KEYSIGHT

RFMW1 - Enabling Next Generation EM Simulation with ADS RFPro 2025

Presented by:
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Solutions Engineer

Abstract

As RF and microwave design requirements become increasing complex, engineers require tools that streamline workflows and enhance simulation accuracy.

ADS 2025 introduces significant advancements in RFPro, enabling more efficient design exploration and validation.

This presentation highlights key updates to the Generation 2 Momentum and FEM solvers.

New Calibration Types that extend accuracy at high frequencies, substrate sweep capabilities for rapid material trade-offs, re-use of simulation results to save time, modal port solvers, enhanced visualization of mesh and fields, FEM interior meshing, near and far field computations.

Explore how these new capabilities simplify the design process, reduce iteration cycles, and improve confidence in achieving performance targets.

Agenda

RFPro Vision

- Designers Focus on Design
- One Platform … One Flow
- Next Generation EM

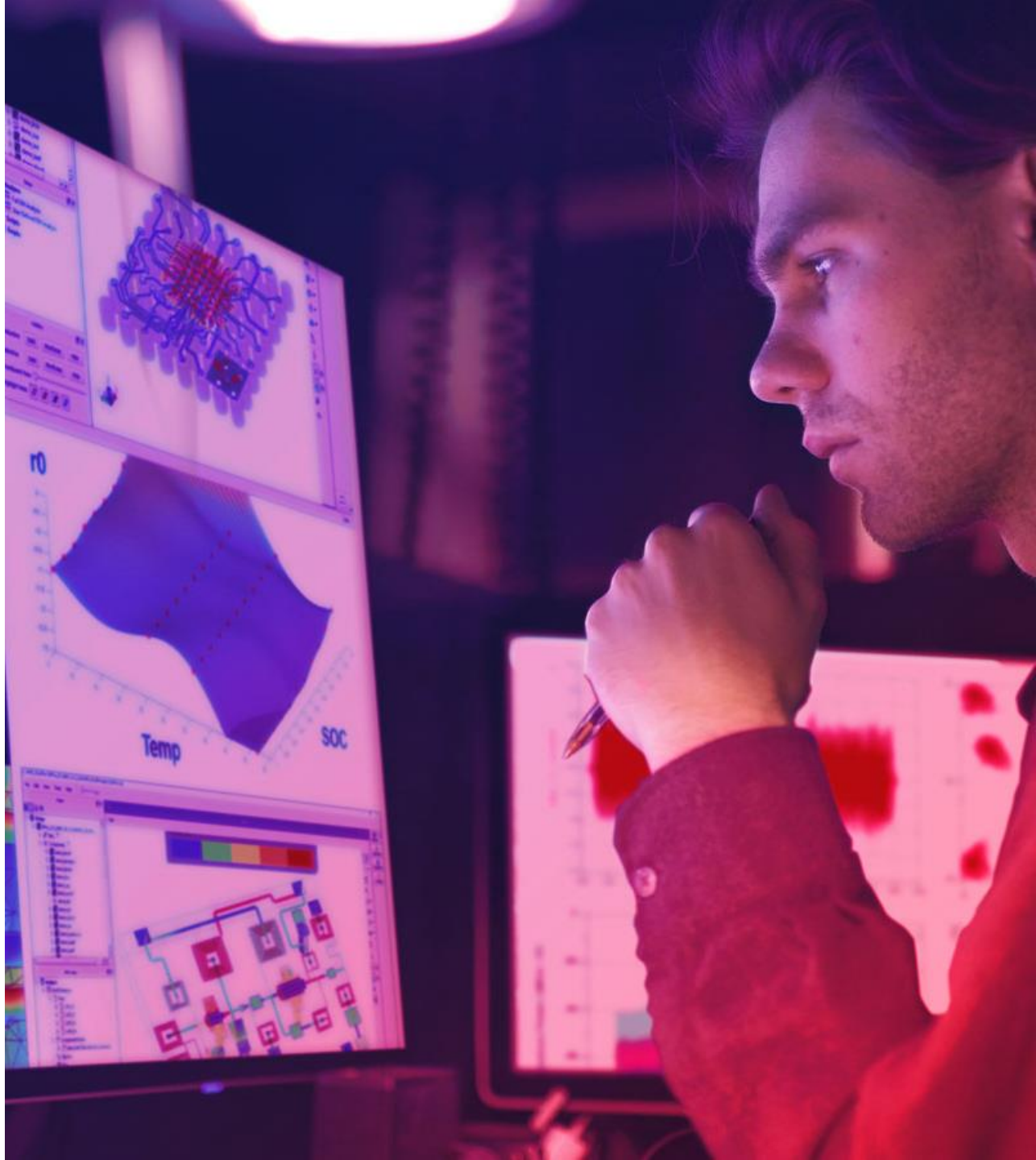
Case Studies with measurement correlation

- Nokia 90G Phased Array
- Menlo Micro MEMS assembly
- Keysight 50G PCB Signal Analyzer

What's New in RFPro for ADS2025

- 7 key new features

Realizing the 1THz Vision



RFPro Vision: EM For Every RF Designer

Designers Focus On Design, Not Setting Up EM Simulations

Main customer requests for the EM flow

Integration

- ✓ Same environment for FEM and Momentum
- ✓ EM Flow that works with multiple design flows from standalone ADS to integrated flows with Cadence, Synopsys, and Siemens EDA tools
- ✓ No manual wiring up of EM results in schematic

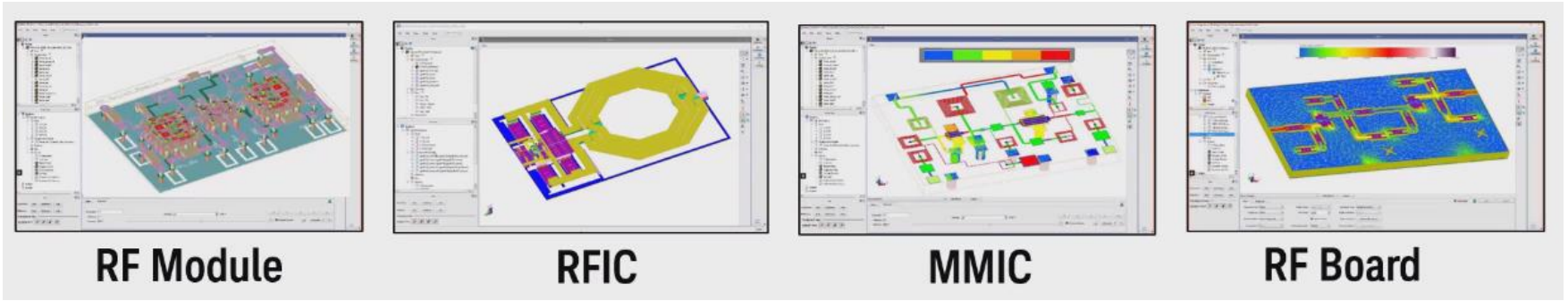
Ease of Use

- ✓ Usable by EM novices with advanced settings for experts
- ✓ Interactive 3D view
- ✓ EM flow for simple structure and scales to full designs and complete RF Modules, including transitions and 3D components

Use Manufacturing Layout

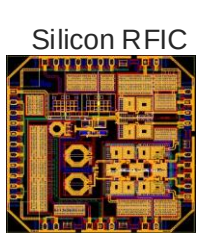
- ✓ No Cookie cutting
- ✓ No exporting
- ✓ No removing active devices/SMDs and placing pins & ports

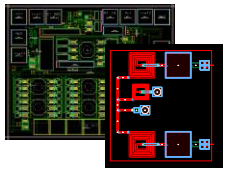
RFPro

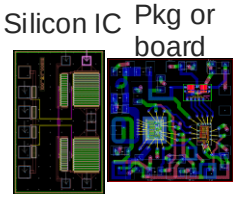


RFPro Vision: One Platform for Integration, Assembly, and EM

- EM design flow for interconnect, chip-level, package, and board-level design
- EM design flow that also supports transitions, 3D components, and complete assembly and analysis of multi-technology/MCM designs
- EM critical pieces of any design without cutting nor modifying the original layout
- EM design flow that integrates into existing design flows
- Next Generation meshers and solvers with intelligent settings and robust HPC capabilities



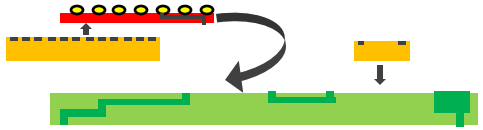




Interoperable, OA based Layouts

Native IC designs

Imported Layouts

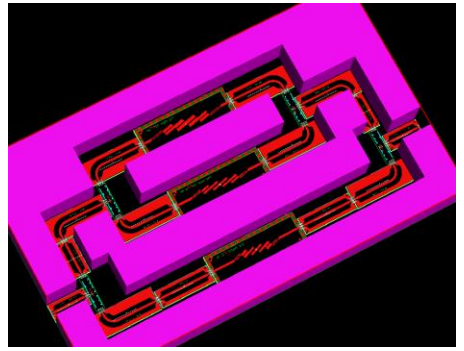


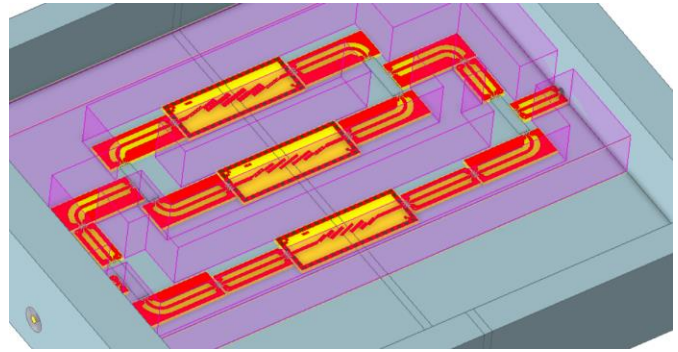
Smart Mount Technology Assembly

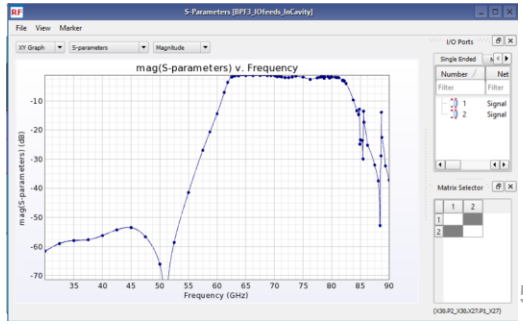
2D/3D Layout

EM Sim (RFPro)

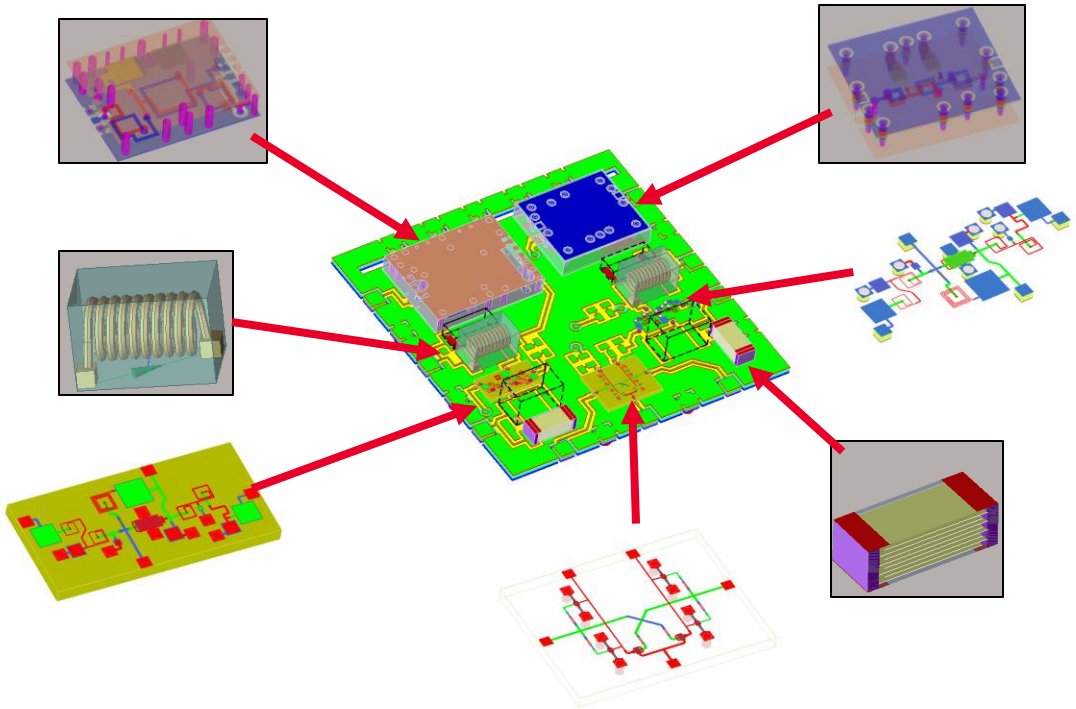
EM Co-simulation







RFPro Vision: Next Generation EM



- EM pieces, nets/paths, to full designs
- Swap out component models for EM on the fly with no edits to layout and no manual wiring of EM blocks
- Dependable accuracy from DC to THz
- Advanced HPC capabilities

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for Keysight ADS and Pathwave RFPro

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Press Releases

Keysight, Synopsys, and Ansys Deliver Radio Frequency Design Migration Flow to TSMC's N6RF+ Process Node

