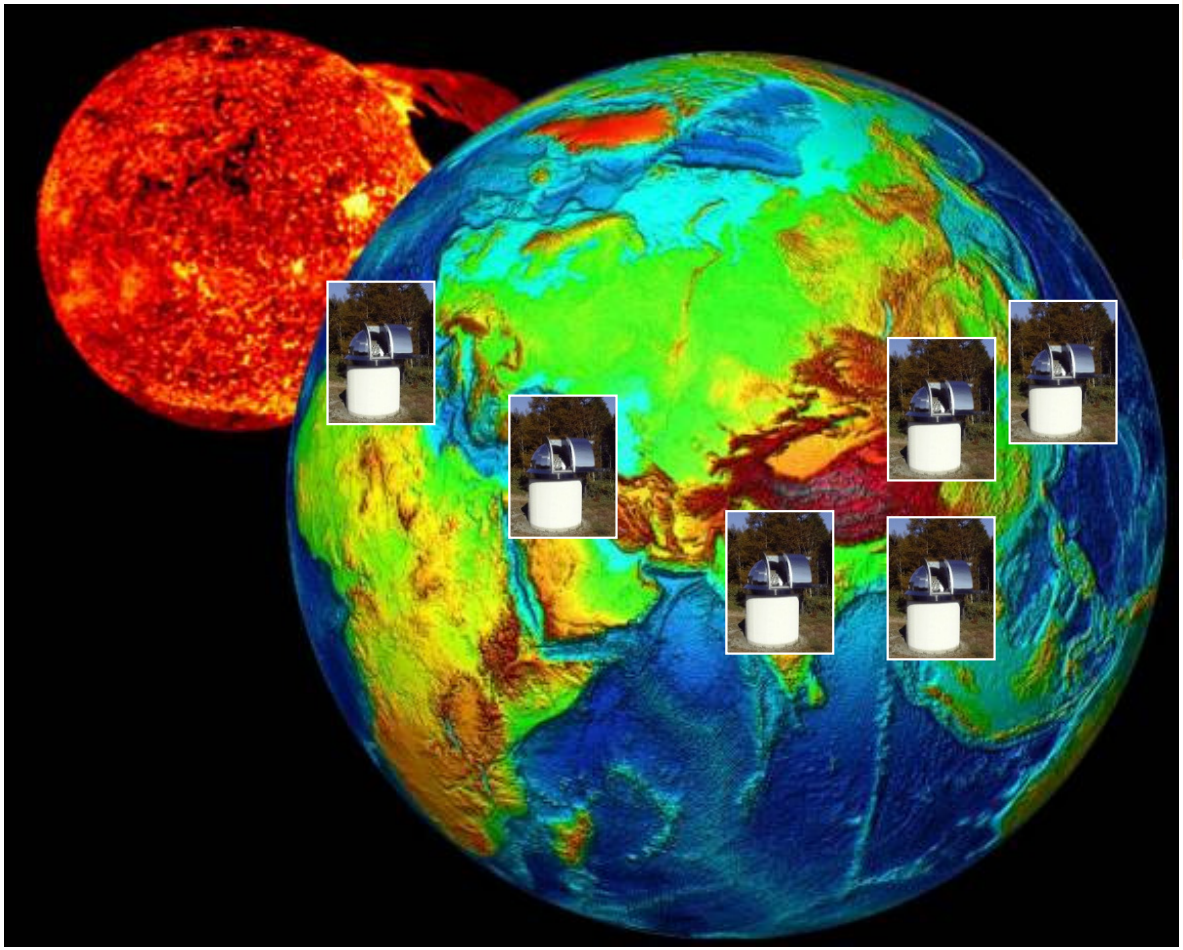
Improvement of instruments and capacity-building activities under the CHAIN-project

S. UeNo, K. Shibata, K. Ichimoto, A. Asai, S. Nagata, G. Kimura, Y. Nakatani, K. Otsuji, T. T. Ishii, **D. Seki**, D.P. Cabezas H. (Kyoto Univ., Japan), J.K. Ishitsuka I. (Universidad Nacional del Centro del Peru), A.A. Ibrahim A.A. (King Saud University, Saudi Arabia)

Purposes of CHAIN Project under the ISWI program

(**C**ontinuous **H**-**a**lpha
Imaging **N**etwork Project)

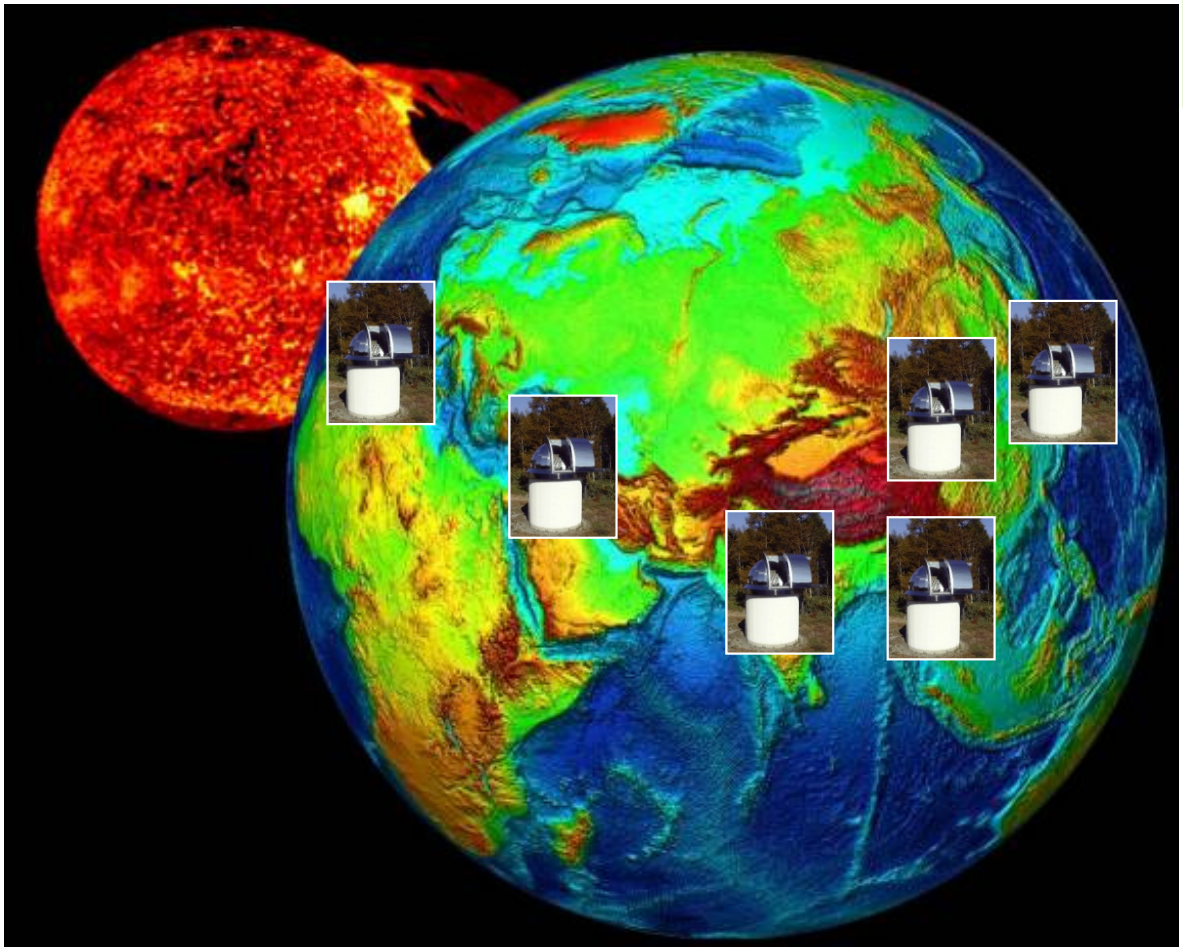


Reinforcement of **multi-wavelength H-alpha observations of the full-disk Sun** by formation of an international network of ground-based solar station

Capacity building: International spread, academic exchange and promotion of the space-weather research including developing countries.

