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

STSM Report:

Measurement of specific absorption rate (SAR) of superparamagnetic iron oxide nanoparticles for clinical applications

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Abstract:

(Up to 100-120 words, suitable for publishing on Action web page)

I spent one tight week in Thessaloniki at the Aristotle University of Thessaloniki to perform nanomagnetic hyperthermia (NMH) measurements and, in particular, to investigate the methods to determine the specific absorption rate (SAR). In Thessaloniki, there is an excellent research group with a professional laboratory facility dealing with NMH. I could learn a lot from them and, furthermore, I managed to establish personal collaboration with them. They presented a series of their essential measurements methods (pulsed hyperthermia, focused hyperthermia, simulations) and gave me a few nanomagnetic materials, with which I can validate my measurement technique in the future.

A. Purpose of the STSM

Describe the purpose of the STSM.

Cancer is one of the major death causes worldwide, with several established and under development therapeutic methods. One promising cancer therapeutic method is hyperthermia, which is used in conjunction with radiotherapy and chemotherapy. It involves raising the temperature of the local environment of a tumour, which results in an enhanced cell death of tumour cells, due to their larger susceptibility to temperature as compared to healthy ones. In addition, local heating may lead to ablative temperatures directly killing the cancerous cells. Hyperthermia using single domain magnetic nanoparticles (MNPs) is intensively studied; MNPs absorb energy from an external source that is usually an alternating magnetic field in the frequency range of a few hundred KHz.

This visit had two main purposes. On one hand, I visited a professional laboratory, where excellent facilities are available for SAR measurement and modelling in order to get familiar with some new important technical details that are usually not reported in publications. On the other hand, it was a great opportunity to establish personal collaborations with the team of the host laboratory.

B. Work Description

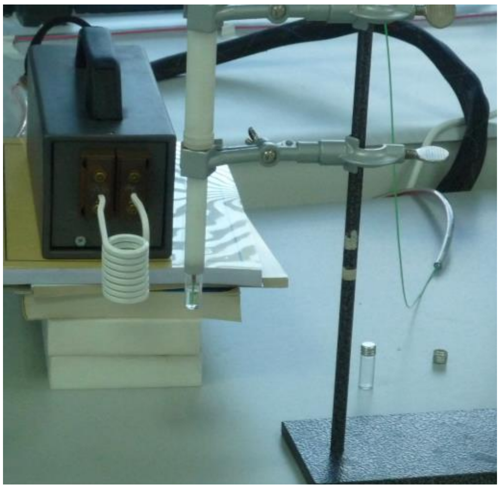


Fig. 1. The resonator (a) and the fiber thermometer (b)

The work consisted of two parts. In the first part, we had a scientific discussion, where I and the Greek Early Stage Researchers (ESR) presented their and our research field in the SAR measurements for NMH hyperthermia. Secondly, we performed together three measurements using their facilities and methods. The computational dosimetry of SAR was also included in the investigations.

One of the experiments involved nanomagnetic hyperthermia with pulsed magnetic field, where the magnetic material was warmed up several times in succession by the pulse rate of magnetic field. The host laboratory has a high power magnetic resonator that can produce up to 30 mT, at 140 and 700 kHz.

The second experiment concerned focused hyperthermia, where we used permanent magnets to minimize the area of magnetic field in a well determined volume. It is known that the static magnetic field causes slower temperature rise, which is a good way to control the warming. The goal of the focused hyperthermia is to localize the warming.

Finally, we carried out a few simulations that compute the magnetic flux density distribution in the different resonators using COMSOL Multiphysics that applies finite element method.

C. Results

Fig.2. A simple device for focused hyperthermia. The magnets in the diagonals are oppositely polarized

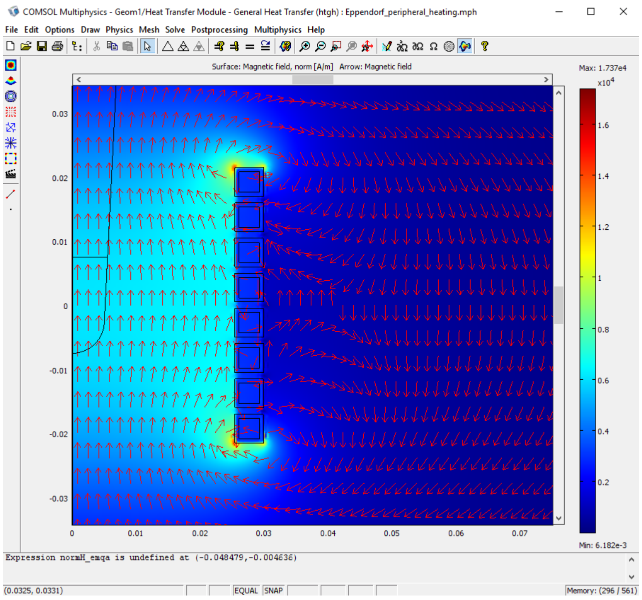


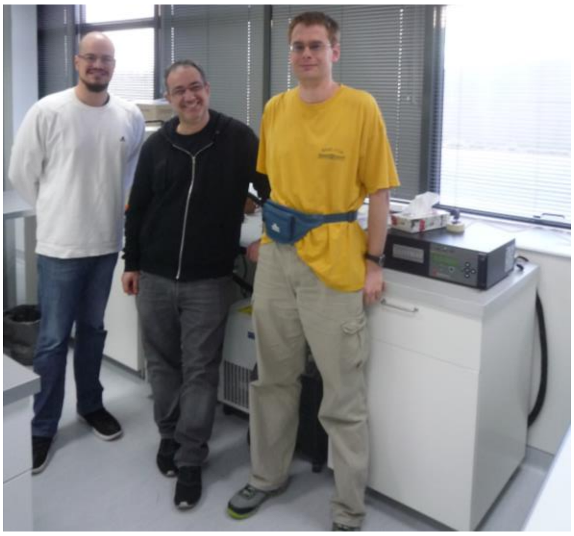
Fig. 3. Magnetic flux density height and direction of one of the coils

During the very short period of the STM the main results and benefit were to see and follow the measurement and computational methods in the Greek laboratory. As far as the measurements mentioned earlier are concerned, those are well managed, thus I could learn to operate a new system, especially the computational modeling which is not available in my lab yet. However, it was very useful to see them live.

The other important benefit of the visit was that I got magnetite nanomaterials used and characterized in the Greek laboratory, thus, I can test with my measurement methods in our laboratory at home. This will be very useful to complete my PhD thesis.

D. Future collaboration with host institution

In the future it is possible that we can test their materials as reference with our methods for interlaboratory measurements.



E. Expected Publications

Following the measurements of the nanomaterials exchanged, we will hopefully result in a publication about the interlaboratory SAR measurements to compare our results.

F. Other Comments

It's important to mention that the host laboratory was relocating into a new campus called Balkan Center when I was there. The relocation process hindered the work, because a few devices were on the way to the new location. Certainly, they couldn't be used at that time.

In this photo there is the contact person, dr. Theodoros Samaras in the middle. On the left of the picture, the ESR from the host group is Nikos Maniotis, who is working towards his PhD and showed me the simulations, and on the right, it is me.

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

We confirm that Iván Gresits has performed the research work as described above.

Contact Person of
Host Institution

Theodoros Samaras

Signature

Name of researcher
Iván Gresits

Signature