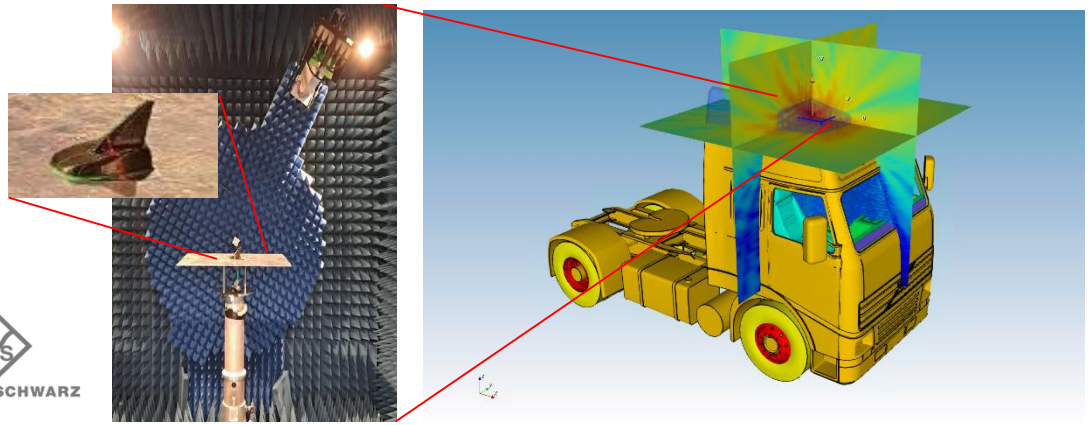
EM-Twin Automotive Tutorial

Antenna placement on the Roof of a Truck

Overview

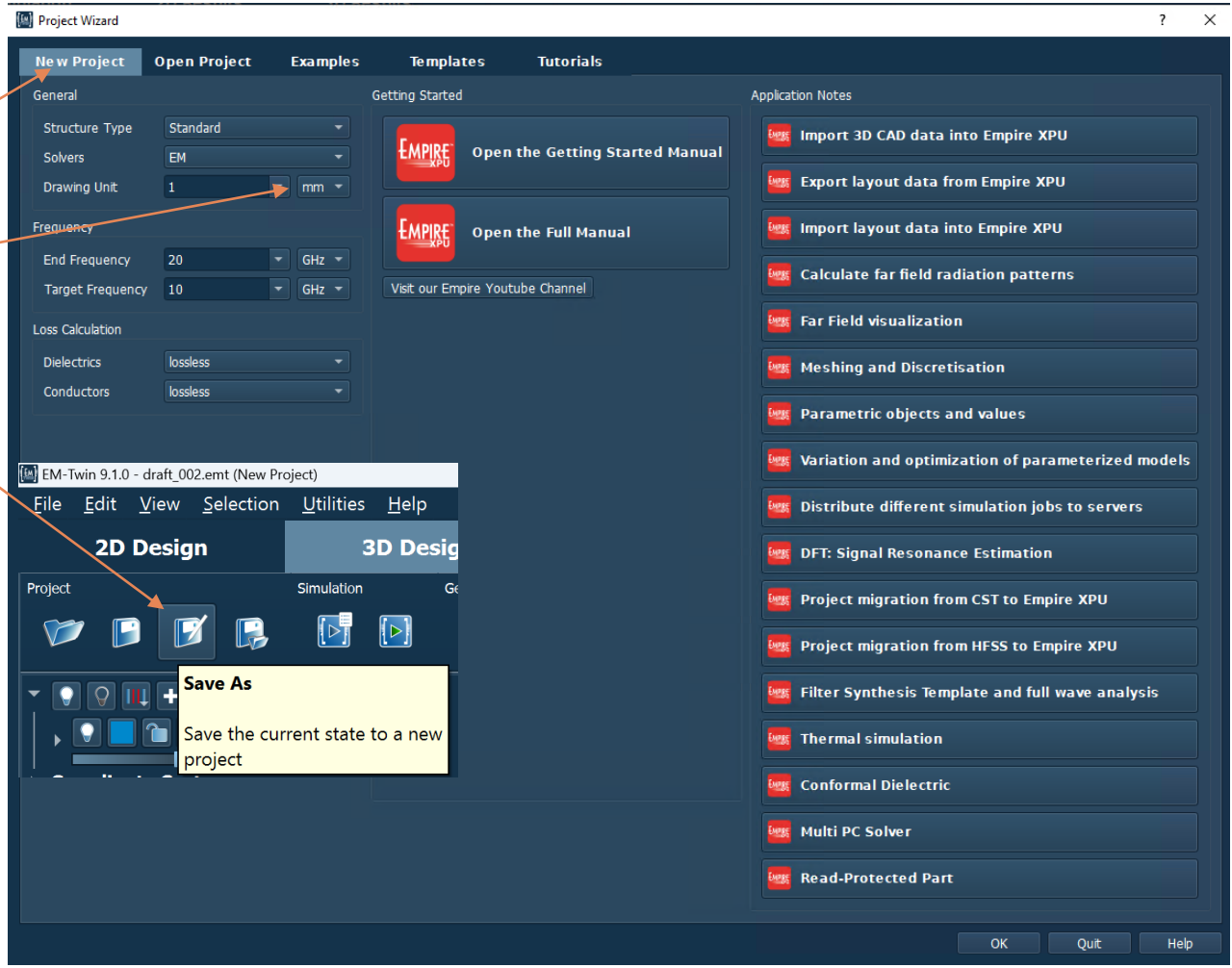
- New project creation
- Using the automotive Wizard
- 3D CAD model import
- Antenna digital twin creation
- Field source placement & alignment
- Simulation set-up
- Model set-up (material definition)
- Simulation
- Near- & Farfield evaluation

Truck with antenna digital twin on roof

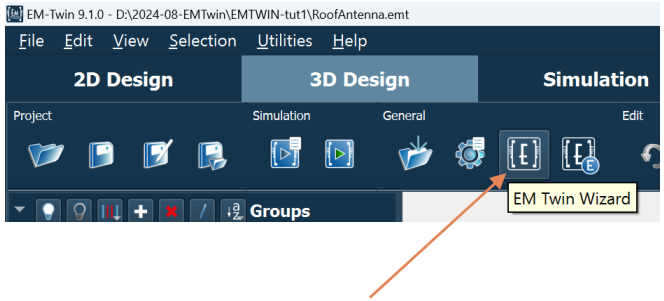


Start

- Start EM-Twin
- Select “New Project”
- Set unit: 1mm
- Press OK
- Press Save as &
  create a storage folder and
  enter file name,
  e.g., “RoofAntenna_Truck”
- Press Save



