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WP 2 Ion Detector Calibrations

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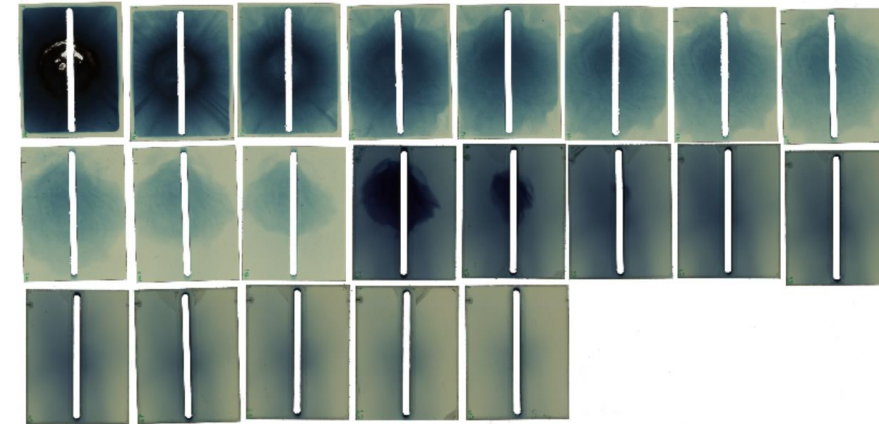
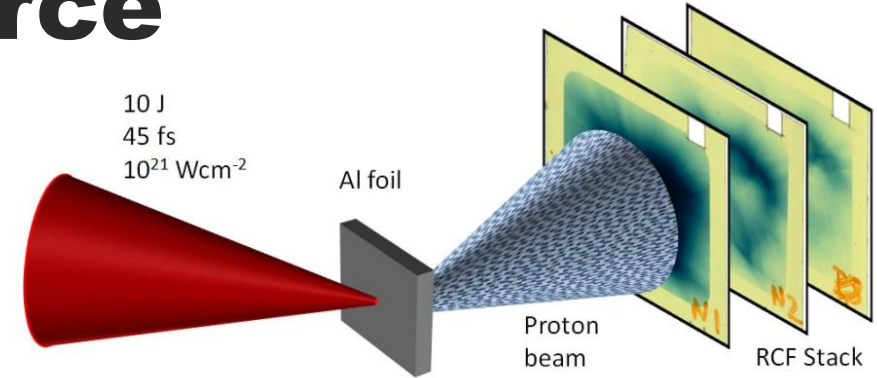
Science and
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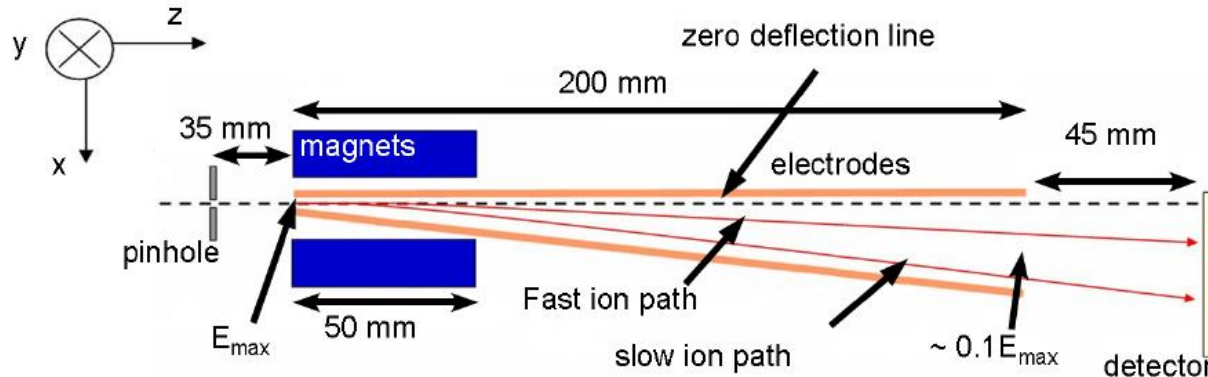
Engineering and
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Ion Diagnostics at the Source

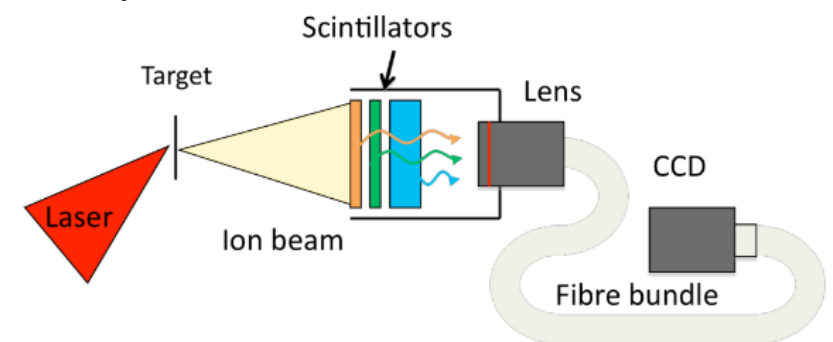
- Aiming for 10^9 15 MeV protons generated from a laser-plasma accelerator (LPA) for radiobiological applications
- LPAs have relied on radiochromic film-based diagnostics
- Not compatible with the high repetition-rate operation of LhARA.
- We need active spectro-spatial detectors



