Fermilab

$\bar{p}$ NOTE #441

Debuncher Kicker Studies

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Ralph Pasquinelli

RJ 12/23/85

DEBUNCHER KICKER STUDIES

A measurement program to improve the match between Debuncher TWT's and kicker tanks was completed in December of 1985. Debuncher tanks, kicker brackets & TWT power splitting circuits were measured in a test set up in the MRRF building. All electrical connections are identical to the tunnel environment.

S_{11} measurements show that matching over a broad band would be quite difficult due to the many wavelengths between the TWT & Kicker Termination resistors. Multistub tuners are capable of matching ALMOST any impedance to 50 Ω but only over a narrow band of frequencies. Figures 1 & 2 show best & worst case TWT load impedance for the Tank measured. The worst case system has a return loss of 11.7 dB using broadband noise techniques. In actual testing, the TWT's were

operated in excess of 140 watts for a period of 24 hours before proceeding to the next test. FIGURE 3

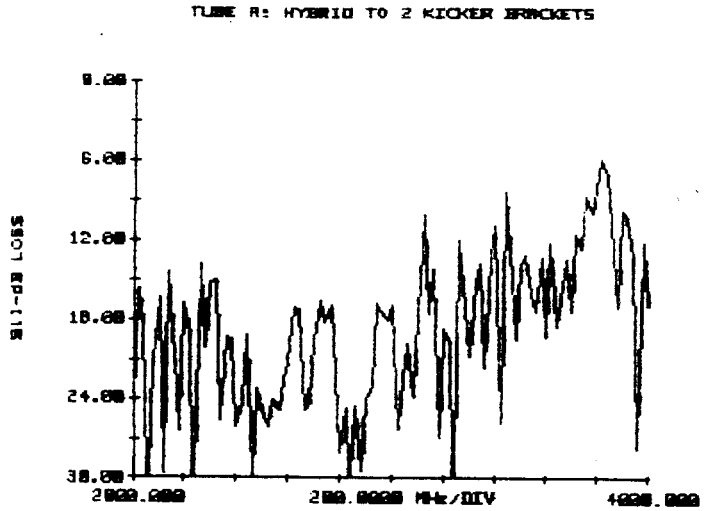
The last test performed was driving one kicker bracket with one TWT at a power level of 150 watts. After 72 hours of running there was no noticeable degradation in performance. This power level corresponds to approx 9 watts per terminating resistor. (They are rated at 10 WATTS) Kicker bracket temperature was 53°C, Kicker bracket resistances were 12.8-13 Ω. Figures 4 & 5 are before and after S_{11} measurements on the Kicker Bracket. S_{11}.

CONCLUSIONS

Kicker to TWT match is about as good as it will ever be and that's not too bad. Tube output power can easily be increased to 120 watts/TWT. This level is approximately 3dB higher than the power levels during the Fall 1985 $\bar{p}$ run.

One major improvement will be the addition of water cooled heatsinks for the Hybrids mounted on the TWT. After a 24 hour running period @ 140 watts, the uncooled hybrid temp was 84°C while the water cooled hybrid remained @ 37°C. Room temp for the test was 22°C & Water Temp 25°C. Tunnel temperatures during the $\bar{p}$ run were typically 38-40°C. The max operating temp for the Hybrids is +85°C. This temperature may easily have been exceeded in the tunnel which could explain the three hybrid failures that occured during the run.

