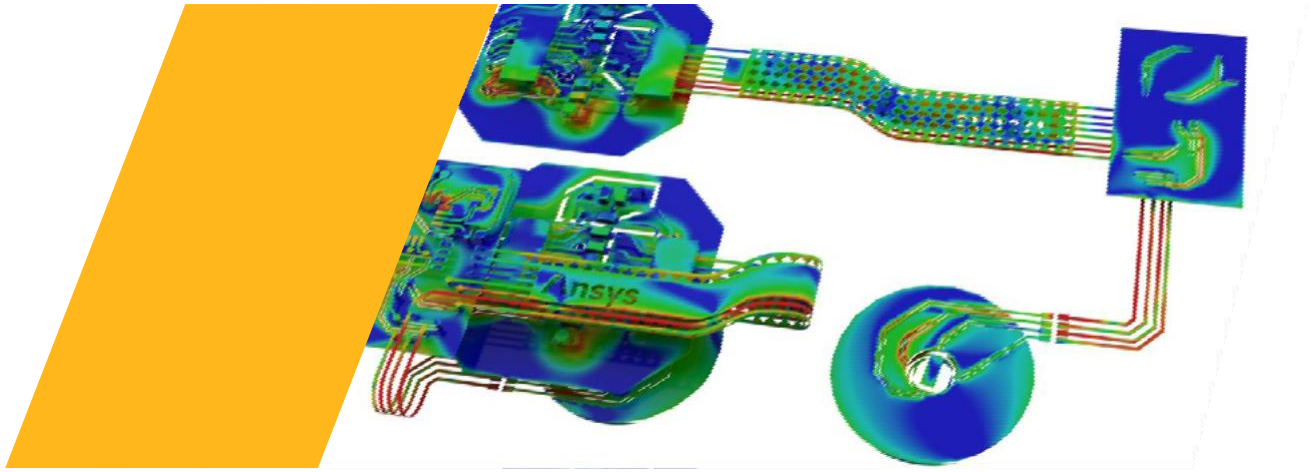
ANSYS HFSS 2022R2 新功能介绍

新科益系统与咨询（上海）有限公司

Agenda



HFSS Highlights

- ✓ HFSS 3D Layout Flex PCB Workflow
- ✓ Encrypted HFSS 3D Layout Components
- ✓ HFSS Performance

2022 R2 What's New
High Frequency

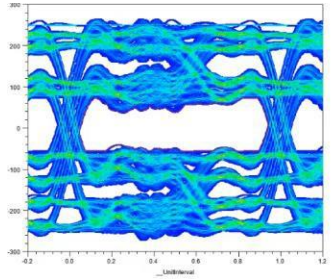
Matt Commens, Senior Manager Product Management

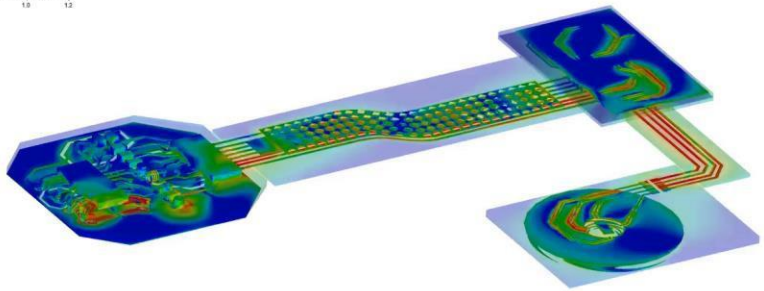
CAD-IT CONSULTANTS

What’s New – HFSS 3D Layout Flex PCB workflow

What’s New

- New HFSS 3D Layout Flex PCB Workflow for any product or system using flex PCBs for connecting systems and components (e.g., connector)





User Benefits

✓ Helps user’s setup flex PCB cable designs in HFSS Layout for rigorous 3D simulations including effects of bends and electromagnetic coupling

End User and Applicable Industries

- Engineers designing or integrated a flex cable deign into their system or product. Both the designer of the cable and the end user. Integrator
- Industries - Consumer Electronics, Aerospace/Defense, 5G/6G, Autonomy

What's New – Encrypted HFSS 3D Layout Components

What's New

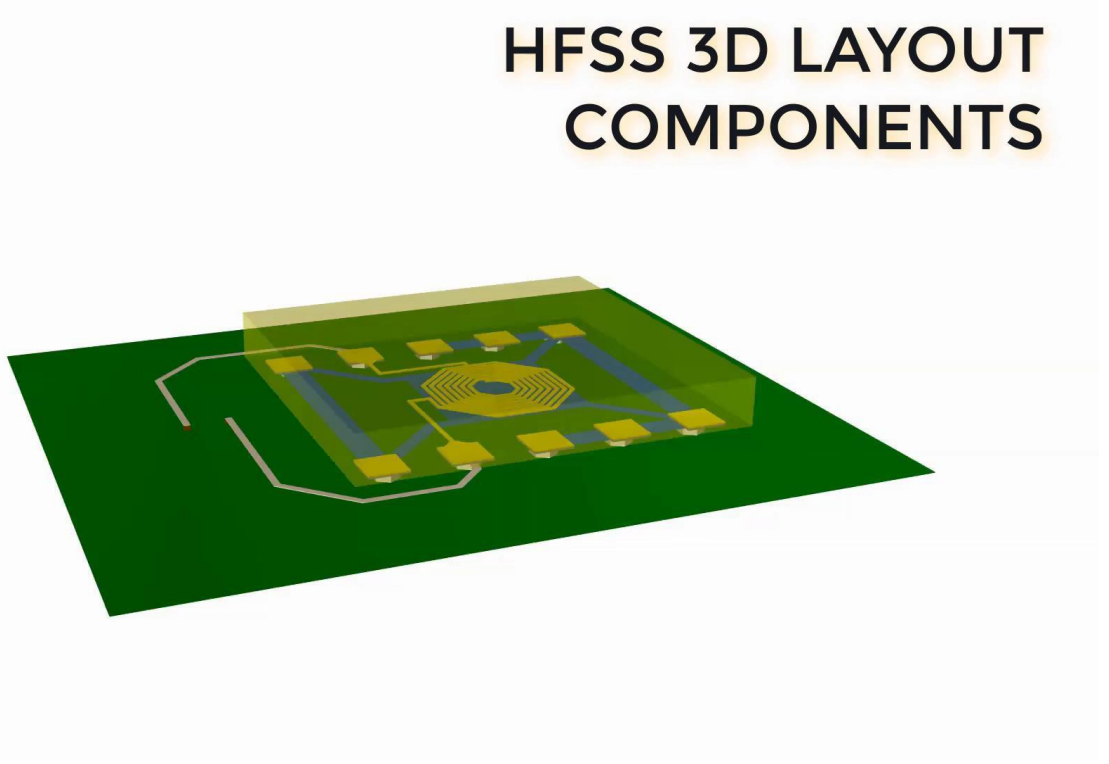
- The capabilities of encrypted HFSS 3D layout components now extend to support IC design flows utilizing standard foundry tech file formats including encrypted tech files

User Benefit

- Enables a smoother workflow from IC design tools into HFSS. This will greatly benefit 3D-IC and bespoke silicon design.

End User and Applicable Industries

- Engineers working with foundry technology files for defining IC stackups will now be able to work seamlessly with these design inputs.
- Industries - 5G/6G, Autonomy, 3D-IC, bespoke silicon design



What's New – HFSS Performance Improvements

What's New

- Significant improvement in Design and simulation turn around time (TAT)

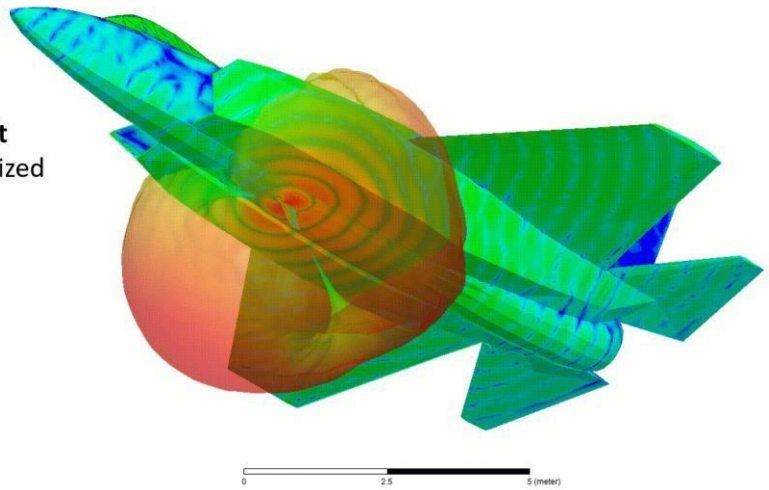
User Benefit

- Faster simulations with the accuracy of HFSS

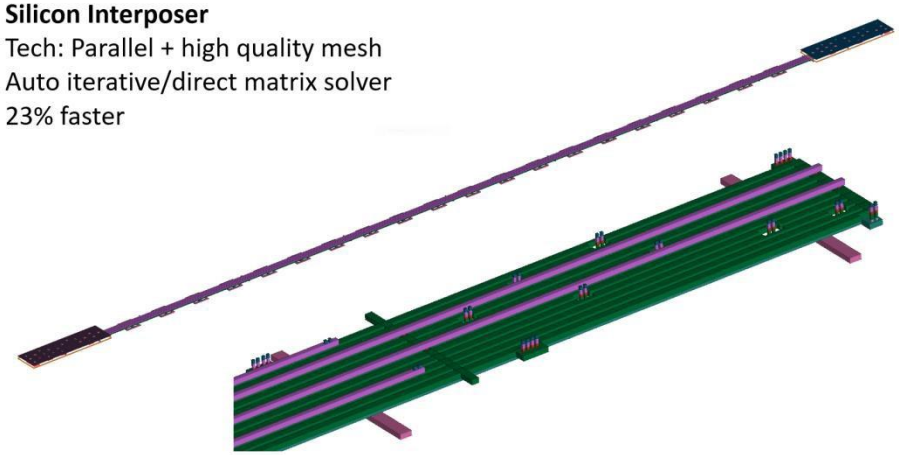
End User and Applicable Industries

- All users of HFSS but especially users solve designs at large scale in size and/or complexity

Antenna on Aircraft
Tech: NUMA Optimized
Windows 4 socket
77% faster



Silicon Interposer
Tech: Parallel + high quality mesh
Auto iterative/direct matrix solver
23% faster



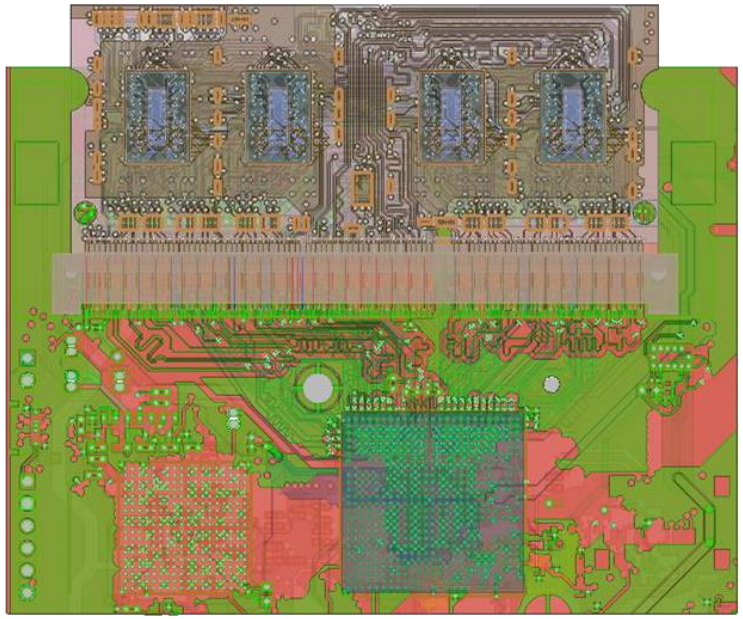
HFSS 3D

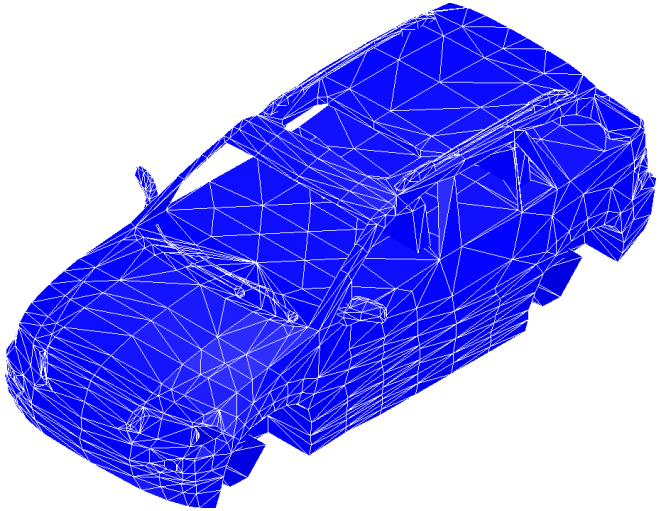
HFSS Capability/Usability

- Mesh Fusion for Layout Component [BETA]
  - Both 3D and layout components leverage mesh fusion
  - Supports component priority option

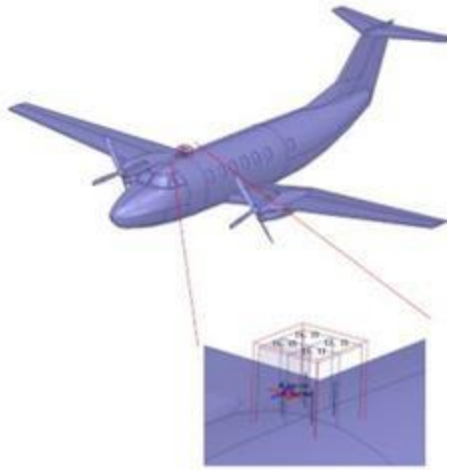
- 3D Component Mesh Priority
  - 3D Component is allowed to override native geometry
  - Component Mesh Region as tool object subtraction

- Lightweight Geometry (STL) for Hybrid Regions [BETA]
  - “Lightweight” STL geometry for hybrid MoM regions
  - Mesh feedback will identify potential STL problems
  - Mesh refinement will proceed from initial STL facets



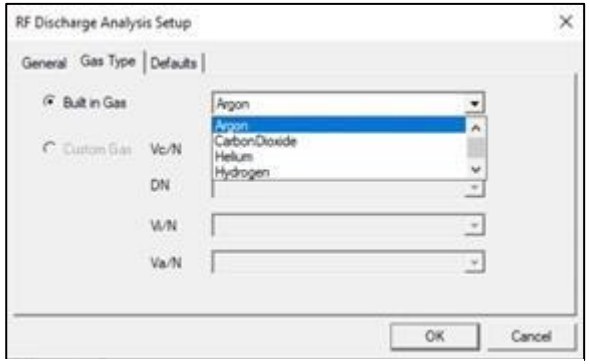


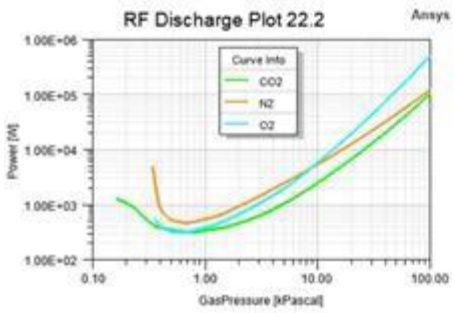
HFSS Capability/Usability

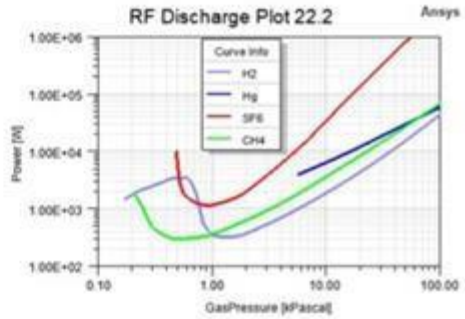


- 3D Component Array on SBR+ Platform
  - Array can be placed in a relative coordinate system
  - Airbox is required to enclose the array

- RF Discharge Official Release
  - Expanded Gas Library
    - Enhanced accuracy for existing gases; CO2, N2, O2 plus new gases; H2, Hg, SF6, CH4
  - Electron swarm parameters verified against experiment (Raju) and BOLSIG+
  - BOLSIG+ based collision frequencies



