Are we resolving coronal strands? Evidence for and analysis of substructure within coronal plasma loop cross-sectional profiles observed by NASA's HiC observations

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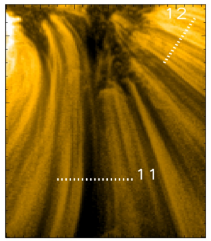
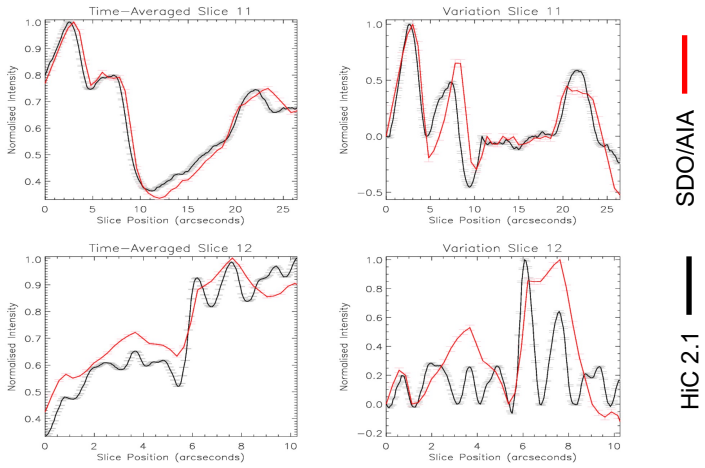
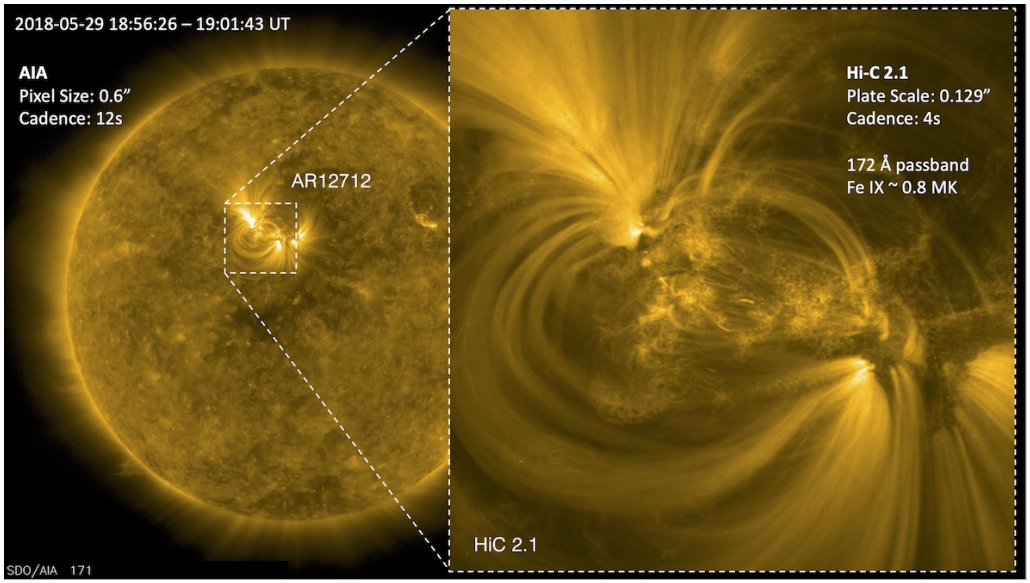
- The High-Resolution Coronal Imager (Hi-C) was launched for a third time on 29th May 2018, resulting in 329 s of 17.2 nm data of target active region AR 12712 were captured with a cadence of approx. 4 s, and a plate scale of 0.129 arcsec^2/pixel.
- Using this data co-aligned with SDO/AIA 17.1nm observations, the widths of 49 coronal structures were examined.
- It is found that Hi-C 2.1 can resolve individual sub-loop strands as small as approx. 202 km, though the more typical strand widths seen are around 513 km.

