

FY2021 Annual Report

Wolf Unit

Professor Matthias Wolf, PhD MPharm



(From left to right) Virginia Woolf, Marie Curie, and Grace Hopper.

Abstract

FY2021 was characterized by the COVID-19 pandemic. Nevertheless, and because of it, the lab rose to new heights with a boost in morale and motivation – we specialized on and expanded upon COVID-related projects from the preceding year. Although it was not possible to compete against big Pharma companies on vaccines, we nevertheless came up with our own vaccine design – 6 final ones among nearly twice the number of initial candidates! Furthermore, we determined structures by cryo-EM of influenza virus, of a bacteriophage with its receptor, and of bacterial pili of an important oral pathogen. Finally, we co-organized and hosted virtually via Zoom Webinar an international symposium on cryo-EM, which featured 32 speakers and attracted more than 300 participants.

1. Staff

- Dr. Matthias Wolf, Professor
- Dr. Hideyuki Matsunami, Staff Scientist
- Dr. Vladimir Meshcheryakov, Staff Scientist

- Dr. Takahide Kono, Staff Scientist
- Dr. Melissa Matthews, Postdoctoral Scholar
- Dr. Chloe Minnai, Postdoctoral Scholar
- Dr. Nadishka Jayawardena, Postdoctoral Scholar
- Dr. Rafael Ayala Hernandez, Postdoctoral Scholar
- Dr. Higor Alves Iha, Research Unit Technician
- Mr. Makoto Tokoro Schreiber, Graduate Student
- Mr. Keon Young Kim, Graduate Student
- Ms. Ting-Hua Chen, Graduate Student
- Ms. Rika Yoshizawa, Research Unit Administrator

2. Collaborations

2.1 COVID Vaccine antigen development and effect of antigen clustering

- Description: This project started during the COVID-19 pandemic. Wolf Unit expressed and purified spike protein and apoferritin. We made several antigens suitable for vaccination studies, including Spike, RBD, ferritin-spike, ferritin-RBD, liposome-spike and spike-rosettes. Antigenicity was evaluated after mice vaccination (in collaboration with Ishikawa Unit) using ELISA and ELISpot. Hamsters were challenged after vaccination to measure efficacy (collaboration with Tottori University). Antigen engineering was performed with input from Laurino Unit.
- Type of collaboration: Collaboration
- Researchers:
 - Dr. Melissa M. Matthews, Dr. Tae Gyun Kim, Keon Young Kim, Dr. Higor Iha, Dr. Vladimir Meshcheryakov, Wolf Unit, OIST
 - Professor Hiroki Ishikawa, Dr. Miho Tamai, Dr. Daiki Sasaki, Immune Signaling Unit, OIST
 - Dr. Fumiko Obata, Prof. Satoshi Shibata, Noriko Shibata, Tottori University
 - Dr. Ofey Hsieh, Academia Sinica, Taipei, Taiwan, Wolf Lab at Institute of Biological Chemistry

2.2 SARS-CoV-2 IgG seroprevalence in the Okinawa Main Island and remote islands

- Description: Sample collection, testing and analysis of patients from Okinawan hospitals.
- Type of collaboration: Collaboration
- Researchers:
 - Professor Kenji Mitsumoto et al, Kyoto University
 - Dr. Melissa Matthews, Dr. Satoshi Shibata, Noriko Shibata, Wolf Unit, OIST
 - Dr. Mary Collins, OIST

2.3 Structure of influenza virus ribonucleoprotein complexes during viral RNA synthesis

- Description: Cryo-EM of influenza virus ribonuclear protein (RNP) during RNA synthesis.
- Type of collaboration: Collaboration
- Researchers:
 - Professor Takeshi Noda, Dr. Yukihiro Sugita, Kyoto University

3. Activities and Findings

3.1 COVID Vaccine antigen development and effect of antigen clustering

We developed and tested 6 different antigens. The manuscript is in preparation. Collaboration with Ishikawa Unit, Laurino Unit and Tottori University.

3.2 SARS-CoV-2 IgG seroprevalence in the Okinawa Main Island and remote islands

Leveraging our anti-spike ELISA, we tested specific groups of patients on Okinawa in collaboration with Kyoto University

3.3 Structure of influenza virus ribonucleoprotein complexes during viral RNA synthesis

We contributed cryo-EM to a study by Prof. Noda at Kyoto University

3.4 Structure of type V pili in *Porphyromonas gingivalis*

Dr. Shibata's work culminated in a publication in Nature Microbiology, which has become a reference in the field.

3.5 Bacteriophage-host receptor interaction

Dr. Kim determined the structure of a bacteriophage receptor in complex with its phage.

4. Publications

4.1 Journals

1. Structure of polymerized type V pilin reveals assembly mechanism involving protease-mediated strand exchange,
Nature Microbiology 5 (6), 830-837.
2. Measuring Dominant Local Structures in Amorphous Materials Using Nanobeam Electron Diffraction
Bulletin of the American Physical Society 65
3. High-Resolution Architecture of Bacterial Outer Membrane Porin Lamb
Biophysical Journal 118 (3), 524a-525a
4. Cryo-EM structures of centromeric tri-nucleosomes containing a central CENP-A nucleosome
Structure 28 (1), 44-53. e4.

