HiC reflight, MaGIXS : sounding rocket programmes for 2018 & 2019

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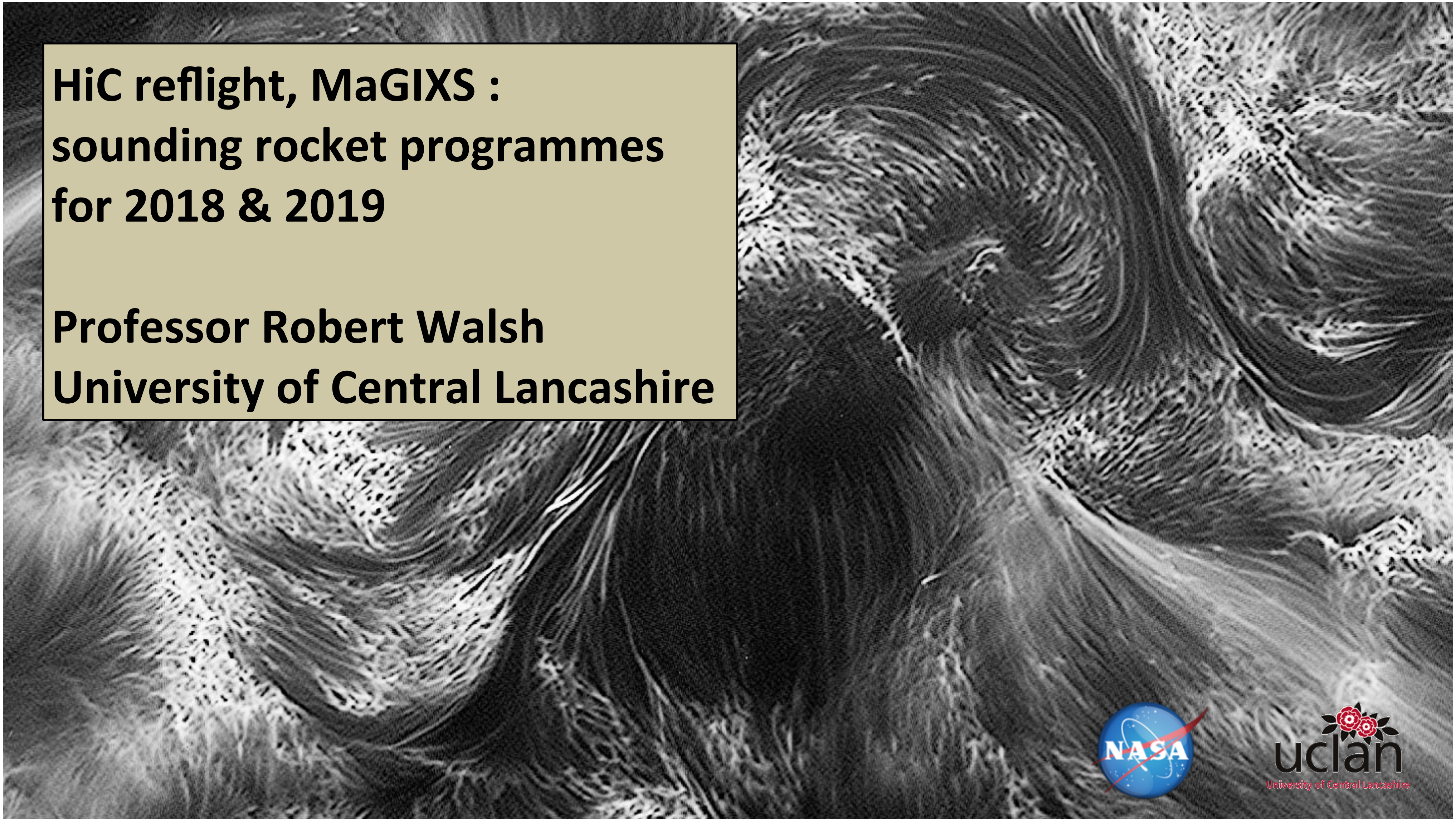
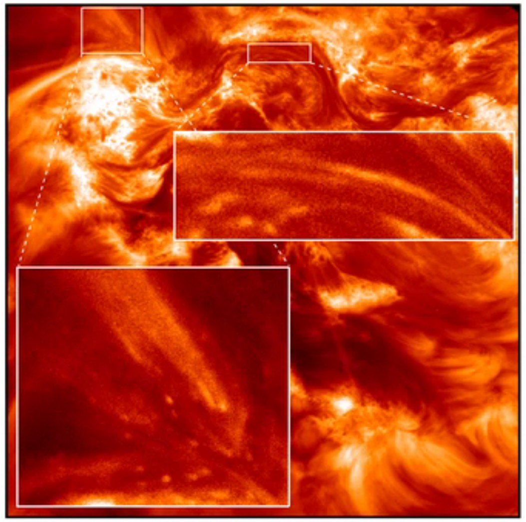


