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Patch Antenna Model for Unmanned Aerial Vehicle

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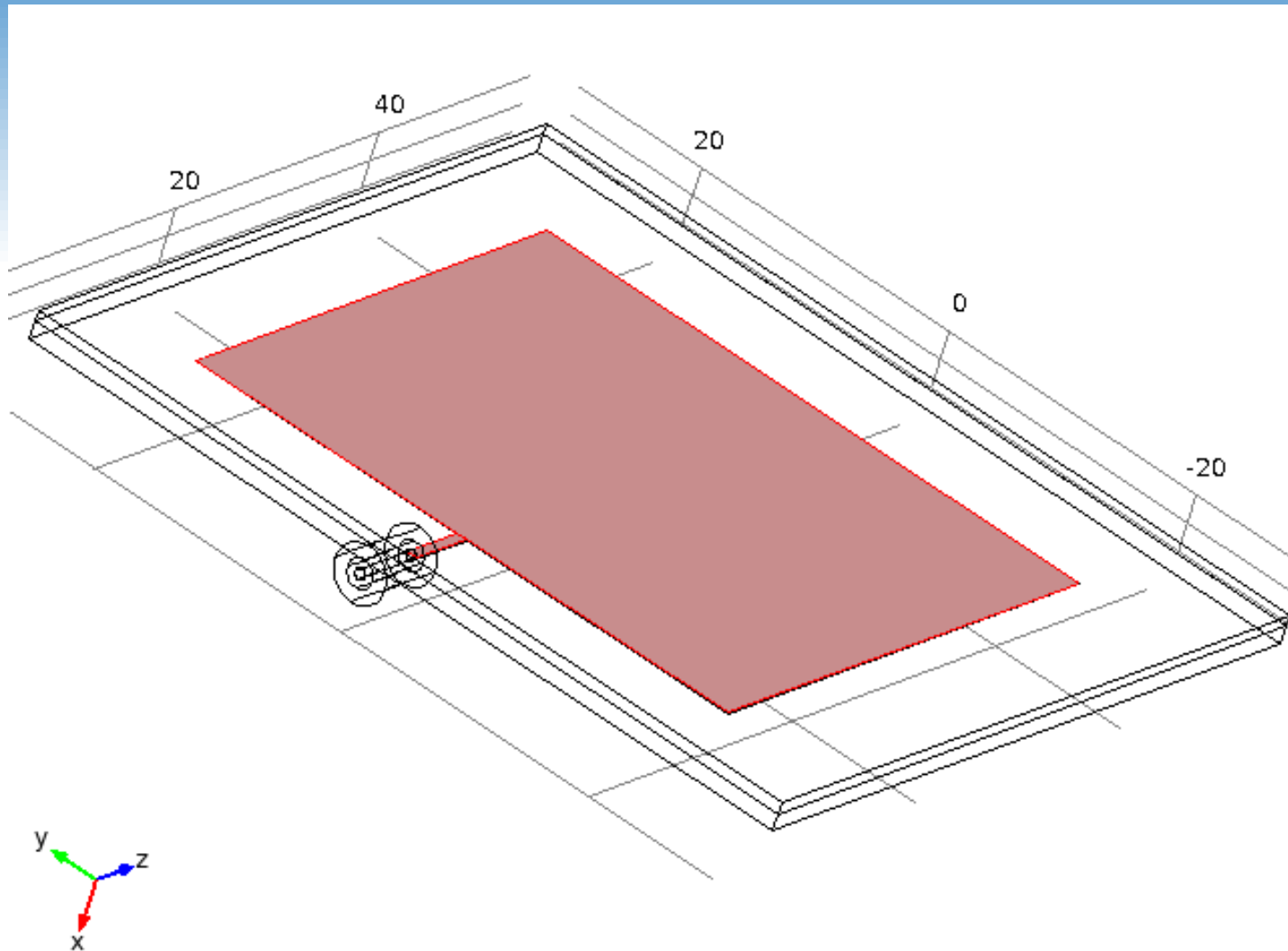
Project Motivation

- **2.4GHz video downlink**
- **Exterior fuselage location**
- **Ease of fabrication & assembly**
- **Wide range of vehicular attitudes**
- **Broad radiation pattern**

Modeling Physics

- **RF module frequency analysis (emw)**
- **3-D model with a single coaxial input**
- **Microstrip feed to active patch area**
- **Impedance boundary condition on metallic layers**
- **Surrounded by air and perfectly matched layer (PML)**

Overall Geometry



Electromagnetic Wave Equation

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

where $k_0 = \omega [\mu_0\varepsilon_0]^{1/2} =$ free space wave no.

