

# CHAIN-Project and Installation of Flare Monitoring Telescopes in Developing Countries

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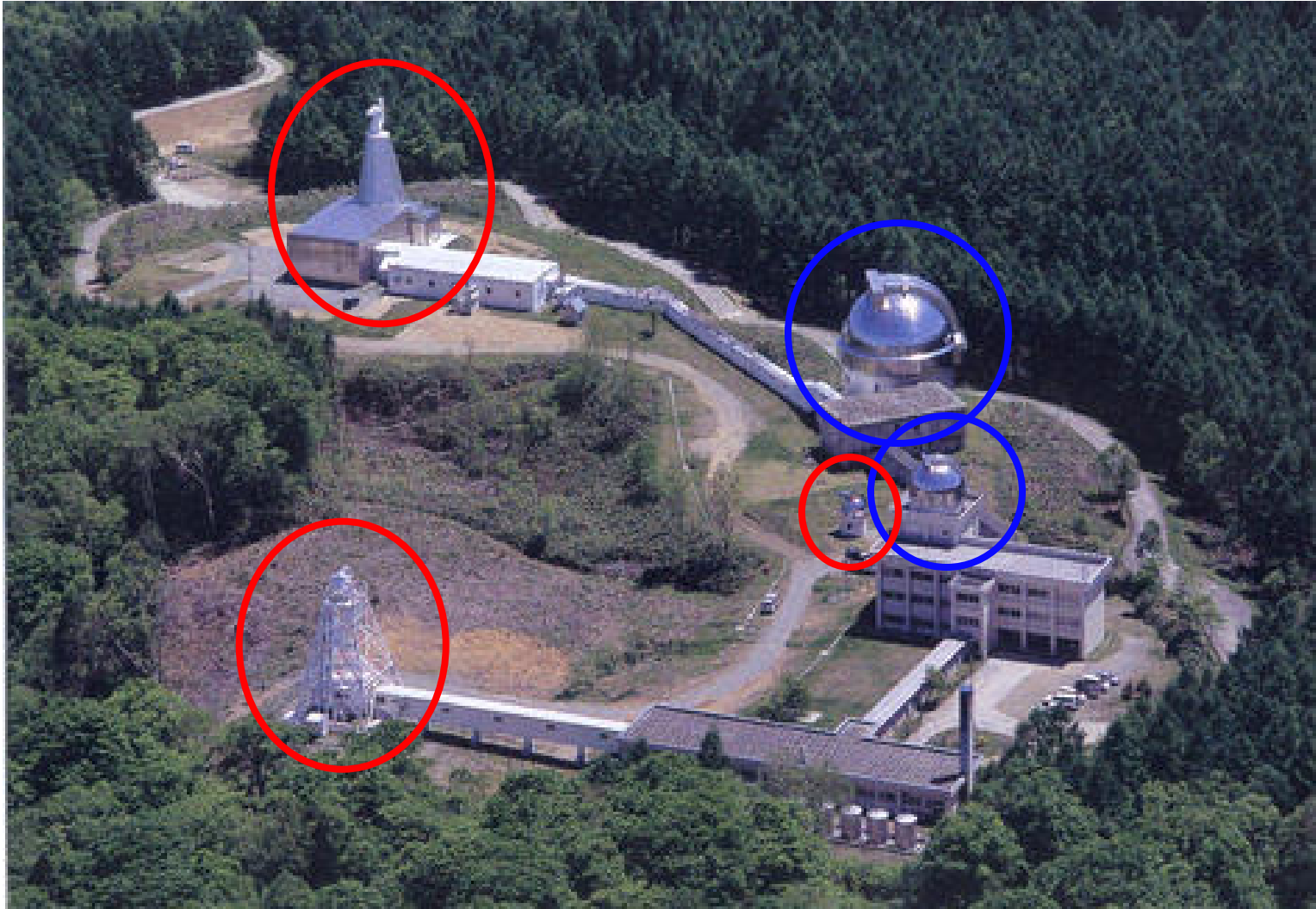
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\* Kwasan & Hida Observatories' Themes of studies and Instruments



Hida observatory

# \* Kwasan & Hida Observatories' Themes of studies and Instruments

## Solarphysics

- Investigation of the structure of the Sun as a star
- The mechanism of the periodic variation of the solar activity
- The mechanism of the active phenomena on the solar surface
- mainly by using observational data

## Solar-astro Plasma Physics

- Investigation of the process of active phenomena in the solar and astro-plasma
- mainly by using MHD simulations

## Solar-system Physics

- Investigation of the origin and evolution of our solar-system
- The mechanism of the variation of the planetary climate
- mainly by using long-term continuous observational data

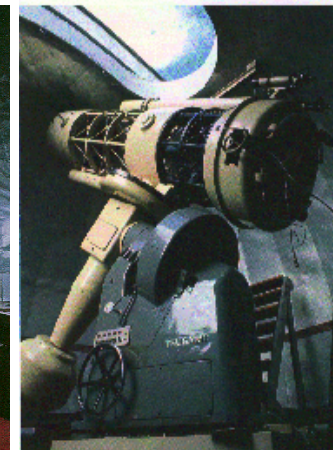
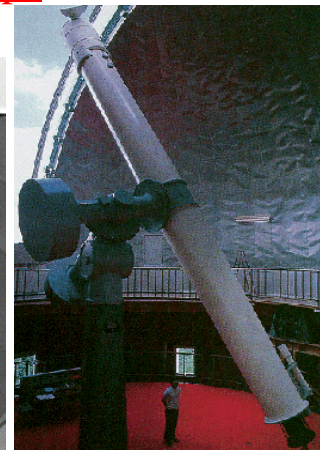
## Solar-stellar Physics

- Comparing active phenomena of stars or compact objects with solar active phenomena
- Investigation of the mechanism of the cataclysmic active phenomena around astro-objects such as variable stars, accretion disks, gamma-ray bursts etc.

### Domeless Solar Telescope

### Flare Monitoring Telescope 65 cm Refractor 60 cm Reflector

### Solar Magnetic Activity Research Telescope

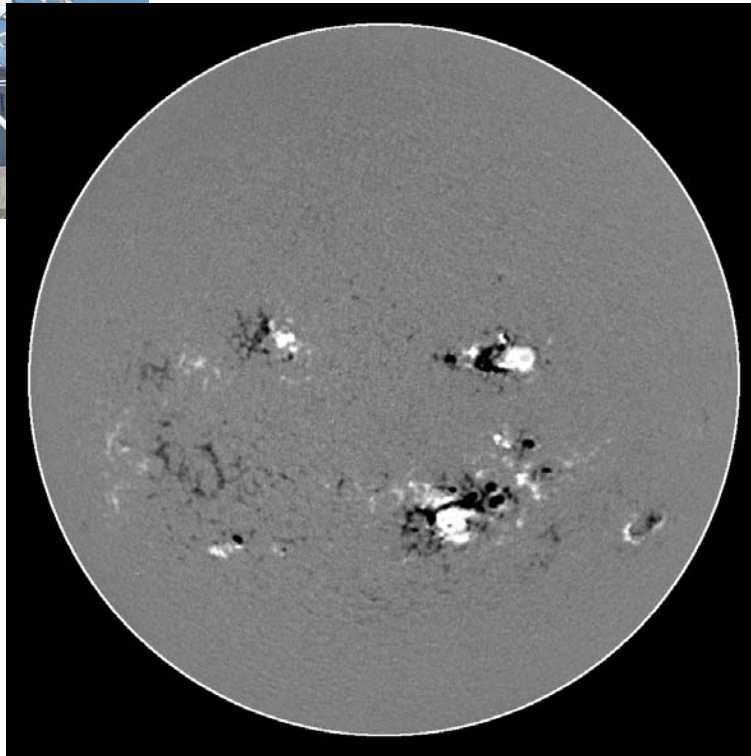


# The Solar Magnetic Activity Research Telescope (SMART)

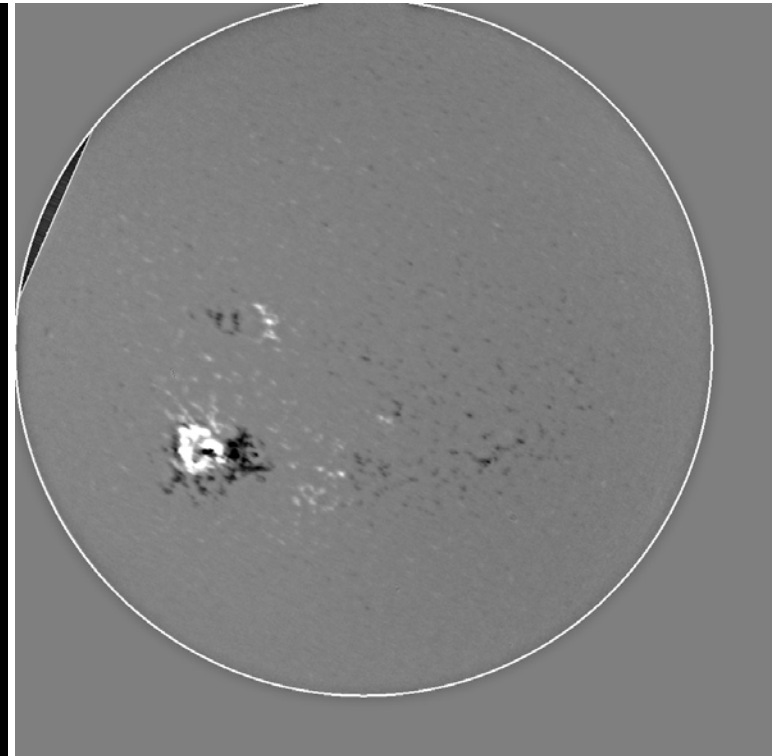


One of large characteristics:

Full-disk vector magnetic field observation



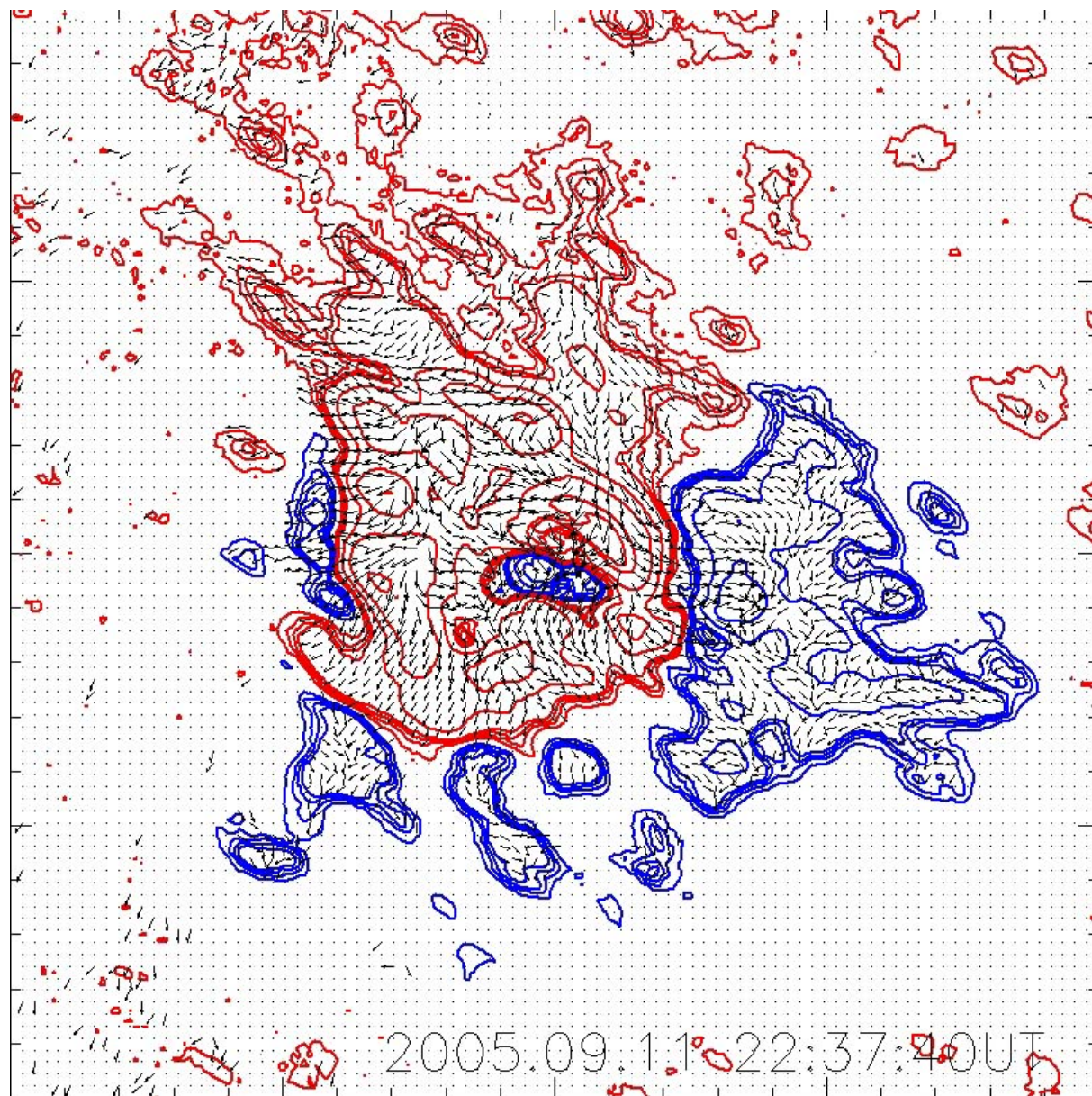
2003. 10. 30



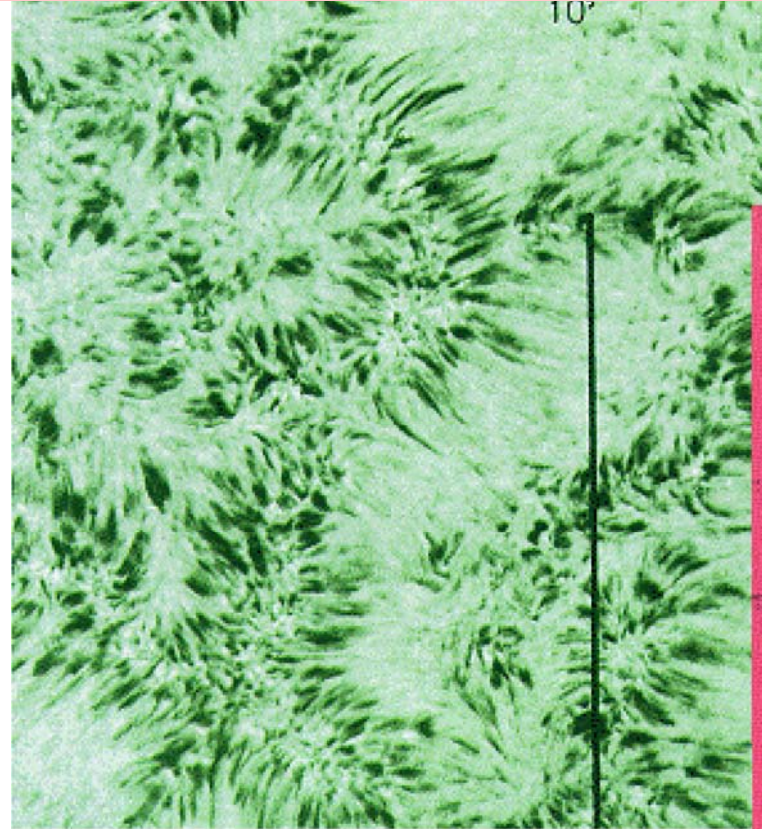
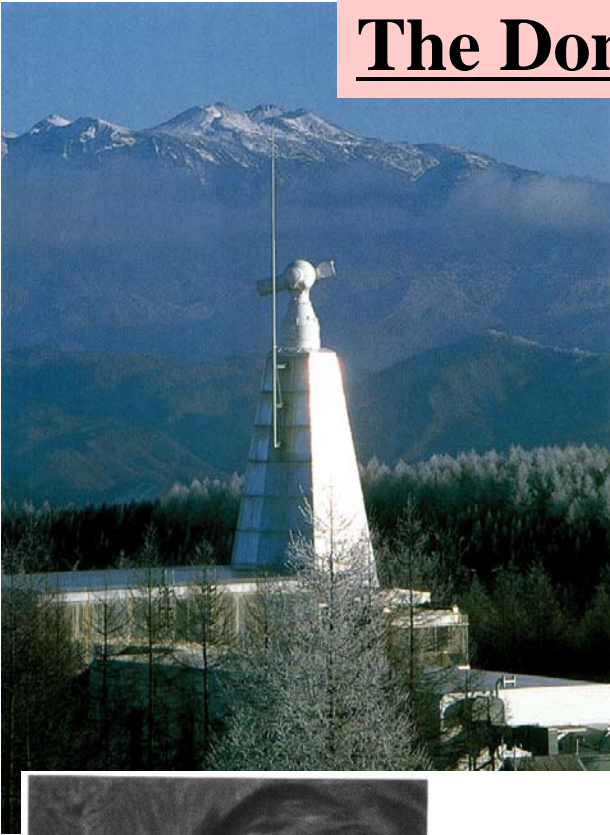
2005. 09. 12

So, it can observe variations of photospheric vector magnetic-field configurations of every active regions on the solar disk.

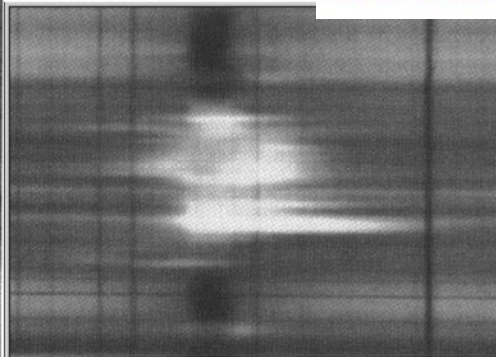
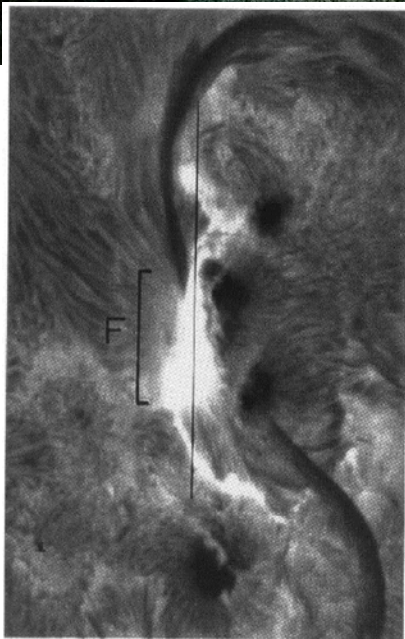
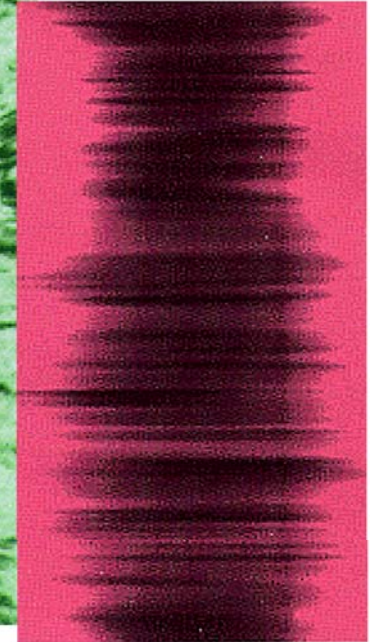
NOAA10808



