VLBA ACQUISITION MEMO #150

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To: VLBA Data Recording Group

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Subject: Draft specifications for VLBA tape and a very brief look at some newer tapes

VLBA recording format

To meet the 12 hour at 128 Mb/s per tape specification, I propose the following example: Record 14x36=504 tracks at 56,000 bpi on a 20,000 foot length of tape. This track density will allow guard bands of at least 10 microns between passes in the same direction and 25 microns between passes in opposite directions. Normal tape speed will be 80 ips and normal speed passes will last 50 minutes.

To achieve the above on a 14-inch reel

Tape thickness	13 microns nominal
Tape width	1 inch nominal
Tape length	20,000 feet on 14-inch diameter reel
Longitudinal elastic Modulus	$>7x10^5$lbs/sq"
Elastic modulus in thickness direction	$>7x10^4$lbs/sq"
Slitting uniformity	better than 20 μm peak-peak
Mechanical uniformity	as good as Fuji H621
Abrasivity	not substantially higher than Fuji H621
Output	3 dB better than Fuji H621 for wavelength of 1 micron (needed for 56,000 bpi) with record current <50 KA/m and gap length 0.3 micron.

Some published performance data

Figure 2.52 from the Video Recording chapter of Mee and Daniel shows the relative output of various tapes for a wavelength of 0.75 microns and Table 2.6 shows the composition and characteristics of video tape materials. Tapes with very high coercivity cannot be saturated with our headstack (which is limited by the magnetic saturation of the single crystal ferrite - the recorders which use very high coercivity tape have metal in the head gap to increase the saturation field), but they may still work better than the lower coercivity tapes.

Some quick-look tests

I have taken a quick look at some sample tapes and the results are summarized in the following table:

Tape	Thickness μm	Signal dB	Slope dB	Min. record %	Comments
Fuji H621	25	0	-7	38	Reference tape
Sony D1	13	0	-7	50	
Ampex ME	13	+3	-7	60	cloggs heads
Ampex MP	13	-2	-6	70	
3M P6-120 MP	13	+6	not measured	80	Special test - see text

Notes: Signal - measured at λ = 0.86 microns - 4 MHz recorded at 135 IPS

Slope - is the ratio signal strength for λ = 0.64 (4 MHz recorded and played back at 100 IPS) relative to λ = 0.86 microns

Min. record - percentage of maximum available record current at which signal strength drops by 3 dB. Only H621 shows a decline in signal with 100% of the available record current.

All the thin tapes handled well and performed as well (except some head clogging was evident with the ME tape) as our standard H621. The quick look results, however, do not show as large a signal enhancement as the data of Figure 2.52 (which predicts that we should get about 10 dB more signal from ME tape compared with the 3 dB measured).

Modelling the loss with a spacing loss plus a gap length loss

$$L = -55\ (0.2/\lambda) + 20\ \log_{10}[(\sin(\pi\ 0.35/\lambda)/(\pi\ 0.35/\lambda)]\text{db}$$

gives

$$L = -15 \text{ dB at } \lambda = 0.86 \text{ microns}$$

and

$$L = -22 \text{ dB at } \lambda = 0.64 \text{ microns}$$

and roughly fits the measurements. An equivalent spacing of 0.2 microns is needed to account for the surface roughness and particle size.

In addition to the quick look at analog performance I was able to record and playback densities up to 70,000 bpi on the H621 and D1 tapes. The Ampex MP tape needs a different equalizer and the ME tape sample clogged heads.

Special test of 8 mm tape

I tested a 6 inch length of 3M 8 mm MP tape by sticking it with double sided tape to the back side of 1 mil tape and observing the short duration (≈50 milliseconds) of sine wave data on a scope. While this is a rather tricky method of measuring the analog performance of a small tape sample I think that there is little doubt that the 8 mm MP tape available in the supermarket is magnetically superior to the sample of 1 inch MP and ME tape from Ampex. Better tests of 8 mm tape need to be made by installing an 8 mm "E" casting on the transport.