$\omega = 2\pi f =$ angular frequency (rad/s)

$\varepsilon_r =$ relative permittivity of medium

$\varepsilon_0 =$ permittivity of free space (F/m)

$\mu_r =$ relative permeability of medium

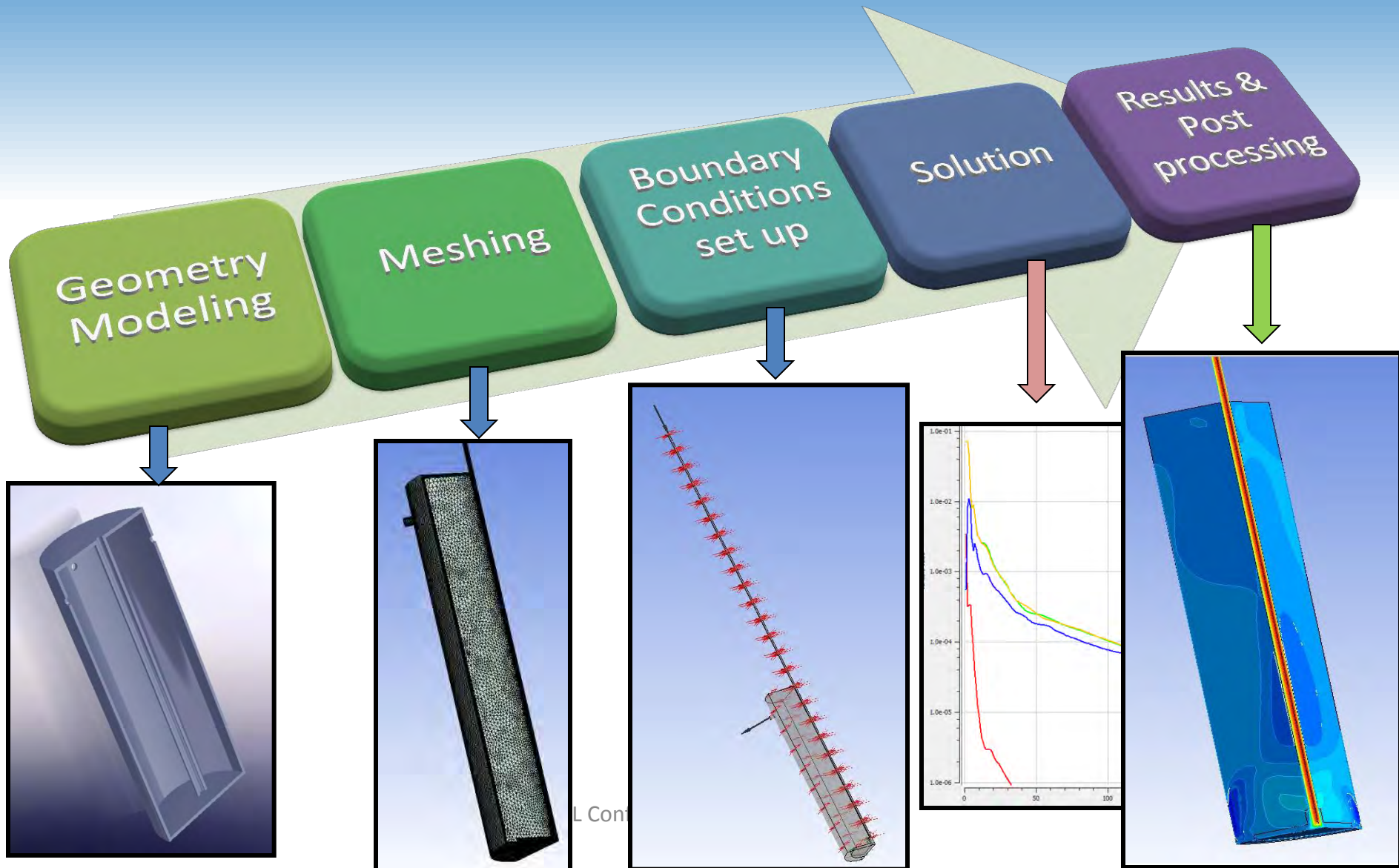
$\mu_0 =$ permeability of free space (H/m)

