

3D CMEs and CME-driven shocks reconstructed from three-viewpoint observations

Li Feng^{1,2}

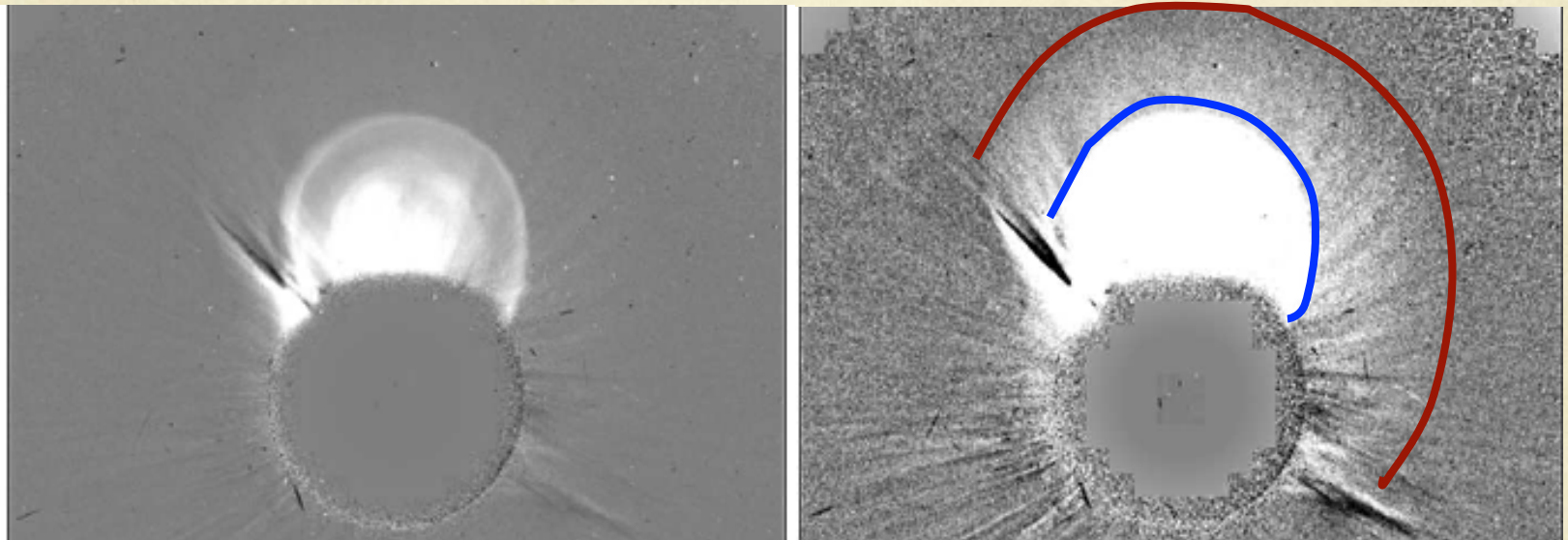
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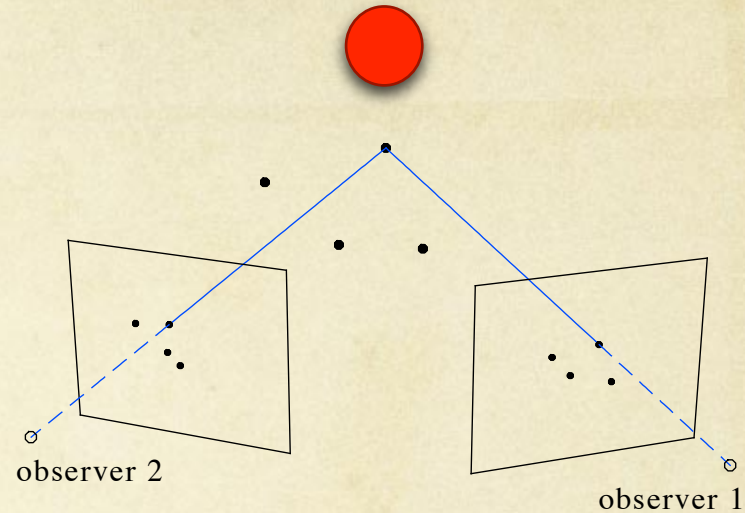
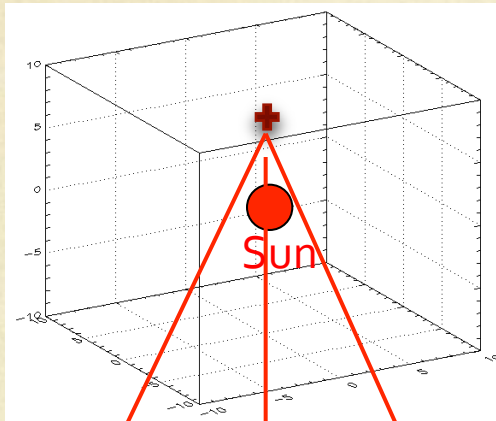
Purple Mountain Observatory, CAS, China

University of Graz, Austria

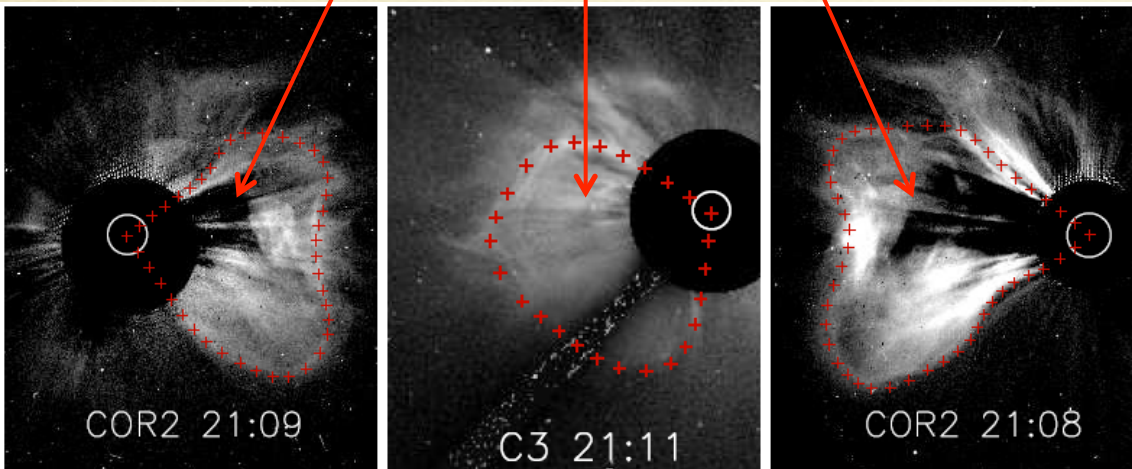
CMEs and CME-driven shocks



Mask Fitting Method

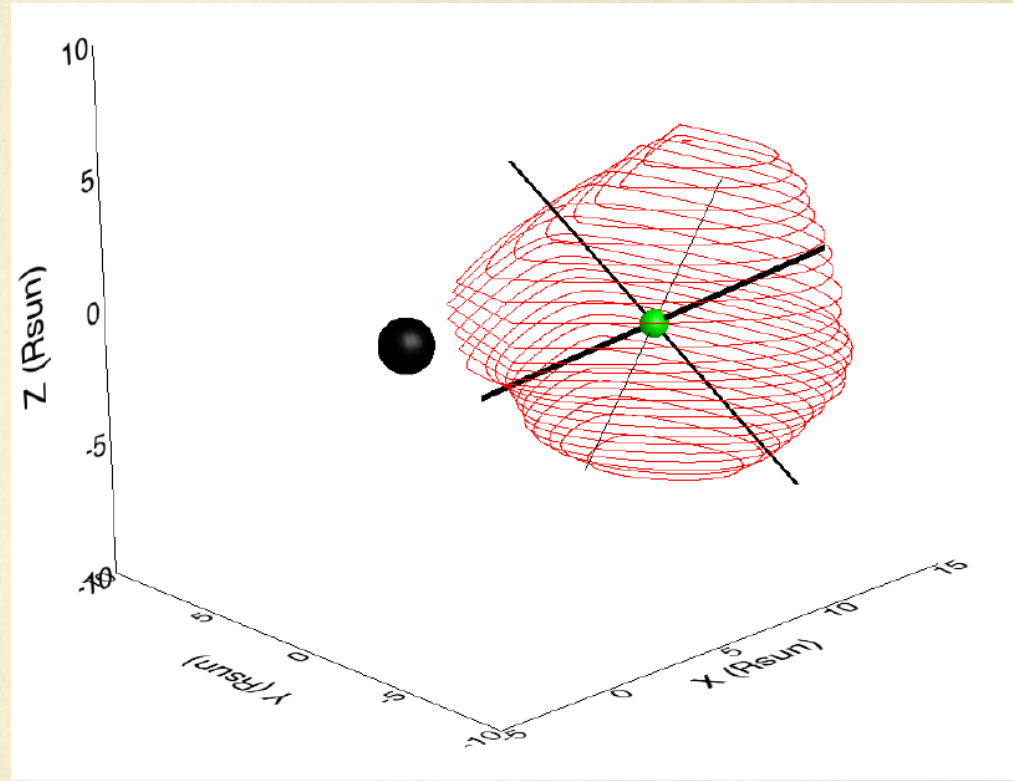
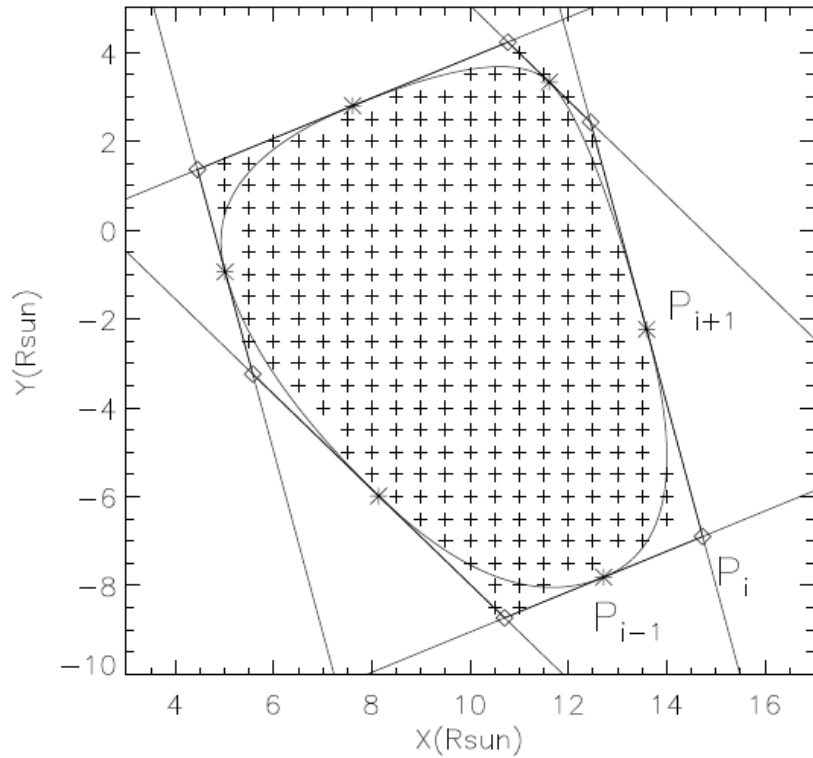


project each 3D grid point



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.