High resolution Coronal Imager (Hi-C)

- Collaboration between **UCLan** and NASA Marshall Space Flight Center (MSFC), University of Alabama – Huntsville (UAH), Smithsonian Astrophysical Observatory (SAO), Lockheed Martin Solar and Astrophysical Laboratory (LMSAL), Southwest Research Institute (SWRI), Lebedev Institute (LI)

- Hi-C is a **narrowband EUV imager** centered on 193 Å.
- Launched July 11, 2012, White Sands New Mexico
- **345 seconds** worth of data
- Pixel size = **0.1"**; spatial resolution of Hi-C is five times better than AIA .
- Cadence = **5.5s**; Hi-C is 2.5 – 6 times better than AIA; FOV= **7'x7'**
- 25 Journal papers published (including Nature)



UCLan involvement

- Purchased camera (Apogee)
- Software for controlling the camera, interfacing with the rocket itself.
- Data available via VSO.
- Post Hi-C (1) have one camera at MSFC, one at UCLan.

Hi-C 2 Flight 2017

- **Science goal-** identify the mass and energy connection between the chromosphere and corona

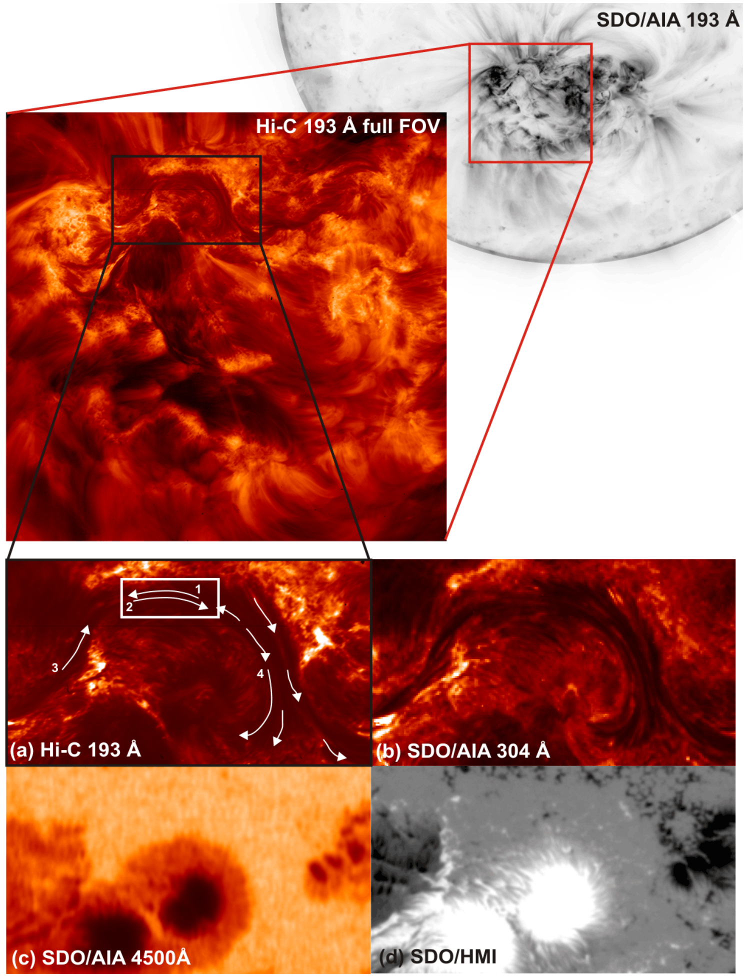
- **Modifications** from original Hi-C
  1. pass-band coating 171 Angstroms
  2. new camera with significantly lower readout noise (CLASP).

- Coordinated observations with IRIS and Hinode
- 5 minute observational window
- 0.25" resolution likely with 4.2s cadence, FOV= 7'x7'

NO DATA !

UCLan involvement

- software for controlling the camera, interfacing with the rocket itself.
- Aspects of cooling control during flight.



Hi-C 2.1 Flight 2018?