$\sigma =$ electrical conductivity (S/m)

Material Properties

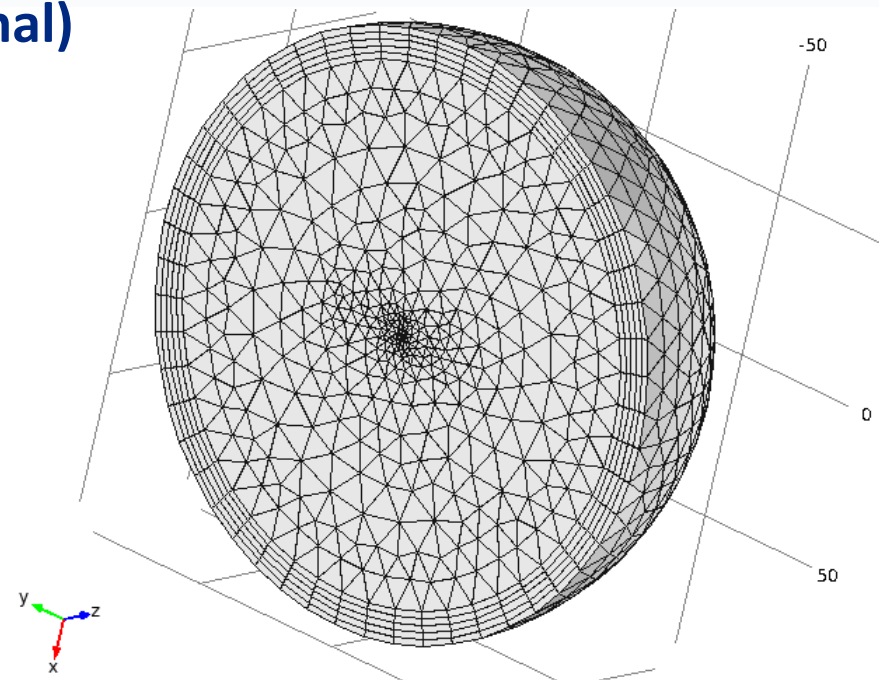
Material	Relative Permittivity (-)	Relative Permeability (-)	Conductivity (S/m)
Mylar®	3.1	1.0	0.0
Copper	1.0	1.0	6e7
Air	1.0	1.0	0.0

