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Dosimetry calibration of radiochromic film used to detect laser accelerated protons

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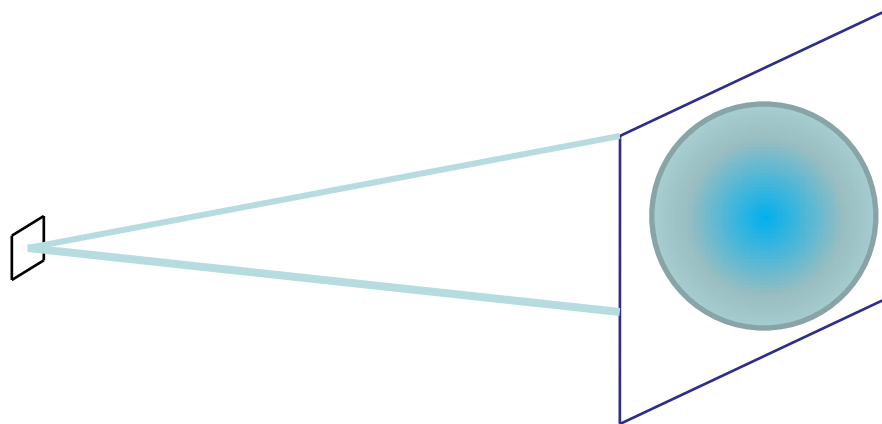
3. University Hospitals Birmingham

Laser ion beam diagnostic workshop, August 2010



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Radiochromic film



- high spatial resolution
- good spectral resolution
- instantaneous data, no post-processing needed

Calibration

RCF exposed to known source of radiation
(monoenergetic ion beam)

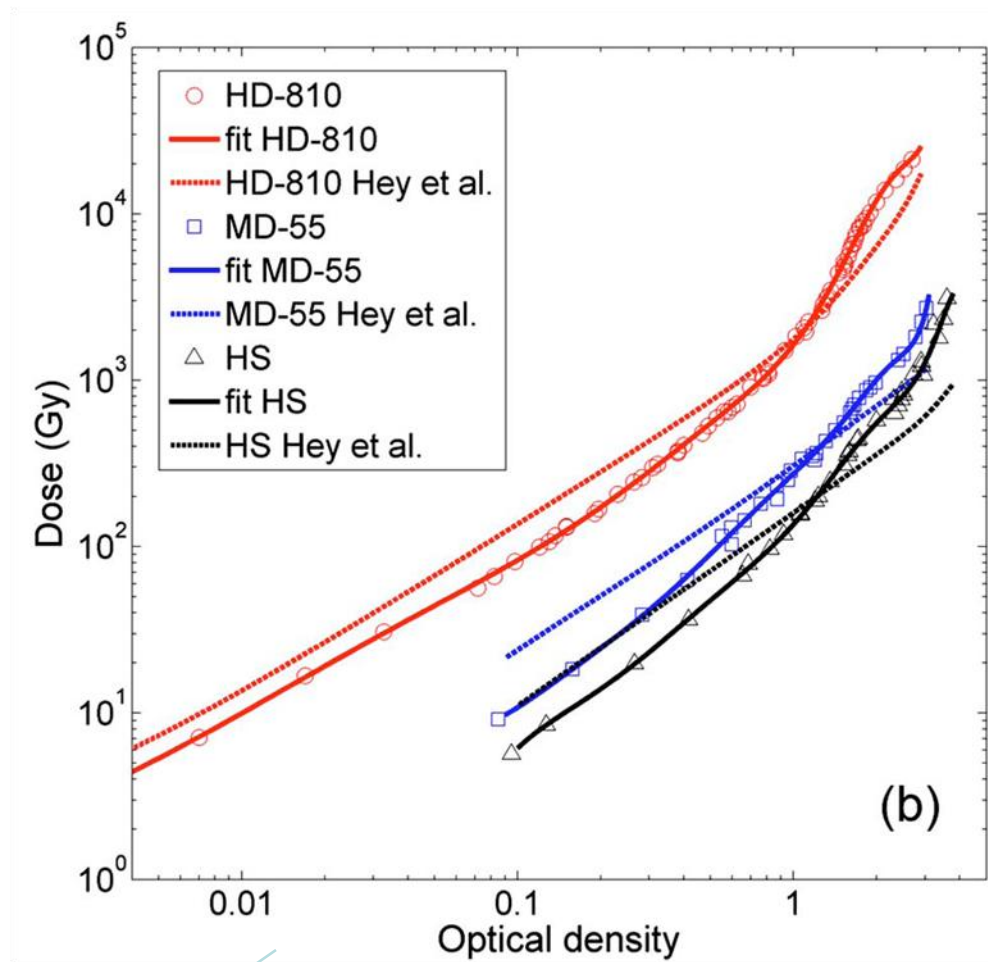


RCF scanned and the signal translated into optical
density (OD) of the exposed film



