2023 School of EE Lab Introductions

Wave

KAIST EE

<Professor Hamza Kurt's Lab.>

Metaphotonics Research Laboratory

■ **Contact information**
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Website : https://kurtresearch.com, https://mpl.kaist.ac.kr

■ **Current state of the Lab. (in 2023 Fall Semester)**

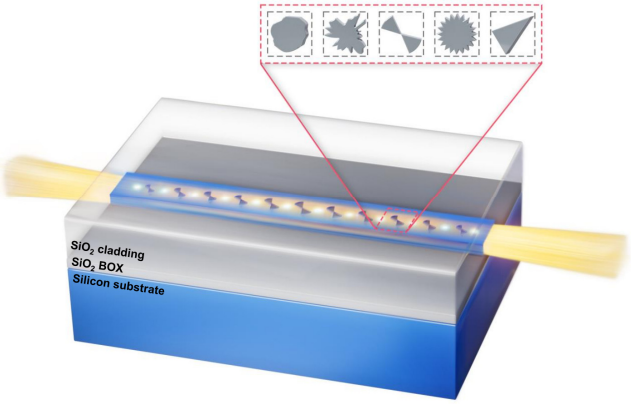
Postdoctoral Fellows : 0 PhD Students: 8 Master's Student: 0 Undergraduate Student: 3

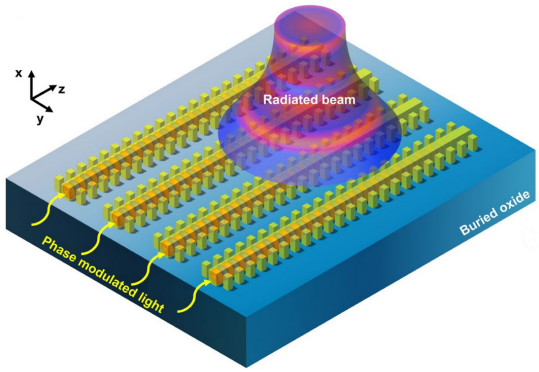
■ **Research Areas**

1. Optical Neural Networks: An optical neural network (ONN) is a physical realization of an artificial neural network with conventional (and usually discrete) optical components. We are interested in implementation of ONN with integrated photonic elements designed by utilizing advanced optimization methods. Processing data all optically in analog domain holds huge potential to alleviate the full potential of machine learning with photonics.

2. Integrated Photonics, Silicon Photonics: Inverse and AI assisted designs and fabrication of nano-photonics and silicon photonic devices. The interaction of light with nanostructures that have variations in the refractive index on the order wavelength or sub-wavelength generates so many rich physical concepts that cannot be easily observed in conventional medium. At this stage, it becomes very crucial to have powerful numerical techniques assisted with AI tools to explore the tremendous novelties of meta-photonics domain for LiDAR and optical computing and programmable photonics applications.

3. Flat optics and meta-surfaces in imaging and display (AR and VR): Recently, meta-surfaces have been identified as promising optical elements in the modulation of the phase, amplitude and polarization of light within a subwavelength thickness. Compared to the bulky, conventional optical elements that use phase accumulation to manipulate light along curved optical paths, two-dimensional meta-surfaces composed of engineerednanostructured antennas arrays allow the realization of the manipulation of light on a flat surface.





■ **Recommended courses & Career after graduation**

Basic level background in "Electromagnetics, Fundamentals of Photonics, and Optics". The academic career is one option. The candidate can also work as a researcher in the R&D departments of private sectors such as Intel, Samsung, Apple, IBM, and Google. There are many examples of such career paths. Interested candidates may contact to the PI and lab representative

■ **Introduction to other activities besides research**

Participation in the international conferences (CLEO, SPIE, IEEE Photonics), being part of the professional societies and their activities (OSA, IEEE), holding social events (hiking, group dining, sport activities), short term scientific visits to our collaborators in different countries (such as US, Spain, Australia).

■ **Introduction to the Lab.**

We conduct fundamental as well as applied research with an interdisciplinary nature covering Engineering and Science. We have published 140 papers in highly prestigious journals. The number of conference proceedings and papers is more than 150.

■ **Recent research achievements ('21~'23) The scientific outcome between 2018-2023 is the publication of total 54 journal articles. Selected articles are given below:**

1. Inverse design of Si-based high-performance vertical emitting metagrating coupler on 220 nm silicon-on-insulator platform," Photonics Research 11 (6), 897-905 (2023).
2. "Experimental demonstration of inverse-designed silicon integrated photonic power splitters," Nanophotonics 11 (20), 4581-4590 (2022).
3. "Curved beam generation and its experimental realization by rectangular prism with asymmetric polynomial back surface," Physica Scripta 98 (1), 015026 (2022).

<Professor Sangsik Kim's Lab.>

KAIST INTEGRATED METAPHOTONICS GROUP

■ **Contact information**

Professor: Sangsik Kim (sangsik.kim@kaist.ac.kr)

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Lab. : E3-2, #3220 (TEL: 042-350-7572)

Website : https://kimgroup.kaist.ac.kr/

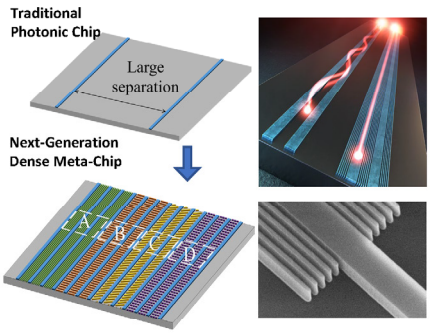
■ **Current state of the Lab. (in 2023 Fall Semester)**

Integrated PhD Students: 1 Master's Students: 2 Undergraduate Students: 4 (+3 PhD students at Texas Tech)

■ **Research Areas**

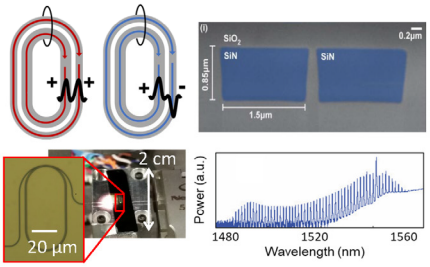
Integrated Nanophotonics	I. Small device size ⇒ scalable & portable system	II. Efficient nonlinear & quantum processes
	II. CMOS compatibility ⇒ mass production & low cost	IV. Nanofabrication ⇒ alignment-free & stable operation

