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NATIONAL ASTRONOMICAL OBSERVATORIES, CAS



Development of the Solar Full-disk Multi-layer Magnetograph for the Chinese Meridian Project II

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20240911

The Chinese Meridian Project II (CMP-phase II) aims to establish a comprehensive ground-based space environment monitoring system

Solar Full-disk Multi-layer Magnetograph(SFMM)

Full-disk Magnetograph Telescope

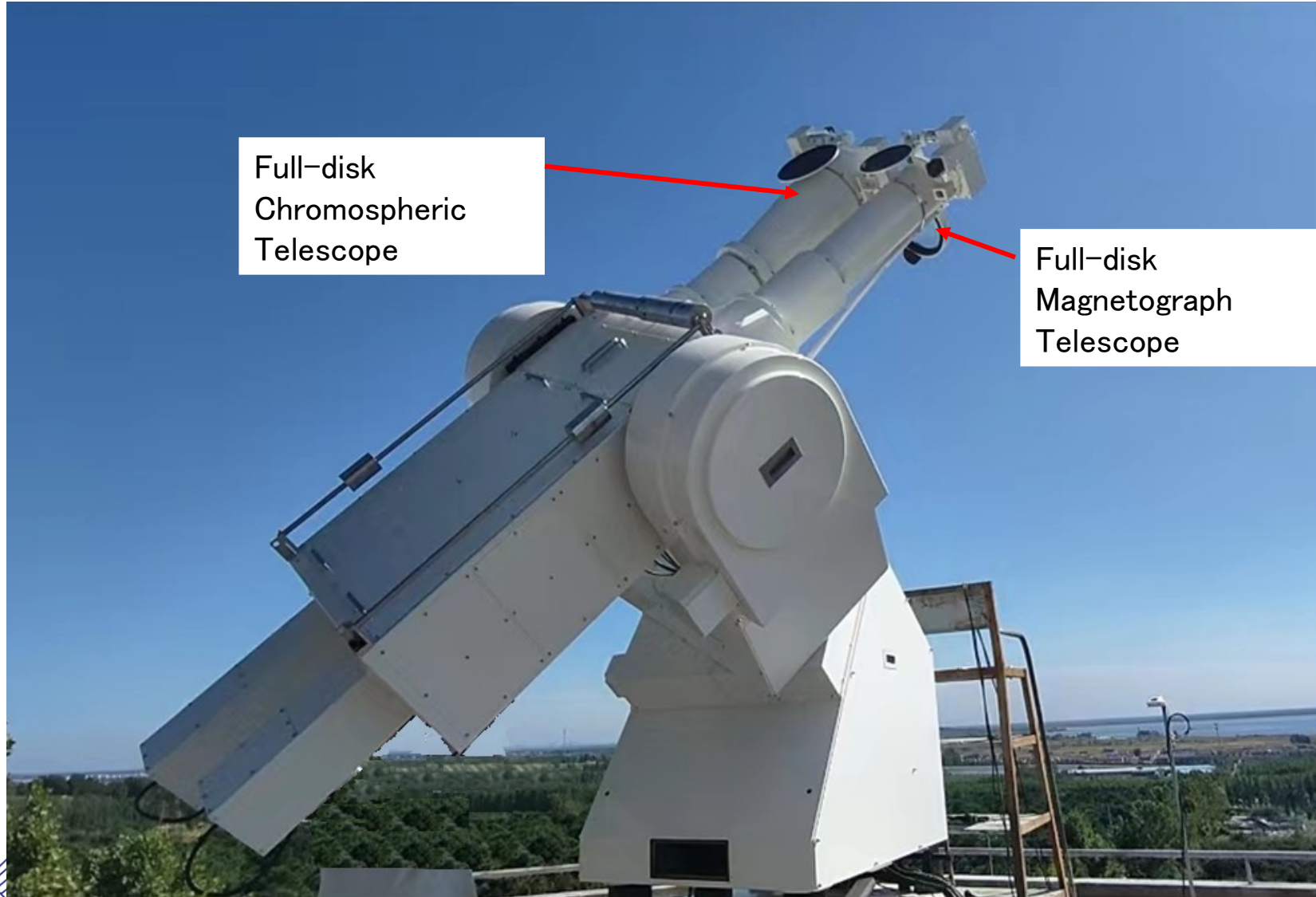
FeI 5324.19Å and H β 4861.34Å ;
alternately measuring at these two wavelengths , to acquire **vector magnetic fields** and **velocity fields** at 532.4nm, as well as longitudinal magnetic fields and velocity fields at 486.1 nm.

Full-disk Chromospheric Telescope

H α 6562.8Å and CaII8542.1Å ;
alternately measuring **velocity field** and **monochromatic image** at these two wavelengths.



Solar Full-disk Multi-layer Magnetograph



The instrument has now entered its official observation and operational phase ;

Station : Ganyu Solar Observatory station ,
Jiangsu Province, China.

Scientific PI :
Professor Yuanyong Deng
Chief Designer:
Dr Yingzi Sun



No.	Parameters	Full-disk Magnetograph Telescope	Full-disk Chromospheric Telescope
1	Aperture	Φ120mm	Φ200mm
2	λ	5324 Å ; 4861Å	6563 Å ; 8542Å
3	FWHM	0.1 Å (@5324 Å) ; 0.085Å (@4861Å)	0.25 Å (@6563 Å) ; 0.44Å (@8542Å)
4	FOV	Φ34'	Φ35'
5	Spatial resolution	2"	1.5"
6	velocity measurement accuracy	100m/s (15min)	100m/s (15min)
7	line-of-sight magnetic field sensitivity	5Gauss (15min)	
8	transverse magnetic field sensitivity	200Gauss (15min)	
9	time resolution	15min	1s (burst mode)

Data types

Full-disk Magnetograph Telescope

FeI
5324Å

vector
magnetogram
velocity map

Hβ
4861Å

longitudinal
magnetogram
velocity
map

Full-disk Chromospheric Telescope

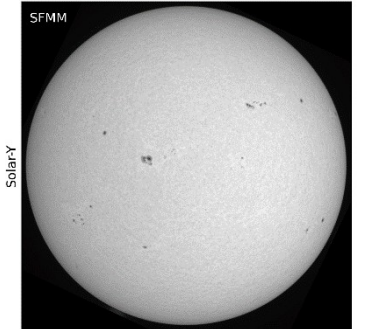
Hα
6563Å

Filtergram
velocity
map

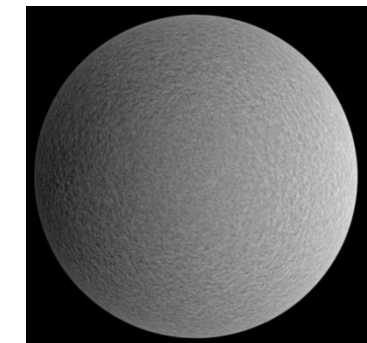
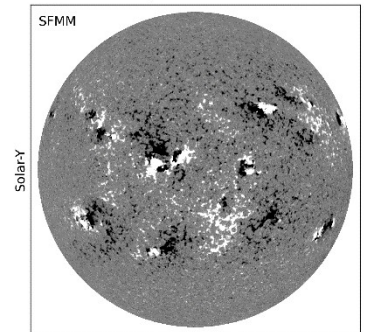
CaII
8542Å