Calibration curve formulated:
Dose = f (optical density of RCF)

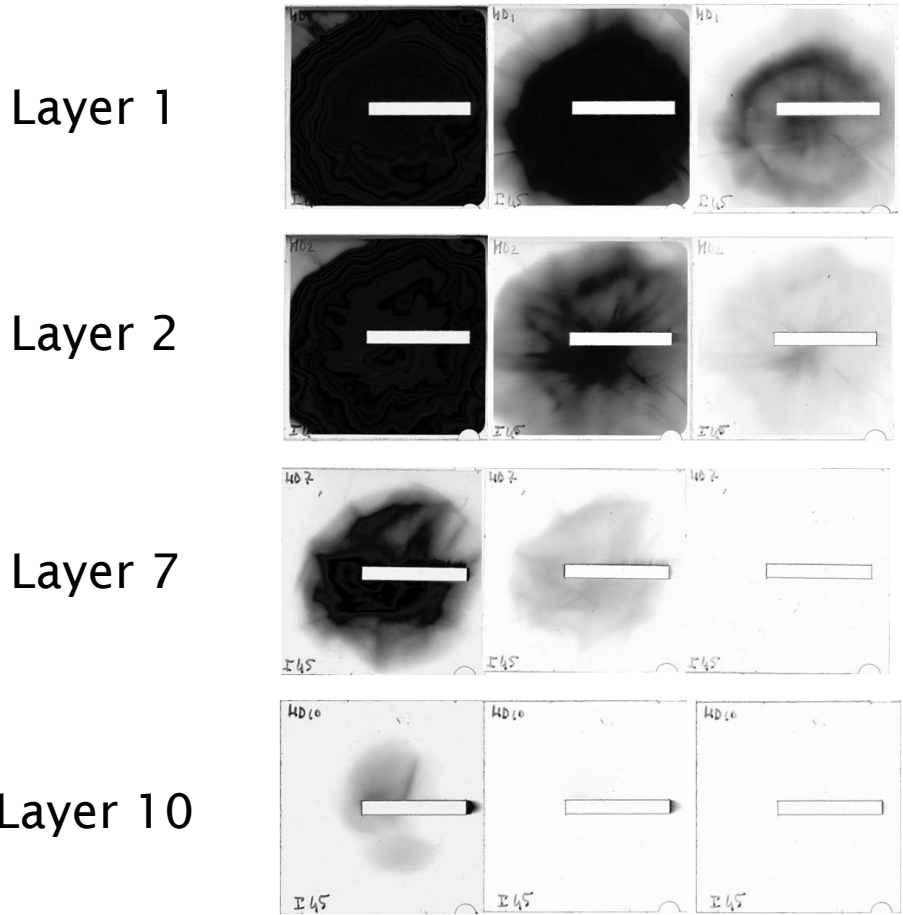
Nürnberg et al. In Rev.Sci.Inst. 80 (2009)



