

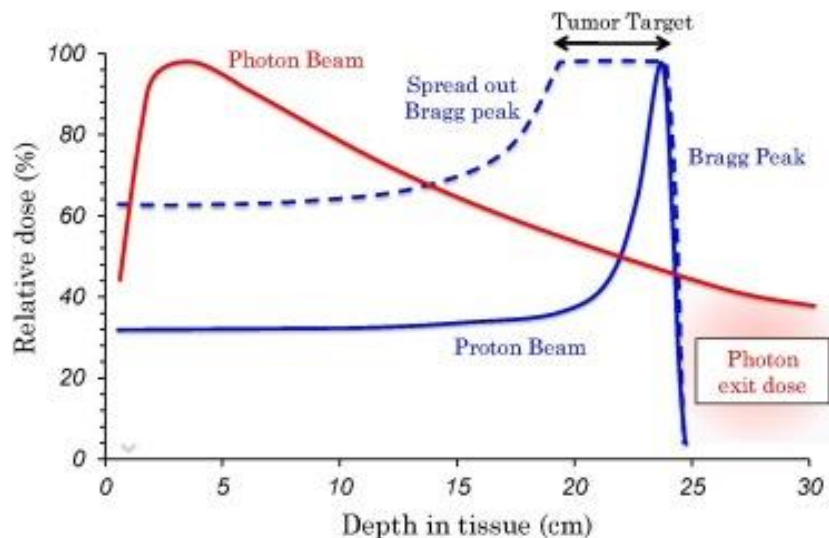
Proton Beam Therapy

HEP Group Day 2025

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Febian Febian, Simon Jolly**

Proton beam therapy

Proton Beam Therapy (PBT) offers a highly localised depth-dose distribution, due to the well-defined range of protons in matter.



Quality Assurance (QA)

To ensure accurate dose delivery in PBT, Quality Assurance (QA) measurements are required.

- Current methods often compromise between speed and accuracy.
- Measurements of beam range, absolute dose, spot position and size.

Develop a detector to make fast, accurate measurements of proton range.

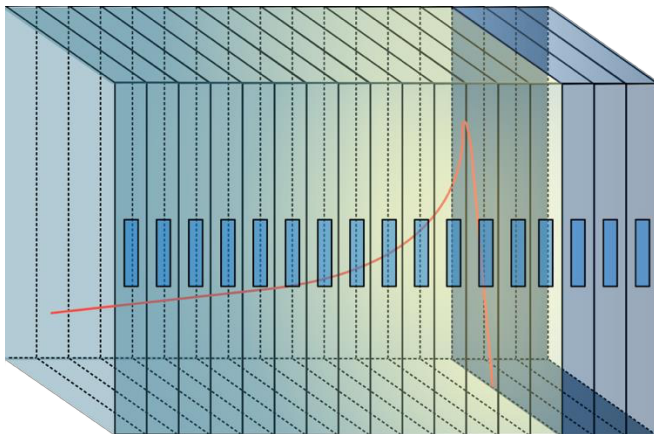


QuARC

QuARC

QuARC = Quality Assurance Range Calorimeter

- Optically isolated polystyrene scintillator sheets of 100 mm x 100 mm x 3 mm.
- Each sheet is coupled to a photodiode. PD read-out by an FPGA.
- Analytical model deployed to fit depth-light curve to reconstruct Bragg curve.