- **Science goal-** identify the mass and energy connection between the chromosphere and corona

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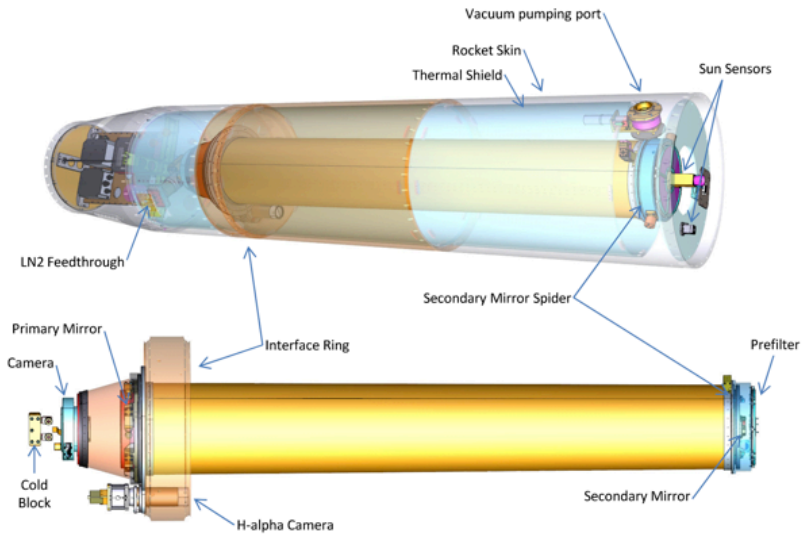
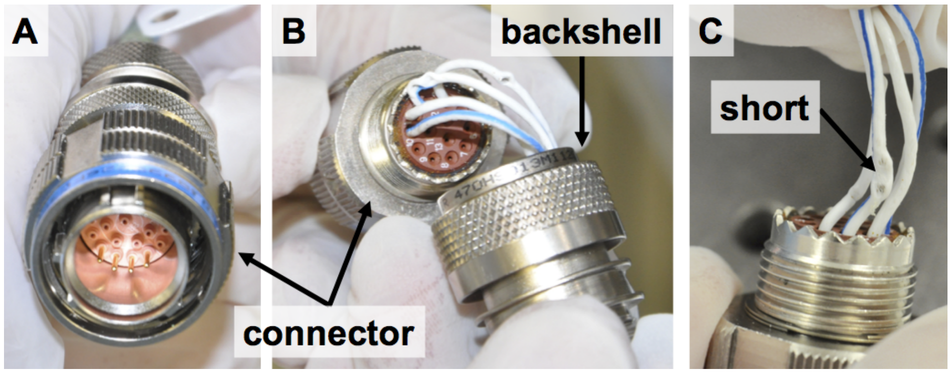


UCLan involvement

- target/image recognition work.



The Marshall Grazing Incidence X-ray Spectrometer (**MaGIXS**) 2019

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2 Smithsonian Astrophysical Observatory
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4 University of Central Lancashire
5 Rice University
6 Naval Research Laboratory
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Scientific Motivation

X-ray spectroscopy provides unique capabilities for answering fundamental questions in solar physics since it is dominated by emission lines formed at high temperatures – particularly in the wavelength range of 6 – 25 Å, which has strong lines from Fe XVII – Fe XXV and other important diagnostic lines.

Yet, not since the 1970's have solar spectra in this wavelength range been spatially resolved.

Using a novel implementation of corrective optics and a revolutionary concept for grazing incidence imaging spectroscopy, MaGIXS will measure, for the first time, the soft X-ray solar spectrum from 6 – 24 Å with ~5/6" resolution (2.8"/pixel) over an 8' slit.

The MaGIXS mission **is complementary to an instrument like the Focusing Optics X-ray Solar Imager (FOXSI)**, which observes higher energy (harder) X-rays than MaGIXS; to be able to track the thermalization of the plasma and acceleration of particles.

Scientific Motivation

What is the frequency of heating in active region structures?

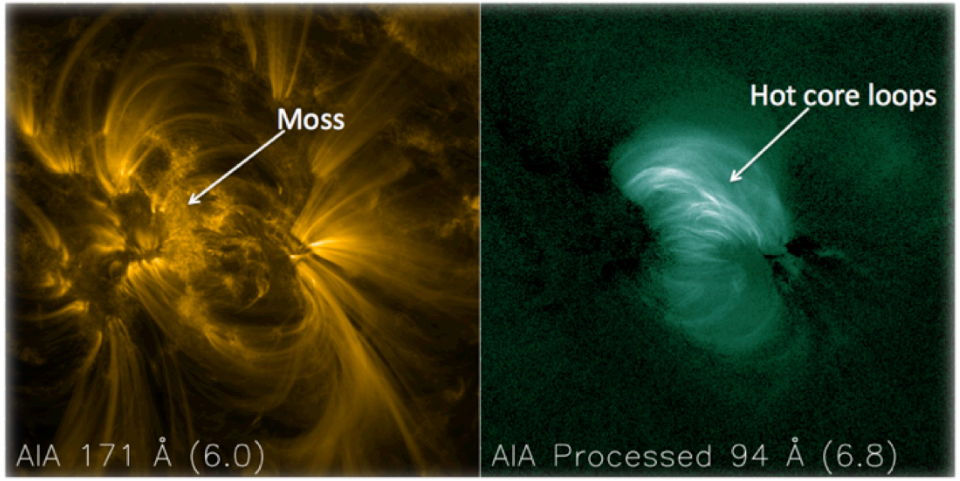
MaGIXS will make four unique observations that will determine the frequency of heating in quiescent active region structures:

1. Relative amount of high temperature, low emission measure plasma
2. Elemental abundances in different solar structures along the slit (FIP)
3. Temporal variability of high temperature plasma observed in Fe XVII (with XRT)
4. Likelihood of non-Maxwellian distributions (Fe XVIII ratios; 94Å AIA)

High-frequency heating (e.g., waves dissipation) :
- Little to no high temperature plasma
- FIP bias > 1
- Steady Fe XVII emission
- Maxwellian plasma distribution

Low-frequency heating (e.g., magnetic reconnection):
- Enhanced high temperature (> 7 MK) plasma
- FIP bias ~ 1
- Dynamic Fe XVII emission
- Evidence for non-Maxwellian plasma distribution

Observation : Relative amount of high temperature plasma



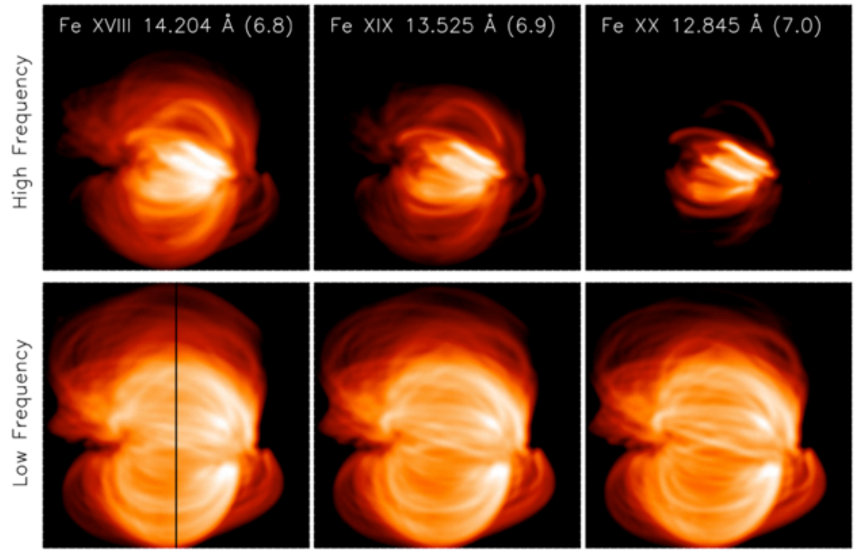
High-frequency heating consistent with wave dissipation.

Low-frequency heating consistent with magnetic reconnection

Simulated active region core using EBTEL:

- Random heating events
- Heating event cadence 1575 s versus 6300 s

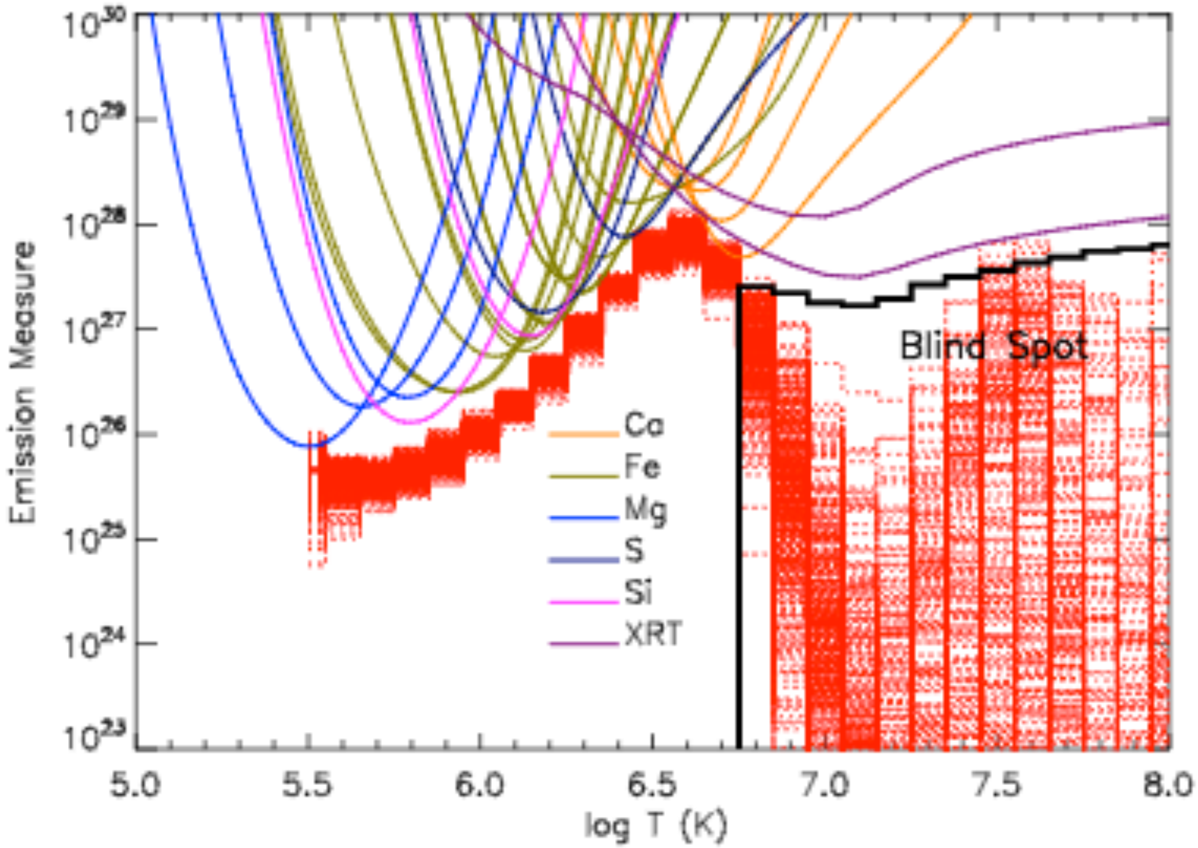
Expected emission quite different at higher temperature lines.



López Fuentes & Klimchuk 2010; Van Ballegooijen 2012; Warren et al. 2012, Winebarger et al. 2011; Tripathi et al. 2011, Viall & Klimchuk, 2013

Current instrumentation "blind" to high-temperature, low-emission plasma

"Blind spot" for high-T, low-emission measure using *Hinode*'s XRT and EIS, so ***relative*** amounts of these plasma populations are not accurately known.



