Coronography at Pic du Midi

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Our strategy for Pic du Midi:

1. Maintain on-going long-term synoptic observations (talk by L. Koechklin this morning)
2. Test new observables
3. Make useful new observables synoptic

Objectives 1 & 2 completement and justify each other

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What new observables

Magnetic fields of course…….

Our projects:

1. Coronal magnetic fields (C2+ and C3)
2. Prominence/Filament magnetic fields

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Coronal Magnetic Fields

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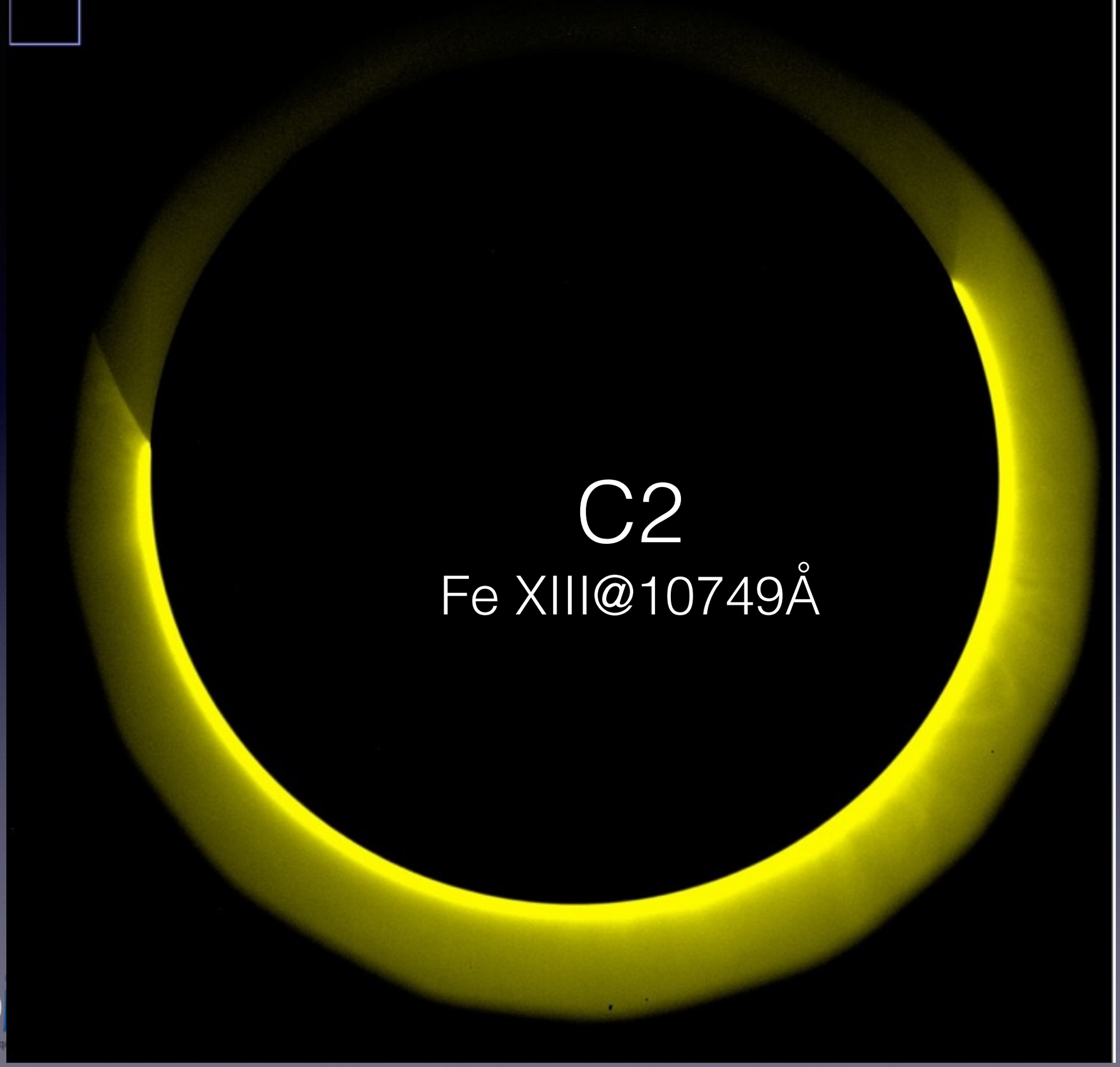
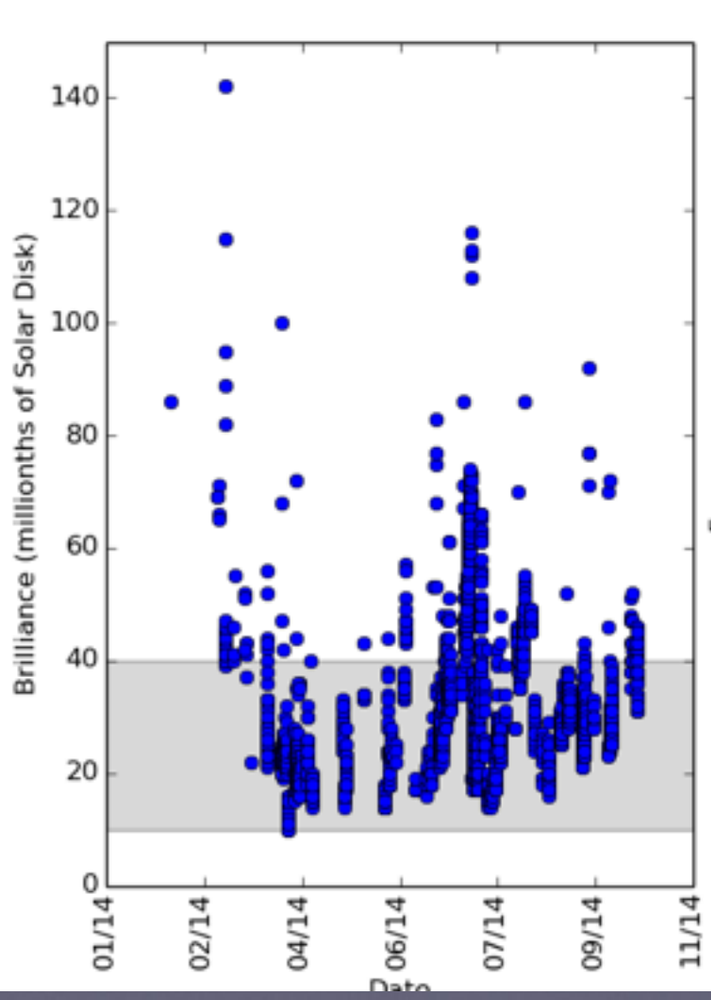
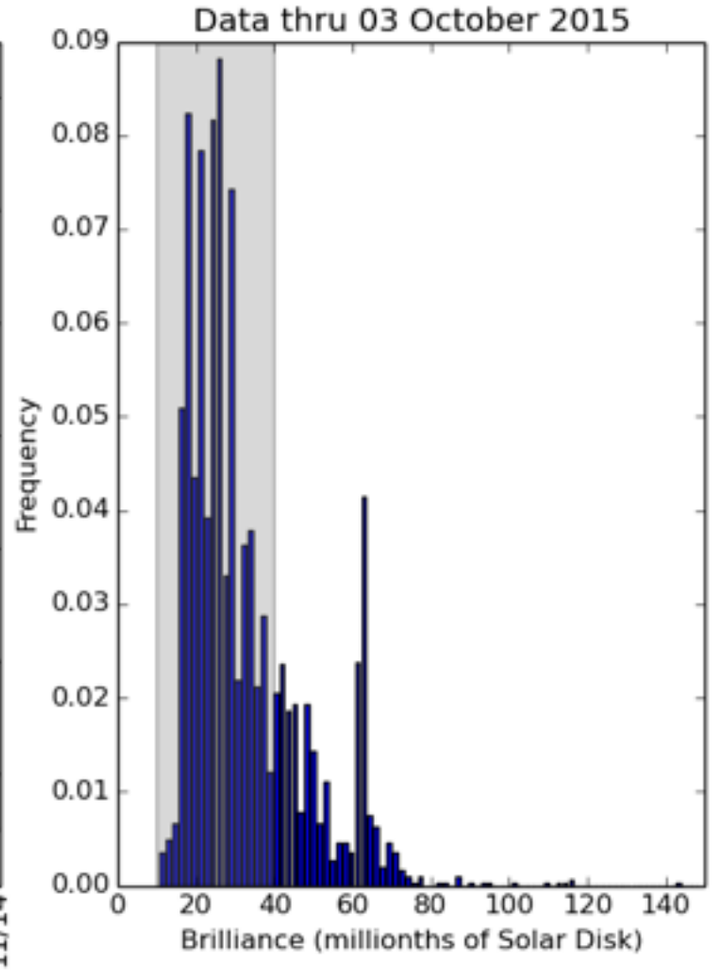
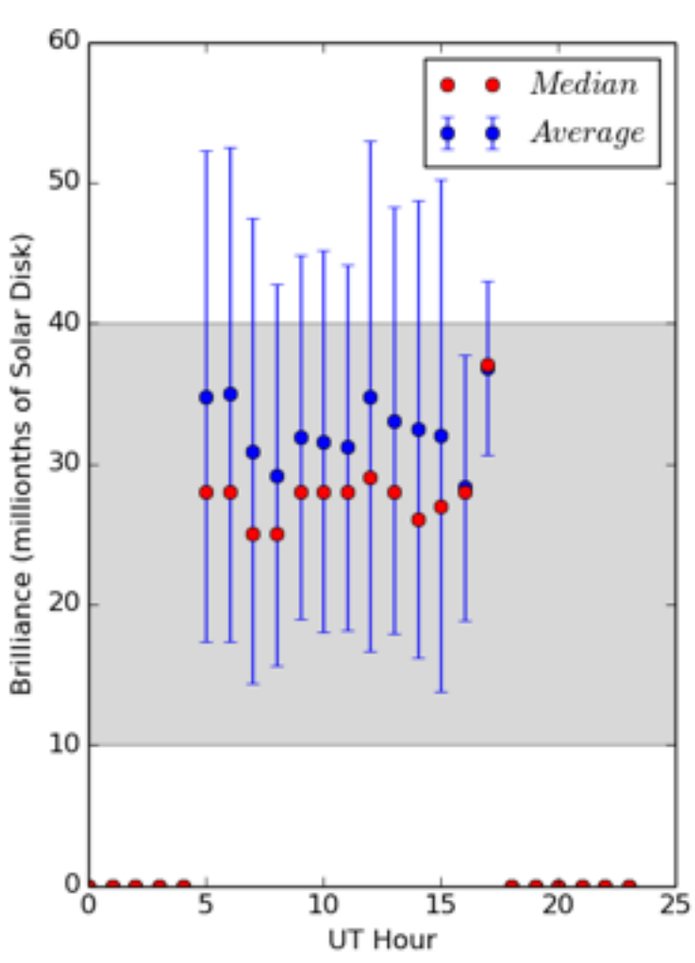
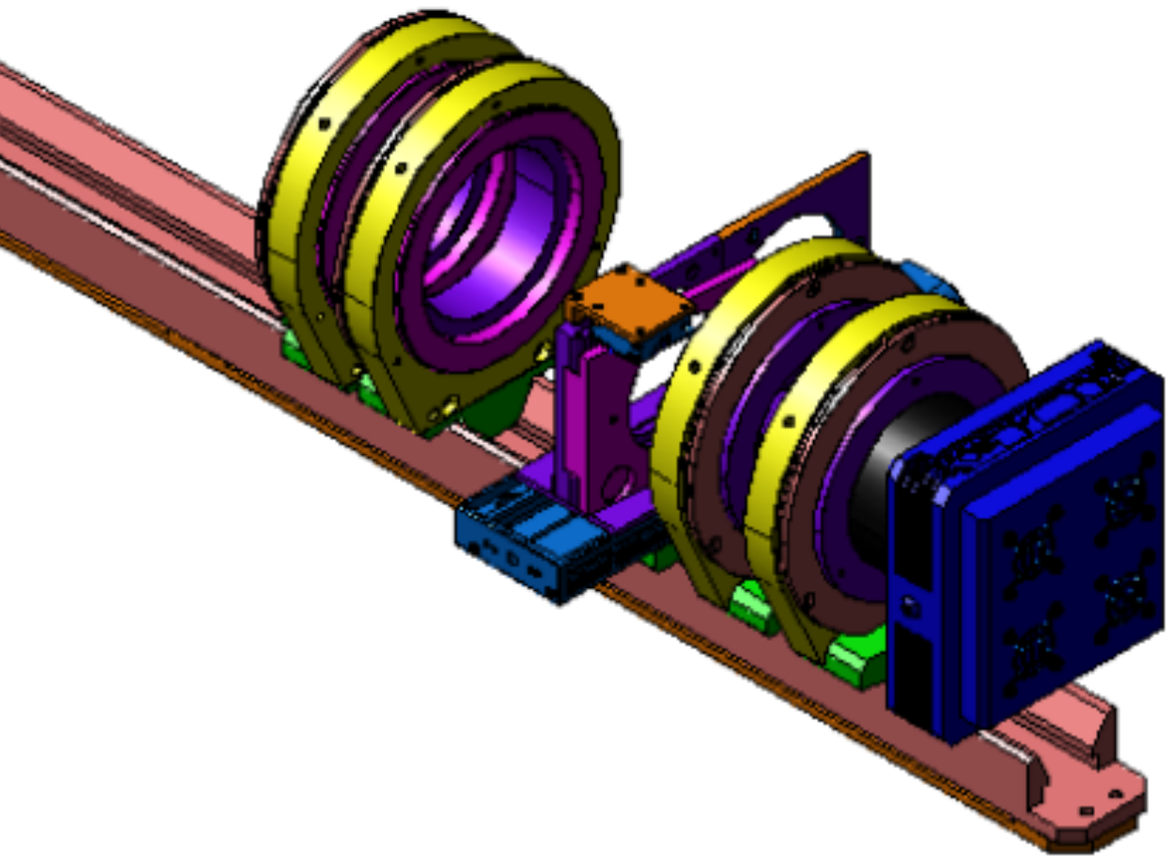