On-Chip Metamaterials



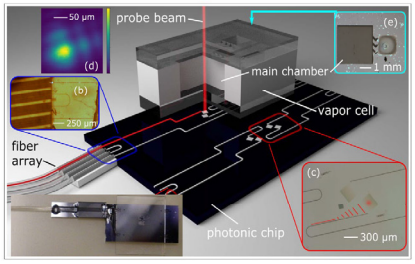
- High-density integration via metamaterials [2,4]
- Record-high coupling length (>1,000x) [4]
- Toward large-scale quantum/AI photonic chips

On-Chip Frequency Combs



- High-Q SiN microresonators
- Concentric microresonators for dispersion engineering [5] ⇒ Microcombs at visible & mid-IR frequencies & CMOS process compatibility
- Emerging quantum source having >100 qubits
- Pulse shapers for quantum process

On-Chip Atomic/Quantum System



- Photonic/Atomic hybrid integration [1,3]
- Collaboration with US NIST team
- Quantum sensor & atomic clock
  ⇒ Freq. referencing & Laser stabilization
  ⇒ Toward <1 cm precision GPS

■ **Recommended courses & Career after graduation**

- **Recommended courses:** Introduction to Integrated Photonics, Nonlinear and Ultrafast Optics, and other photonics courses

- **Career after graduation:** Great for both academia and industry
  - National Labs: KIST, ETRI, KRISS (Domestic)
    NIST , SNL, ORNL (International)
  - Industrial Companies: Samsung, Hyundai, Intel, IBM, IMEC, ASML, NTT, Meta (Facebook), Keysight, Finisar, NeoPhotonics, AyarLabs, Voyant Photonics, Analog Photonics, Hyperlight.

Our recent 3 PhD alumni went to Intel and Lumentum.

■ **Other activities besides research**

Our group strongly supports activities other than research and is open to various options! Since we just started, the detailed activities are up to members.

We usually have a group lunch and happy hours (coffee breaks) when we needed refresh.

■ **Introduction to the Lab.**

Our group is developing novel integrated nanophotonics chips using the semiconductor manufacturing processes. We explore both fundamental science and technical applications, bridging the gap between new science and future technologies. Our group is relatively new and just moved to KAIST in Fall 2022, thus we are looking for highly motivated and brilliant students to join this exciting journey with integrated photonics. For more details, please visit the FAQ page in our group webpage and feel free to email at sangsik.kim@kaist.ac.kr and other members!

■ **Recent research achievements**

[1] K. Kabir, M. Mia, I. Ahmed, N. Jaidye, S. Ahmed, S. Kim, ***Light: Science & Applications***, 12, 135 (2023)
[2] A. Yulaev*, S. Kim*, *et al.*, ***Nature Nanotechnology*** 17, 583 (2022) (*equal contribution)
[3] M. Mia, S. Ahmed, I. Ahmed, Y. Lee, M. Qi, and S. Kim, ***Optica*** 7, 881 (2020)
[4] S. Kim, *et al.*, ***Light: Science & Applications*** 7, 72 (2018)
[5] S. Jahani*, S. Kim*, *et al.*, ***Nature Communications*** 9, 1893 (2018) (*equal contribution)
[6] S. Kim, *et al.*, ***Nature Communications*** 4, 1345 (2017)

<Professor Joungho Kim's Lab.>

TeraByte Interconnection and Package Laboratory

■ Contact information

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Lab: S-112, Nanofab Center E-mail: keeyoung@kaist.ac.kr
Website: http://tera.kaist.ac.kr

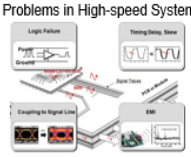
■ Current state of the Lab. (in 2023 Fall Semester)

Postdoctoral Fellows : 0 PhD Students: 14 Master's Student: 15

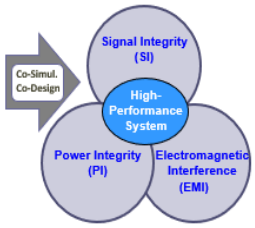
■ Research Areas

Core Research Field

Problems in High-speed System



Core Technologies

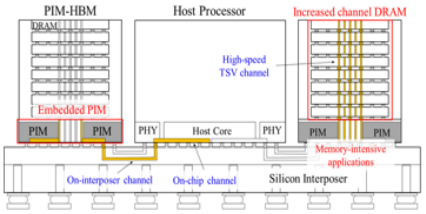


System on Chip (Chip Level)
System in Package (Package Level)
Module & PCB (Board Level)
Cable & System (System Level)

Improvement of Performance, Reliability, Cost Design Cycle

R&D Application: Next Gen. HBM for AI Server

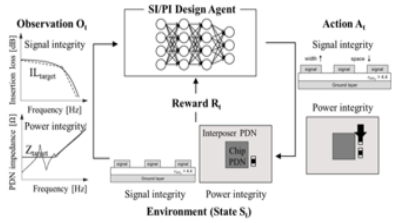
◆Major R&D Area
- ➢SI & PI design of next gen. High Bandwidth Memory (HBM)
- ➢Processing-in-Memory (PIM) Architecture in HBM (PIM-HBM)
- ➢SI & PI of Silicon interposer for HBM chiplet
- ➢SI of TSV (Through Silicon Via) at Stacked Die



< PIM-HBM Architecture on Silicon Interposer for AI Server >

R&D Application: ML-based SI/PI Design

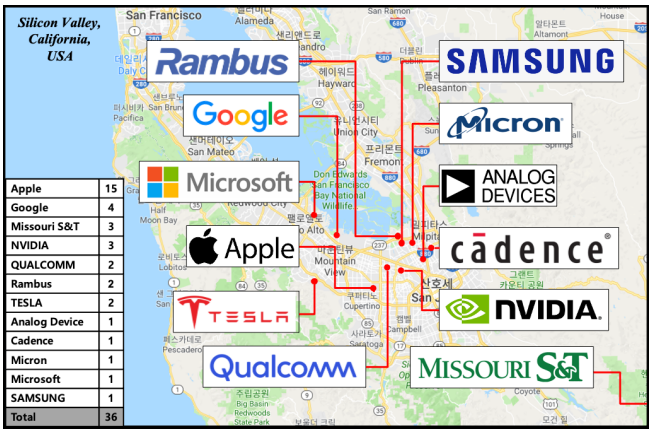
◆ Major R&D Area
- ➢ Machine learning-based SI/PI design of 2.5-D/3-D ICs
- ➢ Deep neural network (DNN)-based eye-diagram estimation
- ➢ Deep reinforcement learning-based decoupling capacitor design for HBM



