

Simultaneous Three-Wavelength Interferometry for Head/Tape Spacing Measurement

Eric Baugh

Advisor: Prof. F. E. Talke

Center for Magnetic Recording Research

**University of California,
San Diego**

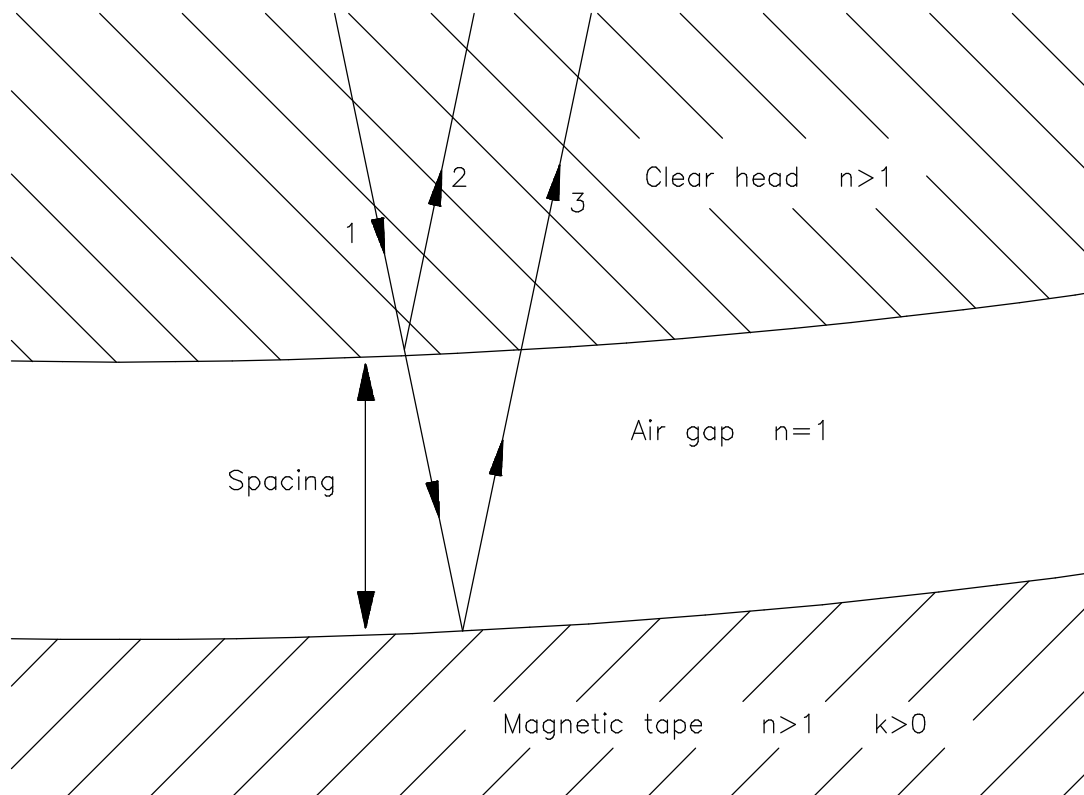


Outline

- **Monochromatic interferometry**
- **Three-wavelength interferometry**
- **Results**
- **Conclusions**

Monochromatic Interferometry

- **replace one half of the interface (preferably the head) with a transparent medium**
- **interference occurs between internal and frontal reflections**



