Coronal loop analysis with Hinode/EIS and SDO/AIA observations

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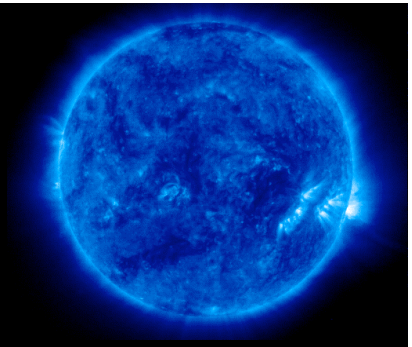
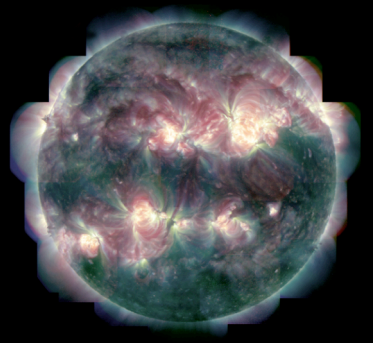
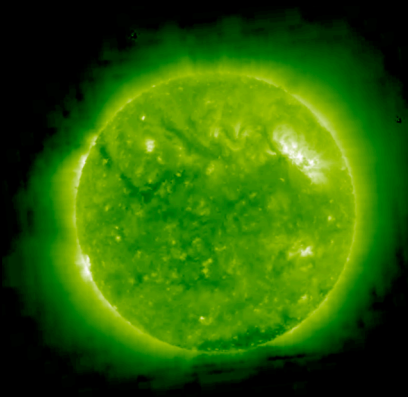
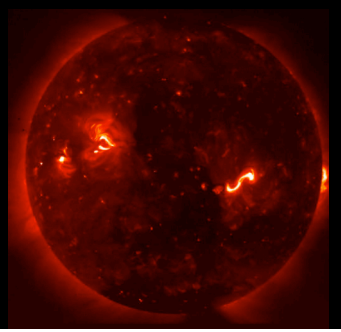
Solar Imaging Instruments

Instrument	FOV	Resolution
SOHO/EIT	FD	5”
TRACE	510”x510”	0.5 - 1”
STEREO/EUVI	FD	1.6”
Hinode/XRT	FD/PD	2”
SDO/AIA	FD	~ 1”





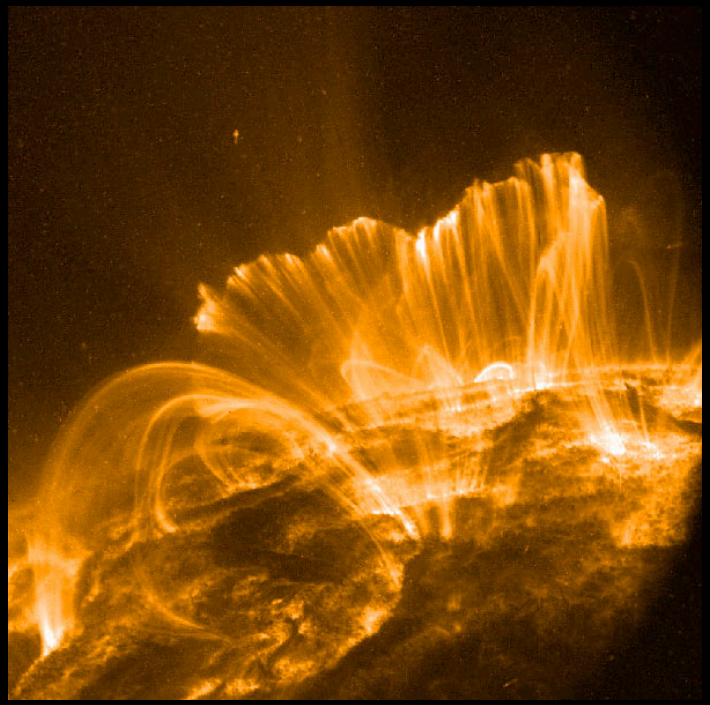


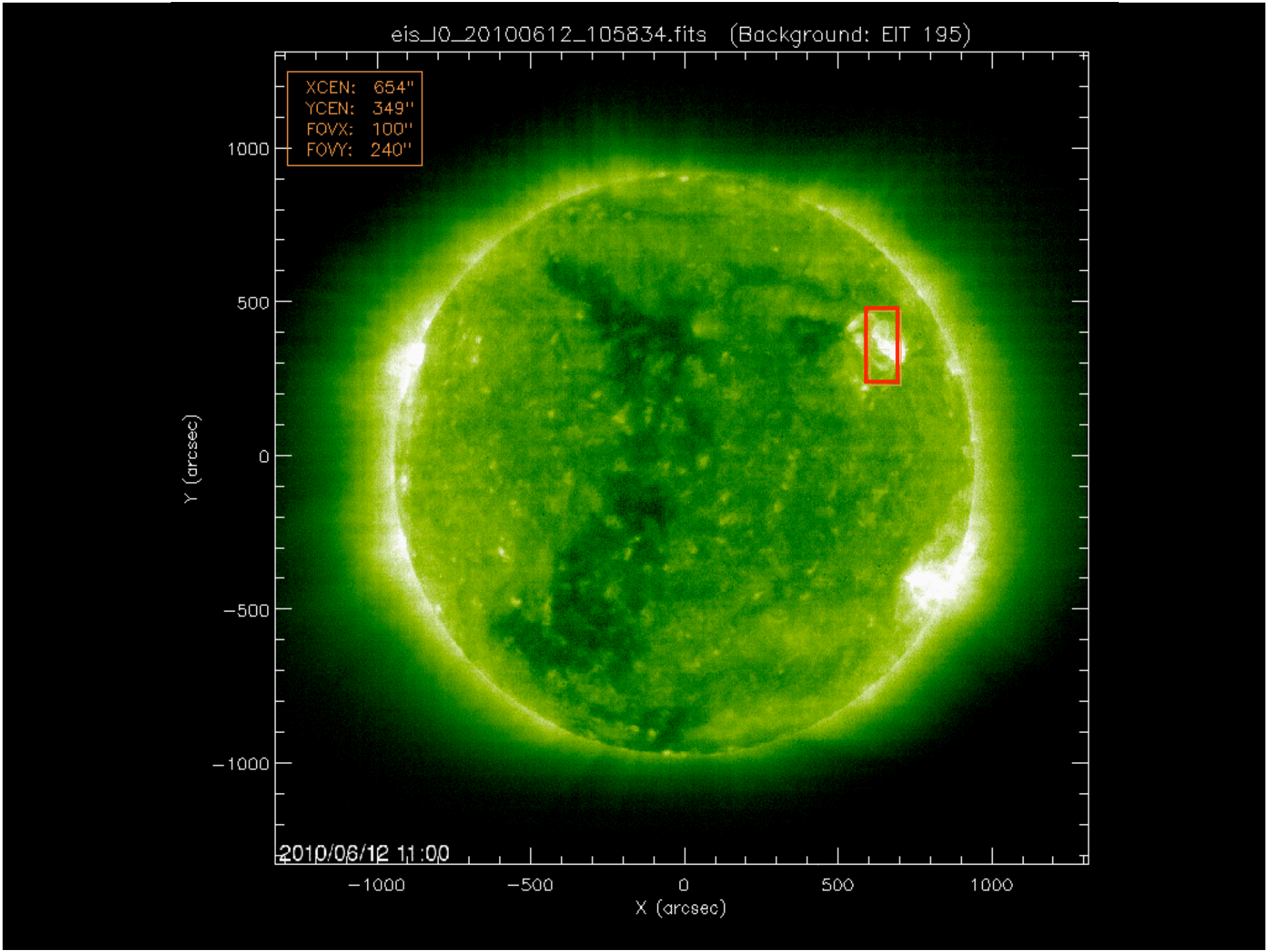


Open questions about loops

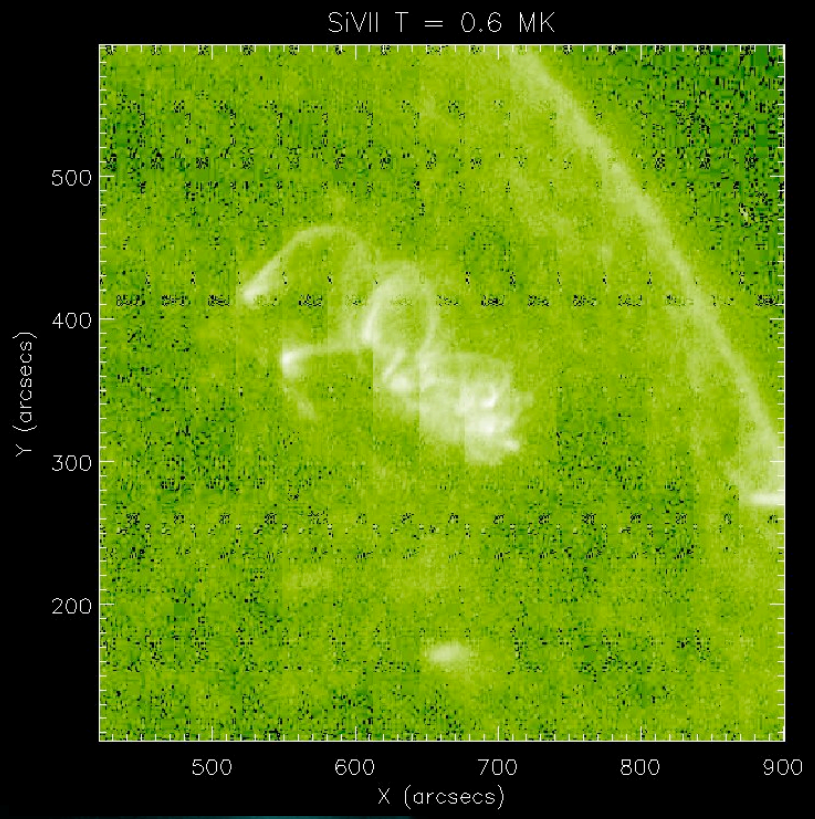
‘Building blocks’ of Active Regions:

