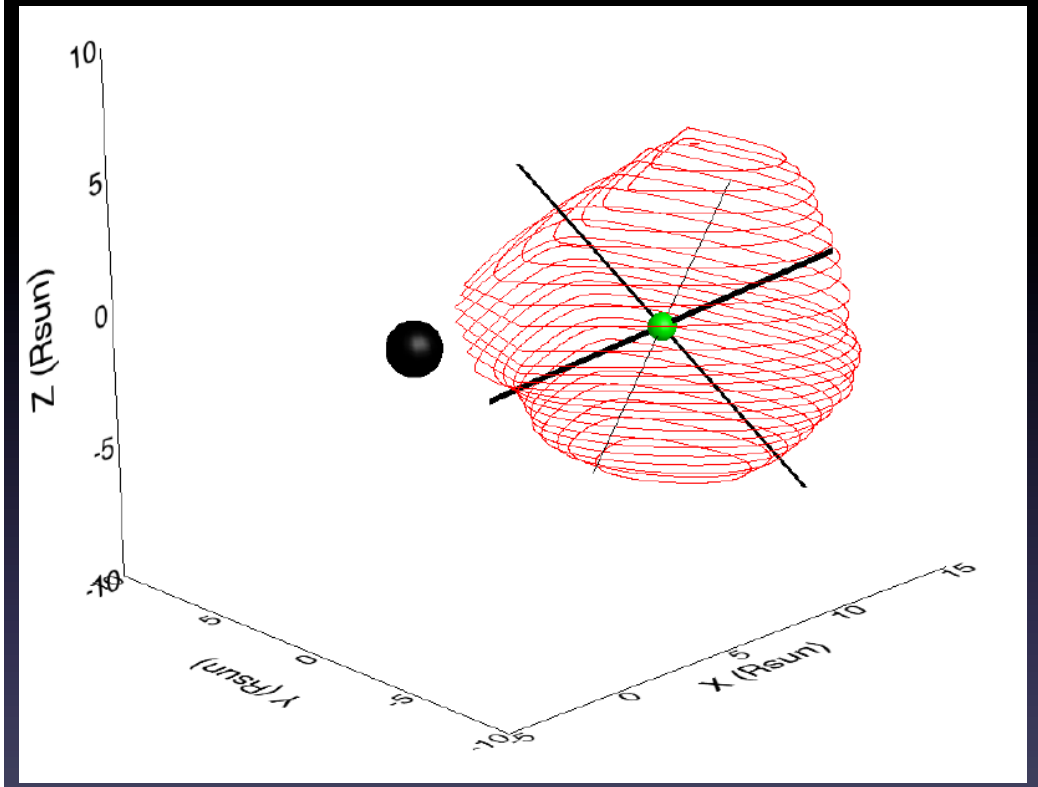


Define and discretise a sun-centred 3D box and project each grid point into three image planes.

A 3D point is considered to be within a CME only when its three projections are all located within the masks marked by red points in the left images.

Mask Fitting Method: method description





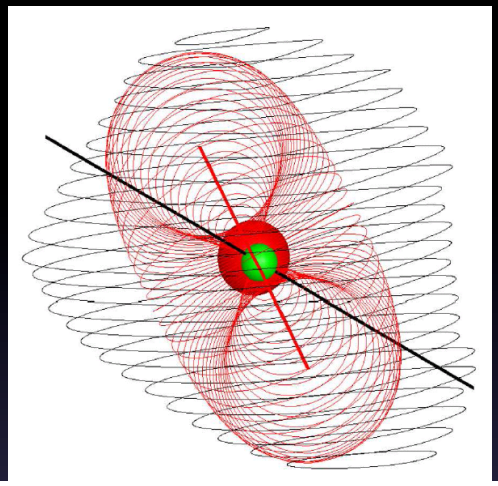
Bezier curves are applied to smooth the reconstruction in each slice of CME.

The stack of all slices form a CME cloud in 3D. Further analyses: geometric centre, eigen values along three principal axes.

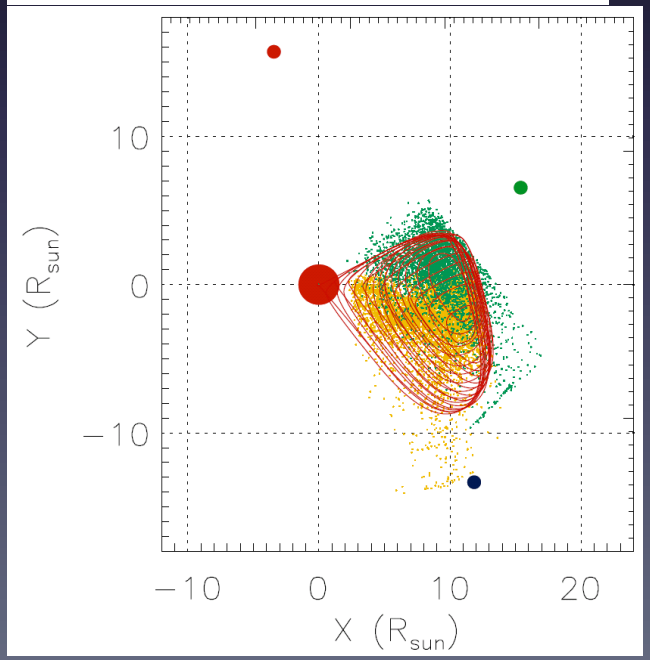
Comparison of the methods

Excluding the LCT+TR method, the latitude of the CME's centre of gravity derived from other methods deviates within one degree and longitude differs within 19 degrees.

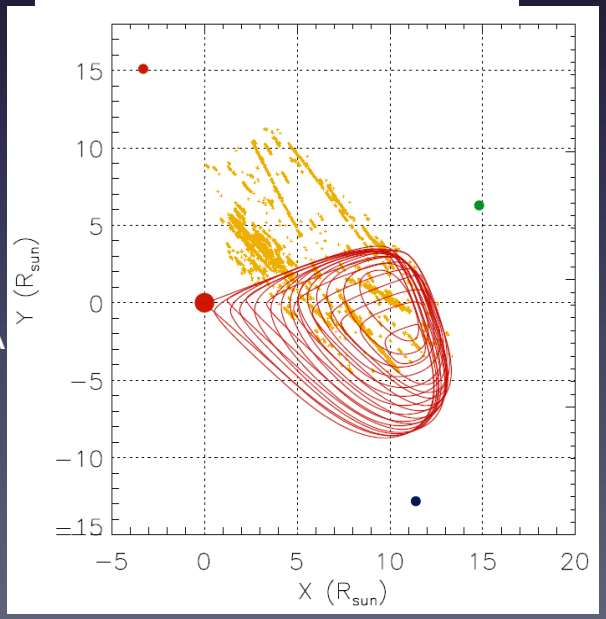
Method	lon.	lat.
MF/GL	-13.3	-7.7
FM[1]	-13.4	-7.3
PR A	-14.6	-7.9
PR B	4.8	-6.8
LCT-TR	27.8	2.8



red: GCS model
black: mask fitting



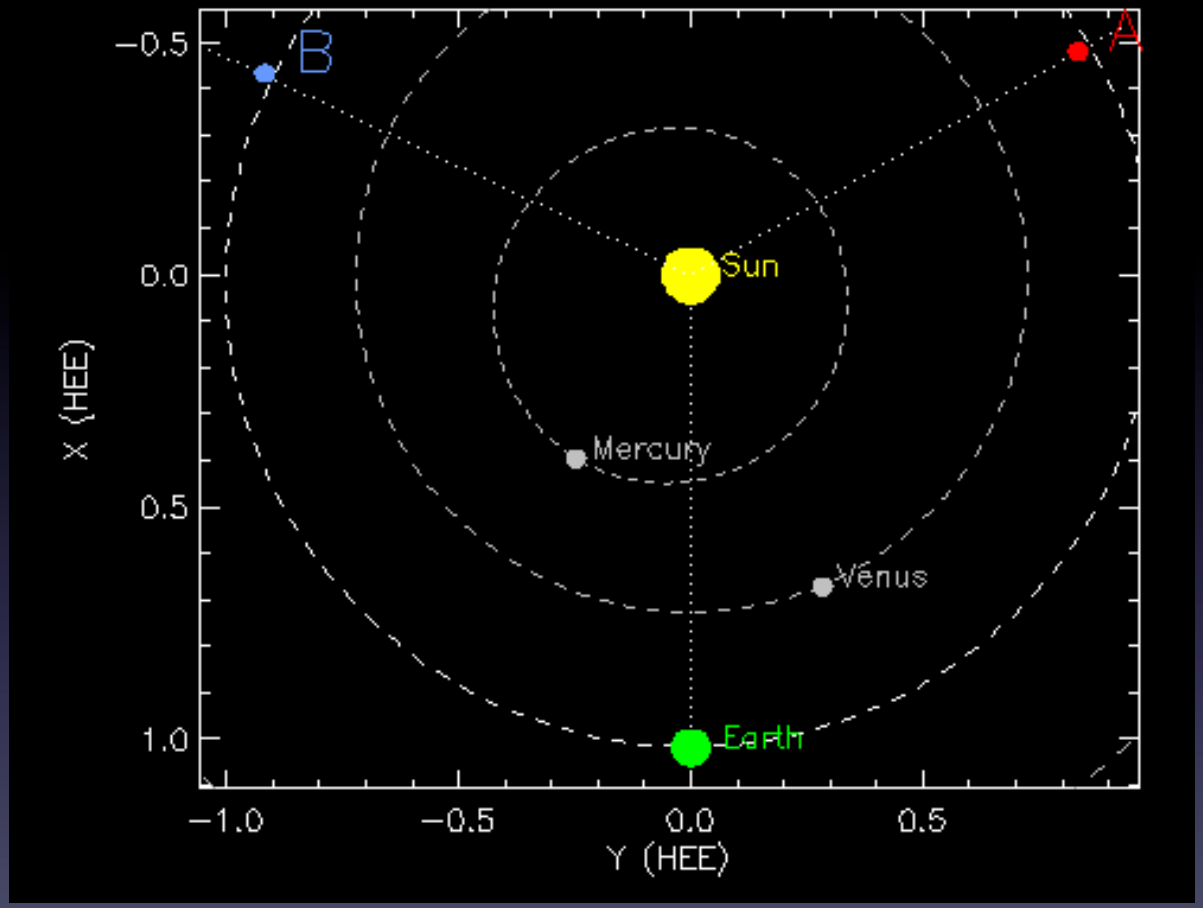
red: mask fitting
yellow: PR A
green: PRB



