RAP

RIKEN Center for Advanced Photonics

2024 - 2025

RIKEN Center for Advanced Photonics
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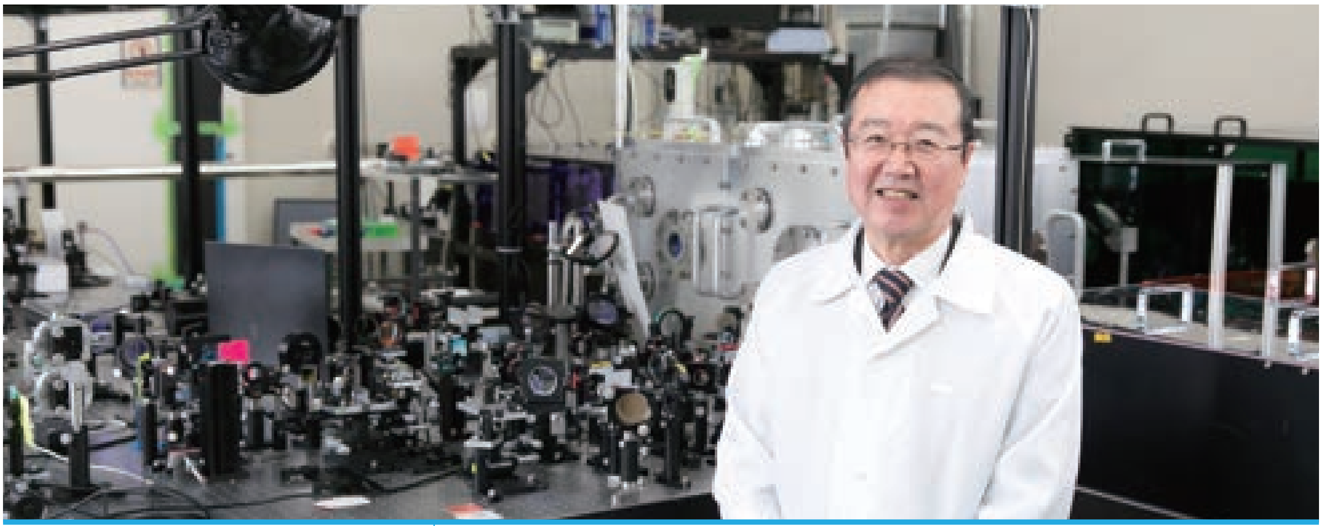
RIKEN 2024-013

RIKEN Center for Advanced Photonics

Attosecond Science Research Team

Team Leader Katsumi Midorikawa Dr.Eng.



▶ Fields

Interdisciplinary Science and Engineering, Engineering, Physics, Chemistry

▶ Keywords

Attosecond Science, Ultrafast Lasers, Strong Field Physics, Nonlinear Optics, Multiphoton Microscopy

▶ Publications

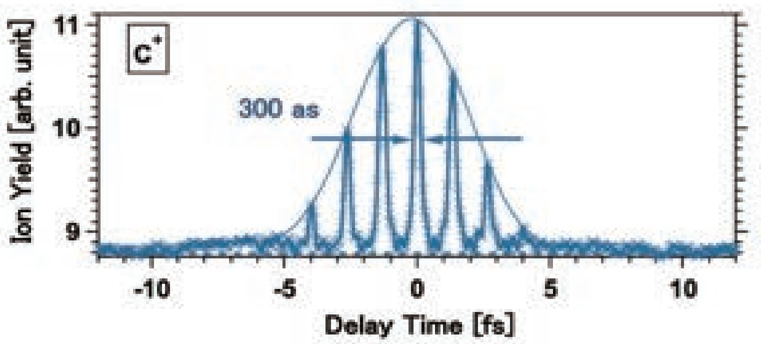
1. Lin, Y-C., Midorikawa, K., Nabekawa, Y.: "Wavefront control of subcycle vortex pulses via carrier-envelop-phase tailoring" , ***Light: Sci. & Appl.*** 12, 279 (2023).
2. Midorikawa, K.: "Progress on table-top isolated attosecond light sources" , ***Nature Photonics*** 16, 267 (2022).
3. Matsubara, T., Fukahori, S., Lötstedt, E., Nabekawa, Y., Yamanouchi, K., and Midorikawa, K.: "300 attosecond response of acetylene in two-photon ionization/dissociation processes" , ***Optica*** 8, 1075 (2021).
4. Lin, Y-C., Nabekawa, Y., and Midorikawa, K.: "Optical parametric amplification of sub-cycle shortwave infrared pulses" , ***Nat. Commun.*** 11, 3413 (2020).
5. Xue, B., Tamaru, Y., Yuan, H., Lan, P., Mücke, O. D., Suda, A., Midorikawa, K., and Takahashi, E. J.: "Fully stabilized multi-TW optical waveform synthesizer: Toward gigawatt isolated attosecond pulses" , ***Science Advances*** 6, eaay2820 (2020).

▶ Member

Yasuo Nabekawa / Yutaka Nagata / Keisuke Isobe / Tomoya Okino / Takashige Fujiwara / Yu-Chieh Lin / Kaoru Yamazaki / Tohru Kobayashi / Takiko Wakabayashi

Expanding the horizon of optical science by attosecond photonics

Recent advances in femtosecond high-intensity laser technology have made it possible to generate intense ultrashort pulses of a few cycles and control their phases. As a result, research on the nonlinear interaction between light and atoms/molecules has progressed dramatically, and new research areas such as high-order harmonic generation, Coulomb explosion, and high-energy X-ray/particle generation have been born. High-order harmonic generation can provide intense attosecond pulses that cause nonlinear optical phenomena in the extreme ultraviolet to soft X-ray region. The generation of high-order harmonics is also a unique physical phenomenon that makes it possible to observe ultrafast phenomena occurring in atoms and molecules on an attosecond time scale. Our team is researching extreme nonlinear optics and attosecond atomic/molecular dynamics using a high-intensity attosecond pulse light source.



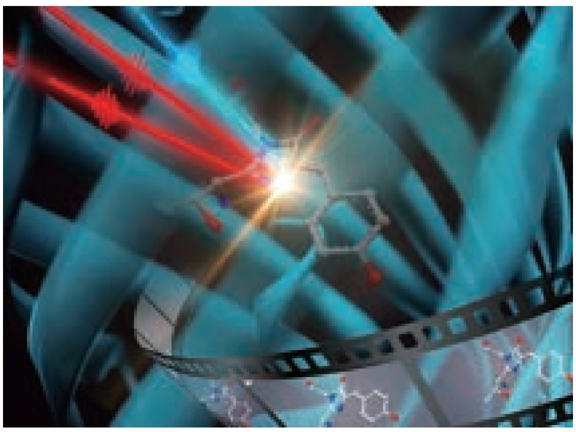
Autocorrelation waveform of attosecond pulse train measured with carbon ion yield from acetylene

Ultrafast Spectroscopy Research Team

Team Leader Tahei Tahara D.Sci.

Elucidating complex molecular dynamics with femtosecond light

Most of the phenomena in nature are realized by the dynamic behavior of molecules. Among them, chemical reactions are critically important, which dynamically cause the cleavage and formation of chemical bonds and alter the nuclear arrangement within the molecules. Even non-reactive molecules are vibrating, which provides rich information about the molecular properties. Because the timescale of such molecular motion is femtosecond (one quadrillionth of a second), femtosecond spectroscopy is essential for elucidating chemical phenomena. Our team investigates the dynamics of molecules from fundamental to complex systems, as well as the molecules in special environments such as interfaces. We extend the frontier of molecular science through the development and use of advanced spectroscopic methods.



Coherent nuclear motion of the chromophore of a protein in reaction

▶ Fields

Chemistry, Physics, Biology / Biochemistry

▶ Keywords

Ultrafast spectroscopy, Nonlinear spectroscopy, Single molecule spectroscopy, Dynamics, Interface

▶ Publications

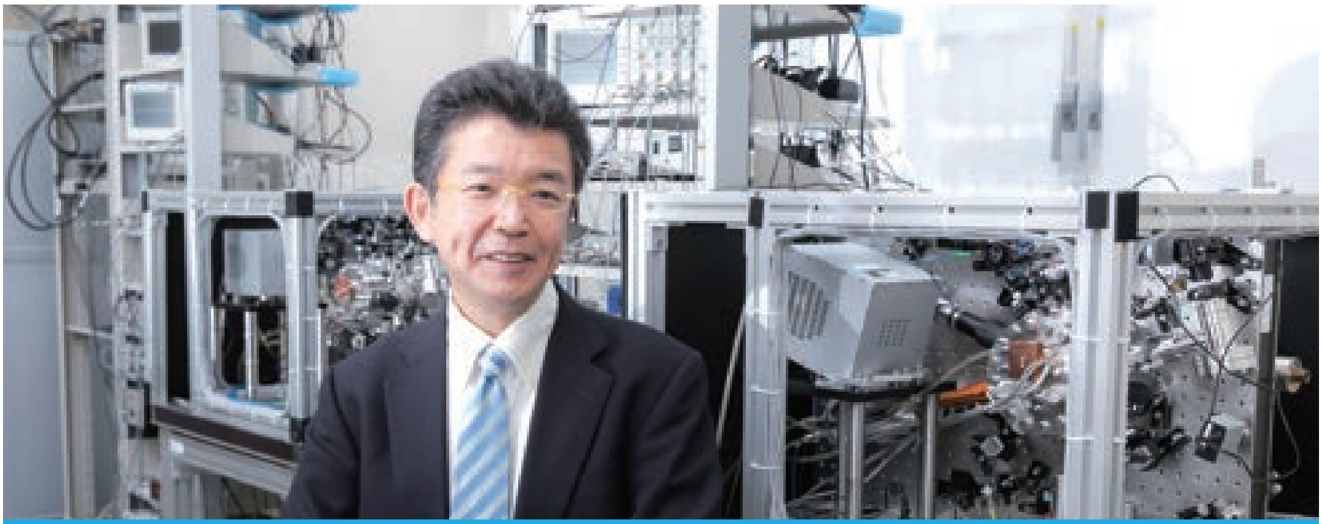
1. Kuramochi, H., Tsutsumi, T., Saita, K., Wei, Z., Osawa, M., Kumar, P., Liu, L., Takeuchi, S., Taketsugu T., Tahara, T.: "Ultrafast Raman observation of the perpendicular intermediate phantom state of stilbene photoisomerization" , ***Nat. Chem.*** 16, 22 (2024).
2. Sung, W., Inoue, K., Nihonyanagi, S., Tahara, T.: "Unified picture of vibrational relaxation of OH stretch at the air/water interface" , ***Nat. Commun.*** 15, 1258 (2024).
3. Kumar, P. Kuramochi, H. Takeuchi, S. Tahara, T.: "Photoexcited plasmon-driven ultrafast dynamics of the adsorbate probed by femtosecond time-resolved surface-enhanced time-domain Raman spectroscopy", ***J. Phys. Chem. Lett.*** 14, 2845 (2023).
4. Chang, C., Kuramochi, M., Singh, M., Abe-Yoshizumi, R., Tsukuda, T., Kandori, H., and Tahara, T.: "A unified view on varied ultrafast dynamics of the primary process in microbial rhodopsins" , ***Angew. Chem. Int. Ed.*** 61, e202111930 (2022).
5. Kusaka, R., Nihonyanagi, S., and Tahara, T.: "The photochemical reaction of phenol becomes ultrafast at the air–water interface" , ***Nat. Chem.*** 13, 306 (2021).

▶ Member

Kunihiko Ishii / Satoshi Nihonyanagi / Korenobu Matsuzaki / Jan Georg Borter

Space-Time Engineering Research Team

Team Leader Hidetoshi Katori D.Eng.