Multiphysics Modeling Procedure



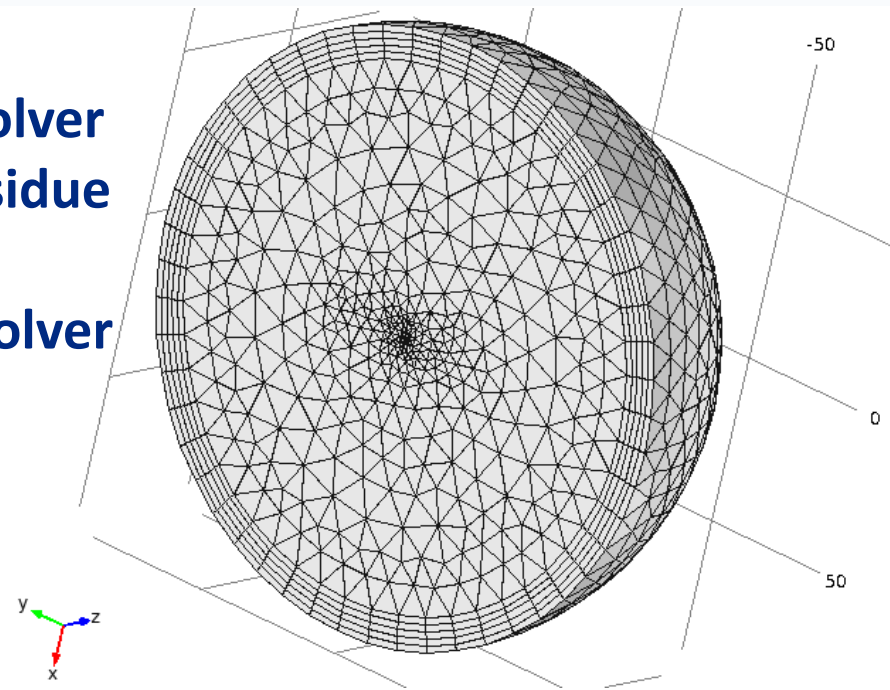
Meshed Geometry

- **General physics pre-defined (normal)**
- **Maximum size – 2mm**
- **Minimum size – 0.054mm**
- **6-layer swept PML**
- **251,907 elements**
- **1,351,802 degrees of freedom**

