

Photospheric and chromospheric observations with solar telescope at Hvar Observatory



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Abstract

The double solar telescope at the Hvar Observatory consists of two Carl Zeiss refractors, one with 217 mm objective diameter used for photospheric observations and the second one with 130 mm objective diameter used for chromospheric observations. Due to a field of view of about 11 arcmin for the photosphere and 7 arcmin for the chromosphere, Hvar solar telescope aims to produce the high-resolution and high-cadence imaging of active regions on the Sun. The modern Pulnix TM-4200GE 12-bit 4 megapixel CCD cameras recording seven frames per second together with the software that automatically selects the sharpest frames allow to study the rapid changes on the Sun in great detail. High-cadence ground-based observations are an important tool to identify and study solar flares, filaments and other solar phenomena that are associated with coronal mass ejections and their propagation to the Earth. Aiming to improve the space weather forecasts using ground-based observations, we compiled the catalogue of Hvar solar telescope observations in the solar cycle 24. In addition, expansion of this catalogue in future will be used for comparison with ALMA-SSALMON observations.

Acquisition system and data storage

Both telescopes are equipped with Pulnix TM-4200GE 12-bit CCD cameras, connected to two PCs in the control room below the dome. The acquisition software displays the real-time images and saves the data time-series in the FITS and JPEG format with corresponding information headers. It also regulates the exposure time automatically and performs the frame selection (from 7 frames per second obtained by CCD) with aim to select the moments of good seeing. The regular observing setup saves every 15 seconds one chromospheric image and every minute one photospheric image. Additionally, a cadence up to 30 images per minute is available for specific purposes. All obtained data are stored in central archive on the server located in Zagreb and are available to public upon request. Daily logs and movies with photosphere and chromosphere observations can be accessed on our website: oh.geof.unizg.hr.