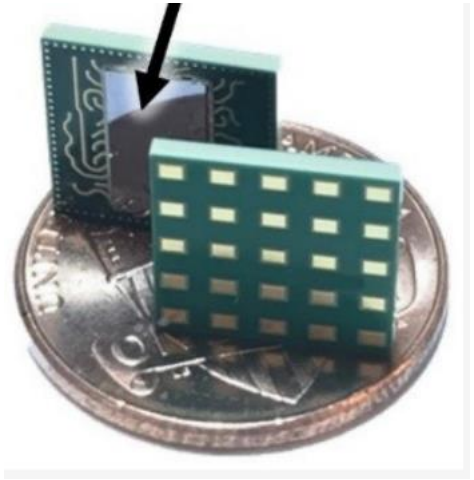
Press Releases

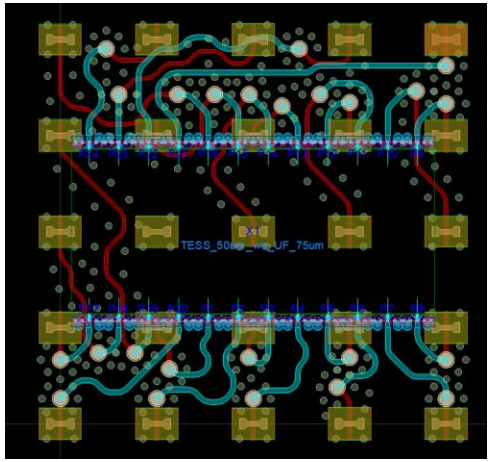
Synopsys, Ansys and Keysight Accelerate 5G/6G SoC Designs with New mmWave Reference Flow for TSMC Process Technology

Press Releases

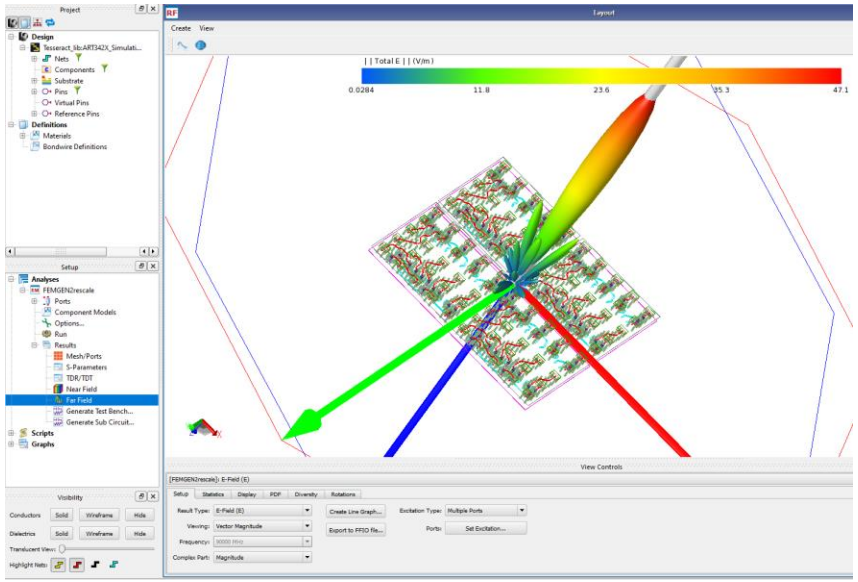
Keysight, Intel Foundry Partner to Certify Electromagnetic Simulation Software for Intel 18A Process Technology

Case Study: Nokia Bell Labs 90GHz W band Phased Array

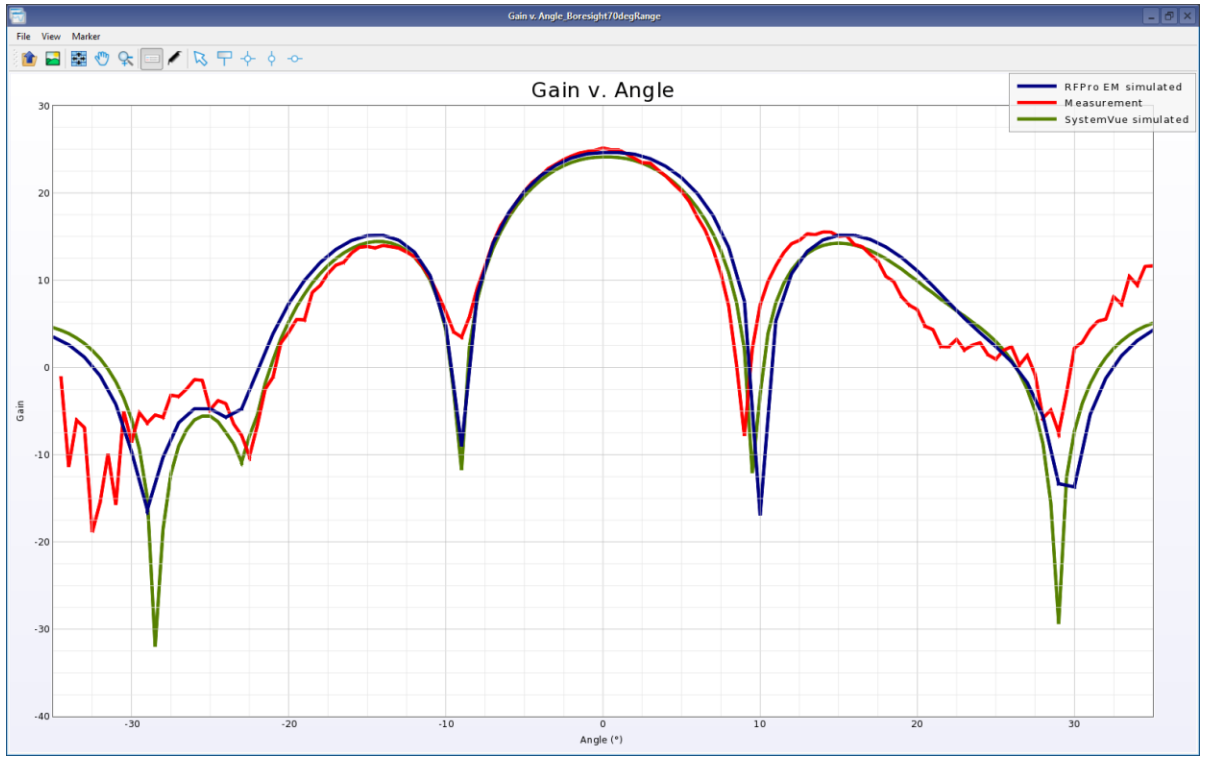




SiGe Chip Smart Mount to 24 Element Array ‘Tile’

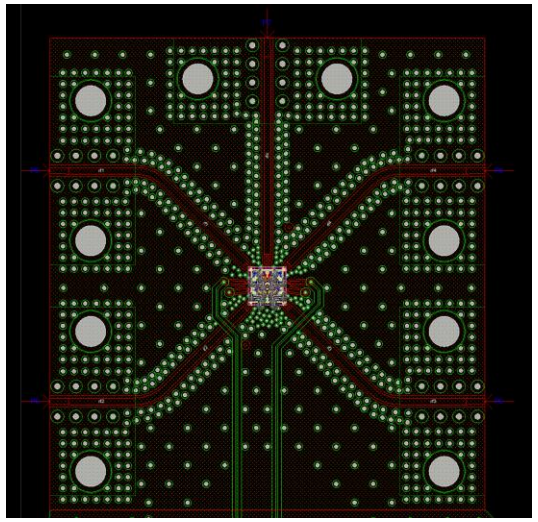


RFPro FEM Simulation of 2x2 Tile Array

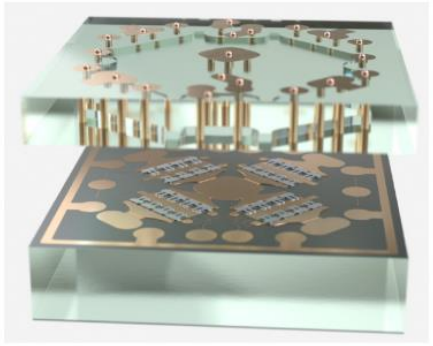


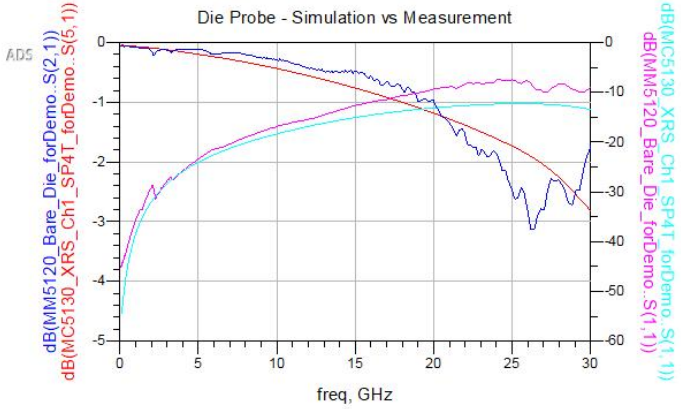
Measurement VS RFPro FEM Simulation VS SystemVue Phased Array Simulation

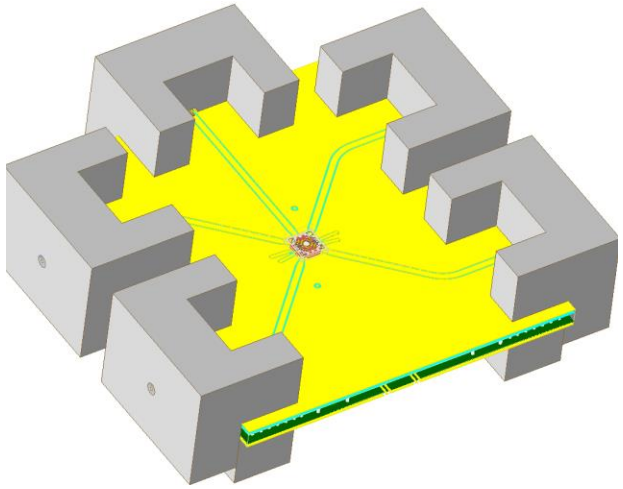
Case Study: Menlo Microwave MM5130 SP4T DC-26G Switch



