SpacePart12 - 4th International Conference on Particle and Fundamental Physics in Space

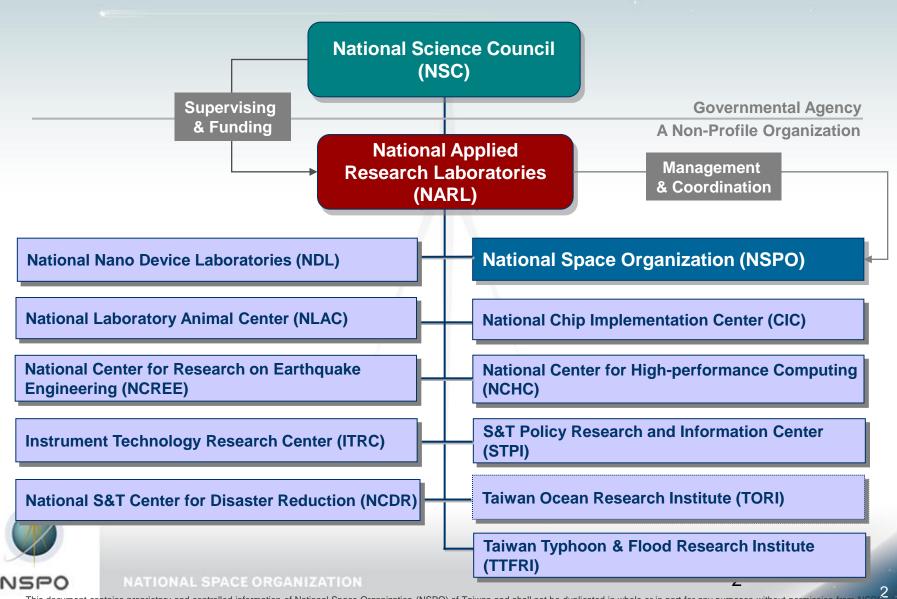


Space Programs in Taiwan

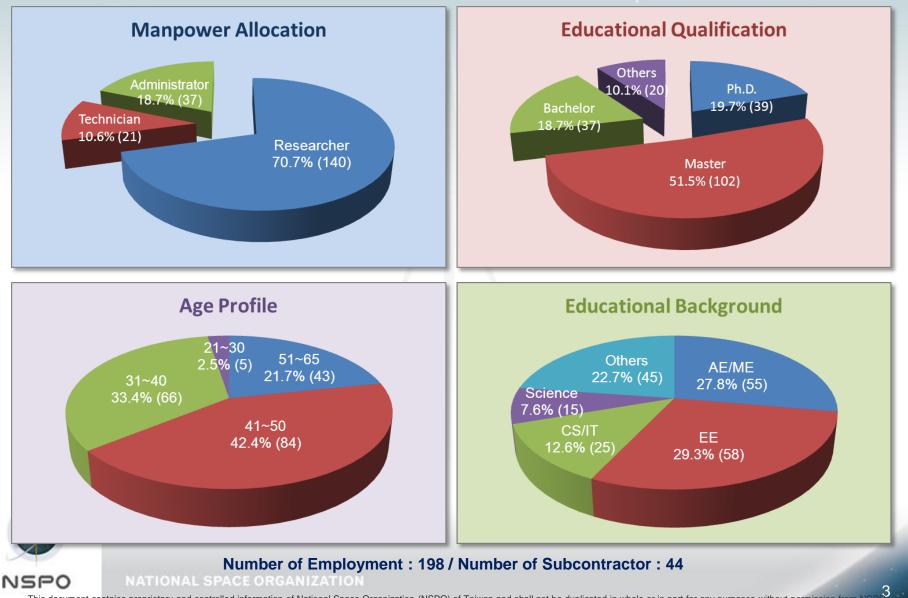
FORMOSAT 5 and FORMOSAT 7

Lou-Chuang Lee NSPO / Academia Sinica November 2012

Organization & Management

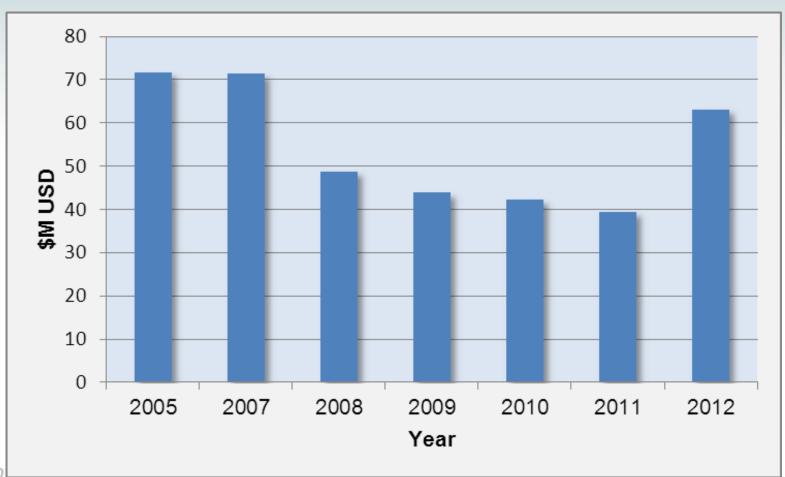


Human Resource



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Budget Profile





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Accomplishments



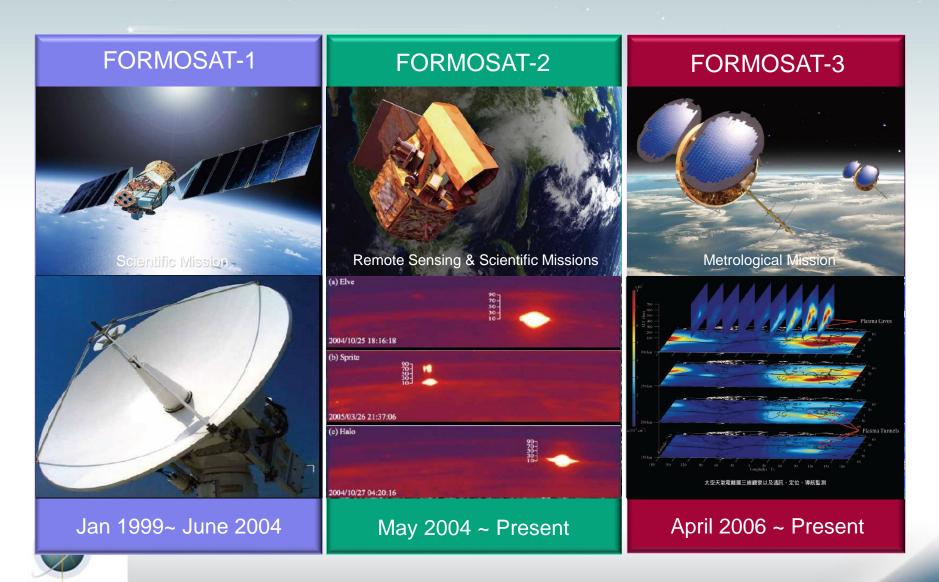
Deployment of 3 Satellite Programs

FORMOSAT-1

FORMOSAT-2

FORMOSAT-3

Mission Achievements



NATIONAL SPACE ORGANIZATION

NSPO

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Major Natural Disaster Supports

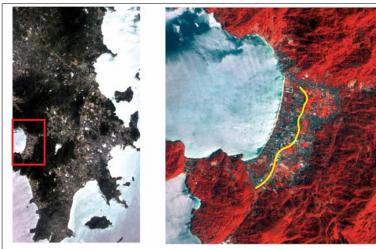
- FORMOSAT-2 has actively provided imagery to support the assessment of the major natural disasters occurred, including Southern Asia Tsunami (2004), Hurricane Katrina (2005), South California Wildfire (2007), Sichuan Earthquake (2008), Haiti Earthquake (2010), Chile Earthquake (2010), etc., since its operations.
- NSPO is one of members of Sentinel Asia and providing support to International Charter – Space and Major Disasters and UNOSAT.



Southern Asia Tsunami (2004.12.26)



Chile Earthquake (99.2.27)





Nature: Gigantic Jets

Nature (vol. 423, 26 June 2003) published an article on "Gigantic Jets", a new class of transient luminous events (TLEs), observed by the ROCSAT 2 Science Team from ground.

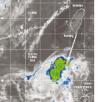
Nature also published a "*News and Views*" article, which provides an historical perspective on our Nature paper.

