Leibniz-Institut für
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Coordinated Observations

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3rd SOLARNET Forum for Telescopes and Databases / 2021 November 15

Coordinated Observations

- Organization of coordinated observing campaigns with other solar ground-based and space-borne telescopes
- Preparation of a public report with best practices for coordinated observations
  $\rightarrow$ deliverable D2.8 due in month 36
- Telescope and instrument description prepared
- Covid-19 pandemic significantly hampered coordinated observing campaigns in 2020 and 2021
- Changes in the project personnel (maternity/parental leave and Marie-Curie Fellowship)

- New post-doctoral researcher hired who starts on 2022 January 1.
- Search for second post-doctoral researcher ongoing
- Postpone deliverable D2.8 until after the 2022 observing season.
- Prepare questionnaire for operators of ground-based and space-borne telescopes and instruments
- Statistics of coordinated observing campaigns
- Assessment and personal experience report by PIs of coordinated observing campaigns

Coordinated Observations 2020

2020 October 13–14

– SST (SOLARNET Service mode campaign (PI: Dominik Utz)

– Hinode (HOP 398) & IRIS

– No coordination possible with ground-based observatories due to high clouds

2020 August 31 – September 14

– GREGOR Science Verification Phase (KIS, AIP, and others)

2020 September 11–19

– VTT (SOLARNET remote campaign (PI: Martin Benko, AISAS)

– Observatórium Lomnický Štít

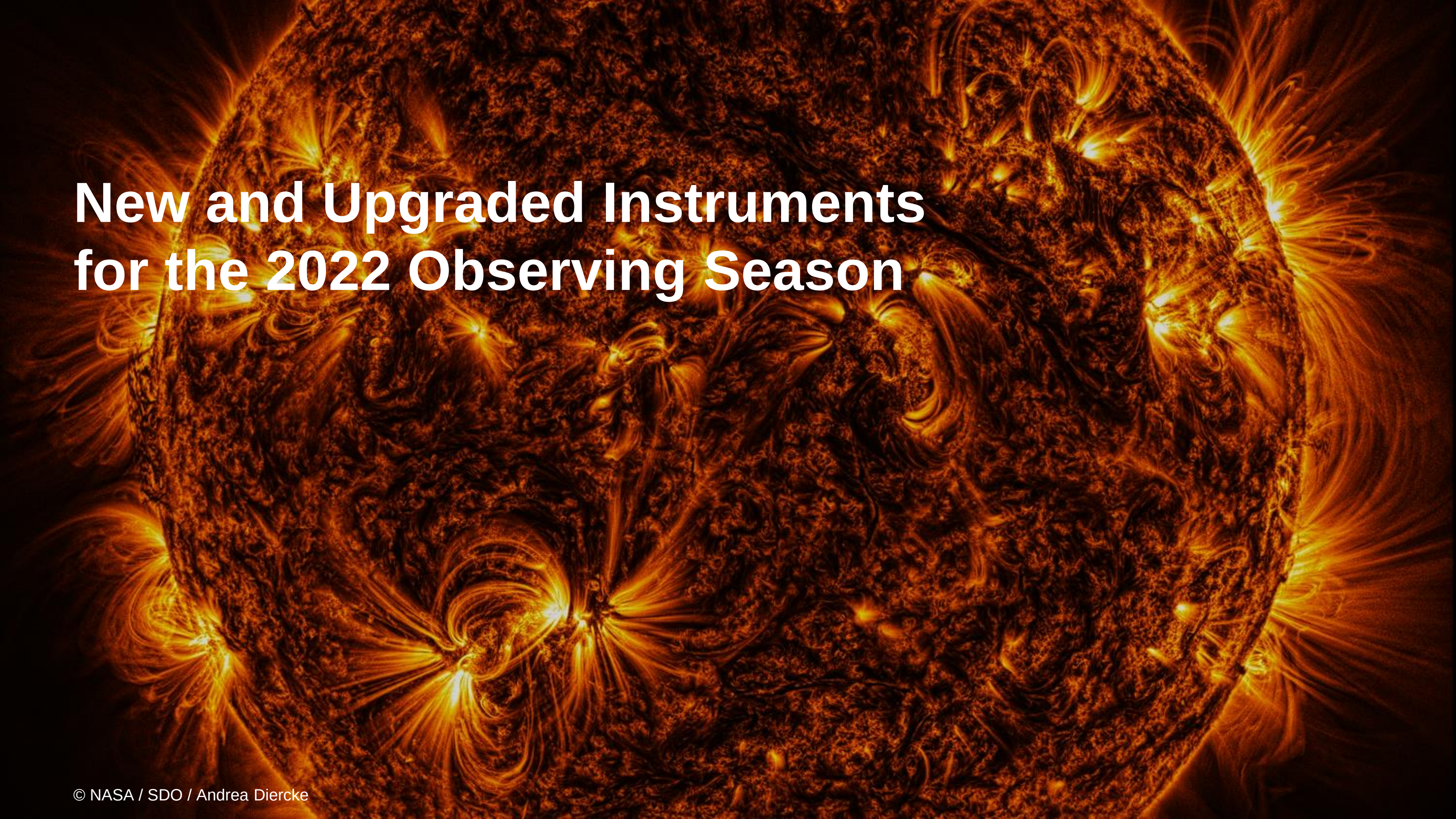
– No coordination possible because of Covid-19 pandemic and telescope problems

