

Treating Cancer with Proton Beam Therapy

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- 我 的 中 文 名 字 是 姜 星 星。



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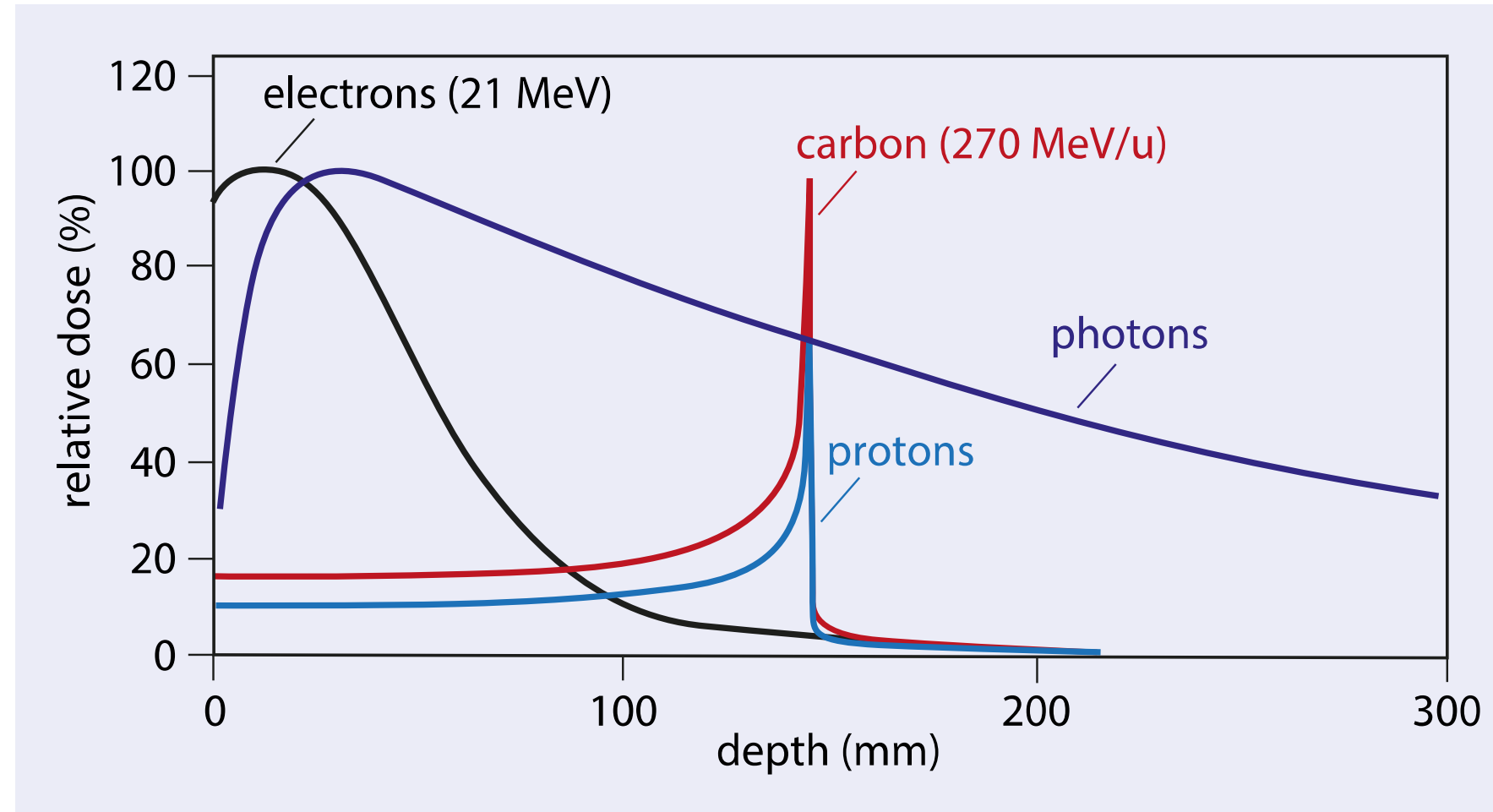


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- 我在 伦敦 大学 学院 工作。
- 我是 质子 放疗 学 的 教授。

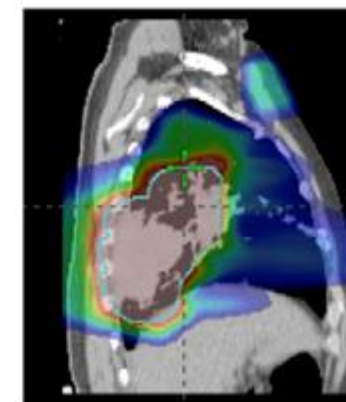
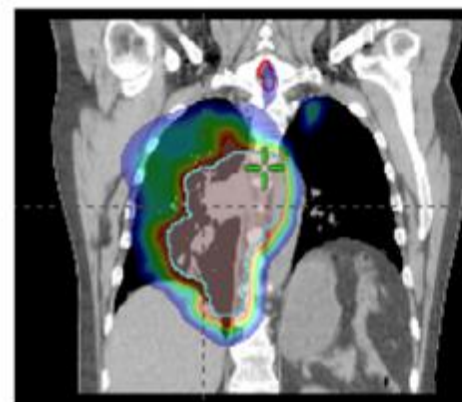
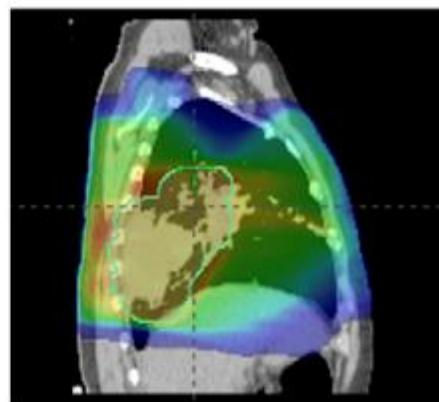
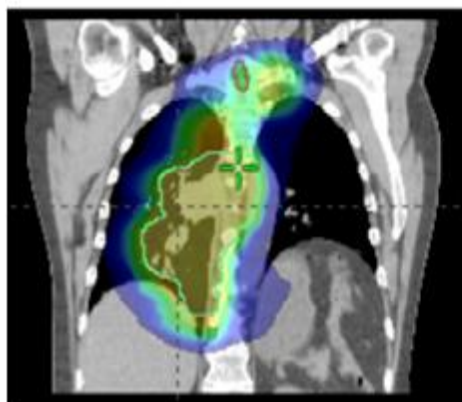
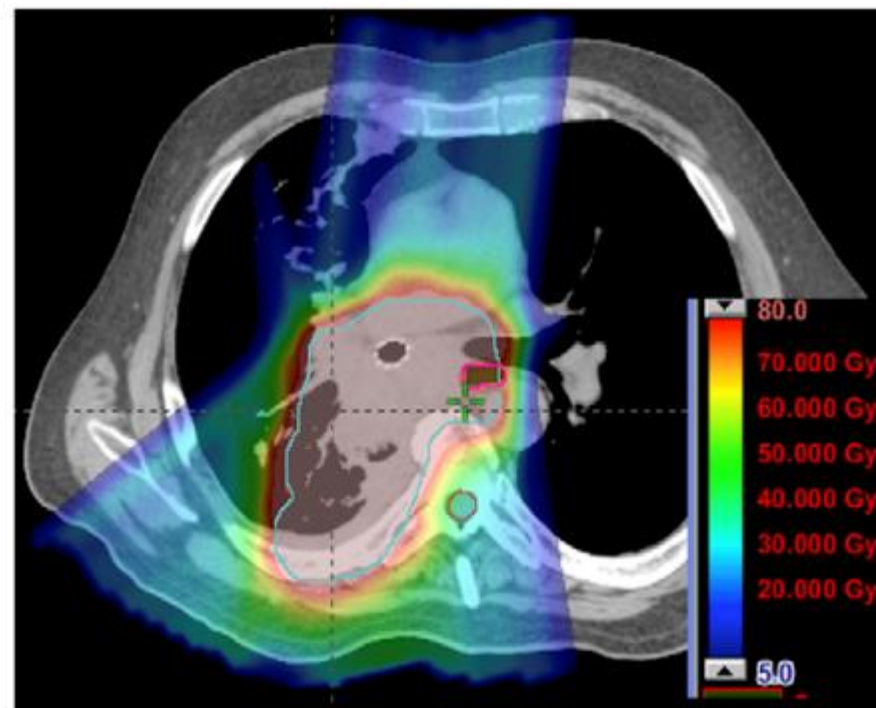
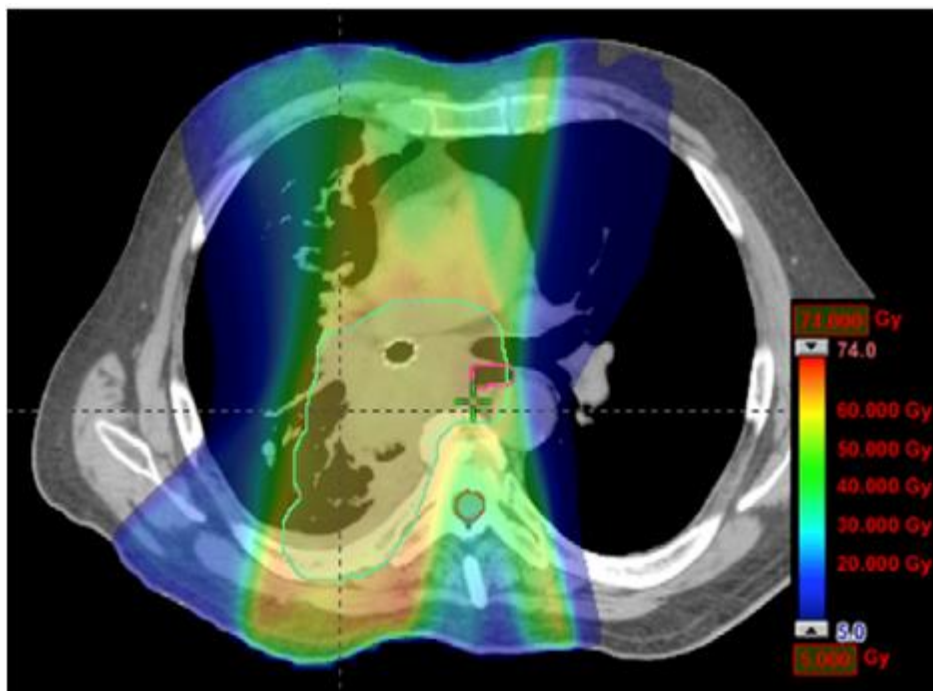


