Application Sheet

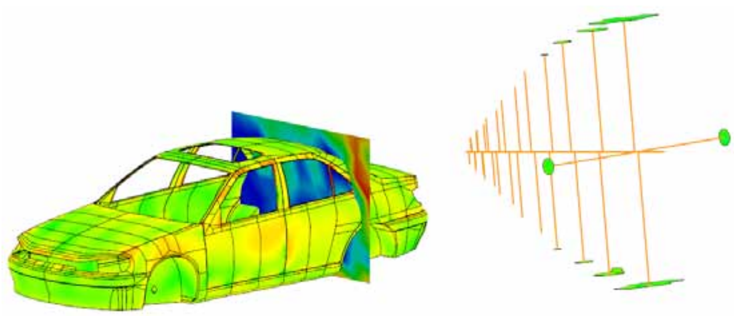
FEKO

Comprehensive Electromagnetic Solutions

EMC/EMI Applications

Antenna Analysis

Broadband antennas such as biconical antennas, log periodic antennas, loop antennas and horns are typically used in EMC test setups. These antennas can be analysed efficiently in FEKO using the method of moments (MoM) solver for which only the surfaces of conductors and dielectrics are discretised. Radiation into open space is taken into account accurately in the MoM formulation without having to introduce special absorbing boundary conditions or additional mesh elements. The adaptive interpolation of results over a wide frequency band reduces the required number of simulated frequency points to obtain a wideband response. POSTFEKO provides a powerful interface for viewing simulation results, including parameters such as the antenna factor, voltage standing wave ratio (VSWR), reflection coefficient, input impedance and antenna gain.

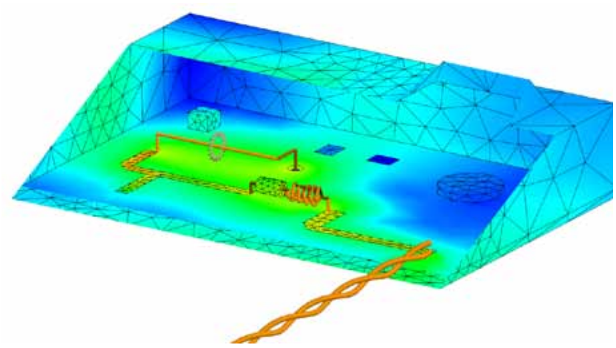


The visualisation of near fields for a full vehicle illuminated by a log periodic antenna

Simulation of Electrically Large Structures

Solving a full vehicle with the MoM may require several GBytes of memory when simulating at a frequency where the structure becomes electrically large. As an example at 900 MHz the wavelength is about 33 centimetres and a mid-size sedan would be about 15 wavelengths long. FEKO's multilevel fast multipole method (MLFMM) allows a model of this size to be solved using only a few hundred MBytes.

Another industry-leading method in FEKO, the windscreen solution method, allows the inclusion of arbitrarily shaped windscreens containing multiple dielectric layers. This method solves an embedded or printed glass antenna without a significant increase in the computational resources. FEKO also provides innovative tools such as the constrained surface tool to create a work surface in the shape of a windscreen. An antenna can be defined in the work surface by using wires, Bézier curves and a set of regularly spaced wires.



The currents induced on a printed circuit board within an enclosure. The voltage to the PCB is supplied via a twisted pair of cables

FEKO offers several high frequency approximation techniques with low memory requirements, such as physical optics (PO), ray launching geometrical optics (RL-GO) and uniform theory of diffraction (UTD). These techniques have been hybridised with the MoM in order to solve models that contain electrically extremely large geometry with parts that are complex. A practical example is the analysis of a horn antenna, solved with the MoM, when in close proximity to a large structure, solved with the PO.

For computationally expensive problems, a variety of high performance computing (HPC) options are available. The FEKO solver supports parallelisation of calculations using central processing unit (CPU) technology via multi-threading, MPI and OpenMP parallelisation to improve the runtime performance of demanding simulations. FEKO also supports the use of GPUs for simulation acceleration using the compute unified device architecture (CUDA) framework from NVIDIA.

Private cloud computing via HyperWorks Unlimited™, a fully configured hardware and software appliance for computer-aided engineering (CAE), allows unlimited software usage on the device. HyperWorks Unlimited™ - Virtual provides convenient and on-demand access to HPC-driven CAE, regardless of location. FEKO, which is certified as Intel Cluster Ready, may be used with confidence to simulate challenging problems on large-scale clusters.

Shielding

FEKO can compute the shielding factors of arbitrary-shaped metallic or dielectric enclosures containing slots or other openings. A plane wave can be used as an excitation to calculate the near fields inside the enclosures or to induce wire currents if the shield is to screen a wire configuration.The calculated fields can be compared to those that would exist in the absence of a shielded enclosure.

Alternatively, the dual problem of having internal sources (elementary dipoles or excitations on wires) can be solved and the radiated near fields or far fields outside the enclosure can be investigated.
It is also possible to account for non-perfect screening materials and take into account the skin effect or the effect of penetration through walls with finite conductivity. FEKO uses a special technique for metallic enclosures where shielding factors of 200 dB or more can be computed.