START= 2000.00000 STOP= 4000.00000 STEP= 20.00000
18 Dec 1985 09:04:26
TUBE A: HYBRID TO 2 KICKER BRACKETS D20-H1-1&2



TWT LOAD S_{11}

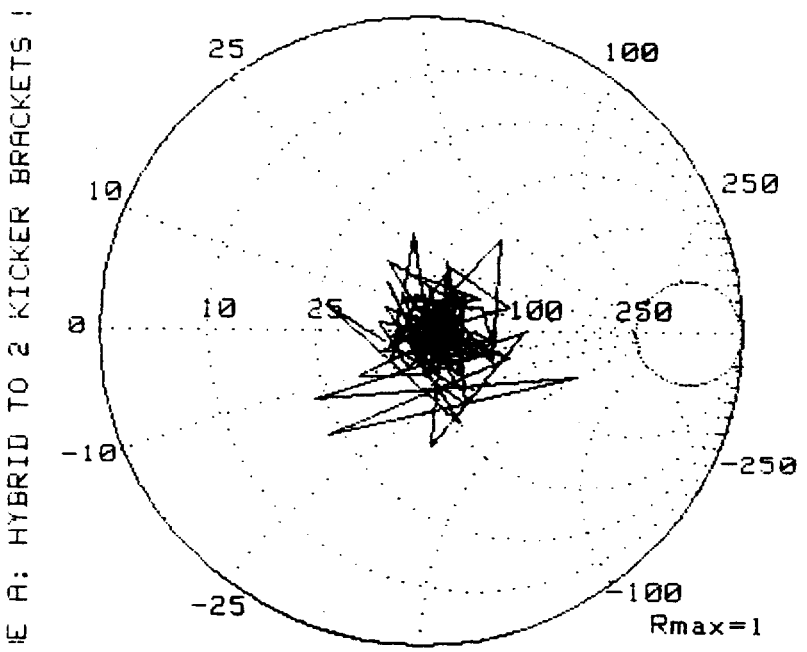
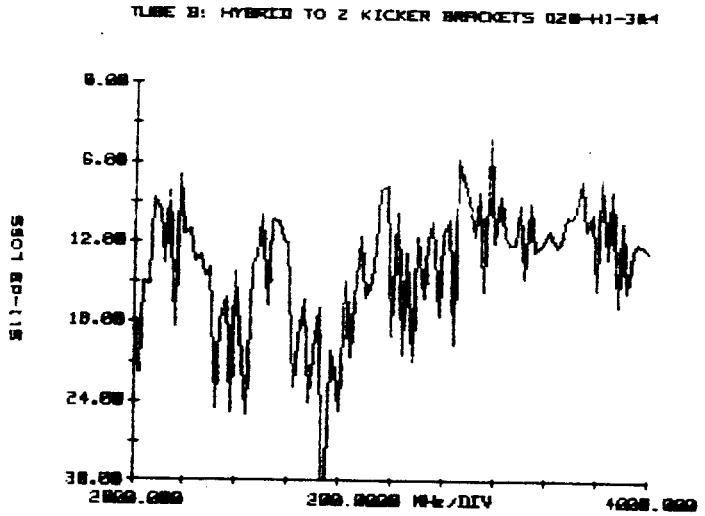


FIGURE 1

START= 2000.00000 STOP= 4000.00000 STEP= 20.00000
18 Dec 1985 09:08:23
TUBE B: HYBRID TO 2 KICKER BRACKETS D20-H1-3&4 Hot Hybrid



