Kick Off Meeting: BM1205 Action

Skin Cancer Detection using Laser Imaging

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COST Office

COST Domain - Biomedicine and Molecular Biosciences (BMBS)

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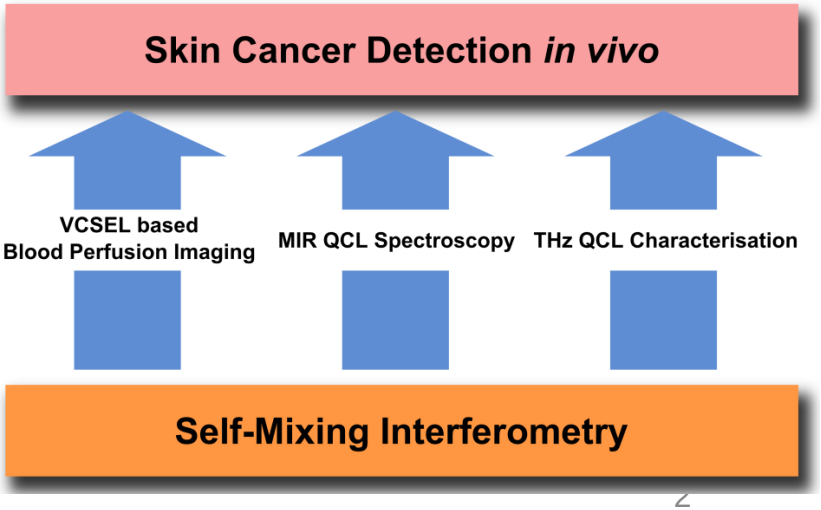
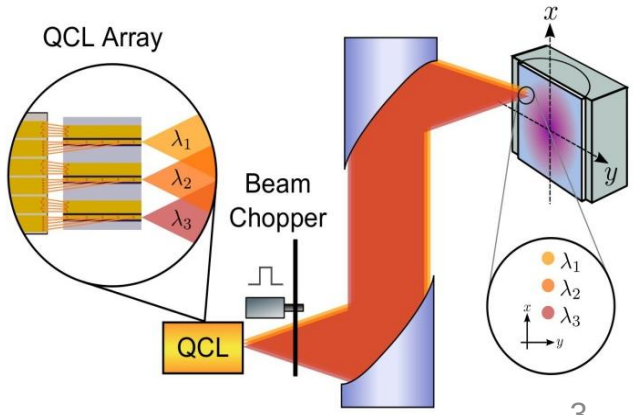
Scientific background (1)

- The existing base of skin cancer diagnostic instruments is based on detection of the ***morphological features*** of skin lesions seen by visible light.
- Network proposed here will pursue ***three interconnected approaches*** *for skin cancer identification and imaging*
  - ***NIR Spectrum*****:** Imaging and measurement of blood flow at the capillary scale is an ideal means of detecting so-called neovascularisation or the increase in disordered blood vessel growth. -
  - ***MIR Spectrum*****:** At the molecular level, specific classes of biomolecules have been observed which are associated with cancer gene expression in skin cells. Spectral signatures in the mid infrared region of the spectrum have been shown to undergo significant variations.
  - ***Terahertz Radiation – the last frontier*****:** terahertz (THz) properties of skin have been observed to change in cancer. THz radiation is known to be highly sensitive to changes in both chemical and physical structure.



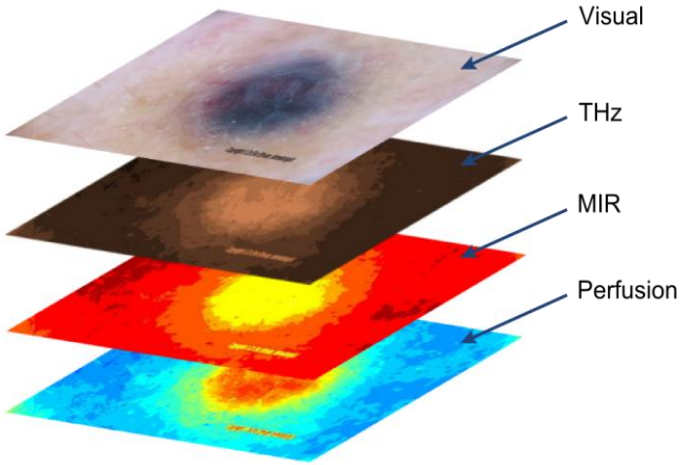
Scientific background (2)

