Name of the TEMPUS CRH-BME representative (for your Institution): Andres Santos

BME GROUP/LABORATORY PRESENTATION: WWW.DIE.UPM.ES/IM/

Biomedical Imaging Technologies (BIT-UPM) is a research group recognized by Universidad Politécnica de Madrid, which has been working on different fields related to biomedical images since 2000. Its main objective is the application of technological solutions to actual clinical or biological problems, especially with the aim of early diagnosis. This has led to research in developing new medical image acquisition and analysis techniques, with the main goal of supporting translational and preclinical research as well as biological systems understanding approaching from organs to proteins, and from image processing to high performance electronics.

With this objective, three main research lines have been carried on:

- Cardiac imaging analysis: The aim of this research line is to contribute to an early diagnosis of cardiac pathologies, by providing functional and quantitative information of the heart state obtained from images (mainly echocardiography, magnetic resonance imaging and computed tomography).

- Functional and molecular imaging: The aim of this line is to apply image processing techniques to extract quantitative functional and molecular information from biomedical images, as a means of improving medical diagnosis and treatment follow-up. In this line, several multimodal and dynamic image processing systems have been developed, producing maps of activity or cerebral metabolism.

- High resolution PET scanners: The aim of this activity is to contribute to the design and implementation of high resolution Positron Emission Tomography (PET) scanners. The main work has been on designing and implementing event acquisition modules, characterizing new architectures and detector configurations, and improving image reconstruction methods.

- Microscopy image analysis for biological understanding: The aim of this activity is to develop image analysis methods that allow processing and measuring data acquired with the most recent state-of-the-art microscopy technologies for biomedical understanding. These technologies provide multidimensional in-vivo observations of organism models such as zebrafish. Thus, image analysis is required to approach new challenges in systems biology at the different genetic, proteomic, cellular, organic and individual levels.

To support these activities, the group has expertise in image processing, image registration, motion correction and compensation, cell tracking and morphological segmentation, characterization of new architectures and new detectors by means of simulations, tomographic reconstruction and design of acquisition modules with programmable logic.

To achieve these objectives, the group has long-standing collaborations with several hospitals and clinical and biological groups, like Hospital G.U. Gregorio Marañón, Hospital Puerta de Hierro (Madrid) and Hospital Clínic de Barcelona. Other relevant international collaborations are with National Institutes of Health (Bethesda, MD, USA), Biomedical Engineering Dept., Johns Hopkins Univ (Baltimore, MD, USA), Joint Department of Physics. Royal Marsden NHS Foundation Trust / Institute of Cancer Research.Londres (UK) y German Cancer Research Center (DKFZ –

Heidelberg, Germany).

The group is also recognized as participant (CB06/01/1044) in CIBER-BBN: Networking Biomedical Research Center in Bioengineering, Biomaterials and Nanomedicine (IniciativaIngenio 2010, programaConsolider, acciones CIBER del Ministerio de Sanidad y Consumo, ahoraMinisterio de Ciencia e Innovación) since 2008.

As a result of this activity, 36 papers in international journals (included in JCR) and around 100 communications in international conferences have been published in the last 5 years. Another important result has been the 8 Ph.D. Thesis defended in this same period.

Further information about the group activities can be found in http://www.die.upm.es/im/

Group members:
Director: Prof. Andres Santos
Associate Professors: Maria J. Ledesma Carbayo,GeorgiosKontaxakis
Researchers: 5 post-doc
PhD students: 8 students

BME EDUCATION		
Names…	Master en Ingeniería Biomédica. Master en Telemedicina y Bioingeniería. Doctorado en Ingeniería Biomédica	
COURSES AVAILABLE IN ENGLISH? (IF YES, ON WHICH LEVEL?)		
• BSc:	• MSc: YES	• PhD: YES
ECTS: Total number		
• BSc:	• MSc: 120 / 60	• PhD:

BILATERAL AGREEMENTS WITH OTHER UNIVERSITIES? (LIST THOSE UNIVERSITIES)

