Optimization of a Dual Band Slot Antenna using ANSYS® HFSS and optiSLang®

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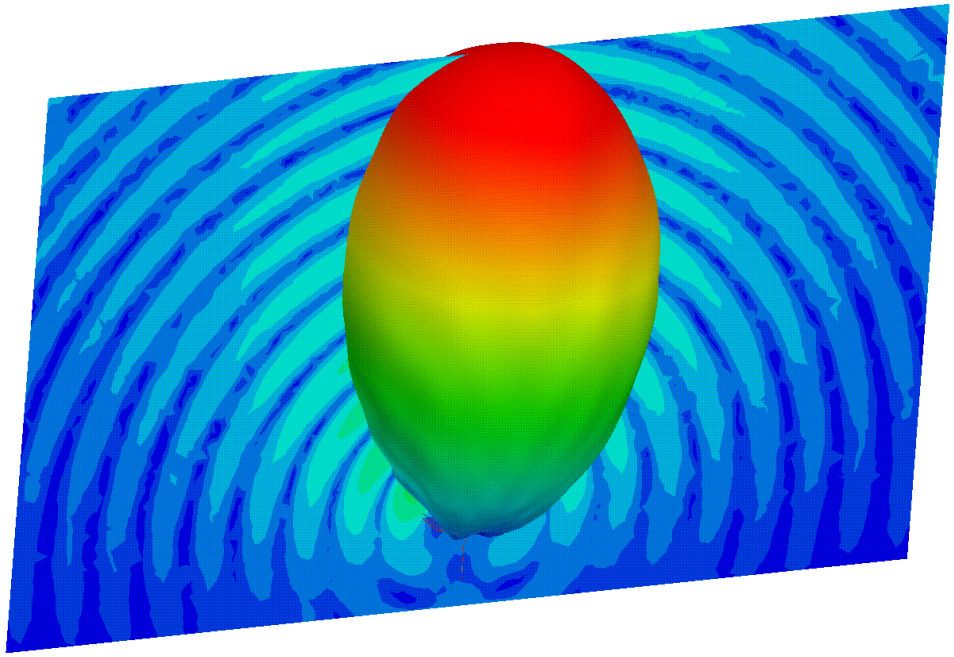
Antenna Simulation

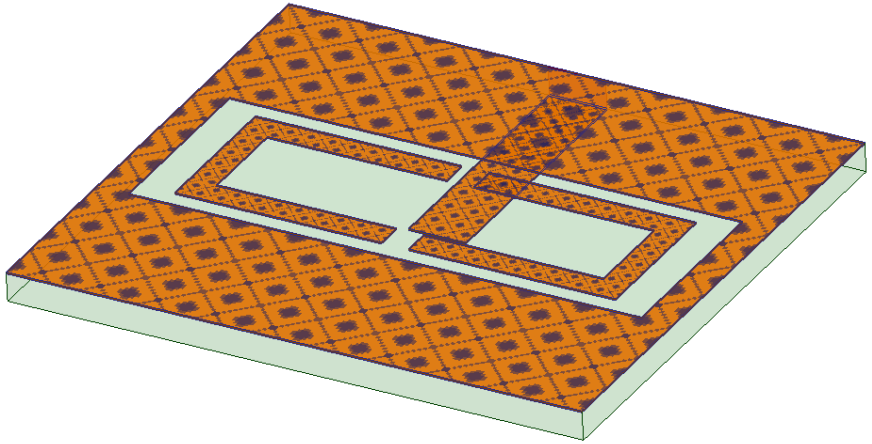
- Tricky business to adjust antennas:
  - Minimize return loss
  - Radiation pattern: Main lobe, side lobes
  - Polarization
  - Band width
  - Several bands
  - Impedance matching: Smooth transition from 50Ω to 377Ω



