Introduction: Medically refractory epilepsy (MRE) is a serious neurological condition that occurs when seizures cannot be controlled by medication. For MRE patients, surgical resection of the epileptic focus (EF) – the brain region responsible for seizures – can alleviate seizure occurrence and improve overall quality of life [1]. However, about 50% of MRE patients continue to have seizures after surgery [2]. Poor surgical outcomes can occur due to inadequate characterization of the EF and its relationships with surrounding neural networks. Recent advances in medical imaging have seen the increased use of magnetic resonance imaging (MRI) and positron emission tomography (PET) to non-invasively map out brain structure and function in epilepsy. Specifically, multimodal imaging combining PET and MRI (hybrid PET/MRI) can improve localization and delineation of the EF prior to surgical resection and shed new insight into seizure-induced structural abnormalities that may be the cause of surgical failure [3]. This study combined 18F-fluorodeoxyglucose PET (FDG-PET) and diffusion MRI to investigate white matter (WM) integrity in MRE patients.

Methods: A 30-minute FDG-PET scan and serial MRI scan were acquired simultaneously on 14 MRE patients using a 3T hybrid PET/MRI scanner (Siemens Biograph mMR). We used asymmetry index (AI) mapping to detect the EF as brain areas showing the largest decrease in glucose metabolism between hemispheres. WM fiber tracking was performed using diffusion tractography at three distances from the EF: 3mm, 9mm, and 15mm. Fiber tractography was repeated in the contralateral region (opposite to EF), which served as a control for this study. WM fibers were quantified by calculating the fiber count, mean fractional anisotropy (FA), mean fiber length, and mean cross-section (CS) of each fiber bundle. WM integrity was assessed through fiber visualization and by normalizing ipsilateral fiber measurements to contralateral fiber measurements.

Results: AI mapping findings were concordant with clinical reports on seizure-onset localization in over 60% of our patient cohort. Normalized fiber measurements were the lowest at a distance of 3mm from the EF, where mean FA, fiber count, and mean fiber length were decreased in 14/14 (100%), 13/14 (93%), and 12/14 (86%) patients, respectively.

Discussion: We verified the utility of AI mapping in detecting the EF based on regions showing decreased FDG-PET activity. PET-guided diffusion tractography around the EF revealed fiber tract differences between ipsilateral and contralateral WM. Interestingly, WM abnormalities were most apparent in WM closest to the EF (3mm). PET-guided diffusion tractography is a powerful tool for detecting EF and assessing WM integrity around EF in MRE and can be used to further enhance decision making in epilepsy surgery.