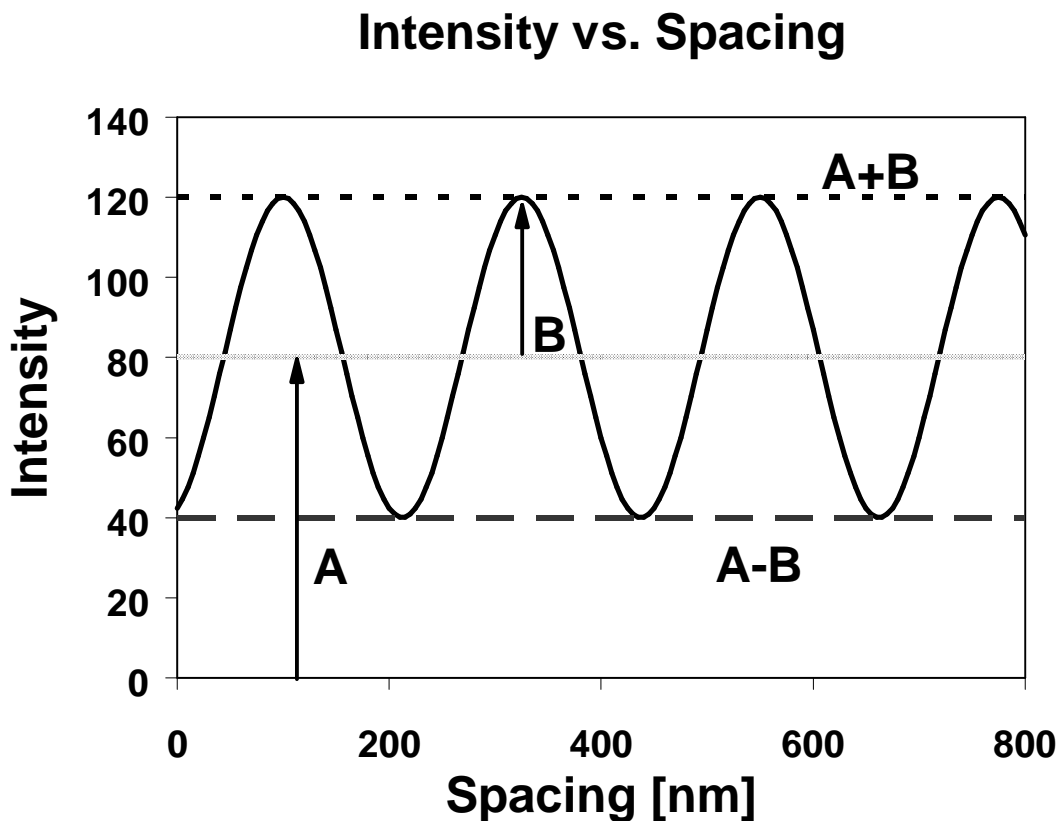
- **assuming single reflection theory for smooth, parallel surfaces, intensity is related to spacing as:**

$$I = A + B \cos \left(\frac{4\pi h}{\lambda} - \phi \right)$$

where:

$I(x,y)$	measured intensity
$A(x,y)$	DC offset
$B(x,y)$	fringe variation
$h(x,y)$	spacing value
λ	wavelength of illumination
$\phi(x,y)$	phase shift upon reflection

- **terms A and B arise from different strengths of interfering wavefronts**
- **terms A and B must be determined before the spacing can be found**
- **this is done by a physical "unloading" process**



