# Digital and Analogue Photographic Parallels

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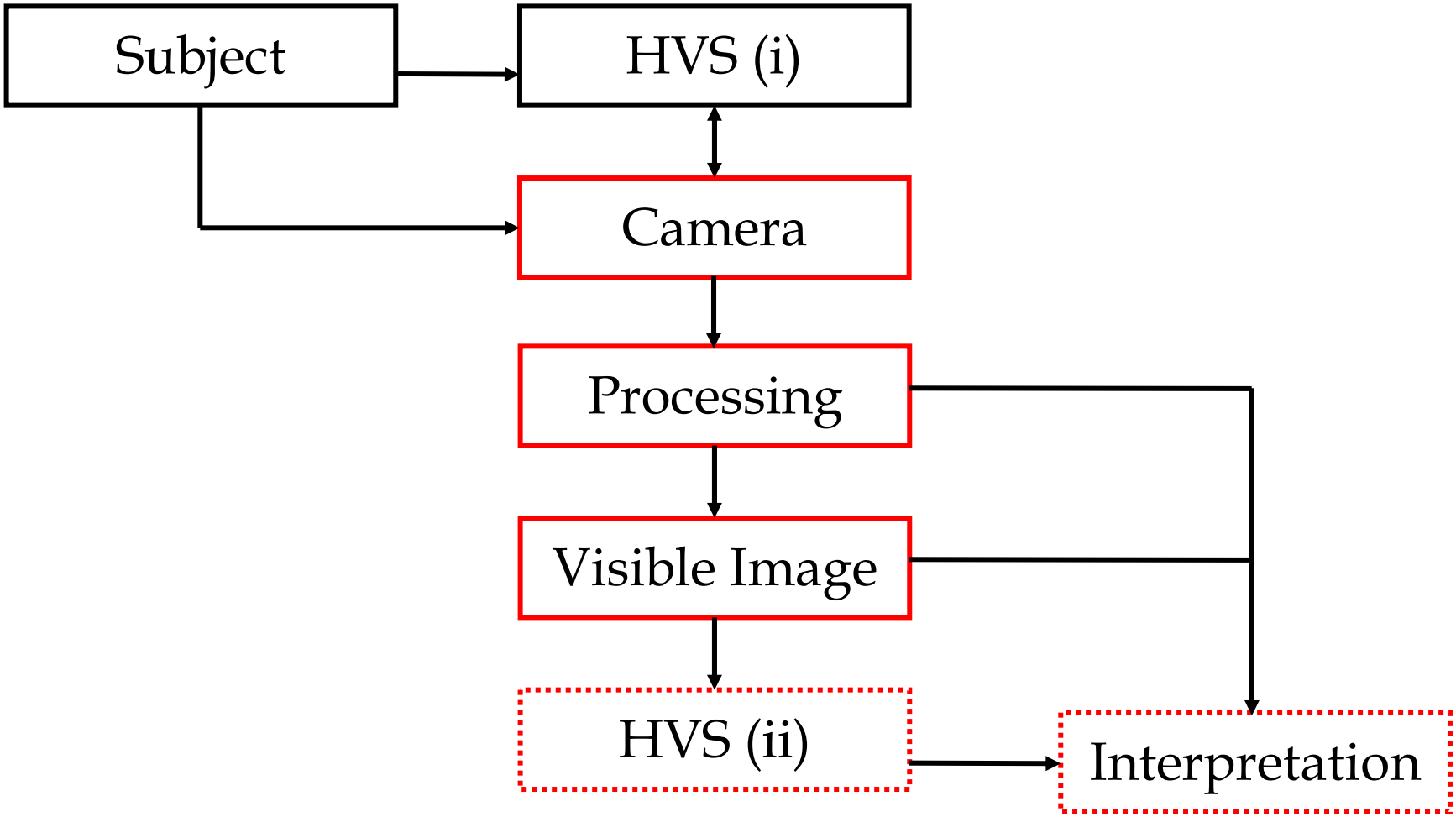
# Image Pathway



# Parallels (I) Ag

## Tone and colour reproduction (1890s onwards)

### Sensitometry

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

### Artefacts

- Noise (graininess, granularity)
- Edge effects

# Parallels (II) Si

## 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

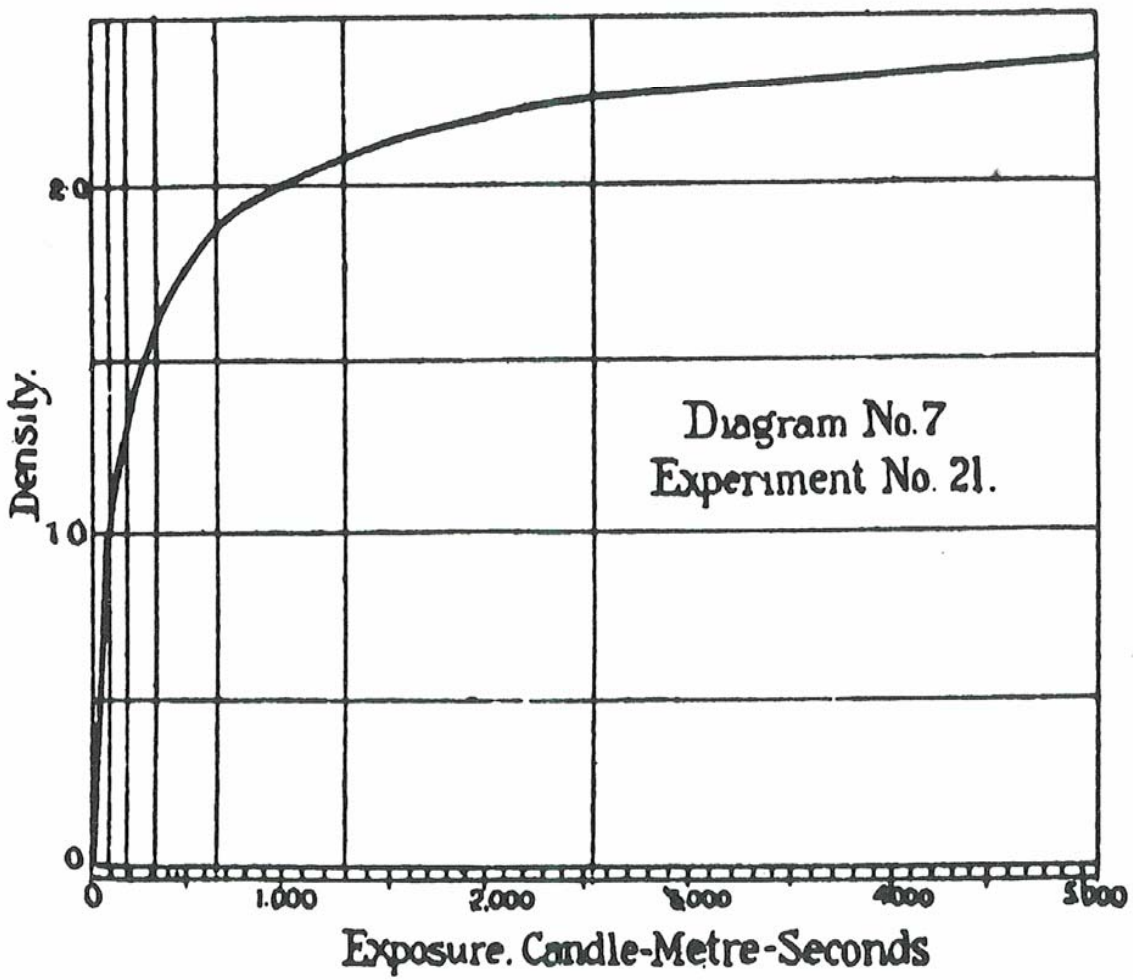
$$D_T = log_{10}\left(\frac{1}{\tau}\right) = log_{10}\left(\frac{I_o}{I_t}\right)$$

Optical density as measure of Ag image:

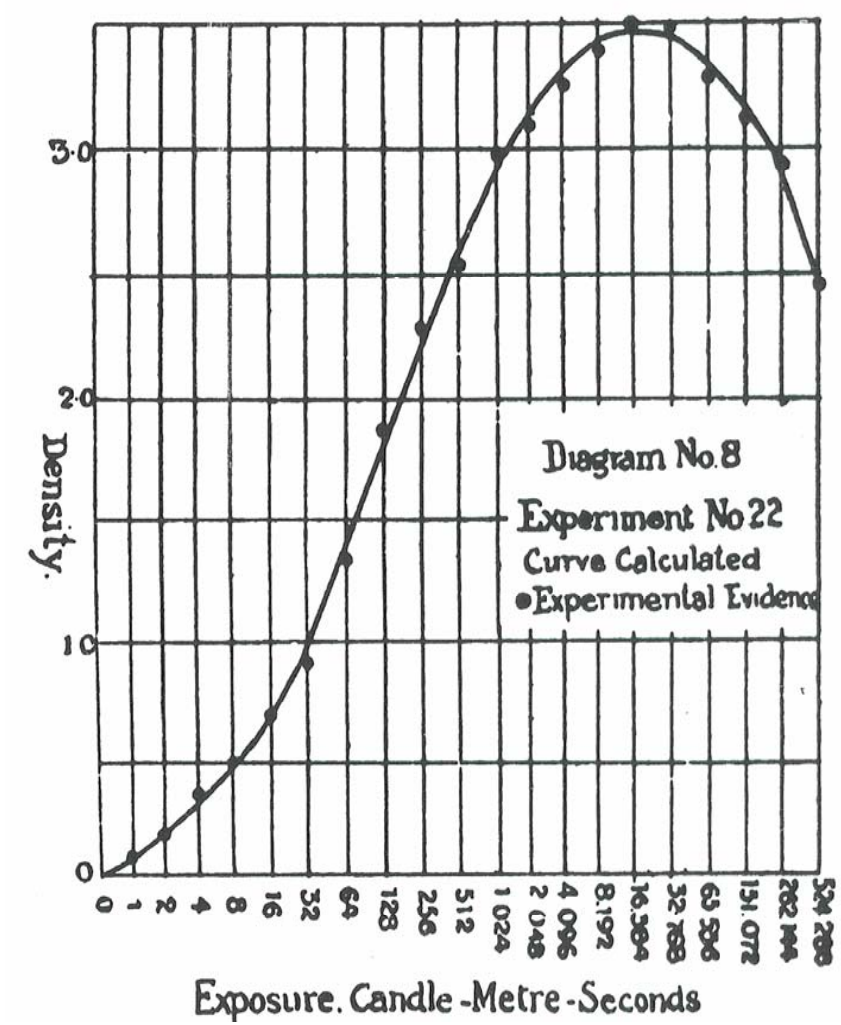
Density is approximately linear with the concentration of image silver present.

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

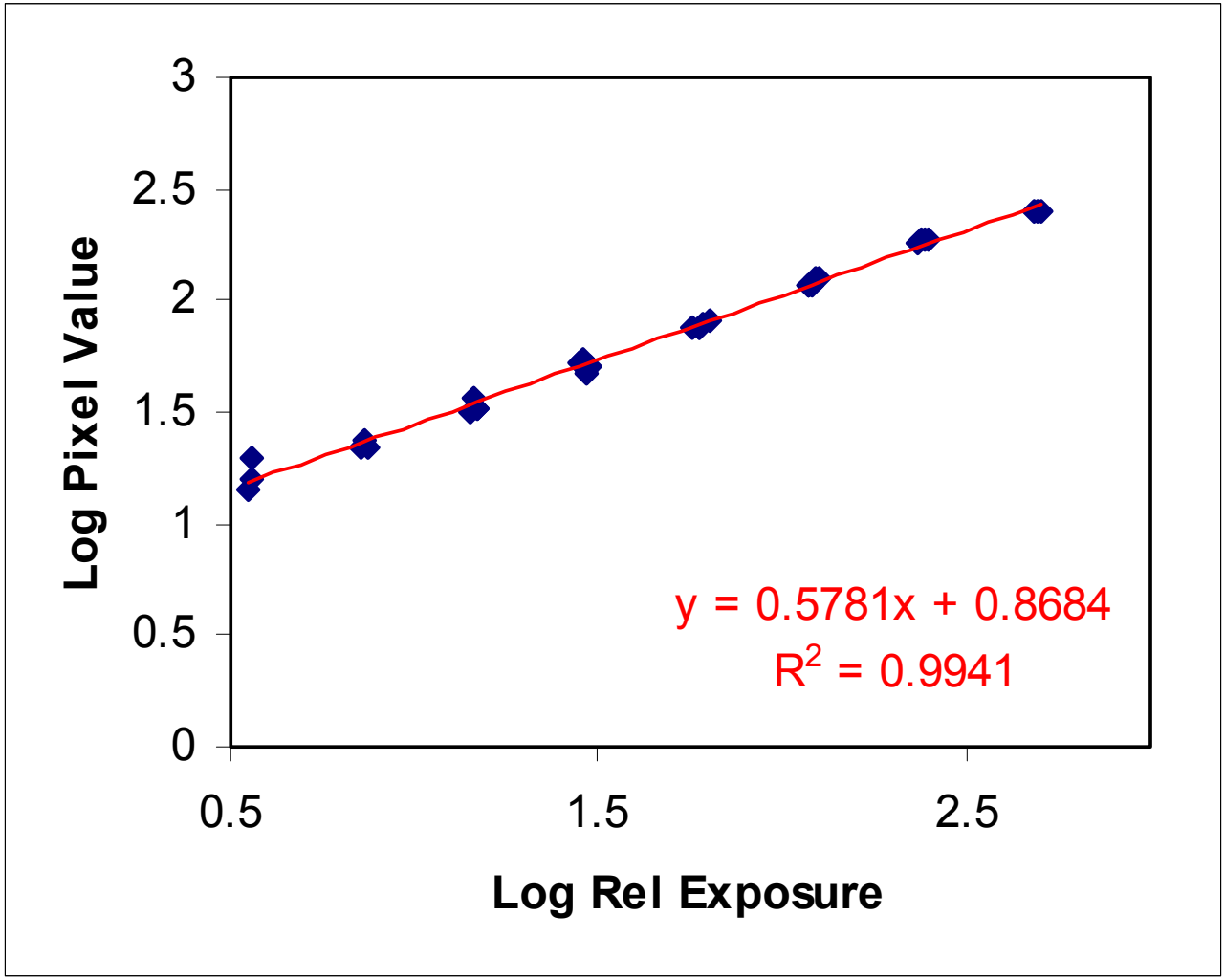
# Photographic Characteristic (I)