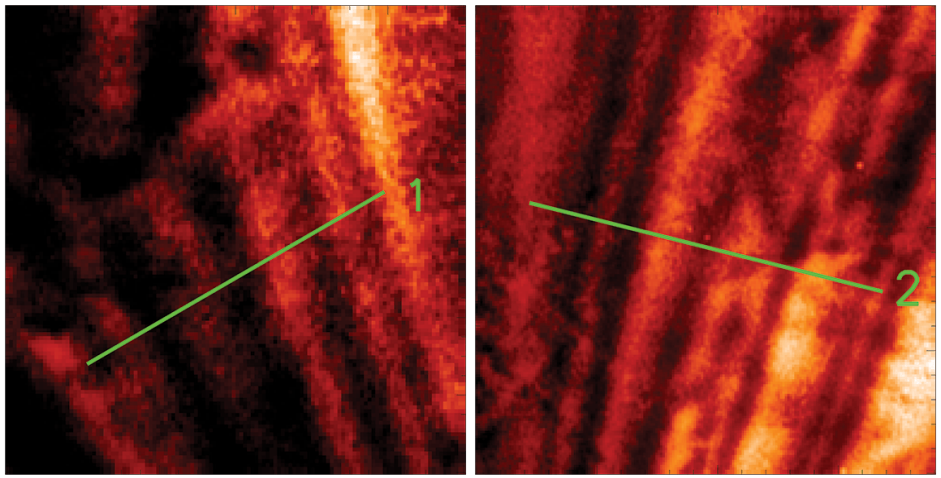




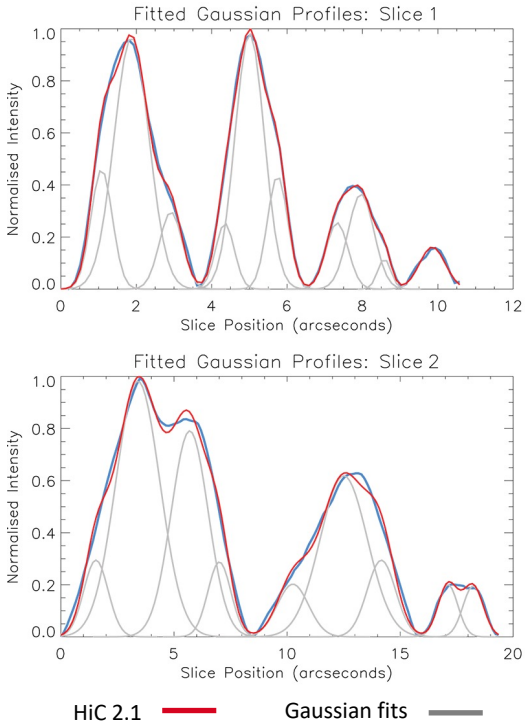


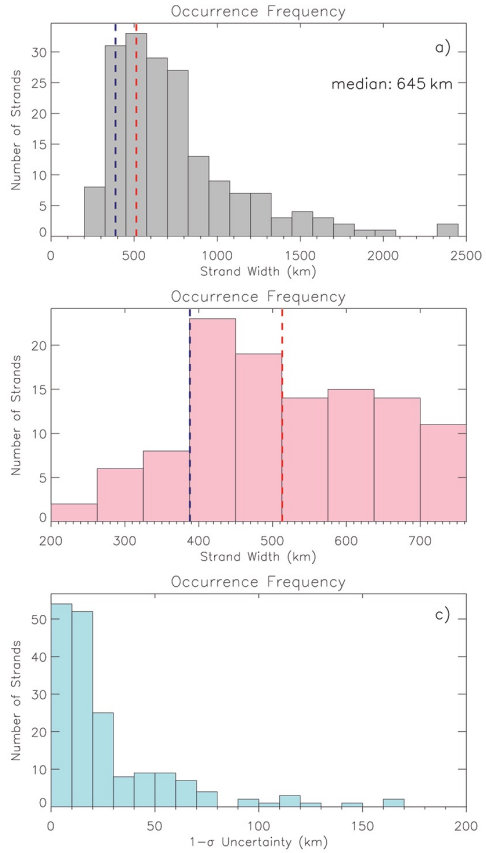
- With the aid of multi-scale Gaussian normalization, strands from a region of low emission that can only be visualized against the contrast of the darker, underlying moss – this part of the corona is filled ubiquitous, low emission, low density magnetic elements.
- Use the QR code to download *Williams, Walsh et al 2020, ApJ, 892, 134.*