# The Domeless Solar Telescope (DST)



H-alpha



Large characteristics:

High resolution imaging and spectrum observation with high wavelength resolution and multi-wavelength spectrum measurement

## \*\*\*\* The Role of Solarphysics \*\*\*\*

(1) Yardstick of studies of structures and evolutions of stars

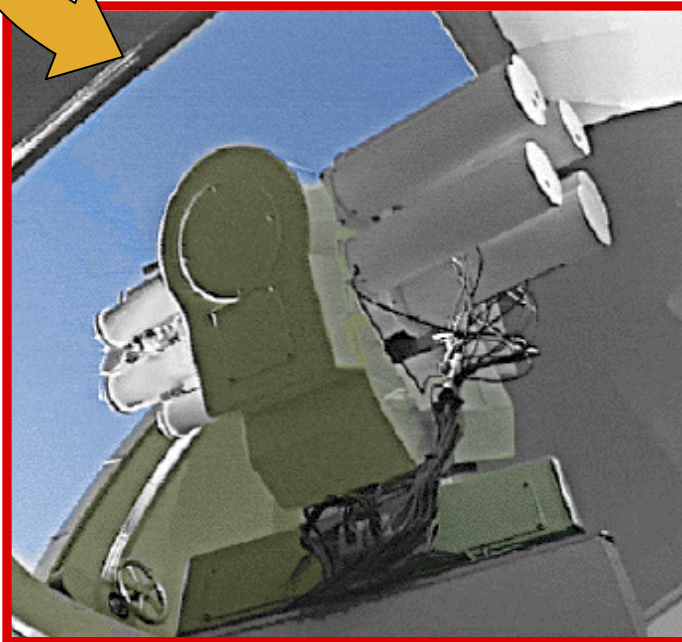
(2) Laboratory of the studies of active phenomena in the plasma of the whole universe

(3) Developing the method and technique of astronomical observations

(4) Studies of the environmental variation of the Solar-terrestrial system

## About The Flare Monitoring Telescope (FMT) at Hida Obs.

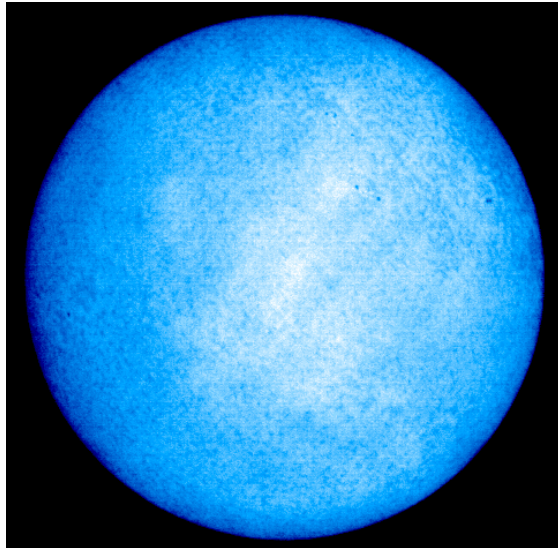
[http://www.kwasan.kyoto-u.ac.jp/general/facilities/fmt/index\\_en.html](http://www.kwasan.kyoto-u.ac.jp/general/facilities/fmt/index_en.html)



- The FMT was constructed in 1992 to investigate the long-term variation of solar activity and explosive events.
- It has been a part of the Solar Terrestrial Energy Program (STEP 1990-1997) .
- The FMT consists of 6 small telescopes, five of which observe the full-disk sun at different wavelengths or in different modes. The remaining one is equipped with a guider for accurate tracking of the sun.
- The five telescopes **SIMULTANEOUSLY** observe the full-disk sun at different wavelengths around H-alpha absorption line. Therefore, the FMT can measure the vector velocity field of moving structures on the full solar disk without the effect of the seeing.

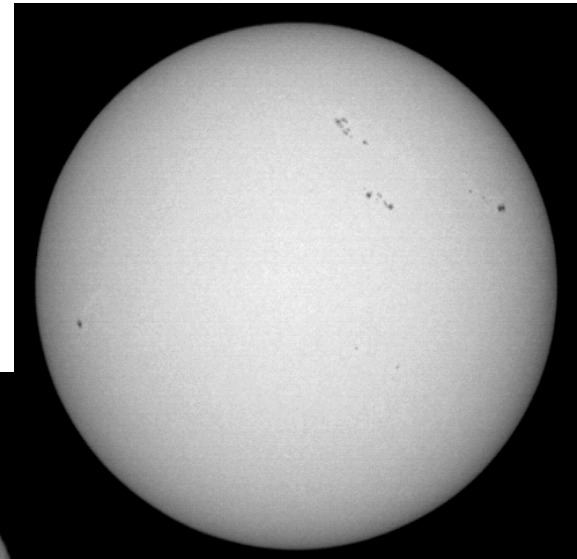


Present FMT has observed in these 5 modes.



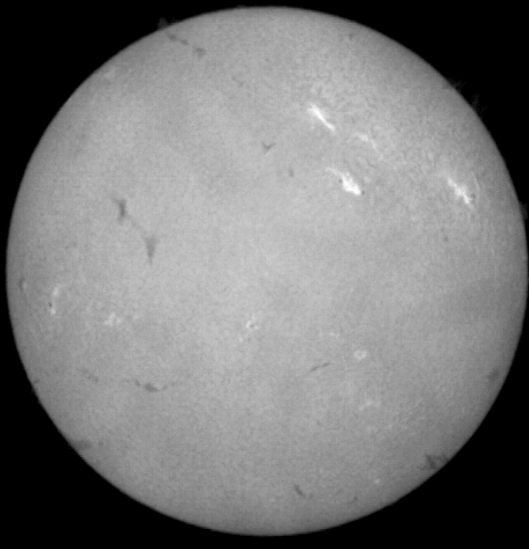
H $\alpha$  - 0.8Å

H $\alpha$  + 0.8Å

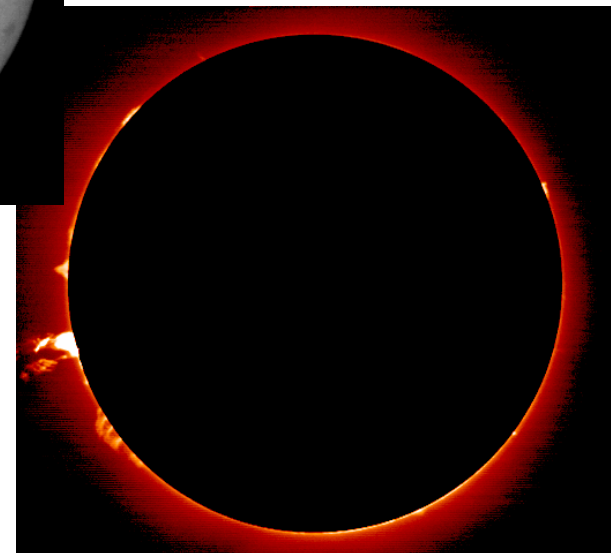
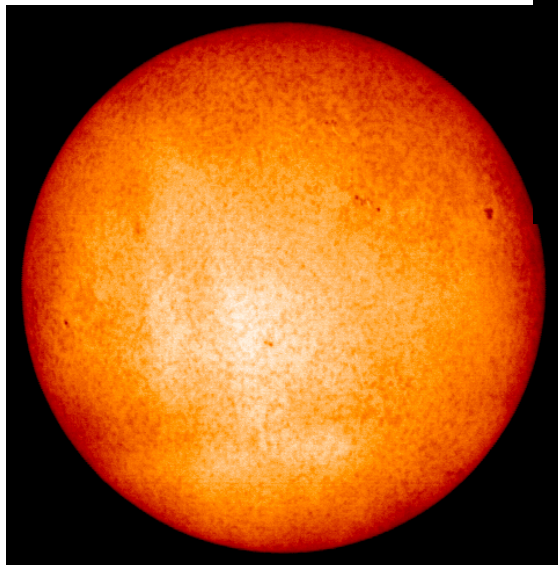


Red Continuum

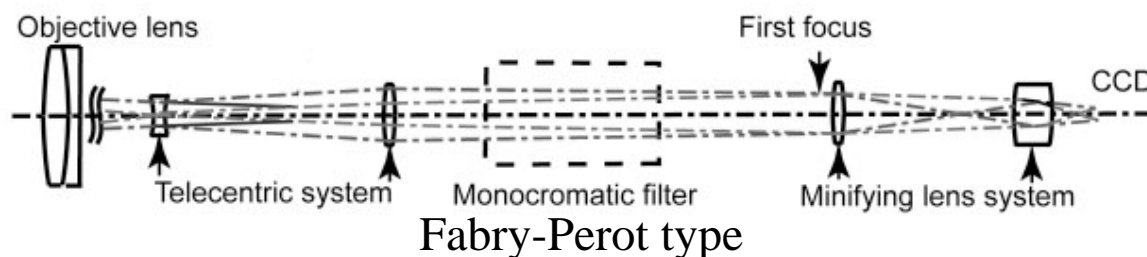
H $\alpha$ Prominence



H $\alpha$ LineCenter



## Hida Flare Monitoring Telescope (FMT)



Optics	
Diameter	64 mm
F-ratio	30
Focal length	1920 mm
Spatial resolution	1.8 arcsec

Filters	
Telescope name	Central / Passband
Ha center	6562.8 / 0.42 A
Ha +0.8 A	6563.6 / 0.5 A
Ha -0.8 A	6562.0 / 0.5 A
Continuum	6100 / 60 A
Prominence	6562.8 / 3 A

Telescope was manufactured by Nishimura Co. Ltd.  
 Lens system was manufactured by Minolta Co. Ltd. (Now:Konica-Minolta)  
 Filters were manufactures by Day star Co.Ltd.