# Photographic Characteristic (II)

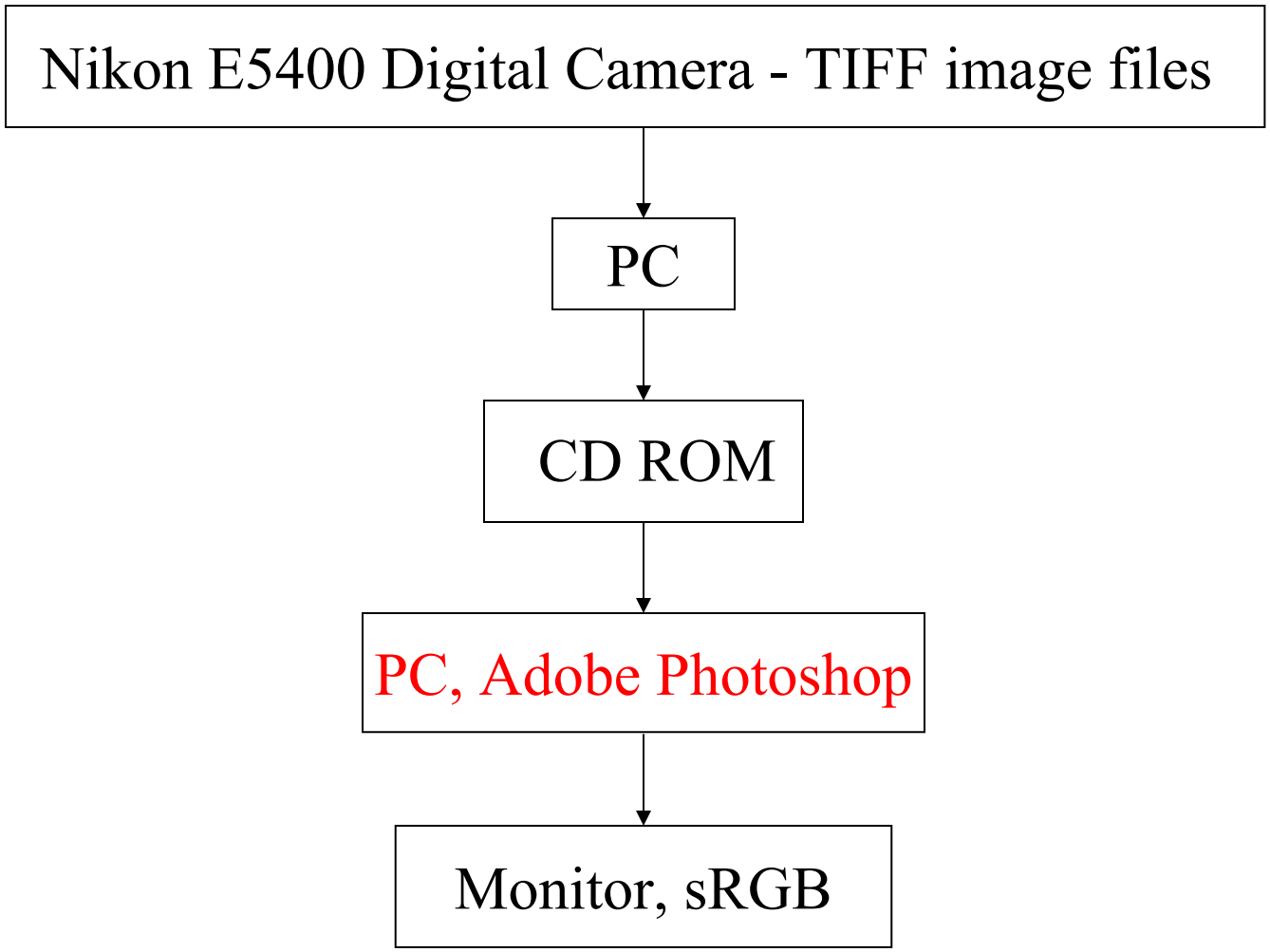


# Digital Characteristic (II)



# GretagMacbeth ColorChecker

# Digital Route Examined



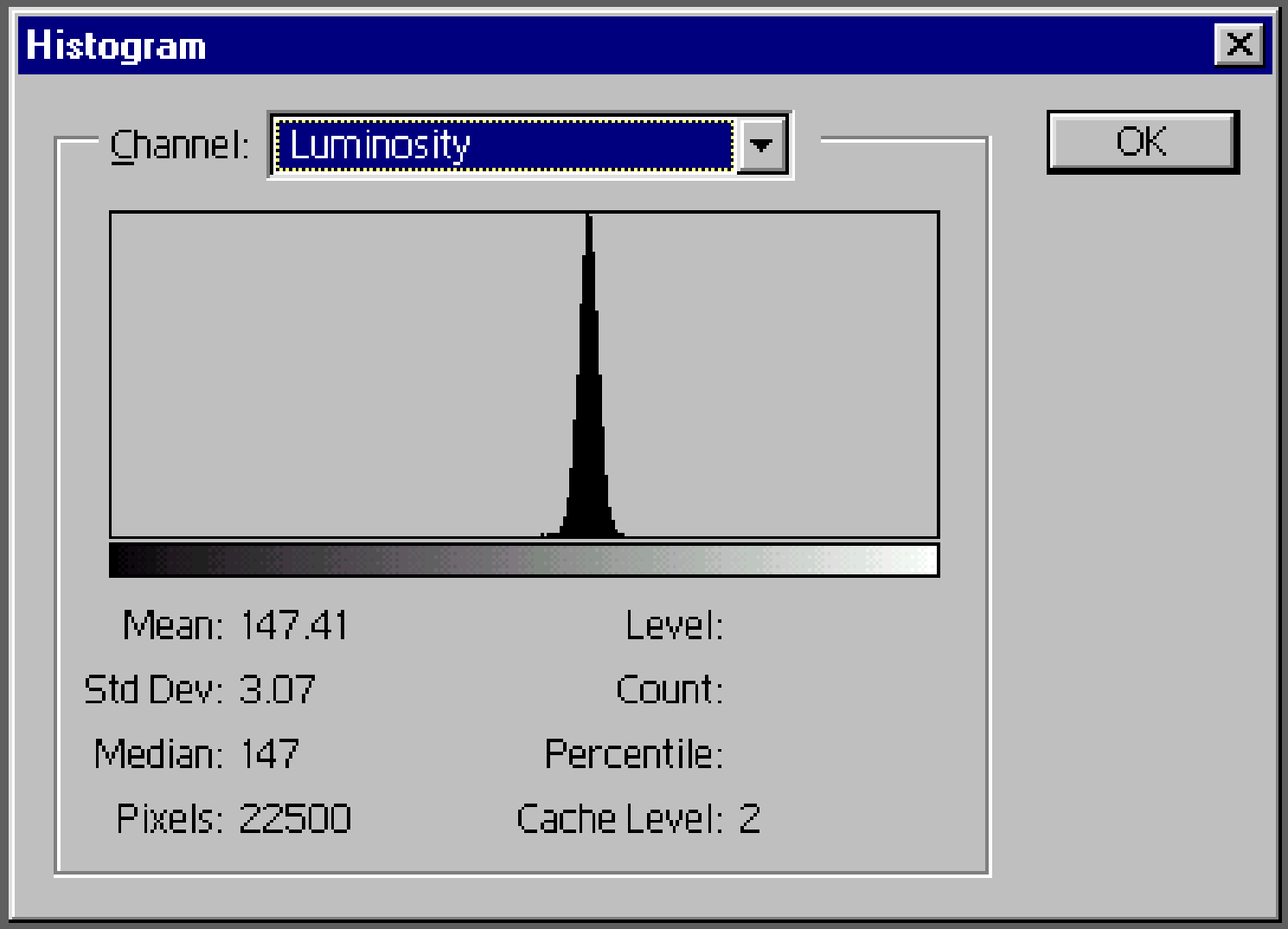
# Photoshop & Image Evaluation

## Data from images

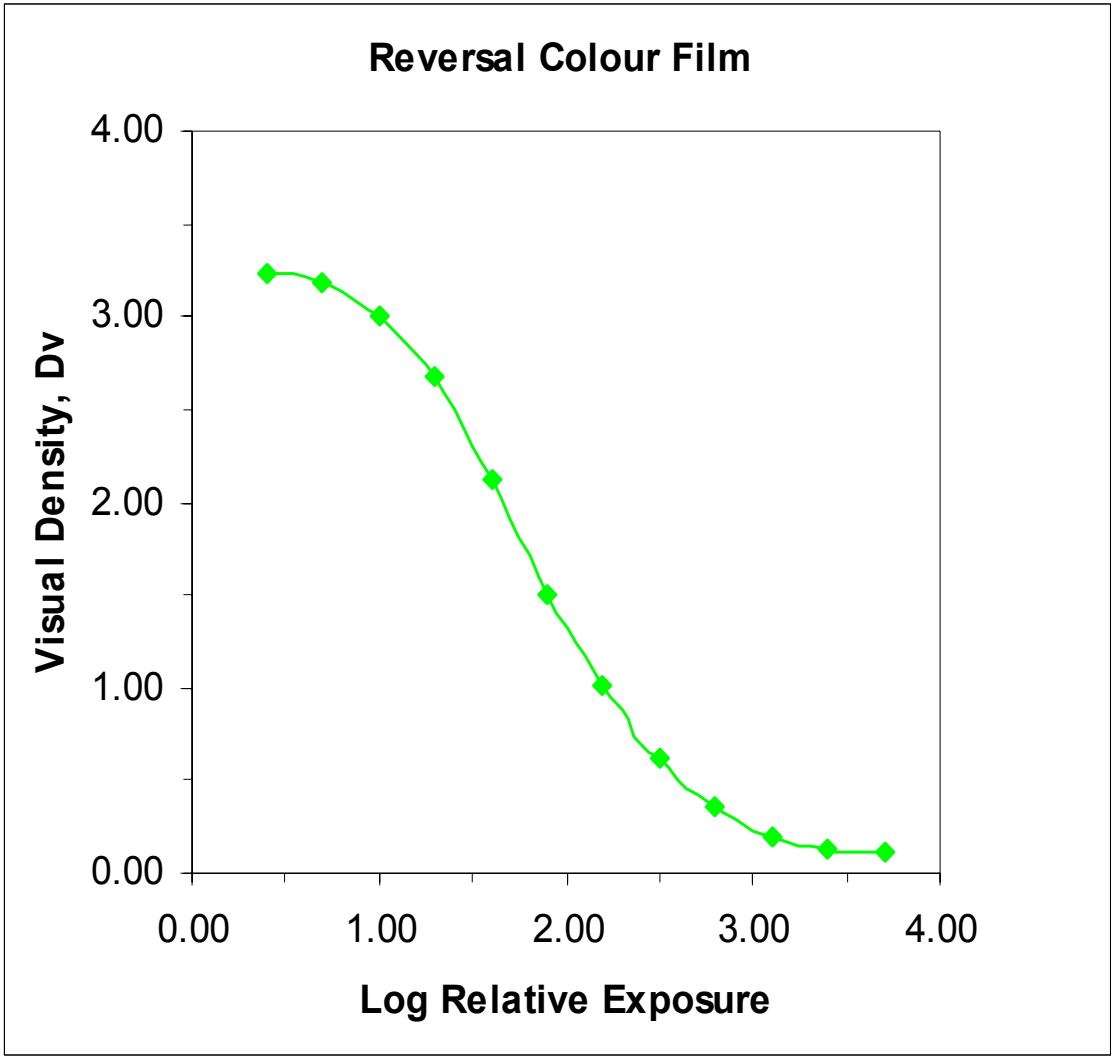
- Image histogram gives large-area data
- Colorimetric data, CIE u'v', CIELAB
- Image histogram gives small-area data