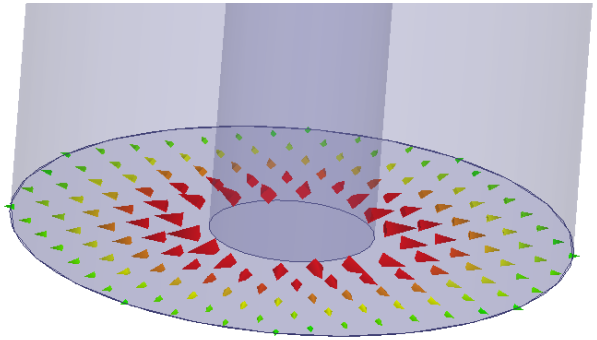
- Use simulation to
  - Validate that antenna design meets requirements.
  - Gain understanding of the design.
  - Optimize the design.

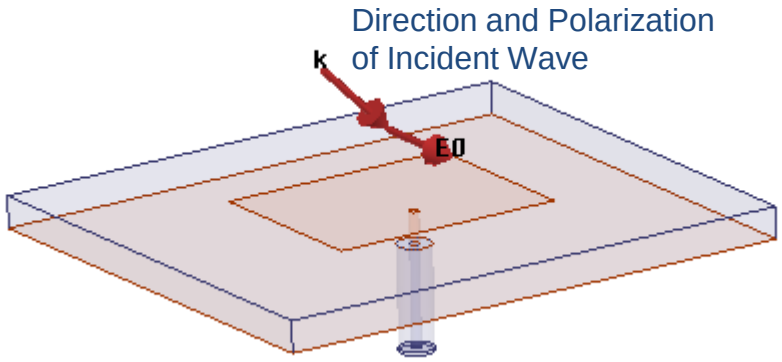
Antennas: Simulation Setup

- Boundary conditions:
  - Radiation, perfectly matched layers
  - Conducting surfaces
  - Symmetry



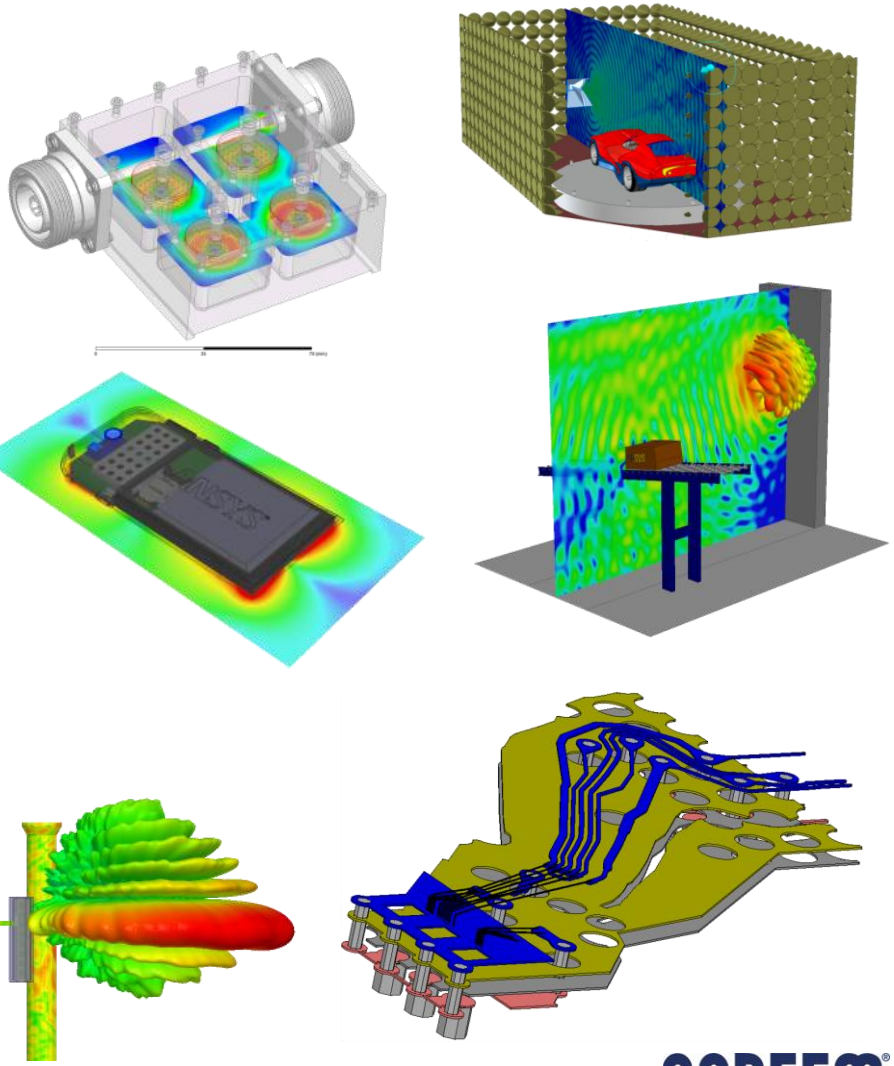
- Excitations:
  - Wave ports → Infinitely long wave guides
  - Incident waves