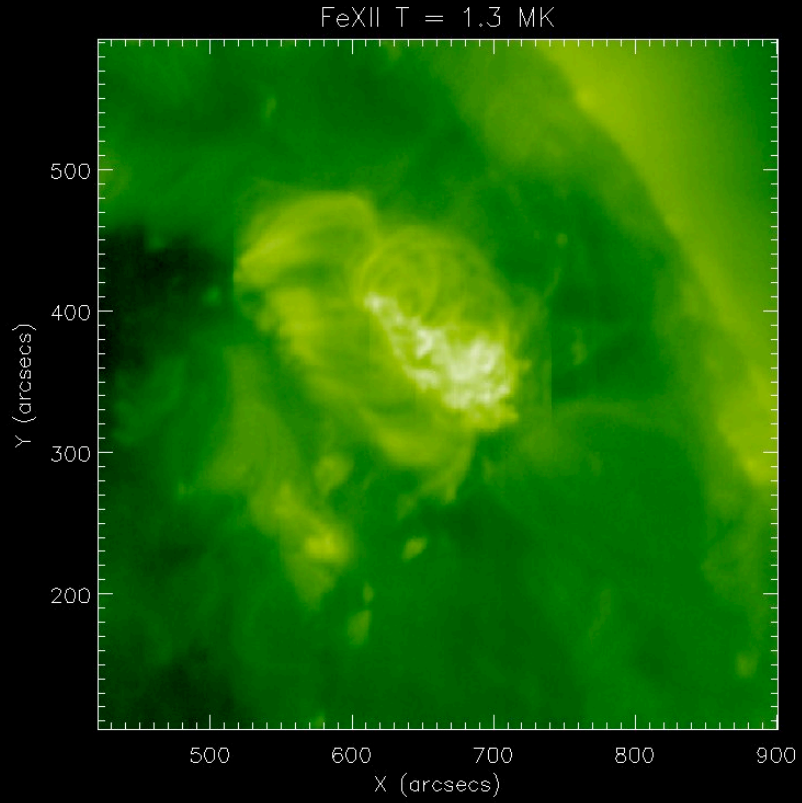
- Dynamic or stable?
- Source of heating?
- Isothermal?
- Structure
  - Multiple strands?
- Do all loops share common properties?
- Combining observations is key.



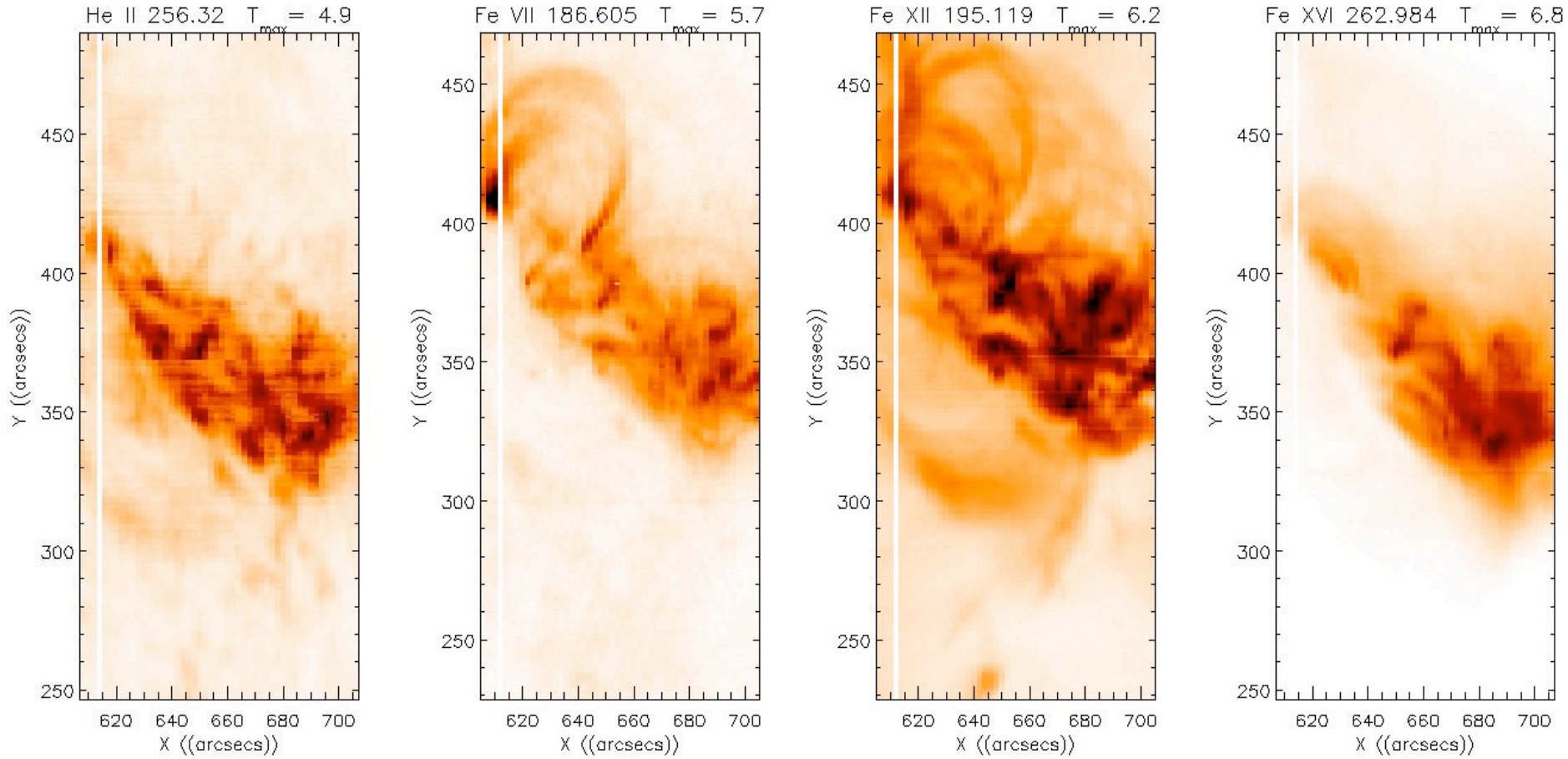

eis_l0_20100612_105834.fits (Background: EIT 195)
XCEN: 654''
YCEN: 349''
FOVX: 100''
FOVY: 240''
1000
500
0
−500
−1000
Y (arcsec)
2010/06/12 11:00
−1000
−500
0
500
1000
X (arcsec)

