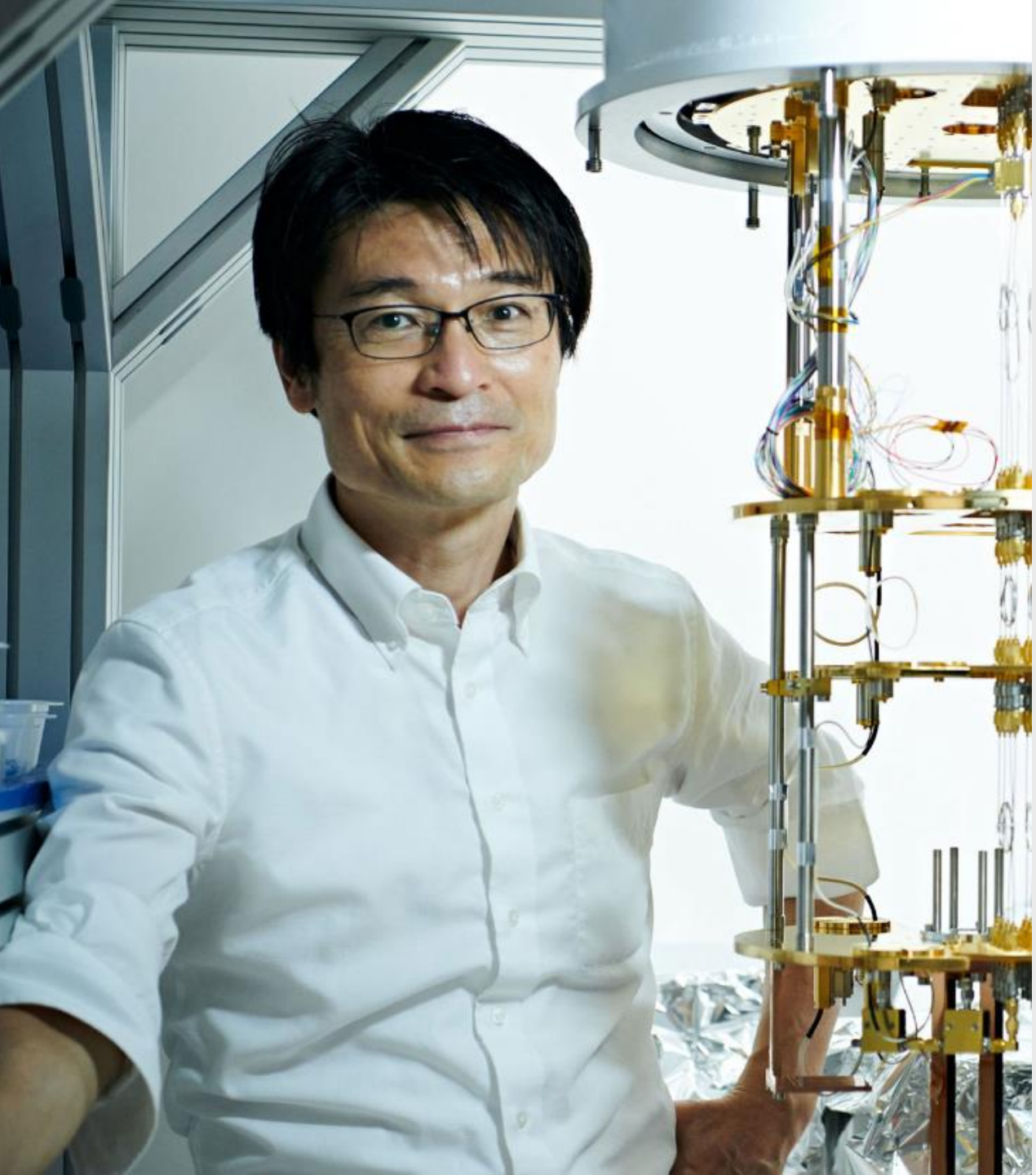


kosaka laboratory

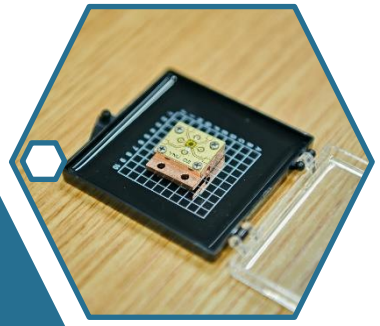
kosaka-lab.ynu.ac.jp

Kosaka Laboratory

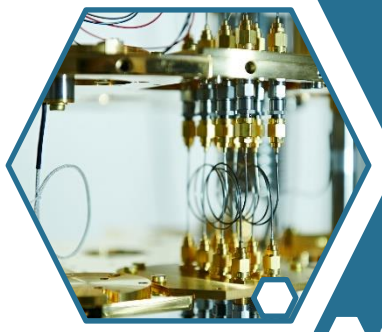
Vision

At Kosaka Laboratory, we rely on the quantum mechanics of the microscopic world to develop quantum repeaters and quantum computers. Our research is core to establishing quantum communication for the quantum internet, a crucial infrastructure for future society. Combining optics and quantum information, we strive to be at the forefront of quantum technology innovation.

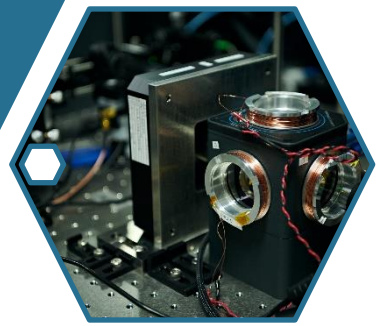
kosaka laboratory



Diamond quantum repeaters



