



*"PIERO CALDIROLA" INTERNATIONAL CENTER
FOR THE PROMOTION OF SCIENCE
and International School of Plasma Physics*



**CENTRO
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ENRICO FERMI

**UNIVERSITÀ
DELLA CALABRIA**



INTERNATIONAL WORKSHOP ON IMAGING

*Villa Monastero, Varenna, Italy
September 4 – 8, 2017*

Sponsorship:



PROGRAMME

Monday, 4 September

08:30 *Registration*

10.00 *Coffee*

10:30 **Welcome**

BIOMEDICAL IMAGING

Chairman: Marco Paganoni

10:45 **O1.1** **EU strategy for bioimaging infrastructure**
Silvio Aime

11:30 **O1.2** **CERN and biomedical imaging** *Manuela Cirilli*

12:15 *Group photo*

12.30 *Lunch*

Chairman: Maria Carla Gilardi

14.30 **O2.1** **Segmentation of Biomedical images**
Elisabetta De Bernardi

15.00 **O2.2** **Quantification of biomedical images in oncology/neurology**
Francesca Gallivanone

15.30 **O2.3** **Machine learning in image analysis**
Christian Salvatore

16:00 *Coffee*

16.30 **O2.4** **X-ray phase contrast imaging: an extraordinary tool for structural
and functional biomedical investigations**
Alberto Bravin

17.00 **O2.5** **Image Guided and Adapt Radiotherapy: the key to success**
Pietro Mancosu

17:30 **POSTER SESSION**

19.30 *Welcome Reception at Hotel Royal Victoria*

Tuesday, 5 September

IMAGING FOR CULTURAL HERITAGE, HOMELAND SECURITY, ENGINEERING

Chairman:

- 09:00 O3.1 Multi-scale imaging *Koen Janssens*
- 09:45 O3.2 Non-invasive in situ spectroscopic methods and synchrotron radiation X-ray techniques for the study of the alteration process of artists' pigments
Letizia Monico
- 10:30 *Coffee*
- 11:00 O3.3 Neutrons for CH *David Mannes*
- 11:30 O3.4 Photoluminescence microscopy *Austin Nevin*
- 12:00 O3.5 Micro-analyses of artistic materials at ESRF
Marine Cotte

12:30 *Lunch*

Chairman:

- 14:45 O4.1 Applications of muon tomography
Paolo Checchia
- 15:30 O4.2 X-ray microtomography for cultural heritage
Raffaele Giuseppe Agostino
- 16:00 O4.3 Some examples of imaging for engineering
Vincenzo Formoso

16:30 *Coffee*

17:00 **POSTER SESSION**

18:45 *Concert and Reception at Villa Cipressi*

Wednesday, 6 September

TRAINING ON SOFTWARE FOR IMAGING

Chairman: Anders Kaestner

09:00 **T5.1** **Anders Kaestner** *CT Fundamentals*

09:45-12:45 **Training session I**

10.30 *Coffee*

12.45 *Lunch*

Chairman: Alessia Cedola

14:45 **T6.1** **Alessia Cedola** *Beyond CT*

15:30-18:30 **Training session II**

16:30 *Coffee*

18.30 *End of session*

TRAINING SESSION

Introduction to computed tomography

Anders Kaestner

Neutron Imaging and Activation Group, Paul Scherrer Institut, Switzerland

In many scientific applications, it is important to observe the contents of a sample without cutting it into pieces. Computed tomography (CT) offers a method to non-destructively acquire three-dimensional information representing the spatial distribution of different materials in the sample. It is an indirect measurement that requires the acquisition of projection data that is reconstructed into the volume of the sample. The reconstruction is an inversion operation that is solved using either algorithms based on the analytical solution or iterative methods that finds the material distribution. CT can be performed using different radiation types like X-rays and neutrons to observe different characteristic features in the sample.

In this lecture, we will provide you the background to understand the steps needed to successfully reconstruct a set projections into a volume data set. Questions like these will be answered:

- What is the importance of a good geometry description?
- How does the acquired dose affect signal to noise ratio?
- How many projections are needed?
- Which artifacts can be observed in a reconstructed image and how can they be removed?

We will also give a short overview of open source tool that can be used to process imaging data. This lecture will be the starting point for the practical exercises where you will reconstruct CT data.

