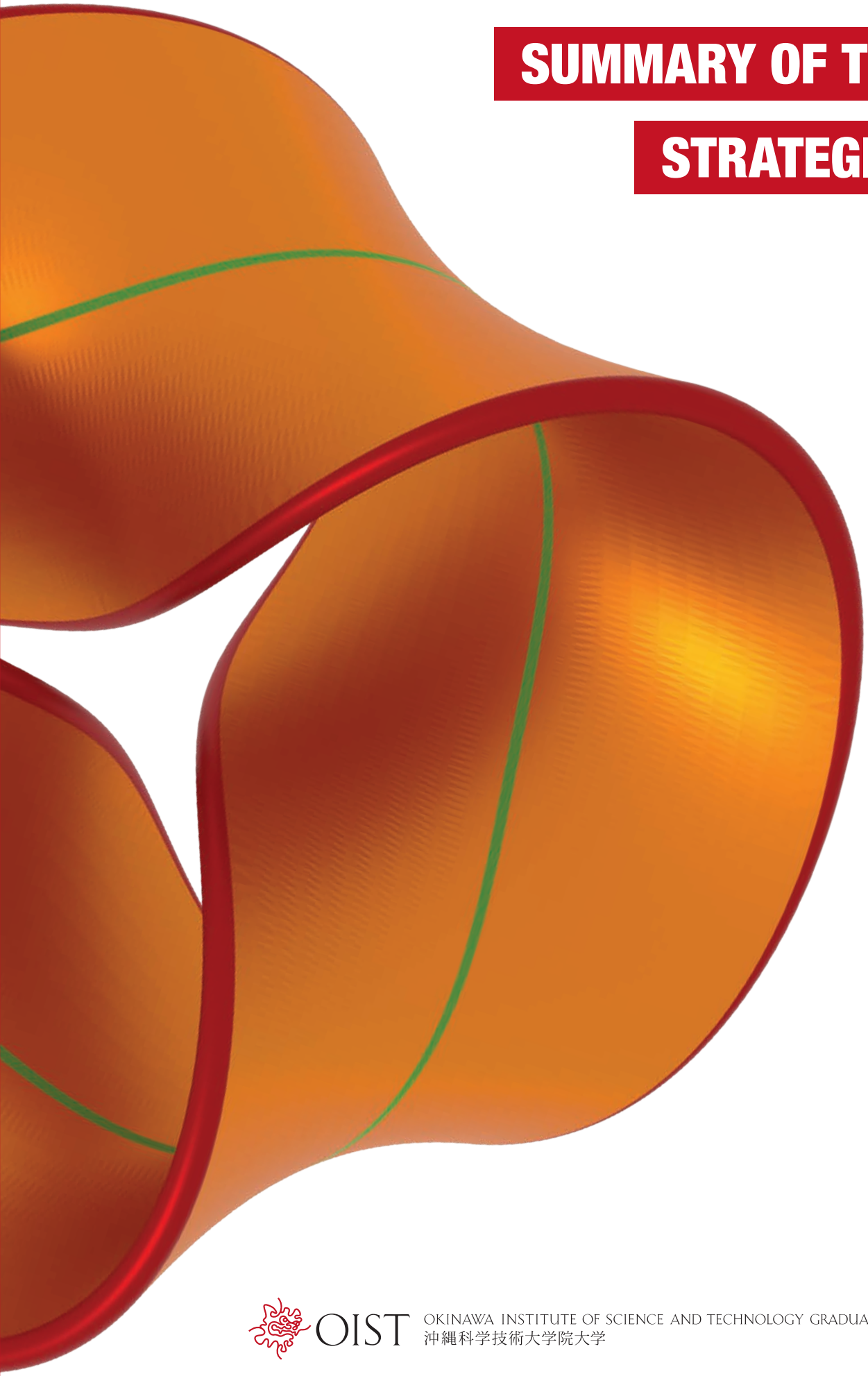
SUMMARY OF THE OIST STRATEGIC PLAN

2020–2030



OIST OKINAWA INSTITUTE OF SCIENCE AND TECHNOLOGY GRADUATE UNIVERSITY
沖縄科学技術大学院大学

"Innovation comes only from an assault on the unknown"

Sydney Brenner (1927-2019)
President, the Okinawa Institute of Science
and Technology Promotion Corporation (2004-2011)
Nobel Prize for Physiology or Medicine 2002

ON THE COVER: The cover image depicts a Möbius band with three half twists arising from the limit of a sequence of tetrahedral rings, all connected with a minimal, uniformly distributed twist angle. Like all Möbius bands, this surface has only one side and one edge. The shape is the first member of a previously undiscovered hierarchy of increasingly complex, knotted surfaces constructed from closed space curves. Credit: Michael Grunwald, Johannes Schönke, and Eliot Fried, Mathematics, Mechanics, and Materials Unit

ABOUT THIS DOCUMENT

This document is a summary of the *OIST Strategic Plan 2020-2030*. OIST was initiated with an act of the Japanese Diet in 2009. The broad aims for OIST in that legislation were to provide internationally distinguished research and education and contribute to the promotion of Okinawa. OIST's guiding principles (p2) and the strategic goals (p24) are true to that original concept of OIST. The complete document details the actions that we will take to achieve the strategic goals and can be found at: www.oist.jp/strategic-plan

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THE STRATEGIC PLANNING PROCESS

Extensive consultation with OIST leadership, faculty, research and administrative staff, and students informed the *OIST Strategic Plan 2020-2030* between August 2018 and its approval by the Board of Governors in May 2019. Active management and implementation began in September 2019, evolving to take account of progress, new opportunities and changes in circumstances.

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ABOUT THE STRATEGIC GOALS

Relevant strategic goals are listed at the top of the pages. Read them in full on page 24.

1. To develop as a world-leading university and an international research hub
2. To deliver a world-class PhD program
3. To translate discovery into impact
4. To contribute to the societal and economic well-being of Okinawa
5. To maintain excellence in governance
6. To foster an efficient administration
7. To support partnerships in Okinawa between academia, industry and government
8. To create an entrepreneurial culture
9. To attract the best talent
10. To build an inclusive and welcoming community
11. To build a modern, attractive, state-of-the-art campus
12. To promote responsible stewardship of the environment
13. To communicate our contributions locally, nationally and globally
14. To maintain diversity, well-being and an open, collaborative culture
15. To plan for sustainable growth and long-term excellence
16. To complement funding through grants, sponsorship and philanthropy

ESSENTIAL OIST

In the eight years since OIST's inauguration, we have made significant progress. Here are the essential figures and short history of OIST.

OUR MISSION:

We are a pioneering graduate university. We conduct research that bridges disciplines to explore new frontiers of scientific knowledge. We educate a new generation of scientific leaders. We are a catalyst for an innovation hub in Okinawa.

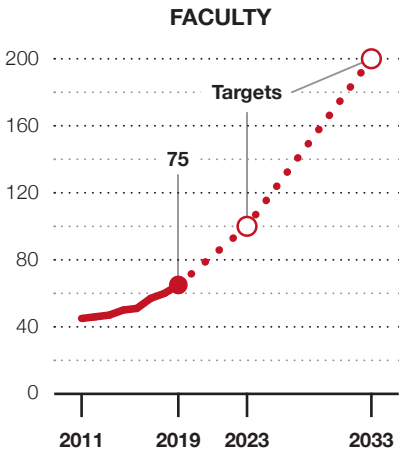
OUR ACHIEVEMENT:

OIST is ranked 9th in the world by the Nature Index 2019. Its normalized share, a measure of OIST's Nature Index output as a proportion of its overall output in the natural sciences, puts it in a league with the likes of Princeton University, Swiss Federal Institute of Technology in Lausanne (EPFL) and other prestigious institutions.

RANK 1 in Japan

RANK 9 in the world

OUR GROWTH:



OUR HISTORY:

JUN. 2001
Minister of State for Okinawa and Northern Territories Affairs and Minister of State for Science and Technology Policy, the Honorable Koji Omi, announced a plan for a new international graduate university in Okinawa

APR. 2003
Onna-son selected as OIST location

MAR. 2005
OIST Promotion Corporation founded through an Act of the Japanese Diet

AUG. 2005
Sydney Brenner appointed president of OIST Promotion Corporation

MAR. 2007
Construction of campus started

JUL. 2009
OIST School Corporation Act ratified

MAR. 2010
First lab opened in Onna-son

NOV. 2011
Jonathan Dorfan appointed 1st president

NOV. 1, 2011
OIST accredited as a university

JUN. 2012
Lab 2 opened

SEPT. 1, 2012
OIST accepted first graduate students

MAR. 2015
Lab 3 opened

2016
Engineering support building opened

JUL. 2016
Marine Station inaugurated

GUIDING PRINCIPLES:

- We want to be recognized for world-leading, cross-disciplinary research that benefits humanity.
- We want to be the destination of choice to work learn and collaborate, linking science to education, leading to innovation and entrepreneurship, supported by an efficient administration.
- We want to be the partner of choice for innovation and a catalyst in Okinawa, promoting economic growth and sustainable benefits, addressing problems important to Japanese and global society.

OUR VALUES:

- RESPONSIBILITY
- EXCELLENCE
- RESPECTFULNESS
- DIVERSITY
- TRANSPARENCY
- COURAGE
- SUSTAINABILITY
- FREEDOM

OUR VISION:

THE ADVANCEMENT OF KNOWLEDGE FOR THE BENEFIT OF HUMANITY

JAN. 2017
Peter Gruss appointed 2nd president

2018
First PhDs graduated

DEC. 2018
I² Innovation Incubator established to foster start-ups arising from OIST research

2019
Lab 5 preparation started

DEC. 2019
Lab 4

2021
Cabinet Office completes its review of OIST

2022
The strategy for faculty appointments for the next 5 years to be reviewed

2024
Lab 6

2026
Lab 7

2027
New external review to develop next 5-year strategy for faculty appointments

2028
Lab 8

2030
Lab 9

A UNIVERSITY OF BRIDGES

OIST has the potential to take its place among the stars of the academic world. According to president Peter Gruss, the university is just getting started.