C2
Fe XIII@10749Å

Coronal Magnetic Fields



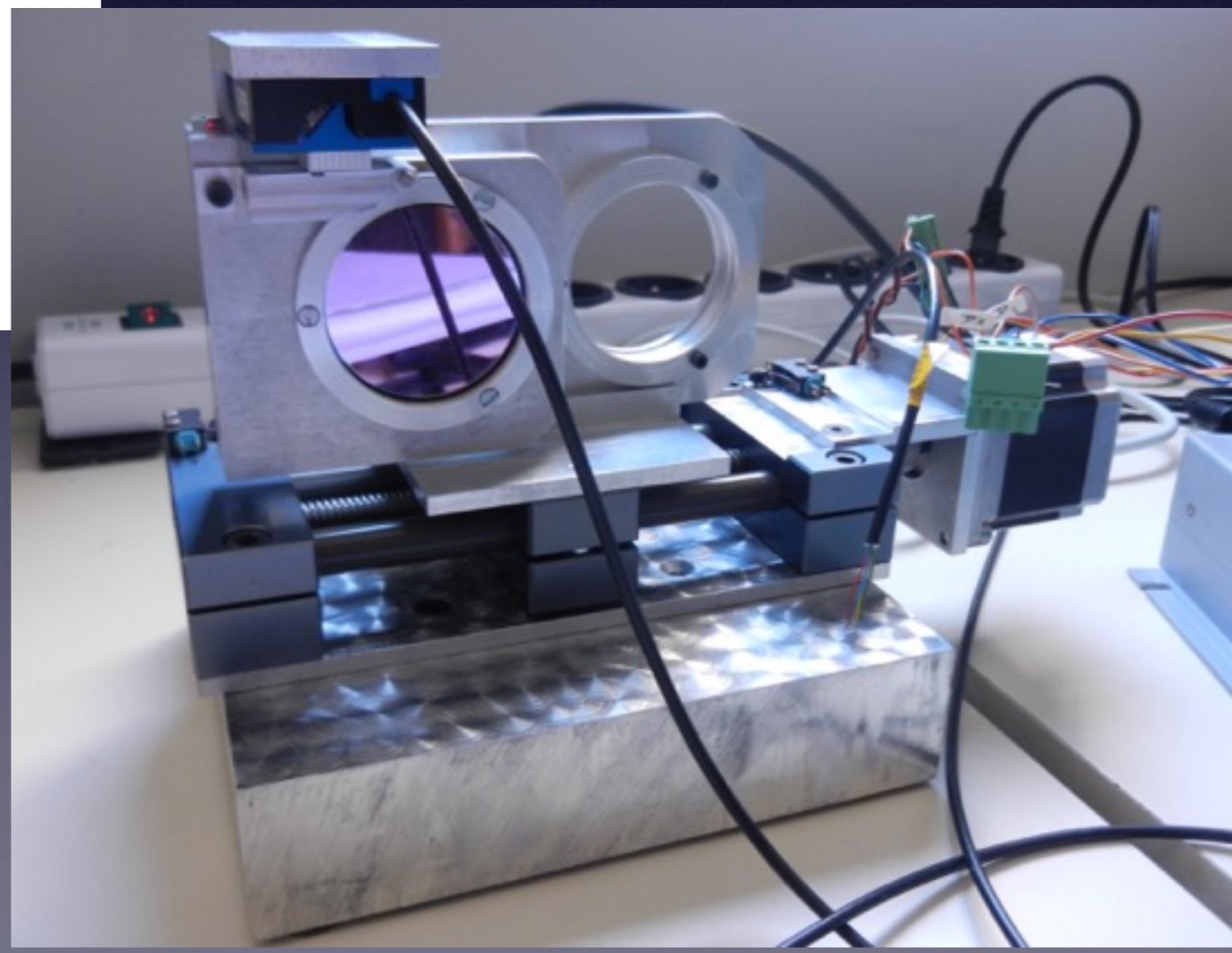






C2+

being installed
tomorrow



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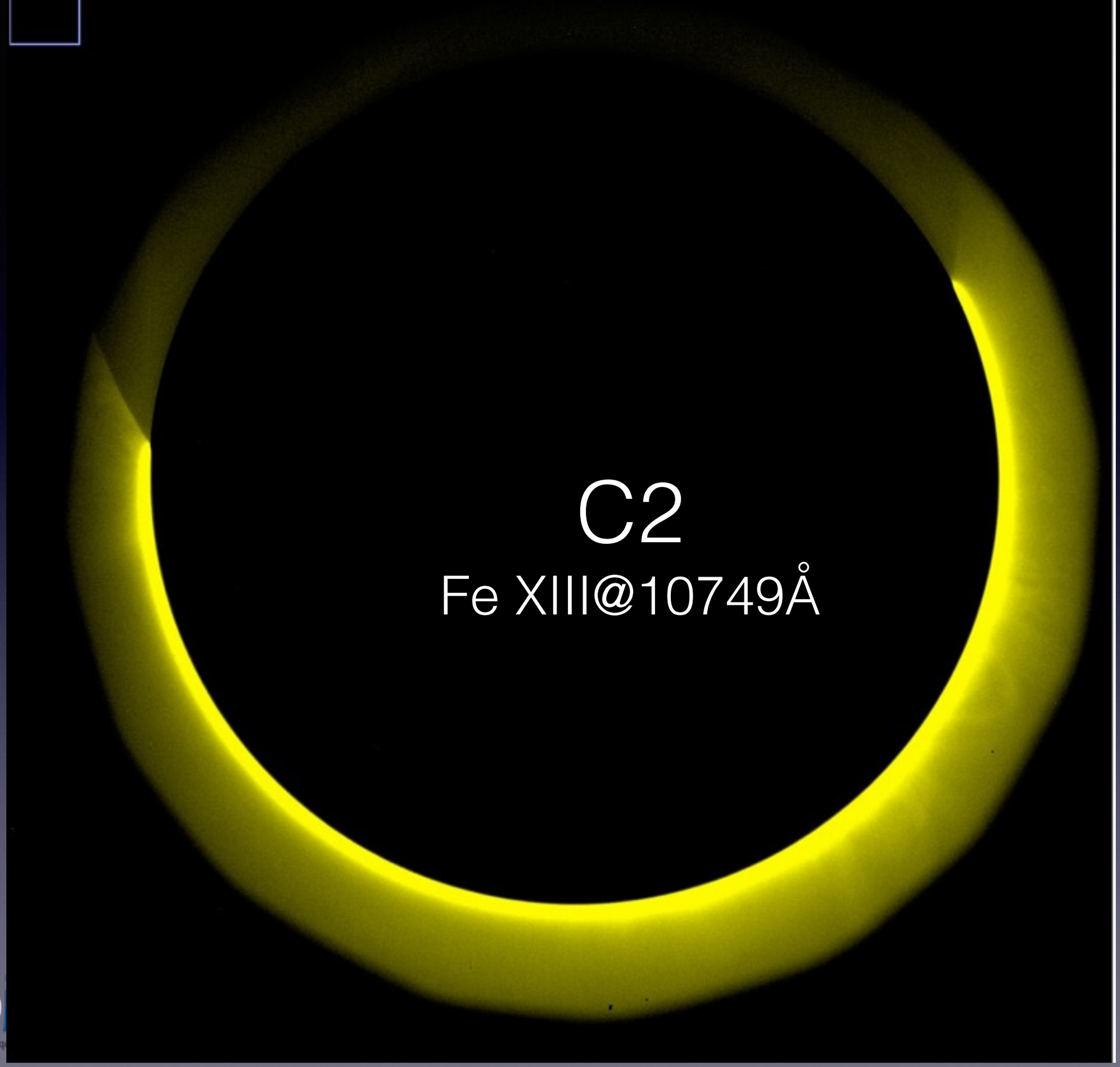