Introduction

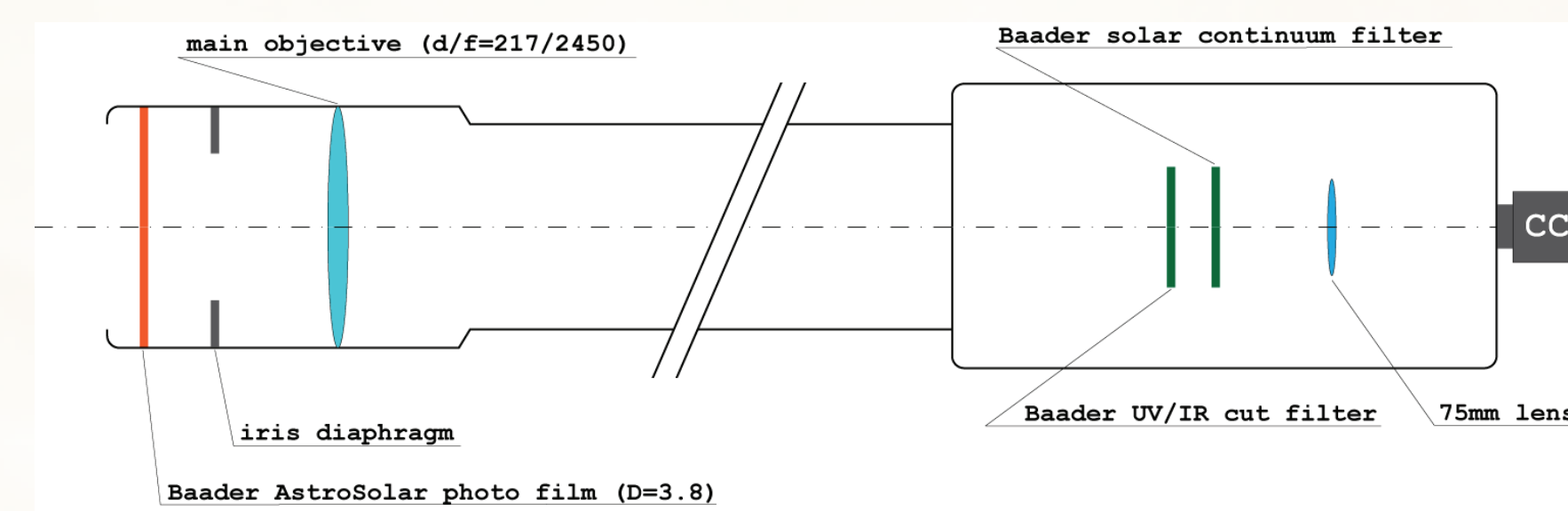


The double solar telescope at Hvar Observatory was built in 1972. Since that time, continuous development of the telescope and its acquisition system followed the rapid evolution of the electronics and computers. In 1997 the original photographic material acquisition system was replaced by a video-recording system, and then again in 2004 with 1MPix 10-bit CCD camera. In 2010, the fourth generation of acquisition hardware and software was installed and several improvements on the optical telescope design were made. As a result of tight collaboration between the Faculty of Geodesy and the Institute of Physics (IGAM) of the University of Graz, Hvar Observatory implemented similar acquisition system as the Kanzelhöhe Solar Observatory. Since 2011, the Hvar solar telescope operates continuously in solar cycle 24 with the aim to complement Kanzelhöhe full-disc images by Hvar active-region high-resolution images.



