NARLabs

NARLabs Introduction

Established in June 2003, National Applied Research Laboratories (NARLabs) has combined 7 national laboratories into an independent non-profit institute under the guidance of the National Science and Technology Council. With its four major missions, establish R&D platforms, support academic research, promote frontier science and technology, and foster high-tech manpower, NARLabs is striving for "global excellence, local impact." It endeavors to translate academic research results into real businesses and emerging industries in the hope of making contributions for the benefit of social welfare.

Prospect

As NARLabs is embracing its 20th anniversary, another revolution in technology has also arrived. Facing new technological torrents and challenges, NARLabs works in accordance with national policies to lead technological innovation and take on the role of a national laboratory. NARLabs is at its turning point.

Looking forward to the future, NARLabs will pursue multidisciplinary integration and newly applied technologies, which include AI, big data, unmanned vehicles, the Internet of things (IoT), and biotechnology based on existing scientific research domains to respond to environmental impacts and social changes. NARLabs will spare no effort in its role to establish R&D platforms and enable innovative technologies, exhibiting its irreplaceable value in national technological development.

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Taiwan : The High Tech Island

Taiwan : The High Tech Island

- *A Small, Agile and Resilient Island*

	Global Market ($USD)		Taiwan Output Value ($USD)	
2022	574.1 billion		161.0 billion	
2021	555.9 billion	*3.3%*	136.1 billion	*18.5%*

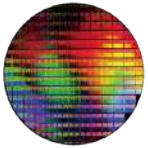
- *The Most Complete Semiconductor Industry Chain*

Taiwan : The High Tech Island

Current Status of Taiwan Semiconductor Industry

Semi. Foundry Global No.1	Output Value 2022: US$ 89.49 billion 2021: US$ 64.70 billion
IC Assy. &Test Global No.1	Output Value 2022: US$ 22.82 billion 2021: US$ 21.28 billion
IC Design Global No.2	Output Value 2022: US$ 41.07 billion 2021: US$ 40.49 billion
Memory Global No.4	Output Value 2022: US$ 7.85 billion 2021: US$ 9.60 billion

- **Occupy 63% of global foundry market**
  TSMC's 3nm process has entered mass production, demonstrating a compatible yield to its 5nm process. The 2nm process is expected to be ready in 2025.
- **Occupy 58% of global IC assembly and test market**
  ASE continuously develops System in Package (SiP), 2.5D and 3D packaging technologies.
- **Occupy 22% of global IC design market**
  MediaTek first announced 5G SoC in 2019.

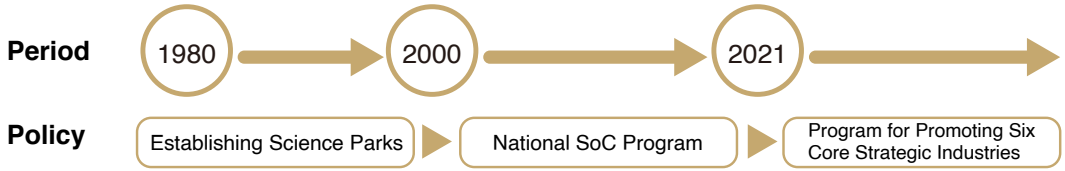


	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
TSMC	10nm		7nm		5nm		3nm			2nm
Samsung	10nm			7nm	5nm		3nm			2nm
Intel	14nm			10nm		7nm	intel4		20A	18A
GFS			12nm							
SMIC	28nm			14nm						
UMC		14nm								

Taiwan's Key S&T Policies and STPI Missons

Taiwan's Key S&T Policies and STPI Missons

Taiwan Semiconductor Policy Pathway



Recent Semiconductor Promotion Policies in Taiwan (by National S&T Council, NSTC)

