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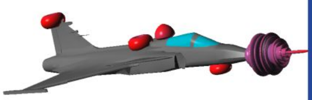
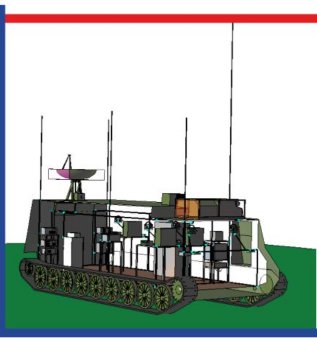
EMC Analyzer

MULTIFUNCTIONAL
and POWERFUL SPECIALIZED EXPERT SYSTEM
for cost-effective electromagnetic compatibility analysis
and design in complex co-site systems
and/or in spatially-limited ground/water areas



A new era
in EMC analysis
and prediction!



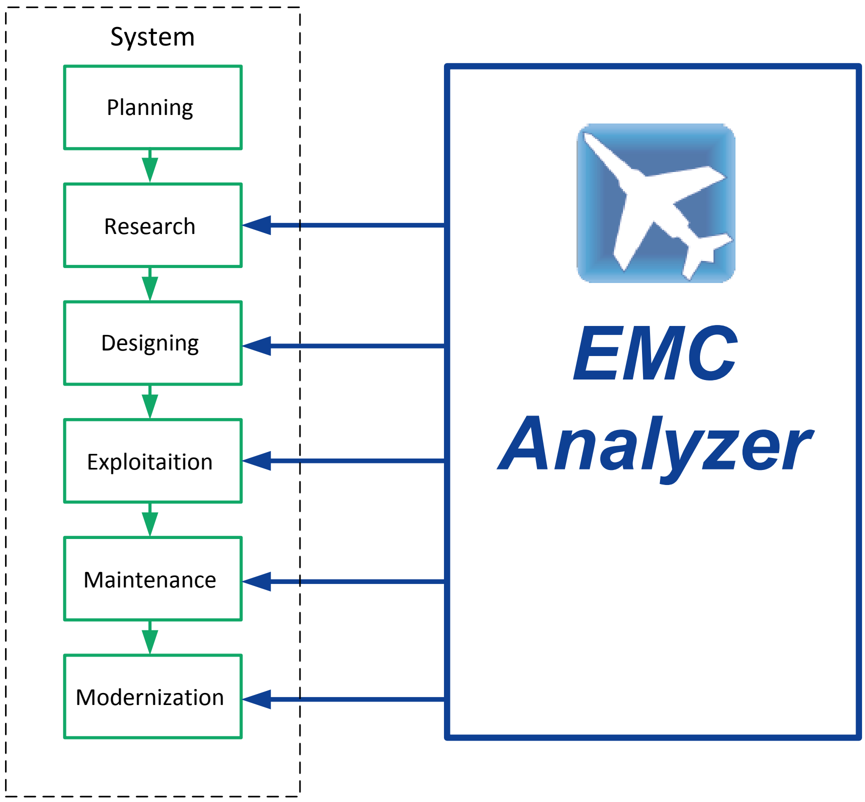
GENERAL DESCRIPTION

The "EMC-Analyzer" specialized expert system is a unique software proposal in the international software market, providing the analysis and the solving of the most complicated EMC problems at a system level ("as a whole") by using the modernized resumptive platform of known research program IEMCAP (USA) in a combination with original and effective EMC models and technologies developed in USSR and Belarus (e.g., a technology of nonlinear discrete EMC analysis and radio receiver behavior simulation).

"EMC-Analyzer" is capable to provide essential simplification, acceleration, and reduction in price of works on area of EMC problems detecting and solving in local on-board and ground-based systems.

"EMC-Analyzer" can be efficiently used at all stages of life cycle of these systems (preliminary research, detailed designing of system and subsystems, systems exploitation, support, modernization, etc.), but its application is especially effective at early stages of the life cycle (such as research and design).

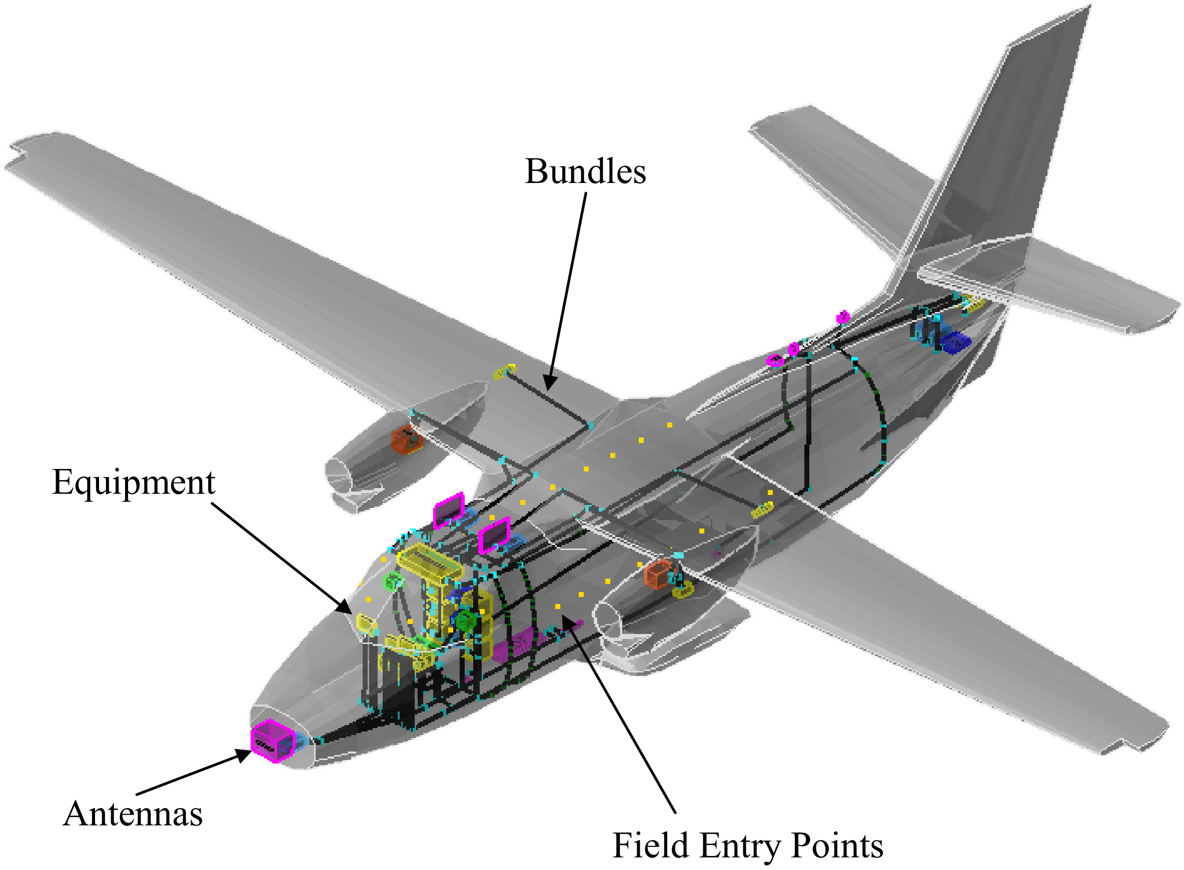
Pessimistic nature of EMC estimation results allows to decrease essentially risks of losses caused by probable electromagnetic incompatibility of on-board or ground-based system equipment during designing of these systems.



APPLICATION AREA

Intrasystem EMC analysis, design, and maintenance of on-board systems (aircraft, helicopter, missile, satellite, ship, vehicle, etc.) by taking into consideration the following:

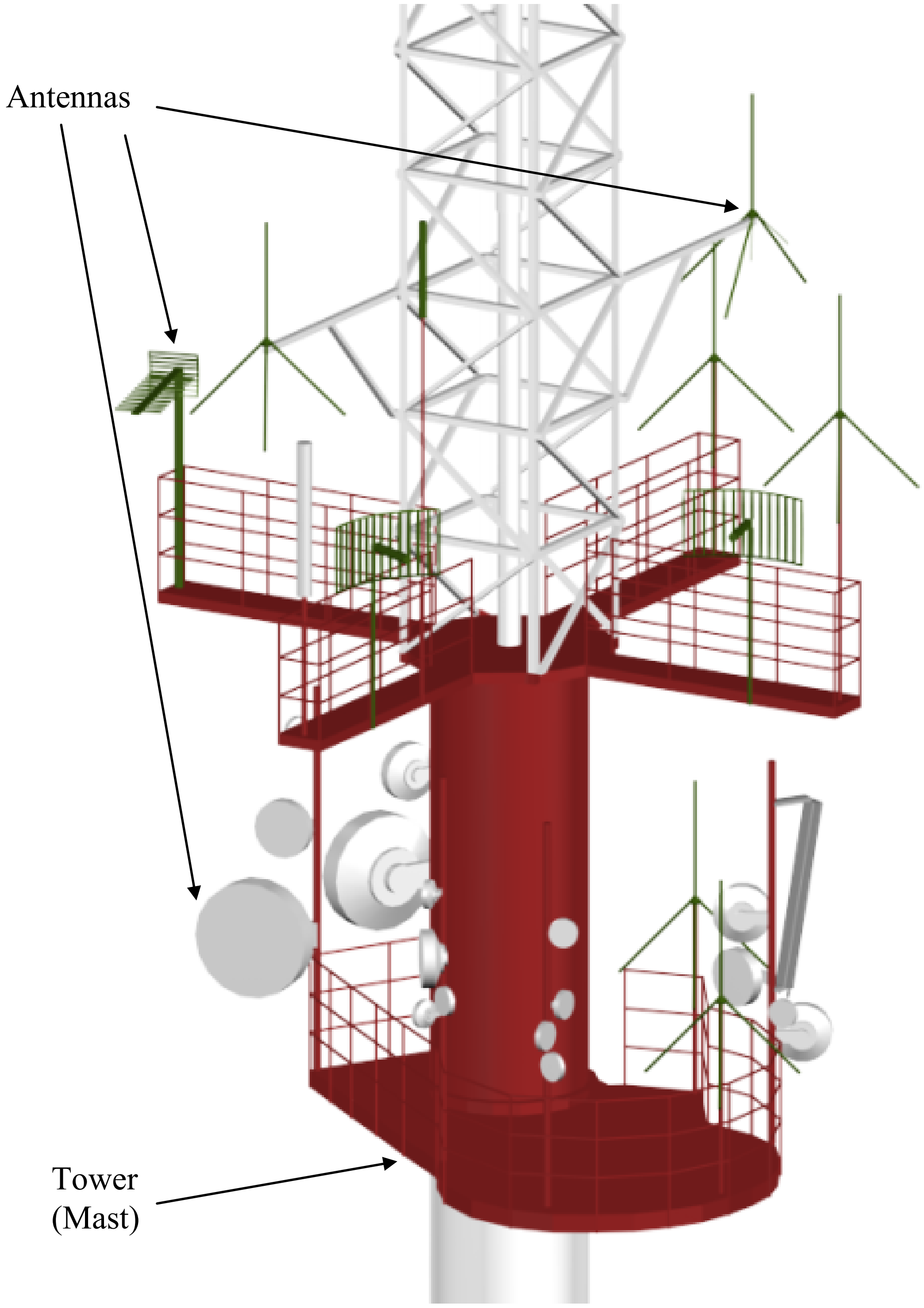
- various on-board radio and electronic equipment (radio systems, computers and control systems, data-measuring systems, power supply equipment);
- different on-board spurious electromagnetic couplings ("antenna to antenna", "field to antenna", "antenna to wire", "wire to wire", "field to wire", "case to case", "field to case");
- external electromagnetic environment (EME) formed by various ground-based radio systems of different radio services (radio communication, radar, radio navigation, radio monitoring, etc.), as well as by spatially distributed radiofrequency (RF) devices and systems.



APPLICATION AREA

Intrasystem EMC analysis, design, and maintenance of local ground-based systems (building, antenna tower) by taking into consideration the following:

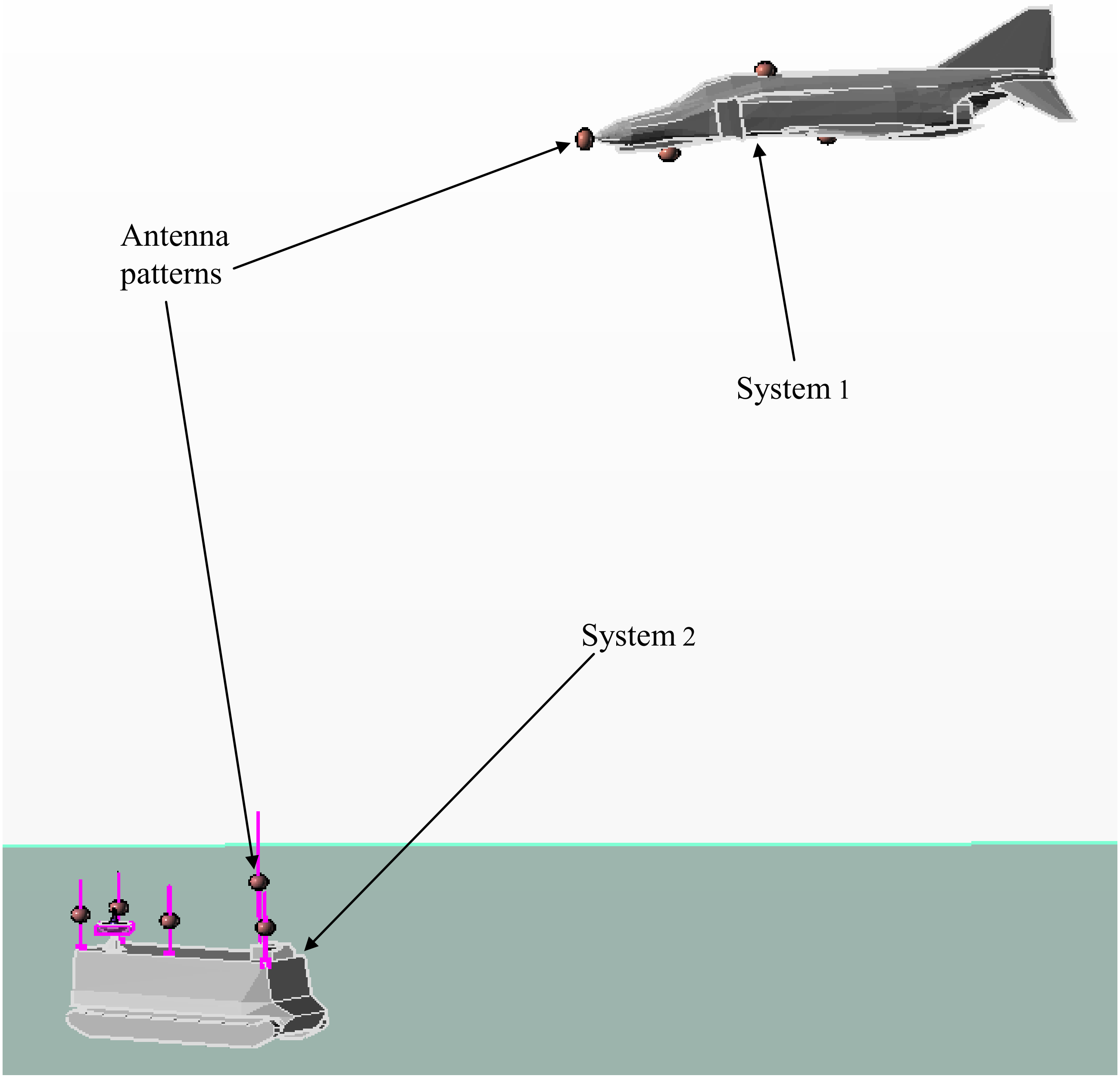
- various radio subsystems of different services (radio communication, radar, radio navigation, radio monitoring, etc.);
- spurious electromagnetic couplings of type "antenna to antenna";
- external EME.



