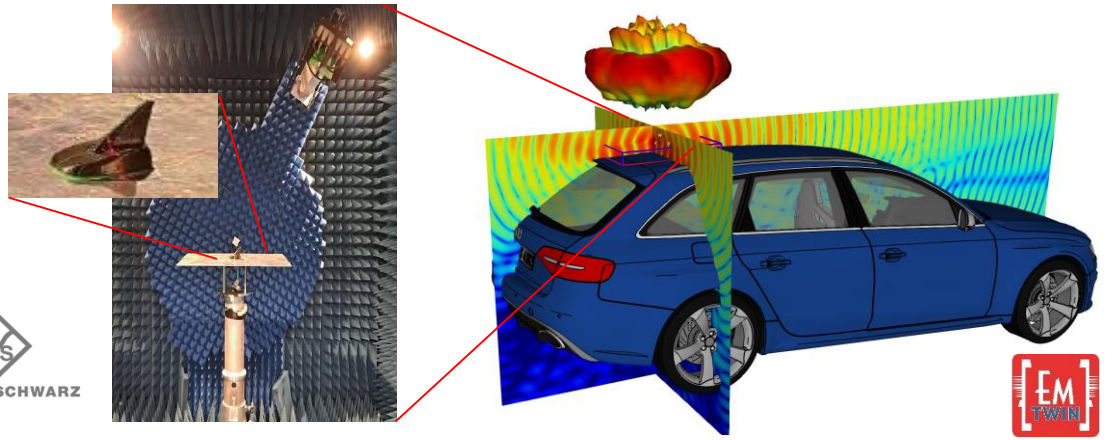
EM-Twin Automotive Tutorial

Antenna placement on the Roof of a Car

Overview

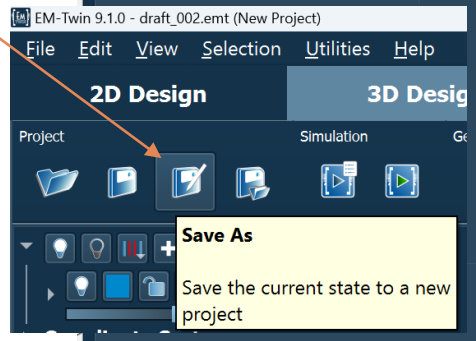
- New project creation
- Using the automotive Wizard
- 3D CAD model import
- Antenna digital twin creation
- Field source placement & alignment
- Simulation set-up
- Car model set-up (material definition)
- Simulation
- Near- & Farfield evaluation

Audi car with antenna digital twin on roof

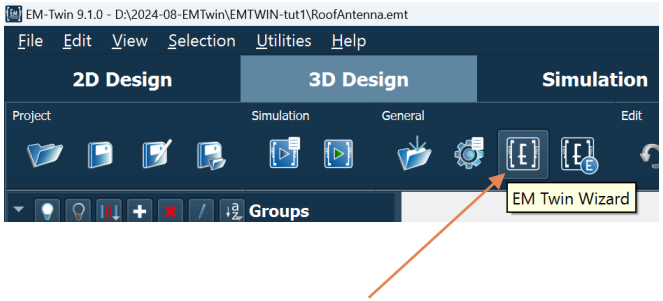


Start

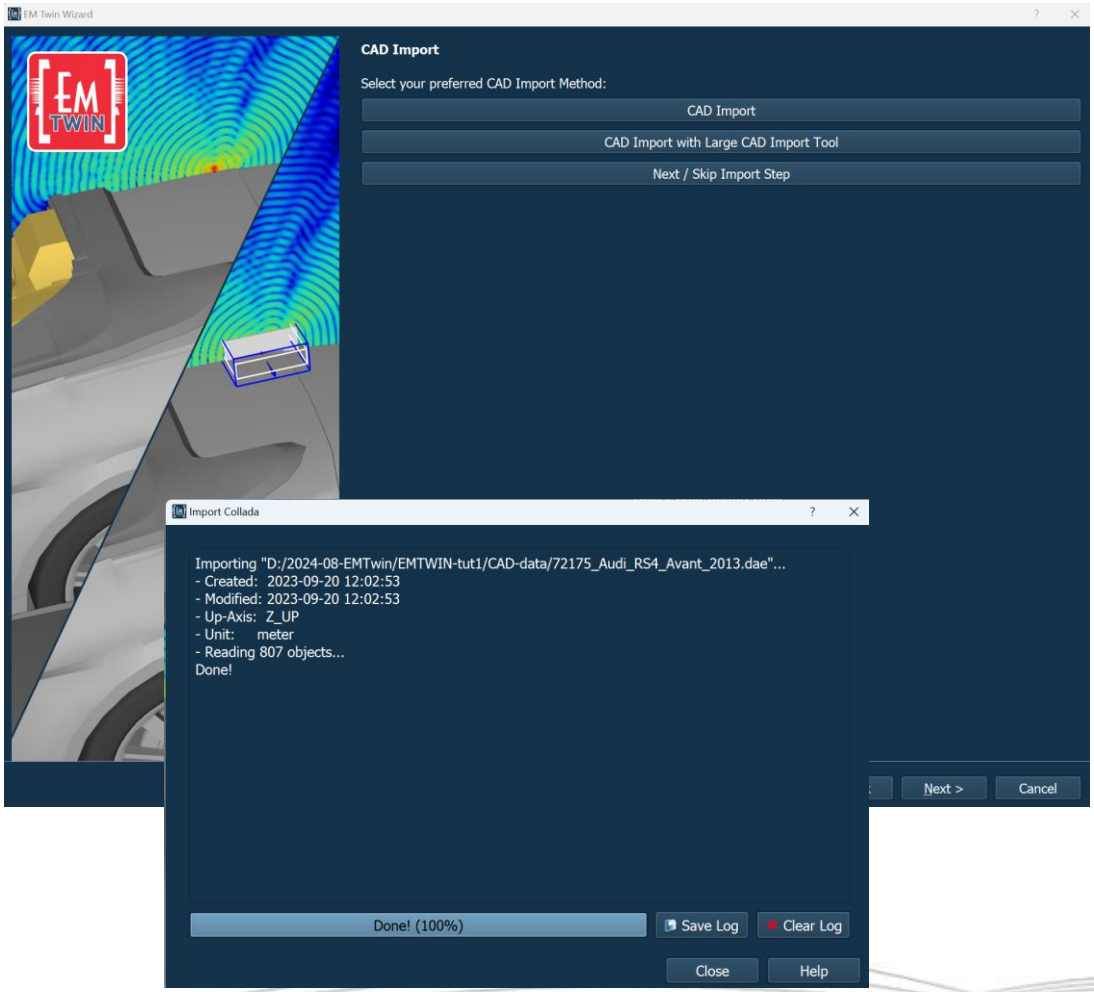
- Start EM-Twin
- Select “New Project”
- Press OK
- Press Save as &
  create a storage folder and
  enter file name,
  e.g., “RoofAntenna_Car”
- Press Save



Wizard step 1: CAD Import

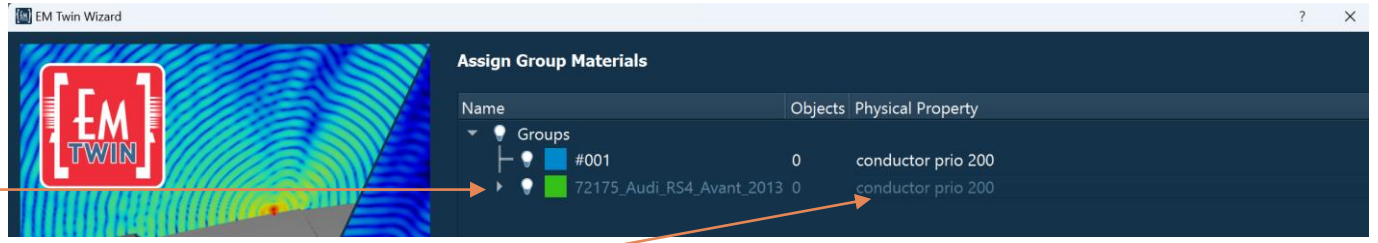


- Under 3D Design > General, click on the icon “EM Twin Wizard”
- The first step is to import the CAD geometry of the complete vehicle
- Click on ‘CAD Import‘ and locate the Collada file “72175_Audi_RS4_Avant_2013.dae”
- Click Close once the import is finished and continue with Next

