Leibniz-Institut für
Astrophysik Potsdam

Multiwavelength study of penumbral decay using GREGOR, VTT, DST, NST, and Hinode.

Meetu Verma[1]

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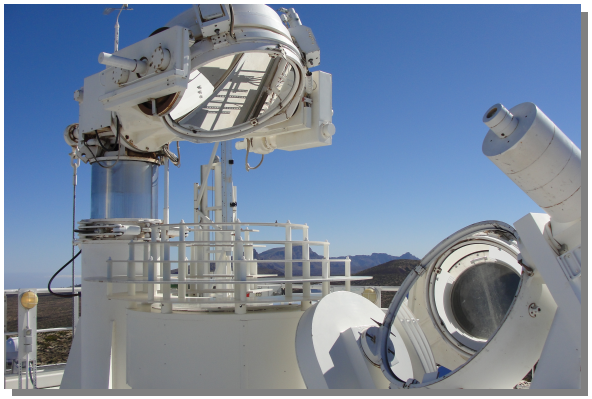
Motivation

- To exploit the maximum potential of available ground-based as well as space-borne telescopes
- Multi-instrument and multi-wavelength observations
- Various instruments
  - Visible and EUV Imager
  - Fabry-Pérot Interferometer
  - Spectrograph
- Information on the propagation of changes from photosphere to chromosphere and even to transition region

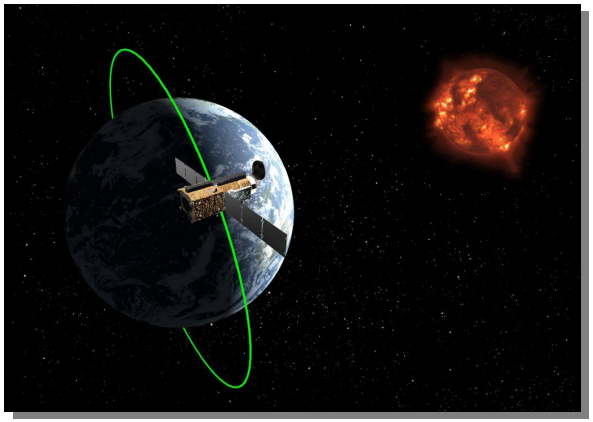
Motivation

GREGOR



VTT

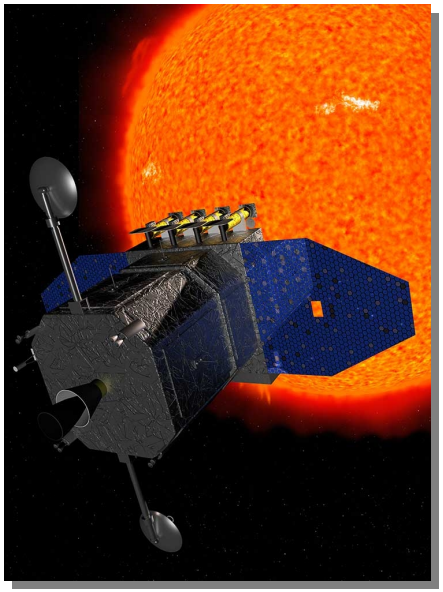
HINODE



NST

DST

SDO



Proposed Observations

Active Region Filaments: Observing Shear Flows and the Evolution of Magnetic Shear along Magnetic Neutral Lines with GREGOR, VTT, DST, NST, and Hinode

- GREGOR
  - HiFI: G-band (λ430.7nm), blue continuum (λ450.6 nm)
  - GFPI: spectroscopic data - Fe I (λ617.34 nm) and Fe I (λ543.4 nm)
  - GRIS: spectropolarimetric data - Si I (λ1082.7nm) He I (λ1083.0 nm)
- VTT – Echelle spectrograph - spectral data Hα and Na D_2
- DST
  - IBIS: Ca II (λ854.2 nm), Na(λ589.0 nm), and spectroscopic Hα
  - ROSA: Images in G-band, Ca IIK, and Hbeta
  - FIRS: Spectropolarimetric data in 1083.0 nm spectral range
- NST
  - BFI: TiO
  - NIRIS: spectroscopic data He I triplet (λ1083.0 nm) range
  - FISS: Hα and Ca II H (λ854.0 nm)
- Hinode – SP: Fast scans Fe I (λ630.15nm) & (λ630.25nm)

Observations

DATE	TELESCOPES	REGION
16/09/2016 – 19/09/2016	VTT, Hinode	AR12592, AR12593
20/09/2016	VTT, DST*, Hinode	AR12594
21/09/2016 – 23/09/2016	VTT, GREGOR, DST*, NST** Hinode***	AR12593
24/09/2016	VTT, GREGOR, NST, Hinode	AR12597
25/09/2016	NST, Hinode	AR12597
26/09/2016	VTT, GREGOR, Hinode	AR12597
27/09/2016	VTT, Hinode	AR12597
28/09/2016	VTT, GREGOR, DST, Hinode	AR12597
29/09/2016	VTT, GREGOR, Hinode	AR12597, Filament in NE

