PBAR NOTE 584
COMPARISON BETWEEN A LOSSY MAGNETIC ABSORBER AND A LOSSY ELECTRIC ABSORBER

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INTRODUCTION

For the 4-8 GHz Debuncher Upgrade, attenuation of the microwave modes in the beam pipe is very important. So far most of the studies in microwave mode absorbers have been involved with lossy magnetic absorber. (Most notably Emerson & Cuming MF190.) Lossy magnetic absorber has been chosen for aperture reasons. This is because electric fields are weak and magnetic fields are strong at the beam pipe walls. However, most lossy magnetic absorbers are not well suited for high vacuum situations especially when subjected to high RF power in stochastic cooling kickers. It will be shown in this note that a lossy electric absorber with a large dielectric constant can achieve high attenuation constants but at a reduced bandwidth.

MATERIAL PROPERTIES AND WAVEGUIDE GEOMETRY

Specifically, this note will compare Emerson & Cuming MF190 with Silicon Carbide (SiC). The microwave properties of these two materials at 6 GHz are shown in Table 1.

Property	MF190	SiC
Dielectric Constant Magnitude	25.0	30.0
Dielectric Loss Tangent	0.1	0.3
Relative Permeability Magnitude	4.0	1.0
Magnetic Loss Tangent	0.75	0.00

Table 1. Microwave properties of absorbing material at 6 GHz.

There are two types of geometry that are studied in this note. The absorber placed on the top walls of the waveguide (top-bar) is shown in Figure 1. The absorber placed on the side of the waveguide (side-wall) is shown in Figure 2. This note will consider the attenuation of the TE^{Z}_{10} mode only in a waveguide that measures 40mm by 40 mm. This note will use the formulas developed in Pbar Note No. 583.