# Tone Reproduction Studies

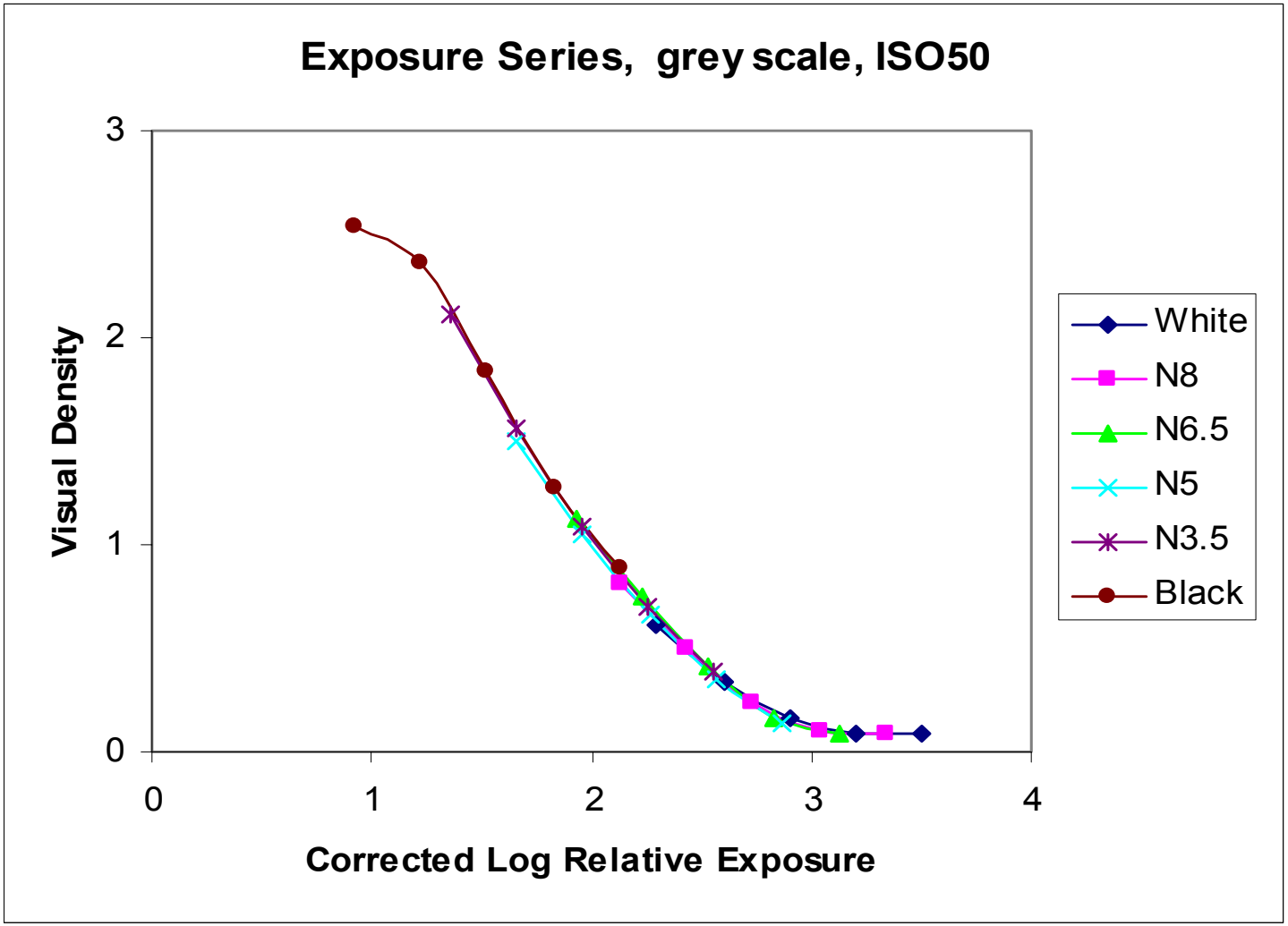
# Histogram from Selected Area



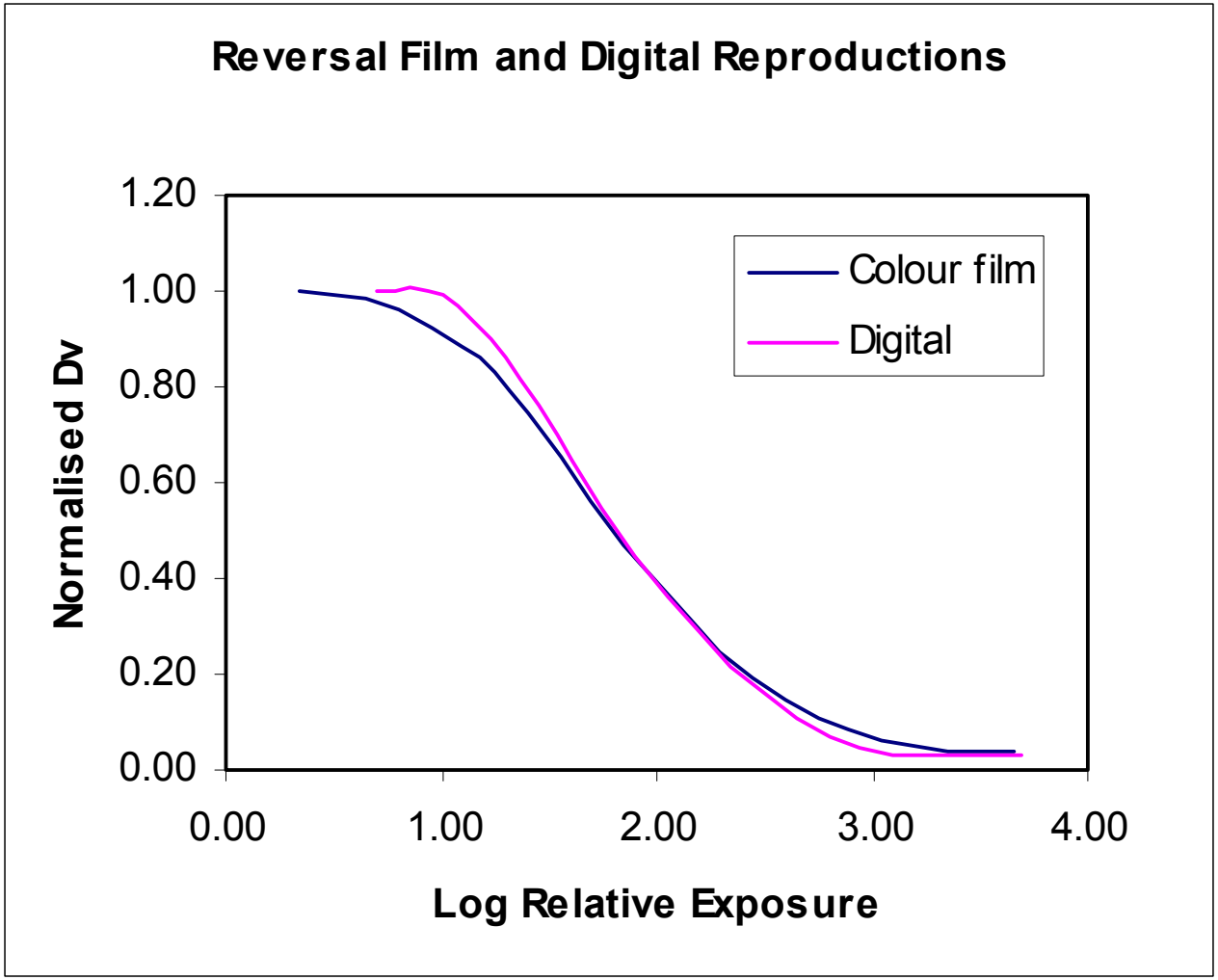
# Colour Reversal Film



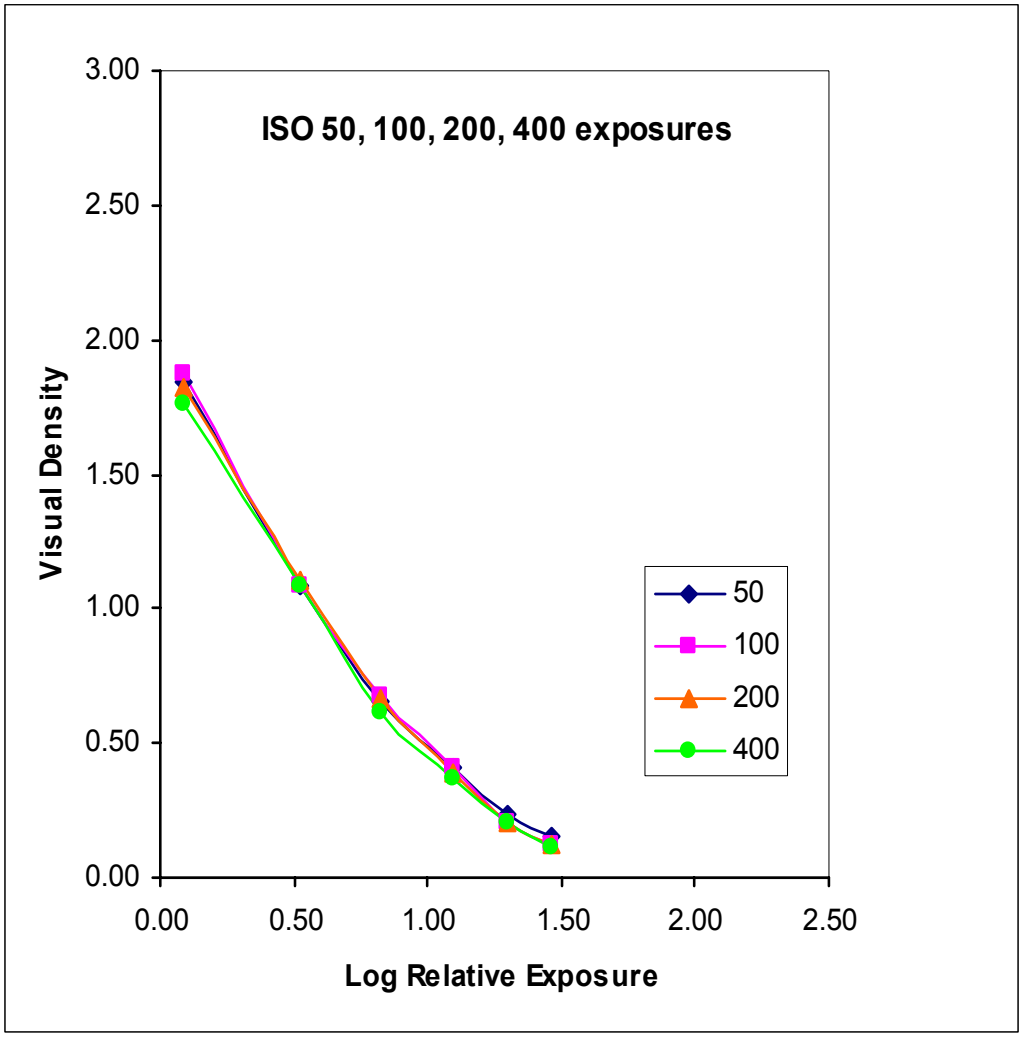
# Camera TIFF to Monitor (sRGB)