▶ Fields

Interdisciplinary Science and Engineering, Engineering

▶ Keywords

Quantum electronics, Atomic clock, Quantum metrology, Optical lattice clock, Relativistic geodesy

▶ Publications

1. Takamoto, M., Ushijima, I., Ohmae, N., Yahagi, T., Kokado, K., Shinkai, H., and Katori, H.: "Test of general relativity by a pair of transportable optical lattice clocks", ***Nat. Photonics*** 14, 411-415 (2020).
2. Ushijima, I., Takamoto, M., and Katori, H.: "Operational magic intensity for Sr optical lattice clocks" , ***Phys. Rev. Lett.*** 121, 263202 (2018).
3. Takano, T., Takamoto, M., Ushijima, I., Ohmae, N., Akatsuka, T., Yamaguchi, A., Kuroishi, Y., Munekane, H., Miyahara, B., and Katori, H.: "Geopotential measurements with synchronously linked optical lattice clocks" , ***Nat. Photonics*** 10, 662-666 (2016).
4. Yamanaka, K., Ohmae, N., Ushijima, I., Takamoto, M., and Katori, H.: "Frequency ratio of ^{199}Hg and ^{87}Sr optical lattice clocks beyond the SI limit" , ***Phys. Rev. Lett.*** 114, 230801 (2015).
5. Ushijima, I., Takamoto, M., Das, M., Ohkubo, T., and Katori, H.: "Cryogenic optical lattice clocks" , ***Nat. Photonics*** 9, 185-189 (2015).

▶ Member

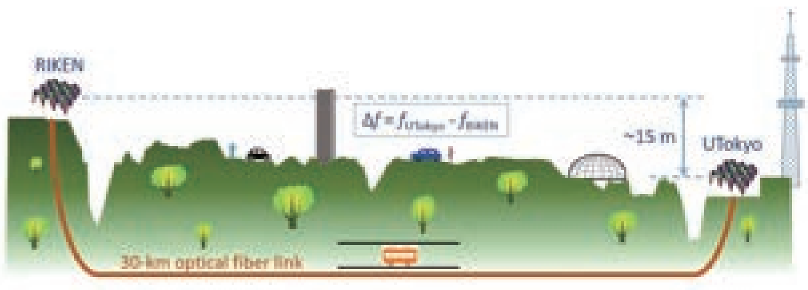
Masao Takamoto / Atsushi Yamaguchi / Shinji Ito

Relativistic Space-Time Engineering with Ultra Precise Atomic Clocks

Clocks have served as a tool to share time, based on universal periodic phenomena; humankind relied upon the rotation of the earth from antiquity. The radiation from an atom provides us with far more accurate periodicity. The state-of-the-art atomic clocks sense the relativistic space-time curved by gravity, which reveal the difficulty of sharing time with others. Moreover, such clocks may be used to investigate the constancy of fundamental constants, where the foundation of the atomic clocks is anchored.

Optical lattice clocks raised the possibility of ultra-stable and accurate timekeeping by applying the "magic wavelength" protocol on optical lattices. Since the proposal of the scheme in 2001, the optical lattice clocks are being developed by more than 20 groups in the world, and the clocks are surpassing the uncertainty of the current SI second, becoming one of the most promising candidates for the future redefinition of the second.

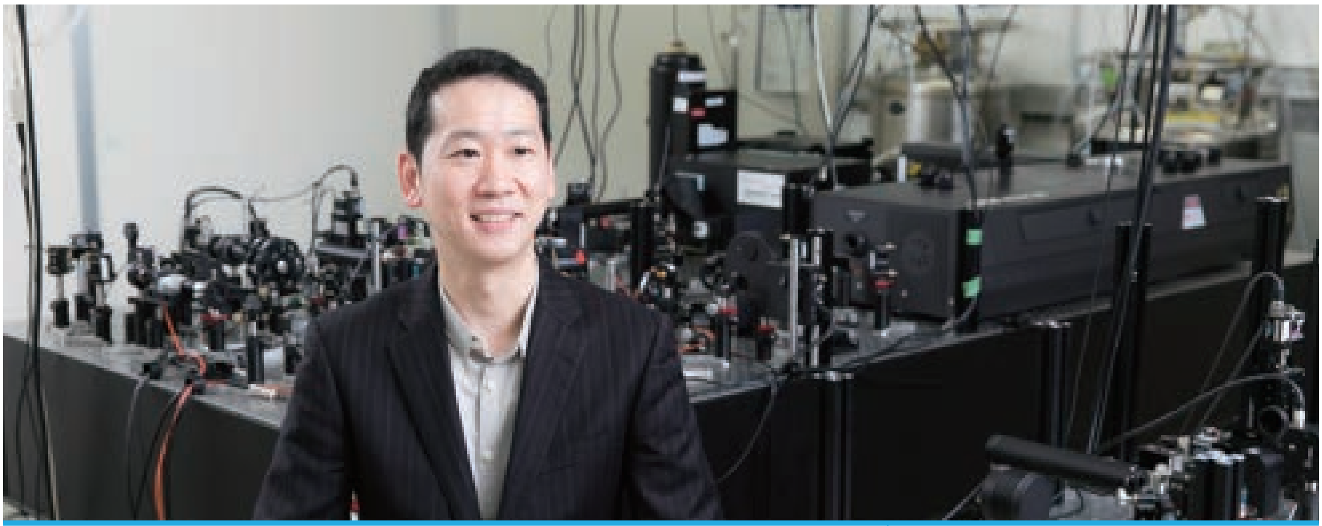
Our team develops highly precise and transportable optical lattice clocks capable of long time operation by introducing advanced techniques in the field of atomic physics and quantum optics; we thus explore applications of "space-time engineering" that fully utilize the novel time resource provided by such clocks. For example, a transportable ultraprecise atomic clock, which may be taken out into the field, will function as a gravitational potential meter. We experimentally investigate the impact of such relativistic geodesy and new roles for clocks in the future.



Remote frequency comparison of optical lattice clocks between RIKEN and the University of Tokyo (UTokyo) reveals their different tick rates as predicted by general relativity.

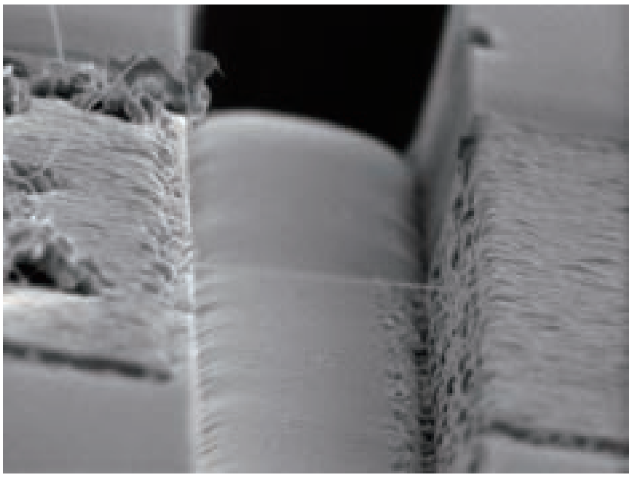
Quantum Optoelectronics Research Team

Team Leader Yuichiro Kato Ph.D.



Towards optoelectronic devices that utilize the quantum nature of electrons and photons

Advances in device fabrication techniques have enabled integration of individual nanomaterials, where single electrons and single photons could be addressed. We exploit state-of-the-art nanofabrication technologies to develop and engineer optoelectronic devices with novel functionalities that can only be achieved by utilizing the quantum nature of electrons and photons at the nanoscale. We investigate devices that would allow for control over the interactions between electrons and photons at the quantum mechanical level, which would lead to quantum photon sources and optical-to-electrical quantum interfaces.



Scanning electron micrograph of a suspended carbon nanotube field effect transistor

Fields

Engineering, Physics, Chemistry, Interdisciplinary Science and Engineering

Keywords

Optoelectronics, Quantum devices, Nanoscale devices, Carbon nanotubes, Photonic crystals

Publications

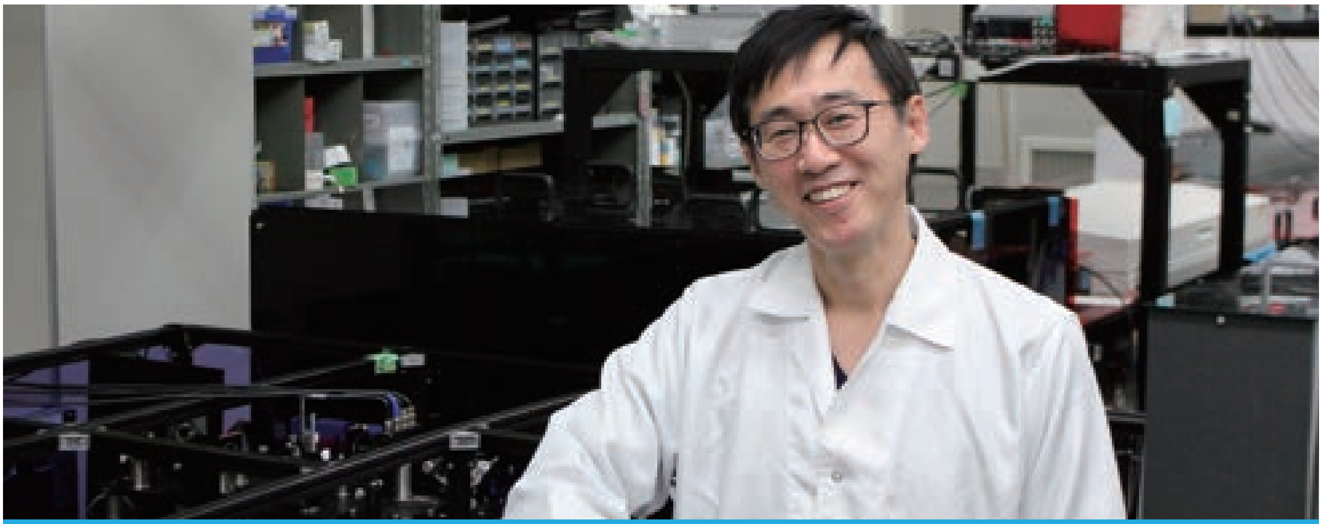
1. Fang, N., Chang, Y. R., Fujii, S., Yamashita, D., Maruyama, M., Gao, Y., Fong, C. F., Kozawa D., Otsuka, K., Nagashio, K., Okada, S., Kato, Y. K.: "Room-temperature quantum emission from interface excitons in mixed-dimensional heterostructures," ***Nature Commun.*** 15, 2871 (2024).
2. Fujii, S., Fang, N., Yamashita, D., Kozawa D., Fong, C. F., Kato, Y. K.: "van der Waals decoration of ultra-high-Q silica microcavities for $\chi^{(2)}$-$\chi^{(3)}$ hybrid nonlinear photonics," ***Nano Lett.*** 24, 4209 (2024).
3. Fang, N., Chang, Y. R., Yamashita, D., Fujii, S., Maruyama, M., Gao, Y., Fong, C. F., Otsuka, K., Nagashio, K., Okada, S., Kato, Y. K.: "Resonant exciton transfer in mixed-dimensional heterostructures for overcoming dimensional restrictions in optical processes," ***Nature Commun.*** 14, 8152 (2023).
4. Kozawa, D., Wu, X., Ishii, A., Fortner, J., Otsuka, K., Xiang, R., Inoue, T., Maruyama, S., Wang, Y., Kato, Y. K.: "Formation of organic color centers in air-suspended carbon nanotubes using vapor-phase reaction," ***Nature Commun.*** 13, 2814 (2022).
5. Otsuka, K., Fang, N., Yamashita, D., Taniguchi, T., Watanabe, K., and Kato, Y. K.: "Deterministic transfer of optical-quality carbon nanotubes for atomically defined technology," ***Nature Commun.*** 12, 3138 (2021).

Member

Hiroyuki Nishidome / Mengyue Wang / Ufuk Erkilic / Clement Deleau

Ultrafast Coherent Soft X-ray Photonics Research Team

Team Leader Eiji J. Takahashi D.Eng.



