

Analysis of August 31, 2007 Filament Eruption



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STEREO/SECCHI Dublin March 2010

Outline

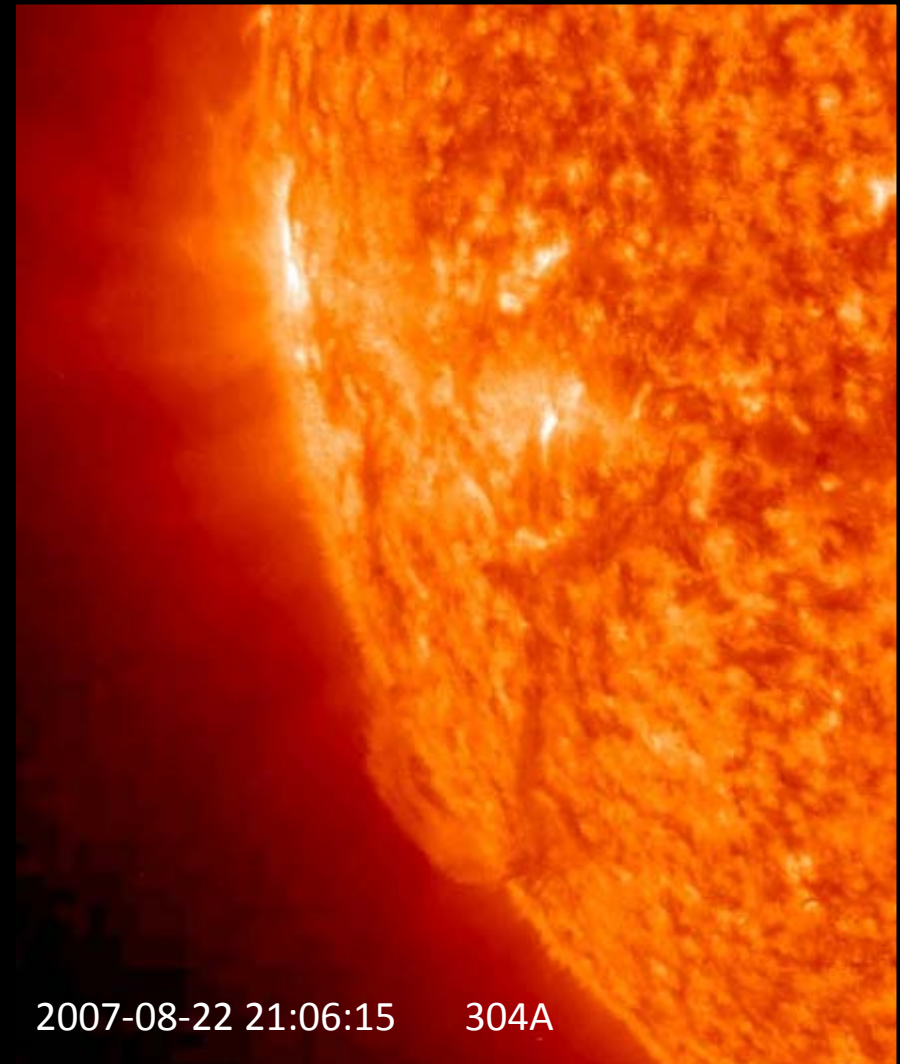
- Pre-Eruption: Context & Stereoscopic Analysis
 - Determine Chirality from Barb
- Possible cause of Eruption: Loss of equilibrium via weakening of overlying arcade
- Eruption: Confirmation of Chirality
- Stereoscopic Reconstruction of Prominence Eruption and CME

U-Shaped Filament on August 22, 2007

Stable throughout disk transit; erupts as approaches west limb

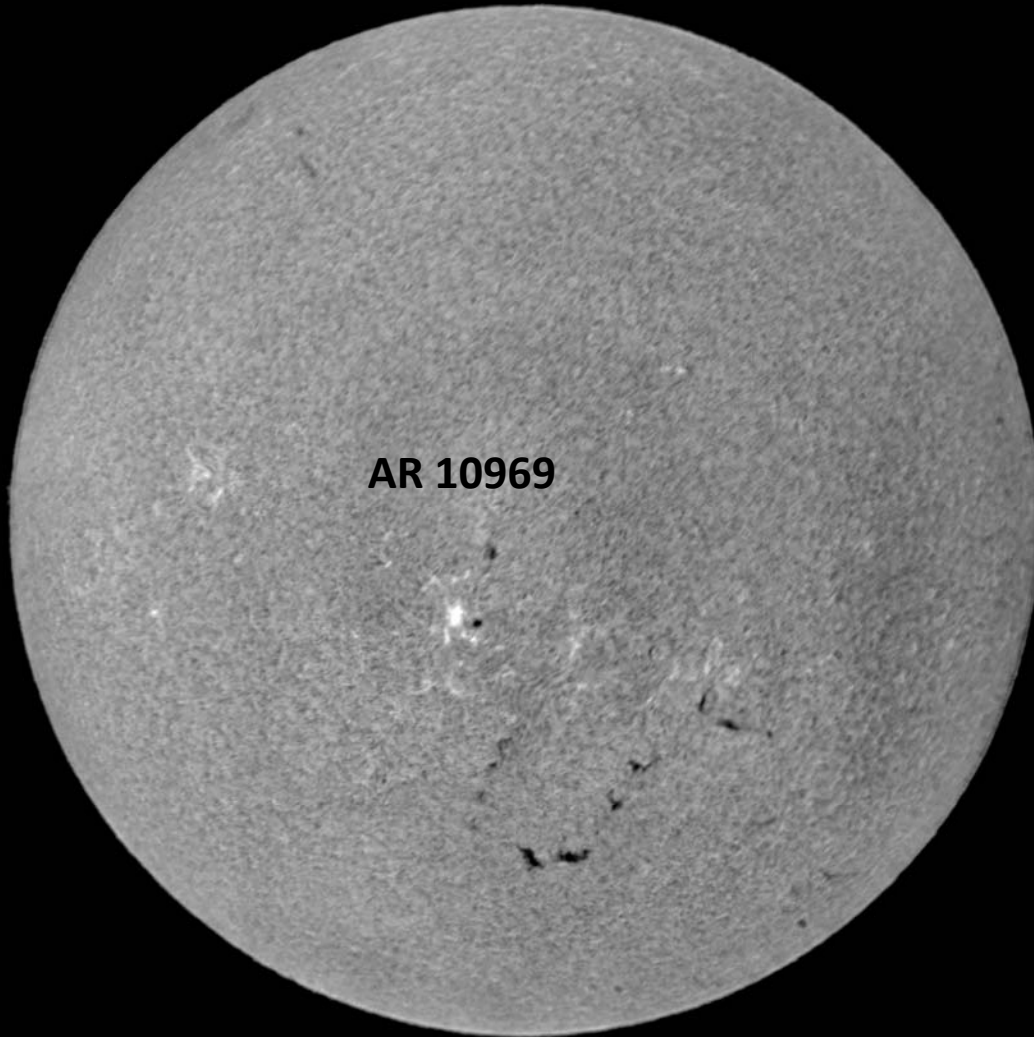
East limb: U-shape of the prominence is already clear visible STEREO A (Ahead) EUVI 304

Note active regions near tops of the U





Prominence in H α on 8/27 and 8/29/2007

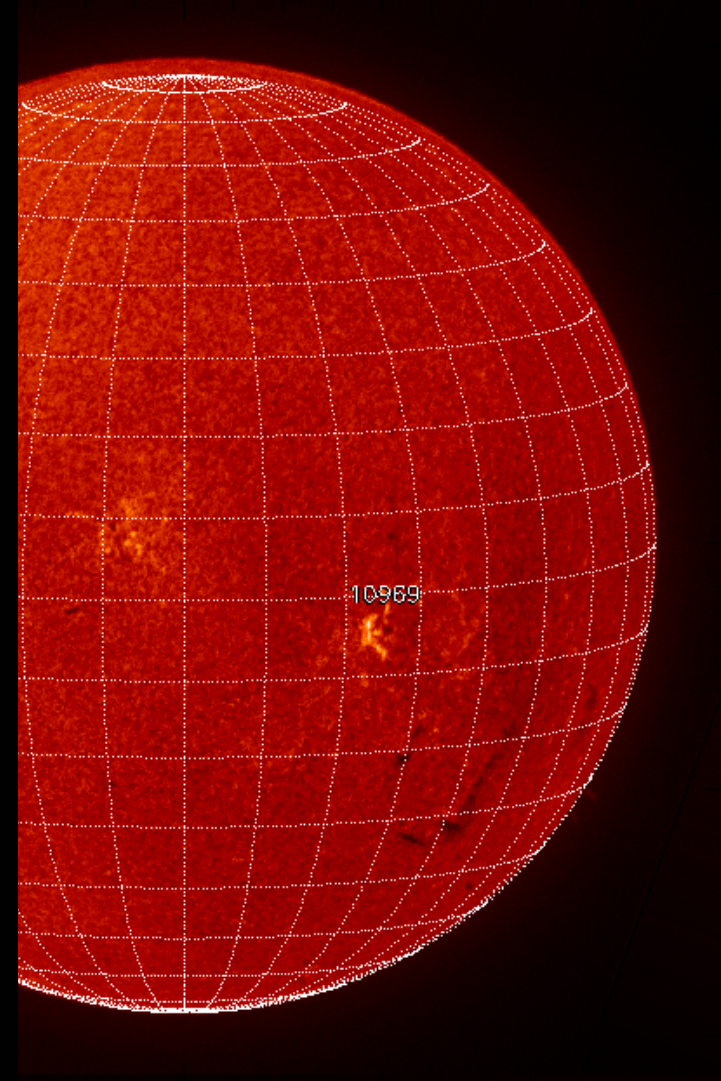


AR 10969

Kanzelhoehe Solar Observatory
2007-08-27 06:01:07 UT

2007-08-27 06:01:07 UT

Kanzelhoehe H-alpha 29-Aug-2007 13:15:24.000



10969

0 500 1000
X (arcsec)

