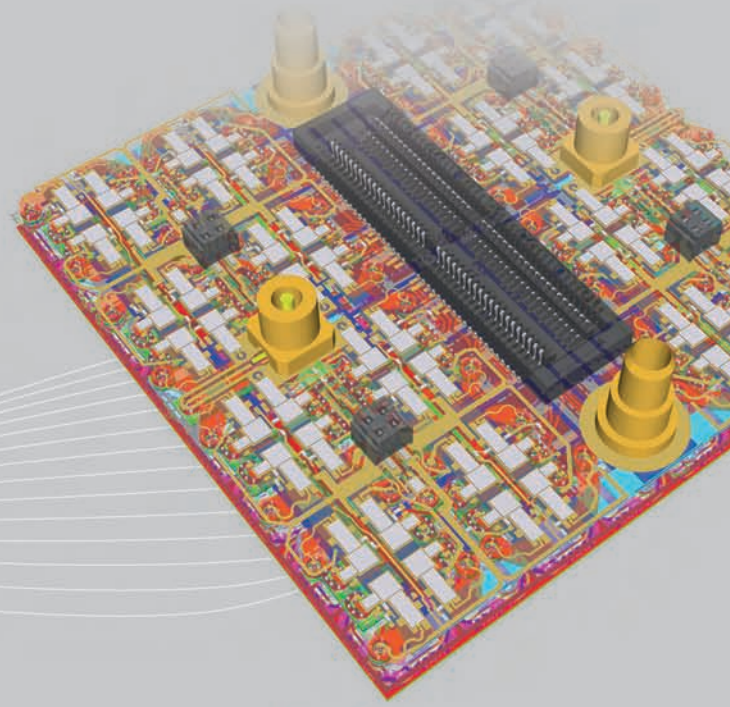
THE MORE EFFECTIVE 3D-EM SIMULATION TOOL

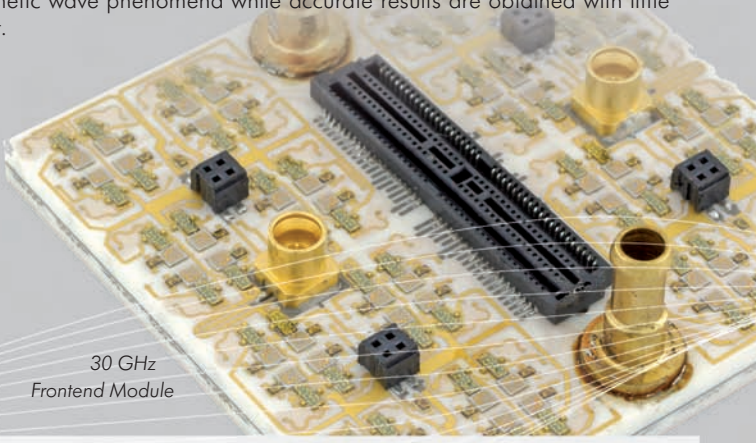
→ EMPIRE XCcel™



IMST

EMPIRE™ XCcel

EMPIRE XCcel's applicability ranges from analyzing planar, multi-layered and conformal circuits, components and antennas to multi-pin packages, wave-guides, and SI/EMC problems including the device's operational environment. Time signals, scattering parameters, and field animations are generated accurately for a broad frequency range within only one simulation run. Monitoring and animation capabilities give physical insight into electromagnetic wave phenomena while accurate results are obtained with little effort.



30 GHz
Frontend Module

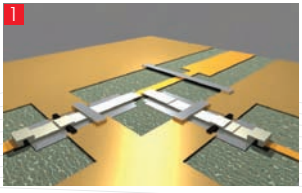
Features:

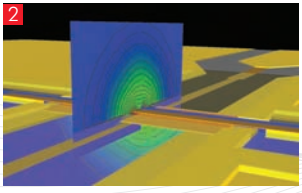
- Easy-to-use structure editor optimized for a fast model set up
- Import, export and modification of 2D layout data and 3D CAD data
- Automatic and user-controlled meshing including fast 3D mesh viewing
- Parametric geometry and parametric physical properties
- Library elements for various ports and objects
- Condensed ports for embedding active devices
- Plane wave, multiple port, hollow waveguide excitation
- Perfect Geometry Approximation (PGA) for curved and off-axis structures
- Batch job queuing, parameter sweep and optimization
- Smart signal processing and automatic post processing
- 3D near and far field visualization and animation
- Job distribution (Remote control) and job sharing (Cluster solver) capability