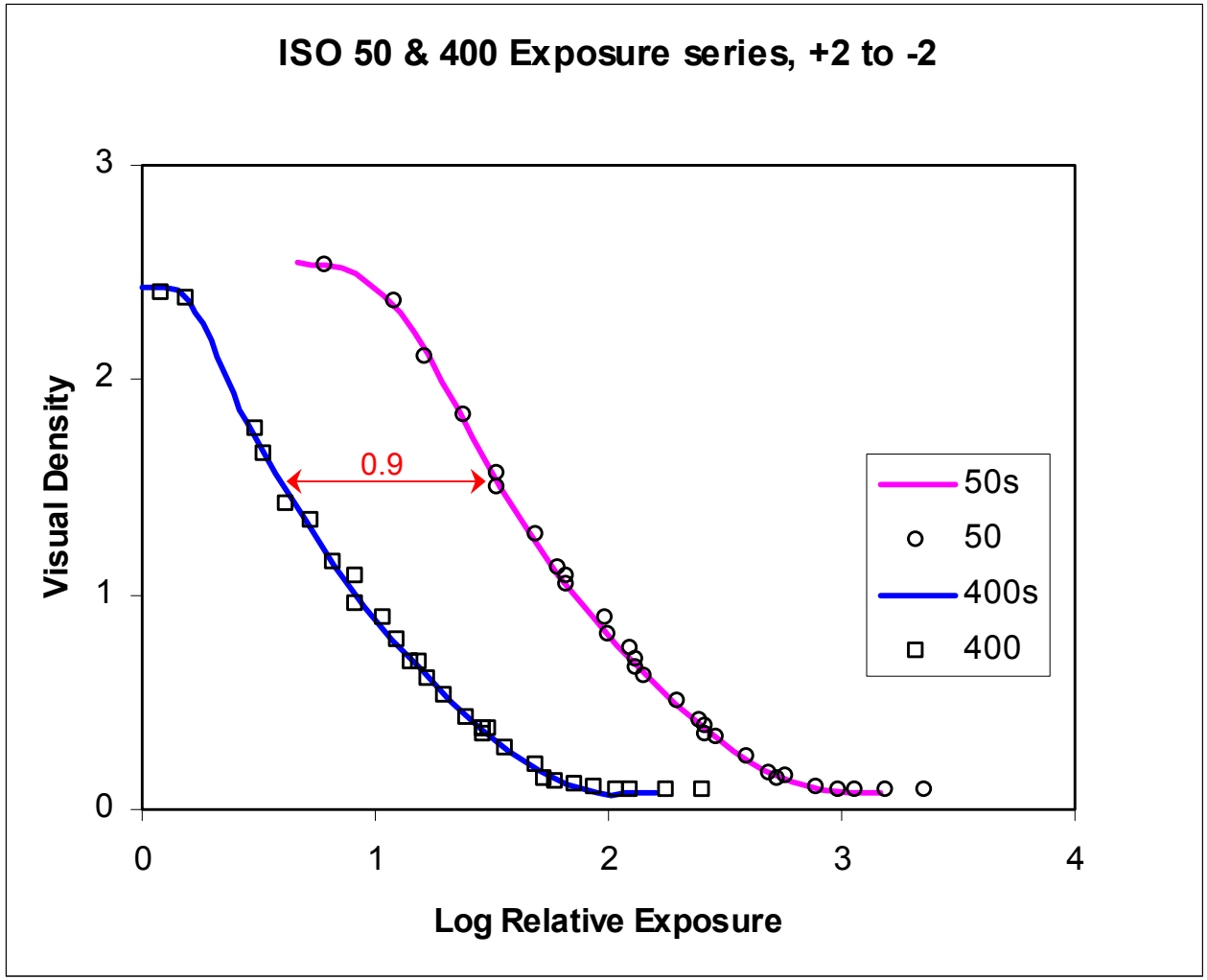
# Tone Reproduction



# Camera TIFF to Monitor (sRGB)

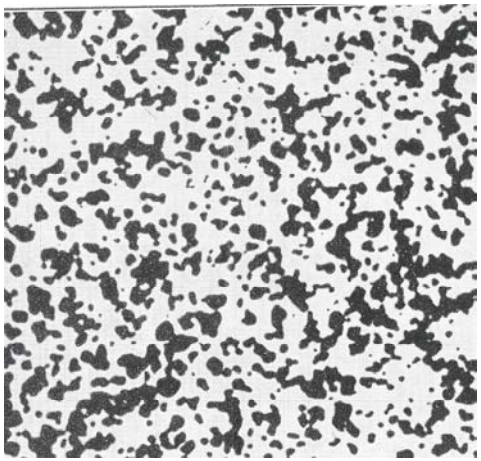


# Camera TIFF to Monitor (sRGB)

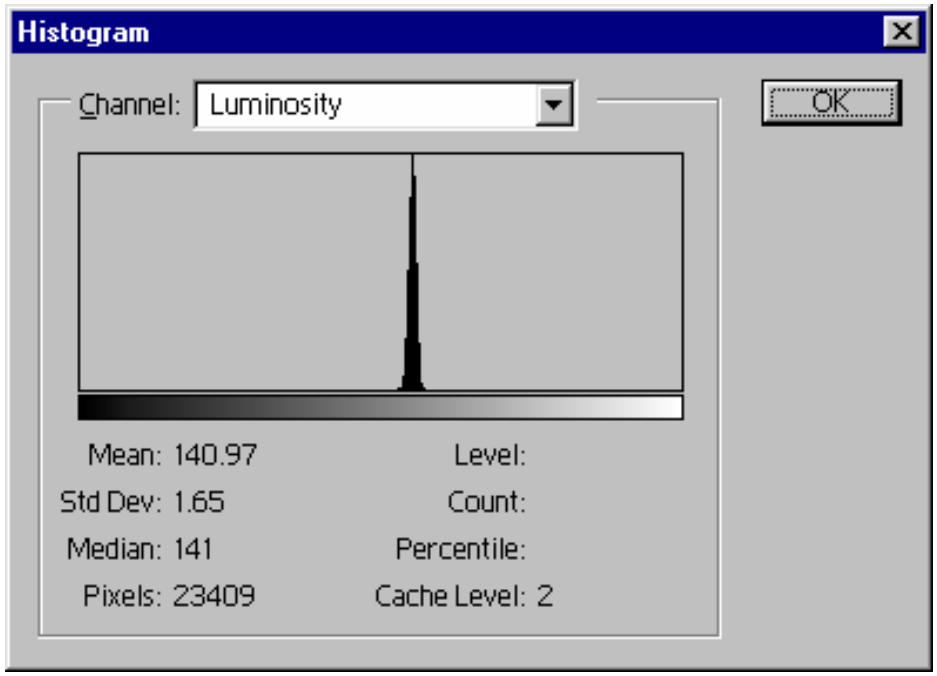


# Tone Reproduction

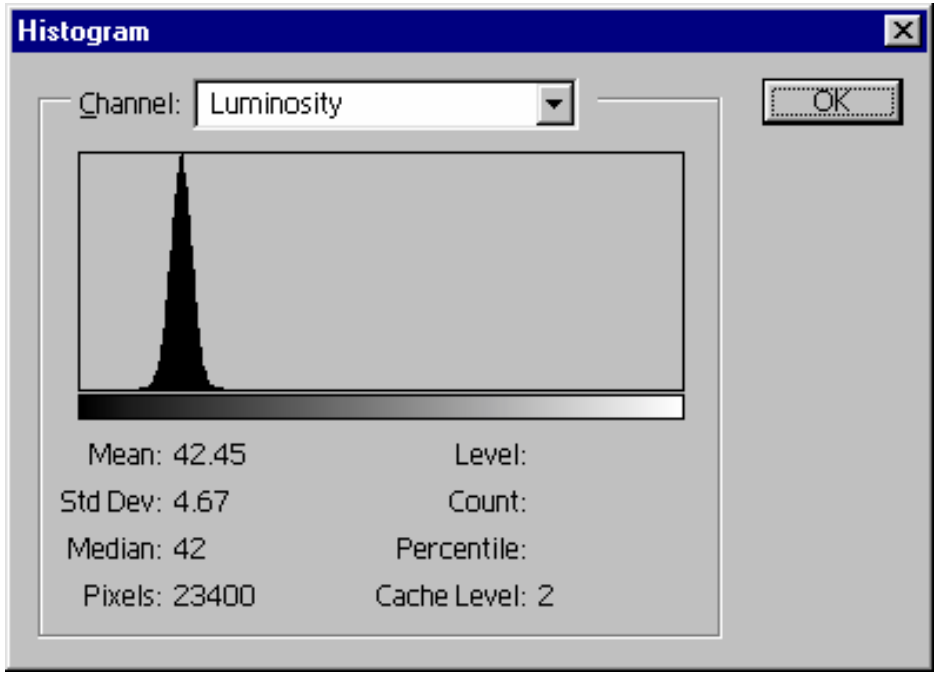
# Silver and Digital Noise



# Digital Noise

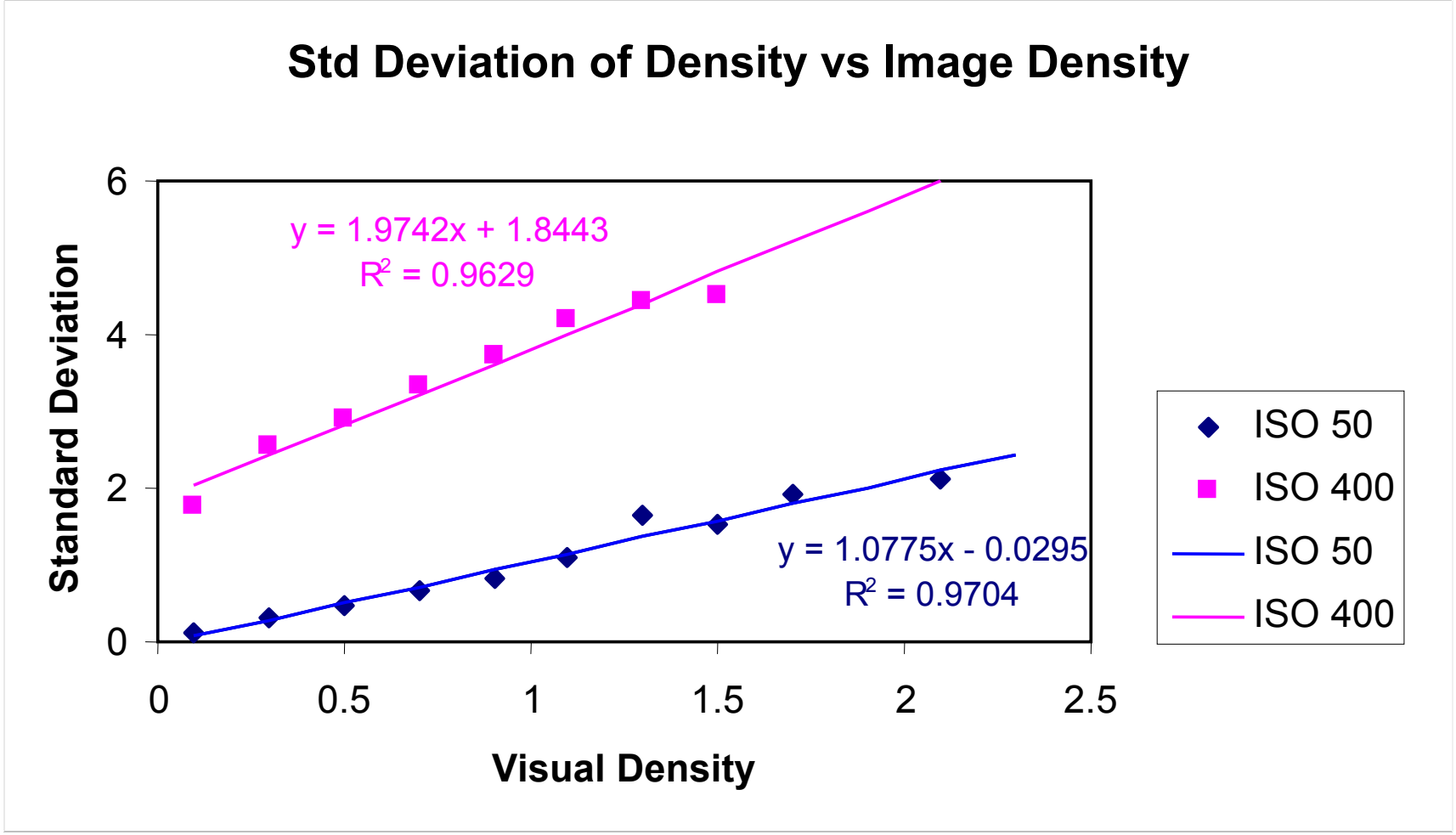