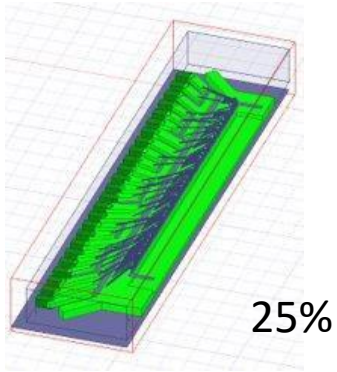




- Additional Enhancements
  - Adapt FEBI with ABC official release
  - Continuing expansion on interactive dialogs

HFSS HPC/Performance

- Low Memory Mesh Adaptation
  - Improves the peak memory usage of direct solve involving large number of excitations



Ver.	#RHS	#unknown	Memory	Runtime
22.1	126	2,593,433	30.1 GB	00:05:59
22.2	126	2,593,433	22.5 GB	00:05:39

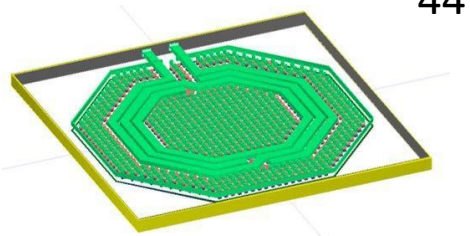
25% less memory

Ver.	#RHS	#unknown	Memory	Runtime
22.1	264	6,217,999	88.2GB	00:26:08
22.2	264	6,217,999	44.4GB	00:25:26

BAW Filter Module
50% less memory

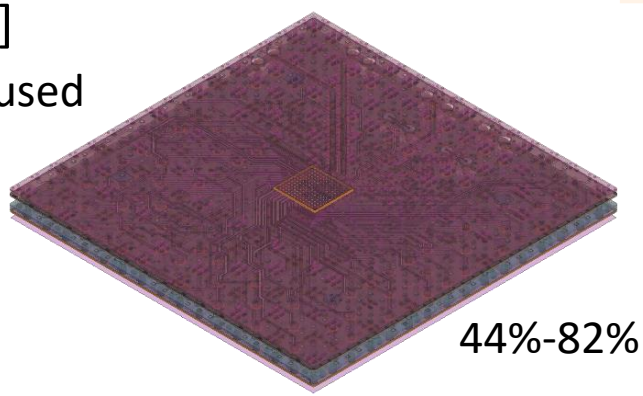
- Enhanced Auto S-matrix Only Solve
  - Improve memory usage in frequency sweep via an improved S-matrix cutoff

44% faster



Ver.	Max Freq in Parallel	Sweep Memory	Sweep Time	Smatrix Cutoff
22.1	1	32.1GB	00:21:55	1.8 THz
22.2	3	31.8GB	00:12:12	366 MHz

- AMD Math Library for Direct Matrix Solver [BETA]
  - Automatic detection of CPU vendor, math library is used only when AMD CPU is detected



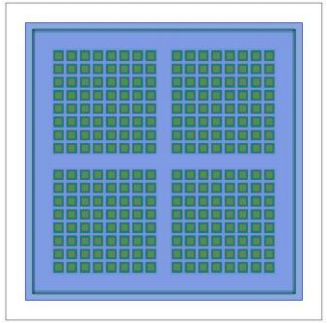
Num Cores	Without AMD lib	With AMD lib
8	0:17:46	0:09:45 (1.82x)
16	0:11:04	0:06:59 (1.58x)
32	0:08:13	0:05:42 (1.44x)

44%-82% faster

HFSS HPC/Performance

- Accelerated Mesh Fusion Solver [BETA]
  - Multi-node distributed matrix assembly and field recovery including 3D component array
  - Improve distributed matrix solve performance

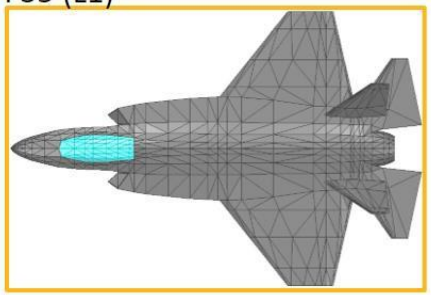
4-nodes, save field off
2.4X speed up



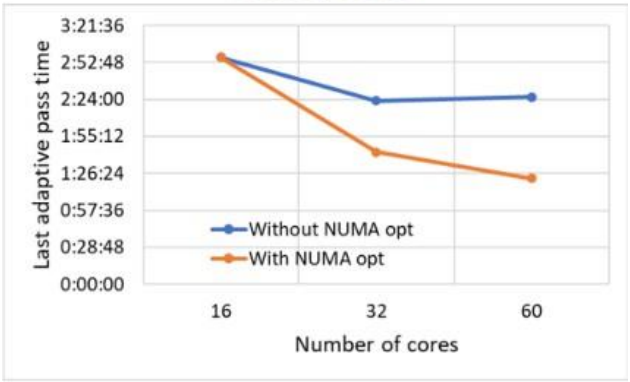
4-nodes, save field
1.5X speed up

- Support Auto HPC on NUMA Machines [BETA]
  - NUMA: Non-Uniform Memory Access
  - MPI task # based on the number of detected sockets
  - Single task will not span beyond one socket

F35 (L1)



Windows 4 socket machine
16 cores / socket



- Scriptable Data-mining of Performance Data
  - Using object-oriented scripting framework

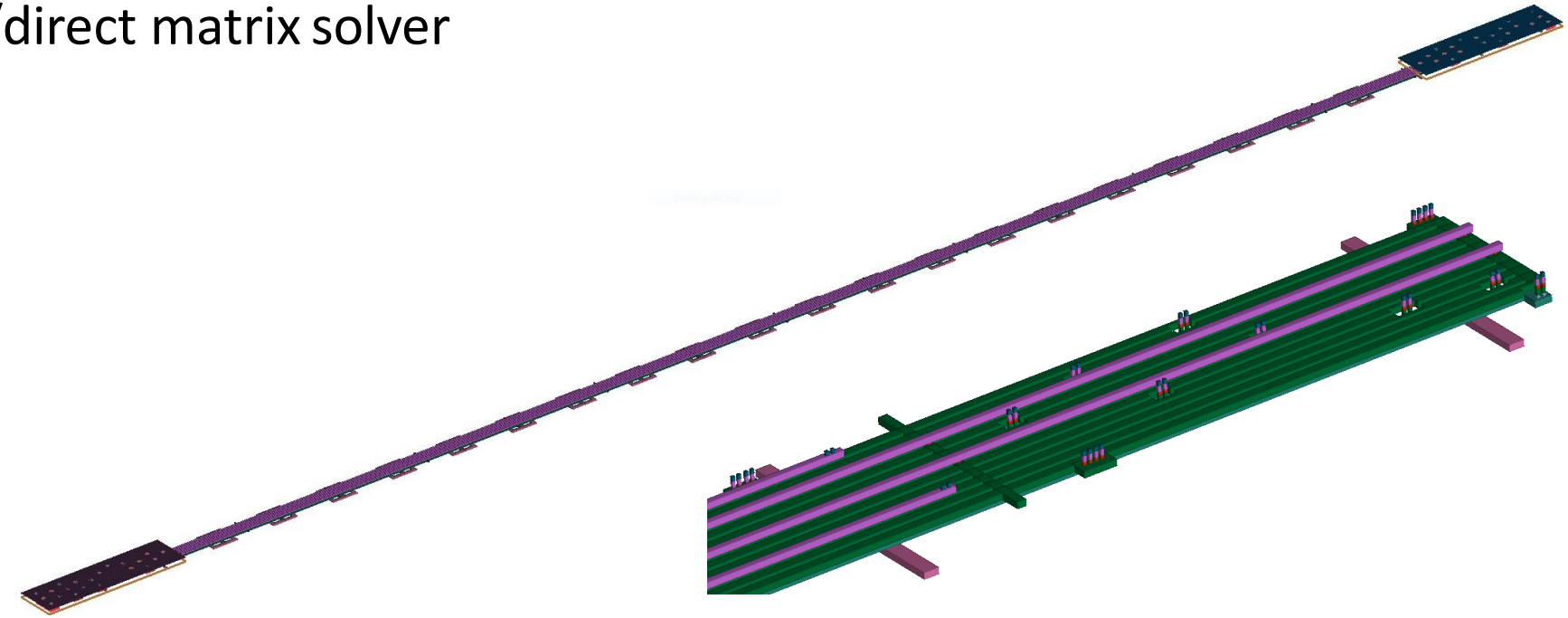
HFSS Performance Example

Silicon Interposer

Tech: Parallel + high quality mesh

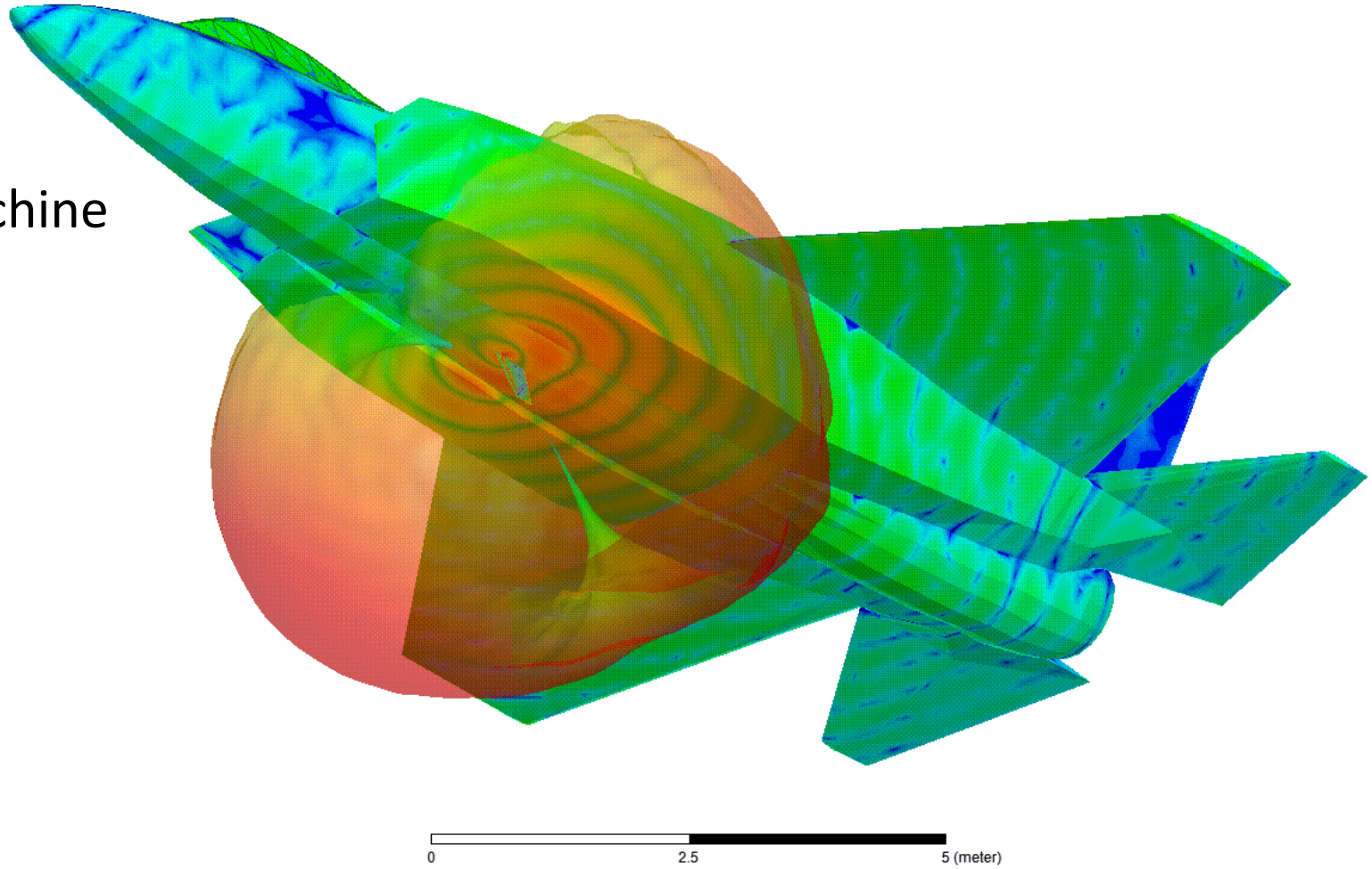
Auto iterative/direct matrix solver

23% faster



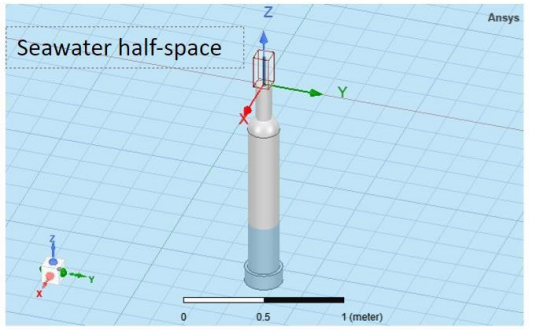
HFSS Performance Example

Antenna on Aircraft
Tech: NUMA Optimized
Windows, 4 socket Machine
77% faster

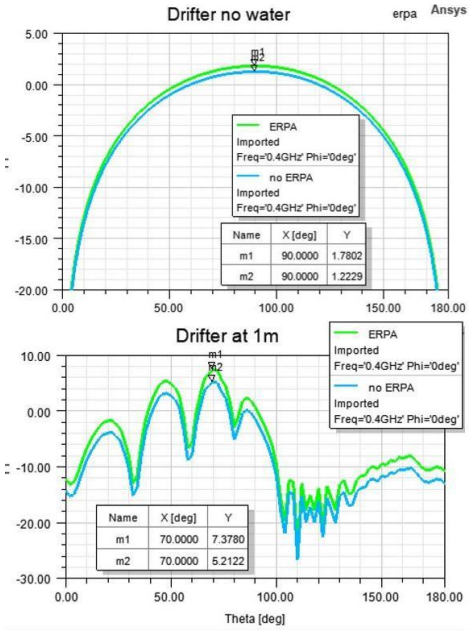


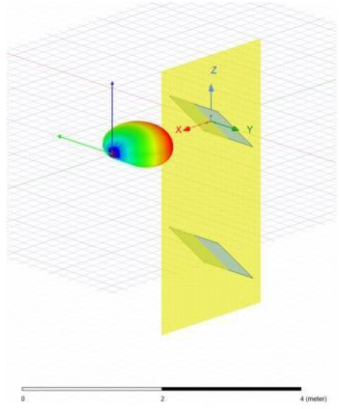
HFSS SBR+

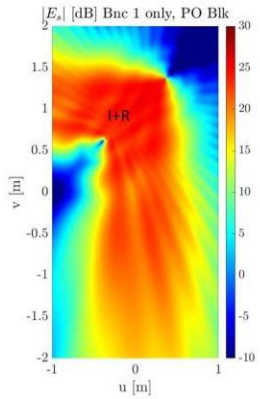
- Include Region Loss in Directivity
  - Includes material loss in radiated power calculations
- GO Blockage Model
  - When the lit region is small, or in deep-shadow, GO (Geometry Optics) identifies shadow regions explicitly
    - Benefit: Better shadows, better destructive interference
- Report Ray Stats
  - Summation of ray stats for all Tx antennas
  - Reported ONCE per simulation
  - Items with 0 contributors are omitted

