VLBA ACQUISITION MEMO #279

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To: VLBA Data Acquisition Group

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Subject: Reel Alignment Tolerance

The tape can crinkle or fold over at the edge on the I/O rollers with tape reel misalignment (see Figure 1). The tape must bend in the hard direction to accommodate misalignment. From beam theory (fixed at one end, free at the other) the displacement y at a distance l from the I/O roller is given by

$$y = \frac{4 T_o \, l^2}{Y \, w^3 \, t}$$

where

t	=	tape thickness (16 μm)
T_o	=	torque on a tape at I/O roller
w	=	tape width (1")
Y	=	Young's modulus (6×10^5 psi)

If the tape tension varies linearly from zero to one edge to a maximum at the other edge, the torque equals

$$Tw/6$$

Where T is the total tension.

So that for a torque sufficient to put all the tape tension (0.4 lbs) into one edge leaving the other limp, the displacement is 0.02" at a distance of 5 inches. If the tape is forced against one of the I/O roller flanges with force f an additional torque of

$$f \, R \, \theta$$

where

R	=	radius of I/O roller (0.375")
θ	=	wrap angle (~π radians)

assuming the tape is free to slide on the cylindrical surface of the roller.

From Timoshenko's chapter on buckling of plates, the critical force for buckling the tape is approximately

$$f_{cr} \sim 4\pi^2 Yt^3/d \sim 0.05 \; lbs$$

where

d = distance of force from the section of tape supported by the roller - see Figure 1

$$\sim (2Ra)^{1/2} \sim 0.1 \; inch$$

where

a = flange height ~ 0.02

For a thin tape the buckling torque is lower than T_o so that

$$y \sim \left(\frac{4\pi^2 Yt^3}{d}\right)\left(\frac{R\theta l^2 4}{Yw^3 t}\right) \sim 16\pi^2 t^2 R^{1/2} l^2 \theta/(2^{1/2} a^{1/2} w^3)$$
$$\sim 0.01 \; inch$$

The allowable displacement can be increased by placing the flanges of the roller further apart. If the flange separation exceeds the tape width by b the added displacement is

$$lb/(R\theta) \sim 0.05 \; inches$$

$$for \; b = 0.01 \; inches$$

Metrum's specification for the reel table alignment is such that a plane perpendicular to the motor axis and in the center of the reel should lie in the center of the vacuum columns ±0.001". This very stringent specification is good enough to ensure that there is no buckling of the tape. However, bent flanges and scatter wind (on the take-up and non-self-packing reels) is likely to make it hard to do better than ±0.01". Reel table alignment needs to be checked fairly regularly and consideration should be given to increasing I/O flange separation from 1" to 1.01". Some tests done with an I/O roller sleeve with flange separation of 1.01" clearly demonstrates that more margin can be obtained with a modified I/O roller design.

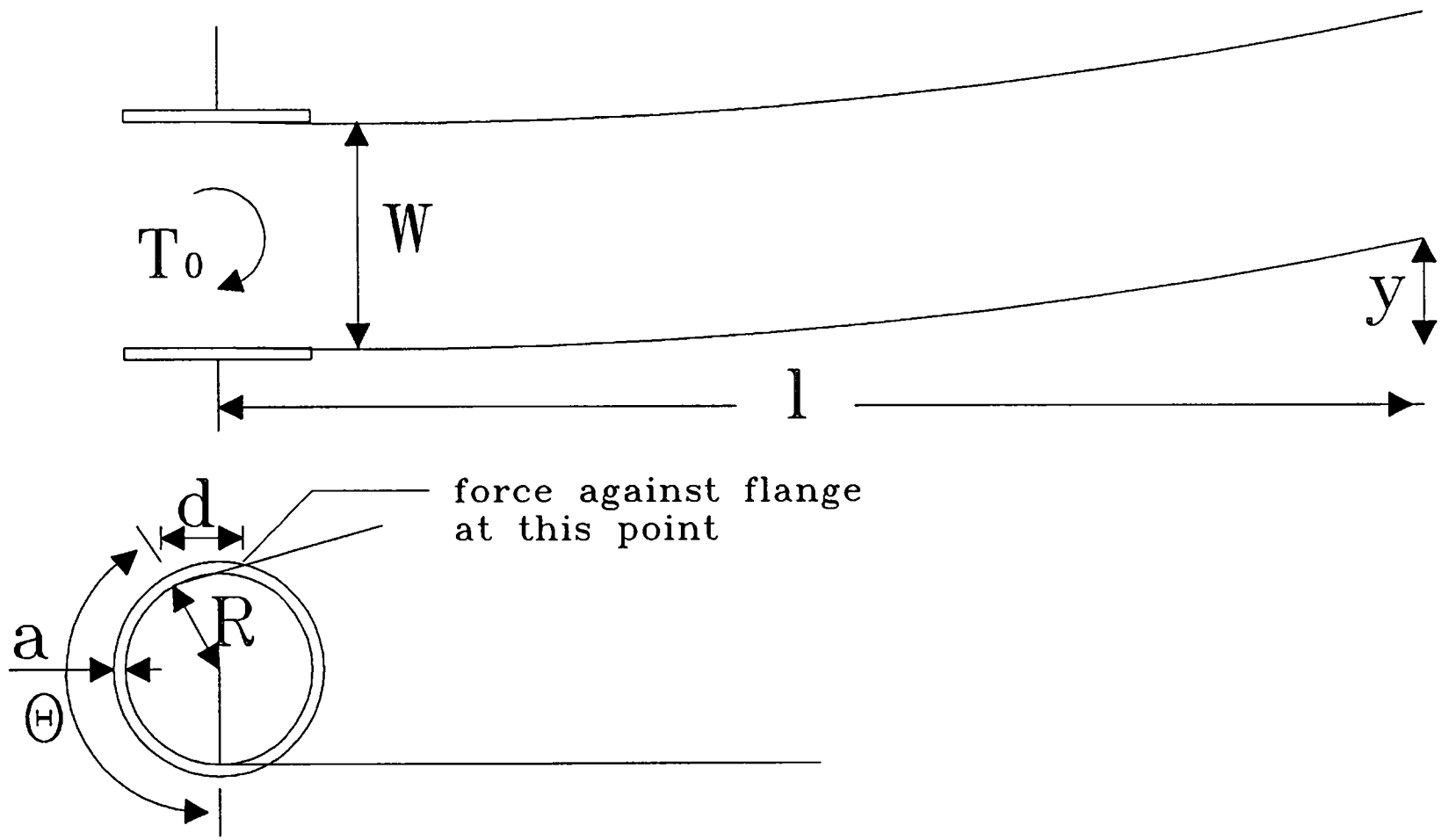

FIGURE 1. I/O ROLLER GEOMETRY