Sub-second cadence observations of active region transient brightenings by DKIST/ViSP

Sarah Riley[1], Jiong Qiu[1], Dana Longcope[1], and Gianna Cauzzi[2]

[1]Montana State University
[2]National Solar Observatory

Solar Physics Division 2026
2026 Aug 12

Introduction

Guiding questions

- What mechanisms are heating the quiescent/active region chromosphere?

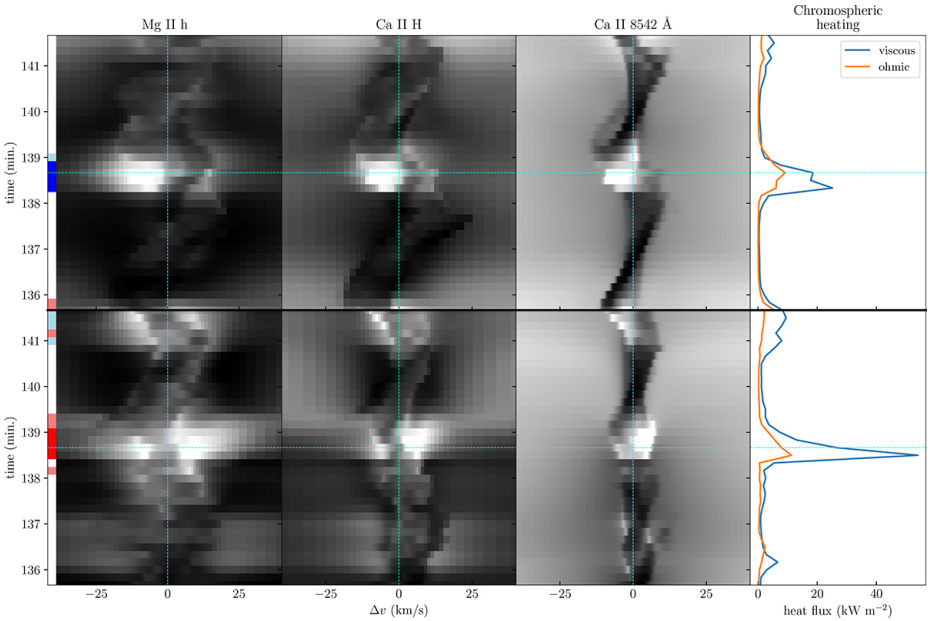
Guiding questions

- What mechanisms are heating the quiescent/active region chromosphere?
  1. What are the **spectroscopic features** related to these heating mechanisms?
  2. What are the elementary **temporal-spatial scales** of the features?
  3. *How do these properties compare with modeled heating mechanisms?*

Introduction

Guiding questions

- What mechanisms are heating the quiescent/active region chromosphere?
  1. What are the **spectroscopic features** related to these heating mechanisms?
  2. What are the elementary **temporal-spatial scales** of the features?
  3. *How do these properties compare with modeled heating mechanisms?*



- Dynamic spectra of blue (top) and red (bottom) grains in Bifrost QS models ($\bar{w} \sim 0.25''$, $\bar{t} < 60\ s$)

(Udnæs and Pereira., 2026. A&A 706)

Introduction

Guiding questions

- What mechanisms are heating the quiescent/active region chromosphere?
  1. What are the **spectroscopic features** related to these heating mechanisms?
  2. What are the elementary **temporal-spatial scales** of the features?
  3. *How do these properties compare with modeled heating mechanisms?*

ViSP sit-and-stare

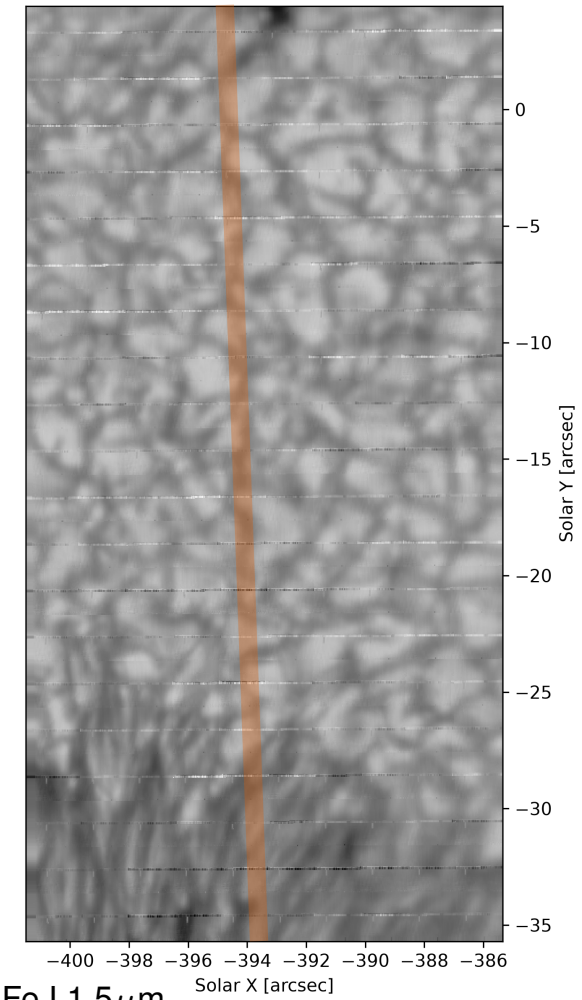
ViSP's highest resolution so far

Along Slit : $\sim$0.02 - 0.03″/pxl
Slit Width : 0.0538″/pxl
Cadence : 25 - 26 ms
Seeing r_0 : $>$ 9 cm

