（別紙様式２）

フォトンサイエンス国際卓越大学院プログラム（XPS）

光科学特別実習　報告書

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As a special training for a program of excellence in photon science (XPS program), I attended the virtual international congress of Pacifichem 2021 which was held from Dec. 16th to Dec. 22nd in 2021, and presented my recent research progress about high-speed fluorescence lifetime imaging microscopy (FLIM) and imaging flow cytometry based on fluorescence lifetime. This attendance and presentation at the international congress were exceptionally accepted as the special training in XPS program due to COVID-19 pandemic situations. My presentation was given at around 4 AM (Japan standard time) on Dec. 21st via zoom. The reason why I had to give my presentation so early in the morning (or so late in the evening) is that the congress was held in the US time zone. Since it was only about 2 months before the date of the congress when the format of the congress was decided to be changed to fully virtual, the schedule of the congress was not modified based on the countries of residence of speakers, which was inconvenient mainly for the speakers in Asia. In addition, the congress did not offer any platform for the speakers to stream their pre-recorded presentations in their live sessions instead of the speakers although they offered a video recording system for on-demand viewing. As a result, most of the presenters, including me, had no choice but to give their live presentations regardless of the time.

The symposium in which I gave my presentation was “Next-Generation Cytometry: Technologies & Applications” whose first session started at 3 AM and ended at around 6 AM (JST) on Dec. 21st. In this session, a variety of presentations related to cytometry were given by 4–5 people including me. The first presentation was a comprehensive talk about cytometry given by a professor. In this presentation, I asked a question about multiple drug resistance (MDR) for cancer treatment and how to avoid MDR. Then, he showed me a few potential solutions including reinforcement of anti-cancer drug retention inside cells and synergy effect with optothermal therapy. The next speaker presented high-speed fluorescence imaging flow cytometry and its application for cancer detection. Because he was a chair of the session, I had to do a chair temporarily instead of him. I also asked a question for him about the image data processing of his imaging flow cytometer and how to handle the data. The next was my turn.

As shown in Fig. 1a, I presented my research progress about the development of high-speed FLIM and its applications in 20 minutes (15-min talk and 5-min Q&A). FLIM has gained much interest from researchers since it is known as a useful tool that offers valuable information about the microenvironment of fluorescent molecules such as pH, viscosity, and temperature without being affected by the concentration of the fluorescent molecules, the fluctuation of excitation intensity, and photobleaching. However, conventional FLIM techniques suffer from the low image acquisition speed, which may be ascribed to a more difficult imaging scheme than fluorescence intensity imaging, and thus are used for limited biological applications regardless of whether they are time-domain or frequency-domain methods. Although recent progress has enabled video-rate FLIM or faster, it still falls short in capturing ultrafast cellular dynamics (e.g., intracellular calcium signaling) or analyzing large cell populations by high-throughput imaging flow cytometry due to the unsatisfied image acquisition speed. In my presentation, I introduced high-speed FLIM by applying one of the telecommunication technologies to FLIM and demonstrated the image acquisition of some biological samples stained by fluorescent dyes at an unprecedentedly high frame rate with fluorescence intensity and lifetime. The frame rate of my FLIM setup was more than 1,000 times higher than that of conventional FLIM.

During the Q&A session, I got several questions from 2 people (Fig. 1b). One part of them was something technical about my FLIM setup (for example, what is the depth of focus of your imaging system? or can you detect multiple wavelength ranges of fluorescence?). The other one was about underlying mechanisms of fluorescence lifetime (for example, what is the factor to change the fluorescence lifetime of fluorescent molecules in your experiment?). All of the questions were invaluable and useful for me to know which parts of my research (and my presentation) were difficult to understand. In addition, after the first session, I had a precious opportunity to chat

with other researchers and got interesting application ideas of high-speed FLIM from them. I want to try these applications in the future.

Overall, the attendance and presentation at Pacifichem 2021 was a good experience for me (Fig. 1c). Lastly, I would like to appreciate XPS, JSPS Grant-in-Aid for JSPS Fellows, JSPS Core-to-Core Program, ImPACT program (CSTI, Cabinet Office, Government of Japan), Konica Minolta Science and Technology Foundation, White Rock Foundation, and Precise Measurement Technology Promotion Foundation, which have funded my research and allowed me to study not only in a highly interdisciplinary and exciting research field but also gave me opportunities for this presentation at international congress and discussion with specialists in many fields.