APPLICATION AREA

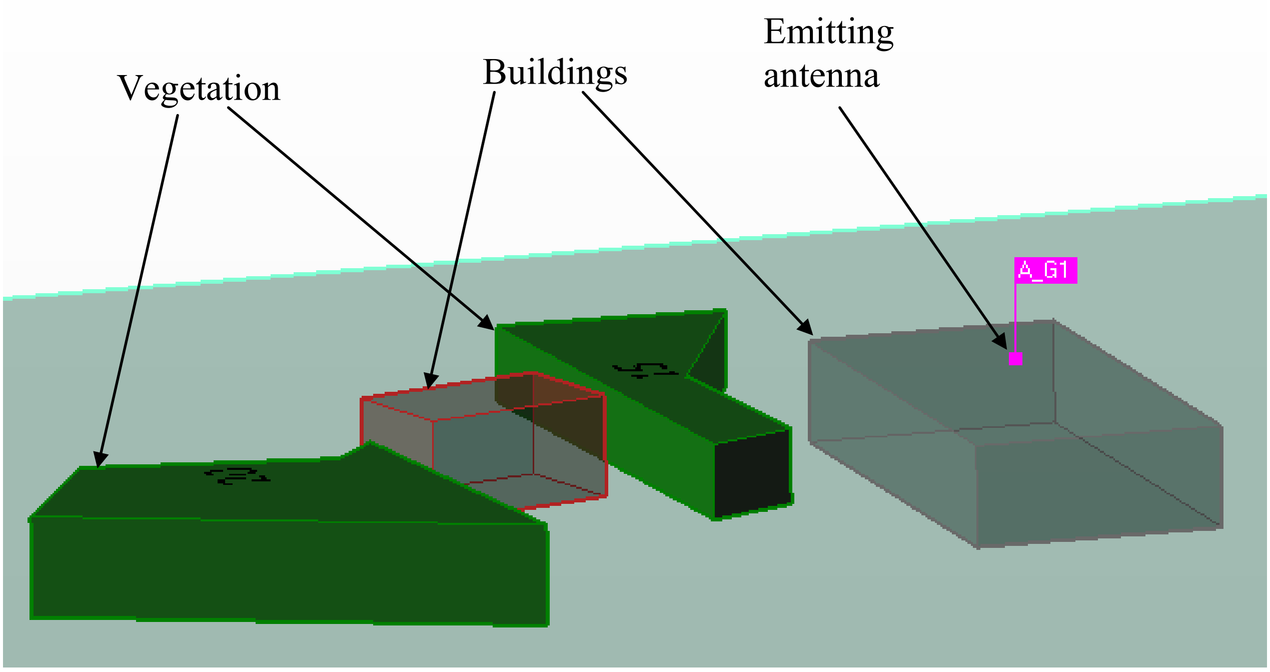
Intersystem EMC analysis, design, and maintenance of spatially-limited ground/water areas and aggregate systems (airport, seaport, military base, radio communication and control center, campus, etc.; several aircrafts, helicopters, ships, etc.) which may contain:

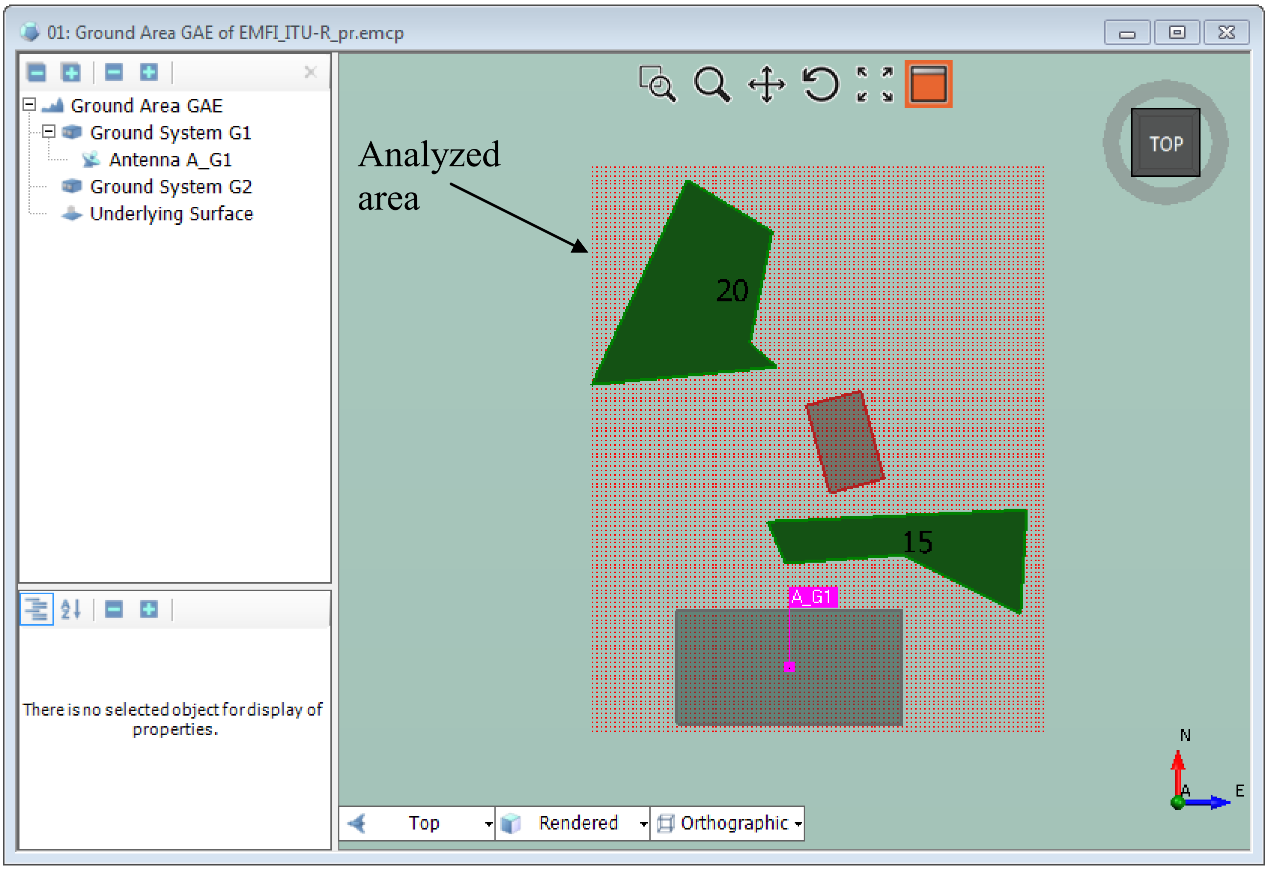
- several on-board systems;
- several ground-based systems;
- pieces of vegetation.



APPLICATION AREA

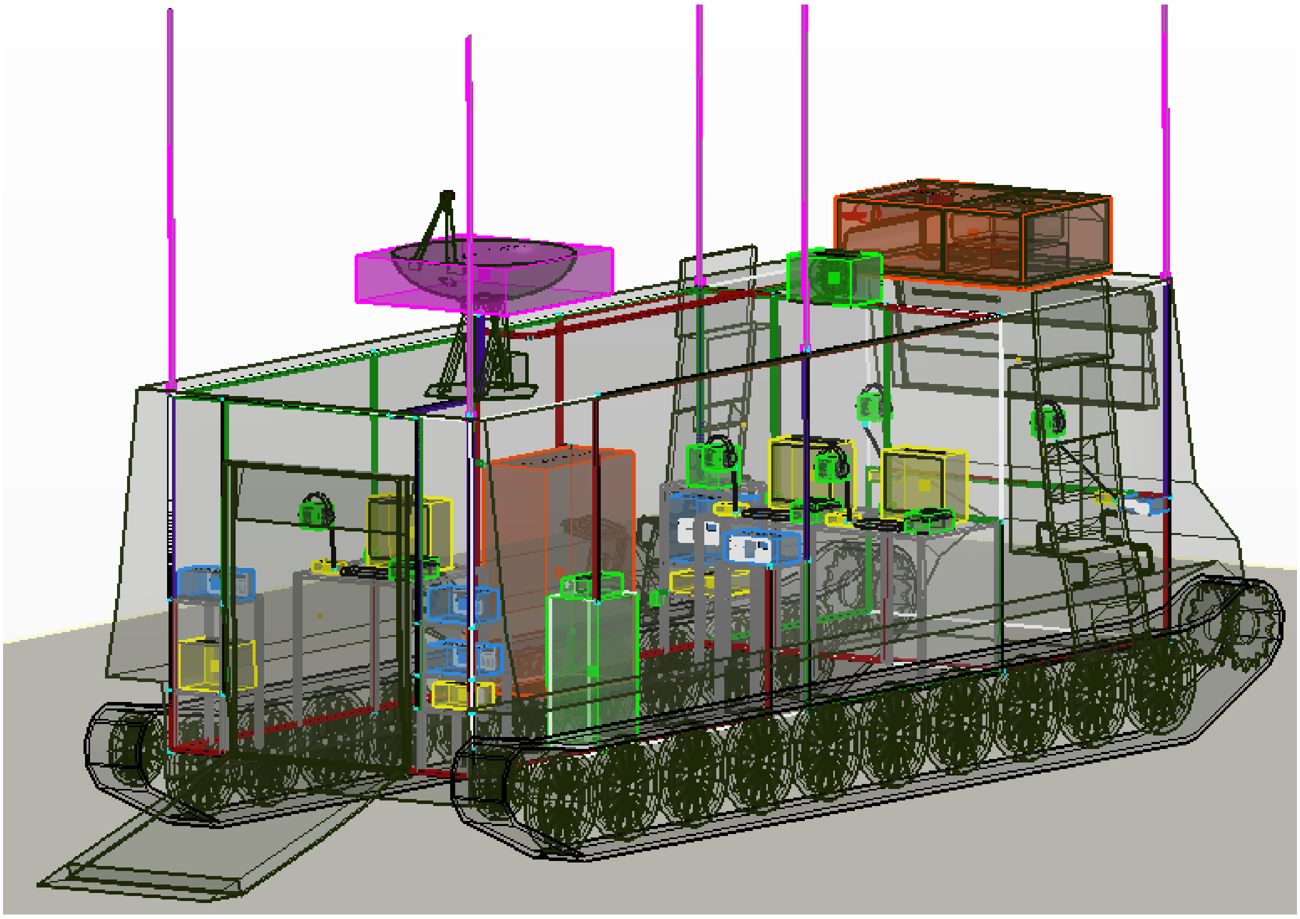
Analysis of the electromagnetic ecology and electromagnetic safety of radio transmitters located in a spatially-limited ground/water area by calculating the total electromagnetic field intensity (EMFI) distribution over the area.