red: mask fitting
yellow: LCT+TR

Feng, et al., 2013, SoPh

CME event : started from 2012-07-12

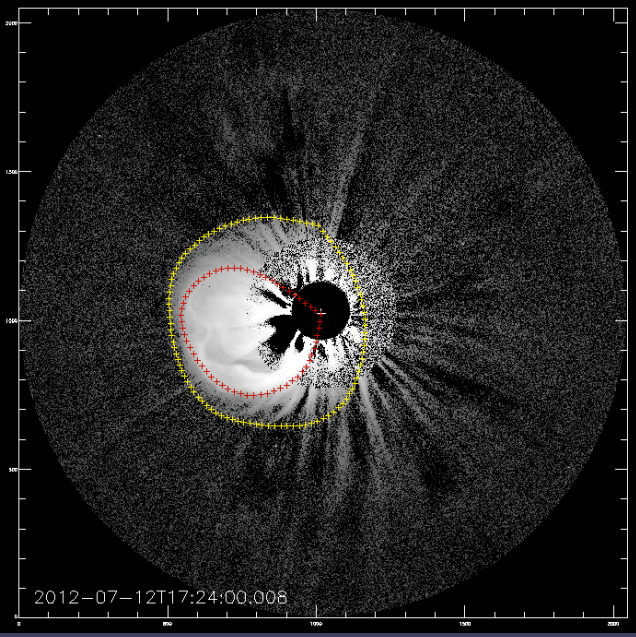


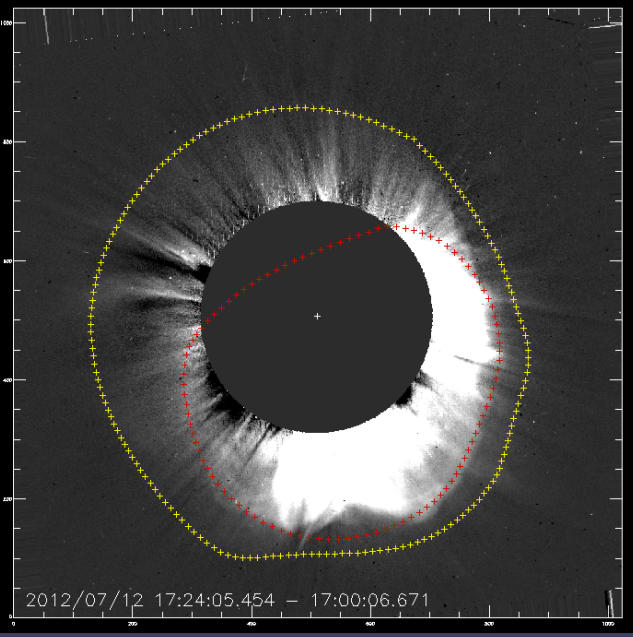
Data coverage:

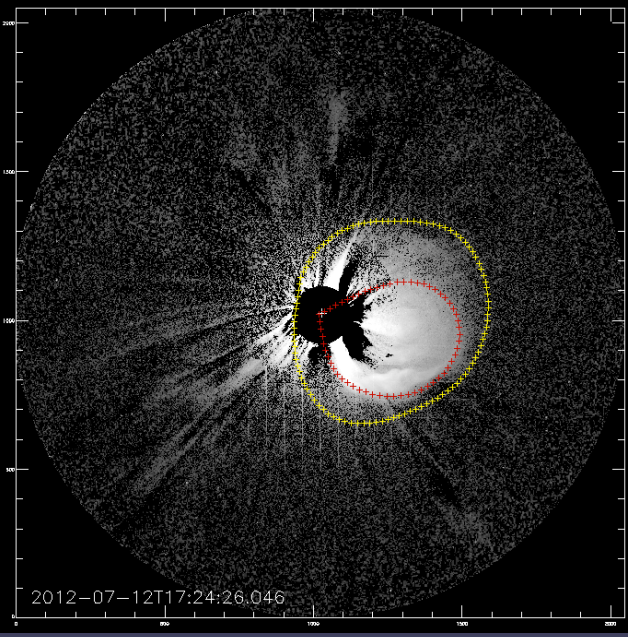
Continuous SECCHI COR and HI data

Data gap from about 17:30 to 23:00 for LASCO C2 and C3

Tracing CME and CME-driven shock



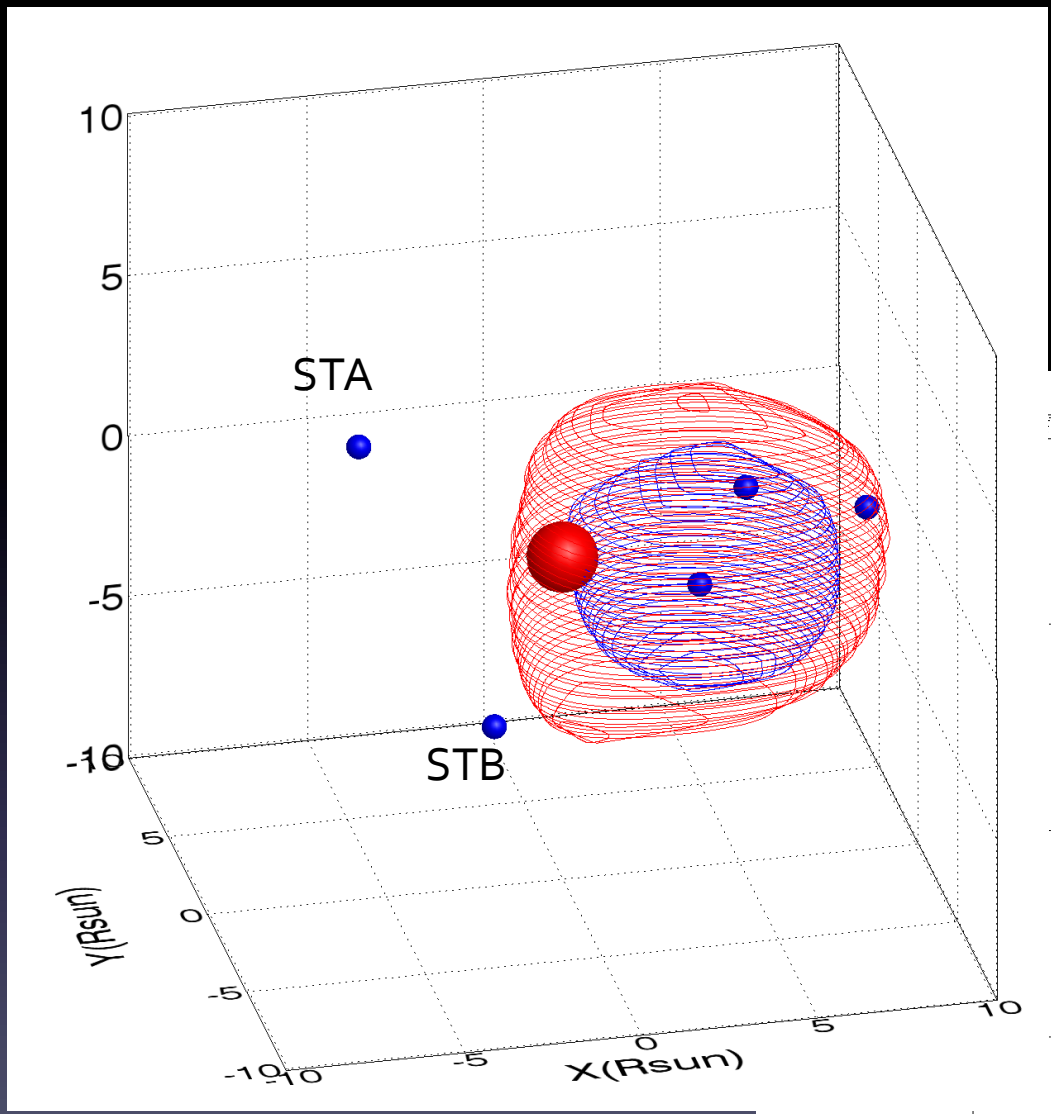


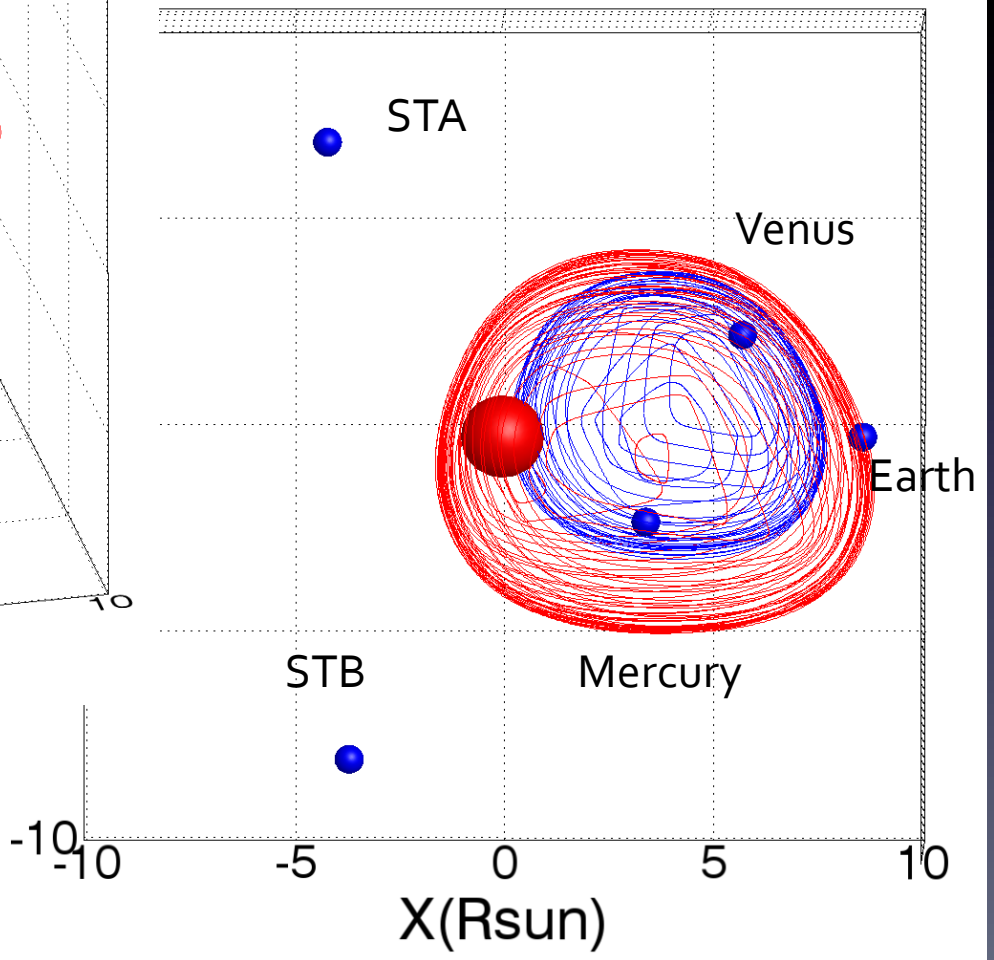


COR1+COR2 A

LASCO C2