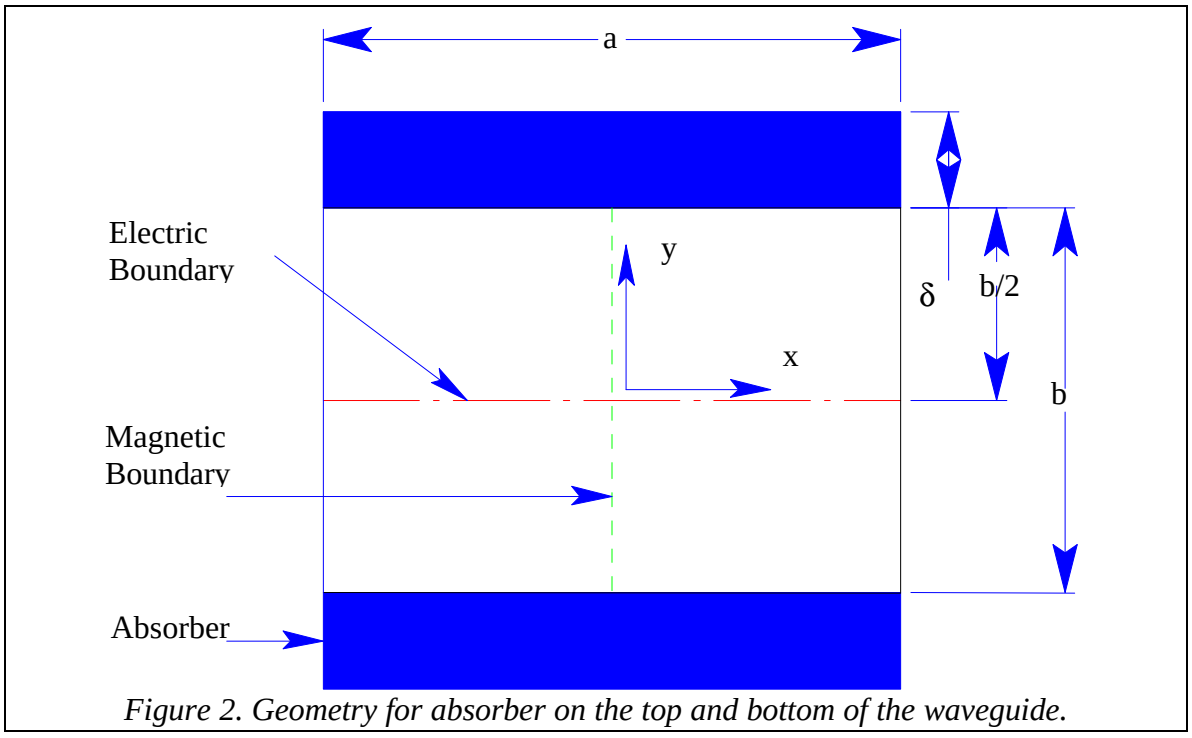

Figure 2. Geometry for absorber on the top and bottom of the waveguide.

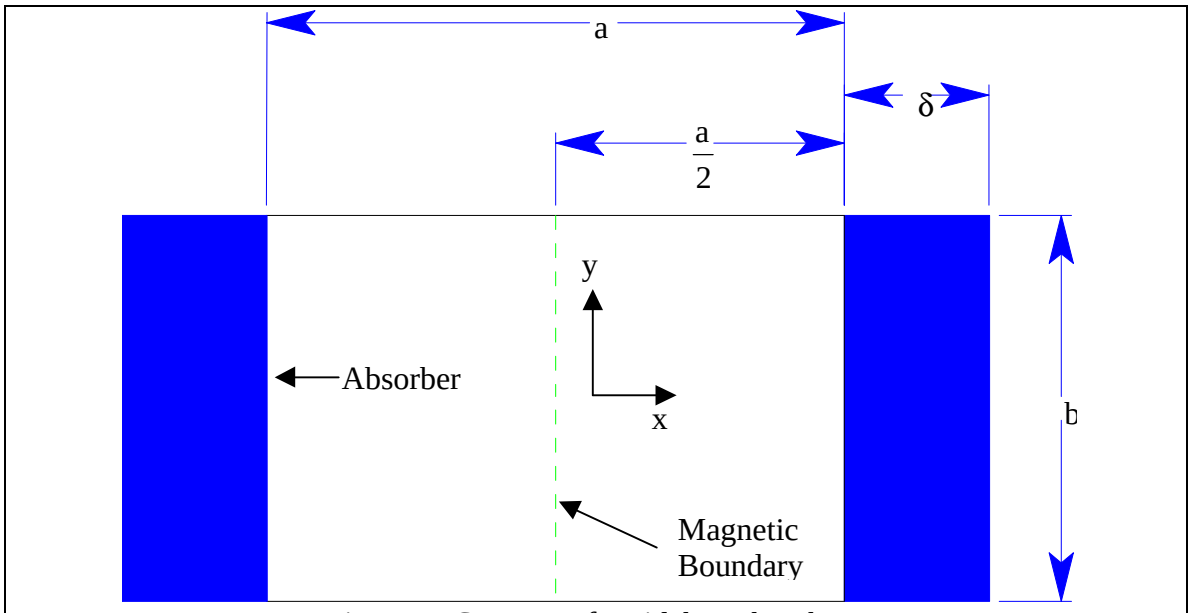

Figure 2. Geometry for sidebar absorbers.