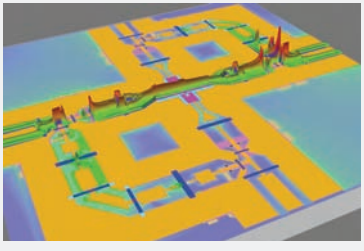
MULTI-LAYERED COMPONENTS

The accurate electrical characterization of planar and multi-layered components, like junctions, discontinuities, feedthrus or lumped elements becomes more and more important in the design of microwave circuits. Only a full 3D-field solver can accurately determine the electromagnetic behavior for high frequencies.

Because of the frequency dependence of quasi-TEM modes, the excitation is challenging for conventional time domain solvers. For this task, EMPIRE features a ‚matched' source which excites the structure correctly over the whole frequency range.



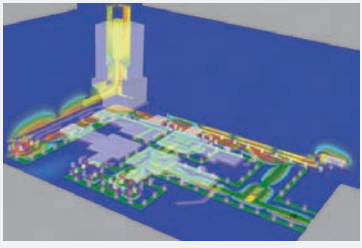




MEMS switching configuration designed with EMPIRE XCcel™. RF cross (pict. 2) and MEMS single-pole double-throw (SPDT) switch (pict. 1) are shown in detail.

FEATURES

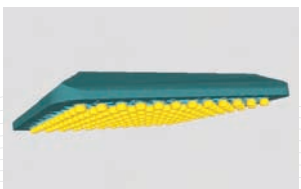
- Fast and accurate frequency dependent loss models
- Distributed and lumped RLC elements
- Match source excitation for TEM-like feeding
- Sequential and simultaneous lumped port excitation
- Layout generation features
- Parameter variation and optimization capability
- Fast and easy layer stack set up



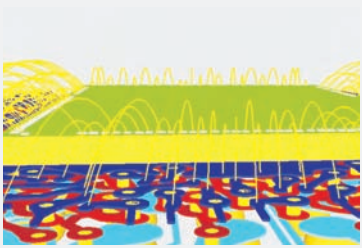
LO Distribution network in multi-layered LTCC: electric field at 30 GHz

EMBEDDED DEVICES

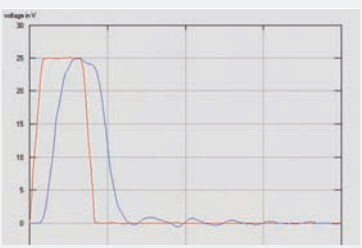
ASIC, RFIC or MMIC chips are often embedded in plastic or ceramic packages. Bond wires, lead frames, and package material can lead to parasitic effects even at low frequencies. EMPIRE offers the possibility of defining inner ports where the non-linear or active elements are located. The passive and linear environment can be analyzed by the simulator resulting in a multi-port scattering matrix. This matrix can then be used to design matching networks, for de-embedding purposes, or for a package equivalent circuit parameter extraction. Thus large signal, multitone and noise analysis is applicable, too. IMST offers consulting for device characterization and modelling of plastic and ceramic packages.



Full 3D-EM-Modelling of a PBGA – 12x12 Plastic Ball Grid Array.



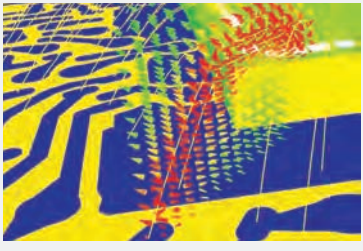
Signals are routed thru vias to the top layer and bond-wires connect die pads.



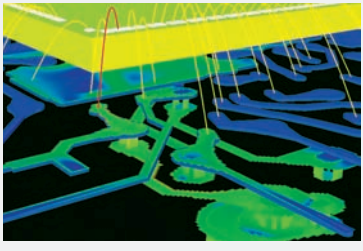
Signals distortion along path from ball grid to die pad.