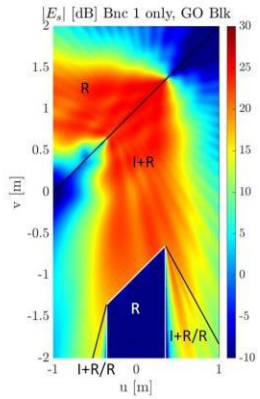


2.1dB difference, 6.5X longer







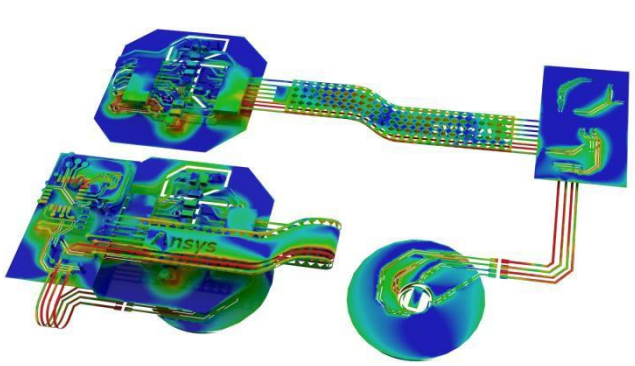


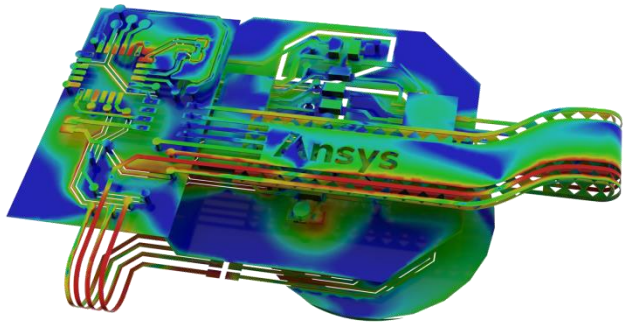
SBR Ray Stats			Num Launched = 22561; Num Blocked = 26198; Num Split = 469214; Num Exceed Max Bnc = 250770; Num Escaped = 241005; Num Contributed = 491775
			(Refl Depth, Num Branches Escape/Terminate at) = (1,18353); (2,5531); (3,3970); (4,5964); (5,11710)
			(Trans Depth, Num Branches Escape/Terminate at) = (2, 21108); (4, 63508); (6, 61159); (8, 35456); (10, 11731); (12, 2272); (14, 230)
CW Ray Stats			Num Rays Launched = 1440; Num Rays Traced = 1440; Num Footprints (Across All Rays) = 98577
			Longest Ray Len (m) = 0.0659371; Shortest Ray Len (m) = 0.0273400; Average Ray Len (m) = 0.0466667
			Source Counts by Initialization Failure Condition: Closest Point Not Metal = 1
			Ray Counts by Termination Condition: Geodesic Hit an Edge = 1438; Natural Decay = 2
			Histogram: (Num Fpt per Ray Range, Num Rays) = (39 - 51, 285); (52 - 64, 352); (65 - 77, 263); (78 - 90, 427); (91 - 99, 113)

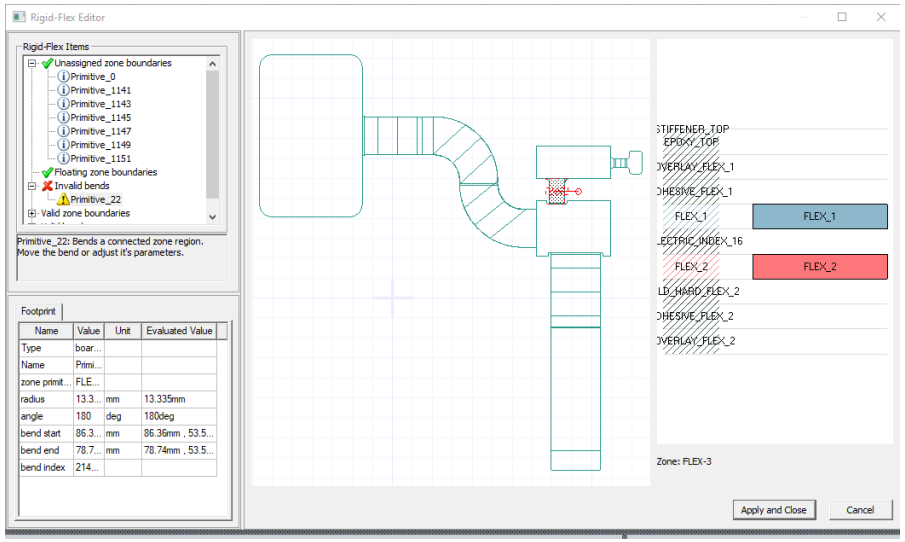
HFSS 3D Layout

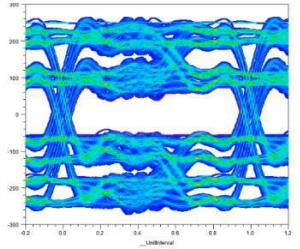
Flex PCB Workflow [Beta]

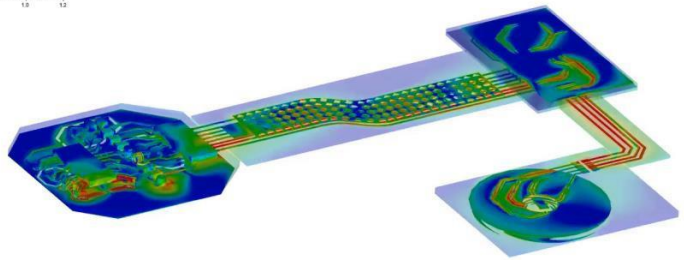
- ECAD-centric workflow for Flex PCB
  - View and edit as a PCB
  - Dedicated workflow to define zones and bends
  - Hierarchical support with 3D Components







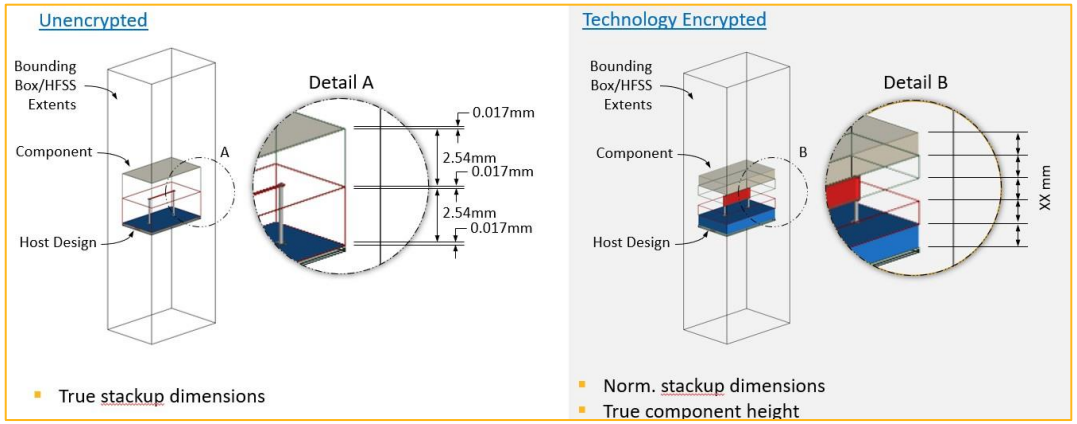


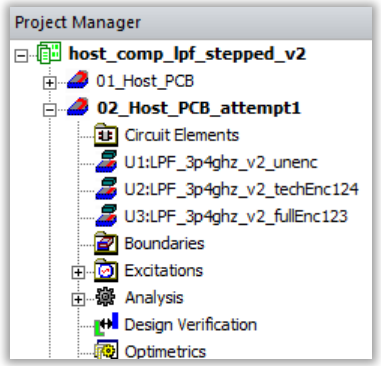


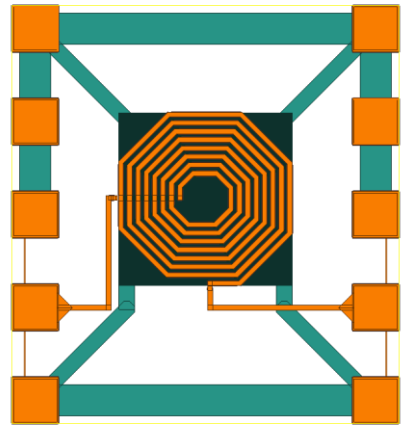
- Specialized Flex PCB Meshing
  - Automated region partitioning
  - Fast, robust and high-quality bend generation
  - Classic or Phi+ for volume mesh

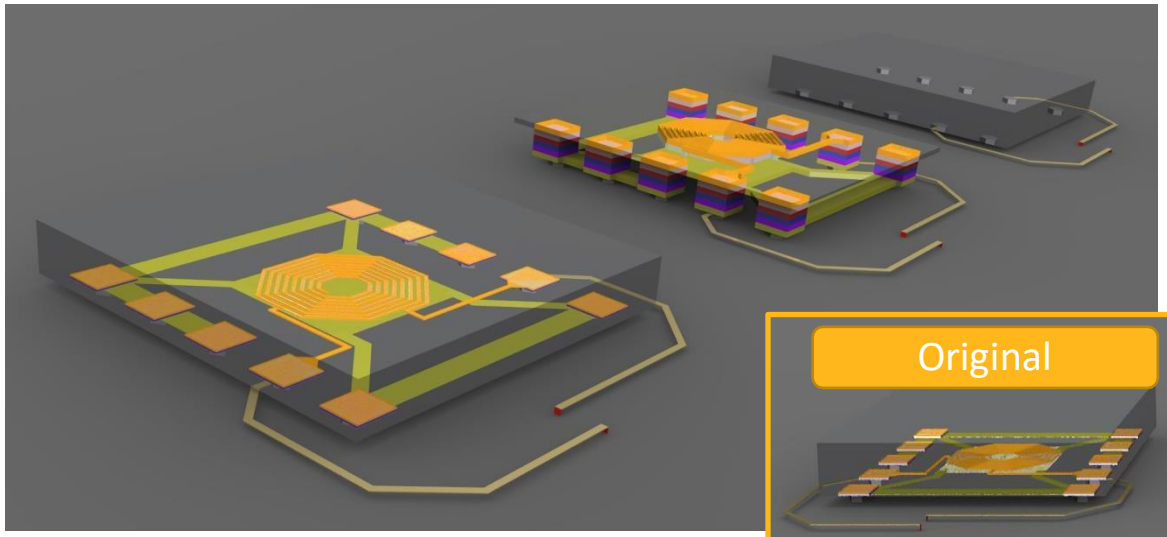
Encrypted HFSS Layout Components

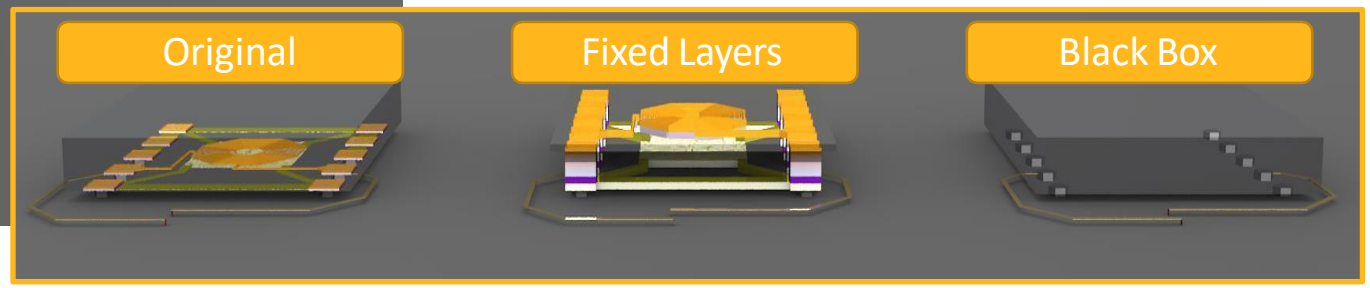
- Fields post-processing for encrypted technology
- Mesh seeding and Mesh Fusion
- Improved performance and usability
- Internal-key component generation
- Password-less editing for encrypted technology





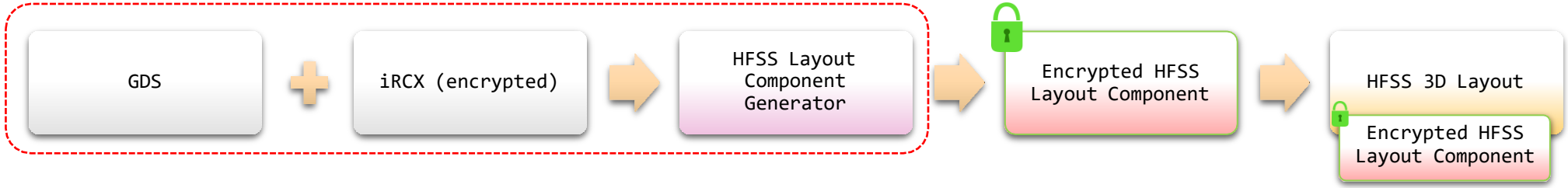


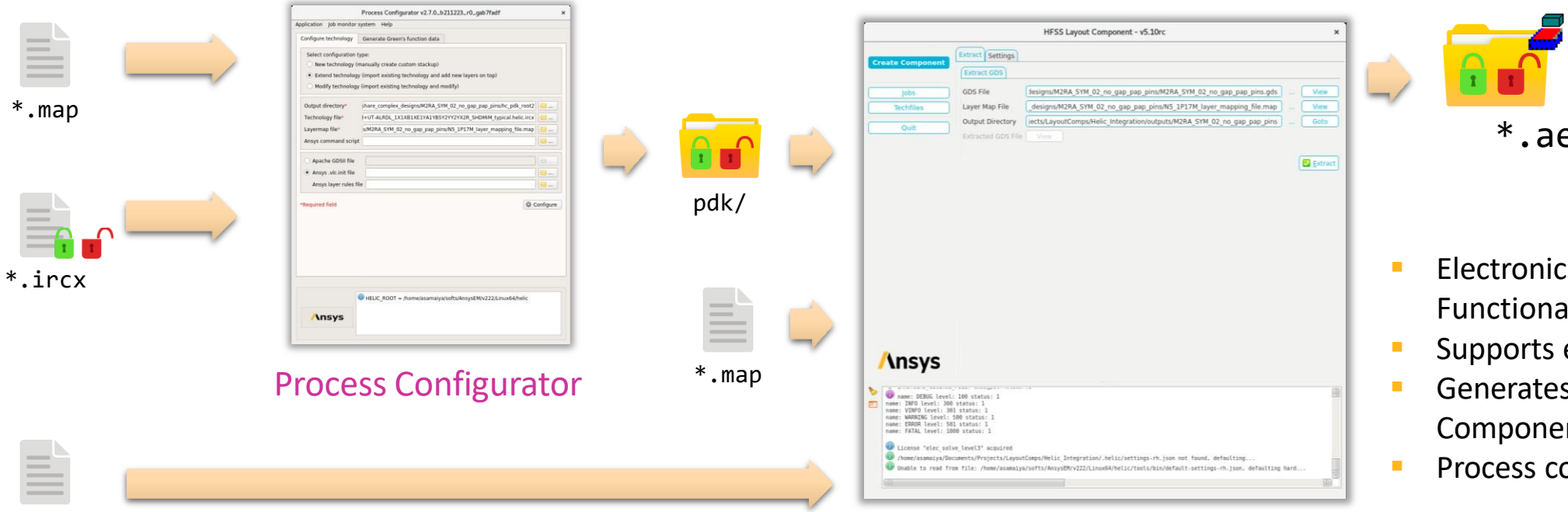




HFSS Layout Component Generator for GDS + iRCX

2022 R2
(supports encryption)

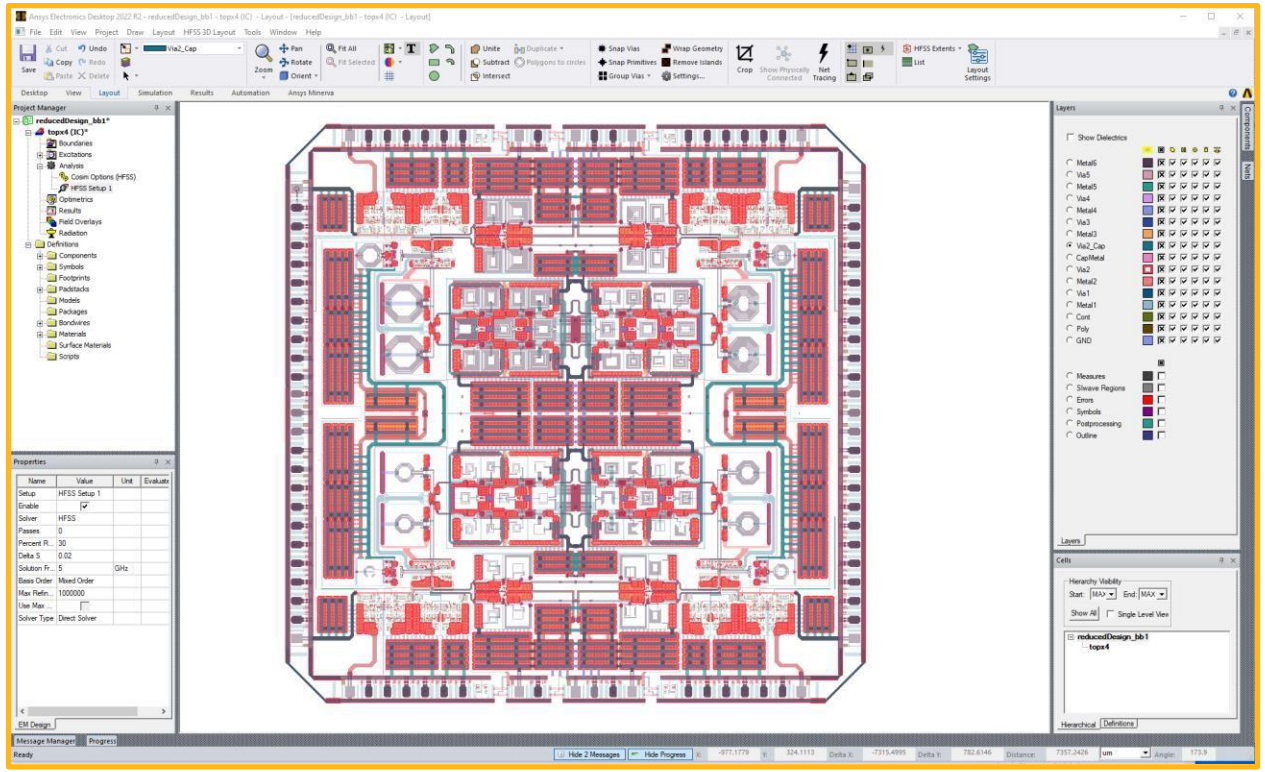




- Electronics Enterprise Functionality
- Supports encrypted iRCX
- Generates HFSS Layout Component
- Process corners and LDE

