

Earth Observations in China

Present Status and Future Developments

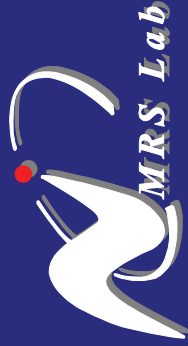
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Center for Space Science and Applied Research, CAS

Vice General Designer of China Lunar Exploration Program



Outline

- I. Introductions
- II. Present status of China earth observations
- III. Development for 11th five-year-plan (2006~2010)
- IV. Future developments

I. Introductions

The role of space activities in a country's overall development strategy is becoming increasingly salient, and their influence on human civilization and social progress is increasing.

It has been 50 splendid years since China embarked on the road to develop its space industry, starting in 1956. For half a century, China has worked independently in this field. It has made eye-catching achievements, and ranks among the world's most advanced countries in some important fields of space technology.

The development of the space industry in China now faces new opportunities and higher requirements. In the new stage of development, China will adhere to the scientific outlook on development as guidance, center its work on the national strategic goals, strengthen its innovative capabilities and do its best to make the country's space industry develop faster and better.

- *Chinese government have paid great attention to space technology application activities for sustainable development of economic and social progress and benefits.*
- *The main objectives are:*
 - *To meet the growing demands of economic construction, national security, science and technology development*
 - *To explore outer space and learn more about the cosmos and the Earth;*
 - *To promote social progress and benefit.*

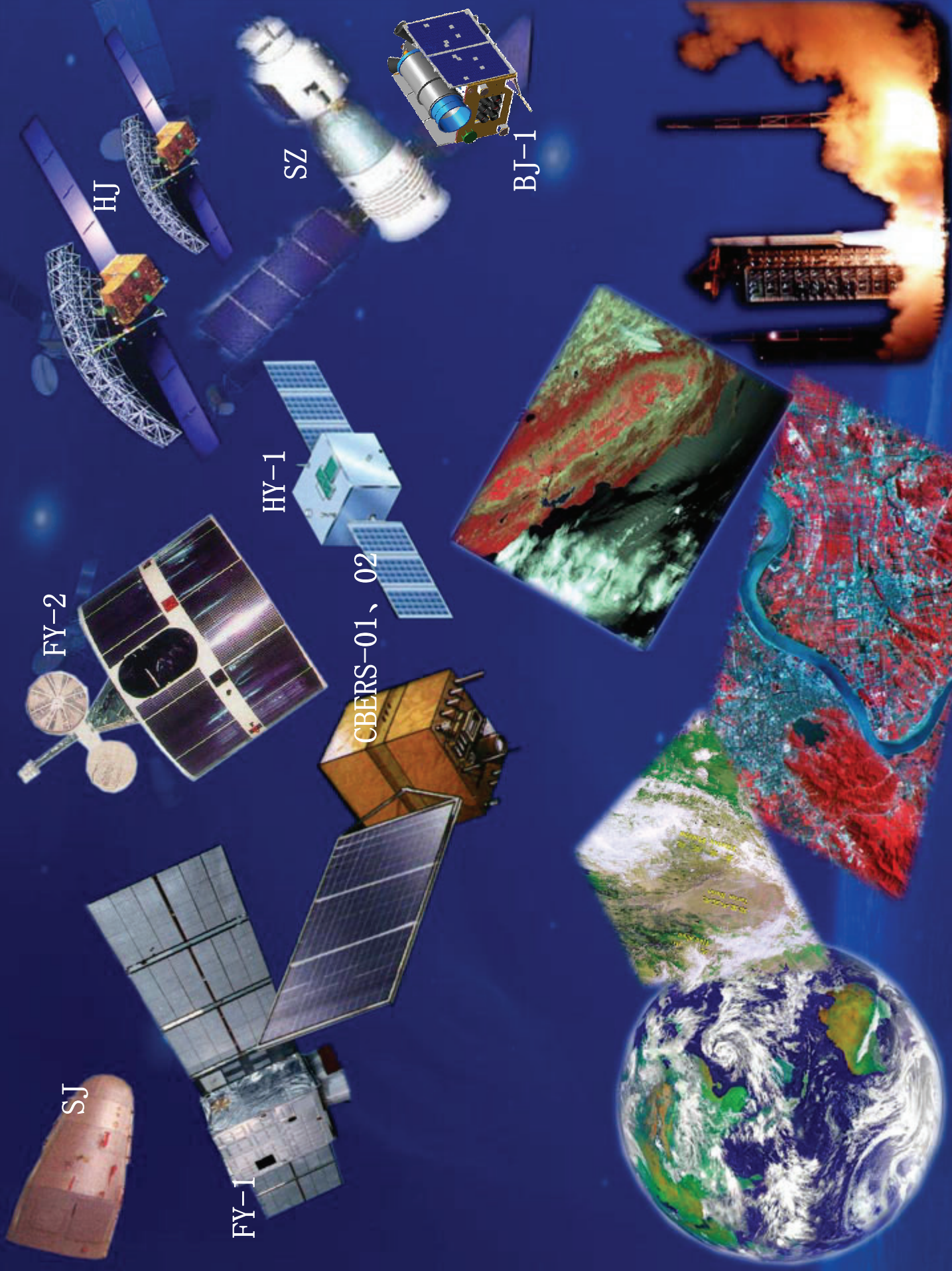
- *New stage, new tasks*
 - *To build a long-term, stably operated Earth observation system, and a coordinated and complete national satellite remote-sensing application system;*
 - *To achieve the initial transformation of applied satellites and satellite application from experimental application type to operational service type.*

II. Current Status of China Earth Observations

- 1. The fields and scale where satellite remote-sensing is used have been constantly expanded. Breakthroughs have been made in a large number of key application technologies; infrastructure facilities have been strengthened; the technological level and operational capabilities of the application system have been notably improved; and a national satellite remote-sensing application system has taken shape.*

2. *Satellite remote-sensing application systems has been put into regular operation in many important fields, particularly in meteorology, mining, surveying, agriculture, forestry, land mapping, water conservancy, oceanography, environmental protection, disaster mitigation, transportation, and regional and urban planning. They are playing an important role in the nationwide land resources survey, ecological construction and environmental protection.*

- ### 3. *Launched series Earth observation satellites*
- *Earth Observation Satellites (account for more than 60% of the total number of Chinese satellites)*
 - *Start From April 24, 1970, "DFH (Dongfanghong)"*
 - *By June of 2007 launched more than 100 satellites of various types, with a flight success rate of over 90%*
 - *"DFH (Dongfanghong) " telecommunication*
 - *" FY (Fengyun) " meteorological*
 - *" SJ (Shijian) " scientific research*
 - *" ZY (Ziyuan) " earth resource*
 - *" HY (Haiyang) " oceanography*
 - *" HJ (Huanjing) " environment*
 - *" SZ (Shenzhou) " China Manned Program*



HJ

SZ

BJ-1

HY-1

CBERS-01, 02

FY-2

SJ

FY-1

4. Main Applications of the Earth observation technologies

- Meteorology
- Disaster
- Mining
- Surveying
- Agriculture
- Forestry
- Oceanography
- Water conservancy
- Seismology
- Urban planning
- Environmental Monitoring and Control

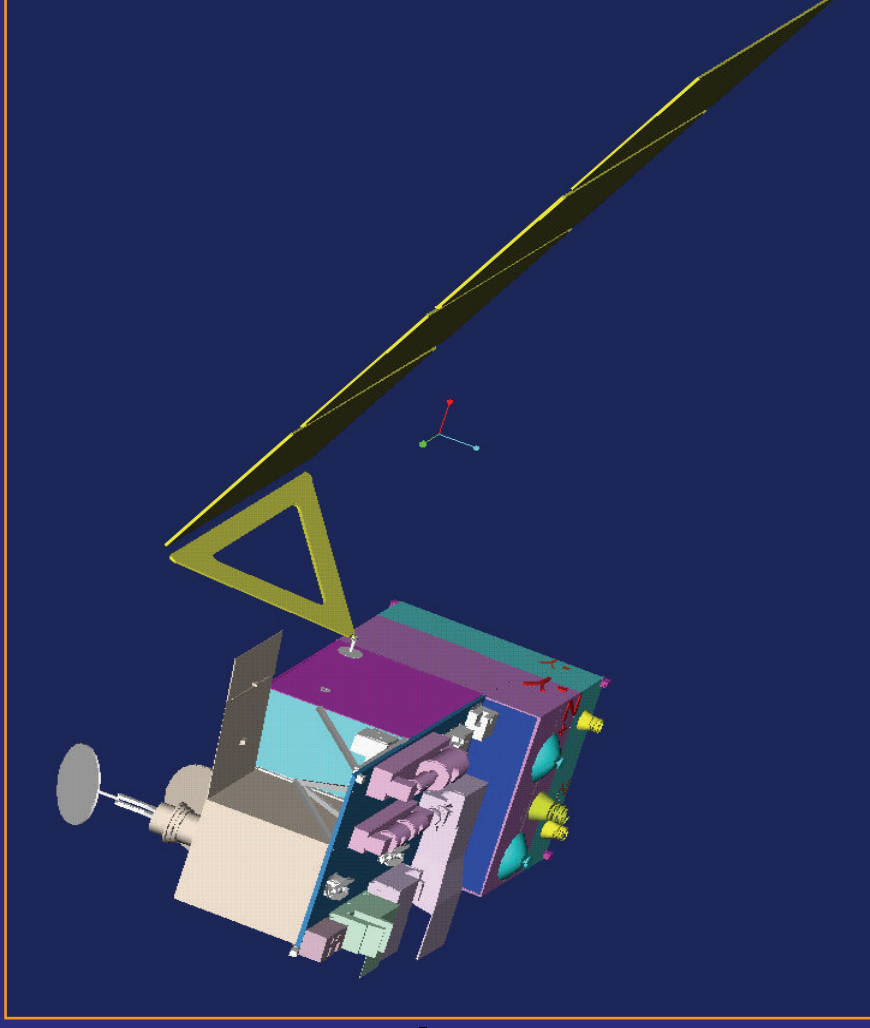
III. Development for the 11th five-year-plan

- Goal for the 11th Five-Year-Plan (2006~2010)
 - Development and launch of new generation polar orbit meteorological satellite, sea water color satellite, ocean dynamic environment satellite, China-Brazil earth observation satellite and high-resolution stereo mapping satellite;
 - Development of new generation geostationary orbit meteorological satellite;
 - Preliminarily setup the environment and disaster monitoring small satellite constellation;
 - Start and begin to construct high-resolution earth observation system engineering, preliminarily setup a long-term, stable space-based earth observation system;
 - Development and test of new technology, new material and new applications.

