Biophotonics in Cancer Detection: technologies and sensing workshop

[COST BM1205]

@ Porto 4-5 May 2015

Current research in new technologies and sensing strategies to assist cancer early detection is of paramount interest for society. Biophotonics addresses this challenge seeking the development of novel photonics tools, combining different interrogation and measuring principles, and often combining a biological or biochemical interface to enhance detection specificity and sensitivity. The combination of these approaches with advanced imaging techniques allows spatial resolution and possibly non invasive and in vivo photonic / optical imaging of suspicious tissues. These possibilities push the scientific community in developing this research field.

The workshop on Biophotonics in Cancer Detection will present state of the art research work being developed towards these goals within the BM1205 COST member countries, presenting new ideas on promising approaches, such as speckle interferometry, diffuse reflectance spectroscopy, optical coherence tomography, confocal imaging, THz spectroscopy, new laser sources, photo-acoustics, and their applications to (skin-)cancer detection in background.

We expect this workshop to motivate young researchers to enroll in the field, and to stimulate the mixing of approaches and the establishment of new scientific collaborations.

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10h00-10h20
The Use of Dermoscopy and Reflectance Confocal Microscopy in the analysis of various skin lesions, Marija Buljan, *Department of Dermatology and Venereology, University Hospital Centre "Sestre milosrdnice", Zagreb, Croatia - Contribution talk*

10h20-10h45
Optical Coherence Tomography for skin cancer detection, Marilena Giglio, *Dipartimento Interateneo di Fisica, Università and Politecnico di Bari, Italy - Contribution talk*

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Application of circularly polarized light for optical biopsy and cancer diagnostics, Igor Meglinski, *Opto-Electronics and Measurement Techniques Laboratory, University of Oulu, Finland - Invited talk*

4th May, afternoon: photoacustics for skin

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Optical fiber tools for single cell manipulation and diagnostics, Pedro Jorge, *Center for Applied Photonics/INESC-TEC, Porto, Portugal - Invited talk*

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11h20-11h40
Linewidth measurements of a mid-infrared quantum cascade laser by self-mixing technique for sensing application, Maria Carmela Cardilli, *Università degli Studi di Bari, Via Amendola, 173 70126, Bari, Italy - Contribution talk*

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5th May, afternoon: tumoral tissue diagnosis

14h00-14h35
THz absorption and reflection imaging of colon tissues embedded in paraffin, Irmintas Kasalynas, *THz Photonics Laboratory, Center for Physical Sciences and Technology, Vilnius, Lithuania - Invited talk*

14h35-14h55
Tera-Hz imaging and spectroscopy of carcinoma-affected gastrointestinal tissue, Faustino Wahaia, *BioCareers Group/INEB - Inst.Eng.Biomédica, Univ. do Porto, Portugal - Contribution talk*

14h55-15h30
Excitation-Emission Matrix Fluorescence Detection and Synchronous Fluorescence Spectroscopy of Skin Tumours, Ekaterina Borisova, *Institute of Electronics, Bulgarian Academy of Sciences, Bulgaria - Invited talk*

15h30-15h50
Excitation-emission matrices (EEMs) measurements of malignant melanoma lesions, Tsanislava Genova, *Institute of Electronics, Bulgarian Academy of Sciences - Contribution talk*

16h00
BM1205 Working groups meeting

2 Abstracts

Optical techniques in skin diagnostics

Is there information in the noise? OCT speckle reflects on clinically relevant tissue properties, Mitra Almasian, *Dept. of Biomedical Eng. & Physics, Academic Medical Center, Univ. of Amsterdam, The Netherlands*

Optical Coherence Tomography (OCT) is a high resolution 3D imaging modality used in the medical clinic. OCT is based on low-coherence interferometry. The images are build-up from interference of the backscattered light from the tissue and the reference beam. This entails the detection of the sub- interference effects caused by small phase differences of the backscattered light from the sample; speckle. Speckle is the noise that is inherent to the OCT technique. By averaging the images, speckle noise can be reduced in order to create sharper images. However, as speckle originates from the backscattered light of the individual scatterers in the sample, it contains valuable information as well. Tissue parameters such as size of the scatters, (sub) cellular organization, tissue morphology and blood flow can be retrieved using the speckle noise in OCT. By quantifying these parameters we aim to set a step closer to an optical tool to stage and grade lesions suspicious of cancer.

