

# **Simultaneous Three-Wavelength Interferometry for Head/Tape Spacing Measurement**

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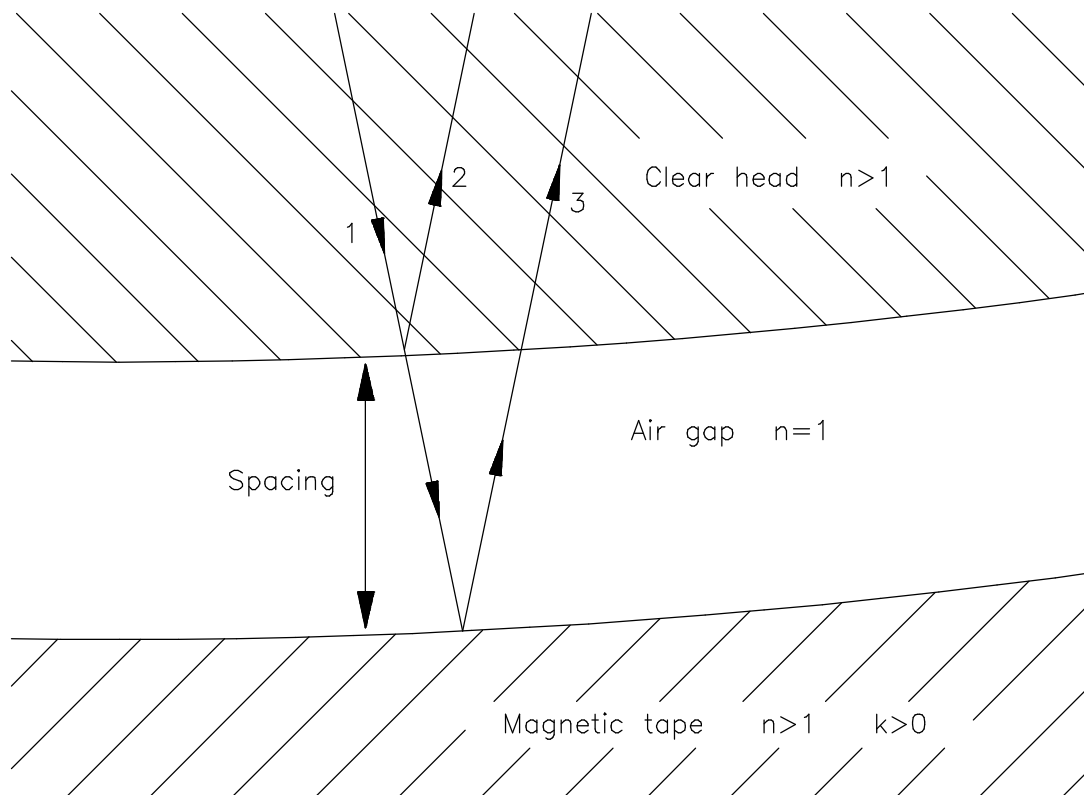