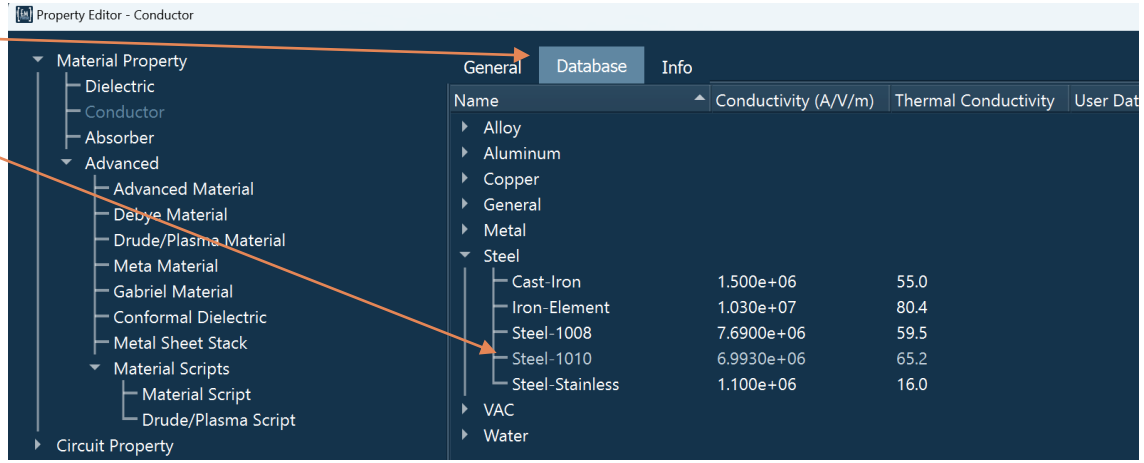


Wizard step 2: Material assignment

- Open Group list of imported Audi CAD by click on arrow



- Double click on physical Property of Audi groups and change to Steel:
  - Select Database
  - Select Steel-1010
  - Press OK

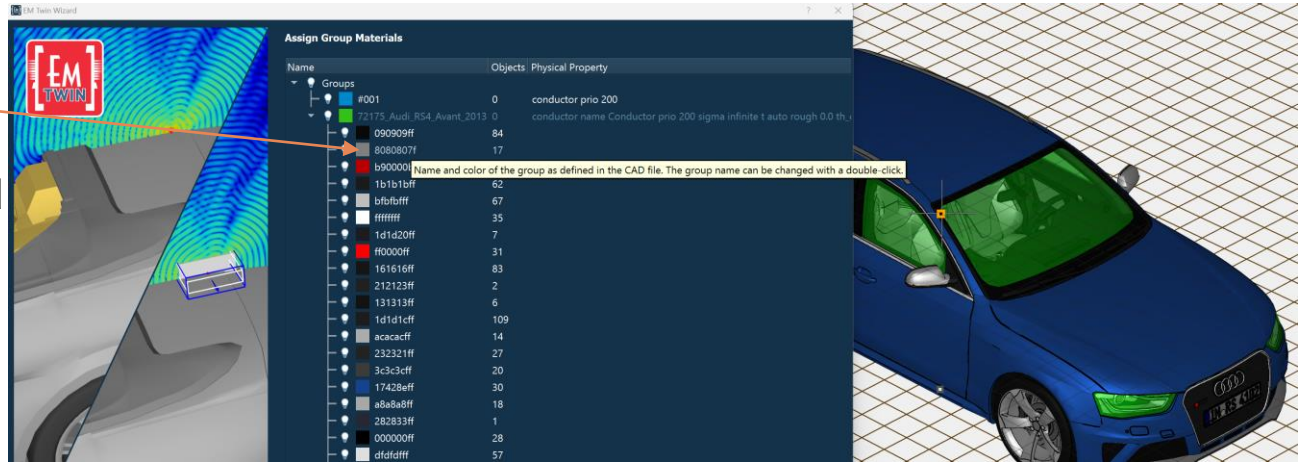


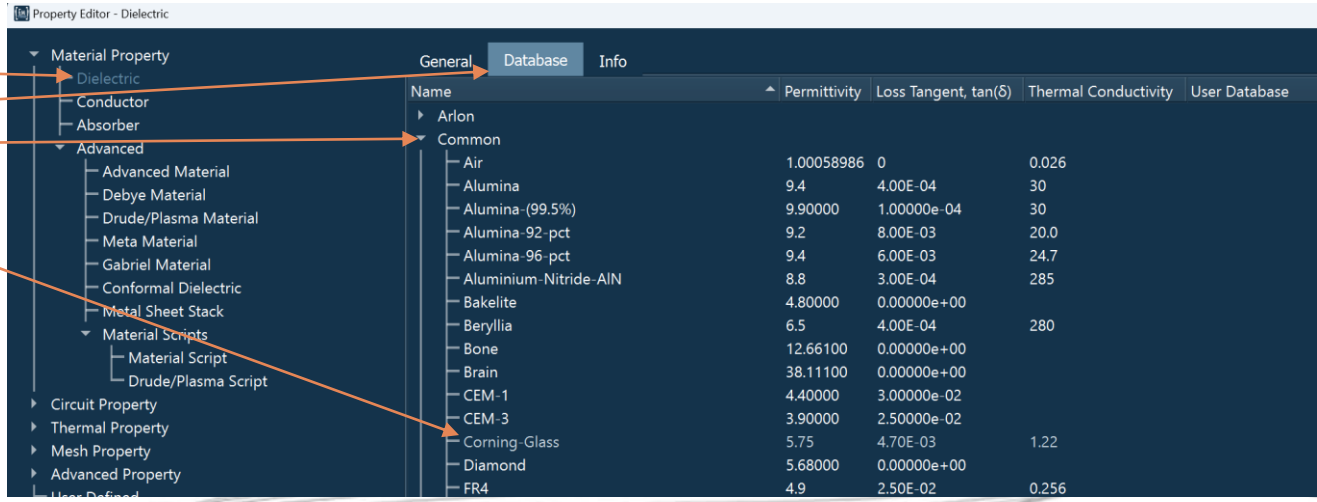
The Physical property of the top group is inherited to all Sub-groups.
This property is changed from ideal conducting metal (default) to steel.

Wizard step 3: Material assignment

Hovering with the mouse pointer over different groups highlights the corresponding objects in the preview window

- Move the mouse to the group ‘8080807f’ (grey color); the corresponding objects are marked in green (glass windows, lamp,..)
- Double click on the group name and change name from ‘8080807f’ to ‘Glass’
- Right click on the name and choose ‘Edit property’
  - Select Dielectric
  - Select Database
  - Select ‘Common’
  - Select ‘Cornig Glass’
  - Press OK
- Press next and confirm changed group settings





Wizard step 4: Create & place source

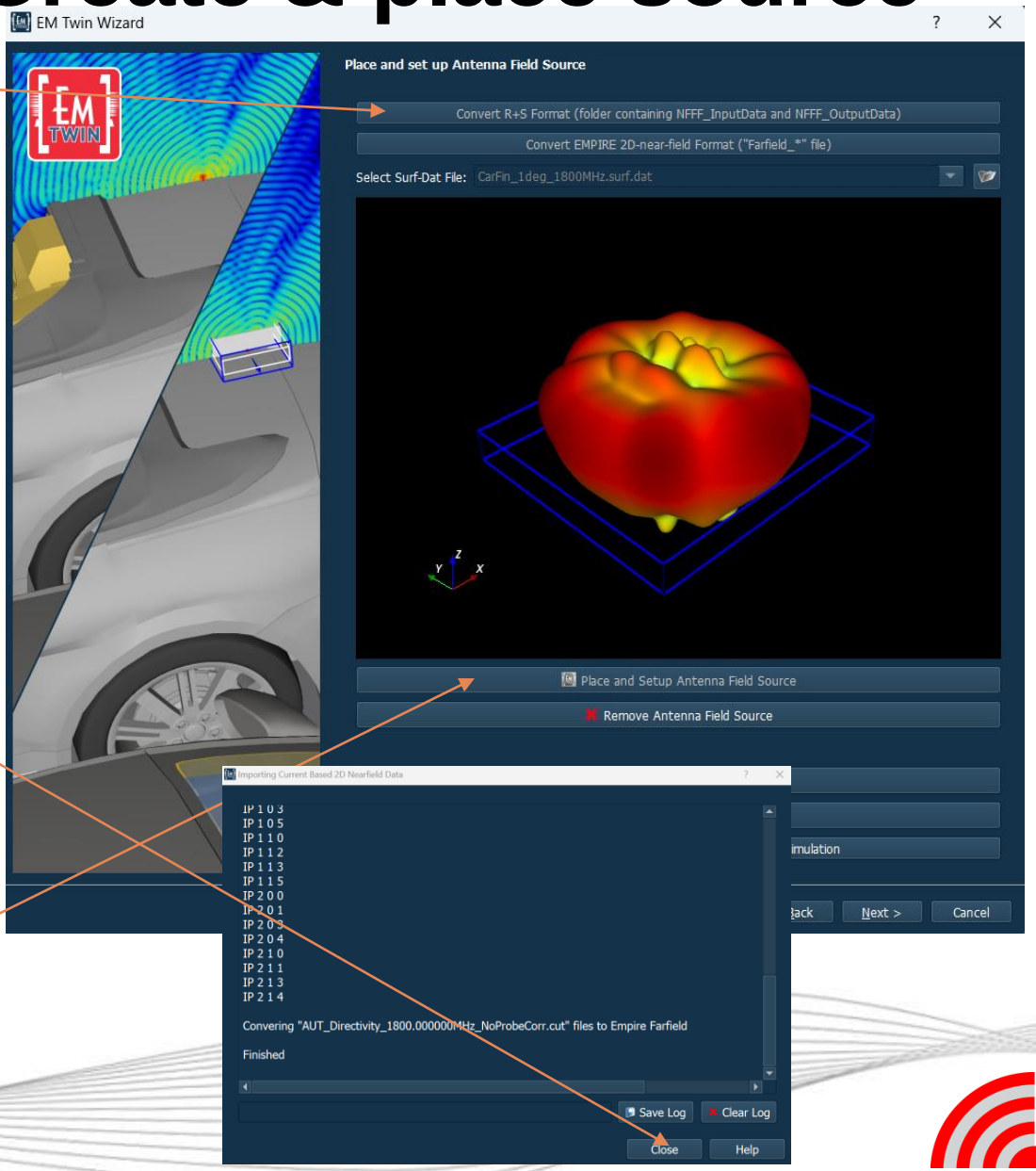
- Select option Convert R+S Format
- Locate folder “R_S_Source_data” and left-click on folder name (CarFin_1deg)
- Choose 1800 MHz as import frequency