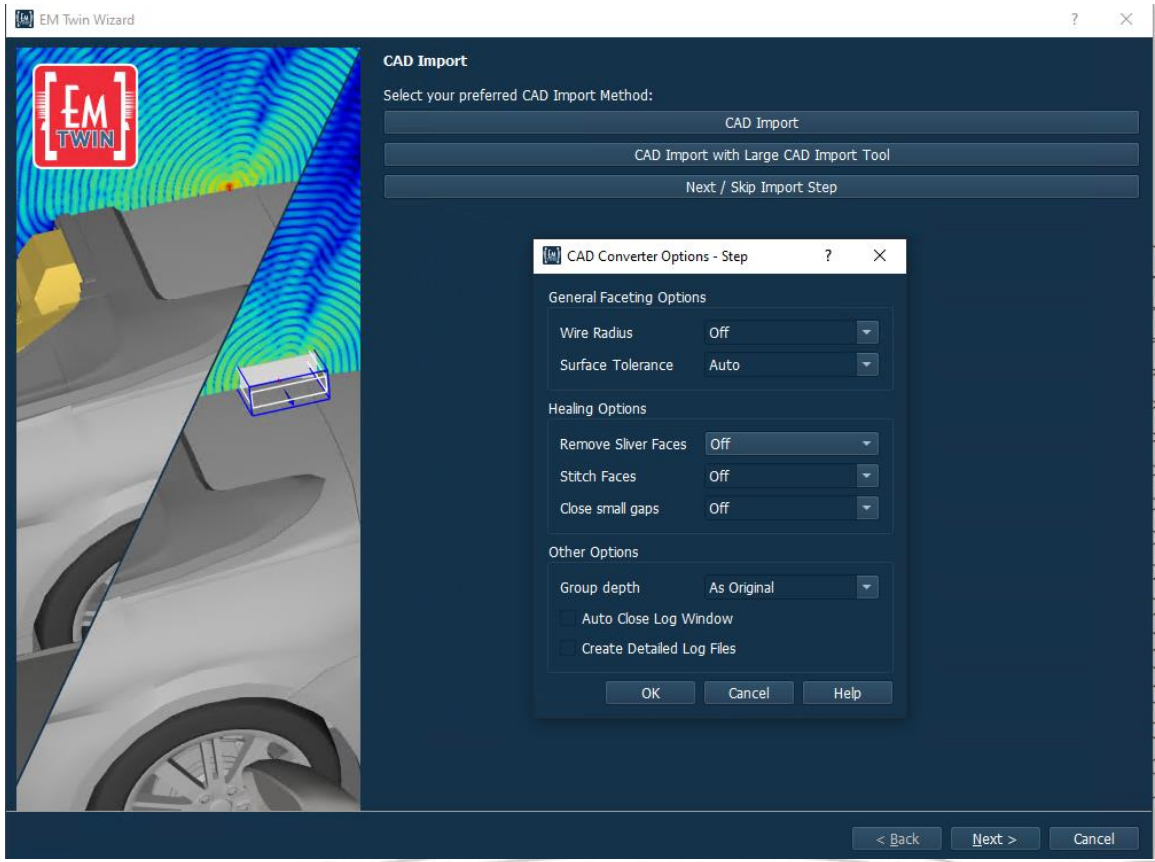
Wizard step 1: CAD Import



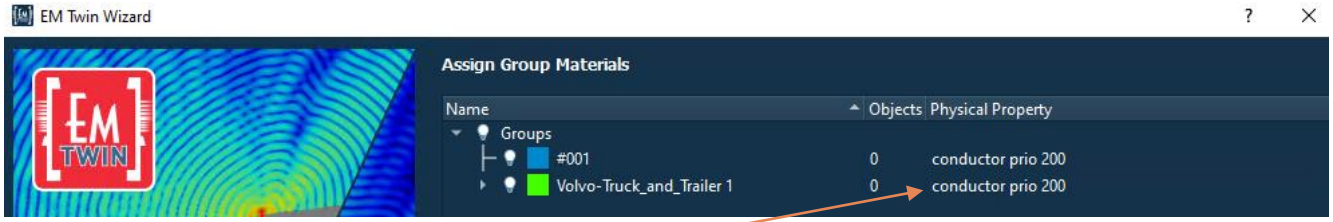
- Click on the icon “EM Twin Wizard”
- Click on ‘CAD Import‘ and locate the STEP file:

“Volvo-Truck_and_Trailer 1.stp”

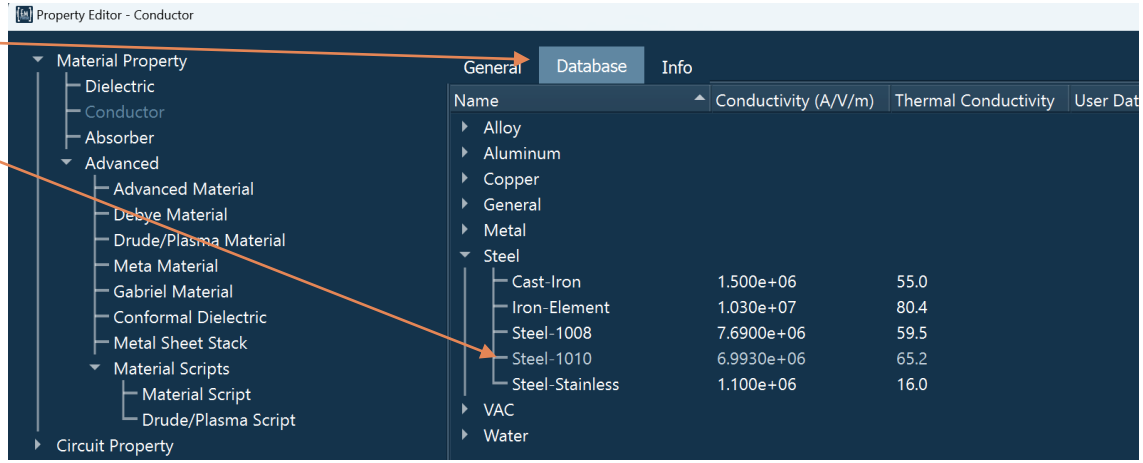
- Accept Defaults, OK
- Click Close once the import is finished and continue with Next



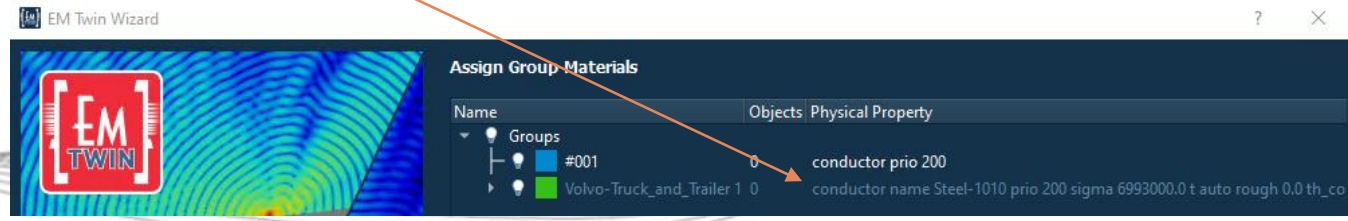
Wizard step 2: Conductor assignment



- Double click on Physical Property of Volvo-Truck… parent group 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 PEC (default) to steel.



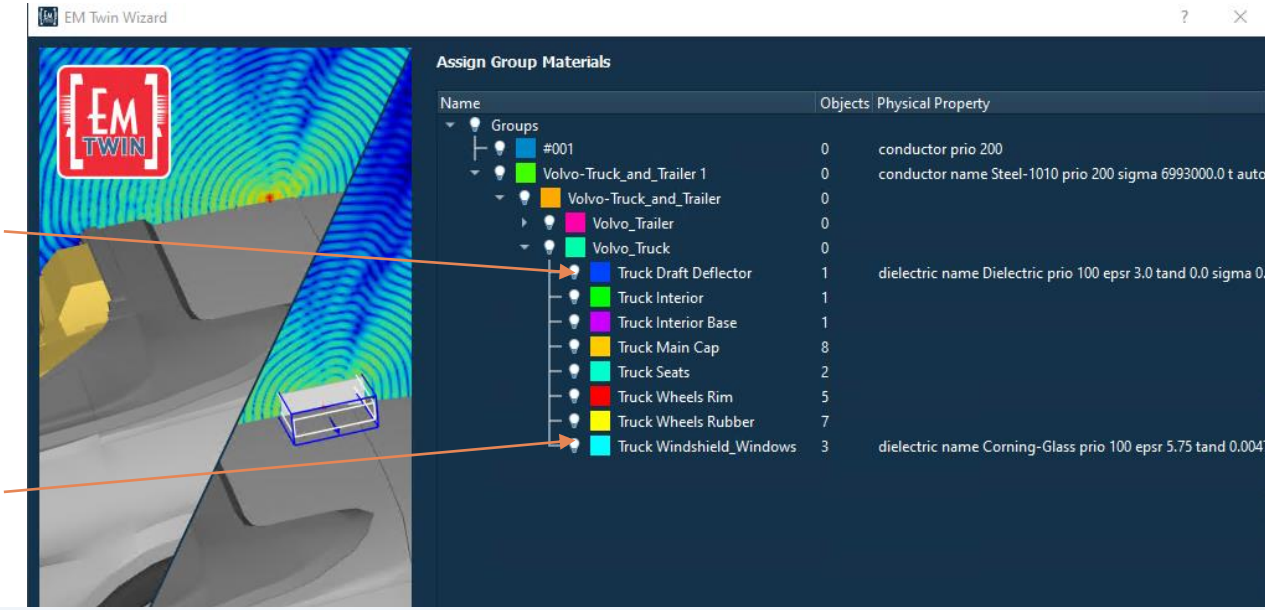
Wizard step 3: Dielectric assignment

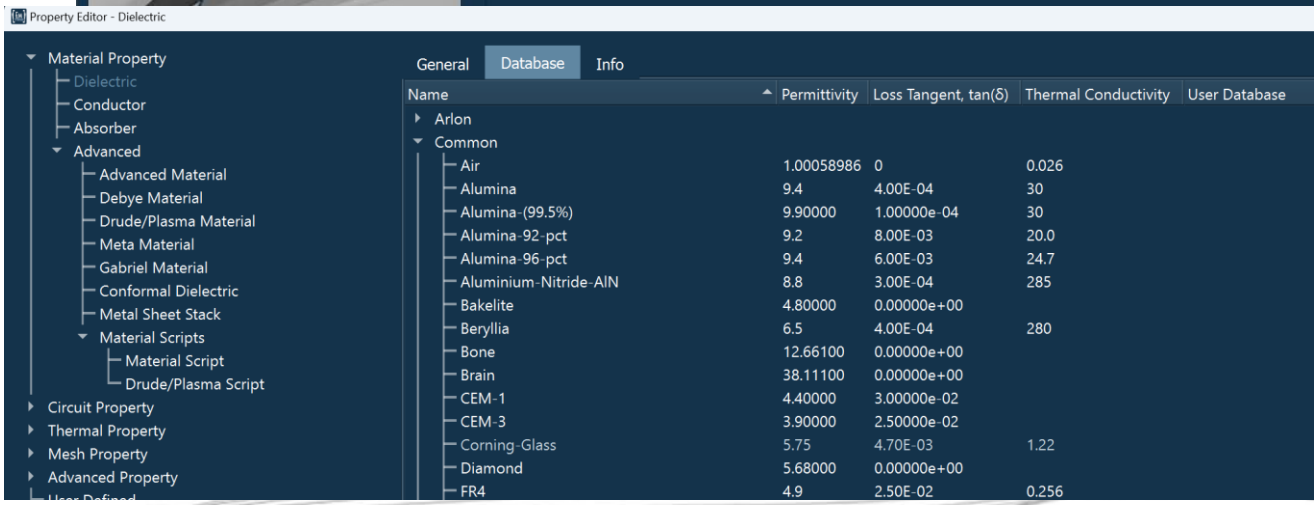
- Open Group Volvo-Truck…
- Open Subgroup Volvo_Truck
- Right click on the group …Deflector
- Choose ‘Edit property’
  - Select Dielectric
  - Enter 3 for permittivity*
  - Press OK