ISO50 N5

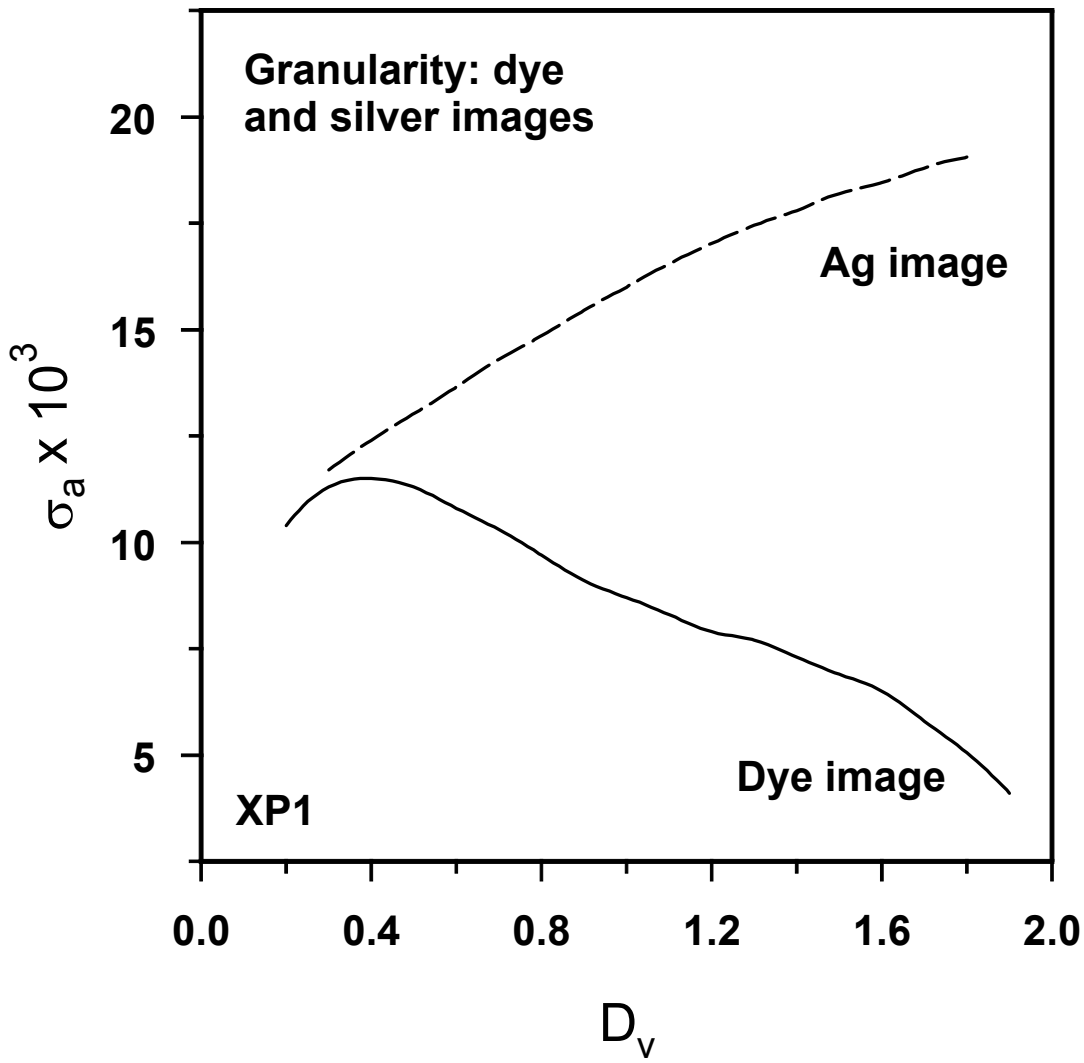



ISO1600 N8.5

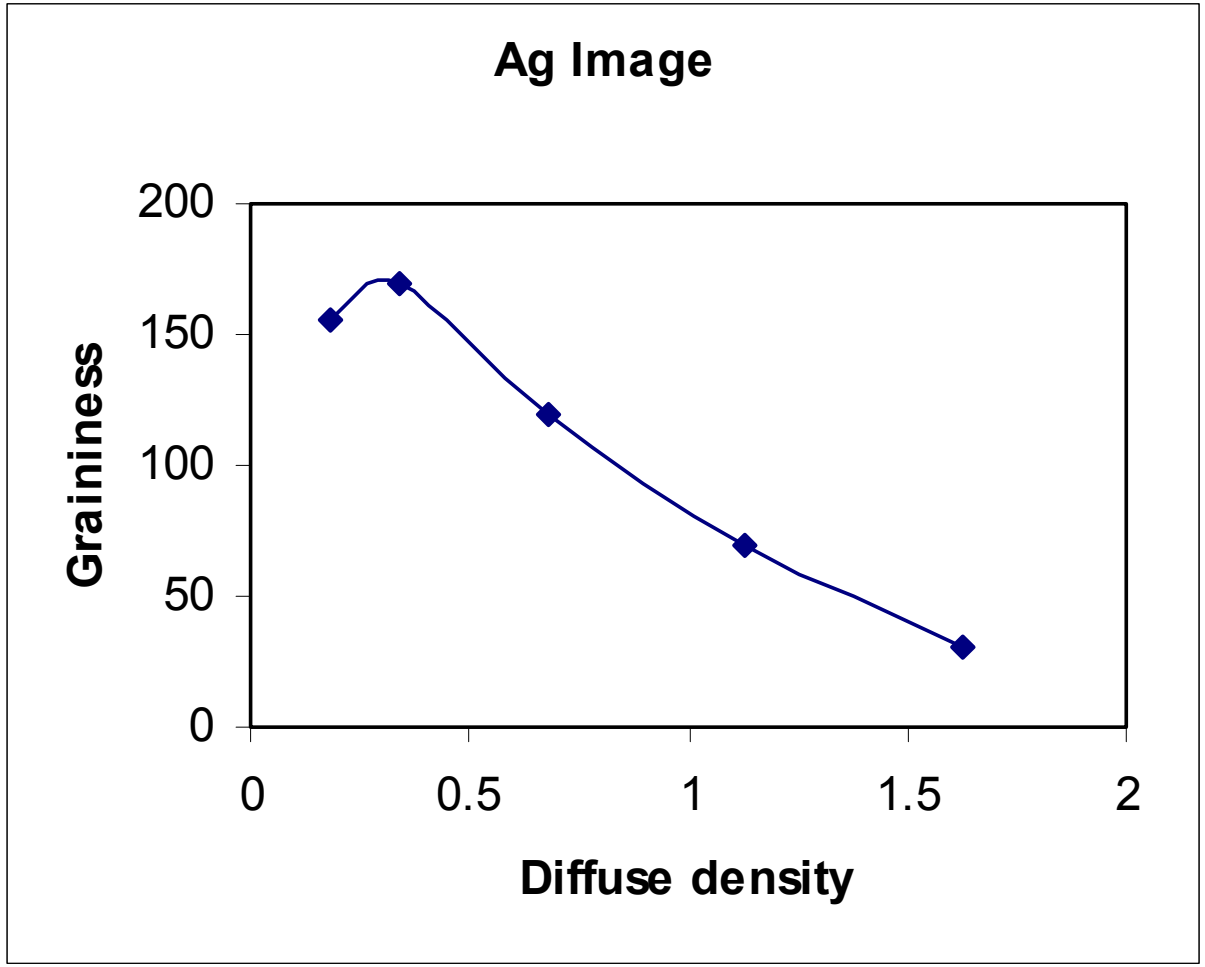
# Digital Noise



# Photographic Emulsion Noise

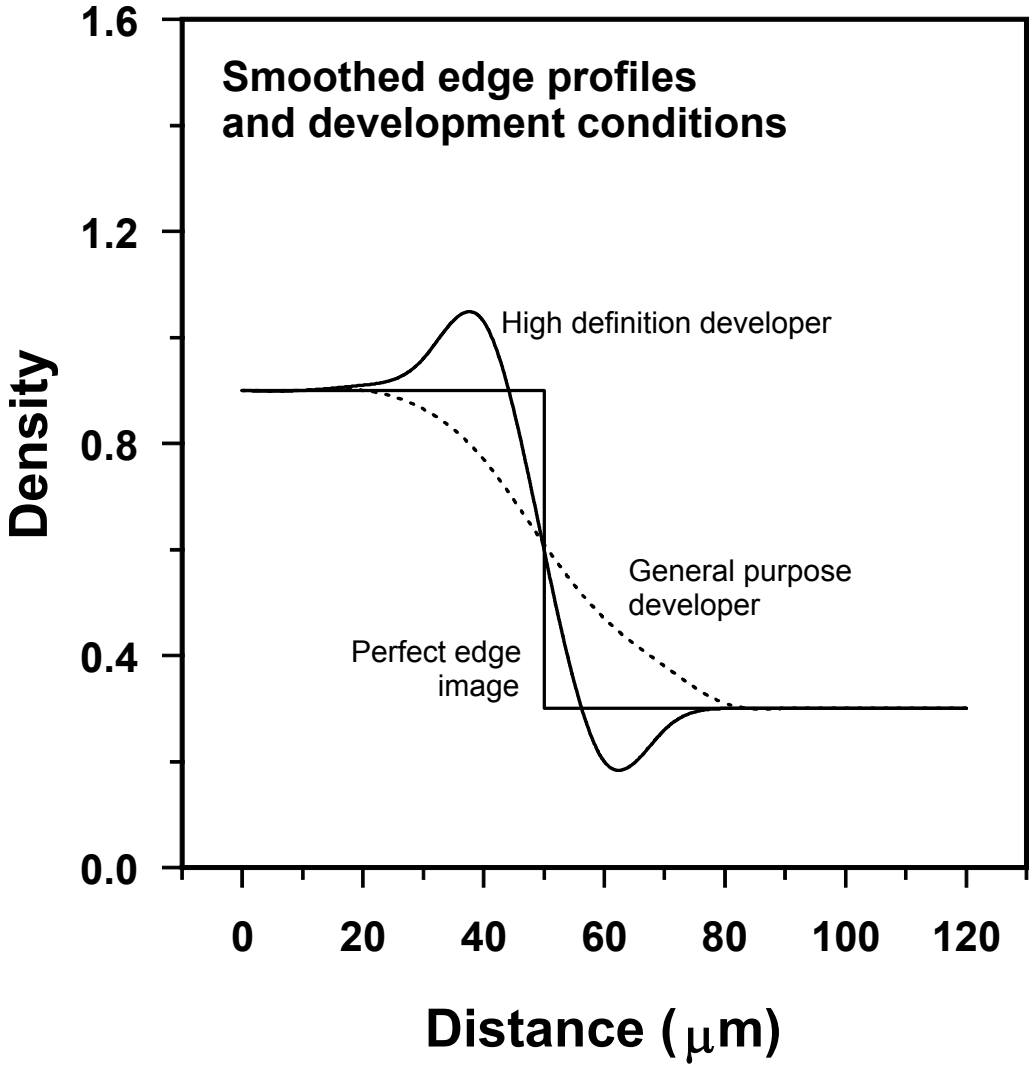


# Silver Image Graininess

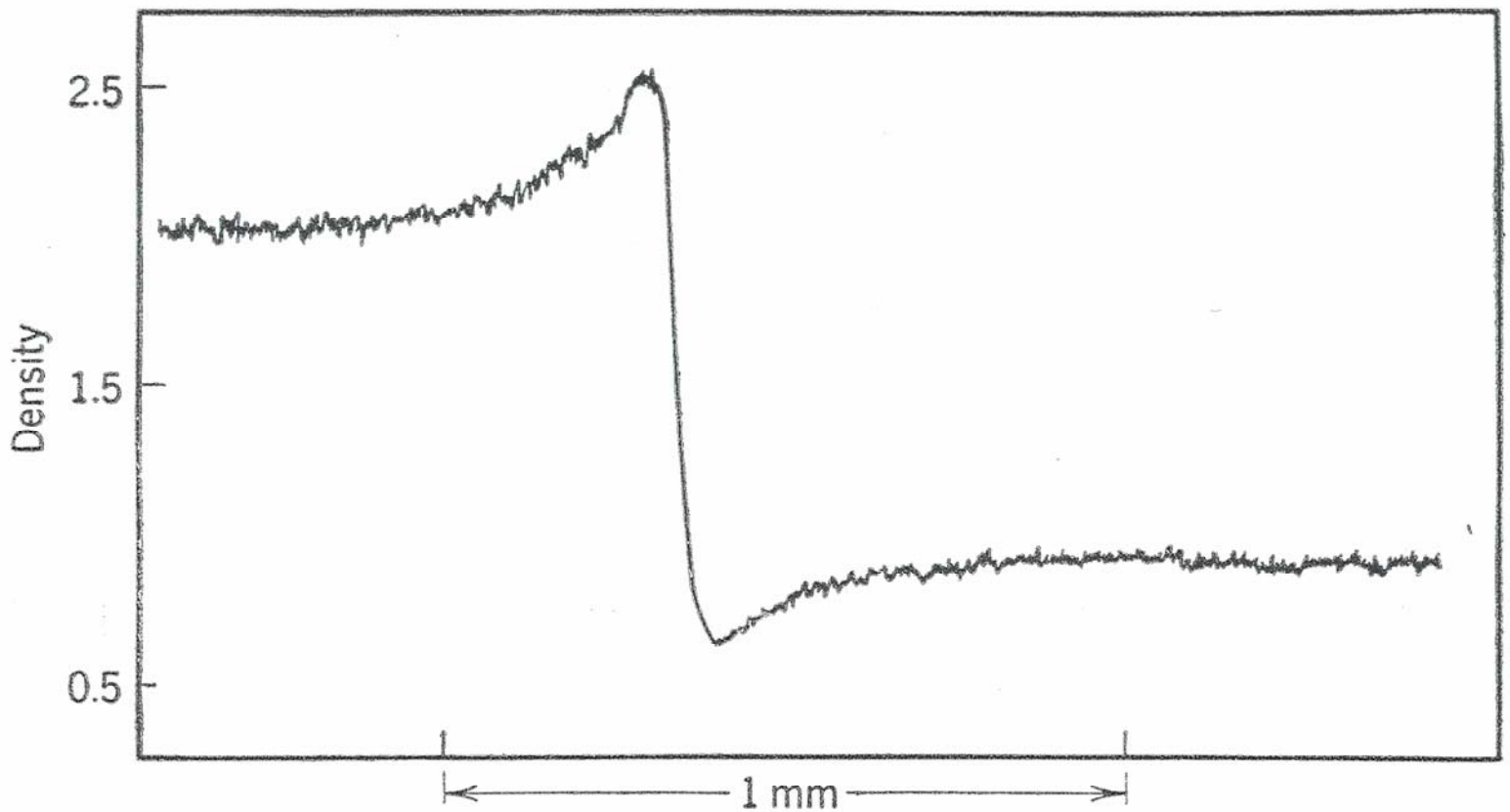


# Gretag Macbeth ColorChecker

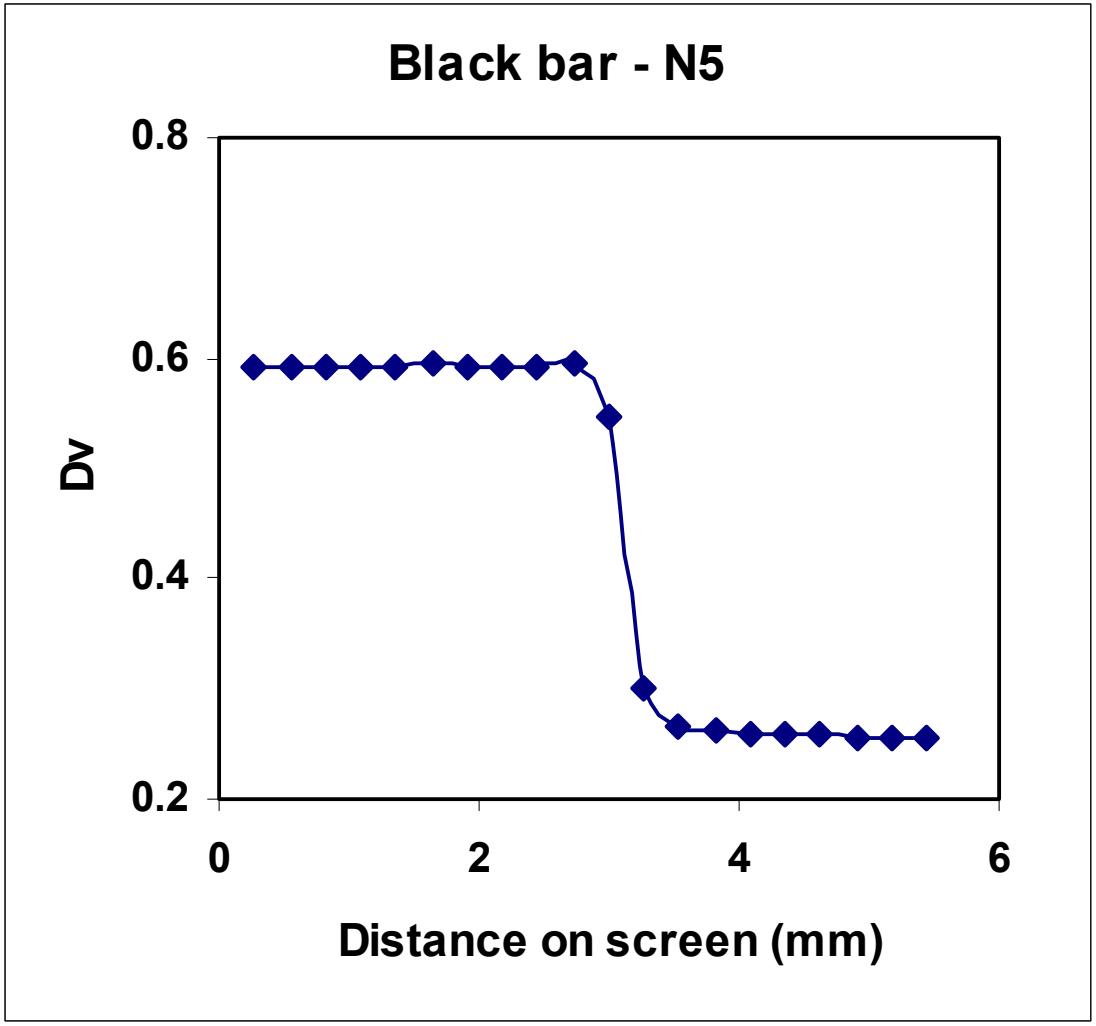