Observational & Scientific Themes of CHAIN Project

(**C**ontinuous **H**-**a**lpha
Imaging **N**etwork Project)



(1) 3D velocity field measurement of eruptive phenomena on the solar surface

(2) Detection of shock waves (Moreton wave) generated by solar explosive phenomena

(3) Estimation of solar UV radiation and comparison with ionospheric variation

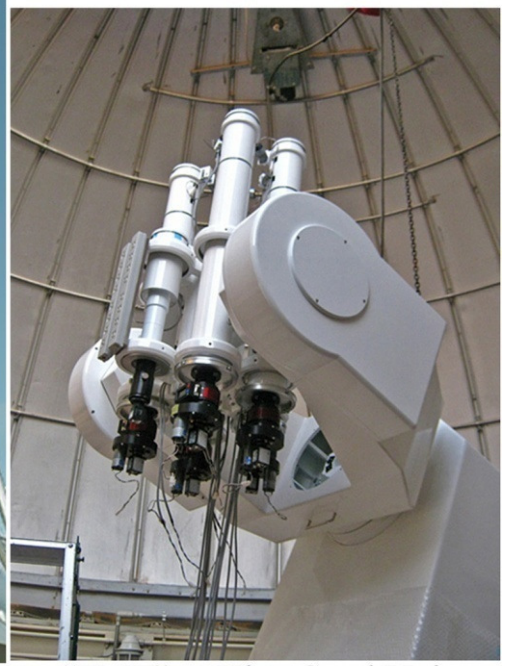
Improvement of instruments under the CHAIN-project (2016-2019)

Main three stations at present

Three solar telescopes of the CHAIN project

"SMART" at Hida Obs. (Japan)

"FMT" at National Ica Univ. (Peru)



"FMT" at King Saud Univ. (Saudi Arabia)

1) SMART telescope
(Solar Magnetic Activity Research Telescope)
at Hida Obs., Japan
(2003 Oct. ☐)

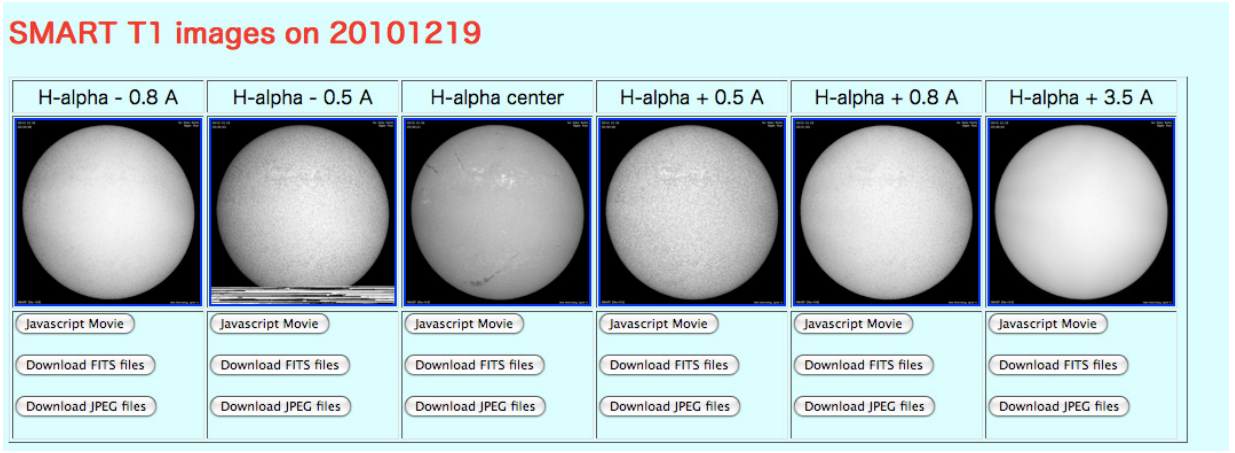
2) FMT telescope
(Flare Monitoring Telescope)
at National Ica Univ., Peru
(2010 Mar. ☐)

3) FMT telescope
at King Saud Univ., Saudi Arabia
(2015 Oct. ~)

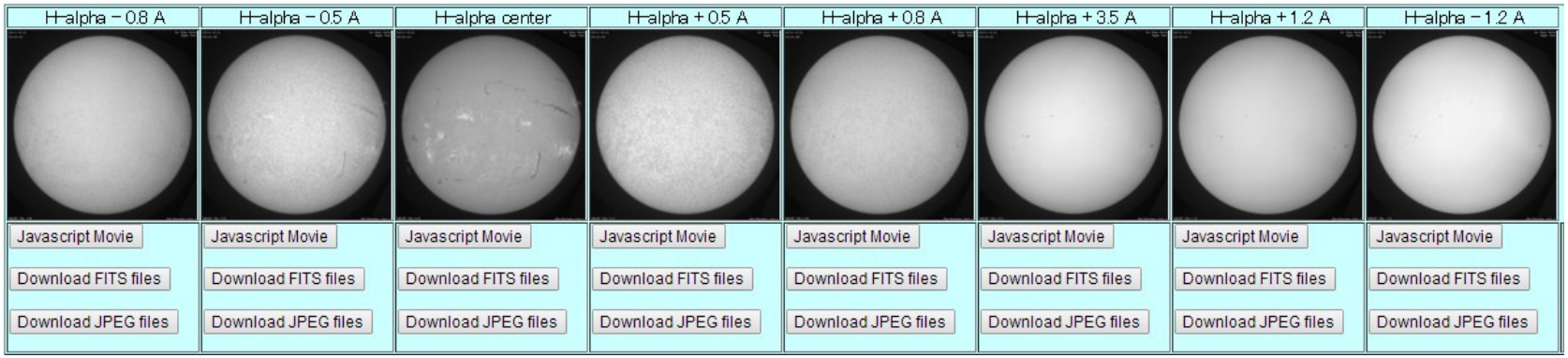
The largest observational characteristics of the CHAIN: Multi-wavelength imaging around H-alpha line

SMART telescope at Hida Obs. Japan:

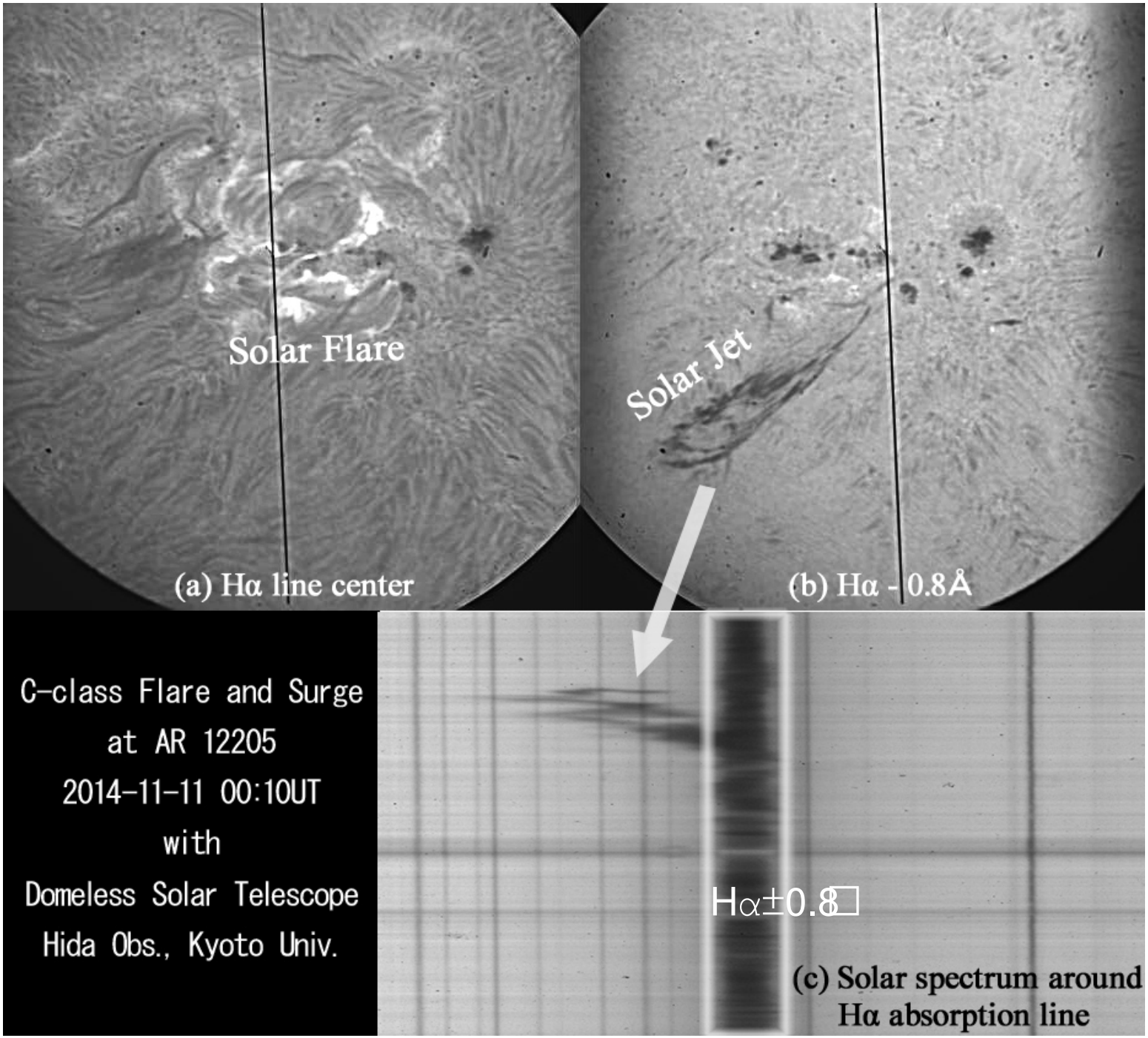
1) 5 wavelength observation / 2 min (2005 Jul – 2011 Feb)