The Use of Dermoscopy and Reflectance Confocal Microscopy in the analysis of various skin lesions, Marija Buljan, *Department of Dermatology and Venereology, University Hospital Centre "Sestre milosrdnice", Zagreb, Croatia*

Over the last decade, dermoscopy has become widely used technique which, in hands of trained user, significantly improves diagnostic accuracy. Dermoscopy requires a high quality magnifying lens and a powerful lighting system. This allows examination of skin structures and patterns. In addition to its well-documented value in improving the diagnosis of skin tumours, dermoscopy has been shown to facilitate the clinical recognition of several inflammatory and infectious diseases, as well as their discrimination from skin tumours. Reflectance Confocal Microscopy (RCM) is a novel imaging tool that permits the real-time examination of the skin at a resolution approaching histologic detail. RCM as a non-invasive technology may serve in the routine practice guiding the clinician towards an accurate diagnosis of tumoral, inflammatory and infectious skin lesions. However, RCM is a technique which requires a lot of training and experience. Dermoscopic structures and global dermoscopic patterns can be precisely correlated with confocal images. It has been shown that combining two methods (dermoscopy and RCM) improves the diagnostic accuracy in the analysis of various skin lesions, including skin cancer detection.

Optical Coherence Tomography for skin cancer detection, Marilena Giglio, *Dipartimento Interateneo di Fisica, Università and Politecnico di Bari, Italy*

Our contribution to the research is in the field of optical coherence tomography (OCT). OCT is equivalent to ultrasound, except it uses back-scattered light instead of sound waves, to produce micrometer-scale cross-sectional images. The maximal imaging depth, due to loss of signal by scattering and absorption of light within the tissue, is approximately 2 mm. This attenuation of OCT signal is thus directly related to the micro scale organization (scattering by e.g. cellular structures) and biochemical composition (absorption by e.g. hemoglobin) of the tissue. It can be quantified through the attenuation coefficient (μoct), which is obtained by fitting the decay of OCT signal versus depth. We thus hypothesize that μoct measurement allows for assessment of morphological and physiological changes occurring in tissue during cancer development. Second, in order to obtain optical properties from layers thinner than needed for a reliable µoct measurement, we hypothesize that µoct related variations in local speckle contrast could contribute to this. Experimental results of attenuation vs. speckle measurements will be shown.

Investigating different skin and gastrointestinal tract (GIT) pathologies (in vivo and ex vivo) by Optical Imaging, Aleksandra Zhelyazkova, *Bulgarian Academy of Sciences, Emil Djakov Institute of Electronics, Bulgaria*

The second most commonly diagnosed type of cancer is this of skin and gastrointestinal tract (GIT) tumours also are in the "top ten" positions. Most of them could have better prognoses for the patients, if earlier and precise diagnosis is applied. It is important to develop and combine diagnostic techniques for accurate early stage diagnosis to improve the chances for curative action for the skin and GIT tumours. Optical methods are very promising for noninvasive diagnosis of skin and mucosa tumours, leveraging the advantages of deep imaging depth, high resolution, fast imaging speed, and reach endogenous fluorophores. The aim of the current project is to investigate different skin and gastrointestinal tract (GIT) pathologies (in vivo and ex vivo) by optical imaging. It was used a digital microscope Dino-Lite modified with 4 blue (450 nm), 4 green (545 nm), 4 red (660 nm) and 4 infrared (940 nm) diodes and adapted for the monitoring of skin and GIT pathologies. Blue light (450 nm) penetrates less than 1 mm in depth and provides information about superficial layers of the skin. Green light (545 nm) provides information about blood distribution and the red light (660 nm) penetrates into the skin tissue several millimeters in depth, which provides information about melanin. Infrared light (940 nm) gives us the information about the deeper skin layers. A prototype device "SkImager" with polarized LED light at several spectral regions was used, for illumination of ex vivo samples (different malignancies) obtain after surgical removal from different patients and round skin, spot of diameter 34 mm or 11 mm, imaged by a CMOS sensor via cross-oriented polarizing filter. That investigations allow to obtain RGB image at white LED illumination for revealing subcutaneous structures; four spectral images at narrowband LED illumination (450, 540, 660, and 940 nm) for mapping of the main skin chromophores and diagnostic indices and autofluorescence images under UV (365 nm) LED irradiation for mapping of the skin fluorophores [1]. The chromophore maps reflect the spatial chromophore concentration distribution in skin and GIT samples. The combinations of monochrome images were used to calculate eight parametric maps of the illuminated skin and GIT samples: epidermal melanin distribution, dermal melanin distribution, total haemoglobin distribution, bilirubin distribution, erythema index map and fluorescence intensity distribution.