### CCD system. [After 2006 May]

CCD Takenaka System Co.LTD/ Digital Full Frame Shutter Camera  
 FC1500CL (CamLink)

Time cadence every 20 seconds in the routine observation (changeable)

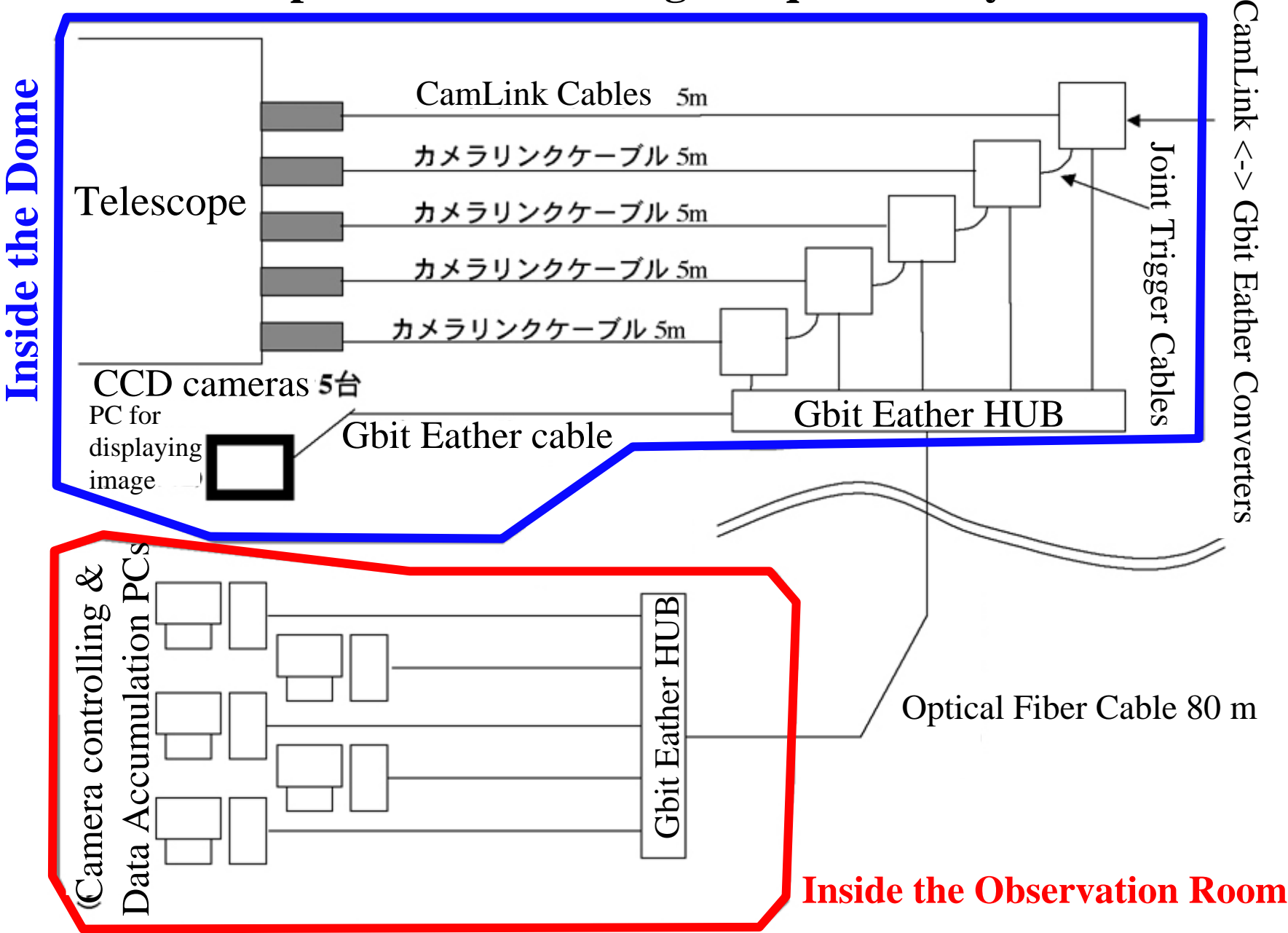
Bit Depth 10 bits

Pixel Number 1392x1040 => 2.1 arcsec/pix

Typical exposure time 4 ms, Simultaneousness **64 ns** << seeing timescale

Photon noise 2.0 % (corresponds to 2 km/s of the Doppler velocity)

# Composition of the Image Acquisition System



# FMT Data Archives on the Web

[http://www.kwasan.kyoto-u.ac.jp/general/facilities/fmt/database\\_en.html](http://www.kwasan.kyoto-u.ac.jp/general/facilities/fmt/database_en.html)

Various data which have been obtained by the FMT during about 15 years are now publicly opened.

At present, this data archive consists of the following four contents.

京都大学 大学院理学研究科附属天文台 >> 日本語

**Kwasan and Hida Observatories**  
Graduate School of Science, Kyoto University, Japan

アドレス : @ [http://www.kwasan.kyoto-u.ac.jp/general/facilities/fmt/database\\_en.html](http://www.kwasan.kyoto-u.ac.jp/general/facilities/fmt/database_en.html) > 移動

Home >> Observations >> Data Archive >> FMT

**About**  
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Open Day  
Entrance Exam.  
Practice &

**The Flare Monitoring Telescope (FMT) Data Archive**

**About the FMT**

**FMT Event-List**  
You can find a "FMT Event-List" which lists all events found using the FMT images.

**Movies of Outstanding Events**  
Please enjoy movies of flares, filament/prominence eruptions, surges etc.

**Real-time Images**  
Access to current solar images obtained by the FMT.

**All Digital Raw Images Download Site**  
You can freely download all FMT raw data in PGM-format.

# H alpha Prominence Event List [Apr/2001]

Classification & Note

Event ID No.	DATE (UT)	START TIME	MAXMUM TIME	END TIME	POSITION	CLASS	HEIGHT [Mm]	LENGTH [Mm]
<a href="#">FMT-P-1184</a>	20010401	22:18	23:02	25:58	ES20-30	E2	81	81
<a href="#">FMT-P-1185</a>	20010402	00:04	00:20					
<a href="#">FMT-P-1186</a>	20010404	04:24	04:29					
<a href="#">FMT-P-1187</a>	20010404							
<a href="#">FMT-P-1188</a>	20010404							
<a href="#">FMT-P-1189</a>	20010405							
<a href="#">FMT-P-1190</a>	20010405							
<a href="#">FMT-P-1191</a>	20010406							
<a href="#">FMT-P-1192</a>	20010406							
<a href="#">FMT-P-1193</a>	20010406							

## H alpha - C

All active phenomena which has been found in the FMT data are listed for each month and their physical characteristics and classifications are described in each list.  
 If you click an event ID No., you can see corresponding GIF images of the active phenomenon.

Classification & Note

Event ID No.	DATE (UT)	START TIME	END TIME	POSITION	CLASS	SIZE
<a href="#">FMT-B-14803</a>	20010401	07:11	07:34	S13 W85	E1,IB	S
<a href="#">FMT-B-14804</a>	20010401	07:30	07:50	N10 W09	IA	S
<a href="#">FMT-B-14805</a>	20010401	07:39B	07:47	N16 W36	IC	S
<a href="#">FMT-B-14806</a>	20010401	07:45	07:53	N12 W32	IIC	S
<a href="#">FMT-B-14807</a>	20010401	08:01	08:12	S13 W85	IB	S
<a href="#">FMT-B-14808</a>	20010401	08:03	08:08	N34 E19	IIA	S
<a href="#">FMT-B-14809</a>	20010401	08:14	08:18	N10 W09	IB	S
<a href="#">FMT-B-14810</a>	20010401	22:18B	22:41	N16 W60	IIC	M
<a href="#">FMT-B-14811</a>	20010401	22:28	22:55	N25 W30	IB/IC	M
<a href="#">FMT-B-14812</a>	20010401	22:31	23:19	N14 W60	E2	-

# 1. Event Lists

## 2. Movies of Outstanding Events

FMT MPEG movies of outstanding events are distinguished into the following four categories and archived.

