Report from EFOMP Visiting Travel Award Winner 2002

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During my stay in Jena from 1 to 23 August 2002 (sponsored by EFOMP Travel Award 2002) I visited the Centre of Biomagnetism and the Institute of Diagnostic and Interventional Radiology – NMR Department. Both institutions are parts of the Friedrich-Schiller University Hospital Jena.

The main area of research in the Centre for Biomagnetism was connected with measurements of magnetic signals produced by the brain and heart. Magnetic fields generated by these organs are very weak (human heart: 10^{-11} - 10^{-10} T, human brain: 10^{-12} - 10^{-14} T). In order to measure such small values special experimental conditions are required.

Firstly the measurements are conducted in magnetically and electrically shielded rooms. Two strategies are available for magnetic shielding, namely passive shielding and active shielding. Passive shielding is based on diverting the magnetic flux by means of layers of ferromagnetic material (μ-metal) or by attenuation of interfering ac (alternating current) fields with conductive shells made of copper or aluminium. In active shielding magnetic coils are used to cancel the effects of fringe fields. In many cases active shielding can be employed to supplement passive shielding. In the Centre for Biomagnetism I was able to learn about possible shielding systems and to see two shielding rooms where animal and human measurements were performed. In addition I saw a new shielding room that was being prepared for work in a new building.

The second condition for good biomagnetic measurements is a very sensitive measurement system. This is exemplified by a SQUID-system (Superconducting Quantum Interference Device). Two SQUID systems were available: *Philips* biomagnetometer and the Jena 16-channel 'micro'-SQUID device. The commercial device designed and manufactured by *Philips* was a biomagnetometer system with 31 channels (each of which could be individually optimised) for operation inside a shielded room. The field noise of the system is less then 10 $fT/Hz^{1/2}$ at 1 Hz. It is used for magneto-encephalography and magneto-cardiography measurements. During my stay in the Centre I participated in magneto-encephalography measurements performed with children suffering from epilepsy. I was able to familiarise myself with the measurement system and take part in the analysis of registered signals.

These research studies require high spatial resolution that covers an area of about 9 cm^2 with more than 10 channels. Such systems are not commercially available and therefore an ultra-high spatial resolution 16-channel 'micro'-SQUID device was developed and manufactured in

Jena. Typical value of the flux density noise for this system is about 22 $fT/Hz^{1/2}$ at 1 Hz. This device is mainly used for experiments with animals. I was able to assist in the biomagnetic measurements of rabbit's heart.

I was also able to see the fabrication of SQUID sensors and systems in the Institute for Physical High Technology Jena, Department of Cryoelectronics. In this institute they build instrumentation/devices for magneto-cardiogram measurements in an unshielded environment, and I had an opportunity to participate in such MCG registration.

In the Institute of Diagnostic and Interventional Radiology I was able to observe imaging by standard Magnetic Resonance Imaging (MRI) techniques. The scanner used in this department is a *MAGNETOM Vision Plus VB33A* manufactured by *Siemens* (software package *Numaris 3.0).* The static magnetic field in this MRI device is 1.5 T with gradients of 24 mT/m. Different RF-coils are used depending on which part of the body is examined. Many coils are available, e.g. head coil, head/neck coil, spine coil, breast coil, pelvic coil, and shoulder coil. I was introduced to concepts of measurement parameters and their influence on the resultant image. After scanning I was able to see how the images could be analysed and gained some appreciation of the potential for diagnosis.

I was able to assist with research connected with pulsed-field gradient nuclear magnetic resonance. These measurements were carried out with the use of a head phantom of diameter 17 cm, filled with water.

Visiting the Centre for Biomagnetism and the MRI Department I gained an appreciation of the Magnetic Source Imaging technique, based on biomagnetic measurements and magnetic resonance imaging as a means of localising magnetic sources in the brain.

From August 10 to August 14 the 13th International Conference on Biomagnetism BIOMAG 2002 took place in Jena. I was fortunate enough to be able to attend the lectures given during this conference that presented a broad spectrum of biomagnetic studies. It was very helpful for development of my knowledge collected in the Centre for Biomagnetism.

My stay in Jena had not only scientific nature. Jena is a very interesting historical city with a university founded in 1558. Many places surrounding Jena have an important historical and cultural heritage. My trip to Germany enabled me to learn new things within the field of Medical Physics as well as European culture and history.