Christoph Rose-Petruck

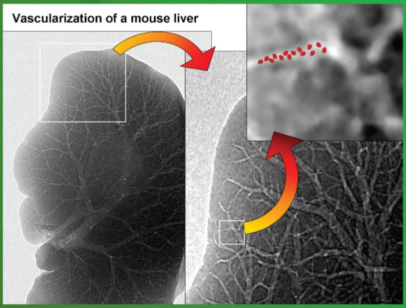
"Biomedical Imaging with Partially Coherent, Laser-Driven Plasma X-Ray Sources"

Ultrafast, high-intensity laser pulses incident upon condensed matter targets are used to generate high-density plasmas that emit x-ray pulses with sub-picosecond temporal length and significant transverse coherence.

The short pulse length has been exploited for ultrafast dynamics measurements of solvated transition metal complexes by XAFS spectroscopy.

The high transverse coherence of the x-rays has been used for in-line holographic hard x-ray imaging of biomedical materials and tissue. The employed phase-sensitive x-ray imaging method is fundamentally different from conventional x-ray shadowgraphy because the mechanism of image formation does not rely on differential absorption by tissues. Instead, x-ray beams undergo differential phase shifts when passing through an organ and subsequently interfere constructively or destructively at the x-ray detector. Hence, tissues are distinguished by the differences between the real parts of their refractive indices rather than their absorptive properties. This imaging method is more than a thousand times more sensitive to density variations of tissues than conventional absorption methods and enables imaging of soft tissues with high contrast without the use of contrast agents. The presentation will discuss the principles of the technique and its application to the imaging of murine livers with various tumors. The specific focus of this work rests on the imaging of the angiogenesis during the development of hepatocellular carcinoma and other cancers metastasizing in the liver.

A further refinement of the imaging method relies on ultrasound waves simultaneously applied to the tissues during x-ray imaging. Due to the tissues' differential acoustic impedance, differential movements are induced that can be detected with high contrast by x-ray phase-sensitive imaging.



Christoph Rose-Petruck received his diploma in Physics from the Technical University of Hannover in 1988 and his Ph.D. from the Ludwig-Maximilians University, Munich, in 1993 under the supervision of Karl Kompa. His research at the Max-Planck Institute for Quantum Optics focused on reactive collisions of state-selected molecules. Rose-Petruck joined Kent Wilson at the University of California, San Diego, where he worked on ultrafast x-ray generation and diffraction. He is an Associate Professor of Chemistry at Brown University focusing on ultrafast x-ray source development, studies of the structural molecular dynamics during chemical reactions, and phase-sensitive biomedical x-ray imaging.

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