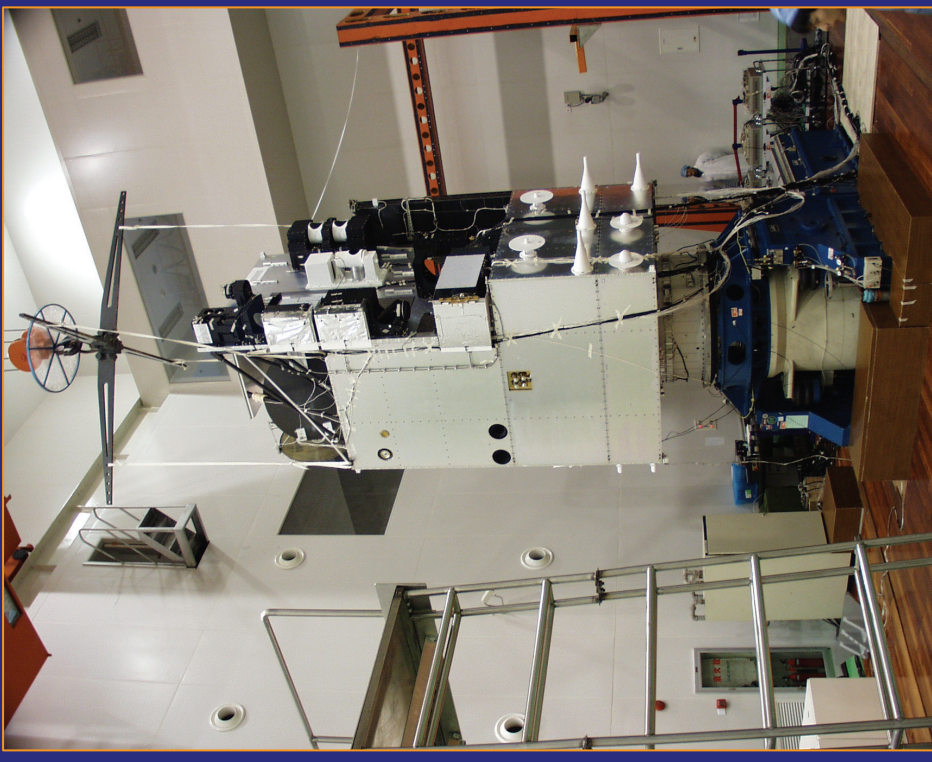
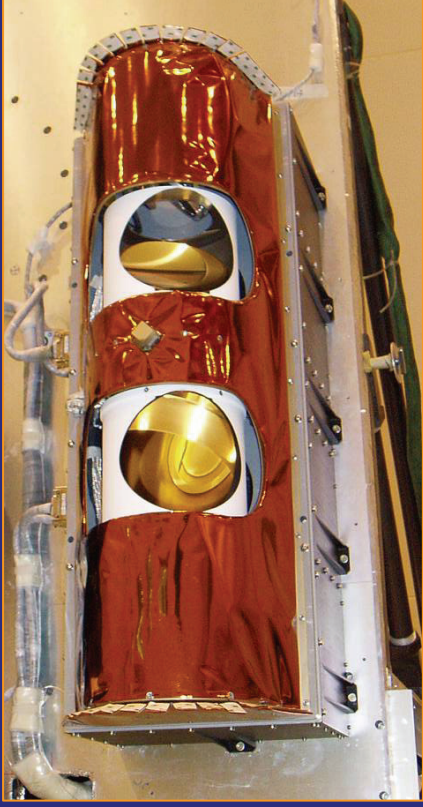
-
- Future Earth Observation Program
 - FY-3
 - HY-2
 - FY-4
 - HJ Series
 - ZY Series (Including SAR Sat.)
 - +Specific Purpose Small Satellite

FY-3 Satellites

- FY-3 meteorological satellite program will include 2 experimental and 9 operational satellites, planning to work up to 2020 year.
- FY3 has 11 payloads and first satellite will launch 2008.



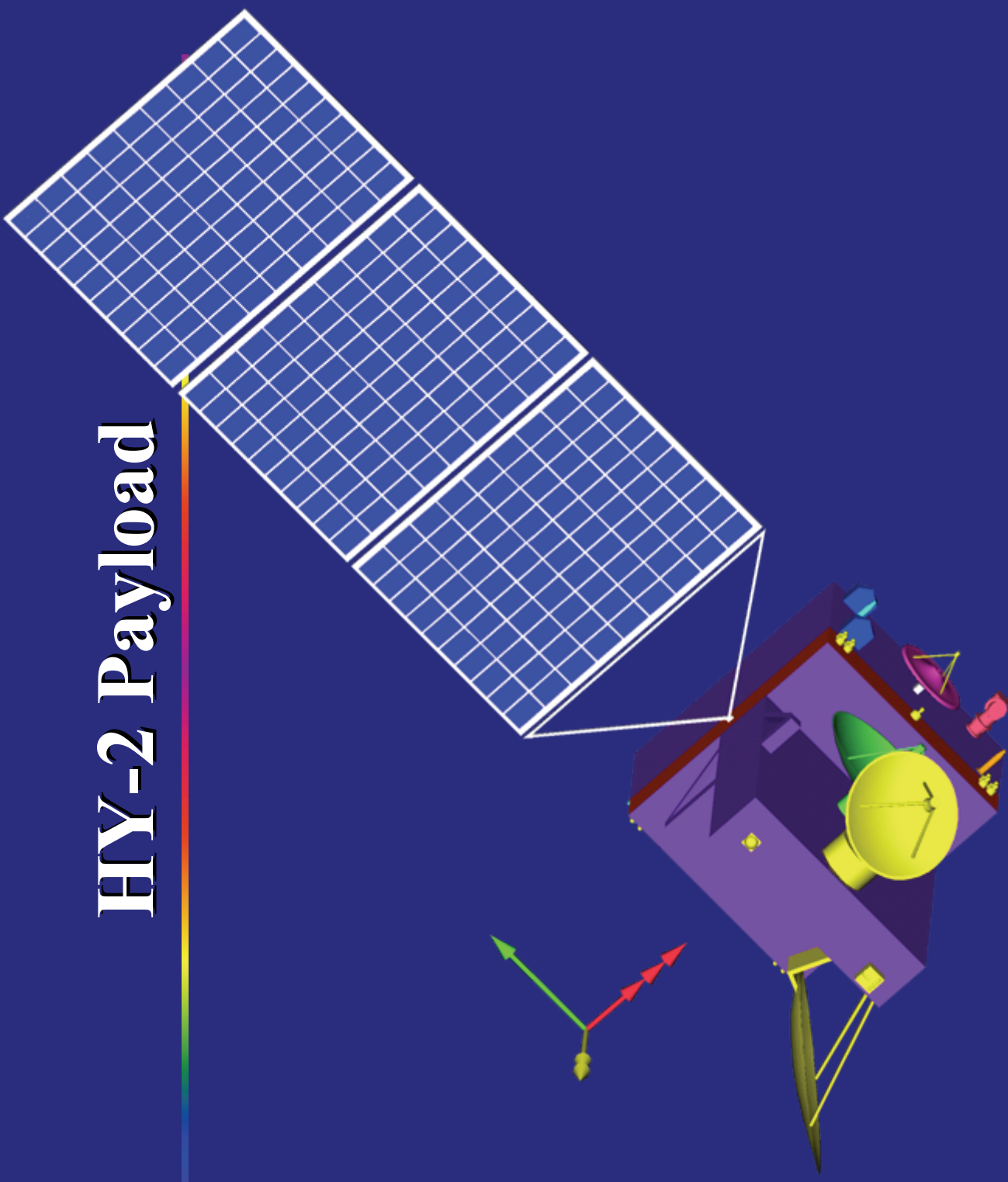
FY-3 The Microwave Humidity Sounder



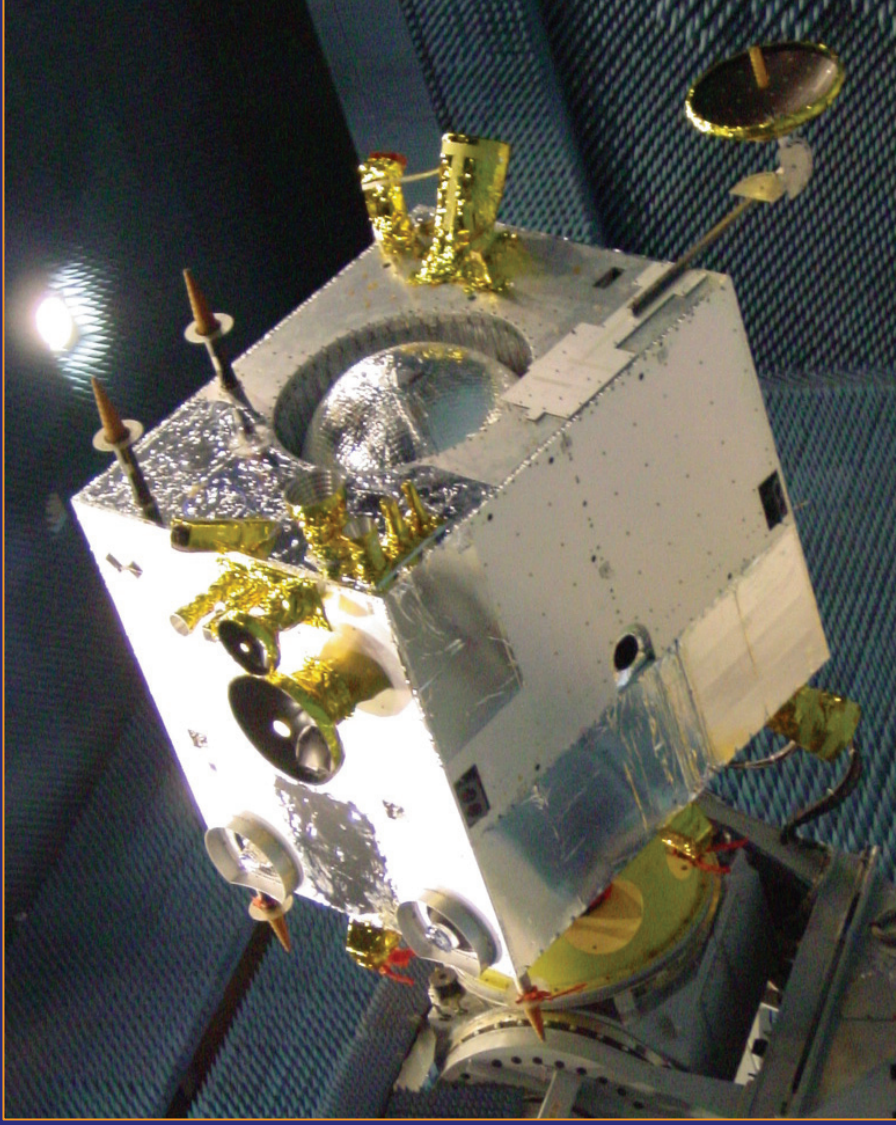
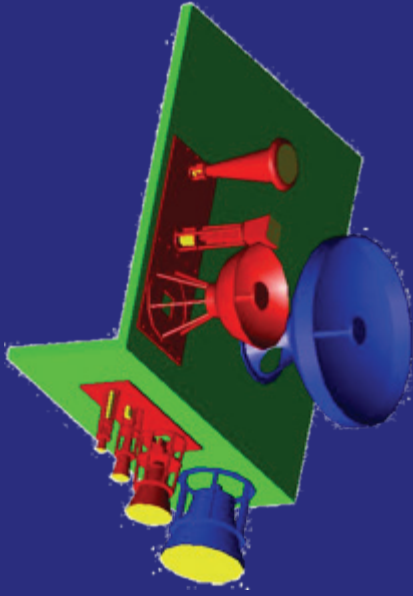
HY-2 Oceanic Dynamic Environment Measurement Satellite

