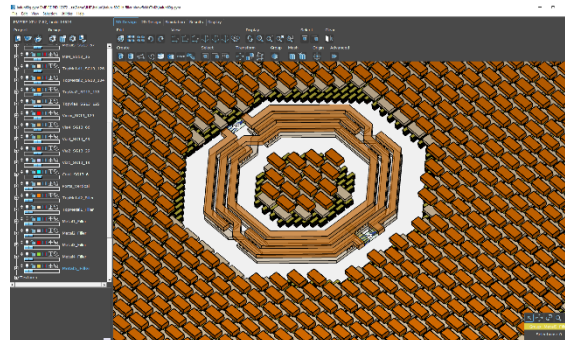
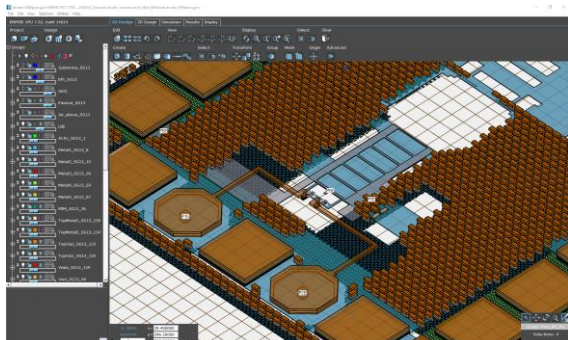




# Empire XPU: 3D EM for RFIC

**EMPIRE XPU is a high performance, high speed 3D RF EM solver. It is FASTER than other 3D EM solvers by using a unique on-the-fly code generation.**

Instead of using a pre-built solver engine designed for average engineering PCs, EMPIRE XPU will generate a solver on-the-fly that is optimized for your actual target system and simulation task. This results in impressive FDTD performance on high-end CPUs, much faster than other 3D EM solvers.



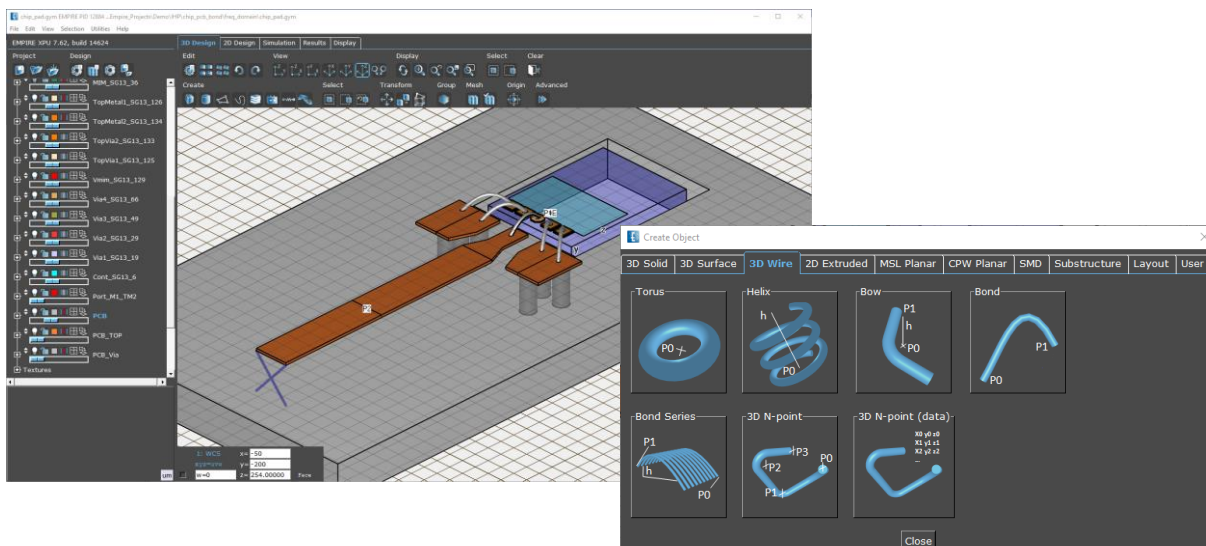
RFIC related applications of EMPIRE XPU include:

- RFIC layouts with large polygon count, e.g. patterned grounds, via arrays or analysis of filler structure influence
- Electrically large structures at mm-wave frequencies, e.g. on-chip antennas with lenses and chip environment
- RF package modelling, wire bonding, eWLB
- and other challenging designs where other EM simulation tools hit the limits for memory requirement or simulation time.