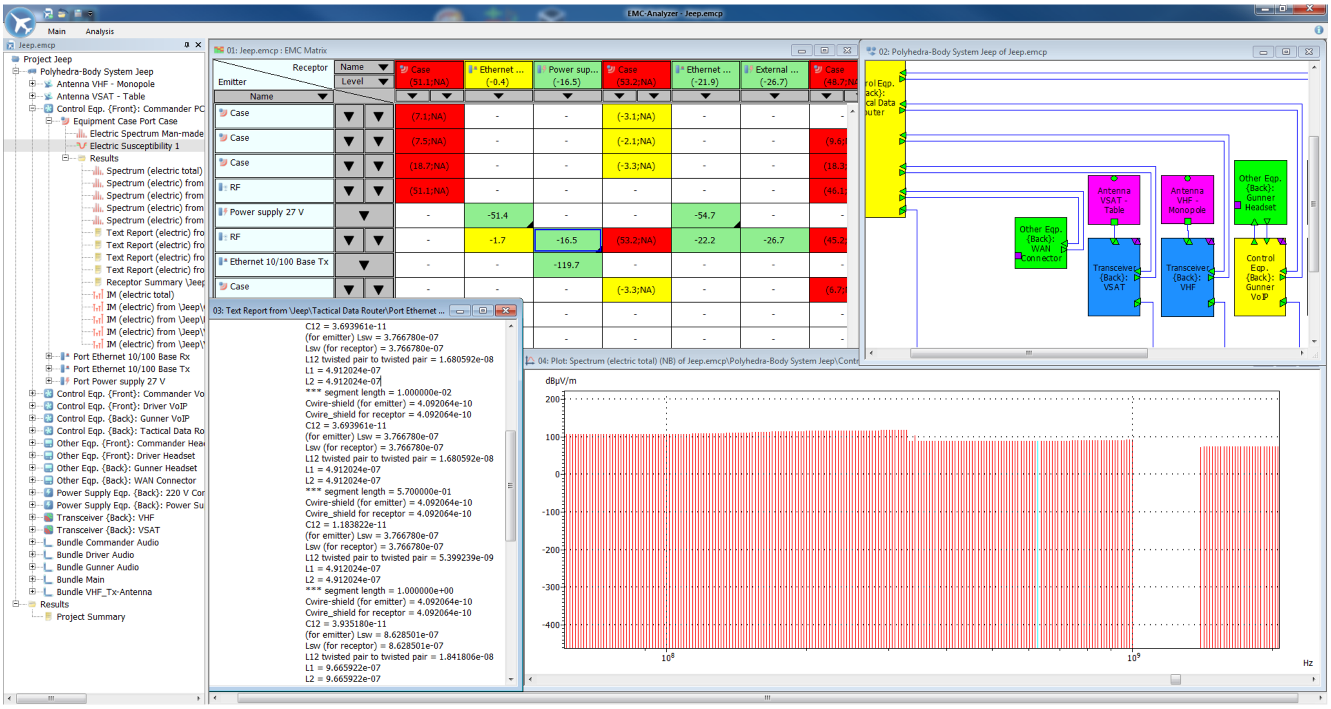




FUNCTIONALITY

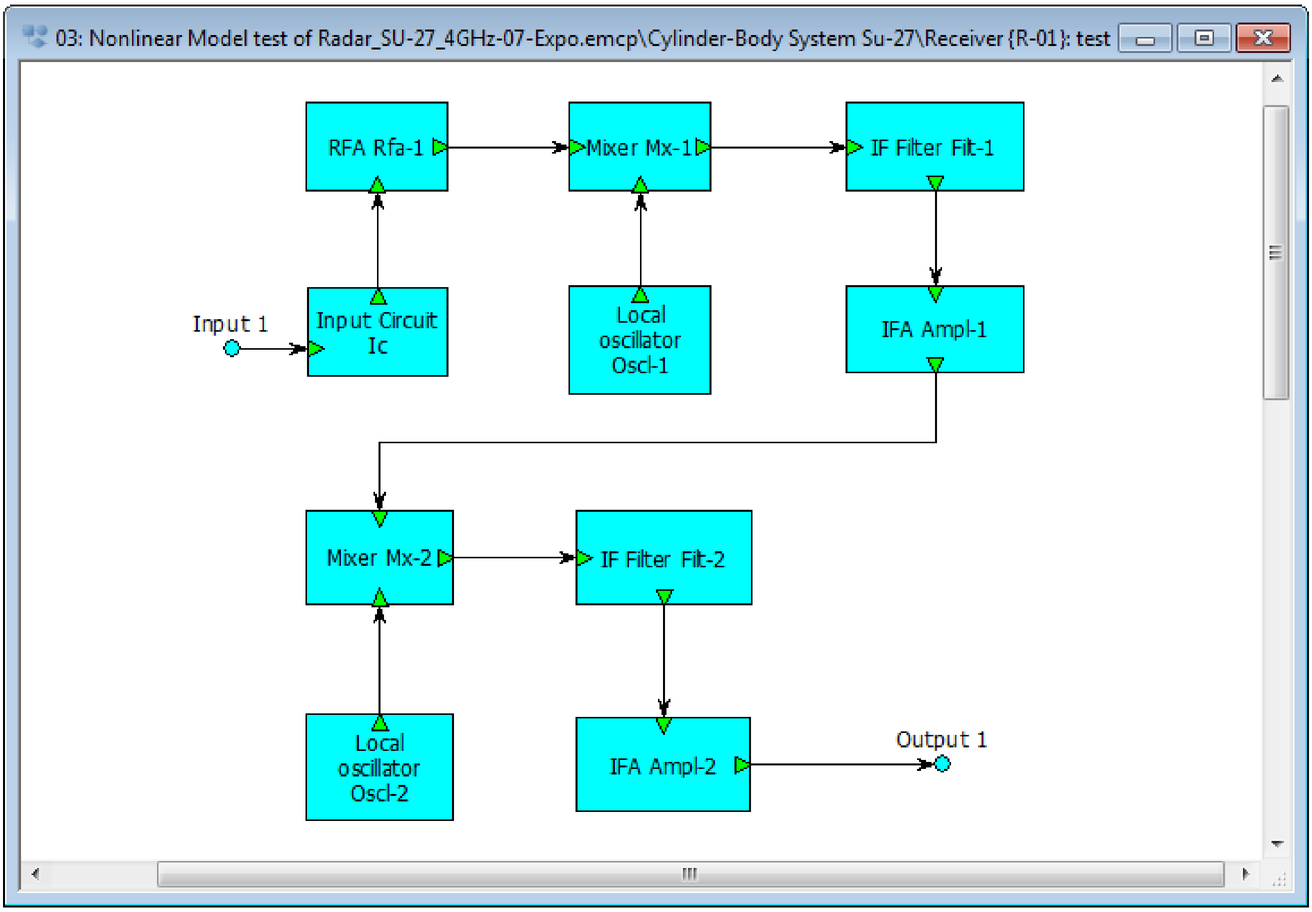
Linear analysis of EMC: linear simulation of signals and disturbances, detection of linear interference, calculation of the interference intensity, finding the sources of linear interference.

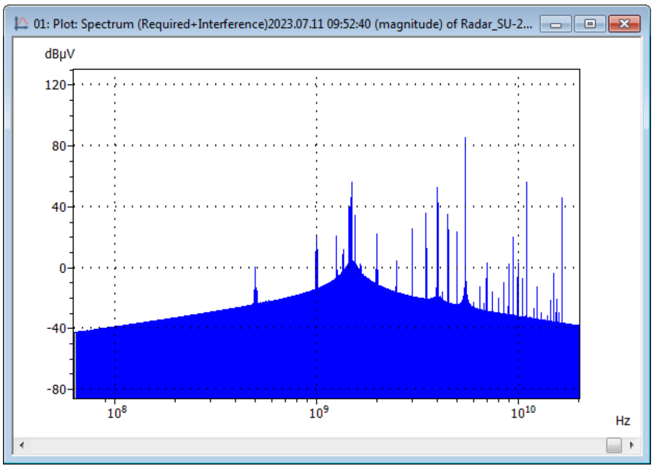


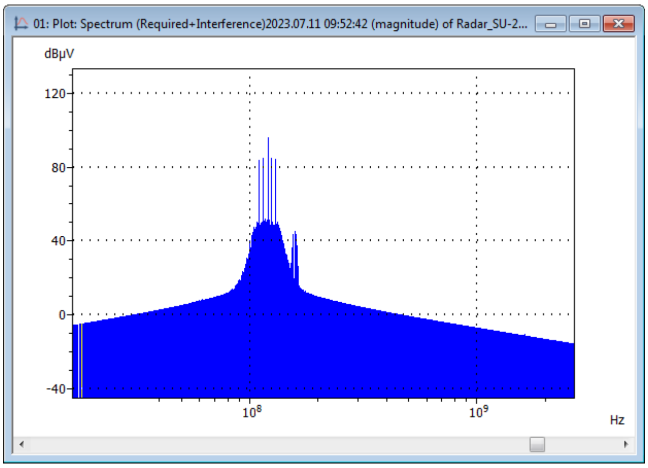


FUNCTIONALITY

Nonlinear analysis of EMC: detailed nonlinear behavior simulation of radio receiver operation in severe EME, detection of linear and nonlinear interference, calculation of the interference intensity, finding the sources of linear and nonlinear interference.

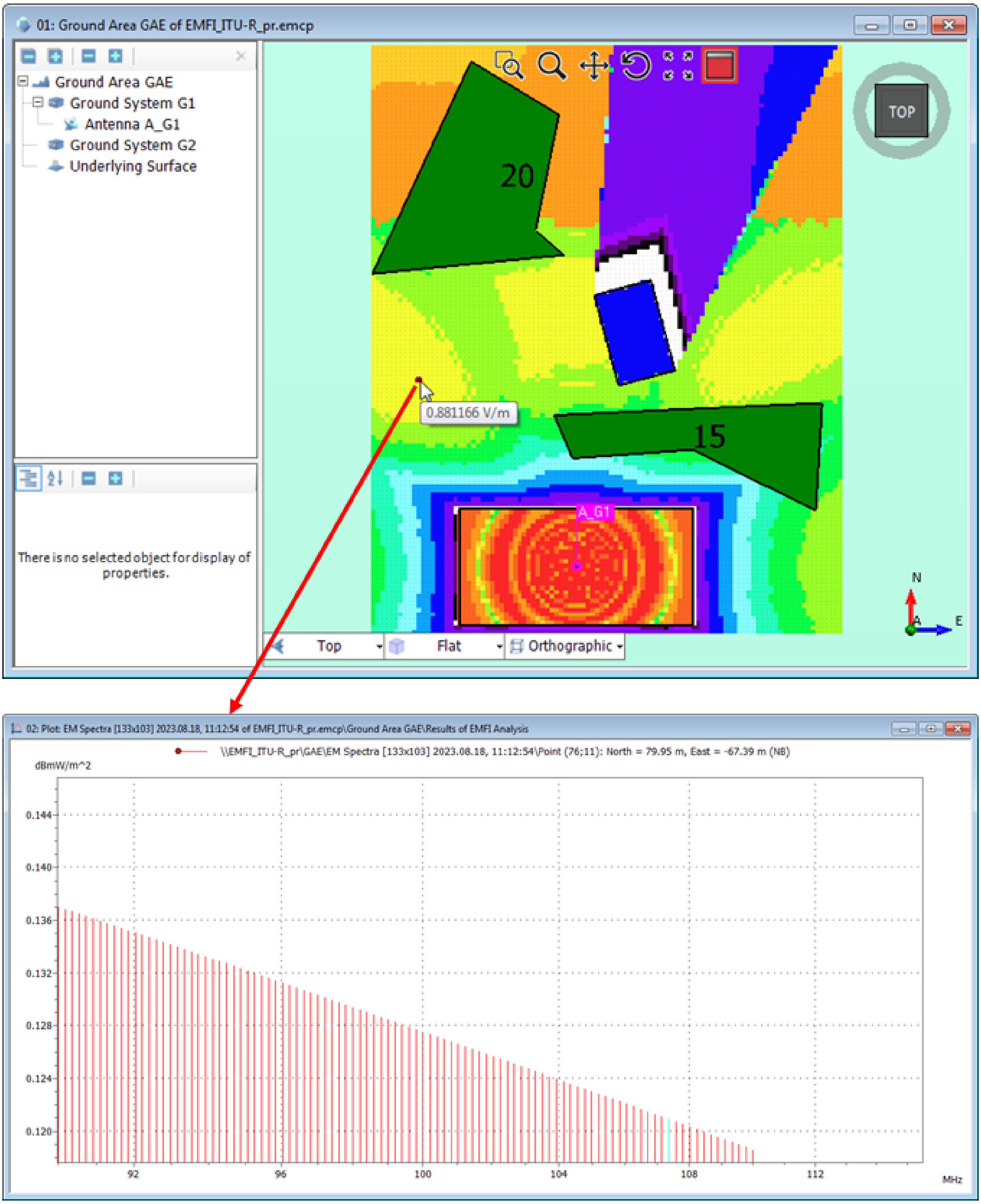






FUNCTIONALITY

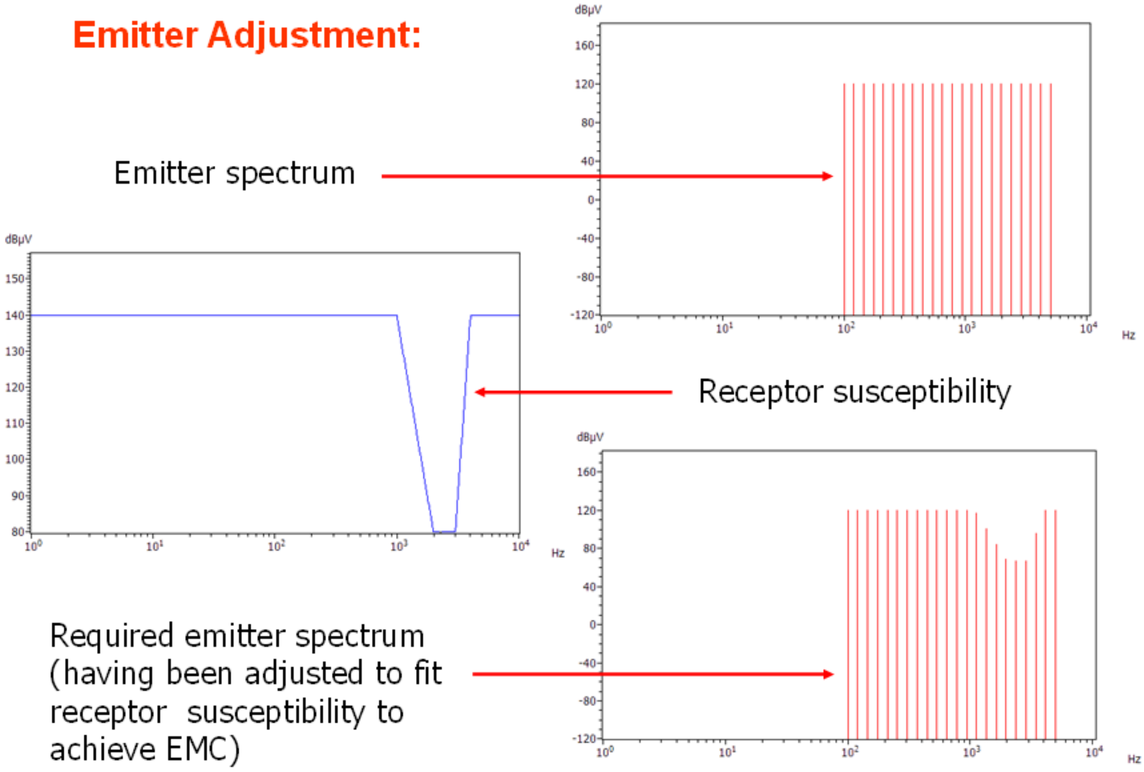
EMFI analysis: calculation of the field distribution in the spatially-limited ground/water area. Analysis results are represented as color map (EM Field distribution), numerical values (EM field intensity), and graphs (EM spectra).



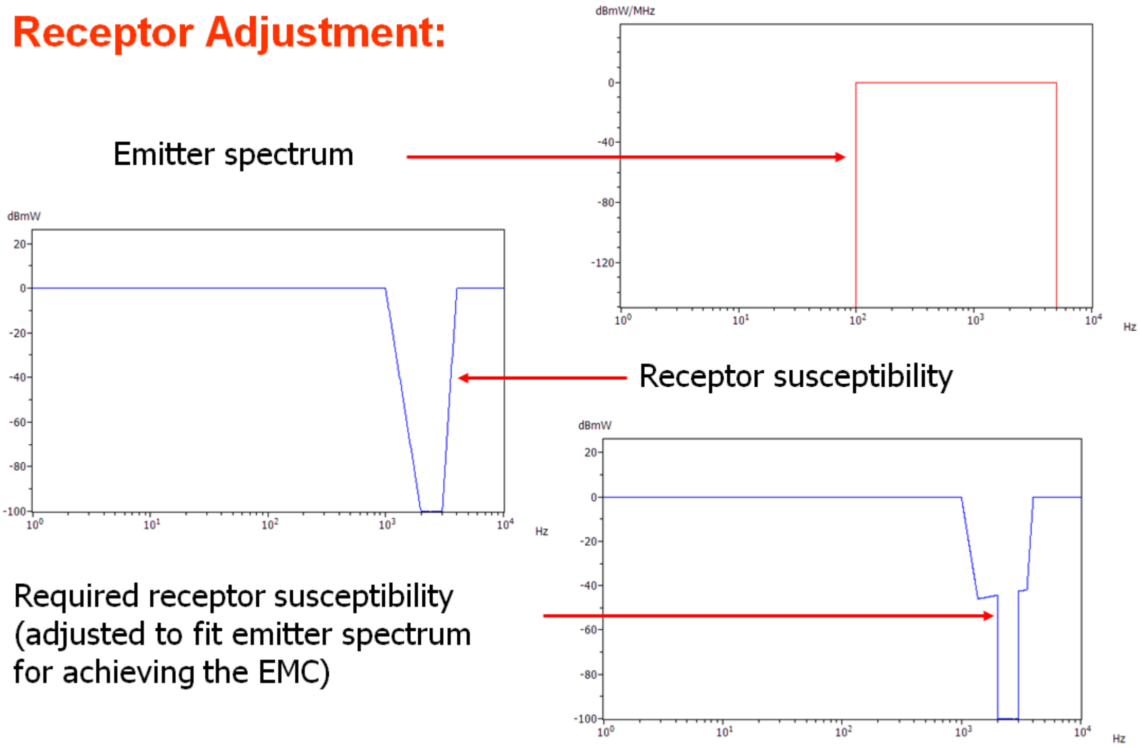
FUNCTIONALITY

Automated adjustment of equipment characteristics in order to solve the EMC problem.

