EM-Twin Automotive Tutorial Antenna placement on the Roof of a Truck

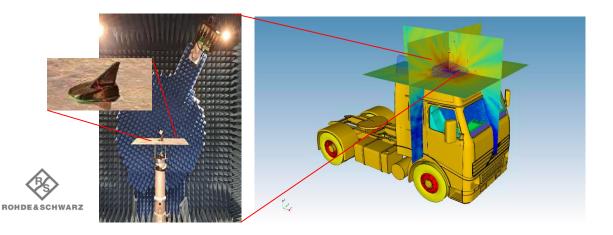


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Overview

- 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





I M

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

New Project	Open Project	Examples	Template	es Tutorials	
General	open rioject		Getting Started		Application Notes
Structure Type	Standard				Import 3D CAD data into Empire XPU
Solvers	EM		EMPIRE	Open the Getting Started Manual	
Drawing Unit	1	🗩 mm 👻			Export layout data from Empire XPU
Frequency			Empire	Open the Full Manual	🔙 Import layout data into Empire XPU
End Frequency	20	▼ GHz ▼			🚾 Calculate far field radiation patterns
Target Frequency	10	▼ GHz ▼	Visit our Empir	re Youtube Channel	Far Field visualization
Dielectrics	lossless				Meshing and Discretisation
Conductors	lossless				
					Parametric objects and values
EM-Twin 9.1.0 - c	raft_002.emt (New	Project)			Variation and optimization of parameterized mode
<u> F</u> ile <u>E</u> dit <u>V</u>	iew <u>S</u> electio	n <u>U</u> tilities	<u>H</u> elp		Distribute different simulation jobs to servers
2D D	esign	3	D Desig		DFT: Signal Resonance Estimation
roject		Simulation	Ge		📴 Project migration from CST to Empire XPU
		, 💽			🚾 Project migration from HFSS to Empire XPU
r 💡 🖗 🛄	+ Save As		-		🔤 Filter Synthesis Template and full wave analysis
•		urrent state	to a new		🚾 Thermal simulation
	project				🦉 Conformal Dielectric
					🚾 Multi PC Solver



Wizard step 1: CAD Import

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- 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

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rour preferred CAD Import Method: CAD Import with Large CAD Import Tool Next / Skip Import Step CAD Converter Options - Step ? × General Faceting Options Wire Radius Off • Surface Tolerance Auto • Healing Options Remove Silver Faces Off • Stitch Faces Off • Stitch Faces Off • Close small gaps Off • Other Options Group depth As Original Auto Close Log Window Create Detailed Log Files	iport				
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Other Options Group depth As Original Auto Close Log Window		Stitch Faces	Off		
Group depth As Original Auto Close Log Window		Close small gaps	Off		
Group depth As Original Auto Close Log Window		Other Options			
Auto Close Log Window			As Original		
Create Detailed Log Files					
		Create Detailed Lo	g Files		



Wizard step 2: Conductor assignment



 Double click on Physical Property of Volvo-Truck... parent group and change to Steel:

	;1.	📓 Property Editor - Conductor				
 Select Database Select Steel-1010 Press OK 		 Material Property Dielectric Conductor Absorber Advanced Advanced Material Debye Material Drude/Plasma Material Gabriel Material Conformal Dielectric Metal Sheet Stack Material Scripts Material Script Drude/Plasma Script 	General Database Info Name Alloy Alloy Aluminum Copper General Metal Steel Cast-Iron Iron-Element Steel-1008 Steel-1010 Steel-Stainless VAC Water Water	 Conductivity (A/V/m) 1.500e+06 1.030e+07 7.6900e+06 6.9930e+06 1.100e+06 	Thermal Conductivity 55.0 80.4 59.5 65.2 16.0	User Dat

The Physical property of the top group is inherited to all Sub-groups.