C2
Fe XIII@10749Å

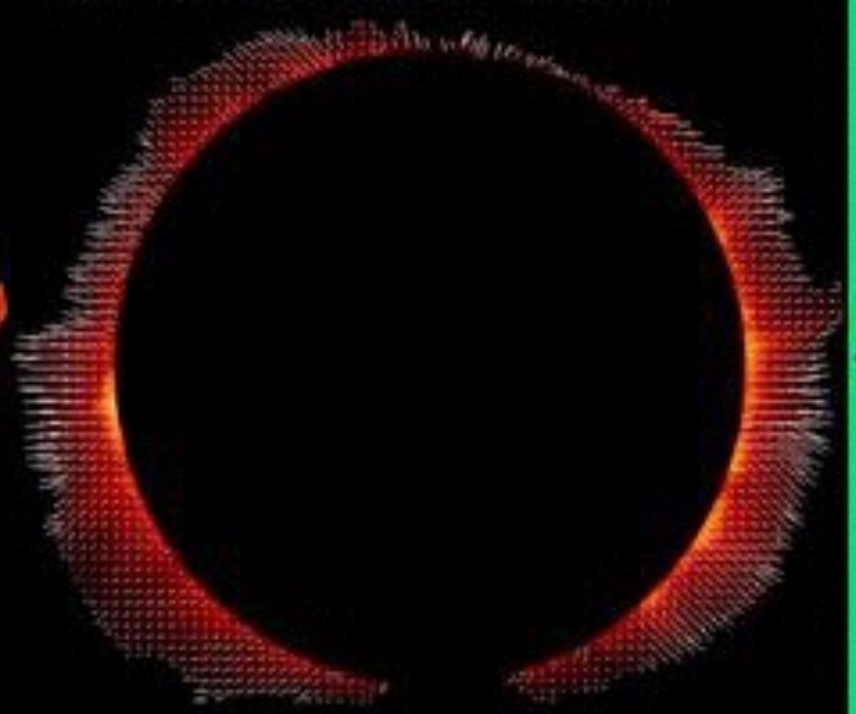
FeXIII 1074.7 Intensity 4/21/05

FeXIII 1074.7 Line-of-Sight Velocity 4/21/05

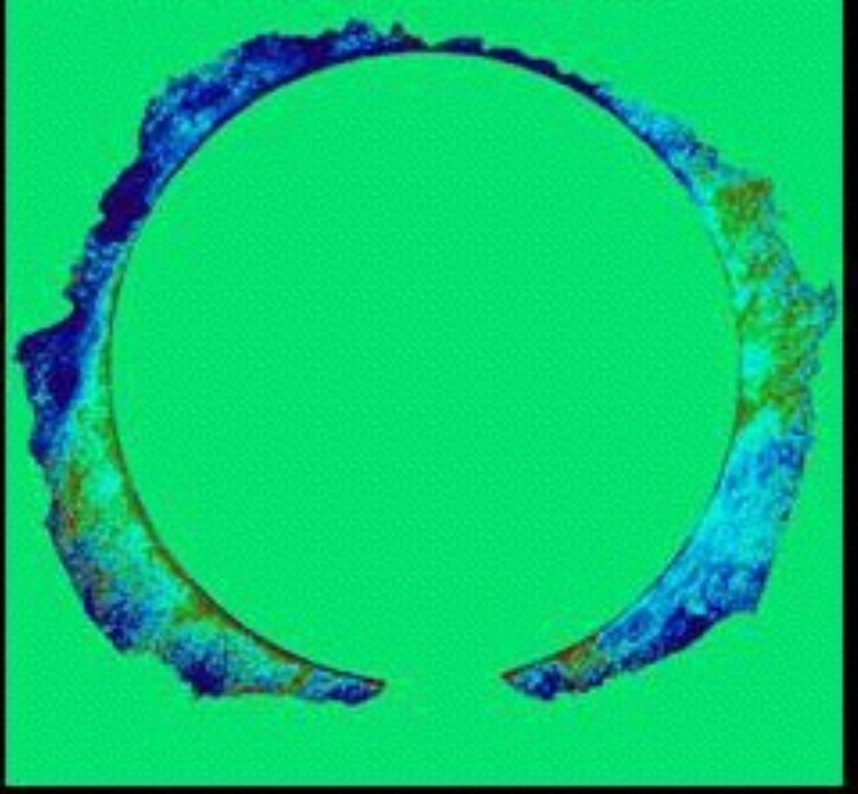
FeXIII 1074.7 Linear Polarization 4/21/05

FeXIII 1074.7 Line Width 4/21/05

FeXIII 1074.7 Azimuth of B 4/21/05



FeXIII 1074.7 Longitudinal B 4/21/05



C3

<u>Fully new CORONAGRAPH:</u>

- Diameter 300mm
- Focal 3000mm (f/10)
- Resolution 1-2 arcsec
- Field of view 1.3R$_\odot$ ou 2946 arcsec
- CMOS detectectos 1.5 arcsec de resolution
- Fe XIII 10749Å line, full profile, 0.20Å
- Lyot-Šolc filter , with length< 10cm

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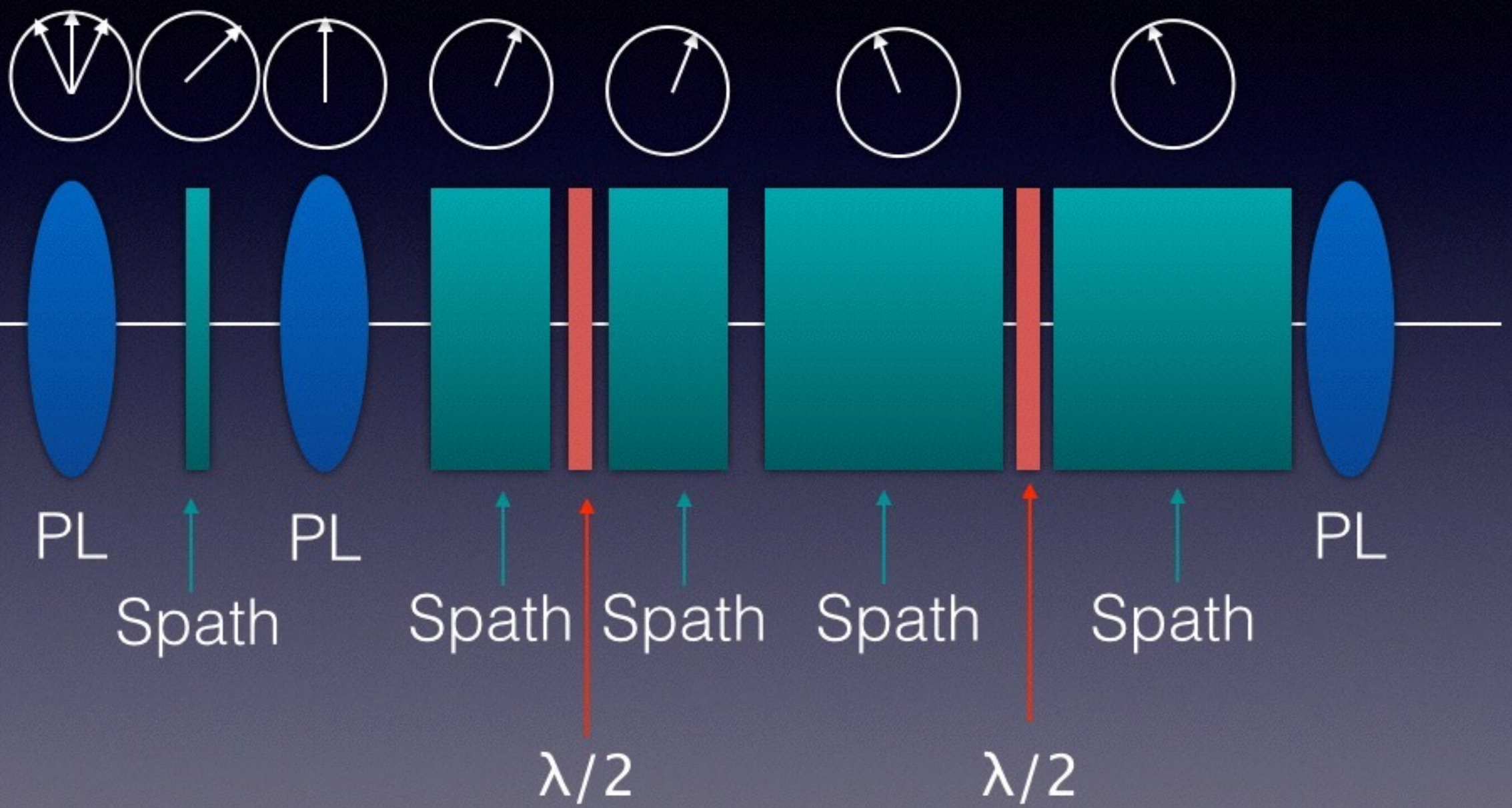
C3



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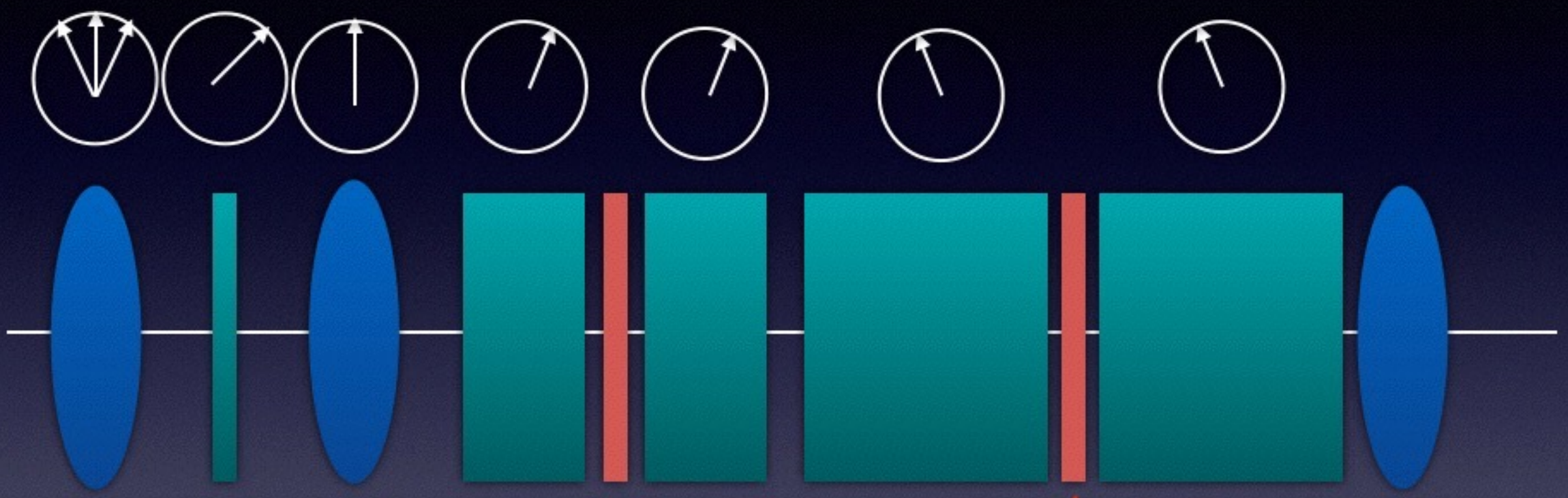
C3