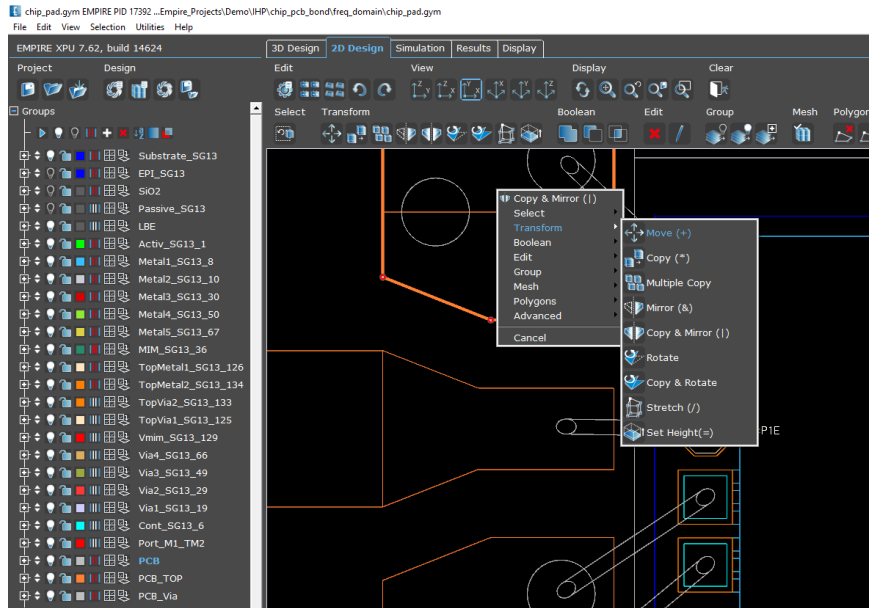
## The perfect tool for mixed planar + 3D EM work

With integrated **3D and 2D editors**, EMPIRE XPU supports efficient modelling of mixed planar + 3D designs.

**Predefined templates for your technology** enable very fast and efficient modelling from GDSII files, very similar to 2.5D EM solvers: select the technology template, load a GDSII file and your model is almost complete.



For 2D layout features, switch to 2D editor mode for powerful layout editing features.



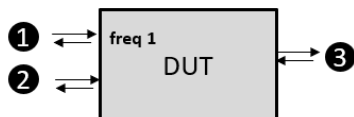
## Time domain simulation, frequency domain results

Empires solver is based on FDTD, which is a time domain simulation method. Frequency domain results (S-Parameters) are created automatically from the time domain data, resulting in wideband results from a single solver run.

The comparison below shows the internal difference to frequency domain methods. In frequency domain, the solver needs to calculate all frequencies of interest, one after another. In time domain, we excite one port at a time, and get the full frequency sweep for that excitation.

### Method of Moments, FEM

- Frequency domain solver
- Full S-Matrix for one frequency

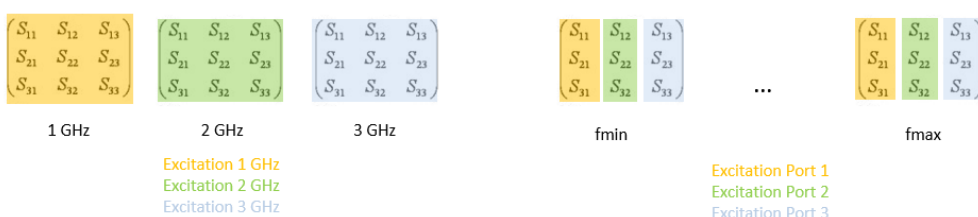


### FDTD

- Time domain solver, pulse excitation
- One column of S-matrix for complete frequency range



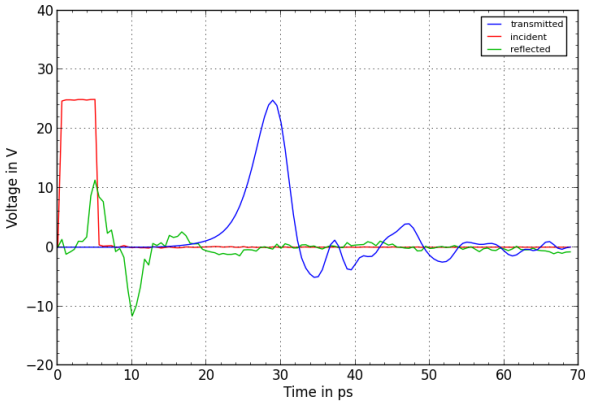
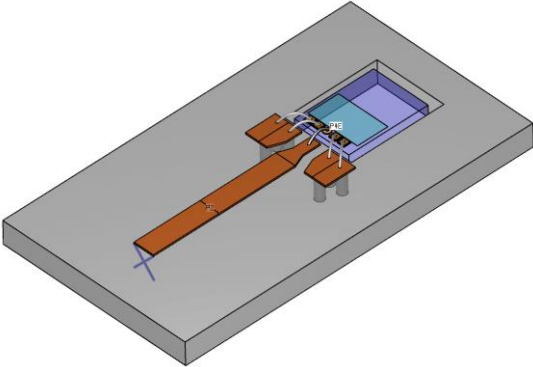
FFT time domain -> frequency domain



Example for multi-port circuits: excitation at port  $n$  will provide results for reflection  $S_{nn}$  and all transmission from port  $n$  to all other ports. This might be sufficient to analyze filters and divider, or cross talk. Only if the full S matrix is needed, all excitations at all ports must be calculated.

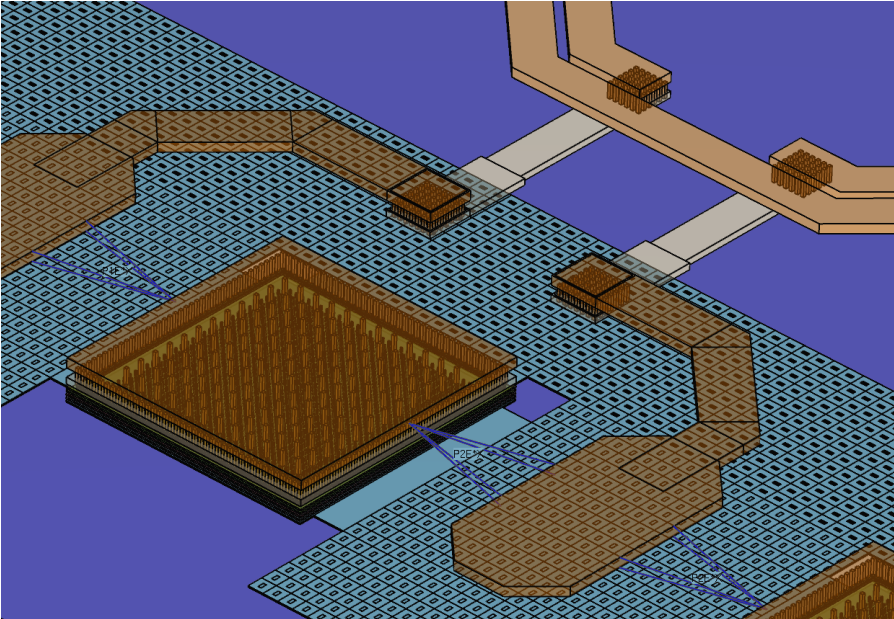
### Evaluate time domain results

In some cases, it is also useful to study the time domain results directly. One example is optimization of a chip-to-board transition where TDR (time domain reflectometry) helps to identify the actual location of discontinuities. The excitation pulse shape can be defined as needed.