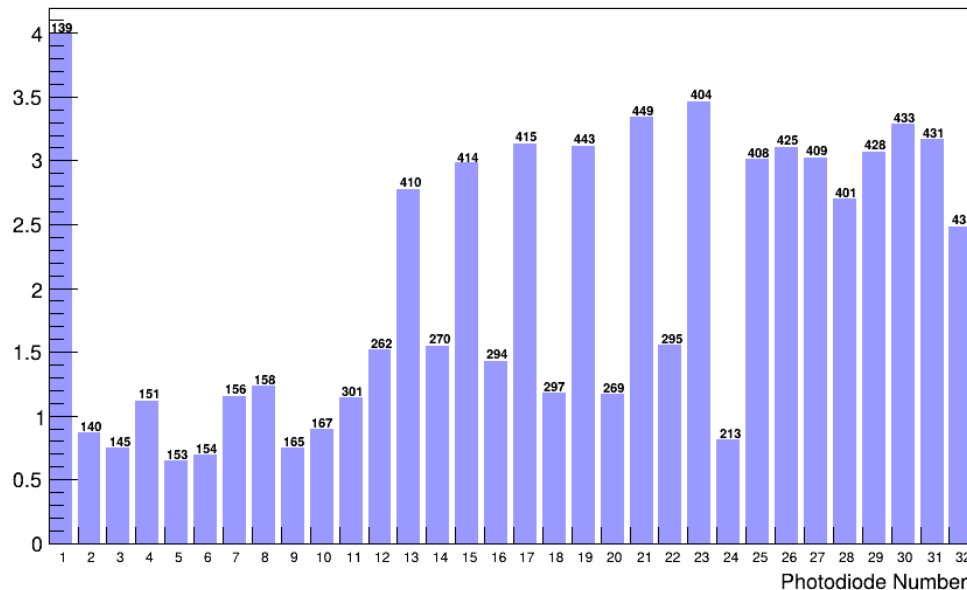
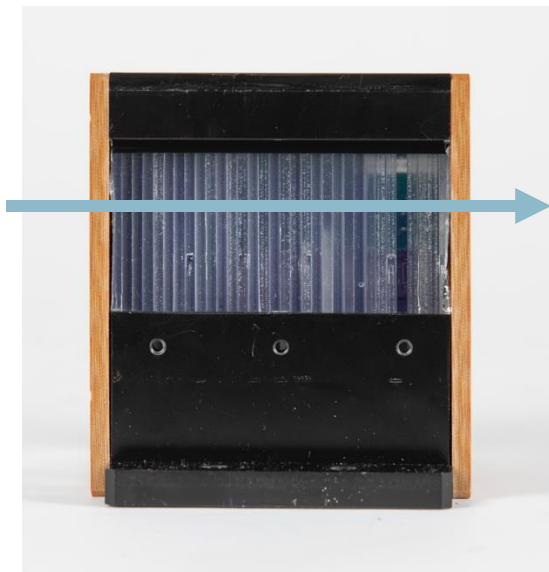
What's new in PBT?

- New polished scintillators
- Photodiodes on both sides of the scintillator
- Improved mechanical set-up



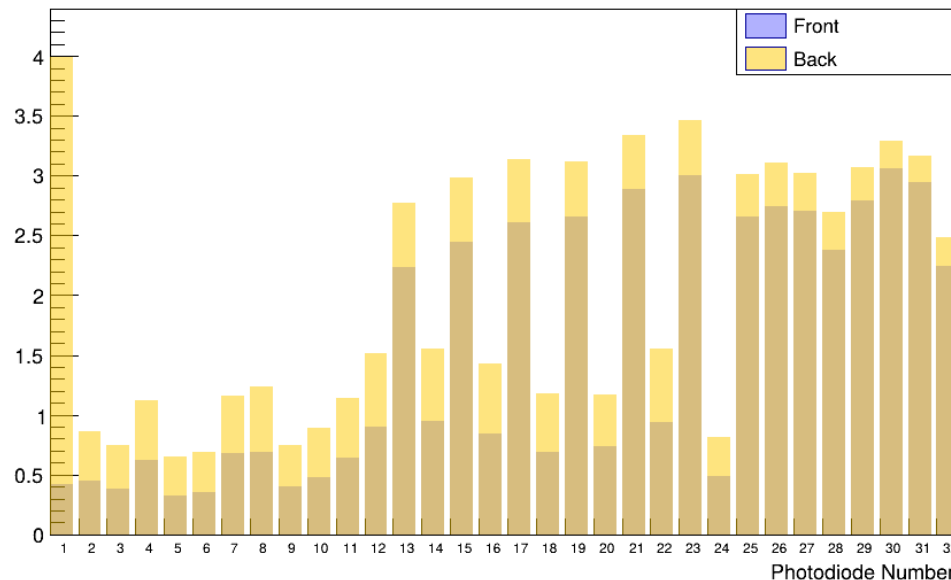
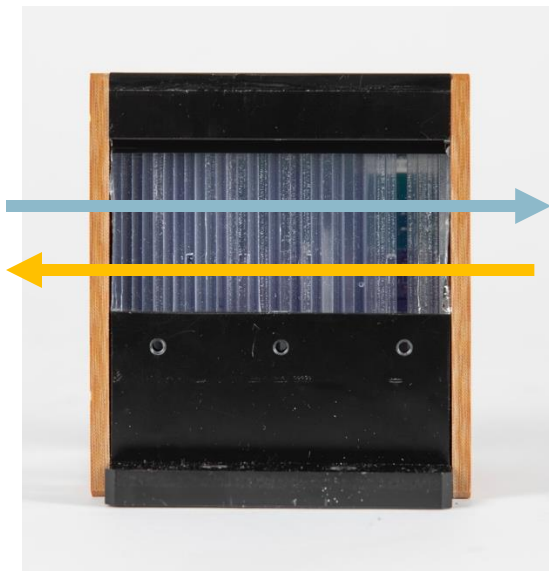
Beam Test at PPTC: April 2025

