

art and science

Fluorescence dosimetry using household materials

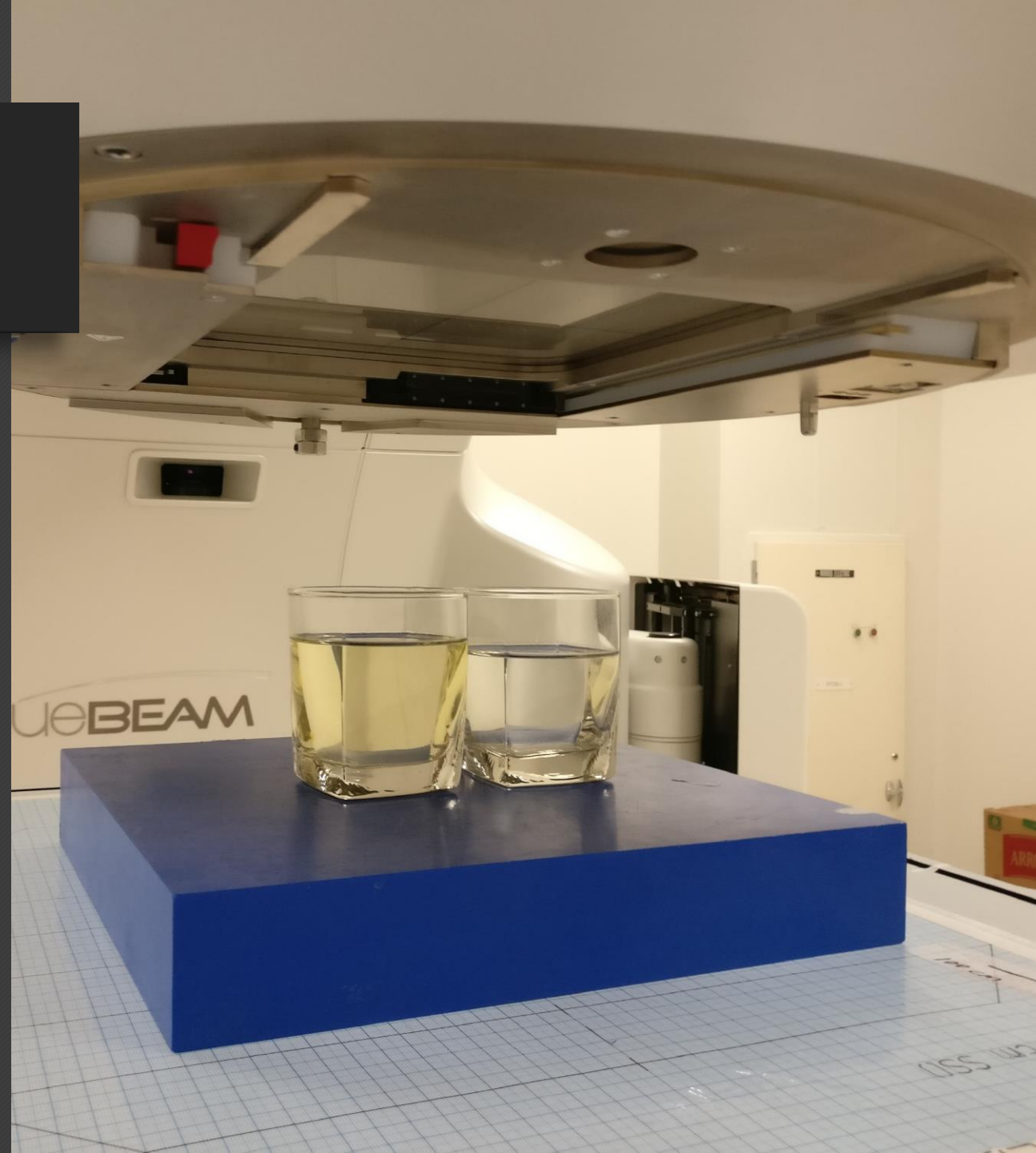
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Background