Are we resolving coronal strands? Substructure analysis



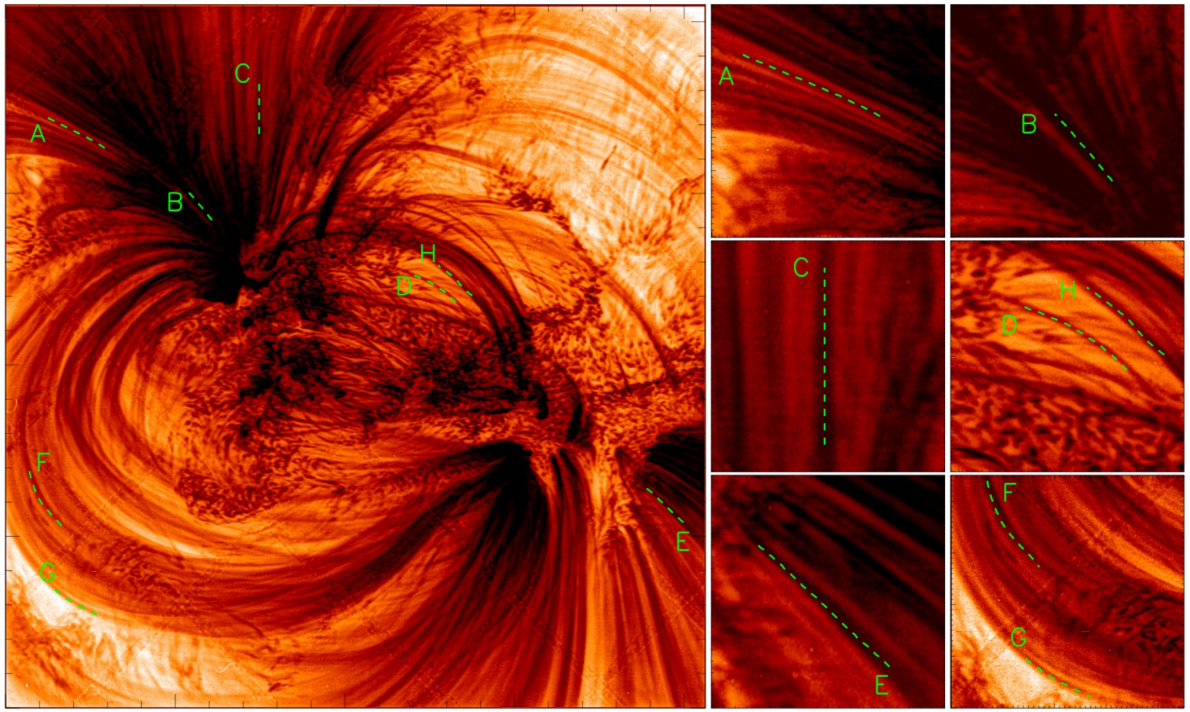
- Even at these superior spatial scales there may be evidence for further sub-structuring within the HiC strands themselves.
- The width profile intensity variations are reproduced by simultaneously fitting multiple Gaussian profiles using a nonlinear least-squares curve-fitting method.
- In total, 183 Gaussian profiles are examined and the full width at half maximum determined.
- Most frequent structural widths were about 450–575 km with 47% of the strand widths beneath SDO/AIA 17.1nm resolution.

