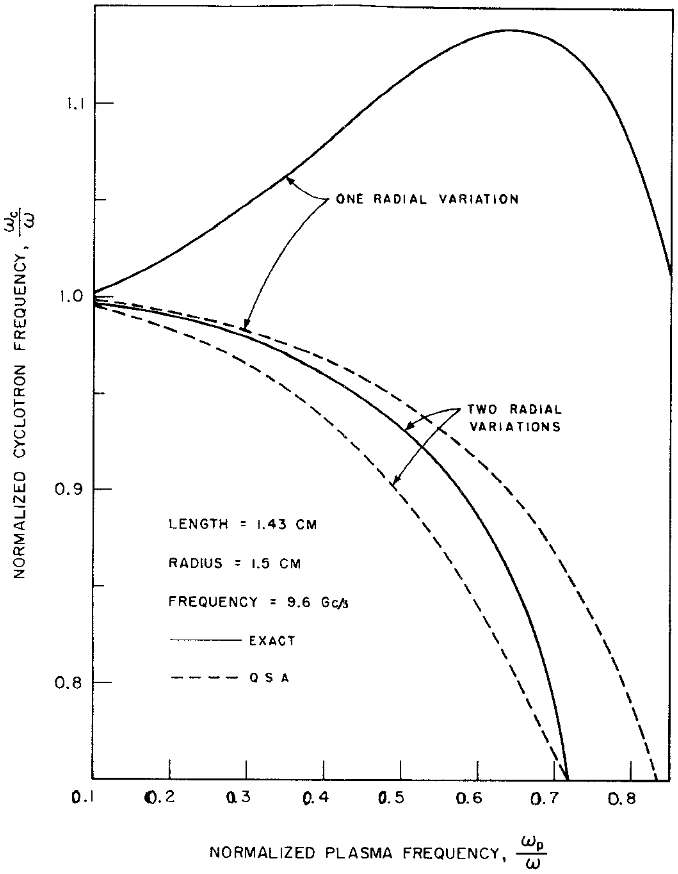

Fig. 4. Theoretical curves for plasma resonator experiment.

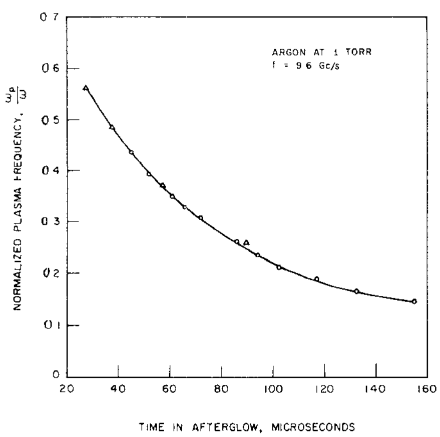

Fig. 5. Experimental plasma decay characteristics. The circular data points represent resonances with one radial variation, while the triangles represent resonances with two radial variations.

The model for these calculations consisted of a circular cylindrical, unclad plasma column; the plasma was considered to be cold, collisionless and homogeneous within the column. Solid lines are used to illustrate solutions obtained through an exact solution of Maxwell's equations while the dashed lines are used for solutions obtained through use of the quasi-static approximation. Both sets of curves are presented to illustrate the discrepancies that would arise if the quasi-static solutions were used to reduce the experimental data.

A plasma decay curve, obtained by reducing the experimental results of Fig. 3 through the use of the exact curves of Fig. 4, is shown in Fig. 5. Good correlation exists between the decay characteristics obtained through the use of the mode with one radial variation and those obtained through the use of the mode with two radial variations. Some discrepancies should exist, since the theoretical model consisted of a lossless, homogeneous plasma while the experimental plasma was lossy, as is apparent from the width of the resonances, and must have had large longitudinal gradients because of diffusion to the cathodes along the magnetic field lines.

An examination of Fig. 4 shows that in the region of parameters for which the experiment was performed, the resonance is very sensitive to small changes in magnetic field, but relatively insensitive to changes in plasma density. It would thus be expected that rather large spatial inhomogeneities could exist in the plasma without destroying the resonance, but small inhomogeneities in the magnetic field would seriously deteriorate the resonance. This was found to be the case experimentally.

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A Parallel-Strip Point-Contact Diode Mount for Video Detection of Millimeter Waves

This correspondence presents measurements of the performance of an experimental parallel-strip transmission line mount for point-contact diodes (see Fig. 1). These results are an extension of work reported previously [1]. The mount has been used with tunnel-diode, back diode, and ordinary diode detectors at wavelengths of 3.3, 2.1, and 0.84 mm. The sensitivities of the diodes in the new mount compare favorably with reported results for in-line waveguide diodes [2]–[4]. As the signal wavelength decreases, the fabrication of waveguide diode mounts becomes increasingly difficult; therefore, the parallel-strip mount does effect some construction and experimental advantages over such waveguide structures. A detailed description of the parallel-strip mount is given in Gerdine and Barnes [6].

The most comprehensive measurements were made at 3.3 mm because of the availability of laboratory components. A block diagram of the experimental circuit is shown in Fig. 2 and it should be noted that the diode mount was enclosed in a metal box to eliminate background ac pickup. The reference input power for the sensitivity ratings is the input power to the sending horn. The power from the horn was coupled by a dielectric lens to the diode mount input and the spacing between horn and lens was approximately 4 inches. The spacing between the lens and diode mount was adjusted for maximum video output.

