The Interface of a flat head and a flexible tape

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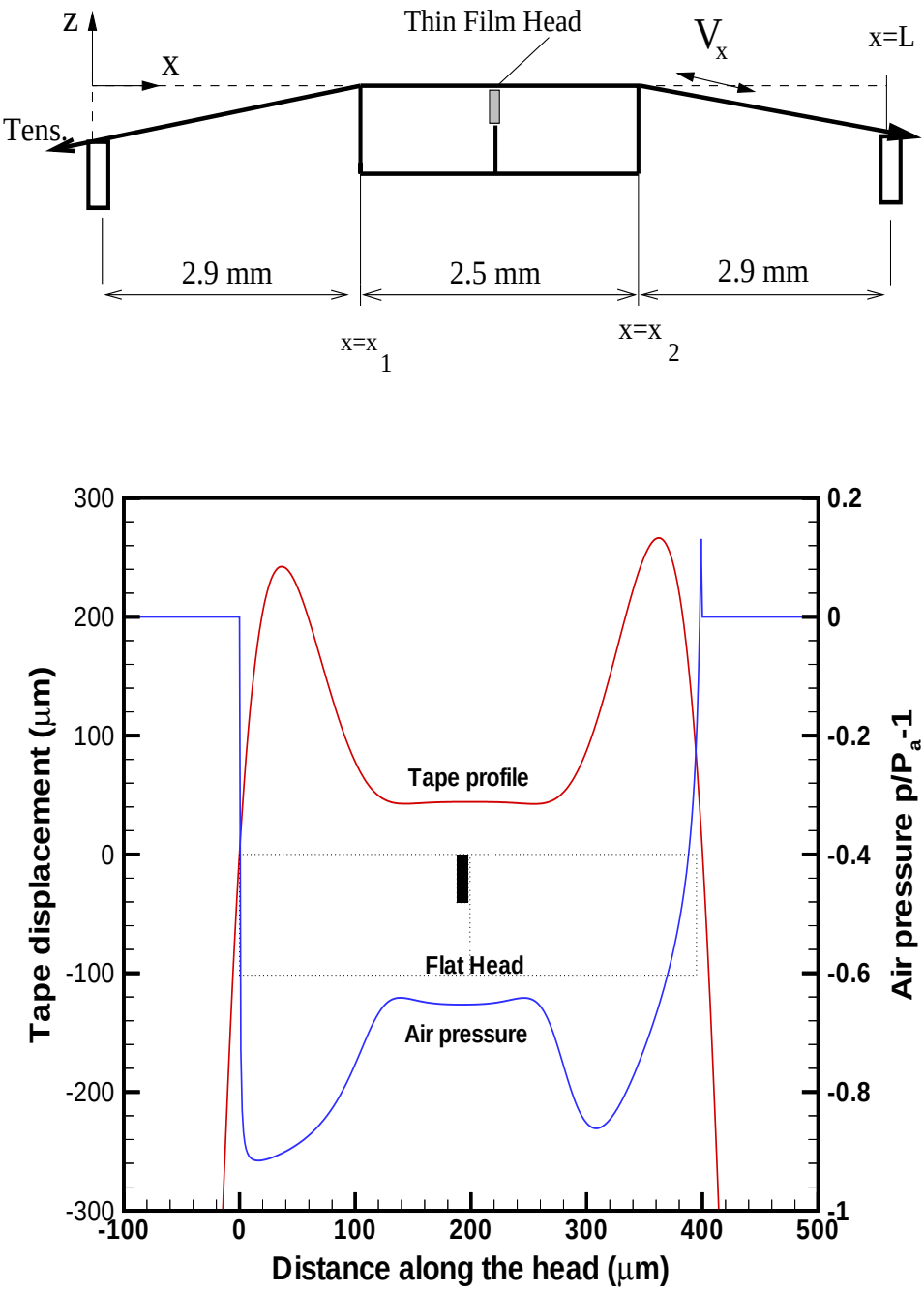


Figure 1: Equilibrium of a flat head with moving tape. Tape speed = 2.54 m/s (100ips), tape tension = 87 N/m (8oz/in), tape thickness = 12 μm.