OIST is a university of bridges: From the physical bridges spanning the rainforest gullies between our remarkable campus buildings; to the scientific, economic, and cultural bridges we are strengthening between Okinawa and mainland Japan; to the far-reaching intellectual bridges stimulating collaboration between OIST faculty and the very best of the global research community.

The founders of OIST, including Nobel Laureates Sydney Brenner, Jerome I. Friedman, Torsten Wiesel, and Steven Chu, as well as Japanese statesman Koji Omi, had a vision to establish an institute that would conduct 'best-in-the-world' research. After only eight years we have made significant progress towards realizing that vision: a recent normalized Nature Index ranking of global research organizations places us first in Japan and number nine in the world for the proportion of high-quality scientific papers relative to our total output of natural-science articles. How has a 'new kid on the block' achieved this in such a short time?

Peter Gruss, president of the Okinawa Institute of Science and Technology Graduate University, giving the welcoming address to the class of 2019.

A BRIDGE TO THE STARS

In any organization there are two types of thinkers: those who dream of the stars, and those more concerned with keeping a solid foothold on Earth. We want OIST scientists to reach for the stars and demand the impossible. We want to take care of the groundwork so they can be free—financially, academically and administratively—to explore the cutting edge of knowledge. At OIST we strive to make sure that we have an administration that is as efficient as possible within our regulatory environment.

At many institutions across Japan and the world, much of a senior academic's time is spent on administration and grant applications, leaving less time for research. Here at OIST, we do all that we can to reduce the demands of grant applications and other administrative tasks so that our faculty can devote themselves to research.

A BRIDGE TO EXCELLENCE

OIST follows the formula that my previous institute, the Max Planck Society, has applied for the last hundred years: hire only the best. OIST funds brains, not projects. One of the conspicuous differences between us and most other organizations around the world is that we have stable funding, opening the door to highly creative, high-risk but high-potential research. This kind of funding is absolutely critical to OIST sustaining its place as a globally pre-eminent research institution. We cannot rise to the top and build upon our success without the high-trust funding that has underpinned such rapid achievement. High-trust funding,

however, does not come with low accountability. Quite the opposite. Every five years an internationally renowned team of experts reviews the performance of each faculty member against rigorous global benchmarks. Only then are recommendations made for the five-year funding period ahead.

A BRIDGE TO THE WORLD

Okinawa is an island of 1.45 million people with beautiful green forests and pristine blue waters and a busy capital city about an hour's drive from OIST. It is an instantly attractive place to live or to visit. While connected to the mainland of Japan and to many of Asia's biggest cities by a short flight, its relative remoteness offers space to contemplate work without distraction.

Academics come to OIST from all over the world, including mainland Japan, for the level of independence we provide. Furthermore, we can offer tenure track to the right people where other institutes cannot, helping retain promising young researchers and allowing them to develop. A high proportion of our Assistant Professors are Japanese.

Our international mix fosters collaboration and understanding across borders. This year we advertized 10 new positions and received 1,544 applications. The same is true for graduate students: From 1,540 applications for graduate study, we admitted 54 excellent scholars. Clearly, OIST is proving an attractive destination for research.

In this, I believe we can be an exemplar. We can model the essential criteria for research excellence, enhance Japanese research capability, and provide valuable insight to the wider research community.

A BRIDGE TO OKINAWANS

OIST is determined to deepen its connections with its neighborhood. We have a spectrum of activities for Okinawan communities both on and off campus. Of the many programs, my favorite is our annual 'open house', where most of the labs open their doors and arrange hands-on activities for children and families. Last year about 5,000 people attended.

We are very fortunate to have the town of Onna-son as our home, and seek constantly to make the most of the opportunities a leading research institution can to create for its neighbors. We already employ 200 Okinawans and see an opportunity for further growth. In Europe in the 1960s and 70s a lot of money went into developing research institutions and research itself. Now 50 or 60 years later, those institutes have become the nucleus for new towns, businesses and opportunities. We want to repeat that example. I want OIST to be an anchor institution in Onna-son and Okinawa — a place that is bustling with energy. In addition to housing, we want to support the establishment of an International Baccalaureate school, start-up businesses, and possibly a research center with a world-renowned tech player. North of the OIST campus we have the opportunity to develop an OIST Innovation Park in which people from OIST, Onna-son and elsewhere can live and work, showcasing exciting invention, stimulating new enterprise, creating a model for sustainability, and providing another reason for visitors to come to this extraordinary part of Japan. OIST can provide the intellectual core in partnership with Onna-son to create the necessary space and environmentally sound infrastructure for a future-focused, innovation-led community and engine for economic success, building Okinawa's high-tech future.

Jobs created by the development of OIST will be highly skilled and lucrative, creating a pipeline of opportunity for local people. Our incubator facility aims to spin off companies from OIST research. We are adept at driving proof of concept or validation of our intellectual property. To move to the commercial stage, venture capital is required. Japan has only 3% of the venture capital that is available in the United States, and yet it is the third largest economy in the world. We have hard work to do to bring good ideas to commercial reality.

A BRIDGE TO THE BEST

In June 2019, we created the Basic Research Institutions Delivering Graduate Education (BRIDGE) network with four other world-leading graduate research institutions: The Rockefeller University (USA), the Francis Crick Institute (UK), the Weizmann Institute of Science (Israel) and the Institute of Science and Technology Austria. The BRIDGE network aims to strengthen excellence in scientific research and education through collaboration and exchange. All five members of the BRIDGE network, among the world's most successful scientific institutions, recruit and operate in a global environment and promote cooperation across institutional, political and disciplinary boundaries. I am proud that OIST is welcome in such illustrious company.

BUILDING THE BRIDGES

We have achieved great things in a short space of time, but need to grow to realize the dreams laid out by our founders. Institutional growth should not impair our quality. On the contrary: Evidence points to 300 professors as the critical mass required to make global impact. Caltech is a small, private university in the USA which is extremely successful in terms of the quality of science per principal investigator. It serves as a notable model. Furthermore, statistical analysis we undertook reveals that from a certain number of principal investigators upward, there is a step change in productivity.

THREE GOALS

OIST is a wonderful but unfinished symphony. It was founded with the mission to be among the best in the world. We have made a formidable start, but there is more to do. Our three objectives of providing world-leading research, education and technology development in Okinawa are showing great promise. After just eight years we have taken our place among the research world's brightest stars, demonstrating that the OIST concept works.

From here, we need to accomplish the necessary growth while maintaining research excellence. With the right support, the vision can be achieved. ■

Peter Gruss
President, OIST

DISCOVERING THE ECOLOGY OF OKINAWA

A community project is recording the plants and animals of the island.

Okinawa is a sub-tropical island between the Japan mainland and Taiwan. Geologically, the island was formed when ancient coral reefs met continental uplift, creating an island of two halves. The north is wild and mountainous, with steep hills covered in lush jungle, and the evergreen trees are draped with epiphytic orchids, competing for the attention of thousands of insect species. The south is hilly and more densely populated, a city fringed by sandy beaches.

Around the coast, patches of mangroves form a buffer for the waves and a nursery for young fish, while further out from the beaches, coral reefs shelter hundreds of fish species in every hue imaginable. Of the Japanese prefectures, Okinawa has the most diverse collection of plants and animals.

Okinawans are the biggest authority on the ecology of their island, which is why Assistant Professor Evan Economo tapped into their knowledge for the OKEON Churamori project (Okinawa Environmental Observation Network).

"As scientists we get excited if we publish a paper in a high-profile journal like *Nature*, but people on the island want to see that our research has some relevance to their lives," he says. Economo heads the Biodiversity and Biocomplexity Unit at OIST and has partnered with local schools, museums, companies and government officials to establish a long-term documentation of the plant and animal species on the main island of Okinawa. They are using surveys, insect traps, camera traps, and audio recordings in 24 locations around the island to establish what plants and animals are here now and whether it is changing over time. The research is doing triple duty by being used as an education tool for the science classes of Okinawa and an ecological monitoring tool for the Okinawan prefectural government, as well as being world-leading research in its own right.

"The three biggest threats for biodiversity around the globe are land use change, climate change and invasive species, and we can use Okinawa as a model system to see how these threats play out in the microcosm of an island," says Economo.

Advanced technologies such as machine learning and genomic sequencing make surveying more efficient, and combined with old-fashioned trekking through the forests it is establishing a comprehensive picture of the wildlife of Okinawa.

