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A Decade in 4D Live Microscopy: Looking Under the Hood

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I want to take you on a journey through the last ten years of my field of research - 4D live microscopy. Live microscopy allows us to observe living cells in real-time and capture dynamic processes as they unfold and evolve in 3D space. This capability provides invaluable insights into the complex and dynamic nature of biological systems, as well as stunning imagery. I'll be focusing on technical innovations while ensuring that the methods are contextualized within their respective applications in dementia research, regenerative medicine, and developmental biology.

Our journey begins at Cambridge University, where I completed my PhD and served as Head of Imaging at the Dementia Research Institute. Here, I worked on super-resolution, a technique that allows us to surpass the diffraction limit of conventional optical microscopy. Together with medical scientists, we used these methods to study phase transitions of molecules thought to be involved in amyotrophic lateral sclerosis (ALS).

Following my time in Cambridge, I started my own group at the Arctic University in Tromsø. Driven by application needs, my focus shifted to the development of ultra-fast confocal microscopy methods tailored to tissue imaging in the context of regenerative medicine. Specifically, we developed a confocal microscope that can record an entire volume in a single camera exposure. With this machine, we managed to capture tiniest cellular organelles in engineered human heart tissue - an achievement I believe will have wide-ranging implications for therapeutic strategies in heart repair.

The final leg of my talk covers my time at the European Molecular Biology Laboratory in Heidelberg, Germany, where I concentrated on the development of light-sheet microscopy. This technique has revolutionized our ability to study the developmental biology of maritime specimens, providing detailed insights into how entire living organisms develop on a cellular level. Recently, we finalized a similar method in Tromsø, which will allow us to study the immune system of farmed fish, with the hope of improving the conditions in which these animals are raised.

Reflecting on this decade, I must conclude that live microscopy is truly at the crossroads of biomedicine, engineering, and physics.

Presenter: Prof. STRÖHL, Florian (UiT)

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