COMPLEX MICROWAVE TRANSMISSIVITY OF TREE CROWNS

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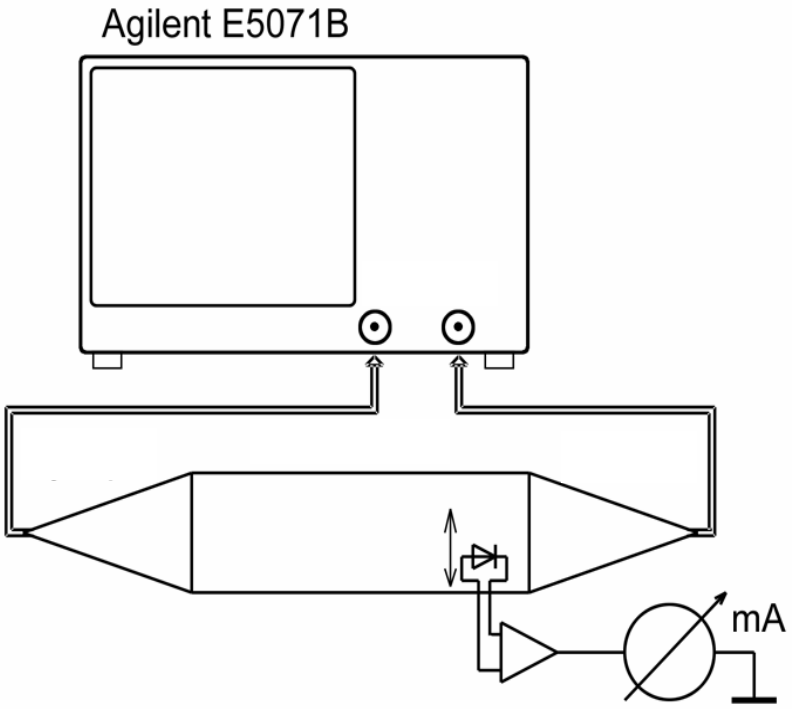
WAVEGUIDE TRANSITION SYSTEM

- Vector Network Analyzer.
- Two measuring wide band horn antennas with coaxial input. Horn aperture is 350×260 mm. Antennas operate in the frequency band of 800…10000 MHz.
- Measuring camera in the form of rectangular waveguide section with a cross section of 350×260 mm and a length of 1500 mm.



MEASURING TECHNIQUE

$$T = \left| \frac{(1-R^2)e^{j\gamma d}}{1-R^2 e^{2j\gamma d}} \right|^2 \qquad T \approx \left| e^{j\gamma d} \right|^2$$

$$T_0 \approx \left| e^{j\gamma_0 d} \right|^2$$

$$\gamma = \sqrt{k_0^2 \varepsilon - \left(\frac{\pi}{a}\right)^2} = k_0 \sqrt{\varepsilon} \sqrt{1 - \frac{1}{\varepsilon}\left(\frac{\lambda}{2a}\right)^2} = \gamma_0 \sqrt{1 - \frac{1}{\varepsilon}\left(\frac{\lambda}{2a}\right)^2}$$

$$T_0(dB) \cong \frac{T(dB)}{\sqrt{1 - \left(\frac{\lambda}{2a}\right)^2}}$$

MODEL

The wave number for coherent field in a tree crown is

$$k = k_0 + \frac{2\pi N f(\hat{o},\hat{o})}{k_0}$$

where k_0 is the wave number in free space, *N* is the number density of scatterers, $\vec{f}(\hat{o},\hat{i})$ is the complex scattering amplitude. The complex refraction index is

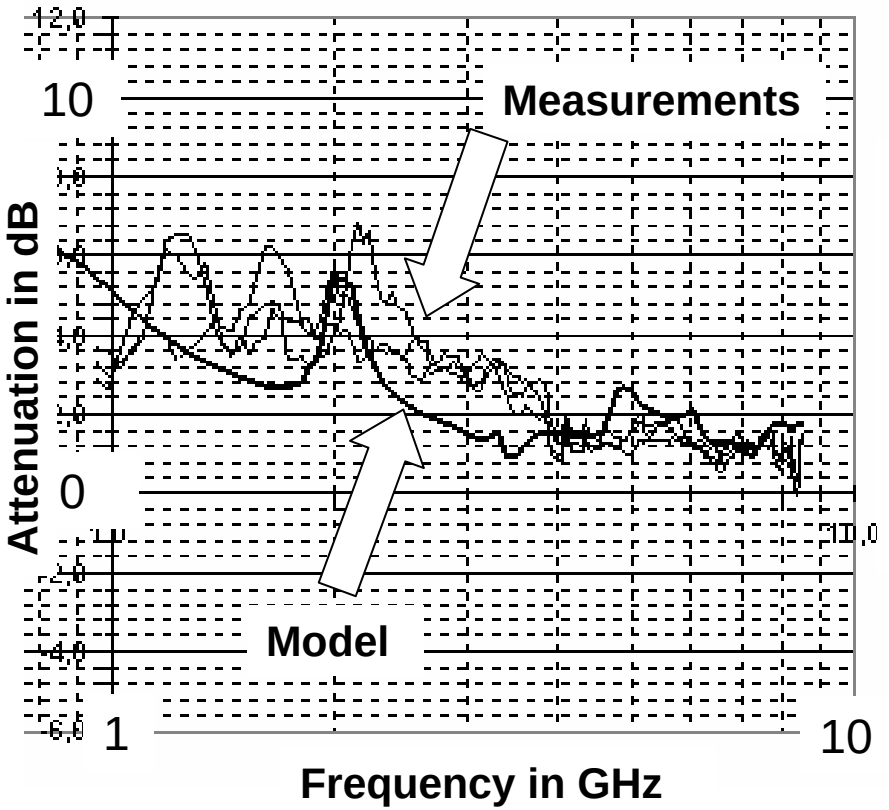
$$n = 1 + 2\pi f(\hat{o},\hat{o})\frac{N}{k_0^2}$$

