Tracking the evolution of erupting coronal cavity using PROBA2/SWAP EUV images

16th PROBA2 Science Working Team (SWT) meeting

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Introduction

Cavities appear as dark features over the solar limb and are believed to be the density depleted cross-sections of the magnetic flux ropes, where the magnetic field strength attains a much higher value compared to the background corona. Cavities may last for days or even weeks and evolve as the dark core part of the CME during the eruptive phase.

Motivation

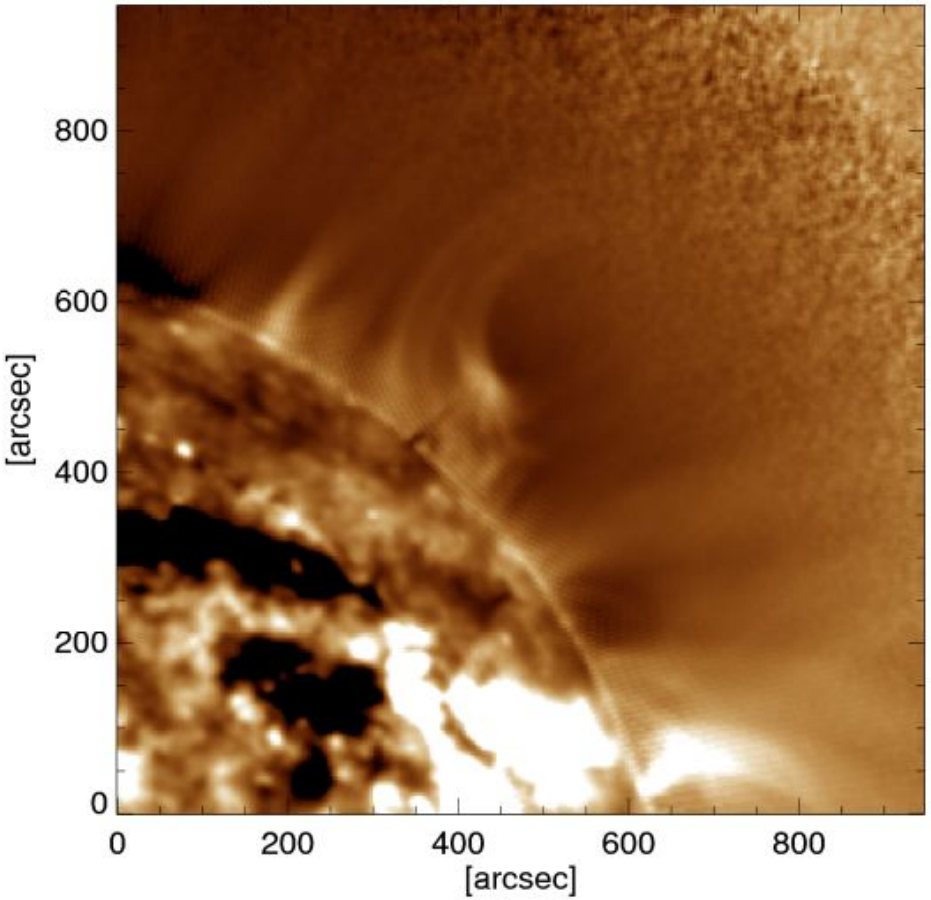
The extended field-of-view of SWAP fills the observational gap between 1 to 2 R_S. Therefore, it enables us to address the following key problems regarding the initiation mechanism of CMEs at lower corona

- The initation height of the CME
- Morphological pre-cursor of CME initiation
- Correspondence between the EUV cavities seen in lower corona and the white light cavities seen during the CME eruption
- Starting from the initiation height whether the CMEs exhibit self-similar expansion or not. If not, then what is the critical height above which it shows the self-similar expansion.
- Role of ideal MHD instabilities to trigger the CME eruption

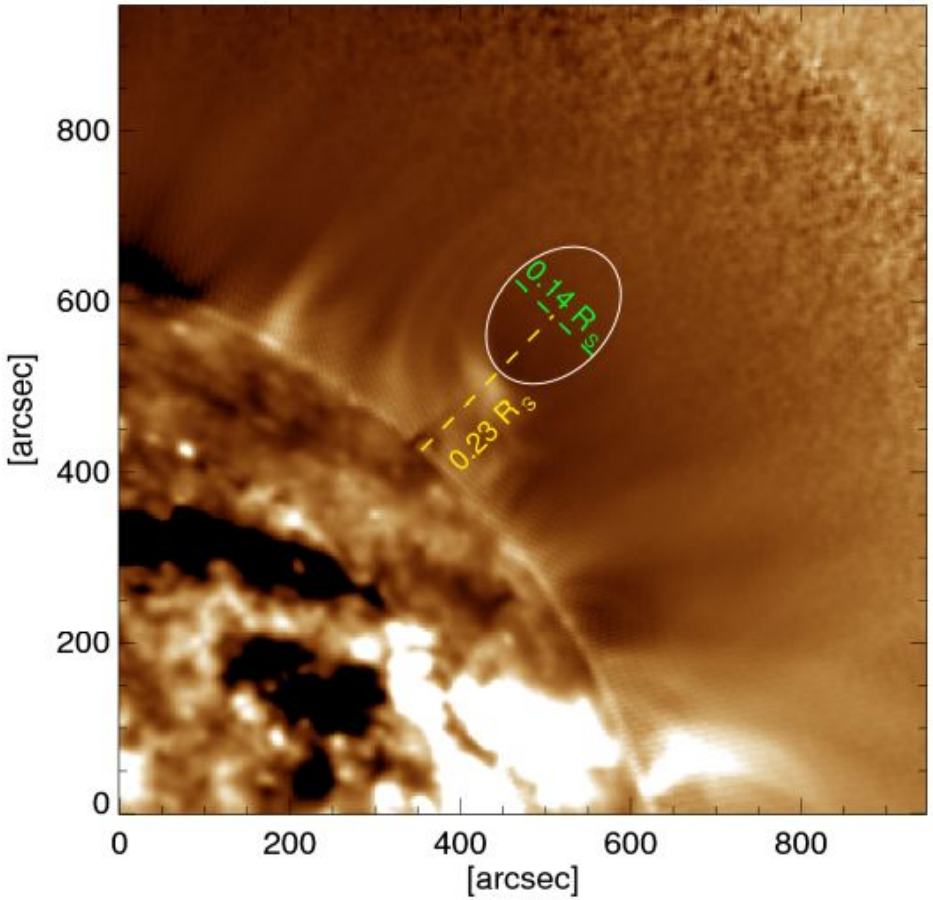
Cavity morphology as seen in SWAP before eruption

Eruption time – around 06:30 UT on 13 June, 2010
Location - North-West solar-limb

SWAP Composite image of the cavity before eruption

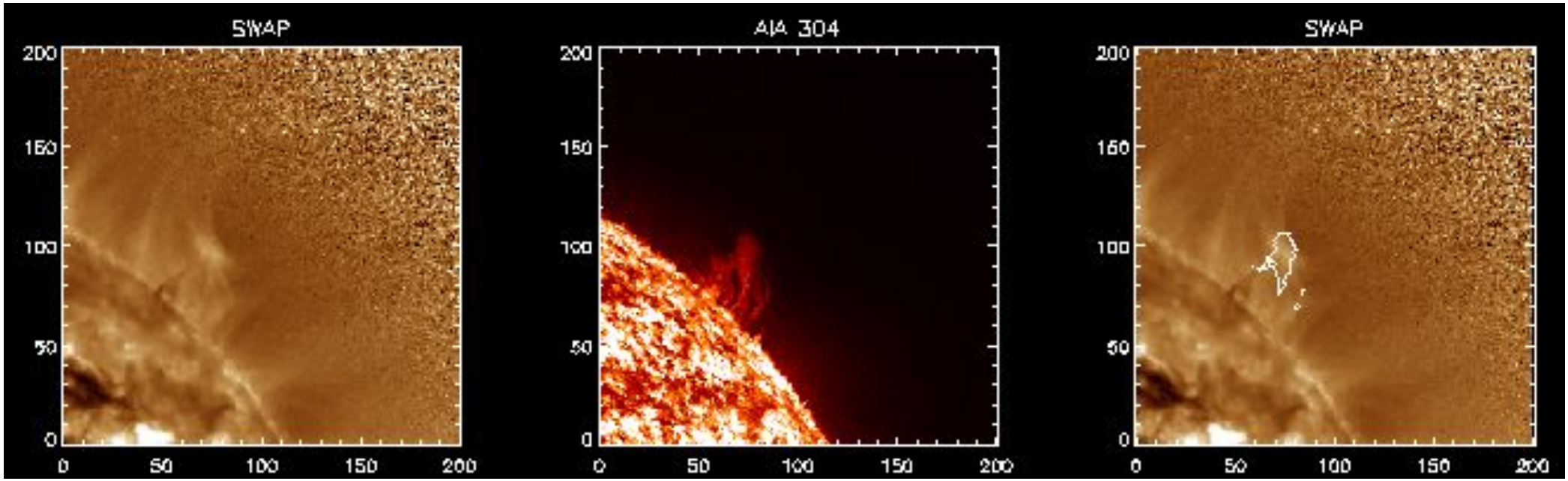


SWAP Composite image of the cavity before eruption



Axis height of the cavity is near about 1.23 solar radii before eruption

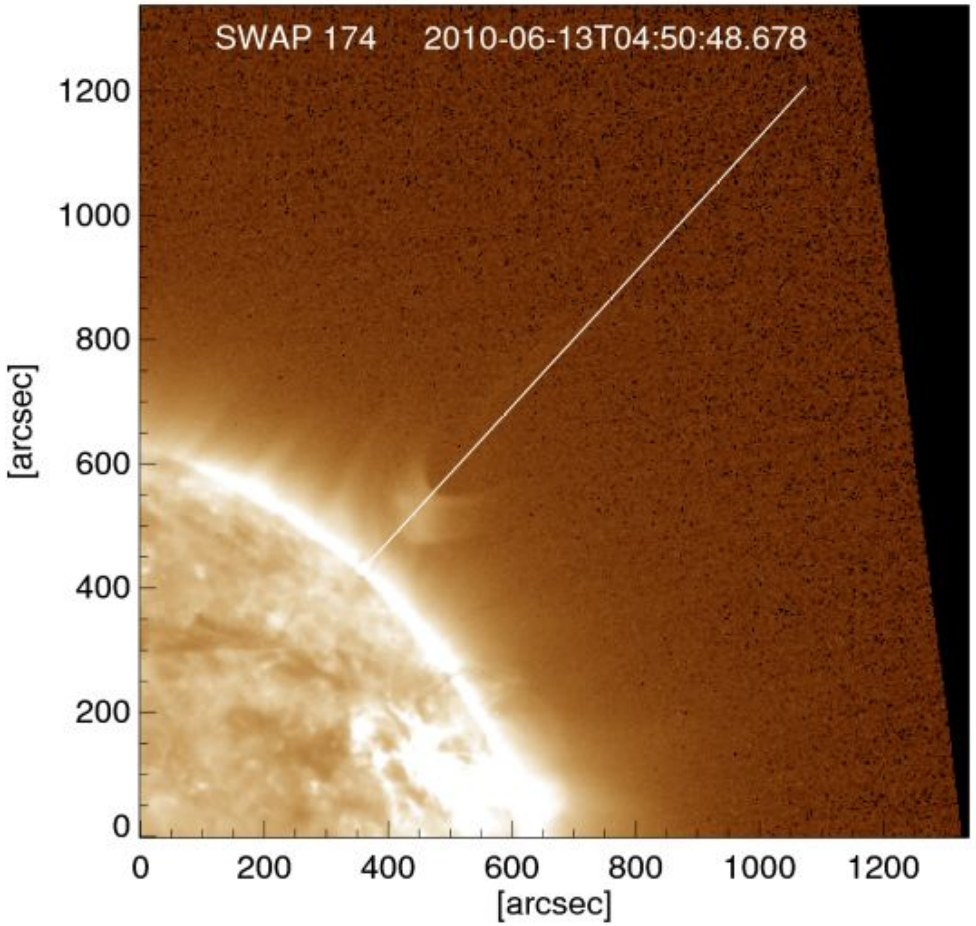
Overlap of coronal cavities seen in SWAP and the prominence material seen in AIA 304