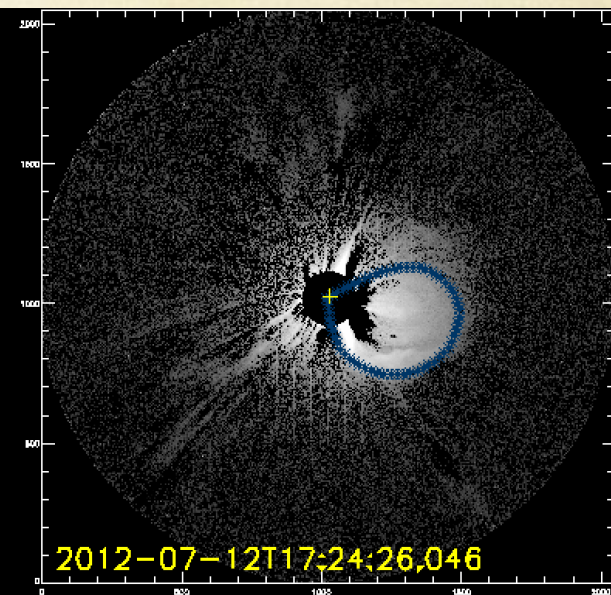
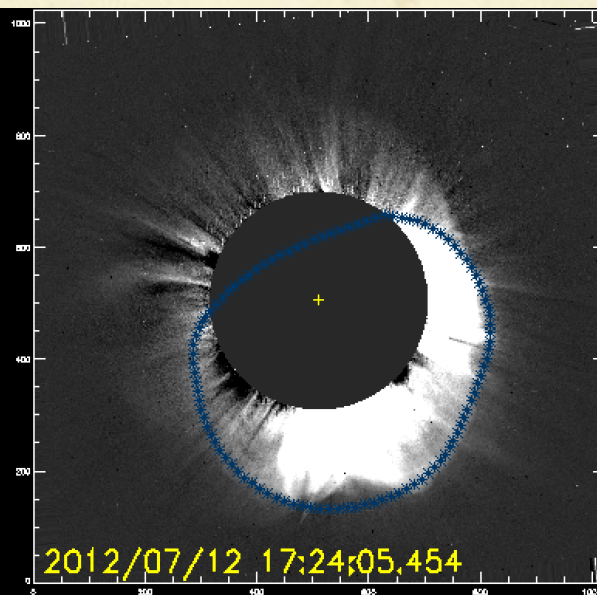
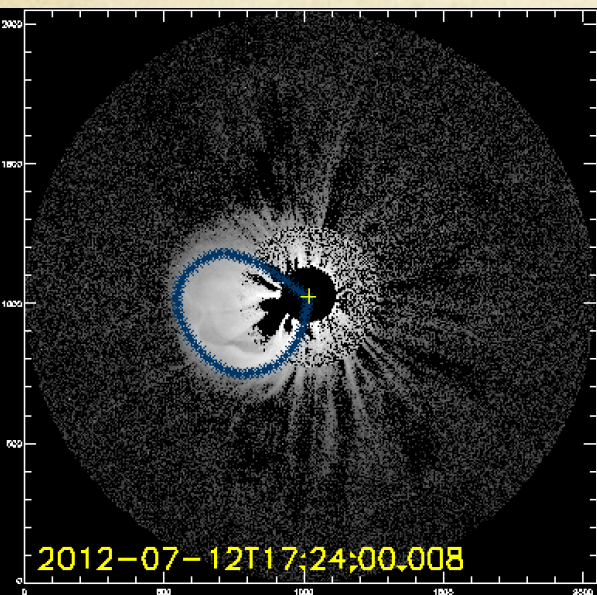
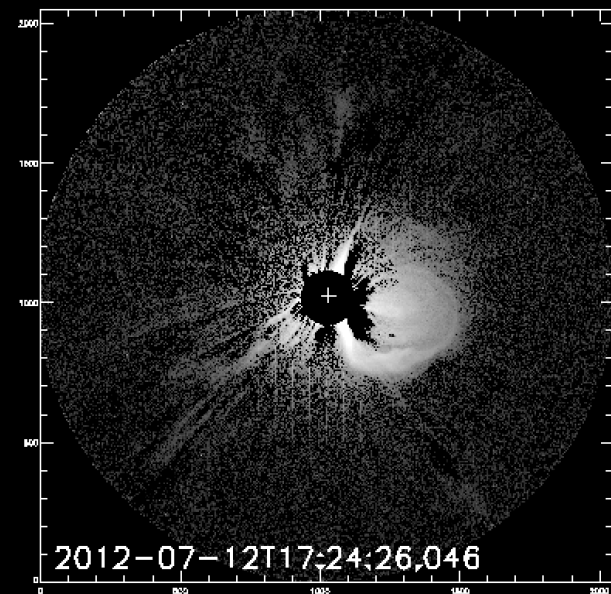
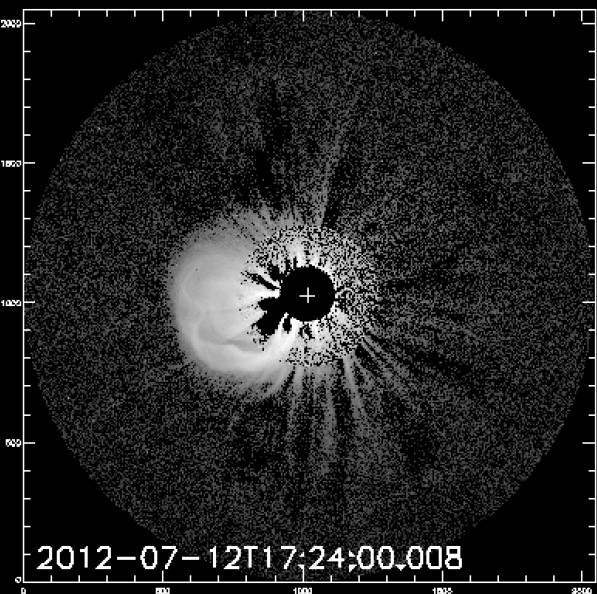
Mask Fitting Method



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

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

3D reconstructions of a CME and its driven shock

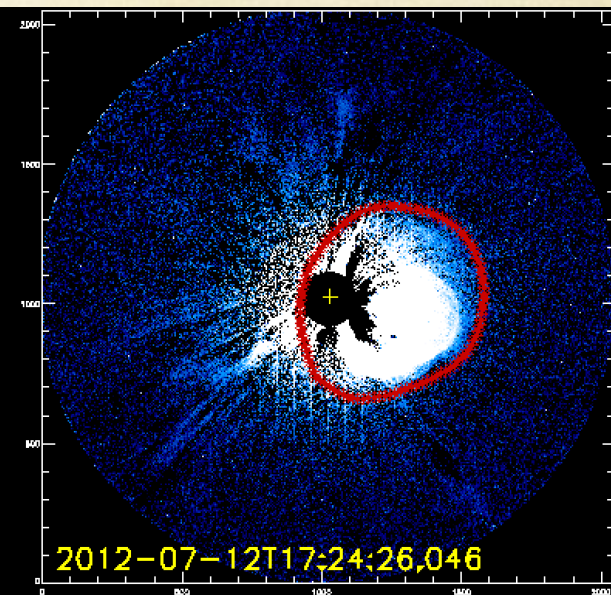
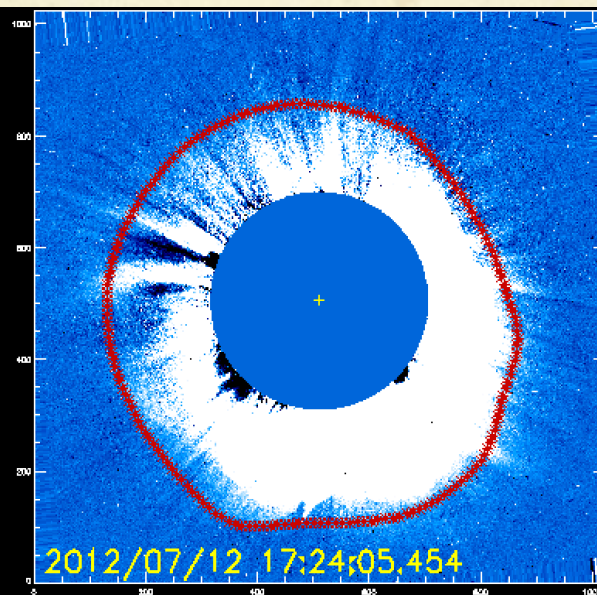
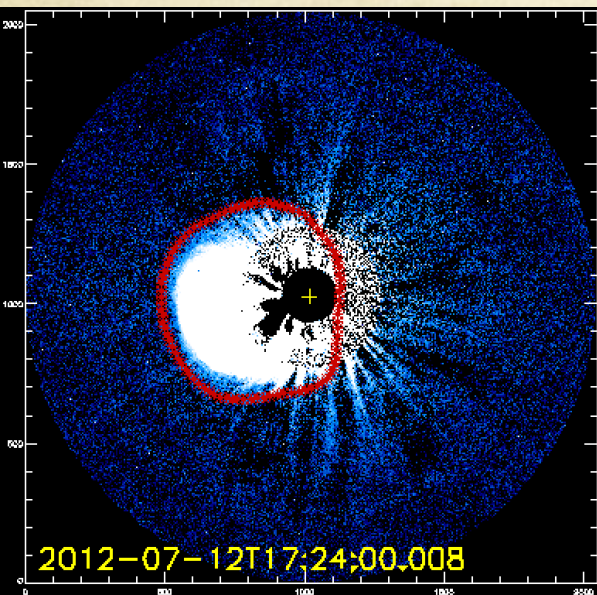
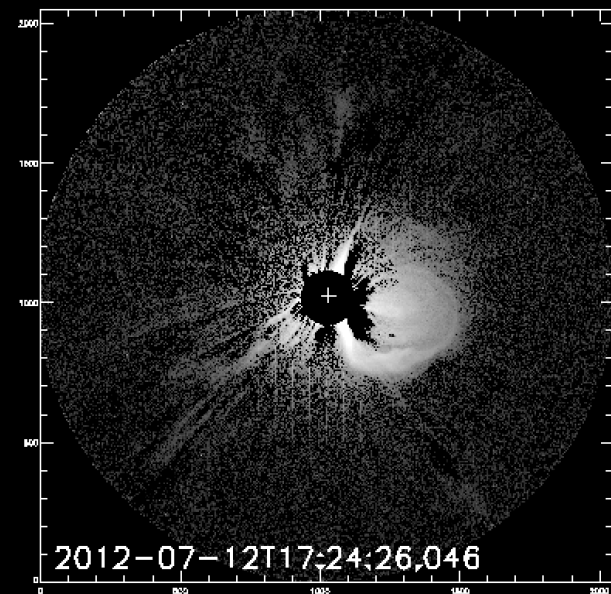
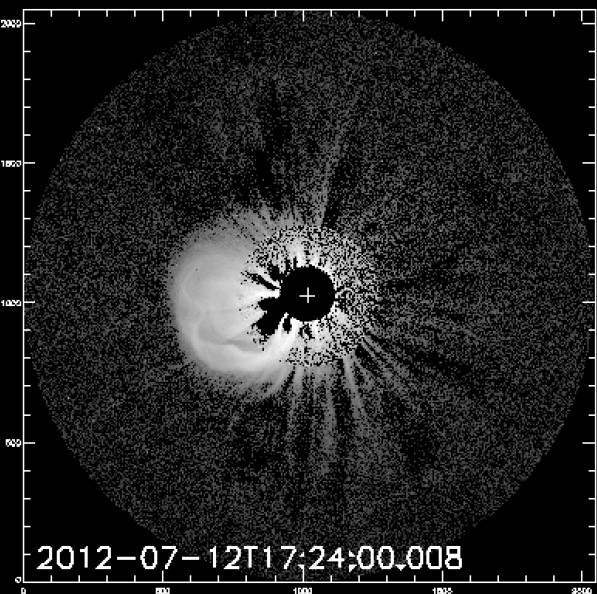


COR1+COR2 A

LASCO C2

COR1+COR2 B

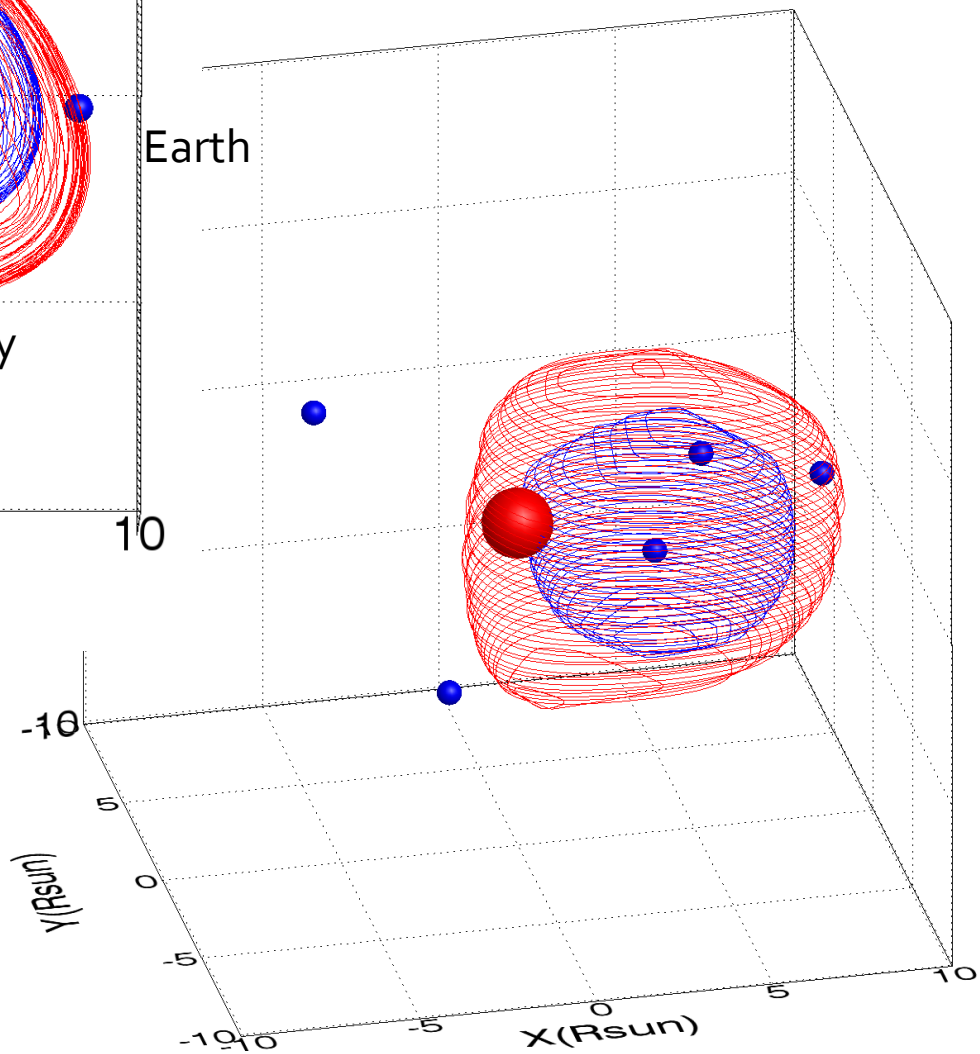
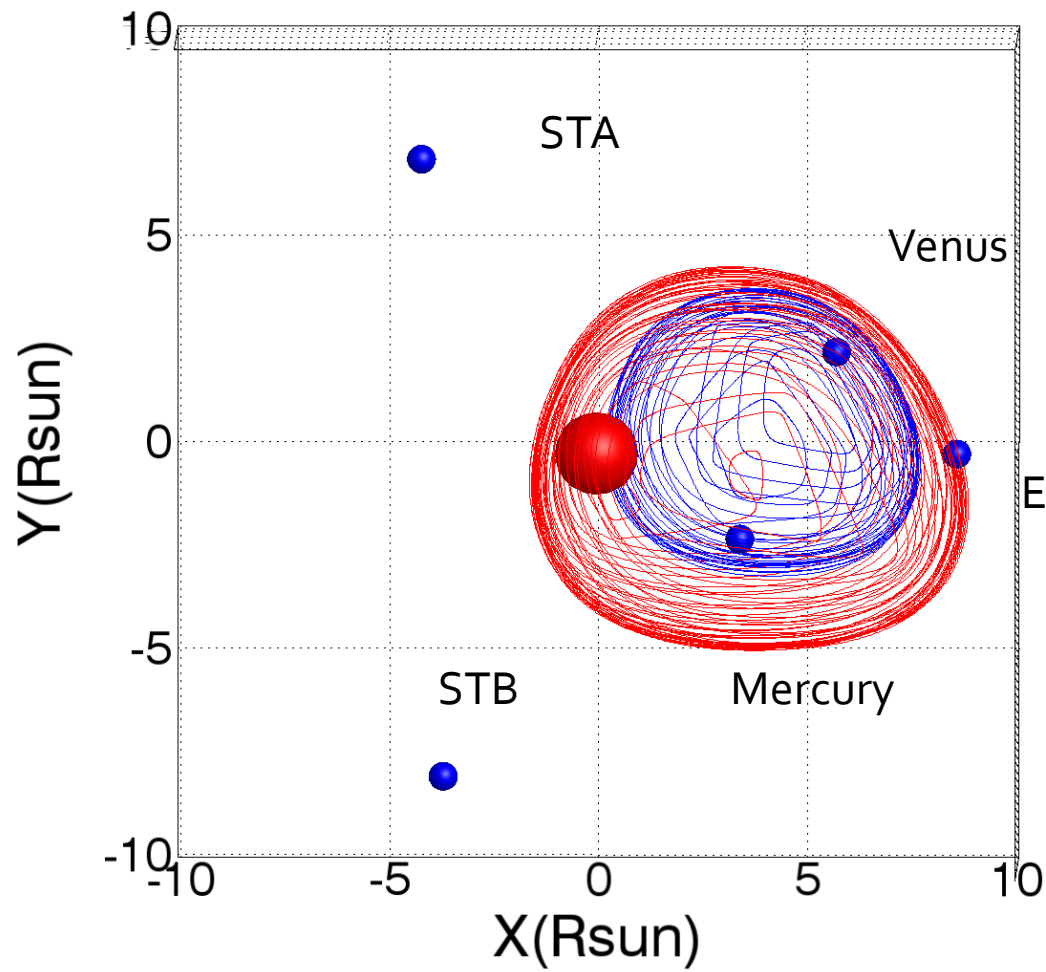
3D reconstructions of a CME and its driven shock