EIS Slot Study

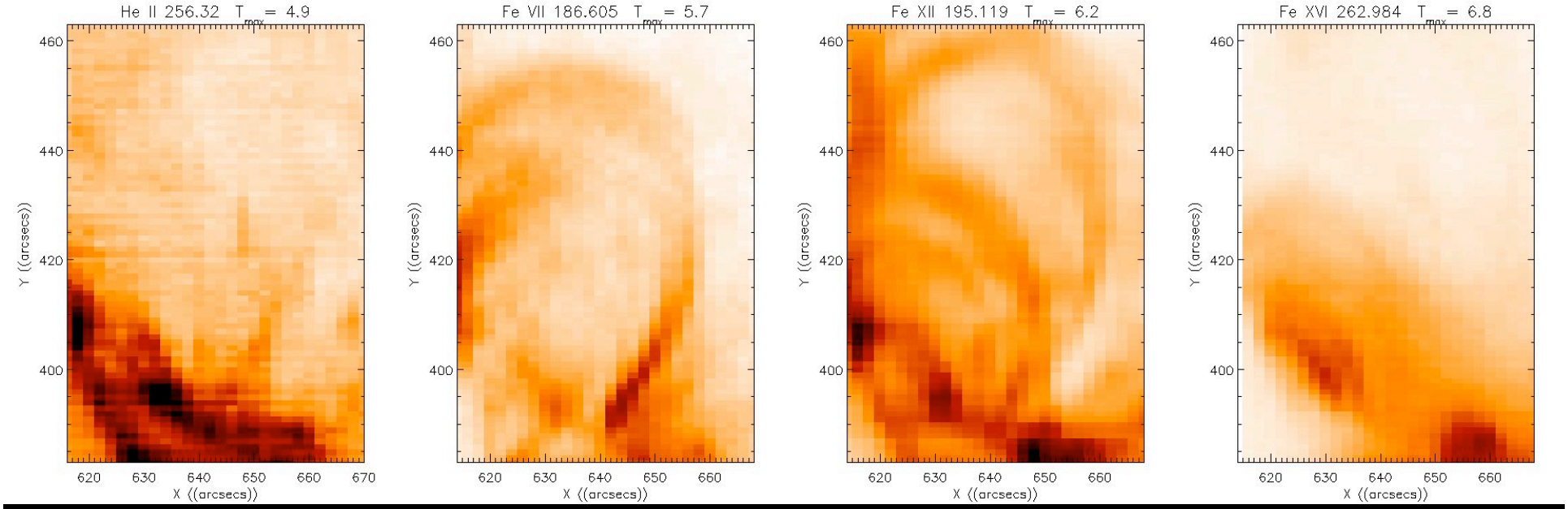


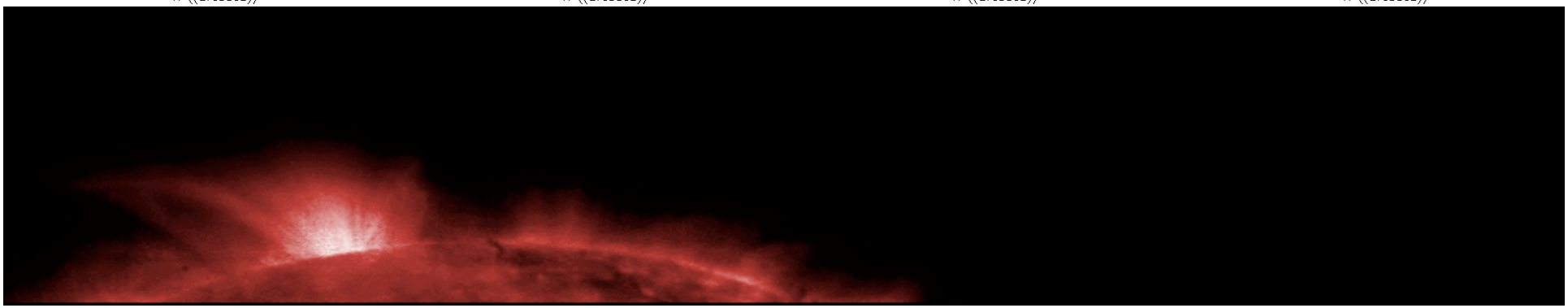


EIS 2” Slit Study



EIS Loop Structure





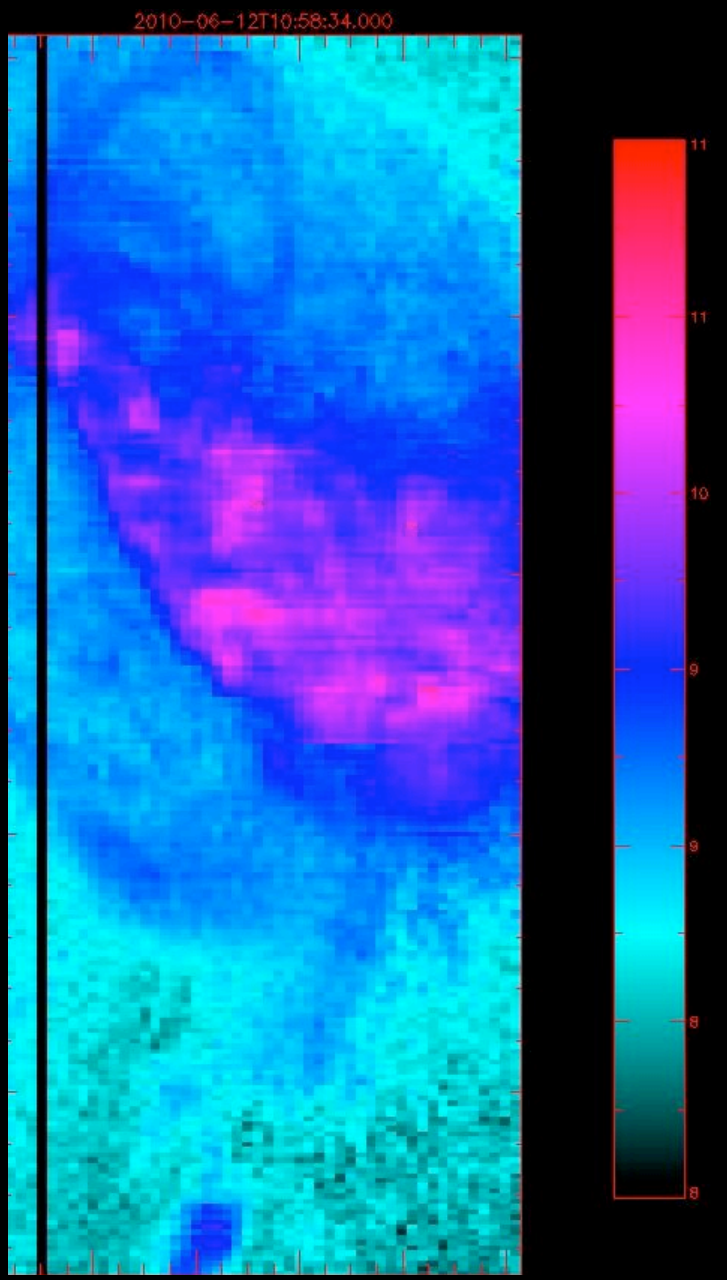
Density

Density was found using the line intensity ratio of:

Fe XII (186.854 + 186.887) / (195.119 + 195.179)

$\rho_{leg} = 4.17 \times 10^{9}\ cm^{-3}$

$\rho_{apex} = 2.4 \times 10^{9}\ cm^{-3}$

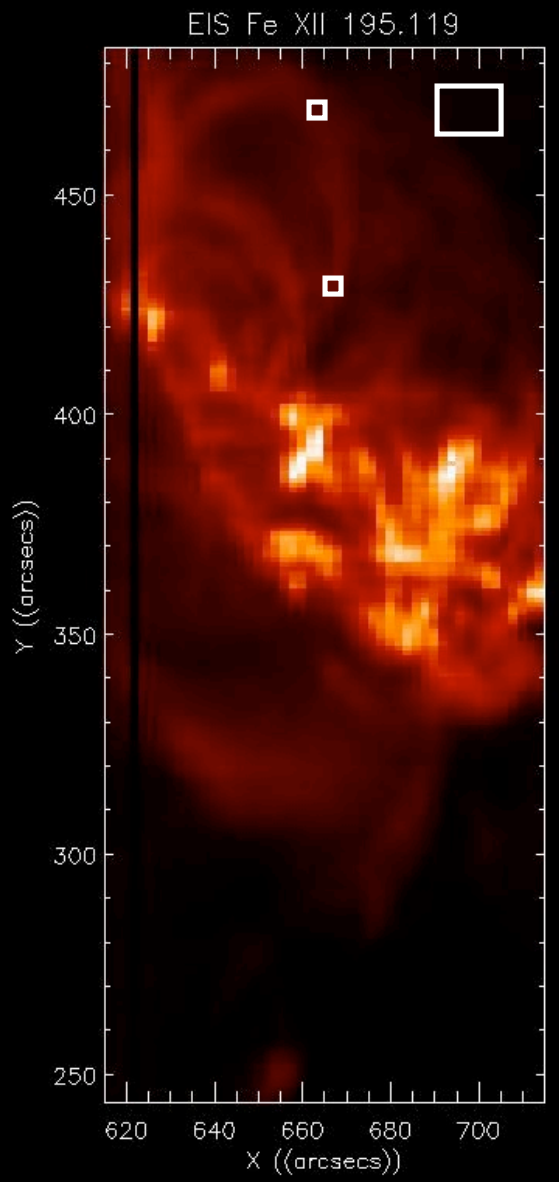


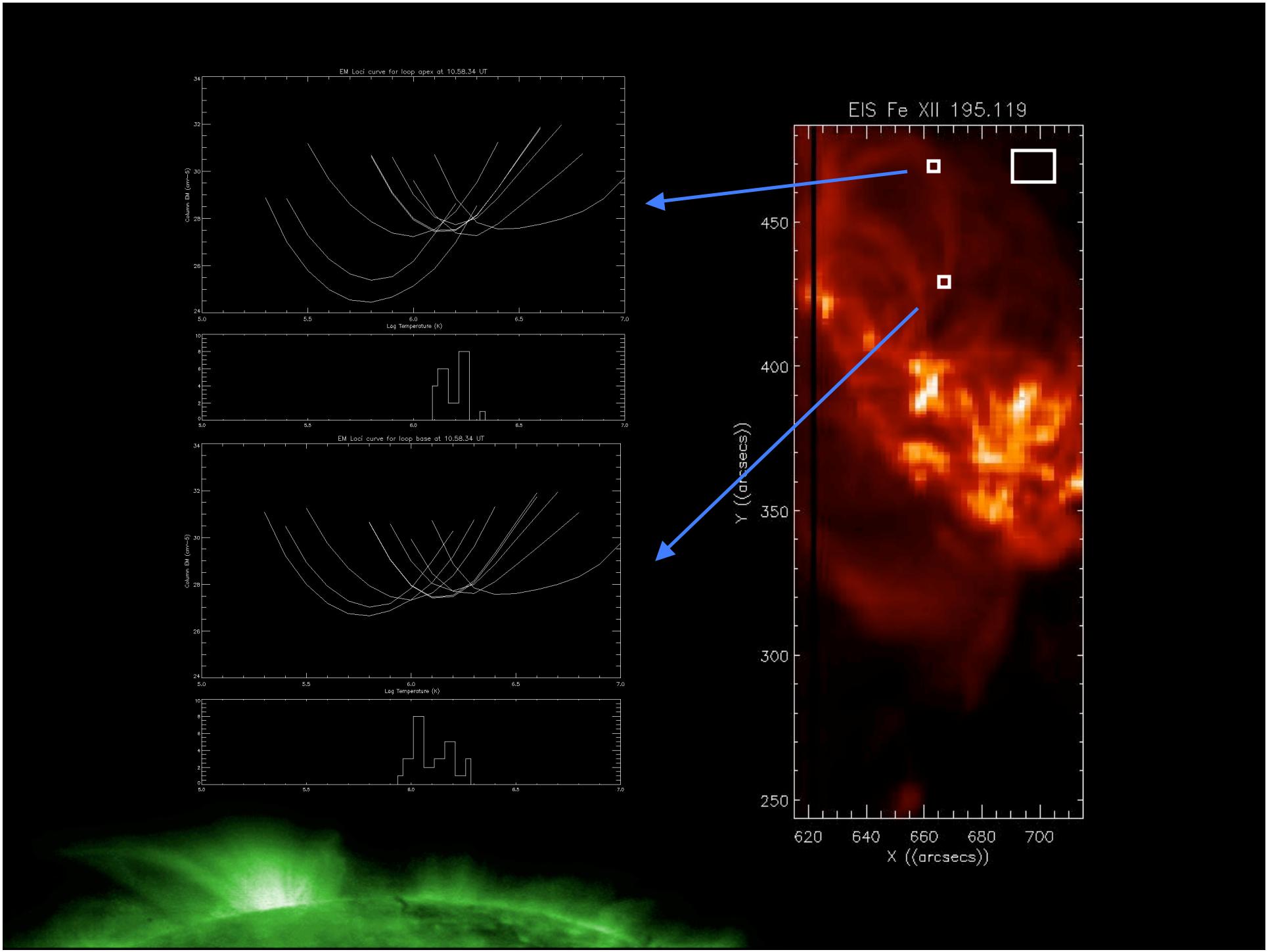
Temperature

The emission measure loci method was used to investigate the temperature of the loop at the base and apex.