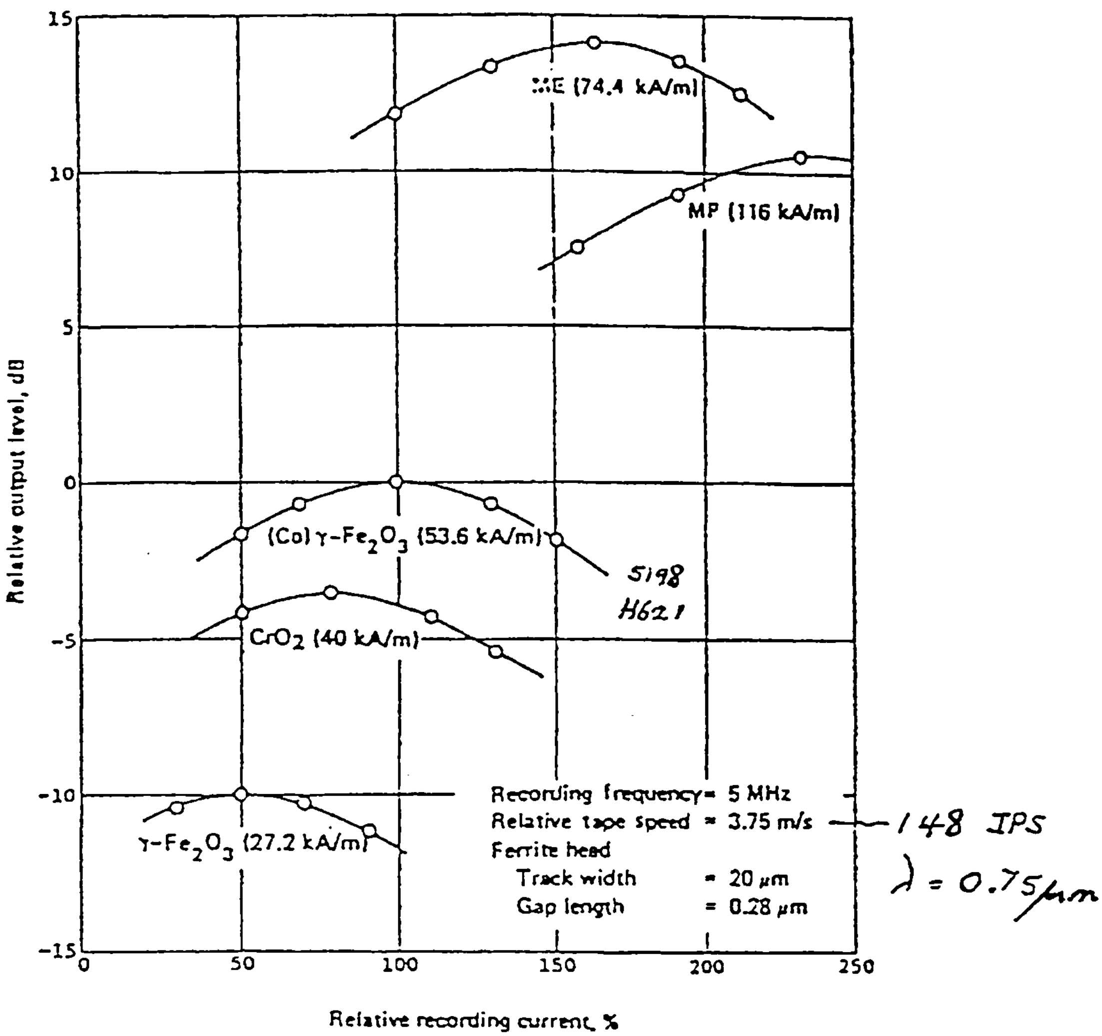

Figure 2.52 Relative output versus relative recording current for various video tapes (noise level: −39 dB).

TABLE 2.6 Video Tape Materials

	γ-Fe_2O_3	CrO_2	Co–γ-Fe_2O_3	Ba-ferrite	Metal: Fe, Co particle	Metal: Co, Ni evap.	Units
H_c	20–35	36–60	40–80	48–160	56–175	70–100	kA/m (4π Oe)
B_r	80–120	100–130	80–120	70–115	150–260	300–440	kA/m (emu/cm^3)
B_m	110–140	130–150	100–145	120–145	220–300	450	kA/M (emu/cm^3)
S	0.7–0.85	0.8–0.87	0.7–0.85	0.6–0.9	0.7–0.85	0.65–0.8	—
Particle size	0.2–0.8	0.3–0.5	0.2–0.6	0.05–0.1	0.1–0.3	—	μm
T_c	675	125	520	340	1000	1000	°C
Crystal structure	Spinel	Rutile	Spinel	Hexagonal	Body-centered cubic	Hexagonal	—
Shape	Acicular	Acicular	Acicular	Platelet	Acicular	—	—

SOURCE: Sugaya (1986).