Contribution ID: **75** Type: **Invited Technical Oral Communication**

Ion Beam Induced Fluorescence Imaging in Biological Systems

Tuesday, 8 July 2014 15:50 (30 minutes)

Imaging fluorescence generated by MeV ions in biological systems such as cells and tissue sections requires a high resolution beam (< 100 nm), a sensitive detection system and a fluorescent probe that has a high quantum efficiency and low bleaching rate. For cutting edge applications in bioimaging, the fluorescence imaging technique needs to break the optical diffraction limit allowing for sub-cellular structure to be visualized, leading to a better understanding of cellular function. In a nuclear microprobe this resolution requirement can be readily achieved utilizing low beam current techniques such as Scanning Transmission Ion Microscopy (STIM). In recent times, we have been able to extend this capability to fluorescence imaging through the development of a new high efficiency fluorescence detection system [These proceedings].

Many of the fluorescent probes that have been developed for high-resolution fluorescence techniques such as confocal microscopy have been optimized for laser excitation. These probes are not necessarily useful for ion or electron excitation. In addition, biological systems typically have some degree of auto-fluorescence which most of the time results in an unwanted background signal that degrades the contrast of the image.

This paper discusses how we have addressed these issues for ion beam induced fluorescence imaging. We will also review previous work on fluorescence imaging in biological systems and show the current state-of-the-art in super-resolution fluorescence microscopy using focused MeV ion beams at the Centre for Ion Beam Application (CIBA), NUS Singapore.

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Session Classification: Session 3 - Nuclear Microprobe Applications: Biology 1