Optimization of simulations to enable MR-adaptive microwave hyperthermia

During hyperthermia treatments, tissue is heated to 40 - 44°C for 60 minutes to locally sensitize tumor cells for chemotherapy or radiotherapy, without introducing additional toxicity. An important open issue in this process is dose optimization, i.e. personalized hyperthermia. Hereto, electromagnetic (EM) fields are currently calculated with a finite-difference time-domain (FDTD) solver from the software package Sim4Life. At Erasmus MC, new hyperthermia devices are being developed that operate inside an MRI. The optimum scenario would be to image the patient in treatment position and thereafter calculate (and optimize) the EM fields. Calculating the EM field per antenna however is time consuming: simulation times are currently half an hour per antenna which presents a clear bottle-neck.

Topic and assignment

In this project, you will evaluate and optimize the speed of the EM simulations while maintaining sufficient accuracy. As a crucial first step, you will explore the attainable accuracy for EM fields inside biological tissue in two dimensions (2D) using existing interpretations of the FDTD method and the finite element method (FEM) in Matlab. This investigation serves to understand inherent differences in the two approaches and their potential for simulation acceleration. The optimal simulation would give accurate results with a reduced overall simulation time so the main goal of this project is to find the optimal simulation settings for HTP that would fit in a MR adaptive treatment planning.

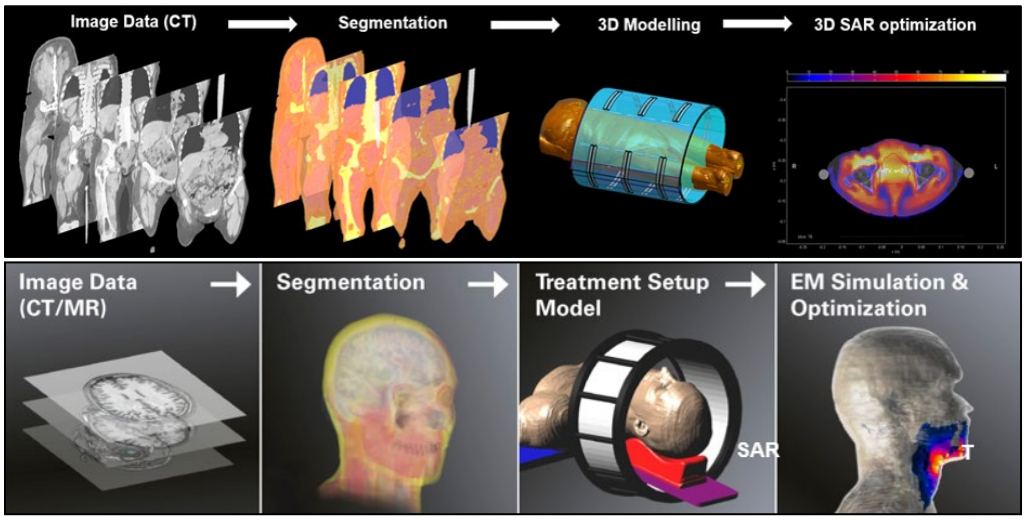

Figure 1: Hyperthermia treatment planning workflows for head and neck and deep pelvic hyperthermia

Information

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