2007-08-29 13:15:24 UT

Kanzelhoehe Solar Observatory H-alpha



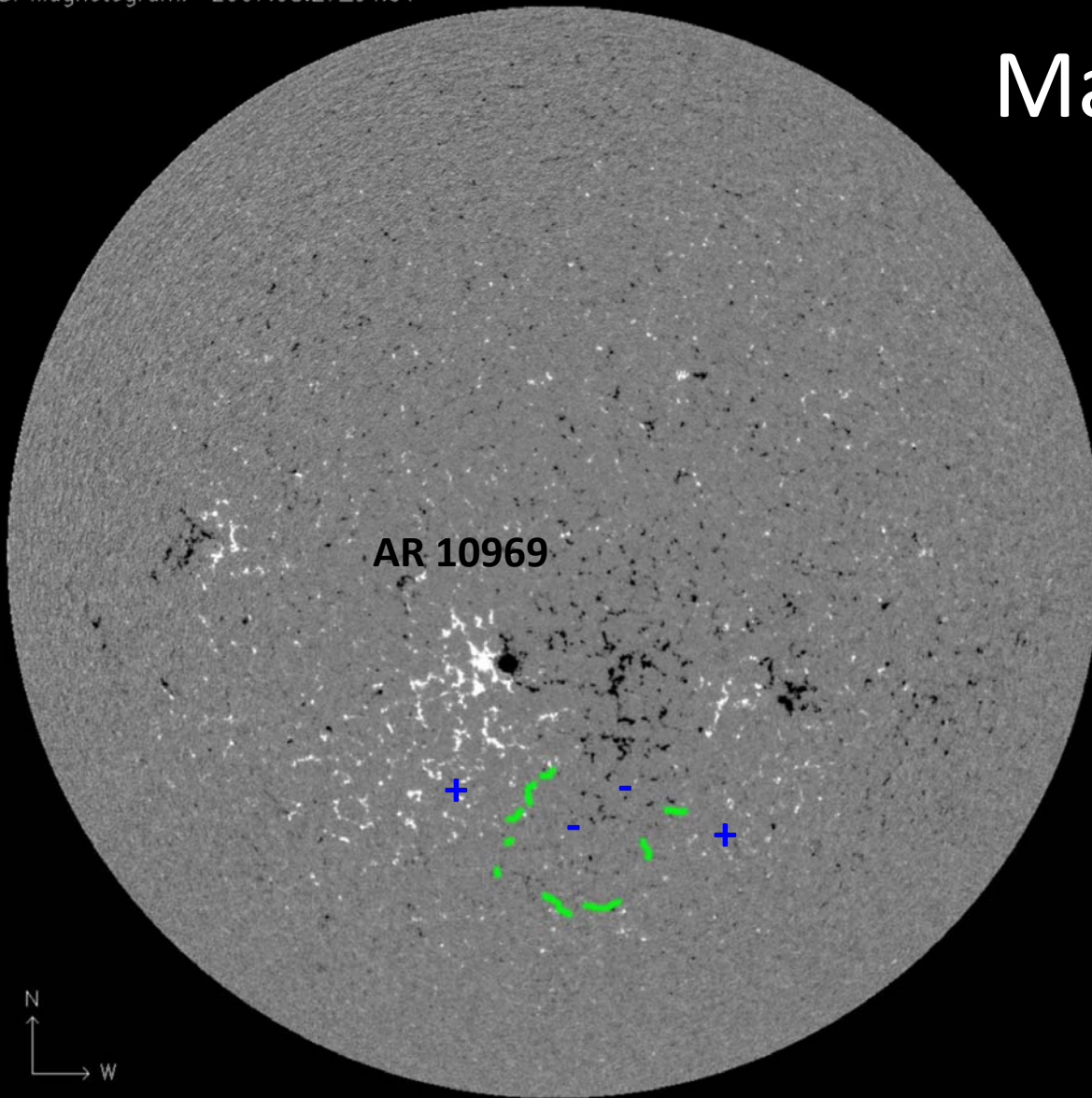
MDI Magnetogram: 2007.08.27_04:51

Prominence & Magnetogram

2007-08-27

Superposition of the MDI magnetogram and KSO H-alpha image of the filament (green)