T_{base} = 1.1 MK

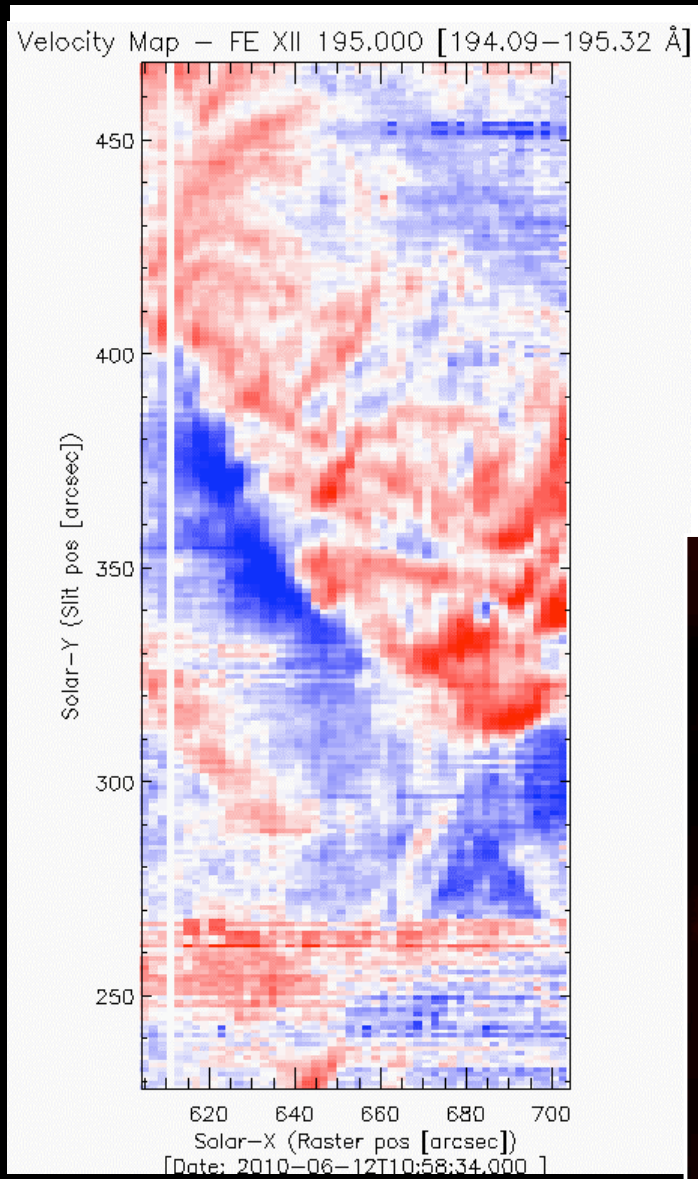
T_{apex} = 1.7 MK

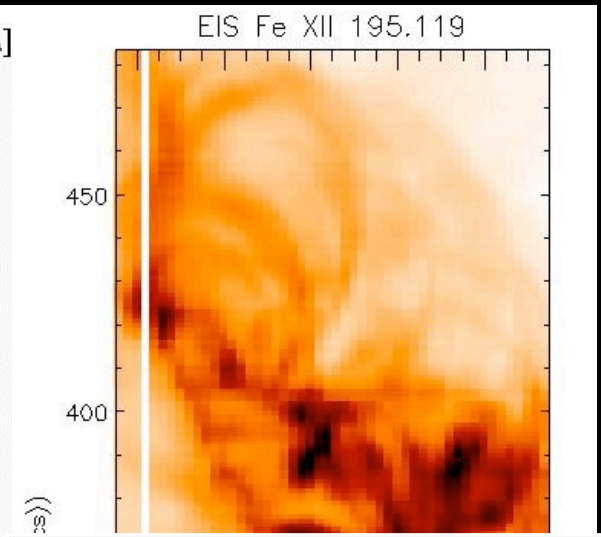


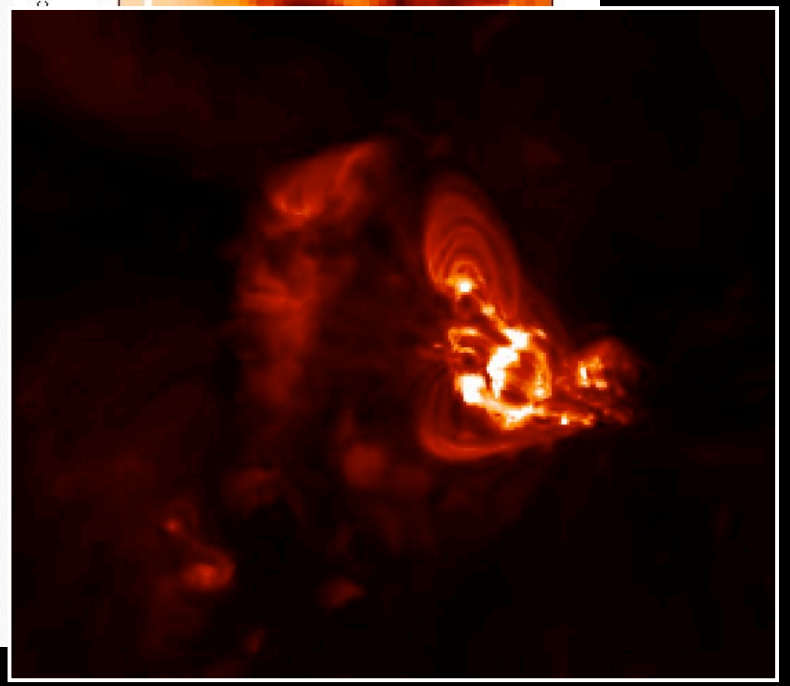

EM Loci curve for loop apex at 10:58:34 UT
Column EM (cm-5)
Log Temperature (K)
EM Loci curve for loop base at 10:58:34 UT
Column EM (cm-5)
Log Temperature (K)
EIS Fe XII 195.119
Y ((arcsecs))
X ((arcsecs))
250
300
350
400
450
620
640
660
680
700

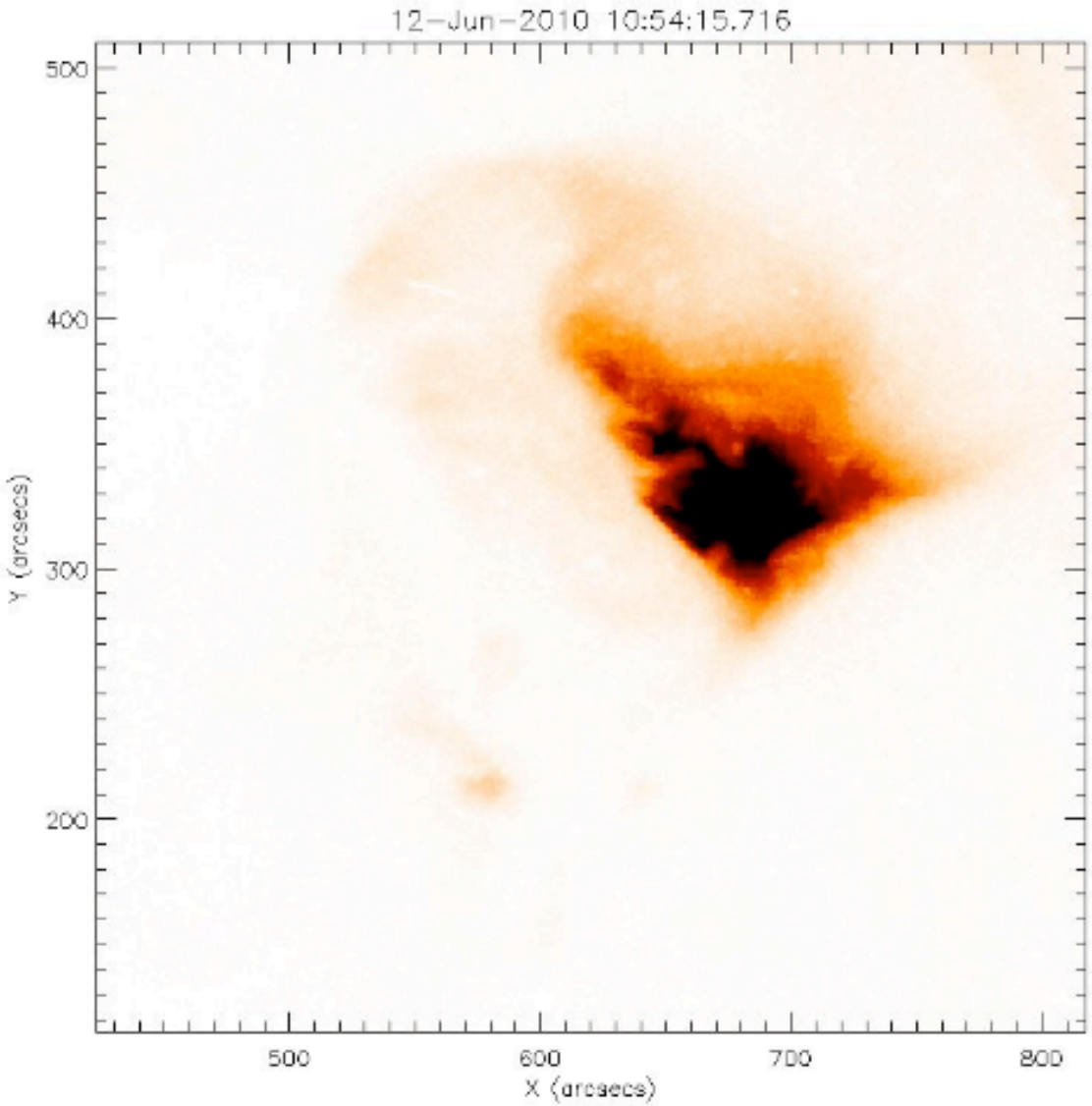
Measured redshifts in both legs of ~ 10 kms^{-1}

