FACES OF MASS SPECTROMETRY / Fanny Caroline Liu

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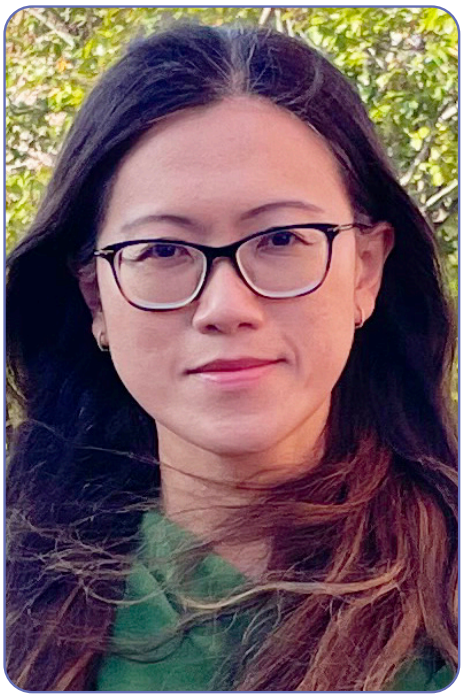

Staying the Course

Fanny Caroline Liu knows how far a combination of patience and resilience will go. Her career path has involved two cross-continent moves, as well as an important pivot in terms of her area of research. Navigating these changes has been difficult, but it has also been rewarding—both professionally and beyond. Furthermore, as an undergraduate student, Fanny Caroline worked multiple jobs to support herself financially. Although this was a demanding time, she managed to succeed in her studies, earning high marks and recognition along the way. These experiences served her well as a researcher because, as Fanny Caroline points out, science is a discipline that requires one to devote a great deal of time and effort to achieve the best results.

Having grown up in Indonesia, Fanny Caroline moved to Germany to study science after finishing high school. She earned her MSc and PhD from Heidelberg University, with a focus on applied physical chemistry. Her studies dealt with the development of optical biosensors during this time.

After finishing her PhD and working as a research scientist at Karlsruhe Institute of Technology for a few years, Fanny Caroline moved to Florida State University as a postdoctoral researcher in 2014, joining the lab of Dr. Christian Bleiholder, whom she knew from her time at Heidelberg University. Fanny Caroline accepted this position at a time when she hoped to shift her area research. She began working with ion mobility mass spectrometry, with a focus on biomolecules. Comparing this new direction with her previous focus, Fanny Caroline notes that although they involved two different techniques, they also shared the same goal of studying biomolecules, especially proteins. Fanny Caroline was ultimately drawn to mass spec research because of its fascinating combination of physics and chemistry.

Fanny Caroline is the co-inventor of tandem-trapped ion mobility mass spectrometry (Tandem-TIMS), an innovative technique for studying heterogeneous systems and solving complex problems. In 2019, Fanny Caroline joined the research faculty at Florida State University. Since then, her efforts have shifted toward working more independently and exploring the applications of Tandem-TIMS for studying complex biological systems. Moreover, Fanny Caroline is proud to be contributing toward biomedical applications and the study of human diseases through her research.

Fanny Caroline has been a member of ASMS since 2016. She is the current Chair of the Early Career Researcher Committee of the Consortium for Top-Down Proteomics and a sponsorship liaison of the International Society for Ion Mobility Spectrometry Board. With the Bleiholder Lab, Fanny Caroline also co-organizes annual workshops on trapped ion mobility spectrometry (TIMS) and Tandem-TIMS

Did your interest in mass spec begin during or after your education in Indonesia?

It was definitely afterward. I left home when I was 18, right after high school, and at that time, I had never heard anything about mass spec. I'm a first-generation college student, and my family background is non-academic. The first time I heard about mass spec was during my undergraduate years in Heidelberg, Germany.

We understand you often worked part time while attending university in Germany. How did this experience influence your career as a scientist?

When I moved to Germany as a student, I had to financially support myself. The living costs in Germany were just too expensive for those in Indonesia to support, which meant my parents could not afford to help me in terms of finances. So, I had to work part time; for the first few years, I did night shifts in factories during the summers. Later on, I started doing scientific research at a lab. It was definitely tough for me to do my studies while simultaneously keeping myself financially afloat. But the whole experience taught me a valuable lesson: Even if the situation isn't ideal, you still have to do your best to achieve your goal. It's all about patience and resilience. Despite juggling such a tough load, I still managed to succeed, graduating from the University of Heidelberg—the oldest university in Germany—and even receiving an award for the second-best undergraduate study at the time! Later on, that same lesson about

When you're working to solve complex problems, it's not enough to just be in separate rooms—you really have to work together.

Celebrating the 2025 Ron Hites Award with (from left to right): Wessley Ferguson, Valentina Rangel-Angarita, Christian Bleiholder, Fanny Caroline Liu, Tyler Cropley, Mengqi Chai, and Jusung Lee at the ASMS 2025 meeting in Baltimore. (Photo courtesy of ASMS.)

patience and resilience also became applicable for me as a scientist. In this profession, sometimes it takes years to get results from research, and you can't give up.