6 Measurements in sequence for full wavelength and polarimetry.
50 msec piezo-rotation stages : 1-2 Hz

λ/2 λ/2

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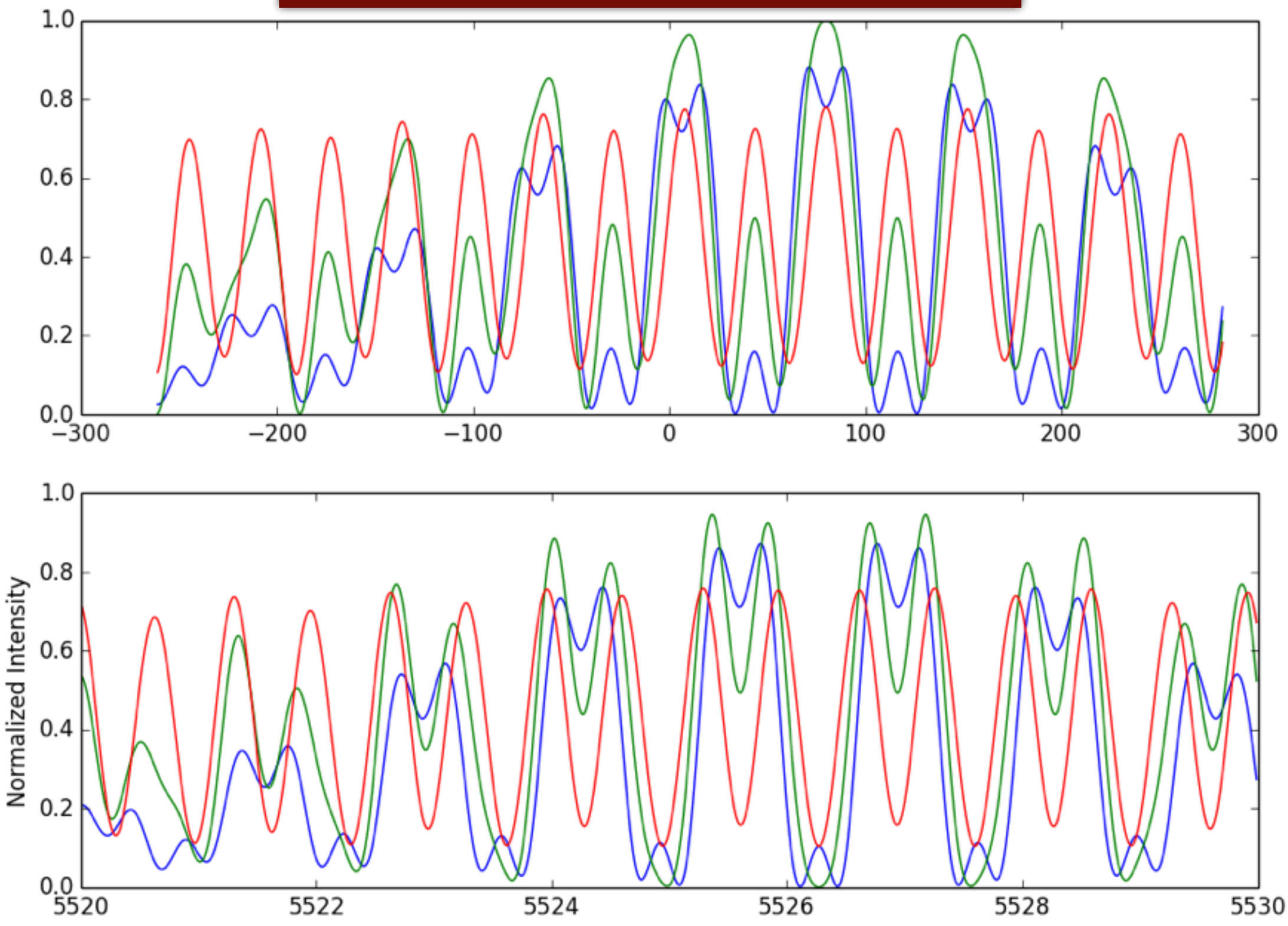
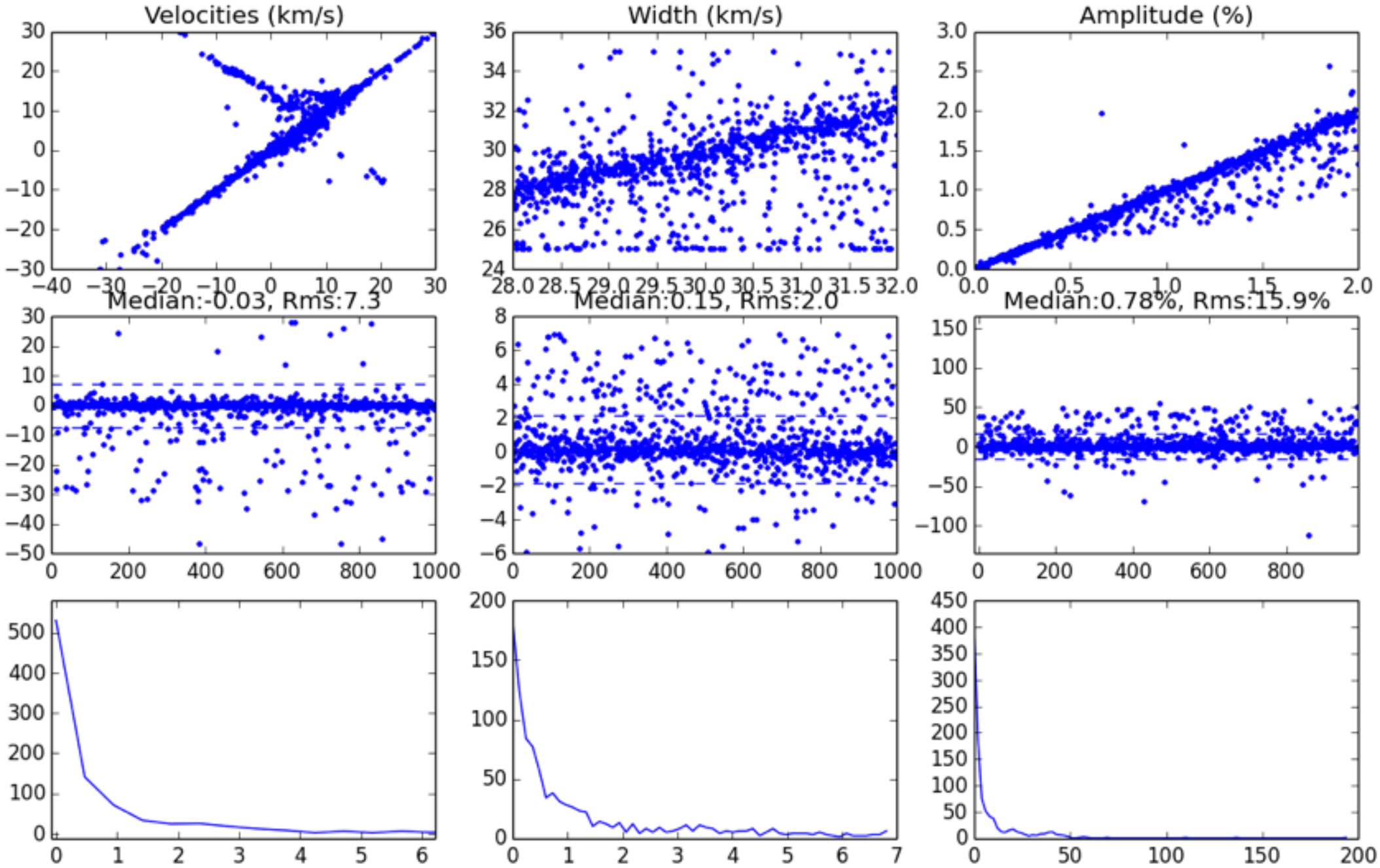
6 Measurements sequential in time make a solvable algebraic system for every λ





Velocity error smaller than 0.5km/s over ±30km/s
Temperature error smaller than 20 000K over 10^6K
Intensity error smaller than 1%

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Other mundane details

Detailed study in 2017, following the successful installation of C2+

Filter prototype funded by OMP

Private funding of up to150 k€

Personnel costs (250 k€/yr) provided by OA

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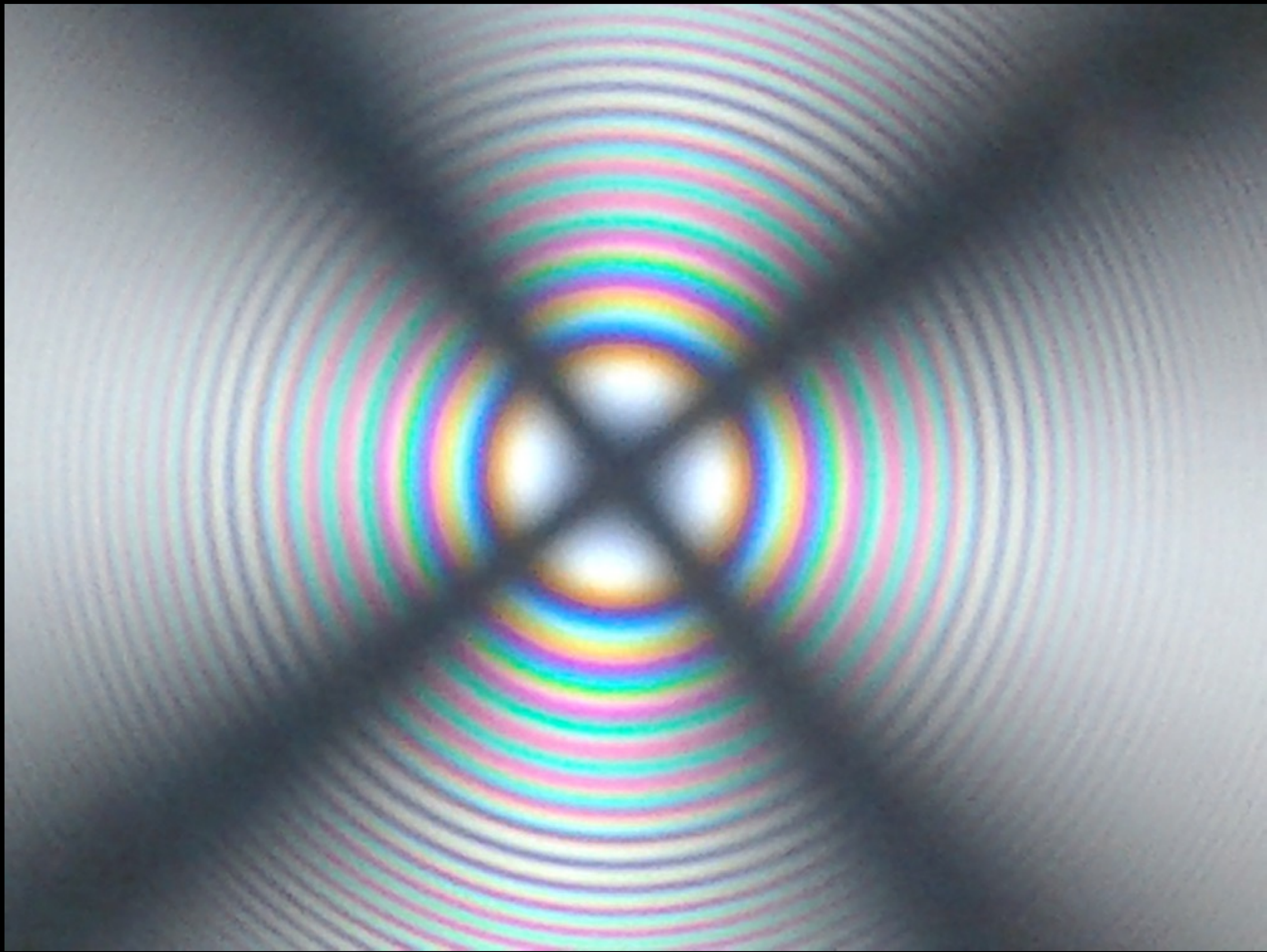