▶ Fields

Interdisciplinary Science and Engineering, Engineering, Complex systems

▶ Keywords

High-power single-cycle laser, Attosecond laser, MIR laser, Coherent soft x-ray, Strong-field physics

▶ Publications

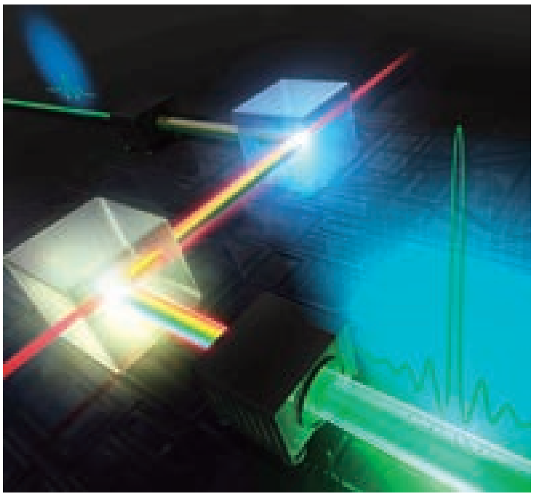
1. Lu, X., and Takahashi, E.J.: "Dual-chirped optical parametric amplification of high-energy single-cycle laser pulses" , ***Nature Photonics*** 18, 99-106 (2024).
2. Bing, X., Tamaru, Y., Fu, Y., Yuan, H., Lan, P., Mücke, O.D., Suda, A., Midorikawa, K., and Takahashi, E.J.: "Gigawatt-class, tabletop, isolated-attosecond-pulse light source" , ***Optica*** 9, 360-363 (2022).
3. Lu, X., Bing, X., Ishii, N., Itatani, J., Midorikawa, K., and Takahashi, E.J.: "100-mJ class, sub-two-cycle, carrier-envelope phase-stable dual-chirped optical parametric amplification" , ***Opt Lett*** 47, 3371-3374 (2022).
4. Bing, X., Tamaru, Y., Fu, Y., Yuan, H., Lan, P., Mücke, O.D., Suda, A., Midorikawa, K., and Takahashi, E.J.: "A Custom-Tailored Multi-TW Optical Electric Field for Gigawatt Soft-X-Ray Isolated Attosecond Pulses" , ***Ultrafast Science*** 2021: 9828026 (2021).
5. Bing, X., Tamaru, Y., Fu, Y., Yuan, H., Lan, P., Mücke, O.D., Suda, A., Midorikawa, K., and Takahashi, E.J.: "Fully stabilized multi-TW optical waveform synthesizer: Toward gigawatt isolated attosecond pulses" , ***Science Advances*** 6: eaay2802 (2020).

▶ Member

Yasuo Nabekawa / Natsuki Kanda / Kotaro Imasaka / Kaito Nishimiya / Dai Ikeda / Rambabu Rajpoot / Ahmed Ramadan Ibrahim / Dianhong Dong / Minshuang Xia

Creating novel ultrafast soft x-ray sources using the extreme nature of laser

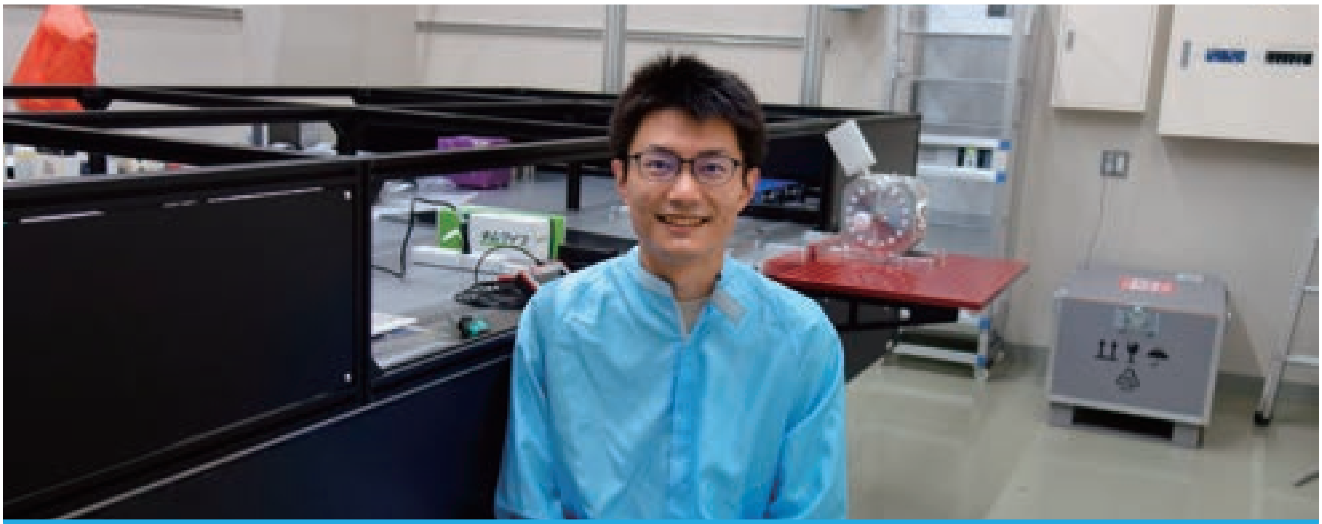
Laser is the ultimate light source created by mankind, and it has become an indispensable tool for our social life. In this laboratory, our main goal is to create an unexplored ultrafast laser by using the extreme nature of laser such as ultrashort pulse, super broadband, high power, and so on. Specifically, we are developing a high-power a few-cycle laser source, and using it to develop novel laser source with full coherence in the soft x-ray region and a pulse width of attosecond region. We extend the frontier of laser science through the development of novel laser sources.



Amplification of single-cycle laser pulses

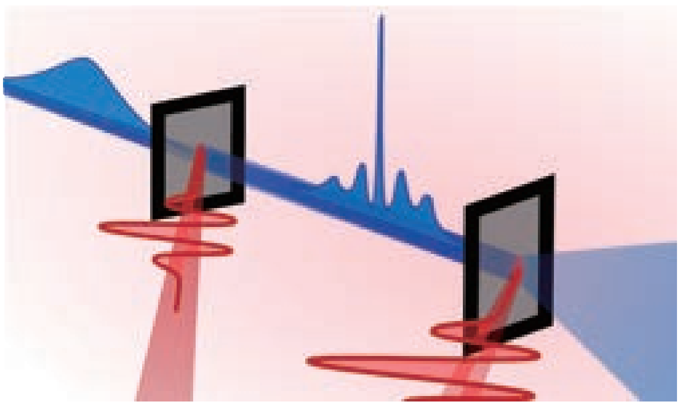
Ultrashort Electron Beam Science RIKEN Hakubi Research Team

RIKEN Hakubi Team Leader Yuya Morimoto Ph.D.



Space-time imaging of the initial steps of chemical reactions with ultrashort electron beams

Electron beams are used for examples in electron microscopy and electron-beam lithography, where high spatial resolution is required. By using state-of-the-art laser and electron-beam technologies, we control the temporal structure of an electron beam with ultimate attosecond resolution and apply the controlled electron beams for imaging and controlling ultrafast chemical reactions. We explore the atomic-scale dynamics of electrons in a material which is the initial step of most photochemical reactions.



Light-wave modulation of an electron beam

Fields

Chemistry, Physics,
Interdisciplinary Science and Engineering,
Engineering

Keywords

Ultrashort electron beam, Electron beam imaging, Nonlinear optics, Attosecond science, Atomic collisions

Publications

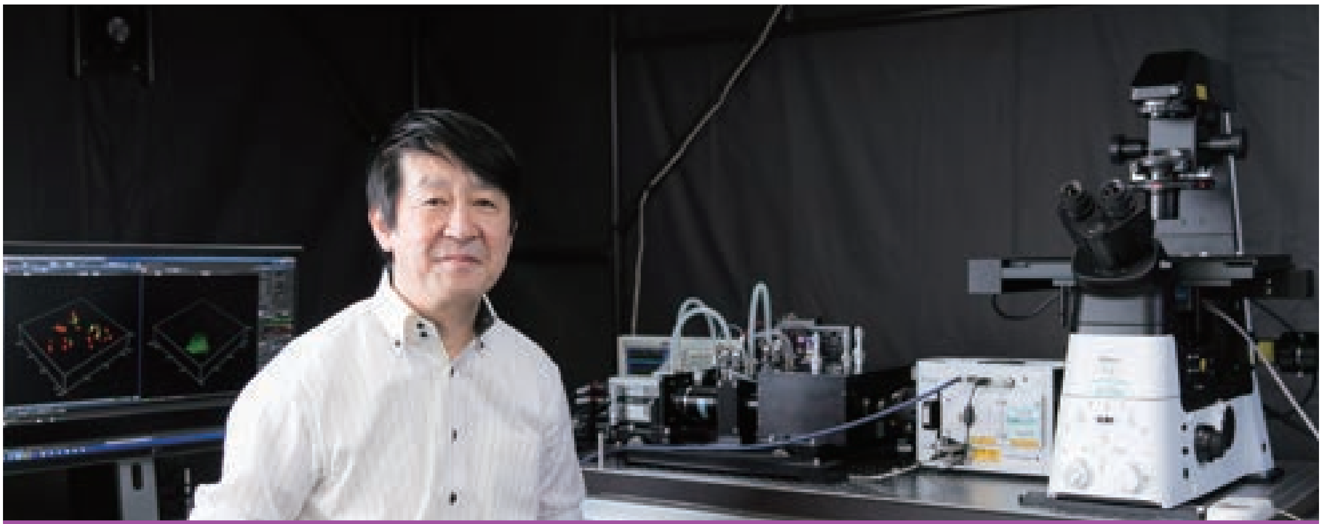
1. Morimoto, Y.: "Attosecond electron-beam technology: a review of recent progress", ***Microscopy*** 72, 2-17 (2023).
2. Morimoto, Y., Shinohara, Y., Tani, M., Chen, B.H., Ishikawa, K.L., and Baum, P.: "Asymmetric single-cycle control of valence electron motion in polar chemical bonds", ***Optica*** 8, 382 (2021).
3. Morimoto, Y., Hommelhoff, P., and Madsen, L.B.: "Coherent scattering of an optically-modulated electron beam by atoms", ***Phys. Rev. A*** 103, 043110 (2021).
4. Morimoto, Y., and Baum, P.: "Single-Cycle Optical Control of Beam Electrons", ***Phys. Rev. Lett.*** 125, 193202 (2020).
5. Morimoto, Y., and Baum, P.: "Diffraction and microscopy with attosecond electron pulse trains", ***Nat. Phys.*** 14, 252 (2018).

Member

Yuichi Tachibana / Marie Ouille / Yui Yamashita

Live Cell Super-Resolution Imaging Research Team

Deputy Team Leader Akihiko Nakano D.Sci.



▶ Fields

Biological Sciences, Complex systems,
Interdisciplinary science and engineering,
Biology / Biochemistry

▶ Keywords

Membrane traffic, Vesicular transport,
Super-resolution live imaging,
Confocal microscopy, Organelles

▶ Publications

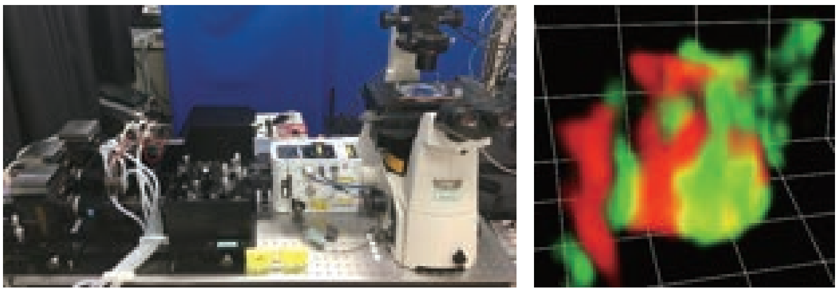
1. Tojima, T., Suda, Y., Jin, N., Kurokawa, K., and Nakano, A.: "Spatiotemporal dissection of the Golgi apparatus and the ER-Golgi intermediate compartment in budding yeast" , ***eLife*** 13, e92900 (2024).
2. Obata, Y., Kurokawa, K., Tojima, T., Natsume, M., Shiina, I., Takahashi, T., Abe, R., Nakano, A., and Nishida, T.: "Golgi retention and oncogenic KIT signaling via PLCγ2-PKD2-PI4KIIIβ activation in gastrointestinal stromal tumor cells" , ***Cell Rep.*** 42, 113035 (2023).
3. Toshima, J. Y., Tsukahara, A., Nagano, M., Tojima, T., Siekhaus, D. E., Nakano, A., and Toshima, J.: "The yeast endocytic early/sorting compartment exists as an independent sub-compartment within the trans-Golgi network" , ***eLife*** 12, e84850 (2023).
4. Shimizu, Y., Takagi, J., Ito, E., Ito, Y., Ebine, K., Komatsu, Y., Goto, Y., Sato M., Toyooka, K., Ueda, T., Kurokawa, K., Uemura, T., and Nakano, A.: "Cargo sorting zones in the ***trans***-Golgi network visualized by super-resolution confocal live imaging microscopy in plants" , ***Nat. Commun.*** 12:1901 (2021).
5. Rodriguez-Gallardo, S., Kurokawa, K., Sabido-Bozo, S., Cortes-Gomez, A., Ikeda, A., Zoni, V., Aguilera-Romero, A., Perez-Linero, A.M., Lopez, S., Waga, M., Araki, M., Nakano, M., Riezman, H., Funato, K., Vanni, S., Nakano, A., and Muñiz, M.: "Ceramide chain length-dependent protein sorting into selective endoplasmic reticulum exit sites" , ***Sci. Adv.*** 6:eaba8237 (2020).

