COMSOL Multyphisics Super Resolution Analysis of a Spherical Geodesic Waveguide Suitable for Manufacturing

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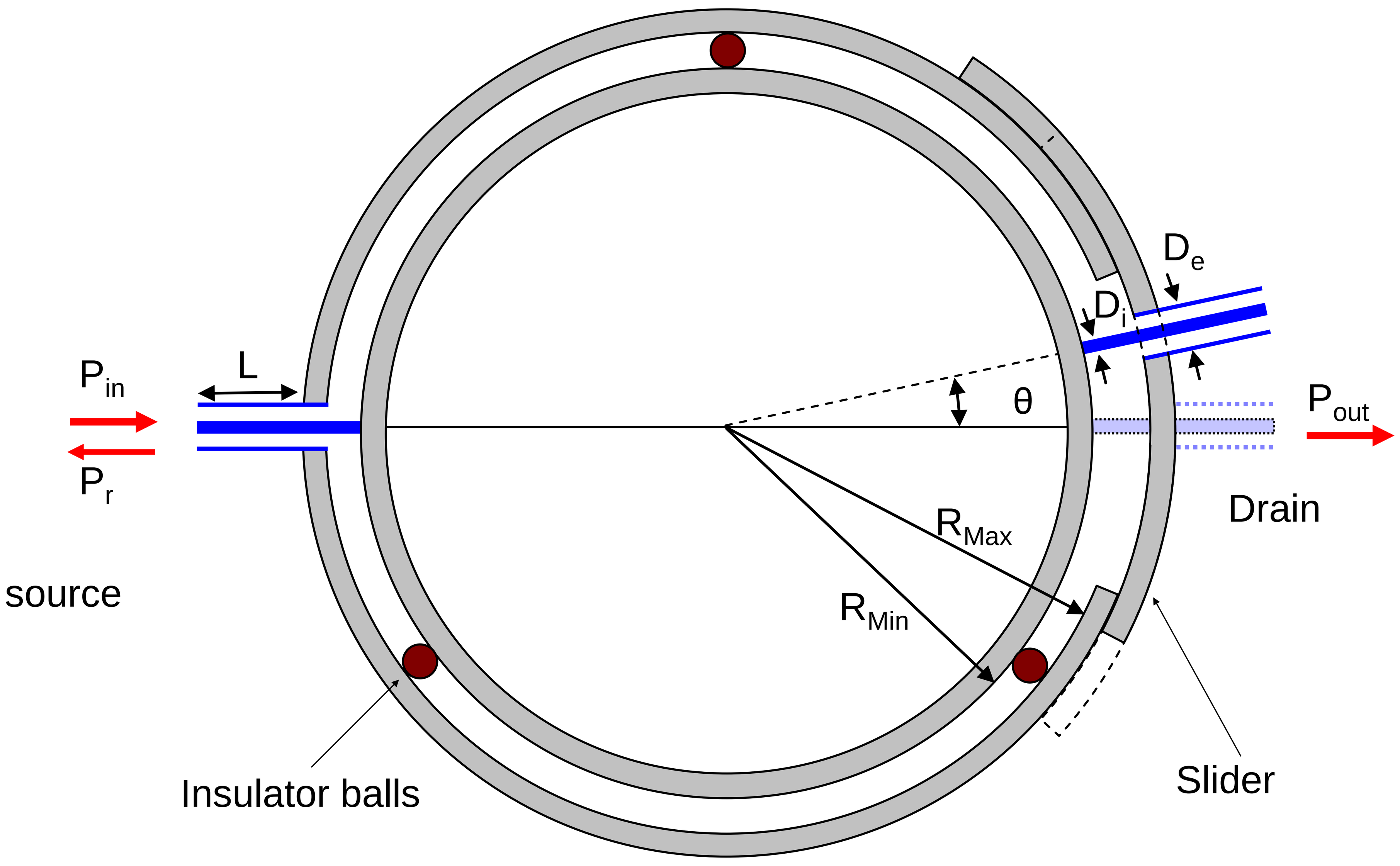
Introduction: It has been proved theoretically (Miñano et al, 2011) that the super-resolution up to λ/500 can be achieved using an ideal metallic Spherical Geodesic Waveguide (SGW). However we are interested to see if the to prove this concept experimentally, we need to consider the key parameters that might influence the reported super resolution properties such as losses, metal type, the thickness of conductive walls.



R_{Min}	R_{Max}	L	D_e	D_i	q	C
145	150	20	20	10	0-5	3.5x10^7
mm	mm	mm	mm	mm	Degree	S/m

Figure 1. Schematic view of the SGW with movable drain designed in COMSOL and their corresponding dimensions.