References: [1] Janis Spigulis, Uldis Rubins, Edgars Kviesis-Kipge, and Oskars Rubenis, "SkImager: a concept device for in-vivo skin assessment by multimodal imaging", Proceedings of the Estonian Academy of Sciences, 2014, 63, 3, 301–308 doi: 10.3176/proc.2014.3.02 Available online at www.eap.ee/proceedings

In vivo skin cancer detection using diffuse reflectance spectroscopy, Ilona Kuzmina, *Biophotonics Laboratory, Institute of Atomic Physics and Spectroscopy, University of Latvia, Latvia*

The aim of current Short Term Scientific Mission was to study in vivo different skin pathologies using equipment for diffuse reflectance and colour measurements, which was developed in the Biophotonics laboratory, Institute of Electronics in Sofia. For this investigation a halogen lamp, spectrometer with detection in wavelength range 350-1050nm and optical fibres for delivering and receiving light were used. Measurements were performed the University Hospital "Tsaritsa Ioanna-ISUL" in Sofia. All ethical issues and approvals for work with these tissue samples were received from the ethical committee of the hospital. Reflectance spectra of healthy skin and different skin malformations - dermal and dysplastic nevi, basal cell carcinoma, squamous cell carcinoma, melanoma – were measured. Obtained spectra and parameters for further application in skin cancer diagnostics will be presented.

Application of circularly polarized light for optical biopsy and cancer diagnostics, Igor Meglinski, *Opto-Electronics and Measurement Techniques Laboratory, University of Oulu, Finland*

The field of cancer diagnostics is rapidly expanding, and as diagnostic technology improves so does the ability to detect and identify the many different types and sub-types of cancer. For the successful treatment the early detection of cancer is extremely important. However, during early cancer onset it is quite difficult for pathologist to differentiate between tissues that may be neoplastic versus normal tissue undergoing dysplastic changes that is unlikely to become neoplastic. Currently, the most widely used methodology for cancer diagnosis is histological analysis with further microscopy investigation. Despite the best laboratory practice the rate of conclusive diagnosis by histological analysis for a range of cancers, including cervical, bladder, skin and oral cancer, is only 65-75%. We demonstrated that circular and/or elliptical polarized light scattered within the biological tissues is highly sensitive to the presence of cancer cells and their aggressiveness in tissues. Moreover, we found that the position of Stokes vector of scattered light on the Poincaré sphere displays the successive stages of colorectal cancer. We use the sphere as a convenient tool for analysis the state of polarization of light scattered within biological tissue; navigating by Poincaré sphere (similar as by terrestrial globe, using longitude and latitude as in GPS navigator) to monitor/determine polarization properties and condition of biological tissues. We envisage that this research will enable the development of a new revolutionary diagnostic tool. For example, this technique could help in confirming the presence of early stages of prostate, melanoma or colon cancer in situ in doubtful cases.

Photoacustics for skin

Optoacoustic imaging of the skin: the interferometric viewpoint, Amir Rosenthal, *Technion - Israel Institute of Technology Technion City, Israel*

Optoacoustic imaging is a highly effective modality for visualizing hemoglobin and melanin. The unique combination of resolution and penetration depth offered by optoacoustic imaging theoretically enables imaging the entire microvasculature in the dermis and may accordingly lead to non-invasive diagnostic tools for skin diseases. Nonetheless, the theoretical limits of depth and resolution can be achieved today only at the expense of unacceptable imaging times owing to the lack of parallel detection schemes for high-frequency ultrasound (up to 150 MHz). To overcome the challenges of high-resolution optoacoustic imaging in the skin, as well as in other organs, we have developed a novel approach for ultrasound detection called pulse interferometry, which is based on the use of highly coherent pulse sources. The wideband spectrum of the sources theoretically enables parallel readout of numerous detectors, which is expected to reduce imaging speed to clinically acceptable levels. Our recent results show that pulse interferometry can also achieve the detection bandwidth and sensitivity necessary for high-resolution skin imaging.

