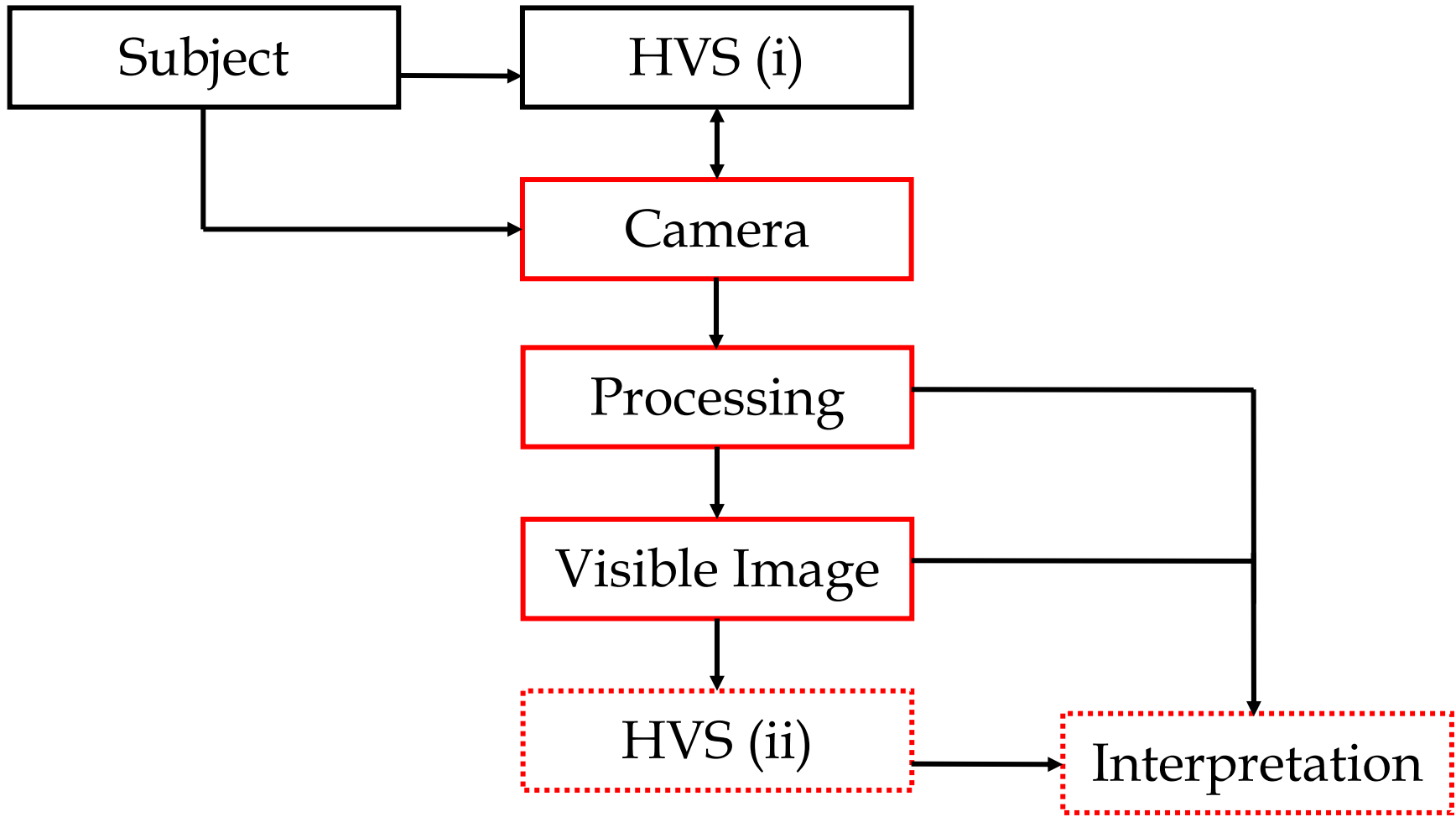


Digital and Analogue Photographic Parallels

Geoffrey Attridge, Sophie Triantaphillidou
Imaging Technology Research Group
University of Westminster

Digital Futures 2007: Visual Aspects of Imaging
Royal Photographic Society, London, 30th October 2007

Image Pathway



Tone and colour reproduction (1890s onwards)

Sensitometry

- The characteristic curve
- Speed of film
- Tone and colour reproduction

Artefacts

- Noise (graininess, granularity)
- Edge effects

Digital reproduction (1980s onwards)

Tone and Colour

- The characteristic curve
- Acceptability of reproductions

Artefacts

- Grain (noise)etc.
- Edge effects
- Contouring *et al*

Tone Reproduction

Hurter & Driffield (1890) - Sensitometry

$$D_T = \log_{10} \left(\frac{1}{\tau} \right) = \log_{10} \left(\frac{I_o}{I_t} \right)$$

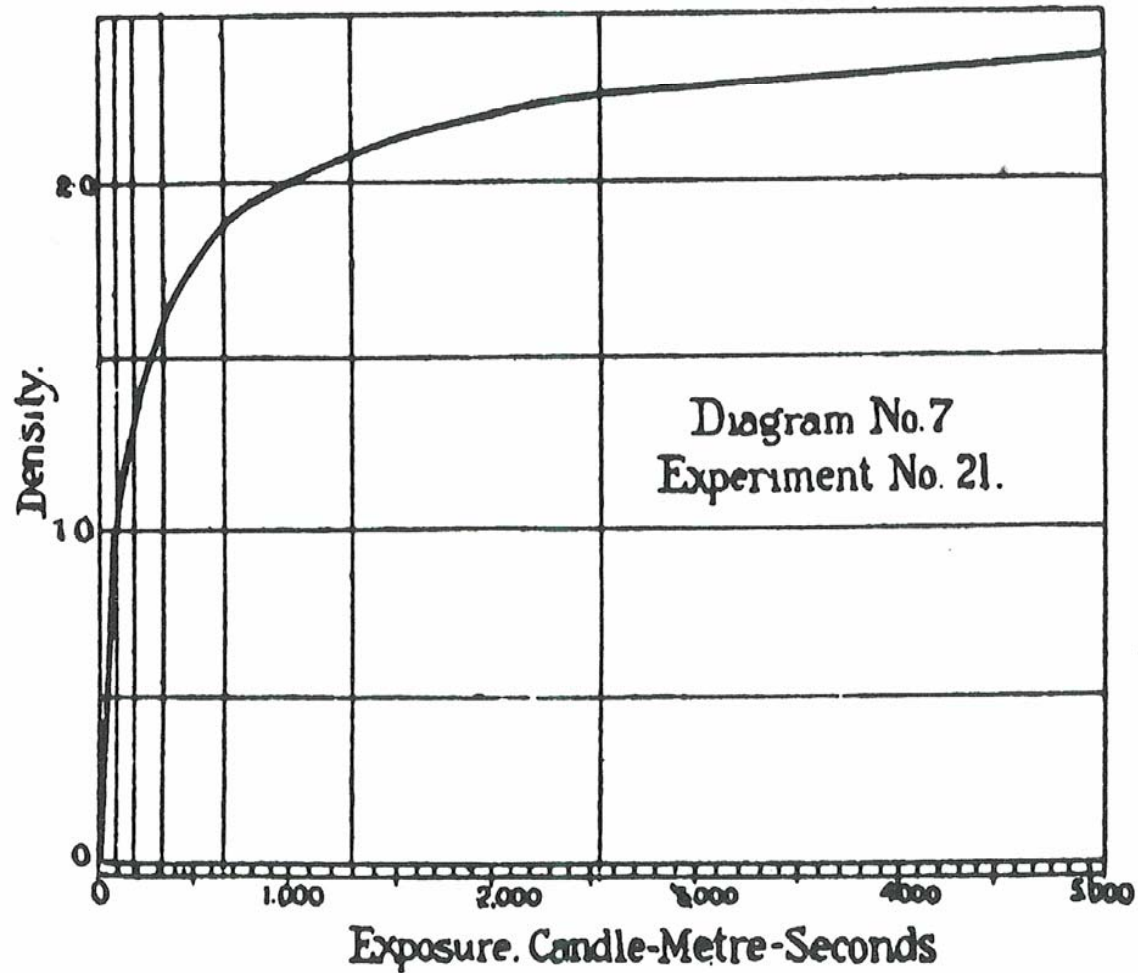
Optical density as measure of Ag image:

Density is approximately linear with the concentration of image silver present.

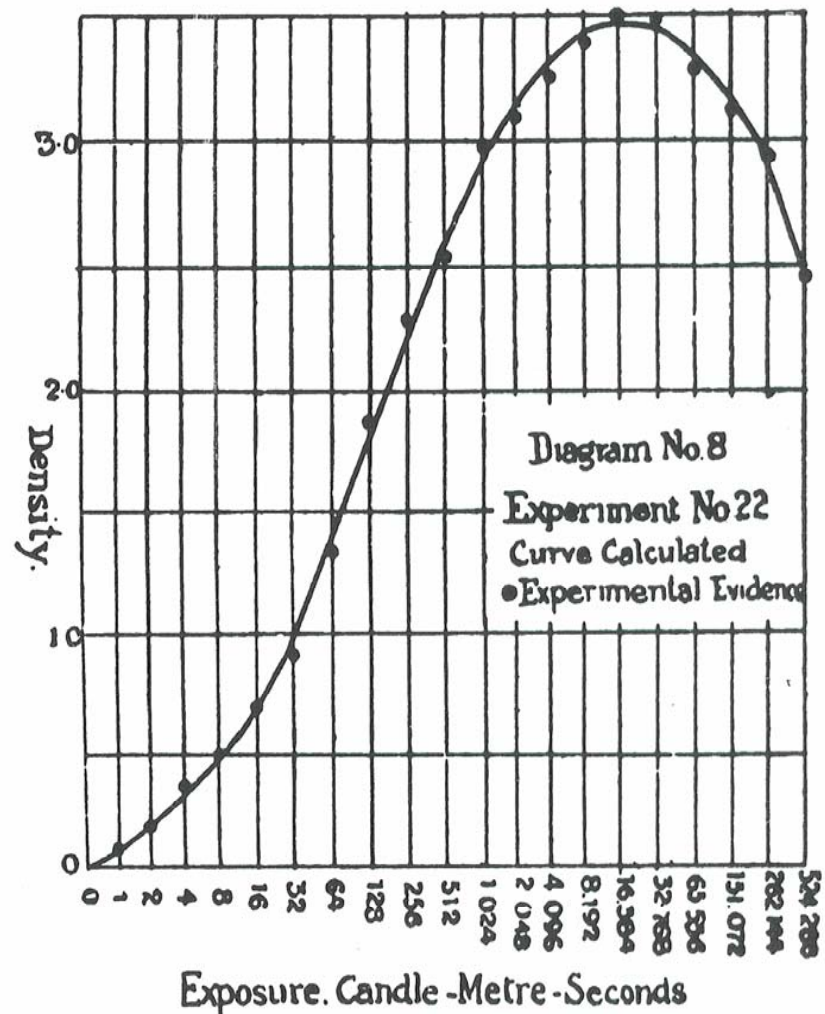
Density is approximately linear with the visual effect of the image silver present.