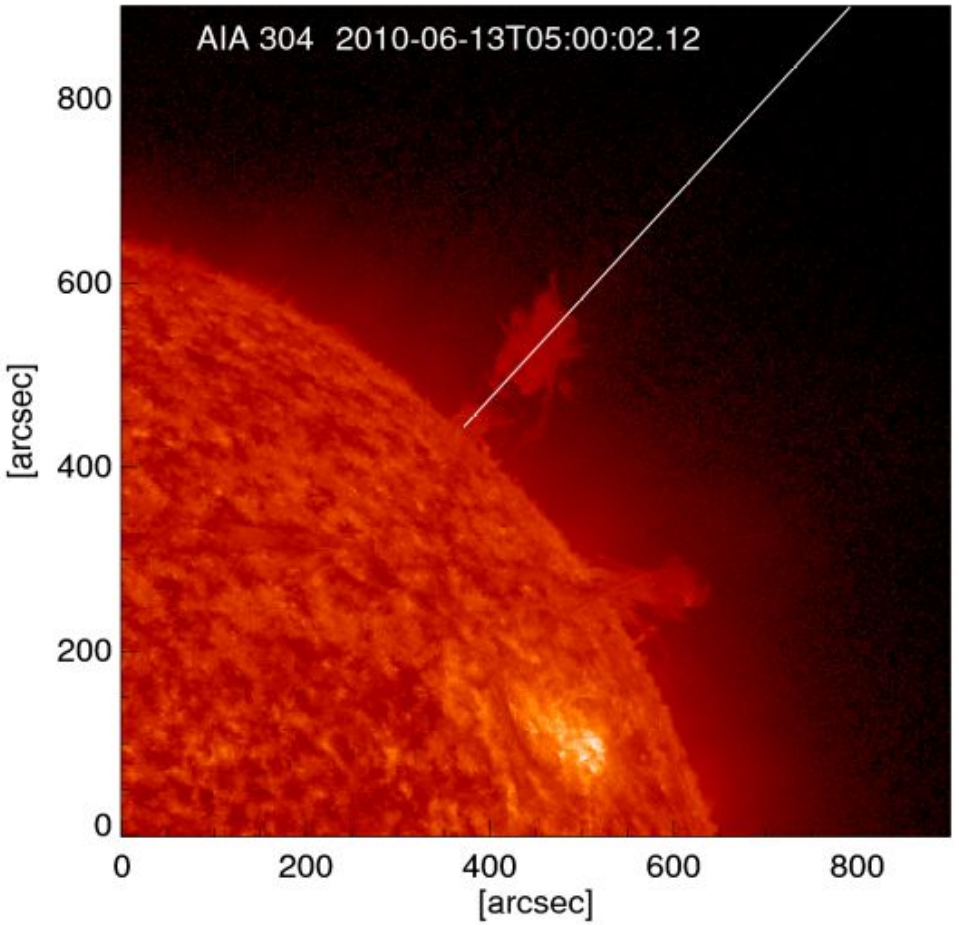


The top of the prominence material and the lower-most part of the cavity almost coincides

Do they maintain this trend during the eruption also ?

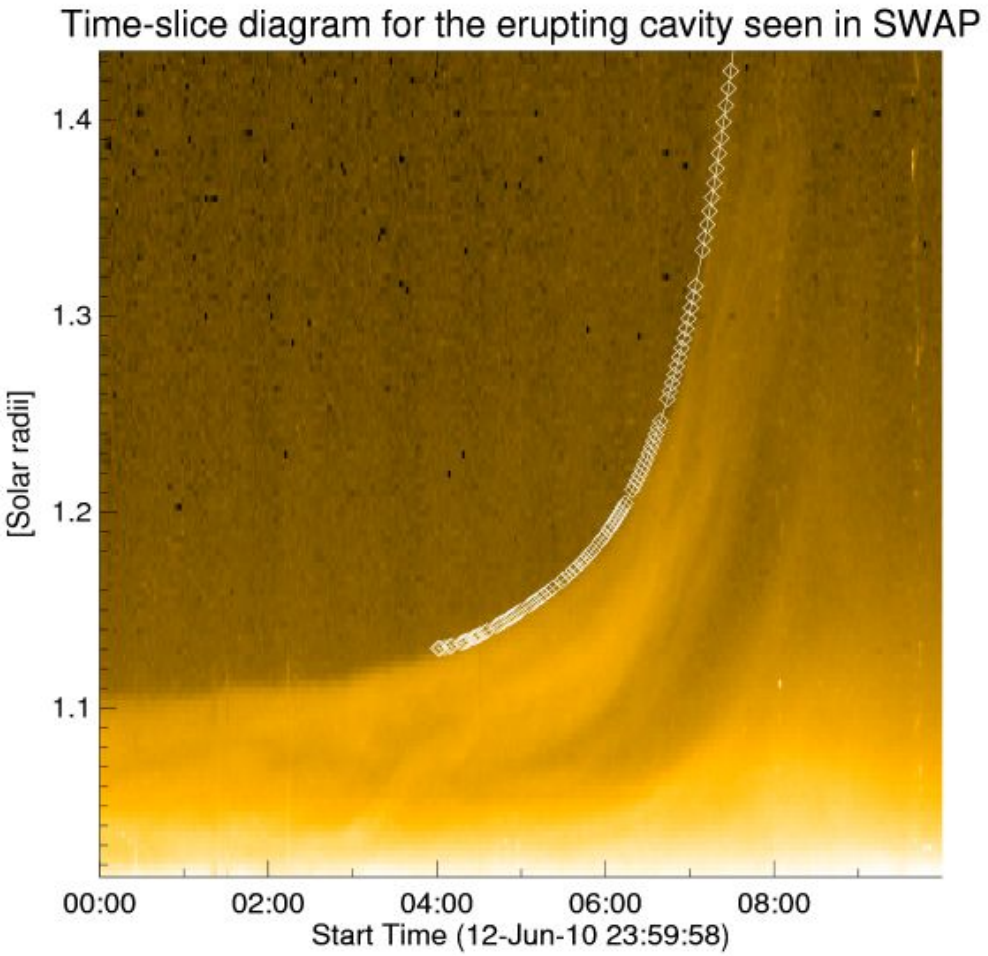
Positions of the slits on SWAP and AIA images along which the height-time profile for the lower-most boundary of the cavity and the top-most part of the prominence have been evaluated

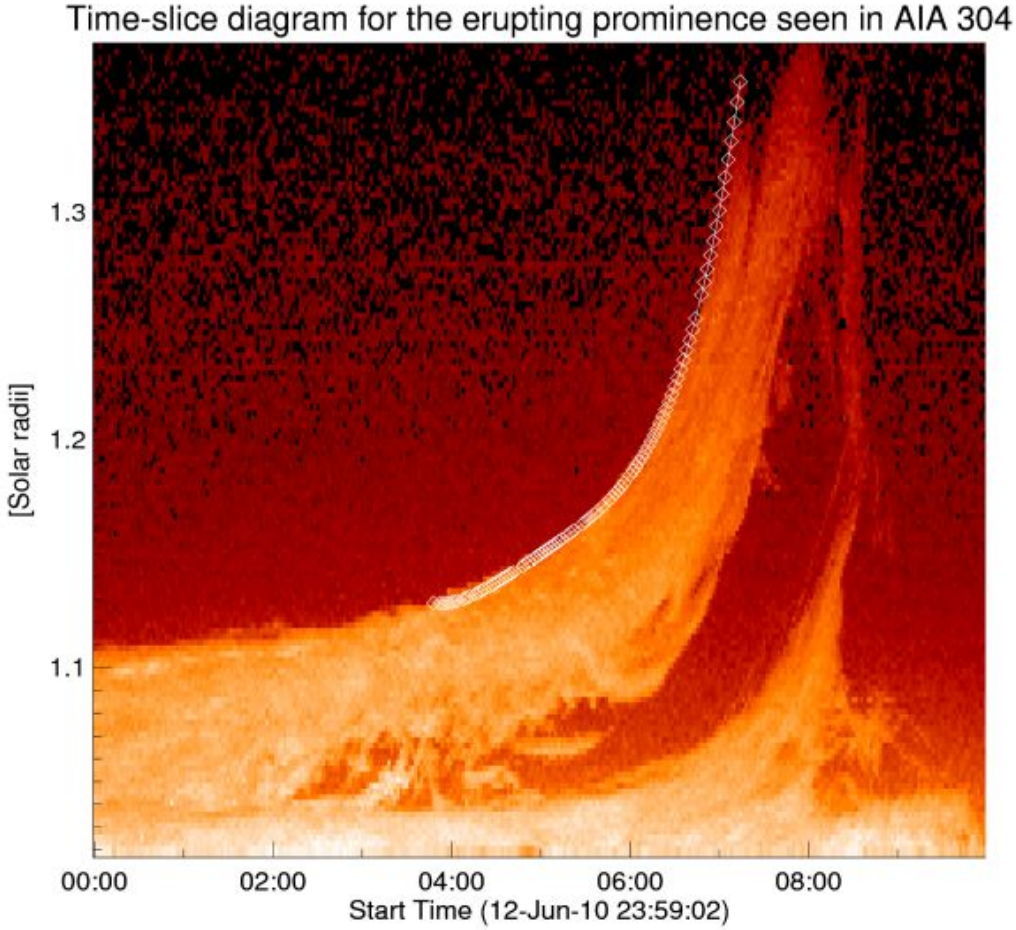




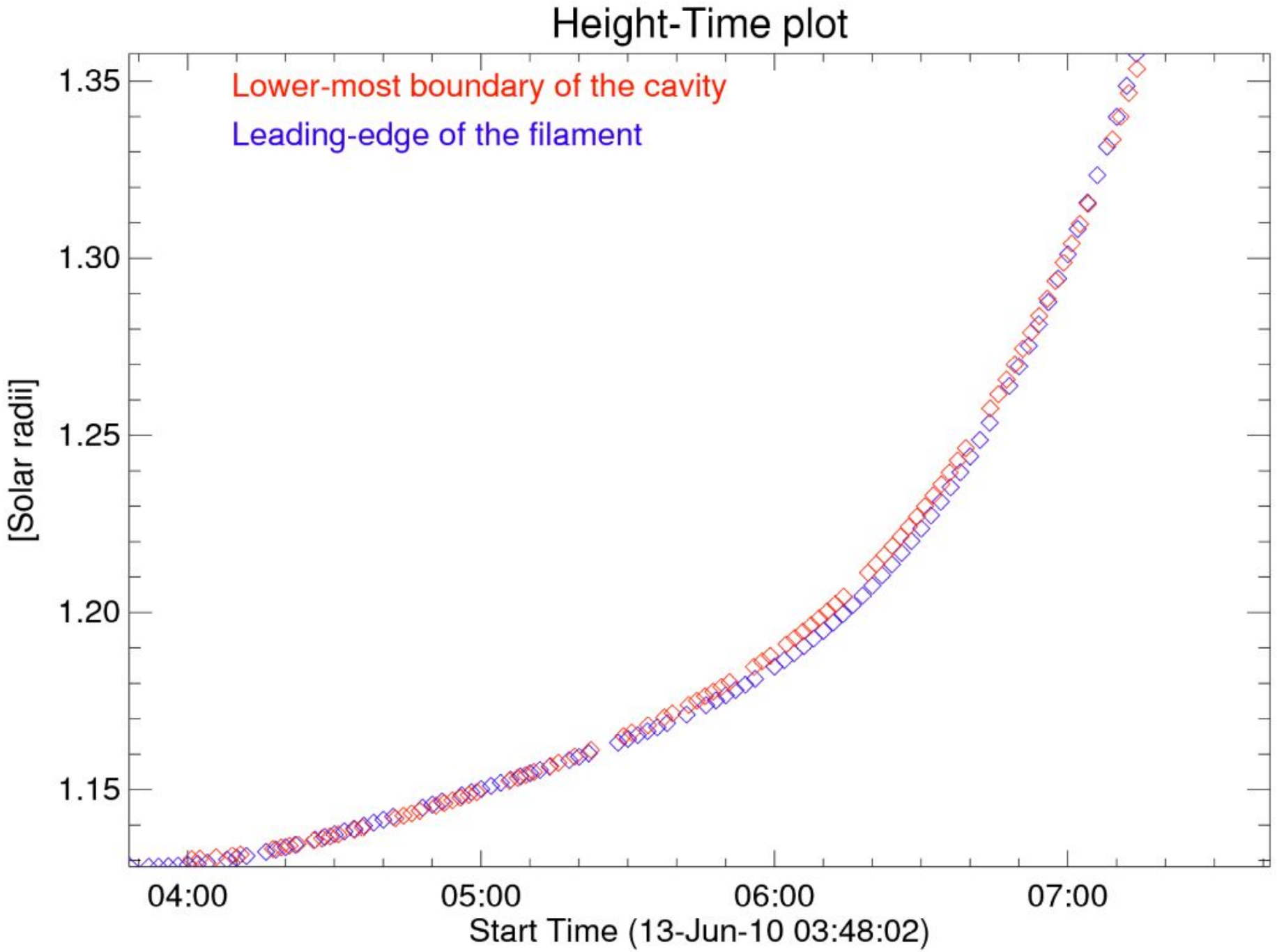
Both the slits are taken along the same position angle