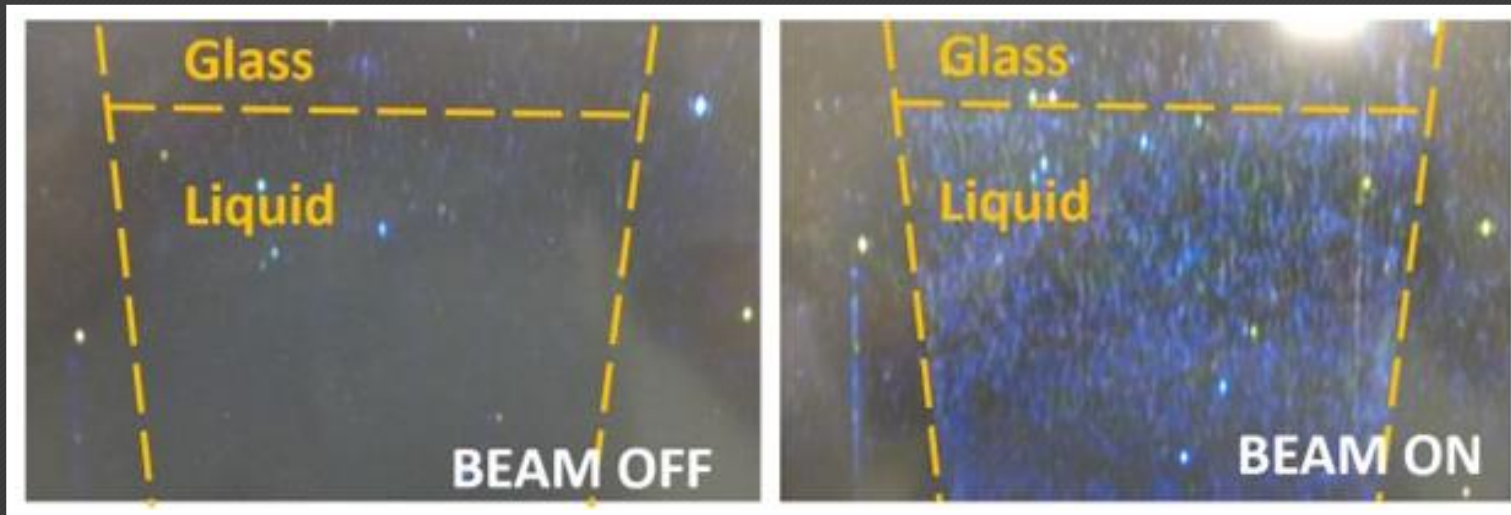
- Some materials fluoresce or scintillate when irradiated
- Fluorescence / scintillation / luminescence has been seriously explored for many applications
 - Beyond the commonly known, there are exciting things like 3D dosimetry using a plenoptic camera and a plastic $10\times 10\times 10$ cm³ cube (Goulet et al.)
- We wanted to explore liquid solutions, and were familiar with tonic water (ft. quinine) and cooking oil (ft. polycyclic aromatic hydrocarbons)

Experiment One

- Two glasses:
 1. peanut oil
 2. tonic water
- We covered bunker light sources with old radiographic film packets
- Treatments delivered
 1. Square fields
 2. Thin sliding window (2 cm)
- Treatments delivered using 6FFF at highest dose rate (1400 MU/min)
- Two consumer grade cameras in bunker



