



# EO Activities in 2014

## Agency Report for WGCV-38

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*CEOS/WGCV-38 Plenary*

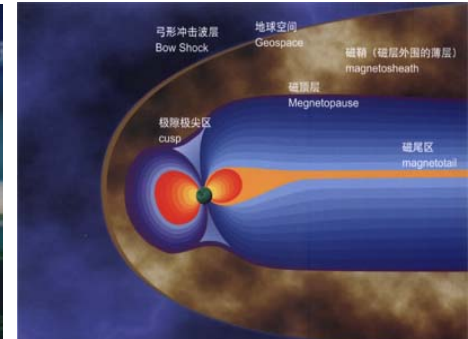
**Institutional Information**

**Grand Events in 2014**

**Activities on Calibration and Validation**

**Future Plan**

- **NRSCC was one of branch centers of Ministry of Science and Technology of China (MOST), and established in 1981 with its mandate in domain of RS, GIS and Navigation:**
  - ✓ To guide and coordinate R&D activities
  - ✓ To manage China National Scientific project
  - ✓ To facilitate the actions of Expert group of RS, GIS, Space explore and Navigation domain
- **To support the development of innovation capability and to foster the new industry**
- **Ten official staffs at present but many secondments**
- **The mode of “condensed kernel, wide network”**



## Academy of Opto-Electronics (AOE), Chinese Academy of Sciences (CAS)

- AOE was established in November 2003. Aiming at national demand and international advanced technology, AOE carries out innovation activities in optoelectronic engineering, aerospace and corresponding EO application technology, becoming a research unit with overall technique functions in the above areas.

## Earth Observation Technology Application Department (ETA)

- ETA is a department of AOE in charge of R&D of EO data processing and application technology, which dedicates to provide open R&D platform for quantitative RS information technology.
- On the basis of ETA, CAS established the **Key Laboratory of Quantitative Remote Sensing Information Technology** in 2014, which focuses on R&D quantitative RS information quality control, information extraction and application mechanism, information service technologies.

- Relationship between NRSCC and AOE**

NRSCC is running in a network support approach, the network virtually consists of 49 institutes from different department.

### Data and Comprehensive Services

- Department of Research & Development
- Department of Information Service
- Department of Geographical Information System
- Department of Meteorological Satellite Remote Sensing
- Department of Remote Sensing Satellite Receiving
- Department of First Aerial Remote Sensing
- Department of Data Management and Industry Development
- Department of Ocean Remote Sensing
- Department of Environmental Remote Sensing
- Department of Earth System Science Data Service
- Department of Disaster Management
- Department of Satellite Surveying and Mapping
- Department of Geographic Information Engineering

### Application Research

- Department of Land and Resources
- Department of Agricultural Application
- Department of Forest Resource and Ecological Environment
- Department of Remote Sensing Monitoring of Natural Disaster
- Department of Space Science Remote Sensing
- Department of Global Change and Sustainable
- Department of Remote Sensing for Natural and Cultural Heritage
- Department of Crust Dynamics and Deep Space Exploration
- Department of Urban Environmental Remote Sensing
- Department of Precision Agriculture Application
- Department of Hyperspectral Remote Sensing Technology and Application
- Department of Research for Wetland Remote Sensing
- Department of Nonferrous Metal Mineral Resources Remote Sensing
- Department of Land Remote Sensing

### System and Equipment

- Department of System Integration
- Department of Remote Sensing System Equipment
- Department of Radar Armaments
- Department of Satellite Navigation System Equipment
- Department of Microwave Remote Sensing Technology
- Department of GNSS Service Performance Enhancement
- Department of Satellite Data Receiving
- Department of GNSS Signal Processing
- Department of Inertial Navigation System and Apparatuses

### Technical Training

- Technical Training
- Department of Hong Kong Research, Development and Training
- Wuhan Technical Training Department
- Department of Proficiency Training

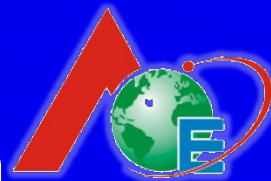
### Local Division

- Department of Local Remote Sensing Contact Service
- Beijing Division
- Hunan Division
- Fujian Division
- Chongqing Division
- Jiangsu Division

### Department of System Integration

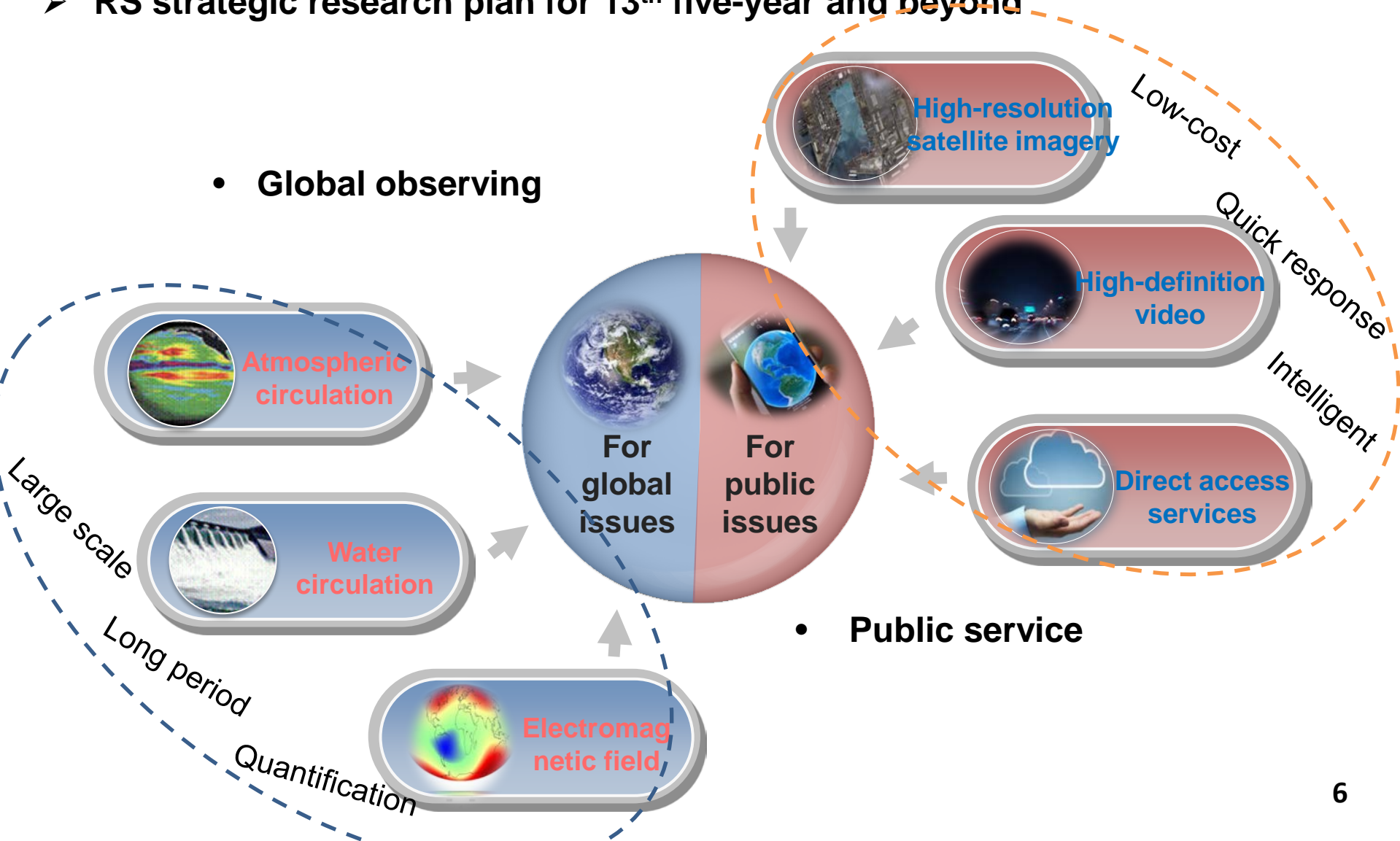
AOE supports NRSCC for RS strategic research, data quality assurance, data sharing and emergency response, etc.