- This action will exploit ***novel laser sources,*** covering wide spectral range from the NIR to the recently opened Terahertz region.
- NIR lasers represent mature commercial technology. Mid-IR and THz lasers are currently being developed and will be ***specifically designed, fabricated and tested*** by a number of partner institutions in the network.
- Sensing and imaging will be based on the ***laser feedback interferometry***, a highly sensitive and compact new technique. Optical, mechanical and electronic hardware required will be designed and constructed by members of the consortium
- ***Specifically, we propose extending the non-invasive interrogation of skin tissue into new range of frequencies, unused so far*** . This will create a way forward in the design of the next generation of detection and imaging systems



Objectives of the network (1)

- The Action will provide an interdisciplinary framework to enhance interaction activities within the field of optical biosensing, between world-class academic groups, clinicians, and system integrators from industry.
- ***The main objective of this Action is to coordinate efforts and enhance interaction of researchers, as well as to promote development and application of early, accurate diagnosis of skin cancer known to be the key determinant of patient outcome***.
- Network scientific **objectives** are:
  - ***Development of VCSEL Array full-field*** *blood perfusion imaging*
  - ***Tissue characterization in mid-infrared*** (MIR) in reflectance mode
  - ***Tissue characterization at terahertz*** (THz) frequencies
  - ***Validation and evaluation*** of combined sensing modalities



Objectives of the network (2)

- Providing a forum for ***cross-pollination of ideas*** and dissemination of best practice;
- Opportunities for ***interaction*** between academic labs, industrial system integrators and clinical end-users;
- ***Training opportunities*** for Early Stage Researchers to gain practical and theoretical experience of techniques outside their own discipline.
- To ***encourage*** applications for Initial Training Networks reflecting the aims of the Working Groups, and support Early Stage Researchers to apply for Marie Curie Intra-European Fellowships

- **The COST is an ultimate choice for this network as it will bring together COST- countries academia, industry and clinical end-users. This would be virtually impossible through any other European funding mechanism.**

Proposed Action Activities:

The Action will increase cohesion between scientists working in fields of Clinical Dermatology, Biomedical Imaging and Sensing, Biomedical Optics, and Laser Technology in Europe and Australia and provide good visibility of COST. This will be achieved through:

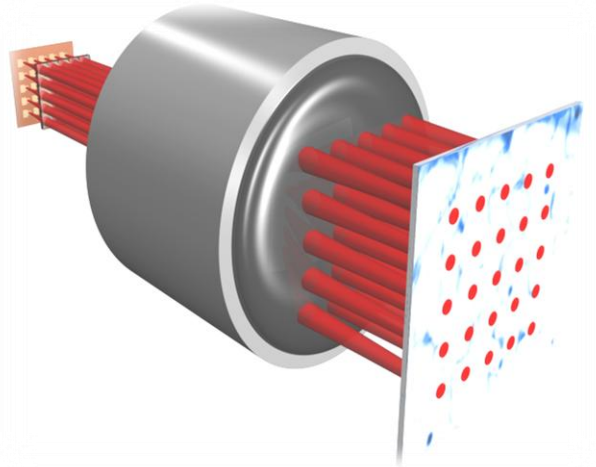
- ***WG meetings*** - including joint meetings
- ***Training Schools*** for young researchers in tissue imaging and technology for melanoma early diagnosis
- ***Short term scientific missions (STSMs)*** – short term exchange of staff and students
- ***Workshops*** will be organized periodically or as part of scientific conferences (topical sessions at conferences)
- ***Open forum*** will be created for the benefit of all participants, internal and external to the COST community.
- Undergraduate and P/G ***lectures, school visits***

Proposed Working Group Activities

- ***WG1: full-field VCSEL array perfusion imaging*** – will develop an ultra-compact, full-field blood perfusion sensing technology based on the 2D laser arrays. Will enable rapid quantification of vascularisation. Clinical evaluation of the system
- ***WG2: Tissue characterization at mid infrared frequencies using QCLs.*** –relevant for diagnosis of skin lesions, will make available additional chemical mapping to the vascular and structural information. Clinical evaluation of the system
- ***WG3: Tissue characterisation at terahertz frequencies using THz QCLs***. Initial work shows potential for discriminating basal cell carcinoma (BCC) from surrounding healthy tissue. Potential to revolutionize in vivo diagnostics. Clinical evaluation of the system
- ***WG4: Validation and evaluation of combined sensing modalities.*** Clinical evaluation of the combination of the multiple investigative techniques in the discrimination of malignant versus non-malignant behaviour in tissue lesions. Image fusion.