"A lot of insects aren't even described yet. It's a monumental task," he says. ■

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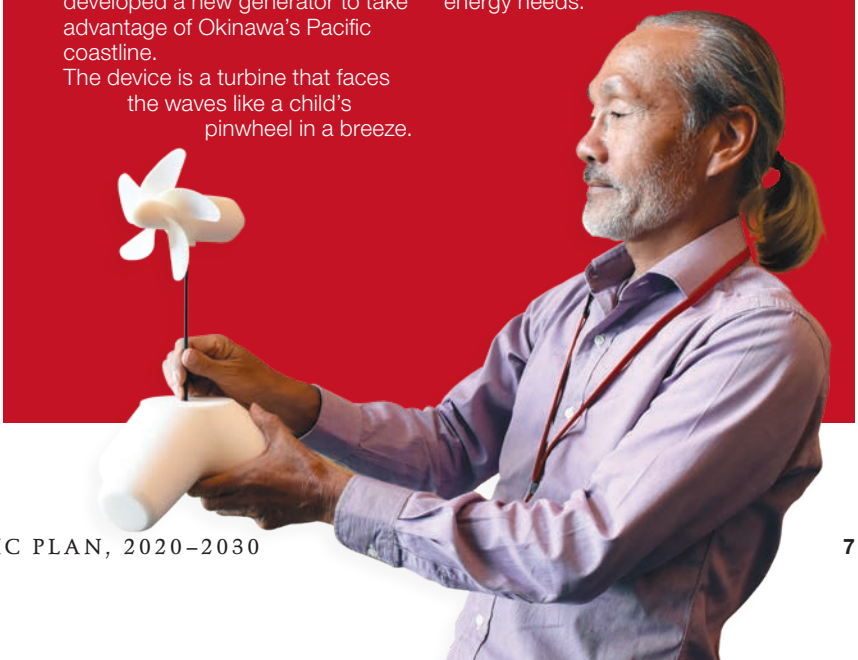
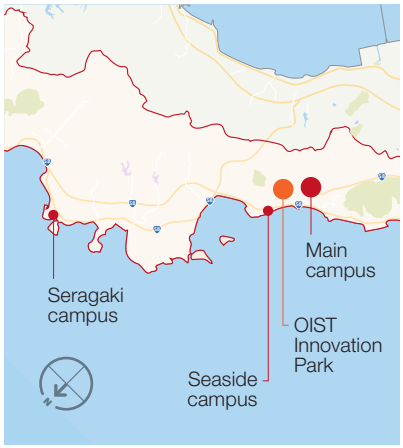
A NEW WAVE OF RENEWABLE ENERGY

The power density in the ocean's waves outstrips most other renewable resources by 10 times. But the expense of converting and transporting that energy from the open ocean is often prohibitive. Accelerator physicist, Professor Tsumoru Shintake became fixated with finding a way to harness wave power when he moved to the island of Okinawa to take up his post as head of the Quantum Wave Microscopy Unit. His team has developed a new generator to take advantage of Okinawa's Pacific coastline.

The device is a turbine that faces the waves like a child's pinwheel in a breeze. Shintake says it can be mounted on the concrete tetrapods that cover much of Japan's coastline and its location, proximal to shore, allows it to be readily maintained, makes transporting the electricity to shore more feasible, and captures the energy of the waves as they are most concentrated as they break. Testing continues, but Shintake hopes his fresh perspective on an old problem could be the breakthrough wave energy needs.

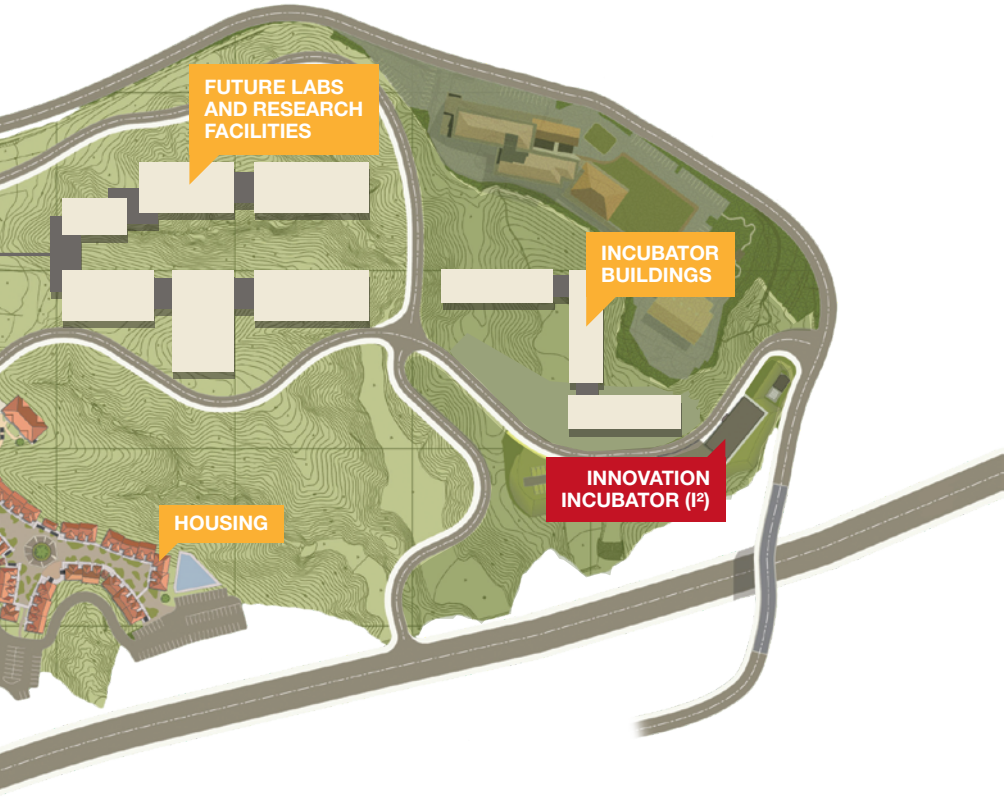


CAMPUS AND FACILITIES



A CROSS-DISCIPLINARY CAMPUS

A beautiful campus is conducive to health and well-being, making people happier and more productive. A joint venture of the firms Nikken Sekkei (mainland Japan), Kornberg Associates (USA), and Kuniken (Okinawa), designed the campus with laboratory buildings on top of hills overlooking the East China Sea and connected by a network of bridges passing over the gullies. They researched successful campuses around the world and the labs were carefully designed to maximize interactivity between administration and laboratory disciplines. Accordingly each lab can accommodate the work of physicists, biologists, chemists, computer scientists, mathematicians and engineers. 'Interstitial spaces' between the laboratory floors for ducting, electricals and IT cabling allow labs to be configured and re-configured rapidly with a minimum of disruption to the working scientists. The campus is designed to withstand typhoons and other natural disasters, while protecting the fragile ecosystems of its location. Featuring energy-saving architecture, the campus has Leadership in Energy & Environmental Design (LEED) silver certification for at least one of the laboratories.



OIST INNOVATION PARK

The OIST Innovation Park, to the north of the existing campus, will provide an exhilarating and high-tech home to the breakthrough innovation and enterprise which flows from world-leading basic research. More than just a commercial zone, OIST Innovation Park – delivered with Onna-son village and industry partners – will inspire and entertain, promoting innovation, and supporting work, life, and play. Start-up businesses will develop within easy reach of sustainable, environmentally advanced homes, linked by future modes of smart, energy-efficient transportation, alongside retail, recreation and community services, eateries, a center for lifelong learning, and a school. Okinawa, with its extraordinarily beautiful coastline, is well-established as a destination for high-quality tourism. OIST Innovation Park will provide another reason to visit, whatever the weather. Creating an outstanding, science-themed visitor attraction in the Park is another part of OIST's blueprint for development.

A RAPID PULSE

Extremely short bursts of light yield insights.

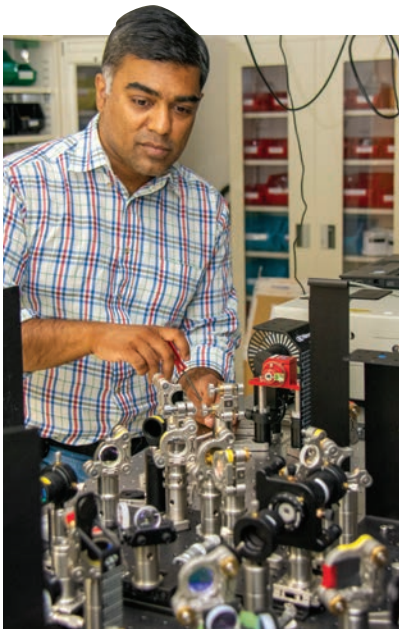
Femtosecond spectroscopy harnesses extremely brief pulses of light to excite electrons in materials and study their behavior on short timescales. OIST's Femtosecond Spectroscopy Unit, led by Associate Professor Keshav Dani, uses this innovative method to explore properties of cutting-edge materials, and to examine phenomena at the far extremes of the electromagnetic spectrum.

Leveraging OIST's culture of innovation, the unit has developed powerful tools using techniques in terahertz spectroscopy or by merging femtosecond light with electron microscopy. This allows the researchers to make 'movies' of how electrons move in materials in space, time, momentum and energy.

The unit applies their capabilities to condensed matter systems like van der Waals materials, which are atomically thin, two-dimensional crystals, relevant to next generation opto-electronic technologies. They also study energy materials and quantum materials.

The unit collaborates with research teams within the university in neuroscience and art conservation. Their femtosecond pulses can stimulate a neurochemical release in non-human brains, thus enabling studies in learning and behavioral mechanisms.

In a collaboration with art conservators, the unit developed methods for taking minute cross-sections of artworks using femtosecond laser pulses, mitigating damage to the artifact. ■



Associate Professor Keshav Dani is a physicist originally from the USA. His team uses ultrafast pulses of light to better understand the properties of 2D materials, which have much heralded applications.

MAKING THE SWITCH

Researchers are developing a switch that can turn genes on and off in response to a chemical prompt.

"The intrinsic functional diversity of nucleic acids is unmatched by any other class of molecules. As a chemist, I was intrigued," explains Associate Professor Yohei Yokobayashi on his decision in the mid-2000s to switch his research focus from proteins and peptides to RNA engineering.

In his Nucleic Acid Chemistry and Engineering Unit, Yokobayashi leads a team of researchers who engineer nucleic acids with sophisticated functions, one of which is to act as a switch.

"We want to turn genes on and off in cells using chemical signals. One way to do that is to use RNA which can recognize small molecules and change its shape in response."

These RNAs are called riboswitches and Yokobayashi's team is focused on designing and testing synthetic versions — not only because they are of immense interest in biotechnology, gene therapy, and other industrial applications — but because they may also help reveal how natural riboswitches work.

There are different ways to make riboswitches in different organisms. "To make riboswitches in mammalian cells, for example, we engineer self-cleaving RNA, called ribozymes, and combine them with other RNA elements, called aptamers, which bind our drugs or small molecules."

The small molecules that activate these switches need to be cell-permeable, non-toxic, and able to bind to aptamer sequences very efficiently, explains Yokobayashi. Examples include guanine, theophylline and tetracycline.