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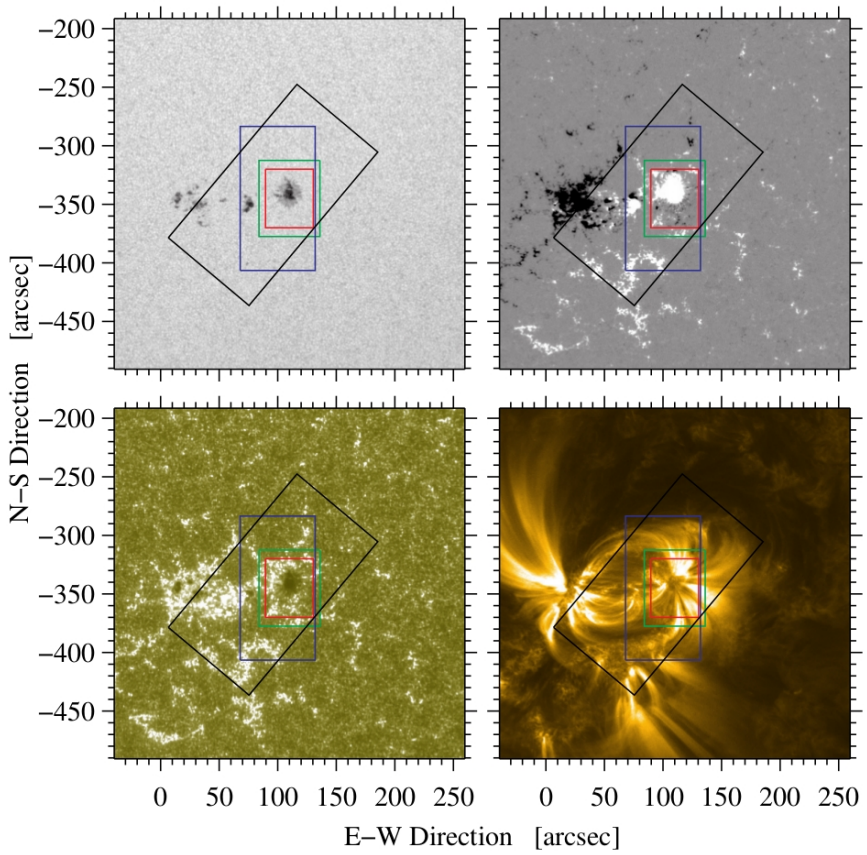
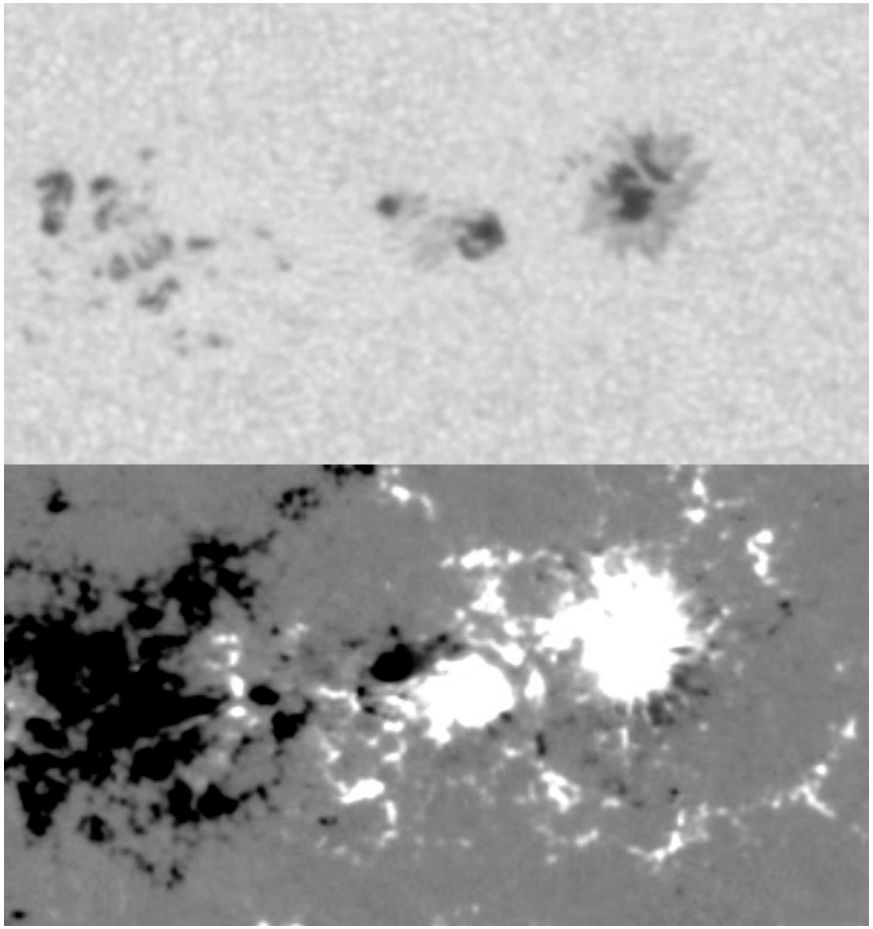
Leading Sunspot in NOAA 12597



- Glimpse of data and preliminary results
- 08:52 UT on 2016 September 24
- Appeared on south east near disk center on September 22
- Position on September 24 (110", -350")
- Classified as β/- simple bipolar region but developed later to βγ/β region with complex neutral line
- Focused on the leading spot
- Mature sunspot with decaying penumbra
- SDO – continuum, LOS magnetogram, 1600 nm, and 171 nm
- Boxes are FOV covered by GFPI, GRIS, Hinode, and VTT

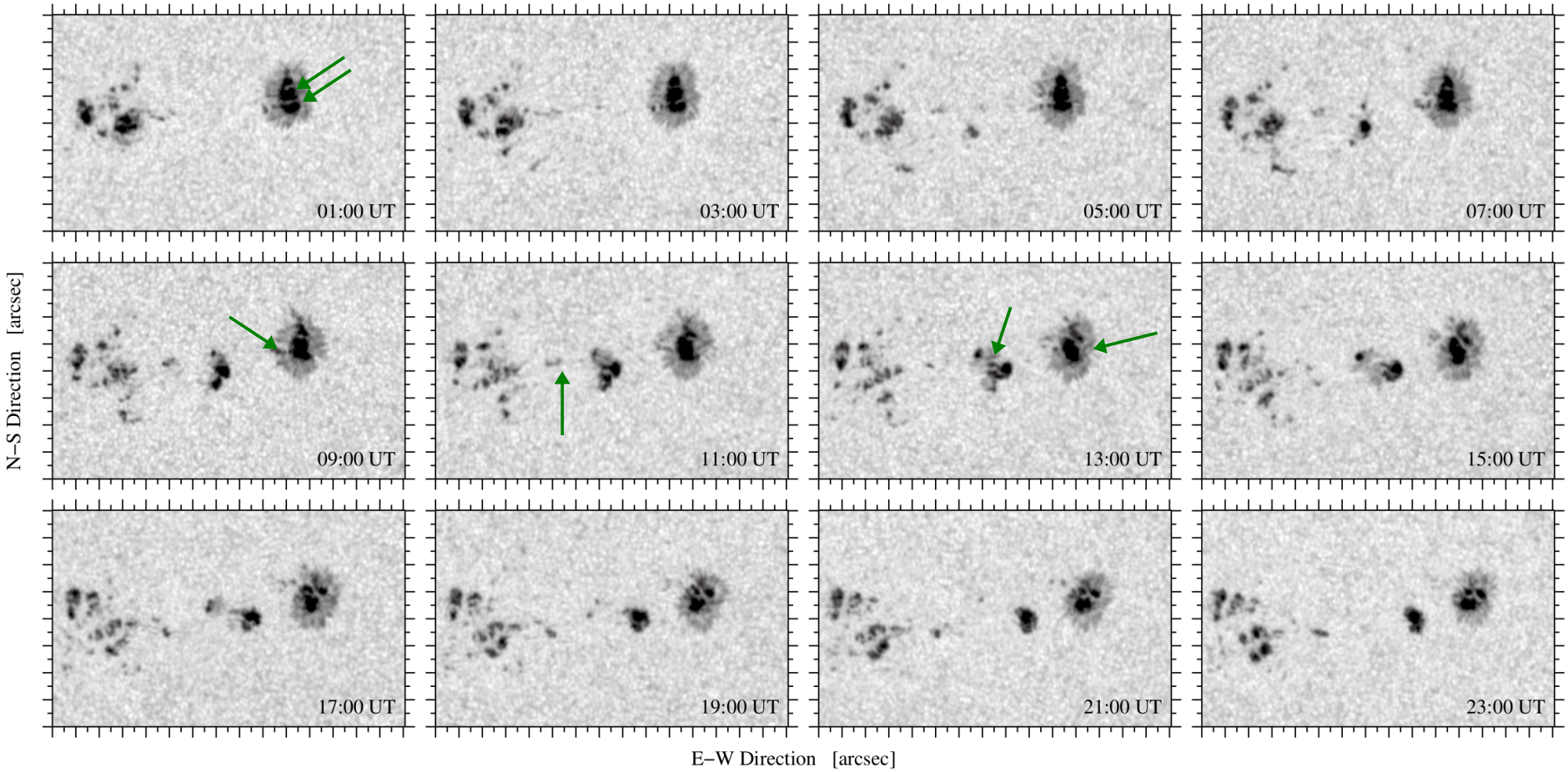
Leading Sunspot in NOAA 12597



- Appeared on south east near disk center on September 24
- Position on September 24 (110", -350") and classified as β/-
- Focused on the leading spot
- Mature sunspot with decaying penumbra
- Two light-bridges, one disappearing
- Appearance of darkened area resembling umbral core on the edge of disappeared light bridge
- Sunspot rotation
- Flux emergence