Intermediate prominence – negative polarity “inside” U



AR 10969

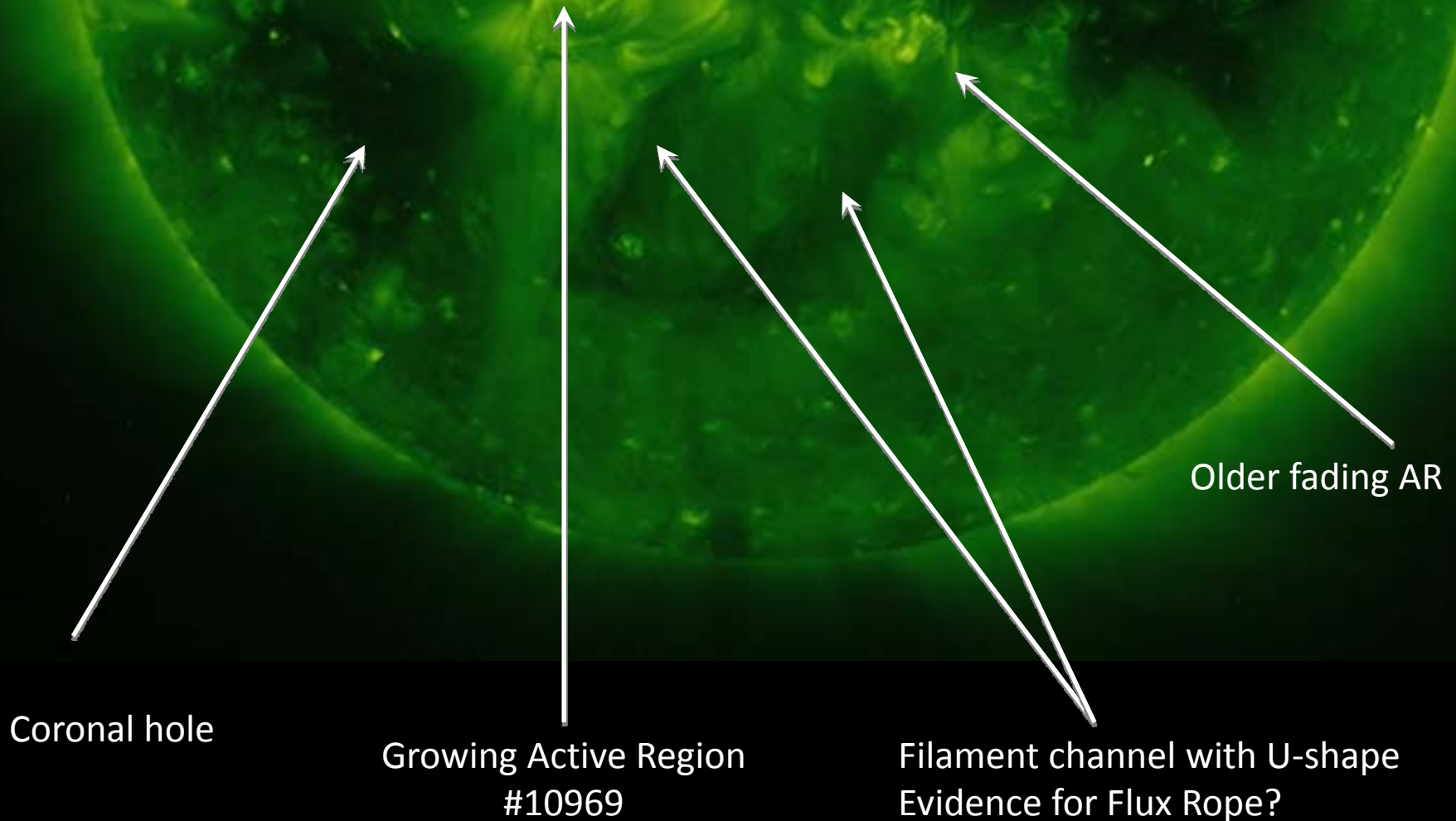
Plot Made 1-Nov-2007

50000 km

New & Old ARs

Coronal Context

STEREO B, 195 Å, 2007-08-25 13:35:30 UT





Pre-Eruption Prominence on 8/23 & 8/26/2007

STEREO B EUVI 304

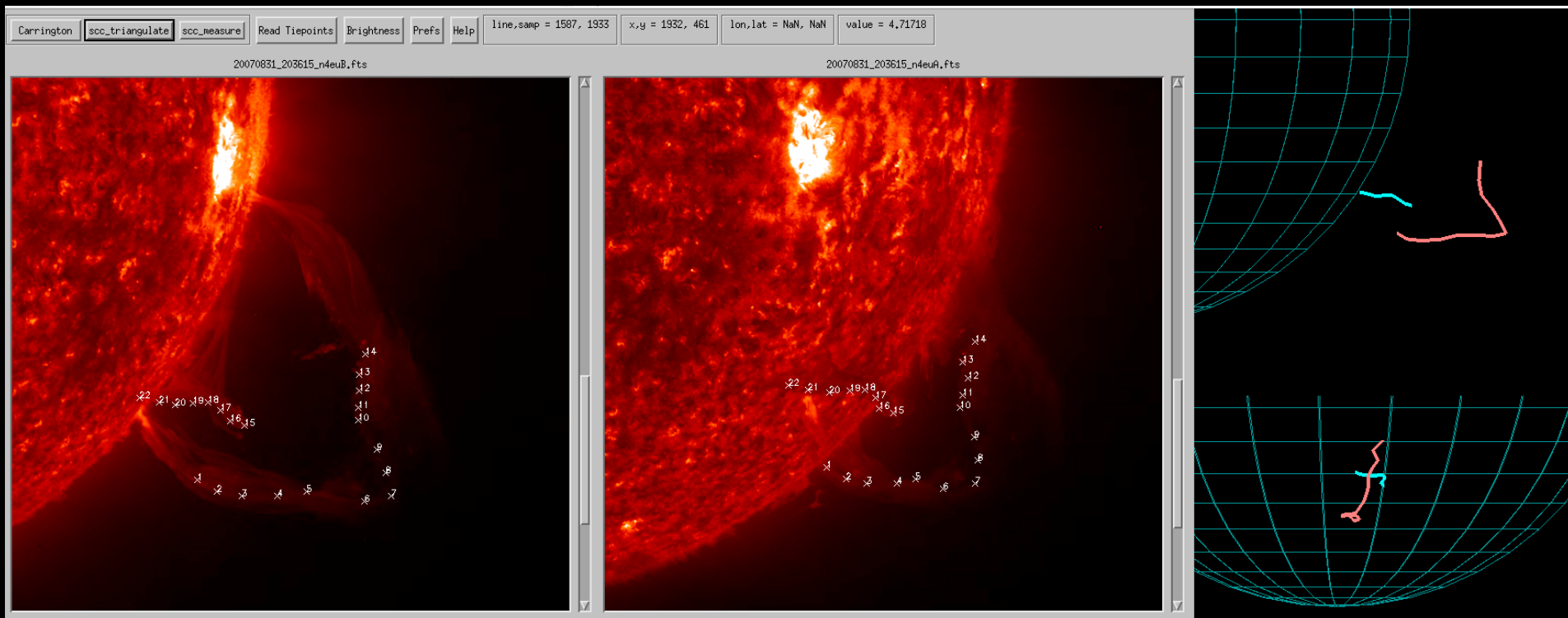


Prominence Eruption on 8/31/2007

STEREO B & A EUVI 304

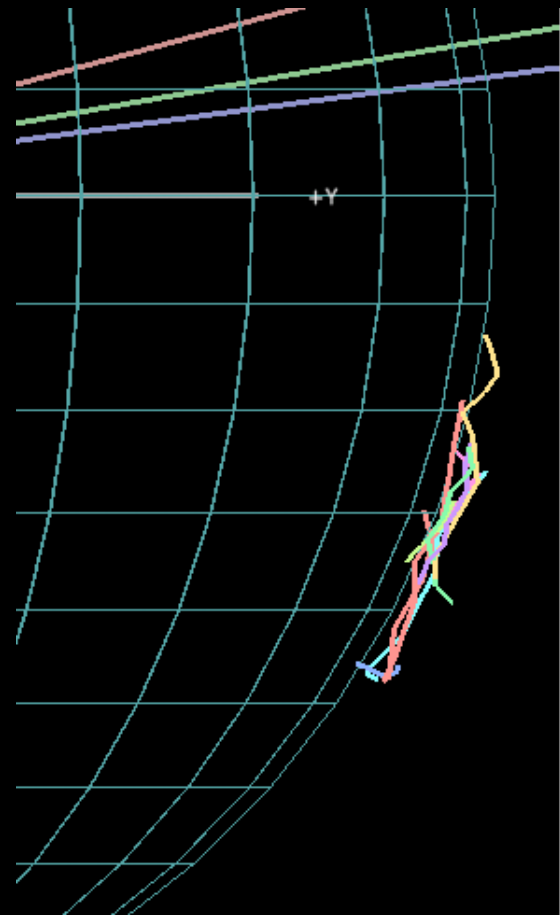
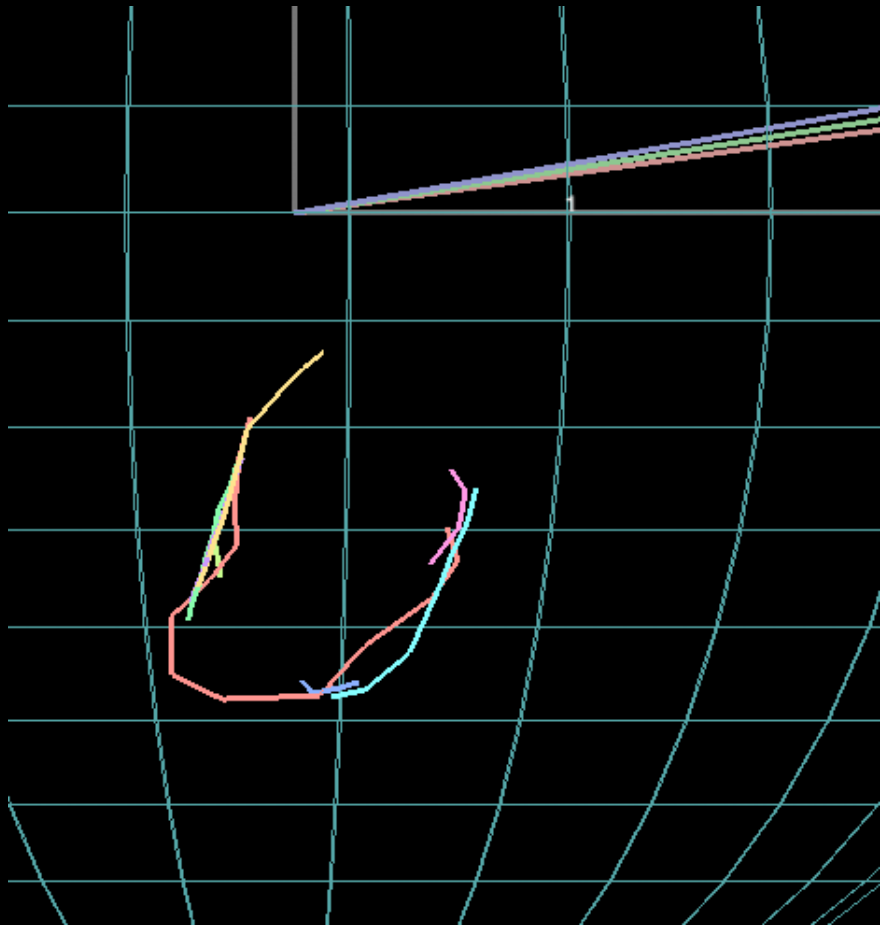
3D Reconstruction of Prominence using Tiepointing & Triangulation and simultaneous A-B pairs

- User marks same features on filament in both images of EUVI 304 A-B pair
 - Tiepoints are constrained to lie in epipolar line
 - Limited by ability to identify same feature in both (A&B) images
- Find 3D coordinates using triangulation on each tie-point pair
- Connects points to display in 3D – limb and central views shown on right below



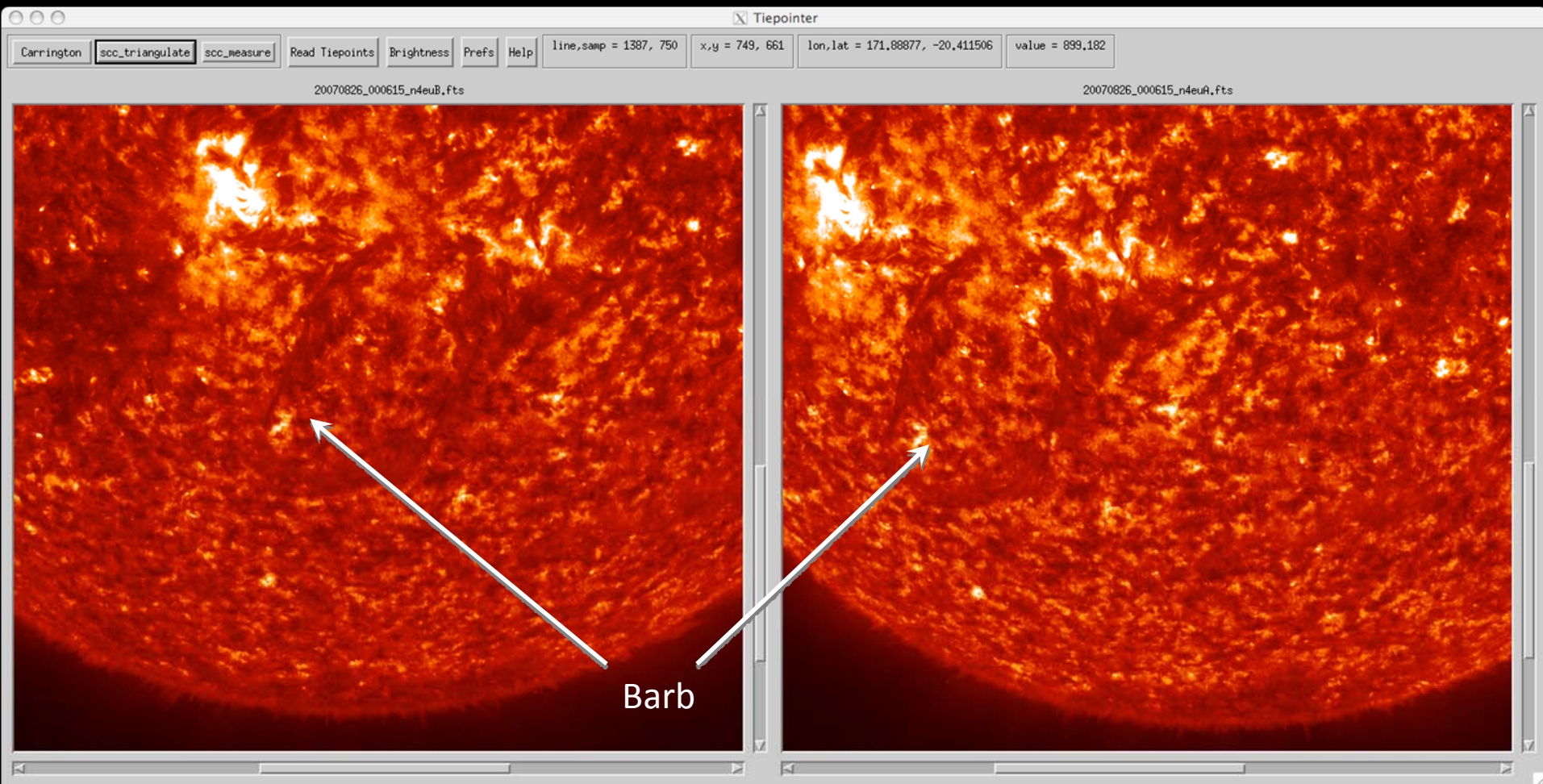
3D Reconstructions from STEREO

- Orange – prominence on 8/23/2007
- Others – prominence on 8/26/2007
- Very stable – see little activity in prominence