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- 对不起, 我 不 会 说 中文。
- I will now continue in English...

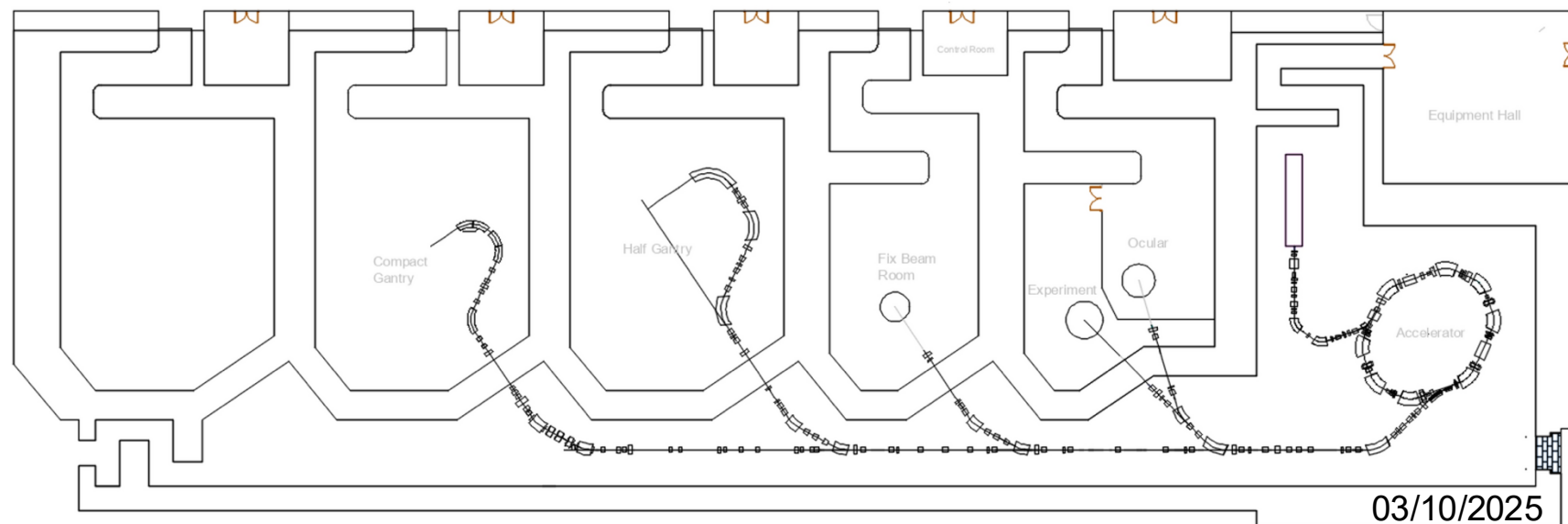
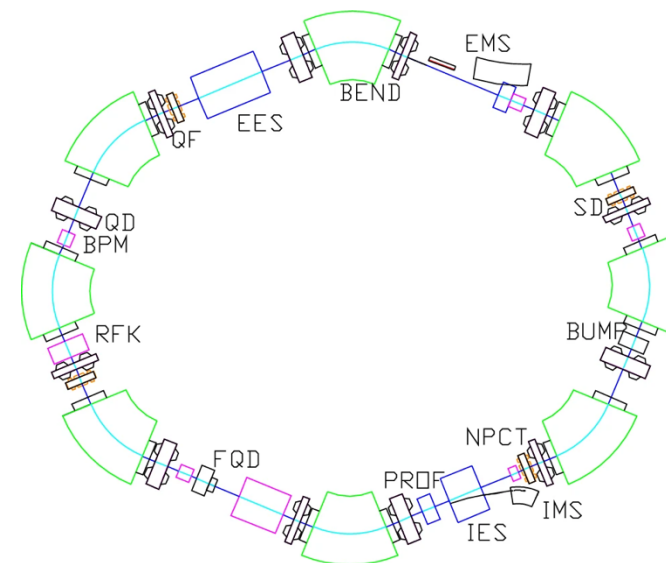
- Unlike X-rays, charged particles stop!
- Electrons, being lighter, scatter and spread out.
- Protons deposit most dose at the *end* of their path: the **Bragg Peak**.



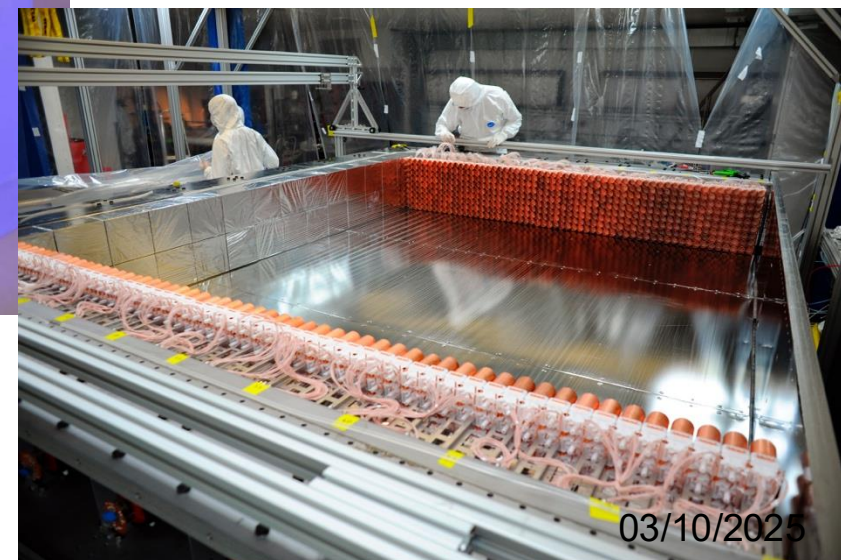
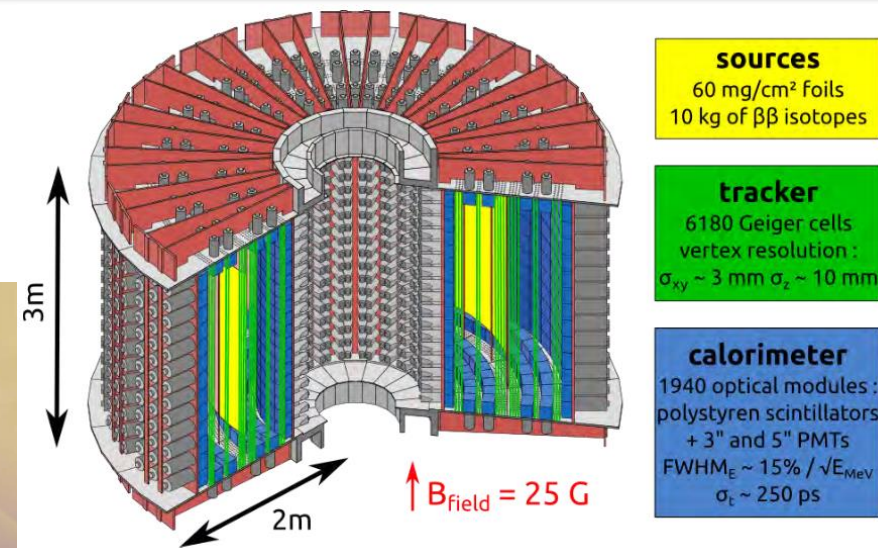
Non Small Cell Lung Cancer Doses



