Photon Frontier Network

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Abstract. A new 10-year program "Photon Frontier Network" has been started in 2008 in Japan in order to establish strong bases in research and education in optical science and technology. This network is formed by many scientists belonging to various organizations in broad range of fields, and with industrial participation. The basic structure and objectives of this program are described.

1 Introduction

Optical science is called "enabling technology", since it has provided innovative approaches in broad range of fields from basic science to industry and medicine. In recent years, there have been significant advances in the development of new light sources and also in the understandings of the nature of light. Due to these advances, many new possibilities are emerging which may provide breakthroughs in various fields.

In order to extend these rapid advances to various fields, it is important to foster young scientists who have strong bases in the frontier of optical science and have broad scopes in the applications. However, there has not been coordinated approach to education in optical science, although optical science is regarded as an important basis in almost all fields of science and technology. We think that favourable environment exists at present, since optical science has been attracting many graduate students due to various interesting themes to work on.

In order to establish strong bases in the research and education in optical science, a new 10-year program "Photon Frontier Network" has been started in 2008 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). This network is formed by many laboratories in broad range of fields and organizations, with industrial participation. In this article,

after a brief review of the historical background in optical science policy in Japan, the structure of this program is described.

2 Historical Background

Importance of optical science in the 21st century has been recognized in many countries and several official reports have been published [1, 2]. OECD has published a report on the emerging field developed by compact and high intensity short-pulse lasers [3]. Based on this activity, IUPAP has formed a Working Group "International Committee on Ultrahigh Intensity Lasers (ICUIL)" [4]. In parallel with this, "Asian Intense Laser Network (AILN)" has been started [5]. Also multinational cooperation with major laser laboratory participation has been started in EU as Laserlab Europe [6].

In Japan, many programs related to optical science are carried out under various schemes supported by MEXT, METI (Ministry of Economy, Trade and Industry), MIC (Ministry of Internal Affairs and Communications), and others. However, since optical science is a multidisciplinary field, it has been difficult to lay out a coordinated strategy on optical science. The Science Council of Japan has studied the importance of optical science, and has issued a Statement "Strengthening Optical Science and Technology for Creating New Fields" in 2005 [7].

Optical science has been included in the Third Science and Technology Basic Plan (FY 2006-2010), where construction of X-Ray Free Electron Laser has been started. In order to form stronger bases for research and education in optical science, MEXT has issued an "Interim Report for the Promotion of Photon Science and Technology" in 2007, in which the basic concept of "Photon Frontier Network" has been laid out [8].

3 Framework of Photon Frontier Network

The new program on optical science is composed of two parts [Fig. 1]. One is the "Photon Frontier Network" under MEXT, which is described in this article, and another is the Research Grants under JST (Japan Science and Technology Agency) on "Evolution of Light Generation and Manipulation". These two programs are coordinated at the Board Meeting attended by the Program Officers responsible for implementing these programs, so that these programs contribute to form the basic structure of optical science and technology in Japan.

Photon Frontier Network, which is a 10-year program, is intended to (1) provide advanced facilities to general users, (2) develop advanced light

sources, and (3) foster young researchers. This program is coordinated by Y. Kato as the Program Director (PD) and Y. Sano, S. Yagi and T. Yabuzaki as the Program Officers (PO). The JST Research Grants, which is a 8-year program, is composed of 2 categories "Team type research" and "Individual type research" coordinated by T. Ito and H. Masuhara, respectively.

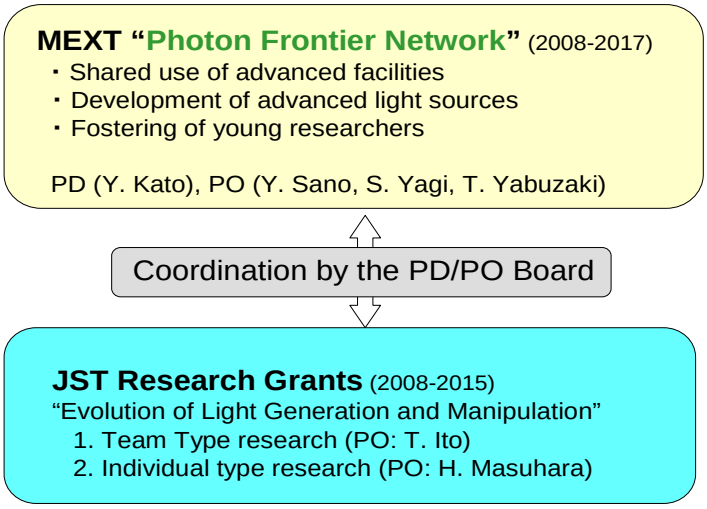

Fig. 1. MEXT "Photon Frontier Network" and JST Research Grants on "Evolution of Light Generation and Manipulation" started in 2008.