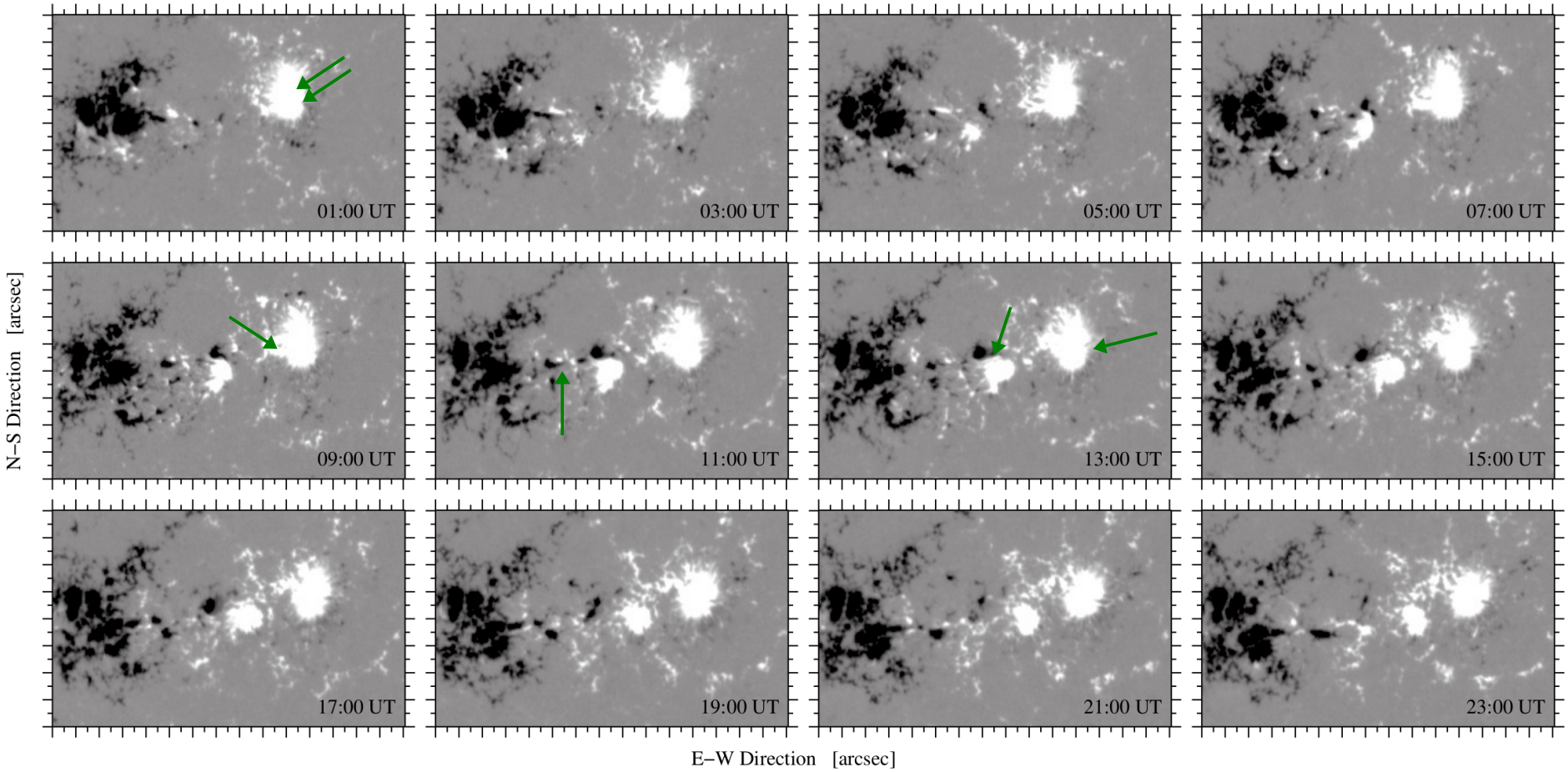
SDO continuum and LOS magnetogram movie

Evolution on the day of observation



- Two light-bridges, one disappearing
- Appearance of umbral core extrusion on the edge of disappeared light bridge
- Flux emergence
- Sunspot rotation
- Pores of different polarity sliding