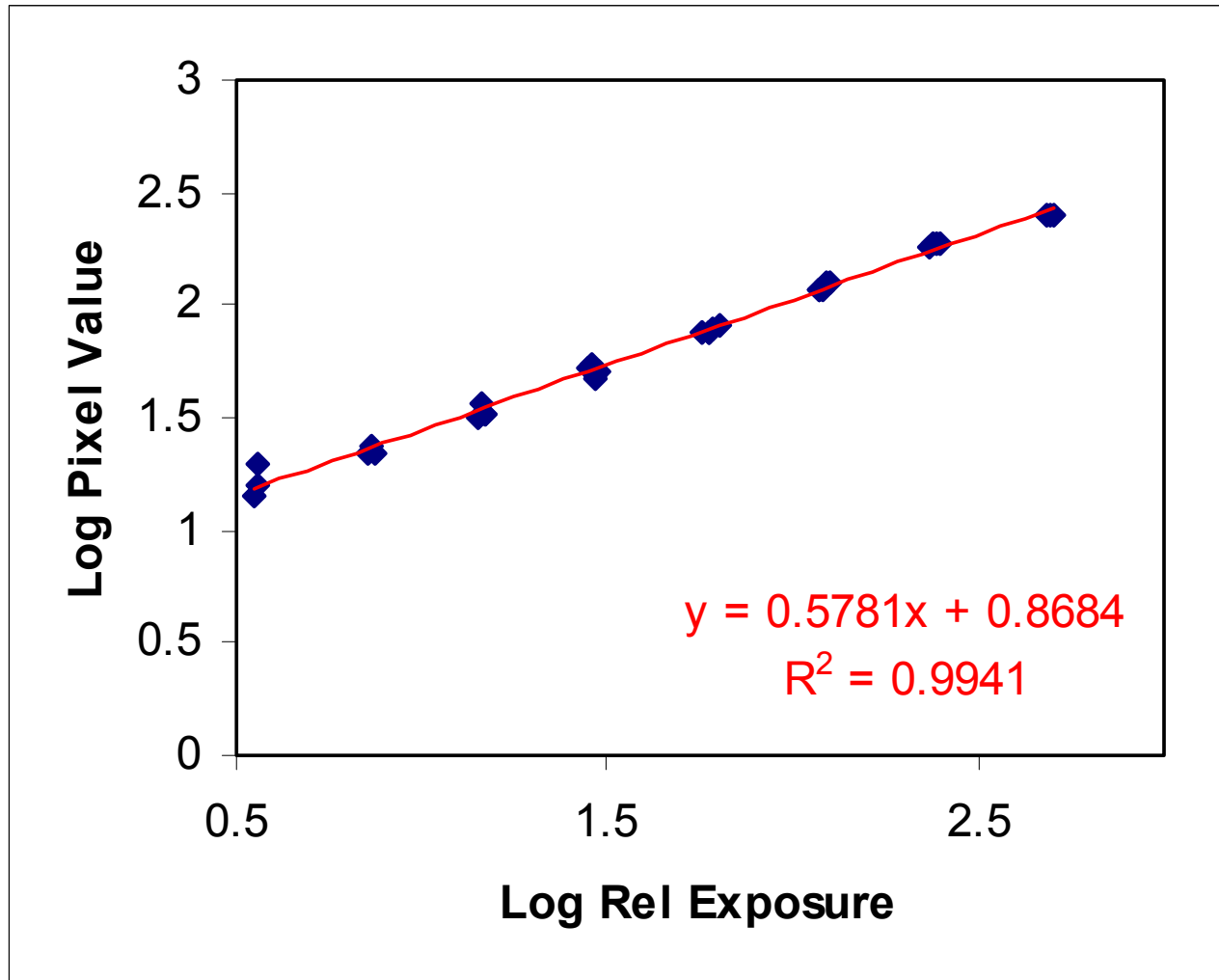
Photographic Characteristic (I)



Photographic Characteristic (II)



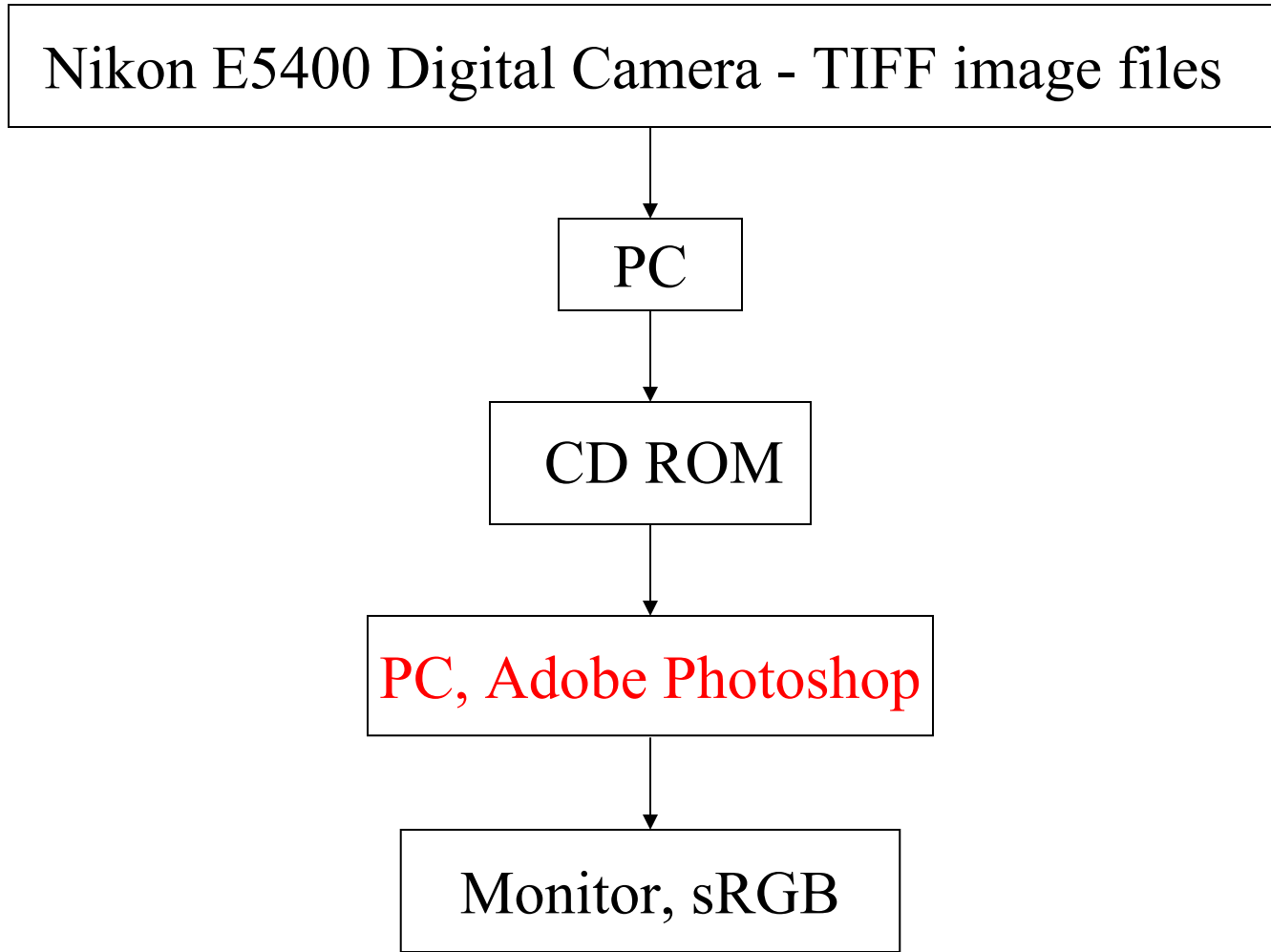
Digital Characteristic (II)



GretagMacbeth ColorChecker



Digital Route Examined



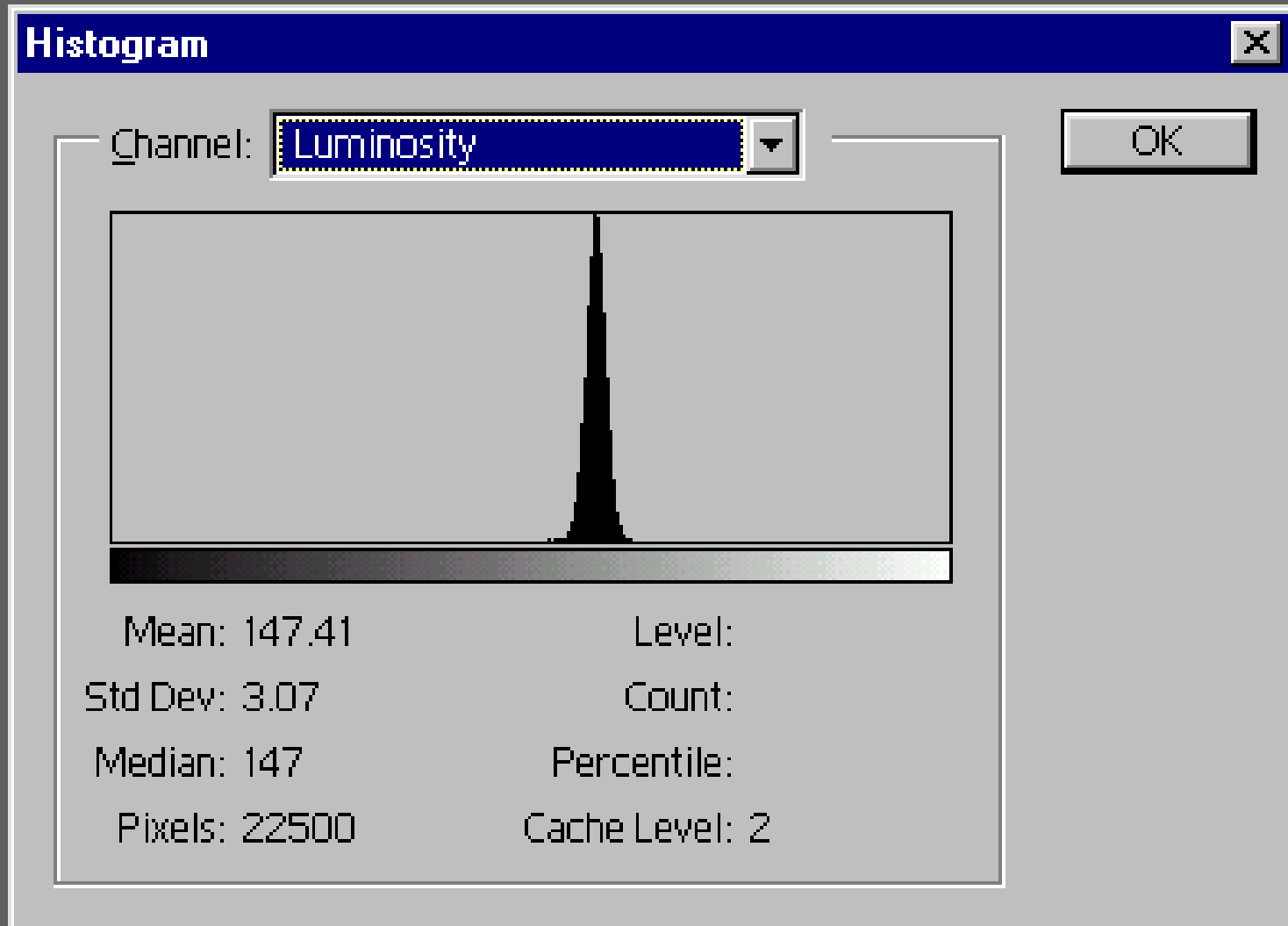
Data from images

- Image histogram gives large-area data
- Colorimetric data, CIE $u'v'$, CIELAB
- Image histogram gives small-area data