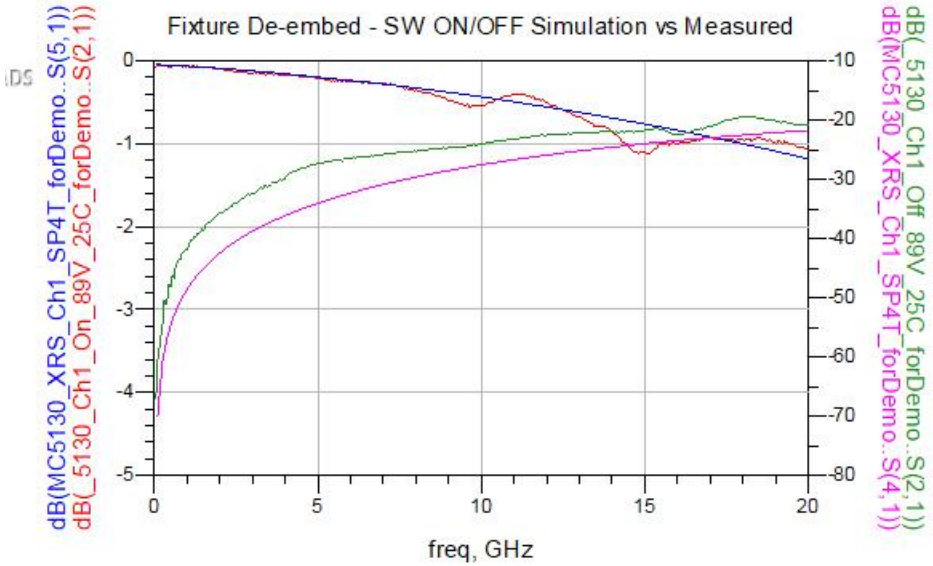
Chip Smart Mount to Test PCB





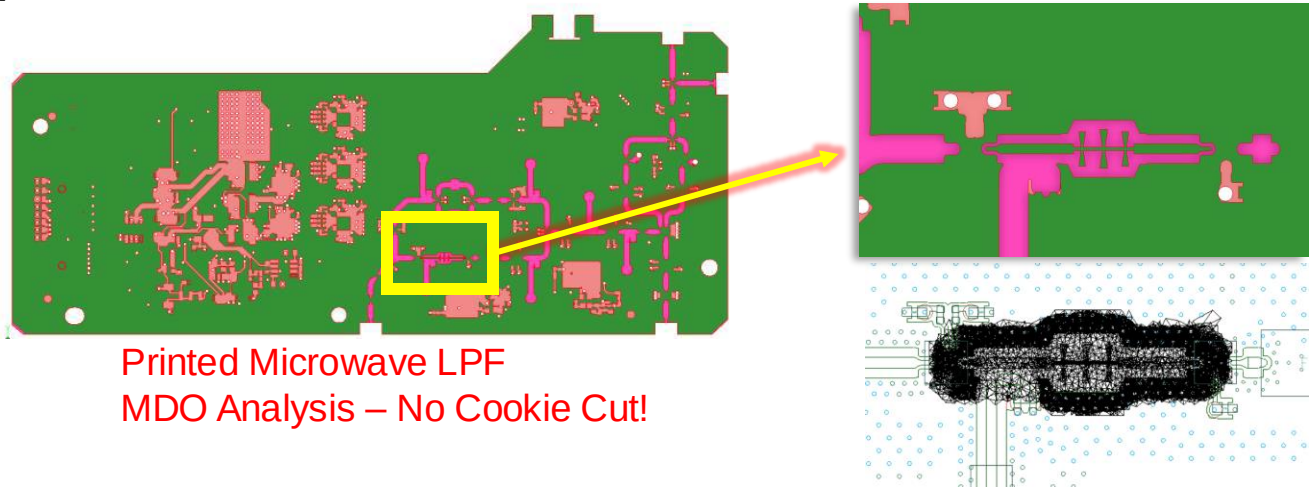


RFPro FEM Simulation with 3D Connectors

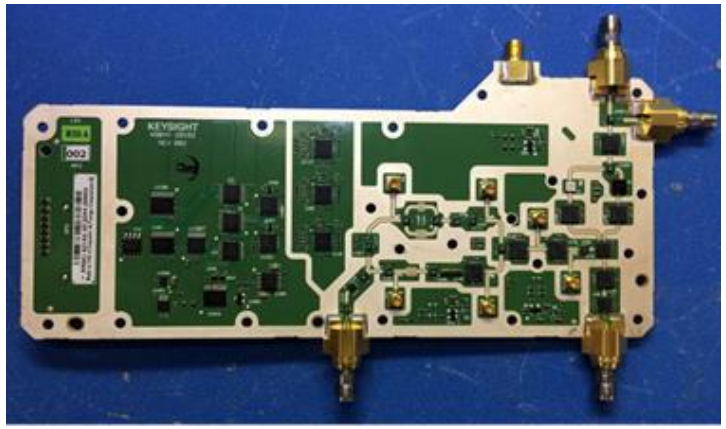


Case Study: Keysight Labs N9042B 50GHz Down Converter PCB

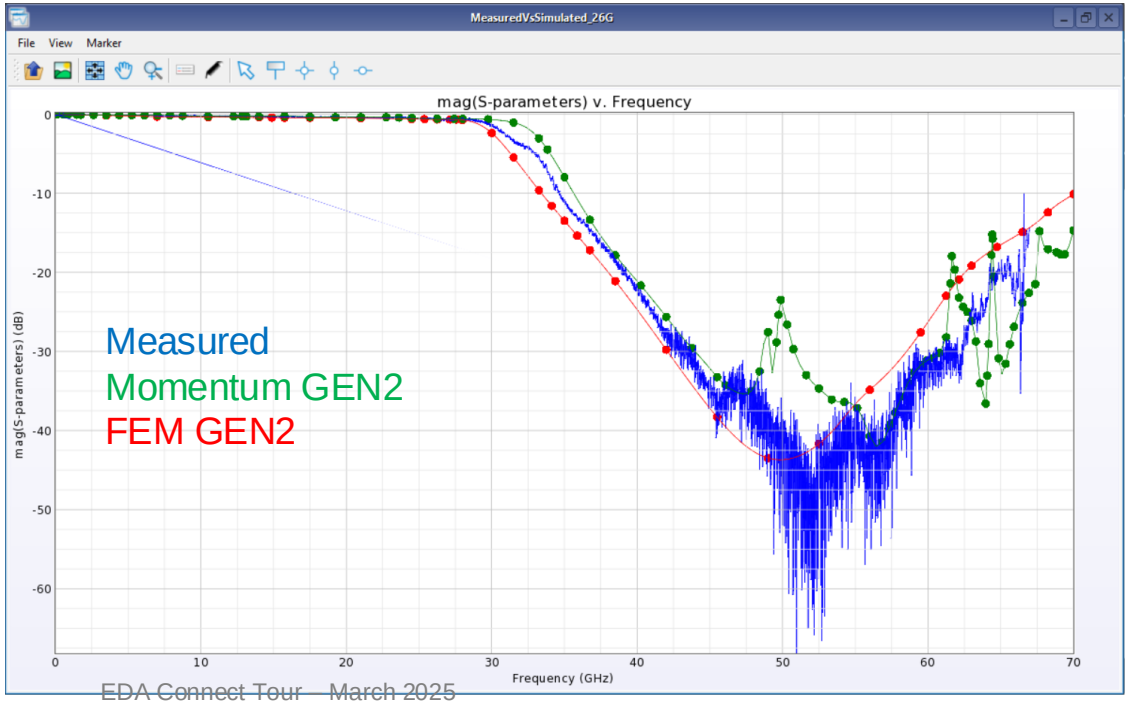
“Simple” Printed Low Pass Filter Design



Printed Microwave LPF
MDO Analysis – No Cookie Cut!

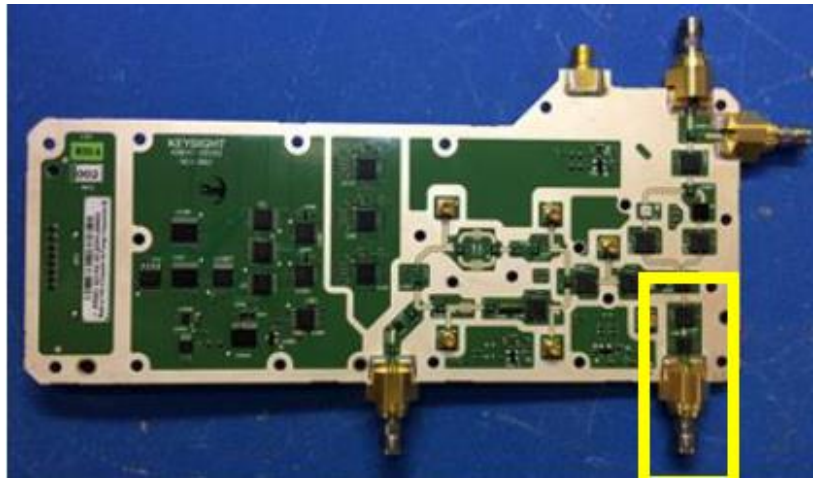


8 x 4 inch
16 metallization layers
~ 250 000 vias
~ 1000 Surface Mounted Components

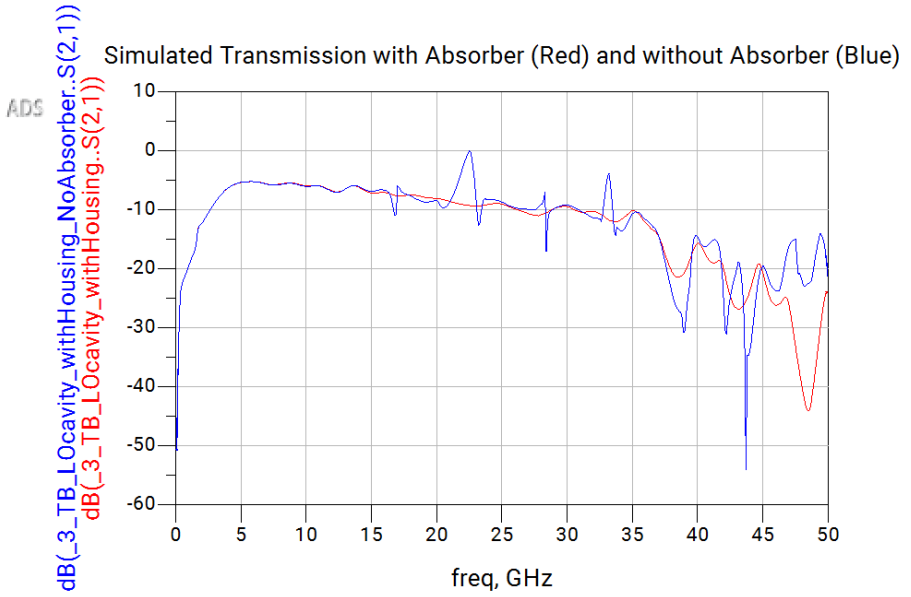


Case Study: Keysight Labs N9042B 50GHz Down Converter PCB

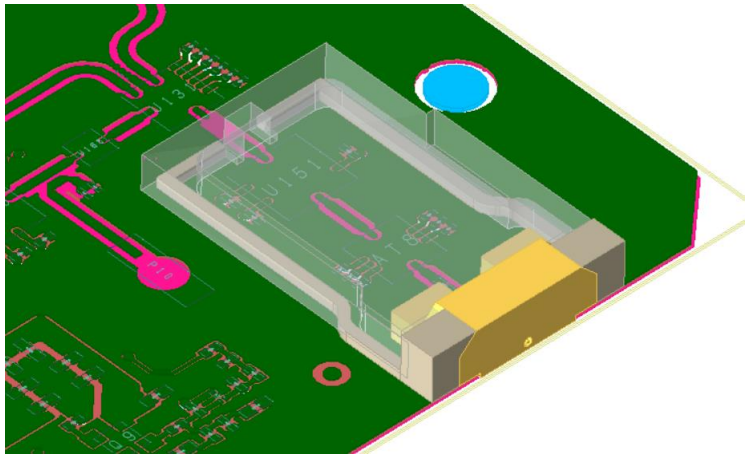
Cavity Resonance Root Cause and Resolution



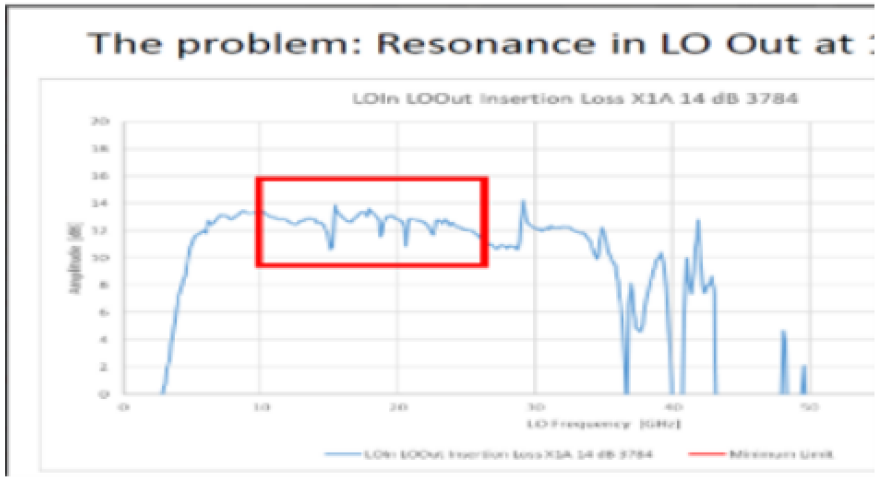
LO Output



LO Output EMPro 3D Shield Connector

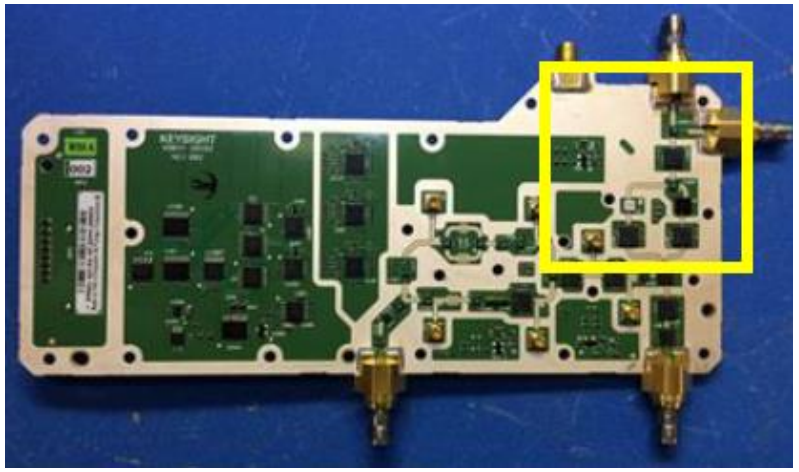


Measured Transmission without Absorber

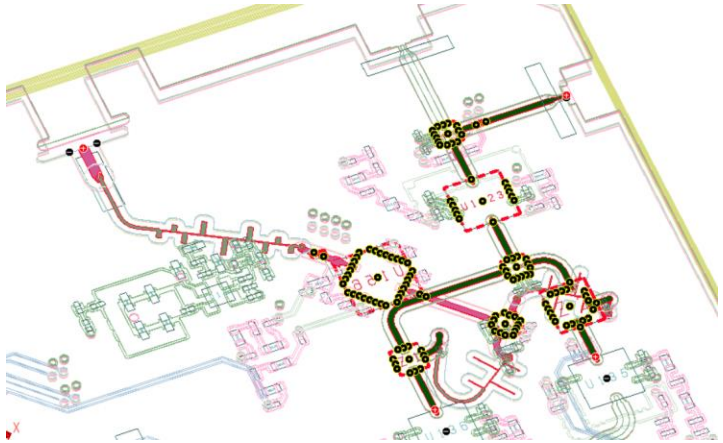


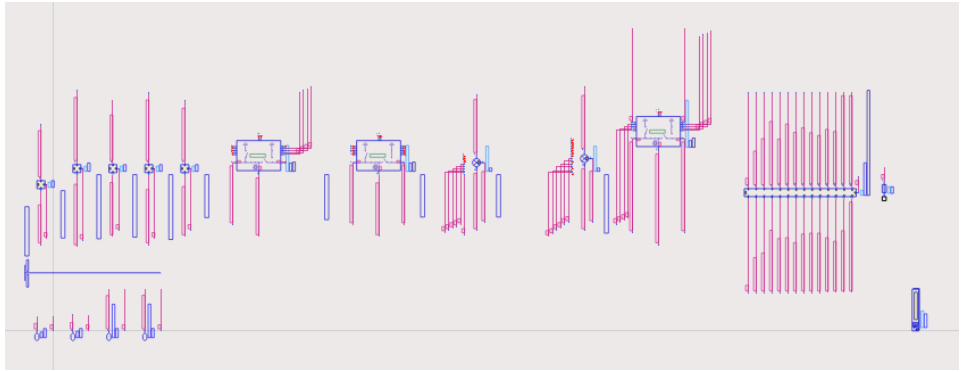
Case Study: Keysight Labs N9042B 50GHz Down Converter PCB