- Flares
- Filament Eruptions
- Surges
- Prominence Eruptions

アドレス : <http://www.kwasan.kyoto-u.ac.jp/Hida/FMT/Movie/file/main.html> 移動

**Movies of Outstanding Events**

**Index**

Disk events

**Flare**

- [The index of Flare](#)
- Select the movie directly

---Select---

GO

**Filament eruption**

- [The index of Filament Eruption](#)
- Select the movie directly

**Movies of Outstanding Events**

**H-alpha movies of Solar Prominence Eruptions and Flares (from July/1992)**

**Disk Events**

**Flare**

**Filament Eruption**

### 3. Real-time Images

Always, four kinds of the latest images (except for continuum image) are uploaded.  
We also use these images for deciding the target region of the day of other telescopes which have small FOV.

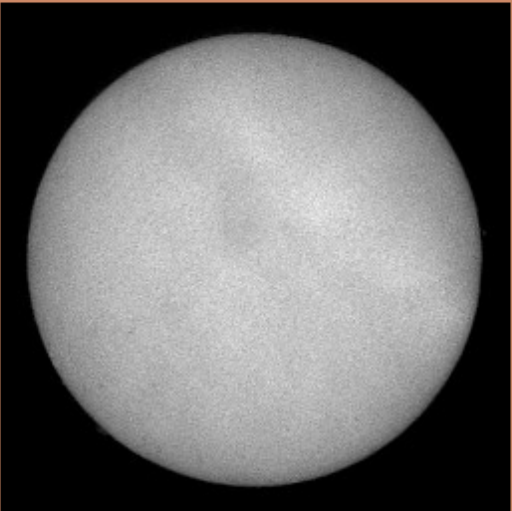

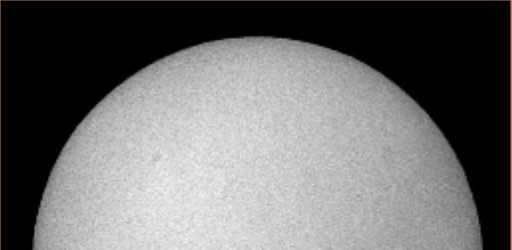

アドレス : [http://www.kwasan.kyoto-u.ac.jp/old\\_pages/Hida/IMG/FMTreal.html](http://www.kwasan.kyoto-u.ac.jp/old_pages/Hida/IMG/FMTreal.html) > 移動

## Flare Monitor Telescope Latest H-alpha Images

(This page is reloaded automatically every 30 sec.)

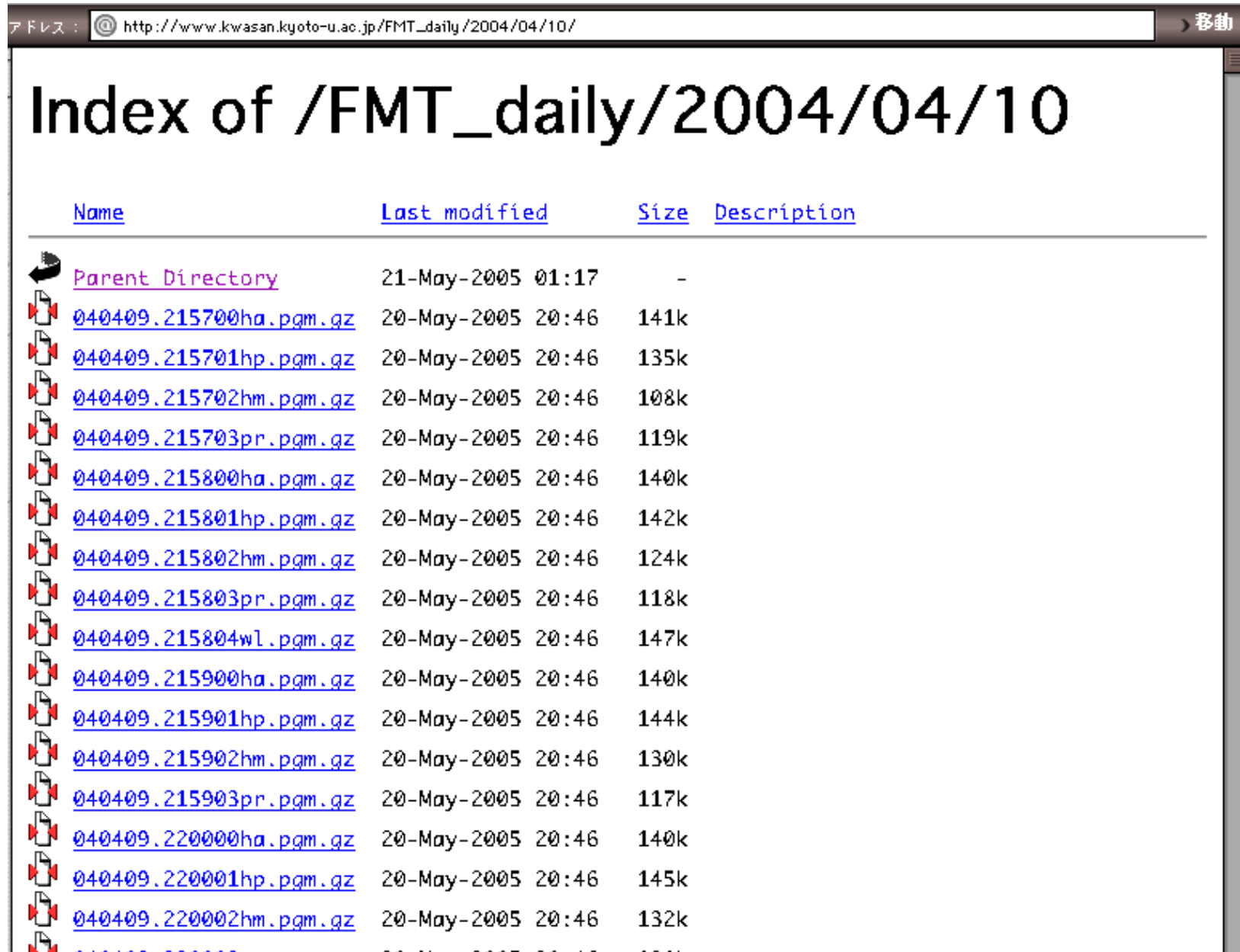
2006.11.25 03:12:30 UT


















Celestial North  
↑

H-alpha Line Center	H-alpha Prominence
	
H-alpha - 0.8 A	H-alpha + 0.8 A
	

## 4. All Digital Raw Images Download Site

All raw data are divided into each day, and compressed, then archived.



<u>Name</u>	<u>Last modified</u>	<u>Size</u>	<u>Description</u>
 <a href="#">Parent Directory</a>	21-May-2005 01:17	-	
 <a href="#">040409.215700ha.pgm.gz</a>	20-May-2005 20:46	141k	
 <a href="#">040409.215701hp.pgm.gz</a>	20-May-2005 20:46	135k	
 <a href="#">040409.215702hm.pgm.gz</a>	20-May-2005 20:46	108k	
 <a href="#">040409.215703pr.pgm.gz</a>	20-May-2005 20:46	119k	
 <a href="#">040409.215800ha.pgm.gz</a>	20-May-2005 20:46	140k	
 <a href="#">040409.215801hp.pgm.gz</a>	20-May-2005 20:46	142k	
 <a href="#">040409.215802hm.pgm.gz</a>	20-May-2005 20:46	124k	
 <a href="#">040409.215803pr.pgm.gz</a>	20-May-2005 20:46	118k	
 <a href="#">040409.215804wl.pgm.gz</a>	20-May-2005 20:46	147k	
 <a href="#">040409.215900ha.pgm.gz</a>	20-May-2005 20:46	140k	
 <a href="#">040409.215901hp.pgm.gz</a>	20-May-2005 20:46	144k	
 <a href="#">040409.215902hm.pgm.gz</a>	20-May-2005 20:46	130k	
 <a href="#">040409.215903pr.pgm.gz</a>	20-May-2005 20:46	117k	
 <a href="#">040409.220000ha.pgm.gz</a>	20-May-2005 20:46	140k	
 <a href="#">040409.220001hp.pgm.gz</a>	20-May-2005 20:46	145k	
 <a href="#">040409.220002hm.pgm.gz</a>	20-May-2005 20:46	132k	



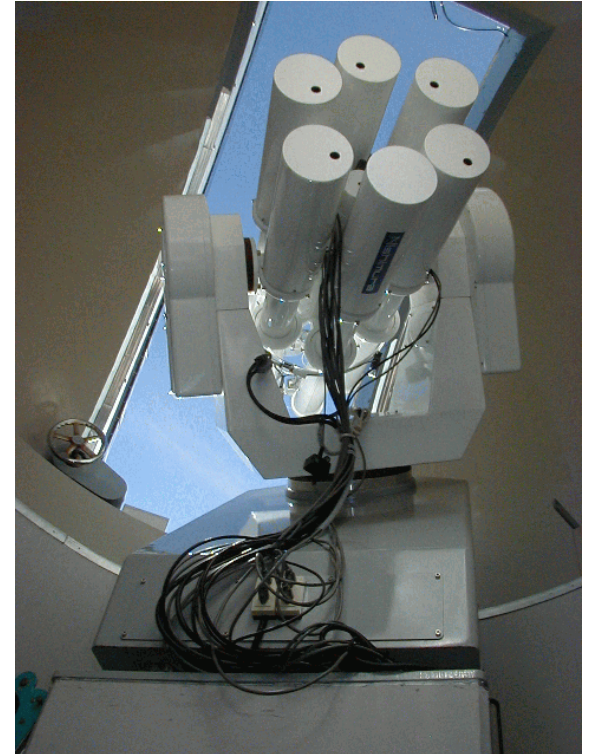
## Typical Examples of the Studies by using FMT Data

