SH41A-1914

High speed imaging system in continuum and H-alpha at Hida observatory for study of high energy particles in solar flares

(SMART-HSI)

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AGU fall meeting 2011.12.5-9 in San Francisco

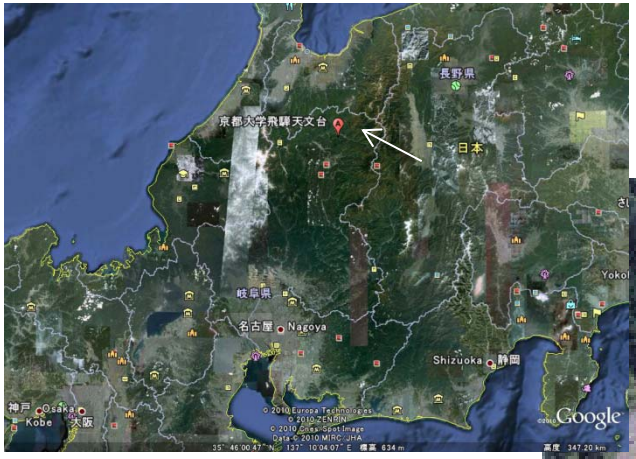
Abstract

A new high speed imaging system was installed on the Solar Magnetic Activity Research Telescope (SMART) at Hida observatory of Kyoto University to study the spatial / temporal evolution of high energy particles in solar flares. Images in Hα (width~3A) and continuum (6547A, width~10A) are recorded simultaneously with two CCD cameras with a spatial sampling of 0.22 arcsec/pix, field coverage of 344” x 258” and a frame rate of 25 fr/sec. Observation is conducted in routine base by focusing an active region of the interest of the day, while full data sets are archived only for periods of flare events for further analysis. After the first light of the system (Aug. 2011), two white light flares were recorded. The observation system and initial results are presented in this paper.

1. Introduction

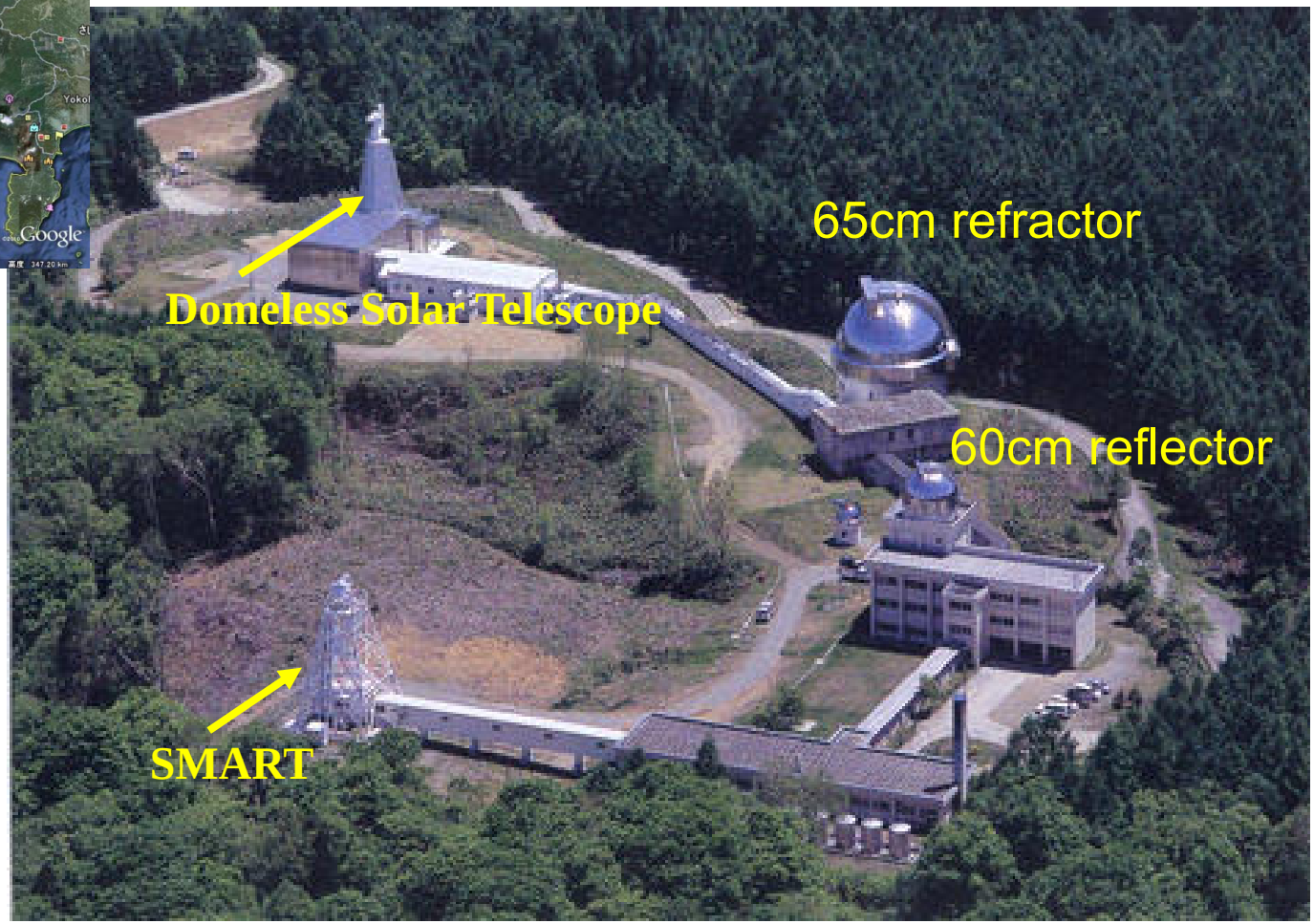
Non-thermal particles are fundamental ingredient of solar flares that carry the bulk energy released in corona and cause subsequent heating of the solar atmosphere to produce the radiation of wide range electro-magnetic waves. The observations of hard X-ray and radio emissions suggest a rapid change of population of high energy particles with a time scale of sub-second. Flare ribbons observed in visible spectral lights (ex. Hα) consists of a number of bright points, and they show drastic evolutions in space and time during the explosive phase of solar flares. Since they are thought to be the locations of the precipitation of high energy particles into the chromospheres, the observations of flare ribbons with high spatial and temporal resolutions provide crucial information on the foot points of the flaring magnetic loops and the location of the particle acceleration. Especially kernels seen in white light are of special interest for their unsettled emission mechanism and the prospected association with the flux of extremely high energy particles. For this purpose, we developed a new high speed imaging system on a 25cm diameter telescope of the Solar Magnetic Activity Research Telescope (SMART) at the Hida observatory of Kyoto University.

