WIPL-D Pro: What is New in v21?

Key features and enhancements introduced in v21 include:

1. Collecting Big Data by 3D EM Simulation:
    a. Fast calculation of 3D radiation pattern
    b. Fast calculation of current distribution
    c. Parallelized calculation of monostatic RCS
    d. Parallelized evaluation of multiple excitation (columns)
    e. Setting an arbitrary number of direction grids to be used either for excitation or radiation pattern evaluation
2. RCS of metallic structures at high frequencies beyond the scope of the direct Method of Moments (MoM) solution
    a. PO solution for bistatic and monostatic RCS
    b. Extrapolation of MoM solution to higher frequencies
    c. Combined extrapolated MoM solution and PO solution

Other notable features and enhancements in WIPL-D Pro v21 are:

1. Novelties regarding radiation pattern (RP)
    a. RP from Selected Elements
    b. Images of selected elements can be included in the calculation of RP
    c. Fast Calculation of RP
    d. Run as Avoided with Extrapolation
    e. New ways to define custom excitation waves and far field directions of interest
2. The Impedance Calculator has been introduced
3. New functionalities in Symbol list
    a. Extended replacing of symbols
    b. New mathematical functions sinpi() and cospi()
    c. Symbol can have up to 4096 characters
4. New type of basis functions - Physical Optics (PO)
5. Current sources (CS)
    a. Where symmetry planes are defined, images of imported CSs are included when calculating RP
    b. Faster calculation of currents leads to a great speed-up for simulations with a large number of elements
    c. Improved the accuracy of the currents computation of segmented plates
6. Calculation of Scattered Near Field Only
7. Copy Layer is more robust and reliable
    a. Nonconvex plates are correctly copied
    b. Wires are ignored if selected
8. Using Green Functions (GF)
    a. Conductivity (σ) can be defined for Half Space
    b. User is warned of an irregular setup
9. Many improvements in the software environment
    a. Keyboard shortcut to start simulation
    b. More icons on the taskbar
    c. Icons in the toolbars can be enlarged
    d. Improved Domains table
    e. Nodes are automatically marked for dimension measurement
    f. Higher and adjustable sensitivity when selecting nodes on high-resolution monitors
    g. Improved display when working with multiple monitors
    h. Smooth scaling of font size
    i. Using the mouse wheel to zoom in and out aligned with similar programs
    j. Switching off “End of simulation” sound
10. Minor improvements and bug fixes
    a. Domain names inherited from CAD projects
    b. STL decimation parameters are stored
    c. Several bugs related to Import have been resolved
    d. New options for saving current coefficients

Enhanced Post-Processing for Smarter Insights!

The upgraded WIPL-G post-processing application offers advanced analysis and visualization of simulation results. Check out the full release notes.

1. Novelties Regarding Radiation Pattern

Working with the current sources has been expanded to include several new features. The improvements will be demonstrated using a horn antenna.

a) Radiation Pattern from Selected Elements

Sometimes it is of interest to perform the calculations considering only some parts of the model structure. The procedure of how to perform the calculations using only selected parts will be demonstrated using a horn antenna.

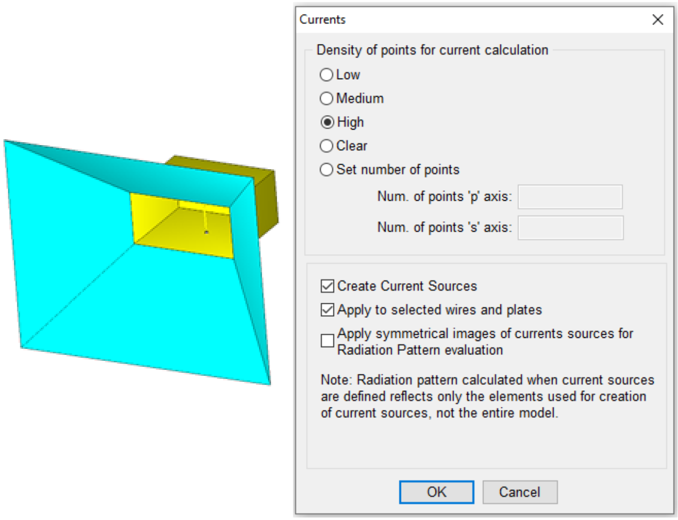


Fig. 1. Selection of elements and setting up the calculation of RP from selected elements.

The user may want to explore what would be the radiation pattern of the structure comprising only the open rectangular waveguide and the wire.

All the plates belonging to the rectangular waveguide (five yellow plates shown in Figure 1) should be selected in the usual way, together with the wire probe. In the next step user should open the Currents menu (Edit/Output Result/ Currents). To set up the calculations using only the selected parts, the user should choose High for current density and check the corresponding fields to activate the options Create Current Sources and Apply to selected wires and plates.

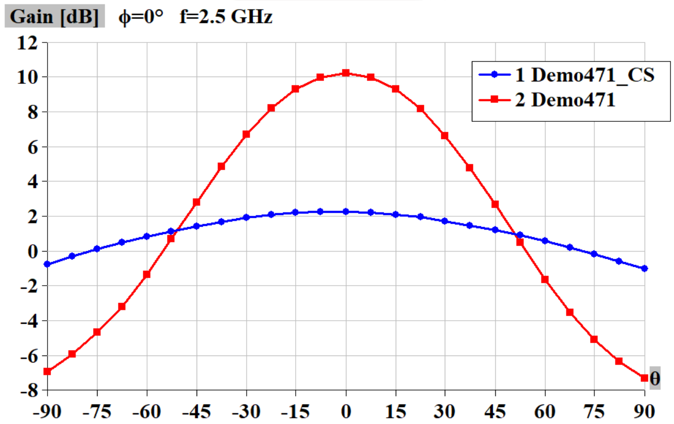


Fig. 2. Comparison of the RP for horn antenna (red) and open rectangular waveguide (blue).

For the cases where a symmetry plane is defined in the project and selected objects have images with respect to the symmetry plane, the field Apply symmetrical images of currents source for Radiation Pattern evaluation should be checked to include the images into the calculation.

When a scattering mode of operation is selected, RCS of selected parts of a structure can be calculated applying the selection of parts and menu options in a similar way as described above.

b) Images of Selected Elements can be Included in Calculation of Radiation Pattern

Starting from version 21, images of the current sources with respect to the symmetry planes will be properly accounted for in the far field calculations.

If the far field calculation resulting only from selected parts of a symmetric structure is required, checking the box Apply images of current sources for Radiation Pattern evaluation should be checked to include images of the selected parts into Radiation Pattern calculation. If the box is not checked, the images will be ignored.

