Purpose: To construct a custom confocal laser scanning microscope (CLSM) capable of resolving individual proton tracks in the volume of an Al$_2$O$_3$:C,Mg fluorescent nuclear track detector (FNTD). The spatial resolution of the FNTD technique is at the sub-micrometer scale. Therefore the FNTD technique has the potential to perform radiation measurements at the cell nucleus scale.

Methods: The crystal volume of an FNTD contains defects which become fluorescent F$^{+}$ centers after trapping delta electrons from ionizing radiation. These centers have an absorption band centered at 620 nm and an emission band in the near infrared. Events of energy deposition in the crystal are read-out using a CLSM with sub-micrometer spatial resolution. Excitation light from a 635 nm laser is focused in the crystal volume by an objective lens. Fluorescence is collected back through the same path, filtered through a dichroic mirror, and focused through a small pinhole onto an avalanche photodiode. Lateral scanning of the focal point is performed with a scanning mirror galvanometer, and axial scanning is performed using a stepper-motor stage. Control of electronics and image acquisition was performed using a custom built LabVIEW VI and further image processing was done using Java. The system was used to scan FNTDs exposed to a 6 MV x-ray beam and an unexposed FNTD.

Results: Fluorescence images above the unexposed background were obtained at scan depths ranging from 5 to 10 micrometer below the crystal surface using a 100 micrometer pinhole size.

Conclusions: Further work needs to be done to increase the resolution and the signal to noise ratio of the images so that energy deposition events may be identified more easily.

Funding Support, Disclosures, and Conflict of Interest:

Natural Sciences and Engineering Research Council of Canada