- Palaiseau - École Polytechnique (F)
- Brest - École Nationale Superieure des Telecommunications de Bretagne (F)
- Patra - Panepistimio Patron (G)
- Napoli - Università degli Studi di Napoli Federico II (I)
- Lausanne - École Polytechnique Fédérale (EPF) Lausanne (CH)

MAIN BME INTERESTS

- Medical Imaging. Image acquisition and processing. Biomedical Signal Processing

ACTIVE PROJECTS

National

- PRECISION: Simulación y tratamiento guiado por imagen en radioterapia. Subprogram INNPACTO: National Scientific Research, Technological Development and Innovation Program. CDTI - Ministerio de Ciencia e Innovación. 2010-2013.
- Imagen médica multimodal en tiempo real para escenarios complejos de tratamiento (TEC2010-21619-C04-03). 6th National Scientific Research, Technological Development and Innovation Program. Ministry of Science and Innovation. 2011-2013.
- AMIT: Tecnologías de imagen molecular avanzadas. Programa de Consorcios Estratégicos Nacionales en Investigación Técnica (CENIT). Ministerio de Ciencia e Innovación. 2010-2013.
- ARTEMIS-CM: Advanced Real-TimE Multimodality Medical Imaging. Program for Developing R&D Activities among Research Groups in Technology (P2009/DPI-1802). Regional Government. 2010-2013.
- Evaluación de la Viabilidad y Utilidad de una Herramienta de Planificación y Eco-Dirección 3D en Cirugía de Metástasis Hepáticas (PI09/91058). Research

project for the evaluation of health technologies. Instituto de Salud Carlos III. Ministry of Science and Innovation. 2010-2011.

- Estudio Multi-Hospital de Sistemas de Simulación y Entrenamiento en la Optimización de la Práctica Clínica en Radioterapia Intraoperatoria (PI09/91065). Research project for the evaluation of health technologies. Instituto de Salud Carlos III. Ministry of Science and Innovation. 2010-2011.
- ITRENIO: Contribución a la mejora y optimización computacional de la imagen tomográfica mediante radiación no ionizante (TEC2008-06715-C02-02). 6th National Scientific Research, Technological Development and Innovation Program. Ministry of Science and Innovation. 2008-2011.
- CIBER Bioingeniería, Biomateriales y Nanomedicina (Grupo CB06/01/1044). Centro de Investigación Biomédica en Red (Acciones CIBER de la Iniciativa Ingenio 2010). Instituto de Salud Carlos III. Ministerio de Sanidad y Consumo. 2008-...

International

- TAHITI: Improving THerapy And Intervention Through Imaging. International Research Staff Exchange Scheme (FP7). 2011-2014.
- Motion Tracking of Myocardial Tissue: Application of non-rigid registration techniques. Research contract with Laboratory of Cardiac Energetics. National Institutes of Health (NIH). Bethesda (MD, USA). 2007-2008.
- EMIL: European Molecular Imaging Laboratories. Network of Excellence of 6th Framework Program (LSHC-CT-2004-503569 priority Life Sciences, Genomics and Technologies for Health). European Union. 2004-2009.

Other

- Advanced Methods for the Estimation of Human Brain Activity and Connectivity. Project COST BM0601. 2007-2011.
- Curricula Reformation and Harmonisation in the field of Biomedical Engineering. Call TEMPUS IV. 2009-2011
- Bimodal PET-MRI molecular imaging technologies and applications for in vivo monitoring of disease and biological processes. Project COST TD1007. 2011-

Patents

- Aparato de adquisición de datos para tomografía computerizada por emisión de radiación gamma y su funcionamiento (P200702836)
- Sistema de medida de tiempo con alta resolución y autocalibrado basado en dispositivo lógico programable (P200401381)
- Sistema escáner multi-resolución para la exploración de micromatrices (P200302104)
- CUSQ: CARDIO US/Quantification (M-003351/2008)

RECENT PUBLICATIONS (LAST 2 YEARS)