The results for different type diodes mounted in the parallel-strip mount are shown in Table I. The tangential sensitivity (TSS) is defined in the standard manner, and the nominal detectable signal (NDS) is defined as the input power required to raise by 3 dB the video output power for no input signal.

Included for comparison, the 1N53 sensitivity measurements were made by replacing the parallel-strip mount and dielectric lens combination by a phase-corrected dielectric lens horn and a waveguide detector mount having a variable tuning termination. The tunnel diodes tested had peak currents in the range from 0.5 mA to 1.5 mA with the most typical values being approximately 1 mA. The peak voltage was typically 0.25 to 0.3 volt. Three to one was the typical peak-to-valley current ratio. Diodes with peak currents ranging from 0 to 0.1 mA were classified as back-diodes and were fabricated from semiconductors doped less heavily than the material used for tunnel-diodes. The silicon used for the point-contact diodes was obtained from 1N53 cartridges.

The results show that the silicon-tungsten point-contact diodes give the best tangential sensitivity for a high impedance video preamplifier, while the gallium arsenide tunnel-diode was most sensitive for the low impedance input into the VSWR amplifier. The principal reason for this is the

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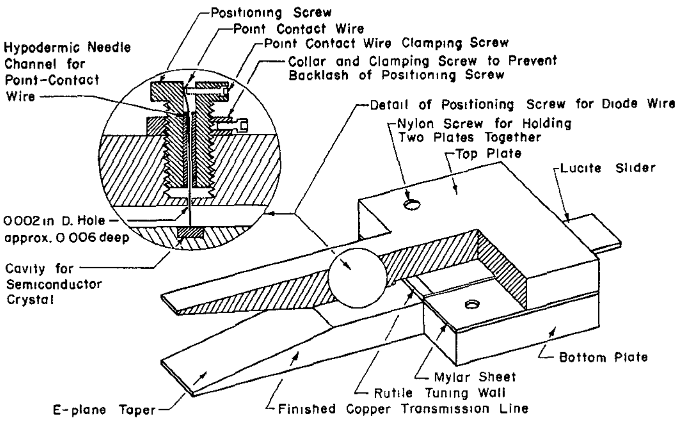

Fig. 1. Parallel-strip transmission line diode mount.

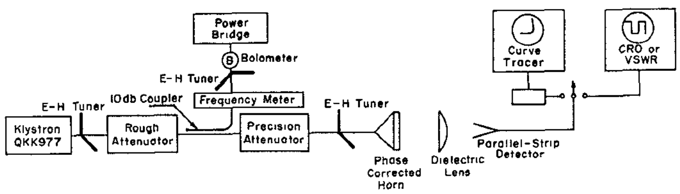

Fig. 2. Block diagram of experimental setup for video detection at $\lambda = 3.3$ mm.

TABLE I

SENSITIVITIES OF DIODE DETECTORS AT $\lambda = 3.3$ MM

Diode Type	Semiconductor	Wire	NDS* (dBm)	TSS† (dBm)
Point-contact diode	Si from 1N53	Tungsten	−36	−41
Point-contact diode	GaAs (Se doped) $\rho = 7.10^{-4}$ ohm-cm.	Phosphor-bronze	−29	−39
Point-contact tunnel diode	GaAs (Se doped) ρ is unknown [5]	Zinc	−42	−22
Point-contact back diode	GaAs (Se doped) $\rho = 7.10^{-4}$ ohm-cm	Zinc	−32	−30
1N53 Cartridge	Si	Tungsten	−17	−29

* Video amplifier: HP 415B VSWR Meter (200-ohm input impedance, ~30 c/s bandwidth).
† Video amplifier: Textronix Type E Preamplifier (10 Megohm input impedance, 50 μV/cm sensitivity, 0.2 c/s to 20 kc/s bandwidth).

TABLE II

RELATIVE SENSITIVITIES OF DIODE DETECTORS AT $\lambda = 2.1$ MM

Diode Type	Semi-conductor	Wire	*Relative Sensitivity
FXR wafer with point-contact diode	Si	Tungsten	0.0 dB
Point-contact diode	Si	Tungsten	6.0 dB
Point-contact tunnel-diode	GaAs	Zinc	2.5 dB
Point-contact diode	GaAs	Phosphor-bronze	<0.0 dB

* Sensitivity relative to FXR diode mount.
* Video Amplifier: Narda 441B VSWR Meter (200-ohm input impedance).

result of the impedance match between the particular diodes and the input of the diode amplifier. While less sensitive, gallium arsenide diodes and the gallium arsenide back-diodes gave improved performance when compared with a 1N53.

At $\lambda = 2.1$ mm, a comparison was made between the strip mount with different diodes and a silicon-tungsten in-guide mounted diode (FXR model 6638A) which was available in the laboratory. This waveguide mount does not represent an absolute standard because of the wide variation of performance which is common to point-contact diodes, but it did serve as a reference to indicate the performance of the new mount. The results are shown in Table II. No quantitative measurements were taken at $\lambda = 0.84$ mm but for detectors in the parallel-strip mount, silicon-tungsten diodes were more sensitive than the tunnel-diodes tested.

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A 150 Mc/s Circulator

The below-resonance operation of strip-line circulators at lower frequencies is not of interest as the low magnetic loss region is quite narrow on the magnetic field axis. Kittle's equation for resonance frequency is

$$f = \gamma\sqrt{[H_A - (N_Z - N_X)M][H_A - (N_Z - N_Y)M]} \quad (1)$$

$$N_X + N_Y + N_Z = 4\pi \quad (2)$$

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