A Kinematic Study of Eruptive Prominences

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Under the direction of
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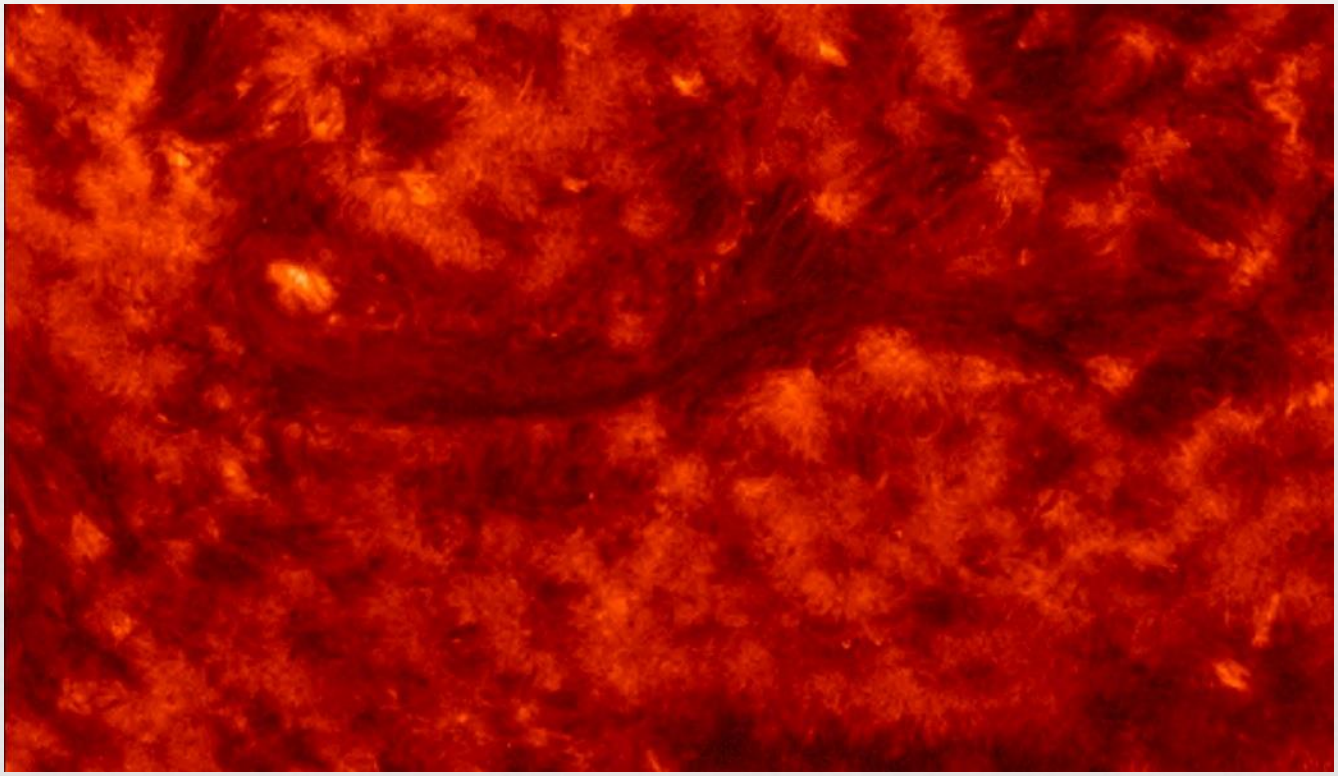
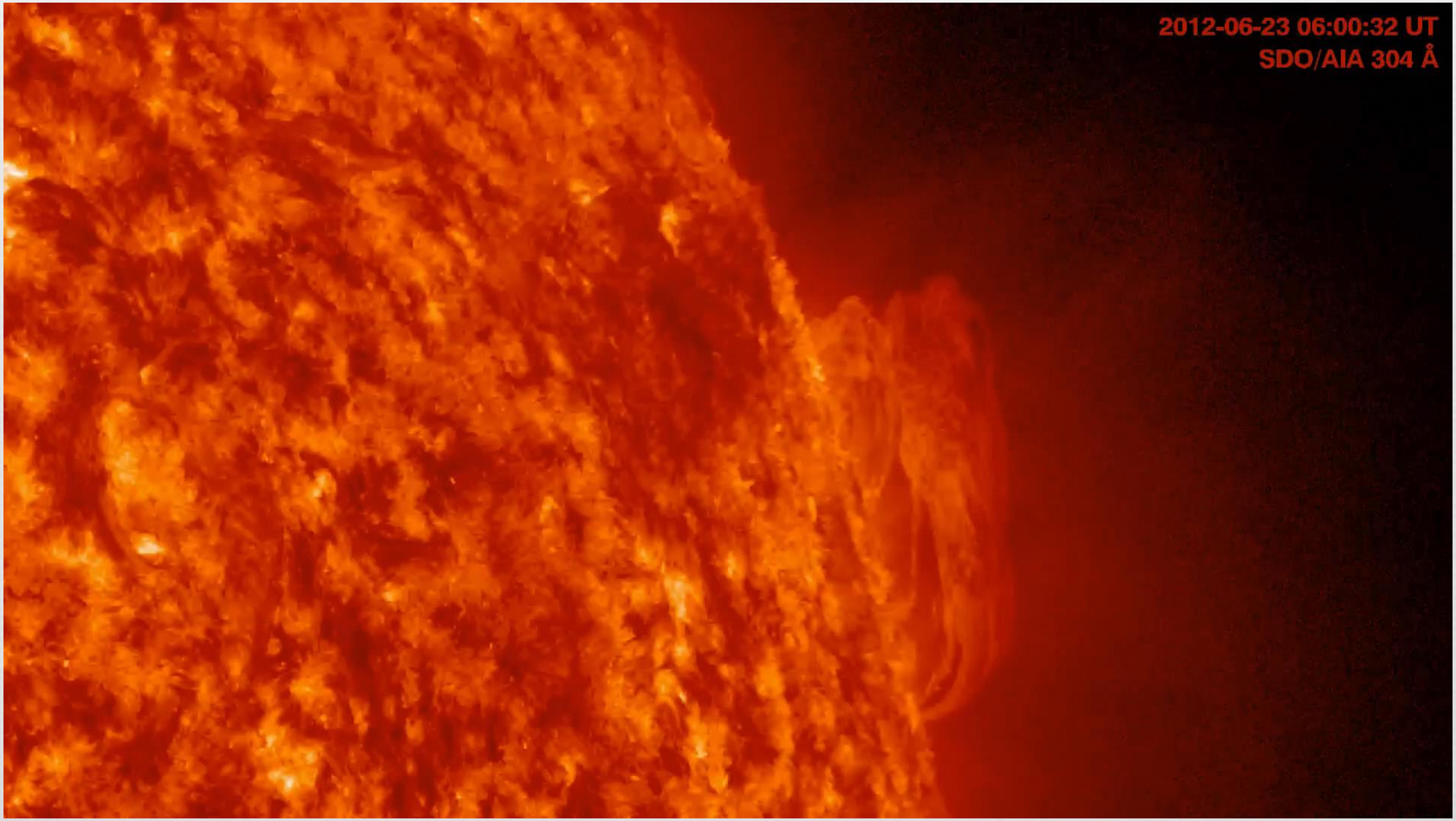
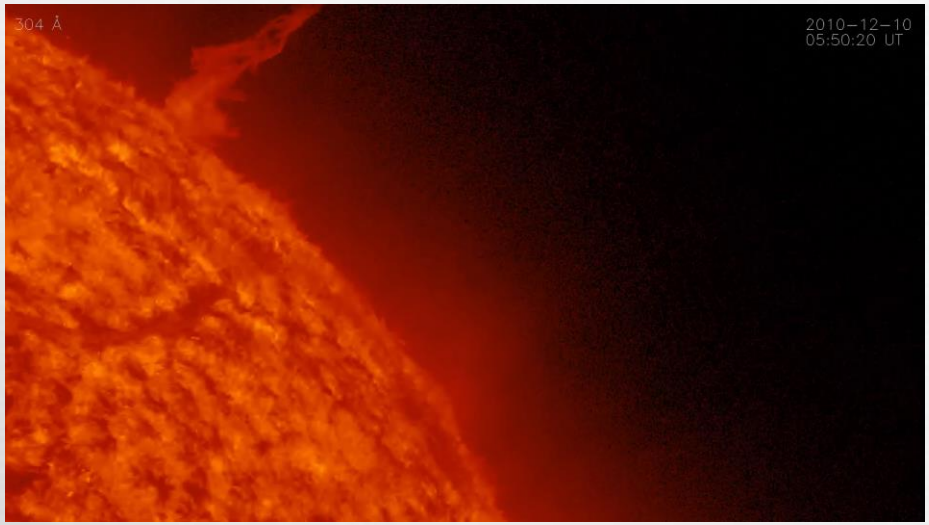
Prominence Structure