- D. Megías, R. Marrero, B.M. del Peso, M.Á. García, J.J. Bravo-Cordero, A. García-Grande, A. Santos, M.C. Montoya. "Novel lambda FRET spectral confocal microscopy imaging method". *Microsc. Res. Tech.*, vol. 72, no. 1, pp. 1-11. Jan. 2009.
- F.G. Zöllner, R. Sance, P. Rogelj, M.J. Ledesma-Carbayo, J. Rørvik, A. Santos, A. Lundervold. "Assessment of 3D DCE-MRI of the kidneys using non-rigid image registration and segmentation of voxel time courses". *Comput. Med. Imaging Graph.,* vol. 33, no. 3, pp. 171-181. Apr. 2009.
- M.A. Luengo-Oroz, J. Angulo. "Cyclic Mathematical Morphology in Polar-Logarithmic Representation". *IEEE Trans. Image Process.*, vol. 18, no. 5, pp. 1090-1096. May. 2009.
- P. Guerra, A. Santos, D.G. Darambara. "An investigation of performance characteristics of a pixellated room-temperature semiconductor detector for medical imaging". *J. Phys. D-Appl. Phys.*, vol. 42, 175101 (11pp). Sep. 2009.
- E. Lage, J.J. Vaquero, A. Sisniega, S. España, G. Tapias, M. Abella, A. Rodríguez-Ruano, J.E. Ortuño, A. Udías, M. Desco. "Design and performance evaluation of a coplanar multimodality scanner for rodents imaging". *Phys. Med. Biol.*, vol. 54. no.

18, pp. 5427-5441. Sep. 2009.

- IM. Schaap, C.T. Metz, T. van Walsum, A.G. van der Giessen, A.C. Weustink, N.R. Mollet, C. Bauer, H. Bogunović, C. Castro, X. Deng, E. Dikici, T. O'Donnell, M. Frenay, O. Friman, M. Hernández Hoyos, P.H. Kitslaar, K. Krissian, C. Kühnel, M.A. Luengo-Oroz, M. Orkisz, Ö. Smedby, M. Styner, A. Szymczak, H. Tek, C. Wang, S.K. Warfield, S. Zambal, Y. Zhang, G.P. Krestin, W.J. Niessen. "Standardized Evaluation Methodology and Reference Database for Evaluating Coronary Artery Centerline Extraction Algorithms", *Med. Image Anal.*, vol. 13, no. 5, pp. 701-714. Oct. 2009.

- M.A. Luengo-Oroz, E. Faure, J. Angulo. "Robust iris segmentation on uncalibrated noisy images using mathematical morphology". *Image Vis. Comput.*, vol. 28, no. 2. pp. 278-284. Feb. 2010.

- A. Gaitanis, G. Kontaxakis, G. Spyrou, G. Panayiotakis, G. Tzanakos."PET image reconstruction: A stopping rule for the MLEM algorithm based on properties of the updating coefficients". *Comput. Med. Imaging Graph.*, vol. 34, no. 2, pp. 131-141. Mar. 2010.

- J.E. Ortuño, G. Kontaxakis, J.L. Rubio, P. Guerra, A. Santos. "Efficient methodologies for system matrix modelling in iterative image reconstruction for rotating high resolution PET". *Phys. Med. Biol.*, vol. 55, no. 7, pp. 1833-1861. 2010.

- G. Wollny, M.J. Ledesma-Carbayo, P. Kellman, A. Santos. "Exploiting Quasiperiodicity in Motion Correction of Free-Breathing Myocardial Perfusion MRI". *IEEE Trans. Med. Imaging*, vol. 29, no. 8, pp. 1516-1527. Aug. 2010.

- N. Olivier, M.A. Luengo-Oroz, L. Duloquin, E. Faure, T. Savy, I. Veilleux, X. Solinas, D. Débarre, P. Bourgine, A. Santos, N. Peyriéras, E. Beaurepaire. "Cell Lineage Reconstruction of Early Zebrafish Embryos Using Label-Free Nonlinear Microscopy". *Science*, vol. 329, no. 5994, pp. 967-971. 20 Aug. 2010.

