2013 Annual Report
Instrument Technology Research Center

NARLabs 國家實驗研究院
儀器科技研究中心
Instrument Technology Research Center
ITRC

300 新竹市科學園區研發六路20號
Instrument Technology Research Center, National Applied Research Laboratories
20, R&D Rd. VI, Hsinchu Science Park, Hsinchu 300, Taiwan
TEL:886-3-577-9911 FAX:866-3-577-3947 http://www.itrc.narl.org.tw

2013 Annual Report
儀科中心 | 中華民國一〇二年年報

Foreword

Message from the Director General

2013 年，是小弟與中心同仁一起奮鬥的第一個完整年度。稟持著「友愛方有情，團隊成大事」的座右銘，與同仁溝通、協調，建構符合社會期許與挑戰新契機的戰略目標。「業務、公關、啦啦隊」是小弟我在中心服務的核心三任務，運用外部的需求力量引導中心轉型，貼近社會脈動；當個超級業務員，拓展中心對外服務網絡；用心與行動來振奮同仁士氣、提升戰鬥力。

中心戰略目標設定為兩項，一是與台灣半導體（與光電）領導廠商合作，共同開發、提升設備產業技術；另一為產學研三方攜手並進，打造創新創業工程平台。因應新型態業務的需求，中心進行了組織整併，建構能獨立運作的工程組，並強化組長的權責（預算、考評、調薪）。

回顧 2013 年，中心對外拓展產學研三方關係的過程是辛苦的一年！八年前法人化之後，對外的互動仍欠缺以「客戶為尊」的信念。這幾年或多或少給予外界些許負面印象，需要同仁以更好的溝通力與服務效能來改善，期許同仁散發「服務是幸福」的正向能量。

2013 年也是儀科中心成果豐碩的一年。在財務報表上，近年來首次在收支餘絀表上轉虧為盈，增加一千萬；自籌收入也大幅提升，若不計算特別補助，成長了約五成。在技術精進的面向上，中心舉辦了「國人自製航太鏡片技術大突破－邁入高科技設備自主里程碑」(A Major Breakthrough in Domestic Aerospace-Grade Lens Technology — Passing a New Milestone in Autonomous High-Tech Equipment) 及「可攜式上皮組織取像儀」(Portable Epithelium Imaging System) 臨床成果發表會。年底交付福衛五號遙測取像儀 (FORMOSAT-5 remote sensing instrument) 予太空中心。此外，與高雄醫學大學簽署合作策略聯盟 (A strategic alliance agreement with Kaohsiung Medical University)，並成立「光學系統整合研發聯盟」(Optical Systems Integration R&D Consortium)，積極強化品牌價值與網絡關係。

如果 2013 年是轉型年，那麼 2014 年就將是躍升的一年。自籌收入預期將再次飛升，突破一億關卡；今年將可與半導體大廠進行數件曝光機光學元件商業交易，年底前預計完成 i-line 步進型曝光機鏡頭模組 (Lens module of i-line stepper)，並舉行商業合作會議，此外協用半導體大廠研製 SEMI 級 ALD 製程設備。

儀科中心秉持著前瞻創新的信念，持續深耕精密儀器技術，為國內學術研究與產業加值盡一己之力。儀科中心將專注於光機電領域、真空科技與生醫應用，結合學術界研究能量，積極協助產業創新發展、迎接未來挑戰。

主任 葉哲良 J. Andrew Yeh

Milestones in 2013

As a national laboratory, Instrument Technology Research Center (ITRC) is dedicated to enhancing its R&D expertise as well as actively participating in domestic and international academic activities, aiming to build up a world renowned research institute.

Vice president Chen-Ying Chi of NARLabs and Prof. Ren Fan of the Dept. of Chemical Engineering, UF inspected ITRC's exhibition booth at SPIE Photonic West 2013.

Press conference on "A Major Breakthrough in Domestic Aerospace-Grade Lens Technology" was held. From right to left are ITRC Director General Jer-Liang Andrew Yeh, former NARLabs President Liang-Gee Chen, and Division Director Aaron Wei-Yao Hsu.

2013/ 01

Deputy Minister Chung-Yuan Mou of the National Science Council inspected ITRC.
The "2013 International Symposium on Precision Machine Tools and Processing Applications and Technologies" was held jointly with National Chung Hsing University.

2013/ 02

ITRC participated in SPIE Photonics West 2013 conference and exhibition in San Francisco, US.

2013/ 03

Co-organized Taiwan-Korea International Technology Interchange Symposium.
A tree-planting activity was held on Arbor Day.

2013/ 04

ITRC held a press conference on "A Major Breakthrough in Domestic Aerospace-Grade Lens Technology-Passing a New Milestone in Autonomous High-Tech Equipment."

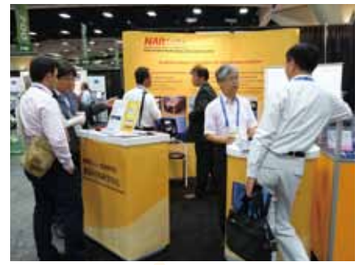
2013/ 05

ITRC attended IEEE International Instrumentation and Measurement Technology Conference (I^2MTC) in Minnesota, US, and secured the right to hold the 2016 I^2MTC in Taiwan.
ITRC attended the International Conference on Shape memory and Superelastic Technologies (SMST) in the Czech Republic, and visited the Czech Academy of Science to discuss mutual cooperation.

ITRC participated in 2013 International Optoelectronics Exposition Taiwan.

2013/ 06

A cooperation agreement was signed with National Tsing Hua University.
ITRC's space-grade optical film technology development team was awarded the Outstanding Achievement Award in the 7th "Award for Outstanding Contributions in Science and Technology".
ITRC participated in a coating competition at Optical Interference Coatings (OIC) in Canada.
ITRC participated in 2013 International Optoelectronics Exposition Taiwan.
A joint research project was completed with RIKEN, the Institute of Physical and Chemical Research in Japan.



ITRC participated in SPIE Optical+Photonics 2013 conference in San Diego, US.

2013/ 07

An incubation cooperation agreement was signed with National Chiao Tung University.
A strategic alliance agreement was signed with Kaohsiung Medical University.

2013/ 08

The "blood glucose colorimetry biochemical analysis test chip" was technically transferred.
ITRC participated in SPIE Optical+Photonics 2013 conference in San Diego, US.
ITRC participated in the 2013 Taipei International Industrial Automation Exhibition.
An incubation cooperation agreement was signed with National Chiao Tung University.

ITRC participated in the 2013 Taipei International Industrial Automation Exhibition.

Group photo of the 5th "*i*-ONE International Instrument Innovation Competition" award winners

2013/ 09

NARL President Ching-Hua Lo inspected ITRC.
ISO 9001/27001 tracking audit was passed.
An incubation cooperation agreement was signed with National Central University.
ITRC participated in Taipei International Invention Show, and received one gold, one silver, and one bronze medal.

2013/ 10

A joint press conference on "Portable Epithelium Imaging System " was held with Kaohsiung Medical University.
ITRC participated in the 2013 Laser Expo Taiwan.
"Optical Systems Integration R&D Consortium" was launched.

Promotion activities were held for extension of the NARLabs service platform, and ITRC sponsored the open house at the Hsinchu area.

2013/ 11

The 5th "*i*-ONE International Instrument Innovation Competition" awards ceremony was launched.
An ultra-precision processing and measurement conference was held.
The project "Development of a portable clinical skin pathology testing platform" was awarded the 2013 Taiwan Photonics Society's Optoelectronics Technology Contribution Award.

NARLabs, NHRI, and NTU jointly established "Magnetic Resonance Imaging System Development and Service Platform".