Diamond quantum interface for the quantum computer network



Fault-tolerant quantum computers with quantum error correction

Team

34

9 Professors / Researchers
14 Students

4 Technical Staff
7 Administrative Staff

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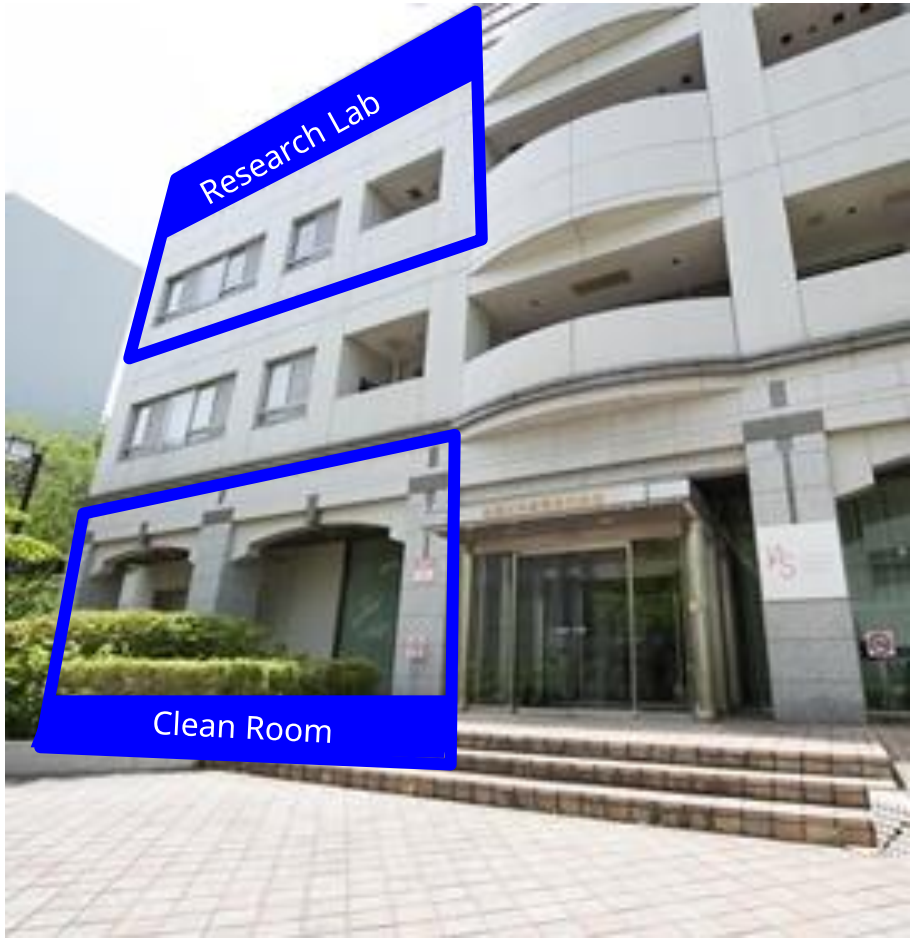
Quantum Information Research Center (QIC)



Institute of Advanced Sciences

Building a circulation system for the creation of knowledge and contributing to society

Foundation

October 1st, 2020
QIC was founded as a global research center within the Institute of Advanced Sciences (IAS) of Yokohama National University.

