

Evaluating Antenna Coverage

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Agenda

Problem

Solution

Hybrid FE-BI Method

SBR+ Method

Questions

Problem

- Antenna coverage in a warehouse
- Eight metallic shelves with various items
- Four Antennas at 433 MHz
- How to evaluate coverage between shelves?
- What quantifies “good coverage”
 - Incident Power
 - Antenna Coupling Coefficient (S_{12})
- Traditional FEM is computationally expensive for electrically large geometry



Solution

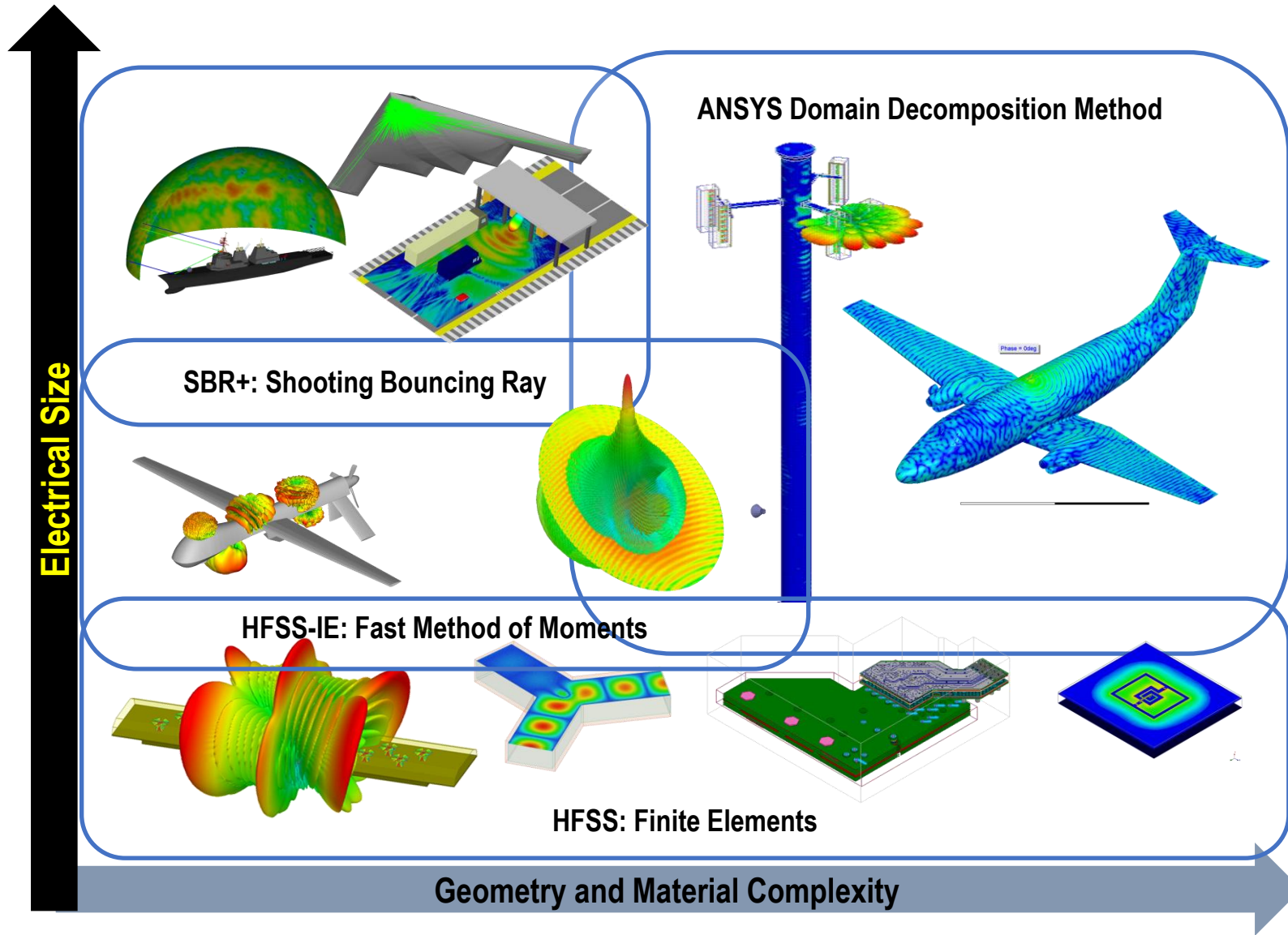
HFSS Hybrid FE-BI Method

- Coverage defined as incident power
- Can model large data sets in a single run
- Plots an infinite number of locations
- Provides best-case incident power
- Ideal for mapping dead zones