- **Dual Frequency (Ku, C) Radar Altimeter and Tri-Frequency Nadir-Looking Radiometer for Atmospheric Correction**
- **Ku Band Pencil-Beam Scanning Radar Scatterometer**
- **Multi-Frequency Microwave Imager**

HY-2 Payload

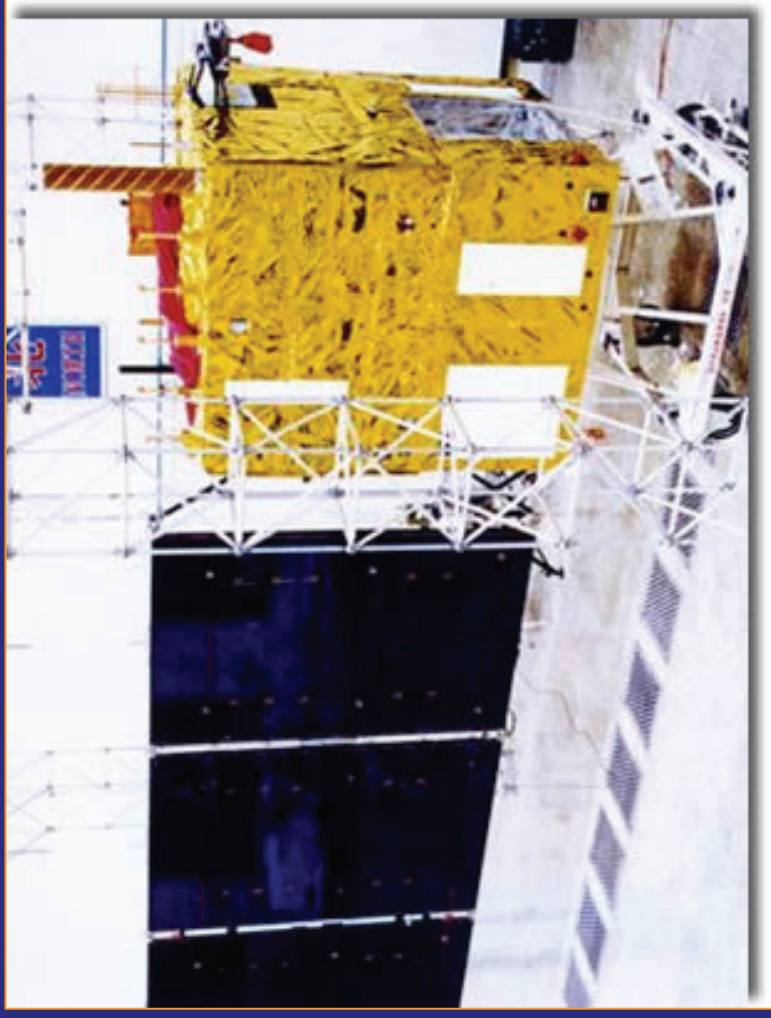


CE-1 Lunar orbit Satellite sounder



ZY Series Satellites-CBERS

CBERS-01/02
CBERS-02B
CBERS-03/04

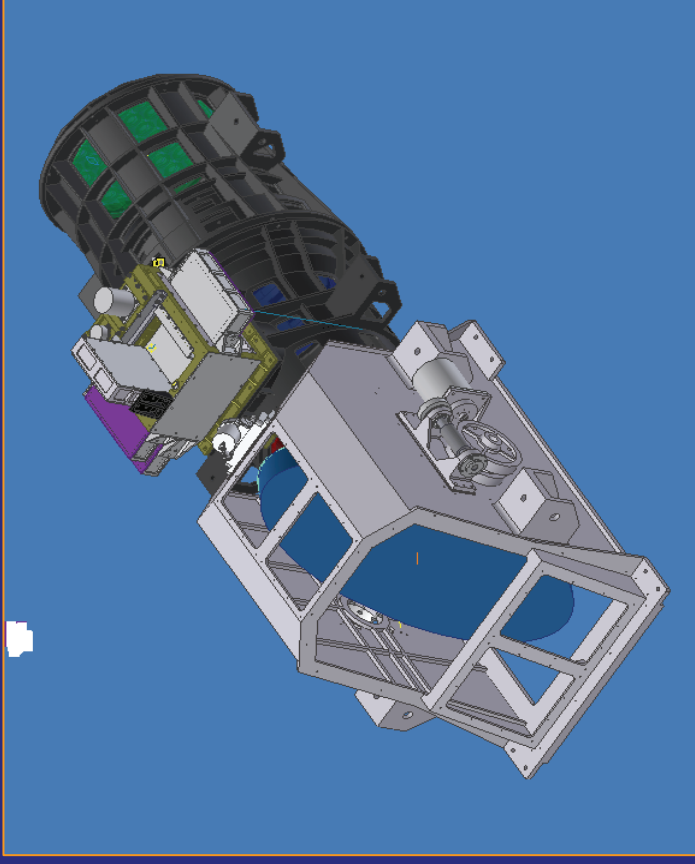


CBERS--China-Brazil
Earth Resources Satellite

ZY Series Satellites-CBERS Payloads

ZY-1 CBERS-01B

ZY03/04 CBERS
(5m/10m)



CCD Camera for CBERS 03/04

ZY Series Satellites-CBERS

Lunched satellites;

CBERS-01:1999/10~2003/08

(mission finished)

CBERS-02: 2003/08~

(in orbit)

CBERS-02B: 2007/09~

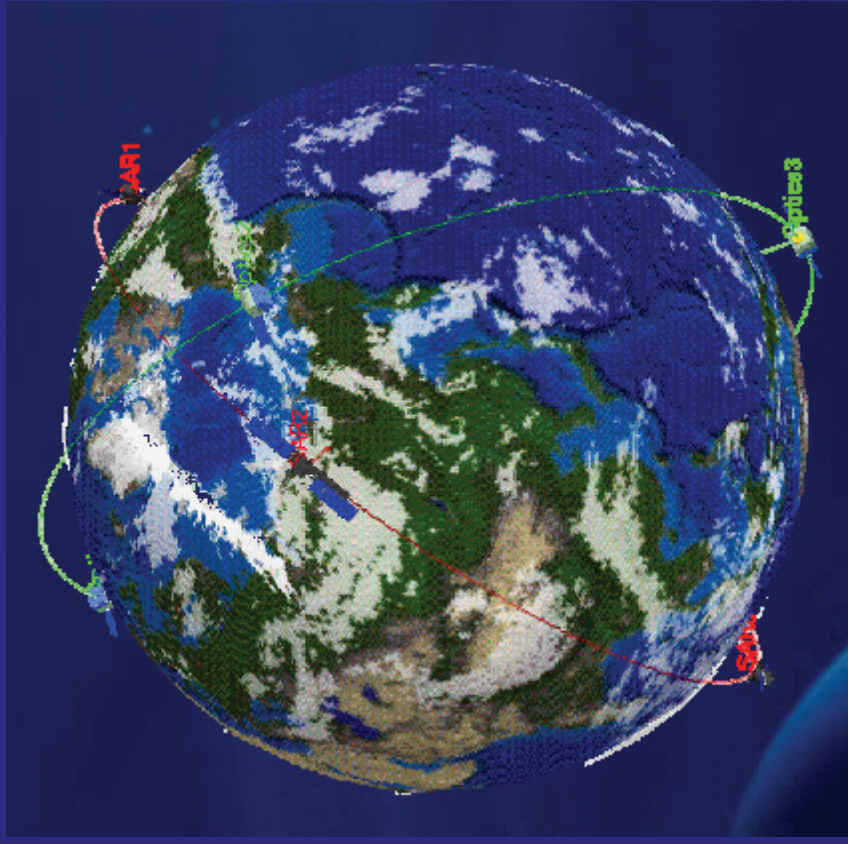
The satellites to be
lunched

CBERS-03/04: 2009



HJ Series Environment and Disaster Monitoring Small satellite constellations

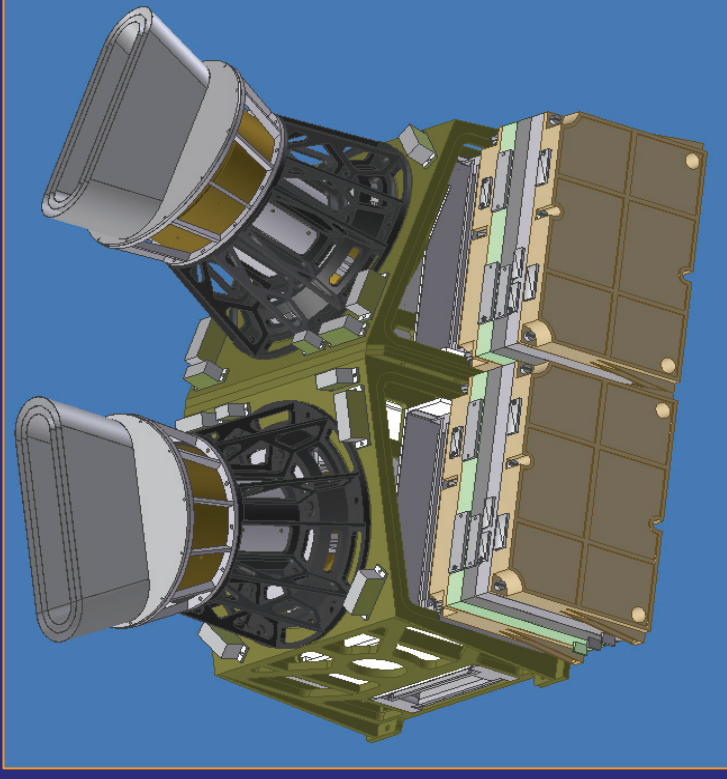
- **Phase A**
 - 3 satellites constellation
 - 2 optical + 1 SAR
- **Phase B**
 - 8 satellites constellation
 - 4 optical + 4 SAR