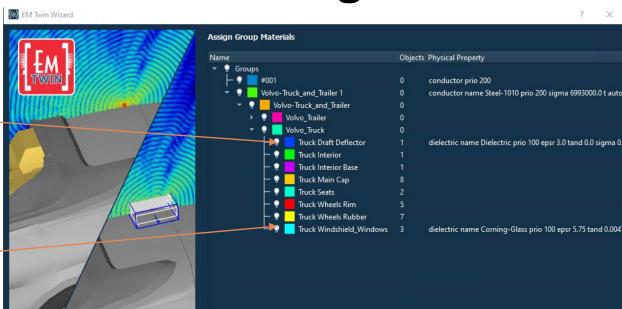
This property is changed from PEC (default) to steel.



Wizard step 3: Dielectric assignment

💷 Property Editor - Dielectr

- 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



Conductor	Name	Permittivity	Loss Tangent, tan(ò)	Thermal Conductivity	User Database
Absorber	Arlon				
Advanced	▼ Common				
- Advanced Material	Air	1.00058986		0.026	
– Debye Material	Alumina	9.4	4.00E-04	30	
Drude/Plasma Material	Alumina-(99.5%)	9.90000	1.00000e-04	30	
Meta Material	Alumina-92-pct	9.2	8.00E-03	20.0	
Gabriel Material	Alumina-96-pct	9.4	6.00E-03	24.7	
	Aluminium-Nitride-AlN	8.8	3.00E-04	285	
Metal Sheet Stack	Bakelite	4.80000	0.00000e+00		
 Material Scripts 	Beryllia	6.5	4.00E-04	280	
Material Script	Bone	12.66100	0.00000e+00		
Drude/Plasma Script	Brain	38.11100	0.00000e+00		
cuit Property	CEM-1	4.40000	3.00000e-02		
ermal Property	СЕМ-3	3.90000	2.50000e-02		
	Corning-Glass	5.75	4.70E-03	1.22	
sh Property	Diamond	5.68000	0.00000e+00		
vanced Property		4.9	2.50E-02	0.256	



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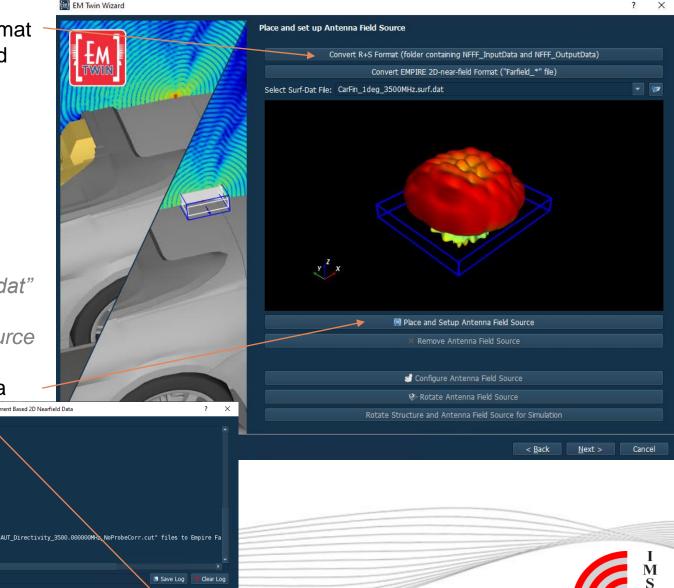