– Could also not be rescheduled in 2021.

Coordinated Observations 2021

- Covid-19 continues to be a problem for coordinated observing campaigns.
- MPS campaign covering Solar Orbiter and GREGOR observations (GRIS/IFU and HiFI) in September 2021
- Solar Orbiter full-disk observations with interspersed high-resolution observations
- Weather at OT and problems with the spacecraft limited the data overlap
- One day of good data with Solar Orbiter and one without

- SOLARNET campaign 2021 April 27 – May 7 Parker Solar Probe's 8th perihelion (PI Stefan Hofmeister & 50+ collaborators)
  - GREGOR solar telescope
  - Swedish Solar Telescope (SST)
  - Goode Solar Telescope (GST)
  - Dunn Solar Telescope (DST)
  - Coronal Multi-Channel Polarimeter for Slowakia (CoMP-S)
  - Expanded Owens Valley Solar Array (EOVSA)
  - Low-Frequency Array (LOFAR)
  - Nancay Radioheliograph (NRH)
  - Siberian Radioheliograph (SRH)
  - IRIS & Hinode



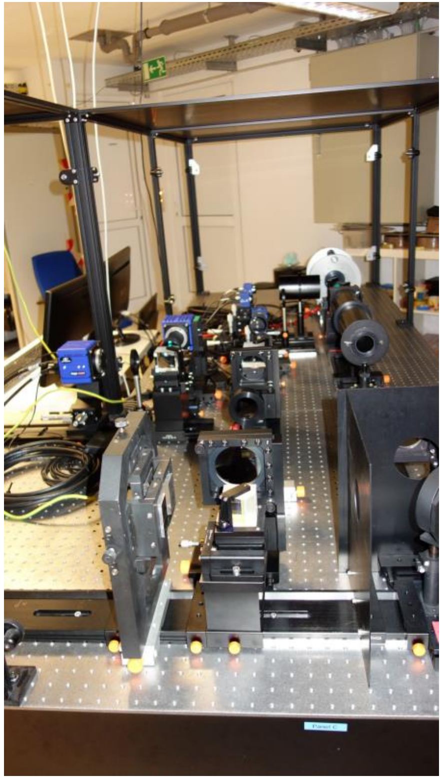
New and Upgraded Instruments for the 2022 Observing Season