Blueshift of 15 kms^{-1}

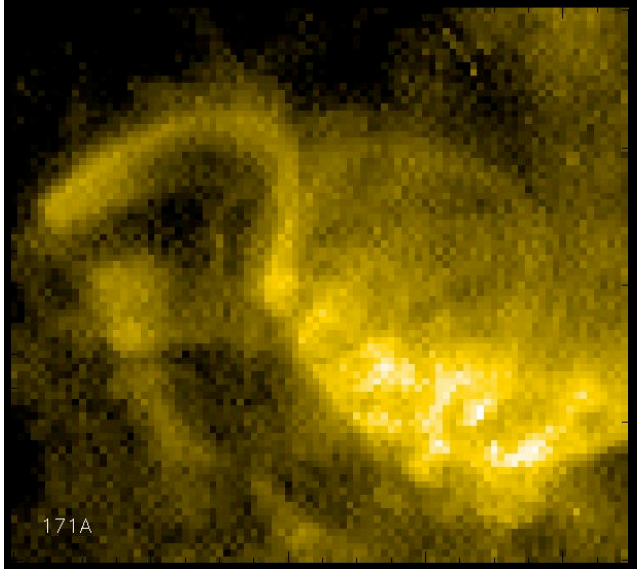


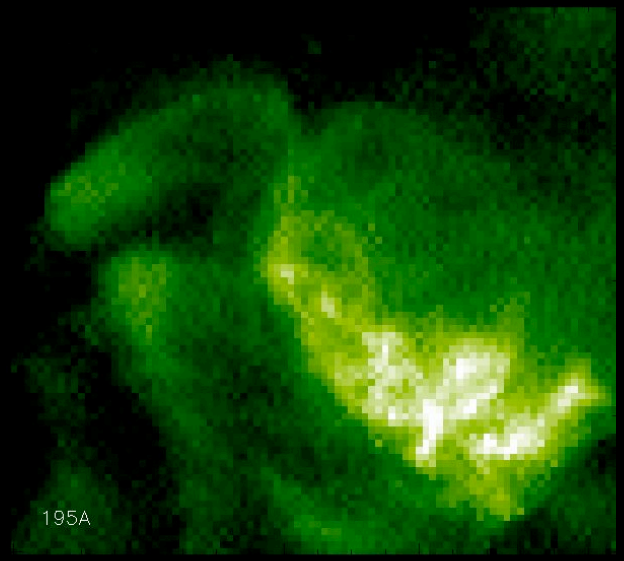


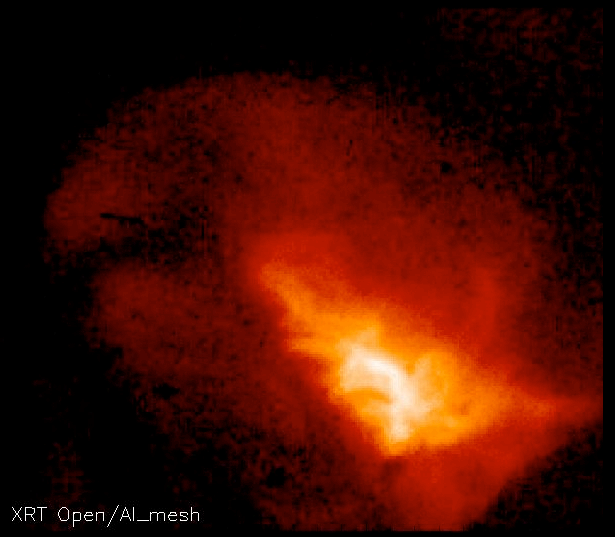


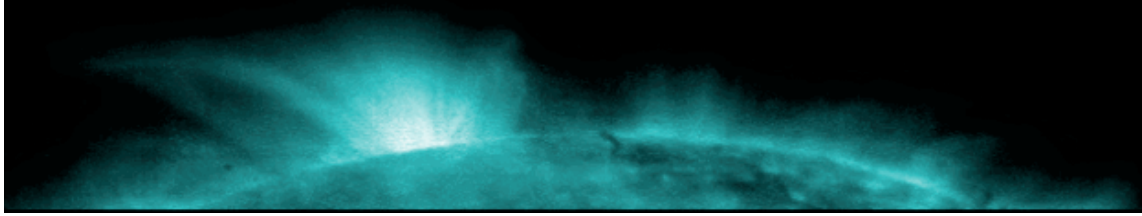

12-Jun-2010 10:54:15.716
500
400
300
200
Y (arcsecs)
500
600
700
800
X (arcsecs)

