

# Heliophysics Missions in China

**National Space Science Center  
Chinese Academy of Sciences**

**2014-08-02**

# Outline

- ◆ **Meridian Project**
- ◆ **Kuafu**
- ◆ **MIT**: Magnetosphere-Ionosphere-Thermosphere Coupling
- ◆ **SPORT**: The first CME Imager from out-of-Ecliptic Plane
- ◆ **ASO-S**: Advanced Solar Observatory in Space
- ◆ **DSO**: Deep Space Observatory
- ◆ **CE-3**: EUV Imager

# Chinese Meridian Project



It is a Chinese multi-station chain mainly along 120°E to monitor geospace environment, starting from Mohe, the northernmost city in China, through Beijing, Wuhan, Guangzhou and extended to Chinese Zhongshan station in the Antarctic.

## Official Kick-off



15 stations, 38 observing sites and 94 instruments: after 58 months of construction, one of the world's most extensive ground-based system for geospace weather monitoring passed the national review for acceptance in Beijing on October 23, 2012 to officially start data collection and scientific research.

# Station Distribution

- Geomagnetic
- Optical-atoms.
- Radio
- Rocket



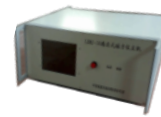
DIM



OFM



FGM



SCM



SED



DEM



ASAI



FPI



LIDA



AURO



CRM



TEL



IPS



DPS IONO



DOPP TEC



METR



HFR



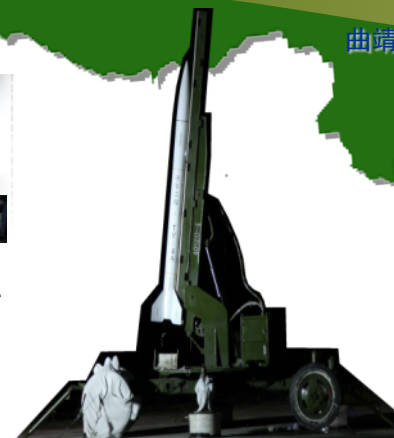
MST



VHF

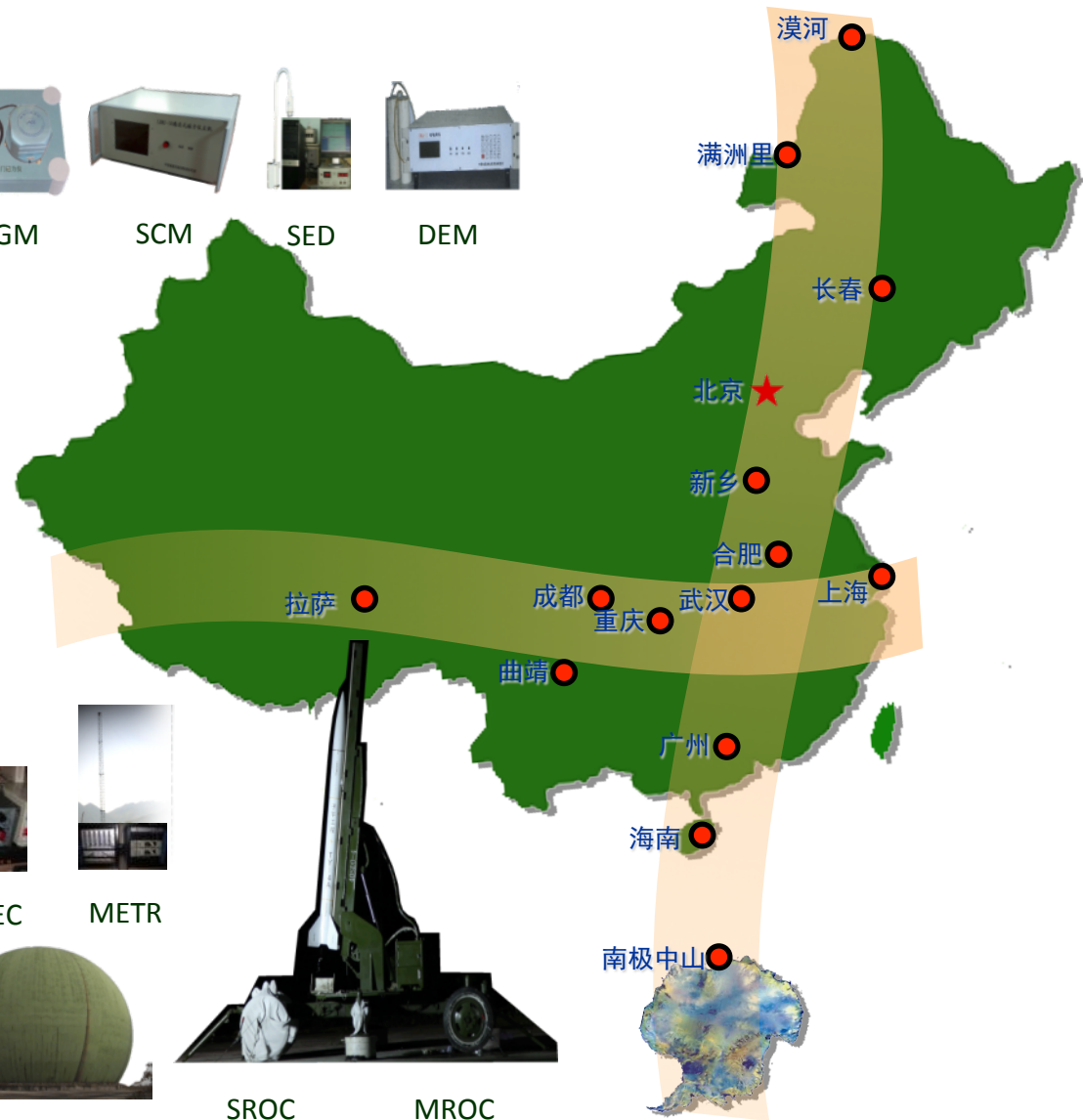


ISR



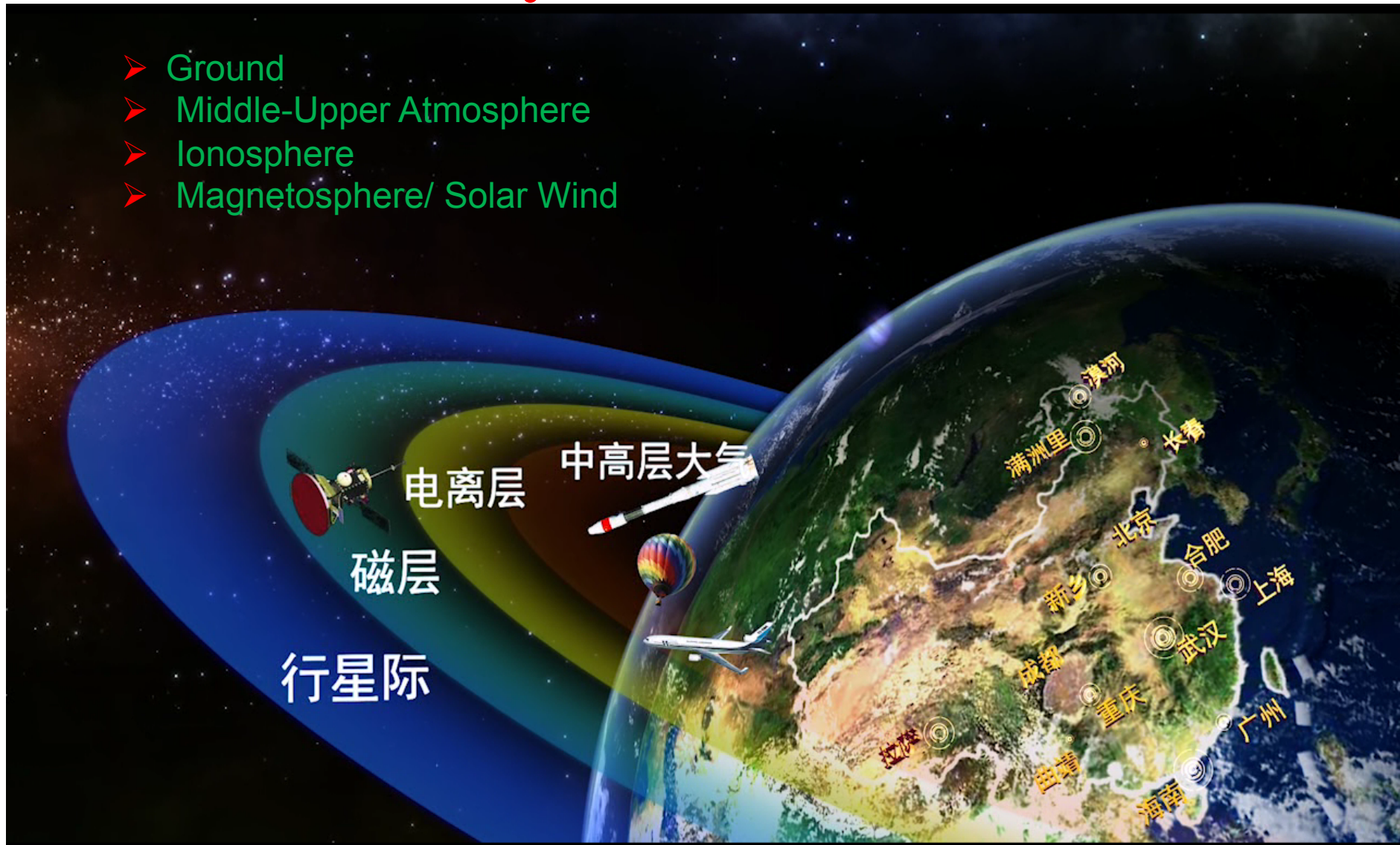
SROC

MROC



# Key Parameters

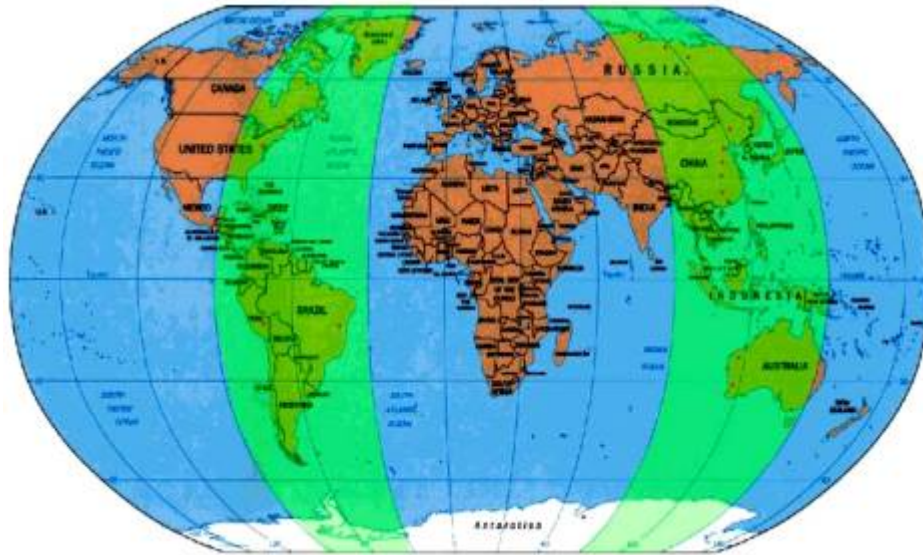
- Ground
- Middle-Upper Atmosphere
- Ionosphere
- Magnetosphere/ Solar Wind



# Status

- Chinese Meridian Project is in full operation.
- Up to July, 2014, it has collected 2.4 TB of scientific data for 64 space environment key parameters.
- More than 150 peer – reviewed paper have been published.