"Powerful electric currents have been detected in discharges between thunderclouds and the upper atmosphere. Carried by gigantic jets, they are a new factor in the model of the Earth's electrical and chemical environment."

tters to nature

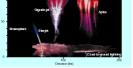
Gigantic Jets between a thundercloud and the ionosphere

igantic jets between a thu



FOT (sel. 8, POTI is related issued) income mattern lists that an index standard income it. DNN recellances and DNN regression of the standard standard standard standard standard standard incomes and with the index standard standard ery, FOTI is protocol at the tips of charmon ery, FOTI is protocol at the tips of charmon endexed when the langeh of the C-rela- ting of the standard standard standard standard is standard at the standard standard standard standard standard standard standard is standard in the standard is a compared with the standard standard standard standard standard is standard in the standard standard is a field for the standard standar	Mouroids, TEF2, Mar TEF1, Irinde duples ultarente ICNA and atradick constraints are to fastback in advanced to a second second with POT1 gof 1). This implies that TEF5 much best afflowed protocol to the second insignation the downserverse services. The second second second second second second insignation to downserverse services are service and seco
meres: the extreme terminus, and along the	
duplexregion. What happens if PCITI loses its ability to interact with one of these two sites? Losges and de Large tested this by errorsing the DNA-binding portion of the prosing.	Hintspheric pitolos Electric jets Victor P. Pasko
creating a derivative called POTI (AOB). This derivative stillasso chated with the TRF1 com- plex, and hence with duplex telemente DNA. But it could not internat with the single- stranded islaments ends, and this resulted in	Powerful electric currents have been thunderclouds and the upper atmosp a new factor in the model of the Earth
a profound disruption of idension length, with bidensess bacarning patidy and oxin- abely decigated. These observations adults from PGTL, Mor TRE, to a negative explaint of televiness length. More significantly, bacane PGTL can internet with both the side of belowerses action and the object portion.	As familier cloud-to-ground lightning a clock of the second second second second second above the clouds is also an important factor in what is known as the global circuit of atmospheric electricity. Reduct strong hereics are natural electromagnetic emissions from
of the chremosome, it muld be the making linkin the hiermose-report countingmodel. Longon and de Lange therefore propose that information about solonness longht, which is massaued by TRF1 through the addi- ty to bind haplest denomic reports, is trans- ferred to the tip of the tolenness through the interaction between PCT1 and TRF1. This	lightning discharges and can propagate through the kinetic strength the 'waveguide' formed by the Earth's surface and the ionized region of the upper atmos- phene, howen use the transplores. In 1925 the physicht C. T. R. Wilson wrote': "The discharges above the cloud vecidid durith los give rate to atmospherics. II, all nos how
Interaction penamulally affects the amount of POTI that is loaded onto single-strand overhangs the more islomeric repeats there are, the more POTI is transferred to the telement tip, and the generic is the reduction in telemente activity (Fig. 1). The next	matriatined, atmospherics frequently or granterin regions of ratio unaccompanied by thandler, they may its such cases be due to chackages of this nature." Wilson was right: on page 924 of thi outer, Saman colleagues mport their obser-
question to how PCITI relays information to tokornerase. It might act as a negative regulator by directly binding to the enzyme complex and inhibiting its catalytic activity. Alternatively, through its DNA-binding within DCITI methods in DNA-binding	vations of several large-scale discharges beambing upwords to an altitude of about 50 km from the top of thursdericlash in the South China-Sea, no associated lightning theSharges were detected in the underlying
activity; POT1 might sequenter telement: DNA and thereby block access of telementer to tossibiritie. The picture is also far from complete in other respects. For instance, POT1 might not function solely as a regulator:	thurdentorm. Builto atmospherics recorder at remote locations in Japan and Antantics, however, shaved that there was a significant flow of current that moved several tense of coulombs of negative charge upwards from the thursdorcloud to the lower timorphese.
Colginet al. ² propose that it also positively controls informance-mediated televiser elongation. The tokenthat approtectivities birds single-stranded televiser. DNA can serve as both a positive and a regaritive regulator	Although syscettrase reports of events such as these — known as 'transient kumi- rous events', or TLB — have been recorded for more than a century, the first trage of one was captured' only in 1589, serendipi-
of telomere length has also been established	tously during a test of a low-light television

in studies of the yant Cdc12 protein^{3,11}.



ISUAL's Science

Los Angeles Times

June 25, 2003

These things are so spectacular, and so startling, and we're just finding it this late in the game.