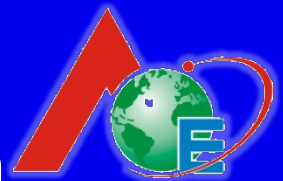
Chuanrong-Li, appointed by MOST a chief scientist to lead an expert group in the domain of RS, GIS, PNS and Space exploration



➤ RS strategic research plan for 13<sup>th</sup> five-year and beyond

- **Global observing**





### ➤ RS strategic research plan for 13<sup>th</sup> five-year and beyond

Planning will focus on the following aspects:

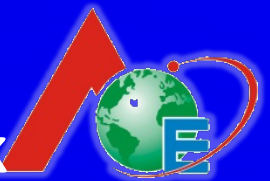
➤ **Space-near space-airborne-ground integrated, visible-thermal infrared multispectral spaceborne radiation benchmark and the corresponding consistent transfer technology**

➤ **Quick observation based on micro-satellite constellation, onboard data processing and RS big data analysis technology, aiming to public services**

➤ **Advanced RS payload technology, public service oriented information processing technology and Earth science remote sensing**

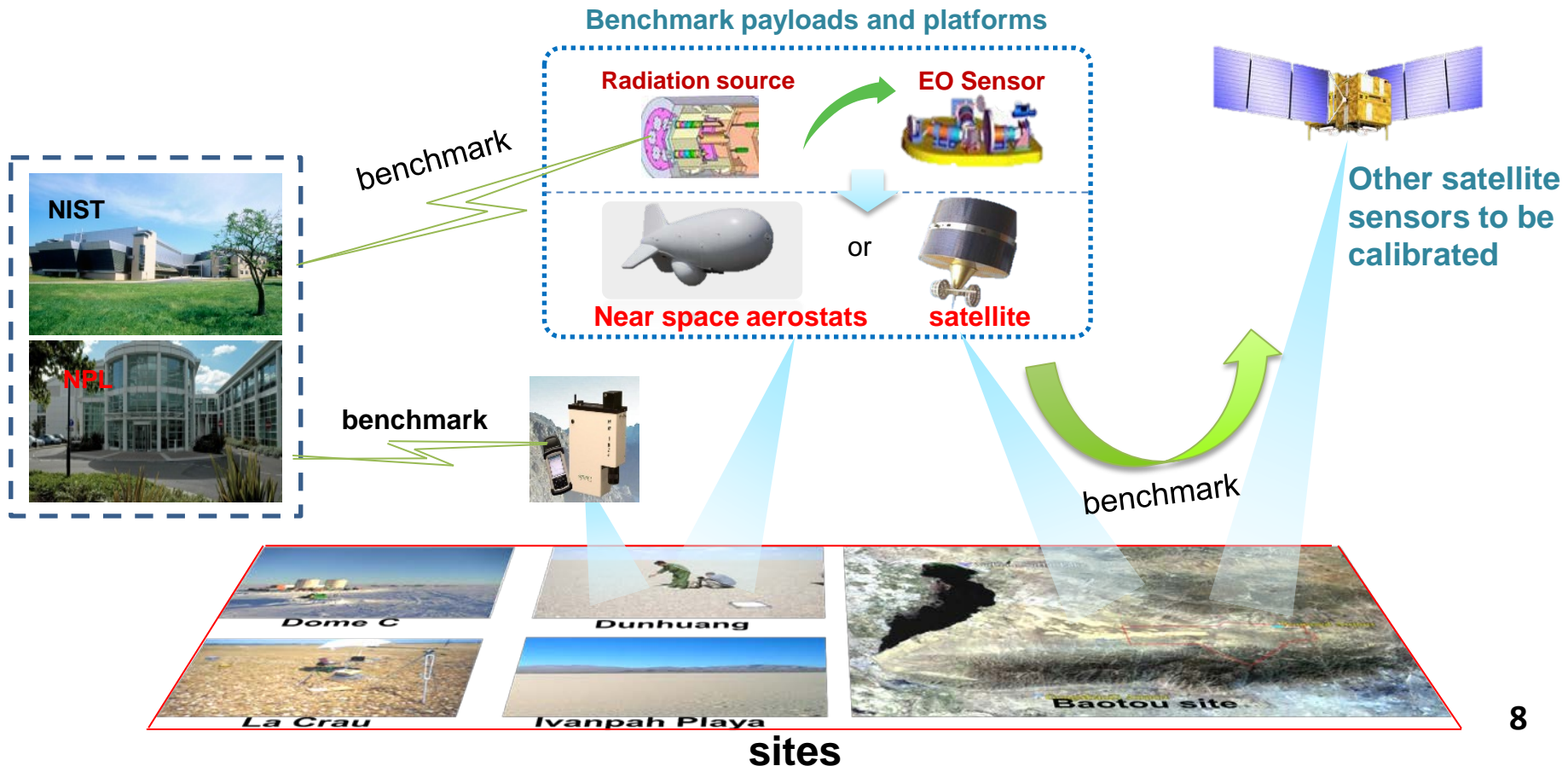
**Evidently improve Chinese satellites calibration accuracy to ensure the consistent data quality and benefit for solving global issues.**

**RS information technology serves public, promoting the development of RS big data and information industry.**



➤ **Proposal of spaceborne radiation benchmark system**

- Achieve high-accuracy and high-stability calibration with SI traceability of in-orbit payloads through benchmark transfer.
- Benchmark platform: **Ground, Airborne, Near space aerostats** and **satellite**







➤ **Proposal on spaceborne radiation benchmark system**

• **Planning (2016~2025):**

~2020: The principle prototypes devices

~2023: The engineering prototype system, tested onboard Near space aerostats

~2025: In operation onboard satellite

• **Work arranged (2015~2017):**

High-precision spaceborne infrared radiation source  
Radiation

- ✓ Emissivity:  $\geq 0.997$
- ✓ Temperature controlling stability:  $\leq 0.01\text{K}$
- ✓ Temperature uncertainty:  $< 0.15\text{K}$

High-precision spaceborne solar spectral radiation benchmark with SI traceability

- ✓ Uncertainty of space cryogenic radiometer:  $\leq 0.03\%$
- ✓ Spectral range: 300nm-2500nm
- ✓ Uncertainty of solar spectral radiation benchmark : 0.2% ( $< 1600\text{nm}$ ); 0.5% ( $> 1600\text{nm}$ )

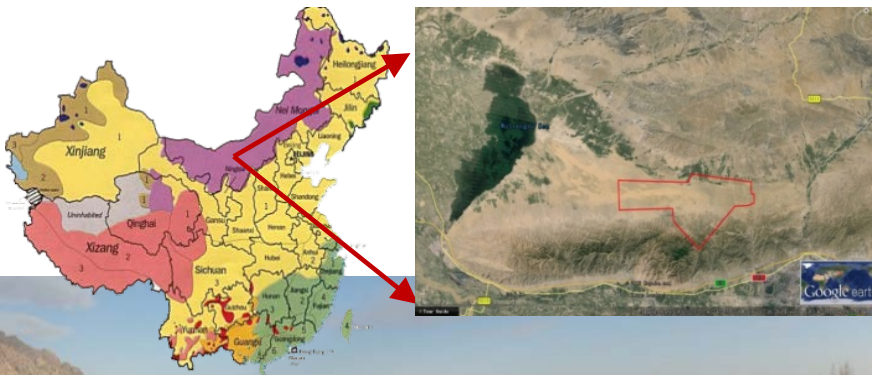
- **Key Laboratory of Quantitative Remote Sensing Information Technology, Chinese Academy of Sciences (CAS) was established in 2014.**

Quantitative remote sensing information acquisition and application

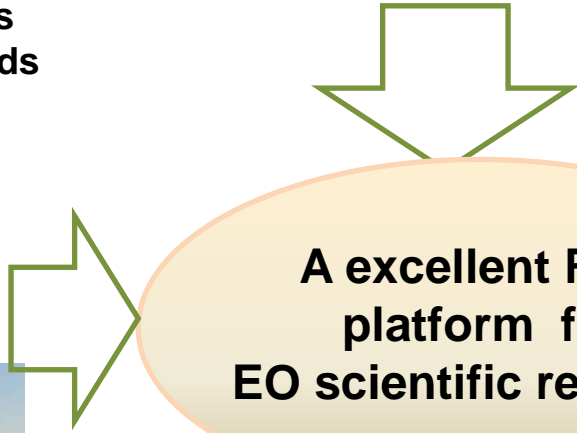
Quantitative remote sensing information quality assurance technology

Quantitative remote sensing information service technology

- Performance assessment for Optical and SAR sensors
- Opening site in accordance with international standards



**Baotou site**



**A excellent R&D platform for EO scientific research**

### ➤ Dragon programme

#### Background:

- ESA, together with the NRSCC, had cooperated in the field of Earth observation application development for more than 17 years. In 2004, The cooperation taken on a new momentum called Dragon.