Evolution on the day of observation



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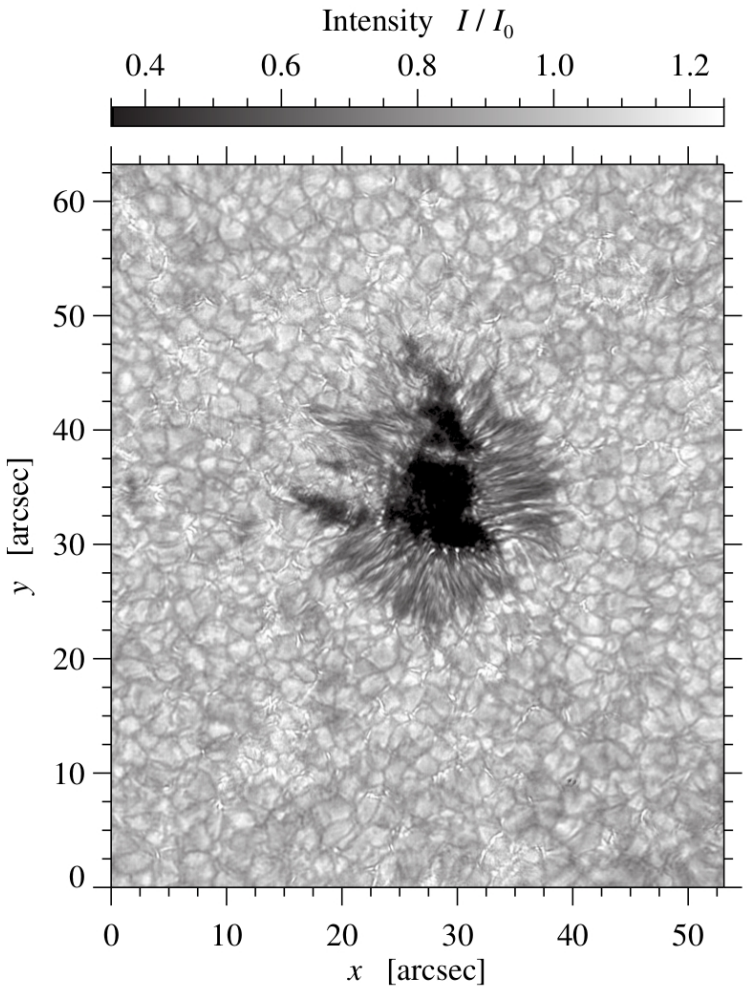
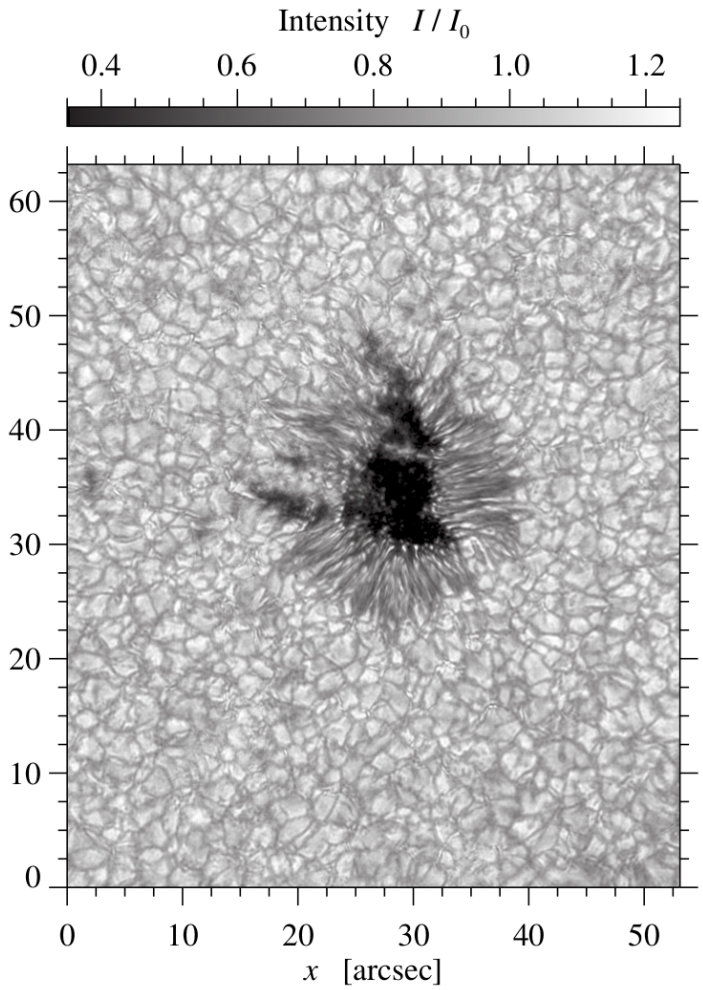
GREGOR High-resolution Fast Imager (HiFI)





G-band and Blue continuum images

Time-series for about 40 min

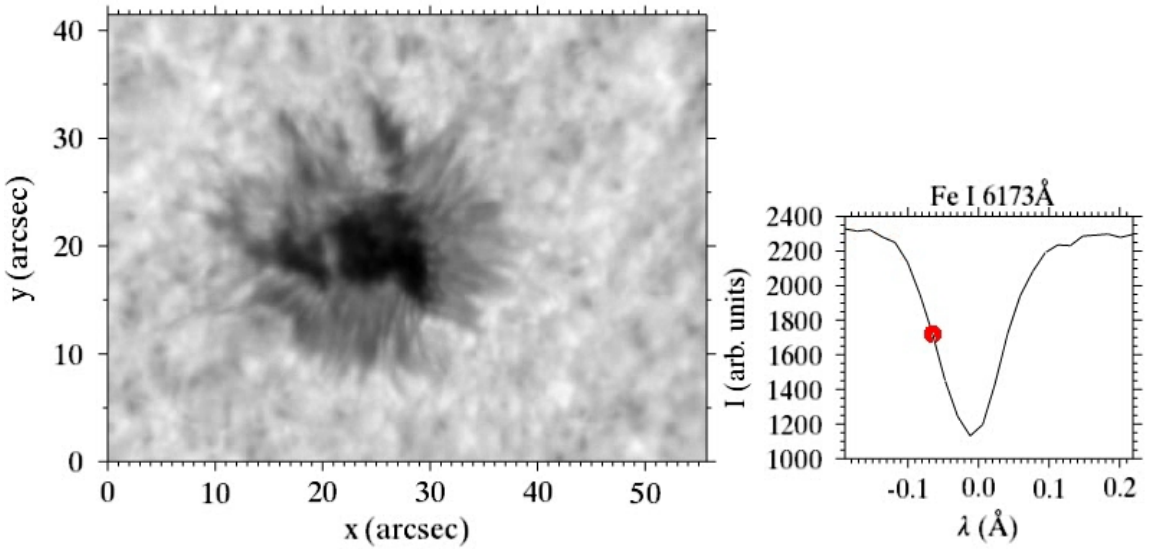
Appearance of darkended umbral core like region

Granulation in the penumbral gap

Evolving light-bridge

Next step – Apply LCT to follow horizontal proper motions

GREOR Fabry-Pérot Interferometer (GFPI)



GFPI line scan movie

- Spectroscopic data in 617.3 nm Fe I line
- Exposure time ~ 10 ms
- One line scan ~ 24 s
- More than 140 scans
- Level1 & Level2 MOMFBD data
- Example of line scan

