

## Description of Supplementary Files

Four m files, “TM\_leakymodes, fdavidenko, fTM, fTMt”, have been added as supplementary files.

The leaky modes for circular dielectric rod can be obtained from TM\_leakymodes on MATLAB software. The leaky modes for circular dielectric rod with  $a=10\text{mm}$  and  $\epsilon_r=4$  have been presented on line 216 in the manuscript. Anyone can compute the leaky modes in the frequency region between zero and the cutoff frequency, 6.63 GHz, by using the TM\_leakymodes. In order to compute the modes, it is firstly necessary to write a initial guess for the first mode at a certain frequency in the line “TM01=[5e9 -.98 .05];% [The operating fr. the phase const. the attnuation const.]”. For example, initial guess for the propagation constant is  $\gamma = 0.98 + 0.05i$  at  $f=5\text{GHz}$ , so initial guess for the phase constant is 0.98 and the initial guess for the attenuation constant is 0.05.

The line “for fr=5e9:-.1e9:.1e9 % The operating frequency” determines the frequency region where the leaky modes will be obtained. For example, the frequency starts 5GHz and finish 100MHz for the description, “for fr=5e9:-.1e9:.1e9”.

The guided modes where exist above the cutoff frequency can be obtained from the “Open\_Boundary\_ChaEq\_TM”. In order to compute the guided modes, it is only necessary to define the frequency range in the line “for f=6.7e9:.1e9:15e9”. For example, the description “for f=6.7e9:.1e9:15e9” computes the guided modes the frequency region between 6.7GHz to 15GHz.

The CST data could not include as supplementary files because the system cannot support the file format. But they will share if they are required by the reviewers.