Vision

QIC is an environment where researchers in quantum information and related fields can gather, exchange information, create ideas on a day-to-day basis, and persistently launch high-value joint research projects. We aim to promote practical research and to build a reputation for carrying out world-class, large-scale research projects by participating as a core organization in national projects and joint international projects.

Team

The QIC Team is made up of professors/researchers of IAS and the Graduate School of Engineering of Yokohama National University. In addition, there are several visiting professors/researchers from other universities and National institutes who have joined QIC for project collaboration. The QIC team brings quantum information to the level together with the cooperation of students.

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Project Overview

Moonshot R&D

Goal 6：Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050

Development of Quantum Interfaces for Building Quantum Computer Networks (QuINT)

- PM & PI: Hideo Kosaka
- FY 2020 - 2025
- Project sponsor: Japan Science and Technology Agency (JST) & Cabinet Office (CAO)

YNU | UTokyo | AIST | NIMS | QST | RIKEN | NICT | KyotoU | TMDU

MIC

Research and development for construction of a global quantum cryptography network

Quantum Repeater Technology (QuREP)

- Coordinator & PI: Hideo Kosaka
- FY 2020 - 2024
- Project sponsor: Ministry of Internal Affairs and Communications (MIC)

YNU | UTokyo | AIST | NIMS | NICT | Toshiba | Furukawa Electric

CREST

[Quantum Technology] Creation of an innovative quantum technology platform based on the advanced control of quantum states

Diamond Quantum Security (DiaQSec)

- PI: Hideo Kosaka
- FY 2017 - 2024
- Project sponsor: Japan Science and Technology Agency (JST)

YNU | AIST | NIMS

KAKENHI

Grant-In-Aid for Scientific Research (S)

Diamond quantum storage (DiaQStore)

- PI: Hideo Kosaka
- FY 2020 - 2024
- Project sponsor: Japan Society for the Promotion of Science (JSPS)

YNU | AIST | NIMS

Moonshot R&D

Moonshot R&D

The Moonshot Research and Development Program is a **large-scale national project** that promotes **challenging R&D projects** with the aim of **resolving difficult societal issues** while bringing together the wisdom of researchers from all over the world. The Cabinet Office has set **nine ambitious goals** to be achieved by 2050, and six of them are handled by JST.

Cabinet Office

JST Japan Science and Technology Agency

QuINT, proposed by Hideo Kosaka, got accepted as one of the twelve projects under **Goal 6**.

Goal 6 (=12 Projects)

fault-tolerant universal quantum computer

Goal 6 Milestones

2030
- Development of NISQ computers of a certain scale
- Effectiveness demonstration of quantum error correction

2040
- Demonstration of distributed NISQ computers
- Calculation of useful tasks under quantum error correction

2050
- Realization of fault-tolerant universal computers

MOONSHOT QuINT Quantum INTerfaces

Hideo Kosaka
Project Manager

QuINT Milestones

2023
- Realize a hybrid quantum interface by developing technologies such as optimal quantum light sources and quantum media conversion

2025
- Hybrid quantum interface that fuses diamond quantum memory and optomechanical crystals, enabling a quantum connection between quantum memories