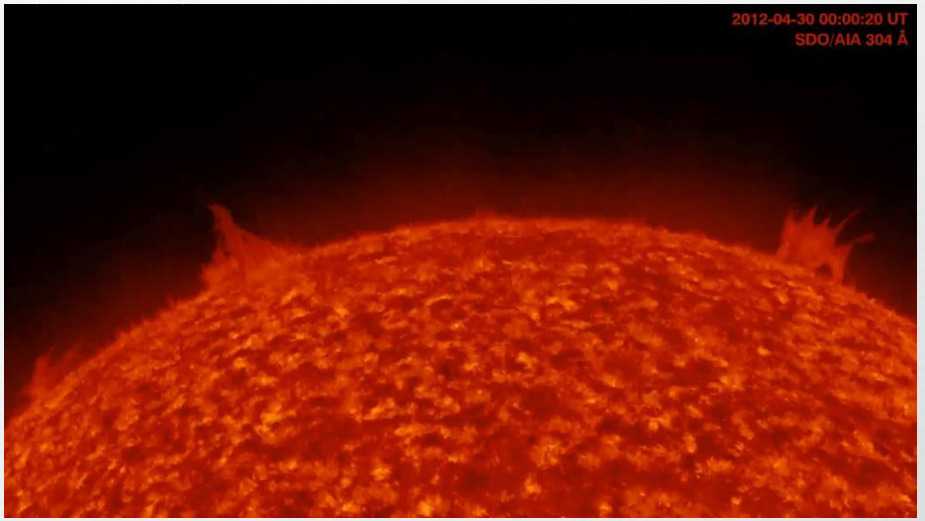
Prominence Eruption



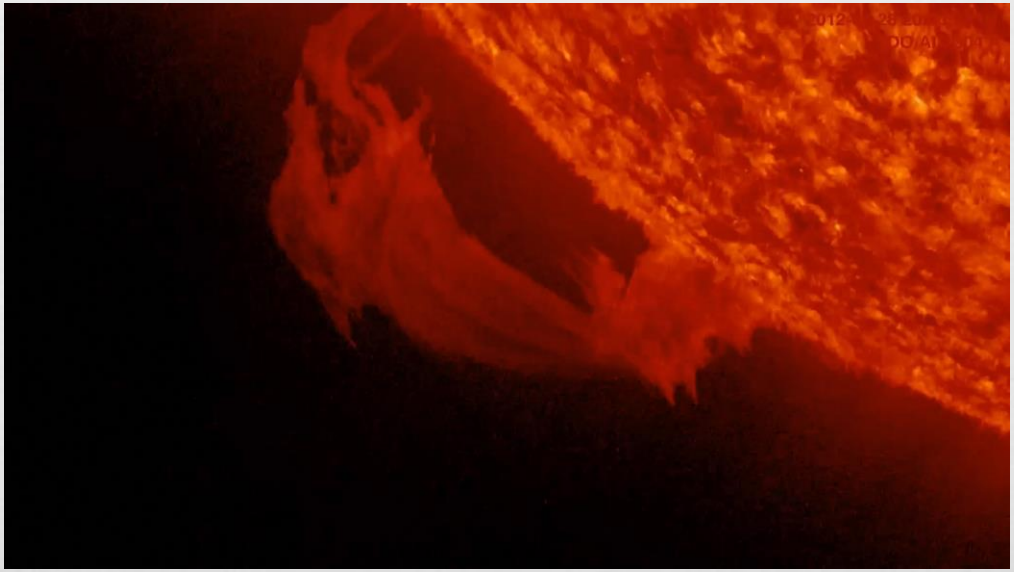
Kink Instability



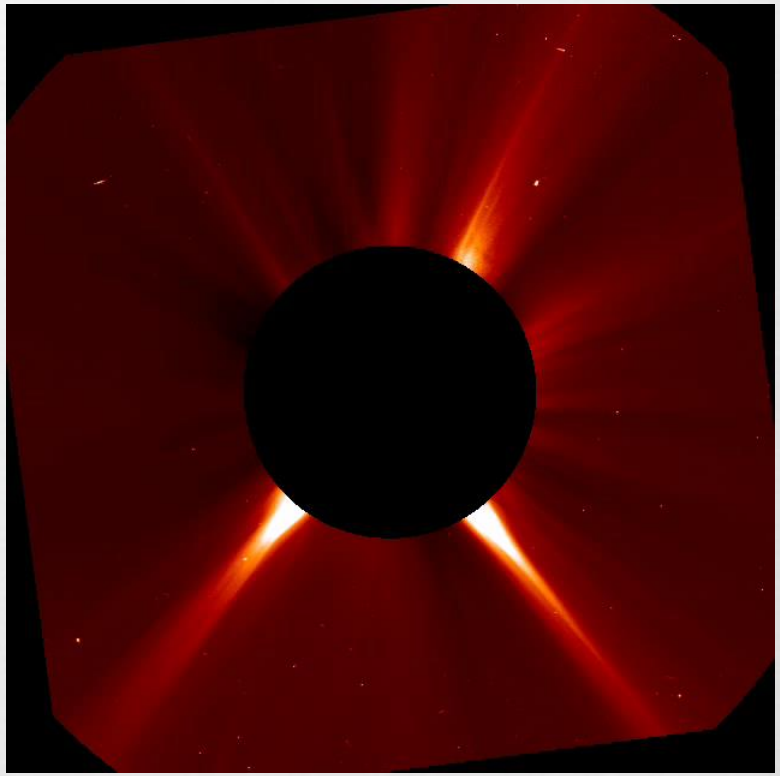
Torus Instability?



Reconnection

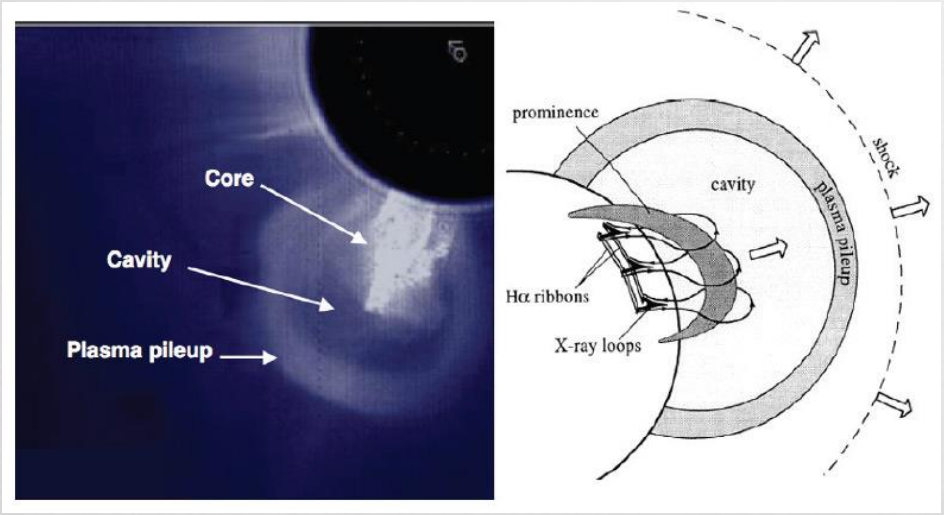


Coronal Mass Ejection (CME) Structure



Three components to a CME

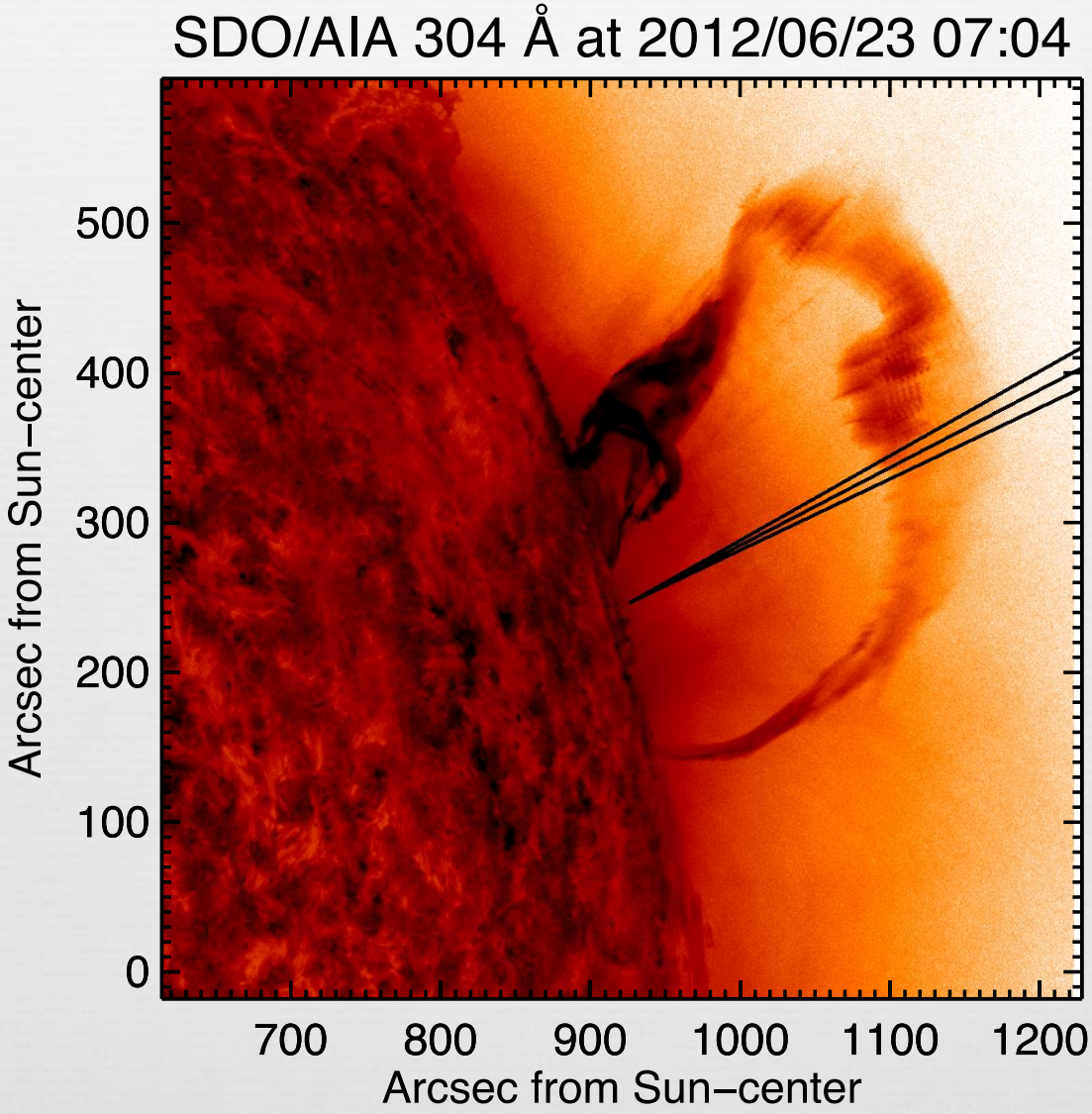
- Bright frontal loop: material overlying the prominence
- Cavity
- The inner core: contains the prominence