FEATURES

- Priority concept which allows the definition of buried components
- Import of DXF, Gerber, GDS II layouts
- Bond-wire and object array generators
- Unlimited number of internal and external ports
- Automatic mesh generator at expert level
- Accurate loss modelling with no impact on simulation speed
- Remote processing for distribution and parallel processing of simulation jobs
- Automatic generation of S-Parameters and Touchstone files (SnP)
- Spice parameter extraction



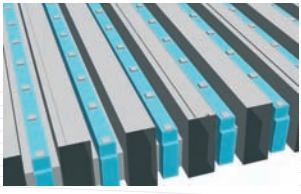
Magnetic field in the vicinity of an exciting wire.

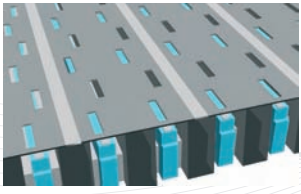


Current density in intermediate layers.

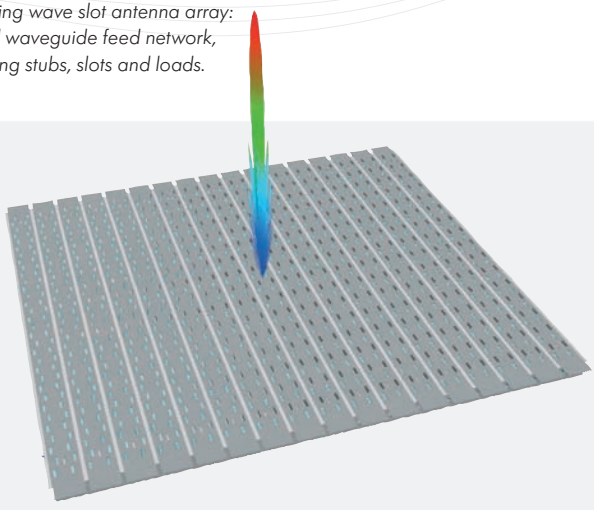
WAVEGUIDE ELEMENTS

Waveguide excitation and termination need special care because of the occurrence of higher order modes at the waveguide ports. TE- and TM-Modes of arbitrarily shaped homogeneous waveguides can be pre-calculated by solving a 2D-eigenvalue problem to be used in the 3D-FDTD algorithm for excitation and S-parameter calculation. An advanced extraction algorithm is applied in the EMPIRE software to separate the mode content resulting in a generalized scattering matrix. Waveguide ports can also be defined inside the structure. A great variety of waveguide elements (transitions, mode couplers, polarizers, junctions or filters) can be analyzed, designed and optimized.



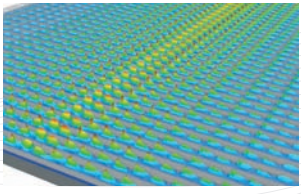


Travelling wave slot antenna array: ridged waveguide feed network, radiating stubs, slots and loads.

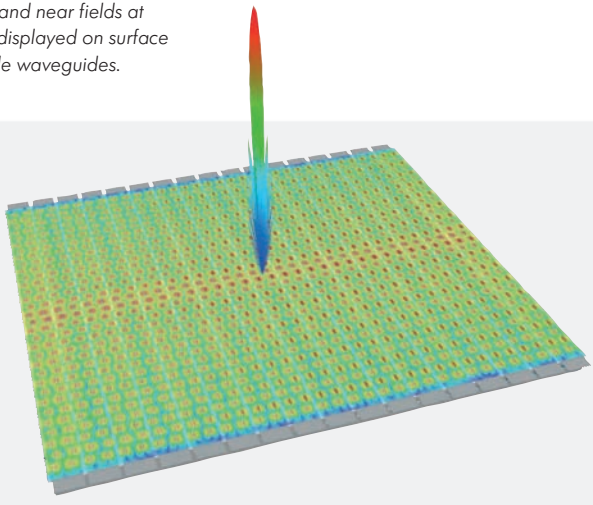


FEATURES

- Calculation of cut-off frequencies for higher order modes
- Mode preview capabilities
- Advanced port manager
- Mode extraction algorithm for multi-mode analysis
- Generalized scattering matrix
- Reference plane adjustment capabilities
- Selectable polarisation angle in circular waveguides
- External and internal waveguide port with high absorption



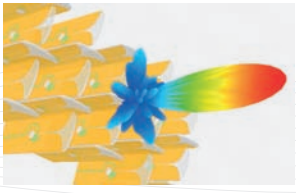
Far field and near fields at 28 GHz displayed on surface and inside waveguides.