Hida observatory

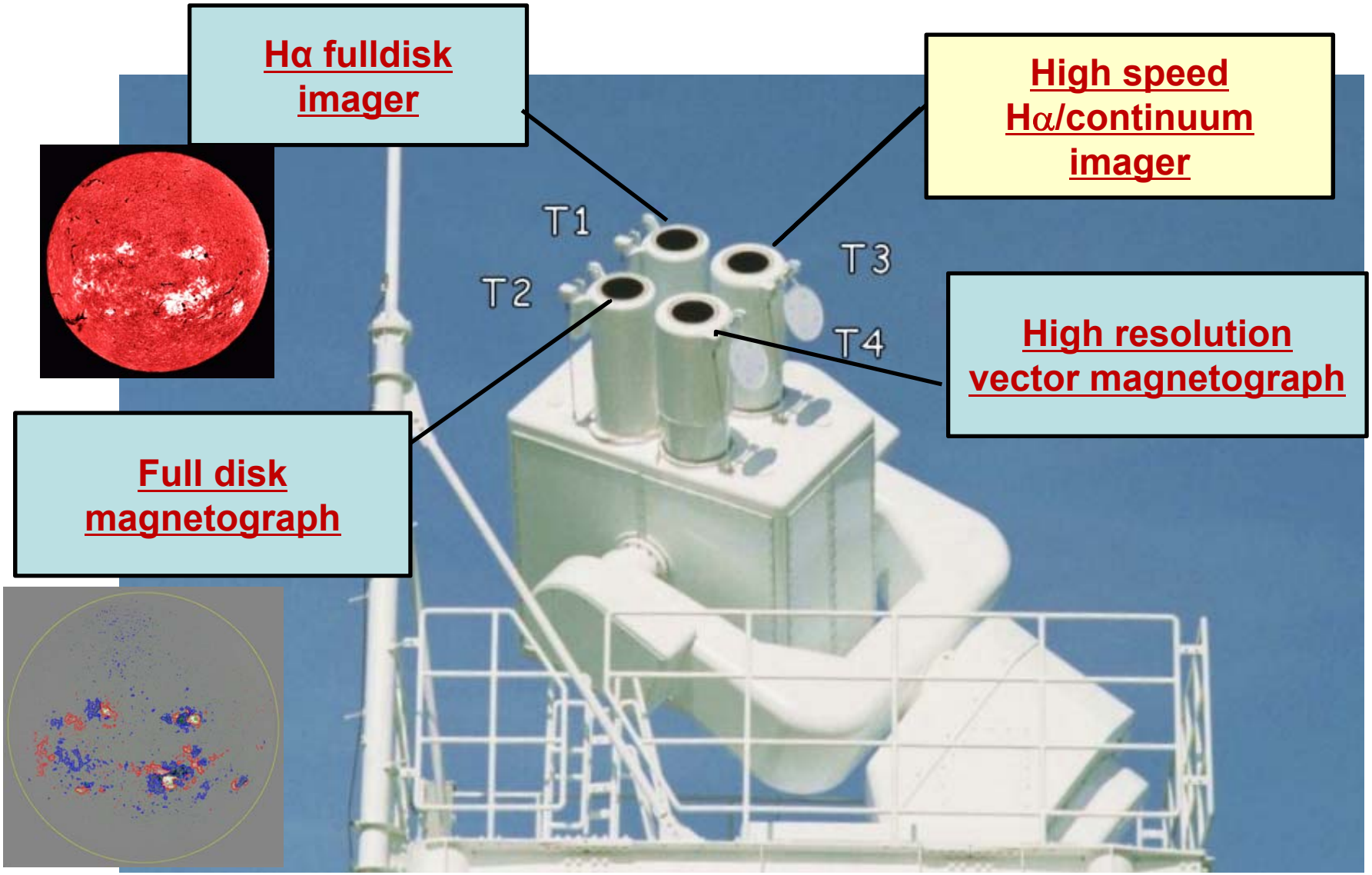


Altitude ~ 1276m

Since 1968

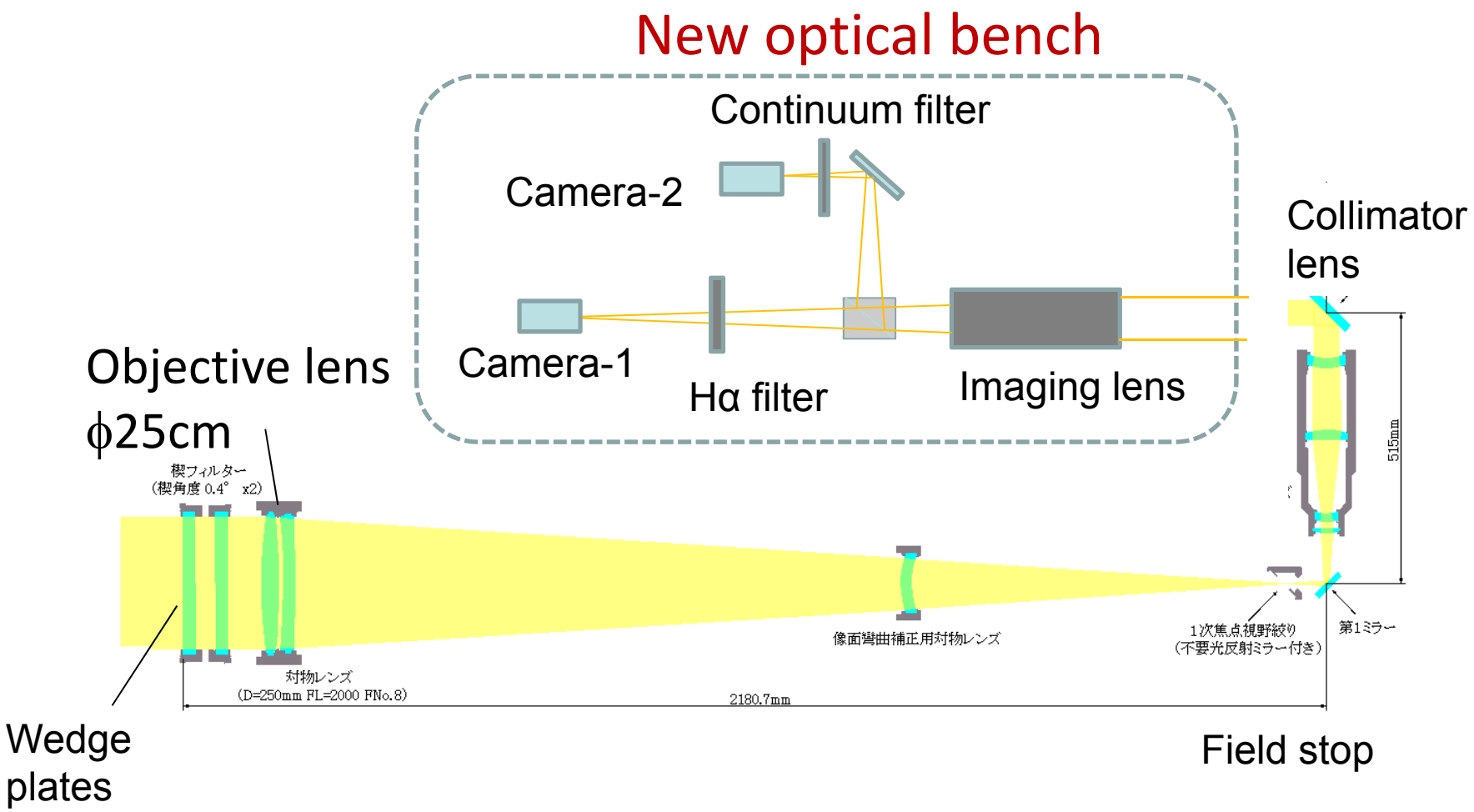


SMART (Solar Magnetic Activity Research Telescope)