Optical feedback based sub-wavelength frequency and displacement detection: an application towards detecting Photo-acoustic wave in tissue, Ajit Jha, *CD6-BarcelonaTech, Spain*

The nonlinear dynamics induced inside the lasers' cavity when subjected to optical feedback (OF) is demonstrated to measure frequency, velocity and amplitude of scatters in motion. So far the use of OF has been limited to measure the amplitude of scatters' vibration having amplitude greater than half the wavelength of emission. Here we present a novel technique that combines OF with frequency modulated continuous wave (FMCW) to measure the amplitude lower than half the wavelength $\lambda/2$ with resolution way below half the wavelength and frequency of vibration in order of MHz range depending upon the frequency modulation. Experiments are performed to measure a Gaussian pulse having amplitude $\lambda/13$ (68.3 nm) with peak to peak error of 4.04 nm. This will open a new door to measure the frequency, amplitude and velocity of photo-acoustic waves in tissue which we intend for future work.

Technologies for optical imaging and sensing

Tissue characterization based on temperature depth profiling using pulsed photothermal radiometry, Boris Majaron, *Jozef Stefan Institute, Slovenia*

I will discuss a rather peculiar experimental technique, called pulsed photothermal radiometry (PPTR). Based on time-resolved measurements of mid-IR emission from the tissue surface, PPTR enables reconstruction of temperature depth profiles induced by pulsed laser irradiation. I will present a few tentative medical applications of PPTR developed recently in our group, such as quantitative characterization of a prototype laser system for skin rejuvenation, analysis of laser treatment of port wine stain lesions, determination of maximal safe laser exposure on individual patient basis, and characterization of hemoglobin dynamics in traumatic bruises (haematomas).

Time resolved single photon cameras for multibeam multi photon live-cell microscopy, Robert Henderson, *The University of Edinburgh, Scotland*

This presentation will cover the design and performance of CMOS single photon avalanche diode (SPAD) camera for highly parallel time-resolved single photon counting (TCSPC). The low fill-factor of the pixels is recovered in a multifocal beam scanning microscope employing a spatial light modulator. The system increases the rate of two-photon TCSPC image acquisition by almost two orders of magnitude over conventional technology. A number of examples are given of live-cell imaging of receptor dynamics as well as in-vivo z-sectioning of zebrafish larvae are given.

Optical fiber tools for single cell manipulation and diagnostics, Pedro Jorge, *Center for Applied Photonics/INESC-TEC, Porto, Portugal*

In the last decades Optical Trapping has played an unique role concerning contactless trapping and manipulation of biological specimens. More recently, Optical Fiber Tweezers (OFTs) are emerging as a desirable alternative to bulk optical systems. In this work the fabrication and characterization of new polymer based fiber optic tweezers is presented. Its advantages and limitations are compared with established techniques. The new possibilities arising form the combination of micromanipulation and sensing capabilities at the fiber tip are discussed, in the context of single cell analysis.

Linewidth measurements of a mid-infrared quantum cascade laser by self-mixing technique for sensing application, Maria Carmela Cardilli, *Università degli Studi di Bari, Via Amendola, 173 70126, Bari, Italy*

The mid infrared spectral range is of interest for biomedical applications as imaging and spectroscopy of biological tissue. An essential requirement for high-resolution spectroscopy applications is the spectral purity of the laser source, which needs to be single mode and narrow linewidth. We measure the linewidth of a 6.2µm DFB-QCL from Alpes Laser, operating in continuous wave near room temperature driven by two different current sources. By using the laser self-mixing technique we assess the impact of the current noise of the driver on the laser linewidth.

Comparison of quantum transport simulators to produce predictive tools in laser design, David Winge, Andrew Grier, *Department of Physics, Lund University, Sweden*

Thanks to a decade of intensive research into THz quantum cascade laser designs the maximum operating temperature has been increasing, however at the moment development has stagnated. Predictive theoretical models offer the possibility of structure optimization and engineering novel designs capable of operation at higher temperature.

During this STSM, the main focus was to investigate the bound to continuum (BTC) structure originally realized by Barbieri et al. in 2004 [1] since it is currently used for most imaging experiments due to its stable CW operation. This was done with two models, the density matrix model developed in Leeds [2] and a model based on non-equilibrium Green's function used currently in Lund [3].