Two Prototype Tested

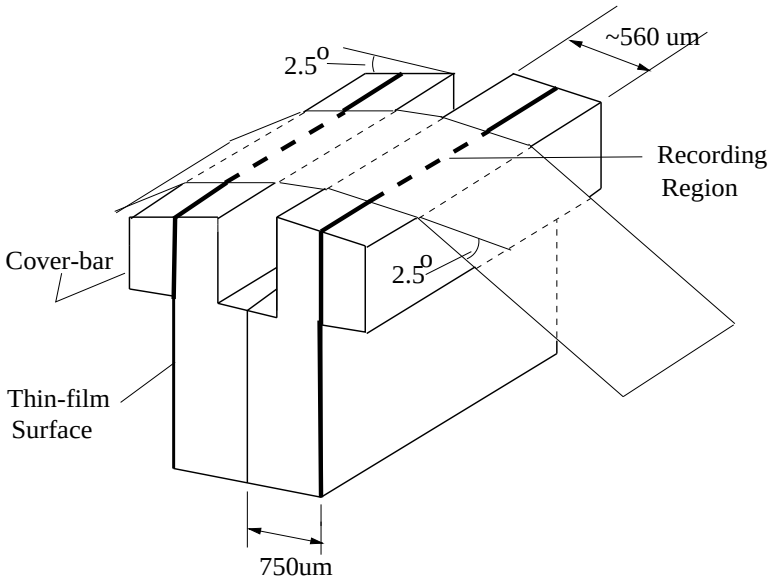


Figure 2: Dual-bar assembly

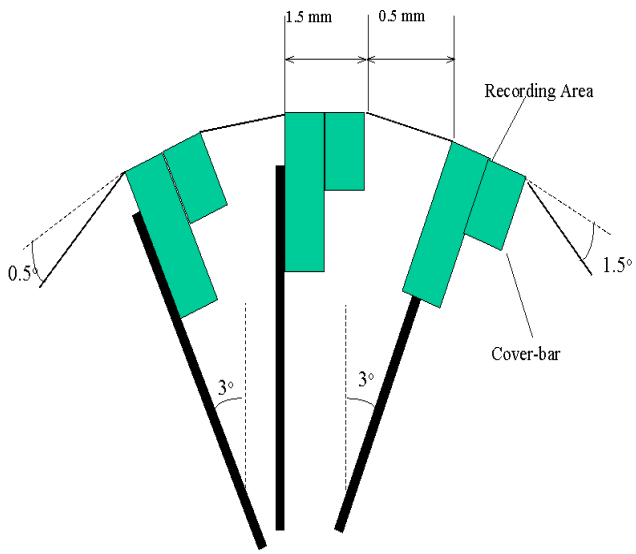
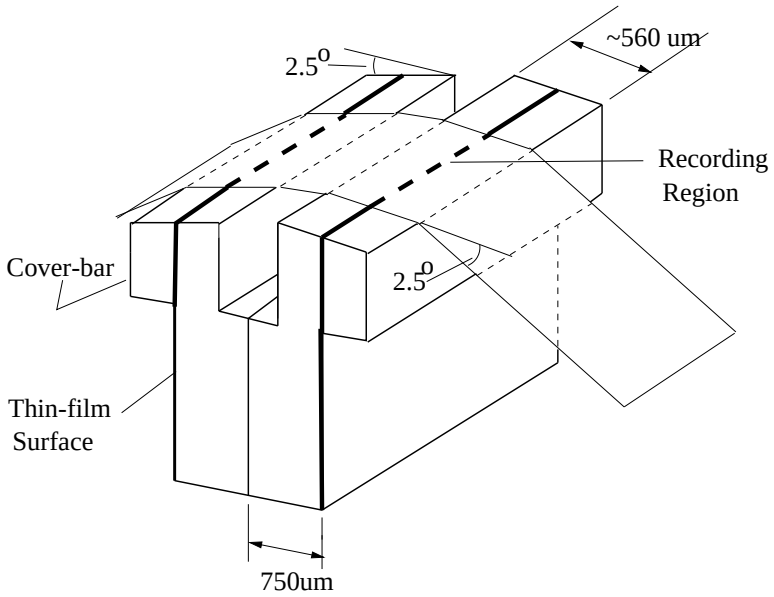