Wizard step 4: Create & place source

- 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

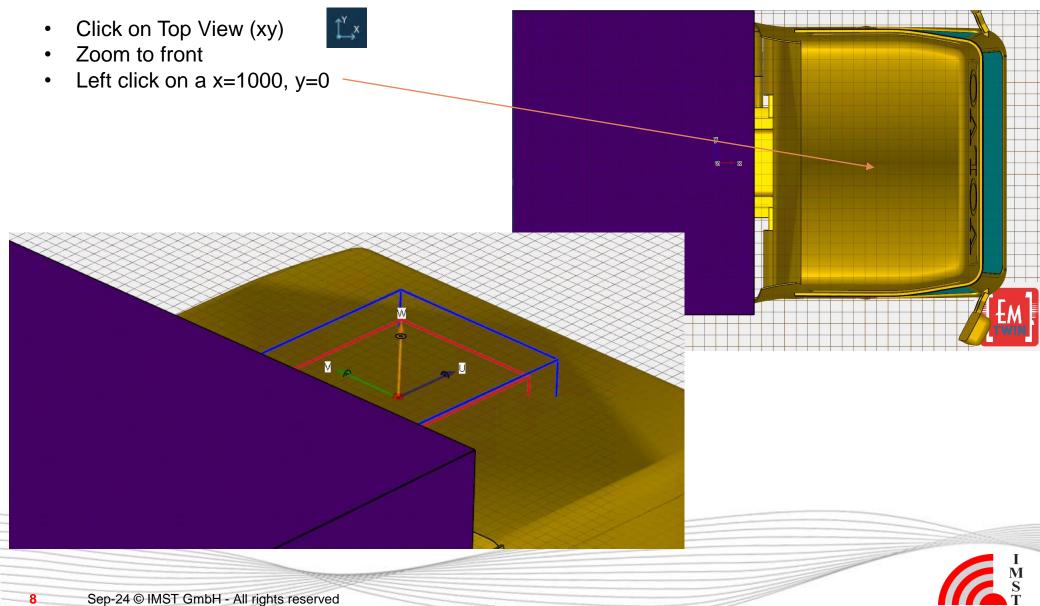
 Click "Place and Setup Antenna Field Source"



Finishe



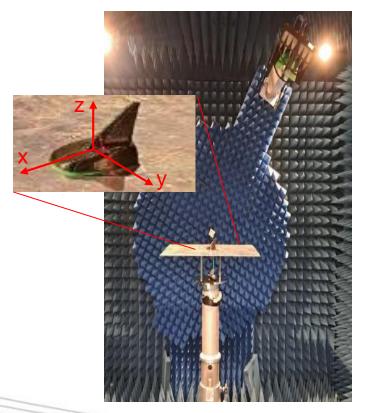
Wizard step 5: Field source placement

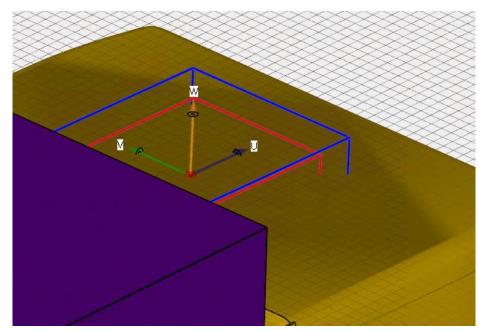




Wizard step 6: Field source placement

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 udirection 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.



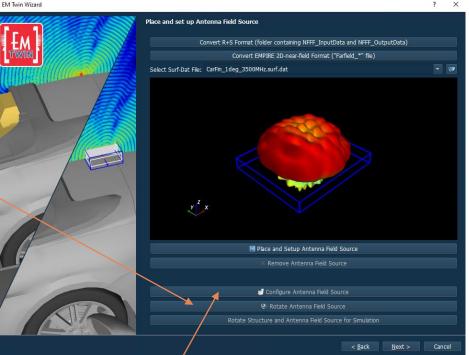


Wizard step 7: Field source placement

- 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

10

[£∗	Library Editor - Antenna Field Sou	irce		?	×
	Field Data				
	E+H-Field Surface File	fnS=	CarFin_1deg_3500MHz.surf.dat		1
	Port				
	Port Number	p1=	1		
	Port Excitation	p1e=	On		
	Power Measurement Oversize	osz=	Tight		
	General				
	Relector Box Size	rsz=	Off		
	Disable Sides DIS	ABLE=	zmin		
	Action				
	Ro	tate St	ucture and Antenna Field Source for Simulation		



- 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



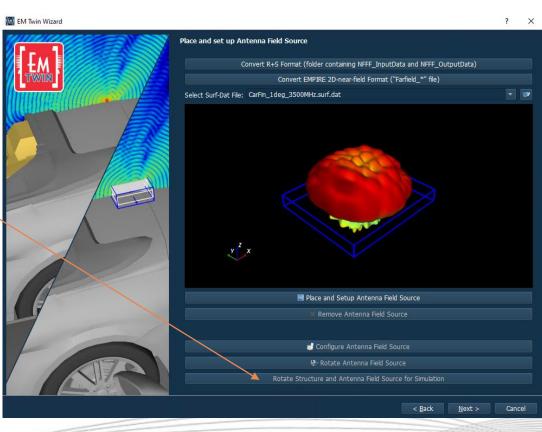
Wizard step 8: Structure rotation for simulation