- Testing response of the new polished scintillator sheets with shoot-through measurements.



Beam Test at PPTC: April 2025

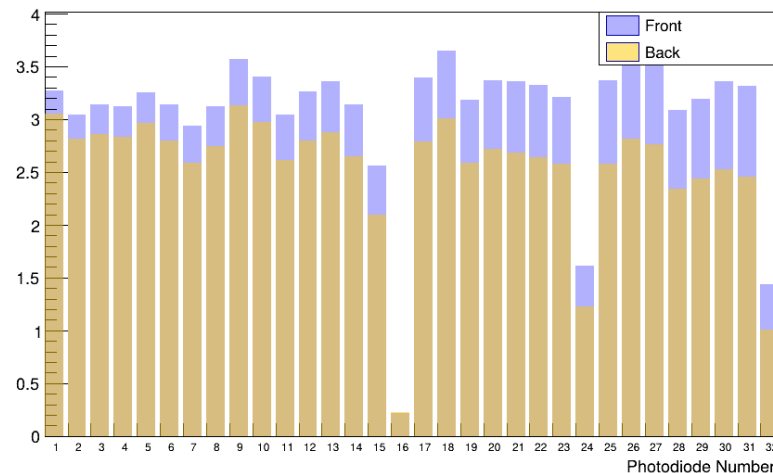
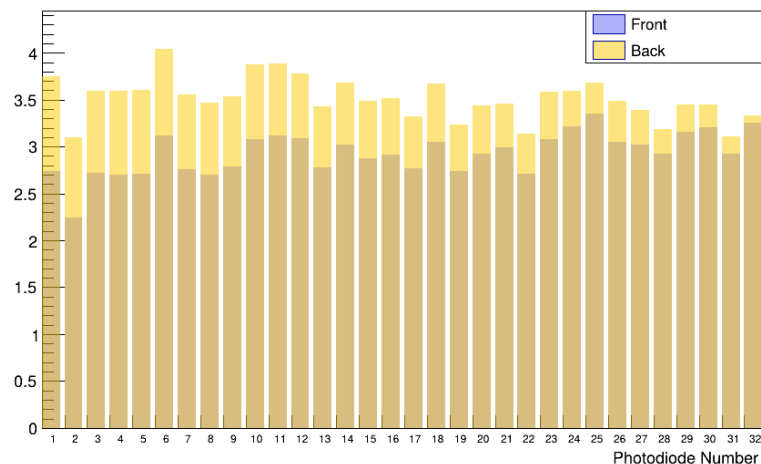
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Beam Test at PPTC: April 2025

