

## Coil with Continuously Variable Pitch

### Introduction

WIPL-D Pro CAD is a software tool comprising of WIPL-D flagship product WIPL-D Pro 3D EM solver and the module for CAD based modelling with automated mesh. It offers the best of both worlds, the efficient EM simulation and easy volume-based modelling.

**WIPL-D Pro** is the state-of-the-art implementation of the Method of Moments code. Part of its features are unique and offer comparative advantage over other competitors: quadrilateral mesh, higher order basis functions, excellent parallelization of code on inexpensive CPU and GPU platforms. However, the meshing is manual, with the help of built-in meshed objects. For the complex CAD geometries, the process of building the model might be time consuming.

**WIPL-D Pro CAD** offers modelling based on modelling of volumes and surfaces, powered with Boolean operations. Numerous built-in primitives allow quick generation of rather complex geometries. Import from popular CAD formats is also supported for structure defined by mechanical engineers at most times. The meshing is automated, via the in-house developed quad mesh. The mesh is adapted for simulation in WIPL-D Pro (quad elements of size up to 2 wavelengths, with particularly meshed curved surfaces and small features).

### Coil Model

In WIPL-D Pro predefined primitive named *Helix* allows modeling of helix, spiral and coil models. However, if the coil winding is non-uniform, or according to analytical expressions, it is more convenient to use WIPL-D Pro CAD. The coil with non-uniform winding might look as in the Figure 1.

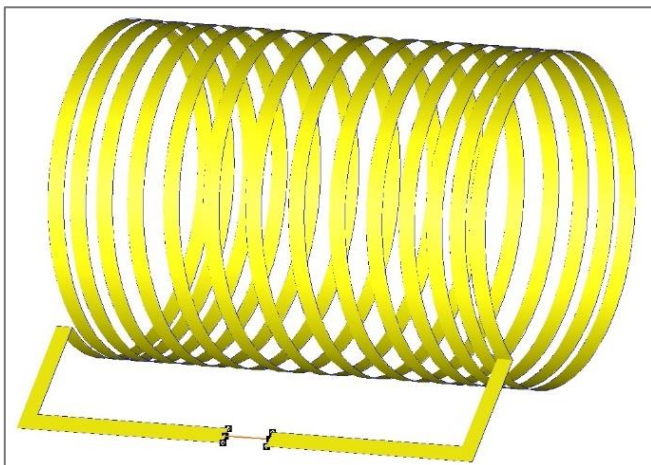


Figure 1. Coil with non-uniform winding

Such a winding can be set as analytical curve in WIPL-D Pro CAD (Figure 2).

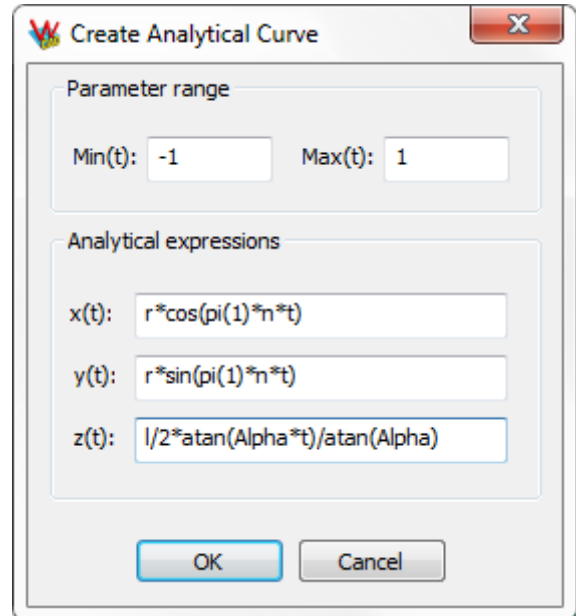


Figure 2. Setting analytical curve

It is required to define WIPL-D symbols before defining the analytical curve:

- $r$  is coil radius
- $n$  is number of turns
- $l$  is coil length
- $\text{Alpha}$  controls the winding

The entire process consists of setting symbols, creating the wire with analytical definition and sweeping the profile along such wire. The shape of the profile will determine whether the coil is modeled as infinitely thin or with finite thickness. The coil is then placed into a metallic frame (Figure 3). The feeding wire is also added. The entire process is straight-forward and can be done very fast.

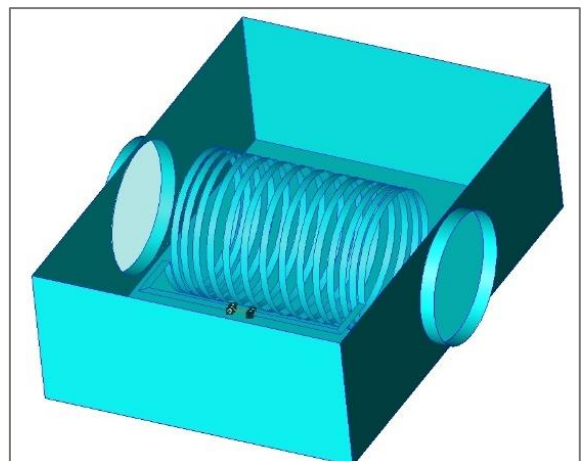


Figure 3. Coil inside of the metallic frame

## Simulation

The meshing lasts couple of seconds and yields simulation ready EM model. The interior is shown in Figure 4.