#### Objectives:

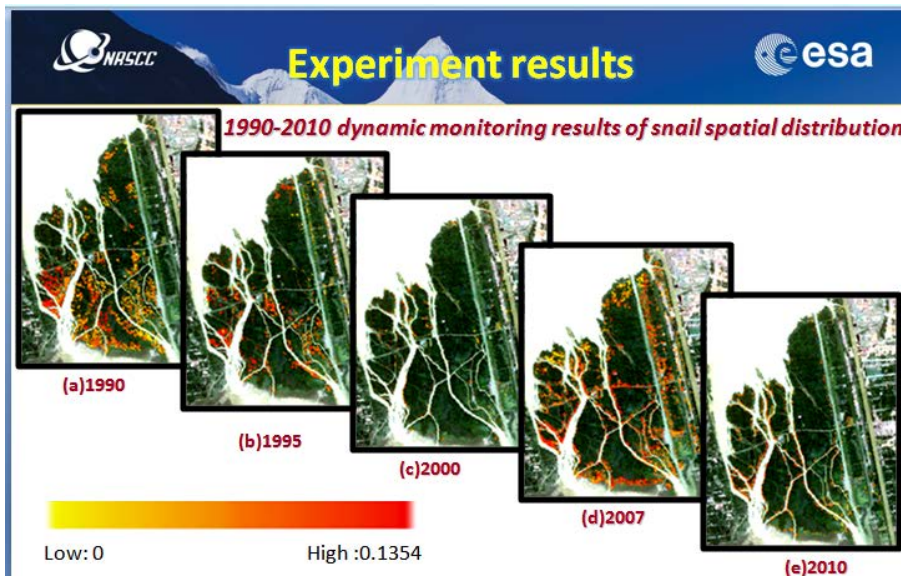
- The Dragon cooperation is targeted towards land, ocean, cryosphere, geodesy, climate and atmospheric investigations in China.

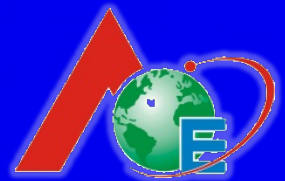
#### Development of Dragon :

- Dragon 1(2004-2008): formally kicked-off in April 2004 ,in Xiamen city in P.R. China. was initiated in 16 priority areas using ESA ERS and Envisat data in China
- Dragon 2(2008-2012): 25 geo-science projects
- Dragon 3(2012-2016): further expanded to a third phase with 51 projects exploiting ESA, TPM and Chinese EO data.
- **Dragon 4: TBD**

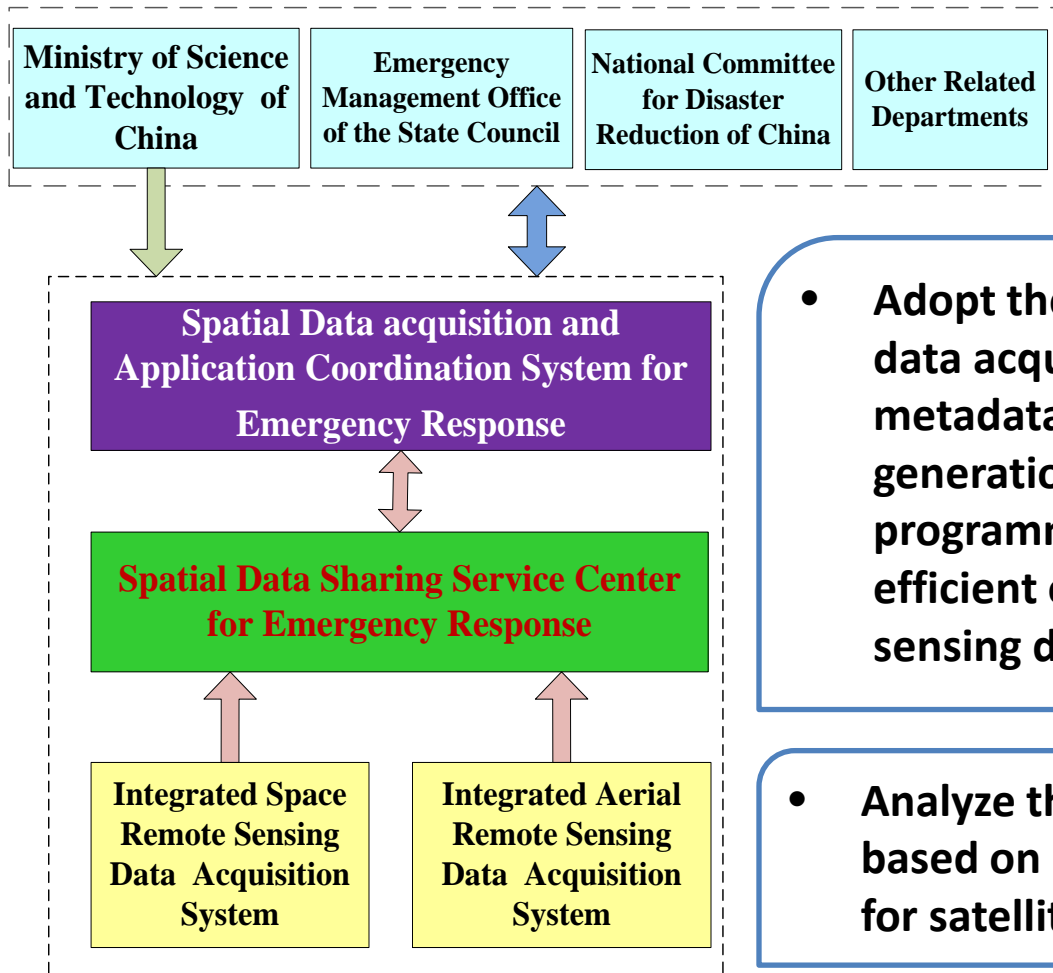
### ➤ Dragon programme

- In Chengdu, China from 26-29 May 2014, more than 300 European and Chinese EO scientists attend the symposium.
- AOE, CAS cooperated with University of Ulster, UK and National Institute of Parasitic Diseases (NIPD), Chinese Center for Diseases Control and Prevention (CCDC) developed the Epidemics' monitoring research project named "Monitoring and Early Warning of Vector-borne Diseases in China by Earth Observation Data Mining (MWVDEODM)".





➤ **Aerospace application coordination system for emergency response and data sharing (ArcSer)**



- **Adopt the universal standards for aerospace data acquisition and exchange, including its metadata, storage format, product generation order and observation programming order etc., which ensure the efficient operation for 15 aerospace remote sensing data acquisition systems.**

- **Analyze the requirements of acquiring task based on disaster states, make the task plans for satellite and aerial system collaboratively.**

➤ **Aerospace application coordination system for emergency response and data sharing (ArcSer)**

- **Disaster experts, government officials and spatial data application users can have conference with each other under the support of the system, which uses 3D technology as disaster information comprehensive display platform.**



- **The system increases the speed of acquiring aerospace data of disaster area, reduces the time for end user to acquire spatial data for disaster reduction, which improve the efficiency of aerospace resources of China for disaster reduction dramatically .**



- In LuDian Earthquake, which was occurred at 16:30, August 3, 2014, UAV was dispatched to a quake lake area on NiuLan River. The high resolution data over the area was obtained at 15:00, August 4. Then the information extracted from the data was used to guide quake lake's disaster rescue and relief.