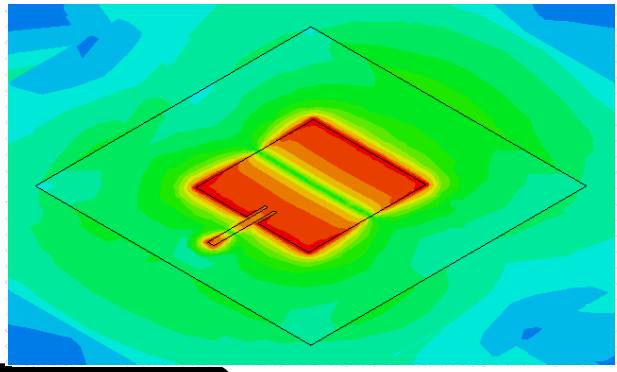


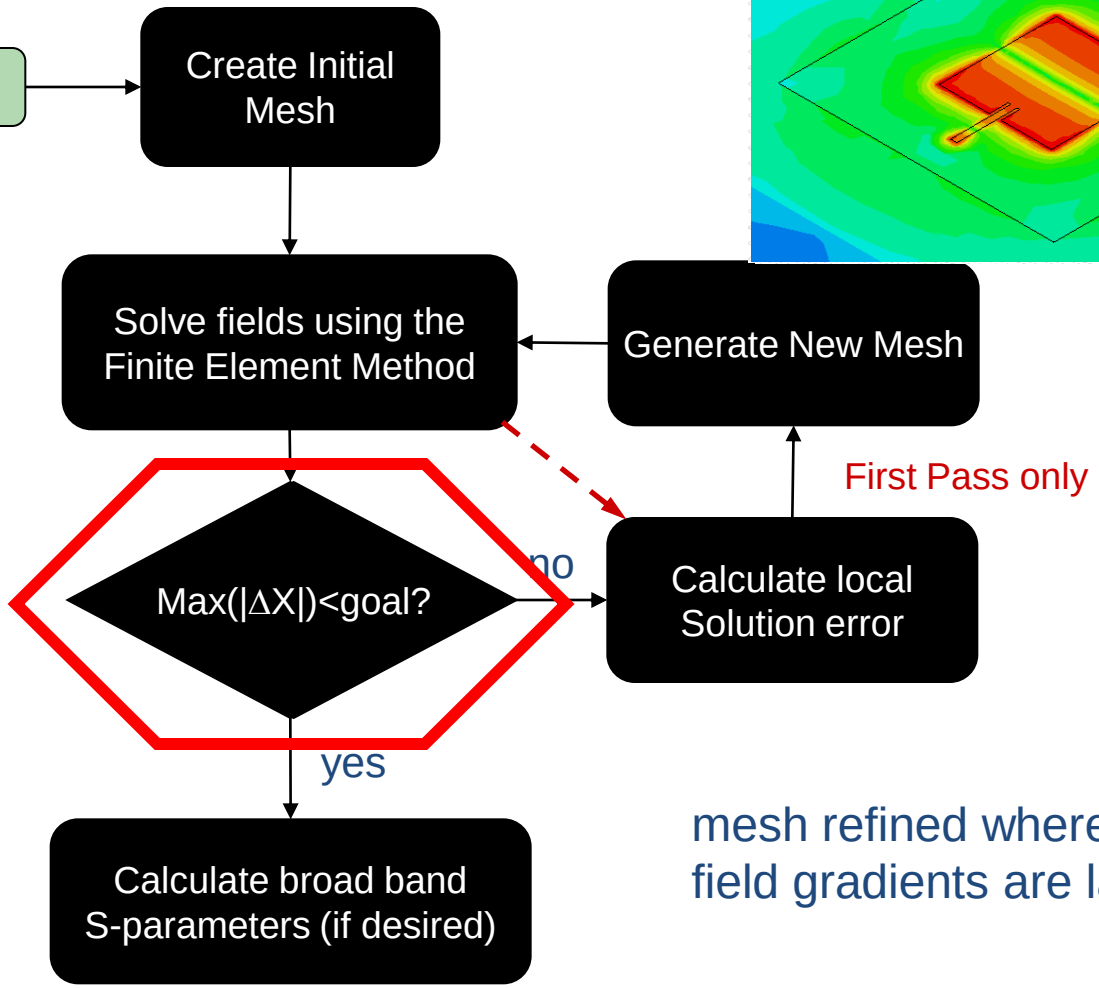
HFSS – High Frequency Structure Simulator