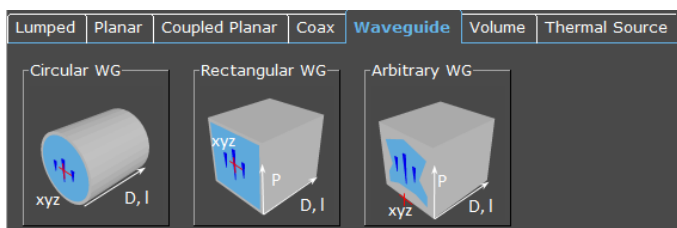
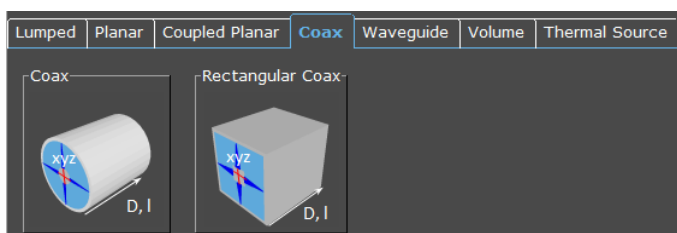
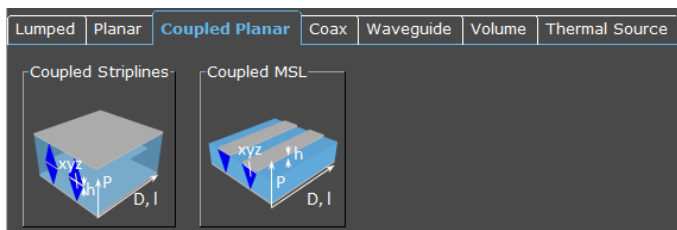
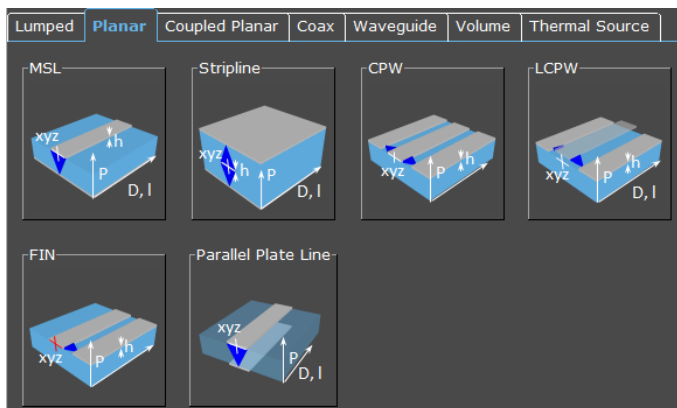
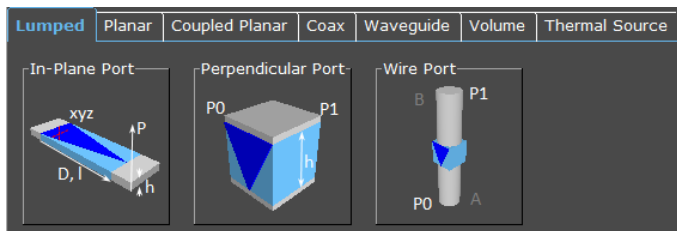
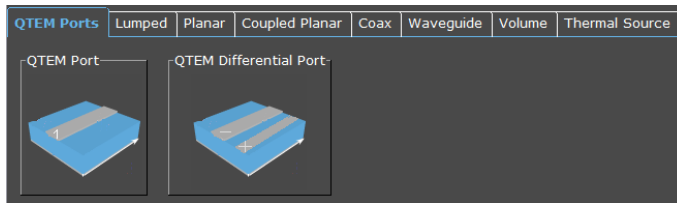
### High simulation speed – Include more realistic details

Empire XPU requires much less memory for large models than FEM solvers, and is much faster than other FDTD solvers. This allows create more realistic simulation models, with less need for simplification of via arrays or slotted metal planes.