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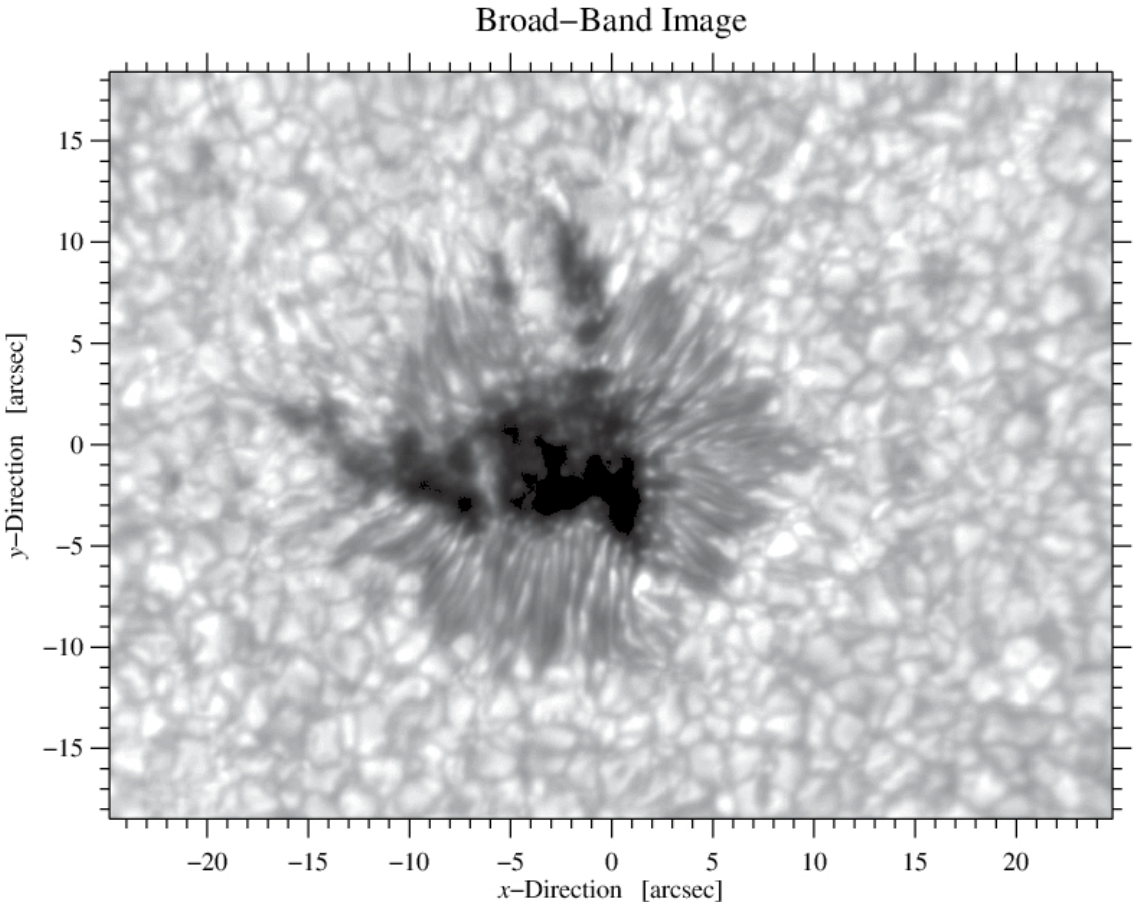

- Spectroscopic data in 617.3 nm Fe I line
- Exposure time ~ 10 ms
- One line scan ~ 24 s
- More than 140 scans
- Level1 & Level2 MOMFBD data
- Example of broad-band image

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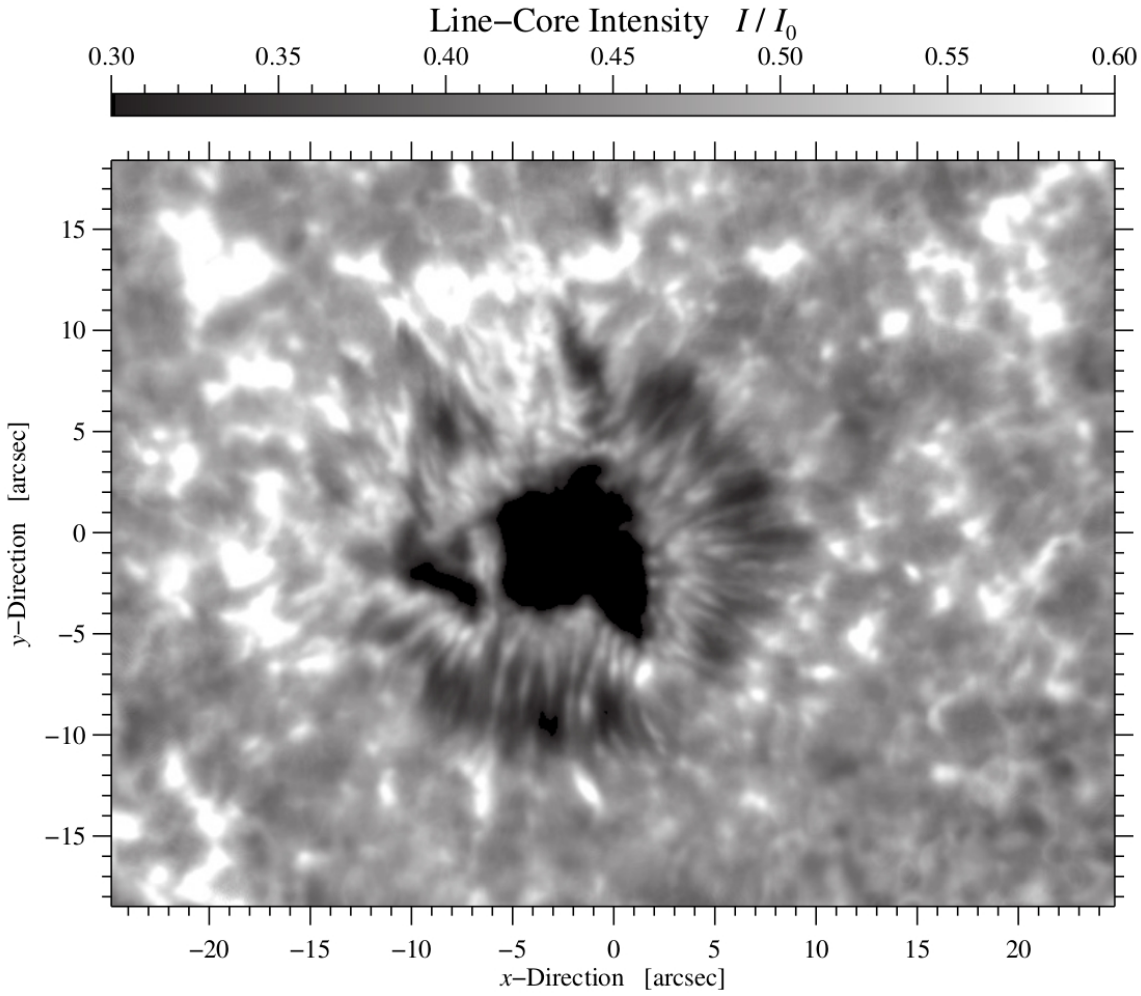

- Spectroscopic data in 617.3 nm Fe I line
- Exposure time ~ 10 ms
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- Level1 & Level2 MOMFBD data
- Example of line core intensity map