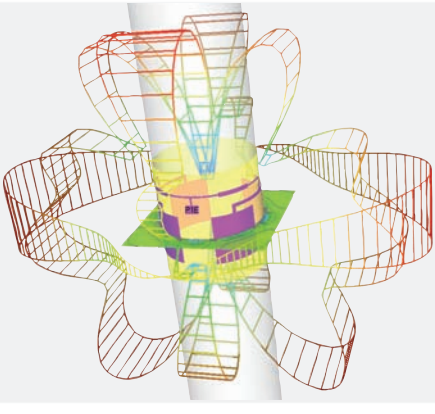
ANTENNAS

For the characterization of radiating elements, free space condition is required. Because of the finite size of the FDTD grid absorbing boundary conditions have to be applied. EMPIRE XCcel™ features the state-of-the-art perfectly matched layer (PML) with adjustable thickness which are attached to the simulation domain to minimize the reflections from the boundaries. By sampling the field around the antenna, the radiation pattern can be calculated by a near field to far field transformation.

With the aid of plane wave excitation also the inverse antenna problem can be investigated as well as mono- and bi-static cross section calculations are possible.



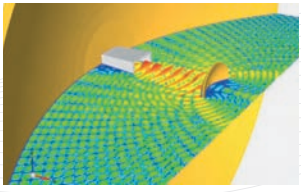
An array of vertically and horizontally polarized Vivaldi antennas showing far field pattern at 12 GHz.



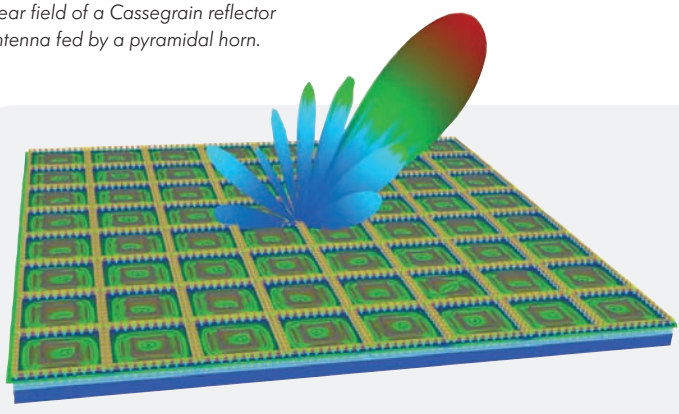
Conformal patch array including feeding network at 2.45 GHz.

FEATURES

- Broadband input impedance calculation
- Different antenna feedings
- Perfectly Matched Layer (PML) boundary conditions
- Near-field analysis
- Radiation patterns for a set of frequencies
- Efficiency, axial ratio and gain calculations
- RCS calculation
- Advanced farfield processing for periodic arrays
- Multi-port excitation with phase shifts
- Near and far field superposition



Near field of a Cassegrain reflector antenna fed by a pyramidal horn.

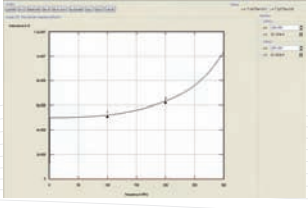


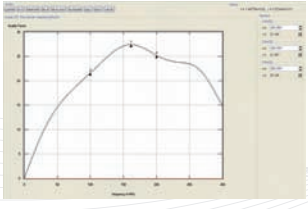
Ka-Band antenna terminal using digital beam-forming for broadband applications.

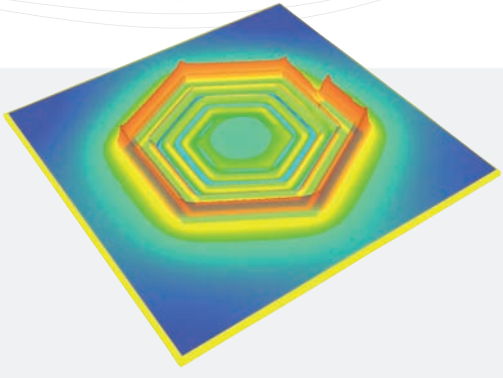
LAYOUT CAPABILITIES

To speed up design flows it is necessary that design and layout generation software rely on common data to prevent errors. EMPIRE XCcel™ supports the industrial layout standards, like the DXF, Gerber and GDS II. Data can be imported, exported or converted into each other.

