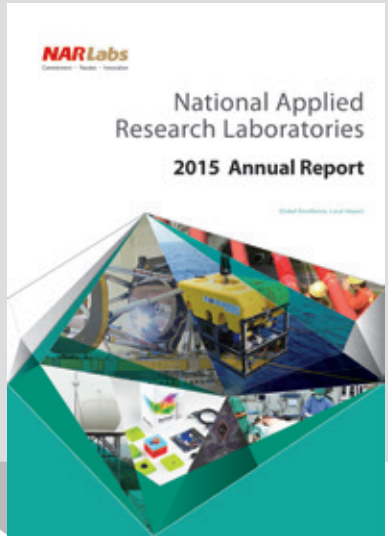
NARLabs

Commitment · Passion · Innovation

National Applied Research Laboratories

2015 Annual Report

Global Excellence, Local Impact



History

2003 NARLabs established

Six labs were founding members of NARLabs

National Chip Implementation Center (CIC)

National Center for High-performance Computing (NCHC)

National Center for Research on Earthquake Engineering (NCREE)

National Nano Device Laboratories (NDL)

National Laboratory Animal Center (NLAC)

National Space Organization (NSPO)

2005

Two more labs joined NARLabs

Instrument Technology Research Center (ITRC)

Science & Technology Policy Research and Information Center (STPI)

2008

TORI established

Taiwan Ocean Research Institute (TORI)

2011

TTFRI established

Taiwan Typhoon and Flood Research Institute (TTFRI)

Contents

Message from the Chairperson

At NARLabs, our vision is the pursuit of global excellence and the creation of local impact. We are dedicated to the development of exceptional research platforms. Over these years, NARLabs has developed innovative applications in the areas of earth and environment, information and communication technology, biomedical technology, and policy research; these results have received public acclaim. We assist domestic industries, government agencies, academic institutions, and other research facilities by integrating the core technologies and facilities of our ten research centers and act as a major force to drive future technological advances in Taiwan.

NARLabs had a fruitful year in 2015. We continued to promote the FORMOSAT-5 and FORMOSAT-7 programs as well as plans to rebuild Taiwan's oceanic research capabilities. In addition, we broke ground on the NCREE's second facility, which will advance near-fault seismic research and modeling, and establish Taiwan as a world-class center for earthquake engineering research. Simultaneously, we prepared to move NLAC to the National Biotechnology Research Park. Pursuant to government policies, we constructed a one-stop service platform for biomedical research in Zhubei City that will establish Hsinchu Biomedical Science Park as a world-class center for innovative medical supplies and products. Following the trend in developing big data, we constructed a petabyte computing platform. We also promoted the governmental plans to integrate industry, education, and research capabilities in developing the next-generation 5G wireless communication technology and a real-time disaster prevention warning system, hoping to help economic development and improve public well-being. Lastly, in cooperation with the Executive Yuan's Productivity 4.0 Plan, we promoted industrial applications of innovative research results in the areas of intelligent machinery and sensors.

Looking to the future, we expect to improve Taiwan's R&D innovativeness and global competitiveness through the efforts of all of our colleagues. By doing so, we hope to provide greater contributions to society and the development of our economy and industries and to create new innovations.

Chairperson
Jyuo-Min Shyu

Message from the President

The warmer weather and signs of spring bring to mind how grateful I am for everyone's continued support and the continued growth of NARLabs' reputation, which is the result of the hard work of all our colleagues.

In 2015, in coordination with the Ministry of Science and Technology's (MOST) efforts to promote advances in domestic technology, I led our staffs to actively enhance technological innovations and cooperation between industry, academia, and research institutions. Some key outcomes include completing the in-house developed remote sensing instrument and advanced ionospheric probe of FORMOSAT-5, the early earthquake warning system service platform, the Taiwan Ocean Radar Observing System, the radar data assimilation technology, the early warning system for bridge collapses, the Braavos big data analysis platform, the self-powered Internet of Things chip and the cloud-based electronic nose, the chips beyond 5-nanometer generation, the automated chip defect inspection system, the breeding of advanced severe immunodeficiency mice, the opening of NLAC's Tainan Facility, and the analysis of domestic technological competitiveness. We provided services to 17,479 users and the platform's services even reach 77,517 cases. Also, we received both domestic and international acclaim and awards, including The Executive Yuan Award for Outstanding Science and Technology Contribution, The MOST Award for Excellent Contributions in Technology Transfer, The Technology Management Award of The Chinese Society for Management of Technology, an R&D 100 Award, etc. In conjunction with MOST, we established an IoT sensor service platform. In addition, we cooperated with various private corporations to set up joint labs, in atomic layer deposition field and earthquake disaster services. We also built the big data platforms to develop an IoT and the Productivity 4.0 Plan to increase Taiwan's competitiveness.

In the coming year, NCREE's second facility and NLAC's facility in the National Biotechnology Research Park will be completed soon. TORI's new marine research vessels are underway. The first satellite produced domestically, FORMOSAT-5, will be launched. Looking further into the future, we expect all of our colleagues to contribute their efforts to the combined strength of NARLabs, allowing us to provide greater contributions to the prosperity and advancement of Taiwan society.

President
Ching-Hua Lo

Organization

Board of Directors & Supervisors

Chairperson	Jyuo-Min Shyu
Managing Director	Guan-Chung Chang, Chung-Liang Chien, Jing-Yang Jou, Yu Wang
Director	Mau-Chung Frank Chang, Bon-Chu Chung, J. Raynien Kwo, Chih-Yuan Lu Kuo-Fong Ma, Huey-Jen Su, Hung-Duen Yang
Executive Supervisor	Wen-Ji Hwang
Supervisor	Der-Tsai Lee, Chein Tai

President Office

President	Ching-Hua Lo
Vice President	Jough-Tai Wang, Tzi-Dar Chiueh
Secretary General	Wen-Yen Chang
Chief Operating Officer	Peter J. Sher

Headquarters

	Director General
Human Resources Office	Chin-Ling Lin
Administration Office	Chien-Chih Hsu (acting)
Planning & Evaluation Office	Ching-Ping Lu
Finance & Accounting Office	Tai-Ling Lian
Business Development Office	Ching-Yin Wang
Auditing Office	Nan-Hung Ting

Laboratories

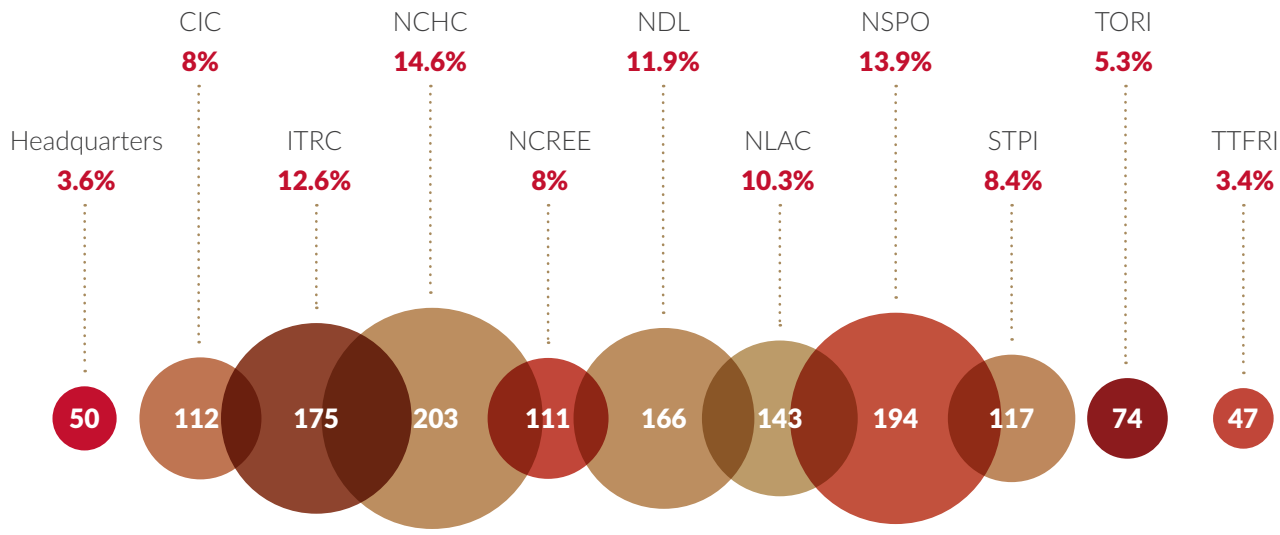
	Director General
National Chip Implementation Center (CIC)	Liang-Hung Lu
Instrument Technology Research Center (ITRC)	J. Andrew Yeh
National Center for High-performance Computing (NCHC)	Ce-Kuen Shieh
National Center for Research on Earthquake Engineering (NCREE)	Kuo-Chun Chang
National Nano Device Laboratories (NDL)	Wen-Kuan Yeh
National Laboratory Animal Center (NLAC)	Chun-Keung Yu
National Space Organization (NSPO)	Guey-Shin Chang
Science & Technology Policy Research and Information Center (STPI)	Yuh-Jzer Joung
Taiwan Ocean Research Institute (TORI)	Hui-Ling Lin
Taiwan Typhoon and Flood Research Institute (TTFRI)	Cheng-Shang Lee

(Organization structure as of May 2016)