2030
- Build the foundation of the quantum repeater network

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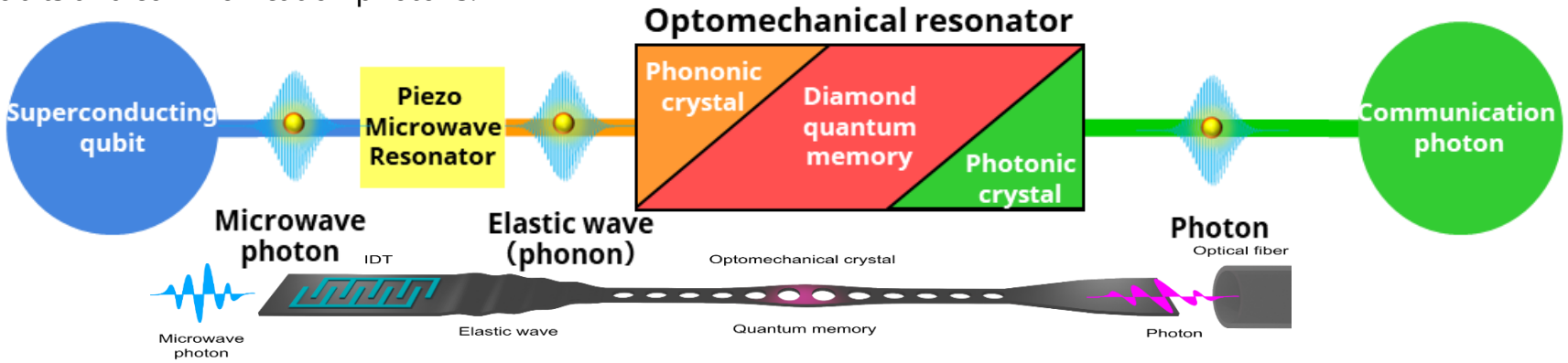
Development of Quantum Interfaces for Building Quantum Computer Networks

Mission

Develop a quantum interface technology that connects:
1. a microwave photon to a quantum memory
2. a quantum memory to a communication photon

➔ Integrate these two technologies to create a quantum interface technology between computing qubits and communication photons.



Project Management

Hideo Kosaka (YNU)
Project Manager

Shinichiro Fujii (YNU)
Associate Project Manager

Kinya Kumazawa (YNU)
Intellectual Property Producer

① Diamond Quantum Memory

Hideo Kosaka (YNU)
Diamond Quantum Memory

Hiromitsu Kato (AIST)
Diamond Quantum Structure

Tokuyuki Teraji (NIMS)
Diamond Quantum Crystal

Shinobu Onoda (QST)
Diamond Color Center

② Optomechanical Crystal

Satoshi Iwamoto (UTokyo)
Photonic Crystal Cavity

Toshihiko Baba (YNU)
Photonic Integrated Circuit

Masahiro Nomura (UTokyo)
Phononic Crystal Cavity

③ Piezo Microwave Resonator

Hideo Kosaka (YNU)
Piezo Microwave Cavity

Nobuyuki Yoshikawa (YNU)
Qubit Control Integrated Circuit

Kazuki Koshino (TMDU)
Quantum Interface Theory

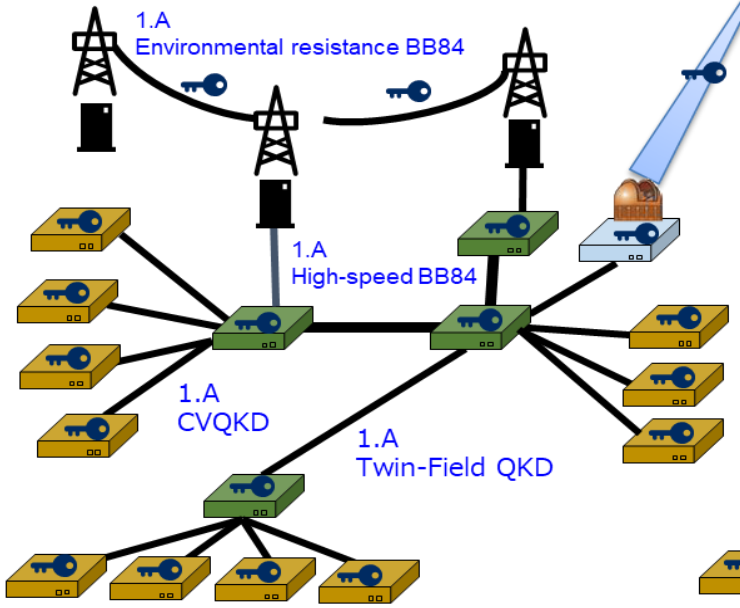
R&D for Construction of a Global Quantum Cryptography Network