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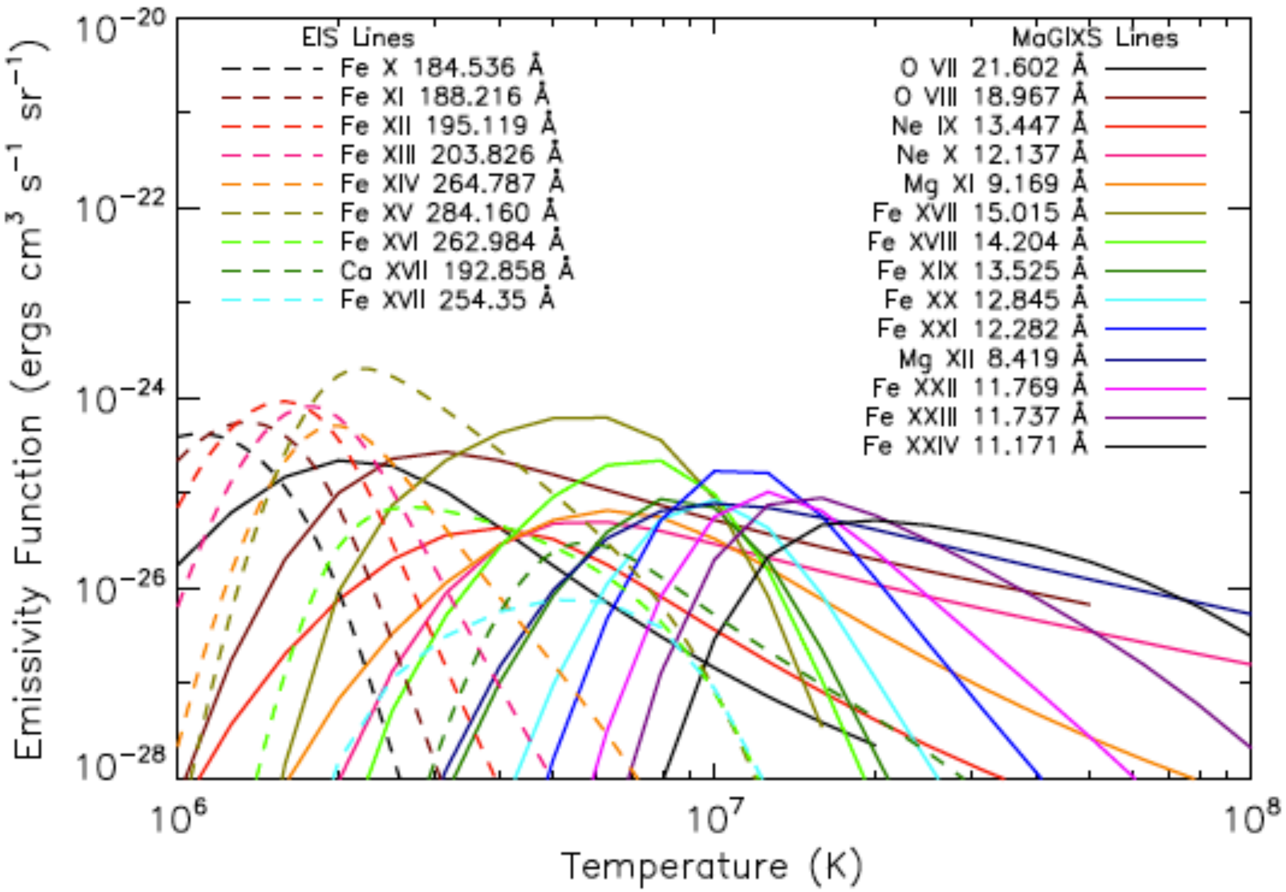
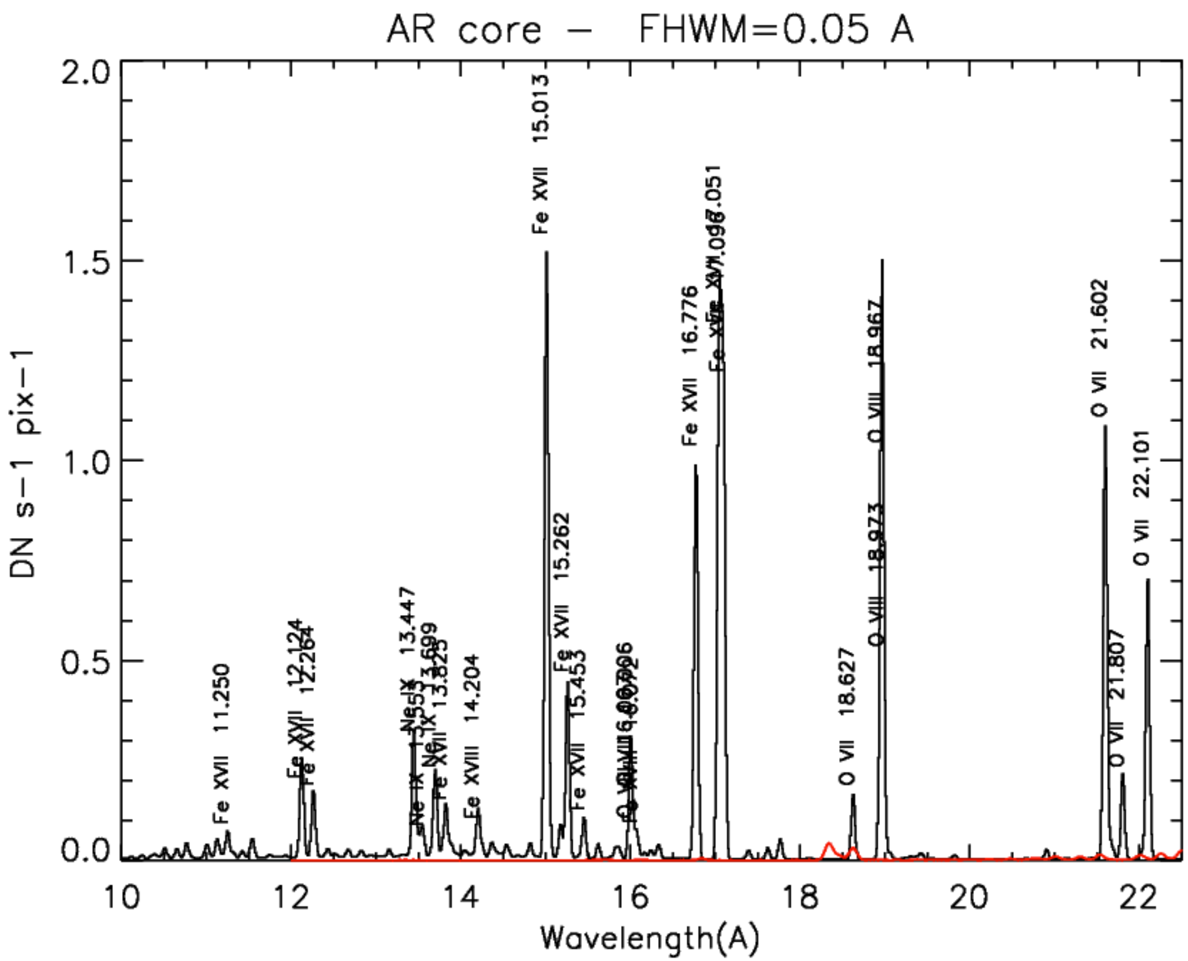