# Edge and Emulsion Response



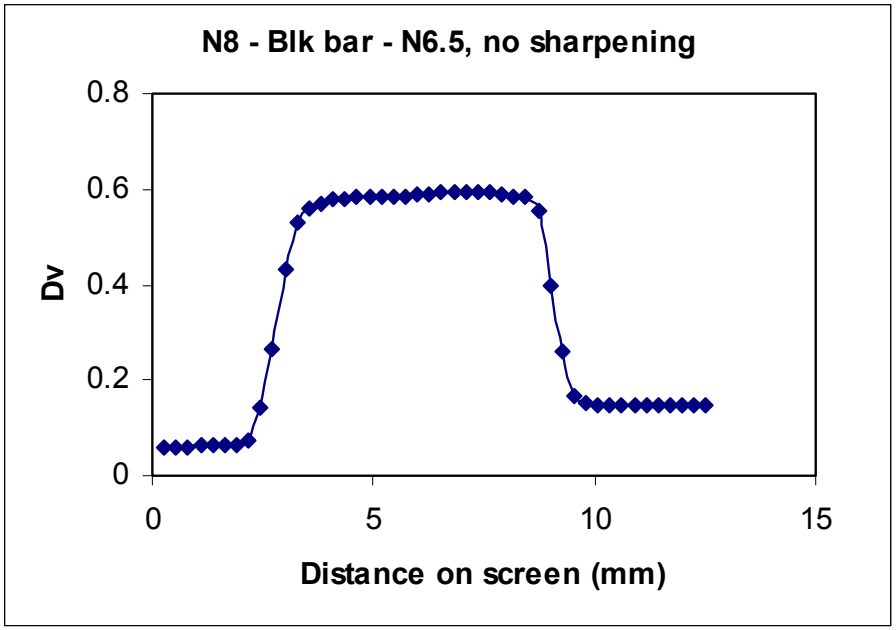
# Ag Edge Profile

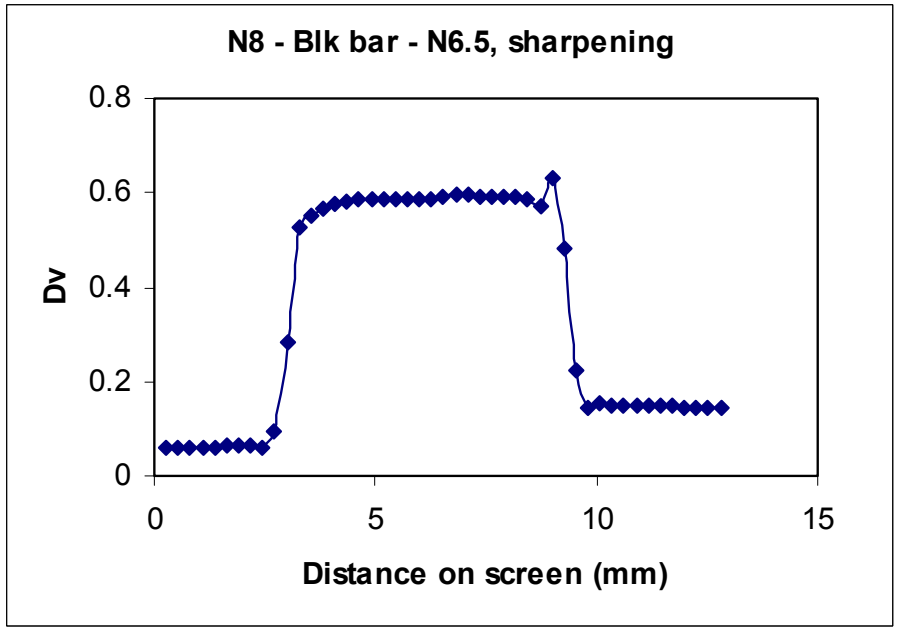


# Edge and CCD Response

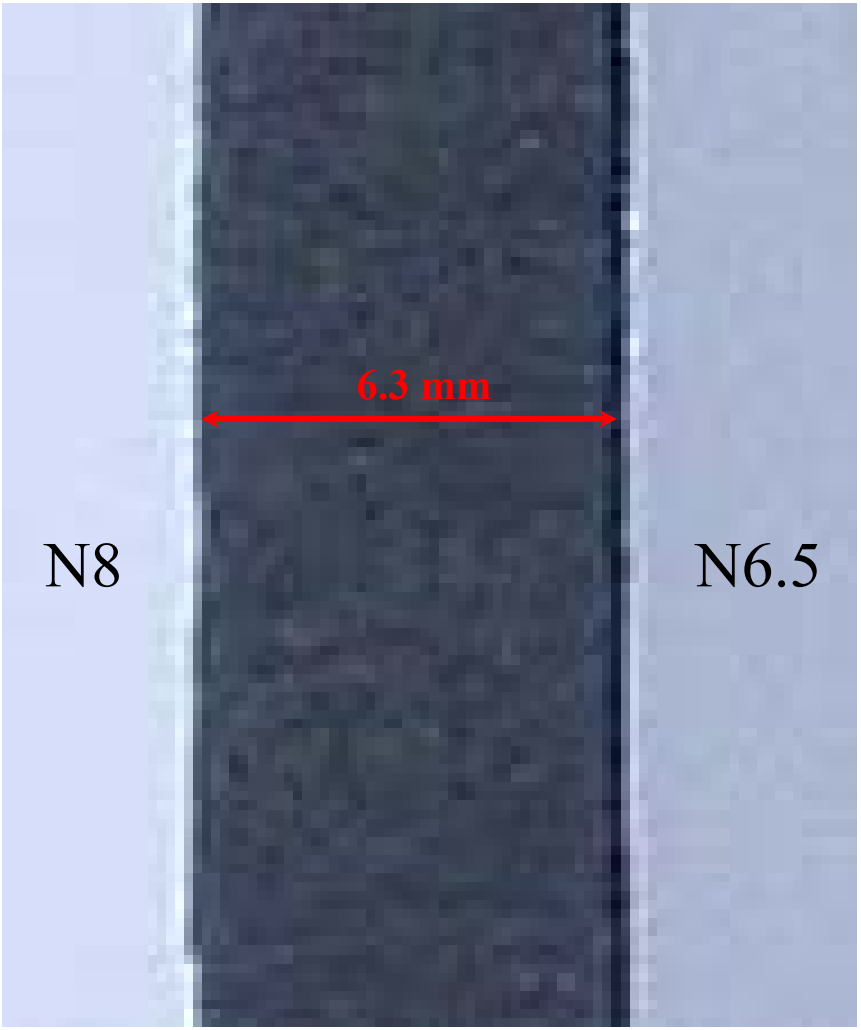


# Sharpening: N8 - black - N6.5



# Sharpness: N8 - black - N6.5



# Digitisation - Artefacts

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