Height-time plot for the lower-most boundary of the cavity and the top-most part of the prominence

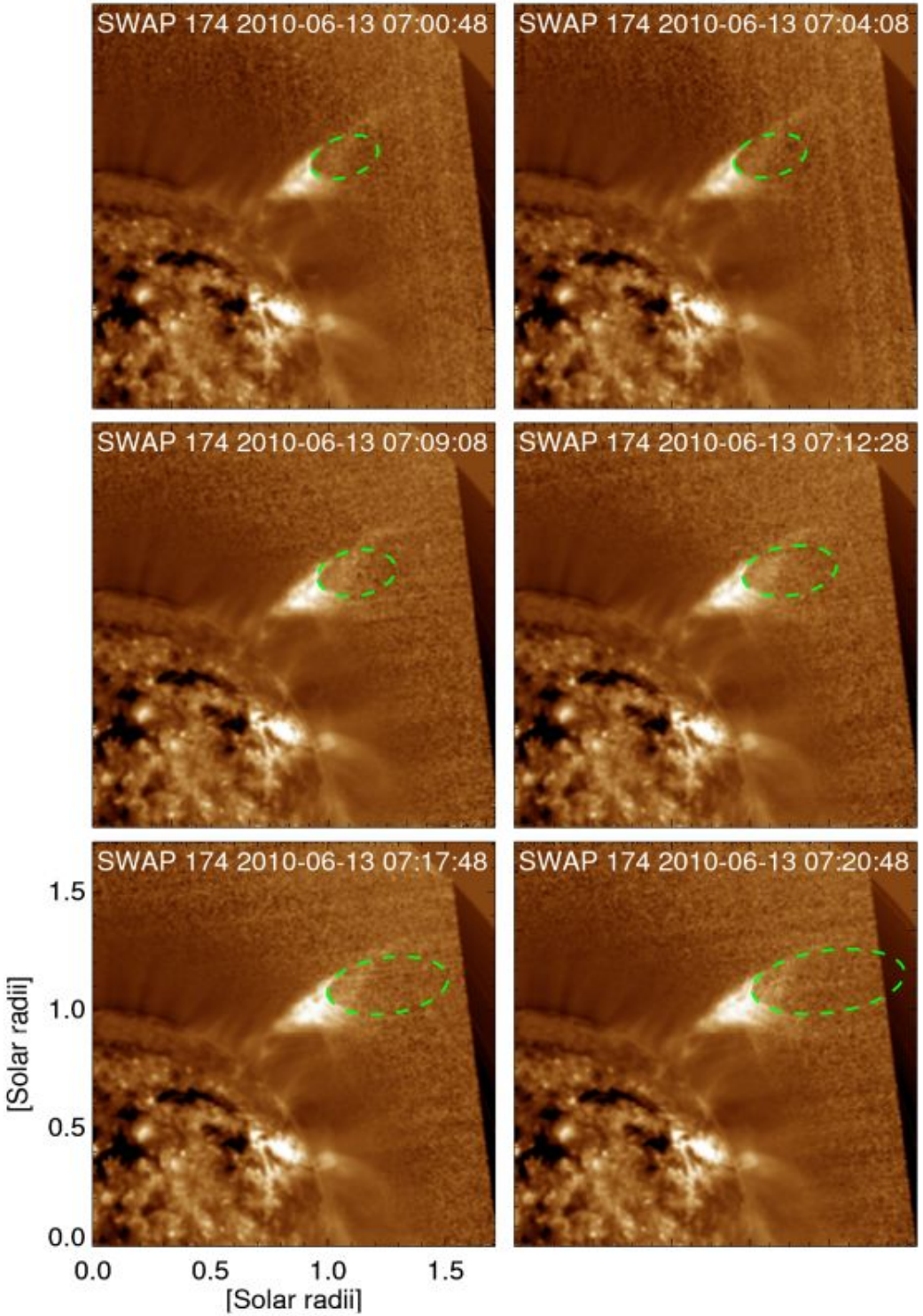




Do these two height-time profiles match with each other?



The two height-time profiles almost coincide. The bottom boundary of the cavity and the top most part of the prominence lie in a same boundary.



Geometrical fitting to the cavity morphology in different time-steps during its eruptive phase within SWAP field-of-view

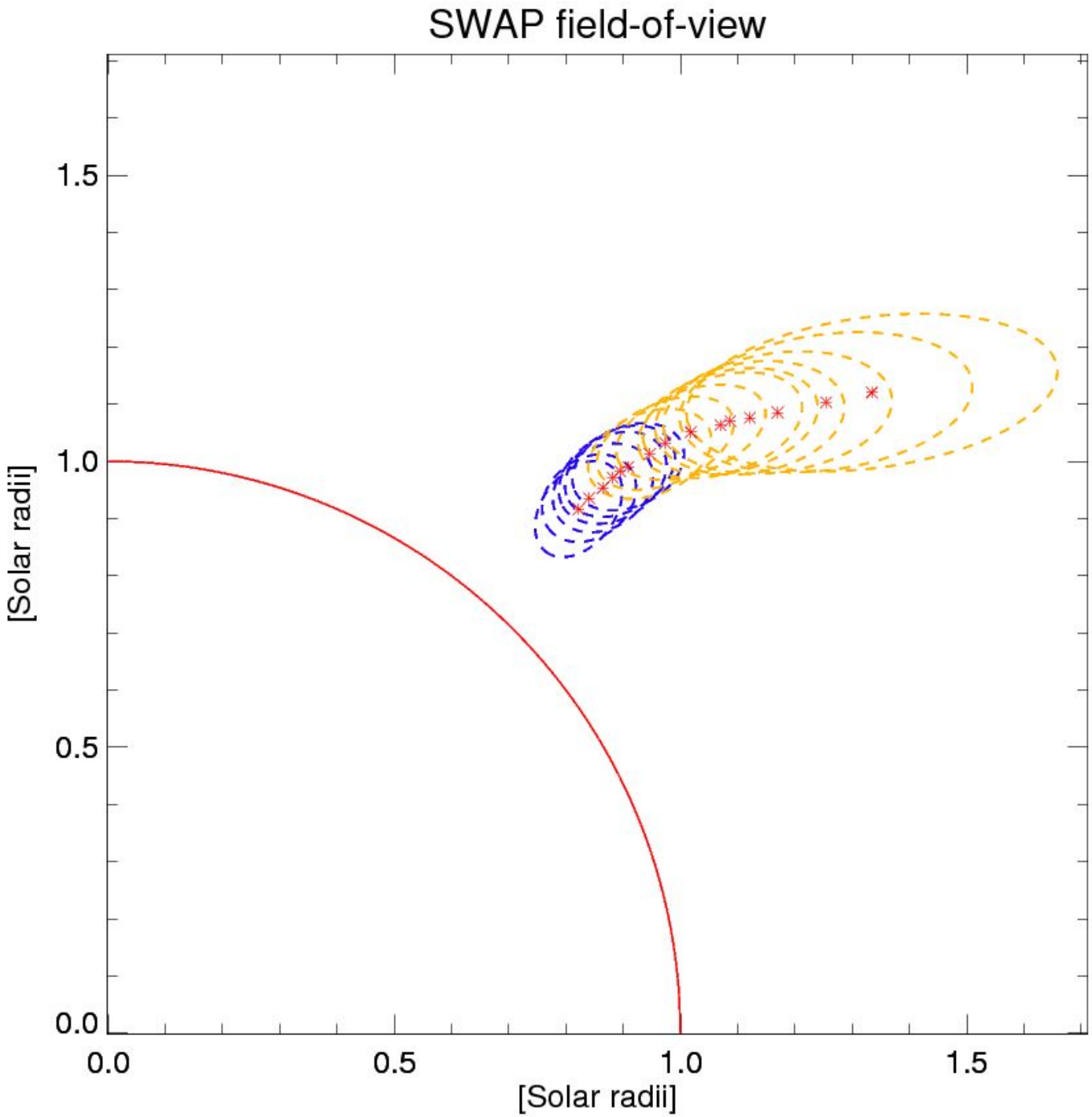
In the AIA field-of-view we could track the evolution of the cavity only up to 1.35 solar radii

The extended field-of-view of SWAP gave an unique opportunity to track the cavity up to 1.7 solar radii

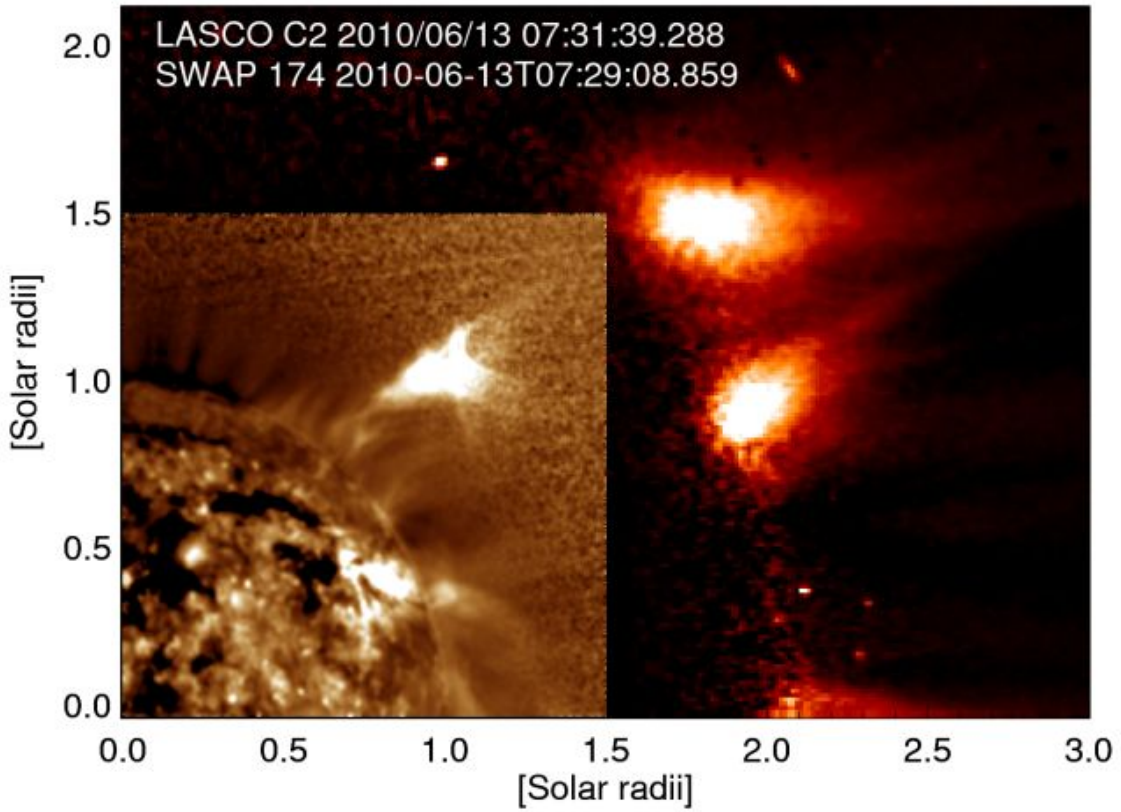
Evolution of the cavity in SWAP field-of-view

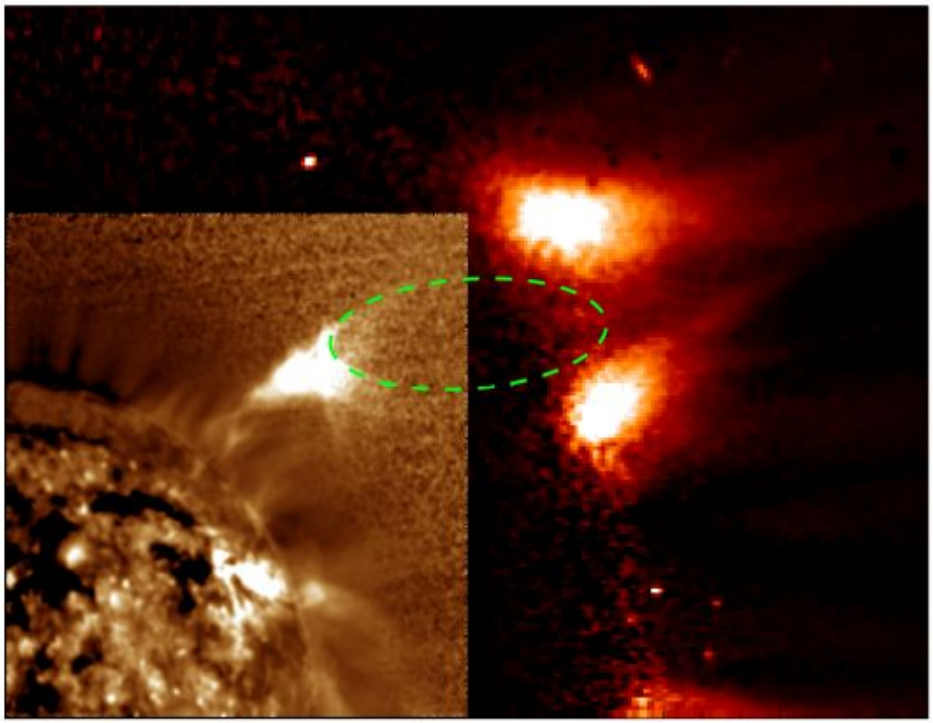
Non-radial motion at about 1.3 solar radii