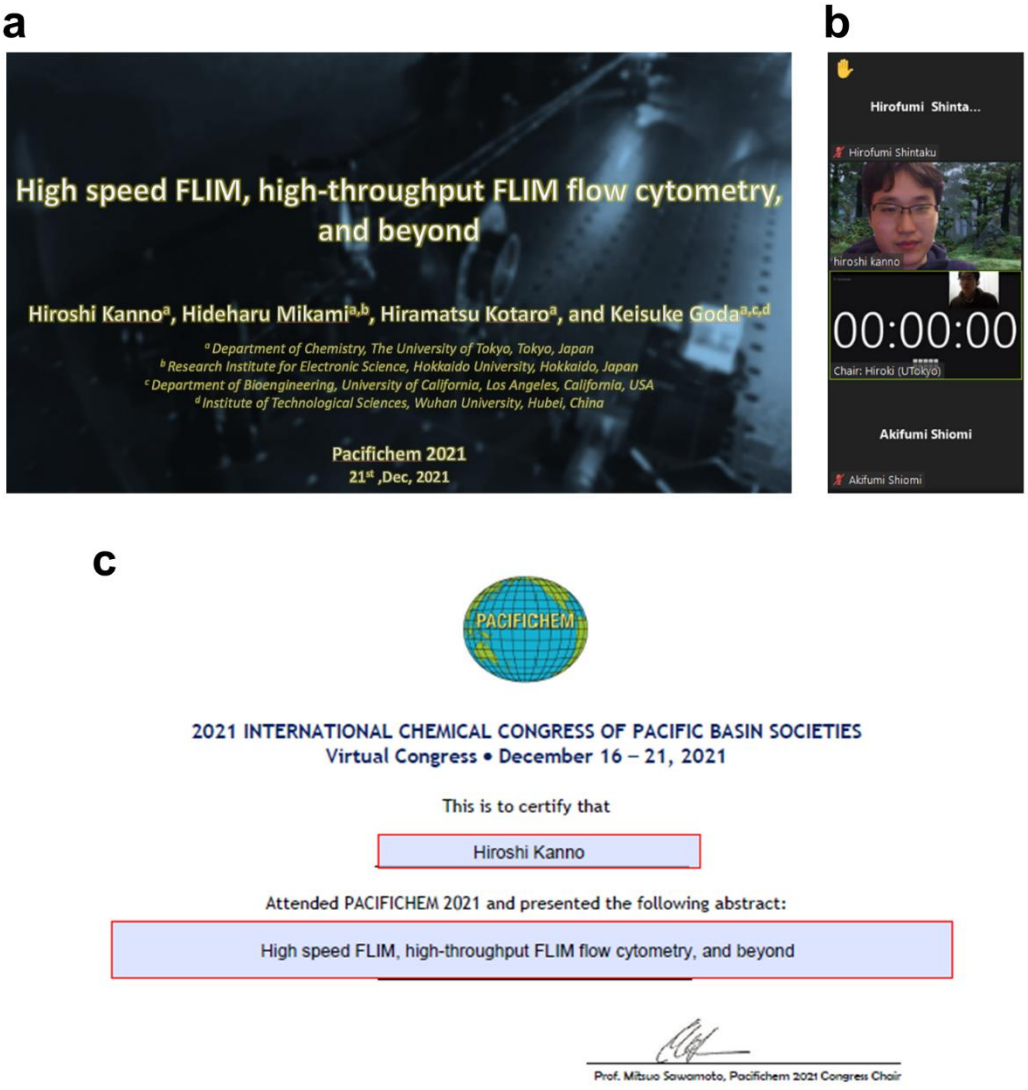

Fig. 1. Images which show I took part in the international congress of Pacifichem 2021. **a,** The first page of my presentation given in Pacifichem 2021. **b,** Zoom window during a Q&A session of my presentation **c,** Certificate for the presentation of Pacifichem 2021.