**Analitical results:**

**Coaxial setup with differents materials**

# **Introduction**

In order to analyze the variation of the permittivity of a coaxial cell culture inside when applied to a microwave beam must first determine if our network analyzer have sufficient sensitivity.  
To obtain the sensitivity to be measured, the S parameters of the coaxial have been analyzed when the interior has different medium. The mediums that will be analyzed are the following:

• Vacuum  
• Distilled water  
• Sea water  
• Cultivation water  
• Cell culture (P = 0.1)

# **Experiment**

//Cal definir els parametres de matlab

# **Expressions**

Expressions only valid for

In general



# **Results**

## Scattering parameters for differents mediums in Matlab

**S21 Vacuum **

**S21 Distilled Water**

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**S21 Sea Water**

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**S21 Culture Medium without Cells**

**S21 Culture Medium with 0.1% Cells**

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**S21 Culture Medium with 0.05 of cells**

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**S21 Culture Medium with 0.025 of cells**

**S21 Culture Medium with 0.0125 of cells**

****

In order to define the culture medium (for different concentrations of cells) in HFSS we will use the **Debye model:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **P** | **Frequency** | | **Relative Permittivity (Real)** | | **Loss tangent** | | **Conductivity (at DC)** |
| **L** | **U** | **L** | **U** | **L** | **U** |
| **0.1** | **1x104** | **3x109** | **335.2686** | **80.5064** | **1.5018e3** | **0.0254** | **0.2968** |
| **0.05** | **1x104** | **3x109** | **225.5160** | **80.7530** | **2.5724e3** | **0.0256** | **0.3227** |
| **0.025** | **1x104** | **3x109** | **115.2145** | **80.8764** | **3.8933e3** | **0.0258** | **0.3362** |
| **0.0125** | **1x104** | **3x109** | **118.6111** | **80.9382** | **5.1988e3** | **0.0258** | **0.3430** |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **MATLAB** | | | | **HFSS** | | | |
| P | **(f= 0.1GHx)** | **(f= 0.3GHx)** | **F = 1GHz** | **f = 3 GHz** | **(f= 0.1GHx)** | **f = 0.3GHz** | **f = 1 GHz** | **F = 3 GHz** |
| 0 |  |  |  |  |  |  |  |  |
| 0.1 |  |  |  |  |  |  | **0.975612**  -0.107228dB |  |
| 0.05 |  |  |  |  |  |  | **0.975185**  -0.109129dB |  |
| 0.025 |  |  |  |  |  |  | **0.975811**  -0.106342dB |  |
| 0.0125 |  |  |  |  |  |  | **0.975817**  -0.106316dB |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Material **(1GHz, Δz=3mm)** |  | σ |  | α | β |  |  |  |
| **Distilled Water** | 81 | 0.0002 | 0.023 | 0.0042 | 188.5 | **0.99998740**  -0.00011 dB | -32.401 | 2.8395x10-4 |
| **Fresh Water** | 81 | 0.0325 | 3.671 | 0.6807 | 188.5 | **0.99795998**  -0.0177 | -32.401 | 0.0453209 |
| **Sea Water** | 81 | 4.0 | 451.77 | 83.78  (287.9218 exact) | 188.5 | **0.77775789**  -2.1831 dB  -7.5025 dB | -32.401 | 5.577407407 |
| **Culture Liquid** | 81 | 0.35 | 39.53 | 7.33 | 188.5 | **0.97825002**  -0.1910 dB | -32.401 | 0.4880246 |

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## Simulation results in HFSS





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# **Conclusions**