Global Quantum Cryptography Network

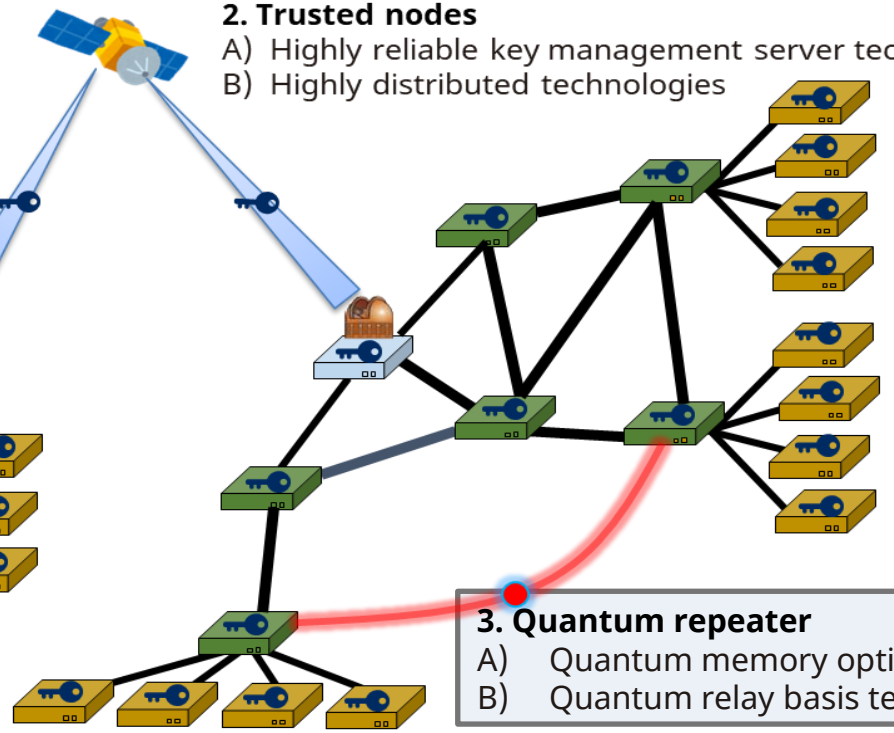
The Ministry of Internal Affairs and Communications of Japan has set the goal of **constructing a global quantum cryptography** in their **Quantum Technology Innovation Policy**.
The development has been classified into **4 categories.**

Ministry of Internal Affairs and Communications, JAPAN

1. Quantum communication – encryption link
A) High-performance quantum cryptography
B) Photon detection



2. Trusted nodes
A) Highly reliable key management server technologies
B) Highly distributed technologies



3. Quantum repeater
A) Quantum memory optical link
B) Quantum relay basis technologies

4. Wide-area network construction and operation
A) Network control and management

QuREP is placed under **category 3** and is responsible for the total scope of this category.

QuREP
QUANTUM REPEATER TECHNOLOGY

QuREP aims to create **longer distance quantum cryptography** and a **more secure repeating of encryption keys** in terrestrial systems when compared to that of trusted nodes.