When did you decide to specifically focus on studying proteins with tandem mass spec?

During my PhD work, my focus was on developing optical biosensors to detect biomolecular interactions. When I started in the Bleiholder Lab (PI: Christian Bleiholder), I started working with ion mobility mass spectrometry. These are two different techniques, but the main goal is the same: to study biomolecules, especially proteins.

We understand that your field of research shifted from focusing on surface chemistry to developing tandem-trapped ion mobility spectrometry. Was this an easy transition?

The answer to that question is both yes and no. When I started in the Bleiholder Lab, I had practically no experience or background with mass spec. So, for the first two weeks, I read a tutorial paper by Professor Raymond E. March on quadrupole ion trap, because I wanted to understand the fundamentals. It was tough at first, but I did understand some of the concepts. And from that paper, I found mass spec to be a very interesting combination of physics and chemistry. During those first two weeks, when I read that paper, that's what really convinced and motivated me to stay in the field.

Since I started working with ion mobility mass spectrometry after my PhD, it took me many years to catch up with the knowledge that my peers might have learned during their PhD studies, or even during their undergraduate years. But although it has been hard work, I still really enjoy the research.

How has the invention of tandem-trapped ion mobility spectrometry (Tandem-TIMS) influenced the mass spec landscape?

Our Tandem-TIMS is a complex but highly useful method. In many of our publications, we have highlighted advanced measurements, which are very useful in studying heterogeneous systems. With Tandem-TIMS, we can perform mobility analysis to study protein conformations, trap ions for longer periods of time to study kinetics, or perform top-down mass spectrometry to learn about the primary structure. We are also able to select ions with specific conformation and perform collisional activation or UV photodissociation on these selected ions. In one of our publications this year, we showed how to use Tandem-TIMS in combination with computational methods to probe hidden protein conformations that cannot be studied by NMR or X-ray crystallography.

We understand you have been with Florida State since 2014. What has that position entailed?

When I came here to FSU in 2014, it was during the period in my career when I wanted to change the direction of my research. Christian Bleiholder had just started his research lab here as an assistant professor the year before, in 2013—he needed a few postdocs to help him build that lab. It's how I got started with fundamental work on trapped ion mobility spectrometry (TIMS) and tandem-trapped ion mobility spectrometry (Tandem-TIMS).

During my PhD work, my focus was on developing optical biosensors to detect biomolecular interactions.

Lunch at a vintage-style restaurant in South Jakarta, Indonesia. (Photo courtesy of Yetty Carolina Liu.)

In 2019, I became a research faculty member, and I began working increasingly independently, focusing more on the biomedical applications of Tandem-TIMS.

Your career path has involved a great deal of moving—from Indonesia to Germany to Florida! How have you found these experiences of moving to different places in the world?

Every move has been difficult, not only because of having to learn new languages, but also because of understanding a new culture and the people each time. Those things are always different from place to place. At the same time, though, it's personally very enriching. For example, I am trilingual; I speak Indonesian, German, and English. Also, in terms of my profession, moving has given me the opportunity to learn more about things on the academic side in differing parts of the world. So, it has been very worthwhile and an opportunity that I greatly appreciate!

How has your involvement in the Consortium for Top-Down Proteomics and the International Society for Ion Mobility Spectrometry helped you to grow and learn as a scientist?

Being part of these organizations has greatly helped me with communication. It involves reaching out to many different people and helping to coordinate various kinds of activities. So, it has given me a chance to develop networking skills, which I believe are very important in the mass spec realm. Just as important, it gives me the opportunity to connect with many of my peers and collaborate with them. For example, I collaborate with my fellow CTDP ECR members on an interlaboratory research initiative, "Ion Mobility-assisted Top-Down Proteomics." When you're working to solve complex problems, it's not enough to just be in separate rooms—you really have to work together.

What are some applications of your research that you are proud to be contributing toward?

Proteins and proteoforms are very complex, heterogeneous systems and are very challenging to study. With Tandem-TIMS technology, we are able to perform advanced measurements that can give new insights into proteins. For instance, we're currently using Tandem-TIMS for studying the structures and antigen-binding properties of multispecific antibodies in collaboration with Johnson & Johnson Innovative Medicine. This is an important focus of my research, because it's crucial for many therapeutic interventions for cancer and other diseases. And I hope my research can contribute to advancements in this important field.

When you are not working and outside of the lab, do you ever make it back to Indonesia to visit your family?

It doesn't happen very regularly, but I make it sometimes! This year, for example, two days after the ASMS meeting in Baltimore (Figure 2), I flew back home to Indonesia to visit my family for three weeks, and also to celebrate my father's birthday! But my family is actually spread out. I live in the United States, my younger sister and parents are in Indonesia, and my older sister and her family are in Germany. Because of the distance between us, it's physically difficult to meet together at the same time. But we do use Google Chat to speak on a daily basis, and we share a lot of pictures with each other, which allows us to keep in touch!