# Outline

- **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:**

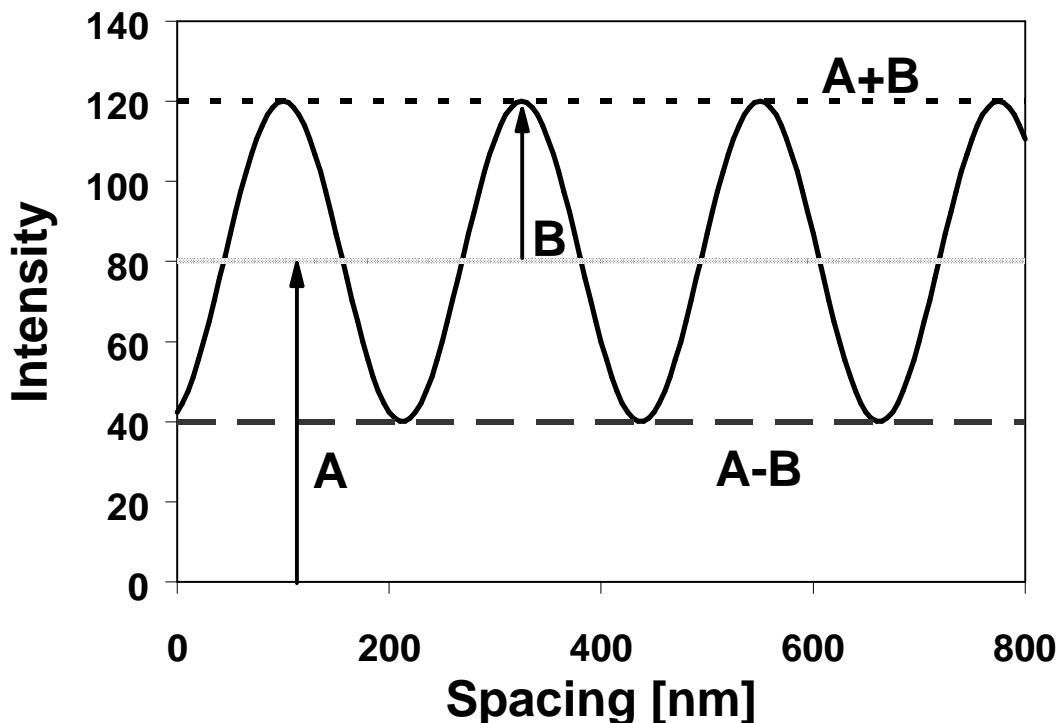
$$I = A + B \cos \left( \frac{4\pi h}{\lambda} - \phi \right)$$

**where:**

$I(x,y)$	measured intensity
$A(x,y)$	DC offset
$B(x,y)$	fringe variation
$h(x,y)$	spacing value
$\lambda$	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**