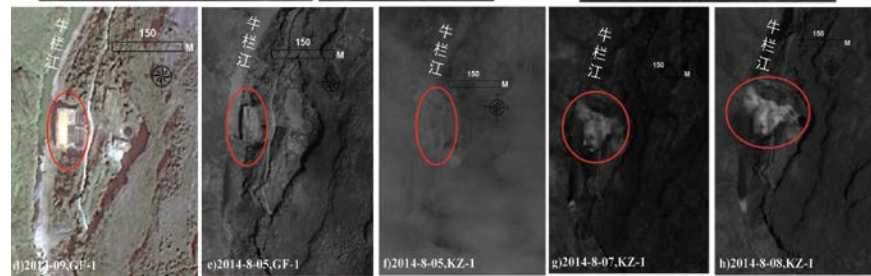
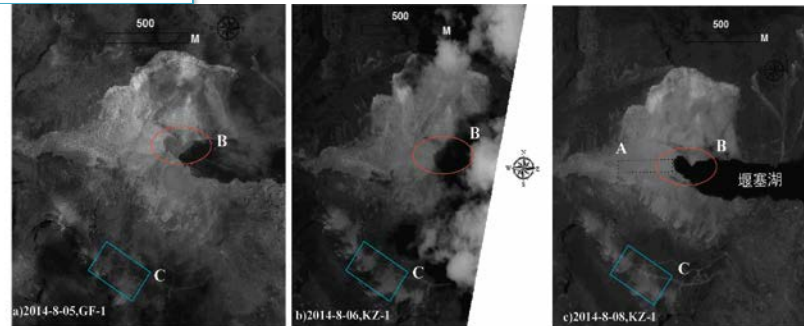
- Acquire the first batch of high resolution remote sensing data (GF-1, KZ-1) within 24 hours after the earthquake.
- Collect a huge amount of aerospace remote sensing data acquired before and after the earthquake.
- Distribute the data to more than 38 institutions , which are affiliated with 20 different Ministries ( more than 90 batches, data volume up to 2.05TB).

Before earthquake	After earthquake
<ul style="list-style-type: none"> <li>• GF-1</li> <li>• ZY1-02C/ZY3</li> <li>• HJ-1A/1B/1C</li> <li>• SJ-9</li> <li>• HY1B</li> <li>• TH01</li> <li>• RISAT-1</li> </ul>	<ul style="list-style-type: none"> <li>• KZ-1</li> <li>• GF-1</li> <li>• ZY1-02C/ZY3</li> <li>• HJ-1A/1B/1C</li> <li>• SJ-9</li> <li>• HY1B</li> <li>• TH01</li> <li>• RISAT-1</li> <li>• SB-1</li> <li>• DB-1</li> <li>• UAV airborne image</li> </ul>

### Fast data acquisition and sharing

Acquisition at 12: 04

Data sharing on the internet at 13:30

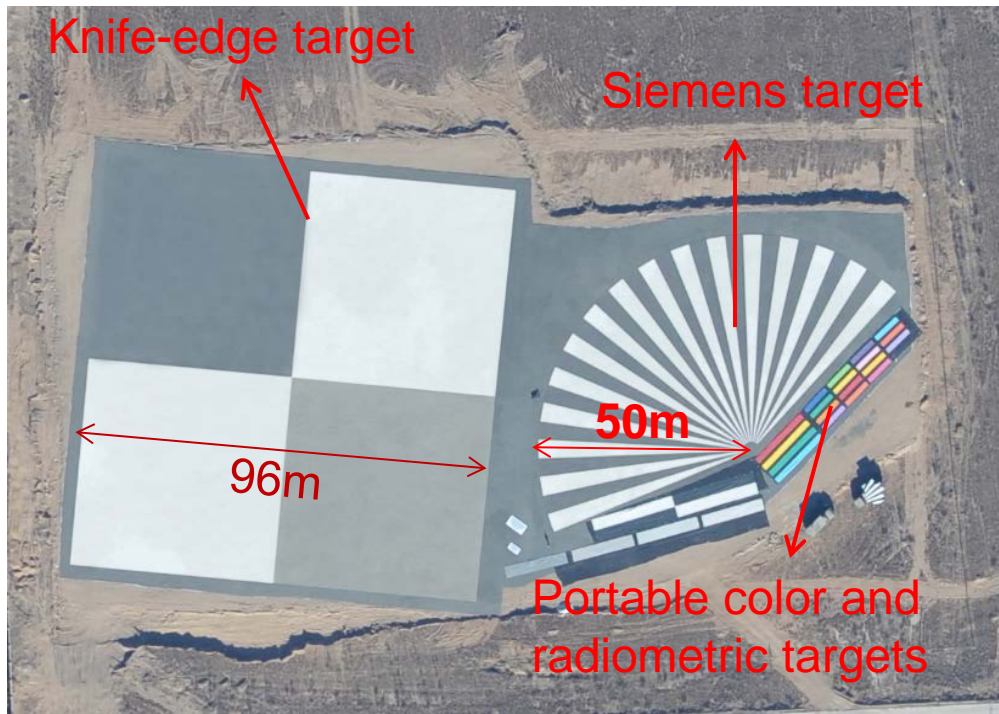




- Baotou site is now one of the four first **demonstration sites of RadCalNet**.

## The requirements of RadCalNet:

- To establish an automated land radiometry measurement network
- To generate sensor-independent TOA radiance/reflectance
- To provide worldwide consistent sensor calibration service