▶ Member

Takuro Tojima / Kumi Matsuura / Natsuko Jin / Daisuke Miyashiro / Kumiko Ishii / Miho Waga / Hideo Hirukawa

Observe nano-scale activities within a living cell by sub-wavelength high-speed imaging

Light is a cutting-edge tool for life science research. Development of useful fluorescent probes and the advancement of light microscope technologies have brought us a new world of "live" imaging within a cell. We are developing super-resolution confocal live imaging microscopy (SCLIM) by the combination of a high-speed confocal scanner and a high-sensitivity camera system. With this method we will observe membrane trafficking and organellar dynamics in living cells at high-speed and sub-wavelength space resolution (4D) and elucidate underlining molecular mechanisms. We will also try to extend this technology to medical and pharmacological applications.



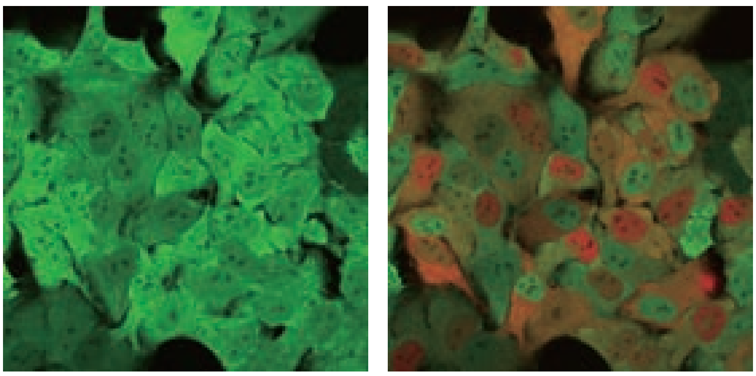
(Left) SCLIM2 microscope.
(Right) Yeast *trans*-Golgi network (red) and clathrin-coated vesicles (green) assembling and leaving there. Captured from a high-speed 3D movie taken by SCLIM2.

Biotechnological Optics Research Team

Team Leader Atsushi Miyawaki M.D., Ph.D

Bioimaging Technologies by use of glowing proteins

We label a fluorescent probe on a specific region of a biological molecule and bring it back into a cell. We can then visualize how the biological molecule behaves in response to external stimulation. Since fluorescence is a physical phenomenon, we can extract various kinds of information by making full use of its characteristics. For example, the excited energy of a fluorescent molecule donor transfers to an acceptor relative to the distance and orientation between the two fluorophores. This phenomenon can be used to identify interaction between biological molecules or structural change in biological molecules. Besides, we can apply all other characteristics of fluorescence, such as polarization, quenching, photobleaching, photoconversion, and photochromism, in experimentation. Cruising inside cells in a super-micro corps, gliding down in a microtubule like a roller coaster, pushing our ways through a jungle of chromatin while hoisting a flag of nuclear localization signal --- we are reminded to retain a playful and adventurous perspective at all times. What matters is mobilizing all capabilities of science and giving full play to our imagination.



Cultured HeLa cells expressing the photoconvertible fluorescent protein, Keade. Before (left) and after (right) multiple, local irradiation of violet laser light, green-to-red color conversion occurred in the cytosol or nucleus of targeted cells.

▶ Fields

Medicine, dentistry, and pharmacy,
Engineering, Biological Sciences,
Biology / Biochemistry

▶ Keywords

Bio-imaging, Fluorescence protein,
Chromophore group

▶ Publications

1. Hirano M., Yonemaru Y., Shimozono S., Sugiyama M, Ando R, Okada Y, Fujiwara T, and Miyawaki A. “StayGold photostability under different illumination modes.” ***Sci. Rep.*** 14, 5541 (2024).
2. Ando R, Shimozono S, Ago H, Takagi M, Sugiyama M, Kurokawa H, Hirano M, Niino Y, Ueno G, Ishidate F, Fujiwara T, Okada Y, Yamamoto M, and Miyawaki A. “StayGold variants for molecular fusion and membrane-targeting applications.” ***Nat. Methods*** (2023).
3. Hirano, M., Ando, R., Shimozono, S., Sugiyama, M., Takeda, N., Kurokawa, H., Deguchi, R., Endo, K., Haga, K., Takai-Todaka, R., Inaura, S., Matsumura, Y., Hama, H., Okada, Y., Fujiwara, T., Morimoto, T., Katayama,K., Miyawaki, A.: “A highly photostable and bright green fluorescent protein” , ***Nat Biotechnol.*** 40, 1132–1142 (2022).
4. Michikawa, T., Yoshida, T., Kuroki, S., Ishikawa, T., Kakei, S., Kimizuka, R., Saito, A., Yokota, H., Shimizu, A., Itohara, S., and Miyawaki, A.: “Distributed sensory coding by cerebellar complex spikes in units of cortical segments” , ***Cell Rep.***37(6), 109966 (2021).
5. Katayama, H., Hama, H., Nagasawa, K., Kurokawa, H., Sugiyama, M., Ando, R., Funata, M., Yoshida, N., Homma, M., Nishimura, T., Takahashi, M., Ishida, Y., Hioki, H., Tsujihata, Y., and Miyawak,i A.: “Visualizing and Modulating Mitophagy for Therapeutic Studies of Neurodegeneration” , ***Cell*** 181(5), 1176-1187 (2020).

▶ Member

Asako Sakaue-Sawano / Masahiko Hirano /
Asako Tosaki

Image Processing Research Team

Team Leader **Hideo Yokota** D.Eng.

▶ Fields

Engineering, Informatics, Computer Science

▶ Keywords

Multi dimensional image processing,
Multi dimensional imaging, Bioengineering,
Image analysis, Medical engineering

▶ Publications

1. Sasaki, S., Mori, T., Enomoto, H., Nakamura, S., Yokota, H., Yamashita, H., Goto-Inoue, N.: "Assessing Molecular Localization of Symbiont Microalgae in Coral Branches Through Mass Spectrometry Imaging" , ***Mar Biotechnol*** (2024).
2. Wang, J., Maeda, E., Tsujimura, Y., Abe, T., Kiyonari, H., Kitaguchi, T., Yokota, H., Matsumoto, T.: "In situ FRET measurement of cellular tension using conventional confocal laser microscopy in newly established reporter mice expressing actinin tension sensor" , ***Scientific Reports***. 13, Article number, 22729 (2023).
3. Takemoto, S., Hori, K., Yoshimasa, S., Nishimura, M., Nakajo, K., Inaba, A., Sasabe, M., Aoyama, N., Watanabe, T., Minakata, T., Ikematsu, H., Yokota, H., Yano, T.: "Computer-aided demarcation of early gastric cancer: a pilot comparative study with endoscopists" , ***Journal of Gastroenterology*** (2023).
4. Umebayashi, M., Takemoto, S., Reymond, L., Sundukova, M., Hovius, R., Bucci, A., Heppenstall, P.A., Yokota, H., Johnsson, K., Riezman, H.: "A covalently-linked probe to monitor local membrane properties surrounding plasma membrane proteins" , ***Journal of Cell Biology,*** 222 (3):e202206119 (2023).
5. Mitsui, T., Mori, A., Takamatsu, T., Kadota, T., Sato, K., Fukushima, R, Okubo, K., Umezawa, M., Takemura, H., Yokota, H., Kuwata, T., Kinoshita, T., Ikematsu, H., Yano, T., Maeda, S., Soga, K., "Evaluating the identification of the extent of gastric cancer by over-1000 nm near-infrared hyperspectral imaging using surgical specimens" , ***Journal of Biomedical Optics.*** Vol. 28. Issue 8, 086001 (2023).

▶ Member

Shin Yoshizawa / Satoshi Oota / Shigeho Noda / Takashi Michikawa / Satoko Takemoto / Sakiko Nakamura / Yuki Tsujimura / Masaomi Nishimura / Shuning Han / Kotaro Oikawa

Image processing research for scientific information

Our goal is to develop original RIKEN data processing technology and multidimensional measurement technology in order to contribute to understanding biological phenomena. We are especially contributing to the fields of mathematical biology, bio-medical simulations as well as medical diagnostic and treatment technology by researching and developing new data and image processing technologies and establishing new tools for quantification of biological phenomena, intended for researchers both inside and outside RIKEN.

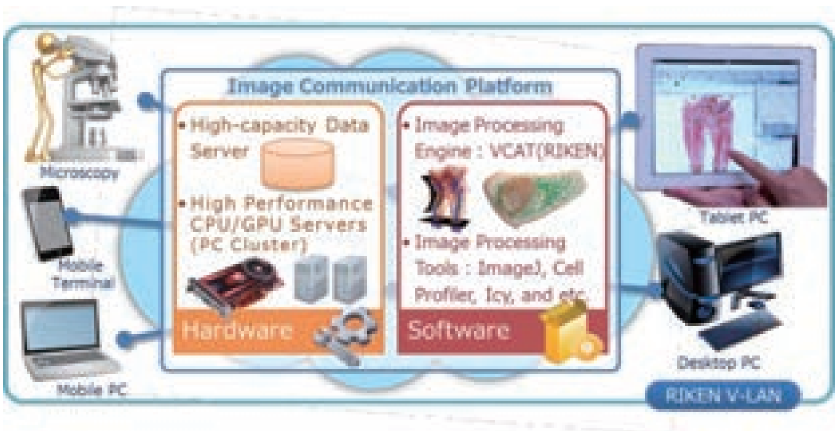
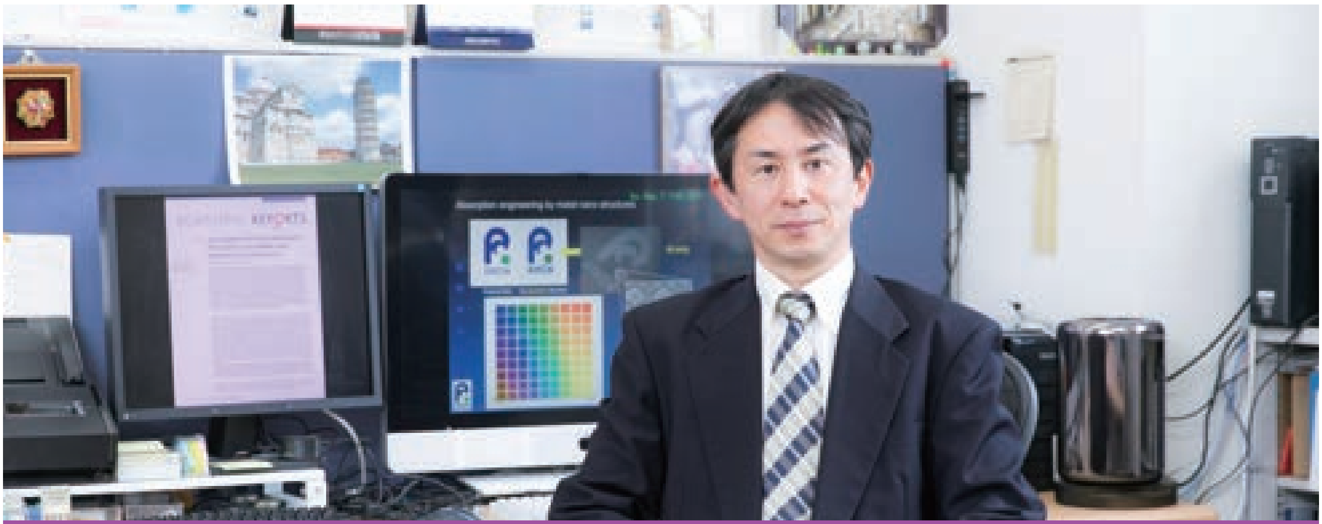


Image Processing Cloud

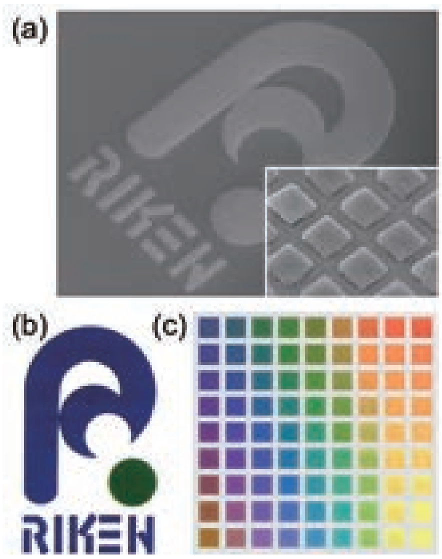
Innovative Photon Manipulation Research Team

Team Leader Takuo Tanaka D.Eng.