2) 7 wavelength observation / 2 min (2011 Mar – 2014 Oct)

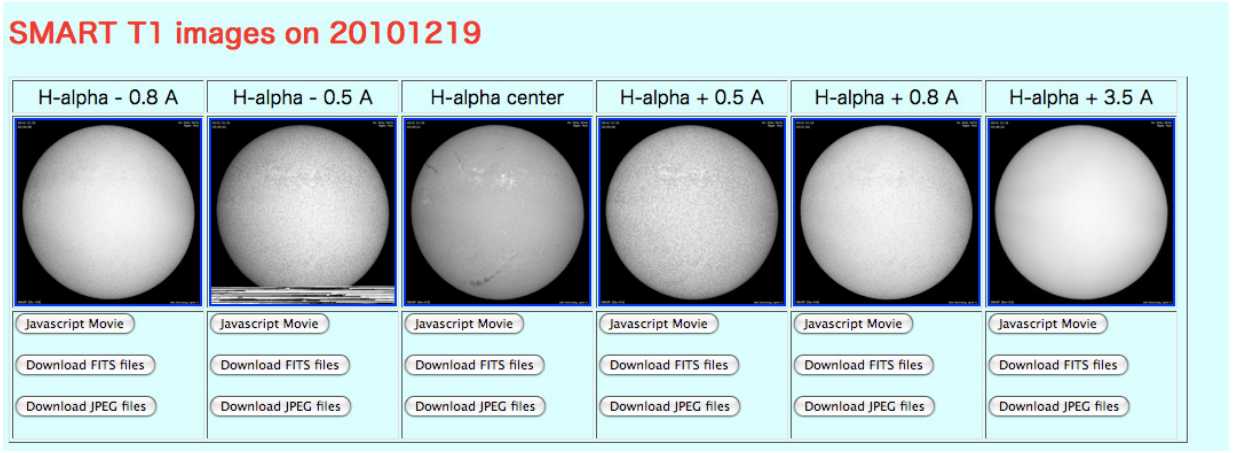


Several wavelengths observation can measure only low velocity field of eruptions. Large Doppler shift cannot be detected.

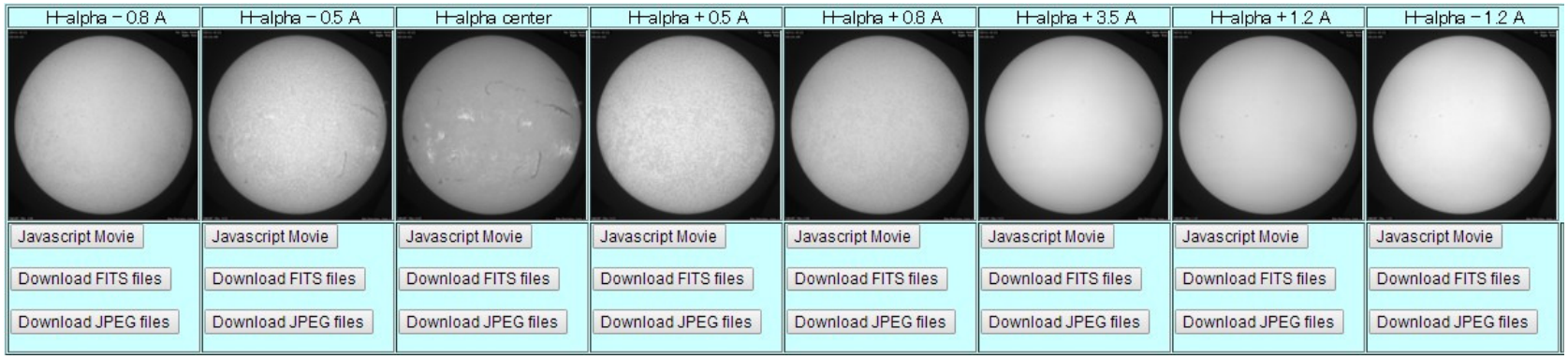


SMART telescope at Hida Obs. Japan:

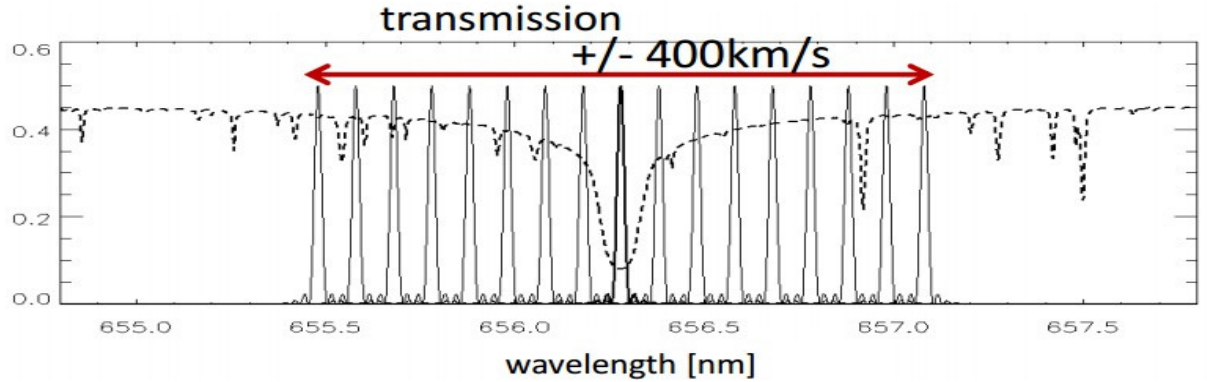
1) 5 wavelength observation / 2 min (2005 Jul – 2011 Feb)



2) 7 wavelength observation / 2 min (2011 Mar – 2014 Oct)

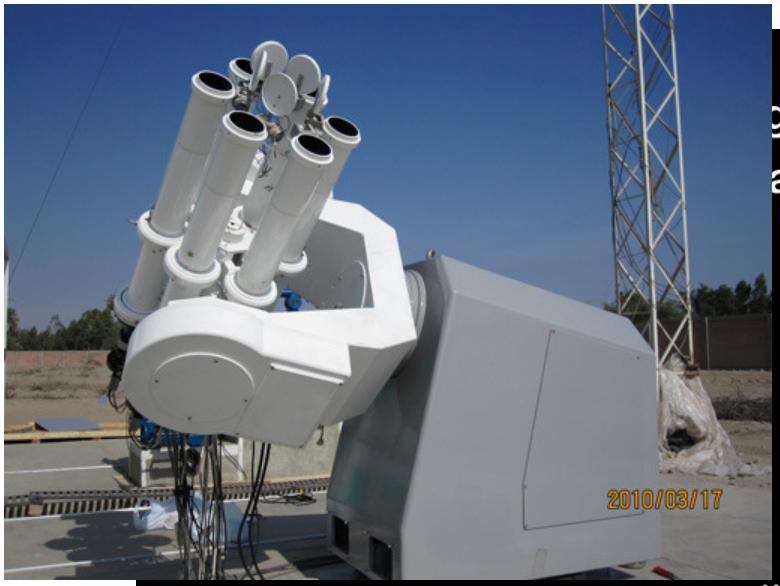


3) 73 wavelength observation (-9.0 to +9.0 A) / 15 s (2016 May – present)



By using a liquid-crystal Lyot filter

FMT telescope at Ica Univ. , Peru:

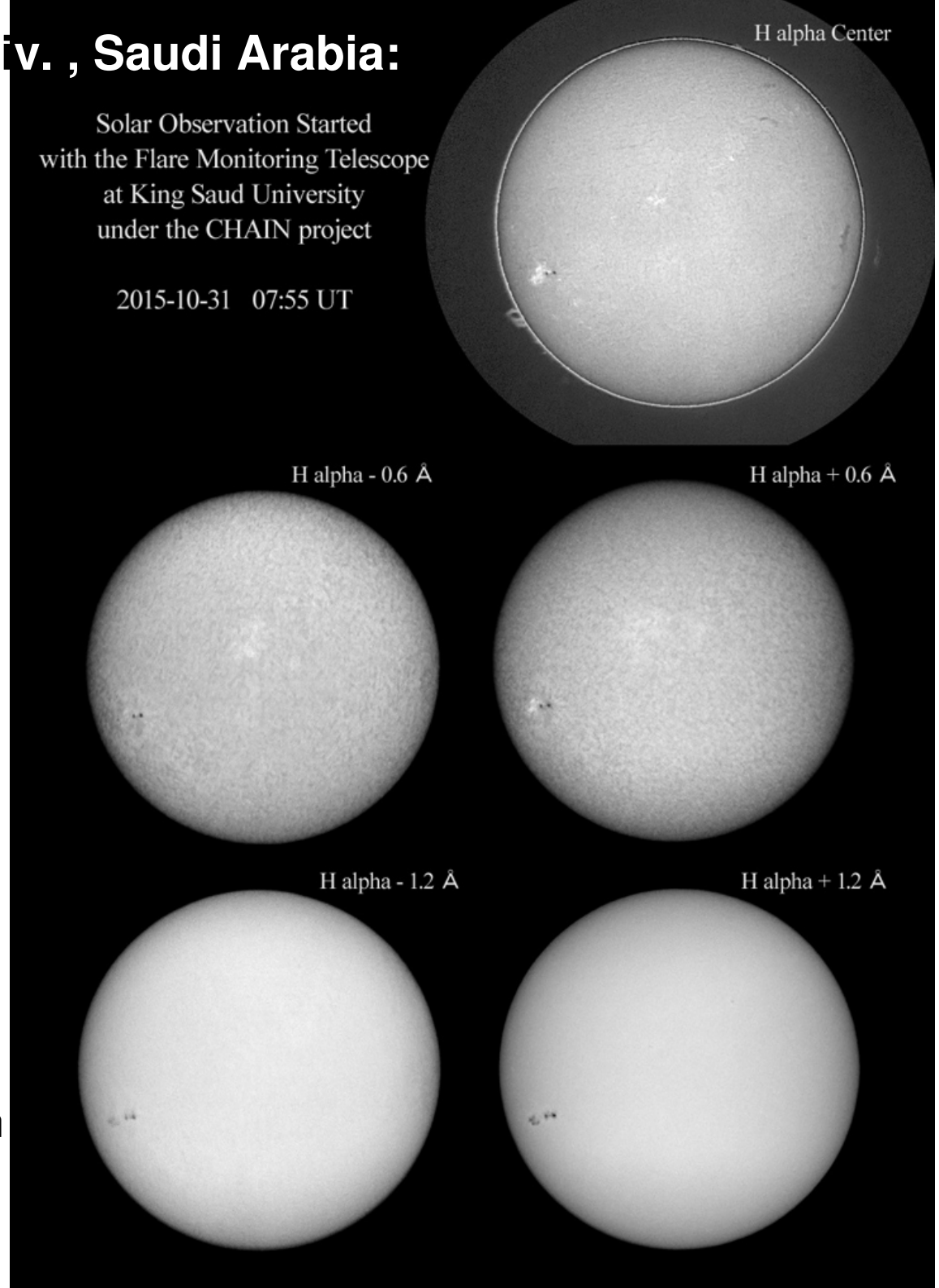


At present, 3 wavelength observation (H-alpha center, +0.8, -0.8 A / 20 s) is being performed by Peruvian FMT. => **~ 40km/s**

FMT telescope at King Saud Univ. , Saudi Arabia:

The completed FMT that started daily solar observation from 2015-10-31 at King Saud University.

At present, 5 wavelength observation (H-alpha center, +-0.6, +-1.2 A /20 s) Is being performed. => **~ 60 km/s**



Improvement of Instruments by Kyoto Univ / SPIRITS Program 2017 Apr. – 2019 Mar.

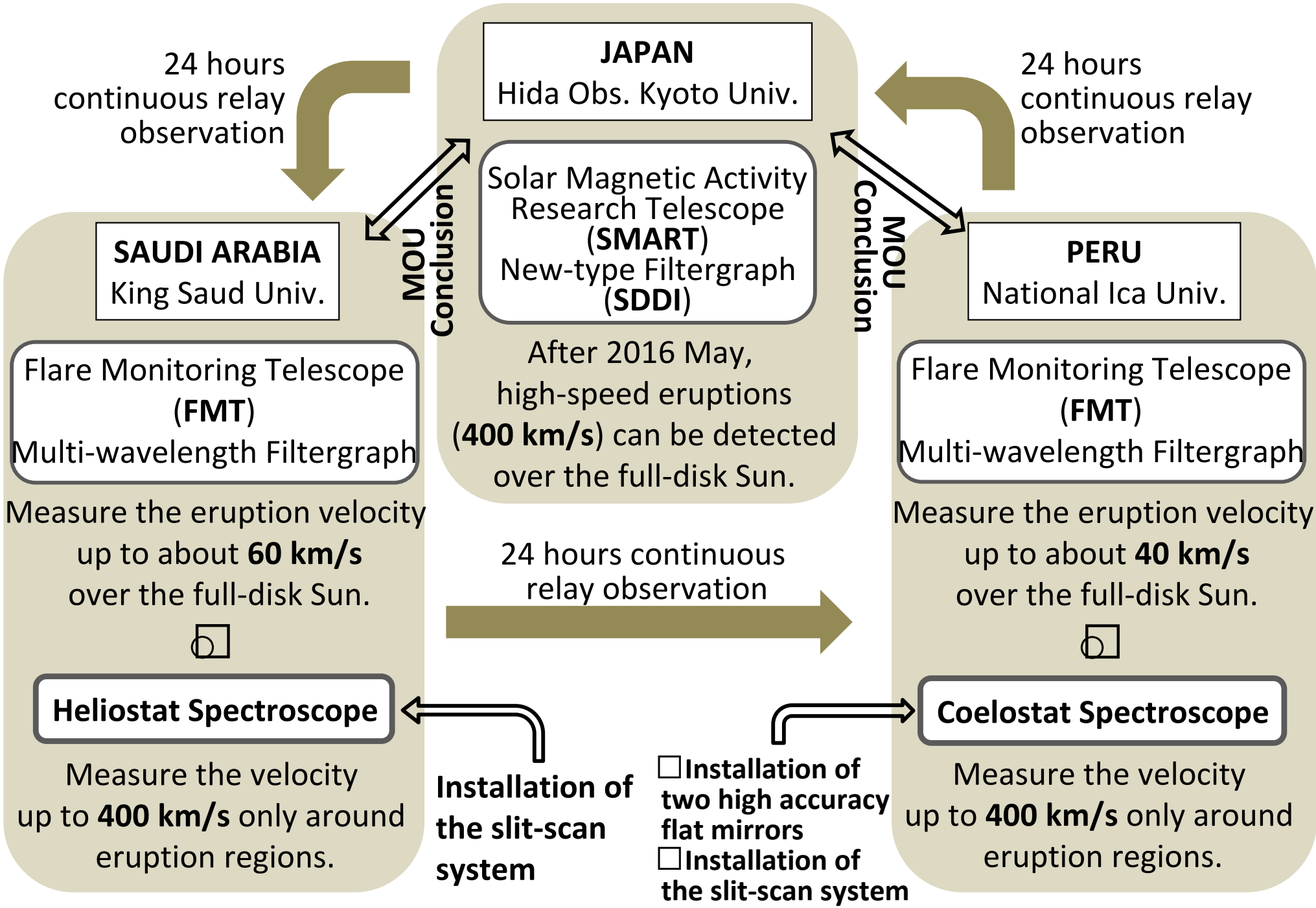
Supporting **P**rogram for **I**nte**r**action-based **I**nitiative Team **S**tudies