HFSS SBR+ Method

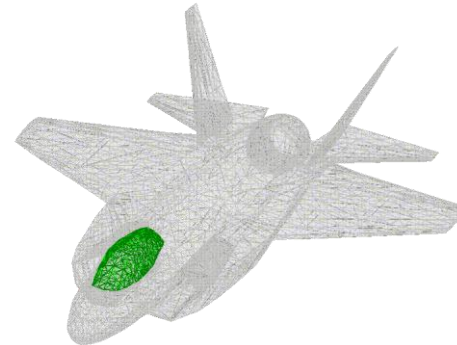
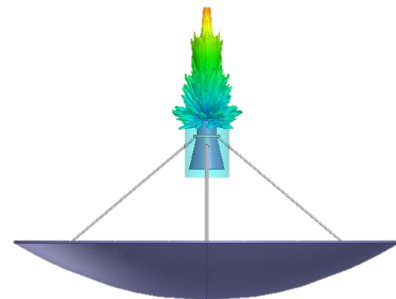
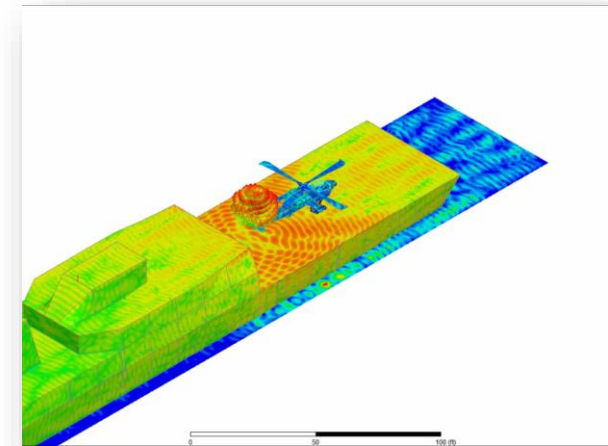
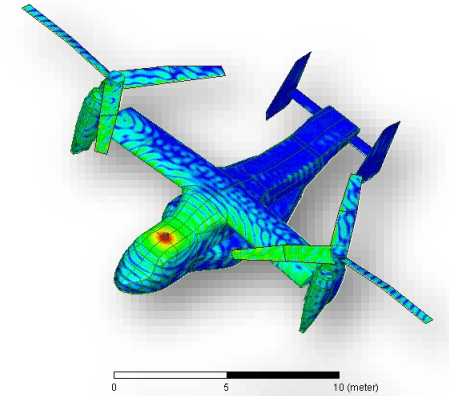
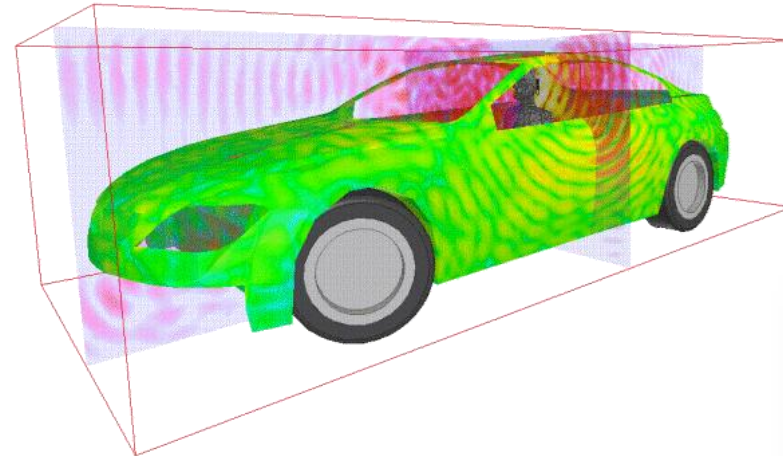
- Coverage defined as antenna coupling coefficient
- Model discrete antenna locations
- Provides real antenna S12 values
- Ideal for plotting real antenna-to-antenna performance

HFSS Simulation Range



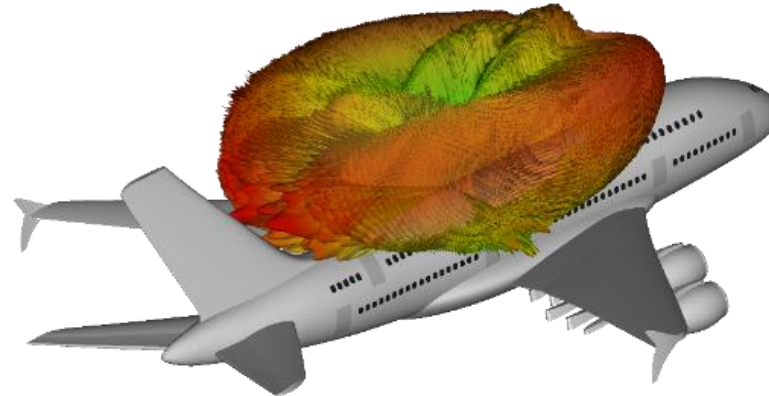
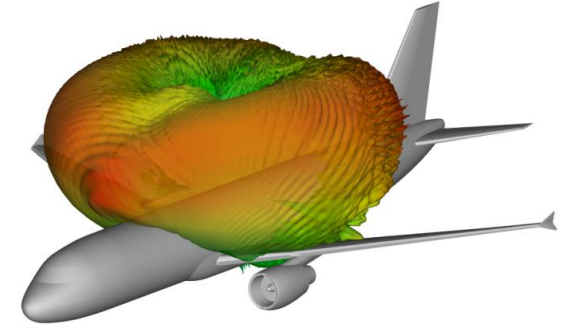
ANSYS HFSS: 3D & Boundary Element

