Photonics and Quantum Technology for Society 5.0

Creating the future with photonics and quantum technologies

Enhancing the global competitiveness of Japan's strengths in photonics and quantum technologies

A Cyber Physical System (CPS) that fuses cyber space with physical space is key for achieving Society 5.0. However, there are some bottlenecks that are impeding investment in society and industry during the age of smart manufacturing using IoT/AI technologies. The SIP project, "Photonics and Quantum Technology for Society 5.0," has carefully selected important technologies in laser material processing, information processing, and communication to clear the bottlenecks and will realize "recapturing a market share in laser processing by commercializing Japanese core technologies," "accomplishing smart manufacturing by optimizing design and process in production," and "starting a highly secure cloud service." The challenge will hasten the coming of Society 5.0.

Program Director

Naoto Nishida

Fellow

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Profile

Naoto Nishida obtained an M.E (Electrical Engineering) in 1978 from Keio University. He joined Toshiba Corporation and worked at the Corporate Manufacturing Engineering Center. He successively held the positions of Director of Corporate Manufacturing Engineering Center, General Manager of Corporate Productivity Planning Div., General Manager of Technology Planning Div., Executive Officer, Corporate Vice President, Executive Officer, Corporate Senior Vice President, Director, Executive Officer, and Corporate Executive Vice President. At present, he is a Fellow at Toshiba. D. Eng.

Research and Development Themes

(1) Laser processing

(i) Proof of smart manufacturing based on advanced integration of cyber (simulators) and physical (laser material processing systems): Development of CPS-type laser material processing system for specific uses

(ii) Smart processing based on Japan's core spatial light modulator technology: Development of high-power-resistant and highly accurate space control technologies

(iii) High-power operation of Japan original photonic crystal lasers

(2) Photonic quantum communication

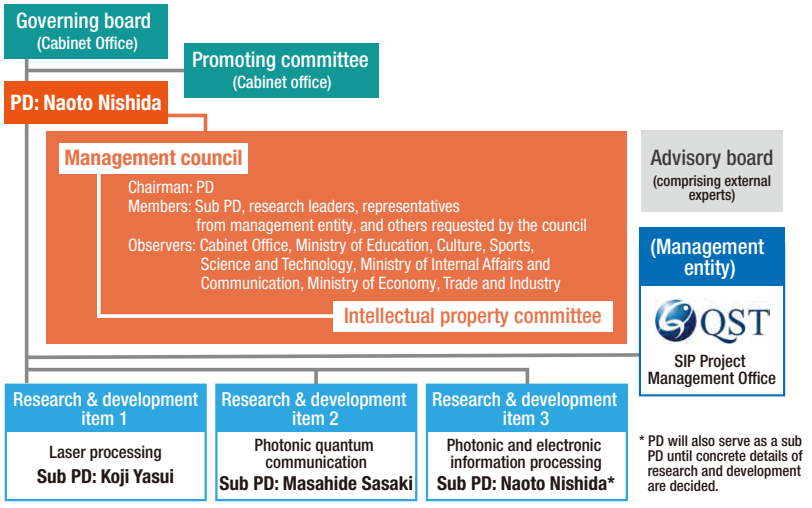
Development of quantum secure cloud technology and demonstration of world-leading secure cloud services with critical data such as electronic medical records, genomic and related information, smart manufacturing information, and so on by integrating quantum cryptography, secret sharing, and secret computation into a network with security that cannot be compromised, even against advances in decryption technologies.

(3) Photonic and electronic information processing

Development of software and middleware for photonic and electronic information processing that solve, for example, combinatorial optimization problems for resources at the high speed required for smart manufacturing over a network to provide cloud services.

Implementation Structure

The promoting committee, which consists of experts from related ministries and agencies and controls operations, is set up under the program director (PD) at the Cabinet Office.
The management council is set up in the National Institute for Quantum and Radiological Science and Technology (QST), the management entity, to support the PD's decisions. The council will decide the policies and goals of the whole program, manage progress, and review research subjects and final goals based on the progress in order to ensure social implementation.



Final Goals

Supplying a test platform and using examples for research and development

We will establish a hub to extract important research subjects, to share plans, etc. for final goals and implementing results into society, and for enhancing the synergistic effects. The hub will supply a test platform for business networks in Japan and overseas, gather technical data, and hold discussions with businesses to help with implementations. Some laser processes tested or adopted by businesses will be fed back into research and development to help businesses get results from commercialization.

Promoting standardization activities

We will operate a quantum secure cloud on a trial basis jointly with users who handle highly confidential data in the medical and smart manufacturing fields. We will promote standardization activities in quantum cryptographic technology and establish a model eco-system with evaluation, validation, and certification in the future in conjunction with formulating operation guidelines.

Developing software on real needs basis

We will develop and provide software for photonic and electronic information processing that solves, for example, combinatorial optimization problems for resources at the high speed required for smart manufacturing over a network. By including feedback from businesses in the software, we will improve and modify it to suit the needs of individual businesses.

Promoting program achievements

We will publicly announce the achievements of research and development proactively and strategically in order to spread them not only to businesses, but also to society as a whole in order to expand world market share and establish a leading position in related industries.

Results

Target results

- The world's highest processing productivity in the manufacturing industry will be attained by implementing CPS-type laser material processing systems (reducing the time required for selecting initial laser processing conditions by 90% compared to the status quo) and by the practical application of spatial light modulator technology that delivers high-accuracy and high-throughput processing (increasing the speed by 10-100 times compared to the status quo).
- With the future application in laser material processing systems, high-brightness* and high-performance photonic crystal lasers will be introduced in an ultra-small light source to achieve sensor technology that quickly detects humans and obstacles for safer mobility (reducing sensing costs drastically and aiming to increase the brightness by 10 times compared to the now widely used semiconductor lasers).
- A quantum secure cloud system in which data are transmitted, stored for backup, and can be accessed for secondary use in a highly secure manner will be realized by developing market-competitive quantum cryptographic systems (with improved tamper resistance and significantly lower cost) and by combining them with secret sharing technology over a network of 100-km range.
- The first software in the world for photonic and electronic information processing will be developed that solves, for example, combinatorial optimization problems in the shortest computational time required for smart manufacturing.

* Optical output per unit area and unit solid angle

Social and economic impact

- Recapture a market share in laser processing by commercializing core Japanese technologies.
- Achieve smart manufacturing by optimizing design and process in production.
- Enhance productivity in the medical and manufacturing fields through safe distribution, storage, and utilization of highly confidential information.