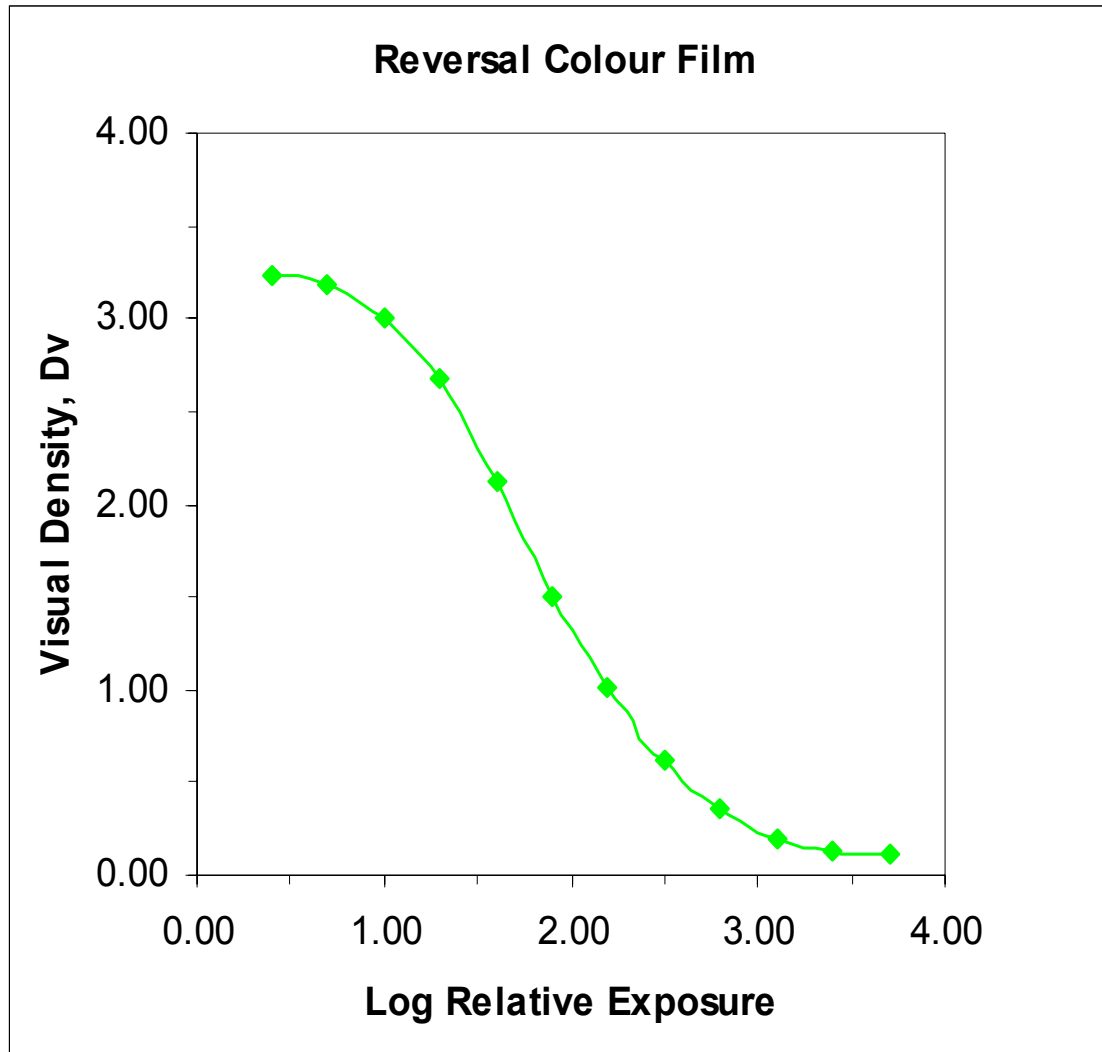
Tone Reproduction Studies

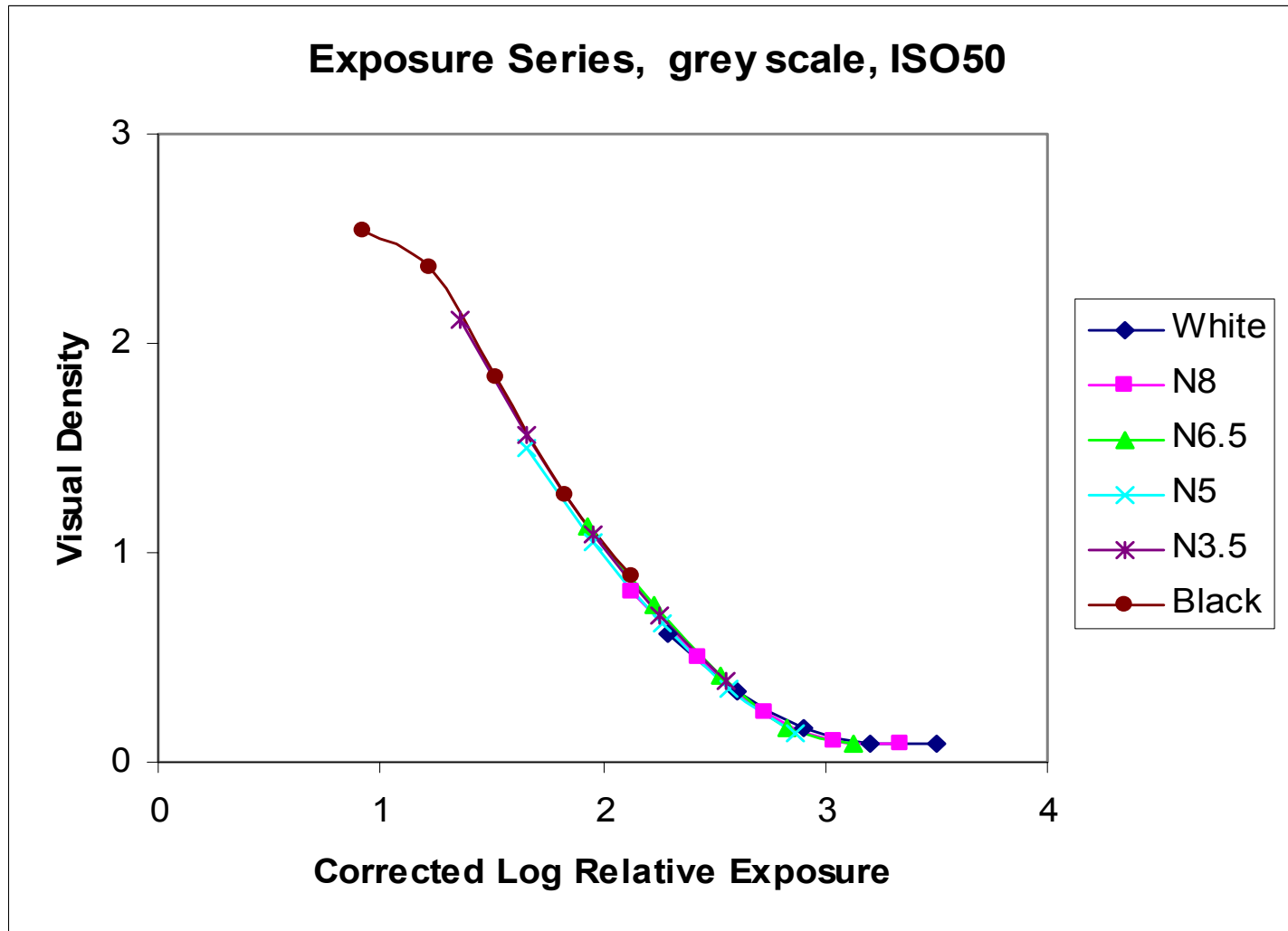


Histogram from Selected Area

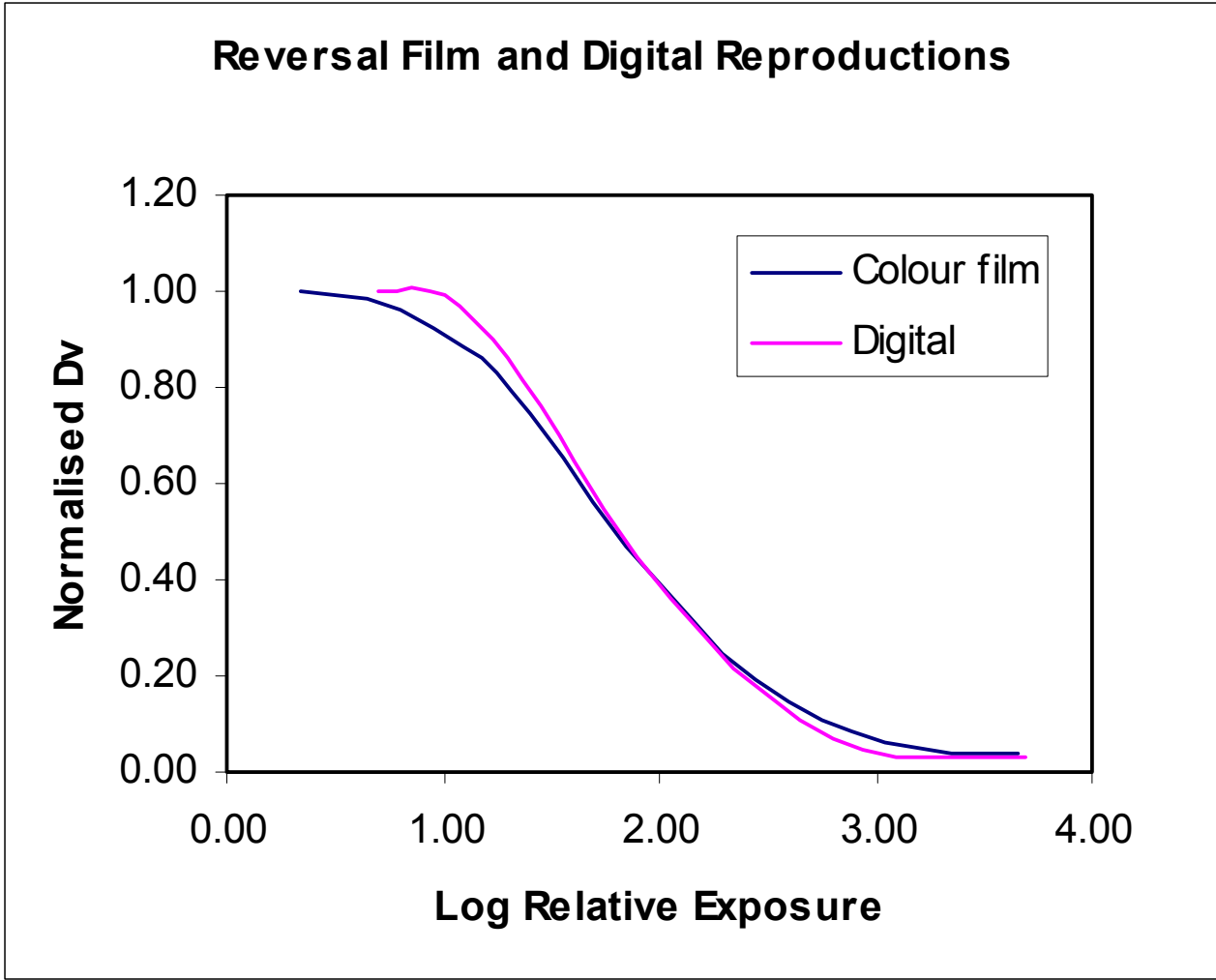


Colour Reversal Film



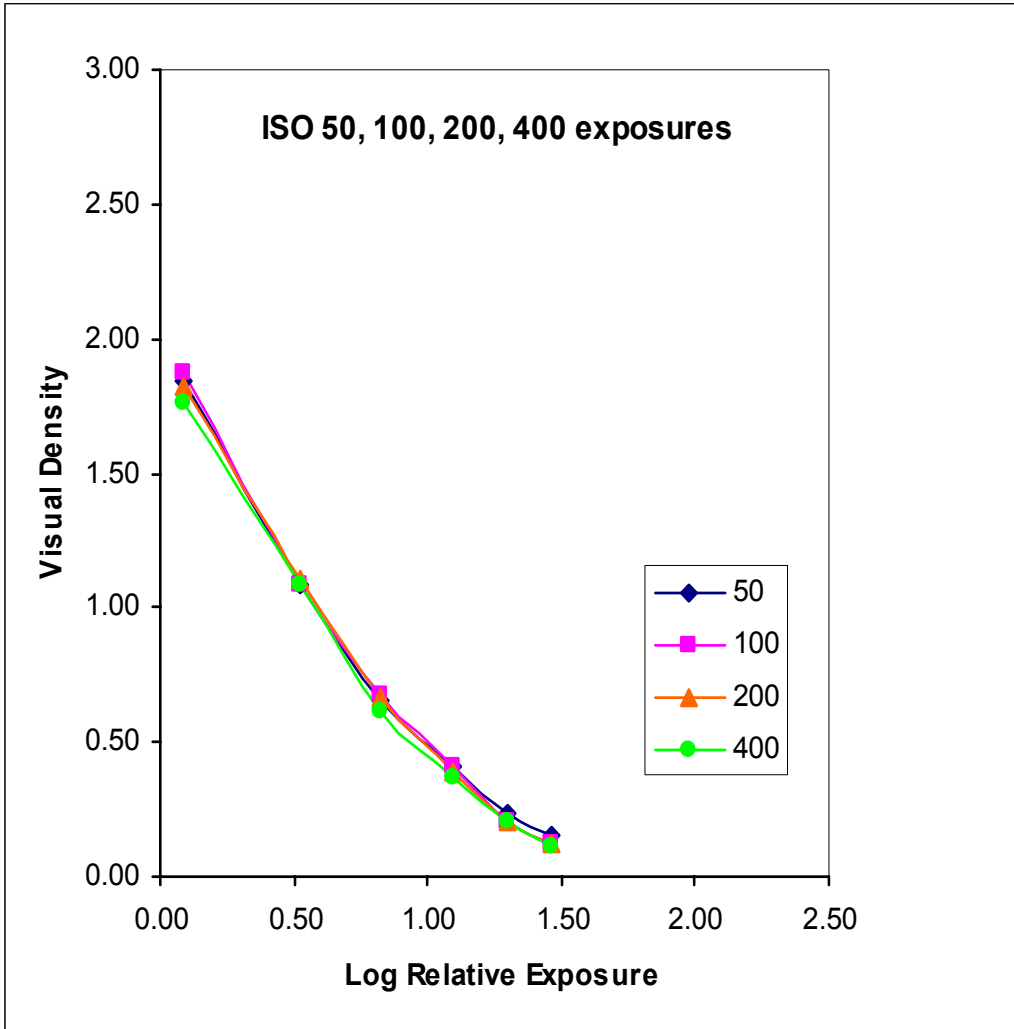


Tone Reproduction

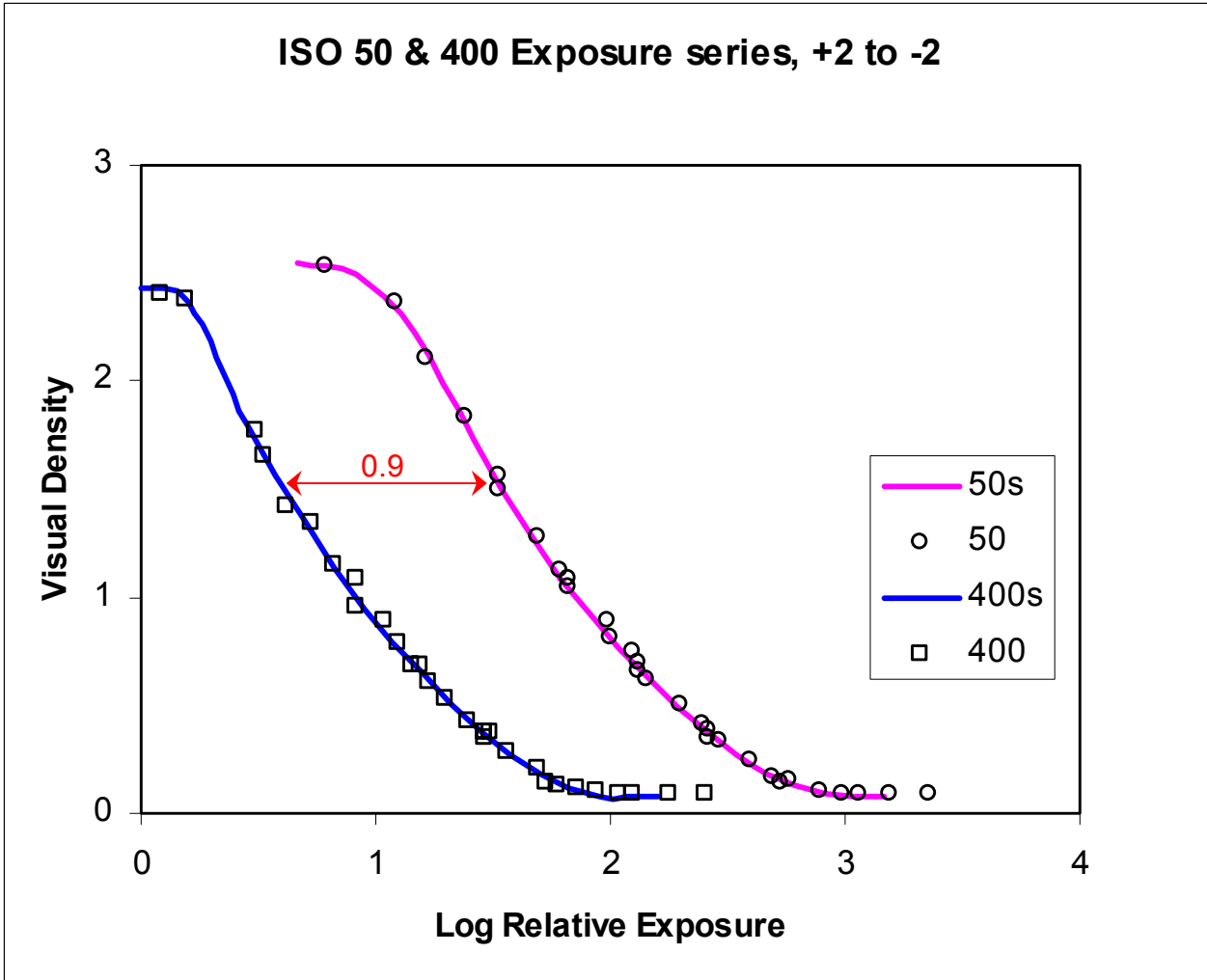




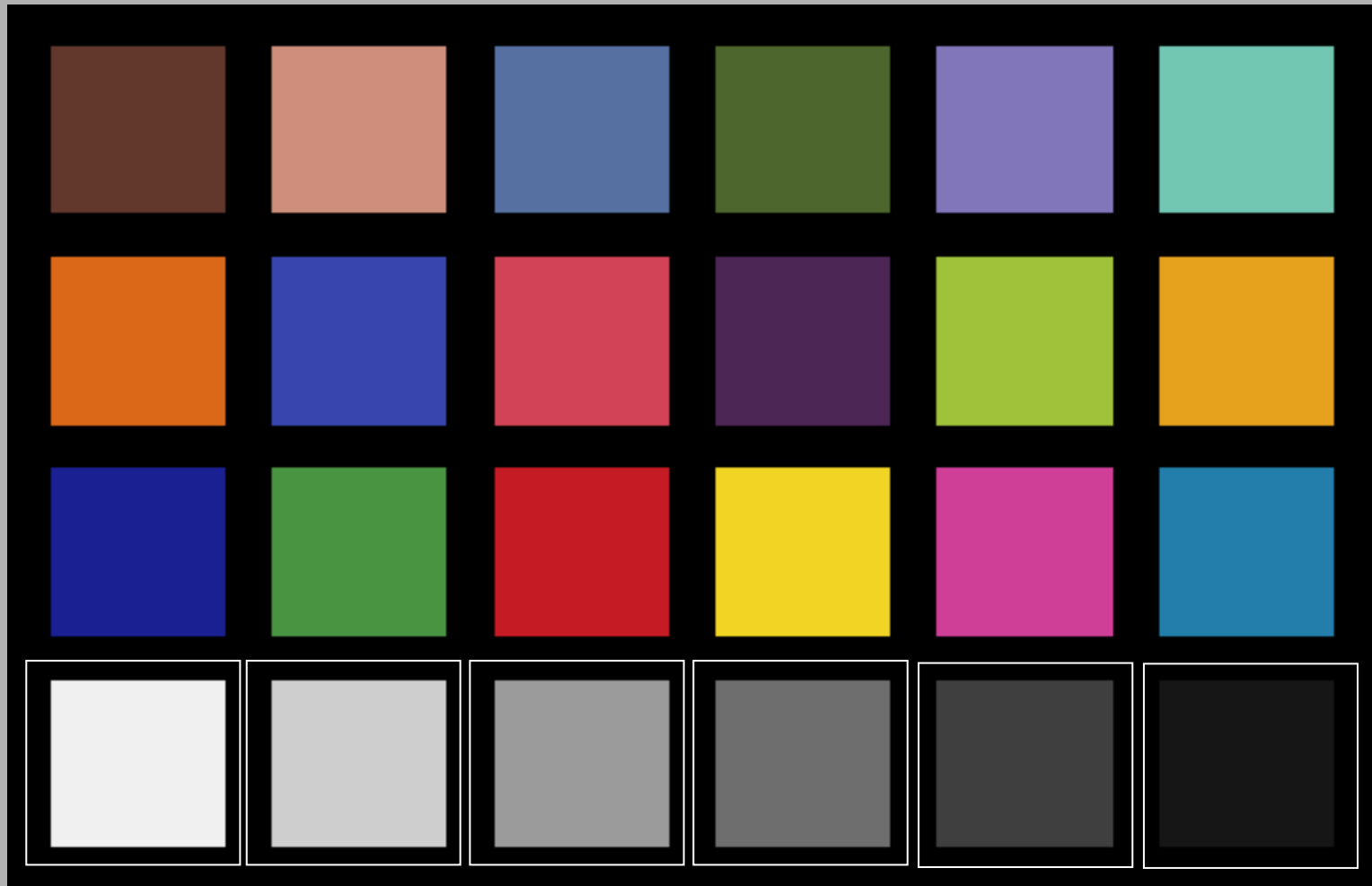
Camera TIFF to Monitor (sRGB)



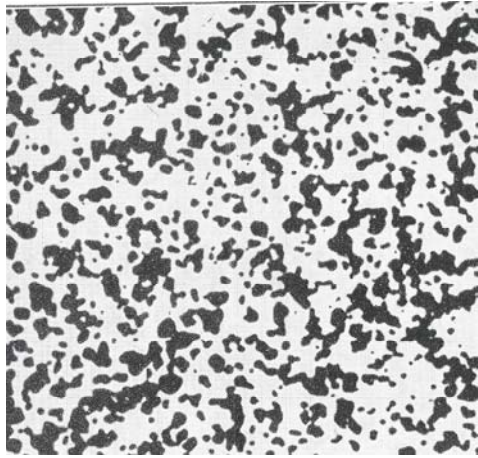
Camera TIFF to Monitor (sRGB)



