



# Project Proposal

## Project Management and Software Development for Medical Applications

### General Info

Project Title: Quantification of U-Fibers from Diffusion Tensor Images in focal epilepsy

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### Project Abstract

Diffusion Tensor Imaging (DTI) provides rich anatomical information about the white matter of the brain, including the possibility to quantify reconstructed fiber pathways. Here we want establish a way, to quantify U-Fibers, a specific subtype of regional neuronal connections.

### Background and Motivation

Focal Epilepsies may be cured by epilepsy surgery, where the seizure onset zone is surgically removed to stop pharmacoresistant seizures. This is much more difficult in about one third of the patients, where no structural lesion is visible in MRI scans, from which the seizures originate. It is known that epilepsy is a network disease, and there is evidence, that inhibitory regional connections are affected. These so called U-Fibers connect one gyrus with its direct neighbors and therefore have a high curvature and a typical length between 30 and 80mm. We want to investigate if DTI can show alterations in U-Fibers in patients with focal epilepsy and no visible structural lesion. In an existing dataset of DTI scans from 40 patients with focal epilepsy, a method should be established to quantify the amount and density of U-Fibers. Different parameters such as U-Fiber count, density and asymmetry measures need to be

calculated and correlated with the clinical data to determine the most sensitive parameter to detect subtle structural changes in cryptogenic focal epilepsy.

### Student's Tasks Description

The student will have to familiarize with the existing data and three different software packages for DTI processing. The software should be compared for their ability to identify and quantify regional U-Fibers using built in functions of the software, no new algorithms need to be developed. The parameters for identification and selection of U-Fibers have to be optimized to tune the methods to the best possible diagnostic yield. Once established, this optimized analysis should be applied to all subjects, most likely using Linux shell scripts or batch tools provided by the software. Correlation with clinical data is performed in close cooperation with the clinical partner. Students will gain experience with processing and quantification of high quality DTI data, the use of several established DTI software packages and learn how to interpret results from advanced imaging methods in the clinical context of a multimodal diagnostic approach.

### Technical Prerequisites

The student should be familiar with basics of neuroimaging data and file formats and the basic principles of DTI. Prior experience with medical image processing would be helpful but is not mandatory. Students should have basic knowledge of Linux Operating Systems and the bash shell or be able to acquire those skills quickly. No specific

Please send the completed document to us ([Ralf.stauder@tum.de](mailto:Ralf.stauder@tum.de)) before the project proposal deadline, April 8<sup>th</sup>. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in the case of acceptance.



programming language knowledge is needed. The necessary software is available and installed on site.

### Administrative Info

Working Time: 300 hours

Project Location: University of Munich Hospital, Campus Großhadern

Required Equipment: No specific hardware required. All required infrastructure is available on site.

### Timeline and Milestones

Week	task
1	familiarization with infrastructure, data and software
2-3	comparison of quantification methods
4-5	optimization of quantification parameters
6-7	application of quantification for clinical correlation
8-9	interpretation of data, identification of problems, selection of cases
10	wrap up and presentation

### References

1: Vollmar C, O'Muircheartaigh J, Barker GJ, Symms MR, Thompson P, Kumari V, Duncan JS, Richardson MP, Koepp MJ. Identical, but not the same: intra-site and inter-site reproducibility of fractional anisotropy measures on two 3.0T scanners. *Neuroimage*. 2010 Jul 15;51(4):1384-94.

2: O'Muircheartaigh J, Vollmar C, Barker GJ, Kumari V, Symms MR, Thompson P, Duncan JS, Koepp MJ, Richardson MP. Focal structural changes and cognitive dysfunction in juvenile myoclonic epilepsy. *Neurology*. 2011 Jan 4;76(1):34-40.

3: Vollmar C, O'Muircheartaigh J, Symms MR, Barker GJ, Thompson P, Kumari V, Stretton J, Duncan JS, Richardson MP, Koepp MJ. Altered microstructural connectivity in juvenile myoclonic epilepsy: the missing link. *Neurology*. 2012 May 15;78(20):1555-9.

4: O'Muircheartaigh J, Vollmar C, Traynor C, Barker GJ, Kumari V, Symms MR, Thompson P, Duncan JS, Koepp MJ, Richardson MP. Clustering probabilistic tractograms using independent component analysis applied to the thalamus. *Neuroimage*. 2011 Feb 1;54(3):2020-32.