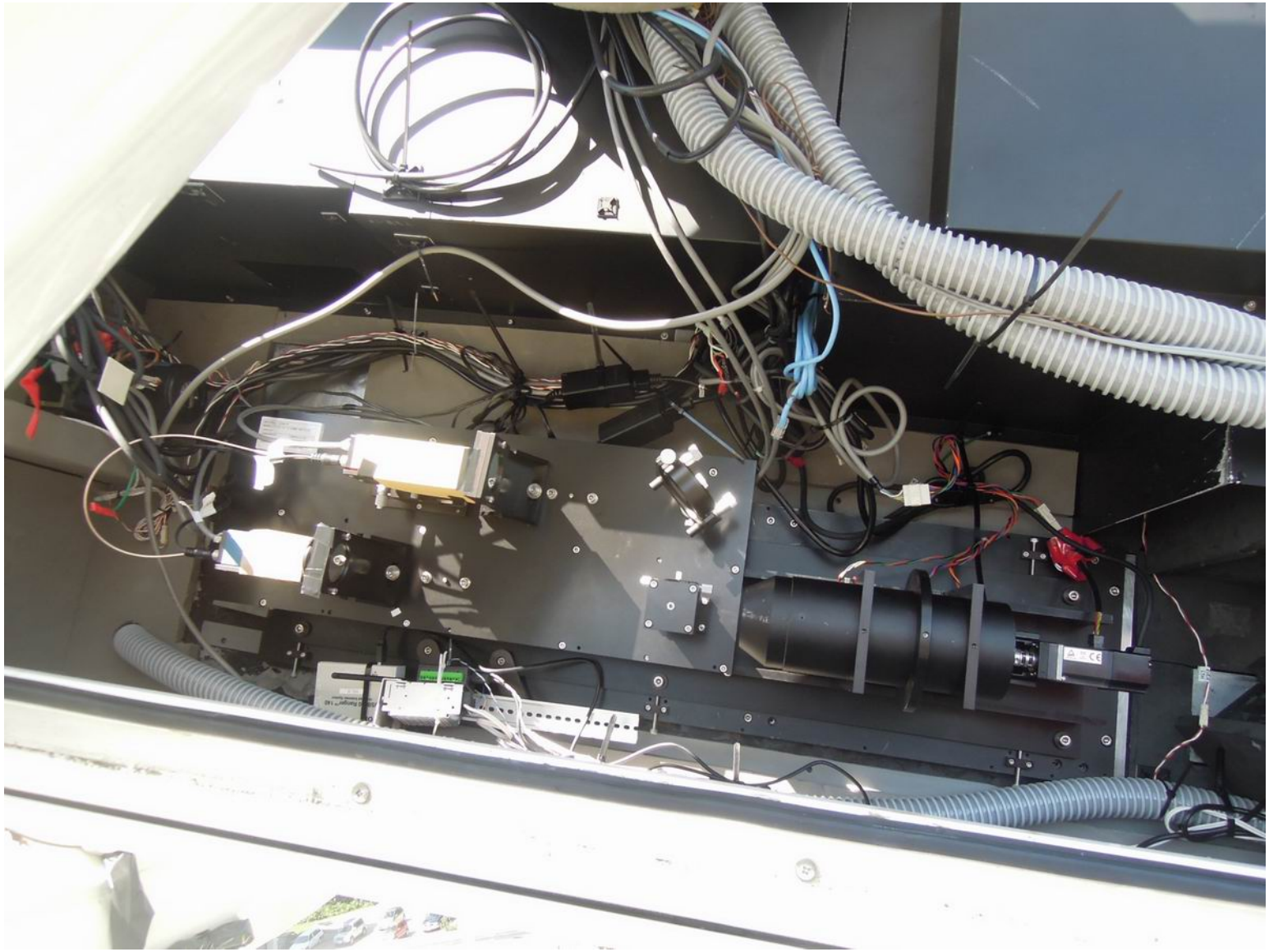


2. Observing system

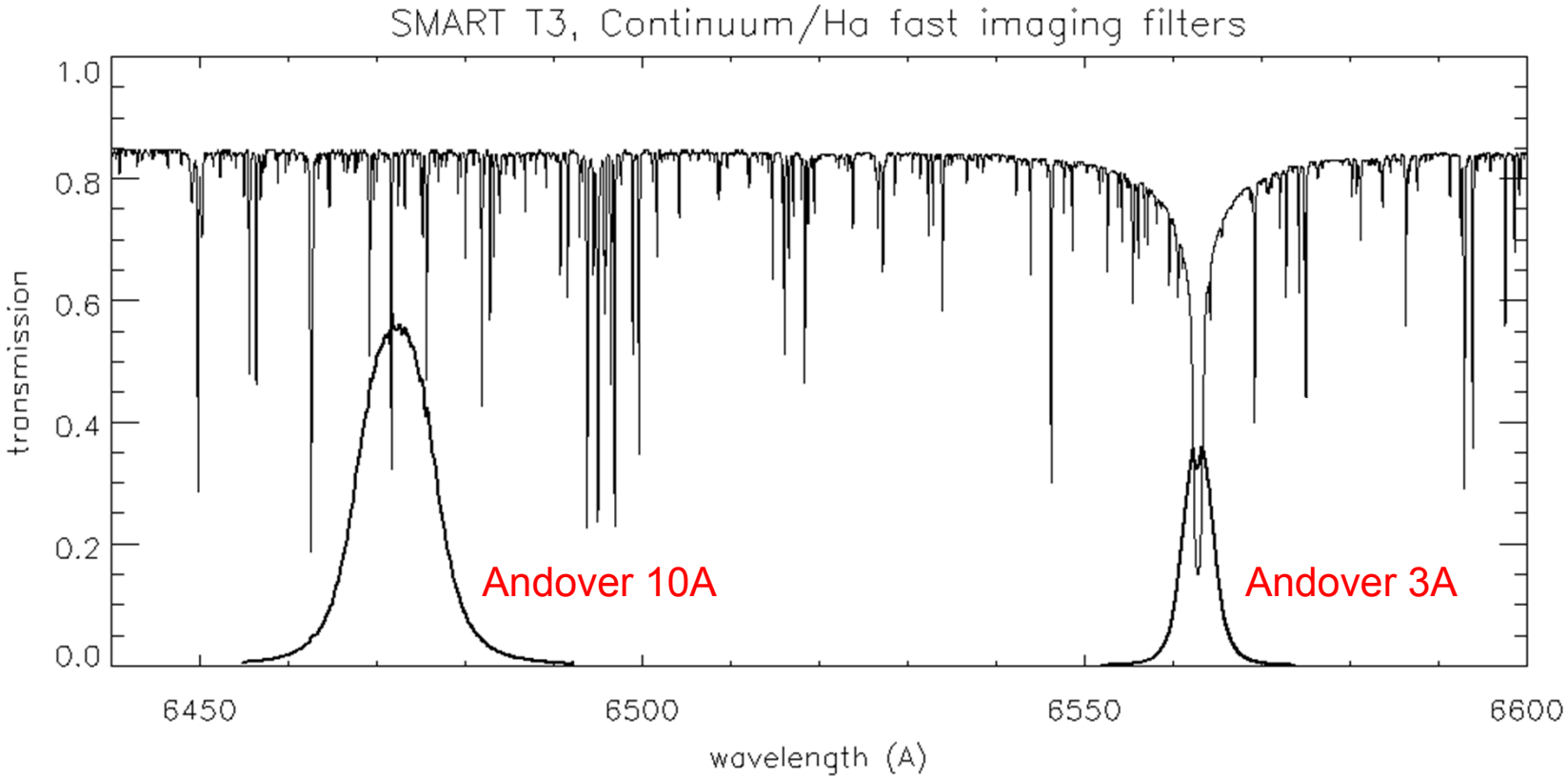
Optical layout



Optical bench



Transmission profiles of continuum and Hα filters



Component description

Component/item	description
Wedge plates (x2)	Rotate to select target region, 6200-7000A bandpass coated
Objective lens	250mm ϕ, f=2000mm, 4 elements, AR coated
Collimator/reimaging	Plate scale=29.1arcsec/mm (0.215 arcsec/pix)
Beam splitter	Transmission ratio 9:1 at 6550A
Bandpass filters	Hα (3A wide), Continuum @ 6547A (10A wide)
Camera (x2)	Prosilica GigE1650, pix.size =7.4µm x 7.4µm 1600x1200pix, 16bit AD, max.rate 32fr/sec
Computer	Windows7, 64bit, HD: 16TB raid-1
Software	Norpix Co., Streampix v.5.0
Spatial sampling	0.215 arcsec/pix
Field of view	344 x 258 arcsec^2
Exposure time	0.2 msec (typical)

Observation features

in comparison with other instruments