Figure 3: Triple-bar assembly

Dual-bar Assembly



- Tape thickness = 15.6 μm,
- Head width = 560 μm,
- Wrap angle = 2.5^o,
- Tape width = 2.54 cm,
- Tape speed = 0-8 m/s,
- Tape tension = 35 N/m

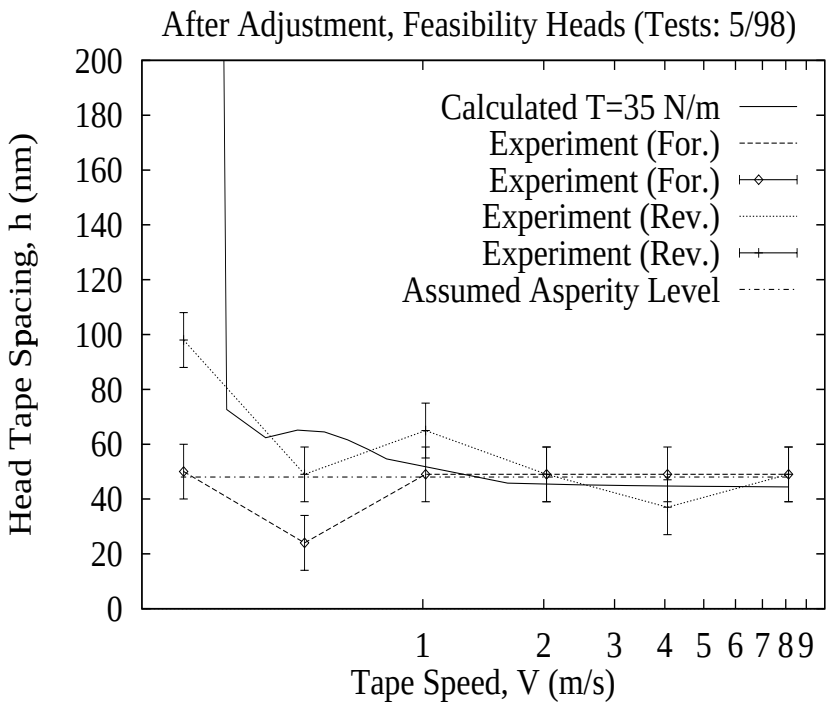


Figure 4: Dual-bar Assembly: Head-tape spacing based on the Wallace formula.

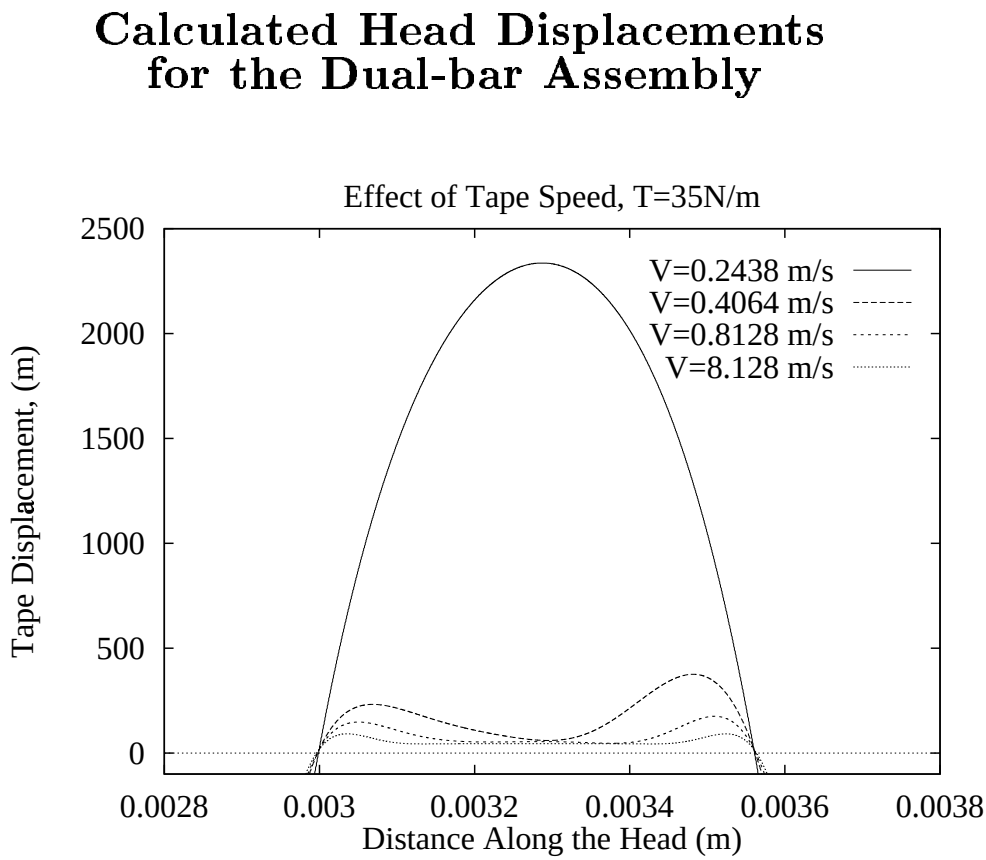
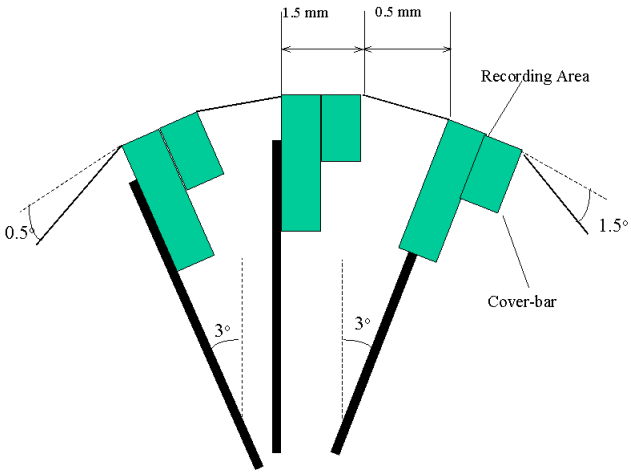


