

# System for simultaneous observation of solar flares in spectral lines of H-alpha and CaII K

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## Summary:

This work presents current state of new system for CCD observations of solar activity manifestations and introduces the first results of simultaneous observations of solar flares in spectral lines H $\alpha$  and CaII K.

System provides synoptic and detail observations of photosphere and prominences in the mentioned lines.

Further part introduces system of data quality management, archiving and availability, and opportunities of further processing.

## Introduction

Observatory Valašské Meziříčí has a long tradition in observing of solar activity. Synoptic photographs of solar photosphere have been taken since 1957 (the International Geophysical year). Later the program was extended: 1970 - sporadic monitoring of prominences, 1979 - details in active regions in photosphere, regular photographing of prominences and sunspots, and 2001 - regular capturing of chromosphere (with TV CCD video cameras).

Since 2008 new 16-bit still image CCD cameras (G1-2000) (1) have been used. For last two years we have been extending and modernizing our observatory's equipment. Observation program is apart of education of high school and university students focused on monitoring solar flares and active prominences.



Figure 1: Left: synoptic telescopes on the platform. Right: Main solar telescopes in the dome.

Figure 2: One of the buildings of Valašské Meziříčí Observatory dedicated mainly to solar observations.

## Technique and methods of observations

Valašské Meziříčí Observatory is situated in southern suburb of the town and solar observations are done in the building dedicated to observations.

For observations are uses following devices placed on common equatorial mount Zeiss VII in a dome:

- Refractor AS 200/3000 mm (Herschel wedge, neutral filter, Solar Continuum, CCD G1-2000) – for observing sunspot groups in the photosphere
- Prominence coronagraph 150/1950 mm, with Šolc H $\alpha$  filter 656,3 nm with FWHM 0,5 nm and thermostat – for observing prominence
- chromospheric telescope 135/2350 mm, effective focus 5170 mm, equipped with H $\alpha$  filter DayStar 0,7 $\text{Å}$  – for observing chromosphere, primary flares
- Calcium telescope Zeiss 80/1200 mm, equipped with calcium filter for CaII K, LS152CaKMD equipped with inner filter FWHM better than 2,4  $\text{Å}$  (3)
- Refractor E 130/1930 mm – taking synoptic pictures of the Sun

On a platform are place two synoptic telescopes for imaging whole Sun disc in spectral line of Hydrogen H-alpha ((LUNT LS60TC H $\alpha$ /B1200 - 656 nm) and Calcium CaII K (LUNT LS60T CaK/B1200 - 393 nm). Both are equipped with CCD cameras G1-2000.

Cameras are controlled with native software SIPS (4) and data are saved into computers and deposited on external hard discs.

Except light images are taken also series of dark frames a flat fields (5). System is continually modernized and comments of observatory employees and visiting students are taken into account.

