TOWARDS CLINICAL INTEGRATION OF MUELLER POLARIMETRY FOR INTRAOPERATIVE BRAIN TISSUE CHARACTERIZATION

Omar RODRÍGUEZ-NÚÑEZ,[1] Éléa GROS, Theotim, LUCAS, Sooyong, CHAE,[2] Christopher, HAHNE, David HASLER[1], Theoni MARAGKOU, Richard MCKINLEY, Philippe SCHUCHT[1], Tatiana NOVIKOVA[2]

[1]Department of Neurosurgery, Inselspital, Bern University Hospital, 3010, Bern, Switzerland,
[2]Institute of Tissue Medicine and Pathology, University of Bern, 3010 Bern, Switzerland
Graduate School for Cellular and Biomedical Sciences, University of Bern, 3010, Bern, Switzerland
SCAN, University Institute of Diagnostic and Interventional Radiology, Bern University Hospital, 3010, Bern, Switzerland
LPICM, CNRS, Ecole polytechnique, IP Paris, Palaiseau, 91128, France
**omar.rodrigueznunez@insel.ch*

Keywords: Mueller polarimetry, polarization, intraoperative imaging, neurosurgery

Precise identification of tumor margins during brain surgery is critical to ensure maximal tumor removal while preserving surrounding healthy tissue. In this work, we present a wide-field Mueller polarimetric imaging system specifically developed to support real-time intraoperative tissue assessment. The system enables full Mueller matrix reconstruction through fast, motion-free polarization modulation, providing detailed maps of polarimetric parameters such as linear retardance, depolarization, and optical axis orientation, features closely related to tissue microstructure and fiber alignment.

Tested on thick, formalin-fixed human brain specimens, the system produced high-contrast images with excellent signal-to-noise ratios, performing on par with a benchmark system based on ferroelectric liquid crystals. The resulting polarimetric maps revealed clear distinctions between gray matter, white matter, and tumor regions, underscoring the method's potential for reliable intraoperative tissue discrimination.

These findings highlight the viability of wide-field Mueller polarimetry as a tool for real-time brain tissue characterization. Future work is aimed at transitioning the technique to in vivo settings, paving the way for its integration into neurosurgical workflows to improve precision during glioma removal.