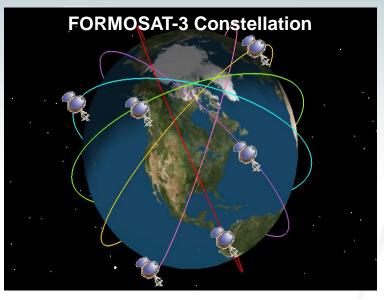
It's sort of like biologists announcing we've discovered a new human body part.



lonosphere



FORMOSAT-3 Program



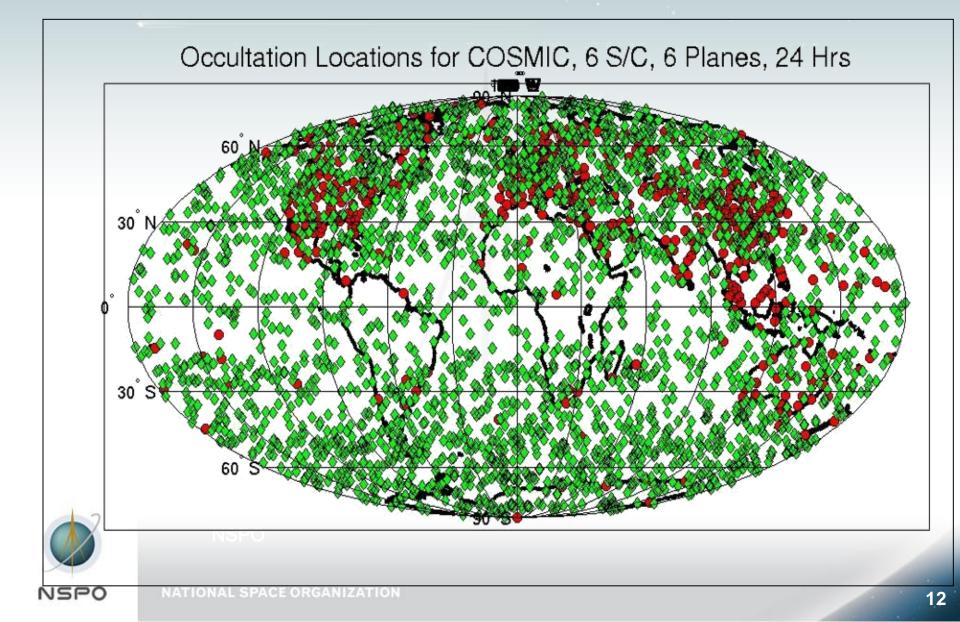


An international cooperation program between NSPO and UCAR (University Corporation for Atmospheric Research), USA

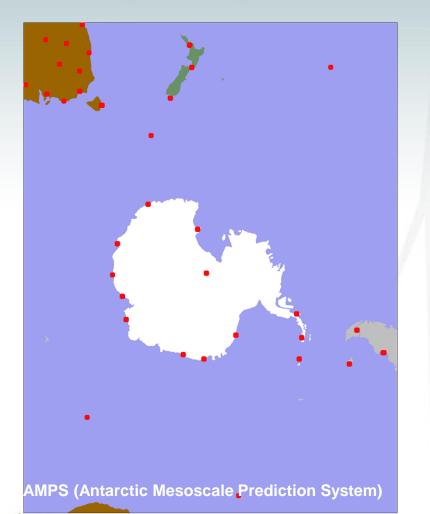
- The FORMOSAT-3/COSMIC system is a constellation of 6 low-earthorbit (LEO) micro-satellites
- Each micro-satellite is cylindrical with weight 70 Kg , diameter 116 cm, height 18 cm
- Satellite parking orbit is approximate 500Km with 72-degree inclination.
- The individual micro-satellite will perform orbital raising maneuvers to get into 6 separate orbital planes nominally phased 24° apart in ascending node. The mission orbit is 700-800 km circular.
- Mission life: 2 years (design life: 5 years)
- Launch Date: April 15, 2006

