Module Number **2a**	**Title:** **Foundations Medical Physics**		
Module type: compulsory elective	**Language:** English		**Group Size:** 18 students
Study semester: 1	**Availability:** winter semester		**Duration:** 1 semester
Workload: 180 hrs	**Credits:** 6 CP	**Contact time:** 30 hrs	**Independent Study:** 150 hrs

1	**Courses** a) Lecture: 1 PPW b) Practical Course: 2 PPW
2	**Intended Learning Outcomes** Upon completion of this course, students will be able to describe some of the physical concepts relevant to medicine, and identify their use in diagnostics and therapy. The students will be able to operate the laboratory equipment as described below, and connect the physical principles to the imaging techniques and technology.
3	**Content** **Lecture:** i. General introduction in physics of medical methods, from principle to functional details. While the introduction covers also aspects that are needed for general understanding, the core of the lecture is designed to serve as theoretical background for the practical course. ii. *Physics of x-Ray tomography*. x-ray production, x-ray absorption and scattering, x-ray detection. Image formation. iii. *Magnetic resonance*. Magnetic spins, Larmor frequency, spin resonance, spin interaction, contrast, electromagnetic induction. iv. *Magnetic resonance imaging.* Spin manipulation, spin relaxation, spin-echo and gradient echo imaging techniques. v. *Ultrasound imaging.* Production and propagation of ultrasounds, imaging, absorption and reflection of ultrasounds, image resolution. vi. Electrocardiography and electroencephalography. Production and transfer of electrical signals in the human body, physical interpretation of ECG and EEG. **Practical Course:** *i. x-Ray tomography*. 3D imaging and artefacts, absorption and scattering, image formation. ii. *Magnetic resonance.* Measuring of the Larmor frequency, free induction decay, measuring of the relaxation times, effect of contrast substance. iii. *Magnetic resonance imaging.* Spin-echo and gradient echo techniques. Effect of work parameters on the image quality. iv. *Ultrasonic imaging.* Measuring of sizes and distances, 3D-imaging and artefacts. Measuring of the heart rate and cardiac output in a heart model. Ultrasonic control of the eye, using an eye model. v. Electrocardiography and electroencephalography. Measuring of own ECG, determination of the heart's electric axis. Measurements of EEG signal (or use of muster data) to determine brain activity triggered by strong factors. Independent component analysis of the EEG.
4	**Teaching methods** Lecture on the concepts of medical physics and their experimental implementation (block of 15 lessons in one week); carrying out experiments in the laboratory, taking, analysis and interpretation of experimental data in the fields of the content (5 blocks of 5 teaching hrs each).
5	**Prerequisites** **Formal:** Proficiency in English level B2 of Common European Framework of Reference for Languages (CEFR) **With regards to content:** Basic knowledge of and interest in mathematics and physics

6	**Examination types** Written report (The report should be about 10 pages per experiment, document the familiarity with the experimental work and contain the data taken as well as their analysis.)
7	**Requirements for award of credit points** Active participation on practical exercise; passing the oral examination prior to each experiment and submission of a report which gets graded with 4.0 or better four weeks after ending of practical exercise.
8	**Module applicability (in other study courses)** None
9	**Assessment** The mark given will contribute to the final grade in proper relation to its credits.
10	**Module convenor and main lecturers** Prof. Dr. Thomas Heinzel, PD Dr. Mihai Cerchez
11	**Further information** Pre-reading material will be handed out 2 weeks in advance of the laboratory course. The lecture is scheduled for the week preceding the laboratory course. The content of both the pre-reading material and the lecture is prerequisite for the admission to the experimental equipment. For safety reasons and for the conservation of high-value technical resources prior to each experiment the students will be examined orally regarding the operational principles of the experiment. Successful examination grants permission to start the experiment.