Raman spectroscopy for translational medicine

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The sharp rise in cancer due to an ageing society and the rapid spread of life-threatening infectious diseases and antibiotic-resistant germs, which is partly due to increasing worldwide mobility but also to the ill-considered administration of broad-spectrum antibiotics represent areas of unmet medical need. An effective and early diagnosis and personalized therapy of cancer and infections requires new methods of differential diagnosis and represents an outstanding task of medicine. There is therefore a great need for new diagnostic methods for targeted early diagnosis of these diseases in order to be able to use targeted therapy as early as possible. During the last years spectroscopic methods have shown their potential to provide a clinician with clinically relevant information to meet the aforementioned medical challenges. Within this contribution we will highlight our recent efforts in translating spectroscopic approaches with focus on Raman spectroscopy towards routine clinical applications. We will start with introducing a series of innovative multi-contrast marker free spectroscopy approaches (both microscopy and endoscopy based) for a precise intraoperative tumor margin control to remove it as completely as possible; and for reliable tumor typing and classification in order to initiate an individualized therapy plan tailored to the patient as quickly as possible. Successful treatment of infections relies on: (I) the determination of the immune response depending on the patient's health status, genetic predisposition, etc.; (II) a rapid identification of the infection causing pathogen and its resistance pattern and (III) response to treatment. Here, we will highlight our recent work towards the application of Raman spectroscopy to tackle the three aforementioned questions. The introduced Raman point-of-care approaches comprise the entire process chain i.e. from sampling to the final diagnostic result, and have a high potential to significantly reduce the critical parameter 'time' to initiate a personalized lifesaving therapy as compared to the gold standard microbiology. In order to ensure that the progress made in this research reaches patients more quickly, the "Leibniz Center for Photonics in Infection Research (LPI)" (https://lpi-jena.de) was acquired as part of the call for proposals by the Federal Ministry of Education and Research (BMBF) for a national roadmap for research infrastructures. The BMBF is funding the establishment of the LPI with 124 million euros. The LPI will be established as a national and international user-open translational infrastructure for novel photonic solutions in infection research and will provide its users with access to an outstanding infrastructure, which will enable them to realize innovative methods for diagnosis, monitoring and therapy of infectious diseases along the LPI service pipelines up to certified products or even products tested in clinical phases.

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Juergen Popp studied chemistry at the universities of Erlangen and Würzburg, Germany. After his PhD in Chemistry he joined Yale University for postdoctoral work. He subsequently returned to Würzburg University where he finished his habilitation in 2002. Since 2002 Juergen Popp holds a chair for Physical Chemistry at the Friedrich-Schiller University Jena, Germany. Since 2006 he is also the scientific director of the Leibniz Institute of Photonic Technology, Jena. Juergen Popp is a world leading expert in Biophotonic / optical health technology research covering the complete range from photonic basic research towards translation into clinically applicable methods. He has published more than 950 journal papers, has been named as an inventor on 15 patents and has given more than 200 invited talks on national and international conferences (among them more than 50 keynote/plenary lectures). In 2012, he received an honorary doctoral degree from Babeş-Bolyai University in Cluj-Napoca, Romania. Professor Jürgen Popp is the recipient of the 2013 Robert Kellner Lecture Award and the prestigious 2016 Pittsburgh Spectroscopy Award. In 2016 he was elected to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows. 2018 Juergen Popp was awarded the renowned Ioannes Marcus Marci Medal of the Czechoslovak Spectroscopy Society, he won the third prize of the Berthold Leibinger Innovationspreis and received the *Kaiser-Friedrich-Forschungspreis*. In 2019 he was awarded the *Ralf-Dahrendorf-Preis für den Europäischen Forschungsraum* and in 2020 he became an OPTICA senior fellow. In 2021 he became a Fellow (FRSC) of the Royal Society of Chemistry.