Yokobayashi's team has recently developed a synthetic riboswitch that, in response to histamine, could activate protein expression. An artificial cell fitted with riboswitches could be used to respond to an allergic reaction by delivering antihistamine or anti-inflammatory drugs, or to deliver a drug payload and then trigger its self-destruction.

The team are also using high-throughput sequencing to analyze tens of thousands of ribozyme and deoxyribozyme mutants, to engineer better riboswitches. One of the synthetic riboswitches recently designed by the team is able to control the expression of a gene that regulates the predatory behavior of a bacteria called *Bdellovibrio bacteriovorus*.

Yokobayashi is currently working with industry partners on gene therapy applications focused on turning therapeutic protein expression on and off.

"With a riboswitch you only need to insert a small sequence in the gene you want to control, so the system is very simple and robust compared to the existing protein-based gene switches." ■

A NOSE FOR BEHAVIOR

Complicated neural processing happens as soon as mouse brains are alerted to smell.

Assistant Professor and head of the Sensory and Behavioral Neuroscience Unit, Izumi Fukunaga researches scent perception in mice in order to understand neural processing of information.

"Humans can tell the difference between the smell of red wine and cheese for example," she says. "Or we can smell different red wines — Californian versus French red wine — and understand something subtle about the scents present in each type. Optimal representation of stimuli in the brain is different depending on behavioral contexts. And context changes all the time."

Fukunaga wanted to understand which part of the brain processes the blunt incoming information, and which part refines our perception. In visual perception, for example, incoming light is not highly modulated until a few steps into processing.

But Fukunaga and colleagues, including an intern, Anzhelika Koldaeva, who later did her PhD in a different unit, discovered that smell is processed differently. "We discovered that the olfactory bulb, the very first smell center of the brain, is already the region where this modulation takes place," says Fukunaga.

In a box, a mouse ambles on a treadmill, its head kept still by a harness so that a microscope can target the mouse's brain. The mouse receives a waft of pineapple scent, a cue that water, a reward for the thirsty work of walking on a treadmill, is available. The mouse, showing its comprehension, starts lapping at the water nozzle.

The mice, genetically modified to have fluorescent neurons when they are active, were trained that pineapple smell would return water and all other smells could be ignored. Then the researchers minutely shifted the recipe of the pineapple smell and rewarded only one variant.

Switching quickly between the training setting in which all pineapple smells returned water, and the modified setting, in which only one variant of pineapple did, the mice showed the ability to keep up with a changing landscape. Their response was correct about 80% of the time, with the mouse realizing within the first few licks that the rules had changed again.

The behavior change "may prove useful to understand how the brain implements solutions that meet ever changing behavioral demands," the team wrote in their paper in *eLife* in 2019. ■

NEURAL COMPUTATION

A recent project from the Neural Computation Unit combined magnetic resonance imaging, blood markers, and patient reports to reveal that there are three subtypes of depression — now the leading global cause of disability.

The unit uses theoretical, neurobiological and engineering approaches to develop machine learning algorithms to elucidate brain mechanisms. They have built robots and virtual agents that can learn a variety of goal-directed behaviors, thereby clarfiying the minimum adaptations necessary for survival and reproduction. Their smartphone robot platform has recently been used as a testing ground for more data-efficient learning.

OUT IN FRONT OF THE RESOLUTION REVOLUTION

World-record imaging feats have been achieved by OIST researchers using state-of-the-art equipment.

Professor Matthias Wolf loads a sub-zero sample into a cryo-electron microscope. Working with the best equipment, top researchers and powerful computing has allowed Wolf insight into viruses, such as the Ebola virus, inset.

Associate professor Matthias Wolf is using recent advances in electron microscopy (EM) to determine the structures of lethal viruses, as well as potentially life-saving ones.

Viruses are miniscule. For example, the diameter of the deadly Ebola virus is equivalent to about 210 atoms. As a result, our knowledge of their structures has been unresolved, but a technique known as cryo-EM is sharpening our view of them.

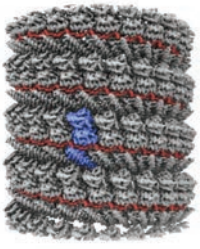
"Improvements in detectors, computational power, microscope optics, and stage stability over the past 10 years have led to a so-called resolution revolution, which now allows us to image individual atoms, in favorable cases," says Wolf, who leads the Molecular Cryo-Electron Microscopy Unit at OIST.

To image a virus using cryo-EM, a sample is snap frozen at cryogenic temperatures, placed under the microscope, and then iteratively imaged. The technique has several advantages over X-ray diffraction, which has been traditionally used for molecular structure studies. In particular, samples don't need to be crystalized, and they are frozen in their natural state, rather than subjected to a high vacuum.

Wolf's group has combined cryo-EM and high-powered computing to determine the structure of a part of the Ebola virus, which killed more than 11,000 people in the 2014–2016 outbreak in West Africa and remains a global threat. At a world-record resolution of 3.6Å, the team imaged the protein sheath that supports the genetic material of the virus, because this structure plays an important role in the replication of the virus. The team reported their work in the prestigious journal, *Nature*.

"Now that we have a clear picture of what this structure really looks like, we are one step closer to figuring out how the whole virus works," says Wolf.

In another imaging triumph using cryo-EM, the team reported in the *Proceedings of the National Academy of Sciences* the structure of a virus that infects cancer cells, but not healthy cells. "Using viruses that specifically target cancer cells and destroy them offers us a new way to fight cancer," says Wolf.



The Seneca Valley Virus was discovered in 2002 and targets a receptor that is expressed in tumor cells in more than 60% of human cancers. "It is a very, very interesting biological target, and it has generated a lot of buzz," says Wolf.

The team identified the critical part of the virus for binding to the receptor. This will help researchers develop ways to enable the virus to avoid being neutralized by the immune system so that it can attack tumor cells. ■

FINDING A NICHE IN MICROFLUIDICS

Choosing to do her PhD at OIST led Shivani Sathish in an unexpectedly productive direction.

Shivani Sathish, trained in genetic engineering, never thought she'd have a patent awarded with more than a year left to go in her PhD. It's all thanks to OIST's innovative PhD program where candidates undergo three lab rotations in their first year. One of those rotations must be outside the candidate's field of expertise, and it's in that rotation, micro/nanofluidics, Sathish really found her niche.

In Professor Amy Shen's Micro/Bio/Nanofluidics Unit at OIST, Sathish is focused on making better, faster diagnostic devices. But along the way, she found time to design and create a working prototype of a point-of-care fluid-handling system, and have it patented.

In the lab, huge pumps control how fluid is delivered to tiny, microfluidic chips. Sathish and research technician, Kazumi Toda-Peters, a fabrication specialist, wanted to shrink the delivery system so it would be comparable in size to the chips and suitable for point-of-care use. "We wanted to make something that doesn't need external power and that you can manipulate by hand," Sathish explains.

The device works as follows: a user puts a drop of blood in the sample collection area; it is then mixed with a stored reagent. The mixture is filtered, removing, for example, blood cells and protein aggregates, and the molecules of interest are delivered to a microfluidic chip. The next component is a bioassay to detect infection, which involves capturing the molecules of interest and washing off of unbound molecules that are collected in an enclosed waste unit. It's a completely sealed system, which minimizes the risk of sample contamination.

Sathish and the team are currently developing proof that the concept works based on sexually transmitted infections (STIs), specifically chlamydia, as the immune response to the infecting bacteria can be detected in blood. While it's still in early stages, the team have managed to detect clinically significant levels of the antibodies. They are now looking for an industry partner to move with them to the next stage of testing: showing that the device can consistently achieve accurate results.

In 10 years' time, Sathish is hopeful this device could lead to a test for multiple sexually transmitted infections (STIs), and that it is as ubiquitous as home pregnancy tests.

Developing the device, and her experience at OIST, has crystallized Sathish's desire to become an entrepreneur. Outside the lab, she has become part of Okinawa's vibrant Latin dancing community, made lots of Okinawan friends, and learned more about the culture.

"Coming here wasn't what I expected – because it was easy. The graduate school and student support section helped with everything. So I didn't have any problems, even though the language was completely different." ■

THE OIST PHD DIFFERENCE

An OIST PhD takes a different approach, aiming to educate a generation of future research leaders who are experts in their chosen disciplines, but also have a working knowledge of other disciplines. We believe this will encourage cross-disciplinary working and thinking, which are increasingly essential attributes for research leaders. The OIST PhD takes five years in total. During the first year, each student completes three four-month rotations in different laboratories, at least one of which is out of their field of interest. Students can receive credit for undertaking external courses, online or off-campus, opening a vast array of specialist course options that OIST is not able to teach. After two years of course work and research training the candidate submits a written thesis proposal for assessment. The next three years of research lead to the PhD thesis and examination. While there are certain core courses and academic themes, the aim is to tailor coursework to suit each student's needs.

Shivani Sathish tests the microfluidic assay device she developed while undertaking a PhD at OIST. An Indian national, she came to Okinawa to study genetics but found a new love in microfluidics.

DARING TO DISCOVER DIFFERENTLY

As an international university in Japan, OIST has taken a non-traditional approach. From administration structure to laboratory design, OIST is breaking new ground.

New technologies and great advances in our understanding of nature often come from the fusion of knowledge from very different disciplines. This can come from, for example, applying techniques and methodologies that are well-established in one field to a completely different set of problems in another field, or combining disciplines to create new fields of research, such as psychophysiology, molecular biology, quantum computing, biophysics and biochemistry. As a result, many traditional universities are encouraging cross-disciplinary research by lowering inter-departmental barriers. Since OIST has never had departments, there is nothing to lower — initiating collaboration across disciplines is in the hands of the researchers themselves.

A DIFFERENT APPROACH

As a very young institution, OIST has the freedom to rethink the structure of a university, for example to encourage and support cross-disciplinary research.

Already, OIST is showing an impressive measure of internal collaboration (facing page), which we ascribe to our structure. In this, we aim to be a model for how universities can re-organize to create a more collaborative environment leading to scientific breakthroughs.