Filtergram
velocity
map

5324-0.08 Å, 2023-09-22T04:43:11 UT



5324-0.08 Å, 2023-09-22T04:43:11 UT



liquid Crystal Filter



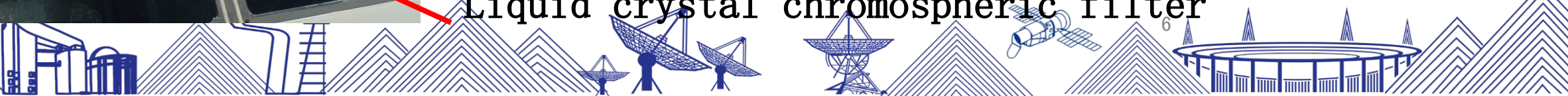
The core innovative device is **LCVRs based Lyot-Filter**

First implementation of liquid crystal filters in a solar telescope (From materials to softwares, **all made in china**)

The totally application of LCVR in astronomy achieved **multi-channel spectral line** observation and every spectral line can quickly scan its **profile**

Liquid crystal magnetic filter

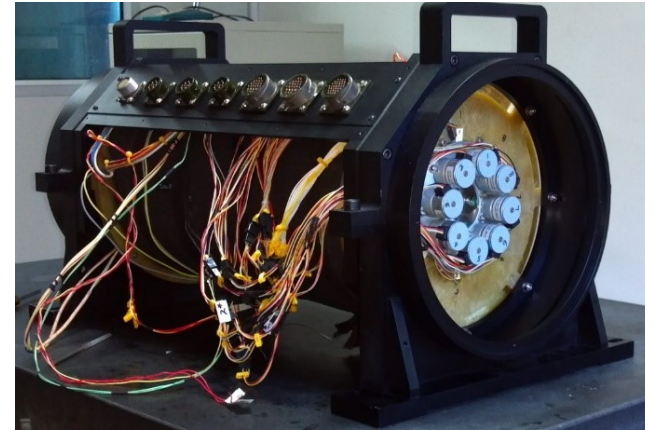
Liquid crystal chromospheric filter



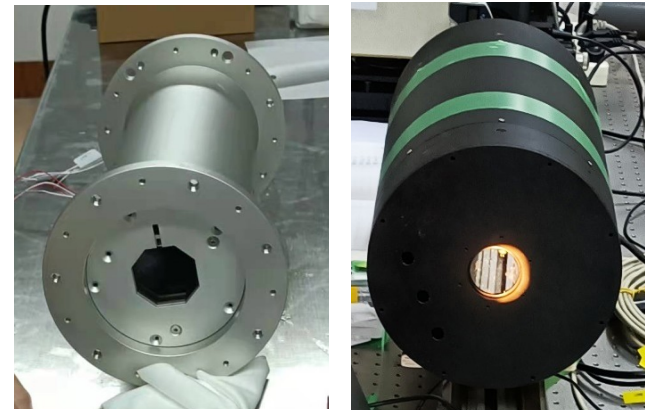
liquid Crystal Filter

Compared with traditional mechanical Lyot-Filter, there are some advancements:

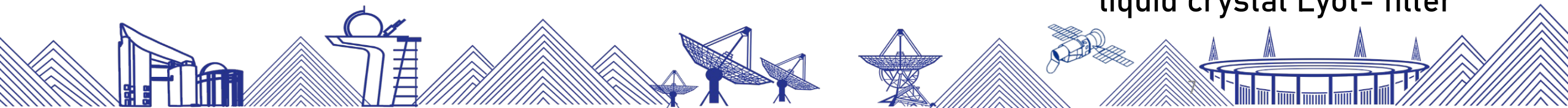
1. modulation response time at every wavelength point reduce : from **10 seconds to 1 mili-second**
2. Reduced **weight and length** at least by half
3. Simpler structure and better sealing performance



traditional mechanical Lyot-Filter



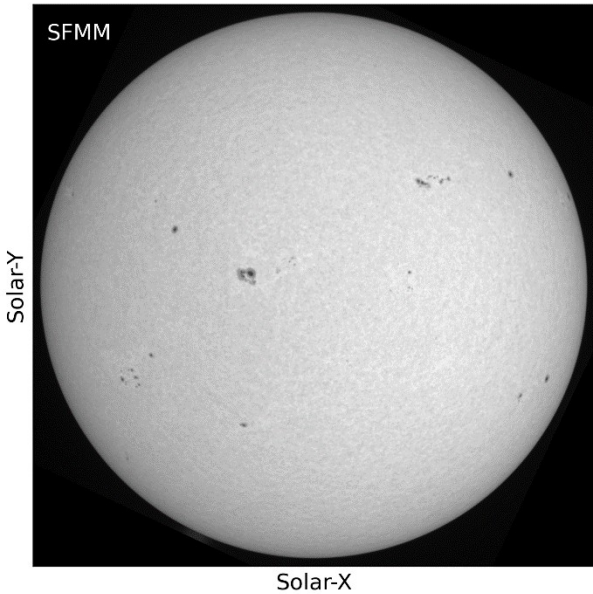
liquid crystal Lyot- filter



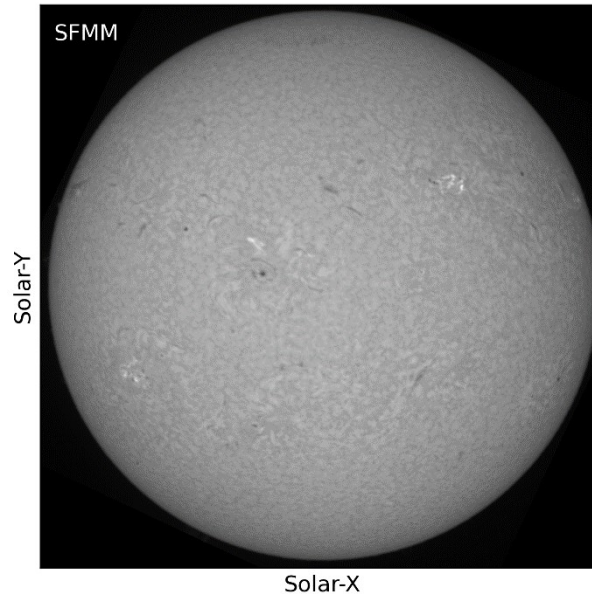
Full-disk Filtergram Samples

(FeI532.4nm, H β 486.1nm, H α 656.3nm, CaII854.2nm)

