

NAR Labs

ANNUAL REPORT
2023



國家實驗研究院
National Applied Research Laboratories

NAR Labs

ANNUAL REPORT
2023

CONTENTS

01 PREFACE	03
Message from the Chairperson Message from the President	
02 R&D SERVICE PLATFORM ACHIEVEMENT AWARDS	08
03 HIGHLIGHTS	22
04 R&D AND SERVICE ACCOMPLISHMENTS	28
05 DEVELOPMENT PLANS	38
06 COLLABORATION CONNECTING INDUSTRY, ACADEMIA, & RESEARCH	43
07 FOSTERING OF SCIENTIFIC AND TECHNOLOGICAL TALENT	47
08 INTERNATIONAL COLLABORATION	53
09 SOCIAL ENGAGEMENT	62
10 MILESTONES	66
11 ANNUAL PROFILE	70
12 OUR LABORATORIES	75

EVOLUTION

2003

National Applied Research Laboratories (NARLabs) was established with six founding labs

- 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

Taiwan Ocean Research Institute (TORI) was established.

2011

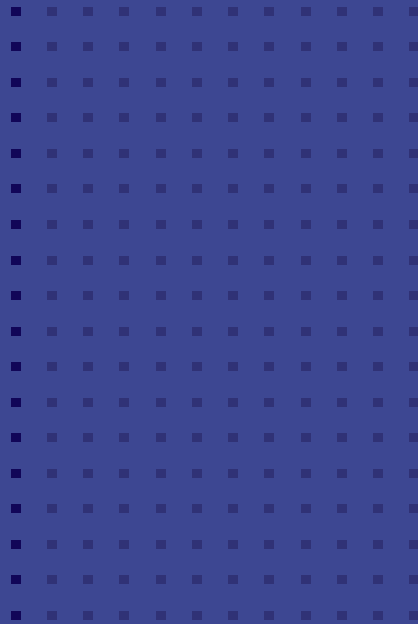
Taiwan Typhoon and Flood Research Institute (TTFRI) was established.

2019

- Taiwan Typhoon and Flood Research Institute (TTFRI) was merged into National Science and Technology Center for Disaster Reduction (NCDR).
- National Chip Implementation Center (CIC) and National Nano Device Laboratories (NDL) were merged into Taiwan Semiconductor Research Institute (TSRI).
- Instrument Technology Research Center (ITRC) was renamed Taiwan Instrument Research Institute (TIRI).

2023

The National Space Organization (NSPO) transitioned into a new legal entity under the NSTC and was renamed the Taiwan Space Agency (TASA)



PREFACE

MESSAGE FROM THE CHAIRPERSON

The National Applied Research Laboratories (NARLabs) was established in 2003. Over the past 20 years, NARLabs has contributed to Taiwan by supporting academia and assisting innovation in academic research.

Looking towards the future, the National Science and Technology Council (NSTC) has already set its 2035 S&T develop vision as “Forward-looking Innovation, Democracy and Inclusiveness, and Resilience and Sustainability”. Moreover, the NSTC has proposed eight forward-thinking S&T platforms:

“Forward-thinking Semiconductors and Quantum Technology,” “AI,” “Space Technology and 6G,” “Cyber Security,” “Precision Health (Disease Prevention and Elder S&T),” “Net-zero Technology,” “Defense Technology,” and “Humanities and Social Issues.” Acting as a juristic entity under the NSTC, NARLabs is committed to supporting the NSTC move towards the 2035 S&T development vision by promoting these eight forward-thinking technologies.

Over the past two years, generative AI has signifi-

cantly impacted the world. Taiwan has garnered attention from across the globe due to our semiconductor industry. Thus, this is a critical moment for Taiwan's scientific research and industrial development. Compared with last year, the Executive Yuan has Taiwan's 2024 S&T budget has increased by 18% (NT\$24.2 billion) to NT\$156.9 billion. As such, Taiwan's 2024 S&T budget has broken records both in terms of percentage increase and overall amount. The Executive Yuan also passed the Taiwan Chip-based Industrial Innovation Program (TCIIP), which aims to leverage chip technology to drive industrial innovation across industries throughout Taiwan. TCIIP will last 10 years, and the first 5 years phase. After the first phase is completed, it is expected that potential innovation will have started to spring forth. The NARLabs Semiconductor Research Institute (TSRI), Taiwan Instrument Research Institute (TIRI), and National Center for High-performance Computing (NCHC) all will play important roles in promoting Taiwan's chip development.

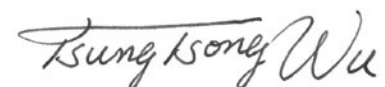
In addition to our strengths in chip technology, Taiwan must also leverage its advantages in semiconductors to bolster the design and application of biomedical chips. In addition, Taiwan also bring together international partners to get ahead of the pack, expand business opportunities in precision health, and drive Taiwan's biotech to become the country's next trillion (NT) dollar industry. Of course, academia and the research community are main driving force behind these goals. NCHC must assist the academic, research, and medical institutions apply AI in precision medicine, while the National Laboratory Animal Center (NLAC) must strengthen R&D on various types of specialized mice. As such, these institutions will play a key supporting role in this process. In addition, 3Rs (Replacement, Reduction, Refinement) are now the focus of research across the globe. In addition to supporting the NSTC promote the 3Rs in research, NLAC will also partner with TIRI and TSRI to make a mark in the developing "organ-on-a-chip" technology.

S&T development goes beyond the close connection of upstream academic institutions with downstream industrial entities. It also requires close ties

between political, social, and economic entities. Currently, net zero emissions is one of the most important environmental issues of our times. In 2023, Taiwan's S&T budget allocated NT\$11.9 billion to develop five key net-zero technologies: "Sustainable and Forward-thinking Energy," "Low (Reduced) Carbon," "Carbon Negative," "Circular," and "Humanities and Social Sciences". For Taiwan's S&T budget to be used in the most efficient manner possible, the NSTC has already partnered with Academia Sinica to jointly establish the "Net-zero Technology Policy Advisory Commission," with NARLabs leading its affiliated "Net-Technology Policy Promotion Working Group". This Commission will coordinate and integrate net-zero technology policy across government agencies, link technological applications with international cooperation, and initiate transformative processes than span generations, disciplines and borders. In addition, Taiwan lead the world towards a brighter future by having the public and private sectors work together with local communities to promote a movement in net-zero living.

In the future, NARLabs hopes it can keep serving as an important partner to academic institutions that are conducting forward-looking research, act as a bridge between academia and industry, finding downstream industrial applications of original academic research, and creating value by creating cross-sector connections. In addition, NARLabs will become an important supporter of promoting the NSTC's 2035 S&T development vision and stay committed to establishing the long-term developmental capacities and competitiveness for the future of Taiwan.

Chairperson



MESSAGE FROM THE PRESIDENT

With the theme of “Moving the Nation Forward Through Innovation,” the National Applied Research Laboratories (NARLabs) held the NARLabs 20th Anniversary and Outlook Summit in July 2023. At the event, Executive Yuan Premier Chen Chien-jen stated that under the direction of the National Science and Technology Council (NSTC), NARLabs must continue to help Taiwan’s entire S&T industrial development ecosystem run smoothly by serving as a bridge between academic research institutions and industrial entities. In addition, Premier Chen stated that NARLabs should utilize its expertise in S&T to establish important partnerships across various disciplines with countries around the world. In addition to driving S&T development throughout Taiwan and across the globe, Premier Chen stated, such efforts will help Taiwan establish S&T diplomacy. NSTC Minister Tsung-Tsong Wu also pointed out that NARLabs should do its best to help upstream academic institutions produce forward-thinking research results and connect such results to innovative applications. Minister Wu also stated that NARLabs should then work with the Ministry of Economic Affairs to improve the welfare of the public by transferring these results to downstream S&T-related industries. NARLabs has been working towards these goals in recent years.

In addition to establishing large-scale instruments and equipment that are impossible for single universities to set up on their own, such as supercomputers, large-scale earthquake shake tables, and the *R/V Legend* research vessel, NARLabs also has created many scien-

tific research platforms. These platforms, which are supported by experts, give researchers the chance to use relevant equipment while helping academia conduct cutting-edge technological R&D. For three years running, NARLabs has held the R&D Service Platform Achievement Awards. These Awards bestow prizes to teams with outstanding research, and aims to produce globally competitive scientific research results by encouraging more academic research teams to use this nationally supported R&D service platform. In 2023, the Awards were written about extensively in *Scientific American*. Such articles weren’t aimed to promote NARLabs, but rather to more effectively drive national-level S&T development.

Chips and generative AI are critical technologies for the next wave of industrial transformation. These technologies will impact the next 20 years of global politics, economics, and social issues. In response to these developments, the NSTC launched the Taiwan Chip-based Industrial Innovation Program (TCIIP). NARLabs will play an important role in TCIIP because the National Center for High-Performance Computing (NCHC) will construct a new 16petaflop GPU supercomputer that will be used for building “foundational models for large-scale generative AI.” NARLabs will subsequently develop innovative solutions across industries by encouraging academic institutions and private companies from at home and abroad to use this generative AI technology. The Semiconductor Research Institute (TSRI) will help advance research on semiconductor materials and advanced components by establishing a forward-thinking environment for semiconductor R&D, which will include advanced packaging services and an integration environment for 1-nanometer atomic-level processes. Moreover, TSRI will expand the foundation for cultivating talent in the design of advanced three-dimensional finFET circuits by establishing a service environment for under 7-nanometer advanced chip design. By upgrading the country’s semiconductor facilities, Taiwan can become a global leader in cultivating semiconductor talent, attract the world’s best students that are interested in semiconductor



technology to study in Taiwan, and help industry, academia, and the research community accelerate the development of advanced semiconductor technology.

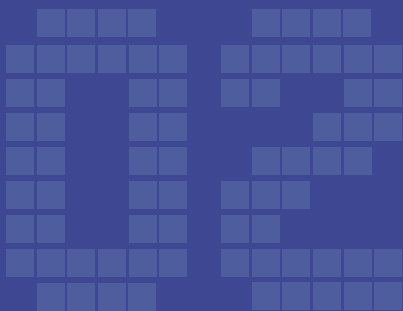
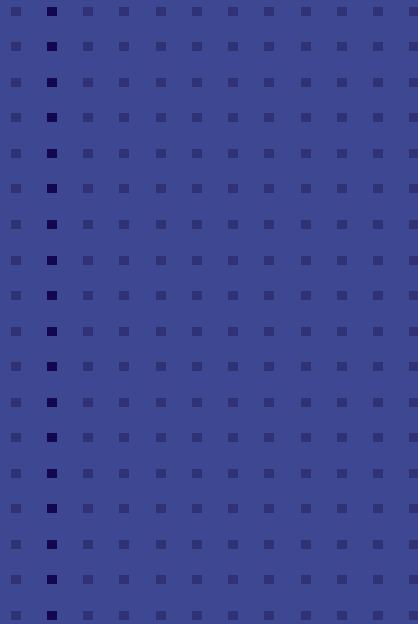
In response to the challenges of climate change, the entire world is actively pursuing net-zero emissions. The NARLabs Net-zero Technology Policy Promotion Working Group is responsible for helping the NSTC formulate net-zero technology development policy from a national perspective. In addition to developing the R&D departments for five major net-zero technologies that include: “Sustainable and Forward-looking Energy,” “Low (Reduced) Carbon,” “Carbon Negative,” “Circular,” and “Humanities

and Social Sciences,” NARLabs will also guide S&T development from a perspective that accounts for social needs. This collaborative effort between public and private sectors aims to build momentum towards a new lifestyle of net-zero emissions.

In addition to staying committed to promoting TCIP and net-zero related tasks, NARLabs published its first sustainability report in 2023. Besides attempting to balance the three major sustainability themes of: “environmental protection,” “social responsibility,” and “corporate governance,” NARLabs hopes to fulfil its executive tasks, promote energy saving, carbon reduction, and social prosperity while helping Taiwan move towards a future of sustainable development.

President

Rao-Jeng Lin



R&D SERVICE
PLATFORM
ACHIEVEMENT
AWARDS

Award Background

With the vision of "Global Excellence, Local Impact" and under the support and guidance of the National Science and Technology Council (NSTC), NARLabs provides various professional R&D service platforms and implements high-cost software and hardware facilities that are difficult for domestic universities to cover in order to assist the academic and research community in advancing scientific knowledge and developing cutting-edge technology, which will ultimately benefit our citizens. To commend industries, government agencies, research institutions, and academicians for employing NARLabs' R&D service platforms to achieve cutting-edge scientific results, NARLabs inaugurated the R&D Service Platform.

Achievement Awards in 2021. The year 2023 was the third time the Awards were presented, and a to-

tal of 5 outstanding teams were awarded the honors. Today's advanced scientific and technological research relies mostly on teamwork and state-of-the-art software and hardware equipment, representing precisely the strengths of the various R&D service platforms established by NARLabs. We hope these awards will encourage the academic and research institutions in Taiwan to collaborate with NARLabs more readily and take advantage of R&D service platforms created through national resolve and the country's most advanced resources to achieve globally competitive research results.



▲ (From left) NTHU Associate Professor Hsin-Yi Chen, TMU Associate Professor Syu-Jyun Peng, NYCU PhD student Cheng-Kuei Lee, NYCU Assistant Professor You-Chia Chang, NYCU Professor Horng-Chih Lin, NYCU Professor Peichen Yu, NCKU PhD student Chien-Yu Chiu, NCKU Distinguished Professor Pau-Choo Chung, NARLabs President Faa-Jeng Lin, NARLabs Vice President Bou-Wen Lin, NCHC Director General Chau-Lyan Chang, TSRI Deputy Director General Chia-Sung Chiu

High Distinction

Achievement

Open AI Pathology Analysis Platform with Integrative Collaboration

Platform

Taiwania 2 AI Supercomputer (NCHC)

Team Members

Pau-Choo Chung Distinguished Professor
Department of Electrical Engineering, National Cheng Kung University (NCKU)

Chien-Yu Chiu PhD student
Department of Electrical Engineering, NCKU

Guan-Wei Lin Research specialist
Department of Electrical Engineering, NCKU

Hung-Wen Tsai Chief of Clinical Pathology
Department of Pathology, NCKU Hospital

Hung-Chih Chiu Attending physician
Department of Internal Medicine, NCKU Hospital

Tsung-Hsuan Wu Postdoctoral Fellow
Department of Electrical Engineering, NCKU

Lin-Chi Yeh Master's student
Department of Electrical Engineering, NCKU

Romel Rudon Master's student
Department of Electrical Engineering, NCKU

Kuo-Sheng Cheng Professor
Department of Biomedical Engineering, NCKU

Wei-Jong Yang Assistant Professor
Department of Artificial Intelligence and Computer Engineering, National Chin-Yi University of Technology

Yi-Shan Tsai Director
Clinical Innovation and Research Center, NCKU Hospital

Huey-Jen Su Distinguished Professor
Department of Environmental and Occupational Health, NCKU

Meng-Ru Shen President & Distinguished Professor
NCKU & Department of Pharmacology, NCKU

Chun-Rong Huang Professor
Cross College Elite Program & Academy of Innovative Semiconductor and Sustainable Manufacturing, NCKU

Excellence

Achievement

IPC for Large-Area and High-Efficiency Metalenses

Platform

Semiconductor Fabrication Service Platform Lithography and Etching Module Validation Service (TSRI)

Team Members

Peichen Yu Professor
Department of Photonics, National Yang Ming Chiao Tung University (NYCU)

You-Chia Chang Assistant Professor
Department of Photonics, NYCU

Excellence

Achievement

T-Shaped Gate Transistor Technology

Platform

Advanced Semiconductor Fabrication Service Platform and High-Frequency Measurement Technology Service (TSRI)

Team Members

Hong-Chih Lin Professor
Institute of Electronics, NYCU

Cheng-Kuei Lee PhD student
Institute of Electronics, NYCU

Honorable Mention

Achievement

Computational Catalysis Tools for Design, Optimization, and Descriptor Development of Green Energy Materials

Platform

Taiwania 1 Supercomputer (NCHC)

Team Members

Hsin-Yi Chen Associate Professor
Department of Engineering and System Science, Department of Materials Science and Engineering, & College of Semiconductor Research, National Tsing Hua University

Honorable Mention

Achievement

PET Machine Learning Quantitative Localization System and Method

Platform

LIONS Data Framework (NCHC)

Team Members

Syu-Jyun Peng Associate Professor
Professional Master Program in Artificial Intelligence in Medicine, Taipei Medical University

Yu-Hsiang Yu Director
Epilepsy Division, Neurological Institute, Taipei Veterans General Hospital

Yen-Cheng Shih Attending physician
Epilepsy Division, Neurological Institute, Taipei Veterans General Hospital

Che-Hao Lee Attending physician
Department of Nuclear Medicine, Taipei Veterans General Hospital

Open AI Pathology Analysis Platform with Integrative Collaboration



Pau-Choo Chung
Distinguished Professor

For years, liver cancer has been one of the top two causes of cancer-related deaths in Taiwan. Last year, around 8,000 Taiwanese died of liver cancer. Thus, National Cheng Kung University Department of Electrical Engineering Professor Pau-Choo Chung and her team partnered with the National Center for High-performance Computing (NCHC) as well as with physicians from various hospitals such as National Cheng Kung University Hospital, Kaohsiung Chang Gung Memorial Hospital, and Taichung Veterans General Hospital to address this issue. Together, they developed a digital pathology AI analysis model that analyzes digital pathology images of tissues in the human body to detect areas of change. The model calculates quantitative indicators related to disease diagnosis, which assists physicians in their diagnoses by providing objective pathological analysis results. The team has currently developed models for liver tumor detection, liver fibrosis AI analysis, and liver fat droplet AI analysis. Several research findings on digital AI pathology have been published in international journals and presented at conferences. The team aims to apply AI technology to assist in the analysis of liver diseases, particularly in the quantitative analysis of hepatitis and liver cancer. This application is expected to contribute to the efficiency of diagnosing and treating liver diseases.