Our pioneering structure dispenses with traditional academic departments. Instead, we organize our administration by physical location. Each lab building houses faculty members in the life and physical sciences, and their research units, together under one roof. Administrative staff sit centrally in the building and share resources and workloads. Laboratories form around a research problem. Often these are cross-disciplinary and bench space will be shared among scientists from different areas working together. Students are free to move between disciplines, developing their learning by following their interests, and gaining understanding and insight into other ways of working.

To facilitate development within a discipline, researchers tag themselves with their interests, allowing communications to be targeted and enabling potential faculty, students, researchers and entrepreneurs to find the relevant thought-leaders on an issue. Virtual networks (themes) of common interests can be quickly formed and dissolved. The compact interconnected campus enables researchers to meet easily and extend their knowledge of other disciplines.

"I think this university is a kind of experiment for the Japanese government. It's completely different from the national university model. **WE HAVE TO COMPLETE THE EXPERIMENT.**"

Masayuki Shibata, Vice President for Financial Management

This structure is repeated at the level of the floor, the building and the whole university to create a 'fractal OIST' model (see lab structure, facing page).

OIST academic leaders include Provost Mary Collins, an immunologist and virologist from the UK, and Dean of Faculty Affairs Milind Purohit, a particle physicist from the USA. They work to support the interdisciplinary environment by running core support facilities and recruiting and supporting OIST faculty members and researchers. OIST Professor Tadashi Yamamoto (also head of the Cell Signal Unit) serves as Dean of Research, with a focus on research strategy and external research collaborations. All OIST graduate students are supported by the Graduate School, headed by OIST Professor Ulf Skoglund (also head of the Structural Cellular Biology Unit).

As we grow, more of the administrative load will be handled at building level, supervised by a senior academic, while the intellectual leadership will come from the themes.

OIST has outstanding, state-of-the-art, research equipment and facilities, including an engineering support building, cleanrooms, imaging, genome sequencing, marine station and environmental monitoring network. These common resources are managed by dedicated researchers and technicians who participate in many projects. Research from theoretical physics to ecology is underpinned by our scientific computing and data analysis section, who work with researchers and IT to deliver high performance computing (HPC) and storage infrastructures attuned to their research needs. Students and researchers are trained in these latest technologies, which is a great career launch.

A university is a community not only of scholars but also those who support them. As such, OIST values and develops our administrative staff, 20% of whom are Okinawans. These staff play the crucial role of enabling OIST research to proceed, and can take pride in the part they play in building a world-leading research institute.

While centralized administration has many advantages, we are also working to identify where decentralized work is of

CONTINUED ON PAGE 16 ↘

BIRDS OF DIFFERENT FEATHERS

Associate Professor Yoko Yazaki-Sugiyama was fortunate to work next door to physicists at OIST. A neurobiologist, she and colleague Makoto Araki were working on understanding the neural mapping of birdsong. In casual conversation, an OIST colleague suggested she involve physicist Mahesh Bandi as his expertise in complex natural phenomena might lend some insight into her birdsong enquiries.

"At first I was hesitant to talk to him because we don't have any common ground. But in talking, we figured what kind of help we could give each other," she says.

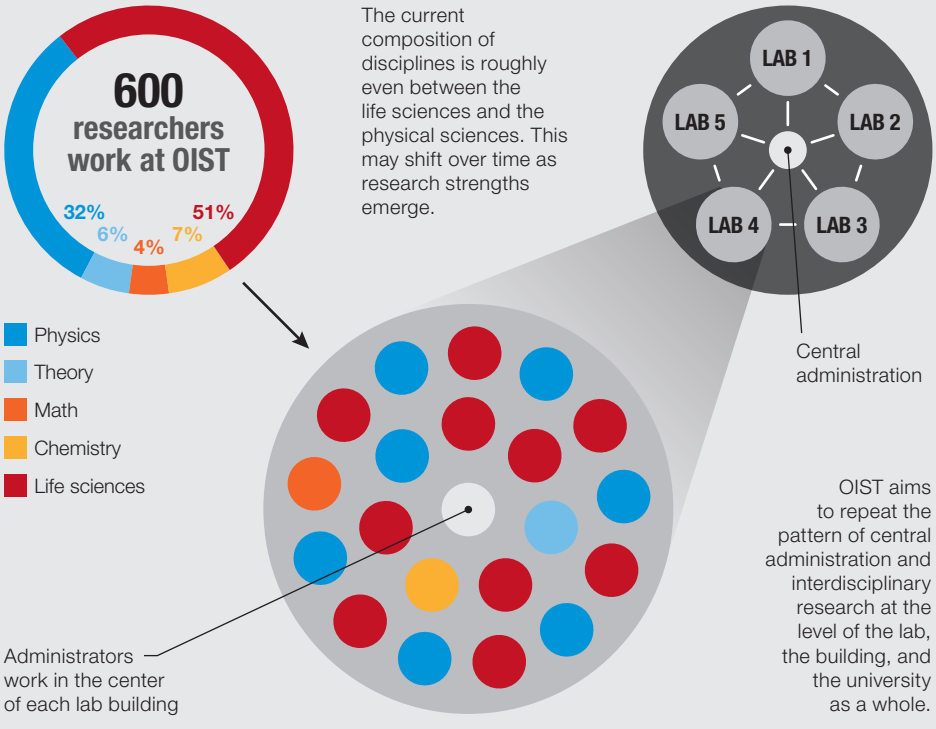
The result was a collaboration and a paper in the famous journal *Science* in 2016. Together, they discovered that parts of a zebra finch's song appear to be hardwired. Even when raised surrounded by other birds' song, the zebra finches couldn't help but sing to the rhythm of their species. The team then worked to identify the brain regions responsible, discovering that the silent periods between chirps had devoted neurons.

Yazaki-Sugiyama says that while such a fruitful collaboration was easy to instigate at OIST, even smaller questions in the daily life of scientists benefit from the multidisciplinary environment.

"Even just a tiny thing. What kind of subjects do we need to use? What kind of materials do we need? We can just knock on the door of the next room which is totally in a different field. It makes it really easy."

LAB STRUCTURE ↓
Each laboratory building hosts several labs working on particular questions. The staff of these labs can come from many different scientific disciplines. Resources, such as supplies, instruments and computing are pooled for efficiency.

INTERNAL COLLABORATIVE NETWORK →
This diagram represents the internal collaborating patterns. Each node represents the clustering of collaborating publications based on the field of research, with the size indicating the number of publications, and the shorter distance between nodes showing higher frequency of collaborations.



"Our mission is stated. But **OUR CULTURE IS MADE OF OUR PEOPLE**."

Tomo Nagase, Vice President of Human Resources

"OIST has a policy of **SUPPORTING FEMALE SCIENTISTS** because if 80% of scientists are men, then we're doing everyone a disservice because there are all those women with something to contribute who are not getting a chance."

Gail Tripp, Vice President for University Community Services (and head of Human Developmental Neurobiology Unit)

the greatest benefit. Our policy is to empower those most capable and informed to make appropriate decisions locally.

AN INTERNATIONAL UNIVERSITY SITUATED IN JAPAN

Although located in Japan, OIST was never envisioned as a typical Japanese university. Instead, the founders always perceived OIST as an international university. Our university policies are therefore in line with global expectations.

We value diversity. Our researchers and students come from every region of the world. Therefore, a culture that celebrates difference, and embraces tolerance and acceptance, is essential to the success of OIST. Our approach was recognized in 2018 by the Optical Society's inaugural Institute Award for Diversity and Inclusion Advocacy.

This diversity naturally gives rise to a commitment to freedom of expression. Whether in university administration, research, ideas, political views, or personal expression, OIST believes all staff should be free to express themselves and their culture. OIST celebrates religious, national and cultural holidays from around the world, as well as Japanese festivals, such as Golden Week and Obon. We have clubs for all manner of sports, cooking, crafts, and of course academic interests.

We recognize that researchers need more than state-of-the-art facilities to do great research: researchers have needs and our approach is to treat staff and students like family. Because more than half of our scientists and students and many of our administrators are international, we have put in place the support structures required to facilitate a smooth transition to life in OIST, Okinawa and Japan. Our University Community Services Division and the HR Relocation Team provide help with visas, housing, daily welfare, financial support, external scholarships or fellowships, travel, and physical and mental health.

Many who come to OIST have young families, so OIST has an on-site child development center and an after-school program where children are cared for and learn in English and Japanese, just a short walk from their parents. Demand for the center has grown almost fourfold in just six years. OIST also offers up to six months paid maternity leave and will hold a staff position open for up to three years.

English is the language of science and the common language of OIST. Therefore, we provide a range of English-language courses for scientists, support and administrative staff and their families. For those who wish to integrate more closely into the local culture, we also provide Japanese language lessons.

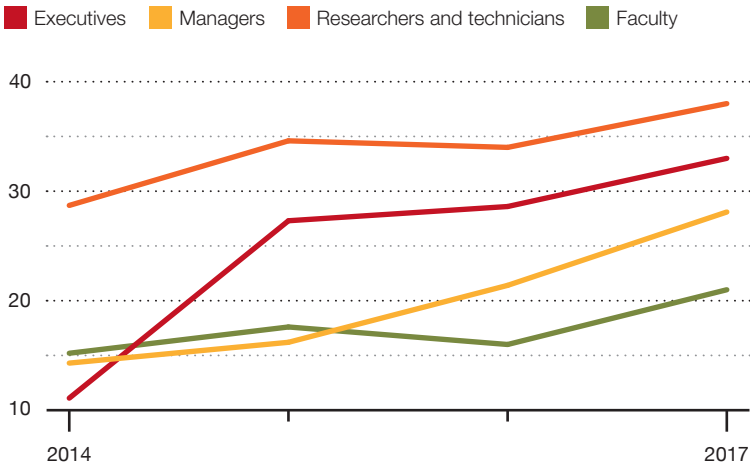
The OIST experience includes access to a medical clinic and the Ganjuu well-being service, which provides counseling for staff, students and families.

