



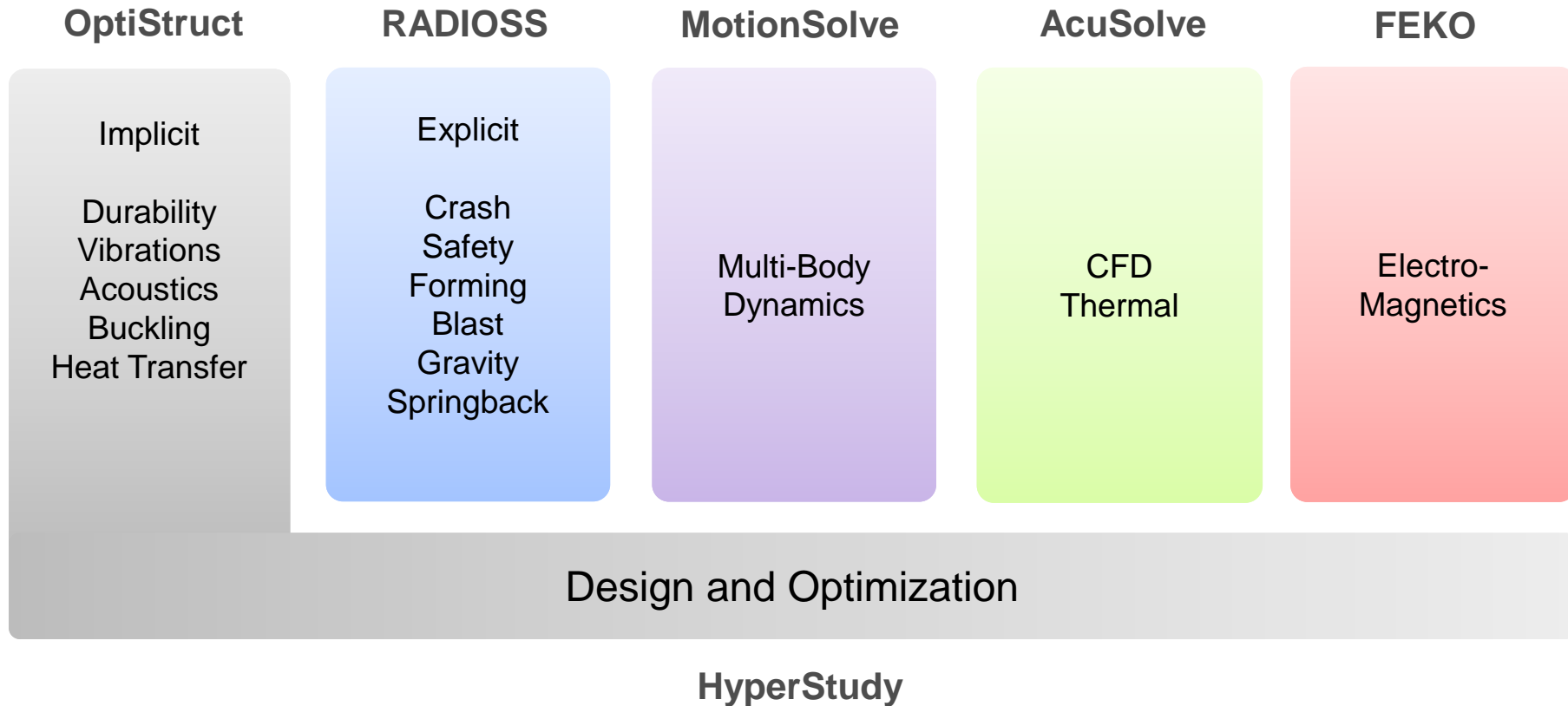
Boosting HyperWorks® Further with Electromagnetic Simulation

Dr Jordi Soler
Director of Business Development
Electromagnetic Solutions
jsoler@altair.com

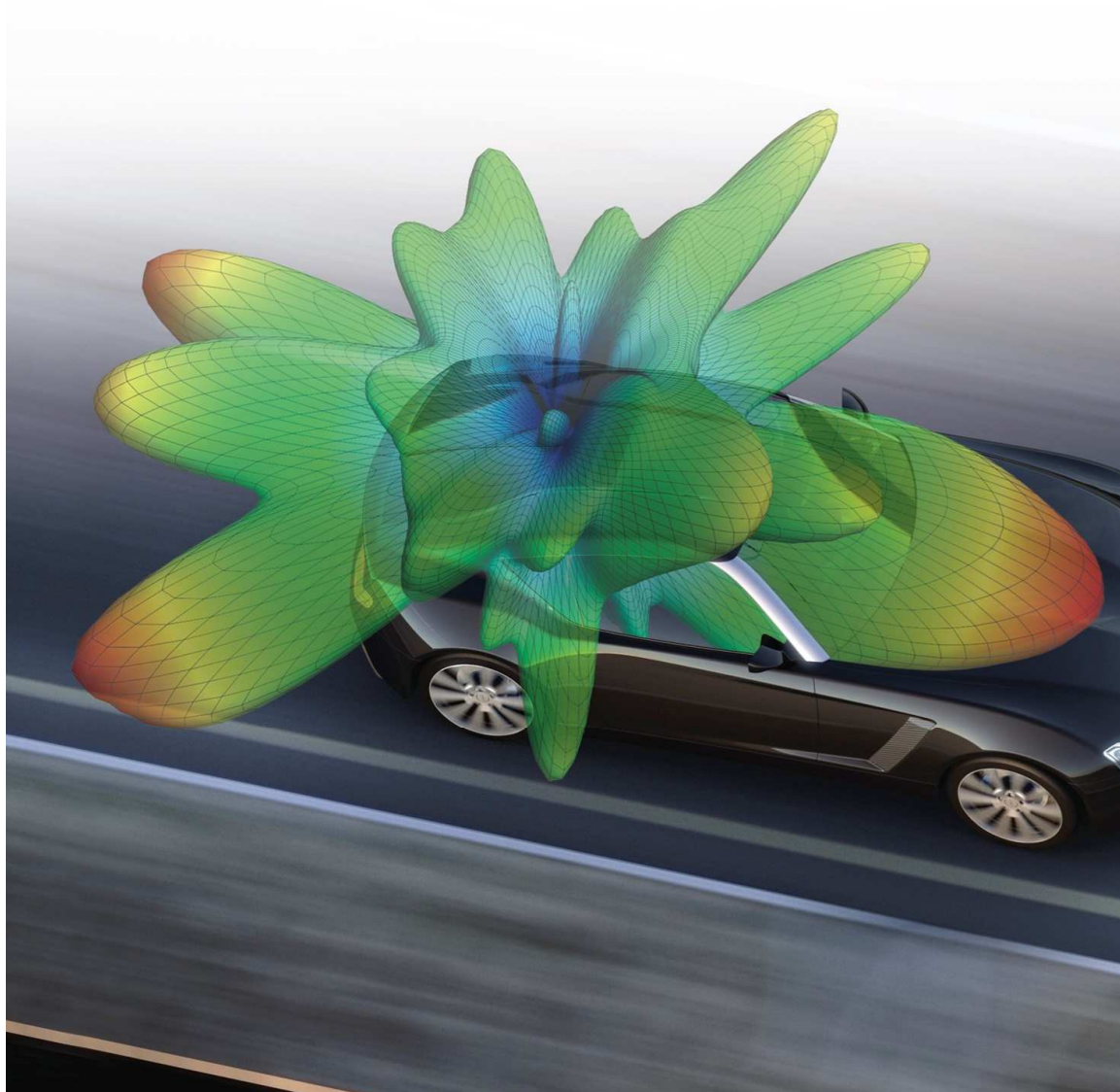


July 7, 2015

Altair Solver Brands



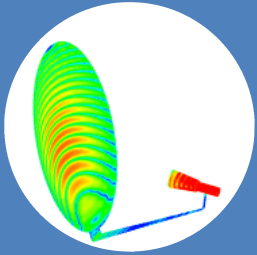
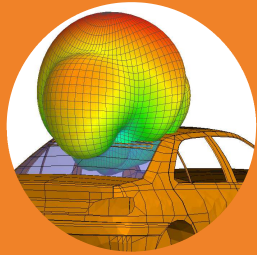
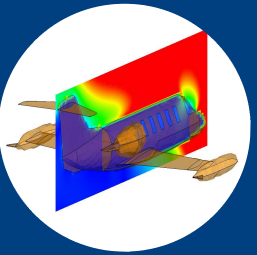
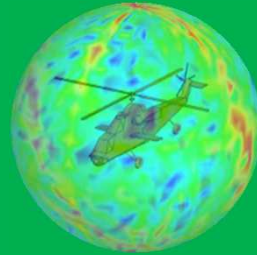
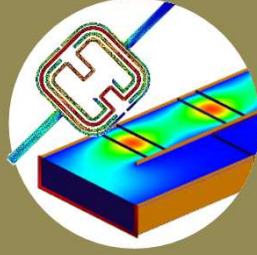
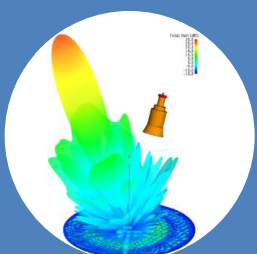
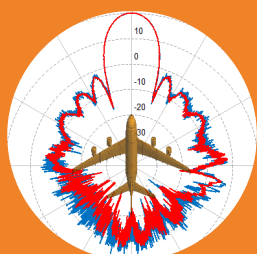

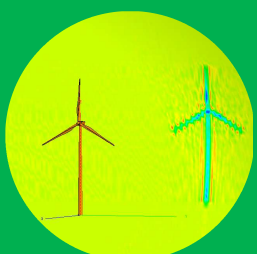
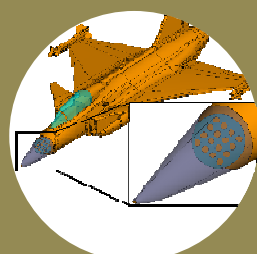
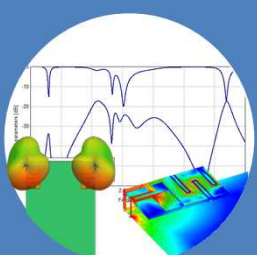
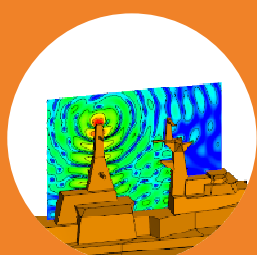
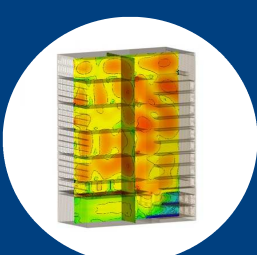
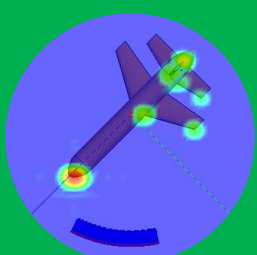
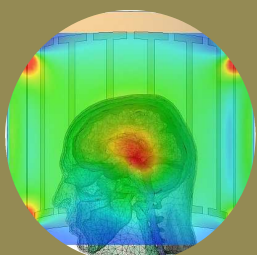
Introducing FEKO



Electromagnetic simulation

Altair FEKO is a leading comprehensive electromagnetic (EM) analysis software suite, widely used in many industries and built on state of the art computational EM (CEM) techniques, to provide users with software that can solve a broad range of electromagnetic problems.

FEKO Key Applications

Antenna Design	Antenna Placement	Electromagnetic Compatibility (EMC)	Scattering	Others
				
				
				

Multiphysics Analysis and Optimization

Main FEKO Industry Sectors



Selection of FEKO Commercial Customers

DAIMLER

NISSAN

DENSO

PSA PEUGEOT CITROËN

ARINC

 AleniaAeronautica
A Finmeccanica Company

 esa

 SAAB

 BLAUPUNKT

LOCKHEED MARTIN

BAE SYSTEMS

Gulfstream
A GENERAL DYNAMICS COMPANY

 SELEX

THALES

 BOEING



NORTHROP GRUMMAN

TOSHIBA

 BOSCH

MASPRO

TAI
TUSAŞ AEROSPACE INDUSTRIES INC.

Esterline CMC Electronics

 MOTOROLA

 YAZAKI



 EADS



 HIRSCHMANN
A BELDEN BRAND

Selection of FEKO Academic Customers

Japan Hokkaido University, Kyoto University, Nagasaki University, Nanzan University, National Defence Academy, Tokyo Institute of Technology, Tsukuba University, University of Tokyo, Yokohama National University, Waseda University, University of Toyama, and more.

Korea, Taiwan, China and Other Regions in APAC

Chung-Ang University of Korea, Chungbuk National University, Chungnam National University, Hanyang University, Hongik University, National Central University, National Changhua University of Education (NCUE), Taiwan, National Sun Yat-Sen University, National Taipei University of Technology, Tatung University, Beijing Institute of Technology, Beihang University, Harbin Institute of Technology, Harbin Engineering University, Nanjing University of Science & Technology, Wuhan University, Institute of Electronics - Chinese Academy of Sciences, and more.

Americas and EMEA

Arizona State University, Clemson University, Cologne University of Applied Sciences, Fachhochschule Aachen, Fachhochschule Augsburg, Georgia Institute of Technology, Johns Hopkins University, MIT Lincoln Laboratory, McMaster University, University of Illinois at Urbana Champaign, Chalmers University of Technology, ETH Zürich, Ohio State University, ElectroScience Laboratory, Oakland University, Pennsylvania State University, Polytecnico di Milano, Reykjavik University, Iceland, Royal Military College of Canada, and more



FEKO Origins and Altair

- **A bit of history:**

- Dr. Ulrich Jakobus starts developing core algorithms of FEKO in 1991 at the University of Stuttgart in Germany.
- Independently, in 1994 Dr. Frans Mayer and Dr. Gronum Smith started EMSS (company) in Stellenbosch (South Africa) to provide EM engineering services to local clients.
- They started collaborating in 1996 and in 2000 Dr. Jakobus joined EMSS full time.
- In 2014 FEKO operating worldwide and positioned as a global leading and growing EM simulation software suite in the market.

- FEKO joining Altair in May 2014

ALTAIR AND EMSS-S.A. CLOSE DEAL

Altair acquired 100 percent of EM Software & Systems – S.A. (Pty) Ltd and its international distributor offices in the United States, Germany, and China this month. This development adds the FEKO® solver to the HyperWorks® suite and strengthens the Altair simulation offering in the aerospace, automotive, and shipbuilding industries in particular, reflecting the commitment of the company to provide comprehensive, best-of-breed solutions to its customers. In addition, in-house electromagnetic expertise crossing multiple industries will enable the company's consulting arm, Altair ProductDesign, to take on more responsibility in customer engagements where this specialised applied engineering knowledge is required.

Altair HyperWorks contains a number of industry-leading solvers, including OptiStruct®, RADIOSS®, MotionSolve®, and AcuSolve®. The addition of FEKO will help to address coupled electromagnetic-thermal and electromagnetic-mechanical problems, among others.

"Electronics and communications technology are driving additional complexity into product development on an unprecedented scale, making computational electromagnetic simulation very important to many of our customers," said James R. Scapa, Chairman and

Chief Executive Officer of Altair Engineering, Inc. "We are extremely happy to welcome the expert knowledge base and cutting-edge technology of EMSS to the Altair family, and look forward to exciting future developments in both FEKO and complementary technologies for multiphysics simulation and design optimisation."

"The full integration of our business and technical teams within Altair's corporate culture has been truly a positive experience for both organisations and our employees," noted Dr Ulrich Jakobus, original author of FEKO, Director and FEKO Product Manager, EMSS. "The strategic alignment of FEKO's software development team within Altair is already driving an exciting technology roadmap for expanded electromagnetic offerings and new multi-physics solutions for our clients."