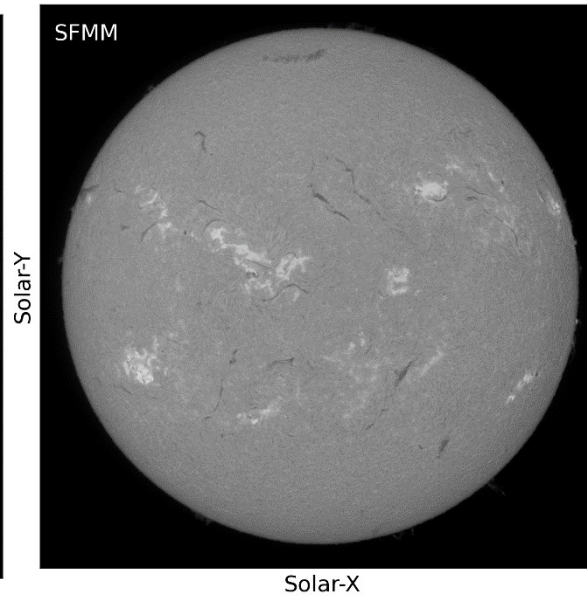
5324-0.08 Å, 2023-09-22T04:43:11 UT



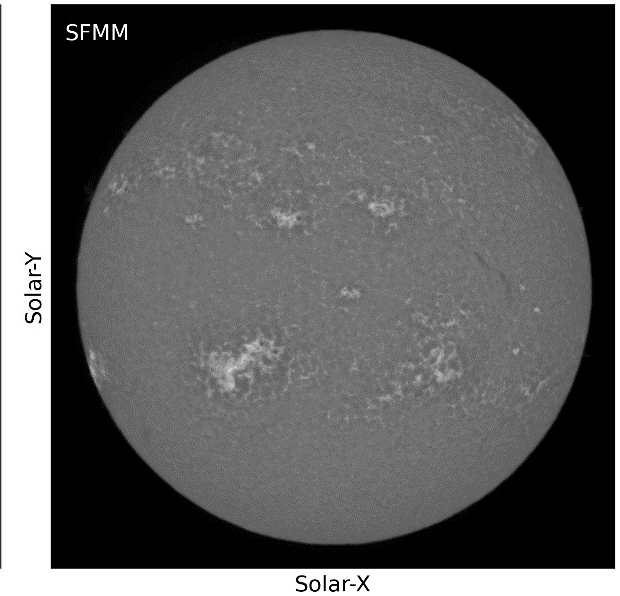
4861-0.10 Å, 2023-09-22T05:33:15 UT




6563+0.00 Å, 2023-09-22T02:34:13 UT



8542+0.00 Å, 2023-04-11T05:14:53 UT



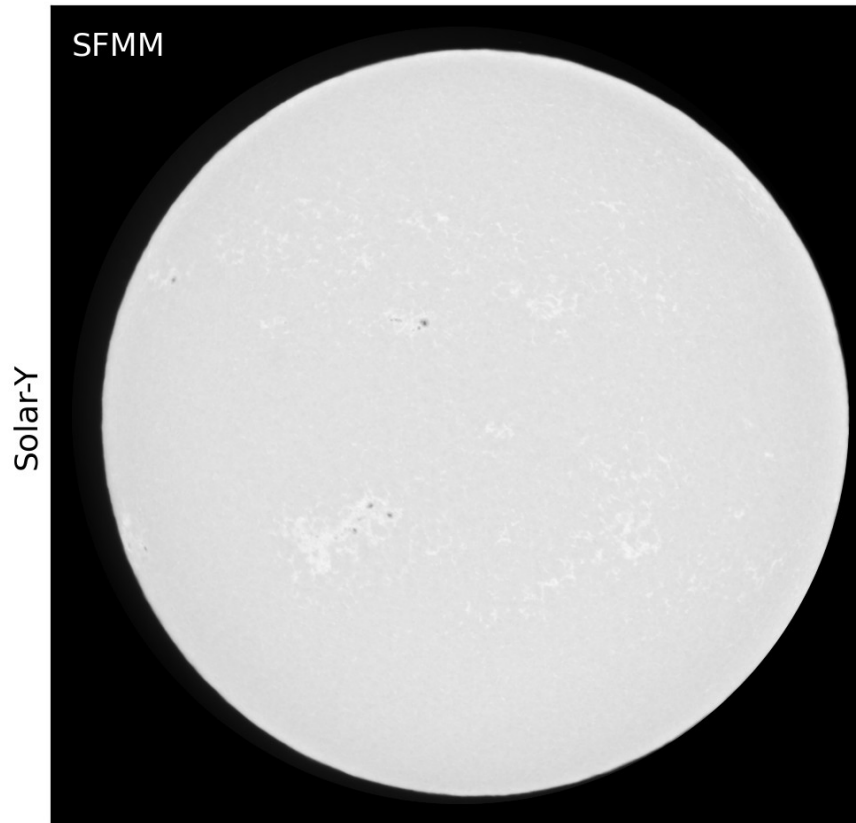
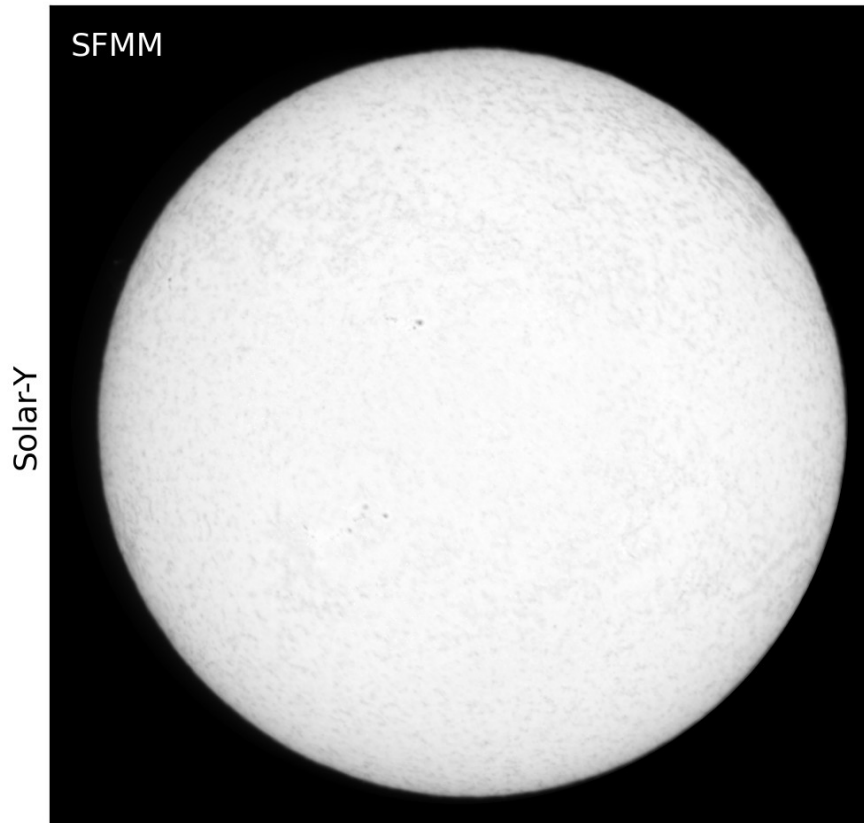
Four spectral lines form heights from the solar photosphere to the mid-to-upper chromosphere, revealing the three-dimensional spatial distribution of different types of solar activity