< Machine Learning-based SI/PI Design >

■ Recommended courses & Career after graduation

- Fundamental of electromagnetics and circuit theory.
- Graduates are currently in various global companies: Samsung Electronics, SK Hynix, Apple, Google, Nvidia, Intel, Tesla, Rambus, and etc.



Apple	15
Google	4
Missouri S&T	3
NVIDIA	3
QUALCOMM	2
Rambus	2
TESLA	2
Analog Device	1
Cadence	1
Micron	1
Microsoft	1
SAMSUNG	1
Total	36

■ Introduction to other activities besides research

We encourage various extra-activities. We participate in activities such as soccer, e-sports and running. Every summer, we go to the beach for a laboratory workshop. Moreover, we are continuing good relations with graduates through frequent meetings and interactions.

■ Introduction to the Lab.

The TERA Lab aims to develop global talent, and many graduates have already entered the world's leading companies. The professor actively leads them to conduct creative research, and there is an atmosphere in which members of the lab can discuss freely. In the field of research, it deals with a lot of future-oriented and practical issues.

■ Recent research achievements ('21~'23)

[1] Best Paper Award, Seonguk Choi and et al, "Deep Reinforcement Learning-based Channel-flexible Equalization Scheme: An Application to High Bandwidth Memory" 2022 DesignCon

[2] Best Paper Award, Hyunwook Park and et al, "Scalable Transformer Network-based Reinforcement Learning Method for PSIJ Optimization in HBM" 2022 Electrical Performance of Electronic Packaging and Systems (EPEPS)

<Professor Hoon Kim's Lab.>

PHOTONICS SYSTEMS RESEARCH LAB

■ **Contact information**

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Lab. : Bldg. E3-2 Room 4210 TEL : 042-350-7633

Website : http://psrl.kaist.ac.kr

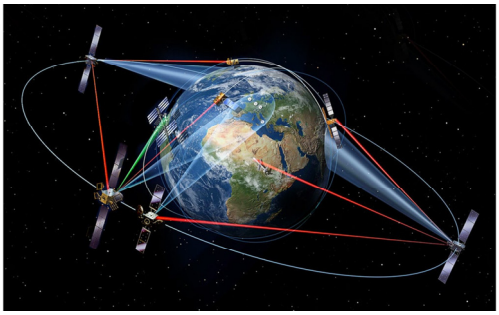
■ **Current state of the Lab. (in 2023 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 12 Master's Student: 4

■ **Research Areas**

Our research is centered around photonic systems and related technologies, including free-space optical communications, high-capacity fiber-optic transmission systems, optical access networks, and lightwave subsystems.

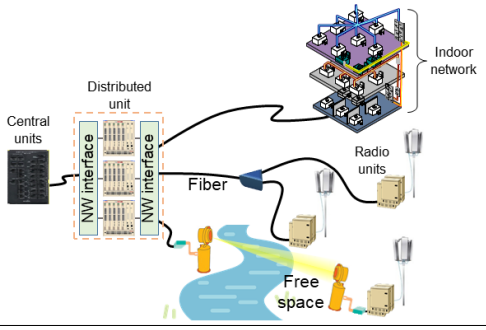
High-speed free-space optical transmission system



In an era of expanding commercial satellite networks and frequent satellite launches, it is expected that we will soon reach a point of radio frequency (RF) saturation. Furthermore, there's a growing need for instant, large-scale data transfer from satellites to ground stations, which existing RF communications struggle to meet. To address these challenges, laser optical communication emerges as a transformative solution. By harnessing light in the hundreds of terahertz range, laser optical communication enables high-speed signal transmission with minimal losses, distinguishing it from RF systems. It can achieve data transmission rates of over tens of gigabits per second, making it a promising option for space communication. Our research focuses on leveraging free-space optical communication technology for various applications.

Transmission technologies for 6G

Optical networks form the backbone of our communication systems. To enable the next generation (6G) mobile communication services, the optical network must evolve into a low-delay, high-speed network, with speeds reaching up to tens of terabits per second. Our research is focused on investigating various cost-effective technologies to achieve this goal.



■ **Recommended courses & Career after graduation**

- Recommended courses include Introduction to Optical Communication (EE441), Introduction to Optical Engineering (EE352), and Digital Signal Processing (EE432).
- Potential career paths after graduation include national research institutes, major companies, and academia.

■ **Introduction to other activities besides research**

- Every spring, we have our annual strawberry party and homecoming event.
- We plan to have a regular sports day with other lab members in KAIST working on photonics.

■ **Introduction to our Lab.**

- Welcome to the Photonics Systems Research Lab, founded in 2014 and led by Prof. Hoon Kim. Prof. Kim has accumulated 22 years of experience in photonics systems, with a career that has included positions at renowned organizations like Bell Labs, Lucent Technologies., Samsung Electronics, and National University of Singapore. Our main focus lies in exploring the fundamental limits of various photonics systems and developing practical implementation methods. Prof. Kim currently serves as the Editor of *Optics Communications* and the Senior Editor of *IEEE Photonics Technology Letters.*
- We actively engage in academic exchanges with international research institutes and universities. We also participate in prominent international conferences such as OFC and OECC.

■ **Recent research achievements ('21~'23)**

- International journal publications : 20, International conference presentations: 18.
- Best Student Paper Awards : Photonics Conference 2021, 2022, COOC2022.