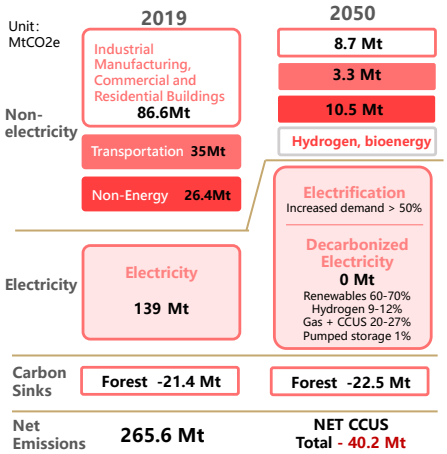
Semi. Research Project	Goal
Angstrom Semiconductor Initiative (2021-2025)	Developing Silicon-Based Semiconductor Technologies
Next-Generation Compound Semi. Prospective R&D Project (2022-2025)	Promoting Compound Semi. Process, Equipment, and Material R&D
Key Emerging Chip Design and Development Project (2022-2025)	Early Deployment of Key Technologies in Next-Generation Chip Design

Taiwan's Key S&T Policies and STPI Missons

Taiwan Net-Zero Emission in 2050

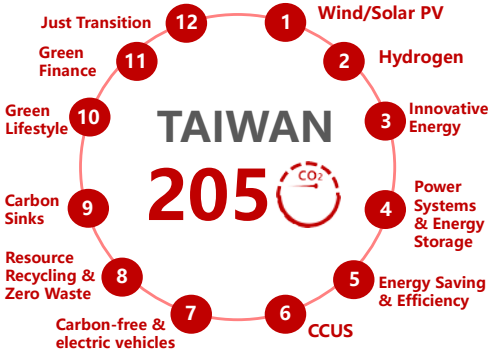
2050 Net-Zero Emissions Plan

Emissions and Absorption Achieve the Net-Zero Target



12 Key Strategies for Net-Zero

National-level Net-Zero Transition Strategy



- NSTC promotes the science and technology related to net-zero transition.
- STPI supports NSTC in advancing the S&T requirements for net-zero, providing relevant research reports.

Taiwan's Key S&T Policies and STPI Missons

STPI Missions

1. To support the government on S&T policy planning
2. To support the government on the development of S&T industry
3. To assist the government in evaluation and management of S&T programs
4. To activate the innovation eco-system of R&D achievements
5. To provide integrated information services

EMPOWER TAIWAN NEW SCIENCE AND TECHNOLOGY
White Paper on S&T
(2023 - 2026)

National S&T Development Plan
(2021 - 2024)
CREATING THE FUTURE

STPI Tasks: The Making of S&T Development Strategy

Intelligent Collaborative Decision-Making Support Platform

Research on the Issues

Intelligent
Issue Analysis

Issue Service
Elastic Search
AI Tools

Issue Data and Literature

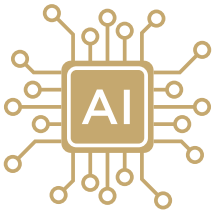
- Academic Publications
- Tech News
- Targeted Countries' Strategies/Policies

Interviews
Surveys
Round Tables
Think Tanks
Govt. Agencies

Issue Analyses & Policy Suggestions

Network Research

Experts, Think Tanks & Govt. Agencies



TSRI ASIC/FPGA Hybrid SoC Design Platform

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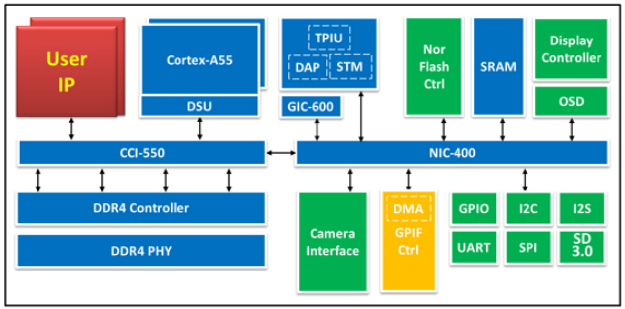
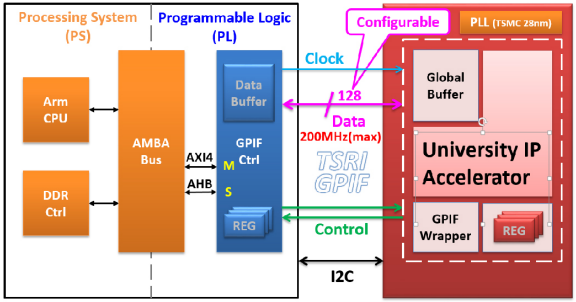