**Intensity vs. Spacing**



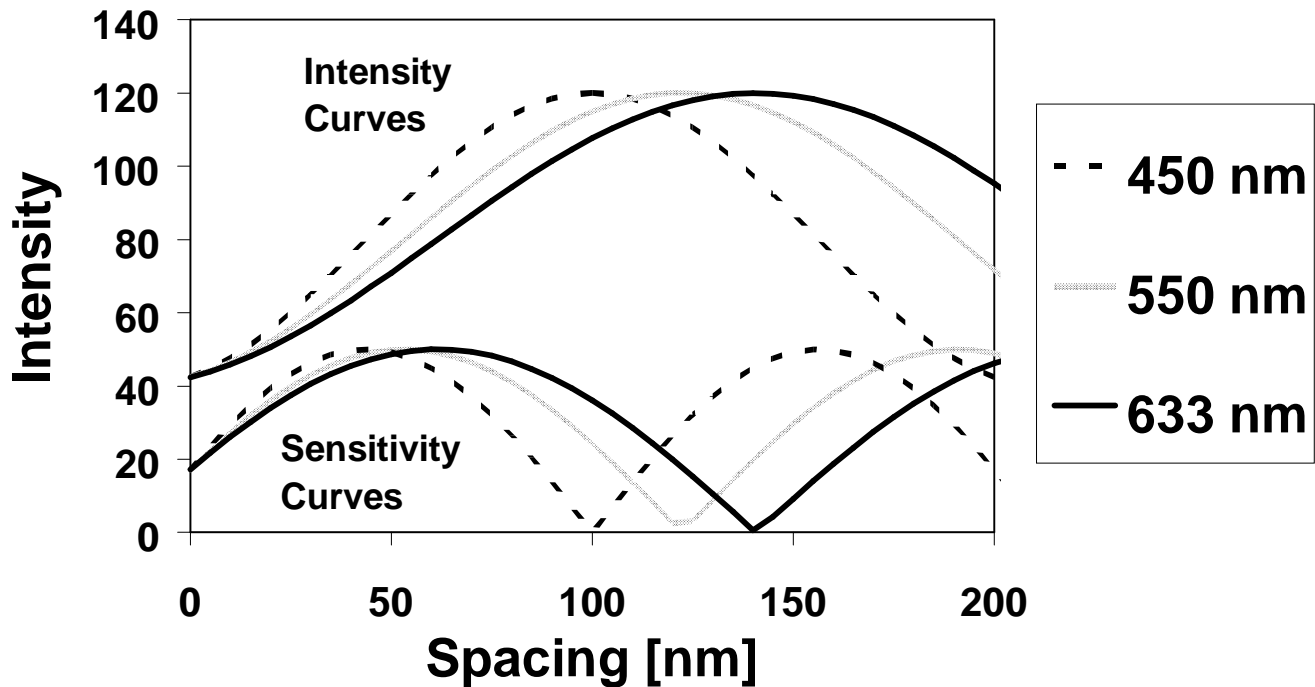
## **3-Wavelength Interferometry**

- **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**



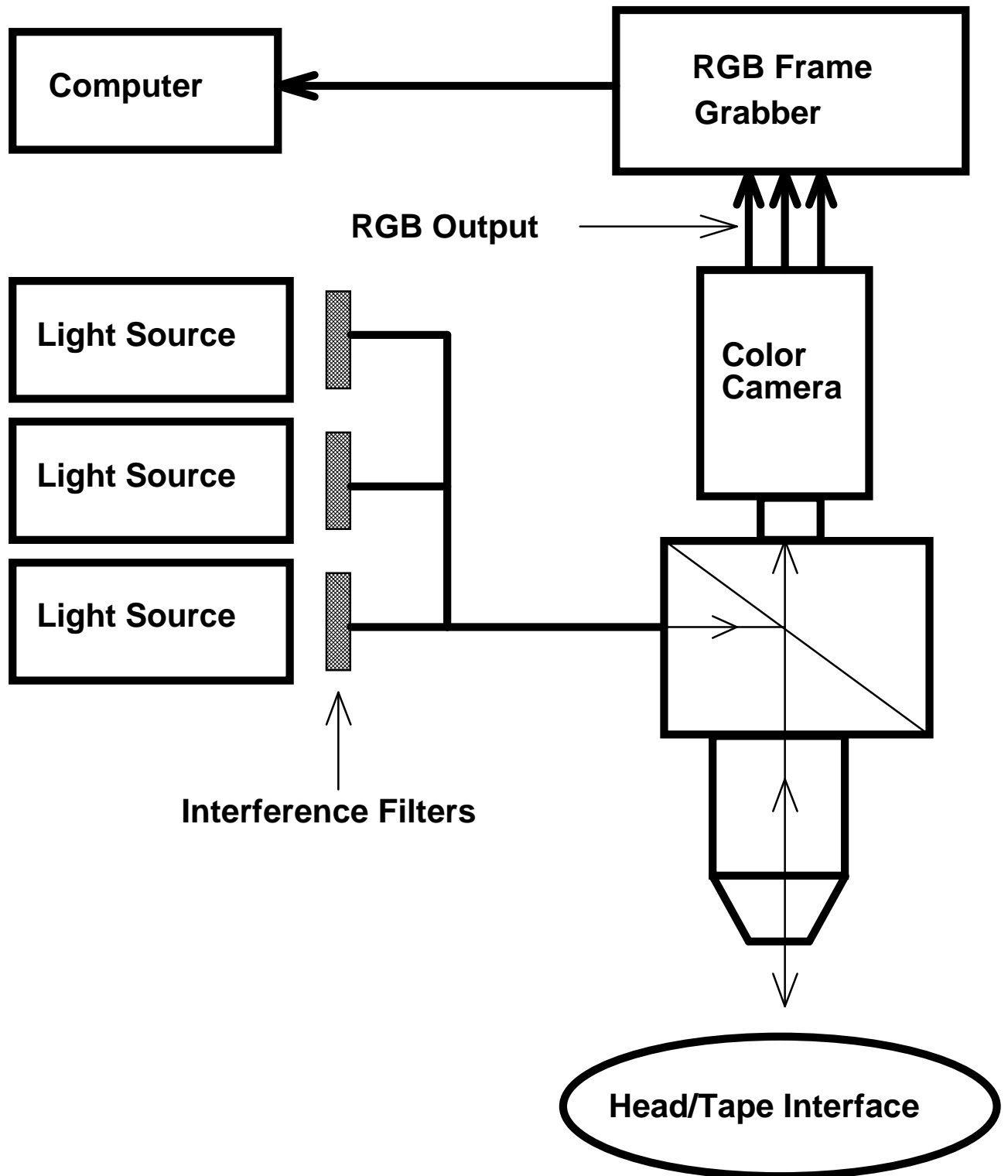
- **Monte-Carlo analysis suggests a reduction in standard deviation by up to 2.5 times**