- High Frequency Structure Simulator
- Full-wave frequency domain 3D electromagnetic field solver
- Multiple Solver Technologies
 - 3D FEM, Frequency Domain
 - Integral Equation/Boundary Element
 - Hybrid FE/BI
 - 3D FEM Transient, Time Domain
- Finite element method with adaptive mesh refinement
 - Provides an **Automatic, Accurate** and **Efficient** solution
 - Removes requirement for manual meshing expertise



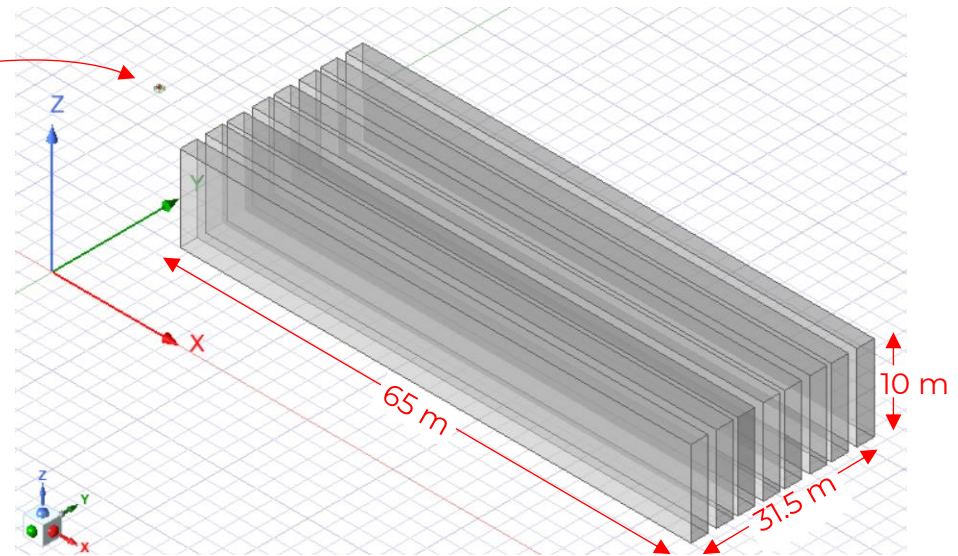
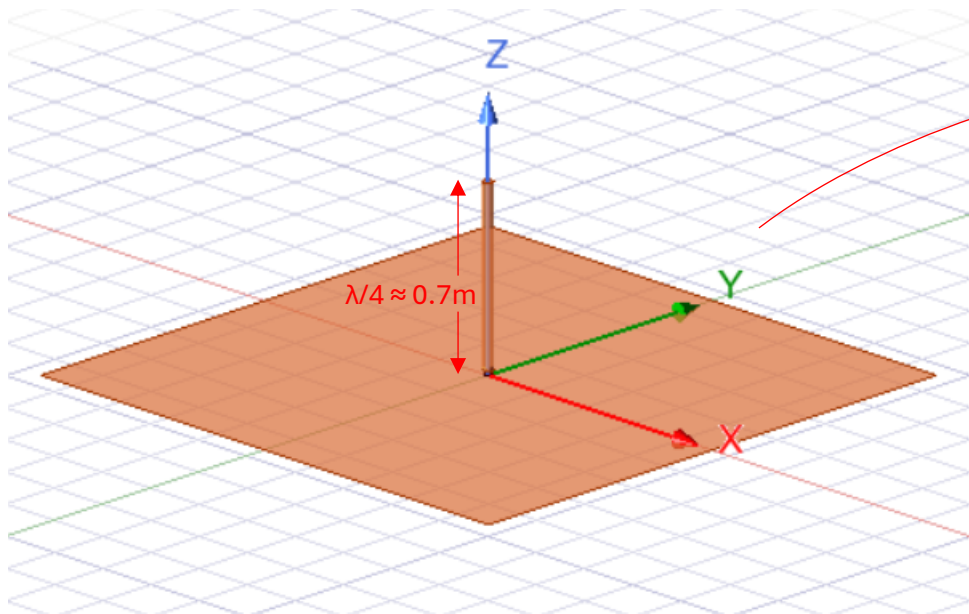
ANSYS HFSS-SBR+: Shooting and Bouncing Ray, Physical/Geometric Optics

- Premier ray-tracing tool for predicting installed antenna performance
 - Focus is on “electrically large” problem
- Enhanced *Shooting and Bouncing Ray Method*
 - Build on SBR with additional physics
 - Physical Theory of Diffraction (PTD)
 - Creeping Wave
 - Uniform Theory of Diffraction (UTD) Rays
 - *Output Data*
 - Installed Radiation Patterns
 - Antenna-to-Antenna Coupling
 - Near-Field Distributions