TSRI ASIC/FPGA Hybrid SoC Design Platform

Simulation acceleration by 50X

Ease System demonstration
by pre-built common platform

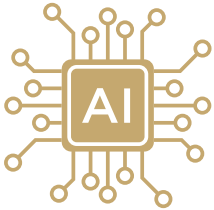
CPU: Arm Cortex-A55 Dual Core, Cortex-M55, SNPS ARC H34

1. Support academic research in Edge AI, NGS, Automotive system chip.
2. Accelerate system integration by pre-build SoC Platform
3. Shorten the time required for IC design development & verification

TSRI & NTU publish ISSCC Paper x3 with System Chip x3 in 2023

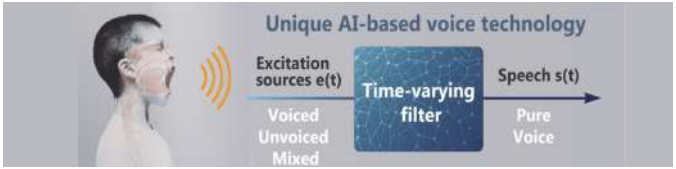
1. A 28nm 11.2 TOPS/W Hardware-Utilization-Aware Neural-Network Accelerator with Dynamic Dataflow
2. A 28nm 142mW Motion-Control SoC for Autonomous Mobile Robots
3. A Fully Integrated End-to-End Genome Analysis Accelerator for Next-Generation Sequencing

Human Whole-genome Sequencing Run Time: couple of days to 40 mins



vMic Noise-free Surface Vibration Microphone

vMic Noise-free Surface Vibration Microphone



vMic is a surface vibration microphone that senses speaking vibrations through contact with the skin near the throat. It will transform the vibration into pure voice, without getting disturbed by environmental noise. With our advanced AI compensation algorithm, vMic thus lets your voice become more real.

Stick-On Type

Clip-On Type

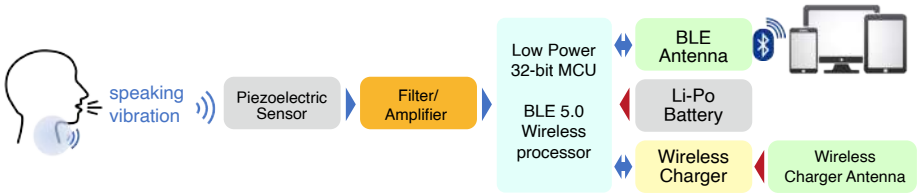
Technical Feature

- Senses sound vibrations directly through the user's skin
- Advanced AI compensation algorithm
- Confronts and solves any unfavorable, noise interference environments
- Convenient sticker and wearable application
- App based, easy to use
- Ultralight and waterproof

App Based

vMic Noise-free Surface Vibration Microphone

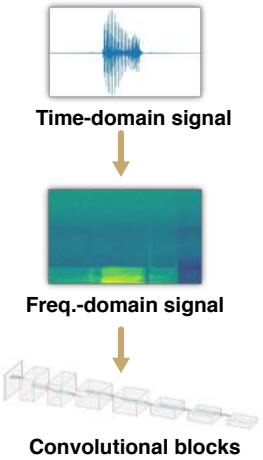
Architecture

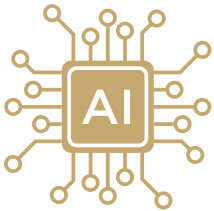


The speaking vibration signals are collected via the piezoelectric sensor, the noise filter, and the signal amplification circuit. The pre-processed signals are further sampled and transformed from analog to digital format. All the digital data is then transmitted through BLE wireless network to a portable device or computer.