Photon Frontier Network is composed of two research consortia; "Advanced Photon Science Alliance" located in Kanto District and "Consortium for Photon Science and Technology (C-PhoST)" located in Kansai District [Fig. 2]. Advanced Photon Science Alliance is directed by M. Gonokami, with its center located at Photon Science Center of the University of Tokyo. C-PhoST is directed by R. Kodama, with its center located at JAEA Center for Photon Science and Technology. These two consortia are composed of several Core Organizations which are described in the following sections. At both of these consortia, it is planned that other organizations will join as Cooperating Institutes after a few years. Therefore it is expected that an extensive research/education network covering most part of Japan is formed in the field of optical science and technology. Collaboration with overseas programs in optical science is also planned to work with the international community.

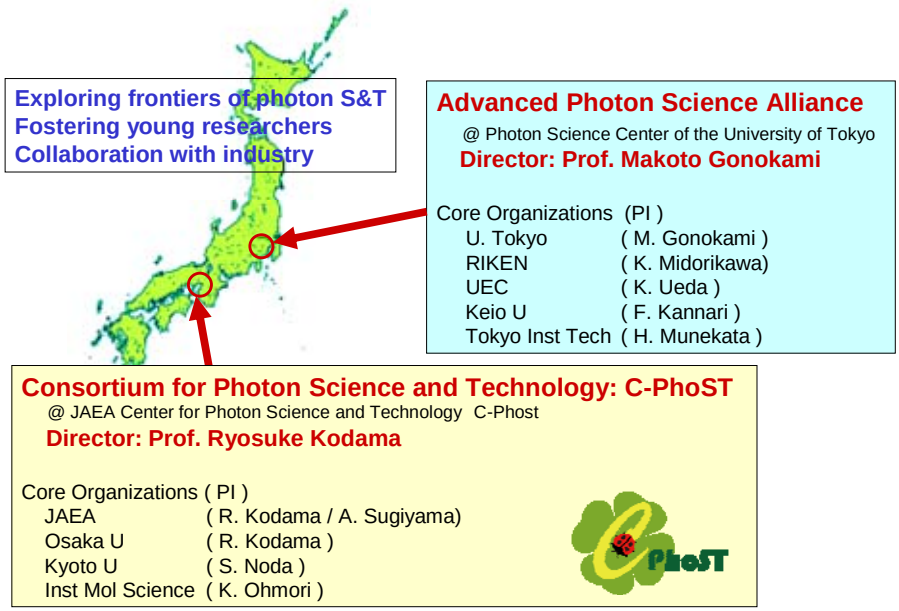

Fig. 2. Photon Frontier Network.

4 Advanced Photon Science Alliance

Advanced Photon Science Alliance is composed of 5 Core Organizations headed by Principal Investigators (written in parentheses): University of Tokyo (M. Gonokami), RIKEN (K. Midorikawa), University of Electro-communications (K. Ueda), Keio University (F. Kannari) and Tokyo Institute of Technology (H. Munekata).

In order to foster young researchers with strong research bases and broad scopes, Advanced Photon Science Alliance is operated under close partnership with the unique education programs which have been tested in these few years. One is CORAL (Consortium on Education and Research on Advanced Laser Science) headed by K. Yamanouchi of University of Tokyo, which is the education program for graduate students with participation of photonics companies as the lecturers to introduce forefront technologies in industrial fields. Another is Elementary Teaching Laboratory and Crisis/Limit Experience Program headed by H. Yoneda of UEC where graduate students plan and operate the education programs by themselves.

Advanced Photon Science Alliance is based on equal partnership of many scientists of various research fields belonging to the Core Organizations for achieving breakthroughs in science and technology which are difficult to implement individually. The research plan comprises several elements [Fig. 3]. The major theme is the collaboration between the frequency standard research [9] and the attosecond science research [10] through control of frequency and phase of the optical waves. Optical frequency standard with 10^{-18} precision generated by an optical lattice atomic clock will be sent through commercial optical fiber network to various users including RIKEN where attosecond and water-window radiation are generated as high order harmonics. Also planned is the development of fiber lasers and ceramic lasers [11] with high power and in UV regions by collaboration between the material science and the laser science researchers.