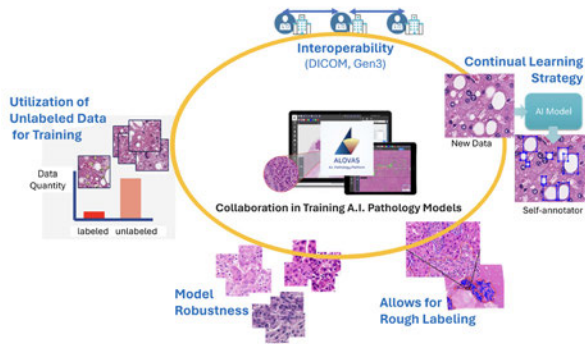


▲ Professor Pau-Choo Chung's laboratory team collaborated closely and achieved remarkable results in the field of healthcare.

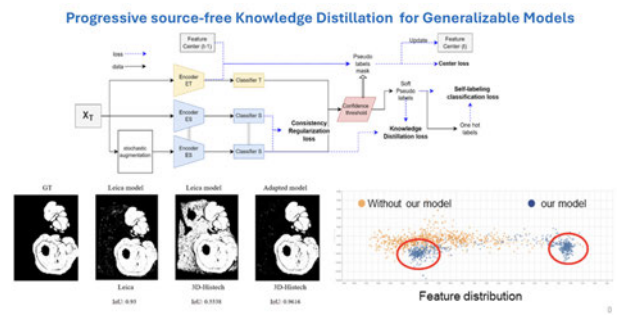
In addition, the team has integrated the research findings of digital AI pathology to establish the ALOVAS Digital Pathology Cloud Analysis Platform on NCHC’s cloud space. This platform provides physicians with a convenient all-in-one digital pathology image analysis integration service by integrating digital pathology image analysis, annotation, pathology AI model training, and AI pathology. Subsequently, the platform’s functionalities were jointly expanded by the AI Capstone Project, which was led by former National Cheng Kung University President Hui-Chen Su, and the clinical trials of current National Cheng Kung University President and former National Cheng Kung University Hospital Superintendent Meng-Ru Shen. They are also developing the world’s first Federated Learning Agent (FLAg) training mechanism. This mechanism, which is being interfaced with the National

Institutes of Health (NIH) system in the United States, is the NIH’s first international partner in pathology image analysis.

The team would like to thank NCHC for providing extensive computational resources, storage space, and bandwidth for the ALOVAS platform. This support has enabled the rapid storage and analysis of pathology images and the efficient training of pathology AI models. Moreover, given that ALOVAS deals with sensitive medical images, NCHC has prevented information from being compromised or stolen by providing comprehensive cybersecurity for the entire system. In instances where the platform’s operational performance falls short of expectations, experts at NCHC provide technical advice to adjust and optimize the computational environment to provide the best results.



▲ Through the ALOVAS platform, smooth communication with physicians is beneficial for the development of excellent AI models.



▲ The pathological AI model developed by Professor Pau-Choo Chung's team demonstrates enhanced stability in analyzing pathological slides from various medical institutions.

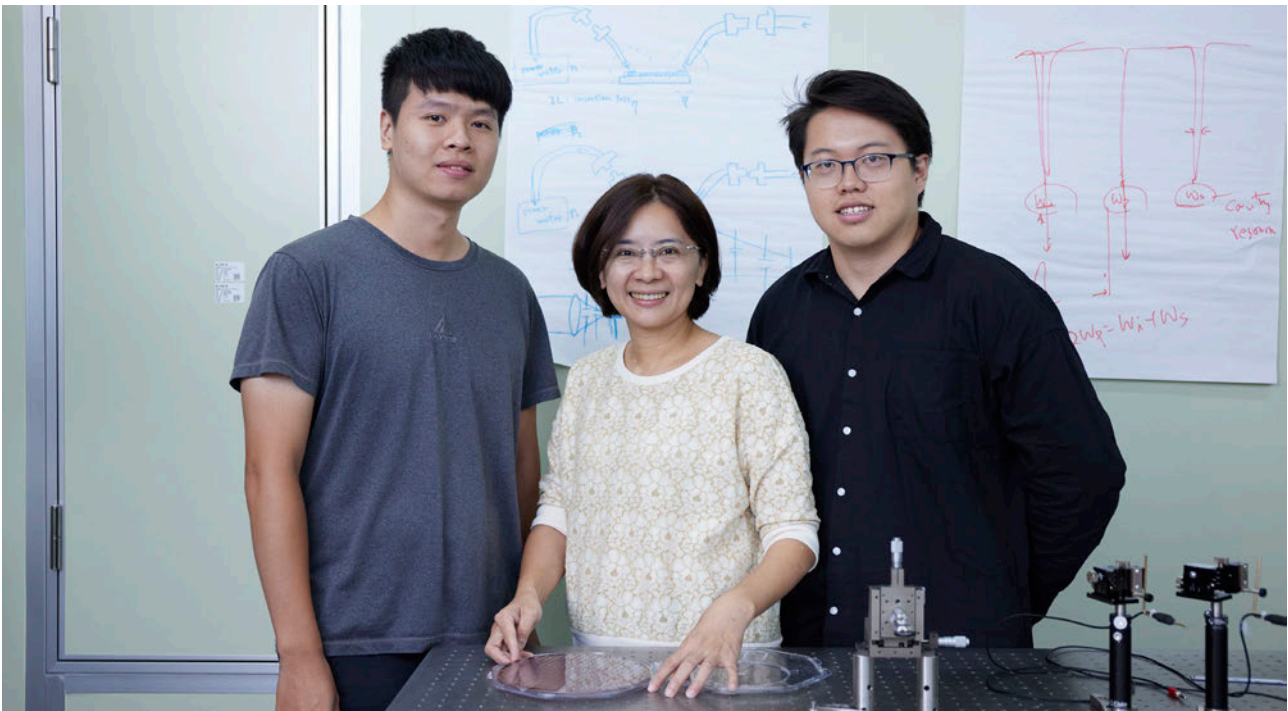
IPC for Large-Area and High-Efficiency Metalenses



Peichen Yu
Professor

Metalenses, which consist of millions to billions of nanopillars, will be a key technology for future camera lenses. Through its optical design, metalenses can bend light and focus images. The height of these nanopillars is only 1/100 to 1/50 of the diameter of human hair. Thus, even if multiple metalenses need to be stacked, it will not exceed the thickness of a credit card. As such, metalenses are considered the best solution for reducing the volume of optical systems.

Metalenses are produced on millimeter-thin wafers using IC processing materials and equipment. National Yang Ming Chiao Tung University Department of Photonics Professor Peichen Yu and her team have developed Intelligent Proximity Correction (IPC) technology. This approach replaces optical simulation with a deep learning lithography model. By leveraging NCHC's computing resources, IPC accurately predicts the morphology and dimensions after photoresist development, which can assist in the precise correction of reticles in target patterns. This advancement raises the resolution to the limit of photoresist. Using the Taiwan Semiconductor Research Institute's (TSRI) processing platform, the team successfully manufactured large-area (8-millimeter diameter) high-efficiency metalenses on eight-inch wafers. This advancement, which opens up possibilities



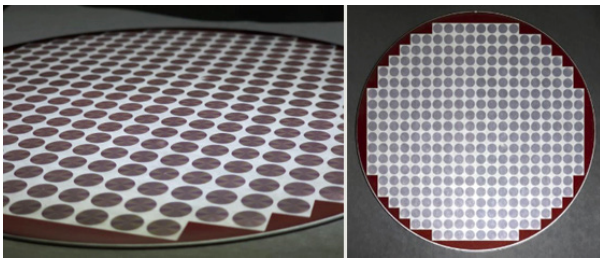
▲ Professor Peichen Yu and team members achieved groundbreaking research in semiconductor and optical technologies through collaboration with Taiwan Semiconductor Research Institute of NARLabs.

for mass production, is expected to have a significant impact on the future development of imaging and sensing modules for mobile phones.

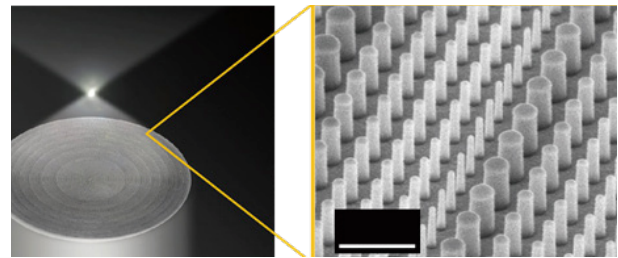
Because metalenses are particularly flat and compact, they can be applied to technology such as medical components, optical inspection, and augmented/virtual reality glasses. In addition to publishing numerous academic papers, Professor Peichen Yu's team has also engaged in several industry-academic collaborations and technology transfers in Taiwan and abroad. These collaborations have involved companies such as Taiwan Semiconductor Manufacturing Company, SUMCO, a Japanese company that is the third-largest silicon wafer manufacturer in the world, Himax, AUO, and TDK (Japan).

Professor Peichen Yu's would like to thank the Na-

tional Applied Research Laboratories (NARLabs) for providing its facilities, which has equipment comparable to industry standards and professional advice from professional engineers. Such substantial assistance and support has significantly shortened the R&D process. In addition, Professor Peichen Yu stated that her partnership with NARLabs has played a crucial role in training many students. By providing an opportunity for research, Professor Peichen Yu's students can now work in advanced CMOS (Complementary Metal-Oxide-Semiconductor) process development after graduation. Such a partnership has helped both National Yang Ming Chiao Tung University and the industry as a whole in terms of talent cultivation and the development of innovative technologies.



▲ The research team successfully manufactured 332 large-area near-infrared superlenses on an 8-inch glass substrate.



▲ The superlens with an area of 25 square millimeters contains approximately one billion nanowires.

T-Shaped Gate Transistor Technology



Horng-Chih Lin
Professor

The concept of T-gate transistors is not new and has been widely applied in the field of compound semiconductors. However, their application in silicon semiconductors is relatively less common. Even though silicon semiconductors have a market share of 90%, they are still not as competitive as other material technologies in certain specialized fields. One example is high-frequency satellite communications, where alternative materials may outperform silicon semiconductor technology.

National Yang Ming Chiao Tung University Institute of Electronics Professor Horng-Chih Lin and his team successfully developed T-gate Transistor Technology for silicon semiconductors using various advanced equipment at TSRI. The equipment includes a green laser system, LAM TCP 9400 poly etcher, ion implanters, sputtering systems for depositing metal, Rapid Thermal Anneals (RTA), and high-frequency S-parameter measurement system. The new process involves T-gate polycrystalline silicon thin-film transistors that can be fabricated without the need for additional etching steps. This effectively enhances the device's transconductance, cutoff frequency (f_T), and maximum oscillation frequency (f_{max}). With an f_T/f_{max} of 62.5/30 GHz, Professor Horng-Chih Lin's T-gate transistor achieved

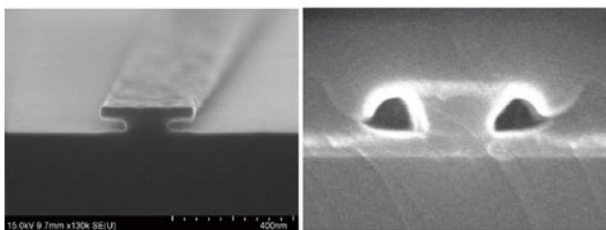


a world record for polycrystalline silicon transistors.

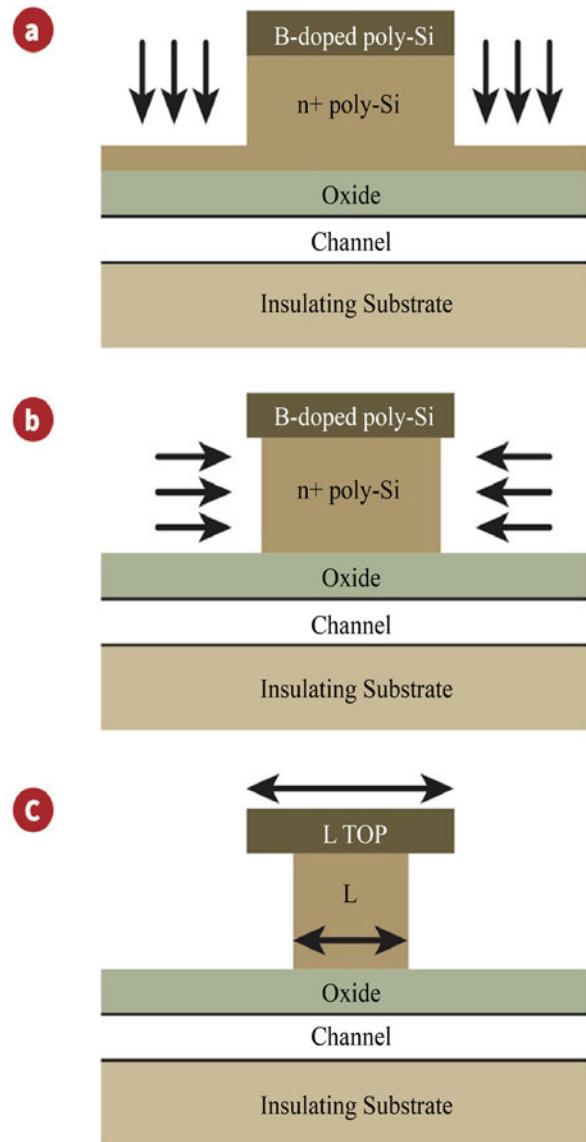
The T-gate structure can also be applied to the fabrication of devices in Lightly Doped Drain (LDD) logic circuits. This application significantly simplifies the complex fabrication processes traditionally associated with LDD devices. Moreover, it offers benefits such as reduced leakage current and self-alignment. In addition to presenting these achievements at major international conferences, Professor Horng-Chih Lin's team has also filed for patents in both the US and Taiwan.

Professor Horng-Chih Lin's team stressed that in semiconductor research, factors such as materials and equipment are often prohibitively expensive. Many critical pieces of equipment cost tens of millions of NTD. As a national-level laboratory, TSRI has played a crucial role in constructing and providing academia access to these expensive resources. As such, TSRI has served as a critical supporter of academic research throughout Taiwan. Professor Horng-Chih Lin's team would like to thank the experts at TSRI for their professional guidance and suggestions during the research process. Despite facing numerous challenges, Pro-

fessor Horng-Chih Lin's team was successful due to their persistence coupled with TSRI's resource support.



▲ The T-Shaped Gate Transistor as seen under an electron microscope (left) along with a cross-sectional view (right).



▲ The team's designed fabrication process successfully produced samples using the LAM TCP 9400 etching machine.

Computational Catalysis Tools for Design, Optimization, and Descriptor Development of Green Energy Materials



Hsin-Yi Chen
Associate Professor

The need to reduce the burning of fossil fuels as an energy source is necessary because it releases greenhouse gases that are causing climate change. Thus, the search for novel green energy technologies has become a crucial mission for scientists worldwide. Storing green energy as hydrogen fuel is at the heart of green energy technologies because hydrogen is readily accessible, easily combustible, and carbon-free.

Long-term storage and transportation of hydrogen remains extremely challenging as it requires high-pressure liquefaction. Recently, scientists have discovered that ammonia might be a potential alternative energy carrier that can provide a more convenient and safe means of storing and transporting energy. The storage and transportation technology for ammonia is well-established. However, traditional methods of catalytic ammonia production require severe reaction conditions that limit its application to green energy technologies. To address this, ammonia production catalysts must be developed to increase the energy efficiency of the process at milder conditions. Similarly, catalysts can be developed for the carbon-free decomposition of ammonia into hydrogen and nitrogen gases.

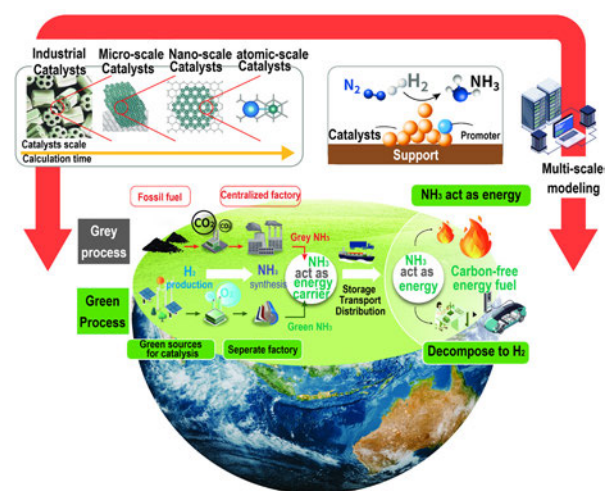


▲ Professor Hsin-Yi Chen's collaboration with NCHC encourages students to participate in NCHC-related courses and utilize resources to enhance research outcomes.

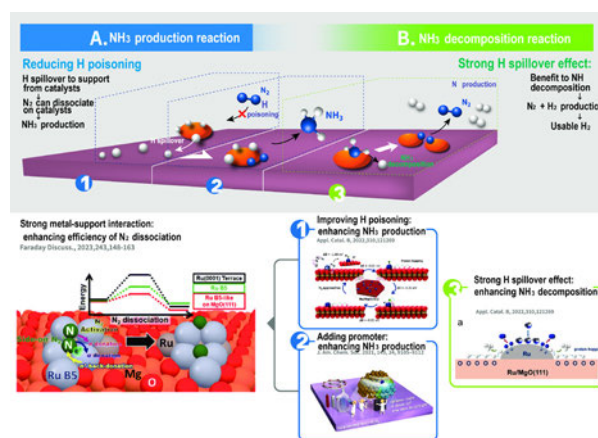
Associate professor Hsin-Yi Chen is primarily appointed in the National Tsing Hua University Department of Engineering and System Science, and also holds joint appointments in the Department of Materials Science Engineering and the College of Semiconductor Research. To explore this issue, professor Hsin-Yi Chen and her team utilized the Taiwan 1 Supercomputer. Through ab initio calculations and computational modelling and simulation methods, Associate Professor Hsin-Yi Chen's team rapidly revealed various atomic-level microscopic properties, such as structure, stability, and electronic structure as well as thermodynamic and kinetic properties of various ammonia conversion catalysts. After understanding the complex steps and key stages of catalytic reactions, they have identified novel design paradigms for such catalysts. By optimizing catalyst materials and predicting the optimal reaction conditions, the team significantly contributed to the design of several catalysts that could overcome the two major chal-

lenges of "hydrogen poisoning" and "high energy consumption in nitrogen dissociation" during ammonia production and decomposition reactions.

Associate Professor Hsin-Yi Chen demonstrated that the integration of computer simulations with experiments helped alleviate the time-consuming and resource-intensive challenges of catalyst design and optimization. With the help of the NCHC's supercomputer, Associate Professor Hsin-Yi Chen's team significantly contributed to the development of high-quality catalysts. This has led to the successful development of a new generation of ammonia production and decomposition catalyst designs aligned with green energy technologies. In the future, Associate Professor Hsin-Yi Chen hopes to accelerate net-zero carbon emissions by developing new materials for green energy technologies that are highly efficient, low-cost, low-energy, and low-carbon.



▲ Carbon-free fuel and hydrogen fuel carriers can be derived from green ammonia synthesis and decomposition reactions.



▲ The team's research outcomes cover both A. ammonia synthesis reactions and B. ammonia decomposition reactions.

PET Machine Learning Quantitative Localization System and Operation Method



Syu-Jyun Peng
Associate Professor

Epilepsy is a longstanding medical condition that may manifest as irregular muscle twitching, mental confusion, and brief lapses in consciousness, with severe cases leading to total loss of consciousness. Epileptic seizures result from abnormal discharges of nerve cells in the brain. In Taiwan, approximately 200,000 people suffer from epilepsy, and around 30% of these cases are classified as refractory epilepsy. For individuals with refractory epilepsy, medication proves ineffective in controlling the condition, necessitating the consideration of surgical intervention to remove the epileptic focus.

The origin of epileptic seizures can be located in different cortical regions of the brain. One common type is known as mesial temporal lobe epilepsy. Before undergoing surgery, physicians typically conduct various non-invasive tests, often utilizing positron emission tomography (PET) to assess glucose metabolism in the brain. The glucose metabolism in an epileptic focus is typically lower, resulting in lower signal intensity. However, when signals from the left and right mesial temporal lobes are very similar, it becomes challenging to discern image differences manually.

Associate Professor Syu-Jyun Peng of Taipei Medical University School of Medicine Professional Master Program in Artificial Intelligence in Medicine has incorporated AI into positron emission tomography (PET). Using Convolutional Neural Network technology within AI deep learning to collect PET glucose metabolism images and input them into an AI model allows it to automatically identify useful features in the images. Associate Professor Syu-Jyun Peng's team to significantly shorten the processing time by having the data be processed by supercomputers



Artificial Intelligence in Medicine



Neuroimaging Analysis



Electrophysiological Signal Analysis



Brain Connectivity Modeling

▲ The infinite potential of AI has been gradually applied across various medical fields, with significant progress seen in epilepsy diagnosis.

after uploading it to the NCHC's LIONS Biotech Cloud Platform. A considerable amount of computational time was saved during the training of the AI model, which led the model to more accurately interpret PET images of glucose metabolism. When interpreted by physicians, the accuracy rate among three experienced doctors was approximately 74.6%. However, the qPET platform, which was constructed from the AI model, achieved a 100% accuracy rate in the interpretation of images of over ten patients.

In the future, Associate Professor Syu-Jyun Peng hopes to utilize PET images of glucose metabolism to further predict the conditions after undergoing epilepsy surgery. In addition, Associate Professor Syu-Jyun Peng hopes to aid physicians in obtaining more accurate diagnostic results by incorporating magnetic resonance imaging (MRI), EEG information, and clinical variables into the AI model.

AI analysis of FDG-PET in MTLT (qPET)

LOAD

ID 03724606 Name TMU Gender F DOB 19900909 Date 20211221

Diagnosis: test123

Onset 18 yr ASM (Antiseizure Medication) FS (Febrile Seizure)

Duration 8 yr CNS (CNS Infection) HI (Head Injury)

RUN

MPRAGE FDG-PET MR FDG-PET Fusion FDG-PET with ROIs

Slide 52

EXPORT Amy L SUV 0.9904 Amy R SUV 0.9271 Side of MTLT by ML model Rt

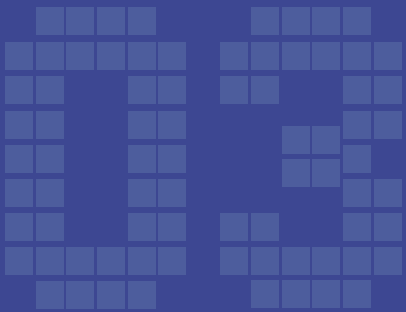
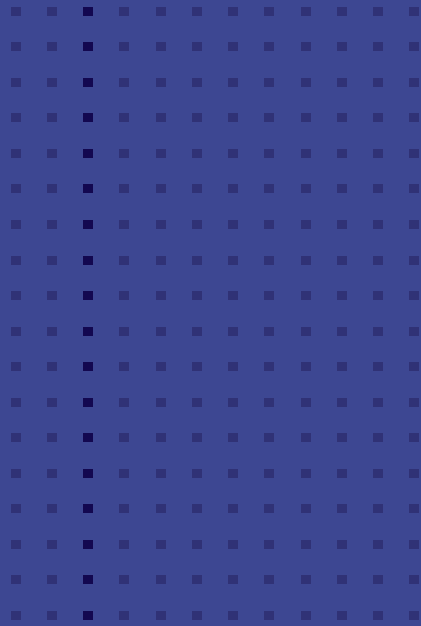
SNAPSHOT Hippo L SUV 0.932 Hippo R SUV 0.9124

Component of qPET

- Unfinish
- Running
- Finish

Copyright 2021, Prof. Syu-Jyun Peng from Taipei Medical University, sjpeng2019@tmu.edu.tw.

▲ Professor Syu-Jyun Peng's qPET platform, designed to assist physicians in evaluating medical images, diagnosing diseases, and generating AI analysis reports for specific brain regions of interest.



HIGHLIGHTS

NARLabs Annual Even: 20-Year Anniversary

Founded in 2003, the National Applied Research Laboratories (NARLabs) celebrated its 20-year anniversary in 2023. On July 11, 2023, with the theme of “Moving Forward Through Innovation,” NARLabs held the “National Applied Research Laboratories 20 Year Anniversary Celebration and Outlook 20 Summit”. Executive Yuan Premier Chen Chien-jen personally attended and stated that he hopes that based on the outstanding results achieved in its first twenty years, NARLabs will be able to grow and have an even greater impact in its second twenty years by helping Taiwan’s academic and research communities move forward and become established as leading competitors throughout the world. National Science and Technology Council (NSTC) Minister Tsung-Tsong Wu also stated that NARLabs must continue to closely cooperate with academia throughout Taiwan. Minister Wu said that NARLabs must also establish a global presence and establish even closer cooperative partnerships with the world’s leading research institutions. According to Minister Wu, this will allow NARLabs to become a globally recognized world-class research powerhouse.

NARLabs also invited National Taiwan University (NTU) President Wen-Chang Chen to deliver a speech with the theme of “NTU’s Academic and Research Outlook and Scientific Research Talent Pools”. Chen’s speech introduced international science and technology development trends, NTU’s important academic research, areas of cooperation between NTU and NARLabs, and the future recruitment and cultivation of relevant talent. In addition, NARLabs President Faa-Jeng Lin also chaired a forum on “Inheritance and Innovation”. In the hopes of creating an even brighter future for NARLabs, the forum asked three former NARLabs presidents Zhuang Zhe-nan, Liang-Gee Chen, and Yeong-Her Wang to offer their views and suggestions regarding NARLabs’s important results in various fields, possible directions of future development, and operational development strategies.



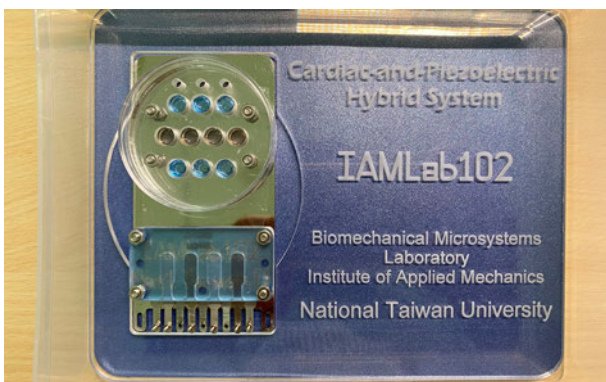
▲ Executive Yuan Premier Chen Chien-jen Delivering Remarks



▲ (From Left) Former NARLabs presidents Yeong-Her Wang, Liang-Gee Chen, Zhuang Zhe-nan, and NARLabs President Faa-Jeng Lin Attending the Outlook 20 Summit

Dual-track Disease Model for Animal Testing and Alternative Technology

NARLabs is committed to developing organ-on-a-chip technology. Taiwan Instrument Research Institute (TIRI) established the “Organ-on-a-chip Optimization Service Platform” in alignment with international standards to help academic research teams in technical specification commercialization services for the manufacturing, sampling, and packaging of organ-on-a-chip technology. The National Laboratory Animal Center (NLAC) has also developed a 3D tumor cell culture method for the rapid and high output requirements needed in preclinical testing platforms of precision tumor treatment. NLAC has also collaborated with the Institute of Applied Mechanics of National Taiwan University to develop a series organ-on-a-chip technology, which includes tumor chips, thrombosis chips and microfluidic devices for high-throughput drug screening. This collaboration has aimed to establish a dual-track disease model that combines animal experiments with alternative technology.



▲ TIRI assisting a team led by Professor Yu-Hsiang Hsu from the Institute of Applied Mechanics of National Taiwan University to create an in vitro biomimetic heart chip based on a piezoelectrically coupled system with cardiac tissue.

Research Vessel R/V *LEGEND* Visits Diplomatic Ally and Opens to the Public for Tours

The research vessel R/V *LEGEND* arrived at the Port of Malakal, Palau on July 20, 2023. This was the first time a Taiwanese marine research vessel held tours for the public while visiting a country with formal diplomatic relations with Taiwan. The Minister of Science and Technology Council of Taiwan Tsung-Tsong Wu personally visited Palau to host the event, giving the officials and public of Palau a firsthand understanding of Taiwan’s capabilities in producing the most advanced marine research vessel. R/V *LEGEND*’s achievements in deep-sea exploration set a milestone in scientific diplomacy between Taiwan and Palau.



▲ Colleagues from TORI explaining the features of R/V *LEGEND* to Minister Tsung-Tsong Wu and Palau officials.



▲ Minister Tsung-Tsong Wu presenting a gift to the Minister of Agriculture, Fisheries, and Environment of Palau.

The Next Generation Forerunner 1 Supercomputer Will Begin Service in 2024

"Forerunner 1" is a next-generation high-performance computing supercomputer based on CPU architecture, which consists of 558 computing nodes with x86-64 architecture and 40 ARM architecture computing nodes, delivering 3.4 PFLOPS of superior performance. "Forerunner 1" completed a series of tests in November 2023 and will succeed Taiwan 1 in 2024, providing support for research in fields such as physics, chemistry, atmospheric science, engineering, and biomedical science.

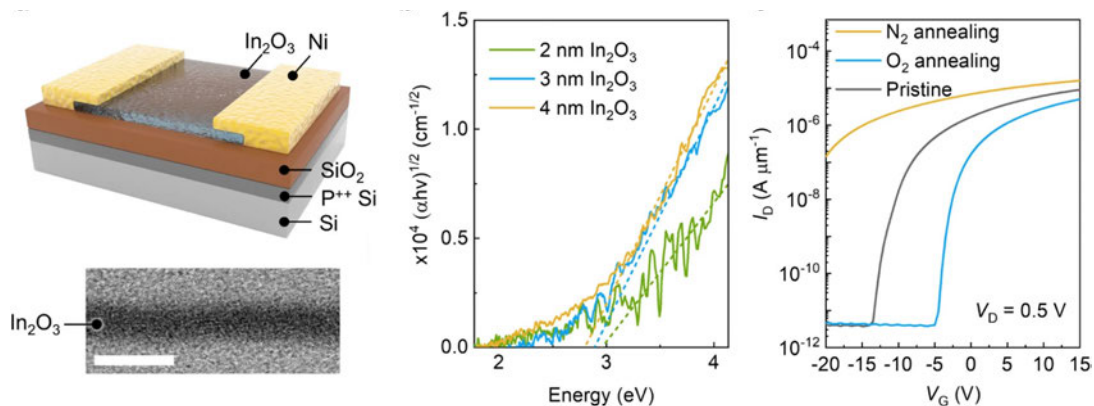


▲ Next Generation Forerunner 1 Supercomputer

TIRI Assists a Joint Team from Professor Der-Hsien Lien of National Yang Ming Chiao Tung University and TSMC to Develop Ultra-thin Indium Oxide Transistors

TIRI's "ALD Joint Lab" assisted a joint team from National Yang Ming Chiao Tung University and TSMC to develop ultra-thin indium oxide transistors. These transistors can effectively control the electrical properties of semiconductor channel

layers and are primarily applied in memory, optoelectronic channels, and low-power semiconductor components. The research results were jointly published in the international journal *Nature Communications*.



▲ An Industry-academia-research Collaboration Jointly Conducting R&D on a New Technology for Modulating the Threshold Voltage of Ultra-thin Semiconductor Layers

Science and Technology Advisory Board Meeting-Planning the Direction of Science and Technology Development for the Next Ten Years

The Science & Technology Policy Research and Information Center (STPI) assisted the NSTC to hold the “Science and Technology Advisory Board Meeting” (STAB Meeting). The advisors at the meeting gave concluding remarks and suggestions after exploring issues such as Net-zero Technology and Semiconductors & AI. The STAB Meeting has served as the highest-level national technology development strategy meeting in Taiwan. After conducting preliminary discussions, STPI and various think tanks assisted the NSTC in selecting two major topics that have widespread impacts on

the future of Taiwan’s industry, economic situation, international cooperation, and social environment. The STAB Meeting aimed to plan Taiwan’s future direction of S&T development by holding exchanges and discussions among domestic and international advisors.



▲ This meeting is convened by Premier Chen Chien-jen, with Chairman Wu Tsung-chung of the National Science Council serving as deputy convener, and President James C. Liao of the Academia Sinica serving as the chief science and technology advisor. Seven domestic and international industry, academia, and research leaders have been invited to participate.

Earthquake Emergency Response Platform

The National Center for Research on Earthquake Engineering (NCREE) has developed an “Earthquake Emergency Response Platform” and a corresponding disaster investigation app. This system allows on-site survey personnel to carry handheld devices, and use the app to upload the collected information such as survey data and photos to the platform in real-time. As such, the NCREE commander as well as internal personnel can immediately grasp the situation at the disaster site, not only enhancing survey efficiency but also strengthening the transmission and sharing of real-time information.



▲ The Earthquake Emergency Response Platform APP



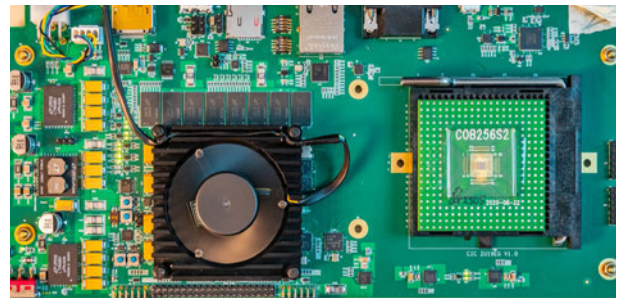
▲ The Earthquake Emergency Response Platform Provides Images of On-site Survey Data in Real-time



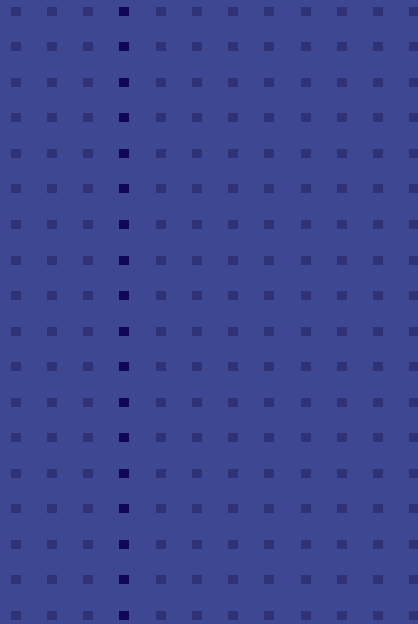
▲ Disaster Response Directors and Other Personnel Can Review Disaster Investigation Results on the Platform

Custom IC Design Acceleration

To accelerate custom IC for specific application, the Taiwan Semiconductor Research Institute (TSRI) has developed “Custom System-on-Chip(SoC) Design Platform” which includes shared reusable circuits, verification and system demonstration services. TSRI has collaborated with teams from National Taiwan University to complete three custom SoCs. These outstanding results were all published at the "Olympics of IC design," the International Solid-State Circuits Conference (ISSCC).



▲ The Custom System-on-Chip Design Platform Accelerates the Development of SoCs



R&D AND SERVICE ACCOMPLISHMENTS

Assisting the NSTC Bring Together Industry and Academia to Promote the TAIDE Program Developing a Trustworthy Generative AI Platform Autonomously in Taiwan

STPI assisted the NSTC in bringing together NCHC, academic experts and the Ministry of Digital Affairs to jointly execute the model development and application services of the Trustworthy AI Dialogue Engine (TAIDE). In addition to being responsible for the overall management of this program, STPI also utilized its research capacities to carry out annotation work and the retrieval and organization of relevant information.