Prominence/Filament Magnetic Fields

Expertise acquired with THEMIS

Can/Should be extended to full disk synoptic observations

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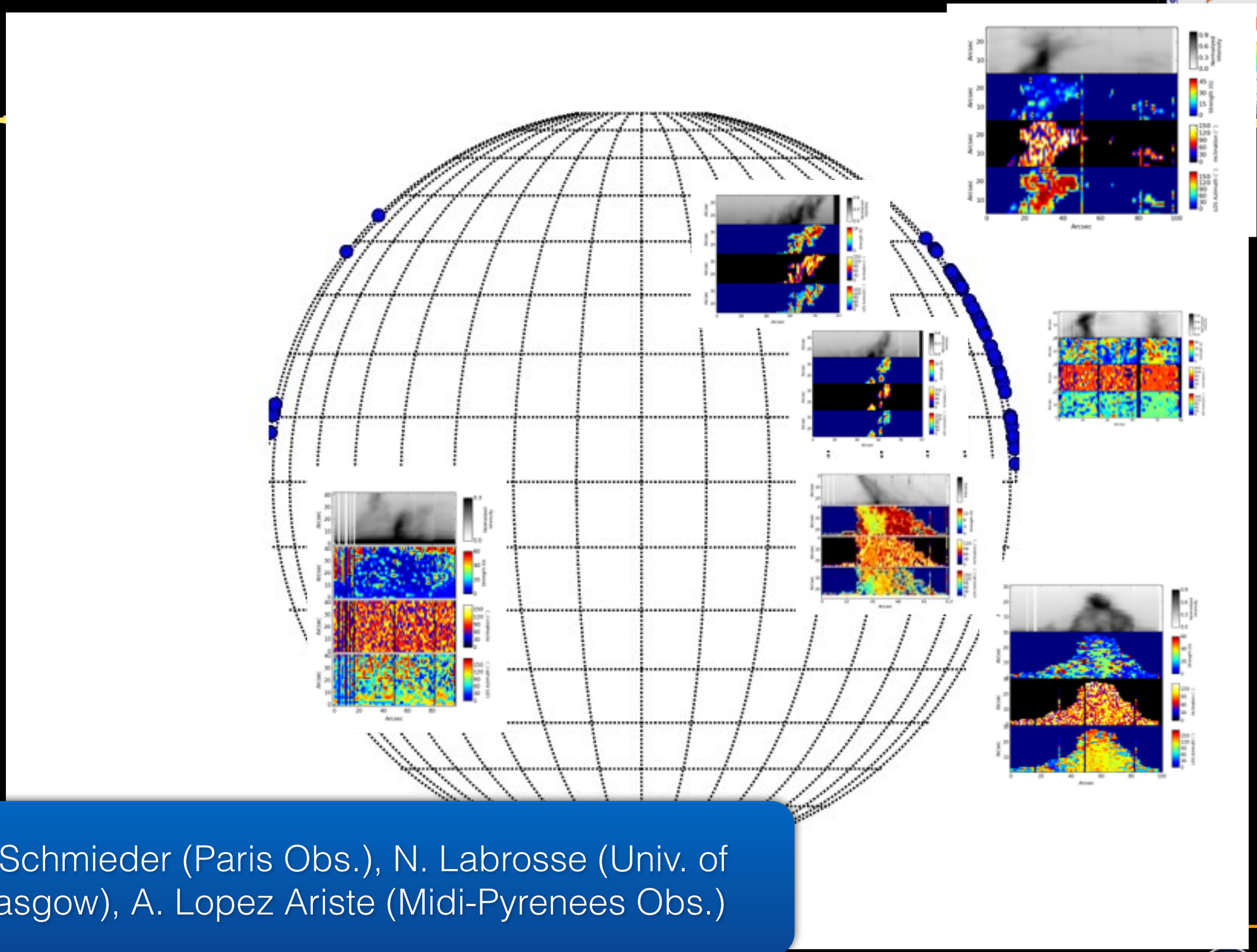
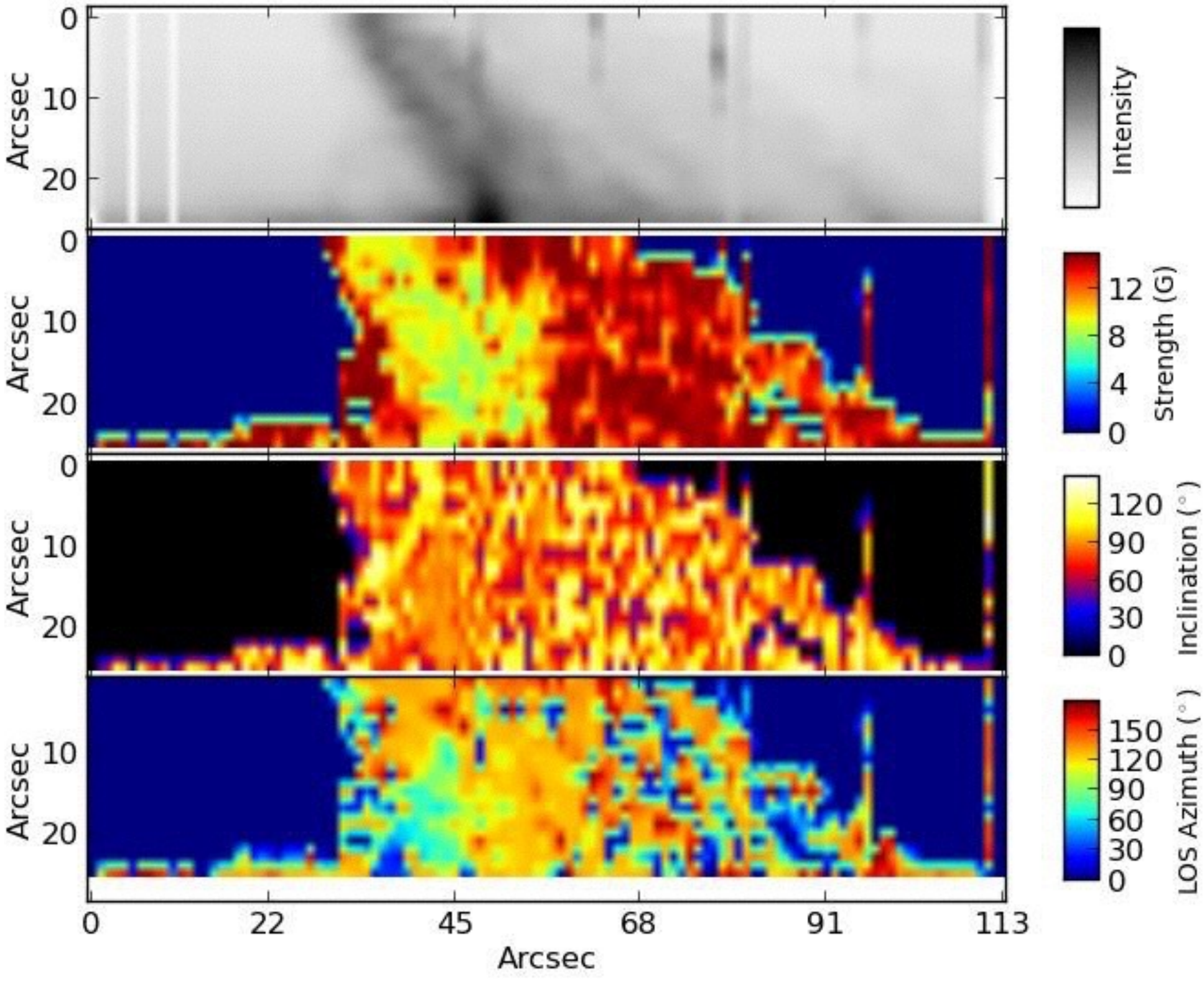
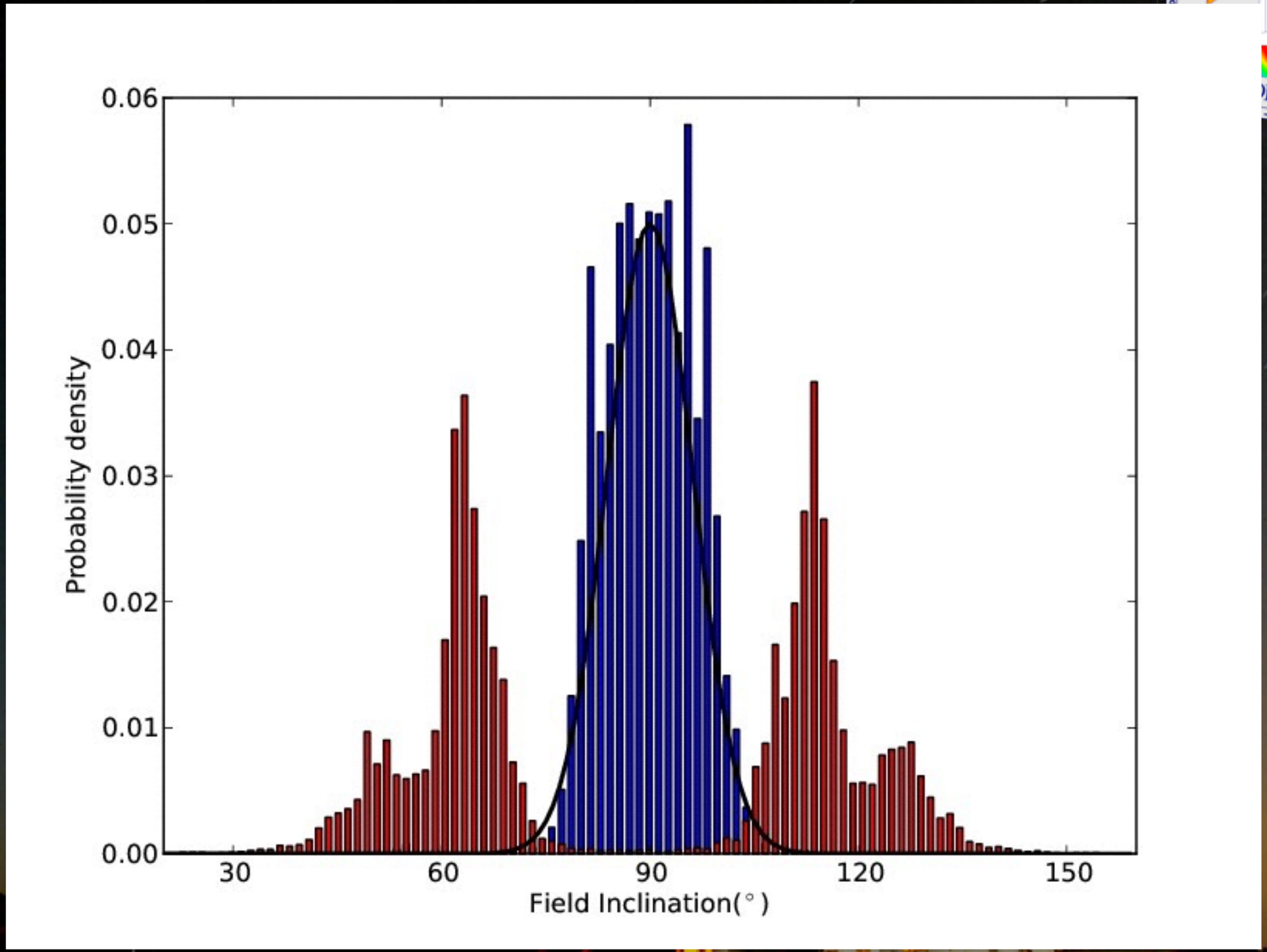
138 Prominences observed with THEMIS in 2014