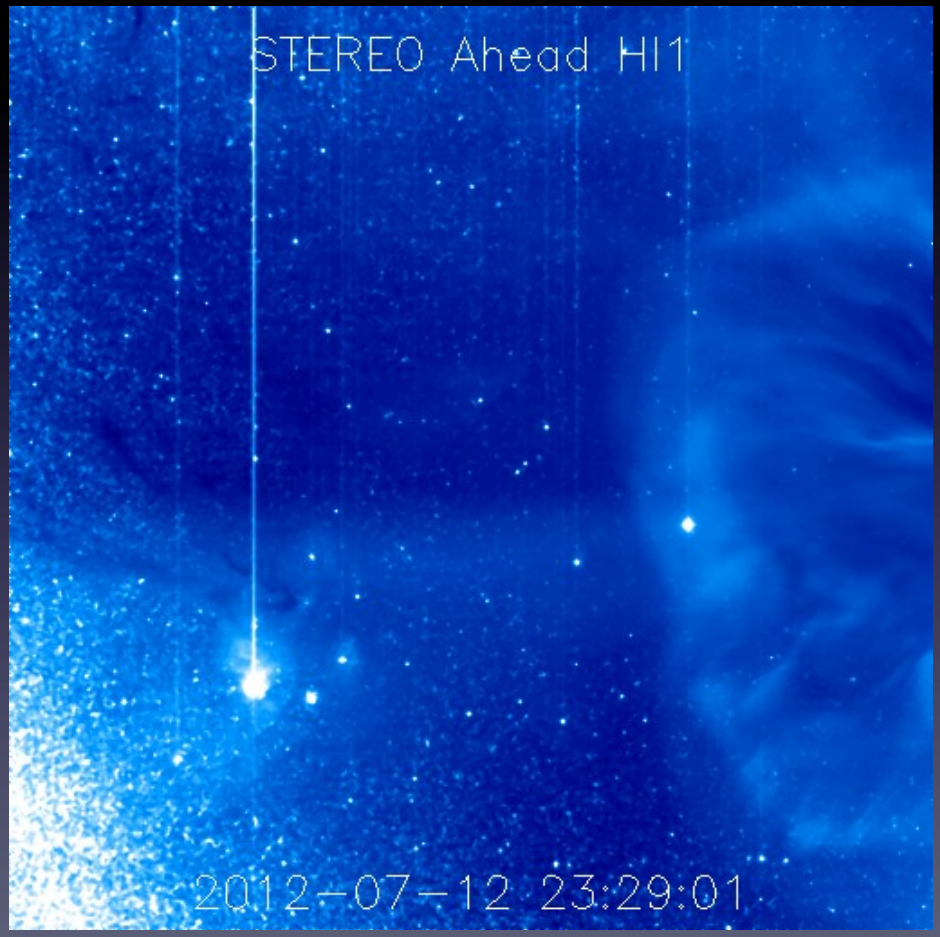
COR1+COR2 B

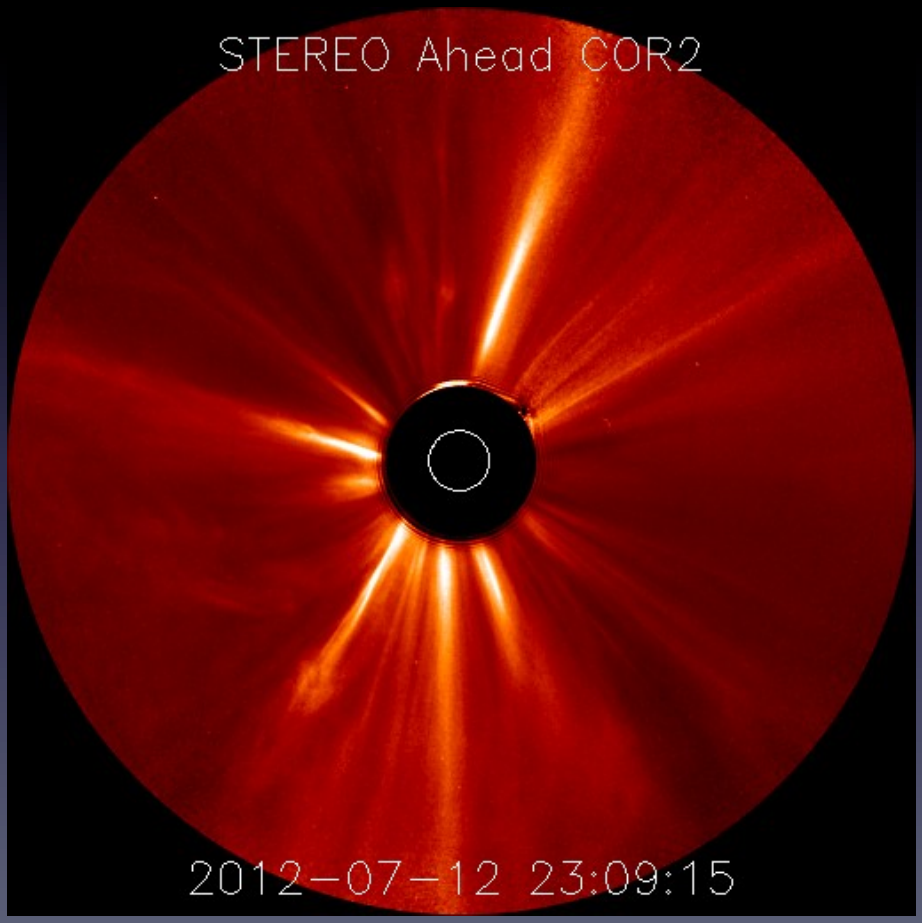

STA
STB
10
5
0
-5
-10
Y(Rsun)
X(Rsun)


STA
Venus
Earth
STB
Mercury
-10
-5
0
5
10
X(Rsun)

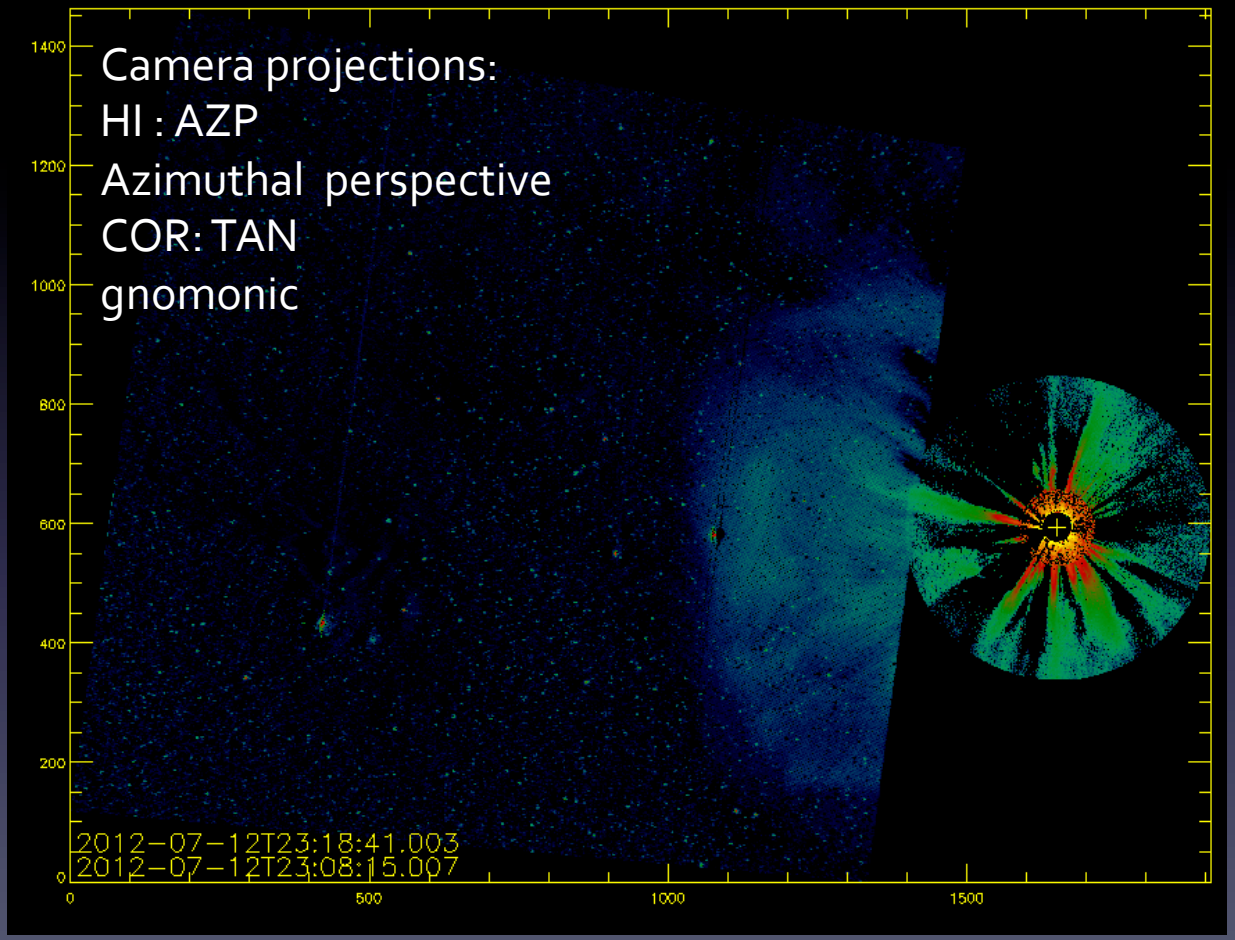
3D reconstruction from COR+HI1 observations

