Module 3: Solvers, Meshing and Solution Setup

ANSYS HFSS 3D Layout Getting Started Course

LE03

Outline - HFSS 3D Layout Solvers and Meshing

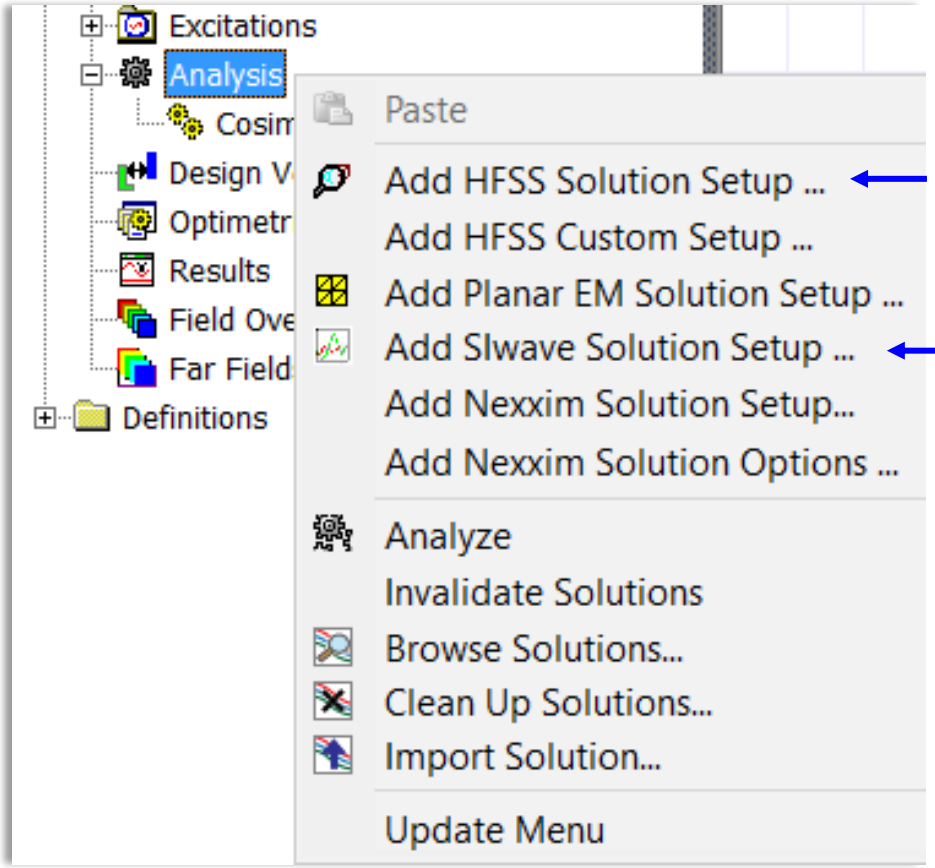
- HFSS Solvers
  - Meshed volume solution space
  - Adaptive FEM (finite element method) solver
  - Planar EM (MoM) solver
  - SIwave Solver
  - DCIR not covered here

- Cosim Options
  - Simulation options area
  - Automatic solution selection
  - Solution selection override
  - Invalidate solution and force simulation

The document "***An Introduction to HFSS***", Chapter 3 ***"HFSS Excitations"*** is available in the online help.

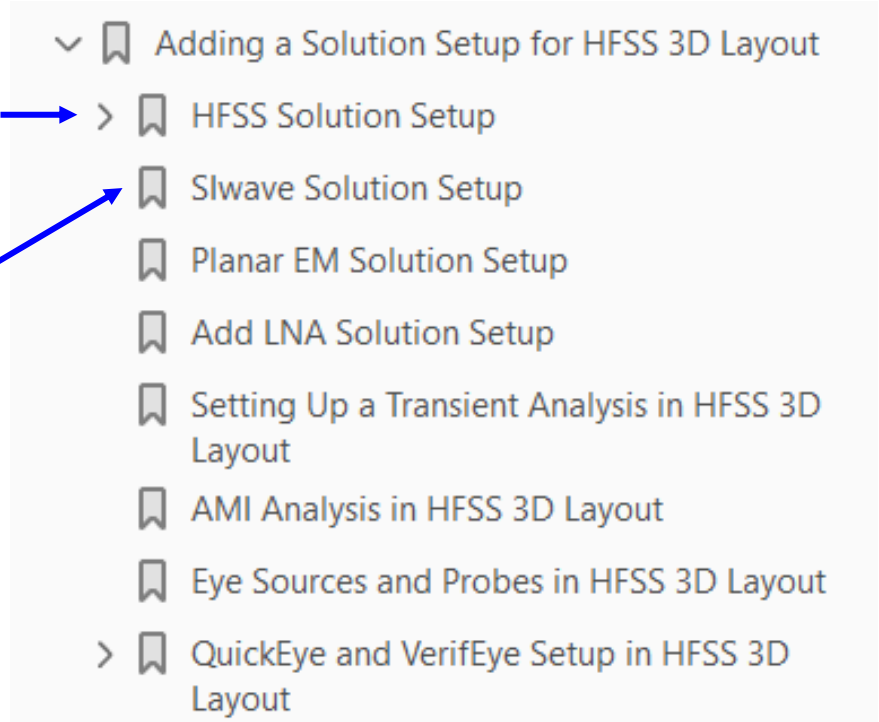
HFSS 3D Layout Solvers - Fully Arbitrary 3D and Planar MoM

The most common solvers chosen in HFSS 3D Layout are the HFSS fully arbitrary 3D finite element Method (FEM) solver and the SIwave solver. A third type of EM formulation is planar EM method-of-moments (MoM).



HFSS 3D FEM solver

SIwave solver



The above-right description comes from the document HFSS.pdf ***An Introduction to HFSS***, chapter on ***HFSS 3D Layout*** table of contents.

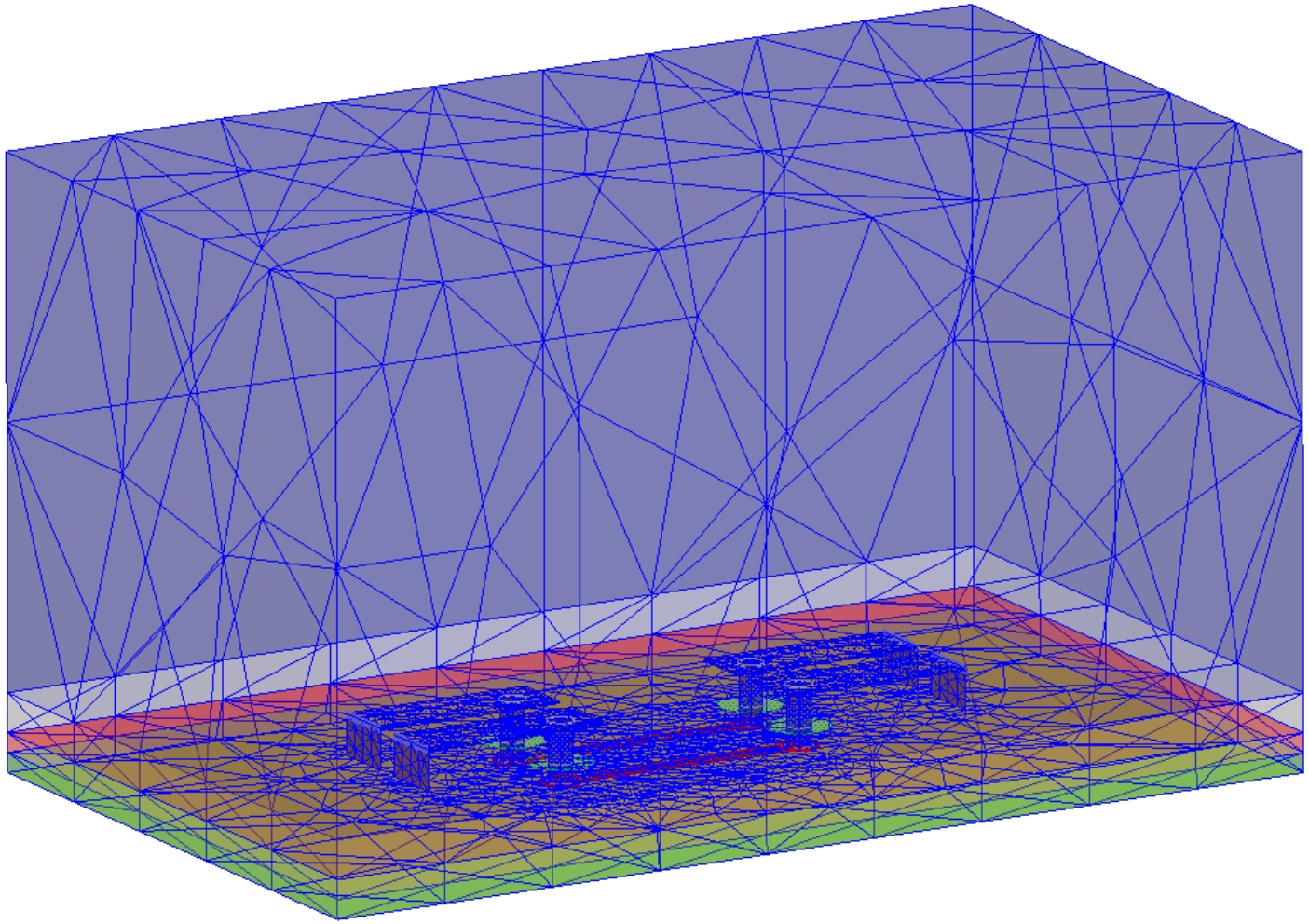
HFSS Fully Arbitrary 3D FEM Meshes the Entire Simulation Space

HFSS finite element method (FEM) simulates the mesh.

FEM solves for fields in a volume.

Extents are the boundaries in which HFSS meshes.