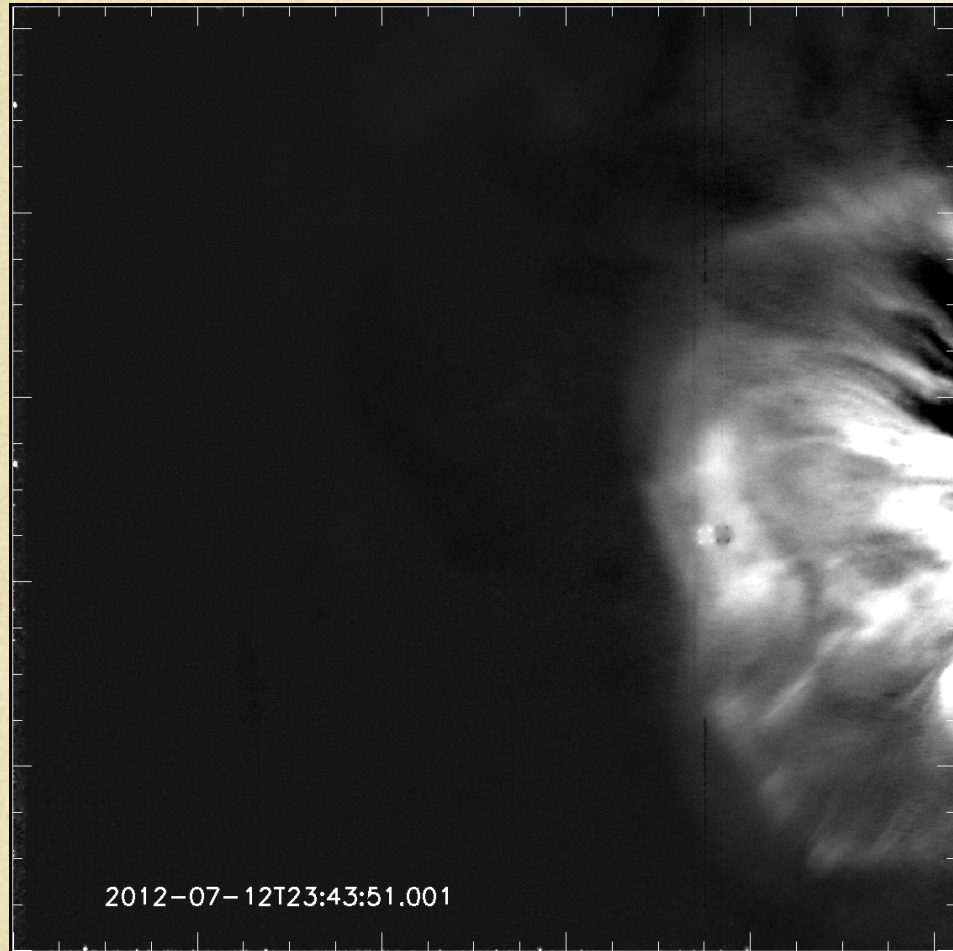
COR1+COR2 A

LASCO C2

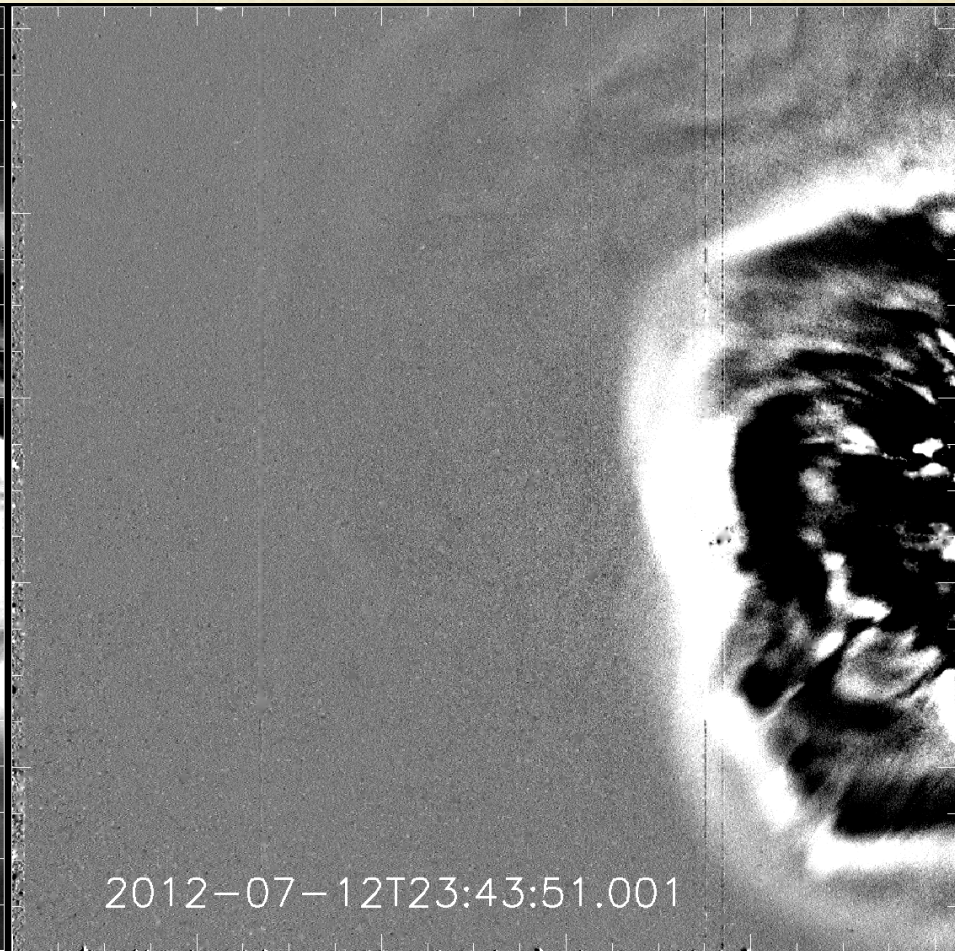
COR1+COR2 B



Extend to HI 1 observations

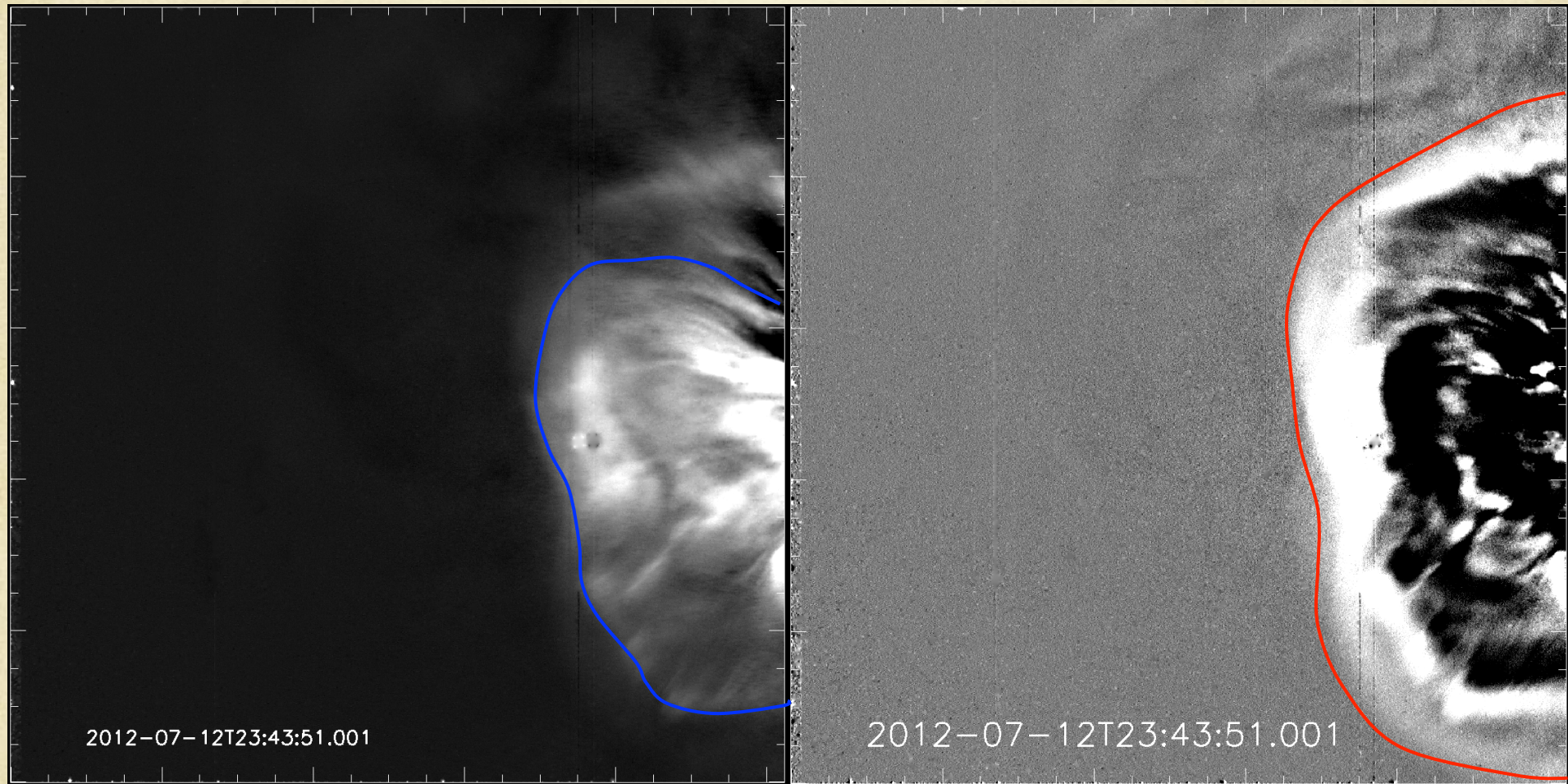


CME tracing



shock tracing

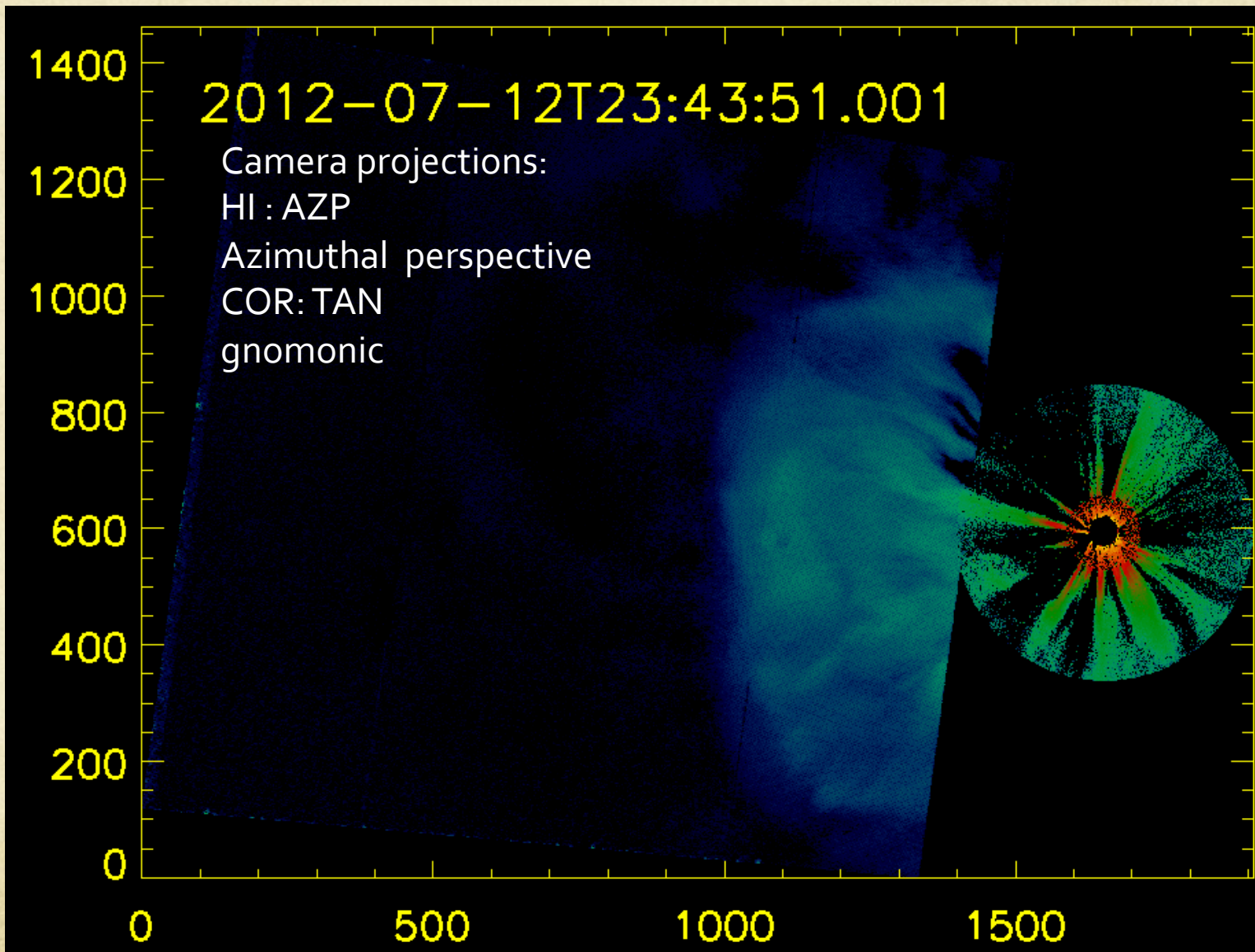
Extend to HI 1 observations



CME tracing