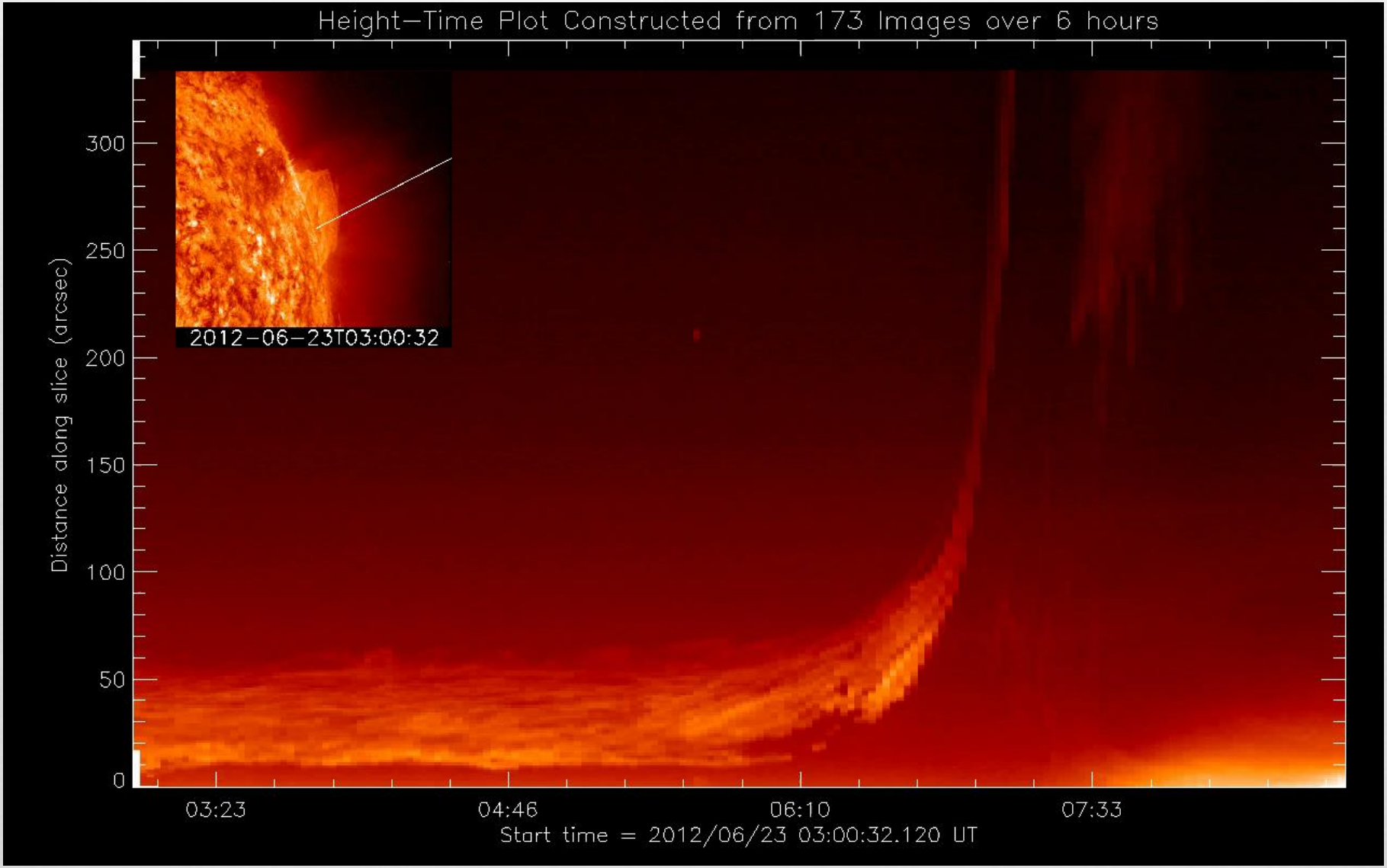
Our Study

- Measure the velocity and height of ~50 prominence eruptions over time.
- Use height-time plots constructed from AIA data to find a curve that best describes the prominence trajectory.
- Project the curve forward in time in order to predict velocity at the LASCO C2 field of view
- Compare predicted velocities with those measured by LASCO using the CACTus catalog.
- Collected fast rise onset heights.