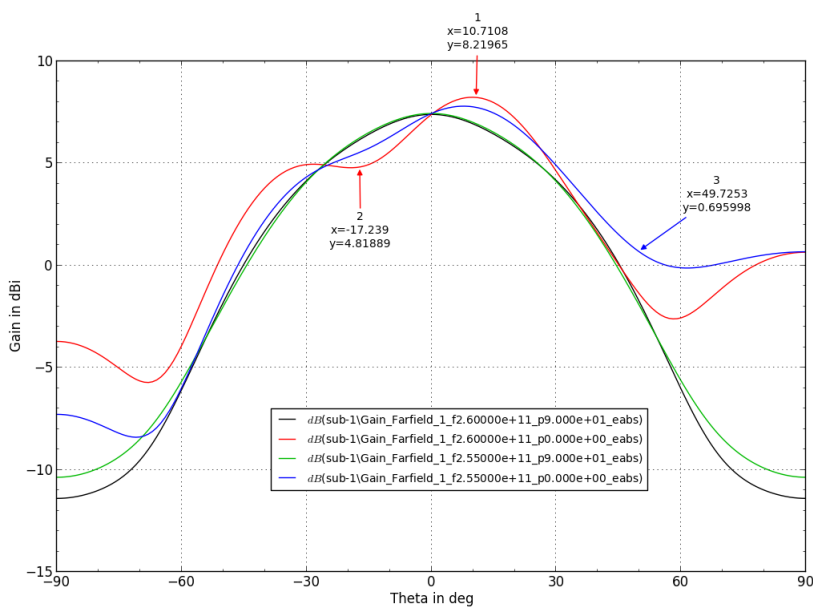
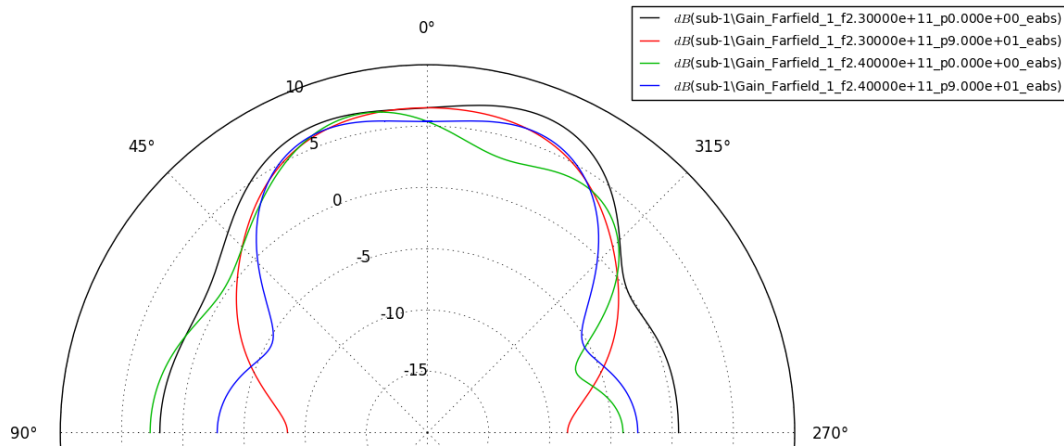
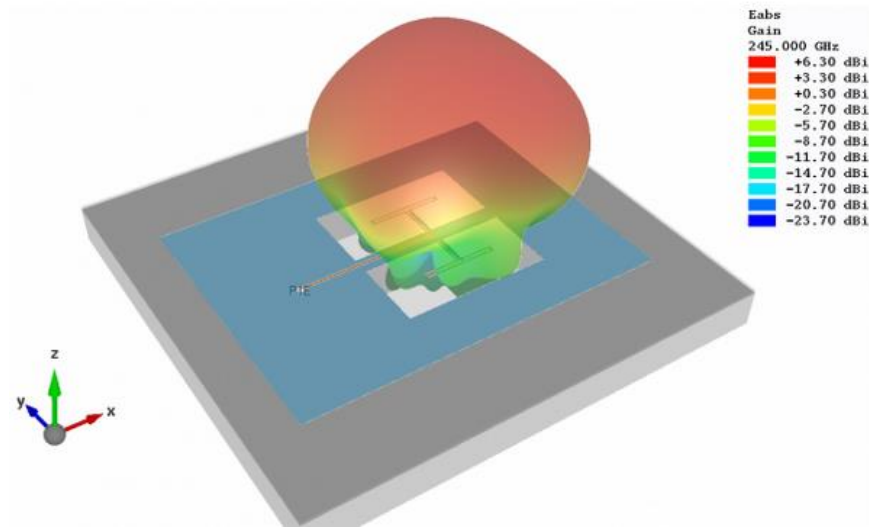
## Port Excitation