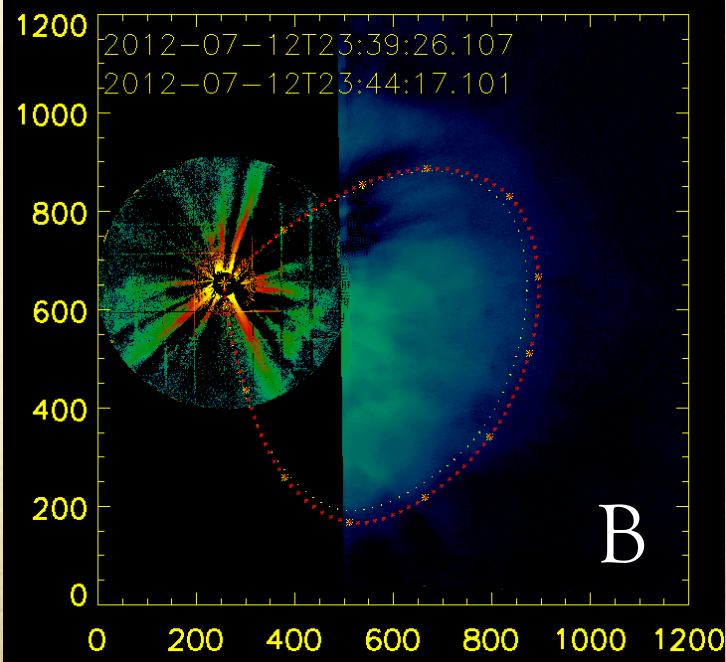
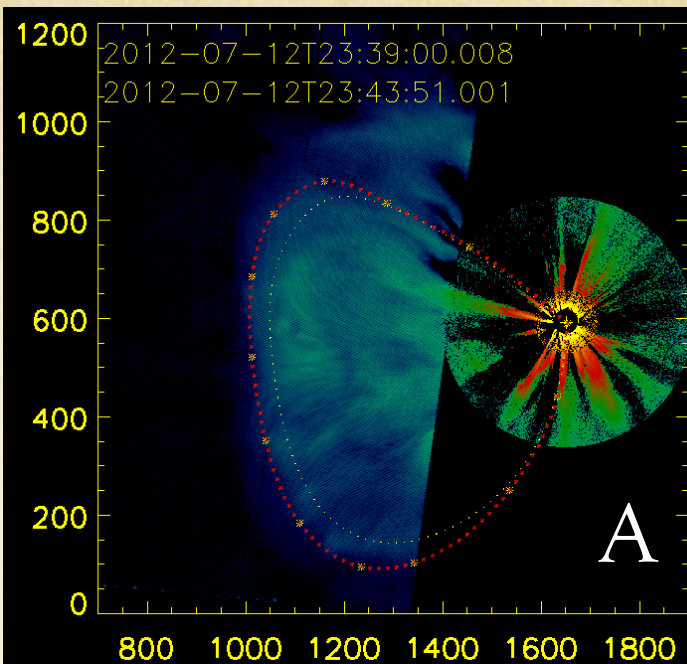
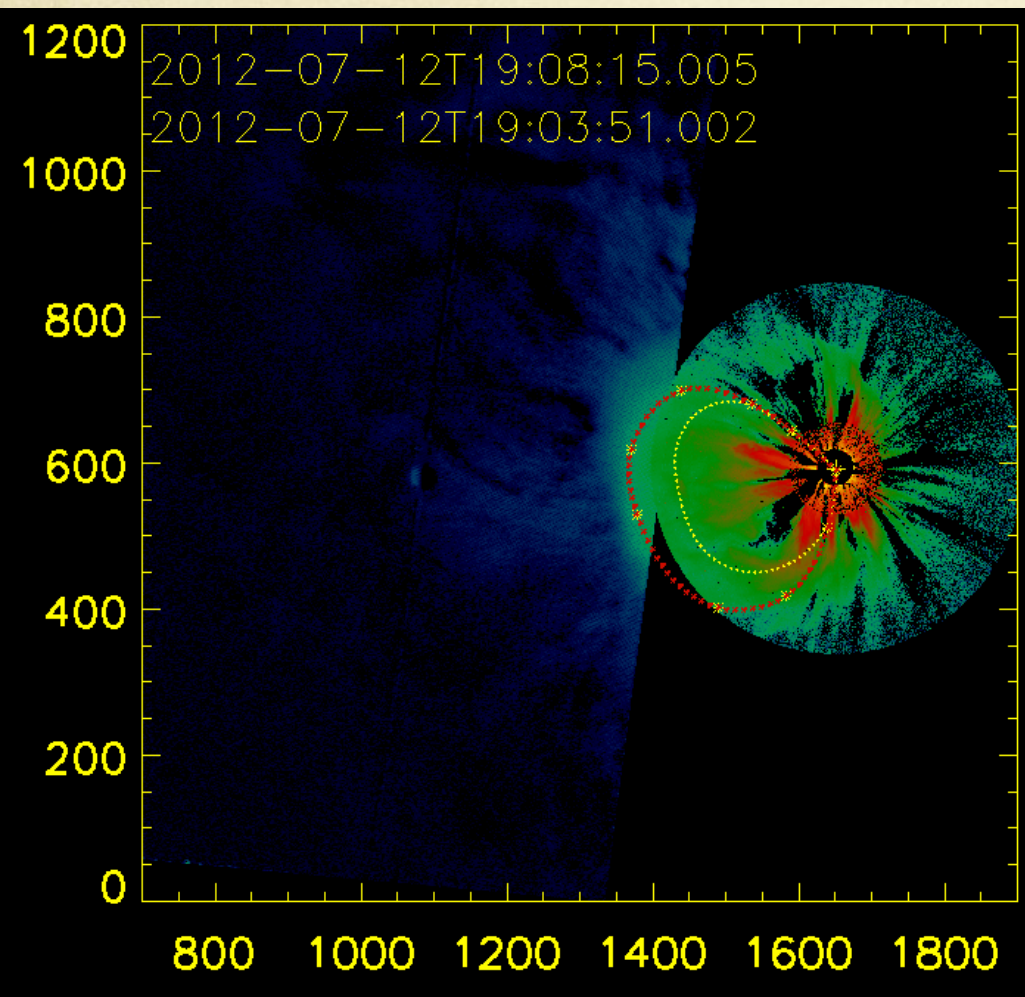
shock tracing

Combined COR+HI1

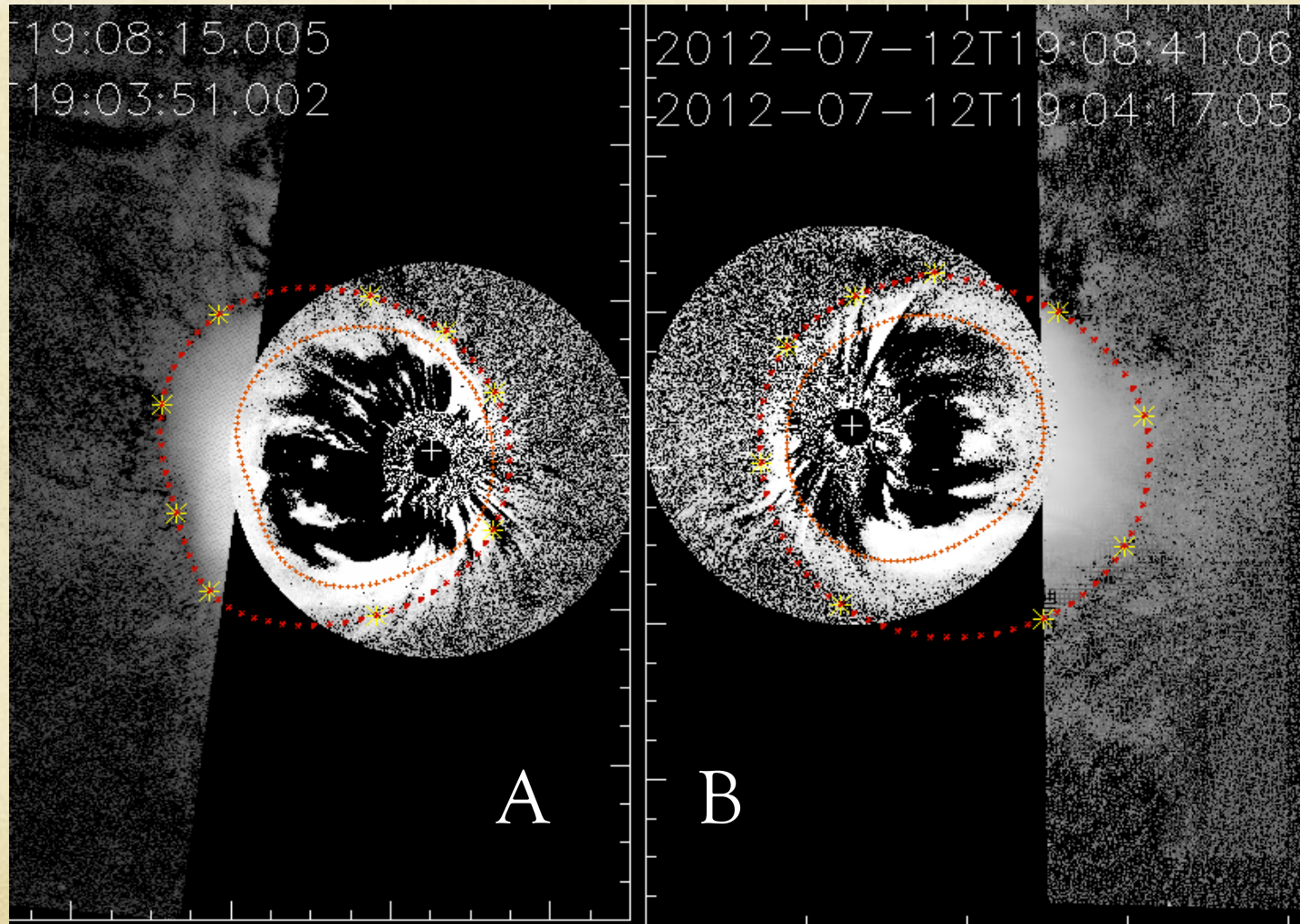


Step 2: trace CME in HI 1

Using the traced CME at an earlier time to trace the CME periphery at a later time