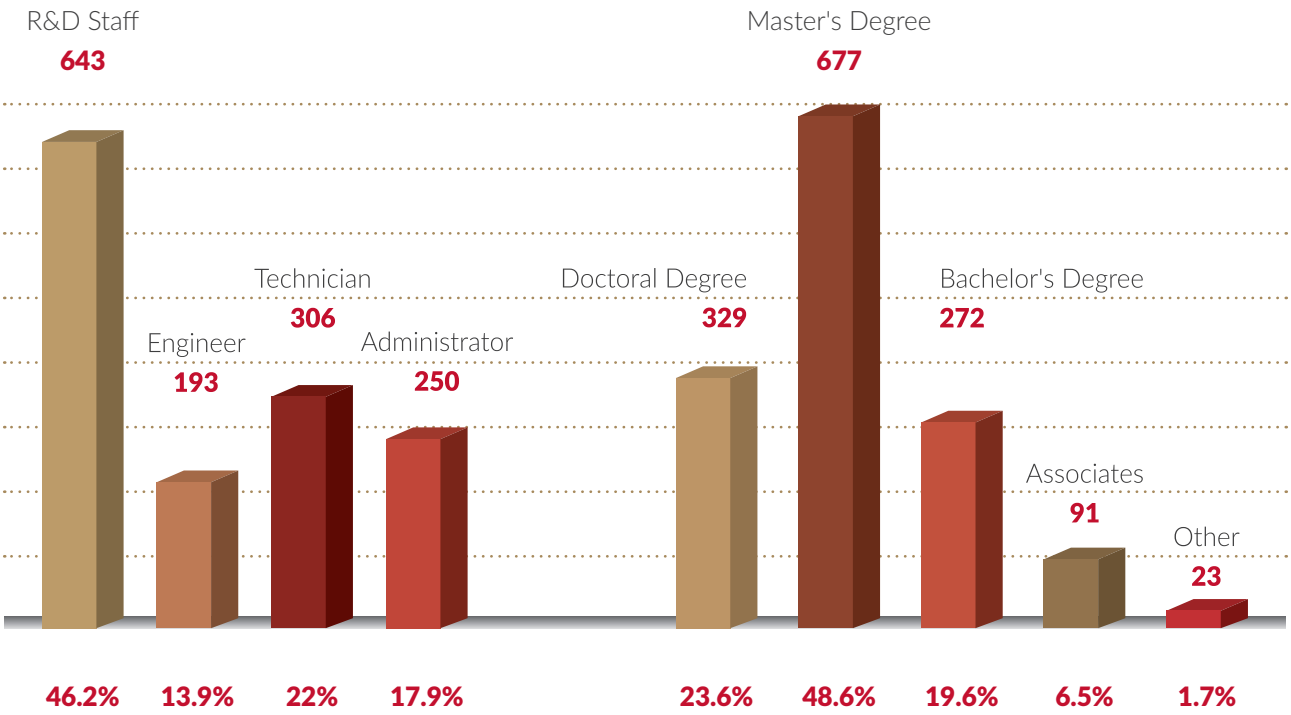
Human Resources

Number of Employees **1,392**

Number of Employees in Laboratories

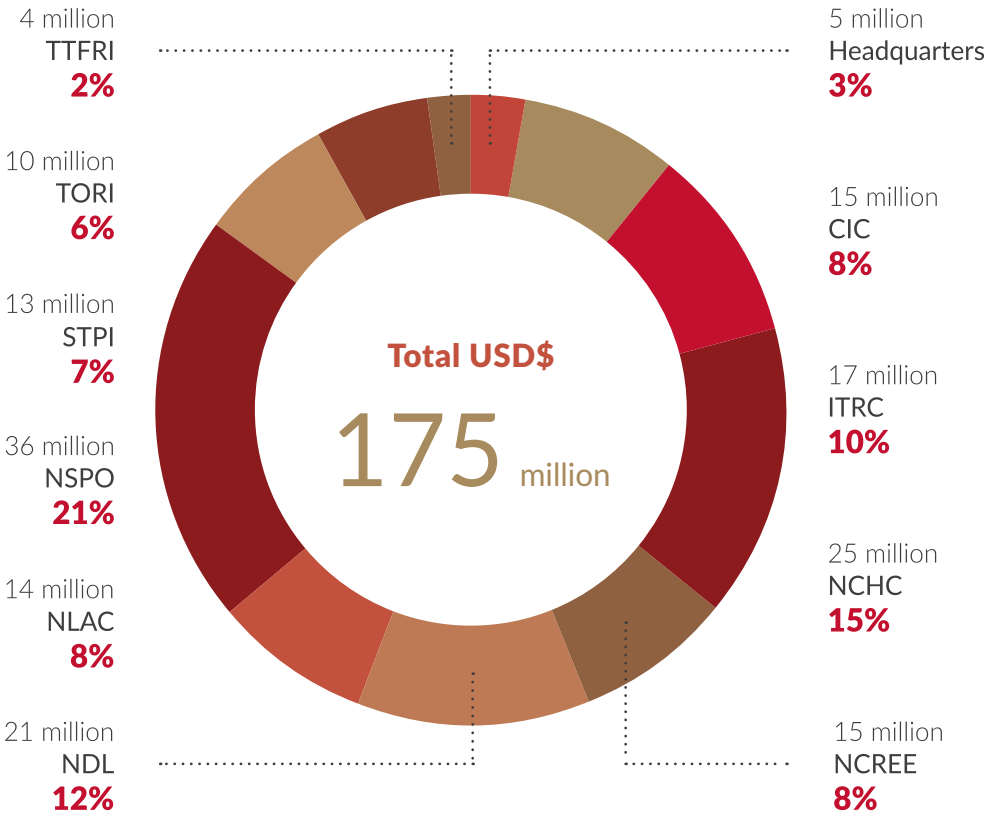


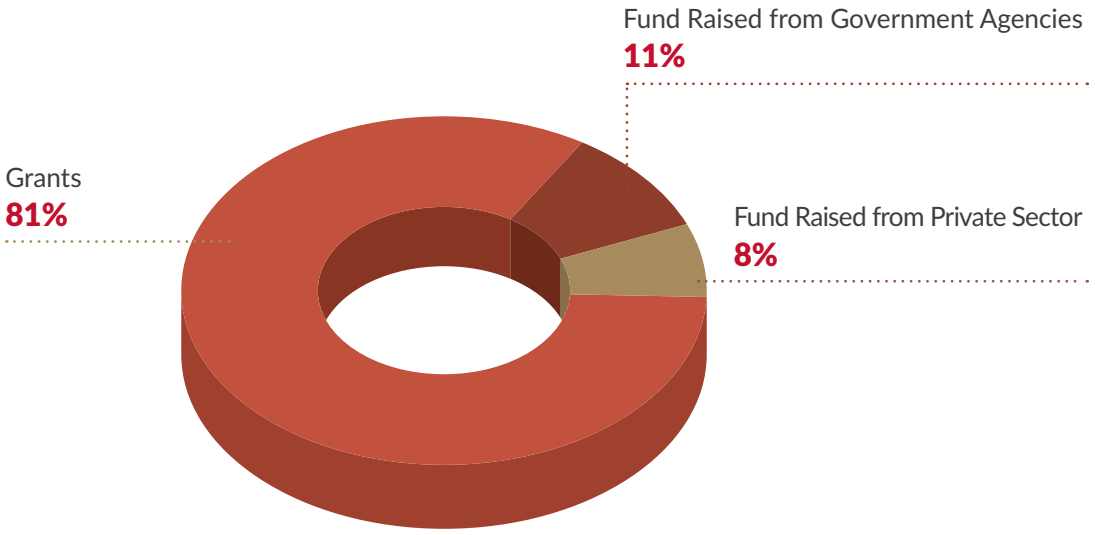
Human Resources Profile



Education Level

Financial Information





Revenue (FY 2015)

Location

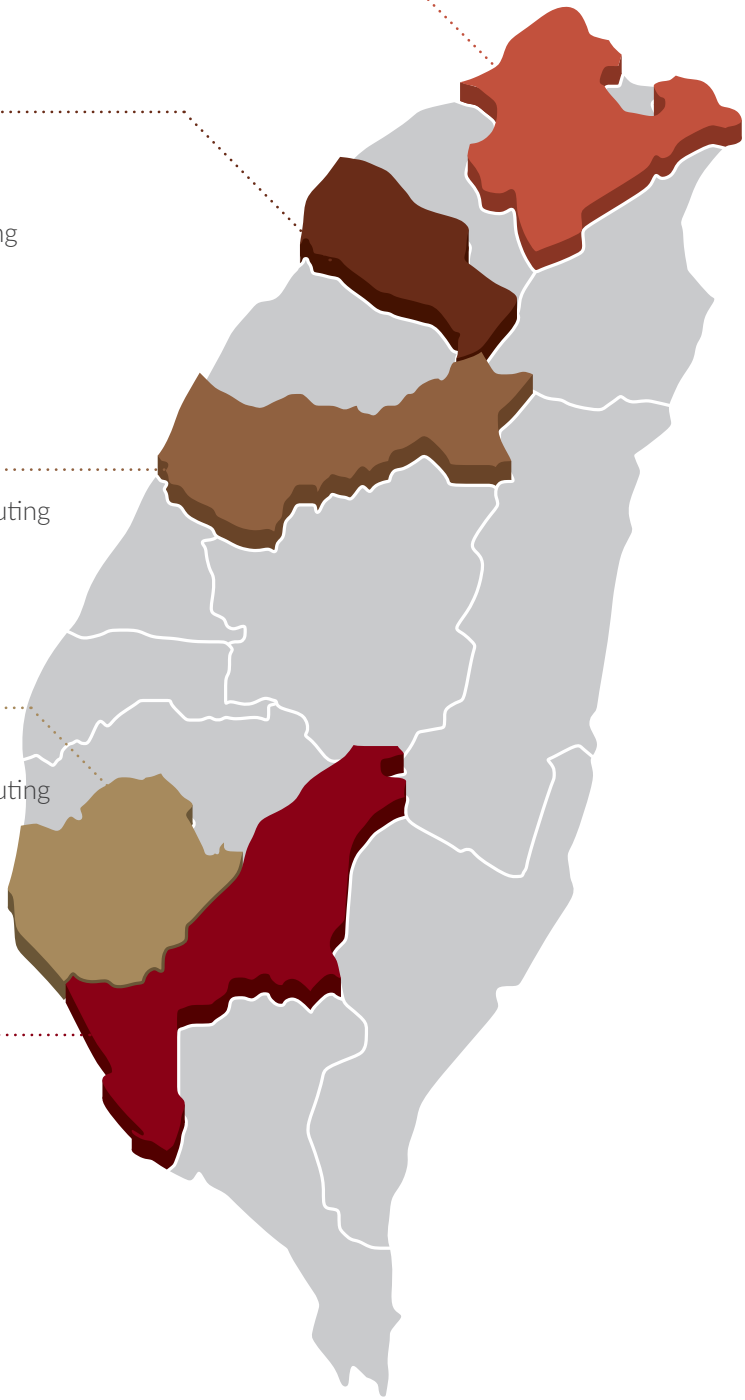
Taipei
NARLabs Headquarters
National Center for Research on Earthquake Engineering
National Laboratory Animal Center
Science & Technology Policy Research and Information Center
＊ Taiwan Typhoon and Flood Research Institute

Hsinchu
National Chip Implementation Center
Instrument Technology Research Center
National Center for High-performance Computing
National Nano Device Laboratories
National Space Organization

Taichung
＊ National Center for High-performance Computing
Taiwan Typhoon and Flood Research Institute

Tainan
＊ National Chip Implementation Center
＊ National Center for High-performance Computing
＊ National Nano Device Laboratories
＊ National Laboratory Animal Center

Kaohsiung
Taiwan Ocean Research Institute



＊ Branch Office

2015 Event Highlights

JAN FEB MAR APR MAY

1/6
Groundbreaking ceremony for NCREE's Southern Laboratory

1/14
NARLabs signed MOU with Soochow University

1/16
Groundbreaking ceremony for NLAC's Building G in National Biotechnology Research Park

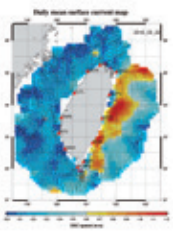
1/29
NLAC singed MOU with Medical Device Innovation Center of National Cheng Kung University

1/30
NARLabs signed MOU with Agricultural Technology Research Institute

1/31
CIC's paper titled "Design and Characterization of the Piezoresistive Pressure Sensor Fabricated in a CMOS MEMS Process" won the 2015 SEMBA's Best Paper Award

3/4
Opening ceremony for Atomic Layer Deposition Joint Research Laboratory of ITRC and Taiwan Semiconductor Manufacturing Company

3/10
TORI completed the Taiwan Ocean Radar Observing System (TOROS) for surface current mapping



3/17
NDL announced "Self-Powered Technology for Internet of Things Chips" as key technologies and innovative applications of next generation nano devices

3/24
CIC announced the world's first "Multi-sensing Single-chip Technology"

3/26
- CIC's paper titled "Multi layer system chip module architectures" won the 2014 National Invention and Creation Award

- NCREE's invention titled "Buckling Restrained Brace" won the 2014 National Invention and Creation Award silver medal

3/31
ITRC hosted the Semiconductor Process Equipment's Key Component Exhibition and Business Alliance Investment Seminar

4/2
Opening ceremony for the 1st round of 2015 From IP to IPO (FITI) Program

4/15
Prof. Jough-Tai Wang was appointed as Vice President of NARLabs

4/21
Opening ceremony for NLAC's Laboratory Animal Care and Surgery Facility in Tainan Science Park

5/1
Prof. Tzi-Dar Chiueh was appointed as Vice President of NARLabs

5/12
NSPO completed in-house development of FORMOSAT-5's optical remote sensing instrument

5/27
NARLabs signed MOU with National Taiwan College of Performing Arts

JUN

6/1-17
TTFRI cooperated with government and academic organizations conducting the Southwesterlies Joint Observation Experiment

6/4
NARLabs signed MOU with Japan Agency for Marine-Earth Science and Technology

6/5
NCREE's papers won the 2015 Tien-You Zhan Paper Award and 2015 Annual Engineering Paper Award from the Chinese Institute of Engineers

6/15
NARLabs cooperated with Ministry of Science and Technology to promote the Internet of Things Sensor Service Platform

6/23
NCHC signed MOU with The New Taipei City Education Department

7/5
Awards ceremony for the 1st round of 2015 From IP to IPO (FITI) Program

JUL

7/14
NCREE announced "Rolling-Type Seismic Isolation Device" as the best anti-seismic solution for people's property

7/24
NARLabs hosted Medical Instrument Value Creation Alliance Technology Presentation and Bio x ICT Forum with National Chiao Tung University Bio ICT Alliance at the 2015 Bio Taiwan Exhibition

7/28
• Official opening for NARLabs History Gallery

• NARLabs signed MOU with Central Weather Bureau

• STPI announced The Policy Research Indicators Database (PRIDE)

7/30
ITRC hosted the 7th *i*-ONE International Instrument Technology Innovation Competition

AUG

8/1
STPI hosted X Fail Conference to encourage the young entrepreneurs achieving success

8/4
NARLabs signed MOU with National Research Council of Science & Technology of Korea

8/15
NCHC lauched Taiwan's first public data analysis platform, the Braavos, for trial operation to academic and research communities

8/17
• STPI hosted 2015 1st SPARK International Conference to share how to translate biomedical research outputs into industrial applications