Pre-SDO Imaging







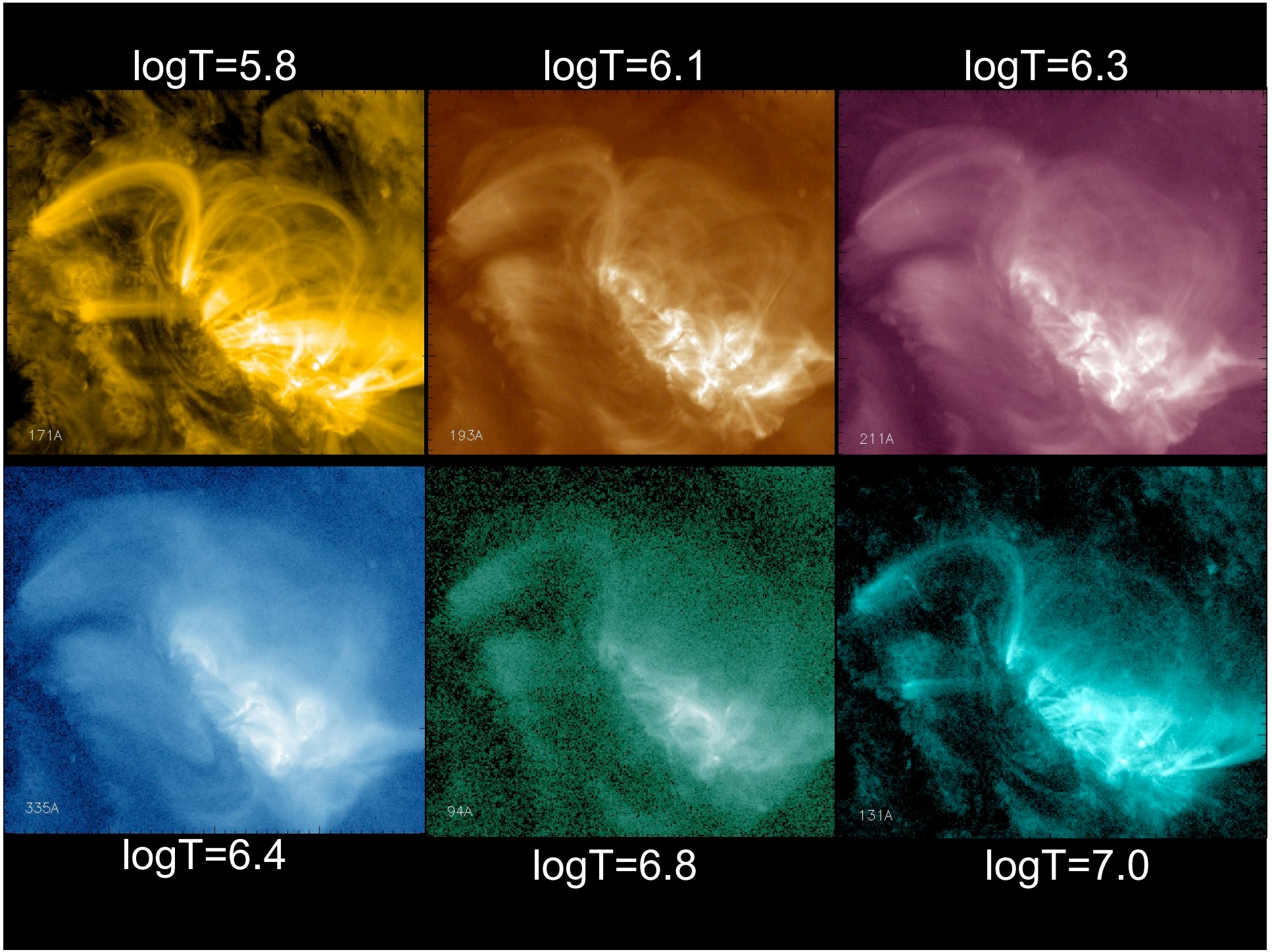


AIA Channels

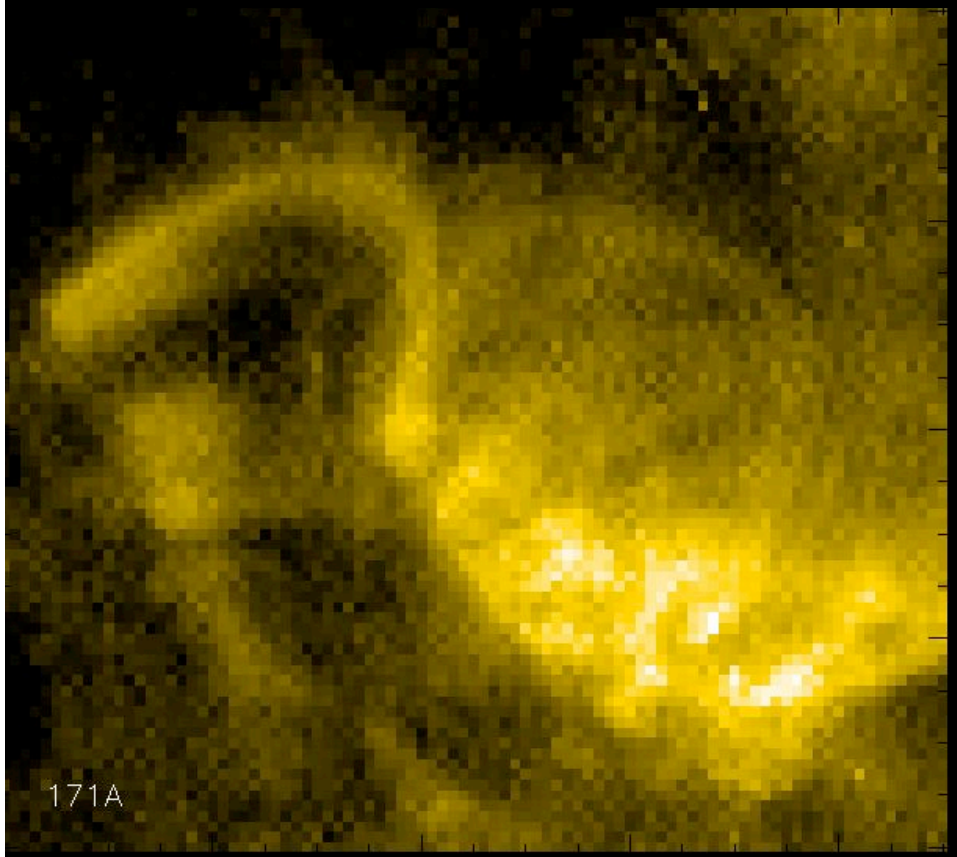
AIA wavelength bands

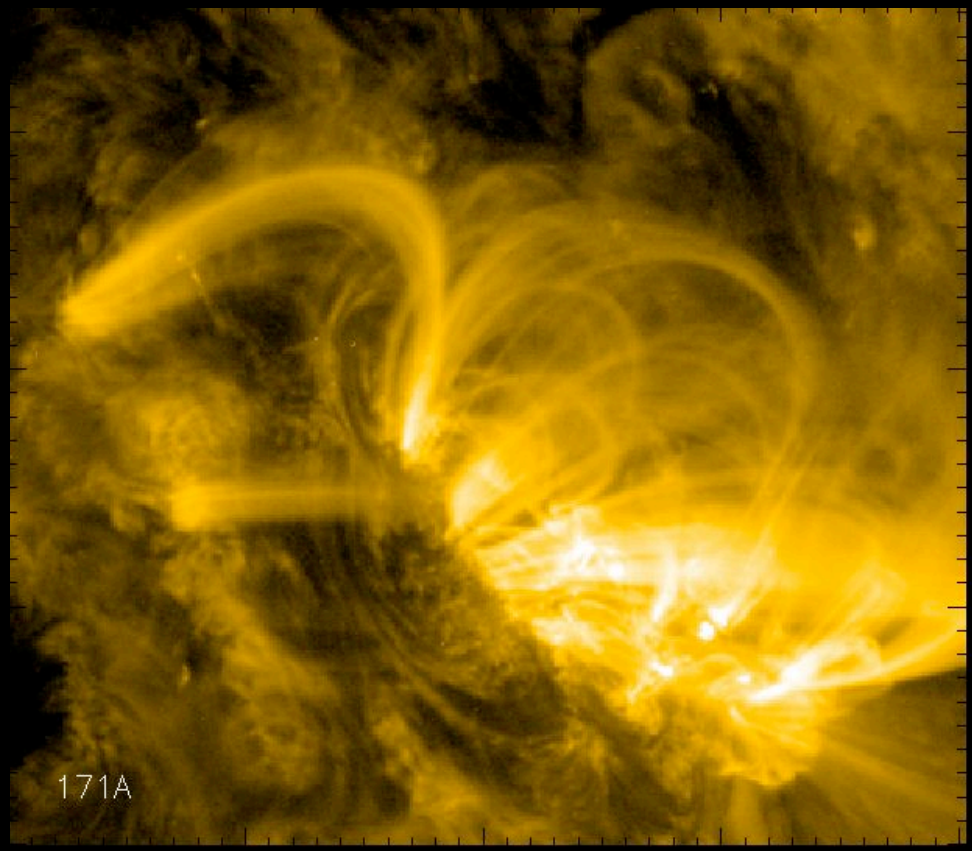
Channel	Δλ††	Ion(s)	Region of Atmosphere*	Char. log(*T*)
Visible	-	Continuum	Photosphere	3.7
1700Å	-	Continuum	Temperature minimum, photosphere	3.7
304Å	12.7	He II	Chromosphere, transition region,	4.7
1600Å	-	C IV+cont.	Transition region + upper photosphere	5.0
171Å	4.7	Fe IX	Quiet corona, upper transition region	5.8
193Å	6.0	Fe XII, XXIV	Corona and hot flare plasma	6.1, 7.3
211Å	7.0	Fe XIV	Active-region corona	6.3
335Å	16.5	Fe XVI	Active-region corona	6.4
94Å	0.9	Fe XVIII	Flaring regions	6.8
131Å	4.4	Fe XX, XXIII	Flaring regions	7.0, 7.2

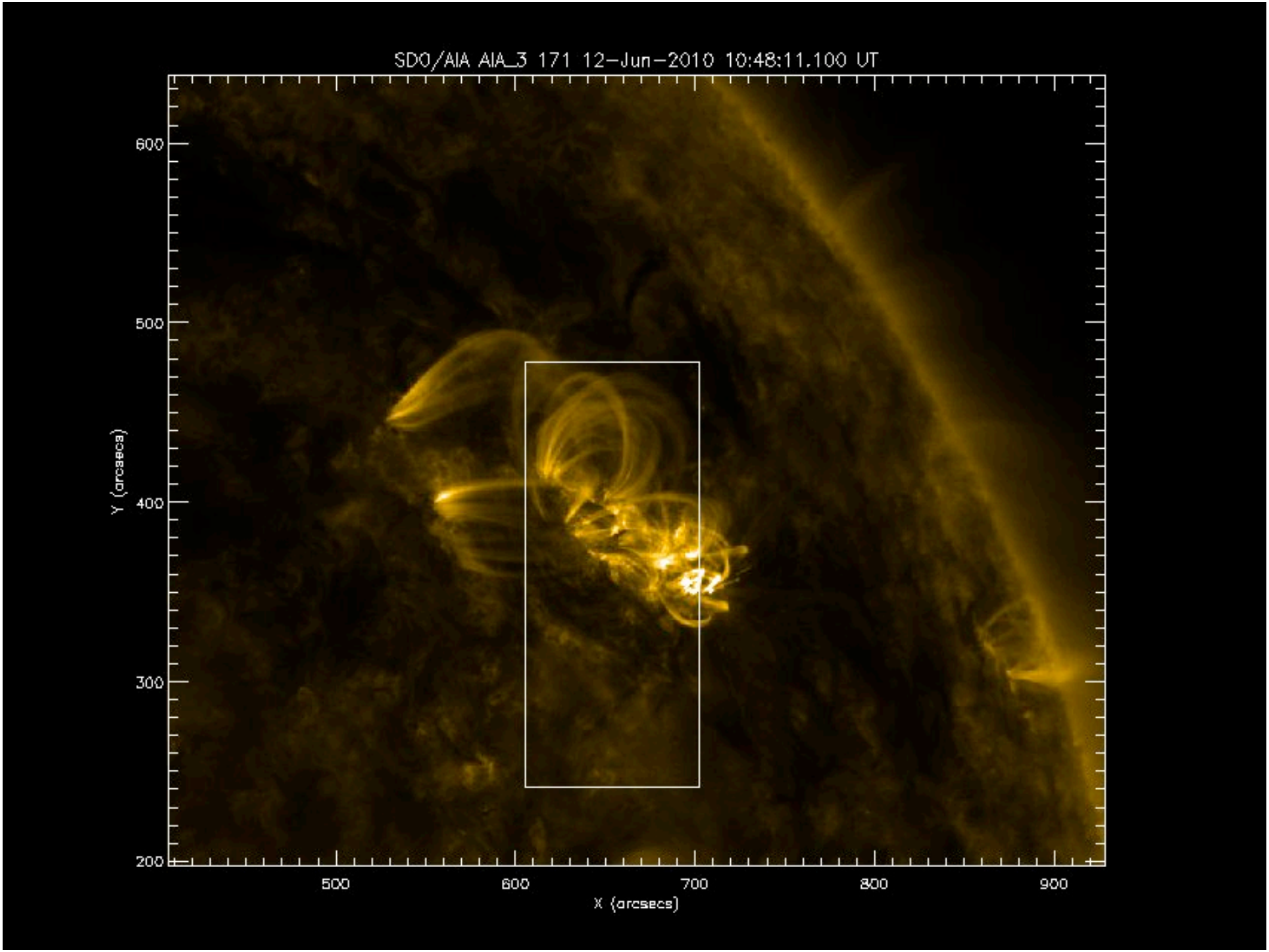
*Absorption allows imaging of chromospheric material within the corona;
††FWHM, in Å

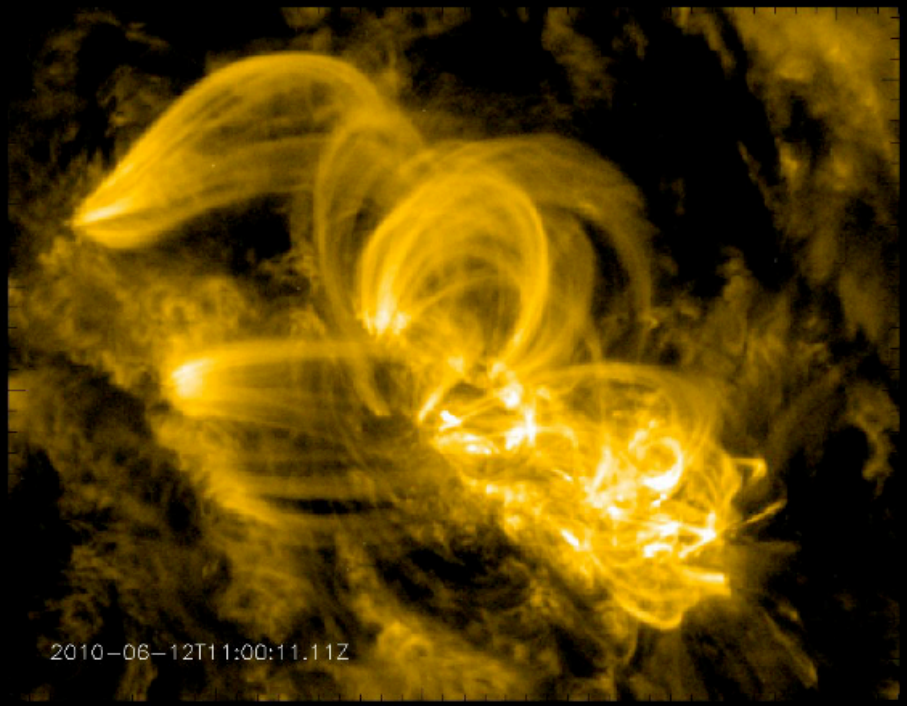

logT=5.8
logT=6.1
logT=6.3
171A
193A
211A
335A
94A
131A
logT=6.4
logT=6.8
logT=7.0