	BFI/Hinode	AIA/SDO	SMART-HSI
Spatial resolution	0.2”	1.2”	0.6～2”
Field of view	< 220”x110”	full disk	344”x258”
accuracy	10^{-2}	10^{-2}	10^{-2}
wavelength	CaH/ conti.	EUV/conti.	Hα/conti.
Time resolution	~20sec	12sec	0.04 sec
Time coverage	24hr/day	24hr/day	0～10hr/day

Data rate & archive

Data rate;

- 1600x1200x25(fr/s)x2(cam)x2(byte) = 192MB/s
- 192(MB/s)x3600(s)x10(hr) ~ 7TB/day

Data archive;

during a event of interest – all data are stored

other periods – 1 set of images per every 5sec is stored after frame selection

QL data is accessible at

http://www.hida.kyoto-u.ac.jp/SMART/T3/

3. Science objective

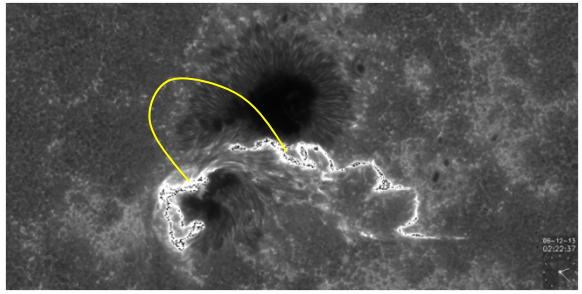
Goal:

To understand the particle acceleration mechanism in solar flares by identifying the acceleration sites in the system of coronal magnetic fields.

To understand the emission mechanism of white light flare.