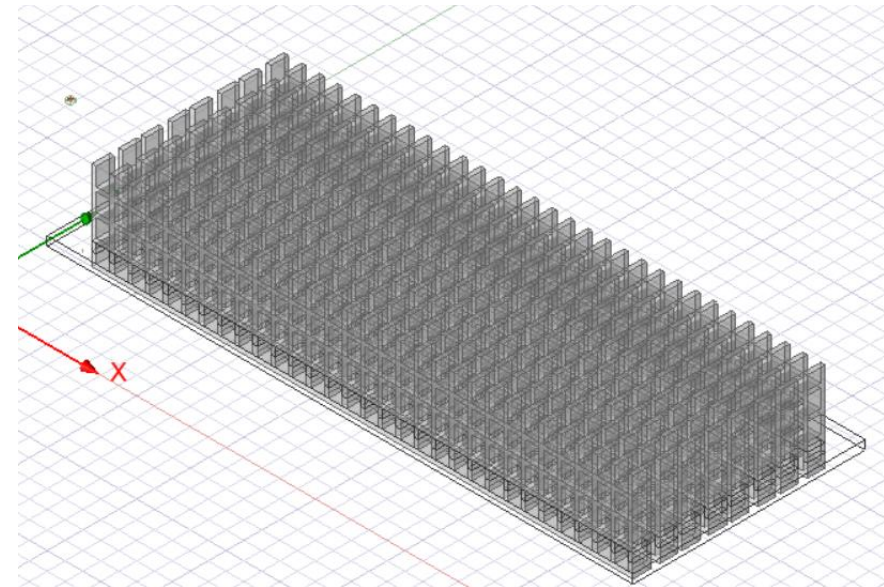
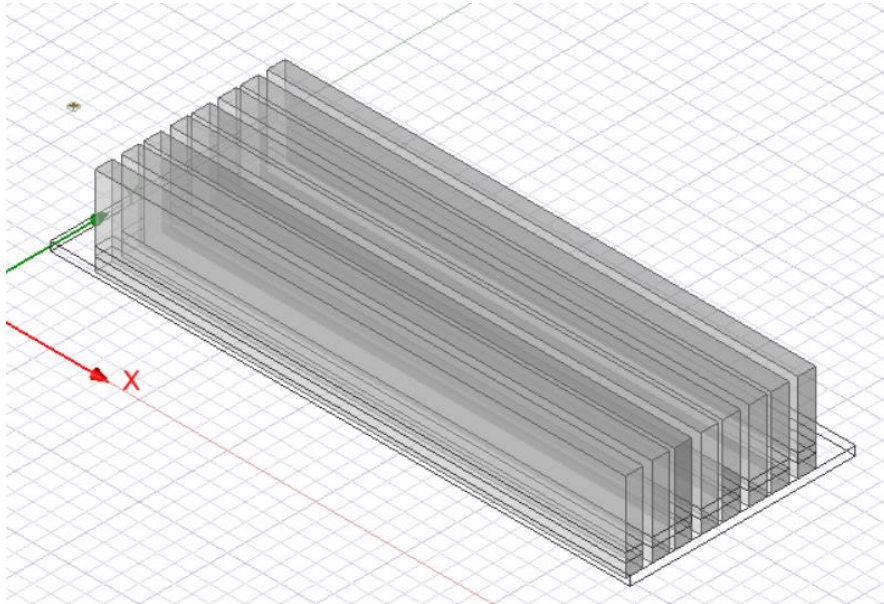
Setup

- Ideal Monopole tuned to 433 MHz
- Simplified PEC boxes or “detailed” metal shelves



Hybrid FE-BI Method

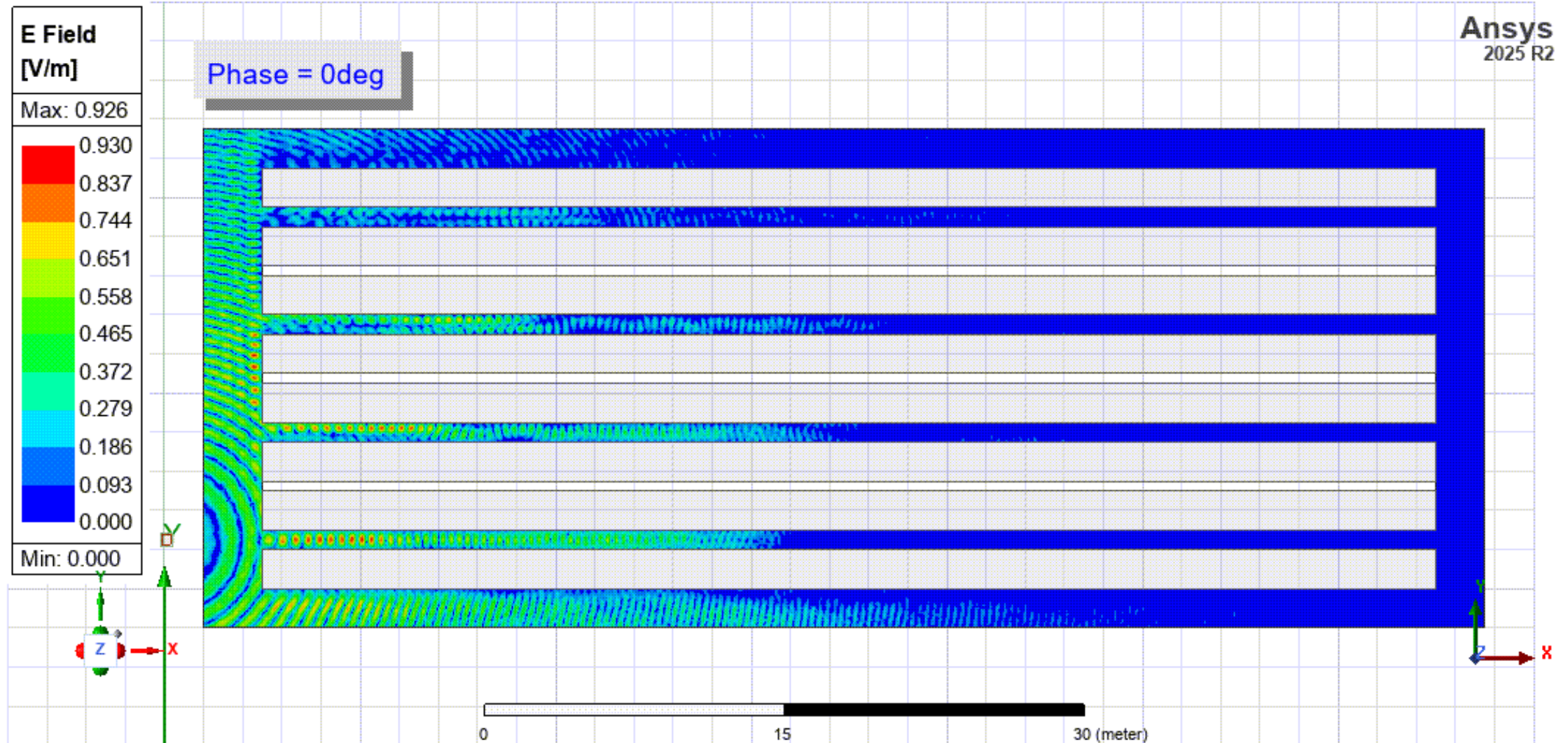
- Uses FEM around transmitter
- IE Method in the surrounding air
- FEM around a plane of interest
- Built-in fields calculator plots $(\int \vec{E} \cdot d\vec{l})^2 * \frac{1}{Z} = Power$
- Probed every 0.5 meter