Slice Selection

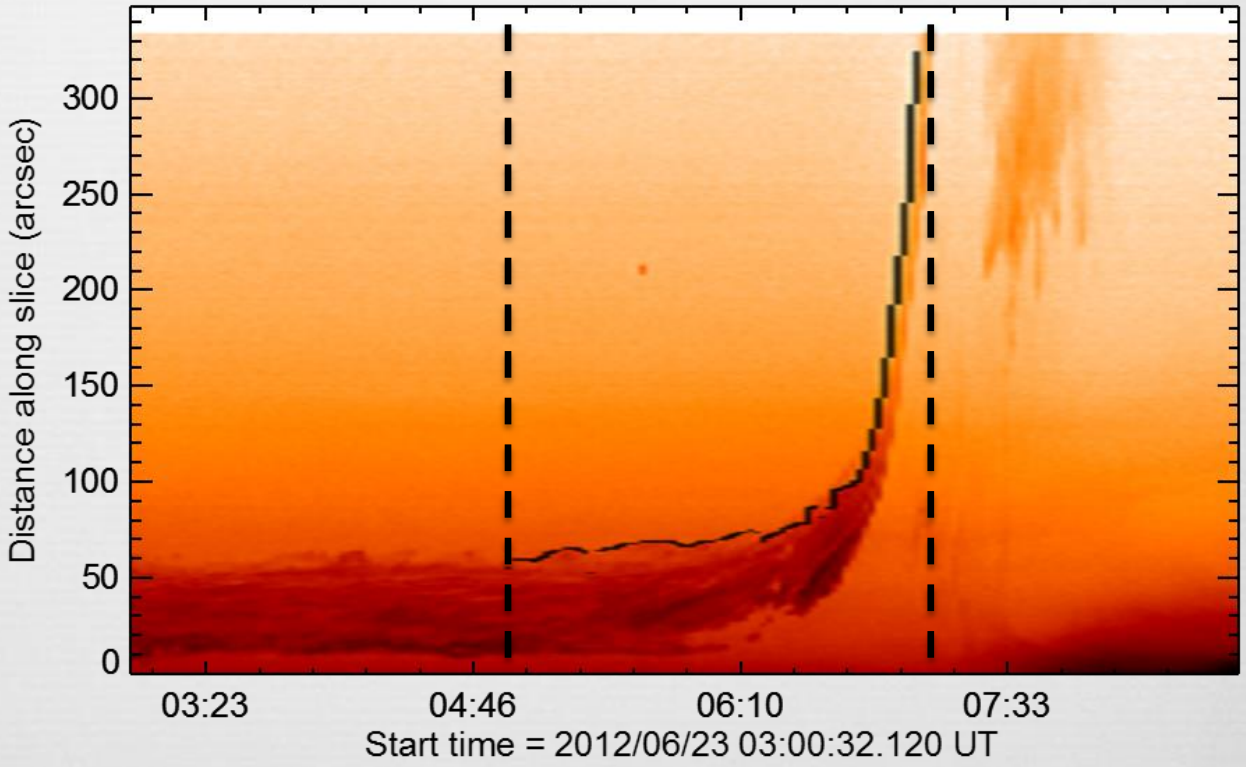


Height-Time Plot

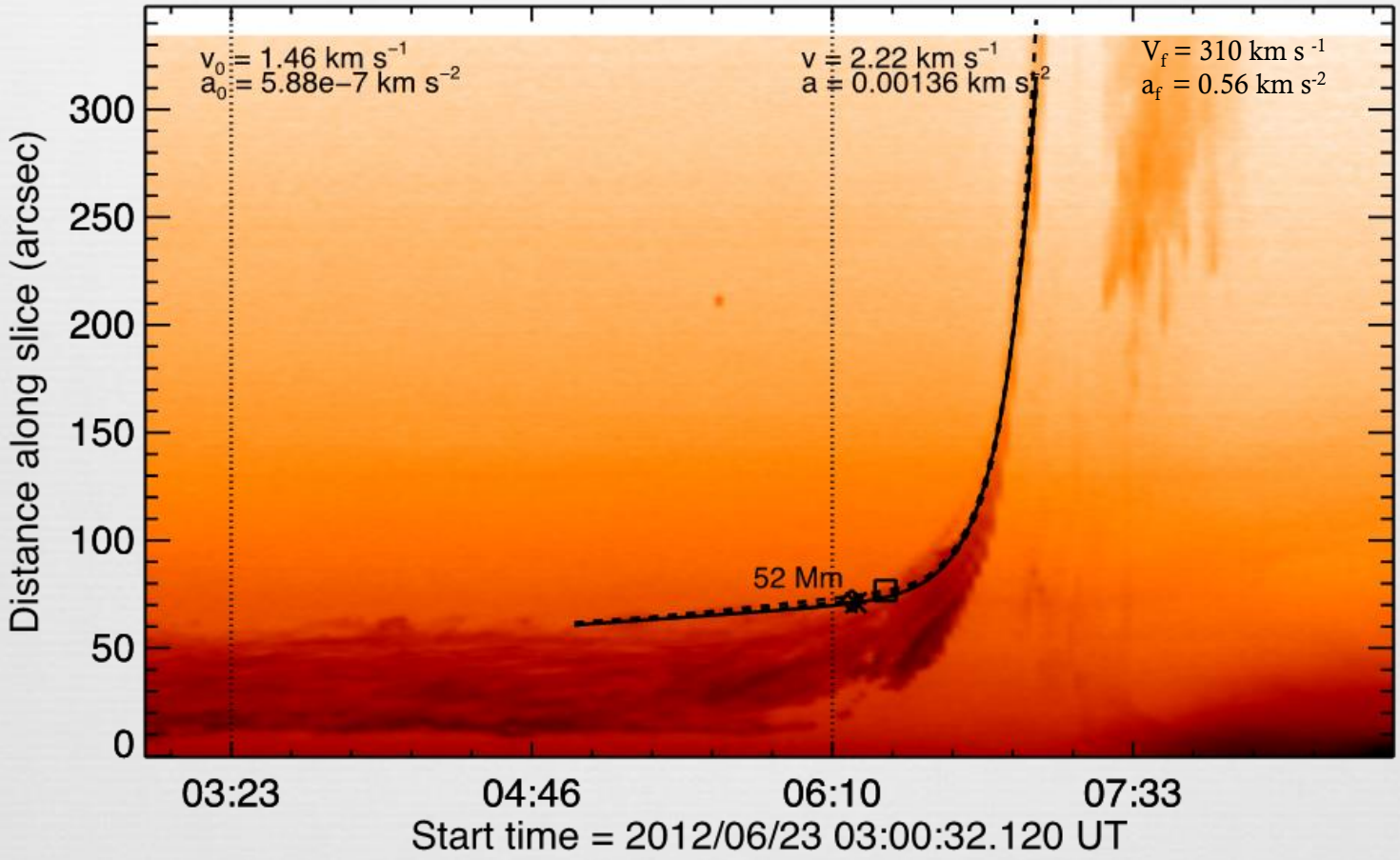


Fitting Procedure

- Canny edge detection algorithm used to detect leading edge of the prominence eruption.
- Modified the input and algorithm parameters to find the best fit.
  - Smoothing
  - Base difference
  - Threshold



Fitting Procedure



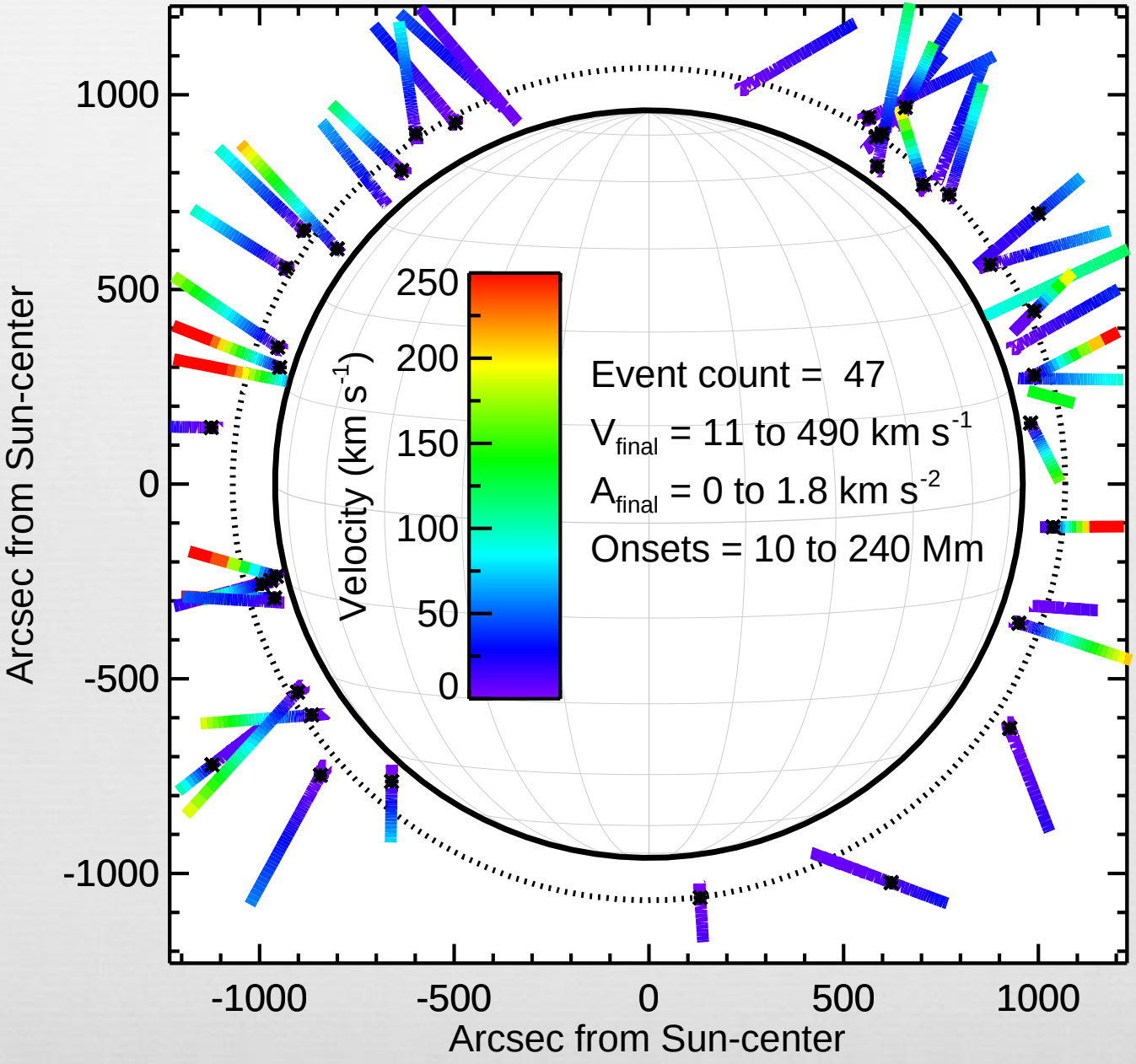
Height function:

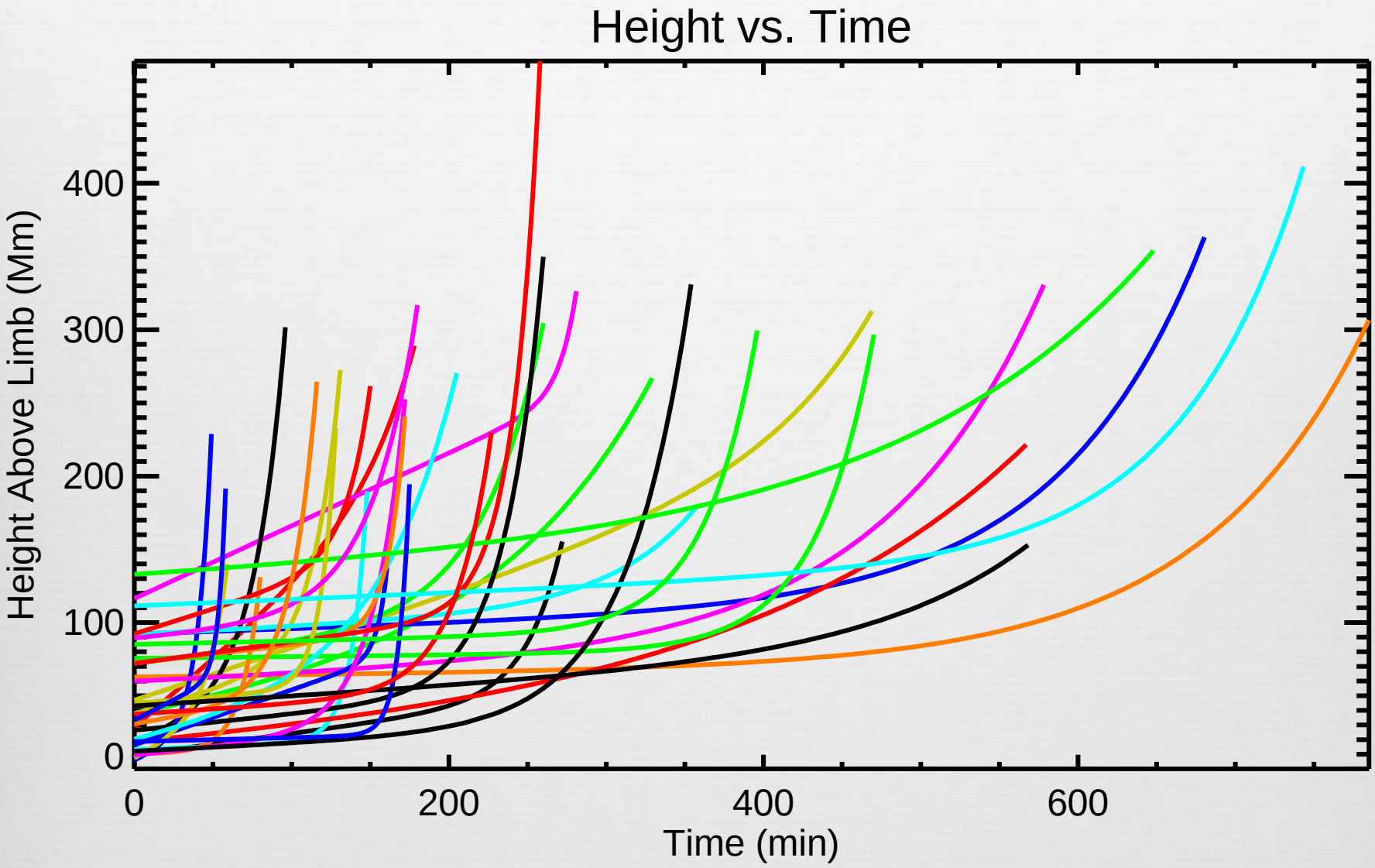
$$h(t) = c_0 e^{(t-t0)/\tau} + c_1(t - t_0) + c_2$$