## International Space Weather Meridian Circle Program (IMCP)



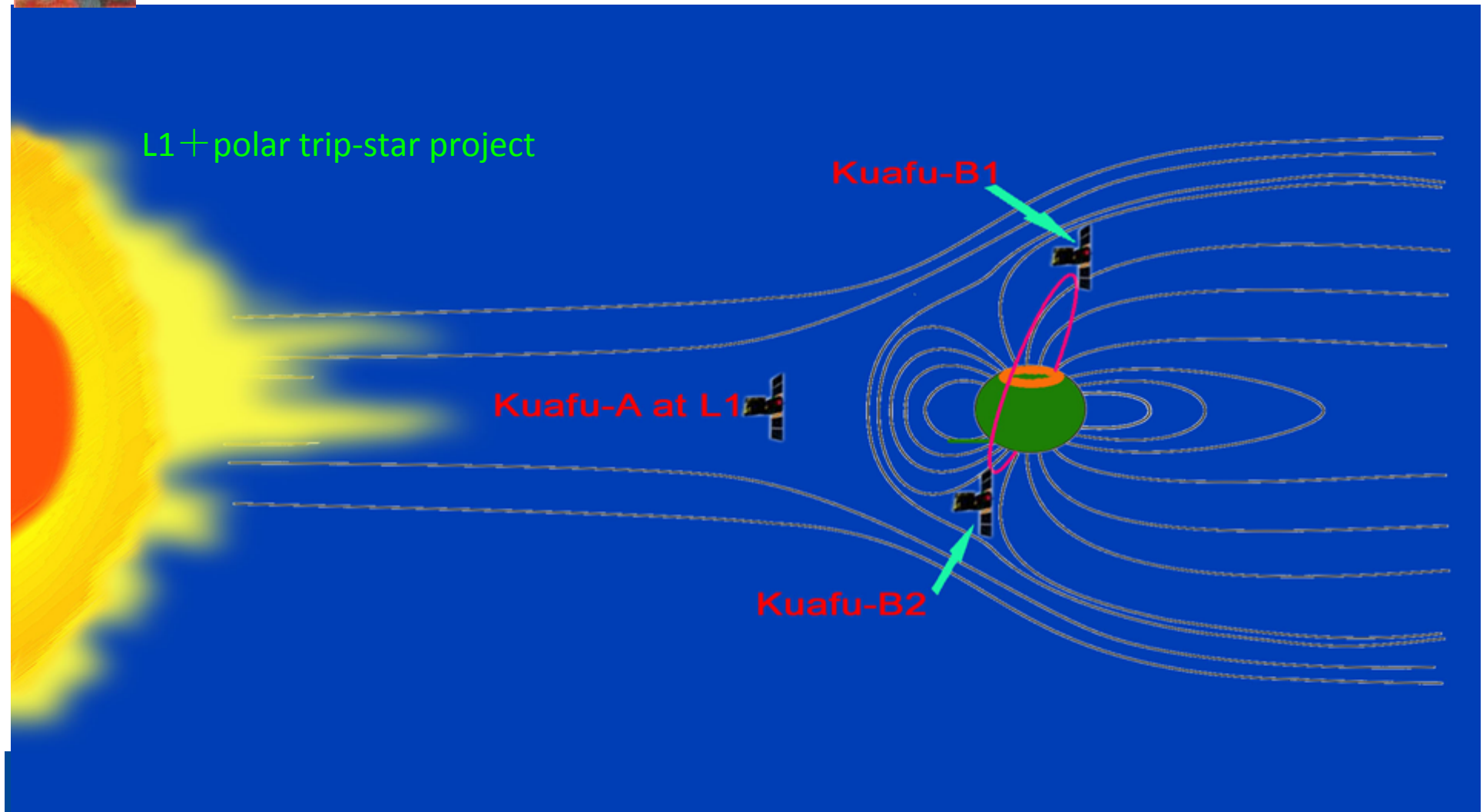
To connect 120°E and 60°W meridian chains of ground based monitors worldwide, in order to provide a global picture of unfolding space weather events.

- The kick-off fund has been secured from the Ministry of the Science and Technology of China (2013).
- The joint research centers between China/Russia, China/Brazil will be supported by the Chinese Academy of Sciences (2013-2015).
- The discussions with other countries including Canada, USA, Australia etc. are underway.