<Professor Seong-Ook Park's Lab.>

Micro Millimeter wave and Antenna Laboratory

■ Contact information

Professor	**Email: soparky@kaist.ac.kr**	**Tel: 010-3412-1451**
LAB.	**Email:**gksthf30638**@kaist.ac.kr**	**Tel: 010-4622-3402**
Website	http://ma.kaist.ac.kr	

■ Current state of the Lab. (in 2023 Fall Semester)

PPhD Students: 14, Master's Student: 4

■ Research Areas

Research at Microwave (Millimeter-wave) and Antenna Laboratory includes electromagnetic theories for antenna analysis, active beam scanning antennas, Radar systems, and synthetic aperture radar.

[Antenna Theory Analysis]

We theoretically and numerically analyze electromagnetic phenomena induced by new materials like nano-materials and metasurface to apply a novel antenna technology.

[5G and 6G Antenna Technologies]

We develop a core technology of active antenna systems to design wide beam scan enhanced gain antenna, 5th and 6th generation mobile channel sounder system, and an accurate calibration with mmWave Antenna Measurement.

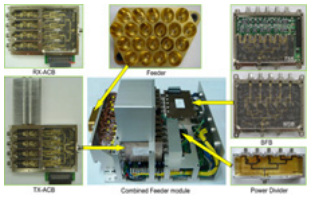
[Radar Surveillance System and Synthetic Aperture Radar(SAR)]

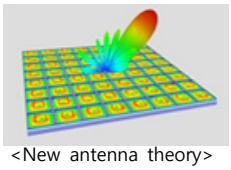
We have realized and develop various radar systems, such as drone detecting system, an active electronic scanning radar, Synthetic Aperture Radar System, and radar target classification using deep learning technologies.

■ mm-wave antenna and SAR Radar Research Center,

The synthetic aperture radar(SAR) enables high-resolution, day-and-night, and weather-independent observation which enables to observe a particular location. Our research focuses on X/Ka-band antenna and SAR radar payload on a 50 kg microsatellite. Ultimately, we are going to apply the SAR data to AI and Deep Learning technologies to predict and monitor natural disasters.

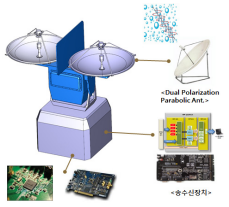
<Antenna System>



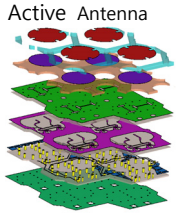


<New antenna theory>

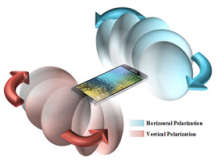
<Radar antenna & System>



Active Antenna

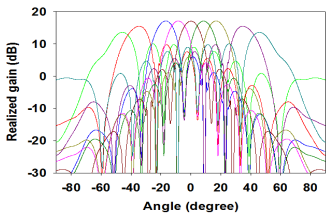


〈5G & 6G Beam-forming antenna 〉

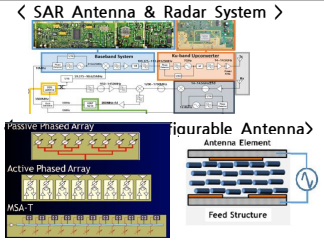


<SAR Radar Image>

〈Active Beam-forming Antenna〉



〈 SAR Antenna & Radar System 〉



■ Recommended courses & Career after graduation

Electromagnetics, Electronic Circuits, and Antenna are recommended for undergraduate courses.
For graduate courses, Electromagnetic Theory, Microwave Engineering, and Antenna Engineering are recommendable. After graduation, there are a wide range of career opportunities such as research institutes, University's professor, military institutes, & companies, *etc.*

■ Introduction to other activities besides research

We hold an annual Homecoming Day to promote interaction between students and alumni, and share information about academic research and industrial trends. Also, there are plenty of soccer matches to maintain a sound body and mind.

■ Introduction to the Lab.

Microwave (Millimeter-wave) and Antenna Laboratory have undertaken a number of government-sponsored projects. Based on the accumulated research experiences, we pursue creative and future-oriented research. Prof. Seong-Ook Park makes leads us to write decent papers on key technologies of our fields. Moreover the lab's atmosphere is fairly friendly and supportive which is the greatest strength of our lab.

■ Recent research achievements (2019~2023)

[1] International referred journal papers about 200, international conference papers about 160, domestic journals about 20, domestic conference about 50, and international/domestic patents of 28.
[2] IEEE AP-S, IEEE EMC Korea Chapter, and *etc*, best paper awards
[3] Drone Detection Radar System **:** Drone detection radar developed by Our lab (KAIST) was deployed and operated successfully at 2018 Pyeongchang Olympics. and currently operating at Jeju international Airport

〈Professor Joonwoo Bae 〉

QIT@KAIST **Quantum Information Teory Lab**	■ **Contact information**		
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	Lab.	**E3-2 3215, 3216, 3203**	**Tel: 7646**
	Website	**https://sites.google.com/view/qitkaist/home**	

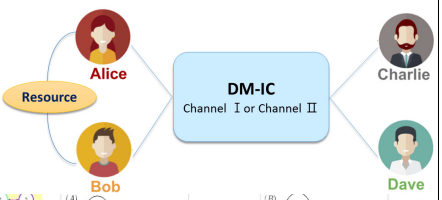
■ Current state of the Lab. (in 2023 Fall Semester)

Research Professor :1 Postdoctoral Fellows : 2 PhD Students: 9 Master's Student: 2

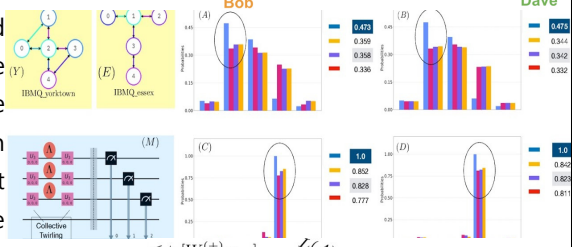
■ Research Areas : Quantum Information Theory - Fundamentals to Applications

We're working on fundamental problems in quantum information theory to understand the information processing in the most fundamental level and to break the limits in today's technologies

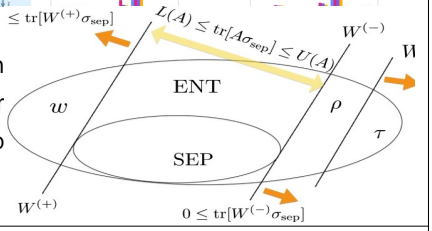
- Quantum protocols : Quantum protocols can realize the information-theoretic security, enhance channel capacities, and open monogamous correlations in a network theory. Quantum protocols are based on resources, entanglement, quantum steering, and non-local probabilities.