Thomson Parabola

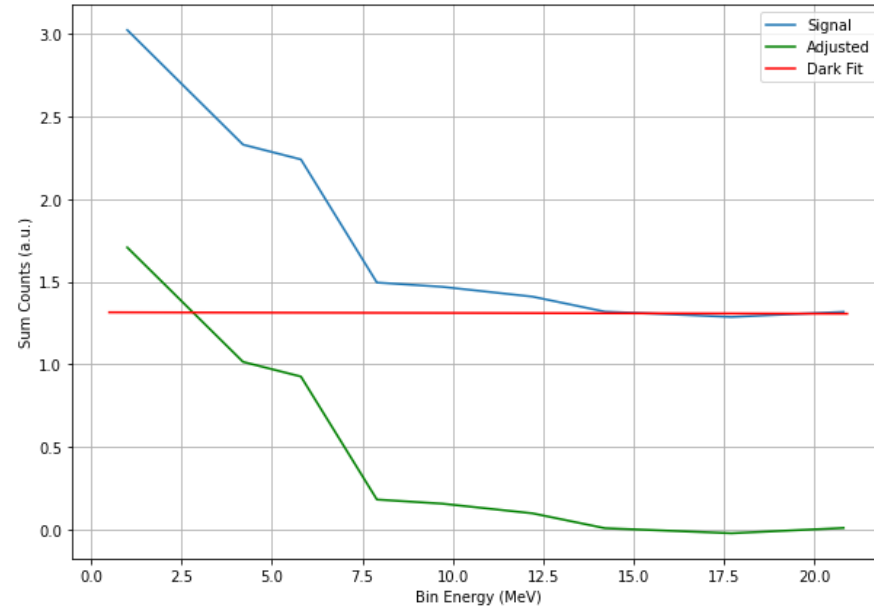
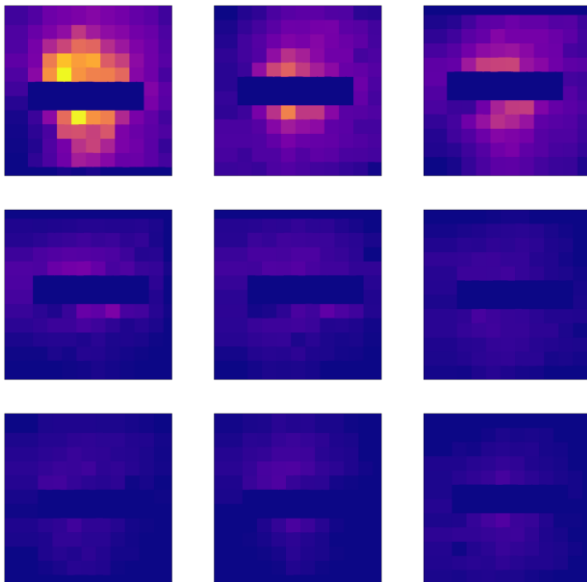


Footprint Detectors



Active Ion Detection - PROBIES

- Combined spectro-spatial proton detector
- Attenuating grid used to sample different energy protons
- Spatial profile interpolated
- One of multiple detector technologies in SCAPA

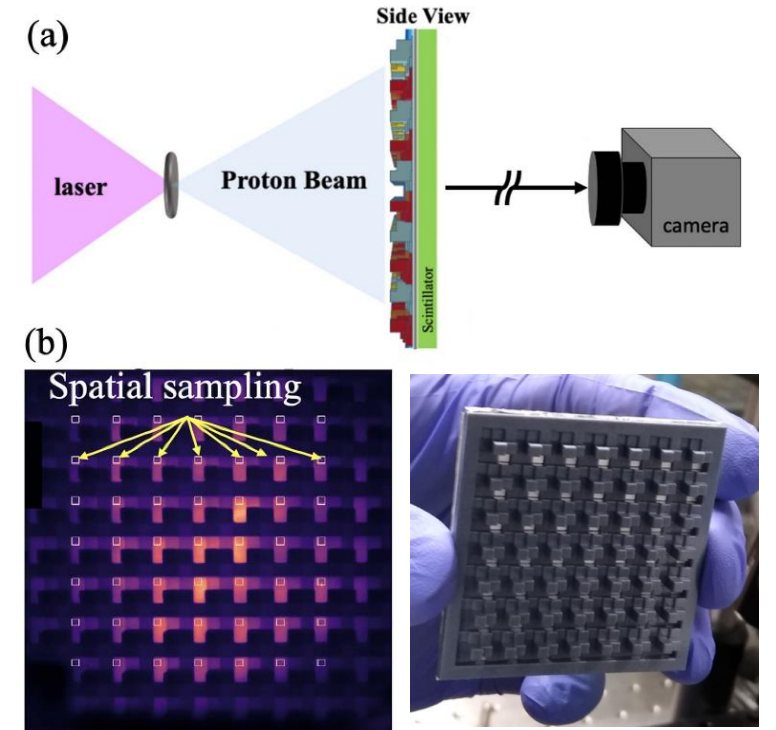


IOP Publishing
Plasma Phys. Control. Fusion 63 (2021) 114003 (10pp)
<https://doi.org/10.1088/1361-6587/ac234a>

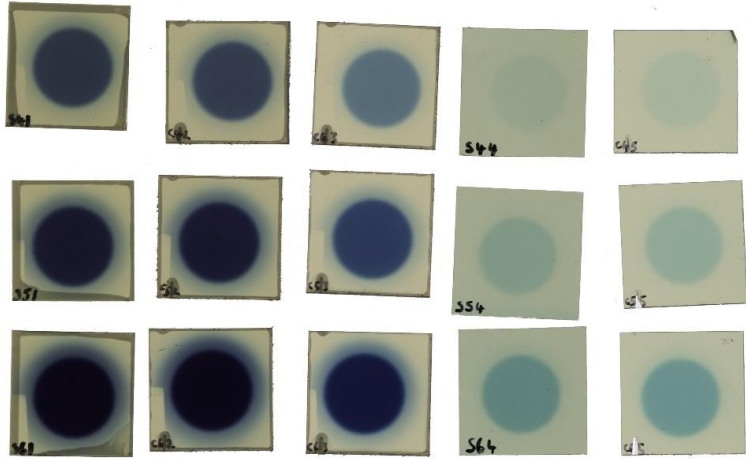
Plasma Physics and Controlled Fusion

Design of flexible proton beam imaging energy spectrometers (PROBIES)