Figure 5: At the lower tension of 35 N/m it takes a considerably higher tape speed to "snap" the tape into contact. Shown are the tape speed of 0.24, 0.41, 0.81 and 8.1 m/s.

- The tape tends to take a "cupped" shape over the head at low speeds ($V < 0.23$ m/s.)
- As the tape speed is increased the "suction" generated under the tape causes the tape to deform toward the surface.

Triple-bar Assembly



- Tape thickness = 15.6 μm,
- Head width = 1.5 mm,
- Wrap angle = 1.5°,
- Tape width = 2.54 cm,
- Tape speed = 0-8 m/s,
- Tape tension = 43-87 N/m

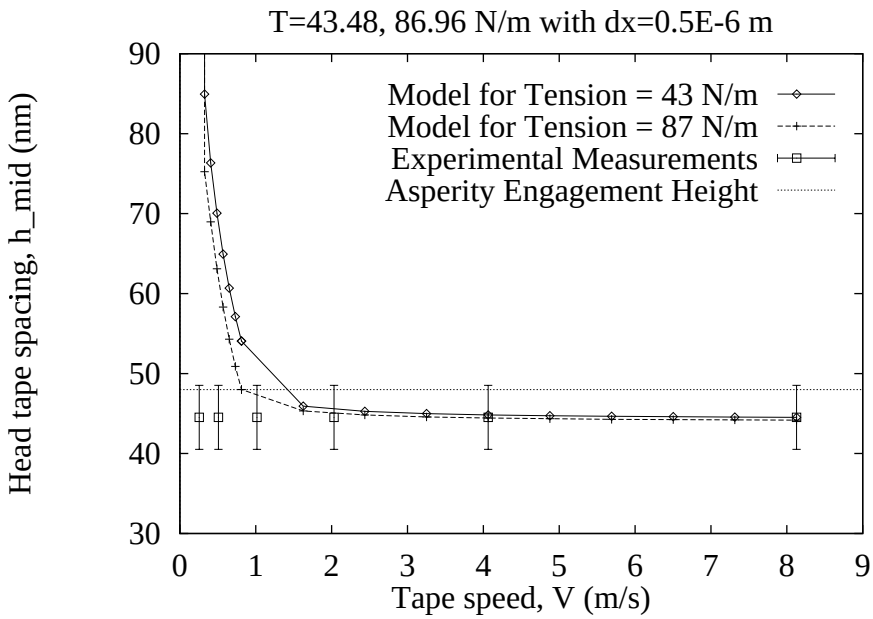


Figure 6: Triple-bar Assembly: Head-tape spacing based on the Wallace formula.

