



# Coronal Fine Structure in Dynamic Events Observed by Hi-C

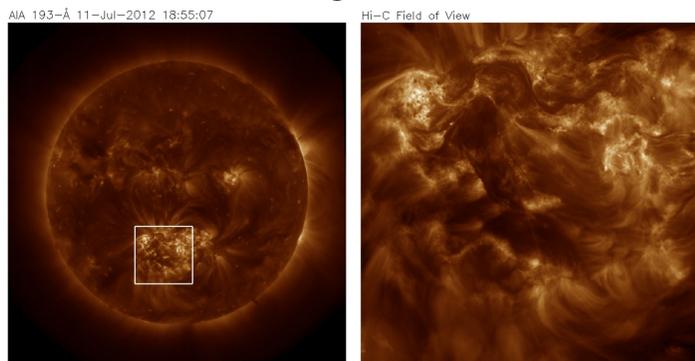
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**Abstract:** The High-Resolution Coronal Imager (Hi-C) flew aboard a NASA sounding rocket on 2012 July 11 and captured roughly 345 s of high spatial and temporal resolution images of the solar corona in a narrowband 193 Angstrom channel. We have analyzed the fluctuations in intensity of Active Region 11520. We selected events based on intensities greater than a threshold determined from the photon and readout noise. We compare the Hi-C events with those determined from AIA. We find that Hi-C detects shorter and smaller events than AIA. We also find that the intensity increase in the Hi-C events is  $\sim 3$  times greater than the intensity increase in the AIA events. We conclude the events are related to linear sub-structure that is unresolved by AIA.

## Background:

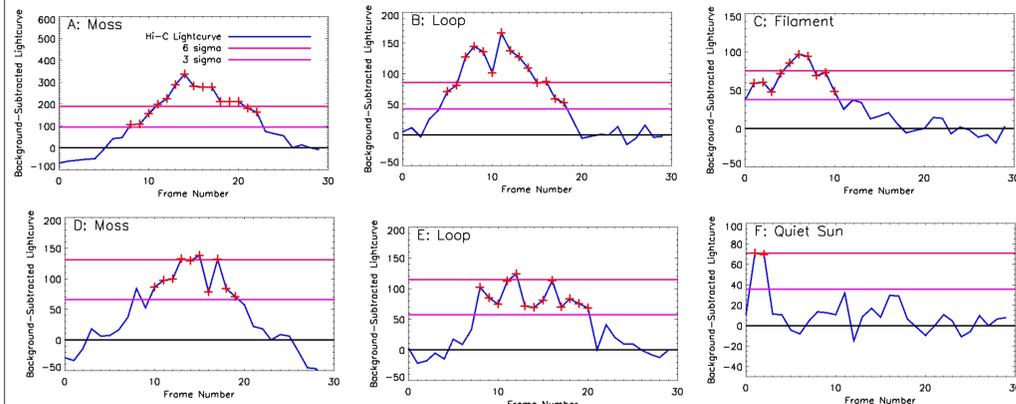
- Hi-C flew on July 11, 2012 and collected 37 full frame images. The first 7 were blurred due to spacecraft motion, we omit these images in this analysis.
- Hi-C observed the Sun in the 193 A passband, similar to the 193 passband on the Atmospheric Imaging Array (AIA).
- Hi-C has  $0.1''/\text{pixel}$ ,  $\sim 0.3''$  resolution, 2 s exposure time, 5.5 s cadence.
- Hi-C field of view included Active Region 11520.



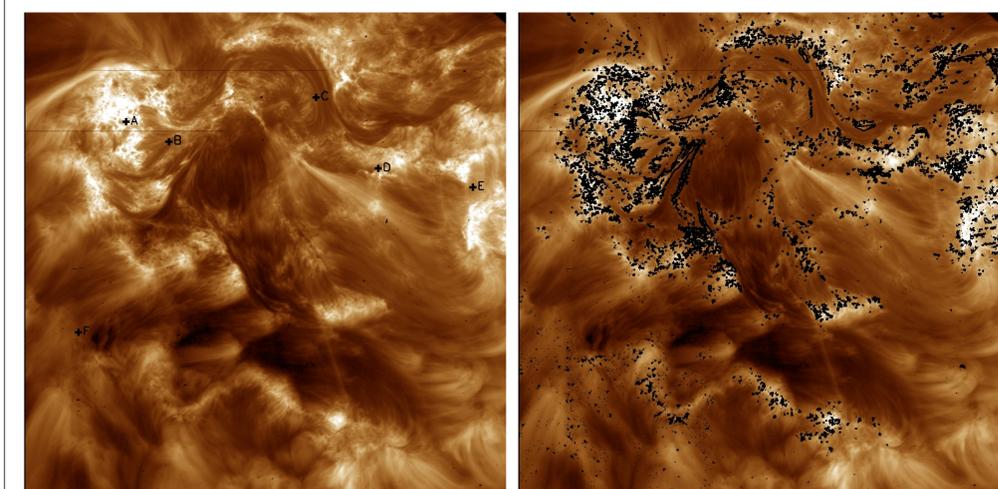
## Analysis:

- The Hi-C data set was co-aligned and converted to photons. The lightcurve of each pixel was analyzed individually. The 8<sup>th</sup> brightest frame in the lightcurve was used to approximate background,  $I_{\text{background}}$ .
- The noise in the signal was calculated as:  $\sigma^2 = I_{\text{background}} + \sigma_{\text{readout}}^2$
- The readout noise of the Hi-C detector varied by quadrant. We used the value from the noisiest quadrant ( $\sigma = 100$  electrons = 5.6 photons).
- We identified pixels where the intensity went above  $6\sigma$  as event pixels.
- We measured the lifetime of the event as the time the intensity stayed above  $3\sigma$ . We only consider events that started and finished during the observation time.
- For each  $6\sigma$  pixel, we found all surrounding pixels that are at least  $3\sigma$  above the background at the same time to calculate the event area.

## Example Lightcurves:



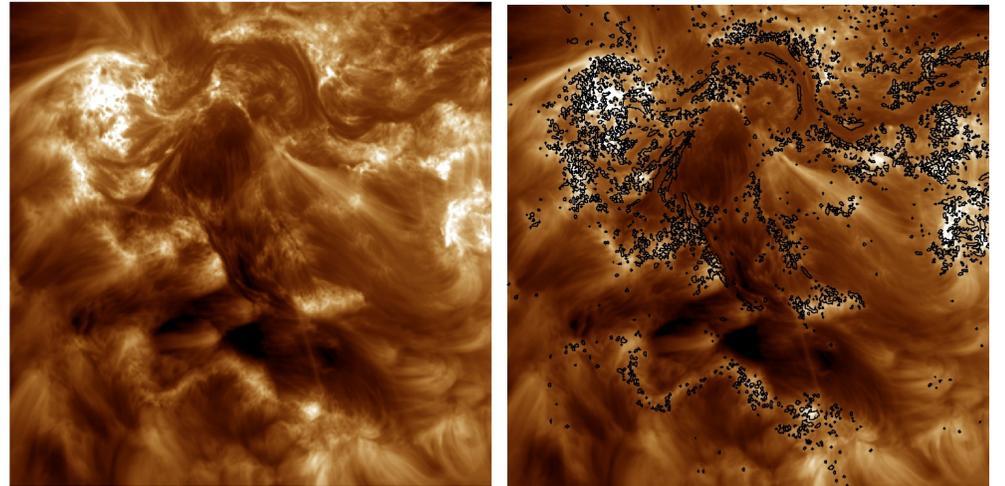
Events were identified as having at least one frame at the 6 sigma level. All frames with intensity  $> 3$  sigma around the 6 sigma frame (shown with red +) were included in the lifetime.



Left panel: Hi-C image. The location corresponding to the six lightcurves are marked. Right panel: All event locations are shown with the black contours. Events tend to occur in moss regions (e.g., A and E) or in locations of quickly evolving loops (e.g., B and D). The long extended loops do not show dynamic behavior.

## AIA Analysis:

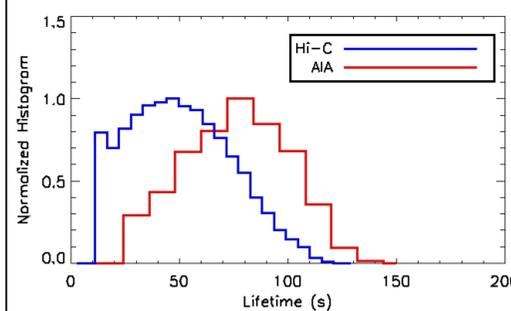
- Identical analysis was applied to the AIA data. The AIA data was analyzed in its native resolution and orientation (i.e., it was not re-binned to Hi-C resolution or rotated to be aligned to Hi-C.)
- The 4<sup>th</sup> brightest frame was used as an estimate of the background.