Emitter Adjustment:

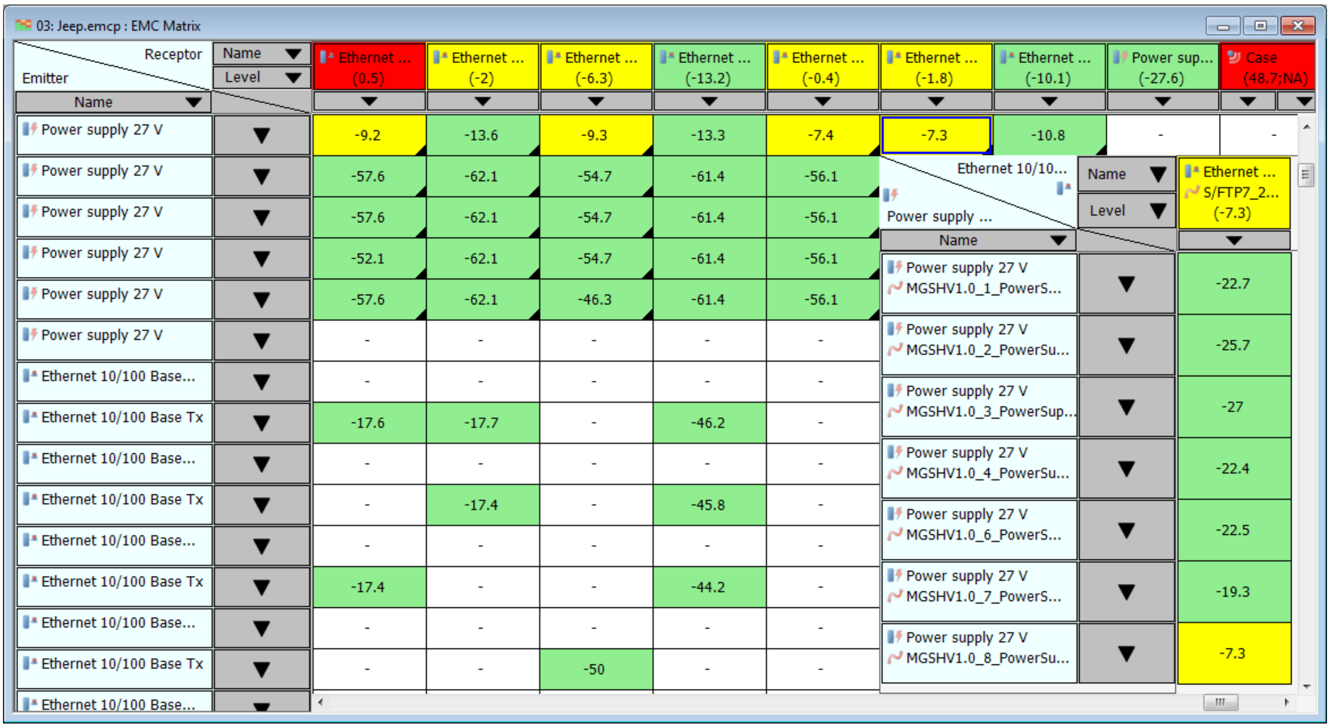


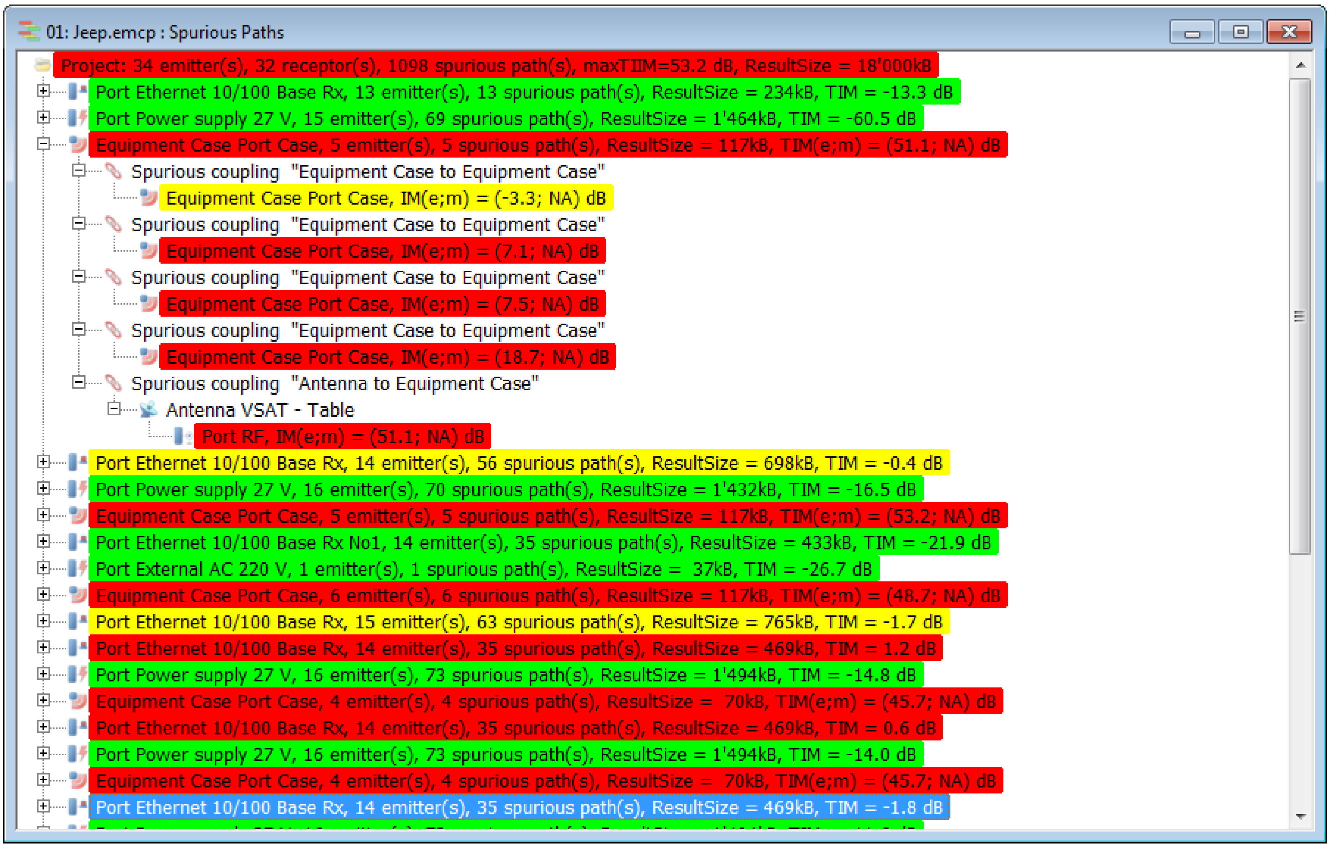
Receptor Adjustment:



FUNCTIONALITY

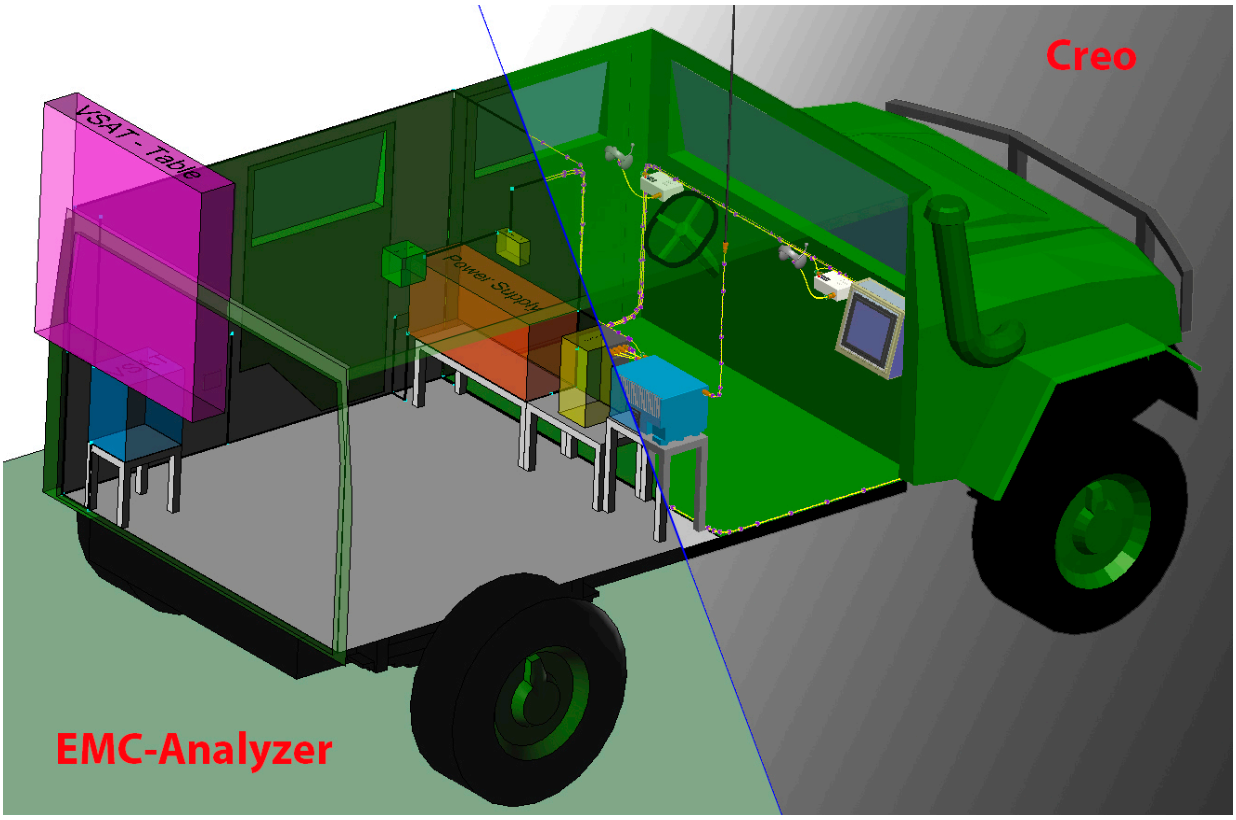
Representation of linear analysis results in the matrix view and in the spurious path tree view.

