Short Course 7
Optical Imaging

Monday, October 18, 14:00 - 18:00 Room Tarragona

I.Organizer and Instructors

Rinaldo Cubeddu

Full Professor, Head of Division (Laser and Photonics in Biology and Medicine, Biomedical Optics)
Politecnico di Milano - Dipartimento di Fisica
Piazza Leonardo da Vinci 32
I-20133 Milan
ITALY
Tel: +39 02 2399 6110
Fax: +39 02 2399 6126
E-mail: rinaldo.cubeddu@fisi.polimi.it

Biographical Sketch (30-50 words): Rinaldo Cubeddu (Alessandria, Italy, 1944). PhD in Physics from the University of Pavia in 1967. Full Professor of Physics at Politecnico di Milano (Milan, Italy) since 1986. Main research interests: non-linear optics, generation of ultra short laser pulses, time-resolved fluorescence spectroscopy and fluorescence lifetime imaging, optical imaging in diffusive media.

Paola Taroni

Associate Professor (Laser and Photonics in Biology and Medicine, Biomedical Optics)
Politecnico di Milano - Dipartimento di Fisica
Piazza Leonardo da Vinci 32
I-20133 Milan
ITALY
Tel: +39 02 2399 6109
Fax: +39 02 2399 6126

E-mail: paola.taroni@fisi.polimi.it
Biographical Sketch (30-50 words): Paola Taroni (Como, Italy, 1963). Ph.D. in Nuclear Engineering from Politecnico (Milan, Italy) in 1987. Associate Professor of Physics at Politecnico since 1999. Her research activity concerns mainly the development of laser systems for time-resolved spectroscopy and imaging, and their biomedical applications (e.g., fluorescence-based diagnosis of tumors and optical mammography).

Alessandro Torricelli

PhD, Researcher (Laser and Photonics in Biology and Medicine, Biomedical Optics)
Politecnico di Milano - Dipartimento di Fisica
Piazza Leonardo da Vinci 32
I-20133 Milan
ITALY
Tel: +39 02 2399 6087
Fax: +39 02 2399 6126
E-mail: alessandro.torricelli@polimi.it
Biographical Sketch (30-50 words): Alessandro Torricelli (Modena, 1968). Master degree in Electronic Engineering (1994, Politecnico di Milano) and PhD in Physics (1999, Politecnico di Torino). Since 1993 he has been working at the Department of Physics of Politecnico di Milano on in vivo time-resolved diffuse spectroscopy and optical imaging.

II.Title of Course

Optical Imaging (Organizer: Rinaldo Cubeddu)

III.Description of Course (150-225 words)

This half-day course will cover Optical Imaging for medical and biological applications, focusing on non-invasive techniques for in vivo bulk tissue investigations, while not dealing with techniques for microscopic (cellular and/or structural) studies (like optical coherence tomography and microscopy).

The study of light propagation in highly diffusive media, like biological tissues, has gained much interest due to the exciting challenge to develop novel in vivo, non-invasive diagnostic tools. Indeed, the possibility to explore bulk tissues by analyzing photons that have traveled through tissue - after being injected or generated by fluorescence - offers potential for applications with great social impact such as tumor detection in the female breast and functional imaging of the brain.

The course is organized in four modules covering: i) Fluorescence lifetime imaging; ii) Photon Migration; iii) Optical Mammography; and iv) Molecular Imaging.

The course is targeted to three types of attendees: engineers/physicists who desire understanding the basics of photon migration and fluorescence in order to develop/use related type of instrumentation; engineers/physicists/managers who need to understand these technologies and the performance achievable in order to manage or work with a development team utilizing these technologies; and people interested in an overview for personal technical development.

IV.Course Outline

I. Fluorescence (Paola Taroni, 1 hour)

- A. Basic theory (absorption, quantum yield, intensity, lifetime)
- B. Experimental techniques (CW, FD, TD)
- C. Application: FLIM

II. Photon Migration (Alessandro Torricelli, 1 hour)

- A. Physics (absorption, scattering)
- B. Theoretical models (RTE, Diffusion, DPDW)
- C. Experimental techniques (CW, FD, TD)
- D. Applications: in vivo tissue spectroscopy, muscle oximetry, and functional imaging

III. Optical Mammography (Paola Taroni, 1 hour)

A. General overview of optical techniques (diaphanoscopy, frequency- and time-domain, spatial resolution)

B. Multi-wavelength Time-resolved Optical Mammography

C. Case studies (Detection of Tumour, Cyst, and Fibroadenoma)

D. Characterization of Bulk and Lesion (optical patho-physiology and demographic data)

IV. Molecular Imaging (Alessandro Torricelli, 1 hour)

A. General overview

B. Physics (surface emission, bulk emission)

C. Applications: animal models, in vivo imaging of tissues

D. Coregistration (Optical Imaging and PET/MRI/CT)