Strategy:

- Identify the connectivity of magnetic fields (=flaring loops) from temporal coincidence of foot point brightenings.
- Examine spatio-temporal evolution of the flaring loop system and the propagation of injection/acceleration site of high energy particles in corona.
- Identify the location of white light flare kernels with respect to the HXR emission sources.
- Determine the geometrical height of the white light emission source in limb flares



Collaboration with:

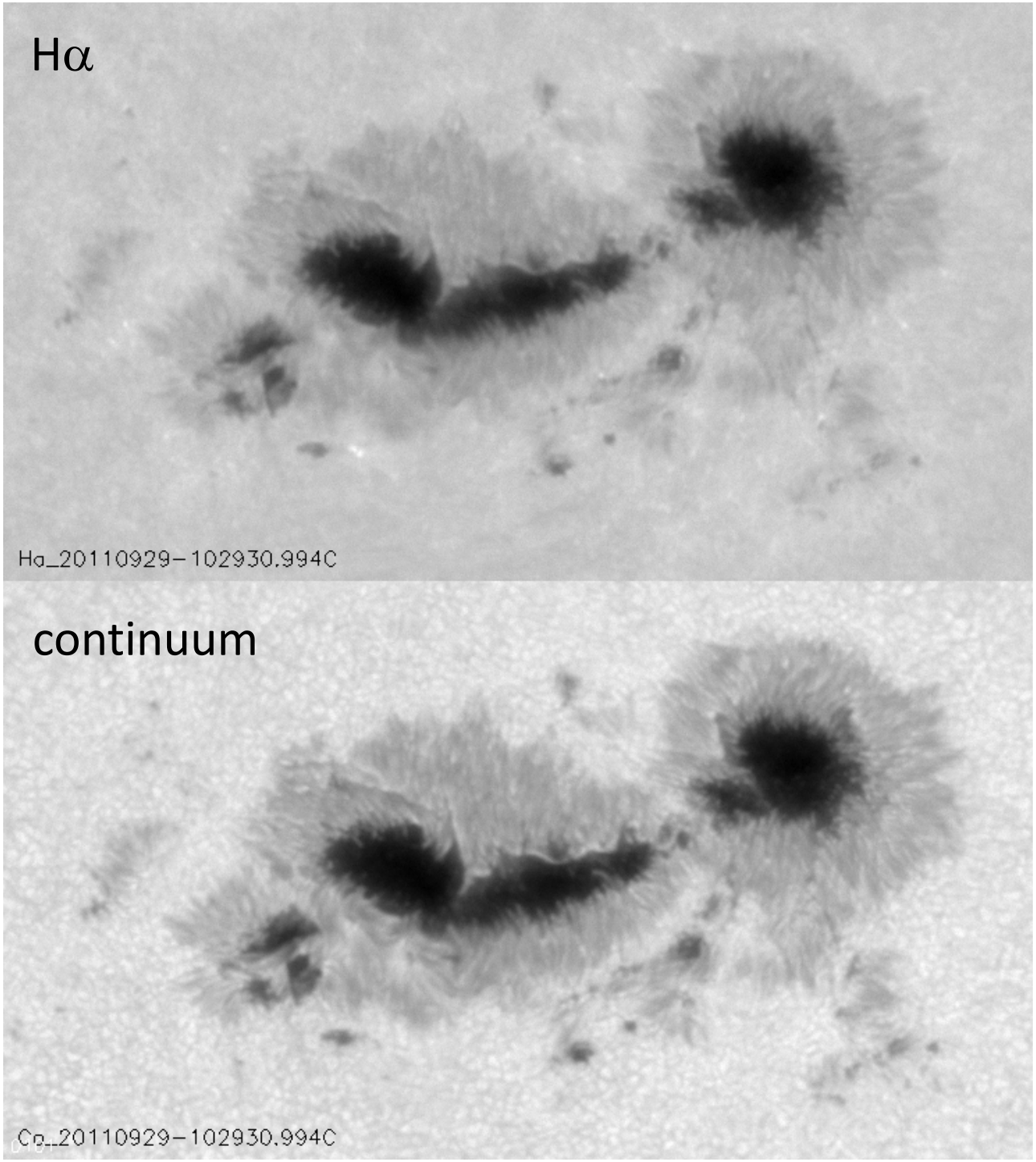
- Vector magnetograph; SOT/Hindoe, HMI/SDO, SMART/Hida
- Coronal imagers; XRT/Hinode, AIA/SDO, EIS/Hinode
- High energy emission data; NoRH, RHESSI
- Coronal field modeling
- Simulation of particle dynamics and transfer