Case Study :

Keyword spotting application





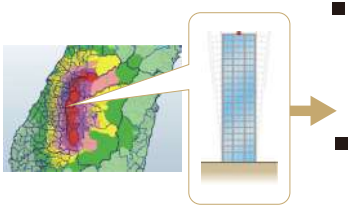
Non-Structural Components (NSCs) Seismic Proof Solutions

Non-Structural Components (NSCs) Seismic Proof Solutions

NSCs Shape Our Lives

NSCs encompass a diverse array of elements and equipment that are indispensable to modern life. Whether it's the plumbing systems within buildings or the process equipment in high-tech facilities, the seamless functioning of modern life relies heavily on the essential supplies provided by NSCs.

Knowing the Seismic Hazard to NSCs

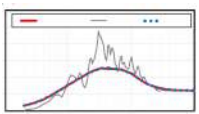


- **Seismic Demands**
  - Site properties
  - Structural properties
  - NSCs properties
- **NSCs Damages**
  - Drop, collapse, casualties
  - Loss functionalities
  - Secondary disasters

Comprehensive Earthquake Engineering Capabilities

NCREE offers diverse software and hardware R&D services for earthquake engineering, including analysis, simulations and testing on NSCs.

Numerical simulations



PSHA

PISA-3D

Assembly testing

Seismic simulator

Suspending NSCs testing

Suspending equipment testbed

Component testing

Multi-Axial Seismic Test System

Non-Structural Components (NSCs) Seismic Proof Solutions

Earthquake Engineering on 3R Chip

High-tech facilities heavily rely on a wide range of NSCs, including energy supply systems, overhead conveyors, stockers, HVAC, and more, to support chip manufacturing processes. Ensuring adequate seismic capacities of these NSCs is of utmost importance. NCREE offers comprehensive software and hardware services that assist in enhancing the seismic performance of equipment, ultimately reducing earthquake risks to high-tech facilities.

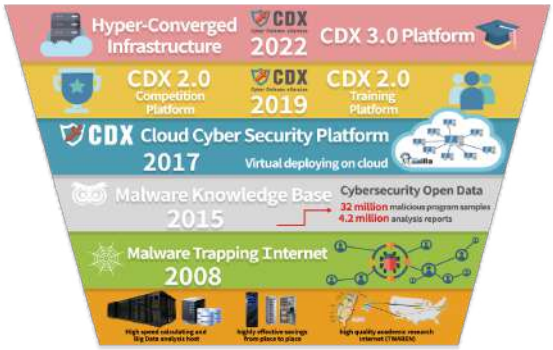
Seismic Qualification on NSCs

Conducting precise seismic capacity evaluations of NSCs through realistic environmental simulations on shaking tables is a highly effective approach to enhance their seismic performance. NCREE has constructed multiple shaking tables with capacities that meet global building codes and industry standards. Additionally, various testing frames have been established to further study and develop the seismic performance of NSCs.

Cyber Defense eXercise

Cyber Defense eXercise

The development of CDX Platform



Platform of cultivating cyber security talents

Aligned with the government's commitment to fostering cybersecurity talents, the National Center for High-performance Computing (NCHC) has taken the initiative to establish the Cyber Defense Exercise (CDX). By harnessing the national-level high-speed network and high-performance computing infrastructure, CDX provides a dedicated platform for hands-on cybersecurity training. Our mission is to offer comprehensive and long-term preparatory instructions that complement traditional school lectures, thereby empowering individuals with practical, real-world cyber capabilities.

Cyber Defense eXercise

Key Features

24/7 Cloud Computing Service

Experience uninterrupted access with our web-based cloud computing service, ensuring you can train anytime, anywhere.

User-Friendly Web Portal

Our intuitive portal allows you to enjoy self-service options and on-demand access for a seamless learning experience.

150+ Vulnerable Host Datasets

Dive into a diverse array of datasets to sharpen your skills and develop effective cybersecurity strategies.

