

## WIPL-D Pro CAD: What is New in v2023?

New features/improvements introduced in v2023 are:

1. **Wrap command - Wrapping of flat bodies over arbitrary complex developable surfaces**
2. **Validate command - automatic validation and robust error fixing adaptive to changes in model topology**
3. **Advanced import of IWP files - automatic creation of simulation ready WIPL-D Pro CAD projects**
4. **Accelerated modeler – smooth work with highly complex geometries**
5. **Support for:**
  - a. **Frequency and Sweep parallel run**
  - b. **Periodic Boundary Condition**
6. **Region selection mode**
7. **Other options/improvements:**
  - a. **Improved export to non-Parasolid CAD formats**
  - b. **Automatic deletion of auxiliary Point Bodies in Snap to Topology/Geometry modes**
  - c. **Comments in History list, enabling selective execution of the commands list**
  - d. **Increased accuracy in creation of analytical curves and surfaces**
  - e. **New antenna types in the Component Library**
  - f. **Expanded list of Predefined Materials**
  - g. **Improved Automatic Transparency rendering mode**
  - ...

### 1. Wrapping of Flat Bodies Over Arbitrary Complex Developable Surfaces

The Wrap command enables wrapping of a flat sheet body over an arbitrary developable surface. Working with this command is straightforward and user friendly. The Wrap operation becomes active when a flat sheet body, in the remaining text referred to as a tool body, is selected. Then, after the Wrap option is chosen, the tool body is deselected, and the user should select a target body which has at least one developable face. After the target body is selected, the reference points on the tool and target bodies should be defined. Before the wrapping is performed, the tool body is automatically translated in such a manner that the reference point on the tool body is aligned with the reference point on the target body. Once reference points are set, wrapping is performed after a click on the OK button. The tool body is deleted, while a corresponding shape is created on the target body. Detailed explanation of particularities related to the use of the Wrap command can be found in the WIPL-D Pro CAD 2023 User Manual.

#### Flat Microstrip Patch Antenna

A structure created using the Wrap command can originate from a flat microstrip patch antenna presented in Figure 1. The particular antenna operates around 1 GHz.

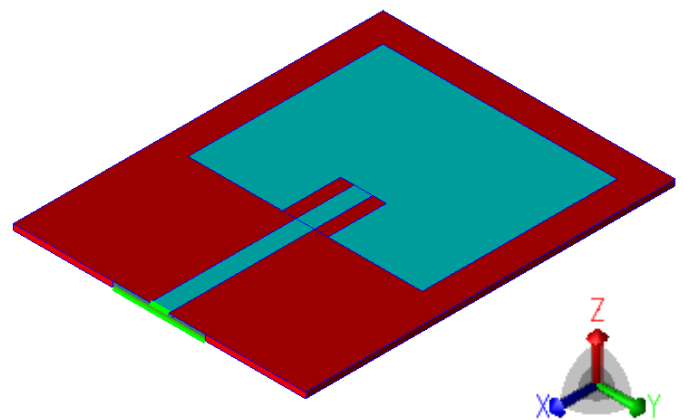
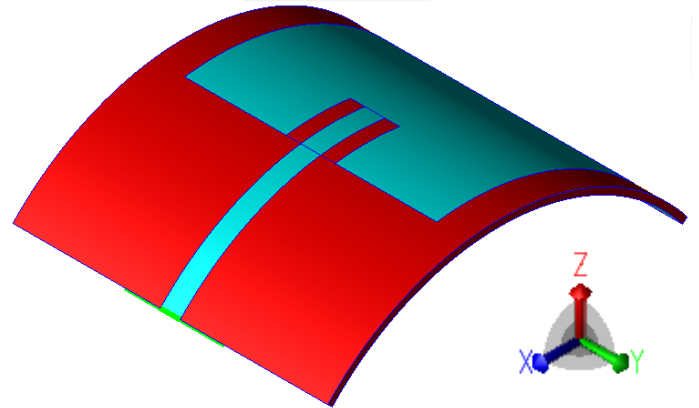


Fig. 1. Flat microstrip patch antenna.