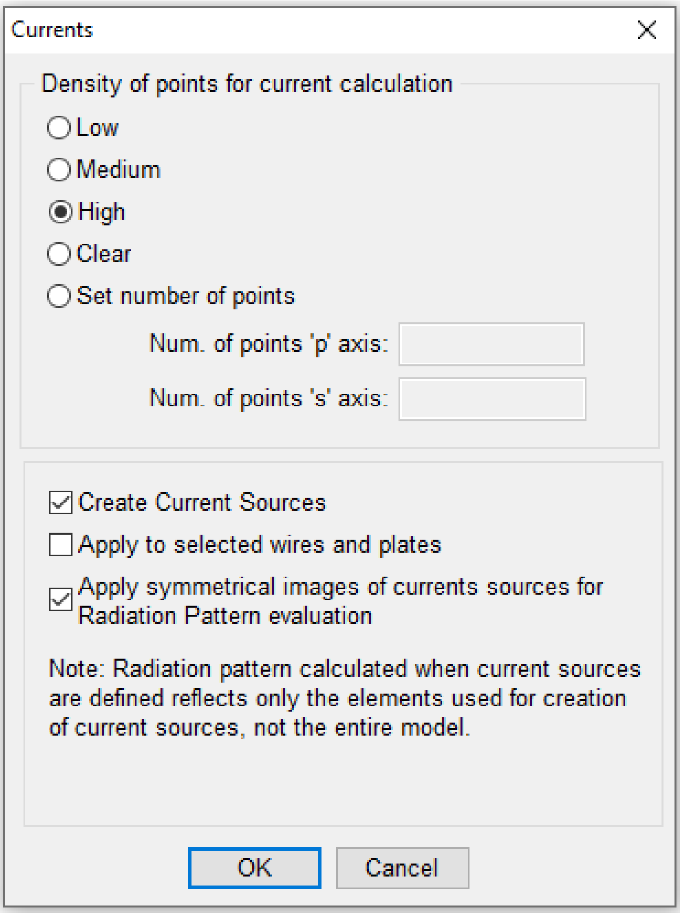


Fig. 3. Images of imported current sources can be easily included in the calculations.

c) Fast Calculation of Radiation Pattern

A novel method of radiation pattern calculation has been developed. The method can be selected by checking Configure/Advanced Modeling/Fast Radiation Pattern evaluation option, as presented in the next figure.

Users are encouraged to use it regularly, and perhaps for mission-critical projects, to verify the results by comparison with the results obtained with the classic method.

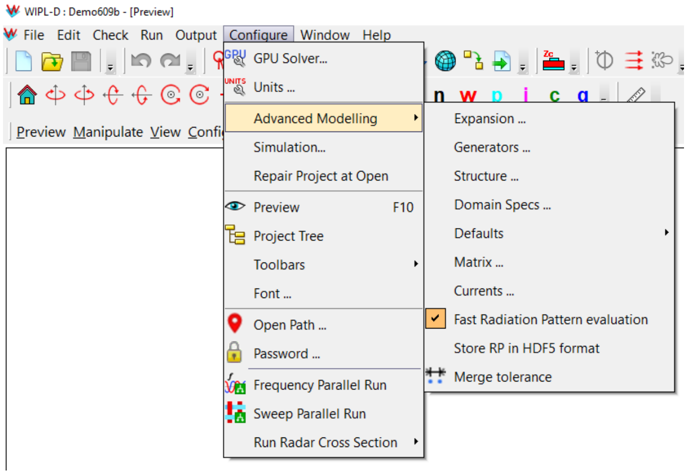


Fig. 4. How to choose Fast Radiation Pattern evaluation.

d) Run as Avoided with Extrapolation

Sometimes it is beneficial to have rough estimate about the values of an important parameter as precise determination of the parameter would require significant computer resources. One illustrative example could be the RCS calculation of a target at a high frequency where the number of unknowns is prohibitive as it would take larger amount of memory than available.

To provide user with a reasonably accurate approximate result in such cases, a new computing option called Run as Avoided with Extrapolation has been introduced. Basic idea behind the new option is to extrapolate current distribution calculated on operating frequency to higher frequency and calculate RCS based on the extrapolated distribution without performing usual MoM calculation at higher frequency. The extrapolated current densities can be combined with Physical Optics (PO) calculation and weighted so that PO weight increases as the desired frequency departs from the frequency where exact solution has been calculated.

Described method is illustrated using model of an aircraft presented in the next figure. The calculations are set up to determine monostatic RCS at operating frequency of 1 GHz as it will be the starting point for extrapolated calculation at 2 GHz. At the operating frequency, model requires around 16.000 unknowns, which increases to around 58.000 at 2 GHz, the amount that is not manageable by the computer in hand. Accordingly, we performed the two extrapolated calculations, one with and one without averaging with PO.

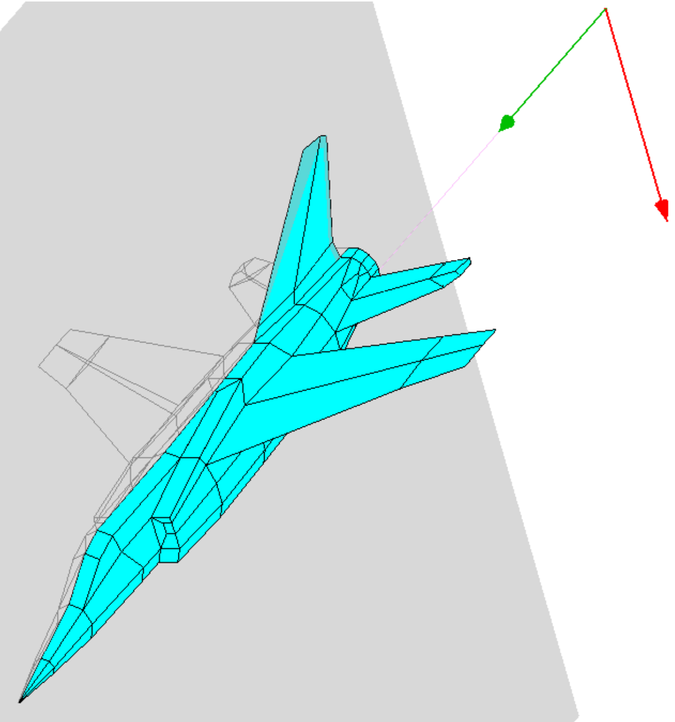


Fig. 5. Model of the aircraft used to demonstrate Run Avoided with Extrapolation (~16.000 unknowns at 1 GHz, ~58.000 at 2 GHz).

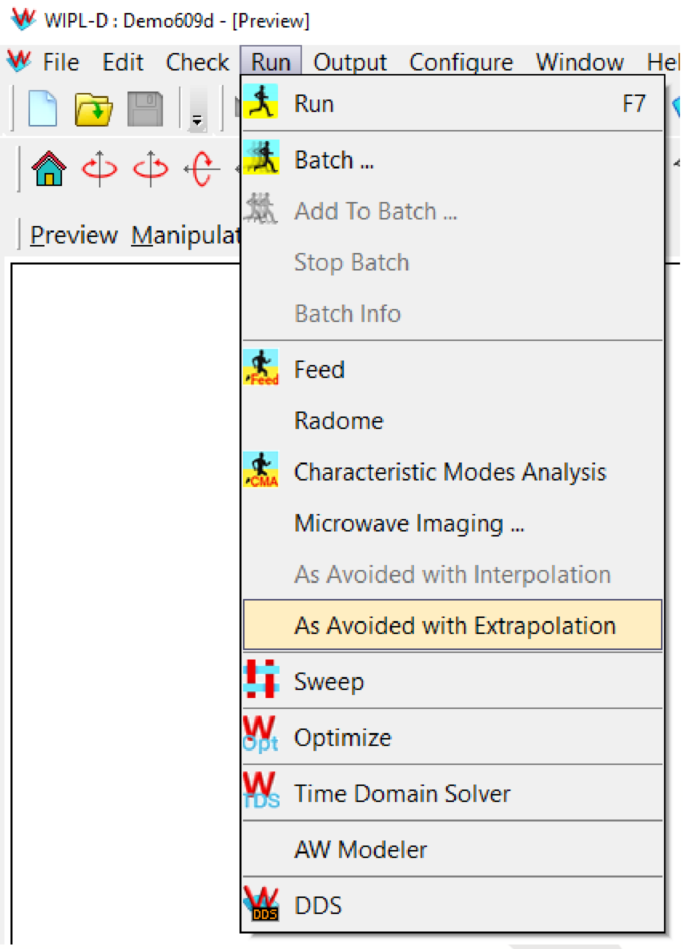


Fig. 6. How to invoke Run Avoided with Extrapolation.