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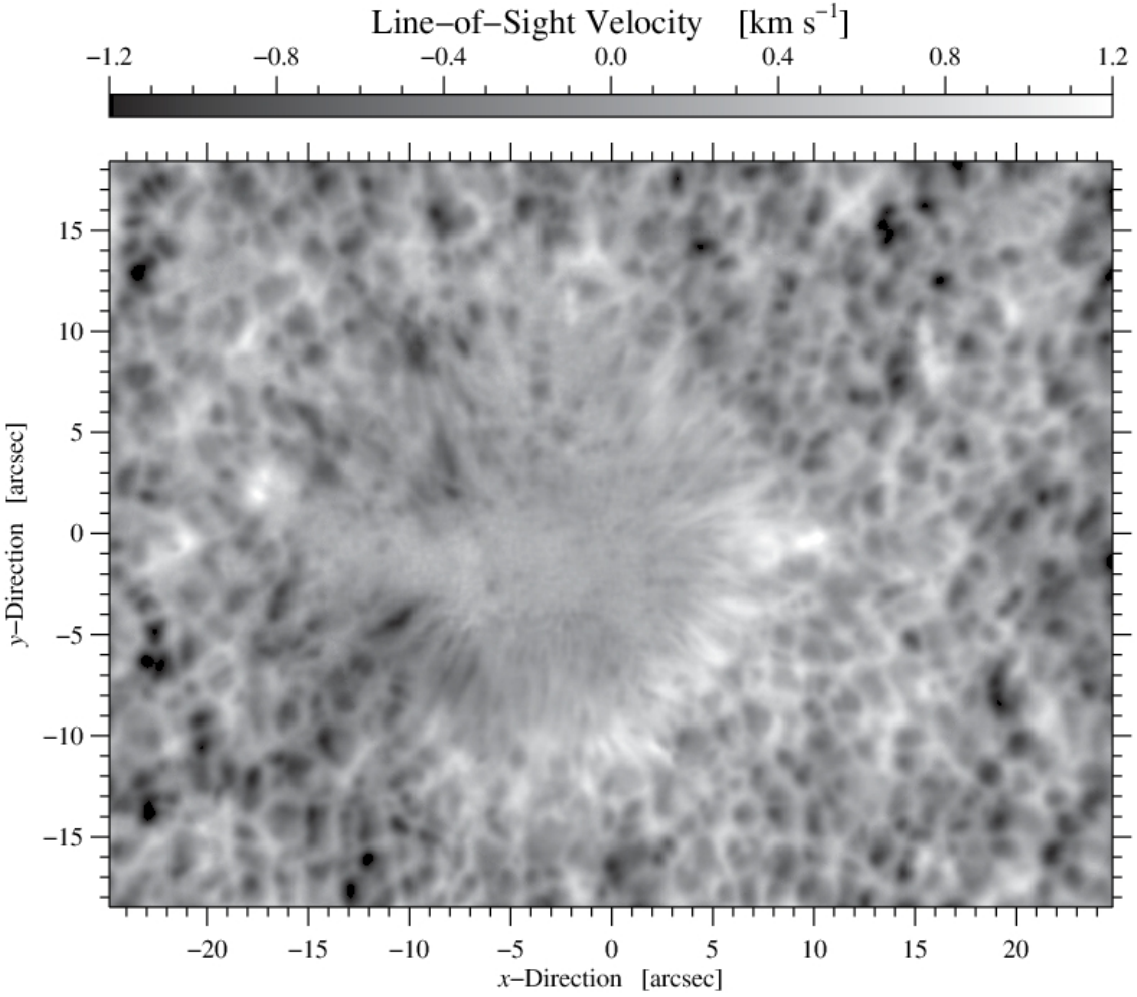
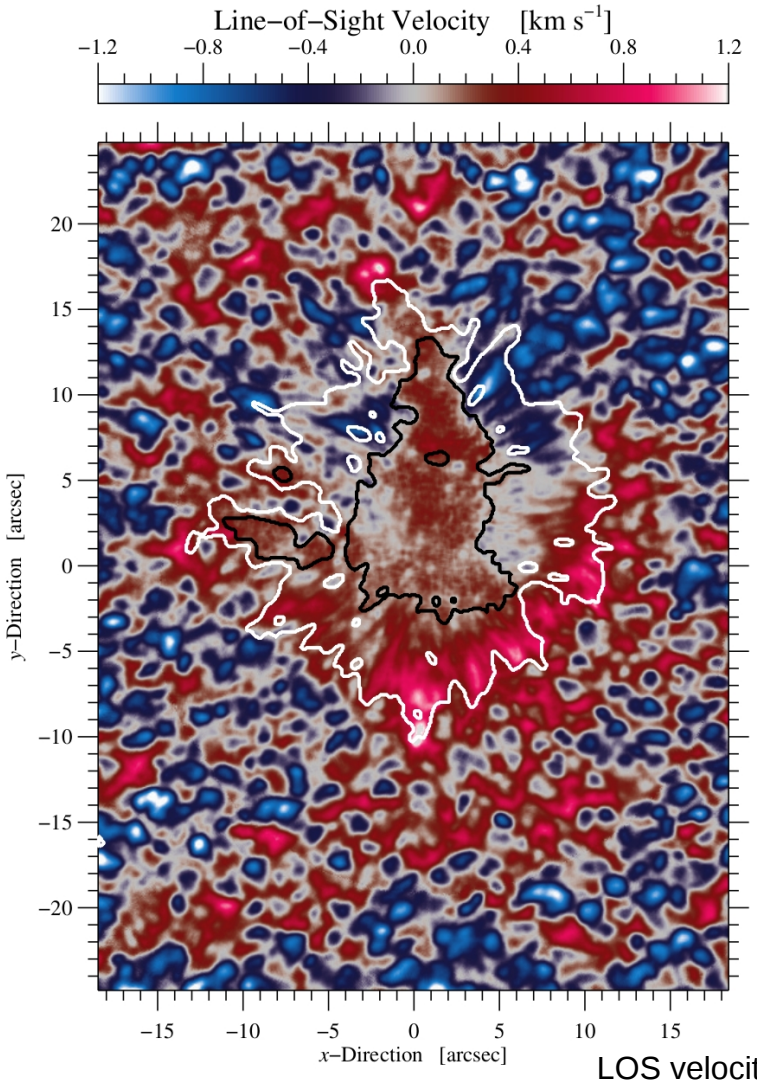


- Spectroscopic data in 617.3 nm Fe I line
- Exposure time ~ 10 ms
- One line scan ~ 24 s
- More than 140 scans
- Level1 & Level2 MOMFBD data
- Example of LOS velocity map

See poster on sTools-GFPI data pipeline

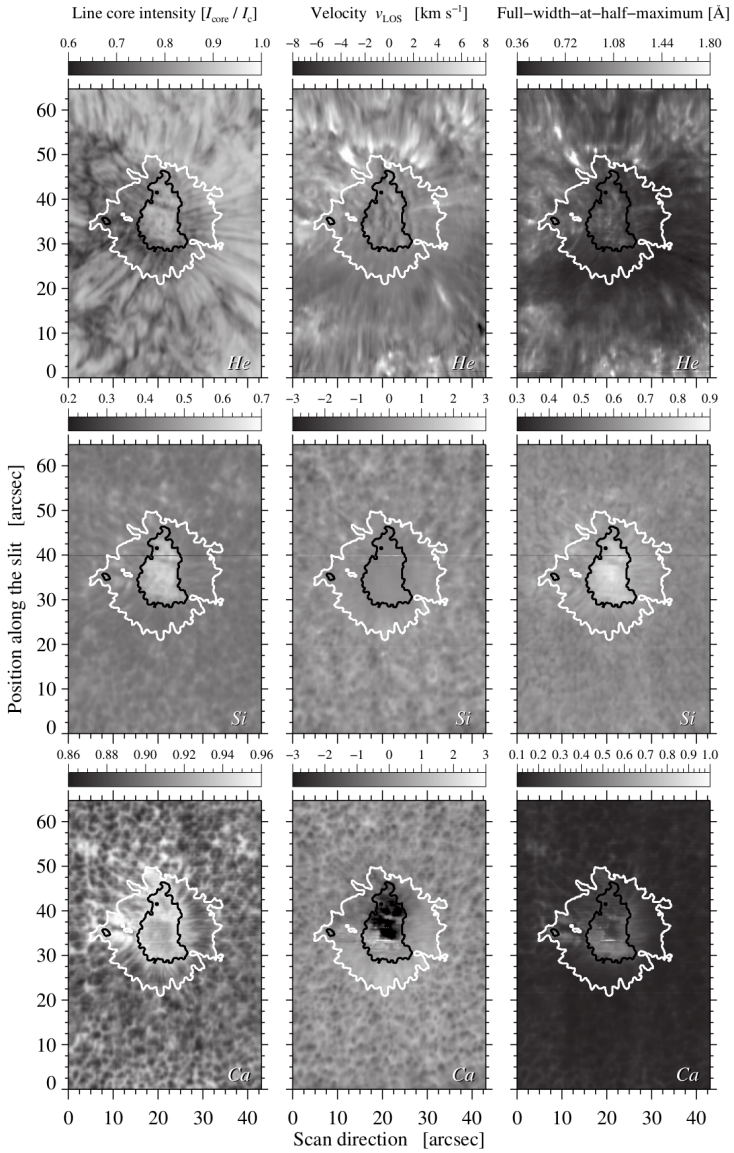
GREOR Fabry-Pérot Interferometer (GFPI)