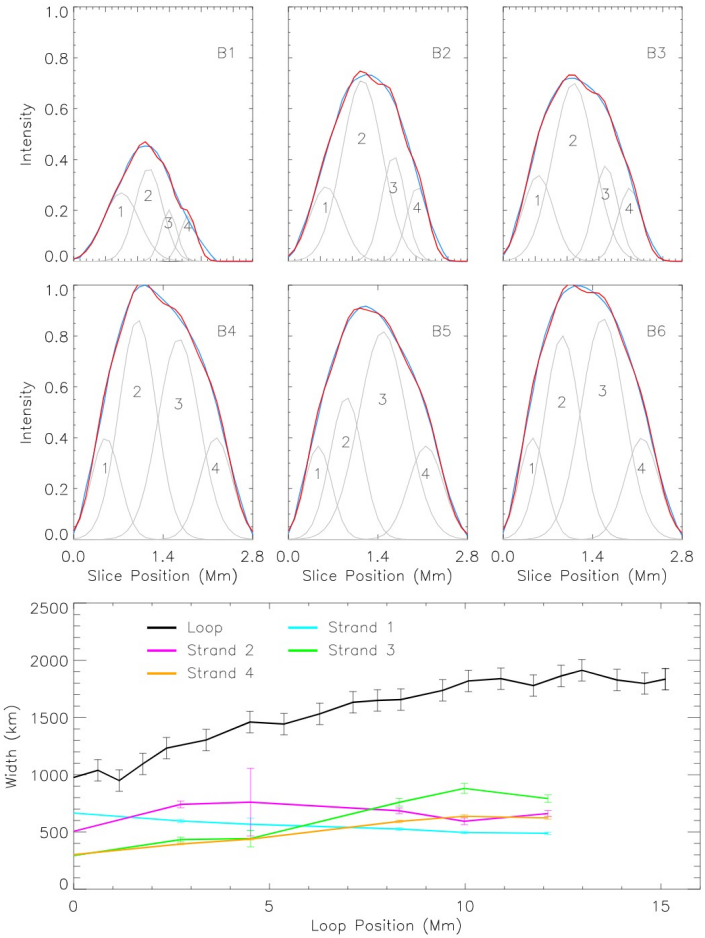




- These appear to be the result of multiple strands along the integrated line of sight that can be resolved, rather than being the consequence of even finer sub-resolution elements.
- Use the QR code to download *Williams, Walsh et al 2020, ApJ, 902, 90*.

Are we resolving coronal strands? Possible strand expansion





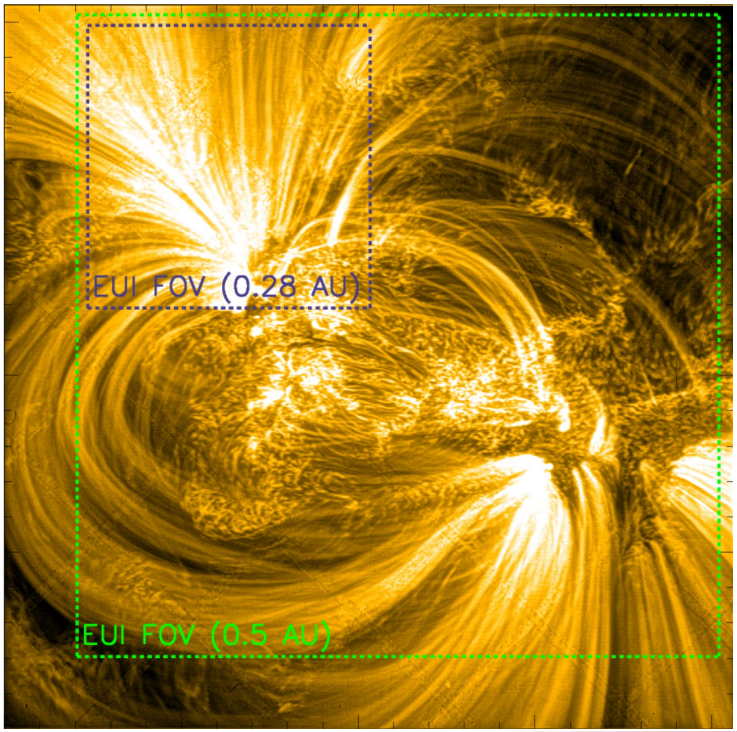
- The change of strand width along strand length is examined for a selection of eight EUV loops and their twenty-two sub-element strands.
- Four of the loops correspond to open fan structures with the other four considered to be magnetically closed loops. Width analysis is performed on the loops and their sub-resolution strands using our method of fitting multiple Gaussian profiles to cross-sectional intensity slices.
- It is found that whilst the magnetically closed loops and their sub-element strands do not expand along their observable length, open fan structures may expand an additional 150 % of their initial width.

- Use the QR code to download *Williams, Walsh et al, 2021, ApJ, accepted.*

Are we resolving coronal strands? Summary

- Hi-C is resolving a key spatial scale of the corona, observing coherent structures than SDO cannot detect – see table for comparative observations.
- Further high-resolution data is required, such as from Solar Orbiter's Extreme Ultraviolet Imager (EUI;≈0.1″pixel-1at 0.28 AU) instrument, to explore the relationship between intensity and width in the hope of under-standing the fundamental geometry of these important structures.

Study	Wavelength (nm)	Strand Width (km)
Peter et al. 2013	19.3	1450-2175 ≤200 (short loops)
Brooks et al. 2013	19.3	640
Brooks et al. 2016	139.3755	266-386
Aschwanden & Peter 2017	19.3	550
Low-Emission Loops	**17.2**	**325-450**
Gaussian Fitted Loops	**17.2**	**450-575**



Hi-C 2.1
4.4`×4.4` FOV
0.129` plate scale
≈ 93 km/px.

EUI at 0.5 AU
3.9`×3.9` FOV
≈ 170 km/px.

EUI at 0.28 AU
1.72`×1.72` FOV
≈ 75 km/px.