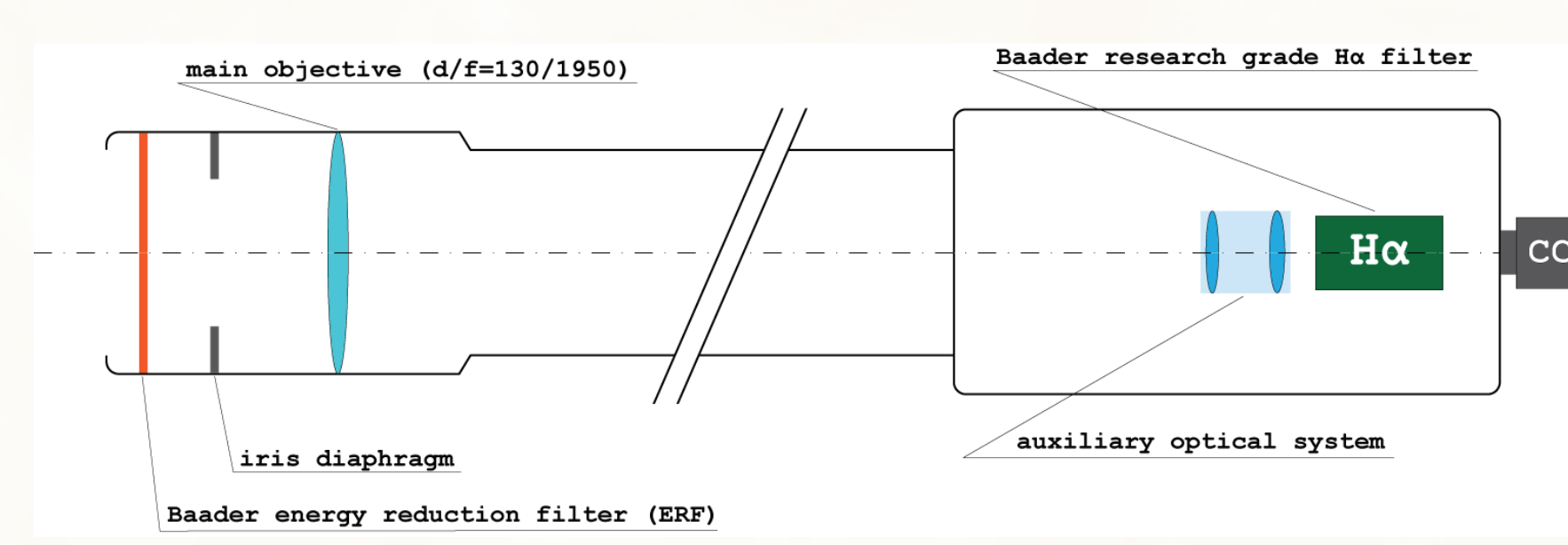
The Photosphere Telescope

The main objective of the Hvar photosphere telescope is achromatic doublet with diameter of 217 mm and the focal length of 2450 mm. The optical system consists of Baader AstroSolar photo film, iris diaphragm, Baader solar continuum, UV/IR cut filter, 75mm lens and CCD camera. The field of view of the corresponding system is about 11.28 arcmin, yielding the resolution of 0.33 arcsec/pix with 4Mpix Pulnix CCD camera.