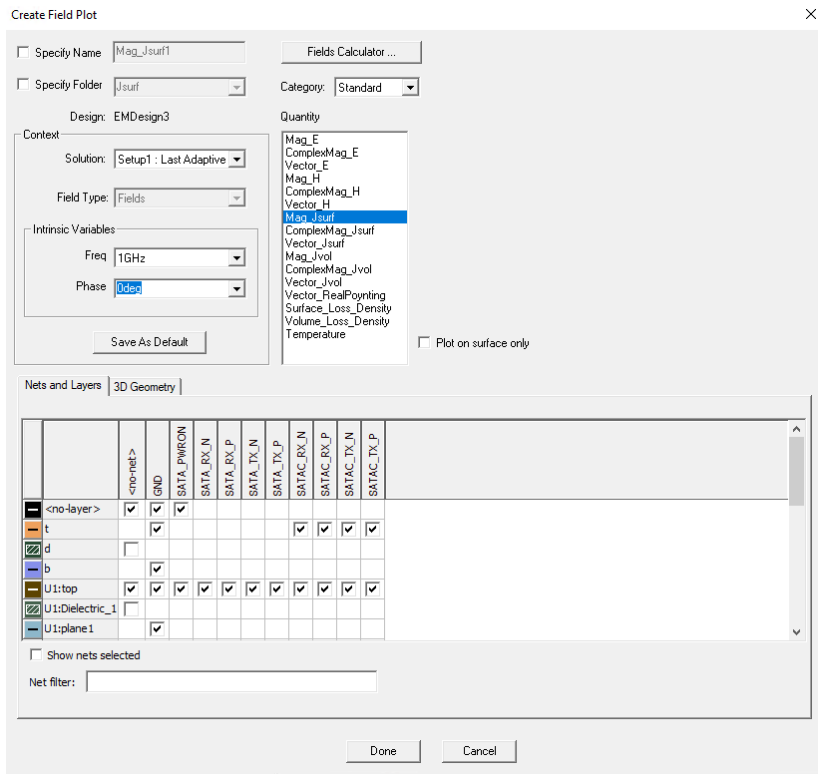
IC Design Mode [Beta]

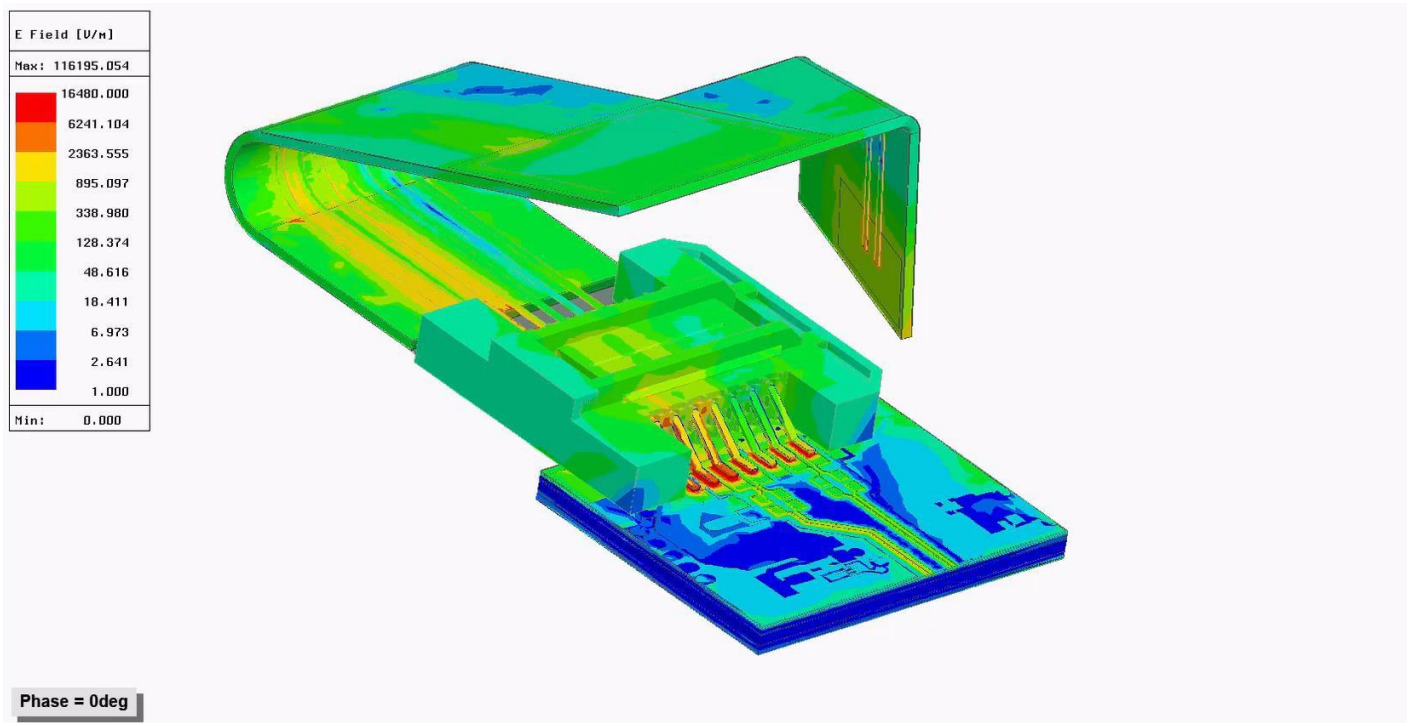
- Integrated ECADXplorer functionality for higher-capacity IC editor
- End-to-end workflow for IC-scale designs: ports, mesh feedback, post-processing,…
- Specialized 3D Layout “IC Design Mode”
- IC focused functionality and scope
  - Hierarchical/cell-based navigation and editing
  - Simulation Setups and options
- Integrated end-point for GDS import



Improved Field and Mesh Overlay Plots

Single dialog selection of Setup, Field Quantity, Layers, Nets, and 3D Geometry

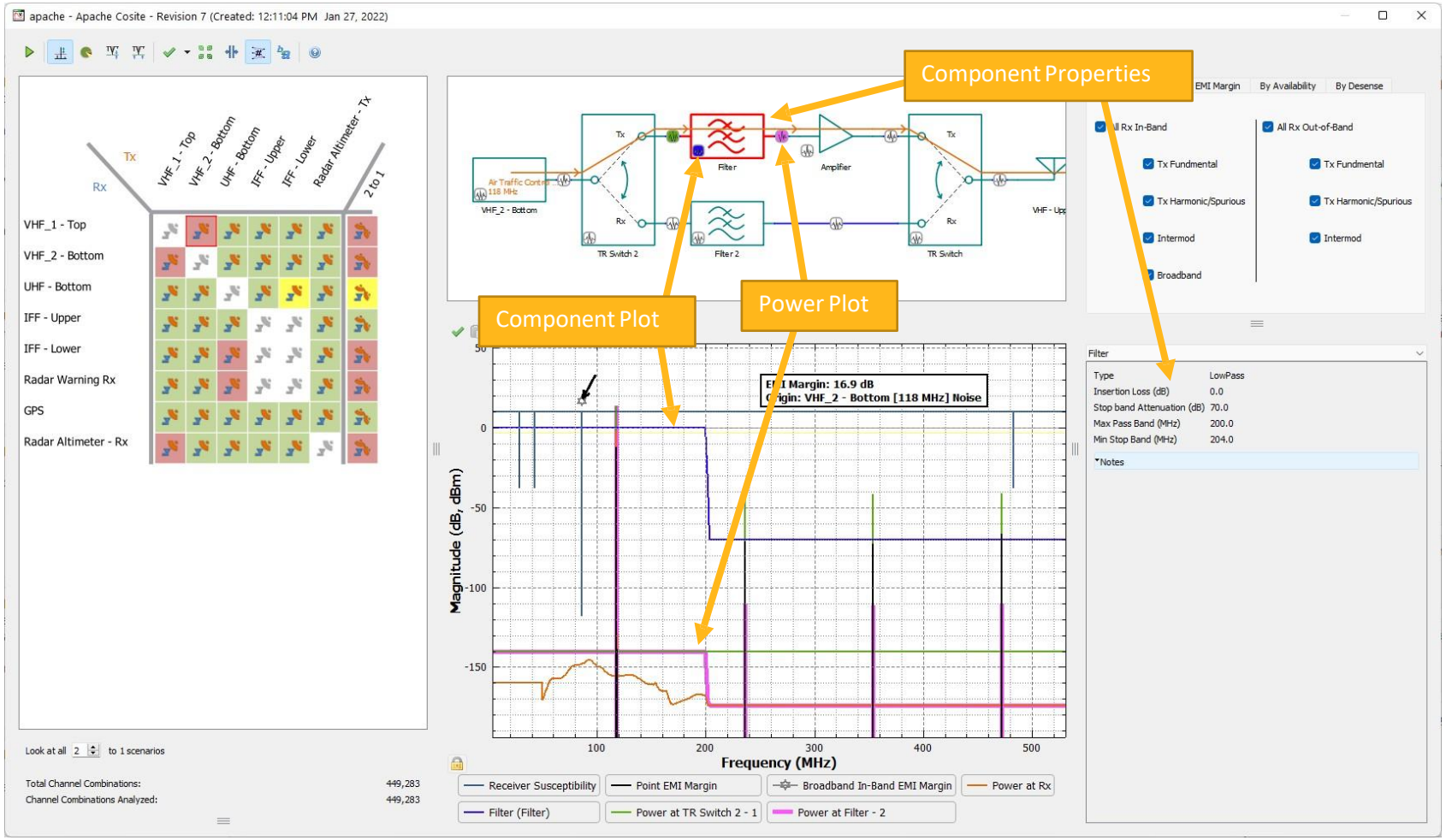




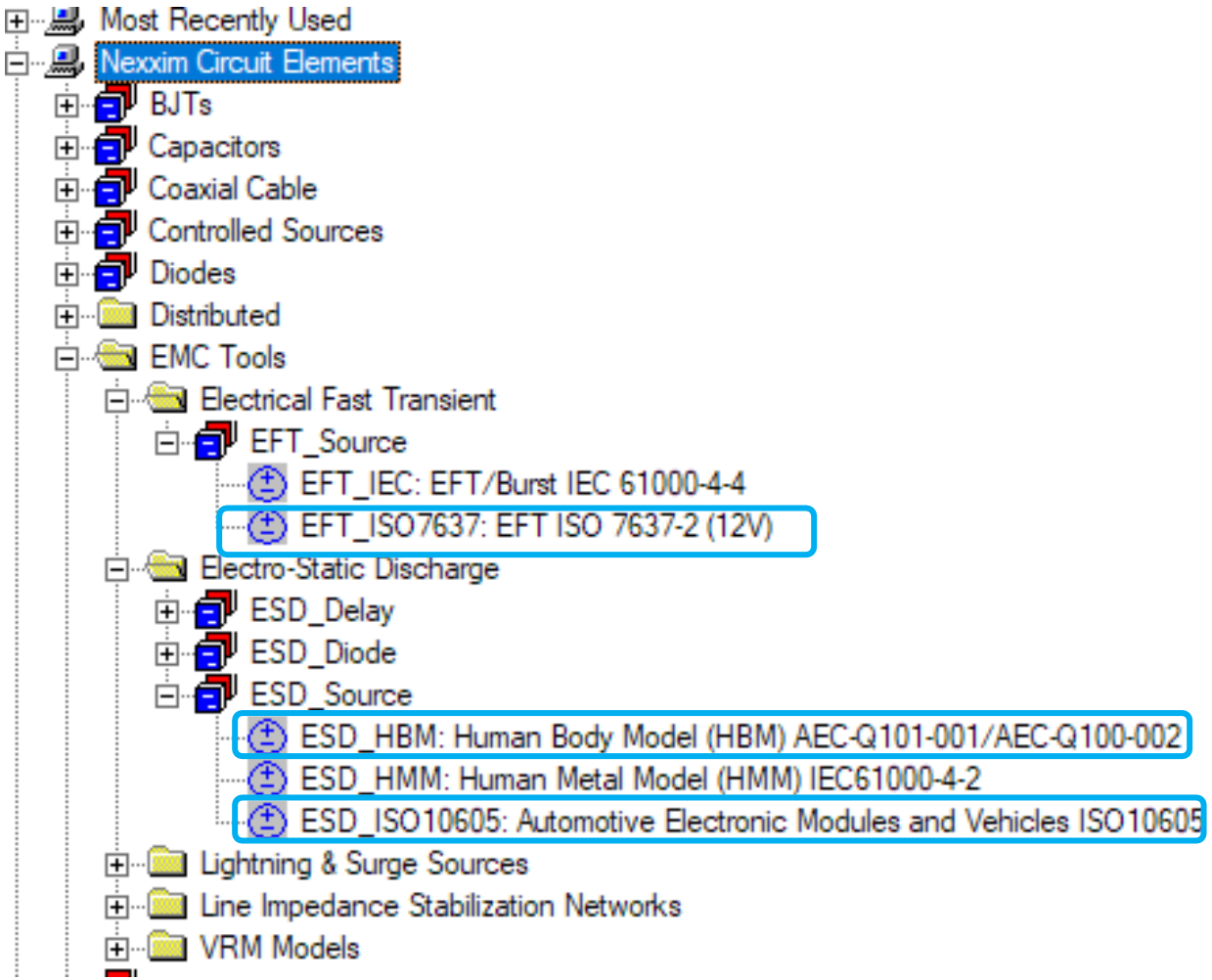
EMIT, Circuit, SPISim, and FilterSolutions

Results Diagnostic Tool

- View component parameters associated with result set
- Toggle spectrum interference plots at points in Tx/Rx chain
- Toggle plot of component insertion loss or coupling
- Identify root cause of saturation from contributors



New Source Components in EMC Tools Library

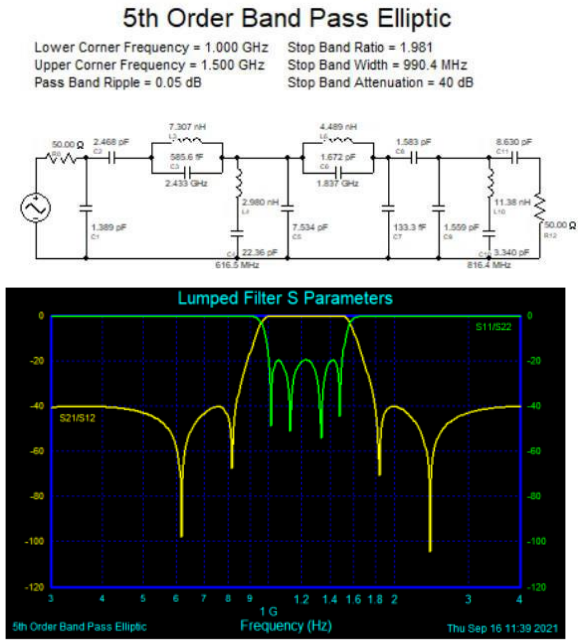


- AEC/JEDEC Human Body Model
- ISO10605 – ESD Road Vehicles
- EFT ISO7637-2
  - Fix for burst
  - Add repeat