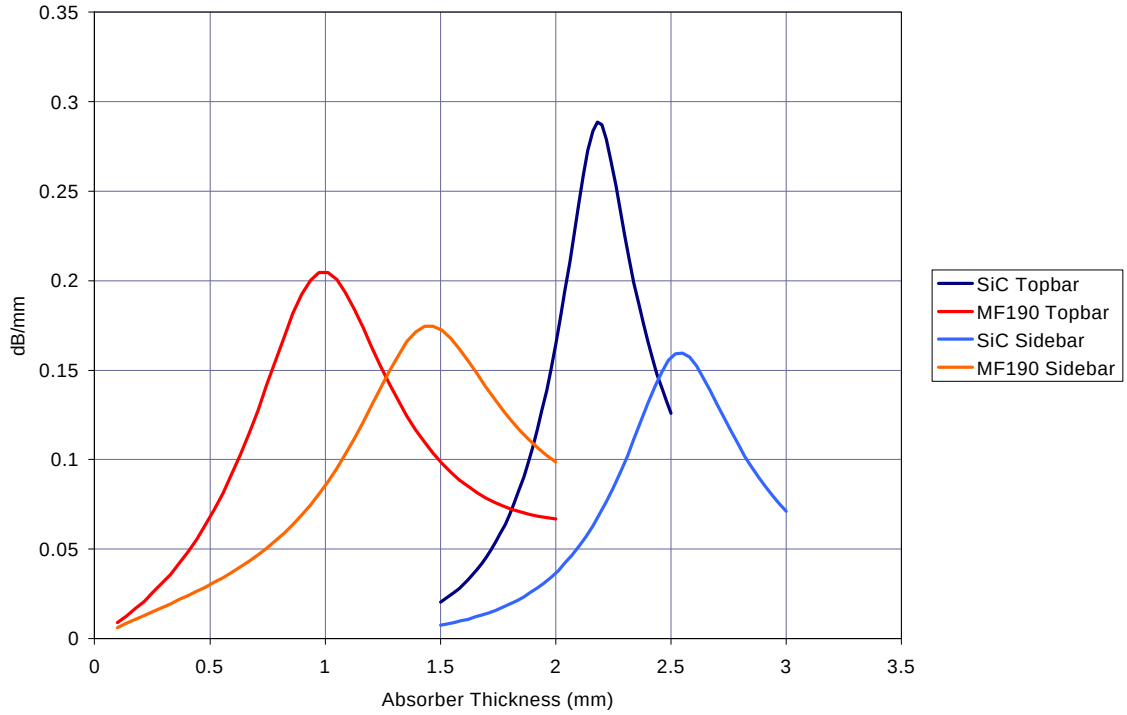

Figure 3. The waveguide attenuation as a function of absorber thickness (d) at 6 GHz.

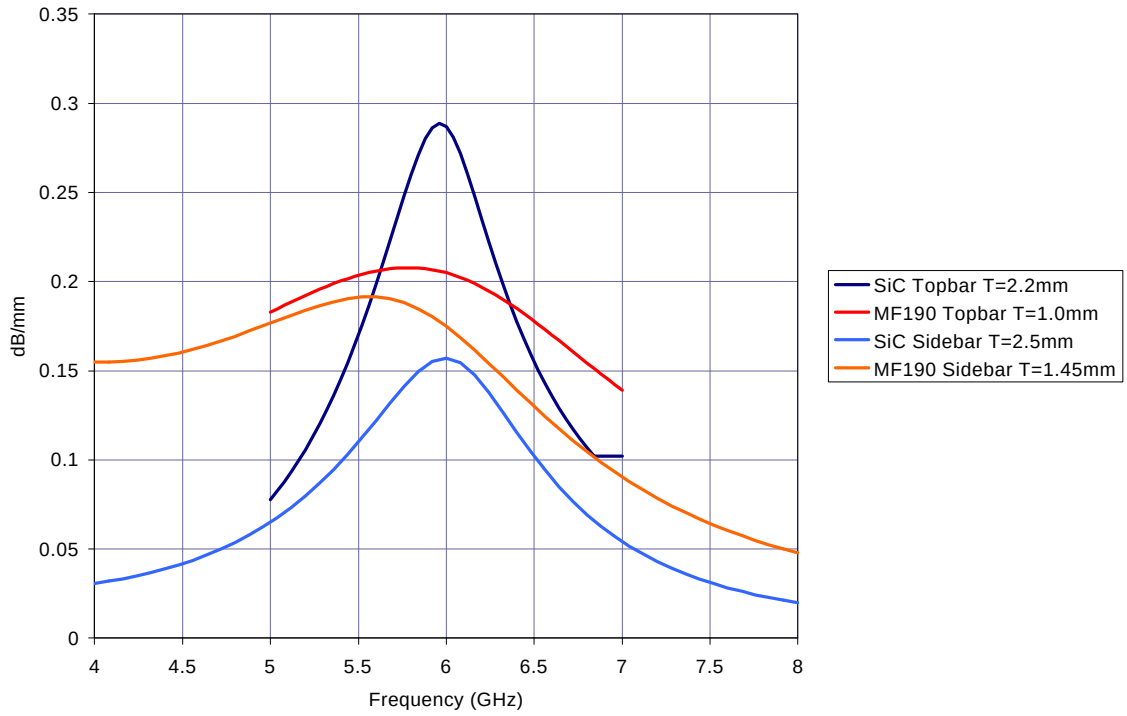

Figure 4. The waveguide attenuation as a function of frequency using thickness that give the maximum at enuation at 6 GHz.