Position angle changes from 310 to 270 degrees



Fitting the cavity morphology in SWAP + LASCO C2 field-of-view





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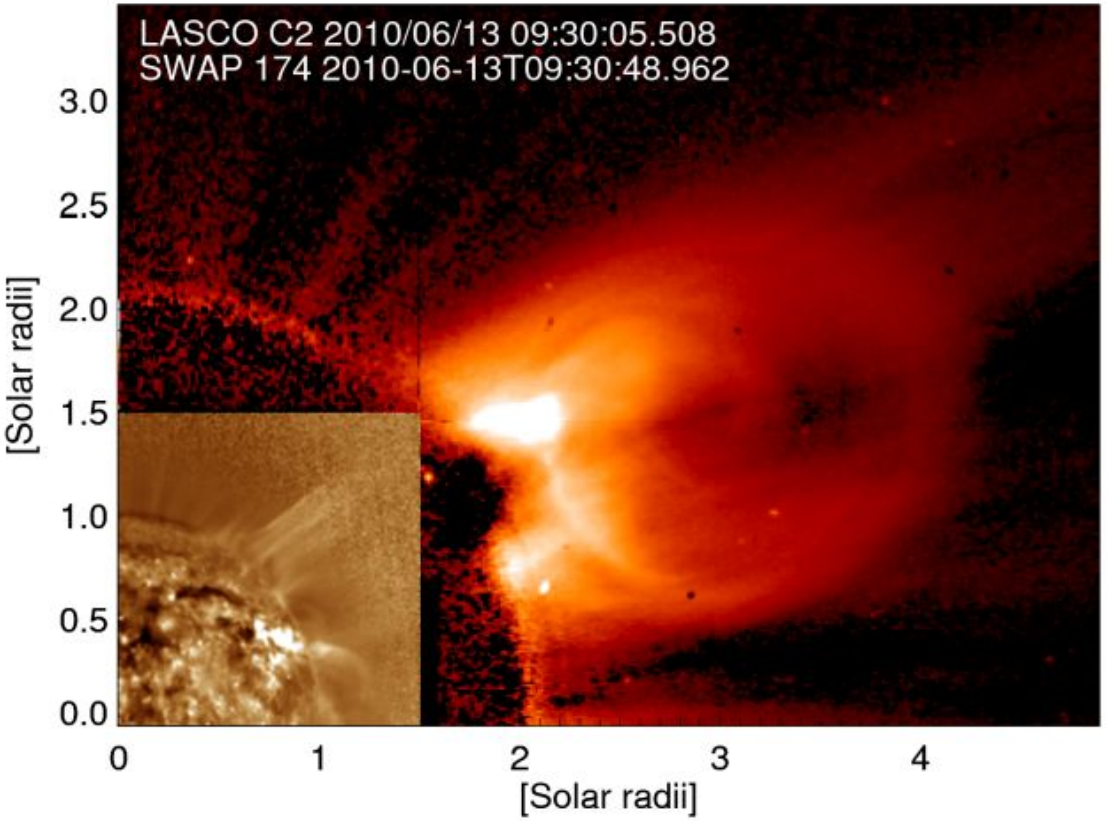
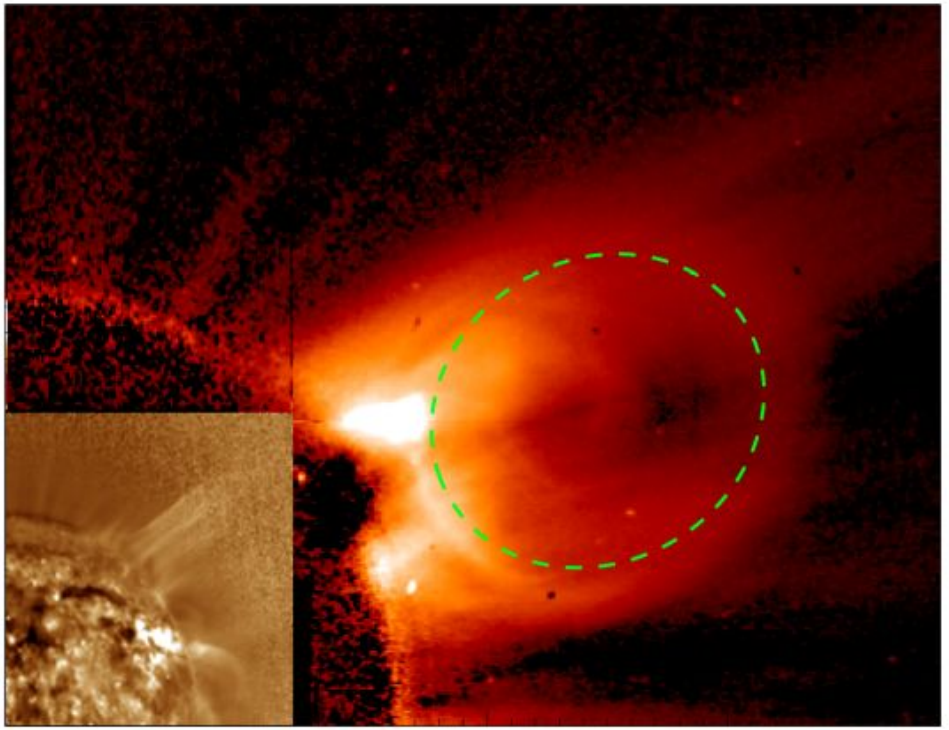
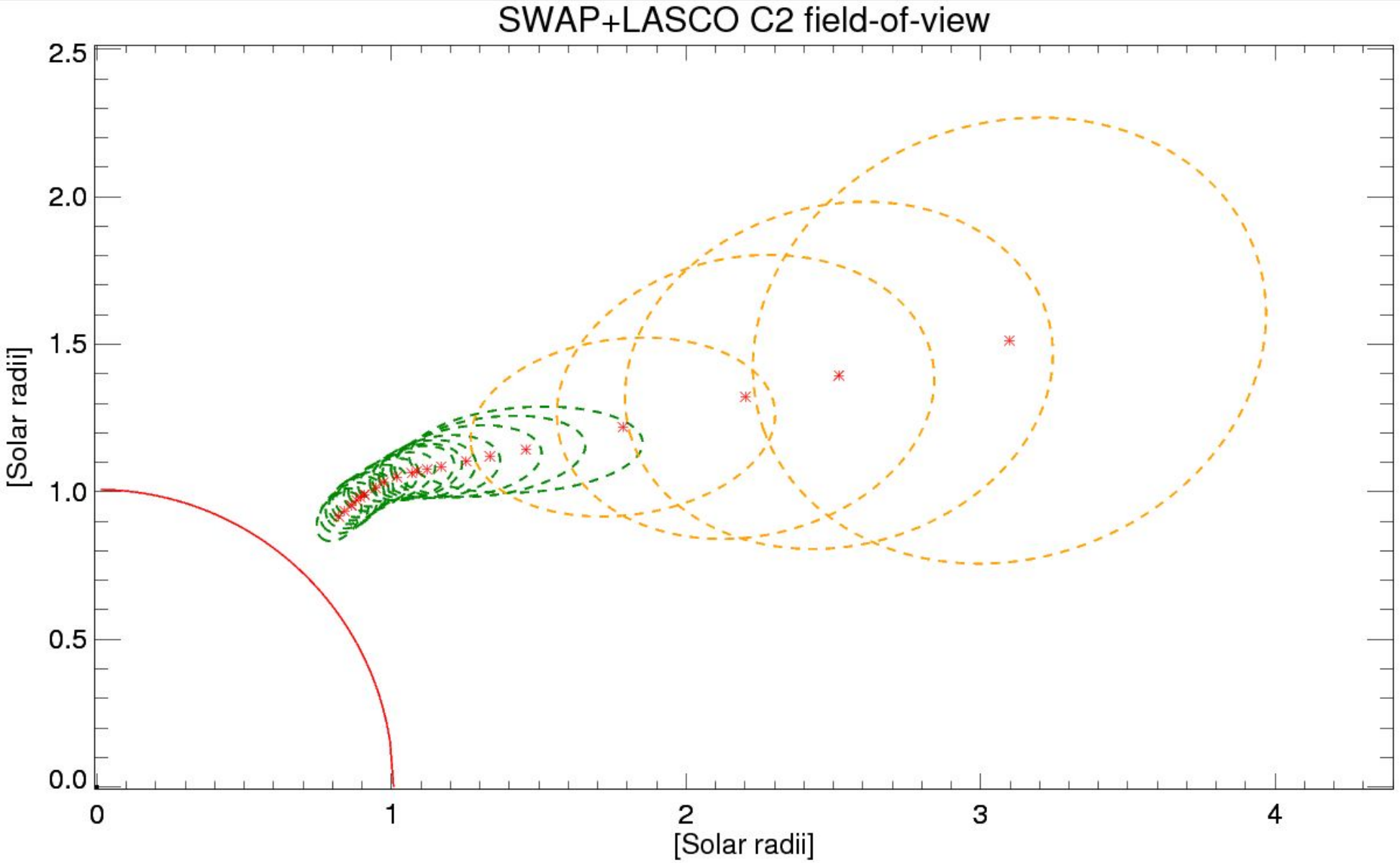
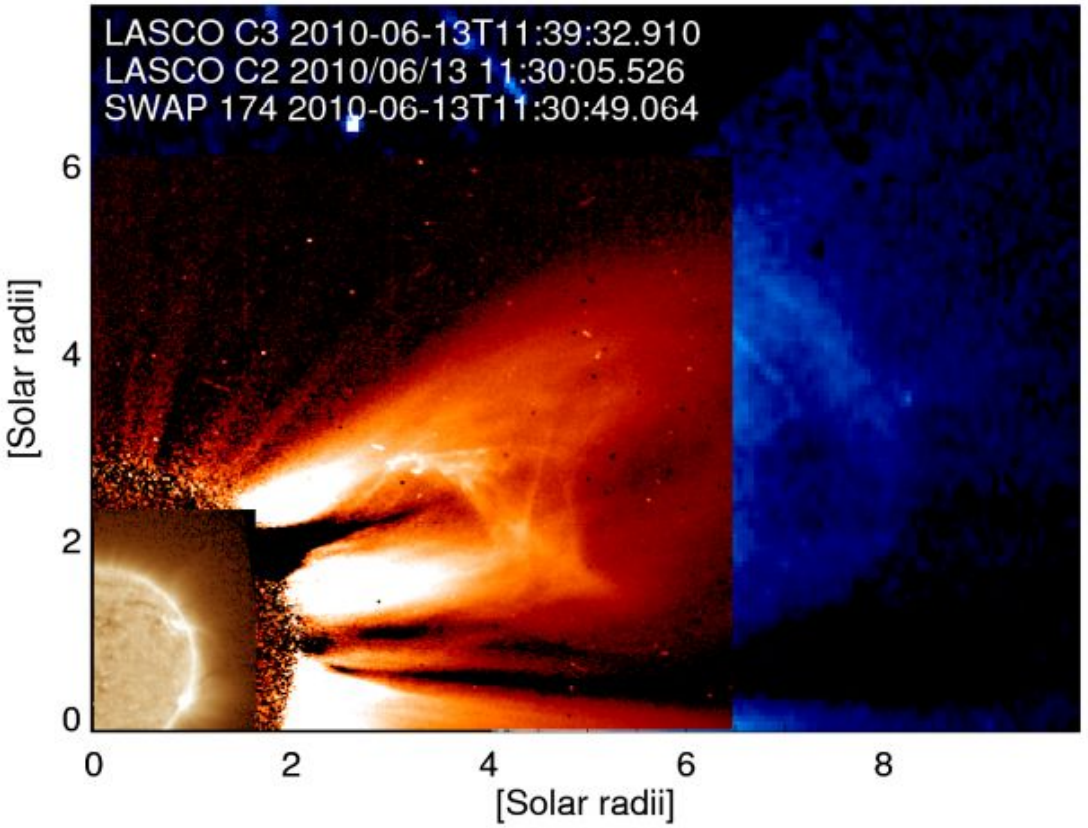