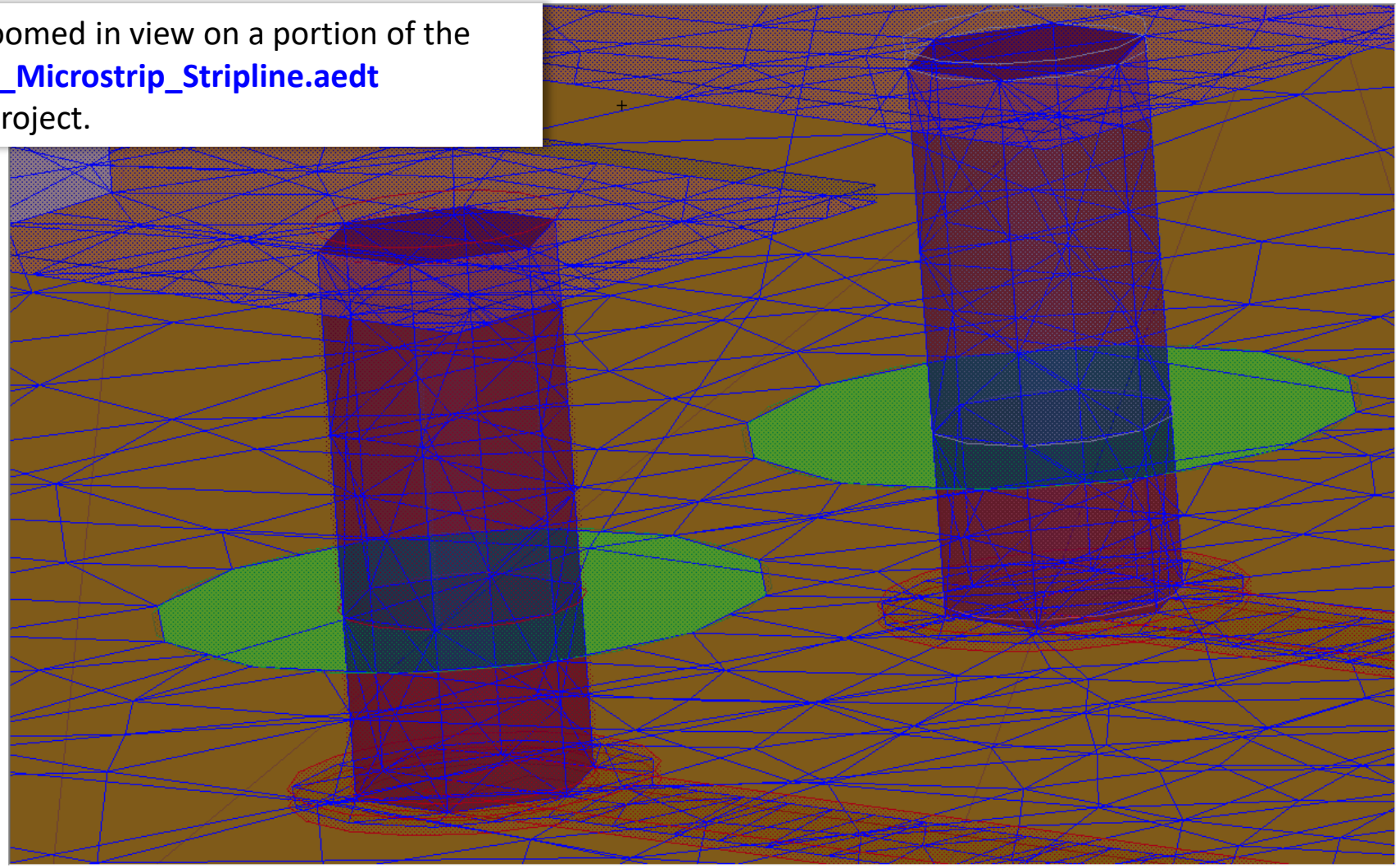
HFSS ***mesh*** is ***fully arbitrary 3D***. The geometry in HFSS 3D Layout is layered.



Transition_Microstrip_Stripline.aedt

Classic Meshing Method in HFSS 3D Layout

This is a zoomed in view on a portion of the **Transition_Microstrip_Stripline.aedt** Example project.

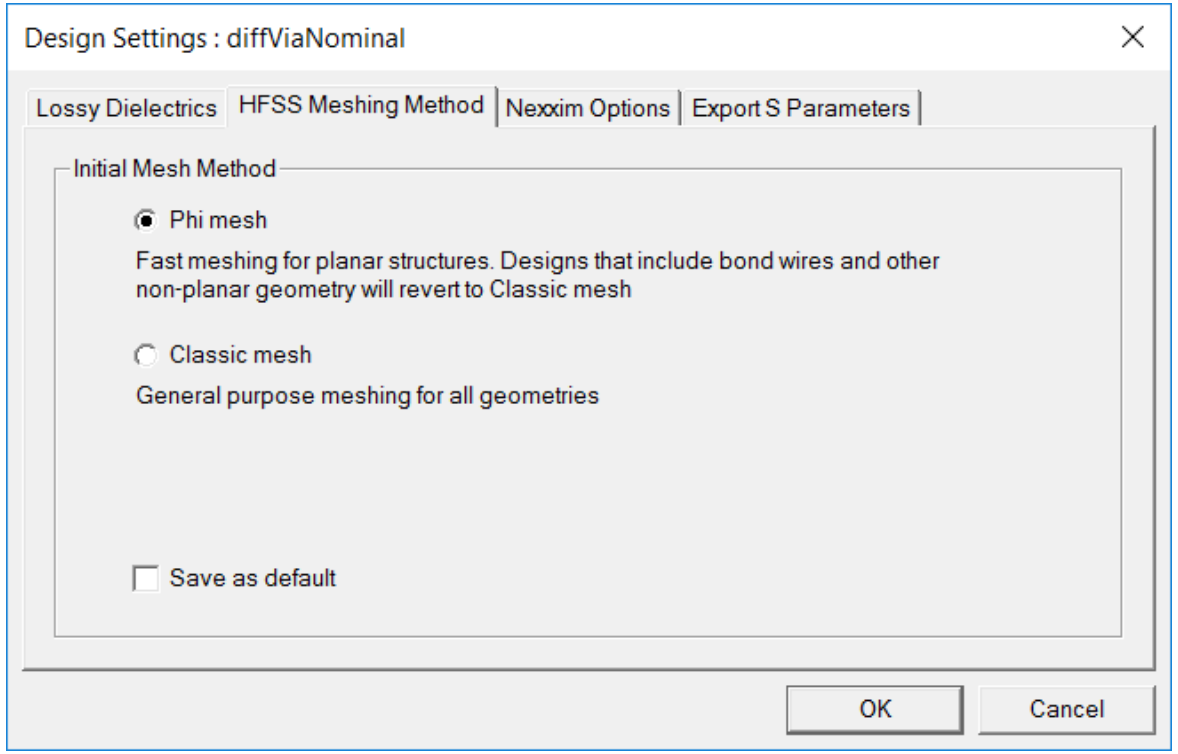


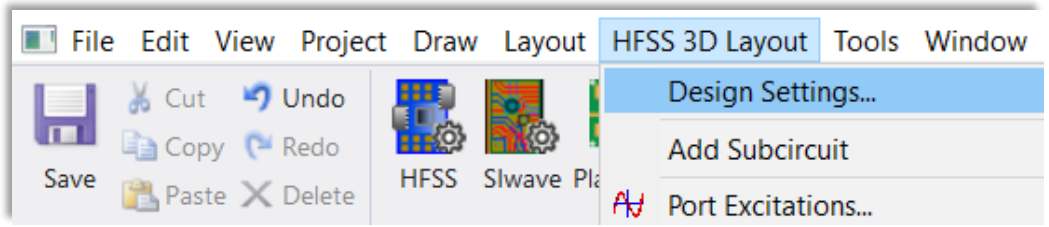
HFSS Meshing Method in HFSS 3D Layout

Phi mesh is a layout-based meshing technology, available in the HFSS 3D Layout interface. This advanced meshing technology is capable of rapidly generating an initial mesh ensuring faster simulations that can be further accelerated and enhanced by using high performance computing.

Classic mesh uses a Bowyer algorithm to create compact meshes for the model with very large length scales. It represents the model very accurately.

How to access Meshing Method: ***HFSS 3D Layout > Design Settings***





See also ***HFSS.pdf***, the section on ***HFSS 3D Layout Design Settings***.

HFSS 3D Layout Meshing Comparison

Phi

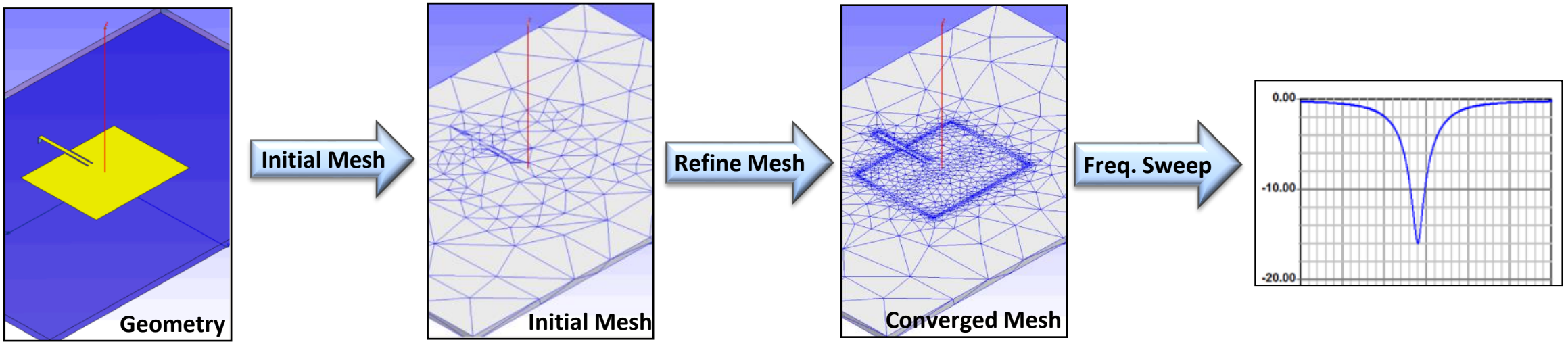
- Approach: From a layout, generate layer by layer 2D triangular mesh. Sweep mesh in stackup (+z) direction to generate tetrahedral mesh elements
- Advantage: Skips heavyweight ACIS and 3D surface mesh generation
- Pro: Extremely fast relative to classic 3D mesh approach
- Con: Only works for stack-up or 'swept in Z' geometries. IC components and packages, PCBs. etc.