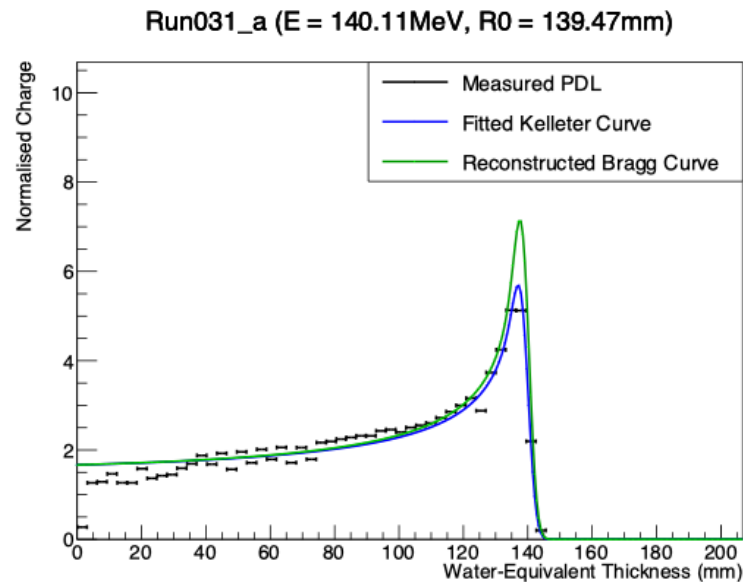
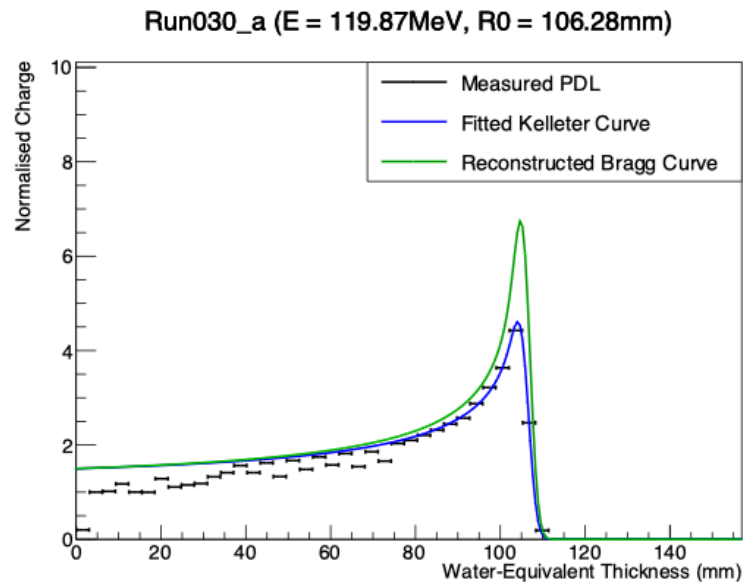
Focusing on module 2, made of polished sheets we also see a different light response for ST front and ST back.

When the board is placed on the left it always sees more light -> **beam misalignment?**



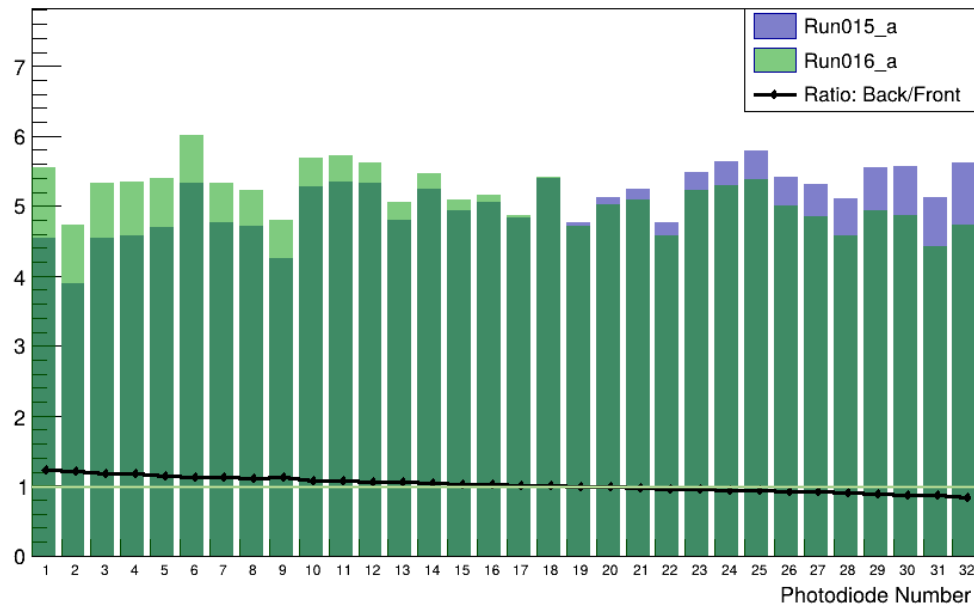
Beam Test at PPTC: April 2025

Looking at the actual BPs measured:



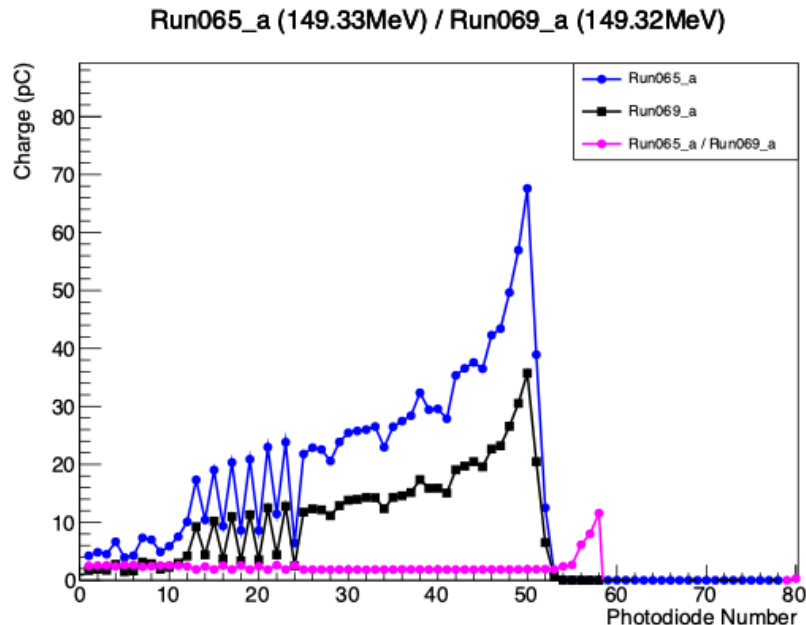
Beam Test at UCLH: May 2025

Confirm if there is a beam misalignment at PPTC or if it's a detector issue



Beam Test at UCLH: May 2025

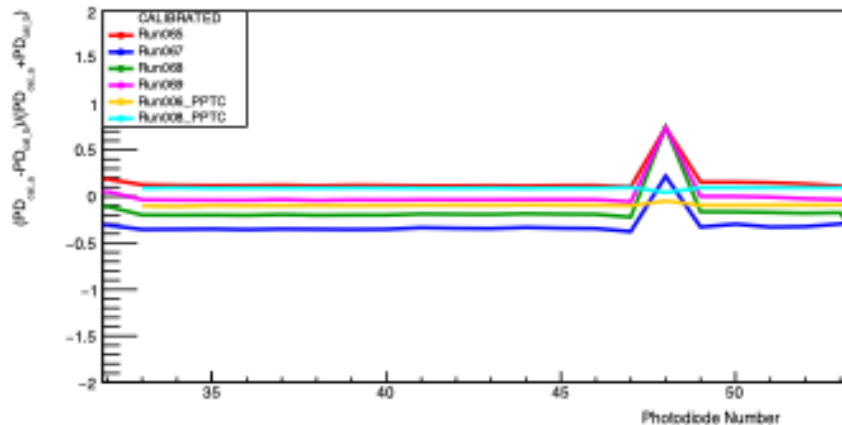
Shift the beam with respect to the centre of the detector to study misalignment issues from Prague



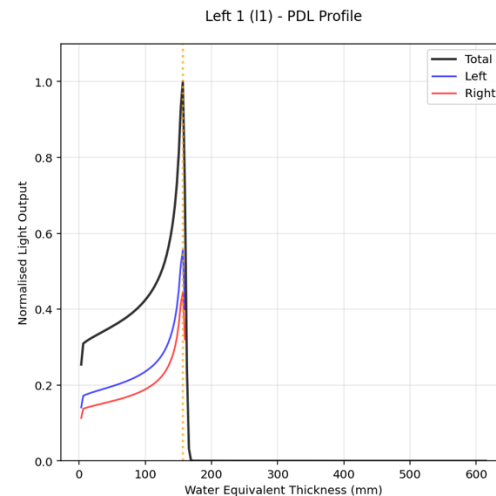
Beam Test at UCLH: May 2025

Shift the beam with respect to the centre of the detector to study misalignment issues

$$shift[i] = \frac{PD_A[i] - PD_B[i]}{PD_A[i] + PD_B[i]} \longrightarrow \text{PPTC beam is shifted } \sim 1\text{cm to the left}$$