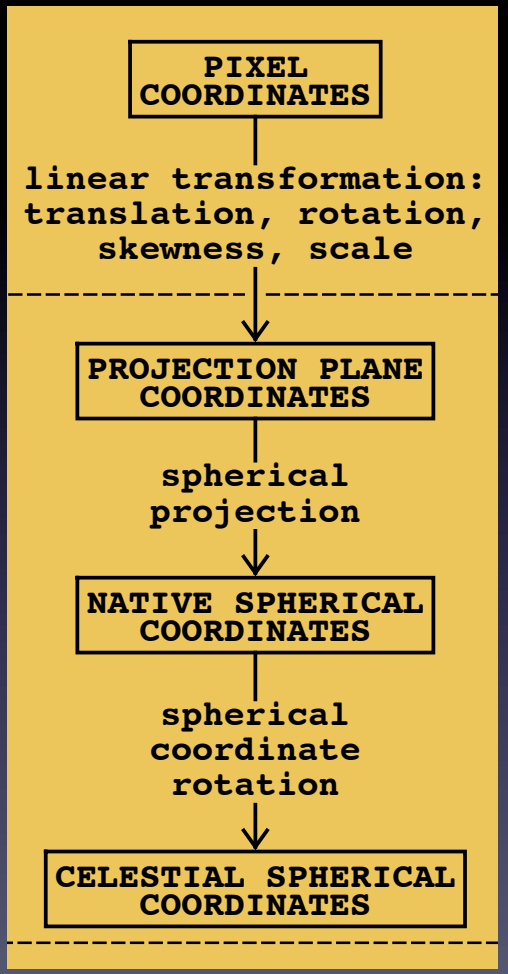
Step 1: combine COR and HI1 images





Step 1: combine COR and HI1 images

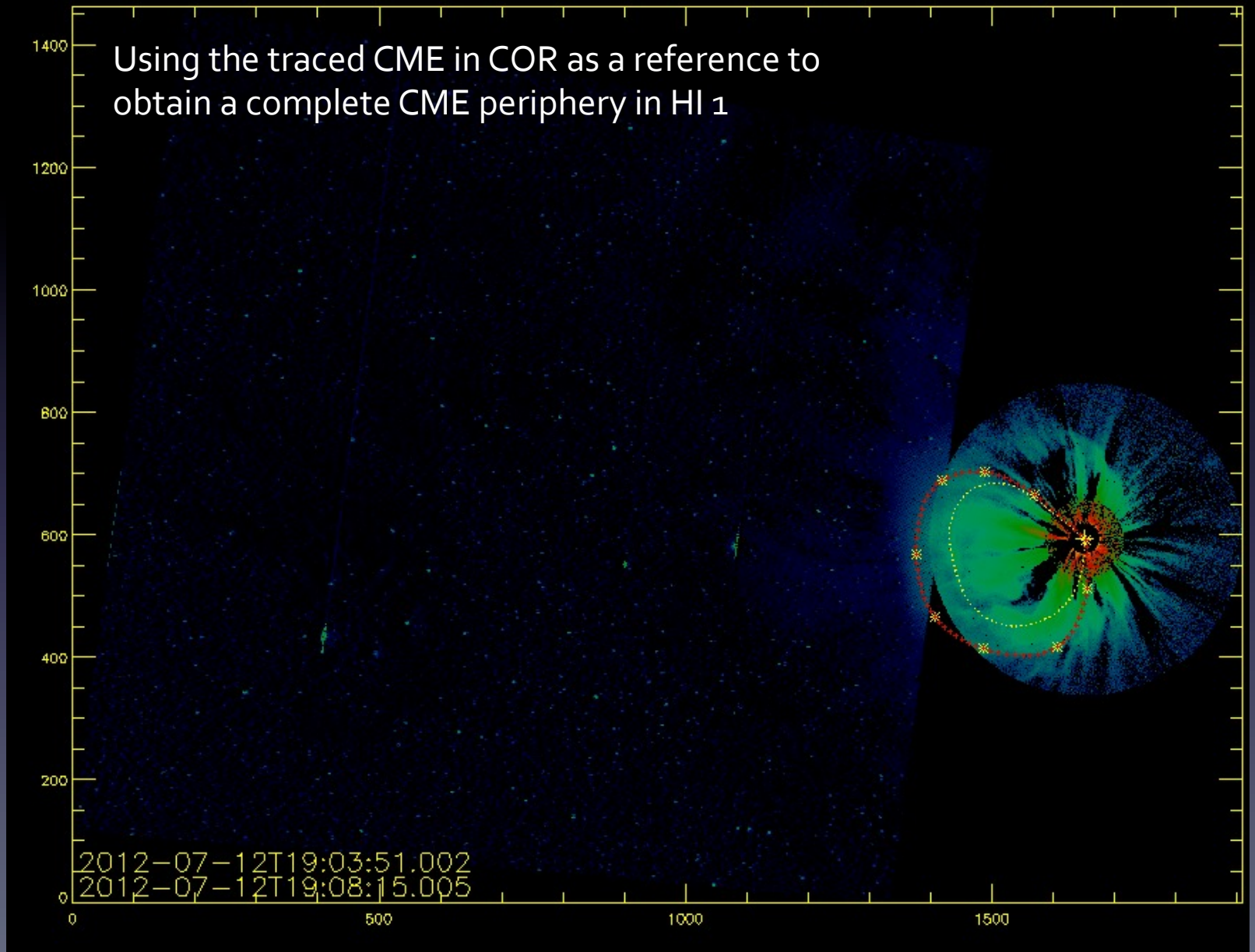




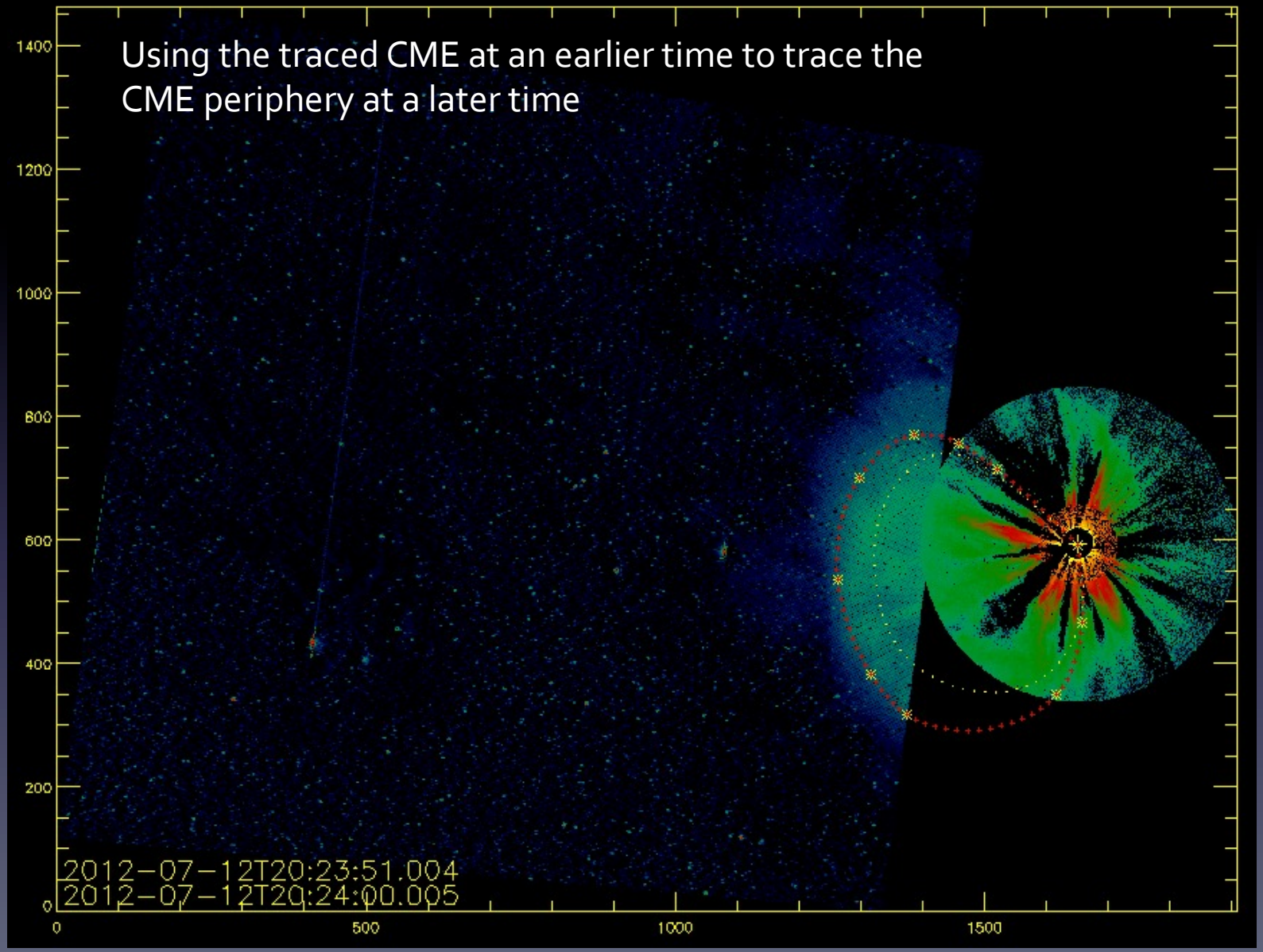
Project HI1 data to the image plane of COR