- Right click on the group …Windows
- Choose ‘Edit property’
  - Select Dielectric
  - Select Database
  - Select ‘Common’
  - Select ‘Cornig Glass’
  - Press OK

- Switch off group …Deflector
- Press next and confirm changed group settings

* To use e.g. Acryl as material



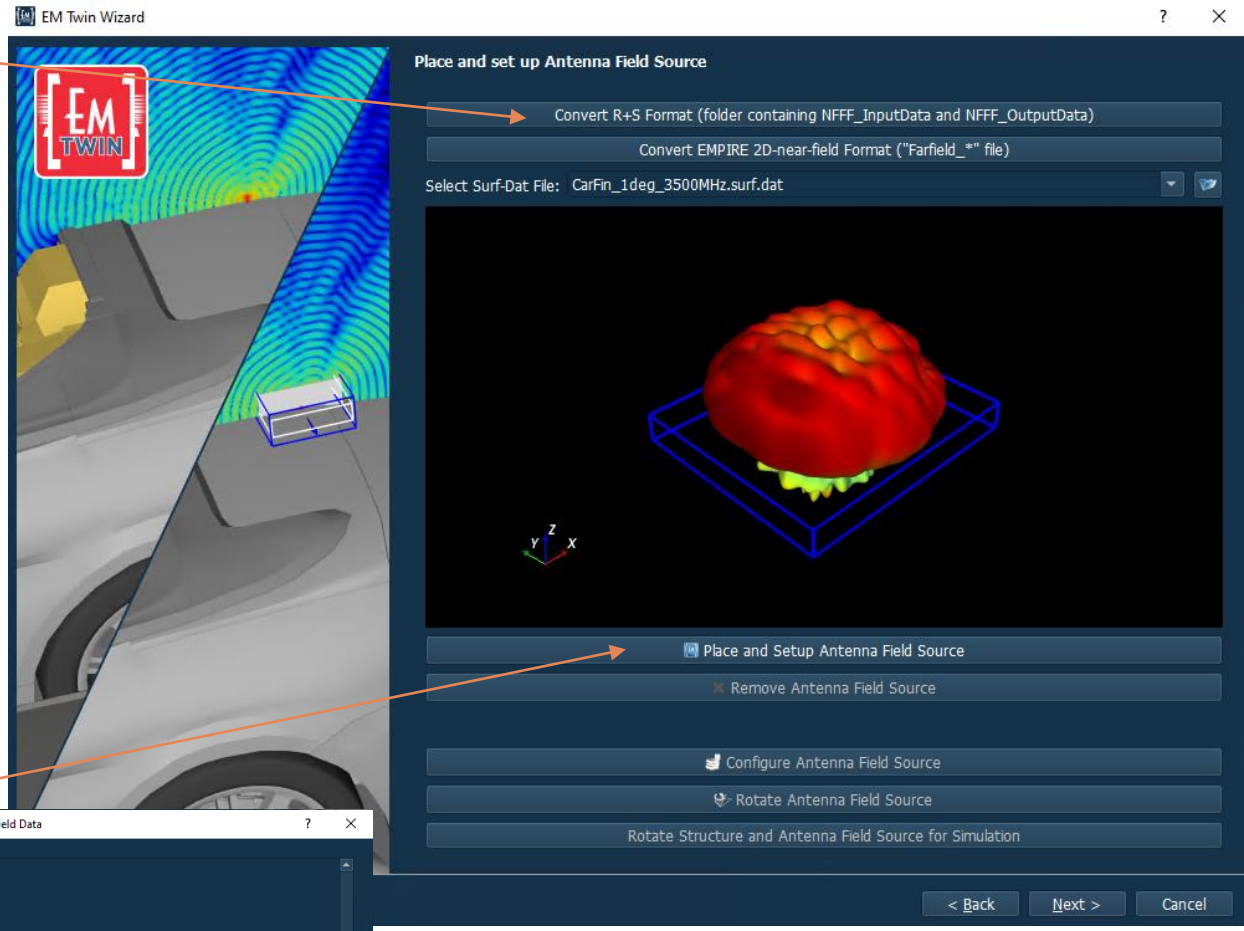


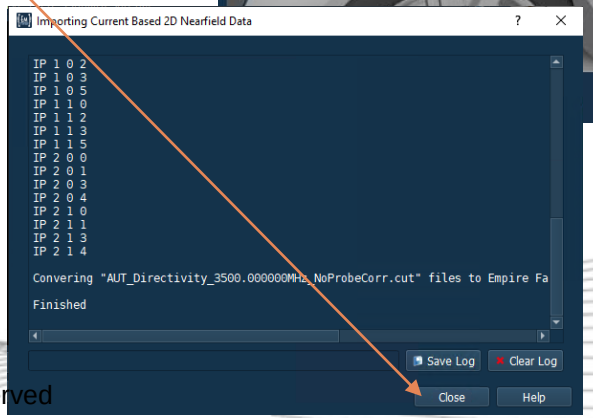
Wizard step 4: Create & place source

- Select option Convert R+S Format
- Locate folder “Source-data” and left-click on folder name (CarFin_1deg)
- Choose 3500 MHz as import frequency
- OK
- Click Close once the import is finished

This way, the source file for the antenna digital twin “3_5GHz.surf.dat” is created in the project folder.
The 3D radiation pattern of the source is shown in the Wizard

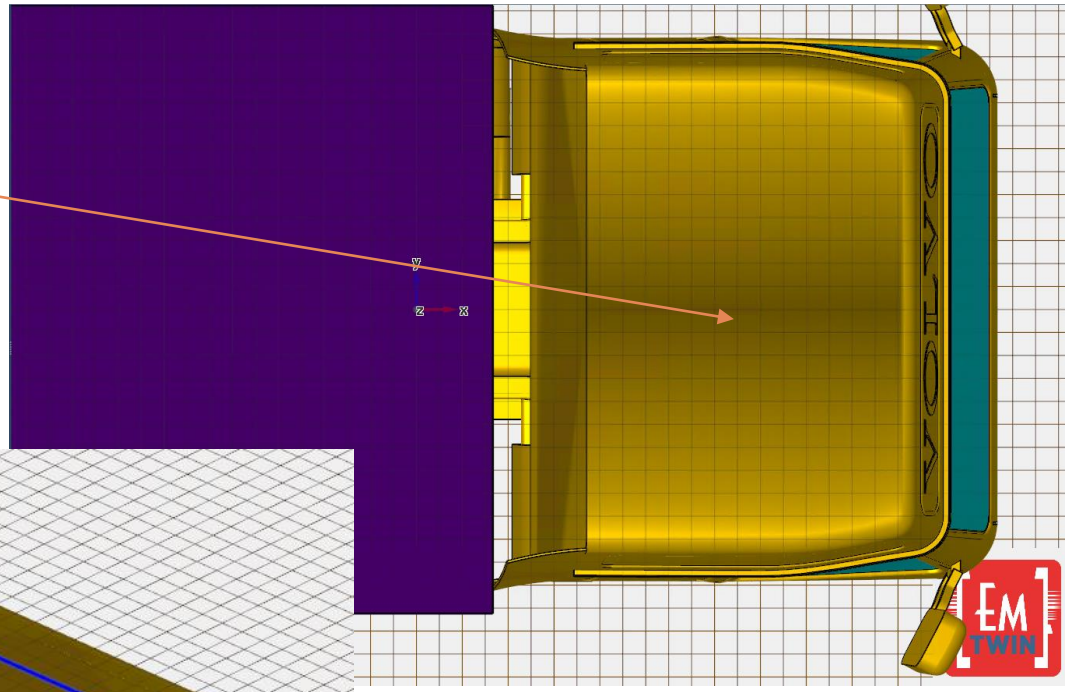
- Click “Place and Setup Antenna Field Source”