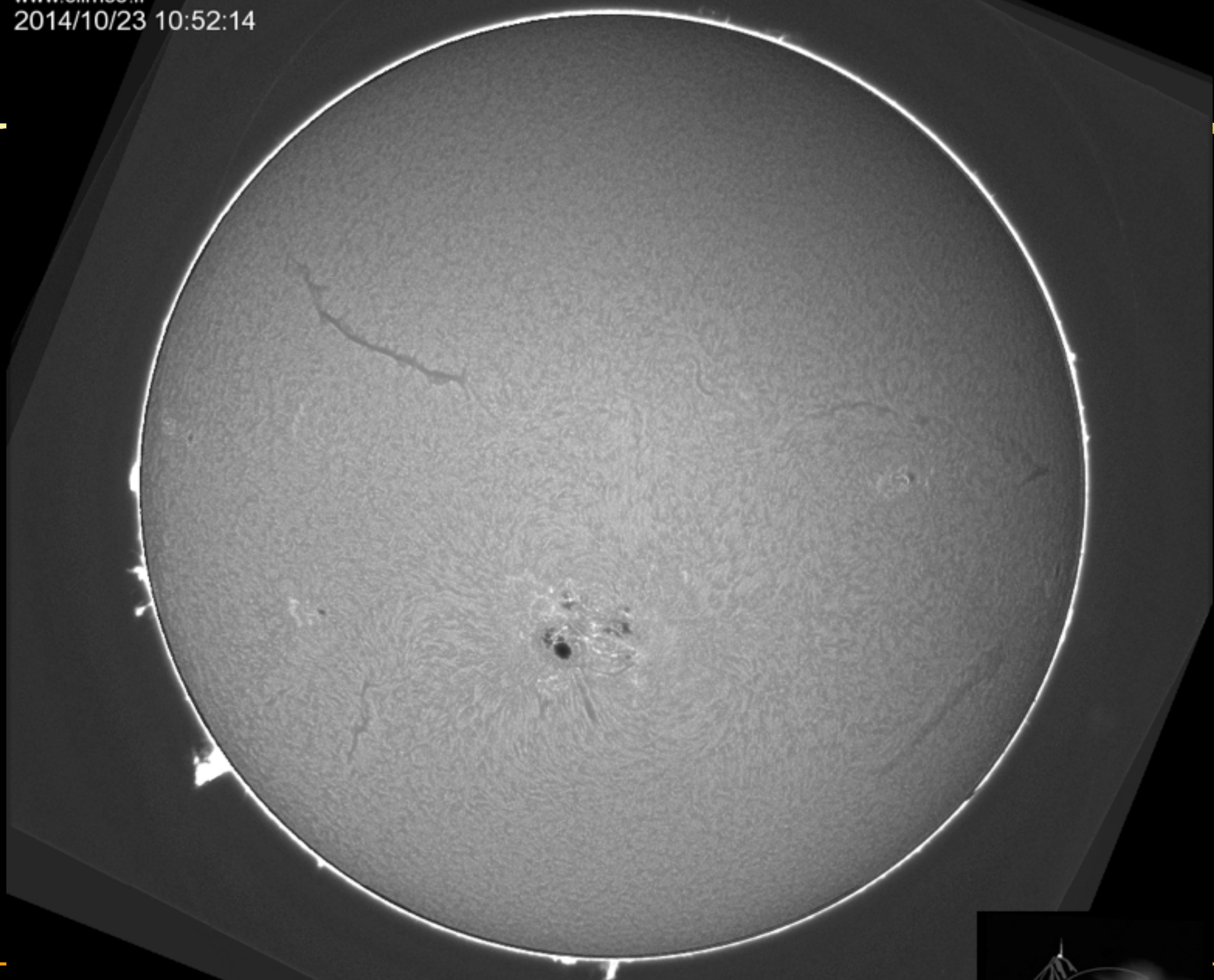
B. Schmieder (Paris Obs.), N. Labrosse (Univ. of Glasgow), A. Lopez Ariste (Midi-Pyrenees Obs.)

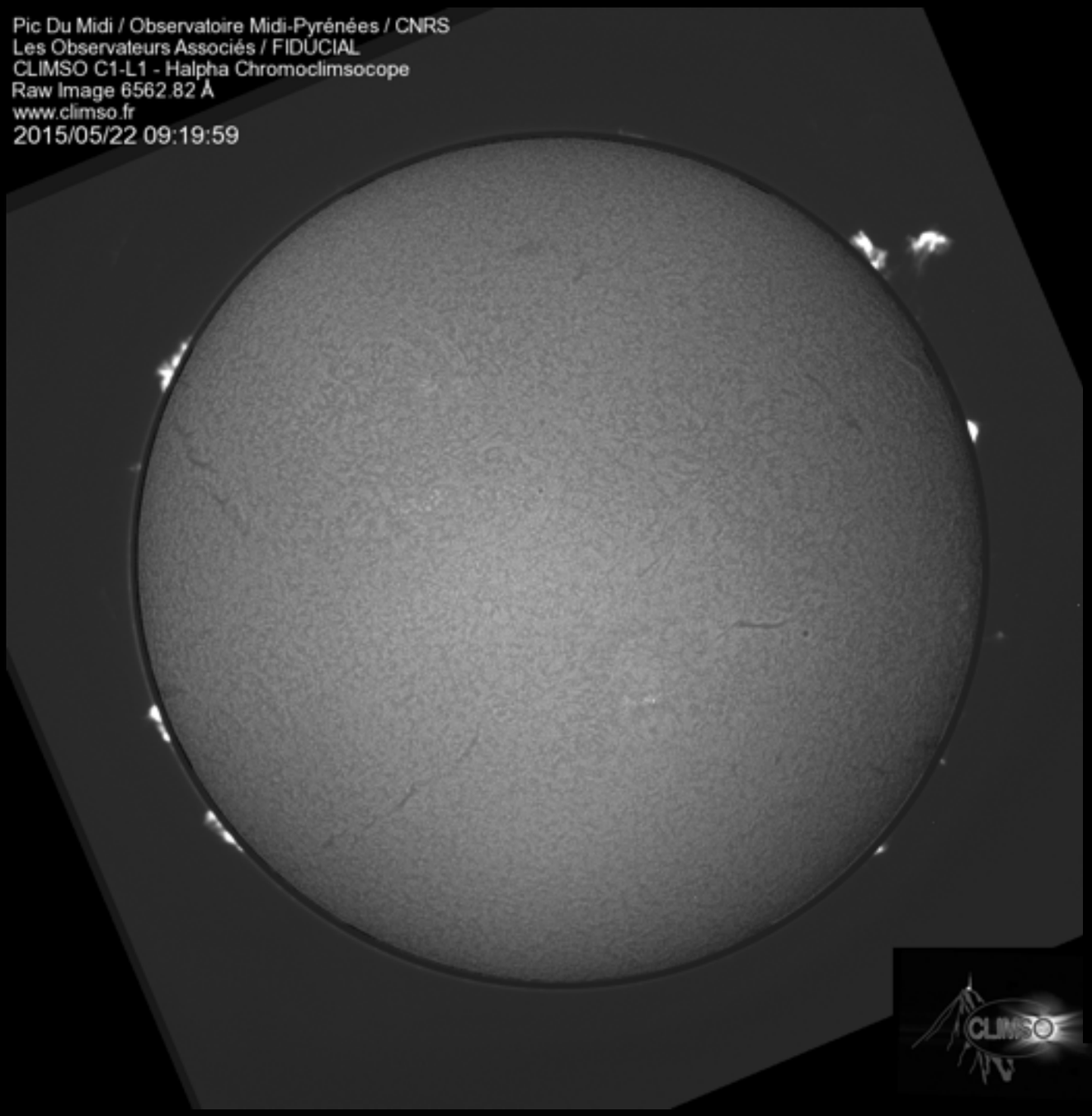

Arcsec
0
10
20
Intensity
Strength (G)
0
4
8
12
Inclination (°)
0
30
60
90
120
LOS Azimuth (°)
0
30
60
90
120
150
0
22
45
68
91
113
Arcsec

138 Prominences observed with THEMIS in 2014



Pic Du Midi / Observatoire Midi-Pyrénées / CNRS
Les Observateurs Associés / FIDUCIAL
CLIMSO C1-L1 - Halpha Chromoclimsocope
Raw Image 6562.82 Å
www.climso.fr
2014/10/23 10:52:14




