MARK IV MEMO #187
VLBA ACQUISITION MEMO #375

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To: VLBA Data Acquisition Group

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Subject: Model for recorder tracking response to capstan and idler surface irregularities

The D.C. tracking sensitivities to a fixed tilt of the capstan a direction away from the vacuum columns for the 96 are:

Capstan (Fixed post configuration):	0.6 μm/arcsec
Capstan (Idler configuration):	0.2 μm/arcsec
Idler:	0.5 μm/arcsec.

The sensitivities to tilts in a direction normal to the line between capstan and idler are much smaller.

The D.C. sensitivities to taper of the rolling surfaces are:

Capstan (in fixed post config.):	2.5 μm/arcsec
Capstan (in idler config.):	0.5 μm/arcsec
Idler:	0.3 μm/arcsec.

The above sensitivities are from VLBA Acquisition memos 122 and 136, and IEEE paper, "A High Data Rate Recorder for Astronomy".

In the case of an irregular rolling surface we can estimate the amplitude of tracking variations produced by a surface whose geometry is tilted with respect to the rotation axis by using the D.C. sensitivities combined with the tracking response filter theory given in VLBA Acquisition Memo #149. Most of the tracking response to a tilt is not instantaneous. The tape "walks" up or down the rolling surface in response to the tilt. The rolling surface and tape path geometry acts as a low pass filter with an approximate amplitude transfer function

$$1/\left(1 + \left(SL/\sqrt{6}\right)\right)$$

where L = distance from Capstan to Idler ~3"
S = $j2\pi/\lambda$
λ = $2\pi R$
R = radius of the rotating surface ~ 0.55"

Thus the peak to peak A.C. response to a wobble in the capstan tilt is approximately

$$2 \times (D.C.\ Sensitivity) \times \sqrt{6}\ R/L$$

$$\sim D.C.\ Sensitivity$$

Tilted surface geometry (lack of angular alignment of roller cylinder with the rotation axis) will produce tracking variations with a wavelength of $2\pi R$ while the fundamental component of a non-uniform taper in the rolling surface have a wavelength of πR and will be reduced by an additional factor of 2 by the low pass filtering action of the rolling surfaces.

A surface irregularity or deposit of thickness τ and area A on the capstan or idler will produce a wobble or taper of order

$$\tau A / \left(\pi R\ W^2/2 \right) \sim 1\ arcsec$$

where τ = thickness - assume 10 μm
A = area - assume 2500 μm^2
R = Capstan radius ~ 0.5"
W = Tape width = 1"

The rough approximation above assumes that the tape elastically deforms over the irregularity. For the fixed post configuration this irregularity would produce a peak-to-peak tracking modulation of about 2 μm which would be reduced by a factor of 2 to 3 in the idler configuration. In either case a relatively small irregularity or deposit can have a fairly significant effect on the tracking performance and emphasizes the need to keep the capstan and idler clean. This tracking modulation is not repeatable because the phase of the capstan with respect to the tape footage will not necessarily repeat and different transports have different irregularities in the capstan and idler surfaces.

In a separate memo, Hans Hinteregger will describe measurements made of the tracking jitter produced by imperfections in the capstan.