- 3D Field Solver
  - 3D Finite Element Method (FEM)
  - Boundary Integral (IE)
  - Mesh Process: Adaptive
- Advanced Boundary Types
  - Radiation and Perfectly Matched Layers
  - Symmetry, Finite Conductivity, Infinite Planes, RLC, and Layered Impedance
- Advanced Material Types
  - Frequency dependent
  - Anisotropic
- Post Processing and Report Type
  - SYZ parameters
  - Field display
  - Near Field/Far Field



Antennas: Solution Process in HFSS





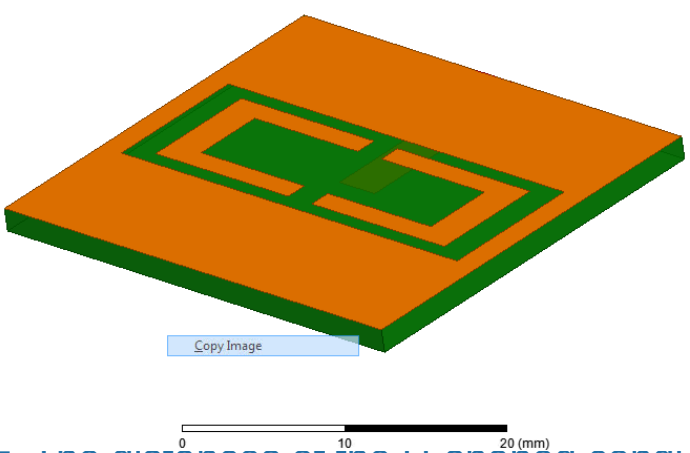
Any variable may be used to define solution convergence.

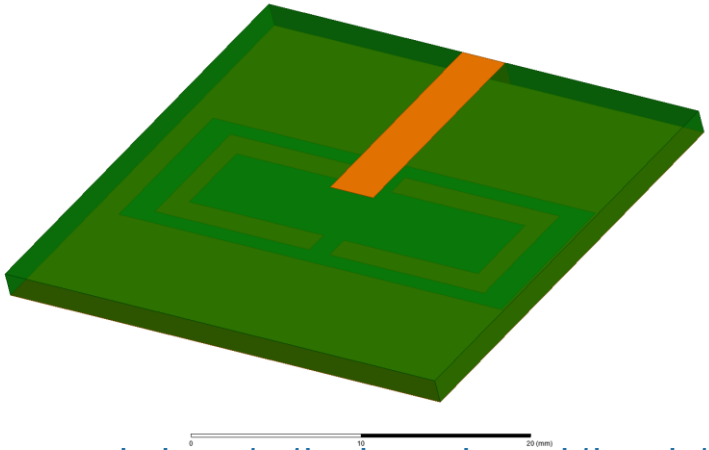
Directivity
Realized Gain
Peak |**E**|
Stored energy
etc…

mesh refined where field gradients are largest!