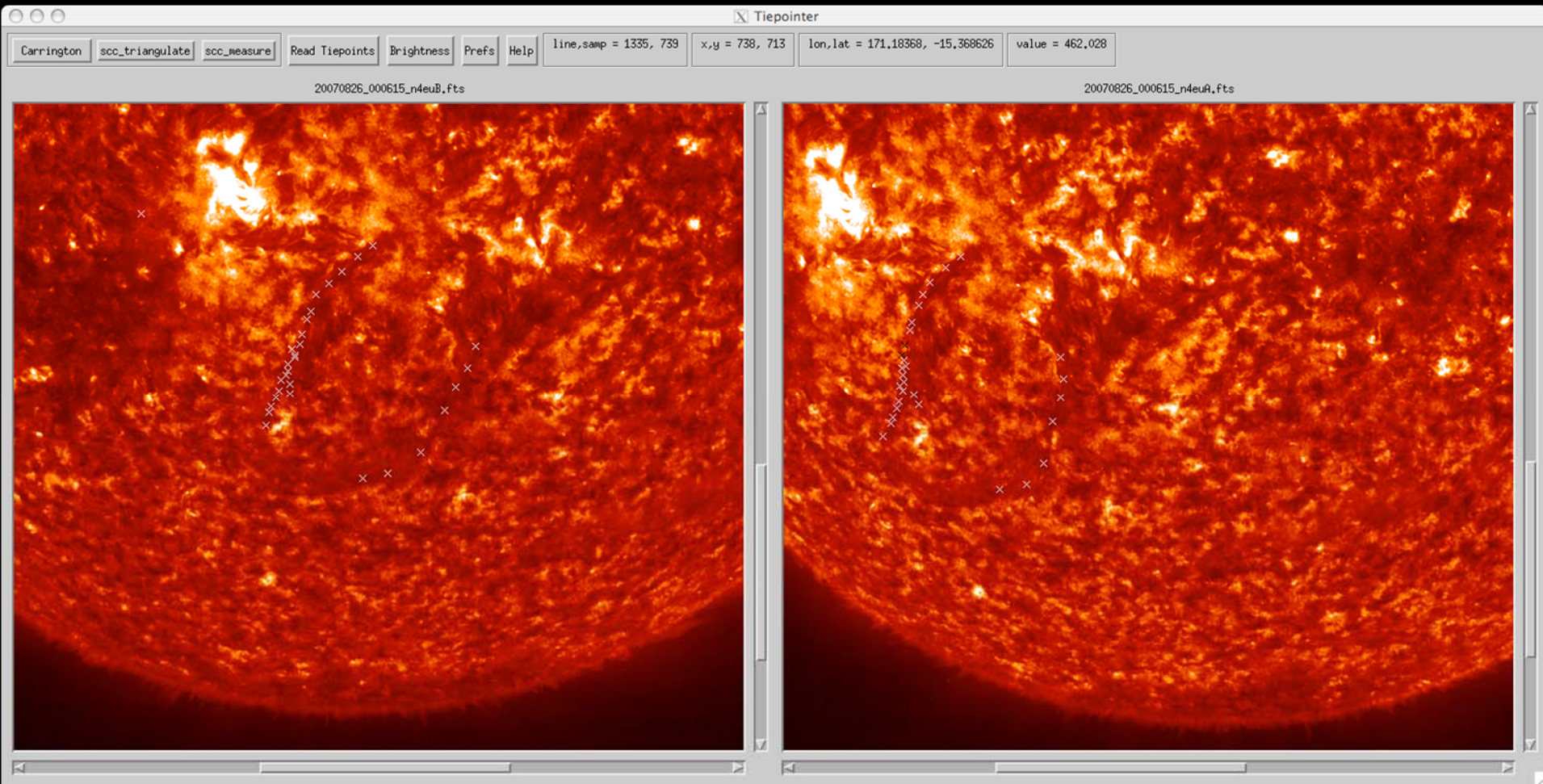
3D Reconstruction of Filament & Barb

STEREO A&B 304 Å, 2007-08-26 00:06:15 UT



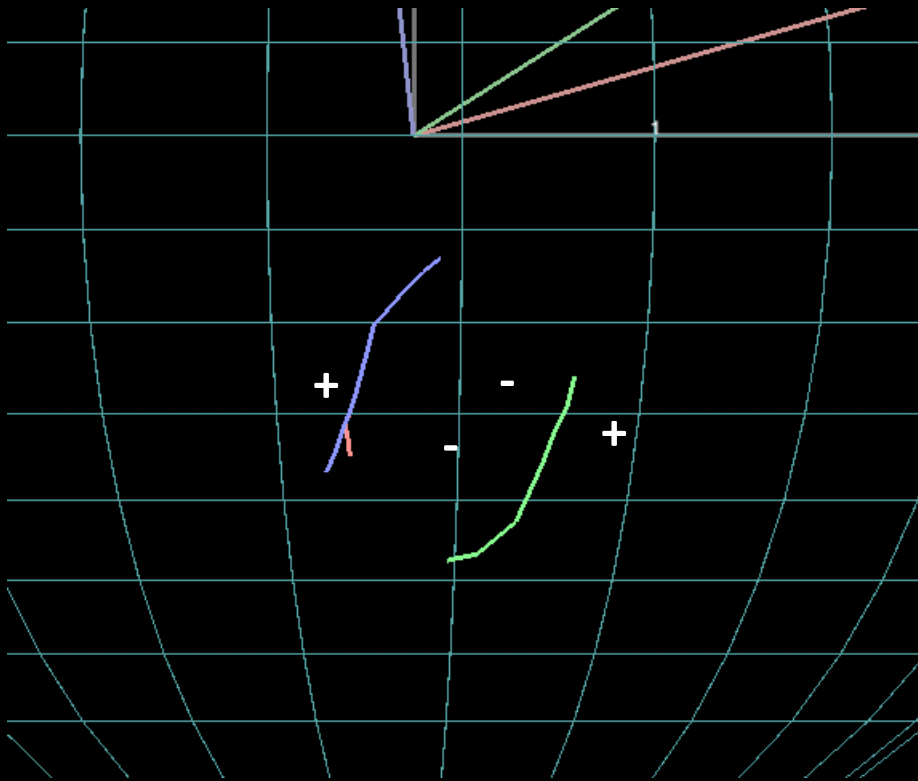
3D Reconstruction of Filament & Barb

STEREO A&B 304 Å, 2007-08-26 00:06:15 UT

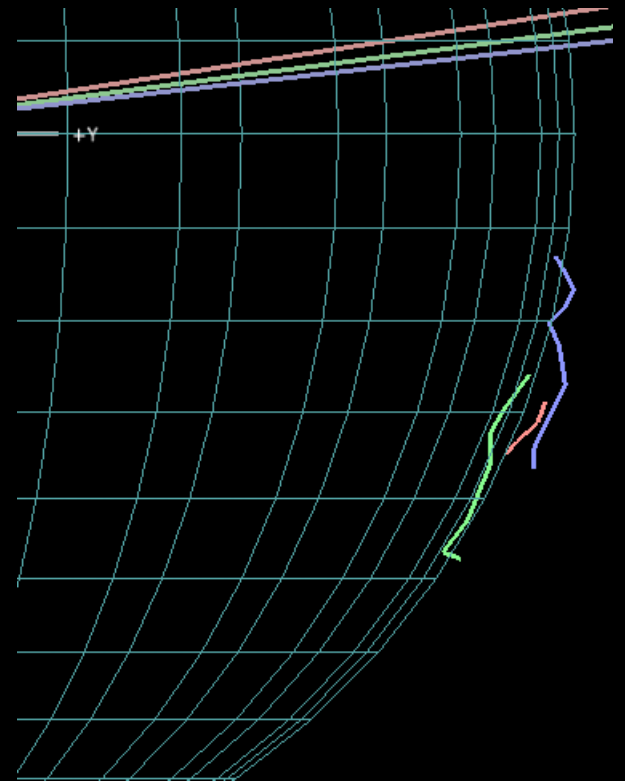


3D Reconstruction of Filament & Barb

STEREO A&B 304 Å, 2007-08-26 00:06:15 UT



Front view

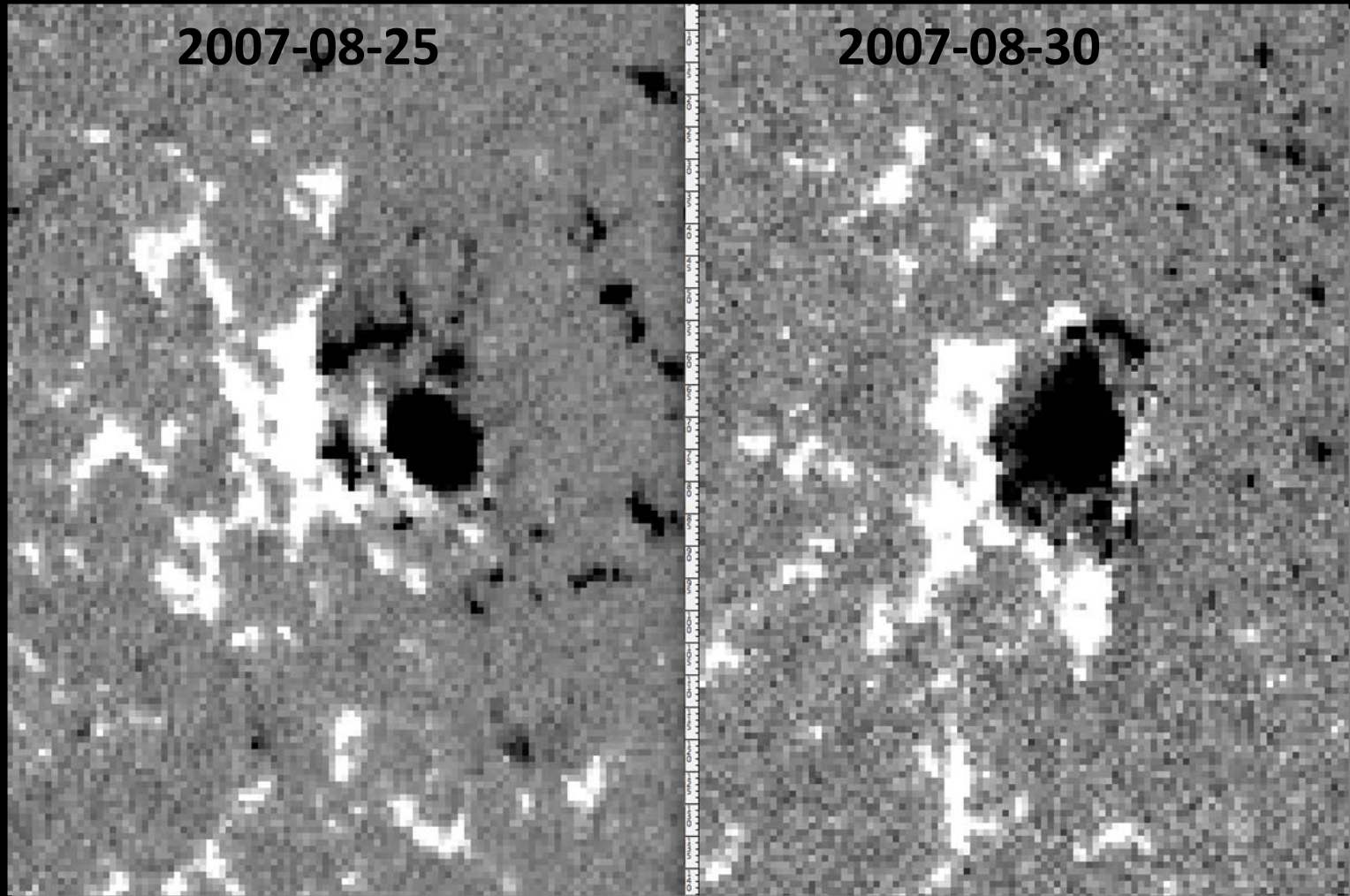


Limb view

- Left bearing barb implies sinistral filament
- Barb goes from surface @ $1 R_s$ to filament @ $1.04 R_s$



Evolution of Active Region 10969: Negative Flux Grows



Positive area 31,000 pix
Negative area 14,000 pix

Positive area 27,000 pix
Negative area 19,000 pix



What Causes the Eruption?

Movie shows cancelling flux on the boundary of filament channel from 2007-08-25 to 2007-08-31

New negative flux of growing AR cancels with positive flux of arcade overlying filament channel

We suggest this weakens the restraining arcade and leads to loss of equilibrium (“tether cutting”) and eruption

See little evidence of increase in stored energy in filament flux system, e.g, no activation episodes

Filament has remained remarkable constant

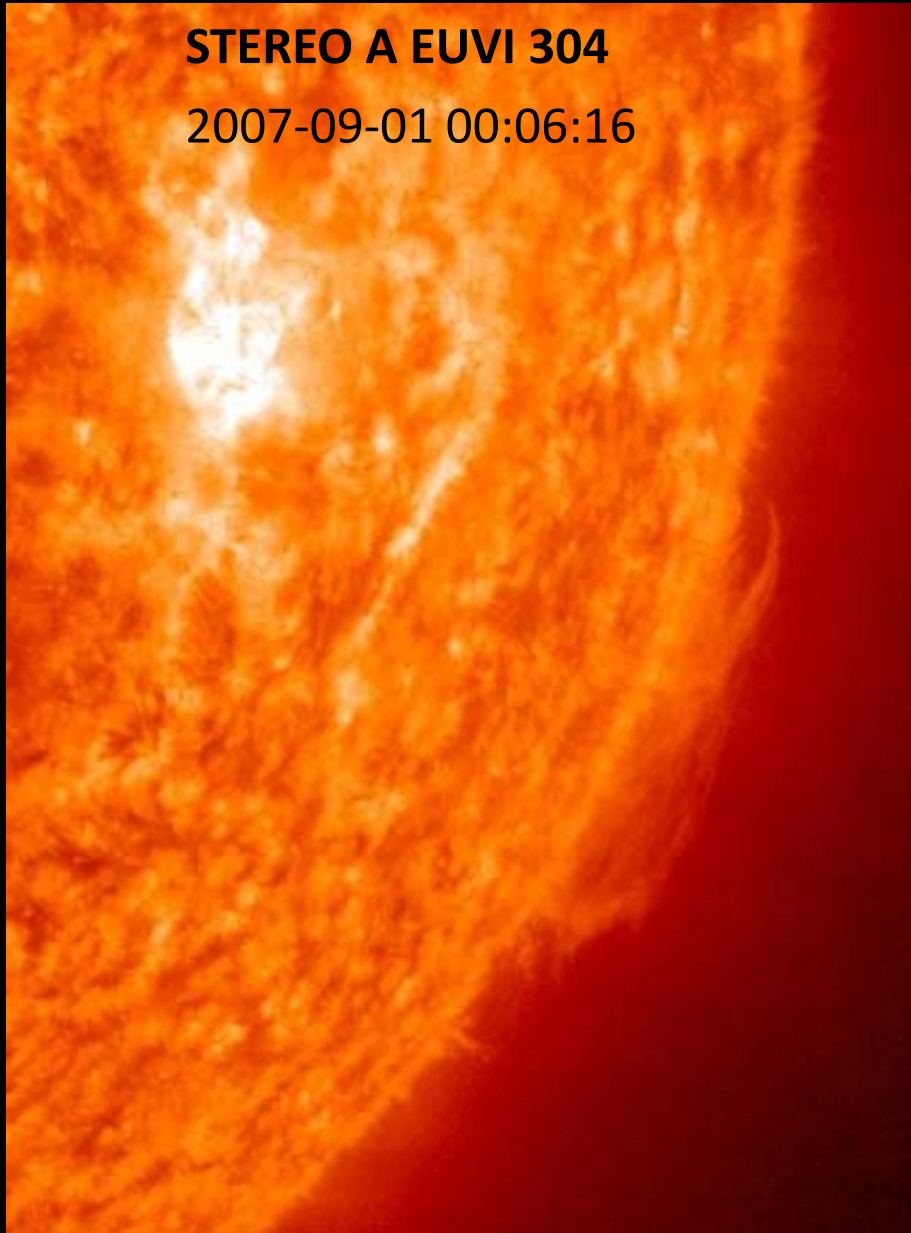
Eruption of Left Side of U Visible at B's West Limb