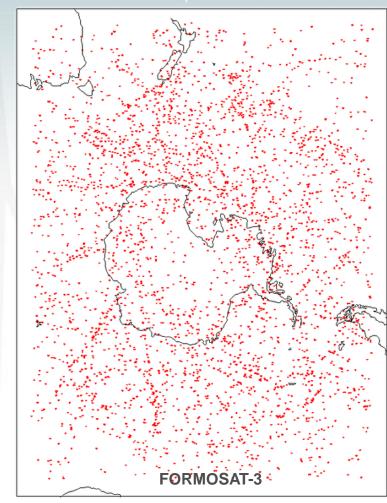
NSPO

GPS Radio Occultation Technology



Weather Data Comparison at Antarctica



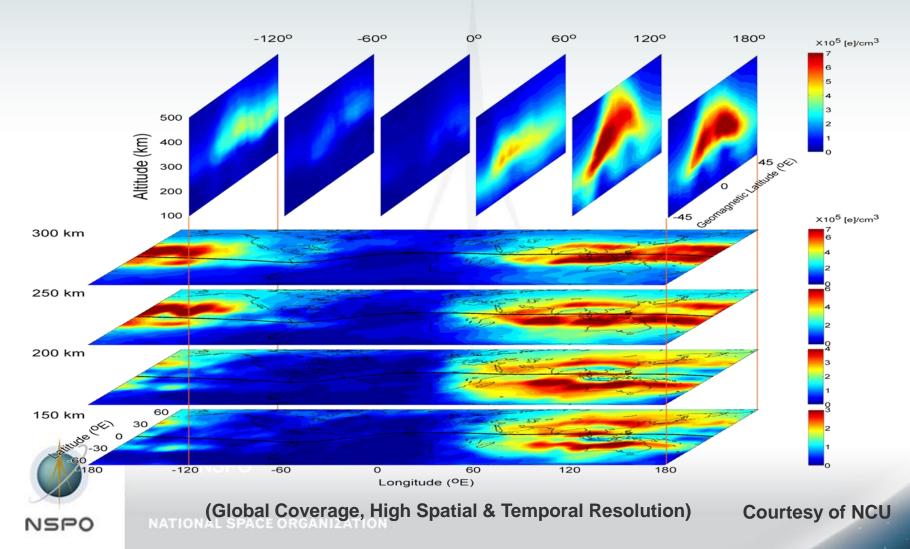




FORMOSAT-3 / COSMIC RO data distribution over 11 days (Right) in comparison with the available data collected from the limited Weather Stations (Left) near Antarctic region daily.

3D Ionospheric Structure

Plasma Cave



FORMOSAT-3 Mission Highlighted by Nature

nature

news

nature 17 May 2001

Array system promises global atmospheric monitoring

David Cyranoski, Tokyo

A Taiwan-US collaboration is hoping that is constellation of microstellites equipped with Global Positioning System (GPS) receivers will provide a valuable new approach to meteorology, climatology and research into space weather.

Most wrather forecasting currently refs on balloons that take readings such as temperature auth humonity ortraff was up from some 900 locales worldwide. But these points are restricted to land, ruling out truly global weather models. Weather satellites give wider coverage, but they gather data by looking stralght down to Earth, yielding little informationabout what is happening at various different altitudes.

But the Taiwan-led Constellation Observing System for Meteorology, lotosphere and Climate (COSMIC) could change that by using an array of microsatellites and a novel technique to improve the coverage and accuracy of data collection.

The six COSMIC microsatelities, scheduled to be launched in mid-2005, will pick up radio signals from 28 existing GPS satellites as they pass through the Earth satmosphere. The microsatellites will observe the refraction (or bending) of the signals, and infer information about atmospheric density from it, atallalitudes. From the density data, researchers will be able to deduce the pattern of pressure and temperature.

"We can also calculate atmospheric moisture near the surface, construct pressure contours, and derive wind fields and other critical quantities," says Tom Yunek of NASAs Jet Propulsion Lab (JPL), which did mucht of the early work on the technique.

The most important advantage

coverage. "The microsatellite constellation will measure some 4.000 points spread uniformly around the globe, with high accuracy, says Chao-Han Liu, president of Taiwans informatic certral University.

Researchers on space weather are also excited about the project, says Ltu. In the

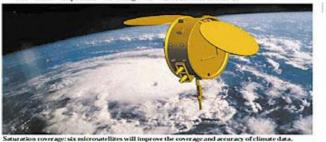
ionosphere, at attitudes of about 80 km, electron density can be mesoured in a similar fashion to the atmospheric density. This will provide valuable information for predicting magnetic storms, which can affect the operations of satellites and powergrids.