The frequency must be selected if an antenna has been measured at several frequency points and if the corresponding nearfield currents have been created

- Click Close once the import is finished

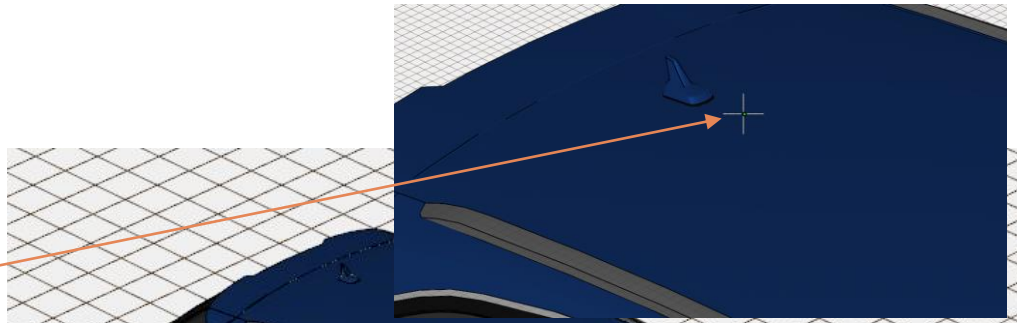
This way, the source file for the antenna digital twin “1_8GHz.surf.dat” is created in the project folder.
The 3D radiation pattern of the source is shown in the Wizard

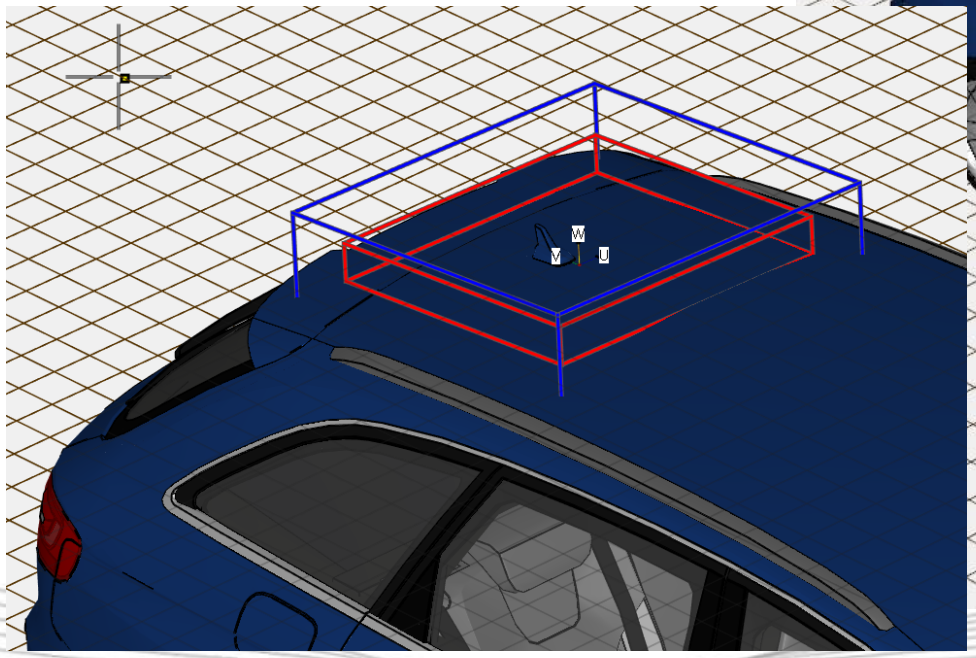
- Click on Place and Setup Antenna Field Source

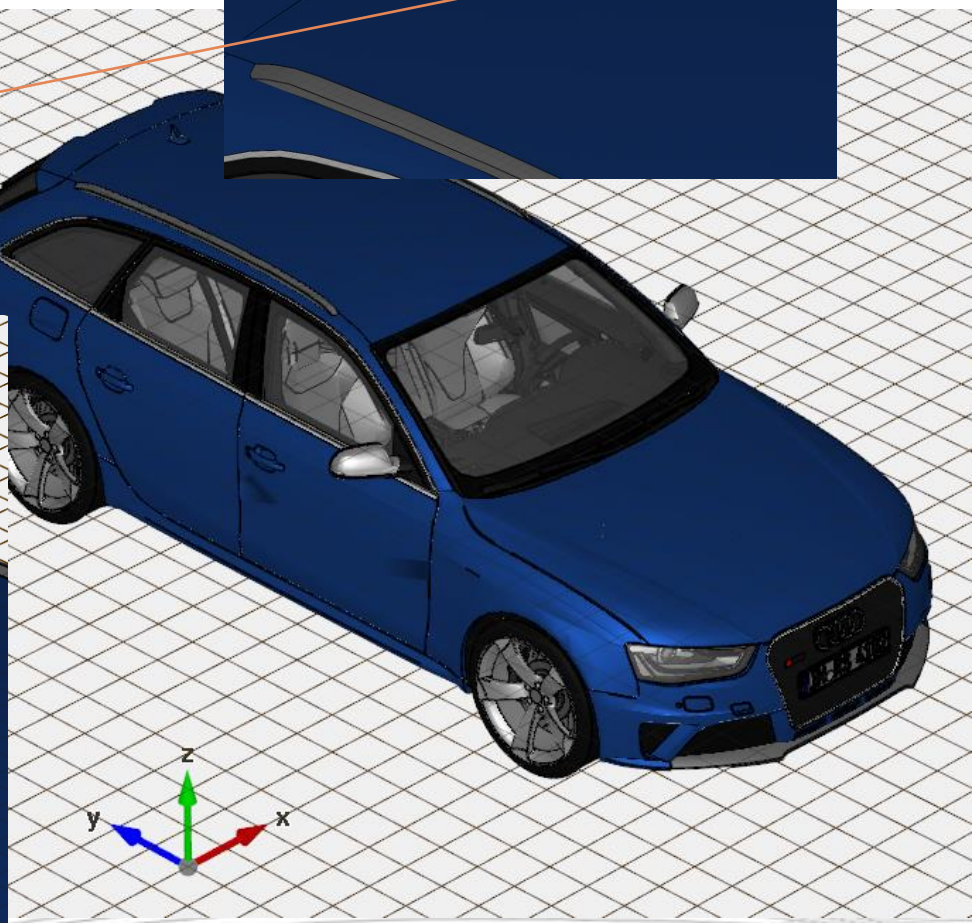


Wizard step 5: Field source placement

- Click on Iso-Z view; the imported 3D CAD model of the car appears on screen
- Zoom in to the rooftop of the vehicle
- Left click on a point along the central axis of the vehicle, close to the dummy shark-fin object