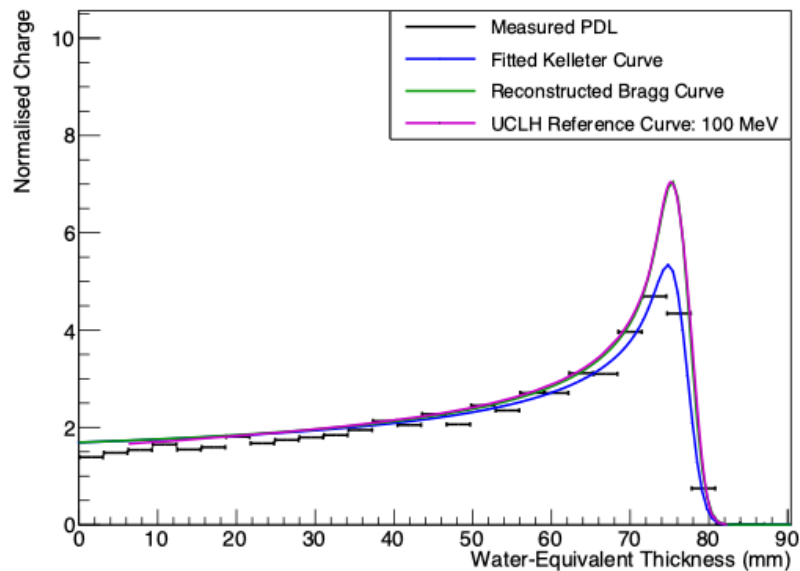


1cm R
2 cm L
1 cm L
centered

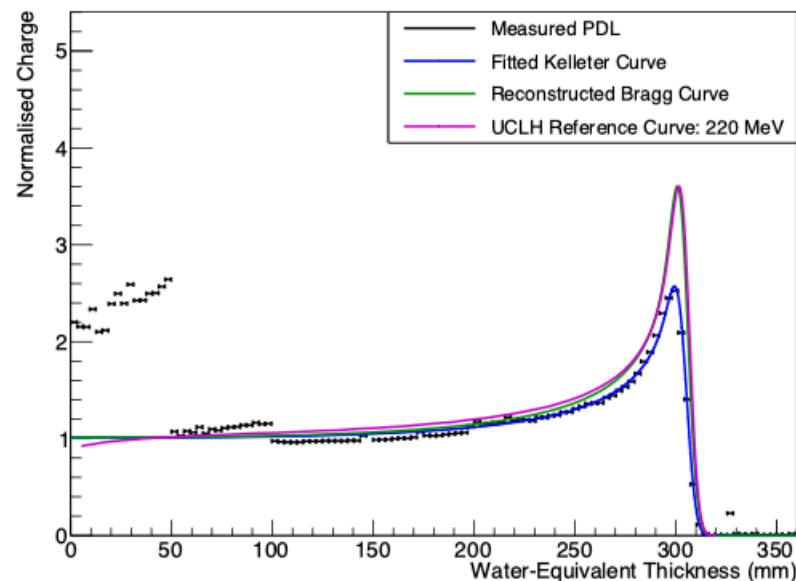


Beam Test at UCLH: May 2025

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



Run034_b (E = 219.26MeV, R0 = 304.31mm)

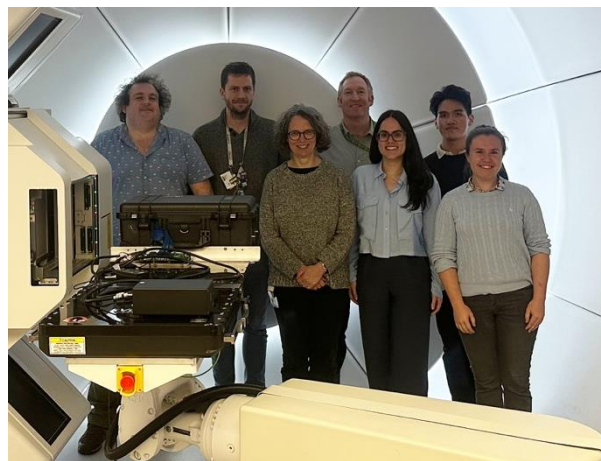


Next Steps

QuARC → QuADPro

Quality Assurance Range Calorimeter → Quality Assurance Detector for Protontherapy

- Integrate a fibre array to measure beam position and spot size
- Beam test in TIFPA @FLASH rates – next week!
- Add photodiode boards to 4 sides of the scintillator
- Upgrade to the electronics



+ Harry Barnett and Matt Warren