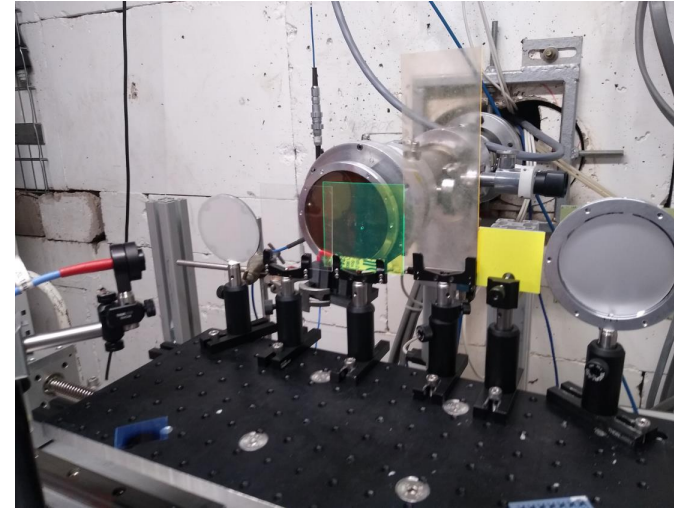
D A Mariscal^{1,✉}, B Z Djordjevic¹, E S Grace², R Hollinger¹, T Ma¹, G G Scott¹, H Song¹, R A Simpson¹, J J Rocca¹ and S Wang¹