Outputs/deliverables from the Action

- ***New knowledge*** of the changes in optical properties of tissue in skin cancer
- Objective estimates of the performance of sensors based on ***novel techniques***
- Potential platform for ***commercial medical device*** manufacturers
- Formalisation and consolidation of existing and new ***academic relationships*** which will lead to future collaborative ventures
- Access to world-class validation trial centres and their clinical end-user group for design feedback
- Long-term European ***community health benefits*** of improved cancer screening



Outputs/deliverables from the Action (2)

- A new generation of young researchers will be equipped with the ***confidence and expertise to cross traditional scientific boundaries*** thus enabling them to become future leaders of the field.
- Development of stable collaboration links ***across the usual divide lines*** between the device engineering – system engineering – clinical environment.
- Incorporation of Australian partners expertise in techniques which are not readily available to European partners
- Joint publications, including high impact multidisciplinary articles, edited books, special topics journal issues

Outputs/deliverables from the Action (3)

- Acquired images in ***three different ranges of the electromagnetic spectrum while performing a similar scan of the tissue using the self-mixing interferometric technique.***
- Investigate the effect of absorption combined with the effects of blood perfusion (dynamic scattering) as well as scattering in superficial tissue layers. Measurement of hydration of stratum corneum (SC).
- Evaluate the benefits of image-fusion and contrast obtained using three different imaging modalities: THz reflection mode self-mixing imaging, MIR reflection-mode self-mixing imaging, and NIR functional self-mixing Doppler-perfusion imaging.
- Will facilitate translational research from the biophotonics to clinical practice

Translation to clinical practise:

Considering the novelty of the proposed diagnostic techniques translation in clinical environment will be performed in number of steps:

- Development and validation of tissue phantoms (especially important for THz region where such phantoms are not existing)
- In-vitro evaluation on prepared samples with active participation of clinicians
- Pre clinical trials on healthy volunteers
- Clinical trials (compact technology transferable to clinical environments)

Relevance of Neovascularisation:

- Neovascularisation is a potential marker of malignant change; has been reported in melanoma as an indicator of progression to metastasis.
- Specifically, the direction of vessel growth seems to be important with radial and vertical growth indicating worsening prognosis. These features will be identifiable using technologies to be developed in WG1 and WG3.
- This is relevant mainly for techniques in WG1 and is only one among several markers we are investigating (WG2,WG3).

[1] Folkman J. et al, Nature 339, (1989), 58-61.

[2] Srivastava A.,Microsc. Res Techniq 2003; 60: 208-224.

[3] Marcoval J. et al.,J Cutan Pathol 1997; 24: 212-218.

The handling of intellectual property (IP) :

Ownership of background remains with the originating partner

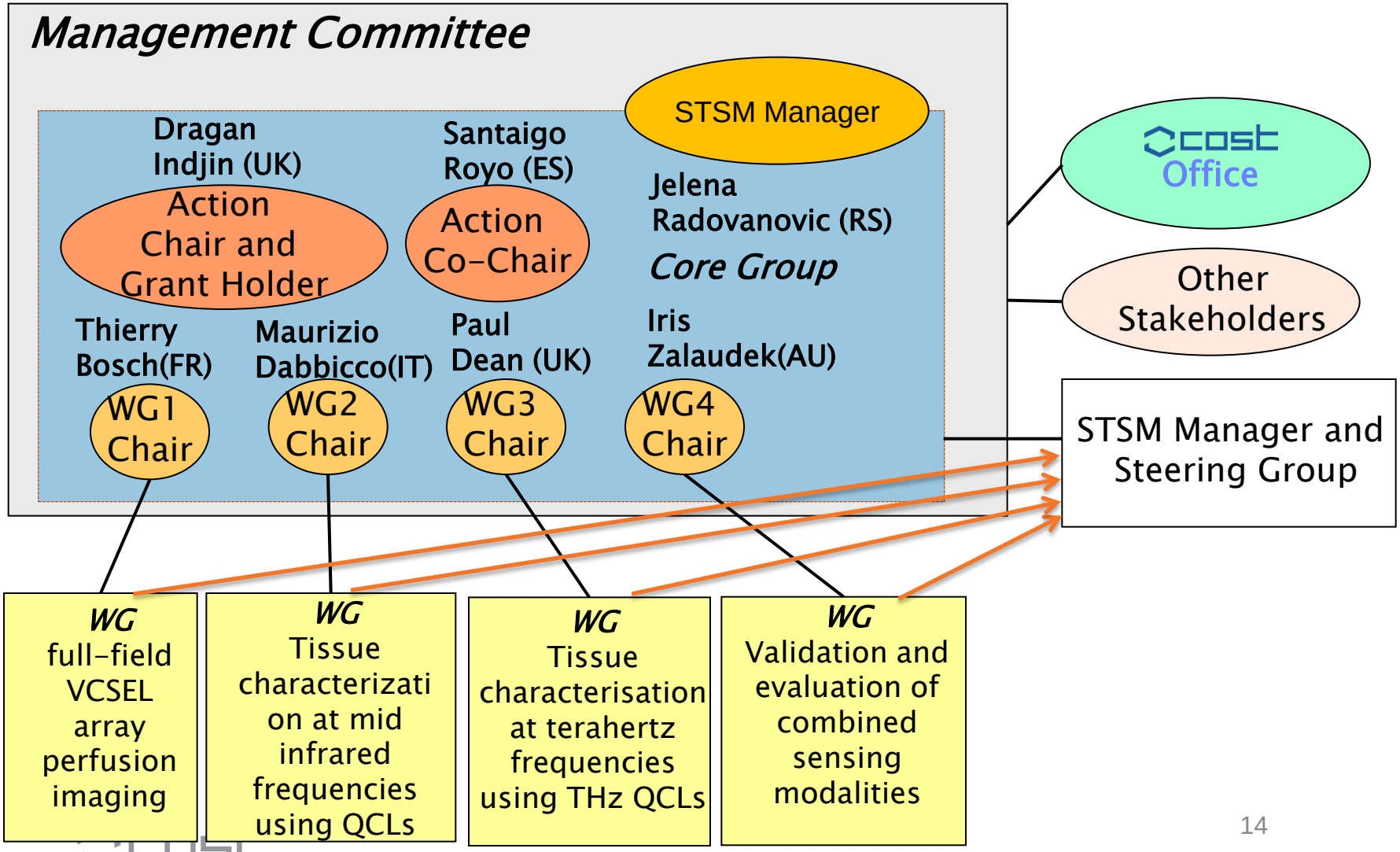
Ownership remains with the partner(s) agreed to have generated the foreground results