For more information on Altair, visit www.altair.com.



Dr Uwe Schramm (Altair Chief Technology Officer), Dr Ulrich Jakobus (FEKO Product Manager at the time, now Vice President—Electromagnetic Solutions at Altair), Mr James R. Scapa (Altair Chairman and CEO) and Dr Gronum Smith (Director of EMSS-S.A. at the time, now Country Manager at Altair (South Africa)) pictured at the official signing ceremony.

Motivations for Joining Altair

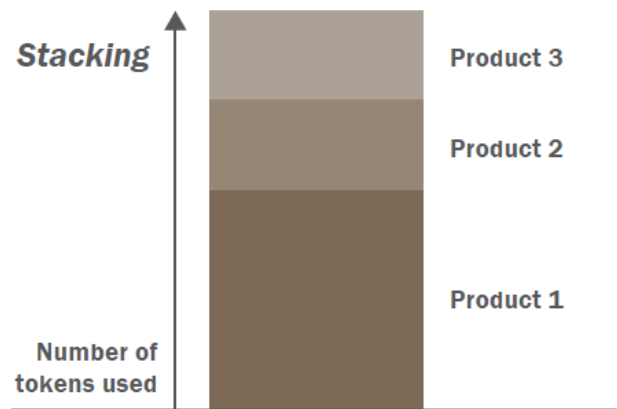
- **Multiphysics simulation**
- **Product development synergy**
- **Even bigger global presence and footprint**



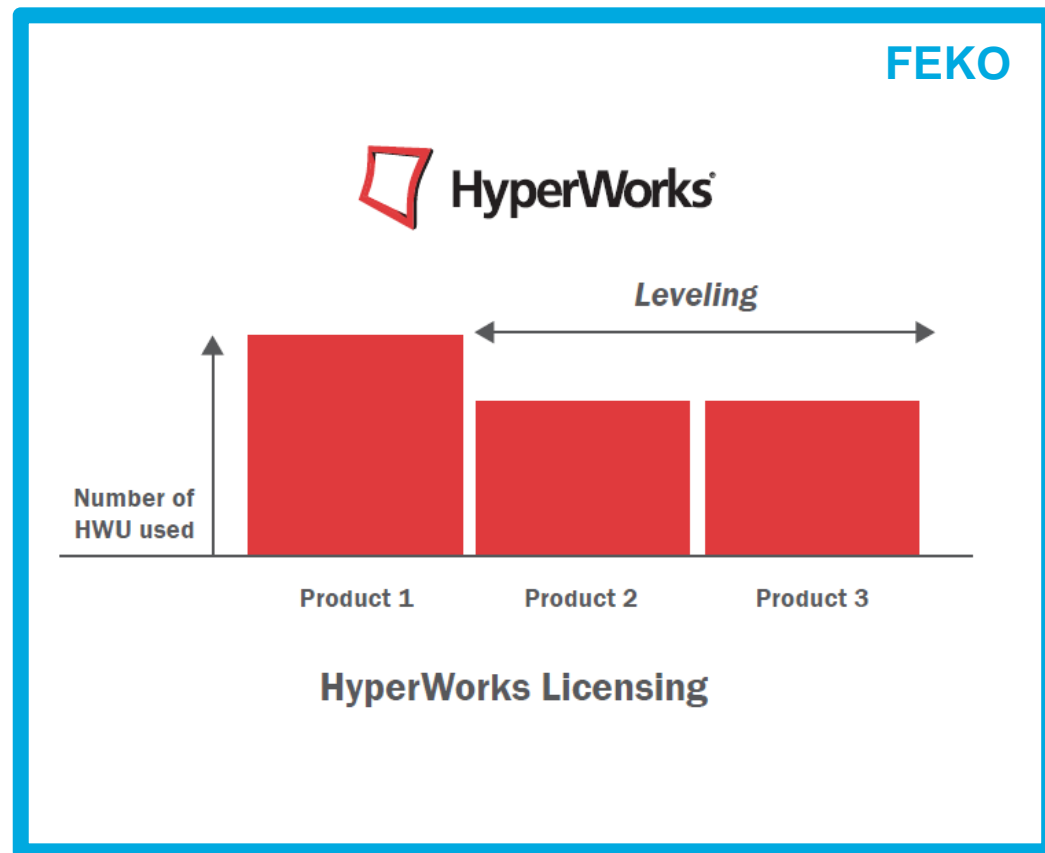
<http://www.altairhyperworks.com/feko>

Innovative License System

HyperWorks delivers exceptional **value** to customers maximizing flexibility and cost efficiency

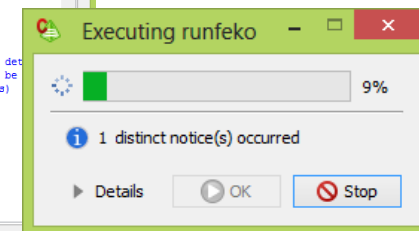
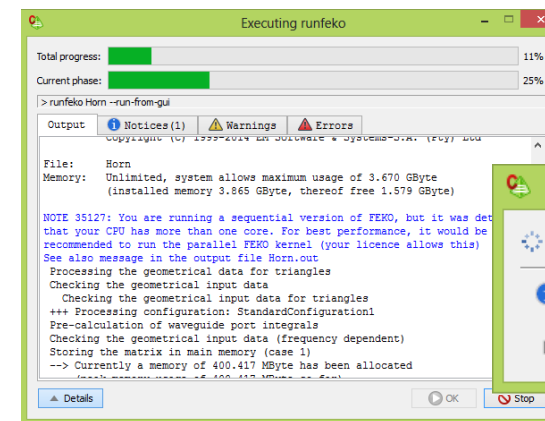
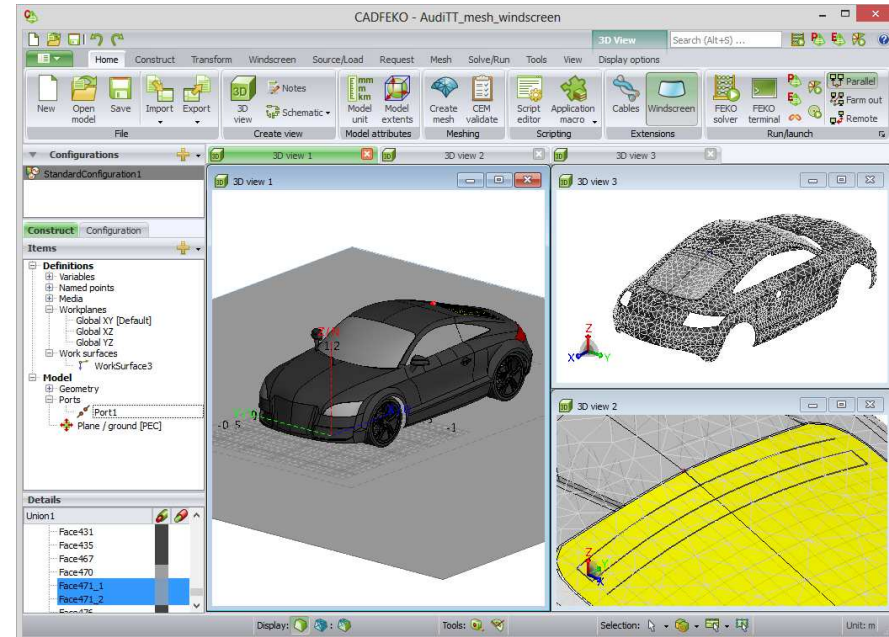
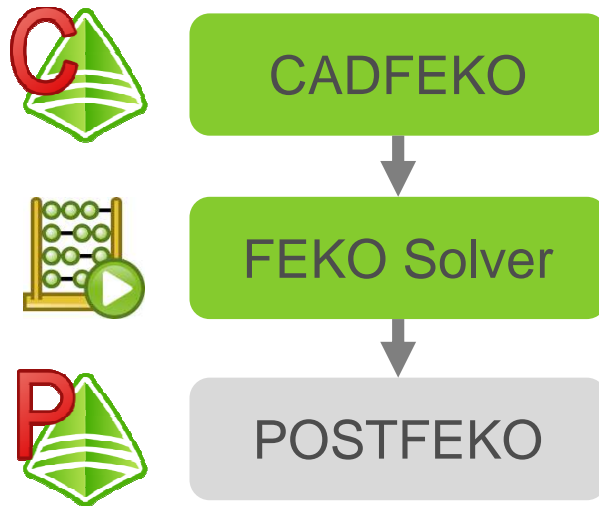


Traditional Software Licensing



HyperWorks Licensing

FEKO UI Components – CADFEKO and Solver



- **CADFEKO:** Model creation / import, definition, simulation and output specification
- **Solver:** Performs calculations

FEKO UI Components – POSTFEKO



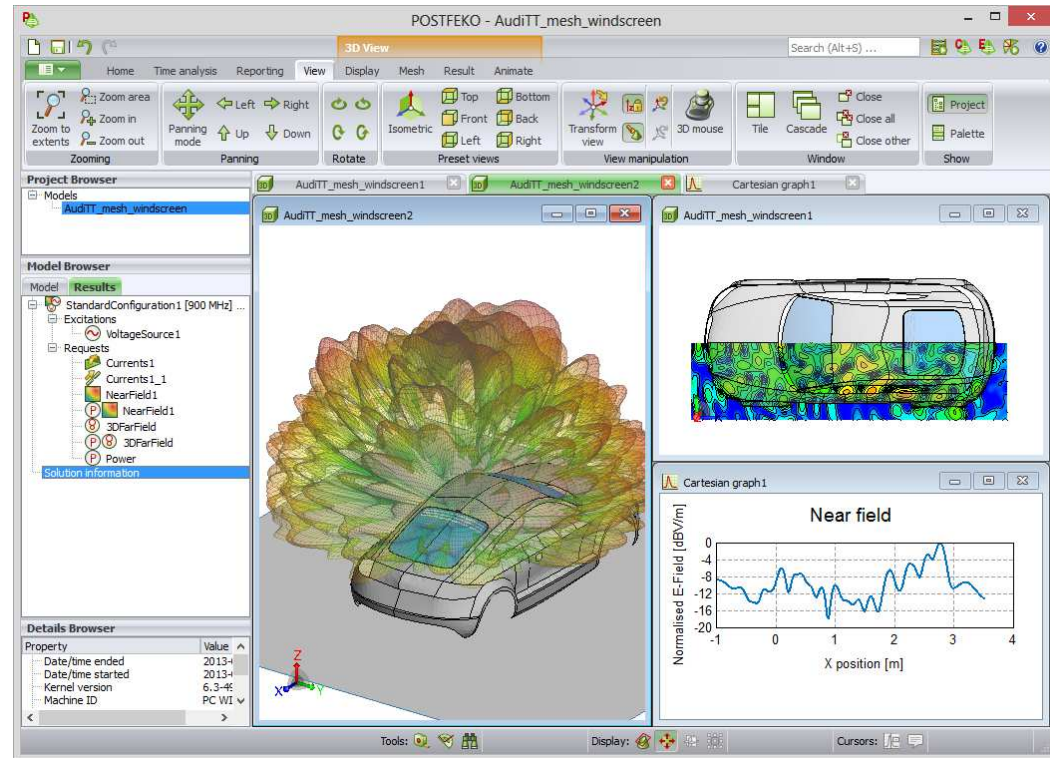
CADFEKO



FEKO Solver

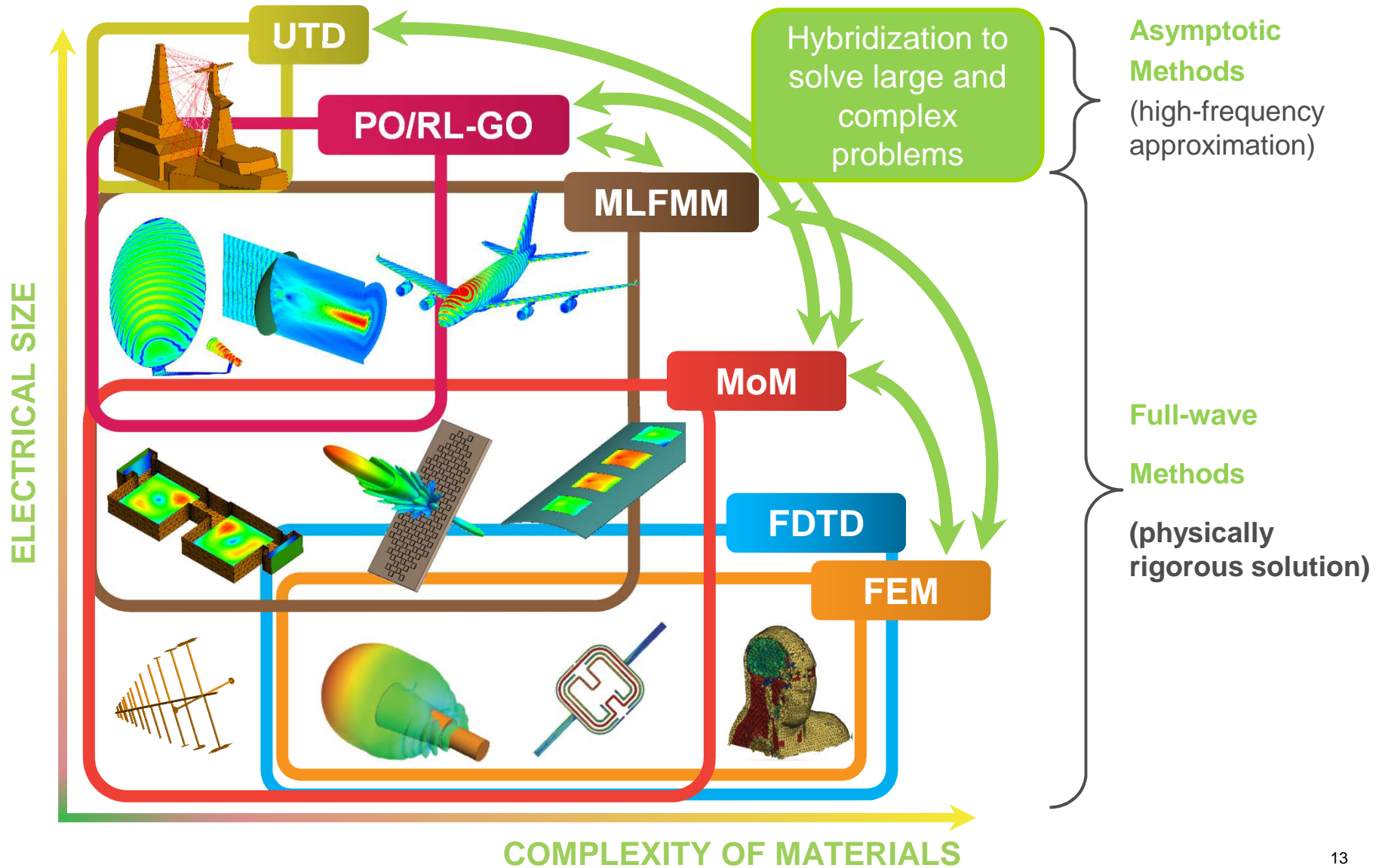


POSTFEKO



POSTFEKO: Post processing of simulation results

Solvers in FEKO – Simulation Map



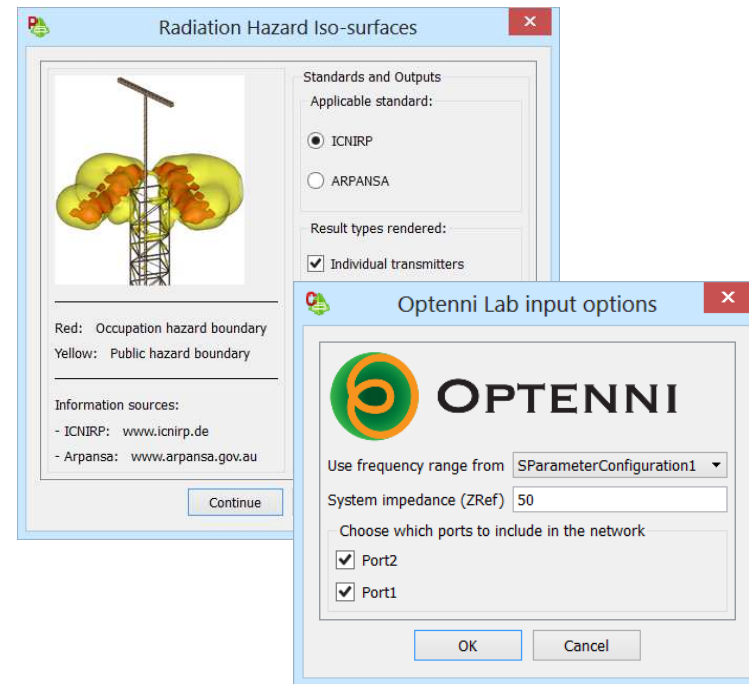
FEKO Productivity Features and HPC

- **FEKO has a set of key productivity features, including:**
 - Cable modelling fully integrated in CADFEKO
 - Windscreen antenna solution
 - Fast analysis of large and finite arrays using PBC and DGFM
 - Special materials, including anisotropic layers (e.g. composites)
 - Characteristics Mode Analysis (CMA)
- **HPC in FEKO includes:**
 - MPI-based parallelization for distributed memory systems
 - Shared memory parallelization based on OpenMP/MPI
 - GPU and multi-GPU support