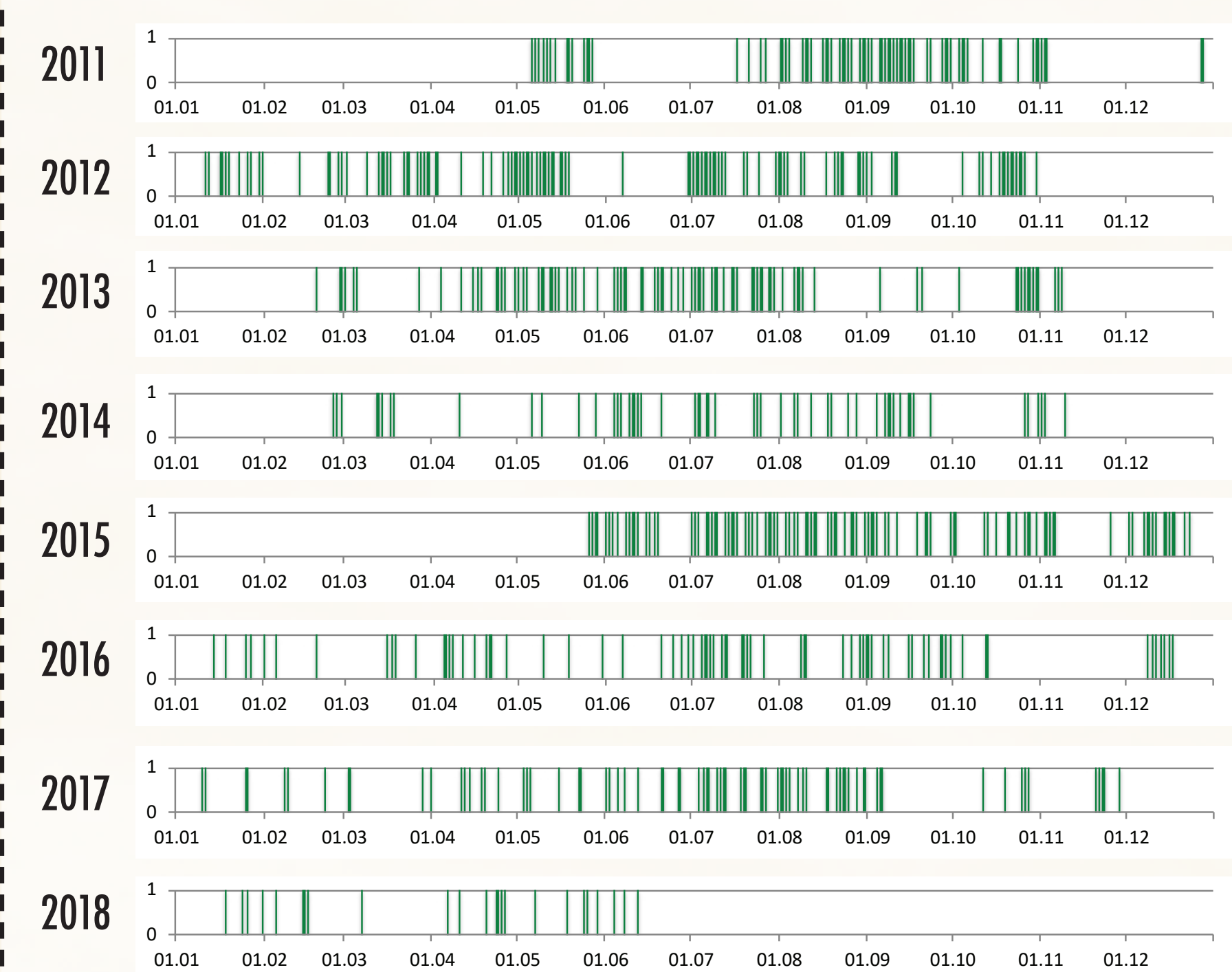
The Chromosphere Telescope

The optical system of the chromosphere telescope consists of an energy reduction filter, iris diaphragm, main objective, auxiliary lens, H-alpha filter with 0.2 Å passband and CCD camera. The main objective is an achromatic doublet with a diameter of 130 mm and focal length of 1950 mm. The field of view with corresponding system is about 7.15 arcmin what gives 0.21 arcsec/pix with 4Mpix Pulnix CCD camera.