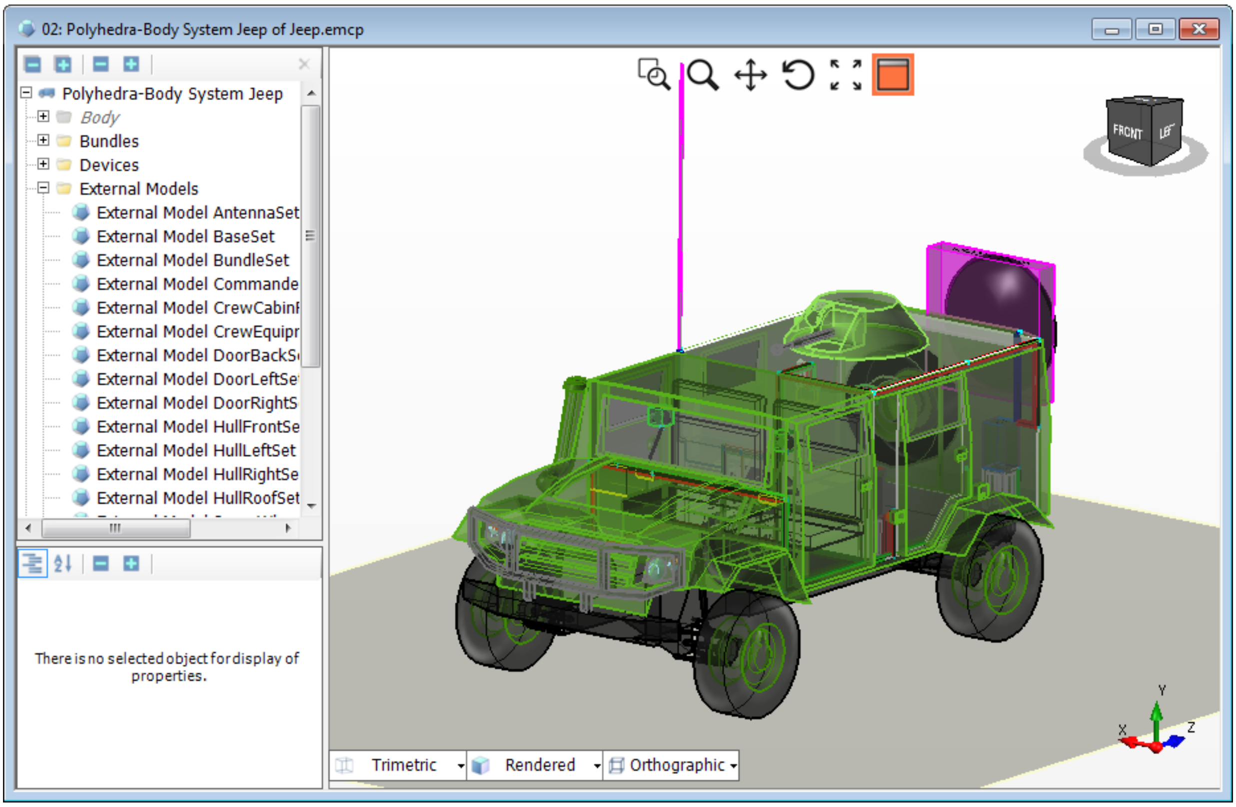




FUNCTIONALITY

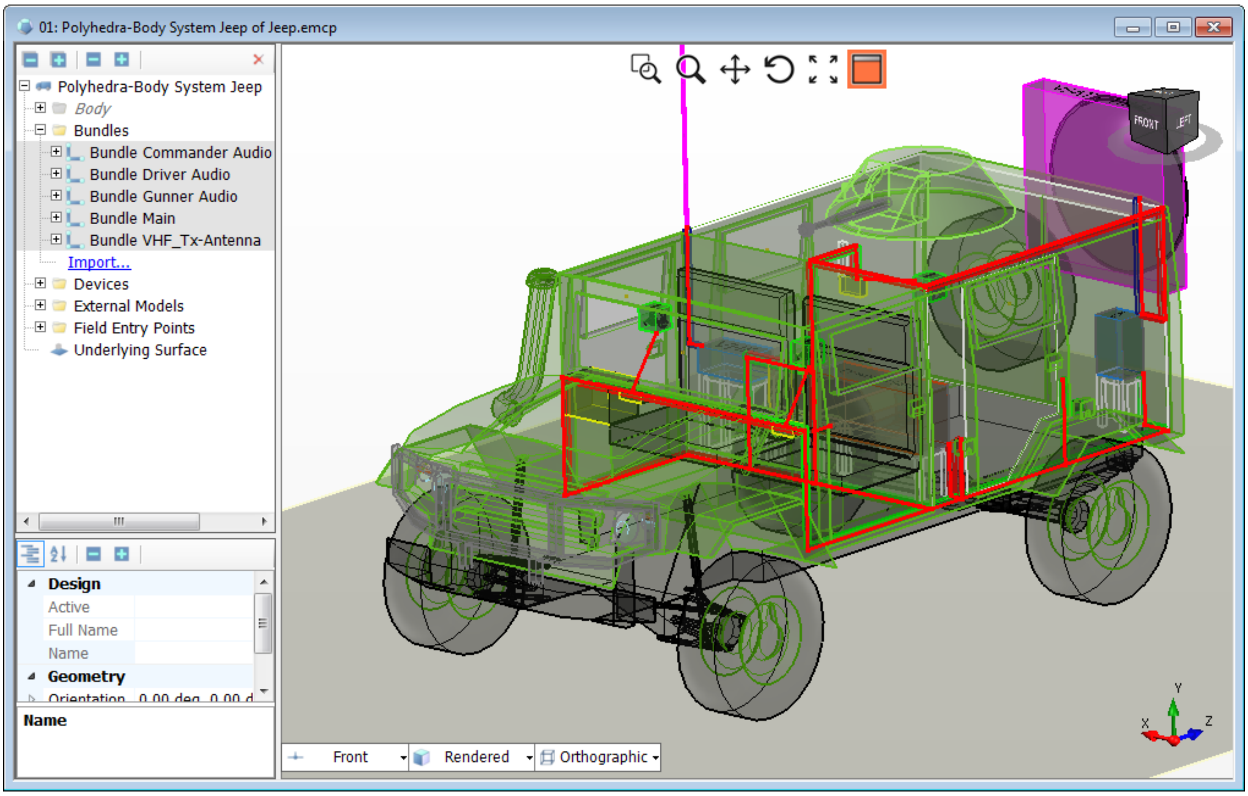
Ability to import the system geometry from CAD software.

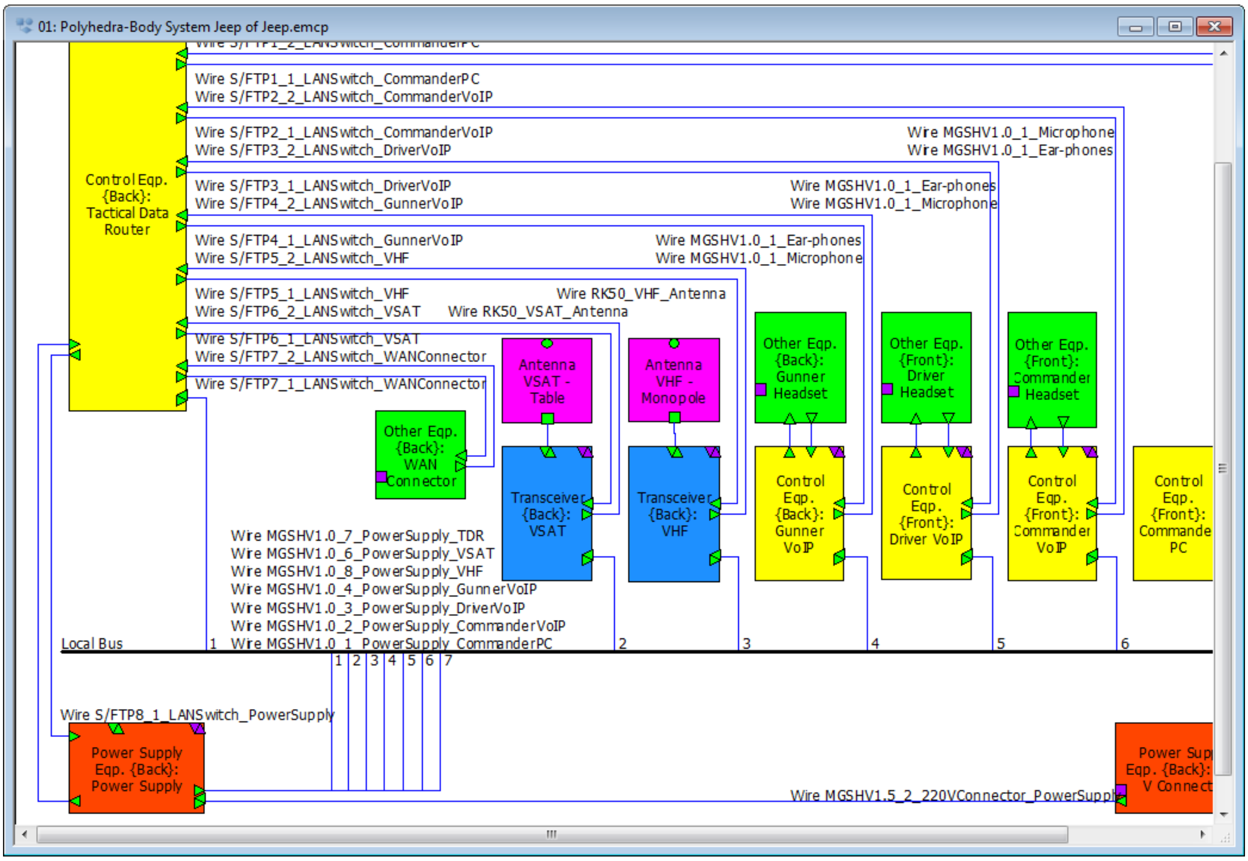




FUNCTIONALITY

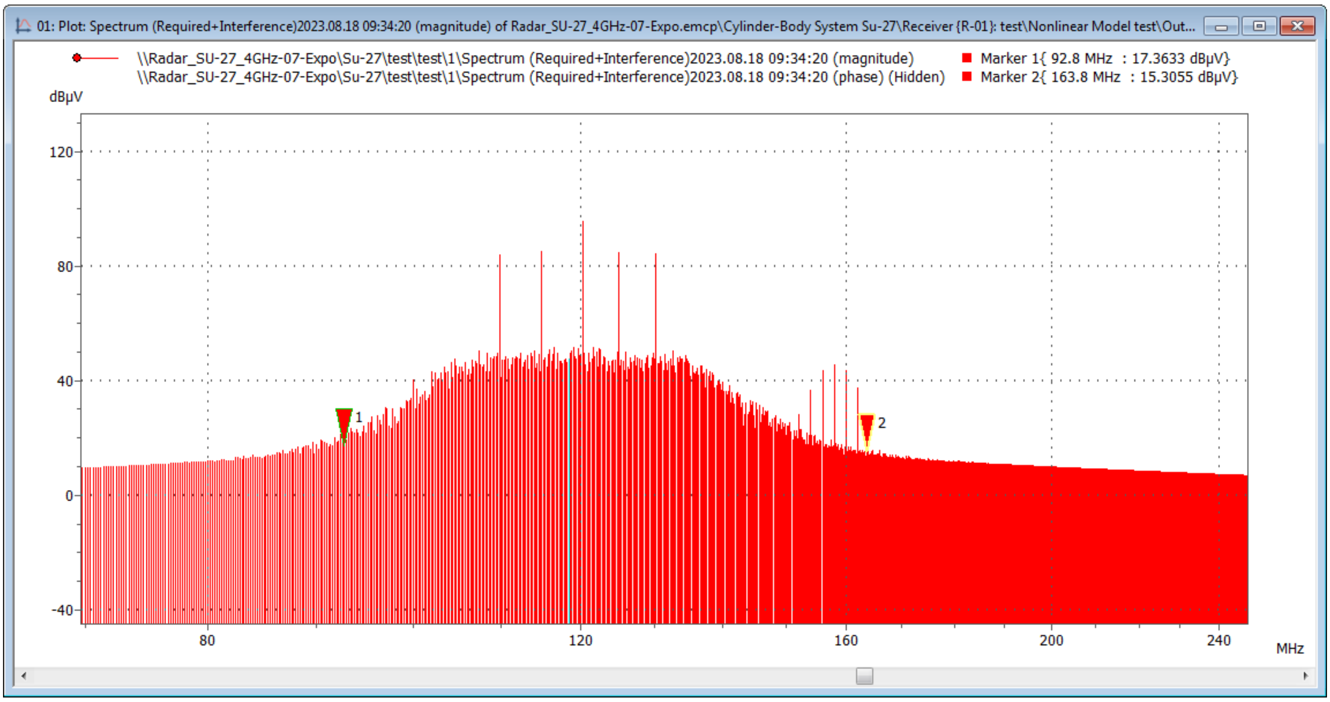
Support of cable networks: creation, editing, and also import of cables from CAD software.

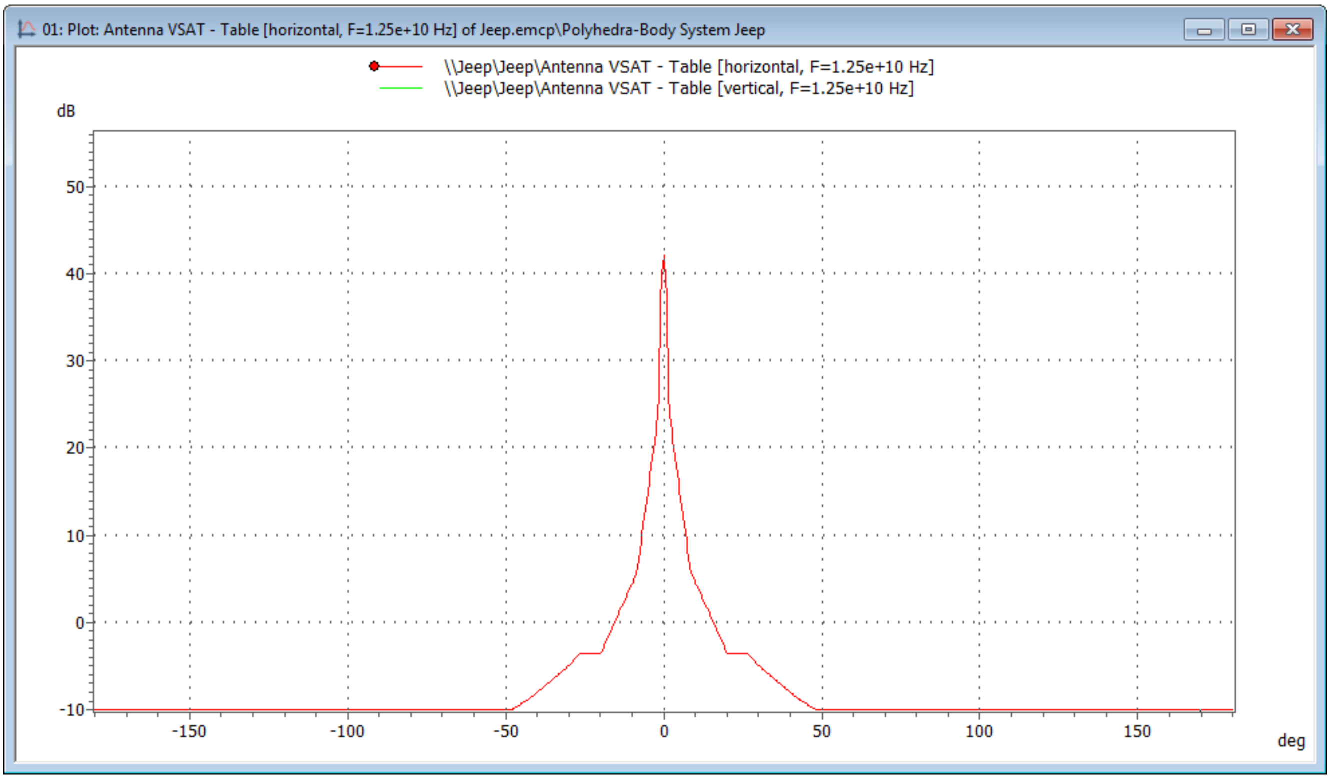




FUNCTIONALITY

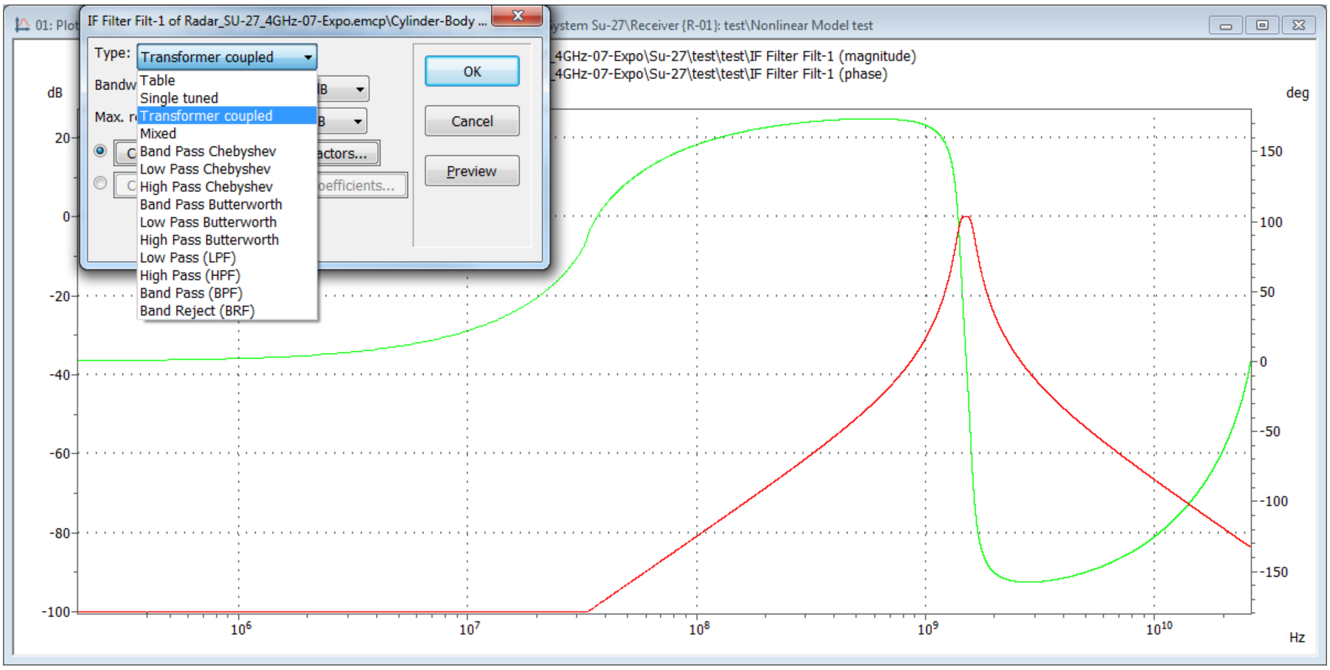
Visualization of plots for various characteristics (spectra, susceptibilities, radiation patterns, etc.). Using high-precision markers to display values on the graph.