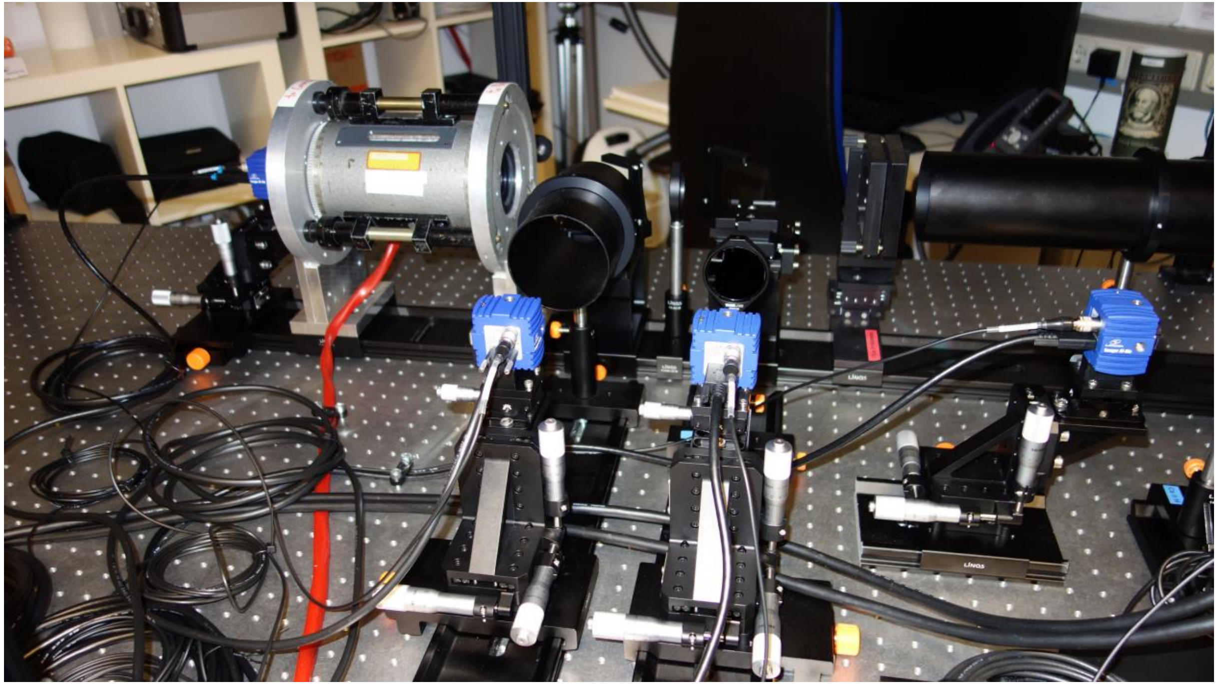
New High-resolution Fast Imager (HiFI+) @ GREGOR

Upgraded High-resolution Fast Imager (HiFI+)

- Three camera control computers with two synchronized sCMOS (16-bit digitization, 50 Hz) or CMOS (12-bit digitization, 100 Hz) cameras each
- Data are written in real-time.
- Near-diffraction limited imaging at high cadence in six spectral windows
  - **HiFI+ No. 1:** G-band at 430.7 nm and blue continuum at 450.6 nm, Imager sCMOS, FOV: 70.7″ × 59.6″ (2560 × 2160 pixel), 20-second cadence, image selection (best 100 out of 500 images), speckle masking image restoration or Multi-Object Multi-Frame Blind Deconvolution (MOMFBD)
  - **HiFI+ No. 2:** Narrow-band (FWHM = 60 pm) and broad-band (FWHM = 0.75 nm) Hα at 656.3 nm, Imager M-lite 2M, FOV: FOV: 76.5″ × 60.5″ (1536 × 1216 pixel), 6-second cadence, image selection (best 50 out of 500 images), MOMFBD
  - **HiFI+ No. 3:** Ca II H at 396.8 nm and TiO at 705.7 nm, Imager M-lite 2M, FOV: 48.2″ × 30.8″ (1936 × 1216 pixel) and 76.5″ × 60.5″ (1536 × 1216 pixel), 6-second cadence image selection (best 100 out of 500 images), speckle masking image restoration
- A data reduction pipeline for Level 0→1 data is available on site, which also provides provisions for image restoration (KISIP & MOMFBD). However, only a very limited number of images can be restored on site.

