



*Best in Filter Designs*

Application Note ANAWR103 (v.2)  
Miniaturized Hairpin Filter Design Using  
Nuhertz Filter Synthesis Software

[www.nuhertz.com](http://www.nuhertz.com)

[www.awrcorp.com](http://www.awrcorp.com)



## Nuhertz Filter Design Software

- Generates filter layout geometries from user- entered design requirements
- Many different filter types are possible
- Miniaturized hairpin design used as an example
- Generates AXIEM<sup>®</sup> EM simulation project directly
- Easy to use graphical user interface (GUI)
- Runs on Windows PCs

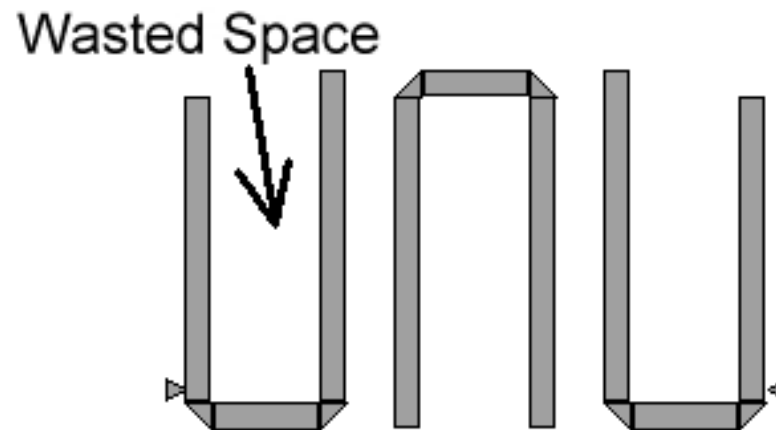


## Tuning and Optimizing

- Synthesized planar filters generally require tuning and/or optimizing to maximize performance
- Tuning is achieved by repeat manual edits and AXIEM simulations
- Optimizations are performed with AWR Direct AXIEM Extraction optimizations, or highly efficient Axiem automated port tuning