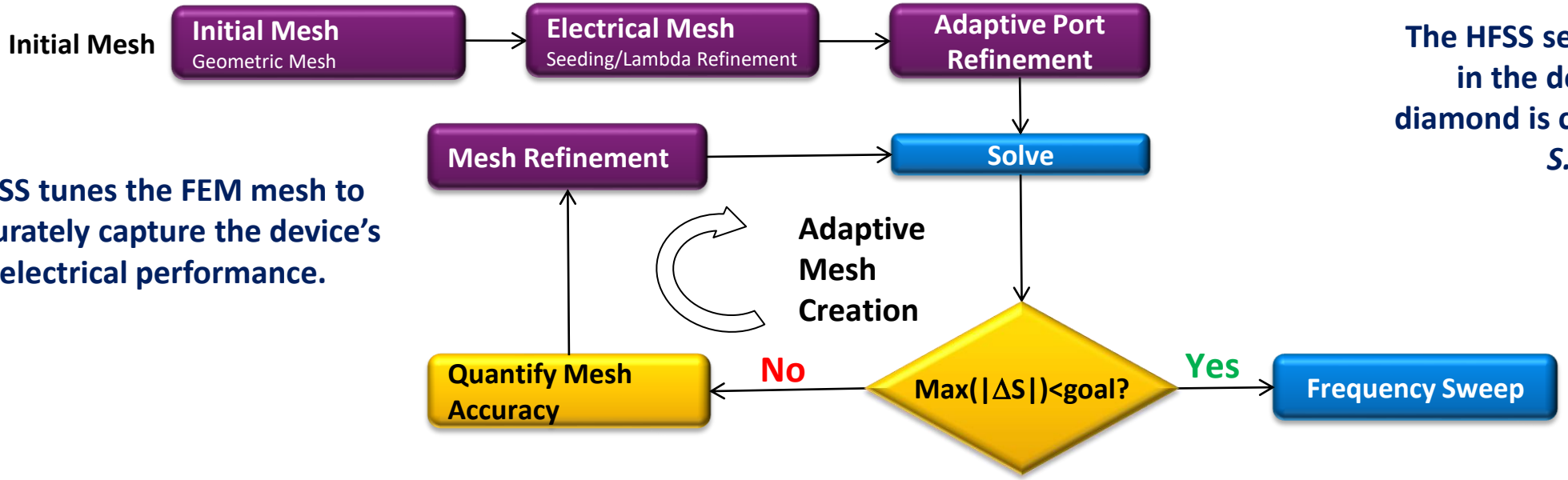
Classic

- Approach: Starts with a 3D surface triangular mesh on all objects and generate a 3D volume mesh throughout simulation domain
- Availability: HFSS (MCAD - arbitrary geometries) and HFSS 3D Layout
- Pro: Works for any arbitrary 3D geometry
- Con: For complex, many layered geometries can require a long time to generate

The document ***HFSS.pdf,*** which can be found in the HFSS online Help, has a section on ***Meshing in HFSS***.

HFSS FEM Automated Solution Adaptive Meshing Process





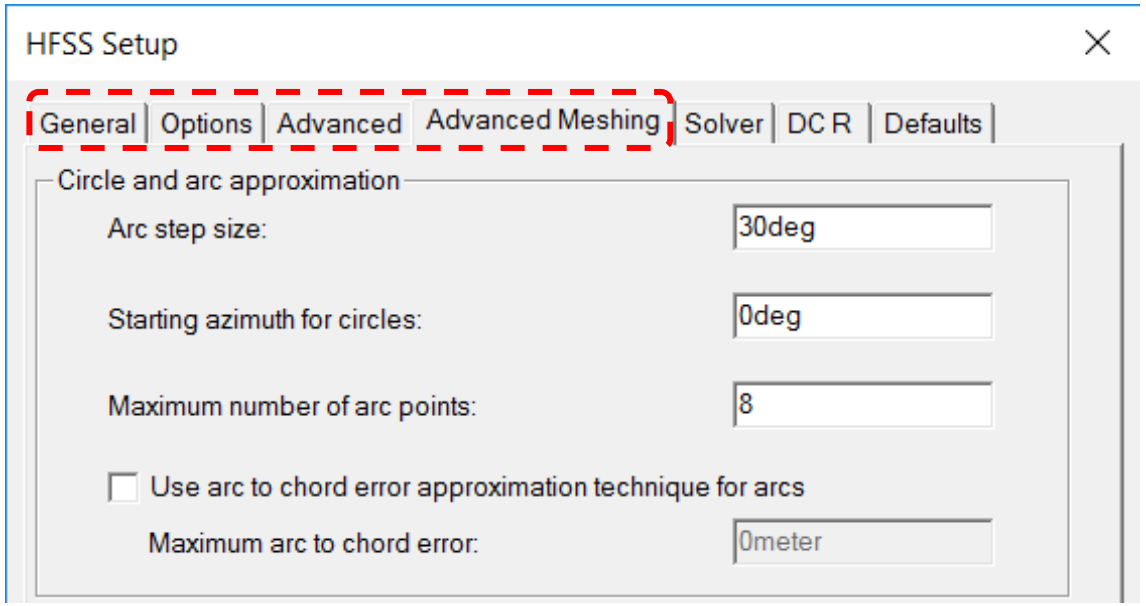
HFSS tunes the FEM mesh to accurately capture the device's electrical performance.

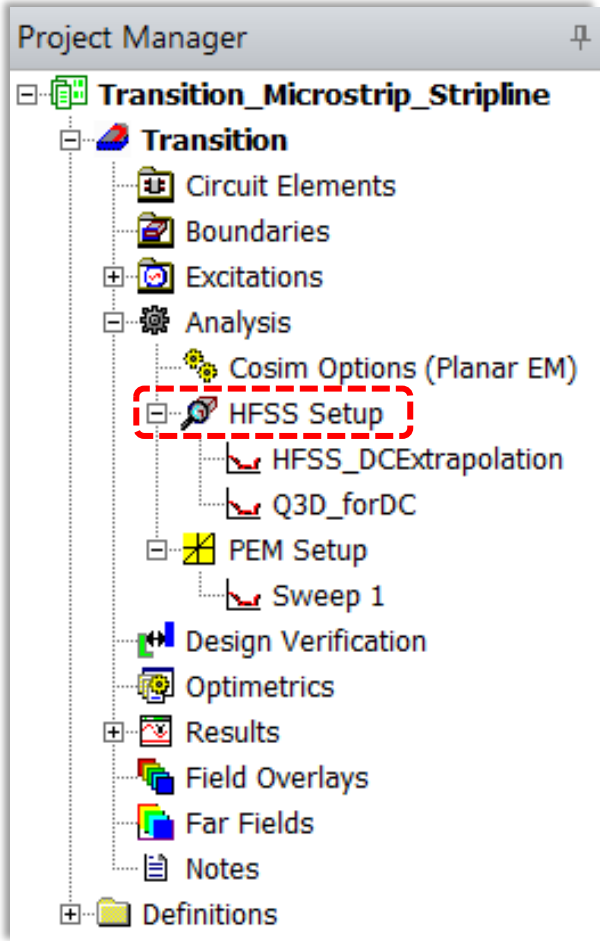
The HFSS setting used in the decision diamond is called *Delta S*.

HFSS Solver in HFSS 3D Layout

FEM meshing in HFSS 3D Layout relates to the HFSS ***Solution Setup***. Most of the tabs in the ***HFSS Setup*** dialog box include meshing options.

Information is available in the ***HFSS Getting Started*** course and in the documentation about the adaptive meshing used in the HFSS finite element solver.





HFSS Solver *Solution Setup* Advanced Tab Vias

Simulation efficiency is important, especially for larger complex structures...

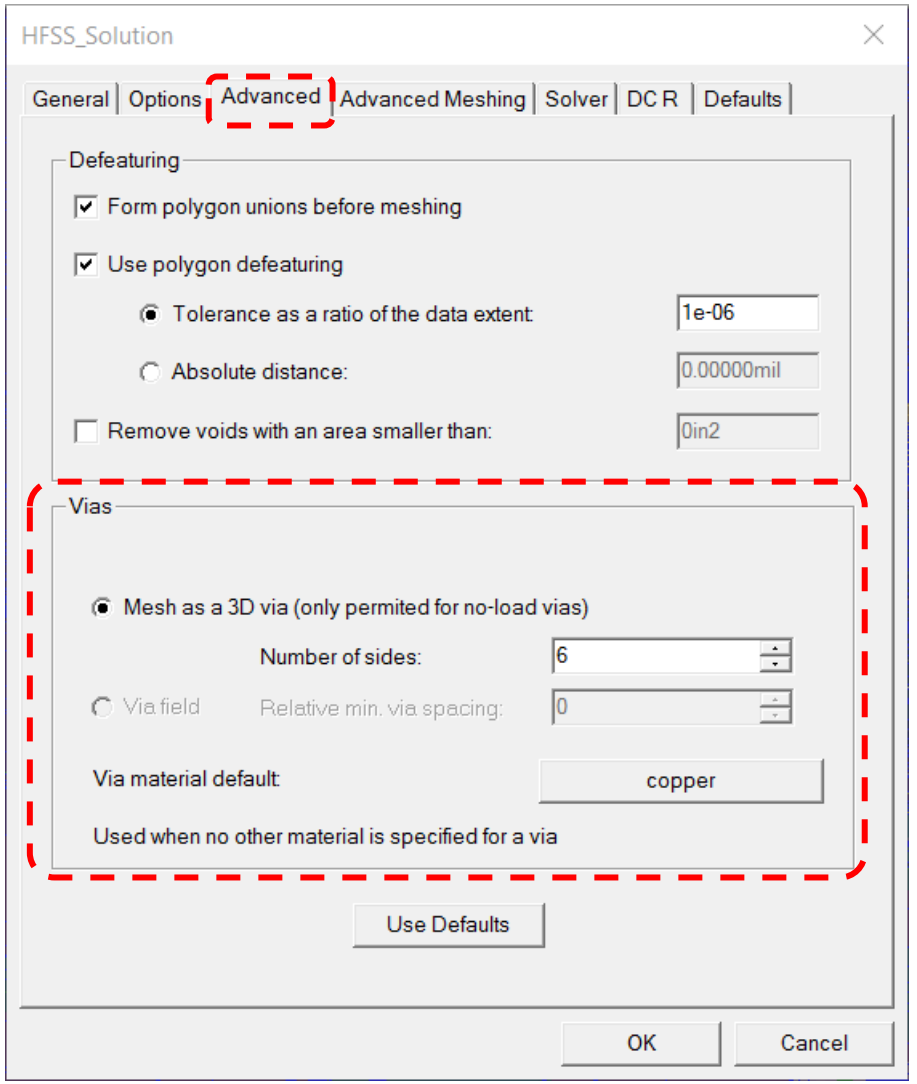
Vias may be modeled as faceted cylinders.

***Mesh as a 3D via**:*

- ***Number of sides**:* number of sides to use when creating the 3D representation; if less than 3, the via is modeled as a flat ribbon.

***Via field**:* it may be possible to reduce the density of via fields and model them using wirebonds without significant loss in accuracy.

- ***Relative min. via spacing***: defines a radius around a via; any via that falls within that radius is eliminated.