The calculations are invoked from Run/As Avoided with Extrapolation menu, where averaging can be switched on/off by checking/unchecking the corresponding box, as presented in the next figure. The frequency at which the extrapolated solution is required should be entered in the field Frequency, and by clicking OK extrapolated solution calculation starts.

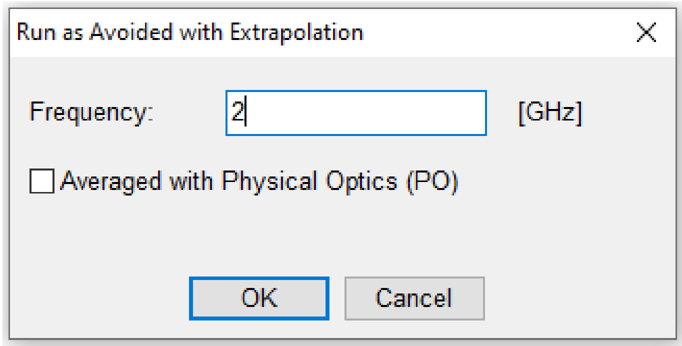


Fig. 7. How to enter extrapolation frequency and switch on/off averaging with PO.

Calculations are extremely fast and last only a fraction of a second on the computer in hand. To establish the reference for the comparison, the exact solution has been calculated on a workstation dedicated to number crunching. The results are compared in the next figure. All four of the methods produce similar results for the angles in the range ±(70°-100°) and around ±180°. For angles around 0°, extrapolated results are close to the exact solution, with extrapolation weighted with PO overestimating the results for RCS approximately by 3 dB while extrapolation weighted with PO underestimates the values by the same value. In this range of angles, PO solution has the largest error (7 dB). In the regions between the peaks, where values of RCS fluctuate rapidly, average values of RCS calculated using all the methods can be regarded as similar. It can be concluded that, from the engineering point of view, the extrapolation method provides reasonably accurate results and is a valuable tool for cases where computing power is limited.

The avoided regime for calculations is set up automatically. The previously described method of fast Radiation Pattern calculation is also automatically invoked when using Run as Avoided with Extrapolation. At this point, the extrapolated calculation works with scattering modes, monostatic and bistatic only, and (A)symmetry, PEC/PMC and Rotation (PEC) setting cannot be used.

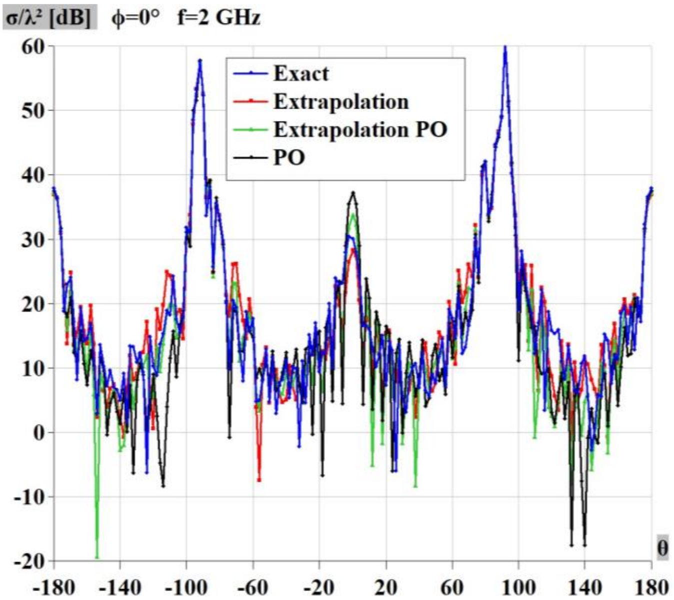
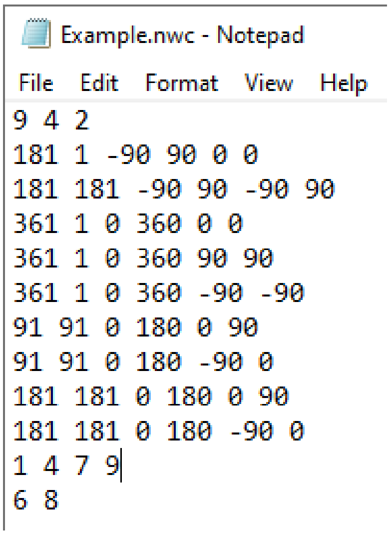


Fig. 8. Exact, approximate extrapolation methods, and PO comparison for monostatic RCS calculations.

e) New Ways to Define Custom Excitation Waves and Far Field Directions of Interest

A new type of file format, .nwc, has been introduced which could be used with Big (Farfield) Data Calculation, where a large number of calculation directions and excitation waves are defined using direction grids. An example is provided in the next figure.




```
9 4 2
181 1 -90 90 0 0
181 181 -90 90 -90 90
361 1 0 360 0 0
361 1 0 360 90 90
361 1 0 360 -90 -90
91 91 0 180 0 90
91 91 0 180 -90 0
181 181 0 180 0 90
181 181 0 180 -90 0
1 4 7 9
6 8
```

Fig. 9. The format of .nwc file to define direction grids.

The interpretation of the data listed in the file is as follows:

In the first line, a total number of 9 direction grids is specified, where only 6 provide data for the simulation, 4 for excitation and 2 for far field calculations. Nine direction grid lines containing grid specification follow. The format is as described for .nwa files. Finally, line 11 presents that 1st, 4th, 7th and 9th direction grid lines will be used to define excitations, while line 12 specifies that lines 6 and 8 describe grids that will be used for far field calculations. More details on specifications of .nwc file can be found in User's Manual.

2. Impedance Calculator

For microstrip and other transmission lines and waveguides, it is convenient to have a tool which will provide information about important electrical parameters such as characteristic impedance, effective dielectric constant, etc., from physical dimensions of the structure. In WIPL-D software suite, such a tool is Impedance Calculator, which is integrated into Microwave Pro program. Recently, the functionality of the Impedance Calculator has been brought to WIPL-D Pro. The feature is invoked from the dropdown menu entry Edit/Tools/Impedance Calculator or by pressing the Impedance Calculator icon from the toolbar.

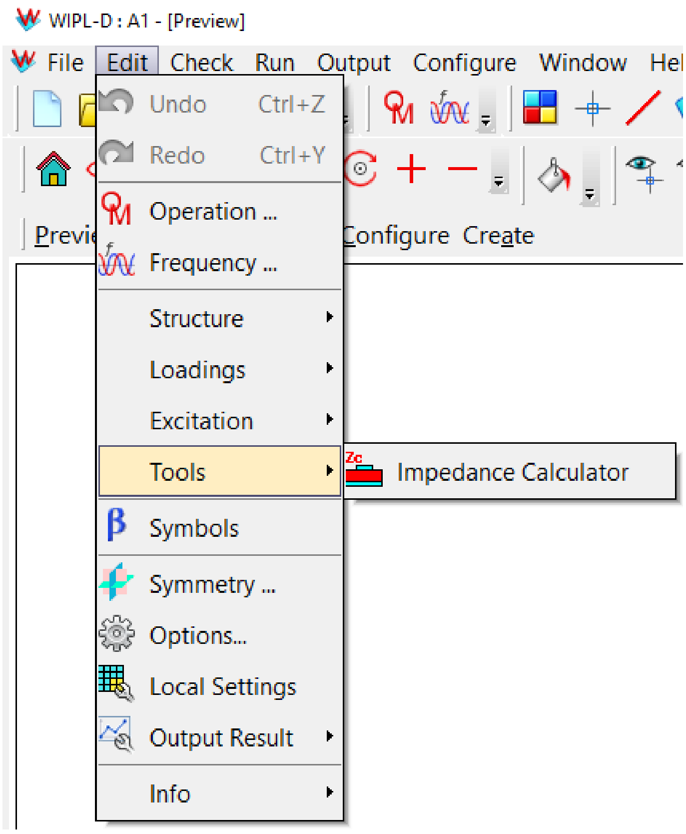


Fig. 10. How to start Impedance Calculator.