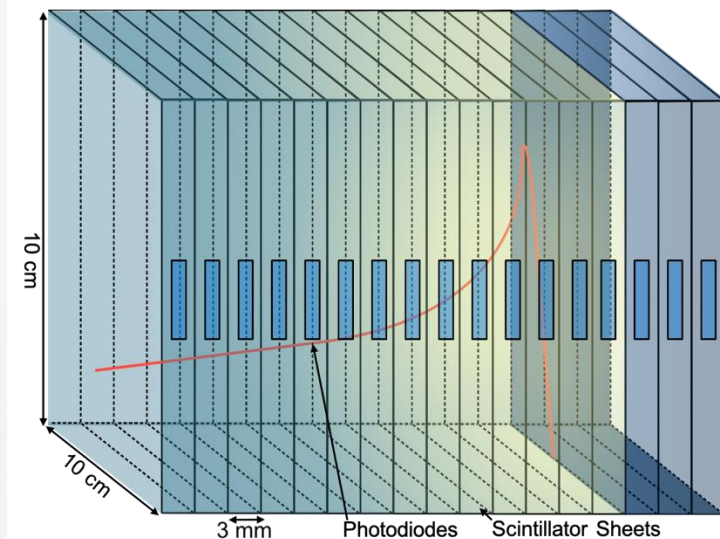
Zhang X, Li Y,
Pan X, et al.
*Int J Radiat
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Phys.* (2010);
77 (2): 357–366
[DOI:
10.1016/j.ijrobp.
2009.04.028](https://doi.org/10.1016/j.ijrobp.2009.04.028)



- Since 2011, involvement has grown from facility design assistance to detector development.
- What technological solutions will assist clinical workflow? ~~Proton-CT~~ Quality Assurance.
- SuperNEMO experiment measures beta decays from radioactive source with high precision:
 - Plastic scintillator modules record beta energy with nanosecond timing.
- What applications in PBT are there for fast water equivalent plastic scintillator...?

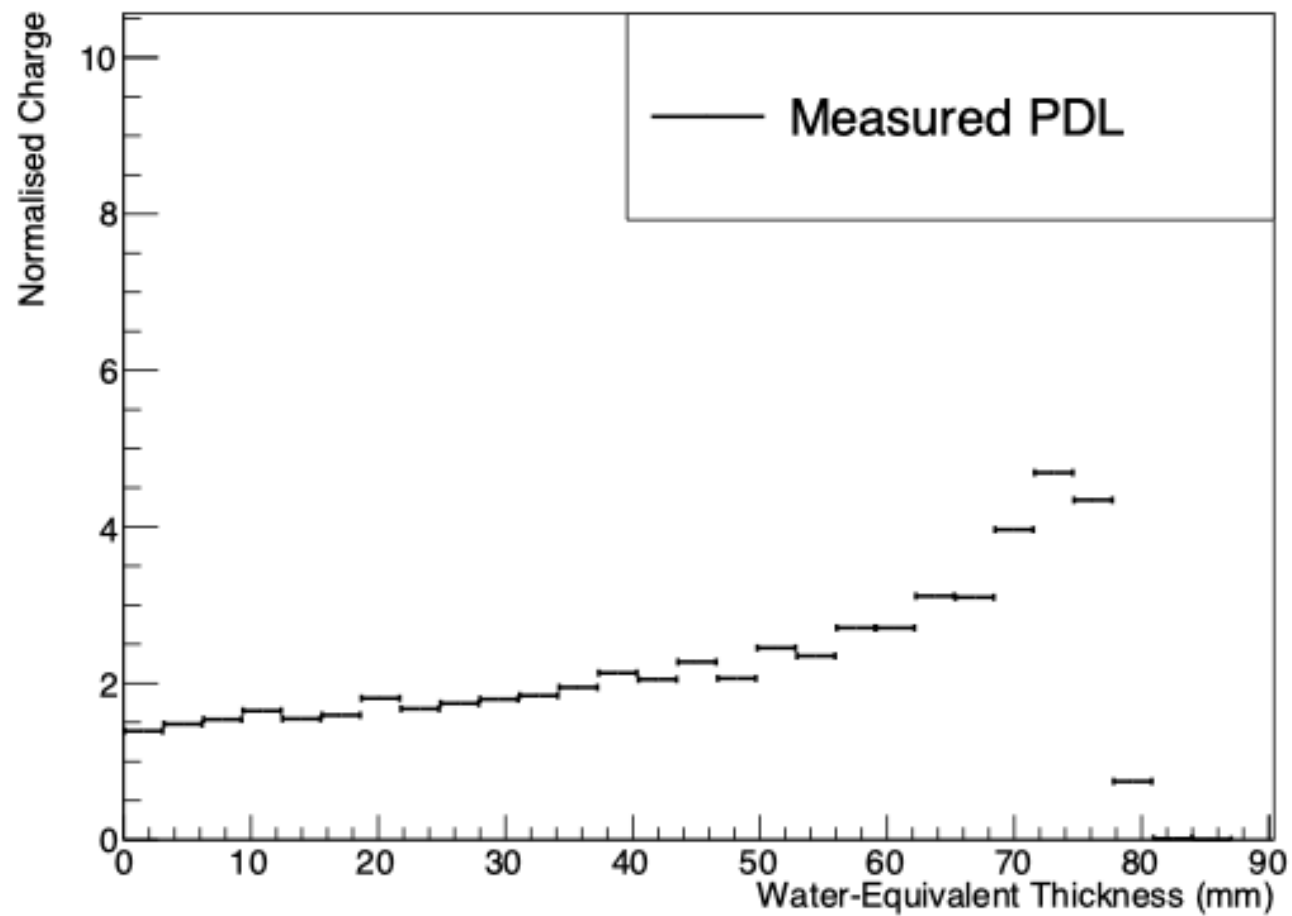


- The Quality Assurance Range Calorimeter (QuARC) constructed from plastic scintillator:
 - Protons intercepted by a series of optically-isolated polystyrene scintillator sheets.
 - Measure light output with photodiodes.
 - Light output of each sheet nonlinear to dose, but quenching described by Birks' Law:
 - Fit data with analytical depth-light model.
 - Reconstruct Bragg depth-dose curve and measure proton range.
 - Photodiodes coupled to fast, modular electronics and an FPGA to read light levels at over 5 kHz.
 - FPGA connects to on-board PC (Raspberry Pi) via USB.
 - Connection to on-board PC via ethernet/WiFi.
- Key benefits:
 - Plastic scintillator inexpensive and water-equivalent.
 - Range reconstructed with single beam delivery.
 - Easy detector setup and no optical artefacts.