Lua Scripting Tool in CADFEKO And POSTFEKO

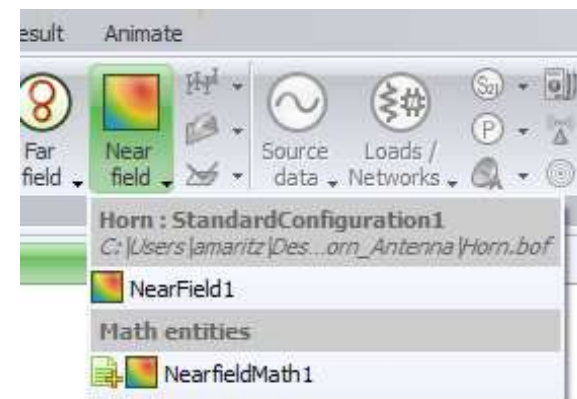
Application Macro scripts:

- Creation of customized dialogs to obtain user input
- Interact with external applications and the operating system.
- To be used as “plug-ins” that extend application functionality.
- General purpose “apps” available on FEKO website
- Full featured IDE for script editing and debugging



Math scripts:

- Used for advanced data processing (the output of a math script is a result that can be plotted on a view, exported or reused in other scripts).



Import and Export Filters

Import Geometry

- ACIS
- AutoCAD DXF drawings
- CATIA V4
- CATIA V5
- IGES
- Parasolid
- Pro/ENGINEER
- STEP
- Unigraphics
- ODB++
- 3Di
- Gerber

Export Geometry

- ACIS
- CATIA V4, V5
- IGES
- Parasolid
- STEP

Import Mesh

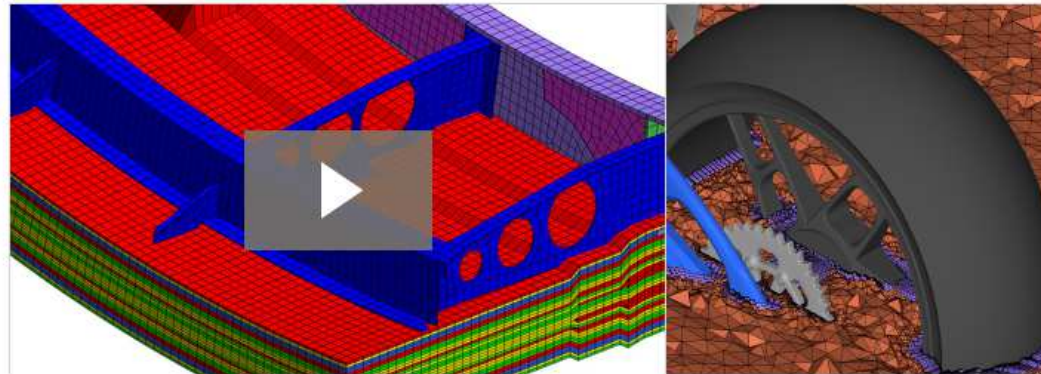
- ABAQUS
- ANSYS CDB
- ASCII data format
- AutoCAD DXF
- Concept
- FEMAP Neutral
- GiD
- NASTRAN
- NEC
- PATRAN
- STL

Export Mesh

- NASTRAN
- STL
- Gerber mesh
- AutoCAD DXF
(mesh boundary)

Altair HyperMesh

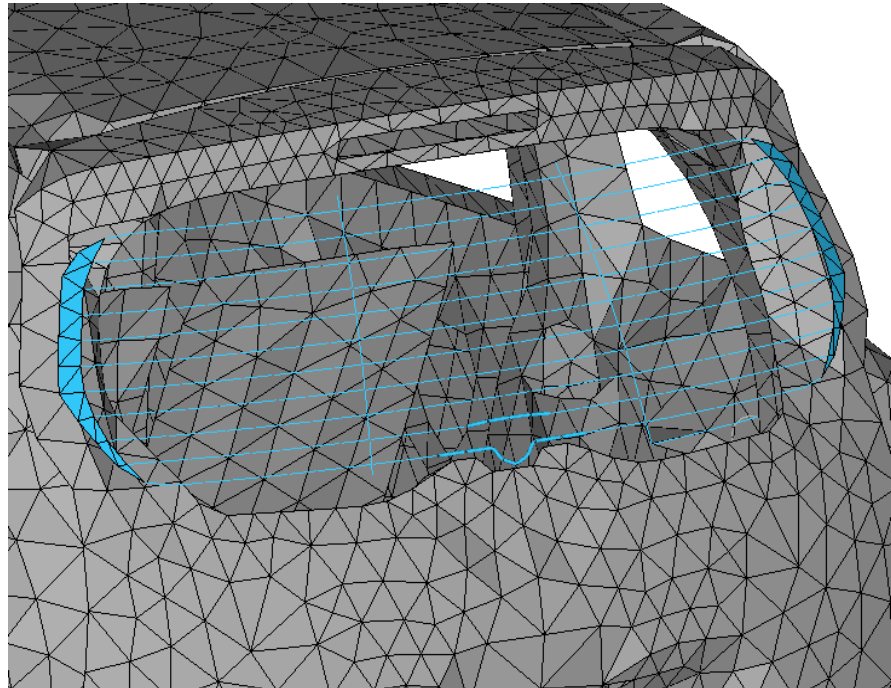
Fastest, Solver Neutral CAE Environment for High Fidelity Modeling



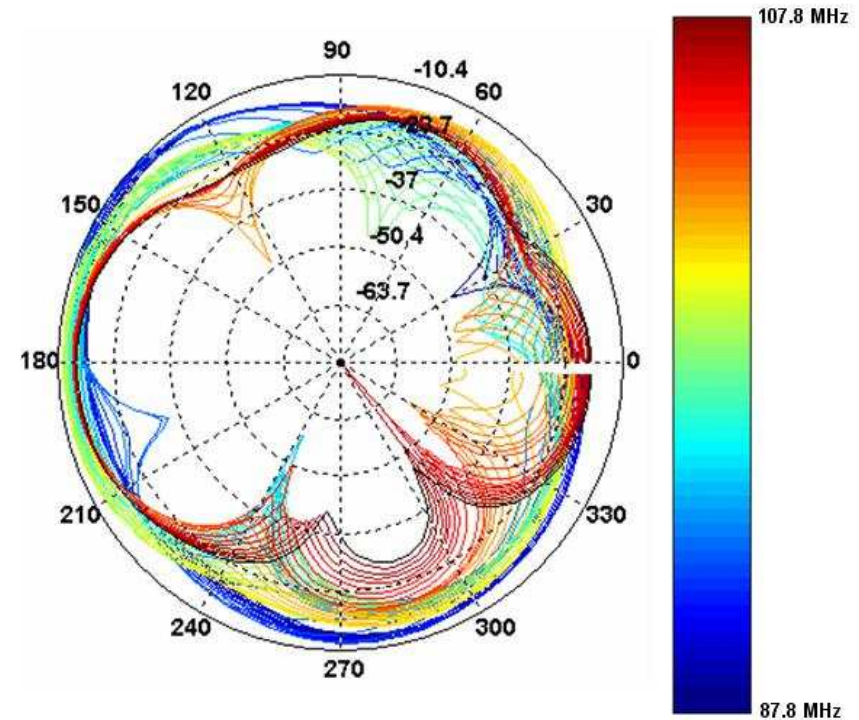
HyperMesh meshes can
also be imported into
CADFEKO

FM Radio Antenna Evaluation

Courtesy of **PSA PEUGEOT CITROËN**



Model of the antenna proposed
by the supplier

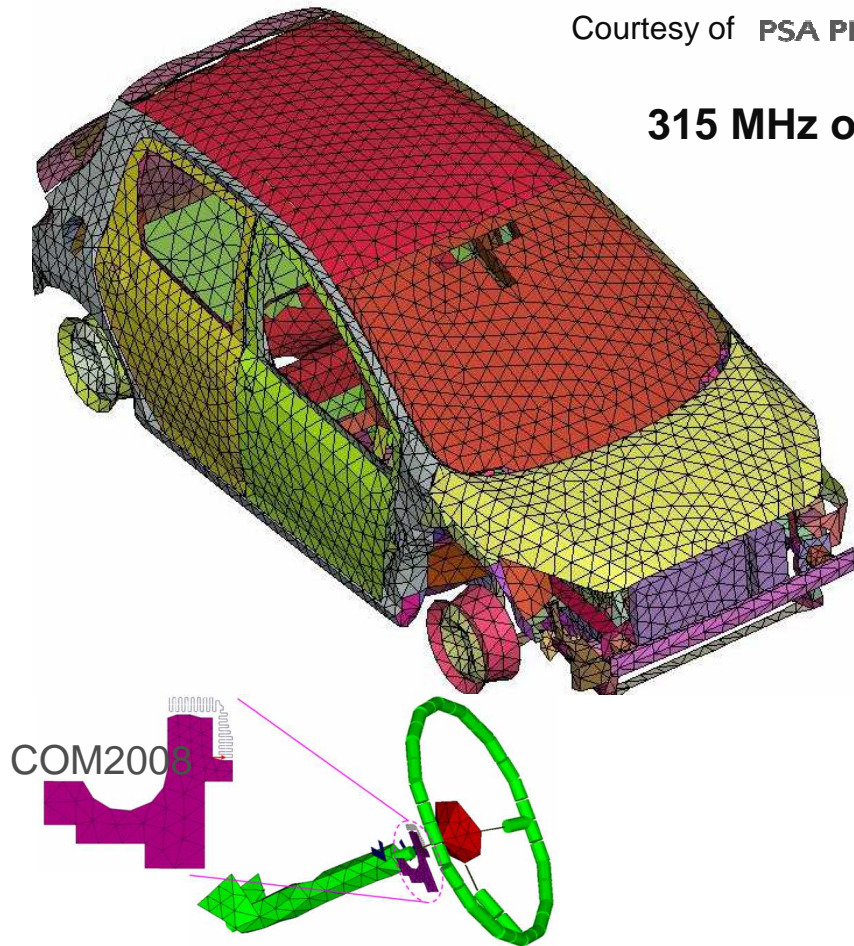


Radiation pattern for the entire
European FM band

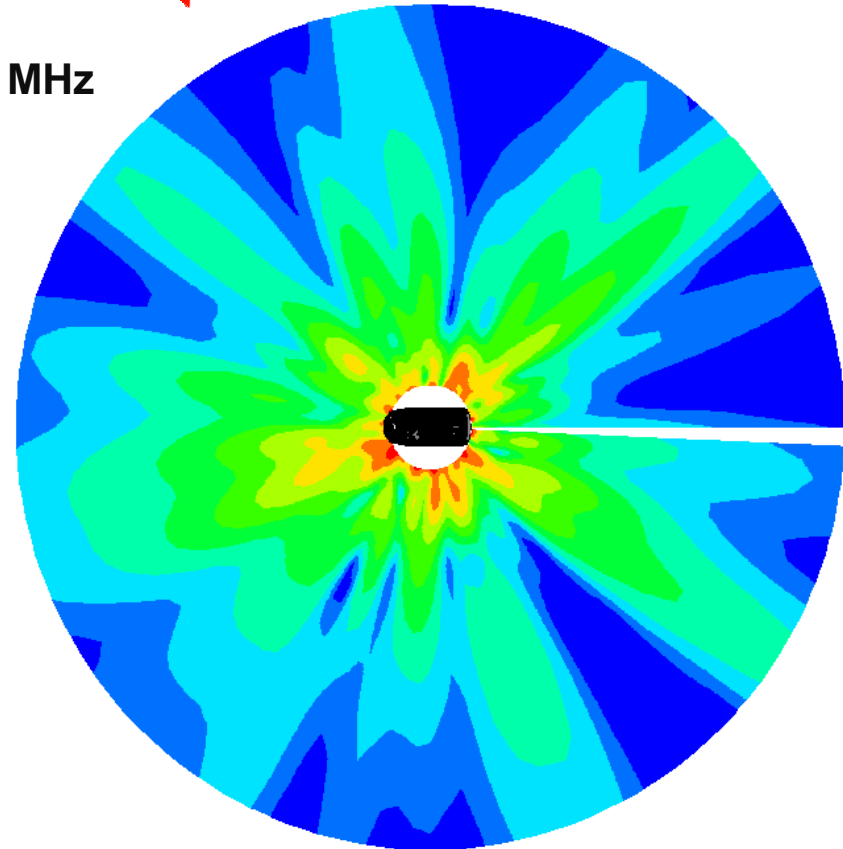
Remote Central Locking Radio-Coverage Evaluation