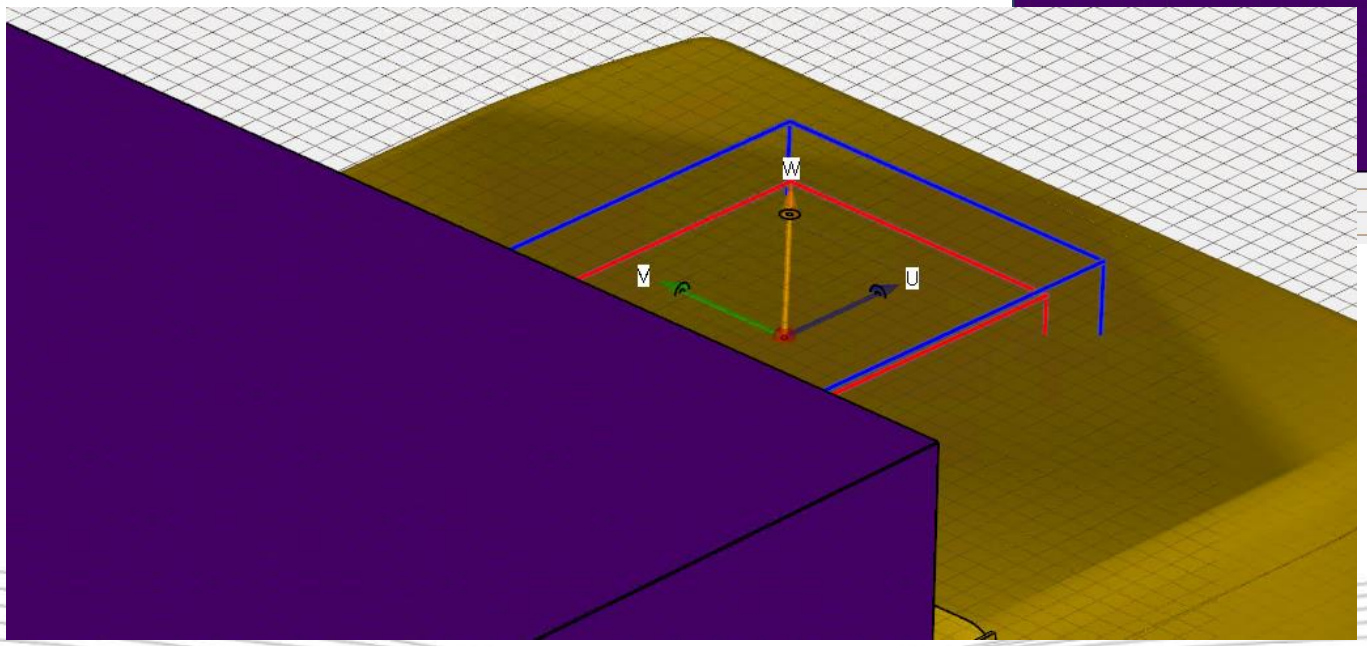




Wizard step 5: Field source placement

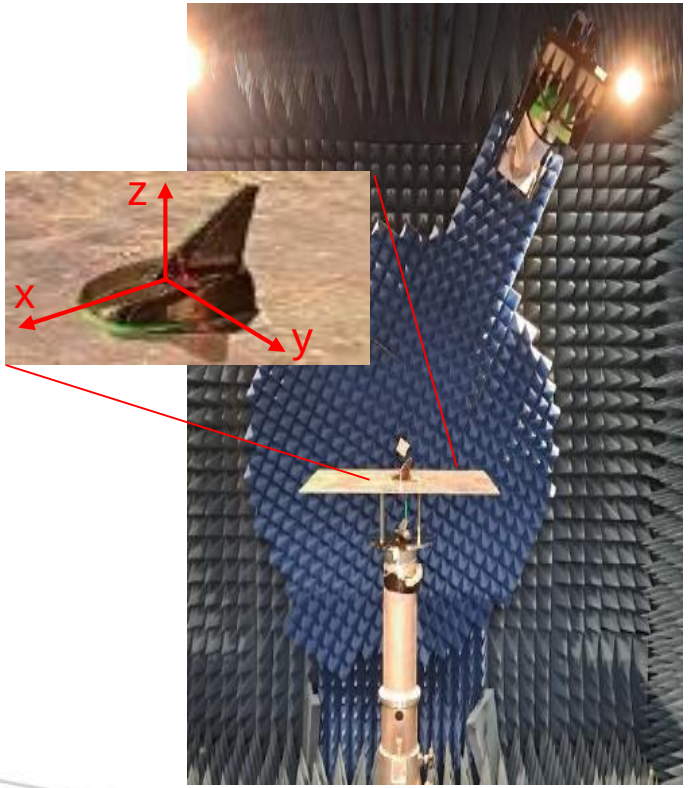
- Click on Top View (xy)
- Zoom to front
- Left click on a x=1000, y=0

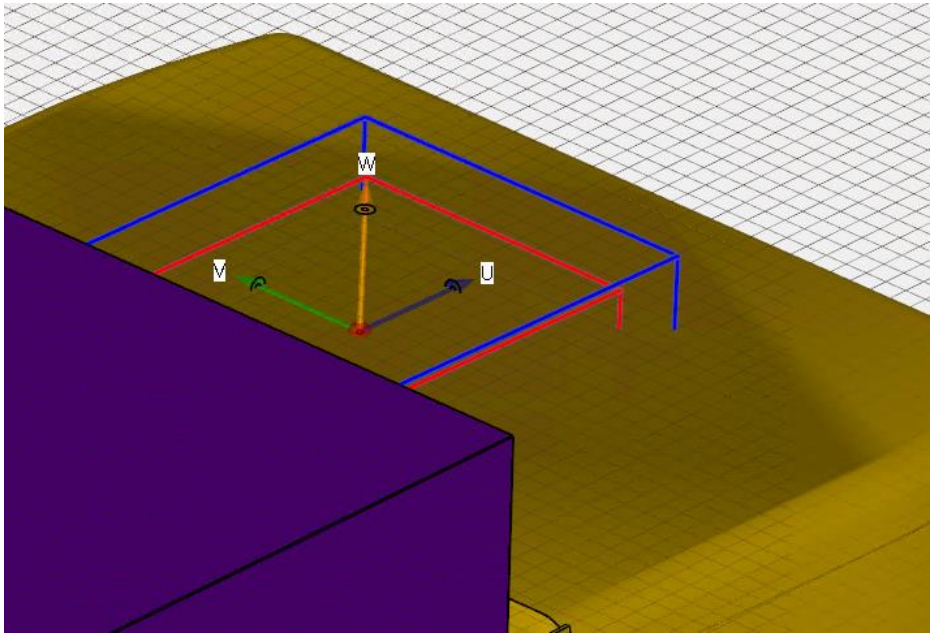




Wizard step 6: Field source placement

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)