# Conclusions

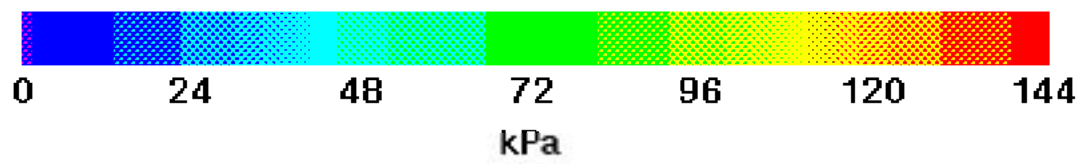
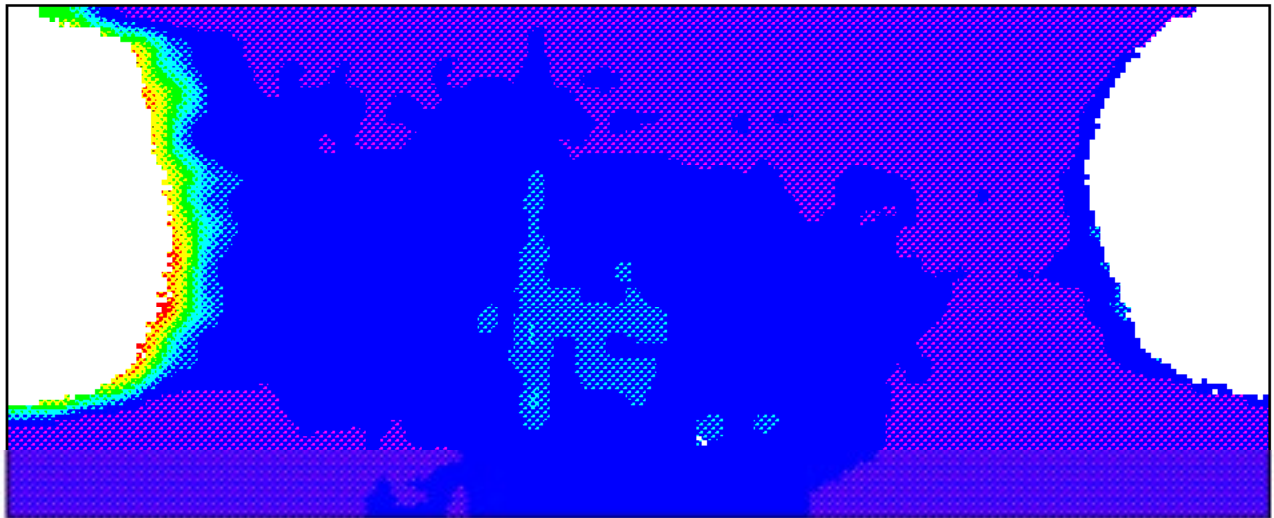
- **three-wavelength technique insensitive to fringe order changes**
- **provides redundancy for measurements below the first fringe order resulting in a reduced standard deviation**
- **spacing map can be used to estimate contact pressures**