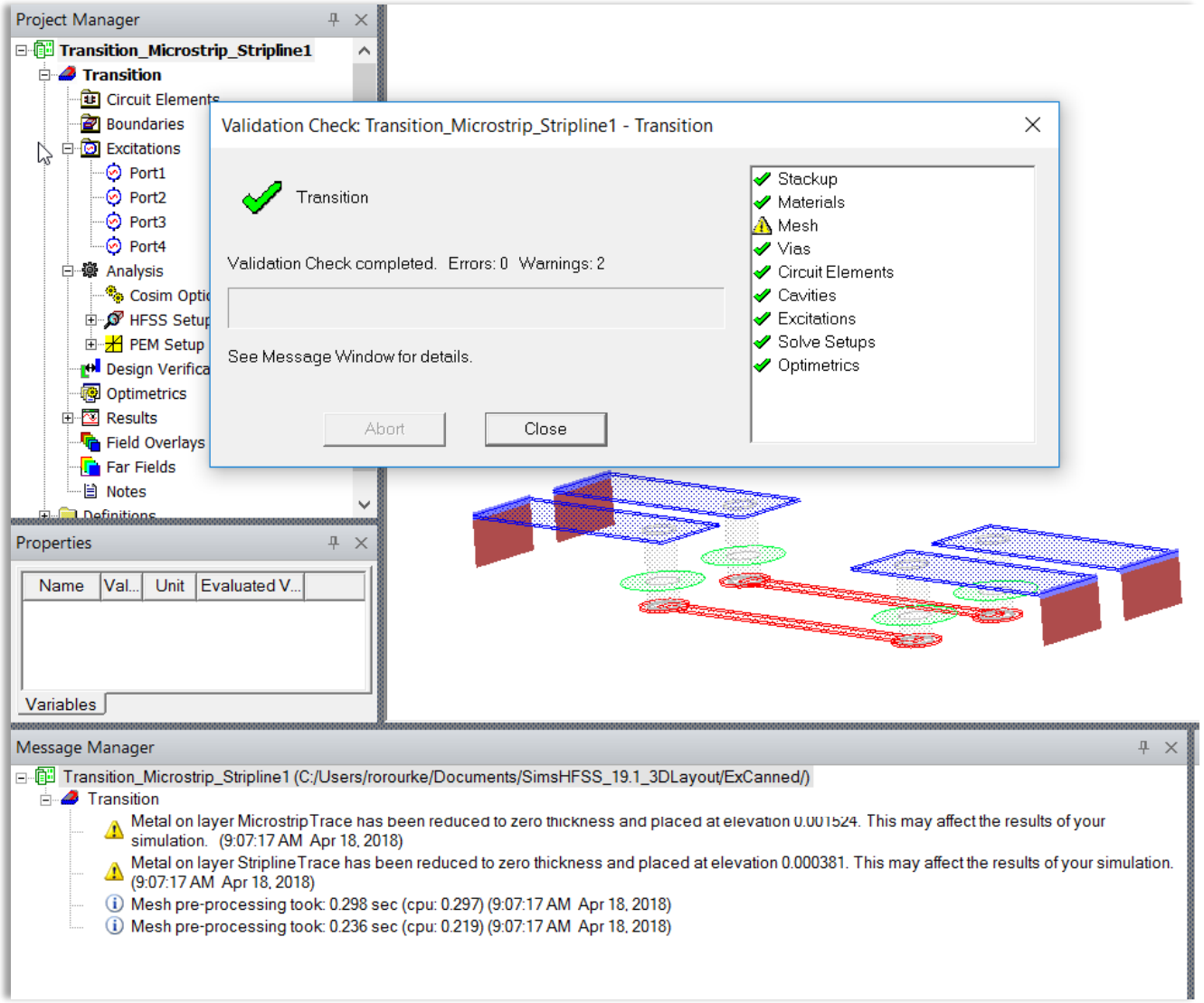
Most of this text comes from ***HFSS.pdf*** ", Chapter 15 section on ***"HFSS Solution Setup"*** and ***"HFSS Setup: Advanced Tab"***.

HFSS 3D Layout Meshing: Thin Metal

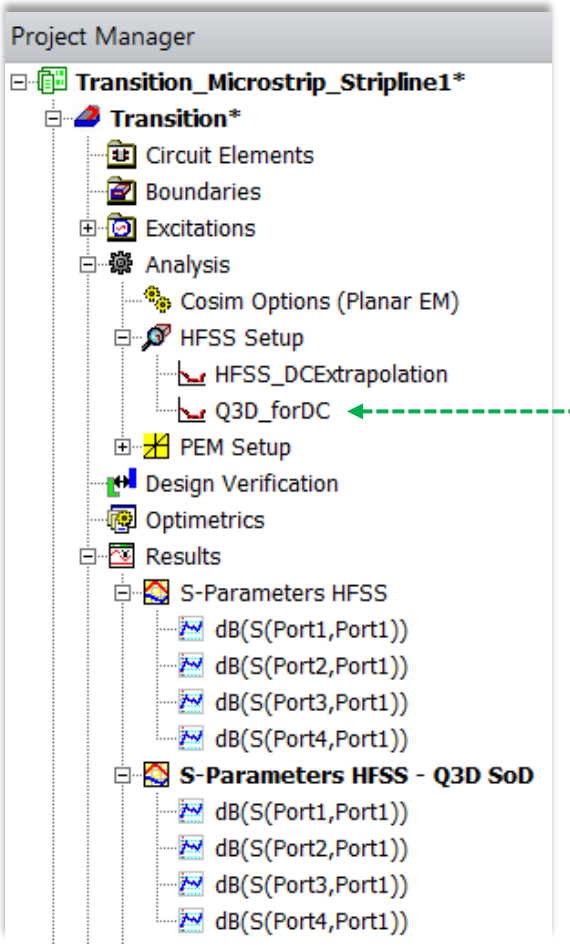
These message only appears the first time the validation is performed, because HFSS changes the thickness of the metal to zero.

In this case, the layer is being converted to a sheet body as a result of thickness thresholds in the HFSS setup. For more control, the thickness can also be explicitly set to 0 in the stackup editor.

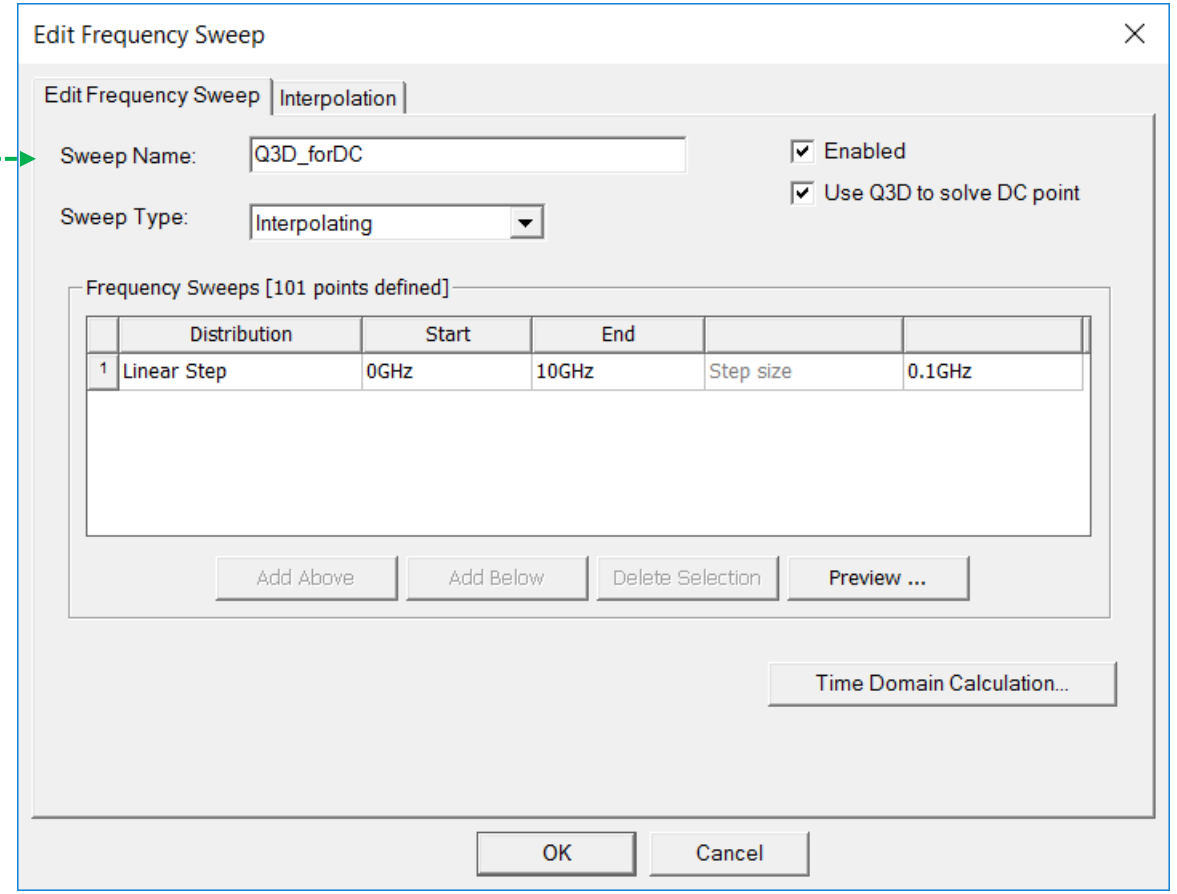
Modeling this layers as sheet bodies can greatly simplify the mesh process and initial mesh size, ultimately resulting in faster simulations. For many geometries, the impact on solution accuracy is minimal.



Q3D for DC in HFSS 3D Layout Frequency Sweep Setup



HFSS 3D Layout offers the choice of using the ANSYS Q3D quasi-static solver to generate the DC behavior of the structure.

