Functional computed tomography using energy resolved photon counting detectors

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The goal of the MARS project and its partners is to perform functional (physiological) imaging using spectral (multi-energy) computed tomography (CT). Specifically we are using pre-clinical CT systems equipped with spectral x-ray detectors to study the composition and function of biological tissues. This is a major advance from conventional CT systems that typically only provide anatomical (structural) information. The MARS scanners incorporates the Medipix3 energy resolved (spectral) photon counting x-ray detectors housed in a purpose built pre-clinical CT scanner. The system uses a variety of image processing techniques including compressed sensing, algebraic reconstruction methods, and material decomposition methods.

Biomedical topics being studied include atheroma (eg. heart disease), non-alcoholic fatty liver (eg. metabolic syndrome), and arthopathies (eg. osteoarthritis). Spectral CT images already obtained include: 1) excised human atheroma decomposed into Ca, Water, and Fat components correlated with specimen histology. 2) qualitative measurement of liver fat in transgenic mice, 3) measurement of glycoaminoglycans in excised bovine cartilage, 4) demonstration that functional labels such as gold nano-particles can be identified in mice.

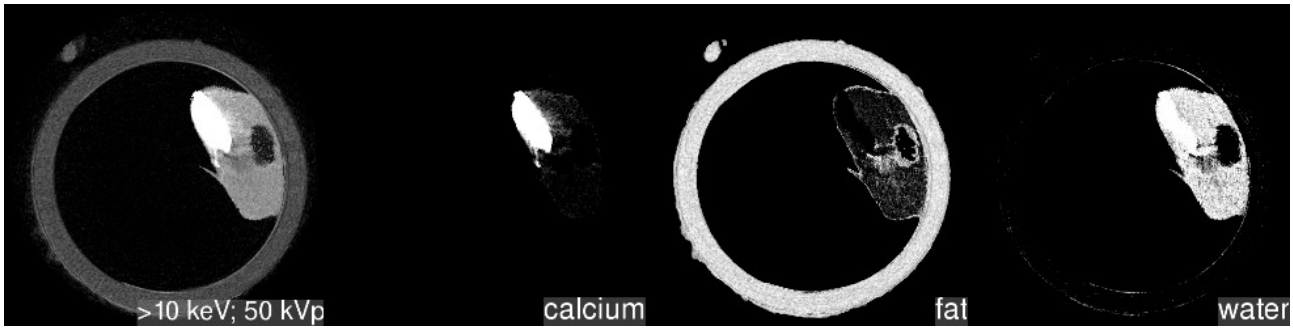

Figure: An excised human atheroma plaque in a 10mm diameter perspex tube imaged on the MARS spectral CT scanner. The left image is a conventional microCT scan using a broad range of energies (10-50keV). The remaining three images are the plaque constituents derived from the from the spectral response of the tissue. The spectral CT data enables identification of the calcium, fat, and water.