New High-resolution Fast Imager (HiFI+) @ GREGOR





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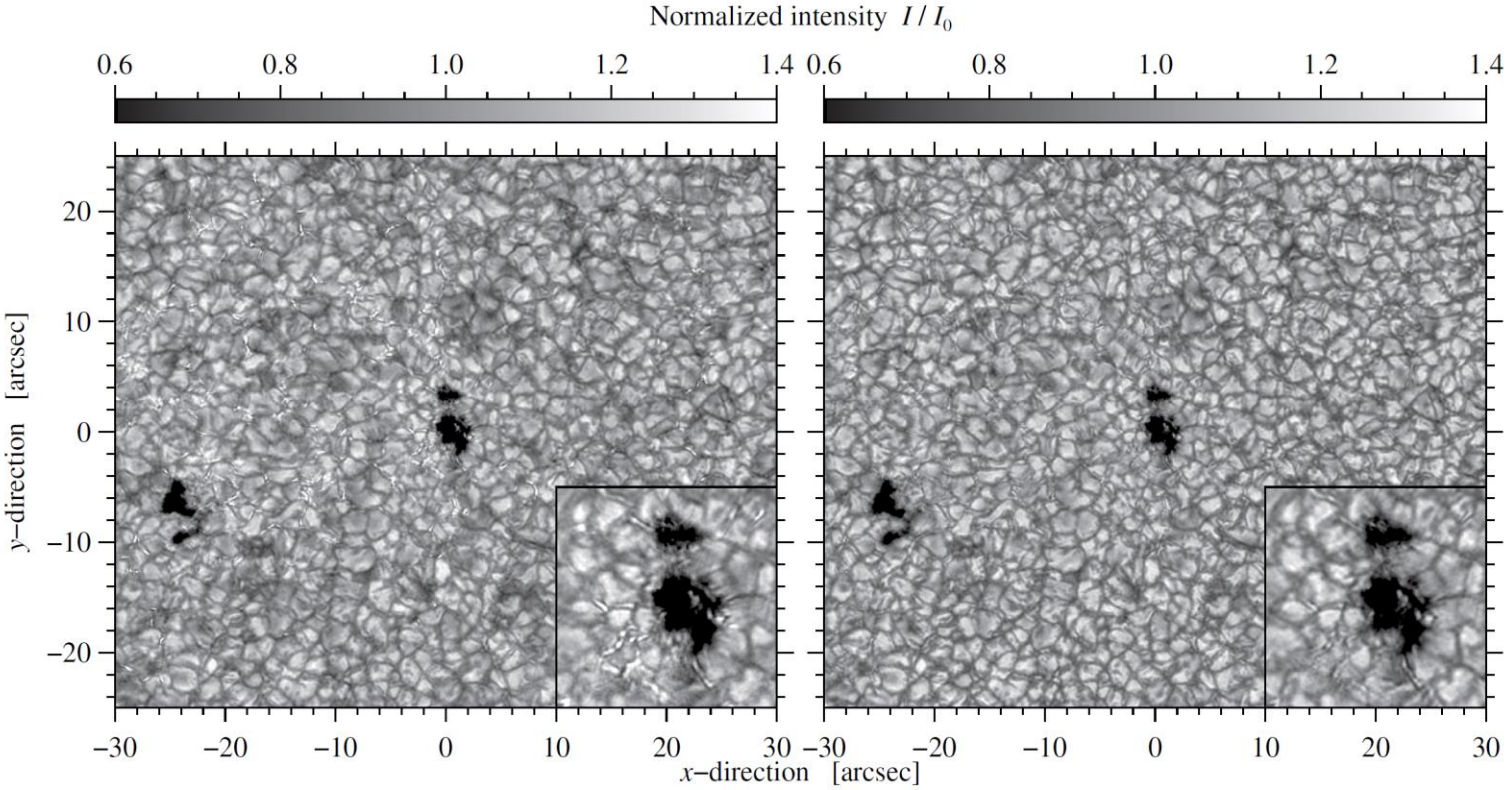