SOHO/EIT vs SDO/AIA






SDO/AIA AIA_3 171 12-Jun-2010 10:48:11.100 UT
600
500
400
300
200
Y (arcsecs)
500
600
700
800
900
X (arcsecs)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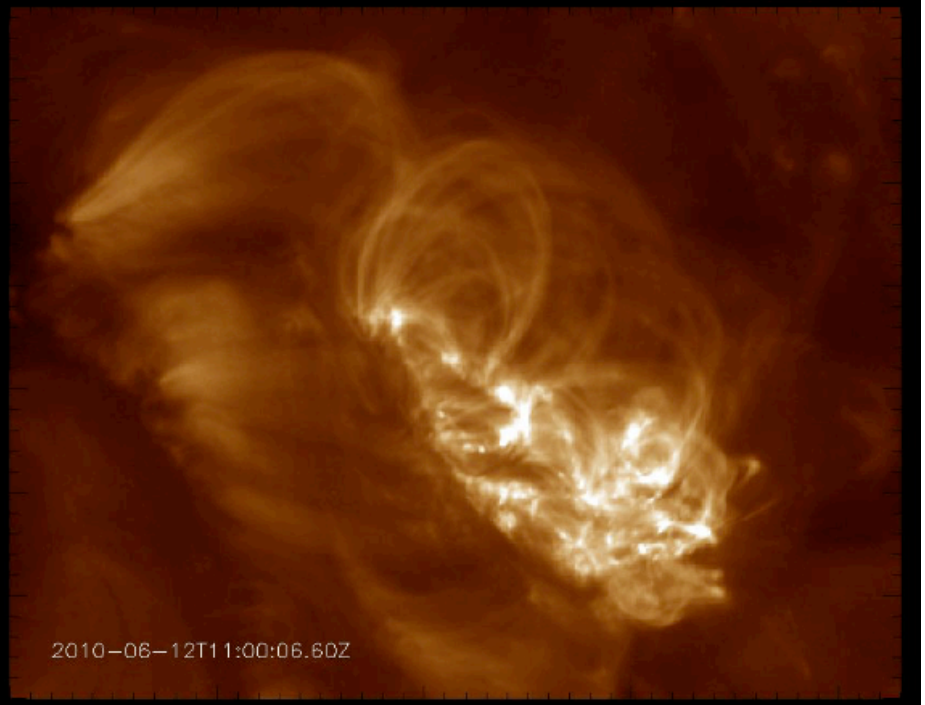
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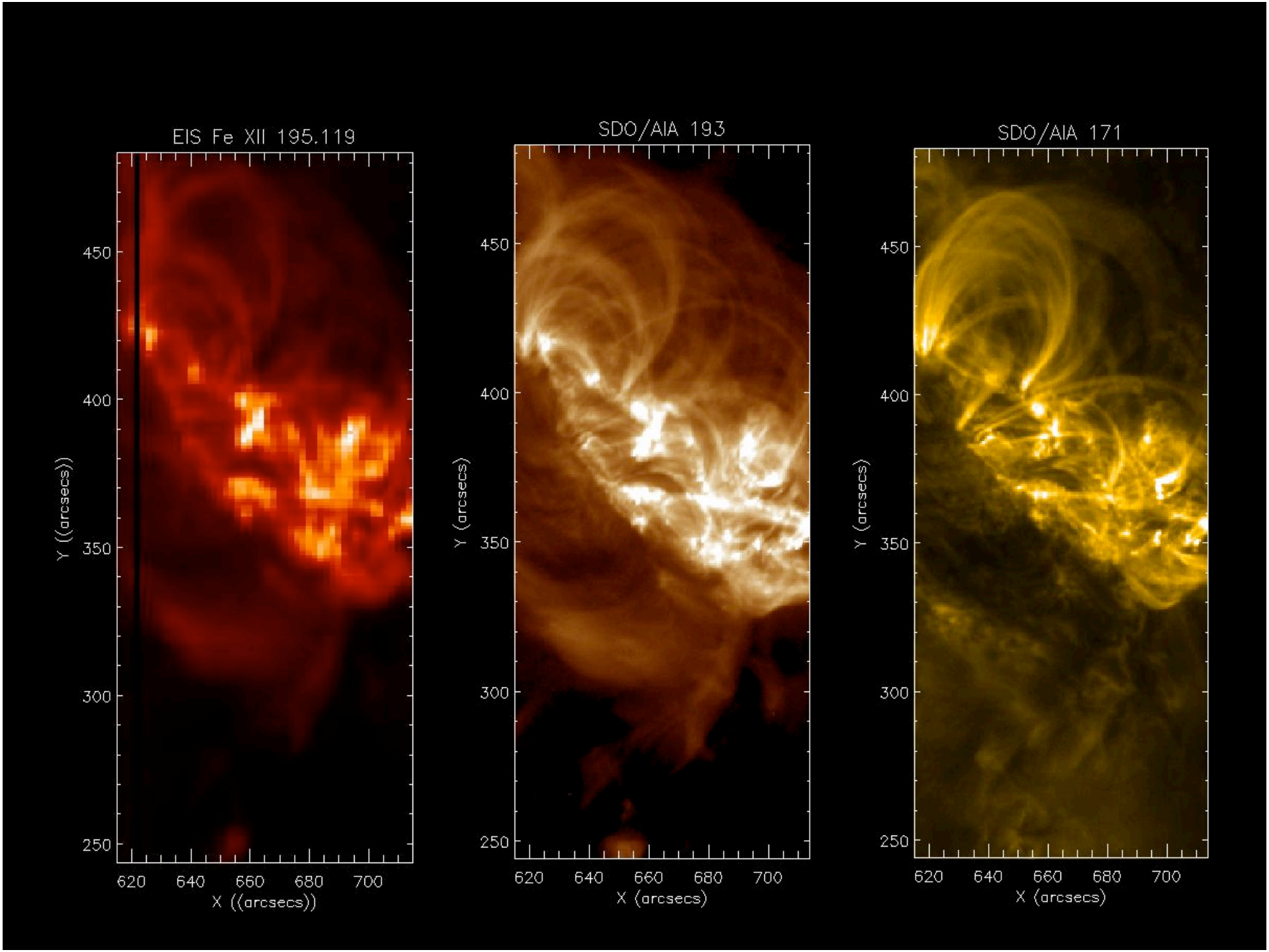
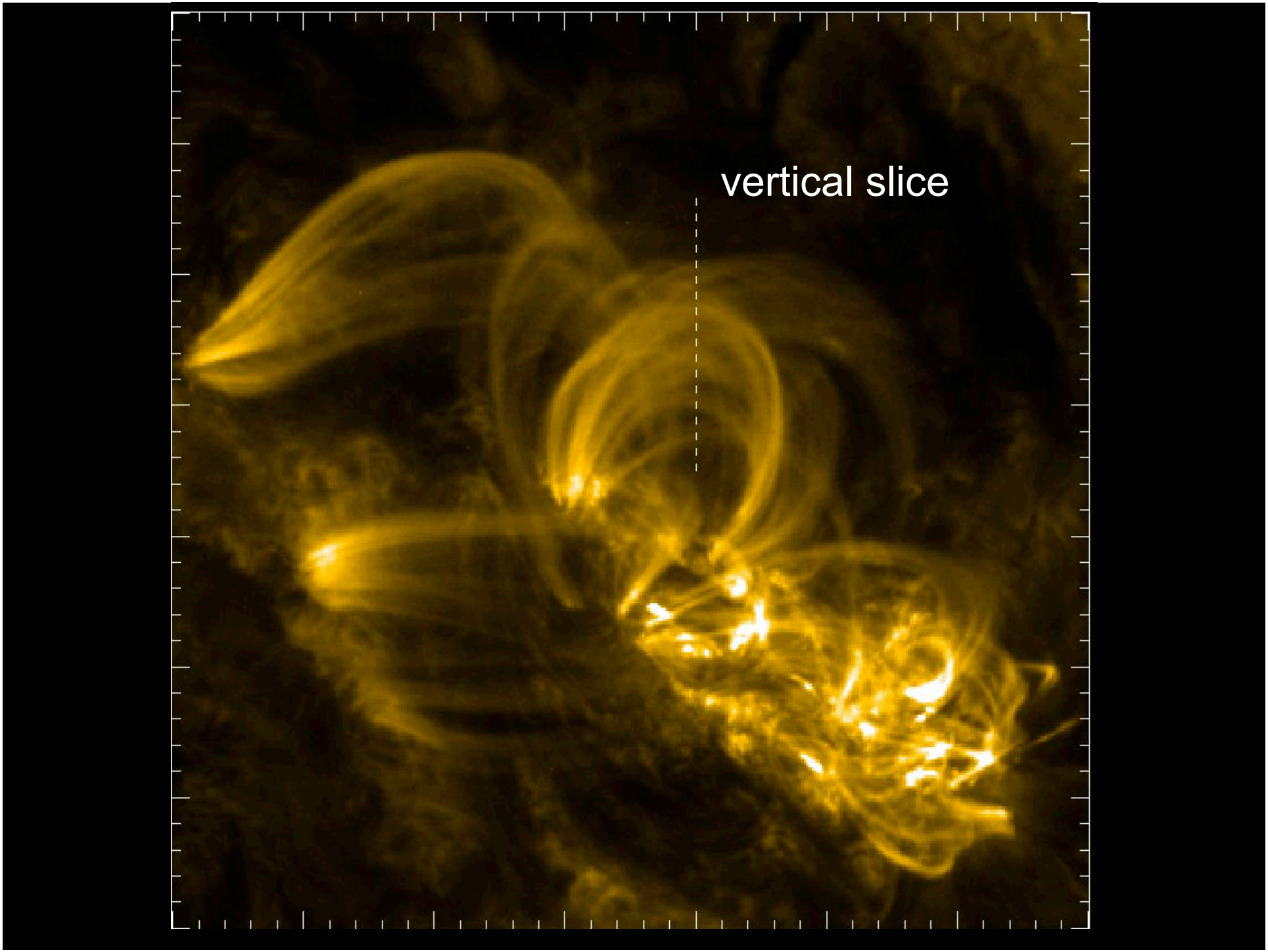
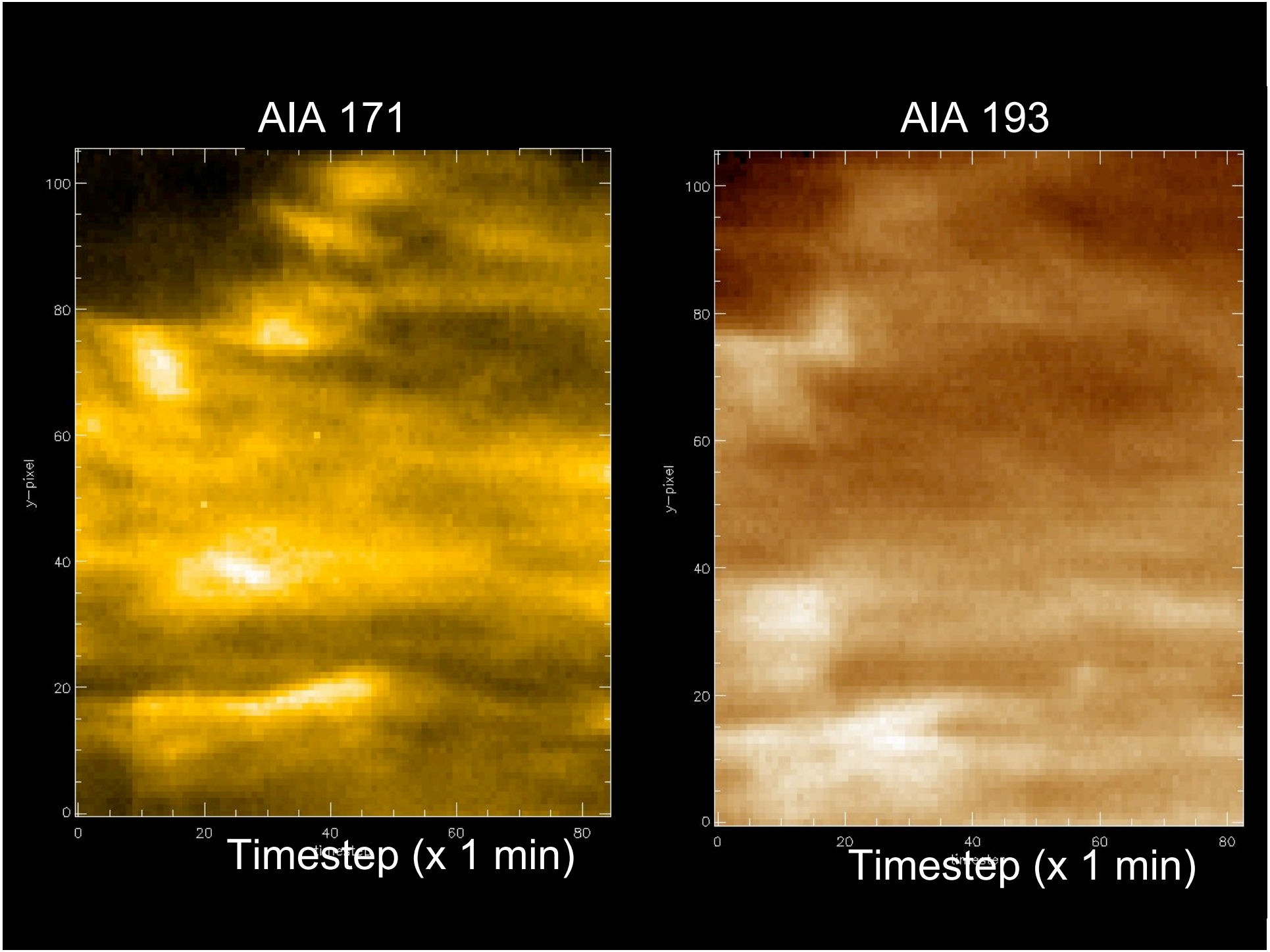
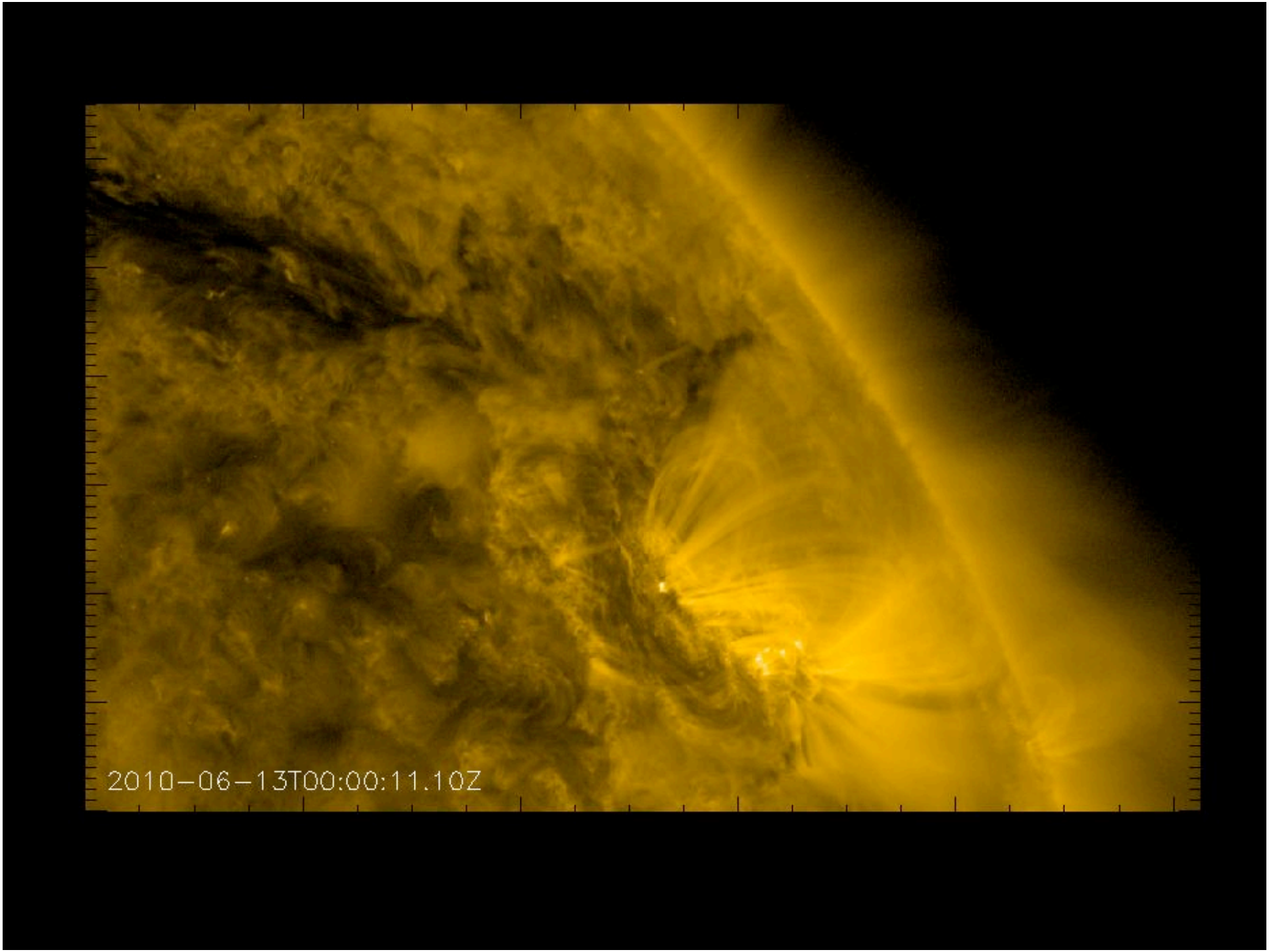