Courtesy of PSA PEUGEOT CITROËN

315 MHz or 433 MHz

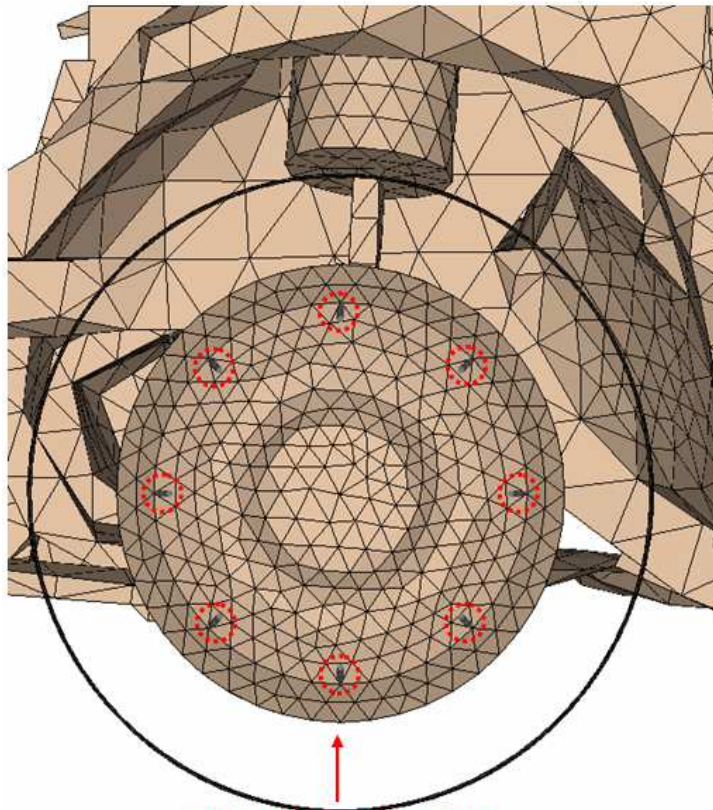


Mesh of the vehicle and PCB + antenna



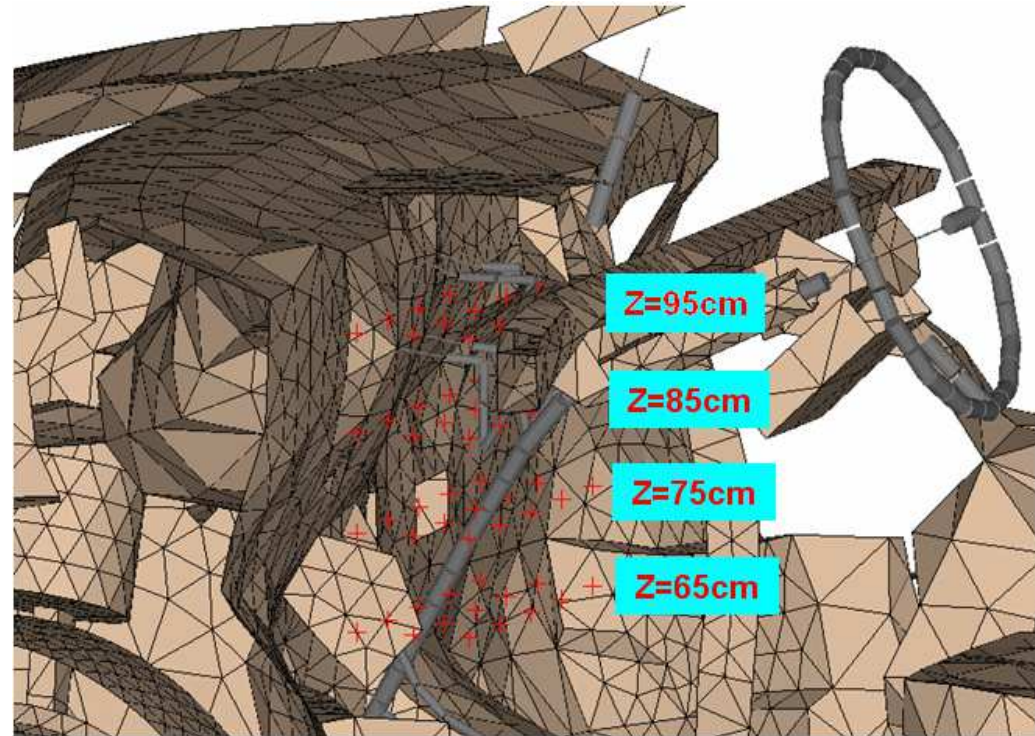
Radio coverage levels 60 meters around the vehicle at 1 meter height

Tire Pressure Receiver Positioning (1)



8 positions de valve

8 valve positions

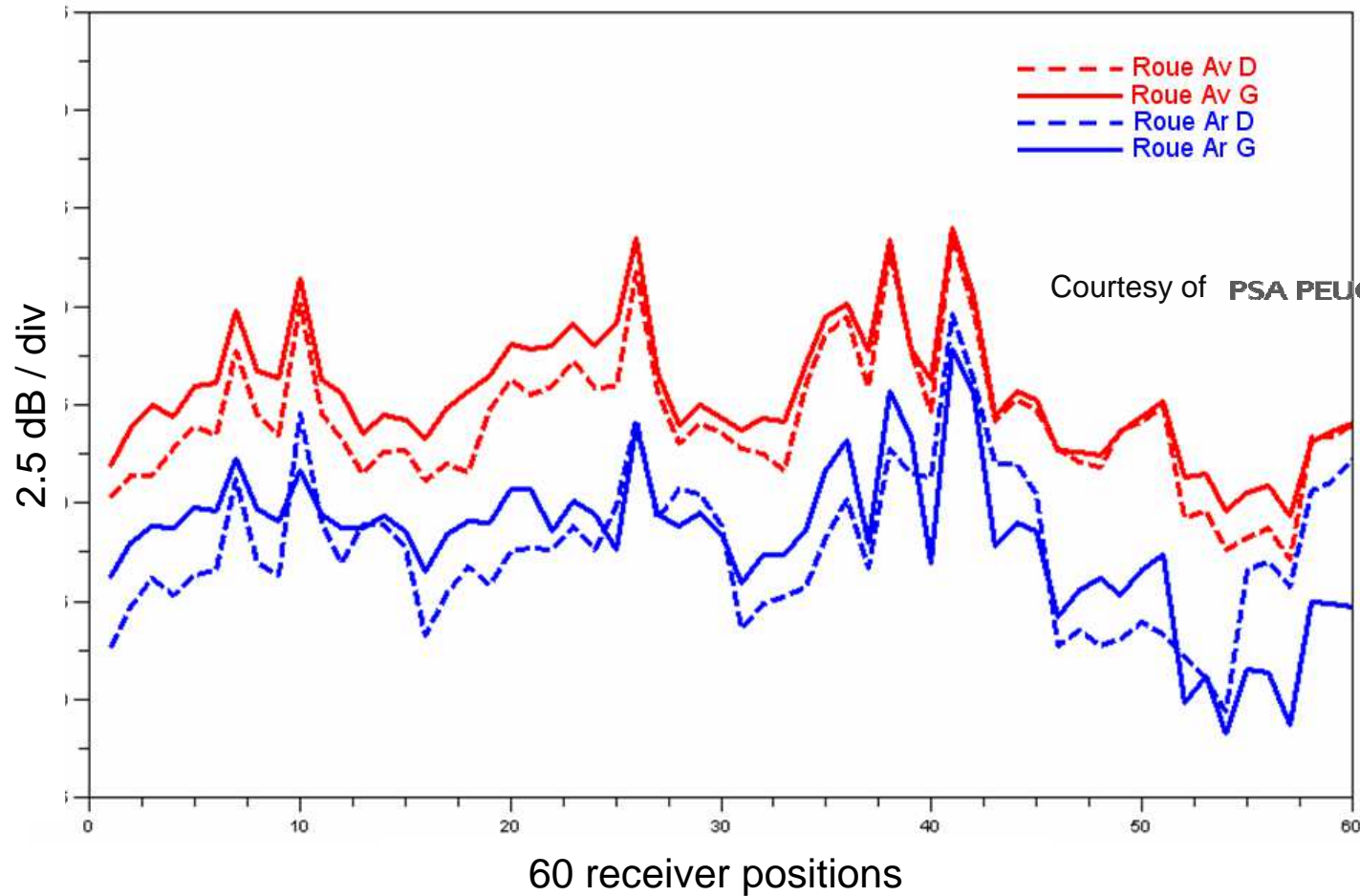


60 receiver positions
(3 x 5 x 4)

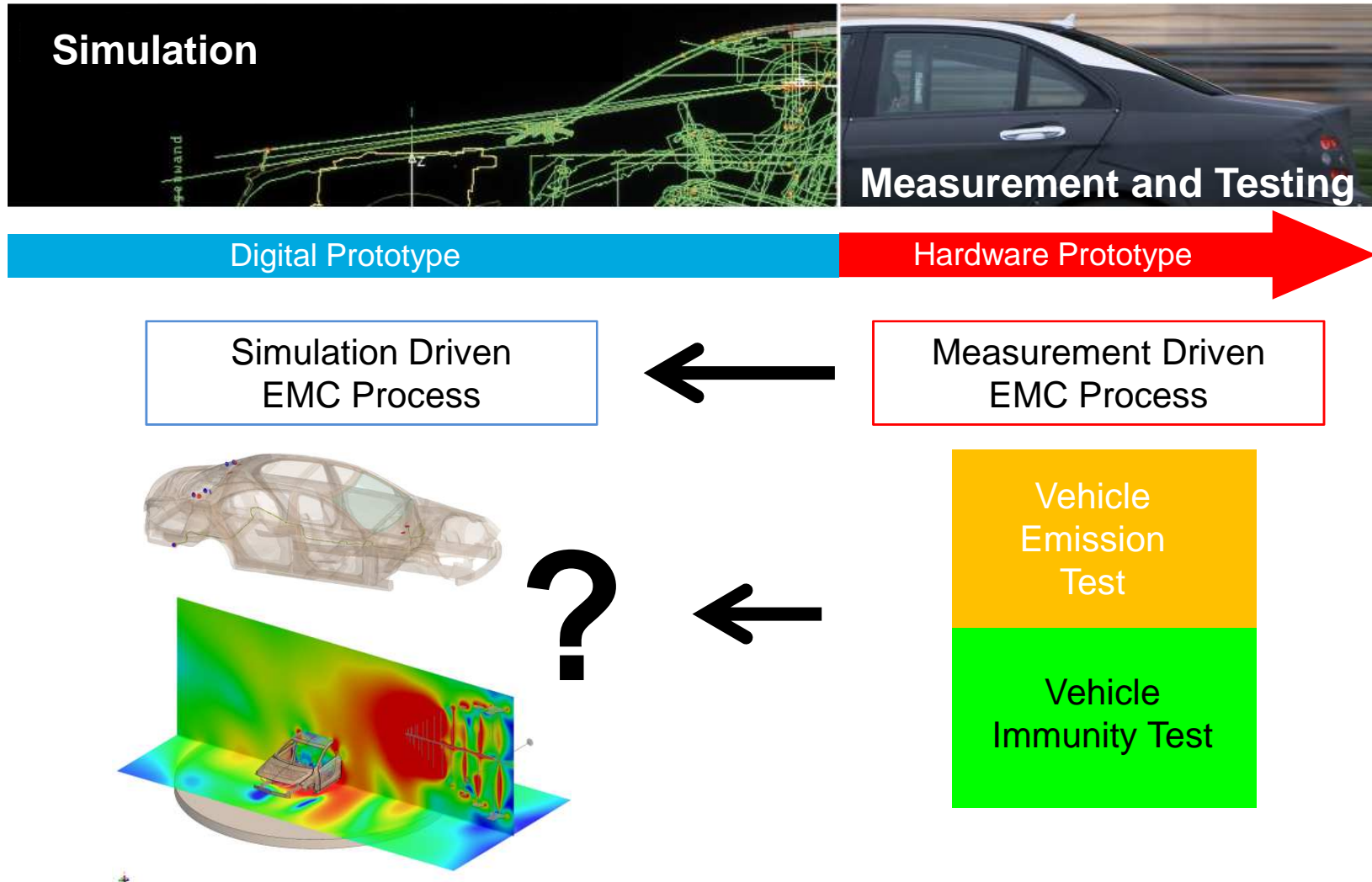
Courtesy of **PSA PEUGEOT CITROËN**

Tire Pressure Receiver Positioning (2)

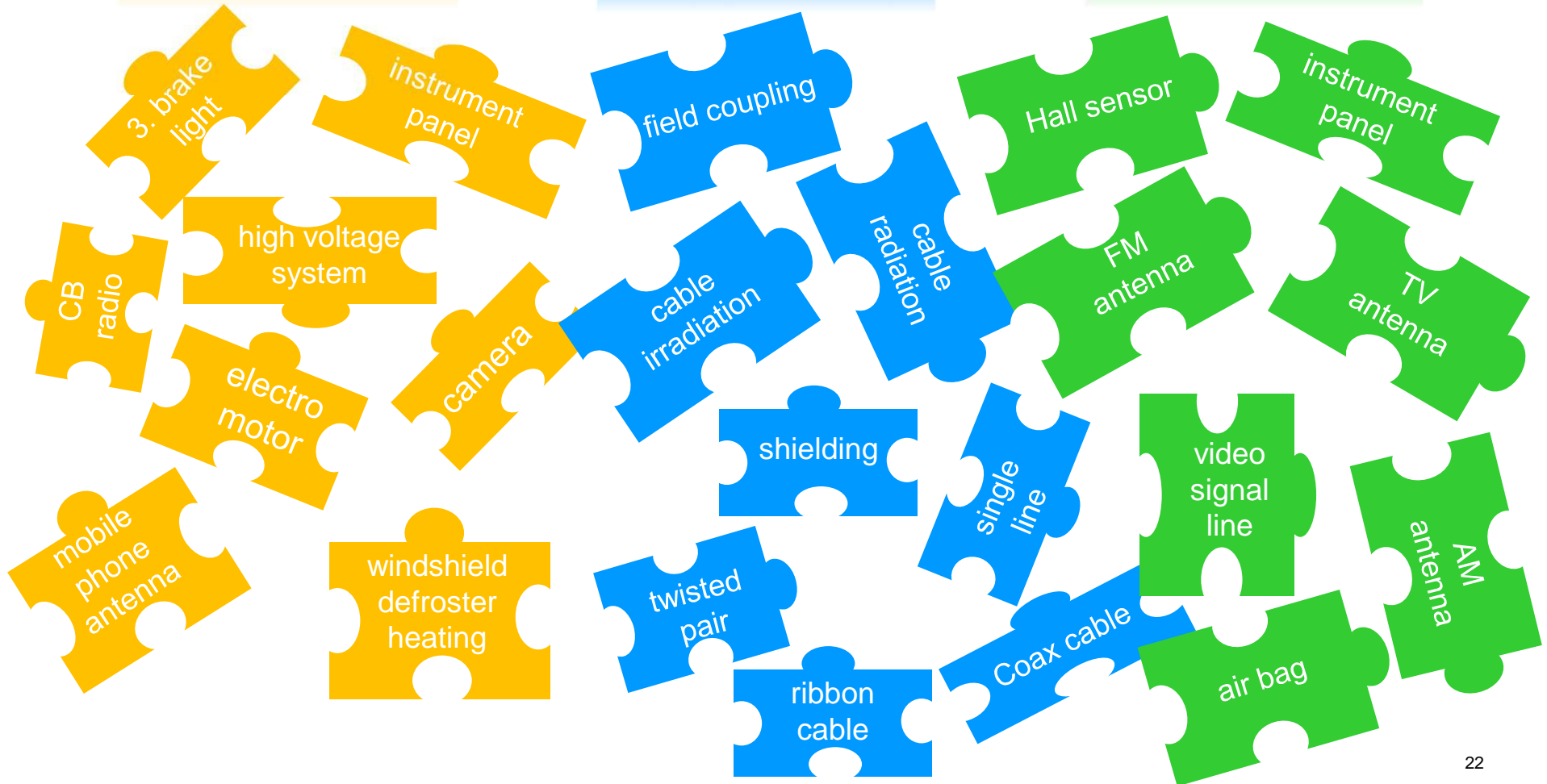
Average over the 8 valve positions



Automotive Electromagnetic Compatibility (EMC)