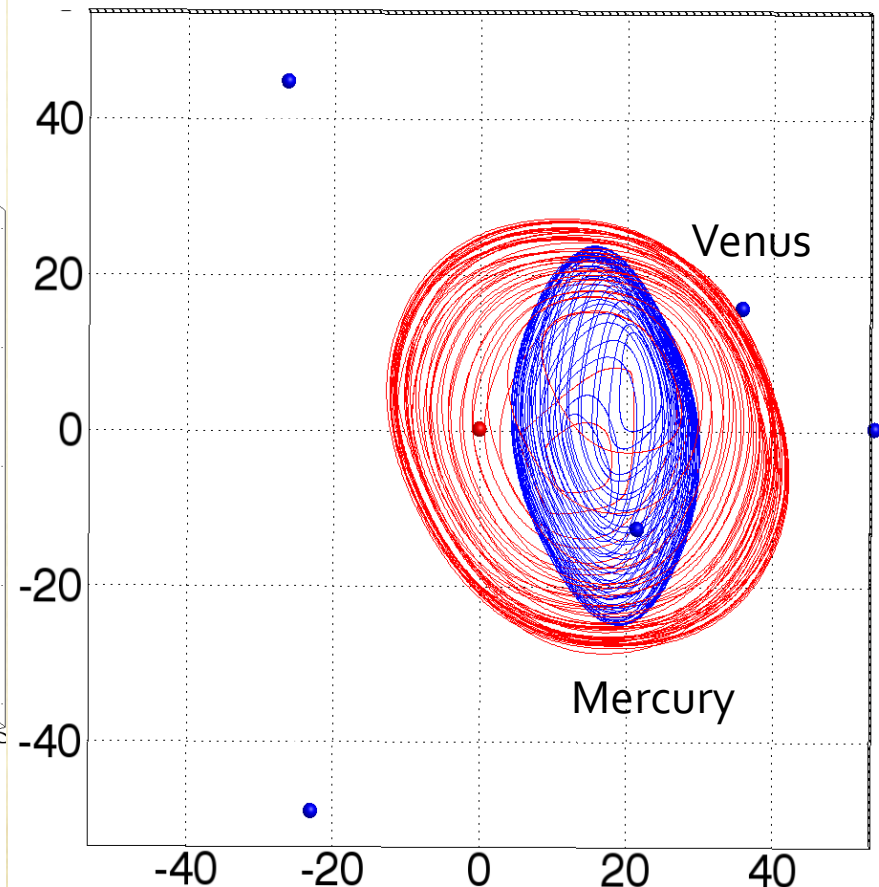
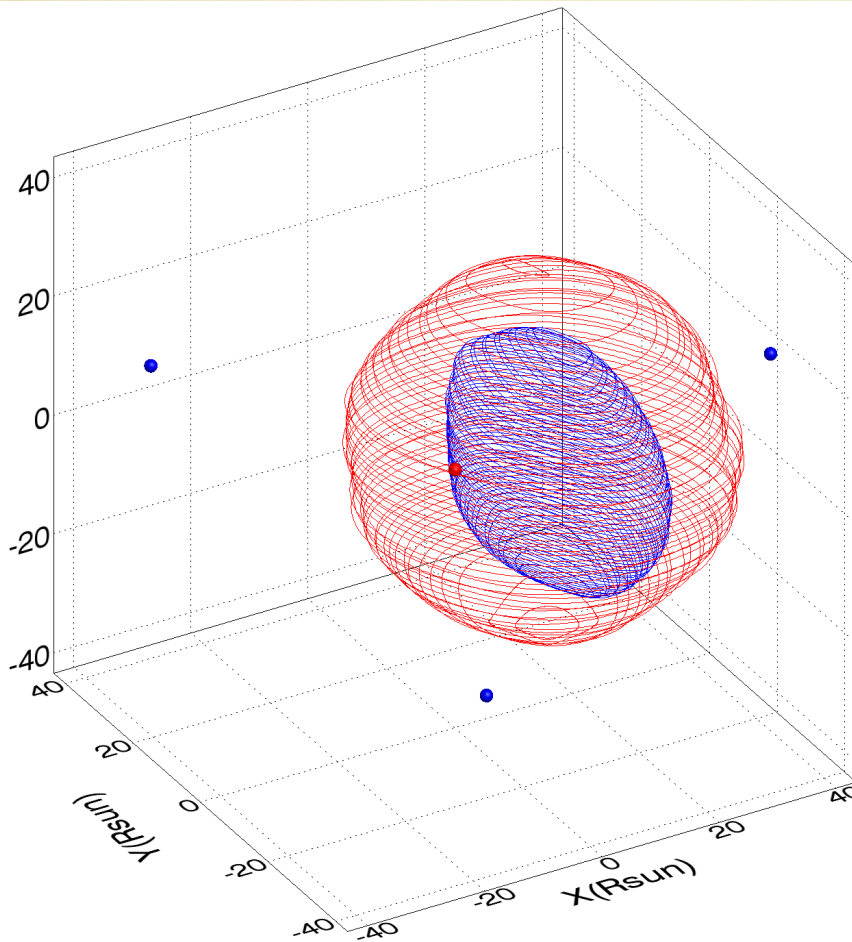
Trace shock in H11: running difference images



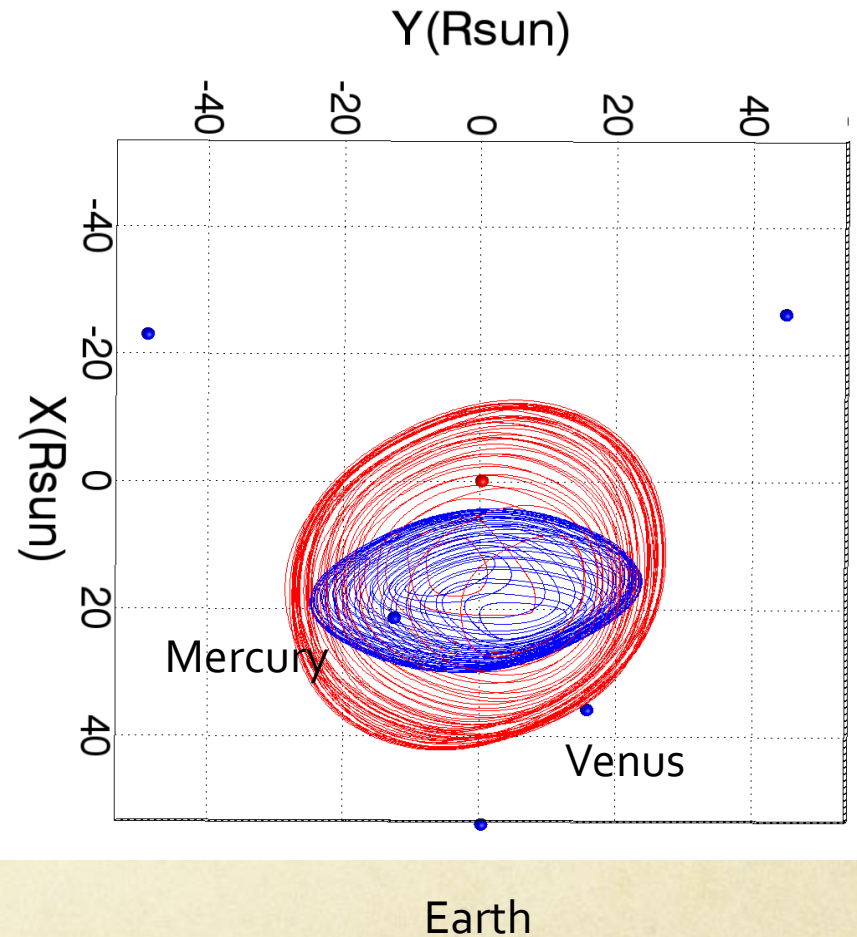
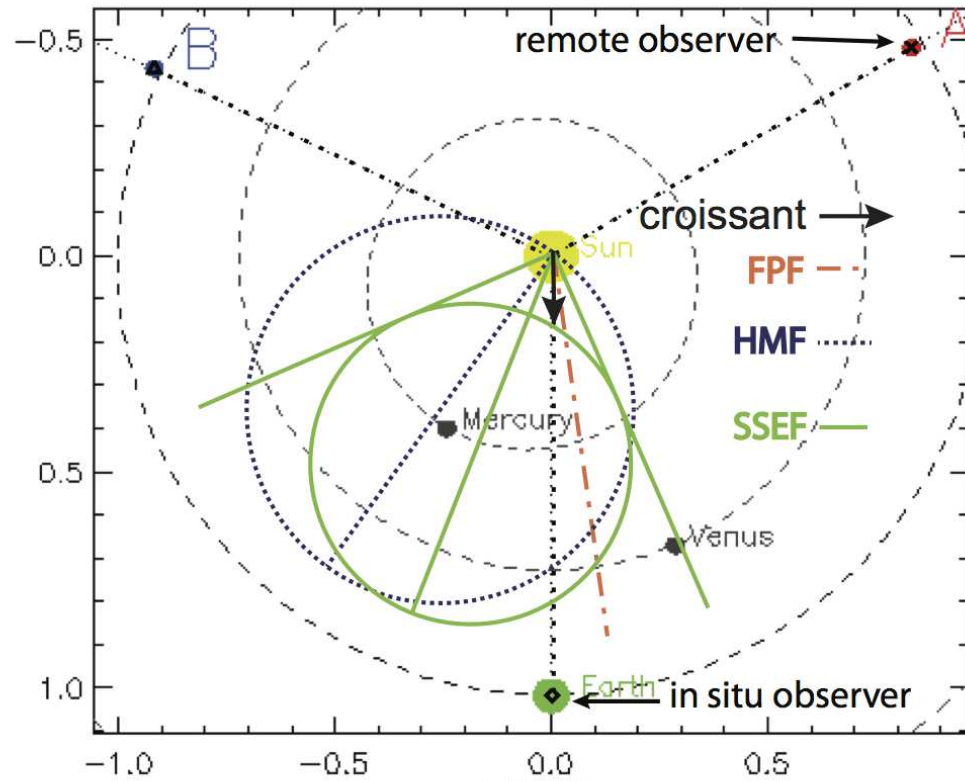
3D mask fitting reconstruction

Blue : 3D CME from STA+STB

Red : 3D shock from STA+STB+LASCO/C3



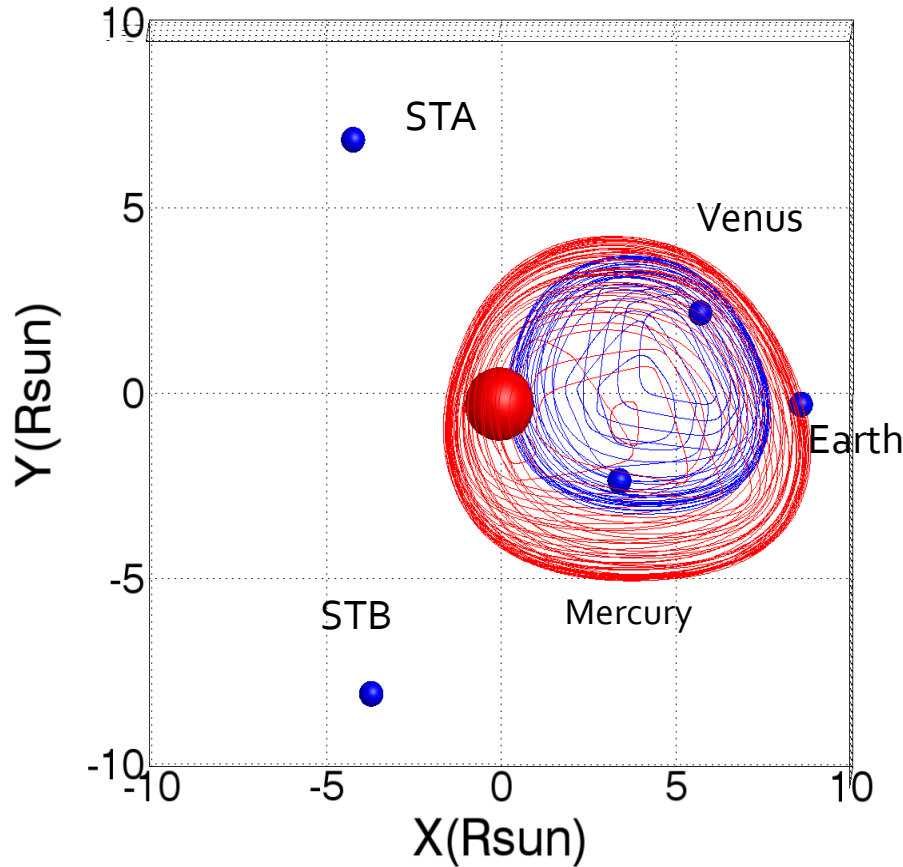
Method comparison of 3D CMEs from COR+HI1