Spectral line profile scanning of the chromospheric $H\alpha$ (6563 Å) and $CaII$ (8542 Å) lines

6563-1.0 Å, 2023-04-11

8542-1.0 Å, 2023-04-11



Solar-X

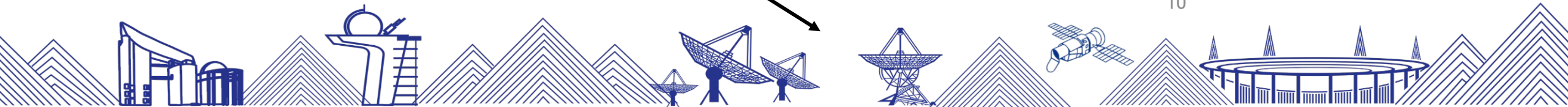
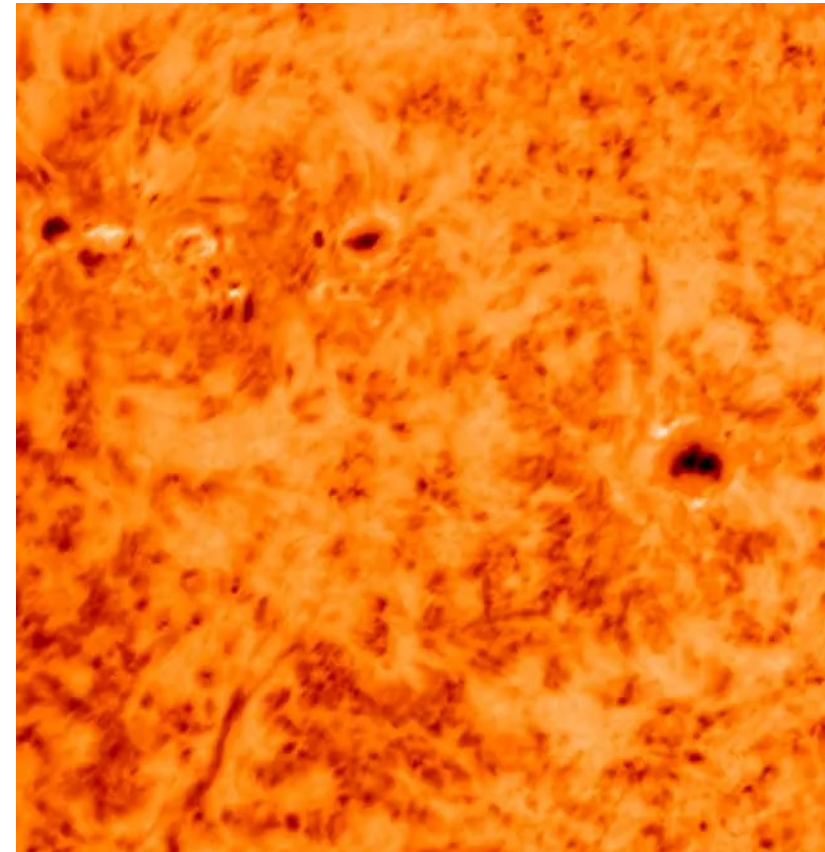
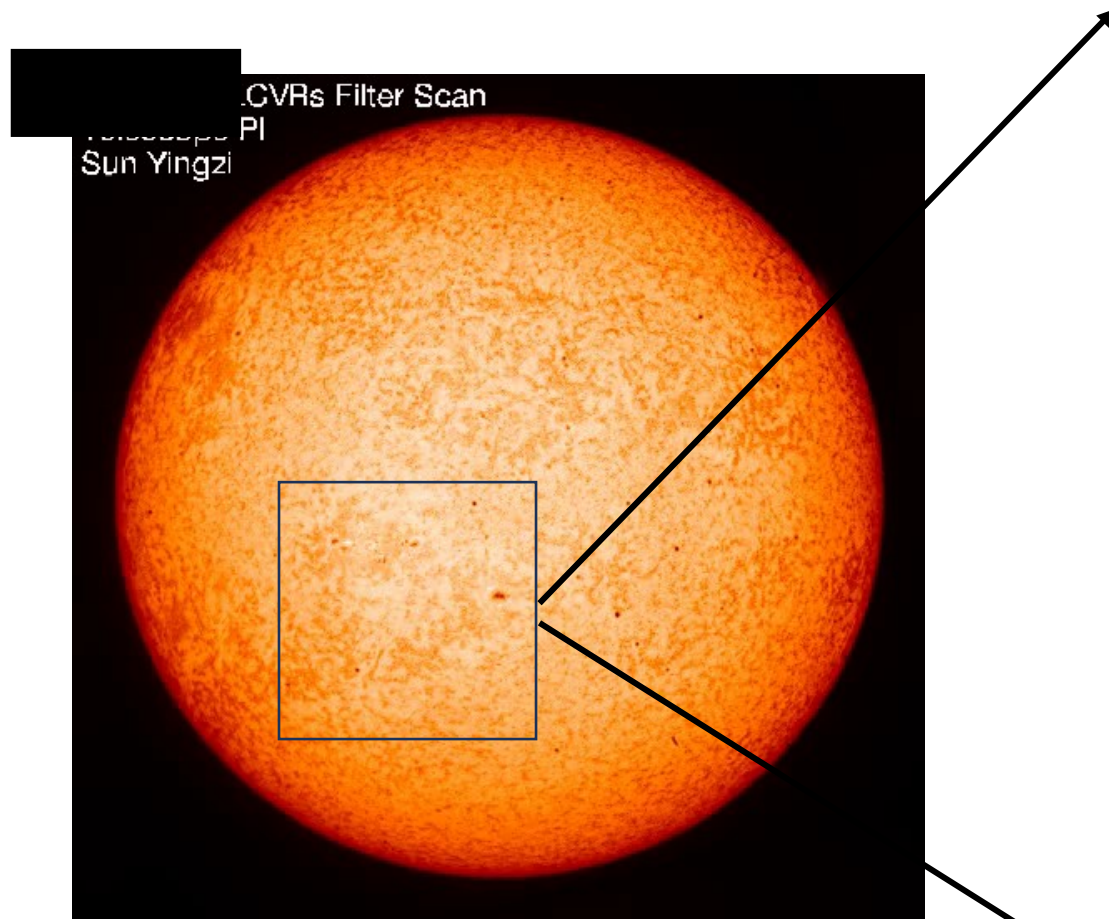
Solar-X

Our LCVR based Filter can reduce the wavelength adjustment of the single spectral point **from seconds to milli-seconds**. The time bottleneck is no longer the previous mechanical execution, but the single frame integration time.