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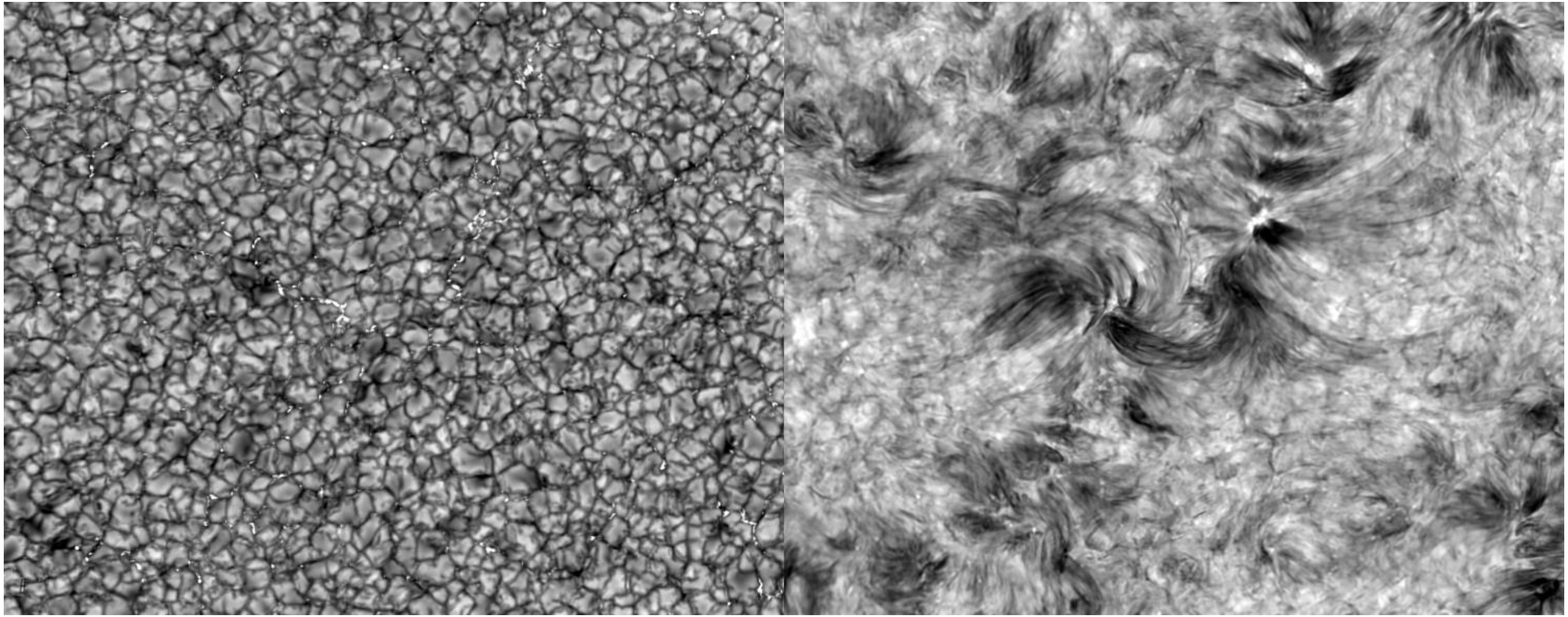

Denker, Kuckein, Verma, González Manrique, Diercke, Enke, Klar, Balthasar, Louis, and Dineva 2018: *High-cadence Imaging and Imaging Spectroscopy at the GREGOR Solar Telescope—A Collaborative Research Environment for High-resolution Solar Physics.* The Astrophysical Journal Supplement Series **236**, 5, doi: 10.3847/1538-4365/aab773

Denker, Dineva, Balthasar, Verma, Kuckein, Diercke, and González Manrique 2018: *Image Quality in High-resolution and High-cadence Solar Imaging.* Solar Physics **293**, 44, doi: 10.1007/s11207-018-1261-1

Kuckein, Denker, Verma, Balthasar, González Manrique, Louis, and Diercke 2017: *sTools—A Data Reduction Pipeline for the GREGOR Fabry-Pérot Interferometer and the High-resolution Fast Imager at the GREGOR Solar Telescope.* IAU Symposium **327**, 20, doi: 10.1017/S1743921317000114

Fast Multi-Line Universal Spectrograph (FaMuLUS) @ VTT

- The availability of fast (30 Hz image acquisition rate) and large-format (48 megapixel) CMOS cameras such as the Imager MX50M cameras manufactured by LaVision GmbH, Göttingen motivates this project.
- The four CMOS cameras will take spectra strictly simultaneously using 2×2-pixel binning and save all data to a powerful host computer in real-time, which will also be used for data reduction on site.
- The Adaptive Optics (AO) system facilitates scanning a field-of-view (FOV) of 120″ × 240″ in about one minute with an image scale of 0.36″ pixel^{-1}.
- FaMuLUS will be a unique instrument, which combines high-spectral resolution, simultaneous multi-line spectroscopy at four wavelength settings, large FOV, high-cadence, and moderately high spectral resolution.

- On-disk observations
  - Hβ 4861 Å — Cr I 5782 Å
    Hα 6563 Å — Fe I 7090 Å
- Prominence observations
  - Sr II 4078 Å — Hβ 4861 Å
    He I/Fe II 5015/5018 Å — Hα 6563 Å
  - Sr II 4078 Å — Hδ 4102 Å
    Na D_1 5896 Å — Hα 6563 Å
- Stokes I inversion of Cr I lines
- PCA-based denoising of spectral lines
- Cloud model inversions of Hα, Hβ, and Hδ