Investigation of **the Vector Velocity Field** of Large-scale Filament Eruptions and of the correlation with CMEs

=> T. Morimoto & H. Kurokawa (PASJ, 55, 505, 2003)

Detection of **Shockwaves in the Chromosphere** that accompany Flares (**Moreton Wave**)

=> N. Narukage et al.(ApJ, 572, L109, 2002)



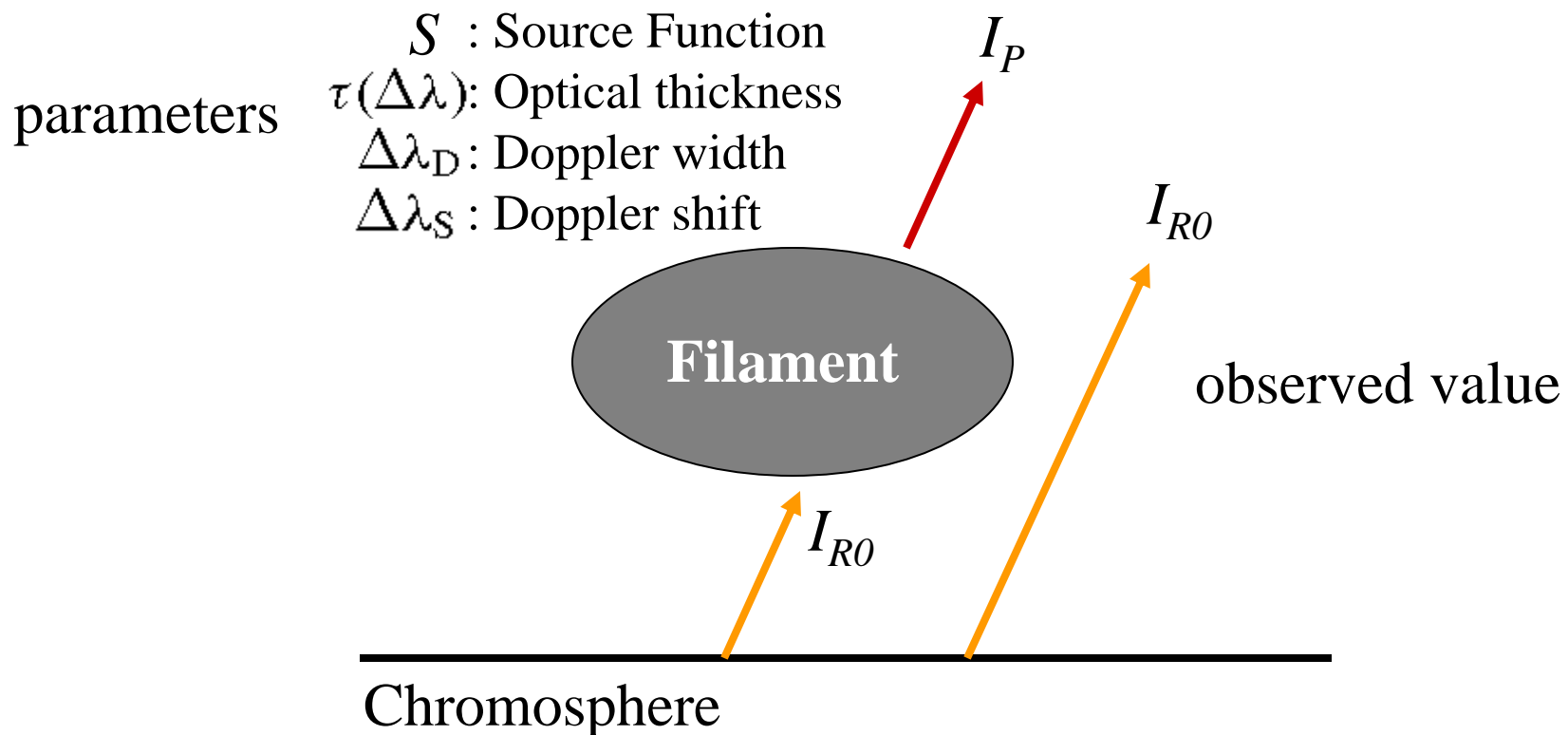
Investigation of **the Vector Velocity Field** of Large-scale Filament Eruptions  
and of the correlation with CMEs T. Morimoto & H. Kurokawa (2003)

Observed contrast:  $C(x, \Delta\lambda) = [I_P(x, \Delta\lambda) - I_{R0}(\Delta\lambda)]/I_{R0}(\Delta\lambda)$

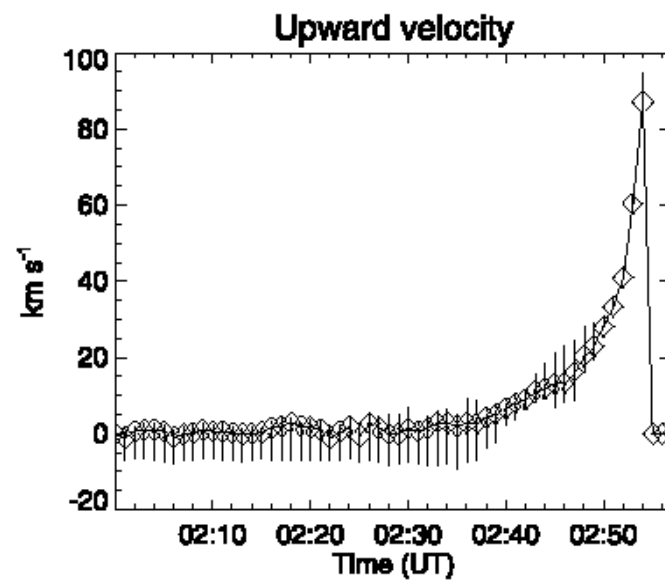
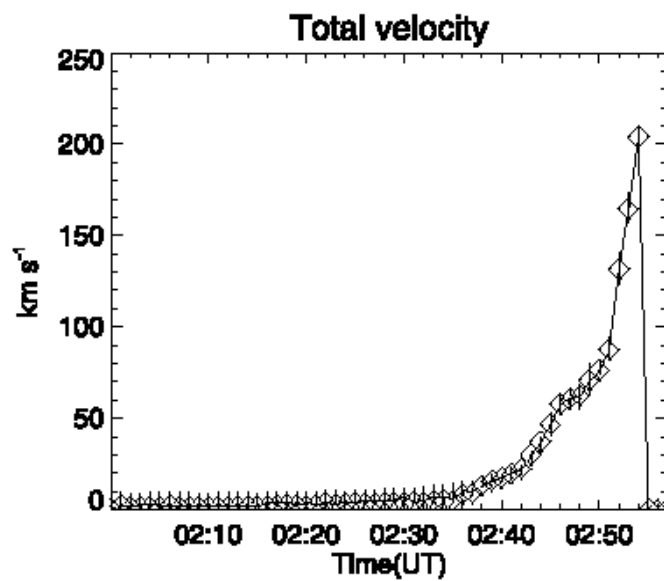
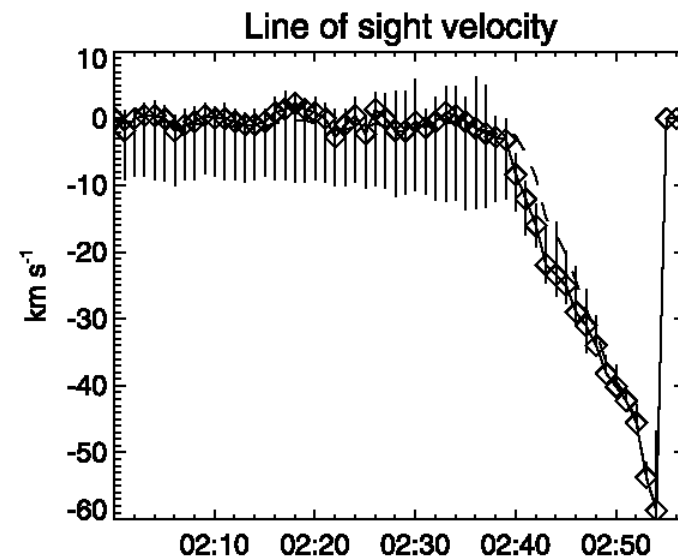
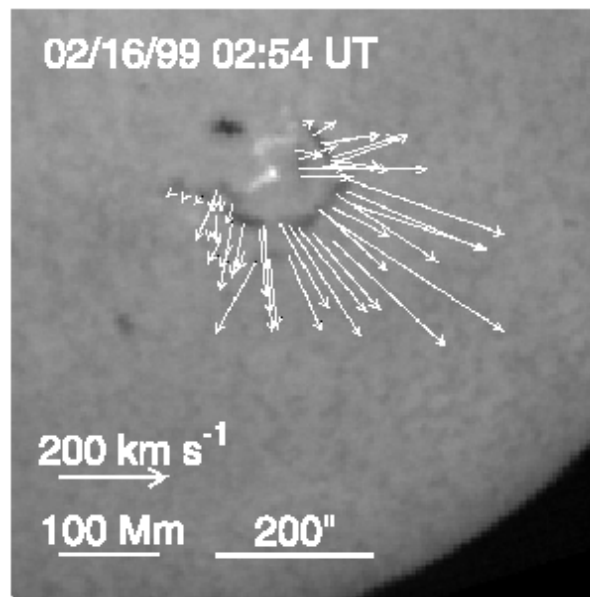
Cloud Model Fitting

$$C(\Delta\lambda) = \left[ \frac{S}{I_{R0}(\Delta\lambda)} - 1 \right] \{1 - \exp[-\tau(\Delta\lambda)]\}$$

$$\tau(\Delta\lambda) = \tau_0 \exp\left\{-\left[(\Delta\lambda - \Delta\lambda_S)/\Delta\lambda_D\right]^2\right\}$$

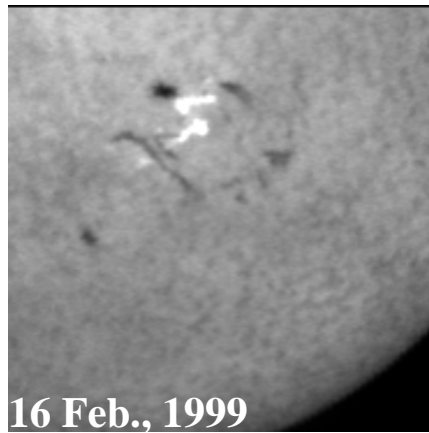


Then they could measure the line of sight velocity of erupting filaments, and by mixing with transversal velocity field, they obtained total velocity strength and radial upward velocity.