The COSMIC system has the potential to significantly improve climatological measurements, says Alari Thomas, director of the Global Climate Observing System secretariat. However, he warms that it will probably take time to develop a reliable system that produces measurements for climate-change applications, and another 20 years or so after that to obtain a meaningful long-term climate data set.

The agreement to build the system, signed on 3 May, involves Talwans National Space Program Office (NSPO), JPL ube US University Corporation for Atmospheric Research in Boulder, Colorado, and several US universities.

Taiwan will pay USS80 million of the estimated USS100 million total project cost and will build the satellites with the help of Orbital Sciences Corporation of Dulles, Virginia, which made a prototype version of the satellite in 1995 foc a proof-of-concept experiment. Talwan will also operate the mission.

"This is a chance to get people really interested in space science," enthuses Luo-Chang Lee, director of NSPO.

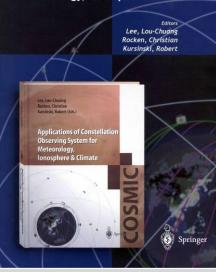


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NSPO

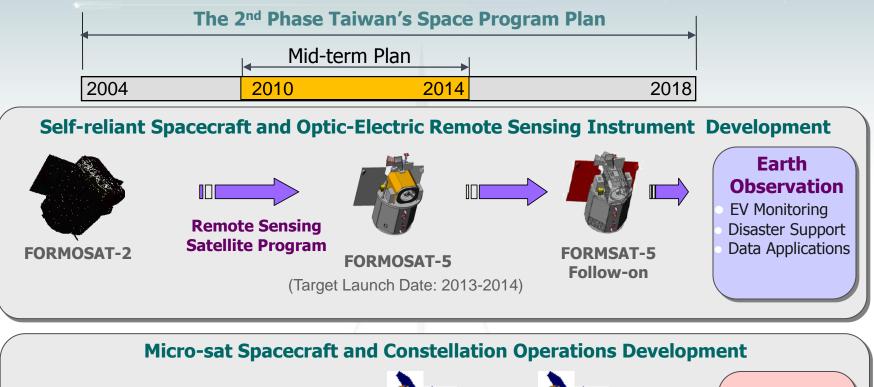
The COSMIC micro-satellites equipped with GPS receivers will provide a valuable new approach to meteorology, climatology and research into space weather. The new system has the potential to significantly improve climatological measurements.

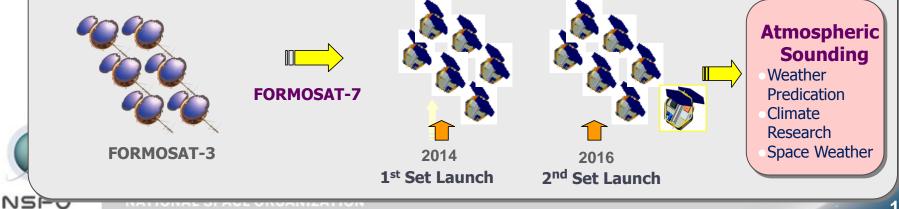
Applications of Constellation Observing System for Meteorology, Ionosphere & Climate



 A special monograph published by NSPO and UCAR on the GPS radio sounding of earth atmosphere and ionosphere.

NSPO's Mid-term Plan (2010~2014)





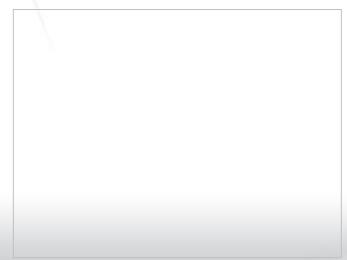
FORMOSAT-5 Program

Missions:

- To build up Taiwan's self-reliant space technology on the remote sensing payload and spacecraft bus
- To develop the key components of the EO-type remote sensing instrument and spacecraft bus by integrating the domestic resources
- To continue to serve the global imagery users' community of FORMOSAT-2
- □ To promote the space science experiment & research