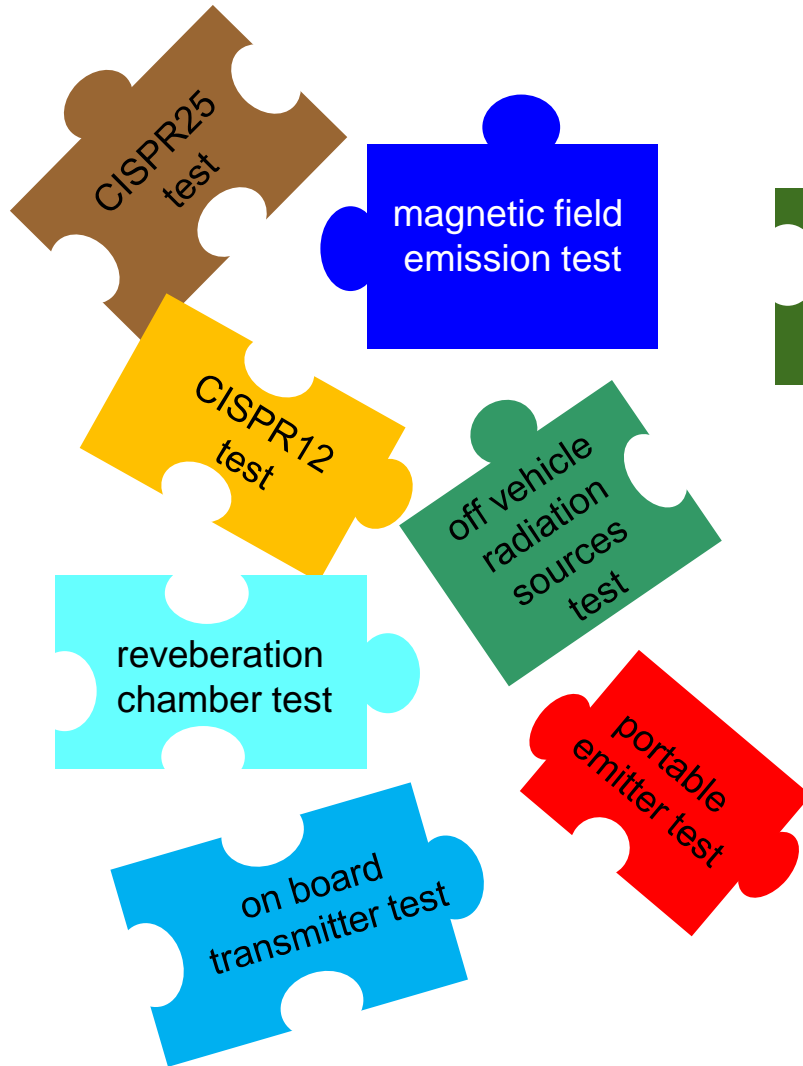


Approach for EMC Simulation

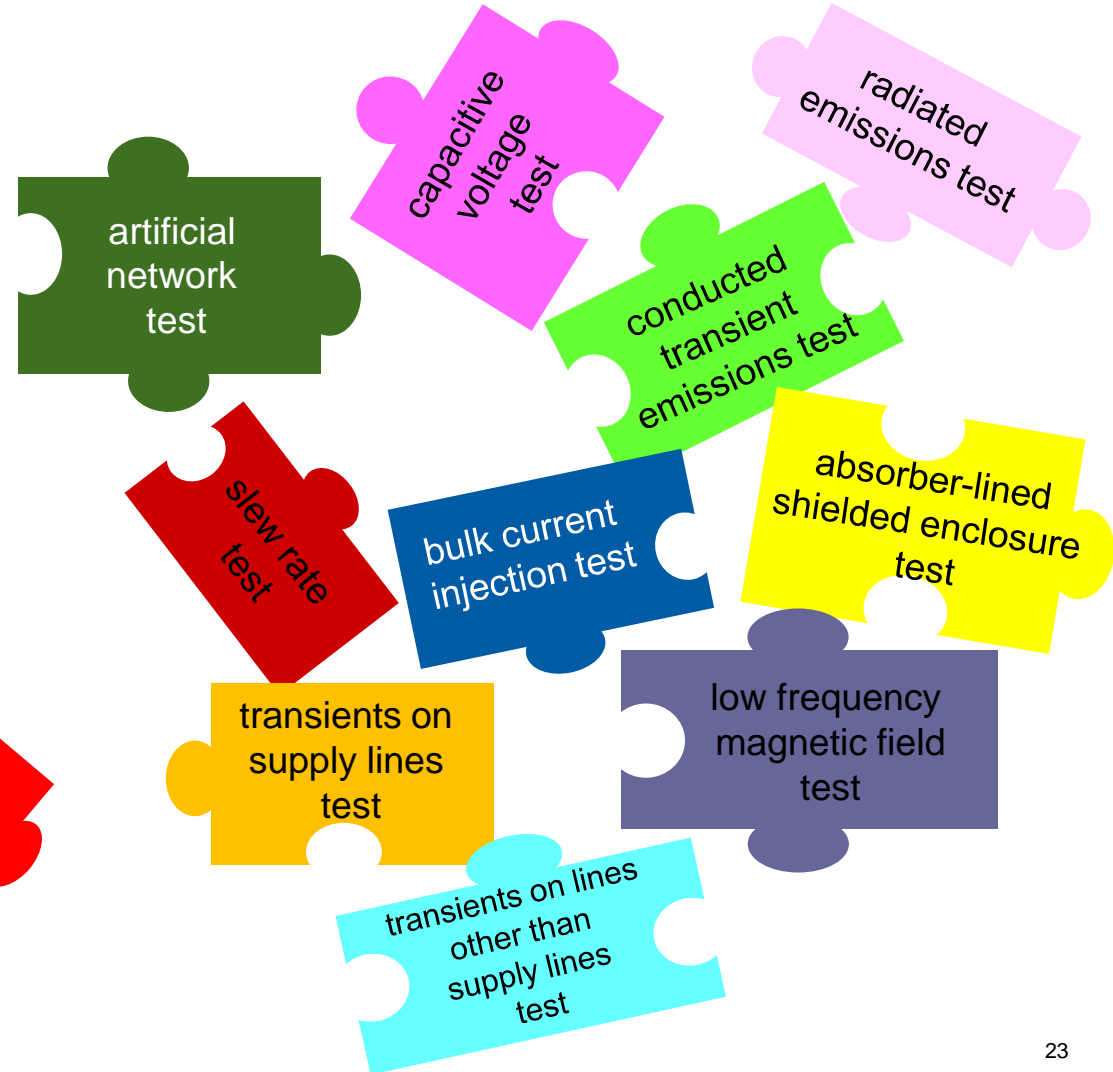


EMC Standards and Regulations

EMC Vehicle Tests



EMC Component Tests

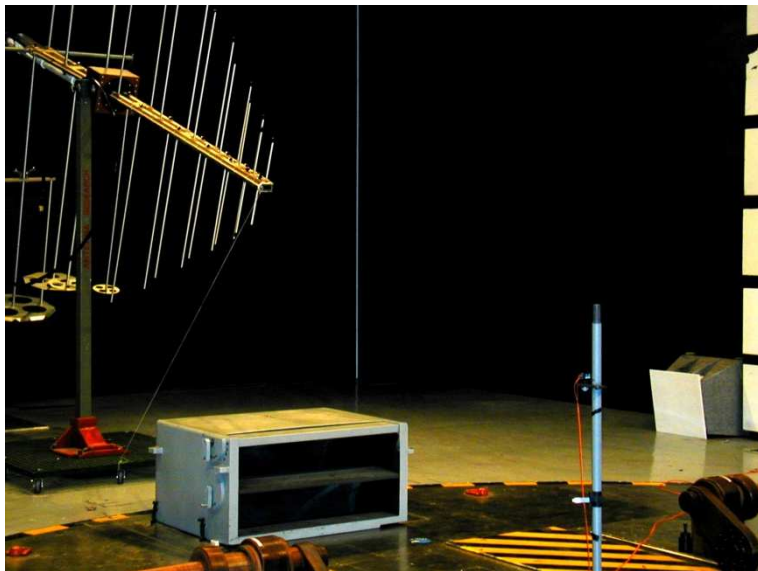


Full-vehicle Test to Be Simulated

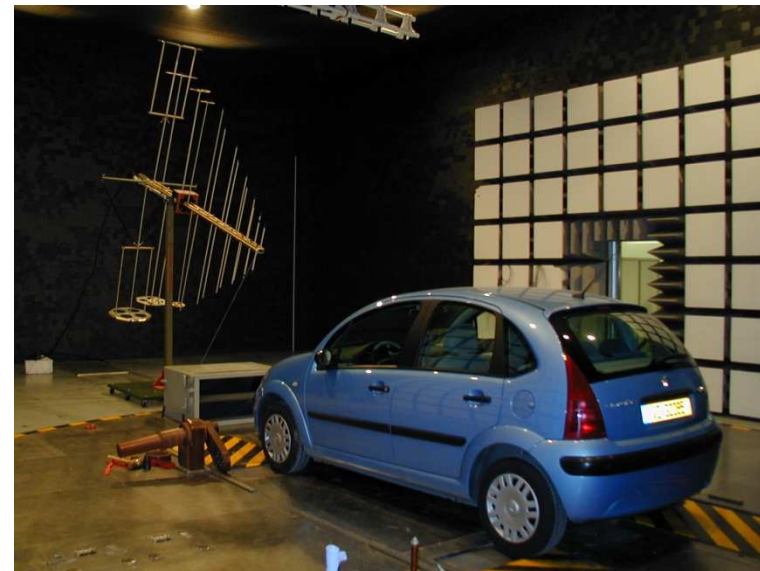
- **ISO 11451-2 substitution method**
 - 4-probe calibration phase
 - Test phase
- **Vertical and horizontal polarizations**
- **Front, rear, left and right incidences**

Courtesy of **PSA PEUGEOT CITROËN**

Calibration phase



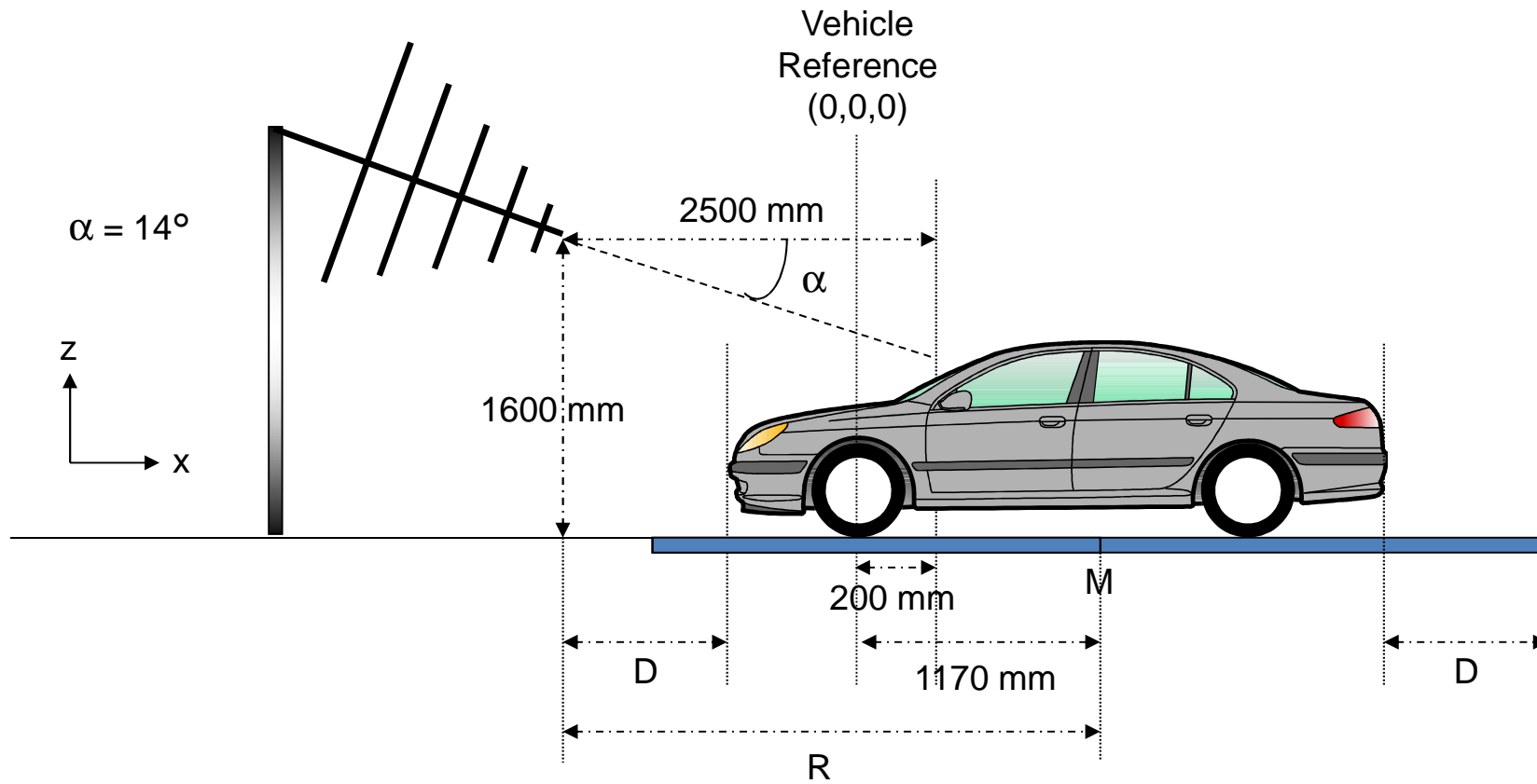
Test phase



Vehicle Immunity Test Setup

- Test phase

Courtesy of PSA PEUGEOT CITROËN 



Vehicle Details

Peugeot 508

- Sedan
- Left-hand drive
- 5 doors
- Non-athermic windscreen
- Full metallic roof
- Diesel engine

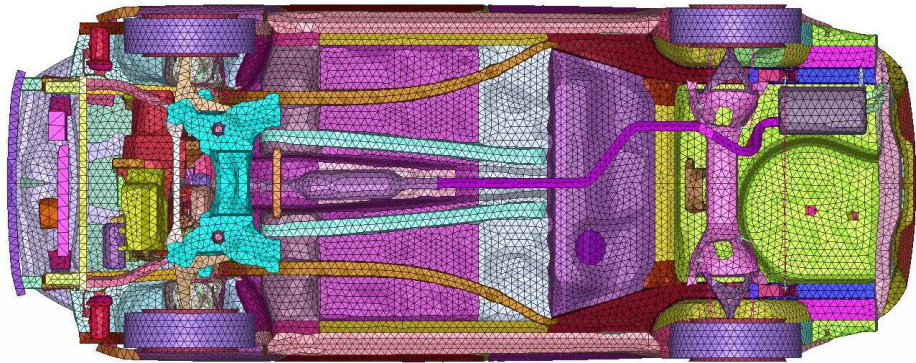
Courtesy of **PSA PEUGEOT CITROËN**



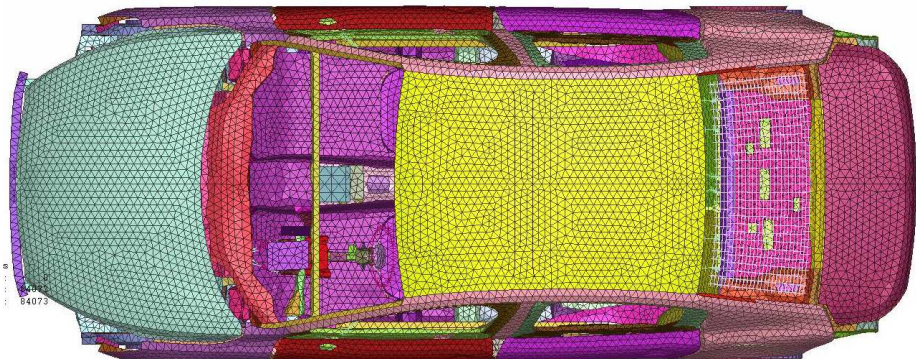
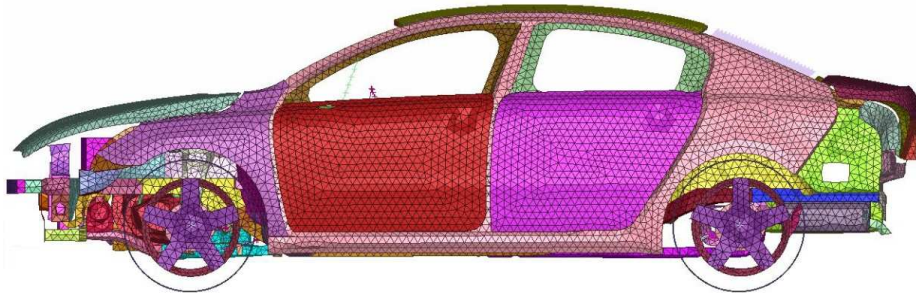
Ref: www.peugeot.fr