Post-eruption: U Right Side Visible at A's West Limb

STEREO A EUVI 304

2007-09-01 00:06:16



STEREO A EUVI 304

2007-09-01 16:46:15



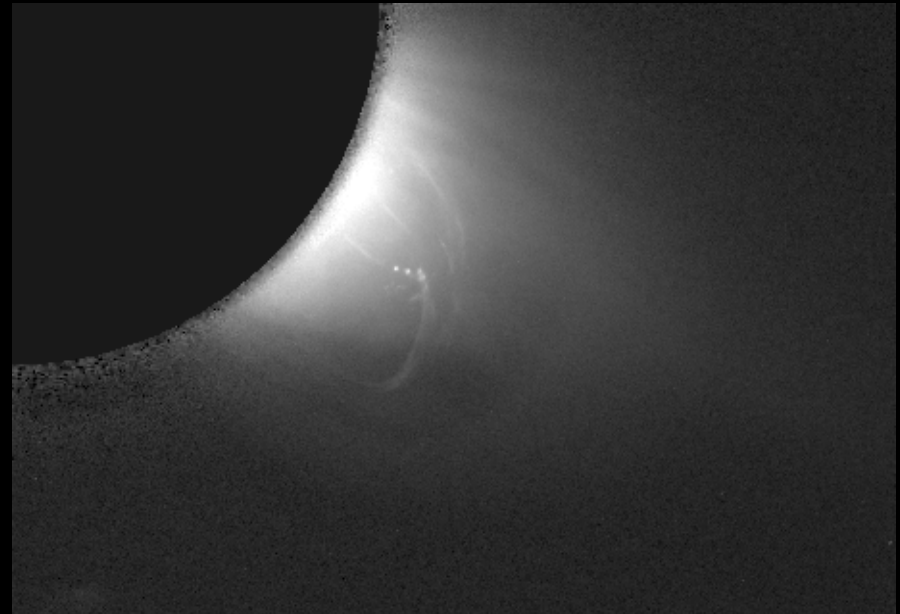
August 31, 2007 Prominence & CME

- Prominence seen also in STEREO COR1 A&B
- CME followed through COR2 and HI1 FOVs

STEREO B COR1

2007-08-31 13:25

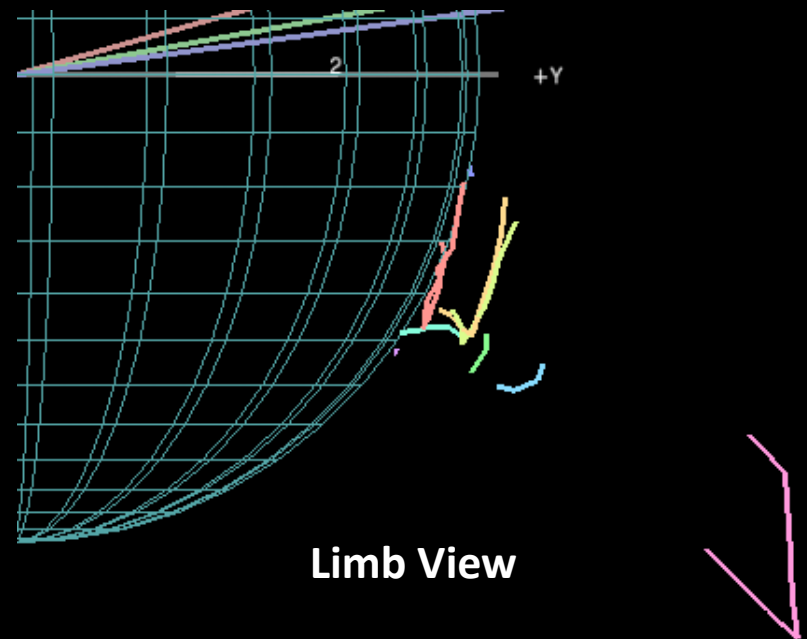
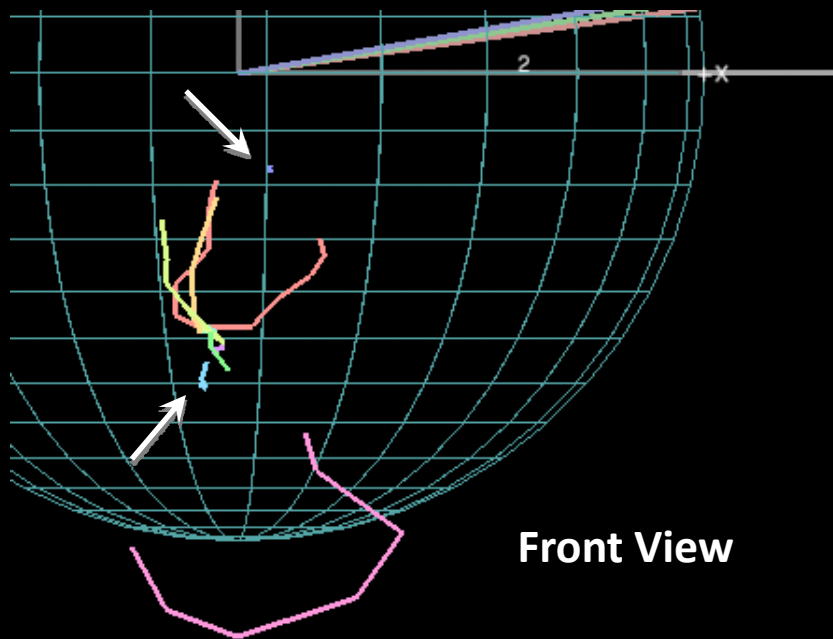
STEREO A COR1



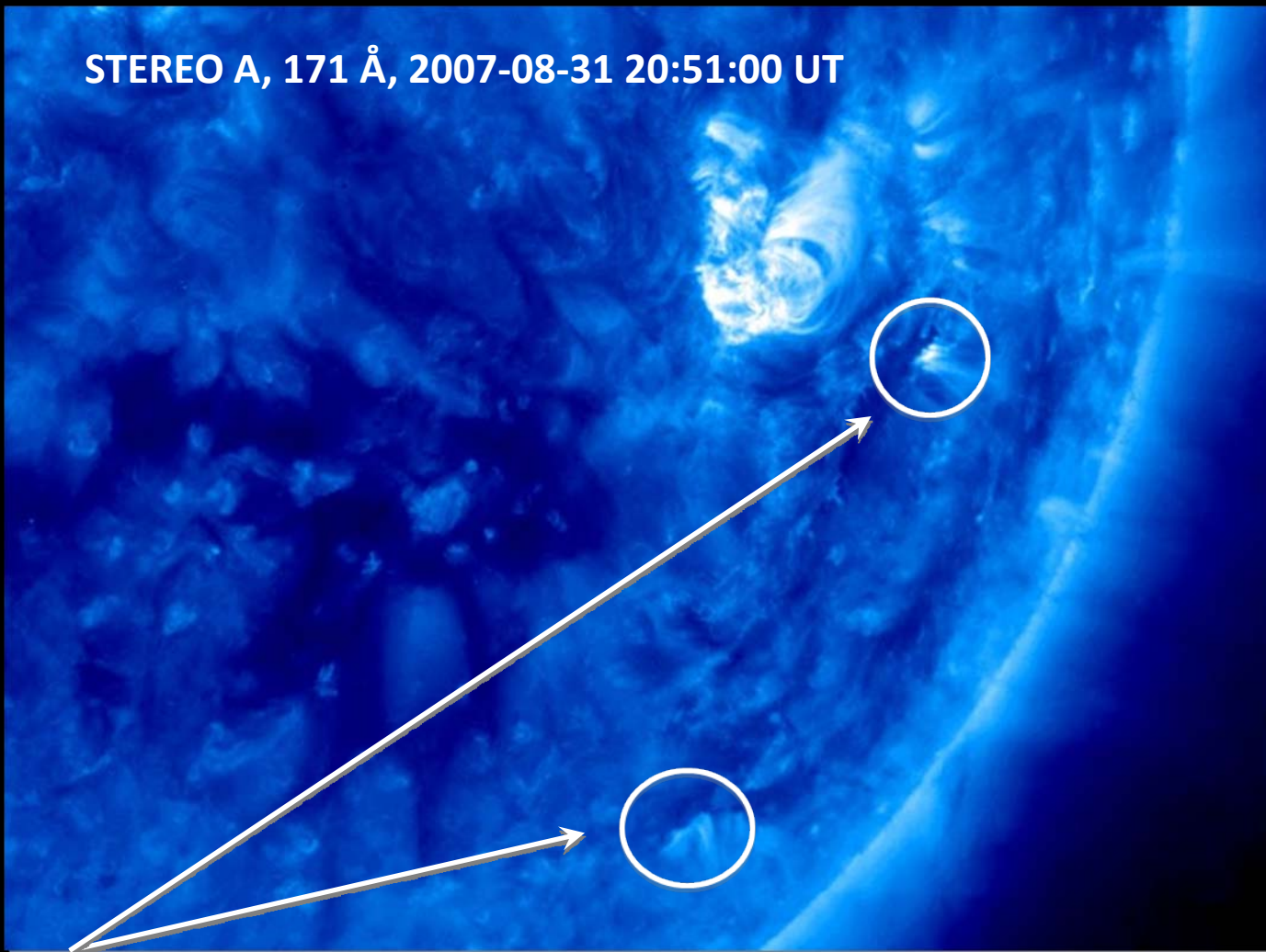


STEREOscopic Reconstruction of Eruption

- Low-lying Orange U is prominence on 8/23
- Yellow, green, turquoise from EUV 304 during eruption 8/31
 - Confirms eruption of left part of U
- High Pink U is prominence on 8/31 reconstructed from COR1
- Arrows point to location of EUVI 171 bright points