- Quantum Computing (Algorithms and Hardware Interface):
Quantum dynamics is special in that it is restricted to linear and invertible transformations, allowing exponential increase of the dimension. This defines non-standard computation based on the laws of quantum mechanics and solve hard problems appearing in cryptographic applications. We develop quantum algorithms that are better fitted with curren quantum technolgoies, and also devote our effots to deal quantum noise.



- Entanglement Theory : Entanglement is a resource in quantum information processing. We are interested in the verification of entangled states, their structure, and the usefulness. We apply various mathematical tools to characterize and prove entanglement properties.



■ Recommended courses & Career after graduation

Courses: EE480, EE547

All careers related with quantum ICT are open for future positions, academic jobs, business, and related companies.

■ Introduction to other activities besides research

The group is international. We often have visitors from Europe, Asia, and the US. We enjoy going out to eat. We will discover nice restaurants nearby.

■ Introduction to the Lab.

Quantum Information Theory (QIT) studies how information is processed in the most fundamental level and characterizes capabilities of quantum systems in information processing. The group aims to advance QIT in a practical point of view. We're interested in feasible quantum information applications, developing its fundamentals, and theoretical tools to solve problems. We interact with computer scientists, mathematicians, and physicists.

■ Recent research achievements (2020-2022)

[1] Contextual advantages and Certification for Maximum Confidence Discrimination, K. Flatt, et. al., PRX Quantum 3 030307 (2022).

[2] Quantum vs. Noncontextual Semi-Device-Independent Randomness Certification, C. Roch i Carceller et. al.,, Physical Review Letters 129 050501 (2022).

[3] Measurement crosstalk errors in cloud-based quantum computing, Seungchan Seo and Joonwoo Bae, IEEE Internet Computing Vol 26 Issue 1 page 26-33 (2022).

[4] A hybrid quantum-classical approach to mitigating measurement errors in quantum algorithms, Hyeokjea Kwon and Joonwoo Bae, IEEE Transactions on Computers, Vol 70 (9) 1401 (2021)

[5] Non-Local Network Coding in Interference Channels, Jiyoung Yun, Ashutosh Rai, and Joonwoo Bae, Physical Review Letters 125 150502 (2020).

[6] Channel Coding of a Quantum Measurement, S. Kechrimparis, et. al., IEEE Journal on Selected Areas in Communications, Vol 38, No 3, 439 (2020), Erratum IEEE JSAC Vol 38 No 5 980 (2020)

[7] Mirrored Entanglement Witnesses, J. Bae, D. Chruscinski, B. Hiesmayr, npj Quantum Information 6 15 (2020)

⟨Professor Youngik Sohn⟩

Quantum Device Lab

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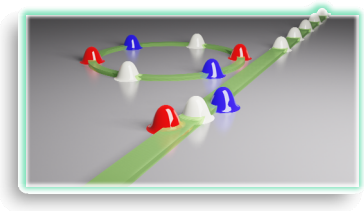
Lab.	**Email:** qdlab@kaist.ac.kr	**Tel:** -
Website	https://qdlab.kaist.ac.kr	

■ **Current state of the Lab. (in 2023 Fall Semester)**

Postdoctoral Fellows : 0 PhD Students: 3 Master's Student: 5

■ **Research Areas**

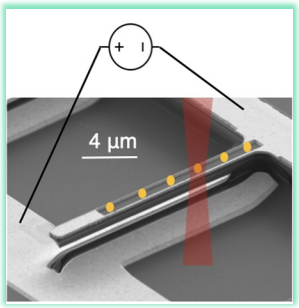


Quantum computing with integrated photonics

Quantum computing is a novel technology that is expected to become a game changer in the field of Chemistry, Material Science, Machine Learning for Artificial Intelligence.

However, building reliable hardware for fault-tolerant quantum computer is an extremely challenging task due to the fragile nature of quantum information. In our lab, we aim to build error-corrected, powerful quantum computer based on integrated photonics platform.

By combining optical circuit, superconducting electronics and RF amplifier altogether on a single integrated photonics platform, it is possible to realize the basic building block of a quantum computer.



Chip-scale quantum repeater for long distance entanglement

Having quantum mechanically pure entangled pair at a far distance is a key milestone pursued by many researchers all around the world. Based on our expertise in diamond color centers and nonlinear quantum photonics, we are working on realizing scalable quantum repeaters.

■ **Recommended courses & Career after graduation**

course: electromagnetics, quantum mechanics, solid-state physics, photonics, optics, fabrication

career: Research scientist or engineers for quantum technologies, Integrated photonics engineer

■ **Introduction to other activities besides research**

All of our members use motion desk! We care about your health and spirit more than anything else.

■ **Introduction to the Lab.**

We have a focused goal of building on-chip feedforward system, which is the most basic component for photonic quantum computer. Reliable, fault-tolerant quantum computer does not exist in the world yet! We want to become a pioneer who builds one.

■ **Recent research achievements (2018-2023)**

- First SCI journal paper produced from QDLAB (Koh et al. (2022))
- Pioneering MEMS fabrication for quantum emitter in diamond (Sohn et al. (2018))
- Professor Sohn is an early member of world's only quantum computing unicorn (PsiQuantum Corp)

< Professor Kyoungsik Yu's Lab. >

<Integrated Nanophotonics Laboratory>

■ Contact information

Professor	**Email:ksyu@kaist.edu**	**Tel: 042-350-7415**
Lab.	**E3-3 #2302**	**Tel: 042-350-7515**
Website	**https://kaist-yu.notion.site**	

■ Current state of the Lab. (in 2023 Fall Semester)

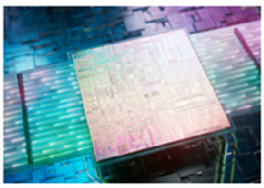
PhD Students: 4 Integrated MS-PhD Student: 2 MS Students: 3

■ Research Areas

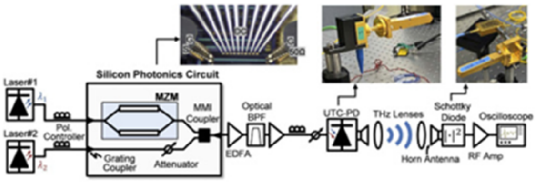
The Integrated Nanophotonics Laboratory is working on both fundamental aspects and practical applications of modern photonics / optoelectronics with special emphasis on integration techniques. Especially, we are interested in device-level integration of photonics / optoelectronics for 5G-optical data transmission, advanced information processing, display, smart sensor, and energy applications.