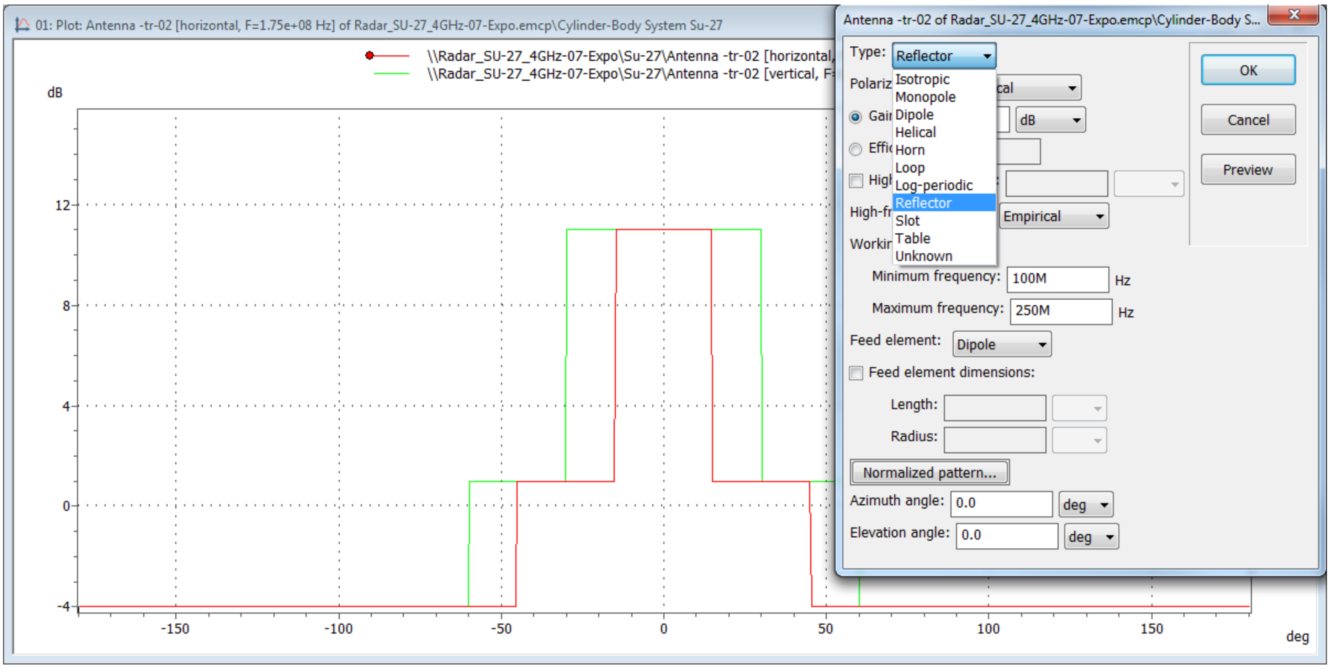




FUNCTIONALITY

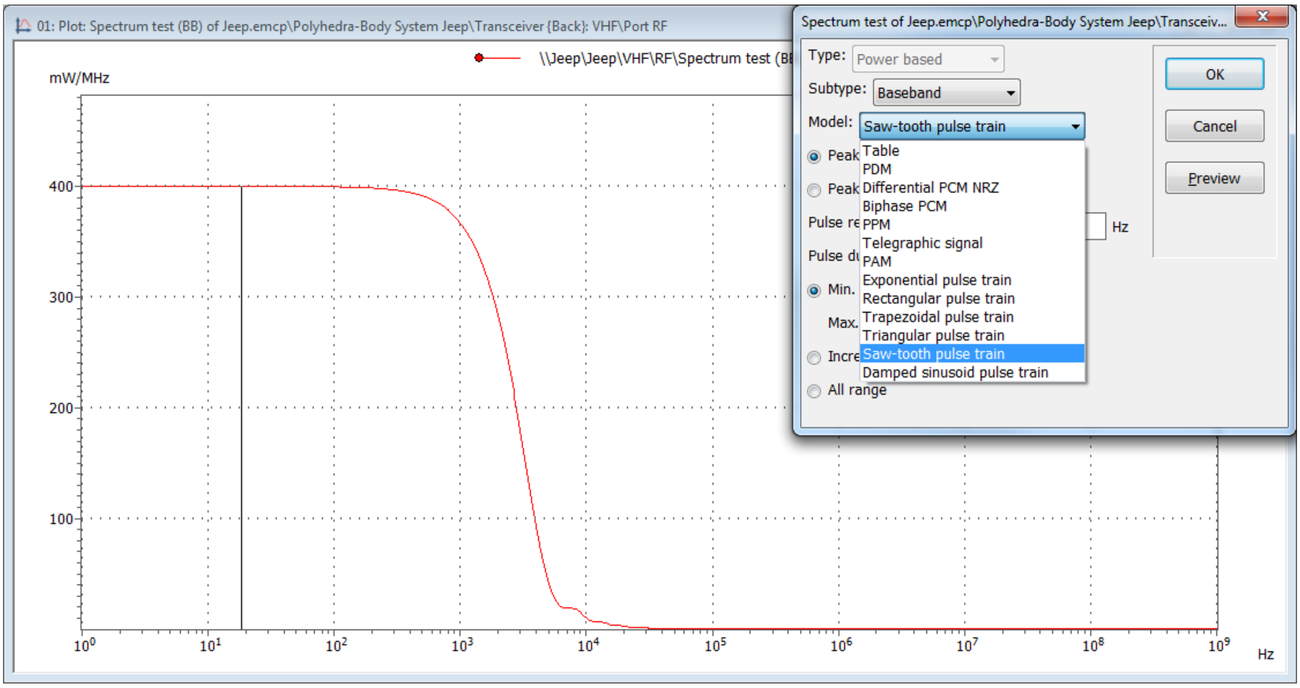
Variety of ***built-in models of filters and antennas***.

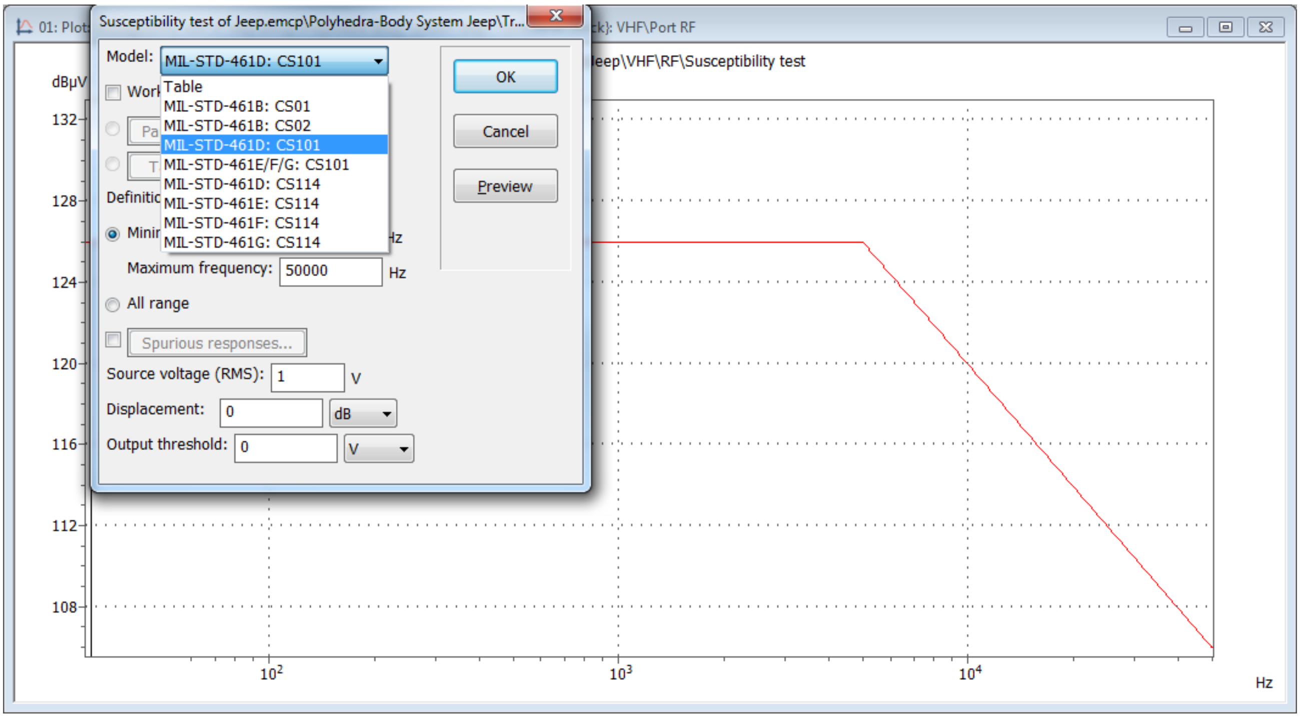




FUNCTIONALITY

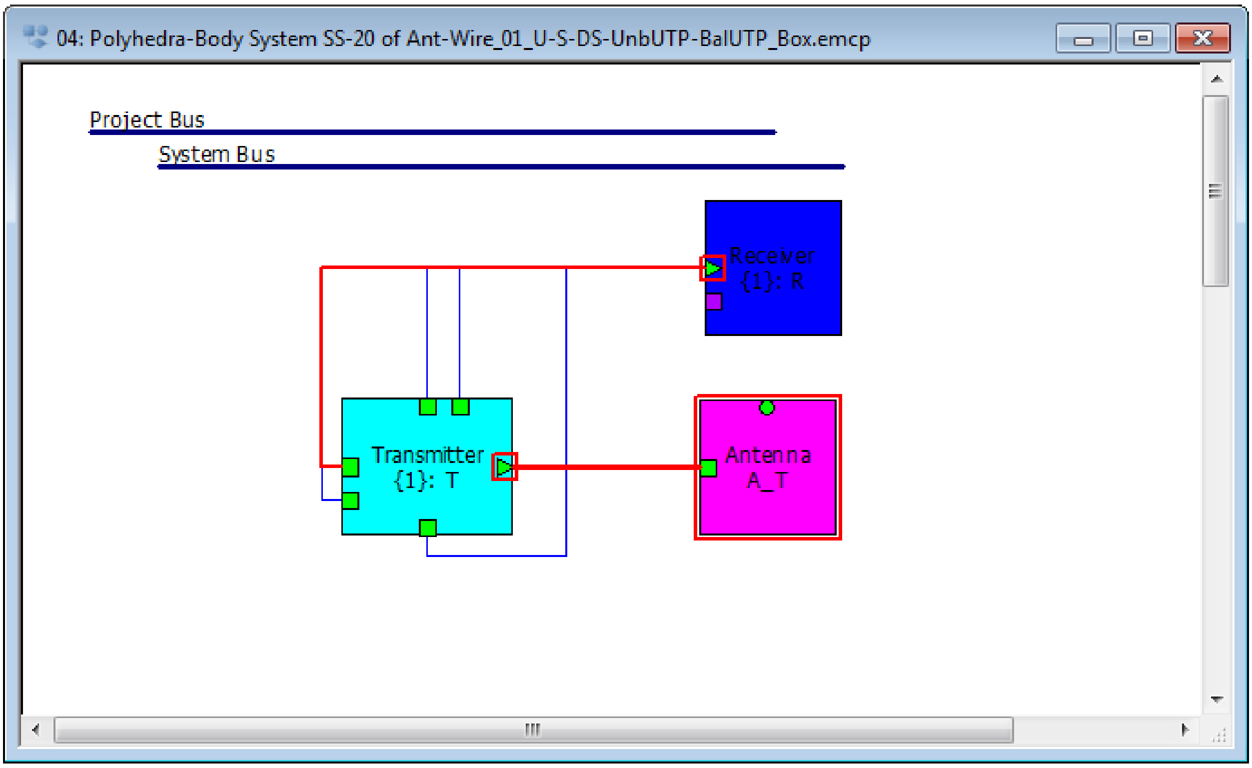
Wide range of ***built-in mathematical models of spectrum and susceptibility***; ability to involve user-defined models.



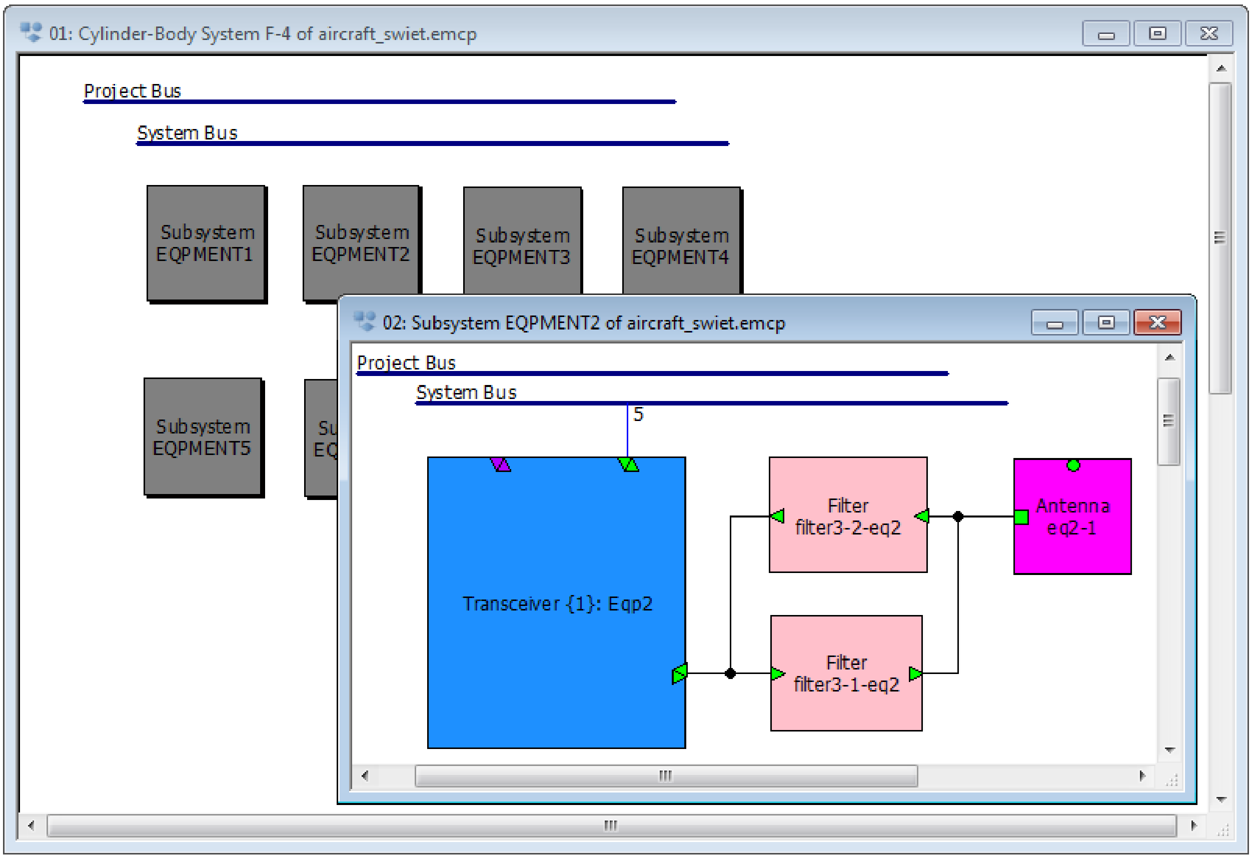


FUNCTIONALITY

Displaying the ***interference propagation paths***.