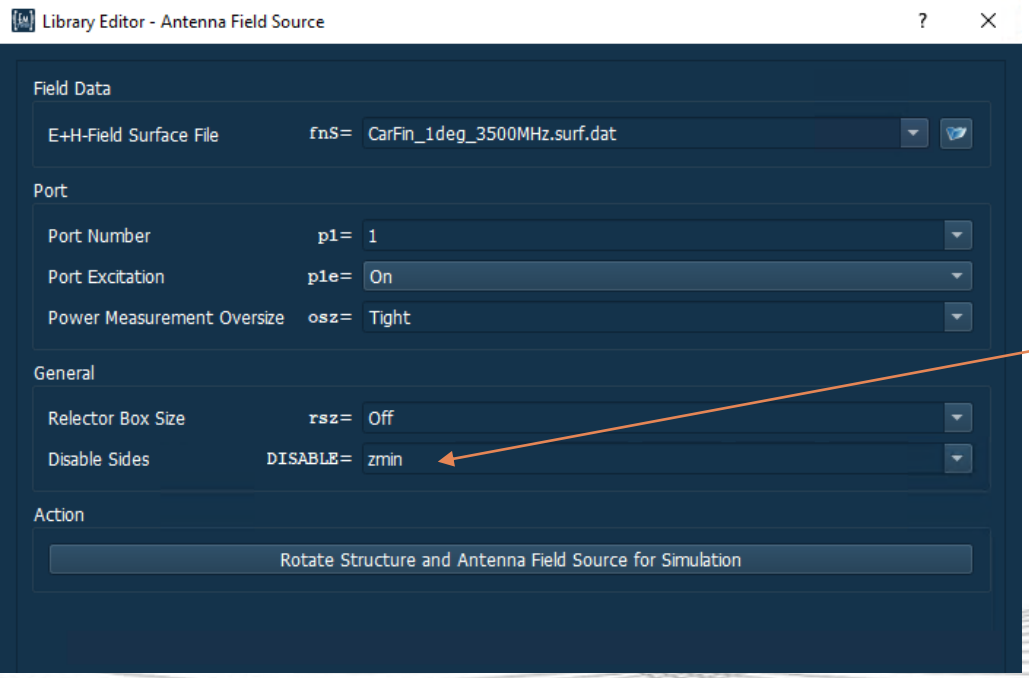


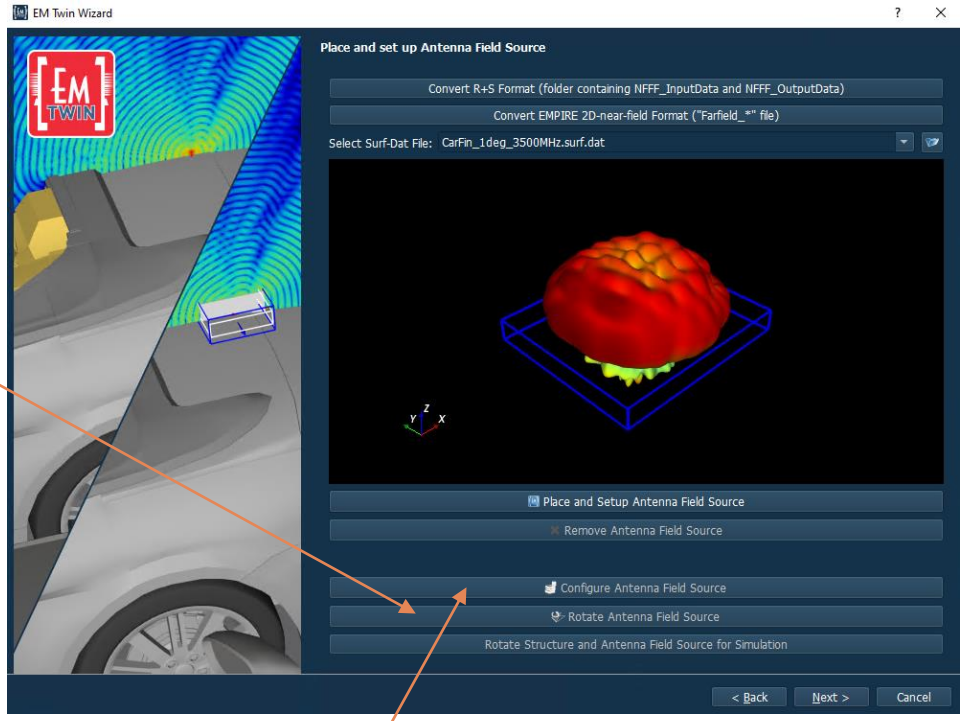


Within the digital antenna twin field source placement, the u-direction corresponds to the x-direction in the measurement (v corresponds to y and w to z).
As the sharkfin module should also be facing forward when using the antenna digital twin source, the u-direction must face forward. By picking a point the w direction is pointing normal to the surface while u and v are not fixed. If u is not parallel to x the Antenna Field Source can be rotated.

Wizard step 7: Field source placement

- If u vector is not aligned with x:
- Select ‘Rotate Antenna Field Source’
- Keep w as rotation axis
- Enter a rotation angle so that u is pointing to front of truck
- Press OK





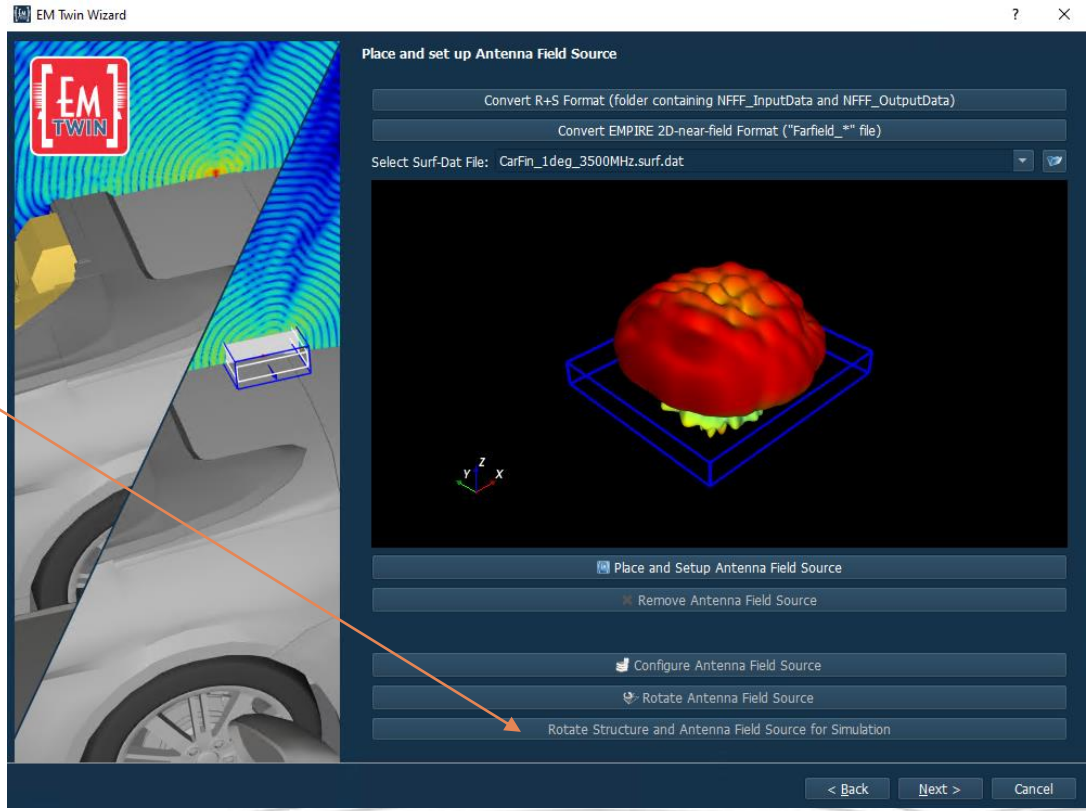
- Select ‘Configure Antenna Field Source’
- Choose General -> Disable Sides: zmin
- Press OK

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

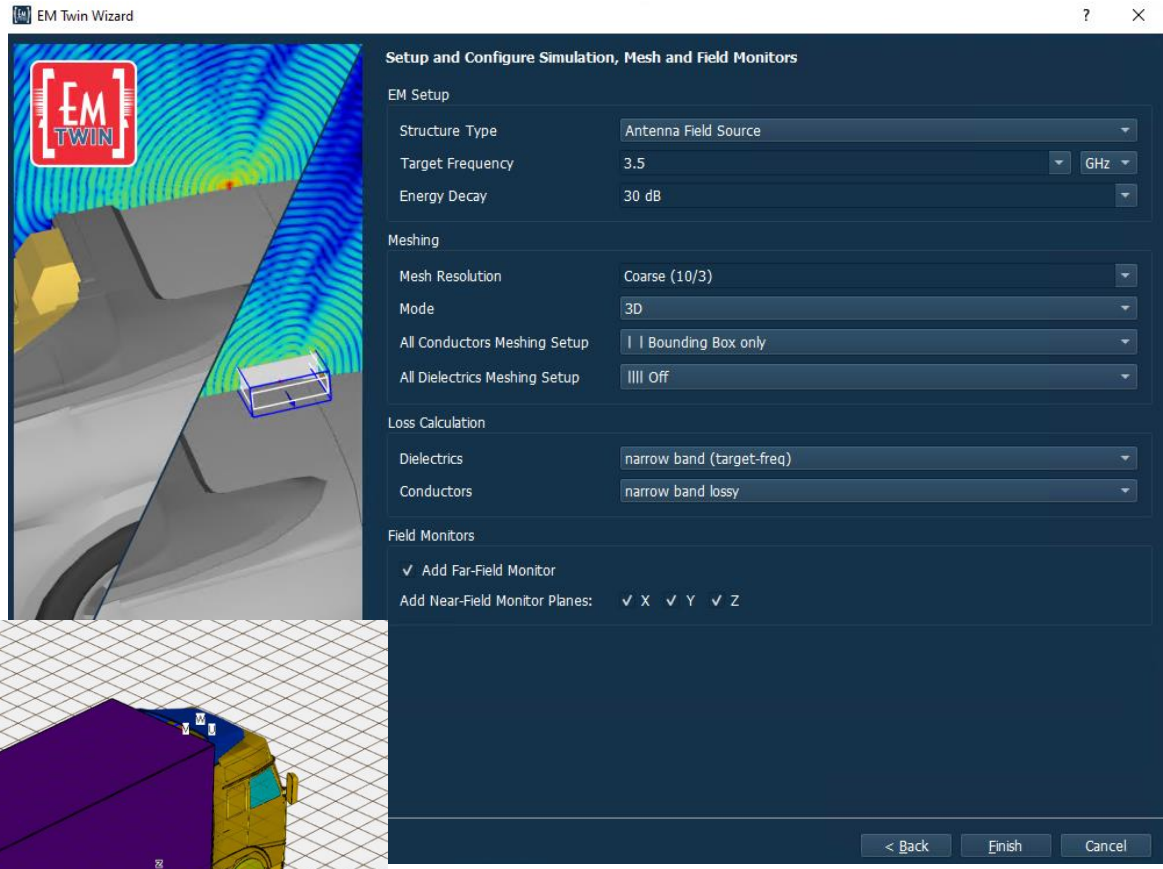
Radiating field sources are box-shaped objects that need to be properly aligned with the Cartesian coordinate systems.
This is usually not the case as the field source is aligned with the normal vector of the roof surface