As part of the MEXT-sponsored Program for Promoting the Enhancement of Research Universities, Kyoto University made the fund of '**SPIRITS**' that is a **trans-border program** consisting of interdisciplinary, **international**, and **interpersonal areas**, aiming to **accelerate the internationalization of Kyoto University** by creating an environment that encourages **pushing the boundaries of frontier research and protosciences**, and promotes the creation of innovative practices.

Our

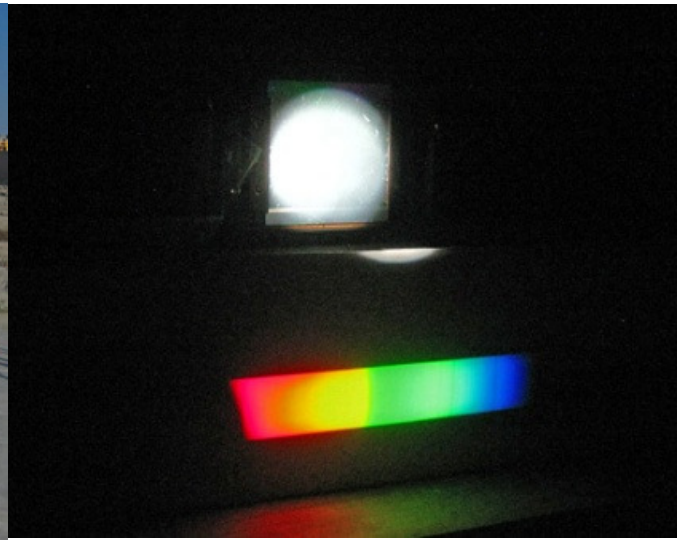
Japan-Peru-Saudi Arabia High-speed Solar explosions Monitoring System

Japan-Peru-Saudi Arabia High-speed Solar explosions Monitoring System



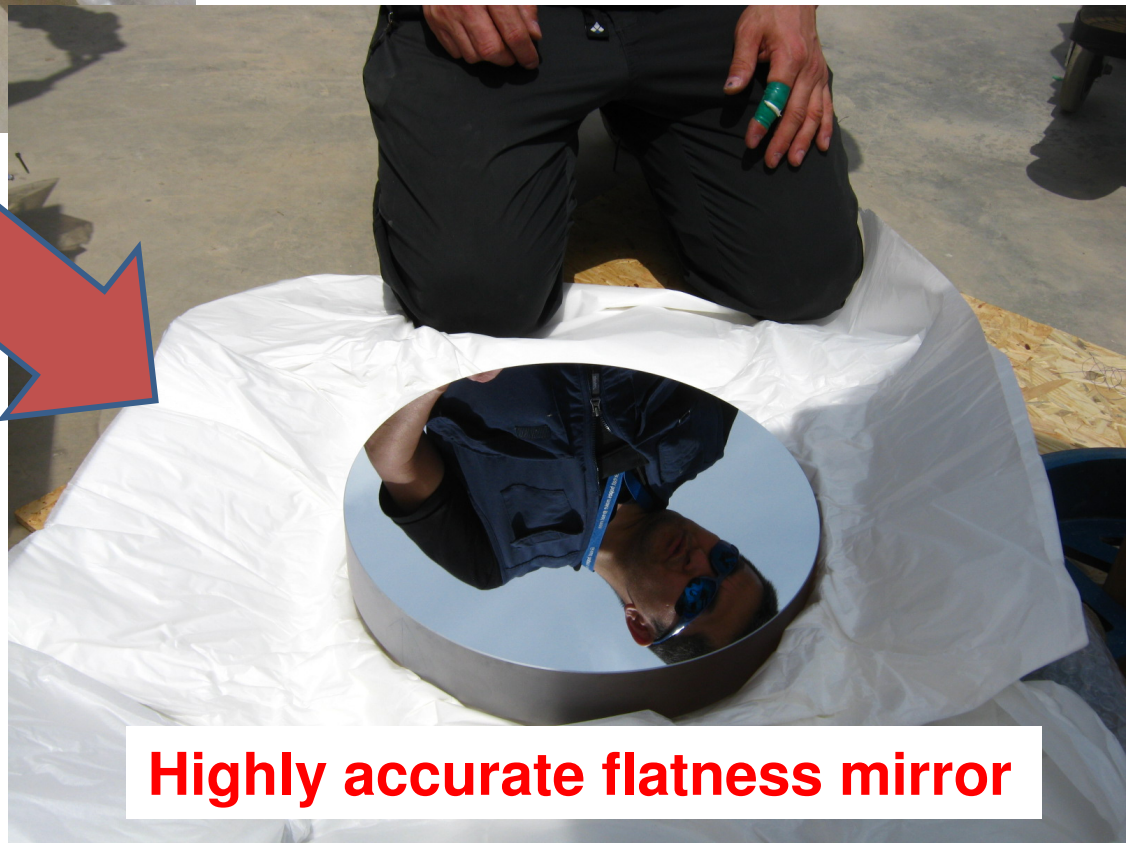
Spectroscopes at Peru & Saudi Arabia

We are equipping spectroheliograph using existing heliostat (Coelostat) and spectroscope of Ica Univ or King Saud Univ., so that filament eruptions that have very high speed (very large Doppler shift) can be tracked.