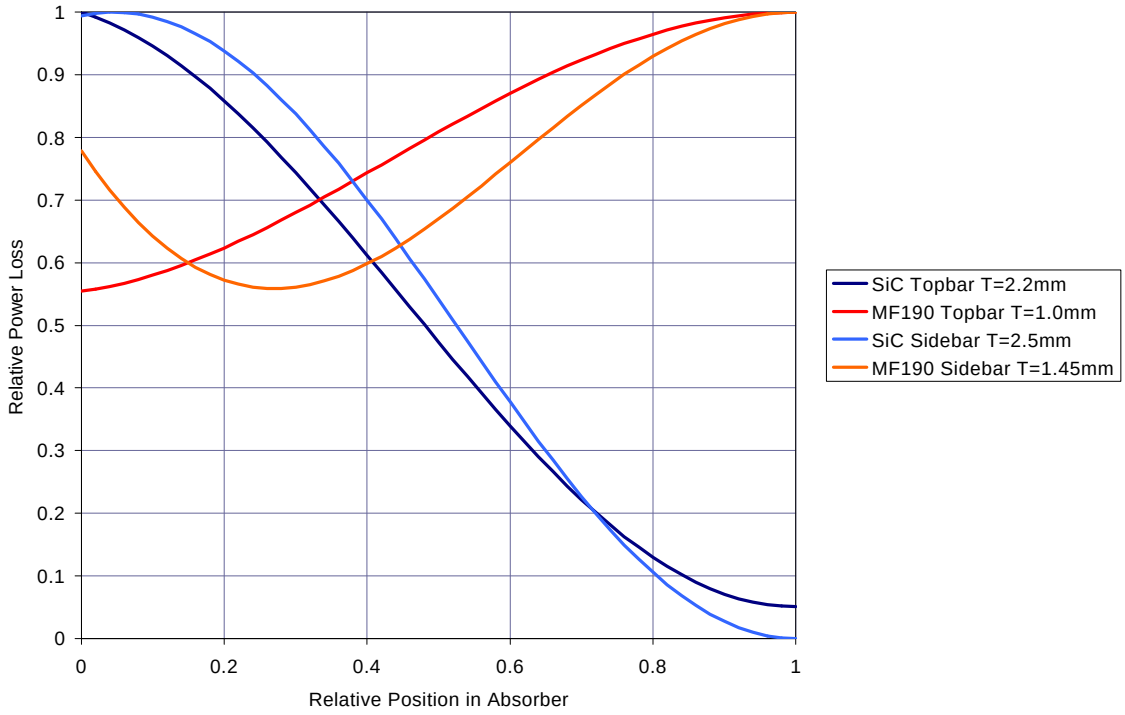

Figure 5. The relative power loss density (normalized to 1) at 6 GHz as a function of position in the absorber. For the side-bar absorber, the power loss is independent of the y coordinate for the fundamental waveguide mode. For the top-bar absorber configuration, the power loss data is shown for x=0 (center of the waveguide)