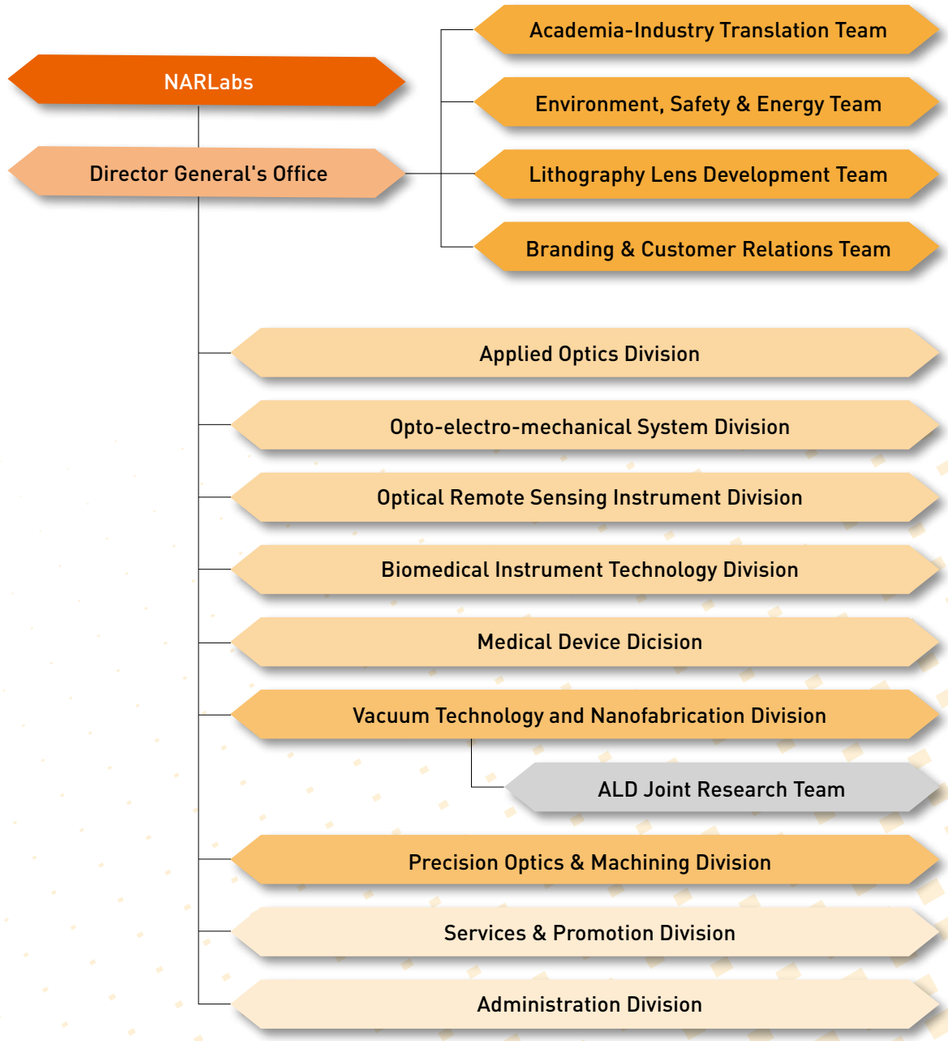
2013/ 12

National Applied Research Laboratories (NARLabs) service platform promotion event was held, and ITRC sponsored its open house at Hsinchu area.
"Optoelectronics Technology Summit Forum" was held.
"Magnetic Resonance Imaging System Development and Service Platform" was jointly established by NARLabs, National Health Research Institute and National Taiwan University.

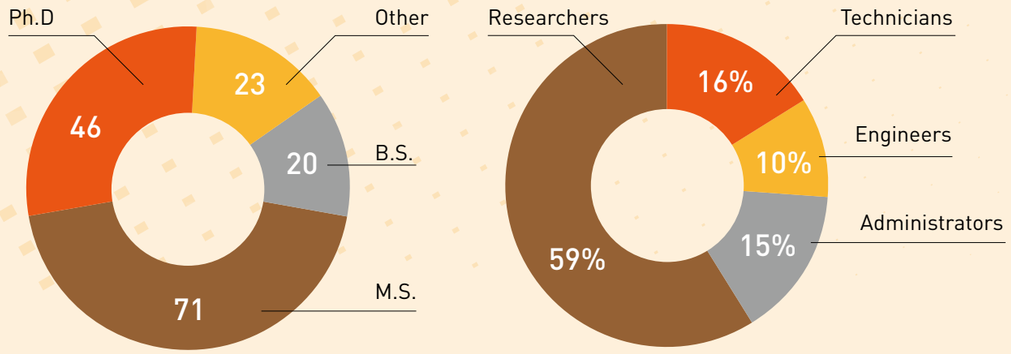
Summary

ITRC relies on prospective R&D and integrated interdisciplinary technology to support Taiwan's academic research and national policies, as well as to meet industry request. As a result, ITRC has become an important provider of R&D capabilities and promoter of economic development.

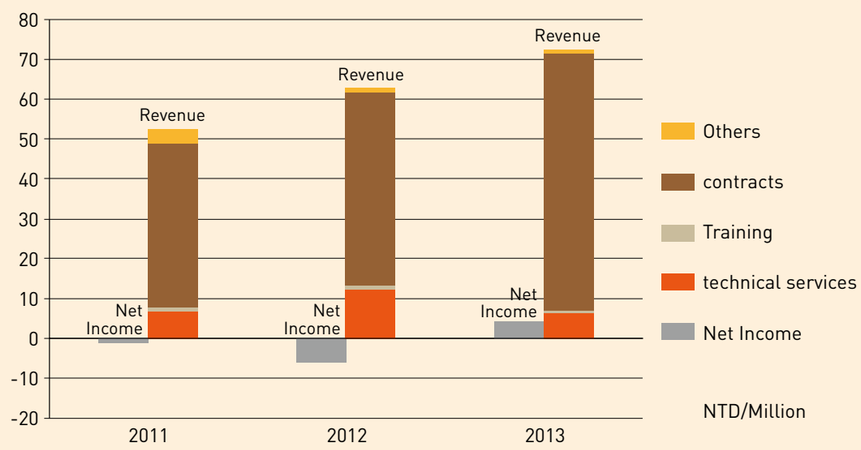
Organizational structure



Manpower deployment



Financial information



Core Facilities

In order to conduct technological R&D concerning instrument development, ITRC has established core facilities in the fields of vacuum technology, nanometer processes, and precision opto-mechanical engineering. Apart from supporting ITRC's research, these facilities also promote resource sharing and cooperation between industry, academia, and research organizations.

Vacuum technology & nanometer processes

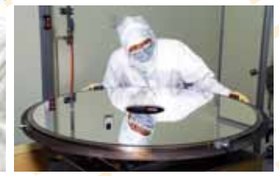
ITRC provides advanced vacuum system development, nano/micro film process development, and inspection/calibration service platforms. Its core facilities include:

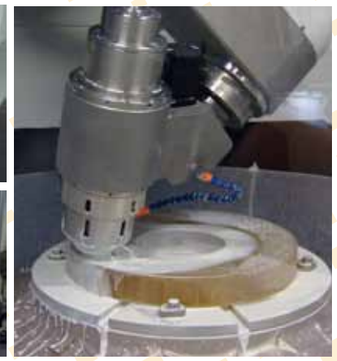
- Large-aperture lens coating system
- Aligner-typed exposure machine
- Transmission electron microscope

Precision opto-mechanical engineering

Having accumulated 40 years of experience in optical polishing technology, ITRC provides precision opto-mechanical elements and systems design and fabrication services. Its core facilities include:

- Large-aperture Aspherical Stitching Interferometer
- Lens polishing and testing equipment
- Ultra-precision diamond turning and milling machine





Areas of Focus

ITRC has long pursued instrument technology research and the development of basic instrument engineering technology. Possessing extensive R&D capabilities and instrument technical service platforms, not only does ITRC assist academic organizations in developing customized experimental instruments and equipment needed for advanced researches, ITRC also realizes its R&D innovations as industrial applications. ITRC is currently promoting the development of next-generation technology, including the fabrication and testing of large-aperture lenses, optical systems, and elements for semiconductor process equipment, ALD technology, automated optical inspection (AOI), and medical optical instruments. ITRC is continuing to enhance Taiwan's academic research capabilities, and help Taiwan's industries develop and derive economy benefits.

ITRC relies on continuing R&D and technological integration to provide assistance and support to Taiwan's academic sectors, and it also strives to create value for Taiwan's industries, and enhance their international competitiveness. ITRC therefore sincerely hopes that the diffusion of its technological capabilities will enable it to grow together with the domestic academia and industrial sectors, which will benefit together with the nation and society.

Important current tasks:

Fabrication and testing of large-aperture lenses

Large-aperture lenses (aperture greater than 100mm) are widely used in aerospace-grade technology, astronomical telescopes, semiconductor equipment, and precision measurement instruments and equipments. These lenses have high technological requirements, and require ultra-precision measurement and polishing technology, precision clamping designs, and precision coating capabilities. In the past, only a small number of technologically-advanced countries, including the UK, the US, and Japan, possessed these capabilities. In order to facilitate the upgrading of Taiwan's industry, ITRC's technology team has created a standard operating procedures for large-aperture lens production and coating, established a lens production and coating technical services platform, and adopted a batch production management model. ITRC currently possesses the ability to produce meter-grade (an aperture of 1000mm) lenses, and plans to strongly promote the domestic production of large-aperture optical elements in the future. If this can be done, it will give domestic firms an alternative to imported equipment, strengthen Taiwan's industry supply chain, cut costs, and boost domestic competitiveness.

Optical systems and elements for semiconductor process equipment

While the semiconductor industry is currently one of Taiwan's most important industries, the local content of semiconductor equipment used in Taiwan is still quite low. In order to assist domestic equipment producers, strengthen Taiwan's semiconductor equipment industry portfolio, and boost Taiwan's competitiveness, ITRC has taken advantage of its experience and technology to develop precision optical elements and systems needed by the precision machinery industry, and precision optical elements needed by semiconductor equipment manufacturers. ITRC's efforts have boosted Taiwan's optical manufacturing technology and strengthened the domestic semiconductor industry chain.

ALD technology

ITRC has been involved in atomic layer deposition (ALD) system design and process development since 2003, and looks forward to the continued improvement of its ALD technologies. ITRC's achievements in ALD technology are step coverage (100%) and thickness uniformity (< 1% thickness variation, 12-inch wafer) currently reach international level. As Taiwan's semiconductor technology develops, and line width continues to shrink, many semiconductor processes, such as the creation of a diffusion barrier layer and seed layer, are converting to ALD technology. ITRC's ALD research team is currently cooperating with internationally renowned semiconductor firms to integrate work on the synthesis of novel precursors and apply PEALD technology to dual Damascene copper internal wiring in semiconductor development. The research team is also working with semiconductor firms to incorporate ALD process capabilities at the upstream level, develop next-generation new material process technology, and aims to achieve a dominant position in next-generation semiconductor process technology.