Coelostat & Spectroscope at Ica Univ., Peru

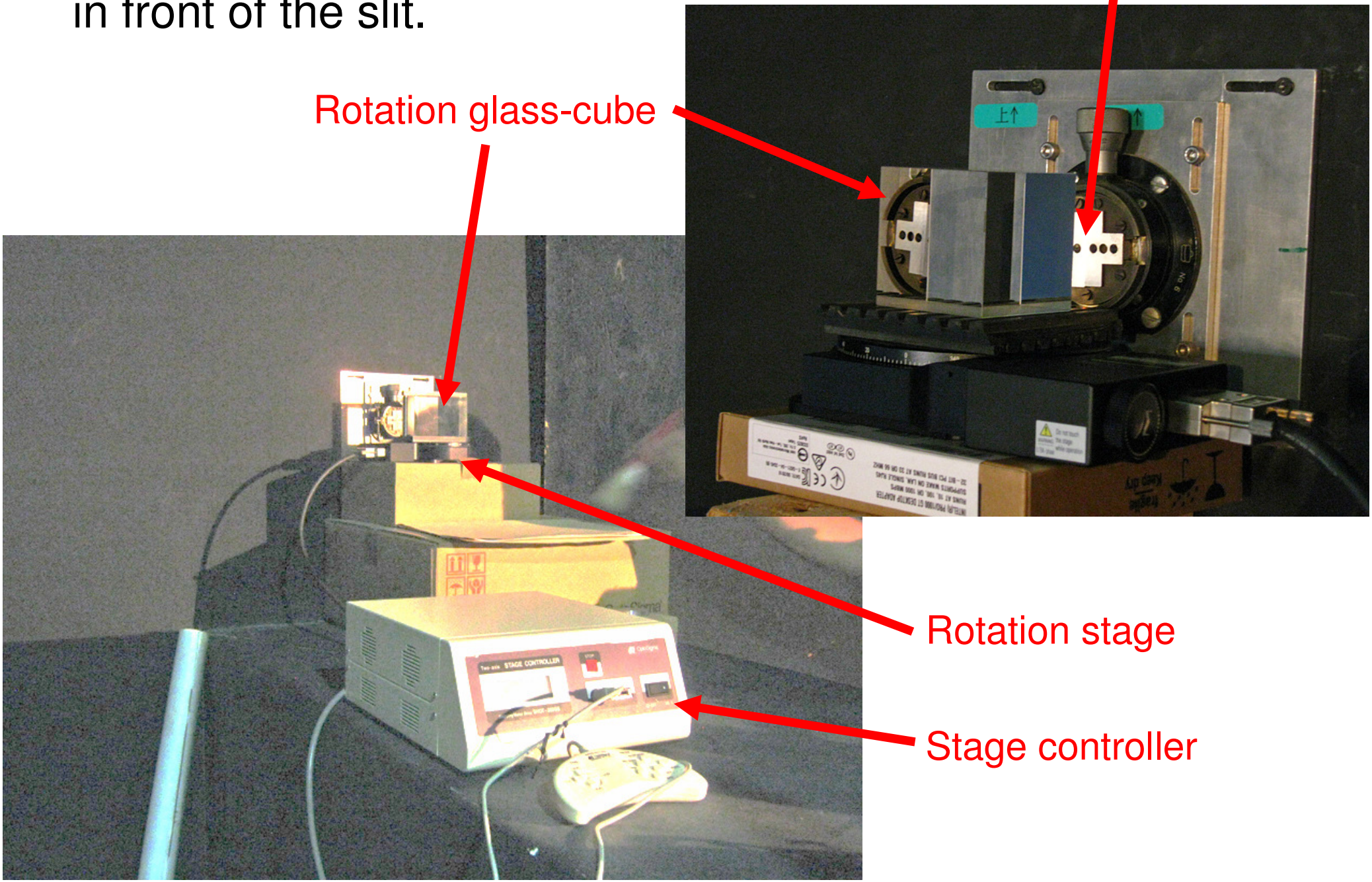
Heliostat & Spectroscope at King Saud Univ., Saudi Arabia



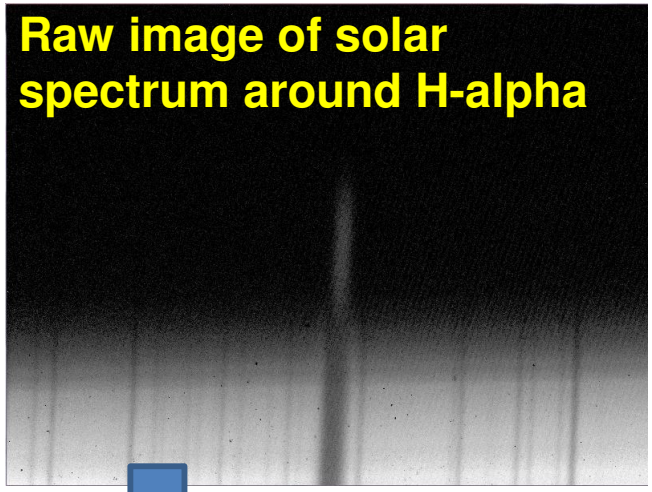
Replace of the 2 flat mirrors of the Coelostat at Ica Univ, Peru:

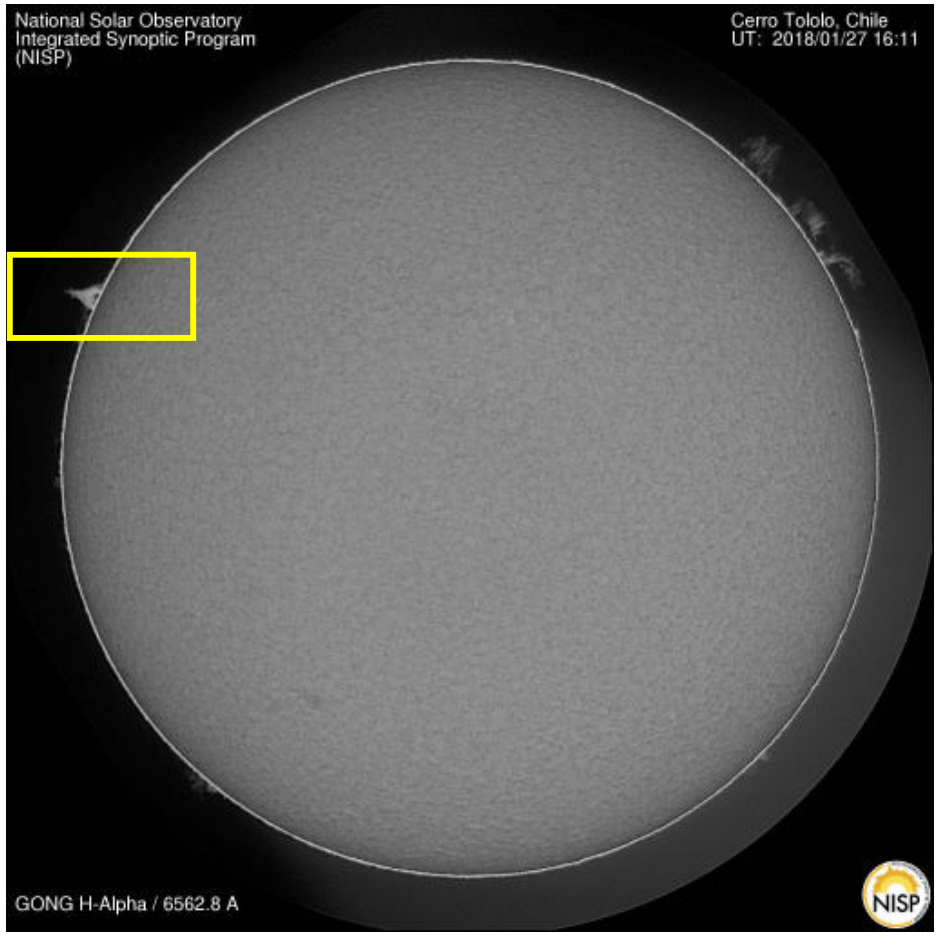
1) 2018-Jan-24□26
2) 2018-Dec-18□20

Installation of the high speed slit-scan system
(rotation glass-cube etc.)
in front of the slit.

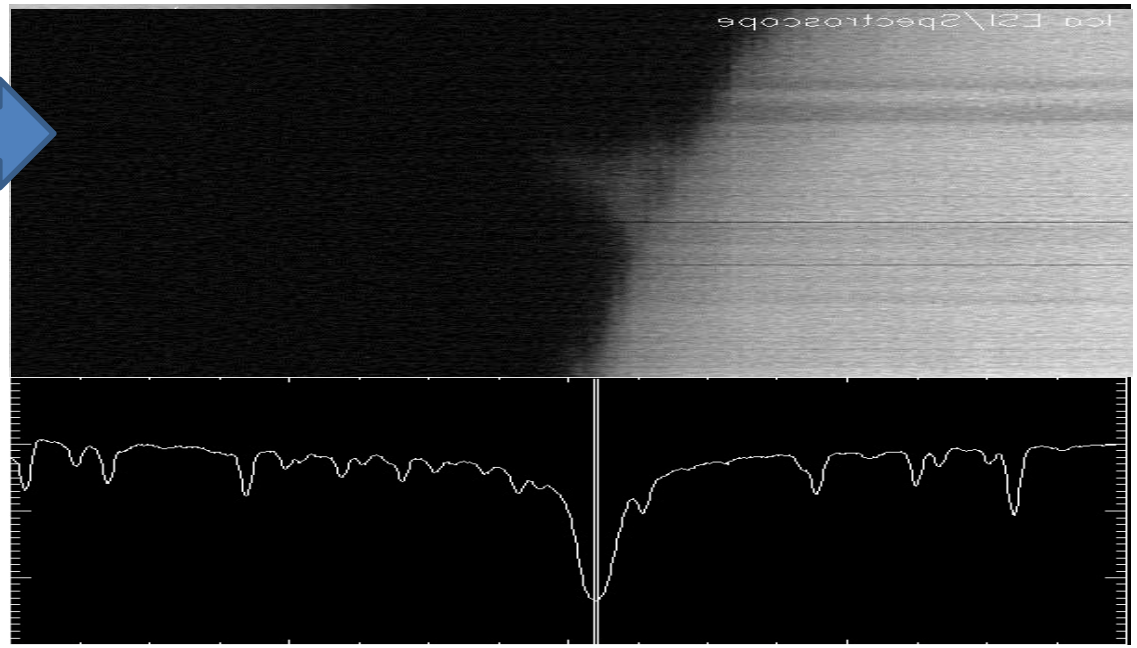


Spectroheliogram
at around prominence
2018-01-27 16:11UT
with the Spectro-heliograph
of National Ica University, Peru
(required time: ~ 10 s)





Spectroheliogram



On the other hand, in King Saud University (KSU), the drive-system of the heliostat is broken.