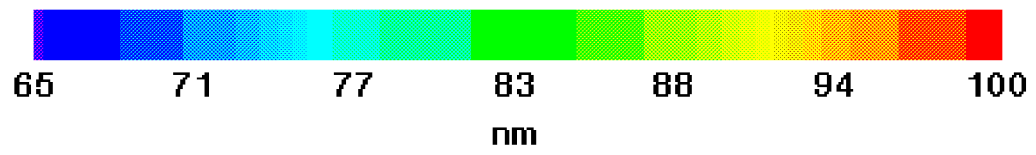
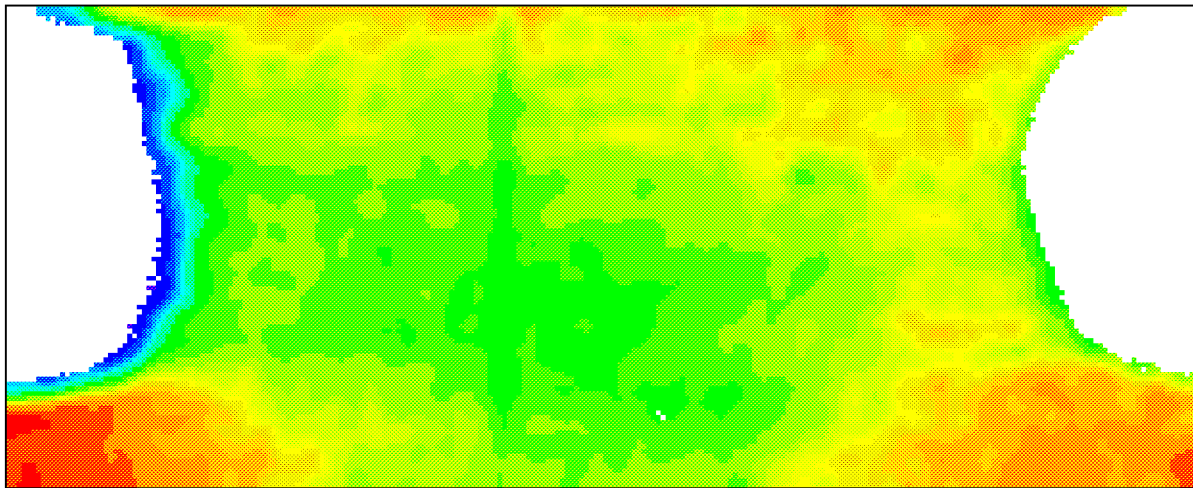
# Experimental Setup