Automated Optical Inspection(AOI) Instruments

Since it established Taiwan's first optical factory in 1974, ITRC has dedicated considerable R&D resources and manpower to the development of optical elements and subsystems and

applications research. ITRC has also been able to meet the optical system design and realization needs of academic researchers, whose research results have diffused back to industry. This process has enabled Taiwan to develop a powerful optical industry, which has achieved a huge competitive advantage in the areas of consumer electronics and automotive products. In view of the burgeoning state of the medium-/small-aperture precision optics industry, ITRC has shifted its R&D resources to the development of precision large-aperture aspherical optical elements and applications for optical imaging systems. To ensure that R&D results actually meet the needs of industrial applications, during 2013 ITRC focused considerable resources on forming an Optical Systems Integration R&D Alliance, encompassing industry, academic researchers, and ITRC's own research team. After the most urgent questions facing industry are confirmed via the alliance's information platform, ITRC's formidable accumulated optical and opto-mechanical system design, electrical control, instrument interface, and image analysis technologies are employed to develop automated optical inspection systems, which are provided to industry for production or value-added application. The alliance is thus enhancing the level of industrial automation, reducing dependence on labor, and creating new competitiveness.

Medical optical instruments

In conjunction with the government's promotion of the biotechnology and medical materials industries, in 2012 ITRC leveraged its long-standing optical, mechanical, and electronic integration capabilities to develop the "Portable Epithelium Imaging System " in collaboration with Kaohsiung Medical University Chung-Ho Memorial Hospital. This device has passed the Class I medical device review from TFDA, making it an approved device, and it is capable of reaching 95% diagnostic correctness. ITRC is currently cooperating with a number of domestic hospitals and medical universities to jointly develop optoelectronic medical testing systems. By promoting the autonomous development of optoelectronic medical instruments in Taiwan, ITRC aims to boost Taiwan's medical equipment technology and added value, while also protecting citizens' health and welfare.

Achievements

ITRC relies on its R&D expertise to strive for technological breakthroughs, and seeks to employ strategic alliances to expand the benefits of its R&D achievements. This year, ITRC completed "aerospace-grade mirrors and Remote Sensing Instrument OSA for the FORMOSAT-5 satellite" and an "Portable Epithelium Imaging System"; ITRC also joined forces with industry, academia, and research organizations to establish an Optical Systems Integration R&D Consortium and "magnetic resonance imaging system R&D and imaging service platform," both of which are considered highly successful and have received considerable media coverage.

From right, ITRC Director General Jer-Liang Andrew Yeh, former NARL President Liang-Gee Chen, and ITRC Division Director Aaron Wei-Yao Hsu.

2013/ 04

A Major Breakthrough in Domestic Aerospace-Grade Lens Technology – Passing a New Milestone in Autonomous High-Tech Equipment

ITRC overcame bottlenecks in large-aperture aspherical lens technology in the successful development of aerospace-grade mirrors for the FORMOSAT-5 satellite, and now possesses the technology needed to produce 1-meter lenses. ITRC's precision corrective polishing has enhanced precision to the level needed for 1-meter lenses, and the ITRC looks forward to cooperating with domestic firms and helping upgrade domestic industry.

Press conference concerning the "Portable Epithelium Imaging System" developed jointly by ITRC and Kaohsiung Medical University

2013/ 10

An Portable Epithelium Imaging System developed cooperatively by Kaohsiung Medical University and NARL

ITRC has worked together with Kaohsiung Medical University Chung-Ho Memorial Hospital to jointly develop a Portable Epithelium Imaging System, which provides a simple, fast, and highly accurate means of determining whether patients have dermal cancer. Developed entirely in Taiwan, this device combines medical and optoelectronic technologies; it has passed the Class I medical devices review from TFDA, making it a successful example of Taiwan-developed medical equipment.

2013/ 10

ITRC joined forces with industry and academia to initiate the "Optical Systems Integration R&D Consortium"

In order to enhance the global competitiveness of Taiwan's technology, ITRC spearheaded the establishment of the "Optical Systems Integration R&D Consortium," which enables ITRC to bridge the technological resources and capabilities of industry, academia, and research organizations, and create a beneficial outcome for both industry and academic researchers.

ITRC launched of the "Optical Systems Integration R&D Consortium."

2013/ 12

NARLabs, National Health Research Institute and National Taiwan University jointly establish a "Magnetic Resonance Imaging System Development and Service Platform"

After signing a cooperation MOU, NARLabs, the National Health Research Institutes (NHRI), and National Taiwan University (NTU) jointly established a "magnetic resonance imaging system R&D and image service inplatform" at Biomedical R&D Center of Hsinchu Biomedical Science Park. The content of the cooperation agreement includes improvement of domestic MRI system R&D and related element technology, and application of advanced MRI to basic biomedicine, animal models, preclinical research, and translational medicine. It is hoped that this campaign will give Taiwan the world's leading imaging platform for neuronal connections in the brain, and give Taiwan a key role in brain research and clinical applications.

Contract-signing ceremony for the "Magnetic Resonance Imaging System Development and Service Platform" cooperation MOU by NARLabs, NHRI, and NTU (From left are Dr. Hsing-Jien Kung, NHRI President, Dr. Ching-Hua Lo, NARLabs President, and Dr. Pan-Chyr Yang, NTU President)

Development of Instrument Technology

As a pioneer in optical technology R&D, ITRC possesses Taiwan's most extensive optical system R&D capabilities, and has the ability to independently design and produce large-aperture aerospace-grade lenses and mirrors. ITRC's 2013 "primary mirror for the FORMOSAT-5 project has channeled R&D capabilities to industry, helped develop illumination and projection lens systems that can be used in semiconductor lithography equipment, and customized precision lens needed in precision machinery and precision measurement equipment. ITRC expects that this work will yield even more fruitful achievements in the near future.

Optical fabrication and testing

ITRC's development of advanced optical elements will provide important support for optical design, production, and testing in various R&D projects, improve the precision of transmission sphere lenses with an aperture of over 4 inches, and enabled the development of production processes for lenses with an aperture of less than 5 mm. The work done at ITRC is expected to improve production methods for optical elements of all sizes. In keeping with the developmental directions of its instrument service platforms, ITRC has extended its R&D reached into aerospace-grade lens polishing and testing technology, ultra-precision processing technology, and opto-electro-mechanical systems integration. The following major achievements were obtained in 2013:

6-inch quartz aspherical lenses

6-inch quartz aspherical lenses are key elements needed in lens for semiconductor lithography stepper, especially for the i-line steppers. Such 6-inch quartz aspherical lens must meet a surface error tolerance of ≤ λ/8. Furthermore, because aspherical lenses have a single optical axis, the lens production process must employ precisely-designed alignment jigs able to ensure a lens eccentricity of ≤10 arcsec. The 6-inch quartz aspherical lens developed at ITRC this year has a surface shape error of 73 nm and eccentricity of 6.8 arcsec. Researchers at ITRC also developed a set of production and testing procedures that can serve as core technology for the development of other advanced lenses.

Optical production and testing R&D team

6-inch quartz aspherical lenses

Blue light microscope objective lens

This microscope objective lens is designed to work exclusively within the blue light waveband (407 nm), and has a magnification of 10X, a numerical aperture (NA) of 0.25, an imaging zone of 1.4mm, and a resolution within the full imaging zone of 2 μm line width (actual test results: MTF > 0.7@ 100 lp/mm, MTF > 0.55 @ 150 lp/mm, MTF > 0.45 @ 200 lp/mm, MTF > 0.35 @ 250 lp/mm). The lens can provide significantly better resolution than ordinary commercial 10X microscope objective lenses, and can be applied to fluorescence imaging of organisms, automated optical inspection, reduced-dimension projection, and other applications requiring high resolution. The development and production of this lens has enabled the development of high-accuracy lens production processes, and allows ITRC to offer customized development services meeting the needs of various applications.

AO – adaptive optics systems

Adaptive optics (AO) systems designed for the 1-meter telescope at Taiwan's Lulin Observatory can improve telescope resolution by a factor of three. After receiving astronomical telescope and AO element specifications from the Department of Astronomy at National Central University, researchers at ITRC performed optical and mechanical design and analysis, produced optical and mechanical elements, calibrated the system in the laboratory, verified system functioning, and finally completed system verification by acquiring images of stars at the Lulin Observatory. This highly lightweight and compact system is Taiwan's first astronomical adaptive optics system.

Blue light microscope objective lens

AO – adaptive optics systems

As a key facilitator of equipment localization, ITRC has been dedicated to developing vacuum coater and fabrication processes for the nanotechnology, space technology and semiconductor industry. The primary goals of ITRC are to accelerate technology innovation, equipment localization and develop value-added products.