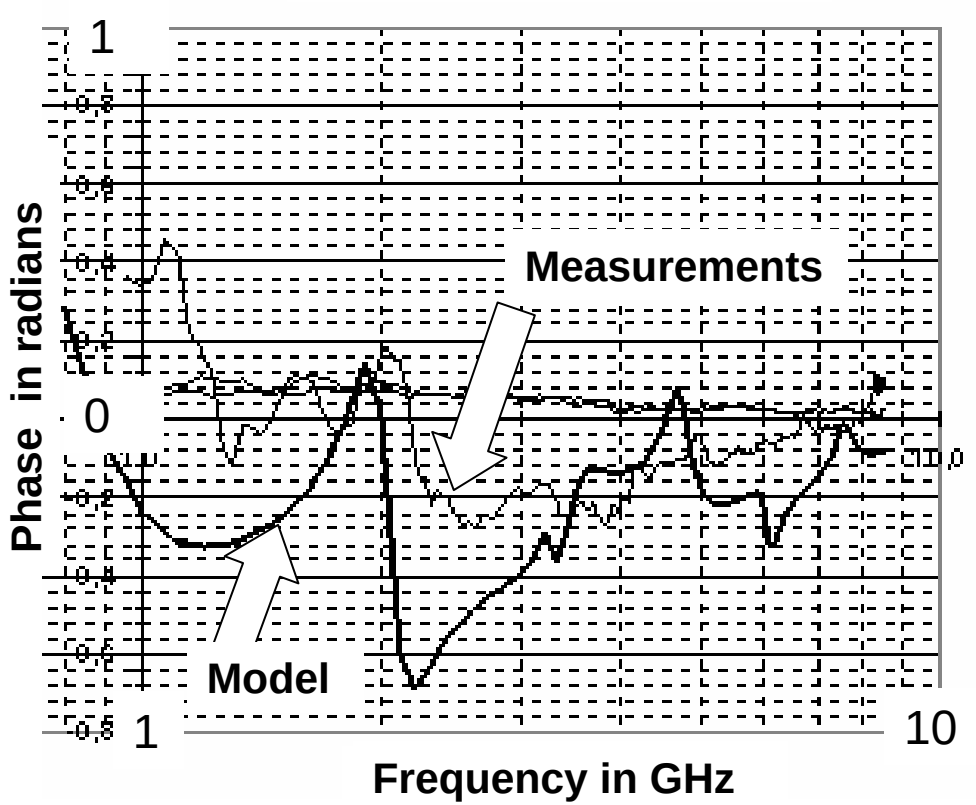
The magnitude of the complex transmissivity is $\left|\dot{K}(\omega)\right| = k_0 \operatorname{Im} n$

The phase of the complex transmissivity is $\Delta\Phi = k_0(\operatorname{Re} n - 1)$