Calabretta & Greisen (2002)

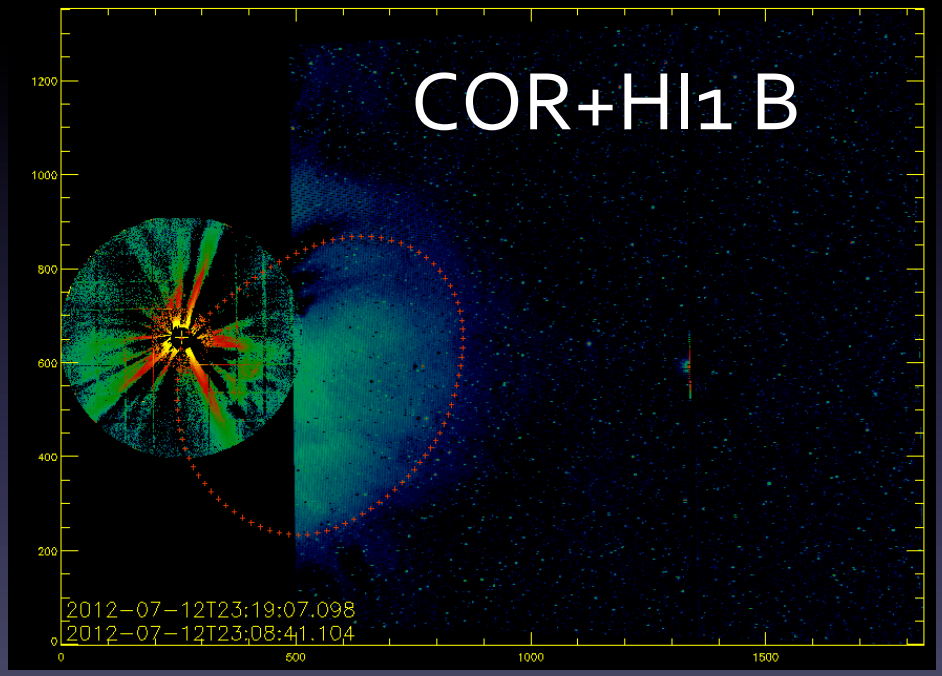
Step 2: trace CME and its driven shock

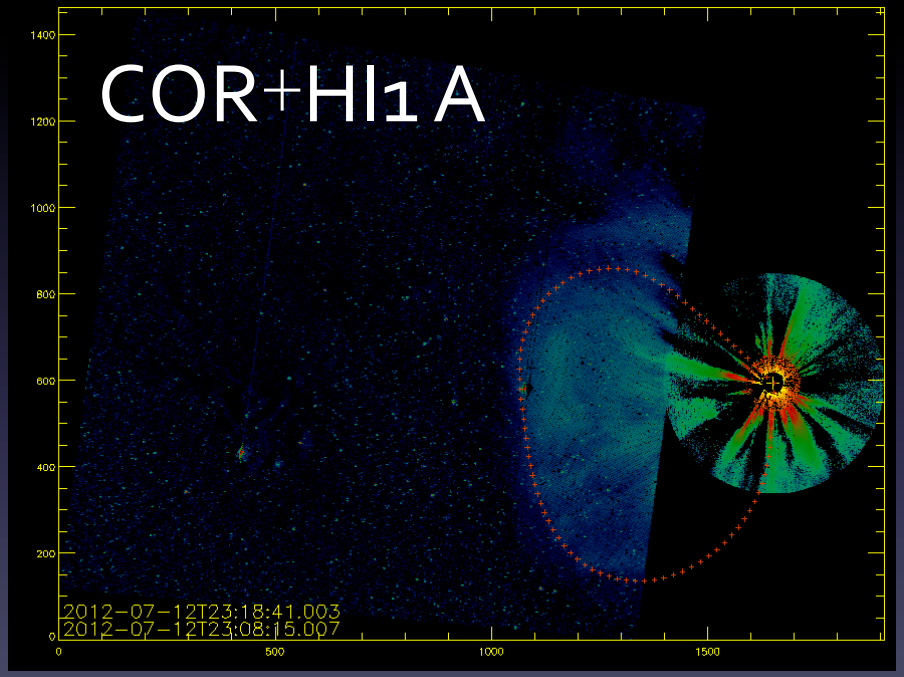


Step 2: trace CME and its driven shock

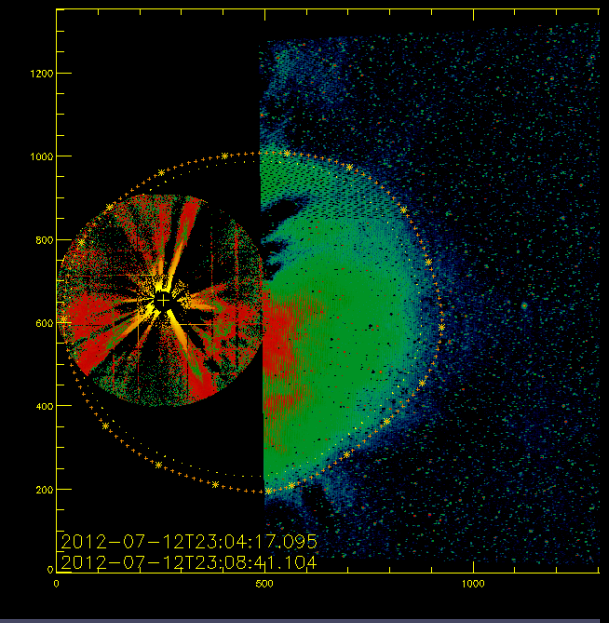


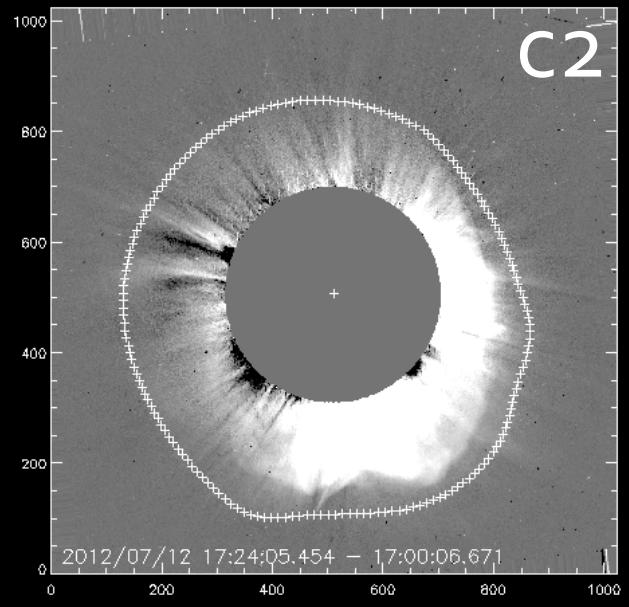
Traced CME peripheries from A and B

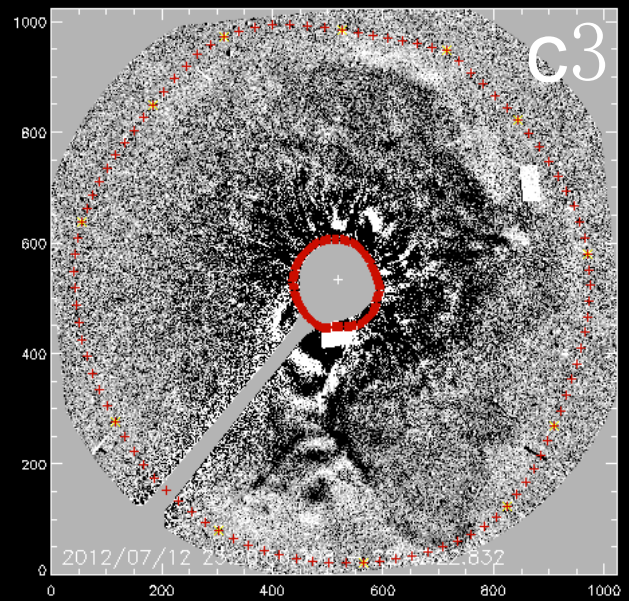