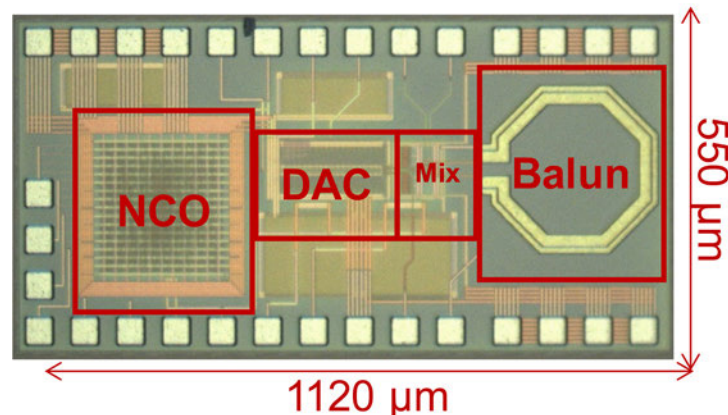


▲ Assisting the NSTC in organizing the TAIDE Public Sector Applied Workshop

Taiwan's First 4K cryogenic controller IC for semiconductor spin qubits

TSRI has developed Taiwan's first ultra-low-temperature (4K) cryogenic controller IC, capable of outputting frequencies from 17.5 to 18 GHz for basic qubit manipulation. Subsequently, digital control

circuits will be added to achieve a more complete qubit manipulation chip performed adjustable frequency, phase, amplitude, and duration.



▲ Ultra-low Temperature (4K) Qubit Manipulation Chip

Offshore Wind Power-Localizing Maintenance Technology

TORI uses advanced seafloor mapping techniques to explore shallow water areas through a portable multibeam echosounder system set on a small vessel. This precise and high-quality seabed topographic information can be applied to further understand the terrain of offshore wind farm sites and conduct preliminary environmental surveys as well as subsequent investigations, such as pile foundation and submarine cable detection. In addition, The Metal Industries Research & Development Centre (MIRDC) has promoted the localization of offshore wind farm operation and maintenance services. TORI has utilized multibeam echosounder systems to conduct seabed mapping operations in the waters of Xingda Port in Taiwan, while assisting the MIRDC in the understanding of the operation planning and workflow of high-precision seabed mapping. This collaboration has enhanced MIRDC's experience in seabed mapping operations while providing a foundation for the development of localized maintenance techniques used in offshore wind power.

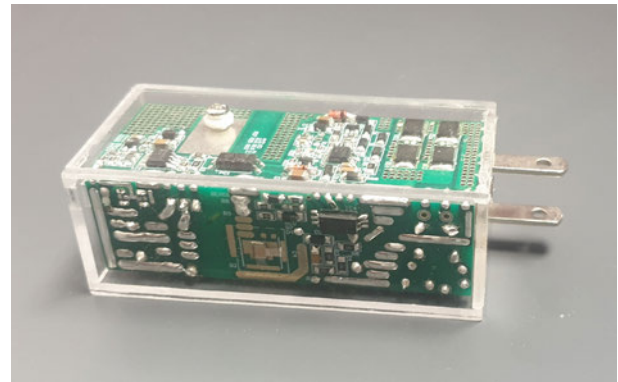


▲ Seabed mapping operations being conducted in Xingda Port Kaohsiung, Taiwan. Kaohsiung, Taiwan.

Providing High-voltage GaN IC Process Service-35 Academic Research Teams Successfully Develop 42 GaN Chips

The high-power gallium nitride (GaN) semiconductor chips surpassed silicon chips in terms of switching speed, thermal management, and power handling. TSMC's 12 V/650 V GaN process provides high-speed and high-voltage 650 V GaN devices, enabling the realization of GaN-on-Si monolithic System on Chip (SoC).

To assist Taiwan's academic community in leading globally and achieving smaller, faster, and higher integration power conversion chips for automotive, industrial, and other high-performance applications, TSRI now offers academic teams GaN integrated circuit design environment and tape-out services. TSRI is the only global institution providing this service with 35 professor teams have utilized this service, resulting in the successful development of 42 GaN chips.

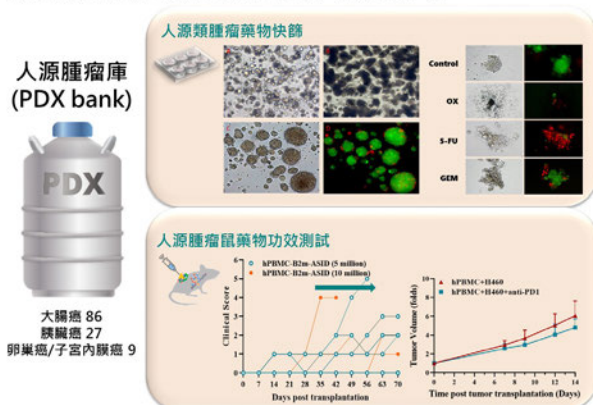


▲ Charger Developed with the 12V/650V GaN IC Design Platform

A Dual-Track Precision Cancer Drug Testing Platform Derived from the NLAC PDX Biobank

NLAC has been dedicated in constructing a patient-derived xenograft (PDX) biobank using self-produced advanced severe immunodeficient (ASID) mice for several years. To comply with the 3-Rs principle, a PDX-based dual-track precision cancer platform is establishing by building a PDX organoid (PDXO) biobank which serves as a resource for further in vitro anti-cancer drug screening system and cancer chip development. In addition, generating different humanized tumor-immune system mouse models to meet the unmet needs of immunotherapeutic drug testing. NLAC anticipates that this dual-track platform would be counted for accelerating the progression of cancer drug and precision medicine in Taiwan.

從人源腫瘤庫發展雙軌腫瘤精準藥測平台



- ▲ The patient-derived xenograft biobank provide resource for establishment of cancer-target drug screening platform (upper panel) and cancer/immune system humanized model (lower panel).

Topological Photonics Research Results of a Collaboration Between TIRI, NTU, and National Chi Nan University are Featured in the International Journal *iScience*

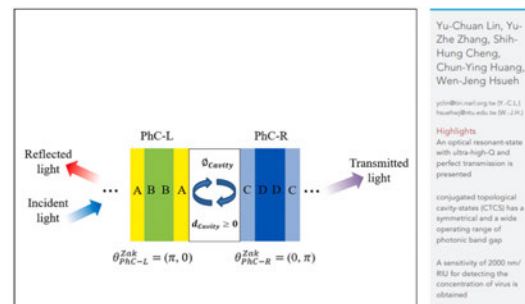
A research team from TIRI, NTU, and National Chi Nan University jointly discovered that embedding optical microcavities into the interface of conjugate topological photonic crystals can induce conjugate topological cavity modes. The resulting exceptional optical resonance properties not only exhibit robust light transmission capabilities, which are capable of resisting the effects of material defects and impurities, but also demonstrate ultra-high-quality optical performance. These research results were featured in *iScience*, a prestigious international journal that is affiliated with Cell.

iScience

CellPress
OPEN ACCESS

Article

Conjugated topological cavity-states in one-dimensional photonic systems and bio-sensing applications



- ▲ Collaborative Development of Topological Photonic Devices with the Academic Community

TIRI Assists the Academic Community in Achieving Another Breakthrough with the "AI-powered Optical Measurement System for Advanced Package Critical Dimensions"

TIRI has partnered with the Precision Metrology Laboratory (PML) from the Department of Mechanical Engineering of National Taiwan University to complete the optical design, tolerance analysis, optical performance tuning, and interferometric measurements of objective lenses, which have subsequently been integrated into optical precision measurement systems. The specifications of

this system comply with SEMI's 2025 technology benchmarks. These specifications have already surpassed the technical requirements needed for advanced packaging in the global semiconductor industry.

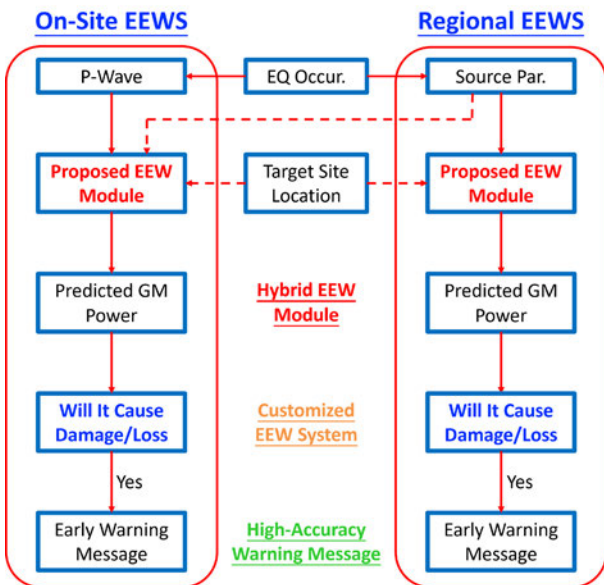


▲ Releasing the Results of the "AI-powered Optical Measurement System for Advanced Package Critical Dimensions"

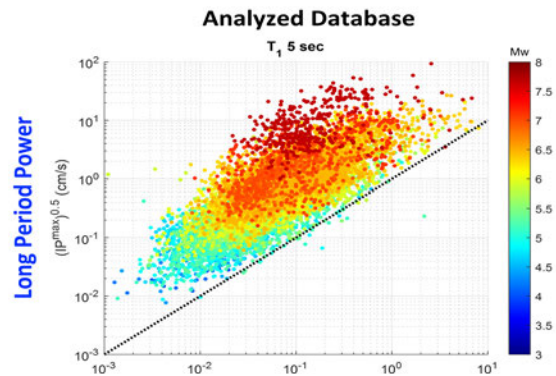
High-power Earthquake Early Warning System

High-power seismic waves can cause damage to structures and high-tech precision processing equipment. However, existing earthquake early warning systems are unable to issue early warnings for high-power seismic waves. Thus, NCREE has developed a “High-Power Earthquake Early Warning Module” that can issue early warnings specifically for high-power seismic waves. This model can be directly integrated into existing on-site or regional earthquake early warning systems.

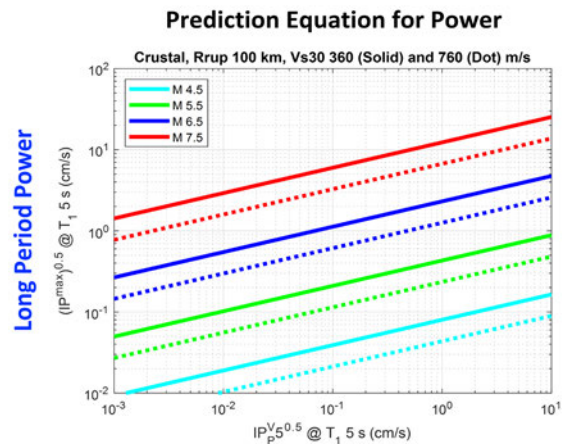
This module assists in damage and disaster reduction by providing structures and high-tech equipment with the capability to execute emergency response operations or activate automated mitigation mechanisms before seismic waves strike.



▲ A Schematic Diagram of the High-Power Seismic Wave Early Warning Module's Applications



▲ Ground Motion Datasets Used During Development

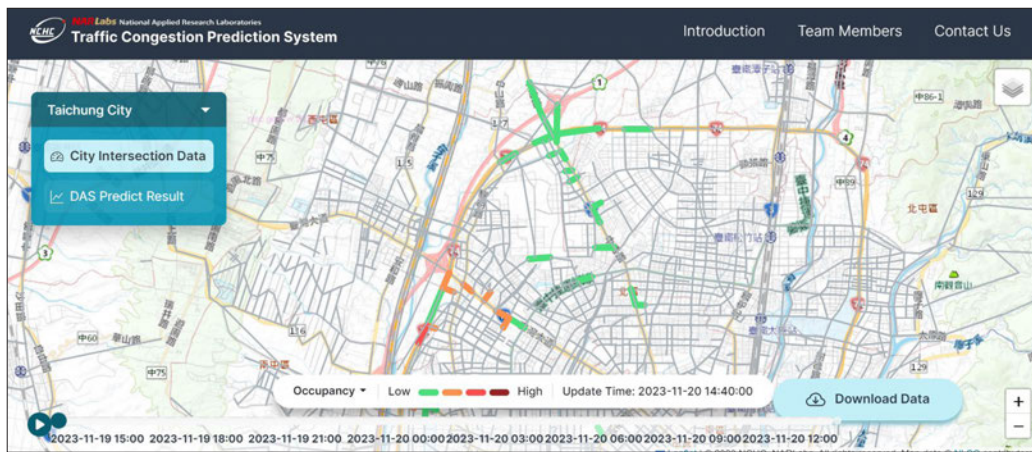


▲ Analysis Results of the High-Power Seismic Wave Early Warning Module

Development of Smart City Applications - Traffic Congestion Prediction System

NCHC has utilized time-space big data integration techniques, combined with cross-team collaboration in AI deep learning model development, dataset services, and visualization presentation technologies, to develop the Traffic Congestion Prediction System (TCPS). By utilizing traffic condition sensors and deep learning image recognition

technologies to collect and analyze real-time traffic data, the platform predicts future traffic flow and congestion situations. This enables adjustments to traffic signals, aiming to reduce congestion and enhance the efficiency and safety of transportation systems.



▲ The traffic congestion prediction system utilizes big data to forecast road congestion conditions 30 minutes ahead

Advanced Medical Device Preclinical Validation Platform

NLAC has assisted clients in conducting advanced medical device testing using laboratory sheep. The safety of iKyphe devices have been tested through ovine spinal fusion surgery. NLAC has also assisted clients in producing research reports, including the safety study based on ISO 10993 and efficacy evaluation. After submission to the US FDA, these research reports were deemed novel technology and selected for the Safer Technologies Program (STeP) to expedite the market listing application process. This marks the first instance of a Taiwanese medical device receiving FDA STeP approval.



▲ A Good Laboratory Practice Study on Laboratory Sheep Confirms the Safety and Efficacy of a Negative Pressure Assistance Device for Spinal Fusion Surgery

Development of Smart City Applications - Street Scene Recognition and Retrieval Platform

Based on deep learning technology, NCHC has partnered with law enforcement agencies to develop an "street scene analysis and investigation technology". The technology led to the creation of a street view retrieval platform, which was trained to recognize signage text by using millions of street view photos taken while driving. When law enforcement agencies receive reports of criminal activity or other emergencies, they can now quickly determine the incident location through street view images and carry out precise police work. In addition to continuously expanding map data to improve recognition rates, cloud API services will also be added in the future to facilitate the Module's promotion to various regions across Taiwan.



▲ A Street Scene Recognition and Retrieval Platform Enables Image-based Location Search Method

Bringing Together the Achievements from Various Government Agencies to Create an Innovative Application Service Website for "Civil IoT Taiwan"

STPI has been executing a "Civil IoT Taiwan" sub-project, which has assisted in transforming the highlights of projects jointly executed by various government agencies into a format the public can enjoy. This project aims to utilize innovative approaches to garner public interest and understanding of "Civil IoT Taiwan". STPI's project has involved creating one comprehensive introductory video, 12 interview videos with various government agencies, and showcasing achievements based on seven applied fields. Additionally, 37 animated videos are designed to help the public better understand the content of "Civil IoT Taiwan"'s overall situation. These materials are disseminated to a wider audience through channels such as Facebook, popular science platforms, and the Tech Job N Talk podcast.

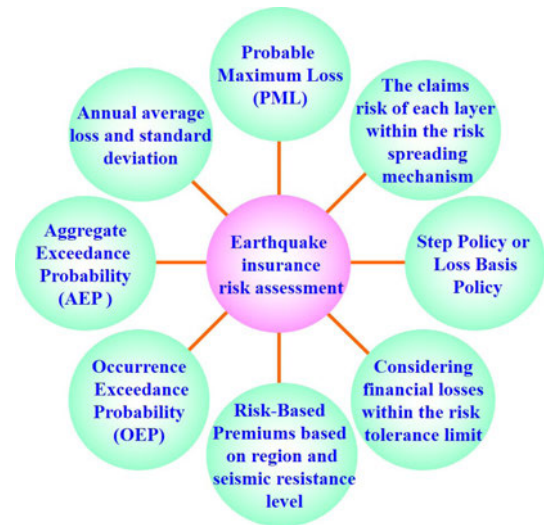


▲ Civil IoT Taiwan Innovative Application Services Website

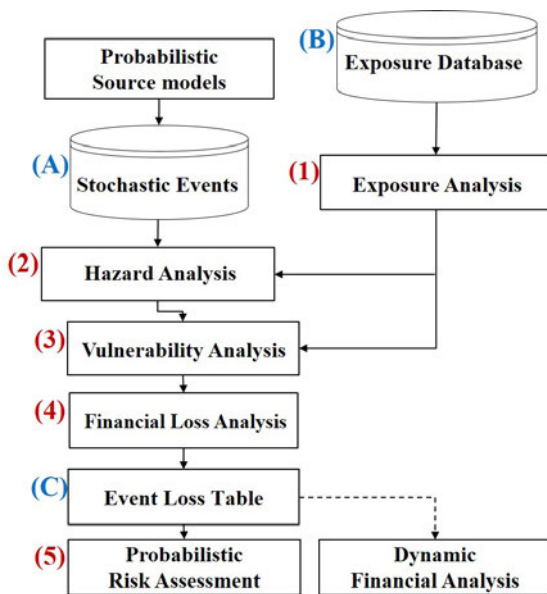
Update and Enhancement of Residential Earthquake Insurance Risk Assessment Model

To assist non-life insurance companies in strengthening catastrophic risk management and proposing risk-spreading strategies, NCREE has updated and enhanced its earthquake insurance risk assessment model for residential houses. The new version of the software is based on open-source geographic information systems, which have enhanced data processing and computational efficiency. The model also includes a built-in geocoding function,

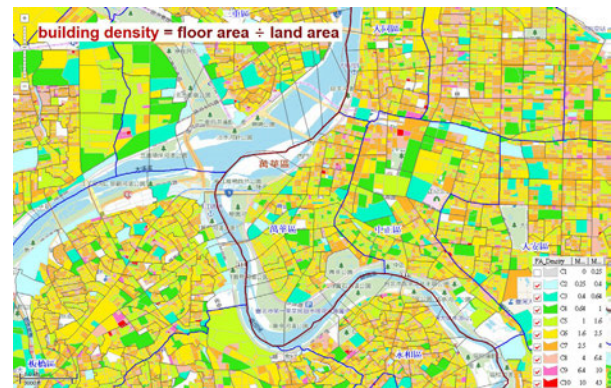
which allows users to obtain the geographic coordinates of insured buildings without the need for internet access. In addition to updating seismic activity parameters, the model has also been refined to improve the assessment of seismic hazards, damage to buildings and their contents, and financial losses.