Lightwave manipulation by subwavelength structures

Our team intensively studies novel photon manipulation technologies using knowledge and experiences obtained from the researches on light wave interaction with sub-wavelength fine structures. These photon manipulation technologies will be applied for three-dimensional nanofabrication systems, ultra-high sensitive molecular sensing devices, and so on. Figure (a) shows a scanning electron microscope image of RIKEN' s logo consists of a sub-wavelength aluminum structure, which absorbs light of certain wavelength determined by its size and shape. Figure (b) shows an observed image of the RIKEN' s logo under white light illumination. Figure (c) shows a demonstrated color palette covering a broad gamut of colors.



Colors created by metamaterial absorber that consists of subwavelength aluminum structure.

▶ Fields

Engineering, Complex systems, Interdisciplinary science and engineering

▶ Keywords

Metamaterials, Plasmonics, Nanophotonics, Near-field Optics, Applied Optics

▶ Publications

1. Chu, C. H., Chia, Y.-H., Hsu, H.-C, Vyas, S., Tsai C.-M., Yamaguchi, T., Tanaka, T., Chen, H.-W., Luo, Y. , Yang P.-C., and Tsai, D. P.: "Intelligent Phase Contrast Meta-Microscope System", ***Nano Letters*** 23, 24, 11630-11637 (2023).
2. Chen, M. K., Chu, C. H., Liu, X., Zhang, J., Sun, L., Yao, J., Fan, Y., Liang, Y., Yamaguchi, T., Tanaka, T., and Tsai, D. P.: "Meta-Lens in the Sky", ***IEEE Access*** 10, 46552-46557 (2022).
3. Tanaka, T., Yano T., and Kato, R.: "Nanostructure-enhanced infrared spectroscopy", ***Nanophotonics*** 11, 2541-2561 (2022).
4. Jung, W., Jung, Y., Pikhitsa, P., Feng, J., Yang, Y., Kim, M., Tsai, H., Tanaka, T., Shin, J., Kim, K., Choi, H., Rho, J., and Choi, M.: "Three-dimensional nanoprinting via charged aerosol jets", ***nature*** 592, 54 (2021).
5. Olaya, C. M., Hayazawa, N., Hermosa, N., and Tanaka, T.: "Angular Goos-H nchen shift sensor using gold film enhanced by surface plasmon resonance", ***J. Phys. Chem. A*** 125, 451-458 (2021).

▶ Member

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Maria Vanessa Balois Oguchi /
Cherrie May Mogueis Olaya /
Takeshi Yamaguchi

Advanced Laser Processing Research Team

Team Leader **Koji Sugioka** D.Eng.

▶ Fields

Engineering, Materials Sciences,
Interdisciplinary science and engineering,
Multidisciplinary

▶ Keywords

Femtosecond laser, Laser processing,
Micro/nanofabrication, 3D fabrication, Biochip

▶ Publications

1. Zhang, J., Obata, K., Ozasa, K., Uzawa, T., Ito, Y., Sugioka, K.: "Rapid manufacturing of glass-based digital nucleic acid amplification chips by ultrafast Bessel pulses" , ***Small Sci.*** 4, 2300166 (2024).
2. Kawabata, S., Bai, S., Obata, K., Miyaji, G., and Sugioka, K.: "Two-dimensional laser-induced periodic surface structures formed on crystalline silicon by GHz burst mode femtosecond laser pulses" , ***Int. J. Extreme Manuf.*** 5, 015004 (2023).
3. Bai, S., Serien, D., Ma, Y., Obata, K., and Sugioka, K.: "Attomolar sensing based on liquid-interface assisted surface enhanced Raman scattering in microfluidic chip by femtosecond laser processing" , ***ACS Appl. Mater. Interfaces*** 12, 42328–4233 (2020).
4. Bai, S., Serien, D., Hu, A., and Sugioka, K.: "Three-dimensional microfluidic SERS chips fabricated by all-femtosecond-laser- processing for real-time sensing of toxic substances" , ***Adv. Funct. Mater.*** 28, 1706262 (2018).
5. Wu, D., Xu, J., Niu, L., Wu, S., Midorikawa, K., and Sugioka, K.: "In-channel integration of designable microoptical devices using flat scaffold-supported femtosecond-laser microfabrication for coupling-free optofluidic cell counting" , ***Light Sci. Appl.*** 4, e228 (2014).

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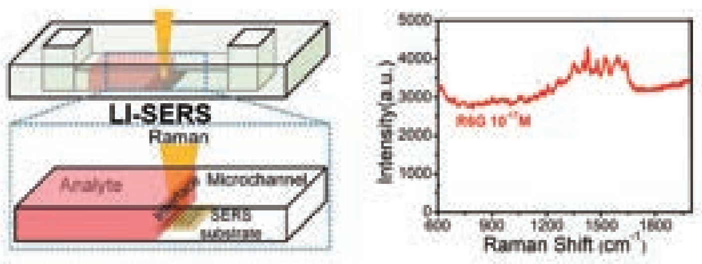
Ashkan MomeniBidzard / Kazunari Ozasa /
Shota Kawabata

Femtosecond Laser 3D Processing: Fabrication of Highly Functional Micro/Nanosystems

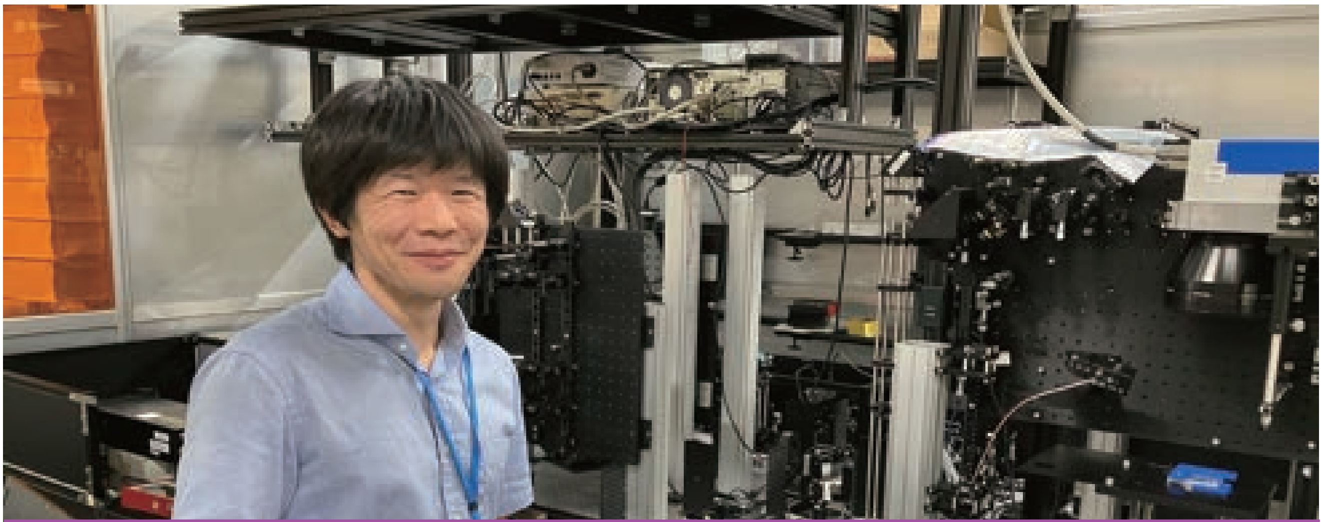
Our research team is developing advanced laser processing techniques which realize low environmental load, high quality, high efficiency fabrication of materials. In particular, by using femtosecond lasers, novel material processing techniques including 3D fabrication, surface nanostructuring, novel nanomaterial synthesis, and tailored beam processing are developed, which are applied to fabricate highly functional micro/nanodevices. As one of examples, our team successfully fabricated 3D microfluidic surface enhanced Raman spectroscopy (SERS) chips by combining different types of femtosecond laser processing (hybrid femtosecond laser processing). The fabricated SERS chips enabled real-time sensing of trace substances as well as ultrasensitive detection of analytes at attomolar-level concentrations. The developed technique will offer high sensitivity diagnosis of diseases such as viral infection and Alzheimer's disease in early stages.



(Left) Schematic illustration of a new SERS sensing scheme (Liquid Interface Assisted SERS: LI-SERS) enabling attomolar sensing.
(Right) Analysis of R6G solution at a concentration of 10^{-17} M by LI-SERS using a microfluidic SERS chip.

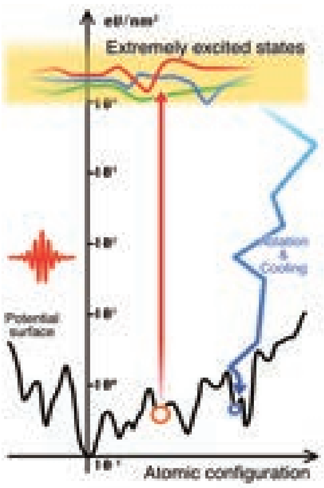
Digital Twin for Light-Matter Interaction RIKEN ECL Research Team

RIKEN ECL Team Leader Shuntaro Tani Ph.D



Constructing Digital Twin for Multi-Scale Phenomena Driven by Photo-Excitation

With the advancement of laser technology, we can now apply laser fields onto materials, the strength of which is comparable to the interatomic bonds of the materials themselves. These strong and controllable light electric fields are expected to be utilized in precise laser processing and various forms of material state control. However, the physics underlying irreversible processes, such as the fragmentation of a continuous solid into discrete atoms, remains not fully understood. At present, extensive trial and error is necessary to control these processes. In this research project, we aim to develop a method to extract the 'context' of phenomena by extensively observing microscopic processes beginning with photoexcitation, through the complete automation of experiments. Utilizing this technique, we intend to elucidate the governing equations of materials' irreversible transformation and construct a digital twin for optimizing these processes.