Optimization of a Dual Band Slot Antenna

- The geometry of the conducting surfaces of the PCB is parametrized by 12 parameters



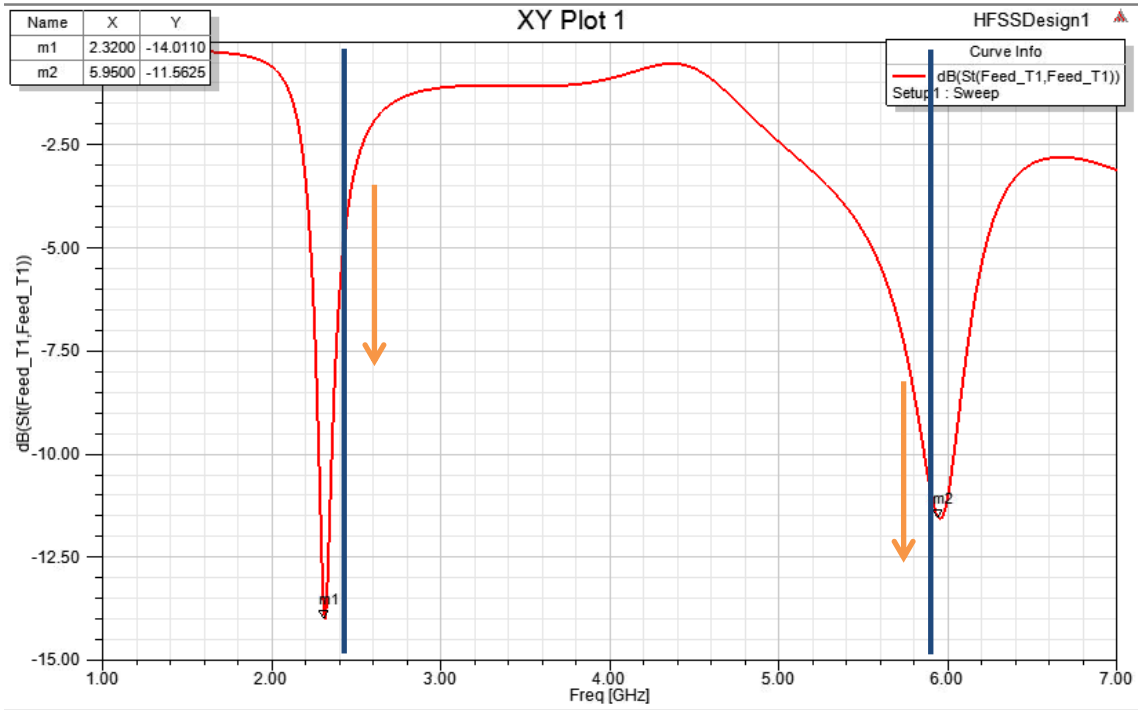


)

  - The distances of the U-shaped conductors in the ground plane to the boundary of the slot on x- and y- direction (*gap1, gap2*)
  - The distance of the two U-shaped conductors in the ground plane to each other (*dd*)
  - The width of the U-shaped conductors in the ground plane in x- and y-direction (*w1, w2*)
  - The length and the width of the microstrip feed line (*lf, wf*)
- [1] S. Gai, Y.-C. Jiao, Y.-B. Yang, C.-Y. Li, and J.-G. Gong: 'DESIGN OF A NOVEL MICROSTRIP-FED DUAL-BAND SLOT ANTENNA FOR WLAN APPLICATIONS',*Progress In Electromagnetics Research Letters, Vol. 13, 75-81, 2010*