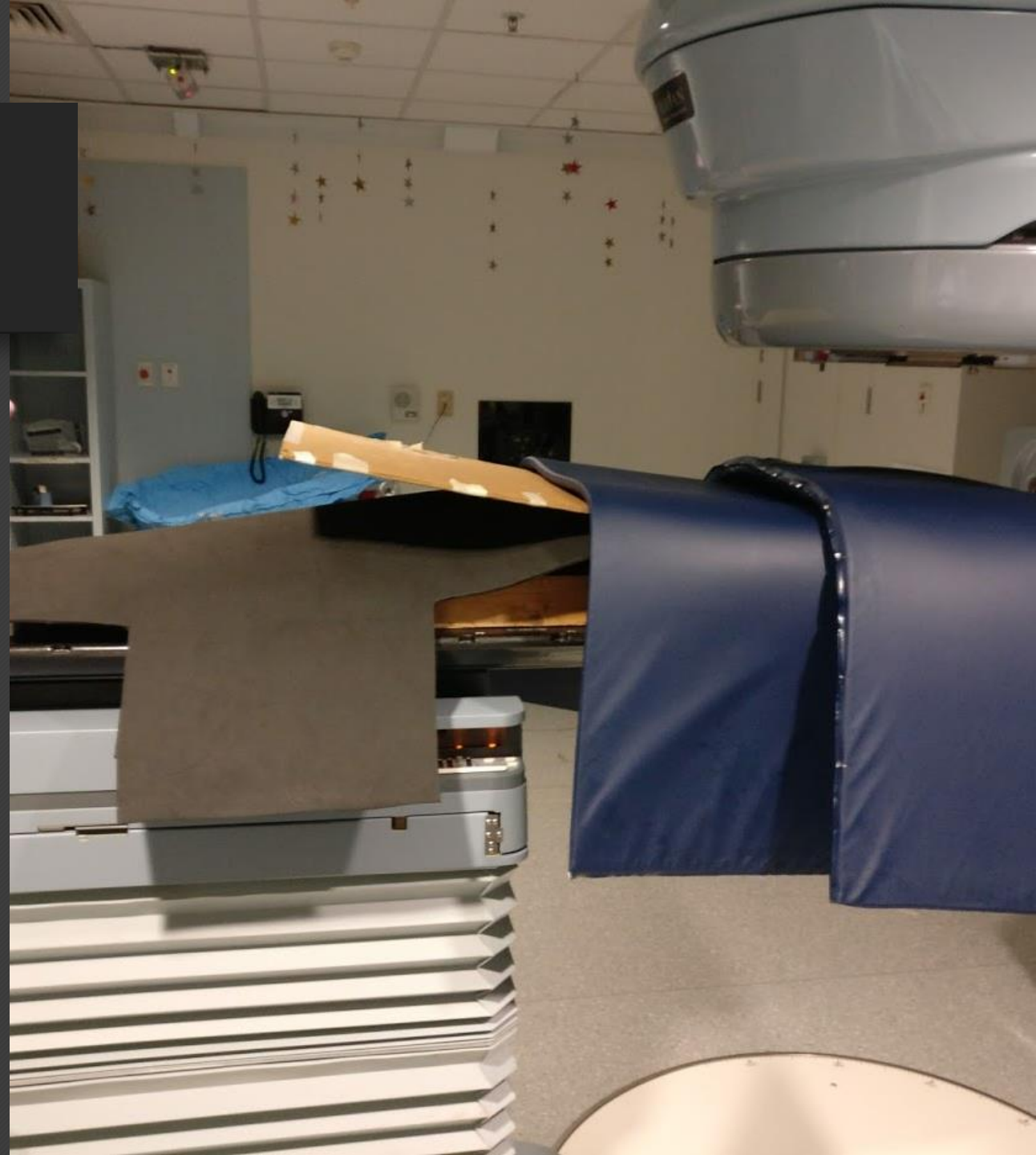
Experiment One



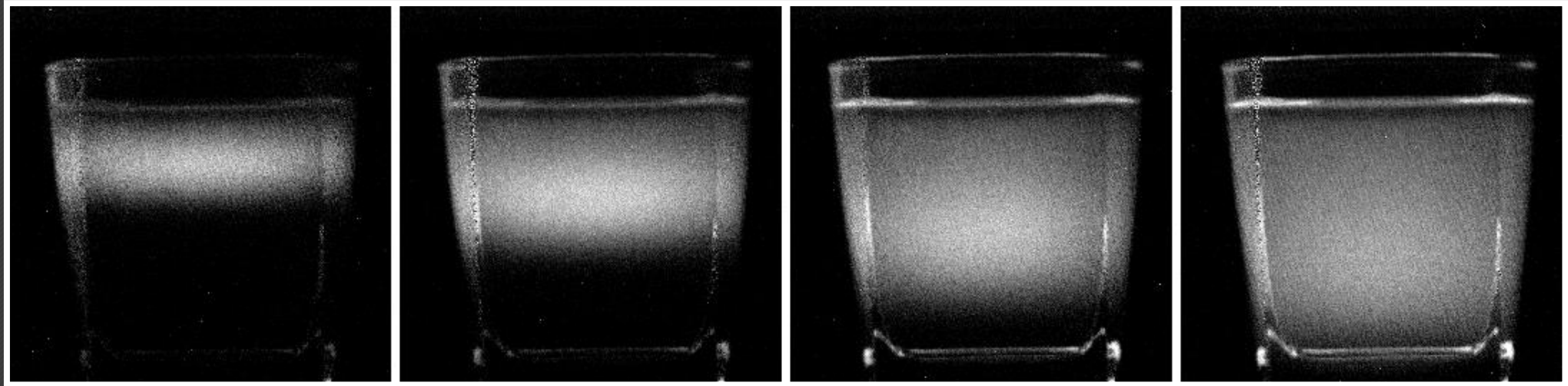
Fluorescence captured on Varian treatment room monitor screen
(in turn captured on mobile phone)