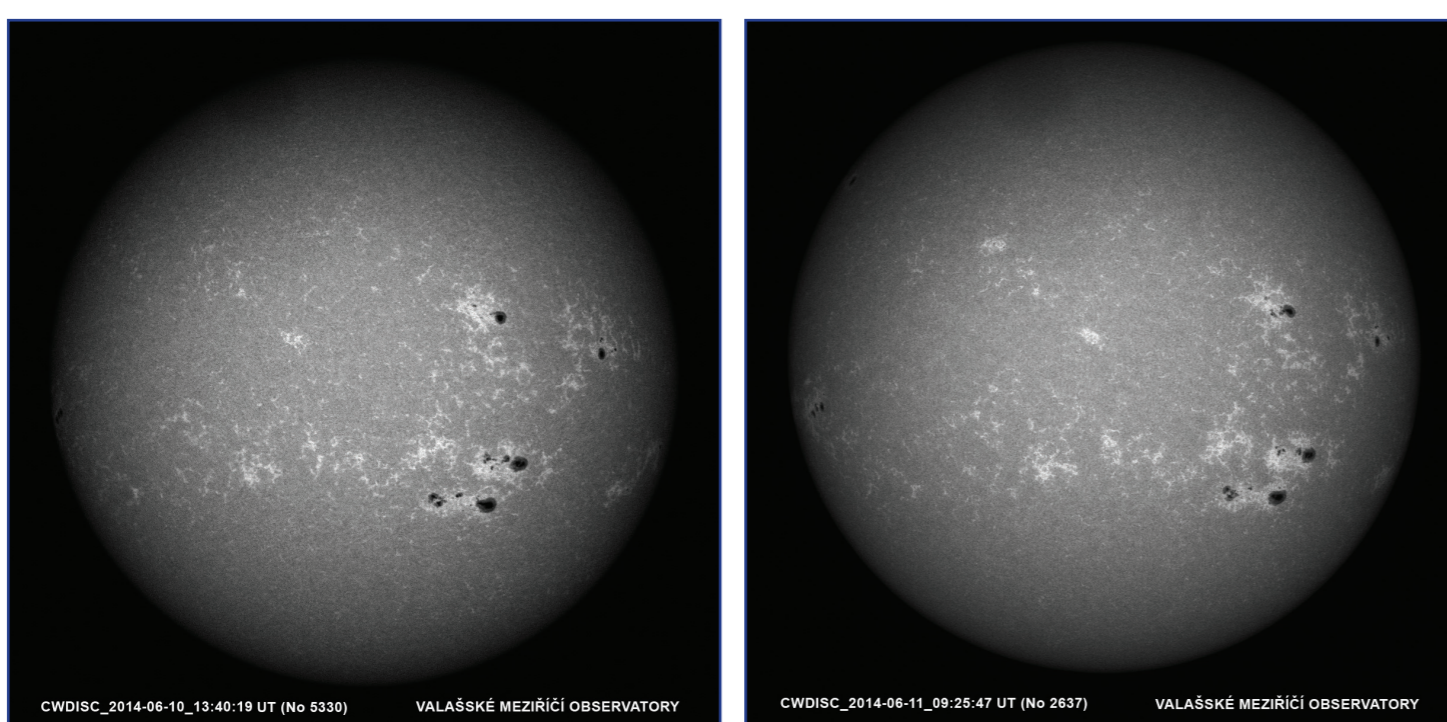


Figure 3: Synoptic observation examples in spectral line CaII K.