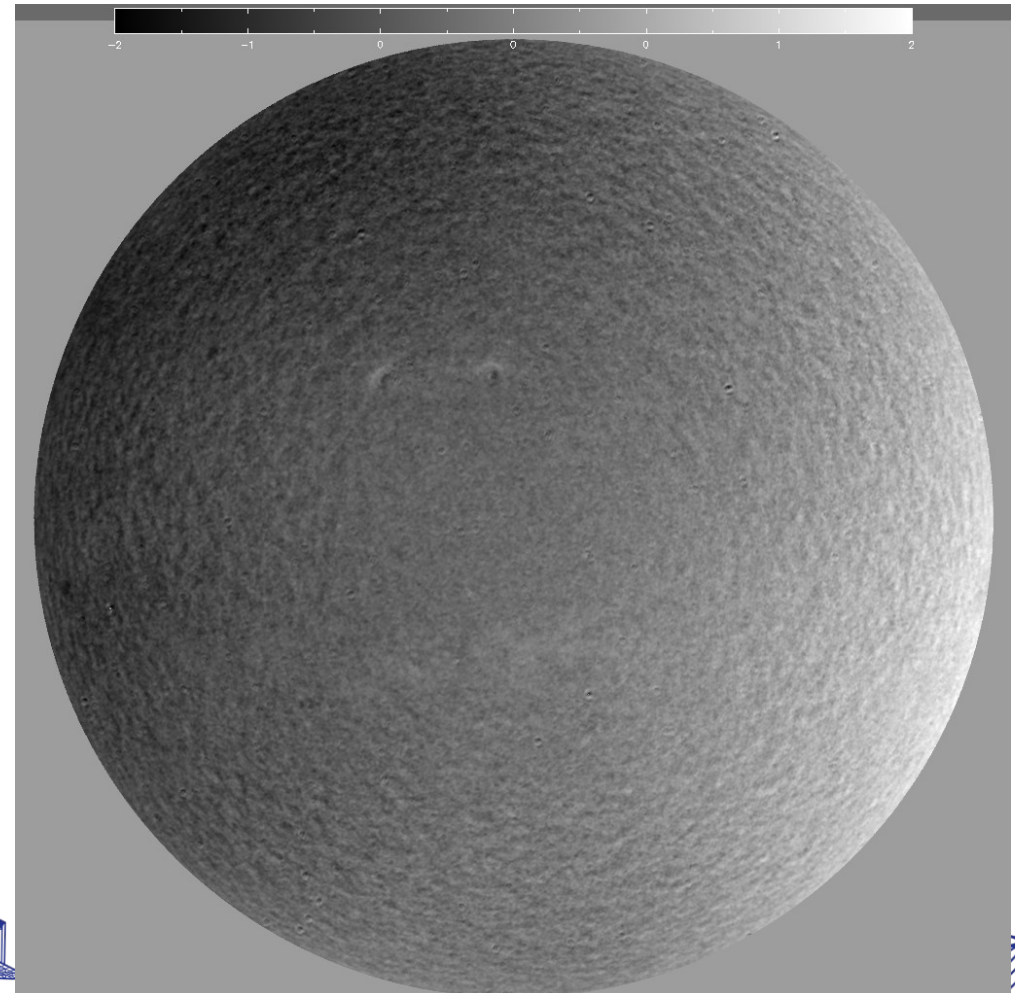
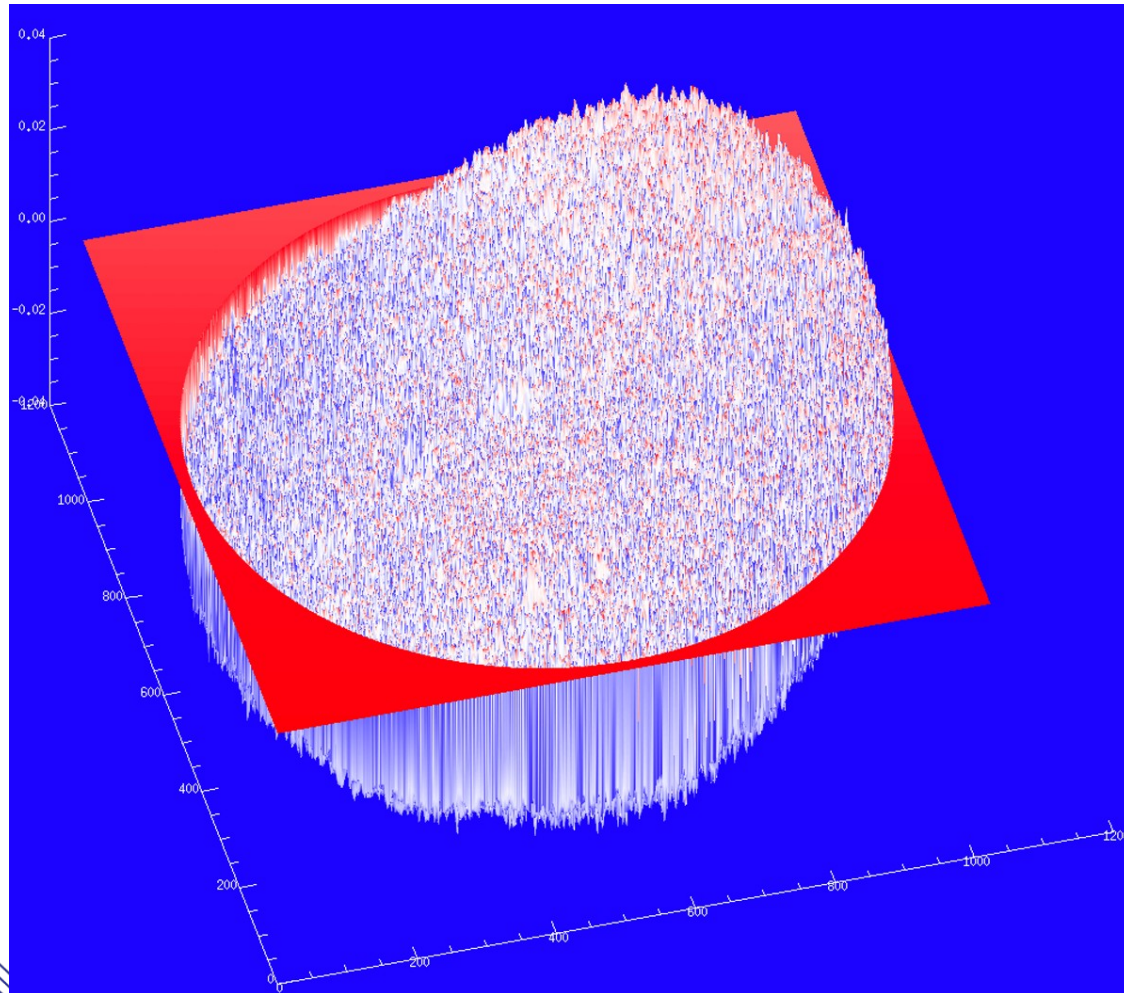
If we observe 81 wavelength points in the profile the $H\beta$, this new type Filter greatly reduced the time .From **over 10 minutes** in the past to the present-**no more than 2 minutes**.