Vacuum coating and micro-instrument technology

This year, the research efforts of ITRC focused on developing space qualified bandpass filter and broad-band anti-reflection (AR) coating for spaceborne remote sensing instrument (RSI), and UV optical coating for lithography stepper lens. Innovative coating tools, such as metal-organic chemical vapor deposition (MOCVD), plasma enhanced atomic layer deposition (PEALD) and forced flow ALD, were built and delivered to the academia. The important achievements of this year are as follows:

Forced flow ALD

The cassette-type forced flow ALD directs the reactant gases flowing through samples with complex structure to achieve conformal deposition of catalysts on surface. The size and composition of catalyst can be controlled by changing cycle number and ratio of ALD reaction, respectively. The non-uniformity of films thickness deposited by using ALD can be controlled at < 1% on 4-inch Si wafer. The forced flow ALD can offer precise film thickness control and excellent dispersion of catalyst, which are keys to lower catalyst loading and production cost.

Forced flow ALD systems

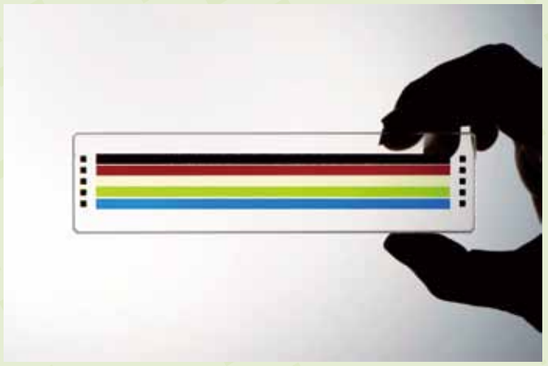
MOCVD subsystems

Most existing MOCVD systems have extremely complicated tubing, and their parts and components are very costly. The MOCVD system developed in this project could be design and manufactured by domestic firms. The project's main achievements include precursor gas flow design, flow control methods, and an MOCVD subsystem. Furthermore, the gas tubing cabinet has a volume approximately 20% smaller than units currently on the market. The gas tubing design shortens gas float distance, and can effectively enhance the precursor utilization rate while reducing process cost. In the future, following verification of a prototype, the system will be optimized and process databases established.

MOCVD subsystems

Stepper lens coatings

In order to prevent lithography stepper equipment from giving rise to ghost images, and requiring increased light energy, ITRC's researchers have designed and applied UV anti-reflection coatings for stepper lens. In particular, addressing developers' different needs, the research team analyzed and designed UV coatings aimed at different substrates, and used the electron-beam evaporation method in conjunction with ion-beam assisted deposition (IBAD) to perform high-precision coating. Researchers have already developed a coating with UV-band reflection of only 0.5%; a 6-inch stepped lens has passed the certification in a test steppers at an international renowned semiconductor company .

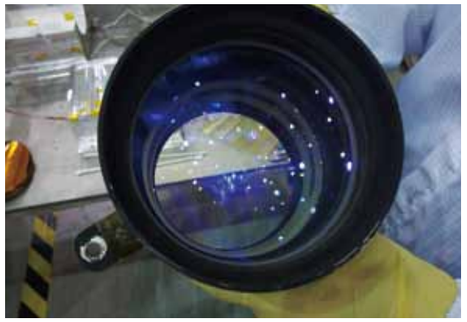


Space-qualified optical filter array

Space-qualified optical filter array

When optical primary and secondary lenses and bandpass filter lens arrays are used in the space environment, coatings must be applied using high-precision technology to ensure long-term durability. Researchers at ITRC have used electron-beam evaporation method in conjunction with ion-beam assisted deposition to enhance the film deposition rate and film structural density, and have also employed a real-time deposition monitoring system to accurately control the thickness and index of refraction of each film layer. The project has currently achieved an average bandpass transmittance in excess of 90%, and an average stop band transmittance of less than 0.5%. Characteristics such as adhesion and surface roughness, radiation damage in a simulated space environment (Co60 irradiation of 35 krad & 1 Mrad), thermal cycling, and resistance to humidity all comply with the requirements of ISO 9211.

Wide-band anti-reflection coatings for RSI correction lens



Wide-band anti-reflection coatings for RSI correcting lenses

When anti-reflection coatings are used in the space environment, coatings must be applied using high-precision technology to ensure long-term durability. ITRC uses electron-beam evaporation method in conjunction with ion-beam assisted deposition to enhance the film deposition rate and film structural density; current average transmittance is > 98.9% @ 450 nm – 900 nm. Characteristics such as adhesion and surface roughness, radiation damage in a simulated space environment (Co60 irradiation of 35 krad & 1 Mrad), thermal cycling, and resistance to humidity all comply with the requirements of ISO 9211.

ITRC's researchers integrate optical, mechanical, and electronic technology capabilities, and employ systematic concepts to perform innovative R&D and develop instrument technologies that can be applied to household care, teaching & research, and industry.

Opto-electromechanical systems integration

ITRC is applying its technical expertise to the integration of instrument systems, and performs tasks including development of power modules, intelligent graphical user interfaces and circuit design, and visual platform technology. ITRC's goal is to develop technological platforms for smart visualization instruments. In the future, ITRC will rely on technological cooperation with industry and academia to establish a domestic R&D group and promote the novel instruments to the visualization, and household care industries. The following results were obtained this year:

Fingerprint image acquisition module

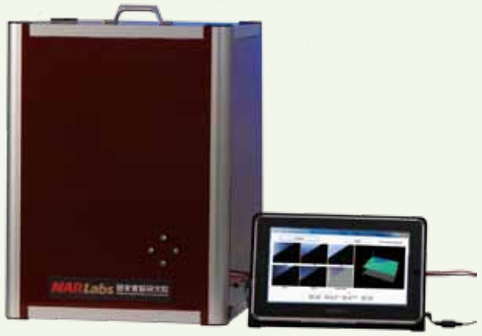
Fingerprint/Palmprint imaging module

This is the first fingerprint/palmprint image acquisition module developed in Taiwan to meet CJIS international standards and be used for organism identification. During the imaging, this module can be attached to a digital single-lens camera. The palmprint module has a total length of 75 mm, a working distance of approximately 515 mm, a field of 180 × 160 mm, a geometric correctness (distortion) of less than 0.8%, an image pixel consistency of over 98%, and a resolution of 1.5 lp/mm. In addition, one more fingerprint module can be attached to the front end of the module.

Portable laser beam shaping

This portable fiber-optic laser source (808nm/5W–30W) beam shaping module comprises spherical and aspherical lenses and an iris diaphragm mechanism; the clear aperture ranges from 1 to 5 mm and the working distance is 90 mm. The module uses aspherical lenses to adjust the focal point of laser beam, and its uniformity is more than 85%.

Portable laser source beam shaping module



Portable wafer edge defect inspection devices

Portable wafer edge defect inspection devices

This device has dimensions of 470 mm × 360 mm × 360 mm, and includes four 12 V white light LED linear shape illumination and image acquisition modules. It can inspect the edge defects on 160 mm × 160 mm unpolished monocrystalline silicon chips, and uses seven-level adjustment of laser lighting. The system can classify test results into four grades, and can provide wafer manufacturers with valuable quality control information. This device is the first one to use two mutually-perpendicular lighting sources to acquire the largest possible scattering images of edge defects, remedying the problem of user interference and unclear defects image that came from the conventional full-scale projection lighting.

Expanding its R&D capabilities in keeping with national policy, ITRC has established a medical optical instrumentation platform. Not only has ITRC developed various types of medical optical instruments, it has also performed medical equipment R&D by integrating industry, academia, and research organizations. In this role, ITRC is protecting citizens' health, promoting domestic industrial development, and stimulating the national economy.

Medical optical instruments

ITRC is using its instrument control technology to achieve the integration of instrument systems, and is employing its optical system R&D capabilities to support domestic academic and industrial researchers to develop medical equipment. ITRC has put its full efforts into the development of medical optical instruments, and aims to promote the upgrading and development of Taiwan's biomedical industry through the realization of R&D results as actual products. This year's R&D results are as follows:

Portable Epithelium Imaging System

Portable Epithelium Imaging System

Developed cooperatively by ITRC and Kaohsiung Medical University Chung-Ho Memorial Hospital, this portable epithelial tissue imager incorporates medical and optoelectronics technologies, and is used to detect skin diseases. The device shines UV light at a wavelength of 405 nm to the basal layer of the skin at a depth of approximately 3 mm, enabling pathologies of the epithelial tissue to be seen at a glance. A spectral homogenizing lens developed at ITRC in front of the main lens enables the instrument to photograph areas containing skin cancer tissue. This instrument can also be used to perform positioning prior to photodynamic therapy at a wavelength of 660 nm, ensuring accurate and effective treatment of cancerous tissue. This instrument has been in development for three years, and has obtained a medical equipment sales permit from the Department of Health

The 2013 Taiwan Photonics Society's Optoelectronics Technology Contribution Award

Taiwan Photonics Society grants the Optoelectronics Technology Contribution Award at its annual photonics convention in order to recognize individuals and groups that have had significant achievements are contributions in the fields of optoelectronics. This year, the ITRC team developing the portable multifunctional opto-electromechanical testing system won the 2013 Optoelectronics Technology Contribution Award for "development of a portable clinical skin pathology testing platform."