X 1.0

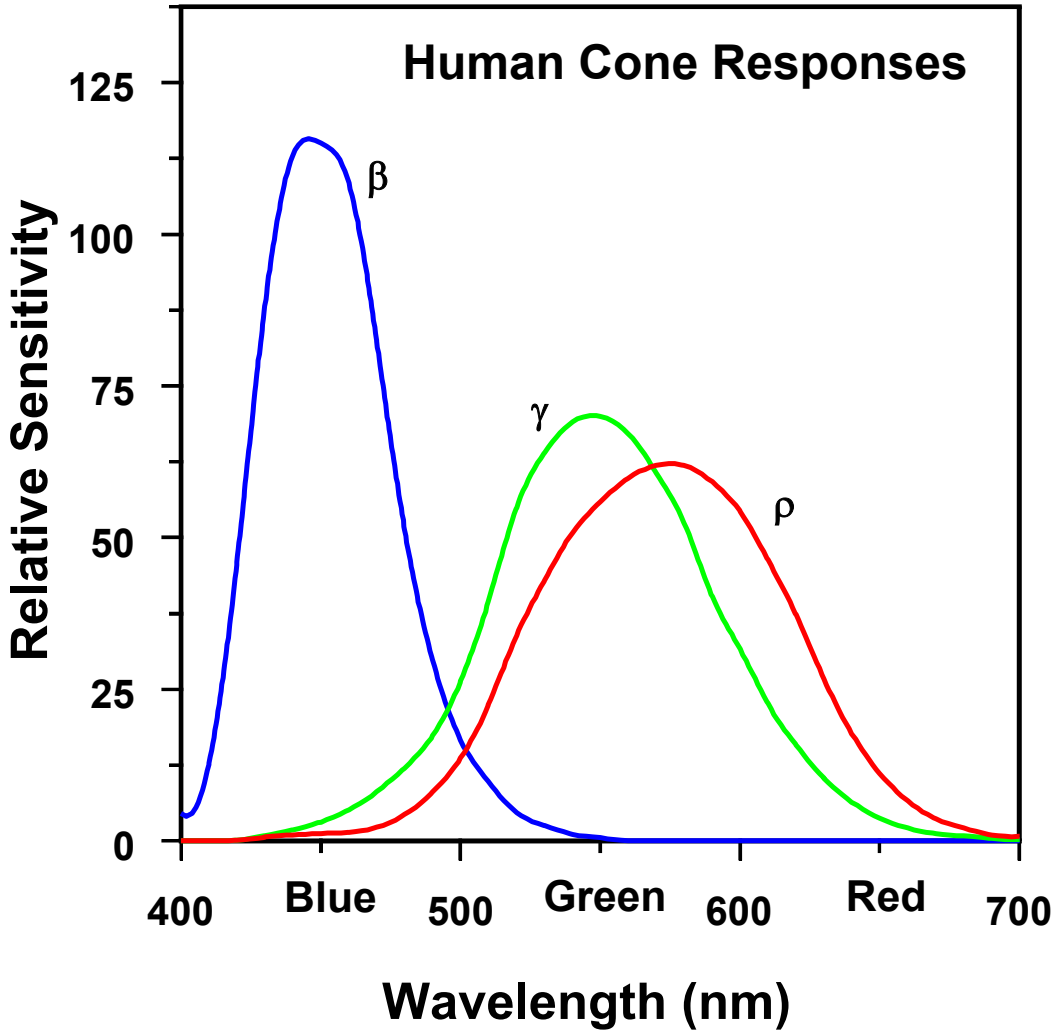
X 2.6

X 7.3

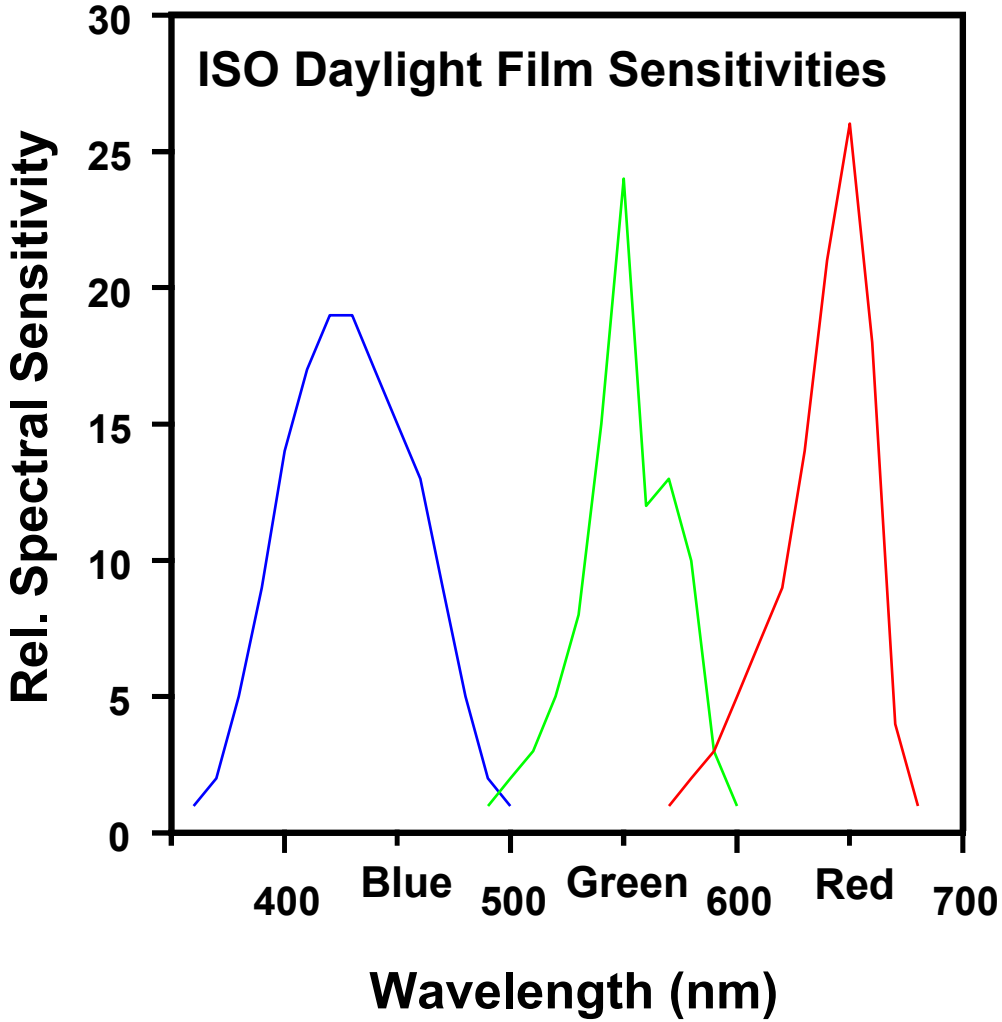
X 12.2

# Colour Reproduction

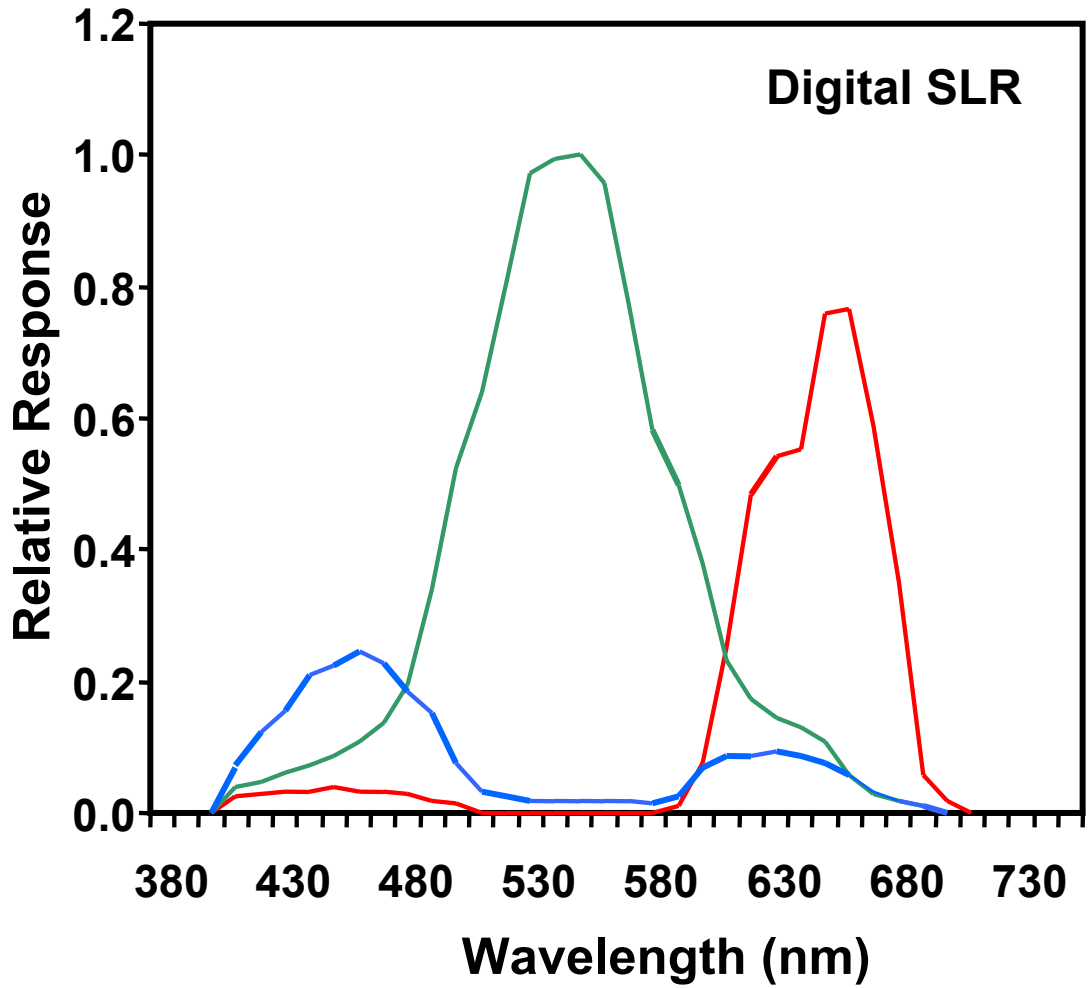
# Human Photopic Colour Vision



# Imaging System (Film)

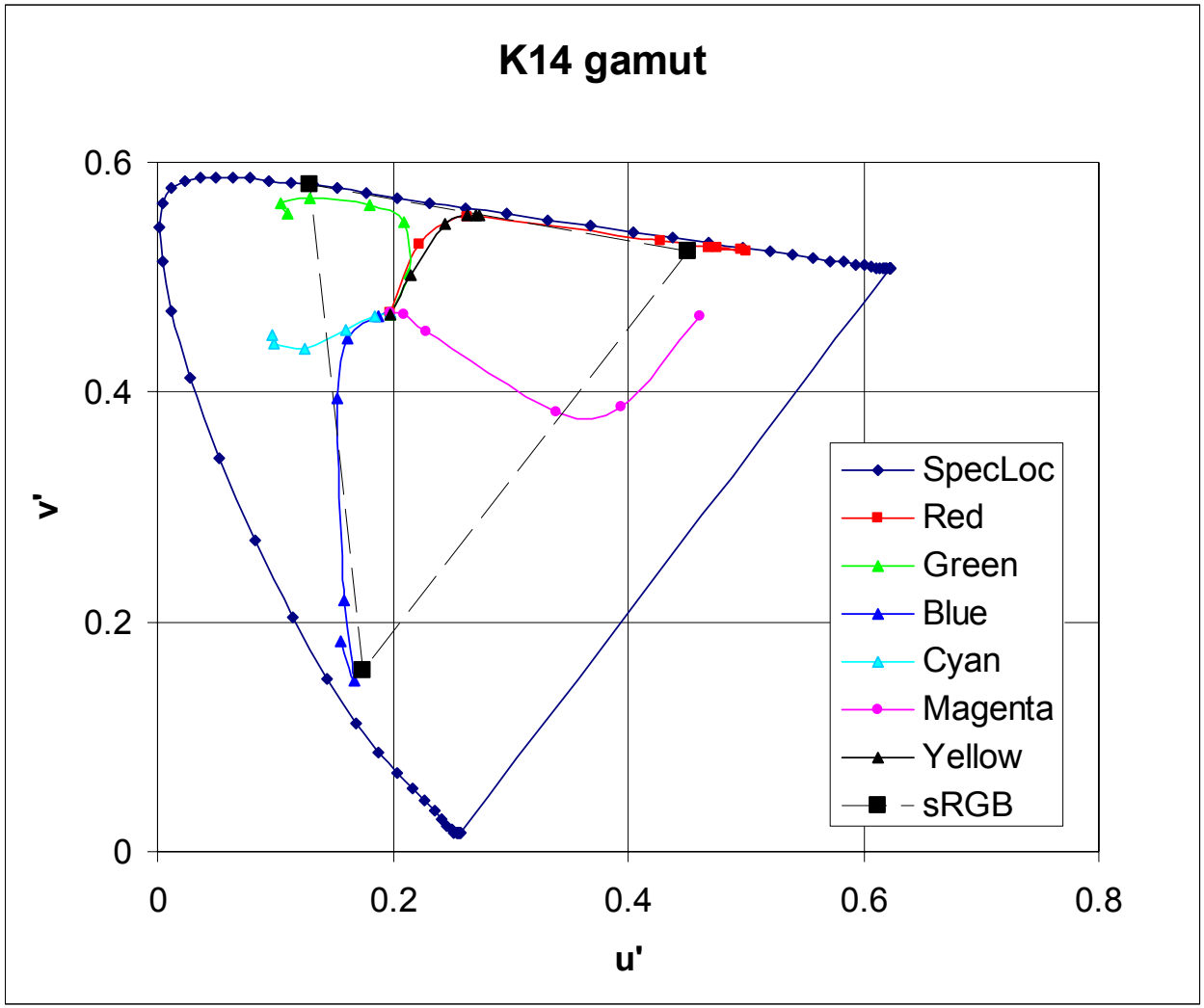