Launch: 2013~2014







Program Schedule







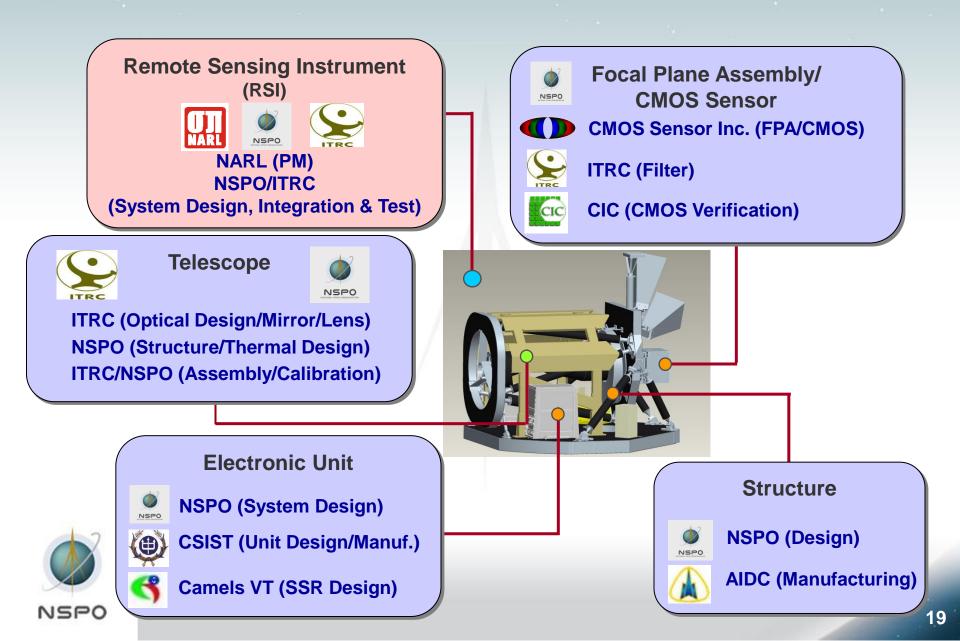
NSPO is responsible for spacecraft design and key components development



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The RSI Domestic Team



Taiwan Made Components

CMDU



LEON 3 Heritage (CGS)

- **Ground Command Processing and Distribution**
- Satellite House-Keeping Data Acquisition
- Satellite House-keeping and Science Data Storage
- Support On-board Failure Detection, Isolation, and Recovery Mechanism
- Support Electrical Power Control
- Support Attitude and Orbit Control
- Support Thermal Control
- Support Payload Operation

PCDU

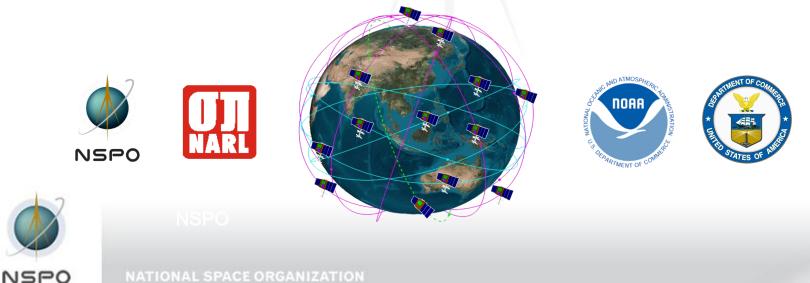


NSPO

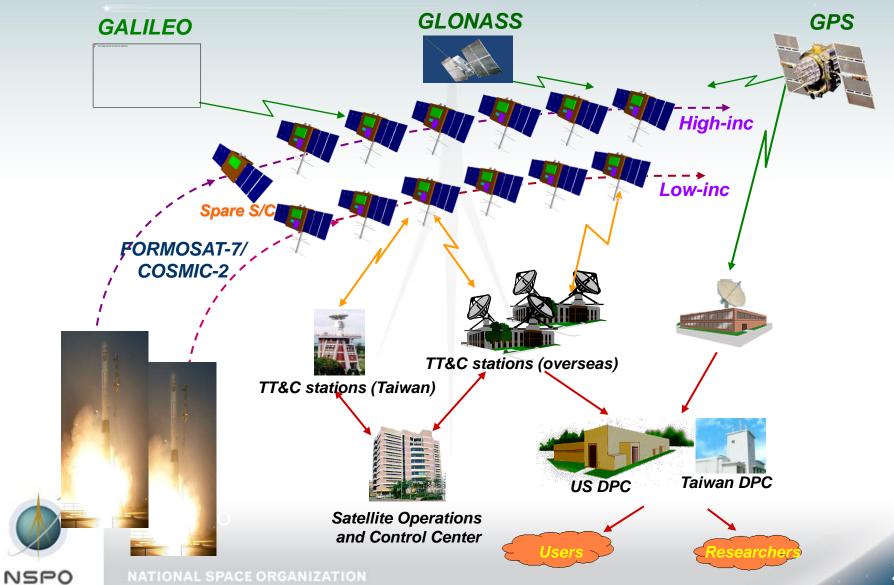
- Provide Primary Power Outlet and Control for Spacecraft and Payload Instruments
- Provide Secondary Power Outlet and Control
- Provide Spacecraft Heater Power and Control
- Provide Ordnance Power and Control
- Provide Power Fault Protection
- Provide Battery Power Regulation
- Receive CDMU Command for Power Control
- Power-related House-Keeping Data Acquisition