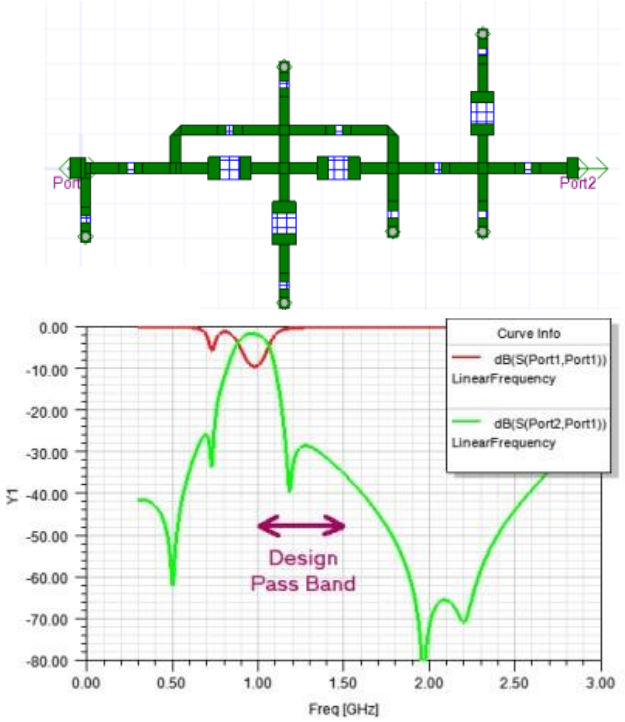
FilterSolutions

1. Primarily infrastructure changes to align with Ansys tools and libraries
2. Improved Automated Discrete Optimization
3. Enabled the ANFS / AWR interface

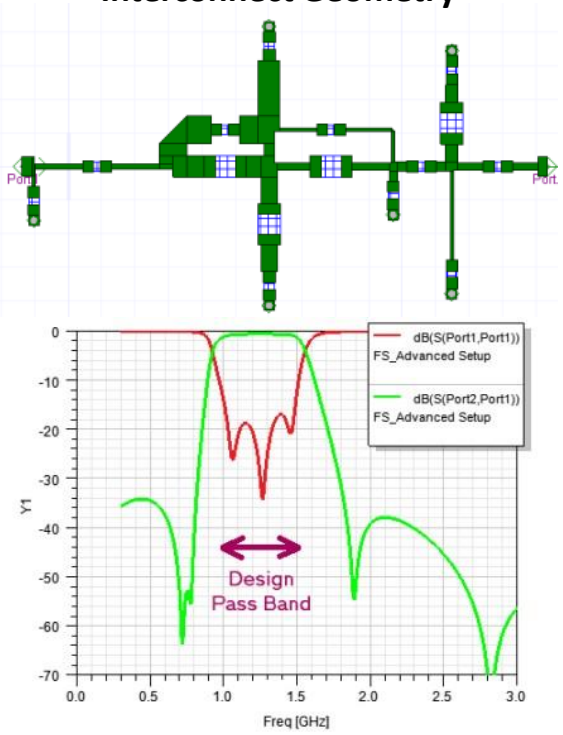
5-Pole Minimum Inductor Zigzag Design Created in FilterSolutions



Unoptimized Layout in AEDT Circuit with Modelithics Elements



Optimized Discrete Elements and Interconnect Geometry



COM-based Optimization in AEDT

Motivation:

- SPISim's COM provide multiple merit matrices for channel such as ERL, ILD and COM
- AEDT's user would like to optimize their HFSS design based on these COM matrices

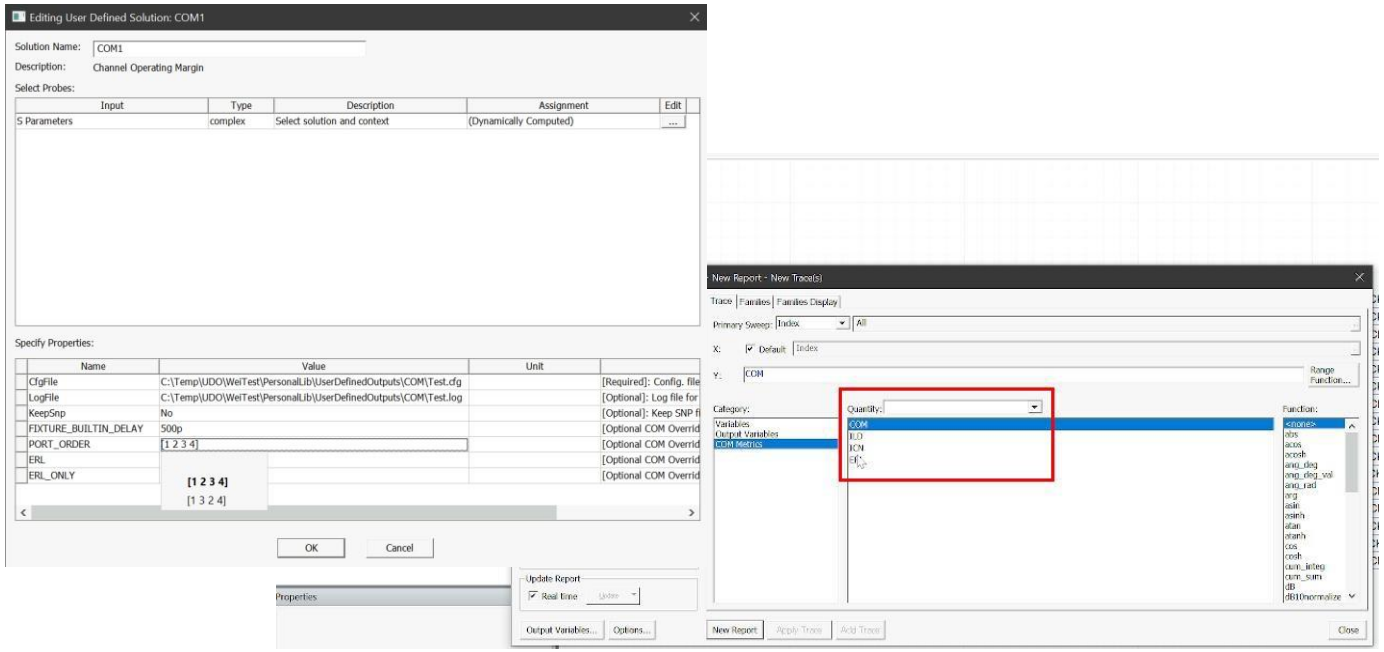
Solution:

- An UDO based approach has been developed to enable such COM based optimization flow.
- UDO flow allows easy customization and extension to support future/more COM reported metrices.

Impact:

- AEDT/HFSS users now can optimize their design based on channel performance metrices provided by SPISim's COM flow.
- Customer training materials may be prepared to introduce such flow (Contact: Isaac Waldron)
- In the long run we may include these metrices as part of AEDT core post-processing.

Silent demo video: [HERE]



launch Ansys

Data Table 1

4

	$trace_out_width [um]	ERL COM1 $d_via_antipad='0.6mm'	ERL COM1 $d_via_antipad='0.675mm'	ERL COM1 $d_via_antipad='0.825mm'	ERL COM1 $d_via_antipad='0.975mm'	ERL COM1 $d_v...
1	65.625000		13.617900			
2	96.875000					
3	100.000000					19.86...
4	128.125000				20.237700	
5	159.375000					
6	190.625000			16.547900		
7	221.875000					
8	253.125000					
9	281.689610	12.370500				
10	284.375000					

Update COM implementation to reference ver. V2.95

Motivation:

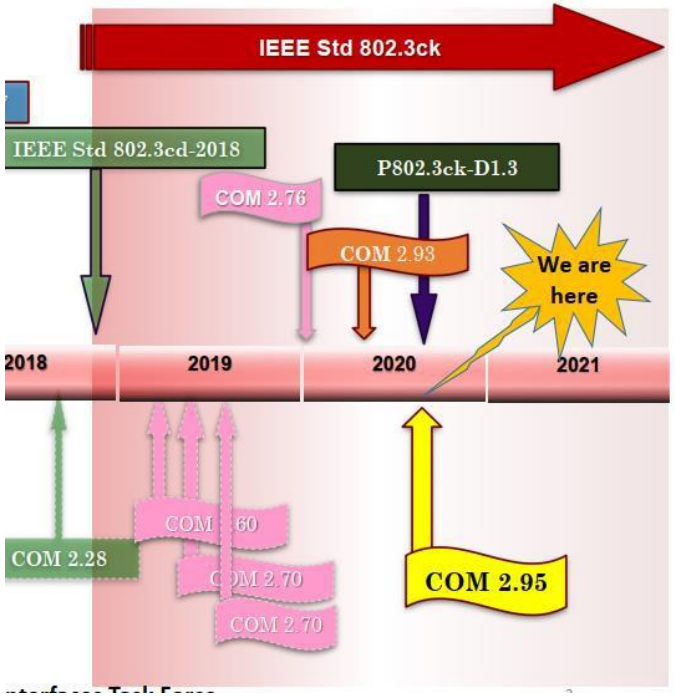
- Phase II of SPISim's COM upgrade to V2.95 (latest official 802.3ck version is V3.4) to support several important enhancement for channel analysis:
- Major enhancements:
  - Added Floating DFE taps
  - Added Eye H/W measurements (C2M), Report EW estimate
  - Board Tx/Rx structure changed
  - Include Tx package for TDR and ERL
- In addition, ~30 new keywords have also been supported.

Solution:

- Enhanced SPISim COM flow in both GUI and batch model to support V2.95 based spec. compliance checking.

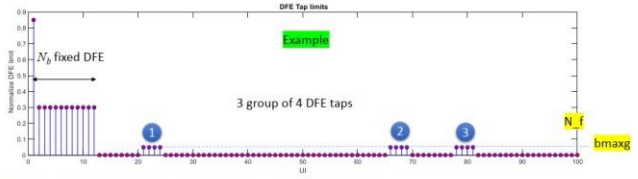
Impact:

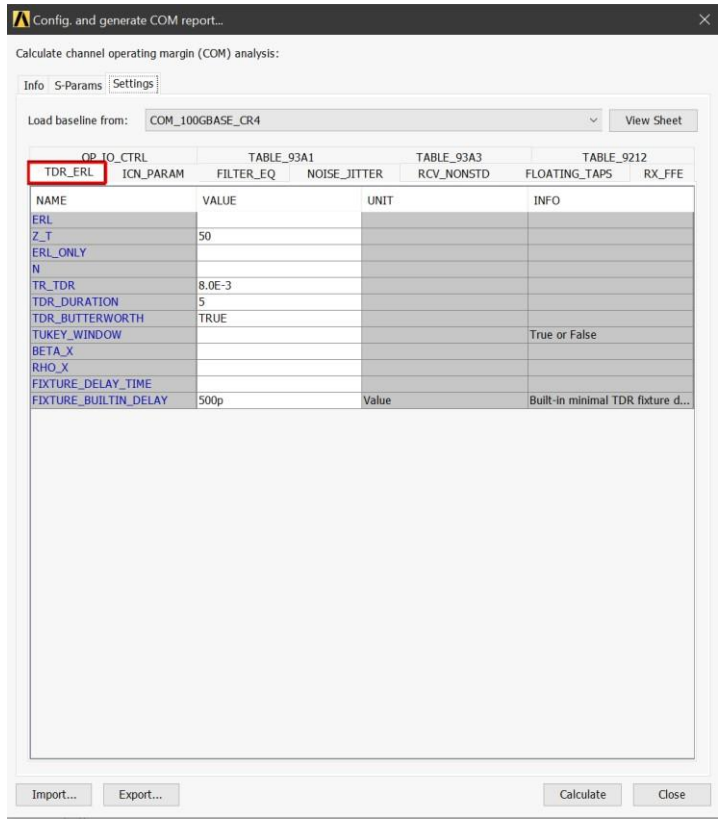
- COM can support 802.3cd and 802.3ck specs. Now
- SPISim's COM does not require Matlab's signal and RF toolbox to run, not like IEEE's reference matlab implementation.
- Accuracy: ERL, COM is < 1dB difference.



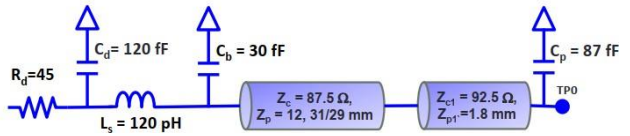
Parameters for Floating DFE Taps and Example
Values Maybe Further Refined

Floating Tap Control		
N_bg	3	0 1 2 or 3 groups
N_bf	4	taps per group
N_f	100	UI span for floating taps
bmaxg	0.1	max DFE value for floating taps





Package Proposal with LC Termination Compensation (single sided model)



Minor activity: Config. conversion utility for ACE/QA:
https://ansys.sharepoint.com/:b:/r/sites/AEDT_SPISim/Shared%20Documents/Compliance/COM/Utility/COMCfgConv.pdf?csf=1&web=1&e=bd2fEu

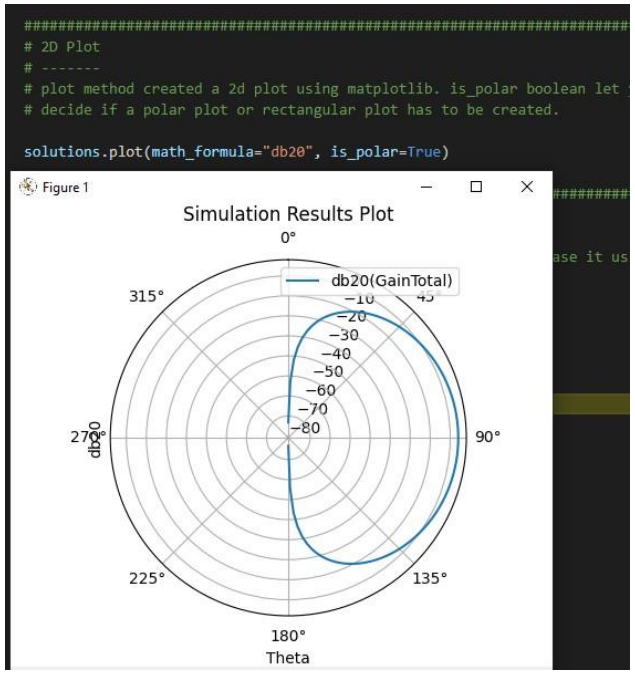
AEDT Desktop and Core

Core Framework

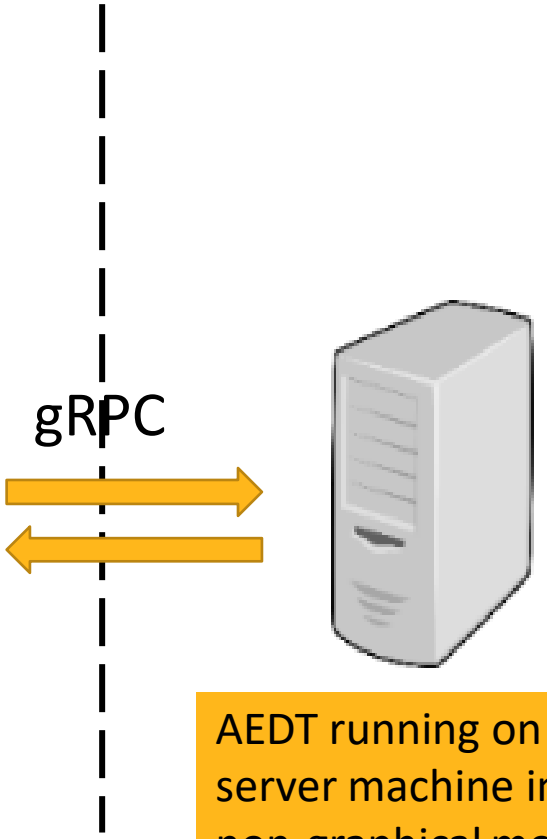
Pervasive Insights

- AEDT script execution from CPython
  - Beta feature in 2022 R2
  - Python script support on Windows in 2022 R2
  - Remote execution of AEDT on Windows or Linux through gRPC
  - All existing IronPython APIs available from CPython
  - Student version supported