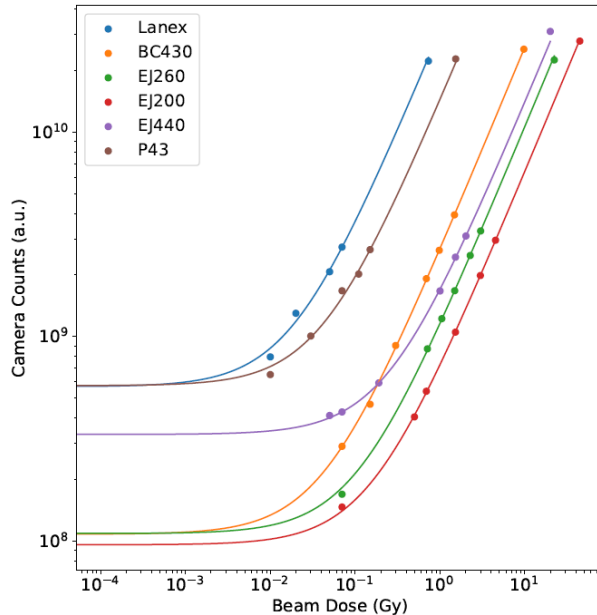
RCF Calibrations



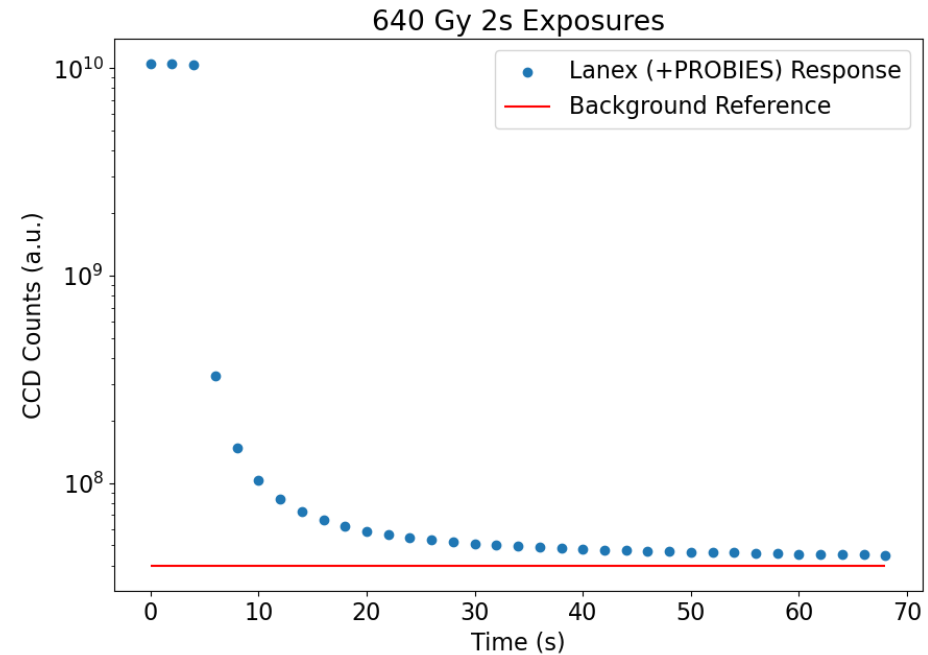
Scintillator Dose Response



Scintillator Energy Response

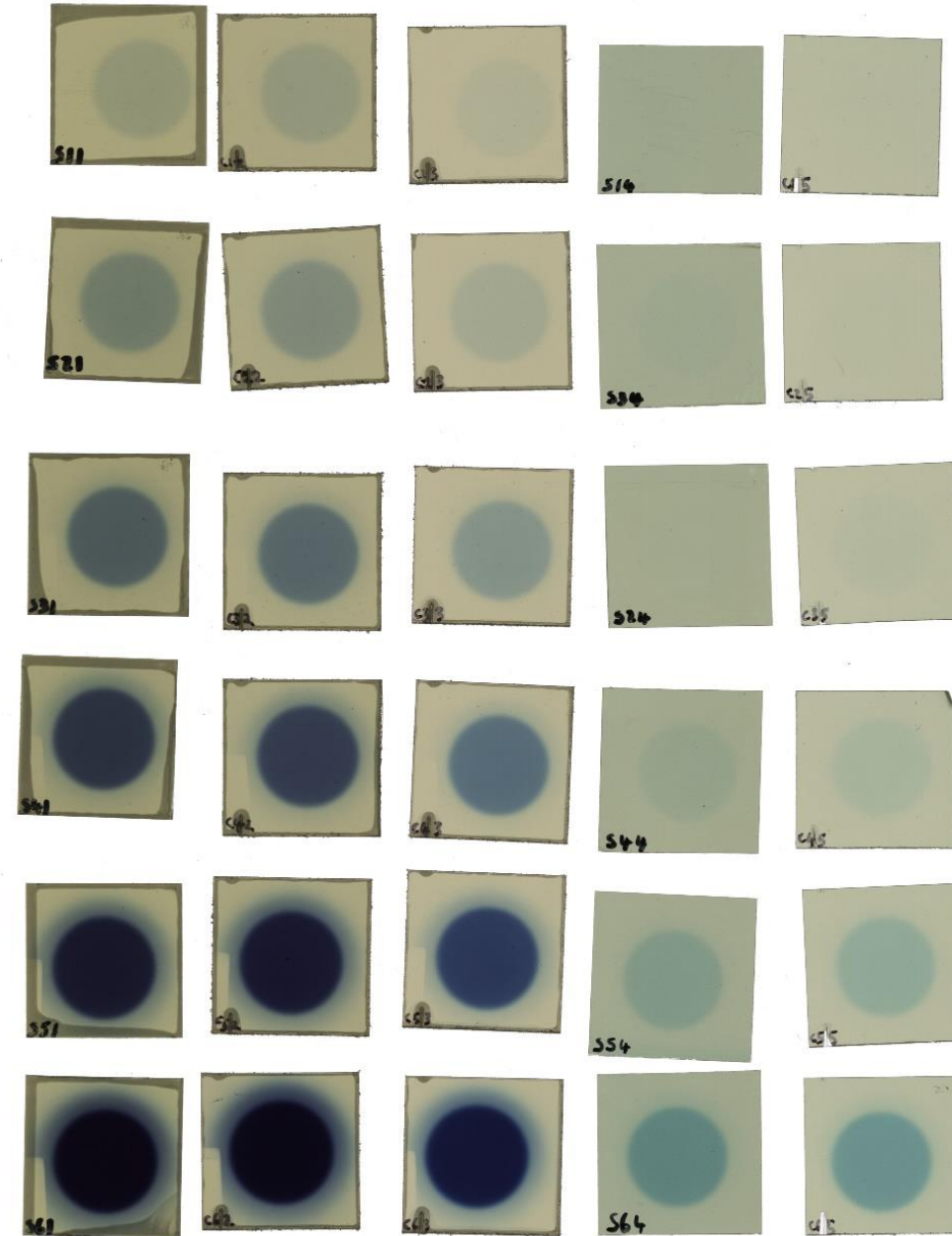
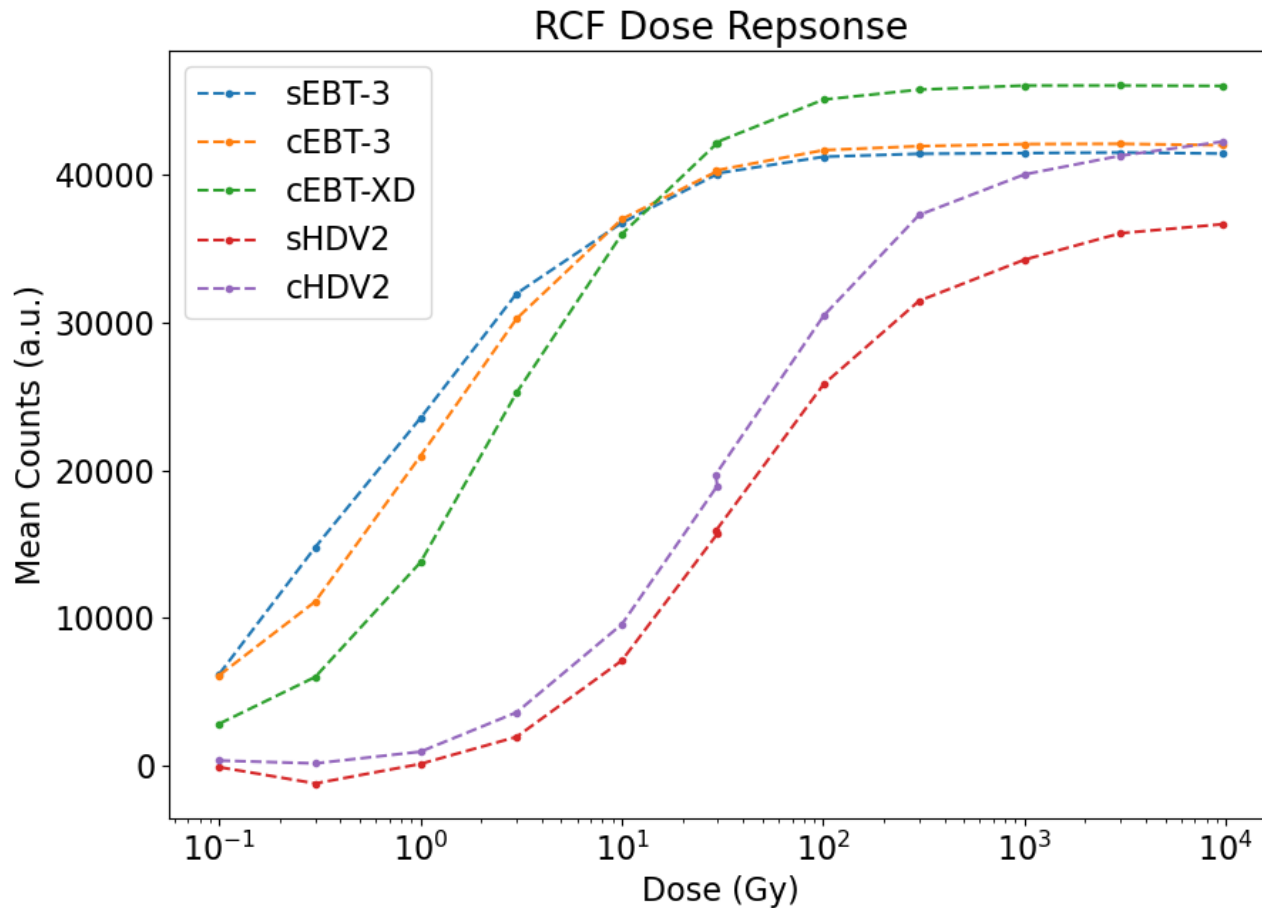


