Leibniz-Institute of Photonic Technology
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The Leibniz-IPHT is a university independent research institute with close connection to the Friedrich-Schiller-University Jena and Ernst-Abbe-Hochschule Jena and member of the Leibniz association. In the Research Group Field-Resolved Optical Precision Metrology we offer an opportunity to write a

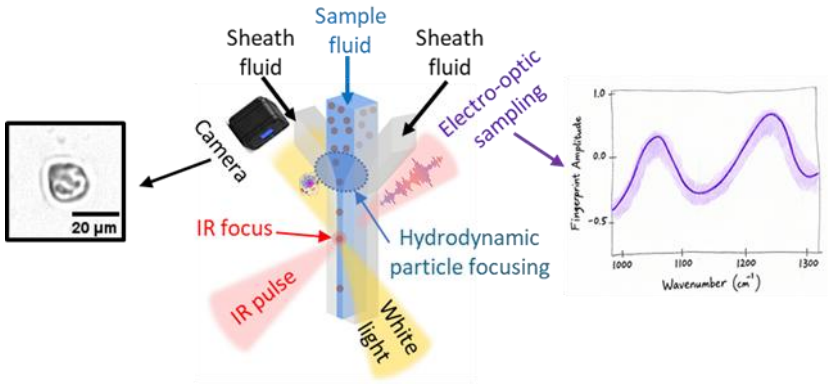
Bachelor's or Master's Thesis

"Field-Resolved Infrared Flow Cytometry: Spectroscopy of Single Cells in Flow"

Flow cytometry (FC) is one of the most important analytical techniques in biomedicine, enabling the counting, characterization, and sorting of heterogeneous cell populations in suspension with single-cell resolution. However, the widely used fluorescence-based approaches require cell staining with specific markers, are limited by photobleaching and spectral overlap, and require prior knowledge of the target molecules. Label-free vibrational spectroscopy methods provide chemically specific information for this purpose. Field-resolved infrared spectroscopy (FRS) overcomes essential limitations of conventional infrared spectroscopy. Based on brilliant, few-cycle mid-IR laser sources in combination with field-sensitive detection, FRS achieves a significantly higher dynamic range than time-integrated methods and, for the first time, enables the measurement of biological cells in their natural aqueous environment with improved molecular sensitivity and detection limits in the sub-µg/mL range[1,2]. In combination with microfluidic chips that guide individual cells sequentially through the IR focus, this opens a pathway towards broadband infrared flow cytometry (IR-FC) with throughput rates in the range of thousands of cells per second.

The aim of the thesis is the further development and characterization of the existing FRS-FC platform as a novel, label-free single-cell analysis technique. Depending on interest and orientation (Bachelor's or Master's), the thesis can focus on different aspects: **(I) Microfluidics** — the further development, characterization, and evaluation of novel microfluidic concepts for defined cell guidance and focusing within the interrogation region; **(II) Imaging of Cells in Flow** — improvement of the existing imaging setup with regard to image quality and frame rate; **(III) Data Processing** — the development of analysis methods for fusing imaging information with field-resolved infrared fingerprints; **(IV) Conducting Application Studies** on a running FRS-FC system.

The thesis offers the opportunity to work at the interface of photonics, microfluidics, and biomedical analytics, and to make an essential contribution to the establishment of a novel label-free single-cell spectroscopy technique.



Interested? Please contact:
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Application:
Please send your complete application documents (resume, certificates, transcript of records) preferably by email in a PDF format.

References:

[1] I. Pupeza et. al., "Field-resolved infrared spectroscopy of biological systems", Nature 577, 52 (2020).
[2] C. Hofer et. al., "Linear field-resolved spectroscopy approaching ultimate detection sensitivity", Optics Express 33, 1 (2025).

Note on data protection:

By submitting your application and the accompanying documents, you consent to the processing of your personal data in connection with the application process. You may revoke this consent in writing or electronically at any time without giving reasons. Please note, however, that a revocation of consent means that any application in progress can no longer be considered.