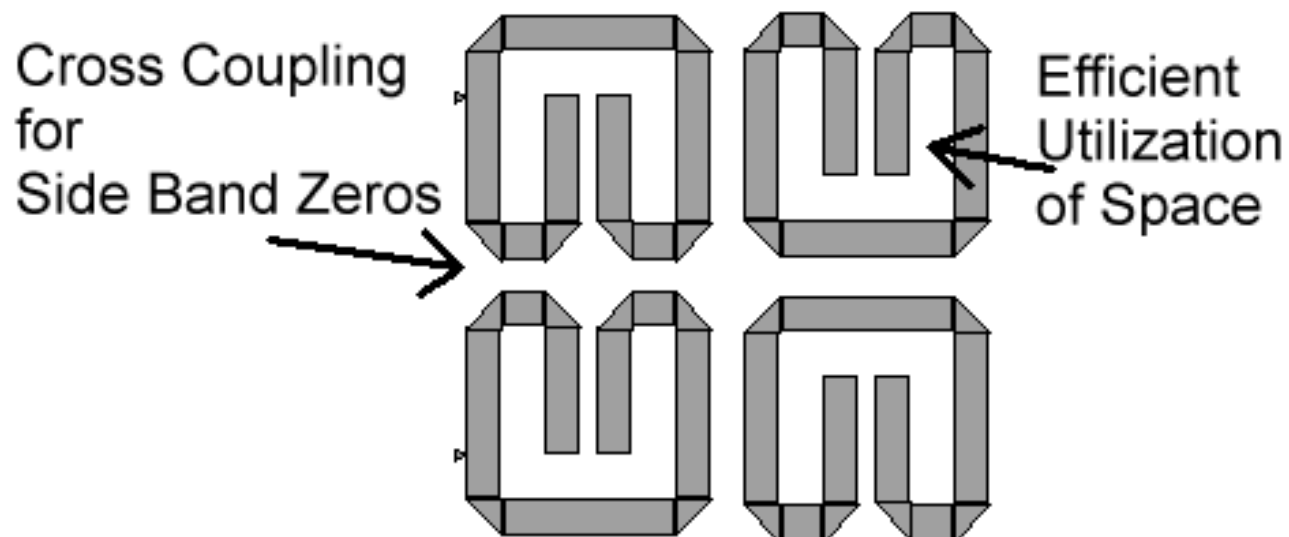
## Goal for Miniaturizing the Hairpin

- Traditional hairpin designs are inefficient in space utilization
- Traditional hairpin designs are all-pole, permitting excessive pass band spread



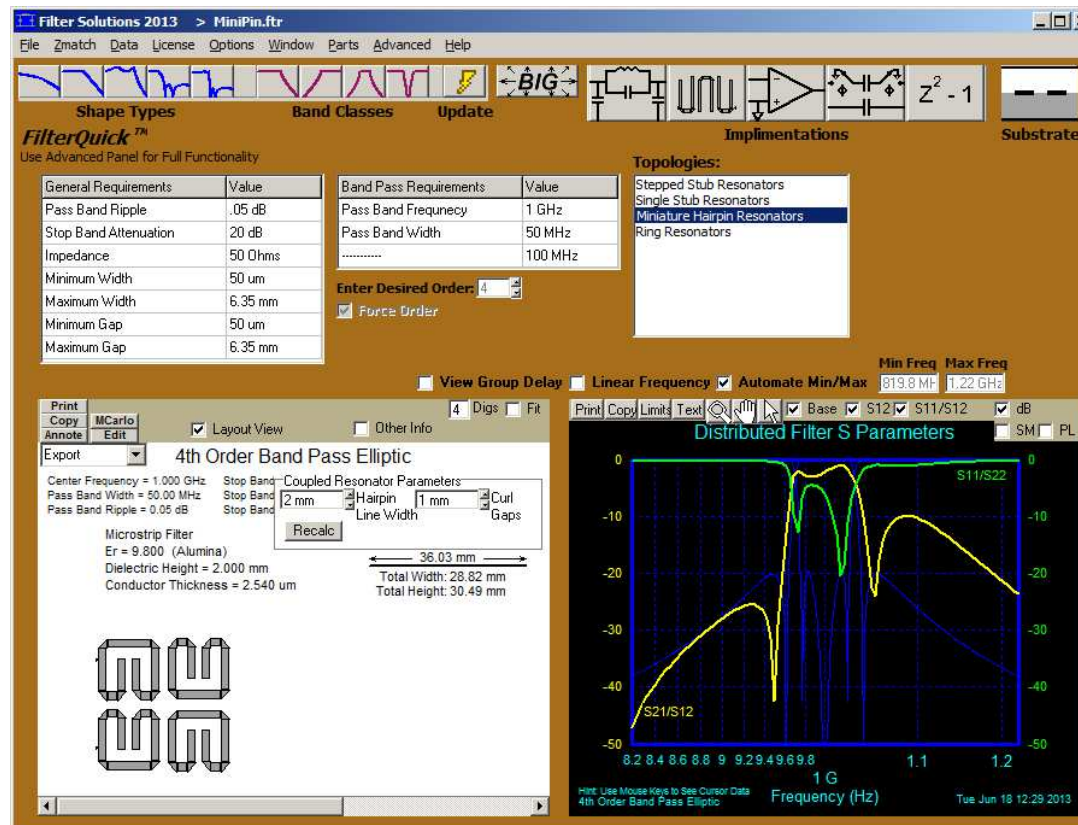
# Miniaturized Hairpin Design With Nuhertz

- Efficient use of space provided by folding over hairpin ends
- Cross coupling produces side band zeros for narrow passbands



