WIPL-D Optimizer

WIPL-D Optimizer is a powerful multi-algorithm optimization tool that is being used by many successful professionals around the world. The tool calculates single solution as well as multiple solutions for complex/multi-criteria optimizations. Thanks to its simple and intuitive graphical interface, you can quickly solve the problem at hand. It enables a high level of design automation of an antenna, antenna system, scatterer, or a microwave circuit.

Optimization Algorithms

Built in optimization algorithms:

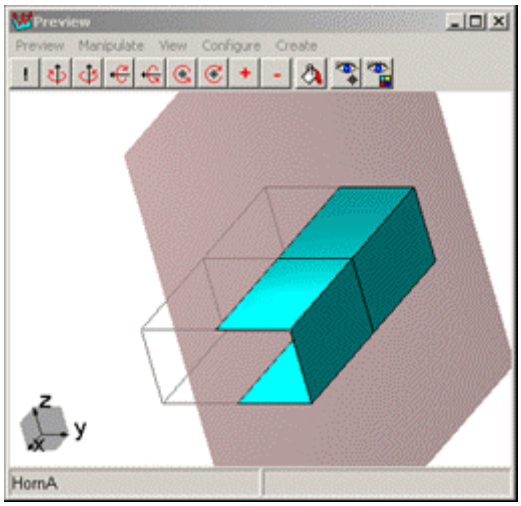
- **Particle Swarm** optimizes the project by simulating the movement of a bird flock or a swarm of bees. It is very useful for optimization problems involving roughly 4-10 variables.
- **Genetic** uses evolutionary logic for finding the best solution. It is one of the best optimization algorithms for multivariable and multicriterion optimization today.
- **Simulated Annealing** uses logic of micro systems cooling for finding the best solution. This is one of a few algorithms that can be used both for coarse optimization and fine tuning.
- **Random** assumes that every optimization parameter is a uniformly distributed random variable in a given space and tries to find the solution by random guessing. Although a slow algorithm by default it is one of the best choices for the first step in a hybrid optimizations.
- **Gradient** is based on an estimation of the gradient of the error function, which is calculated using given optimization criteria, and searching for the minimum in the direction in which function decreases fastest. This algorithm converge to the minimum practically quicker than any other algorithm.
- **Simple Search** systematically explores the optimization space.
- **Simplex** is based on Nelder-Mead simplex algorithm that proved itself for many times in practice because of its ability to skip from one minimum to a better one. It is very quick and most robust local optimizer. Therefore it is ideal for the second step in hybrid two-step optimizations.

Unique feature is that two optimization procedures with different algorithms can be performed in succession. The first one is used for coarse optimization and the second one is used for fine tuning. Thus obtained hybrid methods combine favorable traits of different algorithms, resulting in overall increase of optimization efficiency.

Using hybrid methods, WIPL-D Optimizer enables you to find not only the global minimum, but also a set of the best local minima. Insight into other local minima enables you to find the solution which meets the criteria not included into the cost function (e.g. the solution that could be optimal for fabrication).

Simple Example: Optimized horn antenna

The open end of a rectangular waveguide is a source of electromagnetic waves, but it also represents a discontinuity and causes reflection and creation of unwanted higher modes. A horn is added at the open end to reduce the reflection of the electromagnetic waves at this discontinuity and to diminish the higher modes.