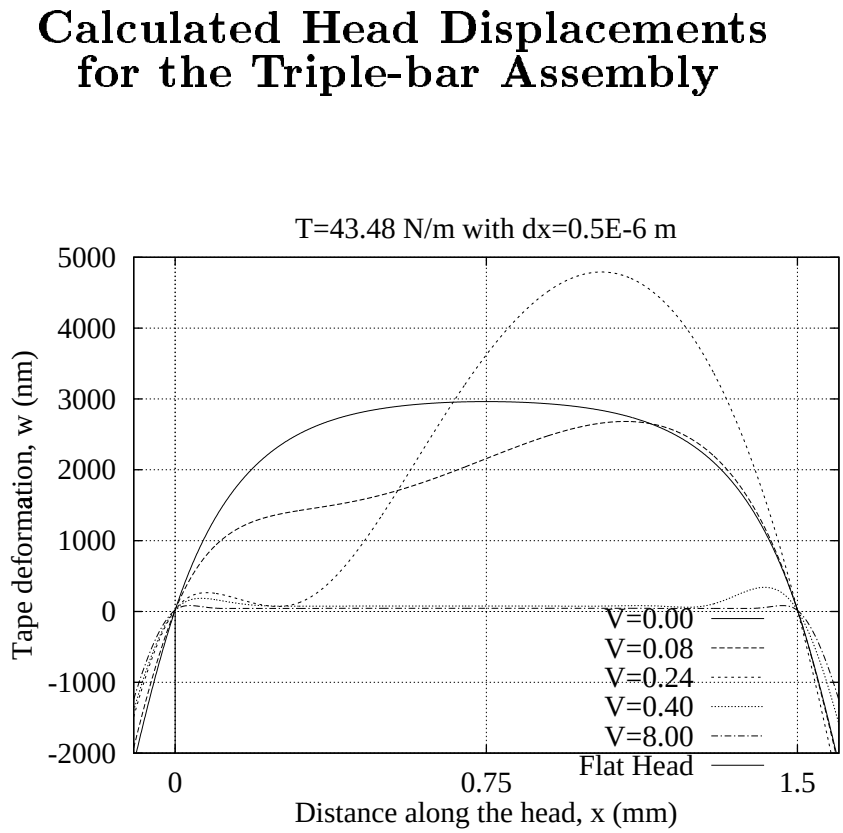
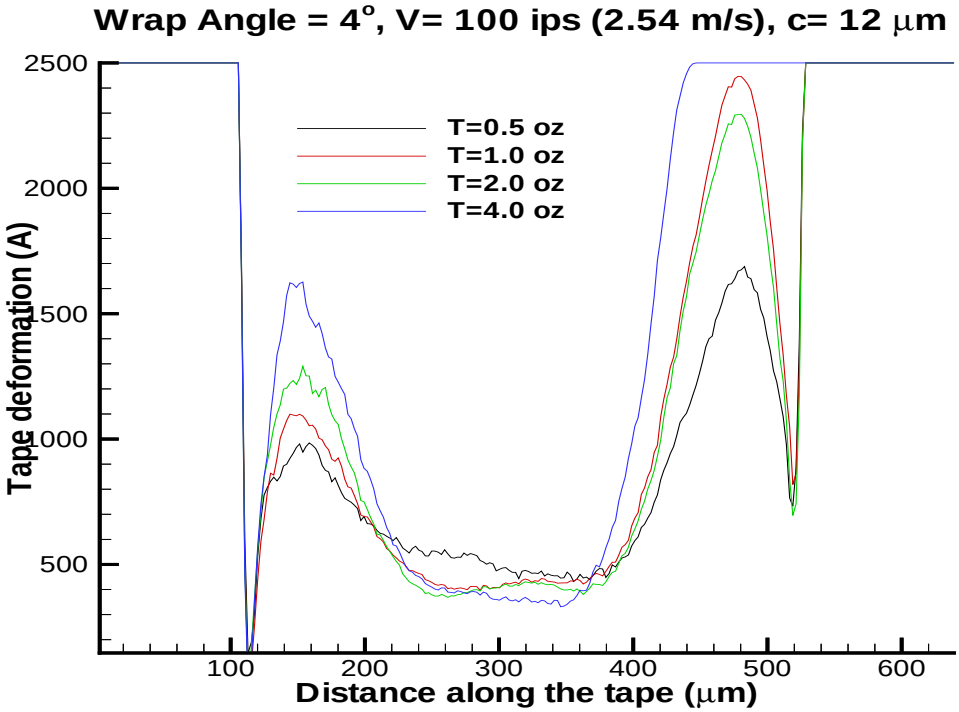