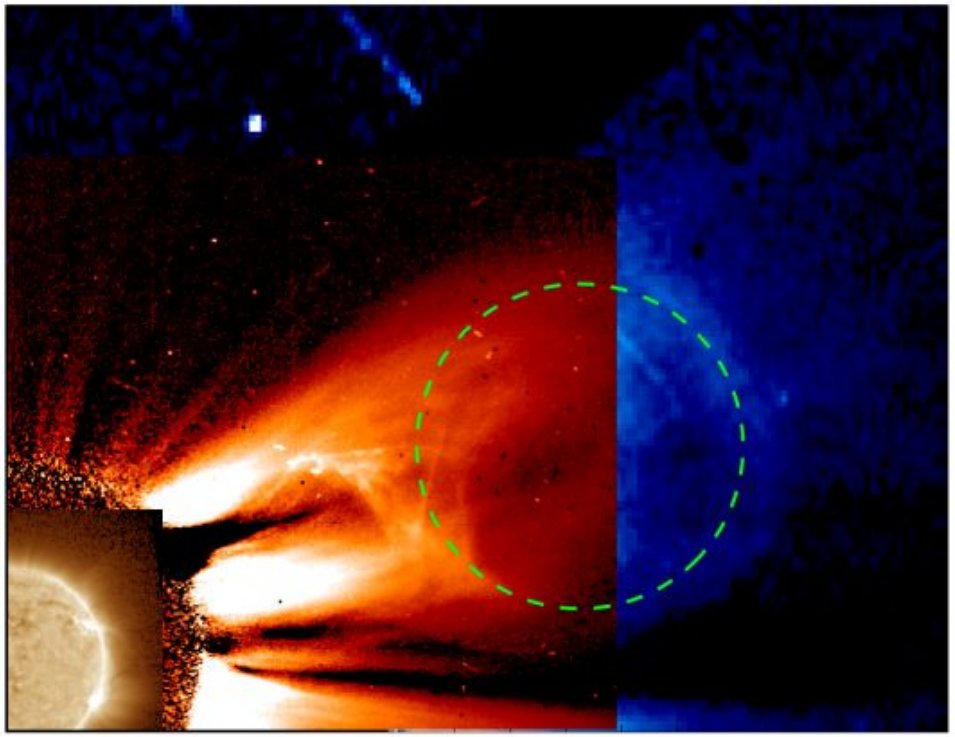


Evolution of the cavity in SWAP + LASCO C2 field-of-view

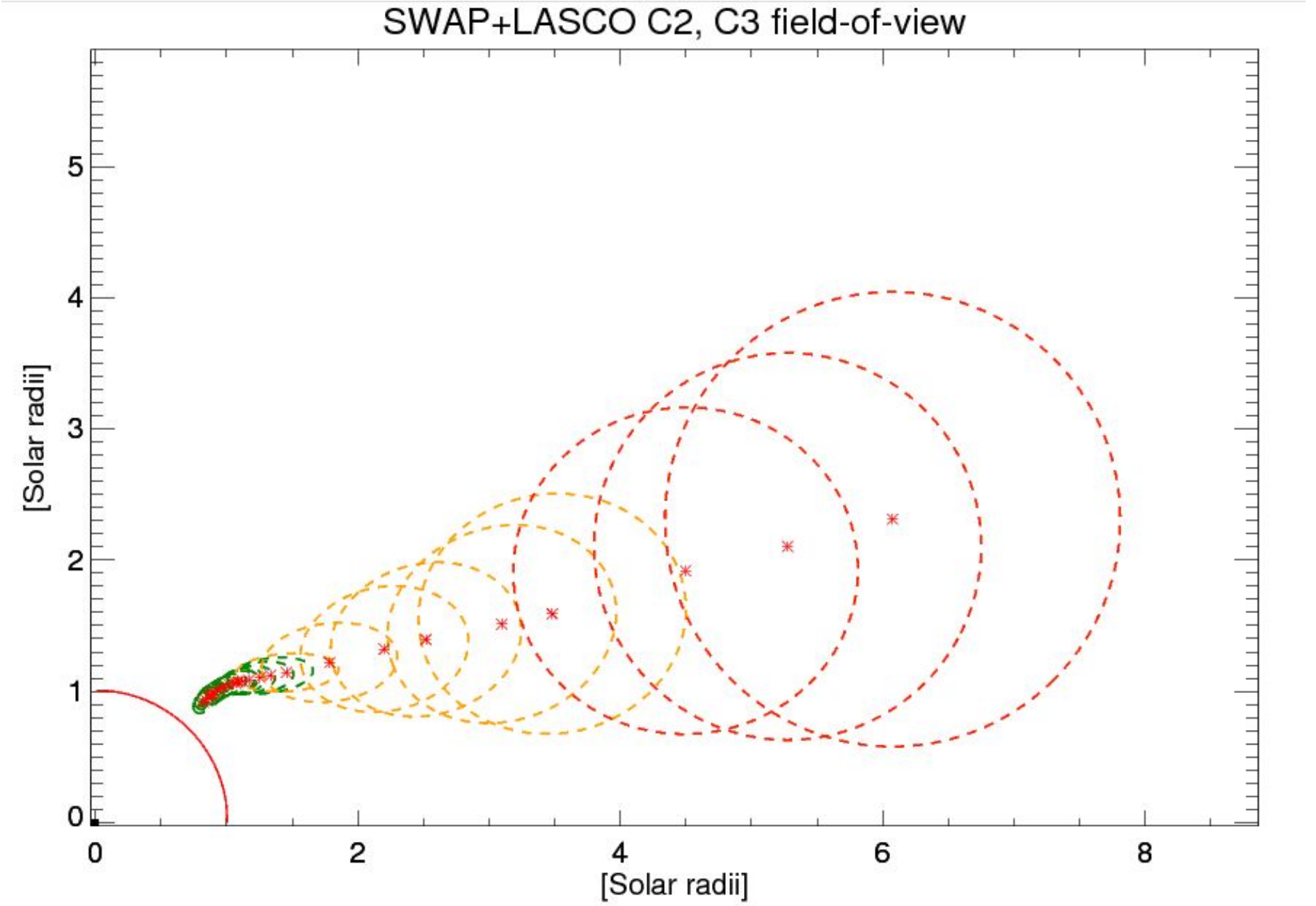


Fitting the cavity morphology in SWAP + LASCO C2 + C3 field-of-view

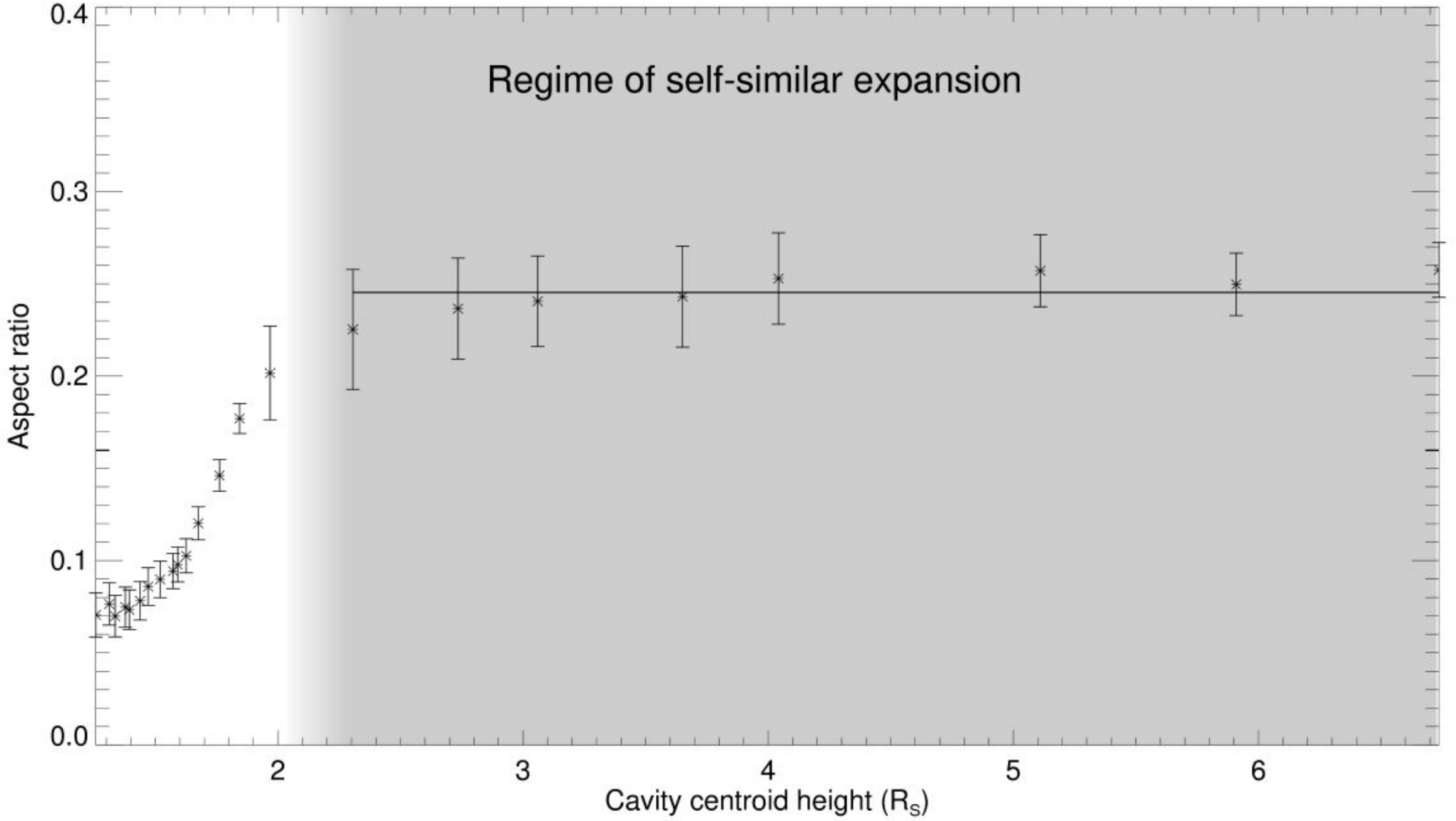




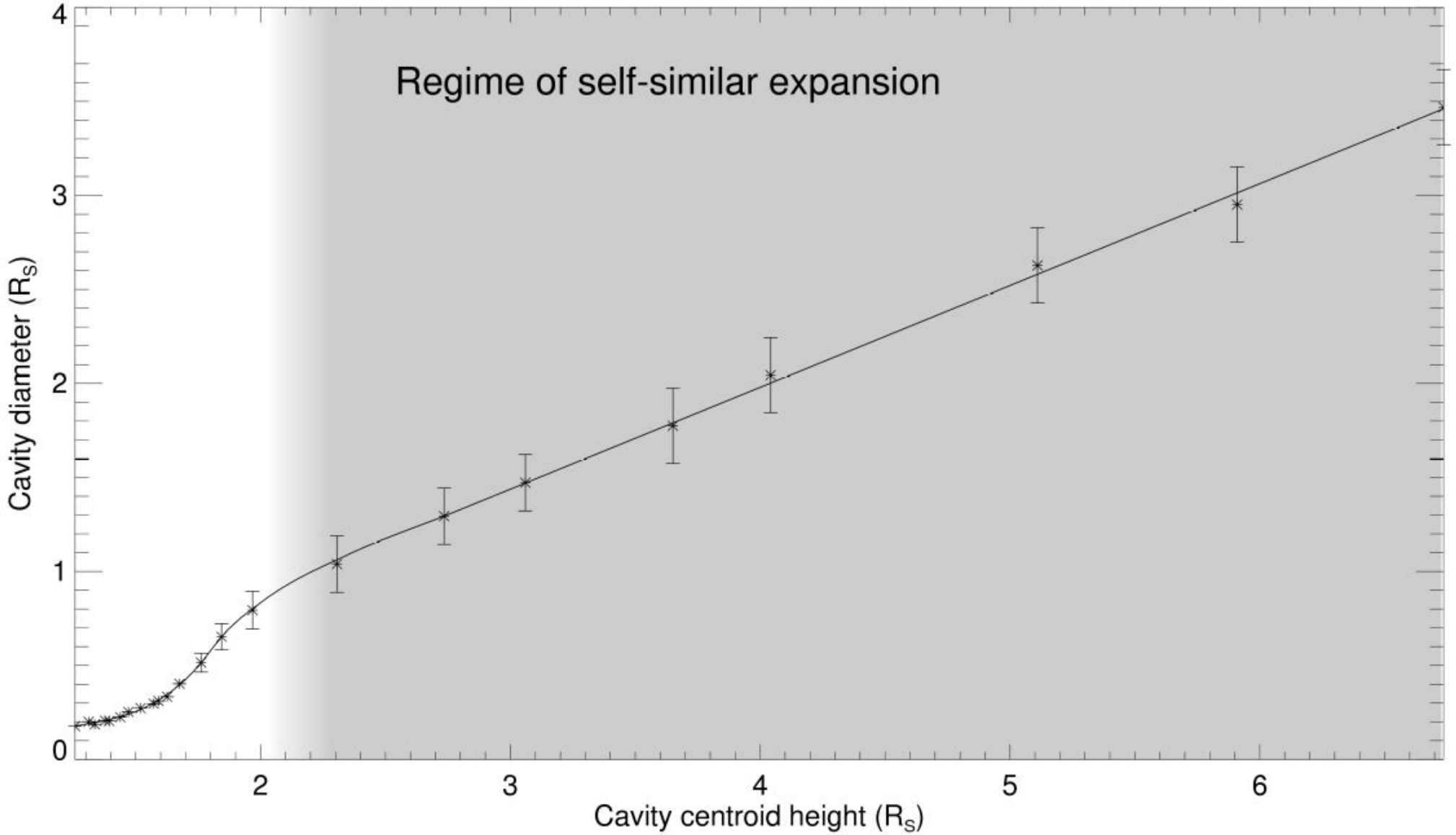
Evolution of the cavity in SWAP + LASCO C2 + C3 field-of-view



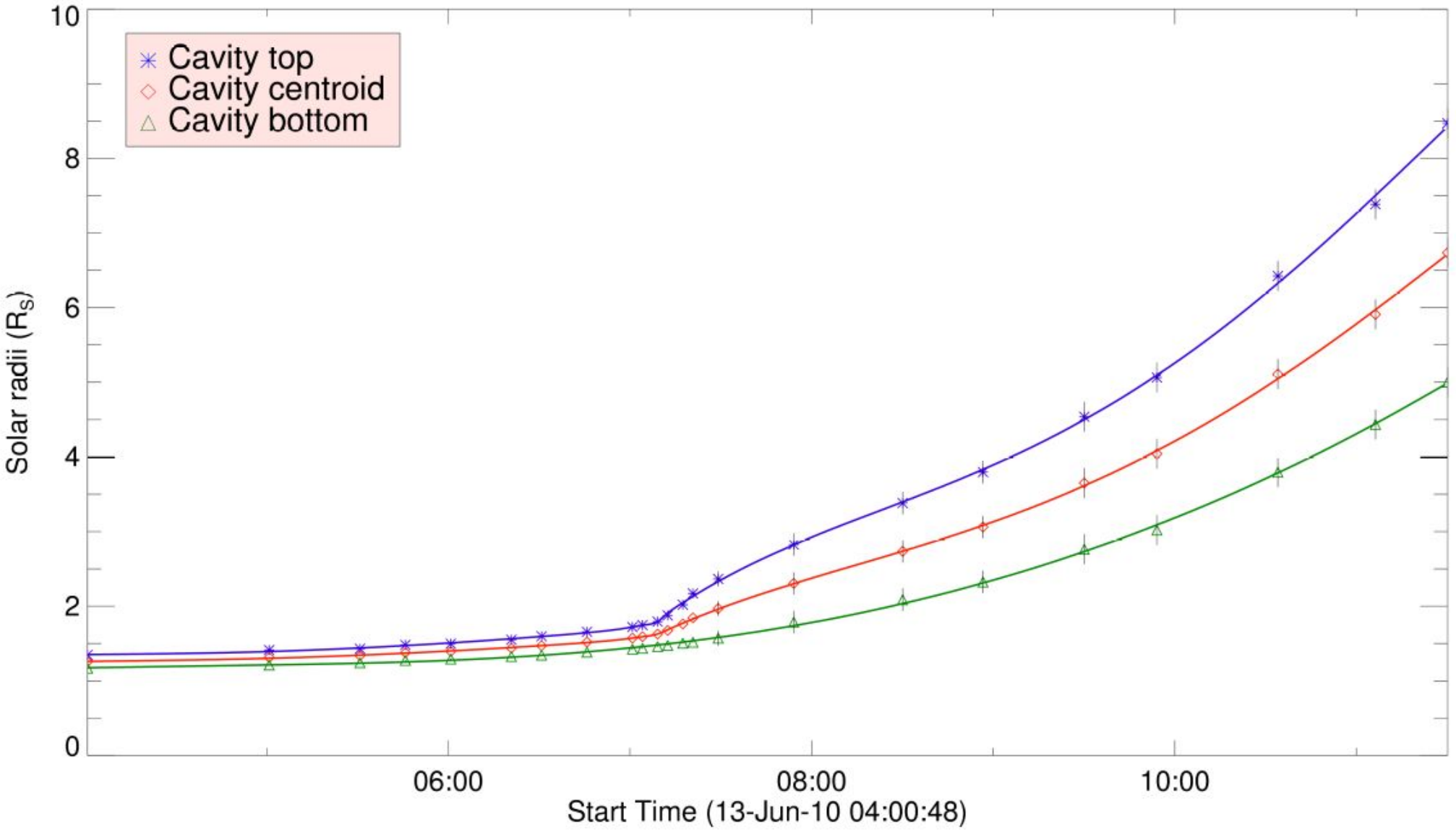
Aspect ratio vs height of the cavity-centroid plot



Cavity diameter vs height of the cavity-centroid plot



Height-time plot for individual cavity top, bottom and centroid



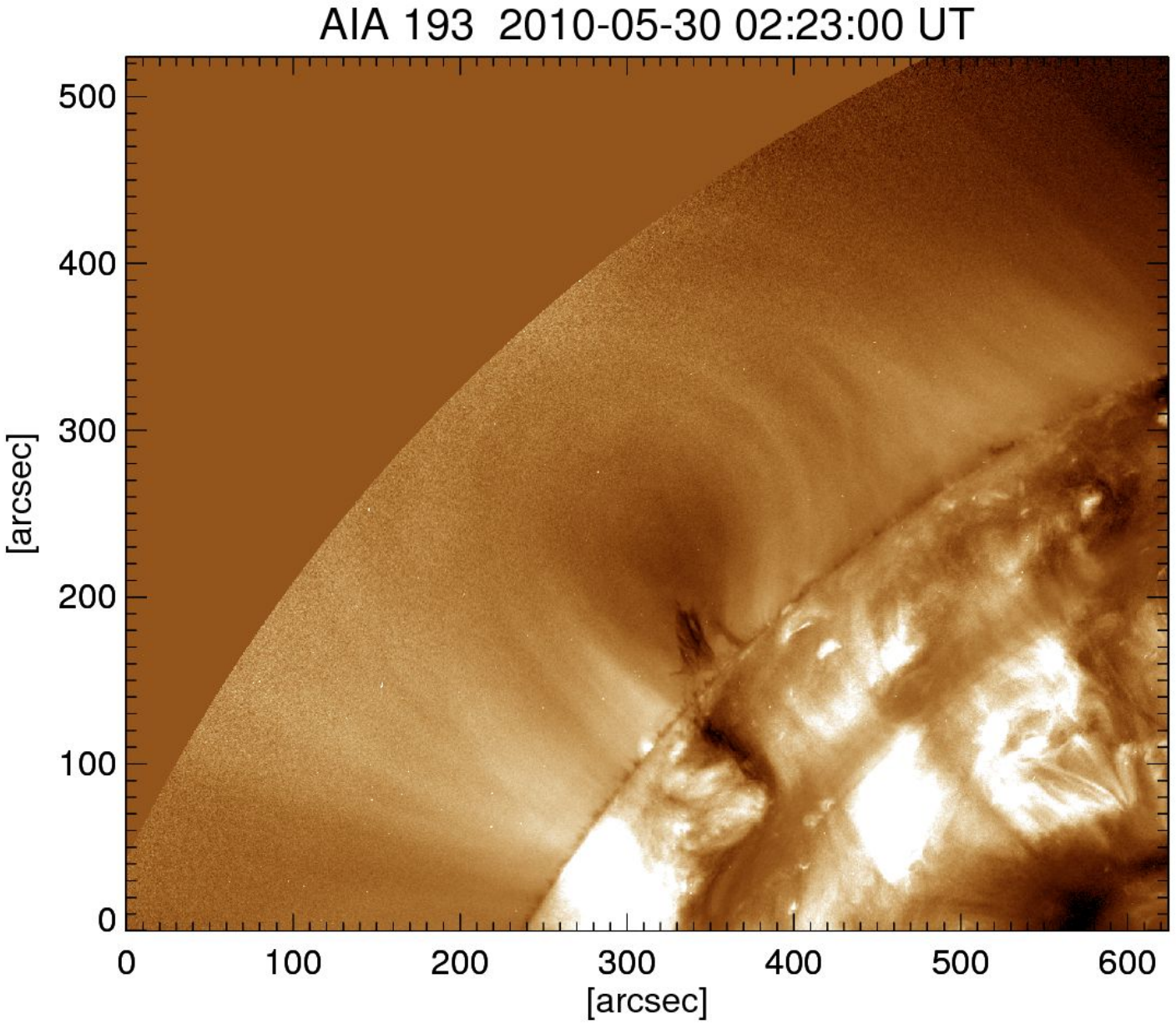
Evolution of the coronal cavity during quiescent phase

We track the quiescent cavity at different times during its passage on the visible solar disk from May 30 to June 13, 2010.

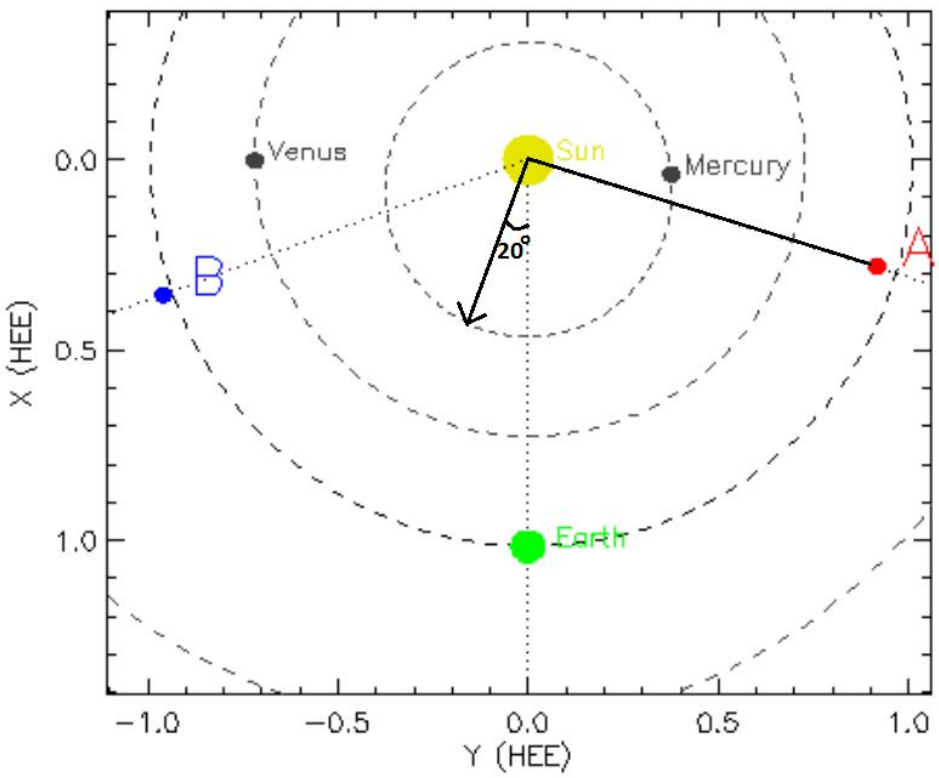
It was first visible in the east-limb on May 30, 2010 at around 02:23:00 UT.

The cavity centroid height was at 1.10 Solar radii.