Observations in solar cycle 24

Distribution of observations 6.5.2011 - 12.6.2018

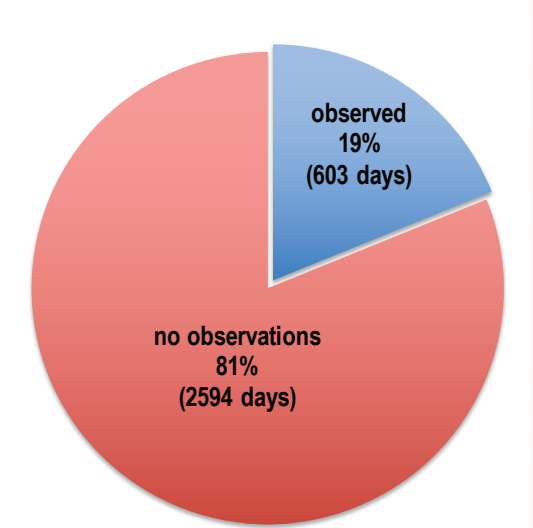


Chromosphere (15s cadence)

- Number of days observing: 603
- Number of images: 593 000
- Total duration: 2471h (103 days)
- Size in archive: 4.73 Tb

Photosphere (60s cadence)

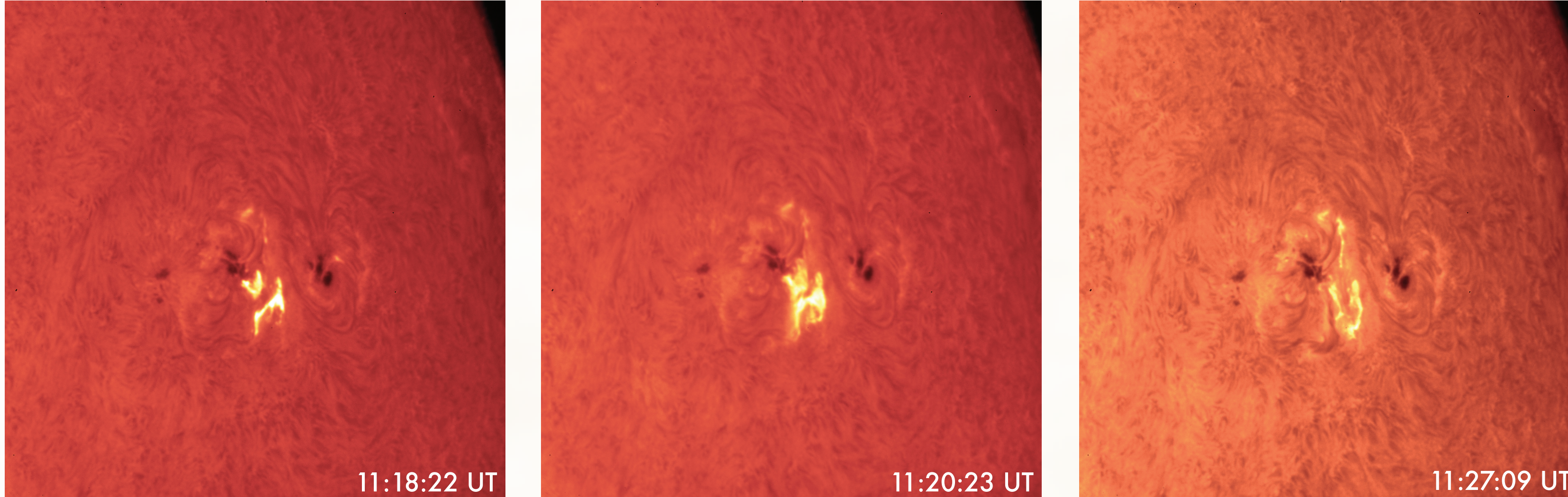
- Number of days observing: 583
- Number of images: 141 000
- Total duration: 2351h (98 days)
- Size in archive: 1.12 Tb