In EMPIRE XCcel™ objects with common properties can be grouped on layers. So, once a layer stack has been created it can be re-used easily for designs of the same process parameters. Several features for checking design rules are included to ease the layout generation.





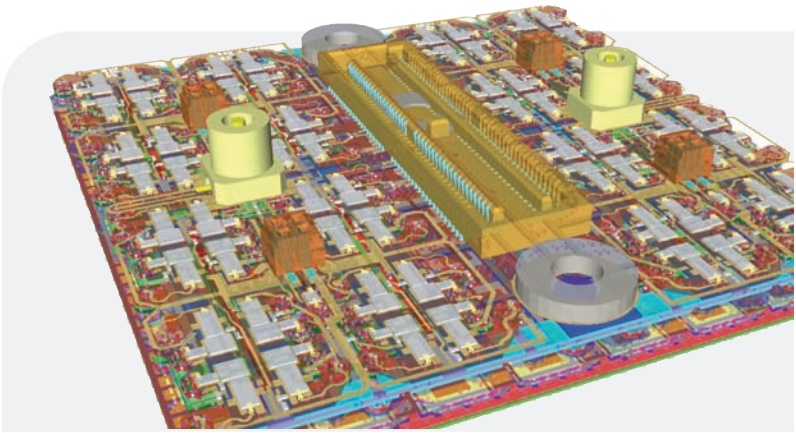


RF-IC inductor: The layout data of common IC design tools can easily be imported into the GUI and accurate results, like impedance, inductance, quality factor, etc. are obtained with little effort.

FEATURES

- Import and export of industry standard layout formats (Gerber, GDS II, DXF 12)
- Connectivity check for RF and DC lines including vias
- Point reduction algorithms for complex layouts
- Under- and oversizing of polygons
- Mapping polygons to user defined grids
- Automatic recognition of circles
- Programmable shapes for generation of, e.g. spirals, tapers, bends, fractals
- Signal path extraction
- Object library for numerous shapes

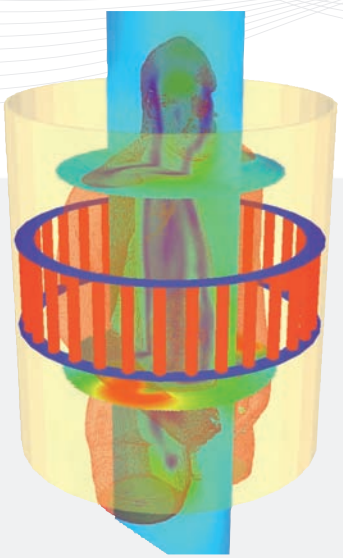
Highly integrated KA-Band Tx frontend module: 8x8 antenna array, LO feed network, 64 power amplifier transitions, 64 x 90 degree hybrid circiuts, 64 IF channels, DC distribution network



EMC AND HUMAN SAFETY

EMPIRE XCcel™ is very well suited for modelling the exposure of a human body with electromagnetic fields ranging from power line frequencies to the micro-wave range. Anatomically based models can be visualized and edited with the graphical user interface. Public models can be imported and specialized models developed by IMST (sitting human, ...) can be supplied, too. Further, a model of the Specific Antropomorphic Mannequin (SAM phantom) is available which is proven for SAR compliance testing of mobile phones.

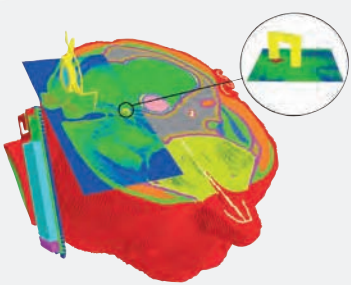
The model can be exposed by plane waves or by near field sources for the evaluation of Specific Absorption Rate (SAR) or Averaged Current Density (ACD).