Hybrid FE-BI Method

Time: ~3 hours

RAM: 102MB

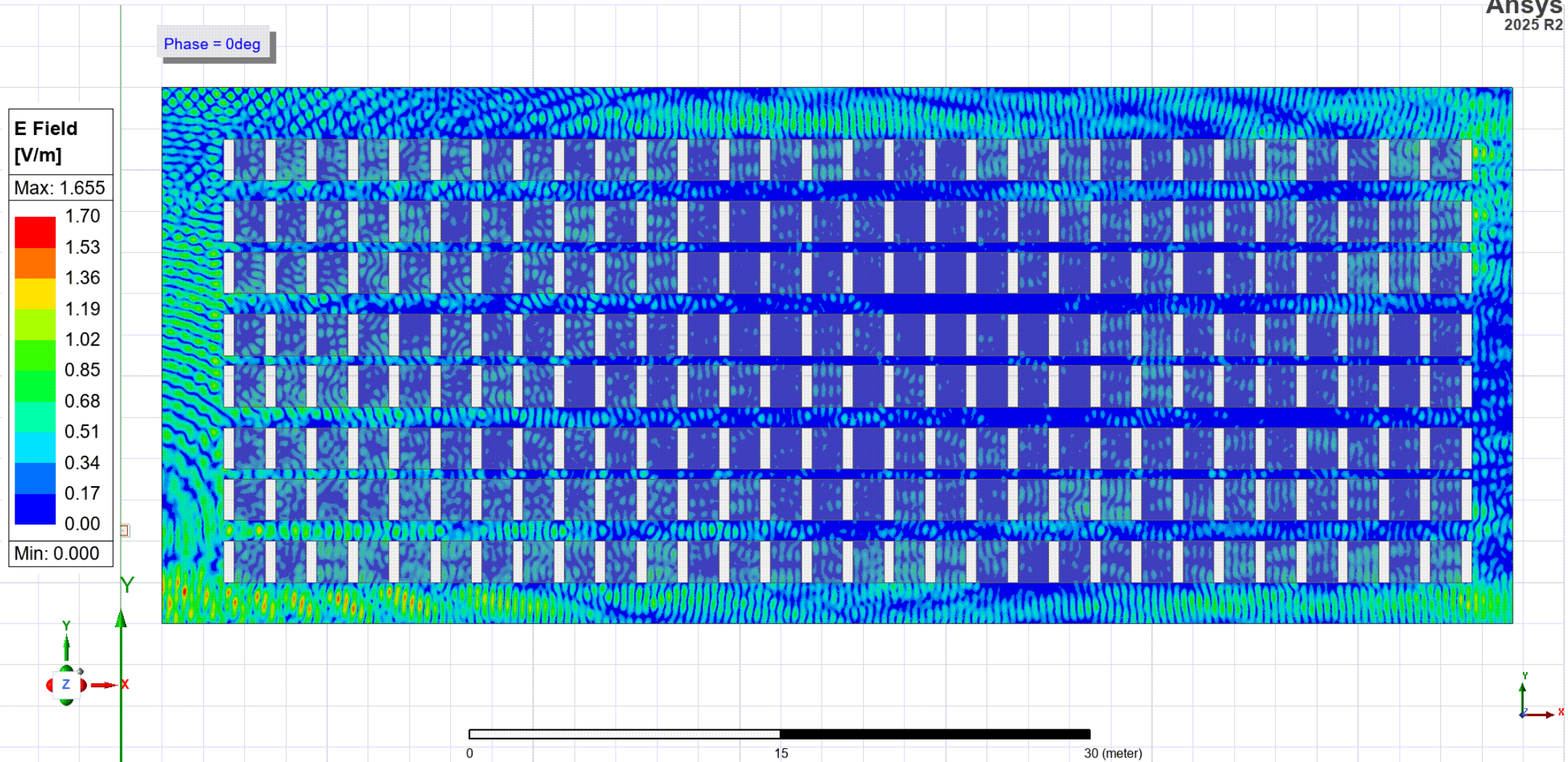


Hybrid FE-BI Method

Time: ~3.5 hours

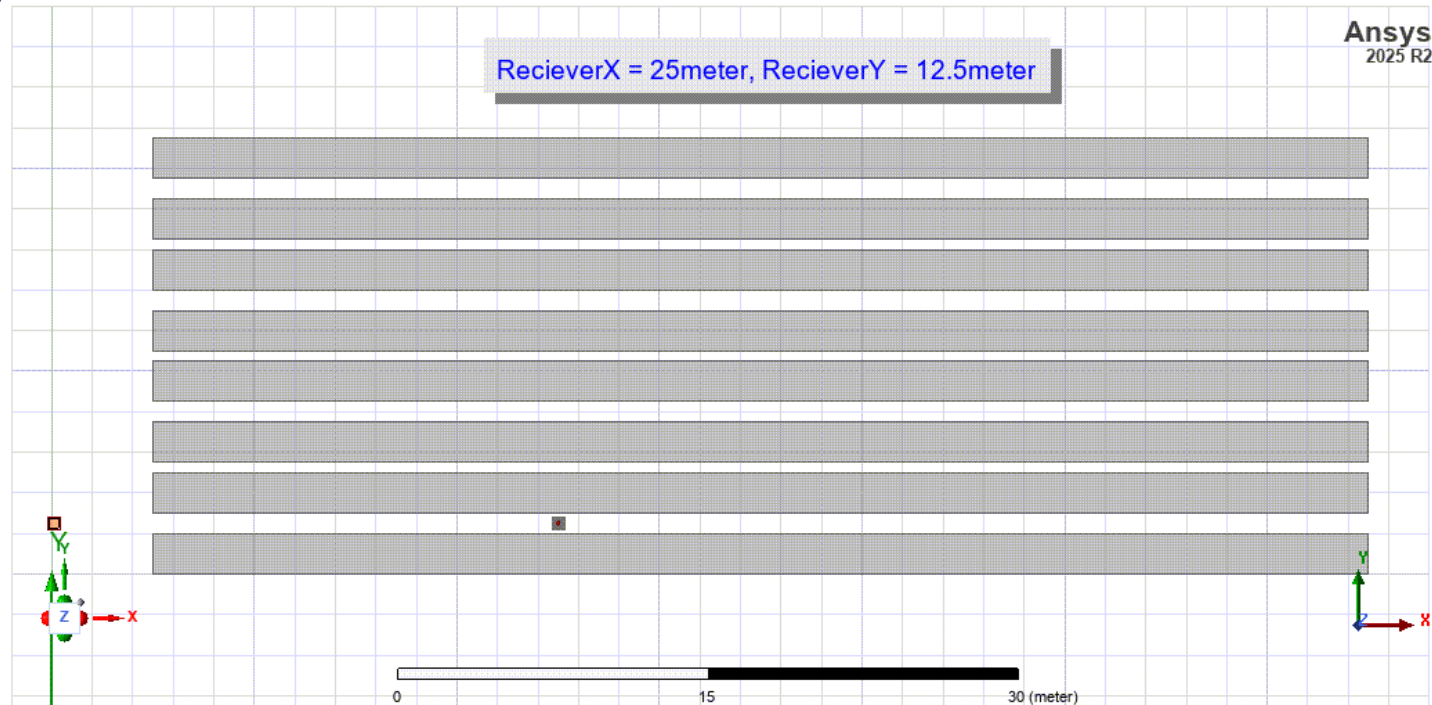
RAM: 217MB

Ansys
2025 R2



SBR+ Method

- Uses ray tracing methodology for entire domain
- Antennas modeled by their Far/Near Field patterns
- Directly extracts Antenna Coupling Coefficients
- A better measure of “real” antenna performance
- Probed every 5 m