• TTFRI launched the Data Bank for Atmospheric & Hydrologic Research

8/28
Opening ceremony for the 2nd round of 2015 From IP to IPO (FITI) Program

2015 Event Highlights

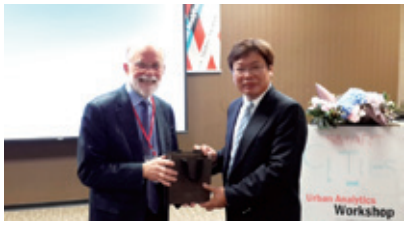
SEP

9/4
NARLabs signed MOU with Taiwan Academy of Banking and Finance

9/6
NDL hosted SemiconNano 2015, with approximately 100 scholars and experts worldwide participating to discuss the latest trends of nano technology

9/10
STPI signed MOU with University of California, Berkeley to cooperate on training program of STB Project

9/15
NARLabs hosted 2015 Smart Cities and Urban Analytics Workshop with Argonne National Laboratory to address issues related to smart city and Internet of Things



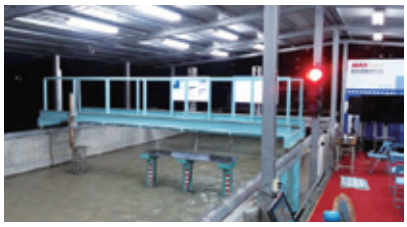
9/22
ITRC announced the Chip Defect Inspection System, a joint research with Gallant Micromachining Co., Ltd. and EPISTAR Corporation respectively

OCT

10/2
• NCREE's "Dual-core Self-centering Energy Dissipation Brace Apparatus" won the 2015 Taipei Int'l Invention Show and Technomart platinum award

• NCHC's "Method for Measuring Cracks Remotely and Device Thereof" won the 2015 Taipei Int'l Invention Show and Technomart platinum award, 2015 Survey Engineering Paper Excellence Award, and 2015 Chinese Institute of Civil and Hydraulic Engineering Paper Award

10/6
NARLabs announced the Early Warning System for Bridge Collapses



10/13
• STPI hosted "Analysis of Taiwan's Competitiveness in Science and Technology" Press Conference & Seminar with Thomson Reuters

• TORI's sea trail of the Large Offset Multi-Channel Seismic System (LOMCS) was accomplished successfully

10/15
NCHC's "Remote Camera Scheduling Method" won the 9th International Warsaw Invention Show gold award and the Thailand Special Award

10/20
TTFRI announced the Radar Data Assimilation System which enhances 6-Hour rainfall forecasting accuracy

10/30
STPI published the first issue of "Research Portal" presenting topic-oriented research achievements

10/31
President Ma Ying-jeou visited NSPO

NOV

11/1
CIC's "Environment Detection Alarm System" and "Sensing System with Modularized Sensing Device and the Initialization Method Using the Same" won the 2015 iENA gold and silver medals

11/2
NSPO completed FORMOSAT-5's comprehensive performance test before delivering to the launch site

11/3
NLAC successfully established the advanced severe immunodeficiency (ASID) mice

11/11
STPI presented the achievement report of From IP to IPO (FITI) Program to the Executive Yuan and approved by the Premier

11/13
NSPO's "Truly Radiation-Hardened Fiber Light Sources" won the R&D 100 Awards

11/16
American Institute in Taiwan (AIT) Director Kin W. Moy Visited NSPO

11/17
CIC announced the "Cloud E-Nose" as an energy harvesting sensing system for home security and smart city management

11/19
NCHC's N-cloud Web Service, Braavos Big Data Analysis Platform and ALPS High Performance Computing Platform received BS 10012 Certification

11/20
NSPO's FORMOSAT-5 project team won the 2015 Technological Management Award of Chinese Society for Management of Technology

11/22
NCHC's Braavos Big Data Service and ALPS High Performance Computing Service Platform received the CSA STAR Certif ication Gold Awards

11/28
NCHC's Sleep Disorder Evaluation Platform won the 100 Innovative Products Awards in 2015 ICT Month

DEC

12/8
NSPO's fiber-optic gyroscope R&D team won The 2015 Executive Yuan Award for Outstanding Science and Technology Contribution

12/9
• NDL published 6 papers during 2015 International Electron Devices Meeting, 2 of which were selected as highlight papers

• NCHC unveiled the Center of Excellence on Cyber-enablement Applications

12/19
CIC hosted 2015 MorSensor Innovation and Application Design Contest

12/31
NARLabs cooperated with National Taiwan University launching cutting-edge medical devices: MOVIS Portable In Vivo Optical Imaging System and The Disposable Chip Detection Technology and Multifunctional Imaging System

Our 10 Laboratories

National Chip Implementation Center

Missions

- To provide high-quality services in design environment, chip fabrication, system integration, measurement, and prototyping production
- To support advanced research and development in IC/System design
- To promote interdisciplinary and academia-industry collaborations
- To cultivate talents in the field of IC/System design

Core Facilities

- Automated IC design softwares
- EDA Cloud design platform
- SoC automated test system
- Microelectromechanical measurement system
- High-frequency measurement system
- Antenna radiation pattern measurement system

Instrument Technology Research Center

Missions

- To execute instrumentation R&D to fulfill national science and technology policy
- To support national science and technology programs and develope frontier instrument-related service platform
- To commercialize novel technologies and support instrument technologies for industry
- To promote popular science education, cultivate talents and provide instrument information services

Core Facilities

- Intelligent manufacturing service platform
- Advanced vacuum equipment and related calibration service platform
- 3D additive manufacturing service platform
- Opto-electro-mechanical system service platform

National Center for High-performance Computing

Missions

- To provide research environments and professional services in HPC, big data and network applications
- To implement R&D of HPC, big data applications and platform integrations
- To enable technology exchange and achievement of HPC, big data and network applications

Core Facilities

- High-performance computers and big data analysis clusters
- Advanced research and education network, TWAREN
- National level off-site storage, replication, and archive facilities
- Large-scale engineering and scientific software and databases

National Center for Research on Earthquake Engineering

Missions

- To enhance pre-quake preparation, emergency response and post-quake recovery
- To integrate research capacities of various earthquake engineering research institutes in Taiwan to enhance the research capability of the nation
- To promote international research cooperation for earthquake hazard mitigation, and play a key role in the earthquake engineering research community of the world

Core Facilities

- 5mx5m Tri-axial earthquake simulator
- L-shaped reaction wall and strong floor testbed
- Multi-Axial Testing System (MATS)

National Nano Device Laboratories

Missions

- To build an openly integrated experimental environment for the R&D of nano-device technologies and electronic systems
- To support domestic academia in advanced research topics
- To promote integrated device technologies and applications in the post-silicon era
- To nurture cutting-edge technology engineers and scientists for Taiwan semiconductor manufacturing industry

Core Facilities

- Pilot run with flexibility for semiconductor device development and process integration
- Testing lines for flexible semiconductor device manufacturing
- Metrology analysis for semiconductor materials
- High-frequency and electrical characterization of semiconductor devices and circuits

National Laboratory Animal Center

Missions

- To provide a variety of laboratory animal species to fulfill the research and industrial demand
- To provide animal testing service for drug and medical devices development with an animal welfare management system that meets the international standard
- To implement the core humane values of animal studies by promoting alternative educational and experimental methodology
- To establish a talent cultivation mechanism to reduce the gap between the academic and industrial need

Core Facilities

- AAALAC International accredited laboratory animal facility
- TAF accredited diagnostic laboratory
- Rodent Model Resource Center (RMRC)
- Genetic Engineered Murine Model Services (GEMMS)
- Preclinical animal surgical and care facility

National Space Organization

Missions

- To establish domestic space technology
- To fulfill pronounced societal impacts
- To promote frontier space science research

Core Facilities

- Satellite I&T facility
- Ground control & operation systems
- Image processing center
- Spacecraft R&D laboratories

Science & Technology Policy Research and Information Center

Missions

- To support the government on S&T policy planning, evaluation and program management
- To perform study of technology foresight and development trend research, and assist planning and establishment of S&T policy
- To collect and establish national and international S&T information and provide integrated services
- To cultivate innovative and entrepreneurship talents and encourage local universities and research institutes to commercialize their research outputs

Core Technologies

- Key issues observation & foresight planning
- Patent mapping & information analysis
- Innovation ecosystem research
- Government S&T program management
- Integrated S&T information services Innovation & entrepreneurship talent
- development

Taiwan Ocean Research Institute

Missions

- To instigate marine technology and ocean science research platforms
- To operate and maintain ocean research vessel
- To support and enhance national marine technology and ocean science researches
- To promote and motivate cutting-edge ocean researches
- To nurture talents for ocean sciences

Core Facilities

- Taiwan Ocean Radar Observing System (TOROS)
- Ocean Bottom Seismometers (OBS)
- Near real-time Data Buoys
- Anchored Sediment Traps
- Remotely Operated Vehicle (ROV)
- Marine Core Repository and Laboratory (MCRL)
- Long offset Multichannel Seismic System (LOMCS)
- Marine Biogeochemical Laboratory

Taiwan Typhoon and Flood Research Institute

Missions

- To establish an atmospheric and hydrologic research platform to serve academia, industry, and government
- To develop key technologies for the simulation, forecast, and warning of typhoon and flood
- To implement an advanced hydro-meteorological monitoring network in the southwestern part of Taiwan for extreme weather events

Core Facilities

- The test platform of meteorological and hydrological models
- Observational facility service platform
- Knowledge Bank for Atmospheric and Hydrologic Research

NARLabs

Commitment · Passion · Innovation

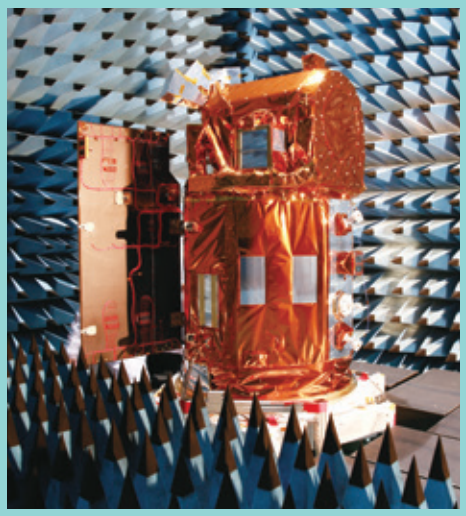
R&D and Service Accomplishments

NARLabs is dedicated to creating cutting-edge scientific R&D platforms to facilitate application of academic research outcomes to industry, government and humanitarian causes. NARLabs plays an integral role in the development and establishment of technology and expensive, large-scale facilities that no single university can afford to maintain. These NARLabs platforms provide technical services for academic research, and help users leverage high-accuracy instruments, software modeling and analytical systems to conduct original and advanced researches.

Earth and Environment

FORMOSAT-5 Satellite Fully Prepared for Launch

Ready to launch and make history



Electromagnetic compatibility test performed for the FORMOSAT-5 satellite

FORMOSAT-5 is the first optical remote sensing satellite made in Taiwan. The satellite system was fully assembled in 2015 and underwent a series of stringent tests such as the comprehensive performance test, satellite end-to-end tests, space and launch vehicle environments tests. The satellite system is now fully prepared for launch, which is scheduled to take place in the third quarter of 2016.

• National Space Organization

The Successful Development of the Optical Remote Sensing Instrument for FORMOSAT-5

Developing the key technology with innovation

The optical remote sensing instrument (RSI) of FORMOSAT-5 will be able to provide images with grounding resolution equal to 2m in black-and-white and 4m in color. Concerning the independent development of the RSI, NSPO have successfully overcome all technical difficulties and bottlenecks and completed the building of the instrument in early 2015, setting a new milestone in Taiwan's space technology.

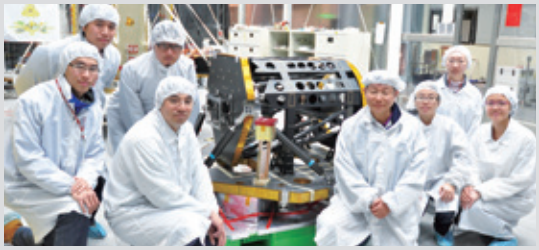
Assembling the FORMOSAT-5 satellite optical remote sensing instrument and spacecraft

• National Space Organization

FORMOSAT-5 Scientific Payload Facilitating Taiwan's Space Science R&D Capacity

20 years of preparation for a moment of probing in space

The advanced ionospheric probe (AIP) is a scientific payload of the FORMOSAT-5 satellite developed by the Graduate Institute of Space Science of the National Central University. In addition, the first multifunctional plasma-measuring instrument ever made using a single detector will be introduced. The AIP has successfully integrated to satellite and completed related environmental testing, significantly elevating Taiwan's space science instrument research capacity.