Experiment Two

- Nothing was detected on the consumer grade cameras, but we observed collimation and dose rate effects
- We decided to use a scientific low light CCD camera and do a better job at removing light
- Experimental arrangement was covered with miscellanea from bunker
- Dark image was subtracted from acquired images
- Delivered square fields to tonic water
- No FFF beams this time ☹️

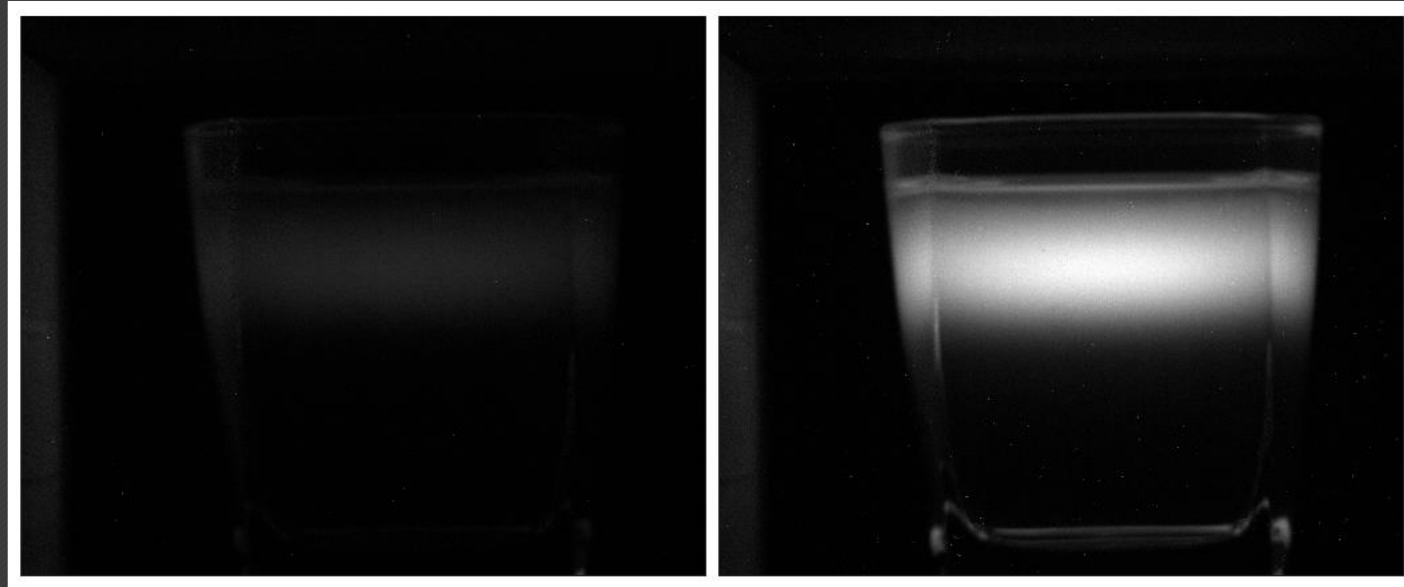


Experiment Two



Electron beams with energies of 6, 8, 12 and 15 MeV