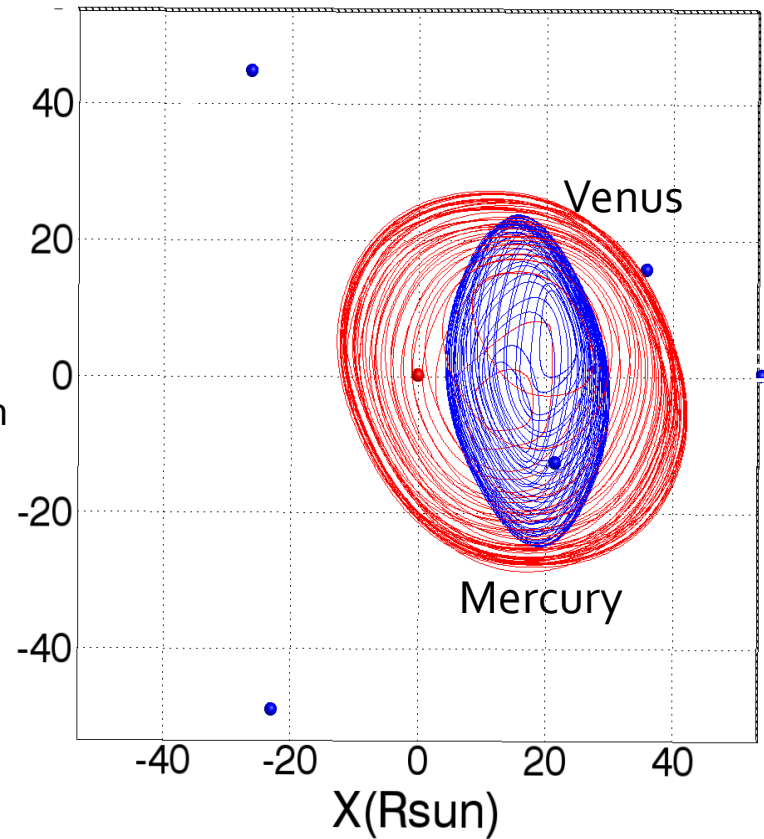
Moestl et al. 2014, ApJ

2012-07-12 CME

Morphological evolution (2012-07-12 CME)

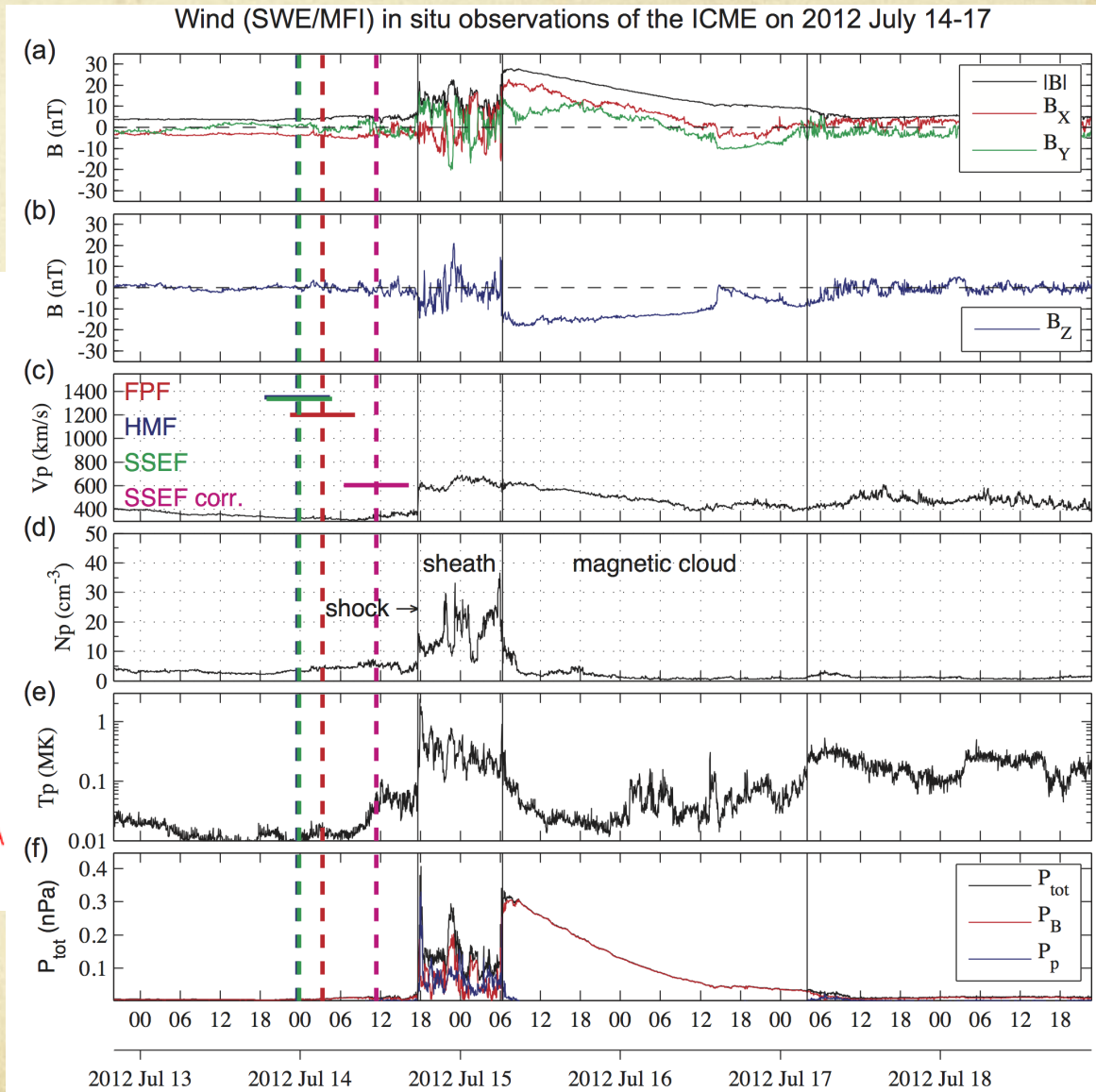
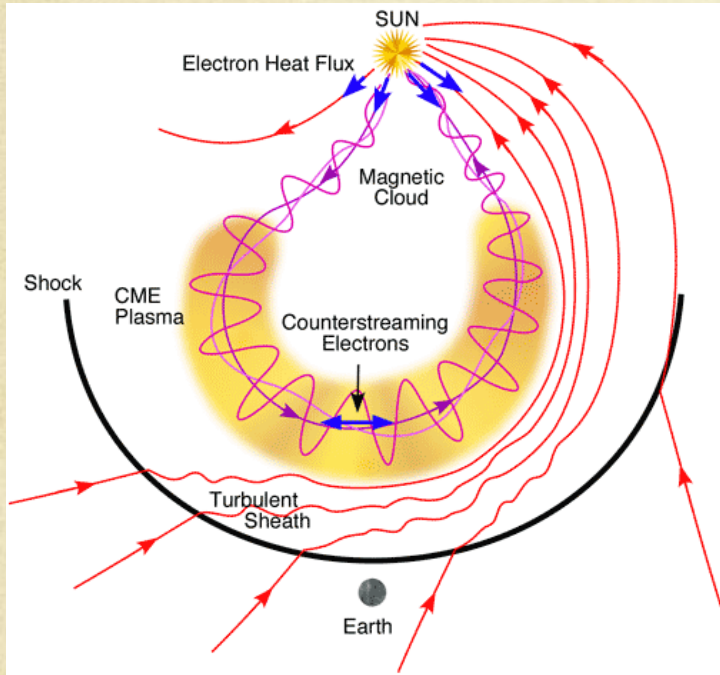