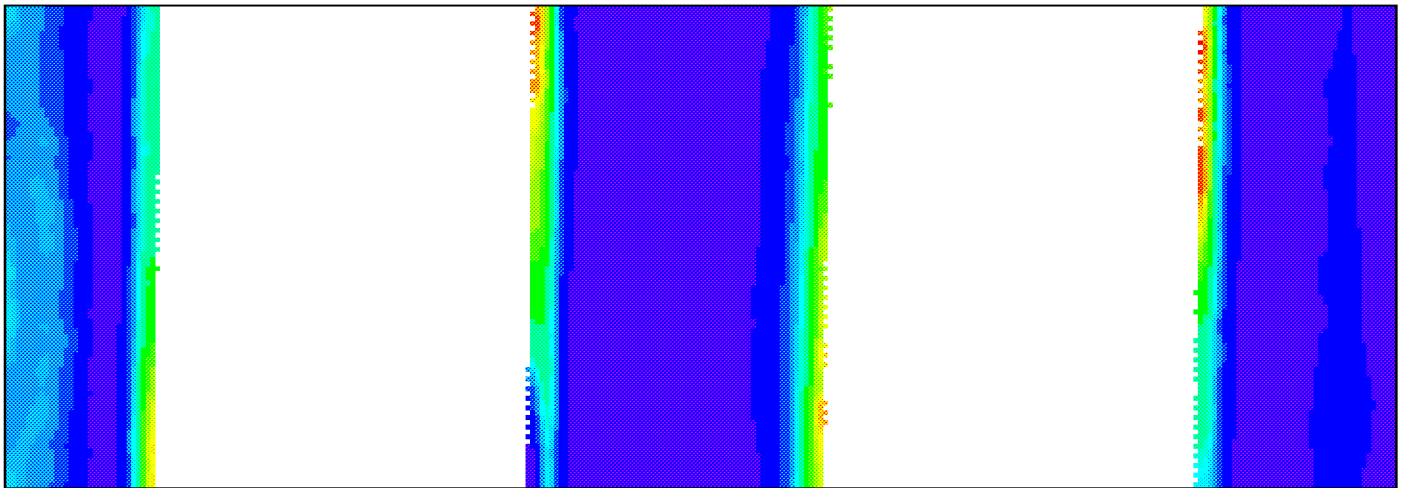
### Contact Pressure Plot



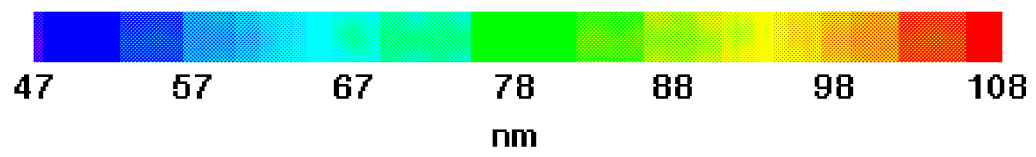
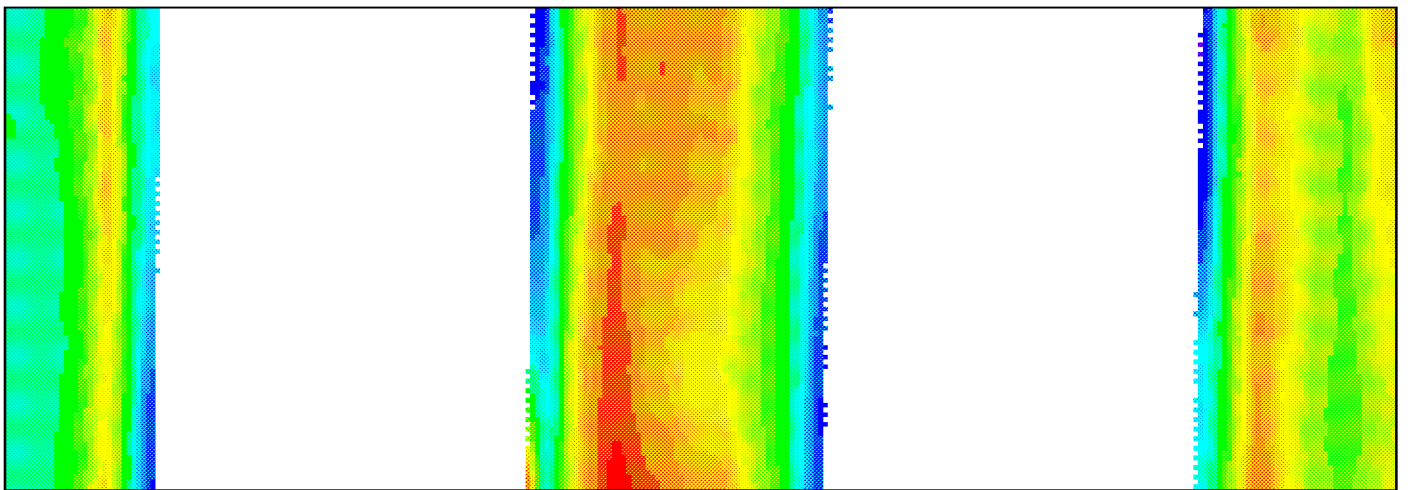
Spacing Plot