LOS velocity movie

- LOS velocities computed using lpff
- More than 140 maps covering time-period of 40 minutes
- Evershed effect
- Not in the sector of decaying penumbra
- The region next to umbral extrusion has granulation properties
- Indication of umbral flashes

GREGOR Infrared Spectrograph (GRIS)



- IQUV Stokes Spectra
- Ca I (λ1083.9 nm, deep photosphere)
- Si I (λ1082.7nm, photosphere)
- He I (λ1083.0 nm, chromosphere)
- Two scans - 09:02 UT & 10:30 UT
- 360/300 steps
- FOV of 62" × 52" / 62" × 42"
- Infer magnetic and flow field information from photosphere to chromosphere
- Line core intensity, LOS velocity, & FWHM

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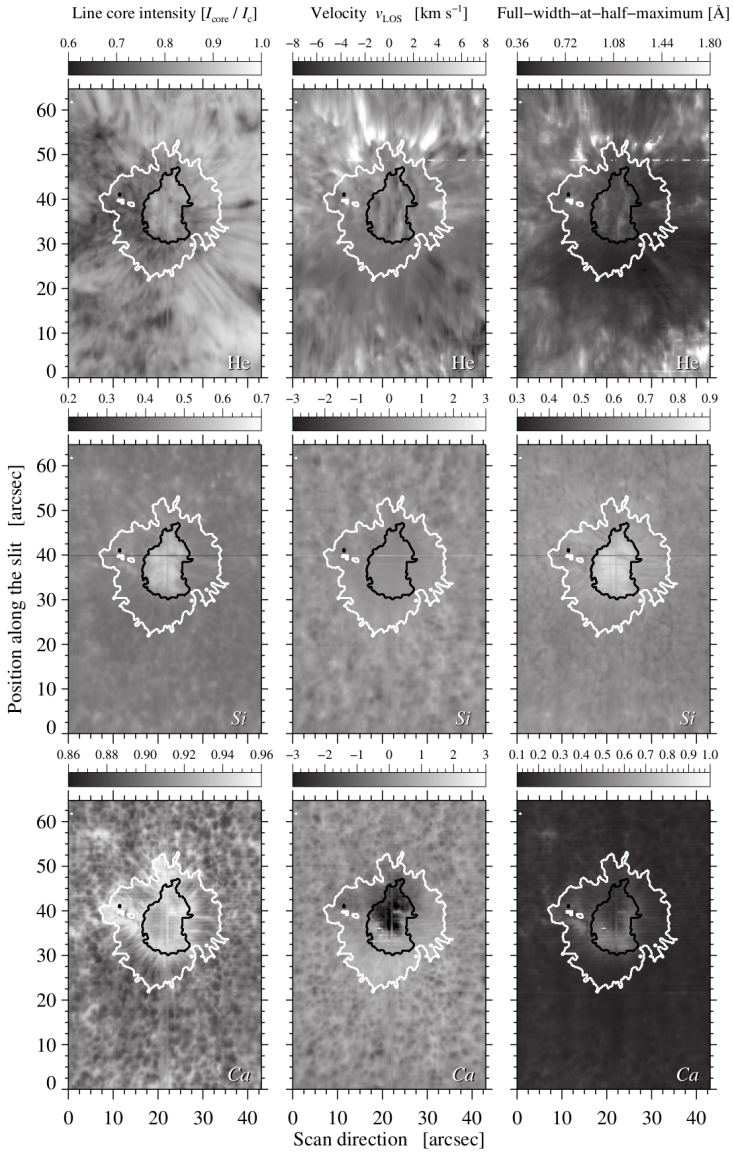

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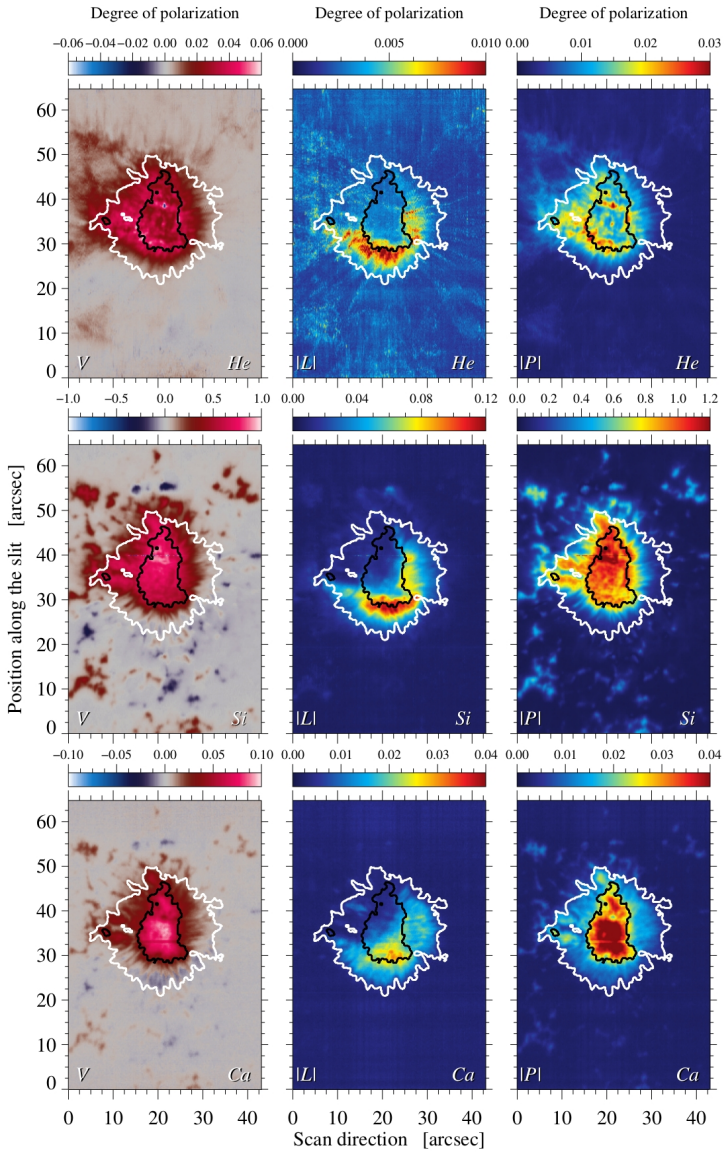