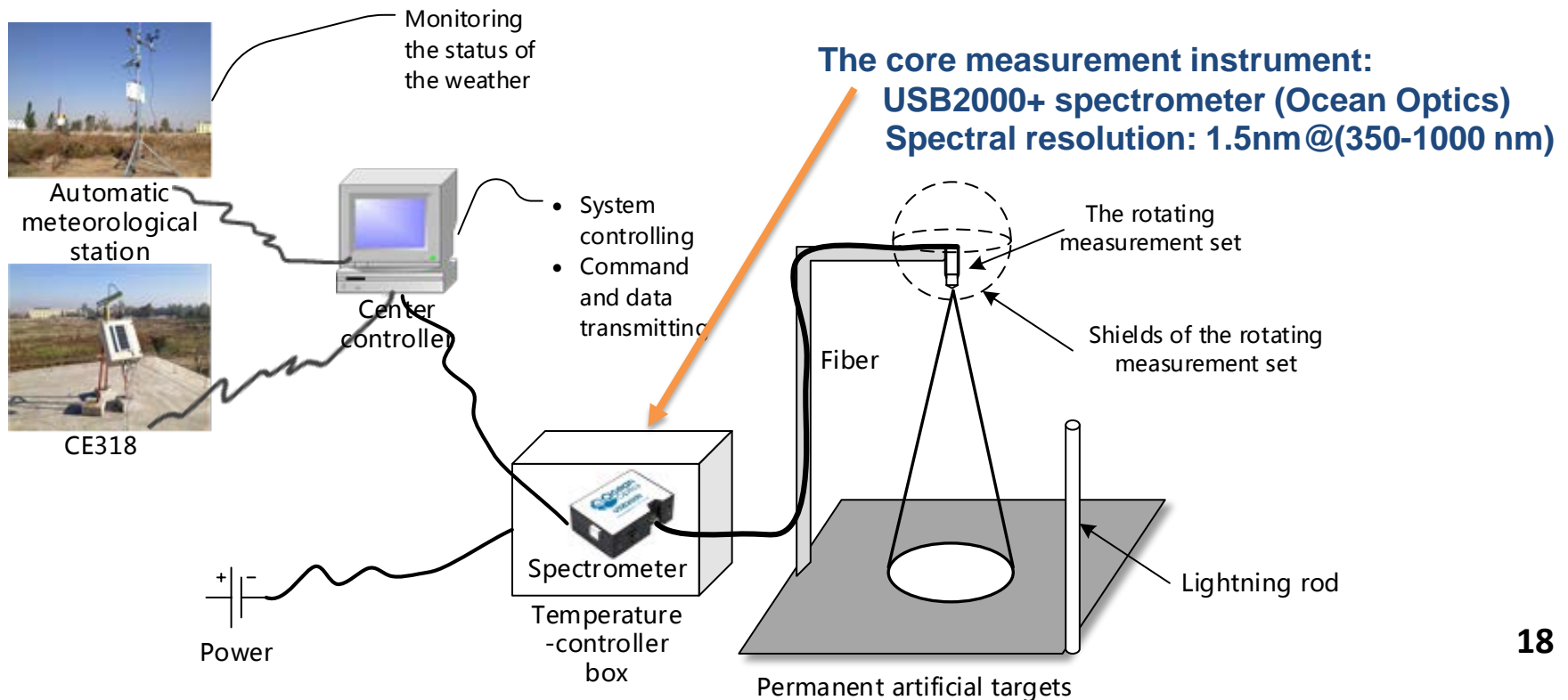


Aerial image of the artificial permanent targets in Baotou site

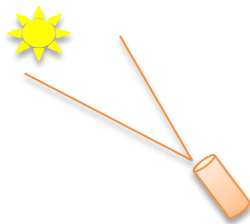
*To meet the needs of RadCalNet, an automated reflectance spectrum measurement system is designed and will be installed on the artificial permanent targets of Baotou site.*

### ➤ The characteristic of Automated Ref. Spec. Measurement System

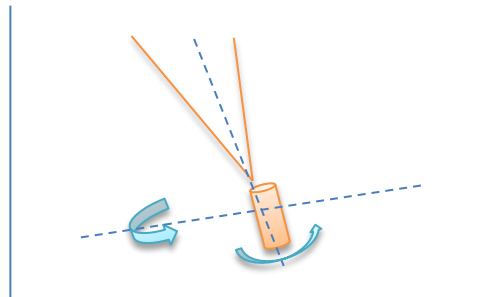
- Hyperspectral measurement, to match with different sensors more conveniently and accurately.
- Measure the hemispherical down-welling radiance and ground reflected radiance with the same detector.
- Automatically adjust the working status according to the weather condition.



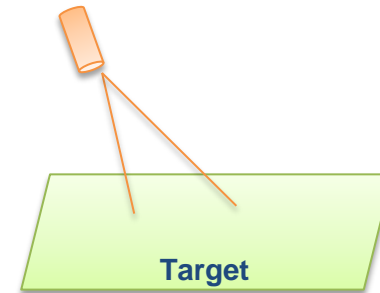
The system is designed to observe the solar, sky and ground in sequence every 10 minutes.



To solar

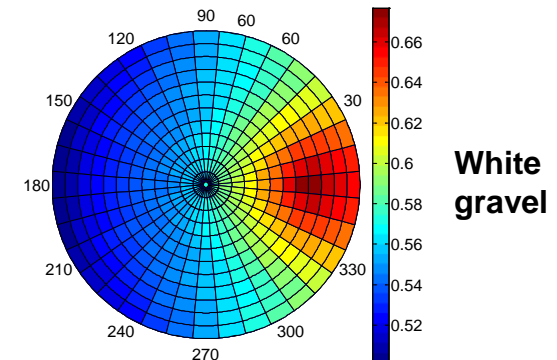
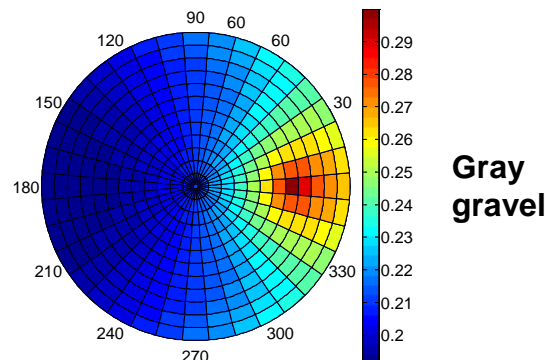
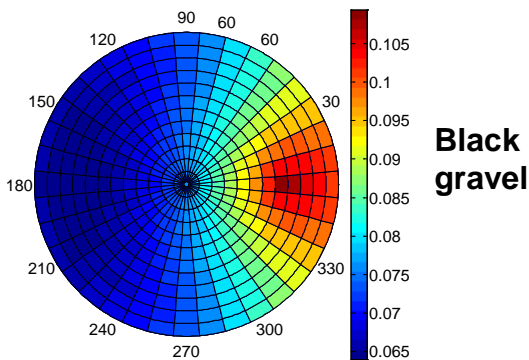


To upper semi-sphere of sky



To ground

The surface reflectance at certain observing direction is calculated with hemispherical-conical reflectance and the BRDF of the surface target .



The sensor-independent hyperspectral TOA radiance/reflectance is acquired with the surface reflectance and atmospheric parameters, and then the channel TOA radiance/reflectance is carried out by the convolution with the SRF.

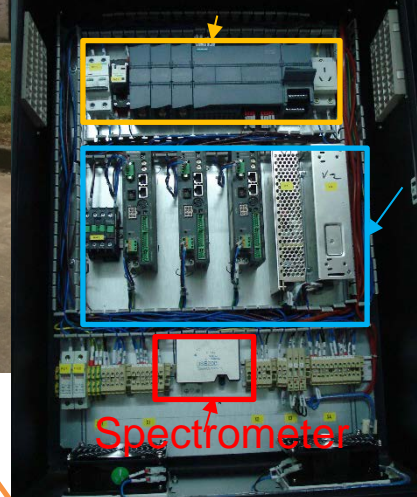
Totally, three systems will be installed beside three gray-scale targets, and the radiometric calibration can be carried out with the 3 channel TOA radiance/reflectances.

- ✓ The support units (an upright post) has a height of ~1.5m with a beam of approximately 0.5m for observation.

System debugging



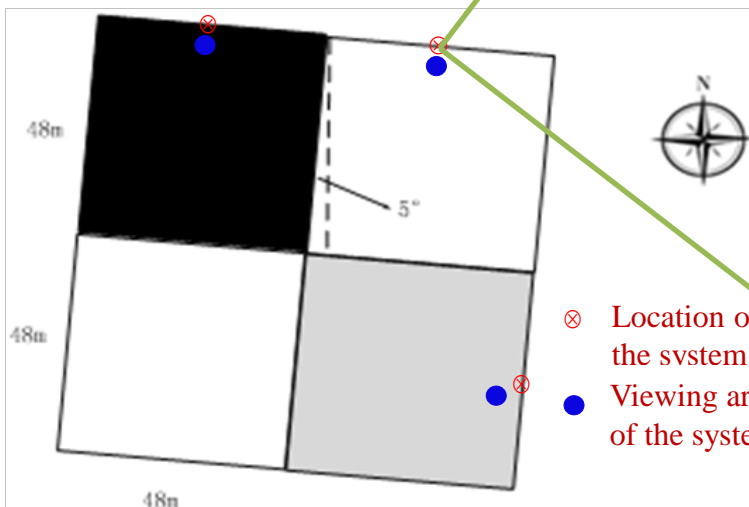
Communication units



control units

Spectrometer

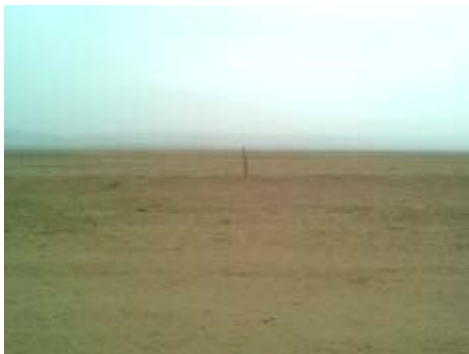
Controlling box





- The landscape of Baotou site is sand and grass, and it has low back-scattering coefficient (-13~-15dB) for deploying SAR calibrators.
- 45 triangular trihedral corner reflectors and 1 active calibrator for **UAV-borne Ku/X-band SAR Cal&Val** were previously developed.