RESULTS

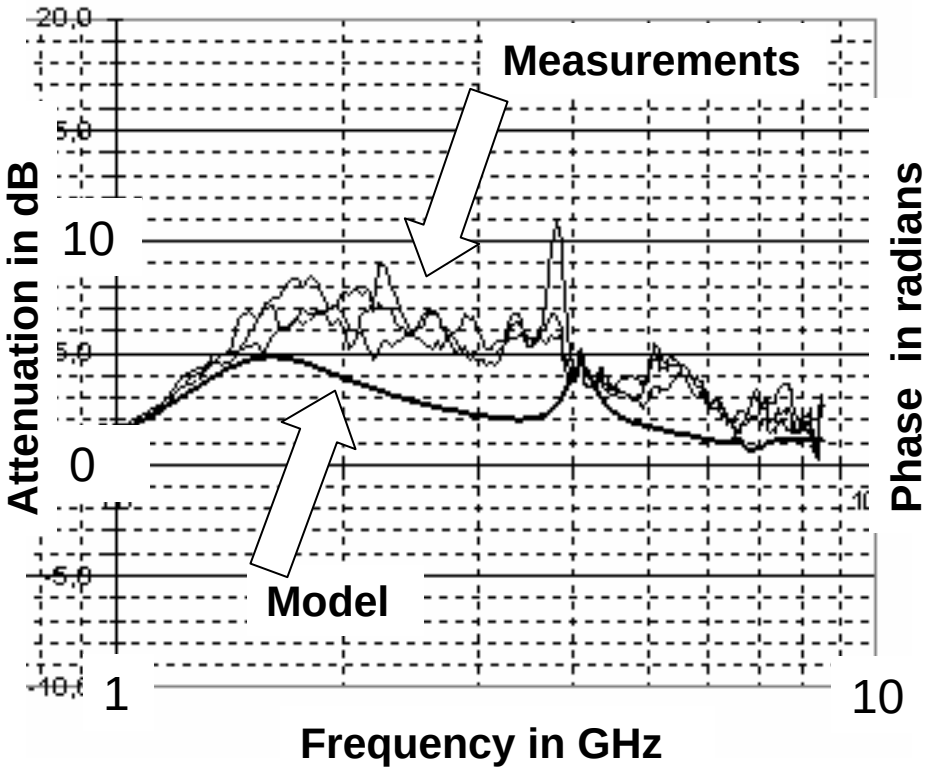
Seven branches with a diameter of 2 cm

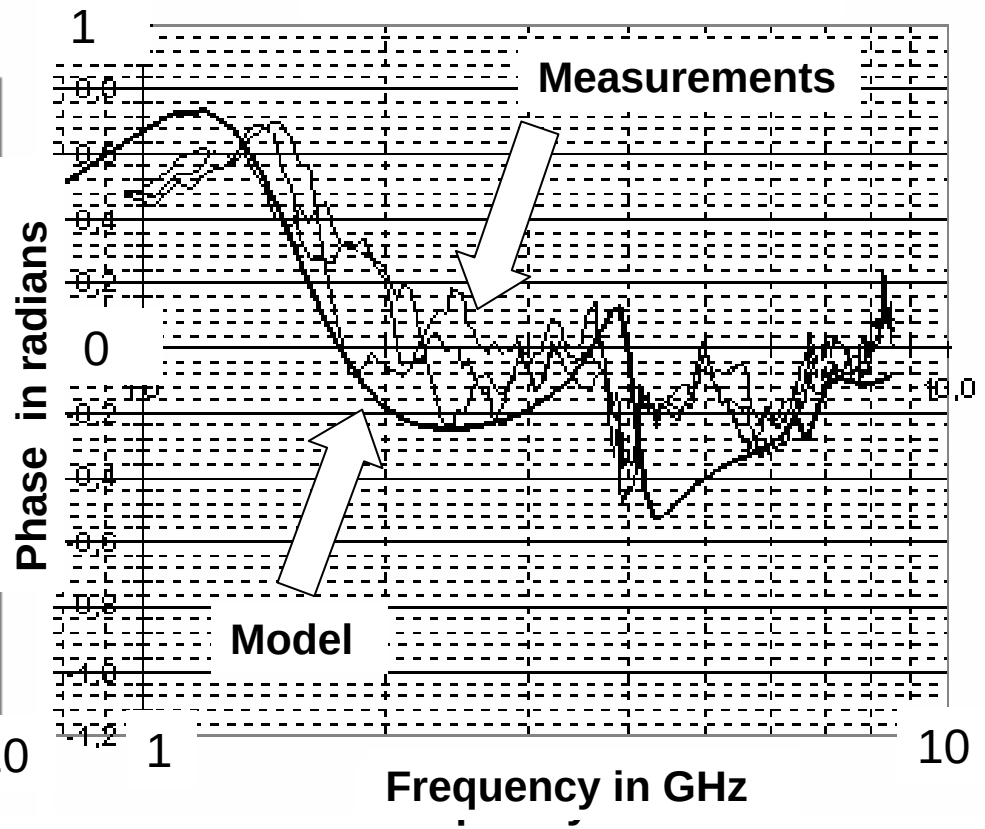




RESULTS

Eleven branches with a diameter of 1 cm





CONCLUSIONS

1. The model successfully predict the frequency dependence of complex transmissivity.
2. Attenuation by branches has resonant form. The abnormal dispersion of refractive index is observed.
3. The observed frequency dependence can be critical in ultra wide signal propagation in tree crowns.
4. Experimental measurements are planned in laboratory conditions and in field conditions for tree components, single trees and groups of trees (depending on season).
5. Complex transmissivity measurements will be conducted in wide wavelength range under continious frequency change and in narrow spectral bands.