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LINE WIDTH AND INVERSION RATIO
OF IRON-DOPED RUTILE

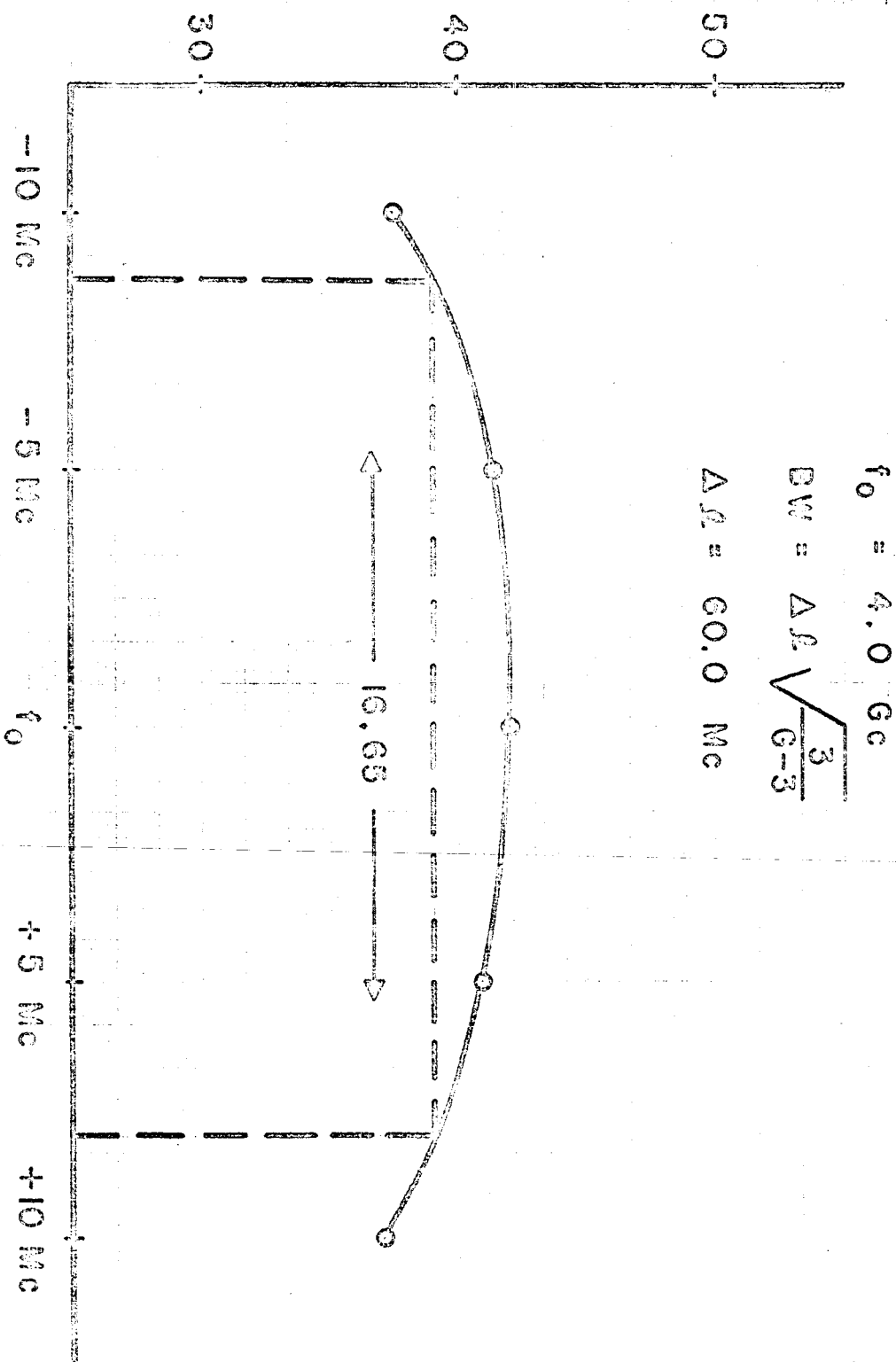
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One of the basic limits on the broadband performance of a TWM is the line width of the active crystal used. To date only two crystals have been employed in practical maser amplifiers, that is, Ruby ($\text{Cr}^{+3} \cdot \text{Al}_2\text{O}_3$) and Rutile ($\text{Cr}^{+3} \cdot \text{TiO}_2$). Ruby has a distinct advantage over Chromium doped rutile in that its line width is approximately twice that of rutile; 57 Mc vs. 27 Mc.

Recent experiments with iron-doped rutile ($\text{Fe}^{3+} \cdot \text{TiO}_2$) have shown that this material is excellent for broadband maser applications. Optimum concentration studies have resulted in measured line widths of 60 Mc and inversion ratios in excess of 15:1. Figure 1 shows the experimental data taken at a center frequency of 4.0 gc. The additional tests taken at other frequencies produced the same line widths (60 Mc) as the typical data given in Figure 1.

Inversion ratios were also calculated from the gain and paramagnetic absorption data taken over the frequency band of 2.9--4.1 gc. Inversion ratios averaged better than 15:1 over the entire band. Table 1 gives the experimental inversion ratios for the data in Figure 1. Table 2 shows the inversion ratio data in the complete 2.9 to 4.1 gc band. Data from 3.5 gc to 3.8 gc was not taken due to unavailability of an appropriate pumping source. Net gains of 20 db per inch have been attained with this material which is sufficient for broadband application.

ELECTRONIC GAIN



$$f_0 = 4.0 \text{ Gc}$$

$$BW = \Delta f \sqrt{\frac{3}{G-3}}$$

$$\Delta f = 60.0 \text{ Mc}$$

FIG. 1 - FREQUENCY DEVIATION ABOUT f_0 (Mc)

INVERSION RATIOS ABOUT 4.0 Gc

<u>FREQUENCY</u>	<u>I. R.</u>
$f_0 = 4 \text{ Gc}$	16.8
+ 5 Mc	16.4
+ 10 Mc	15.9
- 5 Mc	15.4
- 10 Mc	15.8

TABLE No. 1

<u>FREQUENCY</u>	<u>I. R.</u>
2.9	15.8
3.0	16.8
3.1	16.8
3.2	16.3
3.3	16.7
3.4	17.5
3.9	17.6
4.0	16.8
4.1	16.5

TABLE No. 2

	<u>$\text{Fe}^{+++} \text{TiO}_2$</u>	<u>$\text{Cr}^{+++} \text{TiO}_2$</u>	<u>$\text{Cr}^{+++} \text{Al}_2\text{O}_3$</u>
SPIN SYSTEM	5 / 2	3 / 2	3 / 2
LINEWIDTH	60 Mc	27 Mc	58 Mc
QM	50	50	150
INVERSION RATIO	15:1, 1 \rightarrow 4	10:1, 1 \rightarrow 4	4:1
H_{dc} at 4.0 Gc	1.6 Kg	2.6 Kg	3.3 Kg

TABLE No. 3