FORMOSAT-7/COSMIC-2 Program

- FORMOSAT-7/COSMIC-2 is a joint NOAA/NSPO program to deploy an operational constellation system of 12 microsatellites to perform GPSRO atmospheric and ionospheric soundings for weather forecasting and space weather monitoring.
- This will be a follow-on mission of FORMOSAT-3/COSMIC, co-developed by UCAR (US) and NSPO (Taiwan), which will begin to degrade in 2011 (end of life) and data gap is expected due to loss of satellites in next 3~4 years.



System Architecture

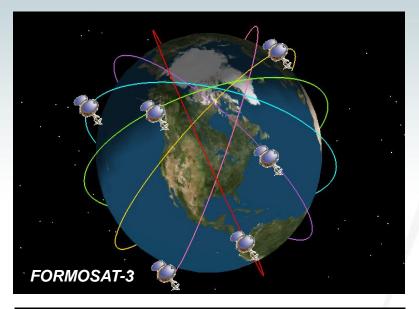


Mission Baseline

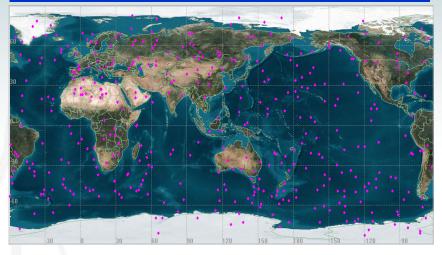
FORMOSAT-7	First Launch	Second Launch
Mission Constellation	6 satellites (inclination ~24 deg, mission altitude ~ 520 km)	6 (or 7) satellites (inclination ~72 deg, mission altitude ~ 800 km)
Mission Payload	Tri-G	Tri-G
Science Payload	 2 Band Beacon Plasma Drift/Fluctuation Sensor (Together around 10kg, 22W) 	Taiwan furnished payload
Launcher	Minotaur IV carrying 6 satellites	Minotaur IV carrying 7 satellites (including 1 spare satellite)
Launch Schedule	2014 Q3	2016 Q3
Communication Architecture Via ground station Mission Duration/ Spacecraft Life 7 years / 5 years SPO NATIONAL SPACE ORGANIZATION		

NS

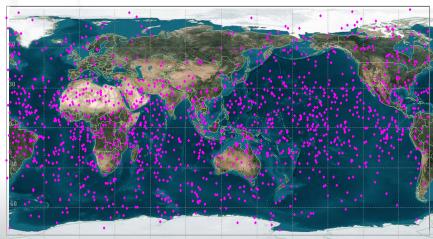
Geographic Coverage Comparison



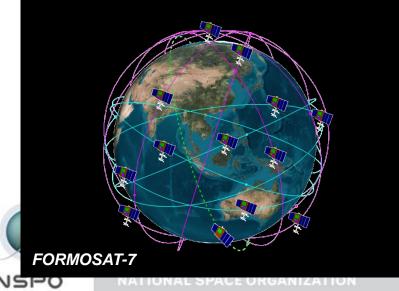








30 0 30 50 90 120 150 180 150 120 90



Participating in AMS-02 Mission

- NSPO has jointed the Alpha Magnetic Spectrometer (AMS) project, coordinated by Nobel Laureate Dr. Samuel C. C. Ting, with a responsibility for conducting thermal analyses and tests of electronics crates.
- AMS-2 has been installed on the International Space Station (ISS).



AMS-02





National Space Organization

A center of innovation and excellence for space technology in Taiwan

Thank You