Glioma, a type of brain tumor originating from glial cells, represents one of the most challenging conditions in neuro-oncology due to their diffuse nature and complex interactions with surrounding brain tissues. The precise mapping of glioma-induced changes in brain structure and connectivity is essential for improving diagnostic accuracy, treatment and surgical planning, and understanding tumor biology.

Diffusion Magnetic Resonance Imaging (dMRI) and tractography have emerged as powerful tools in this context, offering non-invasive insights into the microstructural integrity of brain tissues and the pathways of white matter tracts. These techniques enable the evaluation of the pathological effects of brain tumor growth and the relationship of gliomas with surrounding neural pathways, which is critical for both clinical and research applications.

This research aims to advance the application of dMRI and tractography in the study of glioma, leveraging two distinct datasets. The primary dataset comprises a large collection of imaging data with corresponding lesion segmentations and molecular markers, providing a comprehensive foundation for detailed analysis. An initial assessment of this dataset indicates the possibility to reconstruct high-quality tractography although some preprocessing is required to optimize the data for advanced analysis.

A critical component of this project involves the exploration of spherical deconvolution techniques to enhance the tracking of peritumoral tissue. Current methods often face challenges in accurately delineating fiber pathways in areas of complex tissue architecture, such as those adjacent to tumors. Spherical deconvolution has shown promise in overcoming these limitations by resolving complex fiber geometries and providing more detailed fiber tractography maps.

Through this research, we aim to: (1) refine and validate preprocessing pipelines for large-scale dMRI datasets with brain tumors, (2) investigate the application of advanced fiber reconstruction techniques for improved tractography in glioma-affected brains, and (3) integrate molecular and imaging data to elucidate the relationship between tumor biology and structural connectivity changes. This project is aimed at facilitating future research in the neuro-oncology field, particularly when individual dMRI is not available.

By addressing these objectives, we hope to contribute to the development of more precise and informative imaging biomarkers, ultimately aiding in the diagnosis and management of glioma and enhancing our understanding of tumor effects within the brain.