HJ-1 Satellite Optical payload

🏠 HJ-1 satellite

- Multispectral CCD Camera
(Resolution-30m,
Swath-700Km with two
cameras)

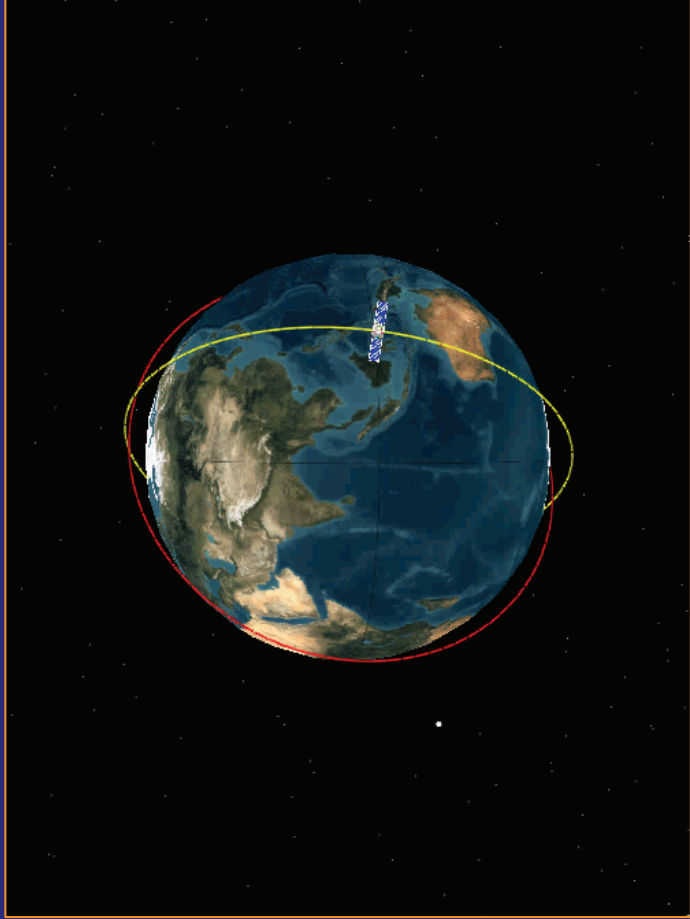


HJ-1 CCD Camera

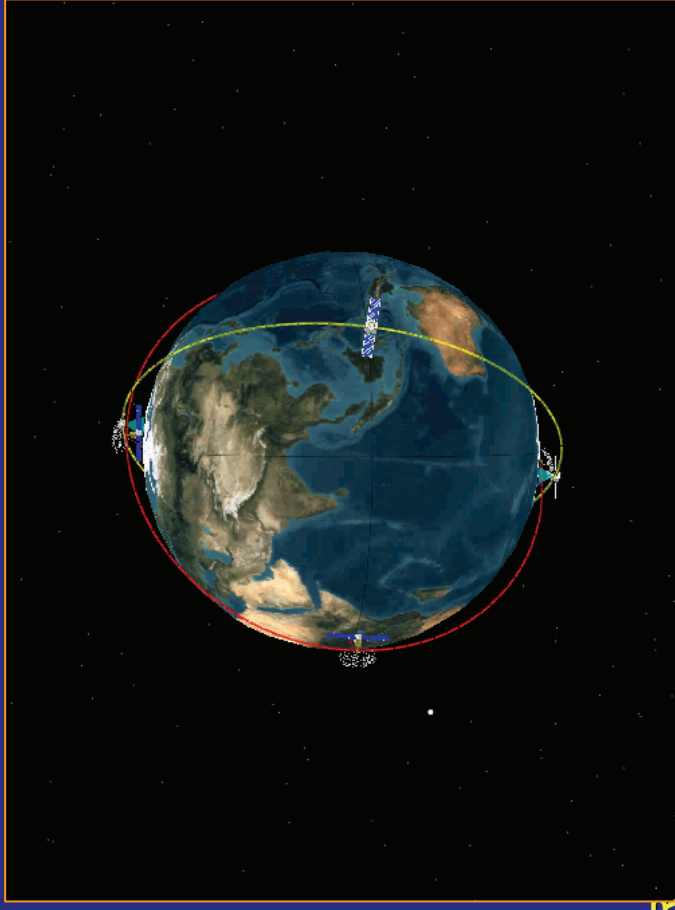
HJ-1 Constellation

First stage: two optical and
one SAR.

HJ-1-A/B, HJ-1-C



Second stage; 4 optical and 4
Microwaves.



IV. Future Development

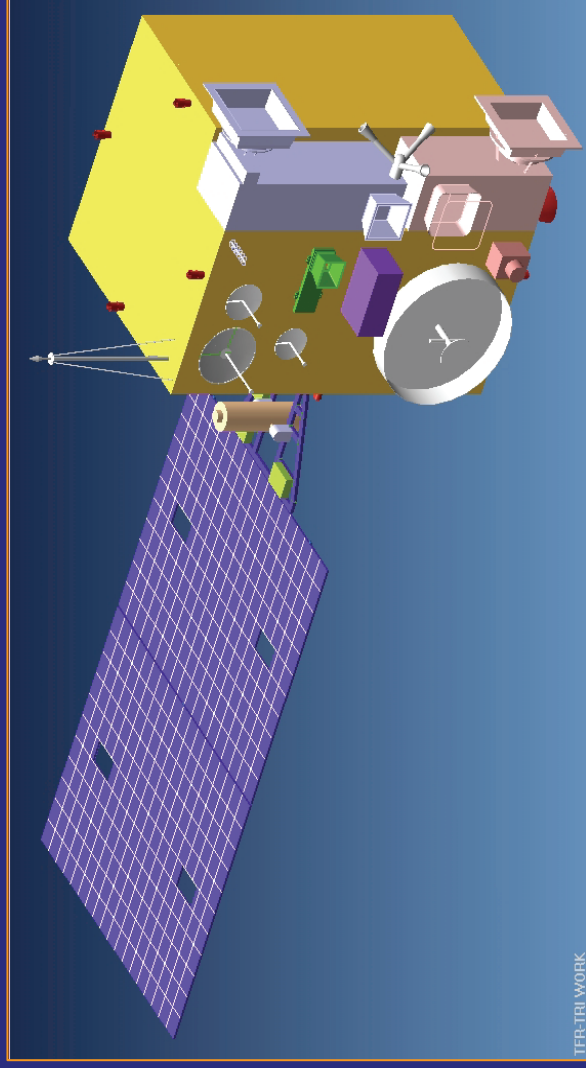
- **Development Goal For Earth Observation in future**
 - The 21st century will witness vigorous development of space activities across the world. China had drafting a space development strategy and plans for the 21st century according to the actual demands and long-term target of national development to spur the growth of the space industry.
 - The long-term tasks including: High-resolution Earth observation system; all-resolution, all-weather, multi-spectral, differential-resolution Earth observation system;

- The short-term development targets (for the next decade) are:
 - To build up an earth observation system for long-term stable operation to conduct stereoscopic observation and dynamic monitoring;
 - To realize manned space-flight;
 - To establish a coordinated and complete national satellite remote sensing application system;
 - To carry out pre-study for deep space exploration centering on the exploration of the moon.

New Concept Research Of New Sensors & Calibration

- **Sensors:**
 - CHIRIS: China High Resolution Image Spectrometer
 - Fourier Transfer Image Spectrometer For Small Satellites
 - 3D Microwave Image Altimeter
 - Synthetic Aperture Microwave Radiometer
- **Calibration:**
 - Test Sites: for optical sensors
 - Test Sites: for microwave sensors
 - Calibration Instruments:
 - Return Signal Simulation
 - Low Noise Radiometer Calibration

FY-4 Satellites



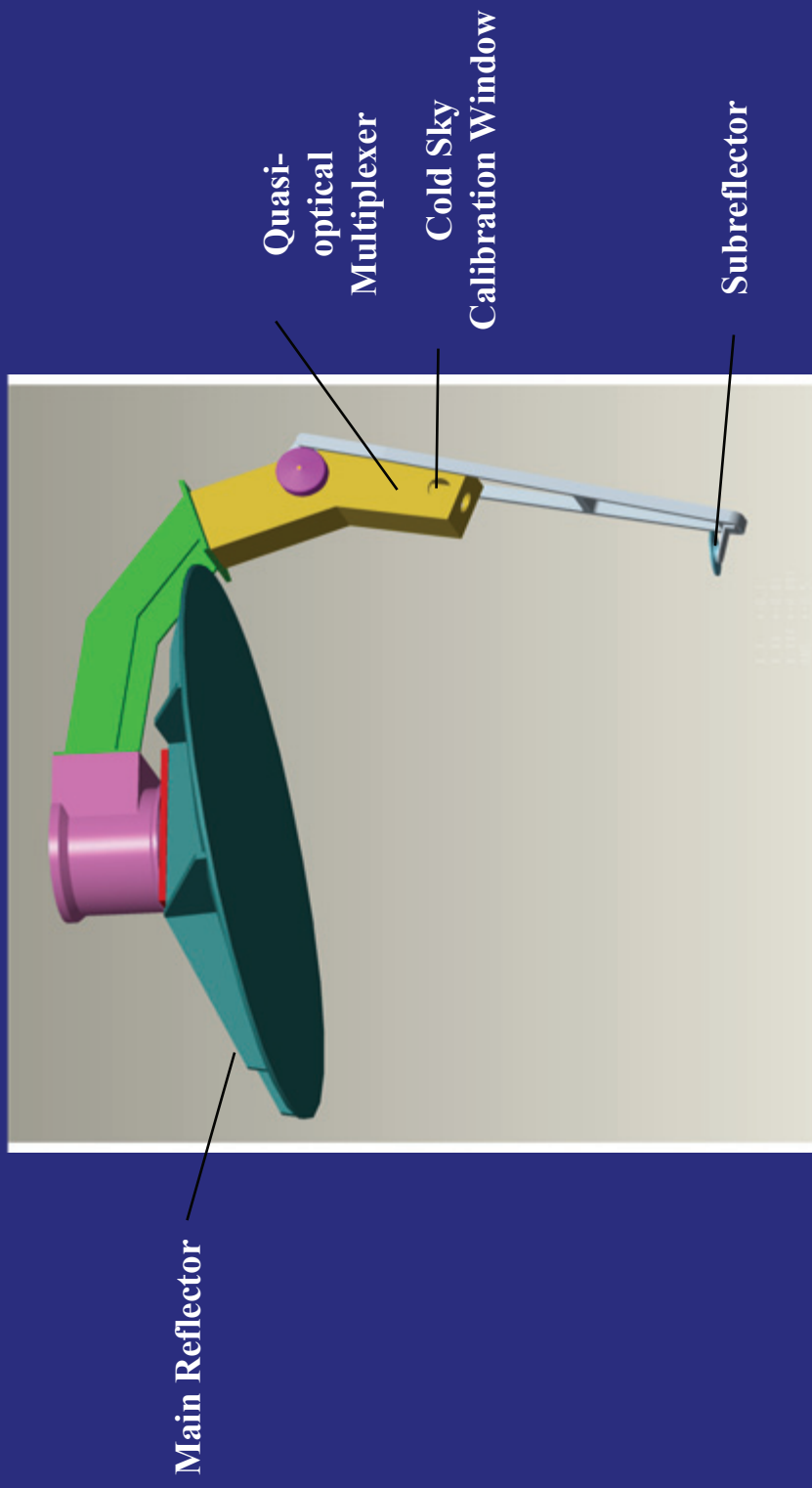
FY-4 01 satellite
payloads

- Imqge radiometer
- Atmospheric
vertical testing
- Lightning imager
- Sun X-Ray Imager
- Space environment
monitoring

