UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Physical Sensors and Systems for Biomedical Signals

2627-2-F9103Q018

Aims

The main objective of the course is to provide the student with the basic knowledge in physical sensors and techniques involved in the acquisition, elaboration and interpretation of biomedical signals. A special focus on scintillation detectors and silicon photomultipliers for the sensors side and magnetic, optical, electronic, probe scanning techniques for the physical systems part will be provided.

Contents

The physical principles at the basis of the acquisition of different biomedical signals will be presented. The signals obtained by means of physical sensors and systems properly developed for biomedical applications will be described together with a series of practical examples. With the support of machine learning techniques available in sk-learn, signals from particle detectors will be analysed.

Detailed program

• Introduction on radiation-matter interactions.
• General principles of particle detection.
• Fundamental principles and instrumentation of Nuclear Magnetic Resonance.
• NMR spectroscopy and relaxometry (in vitro and in vivo).
• Nanomagnetism: Magnetic biosensors and their biomedical applications; Magnetic Particle imaging (MPI).
• Functional near-infrared spectroscopy.
• Electron (Scanning Electron Microscope, Transmission Electron Microscope) and Scanning Probe Microscopy (Atomic Force Microscope, Scanning Tunnelling Microscope).
• Use of the Silicon PhotoMultipliers (SiPM) and scintillating crystals in the detection of gamma rays in the PET.

• X-ray detection (crystals+SiPM or direct SiPM).
• Particle detection and identification using machine learning techniques with real and simulated data

Prerequisites

Fundamentals in classical electromagnetism, quantum mechanics, nuclear and particle physics.

Teaching form

Lectures (40h) and laboratory activity (12h).
Both of them will be held in presence and attendance is warmly recommended.

Textbook and teaching resource

Notes, software, data and scientific articles provided to students during the course.

Semester

First semester.

Assessment method

The evaluation of the student's performance is based on:
final oral examination spanning all the topics covered in the course.
No ongoing tests are planned.

Office hours

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING