

**COST EMF - MED (Action BM1309):  
European network for innovative uses of EMFs in biomedical applications**

STSM Report:

**Towards the next generation of deep hyperthermia research and treatment planning with  
SIM4LIFE**

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**Abstract:**

To deliver personalized thermal medicine, the ErasmusMC Cancer Institute currently uses SEMCAD X as its simulation platform for treatment planning. To maintain our position as world leading center for clinical hyperthermia, we would like to switch to its successor, SIM4LIFE, which would enable multi-physics simulation of new modalities, such as blood flow. Given that the programming interface has been changed, direct contact with the developers of SIM4LIFE enabled the ErasmusMC Cancer Institute to start the switch and SPEAG/ZMT to gather feedback to further tailor their assistance to hyperthermia clinic and research.

A. Purpose of the STSM

SIM4LIFE is the future platform for hyperthermia treatment planning (HTP) using electromagnetic and ultrasonic energy to heat the tissue. HTP is an essential part for personalized thermal medicine deliverance. Currently, the Erasmus MC Cancer Institute uses SEMCAD X (the predecessor of SIM4LIFE) for HTP. I am strongly involved in the transfer from old (SEMCAD X) to new (SIM4LIFE). This STSM is vital to have in depth knowledge exchange with the developers of SIM4LIFE about the new features, such as perfusion, ultrasound, image access, etc. and precise implementation details on data im- and export formats. My training obtained during this STSM is mandatory to facilitating a fast and reliable switch from the experimental to the clinical environment.

B. Work Description

Upon arrival, I made a presentation detailing the current status and implementation of the standard HTP procedure prior to any heating of head & neck and pelvic tumors. SPEAG/ZMT gave a presentation about the advanced features of SIM4LIFE and how these could be exploited to enhance the HTP clinical procedure and applicator plus thermal dosimetry research at the Erasmus MC Cancer Institute.

Initiating the switch from SEMCAD X to SIM4LIFE mainly involved programming. Senior software engineer Sylvain Reboux was the main contact regarding programming details.

To implement SIM4LIFE as a regular tool for HTP in the standard operational procedure (SOP) of clinical hyperthermia it must be an effective and efficient process which can be applied semi-automatically. The general GUI integrated in SIM4LIFE is perfect for single case treatment planning but is not suited for our

environment where HTP has to be performed for many patients. Hence, an adapted GUI which automatically follows the process flow of HTP needs to be developed for streamlined multi patient treatment planning as is the case in a highly clinically active hyperthermia group.

The implementation of this semi-automatic HTP procedure concerns two parts:

**Graphical user interface (GUI):** a first objective was to make a detailed inventory on the differences between the programming interfaces for GUI development in SEMCAD X versus SIM4LIFE.

**Back-end software:** the program which does the actual treatment planning. This consists of importing the patient CT scans and segmenting these in the relevant tissues. A patient model is created, which needs to be positioned correctly in the applicator. The electromagnetic fields generated by the applicator are optimized to maximize energy deposition in the target region, while minimizing energy deposition in sensitive regions.

### C. Results

The graphical user interface is finished.