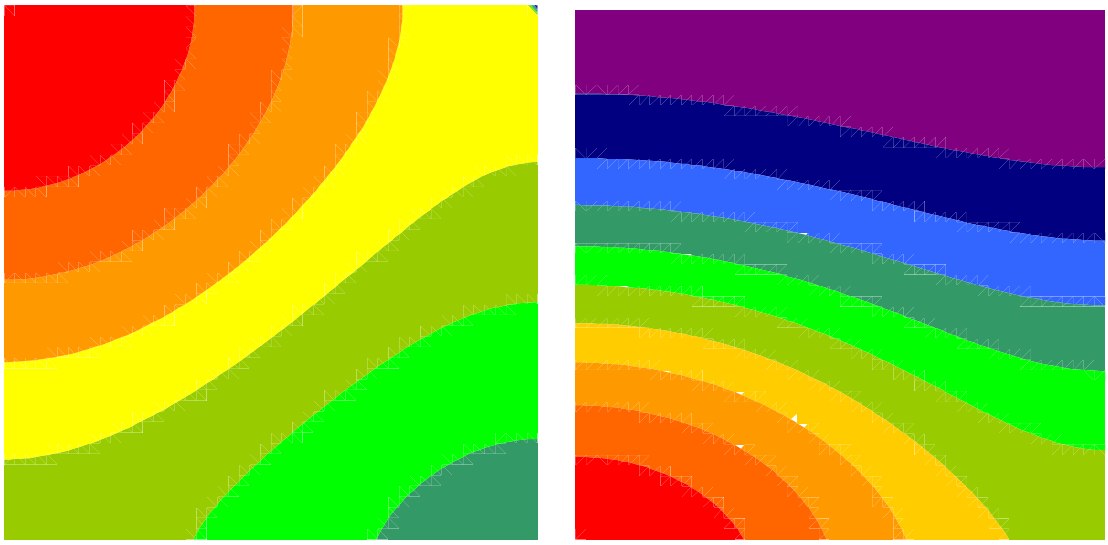

Figure 6. Relative power loss density at 6 GHz for top-bar absorbers. The left picture is for an 1 mm thick MF190 absorber. The right picture is for an 2.2 mm thick SiC absorber. The x axis runs from left to right. The y axis runs from top to bottom.

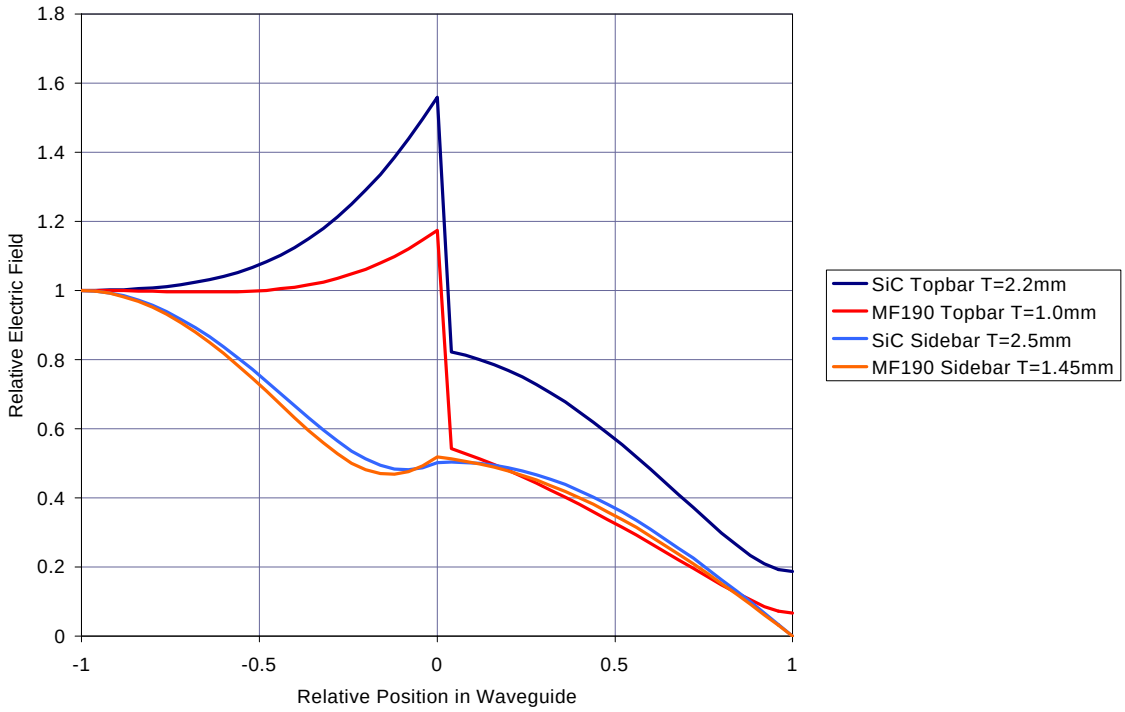

Figure 7. The magnitude of the electric field at 6 GHz as a function of position in the waveguide and absorber. The top-bar data is for x=0 (center of the waveguide). Relative positions greater than 0.0 are in the absorber. Position less than 0.0 are in the waveguide. The center of the waveguide is at u=-1.0