The Impedance Calculator window, with a list of transmission lines and waveguides that can be analyzed/synthesized, is presented in the figure below. The list includes microstrip, stripline, coplanar waveguide, rectangular waveguide, coaxial line, coupled microstrip and coupled stripline. On the top left of the Impedance Calculator window, the electrical parameters of the line/waveguide are presented, while on the top right, geometrical parameters providing electrical parameters from the left side are shown.

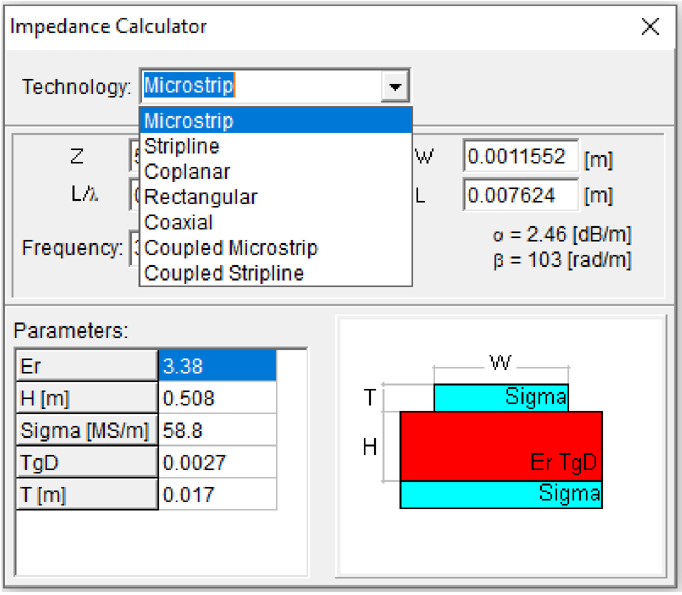


Fig. 11. Impedance Calculator window.

Between the two top parts, there are two arrows. By clicking on an arrow, either the electrical parameters will be calculated based on geometrical parameters (arrow pointing from right to left; sometimes referred to as analysis) or geometrical parameters will be calculated based on electrical parameters (arrow pointing from left to right, sometimes referred to as synthesis).

3. New Functionalities in Symbol List

a) Extended Replacing of Symbols

Sometimes it is important to replace the name of the symbols, not only in the symbols list, but in all the places a symbol appears. Replace in structures right-click command opens a dialog where the name of the symbol can be changed and finds desired symbol in all tables.

Example of changing symbol y, which in this case affects a Nodes table is presented in the next figure.

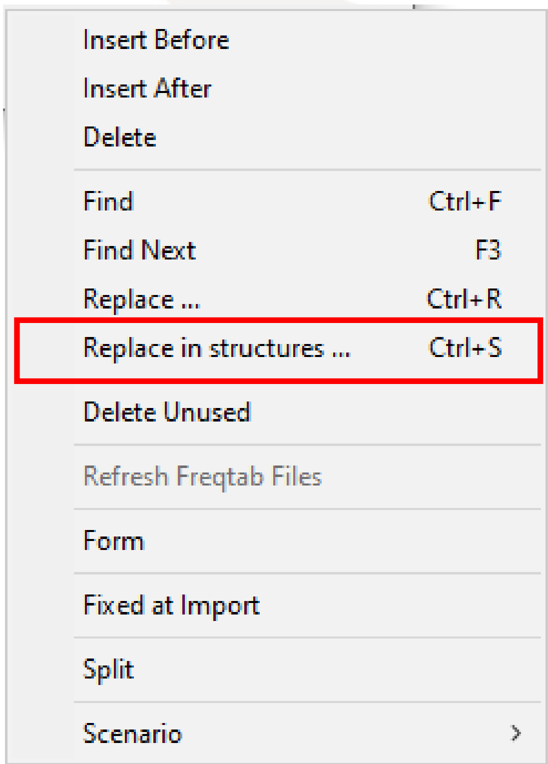


Fig. 12. How to invoke Replace in structures command.

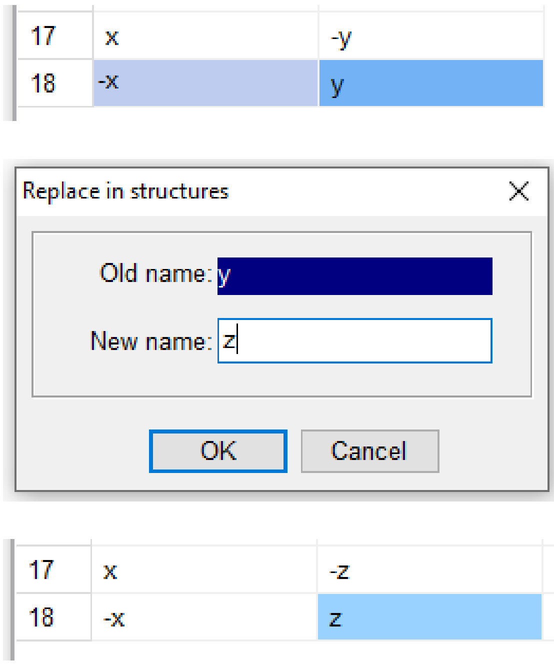


Fig. 13. Using Replace in Structures to replace symbol y with z and effect in the Nodes table.

b) New Mathematical Functions sinpi() and cospi()

New functions related to classic trigonometric functions have been introduced for increased accuracy namely sinpi(*a*) and cospi(*a*). Calculations performed with the newly introduced functions are intended to replace classic trigonometric function for the cases where argument *a* is being multiplied by π (PI). For example, cospi(1)=-1, sinpi(0.5) = 1. When calculating these examples using classic trigonometric functions, there is a very small error which could accumulate and result in noticeable errors in complex expressions.

c) Symbol Can Have up to 4096 Characters

To provide users with more flexibility when using symbolic expressions, the maximum number of characters in symbol name is now limited to 4096.

4. New Type of Basis Functions - Physical Optics (PO)

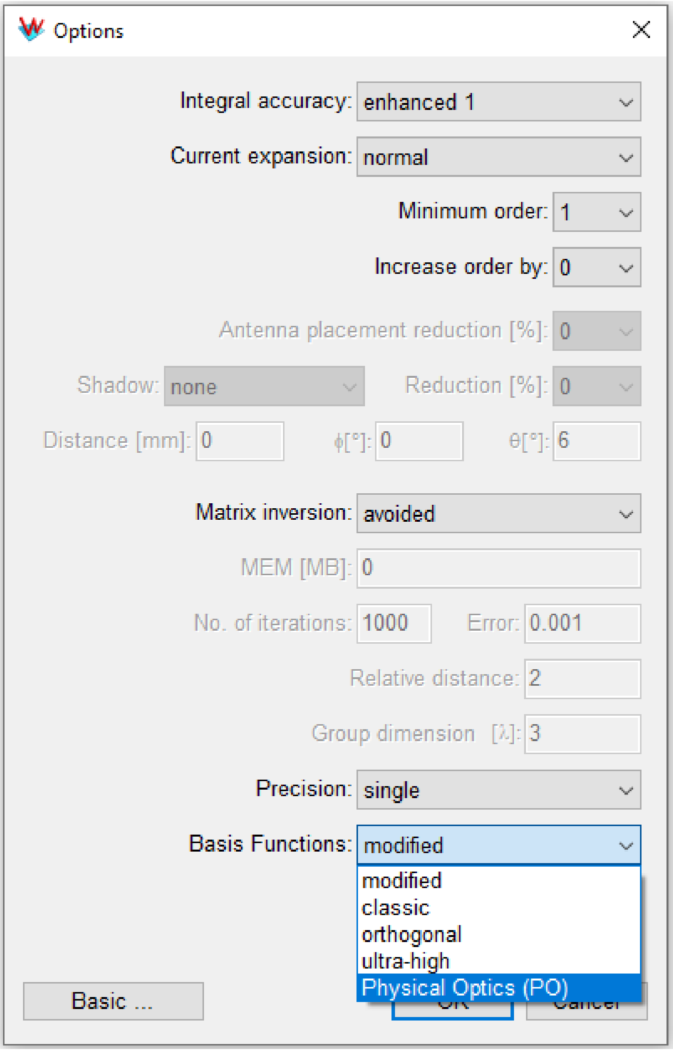


Fig. 14. Selecting Physical Optics (PO) basis function.