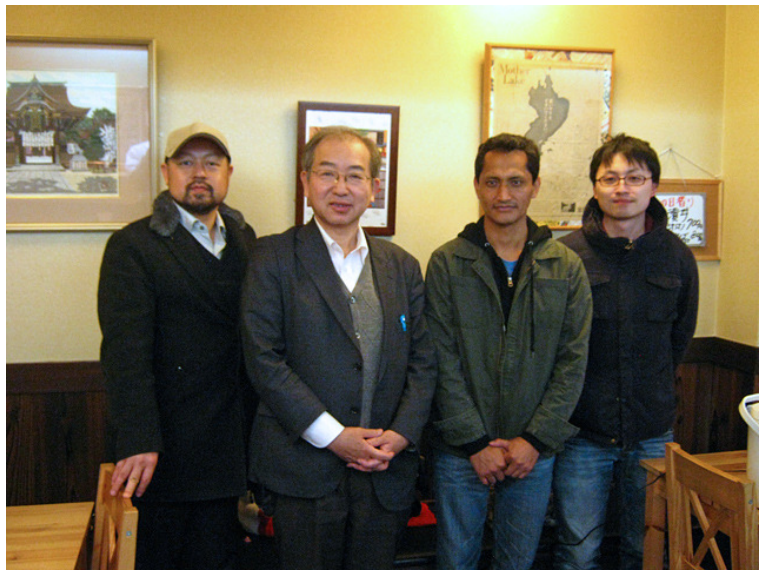
The repair of it by KSU has not been achieved yet.

So, as for the KSU, the solar observation will be done using only their FMT telescope for a moment.

Capacity-building Activities under the CHAIN-project (2017 – 2019)

Receiving an exchange student from Peru

An Peruvian young researcher Mr. Denis Cabezas, who became a solar physicist through the CHAIN project, entered the doctoral course of Kyoto University in April 2017 as a government-financed foreign student.

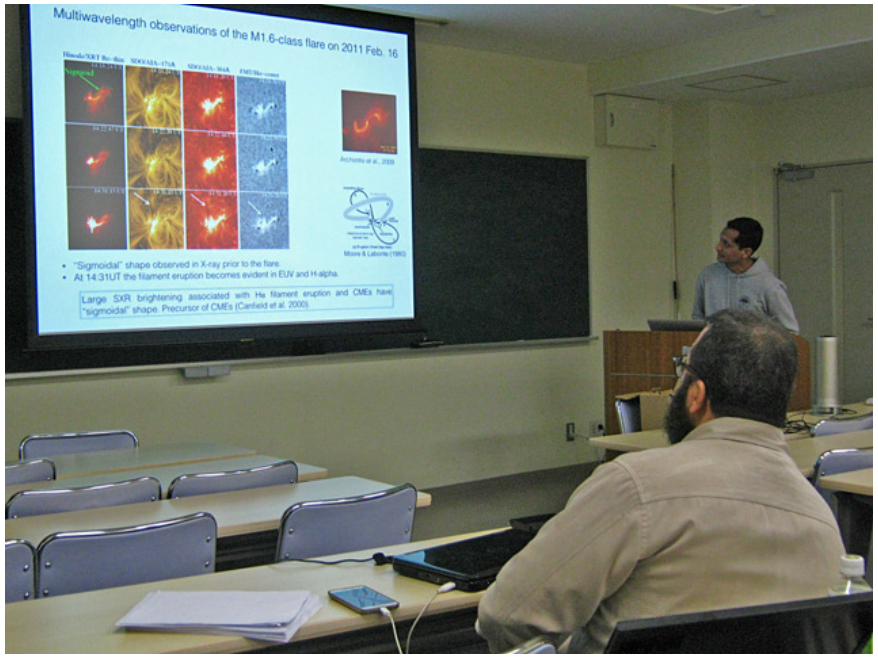


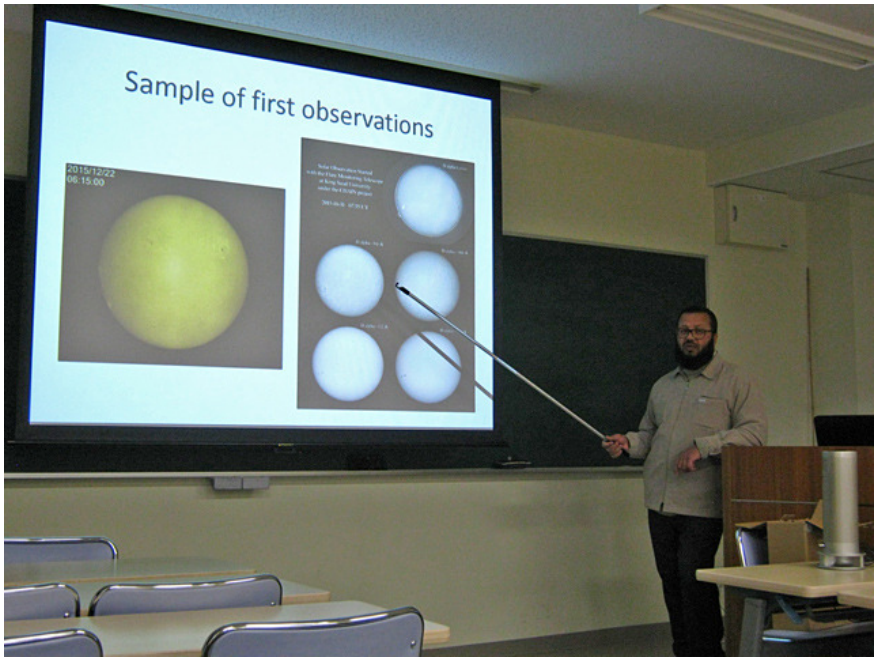
The 4th FMT Data Analysis Workshop

2017 Feb. 13 - 17

at Kwasan Observatory and
Kyoto Univ., Japan

Main purpose:
To promote data analysis
using Saudi Arabian FMT data.





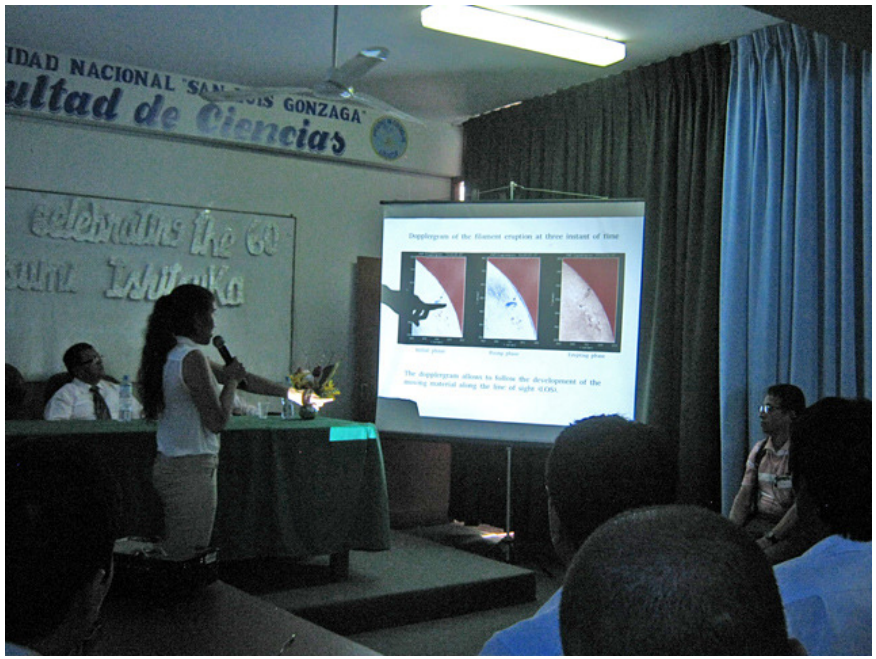
Workshop Celebrating the 60 Years of Dr. Mutsumi Ishitsuka in Peru: Achievements on Solar Physics and Astrophysics

2018 Jan. 29

at National Ica University,
Ica, Peru

Main purpose:

To discuss about recent new results obtained from the FMT data.