Integrated photonics

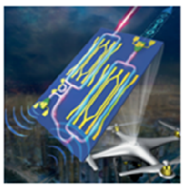
Silicon is the most well known material for electronics, but is also a promising optical medium at near-infrared wavelengths. By taking advantages of advanced fabrication and design techniques developed for electronic circuits, we can now design and build integrated photonic circuits that can complement and sometimes overcome the electronics in a number of cutting-edge applications, such as 'large-scale high-speed interconnects for chiplets', 'optical/wireless communication convergence for beyond 5G, photonic radar and terahertz era', 'high-precision time and frequency reference for quantum sensing', 'energy-efficient optical engines for large-scale information processing and quadratic optimization', and smart sensing – LiDAR (Light Detection And Ranging).



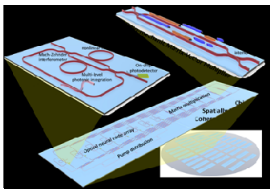
Integrated Photonic circuit



THZ Optical Data Transmission



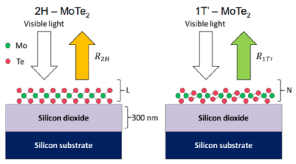
photonic Radar



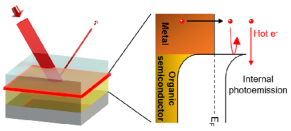
photonic Ising machine

Innovative photonic materials

In addition to conventional group IV semiconductors and III-V compound semiconductor materials, recent innovations in materials research have significantly broadened the scope of modern photonics / optoelectronics. Our group is interested in various emerging materials, such as 2D materials, hybrid materials, and metamaterials.



< 2D phase change material >



< Photodetectors >

■ Recommended courses & Career after graduation

We recommend wave- and device-related courses, such as electromagnetics, semiconductor physics, and optoelectronics. Our alumni members are currently working at universities (**Stanford, UC Berkeley, Toronto, Oxford**), national research institutes (**ETRI, ADD**), and industries (**Samsung, SK Hynix, and PsiQuantum**).

■ Introduction to other activities besides research

We have regular summer and winter retreats, and workshops with domestic & overseas conferences. We also regularly play soccer and badminton. These extracurricular activities are sometimes done with other laboratories with similar research interests.

■ Introduction to the Lab.

Our research group is generally interested in micro-/nano-photonics and optoelectronics, a highly interdisciplinary area with emerging applications in information processing and quantum technologies. Starting from micro-sized optical resonators to subwavelength-scale metamaterials, we cover a wide range of photonic/optoelectronic devices and systems.

■ Recent research achievements (2023)

[1] Kwon, Kyungmok, et al. "Heterogeneously integrated light emitting diodes and photodetectors in the metal-insulator-metal waveguide platform." Nanophotonics 0 **(2023).**

[2] Jin, Yeonghoon, Jongeun Seok, and Kyoungsik Yu. "Highly Efficient Silicon-Based Thin-Film Schottky Barrier Photodetectors." ACS Photonics **(2023).**

[3] Park, Jongwoo, et al. "300-Gb/s/λ IM/DD Transmission Using Integrated SiP OTDM Transmitter." IEEE Photonics Technology Letters 35.10 **(2023)**

[4] Rah, Yoonhyuk, et al. "Low Power Coherent Ising Machine Based on Mechanical Kerr Nonlinearity." Physical Review Letters 130.7 **(2023)**

[5] Son, Gyeongho, et al. "Highly efficient broadband adiabatic mode transformation between single-mode fibers and silicon waveguides." Journal of Lightwave Technology **(2023).**

<Professor **Jong-Won Yu**'s Lab.>

RF System and Solution Lab

■ Contact information

Professor	**Email: drjwyu@kaist.ac.kr**	**Tel: 042-350-3478**
Lab.	**rfsslab@kaist.ac.kr**	**Tel: 042-350-5478**
Website	**https://rfss.kaist.ac.kr**	

■ Current state of the Lab. (in 2023 Fall Semester)

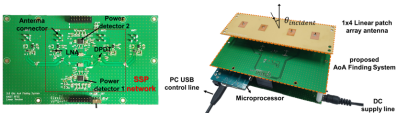
Postdoctoral Fellows : 0 PhD Students: 9+3 (part time) Master's Student: 4

■ Research Areas

RF System Development

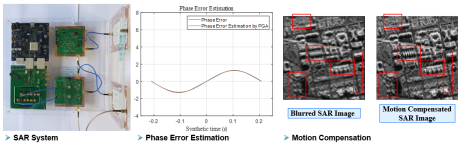
<Direction Finding System>

▶ Multiple Spacing Scheme, Few Antenna Elements, High Accuracy and Wide Coverage, Reduced Output Ports with Switched Six-Port Network



<SAR Motion Compensation Algorithm>

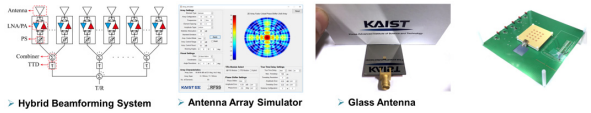
▶ Compact SAR System Design, Phase Error Estimation Method, Motion Compensation Algorithm, Compressive Sensing



Phased Array Antenna System

<mmWave Beamforming System>

▶ Beam Squinting Frequency Dependency of Delay Circuits, Hybrid(PS/TTD) BeamformingArray, mmWavePhased Array Antenna Using Glass, Design of Antenna Array Simulator