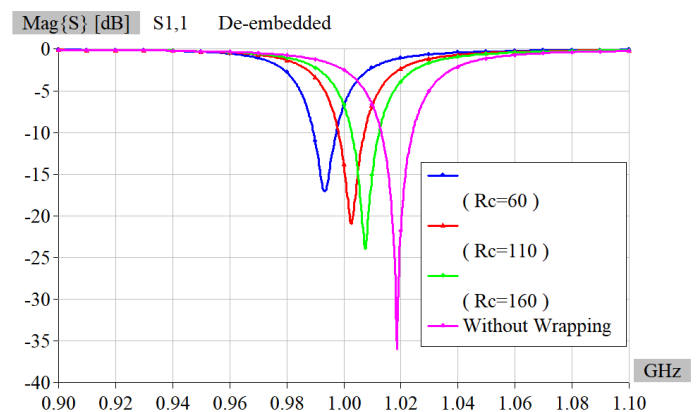
## Wrapped Microstrip Patch Antenna

The same microstrip patch antenna wrapped around a cylinder aligned with the x axis is presented in Fig. 2, while the effect of the wrapping on the S11 parameter of the antenna is illustrated in Fig. 3. Comparing with S11 of the flat microstrip antenna from Figure 1, also presented in the same figure, it can be concluded that wrapping around the x axis has a mild effect on the antenna performance.



**Fig. 4. Microstrip patch antenna wrapped around a cylinder aligned along the y axis.**

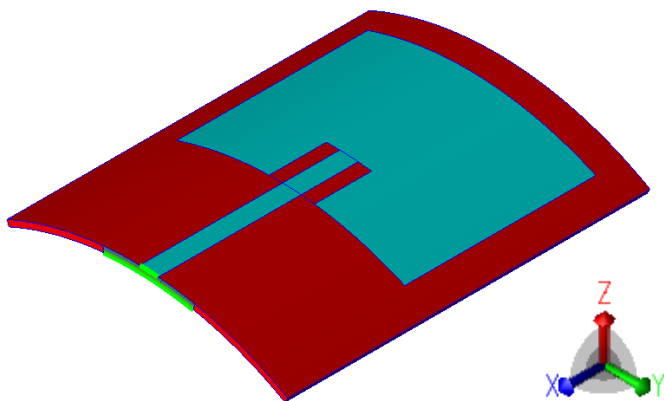
Comparing the performance of the antenna wrapped around a cylinder aligned with the y axis with the performance of the antenna from Figure 3, it can be concluded that wrapping around the y axis has a more pronounced effect on the antenna performance.



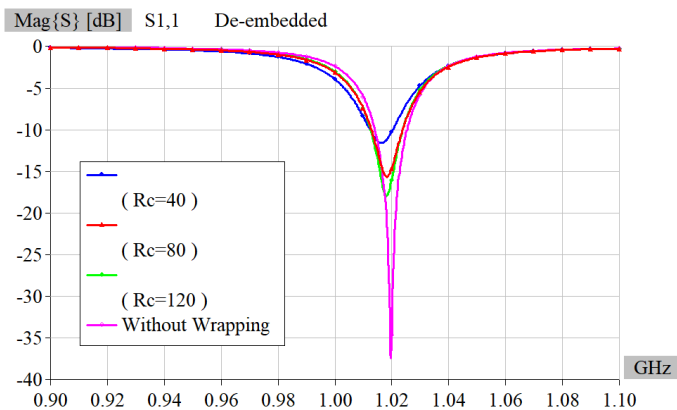
**Fig. 5. S11 of a microstrip patch antenna wrapped around a cylinder along the y axis as a function of wrapping radius  $R_c$ .**

## 2. Validate Command

A new, highly robust, automatic validation and error fixing mechanism is introduced in the new version. The following model errors and inconsistencies are automatically detected when Validation is performed: irregular symmetry specifications; occurrence of faulty geometry; unresolved intersections between bodies; inconsistent domain specifications for faces and adjacent regions; presence of faces with invalid domain specifications; intersections between wires and non-wire bodies; inconsistent domain specifications for wires and surrounding regions; and existence of wires with invalid domain specifications.



**Fig. 2. Microstrip patch antenna wrapped around a cylinder aligned along the x axis.**



**Fig. 3. S11 of a microstrip patch antenna wrapped around a cylinder along the x axis as a function of wrapping radius  $R_c$ .**

Antenna wrapped around a cylinder aligned along the y axis is presented in Figure 4, while the effect of the wrapping on the S11 parameter of the antenna is given in Fig. 5.