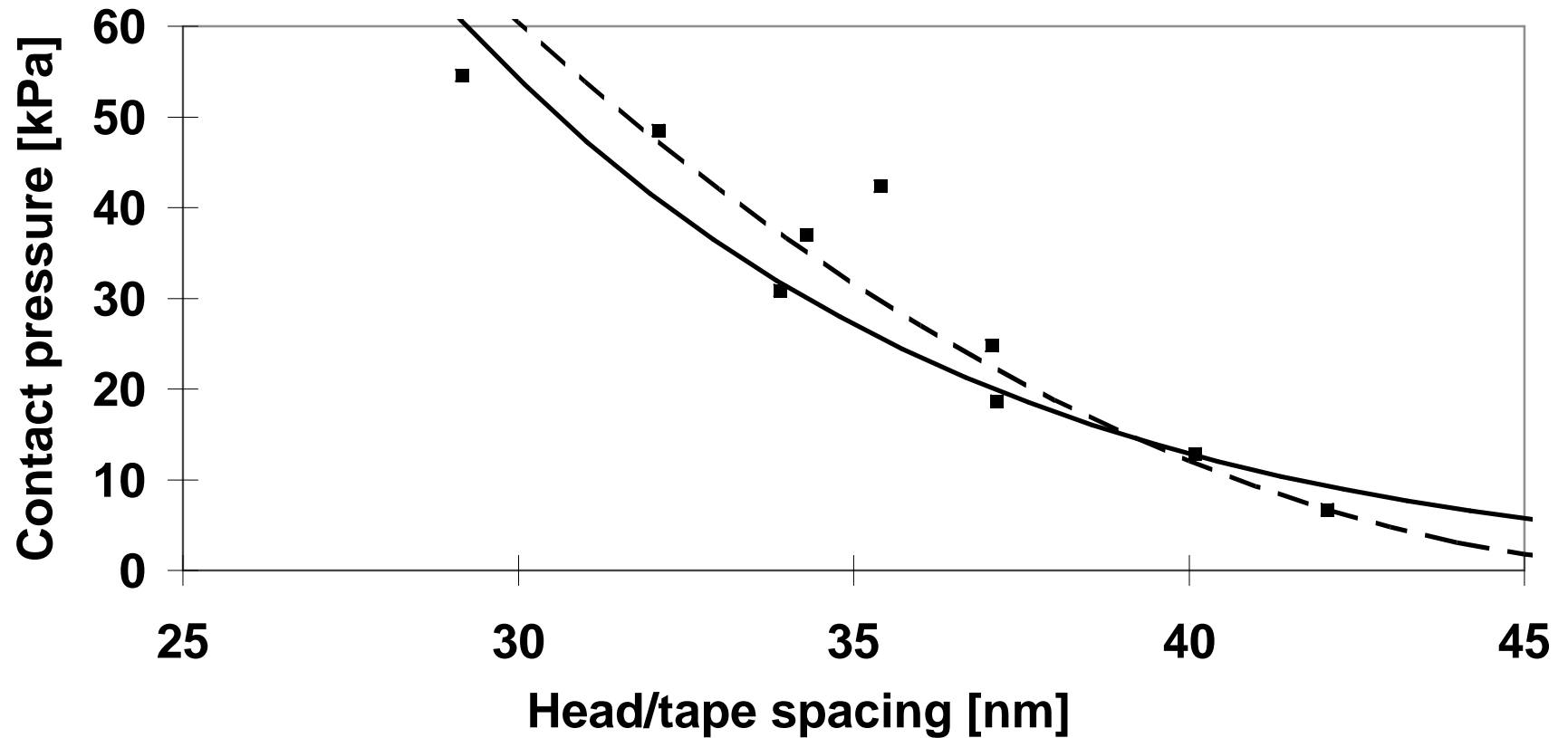
### Contact Pressure Plot



### Spacing Plot



## Comparison of Two Contact Pressure