3 small insulator speheres are located in the waveguide in order to hold the interior balls, in such that 2 metalic spheres stay concentric

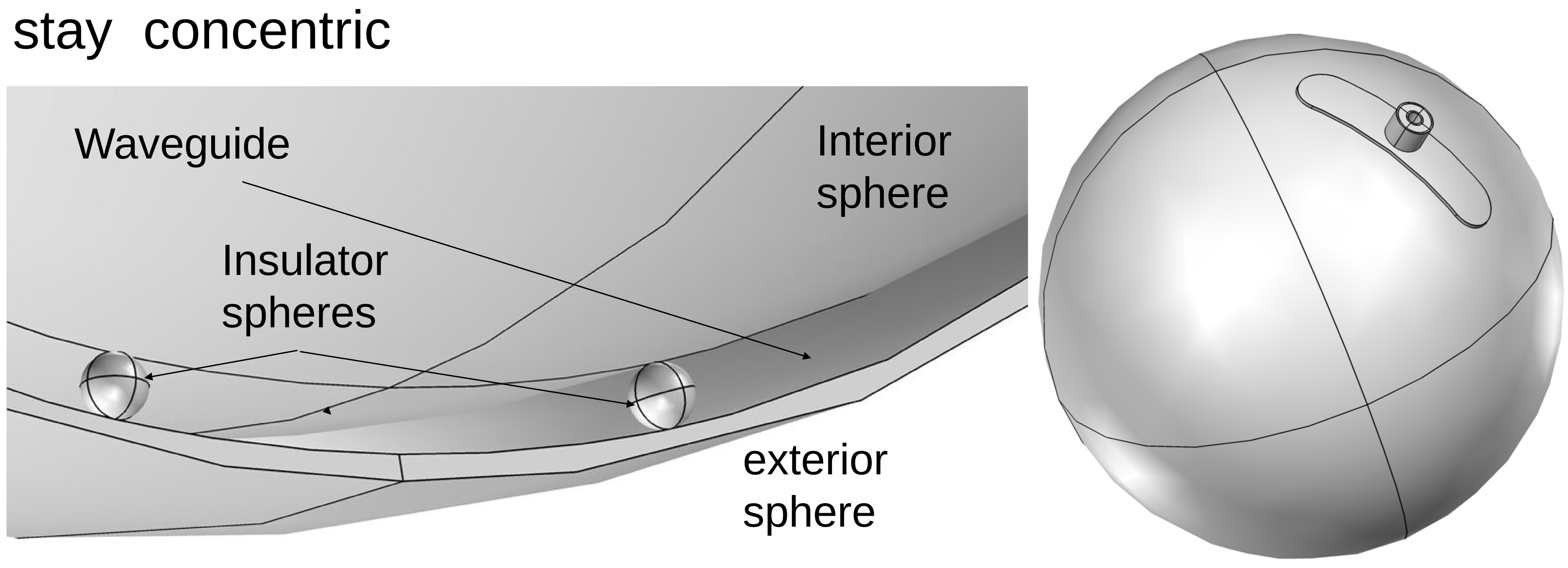


Figure 2. Left: the insulator spheres, that are holding the interior metallic sphere made in COMSOL. Right: The GSW with its slider made in COMSOL

Computational Methods: For analyzing the system we need to solve the wave equation in spherical coordinate. For q≠0 the wave equation in the SGW is not symmetric anymore. More over the presence of the insulator balls makes the calculation even more complicated

$$\nabla \times \mu_r^{-1}(\nabla \times E) - k_0^2(\varepsilon_r - \frac{j\sigma}{\omega\varepsilon_0})E = 0$$

Results: To investigate the influence of the practical limitations on the super-resolution properties, the S parameters are being measured and compared for different value of q.