Introduction to phase contrast tomography

Alessia Cedola

CNR- Institute of Nanotechnology, Rome-Italy

Classical X-ray radiography and tomography are based on absorption and are well-known tools for imaging the internal structure of thick objects with hard X-rays. In the study of low-absorption materials (like biomedical samples) and in particular when details with small differences in density must be detected (as in the structure of the grey and white matter of the spinal cord and brain), the significant degree of attenuation in the sample makes producing a detectable contrast very difficult. In these cases, a better contrast can be achieved by imaging the phase modulation induced by an object in a coherent or partially coherent beam.

Moreover, tomography provides the additional benefit of discriminating the different depths within the sample and providing a 3D sample reconstruction. Several experimental approaches exist for detecting X-ray phase contrast. A simple yet effective phase-contrast method for hard X-rays is based on in-line imaging after free-space propagation.

In this lecture, we will provide you the background to understand the X-ray phase contrast imaging principles of the most used phase contrast techniques. We also provide you a brief description of the phase retrieval algorithms.

Different advanced applications, in the medical field and in the cultural heritage will be shown.

Phase retrieval and tomography reconstruction in free-space

X-ray Phase Contrast Tomography

Alessia Cedola

CNR- Institute of Nanotechnology, Rome-Italy

CNR- Institute of Nanotechnology, Rome-Italy

We will give a short overview of open source tools for the reconstruction of phase contrast imaging data in free-space mode, 3D reconstruction and 3D rendering. This lecture will be the starting point for the practical exercises to reconstruct XPCT data.

A set of raw-data acquired in free-space X-ray phase contrast tomography will be provided to the students together with some open source tool.

The student will train to the final data analysis.

Thursday, 7 September

HYBRID TECHNOLOGIES, NANOSCALE

Chairman:

- 09:00 O7.1 Multi-mode imaging: neutrons and X-ray
Anders Kaestner
- 09:45 O7.2 Technological advances and multimodality in MRI
Alessandra Retico
- 10.30 *Coffee*
- 11.00 O7.3 - X-ray Imaging at the Nanoscale *Peter Cloetens*
- 11.30 O7.4 – Nanoanalysis *Sylvain Bohic*
- 12.00 O7.5 Neuron imaging *Gabriele Biella*
- 12.30 *Lunch*

NEW IMAGING APPLICATIONS

Chairman: Alberto Bravin

- 14:30 O8.1 Range monitoring in particle therapy
Piergiorgio Cerello
- 15:00 O8.2 Consciousness and complexity: from theory to practice
Simone Sarasso
- 15:30 *Coffee*
- 16:00 O8.3 Quantum Imaging *Marco Genovese*
- 16.30 O8.4 Industrial X-ray microtomography for answering
questions in biology *Jozef Kaiser*
- 17:50 *Boat trip and banquet dinner*

Friday, 8 September

OUTLOOK: IMAGING FACILITIES: LARGE AND SMALL

Chairman: Giuseppe Gorini

09:30 **O9.2** **Future of neutron imaging** *Manuel Morgano*

10:00 **O9.3** **Laboratory and synchrotron implementations of edge illumination X-ray phase-contrast imaging**
Marco Endrizzi

10.30 *Coffee*

Chairman: Marco Endrizzi

11:00 **O9.4** **Liquid-metal-jet sources for high-resolution x-ray phase-contrast imaging**
Hans Hertz

11:30 **O9.5** **Imaging at synchrotron sources: state-of-the-art and what will the new sources bring**
Rajmund Mokso