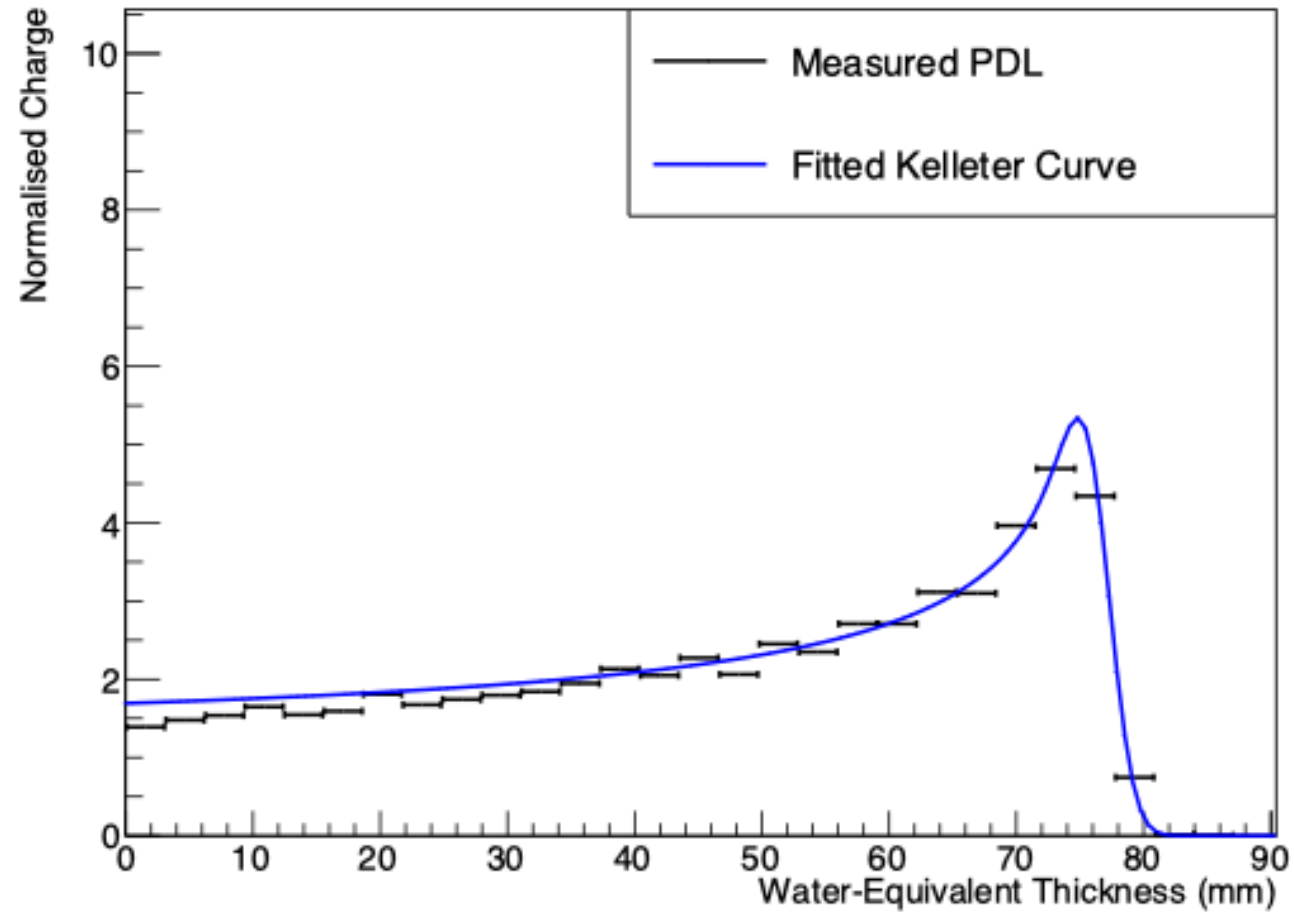
Bragg Peak: 100 MeV

Run053_a (E = 99.49MeV, R0 = 76.82mm)



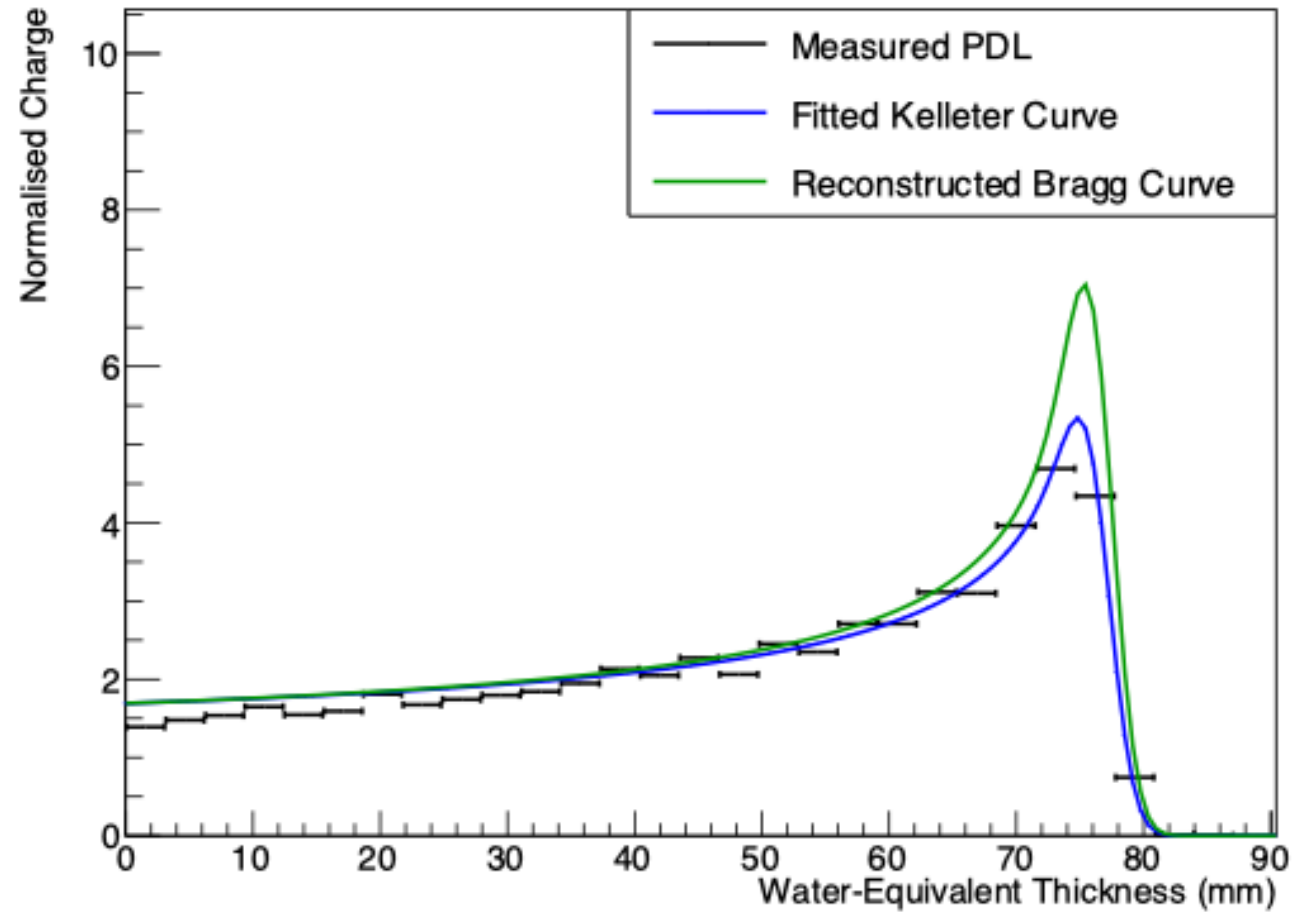
Bragg Peak: 100 MeV

Run053_a (E = 99.49MeV, R0 = 76.82mm)



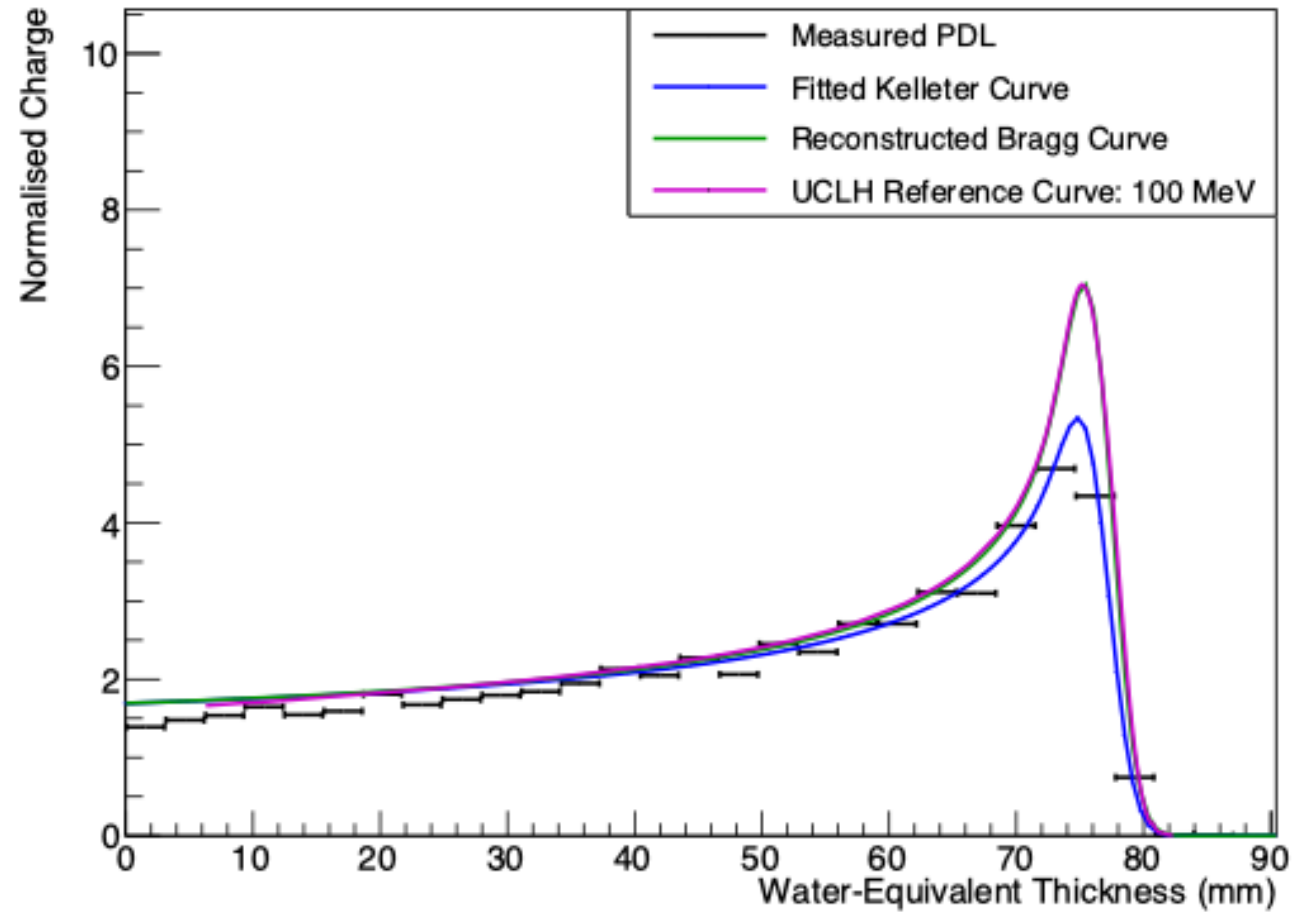
Bragg Peak: 100 MeV

Run053_a (E = 99.49MeV, R0 = 76.82mm)