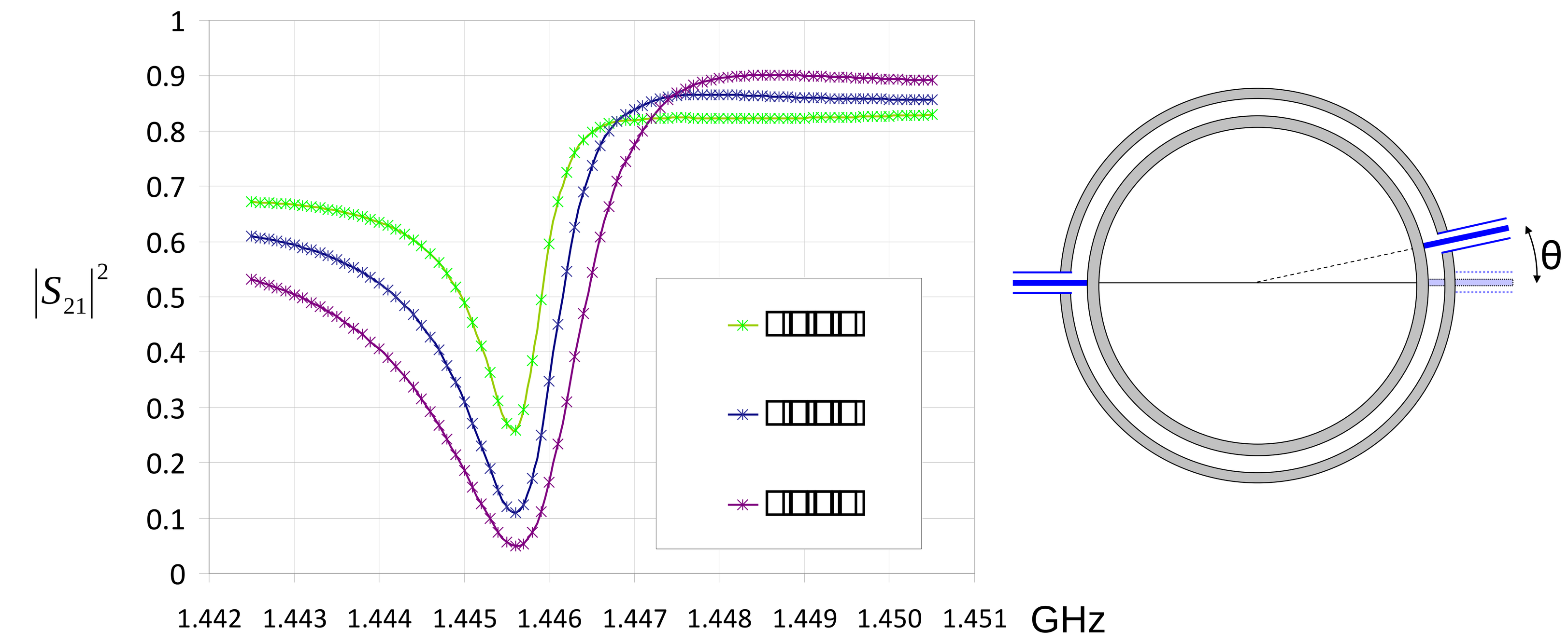


Figure 3.Right: Is the schematic diagram of a SGW without slider.
Left: shows the $|S_{21}|^2$ parameter of this SGW corresponding different angles