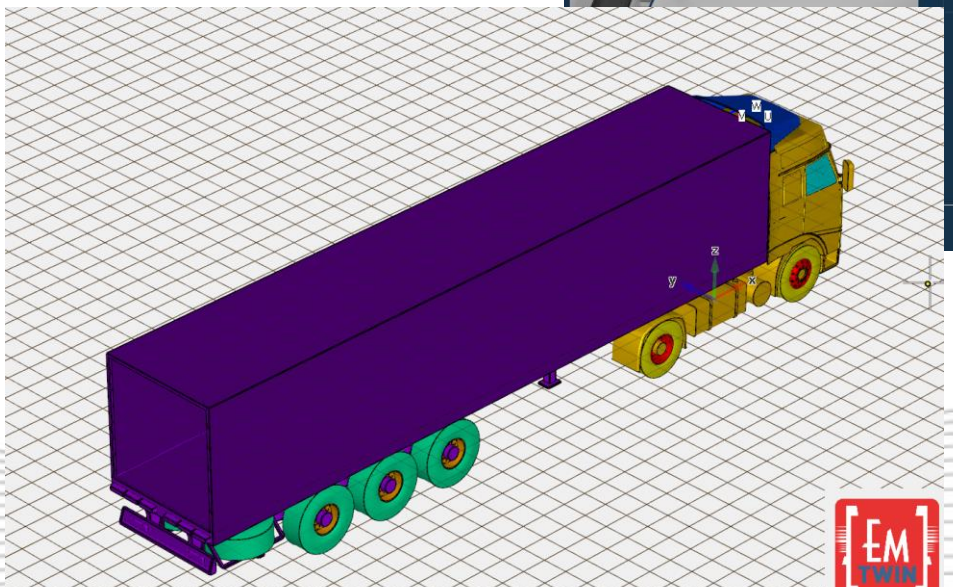
- Click on ‘Rotate Structure and Antenna Field Source for Simulation’
- Click OK if message “No Rotation is required”
- The Field source is now properly aligned with the car and the mesh for simulation
- Click Next



Wizard step 9: Simulation set-up

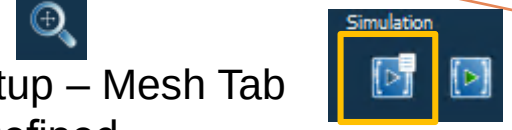
- The mesh setting has an influence on the accuracy of the results
- Option Coarse (10/3) is a good starting point for initial investigations
- Depending on the user's available computing power, finer meshes can be selected later
- Click Finish to terminate the Wizard and return to 3D Design
- Switch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

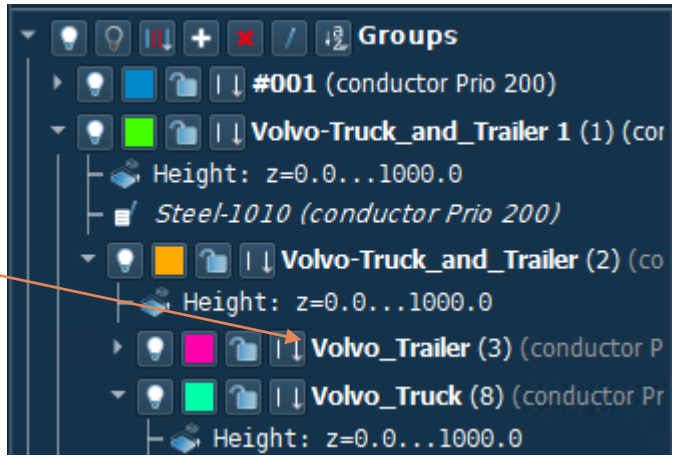


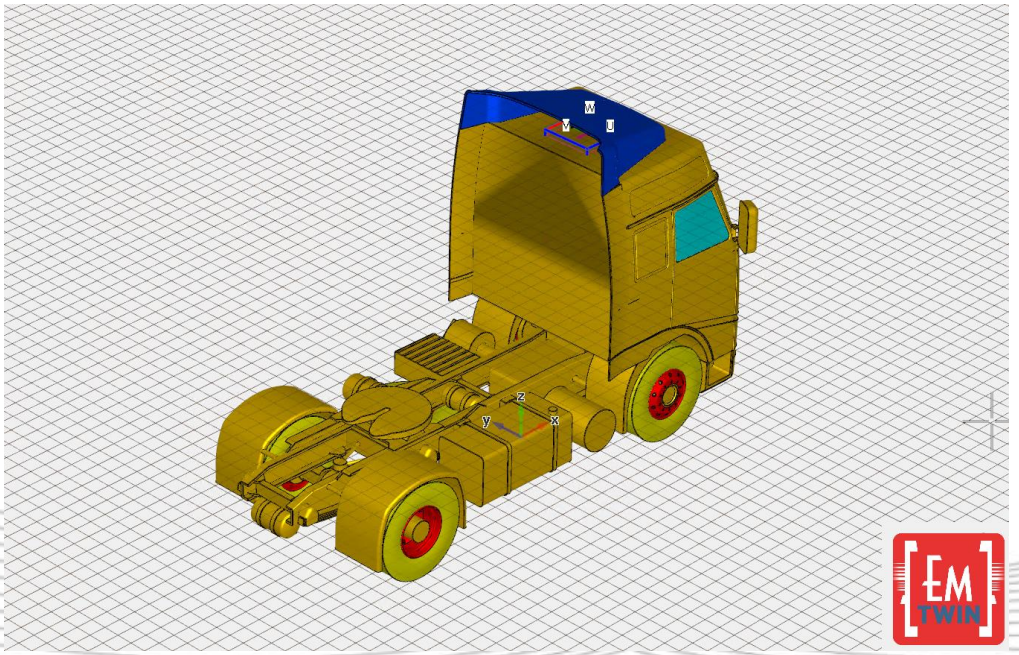


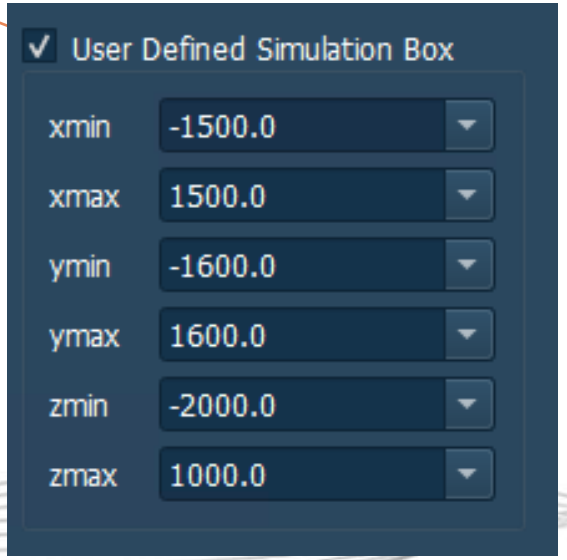
Wizard step 10: Model reduction

- Open Group Volvo-Truck…
- Open Subgroup Volvo-Truck…
- Right click on Volvo_Trailer
- Select Delete, Yes
- Zoom extents
- Click Simulation Setup – Mesh Tab
- Checkmark “User Defined Simulation Box” and enter values
- OK