TWT LOAD S_{11}

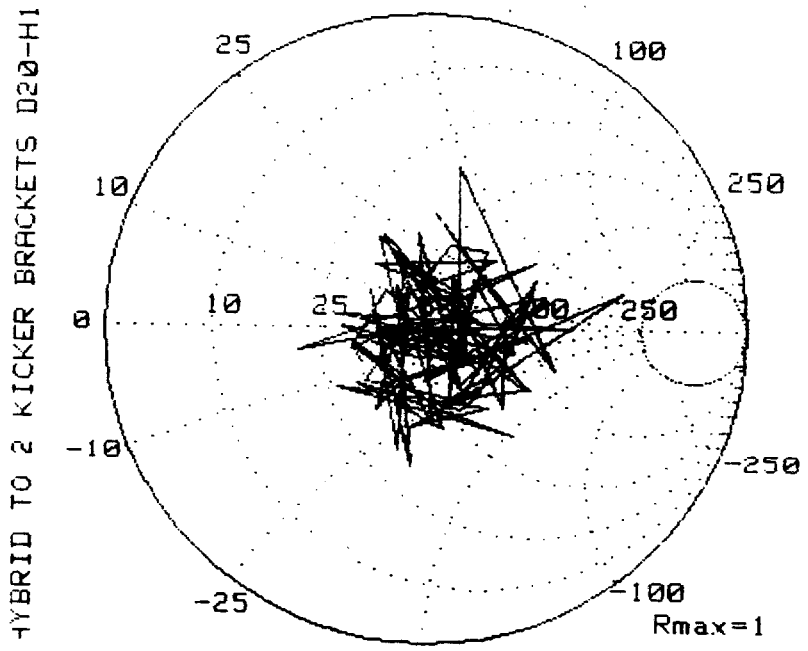
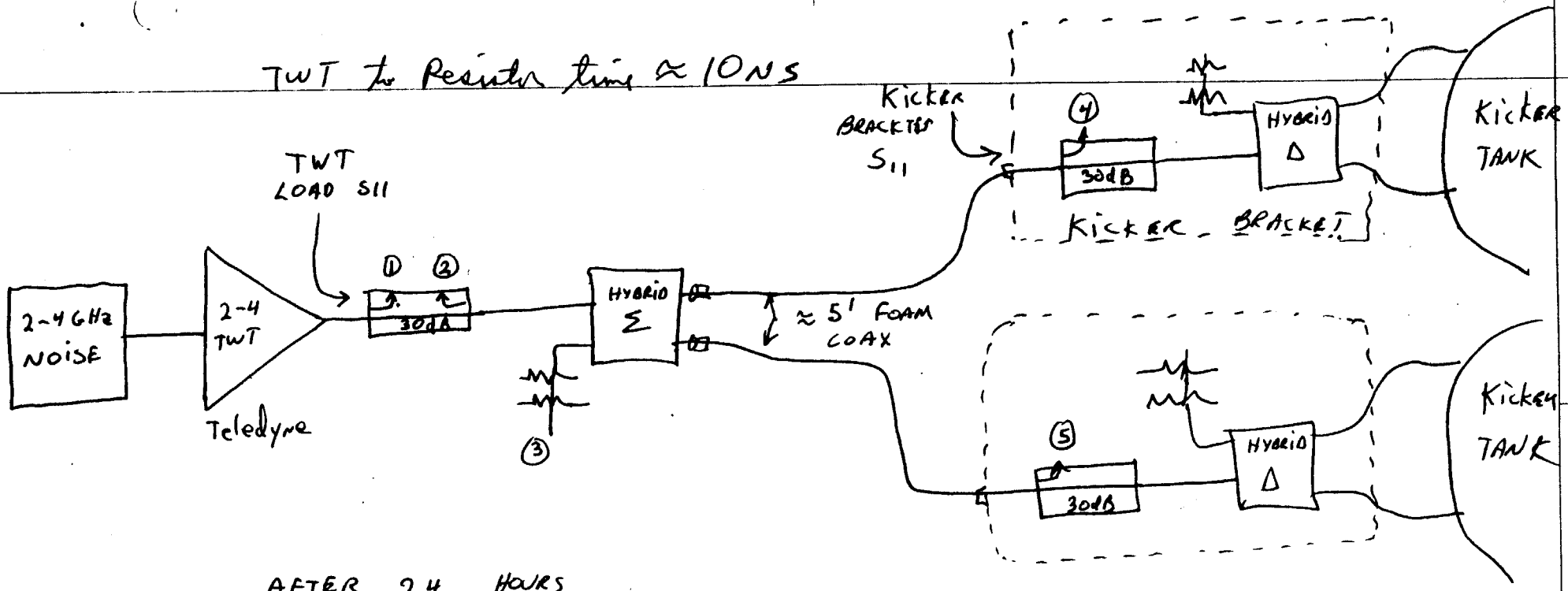


FIGURE 2

TWT to Resistor time ≈ 10 NS



AFTER 24 HOURS
POWER LEVELS (WATTS)