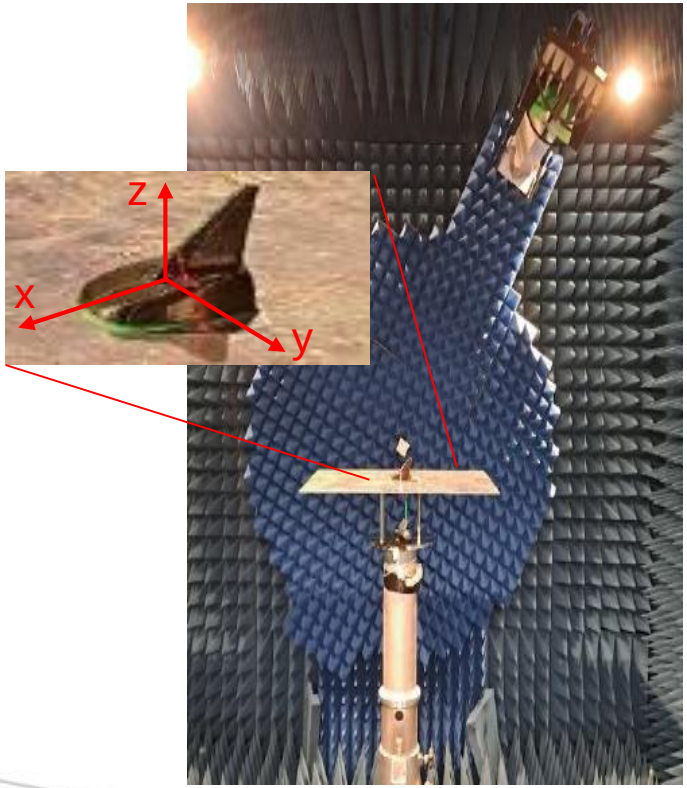


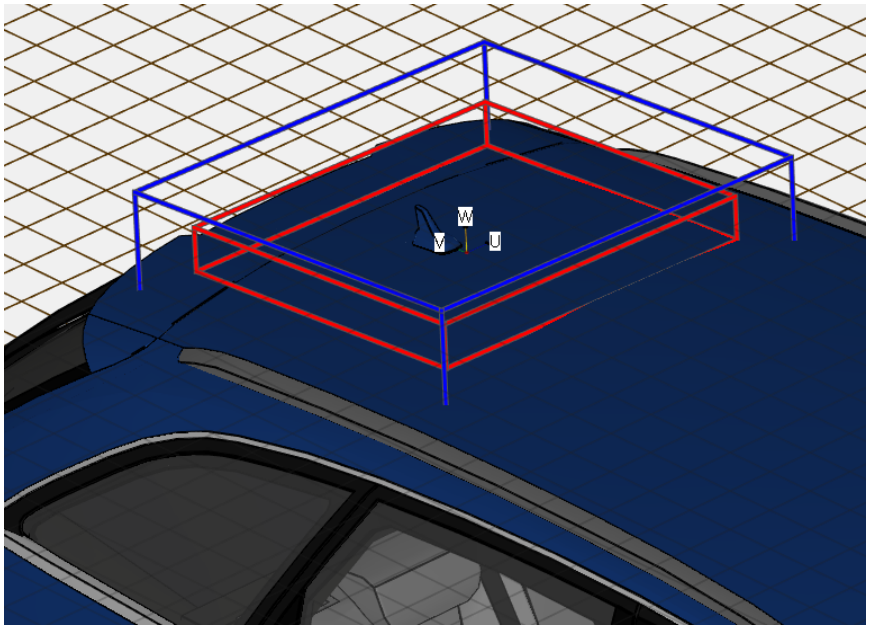




Wizard step 6: Field source placement

The antenna was measured in the chamber with an alignment where phi=0 (x-direction) was aligned with the forward facing sharkfin antenna module (see picture below)



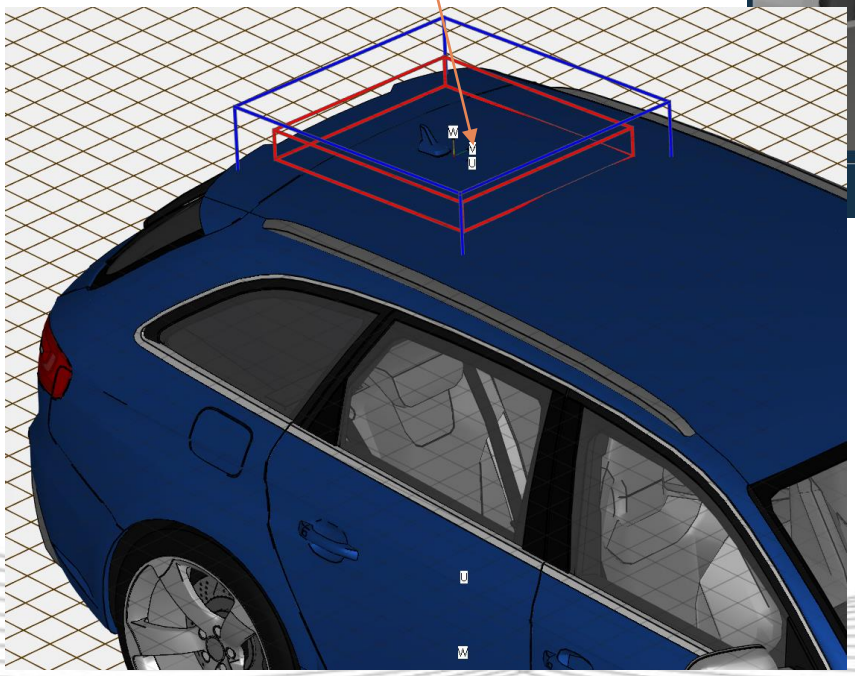


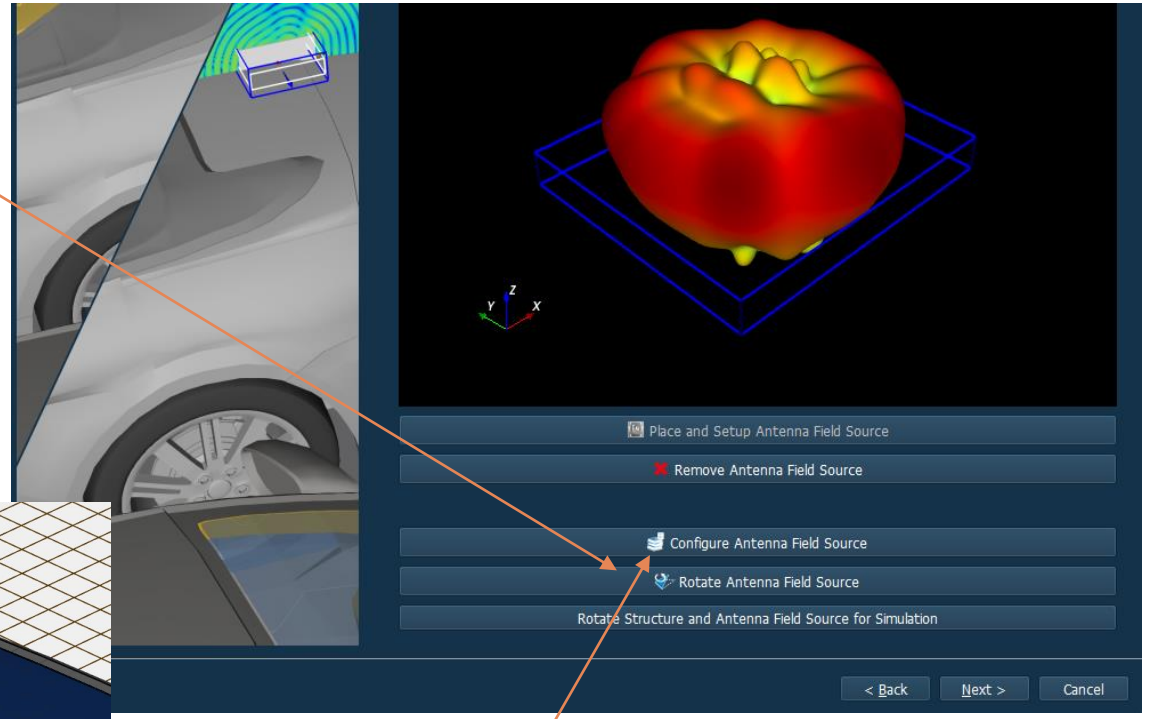
Within the digital antenna twin field source placement, the u-direction corresponds to the x-direction in the measurement (v corresponds to y and w to z).
As the sharkfin module should also be facing forward when using the antenna digital twin source, the u-direction must face forward. The upper right picture shows the u-direction pointing the left side of the car, so this can be achieved by a rotation around w axis.

Wizard step 7: Field source placement

- Select ‘Rotate Antenna Field Source’
- Keep w as rotation axis
- Enter a rotation angle so that u is pointing to front of car
- Press OK

The antenna digital twin field source is now correctly placed on the roof of the car





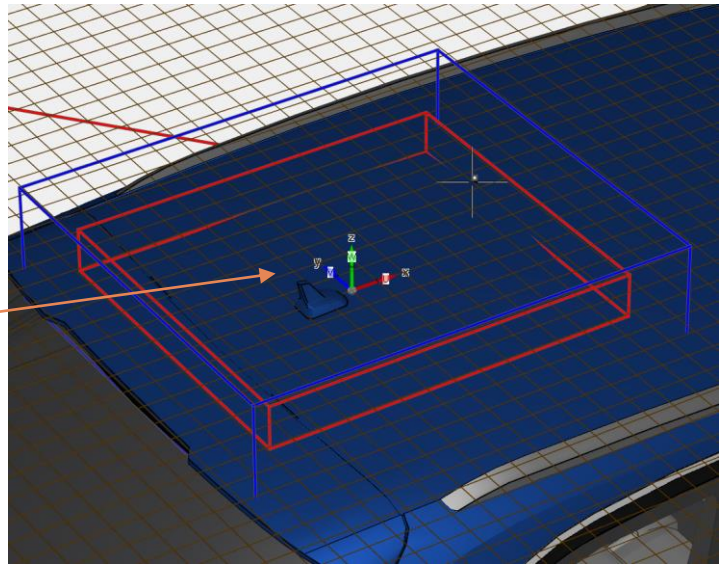
- Select ‘Configure Antenna Field Source’
- Choose General -> Disable Sides: zmin
- Press OK