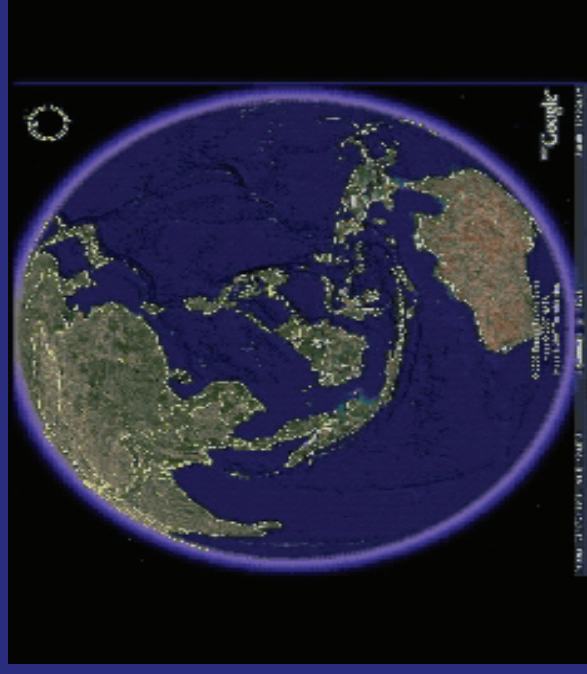
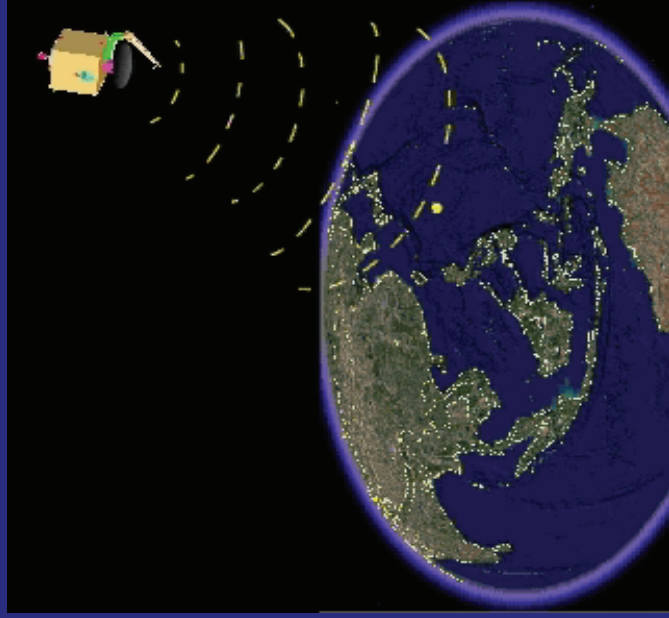
Weight 3200kg, Power 2000W

Real-Aperture Geo Microwave System Concepts

- The diagrammatic sketch of off-axis Cassegrain Antenna



Spiral scanning

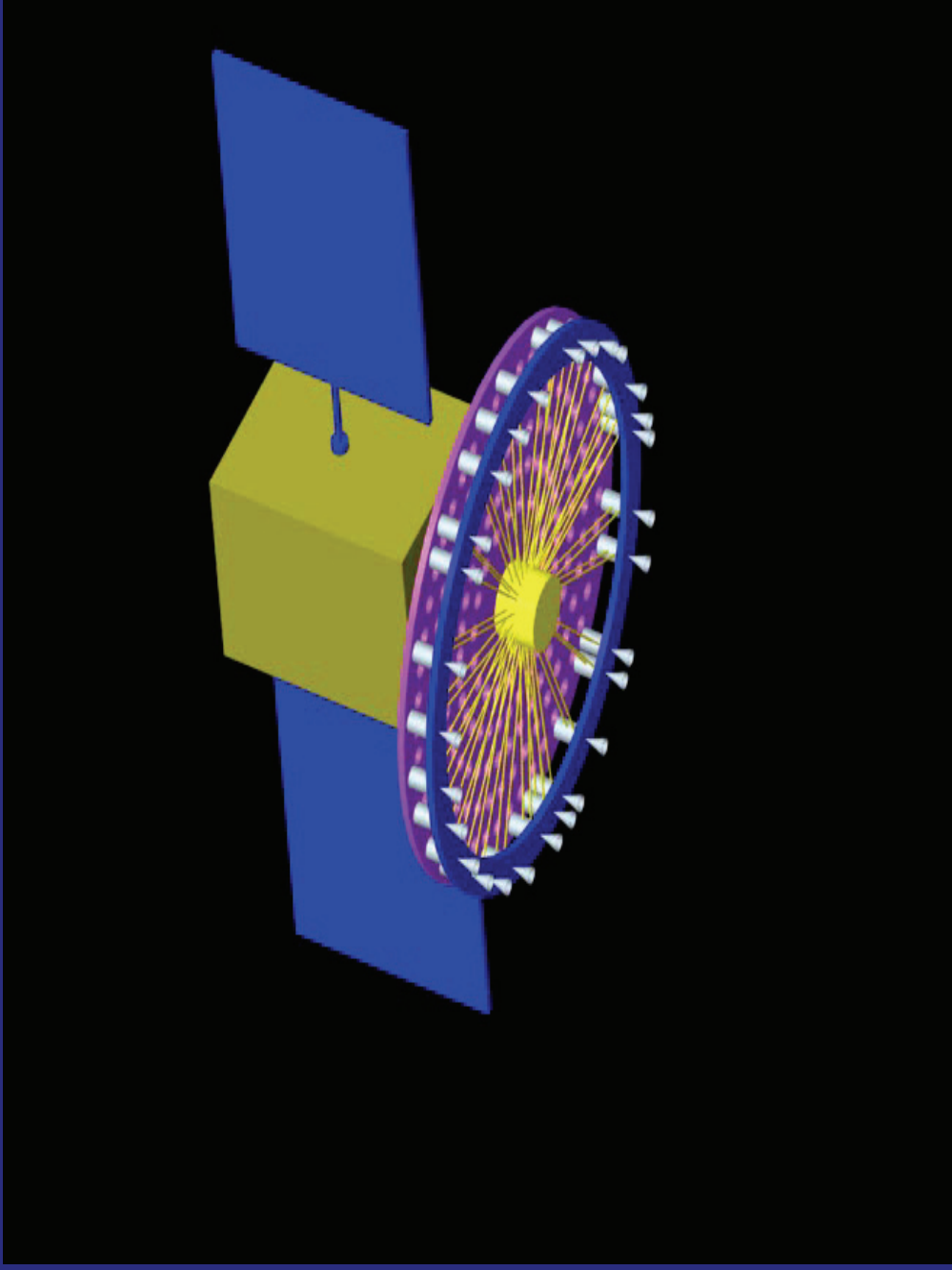


System description

- Main system performances

	Frequency (GHz)	Bandwidth (MHz)	Sensitivity (K)	Antenna Aperture (m)	Nadir Spatial Resolution (km)
Temperature Sounding	118.750±0.2, 0.4, 0.7, 1.1, 1.5, 2.1, 3.0, 5.0	100 ~ 2000	<1	3	37
	424.763±0.15, 0.3, 0.6, 1.0, 1.5, 4.0	100 ~ 1000			10
Water Vapour Sounding	183.310±0.3, 0.9, 1.65, 3.0, 5.0, 7.0, 17.0	300 ~ 4000			24
	380.197±0.4, 1.5, 4.0, 9.0, 18.0	200 ~ 2000			12
Window Sounding	150GHz	1000			29
	220GHz	2000			20
	340GHz	1000			13

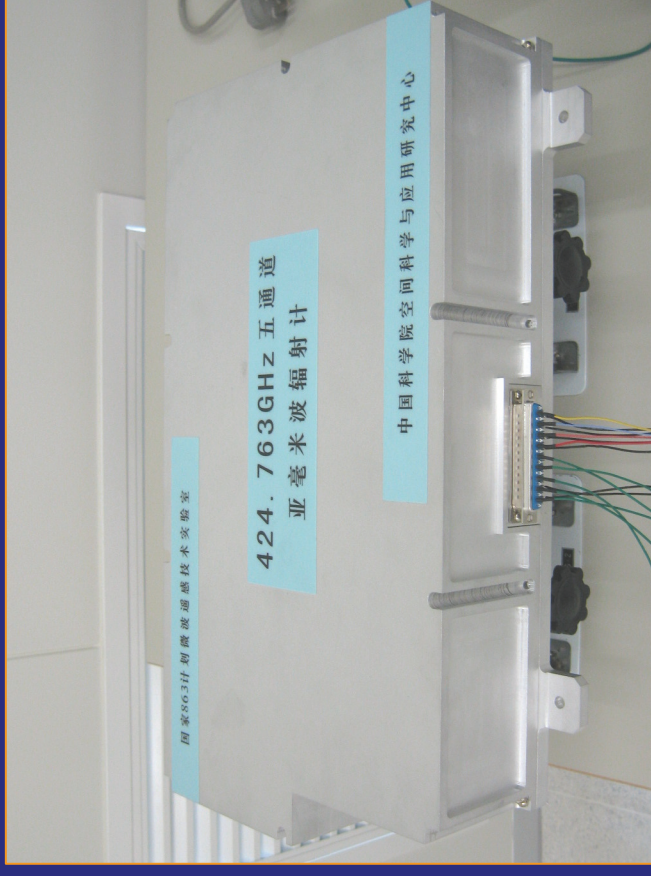
Synthetic Aperture Geo Microwave System Concepts



Terra Hertz (FY-4 Sat.)