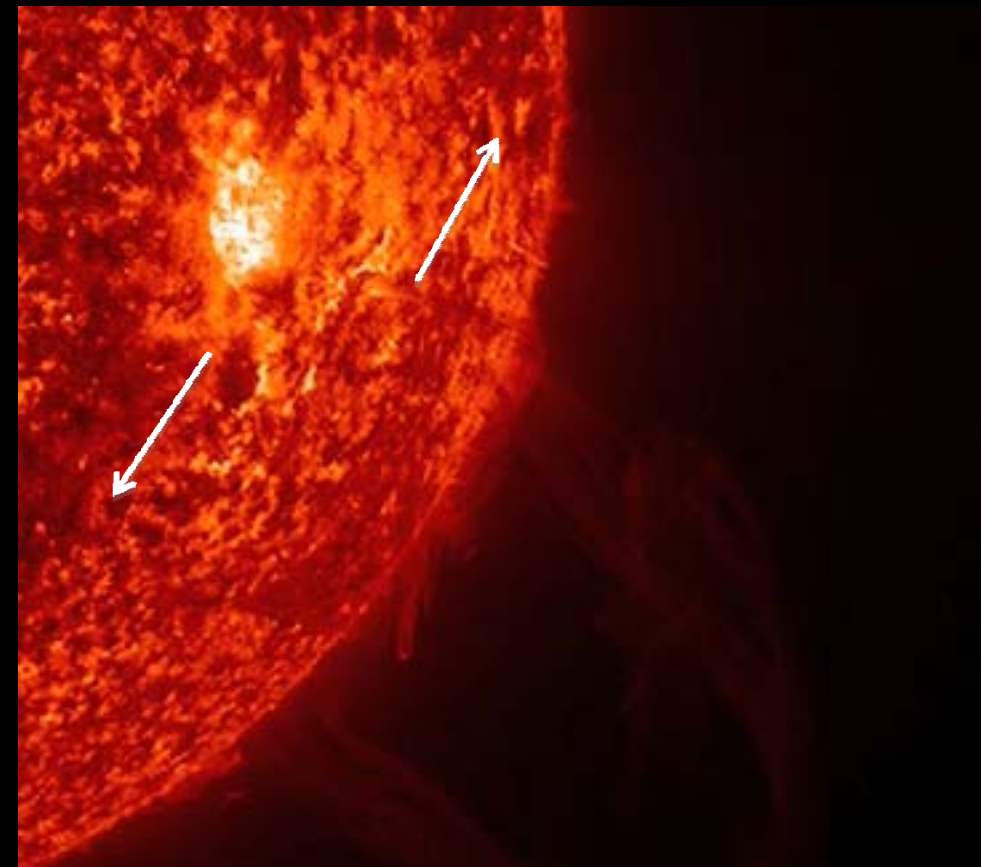


Observe Brightening at Ends of Erupting Segment

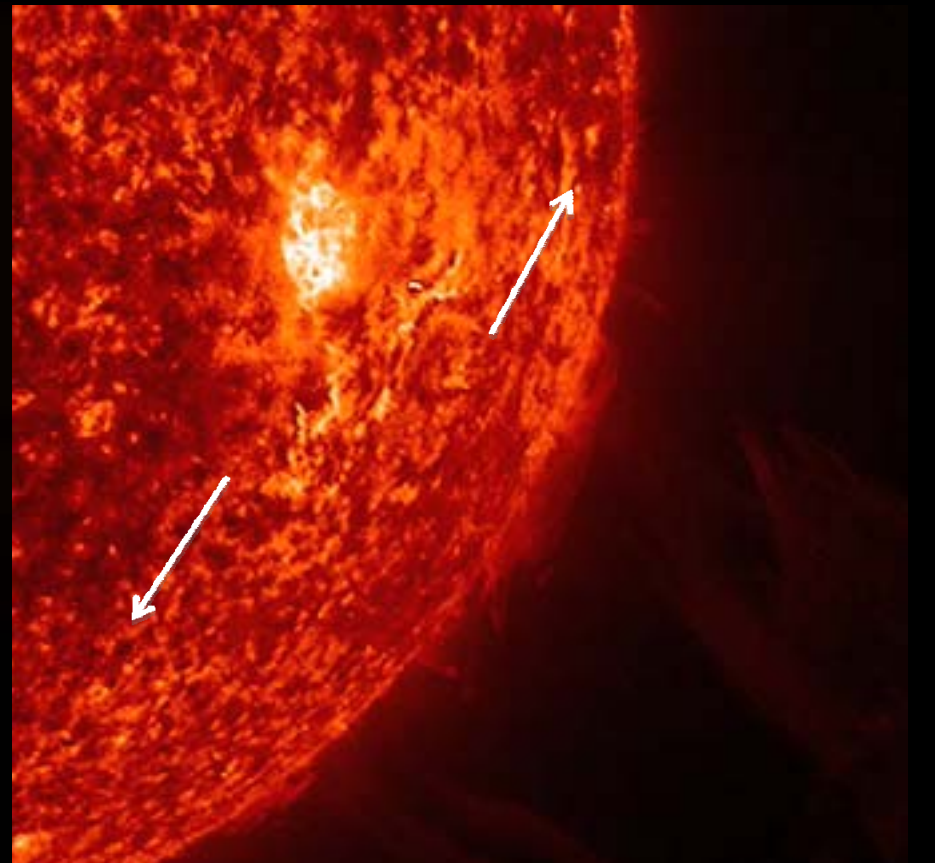


Bright points appeared on the both sides of the filament channel during the fast raising phase of the prominence eruption ala Wang, Muglach & Kleim (2009): Caused by the reconnection between the prominence magnetic field and the cavity or the overlying arcade magnetic field-- visible near the foot-points of the erupting filament

Flares Ribbons Growth Indicates Slant of Overlying Arcade



STEREO A 304, 2007-08-31 20:58:45 UT

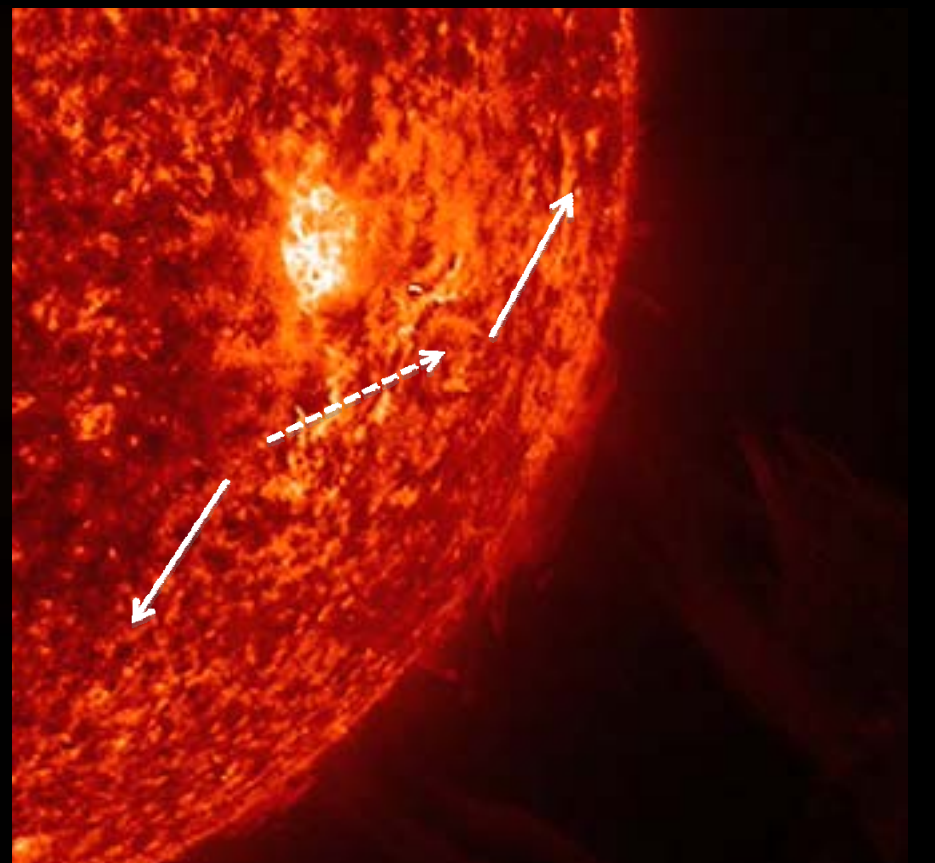


STEREO A 304, 2007-08-31 21:11:15 UT

Flares Ribbons Growth Indicates Slant of Overlying Arcade



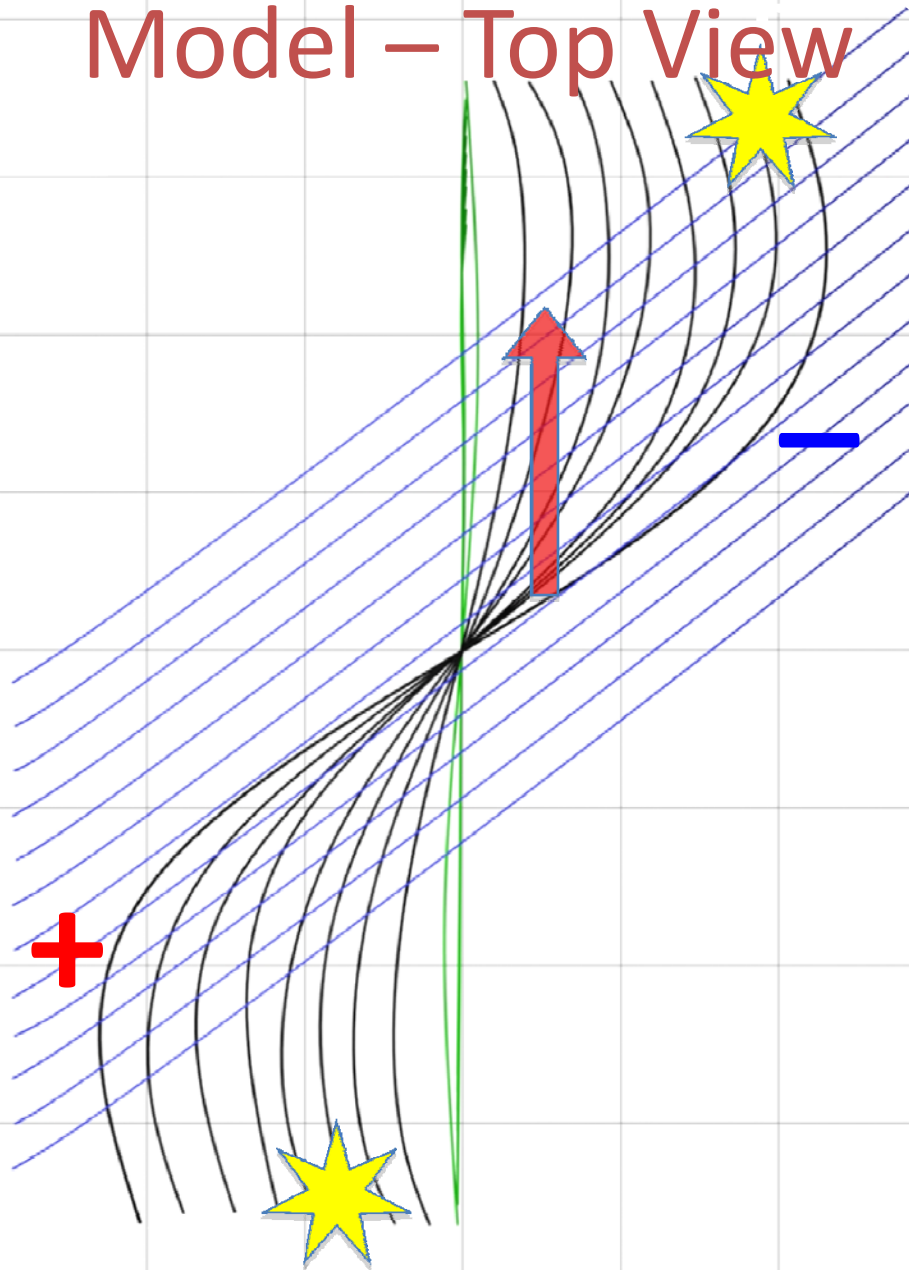
STEREO A 304, 2007-08-31 20:58:45 UT



STEREO A 304, 2007-08-31 21:11:15 UT

Consistent with Sinistral Filament

Model – Top View



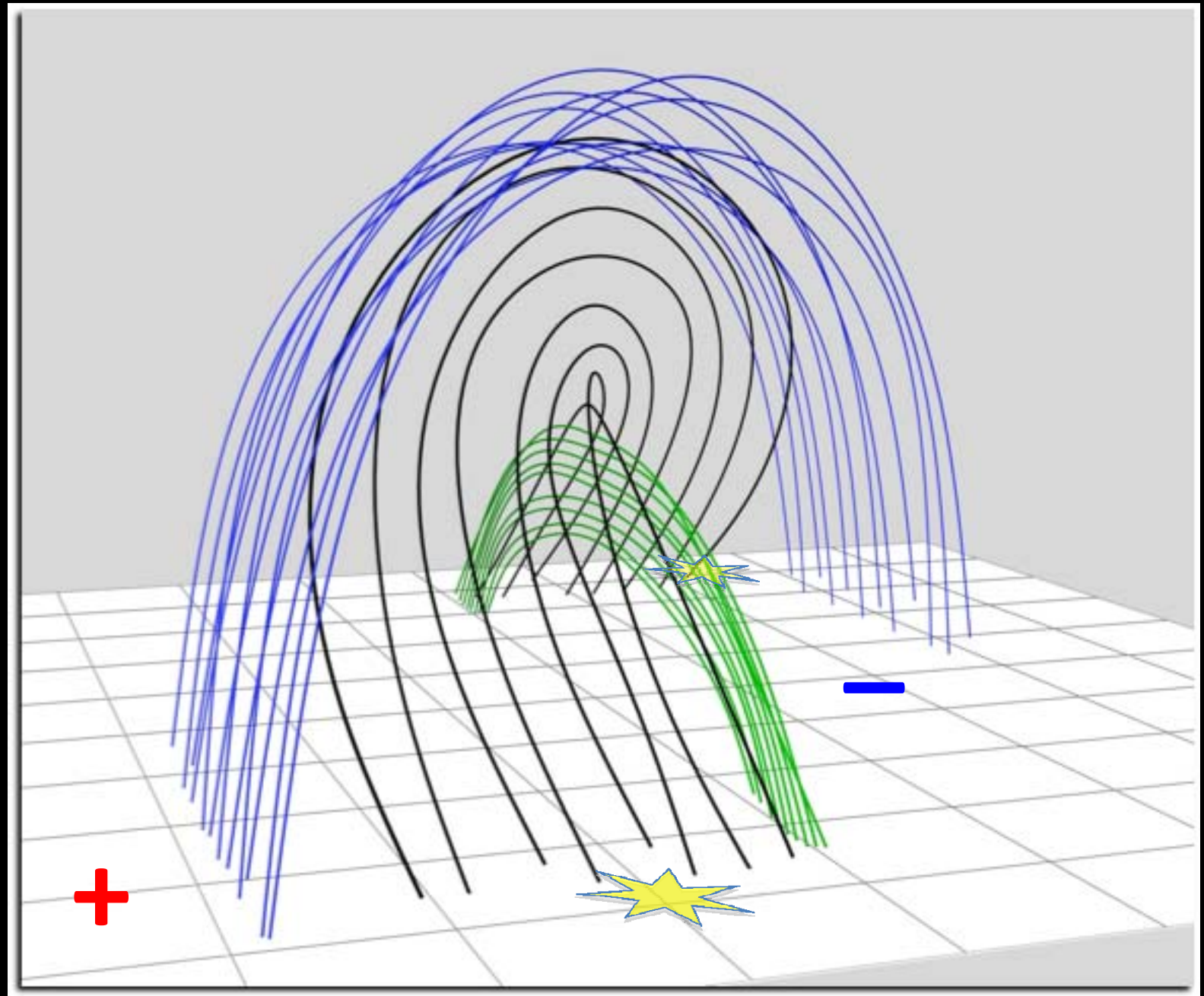
Sinistral filament has right skewed overlying arcade – blue lines. Green lines represent H-alpha filament. Black lines represent filament cavity.

