BACKSCATTERING POLARIMETRIC INVESTIGATION OF BRAIN TISSUES

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We discuss the challenges of using backscattering scanning polarimetry imaging setups for investigating the internal structure strongly scattering tissues, in particular of brain tissue. Traditional imaging approaches often struggle to retrieve subsurface information due to the limited penetration depth of light in biological tissues. By analyzing the polarimetric properties of multiply scattered light in a diffusive regime, we aim to access microscopic scattering features located well beyond the typical penetration depth of light. This enables the exploration of structural and compositional variations deep within the tissue. We outline the technical aspects and practical considerations of implementing scanning polarimetric setups, highlighting their differences from commonly used wide-field surface imaging systems. Furthermore, we detail the mathematical methods employed to calibrate [1] and analyze the measured light scattering data. In particular, we focus on the extraction of key polarimetric parameters from the Mueller matrix, which provide insight into anisotropic light propagation. These parameters are directly linked to the shape, orientation, and spatial distribution of microscopic scatterers. We demonstrate the application of this approach to brain tissue samples, showing how it can reveal critical structural features such as the orientation of white matter fibers, that is essential for understanding neural architecture and pathology. We also discuss the potential integration of time-of-flight measurements to enhance depth resolution and improve contrast in highly scattering environments [2]. By capturing wide-field, high-temporal-resolution data, the setup enables measurement of angular scattering coefficients at 633 nm in human brain tissue (Fig. 1).

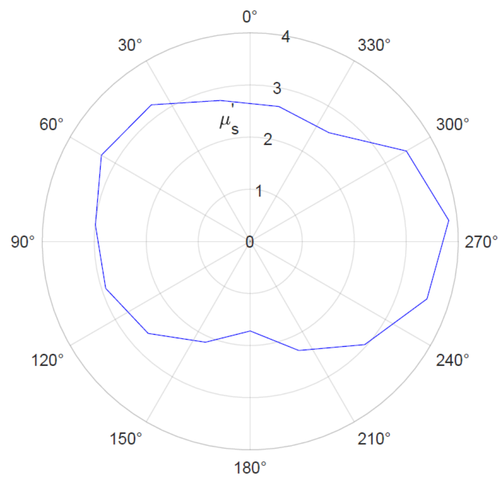

Fig. 1: Angular distribution of the measured reduced scattering coefficient of white matter of a human brain section, at a position where the nerve tract is expected to be highly directional

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[2]. A. Stefanov, et al, Optics Letters, **48**(24), 6396. (2023)