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

EM Twin Wizar			
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1			

		? ×
etup and Configure Simulatio	n, Mesh and Field Monitors	
M Setup		
Structure Type	Antenna Field Source	
Target Frequency	3.5	GHz 👻
Energy Decay	30 dB	
eshing		
Mesh Resolution	Coarse (10/3)	
Mode		
All Conductors Meshing Setup	Bounding Box only	
All Dielectrics Meshing Setup	IIII Off	
oss Calculation		
Dielectrics	narrow band (target-freq)	
Conductors	narrow band lossy	
eld Monitors		
✓ Add Far-Field Monitor		
Add Near-Field Monitor Planes:	✓ X ✓ Y ✓ Z	







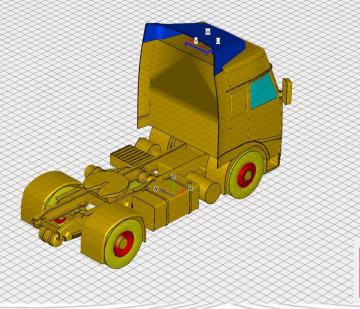
Wizard step 10: Model reduction

- 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

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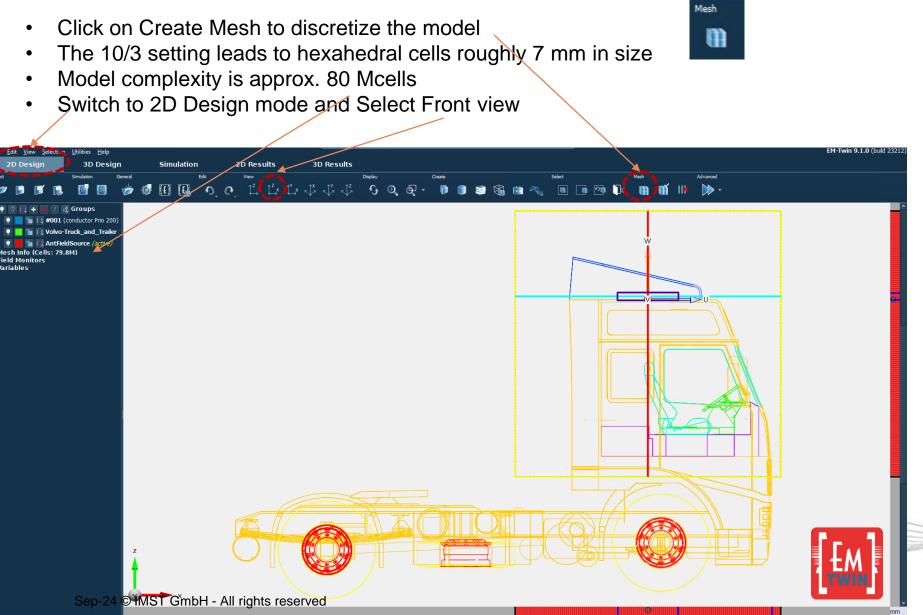
Ð

✓ User Defined Simulation Box					
xmin	-1500.0	•			
xmax	1500.0	•			
ymin	-1600.0	•			
ymax	1600.0	•			
zmin	-2000.0	•			
zmax	1000.0	-			