Phosphor Afterglow



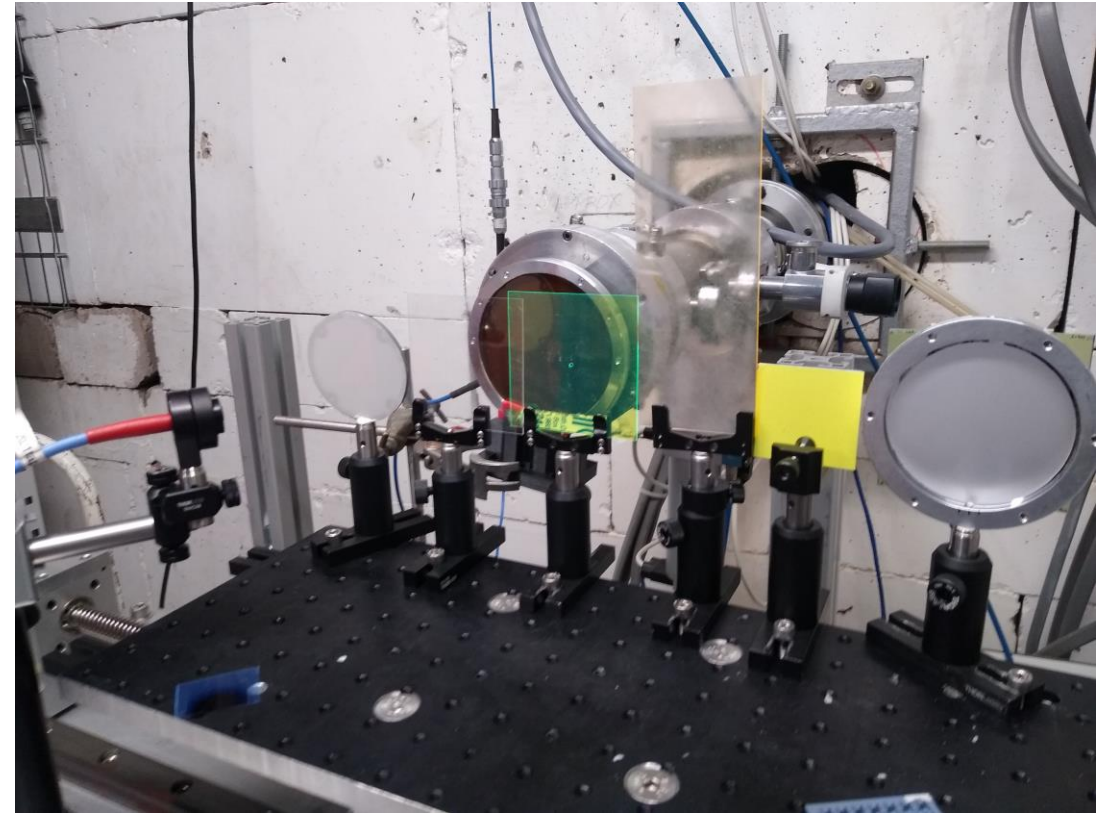
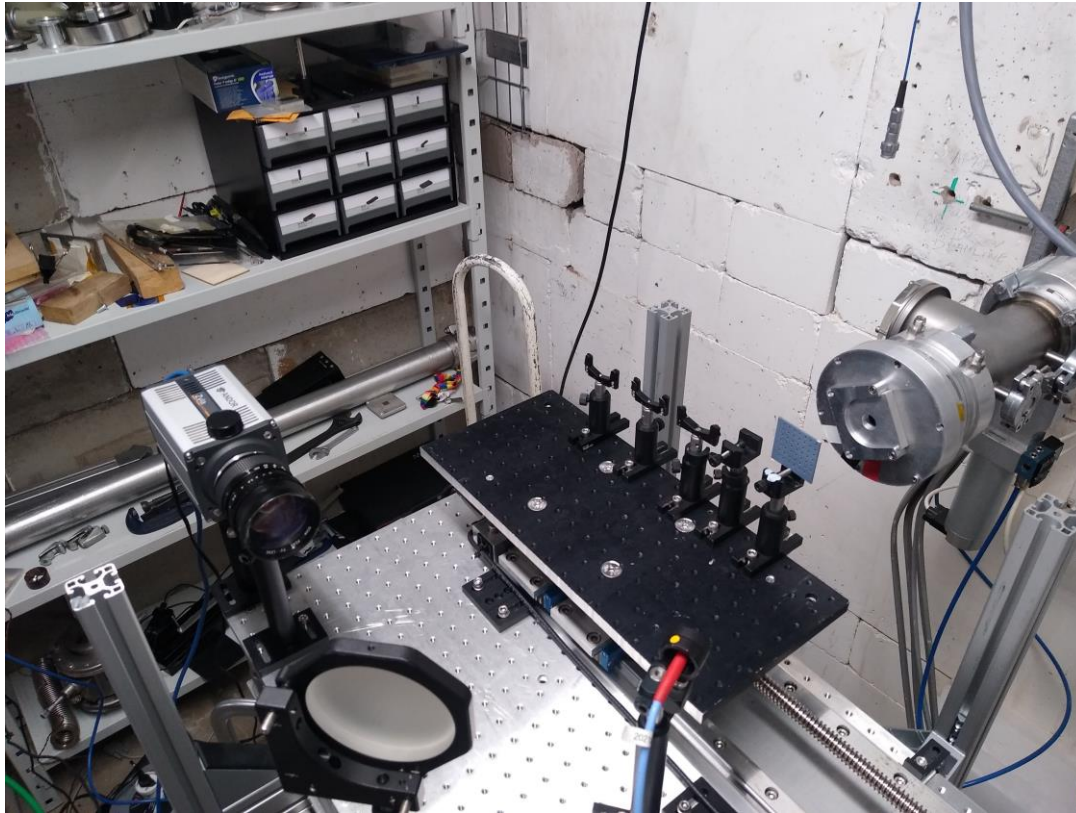
Updated RCF Calibration

- Required for diagnostic cross-calibration
- Well accepted standard
- Maximum spatial resolution