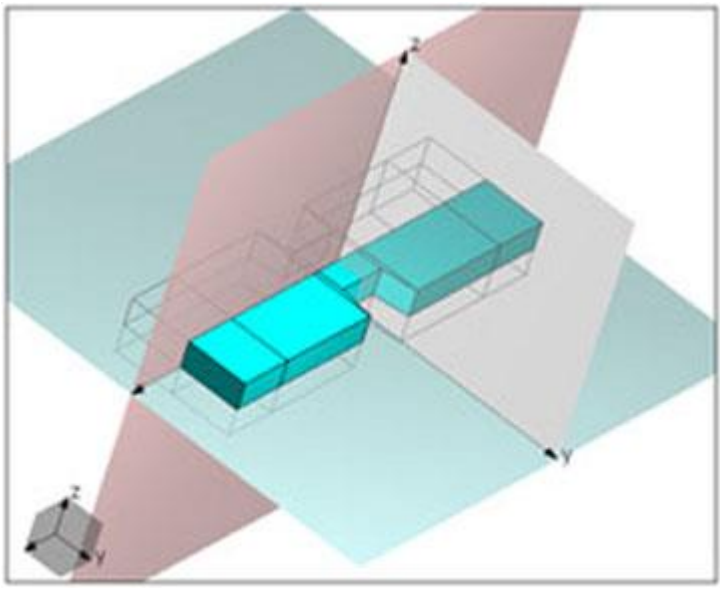
Let us assume that the length of the horn is specified. In that case, we can only change the surface of the open end of the horn in order to achieve greater gain. But, how can we achieve the best possible gain? On one hand, increase of the horn's aperture leads to decrease of the antenna's gain due to changes in the distribution of phase at the opening. On the other hand, by increasing the surface of the opening, the physical surface of the antenna is being increased and so is its effective surface. This leads to the augmentation of gain.

Let's say that we want to achieve the gain along the axis of the waveguide greater than 20 dB, and we wonder how large the surface of the opening needs to be. We than set the optimization criteria and the range for height and width of the horn and then we run the WIPL-D Optimizer.

When the optimization procedure finishes, we get the optimum dimensions for the aperture of the horn. So, by setting only few parameters we obtained optimum dimensions of the horn in just a few seconds.

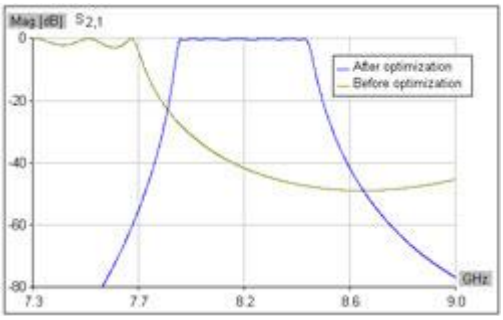
Advanced Example: Automated Design of a Waveguide Filter

This is an advanced example in which you can see the possibility of optimization-based design of a microwave circuit (filter). The aim is to demonstrate an effective procedure for designing waveguide filters consisting of series of coupled λ/2 resonators without good initial guess. The coupling is performed by using arbitrary waveguide discontinuities (e.g., double H steps).

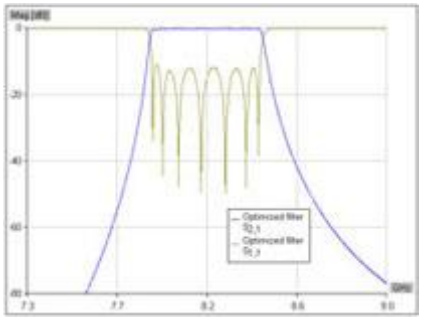


The specifications of the 7-pole filter were -60 dB attenuation from 7.3 GHz to 7.7 GHz and -0.3 dB insertion lost in passband between 7.9 and 8.4 GHz. The filter is manufactured in standard rectangular waveguide technology 153 IEC-R84 (WR-112). Dimensions of waveguide are 28.5 mm of width (A) and 12.624 mm of height (B). The dielectric is air and the metal is copper. The model is made using analytical models of rectangular H double step components in WIPL-D Microwave Pro environment.

The obtained filter mostly satisfies the desired characteristic. Agreement in stopband was excellent (60 dB were obtained) and insertion loss was almost (up to 0.38 dB with losses included) in the range requested. WIPL-D software enables fast and practical waveguide filter design. Even when there is only a theoretical image of solution, WIPL-D Microwave and WIPL-D Optimizer can be used to find the filter that satisfies the given criteria.



S21 parameter before and after optimization



Final S11 and S21 - optimized filter

Three 3D EM models of rectangular horn antenna were simulated. The first model is full model. In the second and the third model are models with one symmetry plane and two symmetry planes applied, respectively. All antennas were easily modeled and simulated very fast using WIPL-D Pro. In addition, 3D radiation pattern and 2D distribution of electric field in the near field region are shown. Usage of Symmetry plane saved memory resources and decreased simulation time keeping desired output results very similar.