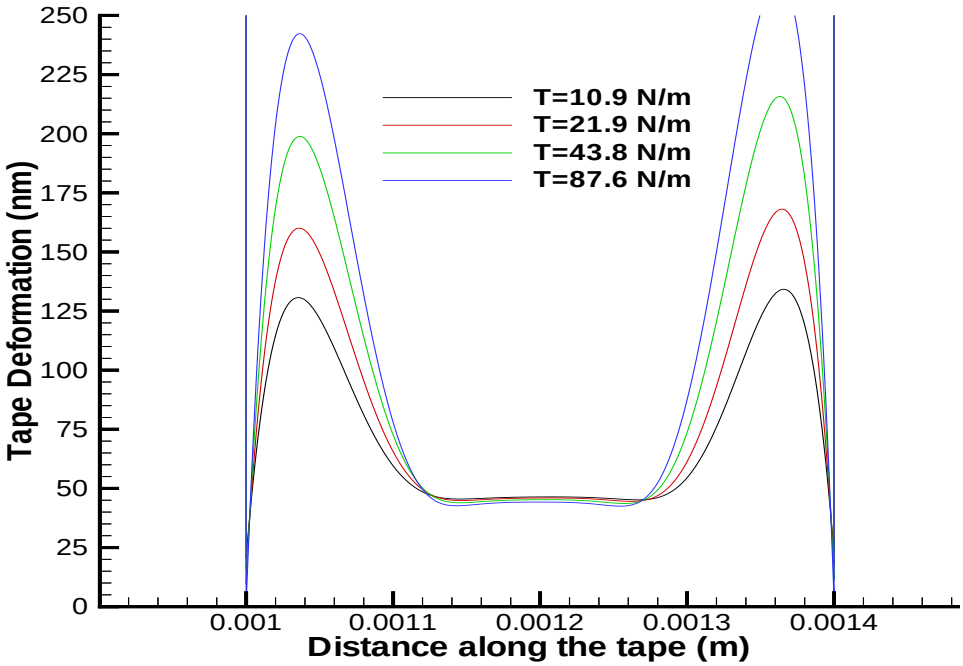
Figure 7: This figure shows the variation of head-tape spacing over the the flat island as a function of tape speed V for tape tension $T = 43$ N/m (5" H_2O vacuum) in the Metrum tape drive.

- The tape tends to take a "cupped" shape over the head at low speeds ($V < 0.24$ m/s.)
- As the tape speed is increased the "suction" generated under the tape causes the tape to deform toward the surface.

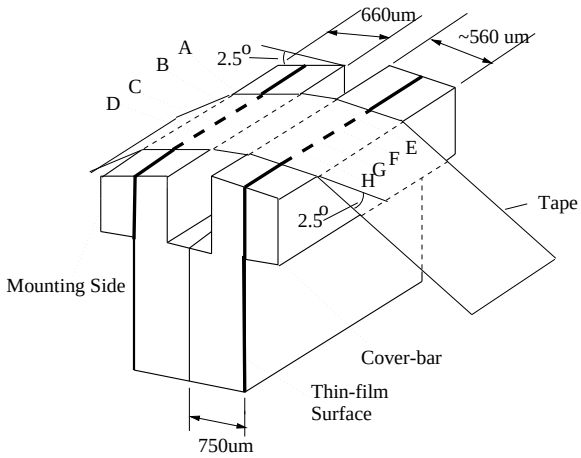
Comparison of Measured and Calculated Head-Tape Spacing

Measurements by Donna J. Kaiser, Quantum, Shrewsbury, MA
Using the Tape Spacing Analyzer, MicroPhysics, Inc.