Scintillator Calibrations

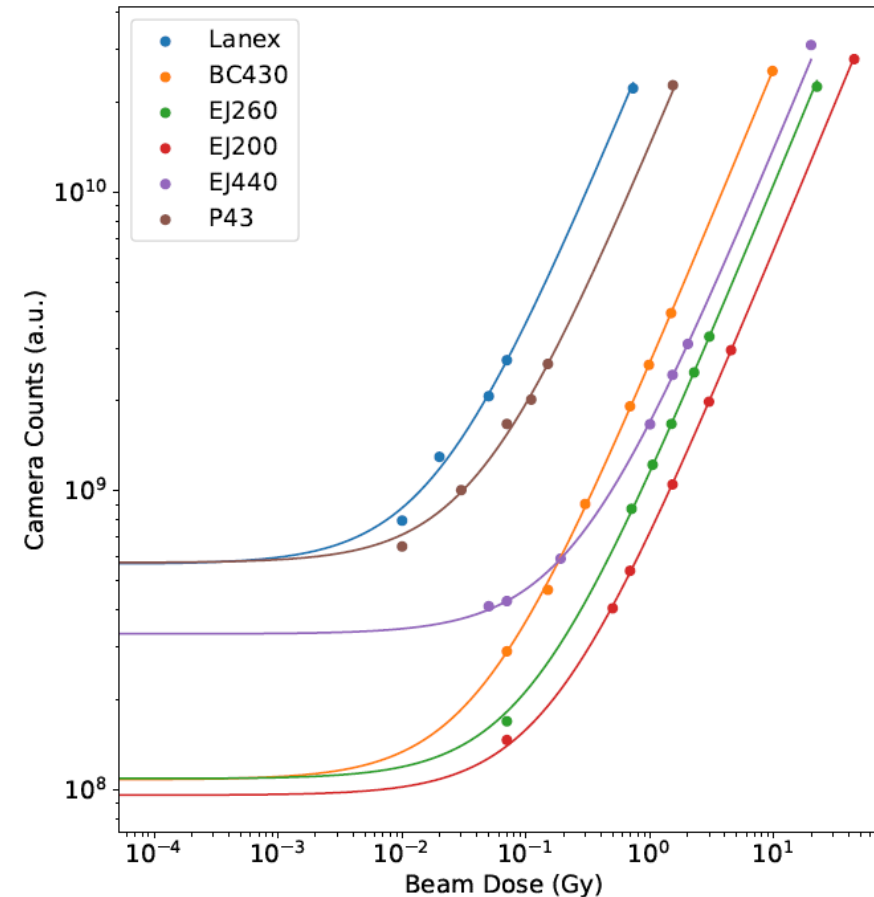
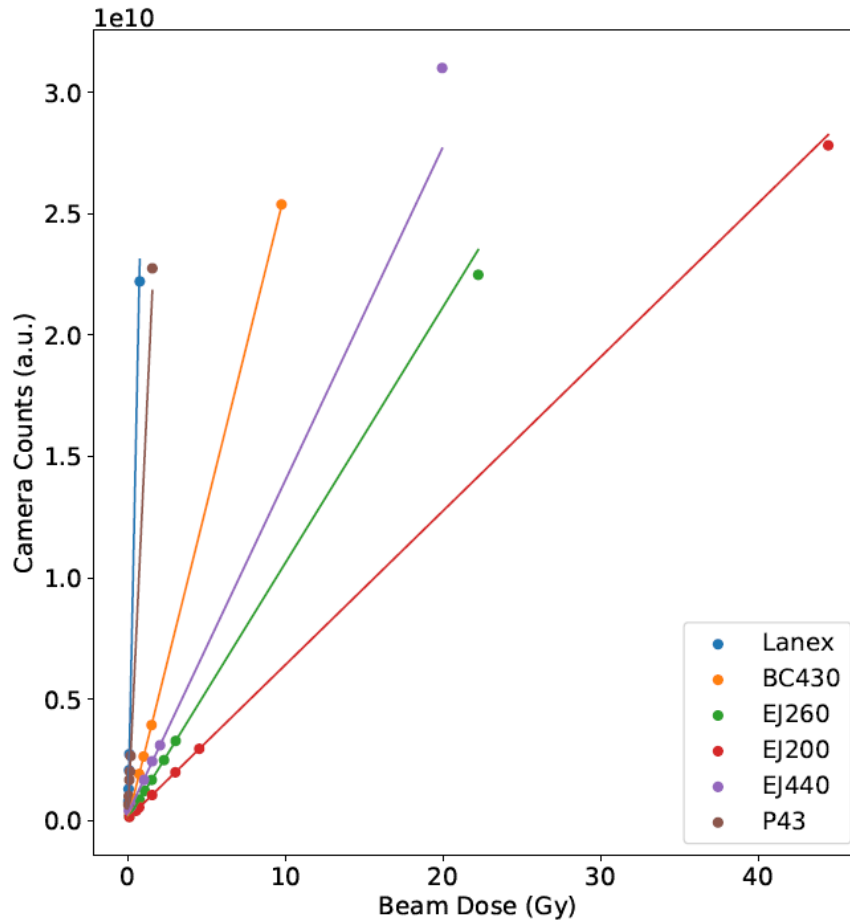
- Aimed for dose-light calibration and spectral response of each scintillator using a grid of variable thickness plastic to sample the emission at different dE/dx values
- 28 MeV beam for the dose calibrations and a 14 MeV beam for the energy response