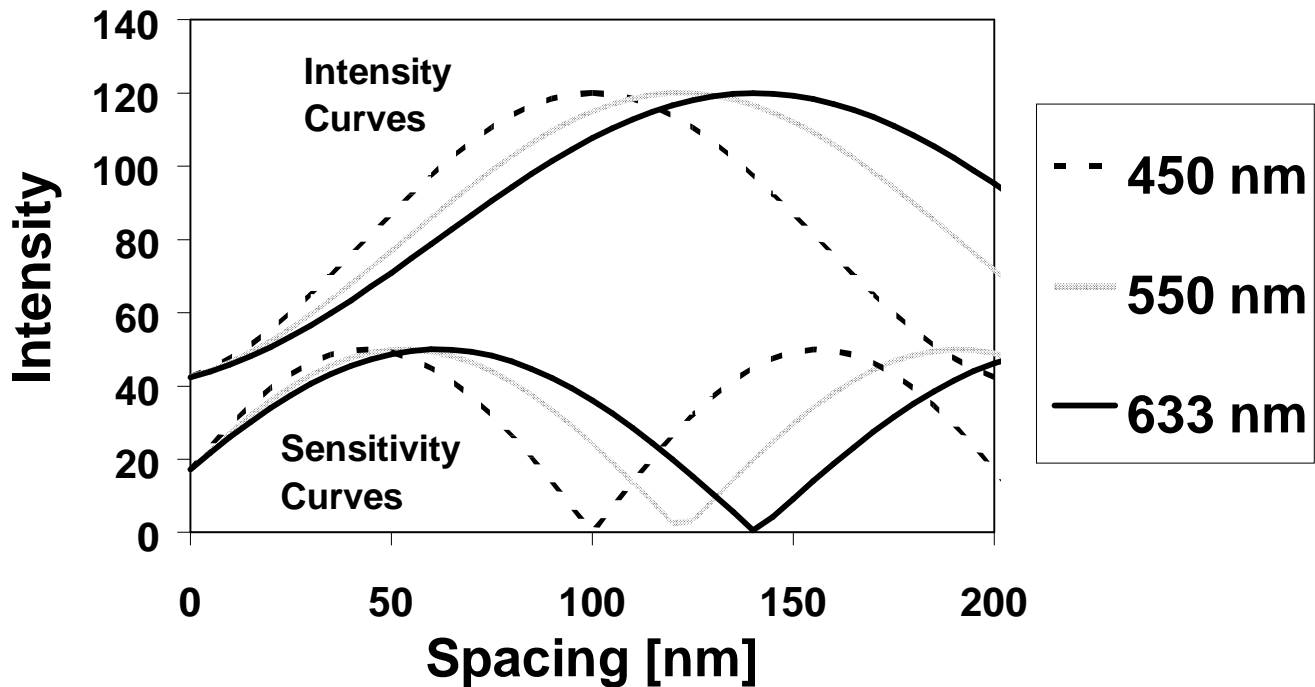
3-Wavelength Interferometry

- use three white-light sources, each with a different interference filter
- couple the light with a 3-into-1 fiber optic cable
- use a color RGB camera and a color frame grabber (8 bits/channel) to digitize image
- combine each spacing by a weighted average:

$$w_i = \left| \sin \left(\frac{4\pi h_i}{\lambda_i} - \phi_i \right) \right|$$

- **weighting factors are based on the slope of the intensity versus spacing curves:**