The zmin side of the field source must be disabled as the antenna was measured on a large metal ground plane

Wizard step 8: Structure rotation for simulation, Delete Shark fin mokup

Radiating field sources are box-shaped objects that need to be properly aligned with the Cartesian coordinate systems.
This is currently not the case as the field source is aligned with the curved roof from the car

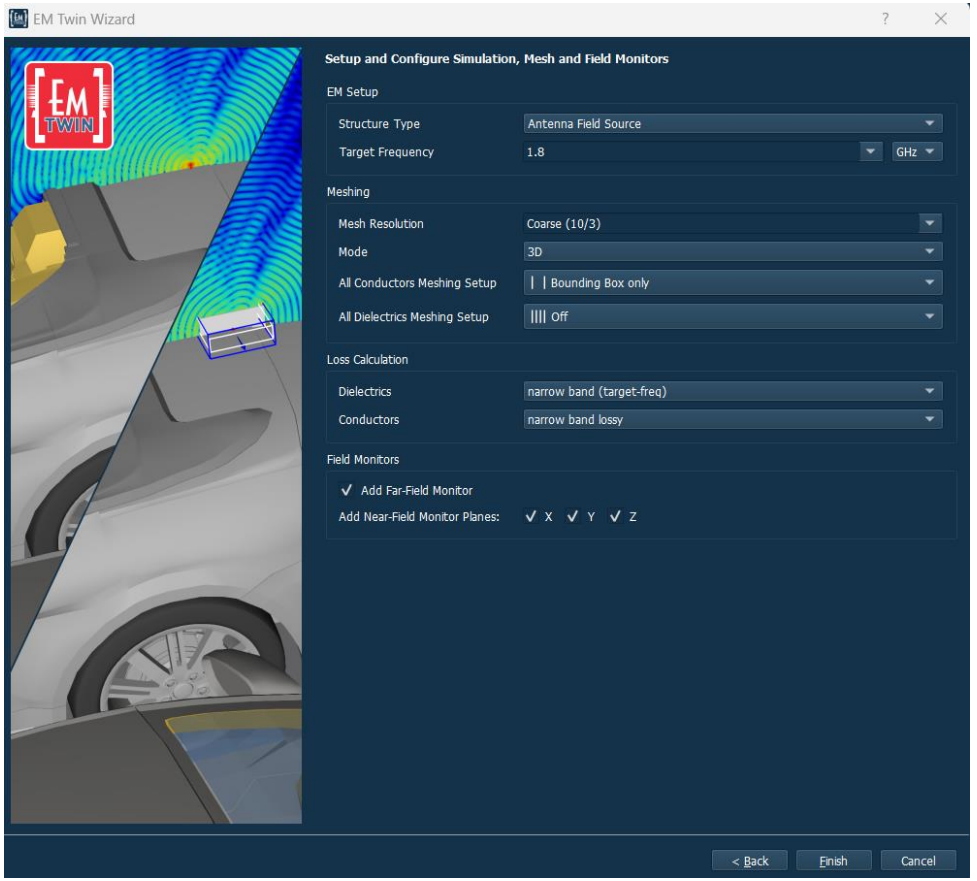
- Click on ‘Rotate Structure and Antenna Field Source for Simulation’
- The Field source is now properly aligned with the car and the mesh for simulation
- Click Next

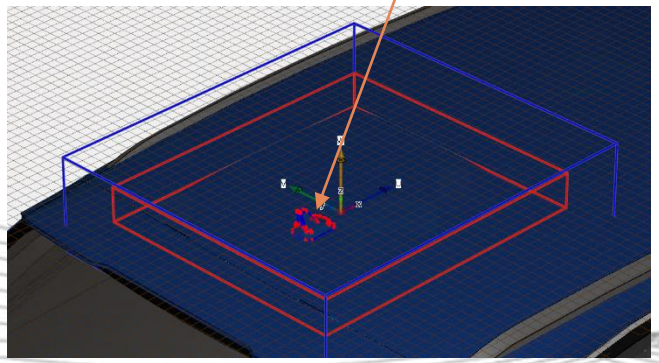


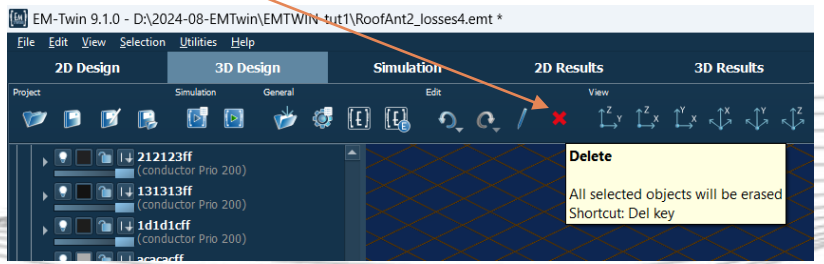
Wizard step 9: Simulation set-up

- The mesh setting has an influence ono the accuracy of the results
- Option Coarse (10/3) is a good starting point for initial investigations
- Depending on the user's available computing power, finer meshes can be selected later
- Click Finish to terminate the Wizard and return to 3D Design