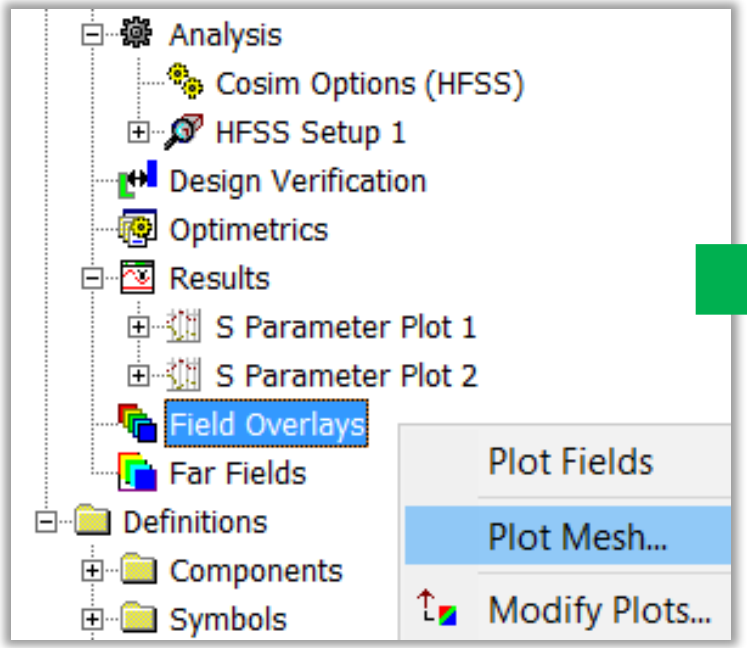


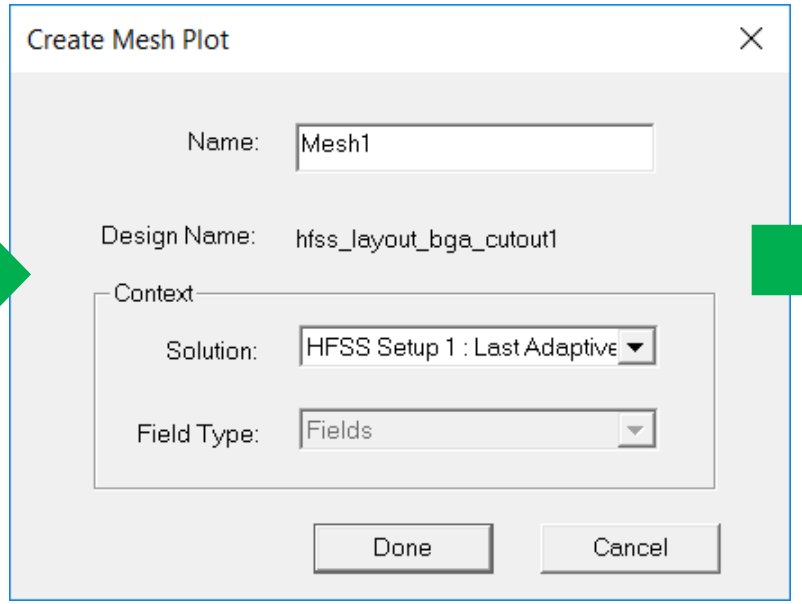
Q3D does not work with HFSS 3D Layout wave ports.

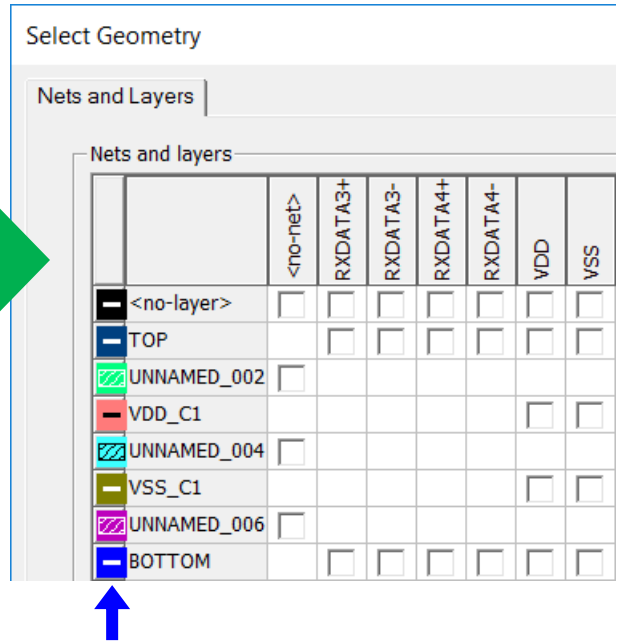
The example **Transition_Microstrip_Stripline.aedt** has HFSS solution setups both with Q3D and without Q3D.

View HFSS Mesh from *Field Overlays*

Creating a view of the HFSS mesh is done in the ***Project Manager*** from ***Field Overlays***. Mesh is specified on geometry, and the third menu in the sequence allows specific choice of geometric objects by layer.





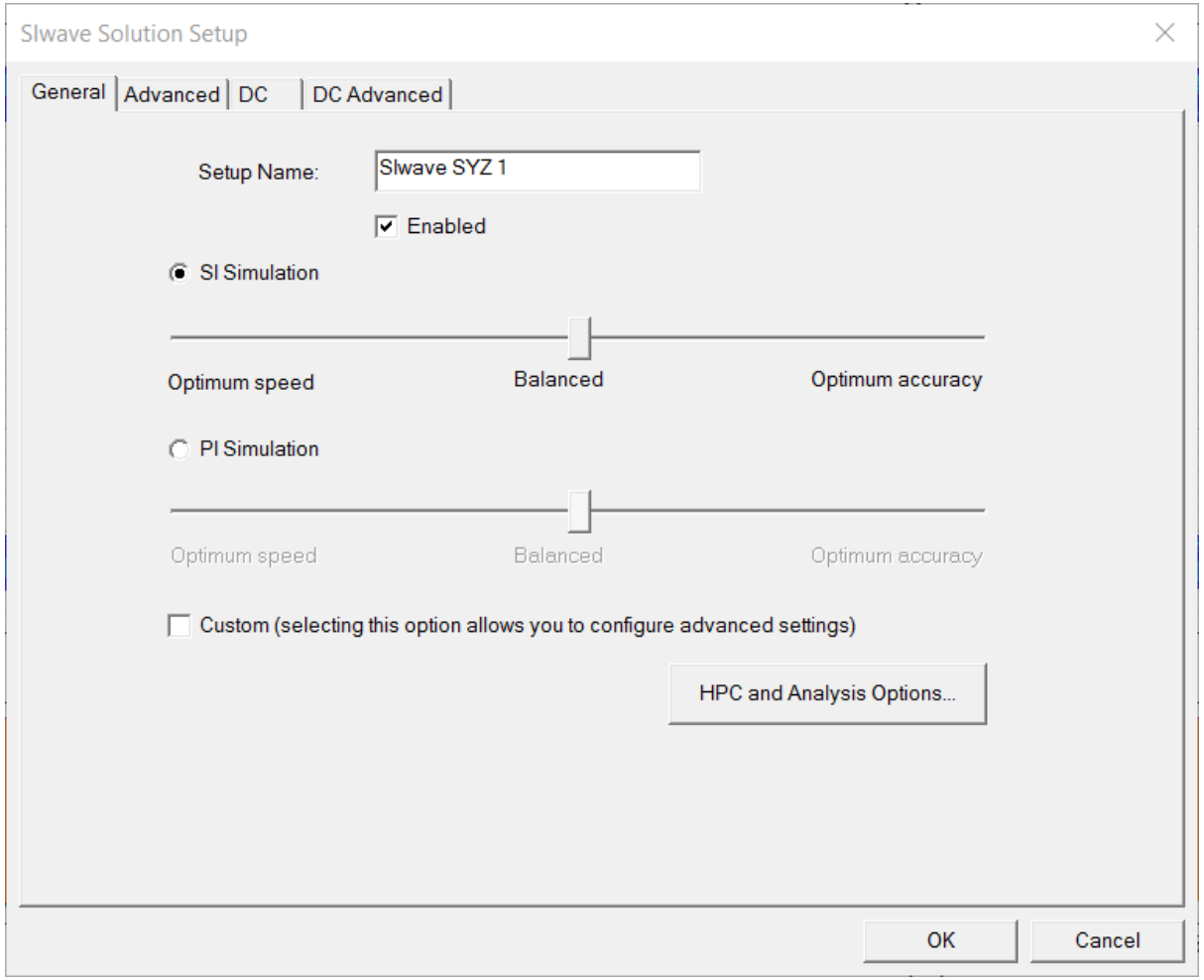


Clicking the layer on the left column checks all the boxes for that layer.

SIwave Solver SI versus PI

The SIwave solver, available in HFSS 3D Layout and shared with the SIwave simulation product, offers a dynamic combination of solver techniques including 2.5D method-of-moments (MoM), 2D finite element method (FEM), and 3D MoM for parameter extraction.

The SIwave solver also has proprietary trace, split plane, via, cavity and fringing models, which come into play with the settings in the ***General*** tab of the SIwave solver ***Solution Setup***.



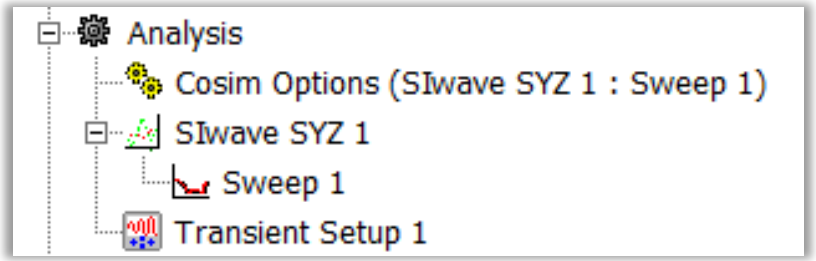
See also ***HFSS.pdf***, Chapter 15. Search on ***SIwave Solution Setup***.