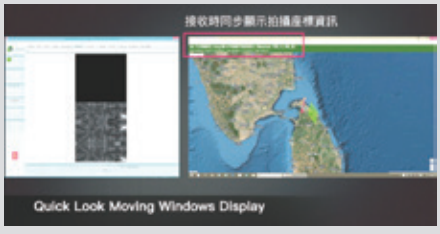
Complete assembly of the FORMOSAT-5 satellite scientific payload

• National Space Organization

FORMOSAT-5 Front-End Satellite Image Processing Technology Makes a Great Leap Forward

Satellite image data ingestion system successfully developed

FORMOSAT-5 satellite image data ingestion system was developed by the National Space Organization. Core technologies such as decompression, decryption, and packet disassembly have been developed. In addition, related software and hardware have been successfully integrated into a complete operational system, the most critical component in image processing. The image data ingestion system has successfully passed satellite to ground system end-to-end tests as well as other related verification tests.



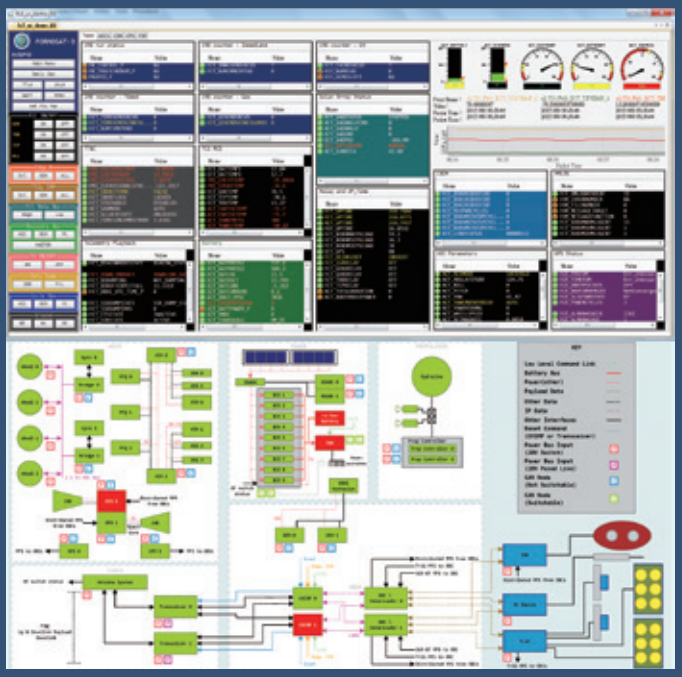
The satellite image data ingestion system

• National Space Organization

A New Era of Ground-based Satellite Mission Control System

XPSOC, a cross platform satellite operation control system

The cross platform satellite operation control (XPSOC) system is the first-ever large-scale satellite control software system independently designed and developed by Taiwan. It is anticipated to be used as the mission-operating platform for FORMOSAT-7. The successful development of XPSOC system has solidified Taiwan's ground-based satellite control development capacity.



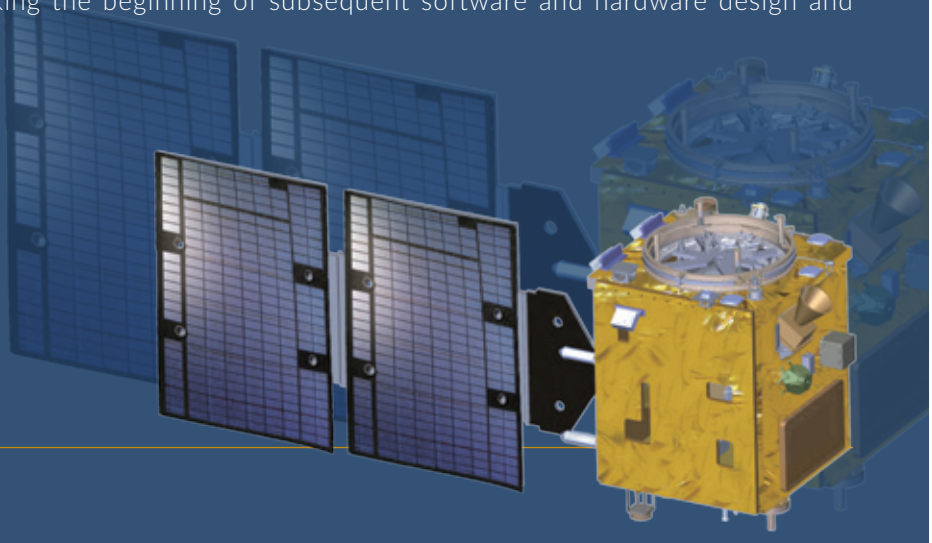
XPSOC system

• National Space Organization

Critical Design Completed for FORMOSAT-7 NSPO-built Satellite

Setting a new milestone domestic for domestic space technology in Taiwan

The NSPO-built FORMOSAT-7 satellite is a 300-kg class satellite carrying a GNSS reflection signal receiver made by NSPO and Taiwan's domestic team. In Nov. 2015, NSPO-built FORMOSAT-7 satellite passed the critical design review, validating satellite design completeness and system interface compatibility as well as marking the beginning of subsequent software and hardware design and manufacturing stages.



FORMOSAT-7 NSPO-built satellite

• National Space Organization

Cloud Network of Early Warning System for Bridge Collapses

Ensuring people's traveling safety

NARLabs integrated its NCREE, TTFRI, CIC, ITRC, NCHC, NDL to successfully develop an early warning system for bridge collapses. The system can estimate the extent of bridge scour at the midstream and downstream of rivers and give warning as early as six hours before the scour emerges. Moreover, the system can monitor water level, flow velocity, and the depth of pier scour and notify the authorities via cloud network. The system had been installed on road and highway bridges in the Jhuoshuei River basin for long-term monitoring and system verification to ensure bridge safety.

The early warning system for bridge collapses had been installed on the Mingchu Bridge

• National Center for Research on Earthquake Engineering

Taiwan New High-Strength Reinforced Concrete

A revolutionary new material for the construction industry

To implement carbon reduction and promote environmental sustainability, NCREE has promoted the "Taiwan new high-strength reinforced concrete structure" in recent years. Specifically, the strength of the steel and concrete was increased and became 1.8 and 3.6 times, respectively, higher than the conventional strength level. Such approach can effectively increase the floor height of buildings in cities, the internal space of buildings, and the external green area, thereby enhancing urban living quality.

• National Center for Research on Earthquake Engineering

Development of Earthquake-Resistant Technology for Nuclear Power Plants

Mastering critical technology, enhancing nuclear power safety

Frequent earthquakes in Taiwan show the importance of earthquake resistance capability of nuclear power plants. In response to the 2011 Japanese nuclear disaster, NCREE has conducted basic research and tests centering on the earthquake resistance capability of nuclear power plants, safety assessment, validation mechanism, and retrofitting technology, and has assisted Taiwan Power Company to ensure adequacy of the earthquake resistance capability and safety of domestic nuclear power plants.

• National Center for Research on Earthquake Engineering

A Comprehensive System for Early Earthquake Warning and Loss Estimation

Constructing an intelligent living space in terms of earthquake hazards reduction

The system provides assessment of structural safety and planning and training for earthquake disaster prevention before earthquakes. The system can give alarm ten more seconds before the arrival of devastating shear waves, helping people to evacuate and automatically closing hazardous pipelines and mechanical equipment to reduce disaster losses. In addition, the system can simultaneously monitor the building structure and assess the building safety, thereby expediting post-earthquake reconstruction.

• National Center for Research on Earthquake Engineering

Establishment of a Large-offset Multi-channel Seismic System

Moving toward a new milestone for marine geophysical exploration in Taiwan

The Large-offset Multi-channel Seismic System installed at Taiwan Ocean Research Institute has been successfully tested during sea trial. Coupled with seismic source arrays (i.e. parallel air gun clusters) and dynamic positioning, this system is able to accurately "diagnose" the geological formations and structures. To ensure our national environmental safety the system will be utilized continuously to obtain thorough knowledge on the natural resources under the seafloor around Taiwan, as well as on the mechanisms of catastrophic earthquakes that occur in the same area.

Sea trial of Large-offset Multi-channel Seismic System; (a) Deployment of the seismic source array; (b) Seismic source with precise GPS (RGPS) (left) and tail buoy (right) in operation; (c) Onsite shooting by the seismic source array; (d) Seismic data acquisition

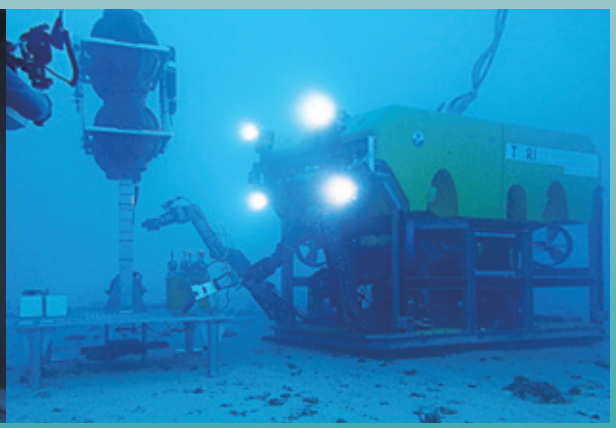
• Taiwan Ocean Research Institute

Maintenance and Operation of Remotely Operated Vehicle (ROV)

Conquering the shallow water of "Mini Ryukyu Islands"

After months of system-wide inspections and maintenance, the remotely operated vehicle (ROV) team practiced at the shallow waters of the Mini Ryukyu Islands. The training exercises included underwater vehicle flying tasks, underwater sonar navigation, manipulator practicing and sample collections; all of the drills were recorded. The next objective is to challenge the deeper waters, in order to meet future mission demands as early as possible.

Pilot and co-pilot performing onsite training inside the ROV control room



Interactions between the ROV manipulators and the scientific collecting platform (elevator) located on the sea floor

• Taiwan Ocean Research Institute

Long-term Deep-sea Moorings

Data buoy operated successfully in the southernmost national territory at Taiping Island

In June 2013, the R/V Ocean Researcher V set up a data buoy at the southernmost national territory at Taiping Island (the largest "natural" island among Spratly Islands). The buoy collected sea-surface meteorological parameters and upper ocean thermal structure and all the data were transmitted back, in an interval of 6 hours, to TORI's databank servers via Iridium satellite network. Measurements including air temperature, pressure, humidity, solar radiation, wind speed and direction, and ocean thermal structure of the upper 200m were all monitored through and displayed on the web. The data buoy system developed by TORI, which is the foundation of the deep-sea moored observation network, was operating successfully for years in open ocean far away from Taiwan. The buoy was temporarily retrieved in Oct. 2015.

Data buoy deployed in the southernmost national territory at Taiping Island

Deployment of data buoy

• Taiwan Ocean Research Institute

Ocean Sediments

Episode I of core hunting

Marine sediment coring system can serve as a time capsule capable of revealing layers of marine sediments that have accumulated since the ancient period. Through the collaborations between academic and research communities, an ocean core and sediment database was established for the seas bordering Taiwan. Such efforts enable the effective use for research results and national resources, and provides crucial referential information for future core site selection.

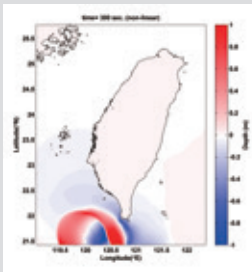
Marine core repository
http://mcrl.tori.narl.org.tw

• Taiwan Ocean Research Institute

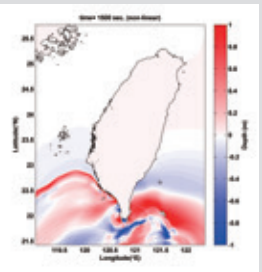
Disaster-prevention Information and Model Integration Platform

Inundation scenario induced by numerical simulation of tsunami

In this study, inundation scenario of west-southern coastal areas of Taiwan was performed through numerical tsunami propagation. Such tsunami is supposed to be induced from the fault line displacement caused by the release of seismic energy which already accumulated over 400 years in the Manila Trench. Preliminary result shows that the Cijin region, which located in the outer area of Kaohsiung Harbor, appears to suffer large-scale inundation and the region would possibly experience significant casualties and property losses.



Distribution of water-level caused by tsunami wave propagation



Inundation result in the Cijin region

• Taiwan Ocean Research Institute

Progress of the In-house R&D on Ocean Exploration and Measurement Instruments

Ocean bottom seismometers, ocean bottom electro-magnetometer, mini-ROV, and TowCam

The vast ocean features a wealth of biological organisms and mineral resources. In order to explore the oceans, specific marine scientific instruments have been developed: deep sea cameras for viewing the dark and deep ocean realm; remotely operated vehicles for exploring unknown waters; and ocean bottom seismometers and ocean bottom electro-magnetometer may locate alternative natural resources buried deep under the seafloor. These advancements can help the general public to better understand the oceans.