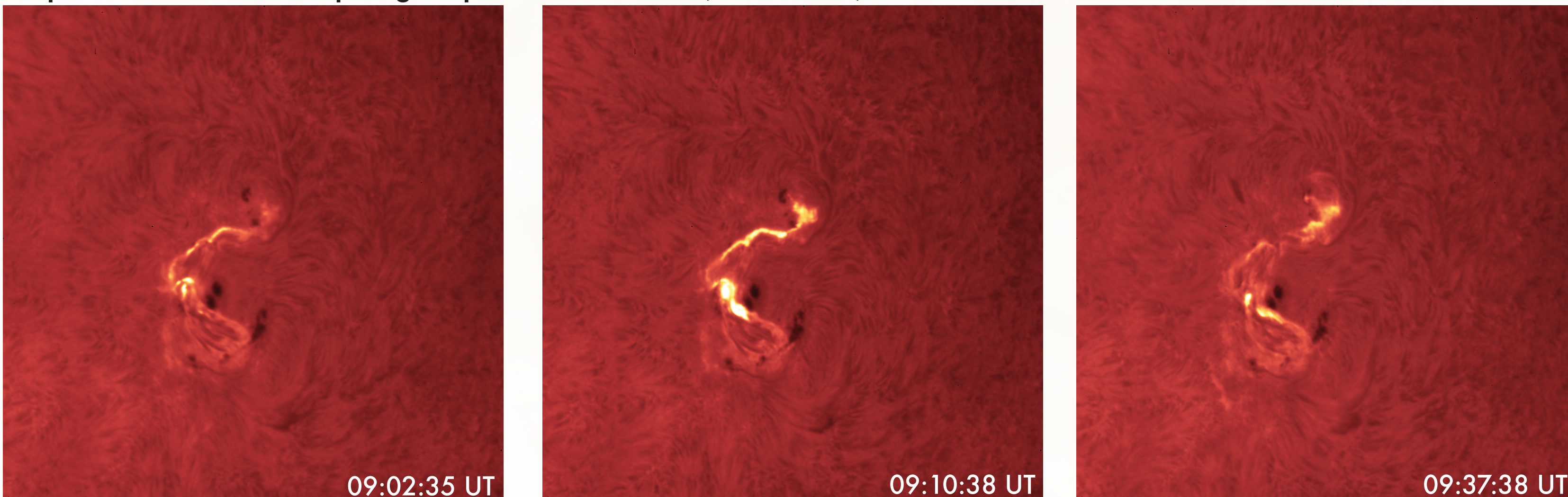
Observations

Chromosphere

21 July 2016, sunspot group: 12567, C7.2 (11:19 UT) flare

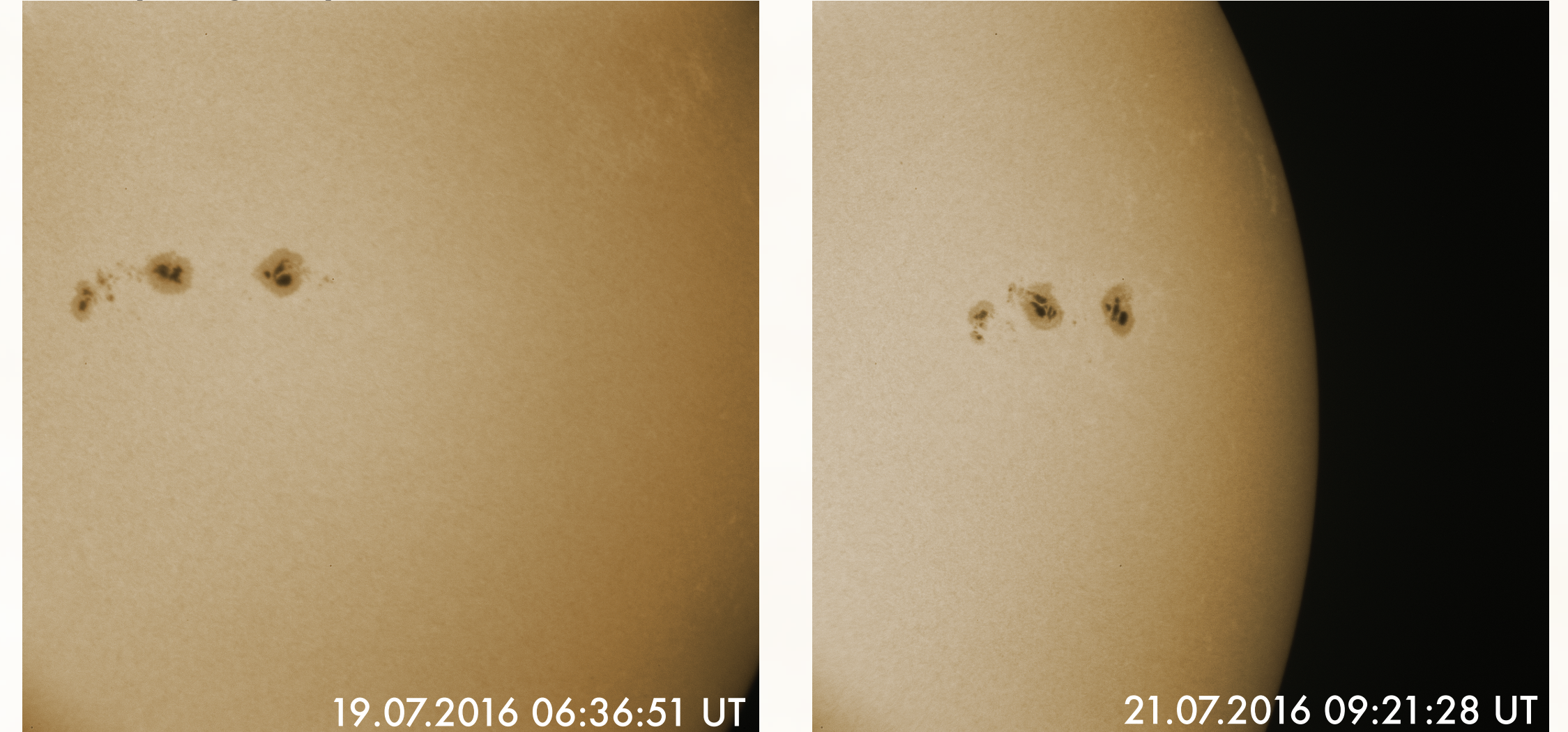


6 September 2017, sunspot group: 12673, X2.2 (09:10 UT) flare

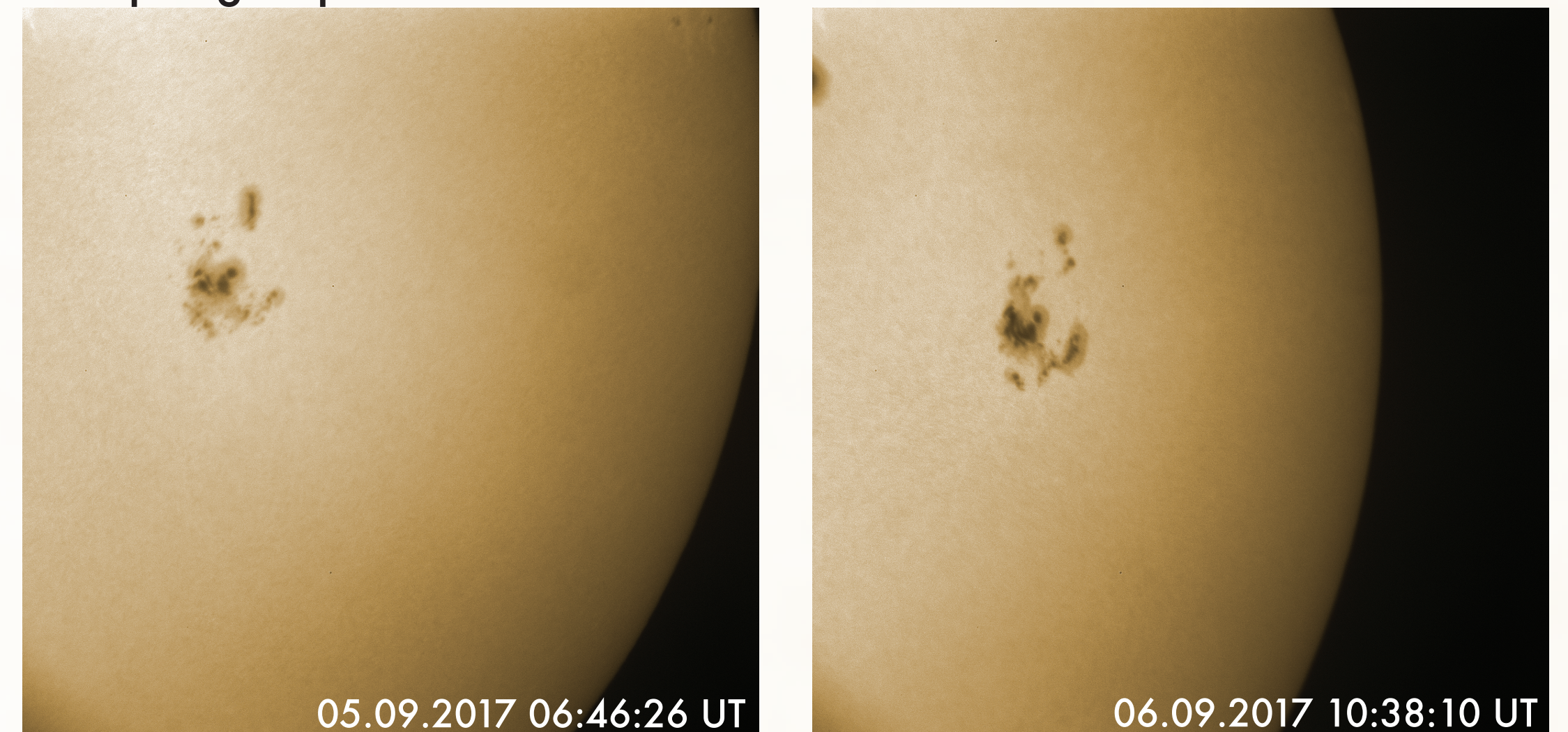


Photosphere

Sunspot group: 12567



Sunspot group: 12673



Acknowledgements:

This work has been supported by the Croatian Science Foundation project 6212 "Solar and Stellar Variability" (SOLSTEL). We thank technicians Nikša Novak and Toni Visković for performing observations on the telescope.

For more information about Hvar Solar Telescope visit: <http://oh.geof.unizg.hr/index.php/en/instruments/solar-telescope>

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