VLBA ACQUISITION MEMO #321

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To: VLBA Data Acquisition Group

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Subject: Factors which influence the tape wind test

Our present wind test used to verify the mechanical performance of a tape is given in the draft tape specification (VLBA Acquisition Memo #299) as:

Tension	= 3.0 N (0.67 lb, 15")
Speed	= 1.72 m/s (67 IPS)

However there are several factors which influence the outcome in addition to tape non-uniformity (see VLBA Acquisition Memo #228).

1] Packing arm

We have never experimented with a packing arm but it is almost certain to prevent non-uniformities from producing a bumpy pack by providing a force which will prevent irregularities from developing into a bump.

2] Reel

Friction between the reel wall and the tape edge as it packs down will produce force which tends to bend up the edges and aid in the instability analyzed in VLBA Acquisition Memo #228. I assume the force against the wall equals that needed to slip the outer turn back onto the pack against the friction between the oxide and the backcoat of the layer below.

Adding reel wall friction to the pack stability inequality of VLBA Acquisition Memo #228 (as modified by VLBA Acquisition Memo #319).

$$\mu + \left(\frac{Yt}{Yr}\right)s + \left(\frac{T}{Yrt^{3/2}r^{1/2}}\right)uvf \leq \left(\frac{Yt}{Yr}\right)^2 (t/(2r))$$

where μ = thickness non-uniformity
s = edge stretch
u = friction between edge and reel wall
v = friction between tape layers
f = fraction of turns pushing against reel wall
t = tape thickness (16 μm)
r = reel radius (7")
Yt = Young's modulus in machine direction (10^6 psi)
Yr = Young's modulus in thickness direction (2.5 x 10^4 psi)
T = tape tension (0.67 lb)

and if each acts separately, the limits for stability using this model are

$\mu \leq 7\%$
$s \leq 0.2\%$
$uvf \leq 11\%$

The pack stability was discussed in VLBA Acquisition Memo #228. To summarize, the pack stability is improved with

a) Reduced tape tension which decreases the effective Yr (theory of Willet and Poesch) and reduces the effect of any reel wall friction.

b) Increased speed which decreases the effective Yr by the addition of an air film (see VLBA acquisition Memo #263).

c) Reduced reel wall friction (clean reel and moderate humidity) which reduces u.

d) Reduced reel size r.

e) Increased tape thickness t.

f) Adequate reel flange clearance to minimize f. All of the above are clearly observable with marginal tapes for which μ, s, or uvf, or a combination, are close to stability limits.

3] Humidity

Since the wall friction increases with humidity, the wind test is more likely to fail when the RH is greater than 50%.

4] Since the tape exhibits visoelastic rheology when significantly strained (over 1%), a tape which fails the test may need relaxing to remove stored strains generating non-uniformities. There are several components of relaxation having time scales from a few seconds up to about 100 hours. A prepass at high speed and low tension often removes some stored strains. Storage in a good packing state for several days will relax further strain. Conversely, storage of a tape in a deformed bumpy state will make it difficult, if not impossible, to restore. Tests show that a failed wind leaves an impression of the bumps, especially the folded-up edges, on the limp tape in the form of ripples. The ripples and the pack can normally be restored in a few passes unless the deformed pack has been left for several hours.