

High-resolution infrared spectromicroscopy for molecular characterization of low-LET bystander effects

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A central challenge to improving the existing understanding of low LET radiation-induced bystander effects (BSE) is how to detect – nondestructively and in real-time – BSE-induced chemical and structural changes in cells and tissue. Existing approaches often involve measuring “marked” cellular events using methods that can require cell labeling, fixing, or staining of targeted biomolecules. However, BSE in biological systems is the result of a myriad of triggered biological and chemical processes that are spatially, temporally, and dose-dependent. To add a vital extra dimension to the knowledge of BSE, one must be able to establish an associative analysis of the chemical and structural changes inside individual cells. One must also link these molecular changes to specific RNA, DNA or protein targets, and identify associated cellular events both spatially and temporally.

To meet these needs, we have begun the development of Fourier transform infrared spectromicroscopy for the imaging of BSE-induced chemical and structural changes in lipids, proteins, nucleic acids inside individual cells. The spatial range of effectiveness of BSE, measured at micron-spatial resolutions, is quantified by analyzing infrared absorption spectral character (e.g., absorption band shape, intensity, and peak position) in the mid-infrared region. The mid-infrared spectra of single cells are very sensitive to chemical and conformational changes in biomolecules.

In this poster presentation, we will highlight results from the first phase of our instrumentation development effort. We will also present data from our initial experiments, in which we used the 12.5 keV X-ray microbeam at the Advanced Light Source (ALS) Beamline 10.3.1 to irradiate segments of monolayers of human mammary epithelial cells. We then characterized the effectiveness of BSE by studying both the targeted and untargeted cells using the infrared spectromicroscopy facility at ALS Infrared Beamlines 1.4.3 and 1.4.4.

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