Wizard step 11: Model discretization





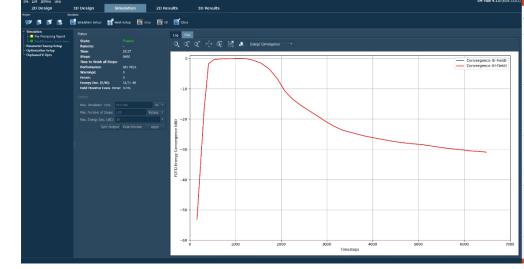


Step 11: Simulation

- 1. Press Icon Start Simulation
- 2. Press OK

<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>S</u> election	<u>U</u> tilities <u>H</u> elp			
2D Design	3D Desig	n	Simulation	2D
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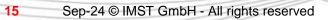
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		* * FIELD SOURCE: D:	3.455 Gytes s see of the set of	
			simul sub-1 (1%)	



Simulation log output at startup

Energy convergence shown during simulation

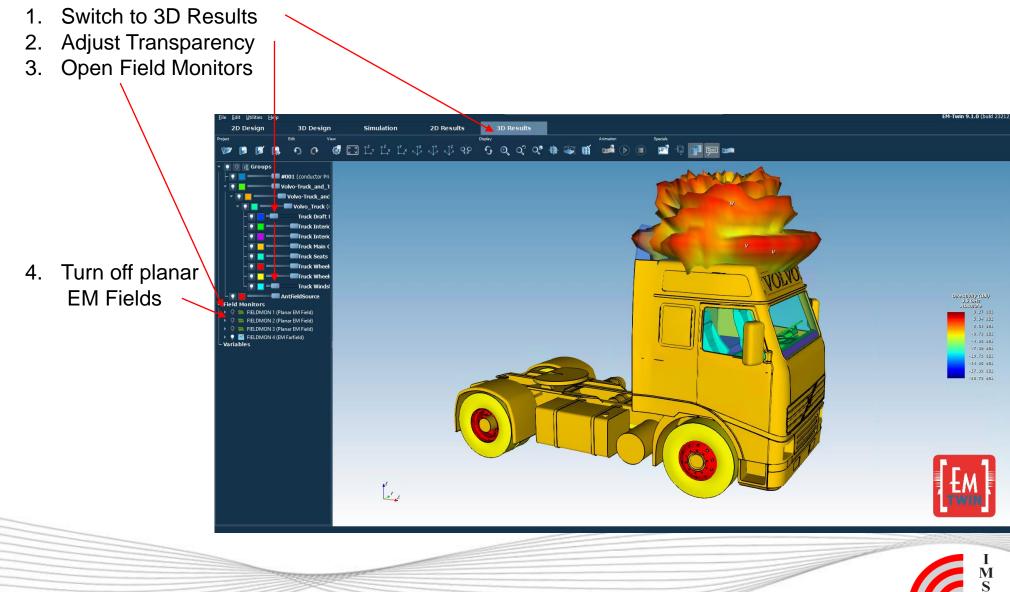
Simulation stopped after 30 dB energy decay reached, postprocessing started







3D Results: Far-field pattern

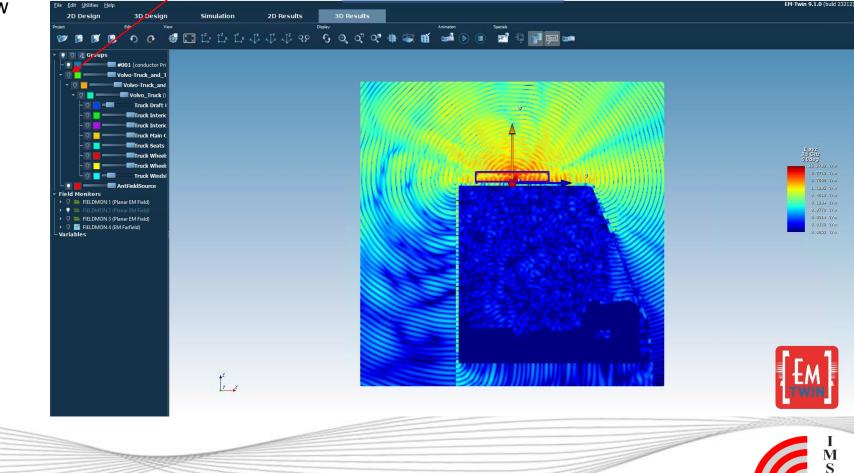




3D Results: Near-field distribution

- 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