▲ Functions for the Residential Earthquake Insurance Risk Assessment in Taiwan



▲ Schematic Diagram of the Residential Earthquake Insurance Risk Assessment in Taiwan



▲ The Distribution of Building Density in the Taipei Metropolitan Area According to the Smallest Statistical Unit

Promoting the Development of the Marine Industry through Indigenous Technological Innovation

TORI, National Sun Yat-sen University, and the Industrial Technology Research Institute have jointly executed a commissioned project for the National Museum of Marine Biology and Aquarium to create an "Integrated System for Remote Underwater Wireless Image Transmission". This project aims to break away from traditional museum approaches that rely mainly on indoor displays of live animals and specimens, static signboards, and guided tours on handheld devices. Instead, it seeks to present real outdoor environments and biological changes to the public. TORI is responsible for the research and integration of the "Unmanned Surface Vehicle System and Remote-Control Platform". At present, this project has entered its second phase focusing on the development of an "Unmanned Underwater Vehicle and Winch Remote Control Interface System" and "Aquatic Unmanned Vehicle Control System Integration" for hydrographic operations at sea. The project, expected to be completed by

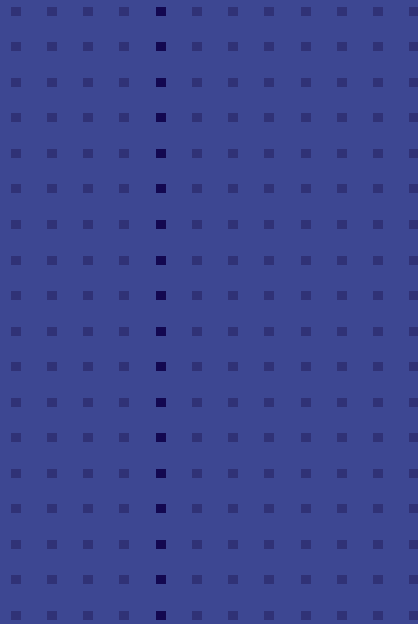
May 2024, aims to promote the development of the marine industry through autonomous innovation technology.



▲ A First-generation unmanned surface vehicle system.



▲ Field testing of an unmanned surface vehicle in an actual maritime environment.



DEVELOPMENT PLANS

Cross-agency Promotion of Net-zero Research-Moving Towards 2050 Sustainability Goals

NARLabs and Academia Sinica jointly signed the “Ocean Energy and Ocean Technology Research and Development Collaboration Agreement” on March 28, 2023. NARLabs has provided crucial technology and services for scientific research facilities to support Academia Sinica in conducting basic research of ocean energy. This partnership aims to explore the potential of generating power via ocean currents (such as the Kuroshio Current) with a goal of producing competitive solutions on an international level.

TORI and the National Center for High-performance Computing have also partnered to collect geophysical data by using the research vessel R/V *LEGEND* for imaging sedimentary structures

below seafloor. This partnership has likewise utilized NCHC’s intelligent point cloud technology to construct 3D geological models below seafloor offshore Taiwan. In addition, the partnership has assisted in the selection and construction of carbon sequestration sites as well as solving engineering issues related to needs in maritime transport.

Through promoting the exchange of expertise across various fields in order to achieve conventional sustainable development goals, these partnerships will bring Taiwan closer to the national goal of achieving net zero emissions by 2050.



▲ NARLabs President Faa-Jeng Lin (right) and Academia Sinica President James C. Liao (left) signing a cooperation agreement.

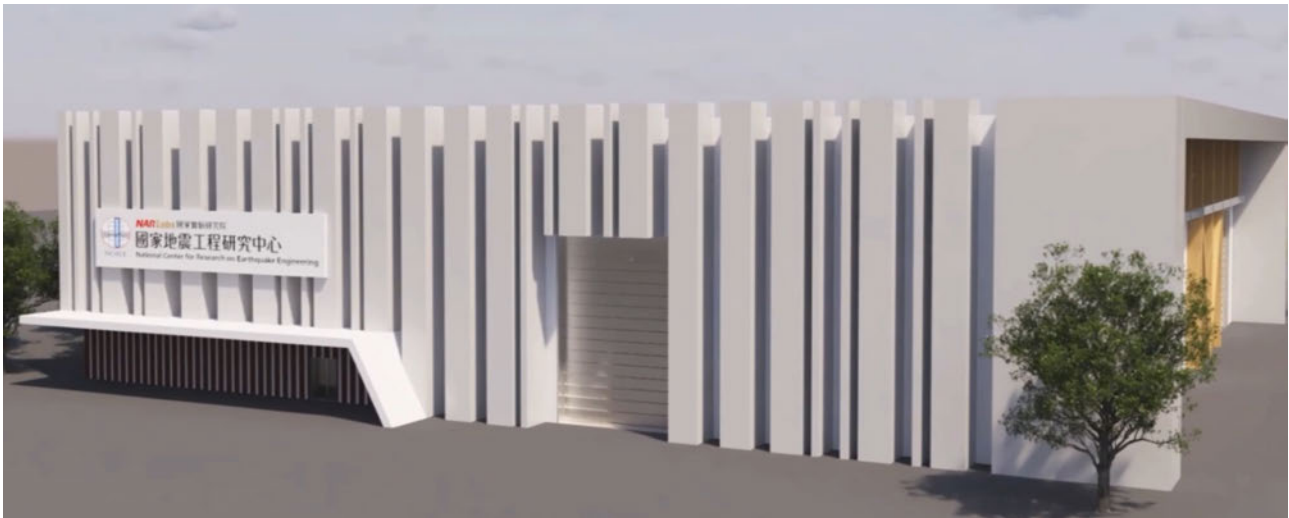


▲ Group photo of the guests attending the signing ceremony.

Promoting the Establishment of a Smart Disaster Prevention and Monitoring Platform for Offshore Wind Turbines and Supporting Structure

To align with Taiwan’s goal of achieving net zero emissions and energy transition policies, NCREE has been committed to the R&D of smart disaster prevention technologies for offshore wind turbines. As such, NCREE is planning to establish a “Green Energy Facility Testing Laboratory,” which focuses on the design and analysis of offshore wind turbine design, R&D on smart disaster prevention monitoring technology, and the establishment of testing platforms. Through the power of technolo-

gy, this project aims to help Taiwan achieve energy autonomy and sustainable development goals by facilitating industry-academia collaboration and technological development, enhancing Taiwan’s capabilities to conduct R&D of the wind power industry, reducing operational risks, and strengthening the localization of wind power industry value chains.



▲ Planning the New Laboratory for Green Energy Facility



▲ Schematic Diagram of a Geotechnical Centrifuge



▲ Fatigue Testing of Wind Turbine Blades

STPI

Assisting the NSTC in Bringing Taiwan-US Scientific Research Exchanges, Talent Cultivation, and Startup Cooperation to New Heights

STPI has been responsible for managing the overall planning of the NSTC's "Taiwan Science & Technology Hub". STPI has partnered with Stanford University to establish a physical location on campus called the "Taiwan S&T Hub @ Stanford Project Office". Additionally, STPI has collaborated with Stanford University to hold several international conferences. These efforts aim to expand opportunities for closer ties with major research institutions in the US while enhancing Taiwan's international presence in scientific research.



▲ Hosting the International Seminar "The Synergy between Semiconductors and AI Technologies" in Seattle

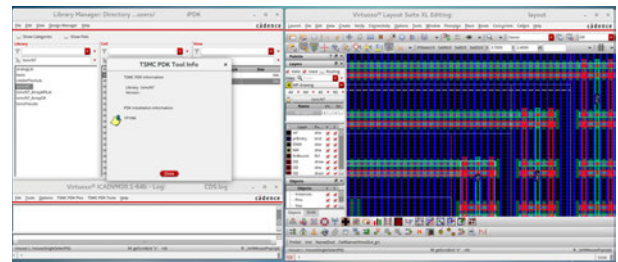


▲ Inaugural Conference hosted by Taiwan S&T Hub in June at Stanford University

TSRI

Establishing N7 FinFET Process to Promote the Design of High-end Chips

The development of integrated circuits has shifted from traditional planar transistors to Fin Field-Effect Transistor (FinFET) technology. To align with TSMC's 7nm (N7) FinFET process and meet the demands for AI, high-speed, and high-performance computing, TSRI is actively cultivating talents in advanced process chip design. In addition to supporting the existing 16nm FinFET process, TSRI also plans to establish an environment for N7 FinFET process chip design and provide corresponding implementation services. Compared to the N16 process, the N7 process offers superior performance with a 30% speed improvement, 55% power reduction, and a threefold increase in logic density. TSRI plans to offer chip design environments and implementation services for the N7 process starting from the first quarter of 2024.



▲ Chip design environment and implementation services for TSMC's 7nm FinFET Process starting from the first quarter of 2024.

3R Strategic Planning and Promotion Program

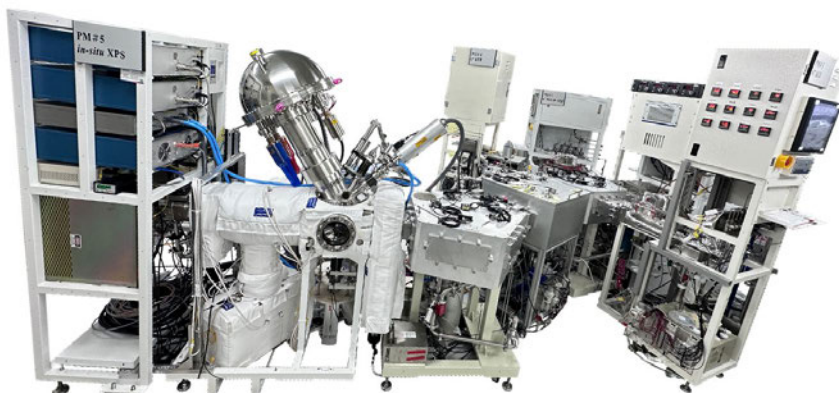
To encourage innovation incorporating the 3R principles, promote scientific advancement, and optimize animal experimentation systems, NLAC introduces key alternative technologies used for international validation of chemicals and animal pharmaceuticals, establishes interdisciplinary integration mechanisms and fosters advanced preclinical validation systems utilizing artificial intelligence or organ-on-a-chip technologies, and develops

cellular and tissue models to replace laboratory animals, assisting in drug screening through in vitro testing. NLAC also implements the 3R principles through an educational approach and enhances professional training in animal experimentation, aiming for more humane animal experimentation techniques.

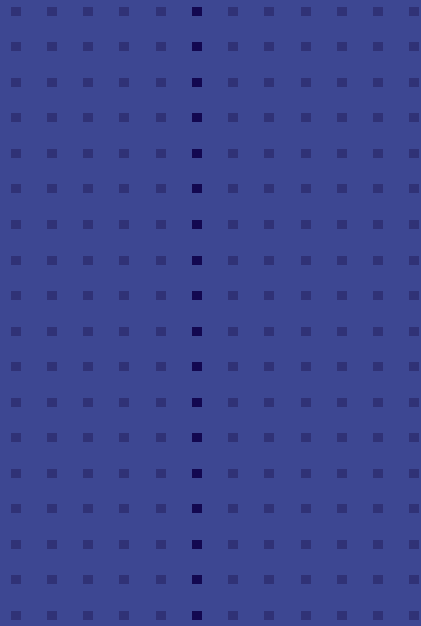
Integrating Vacuum and Optics Technologies to Develop Cutting-Edge Equipment for Semiconductor Research while Creating an Independent Advanced R&D Hub for Space, National Defense, Precision Machining and Optics

TIRI has developed on-site monitoring/detection modules suitable for cluster devices, which includes forward-looking processes and key systems such as on-site monitoring of the Raman spectrum and defect analysis equipment for critical materials and components of EUV process. TIRI's primary goal is to apply these modules to advanced semiconductor processes. In addition, TIRI has estab-

lished a competitive advantage in the development of self-researched and self-made scientific equipment by creating a supply chain for world-class large-aperture non-spherical optical payloads while developing low-earth orbit satellite optical payloads, ultra-precision optical lenses for communication satellites, and optical payloads for CubeSats.



◀ *In-situ* Inspection Equipment for Cluster Semiconductor Processes



COLLABORATION
CONNECTING
INDUSTRY, ACADEMIA,
& RESEARCH

Supporting the Development of Novel Pharmaceuticals and Innovation in Biotechnology

NLAC aims to cultivate and support basic research and drug development in Taiwan. Through providing reliable pathological interpretation for evaluating drug efficacy of novel drugs of fatty liver disease, NLAC has assisted pharmaceutical companies to apply and start clinical trial. In addition, by providing high-quality pre-clinical animal models, NLAC supports the industries to get the financial support from the Ministry of Economic Affairs

A+ Industrial Innovation R&D Program, facilitating the development of Pharmaceuticals and Innovation in Biotechnology.

NARLabs Medical Device Alliance Helps CytoAurora Take Home Second Place at RESI 2023

After winning the 2023 CES Innovation Award, CytoAurora, which has been mentored by the NARLabs Medical Device Alliance, took home second place at the 41st RESI (Redefining Early Stage Investments) Conference. CytoAurora was the only startup company from Taiwan to win an award at North America's largest early investment conference for biotech startups.



▲ CytoAurora Takes Home Second Place at RESI 2023

TSRI

Joining Forces with TSMC for Innovation-Highlighted Paper on Magnetic Memory Integration Takes Center Stage at 2023 IEDM

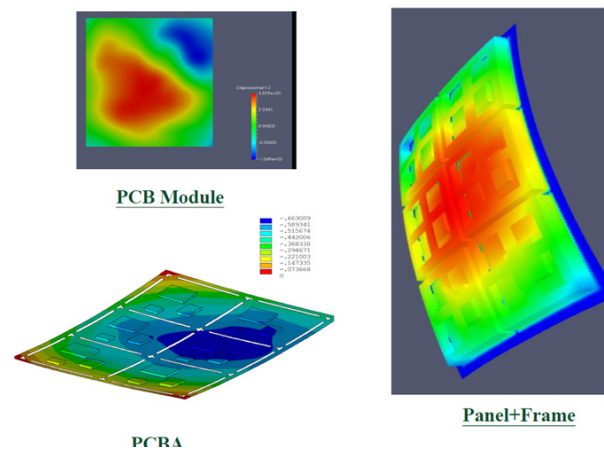
TSRI has established advanced process platforms such as FinFETs, GAAFETs, emerging memories (RRAM, MRAM), novel channel materials, and work function control. In addition, TSRI and TSMC have partnered to develop next-generation semiconductor devices with new materials and struc-

tures. Furthermore, their results in integrating magnetic memory and selector elements were selected as a highlighted paper at the 2023 IEDM.

NCHC

PCBA Cloud Analysis Platform-Assisting Taiwan's Electronics Industry Maintain its Leading Edge

NCHC has brought together expertise in solid mechanics and HPC simulation to develop the Printed Circuit Board Module Analysis Cloud Platform (PCBA Cloud Analysis Platform), which provides semiconductor packaging companies with an effective tool for rapidly evaluating products and designs. Products and processes such as PCBA and electronic packaging are intricate, complex, and often challenging to model and analyze. Thus, NCHC has developed and integrated unique modeling techniques into an automated cloud-based analysis platform. Major Taiwanese packaging companies such as ASE Technology Holding have already adopted this platform, which has helped the country's electronics industry maintain its leading edge.



▲ The PCBA Cloud Analysis Platform Providing Process Warpage Analysis

Integrated Development and Joint Investment in Industry Value Chains for Underwater Scientific Instruments

Taiwan's submersible industry has been developing rapidly. For instance, Awareocean Technology has aimed to create domestically produced underwater vehicles and establish a prototype for industry value chains in Taiwanese submersibles by investing in the design and development of Remotely Operated Vehicles (ROVs). To effectively shorten development cycles, Awareocean has commissioned TORI to assist in manufacturing "ROV Control Interfaces". TORI and Awareocean have jointly invested in the development of underwater scientific instruments by applying TORI's existing expertise in ROV control interface design to Awareocean's ongoing development of ROVs.

AI in Robotic Welding

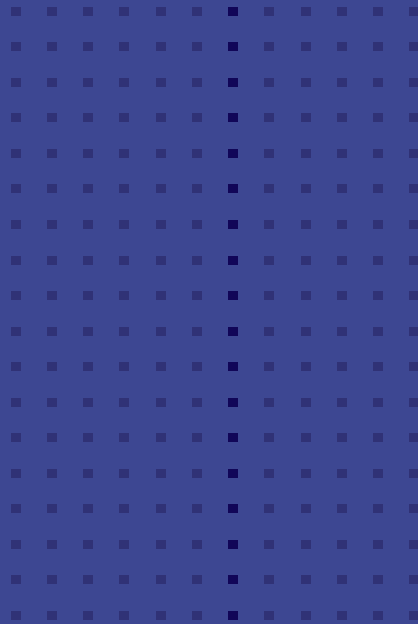
In response to the shortage of welders and the increase in labor costs for steel construction in Taiwan, NCREE has cooperated with four major domestic steel structure construction factories to jointly the industry-academia cooperative research project of NSTC, which aims the develop robotic welding technology to continuity plate within steel built-up box columns. The committee of the NSTC approved the results of the welding parameter database that was established during the first year of the project. Thus, the NSTC provided funding for the project to continue into its second year. This has involved the development of an automated welding platform with practical applications that has combined expert AI-based robotic welding technology with manipulator control.



▲ Members of the NSTC Review R&D Results of This Year's Industry-Academia Cooperation Projects



▲ Progress of NCREE's Research Project



FOSTERING OF SCIENTIFIC AND TECHNOLOGICAL TALENT

Secret Bases of Scientists Exhibition

NARLabs and Taiwan Space Agency partnered with National Taiwan Science Education Center (NTSEC) to put on the three-year “Secret Bases of Scientists” popular science exhibition. The exhibition, which officially opened on March 14, 2023 on NSTEC’s 8th floor circular wing, aims to transform cutting-edge technology into popular science exhibits and games that elementary and middle

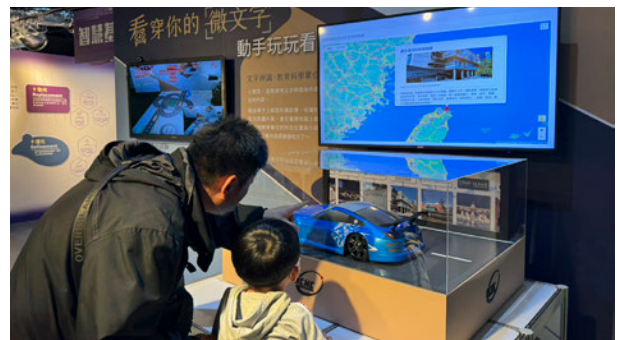
school students can easily understand. Through interactive exhibitions, young learners and parents can enhance their scientific literacy and acquire basic scientific knowledge by gaining a fundamental understanding of the work conducted by national research institutions.