# KuaFu



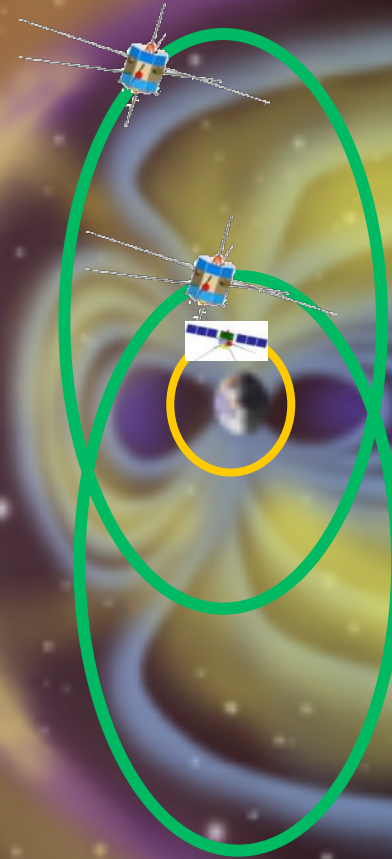
## Solar Storm、Aurora and Space Weather Exploration



# Status

- NSSC and ESA signed Letter of Intent on KuaFu cooperation: Oct. 19, 2012, But ESA ministerial meeting did not approve KuaFu B: Nov. 2012
- Discussions with Russia about possible collaboration on KuaFu were initiated, but without solid output.
- Chinese Academy of Science has decided to put the KuaFu project on hold in May, 2014.

*Concept Study (phase 0) Supported by CNSA (2009)*  
*Pre-study (Phase A) Supported by CAS (2011)*



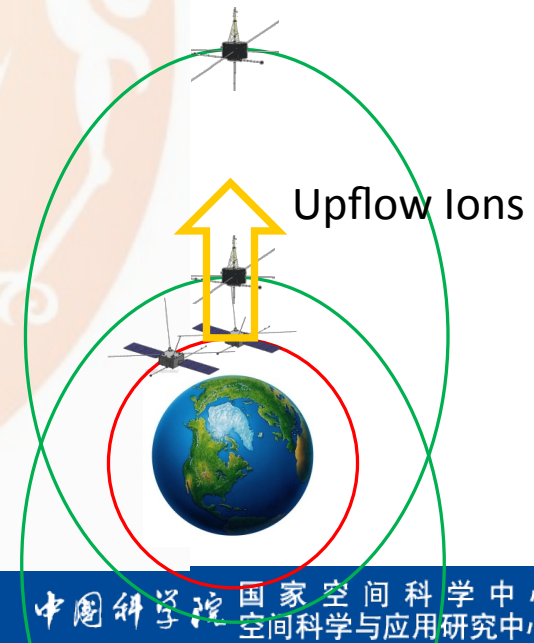
**Magnetosphere—Ionosphere—Thermosphere (MIT)  
Coupling Exploration**

## Scientific Objectives :

- ✓ **Investigate** the origin of the outflow ions and their acceleration mechanisms
- ✓ **Understand** the impact of the outflows ions on dynamic processes in the magnetic sphere, including magnetic storm development
- ✓ **Characterize** the ionosphere and thermosphere storm driven by magnetic storms
- ✓ **Discover** the key mechanism for the magnetosphere, ionosphere and thermosphere coupling

**Period\_MA/ Period\_ITA=9:1**

Spacecraft	ITA	ITB	MA	MB
inclination	90°	90°	90°	90°
perigee	500 km	500 km	1 Re	1 Re
apogee	1500 km	1500 km	7 Re	7Re



# Status

- Concept Study was supported by CNSA in 2009-2010
- Pre-study has been supported by CAS (2011-2014)
- MIT Forum was successfully held in Beijing on October 31 – November 1, 2013. More than 40 scientists from USA, Canada, UK, Germany, Romania and China attended the forum.
- The mid-term evaluation about the pre-study on MIT was carried out in April, 2014.

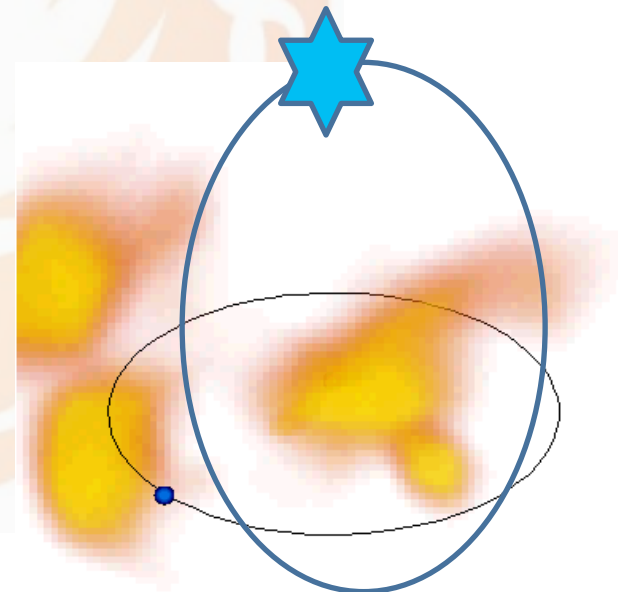
# Solar Polar ORbit Telescope (SPORT)

## ➤ Science Objectives:

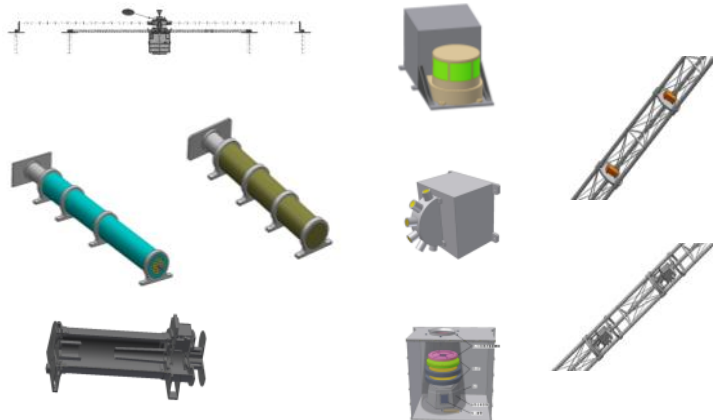
SPORT will be the **first** mission to image the propagation of CME continuously off the ecliptic plane.