Cable Modelling

Cable coupling analysis usually comprises of two calculations namely irradiation (coupling into a cable) and radiation (external fields due to currents in the cable bundle). FEKO also allows coupling between cables by calculating the radiation of a cable while taking irradiation into account (possible induced currents on the cable due to other cables or external fields). Standard multi-conductor transmission line (MTL) theory is a well-established numerical method for simulating electromagnetic coupling between cable bundles and external structures. In FEKO, the MTL technique can be used for arbitrary complex bundle cross sections and any of the numerical solution methods, such as the MoM, MLFMM and finite element method (FEM), may be used to compute the external fields and currents that couple to the cable bundles.

In cases where the standard MTL technique cannot be applied, as it is assumed that the current return path is in the ground plane directly below the cable, FEKO's hybrid MoM / MTL technology can be used.

Example Application

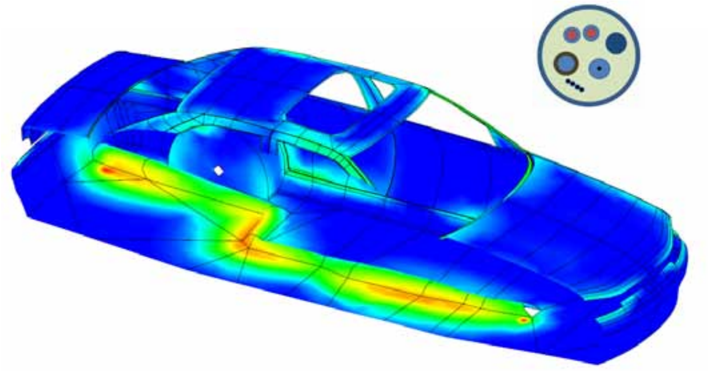
Lightning protection and radio frequency interference (RFI) studies for the Karoo Array Telescope [1] included analysis with FEKO. An indirect lightning strike was modelled using a plane wave excitation. The shielding offered to cables running along the struts of the dish to the feed horn, the bonding of cabling and the effect of different barriers at the base of the pedestal were investigated. After inspecting the surface current densities at the interfaces between parts of the telescope, the lightning down conductor (LDC) was re-designed. This was necessary due to capacitive coupling causing unwanted surface currents to flow on the inside of the structure.

Conclusion

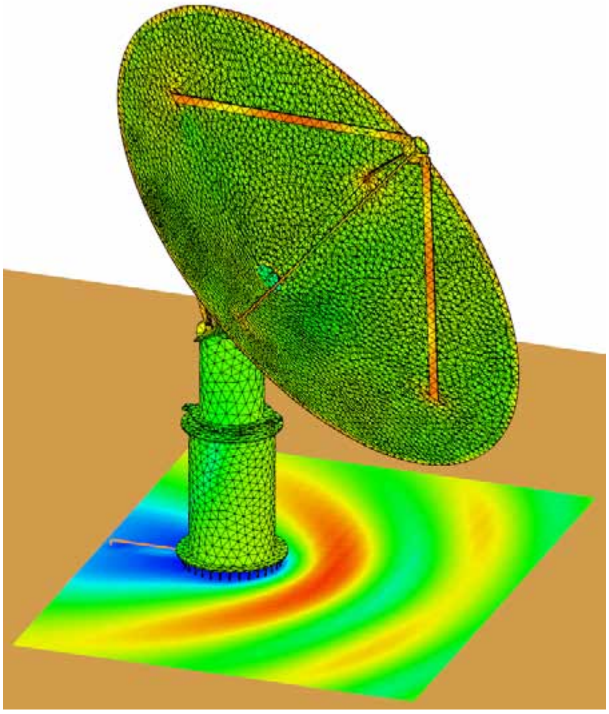
FEKO has many features that make it attractive for a variety of other EMC and EMI simulations. These features include specialised techniques for calculating extremely high shielding values and advanced cable modelling techniques to mention just a few. The numerous solution methods that have been hybridised and efficient HPC capabilities ensures that even large problems can be solved in reasonable times.

References

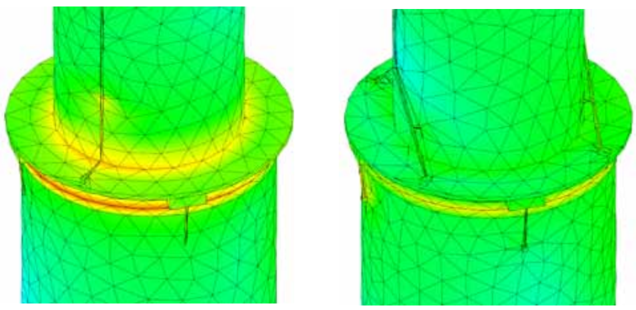
[1] P.G. Wiid, H.C. Reader and R.H. Geschke, "Radio Frequency Interference and Lightning Studies of a Square Kilometre Array Demonstrator Structure", IEEE Transactions on Electromagnetic Compatibility, Vol. 53, No. 2, May 2011, pp. 543-54.



Surface currents caused by a radiating cable running along the inside of a car's bodywork. An example of a cable that can be modelled in FEKO (insert)



The surface currents and near fields during an indirect lightning strike on a scale model of the KAT-7 radio telescope (model courtesy of P.G. Wiid)



Original (left) and altered (right) LDC design for the KAT-7 radio telescope [1]

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