Complex Signal Path Analysis

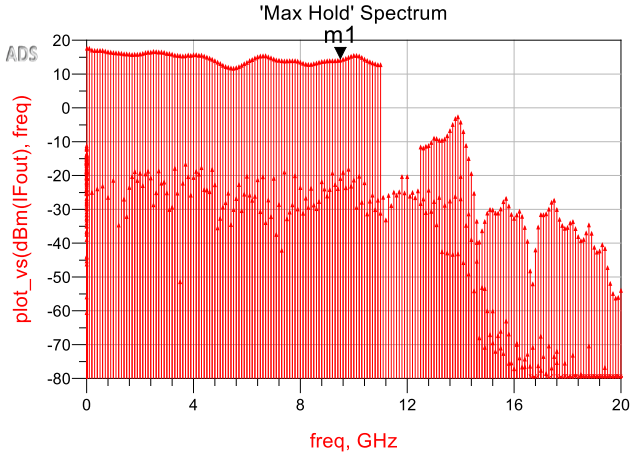


Full Band 50GHz RFin to IFout Downconverter



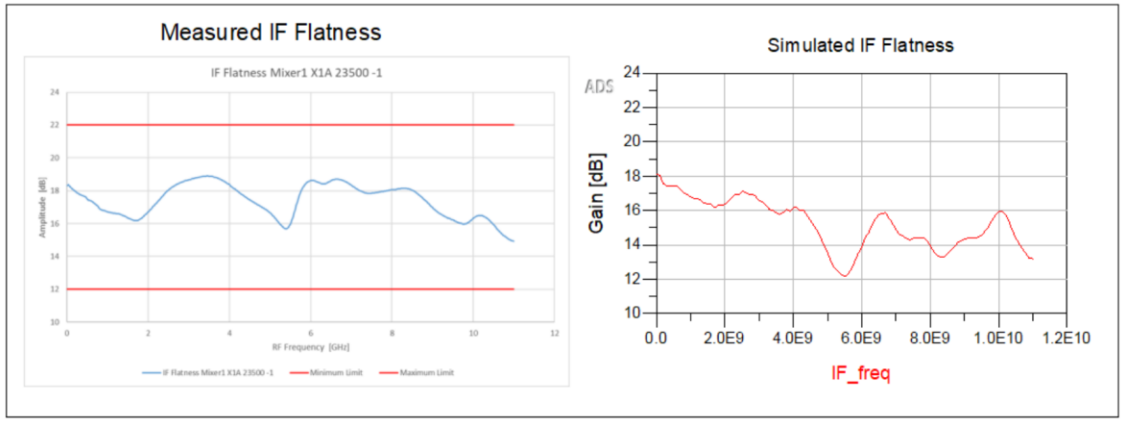


m1
freq=9.500 GHz
plot_vs(dBm(IFout), freq)=14.563
RFfreq=1.400E10



RF x LO Mixing Product

...x_Vload, harm_index_Vload]	...x_Vload, harm_index_Vload]
-1	1



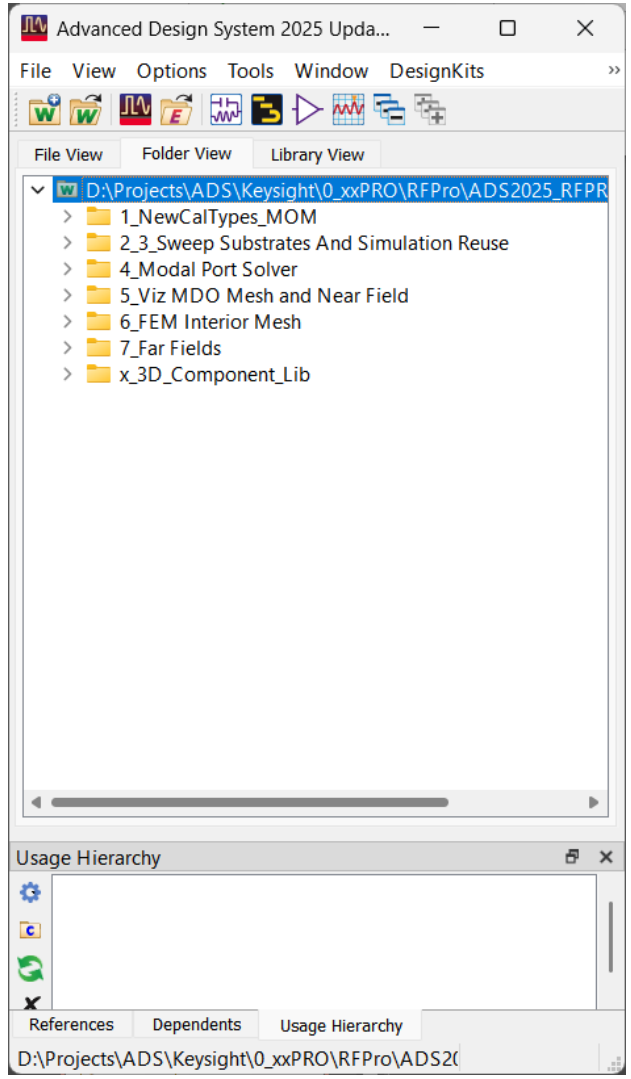
ADS RFPro 2025 Updates

One Page Summary

1. New calibration types extend to high frequencies
2. Sweep substrates
3. Re-use simulation results
4. Modal port solver
5. Visualize mesh and field for MDO simulations
6. FEM interior mesh
7. Far Fields can be computed without Near Field

Workspace Collateral: ADS2025_RFPRo_WhatsNew_v1.1_wrk

Note: Each example folder has ‘readme’ documentation

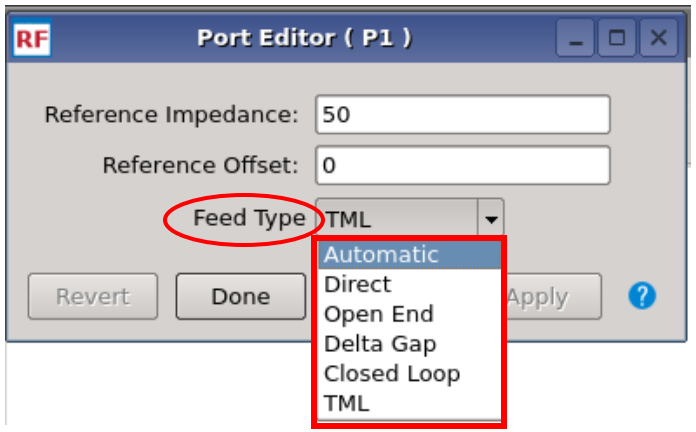


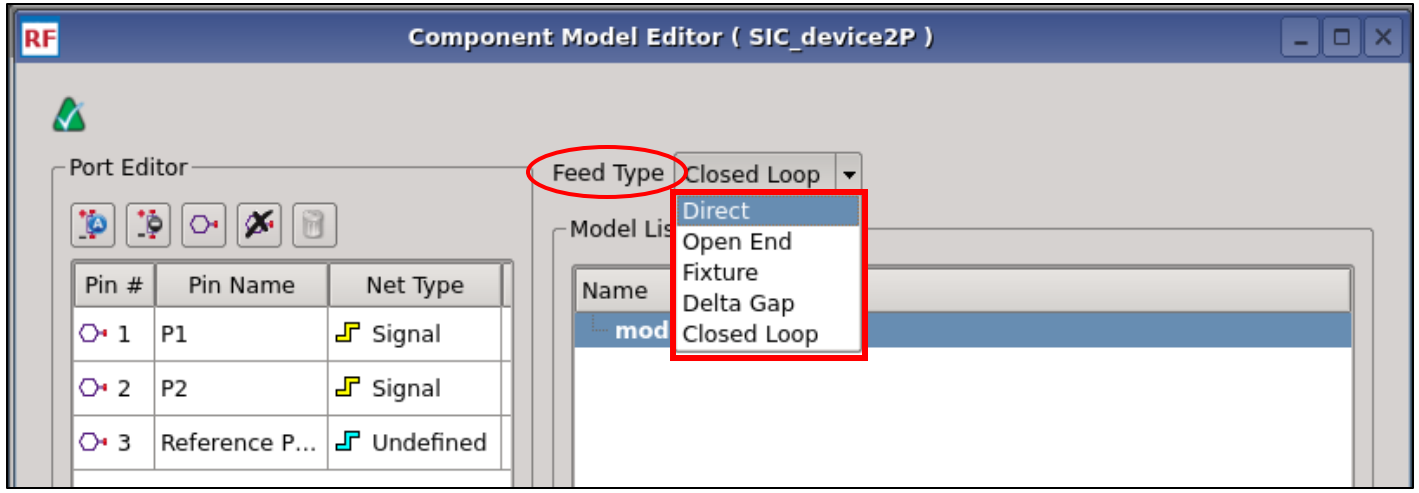
ADS RFPro 2025 Updates

(1) New Calibration Types Extend to High Frequency

Customer value:
- **more accurate HF calibration**
- **easier to use, less confusion**

- NEW **Closed Loop** Feed Type for Component ports and IO ports (horizontal & vertical)
- Extended **Delta Gap** to vertical N-port Components ports and IO ports
- Renamed SMD to **Closed Loop** (SMD was Closed Loop for horizontal 1-port components)
- Renamed None to **Direct**
- Renamed TML0 to **Open End**

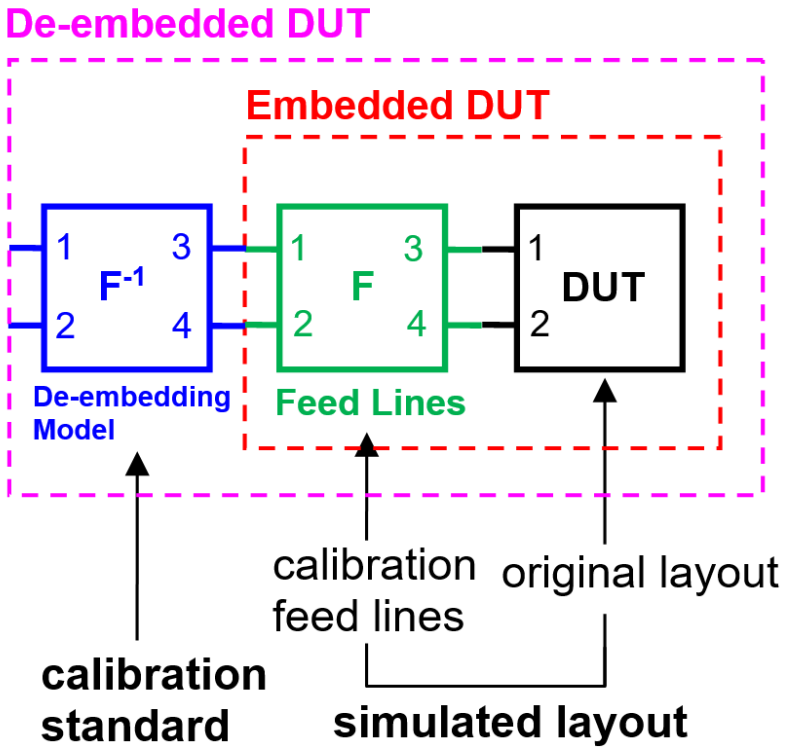




ADS RFPro 2025 Updates

(1) New Calibration Types Extend to High Frequency

Calibration Process & Terminology



DUT - Design Under Test

- original layout of the design with ports

calibration feed lines

- extend the layout of the DUT → **Embedded DUT**
- make the ports physical at HF → Mitigate the HF radiation
- but add coupling to the DUT

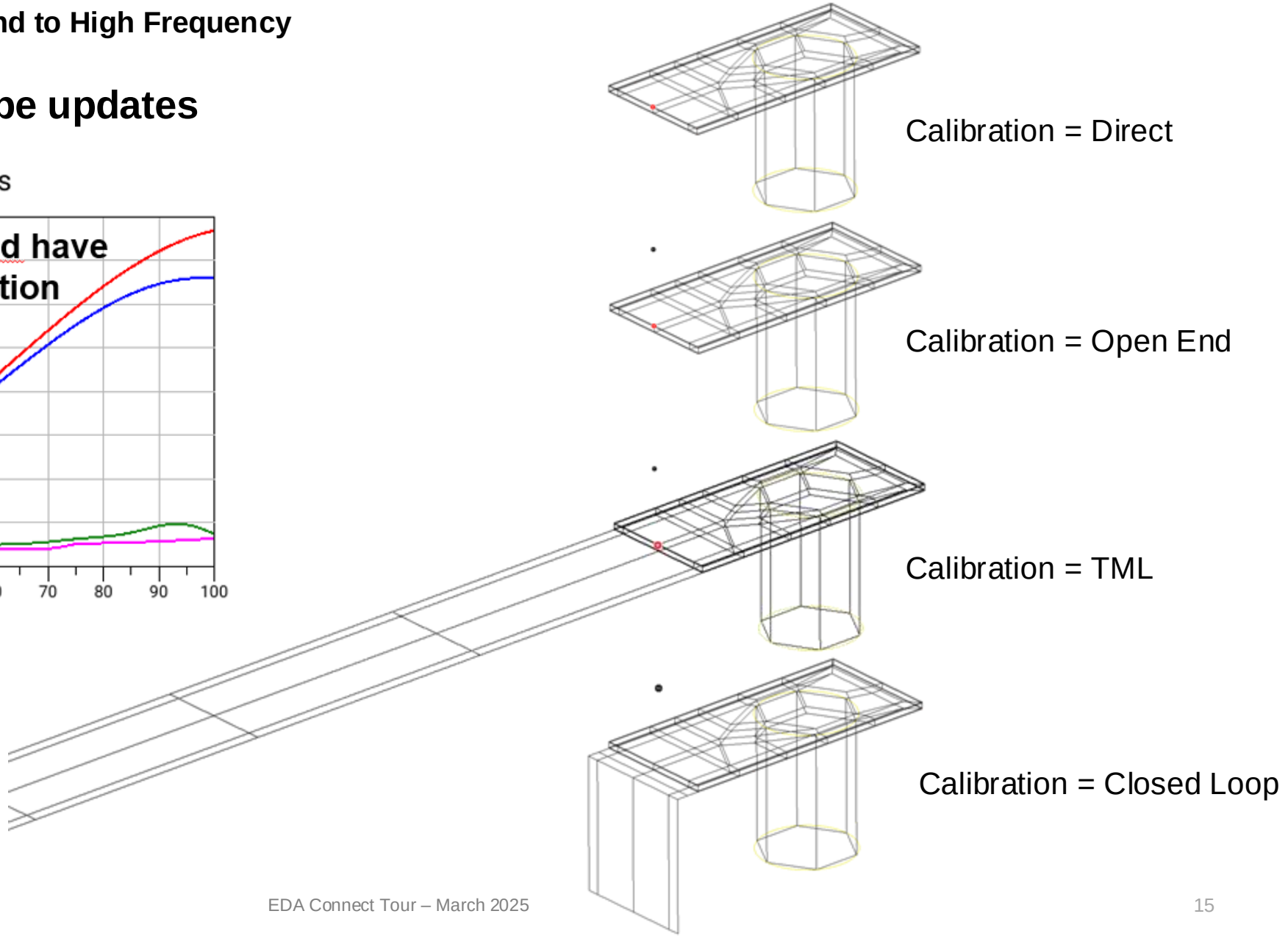
calibration standard

- defines the **De-embedding model**
- removes coupling from the embedded DUT → **De-embedded DUT**