TEST POINT	TUBE A BEST Σ HYBRID	TUBE B WORST Σ HYBRID
①	143	162
②	7	11
③	4	8
④	56	81
⑤	65	53

ALL KICKER TANK DC RESISTANCES 12.8 to 13Ω

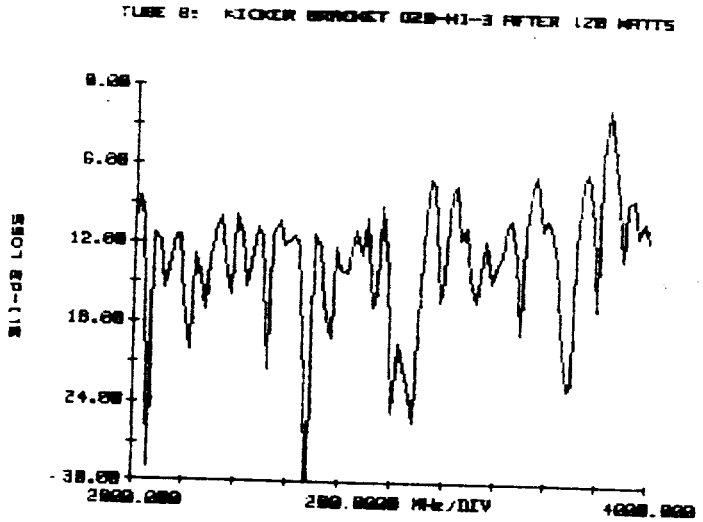
$$S_{11_A} = \left| 10 \log \frac{7}{143} \right| = 13\,dB$$

$$S_{11_B} = \left| 10 \log \frac{11}{162} \right| = 11.7\,dB$$

HYBRID TEMP after 24 hours 37°C WATER 84°C

FIGURE 3

START= 2000.00000 STOP= 4000.00000 STEP= 20.00000
18 Dec 1985 09:18:10
TUBE B: KICKER BRACKET D20-H1-3



KICKER BRACKET S_{11} BEFORE 150 WATT TEST

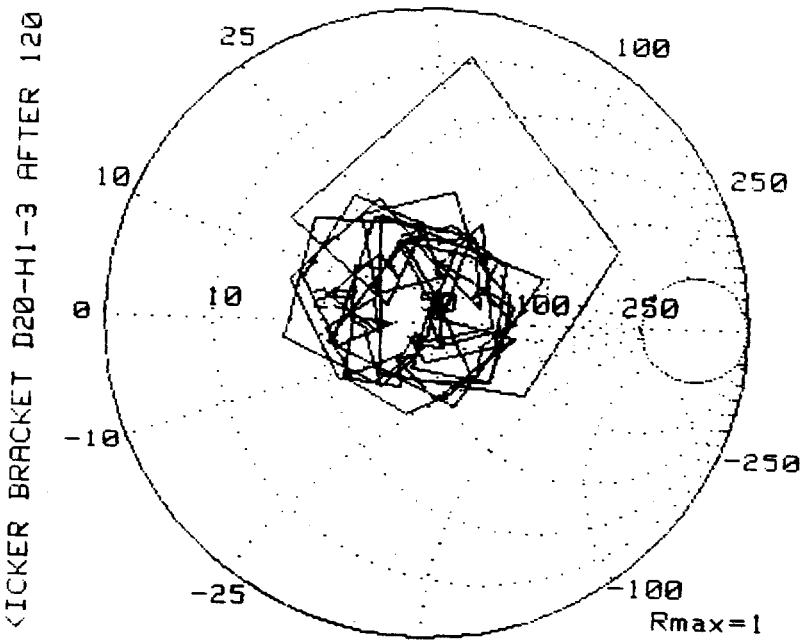
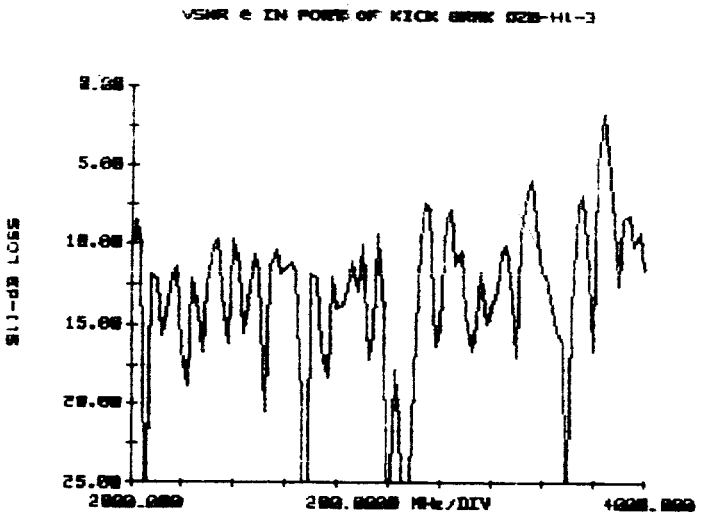