Landscape



April



August

To enhance routine  
Cal&Val capability



**New types of corner reflectors (CRs)** have been manufactured for long-wavelength /spaceborne SAR Cal&Val.



**Corner reflector bases** have been developed for quick deployment of corner reflectors and avoiding repeated position measurement.



**Microwave bar-pattern targets** have been developed for intuitive and accurate assessment of SAR image resolution.



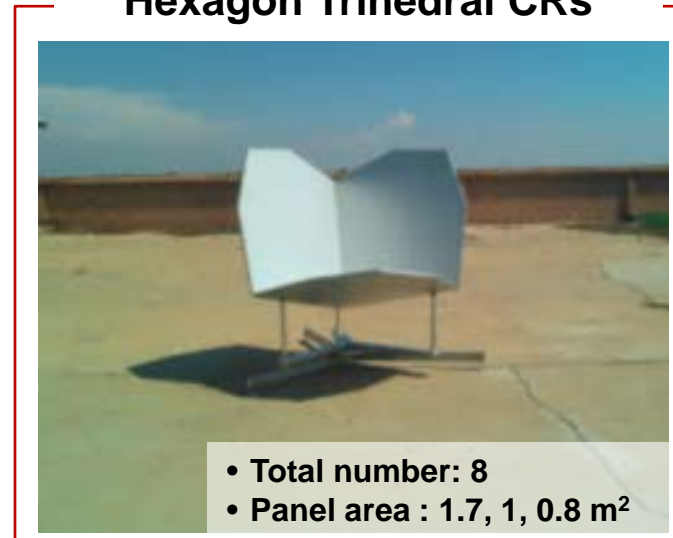
➤ **Corner reflectors R&D:**

■ **Self-illuminating CRs**

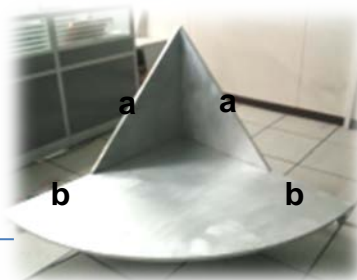
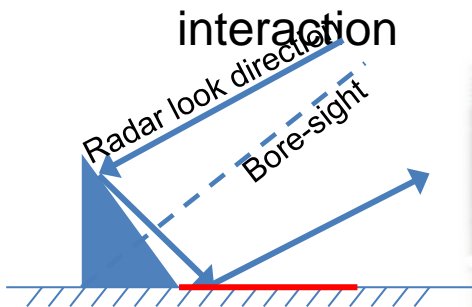
**Square Trihedral CRs**



**Hexagon Trihedral CRs**



■ **Extended bottom trihedral CRs**  
to avoid uncertain panel-ground interaction



**a = 0.8m**  
**b = 1.36m**

■ **dihedral reflectors** for polarimetric SAR calibration

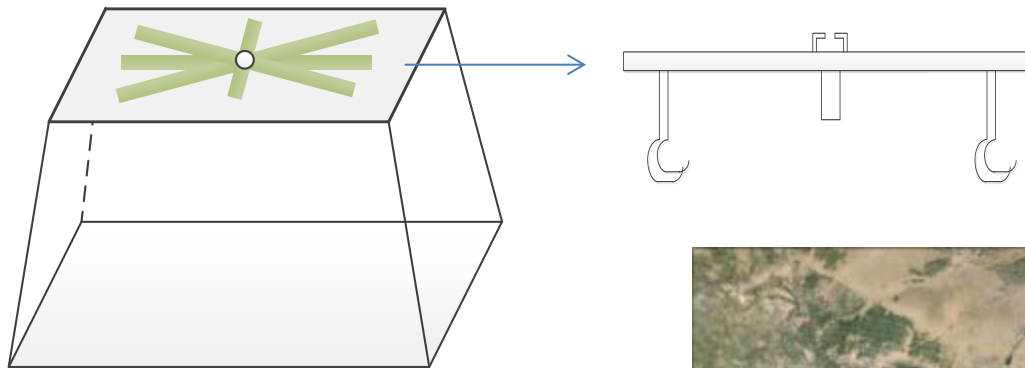


**There are 100 corner reflectors in total at the Baotou site**



### ➤ Reflector bases

For quickly deploying corner reflectors and avoiding repeated measurement of position information, 15 corner reflector bases were constructed and distributed across the site.



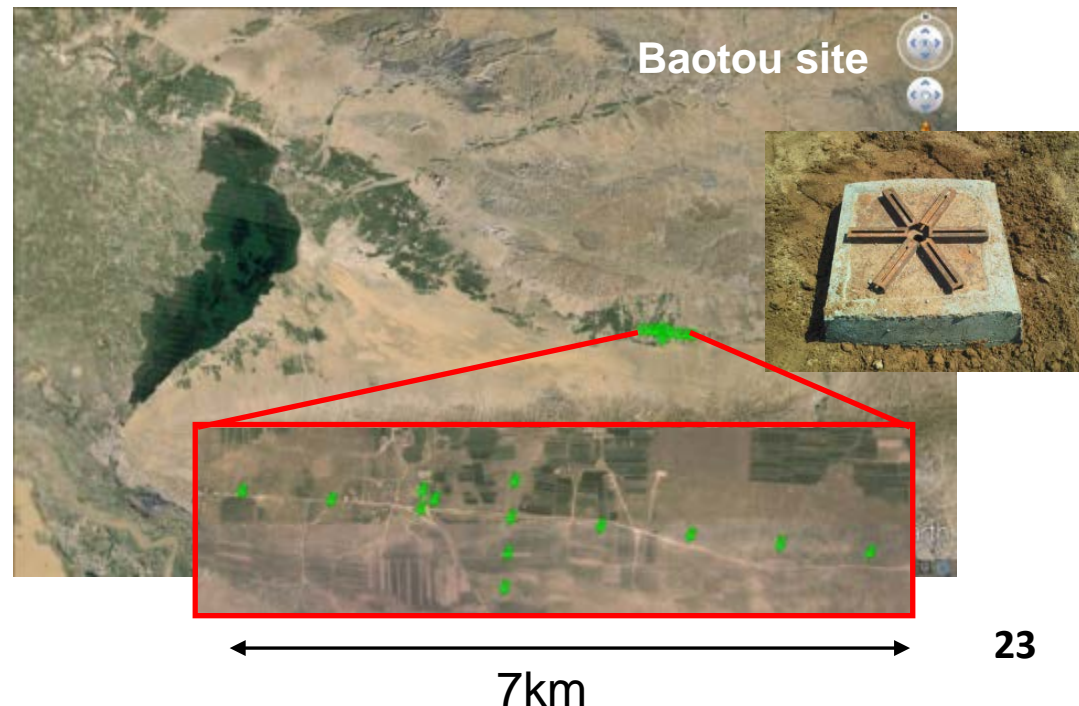
The bases in east-west direction are generally used for antenna pattern verification; while the bases in south-north direction are used for radiometric calibration.

Distribution direction (east-west) is  $95^\circ$  to North, with compromise of transportation convenience and SAR flight direction:

$$\beta = \arcsin \frac{\pm \cos \alpha}{\cos \xi} \approx 10^\circ$$

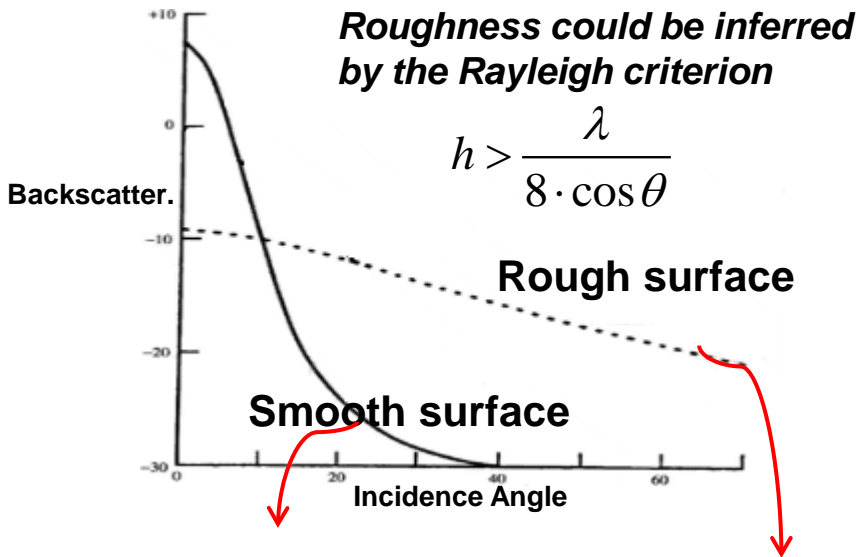
$\beta$  : Azimuth  
 $\alpha$  : Latitude  
 $\xi$  : Inclination