Yellow star represents endpoint brightening in erupting filament (Y.-M. Wang, K. Muglach & B. Kleim, 2009), its location in agreement with magnetic field direction inside sinistral filament (red arrow).

The location of filament endpoint brightening is consistent with reconnection between the rising filament (and filament cavity magnetic fields) with the overlying arcade magnetic fields.



Model - Perspective View



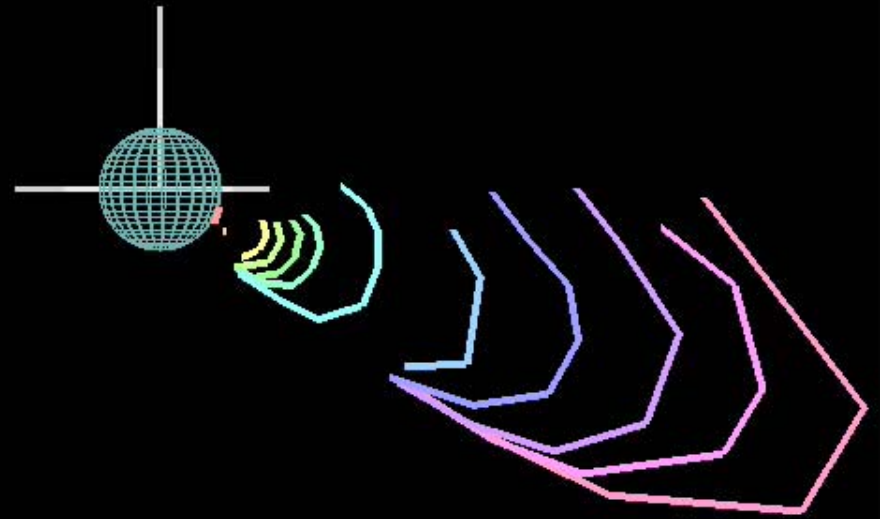


CME

Aug 31, 20
20:37:

STEREO A
August 31, 2007

3D Reconstruction of Prominence & CME



From STEREO
EUVI,
COR1,COR2
A&B

Starting
August 31, 2007



Analysis in progress: Prominence Eruption of February 28, 2010 EUVI B & A

CHI
REO-B
1 - 304

Feb 28, 2010
00:06:15



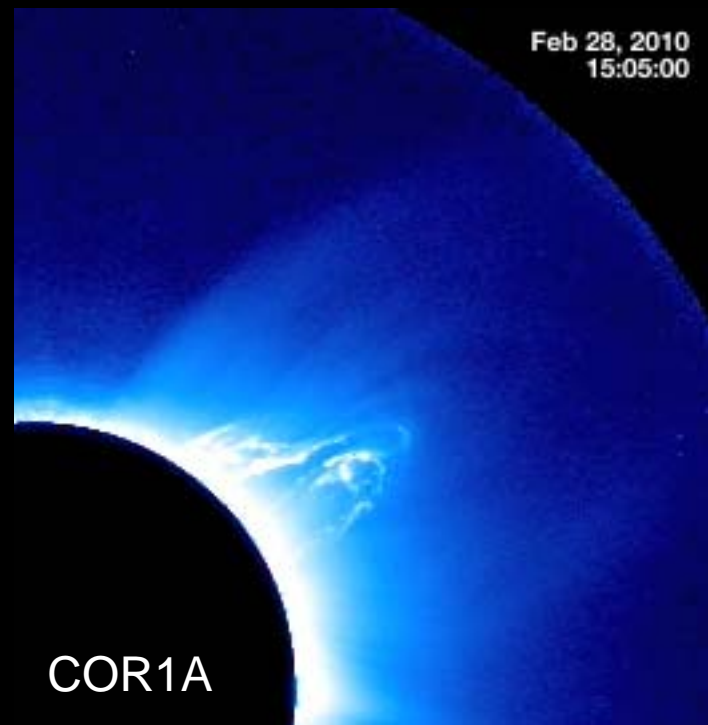
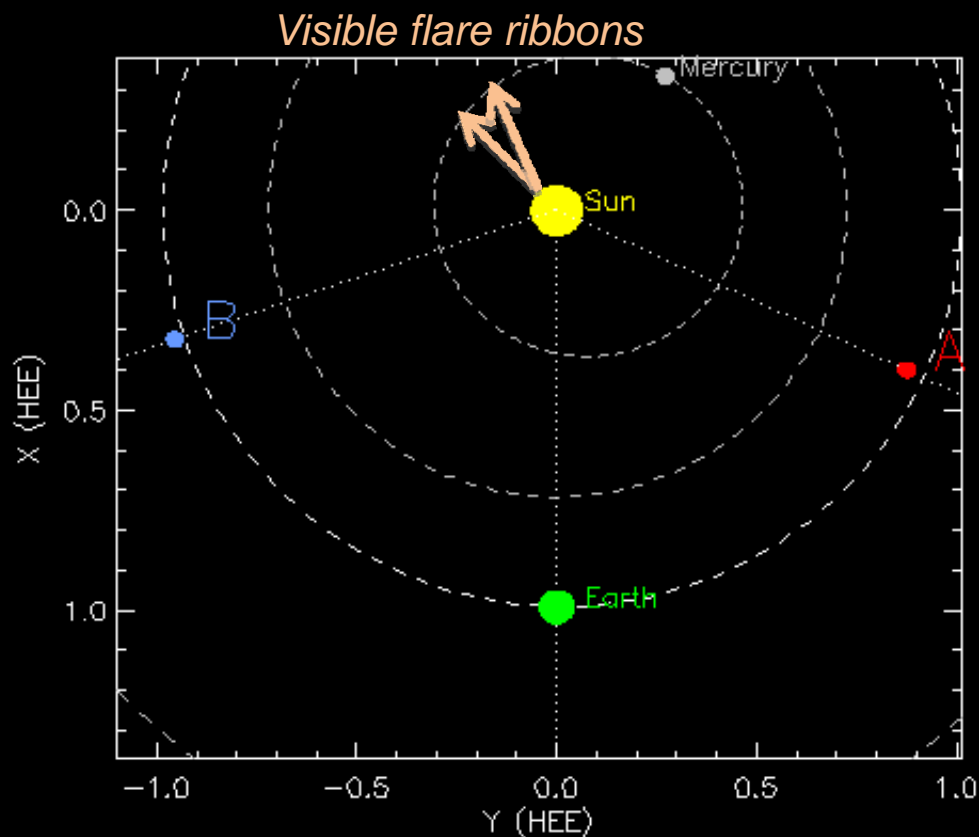
Feb 28, 2010
00:06:15



Feb 28, 2010 Viewing Geometry

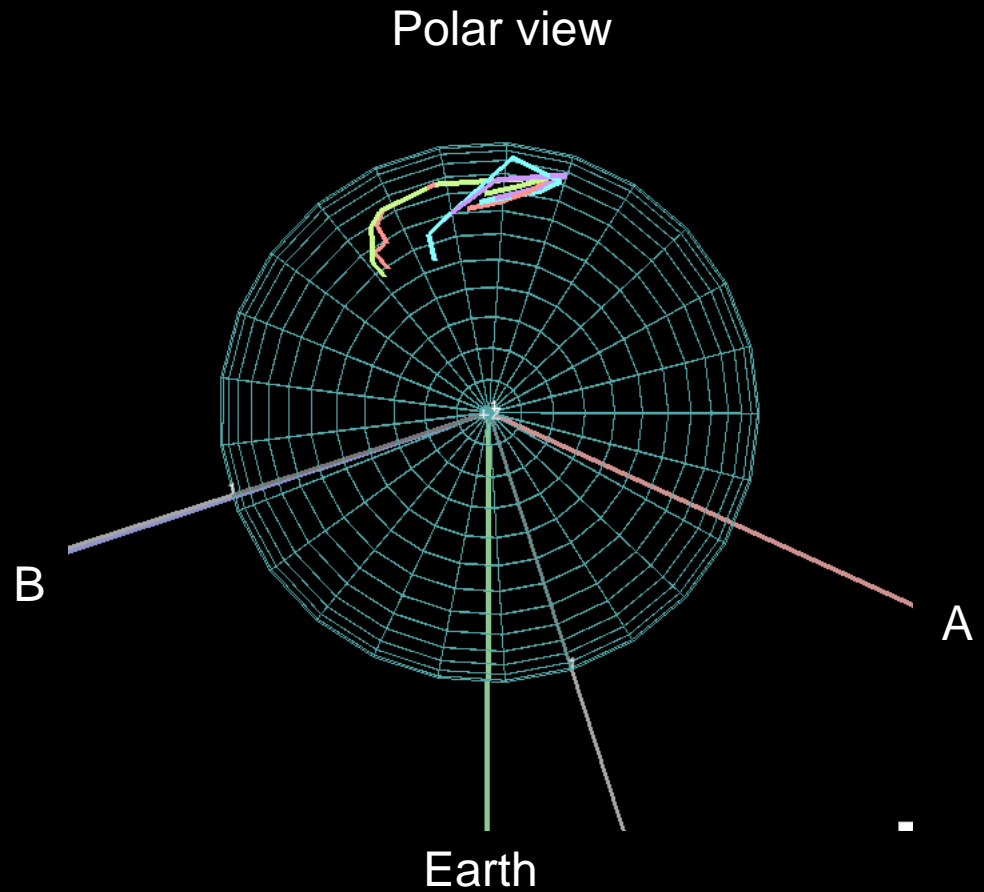
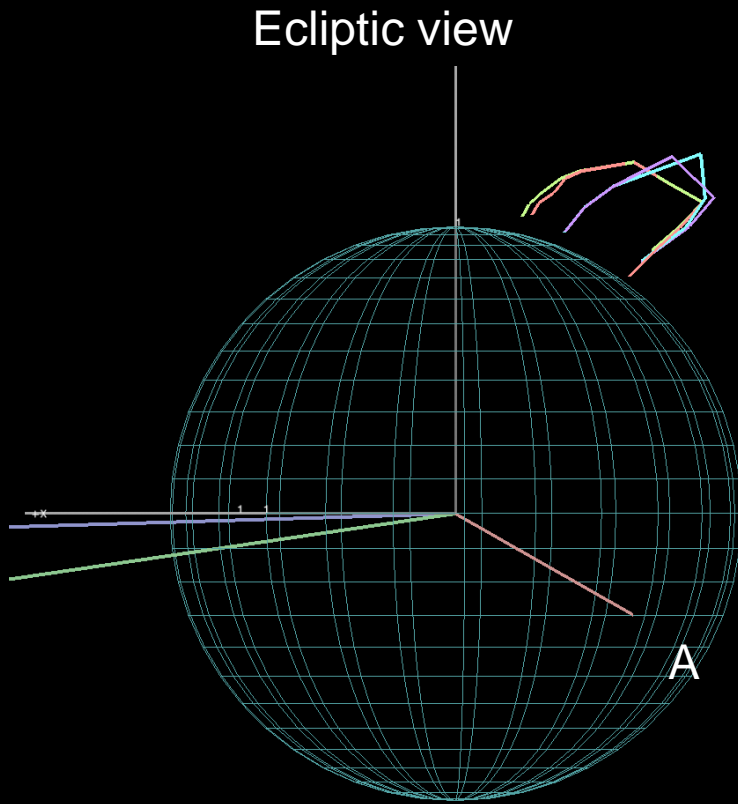
Source region not visible to Earth or A
Flare ribbons at East limb for B