H-alpha wavelength scanning

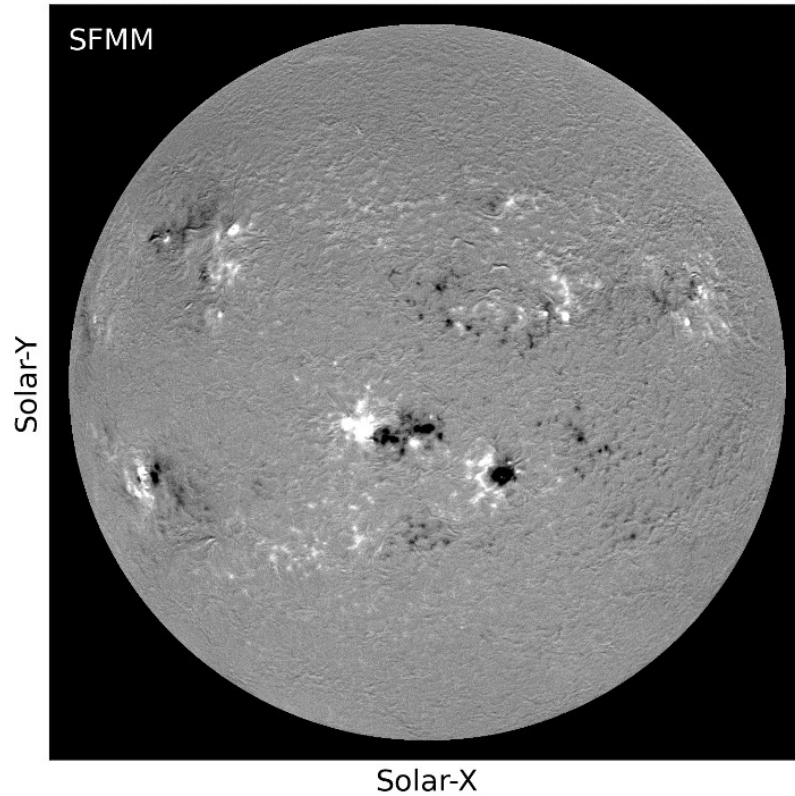


FeI 5324 Å Doppler map ($\pm 0.4\text{\AA}$, 21 points)