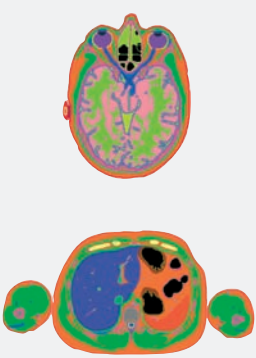


B1-field of a 7 Tesla birdcage resonator for MRT applications

FEATURES

- Arbitrary exposition possible
- Specific Absorption Rate (SAR) calculations with mass averaging
- Averaged Current Density (ACD) with surface averaging
- Maximum value finding
- Sophisticated Voxel editor
- Special algorithm for low frequency calculations
- Compliant to IEEE standard P1528

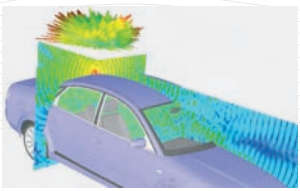




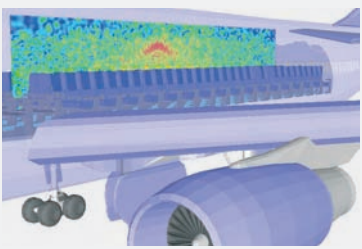
AFRL body model with 40 different tissue types.
1 mm, 2 mm, 3 mm resolutions are available.

CAD DATA PROCESSING

Due to increasing computing power and the highly efficient EMPIRE XCcel™ kernel more environmental details can be included into the modelling that can lead to an even more reliable prediction of RF devices. Often structure data is available from manufactures (e.g. RF connectors, 3D MIM switches, car or plane models) or internet libraries. EMPIRE XCcel™ can import, export, modify and parameterize data based on the 3D STL standard, so arbitrarily shaped volumes and surfaces can be used in the simulation.



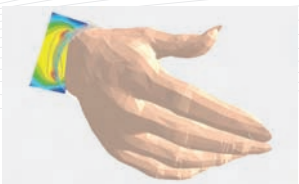
Automotive application: 2.45 GHz antenna on top of a car. Electric field and far field pattern.



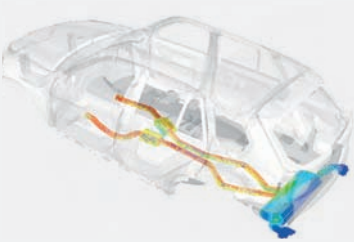
Characterization of WiFi channels inside an A320 airplane.

FEATURES

- 3D-STL data import and export
- IGES, STEP, ACIS import using external converter
- Boolean operations for arbitrary 3D object generation
- Parameterization of imported objects
- Fast 3D rendering for visualization and field animation
- Preview of discretized structure
- Automatic mesh generation
- Healing capabilities
- 3D volume and surface support



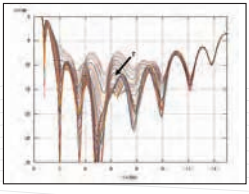
Flexible RFID tag antenna wrapped around wrist: Magnetic near field at 13.56 MHz.

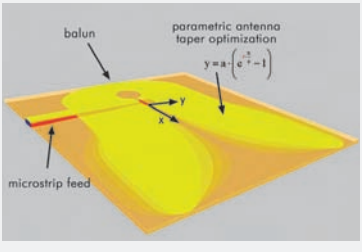


Current density on an exhaust at 10 MHz for studying EMI of engines.

OPTIMIZATION

All geometric or physical values may be parameterized during structure set up. Even parametric equations can be used to define complex shapes, like special taper geometries. This feature in conjuction with a powerful batch processing and a remote control for job distribution within a network cluster enables the user to perform sophisticated parameter studies and yield analysis. A smart, gradient based optimizer is available to reach a user-defined optimization goal within a minimum of time.





UWB Antenna Optimization:

The exponential taper of this Vivaldi antenna is optimized with respect to input reflection, e.g. s11 < -10 db for 3-10 GHz.

RUNNING EMPIRE XCCEL™

EMPIRE XCcel™ is supported for PCs running under Windows XP/Vista/7 or Linux in both 32bit or 64bit mode that enables to exploit the complete memory of the system. To take full advantage of a workstation cluster, the simulator can be executed remotely and simulation jobs may be distributed on different hosts, using an advanced batch job control.

For huge simulation tasks which exceed the memory of a single PC EMPIRE can invoke the hard disk drive using an optimized algorithm so a high performance is still obtained. It is also possible to run a simulation parallel on a PC cluster to increase the memory and performance.

EMPIRE XCcel™ Job Control:

Batch or optimization processes can be controlled on remote hosts to distribute simulation tasks.

CONSULTING AND SUPPORT

Customers of EMPIRE XCcel™ are supported by a group of experienced and competent software developers and application engineers. They are backed up by more than 50 design engineers working with this tool on design projects at IMST.