Where sole ownership cannot be proven, joint ownership or another arrangement will be agreed upon.

Network management and organisation

- ***The Management Committee (MC)*** will be responsible for :
  1. Appointment of the Chair, Vice-Chair, Working Group (WG) leaders, an STSM manager and a website manager who will form the Core Group (CG) along with any other co-opted members at the discretion of the MC.
  2. Budget planning and allocation of funds
  3. Plan MC and WG meetings, Action workshops and Training School events
  4. Coordinate interaction between Working Groups
  5. Evaluate and monitor the progress of the Action
  6. Promoting the Action to potential stakeholders and end users
  7. Host a concluding symposium involving all WGs.

Management Structure



Complementarities with other programs

The COST Actions:

- TD1003 “Bio-inspired Nanotechnologies: from concepts to applications”,

- MP1204 “TERA-MIR Radiation: Materials, Generation”,

FP7 project:

- CHARMING (Project reference: 288786).

ERC Advanced Grant:

- NOTES, “New opportunities in terahertz engineering and science

- - TOSCA, "Terahertz Optoelectronics: from the science of cascades to applications”, ERC-AG-PE7

ITN Project

- - FAST- "French-Australian Science and Technology International Science Linkages Program"

Involvement of Dermatology Groups

The involvement of dermatologists/clinicians has been significantly increased through consultation with stakeholders and preliminary meetings:

- Prof Iris Zalaudek, MD PhD, Department of Dermatology, Medical University of Graz – secretary of the international dermoscopy society, Austria
- Prof Ketty Paris, Chair of Department of Dermatology, University of L'Aquila, Italy
- Susana Puig, MD PhD Research Coordinator, Melanoma Unit, Hospital Clinic, Barcelona, Spain
- Prof Julia Newton Bishop, MD, PhD, Dermatology, Leeds Institute of Molecular Medicine, St James's University Hospital, University of Leeds, UK
- Mario Santinami, MD, Surgical oncologist, Director Melanoma Sarcoma Unit, IRCCS Fondazione Istituto Tumori, Milano, Italy
- Dr Alison Layton, Harrogate and District NHS Foundation Trust, Harrogate/York, UK
- Prof Mirna Situm, "Sestre milosrdnice" University Hospital Centre, Zagreb, Croatia
- Anica Radulović, MD MSc, Institute of Healthcare for Children and Youth of Vojvodina, Novi Sad, Serbia

Biomedical Optics/Biophotonic Groups

- Dr Peter E. Andersen, Technical University of Denmark, Roskilde, Denmark
- Prof Lise Lyngsnes Randeberg, Norwegian University of Science and Technology, Norway
- Prof Steven Wilson, University of Queensland, Australia
- Prof Janis Spigulis, University of Latvia, Latvia
- Professor Kalju Meigas, Tallinn University of Technology, Estonia

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