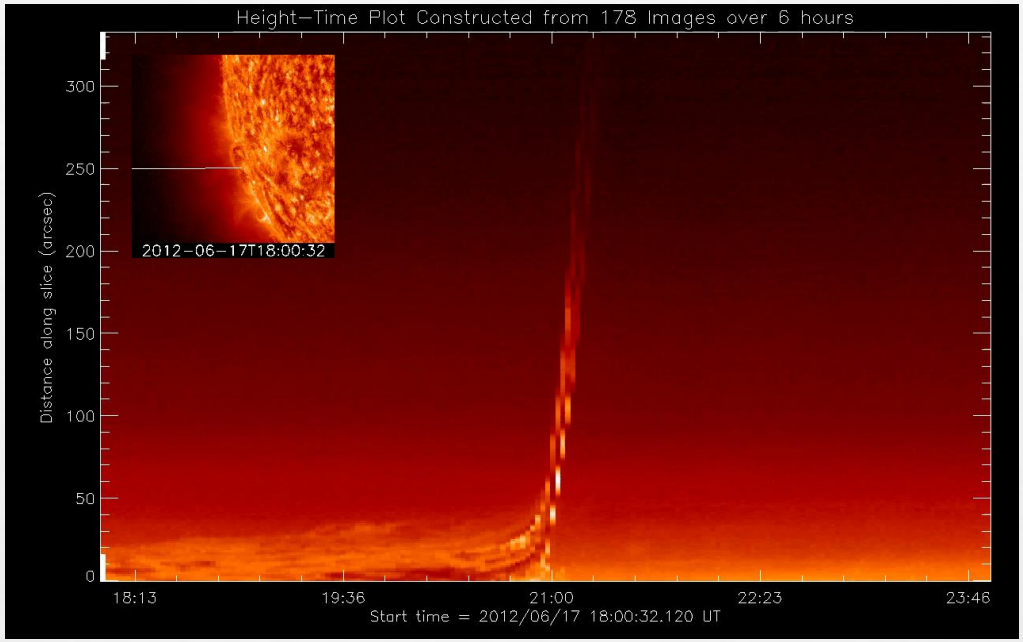
Beginning of the fast rise (Onset of CME):

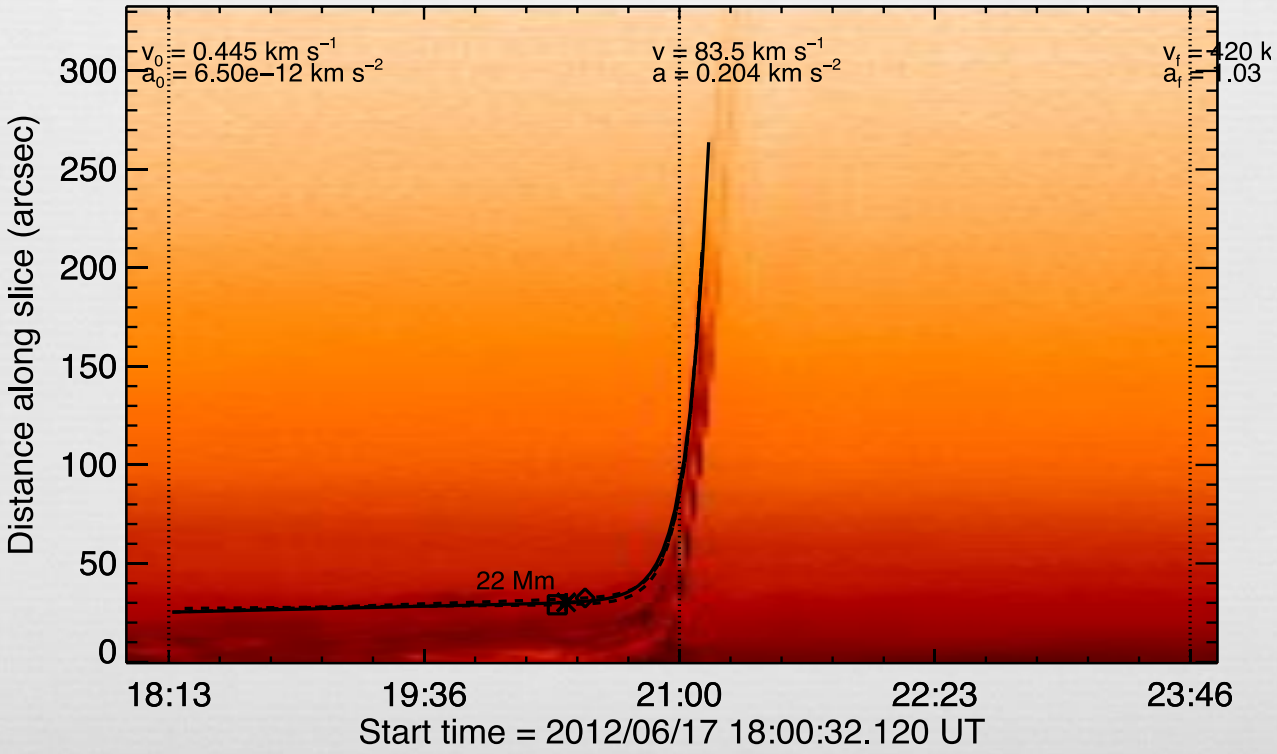
$$t_{onset} = \tau \ln(c_1\tau/c_0) + t_0$$