Pic Du Midi / Observatoire Midi-Pyrénées / CNRS
Les Observateurs Associés / FIDUCIAL
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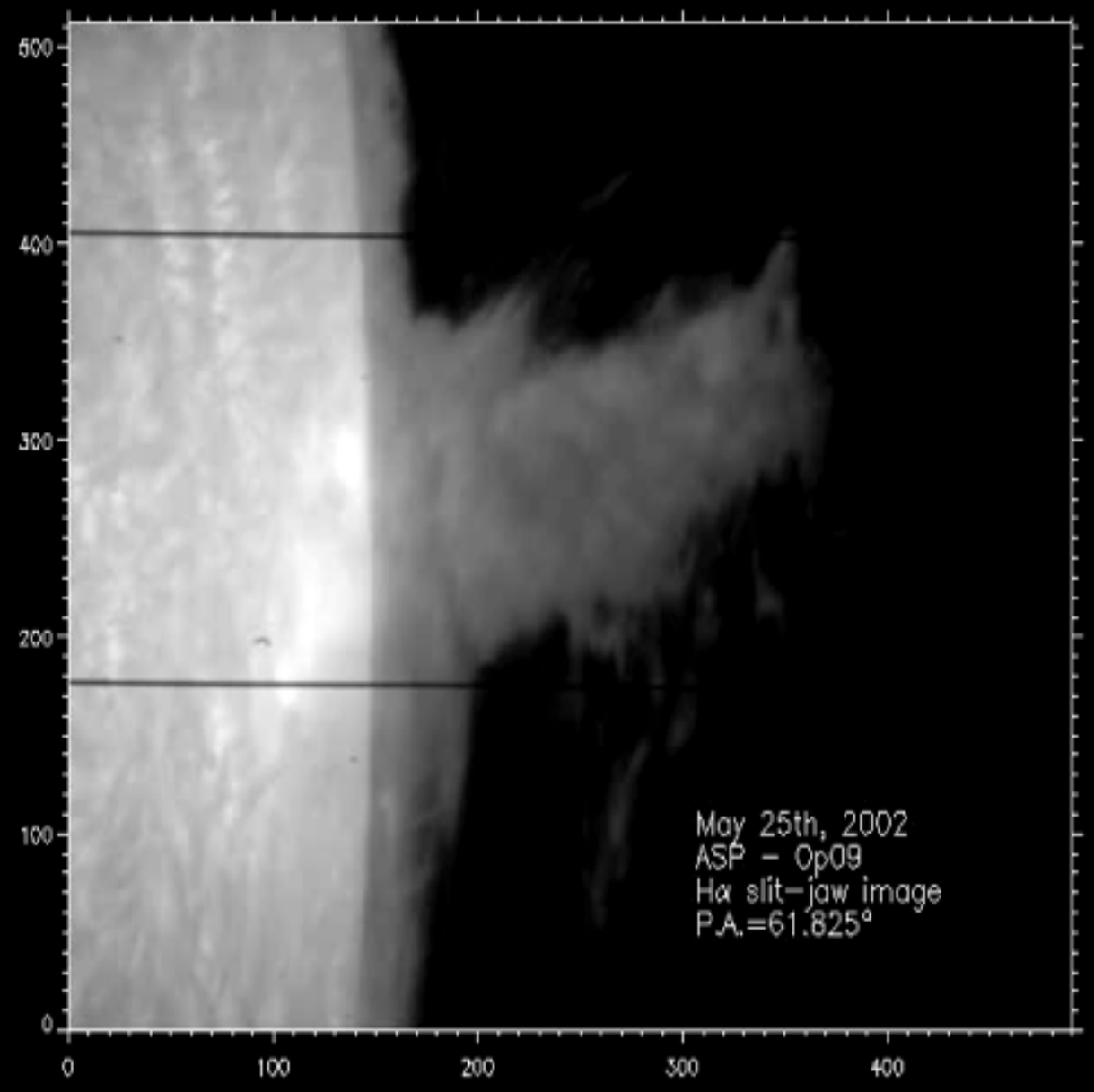
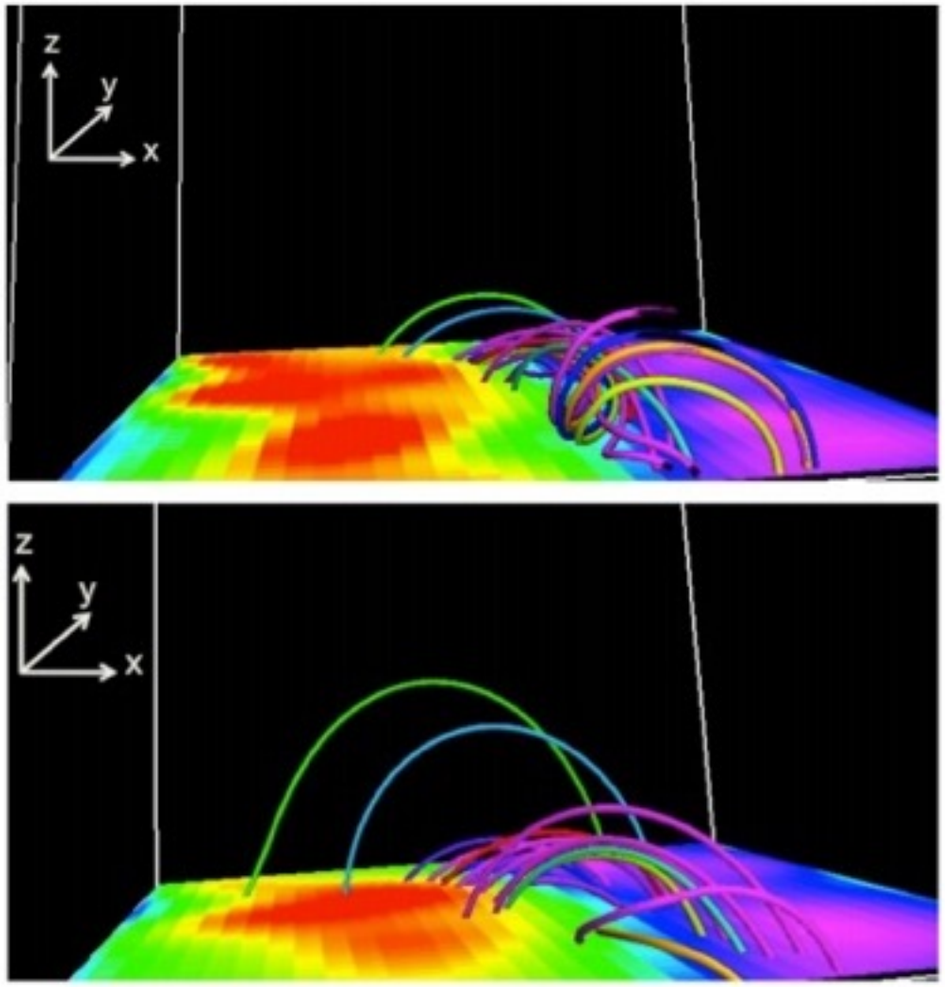
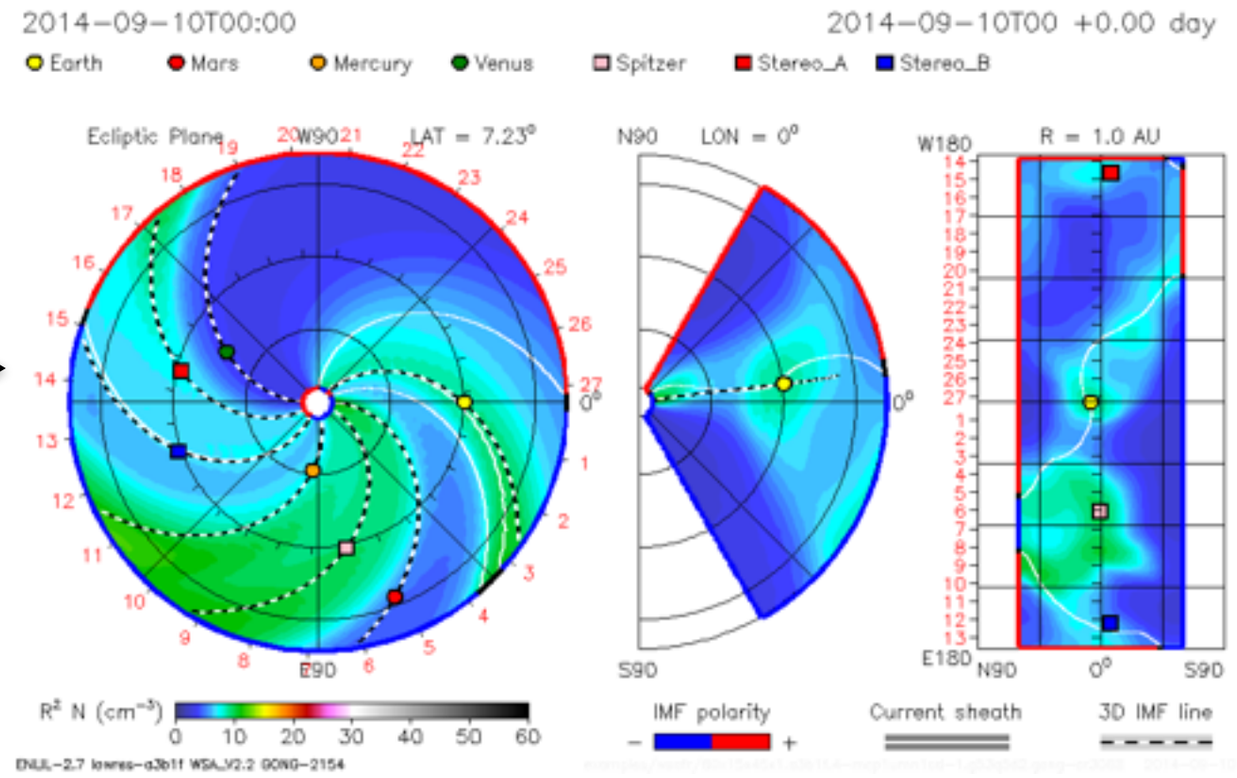
Raw Image 6562.82 Å
www.climso.fr
2015/05/22 09:19:59
CLIMSO


500
400
300
200
100
0
0
100
200
300
400
May 25th, 2002
ASP - Op09
Hα slit-jaw image
P.A.=61.825°

NSO's Space Weather WP



?