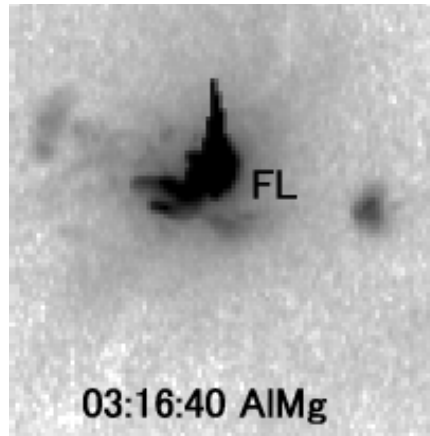
They distinguished whether each active filament really erupted or not by analyzing its time-variation of the radial upward velocity, and investigated the relation with coronal structure and CME.

**FMT**



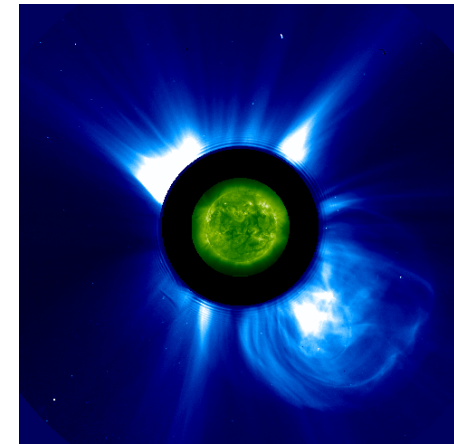
Eruptive: ***E***

**SXT,EIT**

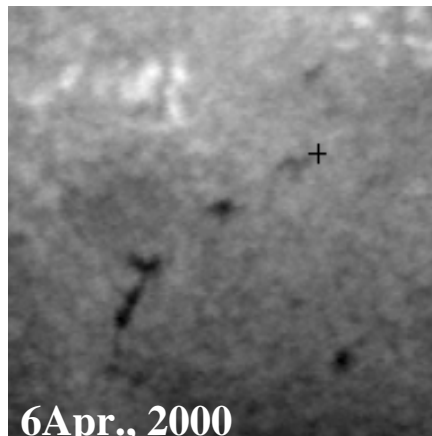


Arcade, Flare ...: ***A***

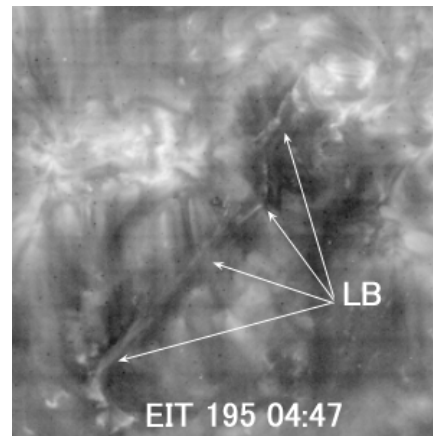
**CME**



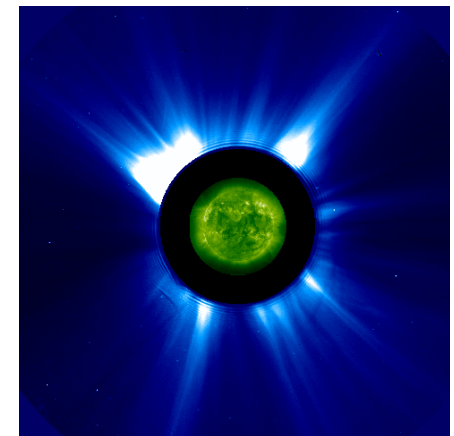
***yes***



Quasi-Eruptive: ***Q***



Localized Brightening: ***LB***



***no***

**Morimoto & Kurokawa(2003 P.A.S.J.)**

As the result, really erupting filaments almost perfectly corresponded to appearances of “coronal arcade structures” and “CMEs”.

No.	Time	Location/NOAA	Type ( $\gamma$ )	SXT	EIT	GOES(min)	CME
1	11/05/92 00:15-02:15	S20W17/	E (43)	A		-	
	.....	.....	...				
26	10/27/98 23:34-36:39	N18E40/8369	Q (0)	-	LB	C1.6	no
27	01/30/99 00:00-01:50	S34E20	E (84)	A		B3.3	
28	02/09/99 03:07-05:22	S27W39/8453	E (13)	A	A/EW/D <sup>†</sup>	C2.3	yes
29	02/16/99 01:42-04:15	S27W18/8458	E (53)	A		M3.2	
30	06/01/99 06:29-07:08	S23E17/8557	Q (0)	LB		C6.2	no
31	01/19/00 00:28-01:47	N08W18/8829	E (36)	A	A/D	C1.4	yes
32	01/28/00 05:35-06:20	S28W20/8841	Q (0)	LB	LB	B4.4	no
33	04/06/00 03:48-05:48	S27W02/	Q (0)		LB	C1.4	no
34	04/25/00 01:05-01:47	N23W27/8972	E (51)	A	A/FE	C1.1	yes
35	05/08/00 04:19-07:40	S21W03	E (45)	A	A/FE/D	B6.8	yes

DB type	A	LB	Total
Eruptive	22 (71%)	0 (0%)	22
Quasi-eruptive	1 (3%)	8 (26%)	9
	23	8	31

DB type (SXT & EIT)	yes	no	Total
Eruptive(A)	8 (53%)	0 (0%)	8
Quasi-eruptive(LB)	0 (0%)	7 (47%)	7
	8	7	15

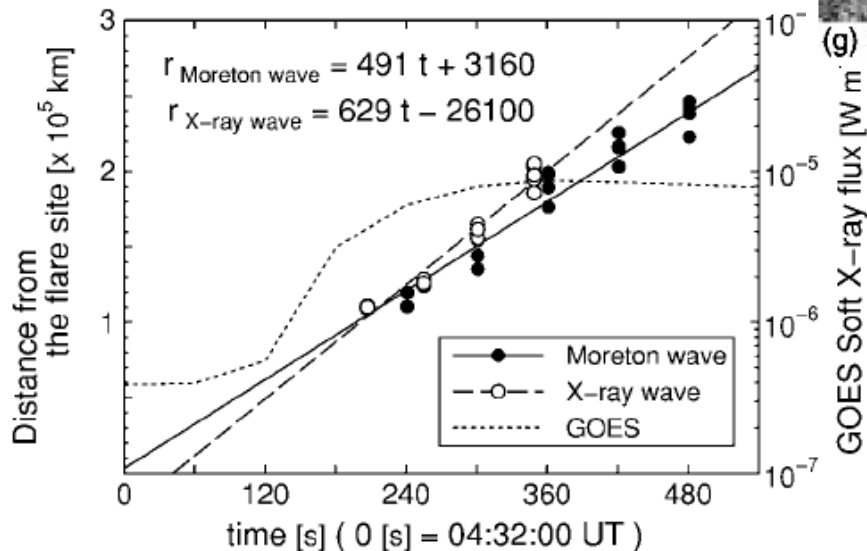
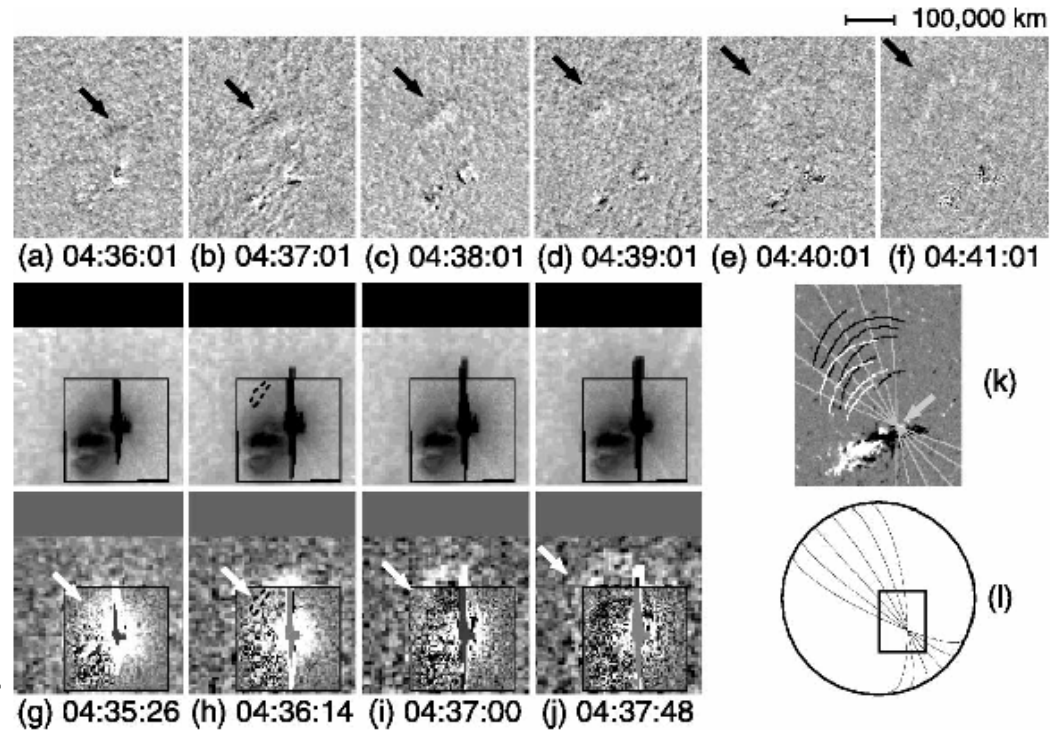
Morimoto & Kurokawa (2003: PASJ)

Future subject is the investigation of the correlation between “the velocity strength and direction of the eruption” and “the strength of effects of the corresponding CMEs on the earth”.