Evaluated using greyscale scans

Colour scale scans

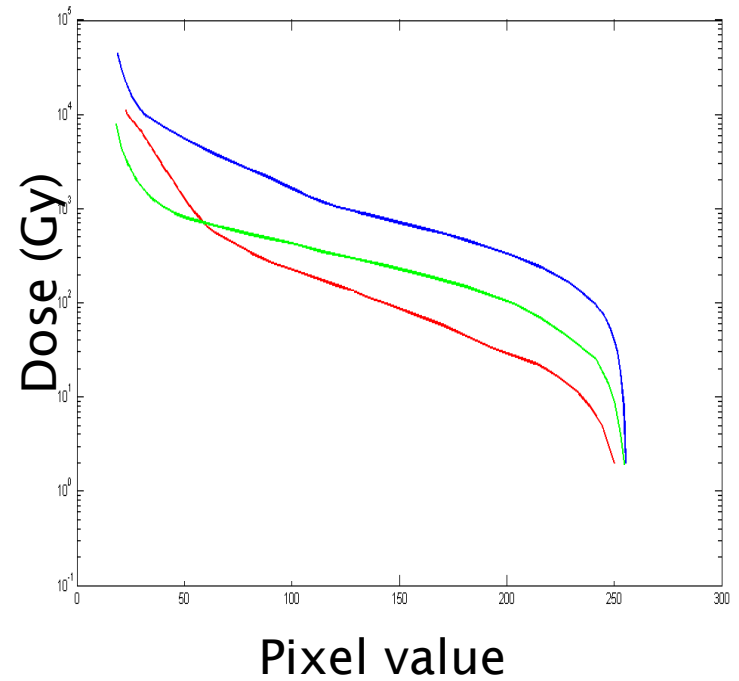
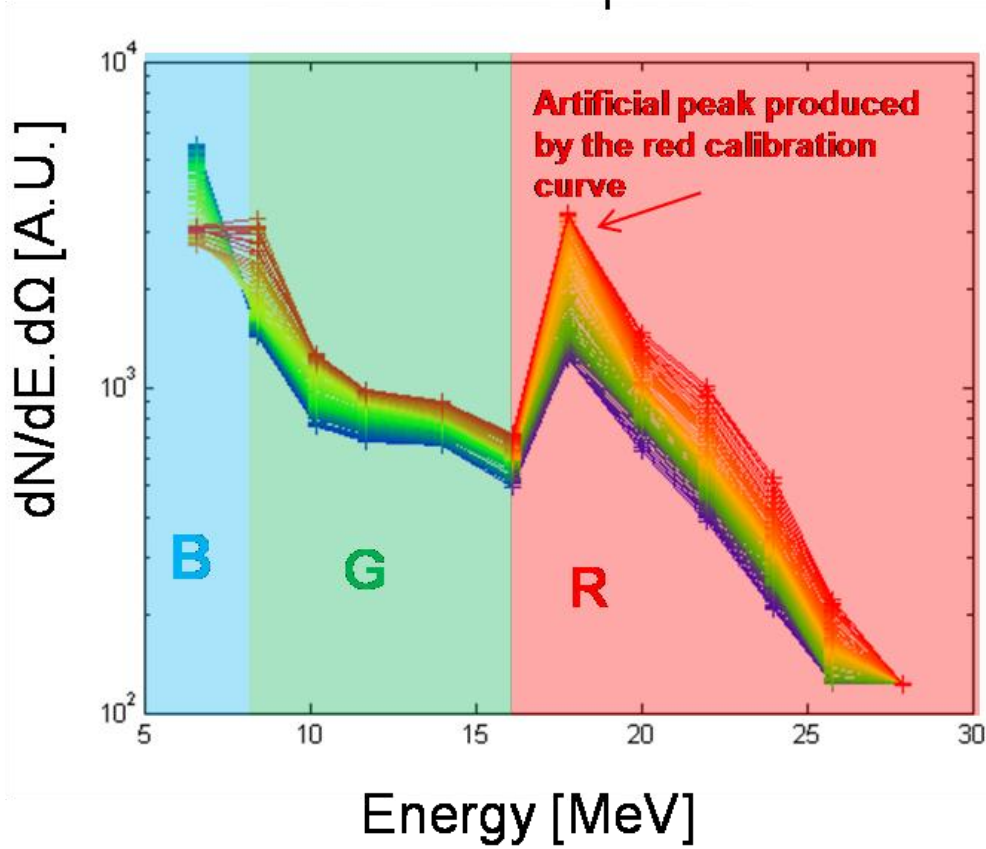
Red Green Blue



- Analysing the images in the separate colour channels; red, green and blue (RGB)
- Seems to increase the dynamic range over which signal can be detected