9.6s pause every 6000 steps ($\sim$150 s) due to data volume

Observed in Hα, Na I 5890Å, and **Ca II 8542Å**

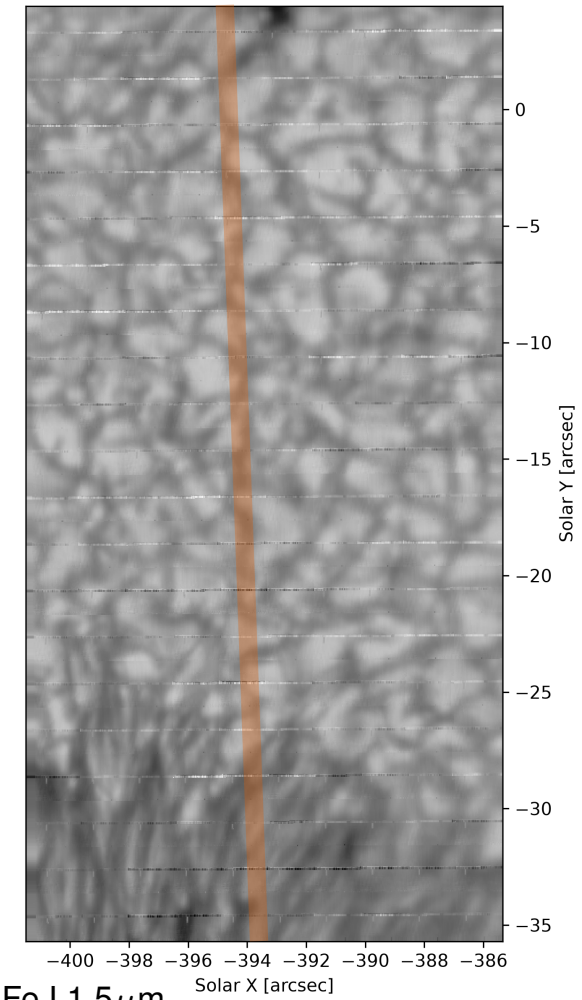
A wider context



DL-NIRSP Fe I 1.5μm

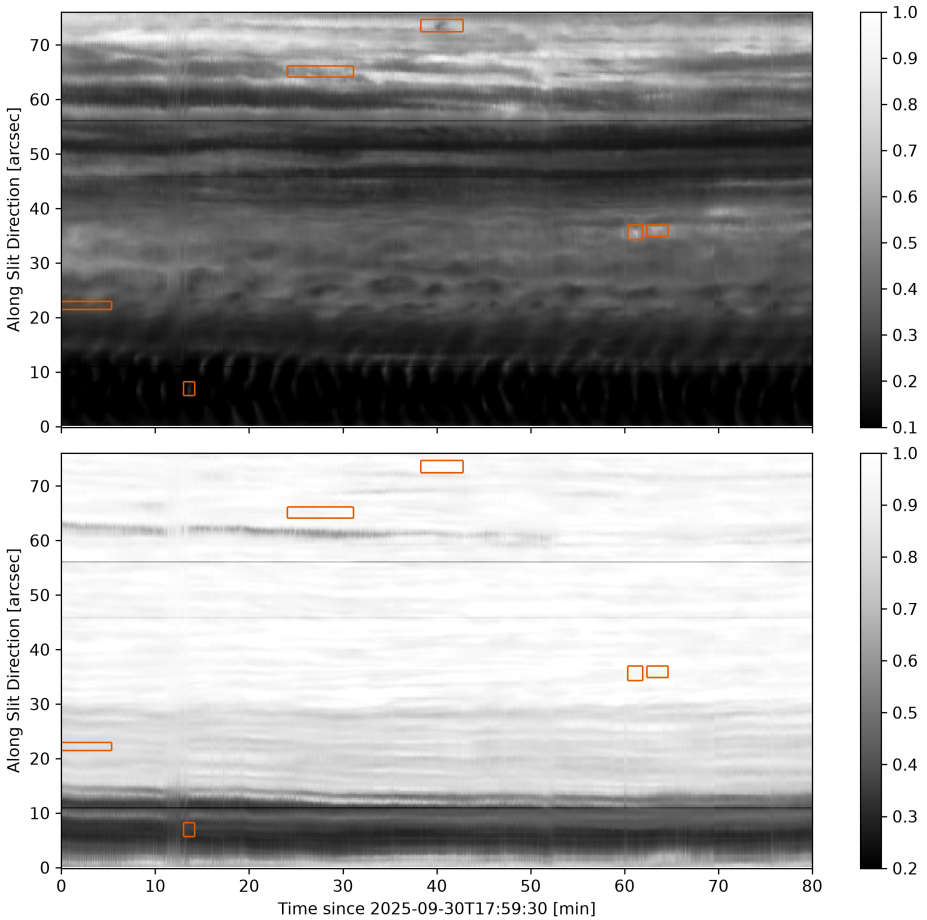
Observations (AR 14232)