4.2 Books and other one-time publications

Nothing to report

4.3 Oral and Poster Presentations

1. Wolf M., 2020.02.27 Chromopalooza, Vienna, Austria, 1-2-3: mono-, di-, trinucleosomes and their impact on chromatin structure
2. Wolf M., 2020.02.21 Meeting of the Japanese Pharmaceutical Manufacturer's Association, OIST, Japan, Cryo-EM in Drug Design
3. Wolf M., 2020.02.03 AMED BINDS Cryo-EM Workshop, OIST, Japan, Asymmetric reconstruction of filamentous proteins by single particle cryo-EM
4. Schreiber M.T., Wolf M.*, Measuring Dominant Local Structures in Amorphous Materials Using Nanobeam Electron Diffraction, *Bulletin of the American Physical Society* (2020), <http://meetings.aps.org/Meeting/MAR20/Session/D10.7>
5. Kim TG, Hyun J, Yu E, Wolf M.*, High-Resolution Architecture of Bacterial Outer Membrane Porin Lamb, *Biophysical Journal* 118 (3), 524a-525a, [https://www.cell.com/biophysj/pdf/S0006-3495\(19\)33816-0.pdf](https://www.cell.com/biophysj/pdf/S0006-3495(19)33816-0.pdf)

5. Intellectual Property Rights and Other Specific Achievements

Nothing to report

6. Meetings and Events

Organized **Asia Pacific Cryo-EM (APAC) Symposium** together with Prof. Lu Gan (National University of Singapore) and Ass. Prof. Chi-Yu Fu (Academia Sinica, Taiwan).

The event was hosted by Zoom Webinar at OIST.

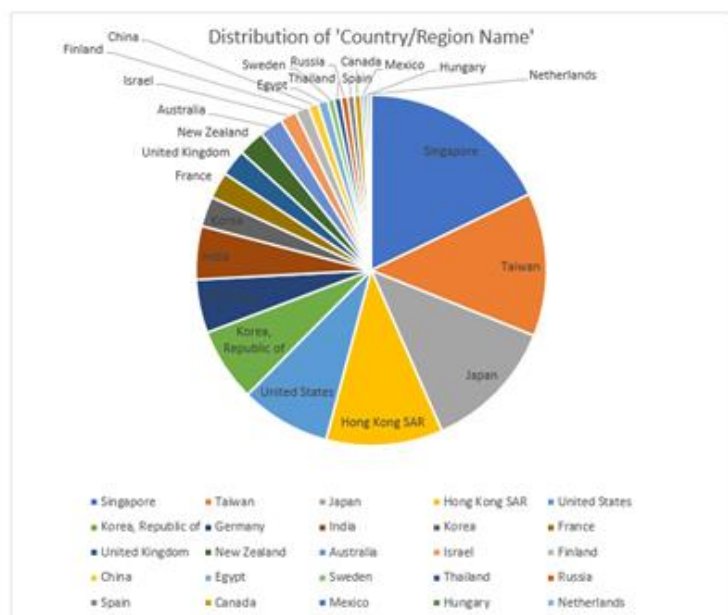
From feedback by participants: “real treat for cryo-EM lovers - best virtual meeting during the pandemic - packed with exciting stories - learned a lot - me and my students enjoyed it a lot - tremendous effort - outstanding meeting with fantastic presentations that showed the breadth of the field - gave me a sense of the camaraderie in the cryo-EM community - the idea of holding a consistent conference over several days gave the meeting a flavour of a ‘real event’, which all of us are missing - The APAC community is very vibrant - well organized, and the presentations were all amazing - fantastic symposium – should consider continuing this symposium annually - I found myself glued to the screen from talk to talk, unlike in other virtual meetings”

Below are the APAC Zoom webinar statistics: **There were 509 registered attendees.**

Date	Time	Topic	Webinar ID	Unique Viewers	Total Users	Max Concurrent Views
Dec 8, 2021	01:26 PM	Asia-Pacific Cryo-EM Symposium	980 5903 2329	163	266	127
Dec 7, 2021	01:26 PM	Asia-Pacific Cryo-EM Symposium	980 5903 2329	203	364	150
Dec 6, 2021	12:55 PM	Asia-Pacific Cryo-EM Symposium	980 5903 2329	240	373	162

Distribution of 'Country/Region Name'

Row Labels	Count of Country/Region Name
Singapore	58
Taiwan	43
Japan	40
Hong Kong SAR	35
United States	27
Korea, Republic of	22
Germany	16
India	16
Korea	9
France	8
United Kingdom	8
New Zealand	8
Australia	7
Israel	5
Finland	4
China	3
Egypt	3
Sweden	2
Thailand	2
Russia	2
Spain	2
Canada	2
Mexico	1
Hungary	1
Netherlands	1
Grand Total	325



6.1 Asia Pacific Cryo-EM (APAC) Symposium

- Date: Dec 6-8, 2021
- Venue: virtual (Zoom Webinar hosted at OIST)
- Speakers:
 - Lexi Walls,
 - Ariane Briegel,
 - Carsten Sachse,
 - Caitong Ng,
 - Christopher Barnes,
 - Yao Cong,
 - Duane Loh,
 - Elitza Tocheva,
 - Elizabeth Wright,
 - Chi-yu Fu,
 - Nadishka Jayawardena,
 - Isabelle Rouiller,
 - Jon Chen,
 - Kelly Nguyen,
 - Kuang-lei Tsai,
 - Lu Gan,
 - Matthias Wolf,
 - Ming-Daw Tsai,
 - Melissa Matthews,
 - Mihnea Bostina,
 - Minhaj Sirajuddin,
 - Moran Shalev-Benami,
 - Min Xu,
 - Naoko Mizuno,
 - Gaia Pigino,

- Shangyu Dang,
- Shee-mei Lok,
- Shujun Cai,
- Olga Sokolova,
- Ji-Joon Song,
- Danny Hsu,
- Koji Yonekura

7. Other

Nothing to report.