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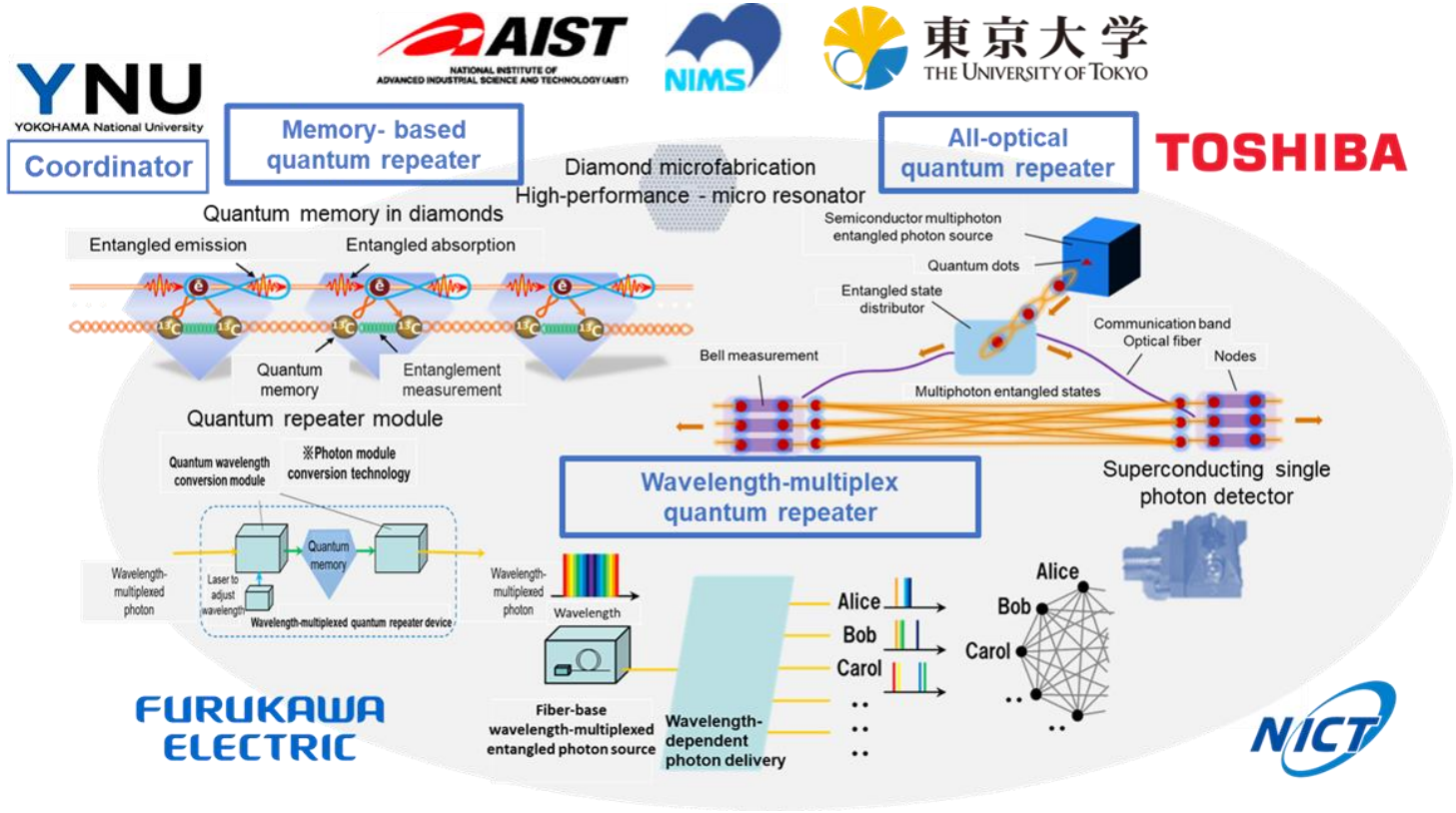
Quantum Repeater Technology

QUANTUM REPEATER TECHNOLOGY

Mission

1. Develop a quantum memory technology that can maintain the quantum state at the repeater point of the network for a certain period
2. Develop peripheral devices and new fundamental technologies, such as an all-photonic quantum repeater and wavelength-multiplexed quantum repeater



① Optical Link Technology for Quantum Memory

Hideo Kosaka (YNU)
Quantum Memory
Quantum Repeater
Technology

Hiromitsu Kato (AIST)
Diamond
Microfabrication

Tokuyuki Teraji (NIMS)
Highly-functionalized
Diamond

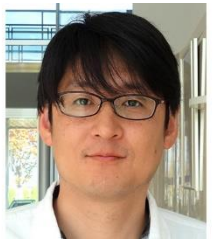
Satoshi Iwamoto (UTokyo)
Diamond
Microcavities

② Quantum Repeater Fundamental Technology

Mamiko Kujiraoka (Toshiba)
All-photonic
Quantum Repeater

Yu Mimura (Furukawa Electric)
Wavelength-multiplexed
Quantum Repeater

Hideo Kosaka (YNU)
Quantum Memory
Photonic Interface



Shigehito Miki (NICT)
Superconducting
Single-photon
Detection Technology

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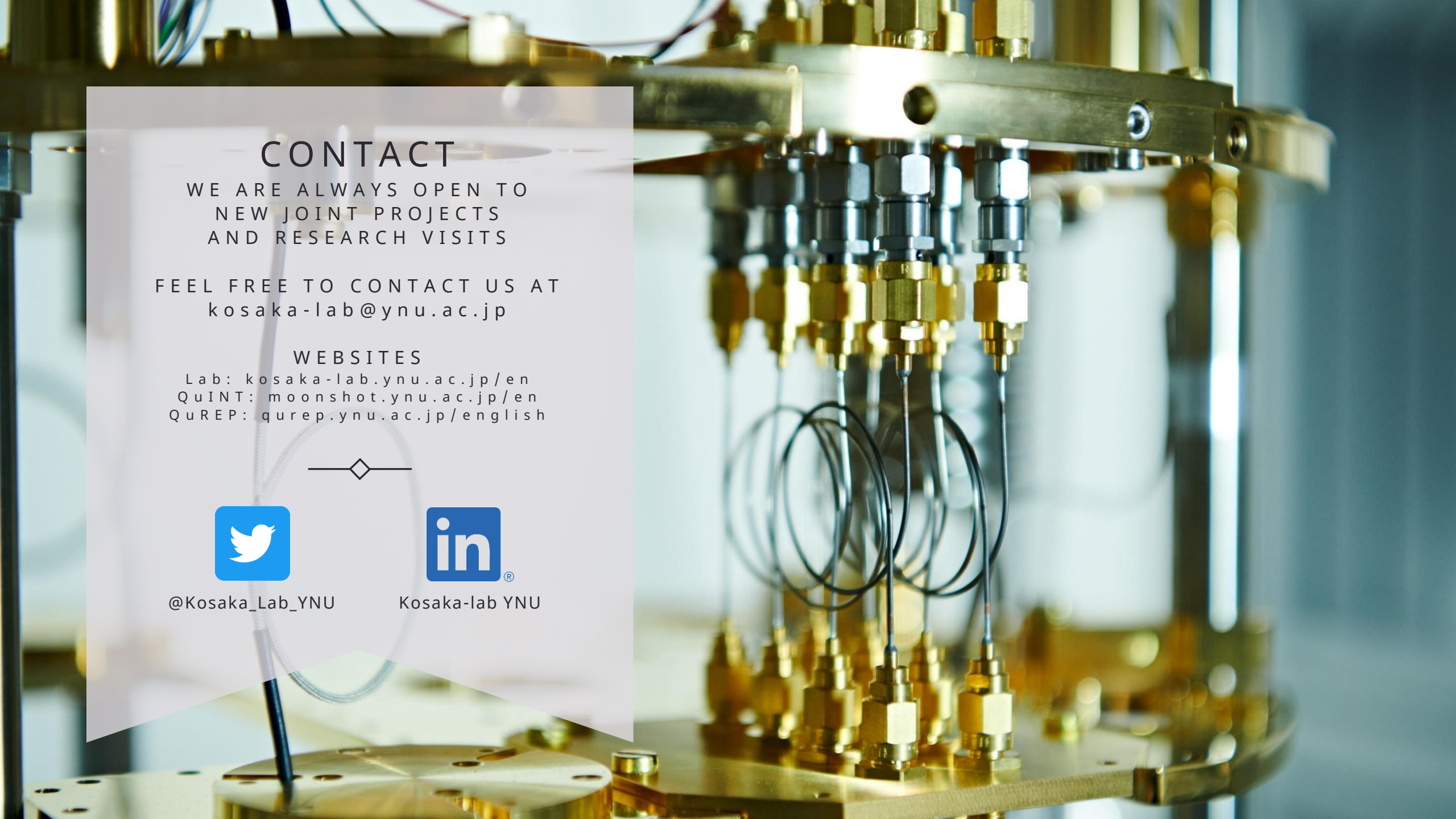

CONTACT

WE ARE ALWAYS OPEN TO
NEW JOINT PROJECTS
AND RESEARCH VISITS

FEEL FREE TO CONTACT US AT
kosaka-lab@ynu.ac.jp

WEBSITES

Lab: kosaka-lab.ynu.ac.jp/en
QuINT: moonshot.ynu.ac.jp/en
QuREP: qurep.ynu.ac.jp/english

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