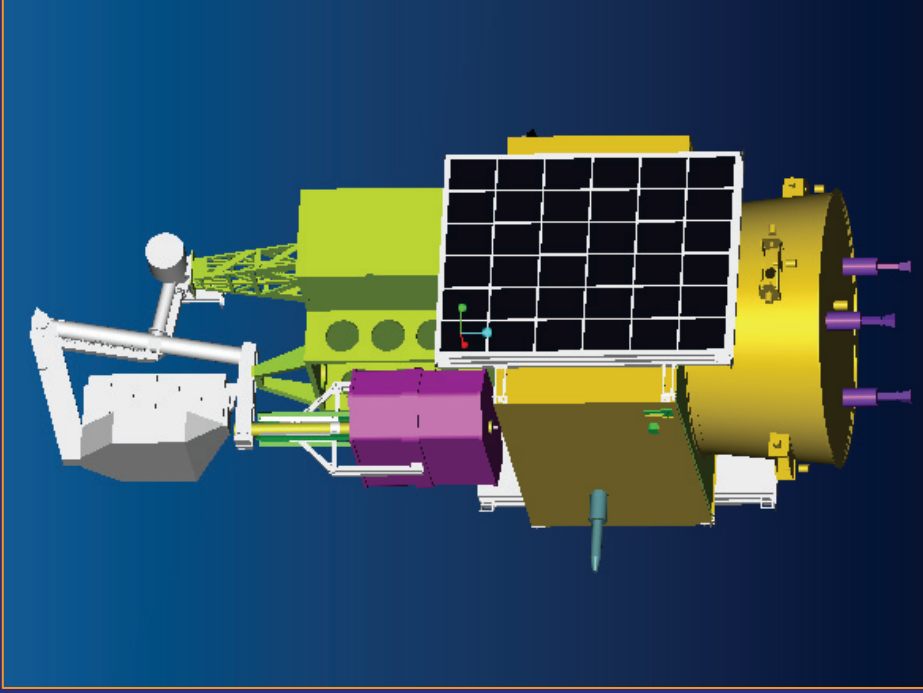
- Terra Herth Image Sounder

- WEIGHT: 65kg
- Power consumption: 80W
- Antenna: 1m
- Antenna scanning; Helic-Conicalstepped scanning
- Frequency Band;
 - 325.15GHz
 - 220GHz, 340GHz
 - 424.76GHz
- Noisy Temperature; 2000K (4 Bands)



HJ Satellite SAR

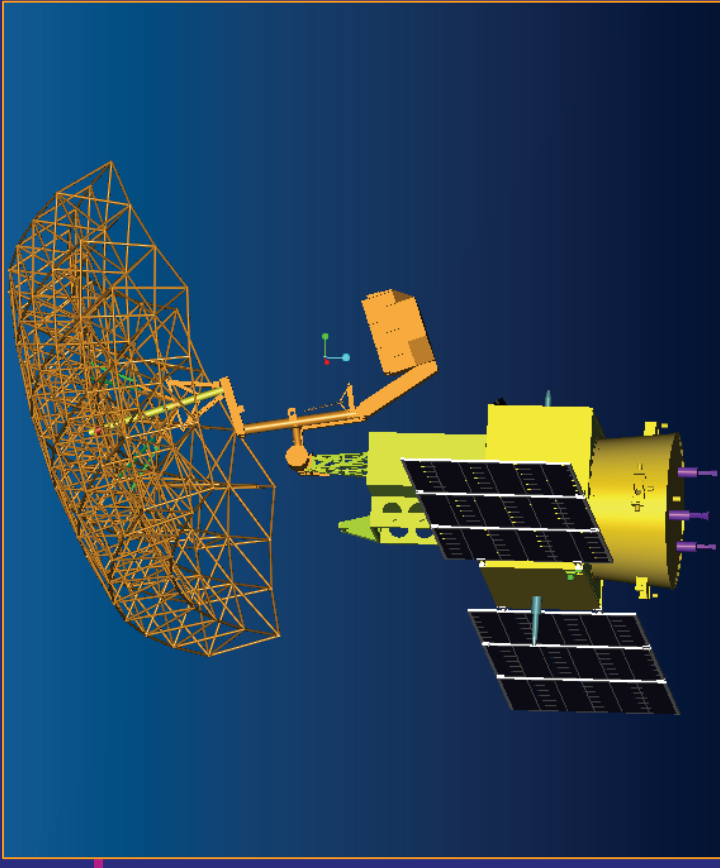
- **SAR** — Small SAR For Environment Monitoring
 - Platform
 - Orbit Type : Sun Synchronous
 - Altitude: 500 km
 - Orbit period: 94min
 - Orbit obliquity: 97°
 - AOCs: three-axis stabilization
 - Measure precision of three-axis: 0.05°
 - Direction precision of three-axis : $\leq 0.1^\circ$
 - Direction stabilization : $\leq 0.001^\circ /s$



Launch Structure



Laboratory Model



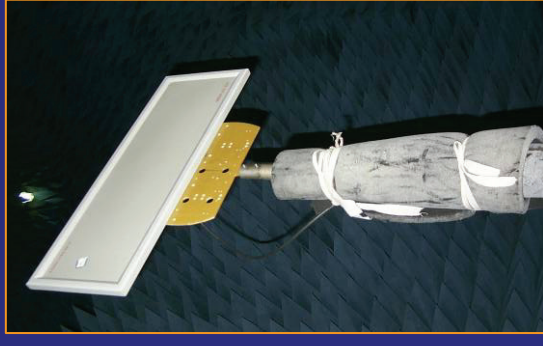
Operating Structure



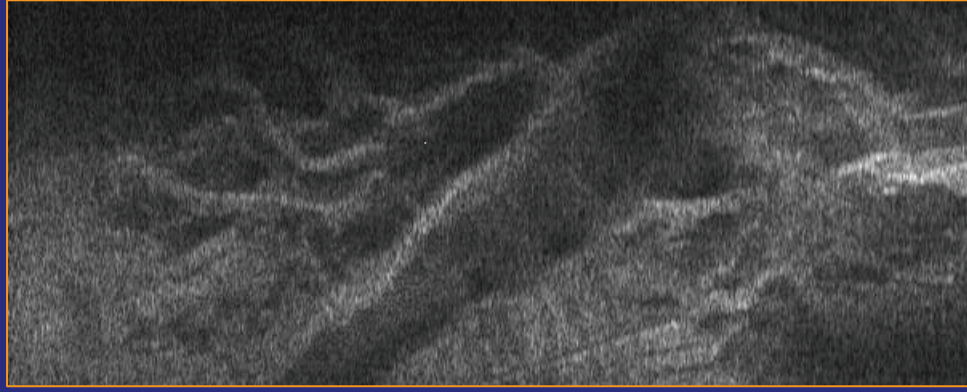
Laboratory Model

New sensor —— China Imaging Altimeter

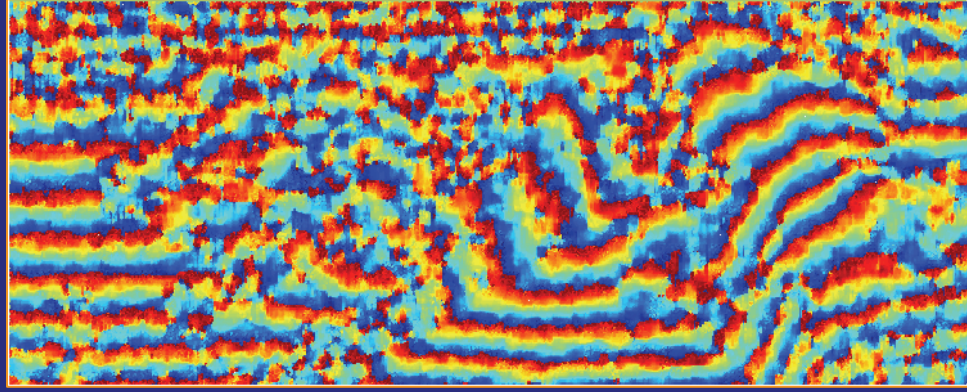
- main specifications
 - frequency: 13.5GHz
 - accuracy: 10cm for altitude, <3cm for evaluation
 - space resolution: 100x200m
 - antenna: 0.8x2.0m
 - experimental instrument



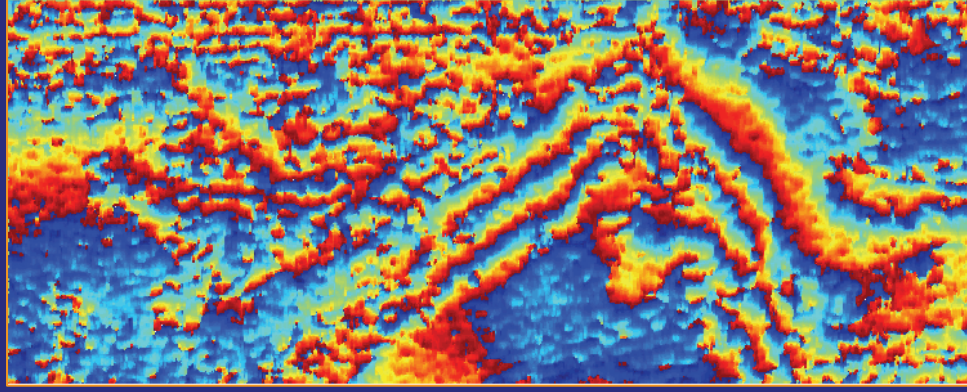
CIALT Images



Amplitude image



Interferogram by
direct estimation



Interferogram with
flat-earth-effect removed

New sensor —— Synthetic Aperture Radiometer

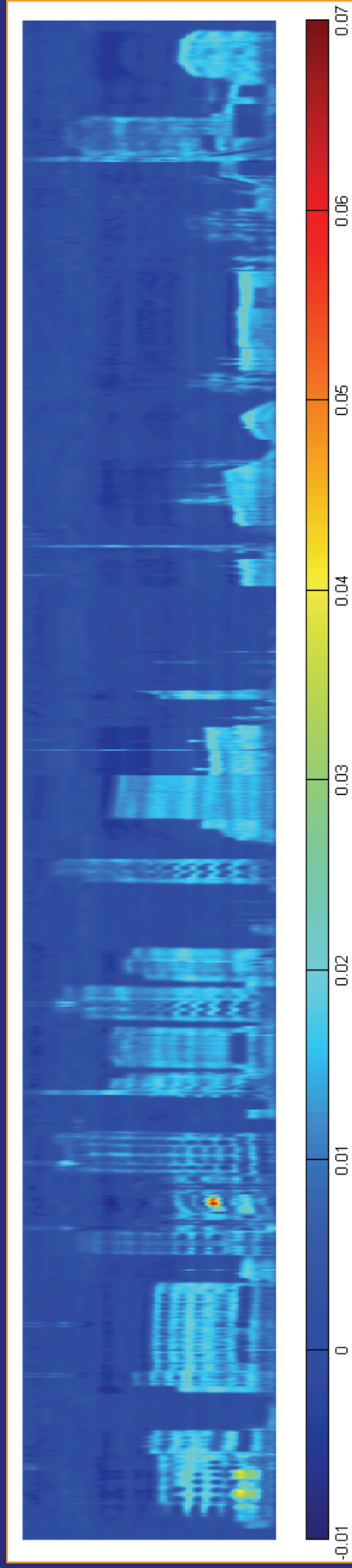
- **Specifications**

- frequency: 9.398 GHz
- bandwidth: 25MHz
- Integration time: 25ms
- Antenna/Receiver elements: 8
- The least spacing between antenna elements: 0.735λ
- Complex correlators: 20 analogue or 24 digital
- Spatial resolution: 2 degree

