Investigating proton energy deposition on the microscopic scale using fluorescence nuclear track detectors

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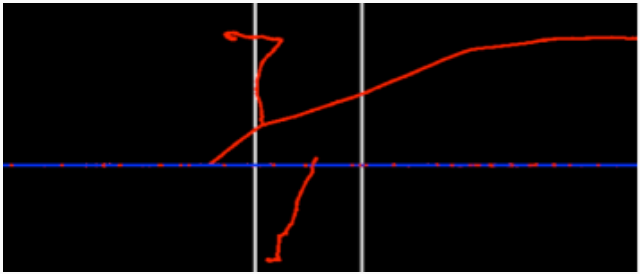
2. Department of Medical Physics and Biomedical Engineering, University College London, UK
3. Department of Radiation Physics, The University of Texas MD Anderson Cancer Center,
4. Department of Medical Physics, Queens University Belfast, Belfast, UK

Motivation



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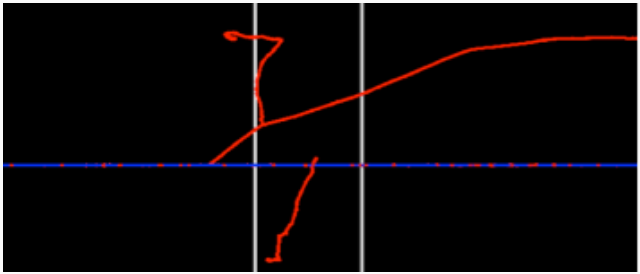

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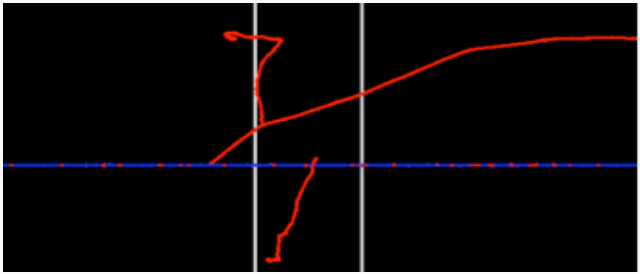

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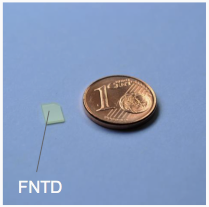
- Monte Carlo simulations offer an exceedingly powerful approach to the quantification of proton energy deposition on the microscopic scale, but whilst they have been well validated at the macroscopic level, their microscopic validation remains lacking
- We explored the potential of Fluorescent Nuclear Track Detectors (FNTDs) as a tool to validate microscopic Monte Carlo simulations of proton energy deposition

What is a Fluorescent Nuclear Track Detector (FNTD)?



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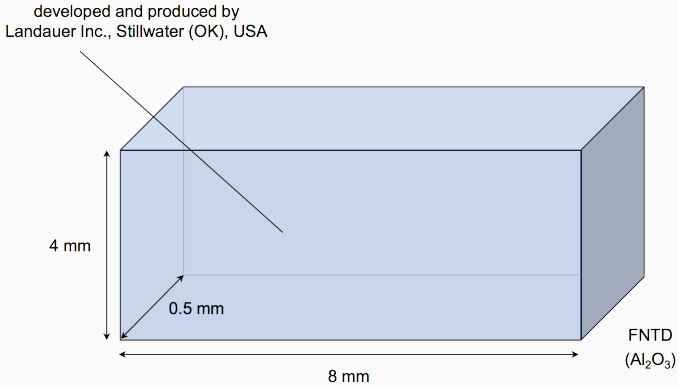