17:24 UT

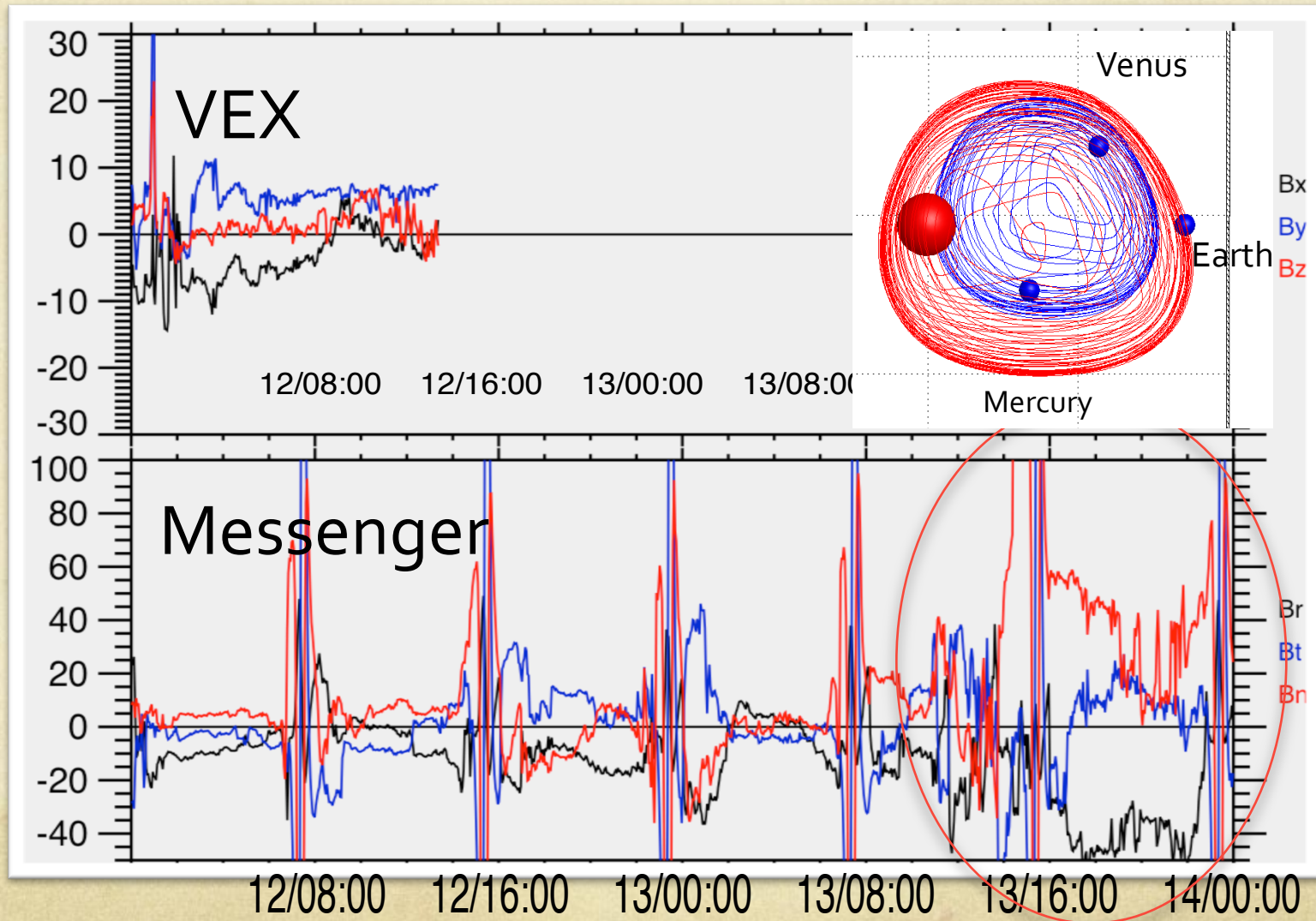


23:20 UT

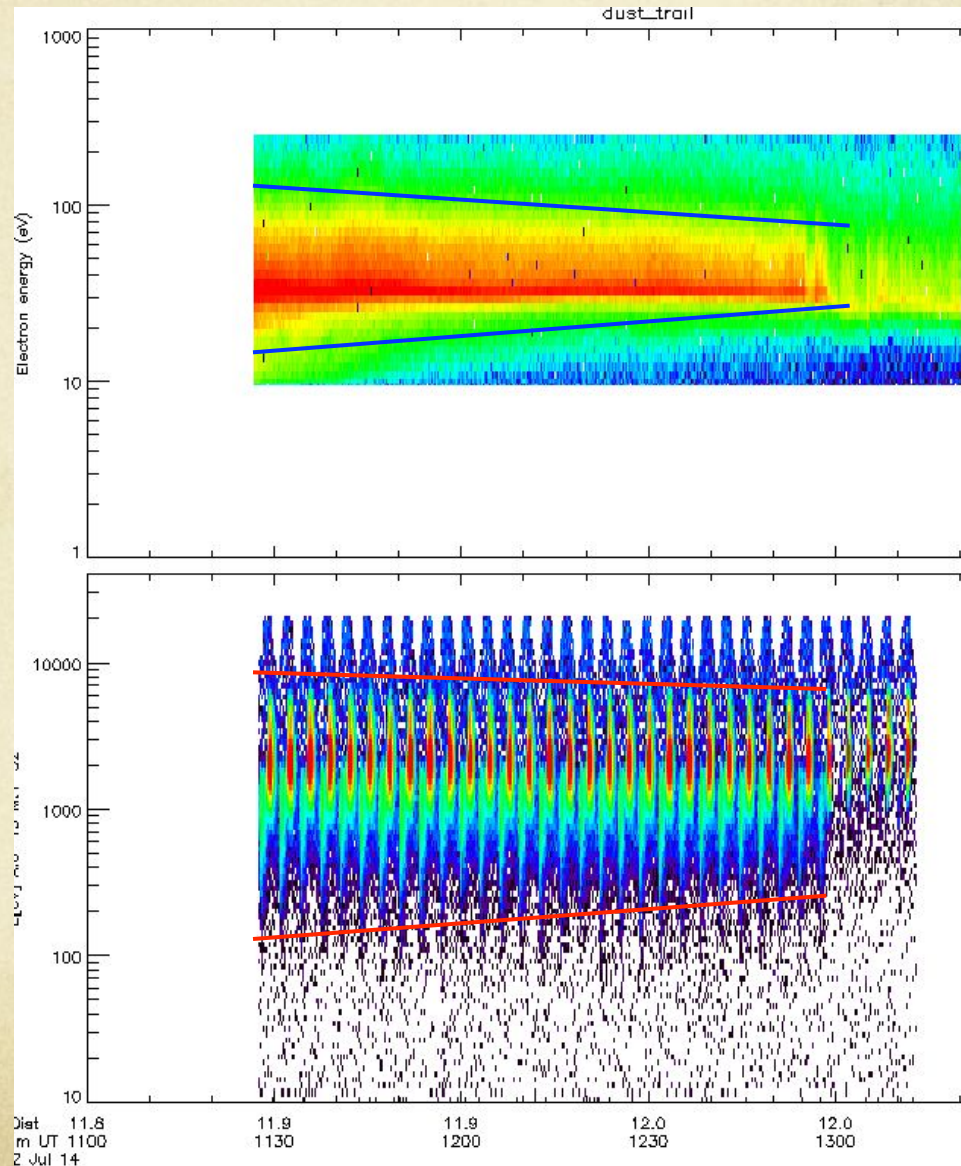
Link to in-situ observations



Magnetic field data of Messenger and VEX



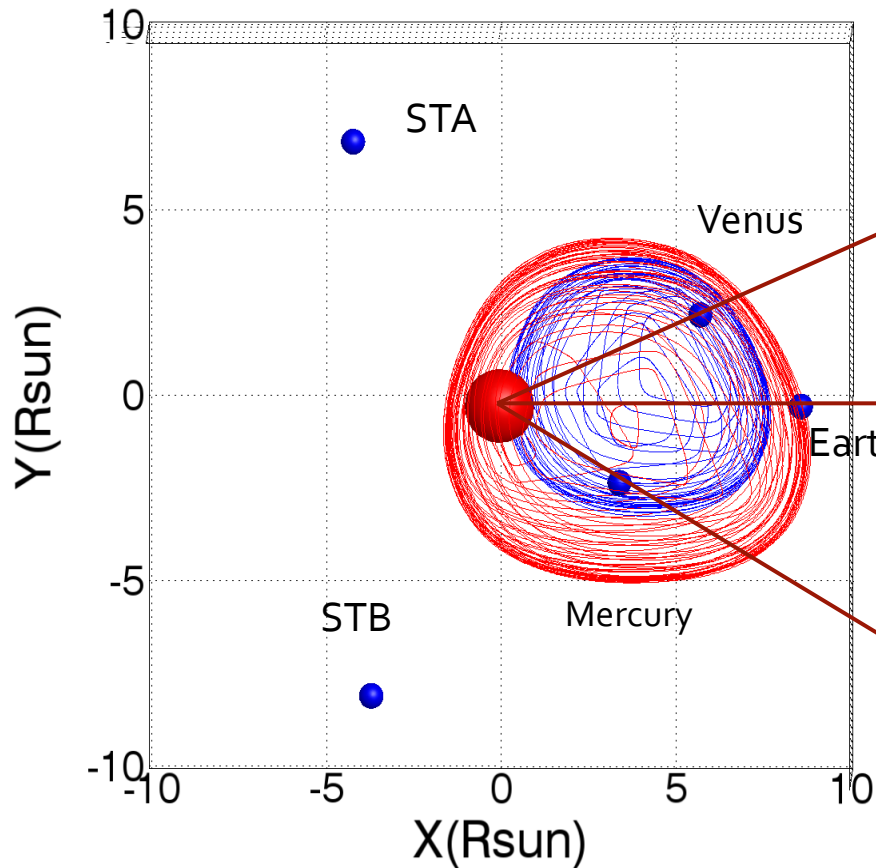
VEX electron and ion spectral width probably heated plasma by the shock on July 14th



electron

ion

Validation of the 3D reconstruction



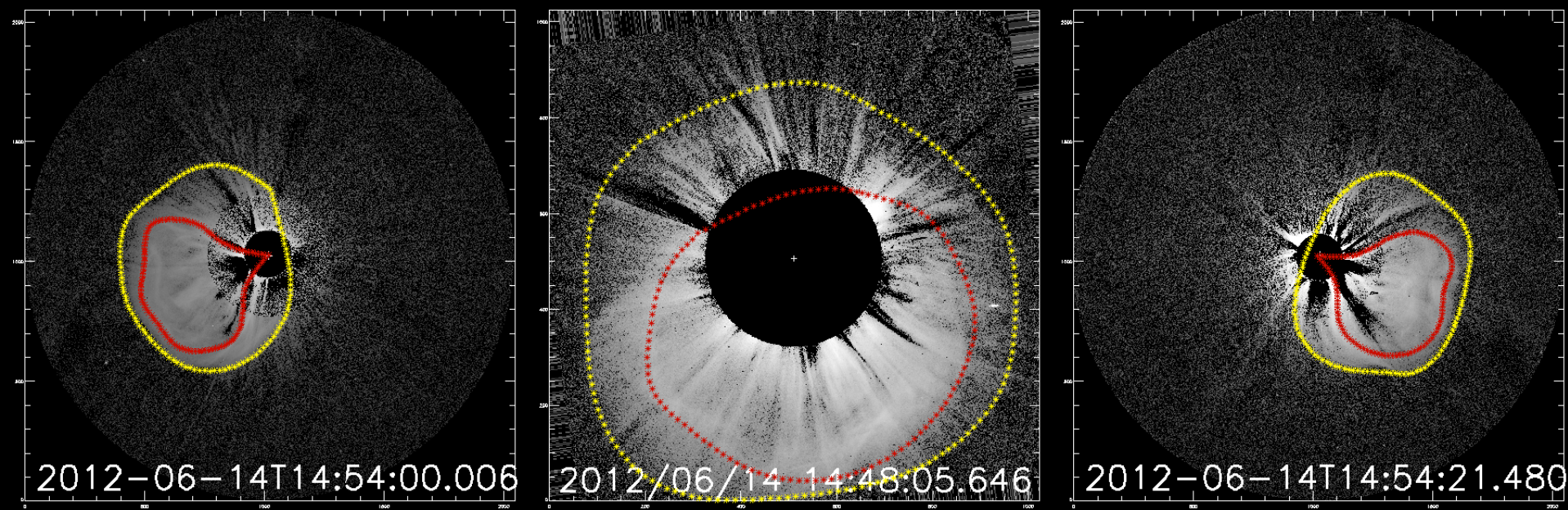
Venus: 0.72 AU, 157 Rs
Shock: < 07-14 11:30 UT
CME: 07-14 13:00 UT

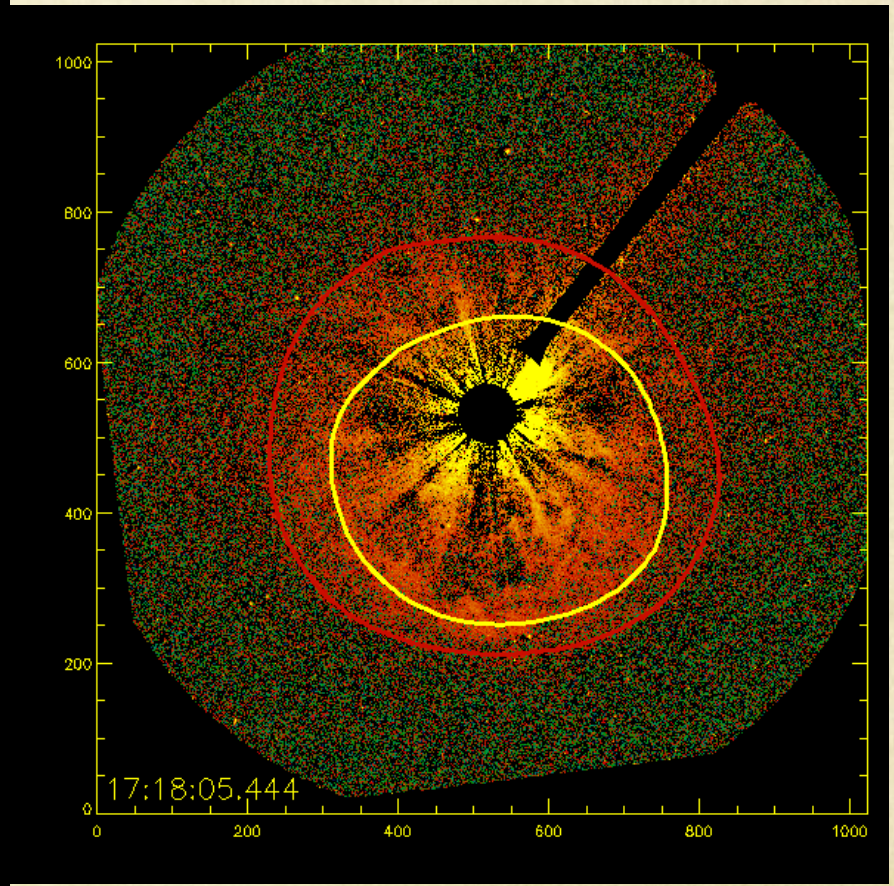
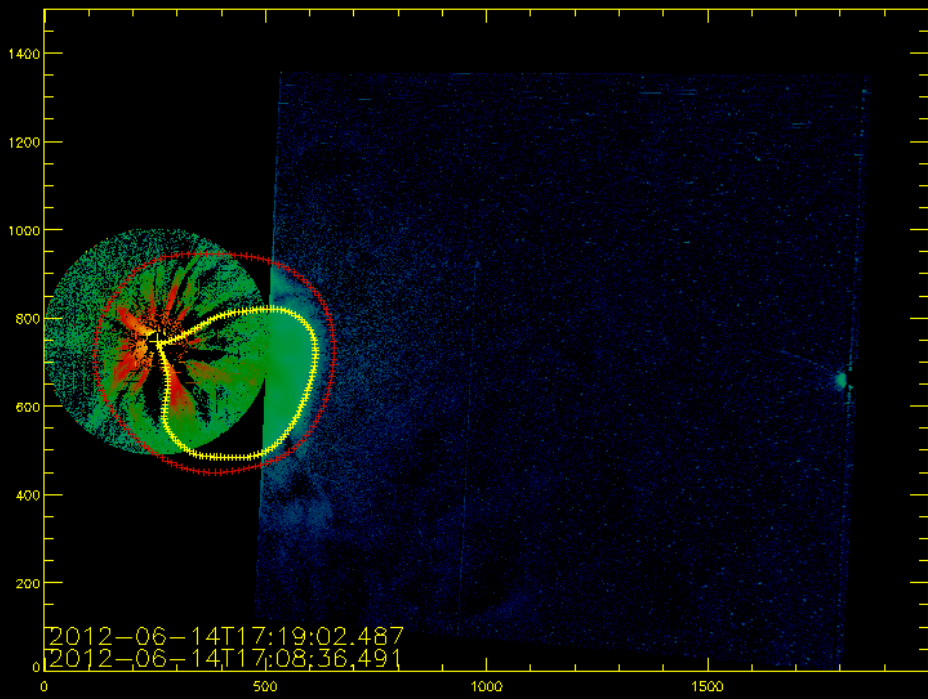
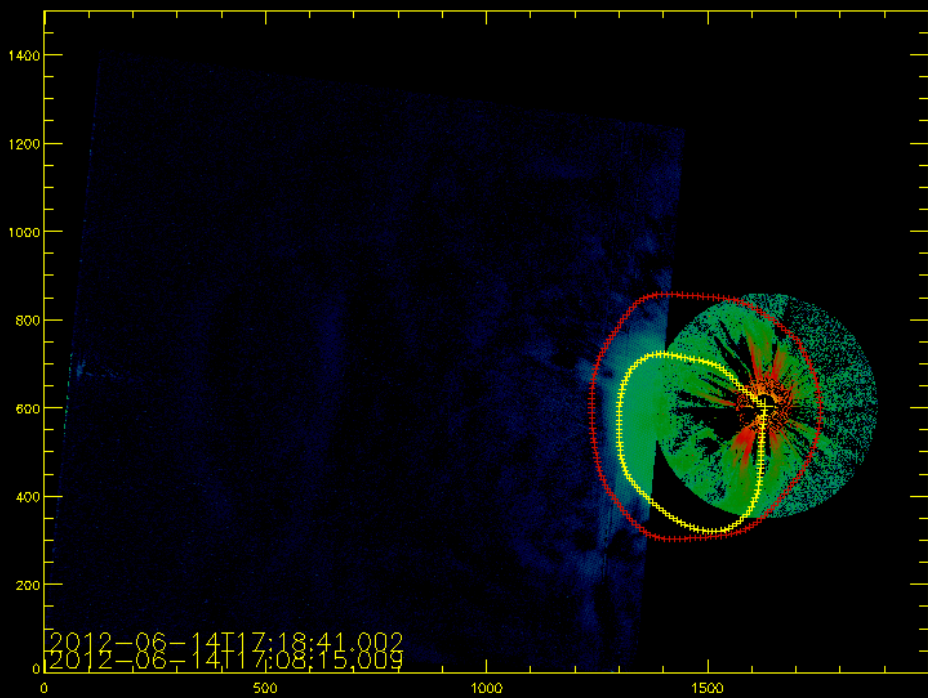
Earth: 1AU, 218 Rs
Shock: 07-15 17:00 UT
CME: 07-16 06:00 UT