Along with freedom of expression, OIST is committed to academic freedom. Under our current funding arrangements, our researchers are free to explore ideas of importance to understanding the fundamental nature of things. Because our researchers are not tied to specific projects or outcomes, they are free to follow an ethical path to results that seem most worthwhile. Data from early experiments can guide subsequent ones, or new developments in the field can open an unexplored pathway.

The high-trust funding model that has been used to support OIST has allowed our researchers the freedom to follow their own judgement, leading directly to the world-class results we have so far achieved. It has also been key to enabling us to recruit the best talent. This is essential if we are to realize our ambition to be a globally recognized research university.

WOMEN BY JOB TYPE (%)

Working towards overall gender parity, OIST is making gradual progress across all our different job families, but there is much work yet to do.



To ensure globally competitive work is produced, we rely upon the judgement of internationally respected external experts to review the quality of our research. Faculty are assessed every five years. Those with tenure are assessed by a five-person External Review Committee, and those without are rigorously evaluated for tenure based on external input. As well as receiving advice from our Board of Governors and Board of Councilors (p19), we convene external panels of world-renowned scientists to review plans and make recommendations for the recruitment profile of faculty over the succeeding five years.

Beyond recruitment, we also concentrate on career development. The C-Hub learning portal has been designed to promote professional development at all levels of employment, with individualized development plans, professional development courses and industry networking.

GROWTH

After only eight years, OIST is still in a phase of rapid growth. A faculty unit is the group of researchers clustered around a faculty member. In September 2019 we had 75 faculty units and we aim to reach 300 faculty units by the mid-2040s, a compounded annual growth rate of 8%.

The target of 300 is not arbitrary. Our research shows that 20 to 30 principal investigators in a single discipline is required to reach a critical mass of intellectual stimulation and knowledge depth. Beyond this, the number of high-quality scientific publications they produce takes a step-like jump.

Similarly, OIST was formed with the intent of being a truly multi-disciplinary research institute. The range of scientific areas we study must be broad enough to foster true cross-disciplinarity and offer sufficient research options and opportunities to be attractive to the most promising graduate students and to scientists who are, or have the potential to become, world leaders in their field. We will need at least a dozen fields of study to yield the breadth required to provide a vibrant research community within OIST that will attract current and future leaders.

Even with this planned rapid growth, it will take many years before the fruits of the OIST endeavor will be fully realized. While we believe passionately in our approach, we cannot predict epochal breakthroughs, groundbreaking innovation, or even when we will become accepted as a world-leading university. This long timeframe is challenging, because it requires continuation of the outstanding political support from the Japanese Government we have received so far.

The initial investment in OIST will be wasted if it is not continued in line with OIST's plans for growth. The projected expenditures chart (below right) shows the level of commitment required by the Japanese government to continue OIST's development into a world-leading university. Administrative expenditure increases only modestly as those structures are largely in place today; the main growth is in the recruitment and retention of outstanding faculty, researchers and students.

As a very young university, we do not yet enjoy significant donations from alumni, retired faculty and philanthropists. We anticipate that these donations will grow as OIST's global reputation grows. The creation of the not-for-profit OIST Foundation in the US is designed to promote philanthropic donations, particularly from Okinawan and Japanese emigrants. Similarly, industry support and partnerships are beginning and will develop over time. Until those revenue streams mature, OIST remains highly reliant on the confidence of the Japanese government. ■

"Support staff are, together with the faculty and researchers, enabling OIST to achieve its goals. When we see what we have enabled, we feel a certain satisfaction. A joy. We are not simply serving; **WE ARE A PART OF THE PROCESS.**"

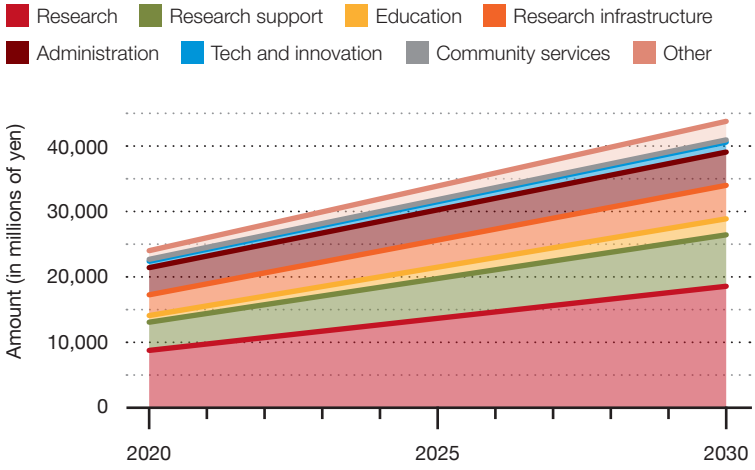
Keisuke Yoshio, Chief Operating Officer

"OIST PhD students have a rare level of access to high-performance computing (HPC) resources. A strong HPC background **MAKES YOU VERY VALUABLE**."

Tim Dyce, Vice President of Information Technology

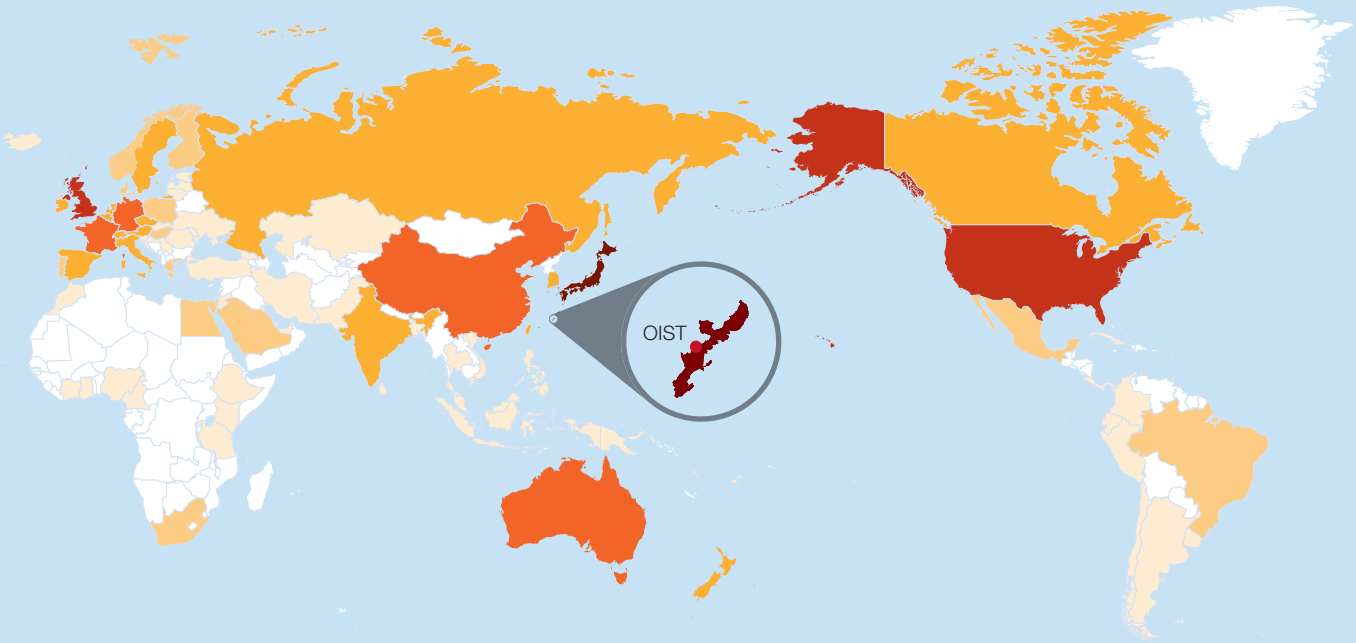
PROJECTED EXPENDITURES, 2020-2030

The increase in expenditure will come principally from the aggressive recruitment of researchers and their support staff.



AN INTERNATIONAL APPROACH

Our commitment to developing into a world-class research university manifests in our international approach. Through international recruitment of leadership, staff, researchers and students we have established ties to 66 nations. These people bring with them academic connections and a fresh perspective on research problems. International collaborations on research problems foster and strengthen our global connections, ensuring we are always in touch with the world's best science.



COLLABORATION WITH OIST

More than 95 research institutes, many of them high profile, have worked with OIST on joint scientific publications. The above map shows the 60+ countries and regions in which collaborating institutions are based. To the left we highlight the Japanese research institutes with whom we have most collaborated.

↑ Joint publications from around the world

1–9 | 10–29 | 30–99 | 100–249 | 250–999 | 1,000+

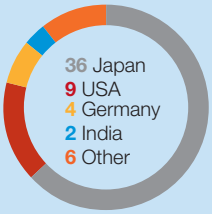
← Top collaborating institutions in Japan

Fewer than 100 papers | 100–199 | 200+

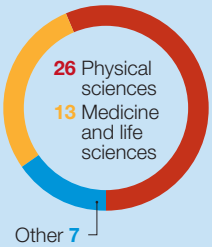
GLOBAL GOVERNANCE

The Board of Governors oversees the business of the OIST corporation. The larger Board of Councilors has a wide membership from Okinawan, academic and business organizations, alumni and OIST employees. Both boards' make-up is deliberately diverse and distinguished.

A GLOBAL GROUP



A DIVERSITY OF EXPERTISE



DECORATED GOVERNORS

4 Nobel laureates

Orders of the Rising Sun* 5

*Grand cordons: 3
Gold and Silver Stars: 2

PLAYING QUANTUM LEGO

Physicists from around the world have gathered at OIST to probe the mysteries of quantum physics by studying artificial systems of ultracold atoms.

Okinawa is renowned for its balmy weather, but OIST theoretical physicist Professor Thomas Busch is interested in what happens much further down the temperature scale. He studies how atoms behave at extremely low temperatures, just a few billionths of one degree above absolute zero (–273.15 degrees Celsius).