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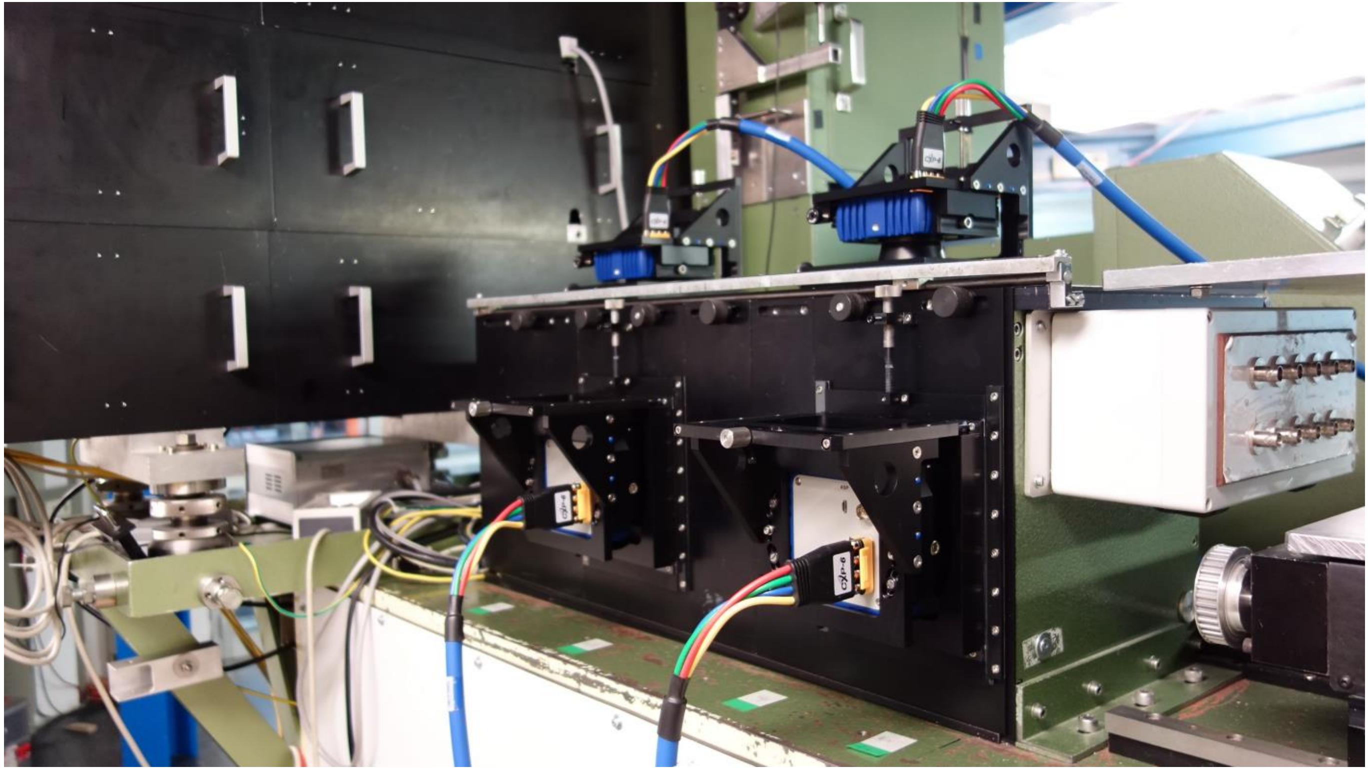