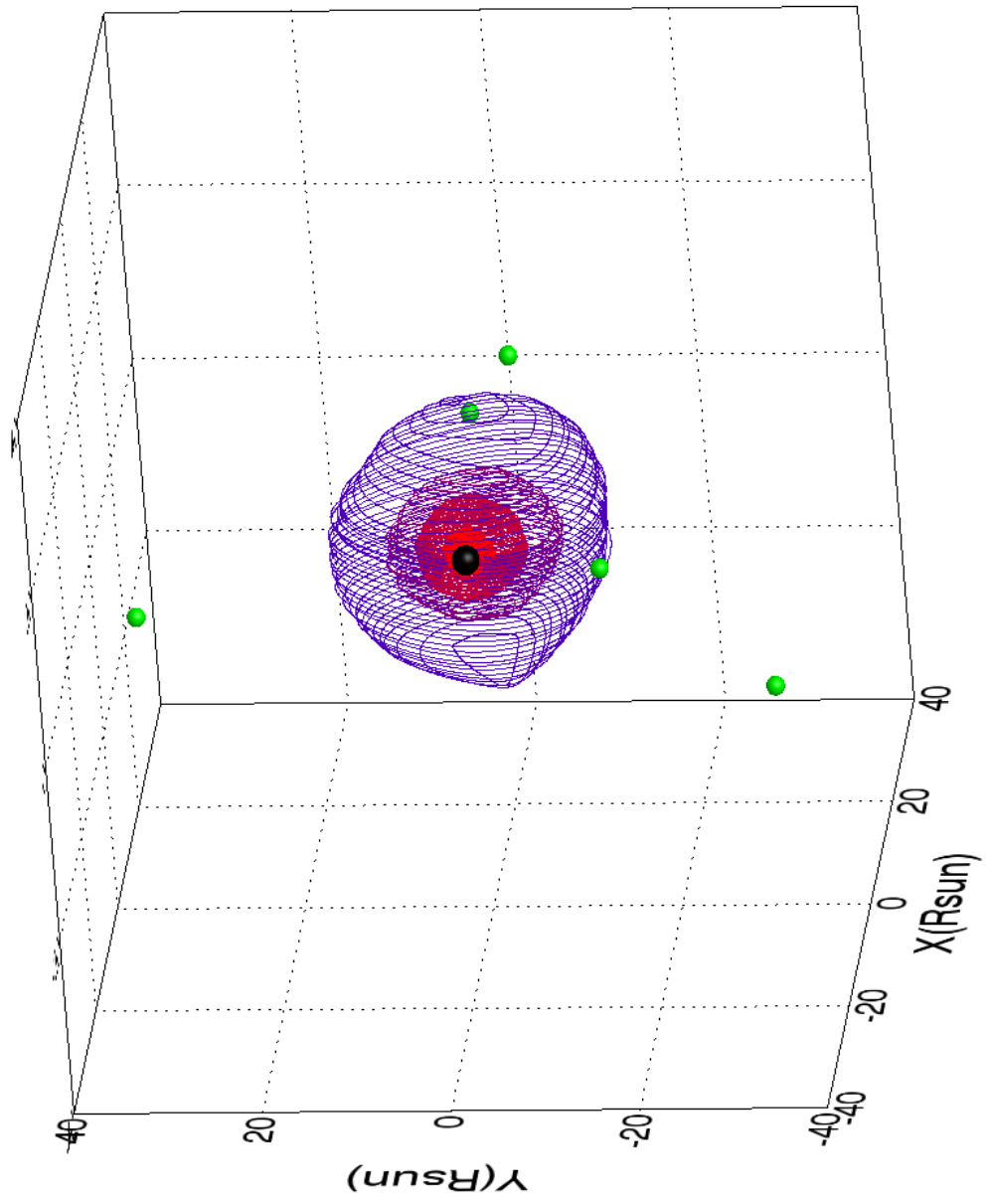
Mercury: 0.46 AU, 100 Rs
Shock: 07-13 11:00 UT
CME: 07-13 17:00 UT

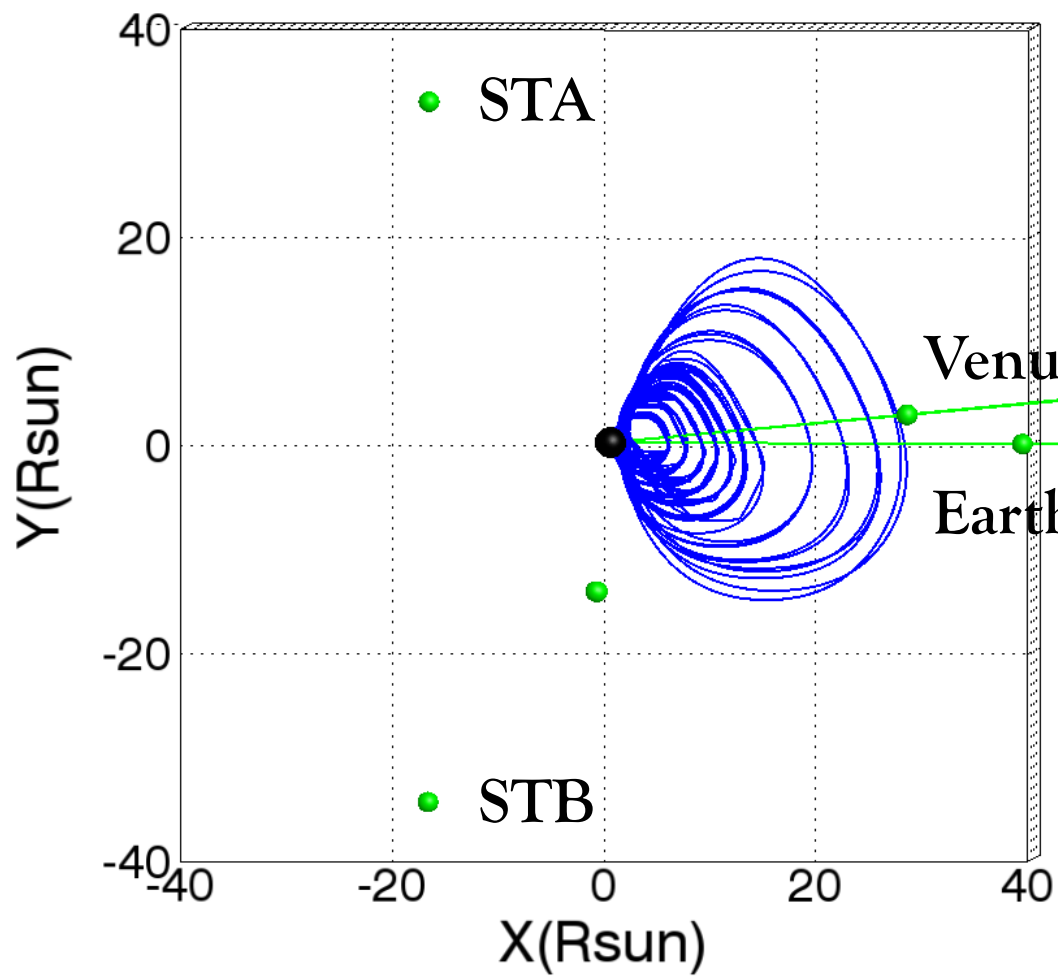
07-12 15:37 UT: Flare onset

2012-07-12 event does not have continuous LASCO observations,
another event on 2012-06-14 being analysed has better data coverage

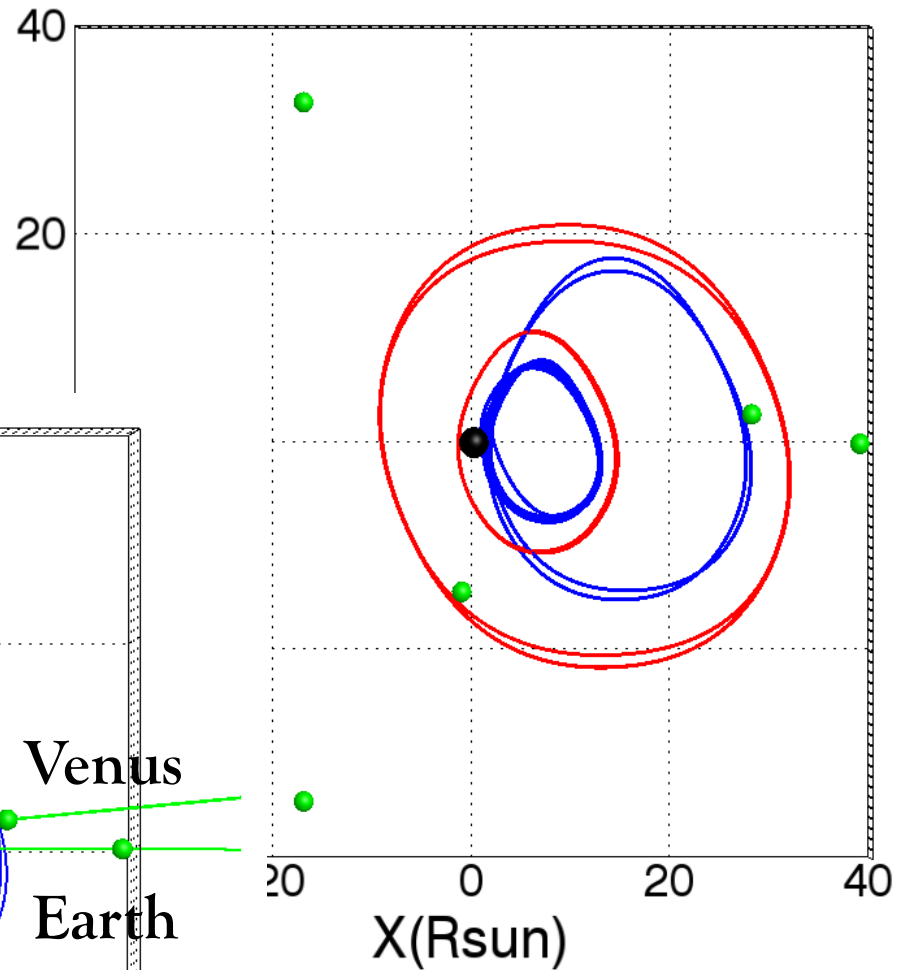








n)



Conclusions and Outlook

We have reconstructed the 3D morphology of CMEs and CME-driven shocks using coronagraph and heliospheric images from three different viewpoints.

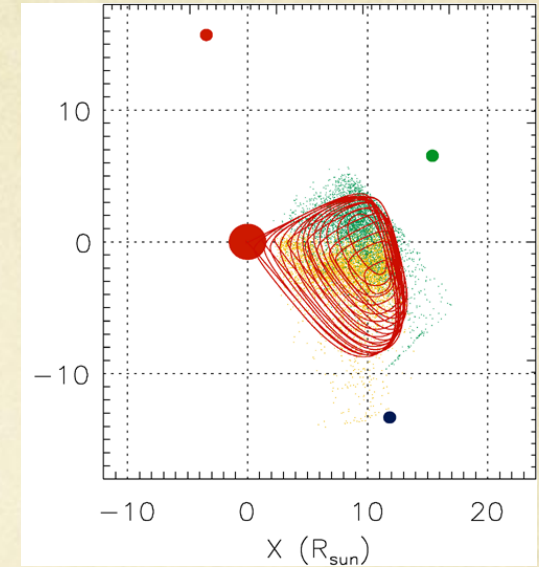
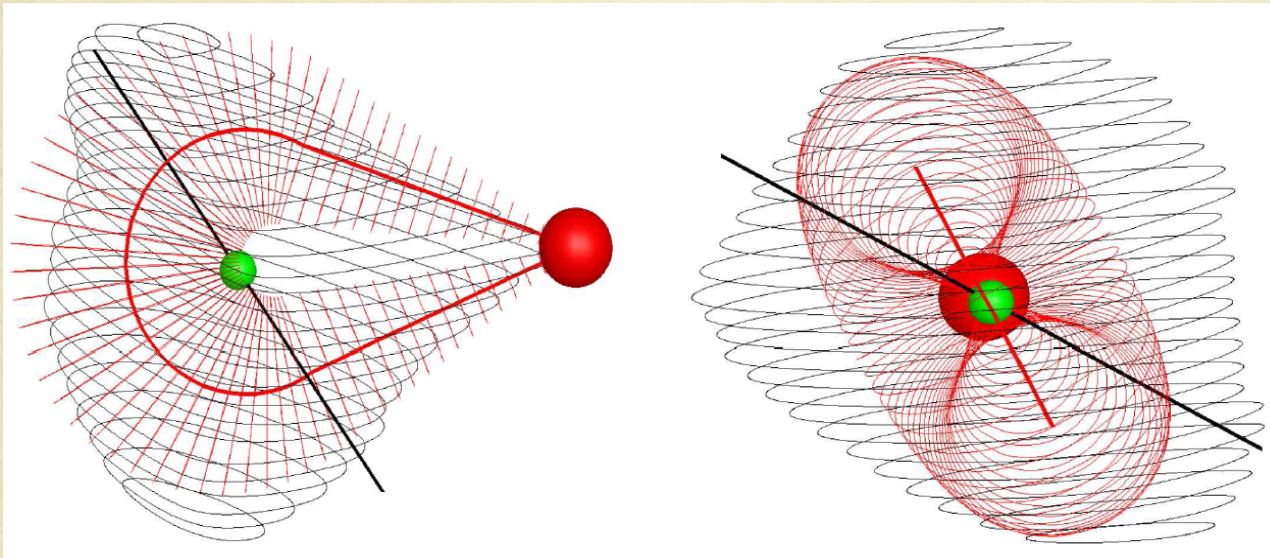
Outlook:

- (1) Kinematics of CMEs and shocks along different directions
- (2) Evolution of stand-off distance along different directions
- (3) CME arrival time prediction at different planetary locations
- (4) Link 3D reconstruction to the in-situ data at different planetary locations

Backup slides

Method Comparison of 3D CMEs from COR

2010-08-07 CME



Black: mask fitting ; Red : GCS forward modelling

Polarization ratio:
green and yellow

Advantage of mask fitting method : no a-priori assumption of the shape