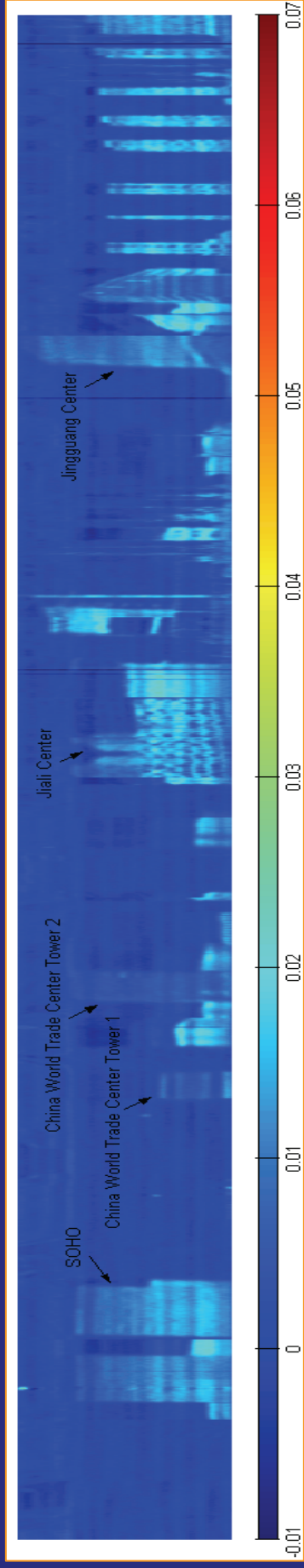


Airborne X-band Synthetic Aperture Radiometer Images

- Retrieved image of Baiyi Road, Beijing

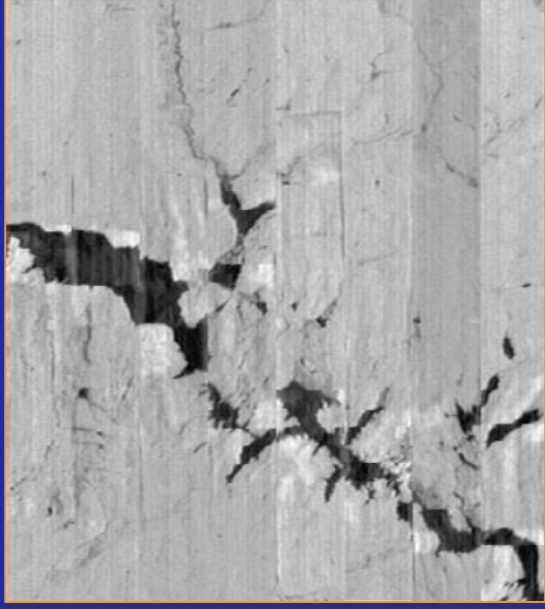


- Retrieved image of DongSanHuan Road (CBD, Beijing)



Airborne X-band Synthetic Aperture Radiometer Images

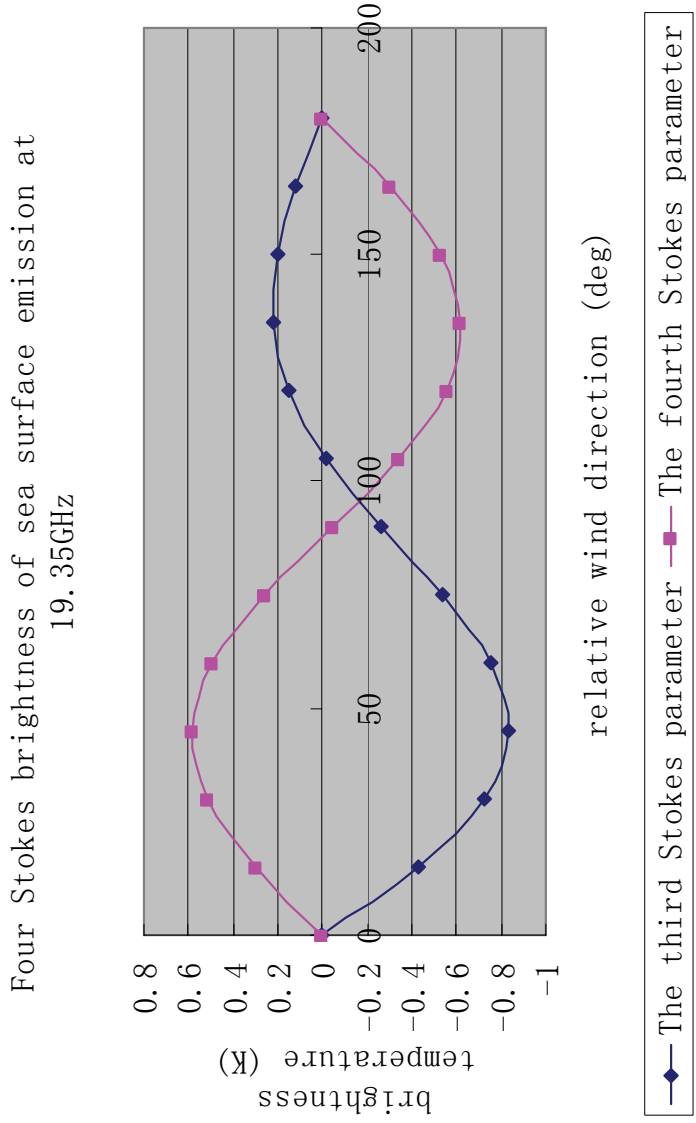
- Retrieved single strip image of Jingpo Lake



SARAD image on 2004.4.14

SPOT image on 2004.4.11

Full Polar-metric Radiometer Concept Research

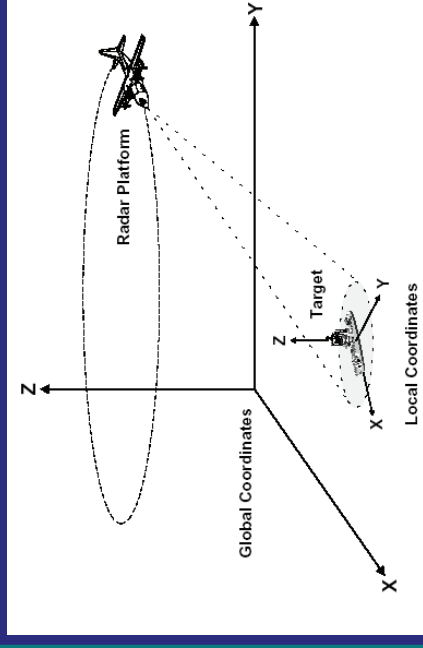
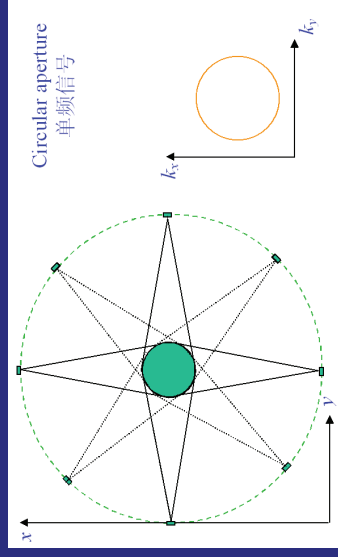
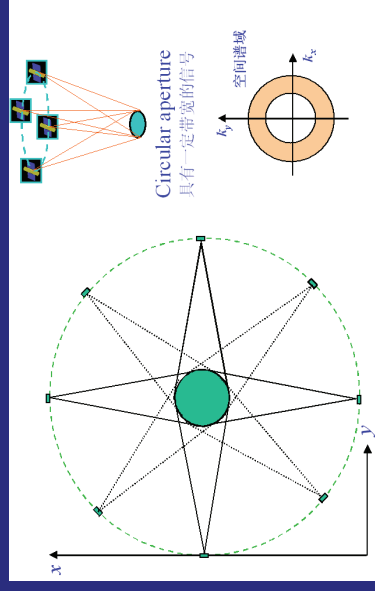
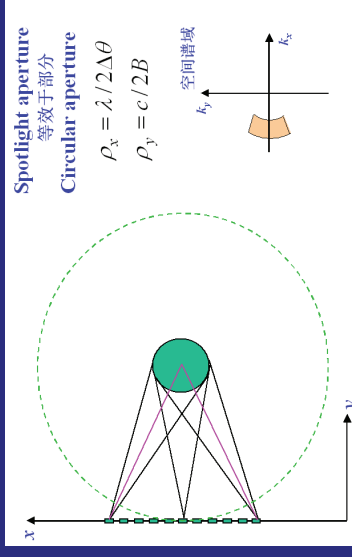
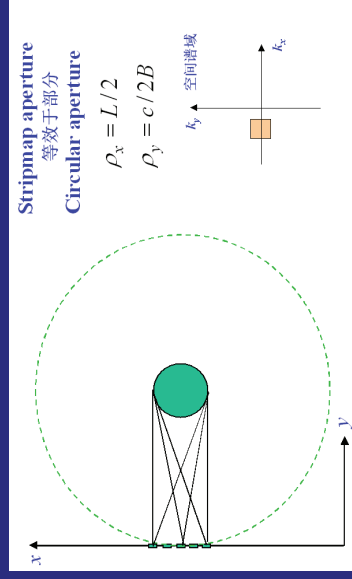