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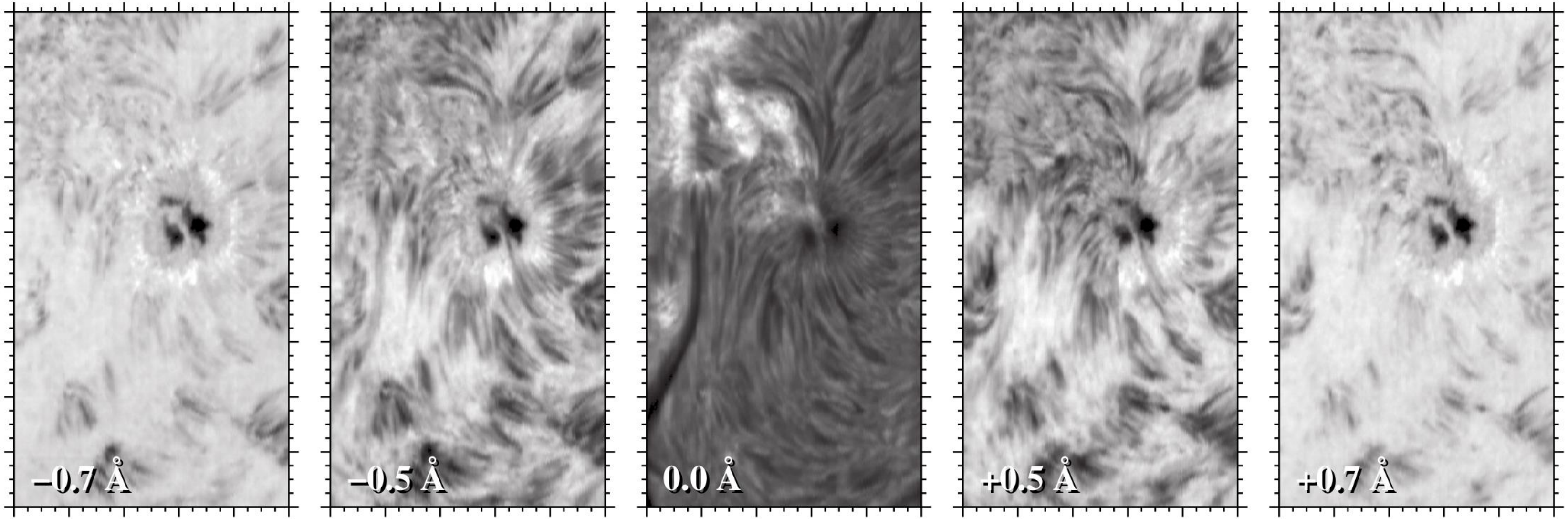

Slit-reconstructed Hα intensity maps (100″ × 180″) at five wave-length settings.

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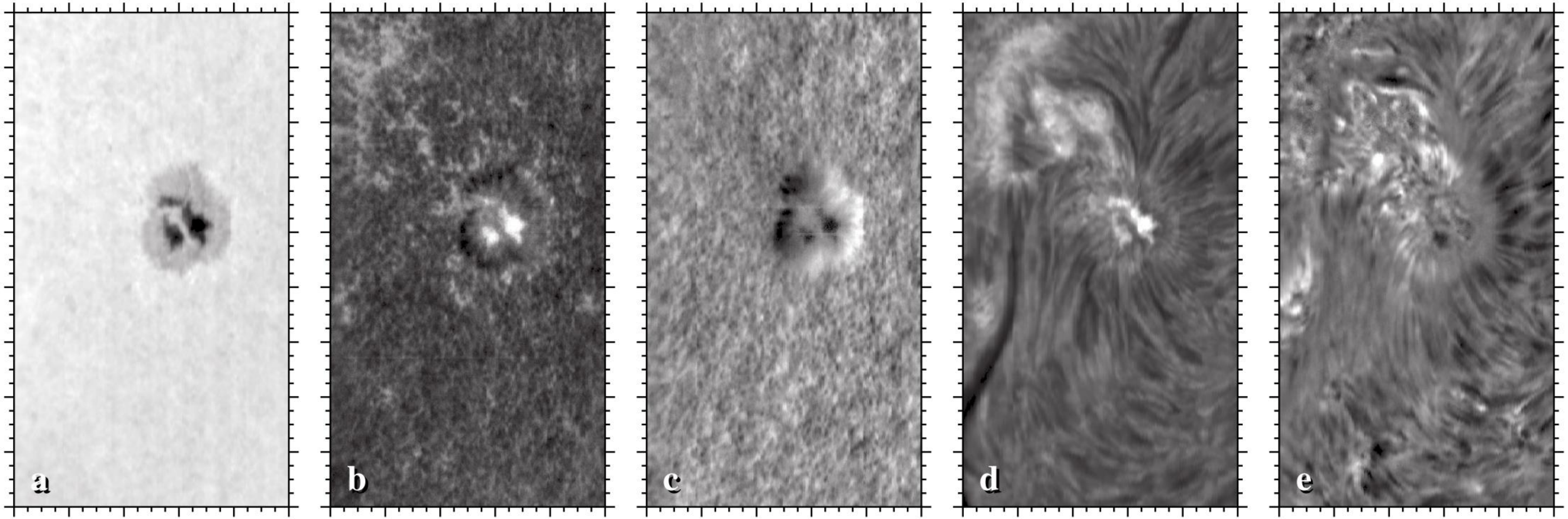

Slit-reconstructed maps displaying (a) pseudo-continuum intensity, (b) Si I line-core intensity and (c) velocity, and (d) Hα line-core intensity and (e) velocity.

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