Satellite	Inclination
TerraSAR	$97.44^\circ$
Radarsat-2	$98.6^\circ$
Sentinel-1	$98.18^\circ$
SkyMed	$97.86^\circ$
ALOS/PALSAR	$98.16^\circ$
HJ-1-C	$97.37^\circ$

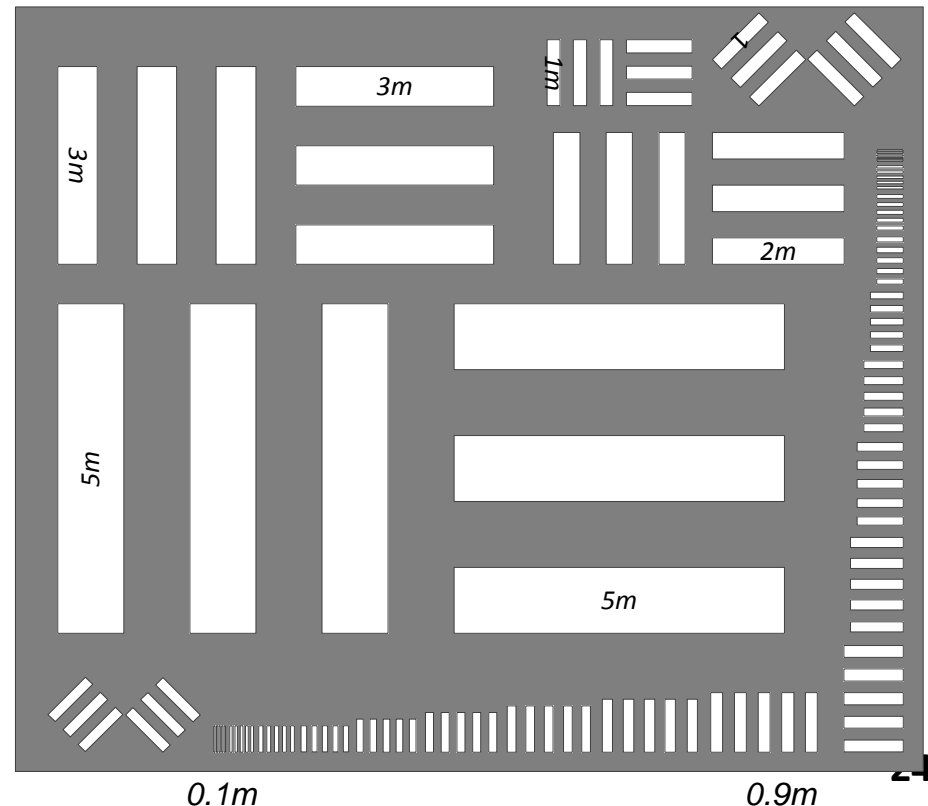
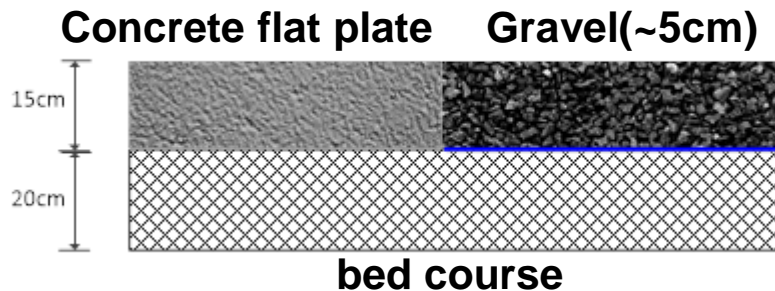


### ➤ Bar-pattern target

It draws the inspiration from optical three-bar pattern target, and exploits the roughness dependence of radar backscattering: concrete flat plate for low backscattering and gravel for high backscattering.



### Designing scheme





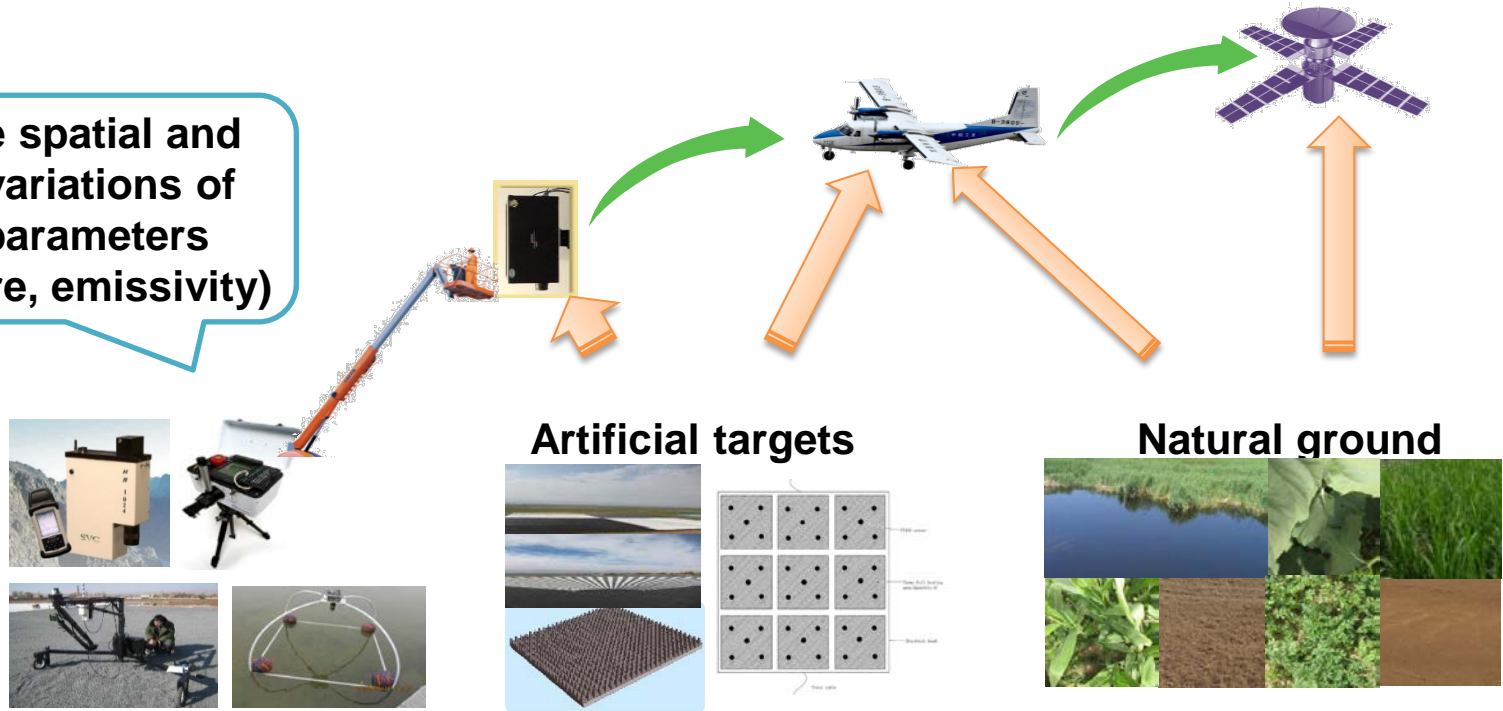
➤ **Bar-pattern target**





➤ **Stepwise Cal&Val system design for infrared sensors**

The severe spatial and temporal variations of surface parameters (temperature, emissivity)