Head Wear Test



- Tape thickness = 15.6 μm,
- Head width = 0.56 mm,
- Wrap angle = 2.5^o,
- Tape width = 2.54 cm,
- Tape speed = 6.9 m/s,
- Tape tension = 87 N/m,
- Relative Humidity = 20%,
- Time = 552 + 600 hours

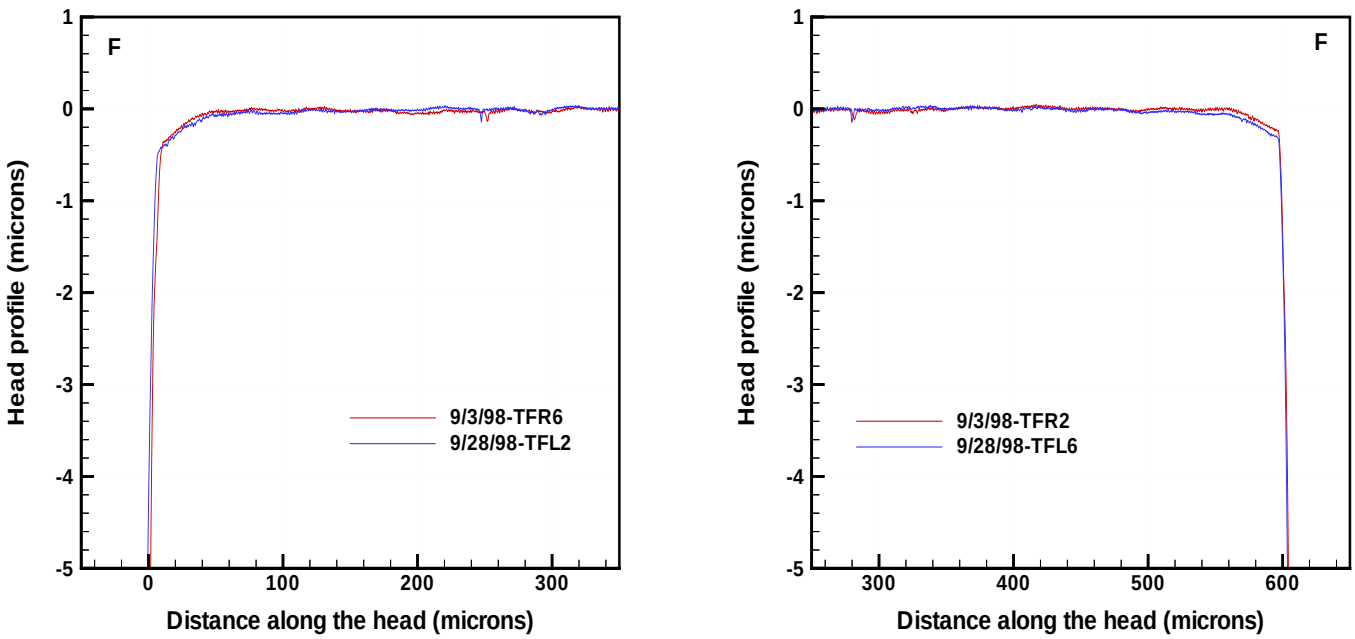


Figure 8: Figure showing the scans of the heads after 552 and additional 600 hours of tape shuttling. Note that the profiles are virtually the same, indicating negligible wear in the 600 hours of shuttling at low humidity.

Model of the Head-Tape Interface

$$\underline{\textbf{Tape Eqn.:}} \quad r_t = D\frac{d^4w}{dx^4} + (\rho_a V_x^2 - T_x)\frac{d^2w}{dx^2} - (p - P_a) - P_c = 0 \quad (a)$$

$$\underline{\textbf{Reyn. Eqn.:}} \quad r_p = \frac{d}{dx}[ph^3\frac{dp}{dx}(1 + 6\frac{\lambda_a}{h})] - 6\mu V_x\frac{d(ph)}{dx} = 0 \quad (b)$$

$$\underline{\textbf{Contact P.:}} \quad P_c = \frac{P_{max}}{\sigma_t^2}(h - \sigma_t)^2[1 - H(h - \sigma_t)] \quad (c)$$