Models

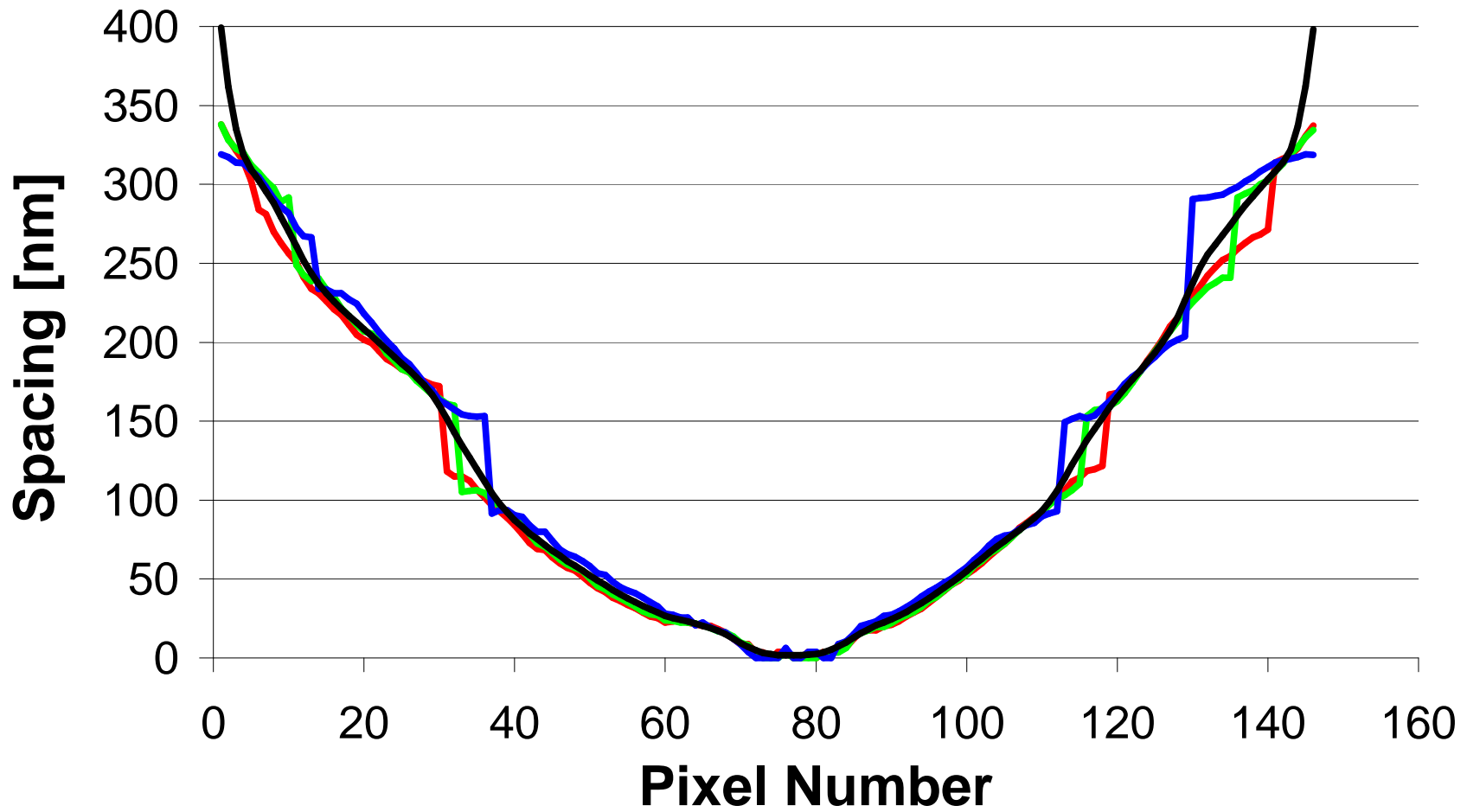


■ Raw Data

- - 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**