Form 7／様式 7

(Report 1)

FY 2012

JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE (JSPS)

Report on JSPS BRIDGE Fellowship Activities

by individual BRIDGE Fellows

1. Fellow's BRIDGE Fellowship ID

BR 120203

2. Affiliated JSPS Alumni Association

JSPS Strasbourg Office, France

ABRAHAM	Emmanuel	Pierre
FAMILY	First	Middle

4. Host Researcher

Name in Full	Affiliation
YASUI Takeshi	University of Tokushima

5. Period of BRIDGE Fellowship tenure

From	11	/	10	/	2012	To	09	/	11	/	2012
	Day		Month		Year		Day		Month		Year

7. Please write on the attached form.
8. Please write on the attached form.
9. Please write on the attached form.

Date: Nov. 23th, 2012

NAME (Print) : ABRAHAM Emmanuel

Signature:

(Notes)

1. Please send this completed form to both your host researcher and your affiliated alumni association as soon as possible after finishing your tenure under the BRIDGE Fellowship program.
2. The names and affiliations of Fellows and hosts and their reports may be given public access.

7. Research network created, sustained and/or strengthened with Japanese researchers through your visit. (Please add lines if needed)

7-1) Research network created:

- **Masaya Nagai (Graduate School of Engineering Science , Osaka University):**
  Visit of his laboratory on Oct. 15th, 2012
  Research topics very closed to my new research interest (development of intense THz sources and applications to nonlinear spectroscopy)
  This new topics is very important for me since my new PhD student just started her PhD. Consequently, this visit was very helpful for me in order to get specific information (more efficient experimental setup and possible applications of intense THz pulses).
  After my visit, I discussed again with M. Nagai by email in order to get more precise information.
  After this first contact with him, I hope that we will be able to collaborate in a near future.

- **Anya McDavis (OIST, Okinawa):**
  Informal meeting on Oct. 27th, 2012
  Initially, I planned to give a seminar in OIST on Oct. 17th. However, due to the presence of a typhoon in Okinawa islands, I had to cancel this trip. Then, I visited Okinawa the next week but could not give a seminar because the host researcher (Anya McDavis) was absent. I simply had a discussion with Catherine Chin from this lab in order to present my work and discuss about a possible collaboration. After this first contact with this lab, future collaborations can be possible (THz generation from femtosecond lasers, application of THz imaging to art science).

Is there a possibility of the above network yielding an application for a JSPS program?

In Europe (France, Switzerland, Russia, Hungary), we currently try to establish a network based on "Intense THz sources and applications". A first seminar was held in Pecs (Hungary) in October 2012. An international network on this research topics, including another research team in USA (MIT and Univ. of Rochester), should be greatly appreciated.

If yes, please state the name of the program and researchers who may participate on both sides.

"Intense THz sources and applications"

France: LOMA (E. Abraham, E. Freysz, J. Degert)
Japan: Univ. of Tokushima (T. Yasui), Osaka Univ. (M. Nagai), Kyoto Univ. (K. Tanaka), Tokyo Univ.
Hungary: Univ. of Pecs (J. Hebling, J.A. Fulop)
USA : MIT (K. Nelson), Univ. Rochester (X.C. Zhang)

7-2) Research network sustained:

- **Noriaki Tsurumachi (Kagawa University)**
  Visit of his lab on Oct. 25th, 2012. I already visited his lab in 2007 since I have some close relationship with this researcher since he spent one year in my lab in Bordeaux in 2000 (postdoc). In the future, we plan to improve our collaboration since Noriaki Tsurumachi recently decided to develop intense THz sources based on femtosecond filamentation in air (this source already exists in my lab in Bordeaux).

- **Kaori Fukunaga (NICT)**
  During my stay, I also had some discussions with Kaori Fukunaga from NICT (Tokyo). We currently collaborate on THz imaging applied to Art Science. Kaori Fukunaga is the leader in her country in this research field with many THz measurements in international museums and churches. Together, we recently wrote a review paper in *Studies in Conservation*. I plan to invite her in my lab to give a seminar in 2013 (this seminar was originally planned in 2012 but it had been cancelled for medical reasons).

Is there a possibility of the above network yielding an application for a JSPS program?