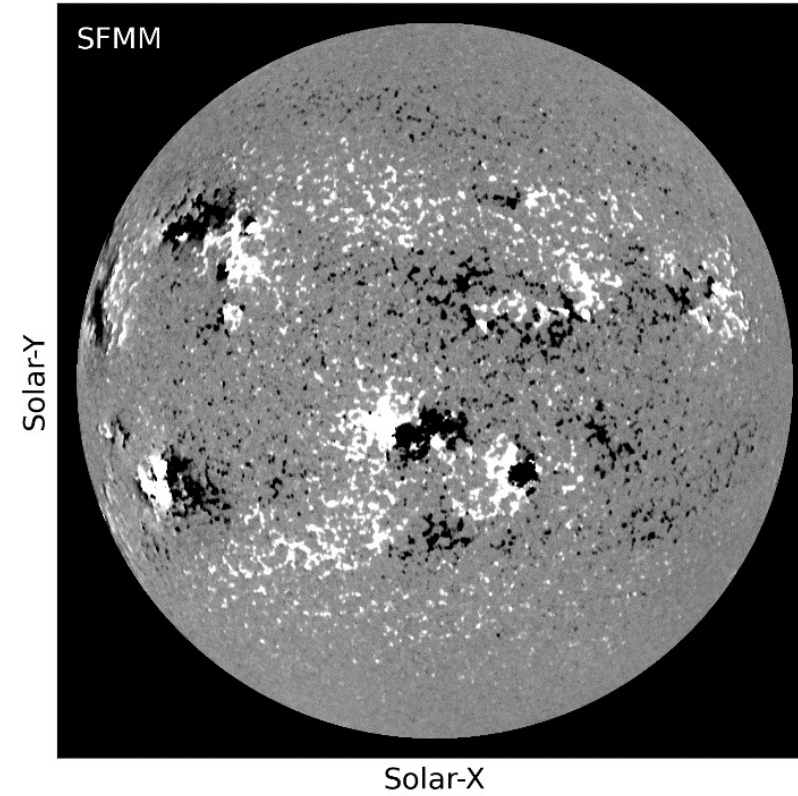


Longitudinal magnetic field in the chromosphere and photosphere

4861-0.12 Å, 2023-06-06T02:28:33 UT

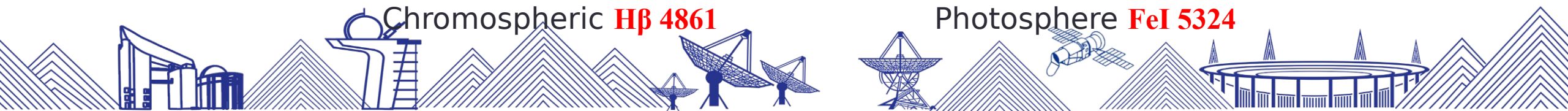


5324-0.08 Å, 2023-06-06T06:03:08 UT



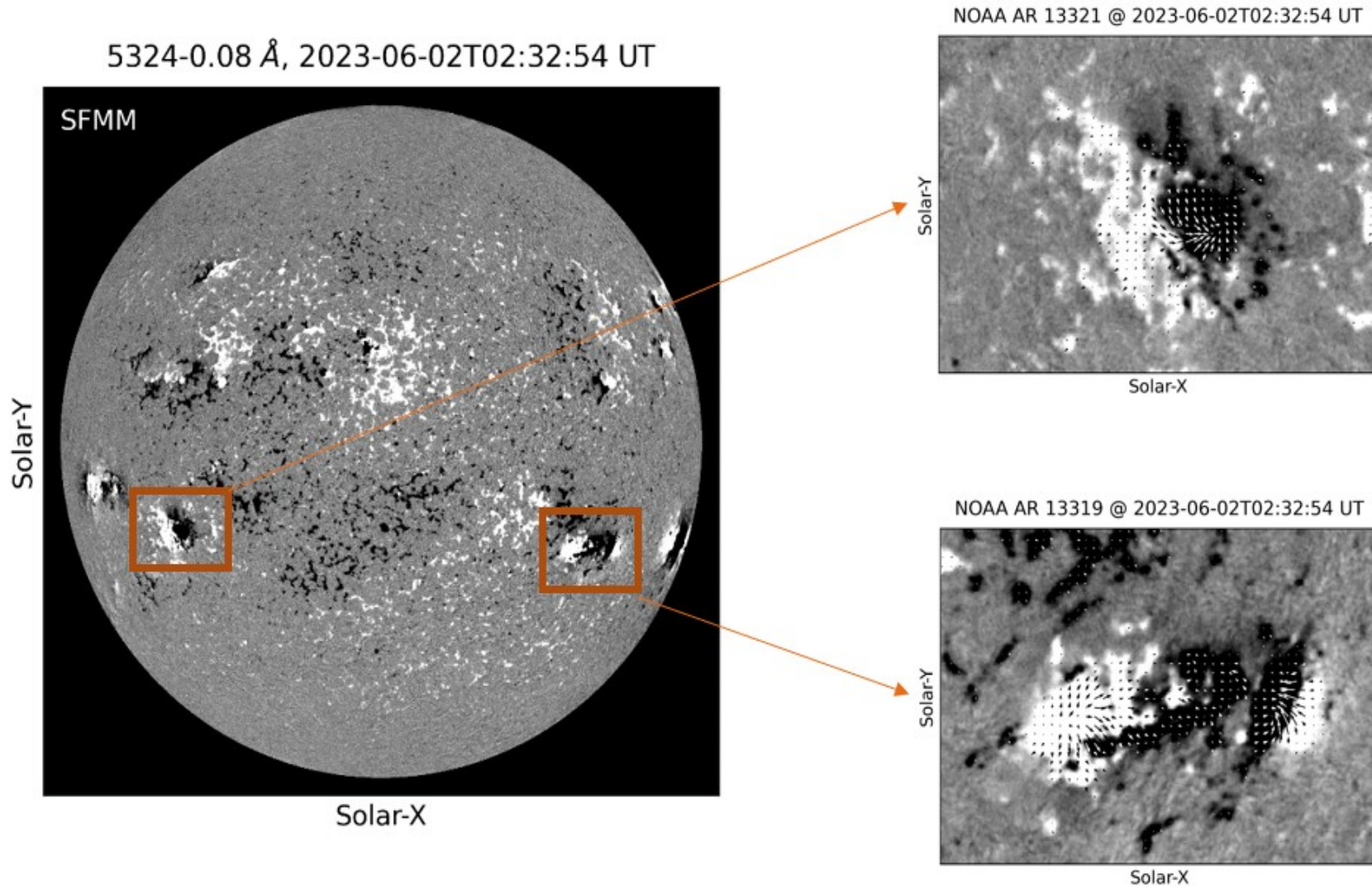
Chromospheric **Hβ 4861**

Photosphere **FeI 5324**



Full-disk longitudinal magnetogram

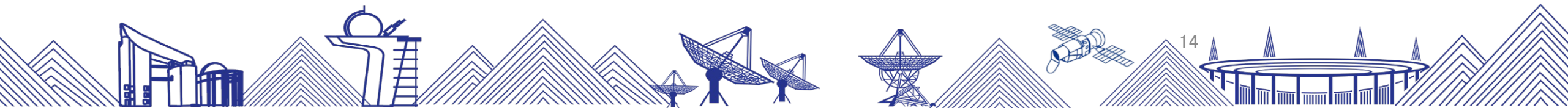
local region vector magnetogram



Conclusion

SFMM has successfully obtained high-quality data since Oct.
2023


Welcome everyone to collaborate and use this scientific
data !



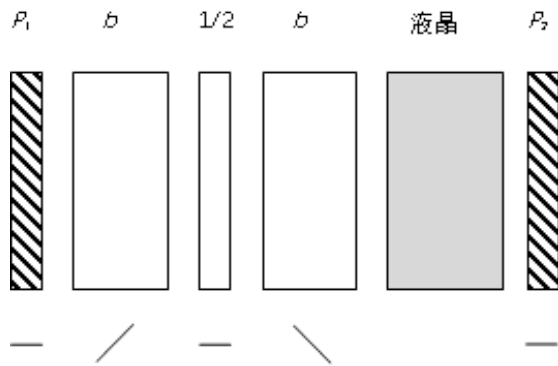


Thank you!