Secure Sandbox Environment

Train fearlessly in a regulated sandbox environment that ensures safety and enhances your cybersecurity expertise.

Cyber Defense eXercise

Highlights

Cutting-Edge Technology

Leveraging cloud computing and virtualization, we establish course environment deployment services, offering diverse field environments for advanced cybersecurity research and practical talent training. This propels the cybersecurity capabilities of industry, government, academia, and research sectors to new heights.

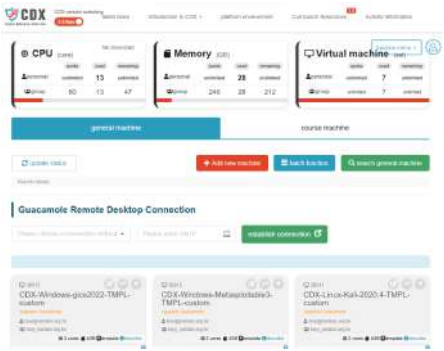
Real-World Network Environments

With virtualization technology, we create authentic network settings and conduct cybersecurity attack and defense competitions using on-demand vulnerability datasets. These dynamic competitions foster valuable technical exchanges among participants from diverse sectors.

Proven Expertise

CDX played a pivotal role as an infrastructure service provider in the Taiwan-US joint Cyber Offensive and Defensive Exercise (CODE 2019) in 2019. Furthermore, our collaboration with enterprises led to the successful organization of the RedAlert72 cybersecurity attack and defense competition in 2021, coupled with an enlightening technical symposium.

Cyber Defense eXercise



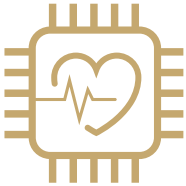
practical environment
rapid deployment

Cyber Seccurity Challenges

Hands-on training

Skill of defending
hackers' attacks

Simulating Internet
actual combat



Organ-on-a-chip
Next-Generation Innovative Tools for Biomedical Research

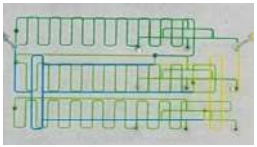
Organ-on-a-chip
Next-Generation Innovative Tools for Biomedical Research

Organ-on-a-chip (OOC) integrate microfluidic devices, organ-specific microenvironment simulation, and MEMS-based biomedical chips, serving as innovative tools for next- generation translational biomedical research. They not only have the potential to replace animal experiments but also accelerate drug development, paving the way for precision medicine. From a technological perspective, OOCs can leverage Taiwan's strengths in integration, which could create new value for Taiwan in the global biomedical research.

Cardiac-chip

- Detect cardiac contraction frequency and strength
- In vitro model for cardiac drug screening and toxicity study

Drug screening-chip

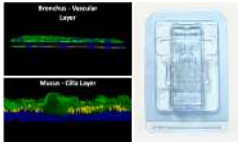


- Microfluidic concentration gradient chip for high-throughput drug screening
- Five concentration gradients and span two orders of magnitude in the same chip

Pythia Biotech Ltd.

- Lung and bronchiole model in the microfluidic system
- Study the respiratory disease
- Tumor microenvironment chip
- Microfluidic gradient chip with 3D tumormicroenvironment system

Lung on a Chip



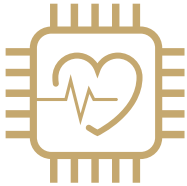
- Bronchus and alveolus-on-a-chip
- Dynamic aerosol delivery system for inhalation
- AI-assisted automated analysis