A wider context



DL-NIRSP Fe I 1.5μm

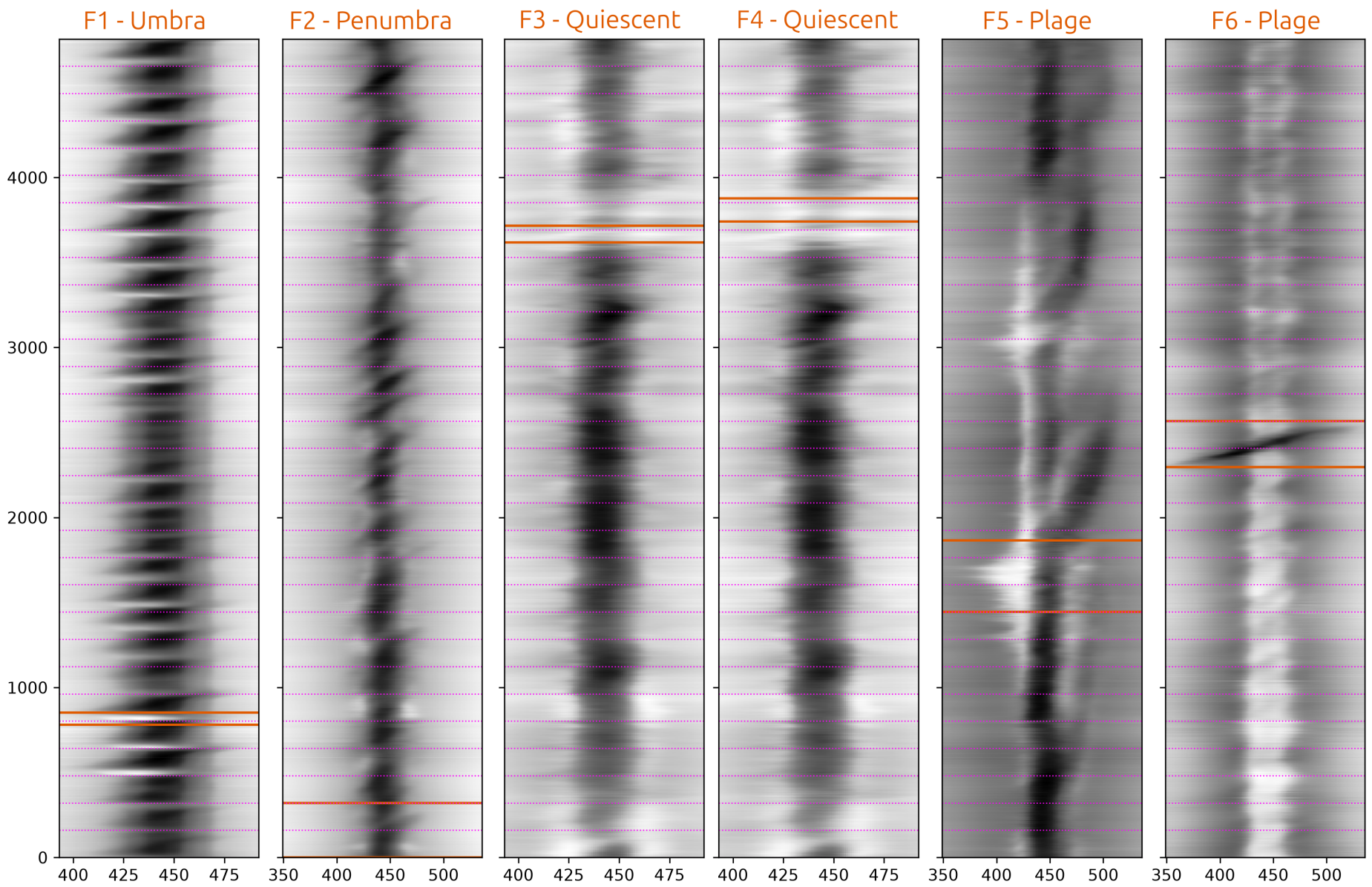
ViSP Ca II 8542Å



We've picked **six** features across the active region.

Introduction

The 4,800-second view



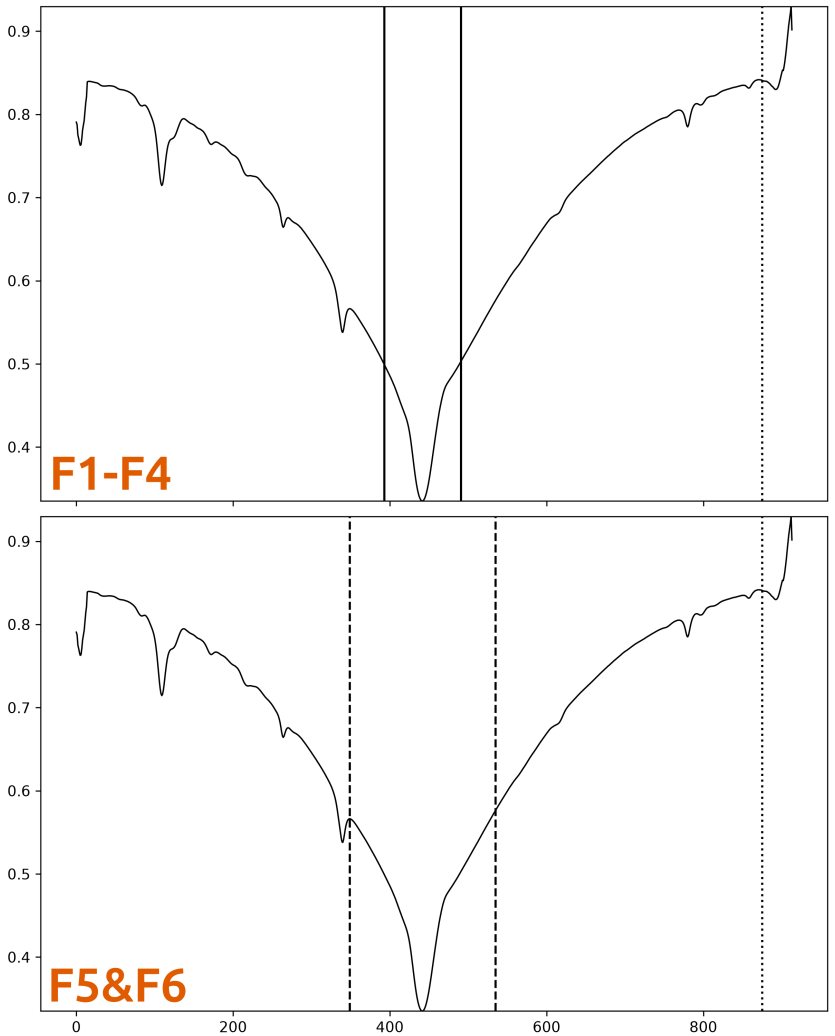
Methodology

Large scale structure

Spectral Clustering

- Continuum normalize the spectra
- k-means clustering algorithm
- Identify the largest connected patch in central cluster

This provides the **size** , **duration** , **line profile shape** of each feature