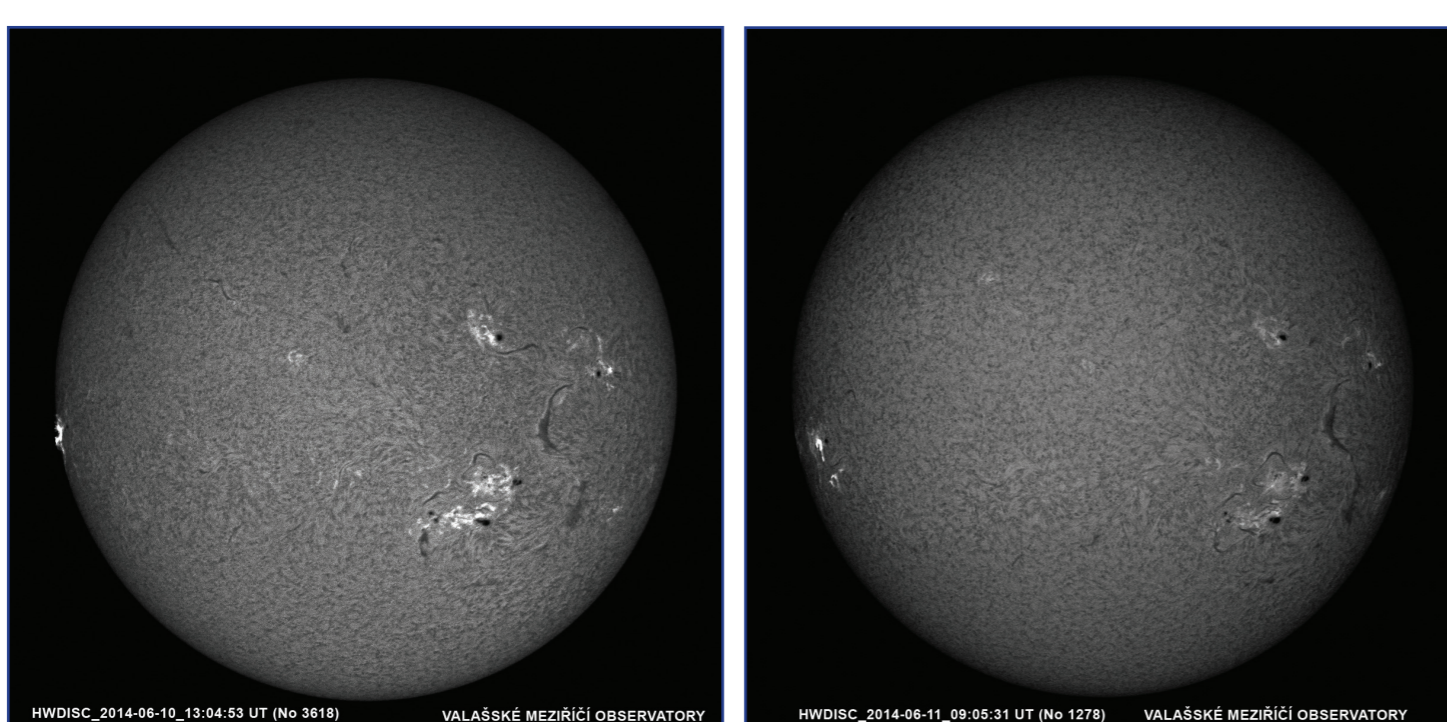


Figure 4: Synoptic observation examples in spectral line H-alpha.

## Observation programme

Main goal of observations is to get the highest quality (from both temporal and spatial resolution point of view) picture of chromospheric flares and other active events, like active and eruptive prominences and filaments. Another goal is to obtain observation material proving long-term development and changes (in the context of days) in morphology of active regions in the photosphere and the chromosphere.

During the observation season (March – November) both whole disc synoptic observations with small telescopes from the platform and detail observations with telescopes in the dome are done. The system is designed and improved to allow simultaneous observations of active processes with every single telescope in the spectral lines of Hydrogen H-alpha 656 nm and Calcium CaII K 393 nm, optionally in the photosphere using Solar Continuum filter (Baader, maximal transmission at 540 nm with FWHM 10 nm).

Images taken with CCD cameras are calibrated with dark frame and flat field, the best images are manually picked (in the case of flares are kept all the original data).

Observations are done systematically, we monitor solar activity using public sources of information and we ultimately focus on obtaining data of chromospheric flares and active prominences.

We are now trying to prepare steps for processing data, focused on:

- Relative photometry of chromospheric flares (general and parts of flares)
- Temporal evolution of ribbon flares' shapes
- Brightness of ribbon flares and their temporal evolution (detail and global characteristic)

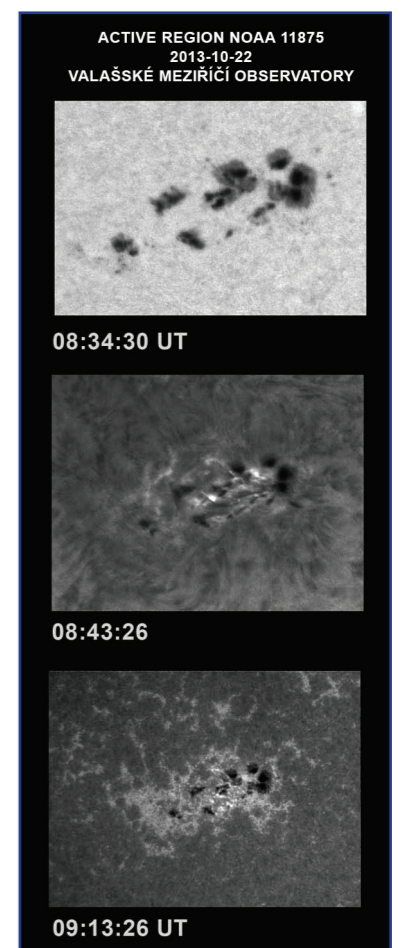


Figure 5: Examples of observation in spectral lines and continuum (NOAA 11875).