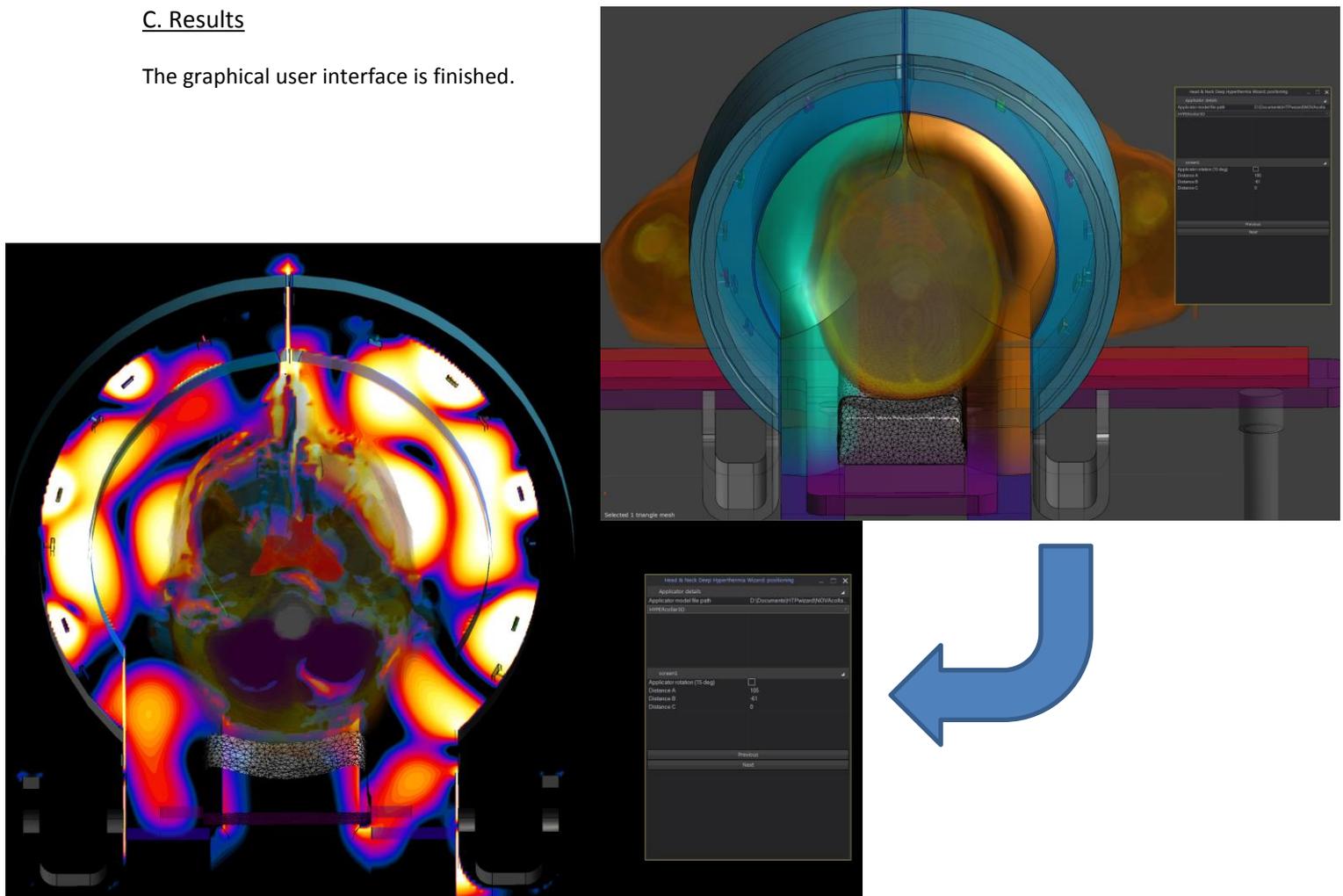


Figure 1: The HTP software asks for patient details and applicator type, after which it automatically creates an applicator model and correctly positions the patient. It sets up the simulation settings and generates the electromagnetic field distribution, which will be optimized by Visualization tool for Electromagnetic Dosimetry and Optimization (VEDO)

I have obtained a much better and more in depth understanding of the Python interface of SIM4LIFE. This is an essential achievement for me in order to be able to implement the automation of SIM4LIFE as a clinical HTP platform.

Achieved milestones:

- Learned where the programming interface of SIM4LIFE differs from that of SEMCAD X. New features have been added (e.g. acoustic and neural solvers) and some features are not yet implemented (discrete vasculature modeling (DIVA), several import formats)
- Some features which are available in the general GUI cannot be accessed through the Python interface. For me this information is very important as it helps to estimate how much work/time is required by ZMT to make this feature available to the Python interface. In addition, this information is essential for timing when I can implement such a feature in the Erasmus MC specific HTP.
- The intensive personal contact with the SPEAG/ZMT members has established a direct contact with the developers a SIM4LIFE enabling easy remote support in the future.

Agreement on development plus implementation of the following features by SPEAG/ZMT, mandatory for adoption by the medical community of SIM4LIFE for HTP:

- Modify SIM4LIFE to import segmented patient CT-slices as currently available in SEMCAD X.

Since I returned from the STSM I worked on the implementation and the current status is:

- Correct position of the patient in the applicator positioning is finished.
- Optimizing of the electromagnetic field distribution in the patient will not be done in SIM4LIFE but using our special in-house developed VEDO (the Visualization Tool for Electromagnetic Dosimetry and Optimization) platform.

Clearly, before the complete HTP software package will be used for clinical treatments, validation needs to be performed.

#### D. Future collaboration with host institution

SPEAG/ZMT agreed to assist us in this transition by implementing features that are crucial for our procedure. In turn, we will provide feedback on SIM4LIFE in general and on especially on hyperthermia-specific features.

#### E. Expected Publications

Multiple publications are expected in the future based on the use of SIM4LIFE as HTP platform at the Erasmus MC. All of them will be indirectly connected to this STSM, as the switch from SEMCAD X to SIM4LIFE opens up research opportunities for studying the influence of blood flow in the big vessels on temperature distribution.

#### F. Other Comments

Many important parts of the STSM have been achieved. Due to the established personal contacts still open parts will be finished overtime. Both Erasmus MC and ZMT/SPEAG have expressed their commitment to work together to finalize the work for a smooth translation of SEMCAD X to SIM4LIFE.

The STSM has been a very supportive instrument for me in building my personal network, trained me in working in a multi-disciplinary environment and provided me with an excellent opportunity to learn about work structure and organization of an internationally active SME. Ultimately, my personal benefits will translate into a benefit for the Erasmus MC hyperthermia group, and most importantly to the patients with cancer that receive adjuvant hyperthermia treatment.

**Confirmation by the host institution of the successful execution of the STSM:**

We confirm that Tim Mulder has performed the research work as described above.

Contact Person of Host  
Institution

*Nicolas Clavannes*

Signature



Name of  
researcher

*Tim Mulder*

Signature