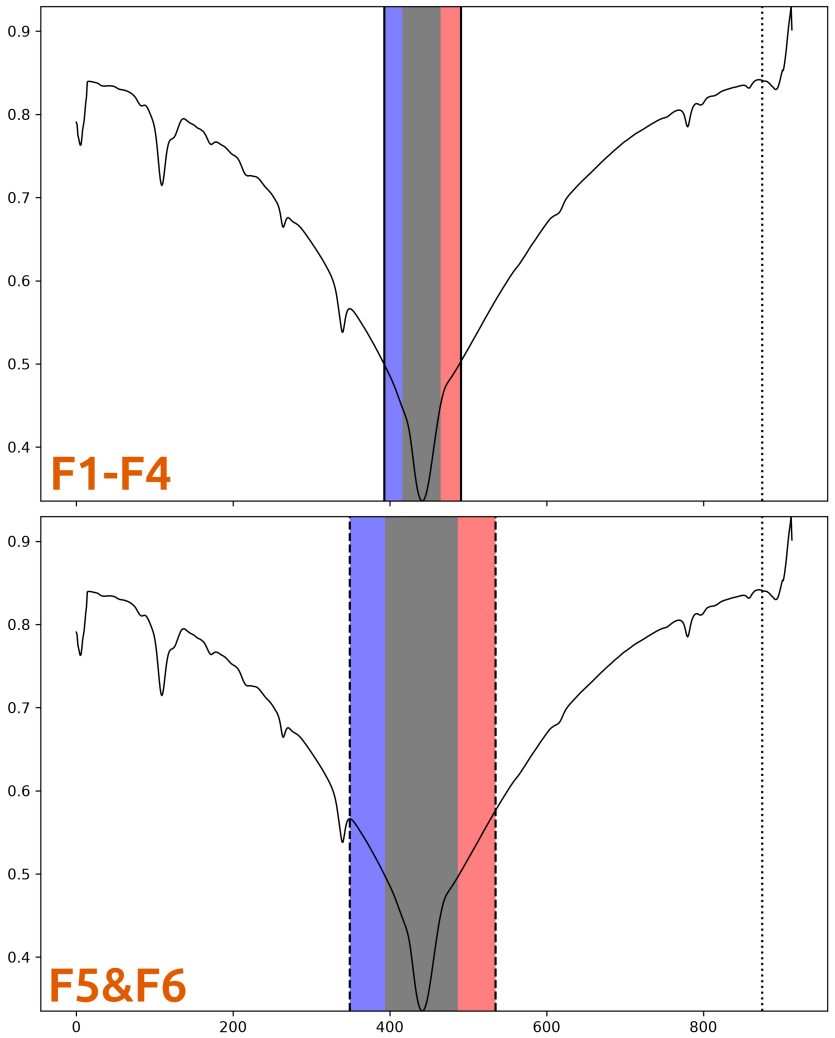
Finer scale structure

Wavelet Analysis

- We split the spectrum into three channels:

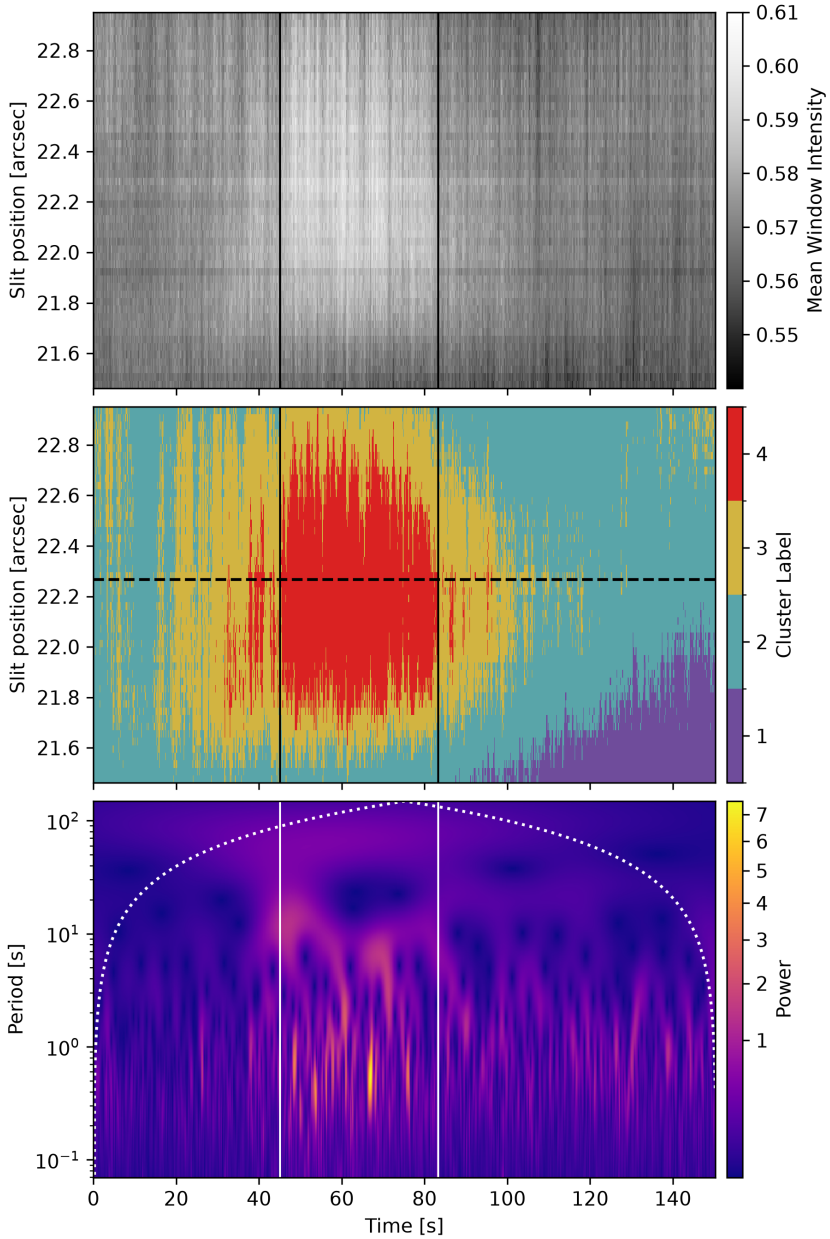
  blue, **central**, and **red**

- Each 6000-step segment for each channel is analyzed separately



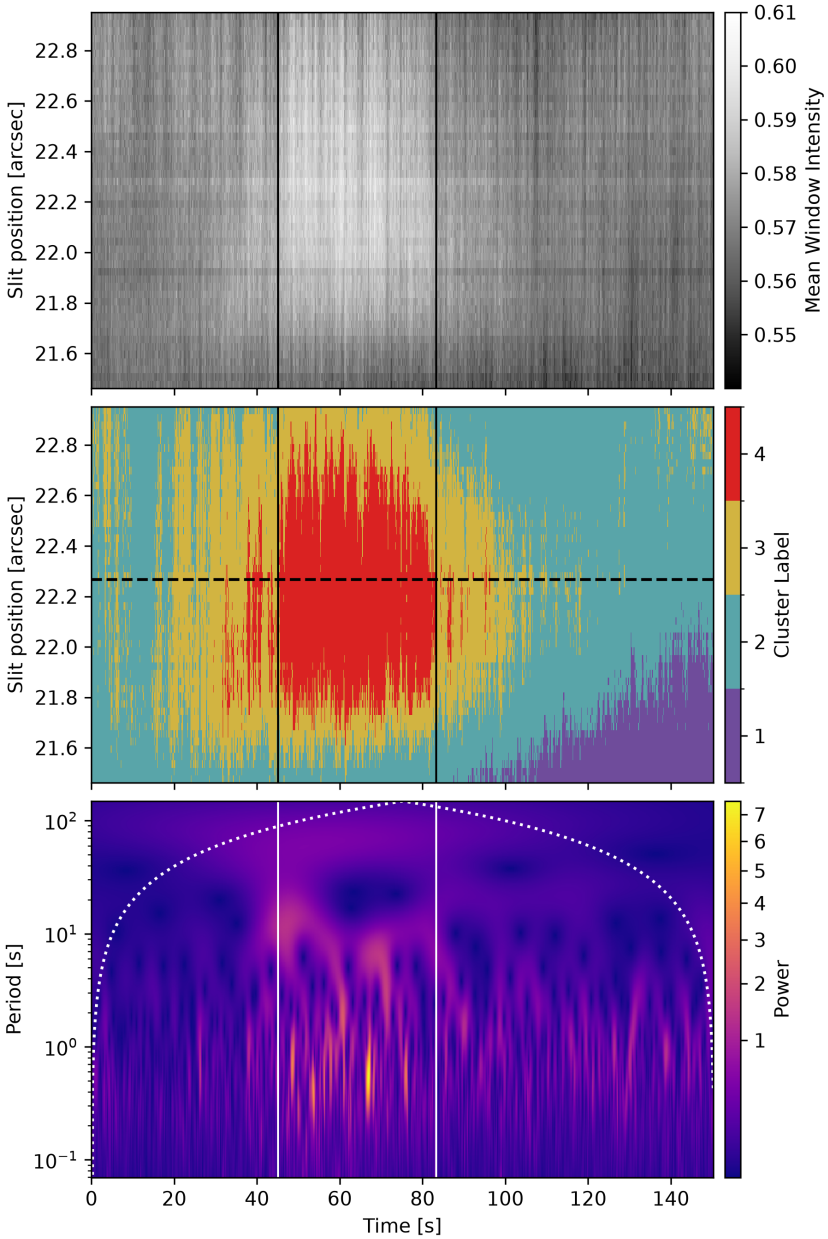
Results