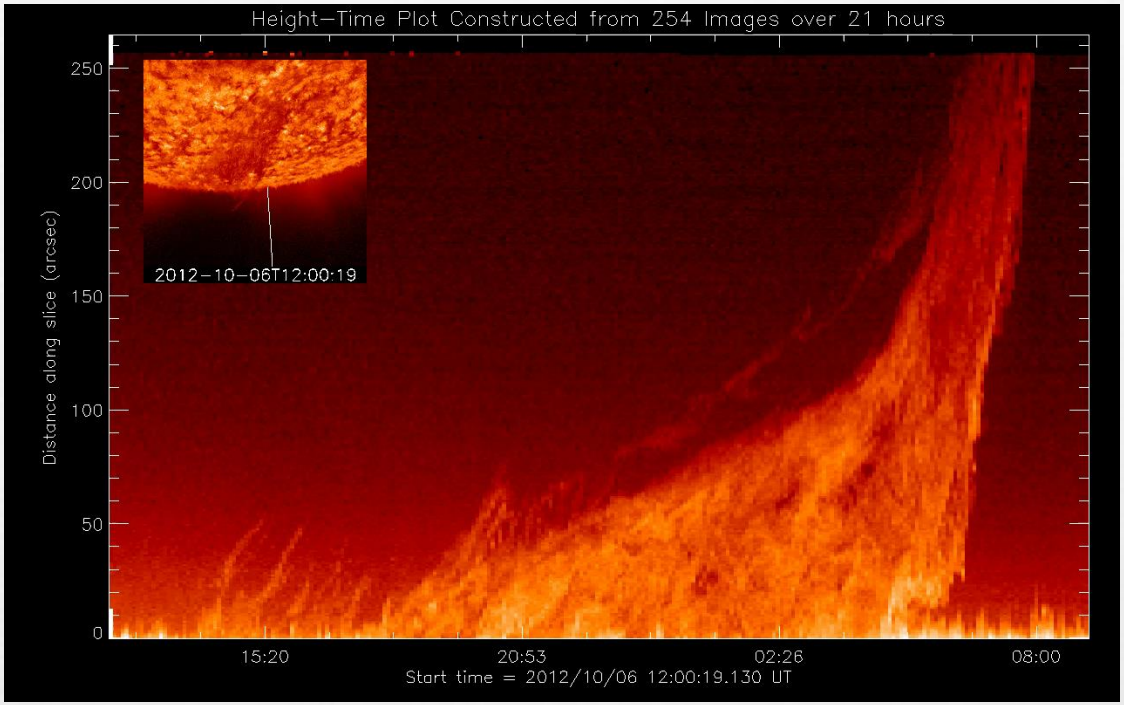
Summary of Slices for all Events

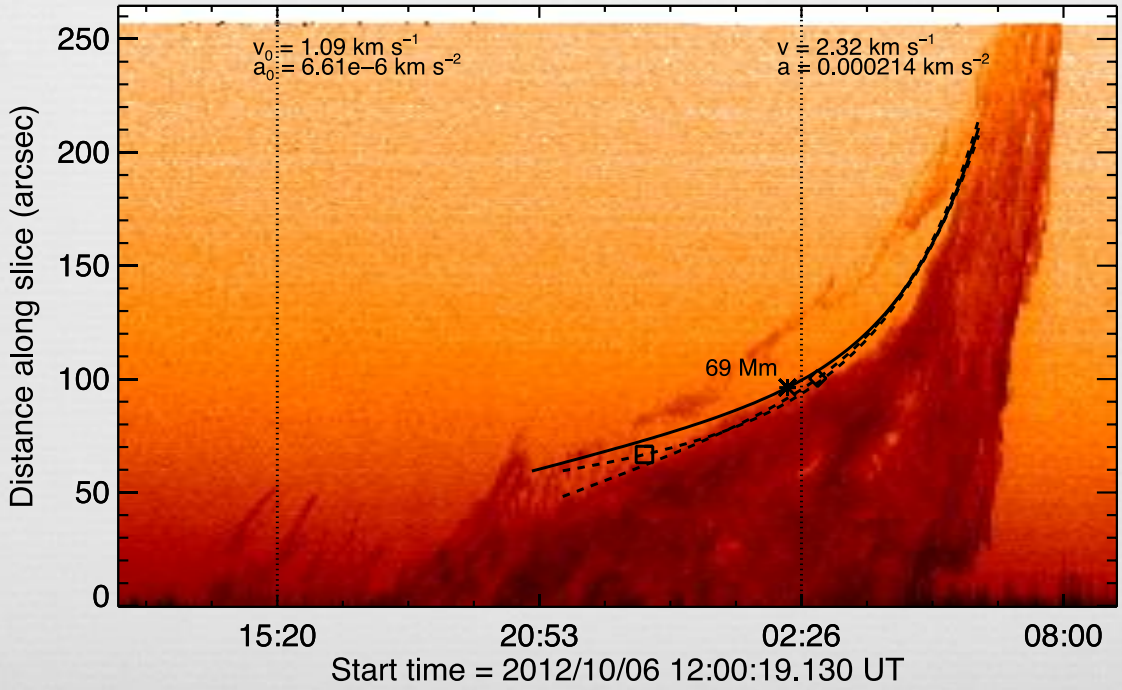


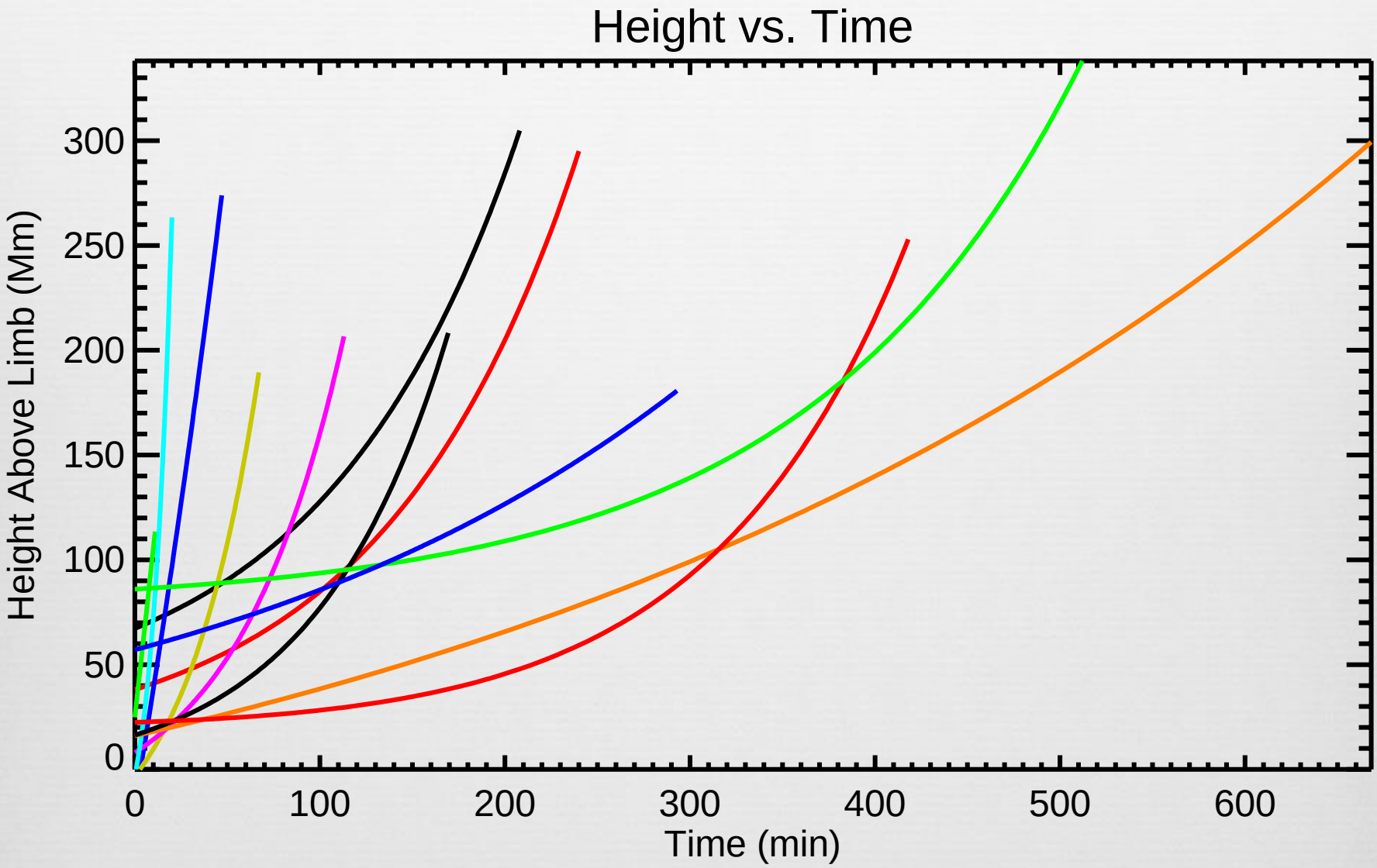

Height vs. Time
Height Above Limb (Mm)
0
100
200
300
400
0
200
400
600
Time (min)


Height–Time Plot Constructed from 178 Images over 6 hours
Distance along slice (arcsec)
0
50
100
150
200
250
300
2012-06-17T18:00:32
18:13
19:36
21:00
22:23
23:46
Start time = 2012/06/17 18:00:32.120 UT

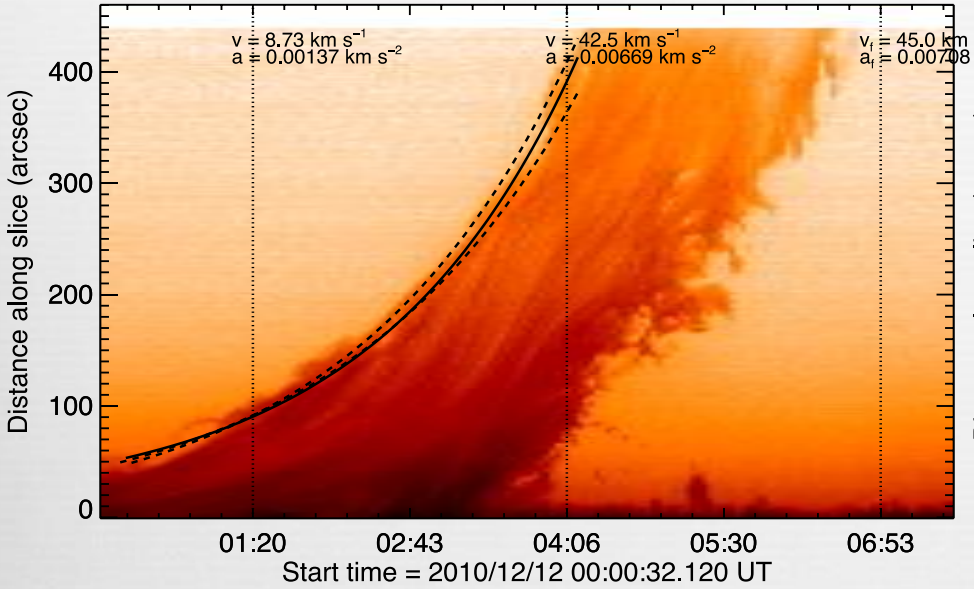

v_0 = 0.445 km s^{-1}
a_0 = 6.50e−12 km s^{-2}
v = 83.5 km s^{-1}
a = 0.204 km s^{-2}
v_f = 420 k
a_f = .03
Distance along slice (arcsec)
0
50
100
150
200
250
300
22 Mm
18:13
19:36
21:00
22:23
23:46
Start time = 2012/06/17 18:00:32.120 UT


Height–Time Plot Constructed from 254 Images over 21 hours
Distance along slice (arcsec)
250
200
150
100
50
0
2012-10-06T12:00:19
15:20
20:53
02:26
08:00
Start time = 2012/10/06 12:00:19.130 UT