Bragg Peak: 100 MeV

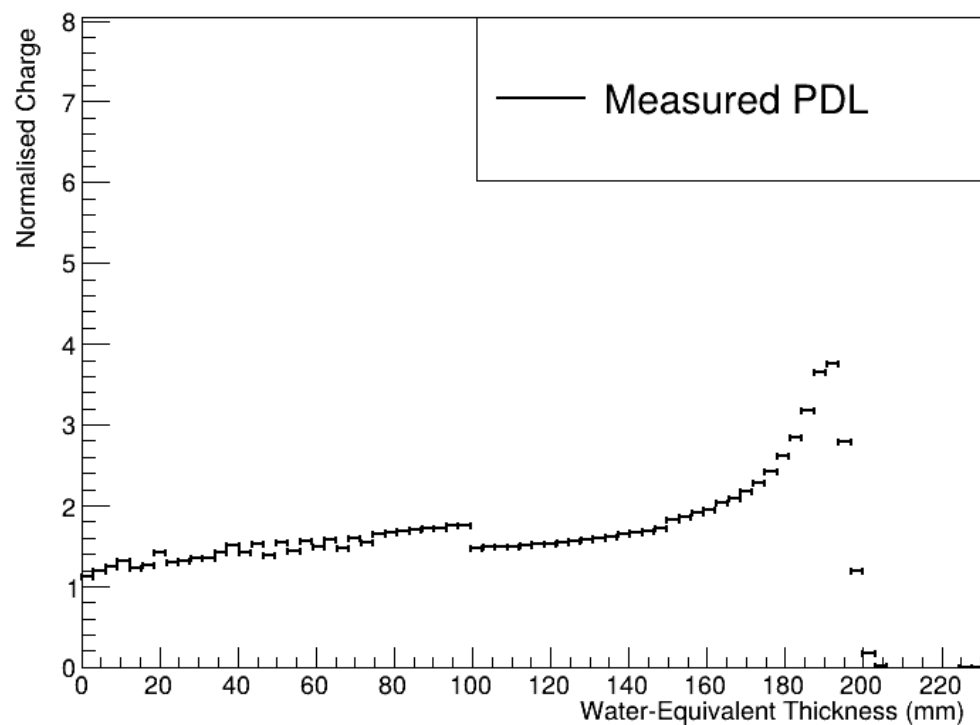
Run053_a (E = 99.49MeV, R0 = 76.82mm)



More Bragg Peaks

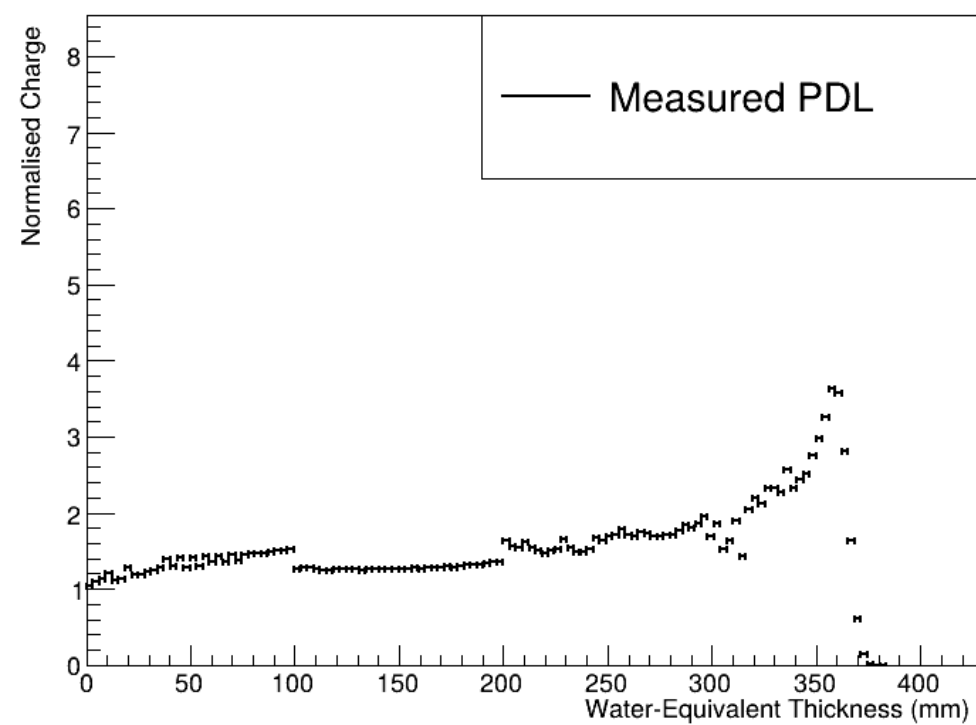
170 MeV

Run044_a (E = 170.22MeV, R0 = 195.78mm)



245 MeV

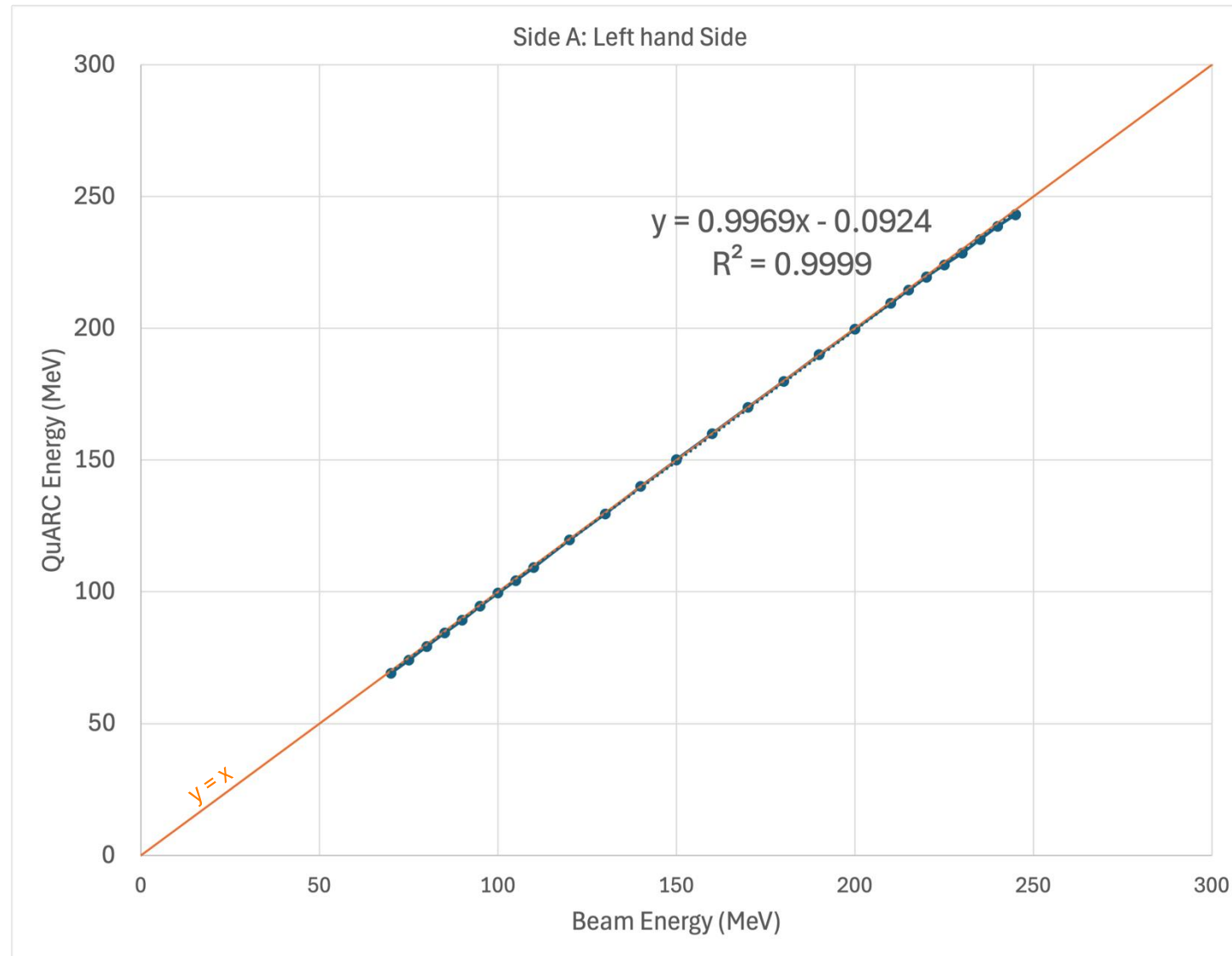
Run025_a (E = 243.43MeV, R0 = 365.09mm)