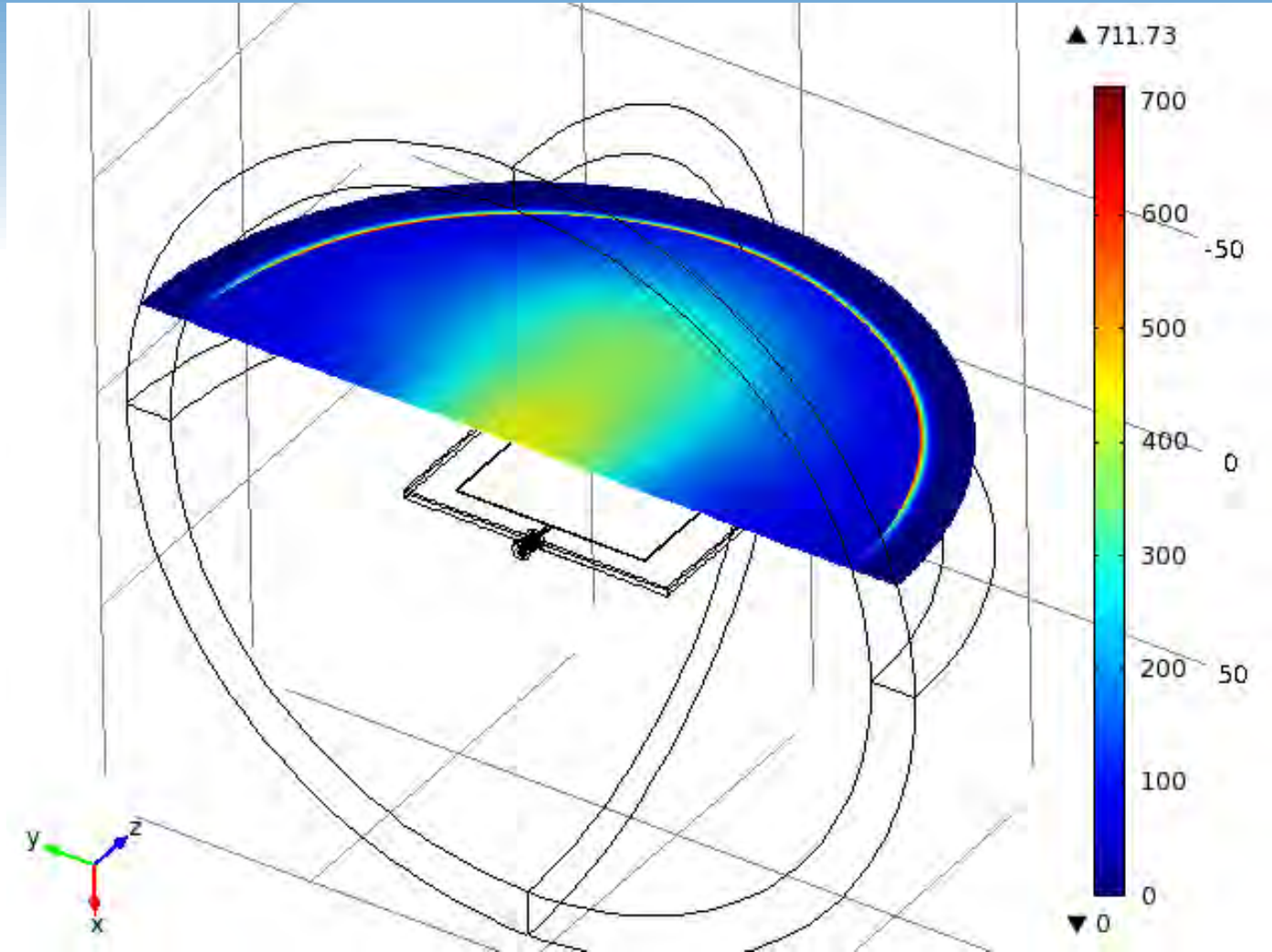


Solvers Used

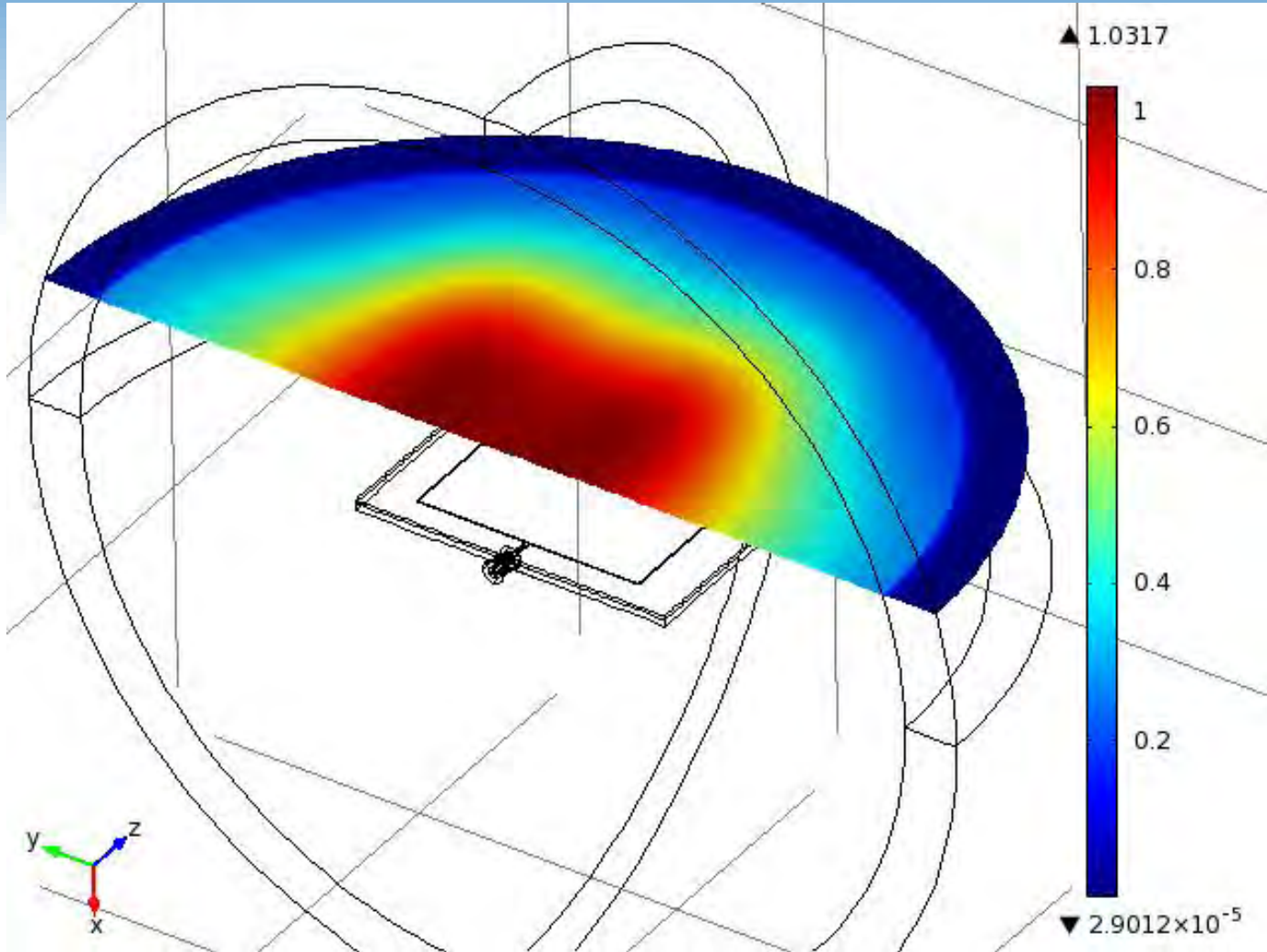
- **MUMPS** – Parallel sparse direct solver
- **GMRES** – Generalized minimal residue iterative solver
- **Paradiso** – Parallel sparse direct solver