<Wide Angle Scanning Antenna Array System>

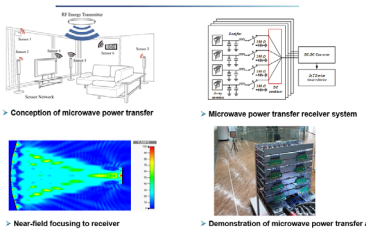
▶ V2V Communication, Wide Beam Scanning Coverage in Phased Array, 8×8 Phased Array Antenna for Beamforming, Compact Calibration Algorithm

Wireless Power Transfer System

<Near-Field WPT System>

▶ 1:N Charging (Multi-Receiver Charging), Free-Positioning Charge, Assemble the Simple Receiver Module, Maximum Efficiency Tracking Control Scheme

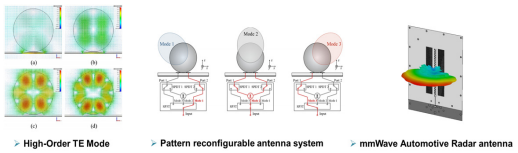
<Microwave Power Transfer System>



RF Antenna Development

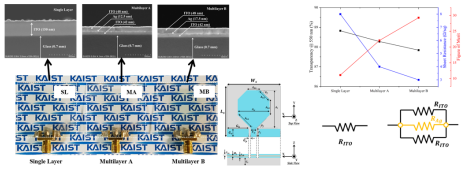
<mmWave/Sub-THz 3D High-Gain Multi-Beam Pattern>

▶ Superdirectivity, Electrically Small Antenna, Electrical Beam-Steering with Simple Feeding Network, Various Applications



<Invisible Antenna>

▶ Efficiency-Improved Material, Invisible Antenna Using ITO/Ag/ITO Multilayer Electrode Films, High Quality Transparent Material



■ Recommended courses & Career after graduation

- Postdoctoral Courses
- Various Government-funded/Government-contributed Research Institute (ex. KISTEP, KRISS, KINS, ETRI, KRRI, ADD etc.)
- Various Major Company (ex. Samsung Electronics, LG Electronics etc.)

■ Introduction to other activities besides research

- Working out with other Lab or Running various programs once a month.

■ Introduction to the Lab.

For the next generation networks, we are trying to make it possible to have above characteristics of the RF systems more appropriate, more reliable, more efficient for the future wireless environment.

■ Recent research achievements (2020-2023)

- International Journal 30, International Conference 15, Award 17, Patent 11

⟨Professor June-Koo Rhee's Lab.⟩

Quantum Information and Communications Lab

KAIST IT Research Center of Quantum Computing for AI

■ Contact information

Professor	**Email: EE building E3-2 3208**	**Tel: 042-350-7416**
LAb.	**Email: EE building E3-2 3217**	**Tel: 042-350-7516**
Website	**http://quic.kaist.ac.kr**	

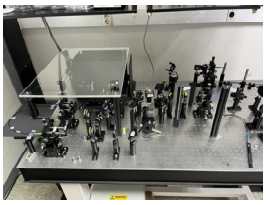
■ Current state of the Lab. (in 2023 Fall Semester)

Research professor: 1 Post-doctoral: 1 PhD Students: 3 Master's Student: 3

Team leader: Dong-Ha Kim (010-4443-8755)

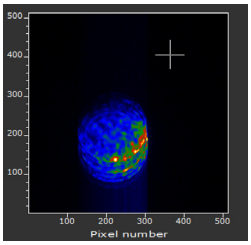
■ Research Areas

√ Satellite based Quantum Key Distribution (SQKD)



Since the successful demonstration of a satellite-based quantum key distribution (QKD) system by a research team from the University of Science and Technology of China (USTC) in 2017, the world has been fervently engaged in a competition to secure future technologies. South Korea is also actively conducting research related to this field, and we are conducting research specifically on entangled photon pair (EPP) sources, which is one of the essential technologies for achieving this project. In this research, we utilize optical experimental setups to observe and confirm phenomena that demonstrate quantum properties.

√ Quantum Ghost Imaging



The imaging technique allows the reconstruction of an image without directly detecting the photons that interact with the object. Despite a single photon from the signal not hitting the detector, the object can be obtained by utilizing the correlation between the detected signal and idler as the unique properties of the entanglement and non-locality of quantum mechanics.

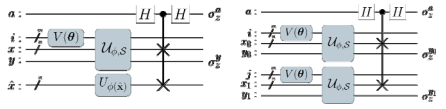
Advantages:

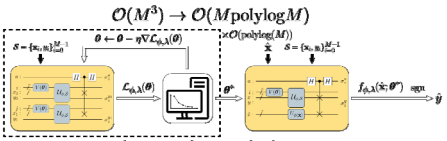
1. Low light sensitivity
2. Have better noise reduction compared to classical imaging techniques *under specific conditions.*

Main focus:

1. Develop the entangled photon pair.
2. Measure the correlation between entangled photons.
3. Increase the speed of object detection while maintaining SNR.

√ Quantum Approximate Support Vector Machine



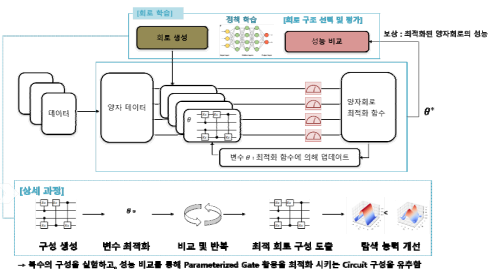


QASVM을 위한 양자 복합 지도 기계학습 알고리즘 구조도

A kernel-based quantum classifier is the most practical and influential quantum machine learning technique for the hyper-linear classification of complex data. Variational Quantum Approximate Support Vector Machine (VQASVM) algorithm demonstrates empirical sub-quadratic run-time complexity with quantum operations feasible even in NISQ computers.

We experimented our algorithm with toy example dataset on cloud-based NISQ machines as a proof of concept. We also numerically investigated its performance on the standard Iris flower and MNIST datasets to confirm the practicality and scalability.