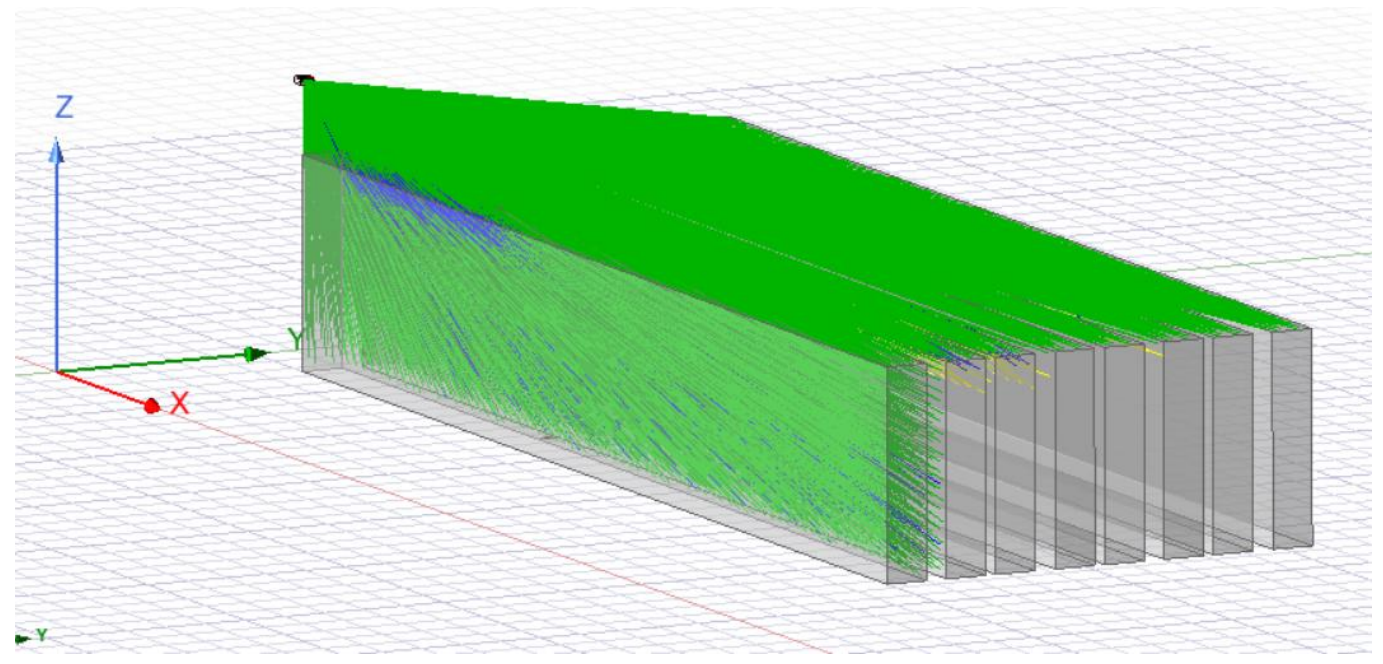
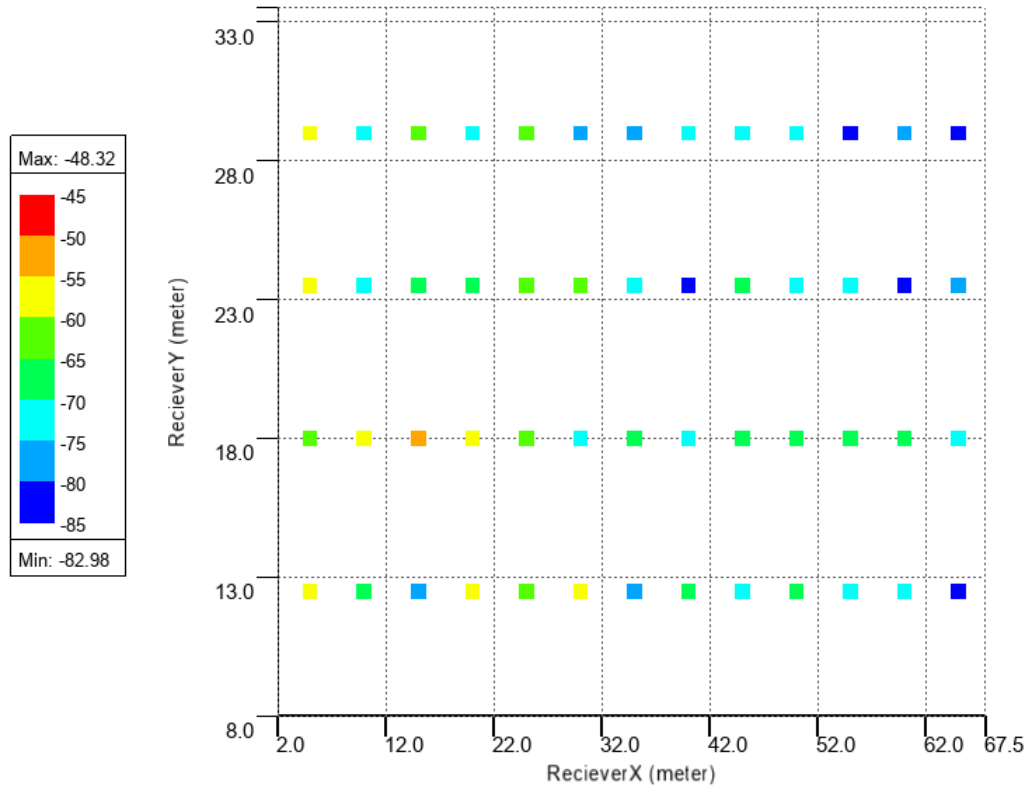