The imaginary and real part of coil impedance are shown in Figure 5.

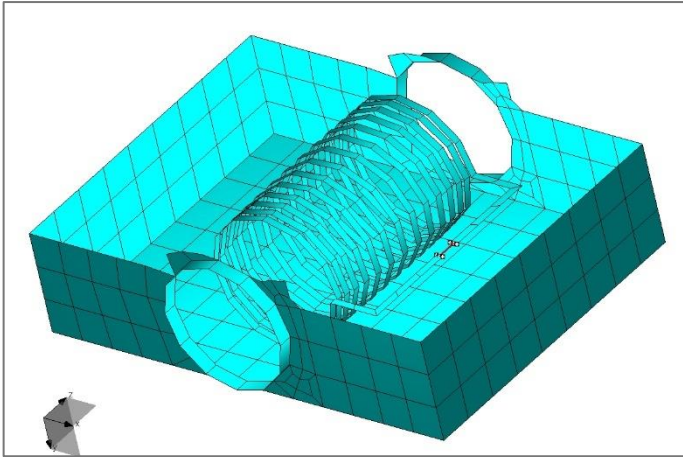


Figure 4. Final mesh of the structure

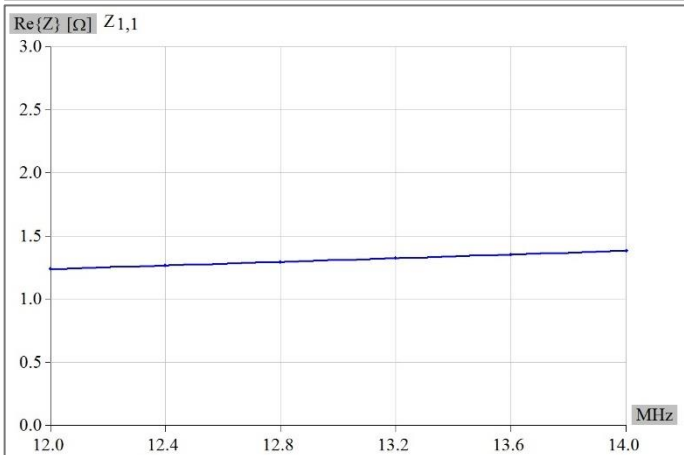
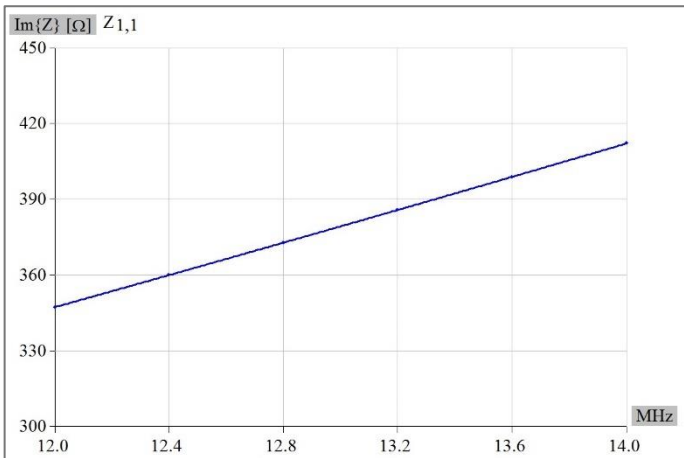


Figure 5. Imaginary and real part of coil impedance

The model has very small number of mesh elements, and requires under 1,000 unknown coefficients to be simulated. Simulation typically lasts couple of seconds per frequency point

on any given desktop PC or laptop. It is even shorter if finite thickness is not taken into account.

The magnetic field inside of coil is shown in Figure 6.

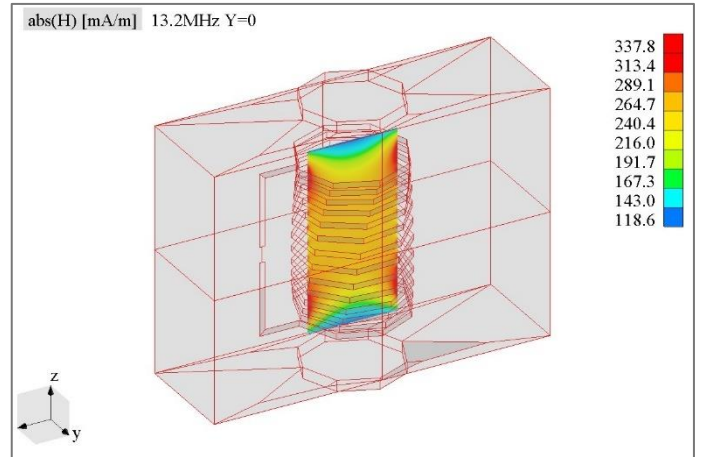


Figure 6. Magnetic field inside the coil