Empire offers a wide range of port excitation, both generic and for specific transmission line type.



# Antenna Pattern

Empire offers a wide range of antenna pattern calculations. Antenna diagrams can be visualized as 3D patterns or 2D plots.



## Thermal Solver

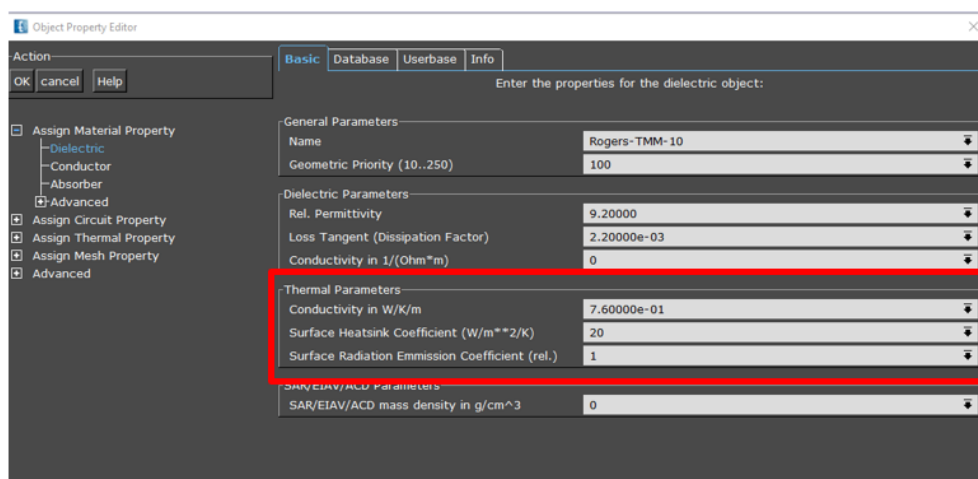
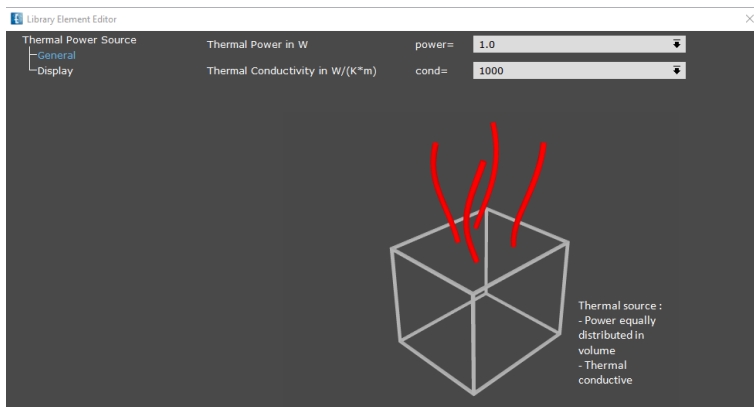
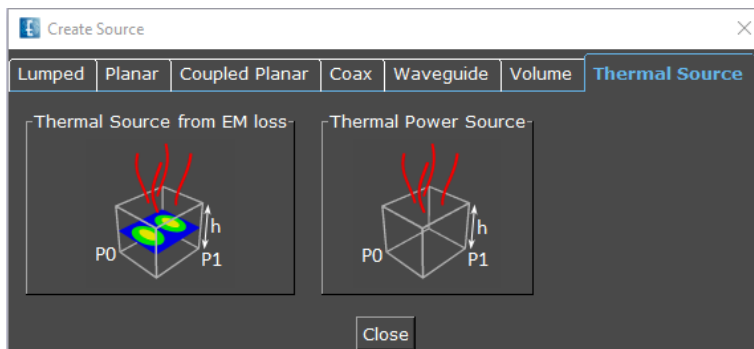
A thermal solver option is available for Empire XPU. This thermal solver calculates the static solution.