- ✓ Imaging & tracking interplanetary CMEs propagation
- ✓ Observation on solar high latitude area

Orbit realization	solar polar orbit (with the gravity assist of Jupiter)
Inclination	$>72^\circ$
perihelion	0.7AU
aphelion	3~5AU



# Scientific Payload



CME and ICME imaging	1	Synthetic aperture radio imager
	2	Heliospheric imager
	3	Large angle coronagraph
Solar Imaging	4	Solar magnetograph
	5	Solar ultraviolet imager (121.6nm)
Particle detectors	6	High energy particle detector
	7	Heavy ion composition detector
	8	Solar wind plasma detector
Wave detectors	9	Fluxgate magnetometer
	10	Low frequency electromagnetic wave detector
	11	Solar radio burst detector

# Status

- Concept Study was supported by CNSA in 2009-2010
- Pre-study has been supported by CAS (2011-2014)
- The Forum on the Solar Polar Orbit Telescope (SPORT) was held at ISSI-BJ on November 24-25, 2013. A total of 30 leading scientists from 7 countries participated in this Forum.
- The mid-term evaluation about the pre-study on SPORT was carried out in April, 2014.

# Advance Solar Observatory in Space (ASO-S)

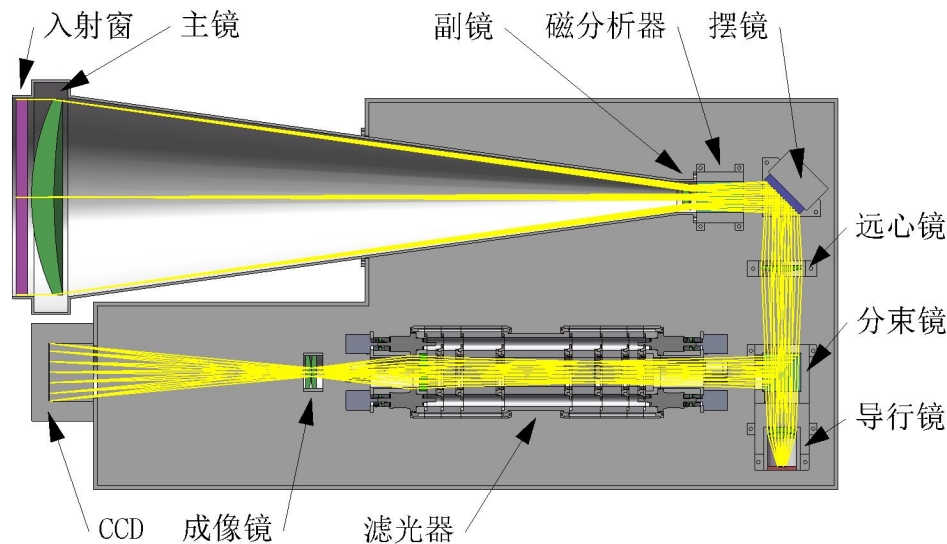
## Scientific Objectives

- Simultaneously observe non-thermal images of hard X-rays, and formation of CMEs, to understand the relationships between flares and CMEs
- Simultaneously observe the full disc vector magnetic field, the energy release of solar flares, and the initiation of CMEs, to understand the causality among them
- Observe the responses of solar atmosphere to solar eruptions, to understand the mechanisms of energy release and transportation, as well as the patterns of dynamics
- Observe solar eruptions and evolution of solar magnetic field, to provide clues for forecasting space weather

# Payloads

- Full-Disc Vector Magnetograph (FMG)**

PI: Yuanyong Deng (NAOC)



FOV : 33'

Diameter : 14 cm

Resolution : 1''

CCD: 4K\*4K

Wavelength : FeI532.4nm

FWHM of Filter : 0.1Å

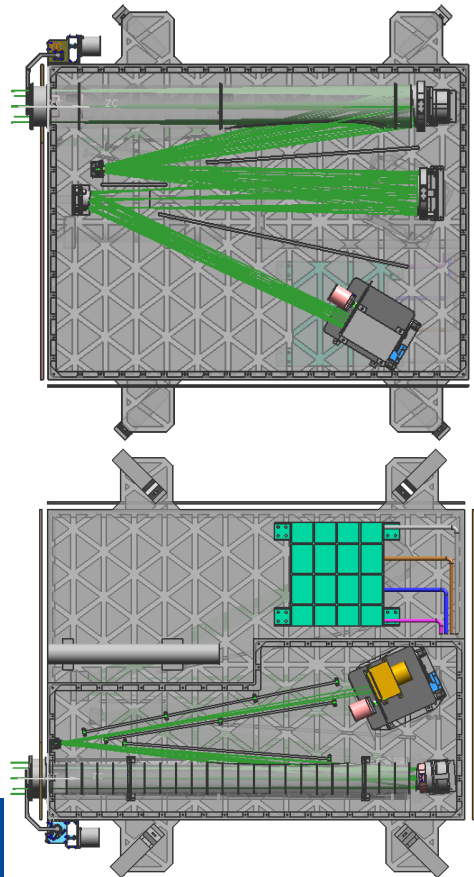
Time Resolution : 2min

Accuracy of  $B_{\parallel}$  : 5 Gs

# Payloads

- Lyman-alpha Telescope(LST)

PI: Hui Li (PMO)