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- Signed V, linear & total degree of polarization
- Small scale magnetic features – unipolar as well as bipolar
- Decaying penumbra sector low linear degree of polarization
- In Si I strong total degree of polarization in the umbral extrusion

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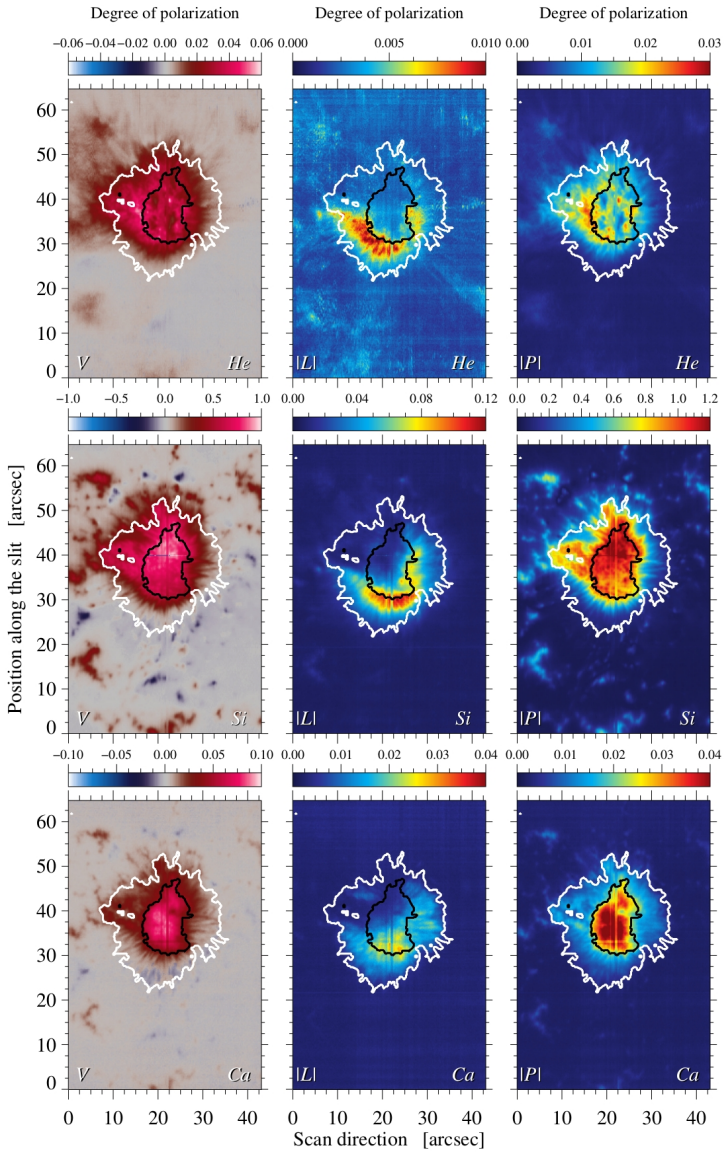

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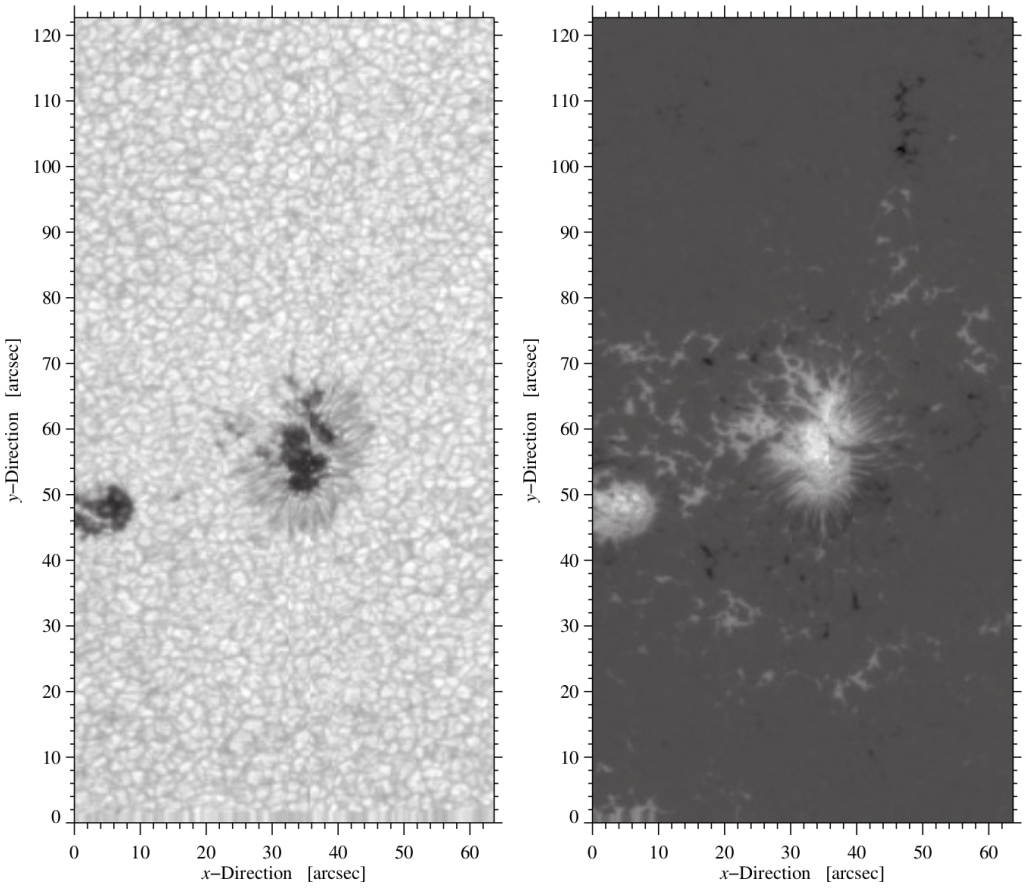
Summary & Future Work



Hinode continuum and magnetic field

- Glimpse of the potential of coordinated observing campaign
- Preliminary results of multi-wavelength study
- The penumbral sector facing region with flux emergence decays first - forms umbral core extrusion
- Flux emergence triggering the decay of penumbra
- Further steps include
  - Inversion of GRIS data
  - LCT on GFPI and HiFI data
  - Analysis of VTT, Hinode, NST data


Thank you!