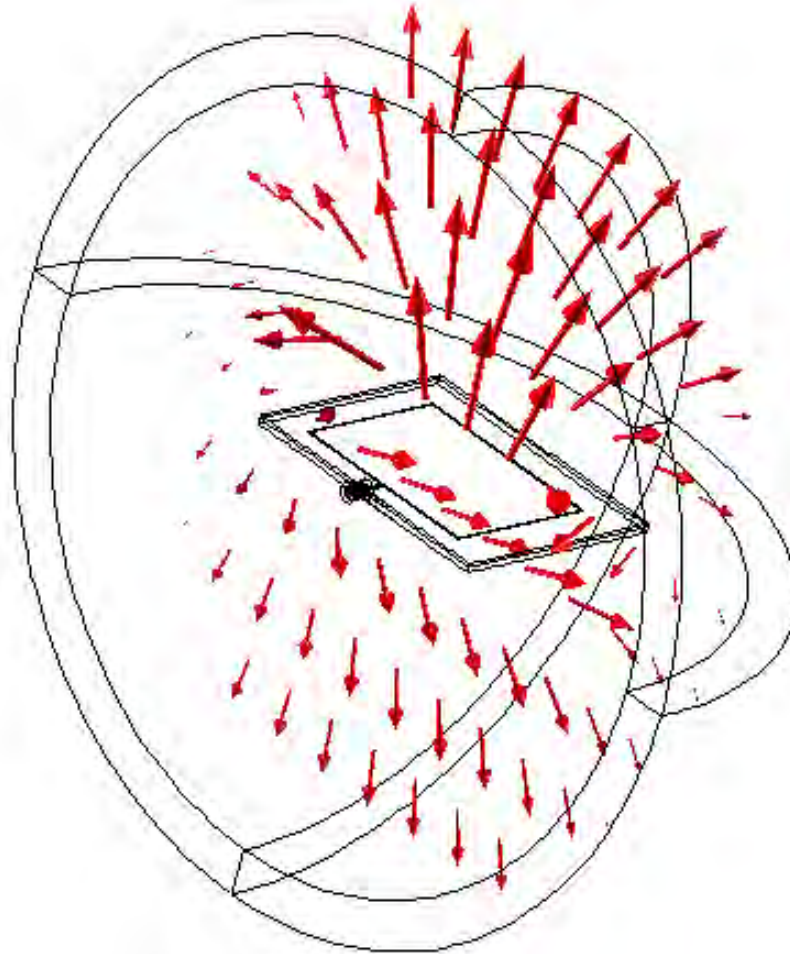
Normalized Electric Field 25mm Above Mesh