Optimization of a Dual Band Slot Antenna

- Goal: minimize the return loss at both frequencies



Optimization of a Dual Band Slot Antenna

- Set up region
- Set up the simulation for a single design point:
  - Boundaries
    - Radiation on the boundary of the region
    - Finite conductivity at metalized surfaces
  - Excitation
    - Lumped port at the end of the microstrip
  - Analysis Setup
    - 5.8GHz
    - 2.4GHz with mesh linked to the 5.8GHz setup
    - Frequency sweep 1.5GHz – 7GHz
- Solve
- Postprocessing
  - Return Loss
  - Currents
  - Gain

Optimization of a Dual Band Slot Antenna

- Remove the frequency sweep and the 2.4GHz setup
- Add a discrete frequency sweep with a single frequency point at 2.4GHz
- Ensure that the parameters are handed down to the workbench and that the return loss at 2.4GHz and at 5.8GHz are handed down to the workbench

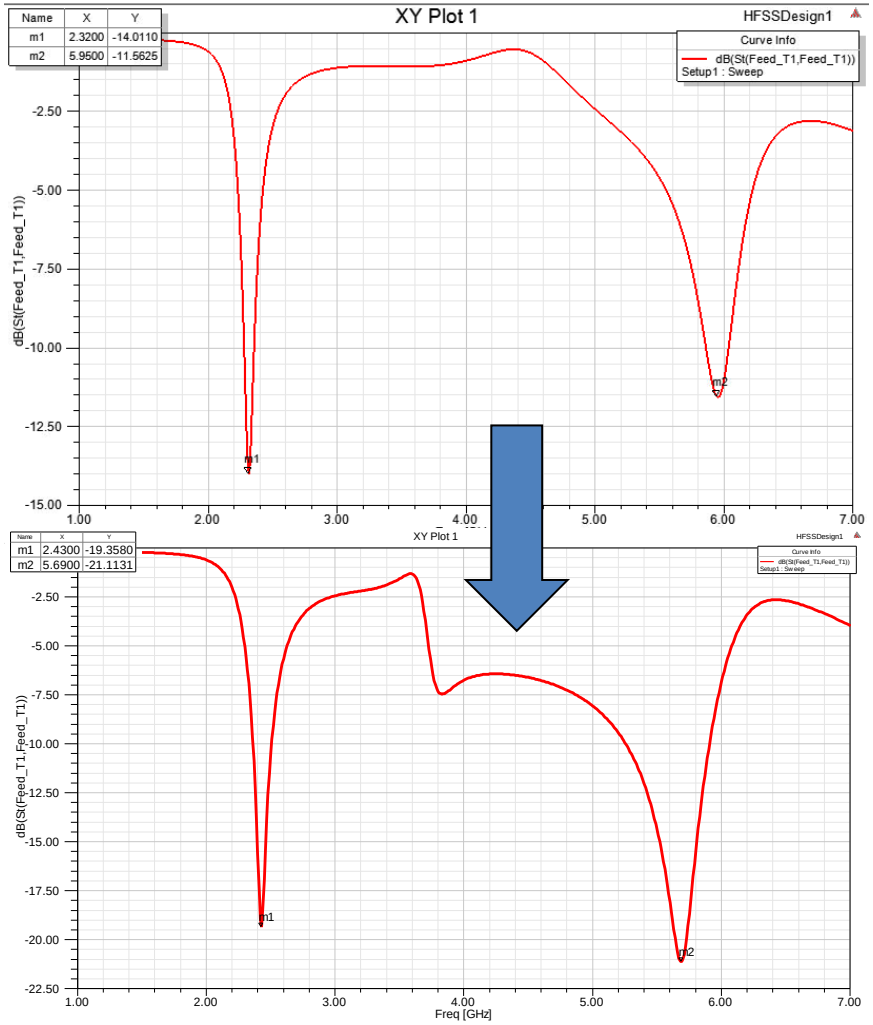
- Add the optimization setup with optiSLang.

- Ensure that the RSM options are set properly!

- Solve

Optimization of a Dual Band Slot Antenna

- Do a validation check
- Much improved Return Loss



Optimization of a Dual Band Slot Antenna

- Resonances