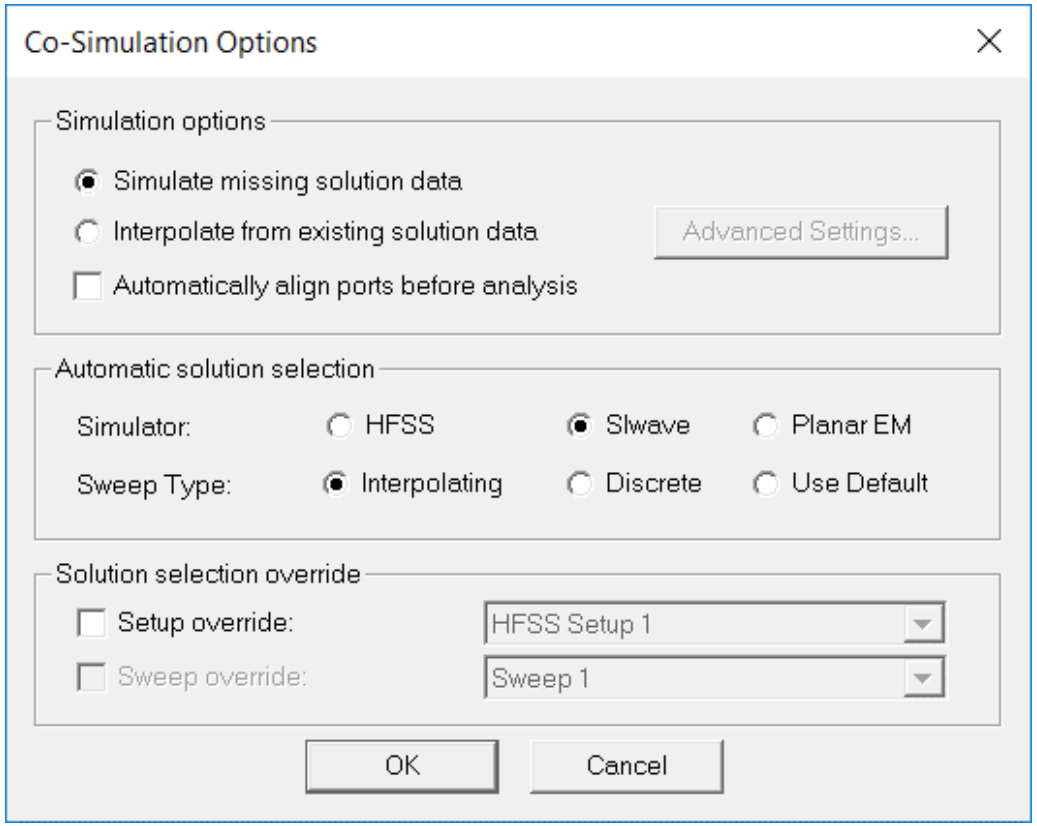
Cosim Options Used for Circuits Calling EM Blocks

Co-Simulation Options apply to Nexxim circuit simulations that include EM (electromagnetic) designs.

In an HFSS 3D Layout project that contains no circuit schematic within a 3D Layout, the ***Co-Simulation Options*** do not affect anything.

When there is a circuit simulation calling an EM simulation design, the simulator indicated under ***Automatic solution selection*** will be used to simulate the EM model block. It will create a new solution setup under ***Analysis.***

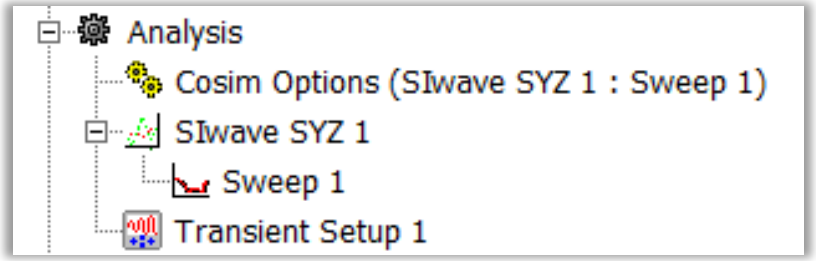


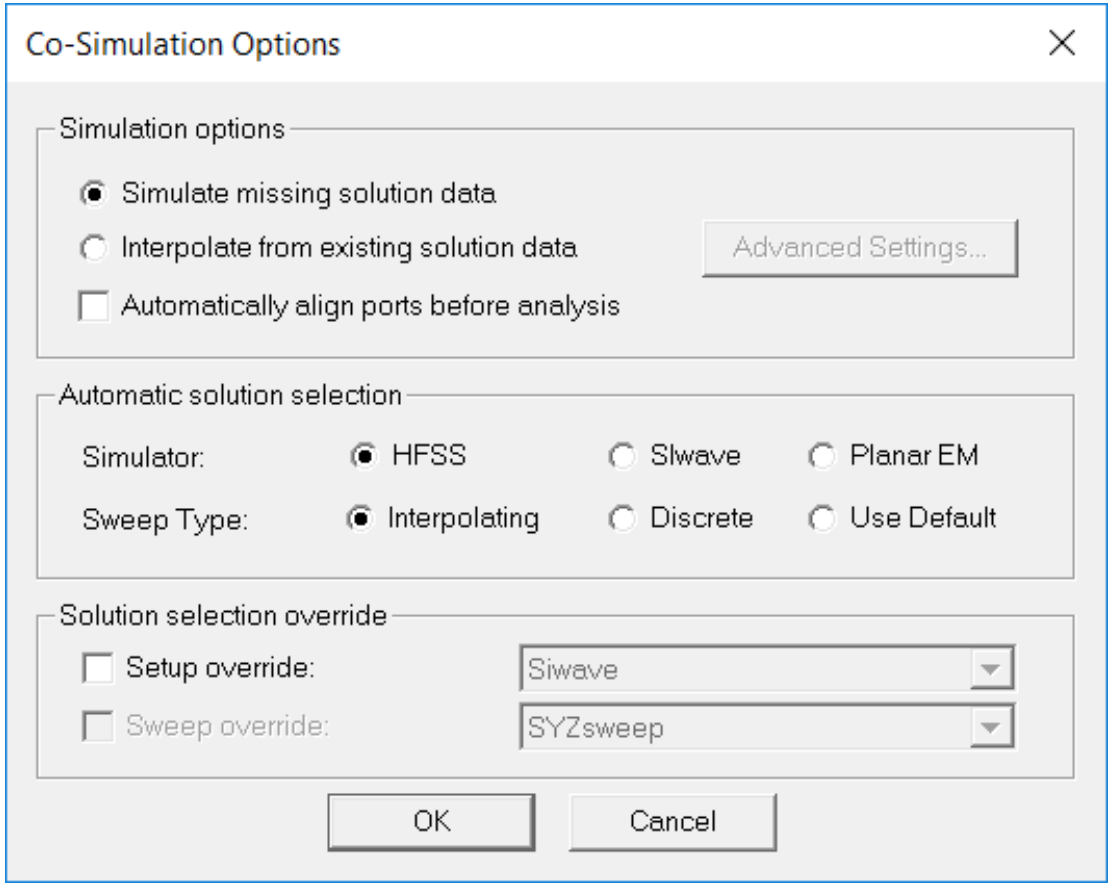


Cosim Option - *Simulate missing solution data*

In the ***Co-Simulation Options*** dialog box, in the ***Simulation options*** area at the top, the ***Simulate missing solution data*** radio button choice tells HFSS to run an EM simulation when the ***Nexxim*** circuit simulator needs EM simulation data that is not already simulated and available. In some cases these simulations can become very long.

Selecting ***Simulate missing solution data*** enables users to invoke only the circuit simulation and automatically get EM simulations as needed.

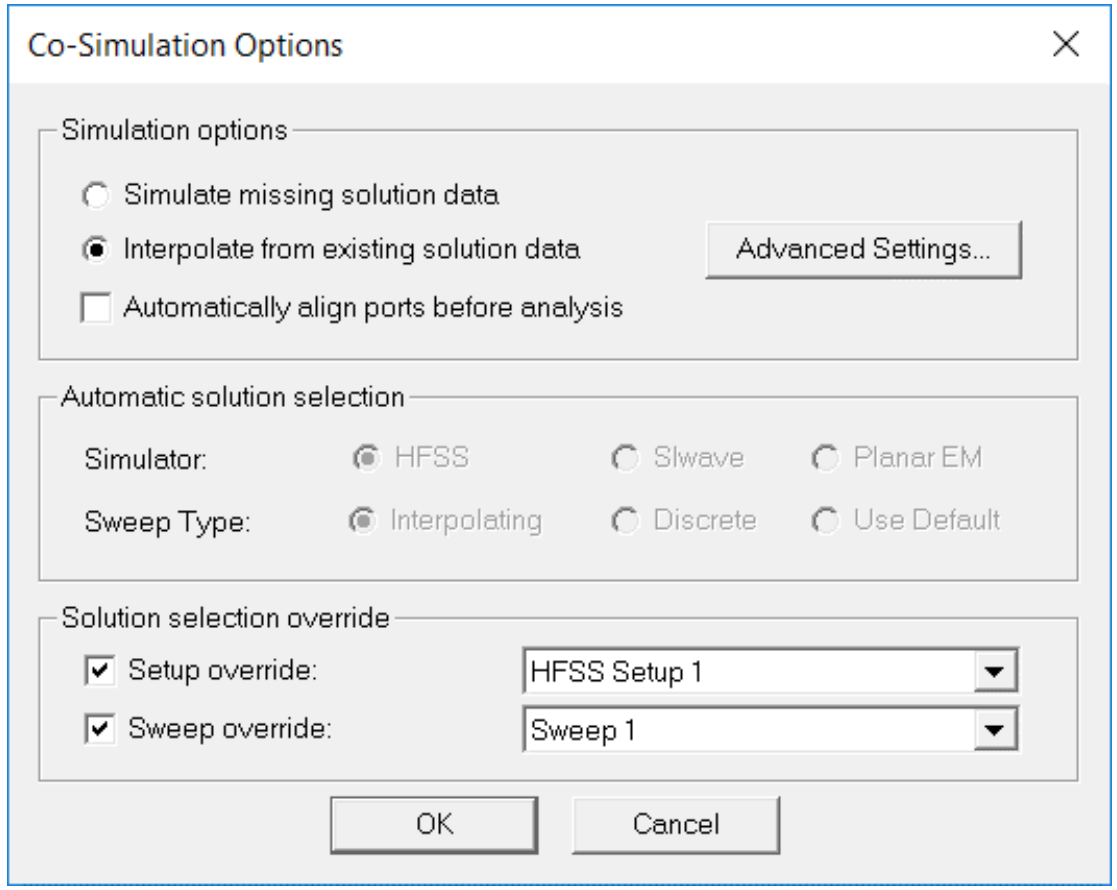




Cosim Option - *Interpolate from existing solution data*

In the ***Co-Simulation Options*** dialog box, in the ***Simulation options*** area at the top, the ***Interpolate from existing solution data*** radio button choice tells HFSS to use EM simulation data already simulated and available. No new EM simulation will get automatically started in order to fill in missing data.

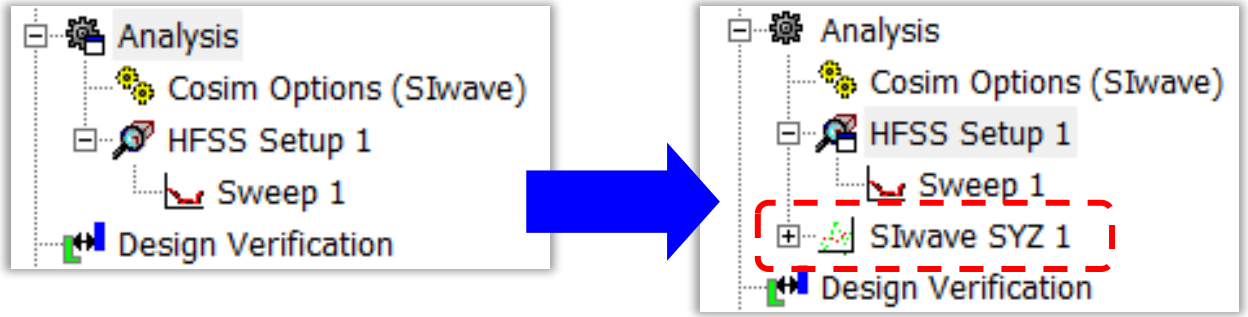
For new HFSS 3D Layout projects, using ***Interpolate from existing solution data***, one can run the HFSS/EM simulation and then the circuit simulation in separate steps.