The 2013 Taiwan Photonics Society's Optoelectronics Technology Contribution Award

Tissue fluorescence/luminescence imaging system

This "portable living tissue fluorescence imaging system" employs a non-invasive approach to observing and quantifying the fluorescence distribution and intensity in living tissue. It can be used for many purposes in clinical and basic research. This prototype system was produced in cooperation with the Department of Rehabilitation at National Taiwan University Hospital, and can measure 520 nm fluorescent dyes excited by a wavelength of 488 nm. This system includes illumination (LED lamp), optical elements, an adjustable focal mechanism, optoelectronics sensing elements (CCD), and fluorescence imaging and analysis system. Thanks to its special design, this instrument will be inexpensive to produce and yield excellent imaging results. It will cost only one-half to one-tenth as much as comparable units currently on the market, while achieving the same or even better results.

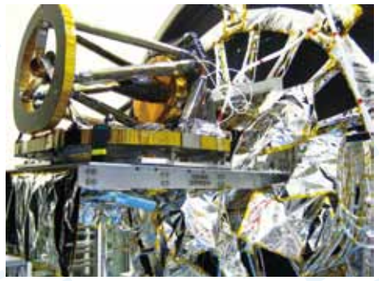
Tissue fluorescence/ luminescence imaging system

Mission-oriented R&D

For fulfilling the goals of national technology policy and the requirements for industrial economic growth, ITRC has participated in many mission-oriented projects led by other government agencies. These R&D projects include the FORMOSAT-5 remote sensing instrument integration project, disaster prevention technology development and utilization projects, typhoon and flooding research and development projects, biomedical technology R& D and certification projects, and many national research programs. ITRC aims to fulfill its responsibility and duty to support national policy in conjunction with other government agencies.

Development of spaceborne remote sensing optoelectronic instruments

Relying on its many years of optoelectronic instrument development and opto-mechanical systems integration experience, ITRC is now in its sixth year of participation in the FORMOSAT-5 remote sensing payload integration project. ITRC's chief duty is to develop and produce a remote-sensing instrument optical subassembly (RSI, OSA) for the satellite, and help perform integrated testing of the payload. In 2013, ITRC completed assembly of the remote-sensing instrument OSA, and developed polishing technology for the imager's 45 cm aperture aspherical lens and bandpass filter production technology. Apart from developing remote-sensing instrument design and assembly technologies in Taiwan, this work has also highlighted ITRC's outstanding R&D capacity.



FORMOSAT-5 remote sensing instrument

FORMOSAT-5 remote sensing instrument

This is the first remote-sensing instrument designed and assembled in Taiwan, and has an aperture of 450 mm and a focal length of 3,600 mm. The primary and secondary mirrors are both aspherical, and were polished and coated at ITRC. The mirrors have a wave front error (WFErms) less than the 35 nm specification, and the mirror reflectance is higher than the specification requirement of 98%. In addition, the assembled remote-sensing instrument has an optical modulation transmission function (MTF) better than the specification requirement of 0.3 at a spatial frequency of 50 lp/mm. The RSI has been turned over to the National Space Organization for thermal vacuum cycle testing.

Biotechnology research and verification Project

ITRC is employing its core capabilities and R&D expertise to integrate academic research resources and implement Biotechnology Research and Verification Project. ITRC expects that the establishment of clinical, academic, and industrial integration platforms will accelerate the research result translation and promotion as well as support the vigorous growth of Taiwan's biomedical industry. Major results of the year:

Signing cooperation MOU of "Magnetic Resonance Imaging System Development and Service Platform"

In order to promote the development of advanced medical imaging industry in conjunction with the Executive Yuan's "Taiwan Biotechnology Take-off Action Plan" as part of the Six Key Emerging Industries concept, the NARLabs, National Health Research Institutes (NHRI), and National Taiwan University (NTU) have signed a " Magnetic Resonance Imaging System Development and Service Platform" cooperation MOU. In line with this cooperation agreement, ITRC will contribute its biomedical optoelectronics technology capabilities to the research capacities of the NHRI and NTU College of Medicine. The three parties will jointly establish a magnetic resonance imaging system development and service platform (i.e. magnetic resonance imaging laboratory) in the R&D building at the Hsinchu Biomedical Park.

Contract-signing ceremony for the " Magnetic Resonance Imaging System Development and Service Platform " cooperation MOU

Completion of the "Planning Report for Laboratories in the R&D Building, Hsinchu Biomedical Science Park"

In conjunction with the construction of a new R&D building at the Hsinchu Biomedical Science Park, ITRC is responsible for the core laboratory planning. This year ITRC completed eight laboratories planning, including biomedical optoelectronic imaging and information, biomedical chip and assistive device, drug development and transmission, biomedical material and composite medical materials, in vitro diagnosis, system and mechanism production, product verification and validation, and preclinical testing laboratory. In the future, ITRC will strive to effectively utilize those laboratories' experimental facilities to support academic research, to enhance the standards of scientific and technological research, and to promote the development of Taiwan's biomedical industry.

Potential teams counsel and commercialization of R&D results

Through resources integration and intensive contact core technology from research communities, ITRC is assisting R&D teams in medical device development process. This year, ITRC counseled nine research teams, including two start-ups, three teams from National Tsing Hua University, Taipei Medical University, and National Cheng Kung University, respectively, and four teams through sophisticated medical device programs.

Development of instruments used in disaster prevention

Taiwan is located in an area of high seismic activity, and is also subject to many typhoons during summer. With early warning, the damages caused by typhoons and flooding may be reduced so that residents' life and property can be protected. For achieving the goal, ITRC is integrating and applying domestic instruments technologies and research capabilities to establish the disaster-prevention instruments in Taiwan. ITRC's efforts include the development of an early warning system for landslide-prone areas, rapid image acquisition and assessment technology, and electronic components and subsystem modules that are weather-resistant or suitable for installation on bridge piers to monitor flooding. By supporting Taiwan's disaster-prevention technology development teams, ITRC aims to safeguard people in Taiwan and their homes.

This year's results include:

Practical applications of a four-wavelength camera mounted on a lightweight unmanned helicopter

Deployment of a mountainside landslide area fast image acquisition and identification system

In view of the fact that aircraft could not fly and obtain images of affected areas during and immediately after the devastating Typhoon Morakot, ITRC has begun planning the use of lightweight instruments mounted on unmanned aerial vehicles (UAV) to survey disaster-stricken areas. This approach will provide an important means of obtaining real-time images of large areas and identifying the worst-off locations in disaster zones. Based on this concept, ITRC has successfully developed an unmanned helicopter offering a high degree of flexibility, economy, and versatility. By mounting a fast image acquisition and identification system on this UAV, it will be able to quickly identify the extent of flooding or landslides in the wake of a natural disaster.

Imaging surface flow velocity monitoring device

ITRC has also developed a map selection program for enhancing post-processing speed and reducing image overlap. Following the processing of image data, the system can generate digital terrain models (DTMs) and digital orthophoto maps (DOMs) compatible with the kmz file format used by Google Earth.

Development of a river surface flow velocity observation and analysis system

River flow is an important information for hydrology. In order to reduce the uncertainty of high flow measurements, most researchers currently use non-contact measurement methods. The portable river surface flow velocity image observation system developed by ITRC can increase image quality and the precision of measurements. In addition, ITRC also uses radar level meter and microwave radar velocimetry instrument to perform analysis of flow velocity and water stage differential. The results of this research can be used to establish high water level information for specified areas. In the wake of torrential rains and flooding, this method can be used to roughly determine river flow velocity using only a water level gauge, and thus provides a simple method that can be used by disaster prevention units.

Four-bands camera carrier system for a lightweight unmanned aerial vehicle

This lightweight imaging payload system comprises two high-resolution full-frame digital single-lens reflex cameras. With a long-life lithium battery, the system can take 800 to 1,000 photographs over the course of 1 to 1.5 hours in the air.

The system has a weight of only 4.6 kg, and possesses an automatic vertical stability and vibration-prevention design in order to minimize the swaying during photography. The system's electronics include RGB and NIR band imaging systems to ensure that the error in photograph synchronization is less than 1 ms. The single camera has 32 GB of memory (expandable to 64 GB), and contains a 12 megapixel high-resolution imaging module that can be used to monitor living environment safety, natural disaster scope, ecological diversity and changes, and conservation of endemic species.

Four-bands camera carrier system for a lightweight unmanned aerial vehicle

Customizable bridge pier multi-terminal signal data transmission system

Customizable bridge pier multi-terminal signal data transmission system

This system obtains data from bridge sensors designed by the National Chip Implementation Center (CIC), and relies on encoding/decoding to transmit the signals to a cloud system at the National Center for High-Performance Computing (NCHC). The system employs a 32-bit data format, and data comprises ID name, node name, sensor data number, and error code. The system's wireless point-to-point transmission distance is 2 km. Wireless on-site data transmission rate: > 3 Mb/s. Maximum operating temperature is 65°C. Each sensor node has an acquisition rate of 400 Hz.