Vehicle Simulation Model

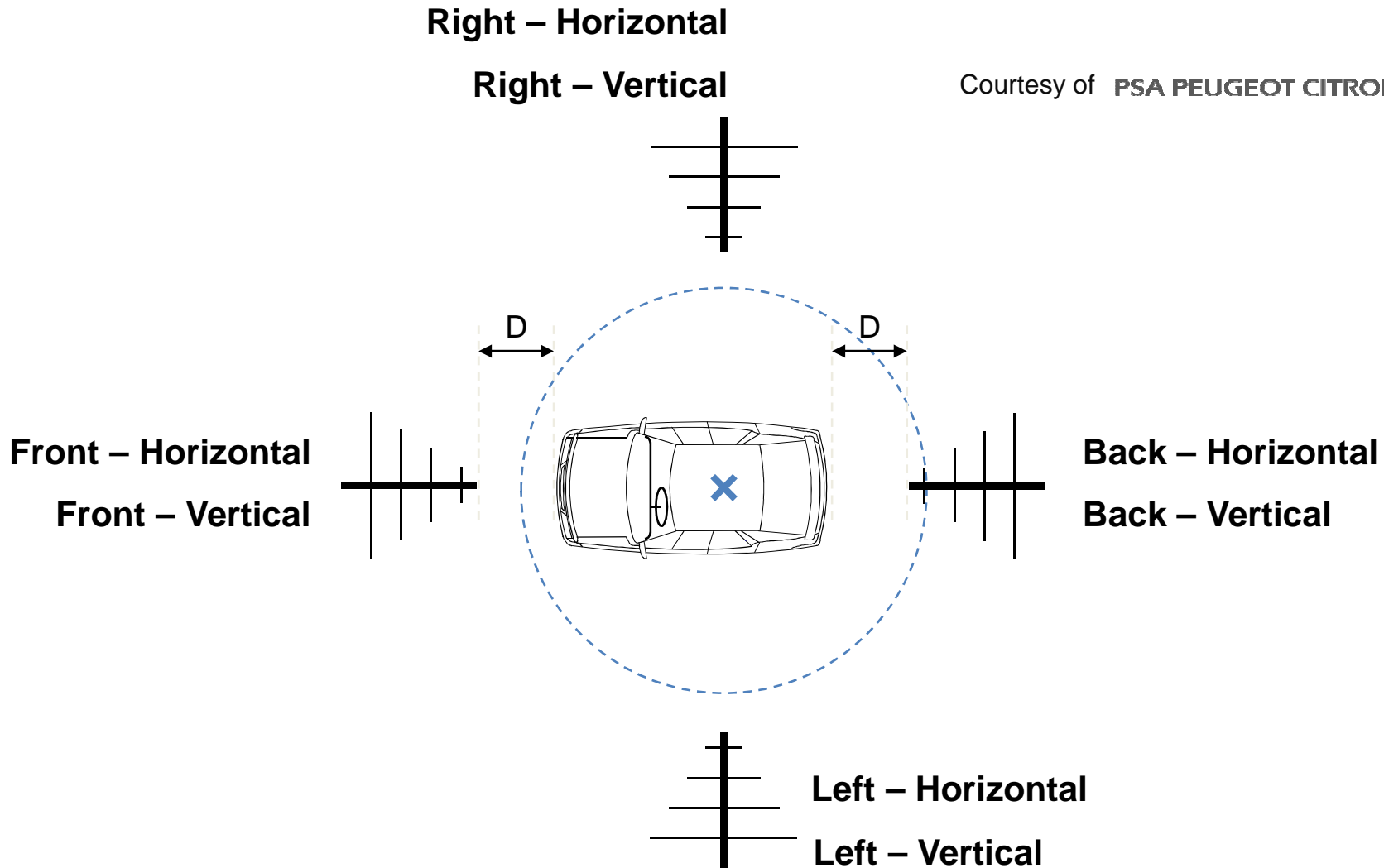
Courtesy of **PSA PEUGEOT CITROËN**



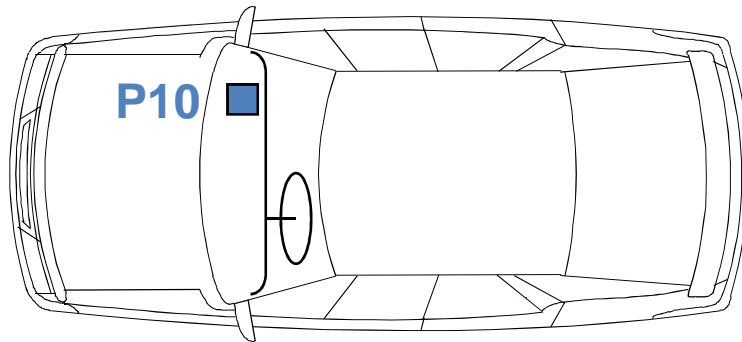
Surface mesh : 0-thickness
Wire mesh : Radius
Conductivity : PEC



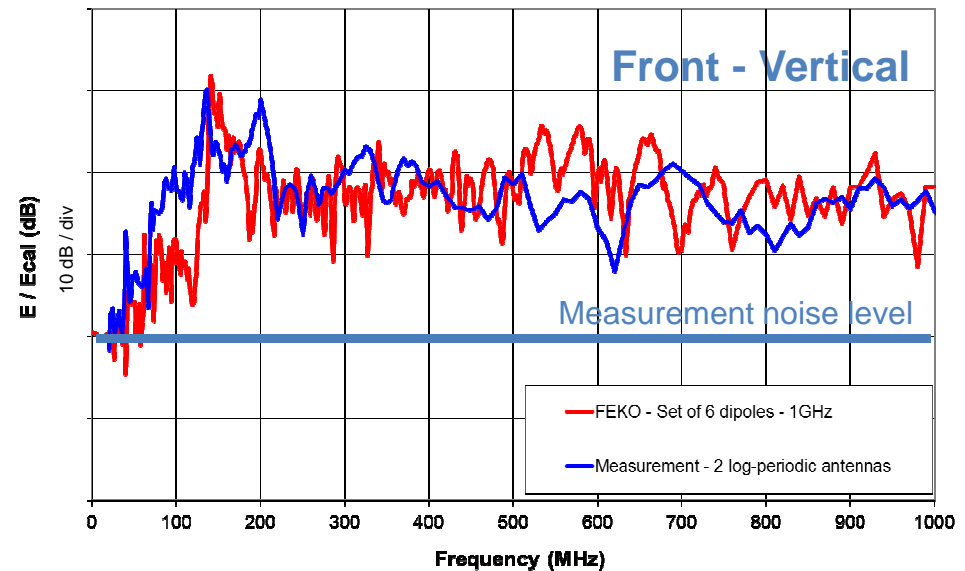
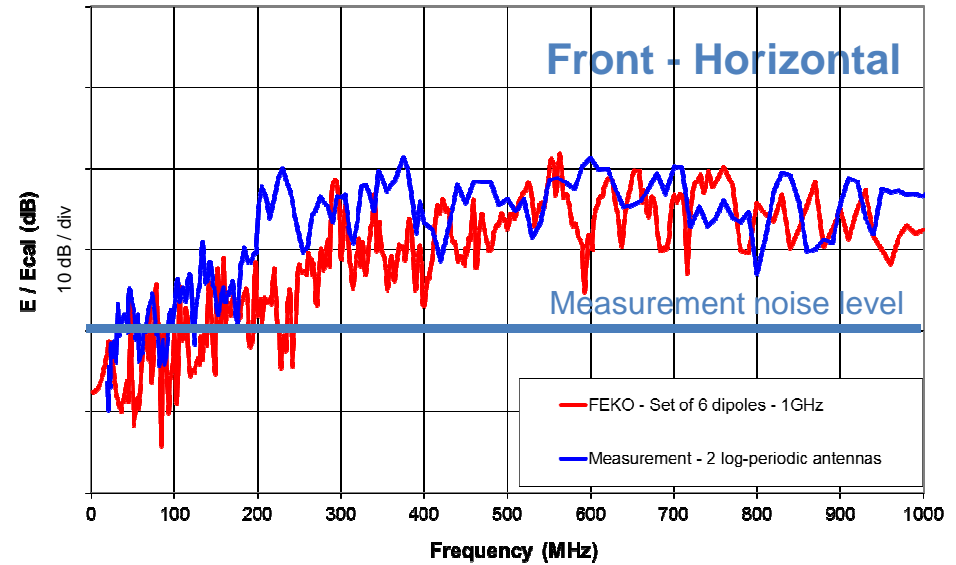
Simulation cases required using FEKO 2 configurations



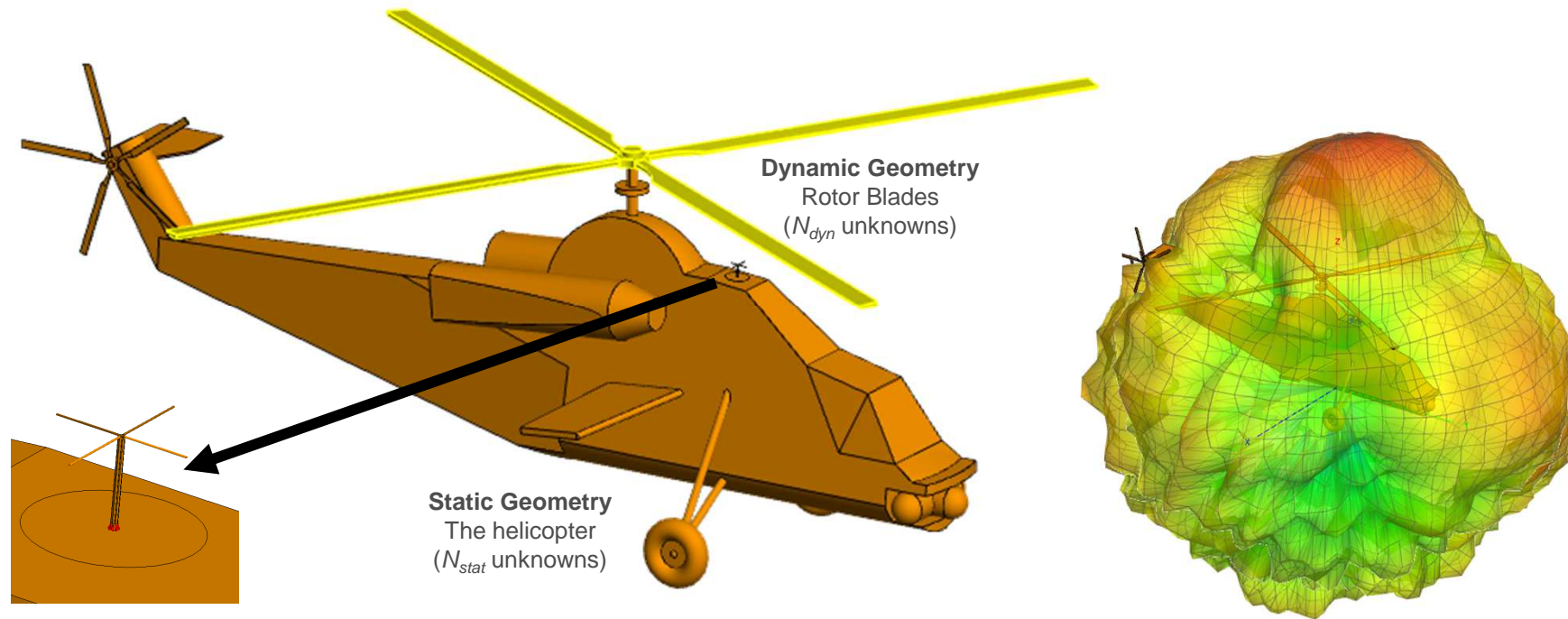
Position P10 (ADML) – Simulations Vs Measurements



Courtesy of **PSA PEUGEOT CITROËN**

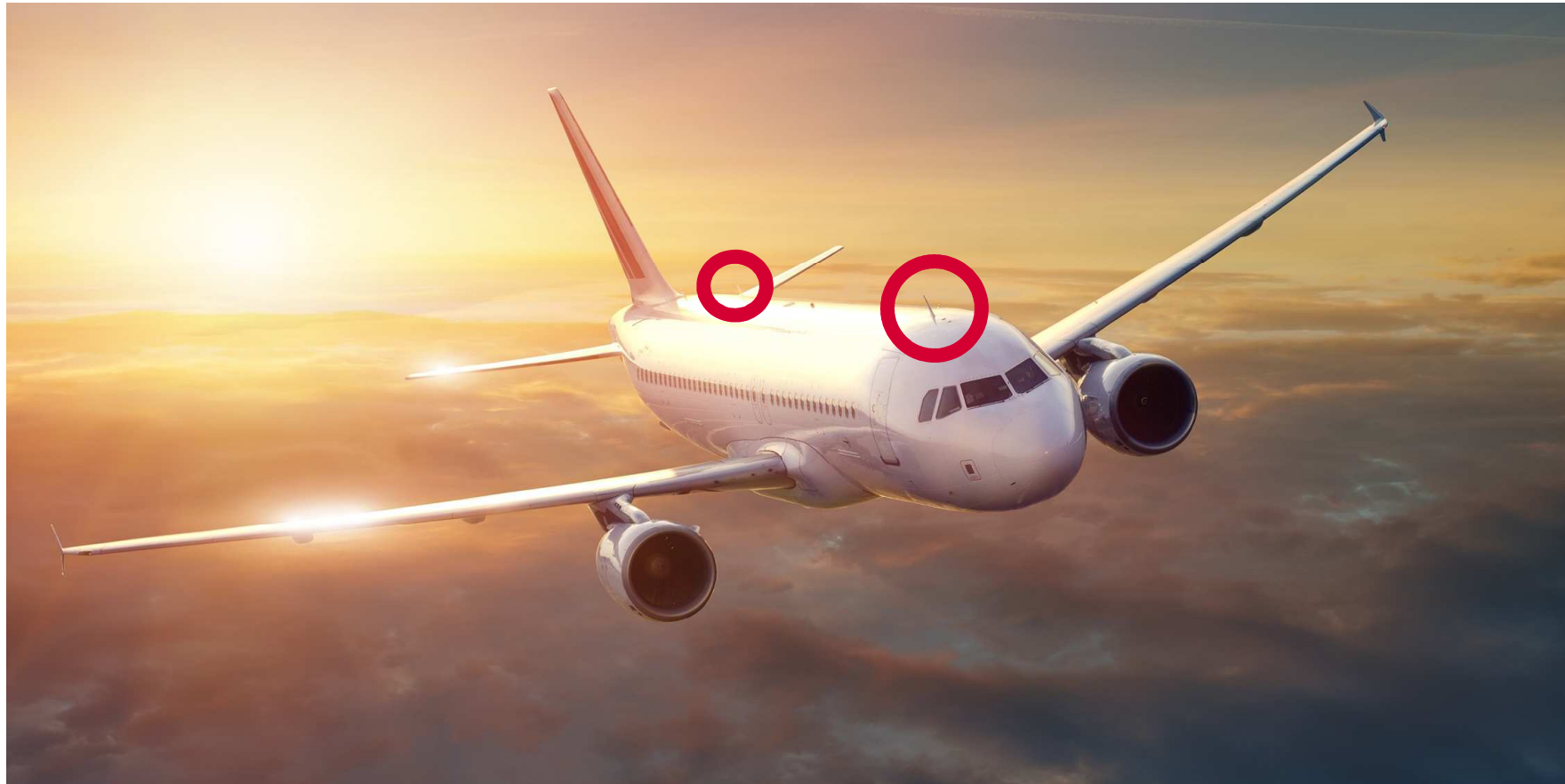


Antenna Placement – Helicopter Rotor Modulation



Numerical Green Function (NFG) in FEKO permits to reduce simulation time by 2.25X (from 36h without NGF to 16h with NGF)