Experiment Two



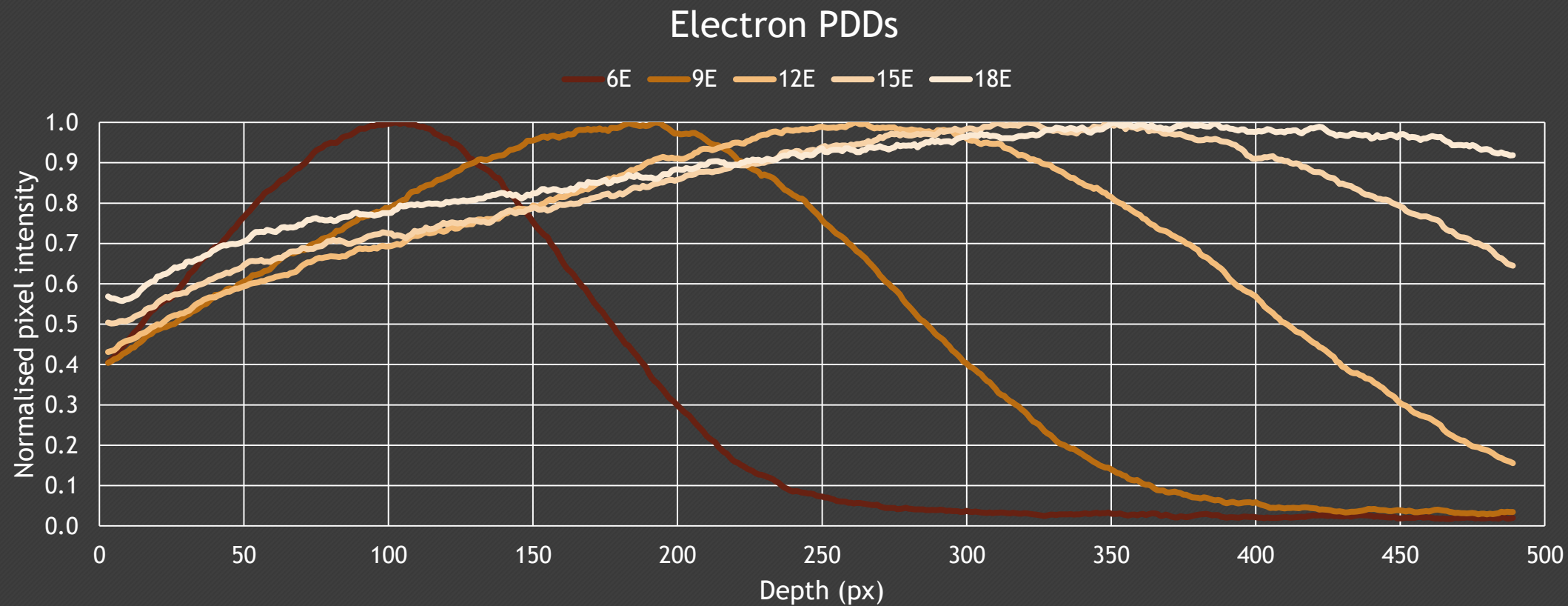
400 MU/min and approx. 2000 MU/min dose rates (same windowing)

Experiment Three

- Adjusted experimental setup, improved darkness with constructed frame and thick cloth, controlled 2 second exposures, round gel container (i.e. used for optical imaging) used instead of drink glasses
- Electron deliveries at 400 MU/min
- HDR electrons at ~2000 MU/min
- Photon deliveries at 600 MU/min
- Sliding window IMRT field delivered