In the joint study, emphasis was put on the different dephasing rates in this structure. These rates govern many of the transport features impeding the linewidth of the gain peak and threshold current density. In addition they will determine the balance in the structure towards coherent and non-coherent transport.

Results will be presented showing the features of each model and how comparative studies of this type can benefit both host and home institutions.

Refereces: [1] S. Barbieri, J. Alton, H.E. Beere, J. Fowler, E.H. Linfield, D.A. Ritchie, Appl. Phys. Lett. 85(10), 1674 (2004); [2] A. Wacker, M. Lindskog, D. Winge, IEEE J. Sel. Topics Quantum Electron. 99, 1200611 (2013); [3] T. Dinh, A. Valavanis, L. Lever, Z. Ikonić, R. Kelsall, Phys. Rev. B 85, 235427 (2012)

Analysis of Risken-Nummedal-Graham-Haken instabilities in quantum cascade lasers, Nikola Vukovic, *School of Electrical Engineering, University of Belgrade, Serbia*

Quantum Cascade Lasers (QCLs) producing picosecond pulses of high peak power will find numerous novel applications for time-resolved MIR spectroscopy, free space communication, remote atmosphere sensing, cancer detection etc. Experiments in [1] evidence that some QCL structures exhibit features of multimode Risken-Nummedal-Graham-Haken (RNGH) instabilities [2,3] at low excess above lasing threshold ($p_{th2} < 1.1$). The onset of such instabilities and excitation of regular self-pulsations may provide practical means to produce picosecond pulses in the MIR spectral range. We show that low second threshold for Risken-Nummedal-Graham-Haken (RNGH) instabilities in quantum cascade lasers (QCLs) is caused by induced gratings of the medium polarization and carrier population and by diffusion of carriers and coherences. We thus explain RNGH instabilities in QCLs without making an assumption on a built-in saturable absorber and predict regular Risken-Nummedal-Graham-Haken self-pulsations in short cavity QCL lasers.

References: [1] A. Gordon et al., Phys. Rev. A 77 (2008), 053804. [2] H. Risken and K. Nummedal, J. Appl. Phys. 39 (1968), 4663. [3] R. Graham and H. Haken, Z. Phys. 213 (1968), 420.

Tumoral tissue diagnosis

THz absorption and reflection imaging of colon tissues embedded in paraffin , Irmintas Kasalynas, *THz Photonics Laboratory, Center for Physical Sciences and Technology, Vilnius, Lithuania*

A compact system was developed for THz imaging of the adenocarcinoma-affected human colon tissues simultaneously in transmission and reflection geometry. The contrast between tumor and control tissues fixed in paraffin was found up to 23% at 0.6 THz frequency. The results corroborate with previous histologic findings and confirm that the THz imaging can be used to distinguish adenocarcinoma-affected areas even without water in the tissue.

Tera-Hz imaging and spectroscopy of carcinoma-affected gastrointestinal tissue , Faustino Wahaia, *BioCareers Group/INEB - Inst. Eng. Biomédica, Univ. do Porto, Portugal*

Terahertz radiation has very low photon energy and thus it does not pose any ionization hazard for biological tissues. Due to these characteristic properties, there has been an increasing interest in terahertz imaging and spectroscopy for biological applications within the last few years and more and more terahertz spectra are being reported, including spectroscopic studies of cancer. The presence of cancer often causes increased blood supply to affected tissues and a local increase in tissue water content may be observed: this acts as a natural contrast mechanism for terahertz imaging of cancer. Furthermore the structural changes that occur in affected tissues have also been shown to contribute to terahertz image contrast.

Although terahertz imaging is thought to have potential as a tool for cancer diagnosis, the exact origin of the contrast on terahertz images often remains unclear and the reproducibility of the results is hindered by sensitive sample preparation. By measuring very thin sections cut from paraffin-embedded tissue blocks prepared according to standard histopathologic procedures, we show that direct comparison between terahertz images and visible microscope images is possible. Our studies demonstrated that specific spectroscopic information in the terahertz regime can be correlated to the underlying cellular structure of tissues and that sub-types of tumors can be identified.