√ Ansatz Structure Search via Reinforcement Learning



Parameterized Quantum Circuit is quantum circuit which parameter can be optimized by Goal of Loss. Ansatz structure of quantum circuit is important task for many algorithms such as Variational Quantum Algorithm, Variational Quantum Eigensolver, cause result of algorithms changes via structure of ansatz. In this work, we used Reinforcement Learning to search optimal ansatz structure with various goals.

■ Recommended courses

Recommended courses are linear algebra, probability theory, quantum mechanics, information theory.

■ Career after graduation

Graduates have emancipated for various careers such as professors (Coventry U UK, IFSTTAR France), and researchers at major companies (Samsung, LIG Nex1, KT, ETRI, NSR).

<Prof. Min Seok Jang's Lab>

jLAB NANO OPTICS

■ **Contacts**

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Lab : E3-2 #2222, #2232 TEL : 042-350-7539

Homepage : janglab.org

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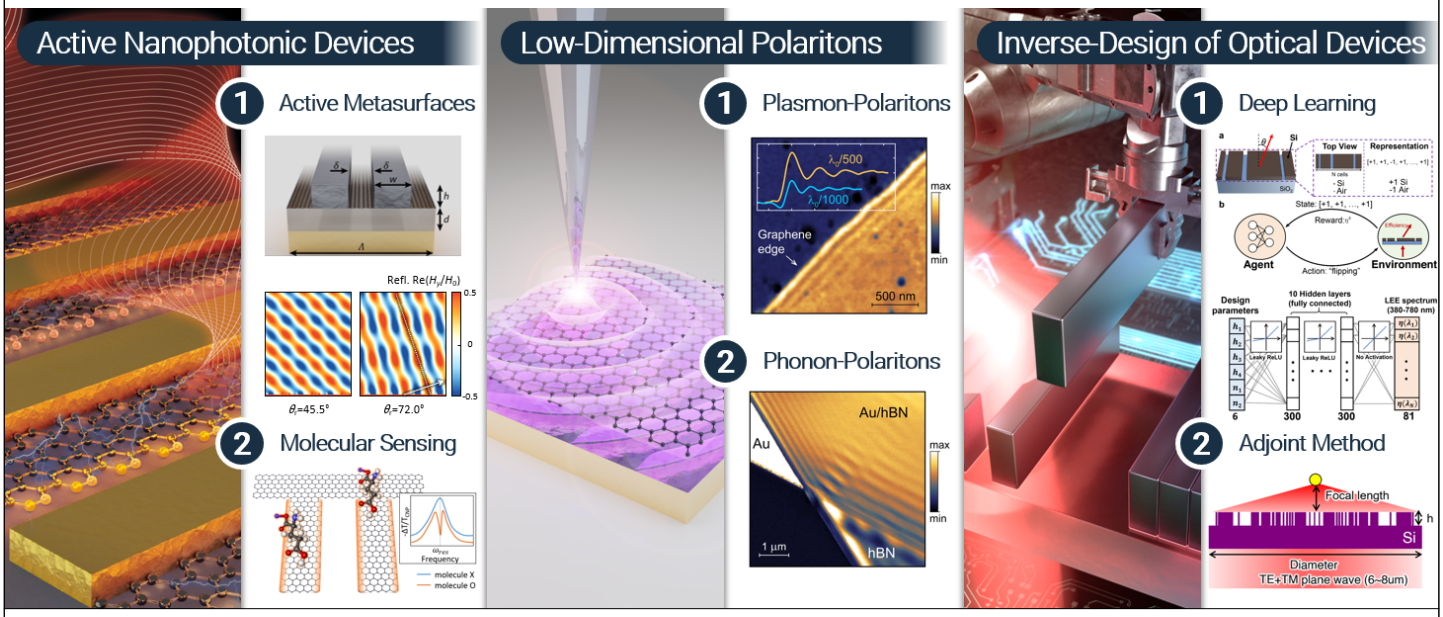
■ **Current member status (2023 Fall): 1 research professor, 1 post-doc, 10 PhD students, 3 MS students, 5 undergrads**

■ **Research Areas**

We understand the properties of light in ultra-small, subwavelength scales and develop technologies in the field of imaging, sensing, information processing, displays, and quantum computing



■ **Recommended courses and Potential career paths**

Theoretical research: To analyze and design photonic device functionalities, courses such as 'Electromagnetics' 'Quantum mechanics', and 'Fundamentals of photonics' are recommended.

Experimental research: The following courses 'Introductions to physical electronics', 'Semiconductor devices', 'Semiconductor IC technology', etc. are recommended to prepare oneself for fabrication of photonic devices.

There's a lot of demand for nanophotonics in both academia and industry, and diverse career paths are possible, whether it be researching in academia or working on display technologies at an industry.

■ **About our lab and prospective team members**

We are currently accepting undergrads who want a research experience in a lab. What we offer:

(1) Research along the **interface between science and engineering**: Understand the fundamentals behind physical phenomena, and apply it for engineering purposes.

(2) You can choose between theory/simulations or experiment, or both, depending on your aptitude or preferences.

(3) Collaboration with other labs abroad.

Our lab prides in our friendly and horizontal lab culture and student-driven researches. We respect every student's own times and schedules, and provide an academic environment to study and research in at one's own needs.

*** About the PI**: I myself was a KAIST undergraduate, class of 2006, who took classes in the same rooms of KAIST and did internships and undergrad research programs, developing my skills as a researcher. Also, having very recently graduated from graduate school, I understand very well the difficulties and problems graduate students go through. I take as a top priority to lead a lab that's the most beneficial for our members, and will try my hardest in **helping students find the research topics of their interest** and **creating a non-authoritative lab atmosphere blooming with fruitful discussions**.

■ **Publications**

[1] "Near-field probing of image phonon-polaritons in hexagonal boron nitride on gold crystals", Science Advances (2022).

[2] "Full 2π tunable phase modulation using avoided crossing of resonances", Nature Communications (2022).

[3] "Real-space imaging of acoustic plasmons in large-area graphene grown by chemical vapor deposition", Nature Communications (2021).

[4] "Complete complex amplitude modulation with electronically tunable graphene plasmonic metamolecules," ACS Nano (2020). **[Front Cover]**

[5] "Self-stabilizing laser sails based on optical metasurfaces," ACS Photonics (2019).