National research programs

In conjunction with national policy, ITRC takes active roles in participating in many national research programs, and seeking to promote the country's academic and industrial development via technological innovation, integration, and value added development models. ITRC participated in the following national research programs during 2013:

Deepening Basic Industrial Technology Projects

Project name	Cooperating unit	Time
System and hydrostatic bearing's basic research for Multi-Axial optical lens grinding Machine	National Tsing Hua University	2013/01/01 2016/12/31
MOCVD key components technology development and manpower training	National Central University	2013/01/01 2016/12/31
Production and analysis of a multi-layer nanometer structure, and establishment of a promotion center	National Cheng Kung University	2013/11/01 2017/10/31

Academic-research cooperative projects

Project name	Cooperating unit	Time
Taiwan New Generation OIR Astronomy (TANGO)	National Central University	22012/02/01 2017/07/31
Extreme UV microlithography technology II (EUVL II)- From illumination and testing of analytical techniques to nanometer elements reliability research	National Chiao Tung University	2013/01/01 2016/12/31

National program on nano technology

Project name	Cooperating unit	Time
Academic-research cooperative project – Development of a large-scale forced flow ALD nanometer reactor for production of hydrogen via continuous visible light hydrolysis and hydrogen separation (2/3)	National Tsing Hua University	2012/08/01 2015/07/31

Technical Services

Capitalizing on its existing vacuum and optoelectronics equipment and human resources, ITRC has obtained ISO/IEC 17025 certification, in calibration laboratories and testing approved by the Taiwan Accreditation Foundation (TAF). ITRC produces more than 200 calibrations and testing reports each year, and provides Taiwan's most professional measurement services to users in all fields.

TAF certified laboratories

Six TAF laboratories of ITRC offer 11 TAF certification items as follows:

Vacuum standard laboratory (TAF laboratory number: 0081)

ITRC's vacuum standard laboratory is the first facility of its kind to receive TAF calibration certification. The laboratory's calibration items include ionic vacuum gauge (KD2002), capacitative vacuum gauge (KD2003), and other vacuum gauge (KD2006). This laboratory serves industry, government, and academic institutions, and issues over 100 calibration reports every year.

Optoelectronic calibration laboratory (TAF laboratory number: 1529 and 2340)

This is the first laboratory to apply for TAF certification after ITRC becomes part of NARL. Because it offers certification items including calibration and testing, this facility has two laboratory numbers. Certification items consist of the four items of luminance meter/brightness colorimeter (KG3012, calibration), gloss boards (KG3027, calibration), radius of curvature (O999, testing), and index of refraction (O99, testing). It is the first laboratory in Taiwan to offer radius of curvature and index of refraction certification.

Optical thin film testing laboratory (TAF laboratory number: 1889)

This is the sole laboratory in Taiwan to perform the optical testing items of film reflectance and film transmittance (O001, testing), and provides comprehensive spectrum measurement services to academic and industrial uses.

Electron microscopy standard laboratory (TAF laboratory number: 1957) and scanning probe microscopy standard laboratory (TAF laboratory number: 1958)

These laboratories employ scanning probe microscopes and scanning electron microscopes to provide line distance calibration service for the ranges of 100 nm-10,000 nm and 80 nm-2,000 nm (KA2014), and can produce line-distance pitch standards.

In line with its goal of supporting academic researches and serving the industry, ITRC provides customized production, repair, and calibration/testing services for vacuum, optical, and electronic instruments and components. A total of 1,989 cases to 167 companies, academic institutes and research organizations were provided during 2013.

Customized fabrication and technical services

The following were some of the many notable technical service cases performed by ITRC on behalf of academic and industrial users in 2013:

Commissioning unit	Case name
China Motor Co., Ltd.	Gloss boards calibration
Merck Taiwan Co., Ltd.	Vacuum gauge calibration
Gintech Energy Corp.	Power meter calibration
Hsintek Optical Instrument Corp.	Surface precision measurements
All Real Technology Co., Ltd.	Metal thin film fabrication
UF Tech Corp.	Flatness measurement
Episil Technologies Inc.	Pitch standards calibration
Chia Le Biomedical Co., Ltd.	Lithography and etching process
Delta Electronic Co., Ltd.	Scanning electron microscope observation
Far Eastern New Century Co., Ltd.	Gloss boards calibration
Opus Microsystems Corporation	Inductively-coupled plasma etching
Mei Huan Solar Co., Ltd.	Reflectance measurement
Academia Sinica	Processing of high-frequency circuit board materials (TMM3)
National Chung Hsing University	Nickel-cobalt electro-casting process
National Cheng Kung University	High-voltage circuit malfunction diagnosis and maintenance
National Taiwan Ocean University	Communications circuit signal analysis
National Taiwan University	Micro lens array and focus adapter
National Tsing Hua University	Critical point drying – biological samples

In view of current energy conservation and carbon reduction trends, ITRC provides the academia and research users with professional certification assistance and consulting services on instrument environment establishment and planning. In 2013, ITRC's power consumption reached 10.68%, which reduced overall power expenses by 3%, compared with 2012.

Instrument experimental environment establishment service

Instrument experimental environment establishment service platforms

ITRC builds up instrument environment establishment service platform, whose task is to provide assessment of the experimental environment at precision instrument facilities and environment establishment planning for government units and cutting-edge academic research teams. ITRC examines environmental quality in a fair and impartial manner, and helps train professional personnel who need appropriate professional licenses or comply with environmental/health/safety laws and regulations. These actions ensure that users capably obtain the best performance of their instruments for better academic researches.

Energy conservation and environmental services

Responding to environmental protection trends and the global need to conserve energy and reduce carbon emissions, ITRC establishes a set of practical procedures for energy analysis and assessment of improvement measures to improve energy efficiency, optimal laboratory safety, working efficiency, and energy conservation. This system provides laboratory personnel a reference of "Energy Saving Performance Contract"(ESPCs), which makes a realistic assessment of energy load characteristics, energy usage distribution, energy efficiency indicators, energy improvement strategies, the cost & benefit of improvement measures and investment payback year. Based on the results of energy analysis, ITRC can assess a laboratory's feasible energy conservation opportunities and solutions, estimate required cost and expected benefit after improvement, and calculate investment payback year for ranking all improvement measures in order of anticipated benefit. This system enables laboratories with limited budgets to determine the optimal investment strategy and energy conservation improvement from an economic perspective.

Achievements during 2013

In 2013, ITRC's power consumption reached 10.68%, compared with 2012. Although the government hiked the price of power, ITRC nevertheless managesdto reduce its power expenditures by 3%, compared with 2012. ITRC offered spatial planning services as part of the "Interdisciplinary Building Spatial Planning Commissioned Service" project for Applied Science Research Center of Academia Sinica. Overall inventories of the building's office and laboratory space as well as recommendations were provided.

Human resources are Taiwan's most valuable asset, and are the source of the nation's competitiveness. For enhancing the quality and quantity of the country's research manpower, ITRC, in 2013, provided training courses for 1,381 people as part of high-tech manpower training programs, for 59 students as part of the i-ONE International Instrument Innovation Competition, which totaled up 1,440 people of training. ITRC also provided 126 domestic PhD and M.S. students with opportunities to participate in ITRC research projects, helping incubate the research manpower needed by Taiwan's high-tech industries and academic institutions.

Training courses

ITRC held the following workshops and seminars in 2013:

01/29-01/30	2013 International Symposium on Precision Machine Tools and Processing Applications and Technologies
02/26-02/27	Basic LabVIEW virtual instrument control class
03/20-03/21	Workshop on film optics and deposition technology—theory
03/22-03/22	Workshop on film optics and deposition technology—laboratory
03/26-03/27	Basic Android 4.X cell phone apps
04/23-04/24	Workshop on optical element design, production, and testing technology
03/20-04/24	Training for R&D managers involved in medical equipment commercialization cases
05/16-05/16	Seminar on SolidWorks Enterprise PDM Corporate Product Data Management
05/16-05/16	Seminar on patent practice (1)
05/17-05/17	Seminar on patent practice (2)
06/05-06/05	Technical forum on 2013 ZEMAX optical modeling
06/24-06/24	Instrument technology training for graduate student, Hsinchu
06/19-07/23	ISO 13485 quality system establishment training
08/19-08/23	Instrument technology training for graduate student, Tainan
08/28-08/29	Workshop on precision opto-mechanical system technology
08/27-08/27	Practical class on expressing appeal and briefing technique
09/02-09/06	Instrument technology training for graduate student, Taipei
09/13-11/15	Optical manufacturing training
10/17-10/17	Workshop on graphene preparation and applications technology
10/22-10/23	Laboratory workshop on nano/micro processes and testing
11/11~11/11	Seminar on new development trends in ultra-precision processing and testing technology

Academia-Industry Collaboration

In 2013, ITRC launched the "Optical Systems Integration R&D Consortium" in order to enhance the competitiveness of Taiwan's industries, to establish an industrial development consensus, and to raise the value of technology. At the same year, ITRC signed various cooperative incubation alliance agreements with National Tsing Hua University, National Chiao Tung University, and National Central University. Looking ahead to the future, ITRC will use its R&D capabilities and all the resources at its disposal to support Taiwan's emerging industries and promising R&D teams, employing an academia-industry collaboration model to achieve win-win outcomes.