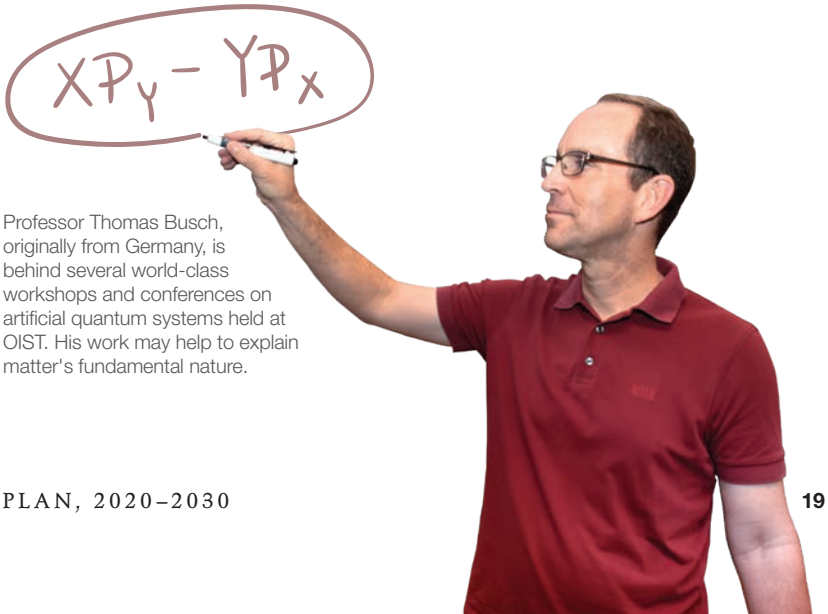
Atomic nuclei, atoms and molcules are all examples of quantum systems in nature. However, Busch, who heads the Quantum Systems Unit at OIST, spends his days designing artificial quantum systems in the hope of discovering new physics. "We're essentially engineers, but for fundamental physics," he explains. "We try to figure out how to build new quantum systems to observe interesting effects. It's like quantum Lego."

As a theorist, Busch designs those systems on a computer, and then collaborates with experimentalists at OIST and around the world to create them in real life. Since 2013, OIST has hosted four workshops on the topic of coherent control of complex quantum systems that brought together some of the leading researchers in the field from around the world. Conferences, workshops, and collaborations are commonplace for researchers, but OIST works especially hard to keep its researchers connected to the world by hosting such events.

Busch acknowledges that quantum mechanics is counterintuitive. "Quantum mechanics is weird. For example, we're really interested in making systems that are in two positions at the same time using strongly correlated, one-dimensional systems. That's one of our big projects."

Artificial quantum systems may hold the key to solving one of the biggest challenges in modern physics — understanding the strong correlations that lead to effects such as non-locality or teleportation. While these are reasonably well understood for systems consisting of two particles, it is not really known what will happen when the number of particles is increased. Progress on this problem will ultimately lead to interesting new technologies such as high-precision measurement devices or systems for information storage.

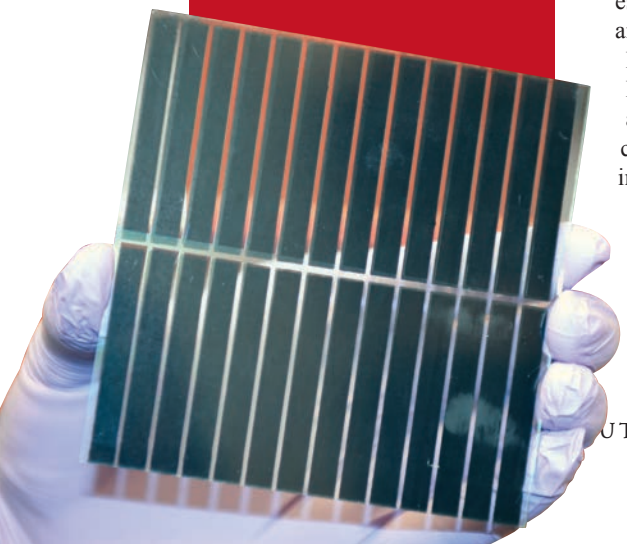
"We know that quantum mechanics is not the ultimate theory of the universe since, for example, it doesn't include gravity," Busch says. "However, it is working very well and we have not yet found any examples where it fails. Maybe a hint of what is waiting beyond quantum mechanics is hiding in systems of three, four or five particles." ■



Professor Thomas Busch, originally from Germany, is behind several world-class workshops and conferences on artificial quantum systems held at OIST. His work may help to explain matter's fundamental nature.

SUNSHINE FOR THE FUTURE

Pervoskites are generating a buzz in sustainability. A promising new material for the next generation of high efficiency, low cost solar cells and optoelectronics devices including LEDs and lasers, they are the subject of study for Professor Yabing Qi and the Energy Materials and Surface Sciences Unit. Qi's team uses cutting-edge tools to examine the complexities of the perovskite material and draw conclusions about their effect on solar cell performance. In recent years experimental perovskite solar cells have overtaken conventional silicon solar cells in achieving sunlight-to-energy conversion. Commerical appeal will be boosted by creating materials that will last a long time under real-world conditions. Qi's group is trying to determine the optimal properties for longevity and performance.



OIST'S CONTRIBUTION TO THE OKINAWAN ECONOMY

Economic stimulus will flow to Okinawa from the activities of OIST researchers and their families.

Okinawa's economy will benefit greatly from the success of OIST. Onna-son derives its income largely from tourism and OIST represents an opportunity to diversify its economy and set it apart from other coastal towns. Jobs at a university, whether in service, administration, technical support or as a researcher, tend to be high-skilled, well-paid and stable. We expect OIST will directly employ 1,000 Okinawans by 2040 making OIST one of the larger local employers.

Apart from direct employment at OIST and spin-off companies, having the institute as an economic focal point will be a stimulus for Onna-son and Okinawa more generally. The need for food, clothing, services and entertainment for OIST staff and families will drive prosperity in the village in a long-term, sustainable fashion.

AN INNOVATION HUB

With a facility of the intellectual capacity of OIST, intellectual property is an inevitable result. Many research institutes struggle to transfer technology from the lab to the commercial world. We have adopted practices from universities with success in technology transfer to drive this process for researchers, aiming to make OIST an innovation hub for Onna-son, Okinawa and Japan. We have established a Technology Development and Innovation Center.

Dr. Robert Baughman, Executive Vice President for Technology Development and Innovation at OIST, says "the key challenge is to identify and develop inventions without perturbing basic research."

When OIST researchers make discoveries that they believe could have commercial application, the Center commissions an external expert assessment. If positive, patents are obtained and then proof of concept (POC) funding is available to develop the idea to the point that an investor could license the patent or form a start-up company.

"POC work is fundamentally different from basic science where you're trying to publish discoveries of original science. It's still research, but it's focused on fine tuning the implementation and confirming marketability, as opposed to just making basic discoveries," says Baughman.

We expect the number of start-ups to grow in proportion to the size of the faculty, eventually reaching several per year.

With support from the Okinawa Prefectural Government and private donations, OIST also runs a start-up program for entrepreneurs from around the world who can benefit from the outstanding resources and research expertise at OIST. Candidates from anywhere in the world can apply to develop their projects in the OIST I^2 incubation center.

"It's been found that bringing in some outside spice makes a kind of entrepreneurial community that's far more dynamic than it would be with just your own homegrown spice," says Baughman.

Venture capital is not as much a part of Japanese culture as in other parts of the world, so we are exploring a university-led venture capital fund, with the aim of achieving self-sustaining investment income.

In time, we expect an ecosystem of start-ups and technology companies to bring vibrancy and information-sharing to the region. Such an environment will attract multi-national tech companies to share the growing workspace and skilled community of OIST and Onna-son. ■

BY THE NUMBERS

OIST's Technology Development and Innovation Center has worked with faculty, researchers and students to manage a portfolio of activities.

20 new invention disclosures annually

25 industry-sponsored research partnerships annually

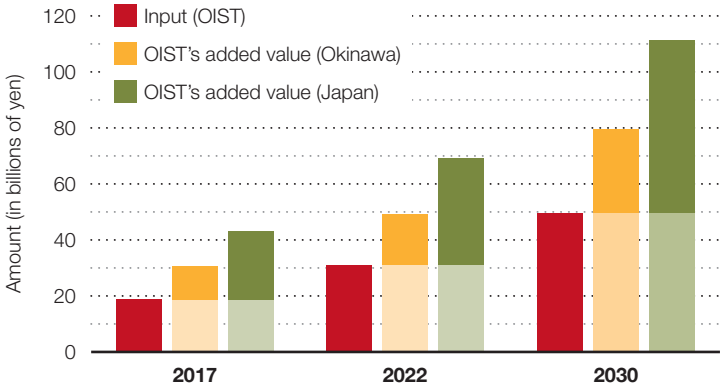
5-7 proof-of-concept projects funded annually

15 workshops and events

5 startups created through OIST

OIST'S ECONOMIC IMPACT ON OKINAWA AND JAPAN

A March 2019 study showed that, for every 100 yen invested in OIST, 163 yen will be returned to the Okinawan economy, on average, and 228 yen returned to the Japanese economy through innovation and economic stimulus.



EMPLOYING OKINAWANS

OIST will grow into one of the larger employers on Okinawa.

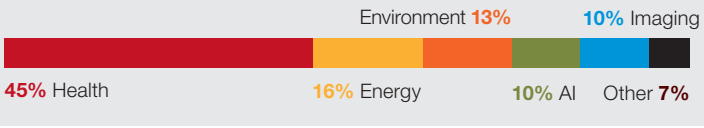
Okinawans directly employed by OIST in high-skilled positions

350 in 2022 → **650** in 2033

Okinawans employed in related activities at all skill levels

500 in 2022 → **1,000** in 2033

135 **PATENTS AWARDED**
Efforts to translate discovery has resulted in an 86% success rate.