- **Synchronous measurement:** reduce the temporal mismatching—Time discrepancy needs to be less than 10 minutes for thermal sensors
- **Large-area “truth” acquirement:** high efficiently acquire measurements in pixel size to decrease the scaling effects in Cal&Val



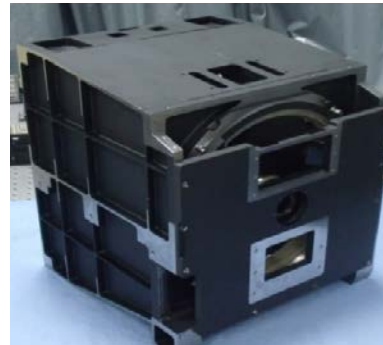
➤ Design of Standard hyperspectral imagers for Stepwise Cal&Val System

**Airborne  
hyperspectral  
imagers**



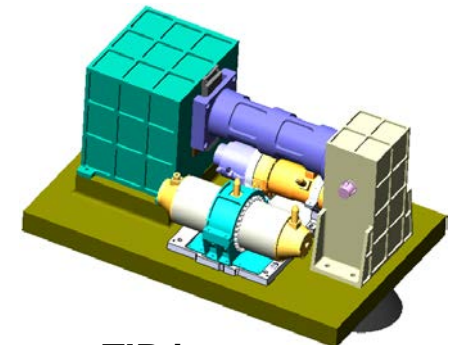
**VNIR imager**

Spectral range: 400-1050 nm  
Spectral resolution: 3.5 nm



**SWIR imager**

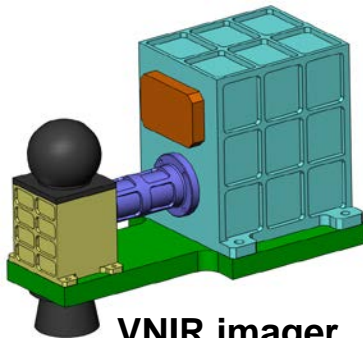
Spectral range: 1000-2500 nm  
Spectral resolution: 10 nm



**TIR imager**

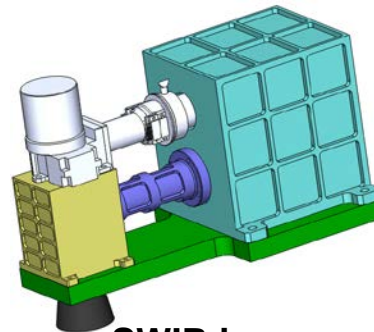
Spectral range: 8-12.5  $\mu\text{m}$   
Spectral resolution: 80 nm

**Ground  
hyperspectral  
imagers**



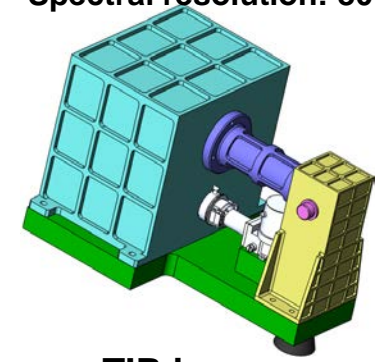
**VNIR imager**

Spectral range: 400-1050 nm  
Spectral resolution: 2 nm



**SWIR imager**

Spectral range: 1000-2500 nm  
Spectral resolution: 5 nm



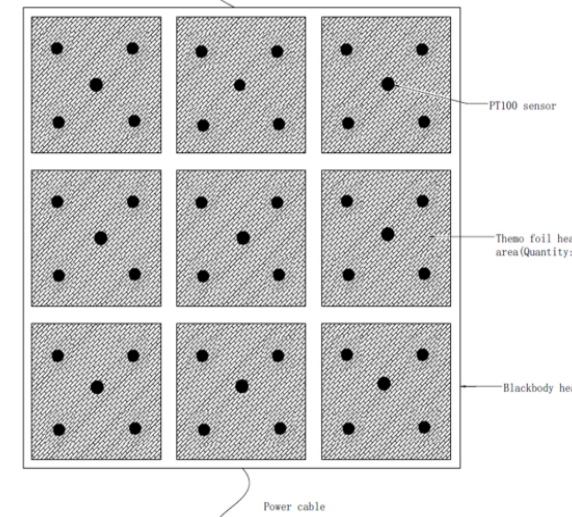
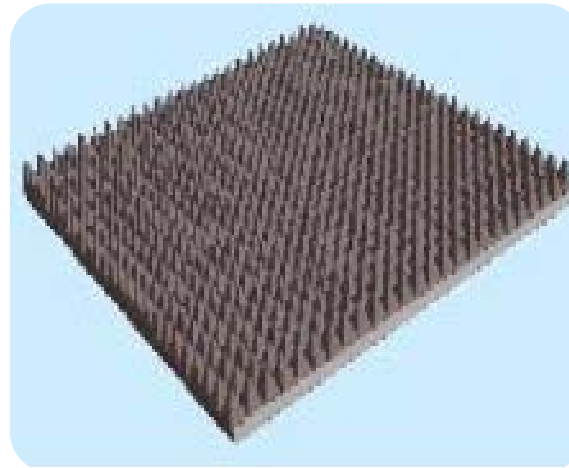
**TIR imager**

Spectral range: 8-12.5  $\mu\text{m}$   
Spectral resolution: 40 nm



### ➤ Self-developed artificial infrared targets and ground measurement instruments

- **High-emissivity target with automatic temperature controlling**, providing the same reference to transfer the benchmark.
- **Low-emissivity target** made of aluminum plate, used to obtain the atmospheric down-welling radiance.



- **Multi-angle automatic emissivity measurement system** with a self-developed rotating platform
- **Water-leaving radiance measurement system** to measure temperature of water body as low temperature target for Cal & Val



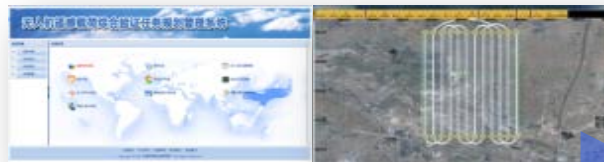
Automatic emissivity measurement system



Water-leaving radiance measurement system

Not only Cal&Val facility, but also a scientific research platform

## Aerial Data Acquisition



Campaign Planning and Management



Flying platform

High Accuracy Standard Sensors

## Artificial and Natural Targets



Great contribution to RS application  
Open platform for R&D

## Field & Meteorological Data Measurement



An omnidirectional and multi-angle automatic observing systems



SVC Spectroradiometer



Automatic sun tracking photometer, CE318



LAI-2000 Plant Canopy Analyzer

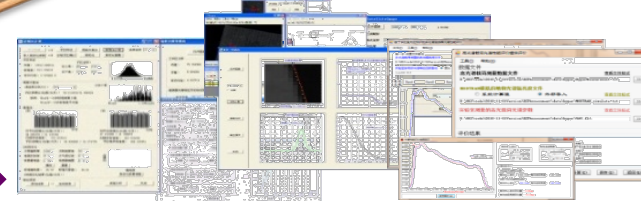


Dynamet Weather Station



Leica TCR1202 Total Station

## Calibration Performance Analysis and Product Validation



Data Processing and Analyzing System



Scientific Analysis Reports of Payload Performance



## Continue supporting on-going EO projects

- Intensity correlation imaging
- TANSAT—Global CO<sub>2</sub> observation and Monitoring
- ChinaGEOSS...

## Plan and launch new EO projects

- Spaceborne radiation benchmark system
- Low-cost and quick-response micro-satellite network
- ...

As the general department of NRSCC, continue to provide technical support in areas like the China GEOSS, which has great demand for product quality.

Based on the Key Laboratory, develop EO data quality assurance and advanced RS information retrieval and service technology.

Based on the Baotou site, establish open international research platform for Cal&Val:

- In Oct. 2014, carry out UAV flight experiment with SAR, visible-infrared multispectral payloads onboard, validating the performance assessment capability of Baotou site.
- Carry out performance analysis experiments for spaceborne sensors, including TerraSAR, Worldview/Geoeye, GF-1, ZY-02C,ZY-3.
- Install and test the target characteristic automatic measurement instruments in Baotou site.





Thank you for attention!