Energy diagram of material destruction driven by ultrafast laser pulses

▶ Fields

Interdisciplinary science and engineering, Physics, Engineering

▶ Keywords

Precision laser processing, Ultrafast spectroscopy, Deep learning, Digital Twin, Autonomous experiment

▶ Publications

1. Endo, T., Tani, S., Sakurai, H., and Kobayashi, Y.: “Probing thermal dissipation dimensionality to laser ablation in the pulse duration range from 300 fs to 1 µs” , ***Opt. Express*** 31, 36027 (2023).
2. Tani, S., and Kobayashi, Y.:"Pulse-by-pulse evolution of surface morphology driven by femtosecond laser pulses", ***J. Appl Phys.*** 133, 143104 (2023).
3. Shimahara, K., Tani, S., Sakurai, H., and Kobayashi, Y.:” A deep learning-based predictive simulator for the optimization of ultrashort pulse laser drilling", ***Commun. Eng.*** 2, 1 (2023).
4. Tani, S., Sugiyama, K., Sukegawa, T., Sato, T., Ishizuka, Y., Taya, S., Feng, F., Komeda, O., Suto, H., Saitoh, H., and Kobayashi, Y.:” Real-time high-spectral-resolution mid-infrared spectroscopy with a signal-to-noise ratio of ten thousand” , ***Opt. Express*** 30, 36813 (2022).
5. Tani, S., and Kobayashi, Y.:"Ultrafast laser ablation simulator using deep neural networks” , ***Sci. Rep.*** 12, 5837 (2022).

▶ Member

My Kagaku-do

Attracted by the infinite possibilities of lasers

Director
RIKEN Center for Advanced Photinics

Dr. Katsumi Midorikawa

A "laser" is an artificially created beam of light that travels in a straight line at a single wavelength. Lasers have a wide range of applications including micro processing, communications, and microscopic observation, and are an important technology, as the Nobel Prize in Physics was awarded to research advances in this field in 2018 and 2023. The Director of the RIKEN Center for Advanced Photonics (RAP), Katsumi Midorikawa, has made significant achievements in this highly competitive field, including the development of the world's highest power attosecond pulse laser.

My encounter with lasers

About 40 years ago, when I was a graduate student, I began researching lasers as a means of generating nuclear fusion, which was regarded as a next-generation source of energy. After completing my post-graduate studies, I participated in a uranium enrichment project at RIKEN to use my knowledge about laser technology. When the project's objective was achieved, I made a research proposal for creating an X-ray laser. Since then, I have been pursuing that ambition.

One discovery after another made the impossible possible

In the early 1980s, the laser community was excited by the idea that X-rays would be the next big thing. However, at RIKEN we could not produce X-ray lasers at that time, as it required a huge excitation laser. While we were thinking about what to do, a revolutionary method called "chirped-pulse amplification" (for which the 2018 Nobel Prize in Physics was awarded) was developed, allowing a dramatic increase in laser intensity, and we realized that it might be possible to use this method to develop a desktop-sized laser device.

However, as we started developing the device, we found that the lack of an X-ray mirror made it impossible to amplify the X-rays with the phase (position of the wave's peaks and valleys) aligned. Around that time the phenomenon of "high order harmonics," for which the 2023 Nobel Prize in Physics was awarded, was discovered, and it was found that although the output would be weak, it was possible to shorten the wavelength in a phase-aligned manner. Using this phenomenon, in 2002 we succeeded in developing an attosecond pulse laser with high output power in the X-ray wavelength range. The method we used is now the international standard for high order harmonics.

Although the development of this device was made possible by discoveries which could be nominated for the Nobel Prize, the actual development of the device was very difficult. We struggled with the lack of laser intensity during the development but were lucky, because we unintentionally removed the hollow fiber used to confine the laser beam, and found that doing this improved the intensity and solved the problem.

Attosecond pulse lasers have changed the world

One of the things we wanted to do was to be able measure the length of attosecond pulses. When you look at the comb-like spectra of high order harmonics, it is easy to imagine a series of attosecond pulses with time widths being aligned. However, measuring pulse widths in the X-ray region, where, unlike in the visible spectrum, there are few optical elements, is not an easy task.

While researchers around the world were taking on this problem, we developed a device that could divide pulses of the attosecond pulse laser into twin pulses and makes them interfere with one another, and we then measured the pulse time width. In 2005 we succeeded in measuring attosecond time using the twin attosecond pulses for the first time in the world. An attosecond is one quintillionth (10-18) of a second, which is short enough to measure the movement of electrons. The ability to observe things on a completely different time scale gave birth to the field of "attosecond science."

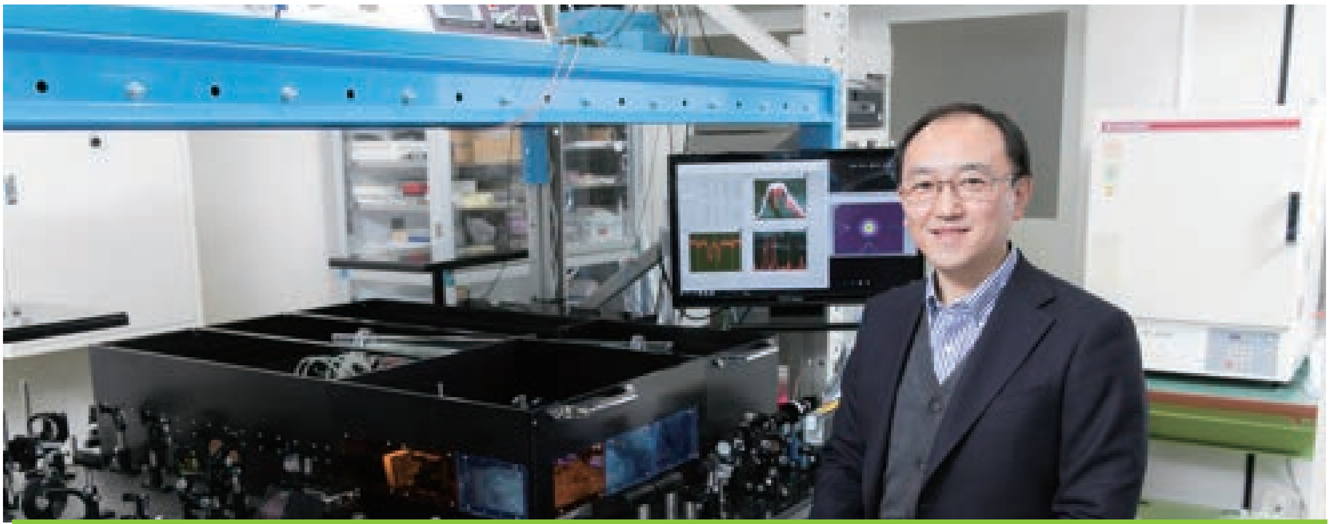
I look forward to seeing young researchers succeed in further developing these achievements, as I would see it as the culmination of my research. However, my own interest in lasers is still insatiable. I am increasingly sympathetic to the words of a renowned Nobel laureate who said that lasers have no limits, only horizons.

Interviews and composition: Akiko Ikeda, Photography: Tadashi Aizawa.

Reprinted from RIKEN NEWS 2024 Summer

Tera-Photonics Research Team

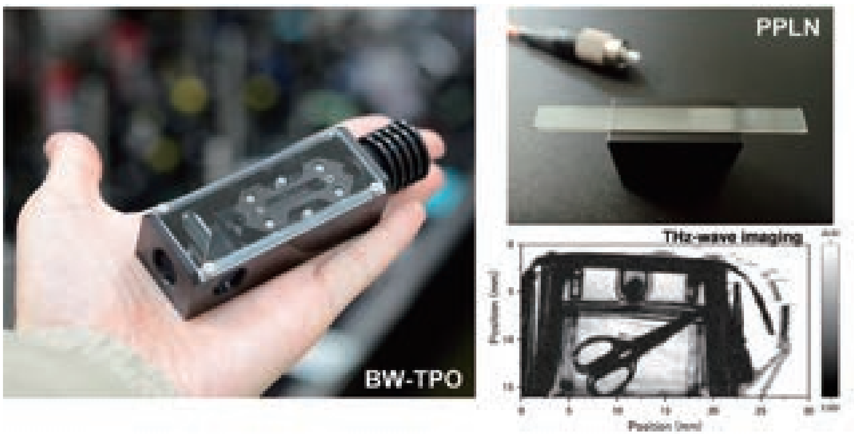
Team Leader Hiroaki Minamide D.Eng.



Leading Terahertz science & applications with innovative Tera-photonics technology

Our team develops state-of-the-art frequency-tunable THz-wave sources which exploit new THz-wave application fields. A nonlinear optical process is utilized for realizing the THz-wave source which lights up the THz-wave gray zone, and our original design and method will be demonstrated. We develop THz sources with high output, wide tunability, high stability and narrow linewidth.

Active collaboration with both internal and external research groups is carried out for exploring new applications by development of instrument combined with new THz-wave sources. Advanced THz-wave technologies are also being developed in cooperation with industry to establish practical THz-wave sources and technologies in the world.



Backward terahertz parametric oscillator (left), PPLN crystals (top right), and THz-wave imaging (bottom right)

▶ Fields

Engineering,
Interdisciplinary science and engineering

▶ Keywords

Development of kilo-watt-power Terahertz-wave source, Sensitive Terahertz-wave detection, Terahertz-wave applications, Nondestructive measurements, Nonlinear optics

▶ Publications

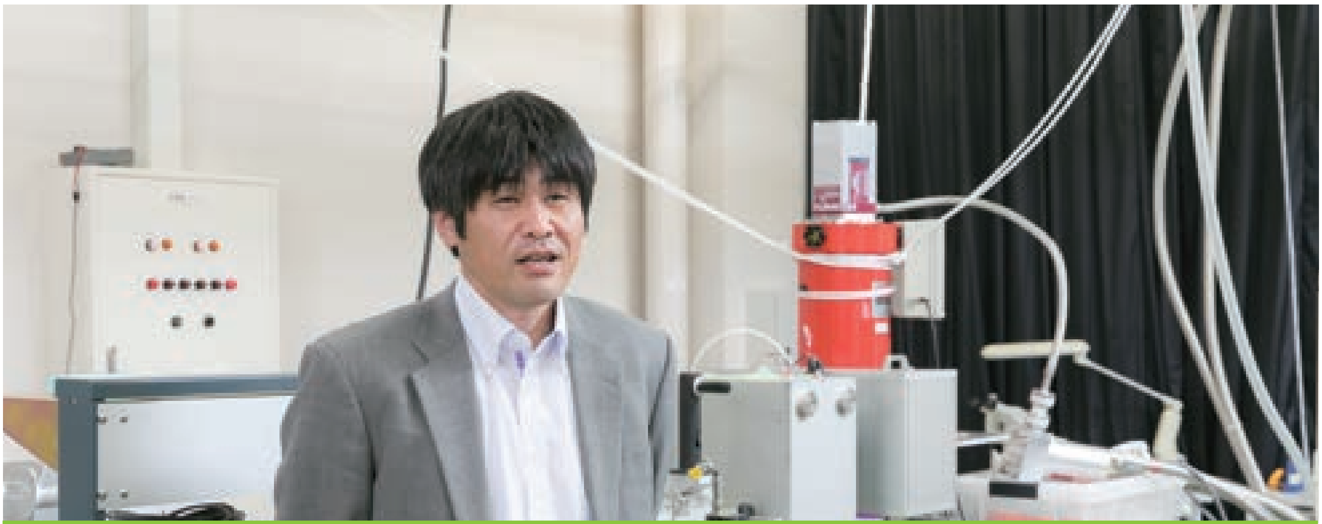
1. Nishida, M., Notake, T., Takida, Y., Hirosawa, K., Ohata, N., and Minamide, H.: "High-repetition-rate injection-seeded terahertz-wave parametric generation pumped by a 1.5 μm sub-nanosecond laser", ***Appl. Phys. Lett.*** 124, 12 121105 (2024).
2. Satou, A., Negoro, T., Narita, K., Hosotani, T., Tamura, K., Tang, C., Lin, T.-T., Retaux, P.-E., Takida, Y., Minamide, H., Suemitsu, T., and Otsuji, T.: "Gate-readout and a 3D rectification effect for giant responsivity enhancement of asymmetric dual-grating-gate plasmonic terahertz detectors", ***Nanophotonics*** 12, 23 4283–4295 (2023).
3. Shirato, M., Takida, Y., Kanno, T., Matsuura, H., Niwano, Y., Minamide, H., Nakamura, K.: "Mutagenicity assessment of high-power 1.6-THz pulse laser radiation", ***Photochem. Photobiol.*** 100, 146-158 (2023).
4. Muldera, J.E., Nawata, K., Takida, Y., Yadav, D., and Minamide, H.: "Tunable backward terahertz-wave parametric oscillator centered at a high frequency of 0.87 THz with injection seeding", ***Opt. Express*** 31, 15 23966-23973 (2023).
5. Tamura, K., Tang, C., Ogiura, D., Suwa, K., Fukidome, H., Takida, Y., Minamide, H., Suemitsu, T., Otsuji, T., and Satou, A.: "Fast and sensitive terahertz detection with a current-driven epitaxial-graphene asymmetric dual-grating-gate field-effect transistor structure", ***APL Photonics*** 7, 12 126101 (2022).