Scintillator Dose Response

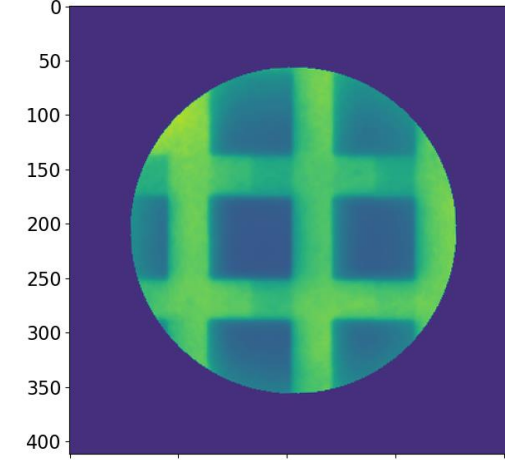
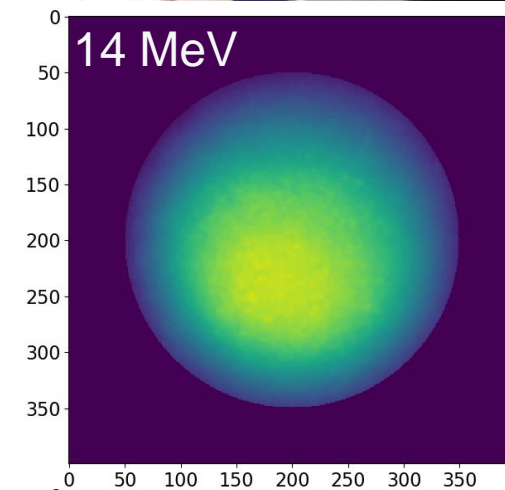
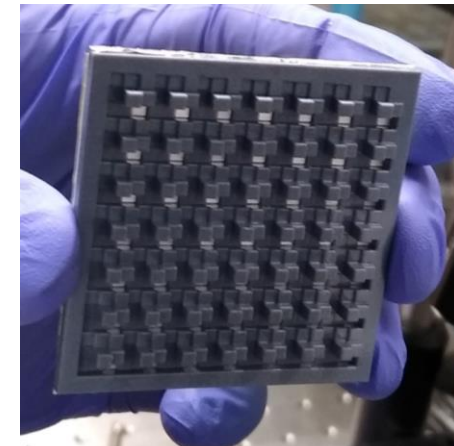
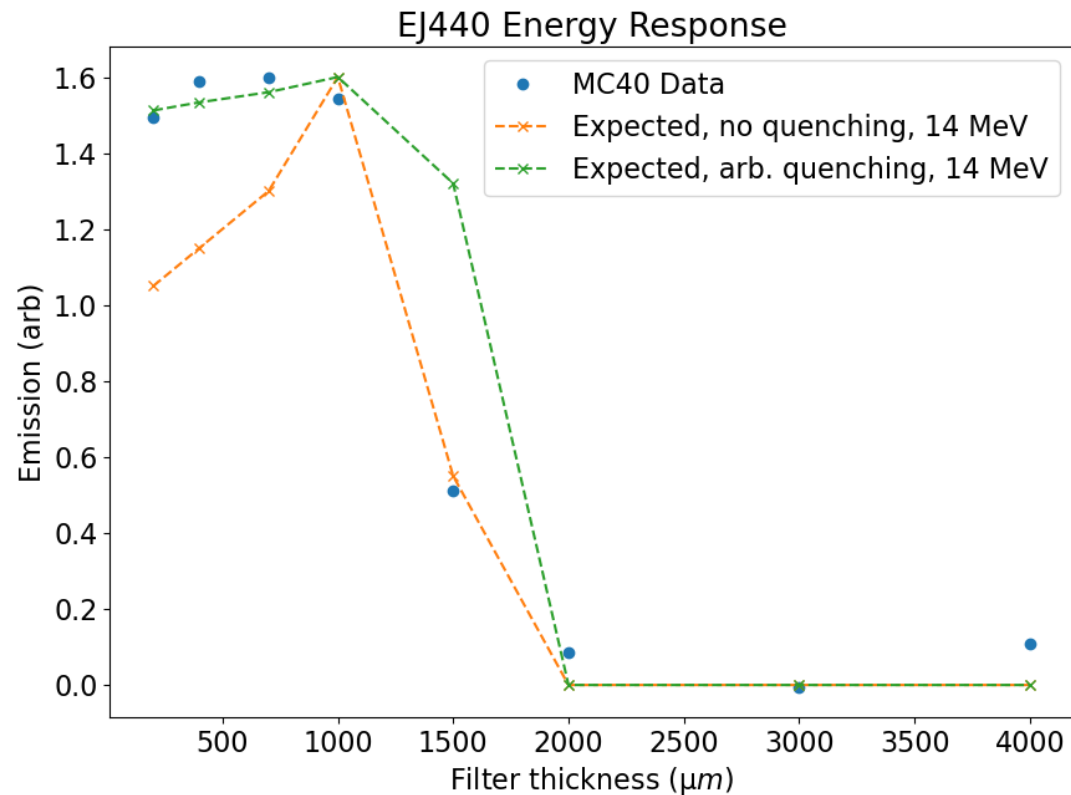
- Calibrations acquired for a range of commonly available plastic scintillators and phosphors over LhARA relevant dose ranges
- Detectors chosen with fast response times, high output and minimal phosphorescence

Dose Linearity (Inc. High Dose)