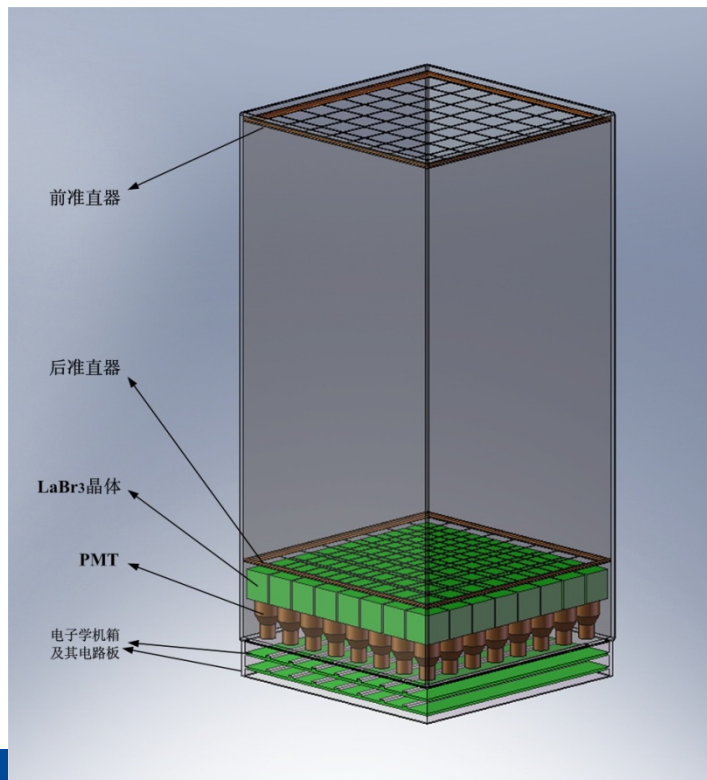


	SCI	SDI
Diameter	60 mm	40 mm
Wavelength	121.6±10.0 nm	121.6±10.0 nm
FOV	1.1 – 2.5 R <sub>☉</sub>	0.0 – 1.2 R <sub>☉</sub>
CCD	2K*2K	4K*4K
Resolution	2.35"/pixel	0.56"/pixel
Exposure	1-2 s	0.2-1 s
Time interval	4-10 s	1-5 s
Attitude Acc.	1.0-2.0"/10s (rms)	1.0-2.0"/10s (rms)

# Payloads

- **Hard X-ray Imager (HXI)**

PI: Jian Wu (PMO)



Energy range: 30-300 keV

Energy Res.: 3% @ 662 keV

Crystal:  $\text{LaBr}_3$

Resolution : better than 6"

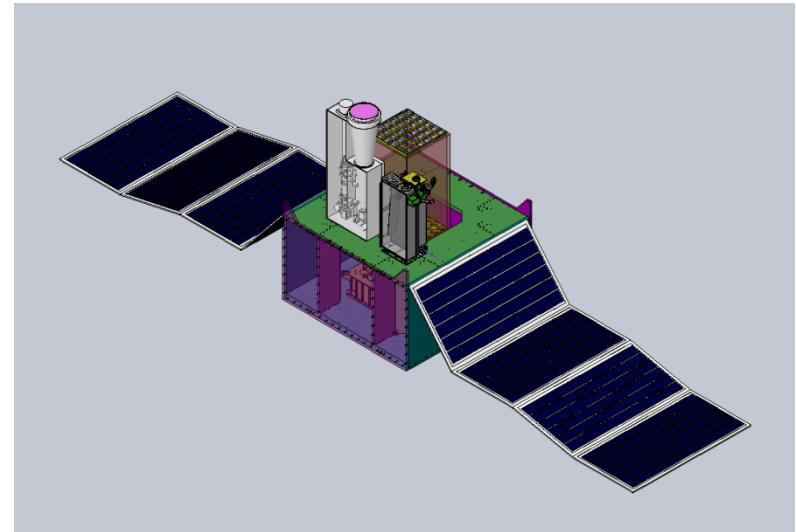
Effective area: 100 cm<sup>2</sup>

Time Resolution : 0.5 s

FOV : 1°

# Mission Requirements

- **Orbit:** solar synchronous
- **Attitude:** 700-750 km
- **Attitude Control:** 3-axis stability
- **Pointing accuracy:**  $0.005^{\circ}/s$
- **Stability:**  $1-2''/10s$
- **Payload Mass:** 250 kg
- **Data:** 140 GB/day
- **Launch date:** 2021
- **Lifetime:** 4 years



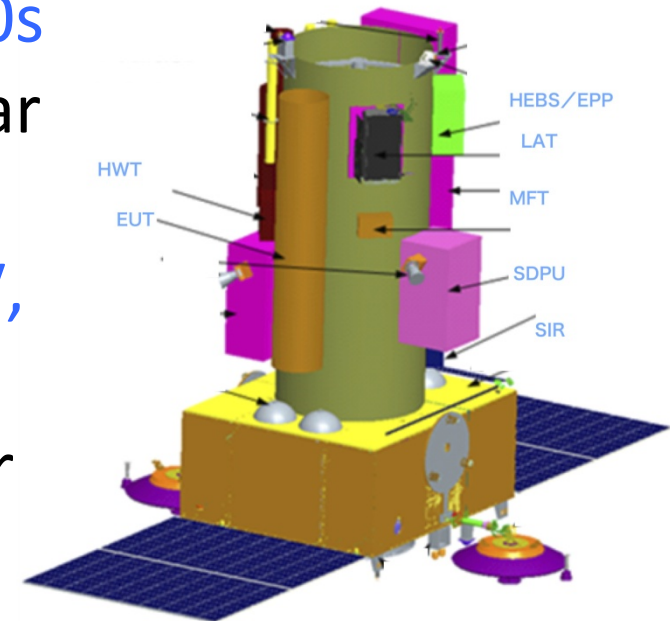
# Status

- Pre-study has been supported by CAS (2013-2015)
- The Forum on the ASO-S will be organized by ISSI-BJ by the end of October this year
- Final selection will be made end of next year