RICE FOR OBESITY AND DIABETES

A strain of rice developed at OIST by the head of the Plant Epigenetics Unit, Associate Professor Hidetoshi Saze, could make a major contribution to diet control in diabetes and obesity, which are serious health problems in Okinawa and around the world.

Rice contains two types of starch; one characterized by linear molecules, and the other by branched molecules. Consumption of japonica white rice, which typically consists of 20% linear and 80% branched starch, leads to quick release of sugar from the starch. To reduce this sudden release of sugar, Saze and colleagues looked to a strain of rice that was developed in Kyushu more than 30 years ago, which contains predominantly branched, digestion-resistant starch, leading to a lower glycemic index and lower blood sugar.

In mice, it has been shown that the Kyushu rice led to reduced body mass after two weeks compared to those fed on a standard diet. By repeatedly crossing local Okinawan rice with the Kyushu rice, Saze and his team made a variety of rice with digestion-resistant starch combined with the traits needed for production in tropical or sub-tropical climates such as Okinawa.

The new strain has been examined for registration as 'OIST Rice'. Saze is hopeful that this new strain will help stem increases in both obesity and type 2 diabetes observed in recent years. In Asia the market, and medical impact could be huge. Saze's team, who won an award for their work, is now investigating how OIST Rice affects the gut microbiota.

A CULTURE OF EXCELLENCE

More than a university, OIST will enrich the Ryukyu cultural landscape.

Dialogue has more dimensions than language. When OIST chose its site on the hill above Onna-son, we made a commitment to engage in a dialogue with our surroundings. Through this dialogue, we aim to better understand the culture of our homeland, and contribute to its upkeep and growth.

We are contributing to the understanding of Okinawa through our research activities such as the OKEON project (p6) and the genome project (facing page), among many others, but our work in this area extends beyond research.

OIST has undertaken a suite of activities and outreach programs to the Okinawan community. Key parts of the campus, including our café, are open to the public year-round, so our neighbours may enjoy the unparalleled views and the architecture of these magnificent buildings. We host an annual science festival at the campus, in which Okinawan families engage in hands-on science learning in our labs. The most recent open day attracted 5,000 participants, demonstrating an intellectual curiosity in our community that we are keen to meet.

Our outreach programs include activities for boys and girls from kindergarten to high-schoolers and an intern program for undergraduates. We host talks, workshops and 'nerd nights' both on and off campus to spark conversation and interest in the future and technology. In this way, we hope to both stimulate interest in the sciences and demonstrate the opportunities therein for Okinawans.

On OIST's annual open day, local families experience hands-on science in our laboratories.

As OIST grows, local, high-skilled, high-remuneration jobs will be created, further stimulating Onna-son and Okinawa's economy. We are committed to making the future together with Okinawans.

Our hopes for future include a nearby school with an International Baccalaureate Diploma Program. Such an international curriculum would service the needs of OIST staff, local families and families from wider Asia seeking high quality educational opportunities for their children that deliver a multi-disciplinary approach to science, technology, engineering, mathematics, arts and humanities. We will strengthen our ties to the local education and research institutions like the University Consortium Okinawa supporting the education and creation of new knowledge industries in 21st Century Okinawa. ■

OIST AND OKINAWAN CULTURAL ARTEFACTS

Okinawa was once the center of the Ryukyu Kingdom, which was in power for more than 400 years from the early 1400s. Powerful, seafaring traders, the Ryukyu people had their own unique culture and identity, from which ceramics, textiles and art survive. OIST researchers have contributed to a 21st century insight into these ancient crafts. Instruments at OIST, including X-ray diffractometers, mass spectrometers, scanning electron microscopes and Fourier transform infrared spectrometers have been used to characterize Ryukyu artifacts.

Bashofu, a fabric made from banana plants, was shown to be more cooling when the traditional method of textile preparation was used; the pigments coloring ancient lacquerware were identified, informing restoration techniques; and the composition of traditional clays for ceramics was pinpointed. These are just a few examples of our ongoing analyses of Okinawan cultural heritage.

DECODING OKINAWAN SPECIALITIES

Okinawan cuisine is famous beyond the archipelago, and now OIST researchers are finding out what makes it so special.

One of the must-try dishes in Okinawan cuisine is sea-grapes, or umi-budo, as they are known locally. This seaweed grows in the form of a soft, green sprig, adorned with millimeter-sized salty bubbles that pop in your mouth as you crunch. It's like a vegetarian version of caviar and, served fresh with a light soy and vinegar dipping sauce, is very popular.

Professor Noriyuki Satoh's Marine Genomics Unit is the first to sequence the genome of umi-budo. Satoh says he was interested in the genetics of this unusual alga, but more practically, he wanted to find a way to share this Okinawan delight with a wider audience.

"Extending the market for umi-budo has two problems. One is culturing conditions; the other is shelf-life." Sequencing the genome may identify methods for overcoming both these obstacles. Potentially, genes for a more robust strain could be selected for breeding experiments.

Satoh has also previously sequenced the genome for another Okinawan speciality, the mozuku seaweed. This brown alga is served pickled and makes a slippery snack whose tartness complements the sweetness of local beer. Mozuku is hardier than umi-budo, but still subject to the vagaries of seawater temperature.

"The local fisherman and the Okinawa prefectural institution for fisheries are always discussing how the mozuku will go this year. So, we would really like to find a strain that is strong against all conditions," says Satoh.

His team has sequenced four distinct strains of mozuku and found they are very different both in appearance and genetics. The diversity may be a benefit, Satoh says, as the range of genes may provide options to confer greater robustness.

The work with local fisheries has been of mutual benefit. Fishermen share their knowledge and catch with the OIST scientists, who in turn are working to understand better the local marine flora and fauna and the conditions under which they thrive.

But aside from the cultural and economic benefits of the collaboration, Satoh says it may also contribute to global understanding of the origin of green plants.

"In umi-budo we found some genes involved in morphogenesis which are normally in green plants. The grape region is like a leaf of a land plant and using similar molecular mechanisms they form the sea-grapes. So perhaps there is an ancestor there. We are very interested and we want to answer these questions." ■

Professor Noriyuki Satoh is a world leader in evolutionary biology. He has decoded the genome for several Okinawan foods, opening the door to their wider consumption.

STRATEGIC GOALS

The full strategic plan is structured around the attainment of these 16 goals.

1 To become a world-leading university, we will create a critical mass of researchers conducting cutting-edge cross-disciplinary research by using our state-of-the-art facilities and by continuing to develop as a local, national, regional and international research hub.

2 To deliver exceptional graduate training, we will provide a world-class PhD program in science and comprehensive support to a diverse group of students with promising talent.

3 To encourage and develop new ideas and innovation, we will create an environment that recognizes the value of risk-taking in the pursuit of knowledge and ensures that resources are available to translate discovery into impact.

4 To contribute to the societal and economic well-being of Okinawa and to seed a local innovation ecosystem, we will develop synergistic relationships with the wider Okinawan community and create an environment that nurtures entrepreneurship and entrepreneurial thinking and build partnerships with national and international universities, industry, and the Japanese Government.

5 To ensure that OIST operates with high international standards of governance, we will continue to refine internal and external governance processes as we grow, and to recruit outstanding individuals to membership on our Board of Governors and Board of Councilors to reflect diversity, equity and inclusiveness and, through periodic self-analysis, high levels of effectiveness.

6 To create an efficient administration for a growing university, we will ensure effective structure, processes and tools, and skilled and highly motivated, customer-oriented and accountable professionals.

7 To promote the intellectual life of Okinawa, we will deepen our relationships with all generations of the Okinawan community through cultural, educational, sports, and career development activities and ensure Okinawan students are provided new opportunities to achieve their potential in global society.

8 To strengthen the benefits of Japan's investment in OIST, we will establish an Innovation Hub and create an entrepreneurial culture, strengthen our ties with Japanese universities and businesses to be an integral part of the Japanese research, higher-education and innovation systems, and extend our strategic partnerships with other universities, research institutes, industry and government, locally and globally.

9 To achieve our ambitions to become a world-leading international research university, we aim to attract the best talents across the University to create an environment in which diversity is valued and people are encouraged to achieve their full potential through opportunities for personal and professional growth.

10 To enrich our staff, students' and family members' experience, we will build an inclusive and welcoming University community with quality on- and off-campus housing, sporting, recreation and community activities, and further develop appropriate child care and educational facilities.

11 To support our world-leading research programs, facilitate research across disciplinary boundaries and enable all members of our community to meet and communicate easily with each other, we will design an interconnected campus with modern, attractive, state-of-the-art buildings that promote interaction and cooperation among different research teams. We will ensure that our administrative, research support and education centers evolve with our growth.

12 To promote responsible stewardship of the environment, we will reduce CO_2 emissions using the latest sustainable methods for our environmentally friendly buildings. Furthermore, as part of our development of facilities we will conduct thorough environmental assessments, protect local plants and animals and encourage environmentally sound work practices.

13 To advance the OIST brand and our international reputation in research, education and innovation, we will broaden the communication of our achievements locally, nationally and globally. We will strengthen our communications with our former students and colleagues through an alumni-relations team and develop an integrated, high-impact communication strategy to support fundraising.

14 To strengthen our internal communications, we will develop an open culture that embraces and values diversity, promotes harmony and well-being and allows everyone to express concerns or opinions freely.

15 To build on our outstanding research and education achievements and to plan efficiently for growth over the next decade, we will work with the Cabinet Office to evolve our current high-trust funding model into long-term stable funding and reasonable multi-year projections for both the baseline and investment budgets, to enable our scientists to pursue ambitious and challenging frontier research across disciplinary boundaries.

16 To complement the baseline funding, we are committed to generating additional resources through external grants, sponsorships and philanthropy by providing attractive opportunities for collaboration in areas of mutual interest, without compromising our autonomy, scientific freedom or ethical principles. ■

Summary of the OIST Strategic Plan, 2020–2030

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