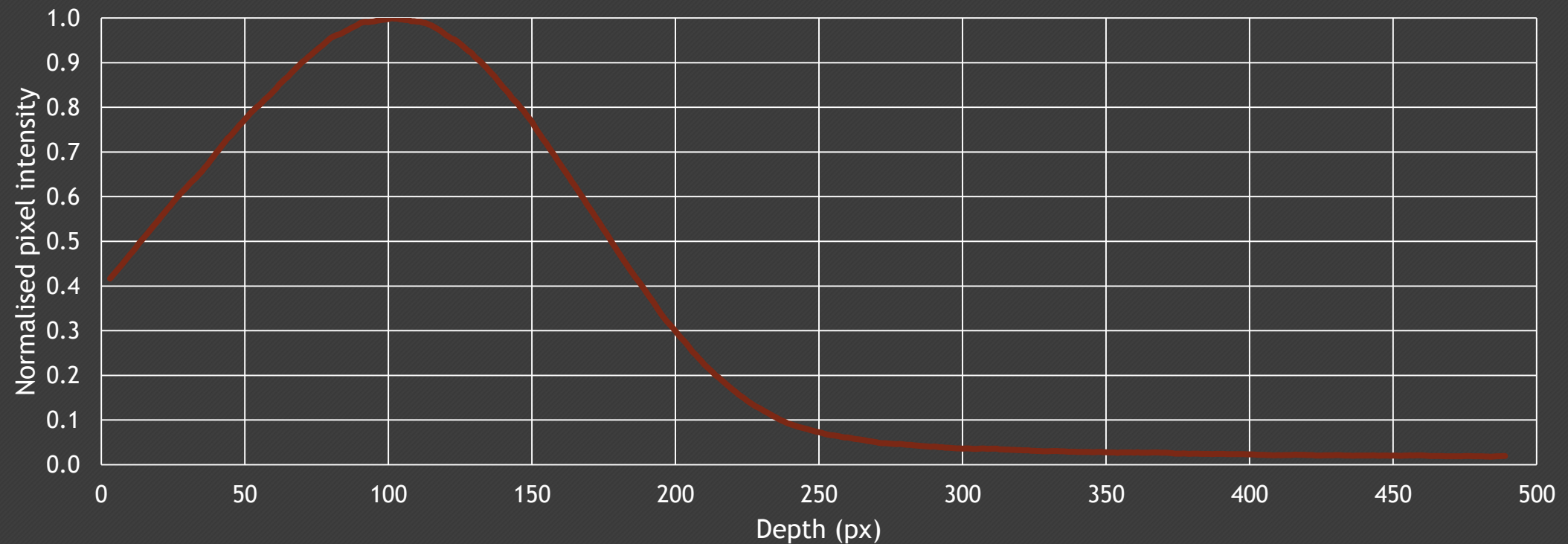


Experiment Three



Experiment Three

High dose rate 6E PDD



Experiment Three



- 6X IMRT sliding window treatment, delivered at 600 MU/min
- The GIF presented to the left has had brightness & contrast modified, and frame rate doubled

Discussion

- Energy dependence was observed for both photons and electrons
- Approximately linear response (will be further verified)
- Calibration question not yet answered
- Bit depth and sensitivity of our low-light camera arrangement is not sufficient for high precision dosimetry purposes, prohibiting quantitative analysis except for highest dose rates
 - Camera allowing smaller focal lengths and increased bit depth to be borrowed from QUT
- Stray radiation can be easily filtered using thresholds

Utility

- 6E high dose rate data has reasonable signal-to-noise; so there is potential to quickly check energy or collect (noisy) beam data. Typical beam data collection for this energy is complicated by ozone production.
- Tomographic reconstruction of 4D dose delivery for IMRT fields, by using collimator rotation.
- Measurement of dose in the build up region

Appendix 😞: Unsuccessful attempt at another 'arty' (or perhaps 'crafty') dosimeter



Radiation Colourimetry

- I didn't make up this word! Colour dosimetry (also known as chromoradiometry) was at one point in history, the standard method by which a dose of therapeutic radiation was verified.
- Colourimetry solutions:
 - Erythema dose
 - Holzknecht pastilles (potassium chloride + sodium carbonate)
 - Sabouraud pastilles (barium platinocyanide)
 - Kiebock strips (silver bromide)
 - Cellulose triacetate (i.e. photographic film)
 - and CELLOPHANE

Blue cellophane

- Radiation has bleaching effect
- I had ambitions - poster prize!
cellophane used for wrap tests!
- Unfortunately this was never going to work as blue cellophane was used for radiation processing (i.e. kG) - but we tried it anyway
- Finding real cellophane was difficult - most 'cellophane' is 'cello' and uses polypropylene, not cellulose
 - FYI: Cellophane dead-folds, cello doesn't