+45° Polar



-45° Polar

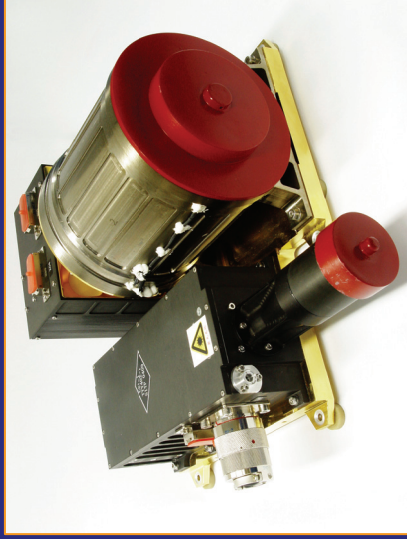
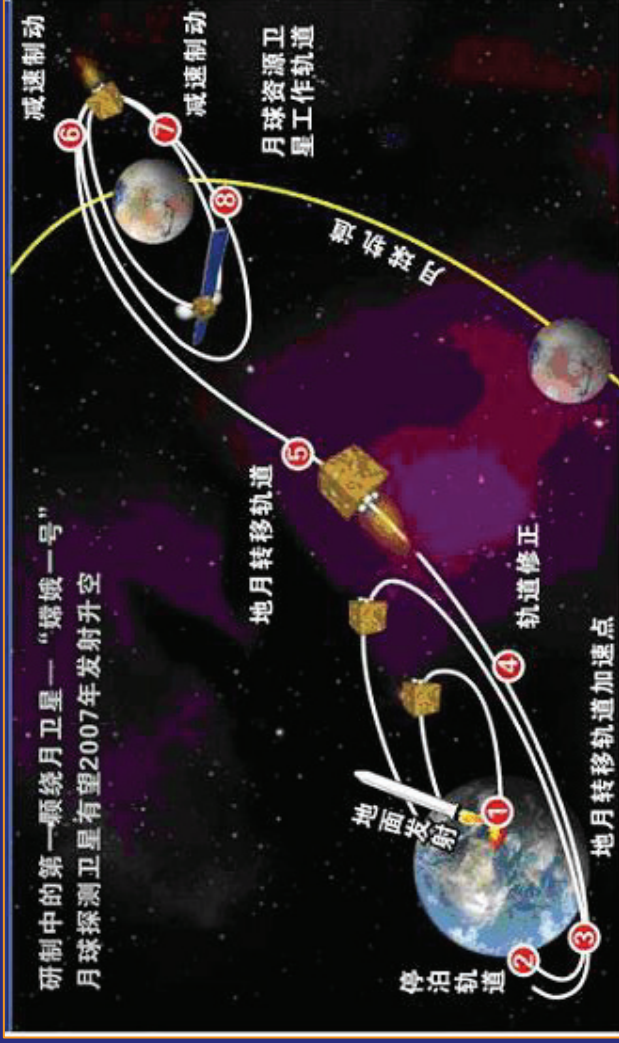
Circular SAR



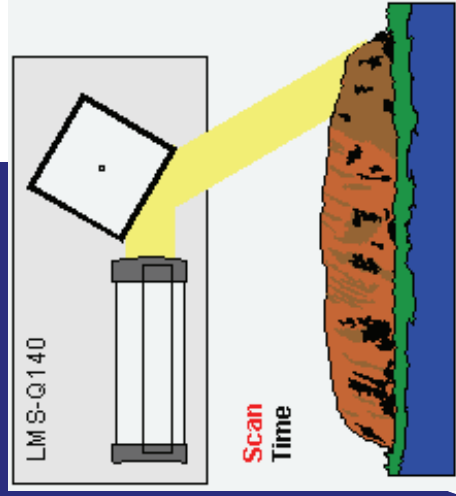
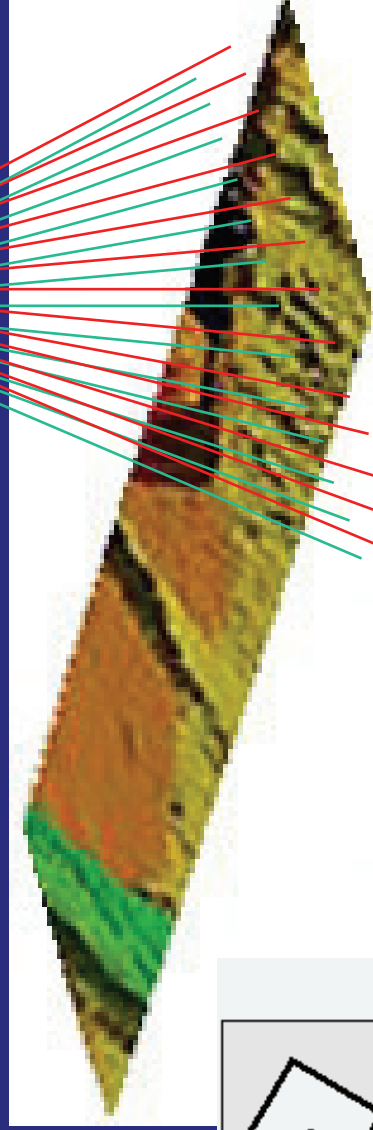
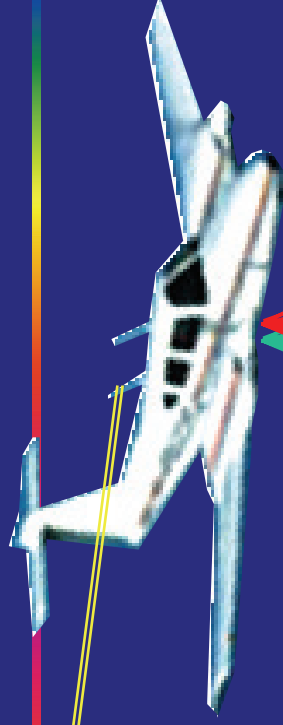
Lunar orbit Laser Altimeter



Orbit Height: 200km
 PRF: 1Hz
 Ranging resolution: 1m
 Laser power: 150mJ
 Pulse Width: 7ns

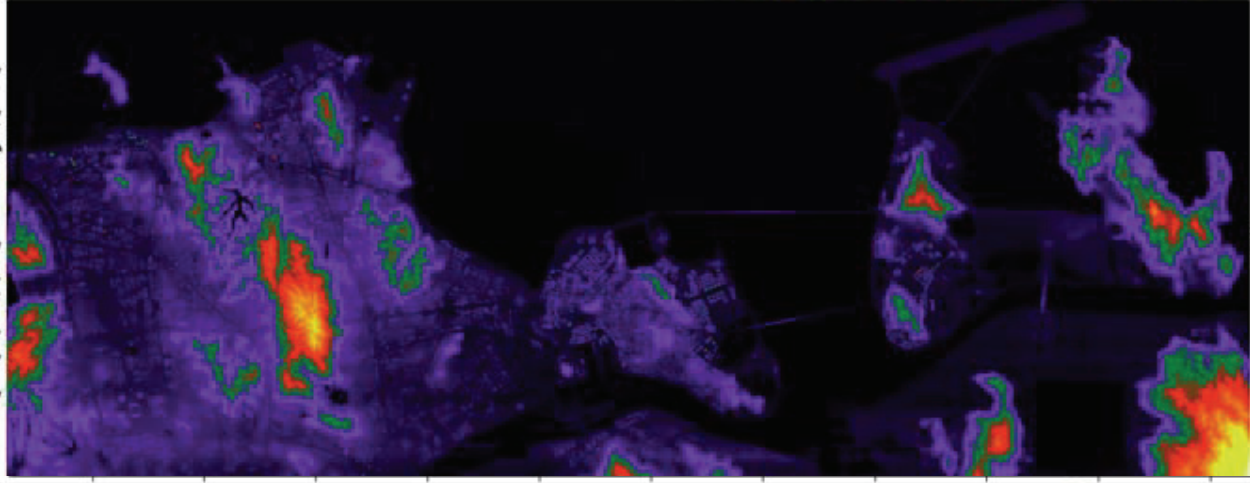


Laser Scanning Image and Altimeter



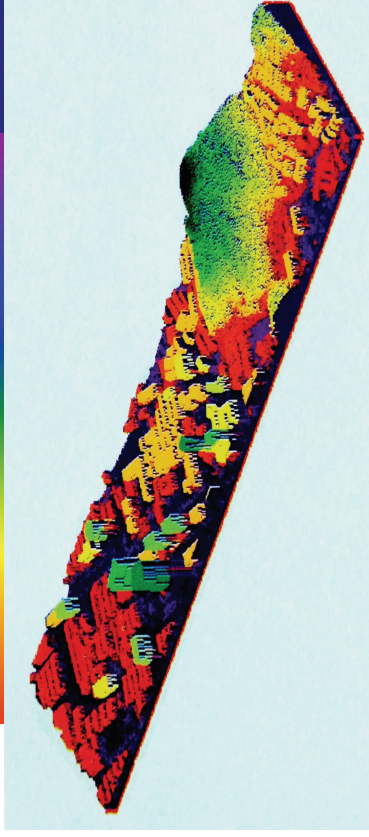
激光扫描测距
行扫描成像

珠海、澳门 DEM 影像图

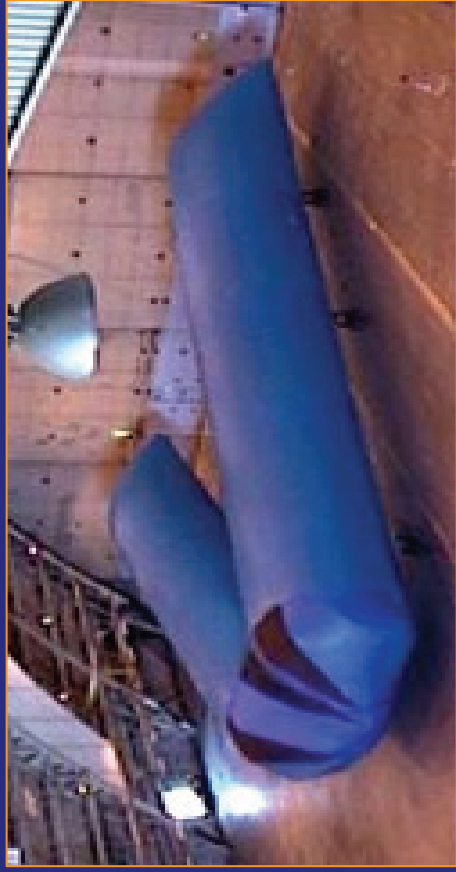


3-D Image

Zhuhai and
Oumen
(MCAO)



Near Earth Space Observation Technology



International Cooperation

During the past 38 years China has successively signed inter-governmental or inter-agency cooperative agreements, protocols or memorandums, and established long-term cooperative relations with several countries.

In the future, China planning develop more international cooperation in earth observation, especially disaster mitigation and environment monitoring and others.

Thanks!