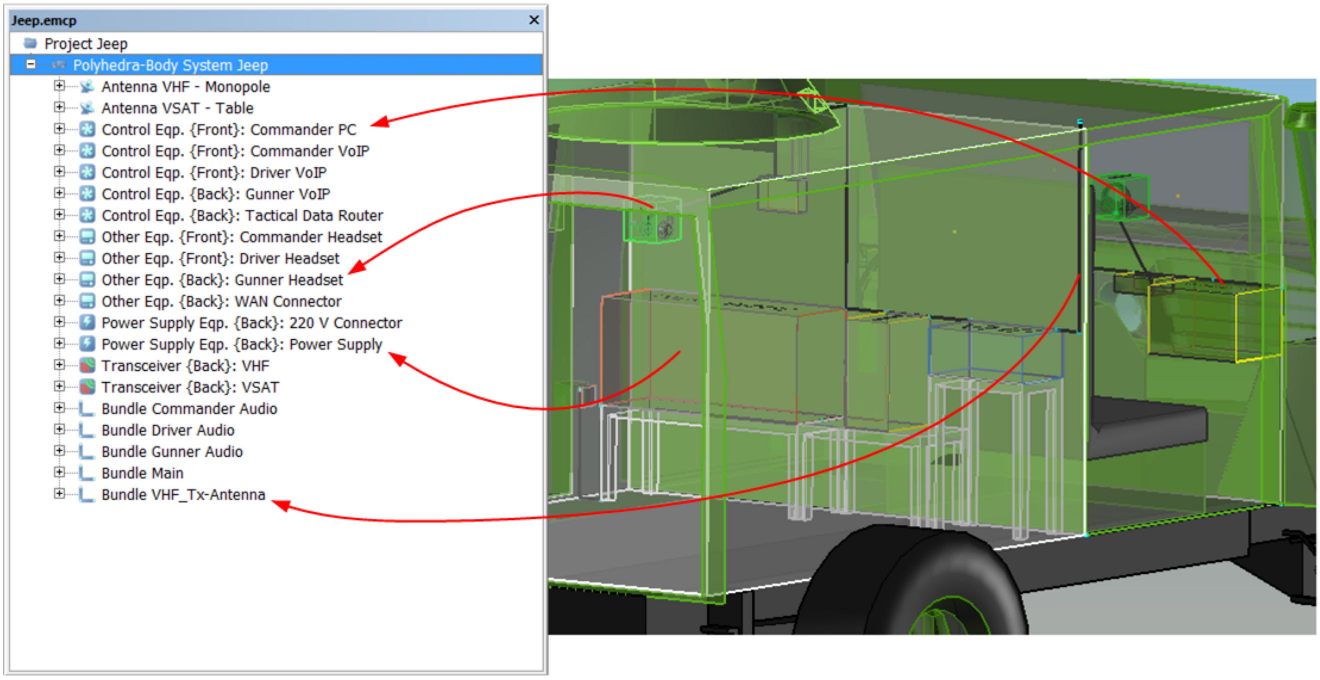


Ability to locate equipment in ***subsystems***.

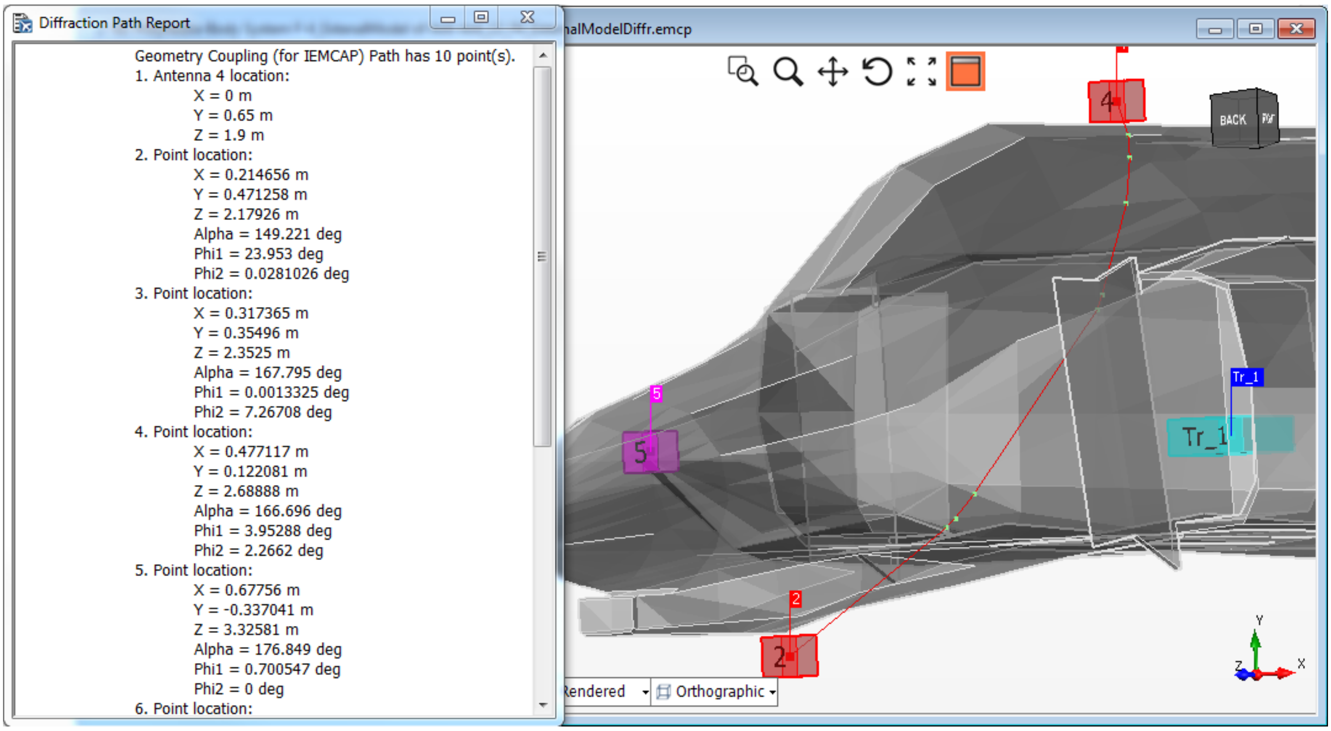


FUNCTIONALITY

Creation of ***effective computer (mathematical) model of on-board radio electronic system***; this model simplifies solving of EMC problems at all stages of system development and application.

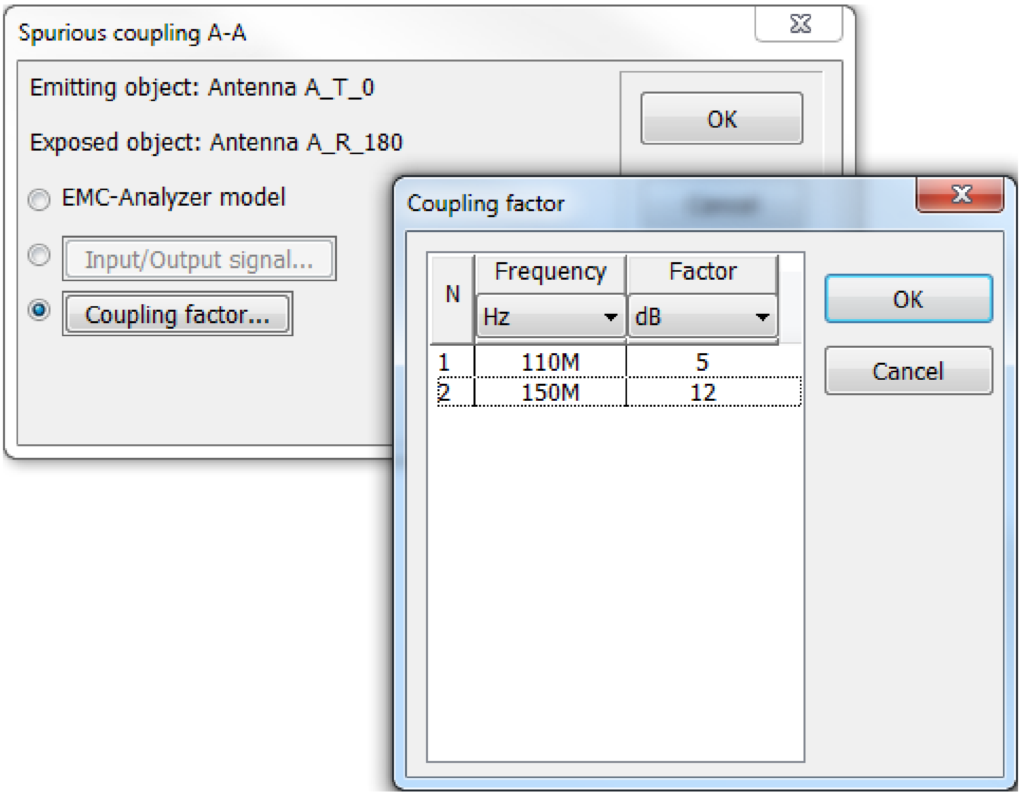


Calculation and displaying of ***diffraction paths***.

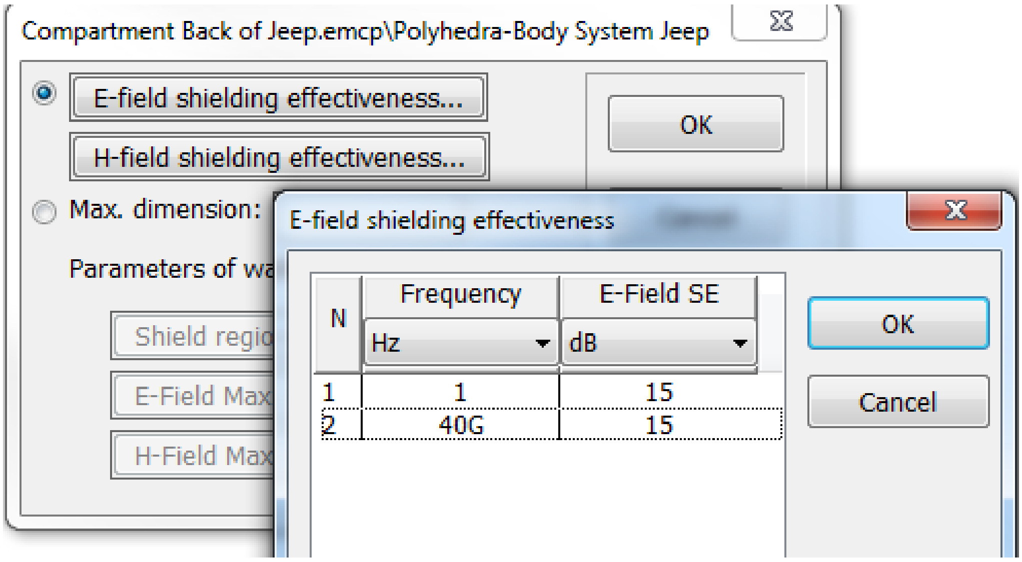


FUNCTIONALITY

Ability to improve the created model by measurements and more precise modeling of separate spurious electromagnetic couplings.

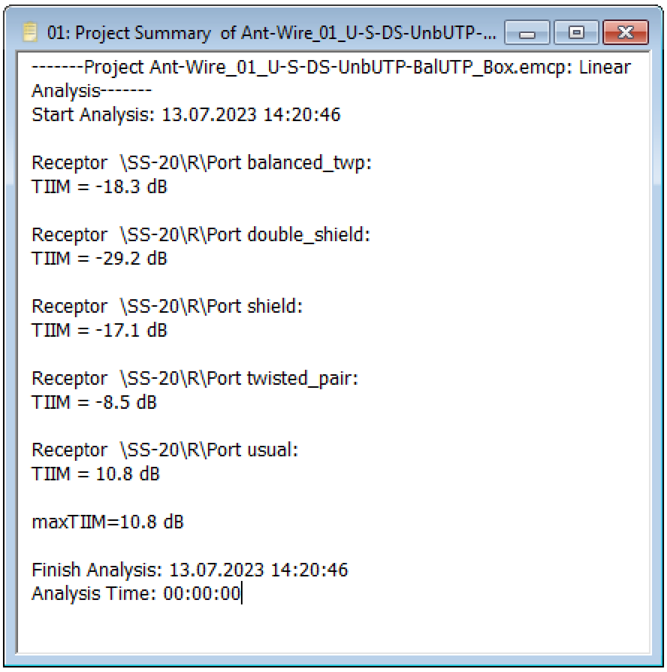


Account for shielding by system body, ability to consider the compartments and field entry points.

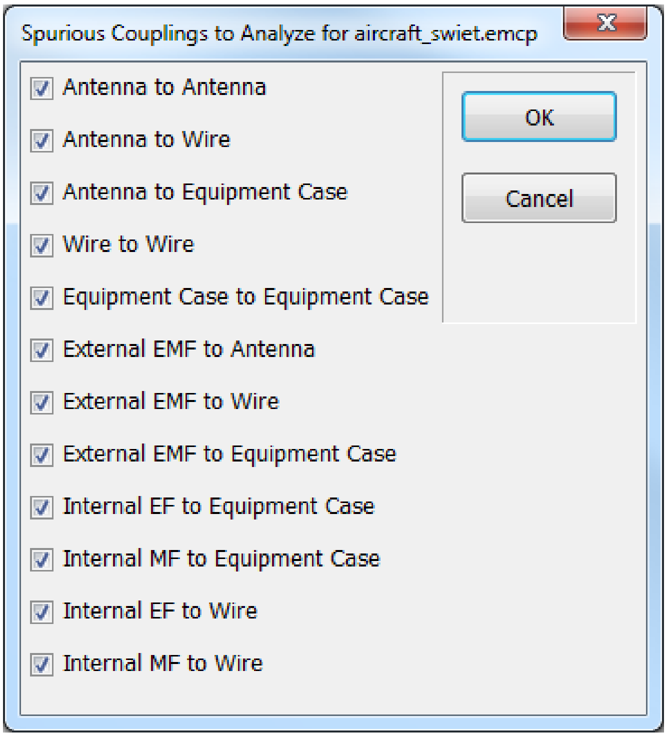


FUNCTIONALITY

Solving the EMC problems of on-board radio & electronic system and local group of on-board systems by using the system-level ***EMC criterion "Total Integrated Interference Margin" (TIIM)***.