IAMLab102

NTU BSSL
Biochemical Sensing System Laboratory

PYTHIA BIOTECH
諭泰生技

Anivance AI



New Approach Methods Qualification Platform in NARLabs

New Approach Methods Qualification Platform in NARLabs

The Next Generation of Drug Development

Drug discovery | GLP test | **IND** | Phase I | Phase II | Phase III | **NDA**

Traditional

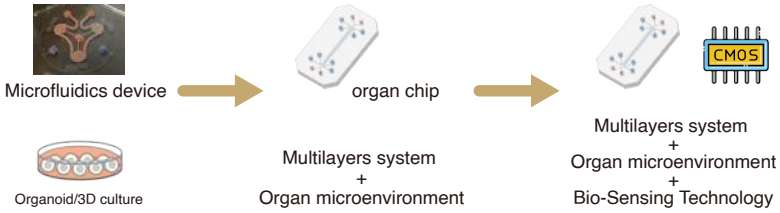
Drug discovery | Pre-clinical trial | Clinical trial

FDA Modernization Act 2.0
- Allows clinical trial leaders to use animal trial alternatives before human clinical trial

Clinical trial

Animal trial, 3D cell culture, organ on a chip, AI + clinical trial

From Microfluidics Device to Microphysiological Systems



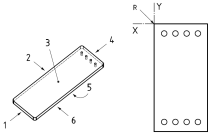
New Approach Methods Qualification Platform in NARLabs

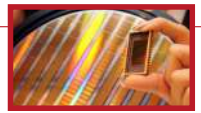
New Approach Methods Qualification Platform in NARLabs

Organ on a chip → **MEMS/LIGA-Like** → **Material** → **Qualification system** → **Applications**

Microfluidics devices
ISO 22916:2022

MEMS、Injection Molding
ISO 294-4:2018、DIN EN 1779





Biocompatibility
Sterilization
ISO 10993、ISO 11135

Cell Culture

PDX bank

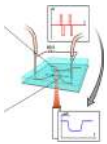
Verification
IEC 61010-1、IEC 61010-2-101:2018
IEC 61326-2-6:2020

Quality system
IEC 60601-2-24:2012、ISO/IEC17025、ISO15189

TAF ISO 13485 GIVIMP

Maskless lithography
Microfluidics Fabrication

CMOS Bio-Sensing Technology



Wireless Real-time Stimulation & Readout with AI

*PDX: Patient Derived Xenograft

OOC Heterogeneous System Integration

High-Speed Computing for Geologic Modeling and Site Analyzing of the Ocean to Achieve Carbon Negative

High-Speed Computing for Geologic Modeling and Site Analyzing of the Ocean to Achieve Carbon Negative

Taiwan Ocean Research Institute (TORI), National Center for High-performance Computing (NCHC)

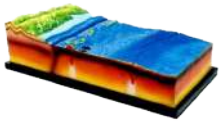
Marine Big Data

Aim Infrastructure-oriented Marine Geological Survey

Develop the Marine Drilling Technology at the Shallow Layer on Research Vessel; Collect Geophysical Data for Imaging the Structures of Carbon Storage

Aim Develop Ocean Floor Simulation In 3D Rendering

Simulation and visualization for land, sea, atmosphere, and space; establish a cloud-based HPC forecasting system for carbon-negative site selection



Aim Develop Geological Intelligent Modeling System

Upgrade smart point cloud for innovative site selection collaborative procedure with 3D geological XR interactive marking; increased interpretation speed by 2x

High-Speed Computing for Geologic Modeling and Site Analyzing of the Ocean to Achieve Carbon Negative

Expected Benefits：Innovative Site Selection and Feasibility Prediction Procedures and Tools ·
Push forward the integration of carbon-negative technologies

Research in net-zero from marine data

TORI

MCS System+ Marine Drilling Technology
Marine Stratigraphic Analysis

Marine Big Data for Sedimentary Structures

Geological AI Point Cloud Modeling

NCHC

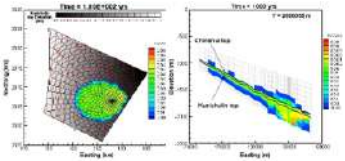
2021 R&D 100 WINNER
R&D 100 Winner
The Oscars of Innovation

Smart Point Cloud Feature Extraction
Optimization of Geological Modeling Algorithm