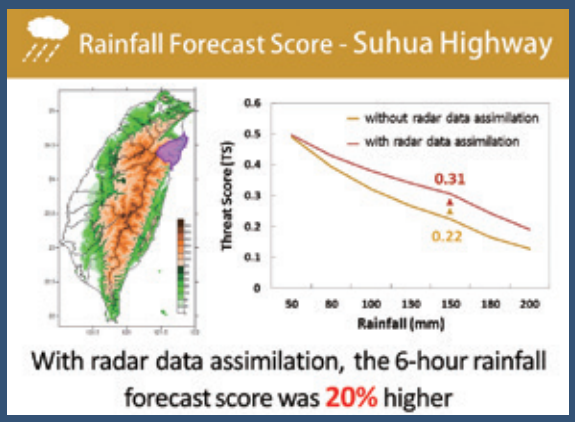
◥ Seabed seismometers (upper left), TowCam (upper right), mini-ROV (bottom left), and ocean bottom electro-magnetometer (bottom right)

• Taiwan Ocean Research Institute

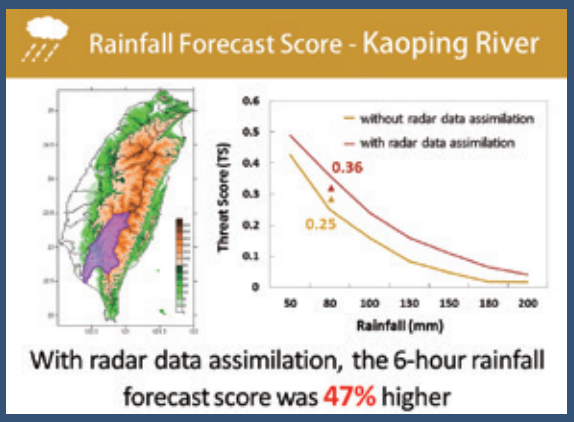
Building a Radar Data Assimilation System

Enhancing 6-hour Rainfall Forecasting Accuracy

The Taiwan Typhoon and Flood Research Institute had worked closely with the Central Weather Bureau to develop a radar data assimilation system. The system was employed to project rainfall from typhoons that led to collapses on the Suhua Highway. The results showed that the 6-hour rainfall forecast score was 20% higher than without applying the system. Similarly, the system was used at the Kaoping river basin, in which the results also showed a 47% improvement. With the radar assimilation system, the two aforementioned organizations will work jointly with disaster prevention and rescue agencies for early warnings of catastrophic weather with heavy rain and in emergency preparedness plans.



◥ After applying the radar data assimilation system to project rainfall from six typhoon events occurred on the Suhua Highway, the results showed that the 6-hour rainfall forecast score was improved by an average of 20%



◥ The radar data assimilation system was applied to project rainfall from four typhoon events occurred in the Kaoping river basin, the results showed that the 6-hour rainfall forecast score was improved by an average of 47%

• Taiwan Typhoon and Flood Research Institute

Data Bank for Atmospheric & Hydrologic Research

Entering the era of big data

To the researchers working at the Taiwan Typhoon and Flood Research Institute (TTFRI), the Earth is their laboratory. They have performed various experiments such as aircraft dropsonde missions, observations using C-band polarimetric radars, and measuring river water levels and flow rates, from which valuable data were acquired. In the era of big data, TTFRI has integrated various data types to build its Data Bank for Atmospheric & Hydrologic Research, which is now officially open to the public. The goal is to provide stable and sustainable information services to the academic and research institutes.

• Taiwan Typhoon and Flood Research Institute

Development of the Safety Assessment Technologies for Disaster-prone Mountain Road Sections

Providing the early warnings for road closure and referential information for making disaster-prevention and disaster-relief decisions

To promptly prevent disasters in disaster-prone mountain road sections caused by the catastrophic heavy rain, TTFRI has developed a security assessment system for road sections labelled by the Directorate General of Highways as key monitoring road sections. The proposed system, which combines the Taiwan Cooperative Precipitation Ensemble Forecast Experiment with physically based shallow landslide simulation, can be used to assess the risk of heavy rain-led mountain road section collapse forecast for the next six hours, providing early warnings for road closure and referential information for making disaster-prevention and disaster-relief decisions.

Experiment platform for mountain road section security assessments. The system provides the information of rainfall-induced landslide that may occur on each road section in the next six hours (assessment is made hourly), in which yellow, orange, or red lights are used to indicate the assessed risk levels, providing referential information to the responsible departments prior to disasters.

• Taiwan Typhoon and Flood Research Institute

Southwesterlies Joint Observation Experiment in 2015

Collecting high resolution meteorological data to understand the mechanism of heavy rain triggered by southwesterly monsoons

TTFRI together with the government agencies, academic and other research institutes, continue to promote joint observational experiments to study southwesterly monsoons. An intensive observation network was conducted in southwestern Taiwan. TTFRI had deployed a C-Pol radar in the Jilai Farm within the area. The observational network is expected to help scientists to better understand the large-scale environment and the characteristics of meso-scale convective system during southwesterly monsoons to improve the accuracy of quantitative precipitation forecast.

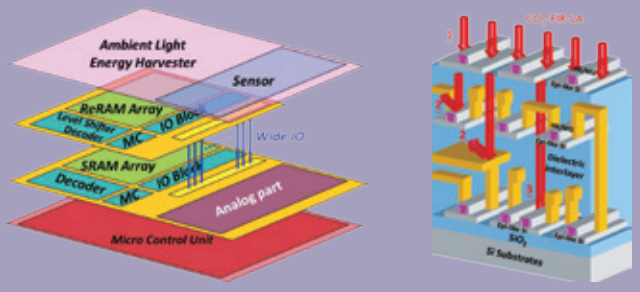
• Taiwan Typhoon and Flood Research Institute

Information and Communication Technology

World's Leading Wafer-level and Three-dimensional (3D) Heterogeneous Integration Technology

Demonstration of through-silicon via (TSV)-free 3D IoT chip technology

NDL for the first time in the world developed the technology of heterogeneous integration of memory, circuit, and sensing unit for 3D Internet of Things (IoT) chips. The heterogeneous integration technology for TSV-free 3D IC features the advantages of low cost, small chip area, and low power consumption, suitable for IoT chips. The technology was selected by the International Electron Devices Meeting to be published as publicity materials.



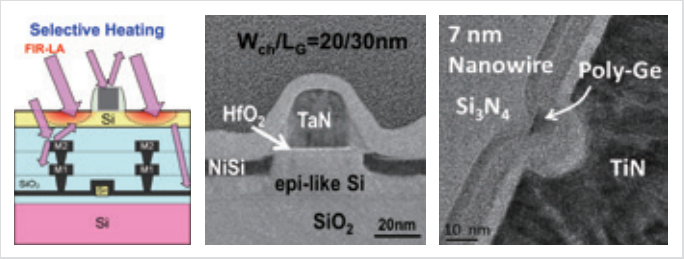
◥ TSV-free 3D IoT chip technology display

• National Nano Device Laboratories

World's First Heating Process Technology for Nanogermanium Electronic Components

Selective heating technology using far-infrared laser

NDL successfully established the far-infrared laser selective heating system and technology suitable for the heating process of electronic nanocomponents. The feature that far-infrared laser can be highly absorbed by materials was used to considerably increase the activation ability of materials and to reduce component damage caused by heat. The technology is applicable to the fabrication of monolithic 3D IC and sub-10nm IC.



◥ The selective heating technology using far-infrared laser was adopted to realize a sub-10nm stackable transistor

• National Nano Device Laboratories

Developing an Advanced Structure for Sub-10nm Devices Using Dry Etching Technology

Diamond-shaped germanium channel gate-all-around transistor

Germanium has a higher carrier mobility than silicon. Therefore, NDL used a simple method of dry etching to fabricate a novel diamond- shaped channel, which can improve the transport performance of electrons and reduce the leakage current during device operation. The gate-all-around structure provides satisfactory gate control ability and thus is suitable for future development and application of the sub-10nm devices.

• National Nano Device Laboratories

Application of Microwave and Laser Annealing to the Semiconductor 3D IC Process Technology

The chemistry-based doping technology was developed under the temperature of 600℃

A number of difficulties have to be overcome during the development of the 7nm devices process. For example, the control capability of gates under the short channel effect was unsatisfactory, and the junction doping was unstable. To solve the doping problem of ultra-shallow junction, a novel annealing process was developed by combining microwave annealing with CO_2 laser annealing to replace the traditional rapid thermal annealing. In this newly developed process, microwave annealing under 600℃ was performed to enable the molecular monolayer dopant diffusion into silicon, followed by CO_2 laser annealing. The result showed that the doping depth was smaller than 5nm.

• National Nano Device Laboratories

MorSensor

In accordance with the concept of brick games, users can rapidly combine sensor systems with various functions to expedite the realization of creativity

The MorSensor wireless sensor brick is a set of modularized electronic components proposed by National Chip Implementation Center (CIC). Each brick undertakes one sensing task, such as power supply, computation, communication, and sensing. Users can select various bricks according to their preference to produce an individualized wireless sensor system. The sensor system can also be combined with sports equipment or clothing accessories for further system integration and display.

MorSensor wireless sensor bricks

• National Chip Implementation Center

EDA Cloud

Electronic design automation (EDA) Cloud, a safe, complete, and convenient environment for IC / SoC design, was developed for the academia using EDA software, computation, and storage required for chip system design through remote access

The EDA cloud has four features as follows : (a) resource sharing by virtual mechanisms, (b) reducing human resources required for server management in the academia, (c) simplifying the process of software installation and configuration, and (d) providing an information protection mechanism for manufacturing processes data.

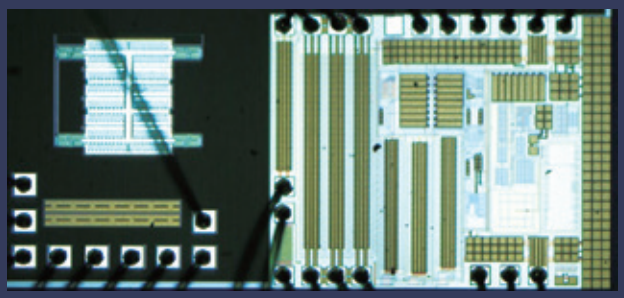
EDA Cloud computing server

• National Chip Implementation Center

Complementary Metal-oxide-semiconductor (CMOS) Sensing Chip Implementation Platform

CMOS microelectromechanical systems (MEMS) : Realizing silicon MEMS oscillators and clock generators

CIC provides 0.18-μm CMOS MEMS and 0.35-μm multi-option CMOS MEMS process service to the academia. In particular, CIC developed the platinum (Pt) in the multi-option CMOS MEMS in 2015. This MEMS process is the world's first process to fabricate gold, platinum, and MEMS structures in the same chip. Besides, the 32.768-KHz silicon MEMS oscillator and clock generator was also verified; a CMOS circuit and MEMS resonator were fabricated onto a chip, achieving the advantages of low cost, miniaturization, and rapid integration.



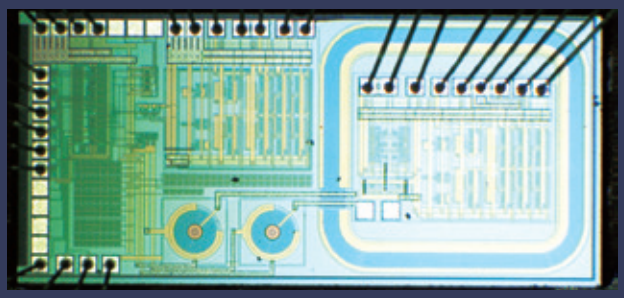
◥ Silicon MEMS oscillator and clock generator

• National Chip Implementation Center

CMOS High Voltage Chip Implementation Platform

The design of AC / DC power supply system chip - CMOS 800V high / low side gate driver

CIC provided 0.5-μm CMOS 800V ultra-high-voltage process service to the academia in 2015, and the CMOS 800V high/low side gate driver was verified. The process platform is ahead of the most advanced process that can be obtained by the academia of other countries. Professionals in the fields of electronics and electricity can cooperate to develop green energy chips. Among the similar institutions in the world, CIC is the only one providing the 60V and 800V high voltage processes to the academia.