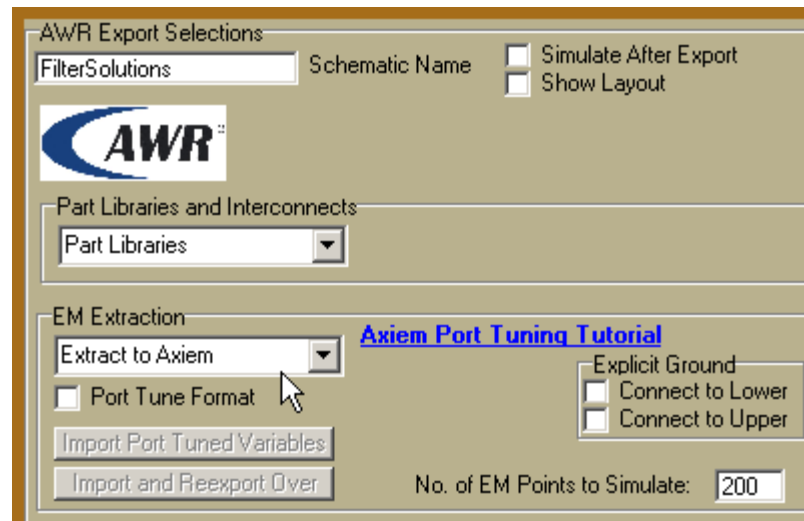
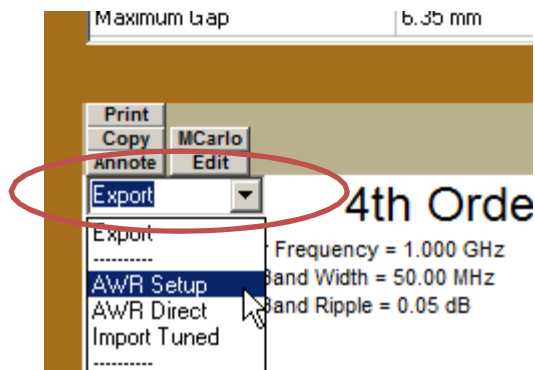
# Miniaturized Hairpin Issues

Closed-form circuit level analyses of folded hairpin filters are generally poor because they don't capture coupling of the folded elements