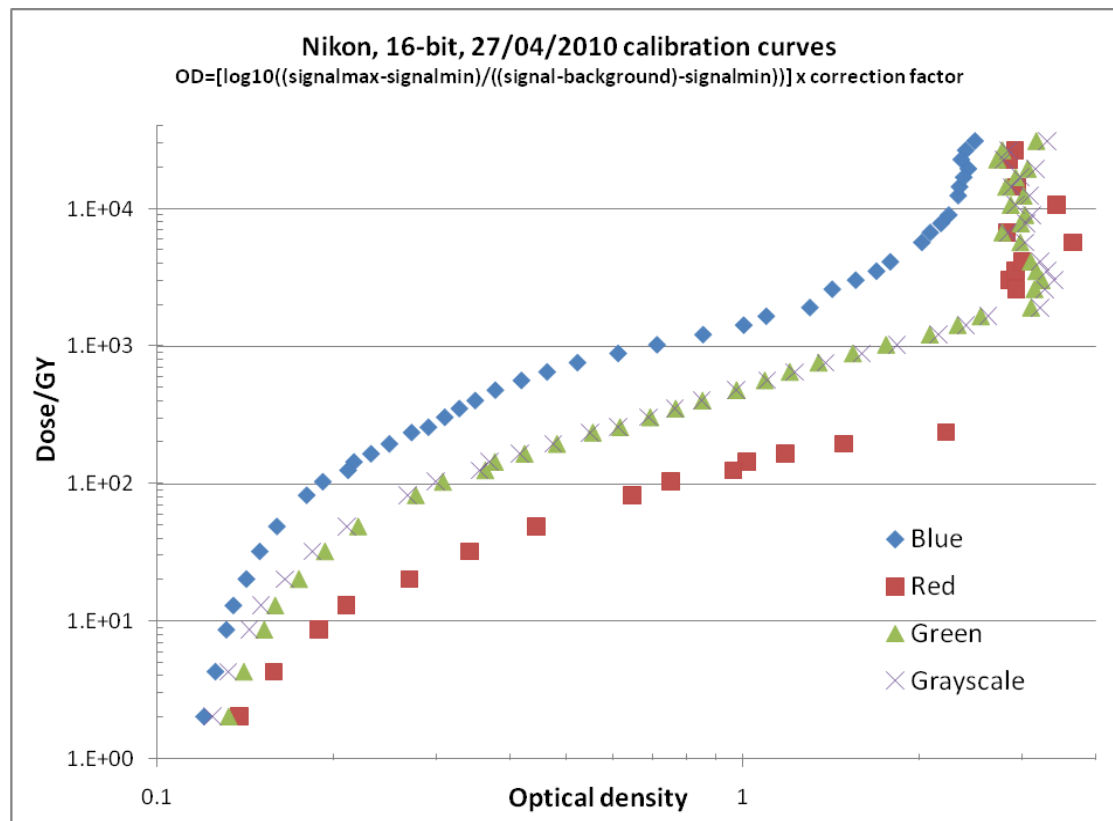
RGB calibration curves

Uncorrected spectrum



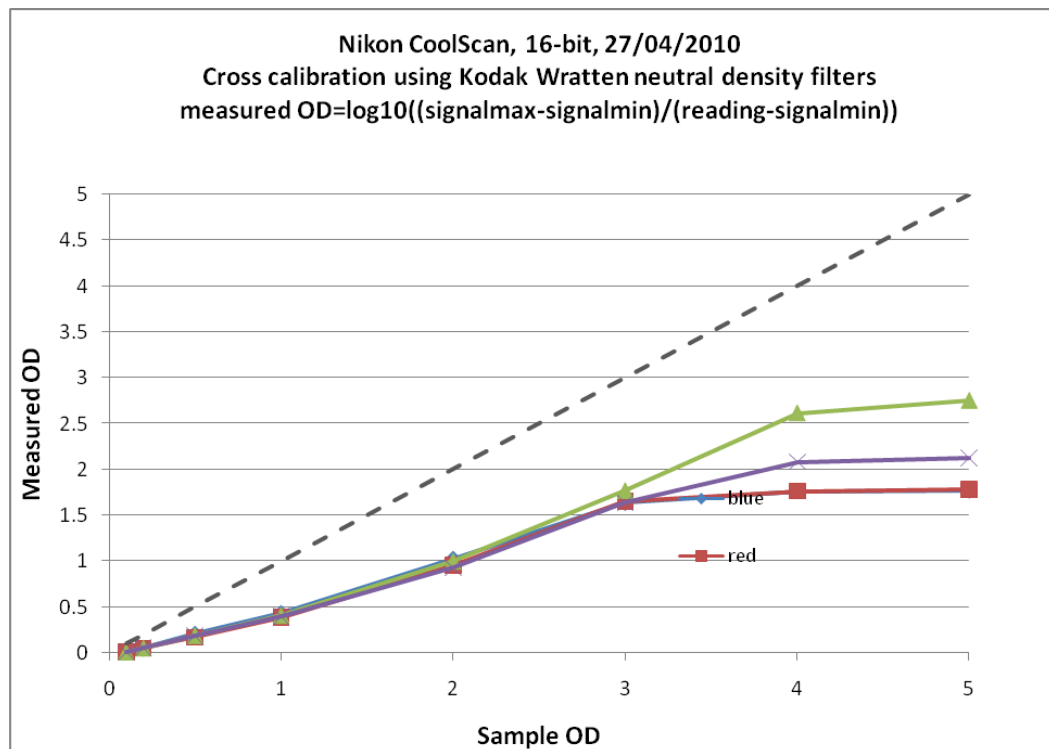
Reconstruction of RGB calibration curves

- Using Nikon CoolScan 9000 and HD-810 film
- RCF layers were irradiated with proton beams with doses from 2.04Gy to 3.12×10^4 Gy using the University of Birmingham's cyclotron



Cross calibration

- Used Kodak Wratten neutral density filters to find that measured OD was less than true OD value
- Correction factors were very different for different scanners and for scanner bit-depth settings



RGB analysis versus greyscale

- RGB colour-scale scans provide better sensitivity and range of proton energies that are measurable
- Red channel is more sensitive than the greyscale channel up to ~ 2 Gy
- At > 1.5 kGy, greyscale channel reaches saturation
- Blue channel has a good response up to 10 kGy

Worth noting

- Cross calibration of every scanner is required for accurate results
- Anomalous behaviour with red channel at > 200 Gy (damage of chemical component of RCF at high doses?)
- Specification overestimates the bit-depth capabilities of the scanner between 8-bit and 16-bit

Correct proton spectra

Corrected spectrum