**Intensity and Sensitivity Curves
for 3 Wavelengths**

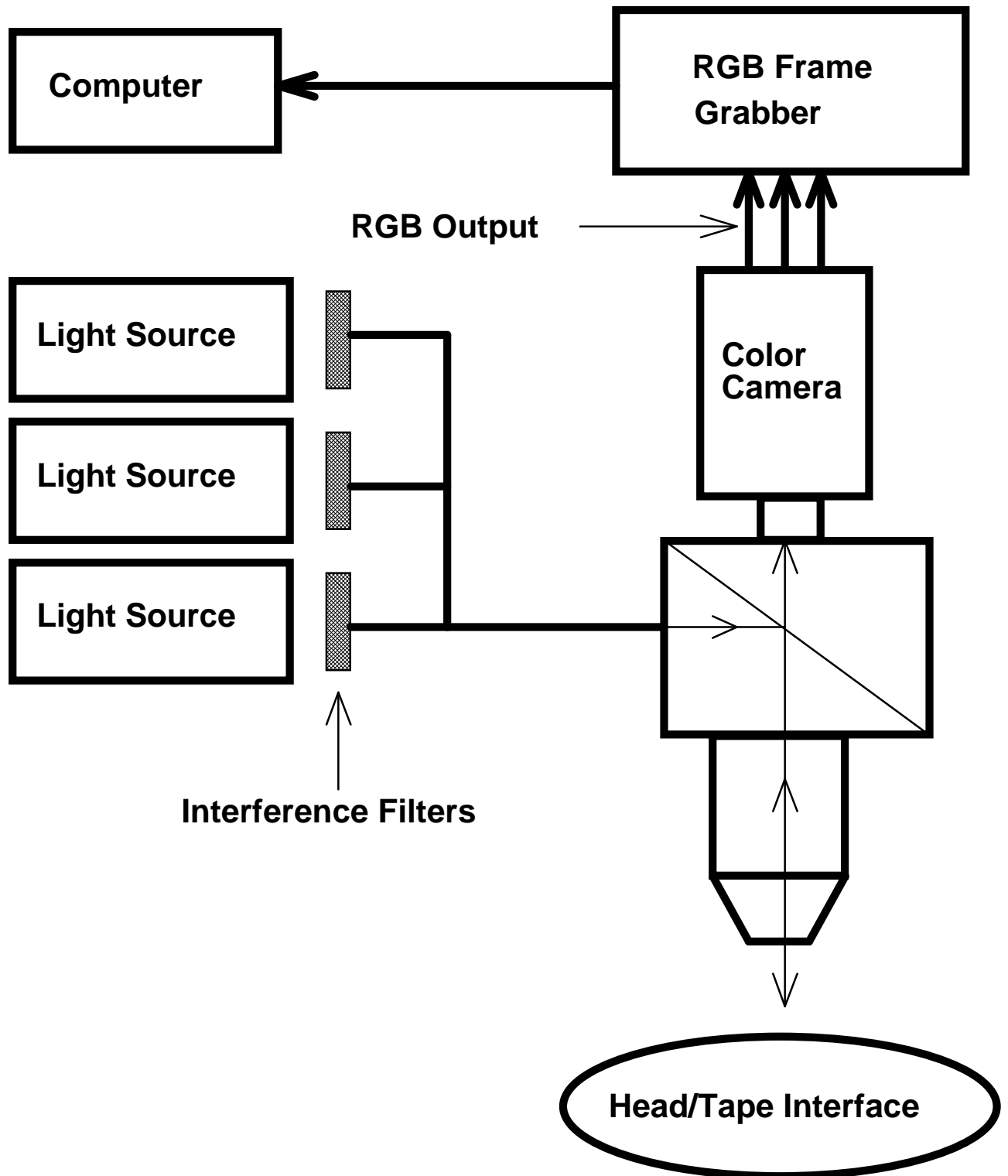


- **Monte-Carlo analysis suggests a reduction in standard deviation by up to 2.5 times**

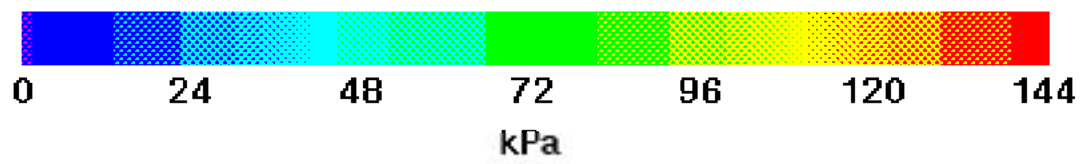
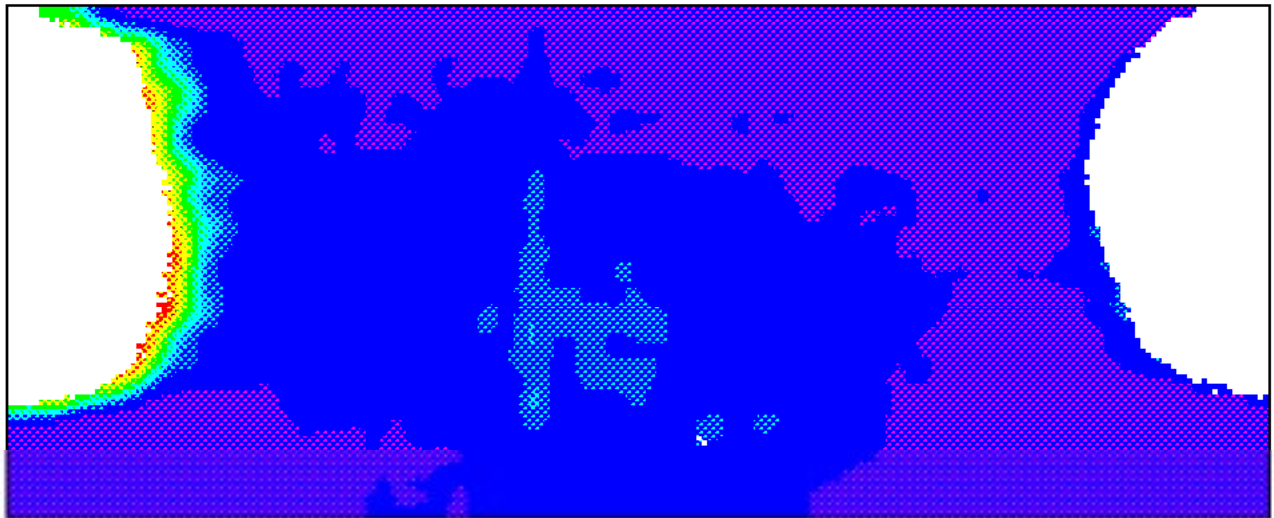
Conclusions