Challenge by OEMs Integrating Antennas in Their Platforms

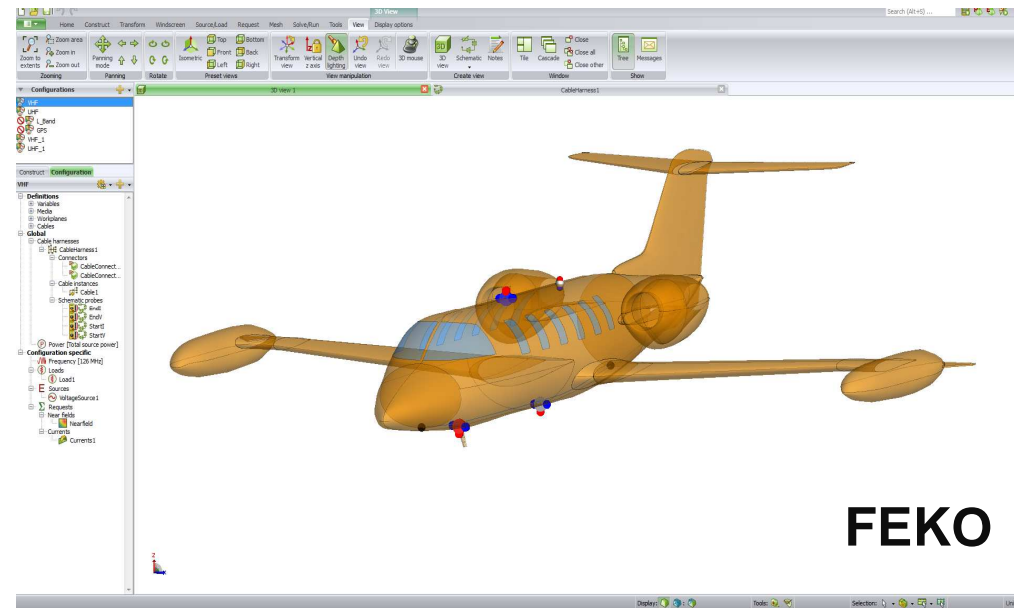


- **Antenna suppliers typically do not want to share the CAD data of their antennas**
- **Interest in solution for OEMs and antenna suppliers to share suppliers' antenna data without exposing their IP**

Combining Measurements with FEKO Simulations



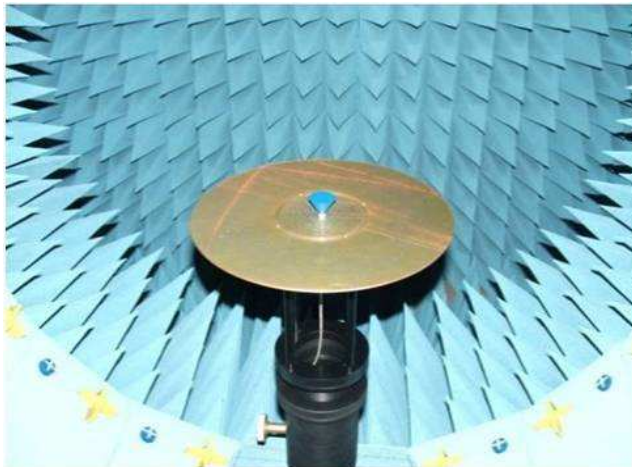
MVG antenna measurement system
with **Insight** (software tool to compute the equivalent current distribution, EQC, from the near field and/or far field measured antenna)



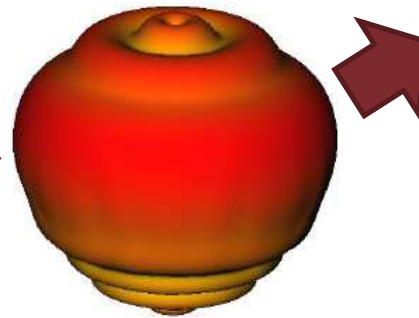
FEKO's model decomposition permits to work with equivalent sources to easily and quickly solve complex antenna placement and EM studies

Preparation and Use of Measured Source

Flush mounted antenna measurement with representative ground plane to impose the correct local boundary condition



Measured data



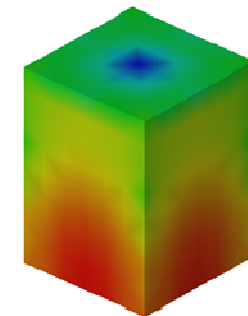
Apply Infinite Ground Plane Boundary Condition

Source Edge Diffraction Extraction (SDE) to eliminate the edge scattering from the ground plane)

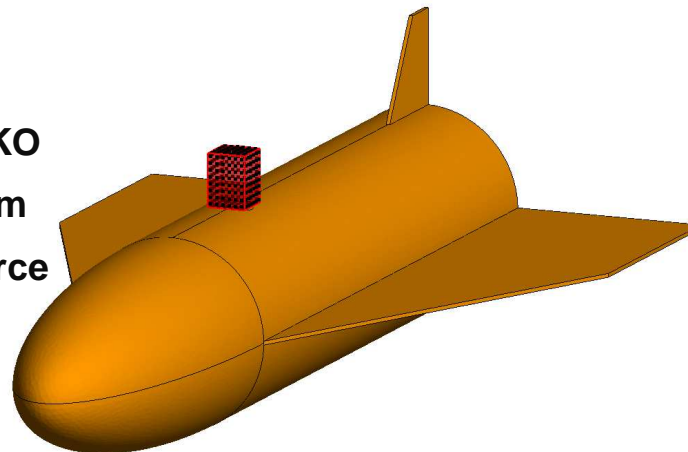


Generation of Equivalent Currents (EQC) on the antenna using MVG's software Insight

EQC represent the near field antenna model that can be imported and used in FEKO

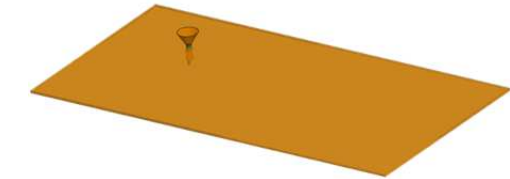
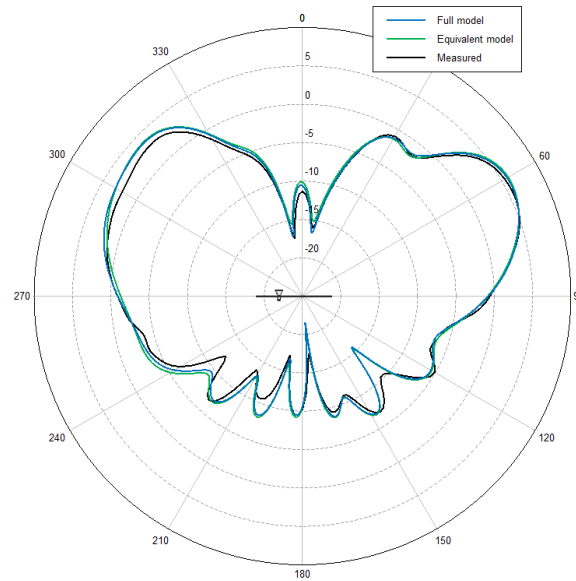
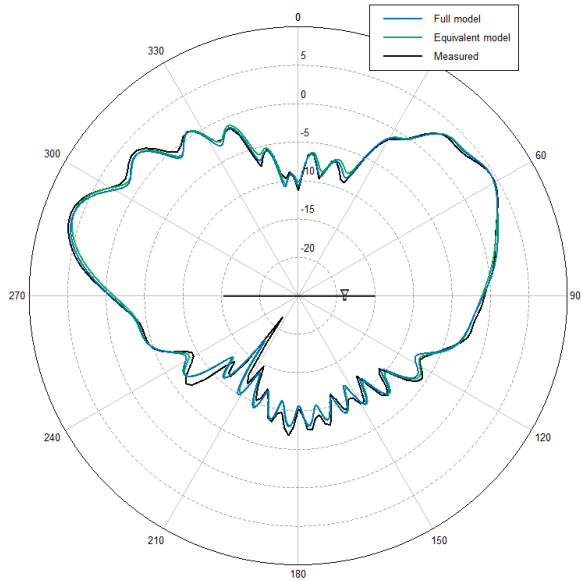


Aperture excitation in FEKO (generated from EQC from Insight) as equivalent source for the antenna

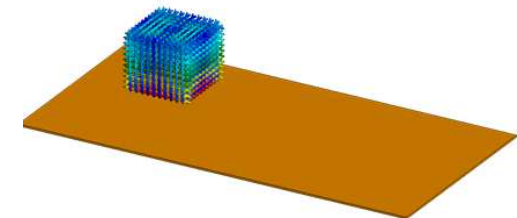
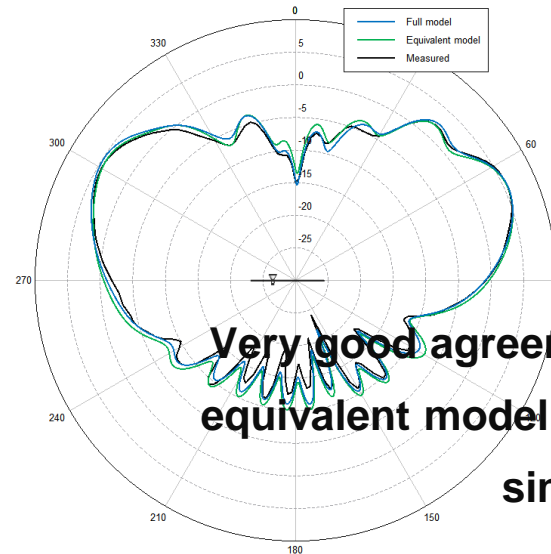
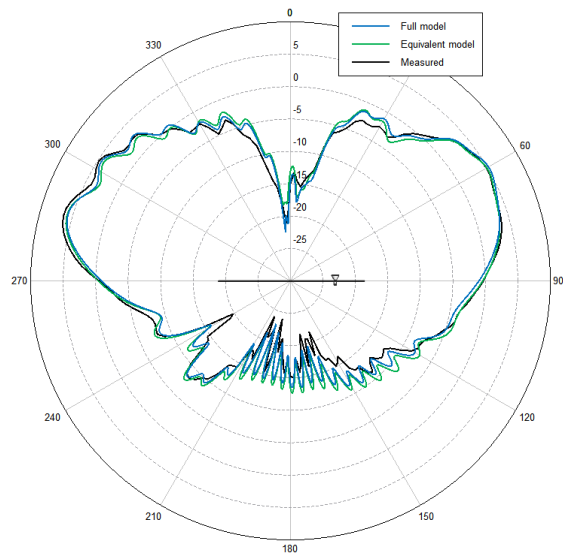


Validation Approach for Mounted Monocone Antenna

3.3 GHz



5.8 GHz



**Very good agreement between near field
equivalent model, full measurements and
simulations**

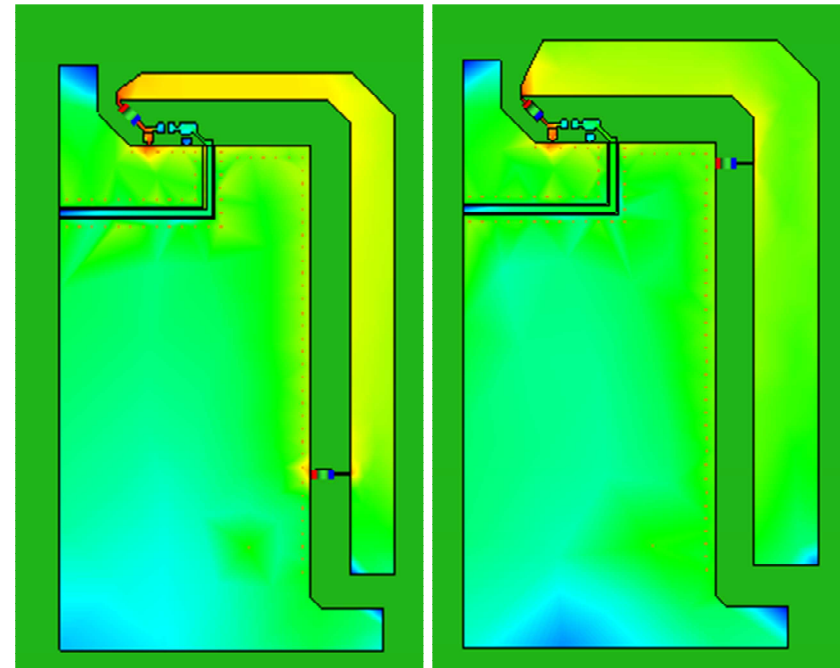
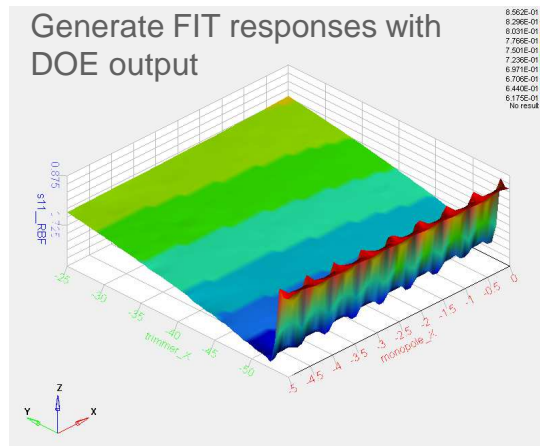
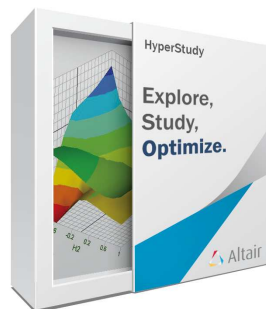
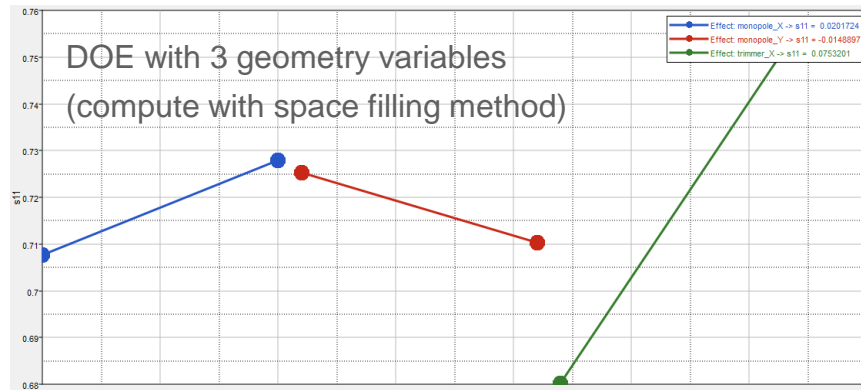
NASA Langley Research Center



Altair's FEKO computational electromagnetic software enables NASA to develop wireless resonant sensors that can measure and mitigate lightning strike damage to composite aircraft

