Breast ultrasound tomography is considered a potentially safer, more reliable and more sensitive alternative to the widely used mammography for breast cancer diagnosis and screening. Vital to achieving this potential is the development of imaging algorithms capable of unraveling the very complex anatomy of the breast and its mechanical properties. Time-of-Flight Tomography (TFT) is the most prominent algorithm, producing sound-speed maps, but the underlying approximation of ray theory means that the algorithm is unsuitable for imaging structures where significant diffraction is present. Accordingly, the maximum resolution of the TFT algorithm is not sufficient to image the fine details of the breast on the scale of a few millimeters. Therefore, iterative full-wave inversion techniques are often subsequently applied to improve the resolution of the TFT image, but they are typically impractically slow or fail because of the uncertainties in the measurements such as 3D effects, noise or transducer characteristics. Presented here is a solution where the TFT algorithm is combined with the Diffraction Tomography (DT) method, avoiding iterations and yet producing a high resolution sound-speed image. It is demonstrated via numerical simulations and experimental data from phantom and patients that ultrasound technology can be engineered to achieve image quality comparable to that of x-ray CT but without the risks associated with ionizing radiation.
Bio:
Dr. Francesco Simonetti is an Associate Professor in the Department of Aerospace Engineering and Engineering Mechanics at the University of Cincinnati, where he has led the Ultrasonic Imaging Laboratory (USIL) since 2011. He was formerly at Imperial College, working to complete his Ph.D. degree from 2000 to 2003, then as a Royal Academy of Engineering Postdoctoral Fellow, and subsequently as an Assistant Professor from 2007 to 2011. He has also been a faculty affiliate of Los Alamos National Laboratory since 2006. Francesco’s research covers the theoretical and experimental aspects of wave mechanics for subsurface sensing, with applications in NDE and medical diagnostics. He is author of more than 80 peer-reviewed papers and conference proceedings in the fields of materials characterization, guided ultrasonic waves, flaw detection, laser metrology, health monitoring of aerospace materials and systems, and breast cancer detection.