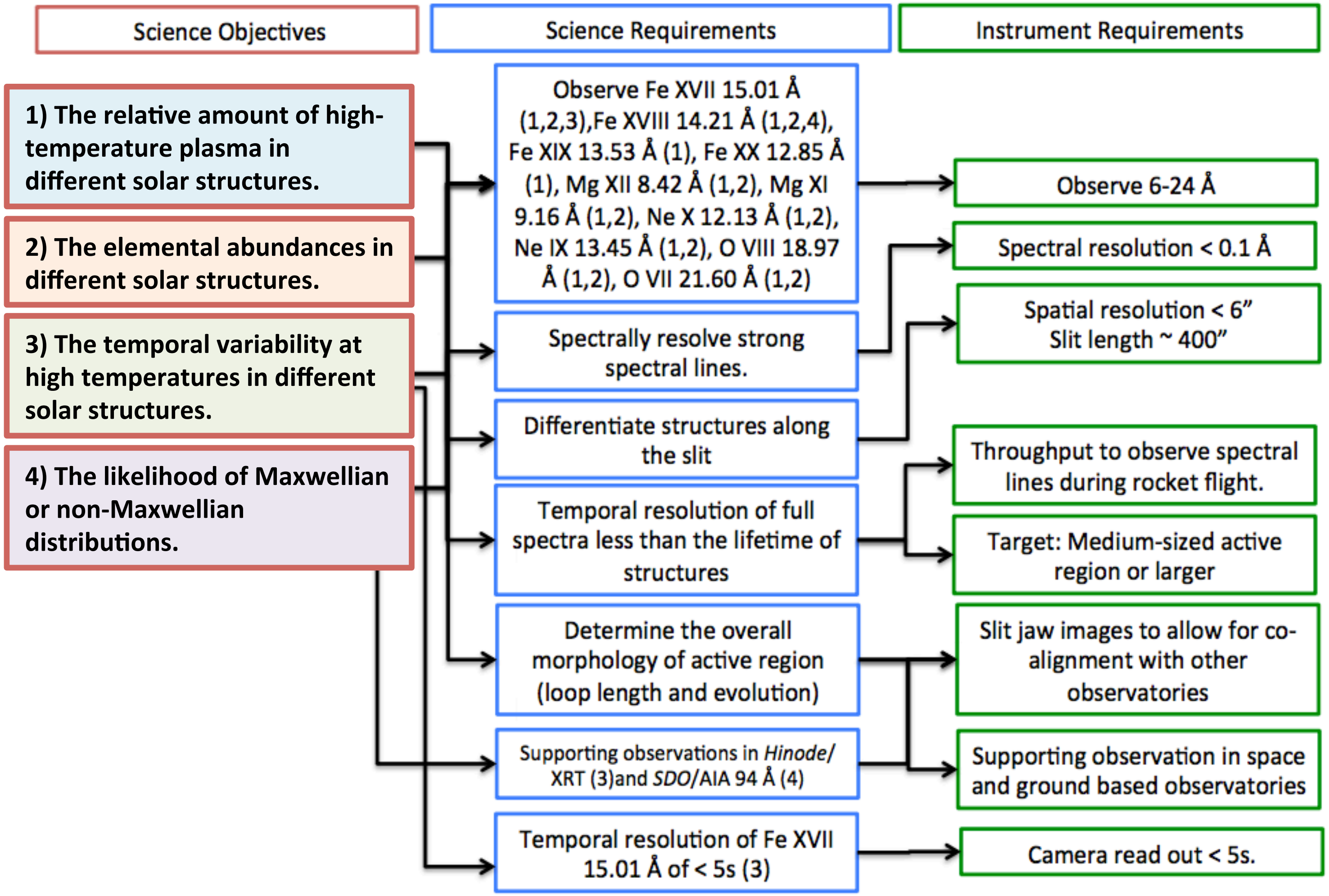
Only in the soft X-ray wavelength range of MaGIXS can we observe the Fe XVII/XVIII/XIX/XX spectral lines and other high-temperature lines on the same detector through the same optical path.