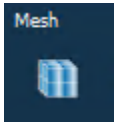


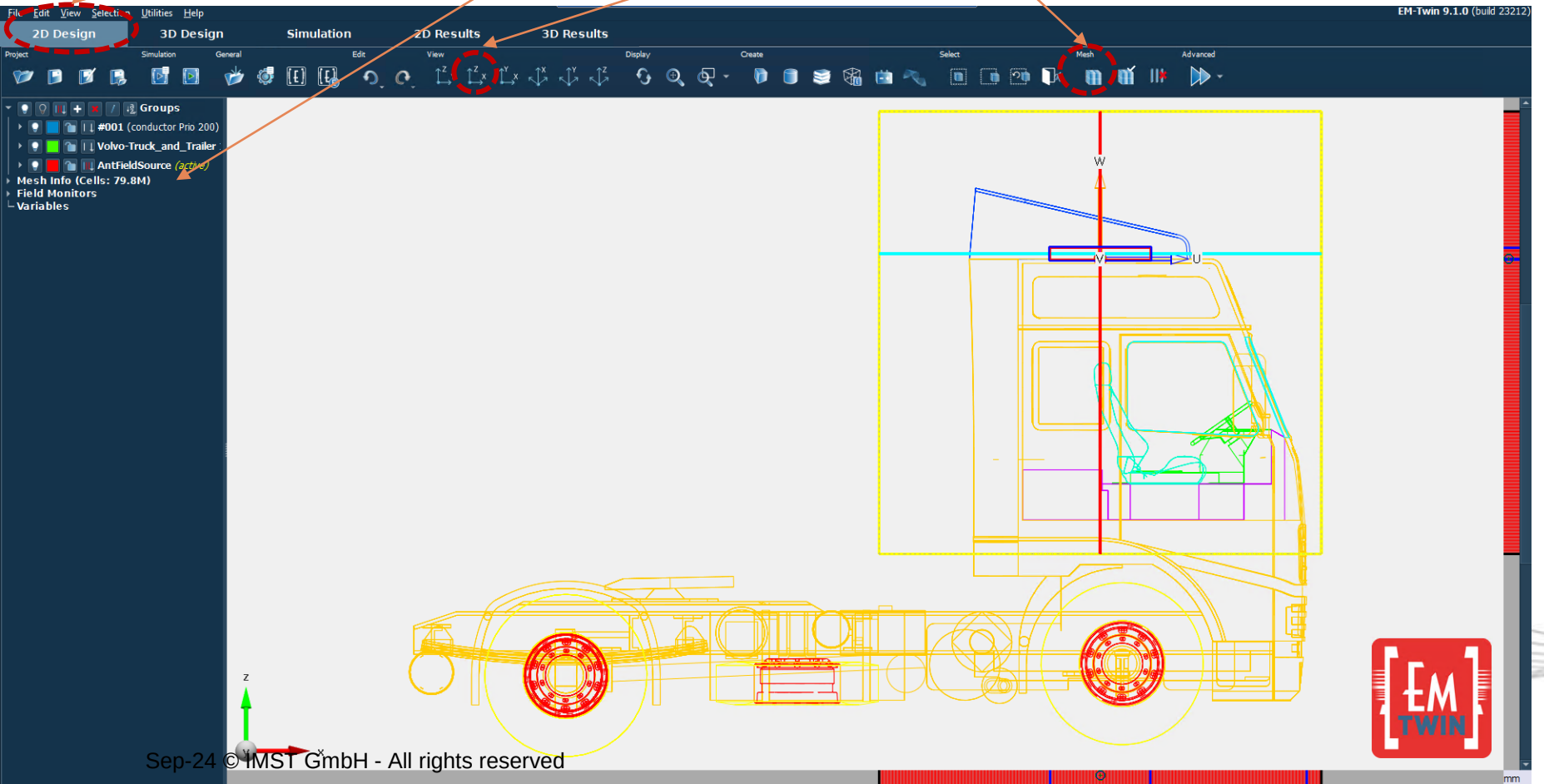




Wizard step 11: Model discretization

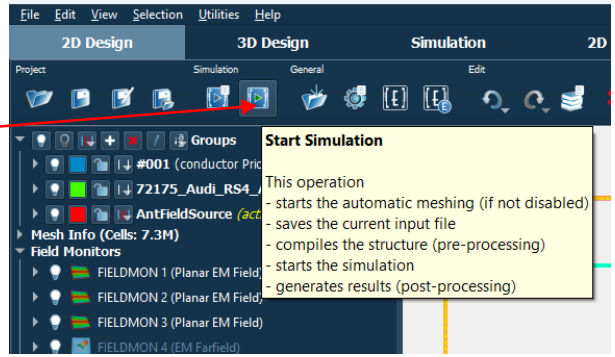
- Click on Create Mesh to discretize the model
- The 10/3 setting leads to hexahedral cells roughly 7 mm in size
- Model complexity is approx. 80 Mcells
- Switch to 2D Design mode and Select Front view