◥ CMOS 800V hight/low side gate driver

• National Chip Implementation Center

A Self-powered Intelligent Gas Sensing System

The self-powered technique based on hydroelectricity was introduced to the technology of Internet of Things (IoT) , and made gas water heaters capable of connecting to the Internet

The system with embedded gas sensor which is capable of monitoring the environment can work without a battery. It can be integrated into commercial water heaters to detect carbon monoxide from the water heaters. To prevent disasters more efficiently, the system can not only give alarm but also transmit alert to mobile phones of remote users or servers of security companies.

◥ A self-powered intelligent gas sensing system

• National Chip Implementation Center

The Establishment of ALD Joint Research Laboratory Promotes the Development of the Semiconductor Industry in Cooperation with Industry and Academia

The independent technologies of semiconductor were vertically integrated to enhance Taiwan's semiconductor R&D capability

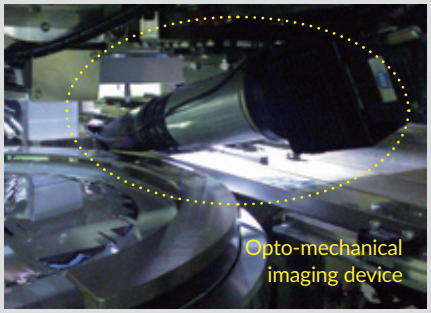
The Instrument Technology Research Center (ITRC) established the ALD (Atomic Layer Deposition) Joint Research Laboratory and signed a cooperation agreement with Taiwan Semiconductor Manufacturing Co., Ltd. (tsmc), as collaboration between the academia and industry suppliers in Taiwan to develop equipment and materials for the ALD process and further facilitate the development of the semiconductor industry in Taiwan.

• Instrument Technology Research Center

◢ Jen-Inn Chyi, former Vice President of NARLabs (fifth from the left), Jack Sun, Vice President of tsmc (fifth from the right), J.Andrew Yeh, the Director General of ITRC (fourth from the left), and all the participants together started the service platform of the ALD Joint Research Laboratory

The Chip Defect Inspection System Opens a New Chapter for the Manufacture of Semiconductor Equipment in Taiwan

The wafer and chip defect inspection system is fully automatic and therefore can increase process yield and the effectiveness of quality control



The chip defect inspection system

ITRC developed the high-performance line array chip defect inspection system in cooperation with Gallant Micor. Machining, a semiconductor packaging equipment manufacturer, and the defect inspection equipment for LED chips in cooperation with Epistar, a leading LED epitaxy manufacturer. With the developed system and equipment, the quality control of chips can be substantially improved, and the costs of human resource, equipment, and time can be reduced.

• Instrument Technology Research Center

Semiconductor Lithography Equipment Lenses Open the Opportunity for the Localization of Semiconductor Equipment

ITRC developed Taiwan's first localized and independently designed and fabricated projection lens for lithography stepper

ITRC has developed the very first localized and independently designed and fabricated projection lens module for a TSV stepper in Taiwan. A number of key components for semiconductor process equipment were also released. The exhibition and business alliance investment seminar attracted nearly 30 firms in the semiconductor equipment supply chain and other related companies in the optoelectronics industry.

• Instrument Technology Research Center

The Optical Systems Integration R&D Consortium Strengthens the Partnership between Industry and Academia

Promoter of industry-academia collaboration projects

Through a variety of Optical Systems Integration R&D Consortium's matchmaking activities, ITRC and consortium members implemented an industry-academia cooperation project named Development of Spectral Compensation Filter and Spectral-Mismatch Calculator for High-Order Solar Simulator, granted by MOST. In addition, Wafer Electrical Test and Circuit Defect Inspection Equipment was undertaken.

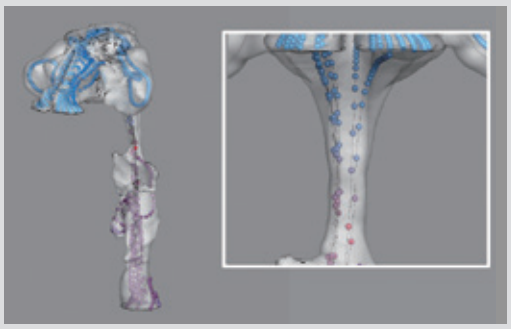
ZrB2 buffer layer process technology and equipment was jointly developed by ITRC, the consortium, Yujay Technology Inc. and Ming Chi Univ. of Tech

• Instrument Technology Research Center

Sleep Disorder Risk Evaluation Platform

Receiving the 100 Innovative Products Awards in IT Month 2015

The Sleep Disorder Risk Evaluation Platform facilitates respiration detection during sleep, which is the world's first one that combines videography, computational fluid dynamics technology, and a cloud system. Patients are asked to undergo cone beam computed tomography. Through the simulation of patients' respiratory tract pressure, the platform can determine whether the patients have sleep apnea and the severity within 15 minutes.



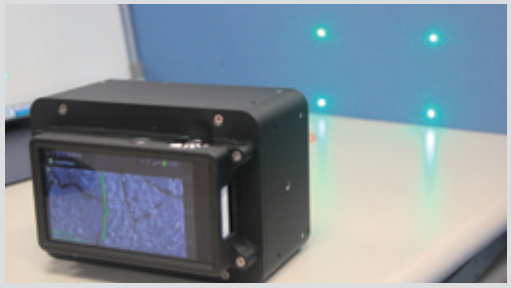
The platform simulates the fluid pressure in the respiratory tract using the method of computational fluid dynamics

• National Center for High-performance Computing

River and Bridge Image Detection and Monitoring System

Receiving the Platinum Award of the Invention Competition in the 2015 Taipei International Invention Show and Technomart

Through autonomous positioning using laser beam and real-time image analysis, the system can obtain crucial parameters that are often difficult to obtain at the site of river and bridges, including water level and flow velocity of rivers and cracks in bridges. The system can be used safely and conveniently because users need not to be at the site personally to measure the parameters or to place reference objects.



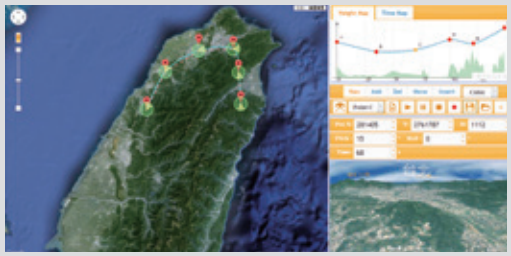
The detection and monitoring system that is easy to carry and operate

• National Center for High-performance Computing

I-Flyover, a Geographic Information Platform

Flying over Taiwan and observing Taiwan

To facilitate the sharing of information related to geographic information system and disaster prevention, National Center for High-performance Computing (NCHC) developed the i-Flyover platform by integrating computational resources, search function, and application software to solve problems of big data and computation. I-Flyover serves as an internet platform for information sharing, which enables users to "fly over" Taiwan and observe every corner of the island.



The interface of i-Flyover

• National Center for High-performance Computing

Ezilla

Using Ezilla to realize education cloud

Ezilla can help service providers to easily construct private cloud and enable users to use cloud services through internet connection at any time and place. The Open Source Software Application Consulting Center of the Ministry of Education and New Taipei City government have used Ezilla to construct education cloud for all schools, that eliminates the boundary of traditional teaching in computer classrooms and enables students to connect to education cloud at any time and place.

The press conference of the release of education cloud developed by NCHC and the Education Department of New Taipei City

• National Center for High-performance Computing

Disaster Management Information Platform

Applying technologies for disaster prevention and rescue

The platform integrates the systems of information, model, management, and display. It allows users to search information of various disasters such as large-scale collapse, flood disaster, climate change, drought and water resource, and earthquake and to develop the prevention technologies including disaster management. Therefore, the information owned by various governmental agencies can be accessed and exchanged conveniently.

• National Center for High-performance Computing

Big Data Analysis Platform

Braavos is the first big data analysis platform in Taiwan

NCHC constructed a big data analysis platform called Braavos, which is the largest computing platform for open big data in Taiwan and was launched for use in 2015. The platform comprises 302 nodes and 1-PB storage space and provides a number of analysis software types, such as Storm and Spark, enhancing national R&D capability and technology competitiveness.

• National Center for High-performance Computing

Biomedical Technology

Establishment of Laboratory Animal Care and Surgery Facility

Leading animal experiments to a new era for development of medical devices

National Laboratory Animal Center (NLAC) established the "Laboratory Animal Care and Surgery Facility" to facilitate medical equipment innovation from prototype to marketing. The said facility features equipment and surgical space comparable to those used for human surgeries, fulfilling all related regulations, offering standardized services of animal surgery verification to domestic institutions. NLAC assists expediting the development process and success rate of medical device development while reducing costs expended for high-class medical devices in early trial periods. The goal is to foster the growth of Taiwan's advanced medical device industry.

The National Laboratory Animal Center celebrated their grand opening of Laboratory Animal Care and Surgery Facility on Apr.21

• National Laboratory Animal Center

Constituting a Laboratory Animal Resource Alliance

Connecting supply networks to provide a complete selection of laboratory animals

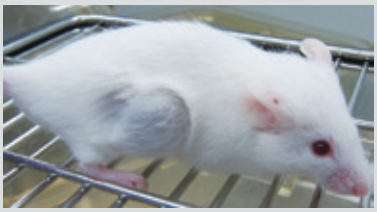
Following the rapid development of the global biomedical industry, laboratory animals have become important resources in preclinical animal studies. The National Laboratory Animal Center connects domestic and foreign lab animal supply units together to form an animal resource alliance that provides a complete selection of lab animals, including rabbits, dogs, pigs, and monkeys, to meet the demands of domestic users and elevate research standards.

• National Laboratory Animal Center

Humanized Mice Made-in-Taiwan

Ideal model for drug tests that opens up limitless future medical possibilities

NLAC is committed to developing prospective lab animals. After two years of enthusiastic efforts, NLAC has successfully established a useful mouse strain: advanced severe immunodeficiency (ASID). The said mice lack congenital and acquired immunity and generally do not reject heterologous cells and tissues. Therefore, human tissues or cells can be xenografted into ASID mice to accurately reflect the actual conditions in patients. Such model will be valuable for drug screening as well as for investigating the causes of diseases and ultimately for developing new therapies. These efforts will benefit significantly to the development and the quality of fundamental research and biomedical industries in Taiwan.



In transplantation experiment using human pancreatic cancer cell lines (AsPC-1 cells), the 100 % tumor incidence in the ASID mice

• National Laboratory Animal Center

Customized Research One-Stop Service (CROSS)

Integrating animal models with related technologies to provide customized animal experiment services as well as a tumor testing service

NLAC provides comprehensive tumor test-related resources and services including specialties of oncology, genetic modifications, animal-related experimentation, 3D medical imaging, and veterinary. NLAC also provides diversified tumor transplantation animal models, and anticancer drug efficacy assessments to facilitate drug development.

• National Laboratory Animal Center

One-stop Service Platform for Medical Device Development

Expediteing the medical devices development and accelerating the products to the markets

In order to promote the commercialization of R&D results and biomedical settlement formation, boost development capability, as well as motivate biotech industry, ITRC established a one-stop service platform conforming to ISO 13485 standards for medical devices, and provided high-quality R&D service equipment. In 2015, these platform and equipment have assisted R&D teams in accelerating their R&D, with over 200 individuals, 20 R&D teams and 2 start-ups being serviced.

• Instrument Technology Research Center

Science and Technology Policy

Patent Information Services : Observing Technology Application-based Competition from Various Perspectives

Providing key information and facilitating scientific research-related resource allocation and achievement application

The Science & Technology Policy Research and Information Center develops various patent analysis methods to analyze the evolution of specific technologies as well as their market competition situation. For the said methods, patent information is combined with industry and market information to analyze the development trends, competition situations, and market dynamics of specific technologies. The analysis results are used as the knowledge base for resource allocation, research topic identification, and results application.

• Science & Technology Policy Research and Information Center

Responding to Social Demands through Prospective Foresight Studies

A methodology for connecting scientific technology development and trends

Taiwan's manufacturing patterns in the future are made by assessing future global trends as well as Taiwan's social demands. Technologies are then selected to realize specific scenarios of Taiwan's future manufacturing. Furthermore, comparative advantage analysis of those selected technologies facilitates decision makers to focus on developing the scientific research fields which Taiwan holds great potentials.