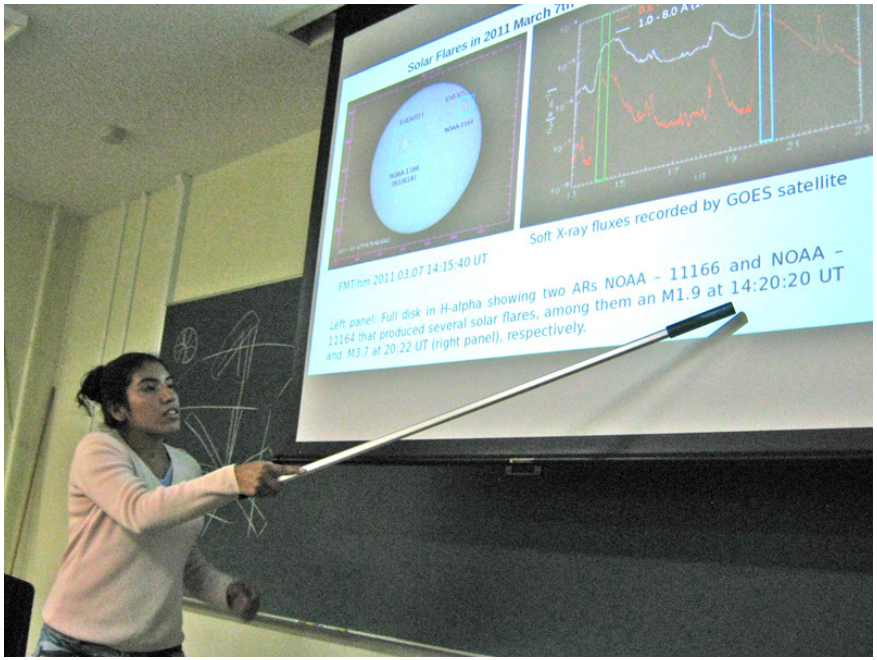
The 5th CHAIN / FMT & SMART International Data Analysis Workshop

2019 Feb. 05 – 12

at Kyoto University, Japan

Main purpose:

To promote data analysis of FMT&SMART data, scientific discussion and writing papers.



Summary

- CHAIN project has promoted ground-based solar observations, researches of solar physics and space weather, mainly by using three solar imaging telescopes in Japan, Peru and Saudi Arabia.
- For the purpose of improving ability to measurement of physical quantities of solar active phenomena, we are adding solar spectroscopes to our CHAIN's instruments.
- Regarding the Peruvian solar station, the improvement of Coelostat and spectroheliograph was already finished successfully.
  => Further higher speed solar explosive phenomena will be treated in our space weather researches.
- As for the Saudi Arabian solar station, the improvement has not achieved yet.
  => In cooperation with King Saud University, we are going to improve the heliostat spectroscope in order to utilize it for space weather researches.
- For recent three years, we have also performed capacity-building activities under the CHAIN project, such as receiving a foreign student, holding data analysis workshops and a symposium in Japan and Peru.
  => After this also, we continue to promote such international education and researches by using our solar data, with adding new spectroscopic data.

Other CHAIN cooperation countries.

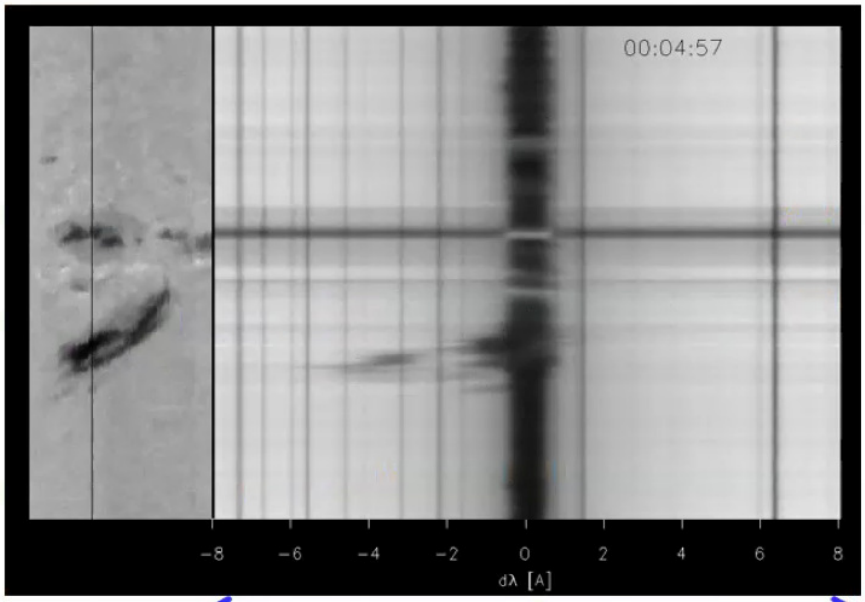
Where is the data?

http://www.hida.kyoto-u.ac.jp/FMT/daily_b2/

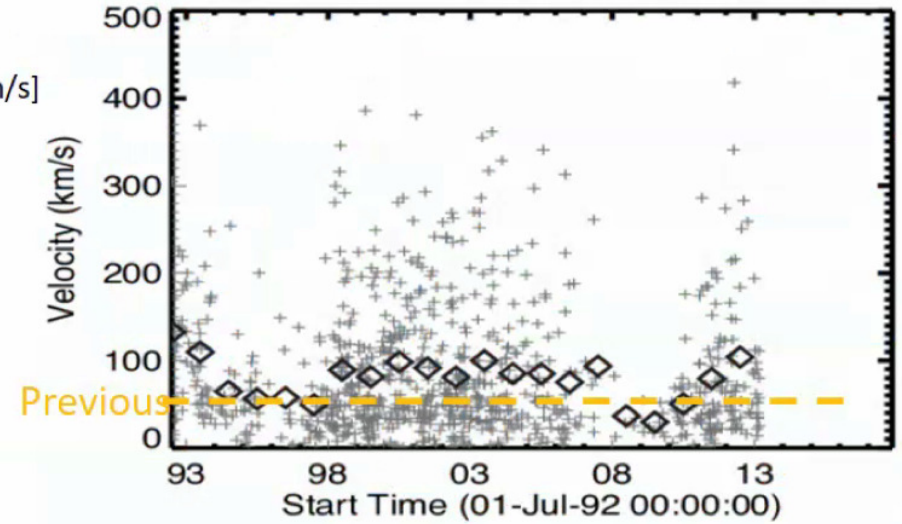
Dynamic eruption !

Hα spectra by DST (2014.11.11)

Previous [+/- 1.2A = +/- 50km/s]



+/- 400km/s



Velocity of erupting prominence on the limb by NoRH (Nobeyama Radio Heliograph) 1993-2013 =>max ～400km/s, average ～100km/s (Shimojo 2014)

Solar Dynamics Doppler Imager (SDDI)

	Previous	SDDI
Wavelength scan range	Ha -1.2 ～ +1.2 A	Ha -9～ +9 A
Spectral resolution	～0.4A (7 positions)	0.25A (73 positions)
Filed of view (FOV)	ϕ 2300“	～2460” × 2460”
Spatial resolution	0.56”	1.23” [cf: resolution limit=0.83”]
Time resolution	60 sec	15 sec -> 12 sec