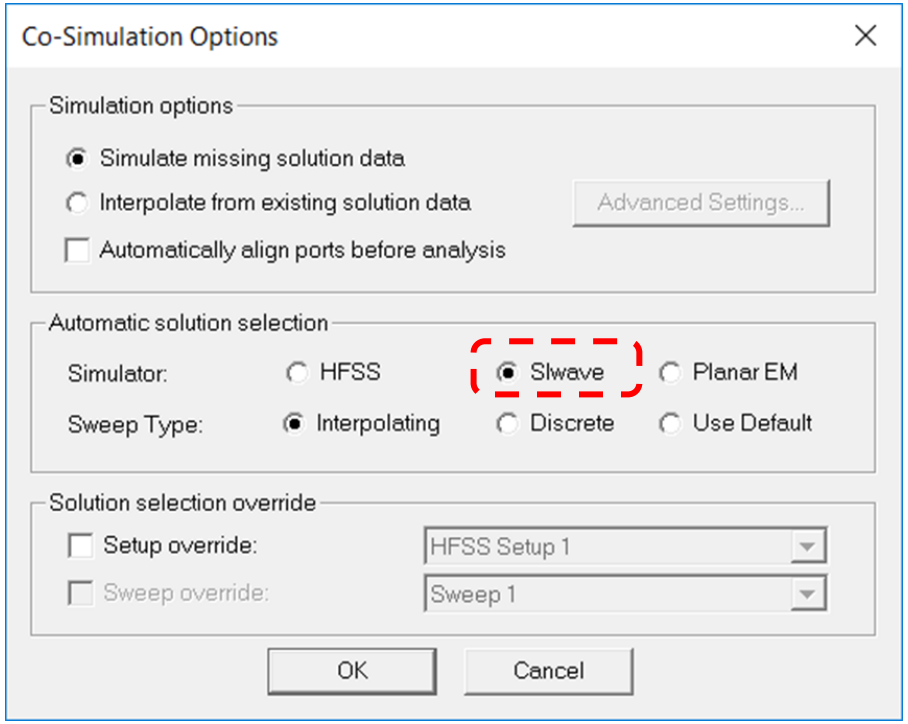


Cosim *Automatic solution selection* Creates a New Solution Setup

In cosimulation, the ***Automatic solution selection*** creates a ***new EM solution setup***. It does ***not*** use any simulation setup already defined.

In the situation shown on this slide, because the ***Automatic solution selection*** indicates Siwave, running the ***Nexxim*** transient (under the circuit design) invokes HFSS 3D Layout to create a new SIwave solution setup and run a simulation with the SIwave solver.



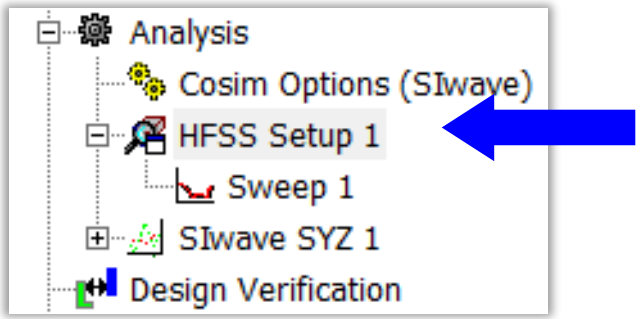


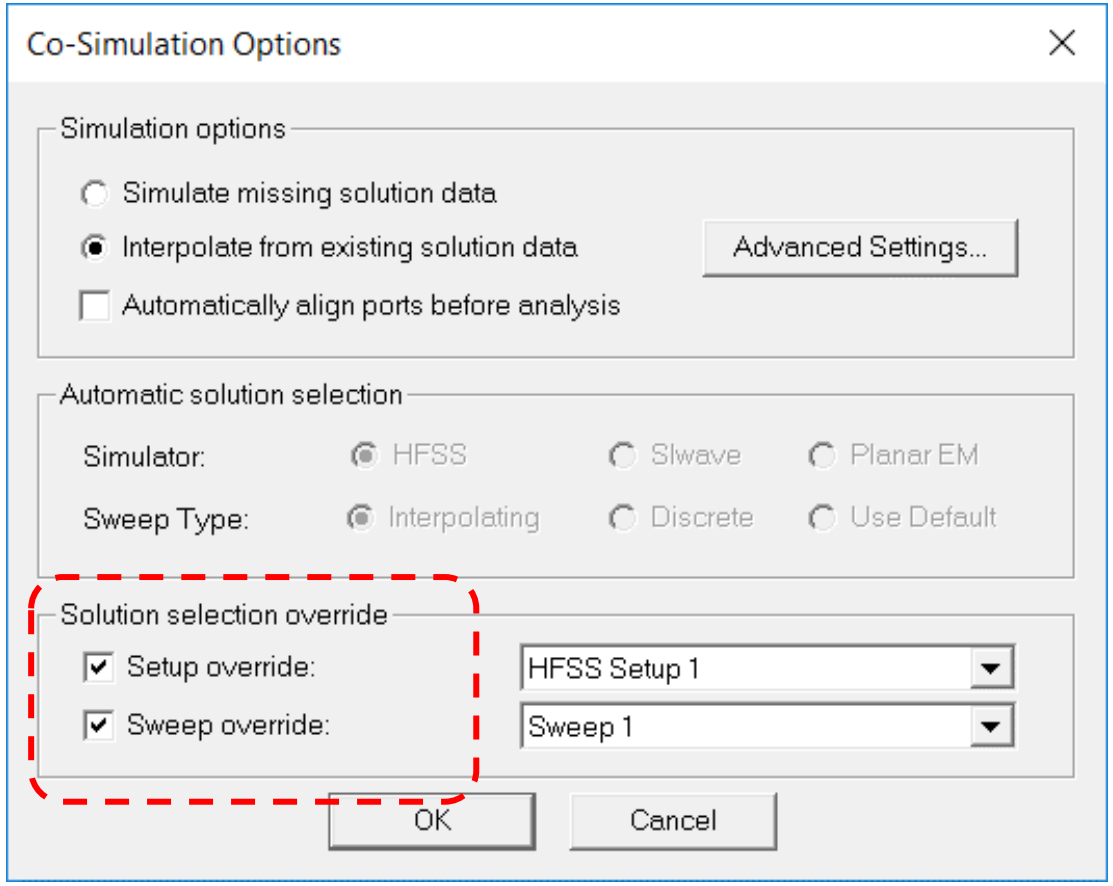
In your HFSS 3D Layout work, if you notice new, additional solution setups appearing under ***Analysis***, those solution setups might be coming from this Automatic solution creating new setups.

Cosim Option - *override* to Simulate a Specified Setup in Analysis

In the ***Co-Simulation Options*** dialog box, in the ***Solution selection override*** area at the bottom, checking the ***Setup override*** and ***Sweep override*** gets HFSS 3D Layout to simulate a specific setup (***HFSS Setup 1*** in this case).

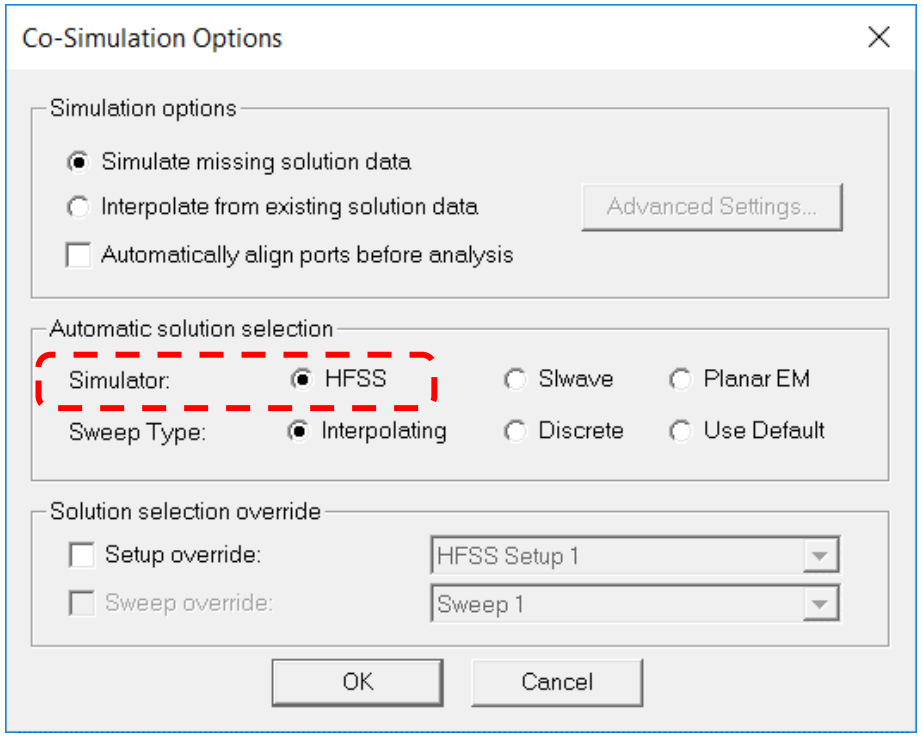
Without selecting these two overrides, even setting the ***Automatic solution selection*** to ***HFSS*** will not get HFSS 3D Layout to use the specified **HFSS Setup 1** if there is a circuit simulation involved.