SBR+ Method

Time: ~1 hour

RAM: 104MB

Antenna Coupling Coefficient S12

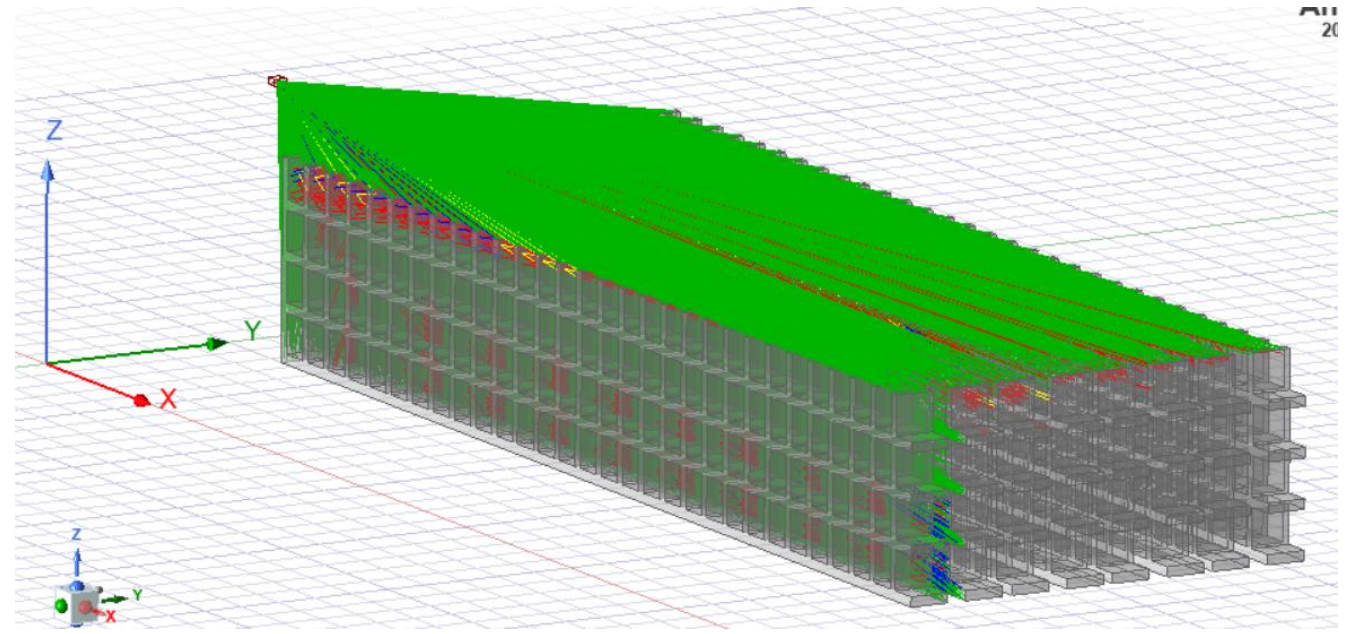
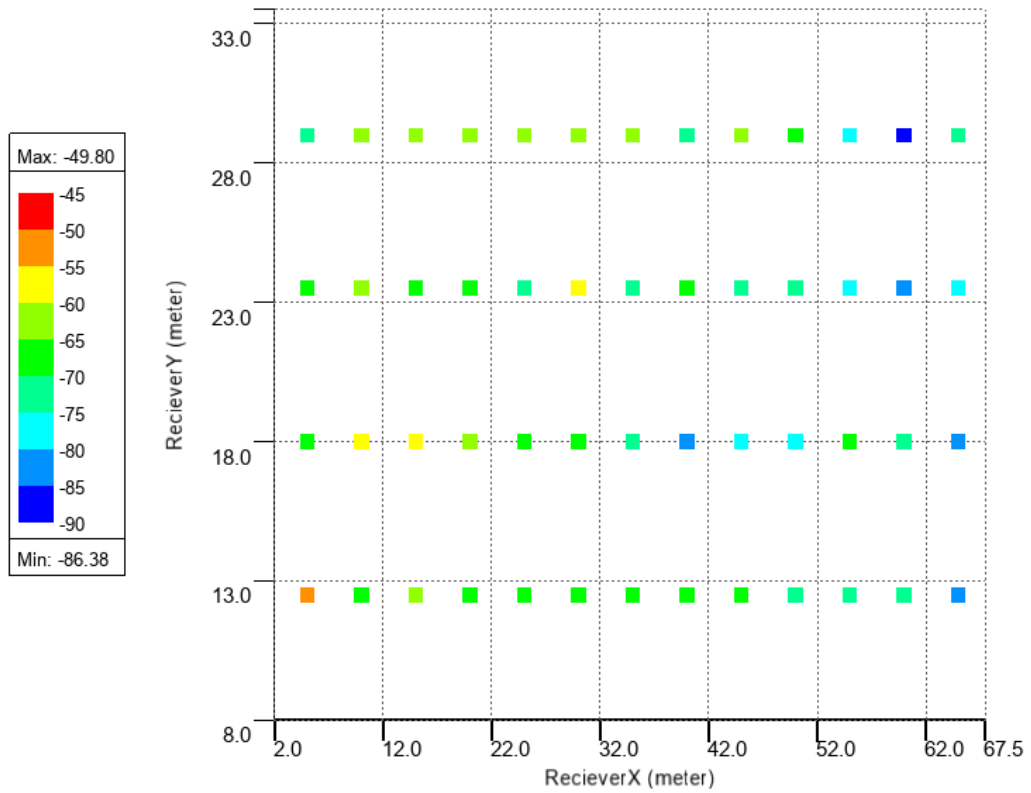


SBR+ Method

Time: ~1 hour

RAM: 178MB

Antenna Coupling Coefficient S12



Discussion

- Questions?
- Comments?

Thank You!