ADS RFPro 2025 Updates

(1) New Calibration Types Extend to High Frequency

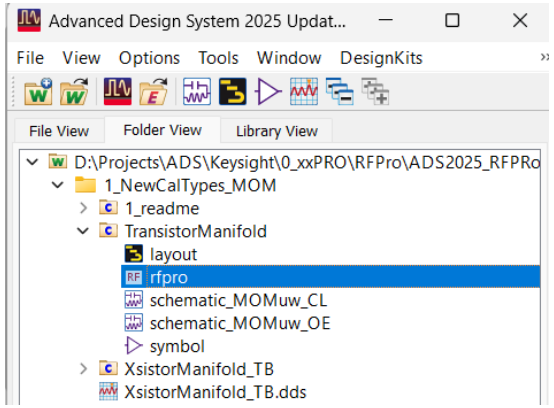
RFPro 2025 feedtype updates



ADS RFPro 2025 Updates

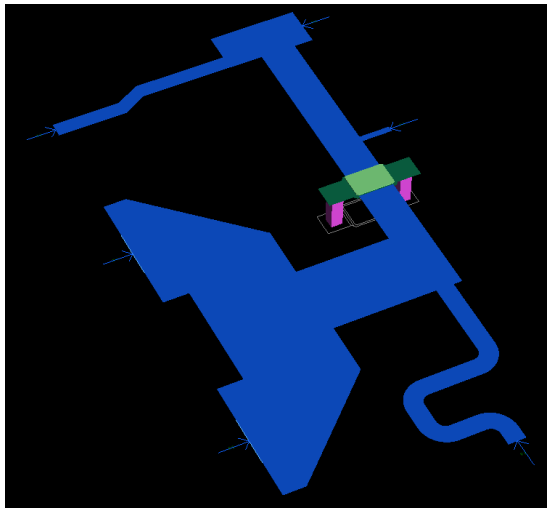
(1) New Calibration Types Extend to High Frequency

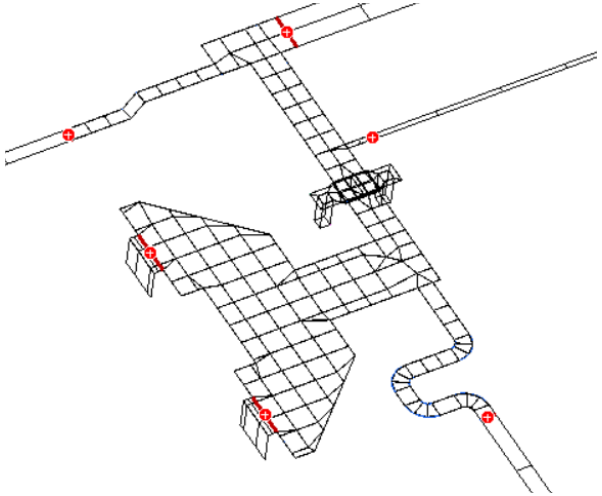
Demo – Transistor Manifold

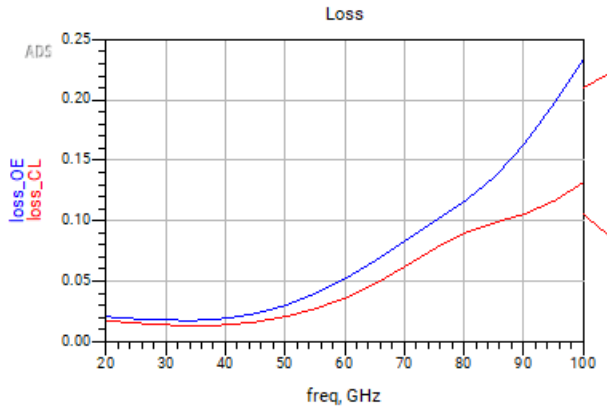


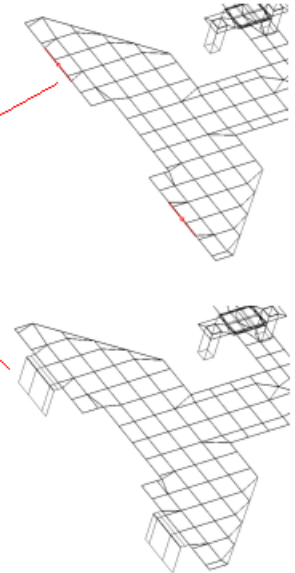
CLOSED LOOP.
New for ADS2025. Whether a top-level port or component port. Physical feed lines are embedded that provide a path for current to flow, thereby reducing radiation.

But, unlike the case of the Delta Gap port, this added feed is de-embedded out.
This port fully calibrates out 'open end' radiation and capacitive fringing without the need to have 1/2 wavelength of space in the layout.







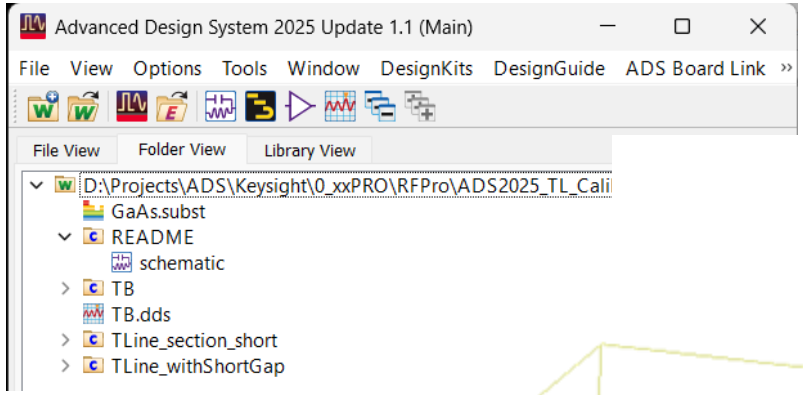


ADS RFPro 2025 Updates

(1) New Calibration Types Extend to High Frequency

How perfect is a calibration?

Demo – Transmission Line with gap filled with a Line section – Momentum MW



L = 2.2 mm
W = 100 um
H = 100 um
GaAs ε_r = 12.9

Transmission line (reference)

TML

TML

Transmission line with gap

TML

TML

Transmission line section

TML

TML

Component ports

→ Direct
→ Open End
→ Fixture
→ Delta Gap
→ Closed Loop

ADS RFPro 2025 Updates

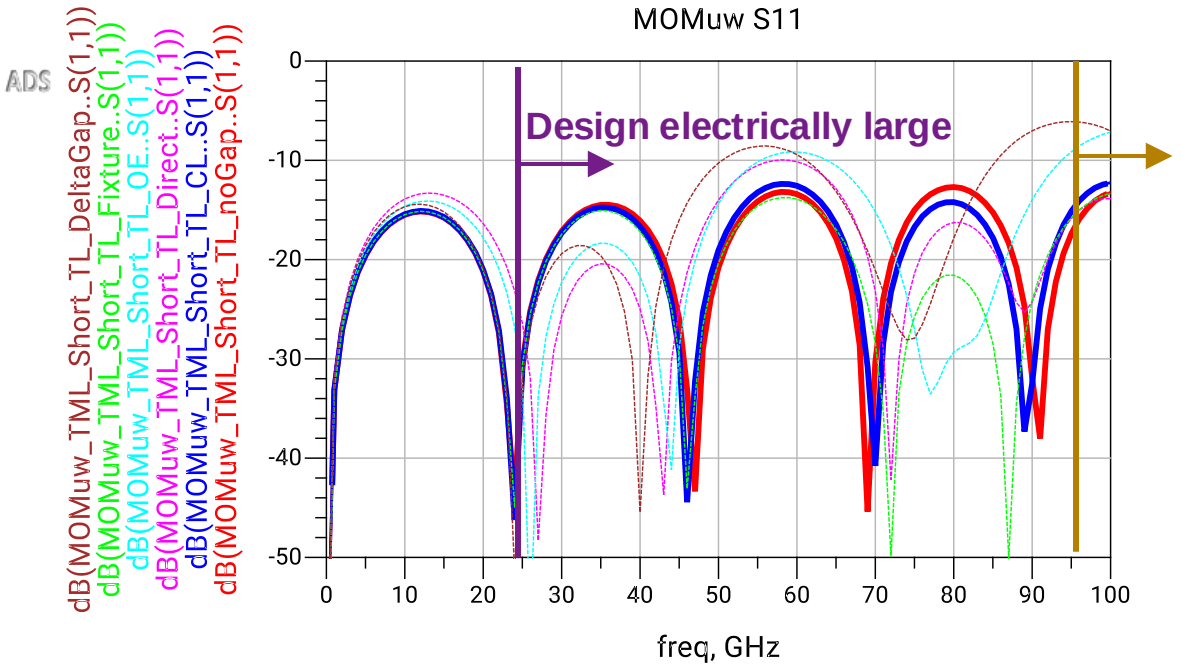
(1) New Calibration Types Extend to High Frequency

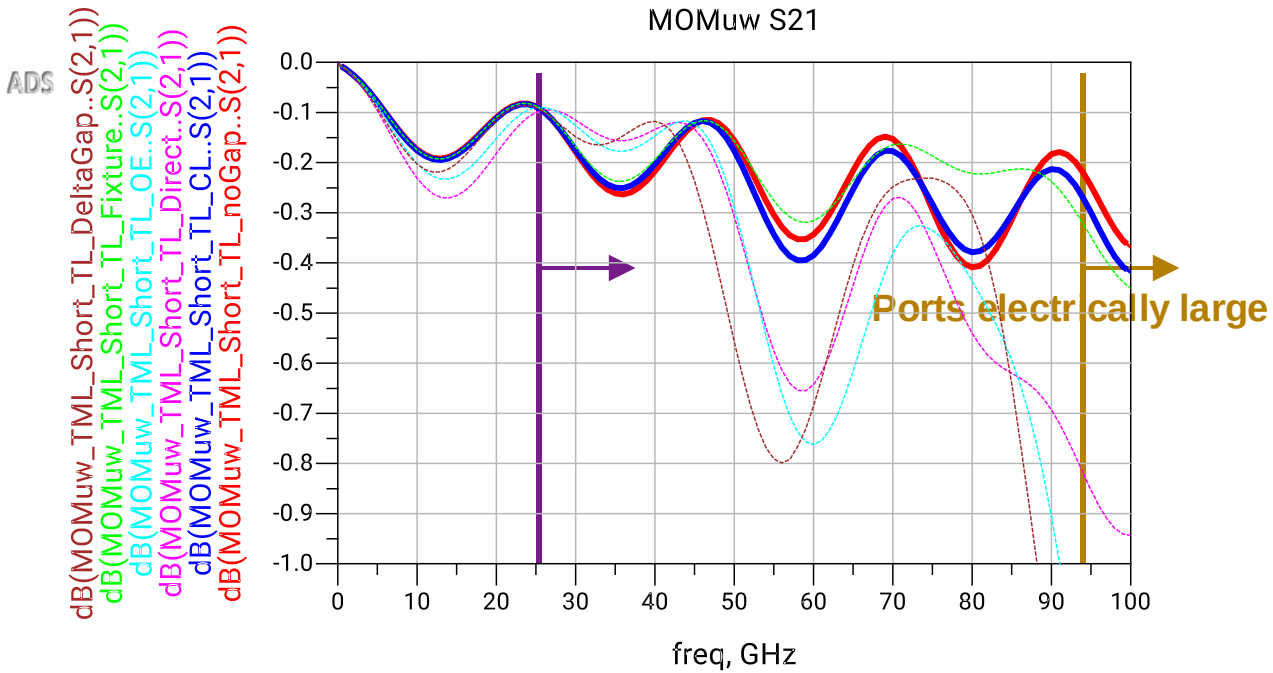
Demo – Transmission Line with gap filled with a Line section – Momentum MW

Reference (no Gap)
Closed Loop
Direct
Open End
Fixture
DeltaGap

Frequency sweep: 0 – 100 GHz

```
--- WARNING ------------------------------------------------------------------
The size of the plus pin for S-parameter port 1 is electrically large
above 96.4839 GHz, S-parameters may become unphysical.
------------------------------------------------------------------------------
--- WARNING ------------------------------------------------------------------
The distance between the layout pins for port 1 is electrically large
above 96.4839 GHz, S-parameters may become unphysical.
------------------------------------------------------------------------------
```





