The 7th edition of the INFIERI School series, held at USP, August 28 to September 9, 2023

Characterizing Organic Scintillators: Construction of Bragg Peaks for Different Materials at Varying Proton Beam Energies

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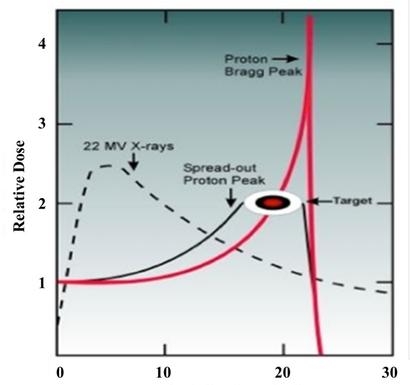
INTRODUCTION

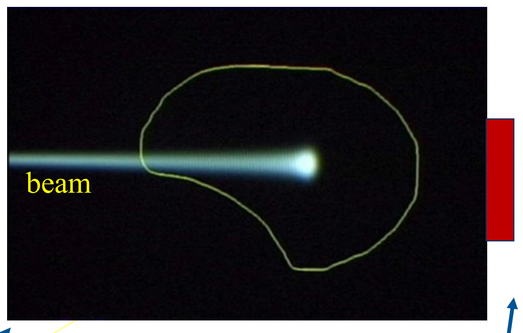
Effective and safe proton therapy for cancer treatment relies on the precise knowledge of the position of the Bragg Peak (BP). Traditional radiation delivers x-rays, or beams of photons, to the tumour or cancer and beyond it. This can damage nearby healthy tissues and can cause significant side effects. By contrast, proton therapy delivers a beam of proton particles that stops at the tumour at the BP, so protons are less damaging to healthy tissue surrounding cancer cells.



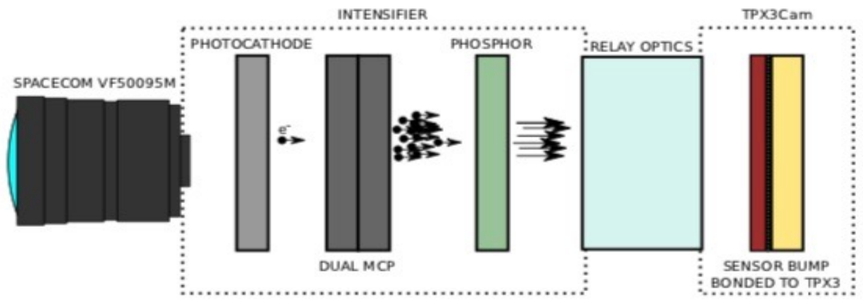
EXPERIMENTAL SETUP

To personalize the treatment for each patient we will use plastic scintillators and a precise camera to detect the Bragg Peak before it is delivered to the tumor.
We will also use scintillators and silicon photomultipliers to detect prompt gammas

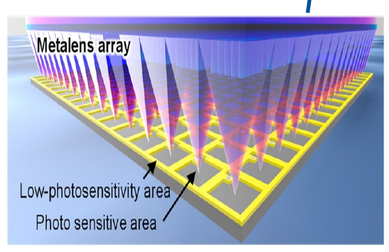
Bragg Peak In scintillating materials fibers or 3D printed organs (~water density)



Timepix Camera



Scintillating fibres (St Gobain Left[1]) and 3D printed crystal (right)s Rare earth (Cerium, Terbium) doped glass. Work performed at Georgia Tech Research Institute