12:00 **O9.6** **STAR** *Riccardo Barberi*

12:30 **Final Discussion**

13:00 *Meeting ends*

POSTERS

Number	Presenter	Institution	Title
P.1	A. Pacureanu	European Synchrotron Radiation Facility, ID17, Grenoble, France	<i>Label-free three-dimensional imaging of biological tissue at the nanoscale</i>
P.2	D. Micieli	Dip. di Fisica, Università della Calabria & Dip. di Fisica "G. Occhialini", Università degli Studi Milano-Bicocca, Italy	<i>A comparative analysis of state-of-the-art reconstruction methods applied to Neutron Tomography</i>
P.3	M. Fratini	Istituto di Nanotecnologia-Laboratorio di Soft and Living Matter, CNR, Rome, Italy & IRCCS Fondazione Santa Lucia Rome, Italy	<i>X-ray Phase-Contrast multiscale-Tomography for the 3D quantitative investigation of the spinal cord neuronal arrangements for preclinical application</i>
P.4	E. Longo	Laboratoire d'Optique Appliquée UMR7639, ENSTA-CNRS-Ecole Polytechnique-Université Paris-Saclay, Palaiseau, France	<i>3D map of theranostic nanoparticles distribution in several mice samples by means X-ray Phase Contrast Tomography</i>
P.5	N. M. Boulton	Idaho National Laboratory 2525 Fremont ave., Idaho Falls, ID. 83402, USA	<i>Commissioning of the NDDL-40 Neutron Detection System at Oregon State University</i>
Number	Presenter	Institution	Title
P.6	J. Ströbel	Department of Physics, Ludwig Maximilians University, Munich Germany	<i>Sub-micron X-ray phase contrast holo-tomography of human osteoarthritic cartilage</i>

P.7	G. Scionti	Università della Calabria Arcavacata di Rende (CS), Italy	<i>MCNPX simulations for the evaluation and shielding of the gamma background on CCD and CMOS sensors for IMAT</i>
P.8	A. Hewat	NeutronOptics Grenoble, 8 Allée des Pampres, 38640 Claix, FRANCE	<i>Choice of CCD & CMOS Detectors for X-ray AND Neutron Imaging</i>
P.9	C. Gramaccioni	Dept. of Physics Univ. of Cosenza, Arcavata di Rende (Cosenza), Italy & CNR-Nanotec c/o Dept. of Physics Univ. Sapienza, Rome, Italy	<i>Nanotomography and X-Ray Fluorescence Microscopy for quantitative Iron concentration map in inflamed cells</i>
P.10	L. Massimi	CNR – Istituto di Nanotecnologie Rome, Italy	<i>X-Ray Phase-Contrast Tomography Investigation of Neurodegeneration in Animal Models</i>
Number	Author	Institution	Title
P.11	L. Arcidiacono	CENTRO FERMI - Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi, Rome, Italy	<i>Time resolved prompt gamma activation analysis from epithermal neutrons applied to gold coins of archaeometric interest</i>
P.12	M. Tesařová	CEITEC BUT Brno University of Technology Brno, Czech Republic	<i>Quantitative 3D analysis at cellular resolution with X-ray microtomography</i>
P.13	D. Di Martino	Dip. Fisica “G. Occhialini”, Università di Milano-Bicocca, Milan, Italy	<i>Neutron imaging and diffraction study of ancient iron tie rods</i>
P.14	T. Minniti	STFC, Rutherford Appleton Laboratory, ISIS Facility, Harwell, OX11 0QX, United Kingdom	<i>Towards high-resolution neutron imaging on IMAT</i>

P.15	A. Mittone	European Synchrotron Radiation Facility, ID17, Grenoble, France	<i>Phase contrast imaging of eyes: a study of feasibility</i>
P.16	C. Cavinato	Mines Saint Etienne, CIS-EMSE, SAINBIOSE, F-42023 Saint Etienne & 2. INSERM U1059, SAINBIOSE, F-42023 Saint-Etienne, France	<i>In situ investigation of Adventitia fibrous microstructure coupling multi-photon confocal microscopy and bulge inflation test</i>
Number	Author	Institution	Title
P.17	J. Kaiser	CEITEC BUT, Brno University of Technology	<i>Implementation of industrial X-ray microtomography for answering questions in biology</i>
P.18	G. Vitucci	University of Milano Bicocca, Dept. Phys., 20125 Milan, Italy	<i>Investigation on image distortion due to MCP electronic readout misalignment and correction via customized GUI application.</i>
P.19	E. Stefanutti	Fondazione S. Lucia, Via Ardeatina 306 00179 Roma, Italy	<i>Multimodal approach for the 3D investigation of the murine spinal cord and brain neuronal and vascular networks</i>
P.20	L. Maugeri	Fondazione S. Lucia, Via Ardeatina 306 00179 Roma, Italy	<i>Study of the spinal cord and brainstem functional activation in response to a controlled motor task using fMRI</i>
P.21	N.C. D'Amico	CDI Centro Diagnostico Italiano S.p.A.	<i>Radiomics and machine learning in the prediction of response to Cyberknife radiosurgery for acoustic neurinoma: a pilot study</i>