Fiber Pathways Alteration Reveals Brain Tumor Typology
Martina Campanella1, Tamara Ius1, Miran Skrap2, and Luciano Fadiga2
1RBCS, Italian Institute of Technology, Genova, Genova, Italy; 2Department of Neurosurgery, Az. Ospedaliero-Universitaria Santa Maria della Misericordia, Udine, Udine, Italy; 3Section of Human Physiology, University of Ferrara, Ferrara, Ferrara, Italy

Introduction
Several brain pathologies affect white matter (WM) fiber pathways1. Highly aggressive lesions significantly impair morphology and functionality of infiltrated WM, less aggressive tumors may simply displace the surrounding brain structures2. This different behavior influences the surgical strategy. Here we propose a novel tractography approach to assess brain-tumor induced alterations, without the need of a priori information about the anatomy of local fibers.

Methods
16 patients diagnosed with brain tumor were considered (5 Meningioma: M#1-5, 7 Low-Grade Glioma: LGG#1-7, 4 High-Grade Glioma: HGG#1-4), and for each of them Mib-1 proliferation index was also calculated. DWI data were obtained by a 3T scanner, 64 directions with a b-value of 1000 s/mm², Eddy current-induced image distortions were first removed. In order to identify multiple fiber populations, PAS-MRI1 was then performed. To speed up computation time, while maintaining good performance, a reduced encoding approach was adopted (16 directions)3. A tumoral region of interest (ROI) was manually drawn from the anatomical MR image, flipped around the sagittal plane to get the homologous region in the healthy hemisphere. This was used as “seed”. A streamline deterministic tractography was performed (0.2 anisotropy and 60 degrees as stop criteria). Taking into account the last voxels of each estimated fiber tract, with a k-means clusterization algorithm, one or two centroid points, toward most of the tracked fibres from the seed projected to, were identified. Hence, drawing a 10mm diameter sphere on them, target regions were obtained. In cases where fibers projected from the seed to two diametrically opposed brain areas (see Figure 1, left panel) two target regions were detected and the fibre bundles connecting them were investigated. When fibres projected from the seed to nearby brain areas (see Figure 1, right panel), only the main target region, the one reached by most of the fibres was regarded. The homologous region mask was dilated by a factor equal to 1.20 and the fibres connecting the dilated mask and the target were tracked. Subsequently, the two ROIs used for tracking in the healthy hemisphere were sagitally flipped to map the contralateral tracts connecting them in the pathological one (See figure 2).

Results
We ponderated the percentage of tracts decrease, dividing the computed value by each patient’s estimated tumor size. Next, we studied the correlation between the resulting ponderated percentage of tracts decrease and the Mib1 indexes. The higher the Mib-1 label was, the more fibres were found destroyed, with a correlation coefficient equal to 0.8349 (See Figure 3).

Conclusion
The results correlated with histopathological tumor features. Our approach might be particularly helpful in those critical cases where the lesion does not involve major/known WM paths and a priori information about the local fibers’ anatomy is lacking, suggesting its possible application as a very precise complementary diagnostic tool.

References
4 Sweet and Alexander, Reduced Encoding Persistent Angular Structure, 572 ISMRM, 2010.