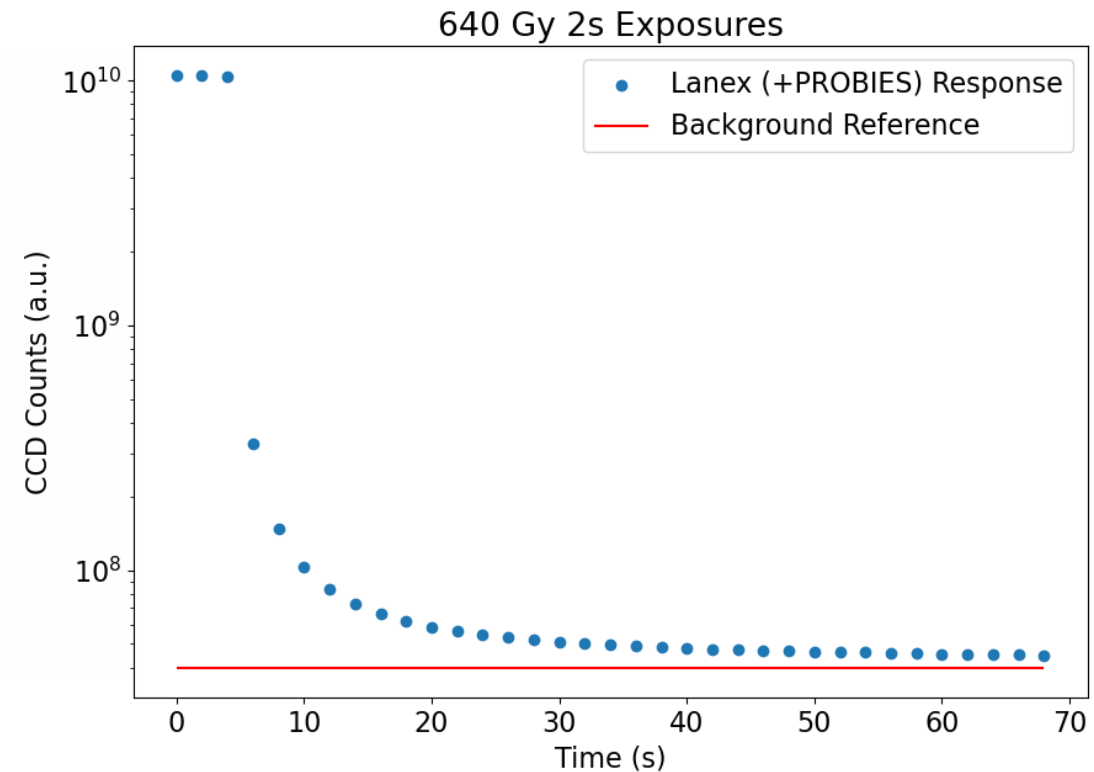
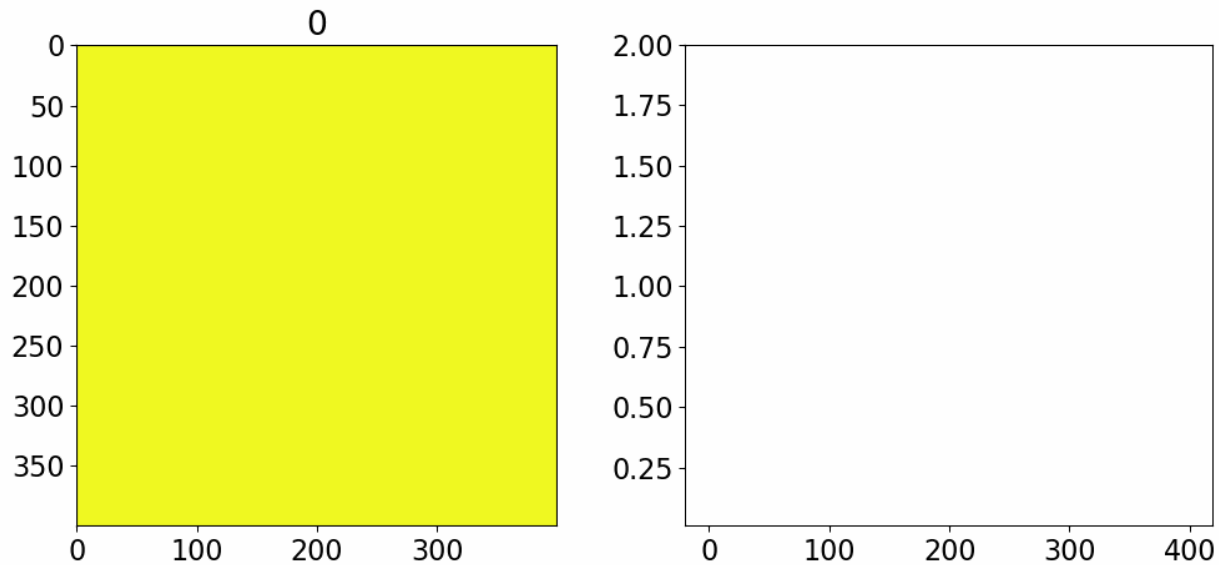
Scintillator Energy Response

- 14 MeV beam used in combination with PROBIES mask to sample the beam at different points of the Bragg peak and measure quenching parameters
- Result was not quite as expected but analysis is ongoing with a second visit planned to improve our dataset



Scintillator Afterglow

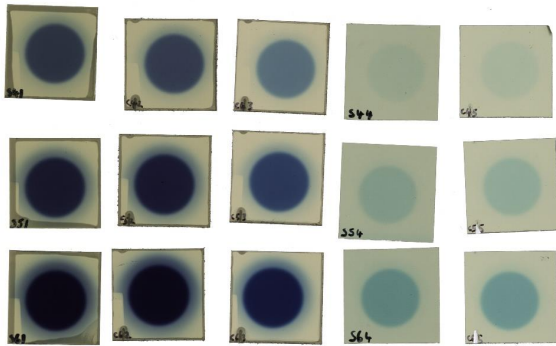
- Experimental work in SCAPA suggested detection of a long timescale phosphorescence present in Lanex
- Irradiation at MC40 with 640 Gy of 28 MeV protons reveals a long timescale (tens-of-seconds) emission after irradiation ends when measured with a time-integrated CCD setup
- This has clear implications for operation at 10 Hz in LhARA and further investigation is planned for our second visit to MC40



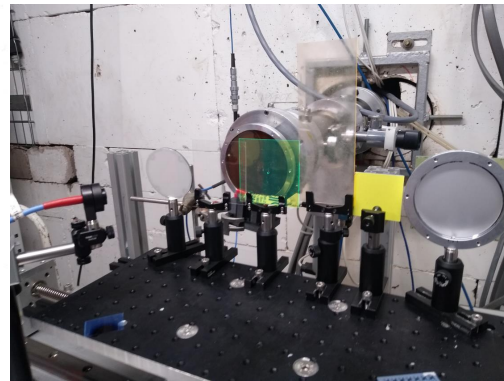
Summary

- Fresh proton number calibrations acquired for RCF
 - Essential for diagnostic cross calibration and useful as a standard diagnostic
- Scintillator responses measured for a variety of commonly used scintillators and phosphors, informing choice of detector for the laser-plasma source and allowing proton number measurement at high repetition-rate
- Further work planned to improved measurements of the spectral response and afterglow

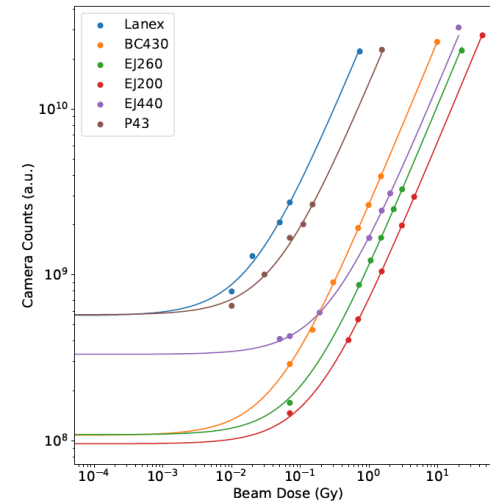
RCF Calibrations



Scintillator Energy Response



Scintillator Dose Response



Phosphor Afterglow