Academia-Industry R&D Consortium

Optical systems integration R&D consortium

The Optical Systems Integration R&D Consortium was initiated to reduce the gap among industry, government, academia, the research community and users. It aims to jointly develop relevant optical system equipment and products through integrated process R&D and strategic cooperation. This consortium draws on resources from any quarters to achieve an industrial development consensus and enhance technological value. There are currently close to 100 alliance members, which encompass companies, academic institutions, and research organizations, including nearly 30 prominent universities. Through the establishment of the Optical Systems Integration R&D Consortium, ITRC will provide various resources, and draw on the technological capabilities of industry, academia, and research organizations, as it assists members to resolve technological and human resources problems. ITRC will strive to achieve a win-win outcome among industry and academic through the joint implementation of industrial technologies including production of large-aperture lenses, semiconductor steppers, and biomedical optoelectronic instruments.

Cooperative incubation alliance agreements signed with prominent domestic universities

In order to promote the development of start-ups and accelerate the commercialization of R&D results, ITRC will contribute its core R&D capabilities and resources to academic institutions, which will in turn provide their incubation center administrative experience, educational support

systems, business guidance services, and resource integration capabilities. The proposed incubation alliance will help academic and research teams to develop new products and services, and help new start-ups.

Incubation alliance results in 2013

1. ITRC variously signed cooperative incubation alliance agreements with National Tsing Hua University, National Chiao Tung University, and National Central University in 2013. This consortium will integrate the capabilities and experiences of ITRC, its academic partners, incubation centers in Taiwan, which accelerates the transformation of Taiwan's R&D results into tangible products and new start-ups.

2. ITRC integrated its optical system design with element manufacturing and testing capabilities to join forces with National Yunlin University of Science & Technology and M&R Nano Technology Co., Ltd. in the "MEMS Microlithography Process Equipment UV Light Narrow Bandpass Filter development and Coating" project, which has set a successful precedent of a win-win-win outcome for industry, academia, and research organizations.

ITRC launched the Optical Systems Integration R&D Consortium in October, 2013

UV filters used in a system were jointly developed by National Yunlin University of Science and Technology, M&R Nano Technology Co., Ltd. and ITRC. The narrow bandpass filter has successfully assembled in M&R Nano Technology Co.

For research dissemination and advocacy of instrument technology, ITRC encourages its R&D teams to meet the industry requests via industry-academia collaboration. In this way, the industry gets more involved in joint technological R&D, increasing product value added, upgrading industrial technology and promoting industry economic benefit.

Industry contract cases

The following are some of the many notable industry contract cases during 2013:

Contract name	Industry categories
Production of a fluorescent imaging filter for a handheld fingerprint/palmprint dual-use identification device meeting CJIS specifications	Photoelectric and optical related industry
Glass lens resistant to high pressure for deep-sea cameras	Metalworking Machinery Manufacturing
Ultra-micro lenses for biomedical testing systems	Computers, Electronic and Optical Products Manufacturing
E-Pin end polishing	Semi-conductors Manufacturing
Development of optical elements for holography	Computers, Electronic and Optical Products Manufacturing
Colorimetry biochemical analysis test chip	Medical Materials and Supplies Manufacturing
Chip back defect testing system	Semi-conductors Manufacturing
Counterfeit prevention mechanism	Computers, Electronic and Optical Products Manufacturing
Microstructure measurement and analysis	Optoelectronic Materials and Components Manufacturing
Precision lens production	Optical Instruments and Equipment Manufacturing
Monocrystalline silicon TSV production	Semi-conductors Manufacturing
PELAD growth Ni film process development	Semi-conductors Manufacturing
SEM observation deposition	Optoelectronic Materials and Components Manufacturing

It has always been a significant mission for ITRC to support academic researches and to promote the development of science and technology. Thanks to long term cooperation with the academia in Taiwan, ITRC has become an ideal facilitator and promoter.

Academia partner contract cases

The following are some of the many notable academic partner contract cases during 2013:

Contract name	Cooperating partner
Forced flow atomic layer deposition system	National Tsing Hua University
Single crystal silicon honeycomb structure etching (2/3)	National Tsing Hua University
Electrochemical process of nanometer composite electrodes	National Taiwan University
A light-separating spectrometer for use in science education experiments	National Tsing Hua University
High brightness 13.5-nm extreme UV illumination R&D (3/3)	National Taiwan University
An electrical real-time measurement system: vacuum pump devices (OLED system)	National Taiwan University
Micro-spectroscopic opto-mechanical module	National Taiwan University
RC adaptive optics system	National Central University
A portable wireless electroneuromyographic signal measurement system	Taipei Medical University
Infrared content temperature system	Kaohsiung Medical University
Production of a PCR testing chip	National Chiao Tung University
Management service for drug fast screening projects	National Cheng Kung University
An opto-mechanical defect testing system with linear scanning image acquisition	Chung Yuan Christian University
Verification of an intelligent skin texture testing instrument	Hung Kuang Institute of Technology

International Cooperation

Aiming to build up a world-class laboratory, ITRC has actively pursued close cooperation and interchange with the world's renowned instrument and opto-electro-mechanical technology research organizations through different channels, including cooperation MOUs, commissioned projects, and joint researches.

Memorandum of Understanding

ITRC has currently signed cooperation MOUs with the following organizations: (1) Optical Information Storage Center, University of Arizona, US, (2) Optoelectronics Research Center, University of Southampton, UK, (3) RIKEN, Japan, (4) Center for Information Storage Device, Yonsei University, Korea, and (5) University of Technology of Troyes, France.

Participation in the international instrument technology organizations

With the goal of enhancing Taiwan's influence in international societies, ITRC actively participates in international instrument technology organizations, and also hopes to enhance its own international visibility and status. ITRC currently participates in the following international organizations:

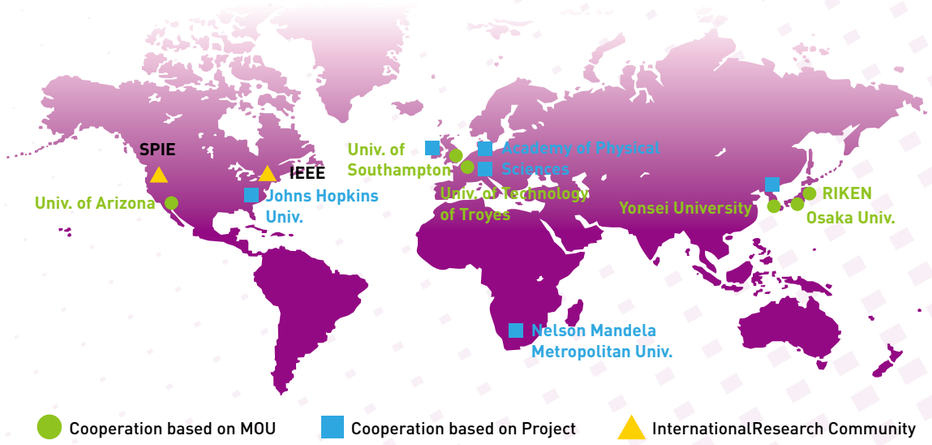
- ASME (American Society of Mechanical Engineers)
- NAMIS (An international research network on Nano and Micro Systems)
- IEEE IMS (IEEE Instrumentation and Measurement Society) Taipei Chapter
- SPIE (The International Society for Optical Engineering)

Cooperative international research projects

In the area of joint research, ITRC is conducting preliminary-stage commissioned projects and joint research with international academic and research organizations, and targets to establish a foundation for future cooperation. The following is a summary of cooperation cases and their progress:

Deepening Basic Industrial Technology Projects

Cooperating unit	Topic of cooperation	Year	Progress
Optical Information Storage Center, University of Arizona, US	Application of CNT to TCO	2009-2014	The two parties have conducted short-term visits, and the American partner has provided samples to ITRC for measurement.
Optoelectronics Research Center, University of Southampton, UK	Key elements of the structure of toroidal metamaterials	2009-2014	The two parties performed structural testing of toroidal metamaterials in 2011, discussed applications in conjunction with filters and CCD chips, and have published several journal papers.
RIKEN, Japan	3D optical metamaterials	2009-2014	The two parties have begun a research project, conducted several short-term visits, and have published a number of journal papers.
Center for Information Storage Device, Yonsei University, Korea	Instruments for green living, energy, and the environment	2010-2015	In 2011, ITRC participated in an alliance conference on Korea's Cheju Island.
Advanced Photonics Research Center, Osaka University, Japan	Production of ultra-smooth, ultra-thin silver films	2011-2016	The two parties have begun a research project, conducted several short-term visits, and are performing bilateral research. ITRC has performed deposition of ultra-smooth, ultra-thin silver films for Osaka University, meeting the needs of the university's Advanced Photonics Research Center.
University of Technology of Troyes, France	Instrumentation and measurement for integrated photonics and spectroscopy	2011-2016	The two parties have conducted short-term visits for the purpose of project discussion and experiments.
Academy of Physical Sciences, Czech Republic (bilateral international joint research project)	Atomic layer deposited Ti_1O_2 and Al_2O_3 coatings on NiTi alloy	2012-2013	ITRC has sent personnel on a short-term visit for the purpose of project discussion and experiments.
Nelson Mandela City University, Republic of South Africa (bilateral international joint research project)	Ultra-high precision diamond processing of molds high-strength aluminum alloy optical elements	2013-2015	The two parties have conducted short-term visits for the purpose of project discussion and experiments.