Excitation-Emission Matrix Fluorescence Detection and Synchronous Fluorescence Spectroscopy of Skin Tumours , Ekaterina Borisova, *Institute of Electronics, Bulgarian Academy of Sciences, Bulgaria*

We will present our recent investigations of the fluorescence properties of cutaneous neoplasia using excitation-emission matrices (EEMs) and synchronous fluorescence spectroscopy (SFS) measurement modalities. Cutaneous tumours fluorescence spectra, namely from basal cell, squamous cell carcinoma, and malignant melanoma, were received from tissue samples obtained after surgical excision during standard procedures for removal of skin neoplasia lesions. Ethical approval for our investigations was received from Ethical Committee of University Hospital "Queen Jiovanna-ISUL" – Sofia, where the samples were obtained. The spectral peculiarities observed will be discussed and the endogenous sources of the fluorescence signal - addressed. Comparative measurements were made, using FluoroLog 3 spectrofluorimeter, on freshly surgically excised skin neoplasia and safety area of normal skin after tumor resection. EEMs were obtained in the region of 280-440 nm – excitation and 300-800 nm emission, and SFS data were obtained in the same excitation-emission spectral range using constant wavelength interval $\Delta\lambda$ in the region of 10-100 nm, with step of 10 nm.

Acknowledgements: This work was supported partially by the National Science Fund of Bulgaria under grant #DFNI-B02/9, COST Action BM1205 "European Network for Skin Cancer Detection Using Laser Imaging", and under personal fellowship of E. Borisova from Foundation UNESCO/L'Oreal "Women in science", Bulgaria – 2014.

Excitation-emission matrices (EEMs) measurements of malignant melanoma lesions, Tsanislava Genova, *Institute of Electronics, Bulgarian Academy of Sciences, Bulgaria*

Malignant melanoma is a skin tumor, characterized with high invasiveness and metastasis. The current standard diagnosis of melanoma depends on the dermatologist's experience and it is not highly précised and subjective. We measured excitation-emission matrices of malignant melanoma lesions fluorescence in order to analyze that spectroscopic modality feasibility for clinical application of MM detection. The investigated tissue samples are excised during standard cancer removing surgical procedure. The measurements are performed with spectrofluorimeter FluoroLog 3 (HORIBA Jobin Yvon, France) through excitation-emission matrix method that allows multispectral evaluation of the spectral characteristics of the investigated tissue samples. We apply excitation in the spectral range of 280-440 nm with increment of 10 nm and detect the fluorescence in 300-800 nm spectral range. The resulted spectra are presented in three dimensional graphics with two axes presenting the excitation wavelengths and the emission wavelengths, and a color contour map scheme, which represents the intensity of the observed fluorescence. The main fluorophores observed, whose fluorescence has a diagnostic meaning, are the amino acids tyrosine and tryptophan, the coenzymes NADH and FAD and the structural proteins collagen and elastin. We can suggest excitation in the range of 300-380 nm to be applied for obtaining the most diagnostically valuable range for MM detection.

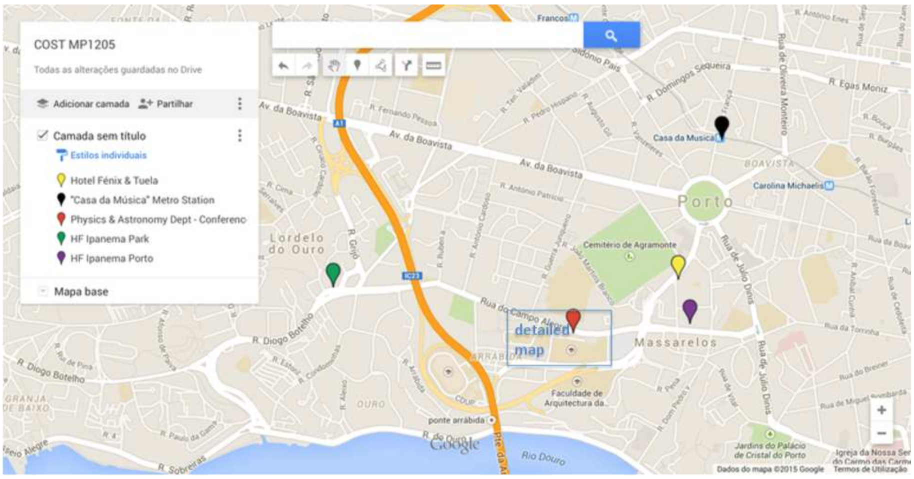
Acknowledgements: This work was supported partially by the National Science Fund of Bulgaria under grant #DFNI-B02/9, COST Action BM1205 “European Network for Skin Cancer Detection Using Laser Imaging”, and under personal fellowship of E. Borisova from Foundation UNESCO/L’Oreal “Women in science”, Bulgaria – 2014.