- **three-wavelength technique insensitive to fringe order changes**
- **provides redundancy for measurements below the first fringe order resulting in a reduced standard deviation**
- **spacing map can be used to estimate contact pressures**

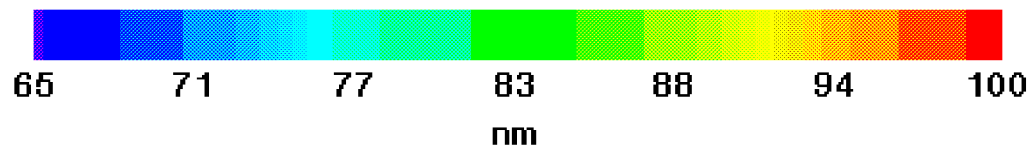
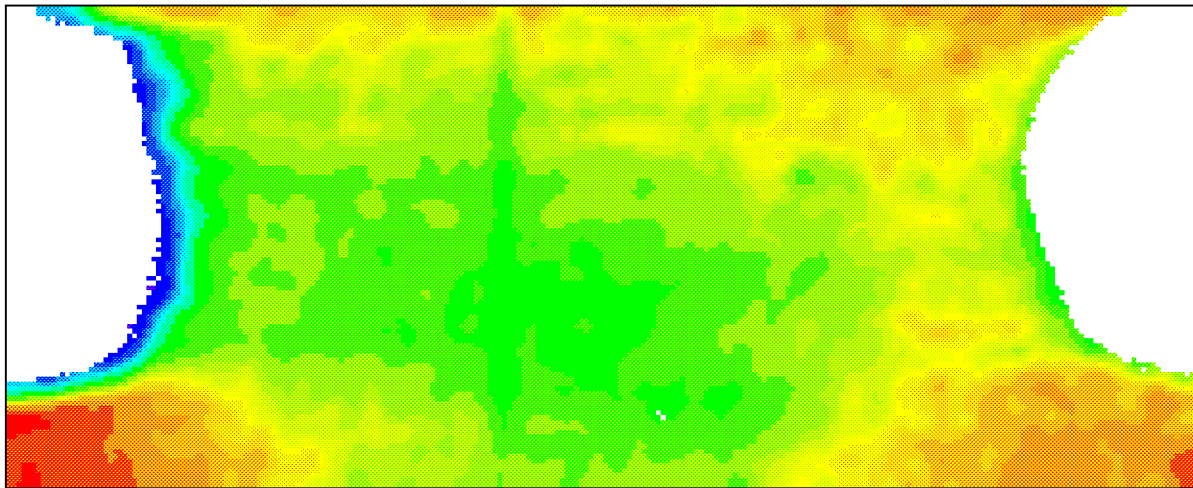
Experimental Setup