It would be great to organize a specific network on Cultural Heritage between Japan and France. This field is very active in Europe with the presence of scientific laboratory inside famous museums such as the C2RMF in the musée du Louvre in Paris. Taking advantage of the unique cultural heritage of both countries, this interdisciplinary network (physicists, chemists, curators, historians, etc.) could be very efficient and appreciated by a wide scientific community.

If yes, please state the name of the program and researchers who may participate on both sides.

"Scientific investigation of Art: Modern Techniques in Conservation and Analysis"

France: LOMA (E. Abraham), C2RMF-Musée du Louvre (M. Menu), CHARISMA European Project
Japan: NICT (K. Fukunaga), Nara (Y. Kouzuma)
Italy: ENEA (G. P. Gallerano)

7-3) Research network strengthened:

- During my stay in the University of Tokushima, I constantly worked with Takeshi Yasui, my host researcher for this JSPS-Bridge fellowship. I know him for 14 years since I met him for the 1st time during our postdoc in Tsukuba. Then, we published many papers together in the field of femtosecond lasers and THz technology.

Is there a possibility of the above network yielding an application for a JSPS program?

Our main interest is THz imaging which is very promising for the development of THz Science and Technology. Many groups in the world develop specific systems to improve the potential of THz imaging to non-destructive inspection and applications to security, biology, food inspection, pharmaceutics, cultural heritage, etc.

If yes, please state the name of the program and researchers who may participate on both sides.

"THz imaging"

France : LOMA (E. Abraham)
Japan: Univ. Tokushima (T. Yasui), RIKEN and Nagoya Univ. (K. Kawase)

8. Results of your research and networking activities in Japan

During my stay in Japan (1 month), my activity was devoted to developing research with my host researcher (THz imaging) and networking. Previous section 7 was specifically devoted to the presentation of the developed networking during my stay. In the present section, I will mainly present the results of my research in the university of Tokushima.

Takeshi Yasui, my host researcher is a leader in Japan for realtime THz imaging using femtosecond laser sources. Two years ago, when I visited him in Osaka, we worked together in the improvement of a fast THz color scanner for realtime THz imaging. The system was able to visualize at video rate 2D objects both in reflection and transmission modes. The purpose of this previous JSPS fellowship was to perform fast THz computed tomography (CT), a specific technique for the visualization of 3D samples. However, at that time, we limited our research for the visualization of 2D cross sections. The result of this research has been presented in international conferences (CLEO2011, IRMMW'THz 2011, TST2012, etc.) and two papers have been published (Optics Letters, IEEE J. Selected Topics in Quantum Electron.).

During the BRIDGE program, in the continuity of the previous work, the goal of my research was to perform real 3D imaging of samples using THz CT. The research was performed with an Indian assistant professor (M. Jewariya) and Master course students. We used an intense THz source based on optical rectification in $LiNbO_3$ crystal associated with the tilted pulse front technique, which is usually developed for THz nonlinear spectroscopy. During my stay, we demonstrated, for the first time to the best of our knowledge, the potential of such an intense THz source for 3D THz CT. We applied 2D spatio-temporal THz imaging system using a combination of non-collinear electro-optical time-to-space conversion and line focusing of a THz beam for real-time line projection across the sample. We were able to demonstrate the potential of real-time THz line projection for fast THz CT. Owing to the 10 ms integration time of the CMOS camera, projection data have been recorded in real-time associated with the continuous rotation of the sample. We quantitatively determined the advantage of optical rectification in $LiNbO_3$ crystal compared to previous works where a ZnTe crystal was used for 2D-ST THz imaging using line focusing. We also demonstrated the potential of the system for effective 3D THz CT with test samples (four metallic bars, a toothpick into a plastic case) and a more realistic one consisting in a medicine capsule. Final result is impressive in term of acquisition time since it takes only 6 minutes to get 36 projections and perform full 3D THz CT of macroscopic samples.

This result of this research will be submitted to Optics Express in December 2012.
Possible future collaboration will be also possible with M. Jewariya since he just got a position in New Delhi in the field of THz technology.

9. Contributions to networking between researchers in your alumni association's country and colleagues in Japan