

Development of ClearPEM-Sonic, a multimodal mammography system for PET and Ultrasound

M. Pizzichemi¹, B. Frisch², E. Auffray², R. Bugalho³, L. Cao⁴, G. Cucciati¹, N. Di Vara^{1,2}, F. Farina⁵, N. Felix⁶, A. Ghezzi^{1,7}, V. Juhan⁸, D. Jun⁹, P. Lasaygues¹⁰, P. Lecoq², S. Mensah¹⁰, O. Mundler⁸, J. Neves³, M. Paganoni^{1,7}, J. Peter⁴, P. Siles⁸, J. C. Silva³, R. Silva³, S. Tavernier⁹, L. Tessonier⁸, J. Varela³

The ClearPEM-Sonic is a multimodal system dedicated to mammography, capable of providing co-registered metabolic, anatomical and structural information through combination of positron emission tomography with ultrasound elastographic imaging. The project is aimed to improve early stage detection of breast cancer through the high-resolution and high-sensitivity metabolic information provided by PEM, and the high-resolution anatomic information from US. Further improvements in the specificity of the system is provided by the ability to rule out non-cancerous findings from PEM, taking advantage of elastography imaging information.

The ClearPEM-Sonic has been developed by the Crystal Clear Collaboration and is currently installed at Hopital Nord, Marseille, in the frame of CERIMED, the European Centre for Research in Medical Imaging.

The detector is based on LYSO:Ce crystals, each of 2x2x20 mm³, grouped in 192 matrices of 8x4 crystals. BaSO₄ is used as coating material and reflector. Read out is performed individually on both 2x2 mm² faces of each crystal, using avalanche photodiodes (APDs). The detector performance has been thoroughly tested during the commissioning phase, confirming a spatial resolution of 1.5 mm, and a DOI precision of 2 mm. The co-registration software developed has proved to accurately superimpose images coming from the different modalities with a precision better than 2mm.

The clinical trial (phase 1) is being carried out on 20 patients with a known breast lesion who have been injected with FDG for a whole-body PET/CT as part of their diagnostic process. Results are compared to conventional imaging and MRI, with biopsy as a golden standard, to validate the use of ClearPEM-Sonic as a clinical imaging instrument for early detection of breast cancer.

¹University of Milano Bicocca, Milano, Italy

²CERN, Geneve, Switzerland

³Laboratrio de Instrumentao e Fsica Experimental de Particulas, Lisboa, Portugal

⁴DKFZ, Heidelberg, Germany

⁵Consortium GARR, Roma, Italy

⁶SuperSonic Imagine, Aix-en-Provence, France

⁷Istituto Nazionale di Fisica Nucleare, Italy

⁸Assistance Publique Hopitaux de Marseille, Marseille, France

⁹Vrije Universiteit Brussels, Brussels, Belgium

¹⁰Laboratoire de Mecanique et Acoustique, Marseille, France