- G. Kontaxakis, N. Bourbakis, K.S. Nikita, C.S. Pattichis."Introduction to the special issue on biomedical image technologies and methods". *Comput. Med. Imaging Graph.*, vol. 34, no. 6, pp. 415-417. Sep. 2010.

- N. Carranza-Herrezuelo, A. Bajo, F. Sroubek, C. Santamarta, G. Cristobal, A. Santos, M.J. Ledesma-Carbayo. "Motion estimation of tagged cardiac magnetic resonance images using variational techniques". *Comput. Med. Imaging Graph.*, vol. 34, no. 6, pp. 514-522. Sep. 2010.

- A. Gaitanis, G. Kontaxakis, G. Spyrou, G. Panayiotakis, G. Tzanakos. "Studying the properties of the updating coefficients in the OSEM algorithm for iterative image reconstruction in PET". *Comput. Meth. Programs Biomed.*, vol. 99, no. 3, pp. 219-229. Sep. 2010.

- P. Aguiar, M. Rafecas, J.E. Ortuño, G. Kontaxakis, A. Santos, J. Pavía, D. Ros. "Geometrical and Monte Carlo projectors in 3D PET reconstruction". *Med. Phys.*, vol. 37, no. 11, pp. 5691-5702. Nov. 2010.

- S. Sampath, J.A. Derbyshire, M.J., Ledesma-Carbayo, E.R. McVeigh. "Imaging left ventricular tissue mechanics and hemodynamics during supine bicycle exercise using a combined tagging and phase-contrast MRI pulse sequence". *Magn. Reson. Med.*, vol. 65, no. 1, pp. 51-59. Jan. 2011.

- E. Perez-David, A. Arenal, J. L. Rubio-Guivernau, R. del Castillo, L. Atea, E. Arbelo, E. Caballero, V. Celorrio, T. Datino, E. Gonzalez-Torrecilla, F. Atienza, M. J. Ledesma-Carbayo, J. Bermejo, A. Medina, F. Fernandez-Aviles. "Noninvasive Identification of Ventricular Tachycardia-Related Conducting Channels Using Contrast-Enhanced Magnetic Resonance Imaging in Patients With Chronic Myocardial Infarction: Comparison of Signal Intensity Scar Mapping and Endocardial Voltage Mapping". *J. Am. Coll. Cardiol.*. vol. 57, no. 2, pp. 184-194. 11 Jan. 2011.

- G. Sportelli, N. Belcari, P. Guerra, A. Santos. "Low-resource synchronous coincidence processor for positron emission tomography". *Nucl. Instrum. Methods Phys. Res. Sect. A.* 2011. doi: 10.1016/j.nima.2010.11.170.

- A. Del Guerra, N. Belcari, M.G. Bisogni, F. Corsi, M. Foresta, P. Guerra, S. Marcatili, A. Santos, G. Sportelli. "Silicon Photomultipliers (SiPM) as novel photodetectors for PET". *Nucl. Instrum. Methods Phys. Res. Sect. A.* 2011. doi: 10.1016/j.nima.2010.11.128.

- G. Sportelli, N. Belcari, P. Guerra, F. Spinella, G. Franchi, F. Attanasi, S. Moehrs, V. Rosso, A. Santos, A. Del Guerra. "Reprogrammable Acquisition Architecture for Dedicated Positron Emission Tomography". *IEEE Trans Nucl Sci.*, 2011. doi: 10.1109/TNS.2011.2113193.

COLLABORATION WITH OTHER INSTITUTIONS (OPTIONAL)

Universities:

- Johns Hopkins (USA)

- École Polytechnique (F)
- EPFL (CH)
- U. Pisa (I)

Research Centers:
- CNRS (F)
- NIH (USA)
- Fraunhofer IGD (D)

Medical Institutions:
- Hospital G.U. Gregorio Maranon
- Hospital Clínic
- Hospital Puerta de Hierro

Other:
-