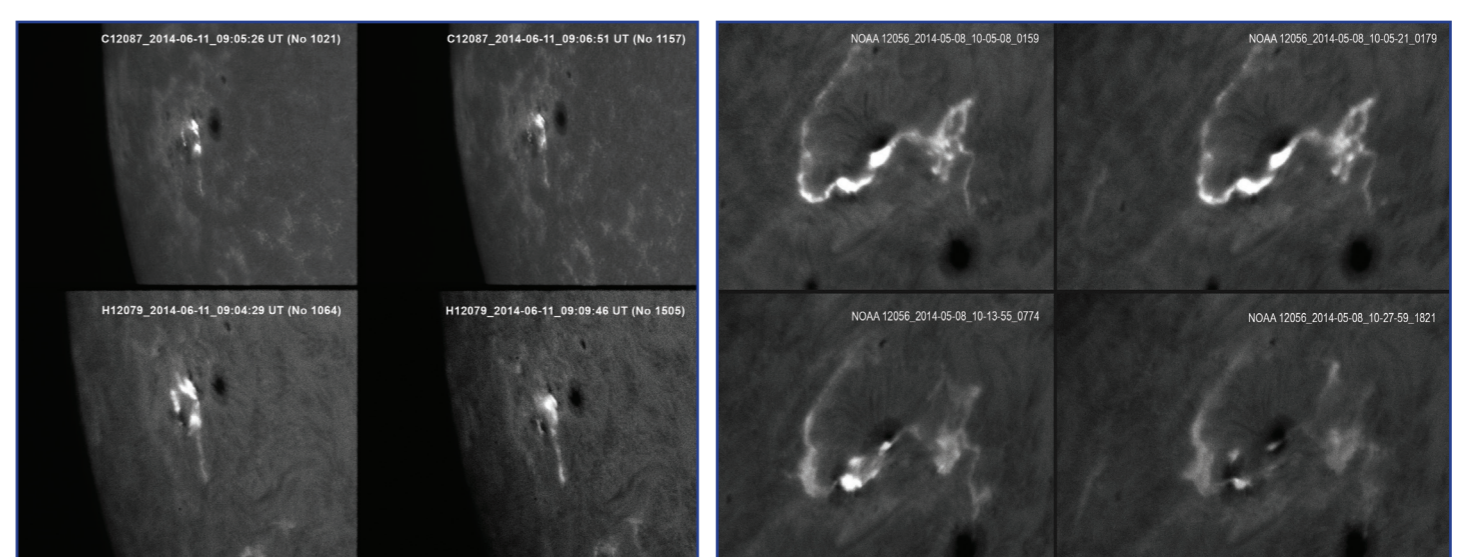


Figure 6: Example of simultaneous observation of a chromospheric flare in the active region NOAA 12087 (June 11, 2014).

Figure 7: Example of observation of the temporal evolution of a chromospheric flare in active region NOAA 12056 (May 08, 2014).

Top: Detail observation in CaII K spectral line.  
Bottom: Detail observation in H-alpha spectral line.