3D Geological Model XR Interaction

Ocean floor Simulation High-performance computing

NCHC



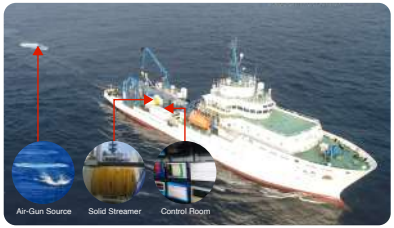
Wave and Current-induced Seabed Erosion and Sedimentation;
Multiphase Flow in Porous Geological Media

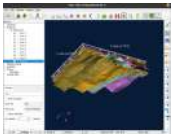
Carbon Migration Simulation and Algorithm Visualization

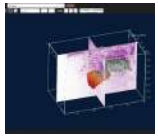
High-Speed Computing for Geologic Modeling and Site Analyzing of the Ocean to Achieve Carbon Negative

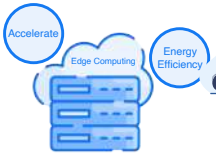
Forward-looking Net-Zero Emission Human-Machine Collaboration R&D

high-speed computing for geologic modeling and site analyzing of the ocean to achieve carbon negative
Edge Computing for Accelerated Transmission and Energy-efficient Resource Management

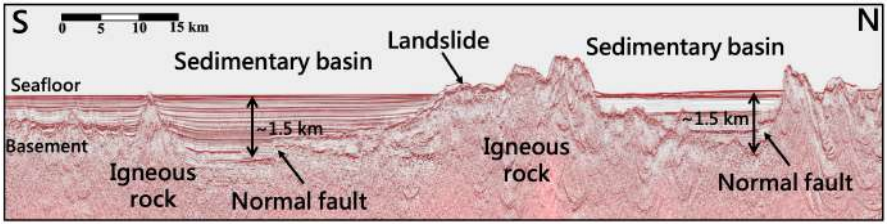








- Visualization for Assisting Automatic Detection of Geological Faults
- Conversion of 2D Seismic Data into 3D Point Cloud Representation

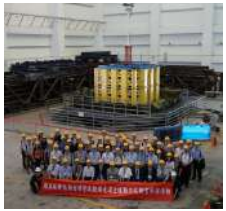


Offshore Wind Turbine Supporting Structure and Critical Component Testing Base

Offshore Wind Turbine Supporting Structure and Critical Component Testing Base

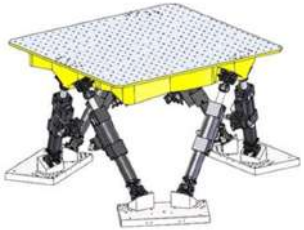
Underwater Foundation and Ground Experimental Platform

- Large-Scale Offshore Wind Turbine Physical Model Experiment (including Soil Liquefaction)
- Wind Turbine Model and Vibration Reduction Device Testing



Critical Components/Supporting Structure Testing Platformfor Wind Turbine

- Dynamic Testing for Wind Turbine Supporting Structures and Key Components
- Simulations of the Mechanical Behavior of Wind Turbine Support Structures and Key Components While Under the Impact of Earthquakes and Typhoons
- Utilization of Scale-Down Underwater Foundation and Ground Model Experiments



NCREE MAST 2m x 2m x with
3500 kgf pad load and longer stroke

Offshore Wind Turbine Supporting Structure and Critical Component Testing Base

Soil Mechanics Laboratory for Offshore Wind Farm Geotechnical Survey

- Physical Properties of the Soil (TAF Accredited)
- Static and Dynamic Characteristics of Soil

1 Static Triaxial Testing System

- Shear Strength of Soil Sample
- High-Precision Volume Pressure Control
- Automated Triaxial Testing System

2 Resonance Column Testing System

- Torsional Resonance
- Torsional Damping
- Bending Resonance
- Bending Damping
- Low-Frequency Torsional Shear (< 2 Hz)

3 Dynamic Triaxial Testing System

- Bender Element Test
- 0-2 Hz Dynamic Loading (Force/Displacement)
- Automated K0 Consolidation Test
- High-Precision Volume Pressure Control Instrument
- User-Defined Input Waveforms