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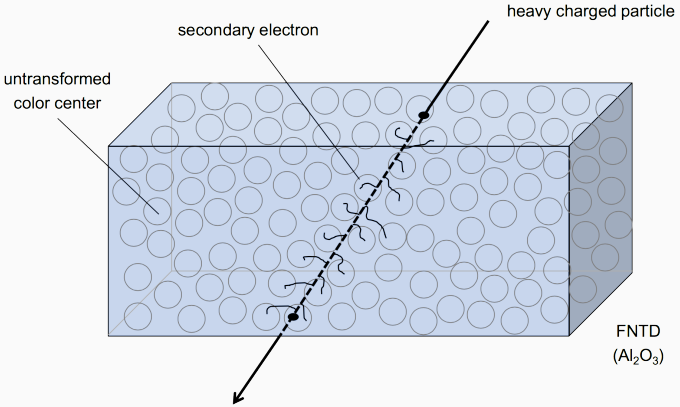

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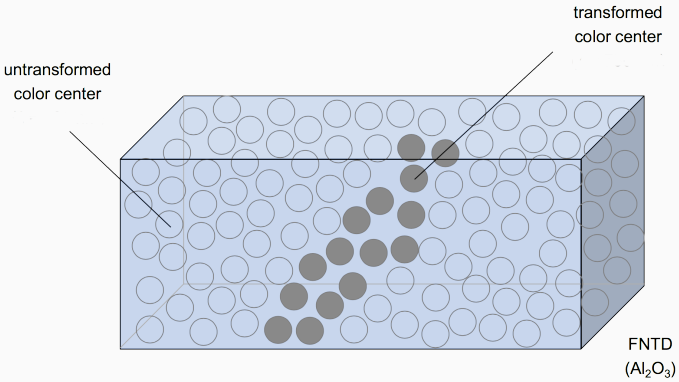

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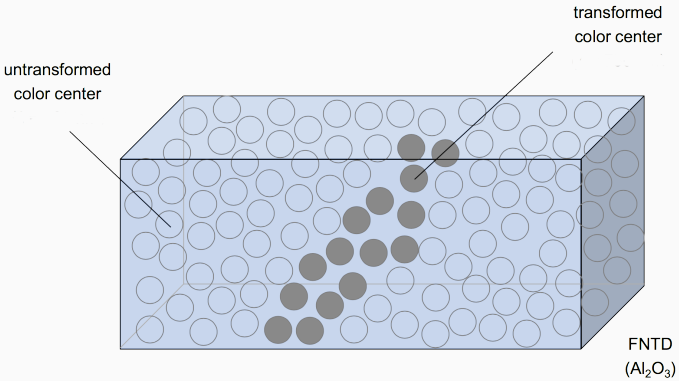

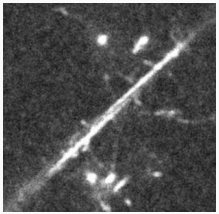

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Our method

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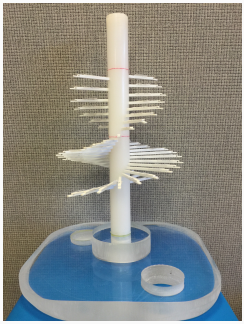
- A custom holder was used to position FNTDs at seven depths (12, 30, 108, 112, 116, 120 and 128 mm)



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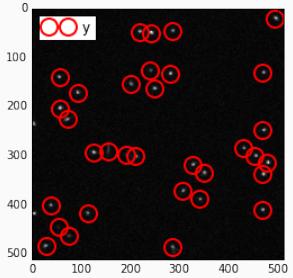

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1. using TOPAS to model the particle spectrum

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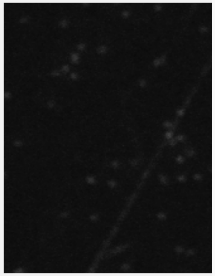
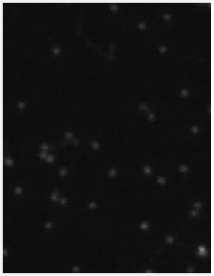
1. using TOPAS to model the particle spectrum
2. using TOPAS-nBio with Geant4-DNA physics to score the track structure of particles through a water surrogate of Al2O3:C,Mg. The mass-density of the water was scaled to match the Aluminium Oxide water-equivalent path length for each FNTD position.