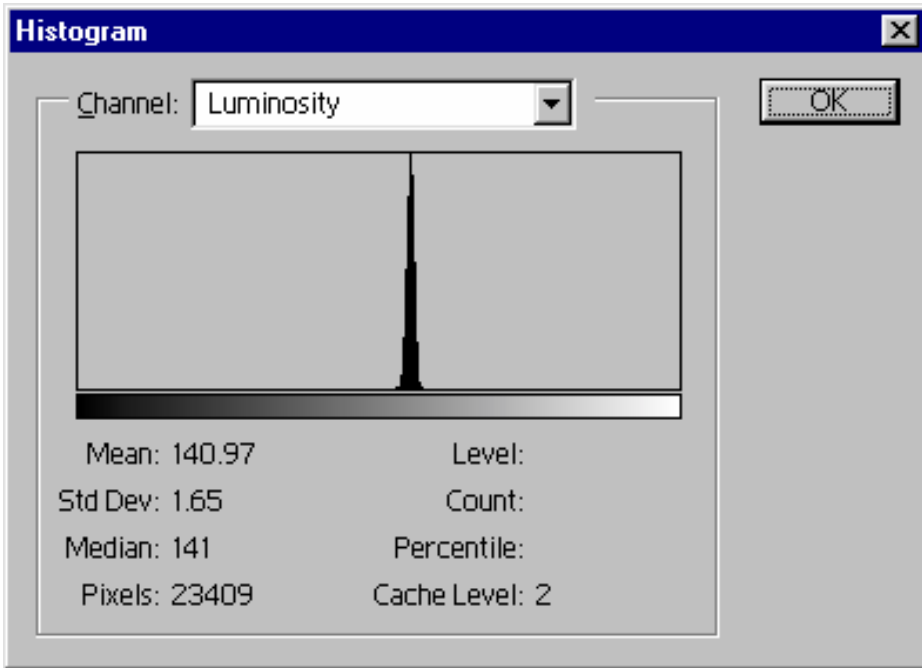
Tone Reproduction



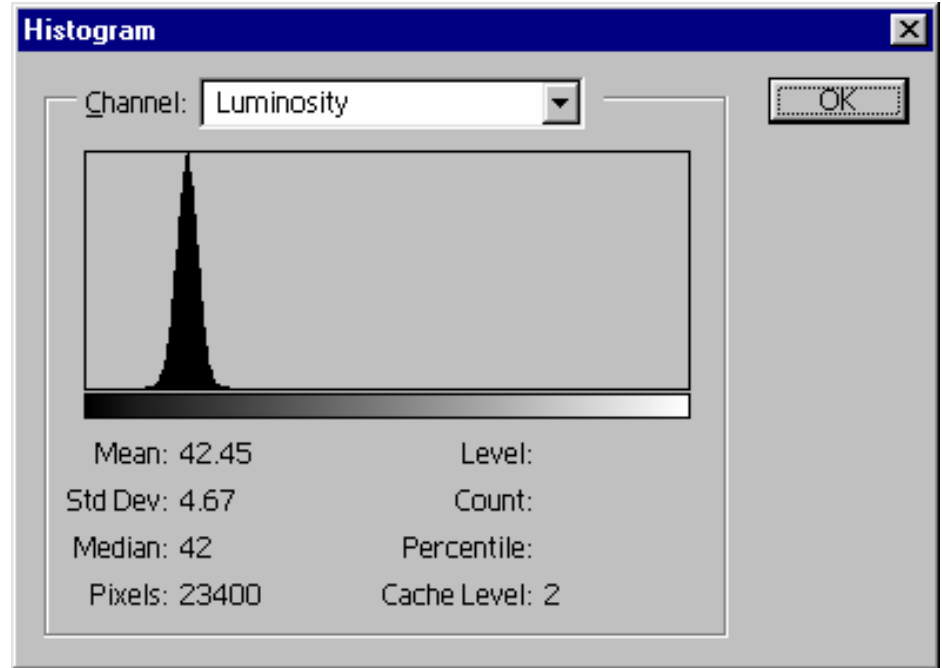
Silver and Digital Noise



Digital Noise

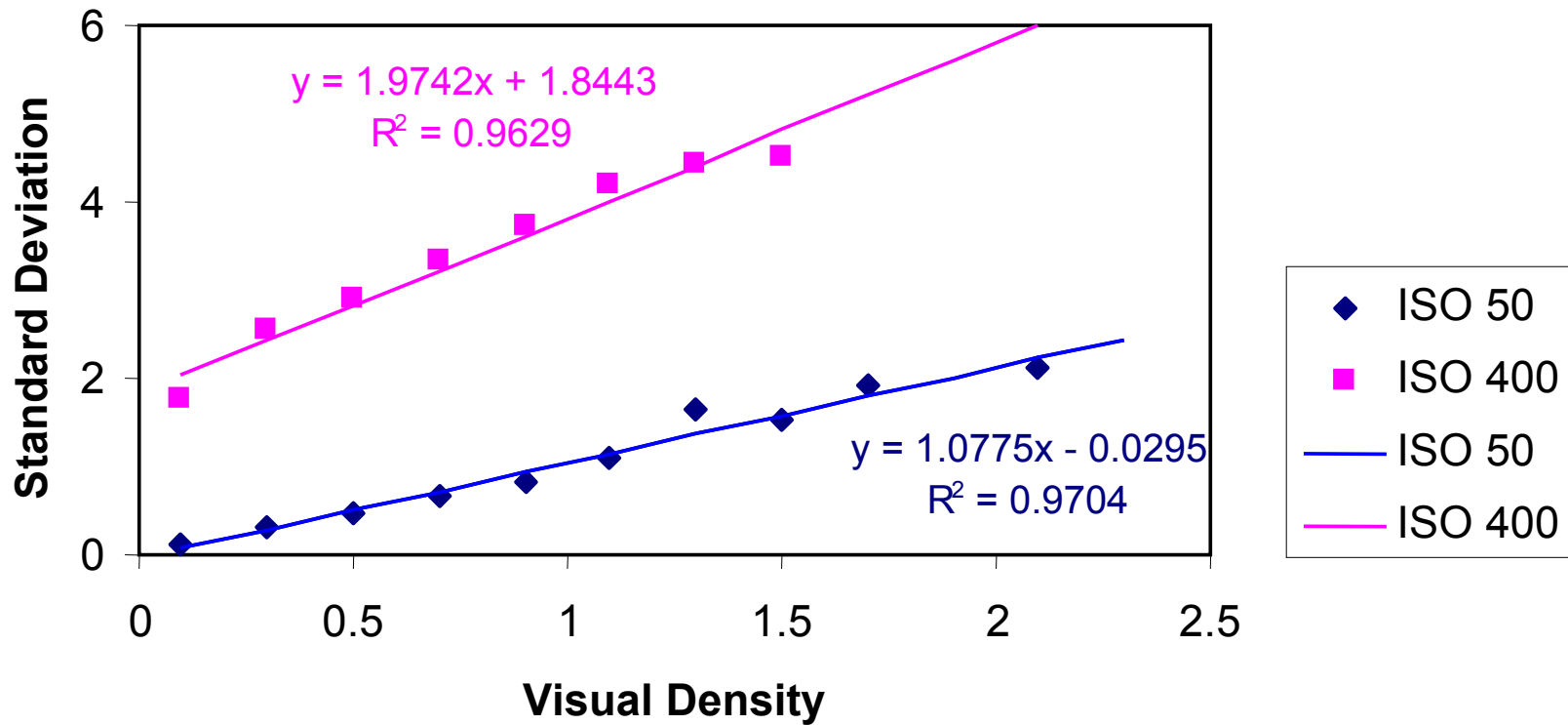


ISO50 N5

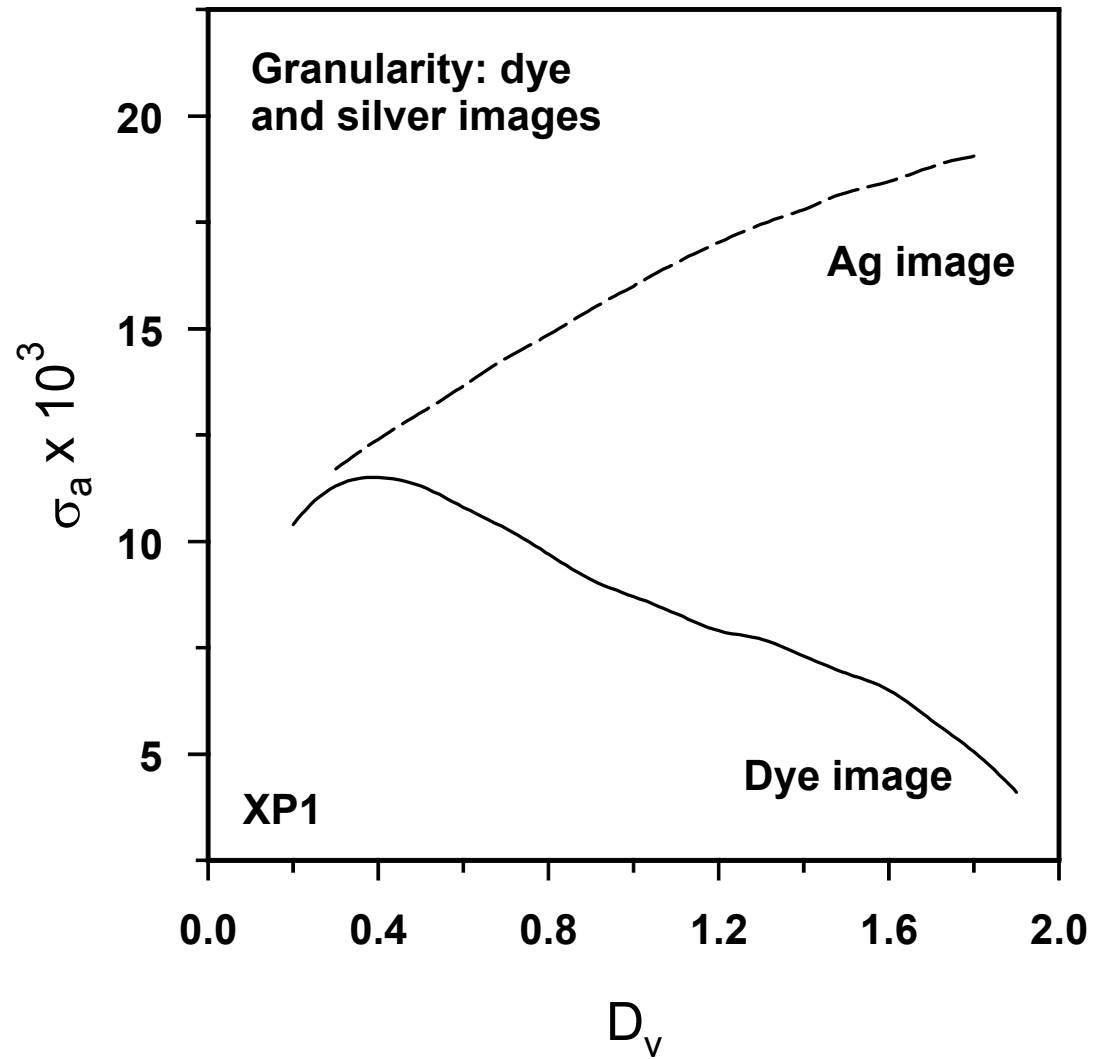


ISO1600 N8.5

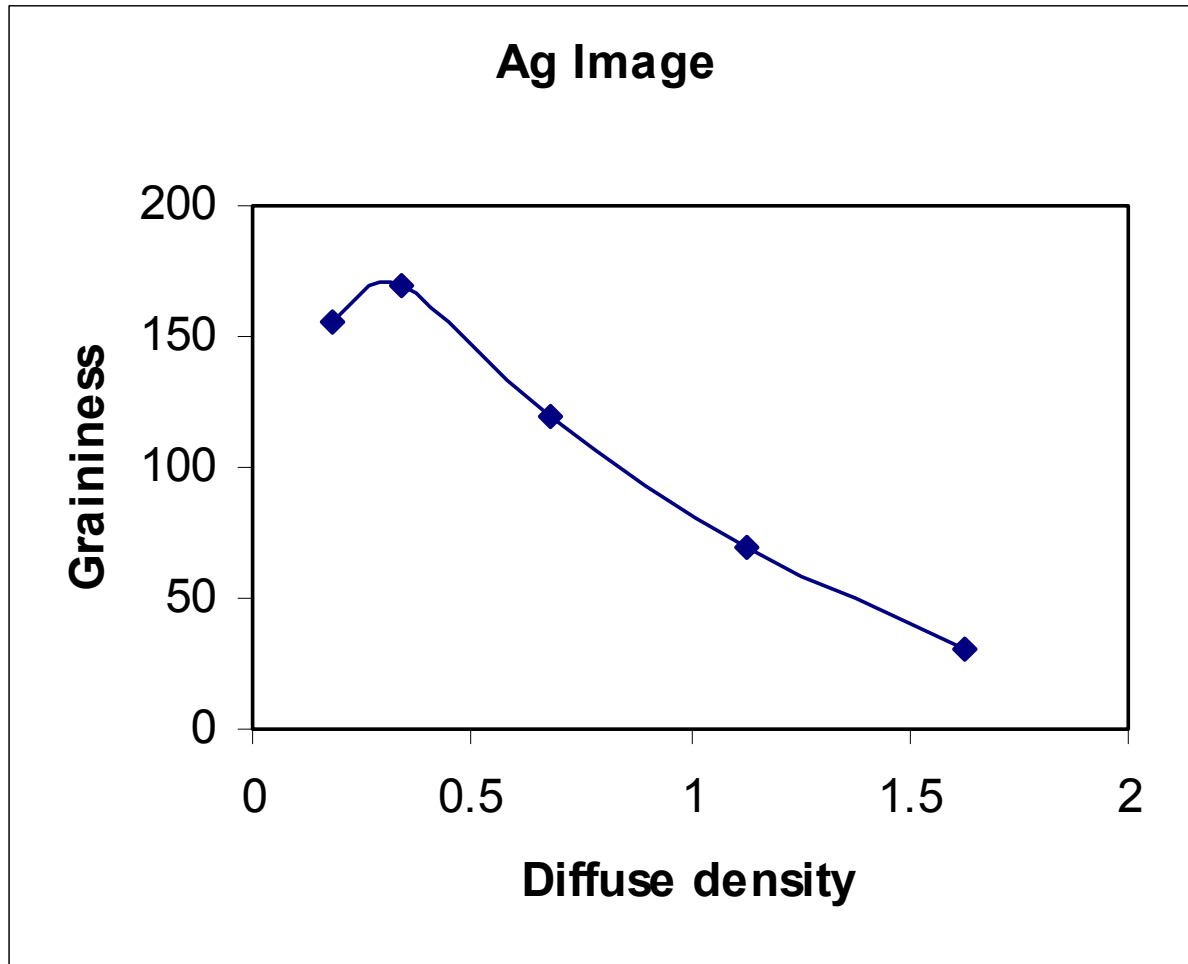
Std Deviation of Density vs Image Density