# Deep Space Observatory (DSO)

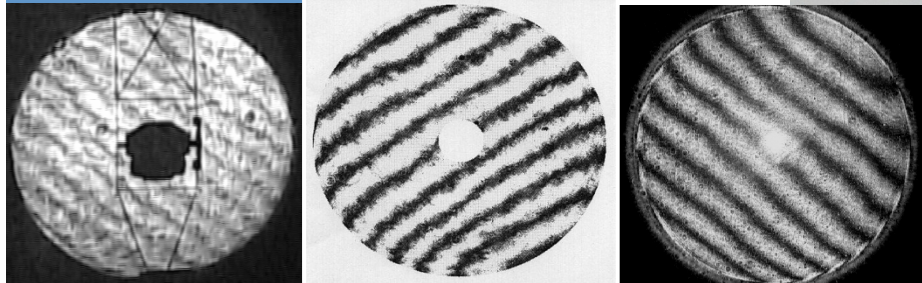
## Scientific objectives:

1. To understand the nature of the solar magnetic field: @0.1-0.15 arc sec, pol. degree of  $2 \times 10^{-4}$  and 30s
2. To explore the mechanism of solar activity: with continuous observations in  $\gamma$ -ray, X-rays, EUV, visible and radio bands
3. To provide physical basis for solar activity prediction



# Testing process of MFT in the laboratory

装卡后1#主镜干涉图：面形优于 $\lambda/35$  RMS  
1#主镜干涉图：面形优于 $\lambda/45$  RMS  
2#主镜干涉图：面形优于 $\lambda/40$  RMS