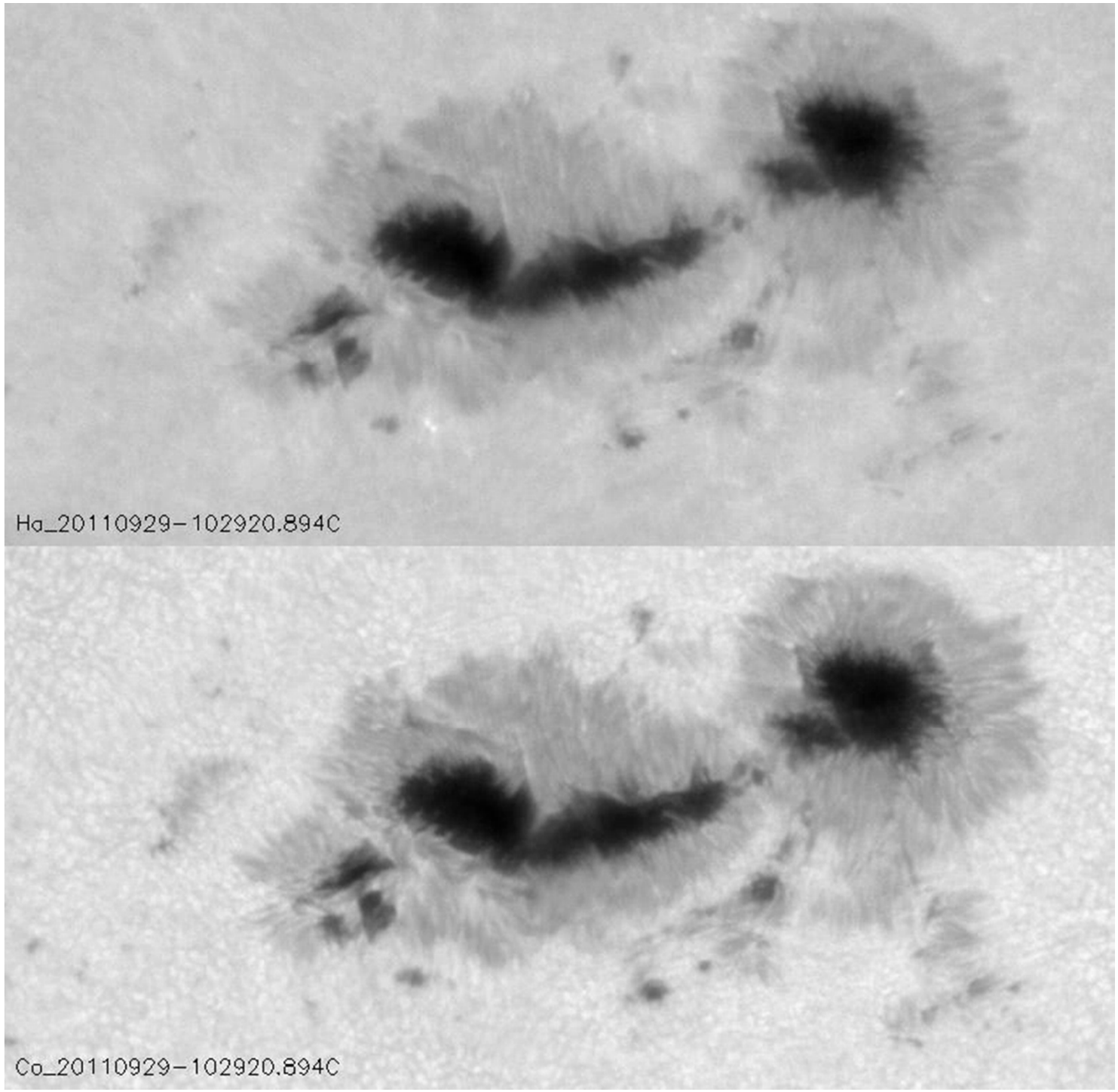
4. Initial results

First light 18 Aug. 2011

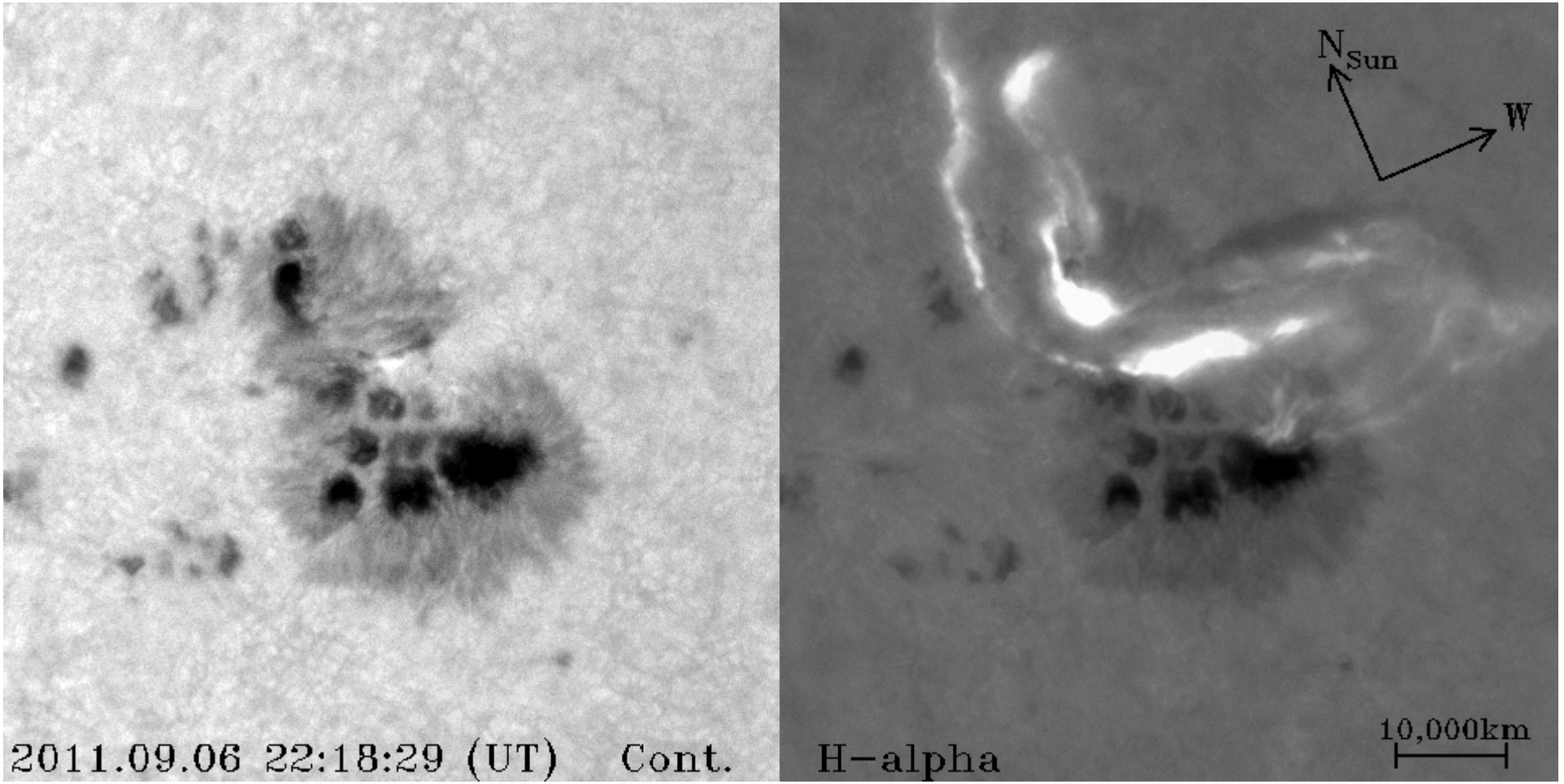
Regular observation from Nov. 2011

White light flares 6 Sep. 2011
7 Sep. 2011

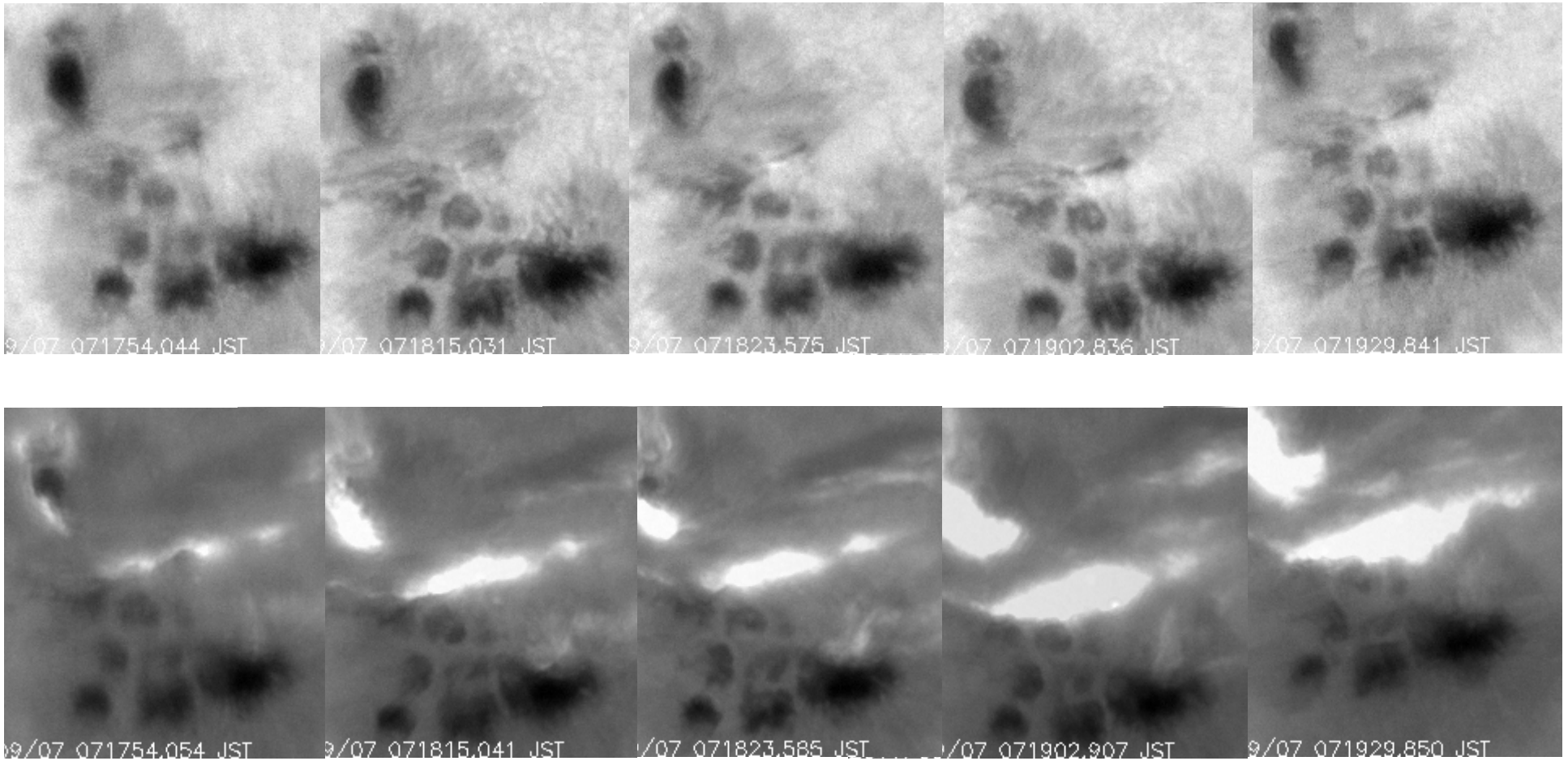

Hα
Ha_20110929-102930.994C
continuum
Co_20110929-102930.994C


Ha_20110929-102920.894C
Co_20110929-102920.894C

White light flare on 6 Sep.2011