Example FNTD images

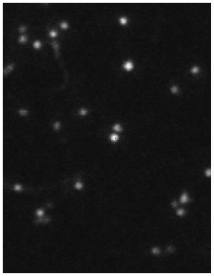
30 mm



108 mm



120 mm



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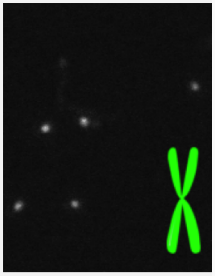

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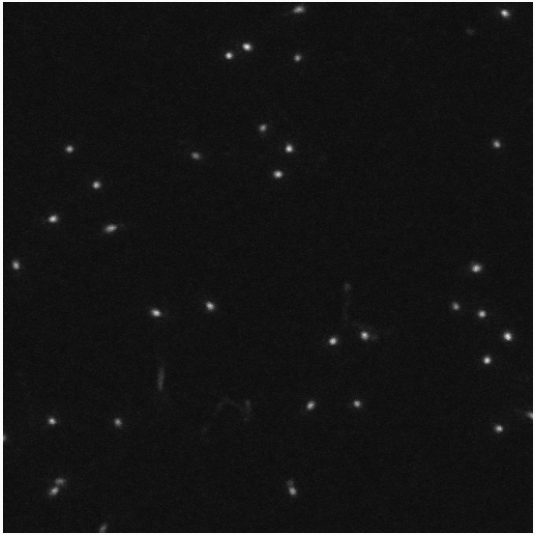

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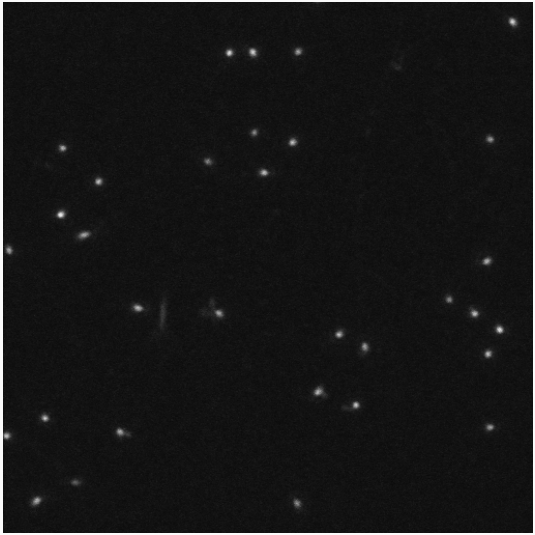

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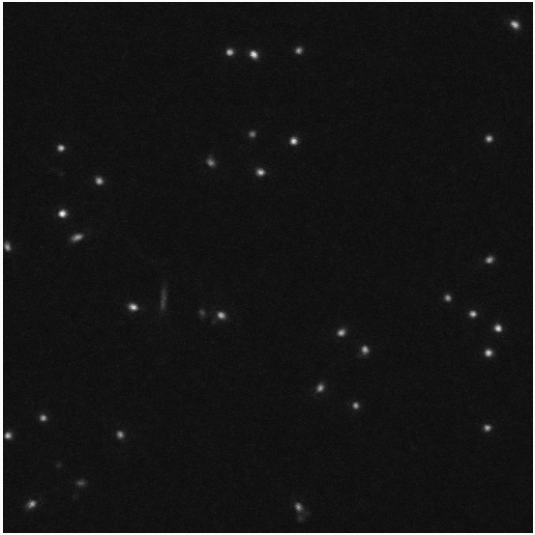