EIS Fe XII 195.119
SDO/AIA 193
SDO/AIA 171
Y ((arcsecs))
Y (arcsecs)
X ((arcsecs))
X (arcsecs)
250
300
350
400
450
620
640
660
680
700


vertical slice


AIA 171
y-pixel
0
20
40
60
80
100
Timestep (x 1 min)
AIA 193
y-pixel
0
20
40
60
80
100
Timestep (x 1 min)


2010-06-13T00:00:11.10Z

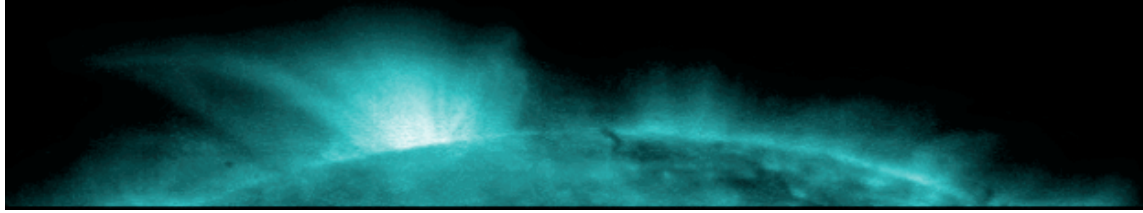
So, what's my point?

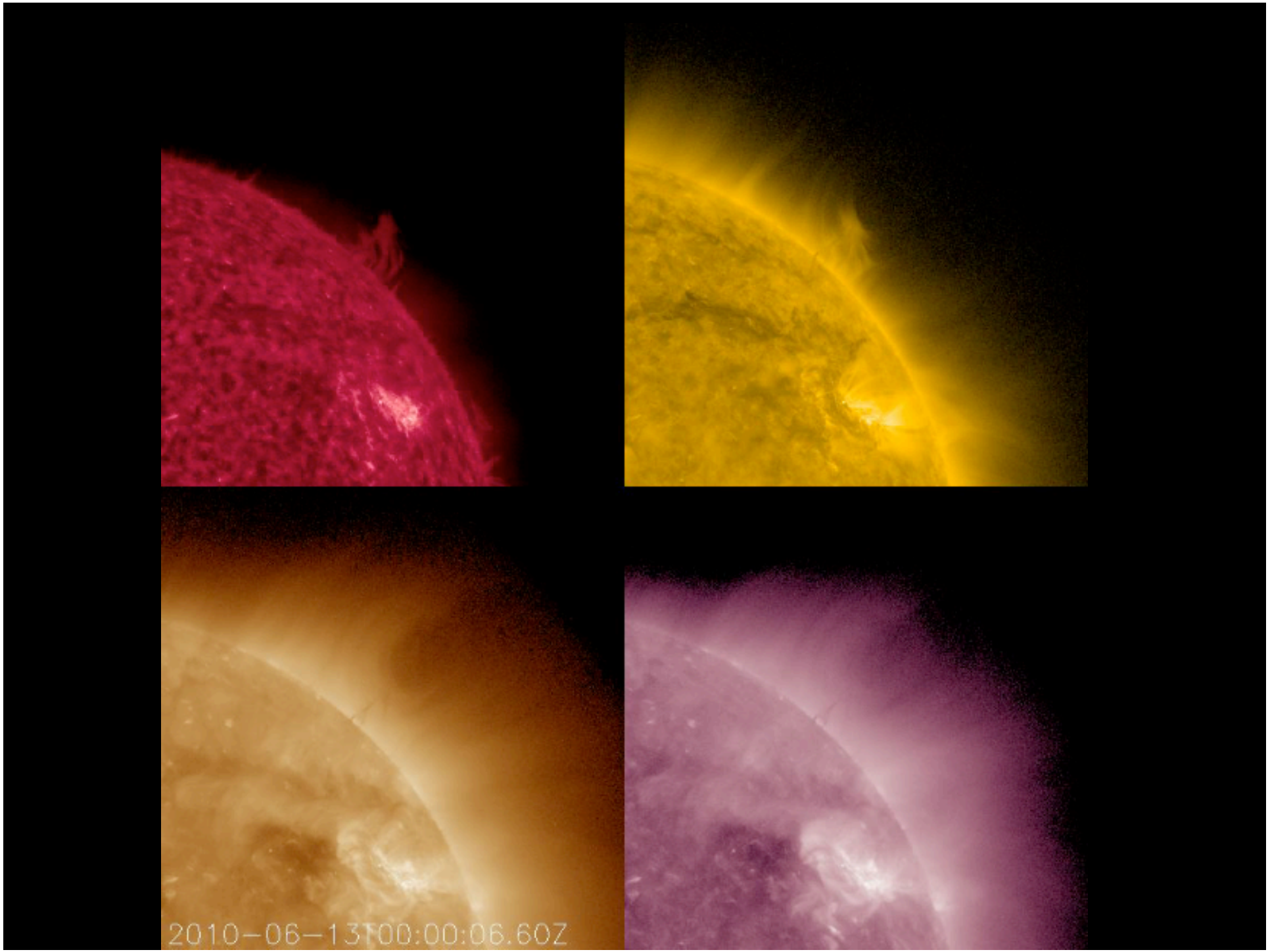
Measurements of density, temperature and velocity agree with published values.

Unprecedented level of detail with AIA

Help to build up picture of a 'typical' loop → constrain models

Not all about the pretty pictures…

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