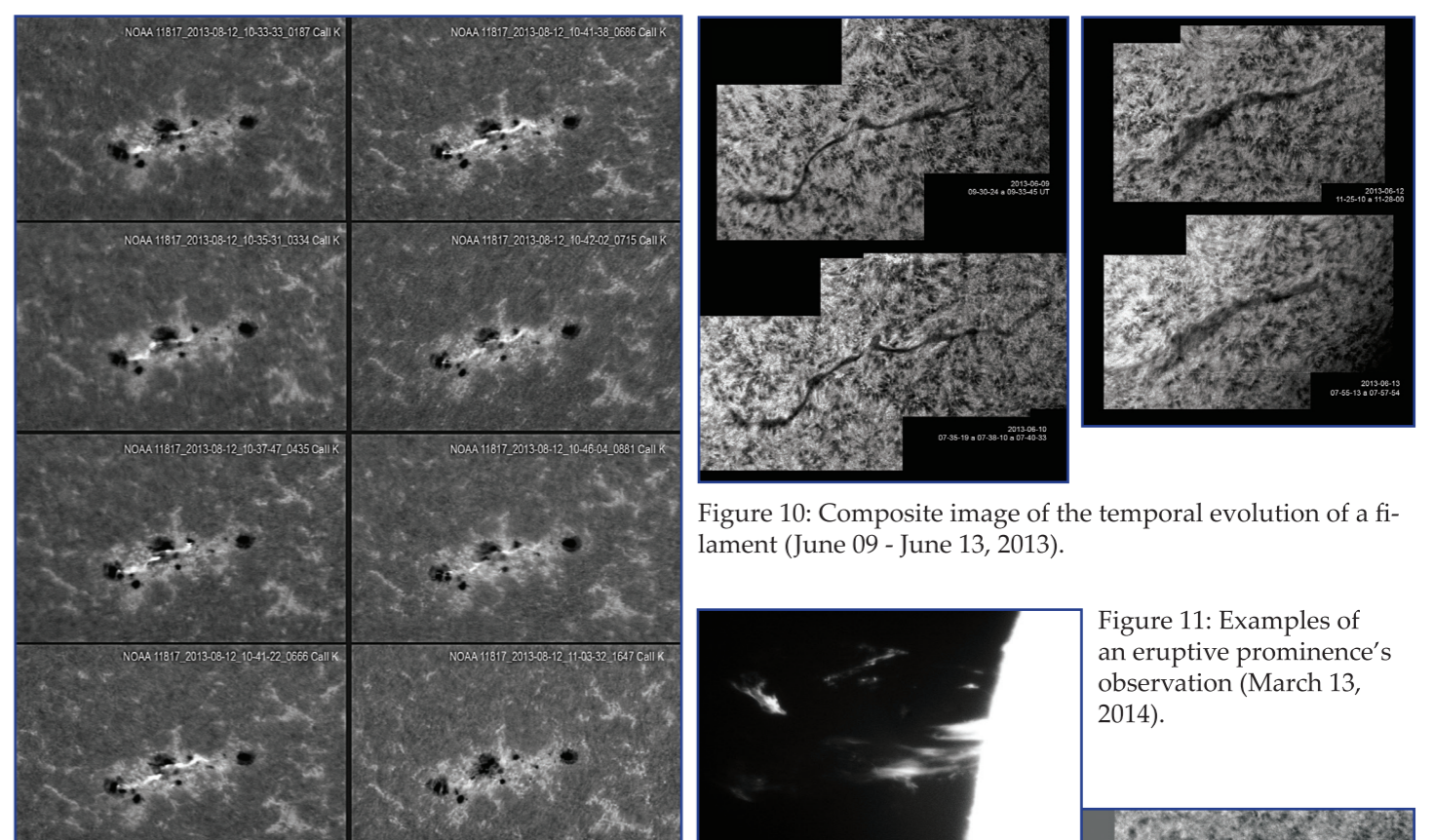


Figure 8: Observation of a chromospheric flare in the active region NOAA 11817 in CaII K spectral line (August 12, 2013).

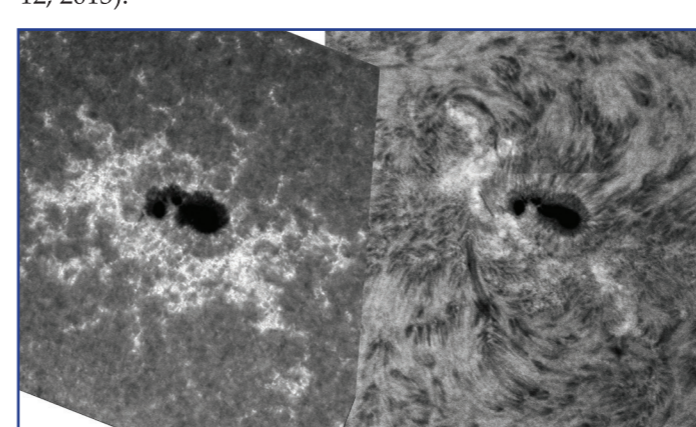


Figure 9: Comparison of images of the active region NOAA 11745 in CaII K spectral line (left) and H-alpha spectral line (May 16, 2013).