Photographic Emulsion Noise



Silver Image Graininess

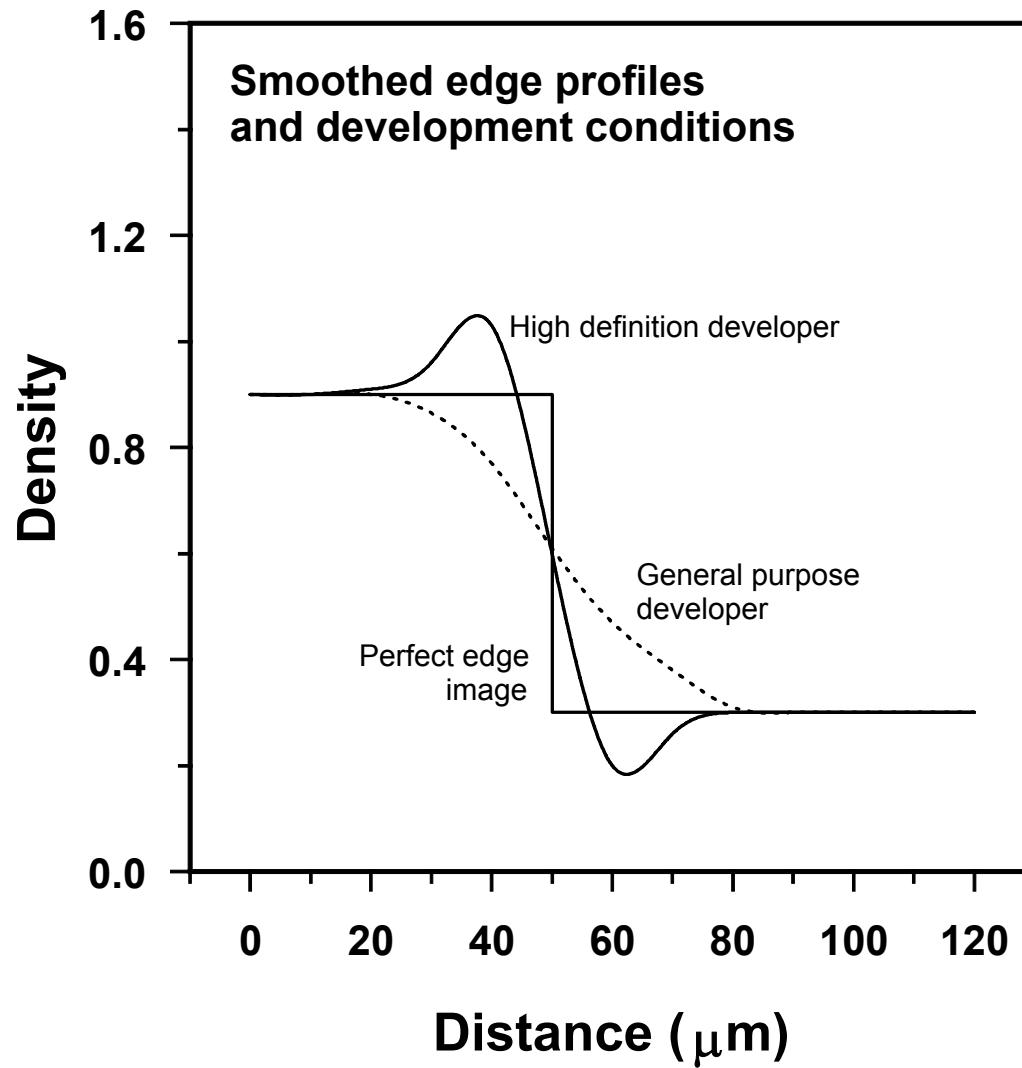




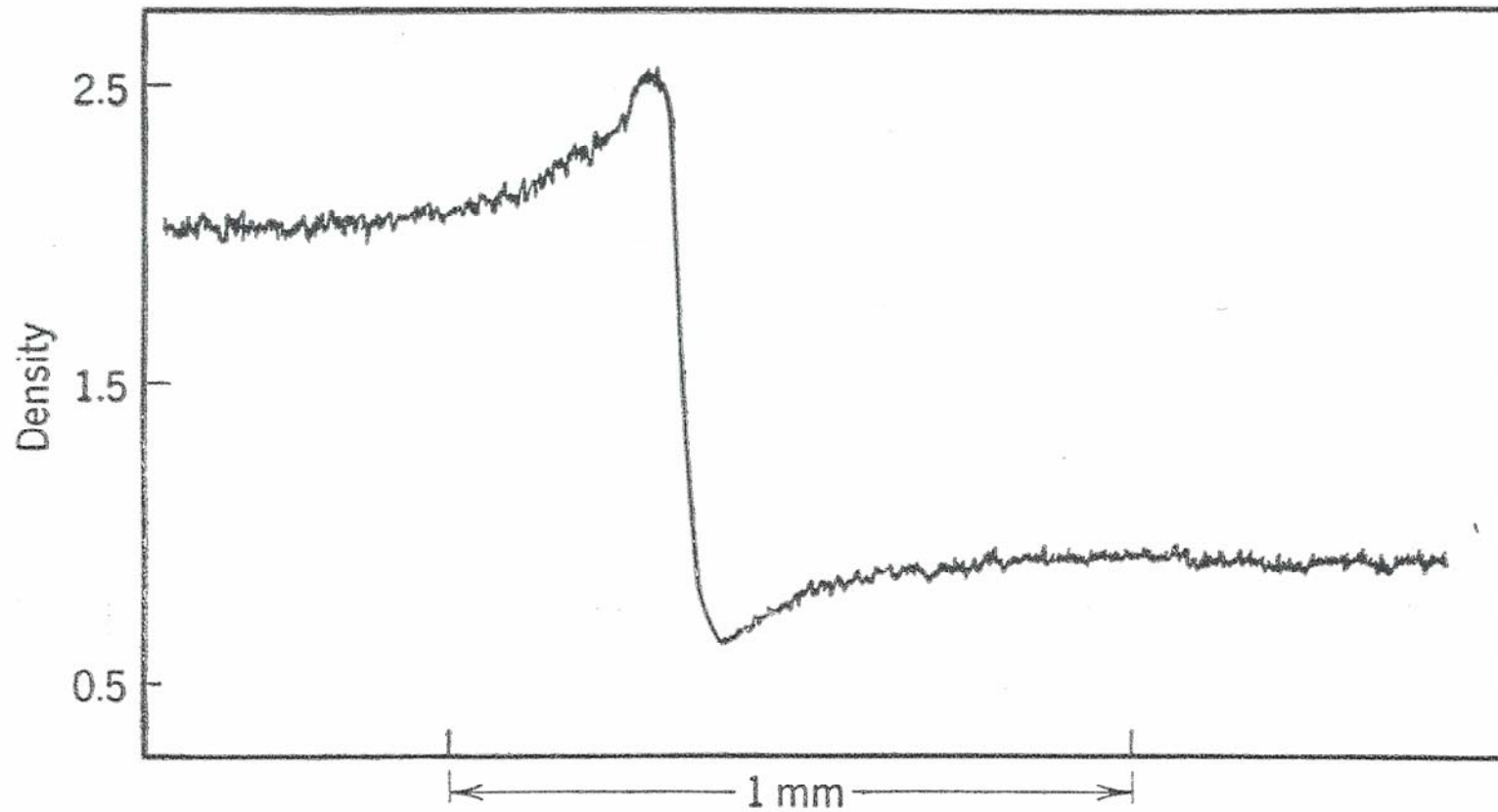
Gretag Macbeth ColorChecker



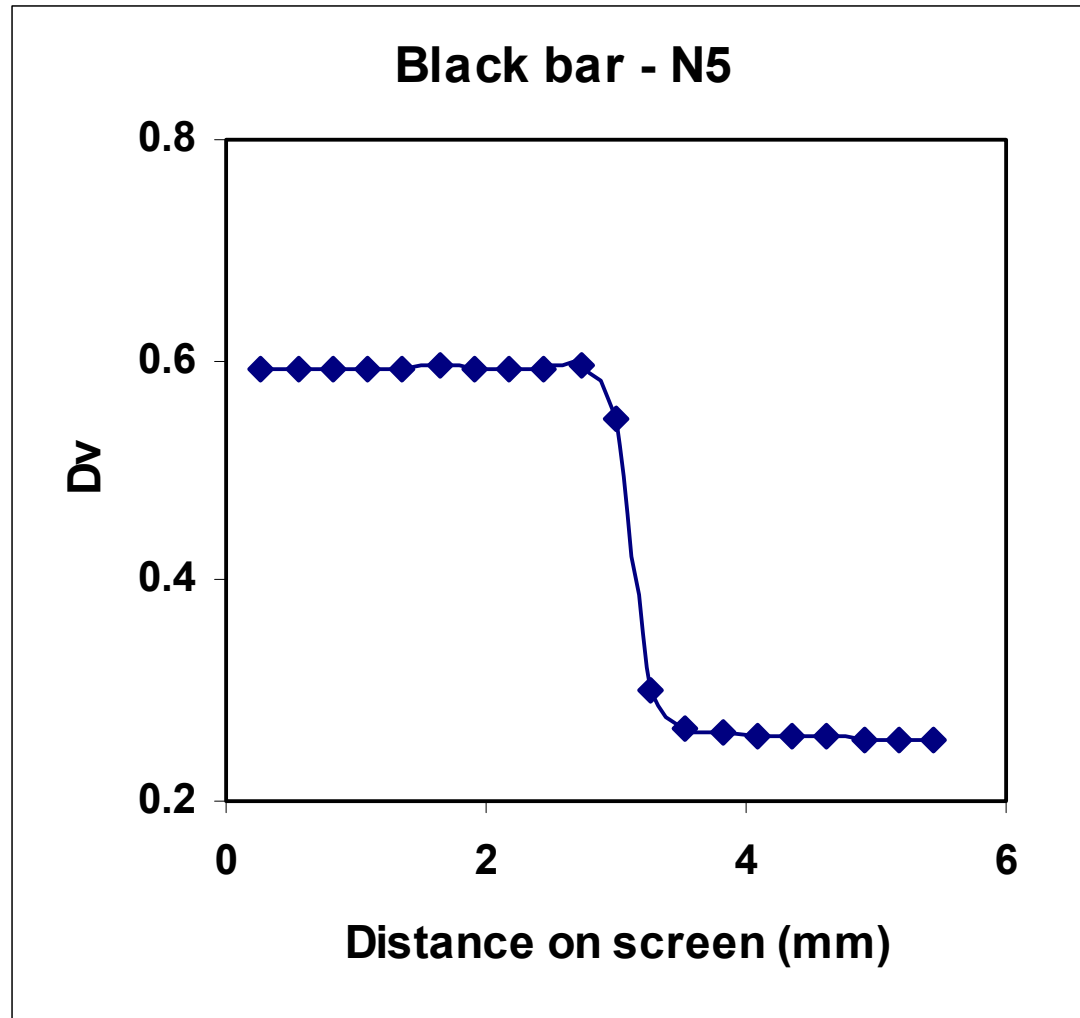
Edge and Emulsion Response



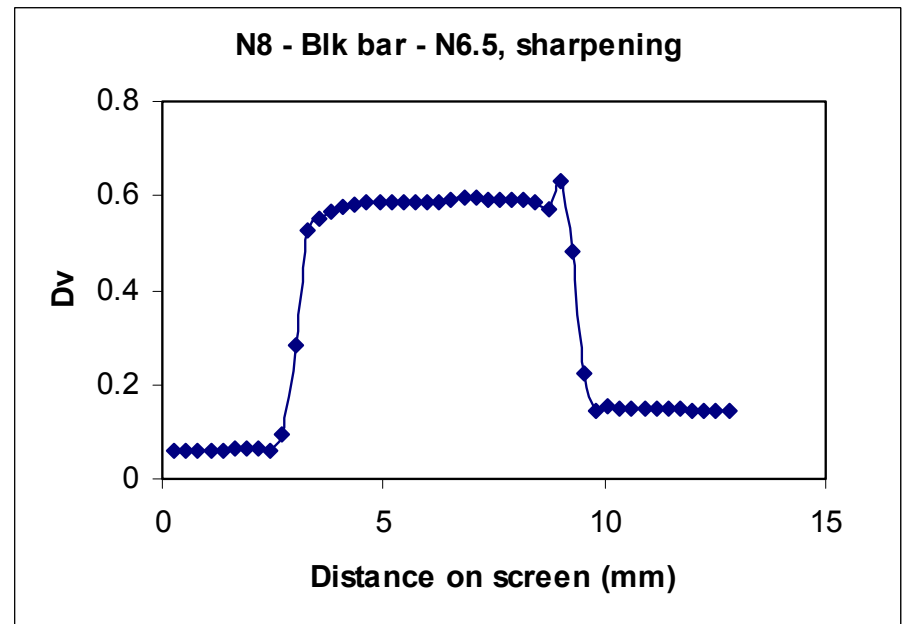
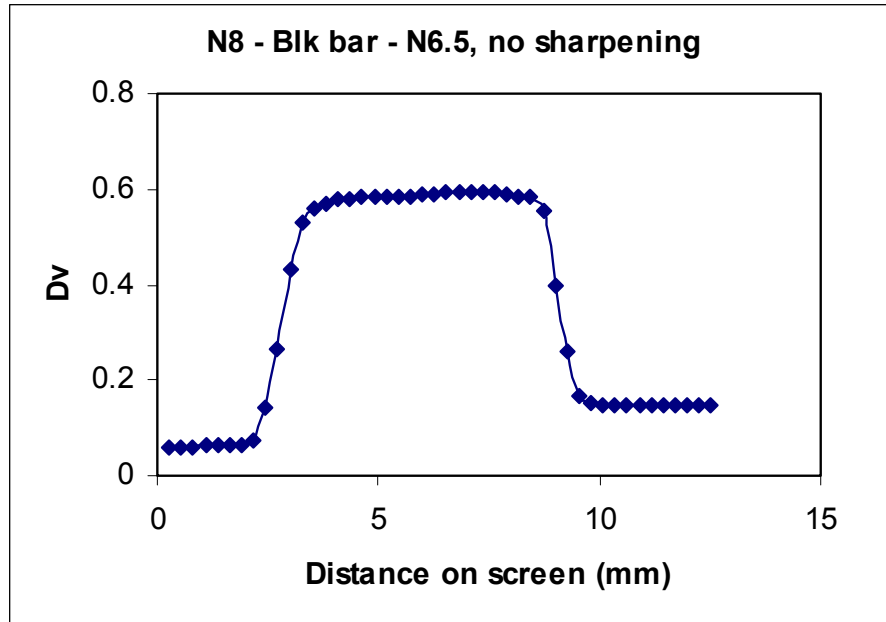
Ag Edge Profile