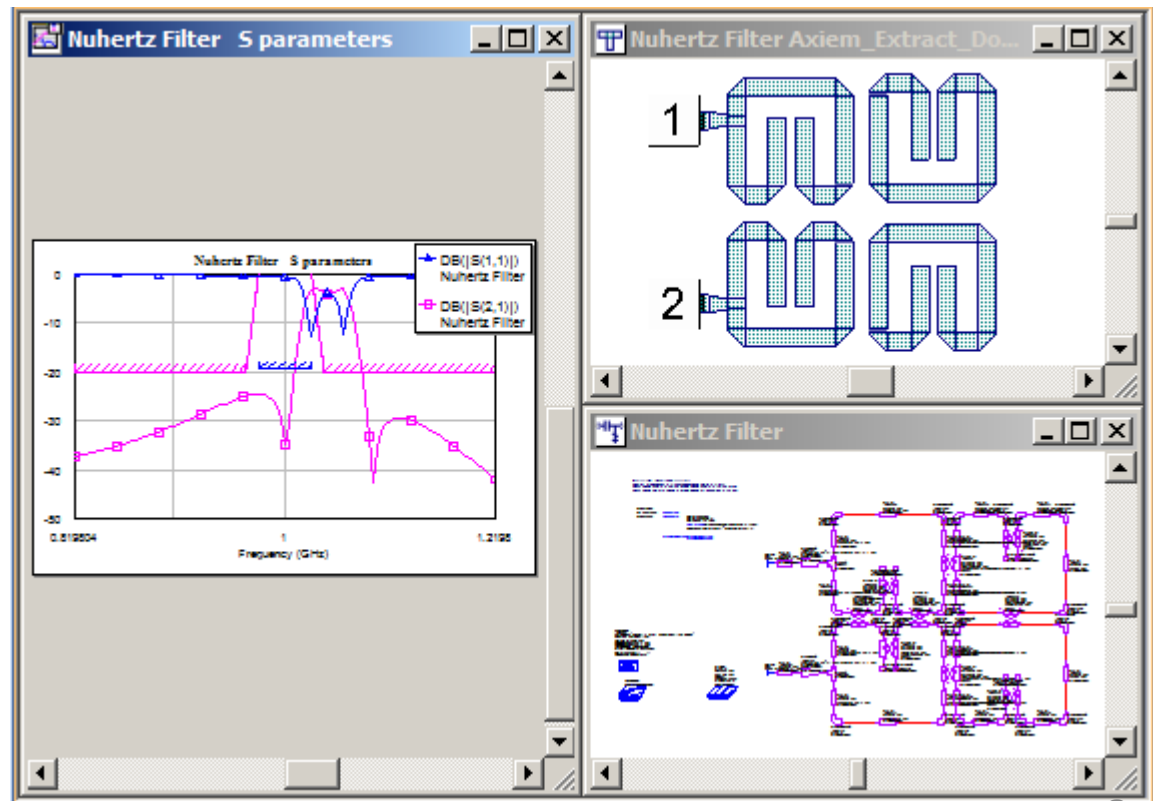
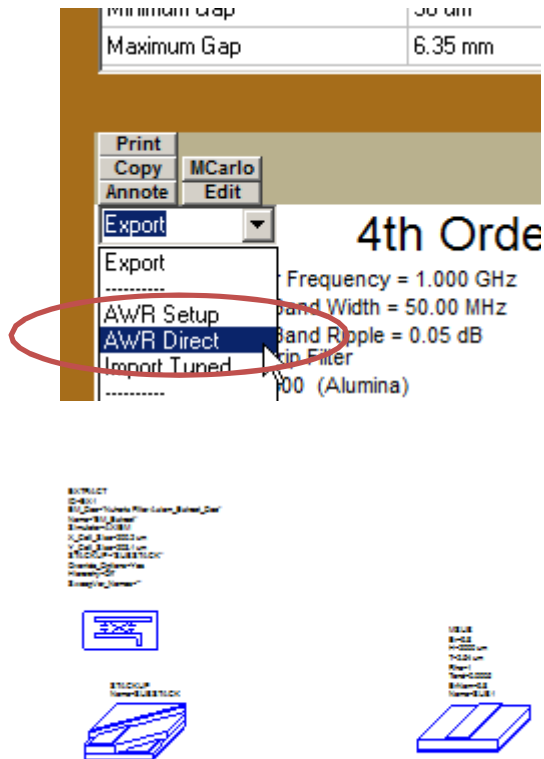
# Manual EM Tuning With NI-AWR Export Control Panel

- Select, “Extract to Axiem”, desired “Points to Simulate” and other selections, and Export