▲ Secret Bases of Scientists Officially Opens



▲ Children Visiting the Exhibition



▲ NCHC AI Identification Exhibit



STPI

Encouraging Young Students to Develop Data Processing and Analytical Skills while Fostering Awareness of Social Issues

For the past 8 years, STPI has been organizing the “Win the PRIDE: Data Storytelling Competition” to encourage young students to learn to use the Policy Research Indicators Database (PRIDE), whose abundant data cursors from a wide array of countries allow participants to gain insights into international trends and broaden their international

perspectives, while developing data processing and analytical skills with a focus on social issues. To align with the needs of the post-pandemic era, the competition is now conducted online, which has allowed more students from central, southern, and eastern Taiwan to participate in the event.



NLAC

Reengineering Approaches to Animal Experiments-Establishing a 3R Education System

NLAC has created an educational ecosystem of laboratory animal science. The Center provides specialized courses for caretakers, technicians, researchers and facility managers to ensure humane practices in practical applications. NLAC also offers foundational courses that bridge theory and practice for biology-related students in graduate programs. The Center also provides on-the-job training, clinician instruction, winter and summer internships for college students. The concept of 3Rs (Replacement, Reduction, and Refinement)

is introduced to the general public through popular science activities.

Partnership between TIRI and ASME Taiwan Section - Cultivating Talent in Smart Robotics

For nine years, TIRI has partnered with the American Society of Mechanical Engineers (ASME) Taiwan Section to organize the “NARLabs Smart Machinery Competition”. This Student Design Competition (SPDC) aims to cultivate talent in smart robotics while encouraging Taiwanese students to participate in ASME's global activities and enhance their international perspectives. This year,

the team “DIT Robotics” from National Tsing Hua University won the design competition while Qiao Xuan-zhao from National Tsing Hua University won the speech competition.



▲ Award Ceremony for the “NARLabs Smart Machinery Competition”

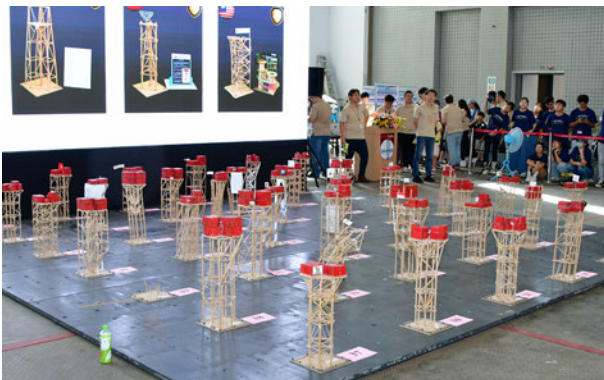
2023 IDEERS Competition - International Competition for Earthquake Engineering Model Construction

Since 2001 NCREE has been holding the Introducing and Demonstrating Earthquake Engineering Research in Schools (IDEERS) event, an international competition for earthquake engineering model construction. The competition aims to provide an outlet for students from both Taiwan and abroad to display their creativity in earthquake engineering while enhancing their international perspectives and professional capabilities. This year, approximately 500 participants from Taiwan, South Korea, Hong Kong, Macau, and Southeast Asia

competed. Each team utilized materials provided by the organizers to design and construct specified building models, which were then subjected to seismic waves of varying intensities to test their cost-effectiveness. The first prize winners in each category were: Graduate Division - National Cheng Kung University (Taiwan), College Division – Duy Tan University (Vietnam), and High School Division - Bukit Merah Secondary School (Singapore).



▲ Group Photo of Participating Students from Various Countries



▲ Model Testing Process



▲ Model Observation

Holding the NARLabs *i*-ONE Instrument Technology Innovation Competition to Cultivate Talent in Scientific Instruments

TIRI has been holding the “NARLabs *i*-ONE Instrument Technology Innovation Competition” since 2009. This competition has attracted 300 outstanding entries and has nurtured a large amount of talent in scientific instruments. In the competition’s 15th year, a team from National Taiwan University won the college & above group and took home a prize of NT\$100,000, while a team from Daan Vocational High School won the high school group and took home a prize of NT\$80,000.



▲ Onsite demonstration at the “NARLabs *i*-ONE Instrument Technology Innovation Competition”

Challenging Supercomputers-Holding the 2nd HiPAC

NCHC has promoted talent cultivation in high-performance computing by organizing the second High Performance Application Competition (HiPAC). This competition encouraged students to explore various acceleration and parallel processing techniques as well as innovative applications on the Taiwan 2 supercomputer. This year, for the first

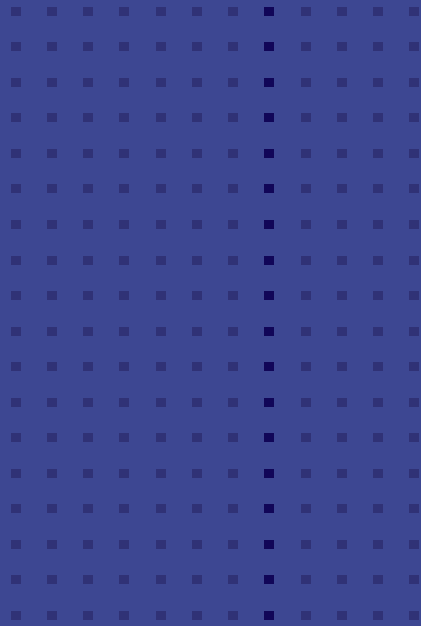
time, NCHC also teamed up with Tsinghua University to cultivate a steady stream of future talent in high-performance computing by hosting the HPC x AI Summer Camp.



▲ Co-hosting the HPC X AI Summer Camp with Tsinghua University



▲ The group photo of the 2nd High Performance Application Competition (HiPAC).



INTERNATIONAL
COLLABORATION

International Partners

With the vision of "Global Excellence, Local Impact," NARLabs is committed to promoting the development of frontier technologies and nurturing science and technology professionals with international perspectives by linking up with top international institutions through a wide range of creative channels. By adopting a people-focused approach, NARLabs can achieve sustainable global development, and utilize technological exchange and collaboration to tackle emerging issues and challenges.



AMERICA

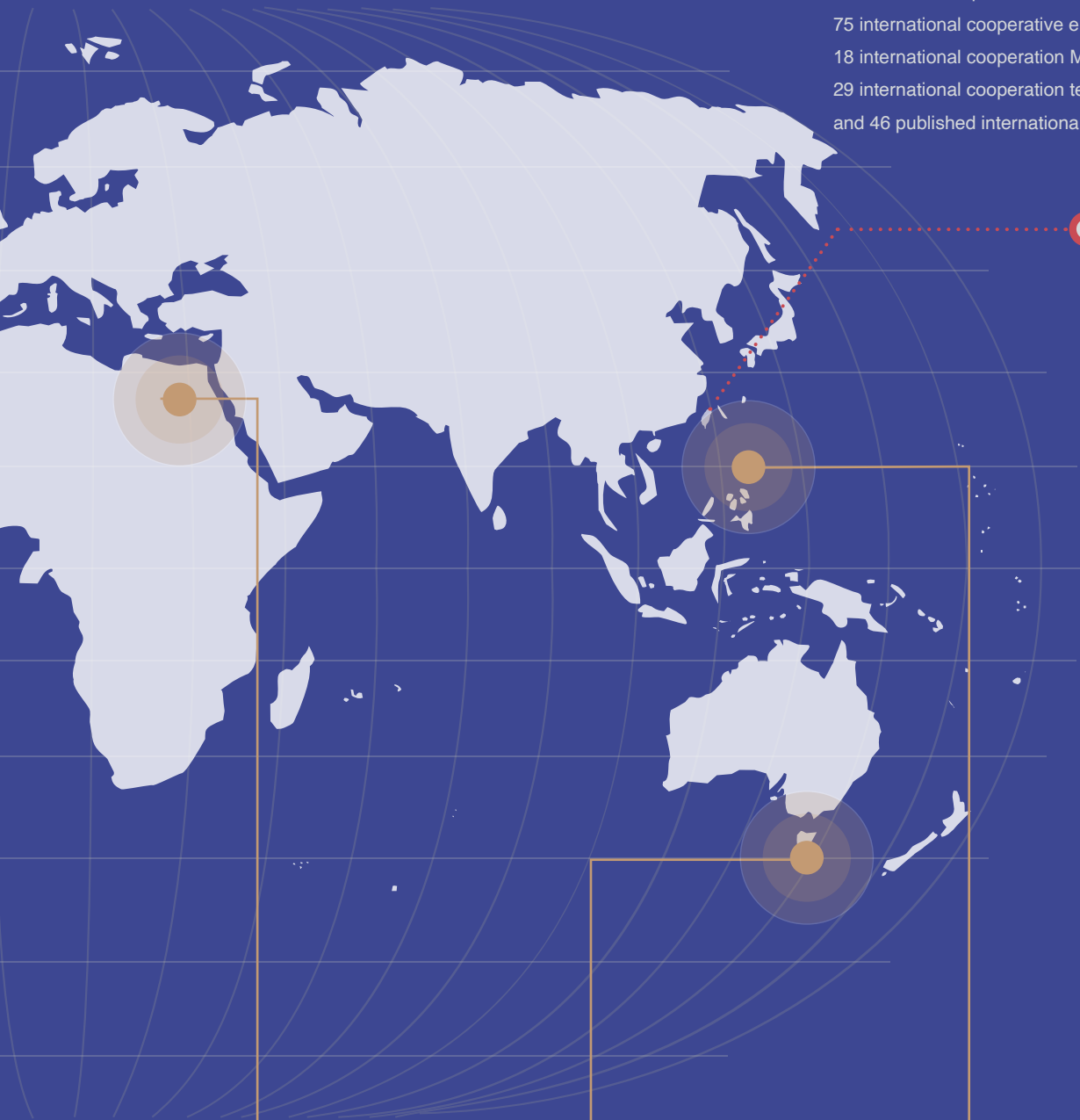
Semiconductors, Medical Technology,
Smart Cities, Disaster Prevention Technology,
Ocean Exploration,
Optoelectronics Technology,
Information & Communication Technology



EUROPE

Semiconductors,
Medical Technology,
Ocean Exploration,
Artificial Intelligence,
High Speed Computing

International cooperation involving 29 countries,
75 international cooperative entities,
18 international cooperation MOUs/Agreements,
29 international cooperation teams,
and 46 published international cooperation papers.



NARLabs

AFRICA

Biomedical Technology

OCEANIA

Information &
Communication Technology,
Semiconductors,
Artificial Intelligence

ASIA

Artificial Intelligence,
Technology Policies,
Ocean Exploration,
Disaster Prevention Technology,
Semiconductors, High Speed Computing,
Cybersecurity Technology

AMERICA

Semiconductors, Medical Technology, Smart Cities, Disaster Prevention Technology, Ocean Exploration, Optoelectronics Technology, Information & Communication Technology

UNITED STATES

- ANL, Argonne National Laboratory
- ASME, American Society of Mechanical Engineers
- AVS, American Vacuum Society
- Broad Institute
- GMU, George Mason University
- iCAIR, International Center for Advanced Internet Research, Northwestern University
- IEEE Instrumentation and Measurement Society
- IMPC, International Mouse Phenotyping Consortium
- ILEE, International Joint Research Laboratory of Earthquake Engineering
- MIT, Massachusetts Institute of Technology
- Moore Nanotechnology
- NCSA, National Center for Supercomputing Applications
- NIH, National Institutes of Health
- NIST, National Institute of Standards and Technology
- NSF, National Sanitation Foundation
- Stanford University
- SEM, Society for Experimental Mechanics
- SPIE, International Society for Optics and Photonics
- PRAGMA, Pacific Rim Application and Grid Middleware Assembly
- UCB, University of California, Berkley
- UCF, University of Central Florida
- UCSD, University of California, San Diego
- University of Hawai'i System
- University of Houston
- UM, University of Michigan
- UTA, University of Texas at Arlington
- UW, University of Washington
- WHOI, Woods Hole Oceanographic Institution

CANADA

- NRC, National Research Council Canada
- UBC, University of British Columbia
- University of Toronto
- WATERLOO. AI, Waterloo Artificial Intelligence Institute
- Mitacs Inc.

EUROPE

Semiconductors, Medical Technology, Ocean Exploration, Artificial Intelligence, High Speed Computing

AUSTRIA

- Medizinische Universität Wien

BELGIUM

- imec, Interuniversity Microelectronic Centre
- UCLouvain, Université catholique de Louvain

CZECH REPUBLIC

- CAS, Czech Academy of Sciences

FRANCE

- CNRS, Centre national de la recherche scientifique

GERMANY

- BFOLD, Berlin Institute for the Foundations of Learning and Data
- Fraunhofer, The Fraunhofer-Gesellschaft
- Freie Universität Berlin
- GEOMAR, Helmholtz Centre for Ocean Research Kiel
- TU Berlin, Technische Universität Berlin
- ZIB, The Zuse Institut Berlin

HUNGARY

- ZalaZONE Automotive Proving Ground

PORTUGAL

- INESC TEC, Institute for Systems and Computer Engineering, Technology and Science

SWITZERLAND

- CERN, the European Organization for Nuclear Research

POLAND

- Łukasiewicz Research Network

FINLAND

- CSC, IT Center for Science Ltd
- LUMI, Large Unified Modern Infrastructure
- IQM, IQM Quantum Computers

SPAIN

- BSC, Direccion de Barcelona Supercomputing Center

OCEANIA

Information & Communication Technology, Semiconductors, Artificial Intelligence

AUSTRALIA

- ANFF, Australian National Fabrication Facility
- OCSE, Office of the NSW Chief Scientist and Engineer
- University of Technology Sydney

ASIA

Artificial Intelligence, Technology Policies, Ocean Exploration, Disaster Prevention Technology, Semiconductors, High Speed Computing, Biomedical Technology, Cybersecurity Technology

INDIA

- CSIR, Council of Scientific and Industrial Research
- IITG, Indian Institute of Technology Guwahati
- IITK, Indian Institute of Technology Kanpur
- ISR, Institute of Seismological Research

INDONESIA

- Diponegoro University
- IEEEA, Indonesian Earthquake Engineering Association
- IPB, Institut Pertanian Bogor
- ITB, Institut Teknologi Bandung
- Matana University
- UAJY, Universitas Atma Jaya Yogyakarta
- Universitas Jenderal Soedirman

JAPAN

- AIST, National Institute of Advanced Industrial Science and Technology
- AMMRA, Asian Mouse Mutagenesis Resource Association
- AMPC, Asian Mouse Phenotyping Consortium
- CIEA, Central Institute for Experimental Animals
- Edgecross Consortium
- IRDA, Institute of Resource Development and Analysis in Kumamoto University
- JAEE, Japan Association for Earthquake Engineering
- JAMSTEC, Japan Agency for Marine-Earth Science and Technology
- JST, Japan Science and Technology Agency
- Kyoto University
- Kyushu University
- Nagoya University
- NICT, National Institute of Information and Communications Technology
- NIED, National Research Institute for Earth Science and Disaster Prevention
- ORI, Ohsaki Research Institute
- RIKEN, Institute of Physical and Chemical Research
- Tohoku University
- Tokyo Institute of Technology
- University of Tokyo

KOREA

- KISTEP, Korea Institute of S&T Evaluation and Planning
- KISTI, Korea Institute of Science and Technology Information
- NST, National Research Council of Science and Technology
- Seismic Simulation Test Center
- SESTEC, Seismic Research and Test Center
- STEPI, Science and Technology Policy Institute

PHILIPPINES

- ASEP, Association of Structural Engineers of the Philippines
- ASTI, Advanced Science and Technology Institute
- DLSU, De La Salle University
- University of the Philippines

RUSSIA

- International Academy of Engineering

SINGAPORE

- APEC, Asia-Pacific Economic Cooperation
- NAMIC, National Additive Manufacturing Innovation Cluster
- NSCC, National Supercomputing Centre

THAILAND

- AIT, Asian Institute of Technology
- EARTH, Earthquake Research Center of Thailand
- KMUTT, King Mongkut's University of Technology Thonburi
- NSTDA, National Science and Technology Development Agency
- Thai-BISPA, Thai Business Incubators and Science Parks Association
- Thammasat University

TURKEY

- Institute of Nuclear Sciences, Ege University
- TÜBİTAK, Scientific and Technological Research Council of Turkey

VIETNAM

- IOIT, Institute of Information Technology
- VNU, Vietnam National University

AFRICA

Biomedical Technology

EGYPT

- GUC, German University in Cairo

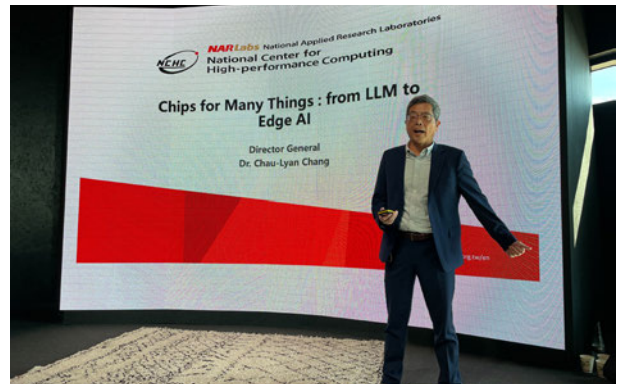
First Year to Participate in the UK's Frontier Tech Exhibition CogX Festival

With a focus on “Protecting Taiwan through Innovative S&T,” NARLabs participated in the UK's Frontier Tech Exhibition CogX Festival from September 12 to 14. At the event, NARLabs displayed six major areas of achievements, which included AI chips, organ-on-a-chip technology, cybersecurity, net-zero, and semiconductor talent cultivation, from seven research centers. Being present at the event

with several exhibits such as a shake table and biomedical chips highlighted Taiwan's prowess in scientific research. In addition, several researchers from NARLabs were asked to give presentations at the expo's Semi Impact Summit. By sharing Taiwan's experiences, these researchers helped expand Taiwan's international visibility and impact.