Prominence seen in A&B 304 and COR1 as it rises



3D Reconstructions of Feb 28, 2010 Erupting Prominence using Tie-pointing & Triangulation

Reconstructions at 5 times

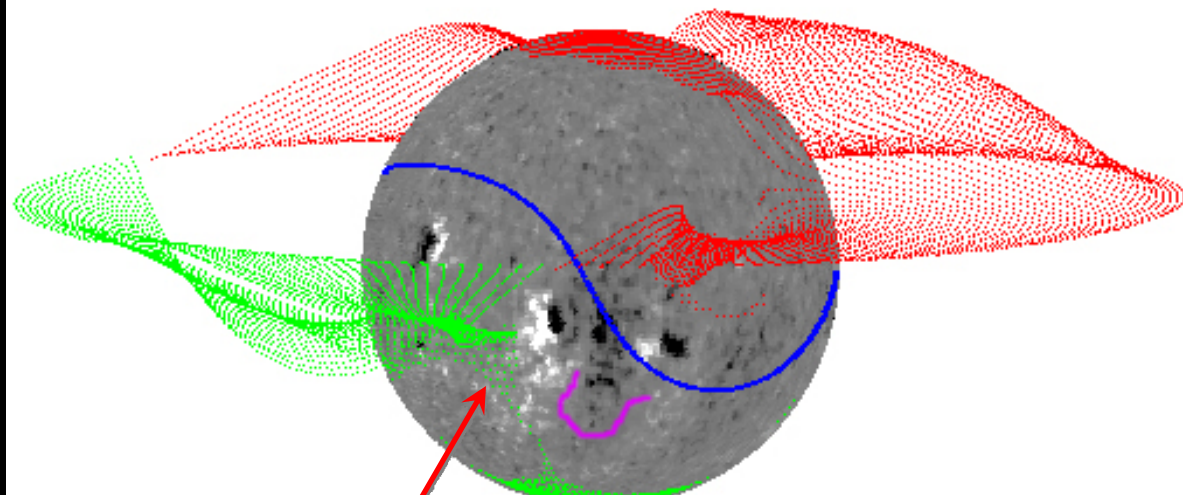


Conclusions – 31 Aug 2007 Eruption

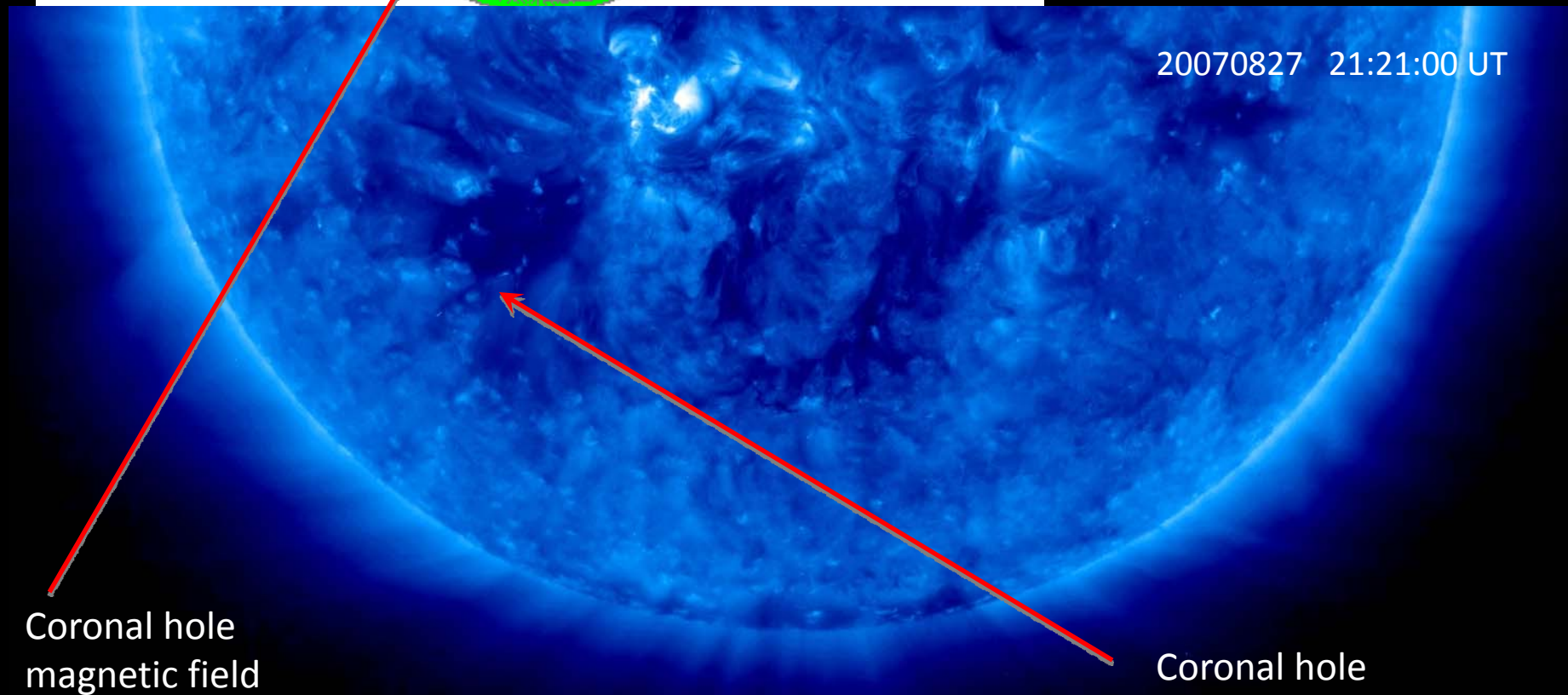
- First 3D Reconstruction of prominence barb from STEREO images - determines chirality
- Sinister chirality from barb consistent with Wang et al “brightening” and flare ribbon progression
- Magnetogram evolution suggests eruption caused by loss of equilibrium via weakening of overlying arcade
 - Need magnetic modeling to verify!
- Prominence and CME follow same trajectory

Backup Slides

From Olga



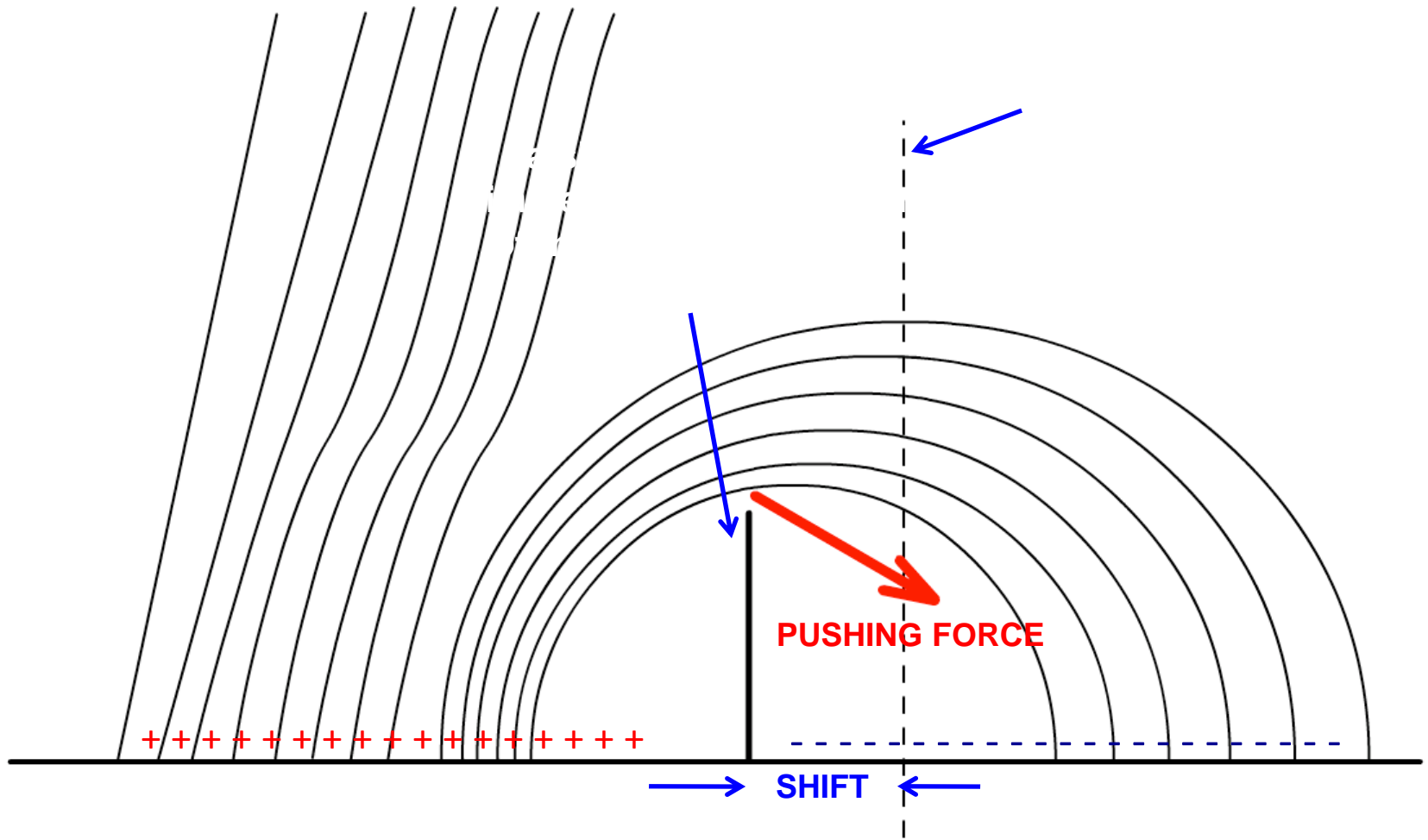
The presence of the coronal hole open magnetic field near the filament channel “pushes” the whole arcade structure and creating a shift of the arcade system above the channel. As a result we observe the horizontal roll of the filament during the eruption.



20070827 21:21:00 UT

Coronal hole magnetic field

Coronal hole



near the filament

The roll effect during the prominence/filament eruption appears very early during the beginning phase of the eruption. The overlying arcade, the filament cavity and filament rise simultaneously, but roll effect, which caused by the arcade shift above the filament channel, presents only in the filament dynamics as a lower scale motion compare with a higher scale dynamics – a non-radial direction of the eruption of the whole filament system, which directly caused by the presence of the coronal hole open field near the filament channel.