A novel type of basis function has been introduced - Physical Optics (PO). This type can be selected for metallic structures only when one of the Scattering operation modes is active. They are most suitable for large scattering problems where an approximate, yet very accurate solution is required.

5. Current Sources (CS)

a) Where Symmetry Planes Are Defined, Images of Imported CSs are Included When Calculating RP

Starting from this version, images of current sources imported into the project with defined symmetry planes will automatically be taken into account when calculating radiation pattern.

b) Faster Calculation of Currents Leads to Great Speed-up for Simulations with Large Number of Elements

A great effort has been put into the new release in order to speed up different calculations in many software modules. This also relates to the calculation of currents, with speeding effects becoming noticeable for a large number of elements.

c) Improved Accuracy of Currents Computation of Segmented Plates

Several special situations where calculation of currents used to produce incorrect results have been detected and behavior corrected.

6. Calculation of Scattered Near Field Only

In certain scenarios, the analysis focuses exclusively on the scattered field associated with a given scatterer. The procedure for enabling this option in WIPL-D Pro is demonstrated using the dielectric cube (Fig. 15)

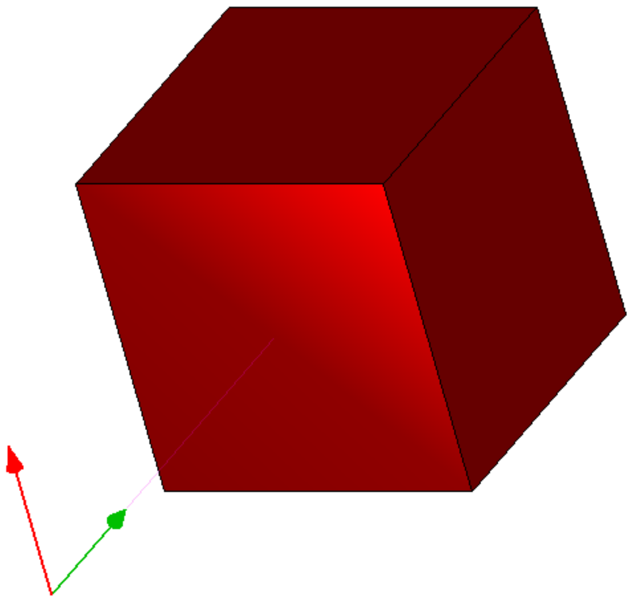


Fig. 15. Dielectric Cube used as a Scatterer.

For the reason of comparison, we first demonstrate a setup to perform standard calculations where the scattered field in all domains is calculated and presented in a 3D graph. The setup and the results are illustrated in Fig. 16. From the 3D plot, one can recognize the typical interference between direct and reflected field.

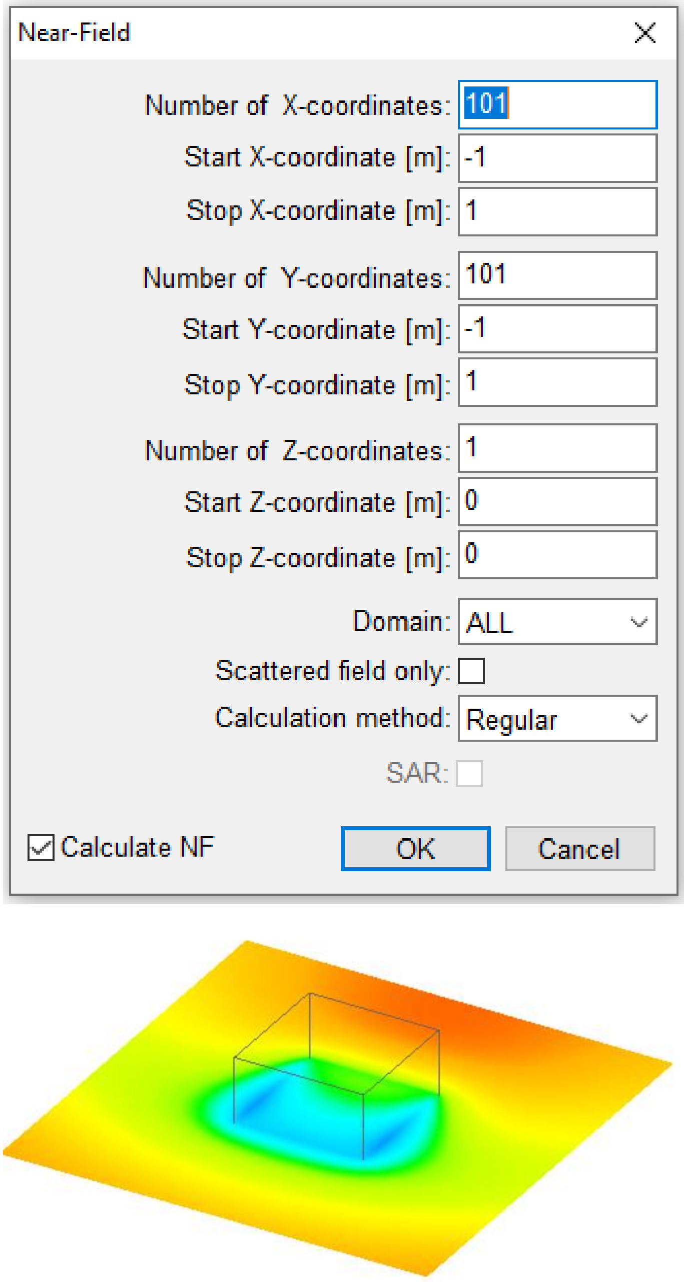


Fig. 16. Setting standard Near Field Calculation and the obtained 3D result for the total electric field.

To calculate the scattered field only, a corresponding field Scattered field only should be checked, as shown in Fig. 17. The calculated 3D near field which represents only the scattered field from the dielectric box is presented in also shown in Fig. 17. The field plot appears as if the dielectric box is radiating and there is no interference with the direct field.