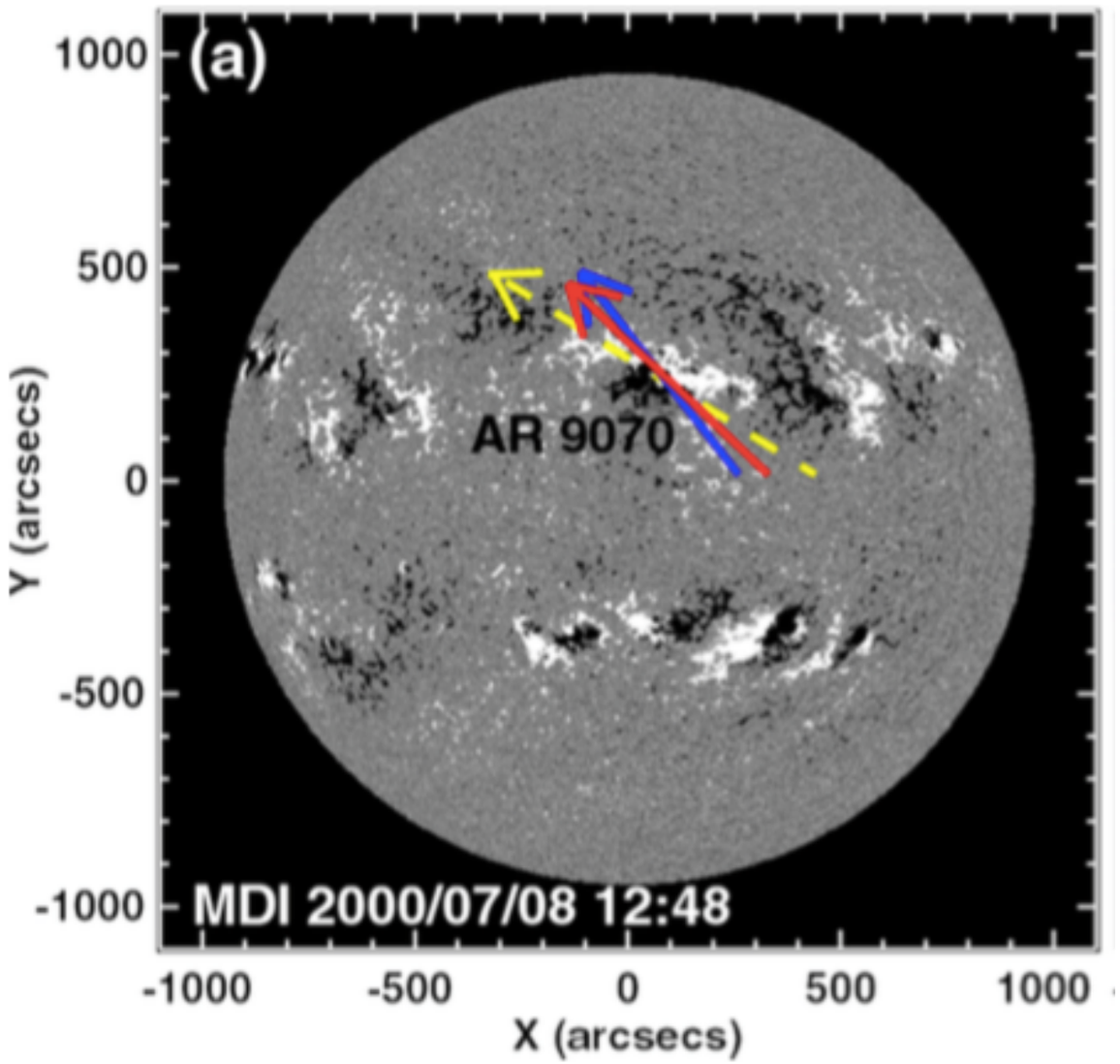


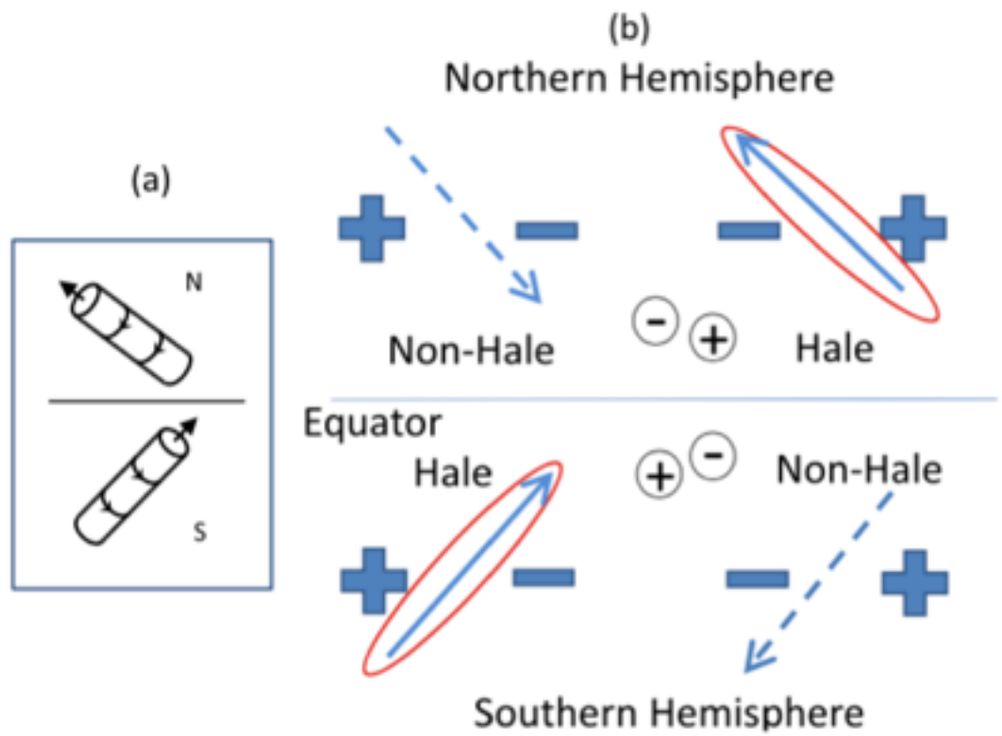
NSO's Space Weather WP

CME Rotation is somewhat controversial. It has been known for a long time that the orientation of interplanetary flux ropes are generally aligned with the polarity inversion line (or filament) at the Sun (Marubashi 1997; Bothmer and Schwenn 1998; Yurchyshyn et al. 2001; Marubashi et al. 2009). However, several authors have interpreted CME observations to indicate rotation during coronal and interplanetary propagation. Yurchyshyn et al. (2009) fitted ellipses to the outlines of halo and partial halo CMEs and compared them with the axis of the associated post-eruption arcades. They reported that CMEs appear to rotate by about 10° for most of the events with about 30–50° for some events (see also Isavnin et al. 2014). Vourlidas et al. (2011) reported an event with a rotation rate of 60° per day. Recently, Marubashi et al. (2015) analyzed a set of more than 50 well observed CME-ICME pairs and found strong support to the idea that an erupted flux rope has its main axis parallel to the polarity inversion line and remains so as it propagates through the interplanetary space. This is also consistent with models in which the flux rope is formed due to reconnection (Kusano et al. 2012). A clear definition of rotation is needed in three dimensions, for example, with respect to the radial direction from the source region.

Gopalswamy (2016)

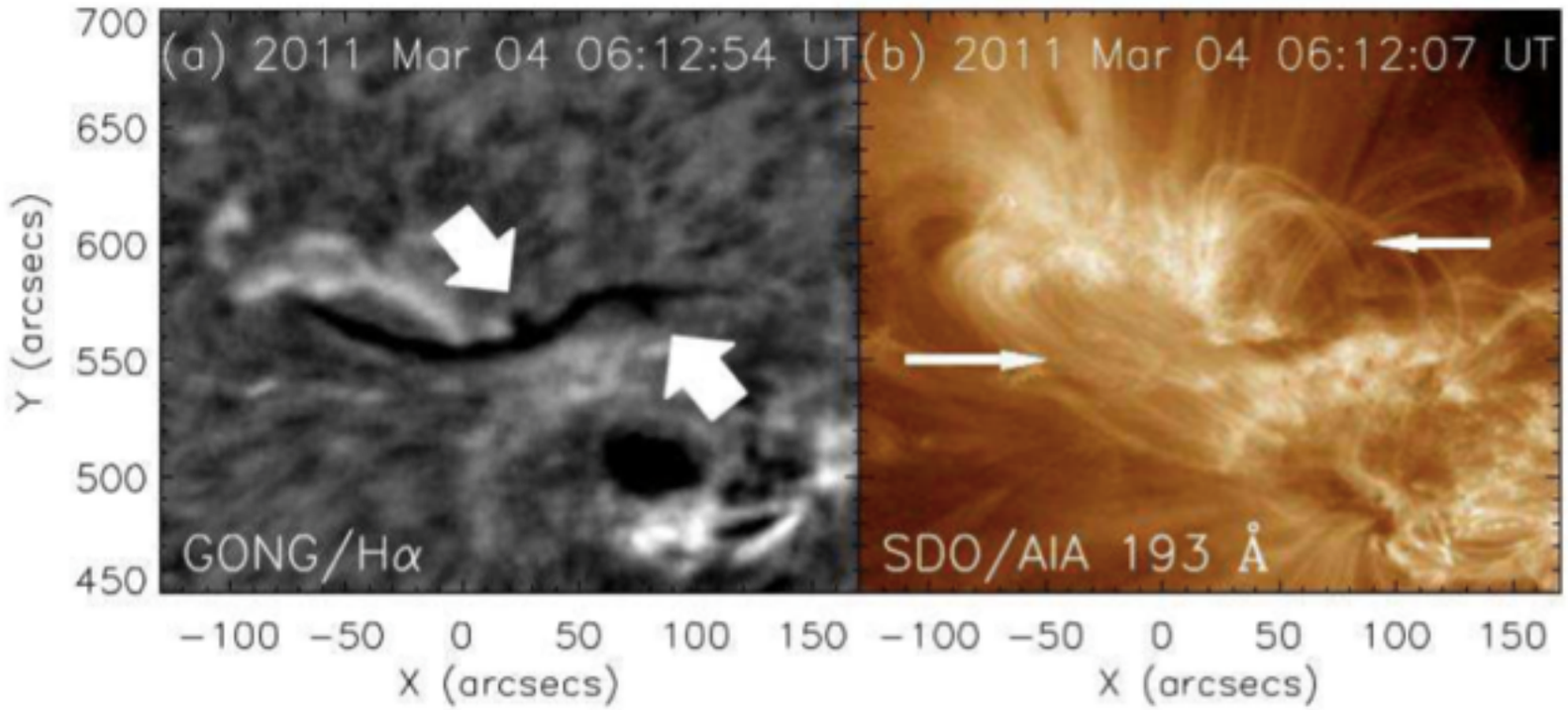
NSO's Space Weather WP





- 54 CME/ICME
- 51 are Interplanetary Flux Ropes
- Flux rope axis within 25^{o} of NL
- Same helicity as source region
- Marubashi et al (2015)

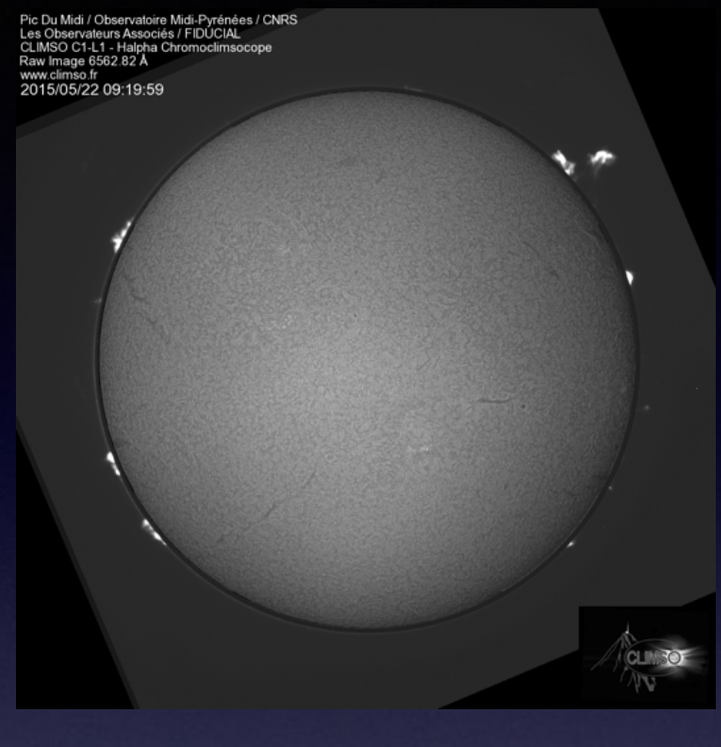
NSO's Space Weather WP



Ouyang et al (2015)

Unfortunately, there are no routine magnetic field measurements for solar filaments, except sparse individual ones (e.g., Kuckein et al. 2009; Xu et al. 2012; Orozco Suárez et al. 2014; Sasso et al. 2014). However, the paradigm presented in Figure 7 of Chen et al. (2014) offers an indirect method to diagnose the magnetic configuration of a filament by combining the information of the sign of helicity and the barb bearing of the filament, i.e., a sinistral filament with left-bearing barbs should have a flux rope magnetic configuration, and a sinistral filament with right-bearing barbs should have a sheared arcade magnetic configuration.

Measure ALL filaments/prominences every day?



Precision vs. global ?
Precision vs. cadence?

2) determine if a stable filament had suddenly become unstable
3) improve space weather modeling.

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