- Science & Technology Policy Research and Information Center

Mechanism Innovation Driving the R&D of Energy Technology

Promoting sustainable high quality of life with energy technology

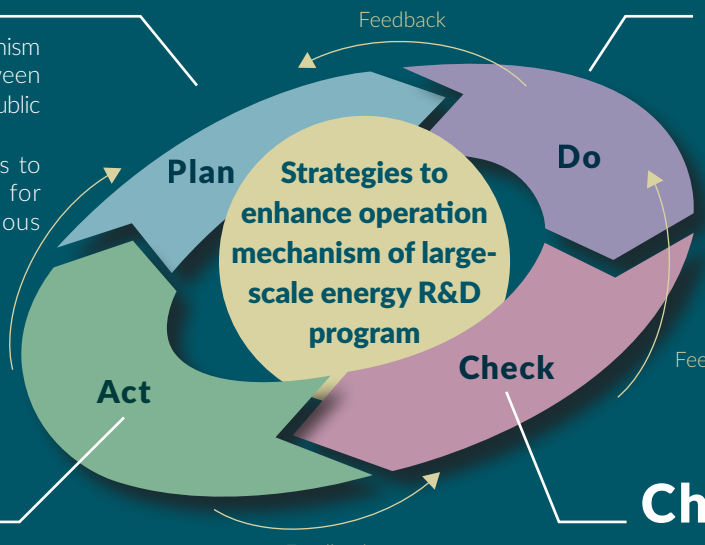
On the basis of innovation systems, this study involves observing international policies and exploring promotion practices. By introducing innovative thinking into various stages of large-scale R&D programs including planning, execution, review, and action, energy technology R&D can be carried out to match social demands. This study is expected to facilitate energy conservation and carbon reduction, thereby promoting sustainable and outstanding quality of life.

Plan

- Establishing a mechanism for interaction between program office and public officers
- Setting up principles to determine priority for investment on various technologies

Do

- Introducing customized R&D supporting strategies in the project review process
- Setting up target-oriented project review process based on common information from different entities



Act

- Developing a communication mechanism amiable to people
- Enchancing staff training, promoting public and private sector cooperation and business matching opportunities

Check

- Conducting on-site visits in order to evaluate and convey R&D impact of the project

Strategies to enhance operation mechanism of large-scale energy R&D program

- Science & Technology Policy Research and Information Center

Brain Circulation of Technology-related Innovation and Entrepreneurship

Policy observations and international comparisons

Assessing and forecasting the brain drain of talents of innovation and entrepreneurship are difficult. Therefore, our team performed a current affairs analysis, studied various international policies (i.e., policies implemented by Singapore, South Korea, Finland, Israel, and Switzerland), and interviewed scholars and experts. The results showed that to retain talents, relevant institutions should actively encourage brain circulation, accept brain gain, pay attention to talent retention, attract talents, develop training systems, and concentrate resources to promote related policies.

• Science & Technology Policy Research and Information Center

2015 Annual Employment Perception Survey Report of Earned Doctorates in NPHRST

Revealing the true thoughts of doctorates in the academia, research, and professional industries using survey data

The topic of this report is to provide an overview of the use as well as the supply and demand of doctorates in various institutions. Investigations were made to gain insight into the current perceived supply and demand of doctorates, gaps between theory and practice, and the doctorate employment market over the next five years. Recommendations were made to solve the issues concerning low birth rate led closing down of colleges and universities, significant theory-practice gap in doctorate education, and retaining talents despite low pay.

• Science & Technology Policy Research and Information Center

Industry 4.0 and iKnow Information Services

iKnow to play a crucial role in the provision of knowledge and information-related services

The Industry 4.0 is affecting and changing the factory "landscape" and even overturns the framework of the entire industry in the future. Meantime, Industry 4.0 will be used to create smart, automated production by facilitating cross-industry/cross-technology fusion and integration. iKnow, a technology industry information service of STPI, will play a key role in providing industry-related knowledge and information to fully inform Taiwanese businesses of the future development and new business opportunities involving Industry 4.0.

• Science & Technology Policy Research and Information Center

Analysis of R&D Competitiveness through Bibliometrics and Patent Indicators

Using quantitative statistics to reveal research capacity and technology development

Bibliometrics and patent data could be used to measure R&D competitiveness of a country. Taiwan ranks 5th in terms of patents granted in the USPTO, ranks 12th in the ratio of high-impact patents, and holds an advantage in electrical machinery, engineering & energy, and semiconductors & machine tools. Taiwan ranks 16th in terms of the number of papers published, and holds an advantage in computer science, engineering, materials science, and physics.

• Science & Technology Policy Research and Information Center

Leading Industrial-academic Collaboration

Working in conjunction with the Ministry of Science and Technology's nationwide S&T development, NARLabs serves as a provider of technological manpower and R&D platforms needed for the innovation economy. NARLabs helps connect upstream R&D results with downstream applications and guide industrial/academic collaboration. From innovation to value creation, NARLabs strives to accelerate the development of value-added applications of R&D platforms and increase the integration of Taiwan's S&T and industry value chain.

Fruitful Industry–Academia–Research Cooperation : Achievements and Successful Cooperation Alliance Expansion

Expansion and clustering of innovation and development impetus

The NARLabs allied with various industrial and academic research institutions to promote industry–academia–research cooperation and explore potential industrial needs. A bi-directional approach was adopted to link the communication between industry and academia, facilitating NARLabs to industrialize its prospect research and development achievements. In this year, we achieved fruitful outcomes in linking industrial and academic research operations and expanded cooperation alliances with institutions including Soochow University, Agricultural Technology Research Institute (ATRC), National Taiwan College of Performing Arts (NTCPA), Japan Agency For Marine-Earth Science and Technology (JAMSTEC), Central Weather Bureau (CWB), and Taiwan Academy of Banking and Finance (TABF). We hope to expand and cluster innovation and development impetus to promote technology innovation in Taiwan and facilitate people's livelihood and social well-being.

Ching-Hua Lo, President of NARLabs, and Wei-Ta Pan, President of Soochow University, signed the MOU on January 14, 2015

Ching-Hua Lo, President of NARLabs, and Jui-Pin Chang, President of NTCPA, signed the MOU on May 27, 2015

Ching-Hua Lo, President of NARLabs, and Mao-Wei Hung, Chairman of TABF, signed the MOU on September 4, 2015

Establishment of Internet of Things Sensor Service Platform

Promoter of the Internet of Things industrial supply chains

The Department of Engineering and Technologies of MOST cooperated with the Instrument Technology Research Center of NARLabs to promote an Internet of Things (IoT) sensor service platform. Targeting to provide opportunities for autonomous and developmental applications of IoT sensors, ITRC together with NDL and CIC of NARLabs signed a MOU with top businesses in Taiwan, including HIWIN Technologies, MediaTek, Mobiletron, and Adavntech-LNC Technology. Through this service platform, it is expected that a representative IoT industrial supply chain will be cultivated.

Dept. of Engineering and Technologies of MOST cooperated with NARLabs to promote an IoT sensor service platform

Outstanding Achievements in the 2015 Taipei International Invention Competition

The NARLabs received 2 platinum, 1 gold, and 3 silver medals, demonstrating our success in research and development innovation

Two platinum medals are: "Method for Measuring Cracks Remotely and Device Thereof" by NCHC which enables accurately measuring cracks in concrete structures; and "Dual-core Self-Centering Energy Dissipation Brace Apparatus" by NCREE which prevents buildings from collapsing during major earthquakes. "Sensing System with Modularized Sensing Device" by CIC received the gold award. NCHC received three silver awards. NARLabs research and development capability has received recognition worldwide and the outcomes are valuable for industrial applications.

NARLabs receiving 2 platinum awards in the 2015 Taipei International Invention Competition

Coestablishing Laboratories, Developing New Manufacturing Techniques

Industry–Academia–Research cooperation creates innovation and value

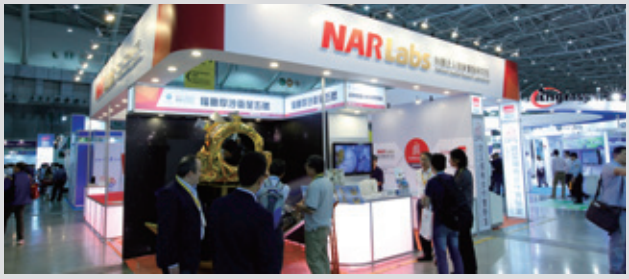
The NARLabs connected the industry and academia for co-creating innovation and value. For example, we cooperated with Taiwan Semiconductor Manufacturing Company to establish the Atomic Layer Deposition Cooperation Laboratory as to co-develop the advanced manufacturing techniques in the semiconductor industry, as well as with Taiwan SECOM to establish the Joint Labs of Disaster Prevention Service as to co-develop earthquake warning services and floods monitoring system.

The NARLabs cooperated with Taiwan SECOM to establish the Joint Labs of Disaster Prevention Service

Demonstrating Smart Hazard Mitigation Technology in the 2015 Secutech

Promoting new opportunities for applications related to the security industry

The NARLabs attended the 2015 Secutech Taipei International Security Exhibition and demonstrated various smart hazard mitigation technology achievements, including FORMOSAT-5 satellite, earthquake warning and structural monitoring, quantitative precipitation forecast of rainfall and flood, disaster management and warning technology for the Zhuoshui River basin, unmanned aerial vehicle image capturing systems, and disaster management sensor chips. In addition, we cooperated with Taiwan SECOM to develop an earthquake disaster management solution, in which a smart IoT concept was adopted to provide innovative applications for the security industry.



The NARLabs exhibited its hazard mitigation technology in 2015 Secutech and provided comprehensive demonstration of smart disaster management applications to the government and industry

Demonstrating Biomedical Information and Communication Transdisciplinary Applications in the 2015 BioTaiwan Exhibition

Grasping biomedicine, expanding the future

The Bio ICT industry has recently become a high potential field for Taiwan's next "diamond" industry. To promote its innovation and transdisciplinary applications, NARLabs adopted a 3-in-1 approach in the 2015 BioTaiwan Exhibition. Specifically, we hosted a biomedical technology theme hall demonstrating our latest related technology, hosted the NARLabs Medical Instrument Value Creation Alliance Technology Presentation, and cooperated with the National Chiao Tung University Bio ICT Alliance to host the Bio x ICT Forum. Through the interactions between industrial and academic experts, we hope to enhance Taiwan's international competitiveness in biomedical ICT field.

The NARLabs cooperated with the National Chiao Tung University Bio ICT Alliance to host the Bio x ICT Forum

Fostering of Scientific and Technological Manpower

Under global competition, talent is our most important resource and also the key to sustain national development. Fostering high-tech manpower is one of NARLabs four major missions. We help establish links between academia and industry via our innovative service platforms. In addition, we continue to tap international human resources, with the ultimate goals of cultivating superior, innovative manpower and boosting Taiwan's international competitiveness.

2015 FORMOSAT-2 Image Application Workshop

Cultivating seed teachers, enhancing space science education

National Space Organization cooperated with the Geography Education Resource Center of the Ministry of Education to host 4 workshops regarding FORMOSAT-2 image application. A total of 160 teachers participated in the workshops, in which courses were offered to understand the characteristics of remote sensing satellites, introduce FORMOSAT satellite series, and practice techniques for using image databases. In addition, the workshops promoted a subsequent short essay competition on satellite image application.

- National Space Organization

2015 3D Printing Innovative Application Competition

Enhancing 3D printing technology in Taiwan, promoting diverse value-added applications

The National Center for High-performance Computing undertook a project of the Ministry of Science and Technology to host the 3D Printing Innovative Application Competition, which is aimed to cultivate talented individuals for 3D printing and to promote the linkage between technology research and development and industrial supply chains. The 1st competition attracted a total of 183 teams from schools of various levels and a variety of occupations. This competition effectively facilitates the 3D printing application development in Taiwan.

The gold award for the social division

- National Center for High-performance Computing

Taiwan Student Cluster Competition

Cultivating talented individuals for high-performance computing in Taiwan

The National Center for High-performance Computing has endeavored to cultivate talented individuals for high-performance computing in Taiwan. The center hosted the Taiwan Student Cluster Competition, the content of which involved computer assembling, hardware efficiency optimization, and problem solving through computer operations. The 5th competition was hosted this year. This competition builds a solid foundation for Taiwanese students participating in high-performance computing tasks.

Group photo of the competition teams in the 2015 Taiwan Student Cluster Competition

- National Center for High-performance Computing

Southeast Asia International Joint Research and Training Program

An open platform facilitating cooperation between Southeast Asia, Taiwan, and the United States

Group photo of SEAIP meeting attendants.

The Southeast Asia International Joint Research and Training Program (SEAIP) hosted a 5-day meeting from December 7, 2015. This program aims to deepen research development in Taiwan and Southeast Asia regions and promote international cooperation and training. The meeting unveiled the Center of Excellence on Cyber-enablement Applications newly established by the Taichung branch of the National Center for High-performance Computing, facilitating Taiwan to become an outstanding international education and research and development center for cooperation between Southeast Asia, United States, and Japan.