Energy Comparison

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Absolute Dose:
NPL
Transmission
Calorimeter (TC)

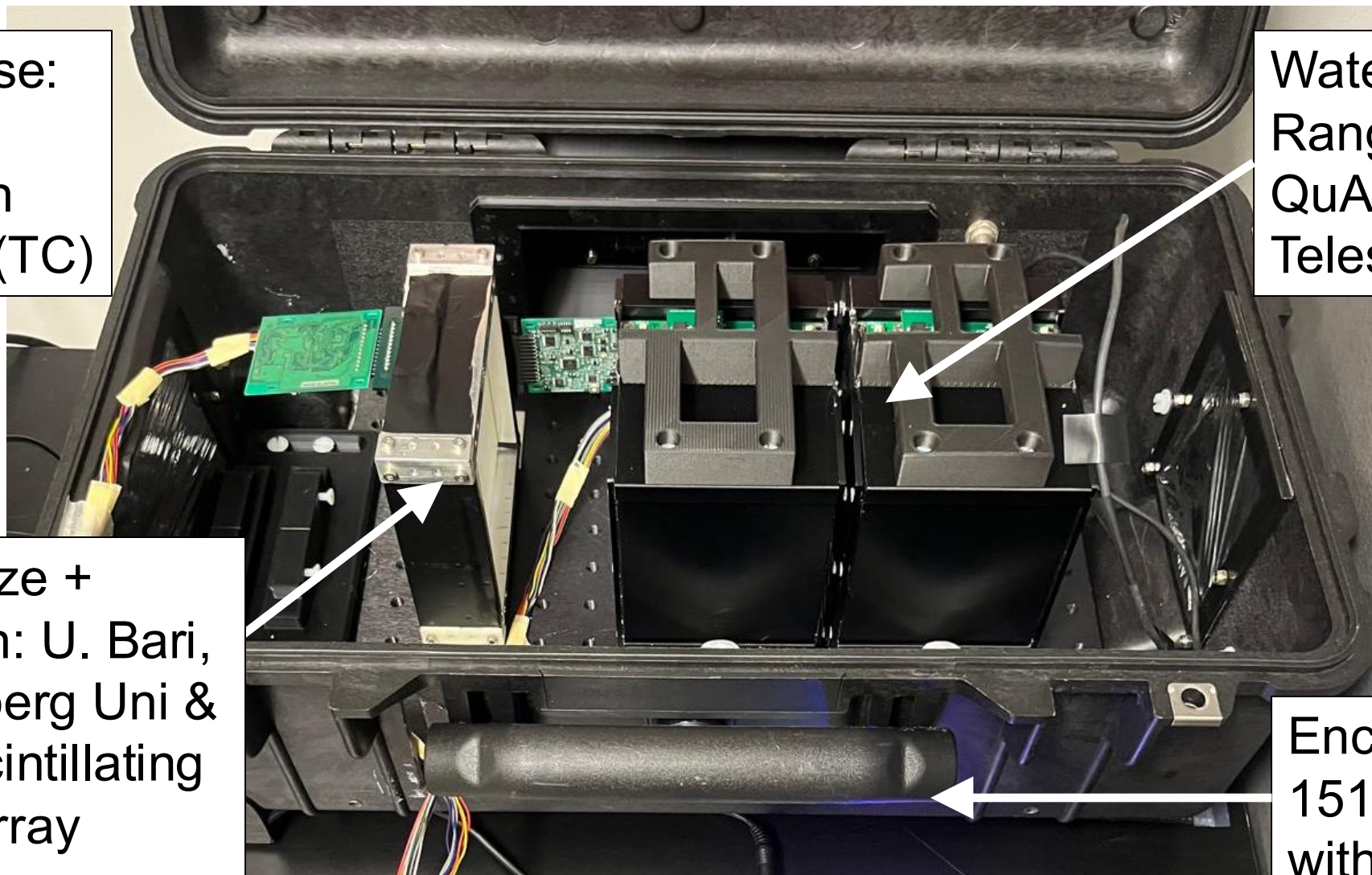
Water Equivalent
Range: UCL
QuARC Range
Telescope

Protons

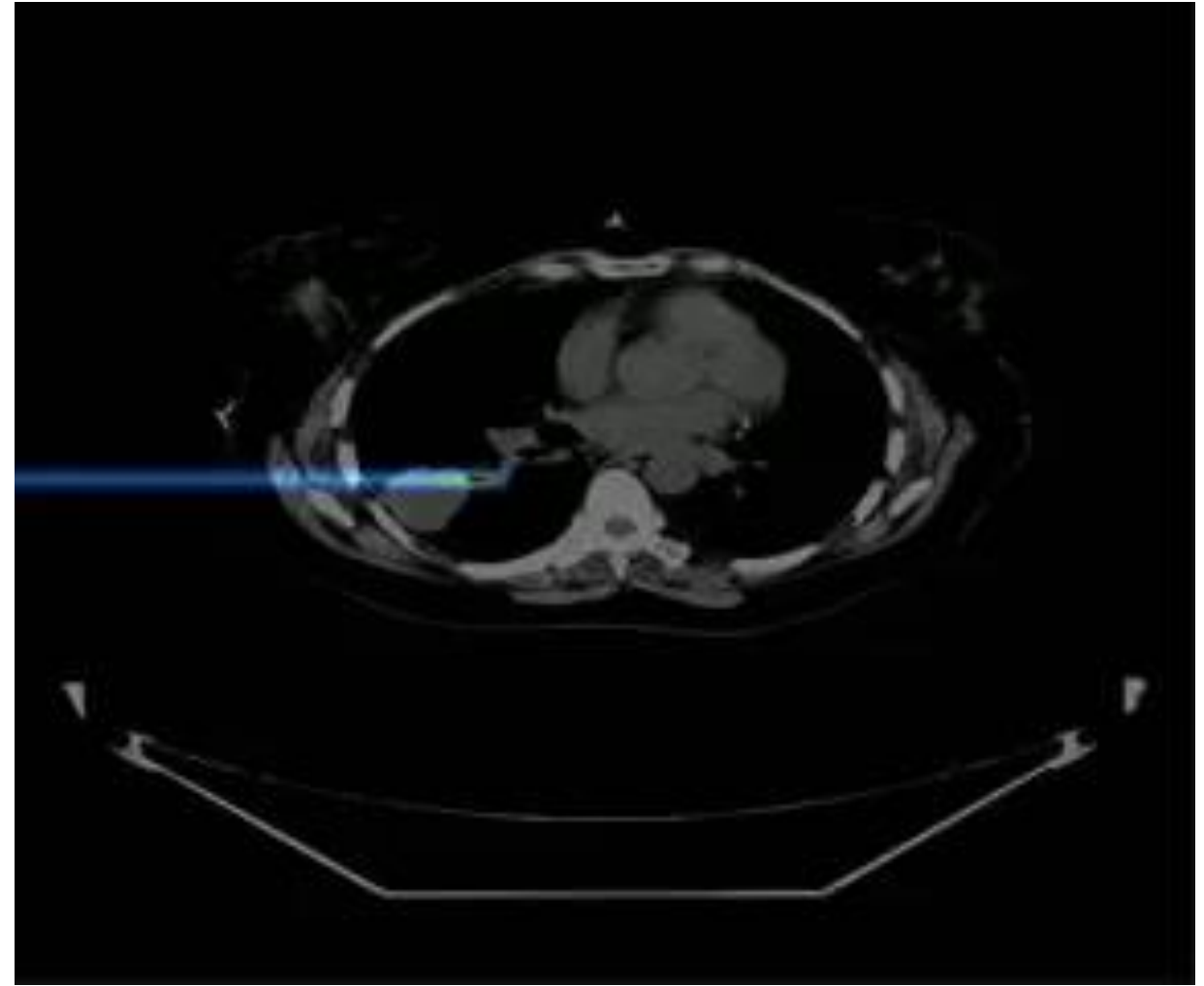
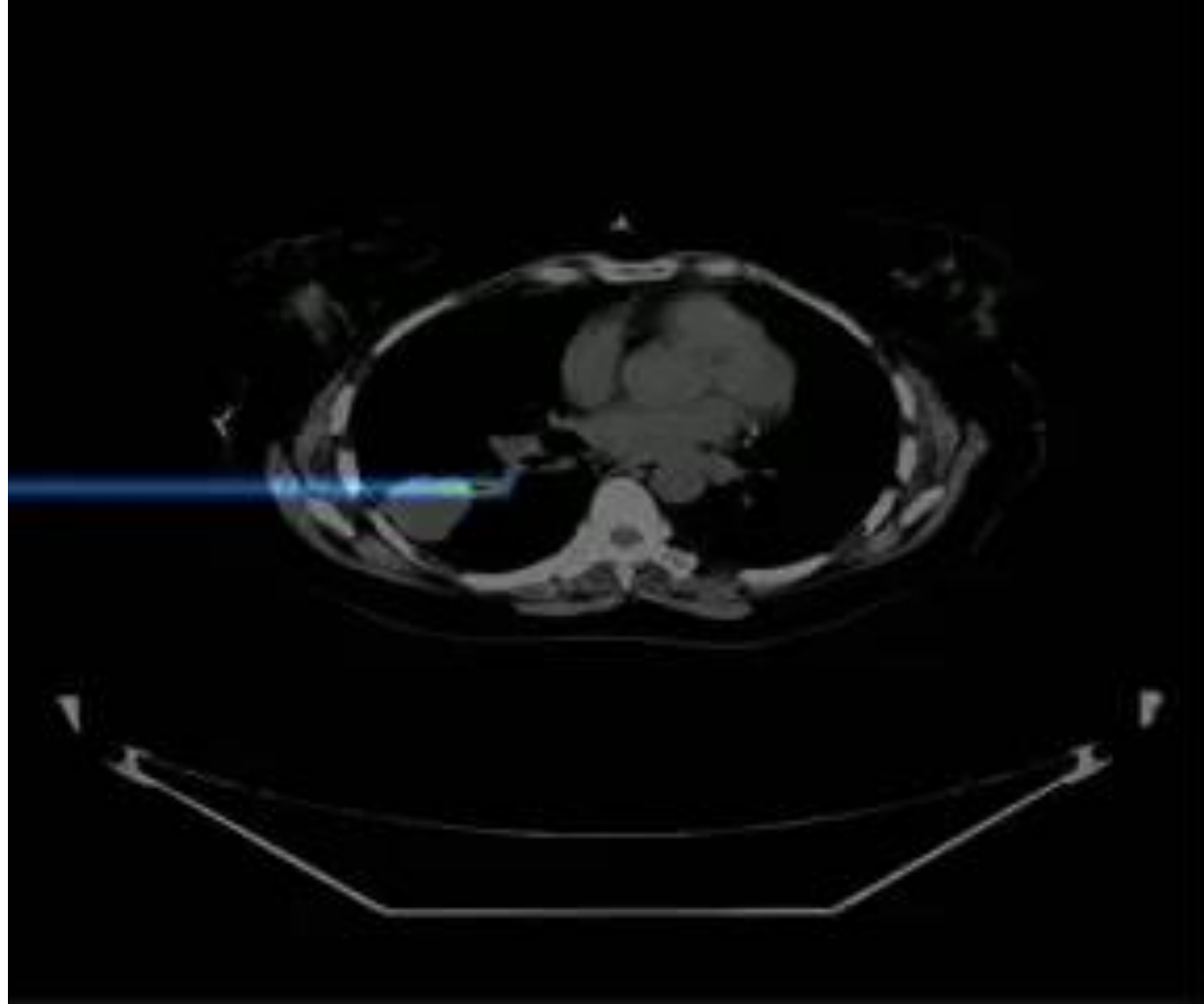