4 Cyclic Simple Shear Testing System

- 0-5 Hz Biaxial Dynamic Loading (Force/Displacement)
- K0 Confining Ring (Teflon Coated)
- High-Precision Volume Pressure Control
- User-Defined Input Waveforms
- Static/Dynamic Triaxial Testing
- Automated K0 Consolidation Testing

5 Direct Shear and Consolidation Testing Area

- Automated Direct Shear Testing
- Automated Consolidation Testing

6 Laboratory Monitoring Area

- Humidity and Temperature Control
- Humidity and Temperature Monitoring

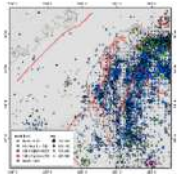
7 Documentation Storage Area

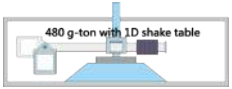
- Record Forms
- ISO and TAF Product Trade Certification Forms
- Transducers

Offshore Wind Turbine Supporting Structure and Critical Component Testing Base

Smart Disaster Prevention Monitoring Platform for Supporting Structure of Offshore Wind Turbine

	Design, Analysis, and Experimental Techniques	Smart Monitoring Technology for Disaster Prevention	Advanced Experimental Facilities for Green Energy
Tasks	• Numerical analysis of full model for OWT lifecycle • Local geotechnical design and analysis for OWT foundation • Model and parameters study of local environmental loads(earthquake, wind, wave, and current) • Physical model test on underwater foundation for SSI of OWT	• Development of advanced instrumentation for OWT • Integration of advanced instrumentation and SCADA • Application of monitoring data to advanced analysis • Ocean Bottom Seismograph (OBS) for seismicity monitoring • Smart Monitoring Platform of OWT for Disaster Prevention	• Geotechnical centrifuge facility and experimental technology • Test facility for jacket's k joint and grouted joint for the supportiing structure and experimental technology • Test facility for blade and experimental technology
Expected Outcome	• To improve the technology of design and analysis for OWT • To better understand the dynamic interaction of multiple environmental loadings for OWT • To develop the design and construction scheme of underwater foundation and monitoring of OWT	• To improve the localization and automation capability of O&M for offshore wind farm • To establish a visualized Smart Monitoring Plat form of OWT for Disaster Prevention to strengthen the structural safety and the operation of OWTs	• Test and validation platform for underwater foundation and fatigue of OWT blades • Index of health and failure mode for OWT and blade
Competent Authority and Potential Users	MOE, Engineering Consultants, Taipower	Taipower, NSTC, MOE, Developers	Wind Power Developers, Engineering Consultants, NSTC (Research Community), MOE (Bureau of Energy, Bureau of Standards, Water Resources Agency) Taipower, INER, EPA, Ministry of Agriculture (ARDSWC), Ministry of Transport and Communications (Freeway Bureau, Directorate General of Highways)





- Soil Liquefaction issue on Western Seabed in Taiwan, Safety of Underwater Supporting Structure for OWT, and Early Warning of Upper Structure for OWT
- Research and Development of Experimental and Monitoring Technologies,On-Site Testing of Phase 2 Wind Turbines in 2026, Feedback for Localization of Phase 3 Wind Turbine Design and Manufacturing by 2027

TSRI : Global IC Design Talent Cultivation

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Based in Taiwan

- Collaboration with Universities EDA/IP vendors
- Collaboration with TSMC

TSMC ADFP

- iPDK
- Std. cell library
- IO cell library
- SRAM and PLL IP
- Documents
- Training material

TIDT: mimic TSRI successful experiences to Global

Taiwan government	Policy formulation	Friendship government	
Taiwan Univ. (Semiconductor Academy)	Joint cultivation	Local Univ. (Semiconductor Academy)	Taiwan Semiconductor Ecosystem
TSRI	IC Design flow environment Setting & Deployment	Taiwan IDT Center	Taiwan IC Design Industry

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