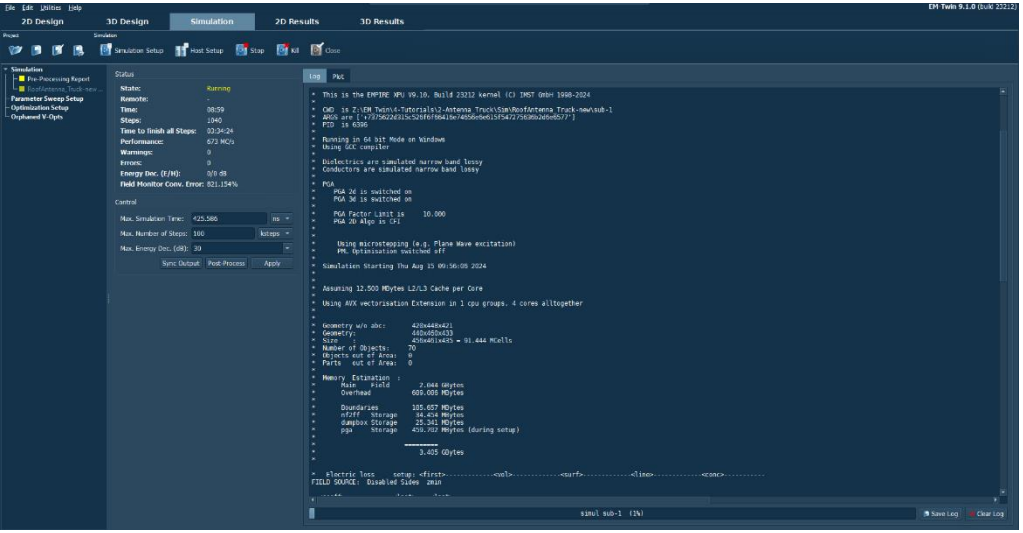




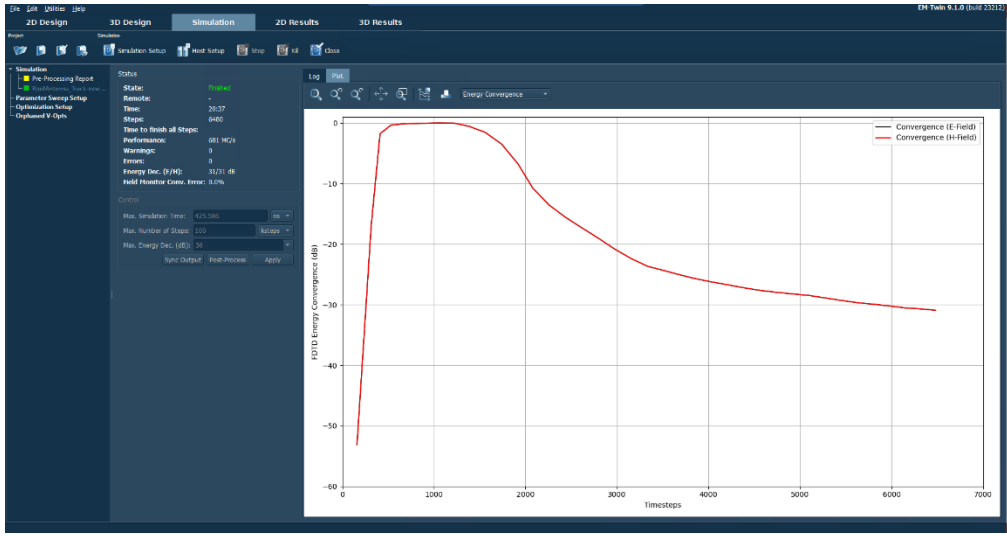
Step 11: Simulation

1. Press Icon Start Simulation
2. Press OK





Simulation log output at startup

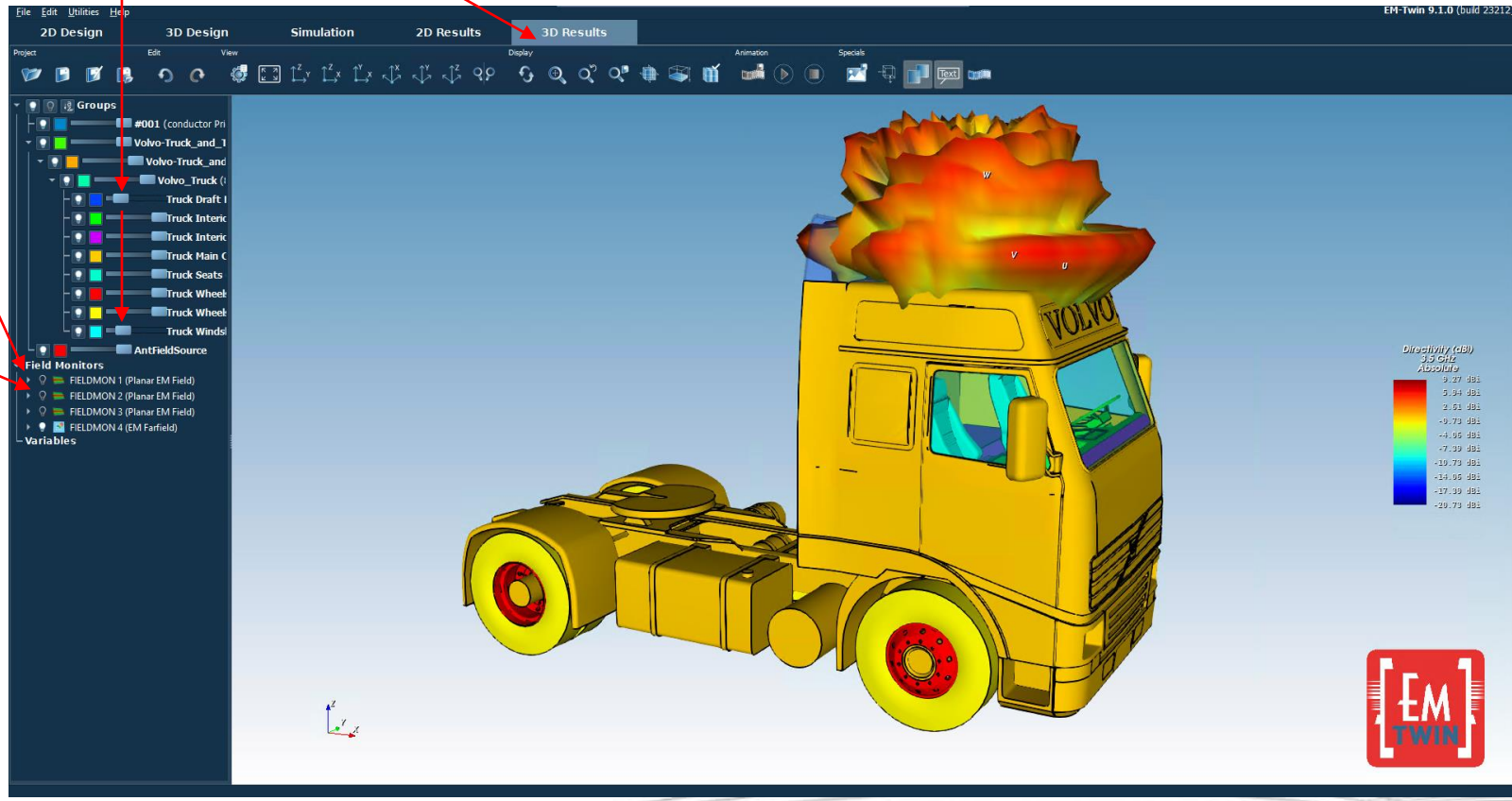


Energy convergence shown during simulation

Simulation stopped after 30 dB energy decay reached, postprocessing started

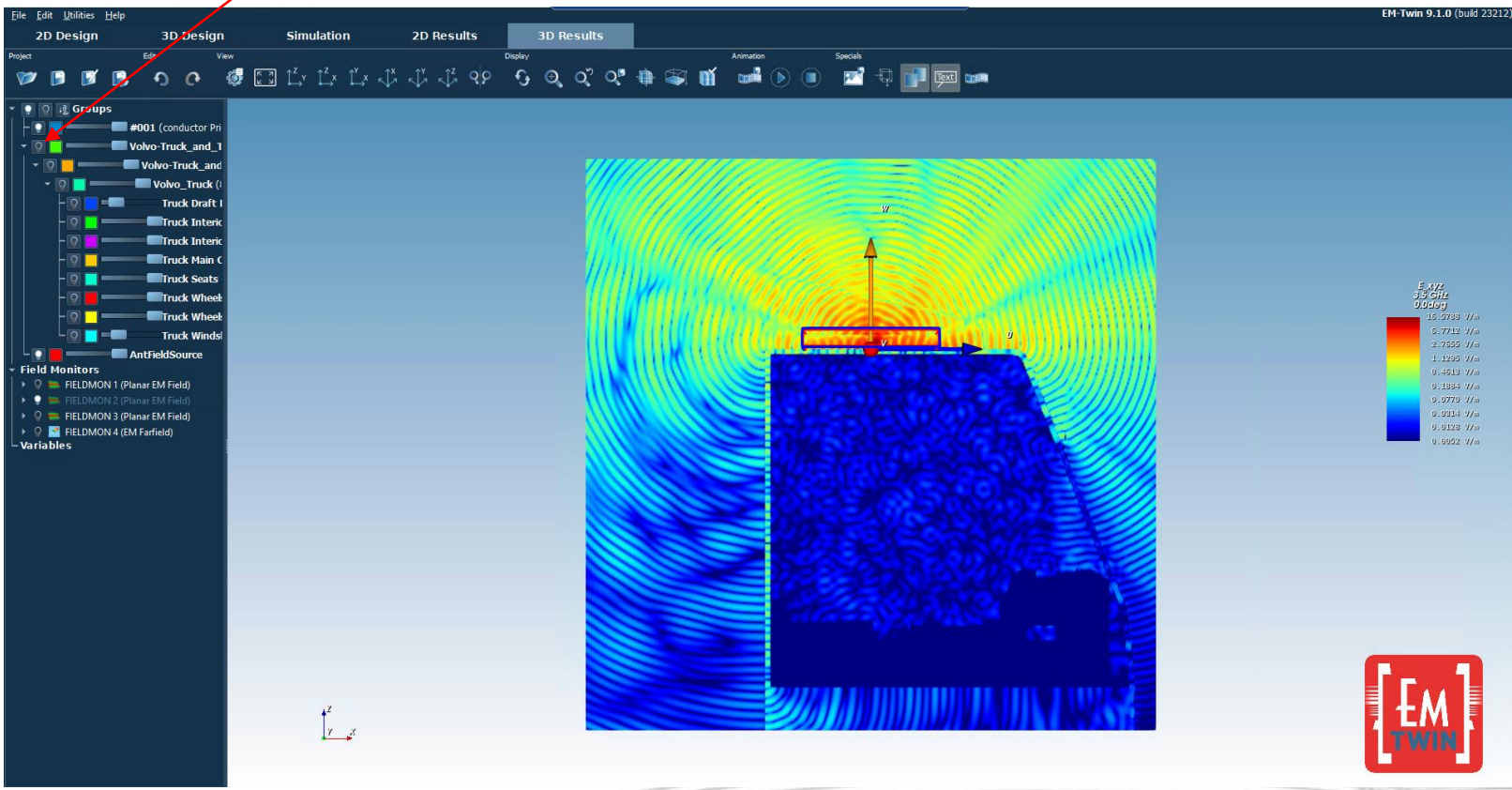
3D Results: Far-field pattern

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



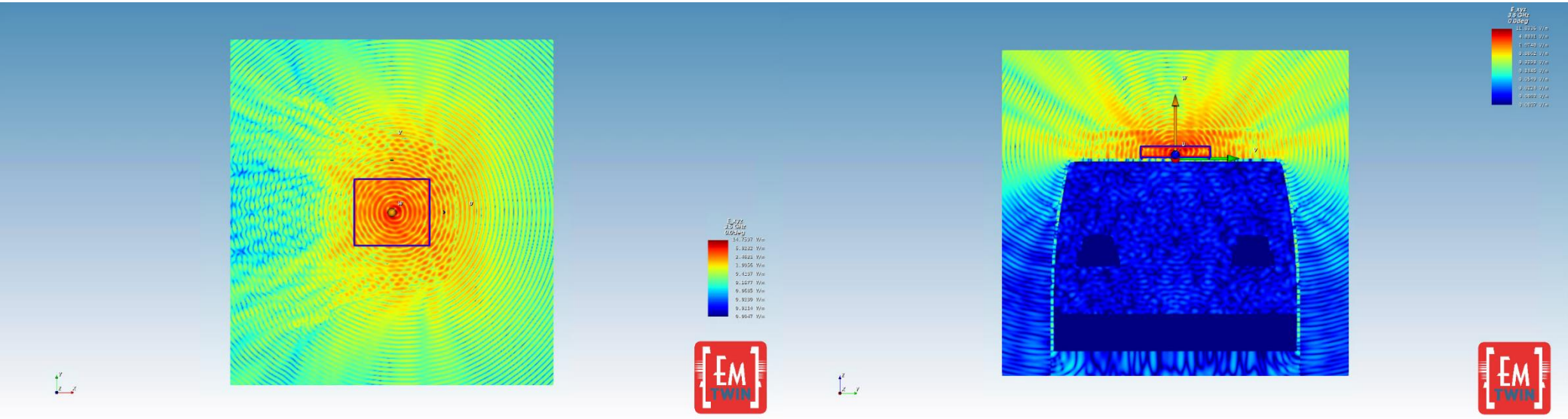
3D Results: Near-field distribution

1. Turn off EM Farfield, turn off group Volvo-Truck…
2. Turn on Field Monitor 2
3. Edit Field Monitor 2
4. Animation Loop Type: Real
5. Front View



3D Results: Near-field distribution

1. Turn on Field Monitor 3 (Animation Type: Real)
2. Top View
3. Turn on Field Monitor 1 (Animation Type: Real)
4. Side View



Top view

Side view