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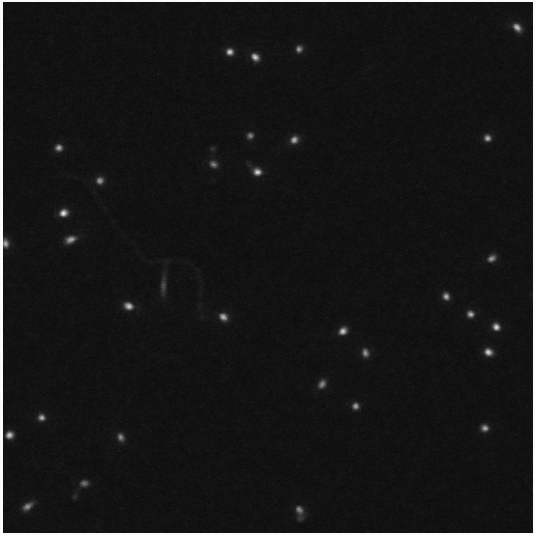

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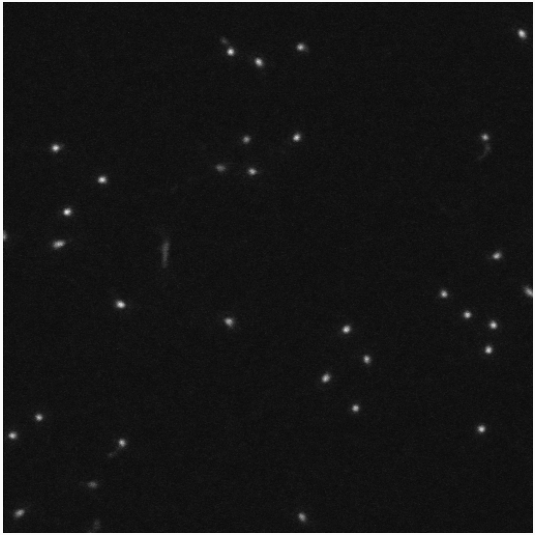

Results: simulated LET versus FNTD median track mass

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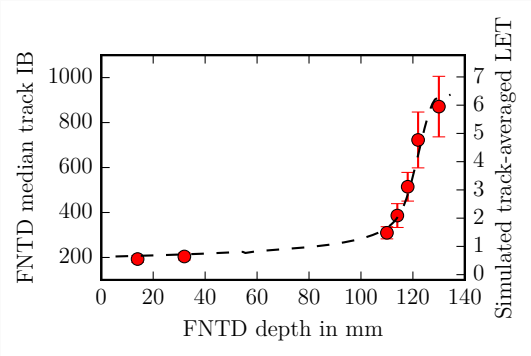

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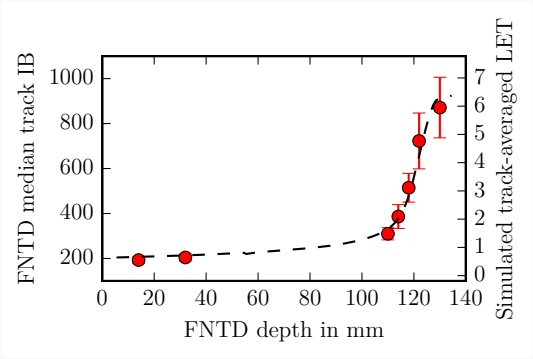

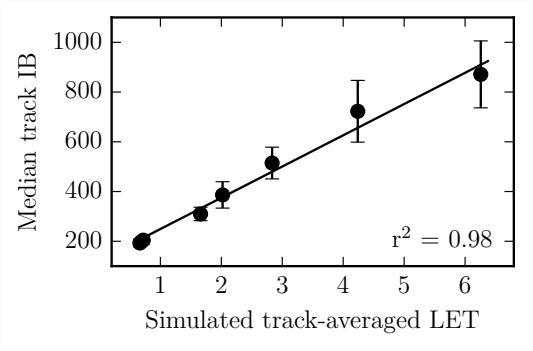

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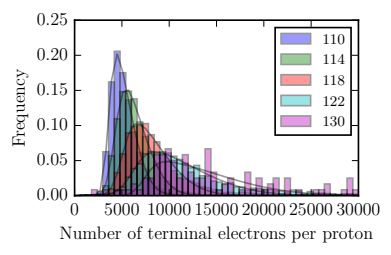