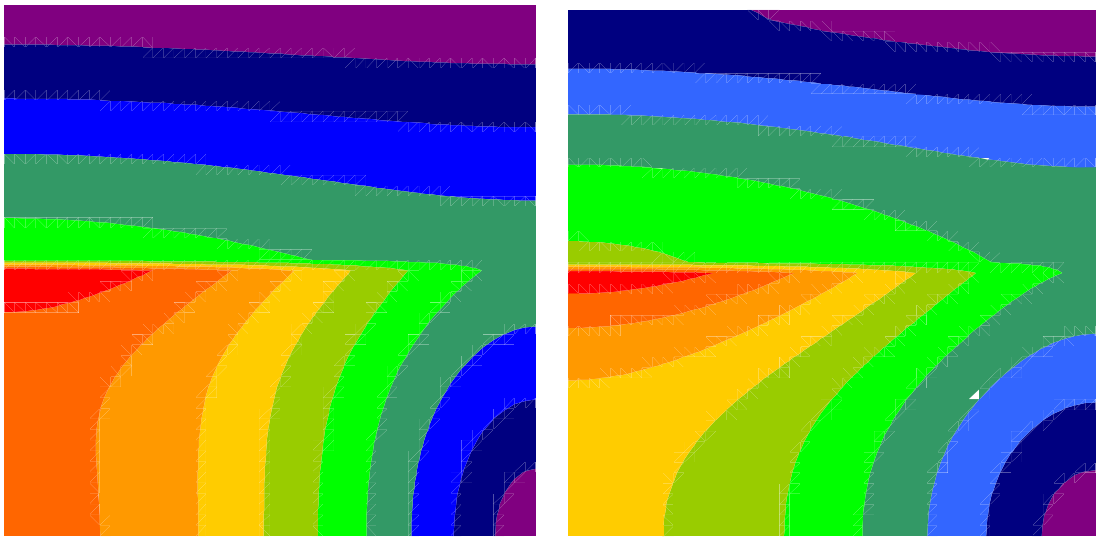

Figure 8. The magnitude of the electric field at 6 GHz for a waveguide with top absorbers. . The left picture is for an 1 mm thick MF190 absorber. The right picture is for an 2.2 mm thick SiC absorber. The center of the waveguide is at the lower left-hand corner of each picture. The absorber starts midway up the y axis.