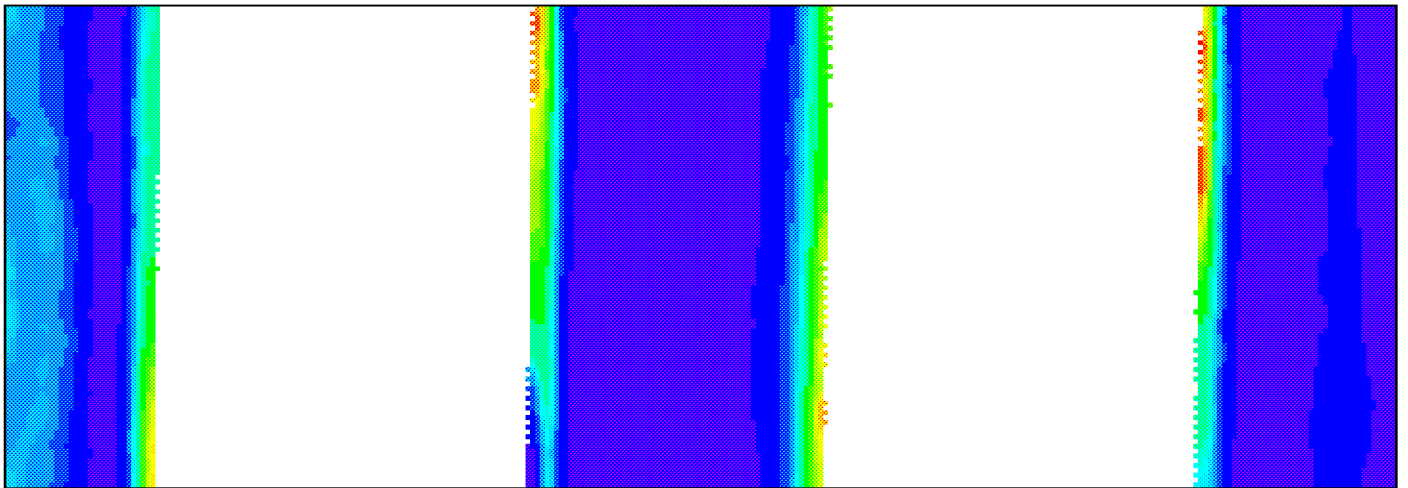
Contact Pressure Plot



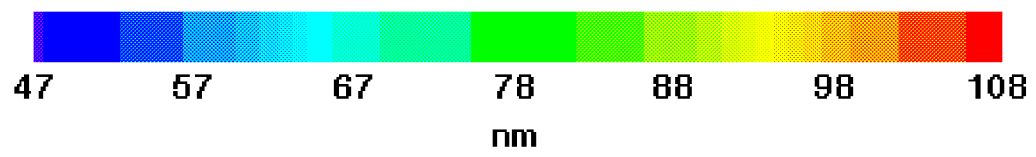
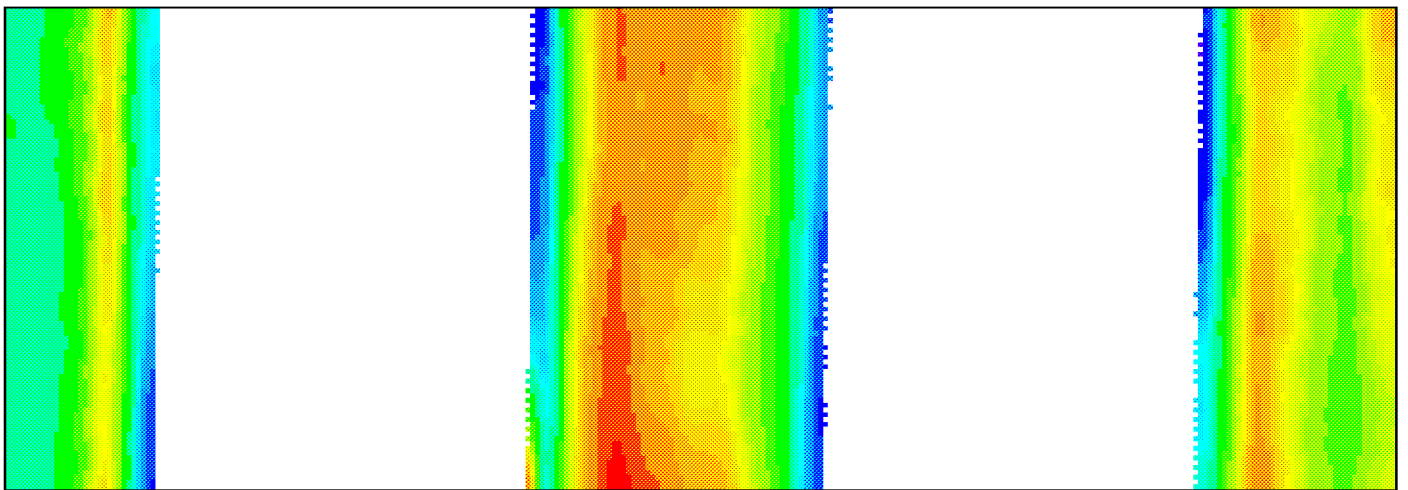
Spacing Plot