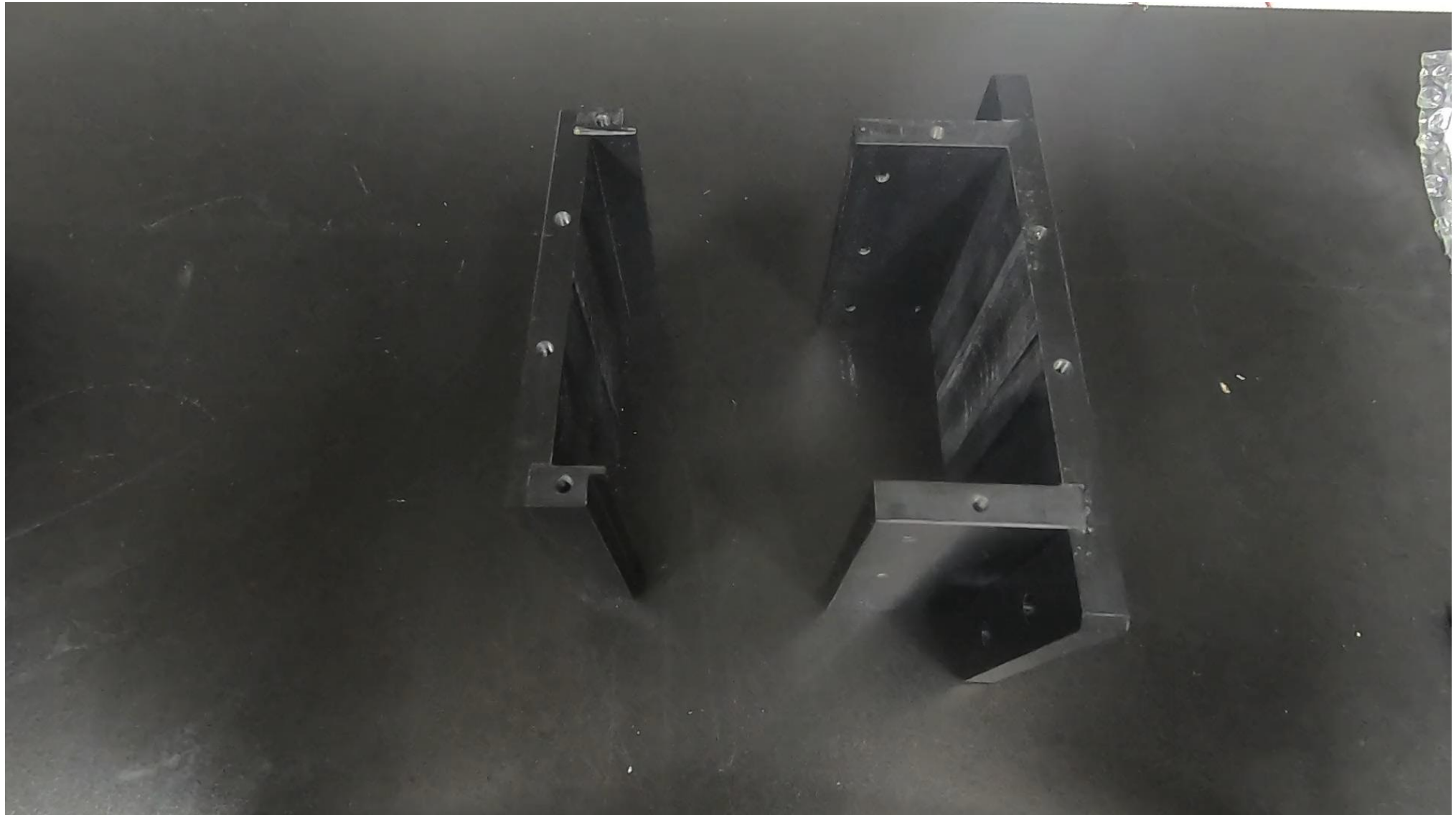
Spot Size +
Position: U. Bari,
Heidelberg Uni &
UCL Scintillating
Fibre Array
Detector