In the previous versions such inconsistencies were automatically fixed, and corresponding commands were written to the History list. The main problem was in the fact that exact names of topological entities (Bodies, Regions, Faces and Edges) were written in the commands. Such mechanism was sensitive to topology changes in the model.

The new Validation and Error fixing mechanism is based on the new Validation command. The new command does not contain exact names of topological entities, but only the operations which should be performed during the error fixing procedure. Possible operations are:

- Fix general topology, which tries to repair geometry entities with faults,
- Modify face domains based on adjacent regions,
- Delete faces with invalid domain specifications, which deletes faces with incorrect domain specifications: D\_i\_i or M\_i\_i, where i is a domain ordinal number,
- Perform intersections between wires and non-wire bodies, which performs an automatic split of all wires by corresponding non-wire bodies,
- Modify wire domains based on surrounding regions,
- Delete wires with invalid domain specifications, which deletes all wires with domain specification M\_0 (a wire surrounded by PEC).

Only the operations selected by the user are performed. It is important to notice that the Validation procedure is always performed before any fix operations, and the fix operations are performed only on entities where they are required. That way Validation and Error Fixing operations are highly robust and adaptive to changes in the model topology.

### 3. Advanced import of IWP files

Import of IWP WIPL-D Pro project file (IWP) geometry was supported in the previous versions of WIPL-D Pro CAD. The option enabled import of geometry defined in an IWP file with an option to unite all wires and plates after the import. Material definitions, distributed and concentrated loadings, excitations and simulation settings were not imported.

In the new version two major improvement of the option are introduced:

- Accelerated and more robust uniting, i.e. knitting, of all connected plates into a single body.

- Reconstruction of regions with automatic recognition and setting of corresponding domain specifications.
- Import of material definitions, face and wire domain specifications, as well as specifications of concentrated and distributed loadings, and excitations.

This way, after an IWP file is imported, a simulation ready WIPL-D Pro CAD model is obtained.

### 4. Accelerated modeler

Dealing with extremely complex models, especially those containing a huge number of excitations, loadings and junctions was time-consuming in the preceding versions of WIPL-D Pro CAD. That was especially the case when a large number of operations over entities having an excitation, a loading or a junction defined was necessary.

The new version brings significant accelerations when working with such models, making the work fast and smooth and greatly improving the experience when working with very complex models.

### 5. Frequency and Sweep Parallel Run

The WIPL-D kernel is CPU and GPU accelerated, with support for an arbitrary number of CPU threads and GPUs. Efficiency of CPU acceleration increases with increasing number of unknown coefficients. However, for electrically small problems and a large number of utilized CPU threads, high efficiency of parallelization is not to be expected. Efficiency of multi GPU acceleration is once again significant for electrically large problems, but rather low for electrically small and midsized problems. Therefore, in order to accelerate simulation of electrically small to midsized problems, while using the full extent of available hardware, Frequency Parallel Run (FPR) and Sweep Parallel Run (SPR) are developed.

These options enable concurrent simulation of multiple frequency points / sweep sub-projects. Parallel simulation of different frequency points / sweep sub-projects for small or midsized problems is enabled, with each simulation using its own part of available hardware resources (CPU threads, GPUs, etc.). In this manner, full utilization of available hardware resources with very high parallelization efficiency is achieved.

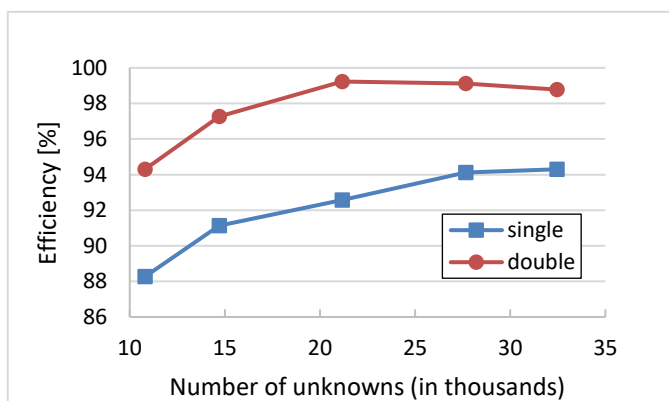
By choosing the Frequency / Sweep parallel run option, the simulation problem is automatically divided into a set of single-frequency / single-parameter problems, which are simulated in parallel in a number of runs defined by the user. The number of parallel runs specifies the number of

projects that are run concurrently. Once the simulation of all subprojects is finished, output files are automatically merged.