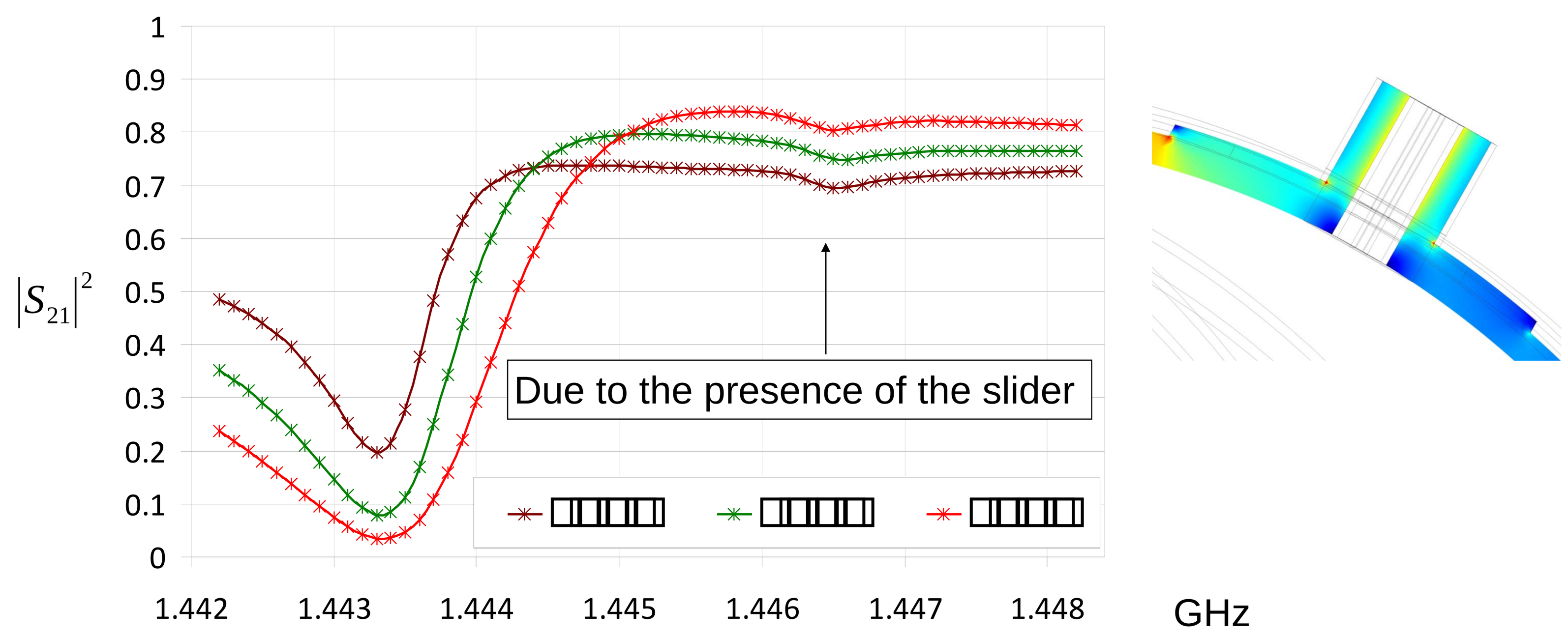


Figure 3.Left: The graph shows the $|S_{21}|^2$ parameter of a SGW with slider for Different angles. The secondary notches are due to the presence of the slider.

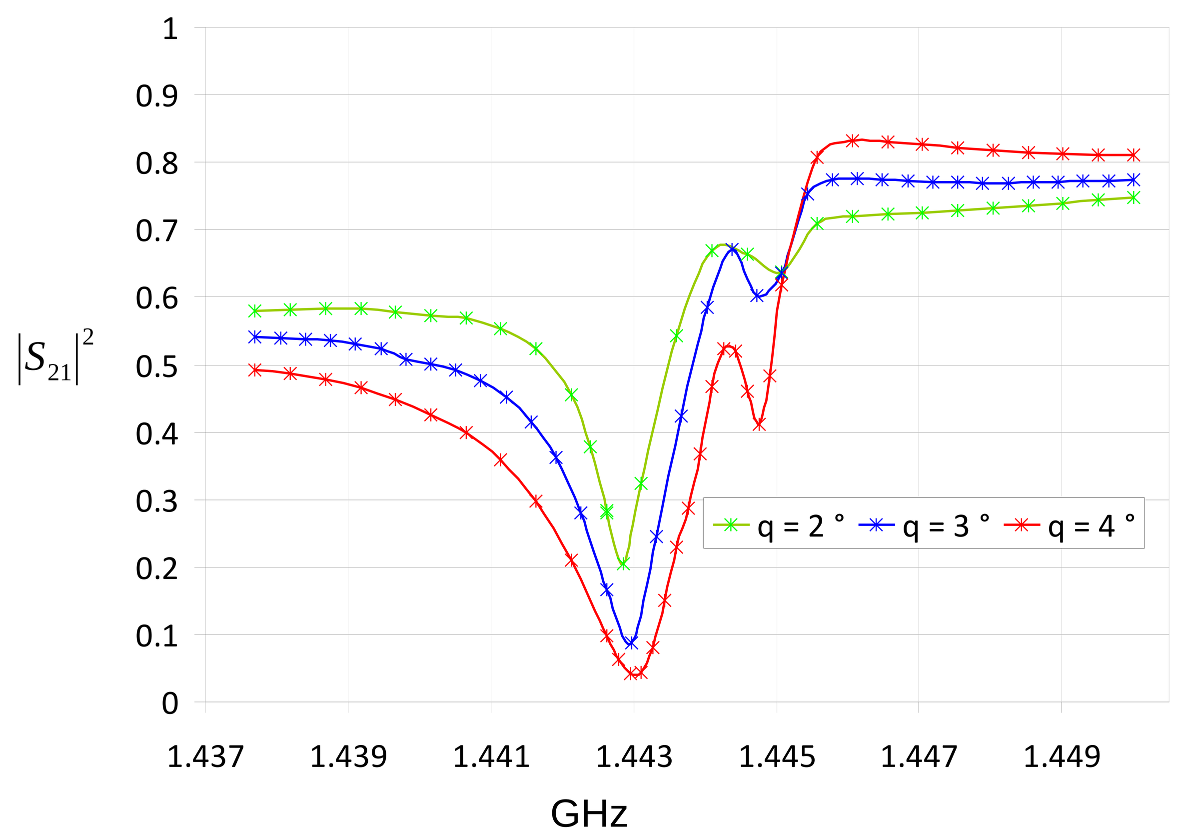


Figure 4. The graph shows the parameter for a real SGW , for different angles

Conclusions: The insulator balls and the slider create more notch on the $|S_{21}|^2$ graph. However they can be recognized by the bandwidth and the central frequency. The most important and distractive influence is coming from the metallic losses. Since the metals are not perfect conductor they influenced the super resolution properties of the SGW.

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