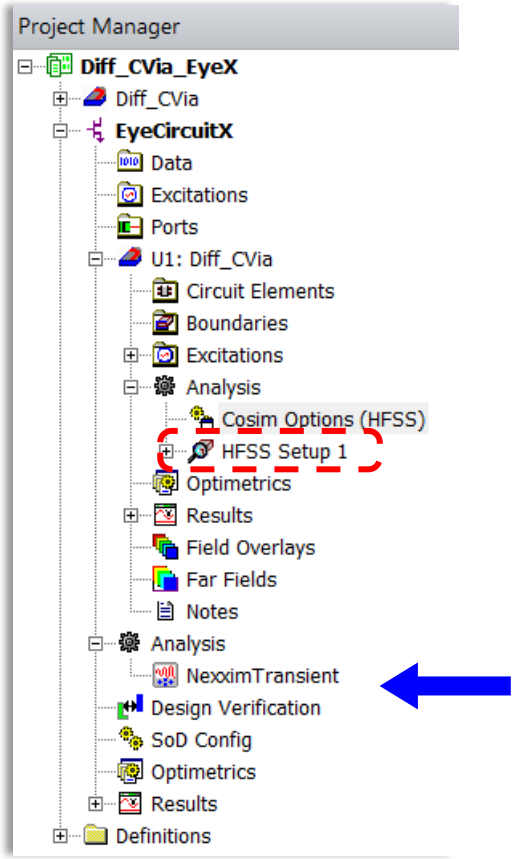




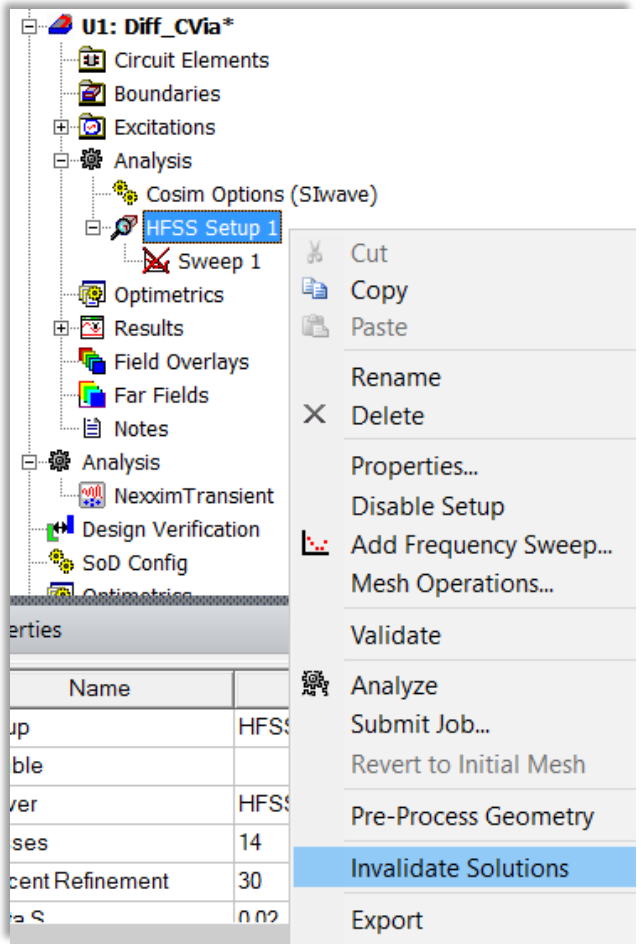
Solution Setup Matching Auto Select Makes New Solution Setup

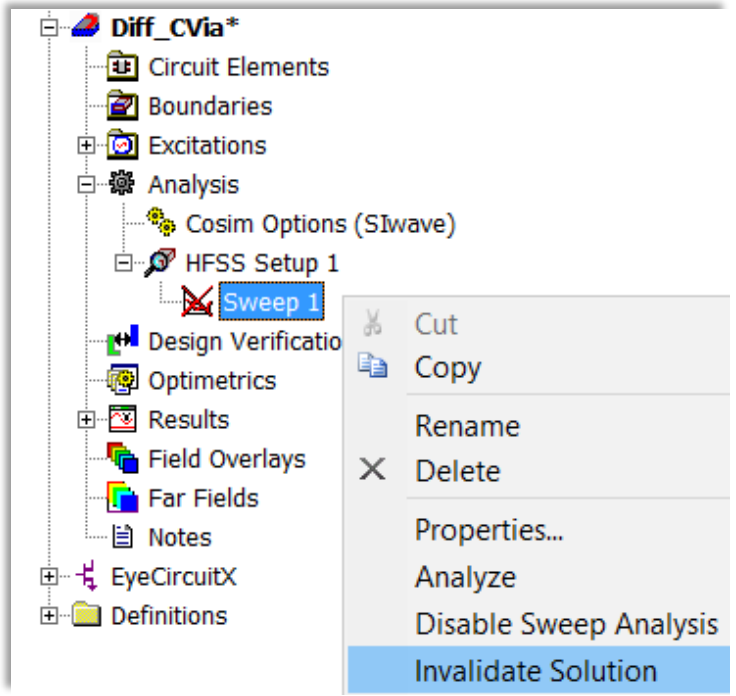
Even though the ***Automatic solution selection*** of ***HFSS*** matches solver with the **HFSS Setup 1**, starting the **Nexxim Transient** analysis will cause the creation of a new **HFSS Solution Setup** (e.g. **HFSS Setup 2**).

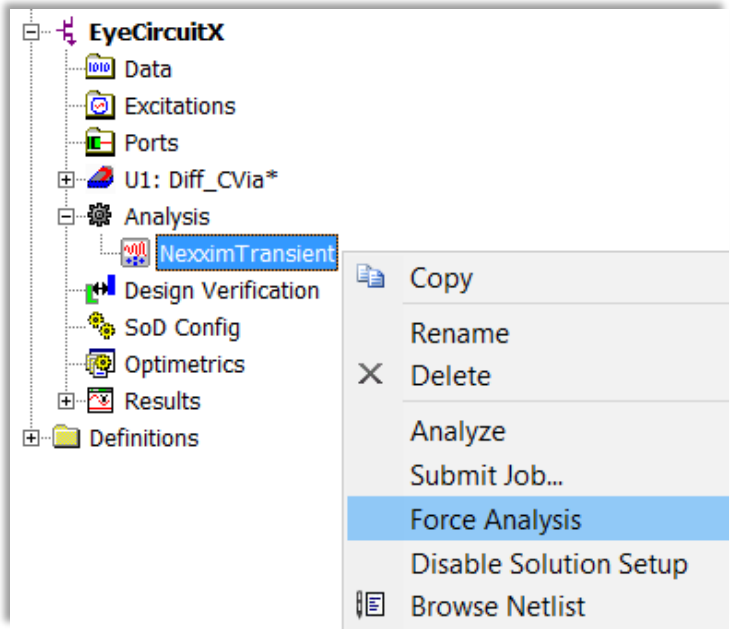




Invalidate Solution and *Force Analysis* (Resimulation)







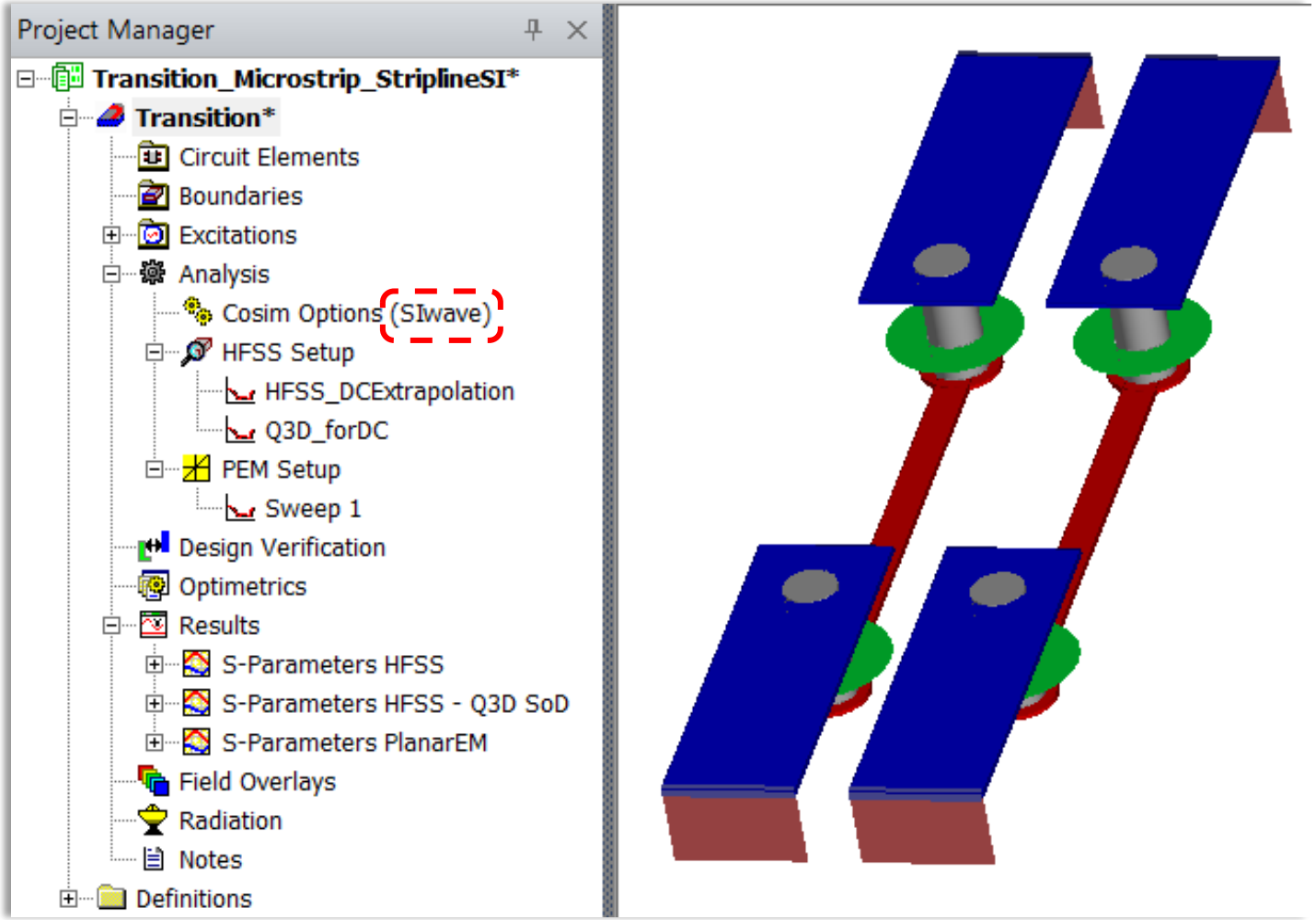
Q: What if there is EM simulation data available, but you want to resimulate anyway?

A: Shown here are several ways to invalidate simulations, sweeps and force a new analysis.

Multiple EM Simulations - No Circuit No Cosim

With no circuit simulation, ***Cosim Options*** have no effect. Both an HFSS and planar EM simulation get run, but no SIwave solver.

Results plots can compare the two different EM simulation formulations on this microstrip transition structure from the HFSS 3D Layout standard examples.




Ansys