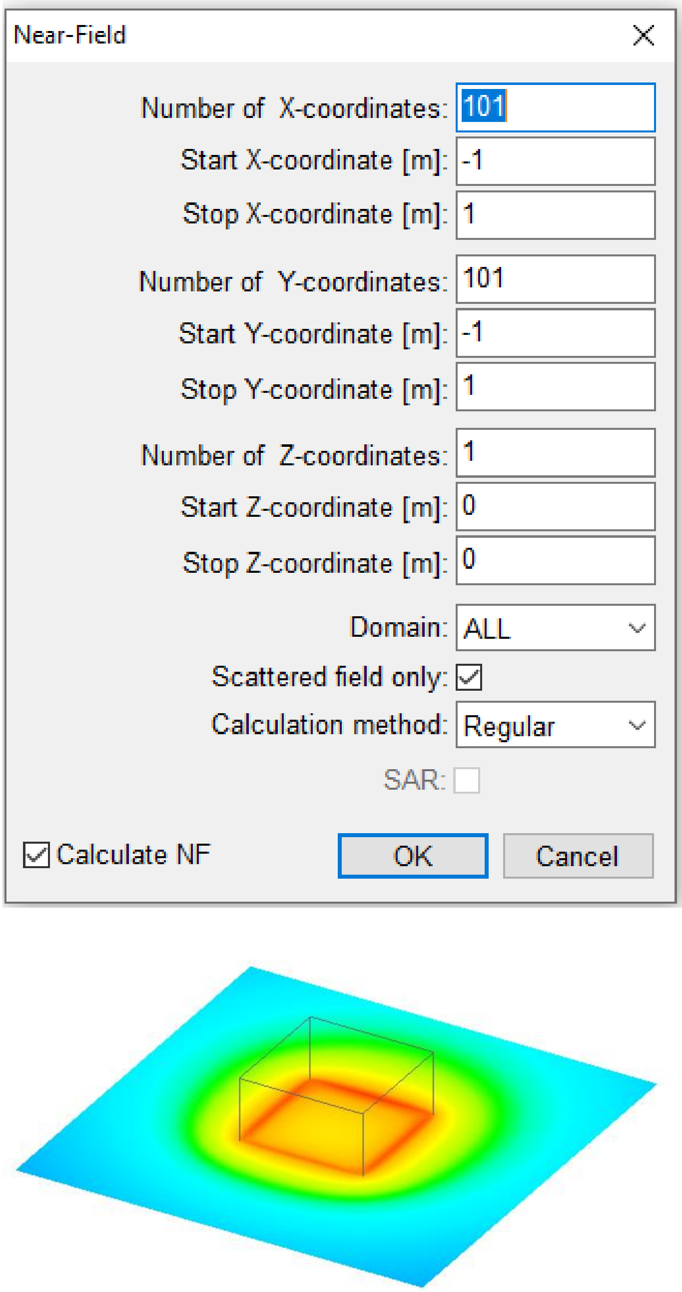


Fig. 17. Setting scattered field only Near Field Calculation and the obtained 3D result for the total electric field.

7. Copy Layer is More Robust and Reliable

a) Nonconvex Plates are Correctly Copied

In previous versions, executing the Copy Layer command along with nonconvex plates could produce significant distortion of object shape, as illustrated in Fur. 18 on the left. Such behavior has been corrected in v21 so that nonconvex plates are handled without causing any errors, as shown in Fig. 18 on the right.

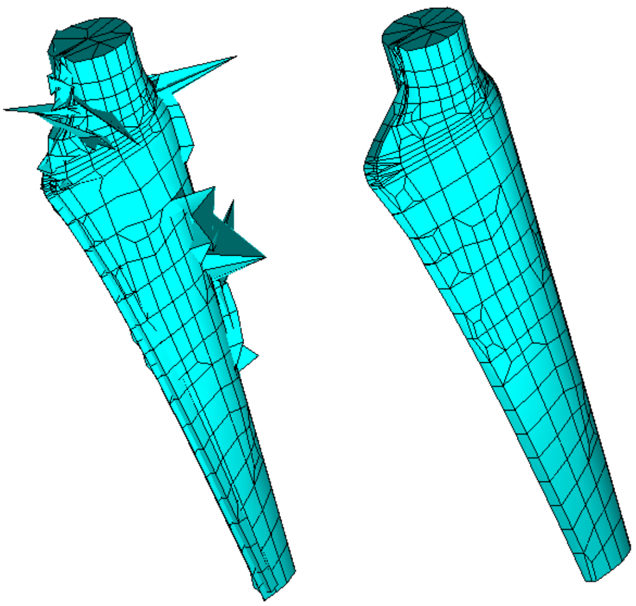


Fig. 18. Copy layer command with nonconvex plates – old versions (left), new version (right).

b) Wires are Ignored if Selected

In previous versions, in cases where a wire is (usually accidentally) included in a Group containing plates which are intended to be copied, applying the Copy Layer command would lead to unexpected results. Such behavior has been corrected so that wires are now completely ignored when performing Copy Layer command.

8. Using Green Functions (GF)

a) Conductivity (σ) Can be Defined for Half Space

In the new version, it is possible to define conductivity for the half space domain (under the ground plane). The new setup is indicated by number 5 as a second number in the first row (instead of 4 for domains without conductivity defined) as illustrated in Fig. 19.

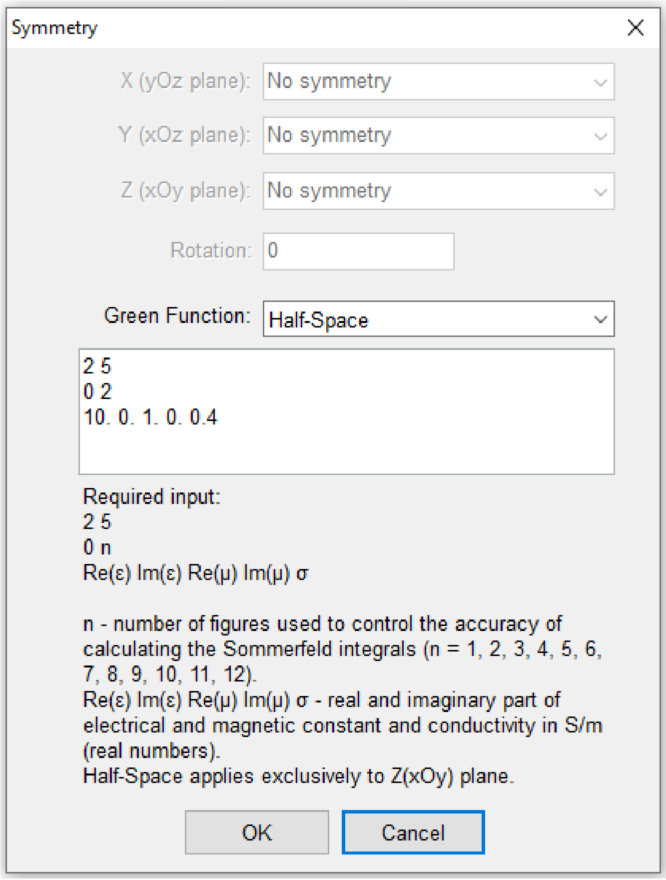


Fig. 19. New layout of the window for setting Half Space Green's function calculation in new program version.

In the third line, where domain parameters are defined, real numbers Re(ε), Im(ε), Re(μ) and Im(μ) are real and imaginary parts of the electrical and magnetic constants, respectively, while σ is the conductivity.

b) User is Warned of the Irregular Setup

In the case that there is some irregular entry in the setup, the entry window will change color to red, prompting the user to make corrections.

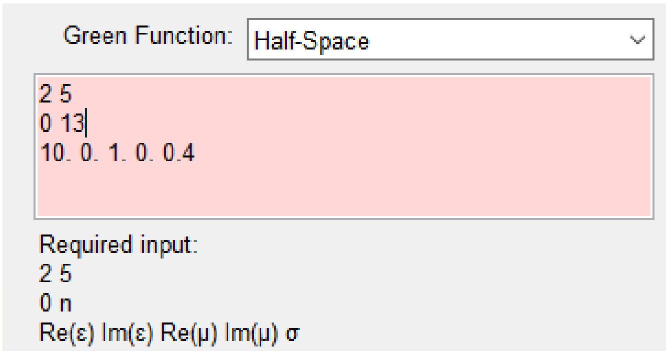


Fig. 20. When something is wrong in the setup (number 13 for accuracy of Sommerfeld's integrals) the user is warned by turning the window color red.