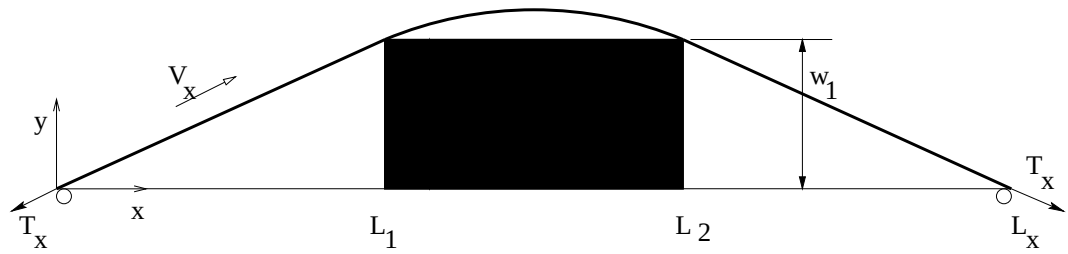
$$\underline{\textbf{Spacing:}} \quad h = w + \delta \quad (d)$$

$$\underline{\textbf{Disp. BC:}} \quad w = -w_1, \frac{d^2w}{dx^2} = 0 \text{ at } x = 0,\ L_x \quad (e)$$

$$\underline{\textbf{Pressure BC:}} \quad P = P_a \text{ at } x = L_1, L_2 \quad (g)$$

(1)

Coordinates for Head-Tape Interface Model



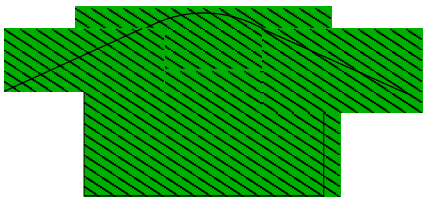
Nomenclature

x	Coordinate axis	P_c	Contact pressure
w	Tape displacement	$P_{max} = 10MPa$	Contact pressure at $h = 0$
h	Head-tape spacing is	$\sigma_t = 48nm$	Asperity engagement height
$D(= \frac{Ec^3}{12(1-\nu^2)})$	Bending stiffness	H	Heaviside step function
T_x	Tape tension	$E(= 4GPa)$	Modulus of elasticity
V_x	Tape speed	$\nu(= 0.3)$	Poisson's ratio
p	Air pressure	$c(= 15\mu m)$	Tape thickness
$P_a(= 101.3kPa)$	Ambient pressure	w_1	Tape disp., $x = 0, L_x$
$\lambda_a(= 63.5nm)$	Molecular mean-free path	r_t, r_p	Residuals
$\mu(= 18.5\mu N s m^{-2})$	Air viscosity		

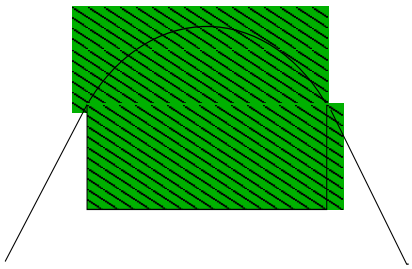
Summary and Conclusions

- The flat-head concept is tested with dual and triple-bar assemblies.
- Head-tape spacing measurements were performed using read-signal measurements and optical spacing analyzer.
- The contact at the head-tape interface is shown to be as robust as predicted by theory.
  - The TSA results indicate existance of air suction.
- No detectable wear was observed after 1000+ hours of tape shuttling.
- Read-signal measurements indicate an unidentified noise source currently attributed to frictional heating.

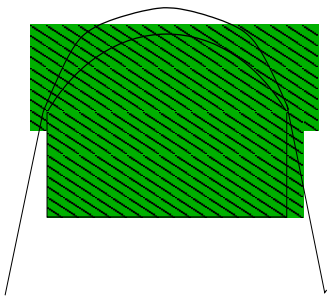
Tape Wrap Configurations



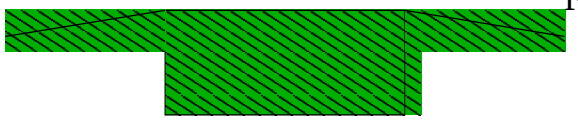
Under-wrapped: Air entrainment problem



Over-wrapped: Good for reducing air entrainment "Stepped-Head"



Too-much over-wrap: Tape may "cup" over the head



Flat Head: Air entrainment creates a self-acting negative air-bearing