Simultaneous consideration and danger estimation of ***spurious electromagnetic couplings of the various nature***.



ADVANTAGES

1) Analysis and solving of the most complicated EMC problems at a system level (“as a whole”) by taking into consideration the intensity of intrasystem interference.
2) Performing the analysis between several complex systems.
3) Quantitative estimation of all available spurious electromagnetic couplings of various physical nature (through antennas, between cables, between equipment cases, through external fields, etc.).
4) Decision-making on EMC compliance or incompliance in case of extremely large amount of spurious electromagnetic couplings.
5) Pinpoint accuracy of spectra representation (up to 1 000 000 frequency samples).
6) Ability of detailed nonlinear behavior simulation of radio receivers operating in a severe EME:
    a) EME can be formed by thousands of unmodulated, modulated, and noise disturbances;
    b) high-accuracy representation of radio receiver’s nonlinearity by using high-order polynomial models (up to 25-th order) can be used;
    c) simulation of nonlinear interference is performed very fast and accurately;
    d) full identification of the sources, reasons, places of occurrence, and parameters of linear and nonlinear radio interference (co-channel, adjacent-channel, image-channel, intermediate-frequency-channel, intermodulation, desensitization, amplitude and phase cross-modulation, reciprocal mixing of local oscillator noise, etc.) can be carried out.
7) Trade-off EMC analysis.
8) Calculation of necessary adjustments of equipment spectra and/or susceptibilities for the intrasystem EMC problem solving, specification generation for the equipment by using system-level EMC criterion.
9) Improvements in models and procedures of the well-known “Intrasystem Electromagnetic Compatibility Analysis Program” (IEMCAP), USA.
10) Compatibility with MIL-STD-461/462 requirements.
11) Compatibility with Windows XP/7/10/11 operating systems.

COMPARISON WITH CEM SOFTWARE

There are many well-known and rather perfect computational electromagnetics (CEM) software declared for solving of EMC problems, e.g., in frequency domain by method of moments (MoM) or in time domain by using FDTD approach. These tools provide the decision of concrete particular problems, e.g., detailed electrodynamics calculation of electromagnetic field distribution, characteristics of electromagnetic couplings between antennas, or characteristics of a particular spurious electromagnetic coupling in an on-board or ground-based radio system.

Therefore all well-known software tools for computational electromagnetics (including the most advanced, perfect, and expensive) do not replace, but only supplement "EMC-Analyzer", providing the following opportunities:

- more precise characterization of separate (e.g., the most important) spurious electromagnetic couplings in an on-board or ground-based system;
- improving the accuracy of the "EMC-Analyzer" by using these results of a more precise calculation of separate spurious electromagnetic couplings.

```
Mixer Mx-1
---Results of polynomial generation---
                  Polynomial coefficients
         1          3.162277660168380e+00
         2          1.000000000000000e+00
----------------------------------------
         100001 points
         NL Filter: Preparing 00:00
         262144 points
         Inverse Fourier transform  00:00
         524288 points in time
         Time domain calculations 00:00
         524288 points in time
         Fourier transform 00:00
         Calculation of phase shift 00:00
         100001 points
         Filter: Computations  00:00
         Calculating and saving spectrum: 00:00
Next step takes 00:00
IF Filter Filt-1
         100001 points
         Filter: Preparing  00:00
         Calculation of phase shift 00:00
         100001 points
         Filter: Computations  00:00
Next step takes 00:00
IFA Ampl-1
---Results of polynomial generation---
         Intermediate model: Exponential limiter
                  IDR     Calculated IDR   Polynomial coefficients
         1        ---          0.00         3.131786214551337e+
         2        ---        135.29        -6.671810536852046e-
         3        ---         81.72        -1.152287255203369e+
         4        ---        135.52         4.965068306494544e-
         5        ---         97.93         4.179435231145908e+
         6        ---        135.93        -1.086108692045681e-
         7        ---        105.58        -8.564509382447271e-
         8        ---        136.52         1.357635865057101e-
         9        ---        110.37         9.876457510049552e-
         10       ---        137.35        -1.454609855418323e-
         11       ---        113.86        -6.400712038985767e-
         12       ---        138.48         4.545655798182258e-
         13       ---        116.64         2.176163163515162e-
         14       ---        140.09        -7.102587184659774e-
         15       ---        119.09        -3.018766728255721e-06
         Root-mean-square IDR prediction error: 0.00 dB
----------------------------------------
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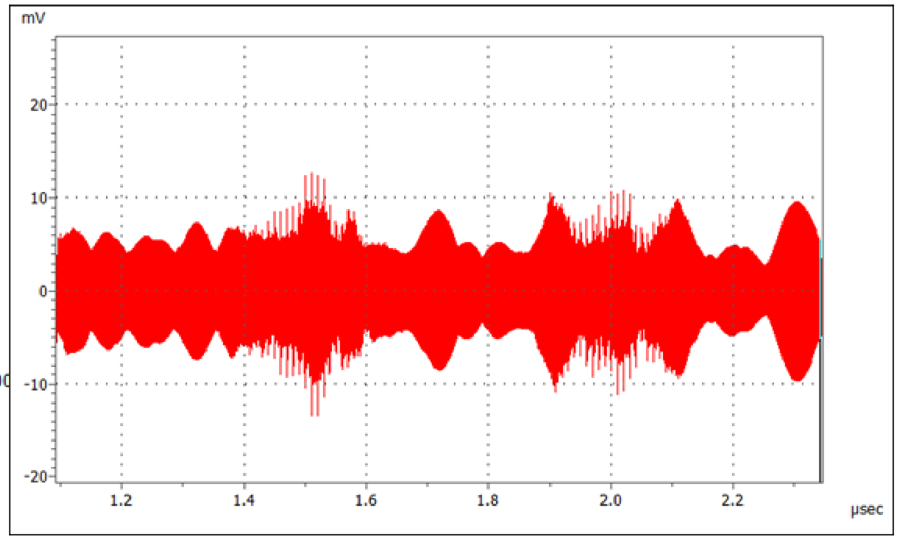
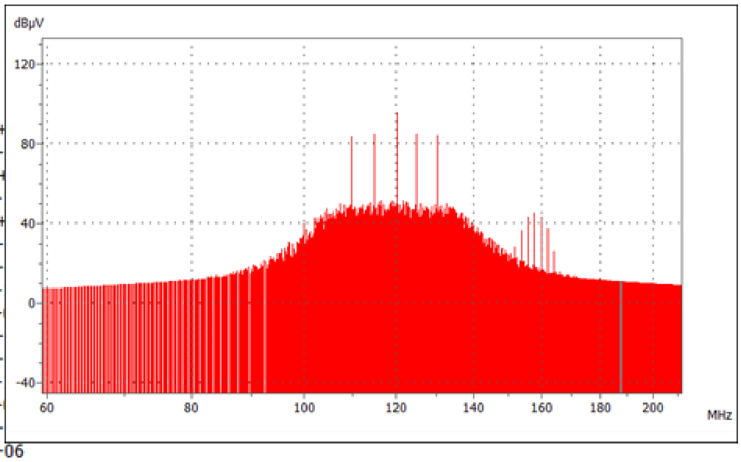




APPLICATION EXPERIENCE

1) Hundreds of original and known models and procedures are used in "EMC-Analyzer". Approximately 80% of them are widely known and published in the scientific literature. Some of these models and procedures are not the most exact; however, the refusal of application of more exact models and procedures is caused by the need of obtaining a useful practical result with reasonable spending of time and computational burden.

2) It is very important that the "EMC-Analyzer" models of spurious electromagnetic couplings provide optimal for practice pessimistic nature of EMC estimations.

According to the published data, the application of these models to the EMC analysis of on-board aircraft equipment yields the following results:

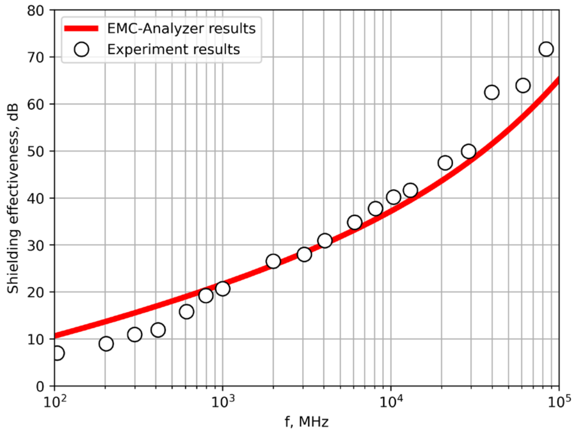
− the probability of a correct prediction of interference presence or absence: 0.82;

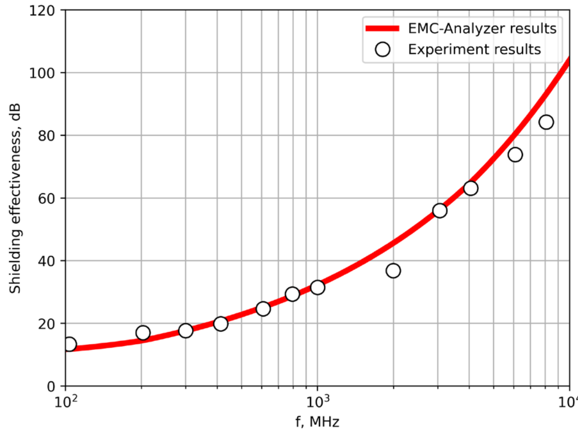
− the probability of a false alarm (the interference is predicted, but in practice it is absent): 0.17;

− the probability of the interference omission (the interference is not predicted, but in practice it is present): 0.01.

Similar results are observed in case of "EMC-Analyzer" application to the EMC analysis of other on-board or ground-based systems: the probability of the interference omission does not exceed 1-5 %.

3) The ability of more accurate definition of characteristics of any spurious electromagnetic couplings existing in on-board or ground-based system is provided in "EMC-Analyzer" (the user must have the results of more exact modeling or measurements). Such feature allows to improve permanently the computer model of on-board or ground-based system created with the help of "EMC-Analyzer"; this makes extremely easier to solve the EMC problems at late stages of system life cycle, in particular, at exploitation and modernization phases (for example, if it is required to enter a new equipment into the structure of a system or to replace separate kinds of the equipment).

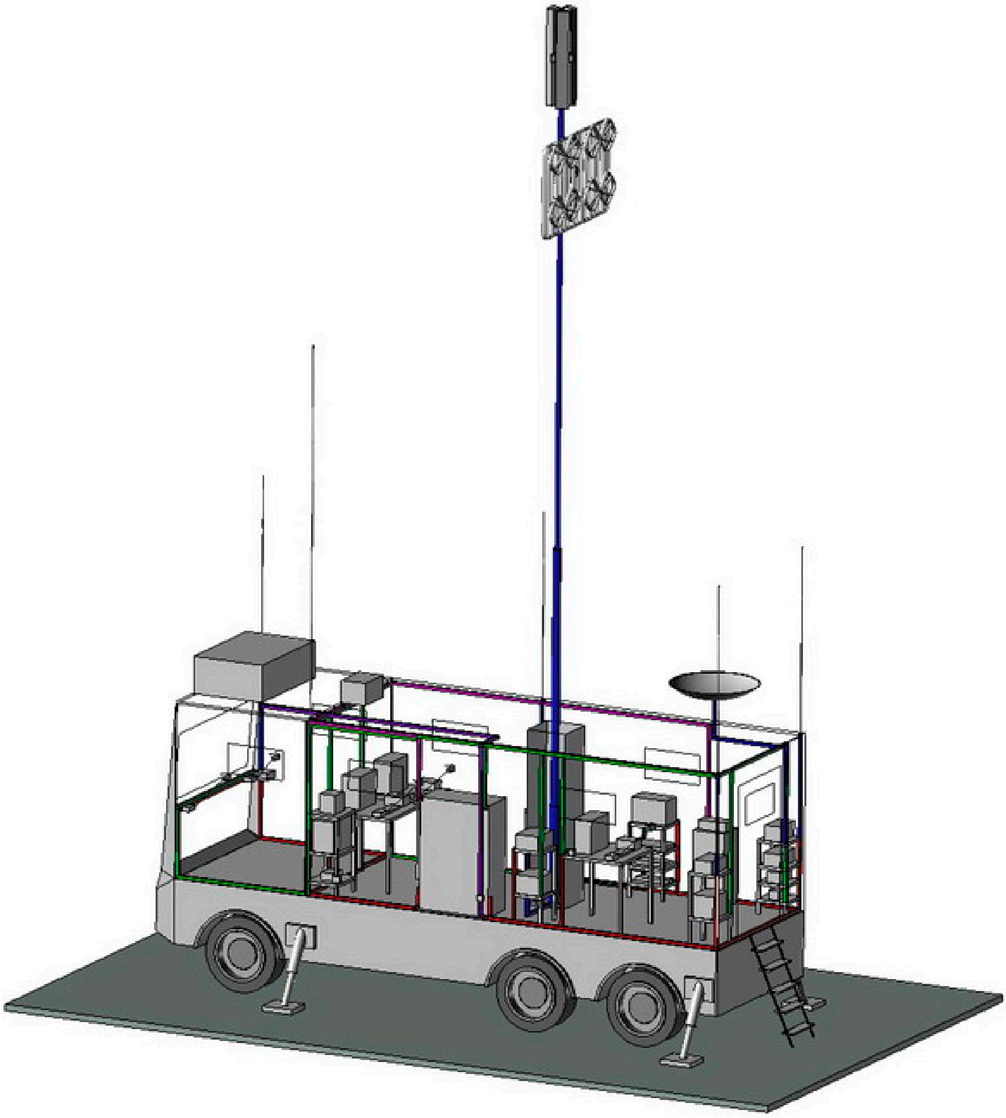




CONCLUSION

Thus, “EMC-Analyzer” is the indispensable assistant for:

- creation of complex radio and electronic systems, reducing the cost of development and realization stages;
- modernization of systems (in the way of replacing or adding the radio electronic equipment, changing equipment allocation, etc.);
- behavior simulation of complex systems for estimation of their ability to work in a very complicated EME.



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