The cavity morphology looks almost circular

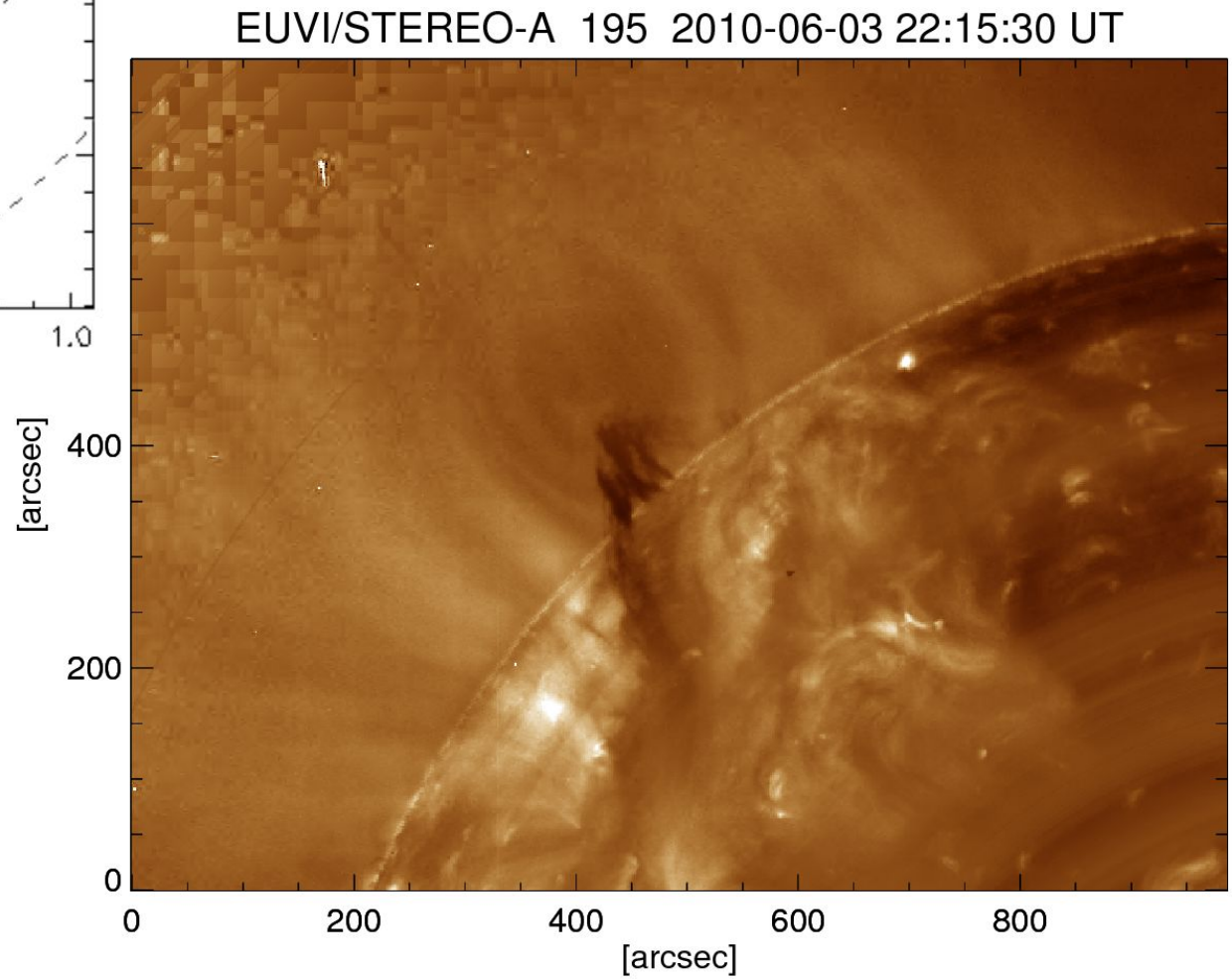


Cavity morphology as seen from STEREO A

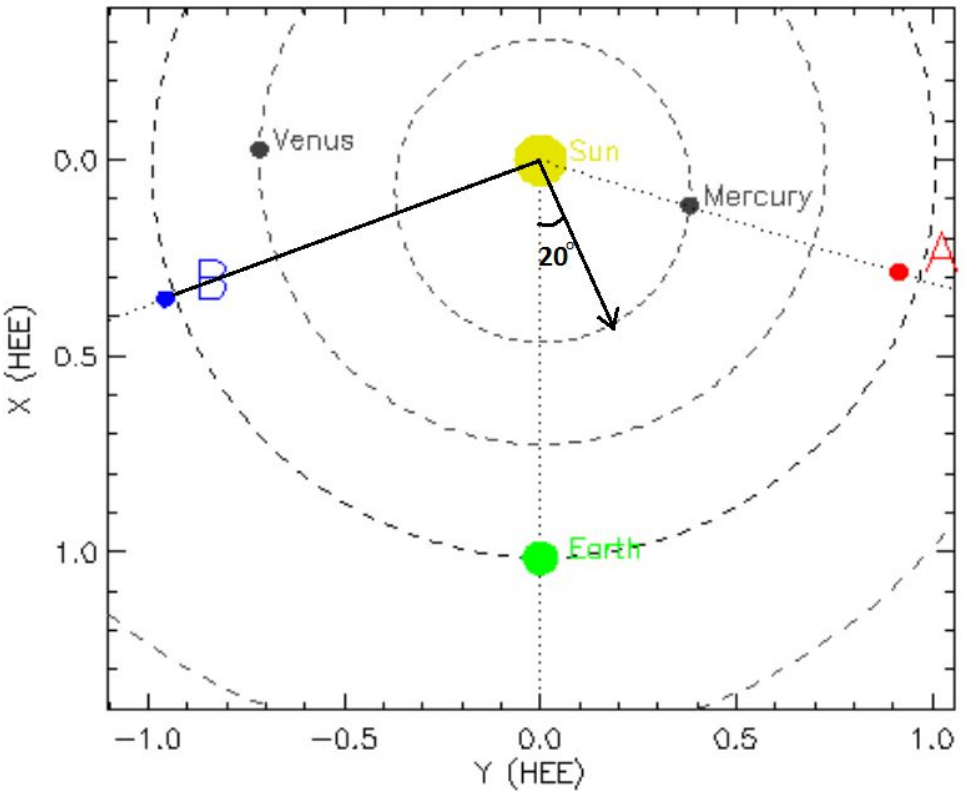


Cavity centroid height - 1.13 solar radii

Cavity morphology looks almost circular

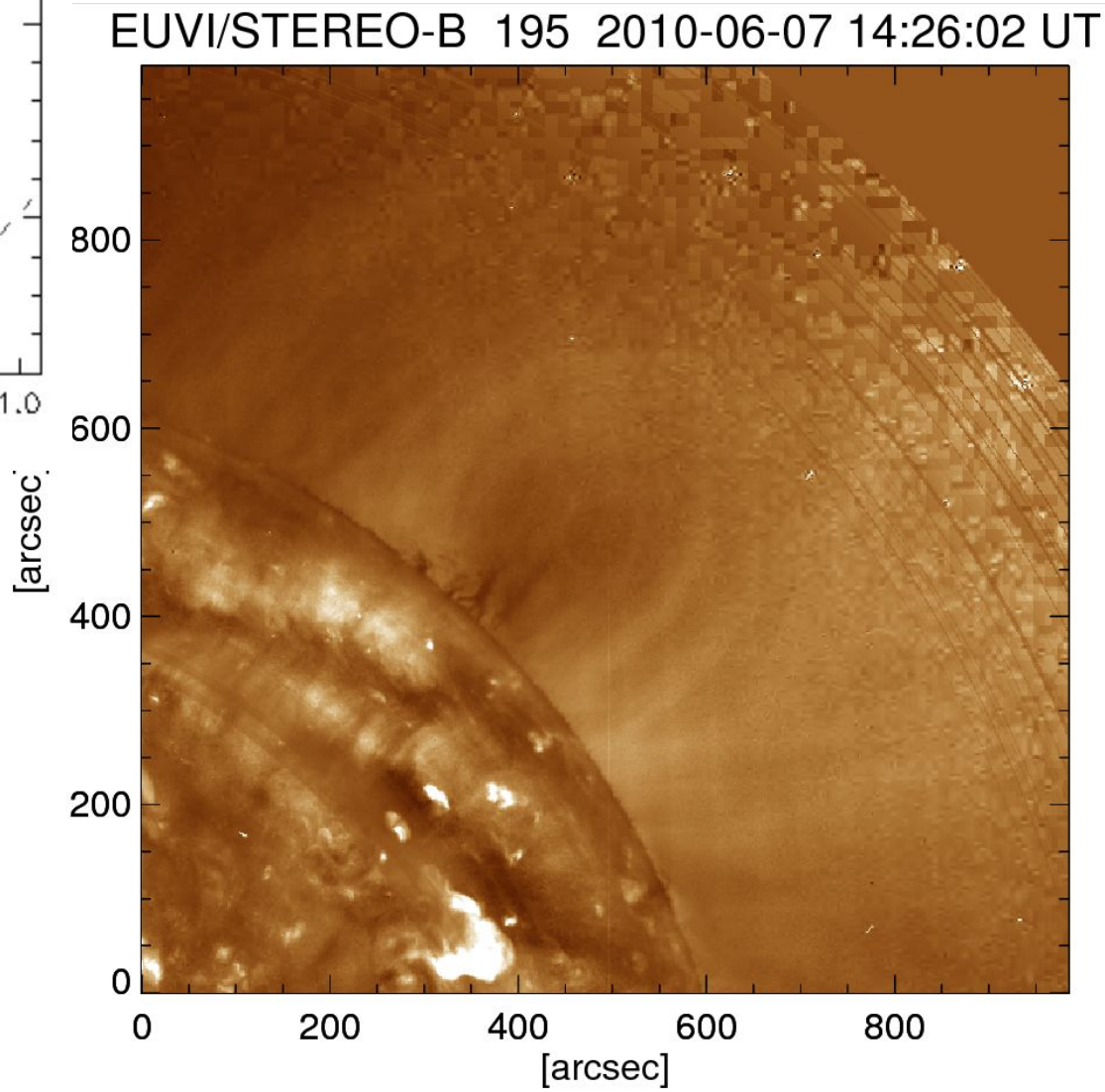


Cavity morphology as seen from STEREO B

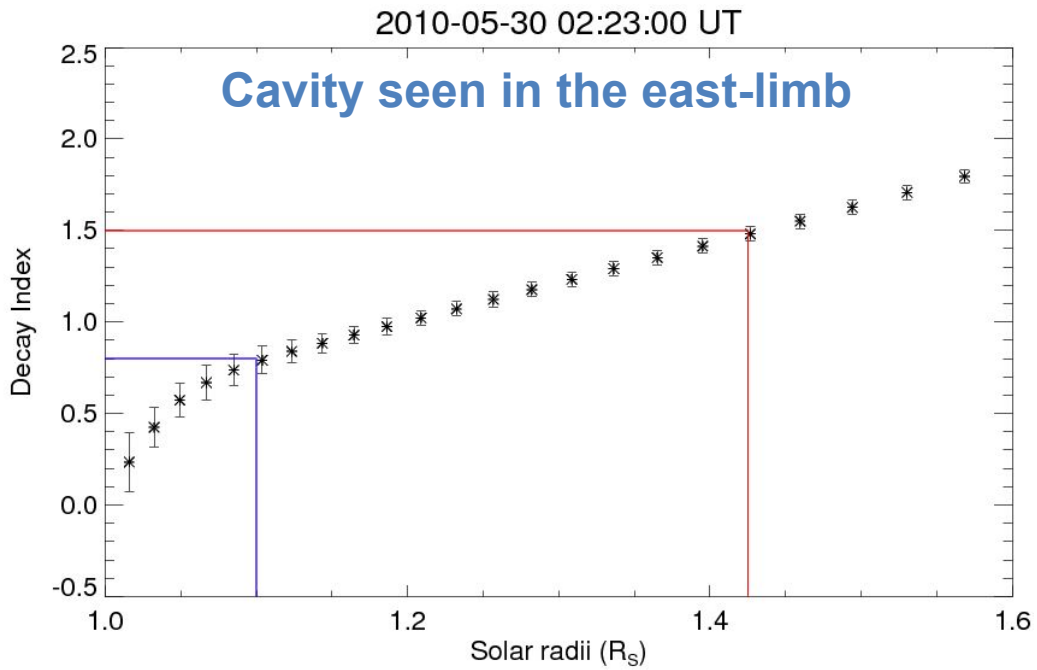


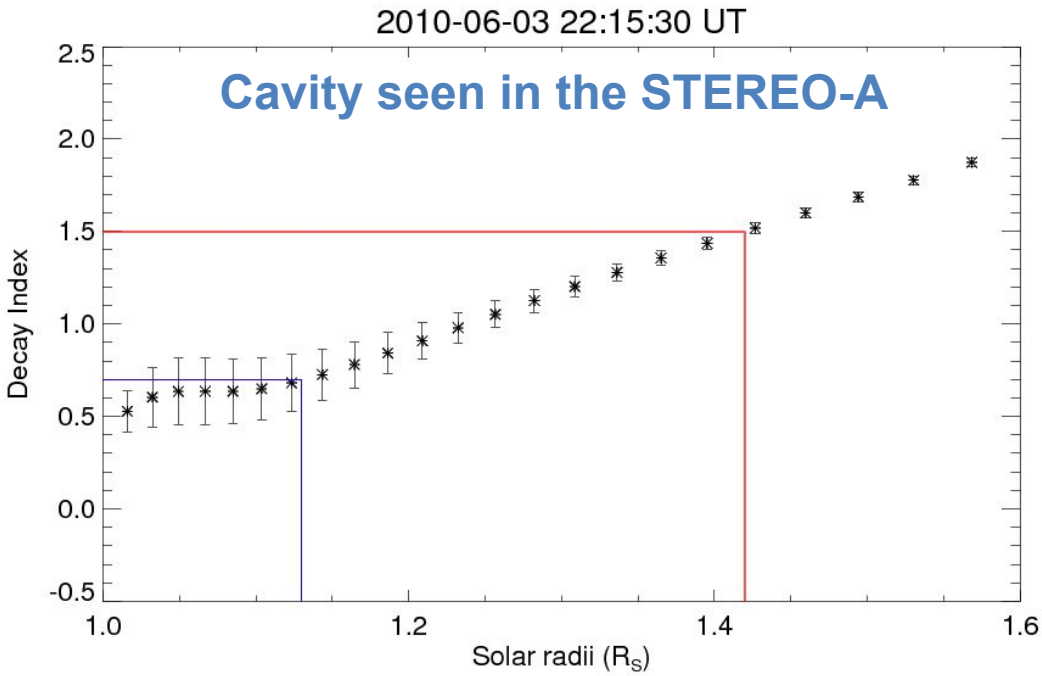
Cavity centroid height - 1.17 solar radii

