Title: "The fascinating evolution of coherent X-ray imaging: from complex applications at synchrotron sources to early detection of breast cancer in hospitals"

Speaker: Prof. Dr. Marco Stampanoni, ETH Zürich and Paul Scherrer Institut

Abstract:

Third and fourth generation synchrotron facilities are powerful tools for advanced X-ray microscopy. This technique relies on the intrinsic coherent properties of synchrotron beams which, combined with suitable optics and algorithms, allows sensing the wavefront disturbances generated by samples and – consequently – to reconstruct their inner structure. During the last decade, tomographic microscopy has been pushed down to isotropic resolutions as small as a few tens of nanometers while, at the micrometer scale, tomographic scans can be performed as fast as hundreds of tomograms per second. These novel capabilities opened new opportunities for a plethora of biomedical applications, enabling, for instance, in-vivo dynamic observation of complex biomechanical mechanisms in small animals and insects or the visualization of foaming processes in metal alloys. Some of the X-ray optics developed for synchrotron experiments have been shown to be compatible with operations on conventional X-ray tubes. A method relying on the coherent properties of X-rays is grating interferometry. Originally developed to measure fundamental properties of a synchrotron beam (such as source size and divergence) grating interferometers have further evolved into sophisticated tools for advanced X-ray imaging in the lab and, very recently, even for clinical applications. The capability of grating interferometers to generate image contrast exploiting refraction and scattering, rather than absorption, can potentially revolutionize the radiological approach to medical imaging because they are intrinsically capable of detecting subtle differences in the electron density of a material (like a lesion delineation) and of measuring the effective integrated local small-angle scattering power generated by the microscopic structural fluctuations in the specimen (such as micro-calcifications in a breast tissue). The talk will discuss challenges of advanced synchrotron-based dynamic tomographic microscopy, grating interferometry and their use in material science, biomedical and clinical applications. At the end, an outlook into the recently approved TOMCAT2.0 upgrade program will be provided, illustrating future capabilities which will be at reach as soon as SLS2.0 will resume operation.

Short bio:

Marco Stampanoni has been Assistant Professor (2008-2013), Associate Professor (2013-2017) and since 2017 Full Professor for X-Ray Imaging at ETH Zurich, within the Department of Information Technology and Electrical Engineering at ETH Zurich. His professorship is affiliated to the Institute of Biomedical Engineering of the University and ETH Zurich, where he leads the division for X-ray Imaging and Microscopy. At the Paul Scherrer Institut, he is the head of the SLS X-ray tomography group. Born on May 10, 1974 in Lugano (Ticino, Switzerland) Marco Stampanoni studied physics at the ETH Zurich. After receiving his diploma in 1998, he graduated at the ETH in 2002 in the area of synchrotron-based tomographic microscopy. For his PhD, he received the ETH silver medal in 2003. From 1998 to 2000 he successfully followed a post-graduate course in Medical Physics. In 2002 he started as an Instrument Scientist at the Swiss Light Source (SLS) of the Paul Scherrer Institut in Villigen, Switzerland. In 2004 he was nominated beamline scientist and responsible for the development and realization of a tomography dedicated beamline at the SLS. In 2005 he was elected Head of the "X-ray Tomography Group" of the SLS. In 2008 he was appointed Assistant Professor (Tenure Track) for X-ray Microscopy at the ETH Zurich and, in 2010, Director of the ETH-Master of Advanced Studies (MAS) in Medical Physics. In 2012 he received an ERC Grant for his project on phase contrast X-ray imaging and won the "Dalle Molle Foundation Award" for his pioneering work on X-ray phase contrast mammography. He is teaching at ETH Zurich in the field of X-ray microscopy. Since 2018 he is the President of the Research Commission of the Paul Scherrer Institut.