# Detection of Shockwaves in the Chromosphere that accompany Flares (Moreton Wave) N. Narukage et al. (2002)

They investigated Moreton waves on the chromosphere obtained the FMT and EIT waves and X-ray waves in the corona.

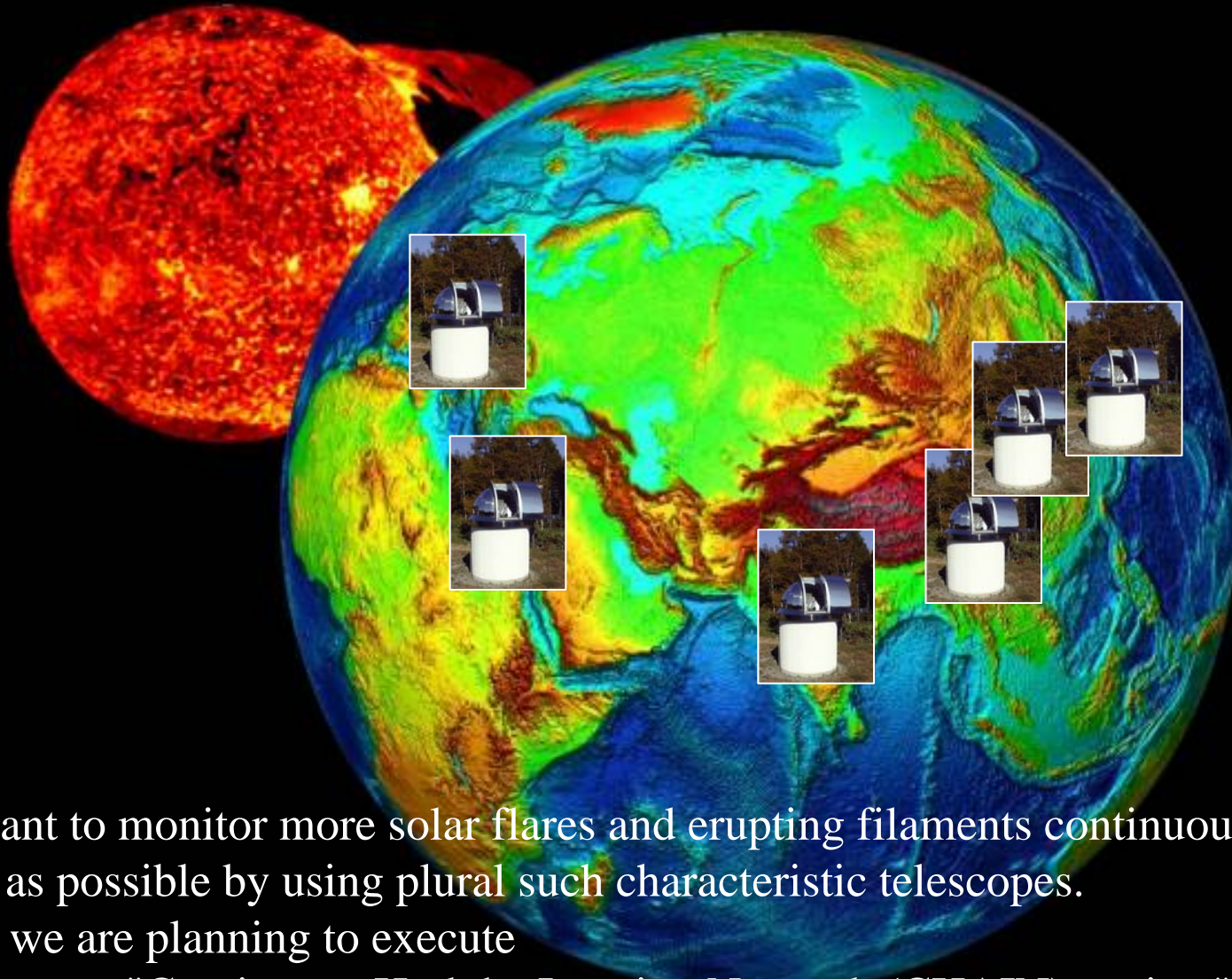
These waves may stand for the front of the shockwaves that accompany flares.



According to their results, Moreton wave and X-ray wave are very similar in the speed, timing and direction, and their speed correspond to expected MHD shockwave. However, EIT wave is different from them.

By the way, (according to Prof. Shibata,) more than half of the Moreton waves that has been detected with all telescopes over the world were observed by this FMT.

# CHAIN Project (Continuous H-alpha Imaging Network Project)



We want to monitor more solar flares and erupting filaments continuously as much as possible by using plural such characteristic telescopes.

Then, we are planning to execute

"Continuous H-alpha Imaging Network (CHAIN)-project".

# Telescopes that are planned to be used in the CHAIN

## 1) Existing foreign similar H-alpha telescopes

China, France, .....

Prof. Shibata, Prof. Kurokawa and Prof. Kitai have begun to contact with foreign observatories.

## 2) Newly installed H-alpha multi-wavelength telescopes

As part of this plan, we are examining the possibility of the installation of the telescopes in developing countries.

This should make not only the effect that the number of flare-monitoring location will be increased, but also the effect that the education and study of the solar-terrestrial physics in the developing countries will be encouraged.



# Plan of the FMT in PERU

Concretely, we are currently examining Peru as a candidate country where a 1st new telescope will be installed.


- \* It can just cover Japanese nighttime
- \* Deep connection with Japan and our university in the astronomical field (cf. Dr.J.K.Ishitsuka's talk)



Google Earth

Currently, there are  
two candidate locations in Peru.

Probability of the fine weather  
at ICA is very high.

A satellite-style map of Peru with yellow outlines of regional boundaries. A red outline highlights a coastal region. Three locations are marked: LIMA with a white diamond, HUANCAYO with a yellow circle, and ICA with a yellow circle. The text 'LIMA' is in white, while 'HUANCAYO' and 'ICA' are in yellow.

LIMA ● HUANCAYO  
ICA

In ICA, there is a plan that  
new institution for educating astronomy  
will be built in near future.  
(New infrastructure will be prepared.)

# Configurations & Costs of the FMT in PERU

We are considering several ways of installing the FMT in Peru.

## \* 4 kinds of configurations of the TELESCOPE

1) Newly manufactured FMT (Equatorial type)

Telescope itself: \$208,250 , Transfer&Construction: \$57,170

2) Newly manufactured FMT (Alti-azimuth type)

Telescope itself: \$233,330 , Transfer&Construction: \$64,170

3) Transferring remodeled FMT (with keeping equatorial type)

Remodeling: \$72,330 , Transfer&Construction: \$57,170

4) Transferring remodeled FMT (remodeled to alti-azimuth type)

Remodeling: \$215,830 , Transfer&Construction: \$64,170

## \* 2 kinds of configurations of the HOUSING

1) Dome type

Housing itself: \$119,580 , Transfer&Construction: \$53,670

2) Sliding-roof type

Housing itself: \$51,330 , Transfer&Construction: \$36,170

## Conclusion (Subjects in the future)

### \* Cutting down required expenses & Finding the fund

- The present estimated cost are too expensive.
- We must select minimum necessary functions.
- In recent years, ordinary expenditure on science and education of Japanese universities are also gradually cut down.
- We
- org

### \* Mea

- Sar
- Pro

Thank you very much.

### \* Man

- Dai
- Ma

Telescope itself, Filters (stability and uniformity of the wavelength), Cameras etc.  
- Management and improvement of the data-processing software

### \* Clerical procedure

- Clerical procedures in Japanese universities are very complicated.  
If we will move the present FMT to Peru, we have to negotiate and adjust very well between both universities with secretaries, in advance.

d.)

\*\*\*\* The Role of the Solar Observation \*\*\*\*  
\*\*\*\* on Studies of the Solar-terrestrial Environment \*\*\*\*

Measurement of various physical parameters of each explosive active phenomenon on the solar surface, such as the size, temperature, velocity field and magnetic-field configuration etc.

Accumulation of sample data of many kinds of active phenomena for the purpose of improving statistical certainty of the prediction of the future solar activity from the present status of the solar surface structures

Investigation of the mechanism itself of such solar active phenomena (Quantitative observation of the detailed process of the active phenomena from the solar interior to the corona)