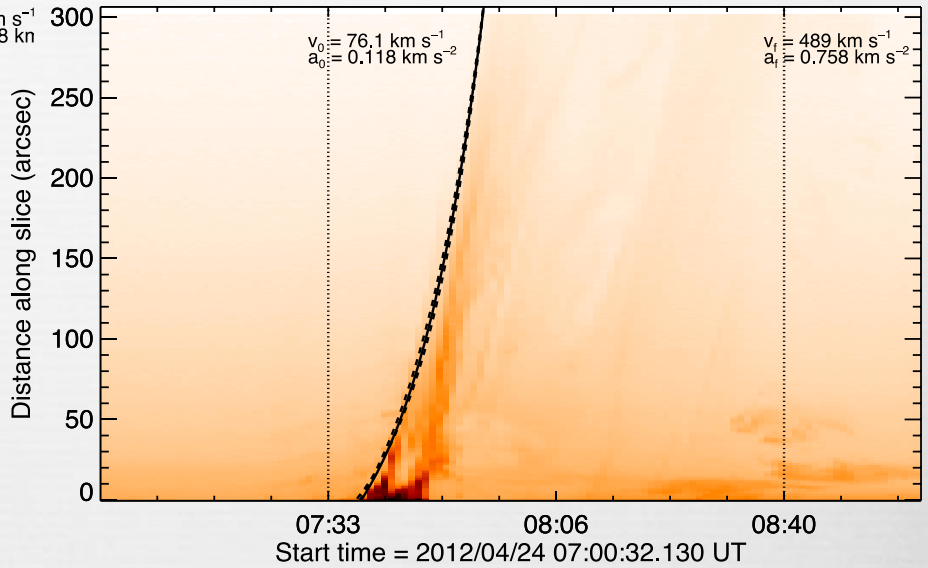

v_0 = 1.09 km s^{-1}
a_0 = 6.61e–6 km s^{-2}
v = 2.32 km s^{-1}
a = 0.000214 km s^{-2}
69 Mm
Distance along slice (arcsec)
250
200
150
100
50
0
15:20
20:53
02:26
08:00
Start time = 2012/10/06 12:00:19.130 UT


Height vs. Time
Height Above Limb (Mm)
0
50
100
150
200
250
300
0
100
200
300
400
500
600
Time (min)