▲ Colleagues from NARLabs Taking a Group Photo at the Event



▲ NCHC Director General Chau-lyan Chang Giving a Presentation at the Semi Impact Summit

Contributing to Basic Scientific Research by Participating in International High-performance Computing Grids

Since as early as 2015, NCHC has operated a Tier-2 site within the WLCG (Worldwide LHC Computing Grid) through the MOU with CERN, providing essential computing resources for research groups engaged in preserving, acquiring, and analyzing LHC data. As of 2023, the application of this grid facility has expanded to encompass the International Gravitational-Wave Observatory Network (IGWN) through the Open Science Grid, strengthening collaboration on astrophysical research, as outlined in the MOU with the University of Tokyo

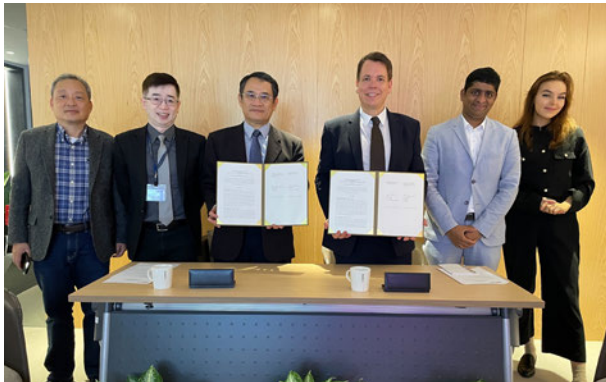
Institute for Cosmic Ray Research (ICRR) in 2019. NCHC has adeptly leveraged its networking and computing expertise, contributing to fundamental research through continuous engagement with international science communities.

Expanding International Partnerships by Signing Cooperation MOUs/Agreements

To expand international industry-academia-research collaboration, promote forward-thinking exchanges in S&T, and develop international talent cultivation, NARLabs signed cooperation MOUs with the Office of the NSW Chief Scientist and Engineer in Australia, the Saxon State Ministry for Science, Culture and Tourism in Germany, Mitacs in Canada, IQM Quantum Computers in Finland, and the Council of Scientific and Industrial Research of India in February, April, September, and December.



▲ Signed MOU with Mitacs, Canada



▲ Signed MOU with IQM Quantum Computers, Finland



▲ Signed STA with the Saxon State Ministry for Science, Culture and Tourism, Germany



▲ Signed MOU with the Office of the NSW Chief Scientist and Engineer, Australia

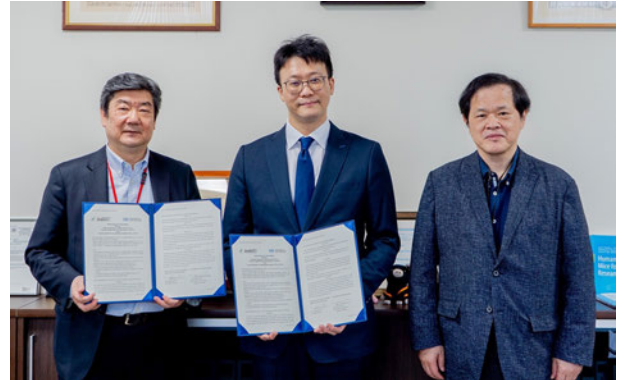


▲ Signed MOU with Council of Scientific and Industrial Research, India

Signing Cooperation MOUs with research institutions in the US and Japan

NLAC and the Regents of the University of California, Davis, on behalf of MicroSurgery Core, Cardiovascular Research Institute, UC Davis (MSC) signed a cooperation MOU to establish an experimental animal microsurgery education hub that focuses on training in surgery techniques and animal handling techniques in Taiwan in the future. In addition, NLAC signed a cooperation MoU with the Central Institute for Experimental Experimental Medicine and Life Science (CIEM) of Japan to establish a cooperation in the research area of experimental animal resources, veterinary diagnosis and treatment, and animal experiment techniques. NLAC aims to expand cooperative opportunities

even further through exchanges and importing technological resources from the US and Japan.



▲ Signed a Memorandum of Understanding with Central Institute for Experimental Animals (CIEA)

R/V *LEGEND* Research Vessel Measures the Ocean's Potential to Act as a Blue Carbon Sink

The National Science and Technology Council has partnered with Palau to collect seabed sediments from the surrounding waters of both countries while promoting a collaborative research project on blue carbon integration in the Northwest Pacific Ocean. This project has aimed to measure the potential of blue carbon sinks and establish scientific investigation methods to support the United Nations' call for incorporating blue carbon sinks into pathways for achieving net-zero carbon emissions. TORI's R/V *LEGEND* has assisted in executing this large-scale project by collaborating with multinational, cross-disciplinary research teams from Taiwan, Palau, and other countries. This partnership has aimed to gain a better understanding of the hydrology and carbon cycling in the waters surrounding Taiwan and the open ocean by spending 44 days at sea to complete three marine scientific survey expeditions.



▲ The R/V *LEGEND* Making its first visit to the Port of Malakal, Palau



▲ Ambassador to Palau Jessica Chien-Yi Lee stepping aboard to visit the research team

Conducting Earthquake Investigations in Turkey and Holding the “The 2023 Turkey and 2022 Taitung Earthquakes and Innovative Disaster Mitigation Technology Conferences”

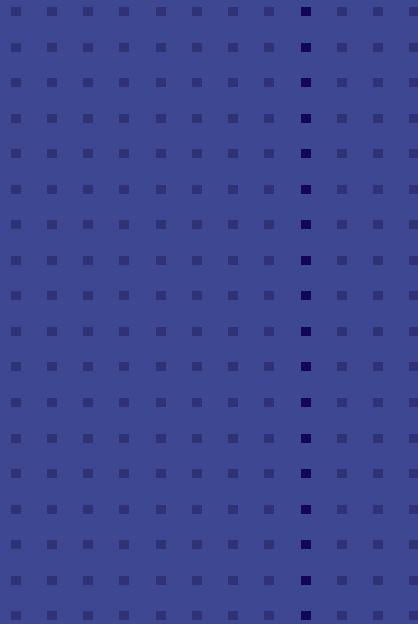
Immediately following the Turkey-Syria earthquakes of 2023, NCREE compiled relevant disaster damage information and dispatched colleagues to the impacted area in Turkey to conduct on-site investigations with Professor Gulen Ozkula and other international scholars. Subsequently, “The 2023 Turkey and 2022 Taitung Earthquakes and Innovative Disaster Mitigation Technology Conferences” were held in Taipei and Tainan. These two seminars aimed to promote the exchange of earthquake engineering and disaster prevention knowledge by sharing insights regarding the aforementioned investigations and the latest seismic disaster prevention technologies.



▲ 2023 Turkey-Syria Earthquake Reconnaissance Mission by NCREE



▲ Members of the Turkey-Syria Earthquake Reconnaissance Team



SOCIAL ENGAGEMENT

Open for Visits! Taiwan Volcano Observatory-Tatun

On December 22, an unveiling activity was held after the NSTC Taiwan Volcano Observatory-Tatun, which is operated by NCREE, finished the first round of optimization on its popular science exhibitions. Visitors got to immerse themselves in the shape-shifting “Immersive Science Theater,” explore a model lava tube, and experience the integration of virtual and real by stepping into a monitoring room equipped with holographic projections.

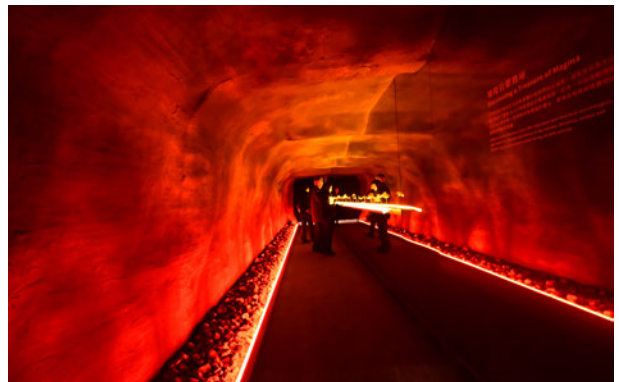
In addition, there were over 20 interactive scientific exhibits for visitors to explore. By using technology to present information on volcanos, the visitors could engage in interactive activities and gain a new perspective on science while enhancing their interest and understanding of volcano science. Taiwan Volcano Observatory - Tatun is scheduled to officially open to the public by reservation in May 2024.



▲ Group Photo of VIP Guests at the Unveiling Activity



▲ The Lobby's “Immersive Science Theater”

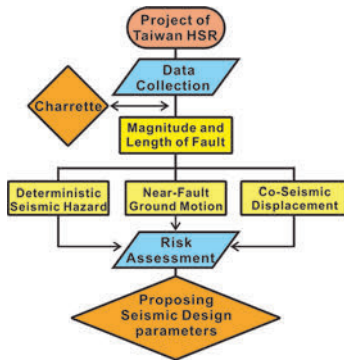


▲ Volcanic Lava Tube

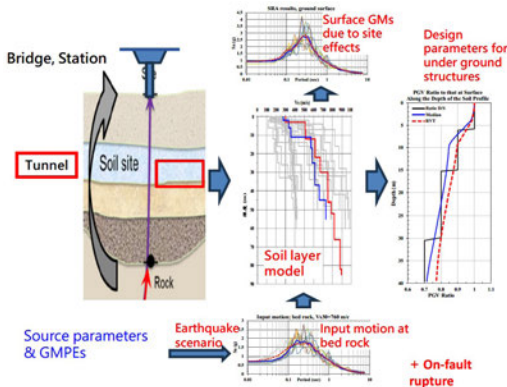
Seismic Hazard Assessments for Critical Public Transportations Located Near Active Faults

In recent years, the emergence of several newly identified active faults has posed significant seismic safety concerns for nearby public transportation systems. NCREE has assisted Taiwan’s high-speed rail and metro systems in evaluating seismic design and reinforcement needs. The seismic hazards, near-fault ground motion, and co-seismic displacements of extreme earthquakes that occur on faults have been assessed through professional analysis techniques and procedures. The aim is to mitigate the impact on the safety of public transportation during near-fault earthquakes by proposing seismic design parameters for critical structures that facilitate the development of corresponding engineering measures.

64



▲ Workflow of Near-fault Seismic Impact Assessments on High-speed Rail Systems



▲ Procedure for Evaluating Site Response and Fault Displacement Based on Scenario of Near-fault Earthquake

“Popular Science Popular Art” -Bringing Together Marine Science and Art

In 2020, Kun Shan University in Taiwan invited TORI to participate in the production of a popular science video series, “Popular Science Popular Art”. This collaborative, interdisciplinary project sparked unexpected creativity by exploring various images and having artists from different backgrounds interpret the ocean’s “depth,” “breadth,” and “colorfulness”. “Popular Science Popular Art” is a production that uses drama, music, and picture books to present the diverse facets of the ocean. This video series, which took three and a half years to make, documented the overall history of ocean exploration. As such, this production was nominated for the “Best Natural Science Documentary Program” at the 58th Golden Bell Awards, “the Taiwanese Emmys”, in 2023.



▲ Side shot of the research team working on “Popular Science Popular Art”



▲ Chance encounter during location scouting for “Popular Science Popular Art”.

Moving Towards International Excellence by Holding the 2023 Science Exploration Fair with the Ministry of Education

Under the guidance of the Ministry of Education K-12 Education Administration, the “2023 Science Exploration Fair – To do, To understand” was jointly held by NCHC, National Kaohsiung Normal University, and five major science museums. This competition attracted 1,127 teams and 2,410 participants from both Taiwan and abroad, making it one of the top three science competitions in the country. Since its inception in 2004, NCHC has been responsible for collecting and storing the works produced every year during this competition.



▲ Enhancing Scientific Understanding at the “2023 Science Exploration Fair – To do, To understand”

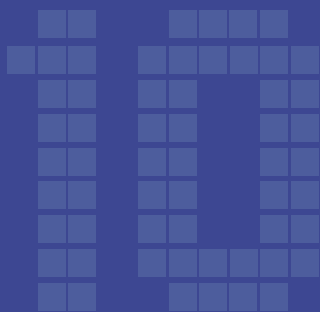
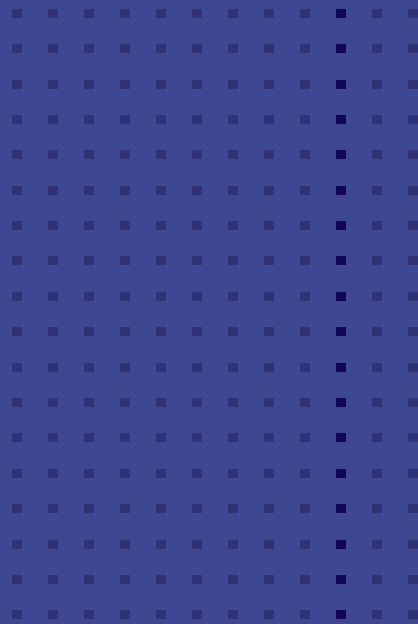
Real-Time Global Map for Confirmed COVID-19 Cases

Traffic to the “COVID-19 Global Pandemic Map,” which was developed by NCHC, has seen continuous growth and has surpassed 35 million views. Since 2020, the “COVID-19 Global Pandemic Map” has been cited in 199 citations in doctoral and master's theses (7 doctoral theses) in Taiwan and 70

papers indexed by Google Scholar. This includes some papers published in journals with an impact factor of 9 or higher. The website has become an important database for conducting epidemiological research on COVID-19.



▲ At One Point, the “COVID-19 Global Pandemic Map” Received 100,000 Visits in One Day and 3 Million Visits in One Month



MILESTONES

1/5 - 8 NARLabs

NCREE, NCHC, TSRI, TIRI, and TAIWAN CAR LAB participated in the 2023 International Consumer Electronics Show(CES) in the United States.

01 JAN.

2/3 TIRI

Distinguished Professor Peter Cheng-Tang Pan of National Sun Yat-sen University takes on the position of Director General of TIRI.

2/6 TSRI

TSRI collaborates with TSMC to implement 7-nanometer chip fabrication services.

02 FEB.

3/1 NCHC

NCHC's "Formosa Open Internet Exchange" has been officially recognized and approved as an Internet eXchange (IX) by the Taiwan Network Information Center (TWNIC).

3/14 NARLabs

The opening of the "Secret Base of Scientists Exhibition" science popularization exhibition, jointly organized by NARLabs, TASA and the National Taiwan Science Education Center.

03 MAR.

2/13 NARLabs

NARLabs signs a Memorandum of Understanding with the Office of the NSW Chief Scientist and Engineer (OCSE) in Australia.

3/27 NCHC

The groundbreaking ceremony for the NCHC Internet Data Center was held.

2/18 - 26 NCREE

NCREE participates in international earthquake reconnaissance in Turkey.

4/18 NARLabs

NARLabs signs an Arrangement on Science and Technological Cooperation with the Sax-on State Ministry for Science, Culture and Tourism of Germany.

5/9 TSRI

TSRI supports the development of system chips in academia and research, and develops the "Custom System-on-Chip Design Platform".

6/29 NCHC

NCHC signs a Memorandum of Understanding with the Keelung City Government.

5/23 NLAC

NLAC signs a Memorandum of Understanding with Central Institute for Experimental Animals (CIEA) in Japan.

6/30 STPI

STPI hosts the selection and award ceremony for the first cohort of the 2023 Innovation and Entrepreneurship Incentive Program (From IP to IPO, FITI).

04 APR.

05 MAY

06 JUN.

07 JUL.

5/24 STPI

The "Taiwan Science & Technology Hub" implemented by STPI officially inaugurates the "Taiwan S&T Hub @ Stanford Project Office" at Stanford University in the United States.

7/11 NLAC

NLAC's Taipei, Hsinchu, and Tainan facilities have all completed the international accreditation evaluation by AAALAC (Association for Assessment and Accreditation of Laboratory Animal Care International).

4/21 TIRI

TIRI, Moore Nanotechnology Systems from the United States, and DKSH Taiwan sign a tripartite international Memorandum of Understanding to jointly plan the establishment of the "Joint Laboratory for Ultra-Precision Machining Technology".

7/26-28 STPI

In line with the 10th anniversary of Global SPARK's establishment and the 2023 Global SPARK Meeting held in Taiwan, STPI hosted international conferences, Asia Showcase events, and training courses in July.

8/1
TORI

Professor Pei-Jie Meng of National Dong Hwa University takes on the position of Director General of TORI.

8/8
NARLabs

NARLabs and Japan's National Institute of Information and Communications Technology (NICT) renew the Memorandum of Cooperation and hold a joint workshop.

10/14
NCHC

The "method for correcting abnormal point cloud" developed by NCHC has been awarded the Platinum Awards in the Invention Competition at Taiwan Innotech Expo.

12/1
NLAC

NLAC signs a Memorandum of Understanding with the Regents of the University of California, Davis, on behalf of MicroSurgery Core, Cardiovascular Research Institute, UC Davis (MSC).

12/5
NARLabs

NARLabs signs a Memorandum of Understanding with IQM Quantum Computers in Finland.

08 AUG.

10 OCT.

12 DEC.

09 SEP.

11 NOV.

9/12-14
NARLabs

NARLabs showcases technological achievements at CogX Festival in London, and NARLabs representatives deliver keynote speeches at the Semi Impact Summit.

9/21
NARLabs

NARLabs signs a Memorandum of Understanding with Mitacs in Canada.