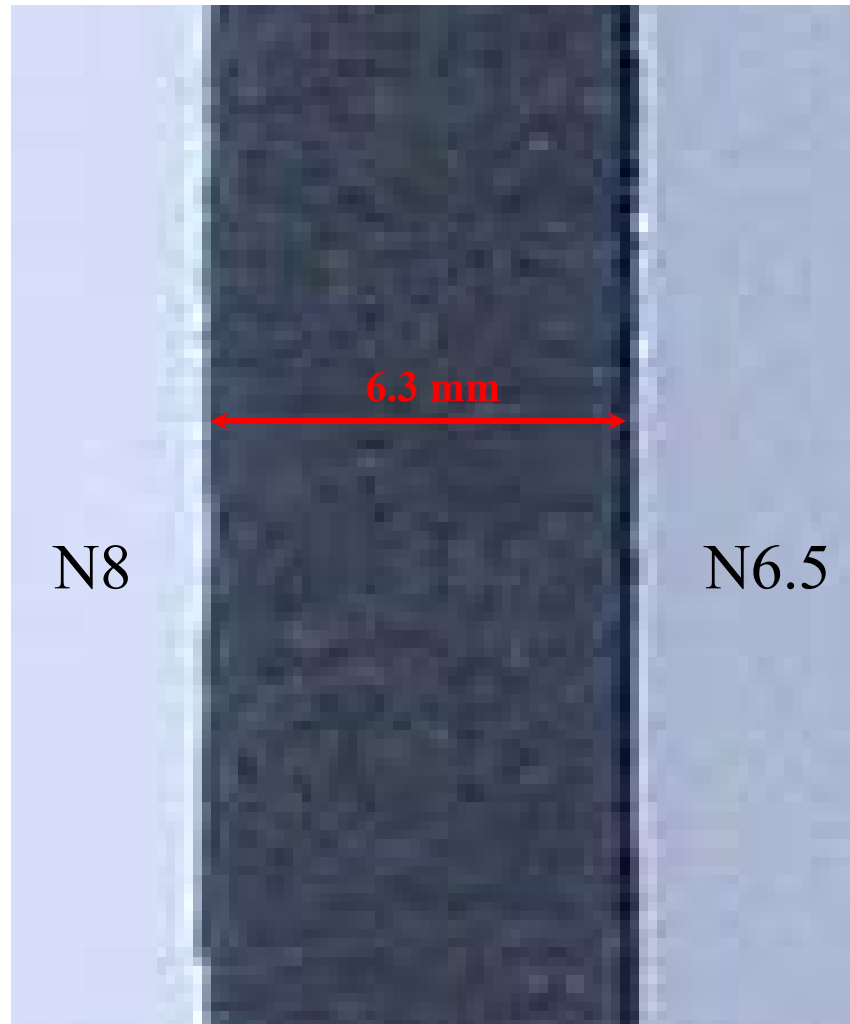
Edge and CCD Response



Sharpening: N8 - black - N6.5



Sharpness: N8 - black - N6.5



- Quantisation errors
 - ❑ contouring (low bit depth, high contrast subject)
- Edge effects
- Moire effects







X7.3

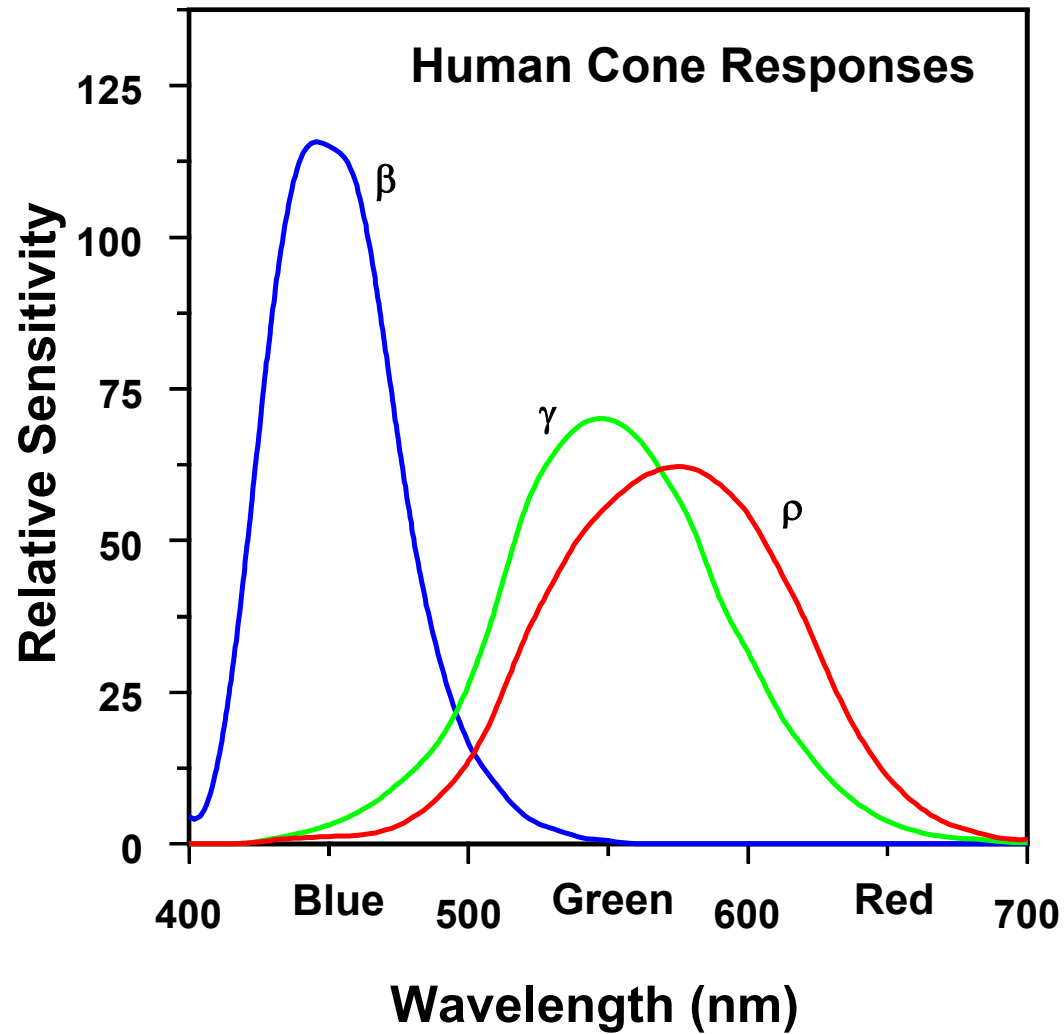


X 12.2

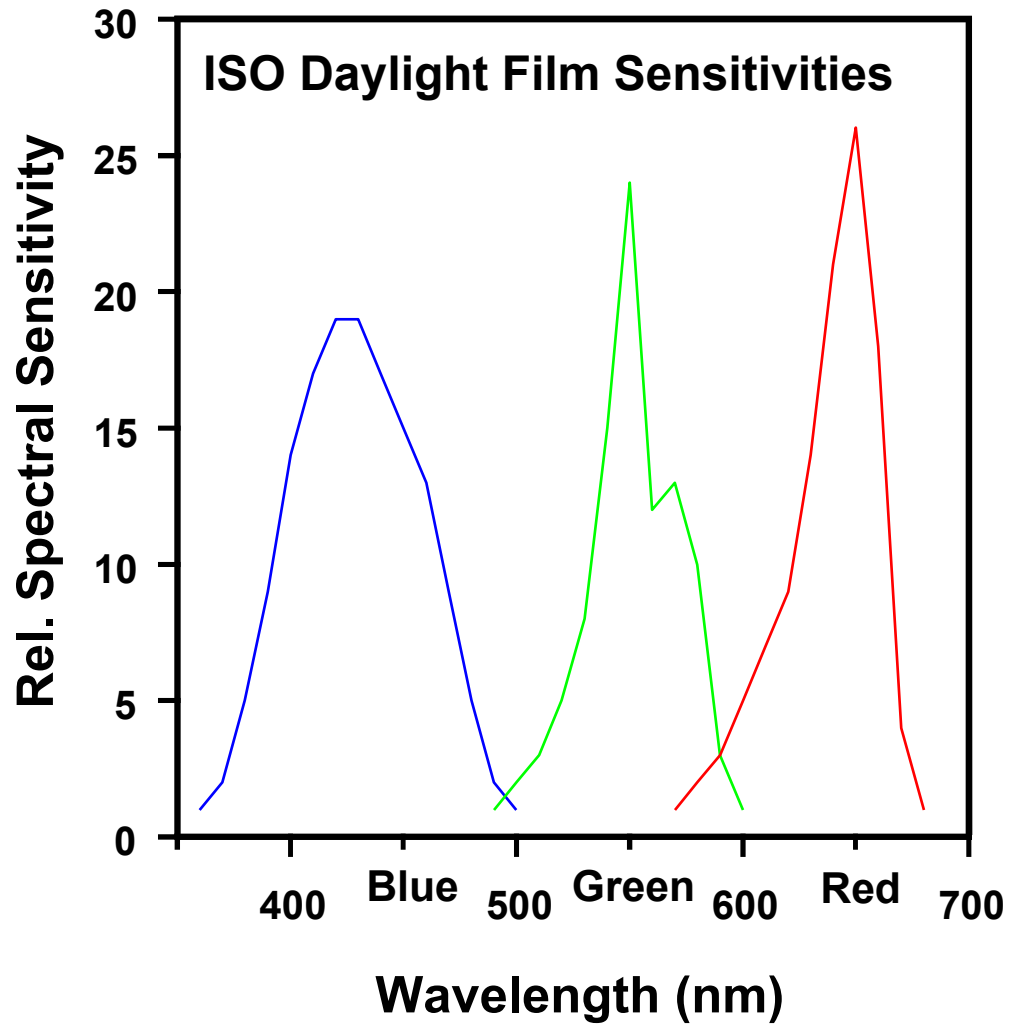
Colour Reproduction



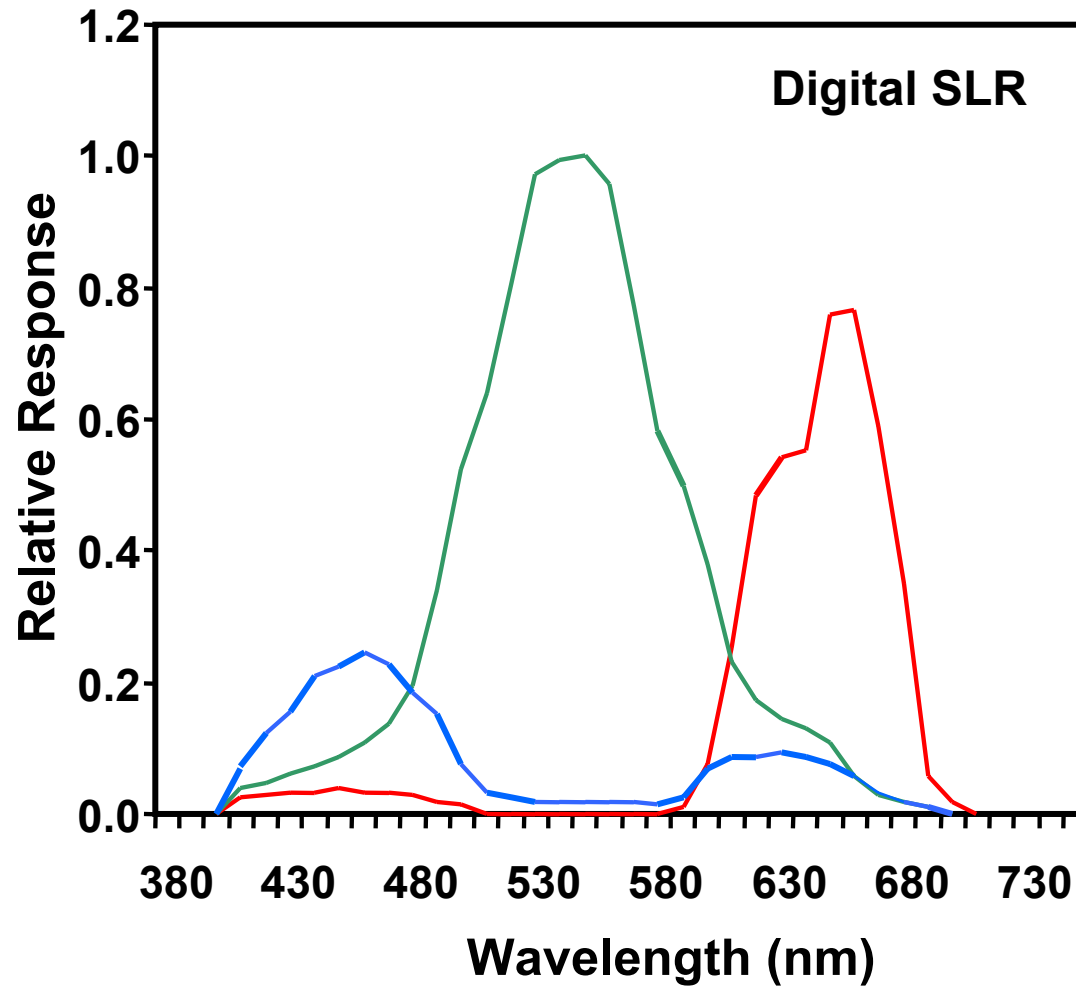
Human Photopic Colour Vision



Imaging System (Film)