# Export to AWR Using Saved Settings, with NI-AWR Direct

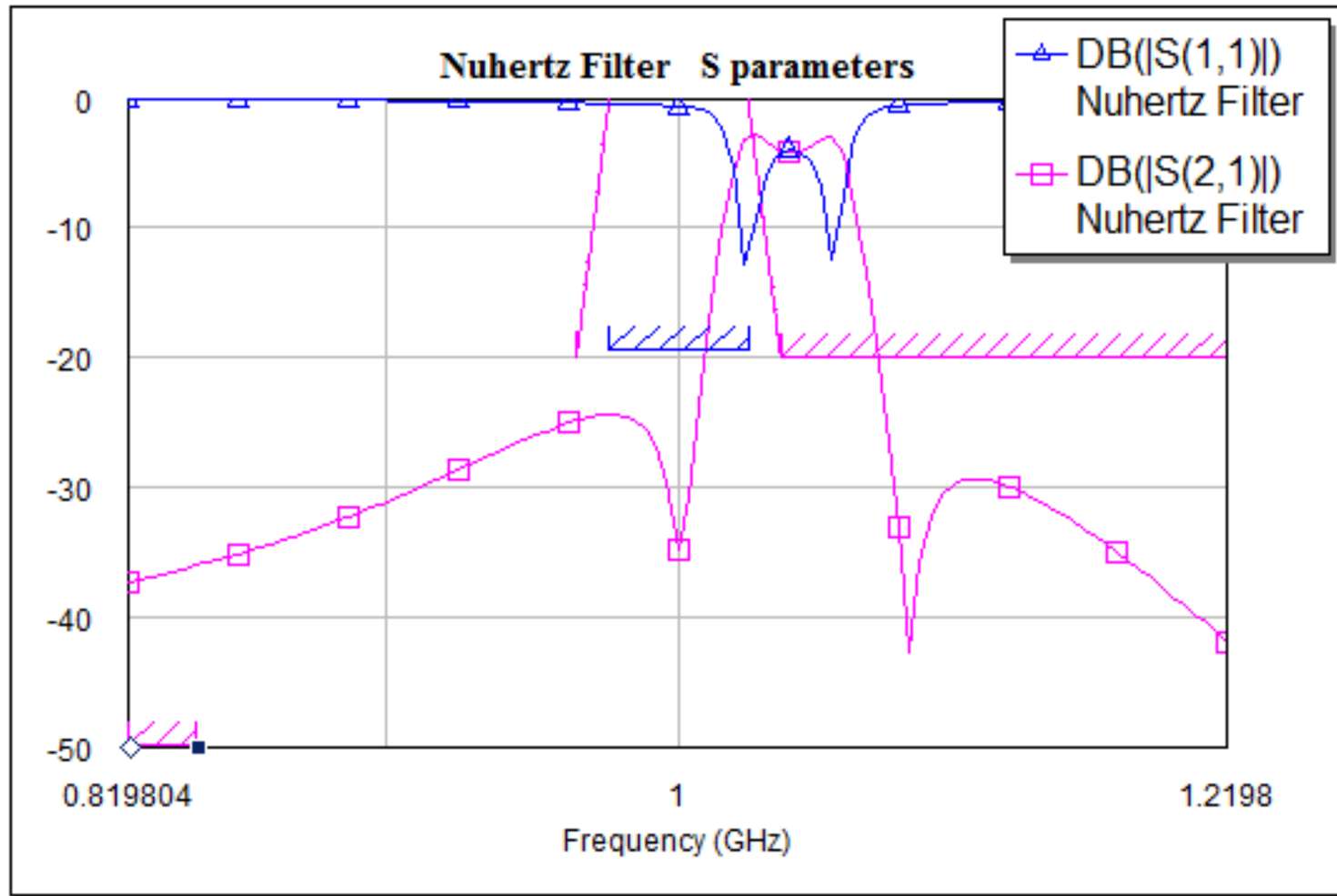
- Stackup and extract blocks are automatically set