▶ Member

Yuma Takida / Joselito Muldera / Deepika Yadav / Alexander De Los Reyes / Yuehong Xu

Terahertz Sensing and Imaging Research Team

Team Leader Chiko Otani D.Sci



Fields

Engineering, Space Science,
Molecular Biology / Genetics, Physics,
Agricultural Sciences, Chemistry,
Interdisciplinary science and engineering

Keywords

Terahertz wave, Spectroscopy and Imaging, Sensing, Structural and Functional control of biological tissues, Superconducting detector

Publications

1. De Miguel, J., Hernández-Cabrera, J. F., Hernández-Suárez, E., Joven-Álvarez, E. Otani, C., and Rubiño-Martín, J. A.: "Discovery prospects with the Dark-photons & Axion-Like particles Interferometer" , ***Physical Review.*** D 19, 6, 062002 (2024).
2. Feng, C. H., Otani, C., and Hoshina, H.: "Characterization of Different Types of Crystallization from Cocoa Butter by Using Terahertz Spectroscopy," ***Appl. Sci.*** 14, 35 (2024).
3. Ikari, T., Sasaki, Y., and Otani, C.: "275-305 GHz FM-CW radar 3D imaging for walk-through security body scanner" , ***Photonics.*** 10, 3, 343 (2023).
4. Yamazaki, S., Ueno, Y., Hosoki, R., Saito, T., Idehara, T., Yamaguchi, Y., Otani, C., Ogawa, Y., Harata, M., and Hoshina, H.: "THz irradiation inhibits cell division by affecting actin dynamics" , ***PloS One*** 16, e0248381 (2021).
5. Lee, K., Génova-Santos, R. T., Hazumi, M., Honda, S., Kutsuma, H., Oguri, S., Otani, C., Peel, M. W., Suzuki, J., Tajima, O., Won, E.: "A forecast of the sensitivity on the measurement of the optical depth to reionization with the GroundBIRD experiment" , ***Astrophys. J.,*** 915, 88 (2021).

Member

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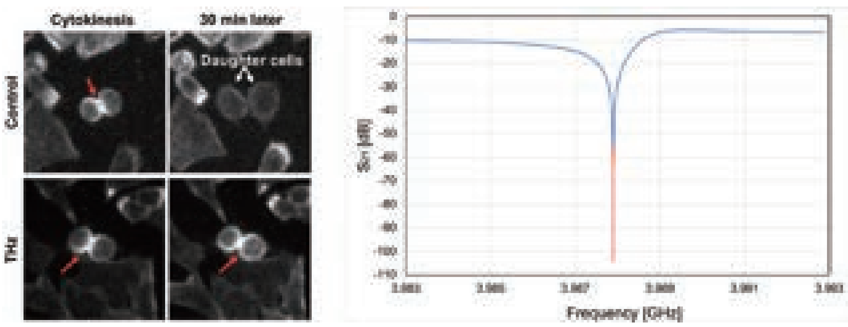
Shusaku Nakajima / Yuto Kamei /
Javier De Miguel Hernandez / Shinsuke Uno /
Yuya Ueno / Ryota Ito

Terahertz Sensing, Imaging and Applications

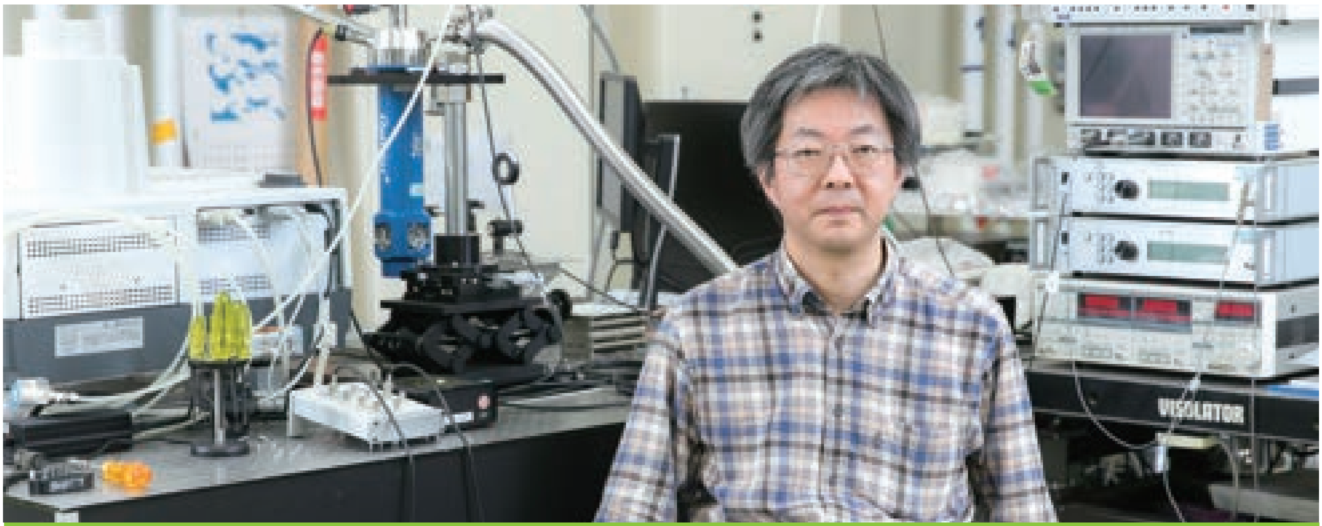
Terahertz (THz) wave has the unique characteristics such as the transparency to many soft materials and their spectral absorption features. These characteristics can be utilized for many applications in various scientific and industrial fields. In this team, we are developing novel technologies, science and applications in THz sensing, imaging, and detection. In particular, we are conducting research and development on the control of molecular structure and function by THz-wave irradiation, high-sensitivity imaging and observations using superconducting detectors as well as the collaborative research and development with companies.



(Left) Inhibition of cell division by actin protein fibrillation in cells by terahertz-wave irradiation (microscopic image).
(Right) VNA spectrum of a thin-film superconducting microwave resonator with a high quality factor (Q_i~10^8).

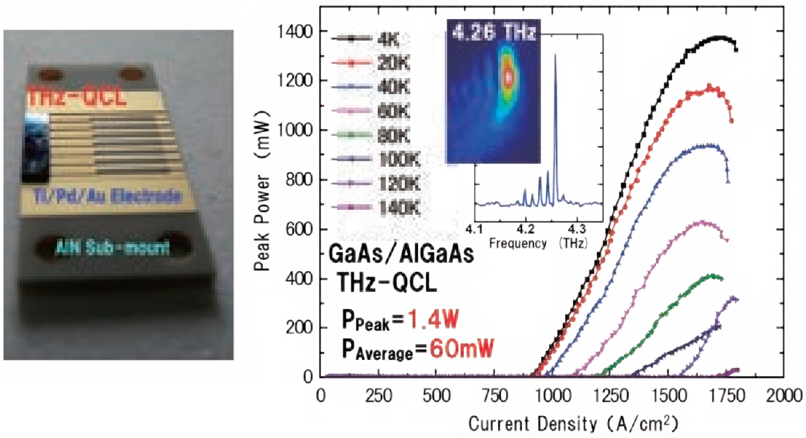
Terahertz Quantum Device Research Team

Team Leader Hideki Hirayama D.Eng.



Development of compact and potable terahertz laser source

Terahertz light having both the transparency of radio wave and the high resolution of light is expected to be used in a wide range of application fields as a light source for various perspective and nondestructive inspections. We are developing THz-QCL (terahertz quantum-cascade laser), which is expected to be a very compact, portable, high power terahertz light source. Through the introduction of a new quantum subband structure and/or nitride semiconductors, THz-QCL aiming for implementation in society is being developed by performing room temperature oscillation and enlarging the operating frequency region which have been impossible so far. By developing the next generation compact terahertz imaging devices, we would like to contribute to the realization of a prosperous society in the near future.



Photograph and operating properties of terahertz quantum-cascade laser (THz-QCL)

▶ Fields

Optical Devise Engineering, Quantum Electronics, Semiconductor Physics

▶ Keywords

Terahertz, Quantum cascade lasers,
Inter-subband transition,
Nitride semiconductors lasers,
Molecular-beam epitaxy

▶ Publications

1. Wang, L., Lin, T. T., Wang, K., and Hirayama, H.: "Clean three-level direct-phonon injection terahertz quantum cascade laser" , ***Applied Physics Letters,*** Vol. 122, pp. 221103 (2023).
2. Wang, L., Chen, M., Lin, T. T., Wang, K., and Hirayama, H.: "Interdiffusion limiting on self-consistent optical gain in terahertz quantum cascade lasers" , ***Applied Physics Express*** Vol. 16, 072004 (2023).
3. Wang, L., Lin, T. T., Chen, M., Wang, K., and Hirayama, H.: "Terahertz quantum cascade laser considering compositional interdiffusion effect" , ***Applied Physics Express*** Vol. 16, pp. 032007 (2023).
4. Lin, T. T., Wang, L., Wang, K., Grange, T., Birner, S., Miyoshi, T., and Hirayama, H.:" Increasing the output power of a heavily doped terahertz quantum cascade laser by avoiding the subband misalignment" , ***Journal of Applied Physics***, Vol. 132, pp. 173101-1-10 (2022).
5. Lin, T. T., Wang, L., Wang, K., Grange, T., Birner, S., and Hirayama, H.:" Over one watt output power terahertz quantum cascade lasers by using high doping concentration and variable barrier-well height" , ***physica status solidi RRL,*** Vol. 16, pp. 2200033 (2022).

▶ Member

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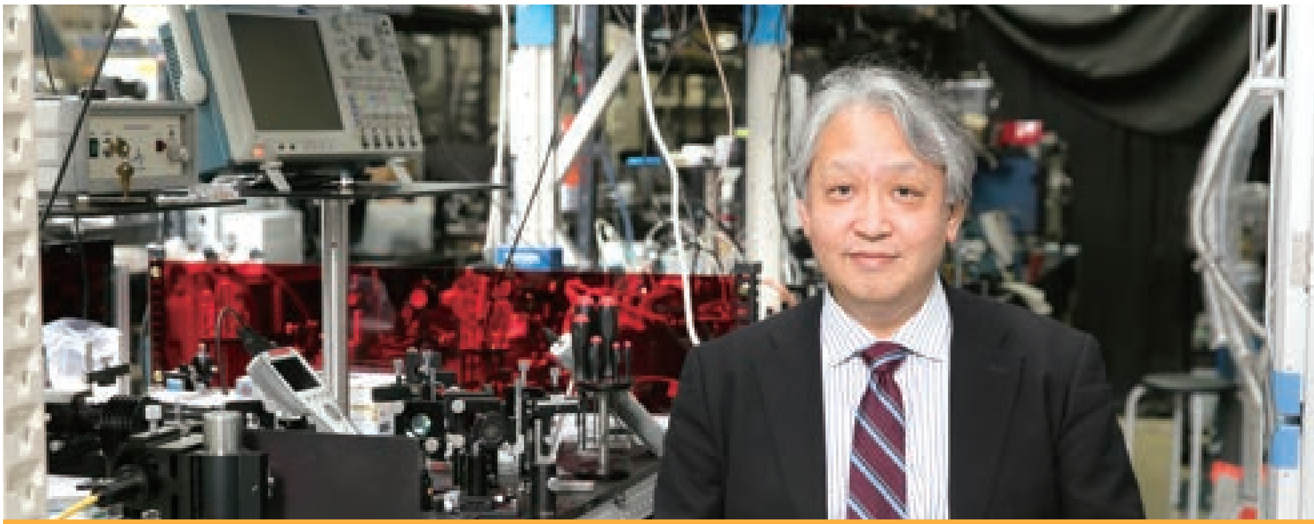
Kenji Yamazawa / Manabu Kadowaki

Photonics Control Technology Team

Team Leader **Satoshi Wada** Ph.D.