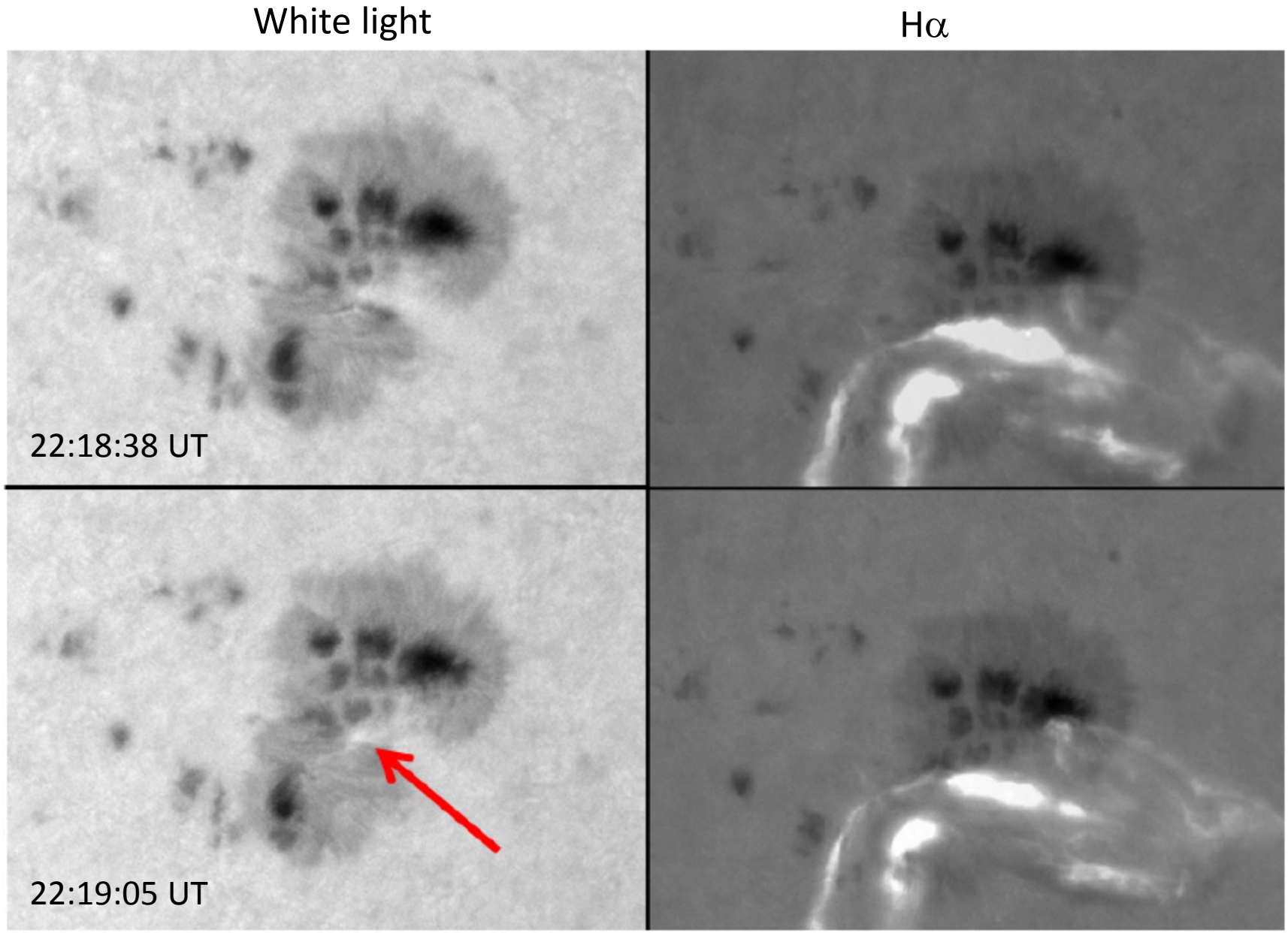


White light flare on 6 Sep.2011



White light flare kernel lasts for 20sec.

White light flare on 6 Sep. 2011

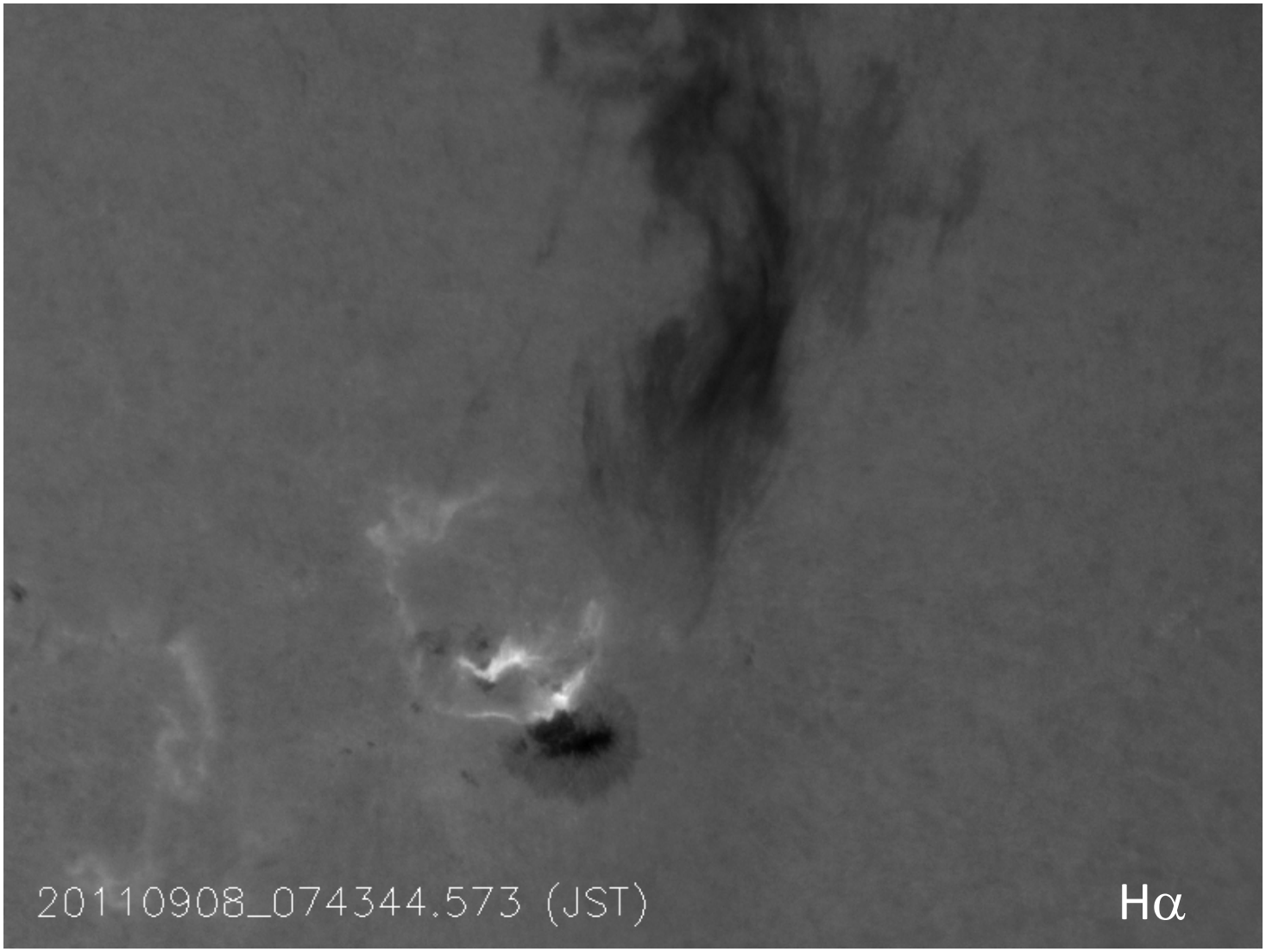


Eruptive flare, 2011.9.7

Hα

Conti.

Eruptive flare, 2011.9.7



5. Summary

A high speed / high resolution imaging system for solar active regions in Hα and continuum wavelengths are now in regular operation at Hida observatory of Kyoto University. The system is aimed to diagnose the spatial / temporal evolution of high energy particles in solar flares by capturing the blast evolution of flare kernels. The data will be open to community soon.

Acknowledgement;

This work was carried out by the joint research program of the Solar-Terrestorial Environment Laboratory, Nagoya University.