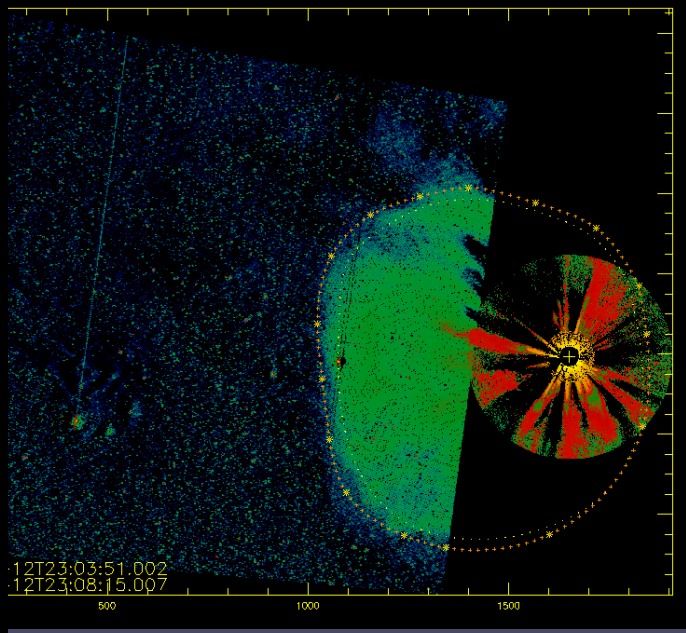


Traced shock from A and B: uncertainties exist

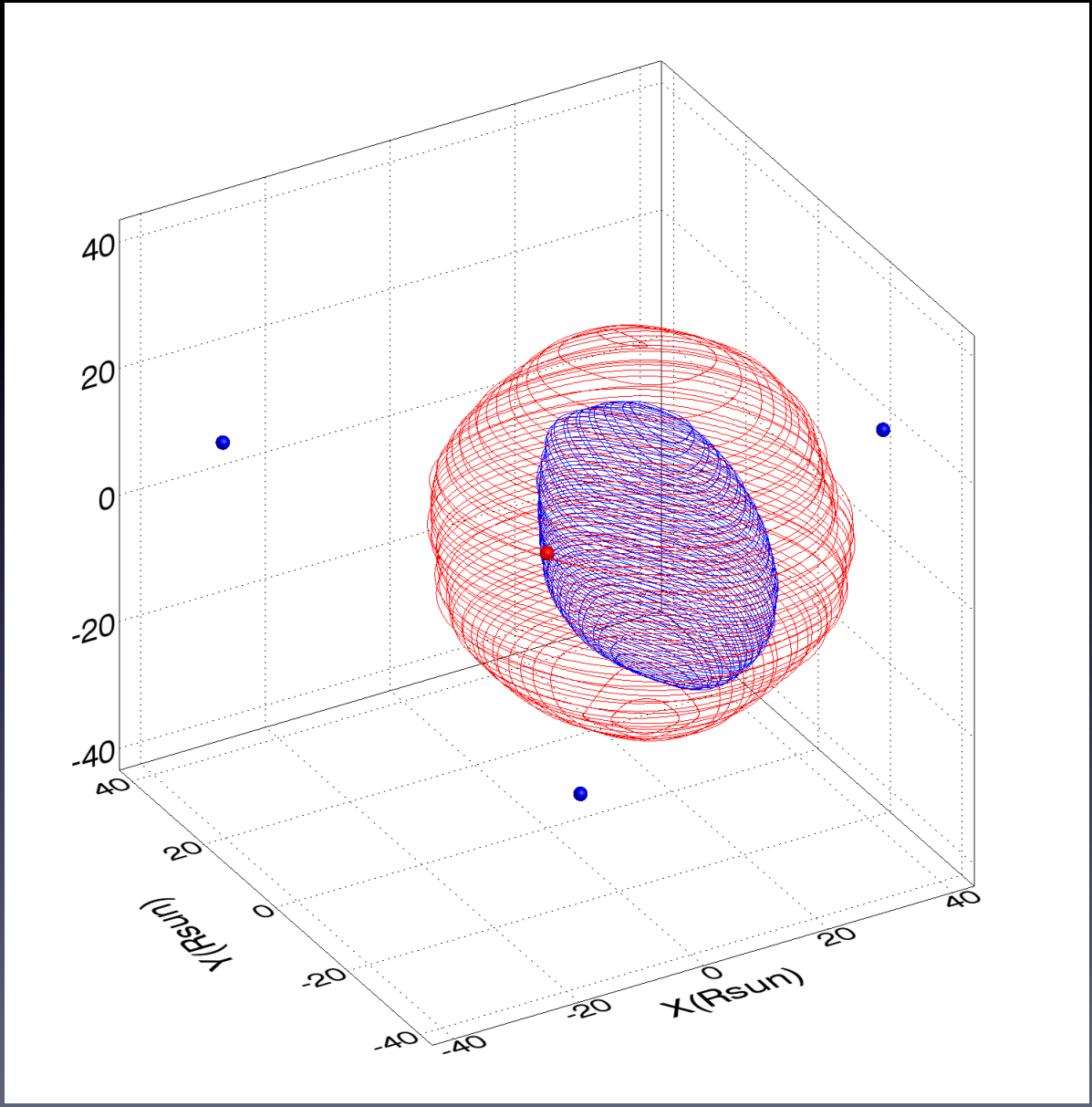


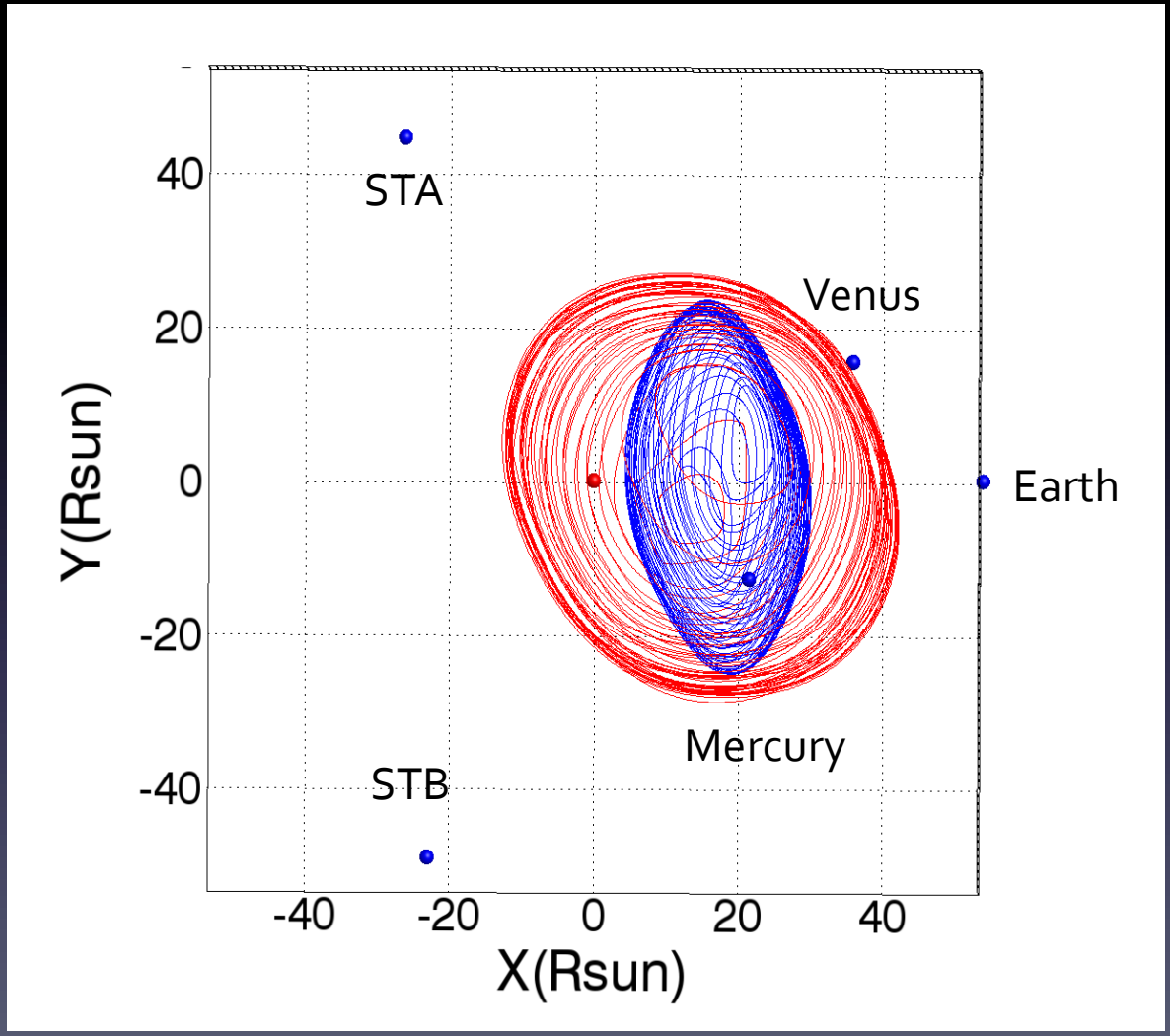




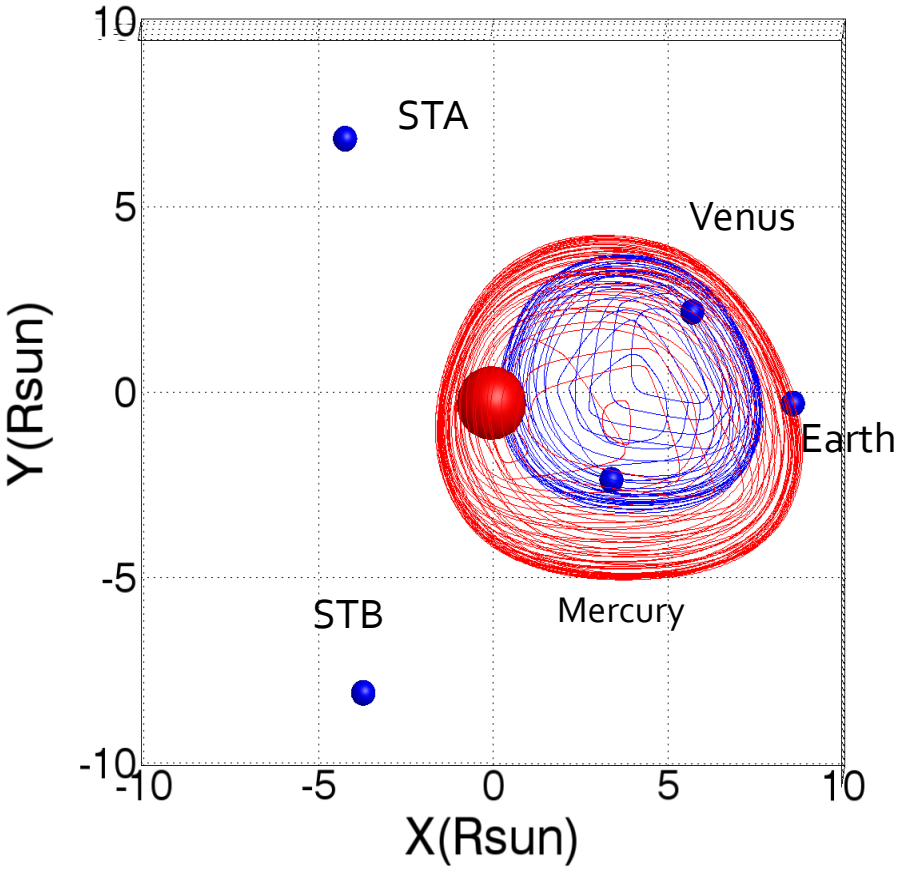


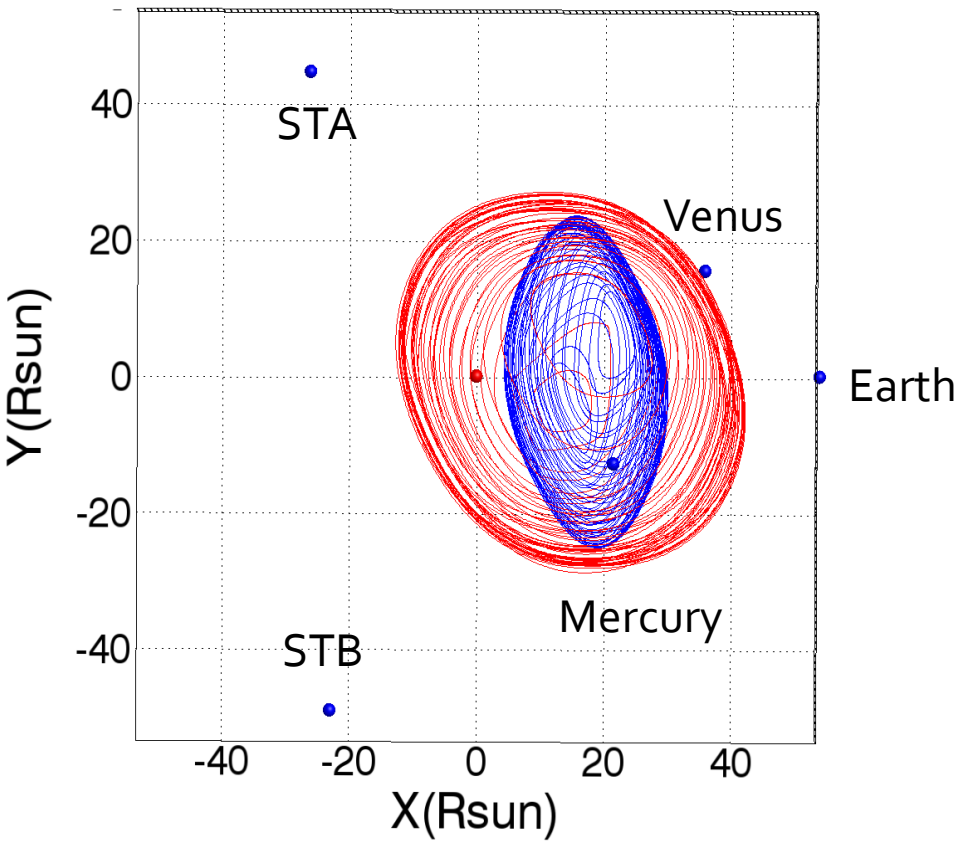
Step3: 3D mask fitting reconstruction




STA
Venus
Earth
Mercury
STB
40
20
0
-20
-40
Y(Rsun)
-40
-20
0
20
40
X(Rsun)