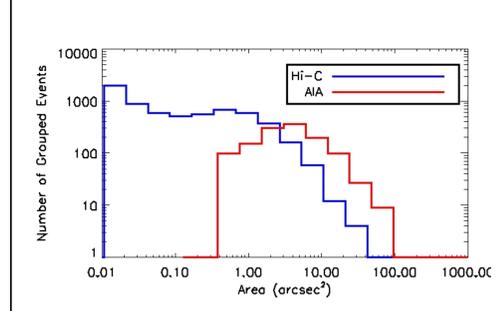
Left panel: AIA image. Right panel: All event locations are shown with the black contours. The location of events are similar to those detected by Hi-C.

## Results:

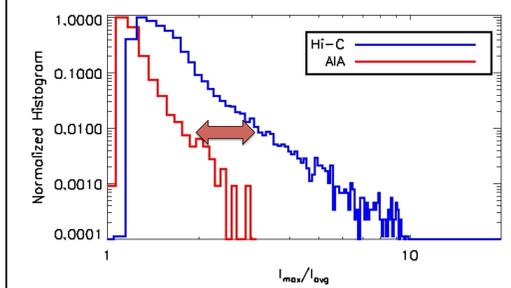
**Hi-C detects shorter events than AIA.** The most typical event lifetime is 80 s, while the most typical Hi-C lifetime is 45 s.



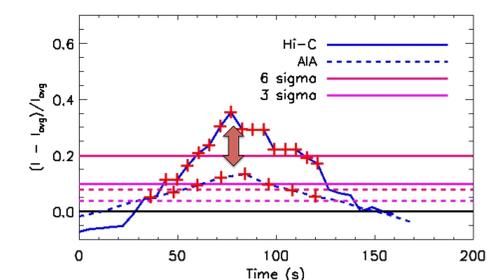
**Hi-C detects smaller events than AIA.** Both Hi-C and AIA detect events to the limit of their resolution.



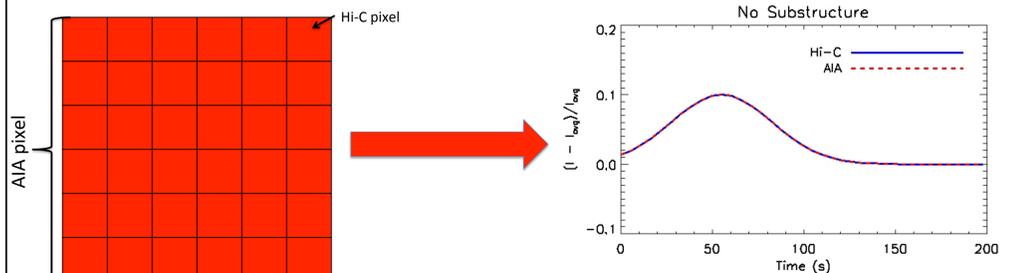
**Hi-C events are brighter than events in AIA.** The intensity enhancement in Hi-C is  $\sim 3$  times that in AIA.



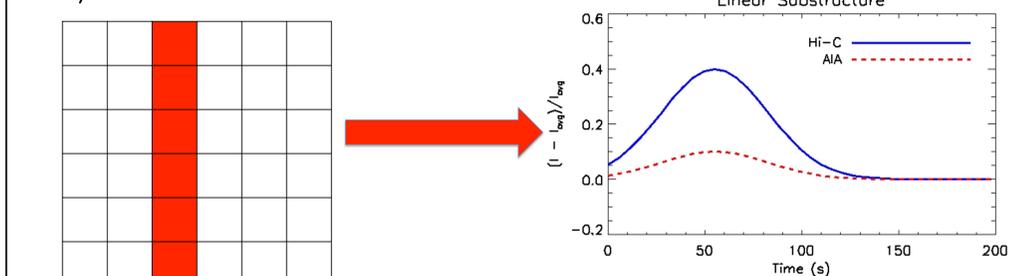
Below is the lightcurve corresponding to point A in the moss. AIA (shown as dashed lines) has a weaker intensity enhancement than Hi-C.



**Why is this important?** If a the brightening occurs in a structure that is resolved by AIA, then the intensity enhancement in the AIA pixel should be the same as any Hi-C pixel.



If a the brightening occurs in a structure that is not resolved by AIA, then the Hi-C intensity enhancement should be larger than the AIA intensity enhancement. If the sub-structure is linear, the difference should be the ratio of the resolutions ( $\sim 4-6$  for AIA to Hi-C).



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