- Select the Shark Fin mockup with a left click
- Press Delete

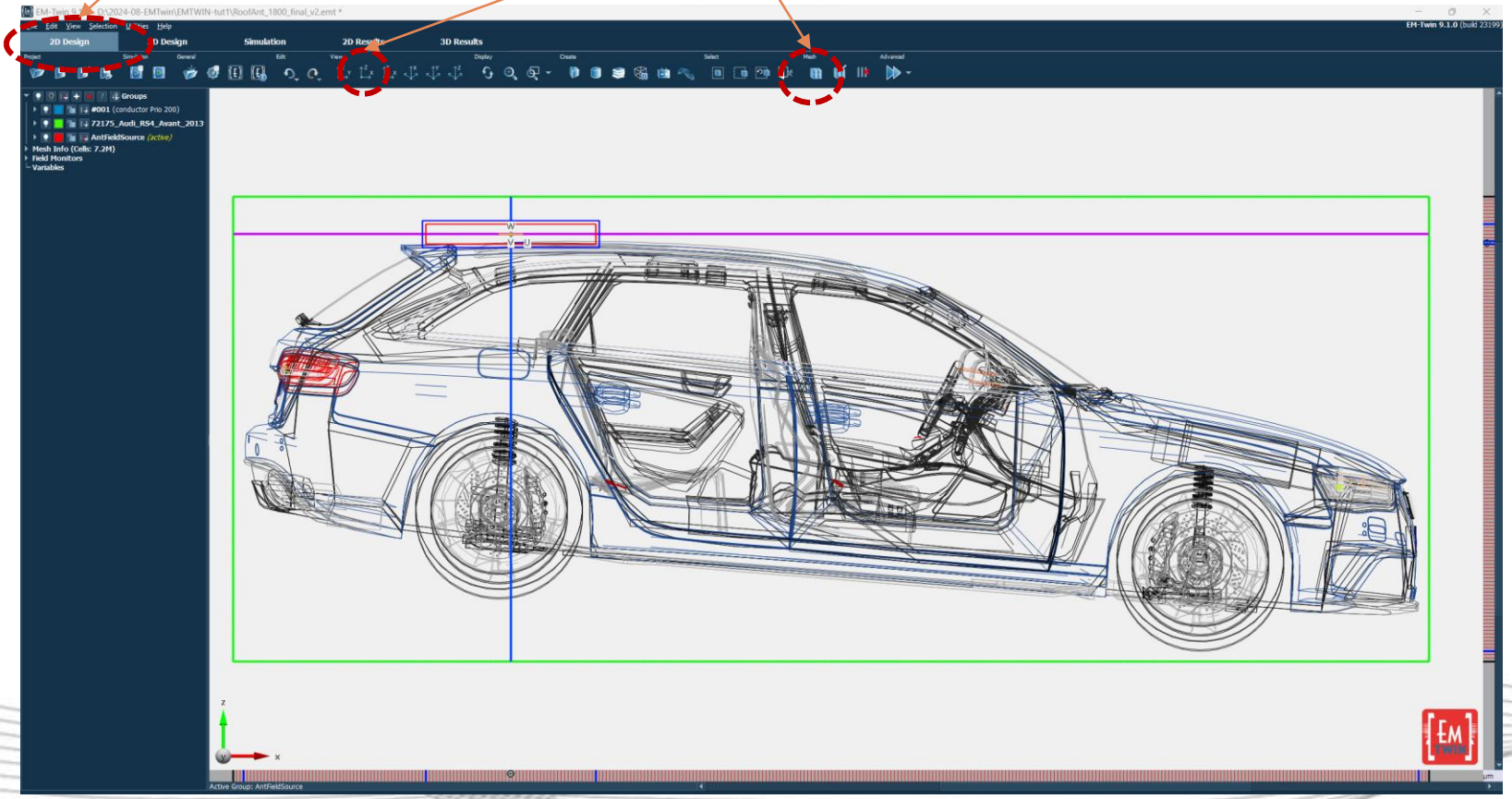






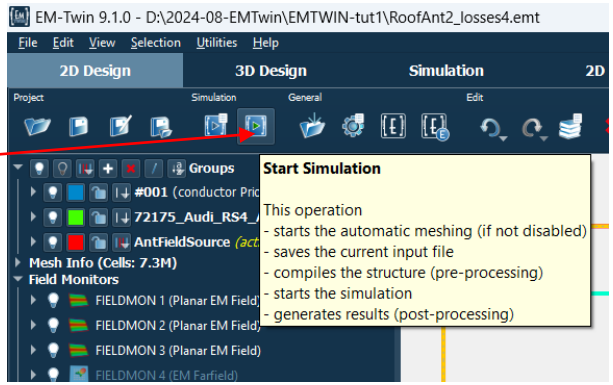
Wizard step 10: Model discretization

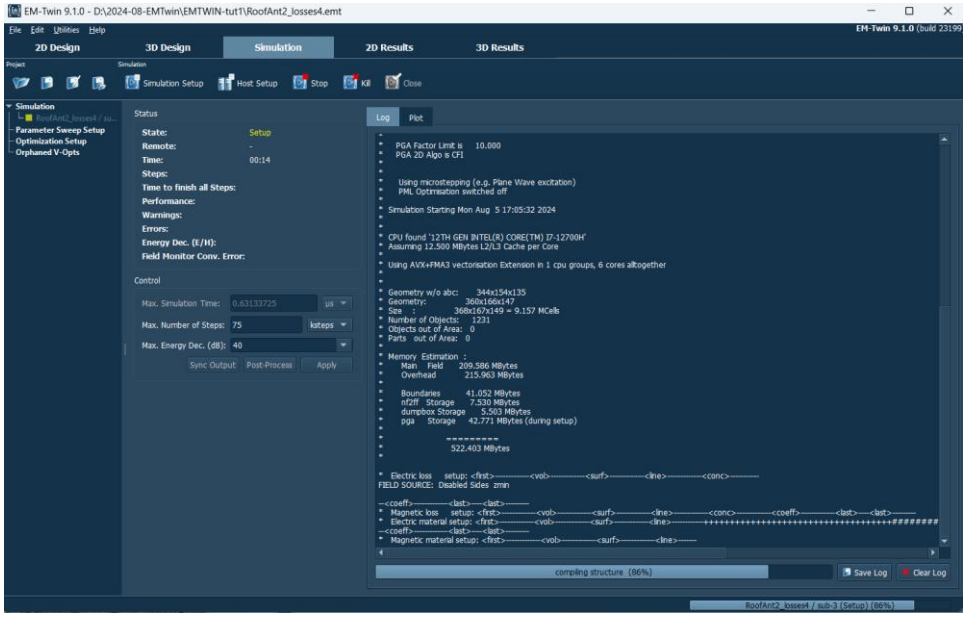
- Click on Create Mesh to discretize the model
- The 10/3 setting leads to hexahedral cells roughly 14 mm in size
- Model complexity is approx. 7 Mcells
- Switch to 2D Design mode and Select Front view
- Notice how the car model is tilted downwards after the rotation that levelled the field box