- Query and Edit plot properties in non-graphical mode



Python script from client machine connects to AEDT on a remote machine

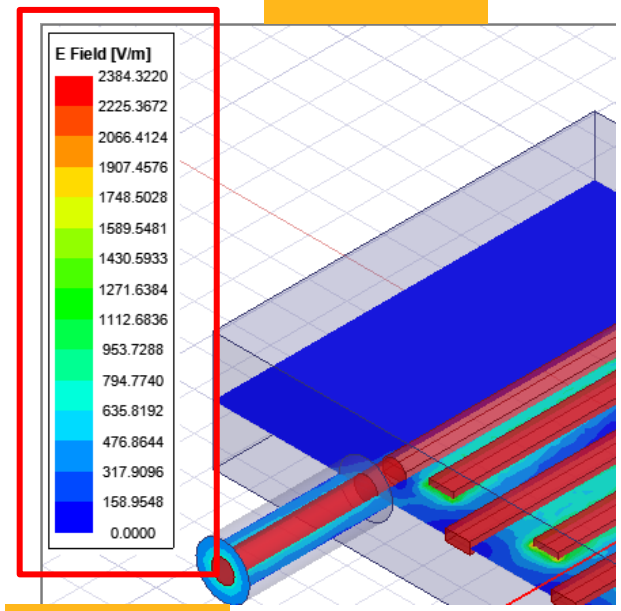


AEDT running on server machine in non-graphical mode

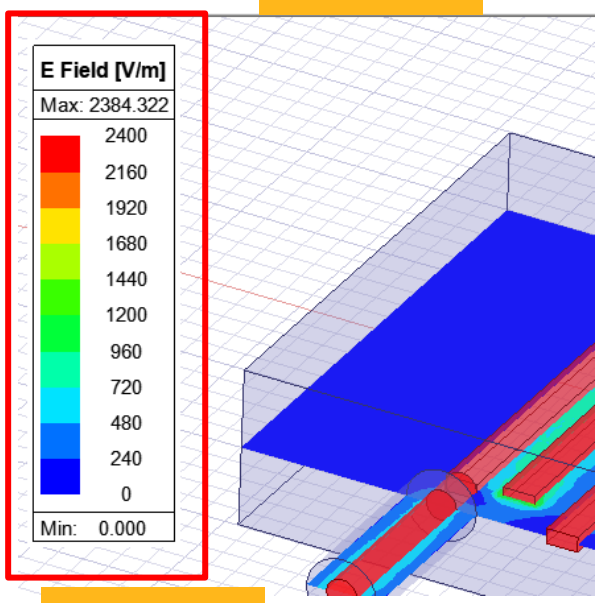
Post processing display improvements

- Rounded numbers in field plot color scale
- Redundant trailing zeros from report axes removed
- Fonts are automatically scaled based upon screen resolution
- Redundant report legend title removed

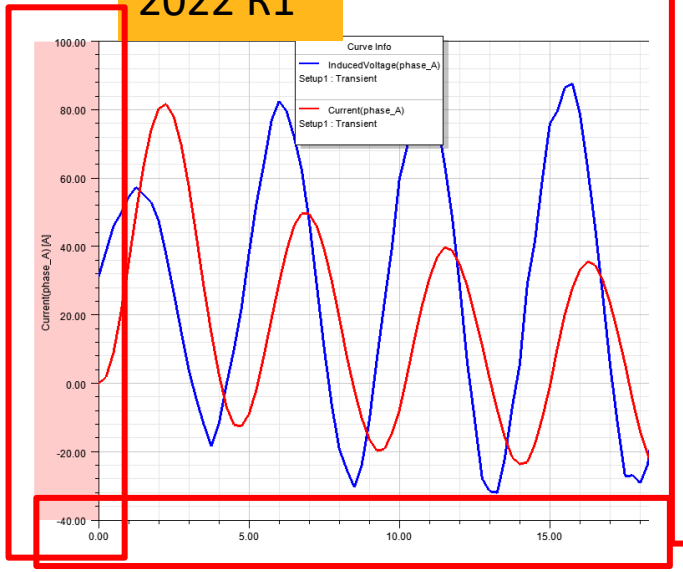
2022 R1



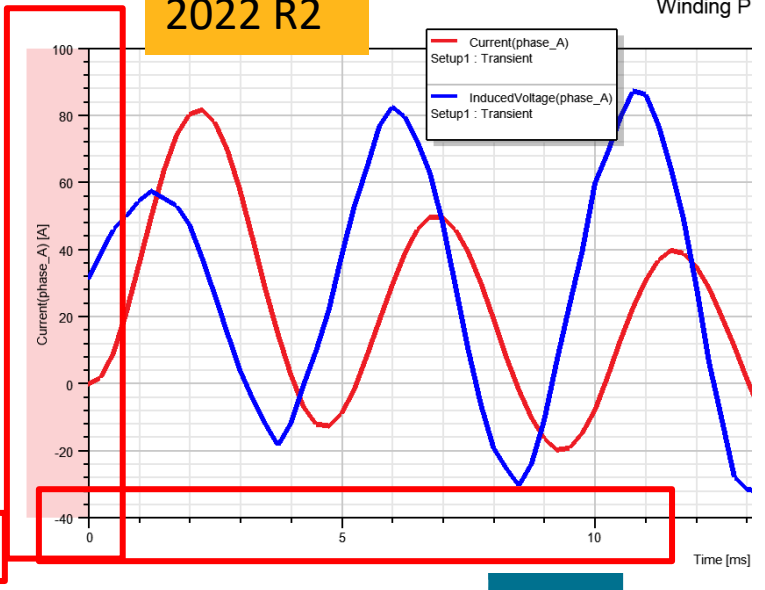
2022 R2



2022 R1



2022 R2

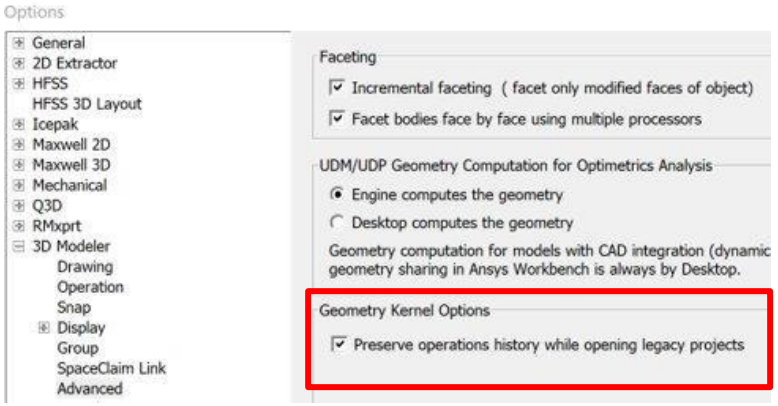


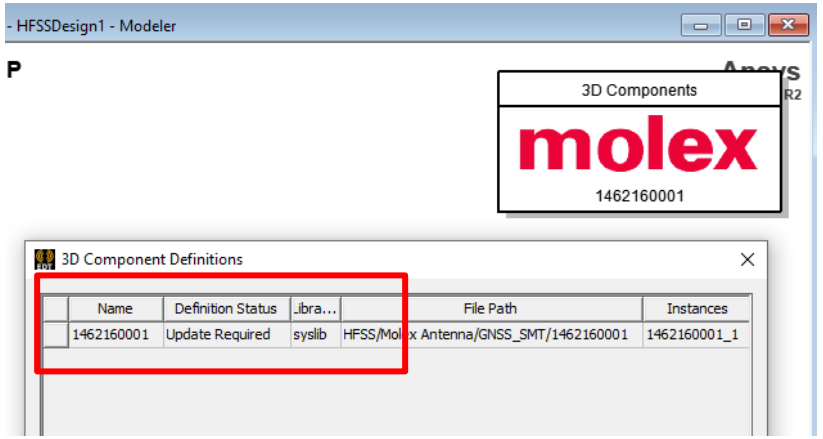
Parasolid kernel for 3D Modeler

- Beta option in 2022 R2
- All 3D Modeler functionality available
  - Except Wrap Sheet. To be supported later

- Option to migrate without model history when history migration fails
  - Geometry parametrization is lost

- Encrypted 3D components embedded in legacy projects are not translated to Parasolid
  - Marked for user to update to Parasolid version
  - Project cannot be solved until such 3D components are updated
- Non encrypted 3D components embedded in legacy projects are automatically translated to Parasolid

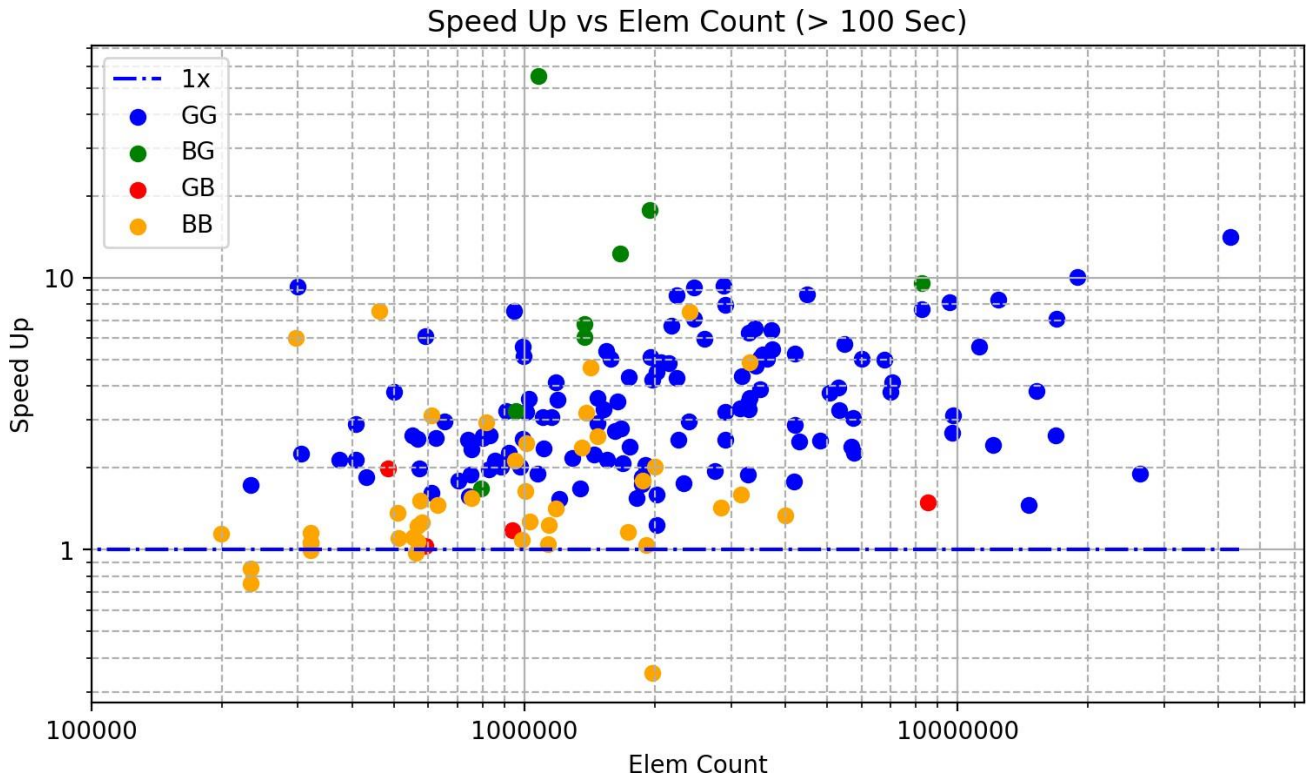


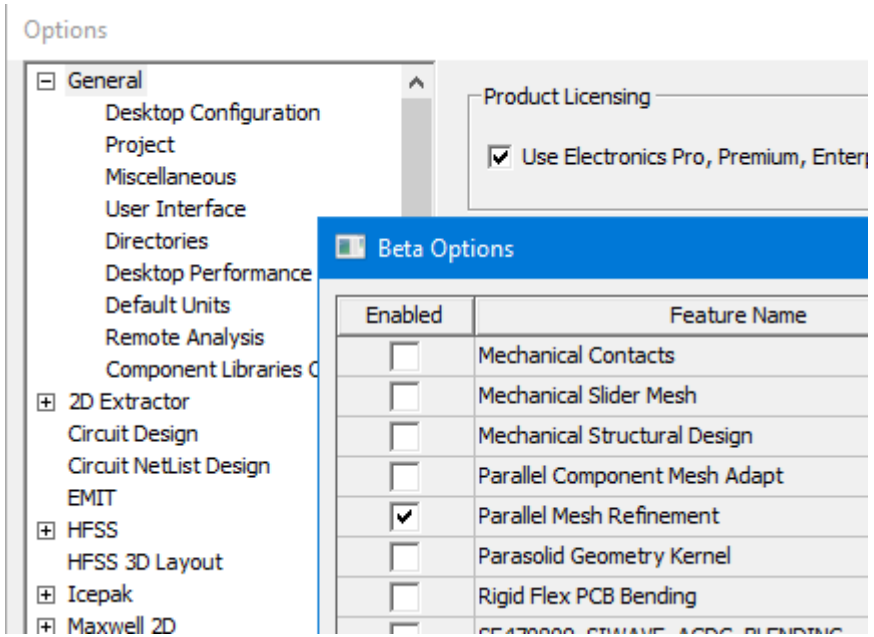


Meshing

2022R2 EBU Meshing features

- Parallel Meshing Refinement PMR [BETA]
  - Load predictor and decomposition (up-to specified # of threads)
  - PMR not supported for Q3D

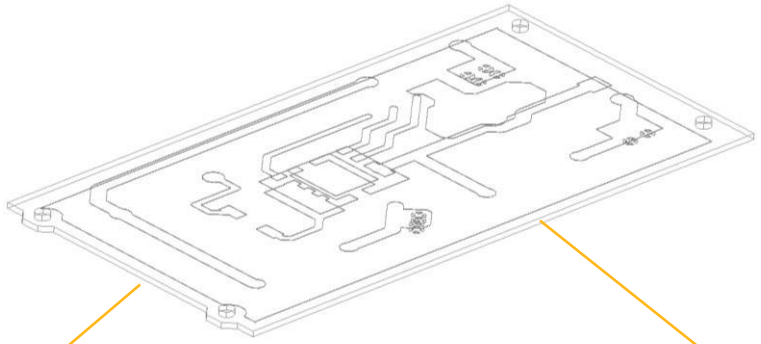




Check box in Beta Options

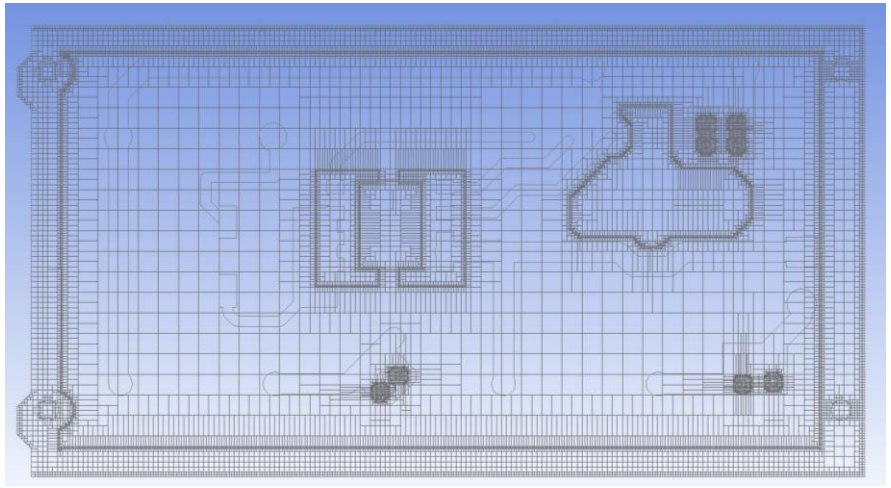
2022R2 EBU Meshing features (Cont'd)

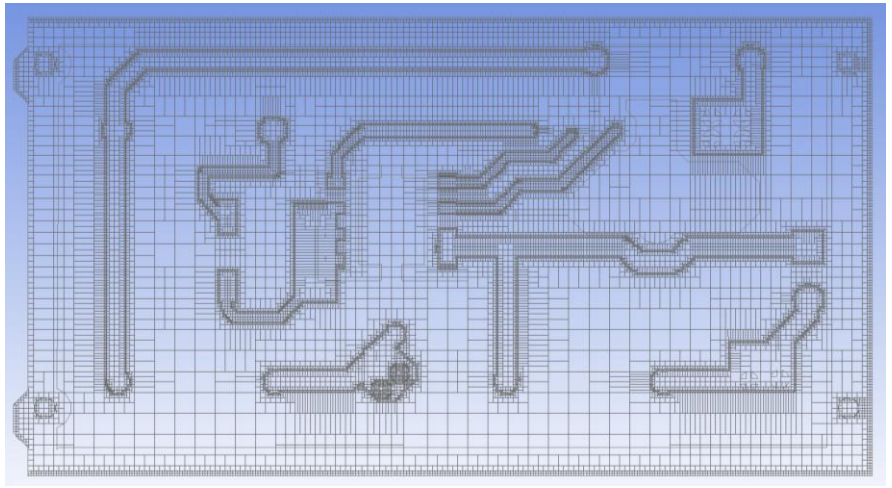
- Layer-by-layer meshing in 2D MLM
  - Auto decomposition in "thickness" direction
  - ANSYSEM_FEATURE_S425570_Icepak_Hdm_Cart2d_Blocking_ENABLE (for AEDT Icepak)