9. Many Improvements in the Software Environment

a) Keyboard Shortcut to Start Simulation

To increase user comfort, a new shortcut has been added to the list. From this release on, F7 can be used to run the simulation from the Preview window.

b) More Icons on the Taskbar and Menus

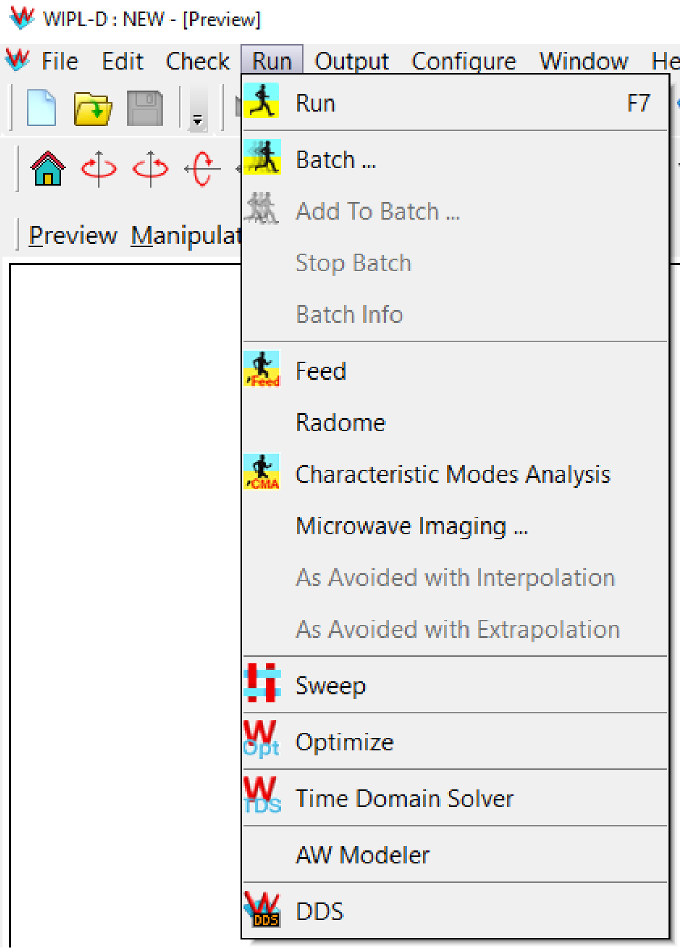


Fig. 21. Icons have been introduced in many menus to make the interface more intuitive and visually appealing.

To make menus more intuitive and pleasing, and to enhance the visual effect, many new icons have been added to the menus (see Fig. 21).

c) Icons in The Toolbars Can Be Enlarged

The size of icons from the toolbars can now be changed. To enlarge the icons, go to Configure/Toolbars/Large Icons. The toolbars with normal and enlarged size icons are shown in Fig. 22.

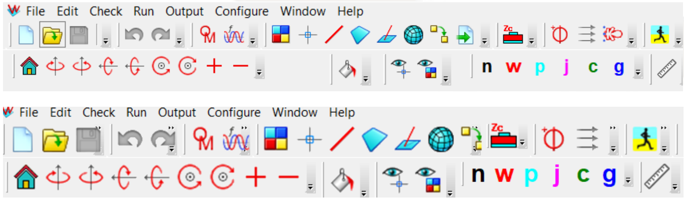


Fig. 22. Toolbars with normal (top) and enlarged (bottom) icons.

d) Improved Domains table

The Domains table has been enhanced to clearly indicate that domain zero is reserved for PEC.

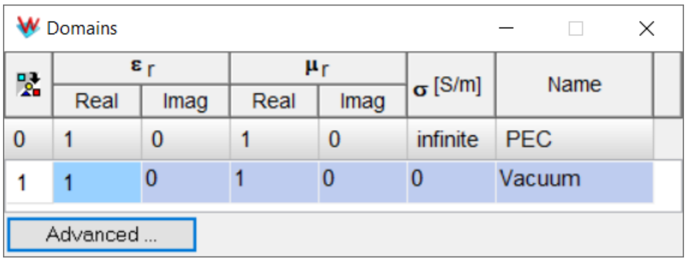


Fig. 23. Domains table – the new preview.

e) Nodes are Automatically Marked for Dimension Measurement

To make the selection of the nodes easier, when performing measurements by applying the Dimension command, automatic marking of the nodes, similar to one used when executing Mark Nodes command, has been introduced (Fig. 24). This helps with the selection of desired nodes when executing Dimension measurements on high-resolution monitors or with highly complex structures with dense node layout.

f) Higher and Adjustable Sensitivity When Selecting Nodes on High Resolution Monitors

Yet another problem could have previously occurred on high-resolution monitors. As the size of a node becomes very small, in some situations, including the usage of the Dimension command, it could be very tricky to select a desired node. To solve this problem, the sensitivity around the nodes has been made flexible. By right-clicking in the Preview window, Node sensitivity can be chosen, and a mouse sensitivity around nodes adjusted to Low/Medium/High, which is shown in Fig. 25.

g) Improved Display When Working with Multiple Monitors

Dialog window behaviors when the program is used with two (or more) monitors installed have been improved and work smoothly now.

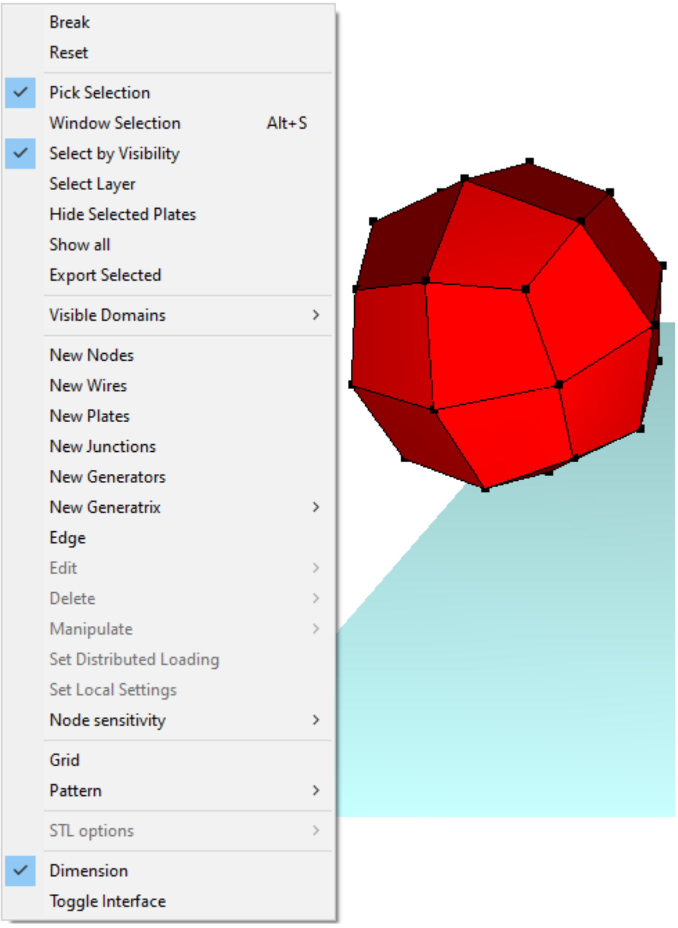


Fig. 24. Nodes are automatically marked when invoking Dimension command.

h) Smooth Scaling of Font Size

In this version, the effect of changing the font size using settings found in Configure/Font has been corrected so that the font changes do not produce illegible fields in menus. This modification now also covers all dialog windows.

i) Using Mouse Wheel to Zoom in and out Aligned with Similar Programs

Zooming in and out using a mouse wheel has been changed to correspond with the behavior common to the general CAD programs. Now, zooming out is occurring when turning the wheel towards the user, while zooming in is accomplished when turning the wheel in the opposite direction.

j) Switching off "End of simulation" Sound

For the benefit of those who were annoyed with “End of simulation” sound, it is now set off by default. It is possible to turn it on by checking the appropriate field in Configure/Simulation menu (see Fig. 26).