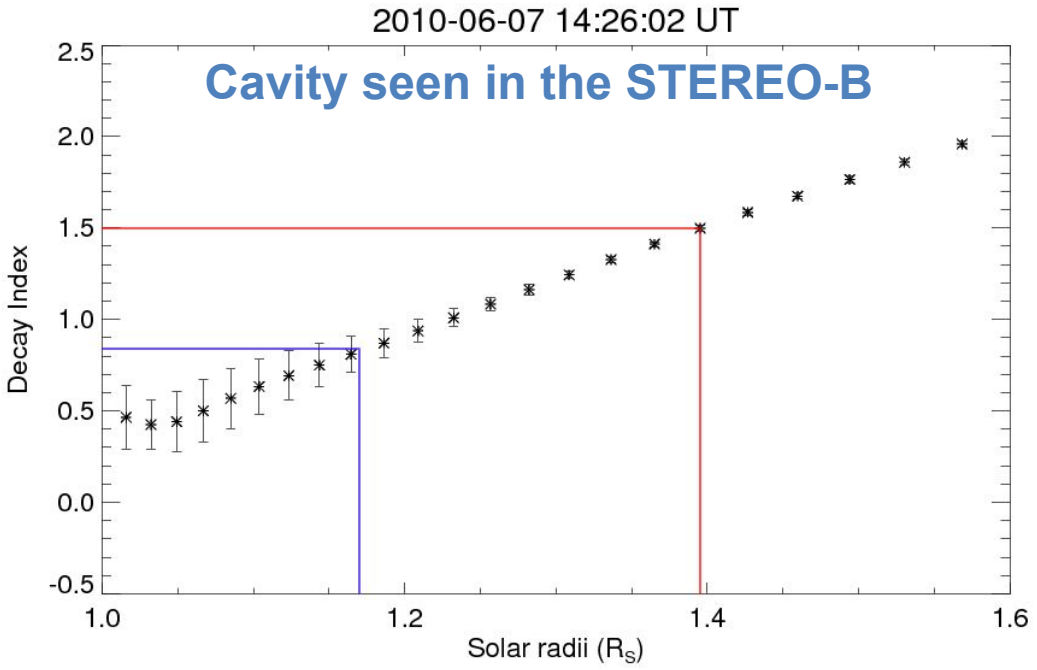
Cavity morphology looks almost circular

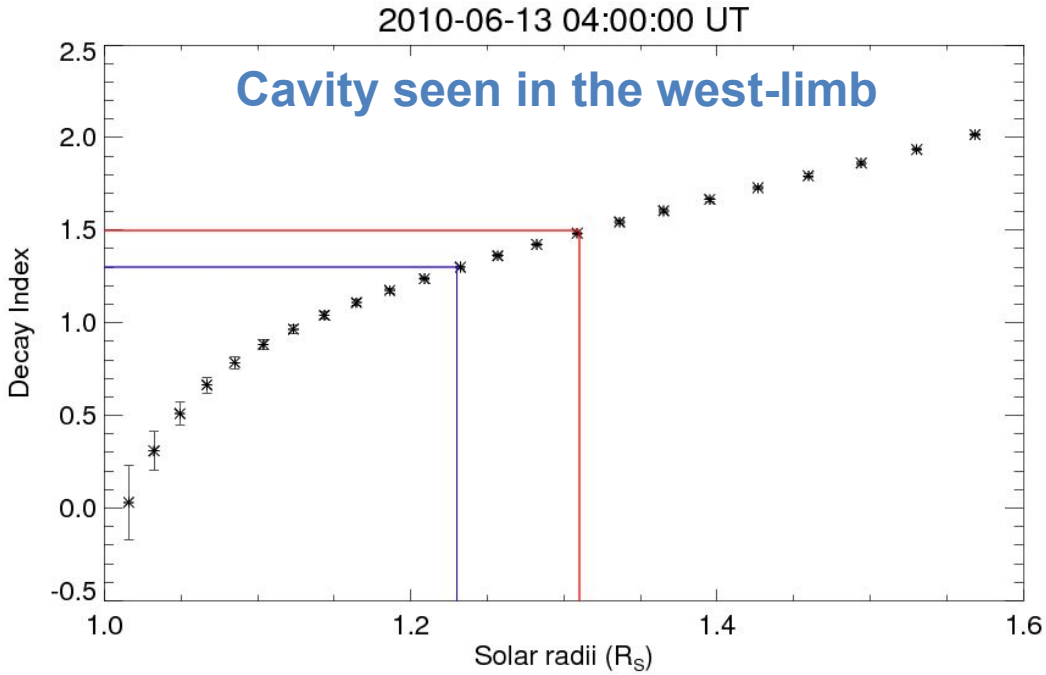


Decay Index profiles for four different dates during the quiescent phase

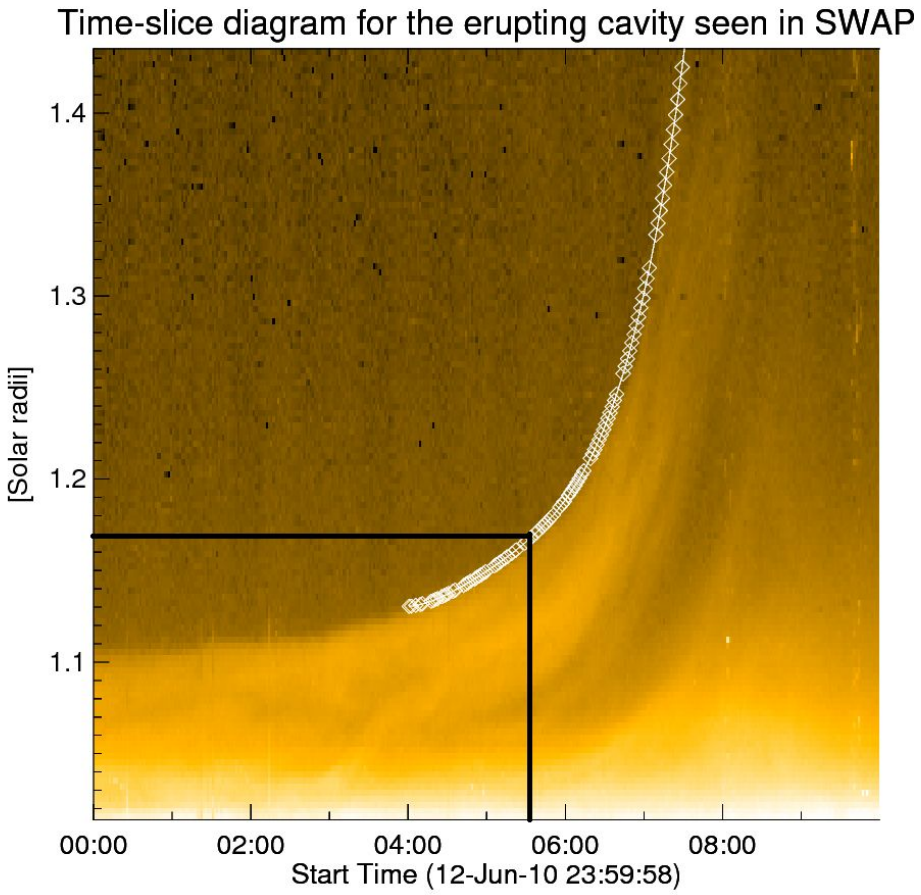








Initial acceleration phase in lower corona

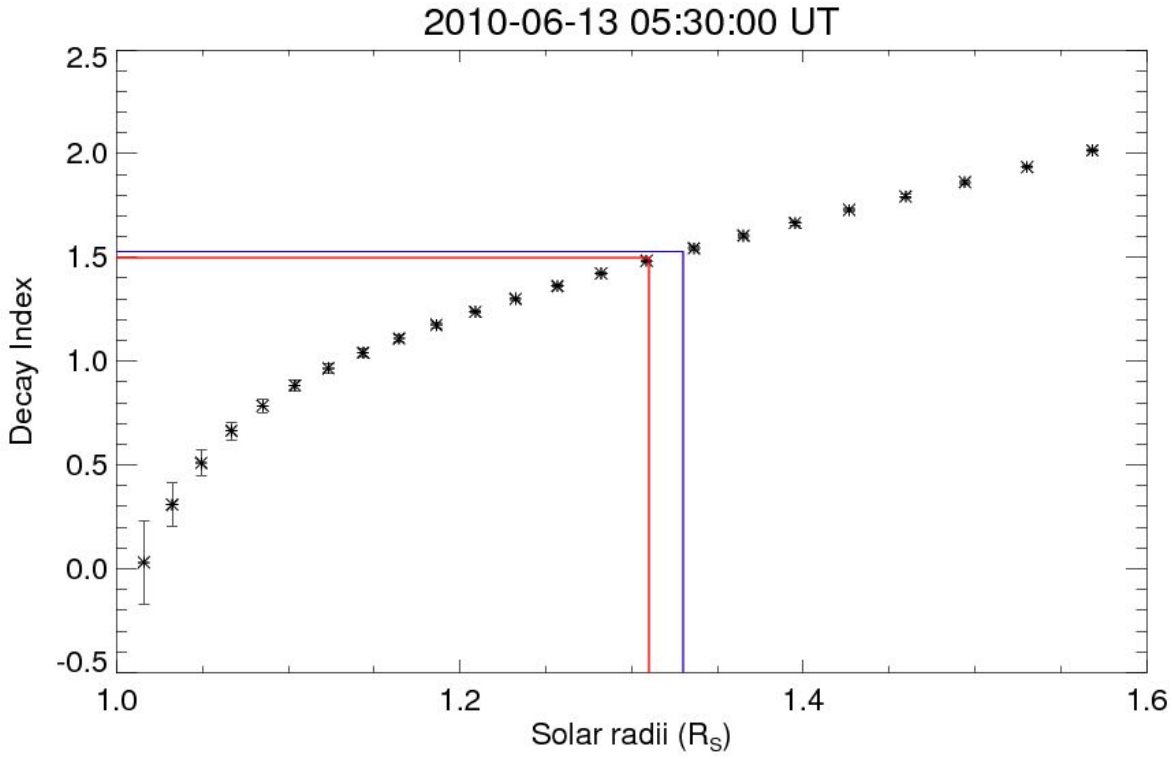


Initial acceleration starts at around 05:30 UT

Cavity bottom height – 1.17 solar radii

Cavity centroid height - 1.33 solar radii

The cavity centroid undergoes initial acceleration after crossing the critical decay index value



Summary :

The height-time profiles for the top of the prominence material and the lower-most part of the cavity almost coincide.

Up to almost 1.3 solar radii in SWAP field-of-view the cavity exhibit non-radial motion. After near about 1.3 solar radii it maintains same position angle (270 degree).

Up to almost 4 solar radii the cavity morphology is best fitted with ellipse. In LASCO C3 field-of-view the cavity morphology is almost circular.

After near about 2 solar radii the cavity maintain its aspect ratio (near about 0.25) and exhibit self-similar expansion.

In the quiescent phase, the cavity centroid height slowly rises from 1.10 to 1.23 R_S during its passage on the visible solar disc from May 30 to June 13, 2010 and its initial circular shaped morphology gradually expanded and evolved into elliptical shape prior to the eruption from the western solar limb.

The cavity centroid undergoes initial acceleration after crossing the critical decay index value.

Thank you