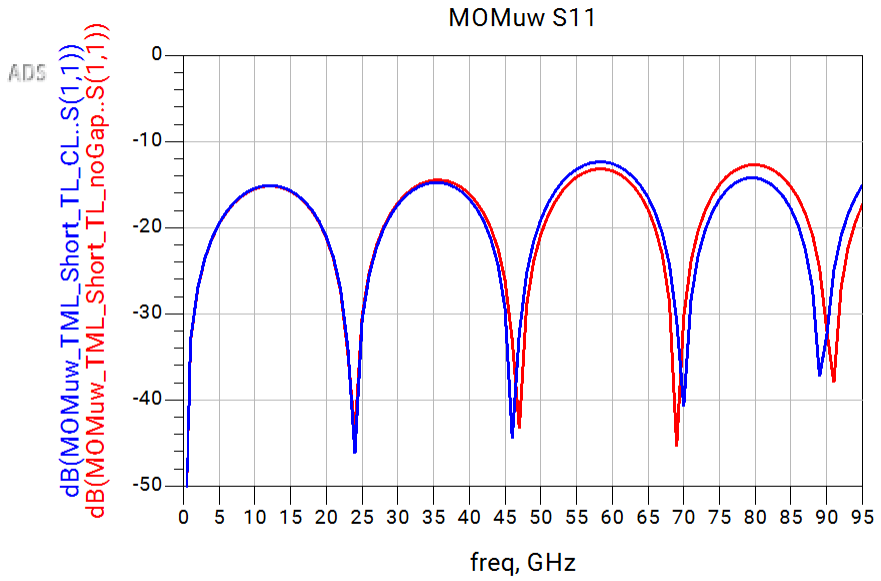
ADS RFPro 2025 Updates

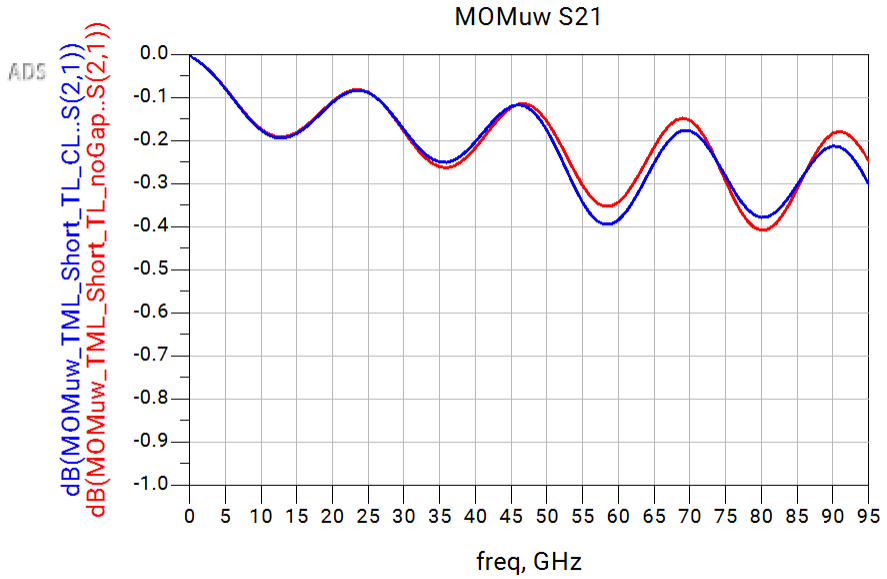
(1) New Calibration Types Extend to High Frequency

Demo – Transmission Line with gap filled with a Line section – Momentum MW

Reference
Closed Loop

How perfect is a calibration?





Closed Loop outperforms at higher frequencies

ADS RFPro 2025 Updates

(2) Simulation Re-use

Demo – No changes to layout or substrate, don't recalculate everything! .

	Sweep Type	Start	Stop	Points	Step	Near Field	Far Field
Simulated	Adaptive	0 GHz	20 GHz			Off	Off
Simulated	Single	2.5 GHz				On	Off

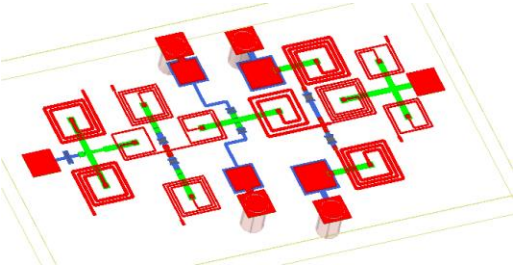
```
Starting Momentum simulation.
Setting environment for using simulator engine
Setting EMPROHOME to C:\Keysight\ADS2025_Update1.1\fem\2025.11\win32_64\bin\
Setting PYTHONHOME to C:\Keysight\ADS2025_Update1.1\fem\2025.11\win32_64\bin\\tools\win32\python (override using EMPRO_PYTHONHOME)
Setting PYTHONPATH to C:\Keysight\ADS2025_Update1.1\fem\2025.11\win32_64\bin\ (override using EMPRO_PYTHONPATH)
Started on: Thu Feb 13 05:06:37 2025
MOMizer: 1.3.15
MOMizer is skipped, reusing existing data!
Starting C:\Keysight\ADS2025_Update1.1\Momentum\2025.10\win32_64\bin\MomEngine.exe
Skip processing of technology, greens functions db, and mesh generation, Momentum Engine reuses existing data!
C:\Keysight\ADS2025_Update1.1\Momentum\2025.10\win32_64\bin\MomEngine.exe --eng_licCxtFile=proj -3D -rf proj proj
License checkout took 0.049 sec
S-parameter simulation
S-parameter simulation started
...initializing
...processing vias
...extracting layout
Layout is electrically small below 86.5 GHz (space wave radiation)
Substrate is electrically small below 43.2 GHz (surface wave radiation)
...reducing mesh
Automatic selection: direct dense matrix solver
Using multi-threading (16 threads)
Matrix size: 3251 (reduced: 2559)
Simulation temperature: 298.15 K
Adaptive frequency sweep started
Previous simulation data is reused (15 samples)
Simulation frequency [1] = 2.5 GHz
...loading Green functions
...creating Basis sections
...allocating interaction matrix
...loading quasi-static matrix
...solving interaction matrix
...calculating S-parameters
Adaptive:   0.0 % of frequency range covered
Adaptive: 100.0 % of frequency range covered
S-parameter simulation finished

Simulation Time: 0:00:04.229291
Simulation Finished
```

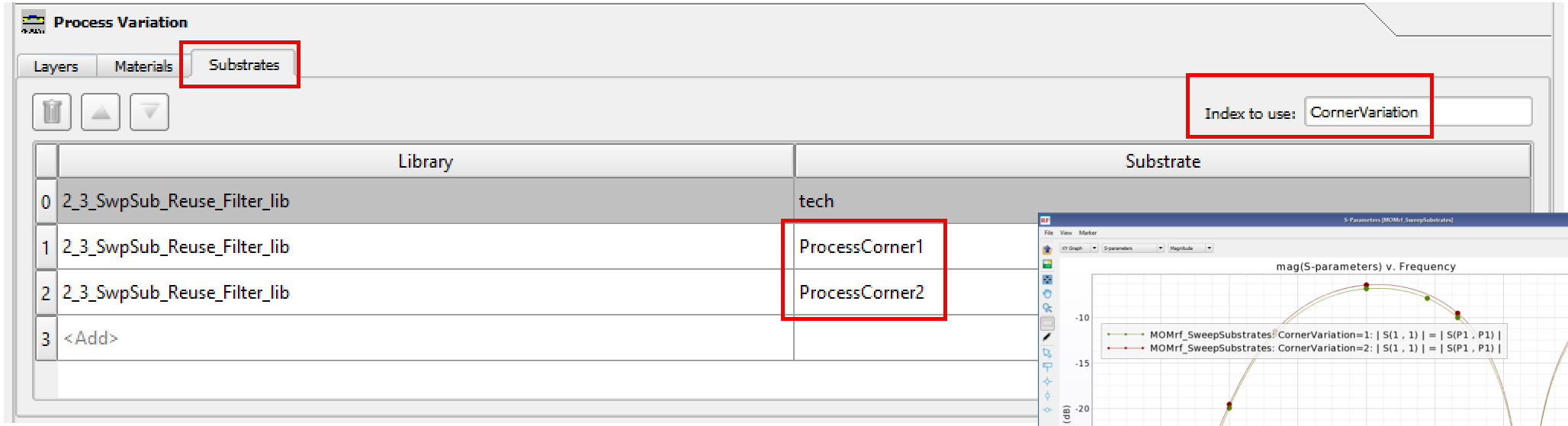
Demo –RFPr **lculation).**

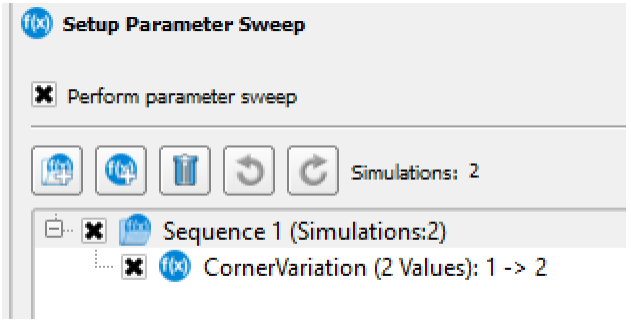
ADS RFPro 2025 Updates

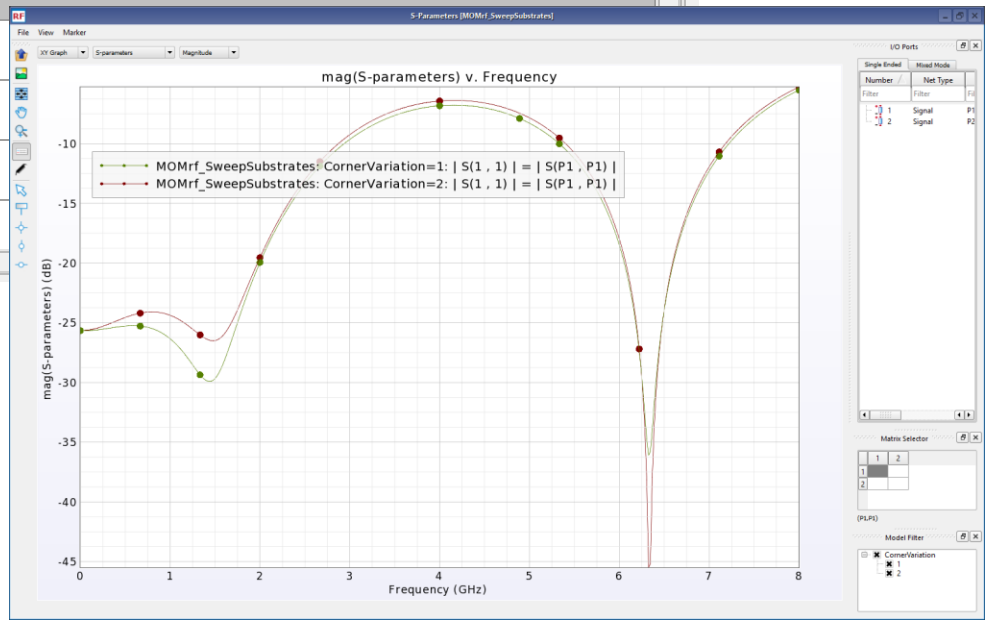
(3) Sweep Substrates



Demo – Simple MMIC Filter. Designers may want to choose a specific substrate to simulate or sweep through 'process corner' substrates.



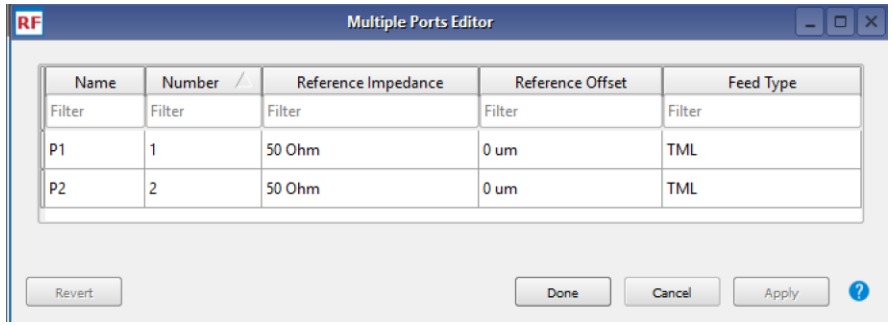


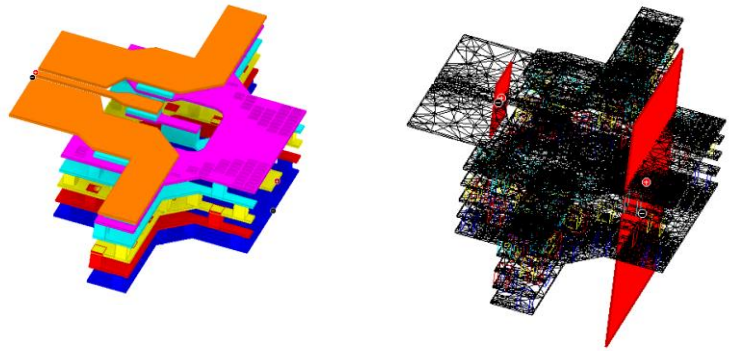


ADS RFPro 2025 Updates

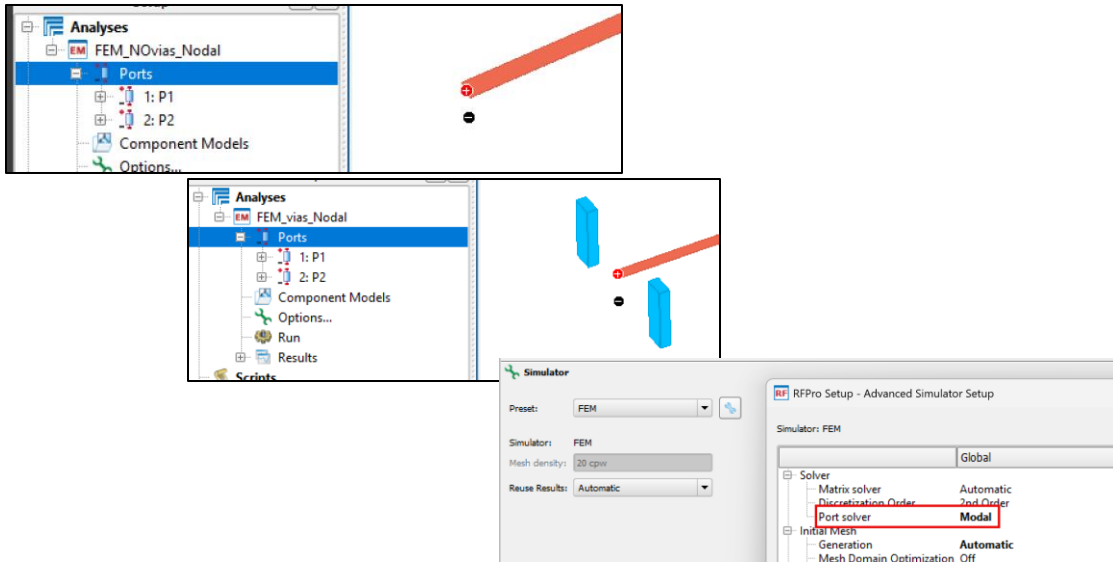
(4) TML Reference Offsets – Modal Port Solver