In order to verify the efficiency of the parallelization, results obtained with a Frequency Parallel Run (FPR) are compared with the results obtained with a regular run. Models with about 10 000 to about 30 000 unknowns are simulated in two modes. In the first mode (FPR is not used) 4 CPU threads and 1 GPU are used. In the second mode FPR is used, where each run used 4 CPU threads and 1 GPU. In this mode the total number of parallel runs was 2. All projects were simulated with Normal matrix inversion, and in Single and Double precision. Hardware used for the simulation has the following specifications:

- CPU: 8 threads / 16 threads
- RAM: 32 GB
- GPU: 2 x GeForce GTX 1080 Ti

Theoretical maximum for acceleration is 2 times, but due to certain overlapping of CPU threads and the delay due to project preparation and merging of the results, actual acceleration is always lower than the theoretical maximum. Efficiency of acceleration, as ratio between achieved acceleration and the theoretical maximum, is shown in Figure 6.



**Fig. 6. Efficiency of Frequency Parallel Run.**

As seen in Figure 6, very high efficiency is achieved for all simulated projects, regardless of the simulation settings. For double precision efficiency is higher than for single precision.

The efficiency for matrix inversion is almost 100% and for matrix fill-in is somewhat lower, therefore the total efficiency is smaller in case when inversion requires less time. Matrix inversion requires less time for single than for double precision, resulting in smaller efficiency for projects with single precision.

## 6. Region Select Mode

In addition to existing selection levels, Assembly, Body, Face, Edge and Vertex, a new selection level, Region, is introduced. Previously it was possible to select a region from the project tree, but in the case of large number of regions, that kind of selection becomes impractical. With the new option work with models containing a high number of regions become very fast and intuitive.

## 7. Other Options/Improvements

### a) Improved export to non-Parasolid CAD formats

When a model is exported to non-Parasolid formats the active model units are saved together with the geometry.

### b) Automatic deletion of auxiliary Point Bodies in Snap to Topology/Geometry modes

During the creation of geometrical primitives when the options Snap to Geometry or Snap to Topology are used, for each point snapped to a geometrical or a topological entity an auxiliary Point Body is created. The point bodies don't have any physical importance, i.e. they have no influence on the final electromagnetic simulation. Additionally, existence of a huge number of such bodies increases the number of entities in the project tree and makes operations with the tree more time consuming, while the tree itself becomes puzzling. To overcome this issue, an option for automatic deletion of all auxiliary point bodies is introduced. The deletion is automatically done immediately after the creation of the geometrical entity for which the creation of auxiliary bodies is required.

### c) Comments in the History list

A new class of command is introduced to increase usefulness of the History List. Namely, all commands which starts with the string "//" are considered as comments, and they are ignored during the execution of commands list.

Any command can be converted to a comment by adding "//" in front of the command text, and converted to actual command again just by deleted the comment string (characters "//").

### d) Increased accuracy in creation of an analytical curve and surface

Analytical curves and surfaces are created by using the fitted curve and fitted surface Parasolid entities, respectively. Advanced algorithms for calculation of the number and position of control points used for a fitted

curve and surface are introduced, significantly increasing accuracy of the created geometry.

**e) New antenna types in the Component Library**

The Antenna Component Library is expanded with three new antenna types:

- Folded dipole antenna modeled as a solid body and fed with a delta generator.
- Bow-Tie antenna printed on a Teflon substrate and fed by a delta generator.
- Yagi antenna with 2 directors, modeled with wires and fed by a delta generator.

**f) Expanded list of Predefined Materials**

The list of predefined materials has been expanded to include additional 67 human tissues.

**g) Improved Automatic Transparency rendering mode**

A new option for rendering the selected entity in Automatic Transparency mode is introduced. In addition to solid rendering of the selected entity which existed earlier, the selected entity can now be presented as transparent as well. This way, inspecting highly complex models becomes much easier.