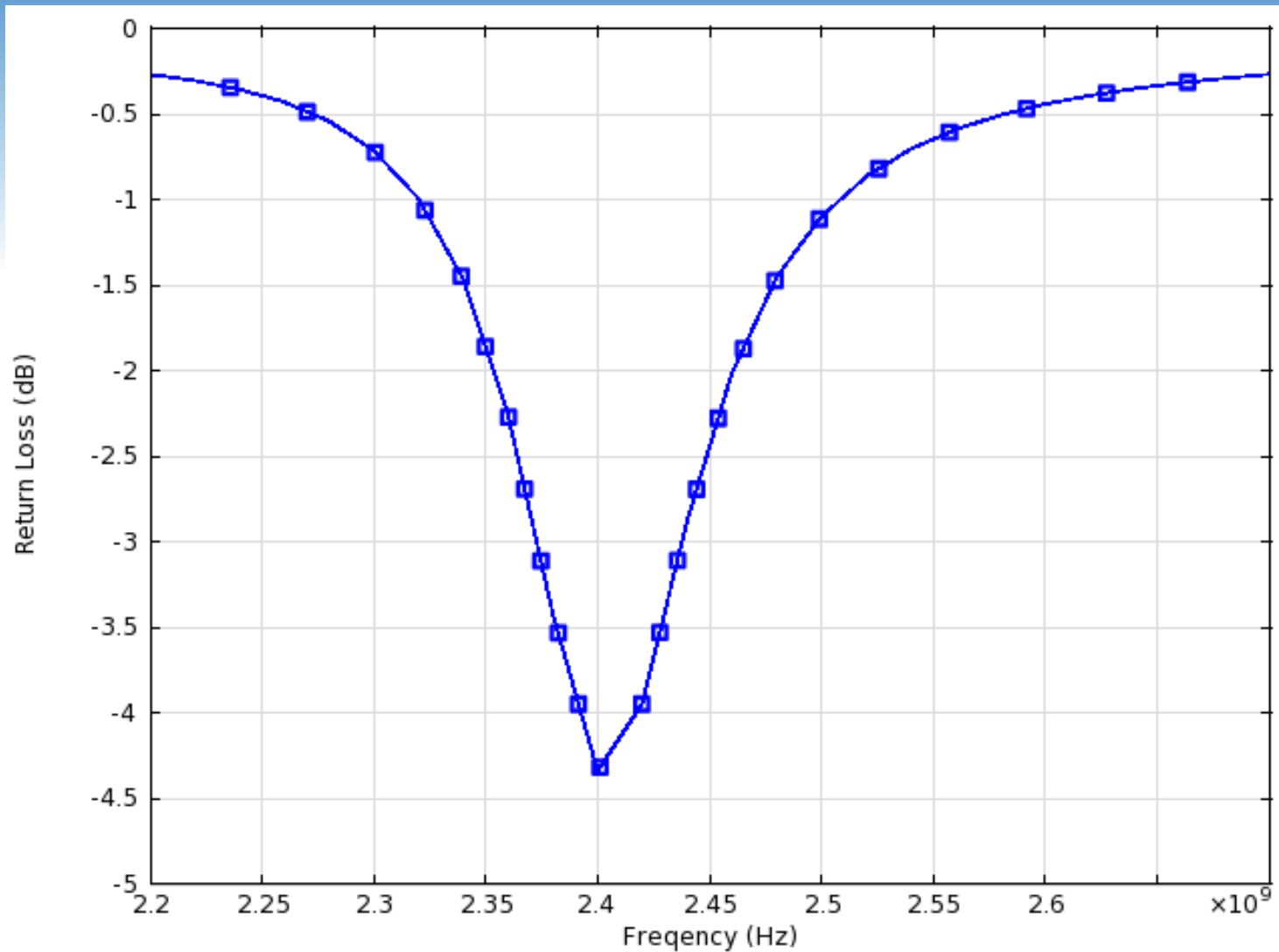
Normalized Magnetic Field 25mm Above Mesh



Average Power Flow Around Patch



Return Loss vs. Frequency



Thanks!

Questions?

Comments?

Feedback?