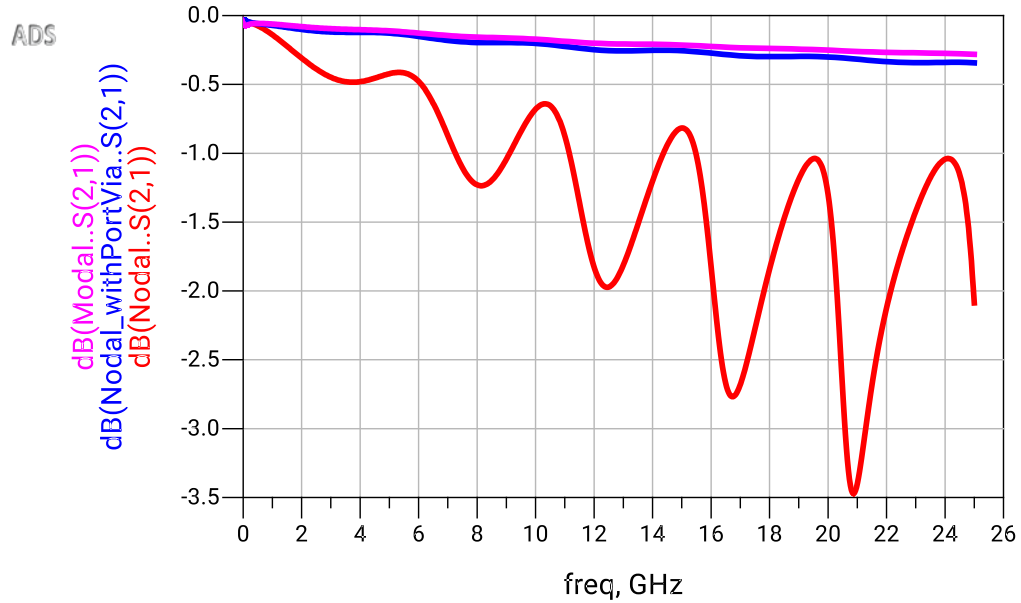
Demo – MoM and FEM 'TML' Feed Type Supports 'Reference Offset'





Demo – FEM Modal Waveguide Port can Solve multi-conductor structures

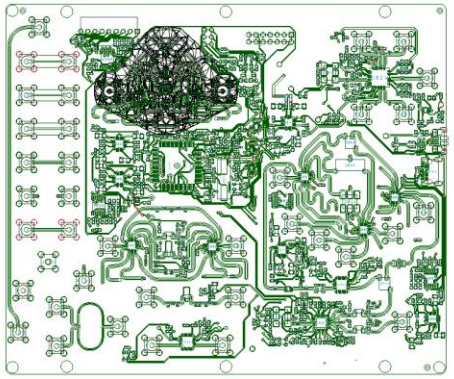


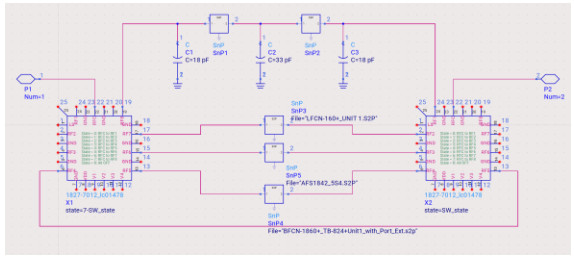


ADS RFPro 2025 Updates

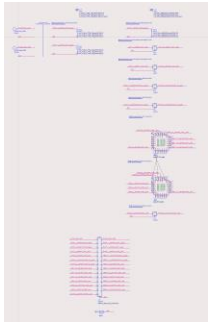
(5) Mesh Domain Optimization – Mesh and Near Field Visualization