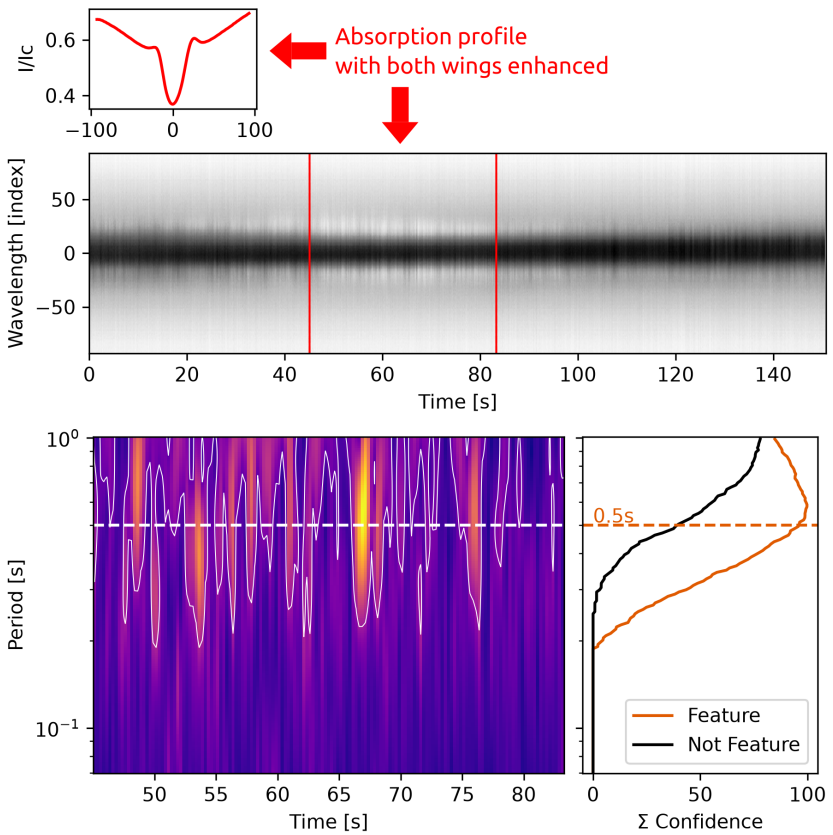
F2 – Penumbra



Results

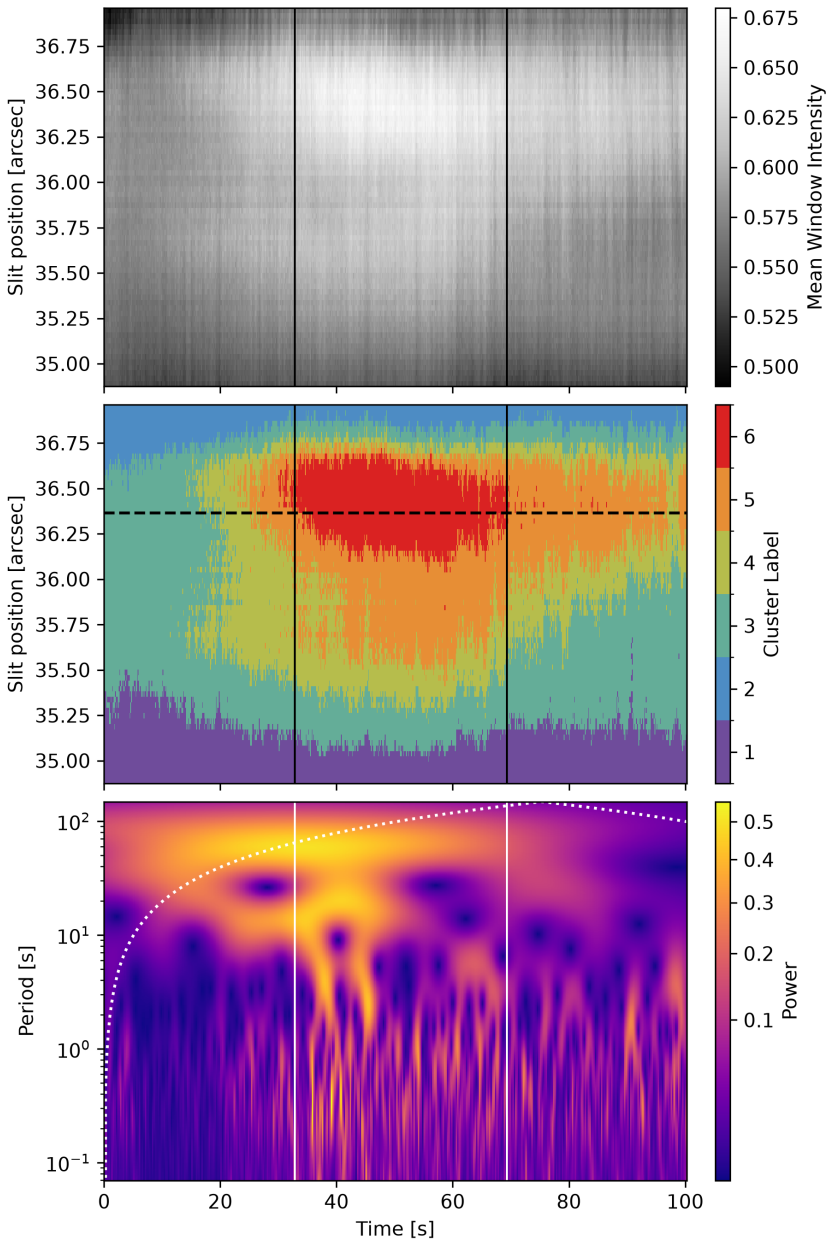
F2 – Penumbra





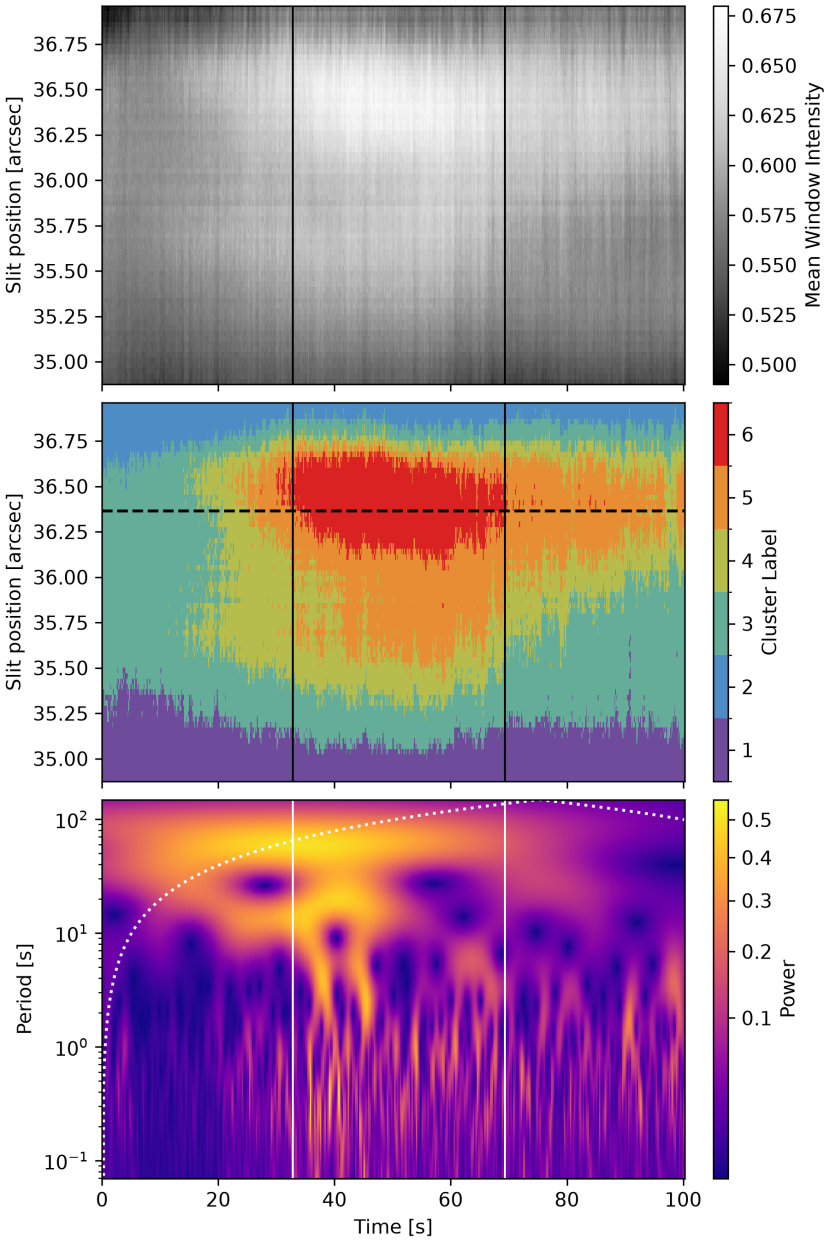
Size	1″
Duration	∼40 s
Smallest Scale	∼**500 ms**