• National Center for High-performance Computing

The 7th *i*-ONE International Instrument Technology Innovation Competition hosted by ITRC

A birthplace for instrument innovation!

The award ceremony of the 7th *i*-ONE International Instrument Technology Innovation Competition

The Instrument Technology Research Center has paid attention to innovative R&D instrument technology. The *i*-ONE International Instrument Technology Innovation Competition has been held by ITRC for 7 years since 2009. It is divided into high school level and college & above level, attracting domestic and international competitors. The awarded works have involved fields including everyday inventions and technology to reflect its emphasis on innovative R&D. Through this competition, ITRC facilitates encouraging young students to apply scientific knowledge, elicit their innovative thinking, and aim to vitalize technology development in Taiwan.

• Instrument Technology Research Center

Frontline of Real-time Relief Operation—Taiwanese Students' Dream "Relief Robots"

ITRC assisted ASME Taiwan Branch in hosting the SPDC

The award ceremony of the 2015 SPDC hosted by the ASME Taiwan Branch

This year, outstanding students from 7 domestic universities participated in the Student Professional Development Conference (SPDC) of ASME. The competition events were divided into two types: a design competition with "Robots for Relief" as its main theme and an English speech competition involving mechanics-related topics. Through this conference, the Instrument Technology Research Center hopes to elicit students' imagination and creativity for science, allowing the world to witness the research capability of students in Taiwan!

• Instrument Technology Research Center

Smart Electronic Academic Institution : Semiconductor Practical Courses

To cultivate advanced and talented individuals for semiconductor technology

According to instrument specifications and availability, the courses mainly focused on 8-inch equipment and were offered to instrument and manufacturing engineers with at least 2 years of experience in industrial or academic nanodevices laboratories. These training courses contributed to cultivating talented individuals in industry.

• National Nano Device Laboratories

IC Design and Implementation Course Series

Assisting beginners in individually completing chip designs through project-based practical courses

This course series was first offered in summer, 2015 and the content of which is divided into full-custom and cell-based courses. In addition to regular classes, basic training courses including chip implementation, IC prototype fabrication, and chip testing were emphasized to assist the students in individually completing IC designs during their first project-based practical course, thereby effectively shortening the gap between industry and academia.

• National Chip Implementation Center

The First SPARK International Conference (2015)

SPARK Taiwan sparks biomedical research achievements

SPARK Taiwan hosted the first SPARK International Conference and compiled SPARK programs from seven countries to share the dissimilar strategies and experiences of each country in cultivating biomedical professionals, developing related products, and converting academic research achievements to value-added applications. The following closed-doors meeting also discussed the common goals and principles of SPARK as well as the potential future operations and cooperation models.

◥ The First SPARK International Conference (2015)

• Science & Technology Policy Research and Information Center

International Cooperation

For international cooperation, NARLabs aims to establish global partnerships and online platforms with its core vision embracing the pursuit of "Global Excellence, Local Impact". NARLabs strives to promote innovative R&D efforts and a range of international collaborative undertakings to establish academic exchange channels for leading researchers in Taiwan and abroad.

Memorandum of understanding Signed between the National Applied Research Laboratories and Its Partners

Enhancing the innovation capability of the National Applied Research Laboratories through transnational cooperation

To expand its international technology cooperation alliance, strengthen its marine science research capability, and reinforce the interaction between Taiwan and Japan, the National Applied Research Laboratories (NARLabs) officially signed a memorandum of understanding with the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) on June 4, 2015 in hope of accelerating marine technology innovation through transnational cooperation.

President Ching-Hua Lo (right) signed a memorandum of understanding with JAMSTEC

Ching-Hua Lo, the President of the NARLabs, signed a memorandum of understanding with Korea's National Research Council of Science & Technology (NST) on August 24, 2015 to expand the cooperation facets between the two institutions. In addition to the National Nano Device Laboratories and Science and Technology Policy Research and Information Center, which have already cooperated with NST, NARLabs also hopes that the National Center for High-performance Computing, National Center for Research on Earthquake Engineering, and National Laboratory Animal Center will closely cooperate with NST. On the same day, NST representatives were invited to discuss with Jyuo-Min Shyu, the Minister of the Ministry of Science and Technology, and Chien Chou, the Director General of the Department of International Cooperation and Science Education of the Ministry of Science and Technology, for further cooperation beneficial to Taiwan and South Korea. In addition, the two parties promised to cohost a Taiwan–South Korea technology seminar in the near future.

Photo of the representatives from NARLabs and NST

EUTW Forum on Environment and Science and European Union Horizon 2020 Project

European Union and international experts and scholars were invited to solve human livelihood problems, thereby promoting the top-notch research achievements of Taiwan and NARLabs to the international community

The EU Horizon 2020 National Contact Point Office (NCP Taiwan) and the European Union Centre in Taiwan hosted the EUTW Forum on Environment and Science in the Liang Kuo Shu International Conference Hall of the College of Social Sciences, National Taiwan University on April 13, 2015. The forum was cohosted by Hsiao-Wei Yuan, the director of the NCP office, and Hung-Dah Su, the director of the European Union Centre in Taiwan. The forum invited experts from industry and academia as guest speakers and faciliated dialogue between attendees from government, industry, and academia.

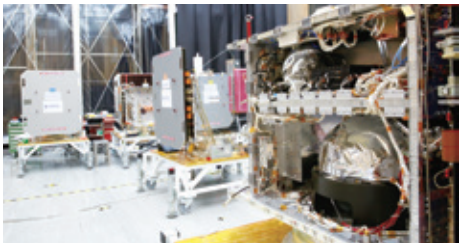
NCP Taiwan has actively encouraged the Ministry of Science and Technology to support Taiwanese professors and scholars in participating in Horizon 2020. As of the end of October, 2015, 10 Taiwanese teams had successfully applied for Horizon 2020. Two centers under NARLabs, the Taiwan Typhoon and Flood Research Institute and National Center for Research on Earthquake Engineering have both applied to participate in Horizon 2020 projects. This facilitates enhancing the research capability and international perspective of NARLabs.

Group photo of distinguished guests participating in the EUTW Forum on Environment and Science

Assembly and Testing for the First Set (6 Satellites) of FORMOSAT-7 Mission Satellites

International cooperation to create next-generation meteorological satellite constellation

FORMOSAT-7 is a meteorological satellite project conducted cooperatively by Taiwan and the United States. The spacecraft bus and the mission and scientific payloads provided by the United States were delivered to National Space Organization in March, 2015. Currently, the spacecraft buses and payloads are being assembled and tested, and various tasks including ground system integration are being conducted.



Assembly and testing for FORMOSAT-7 mission satellites

Hosting the 2015 APEC Typhoon Symposium

Sharing disaster management experience with the Asian-Pacific Economic Cooperation (APEC) Member Economies

The APEC Research Center for Typhoon and Society (ACTS) hosted the 2015 APEC Typhoon Symposium in Manila, Philippine.

President Ching-Hua Lo, who also serves as an ACTS Steering Committee member, led the Taiwan delegation to join the conference. Each APEC Member Economies not only published their latest research results but also shared their management and response measures against disastrous typhoons. President Ching-Hua Lo also visited the University of the Philippines and discussed cooperation with the university president.

◥ Group photo of speakers and honorable guests joining the 2015 APEC Typhoon Symposium

2015 International Training Program for Seismic Design of Structures

Enhancing international reputation through technology diplomacy

To assist countries in Asia-Pacific and Central and South America to improve their seismic design techniques, the National Center for Research on Earthquake Engineering have annually hosted the International Training Program for Seismic Design of Structures since 2002, thereby reinforcing the technology diplomacy of Taiwan. After the course was approved to become an official APEC event, participants actively signed up for the course. In 2015, 26 participants from 11 countries joined the course, and 27 participants from Malaysia also joined the course at their own expense. Therefore, this event has received the attention of various countries.

◥ Group photo of the 2015 International Training Program participants

Social Engagement

For social engagement, NARLabs is commissioned to serve as the guardian of Taiwan by developing innovative science and technology for reducing damages from natural disasters and enhancing the quality of living for people in Taiwan. NARLabs employees devote their efforts to foster Taiwan's technological innovation as S&T volunteers. As climate change causes a growing number of natural disasters, NARLabs researchers have made significant impacts through monitoring and early warning technologies.

Fun Scientific Experiential Activity for Summer Vacation!

One day experience - to be a little scientist, laboratory animal keeper, and veterinarian

To implement the reduction and replacement principles of the Three Rs, the National Laboratory Animal Center has converted difficult laboratory animal science and complex experimental content to fun scientific experimental activities. NLAC also continually developed teaching materials and interactive games for public science education. The center aims to cultivate children's sympathy, respect, and gratitude of life by a pleasant gaming experience.

Little scientists happily demonstrated their hands-on works through scientific experiential activities

• National Laboratory Animal Center

Launch of FORMOSAT-5 and FORMOSAT-7 : Children Drawing Competition

Seeing Taiwan, Launching Your Dream

National Space Organization hosted the "Seeing Taiwan, Launching Your Dream" FORMOSAT Nationwide Children Drawing Competition for children in kindergartens and elementary schools for FORMOSAT-5 and FORMOSAT-7. A total of 3,694 works were received, among which 116 were awarded. The award ceremony was held in December 17, 2015 at the Ministry of Science and Technology. The winner's drawings will be carried by launchers toward the space.

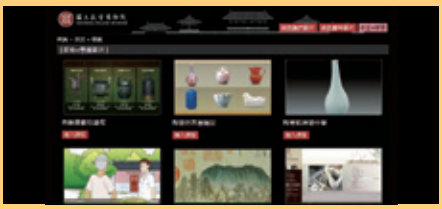
The award ceremony of the FORMOSAT Nationwide Children Drawing Competition

• National Space Organization

National Palace Museum Education Channel and Digital Audio Book Platform

Breaking the barrier of knowledge through information technology

The National Palace Museum Education Channel is a one-cloud-multiple-screen digital learning platform established using cloud technology to share high-quality multimedia materials of the museum with remote villages. The Digital Audio Book Platform was the first DAISY(Digital Accessible Information System) electronic book platform in Taiwan for people with vision impairment.



National Palace Museum Education Channel and Digital Audio Book Platform

• National Center for High-performance Computing

Domestic Traveling Theater Group Performing *Water Resources Being Taken Away*

Teaching the concept of disaster management and water resources preservation to children

The Taiwan Typhoon and Flood Research Institute, Ministry of Science and Technology, Water Resource Agency, and Central Weather Bureau cooperated to create a story drama: *Water Resources Being Taken Away*. This year, a total of 11 performances attracted more than 2,500 viewers. Through each vivid and exciting performance, the audience learned to react and evacuate during disasters, respect the nature, and treasure water resources!

Interesting interactions between the actors and audience during the performance of *Water Resources Being Taken Away*

Children actively answered questions and engaged in games on the stage during the performance of *Water Resources Being Taken Away*

- Taiwan Typhoon and Flood Research Institute

Harmonious Coexistence of Ocean and Humans : Marine Education in Taiwan

Visit of elementary school teachers for the Marine Core Repository and Laboratory, TORI

It can be foreseen that a scenario of global warming will continue over the forthcoming century. Harmonious coexistence of ocean and humans becomes a crucial issue for all human beings. For this purpose, the Marine Core Repository and Laboratory (MCRL) presents paleoceangrahic and paleo-environmental reconstructions from the seas around Taiwan by using marine sedimentary cores. During this camp, all participants were also inspired in ocean sciences and received important messages from marine cores.

All participants met MCRL, TORI

- Taiwan Ocean Research Institute

Joint Observations of Coral Spawning in the Nan-Wan Bay

Innovative coral reef research and conservation

During the coral spawning season at Nan-wan Bay in May 2015, the Taiwan Ocean Research Institute integrated its existing assets and expertise (i.e., ocean radar current measurements, acoustic Doppler current measurements, numerical simulations, sediment sonar sea floor side scanning sonar, live underwater imaging, satellite water color assessments, and diving surveys, etc.) to monitor the relationships between organisms and the marine environment from various perspectives, creating new, innovative research and conservation methods in the process.

- Taiwan Ocean Research Institute

◢ Setting up underwater video cameras for a live broadcast of coral spawning, which received overwhelming responses from the public just like those in sports events

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Publishing Date : May 2016

I Establish R&D Platforms I

I Support Academic Research I

I Promote Frontier Science and Technology I

I Foster High-tech Manpower I

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ISSN 2072-2567
9 772072 256005