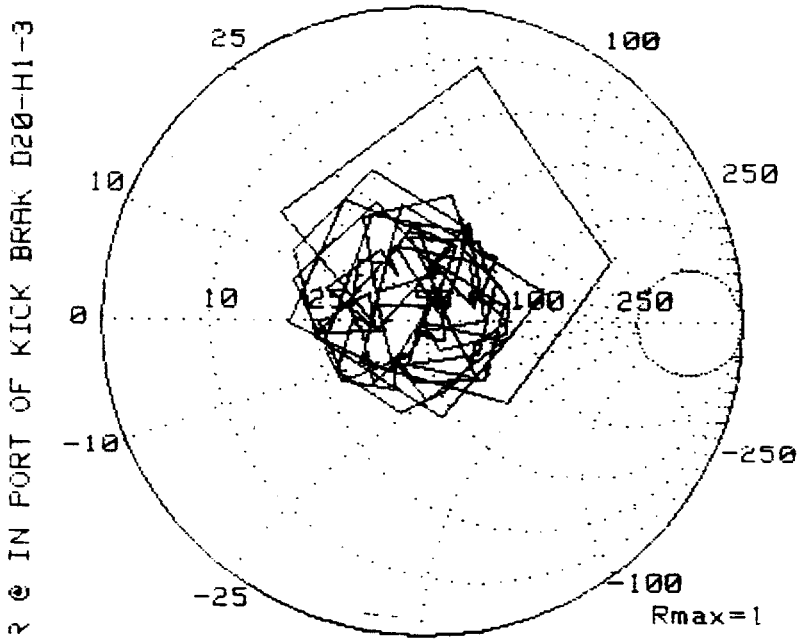
FIGURE 4

START= 2000.00000 STOP= 4000.00000 STEP= 20.00000

23 Dec 1985 13:42:42

VSWR @ IN PORT OF KICK BRAK D20-H1-3





KICKER BRACKET S_{11}

AFTER 150 WATTS

for 72 hours

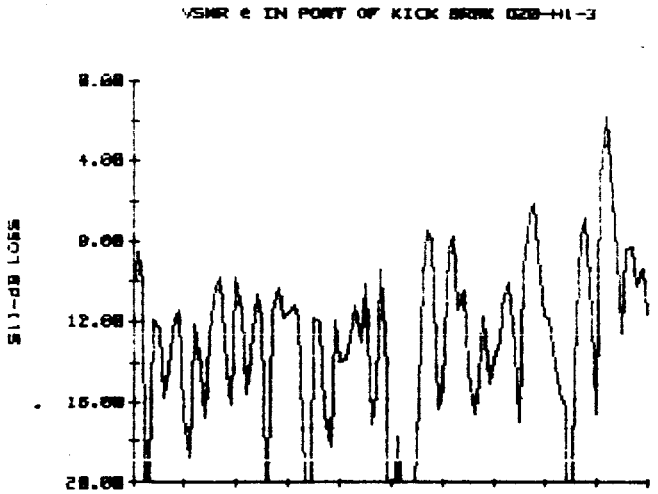


FIGURE 5