AbstractID: 13905 Title: X-Ray Luminescence Computed Tomography via Selective X-Ray Excitation

Purpose: X-ray luminescence computed tomography (XLCT) is proposed as a new molecular imaging modality for imaging X-ray-excitable phosphorescent nanoparticles three-dimensionally, in living subjects. Some of these nano-sized particles can emit near-infrared (NIR) light when excited with X rays and are particularly well suited for in-vivo biomedical imaging because the signals can propagate long distances in tissue.

Method and Materials: The imaging mechanism used in XLCT consists in irradiating the subject using a sequence of programmed X-ray beams, while sensitive photo-detectors measure the light coming out of the subject. By restricting the X-ray excitation to a single, narrow beam of radiation, the origin of the light photons can be inferred regardless of where these photons were detected, and how many times they scattered in tissue. By including an X-ray detector in the system, anatomical imaging is performed simultaneously with molecular imaging via standard X-ray computed tomography. The molecular and anatomical images are spatially and temporally co-registered. Simulations of an XLCT system were performed using an analytical beam model. A preliminary experiment was also conducted using a superficial treatment beam and an EM-CCD camera.

Results: Tracer uptake in a 2 mm-diameter target can be detected and quantified with sub-picomolar sensitivity using less than 1 cGy of radiation dose, a result that makes XLCT potentially more sensitive than PET, currently one of the most sensitive molecular imaging modalities. Provided sufficient signal-to-noise ratio, the spatial resolution of the system can be made as small as needed by narrowing the beam aperture. In particular, 1 mm uniform spatial resolution was achieved for a 1 mm-wide X-ray beam. Images reconstructed from experimental XLCT measurements showed good agreement with the simulation model.

Conclusion: Preliminary simulations and experiments show that XLCT is a feasible approach for small objects, such as research animals or dedicated organ imaging.