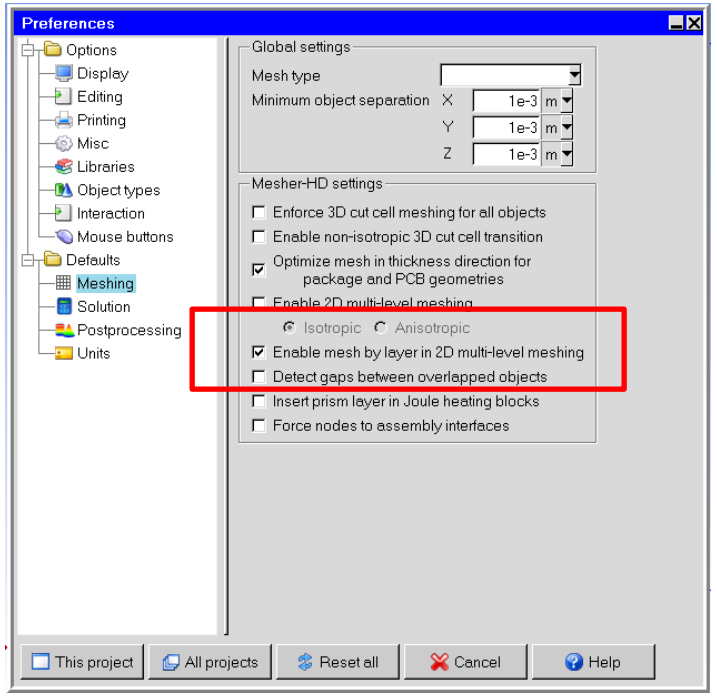


Bottom layer

Top layer



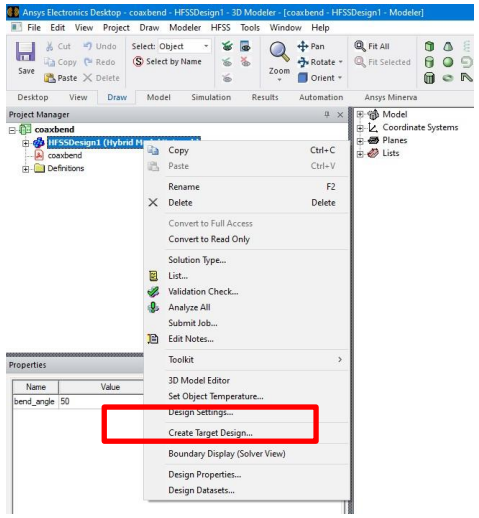


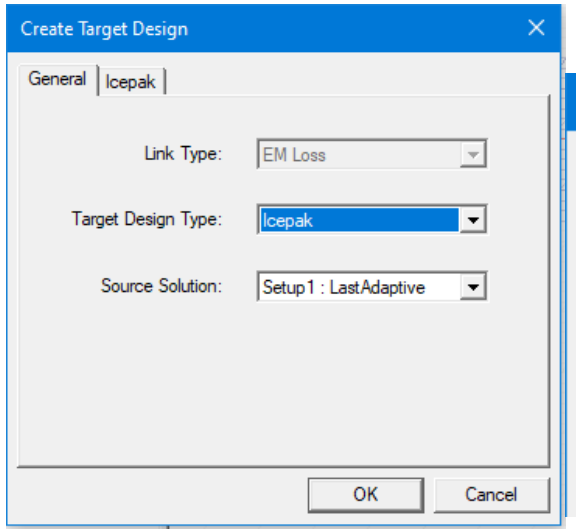


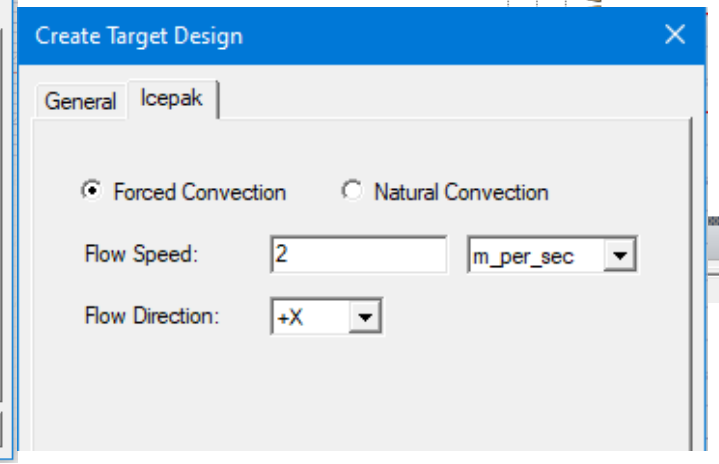
Thermal

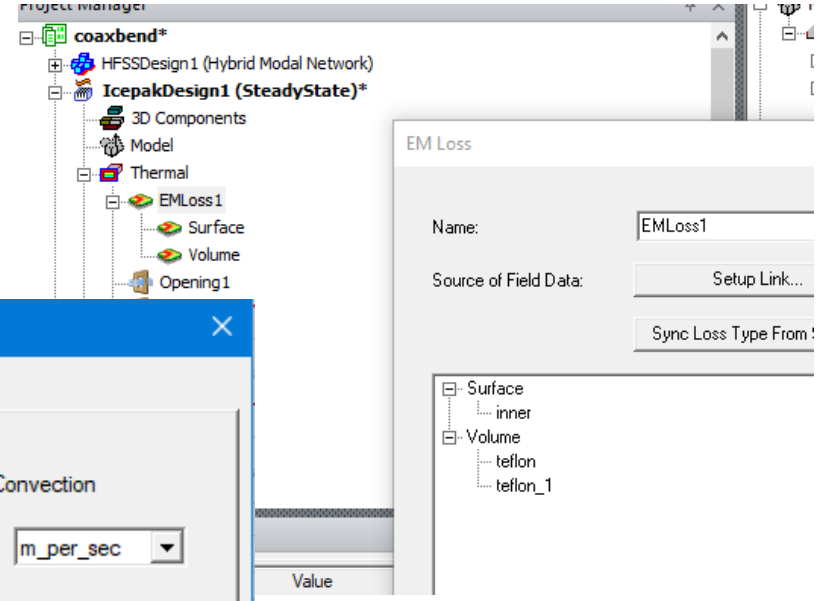
Thermal Design Creation from HFSS/Maxwell/Q3D (Beta)

- Automated creation of linked thermal design from a source EM design
  - Icepak/Mechanical target designs created
  - Source can be HFSS/Maxwell/Q3D
  - 3D components supported
- Boundary conditions and excitations created automatically
  - Forced convection & Natural convection domains (Icepak)
  - Conduction setup (Mechanical)
  - Solution setup created in ready-to-run design







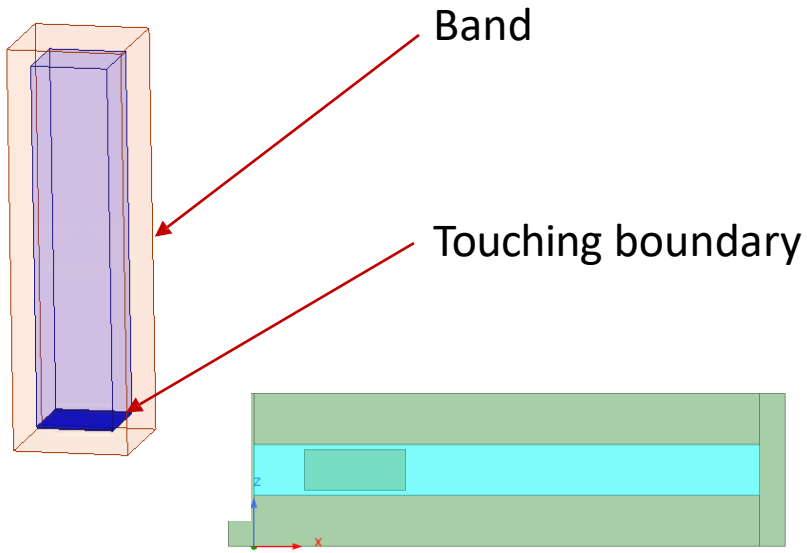


Core Technology/Solvers

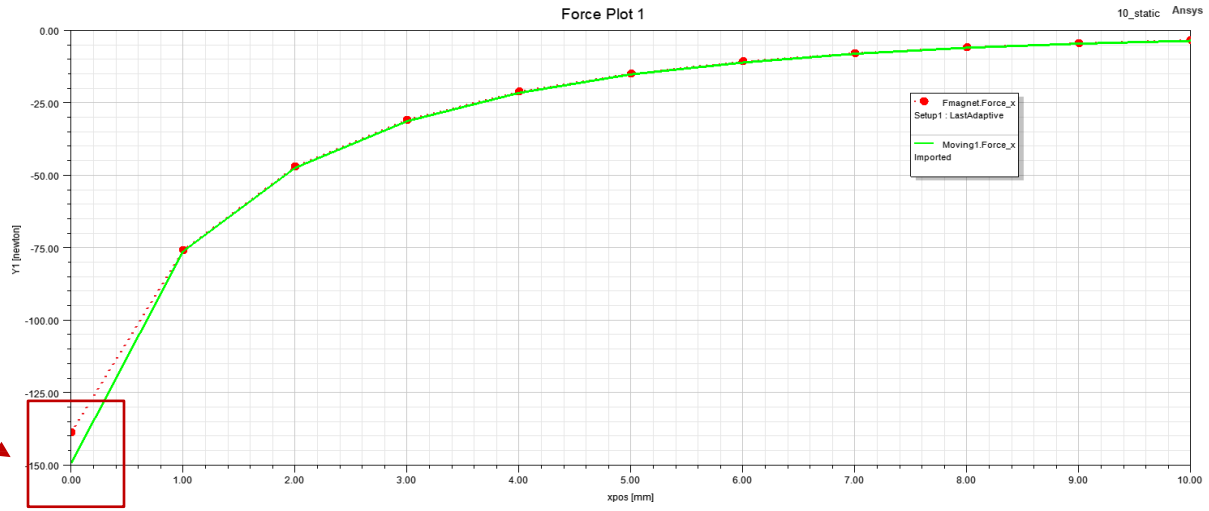
CAD-IT CONSULTANTS

Translation Motion with Moving Part Touching Stationary Part

- In simulation with non-periodic translational motion, the moving part can touch the stationary part
- Requirements of the touching boundary setup:
  - The touching boundary should be defined on the surface of the moving part.
  - At any time step, each touching boundary must either fully touches the stationary part or completely separated from the stationary part. The touching boundary can not partially touch the stationary part at any time.
  - The touching boundary can not touch the boundary of the computational region.

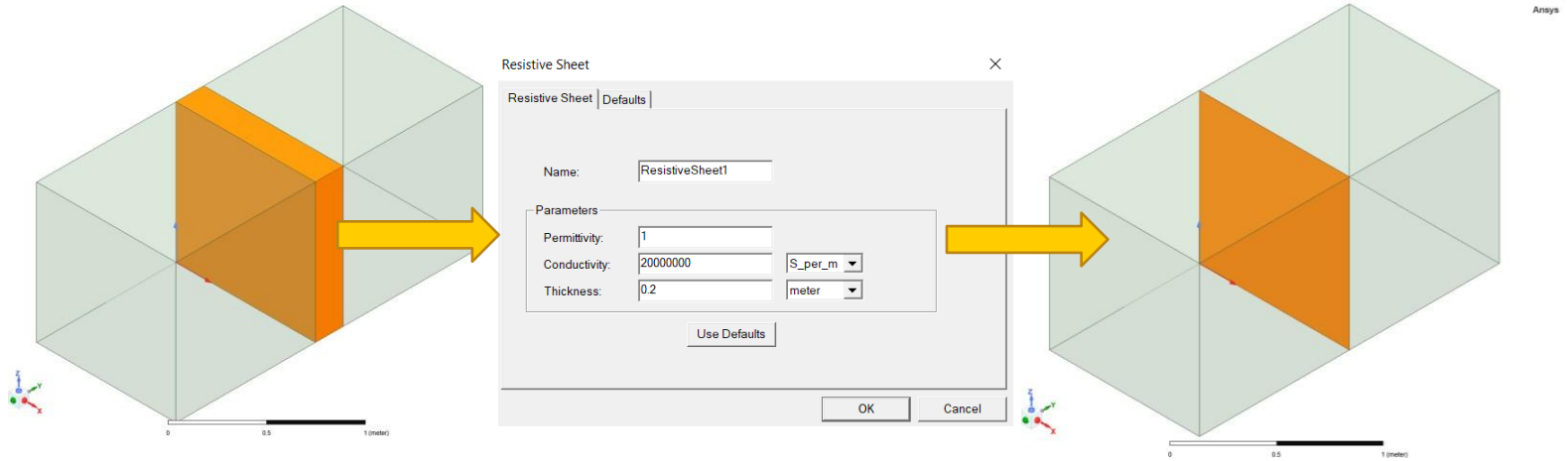


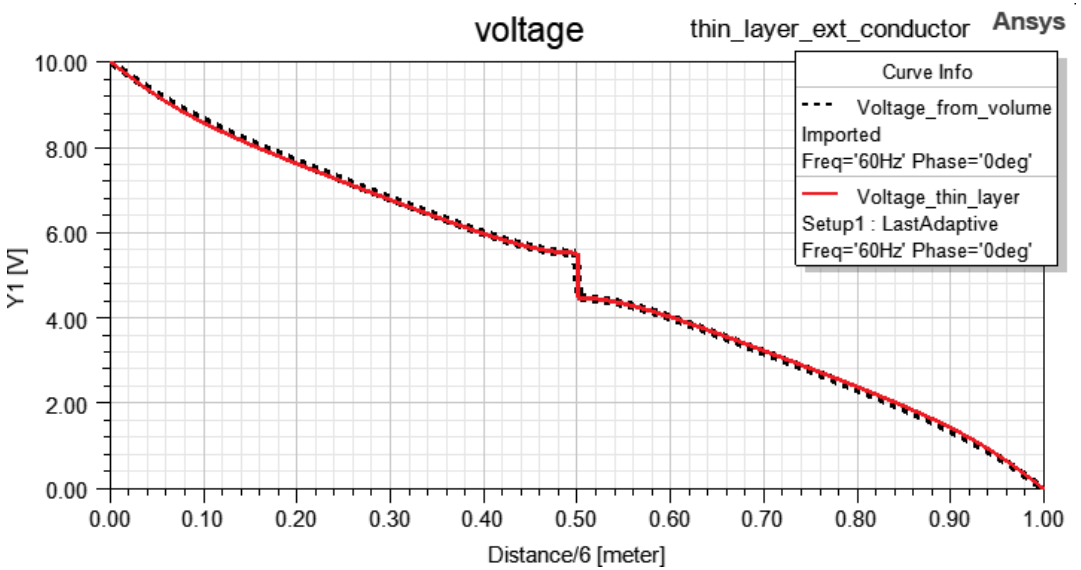
Touching case

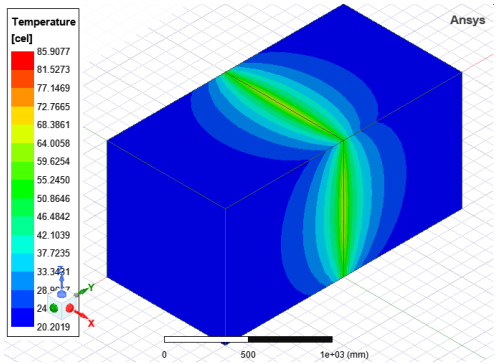


Thin Layer and Insulation Boundary for 3D AC Conduction Design

- Insulating BC
- Thin layer BC
  - Can be used to model:
    - Contact resistance: $\sigma > 0, \varepsilon_r = 1$
    - Insulation capacitive effect: $\sigma = 0, \varepsilon_r > 1$
    - Thin lossy material: $\sigma > 0, \varepsilon_r > 1$
  - Supports thermal coupling