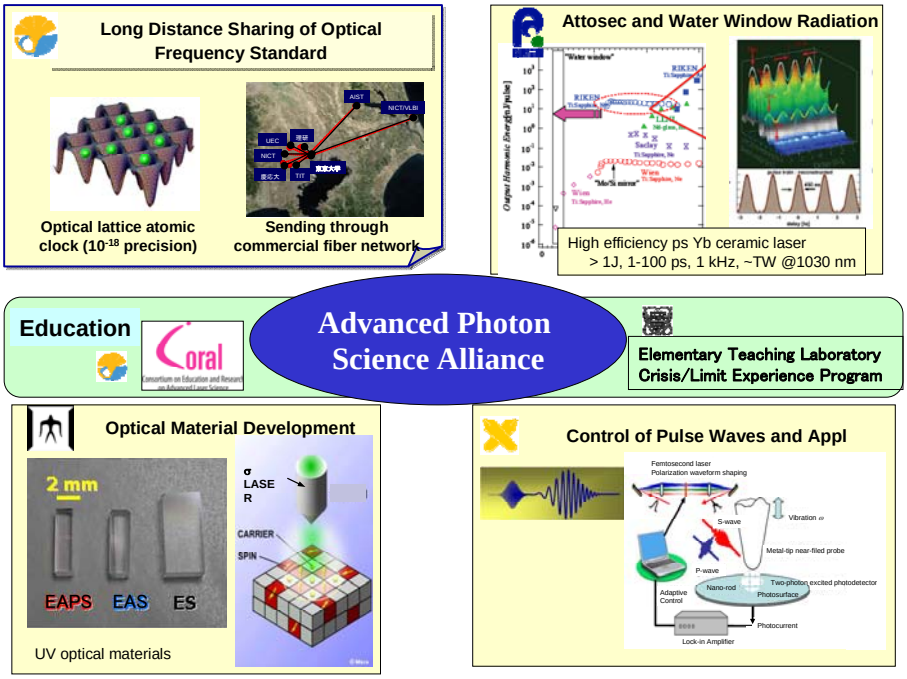

Fig. 3. Advanced Photon Science Alliance

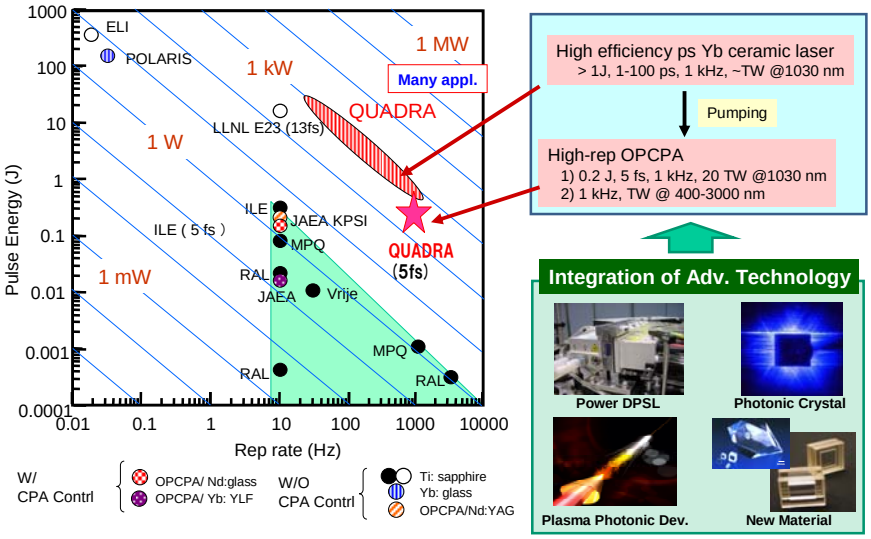

Fig. 4. QUADRA development at Consortium for Photon Science and Technology: C-PhoST

5 Consortium for Photon Science and Technology: C-PhoST

Consortium for Photon Science and Technology (C-PhoST) is composed of 4 Core Organizations headed by Principal Investigators (written in parentheses): JAEA (R. Kodama, supported by A. Sugiyama), Osaka University (R. Kodama), Kyoto University (S. Noda) and Institute for Molecular Science (K. Ohmori).

The major strength of this Consortium is the collaboration between the specialists in two fields: high power lasers and semiconductor lasers. Spatially coherent, high power laser diodes are being developed at Kyoto University as photonic crystal surface emitting laser diodes (PCSEL) [12]. This work will be coordinated with the high power laser research at JAEA Kansai Photon Science Institute, ILE Osaka University and IMS. It is planned that a high quality advanced laser system “QUADRA” will be developed through this collaboration, where LD-pumped high average power Yb ceramic laser (>1 J, 1 kHz repetition rate) will be used to pump OPCPA to generate ultrashort duration, high peak power laser (20 TW, 1 kHz) [Fig. 4]. QUADRA will be

used to generate radiations from THz to gamma-ray regions, to develop plasma photonic devices [13] and to apply quantum control [14] to basic science and energy research.

Emphasis will be placed in the education to foster young researchers capable of taking leaderships in scientific projects through participation to the forefront researches taking place at C-PhoST and also participation to international collaboration activities. The education program will be implemented mainly by collaboration between Osaka University and Kyoto University. Also it is planned that “Optical Science Promotion Organization” will be established at Osaka University which will coordinate research and education in optical science carried out independently at various departments.

6 Conclusion

Scientific research is based on the initiative and originality of each scientist. Therefore it is necessary for scientists to keep focusing on the subjects they are interested in. Also completely new ideas may grow from interactions between the scientists working in different fields, where different views and new insights are obtained.

The two consortia of Photon Frontier Network are composed of very active researchers working in different fields (quantum optics, atomic and molecular physics, solid sate physics, plasma physics, x-ray science, laser engineering, etc.), and with different scales, from standard size laboratory scale to larger size facilities. It is hoped that intense interaction among these top scientists will result in new ideas and new fields which are not born from independent researches.

Also strong interaction with industry will enable working on various problems encountered in real worlds. This very active and interactive environment will be very effective to foster young researchers with broad scope and competitiveness.

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