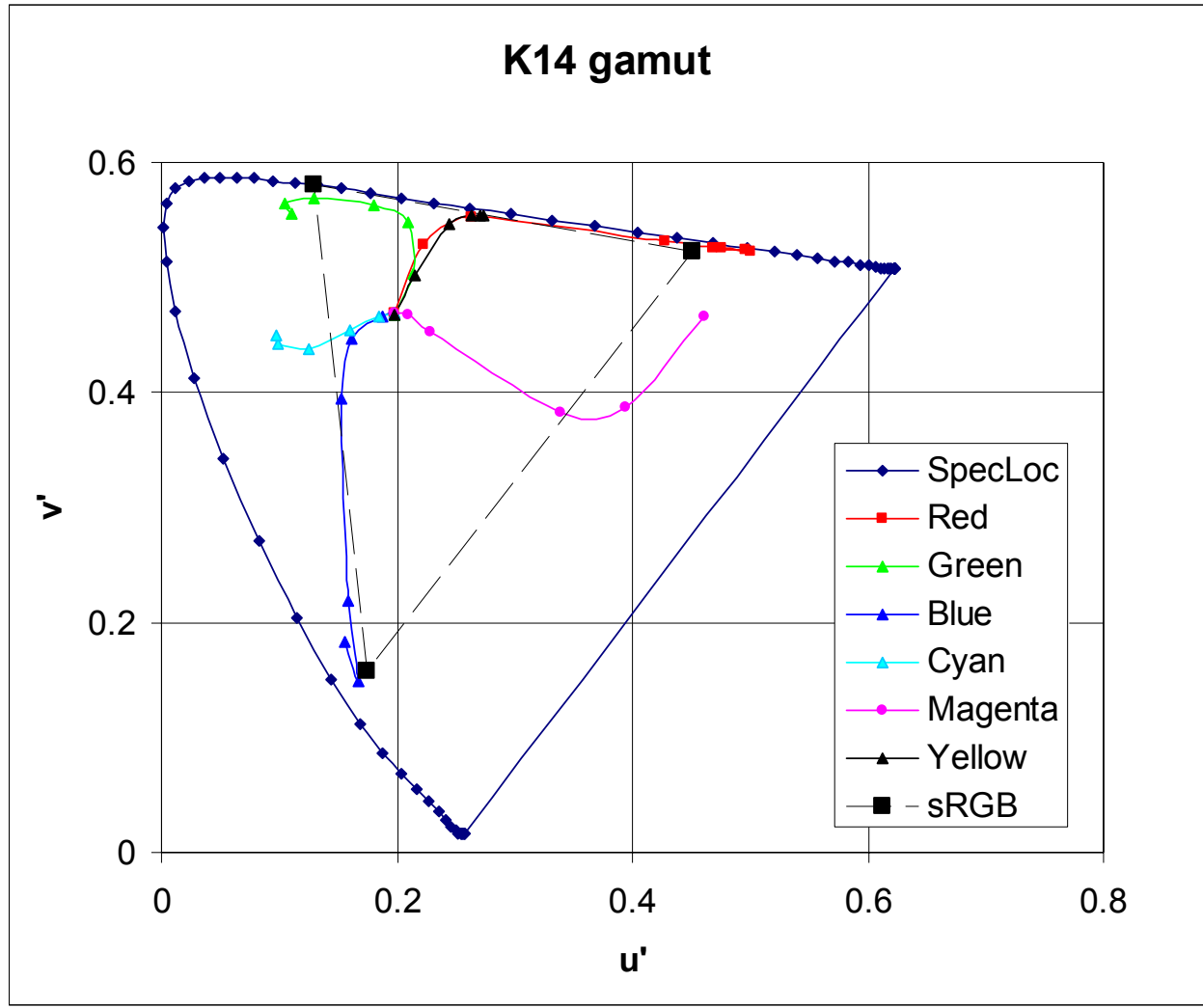


Imaging System (Digital SLR)

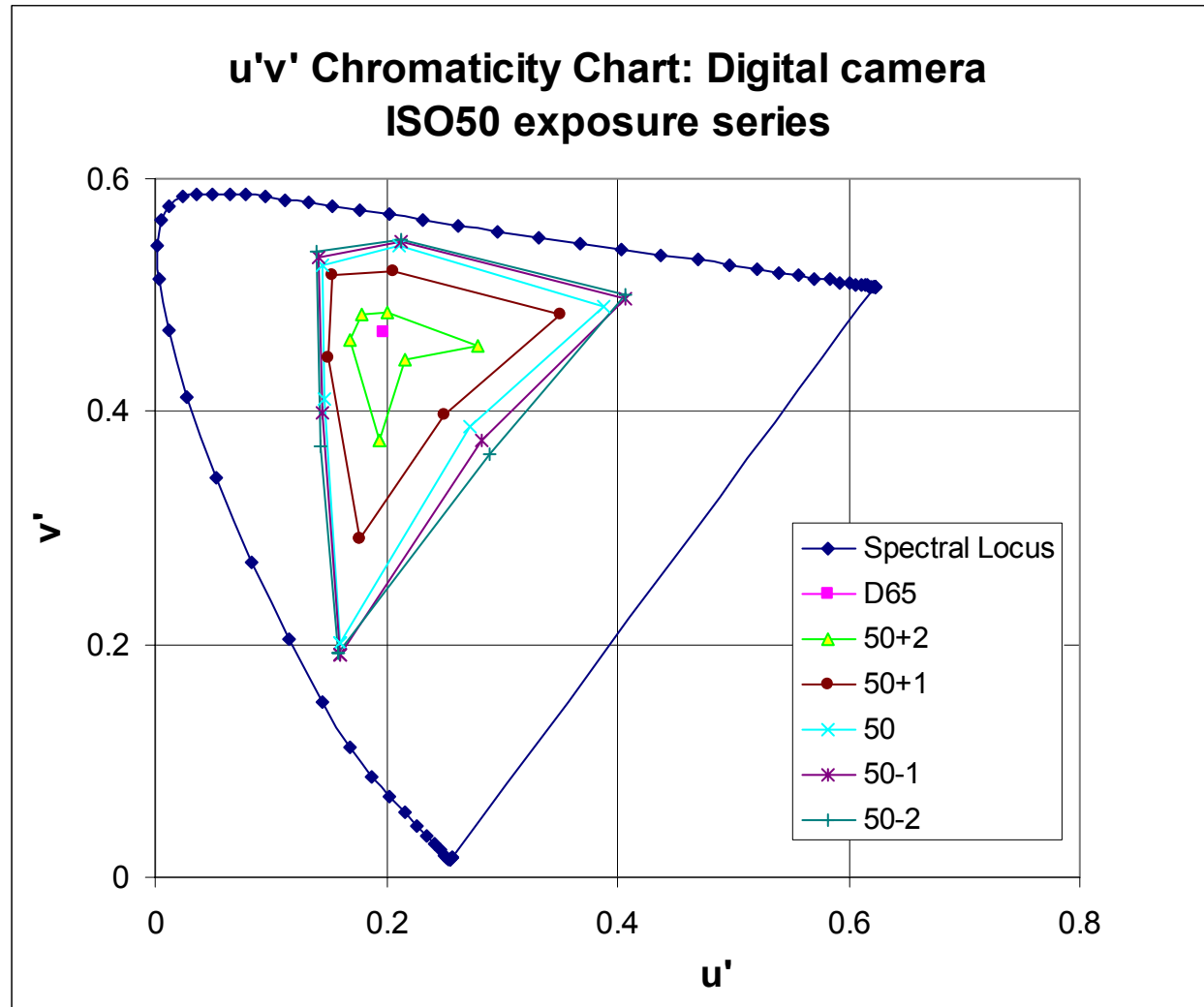


Colour Gamut

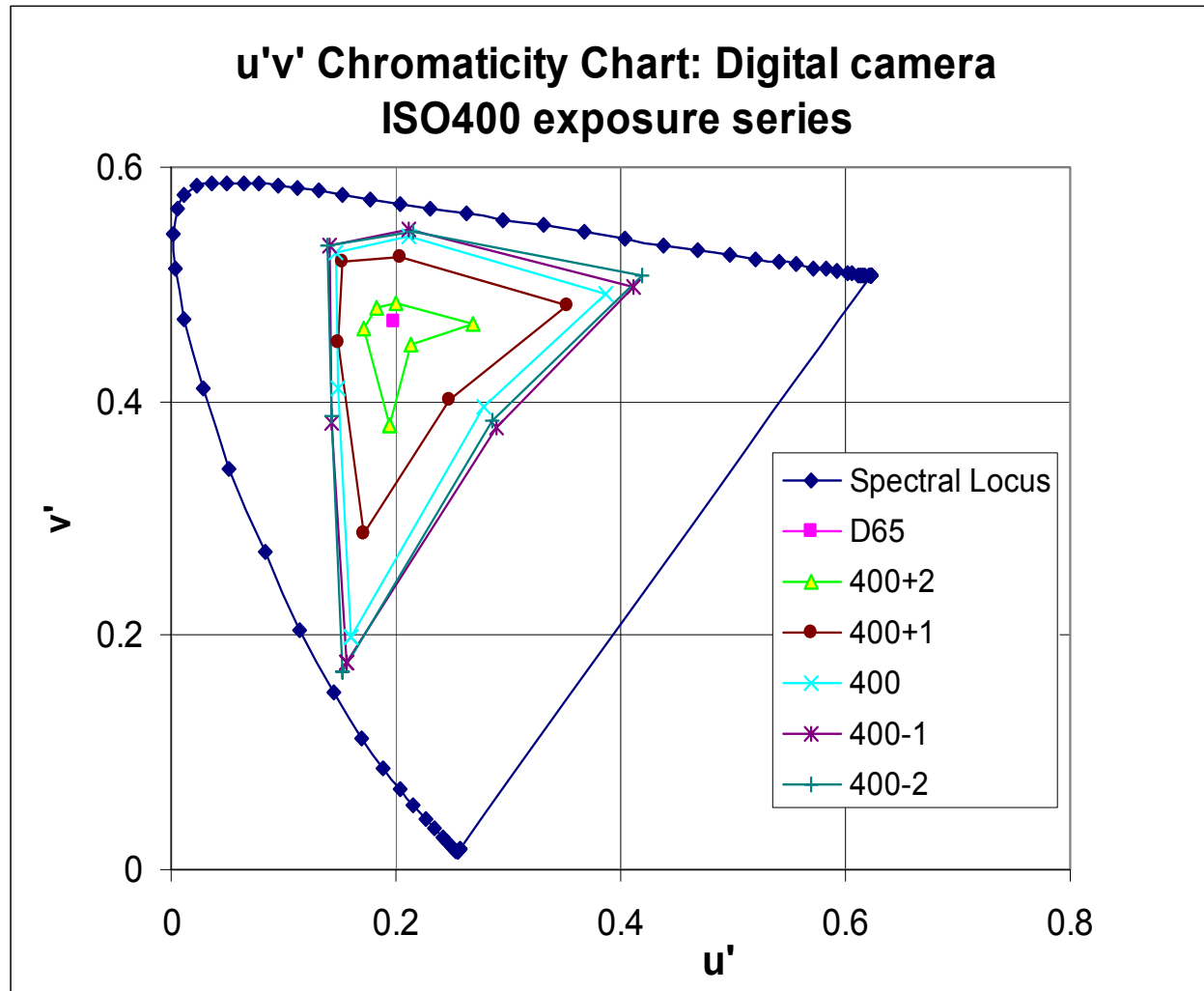




Colour Gamut - Digital (50)



Colour Gamut - Digital (400)



D & A Parallels Exist

- Tone reproduction (D vs Log E)
- Colour reproduction (CIE $u'v'$ diagram)
- Fine detail
- Artefacts