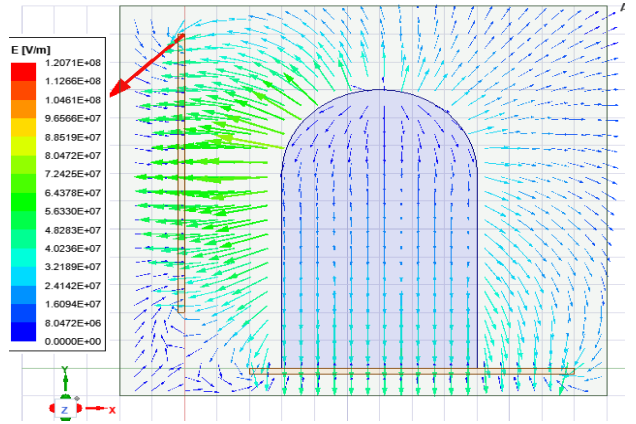
Improvements of Force Calculation in Electrostatic Solver

Surface/Volumetric force density on dielectric materials, conductors and charged objects

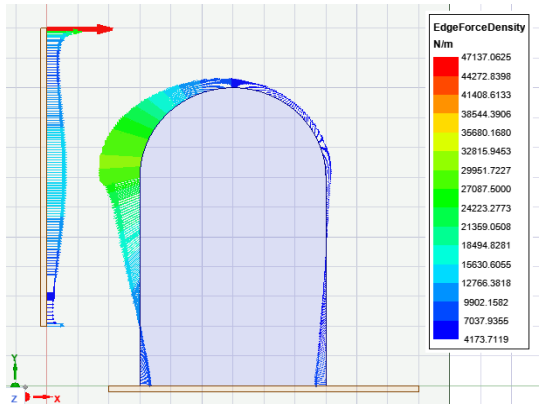
- Field display of surface/volumetric force density

One-way force coupling in WB/AEDT

- Support one-way Maxwell-Mechanical force coupling: surface force density and volumetric force density



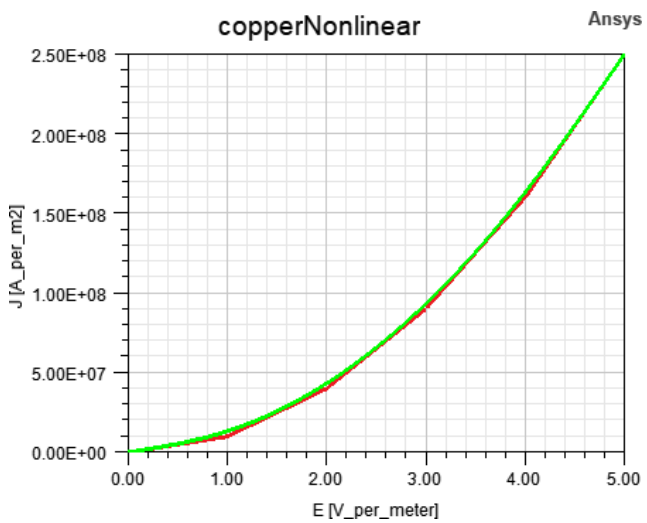
E field

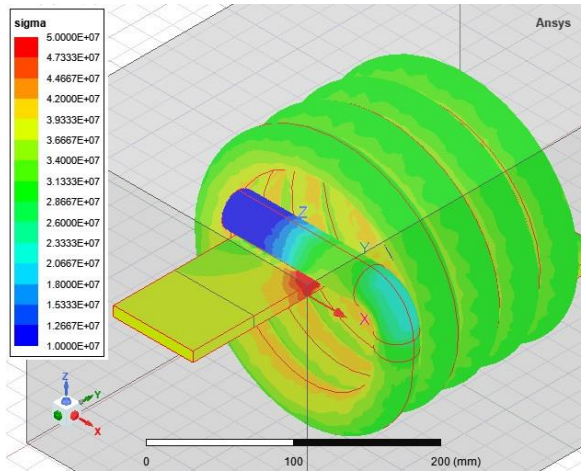


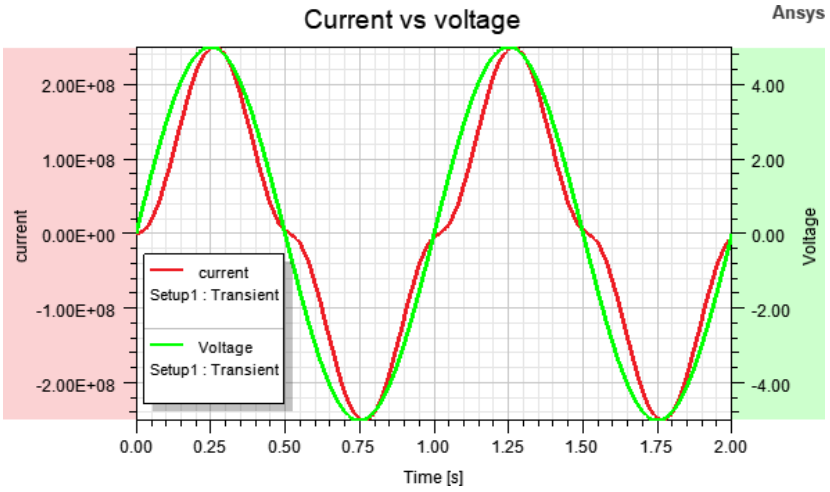
Surface force density distribution

Nonlinear Material for the Electric Transient Solution

- Motivation
  - Semi-conductor and high-voltage industries
- Proposed method
  - The non-linear model was included in the Rosenbrock time-integration scheme
  - Non-linear iterations are not necessary
  - Keep the time interpolation capability for the fields
  - Supports only σ non-linear







Element-Based Harmonic Force Export in .CSV File

Element-Based volumetric harmonic force density export in CSV file with 3D transient

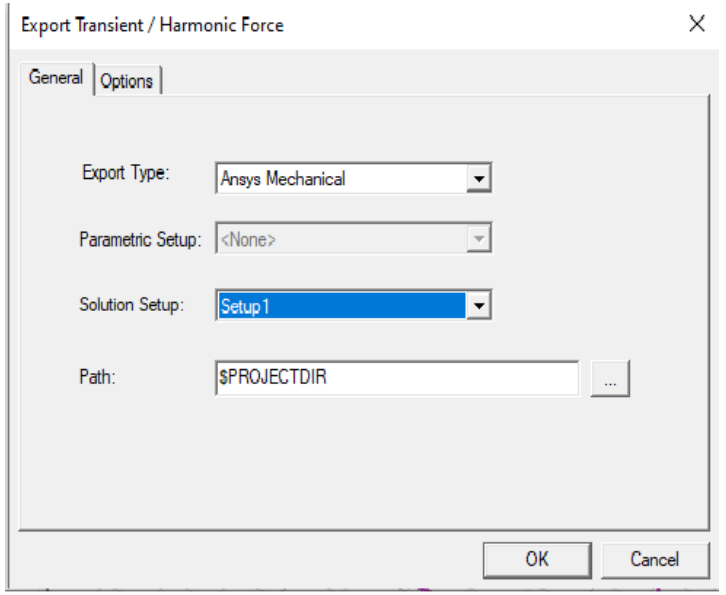
- Export file in post processing: one solving, multiple exports
- Flexible frequency range
- Support variable time step
- Support TDM, Partial model
- One line for one element, multiple frequencies

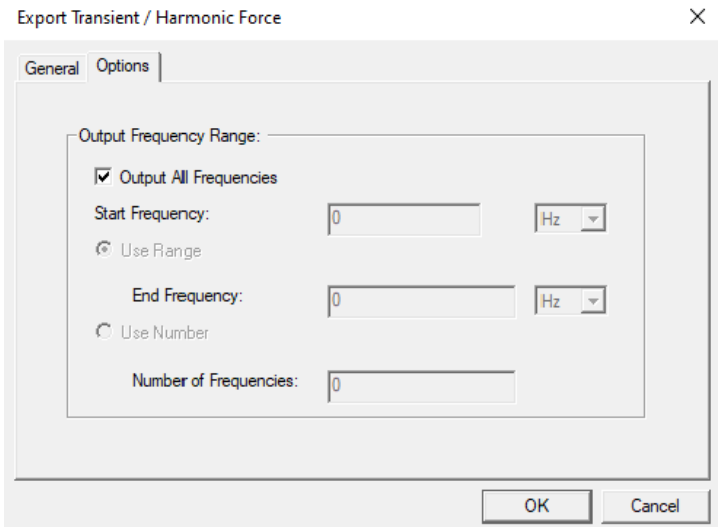
Mapping is done by Mechanical

- Better mapping solution in PCB applications
- Import as external loads in Mechanical

Limitations:

- Only available for 3D transient, element-based volumetric harmonic force



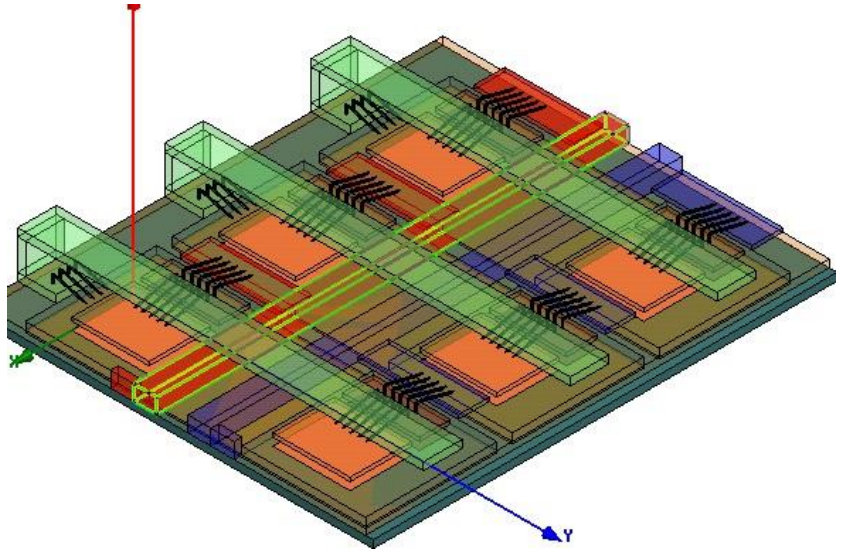


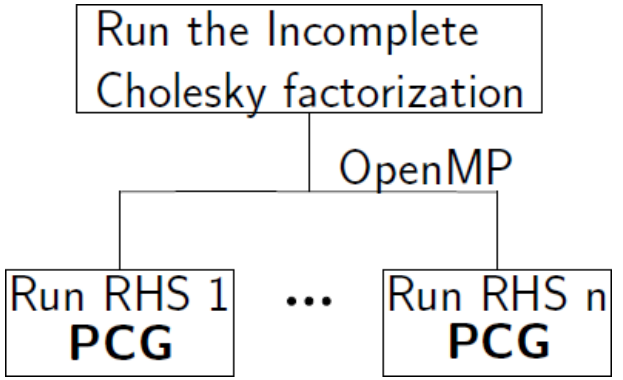
High Performance Computing

CAD-IT CONSULTANTS

3D Electrostatic - Capacitance Matrix Extraction

- Shared Memory Parallel Iterative solver to speed-up capacitance matrix extraction
- Motivation:
  - Need to speed-up capacitance matrix extraction for large matrices
  - Several right-hand-side (RHS's):
    Solve the linear system "RHS" times
  - Large number of DoFs
  - Computation time and memory improvements
- Proposed method:
  - The preconditioner only needs to run once
  - Memory proportional to the number of parallel threads
  - Trade-off between computation time and memory
  - Uses the general Preconditioned Conjugate Gradient (PCG) algorithm in parallel



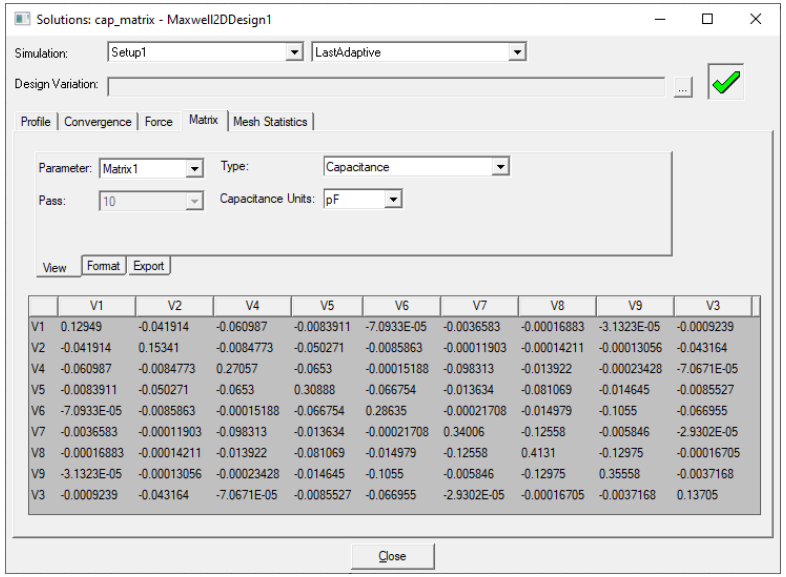


3D Electrostatic - Capacitance Matrix Extraction

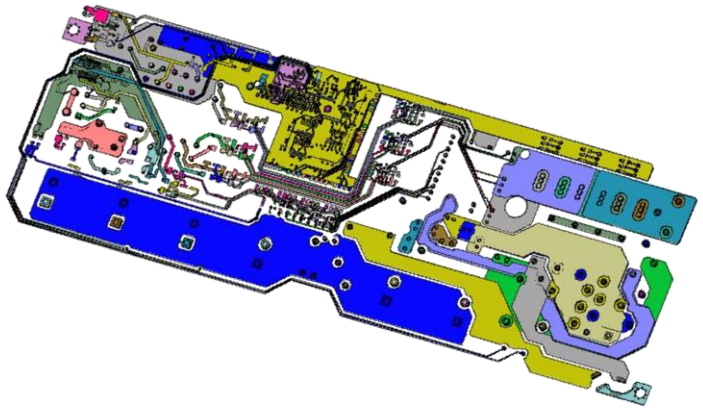
- Benchmark Results > 10x speed up for some cases

	Case A-1		Case A-2		Case A-3		Case A-4		Case B	
NZ	4.6E+07		1.5E+07		4.6E+07		1.5E+07		4.7E+07	
DoF	3.3E+06		1.1E+06		3.3E+06		1.1E+06		3.5E+06	
RHS	108		108		108		108		4	
Cores	8		8		32		32		32	
Method	Time	Mem.	Time	Mem.	Time	Mem.	Time	Mem.	Time	Mem.
PCG Serial	106	1.91	30	0.6	107	1.91	30	0.6	10	2
Direct Serial	14	31.9	3	10.5	14	37	3	10.5	4	18
BLPCG	210	23.3	49	7.6	74	21.3	18	7.6	7	2.9
PCG Parallel	9	5.7	2	1.86	5	9.24	1	3	3	2.7

Times are in minutes and memory in GB.



	V1	V2	V4	V5	V6	V7	V8	V9	V3
V1	0.12949	-0.041914	-0.060987	-0.0083911	-7.0933E-05	-0.0036583	-0.00016883	-3.1323E-05	-0.0009239
V2	-0.041914	0.15341	-0.0084773	-0.050271	-0.0085863	-0.00011903	-0.00014211	-0.00013056	-0.043164
V4	-0.060987	-0.0084773	0.27057	-0.0653	-0.00015188	-0.098313	-0.013922	-0.00023428	-7.0671E-05
V5	-0.0083911	-0.050271	-0.0653	0.30888	-0.066754	-0.013634	-0.081069	-0.014645	-0.0085527
V6	-7.0933E-05	-0.0085863	-0.00015188	-0.066754	0.28635	-0.00021708	-0.014979	-0.1055	-0.066955
V7	-0.0036583	-0.00011903	-0.098313	-0.013634	-0.00021708	0.34006	-0.12558	-0.005846	-2.9302E-05
V8	-0.00016883	-0.00014211	-0.013922	-0.081069	-0.014979	-0.12558	0.4131	-0.12975	-0.00016705
V9	-3.1323E-05	-0.00013056	-0.00023428	-0.014645	-0.1055	-0.005846	-0.12975	0.35558	-0.0037168
V3	-0.0009239	-0.043164	-7.0671E-05	-0.0085527	-0.066955	-2.9302E-05	-0.00016705	-0.0037168	0.13705



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