## Test result (@ $\lambda=633\text{nm}$ )

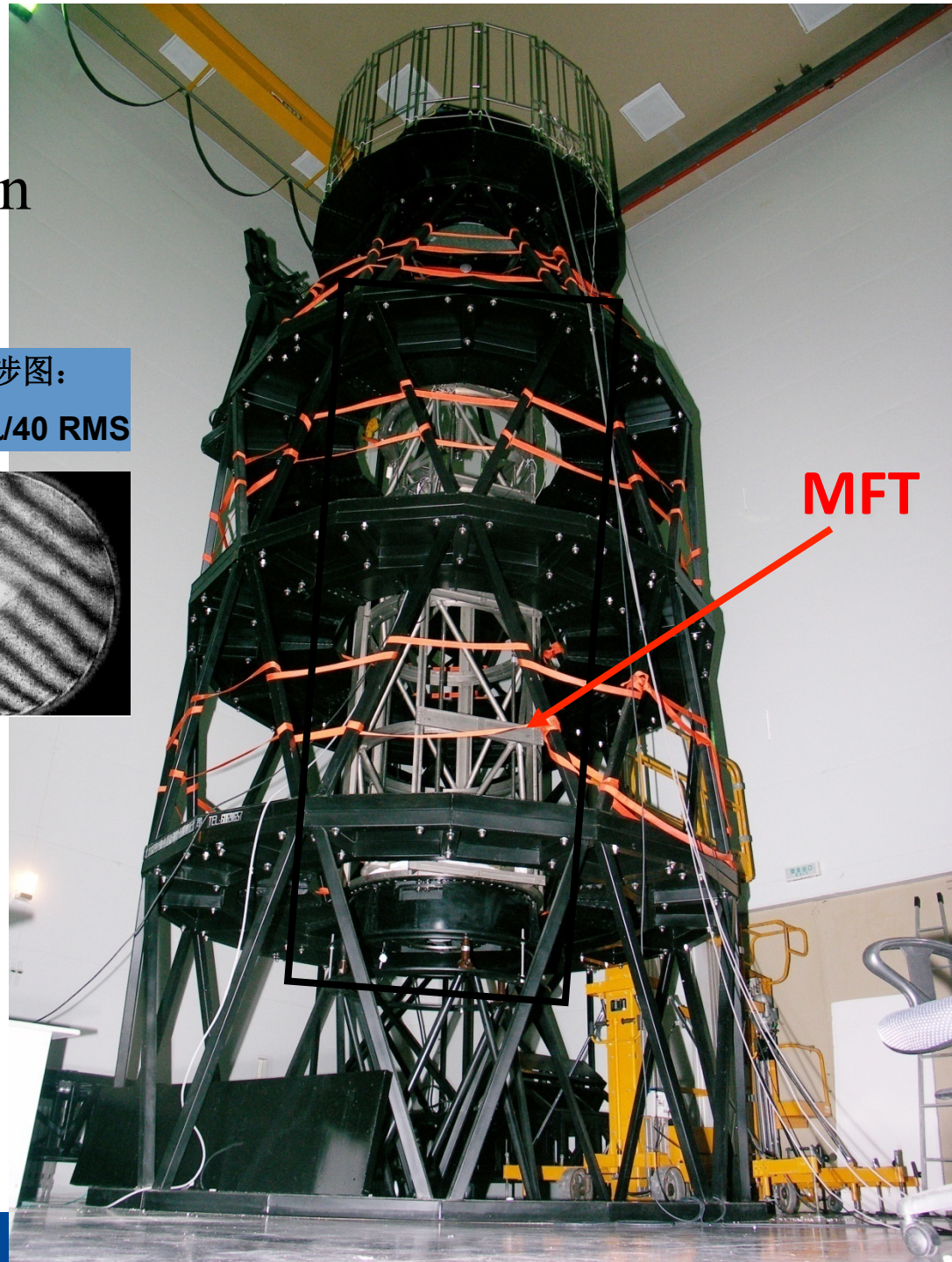
Main lens:  $\lambda/35$  RMS

Autocollimator:  $\lambda/30$  RMS

Image lens:  $\lambda/35$  RMS

whole system:  $\lambda/17$  RMS

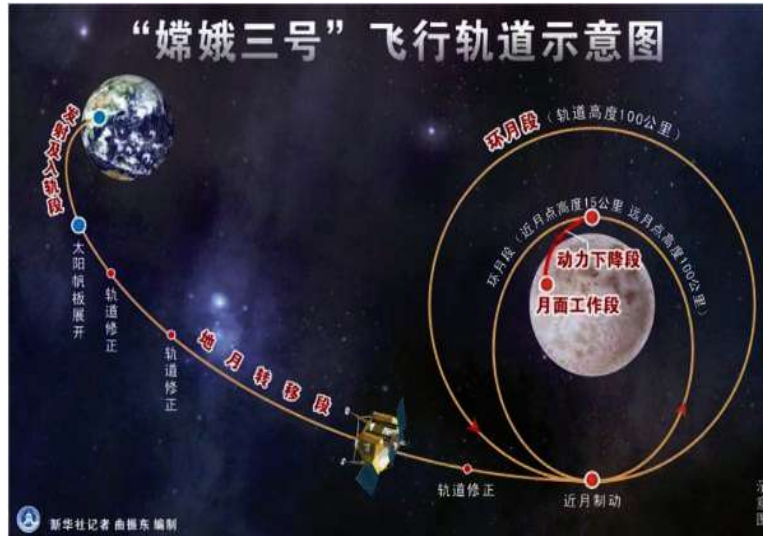
(by Sen Wang et al.)



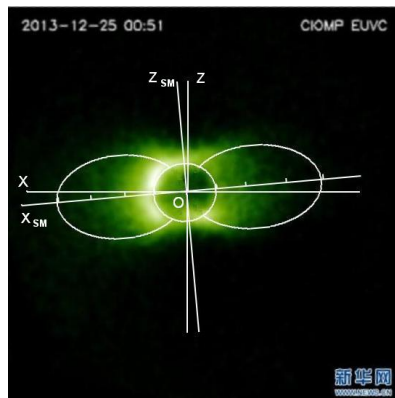
# Status

- Supported by CNSA for pre-study since 90's as a mission called SST
- Re-proposed to CNSA as a major mission in the overall program for deep space exploration in 2011
- It was approved at the level of CNSA and now waiting for approval from higher governmental level for fund

## CE-3 EUV - Imager



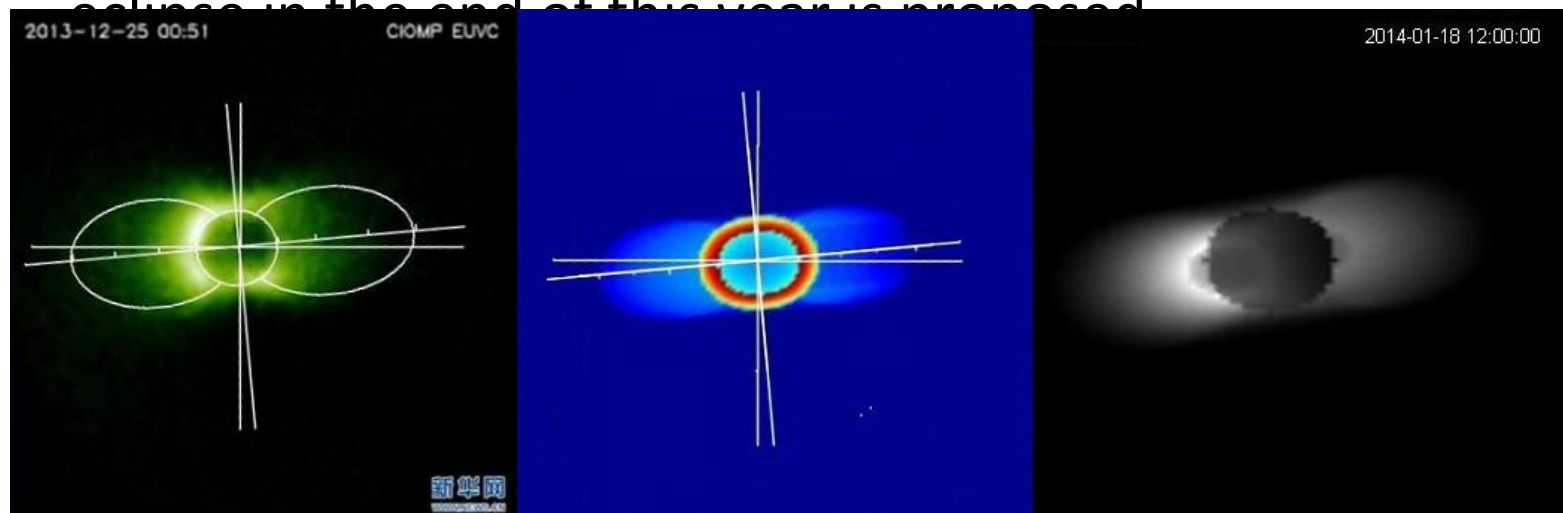
CE-3 was landed on the lunar surface in Dec., 2013



First Image of the Earth's plasmasphere from the moon.

# Status

- More than 1000 pictures of the plasmasphere has been taken.
- Extensive data analysis and modeling are currently underway.
- A unique opportunity to observe the plasmasphere during eclipse in the end of this year is proposed



A photograph of the Earth from space, showing the horizon and a blue and white surface. The text "THANK YOU" is overlaid in the center.

**THANK  
YOU**