Enclosure: Peli
1510 flight case
with patch panel



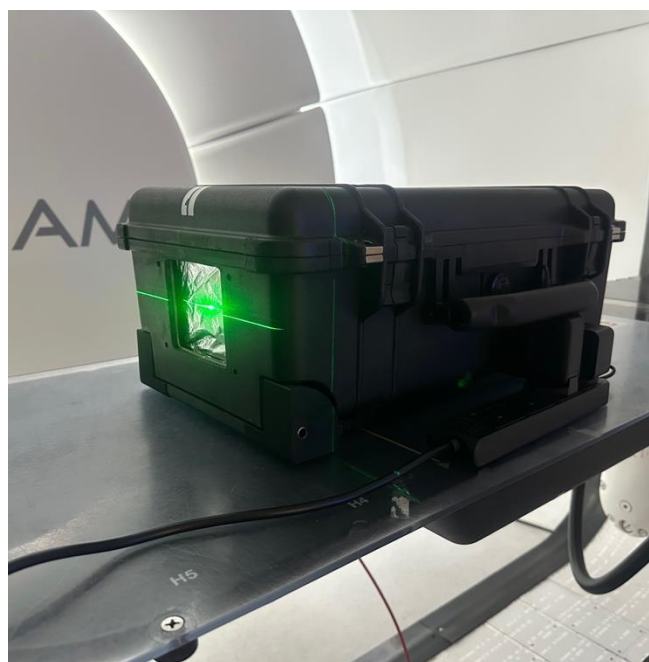
Spare Slides



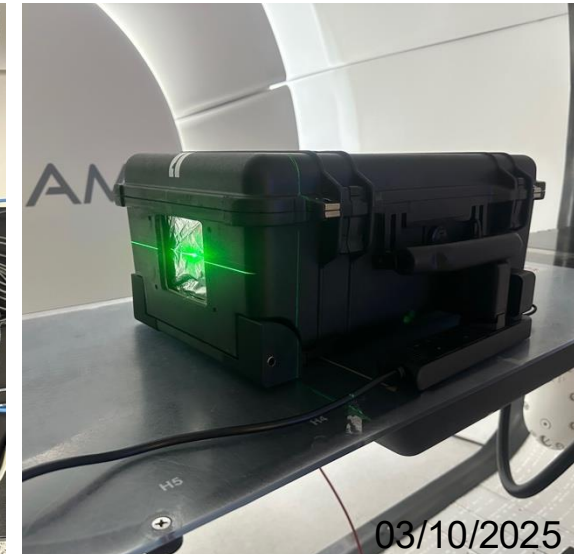




- Able to make direct range measurements.
- Quick to set up: mountable to clinical nozzle.
- Robust: will survive a clinical environment.
- Easy to use: simple set up and interface.
- No software installation: on-board DAQ controlled through web browser.
- Easy to maintain: modular assembly so repair and upgrade straightforward.



- Beam tests at UCLH to evaluate photodiode performance with clinical beams.
- Detector setup with 4 modules (32 sheets, 96 mm total depth per module) to test pencil beam energies between 70–245 MeV.
- Determine range reconstruction accuracy and demonstrate fast live range reconstruction capabilities with web GUI.





UCLH Beam Test Setup

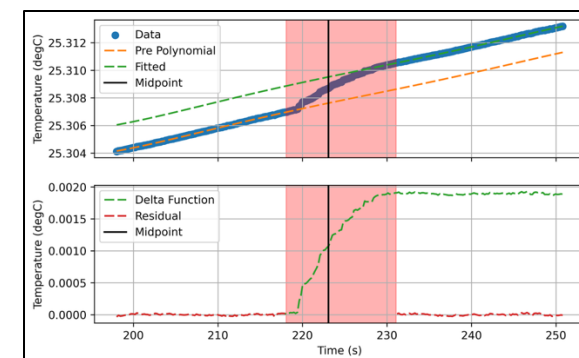
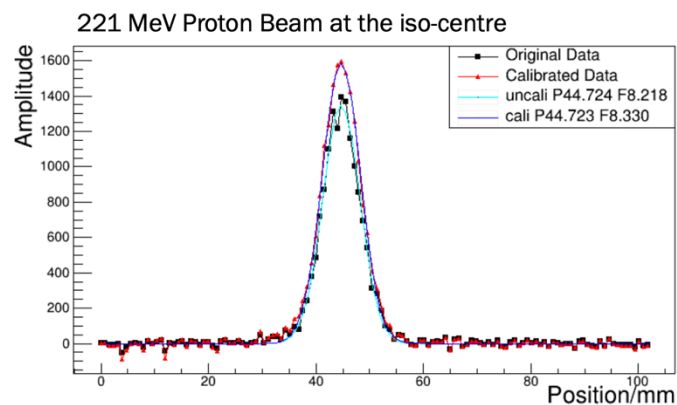
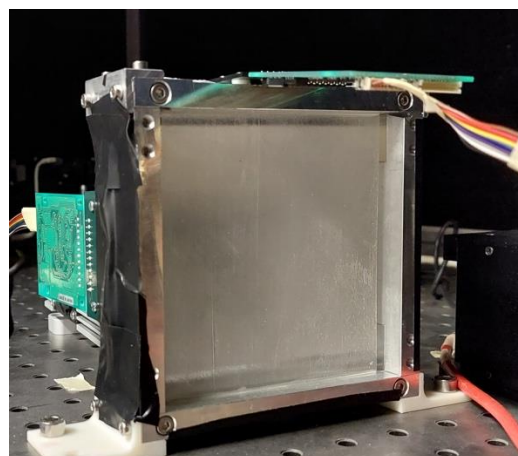
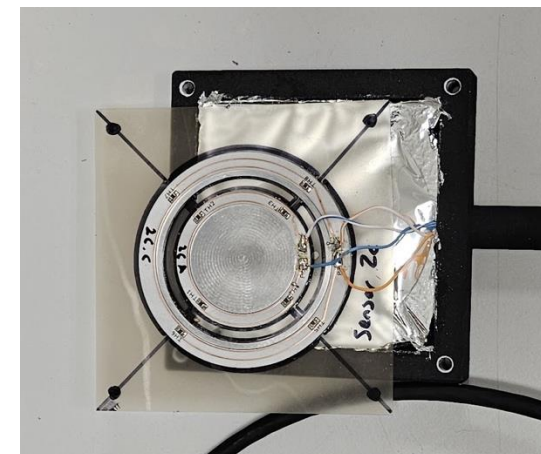
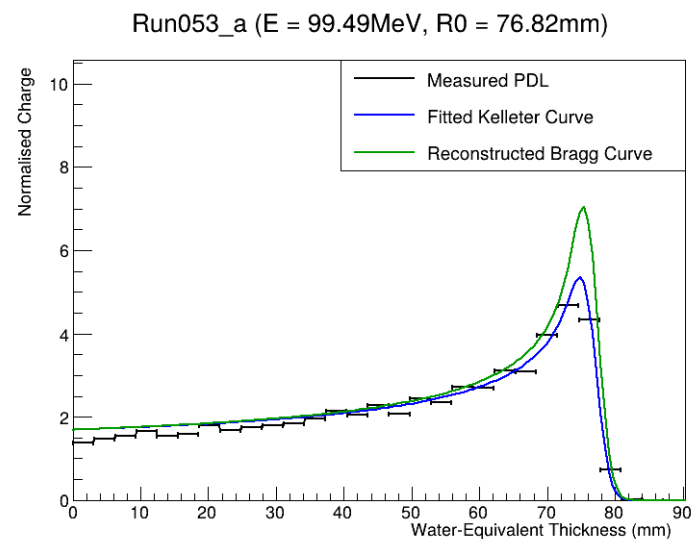
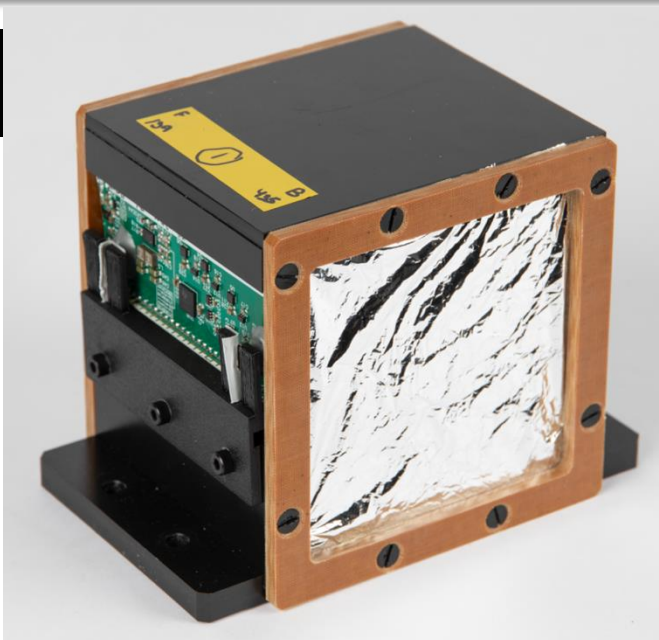
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QuADProBe v2 Components

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Acknowledgements

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Colin Baker

Alison Warry

Andrew Gosling

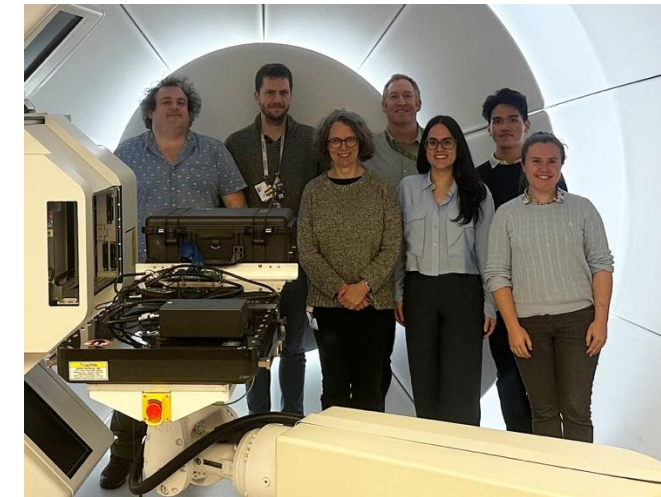
Lee Harrison-Carey

Andrew Poynter



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Tony Price

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