CME and shock evolution



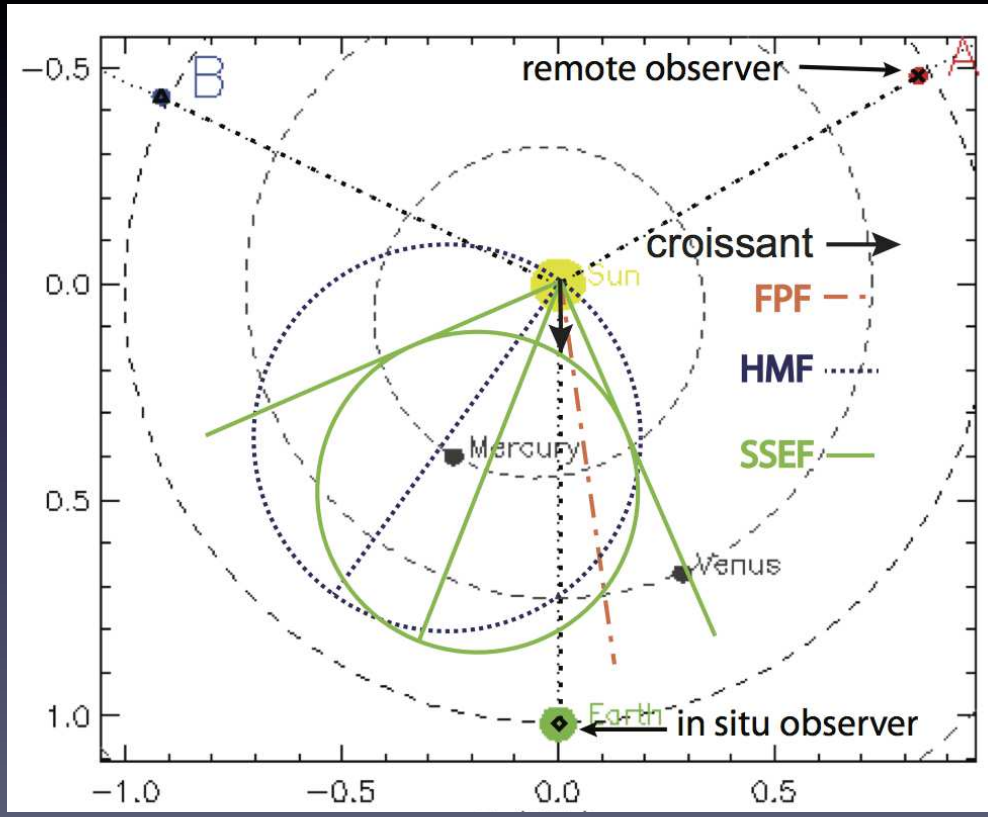


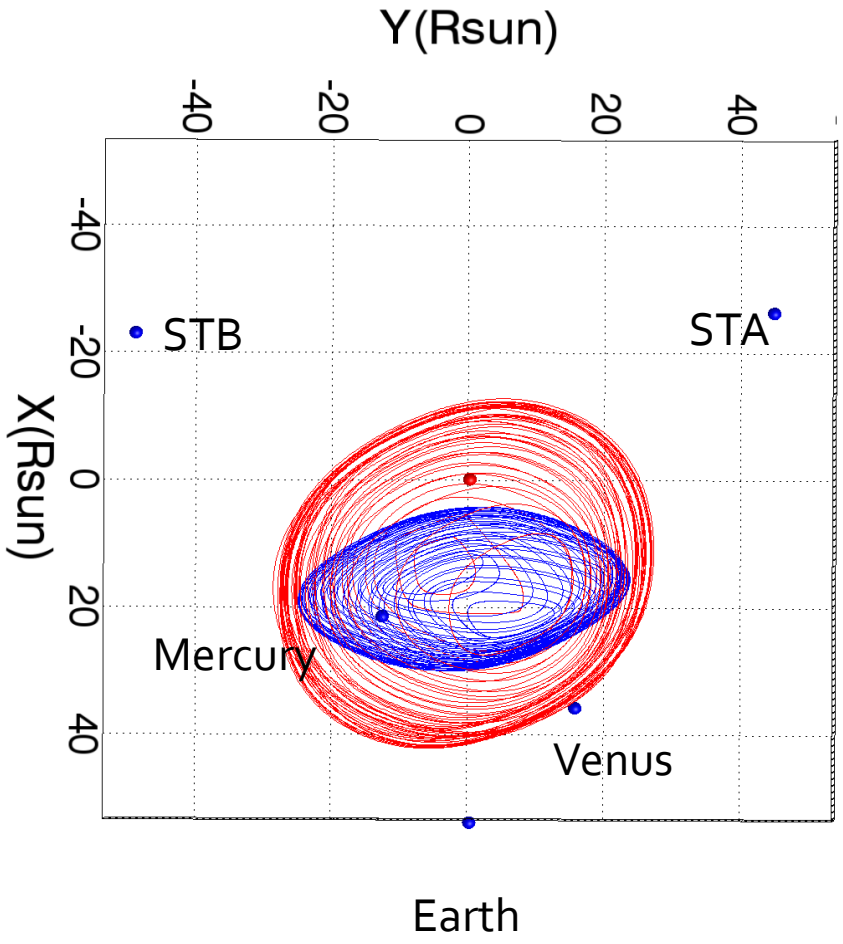
17:24 UT

23:20UT

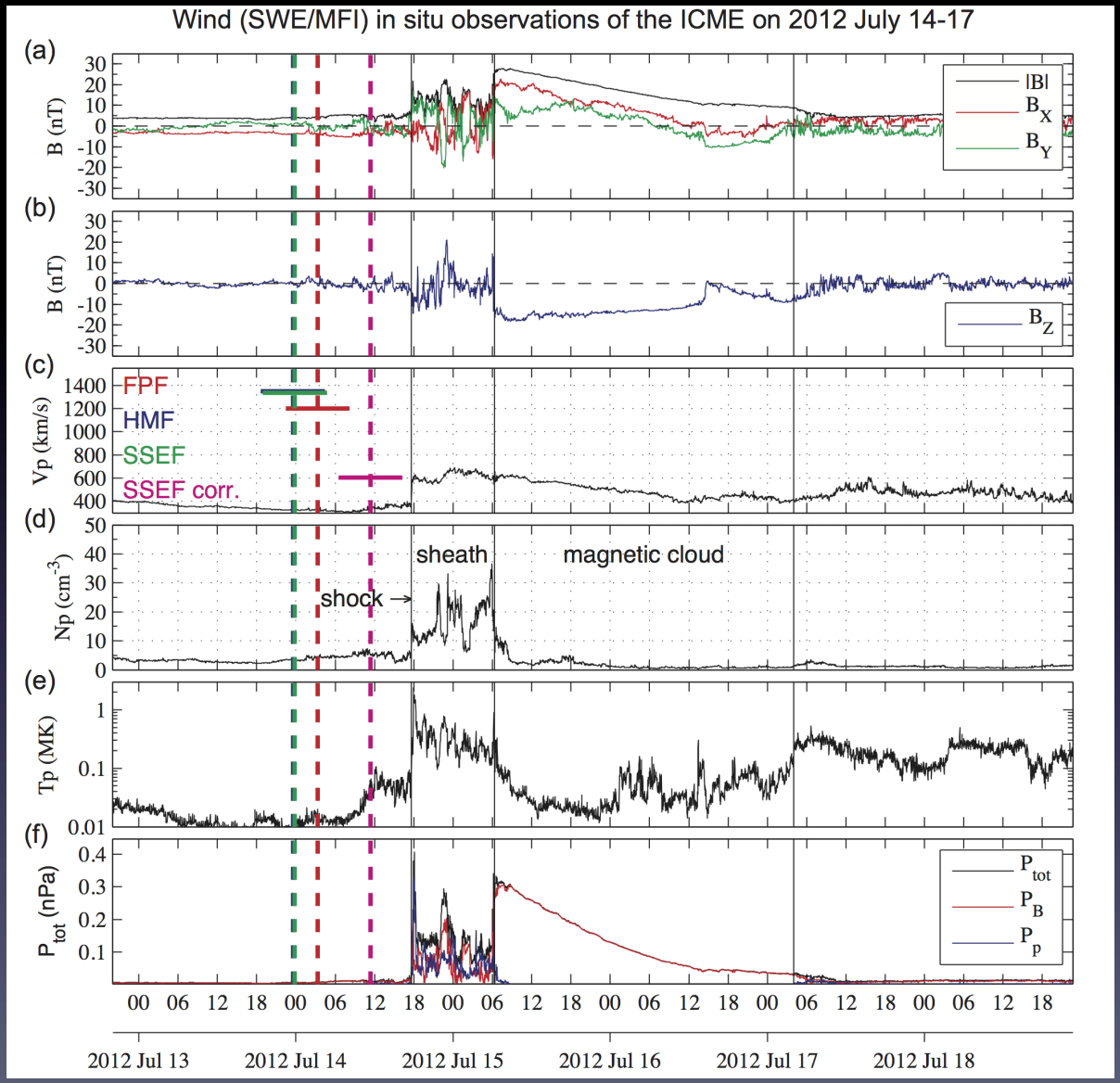
Comparison with other methods

Moestl et al. 2014, ApJ



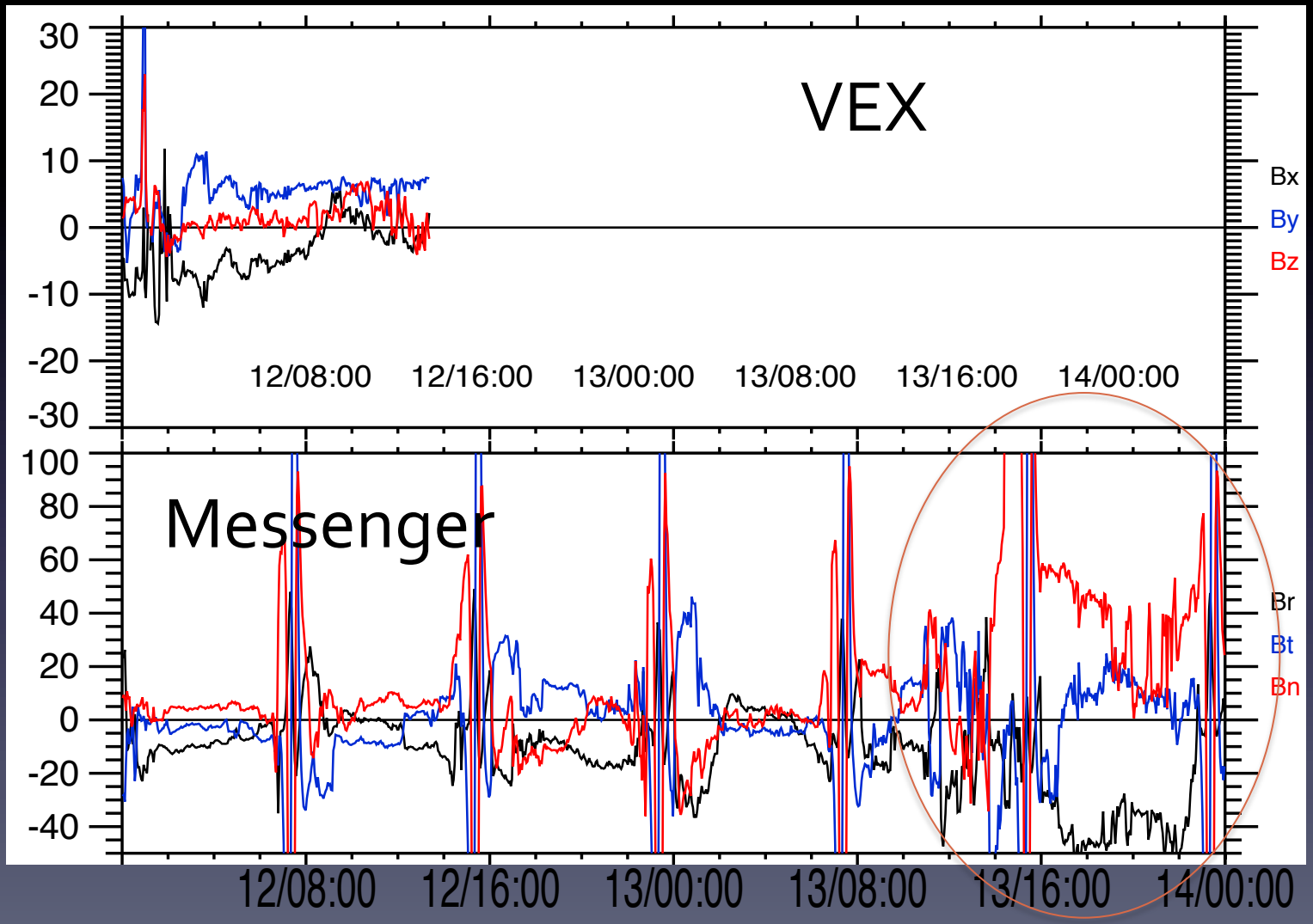


In situ observations



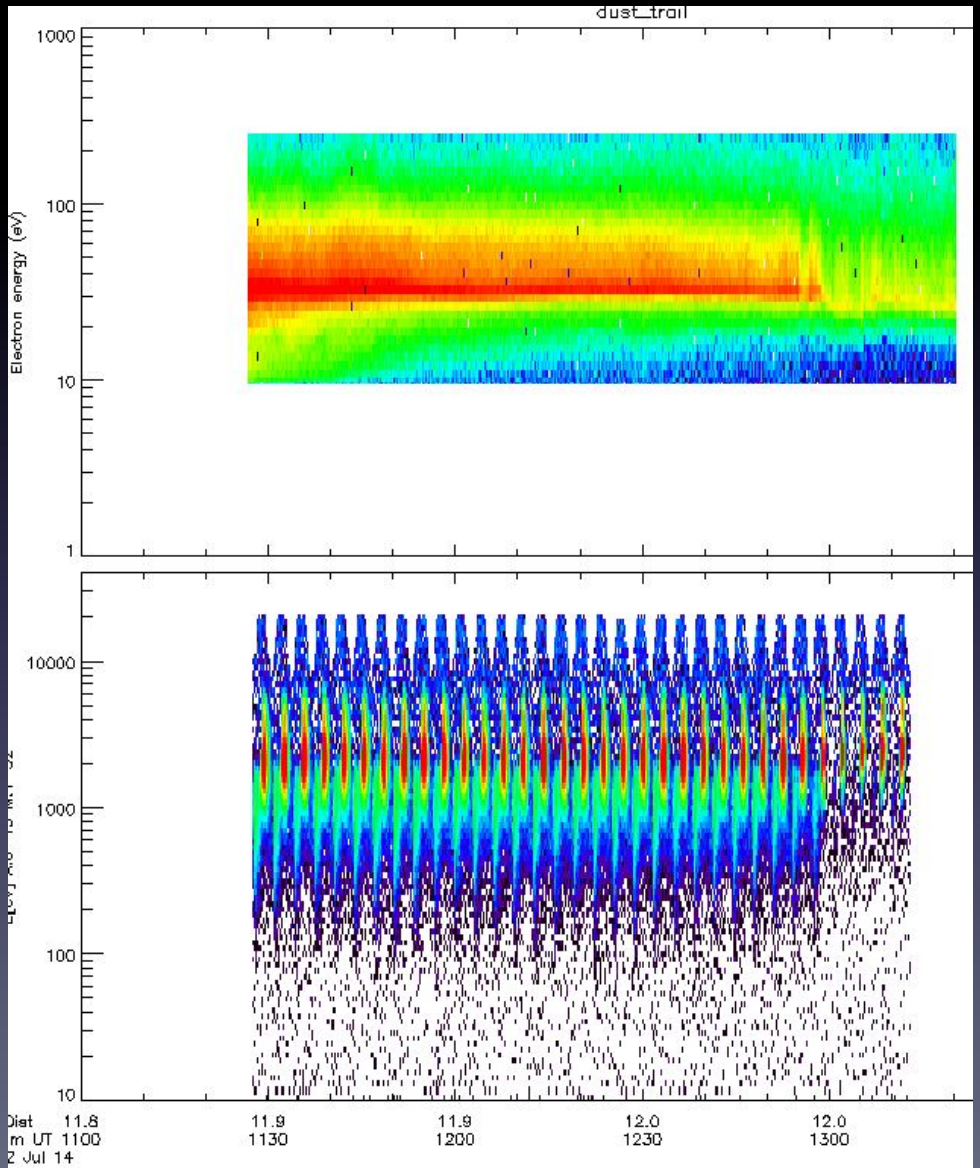
Moestl et al. 2014, ApJ

Magnetic field data of Messenger and VEX



VEX electron and ion spectral width

probably heated plasma by the shock on July 14th?



Outlook

A time sequence of the 3D reconstructions of the CME and its driven shock

1. to analyze their kinematics
2. to have a better understanding of the link between the remote sensing and in-situ observations

Thank you very much for your attention !