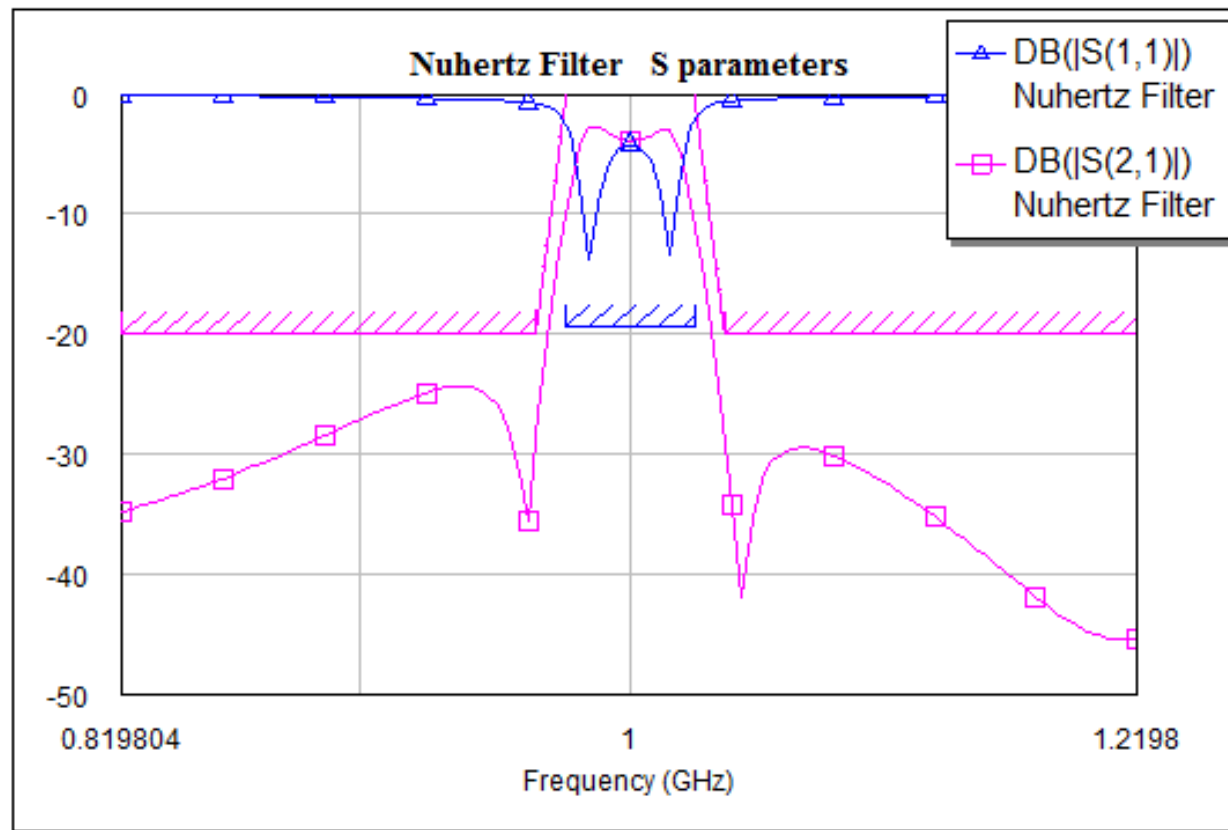


# View and Measure Axiem EM Response



## Pre-tune Center Frequency in AWR (Option)

- May aid the extraction optimization process





# Optimize With Highly Efficient Axsem EM Port Tuning

- Accurate EM Optimization obtainable in **five minutes**, or less

The screenshot displays a software interface for EM optimization. On the left, a panel titled 'Part Libraries and Interconnects' shows 'Part Libraries' selected. Below it, the 'EM Extraction' section has 'Extract to Axsem' selected, with a blue link 'Axsem Port Tuning'. The 'Port Tune Format' checkbox is checked. Below are buttons for 'Import Port Tuned Variables' and 'Import and Reexport Over', with 'No. of EM' partially visible.