Overall Work Performance

Performance measures

Item		Quantity	Units
Technical services and extension	Commissioned production and repair services	1,989	Cases
	Assisting the production of instruments in Taiwan	76	Cases
Training courses	Number of classes	22	Sessions
	Participants	1,381	Persons
	Number of activities	13	Sessions
	PhD and MS students participating in research projects	126	Persons
Academic achievements	Number of unique instruments developed	6	Cases
	Technical reports	87	Cases
	Number of joint advanced research cases	14	Cases
	Cumulative number of R&D service platform	6	Cases
	Cooperative projects with leading international research organizations	8	Cases
	Participation in international academic organizations	9	Persons
Patents	Patents pending	29	Cases
	Patents received	30	Cases
TAF certificated calibration & testing items	Number of items certificated by TAF to conform with ISO/IEC 17025	11	Item
	Maximum aperture that can be measured (for optical testing)	128 mm	mm
	Expended uncertainty of measurement (capability of precision pitch standard calibration in the micrometer and nanometer scales)	0.73%	%

Awards obtained in 2013

ITRC held the following workshops and seminars in 2013:

Competition	Participating work	Award
2013 Taipei International Invention Show and Technomart	Micro-electrochemical multiple real-time quantitative PCR system	Gold medal
	A manufacturing method for nanoparticle chains	Silver medal
	Digital image correlation system	Bronze medal
NARL Award for Outstanding Contributions in Science and Technology	Space-grade optical coating technology development team	Outstanding Achievement Award in the technology development category in the 7th "Award for Outstanding Contributions in Science and Technology"
Award Ceremony, Hsinchu Regional Youth Festival	Wen-Tzu Hsiao, ITRC	2013 Outstanding Youth in Hsinchu Area
Chinese Metrology Society	Yung-Hsiang Chen, ITRC	13th Outstanding Metrologist Award
Taiwan Photonics Society	Development of a portable clinical skin pathology testing platform	Optoelectronics Technology Contribution Award

Chinese Abstract

儀科中心 102 年度執行「儀器科技發展計畫」以及參與本院重要整合型計畫，執行成果包括建構跨領域儀器科技服務平台，支援國家型研究計畫及產學各界所需儀器科技。本年度成功開發多件特用儀器，並獲得數十家媒體大篇幅報導外，更積極推動工程品研發平台與成立產學研發聯盟，運用中心技術能量協助產學界研發創意商品化，創造產業經濟效益，營造產學雙贏成果。而在研發成果的質量控管上，中心於論文發表與專利數皆屢創新高，並屢屢於技術競賽中獲得肯定。中心也藉由國際學術活動與技術交流，展開研究合作、訪問及展覽等，不僅成功提升國際知名度，更加速了中心動能的提升與國際化的發展。

深耕研發 技術為本

本中心以儀器研發為本，以優秀研發能力支援國家科技研究，本年度發表 SCI、EI 國際期刊論文 53 篇，國內外研討會論文發表 120 篇，獲得專利 30 件，並與 8 所國際知名研究單位進行共同研究計畫。完成 6 件特殊儀器開發，包括「400 nm ~ 700 nm 多波長近場光學訊號解調系統」、「顯微偏振光譜檢測技術平台發展」、「快速 RF 射頻掃描顯微鏡驅動系統」、「福衛五號遙測取像儀」、「強制流 ALD 系統」及「可攜式上皮組織取像儀」；其他重要儀器系統、關鍵元組件與關鍵軟體產出眾多，合計 53 件。102 年度發表航太級鏡片自製技術，另與高雄醫學大學附設中和紀念醫院共同發表「可攜式上皮組織取像儀」，獲得近 30 家媒體報導，皆為中心優秀研發實力的具體展現。

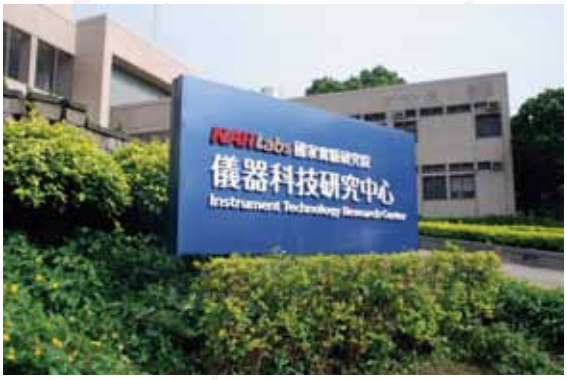
102 年獲獎紀錄

競賽活動	參賽作品	獲獎項目
2013 台北國際發明暨技術交易展	微型電化學多重即時定量 PCR 系統	金牌
	奈米粒子鍊之製造方法	銀牌
	編列數位影像關係裝置	銅牌
國家實驗研究院傑出科技貢獻獎	太空規格光學薄膜技術開發團隊	第七屆「國家實驗研究院傑出科技貢獻獎」技術發展類優等獎
新竹地區青年節表揚大會	蕭文澤同仁	102 年度新竹地區社會優秀青年
中華民國計量工程學會	陳永祥同仁	第十三屆傑出計量工程師獎項
中華民國光電協會	可攜式臨床用皮膚病變檢測平台開發	光電科技貢獻獎

擴散能量，提升產業

儀科中心積極投入技術創新與前瞻研究，102 年度主要成果如下：

- 自製航太鏡片技術大突破：發表航太鏡片自主發展成果，展現 1 米口徑非球面鏡製作技術能力，除支援衛星遙測酬載計畫，相關技術亦積極投入半導體曝光設備光學系統開發與協助天文學術研究。



Instrument Technology Research Center, National Applied Research Laboratories

- 國內技術新突破，癌症診療新紀元：中心與高雄醫學大學附設中和紀念醫院共同發表雙方合作開發的「可攜式上皮組織取像儀」，可簡單、快速而精準地診斷出受測者是否罹癌，讓患者及早發現，及早治療，本產品並已獲得衛生署醫療器材認證。
- 橋接產學，推動光學整合研發：儀科中心成立「光學系統整合研發聯盟」，其結合中心長久以來於光學元件製造領域所積累的技術能量，並整合其他產、學、研各方資源，共同開發先期工程樣品，加速學理概念至樣品試量產的時程，以提升我國高階光學系統製造與銷售的競爭力。
- 與大學簽署育成聯盟 MOU：儀科中心與國立清華大學、國立交通大學、國立中央大學分別簽署育成聯盟合作協議，擴大運用大學創新育成中心的商務輔導能力與中心之核心技術能力與資源，培育研發成果產業化，吸引更多新創事業或研究團隊進駐育成中心，在研發與產學合作方面協助進駐的創業團隊。
- 建立磁振造影系統研發及影像服務平台：中心與國家衛生研究院及臺灣大學簽署合作備忘錄，於新竹生物醫學園區生醫研發中心共同建立「磁振造影系統研發及影像服務平台」，合作提升國內自行研發磁振造影系統與其相關元件技術，促進高階磁振造影應用，並針對國內具潛力之腦連結體研究與認知精神臨床應用進行整合。

儀科中心致力將豐沛的研發能量擴散至產學各界，投入國內半導體設備在地化扎根，以及協助我國廠商厚植競爭力，提升產品附加價值，促進產業轉型升級，創造國際競爭力。

專業技術、創意加值

透過儀器技術服務平台，102 年度完成儀器技術服務 1,989 件，接受與執行產學研委託計畫合約案 73 件。所成立的「光學系統整合研發聯盟」，便是藉由中心研發平台，與產學界共同攜手，將科學創意發想轉化為實際工程品。 中心同時運用研發資源與能量，協助國家培育高階科研人才，102 年度培訓碩博士研究生共 126 人次，並開辦儀器技術高科技人才培訓課程 22 班、科技講座 13 場，培訓 1,381 人次。此外，舉辦 *i*-ONE 國際儀器創新獎競賽活動，提供教學參訪服務 1,593 人次，出版科儀新知 6 期，透過多元發布管道，儀科中心不僅以儀器研發領導者自居，更扮演著科學資訊傳遞以及教育的角色。

展望未來

科技的脈動與產業技術正迅速發展更替，對於儀器的依存是輔車相依，儀科中心所負有的使命將更為重大。所賦予的任務不僅包括支援學術發展以及促進國家科學發展，為配合國家經濟建設與產業需求，目前也積極發展大口鏡鏡片製作與檢測、半導體製程設備光學系統、以及生醫光電儀器等未來產業科技。儀科中心將持續精進研究，配合國家政策發展，提升我國學術研究水準，並提供儀器科技支援，結合產學研技術能量，提升我國產業的全球競爭力，以儀器發展為終始，以促進民生、提振產業為己任，向國際級研究機構目標邁進。

ITRC Annual Report 2013

Publisher
Instrument Technology Research Center, NARL

Publisher
Jer-Liang Andrew Yeh

Publication Date
May 30, 2014