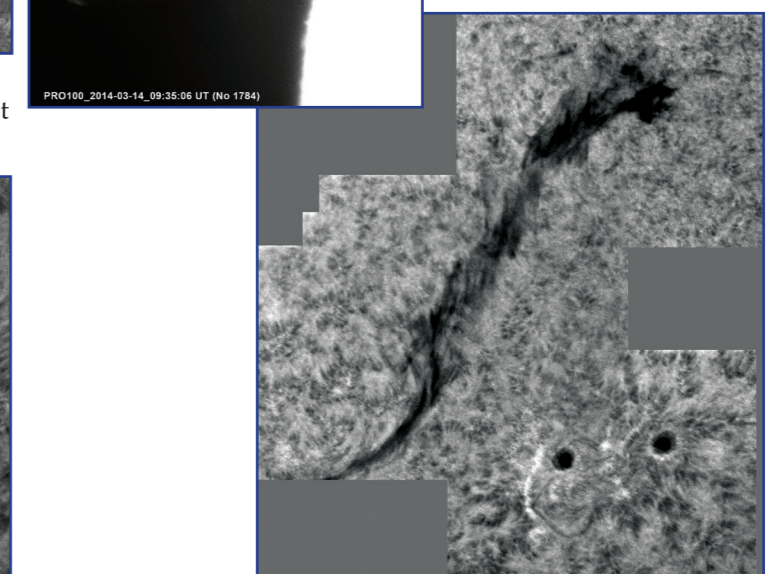


Figure 10: Composite image of the temporal evolution of a filament (June 09 - June 13, 2013).

Figure 11: Examples of an eruptive prominence's observation (March 13, 2014).

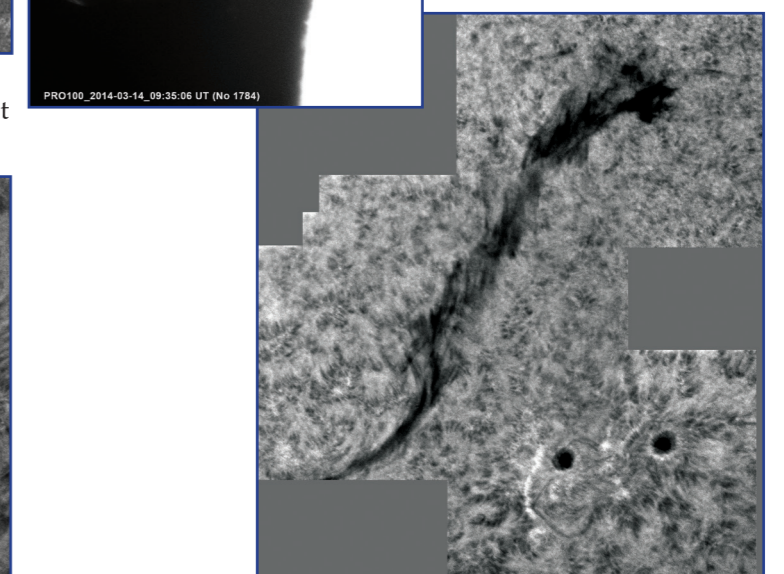


Figure 12: Composite image of an eruptive filament. Bottom right is active region NOAA 11538 (August 06, 2012).

## Conclusion

The goal of this poster was to introduce current technical situation and opportunities at the Valašské Meziříčí Observatory. Further the presentation selected examples of observations in both spectral lines and continuum. At the present time, we go on with standard observations and try adapt the whole system to experience of last two years of work.

We would be pleased to establish cooperation with other institutions, as well as with students for processing and interpretation of observations.

## References:

- (1) G0 and G1 series of imaging/guiding cameras, Moravian Instruments, online <http://www.gxccd.com/art?id=328&lang=409>; (June 18, 2014)
- (2) G2-2000 and G2-4000 CCD Cameras, Moravian Instruments, online <http://www.gxccd.com/art?id=361&lang=409>; (June 18, 2014)
- (3) Filtr Lunt LS152CaKMD vápníkový modul, online <http://www.supra-dalekohledy.cz/filtr-lunt-ls152cakmd-vapnikovy-modul-3-4723.html>; (June 18, 2014)
- (4) SIPS version 2.2 released, <http://www.gxccd.com/art?id=423&lang=409>; (June 18, 2014)
- (5) CCD G1-2000 - CCD pozorování chromosféry na Hvězdárně Valašské Meziříčí, online <http://www.astrovm.cz/cz/odborna-cinnost/porozorvani-slunce/fotograficka-a-ccd-pozorovani/ccd-g1-2000.html> (only Czech); (June 18, 2014)