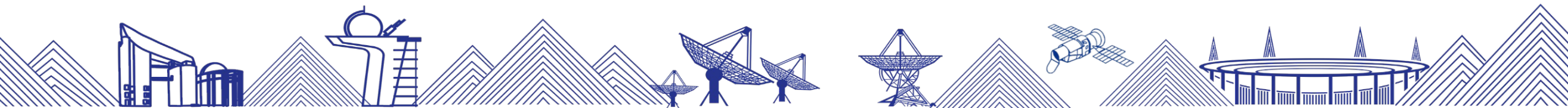
谢谢！



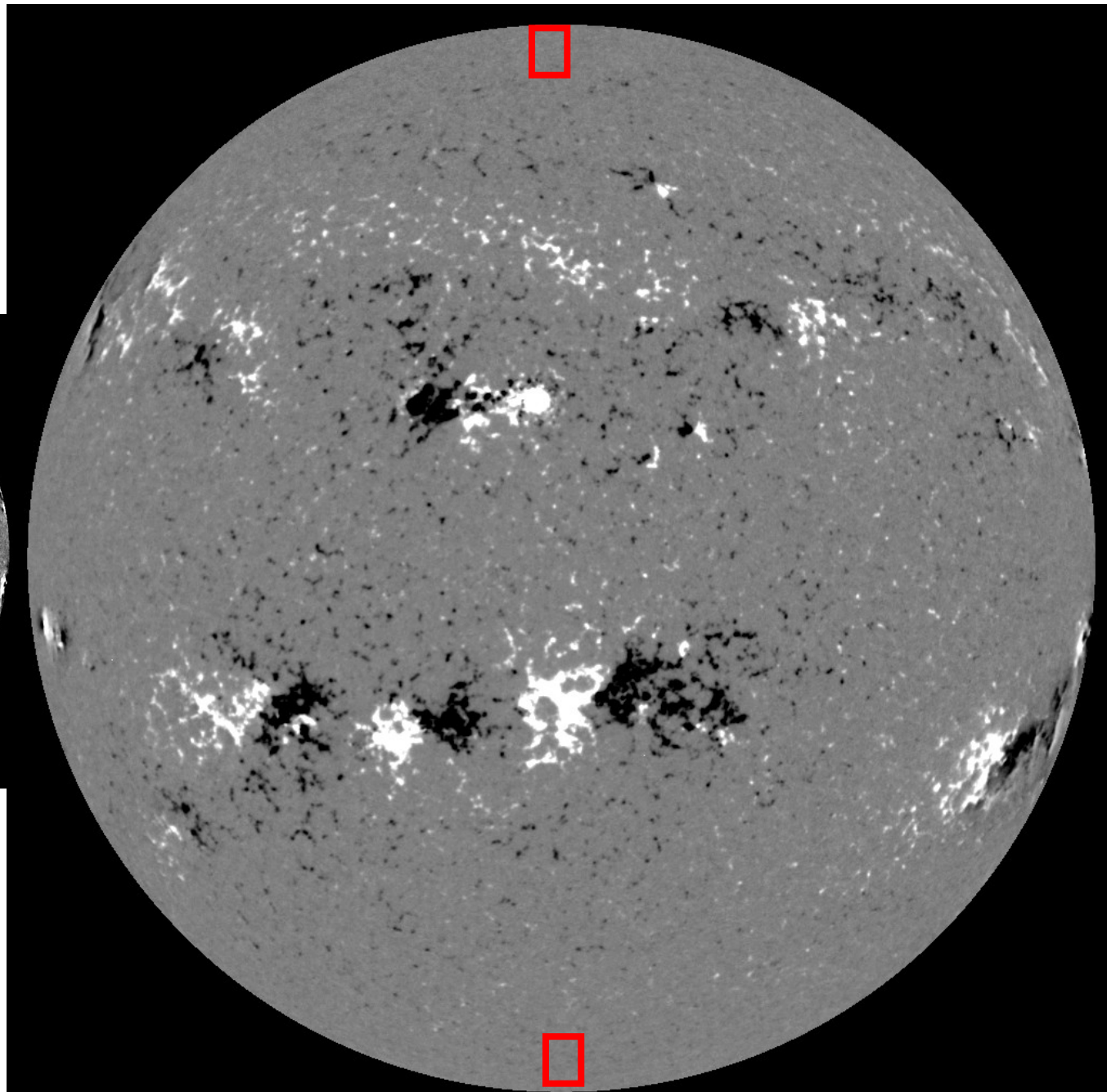
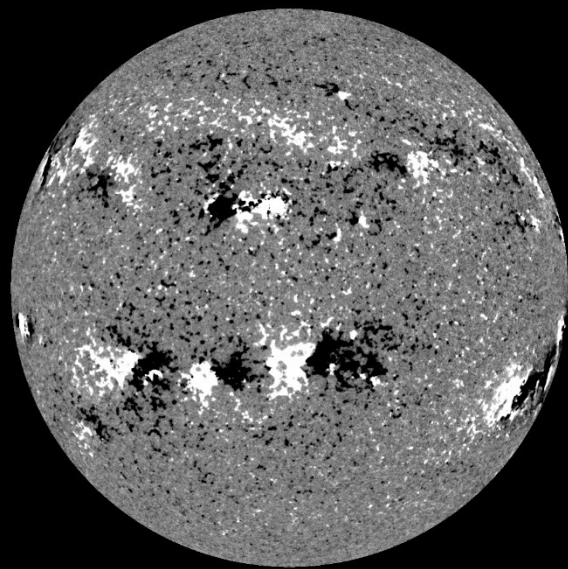
Liquid Crystal Waveplate Extremely Narrowband Birefringent Filter



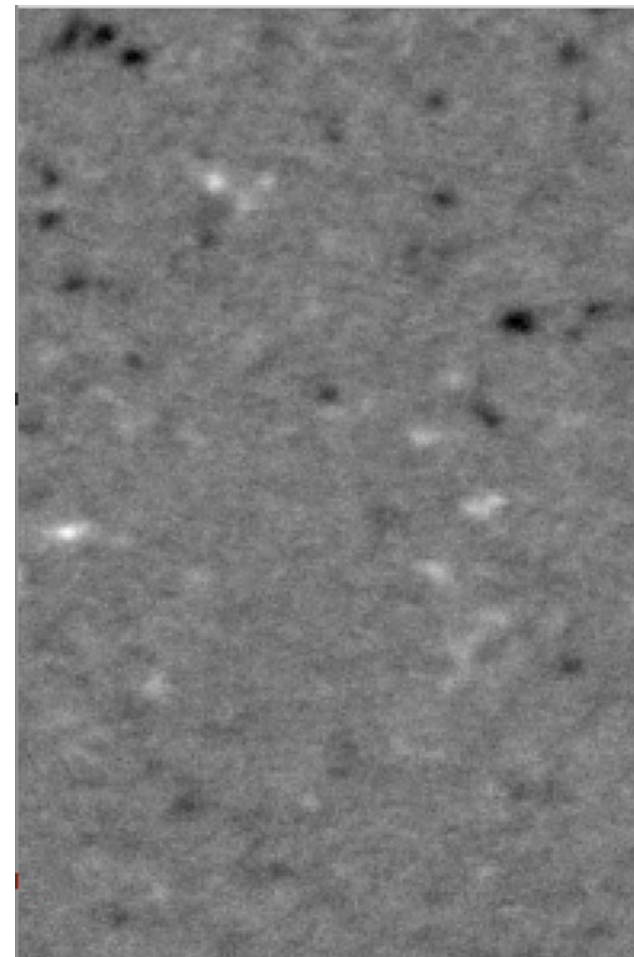
Our new type Filter fills the gap in China astronomy. From materials to softwares, all “Made in China”. All completed by small team that I am responsible. This new type Filter can be customized according to scientist requirements, both narrowband and broadband can be customized according to “what you want”



怀柔“高信噪比”
裂距磁图。



南北极取 4×5.6
平方角分，标准
偏差值 $\pm(3-5.5)$
高斯， $(3.2-8)$ 高
斯；极区磁元
 $40-300$ 高斯



20230418 白杨 15 手
动换波长 21 波长点，
耗时 15 分钟，正负
0.4 埃
左右旋各 128 帧，
20ms 曝光
液晶型透过