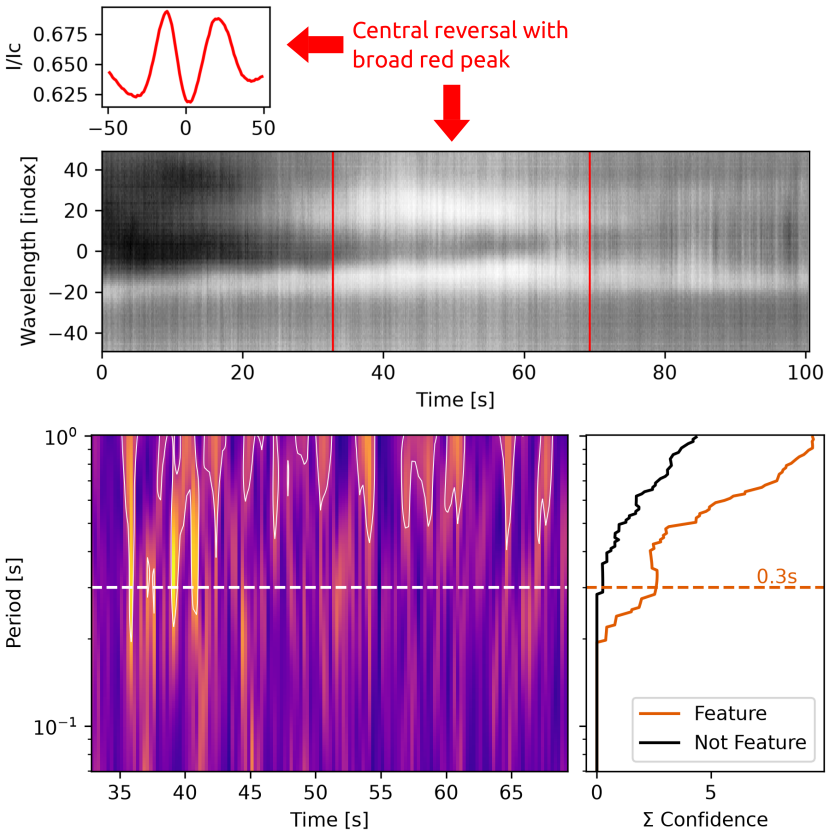
F4 – Quiescent



Results

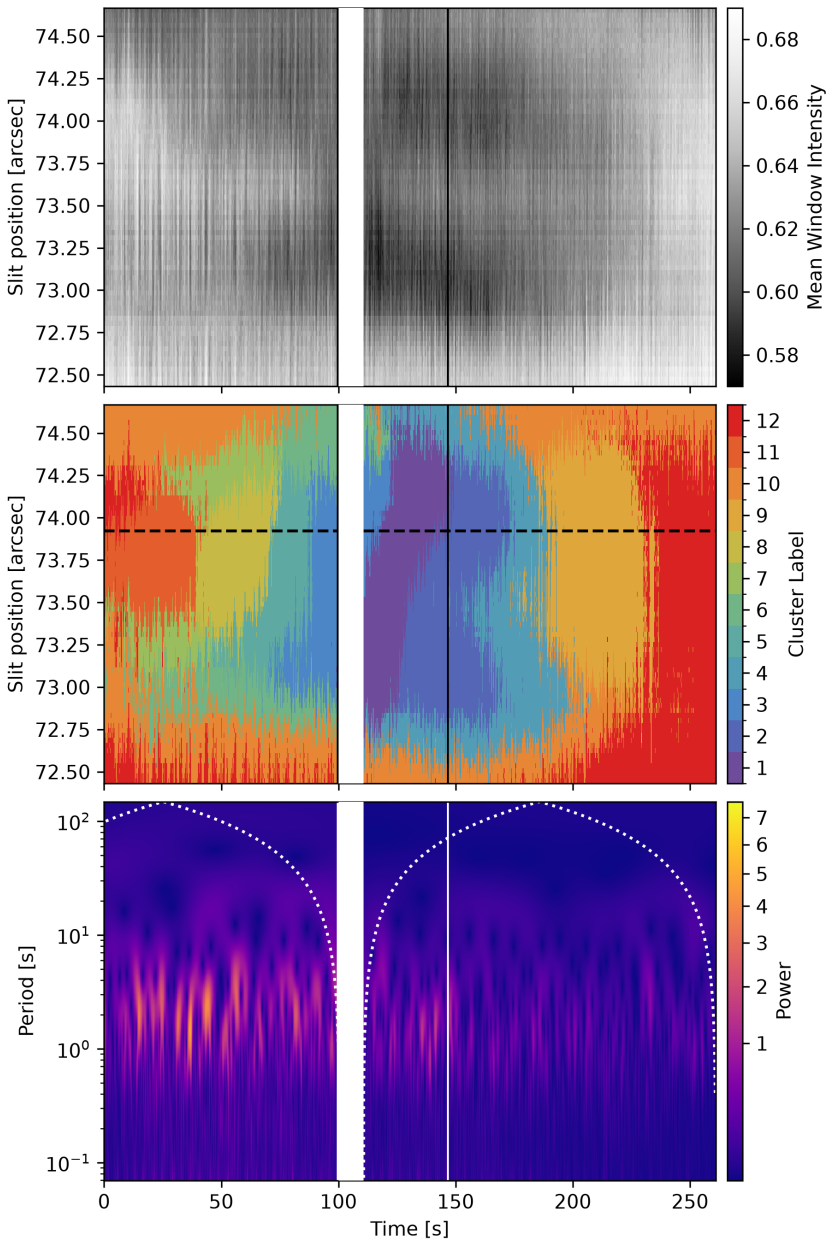
F4 – Quiescent



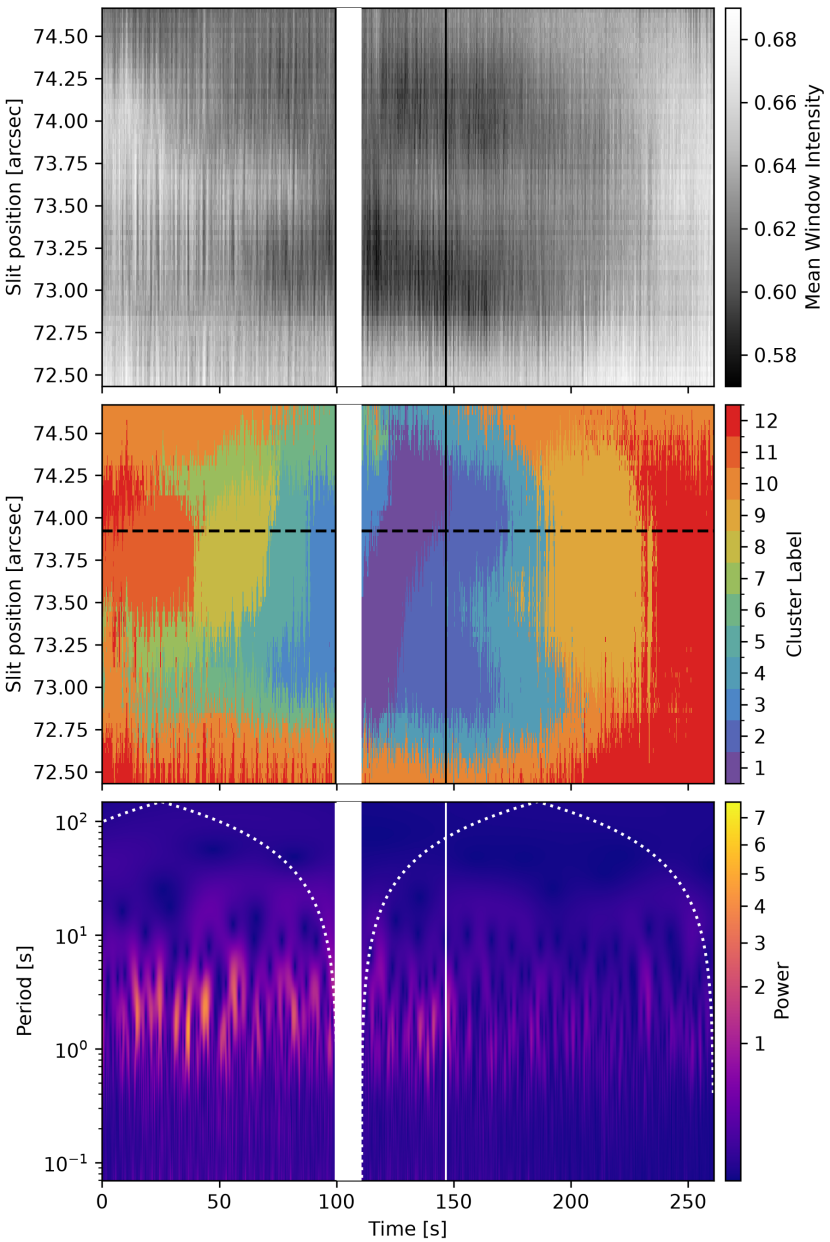


Size	0.5″
Duration	∼30 s
Smallest Scale	**∼300 ms**

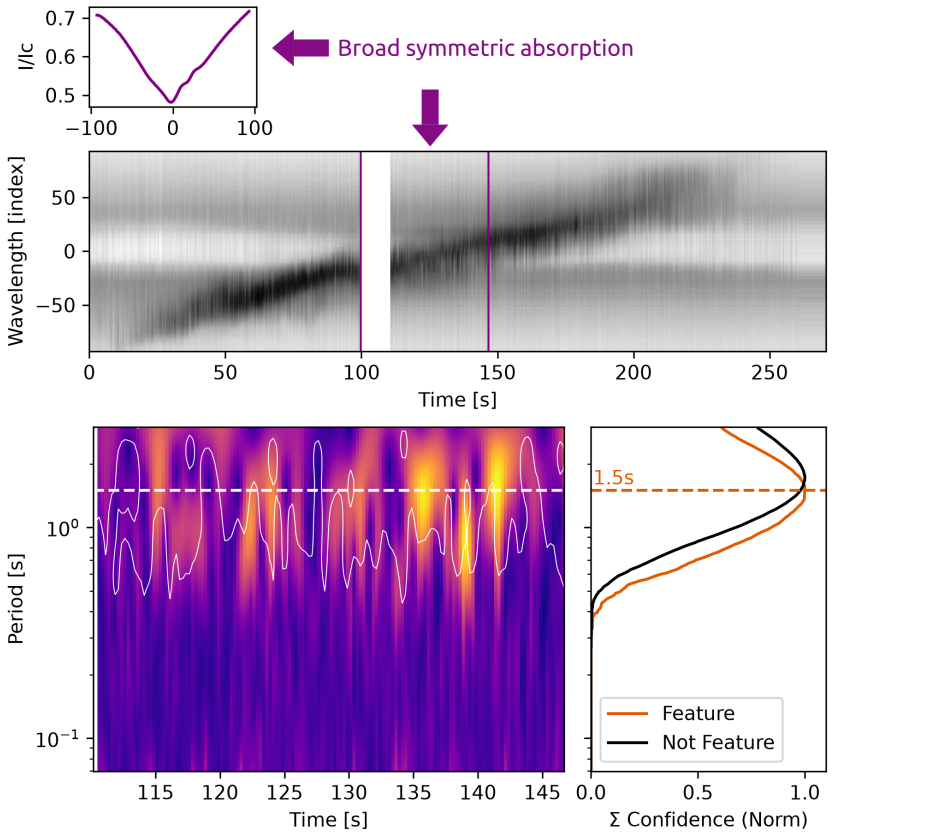
F6 – Plage (Projectile)



Results



F6 – Plage (Projectile)



Size 2″

Duration ∼50 s

Smallest Scale ∼**1.5 s**

Takeaways

So Far

From our analysis of all six TBs

- Size and Duration vary from $\sim 0.5 - 1''$ and ~20 to 150 s
- TBs are characterized by distinct spectral profiles
- Penumbra (F2) and Quiescent (F3 & F4) features have sub-second structure.

Further Study

Plage

- Both regions around plage features (F5 and F6) have a persistent near-second structure.
  - Further study may tell whether this is the case across the plage

Takeaways

So Far

From our analysis of all six TBs

- Size and Duration vary from $\sim 0.5 - 1''$ and ~20 to 150 s
- TBs are characterized by distinct spectral profiles
- Penumbra (F2) and Quiescent (F3 & F4) features have sub-second structure.

Poster #107.29 on **sunspot oscillations observed by ViSP sit-and-stare**

Thank you

Questions?