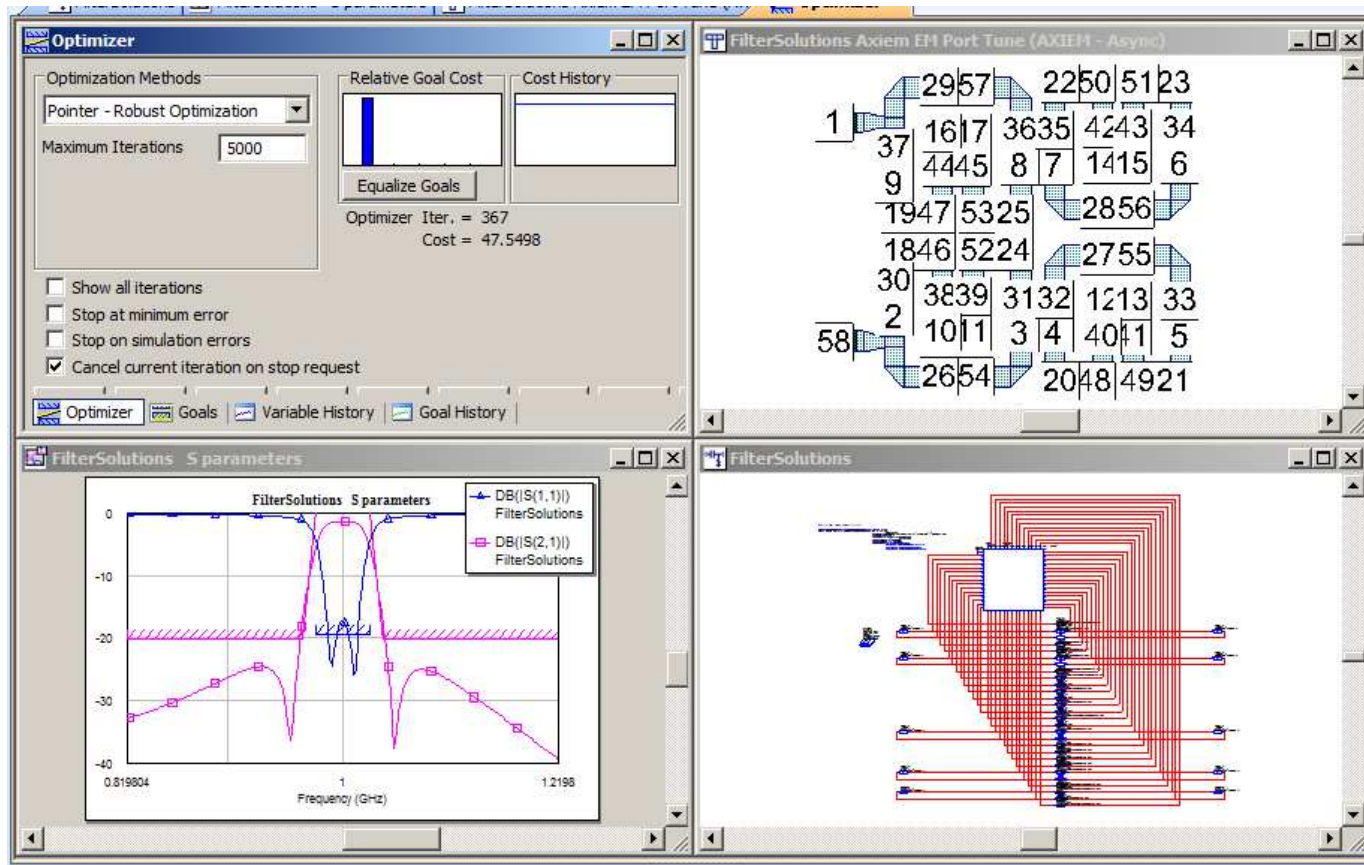
The main area is divided into four panes:

- Optimizer:** Shows 'Optimization Methods' set to 'Pointer - Robust Optimization' and 'Maximum Iterations' set to 5000. A 'Relative Goal' bar chart is visible. Buttons for 'Optimizer', 'Go!', 'Variable His', and 'Goal His' are at the bottom.
- FilterSolutions S parameters:** A plot of S-parameters vs. Frequency (GHz) from 0.016000 to 1.2100. It shows two curves: 'DB(S(1,1))' (blue) and 'DB(S(2,1))' (magenta).
- FilterSolutions Axsem EPI Port Tune:** A table of numerical values representing optimized parameters.
- FilterSolutions:** A circuit diagram showing a filter structure with red traces and a central component.

1	5	16	3	20	5	22	50	23
1	5	16	3	20	5	22	50	23
19	47	8	7	1	6			
30	52	4	2	12	3			
58	2	10	3	4	1			
20	5	20	48	21				

# Port Tuning Optimization

- Optimize and Re-export as needed.
- Accurate results obtainable after one to two port tuning cycles



# Final Axiem Design