Demo – MDO analysis of switched filter bank

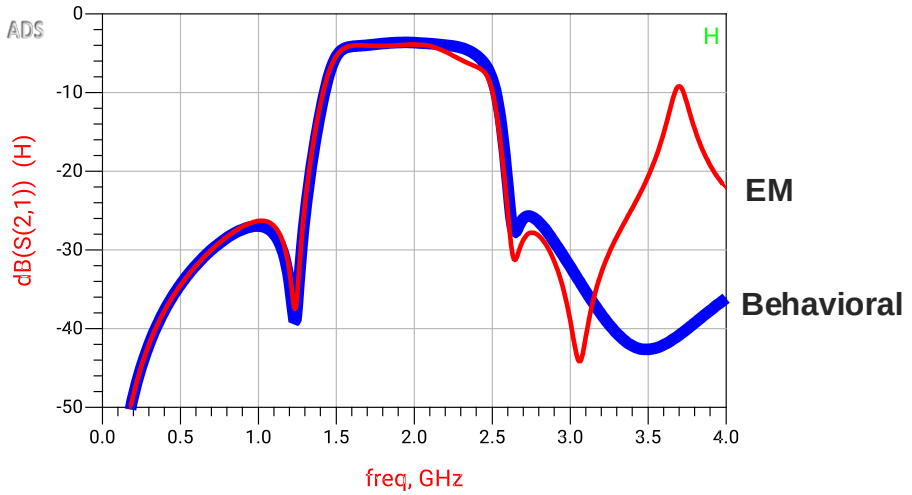




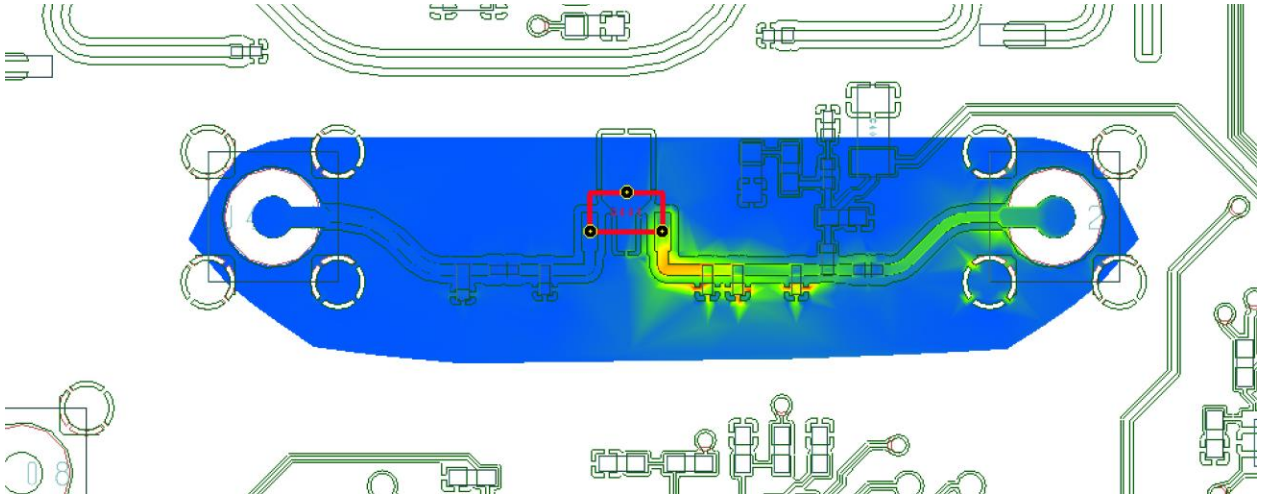
Behavioral

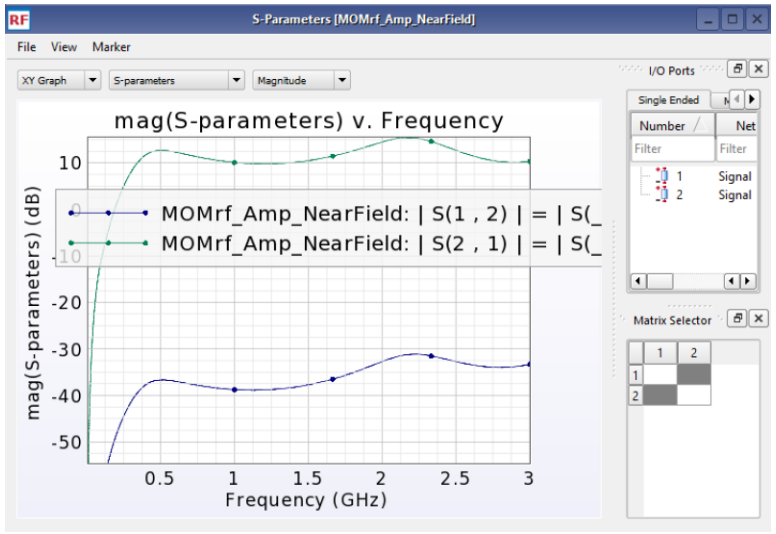


EM



Demo – MDO analysis of PA with non-reciprocal embedded .s2p amplifier model

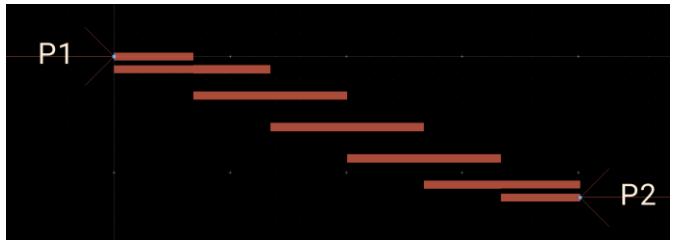




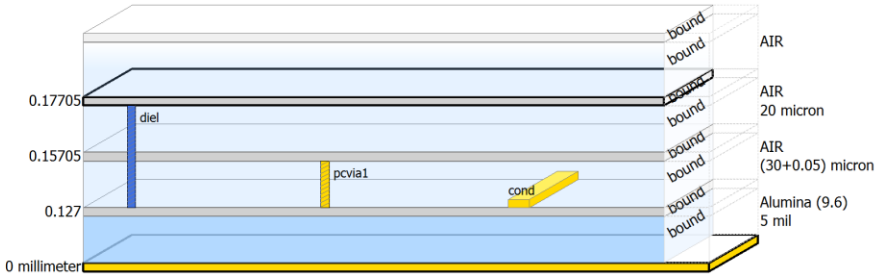
ADS RFPro 2025 Updates

(6) FEM Interior Mesh

Demo – Thin Film mmWave BPF

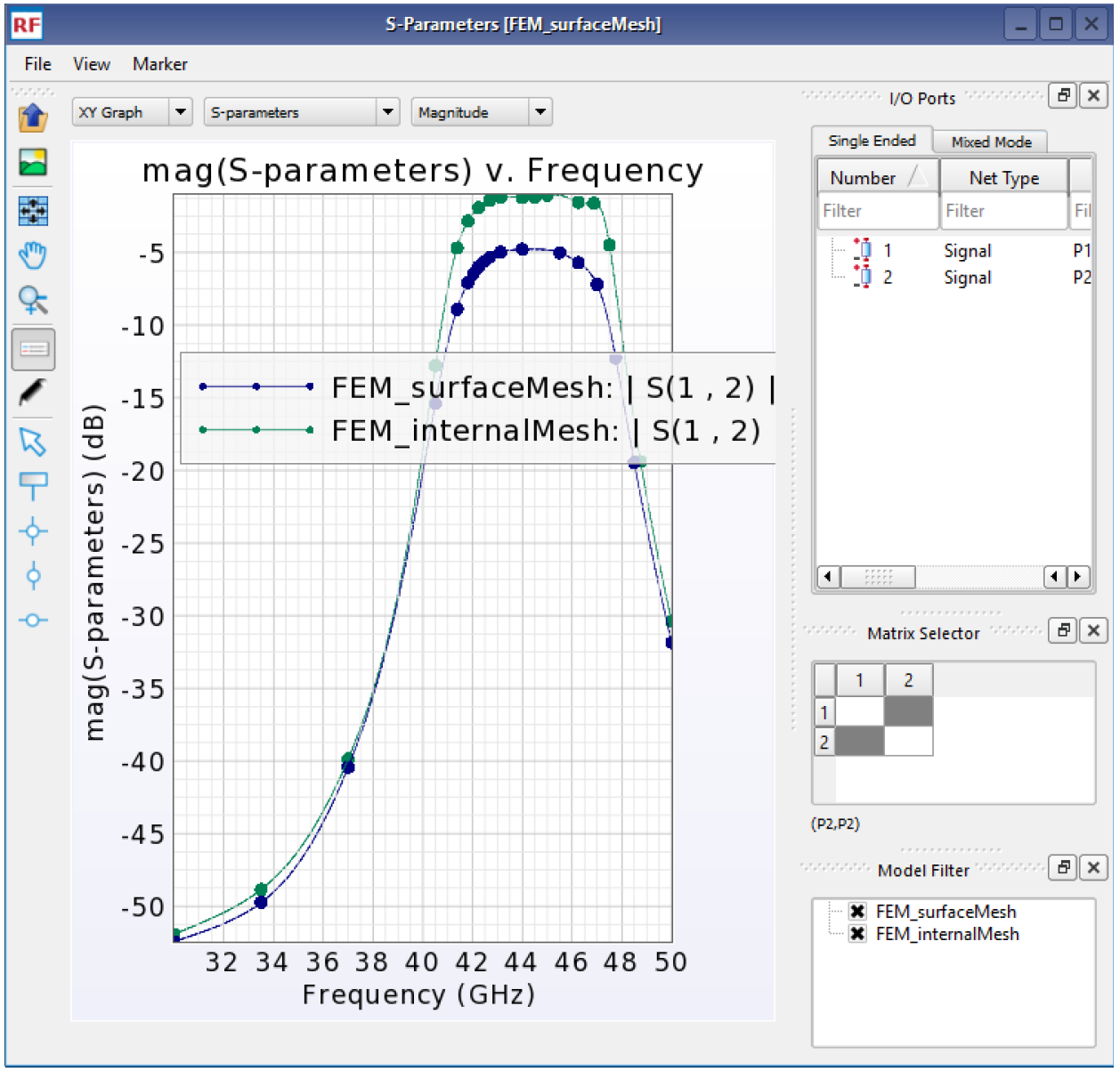


Thick 30um Gold is deposited on top of 50nm TiW, of dis-similar conductivity



Thin 50nm TiW 'cond' metal is set to Internal mesh

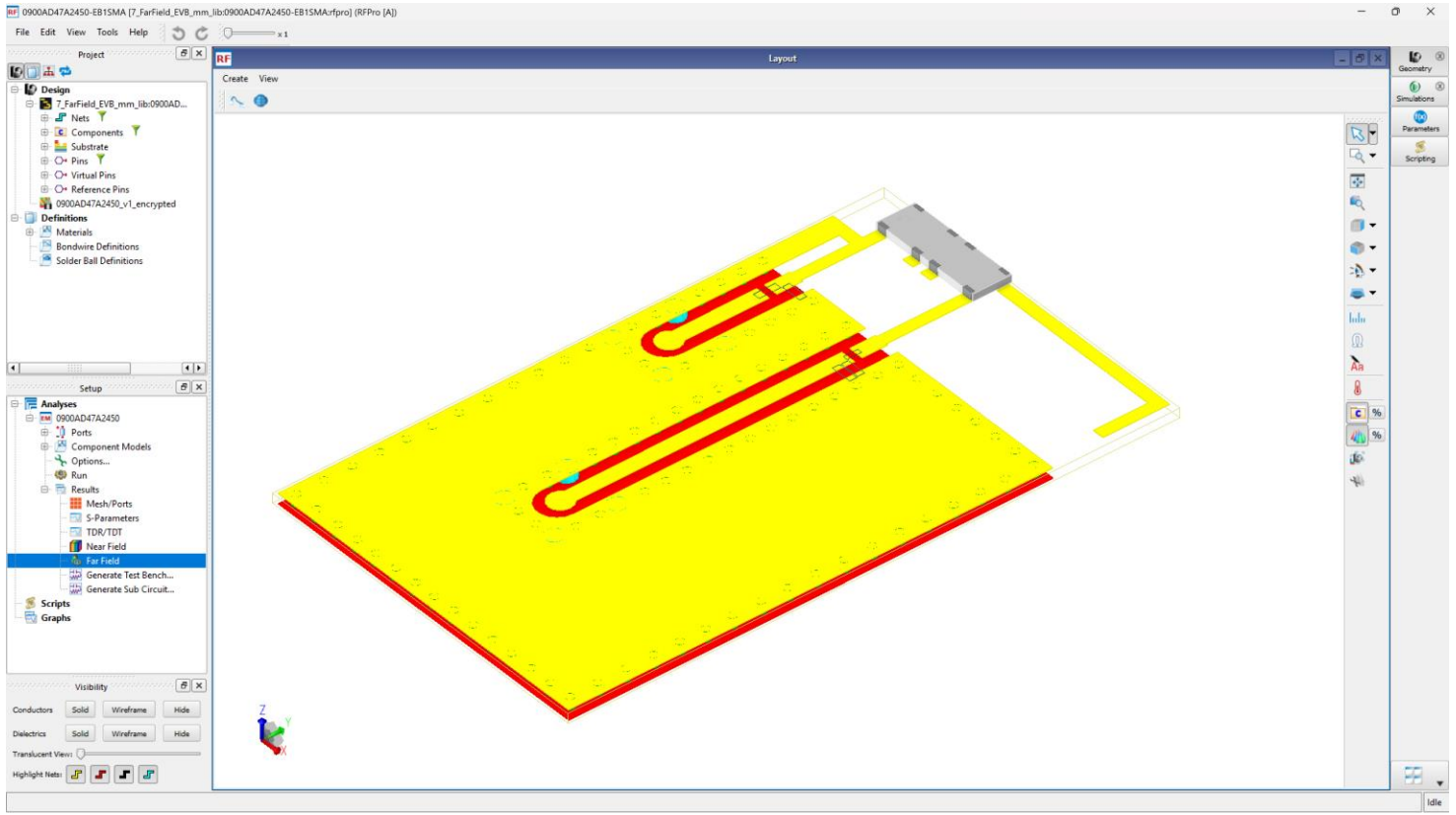
Physical model		
Thick conductor model	**Automatic**	cond (1): Internal
Via conductor model	**Automatic**	

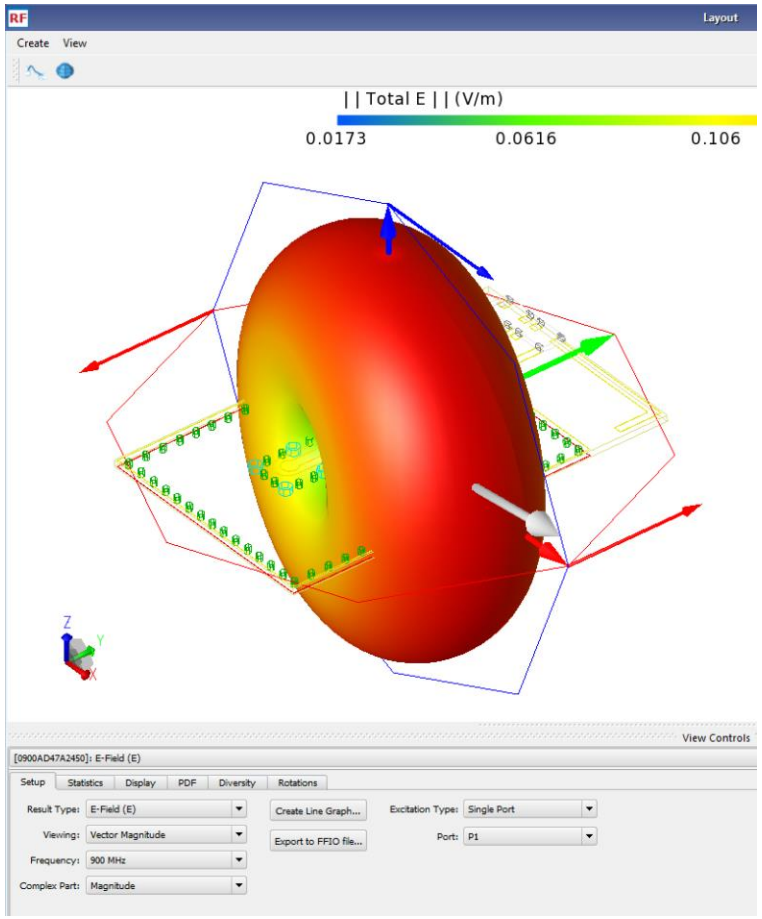


ADS RFPro 2025 Updates

(7) Far Field Computation

Demo – Encrypted Johanson Antenna Mounted on an Eval PCB





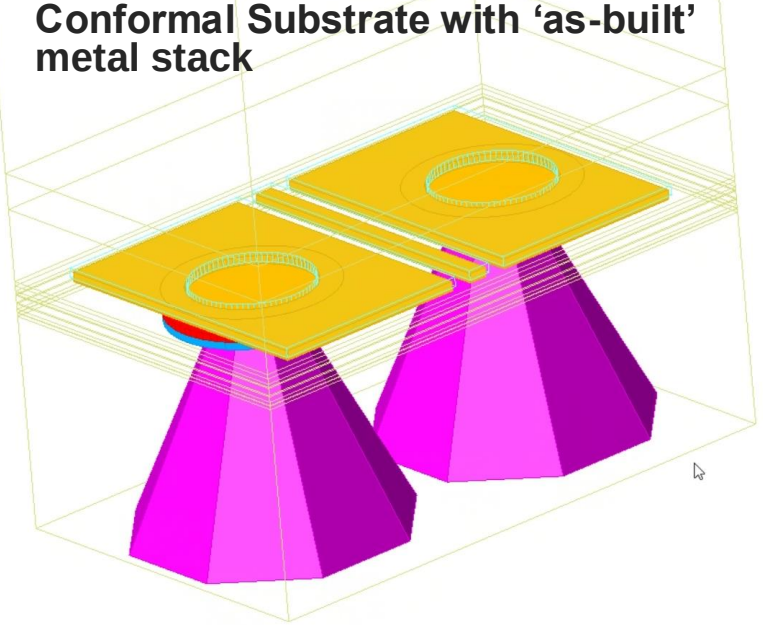
ADS RFPro 2025 Updates

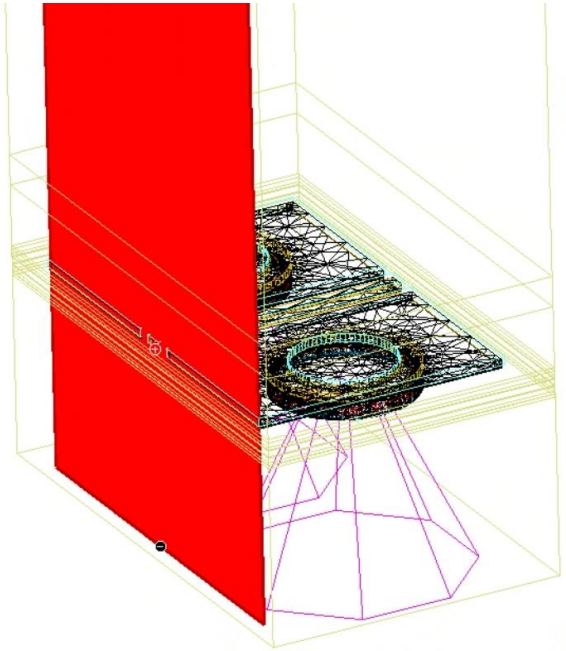
Bonus Thought! Realizing the THz Design

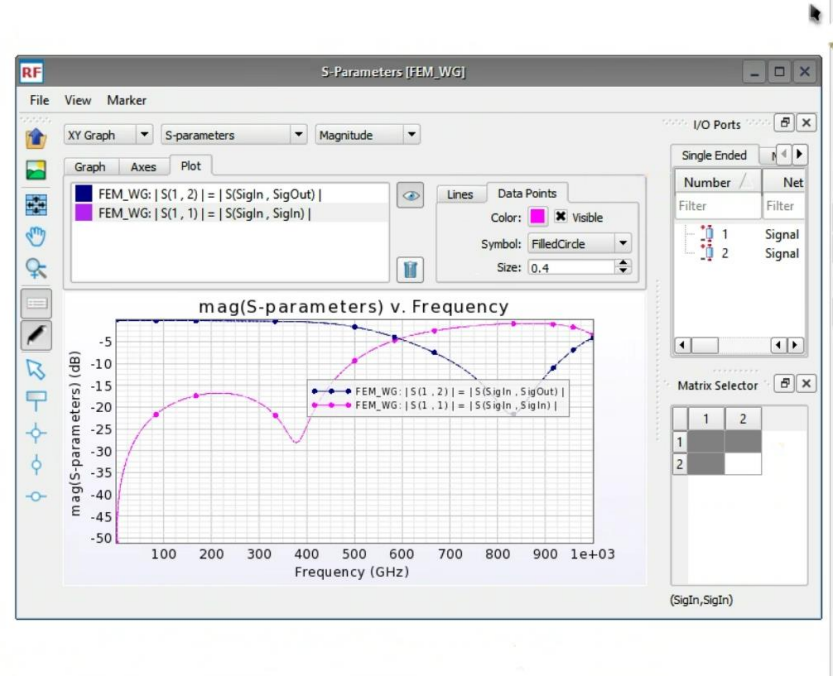
Increasing Frequency means no simplification of physical structures to maintain accuracy. For example:

- **Vias must be modeled as fabricated, no longer orthogonal holes.**
- **Substrates can no longer be considered planar. Conformal nitride layers or stacked metal layers must be simulated ‘as-built’**

Conformal Substrate with ‘as-built’ metal stack







EMPro 3D Component Implemented in Foundry PDK

Summary

- No matter what your application area is, PCB, IC, Module, ADS IS the platform to Integrate and EM simulate your designs
- ADS RFPro 2025 implements 7 new key enablement features.
  - New Calibration Standards
  - Substrate Sweeps
  - Simulation re-use
  - Modal Ports
  - Mesh Domain Optimization Mesh and Fields
  - FEM Interior Mesh
  - Far Field Computation
- No matter your design complexity (1 THz!) ADS has the capability

KEYSIGHT

Thank you