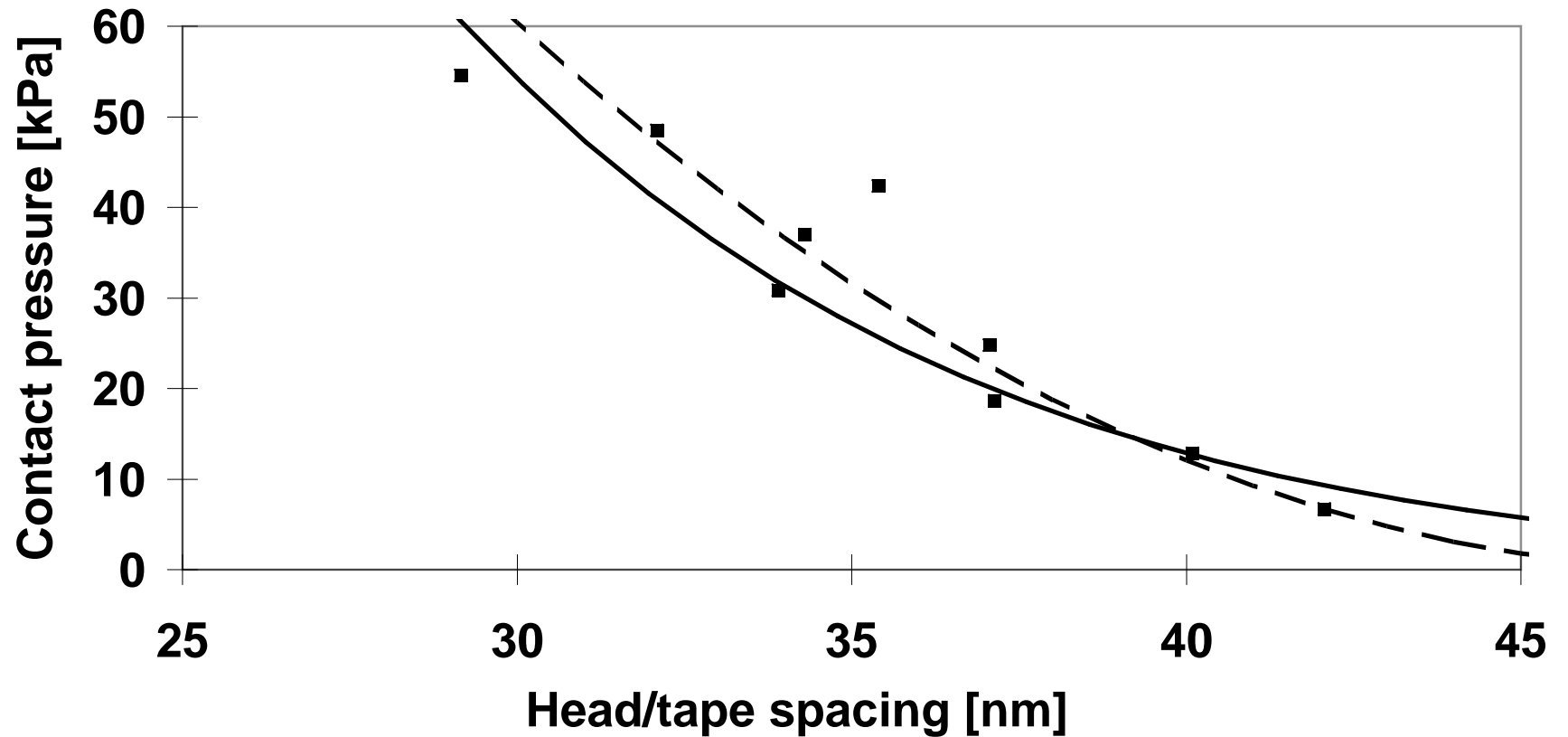
Contact Pressure Plot



Spacing Plot



Comparison of Two Contact Pressure Models

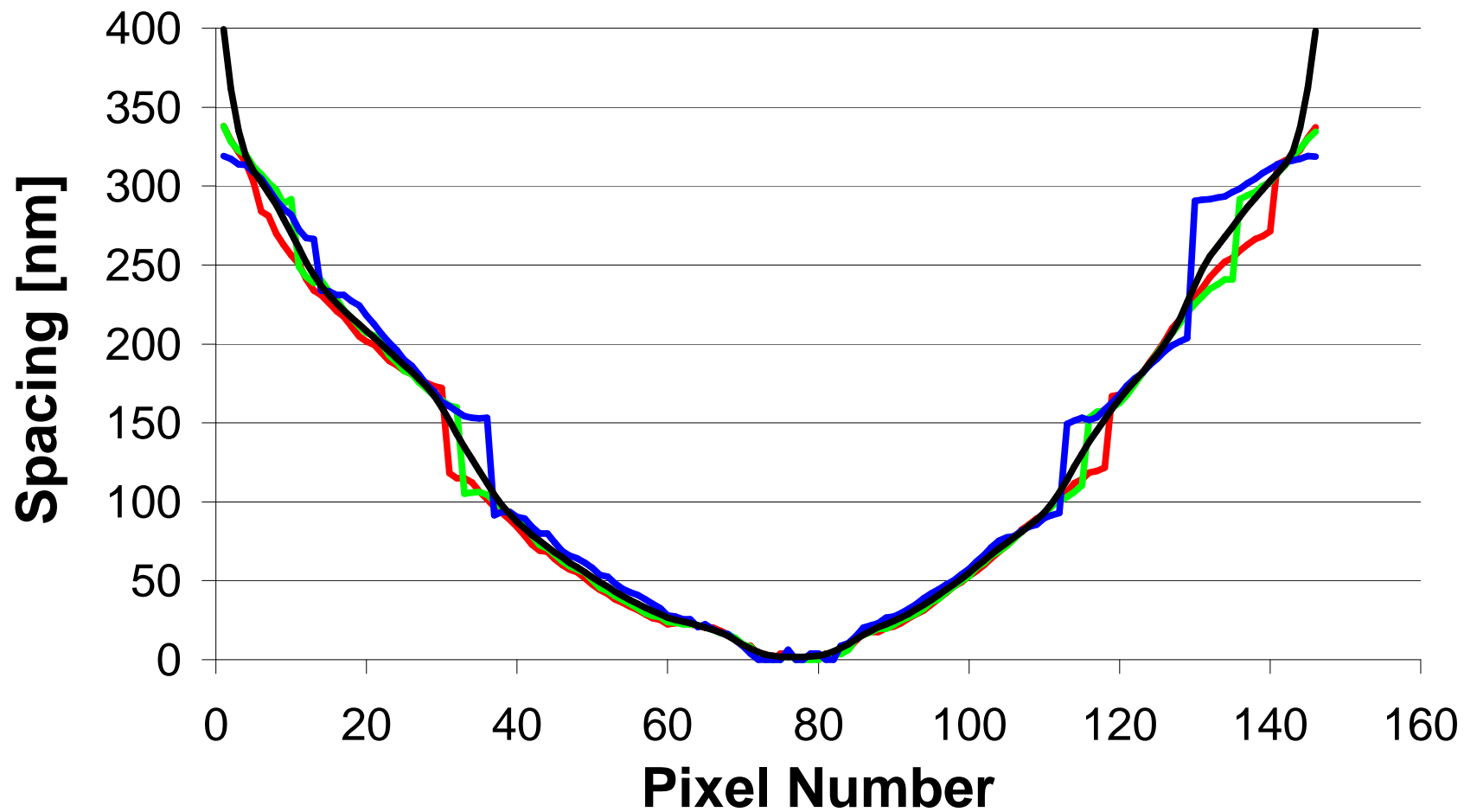


■ Raw Data

- - Parabolic Model

— Greenwood-Williamson Model

Spacing Using Color Camera and Weighted Average



Recent Upgrades

- **capacity for multiple phase shifts (used for clear tapes)**
- **contact pressure calculation and tape parameter library**
- **corrected for camera non-linearity**
- **corrected for camera crosstalk**
- **improved user interface**