Design Problem – HyperStudy Example

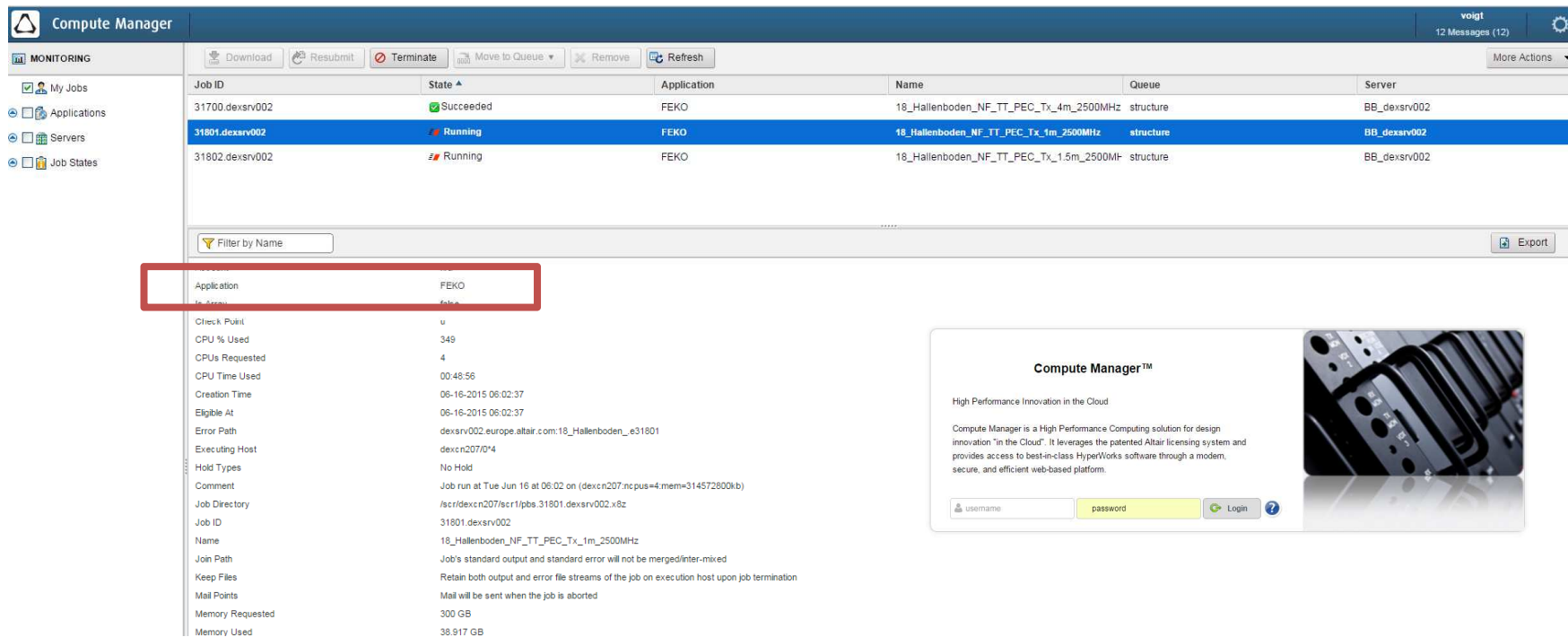
- Design frequency: 433 MHz
- Challenging design optimization



15% improvement in bandwidth (better tolerance to component sensitivity) and **33%** improvement in antenna efficiency over the initial design

FEKO and PBS Works

- FEKO works with Altair PBS Works HPC workload management software built for End Users, Systems and Managers
- Application for web-based job submission, management and monitoring, simplifying HPC for end users:



The screenshot displays the Altair Compute Manager web interface. The top navigation bar includes the 'Compute Manager' logo, user 'voigt', and '12 Messages (12)'. The main area is divided into a left sidebar with navigation options (My Jobs, Applications, Servers, Job States) and a central job monitoring table. The table lists three jobs, with the second job (ID 31801) highlighted in blue and marked as 'Running'. Below the table, a 'Filter by Name' search bar is visible. A red box highlights the 'Application' column, which shows 'FEKO'. To the right, a detailed view of the selected job is shown, including fields like 'Application', 'CPU % Used', 'CPUs Requested', 'Creation Time', 'Error Path', 'Executing Host', 'Job Directory', 'Job ID', 'Name', 'Join Path', 'Keep Files', 'Mail Points', 'Memory Requested', and 'Memory Used'. A login panel for 'Compute Manager™' is also present, featuring a login form with 'username' and 'password' fields, a 'Login' button, and a help icon. The background of the login panel shows a server rack.

Job ID	State	Application	Name	Queue	Server
31700.dexsrv002	Succeeded	FEKO	18_Hallenboden_NF_TT_PEC_Tx_4m_2500MHz	structure	BB_dexsrv002
31801.dexsrv002	Running	FEKO	18_Hallenboden_NF_TT_PEC_Tx_1m_2500MHz	structure	BB_dexsrv002
31802.dexsrv002	Running	FEKO	18_Hallenboden_NF_TT_PEC_Tx_1.5m_2500MHz	structure	BB_dexsrv002

Job Details:

- Application: FEKO
- CPU % Used: 349
- CPUs Requested: 4
- CPU Time Used: 00:48:56
- Creation Time: 06-16-2015 06:02:37
- Eligible At: 06-16-2015 06:02:37
- Error Path: dexsrv002.europe.altair.com:18_Hallenboden_e31801
- Executing Host: dexcn207/0*4
- Hold Types: No Hold
- Comment: Job run at Tue Jun 16 at 06:02 on (dexcn207.ncpus=4.mem=314572800kb)
- Job Directory: /scr/dexcn207/scr1/pbs.31801.dexsrv002.x8z
- Job ID: 31801.dexsrv002
- Name: 18_Hallenboden_NF_TT_PEC_Tx_1m_2500MHz
- Join Path: Job's standard output and standard error will not be merged/inter-mixed
- Keep Files: Retain both output and error file streams of the job on execution host upon job termination
- Mail Points: Mail will be sent when the job is aborted
- Memory Requested: 300 GB
- Memory Used: 38.917 GB

FEKO and HW Unlimited Simulation Appliance

Physical Appliance



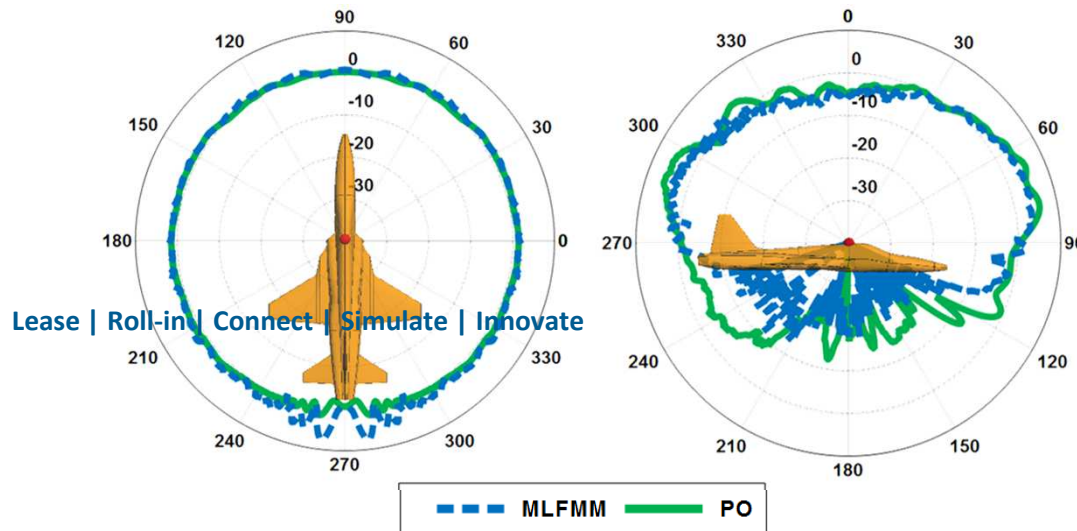
HyperWorks Unlimited

Unlimited use of Altair products per node
Pre-packaged and fully configured
Altair managed, no IT support needed
And more!

Virtual Appliance



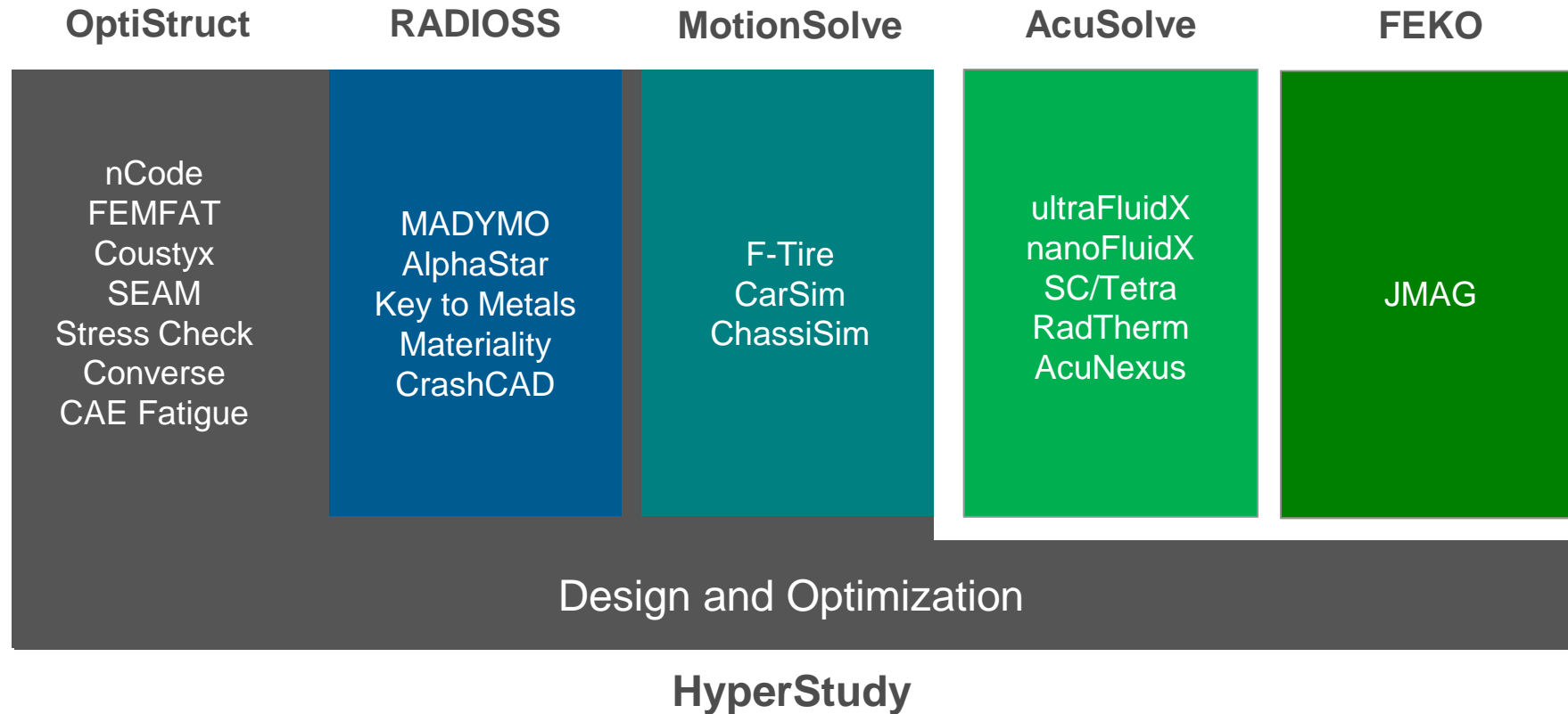
FEKO also now working with HyperWorks Unlimited



F5 Fighter FEKO Simulation at 3.5 GHz

Method	Unknowns	Memory	Runtime
MLFMM	2,980,753	113 GB	35 min
PO	911,887	22 GB	2 min 25 sec

Partner Solutions



Static/Low Frequency EM Simulation of Industrial Applications with JMAG

Actuators

Busbar

Circuit breaker

EM Shields

Generators

Induction heating

Motors

Reactors

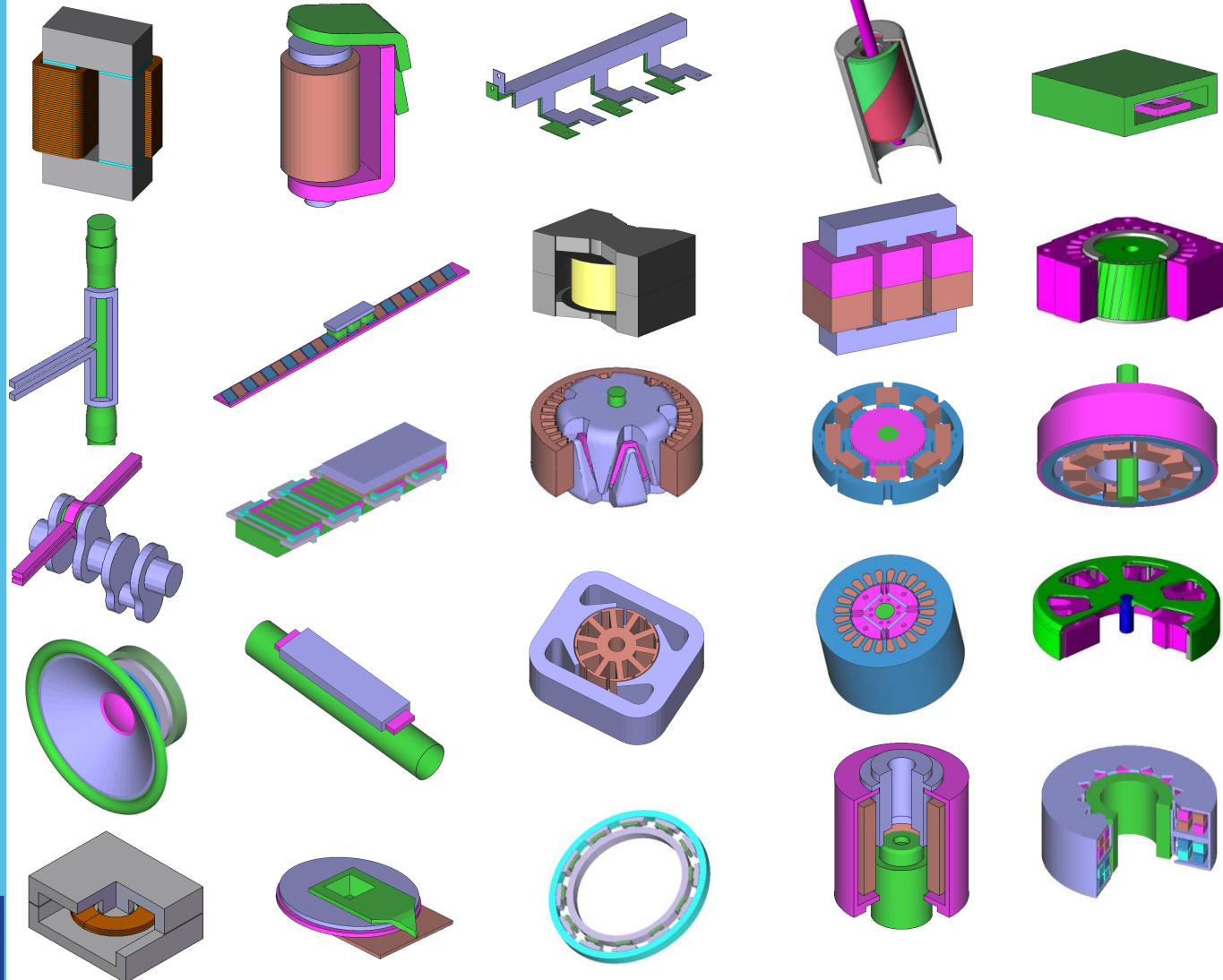
Sensors

Solenoids

Speaker

Transformers

...



Thank You For Your Attention

www.altairhyperworks.com/feko