# Imaging System (Digital SLR)

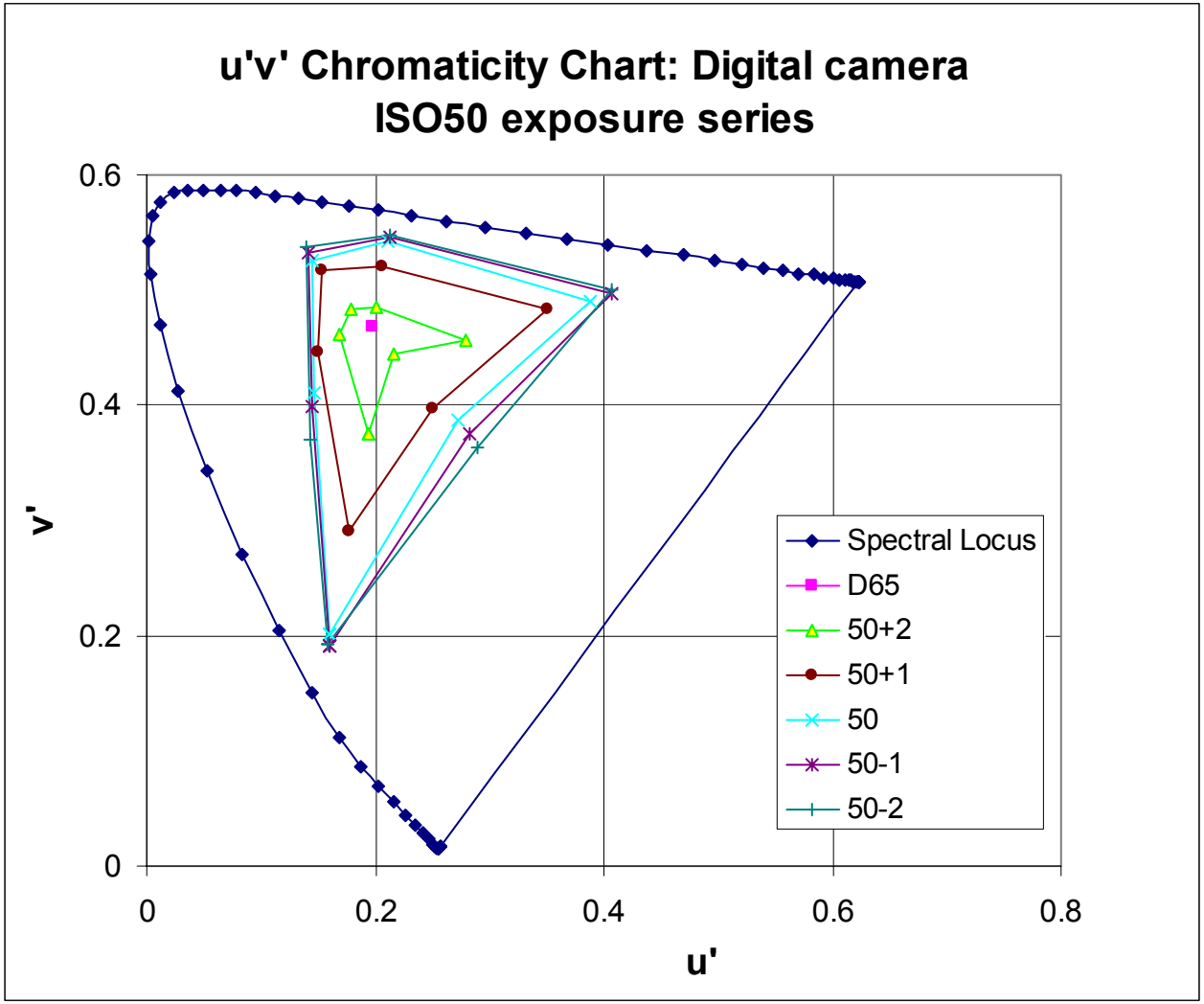


# Colour Gamut

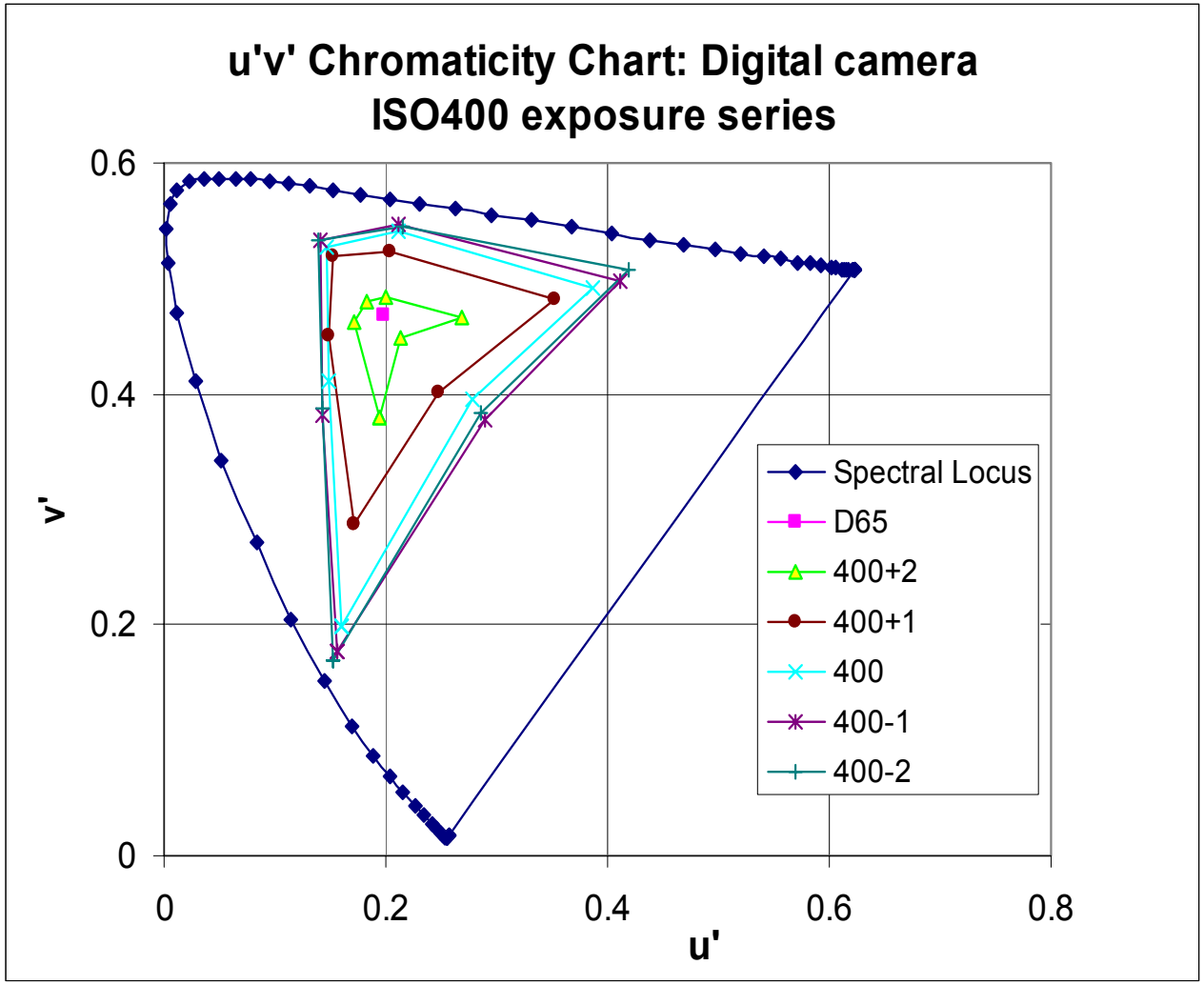
# Colour Gamut - Reversal Film



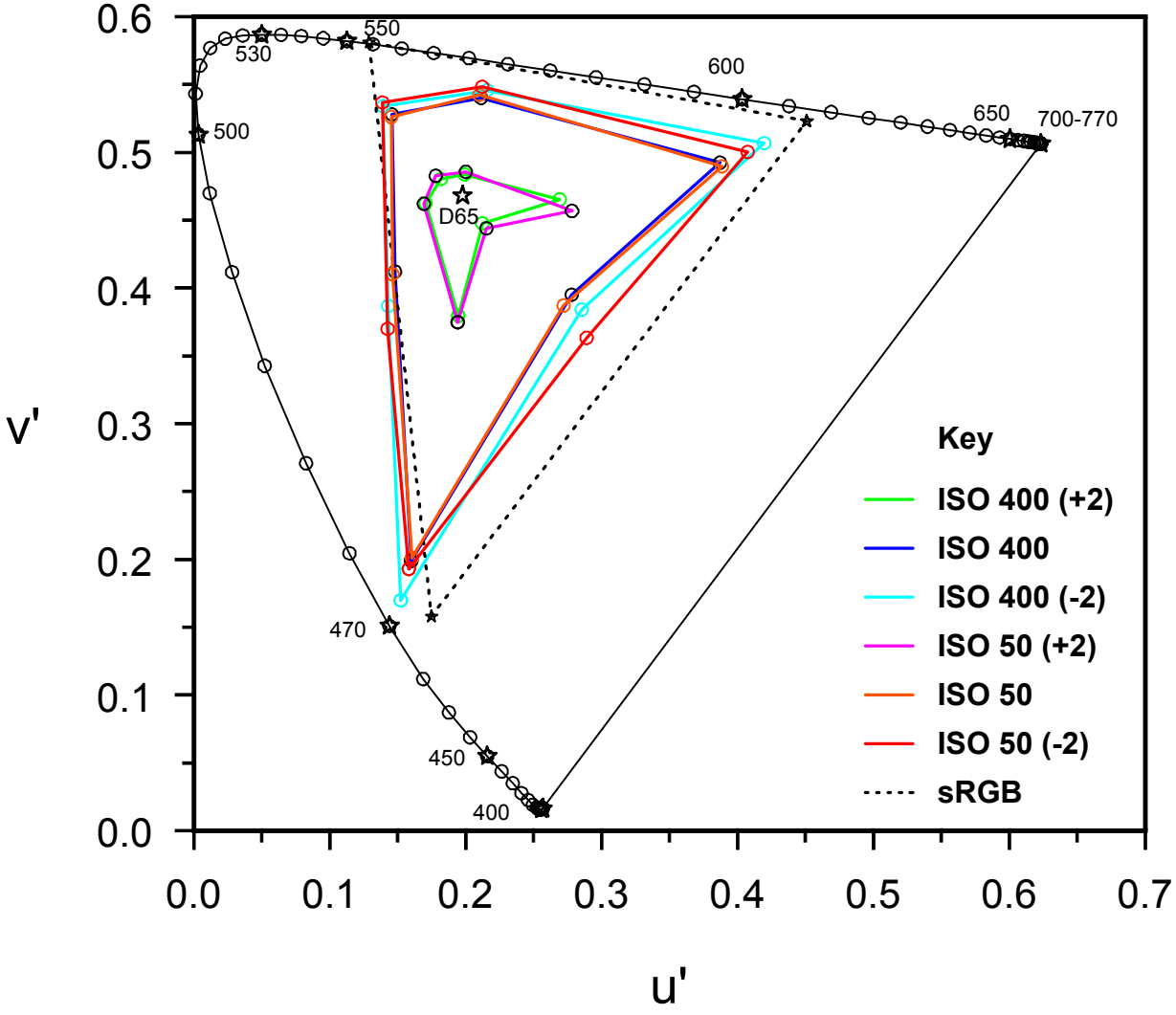
# Colour Gamut - Digital (50)



# Colour Gamut - Digital (400)



# Gamuts - Digital & sRGB



# D & A Parallels Exist

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