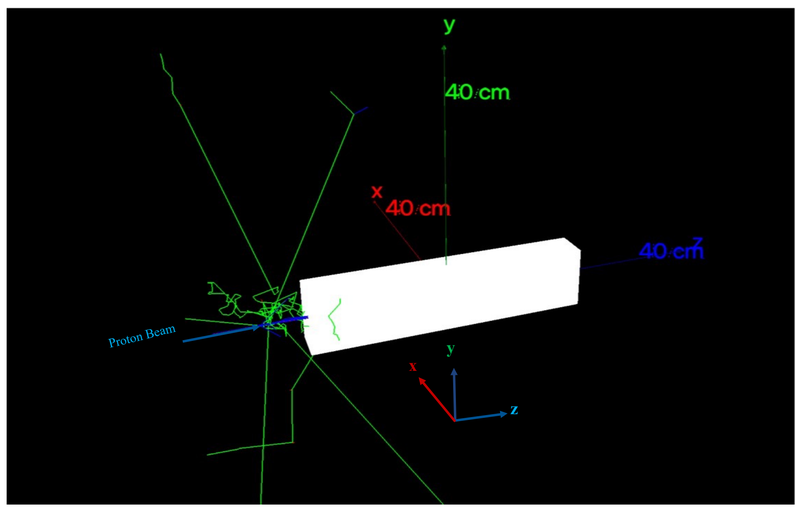


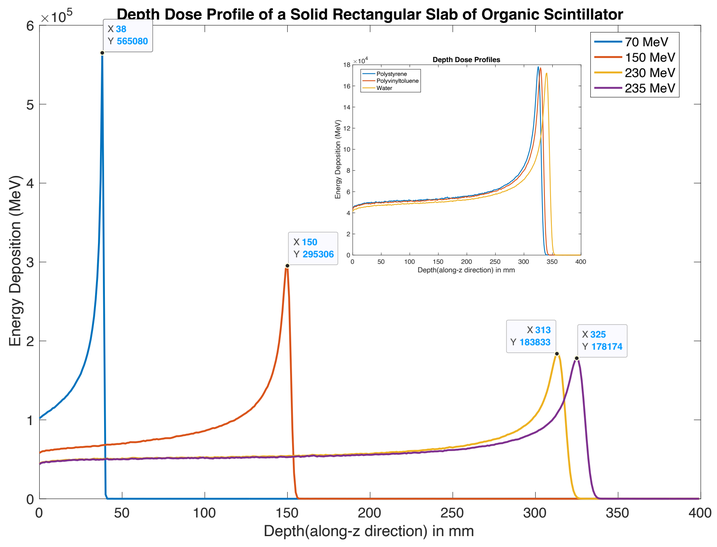
Light Focussing Meta-lenses
Soh Uenoyama and Ryosuke Ota ACS Photonics 2021, 8, 1548−1555* [2]

TPX3 Camera Time res 1.6ns ToA.
Timestamp 260ps 256x256, 55um pixels
Pokiela et al. 2014 JINST 9 C05013[3]
Available in Manchester

GEANT4 SIMULATION

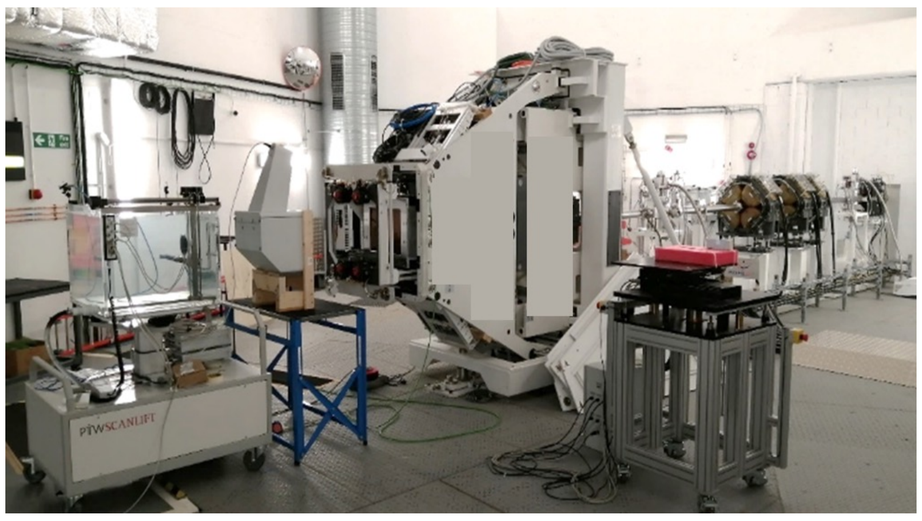
Material of the Solid Slab	Density (g/cc)	BP Position (mm)
Polystyrene	1.06	325
Polyvinyl-tolune	1.023	329
Water	1.0	339
Dimension (xyz)	50x50x400 mm (rectangular)	





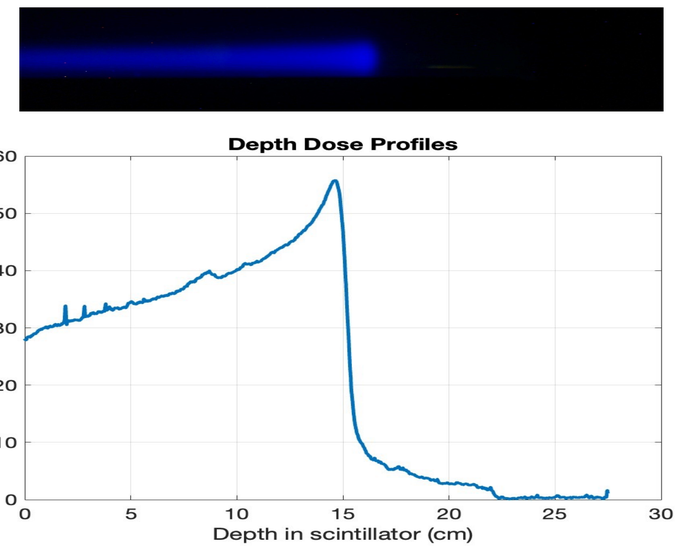
Beam Energy(MeV)	Bragg peak Position(mm)
70	38
150	150
230	313
235	325

EXPERIMENTAL RESULTS



Photograph of the Beamline facility(research room) at the Christie Proton Therapy Centre, Manchester, United Kingdom.

Arducam Autofocus Camera	
Sensor	Sony IMX519
Active Pixels	4656×3496
Pixel Size	1.22×1.22µm
Sensor Res.	16 MP



Picture of the Bragg Peak in plastic scintillator and plot of the extracted data (MATLAB & ImageJ)

CONCLUSIONS: We successfully used plastic scintillating materials and a portable camera to detect the Bragg Peak in the Manchester Christie Proton Therapy Center after simulating the experimental conditions using GEANT4. Further tests will be performed to add the measurement of the prompt gamma to further confirm the beam position.