11/2
NCHC

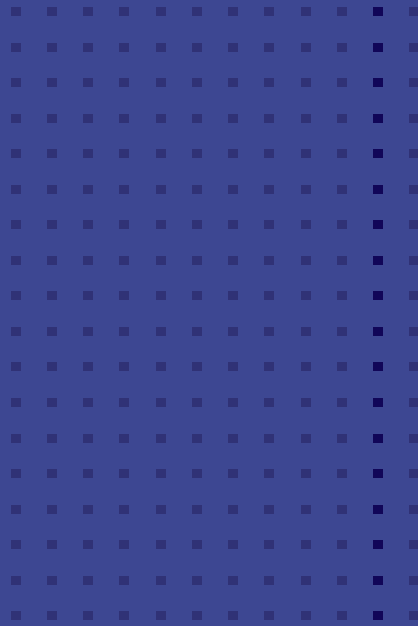
NCHC receives the SGS IT Awards - Excellence in Cybersecurity Management.

12/6
NARLabs

NARLabs signs a Memorandum of Understanding with the Council of Scientific and Industrial Research (CSIR) in India.

12/22
NCREE

NCREE holds unboxing event of the Taiwan Volcano Observatory - Tatun.



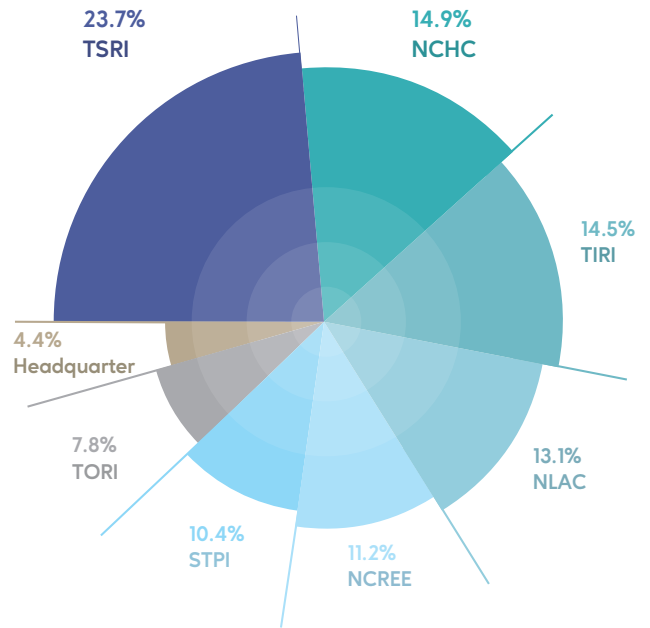
ANNUAL PROFILE

Human Resources

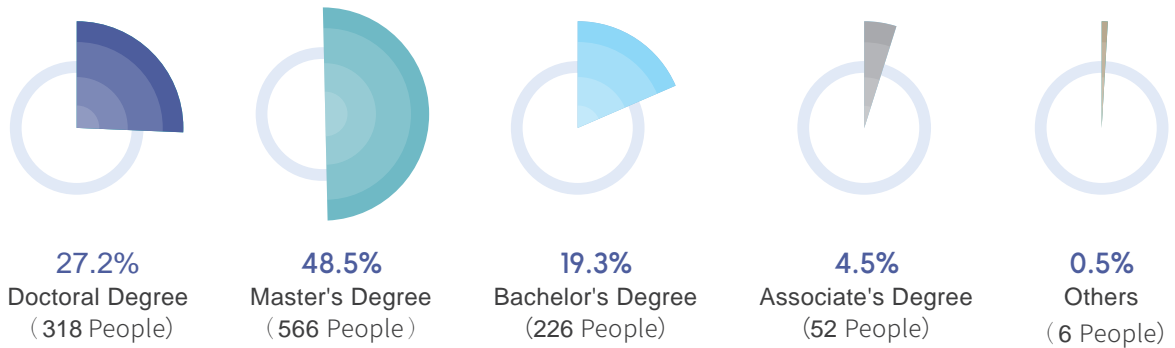
1,168 Employees

Number of Employees in Laboratories

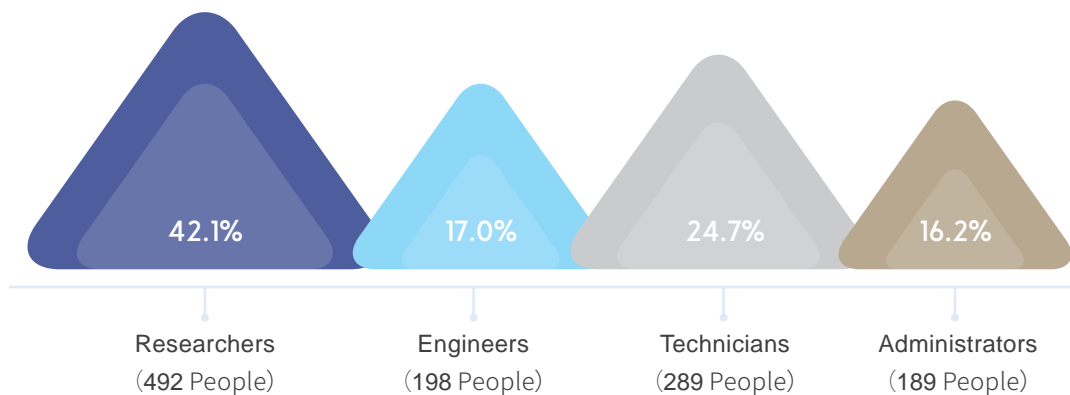
■ Headquarters	51 People
■ TORI	91 People
■ STPI	122 People
■ NCREE	131 People
■ NLAC	153 People
■ TIRI	169 People
■ NCHC	174 People
■ TSRI	277 People



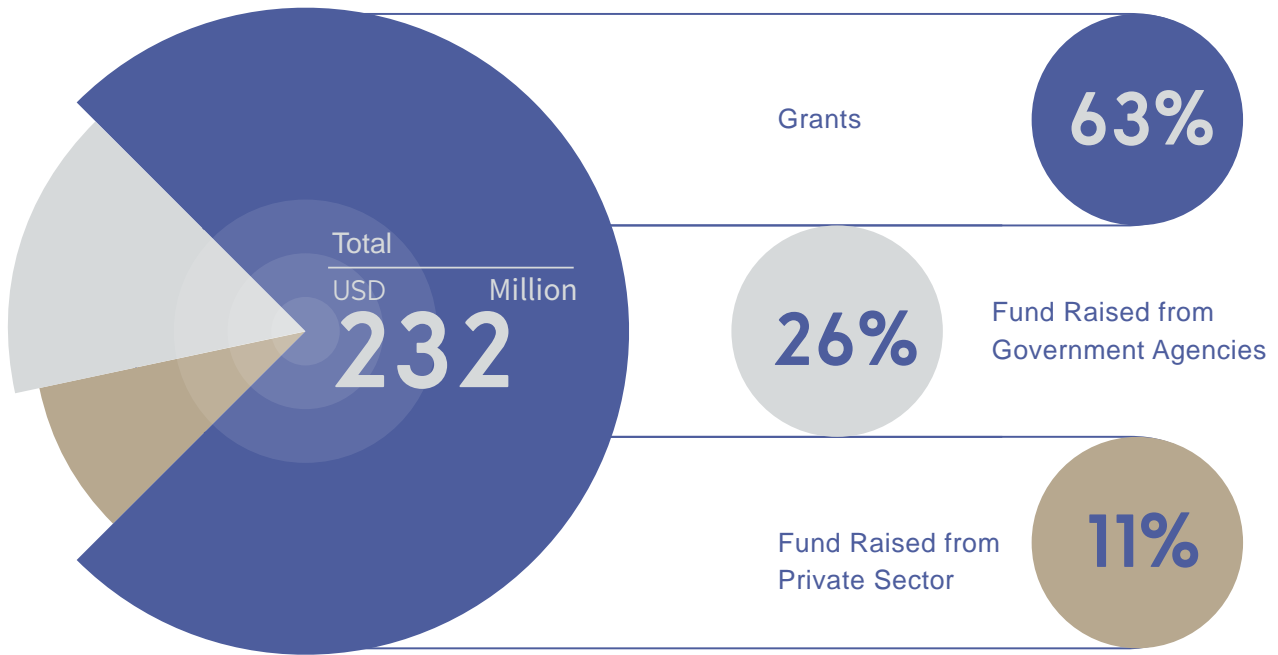
Education Level



Human Resources Profile



Financial Information



72



Organization

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Managing Directors	Dar-Bin Shieh, Huey-Jen Su, Yi-Chun Wu, Hong Hocheng
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Vice President	Bou-Wen Lin
Chief Operating Officer	Yu-Hsueh Hsu

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Operation & Promotion Office	Lung-Yao Chang
International Affairs Office	Mei-Yu Chang
Administration Office	Shu-Chen Lin
Finance & Accounting Office	Min Huang
Human Resources Office	Chi-Nung Yin
Information Technology Service Office	Jyun-Hwei Tsai

Laboratories / Director Generals

National Laboratory Animal Center (NLAC)	Hsian-Jean Chin
National Center for Research on Earthquake Engineering (NCREE)	Chung-Che Chou
National Center for High-performance Computing (NCHC)	Chau-Lyan Chang
Taiwan Semiconductor Research Institute (TSRI)	Tuo-Hung Hou
Taiwan Instrument Research Institute (TIRI)	Cheng-Tang Pan
Science & Technology Policy Research and Information Center (STPI)	Bou-Wen Lin
Taiwan Ocean Research Institute (TORI)	Pei-Jie Meng

Locations

Headquarters



TAIPEI

- NARLabs Headquarters
- National Laboratory Animal Center
- National Center for Research on Earthquake Engineering
- Science & Technology Policy Research and Information Center



HSINCHU

- National Center for High-performance Computing
- Taiwan Semiconductor Research Institute
- Taiwan Instrument Research Institute



KAOHSIUNG

Taiwan Ocean Research Institute

Branches



HSINCHU

National Laboratory Animal Center



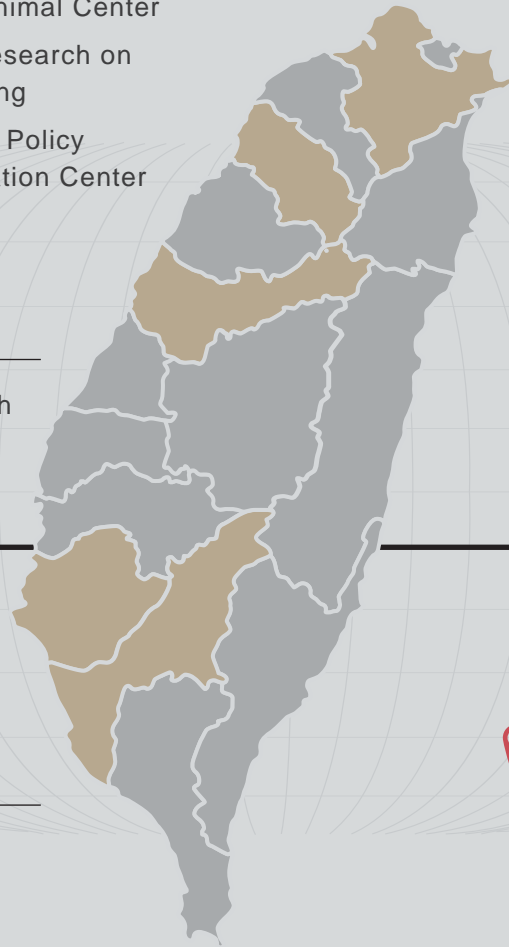
TAICHUNG

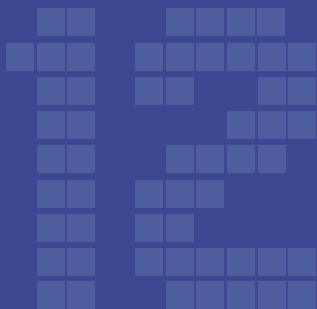
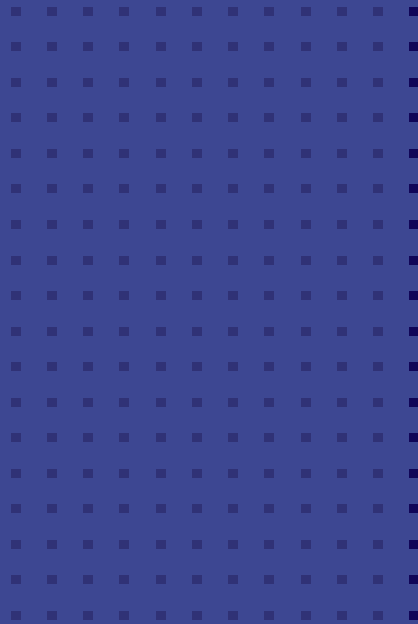
National Center for High-performance Computing



TAINAN

- National Laboratory Animal Center
- National Center for Research on Earthquake Engineering
- National Center for High-performance Computing
- Taiwan Semiconductor Research Institute





OUR LABORATORIES

National Laboratory Animal Center

The National Laboratory Animal Center (NLAC) supports the development of the biotechnology industry and biomedical research. The Center serves as an animal breeding and testing environment, conducts pre-clinical evaluation of new drugs and biotechnology products, and performs microbiota-related research and medical device validation. At the same time, NLAC also supports innovation in relation to the 3R principles (Replacement, Reduction, and Refinement) and promotes alternative methods and alternative technologies to animal testing. NLAC also provides specialized courses for caretakers, technicians, researchers, facility managers, and laboratory animal veterinarians to improve the development of biomedical research.

National Center for Research on Earthquake Engineering

The National Center for Research on Earthquake Engineering (NCREE) focuses on three main research and development axes: “Seismic Performance Improvement,” “Hazard Analysis and Risk Assessment,” and “Monitoring and Early Warning” to meet the needs of pre-earthquake preparation, earthquake strain emergency response, and post-earthquake reconstruction. In addition, NCREE creates industrial value by enhancing R&D capacity and technical implementation for near-fault earthquakes and multiple-disaster scenarios, promoting interdisciplinary collaboration, and strengthening industry-academia partnerships. In the medium term, NCREE aims to enhance the seismic performance of critical infrastructure by developing structural seismic design, evaluations and reinforcement retrofitting and early warning systems and rapid response measures to enhance post-earthquake recovery capabilities in urban and rural areas and move towards the long-term goal of building earthquake-resistant and sustainable homeland.



NCHC

National Center for High-performance Computing

To lay the foundation for Taiwan's capacity in Science and Technology, NCHC is responsible for establishing advanced computing technology throughout Taiwan while providing world-class high-performance computing and network infrastructure for academic research. NCHC, in the spirit of "Driving transformation towards a better future," actively promotes the development of high-performance computing and networking technologies and their applications. Additionally, NCHC conducts research on cybersecurity and data encryption while developing forward-looking technologies such as advanced HPC methods, quantum computing, and big data analytics. NCHC also actively engages in international collaboration and exchanges to guide digital transformation and promote changes towards smart living.



TSRI

Taiwan Semiconductor Research Institute

As a response to technological trends and the rise of emerging applications on the global stage, the Taiwan Semiconductor Research Institute (TSRI) focuses on integrating semiconductor manufacturing and design, providing "Device to System" one-stop semiconductor verification services, and establishing open information and service platforms in semiconductor manufacturing, packaging and testing, integrated circuit design, intellectual property cores, and system integration. Such platforms facilitate a smoother mode of sharing between Taiwan's industrial, academic, and research sectors and accelerate the development and evaluation of technological advancements. TSRI is actively involved in technical fields such as next-gen transistors, random-access memory, high-power components, 3D integrated circuits, and silicon photonics. Guided by its four strategic goals of cultivating talent, serving industry and academia, fulfilling international standards, and innovative R&D, TSRI is set to become a driving force behind the diversification of Taiwan's semiconductor industry. As a world-class semiconductor design and manufacturing research center, TSRI is creating the foundations for developing a thriving and competitive artificial intelligence industry.



Taiwan Instrument Research Institute

TIRI aims to strengthen basic research by focusing on the development of critical technologies in “Cutting-edge Optics,” “Advanced Vacuum Technology,” and “Smart Biotechnology.” In addition, TIRI creates integrated interdisciplinary platforms for services related to instrument technology R&D while serving as an essential partner for academic teams conducting groundbreaking research. As the only research institute in Taiwan capable of meeting the forward-looking research and experimental needs of various academic fields, TIRI plays a vital role in the development of specialized and customized scientific instruments. Furthermore, TIRI actively develops “No.1 in Taiwan” and “world-leading” next-generation semiconductor processes and equipment, cutting-edge defense and remote sensing payload systems, and epidemic prevention-related instruments. TIRI also enhances the efficiency of research resource utilization by nurturing high-level interdisciplinary instrument technology professionals.

Taiwan Ocean Research Institute

TORI actively engages in the independent design and R&D of marine exploration equipment and innovative technologies that serve the research needs of government, academia, and research institutes. By facilitating scientific research, marine engineering, and land investigation missions, TORI strives to propel the development of the marine industry. TORI aims to expand fields of research without being constrained by commercial demands in order to decrease the overreliance on imported ocean detection equipment by developing and mastering key technologies in this area.



Science & Technology Policy Research and Information Center

The Science & Technology Policy Research and Information Center (STPI) is set to become a national-level science and technology policy think tank with a robust foundation of academic and empirical research that aims at providing comprehensive and rapid responses to the many issues faced in related fields. By fully grasping global S&T trends, STPI can provide timely, professional, and objective analyses and suggestions to support any government planning that may affect the industry. STPI's missions include supporting the government on S&T policy planning and the development of S&T industry, assisting in the evaluation and management of S&T programs, activating the innovation eco-system of R&D achievements and providing integrated information services. For many years, STPI has served as a think tank for the govern-

ment's S&T policies. It has continued to support the National Science and Technology Council in drafting Taiwan's science and technology white paper and is also responsible for organizing the National S&T Conference. STPI is also highly committed to facilitating links between knowledge-based policy platforms, industry databases, professional talents, and indicators. Through dual-track policy research and innovative services, these tasks will assist the government in accelerating the national development of science and technology and the innovation of R&D achievements, enhancing the country's overall competitiveness.



國家科技政策智庫

From Data Provider to S&T Policy Think Tank

STPI 科技政策研究與資訊中心
Science & Technology Policy Research and Information Center

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