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To: VLBA Data Recording Group
 From: Alan E.E. Rogers
 Subject: First order model for recorder tracking

Using a simplified model for the tape path which assumes:

- 1] The tape follows a straight path from the region in the vacuum column where the lower edge of the tape contacts to the capstan (see Memo #124 on tape path theory).
- 2] All torques about tape contact exerted by misalignments are balanced.
- 3] No torque passes the capstan (i.e., forward path is not effected by anything following the capstan).

$$S_F = (0.6)\phi_x + (0.1)\phi_u - (\phi_x + 100)(0.02)(\tau_u - 0.5 + \Delta P)$$

$$S_{F-R} = -(0.1)\phi_y + (0.1)(\phi_u - \phi_L) - (\phi_x + 100)(0.02)(\tau_u - \tau_L)$$

where

S_F	=	forward offset in μm
S_{F-R}	=	forward-reverse offset in μm
ϕ_x	=	capstan tilt away from vacuum columns in arcseconds
ϕ_y	=	upward tilt of capstan
ϕ_u	=	downward tilt of upper headstack assembly
ϕ_L	=	upward tilt of lower headstack assembly
τ_u	=	fractional radius of upper reel ($\tau_u = 1 = \text{full}$, $\tau_u \approx 0.3 = \text{empty}$)
τ_L	=	fractional radius of lower reel
ΔP	=	fractional vacuum pressure change

Notes: a] The effect of offset on the reel is the result of an adjustment made in the tape loop position in the vacuum column needed to satisfy the motor current change (the servo is a first order loop and a change in motor current has an associated tape location change). On REC #3 the upper loop position moves in towards the capstan by about 0.1 inch as the supply (upper) reel empties. Likewise a pressure decrease will move the loop in towards the capstan. Friction on the fixed posts (rollers on original machine) produces a change in motor current with reel pack diameter, direction and humidity. This will increase the sensitivity factor substantially (beyond that assumed in the relation above) and we should seriously consider returning to the roller.

- b] The above relations are first order only and do not include smaller second order terms.
- c] The 100 arc second bias angle is the result of the torque exerted in the vacuum column.
- d] The term $(\phi_x + 100)$ is the angle the back of the tape edge makes with the precision plate.