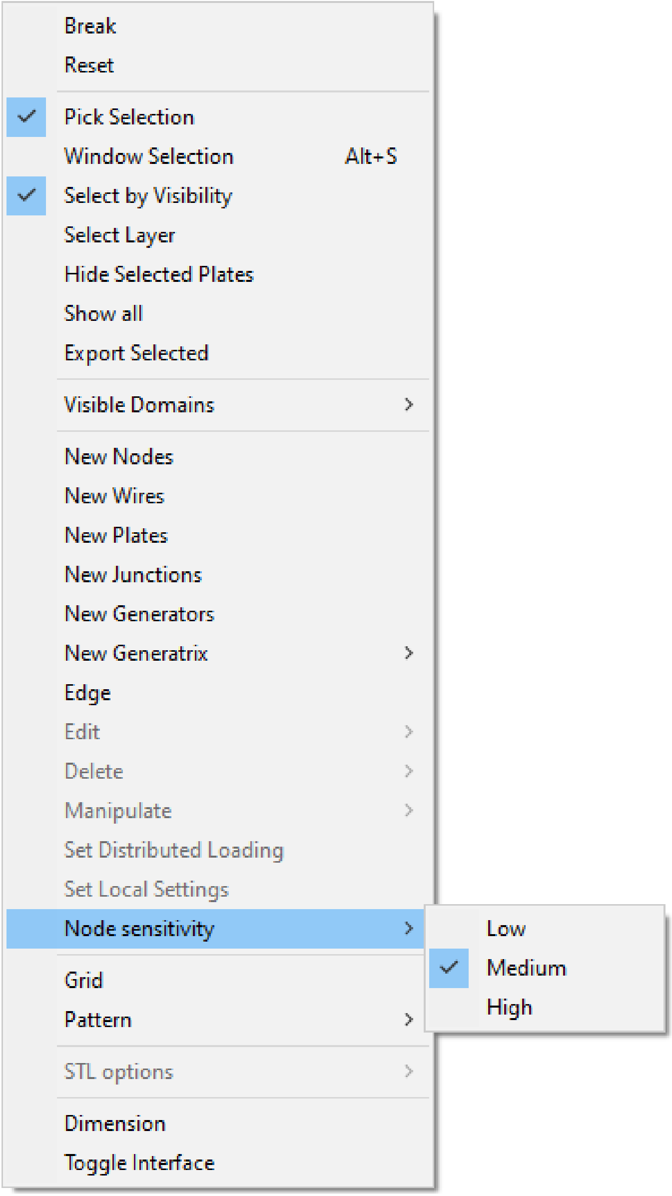


Fig. 25. On right mouse click into Preview window a menu appears where user can select Node sensitivity and choose between three node sensitivities.

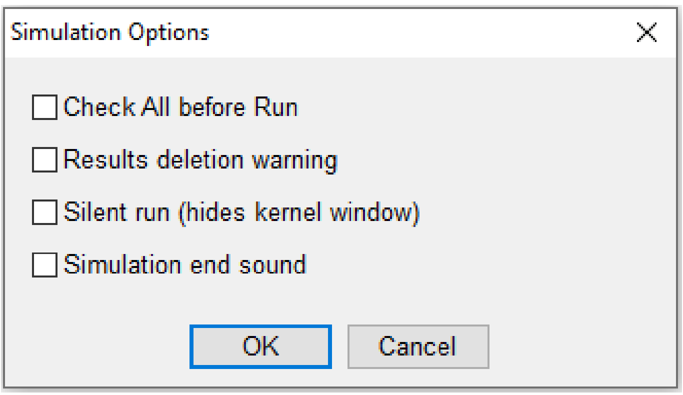


Fig. 26. Switching off “End of simulation” sound.

10. Minor Improvements and Bug Fixes

Much effort has been put to correct some details or introduce features which may not seem to be significant but could improve the user experience noticeably. For example, list of operations that can be executed form the command line is extended to include opening and meshing STL files, and running optimizer, sweeper, time domain solver, and calculation of radome reduction and subsequently the radome run. Power balance calculations have been improved, and field generators can now be included into the power balance calculation. The number of nodes included in the Jun manipulation has been increased. The other improvements are highlighted in the following text.

a) Domain Names Inherited from CAD Projects

For WIPL-D Pro projects obtained from WIPL-D CAD projects, domain names, which have been defined in the original CAD project, are now inherited in Pro project.

b) STL Decimation Parameters are Stored

Parameters defined when performing decimation and/or meshing of STL format files are now stored with the project.

c) Several Bugs Related to Import Have Been Resolved

Several bugs and instabilities occurring when importing WIPL-D Pro projects (using Edit/Structure/Import), related to symbol list mess-up, distortion of the imported model, program sudden termination etc., have been corrected.

d) New Options for Saving Current Coefficients

From version 21, new possibilities are introduced for setting default and temporary options when saving current coefficients. The default settings for succeeding projects can be set by pressing Set As Default button and any project created afterwards will be simulated with these settings. In case that user changes the current coefficients settings as desired and then presses OK (not Set As Default), this will make a change in the settings for current project only, keeping the defaults intact.

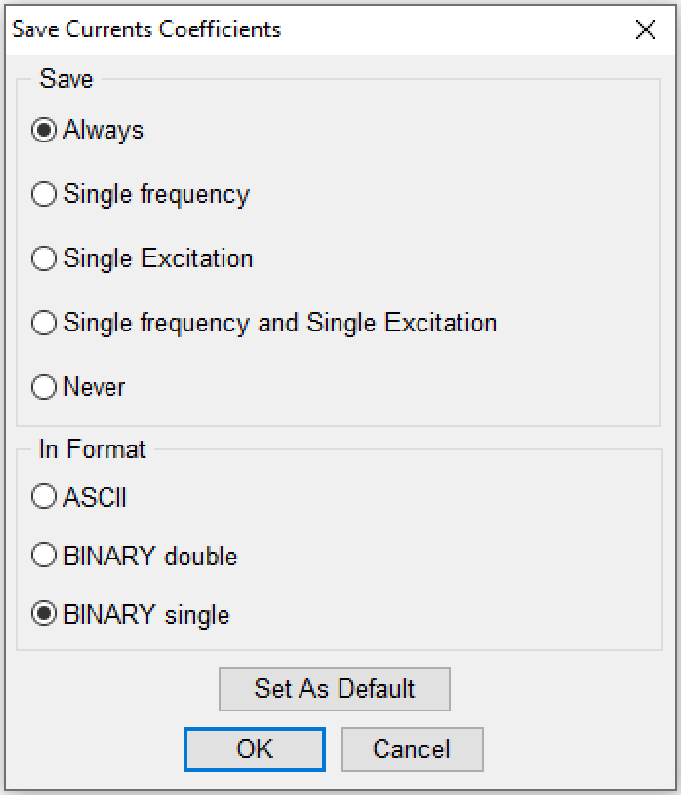


Fig. 27. After a change in setup has been made use Set As Default to set new defaults or OK to keep the choice of settings within the current project only.