3 Practical information

All information related to the event (travel, accommodation, venue location, etc) can be found on the meeting webpage at http://skin-laser-imaging.org/events-2/meeting-porto-2015/ .

Workshop venue

The workshop will be hosted by the Faculty of Sciences of the University of Porto (FCUP), at Rua do Campo Alegre (Link: https://goo.gl/maps/P8qCx), at 10-15min walking distance from the recommended hotels (please check the general map). Once you enter the building (blue arrows

(a)


(b)


Figure 1: (a) general map; (b) detailed map.

in the detailed map), you should turn right.

BM1205 Workshop Venue: FCUP's Central Services building, **Room 003 (ground floor)**

Lunch venue

Lunch has been arranged in one conveniently located restaurant of the university. You will chose a meal from the daily meat/fish/vegetarian menu. You should define your choice upon arrival, where vouchers will be distributed (free of charge). The menu for the two event days is summarized in table 1.

COST ACTION BM1205

Dra. Carla Carmelo Rosa

04-05-2015			
	Rojões à Minhota	Fried pork cooked in a traditional way from Minho Region (with optional pork blood)	Meat
	Bacalhau à Brás	Cod fish in "Brás" way	Fish
	Lasanha Vegetariana	Vegetarian lasagna	Vegetarian

05-05-2015			
	Frango assado no forno com batata assada	Roasted chicken in the oven with roasted potatoes	Meat
	Massa de Atum Gratinada	Tuna pasta gratin	Fish
	Seitan à Kiev	Seitan in "Kiev" way	Vegetarian

Table 1: Lunch offer for BM1205 Workshop and meetings

BM1205 workshop and networking dinner

Casa Agrícola, a cosy restaurant located in the vicinity of the workshop venue and some of the recommended hotels, will host the BM1205 workshop and networking dinner. Interested participants will contribute with 20€ for dinner, and should confirm their attendance a.s.a.p. The dinner contribution should be payed in cash on Monday morning, when registering for the workshop.

Casa Agrícola address:
Rua do Bom Sucesso 241, Porto
http://www.casa-agricola.com

WiFi networking information

Internet connection is available during the event. You should connect to the wifi network "wifi_eventos" with the following credentials:

user sc.wifi.2@fc.up.pt

password: Bm1205

If you fell the need to configure your laptop, please follow the indications in FCUP's Computer Services site, at http://www.fc.up.pt/wireless.

4 Photonics at INESC-TEC

The Centre of Applied Photonics (CAP/INESC TEC) focuses on the development of optical solutions for sensing, imaging and systems integration. The centre directs its know-how and activities to the implementation of added value solutions for demanding applications, and is focused on the development of functional prototypes within those fields, along with a relevant scientific performance.

CAP is located at the Physics and Astronomy Department of the Faculty of Sciences, University of Porto. The main focus of the research group has been on the areas of optical fibre sensing, with some activities on integrated optics and microfabrication, materials research and optical imaging. The intense activity on optical fibre sensors lead to the creation of a spin-off company (Fibersing) in 2004. Since then, the area of optical sensors penetrated into non-traditional optical fibre sensors areas, such as environmental and bio-sensors. Currently, the activity is focused on the development of high performance solutions for extreme sensing applications, such as extreme temperatures and high pressure environments, based on a multidisciplinary approach, involving CAP's diversity of know-how fields as well as of other research centres of INESC TEC.

CAP R&D activities are funded by national and European (FP7) sources, direct contracts with Industry and the European Space Agency (ESA). International relations are often supported by cooperative projects such as bilateral cooperation actions and COST Actions.

5 Local Organizing Committee

INESC TEC& FCUP:

Carla Carmelo Rosa, INESC TEC, University of Porto (FCUP), Portugal

Paulo Marques, INESC TEC, University of Porto (FCUP), Portugal

Ireneu Dias, INESC TEC, Portugal

Luísa Mendonça, INESC TEC, Portugal