

## Computational Imaging on Optically Challenging Surfaces and Through Scattering Media – About the Fun of Utilizing Nature’s Limits

Computational imaging and display principles are “enabling technologies” with the potential to drive transformational changes across multiple future application scenarios: Novel breeds of cameras could see through deep tissue, fog, or smoke. Precise and fast 3D scanners could enhance medical diagnosis and therapy, and become essential for measuring dynamic scenes during robotic surgery, autonomous navigation, or additive manufacturing. Novel 3D display and eye-tracking methods could enable the next wave in AR/VR. Amidst these seemingly endless possibilities, the knowledge about fundamental physical and information-theoretical limits in computational imaging proves to be a powerful tool: Limits often manifest as uncertainty products, allowing us to optimize specific system parameters (e.g., speed) by trading off less critical information for a given application. Moreover, recognizing that our imaging system already operates at the physical limit (e.g., of resolution) can help avoid unnecessary effort and investment.

In this talk, I will highlight the virtue of limits in computational imaging by discussing recent research directions of our group: Among other topics, I will introduce a set of techniques that use so-called “synthetic waves” for computational holographic imaging through scattering media, such as biological tissue, and allow the capture of “light-in-flight” information without the need for pulsed lasers or fast detectors. Furthermore, I will present novel principles for 3D imaging on surfaces with complex reflectance, enabling, for example, fundamentally new techniques for accurate and fast eye tracking.

[Florian Willomitzer](#) is an Associate Professor with the Wyant College of Optical Sciences at the University of Arizona. He directs the [Computational 3D Imaging and Measurement \(3DIM\) Lab](#), where he and his team work on [novel techniques to image hidden objects through scattering media or around corners](#), [unconventional methods for precise VR eye-tracking](#), high-resolution holographic displays, [novel techniques for optical free-space communication](#), and the implementation of high-precision metrology methods in [low-cost mobile handheld devices](#). Moreover, the group develops novel [time-of-flight](#) and [structured light](#) 3D imaging techniques working at depth resolutions in the 100 $\mu\text{m}$ -range.



Prof. Willomitzer graduated in 2017 from the University of Erlangen-Nuremberg in Physics with honors (‘summa cum laude’). He serves/served as Chair and Host of the Optica Incubator on [Imaging Through 100 Scattering Lengths](#), Chair and Committee Member of several [Optica COSI conferences](#), Optics Chair of the [2022 IEEE ICCP conference](#) and Committee member of [Optica FiO](#), [DGaO](#), [ICMVA](#), and [ODF](#) conferences. He is the [recipient of the NSF CRII grant](#), winner of the [Optica 20th Anniversary Challenge](#), OSA Senior Member, and received the [Springer Theses Award for Outstanding Ph.D. Research](#).