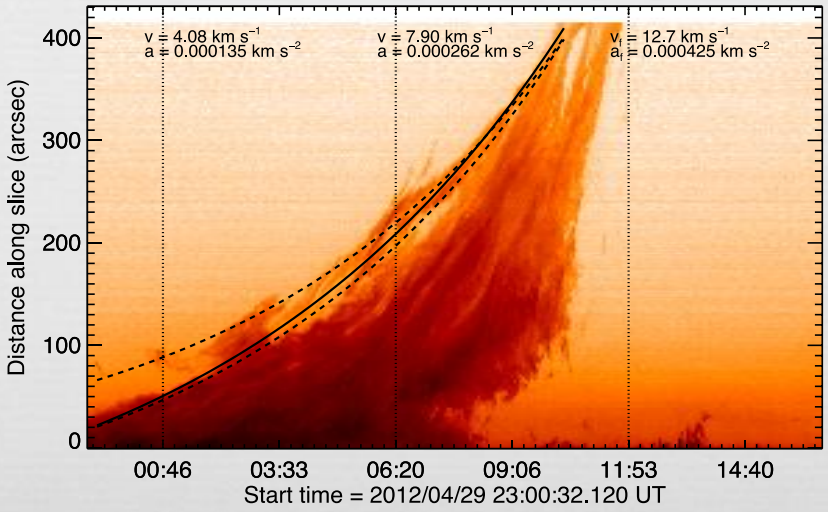
Event Starts Behind the Limb



Active Region

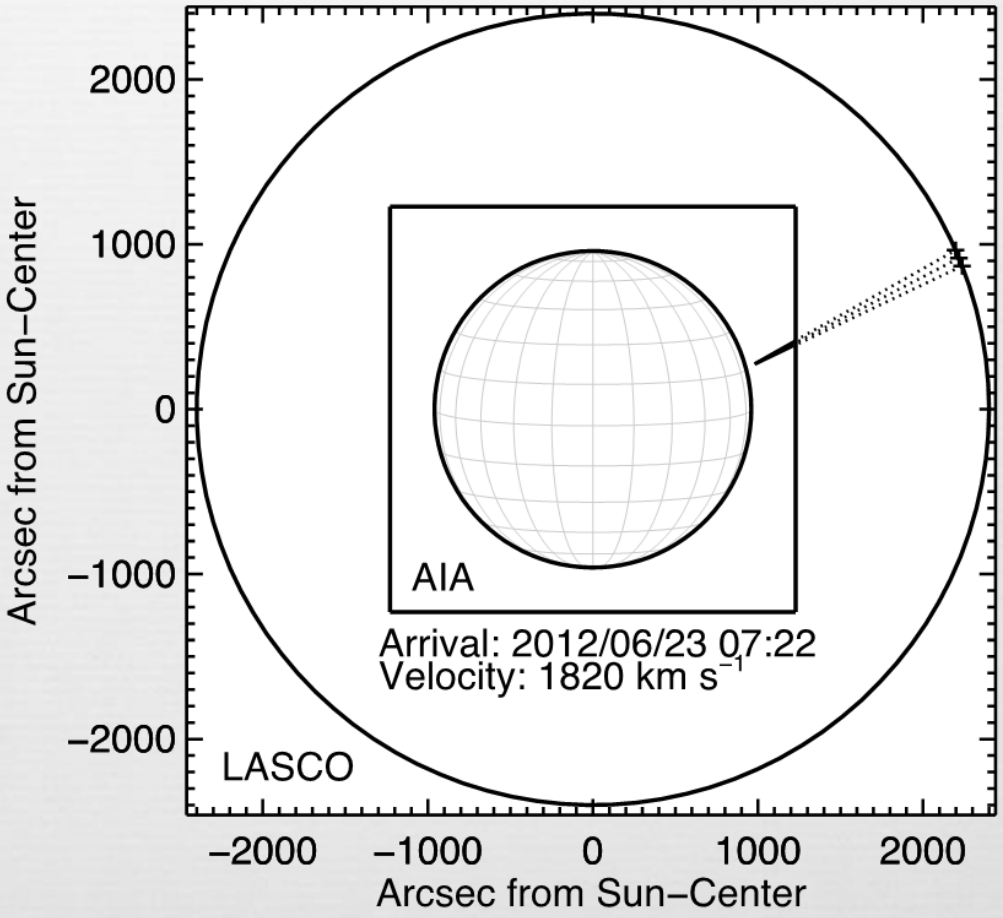


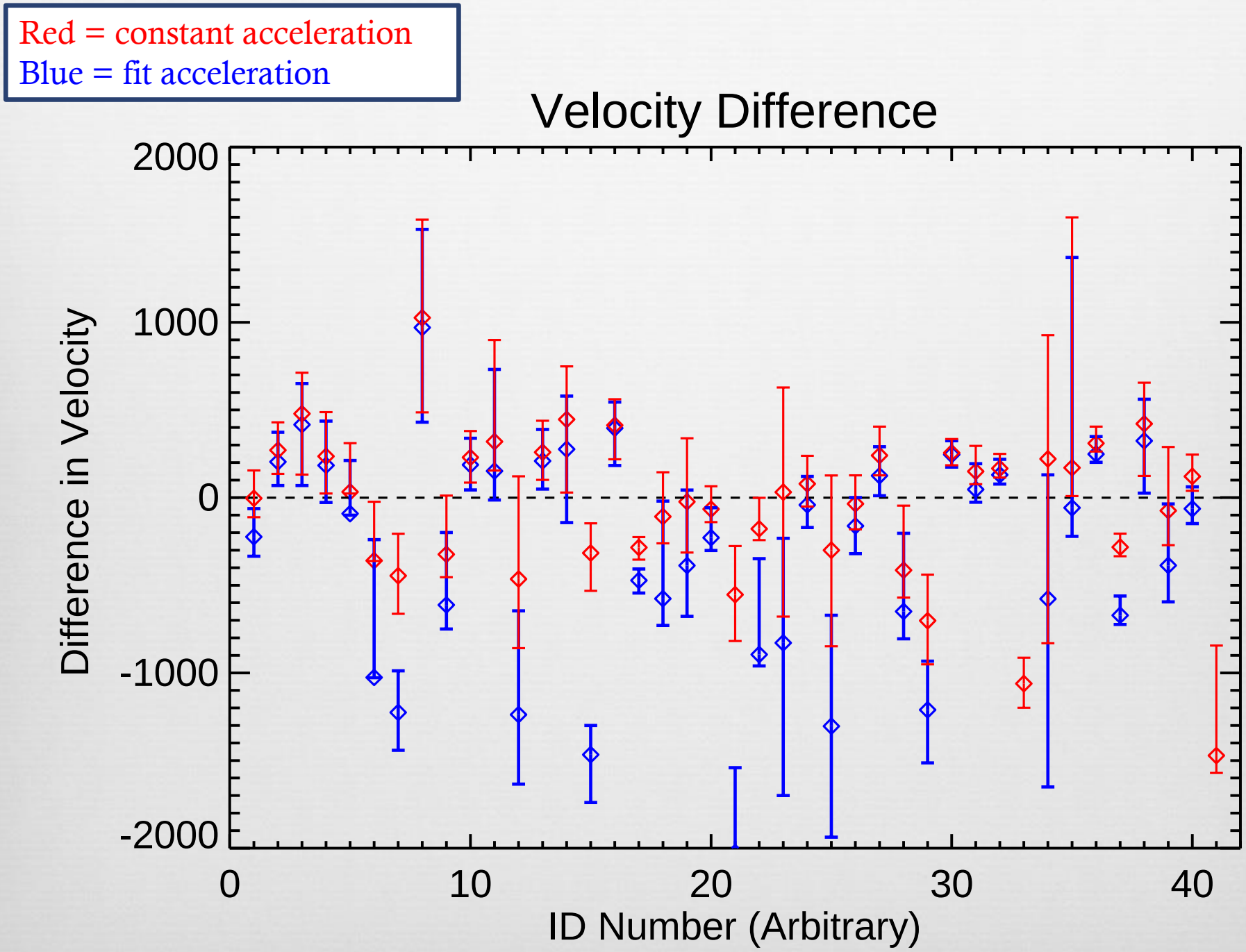
Slow Event



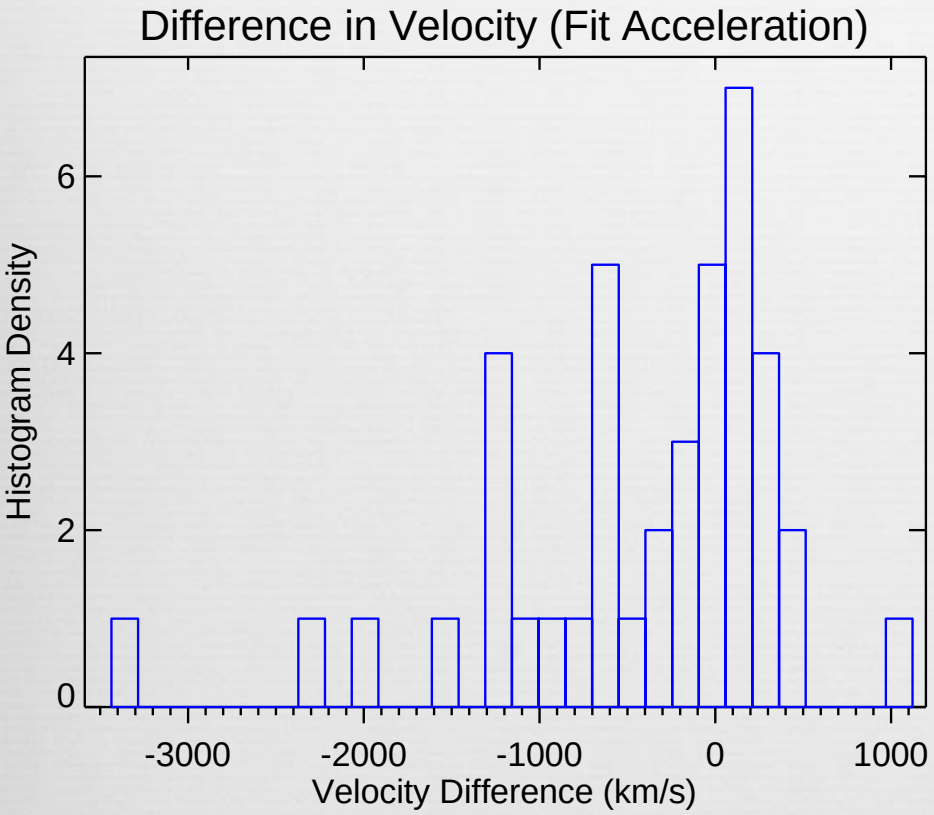
Trajectory

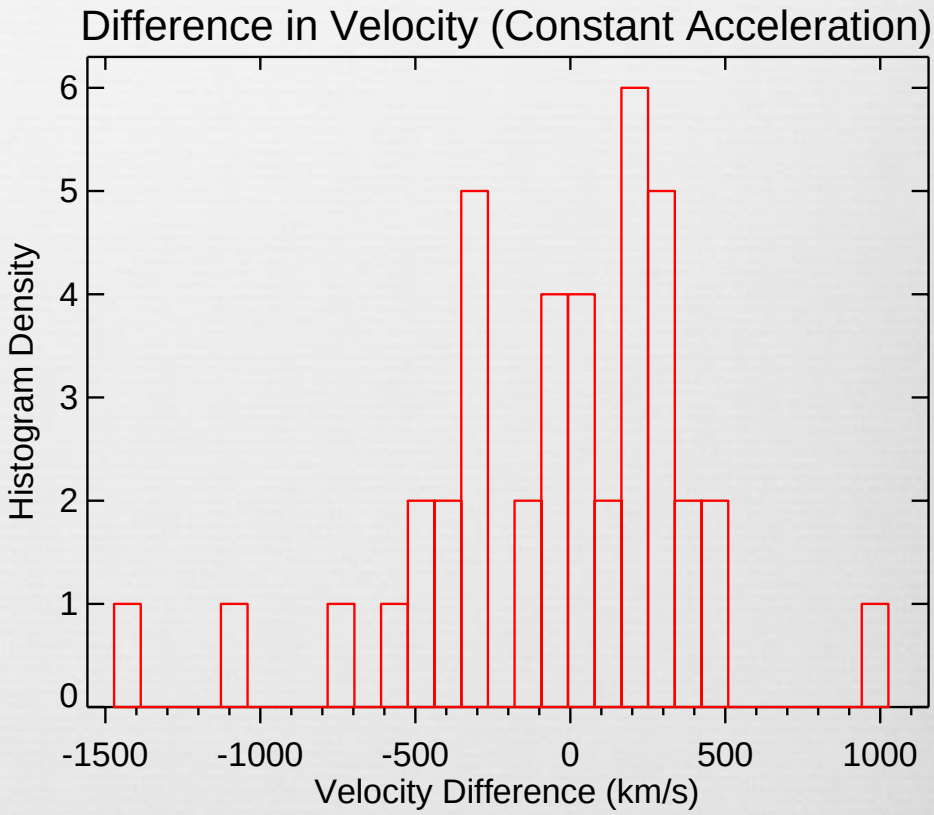
- The fit is projected forward to the LASCO field of view.
- Predicted velocity compared with recorded values (CACTus).




Red = constant acceleration
Blue = fit acceleration
Velocity Difference
Difference in Velocity
2000
1000
0
-1000
-2000
0
10
20
30
40
ID Number (Arbitrary)

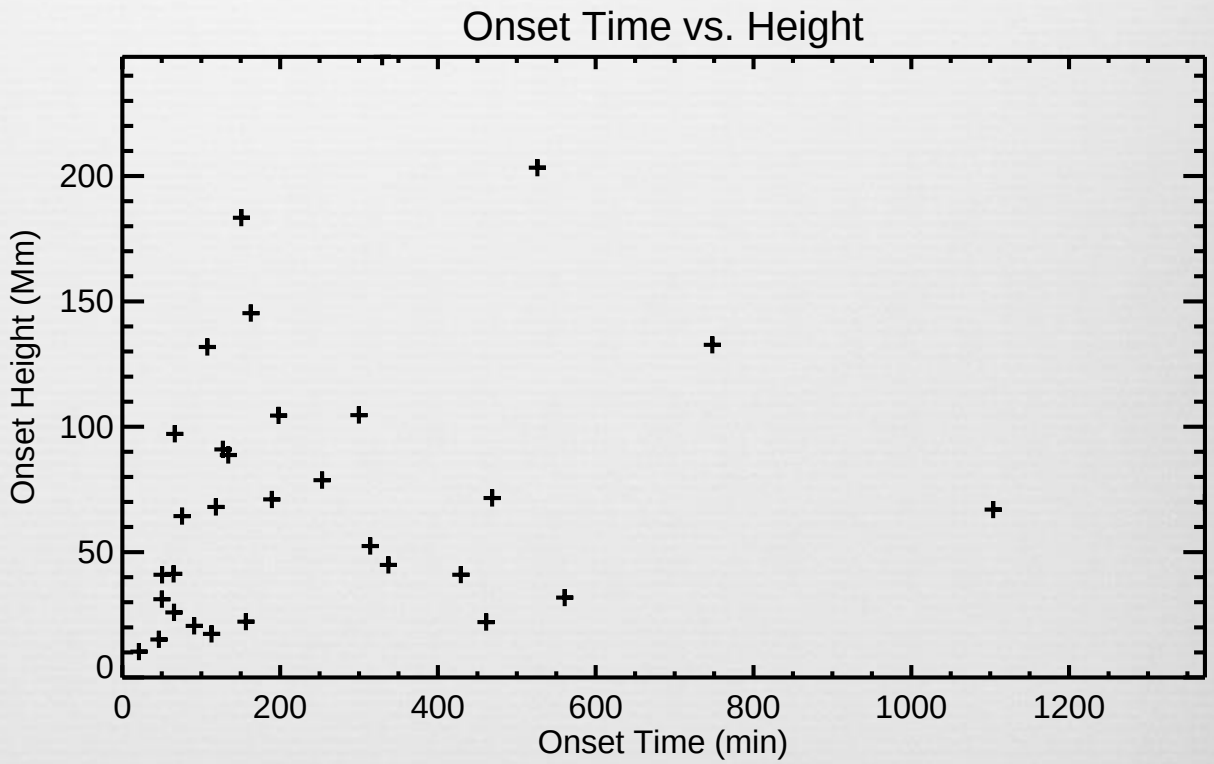
Red = constant acceleration
Blue = fit acceleration





Future Work

- Study eruption mechanisms.
- Look for evidence of reconnection using other wavelengths.
- Process more events
- Compare the decay index of the magnetic field with onset of the fast rise phase.



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