Simulate high-temperature, low-emission plasma



Quiescent AR core (el Zanna & Mason 2014) - CHIANTI v.7.1
FIP bias=3.2 abundances - MAGIXS 1st order (black) and second (red)

Science Traceability Matrix



MaGIXS Instrument Design

Telescope:
Wolter Type-I
Effective Focal Length ~ 1 m

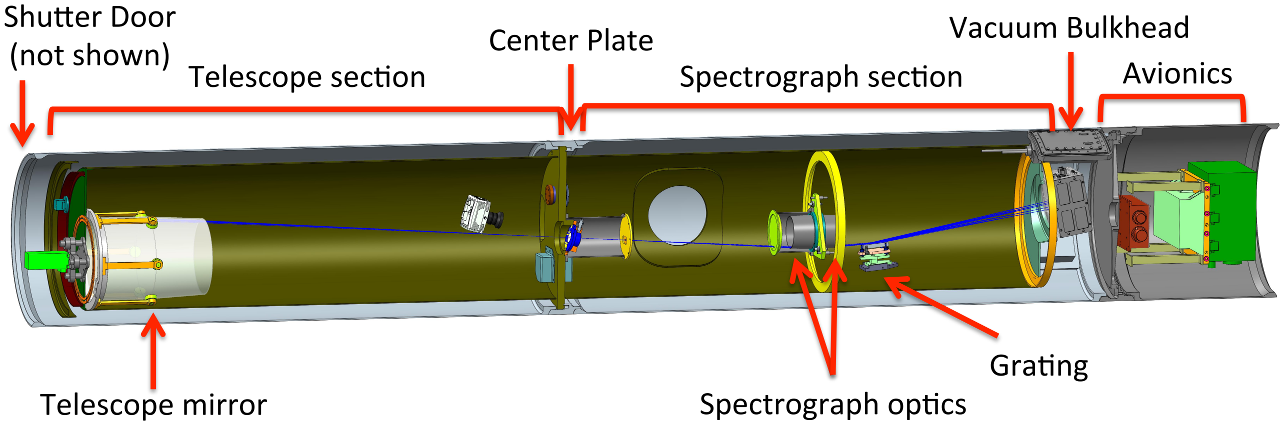
Spectrograph: Two matched parabolic mirrors + Grating

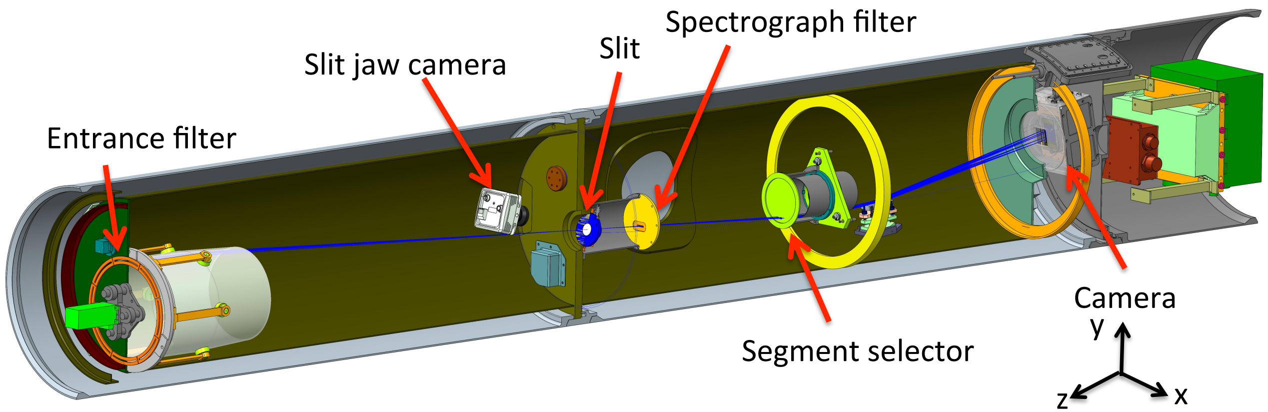
- 6.0 - 24.0 Å (0.5 - 2.0 keV)
- 11 mÅ / pixel
- 2.8 arcsec / pixel

Grating: Blazed Planar Varied Line Space

Technical challenges:

1) Optics manufacturing
2) Grating Development and Manufacturing
3) Alignment





Launch Summer 2019

- Compelling reasons to continue to pursue X-ray spectroscopy in the soft X-ray wavelength range for longer term missions.
- The technological advances from MaGIXS development are far-reaching.
- MaGIXS will fly from White Sands Missile Range in summer 2019.