EMPIRE XCcel™ is distributed worldwide by means of a network of representatives.

Strong and experienced local support teams are frequently trained by IMST engineers in order to supply high qualified first level customer support with fast reaction time.

The IMST EMPIRE XCcel™ support team provides email support with fast reaction time and offers individual training for customers to use the software effectively: empire.support@imst.de

IMST Homepage at
www.imst.com

UPDATES

Due to growing fields of applications and latest developments in research the EMPIRE XCcel™ software will be continuously extended, improved and upgraded. Updates will be free of charge for customers entering into a maintenance agreement. Node-locked and floating license configuration are possible for infinite time or renting periods. Manual updates, release announcements, application examples and more can be found on our web sites.

Just contact your local sales representative or mail to empire@imst.com in order to receive a quotation for EMPIRE XCcel™. Special discounts are available for multiple licenses, for research labs and universities.

EMPIRE XCcel™ Homepage at
www.empire.de

INNOVATION IS IMST

IMST GmbH is a center of excellence and developer of professional radio technology. We are proud to look back on more than 17 years of success. There have been many changes since 1992, but the values that created IMST – innovation, integrity and smart partnerships – have remained. We have held on to this tradition and it has served us well.

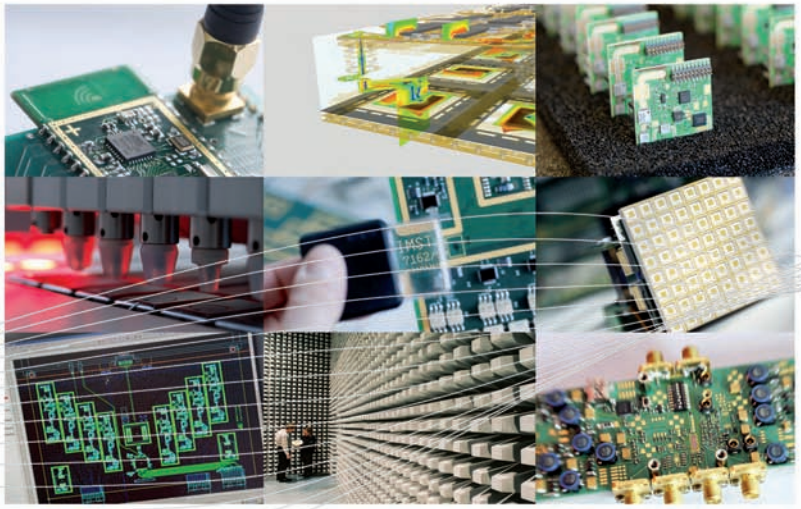
As an engineering company and service provider, IMST is one of the world's leading developers of high-frequency circuits, radio modules and communication systems. We have partnerships in standard business sectors as well as public research. Our strength is our customer-orientated support through every stage of product development – from initial advising to the start of production, we offer a one stop solution!

How does IMST differ from typical engineering companies? Instead of limiting ourselves to our core abilities, we embrace variety, flexibility and learning through research. The equivalent of the IMST model in physics would be a „coupled resonator" – demand and stimulus determine the resonant areas where we „buzz." This makes IMST crisis-resistant even in difficult times and always responsive and reliable. Our customers and partners enjoy sustainable benefits as a result. And, thanks to our links with European research institutes involved in the EU's general programme, we give our customers the competitive edge that comes from direct access to the world's most up-to-date research and development.

www.imst.com

AT A GLANCE

EMPIRE XCcel™ – developed by engineers for engineers – is one of the leading 3D-electromagnetic field simulators. It is based on the powerful Finite Difference Time Domain method (FDTD), which has become an industrial standard for RF component and antenna design. Due to EMPIRE's unique XPU technology (Accelerated Processor Usage) it exhibits the fastest simulation engine known today. With this highly optimized kernel full-wave EM-simulations can now be performed in minutes which used to take days some years ago.



Applications:

- Planar and multi-layered circuits including layout generation
- Microwave passive components
- RF-MEMS structures
- Signal Integrity (SI) and S-Matrix analysis of packages and PCBs
- Single and array antenna design
- Mono- and bi-static scattering cross section calculation
- Waveguide components
- HQ resonators featuring fast broad band loss models
- EMC including safety considerations employing anatomical body models
- Scripting controlled model definition, simulation, postprocessing
- Passive environments of active devices