▶ Fields

Engineering, Physics, Biology / Biochemistry, Agricultural Sciences,
Medicine, dentistry, and pharmacy

▶ Keywords

Particle control and measurement, Medical and agricultural measurement, Trace gas measurement, Natural energy, Space applications

▶ Publications

1. Nakamura, Y., Moriyama, D., Isomura A., Sasoh, A., Tsuno, K., Ogawa, T., Wada, S., and Fukushima, T.: "Laser ablation impulse dependence on beam Spatial-Profile" ***Optics & Laser Technology,*** Volume 169, 110160 (2024).
2. Yumoto, M., Miyata, K., Kawata, Y., and Wada, S.: "Mid-infrared self-difference frequency generation via random quasi-phase-matching in Cr:ZnSe laser" , ***Optics & Laser Technology,*** Volume 169, 110161 (2024).
3. Murakami, T., Morishita, K., Koike, K., Fujii, K., and Wada, S.: " Electrolyte potentials and impedance measurement of polymer electrolyte membrane CO2 reduction electrolyzer" , ***Japanese Journal of Applied Physics,*** Volume 62, Number SK (2023).
4. Tsuno, K., Koike, K., Fujii, K., Ogawa, T., and Wada, S.: "User-on-demand Renewable Energy Supply System Using Modified DC-bus Signaling" , ***IFAC-PapersOnLine,*** Volume 56, Issue 2, Pages 9098-9103 (2023).
5. Nozawa, S., Saito, N., Kawahara, T., Wada, S., Tsuda, T. T., Maeda, S., Takahashi, T., Fujiwara, H., Narayanan, V. L., Kawabata, T., and Johnsen, M. G.: "A statistical study of convective and dynamic instabilities in the polar upper mesosphere above Tromsø" , ***Earth, Planets and Space*** volume 75, Article number: 22 (2023).

▶ Member

Norihito Saito / Kiwamu Kase /
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Shigeharu Moriya / Takayo Ogawa /
Katsushi Fujii / Kentaro Miyata / Masato Otagiri /
Takeharu Murakami / Manabu Inukai /
Tatsuya Shinozaki / Hiroshi Kasuga /
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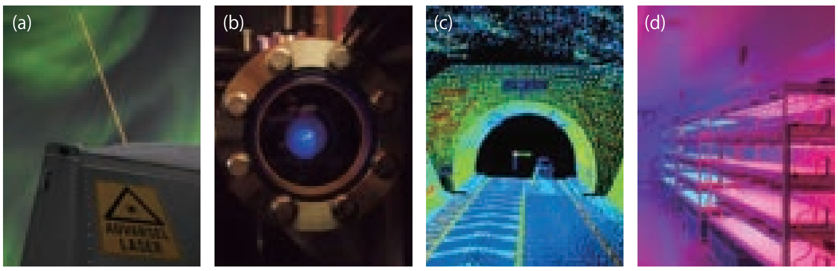
Kei Morishita / Yasushi Kawata /
Akihiro Tanabashi / Saki Miyajima /
Hiroshi Matsutaka /Aya Kashifuku /
Tomohiro Tsukihana / Norihiro Matsuyama /
Noriko Kurose / Yoko Ono / Takeshi Matsumoto /
Miyuki Nara

Development of photonics control technology for science and social issues

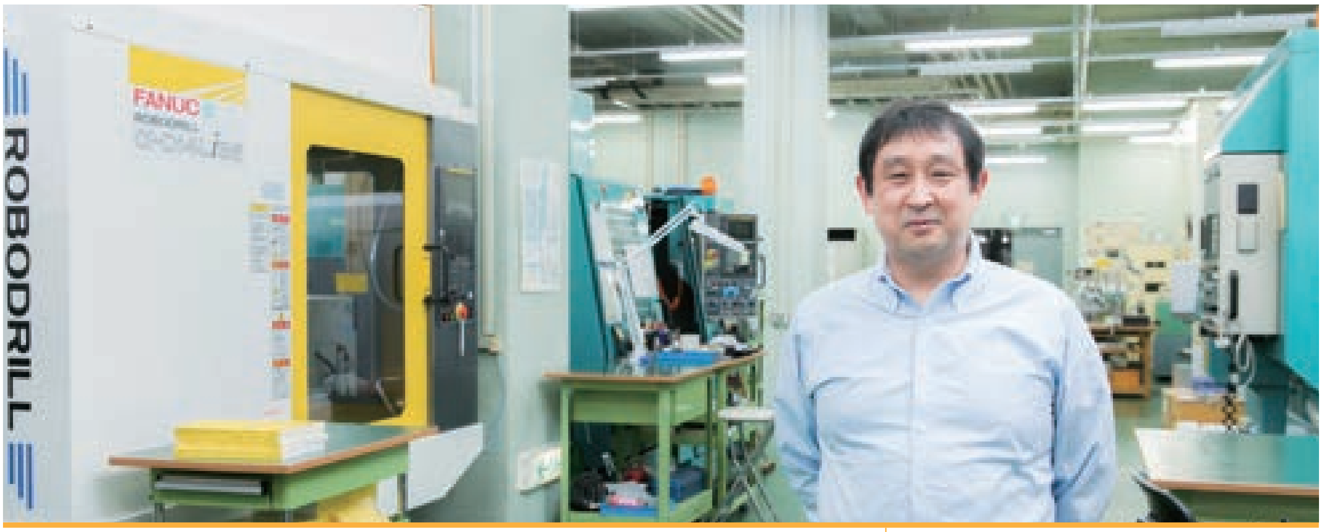
Our team investigates new optical technologies for solving world-wide environmental and energy problems. We are mainly developing remote-sensing system of poisonous gas, lidar as an atmospheric monitor for high energy cosmic ray observation, and solar-pumped laser for advanced energy source. We are also developing tunable laser-based biosensors for biomedical and agricultural applications. These researches will contribute to build and to maintain social environment that humans can live safely. Moreover, we are investigating fundamental research topics including particle control with high power Lyman α coherent source, and development of laser pumped neutron source. New applied researches were performed on the basis of basic research of laser materials, and nonlinear optics. We are also interested in space debris removable with space laser technology.



(a) Sodium LIDAR
(b) Coherent Lyman-α resonance radiation source for ultra-slow muon generation
(c) Laser inspection of infrastructure by courtesy of Shizuoka Pref. and Topcon Corp.
(d) Application of photonics control technology to plant cultivation

Ultrahigh Precision Optics Technology Team

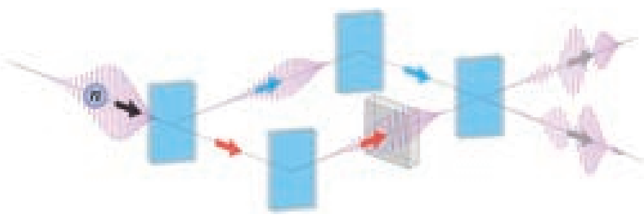
Team Leader Yutaka Yamagata D.Eng.



Developing advanced optical components by ultrahigh precision technology

Our team develops advanced ultrahigh-precision/micro fabrication technologies and their application to scientific apparatuses and devices to support advanced scientific research at RIKEN. Research and development plans of our team include the following four topics: (1) Development of ultrahigh-precision optics including design, fabrication, metrology and computational simulation; (2) Development of ultrahigh-precision/micro fabrication technologies; (3) Development of materials and devices for biology or biochemistry such as microfluidic immunoassay devices.

In all R&D topics, our team collaborates with laboratories inside and outside of RIKEN and helps them to construct the most advanced experimental apparatuses, which will lead to innovative scientific research results.



Newly Developed Supermirror Neutron Interferometer

Fields

Engineering,
Interdisciplinary science and engineering

Keywords

Ultrahigh Precision Machining,
Ultrahigh Precision Metrology, Aspherical Optics,
Production Technology, Neutron Optics

Publications

1. Fujiie T., Hino M., Hosobata T., Ichikawa G., Kitaguchi M., Mishima K., Seki Y, Shimizu M. H., and Yamagata Y.: "Development of Neutron Interferometer Using Multilayer Mirrors and Measurements of Neutron-Nuclear Scattering Length with Pulsed Neutron Source" , ***Phys. Rev. Lett.*** 132, 023402 (2024).
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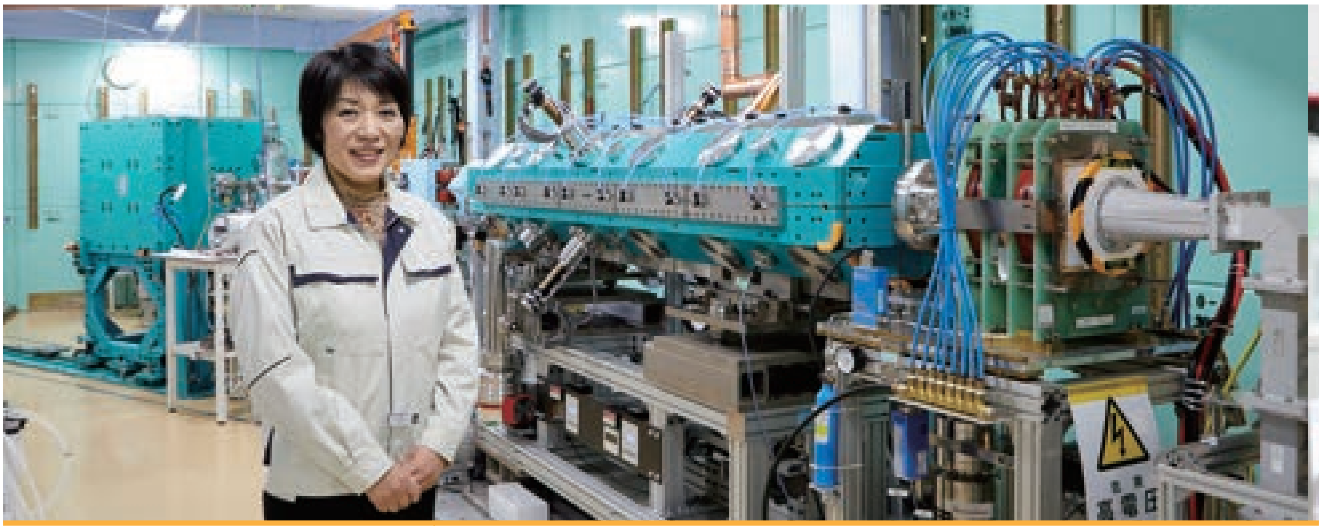

Fields

Physics, Engineering,
Interdisciplinary science and engineering

Keywords

Accelerator-based compact neutron system, Research and development of non-destructive inspection for infrastructures, Detection of salt damage in the concrete by promptgamma neutron activation analysis, Visualization of water and air hole in concrete slabs, Characterization of microstructure and texture evaluation in steels

Publications

1. Otake, Y., Wakabayashi, Y., Takamura, M., Mizuta, M., and Takanashi, T.: "RIKEN Compact Neutron Source Systems RANS Project" , ***Nuclear Physics News, Volume*** 33, Issue 2, Pages 17-21, (2023).
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Research and development of compact neutron system for practical use at anytime, anywhere

The project of RIKEN accelerator-driven compact neutron system (RANS) has two main development goals: the first is the realization of an evaluation and analysis system for use in the field of manufacturing, and the second is the development of non-destructive inspection techniques and equipment for preventive maintenance at infrastructure sites. RANS-II with a total length of 5 m, which can be introduced into the onsite of manufacturing field, has been successfully developed. Neutron salt meter, RANS-μ for outdoor use was successfully used to measure bridge salt density on national highways, and inspection support performance catalogue of MILT. The transportable RANS-III will finally be installed inside a tractor.

The future imaging of compact neutron non-destructive test system on-site