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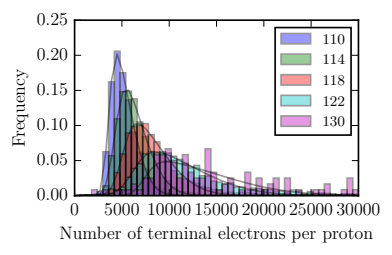

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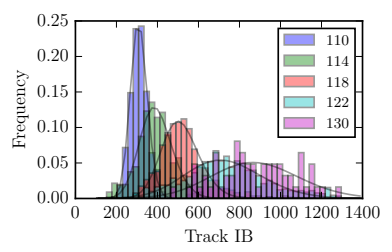

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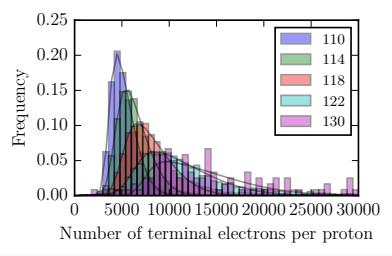

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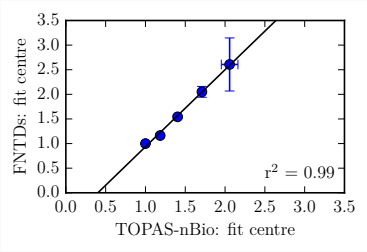

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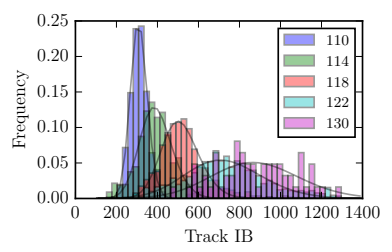

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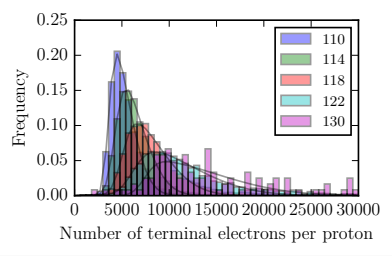

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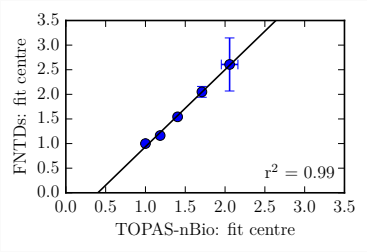

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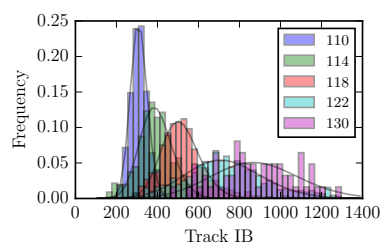

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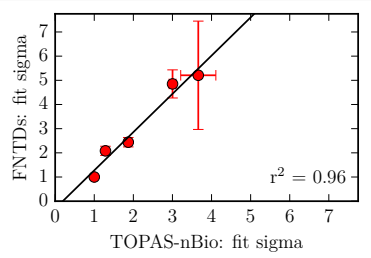

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- Our FNTD data experimentally replicates trends demonstrated in microscopic simulations of energy depositions of individual particles: we obtained statistically significant correlations between experimental and simulated values for “track mass” and the Gaussian sigma of its associated distribution

Thank you for your attention!

MASSACHUSETTS GENERAL HOSPITAL
RADIATION ONCOLOGY

HARVARD MEDICAL SCHOOL

UCL

MD Anderson Cancer Center

Queen's University Belfast

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