The thermal solver supports

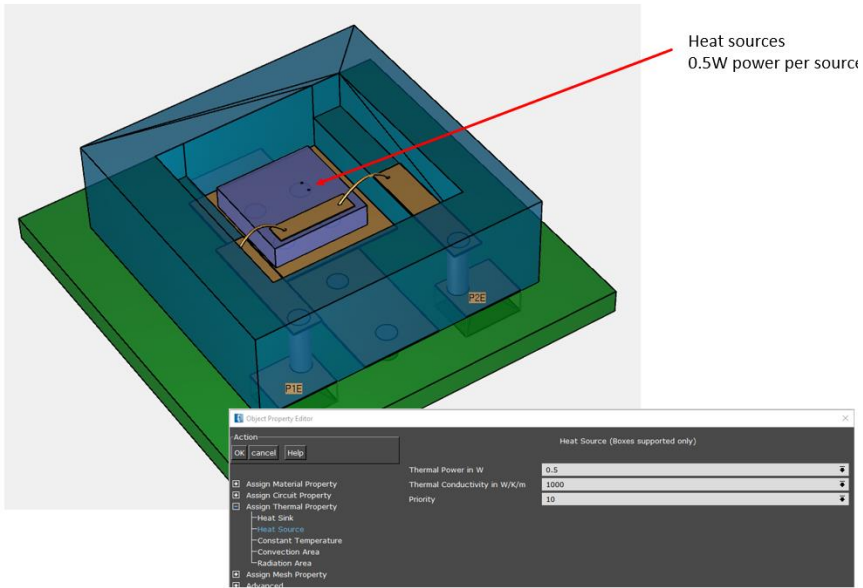
- heat sinks
- convection
- radiation cooling
- fixed temperature areas
- fixed temperature boundaries

Supported thermal sources:

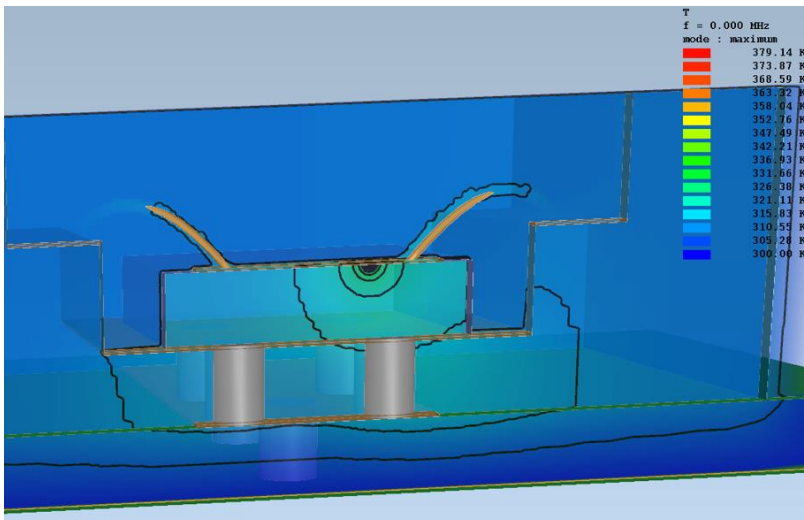
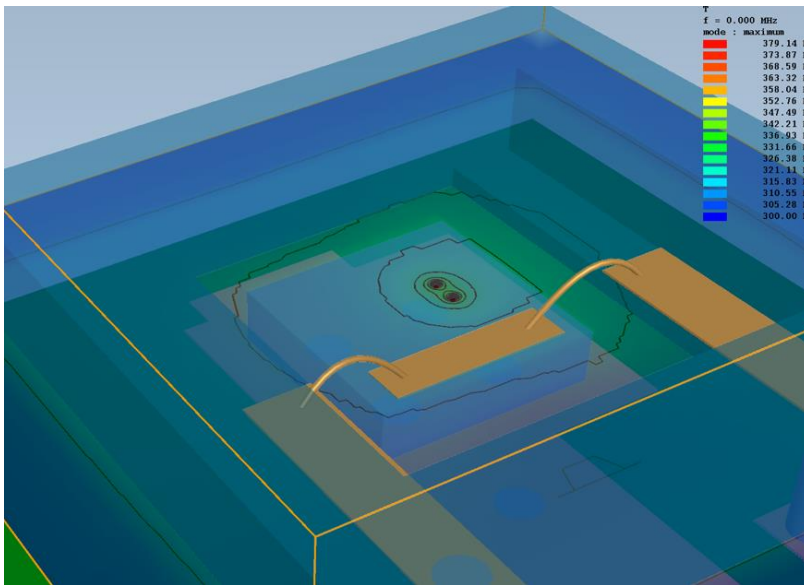
- constant power
- loss power from EM simulation
- constant temperature



- thermal cond.
- convection
- radiation



Static thermal solution:



## Empire XPU System Requirements

Empire XPU is available for Windows and Linux platforms. Recommended OS versions:

- Windows 7, 10, 64 bit
- Windows Server 64 bit
- Fedora 11, Ubuntu 14, RHEL 7, 64bit

## Geometry Import & Export

The editor includes, at no extra cost, import & export for these files formats:

- GDSII
- DXF
- Gerber
- STL (3D)

EM models from **CST** and **HFSS** can be imported, with most material properties automatically converted to Empire. This import is based on the ACIS file format and requires a license for ACIS import/export.

Various **3D CAD file formats** are supported for import and/or export, see [Empire Specification](#). These require a separate license at extra cost.

## License Features and Bundles

For RFIC work, the most relevant license features are:

**EMP\_ED:** User interface with 2D and 3D Editor and viewer, import and export formats: DXF, GDSII, Gerber, STL

**EMP\_SO:** FDTD solver, multi-core, multi CPU support, on single PC

**EMP\_MW:** Solver for TE + TM Waveguide Modes

**EMP\_FT:** Antenna pattern calculation

**EMP\_TS:** Thermal solver

**EMP\_OP:** Optimizer

Parameter sweep is already included in the regular EMP\_SO license option. Feature EMP\_OP is required only for automated optimization.

**EMP\_RC:** Solver remote control, to send simulation jobs to another machine over the network. The remote solver requires a floating or node locked license (license feature EMP\_SO).

**ACS:** Import & Export for the ACIS 3D CAD data file format. This license is required for 3D model import from CST and HFSS.

**EMP\_SP: Empire XPU Silver Package:**

This license bundle includes features EMP\_ED and EMP\_SO.

**EMP\_GP: Empire XPU Gold Package:**

This license bundle includes features EMP\_ED, EMP\_SO, EMP\_MW, EMP\_OP, EMP\_RC, ACS, SAR calculation and circuit simulation option.



Your value added reseller for Empire XPU,  
specialized in RFIC EM simulations:

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58455 Witten  
Germany

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