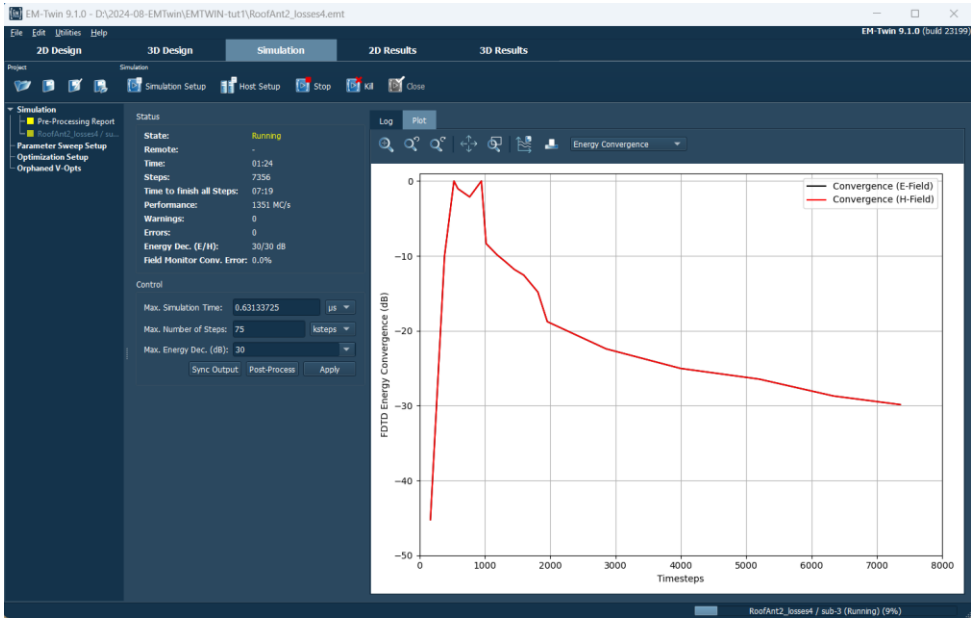
Step 11: Simulation

1. Press Icon Start Simulation
2. Press OK





Simulation log output at startup

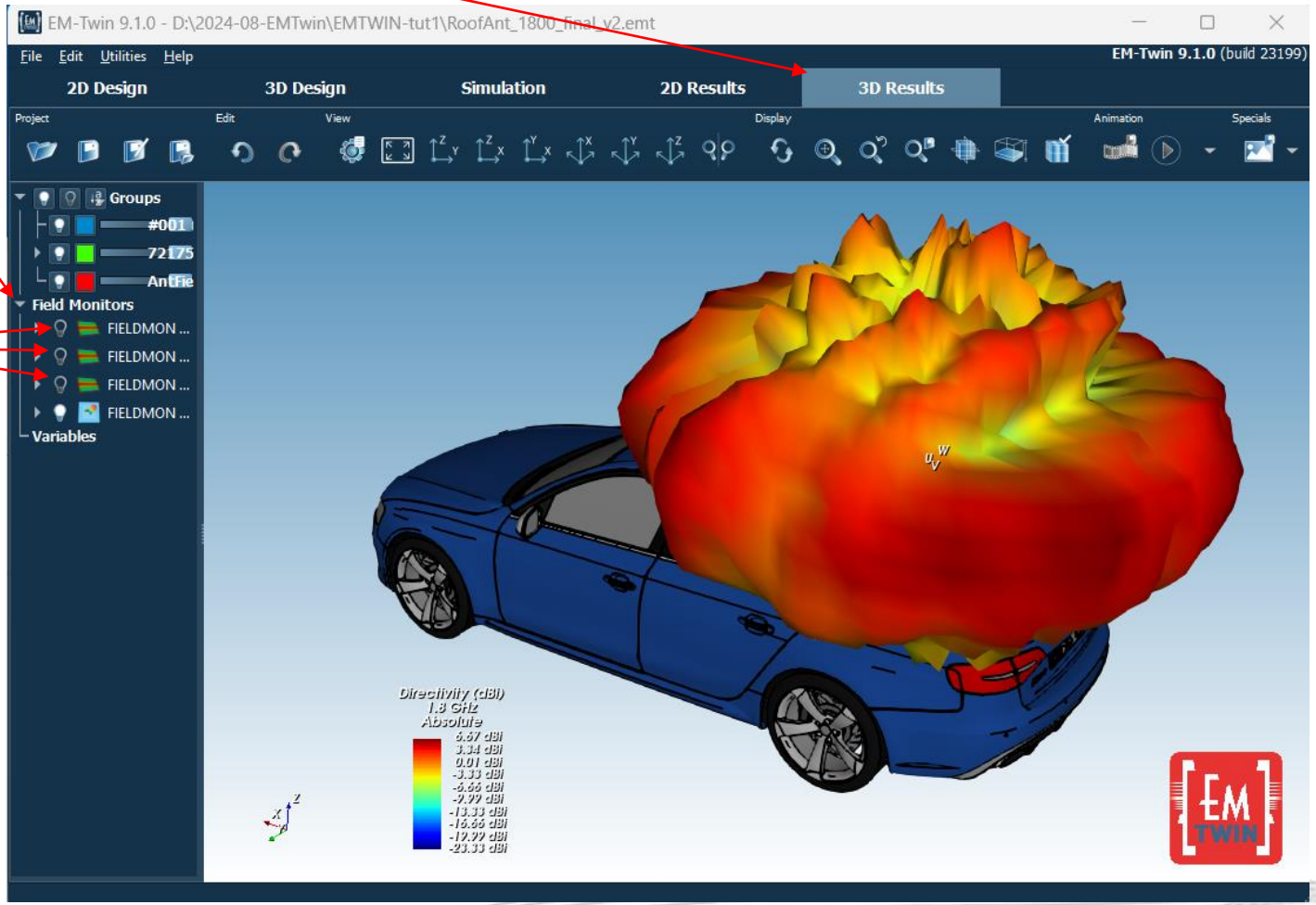


Energy convergence shown during simulation

Simulation stopped after 30 dB energy decay reached, postprocessing started

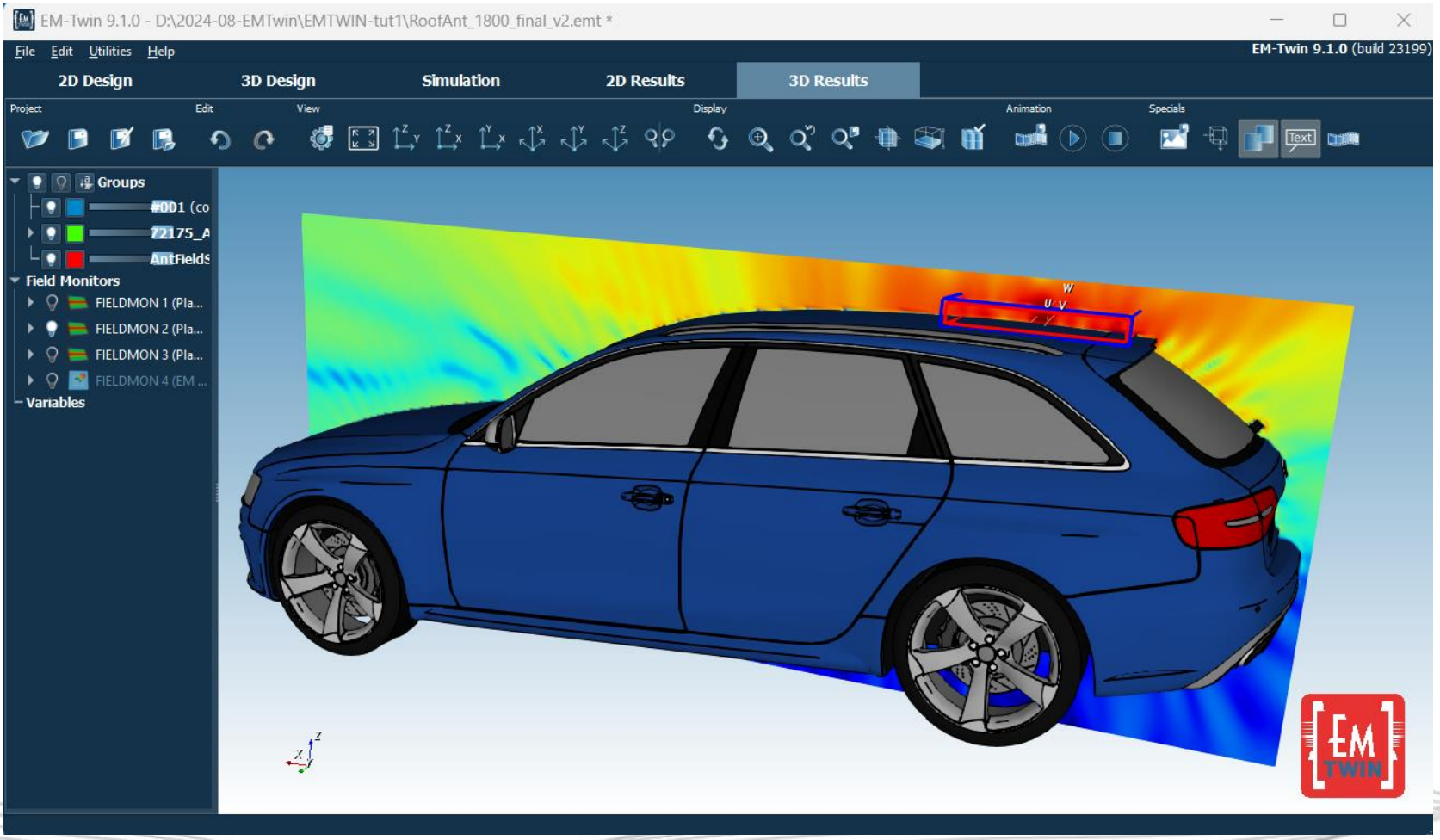
3D Results: Far-field pattern

1. Switch to 3D Results
2. Open Field Monitors
3. Turn off planar EM Fields



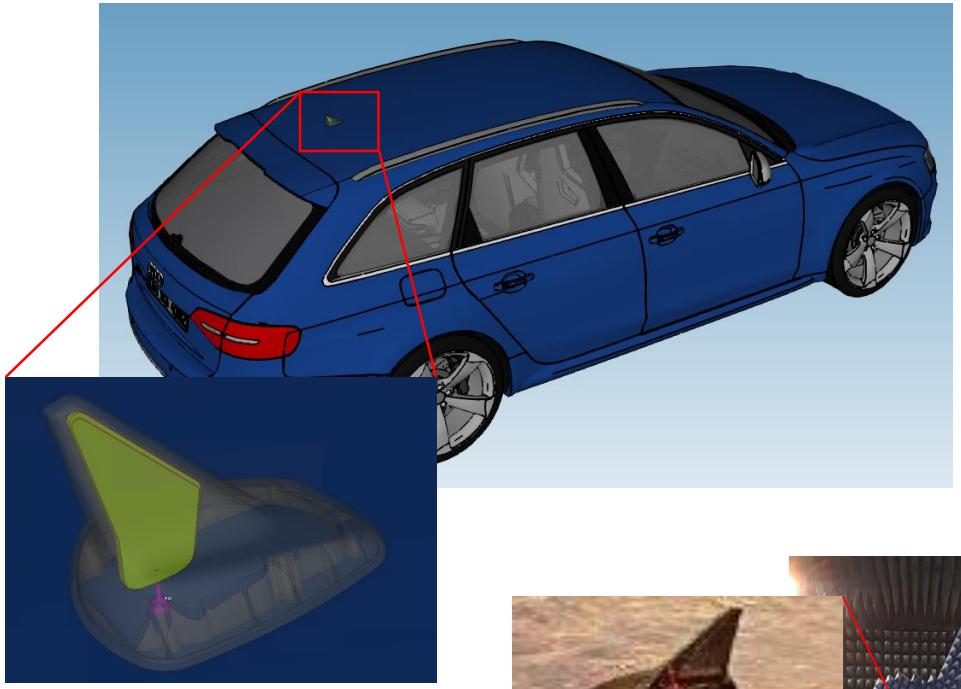
3D Results: Near-field distribution

1. Turn off EM Farfield
2. Turn on Field Monitor 2

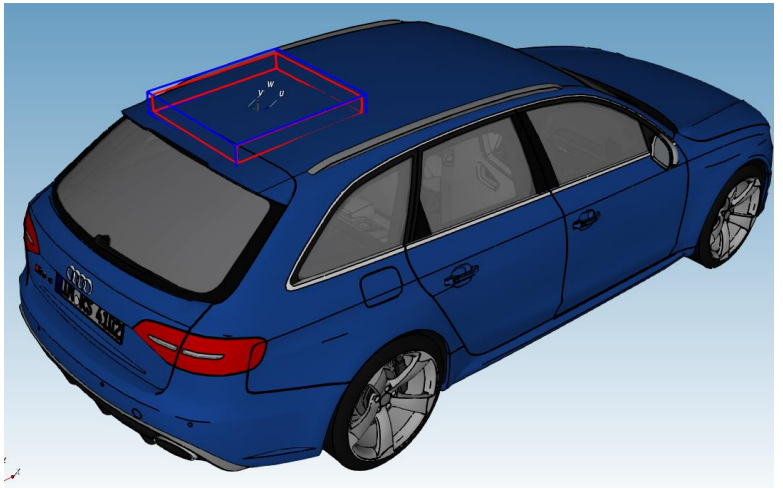


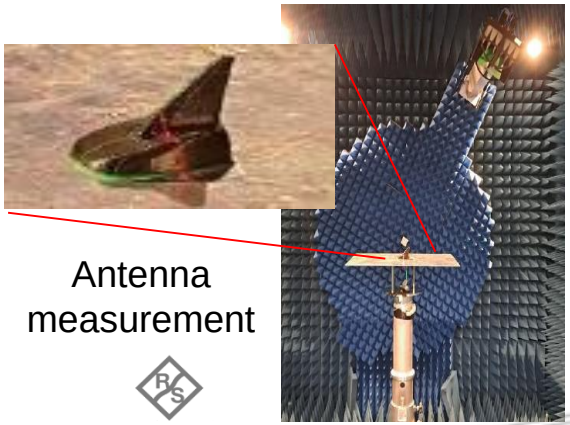
Antenna digital twin vs. full antenna simulation