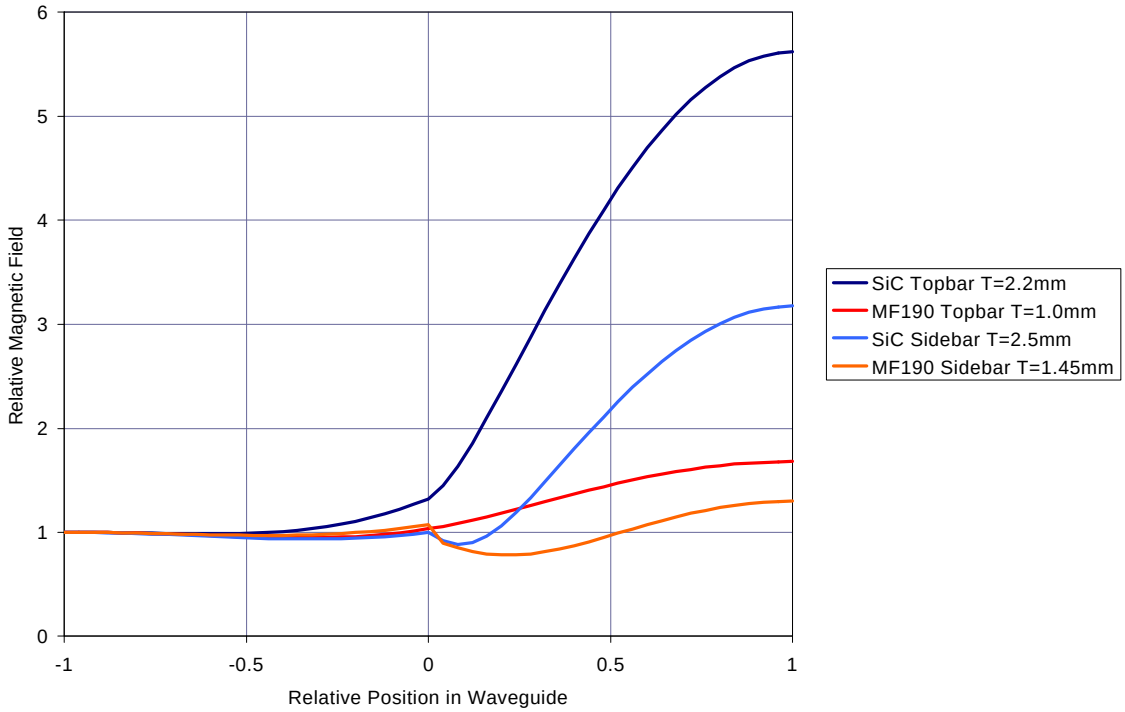

Figure 9. The magnitude of the magnetic field at 6 GHz as a function of position in the waveguide and absorber. The top-bar data is for x=0 (center of the waveguide). Relative positions greater than 0.0 are in the absorber. Position less than 0.0 are in the waveguide. The center of the waveguide is at u=-1.0

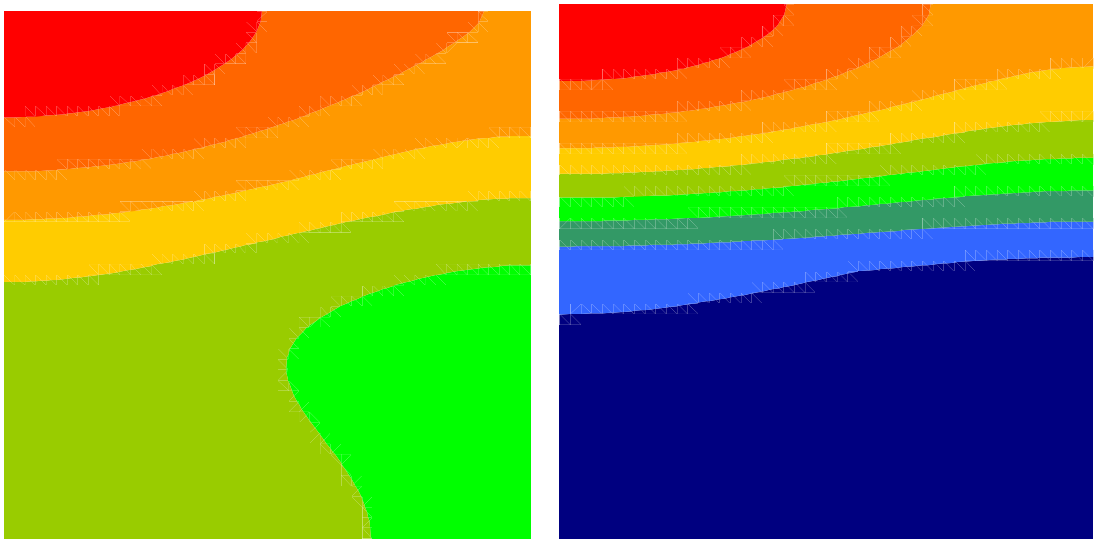

Figure 10. The magnitude of the electric field at 6 GHz for a waveguide with top absorbers. . The left picture is for an 1 mm thick MF190 absorber. The right picture is for nan 2.2 mm thick SiC absorber. The center of the waveguide is at the lower left-hand corner of each picture. The absorber starts midway up the y axis.