Full antenna simulation



Antenna digital twin simulation

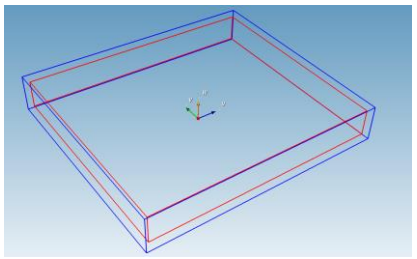




Antenna measurement

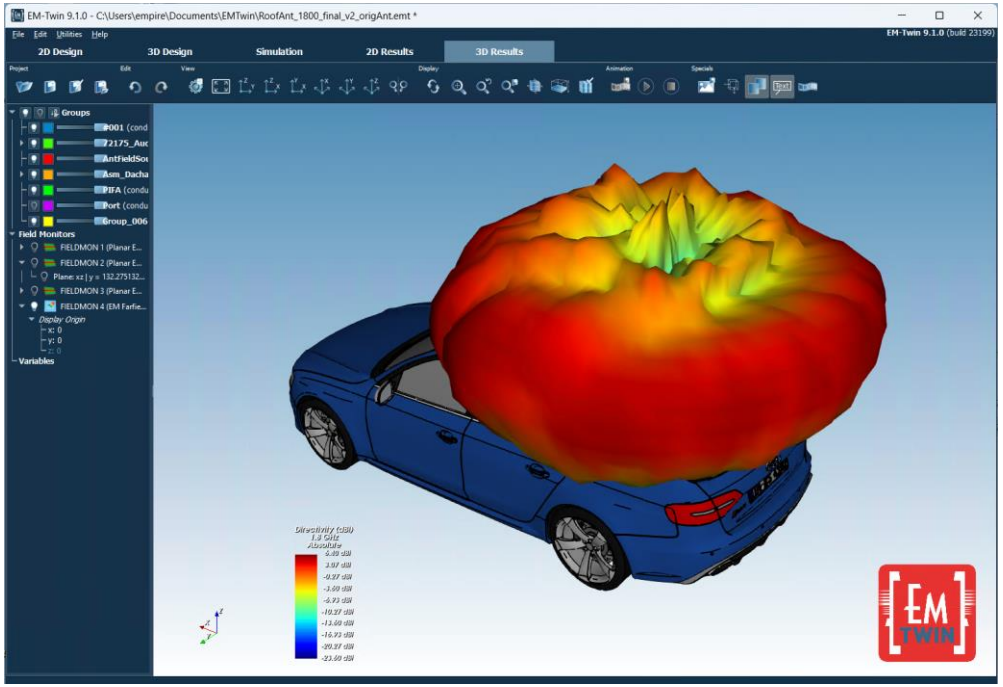
ROHDE&SCHWARZ

Antenna digital twin creation (FIAFTA & EM-Twin)

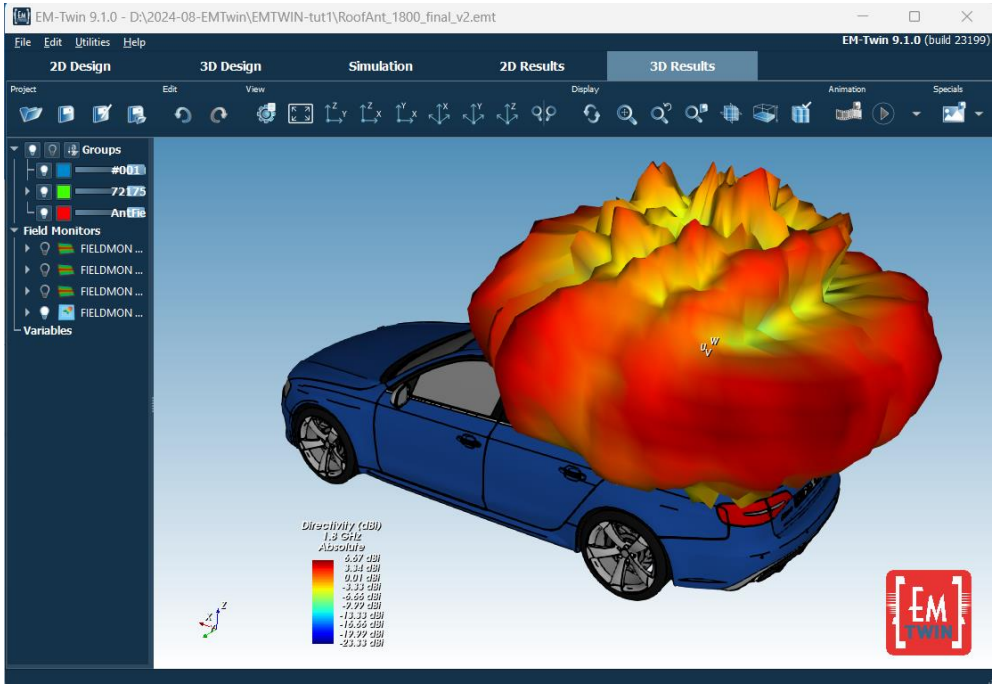


Antenna digital twin vs. full antenna simulation

3D Farfield pattern



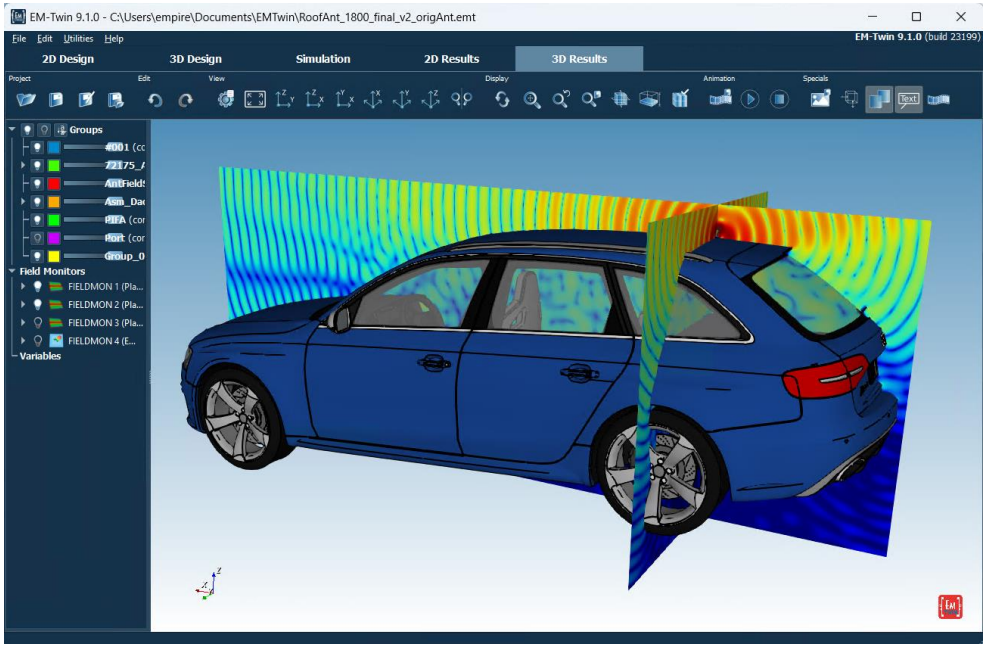
Full antenna simulation: Directivity 6.4 dBi



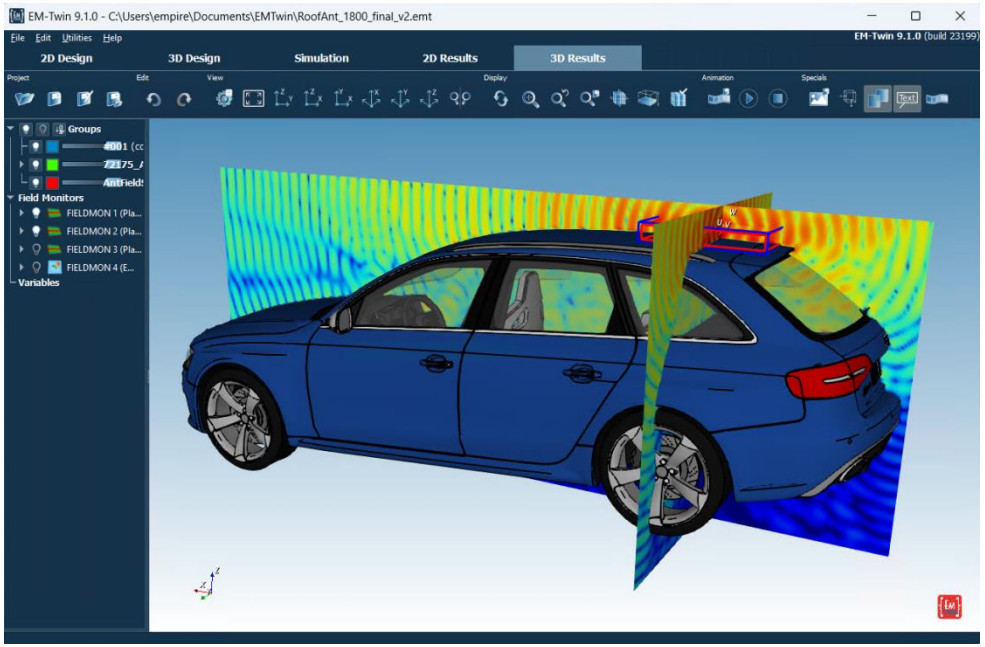
Antenna digital twin: Directivity 6.67 dBi

Antenna digital twin vs. full antenna simulation

Near Field Distribution



Full antenna simulation



Antenna digital twin

The antenna digital twin model achieves an excellent agreement with the full simulation model in less than 2 min simulation time