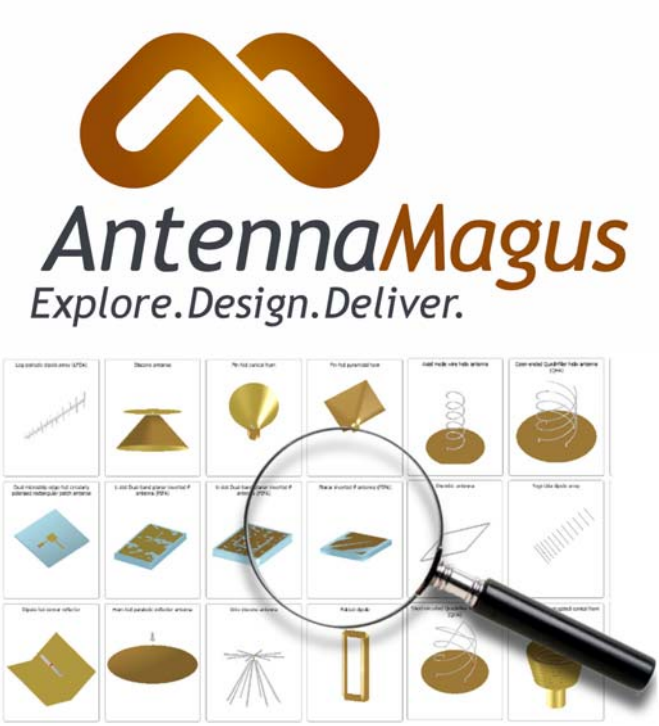
Using Antenna Magus together with FEKO

About Antenna Magus

Antenna Magus is the first design tool of its kind. Its huge searchable collection of antennas can be explored to find, design and export models of designated antennas to FEKO.

Antenna Magus does not aim to replace electromagnetic analysis tools like FEKO. It reduces the time to find and assess feasible antenna topologies for any given application, providing reliable initial designs and validated simulation models.



Explore

- Searchable collection of more than 100 antennas.
- Collection updated regularly to provide users with confidence that all possible antenna designs are considered.
- Information on antennas are provided in a standardised format to simplify the comparison of different antennas.
- Quick summaries, as well as detailed information is provided for each antenna.

Design and Estimate Performance

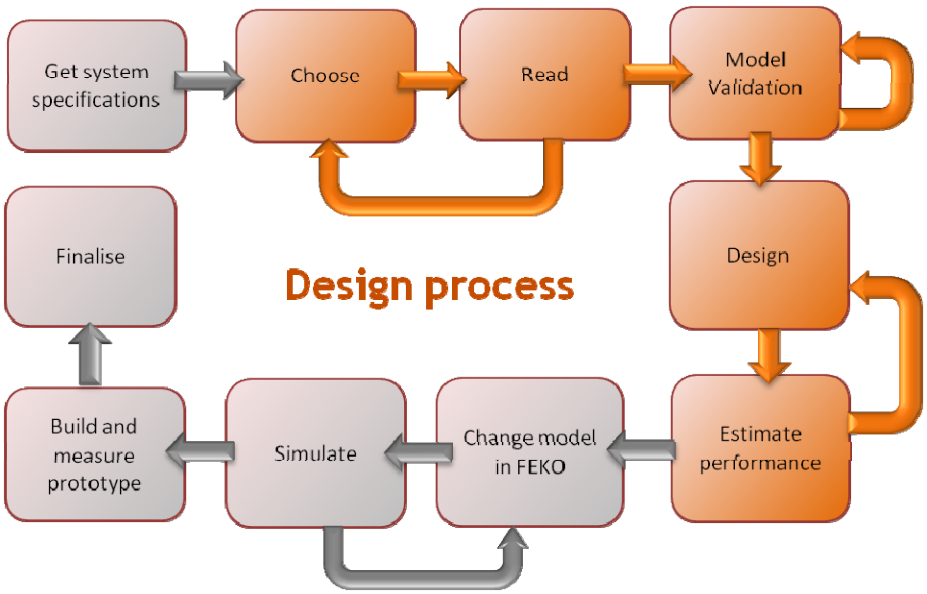
- Antennas are designed to meet performance specifications.
- Thoroughly tested design algorithms ensure that designs meet specified criteria.
- Performance of a designated antenna is rapidly predicted and applicable graphs are displayed, e.g. S-parameters, VSWR, gain.

Deliver and Export Models

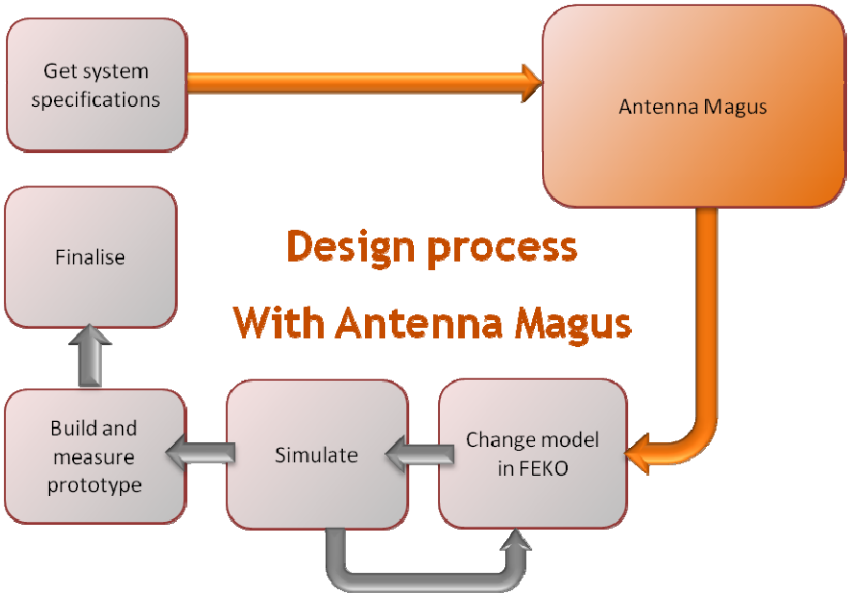
- Easily and instantly generate “ready-to-run” FEKO models from designs.
- The latest FEKO simulation features are incorporated in exported models, making it easier for antenna designers to leverage the strengths of FEKO features.

How does Antenna Magus fit into the antenna design cycle?

The typical antenna design process can be visualised with the following flow-chart:



Antenna Magus aims to shorten and speed up the design process by replacing the orange coloured blocks with itself as one single block. Choosing an appropriate antenna topology, finding information on the antenna, creating and validating a model, designing with this model in place and fast estimates of the new antenna's performance will all be handled by Antenna Magus. The new streamlined antenna design process can thus be visualised with this new flow-chart:



FEKO and Antenna Magus

FEKO is a state-of-the-art EM simulation tool suitable for antenna analysis and antenna placement analysis, among many other applications. It is envisaged that FEKO users will benefit from Antenna Magus in many ways, e.g.:

- ***Rapidly design customized antennas for new applications***. Experienced antenna designers could use Antenna Magus to confirm that they've considered a wide range of solutions for their current design requirements, select an appropriate design, export the Antenna Magus model to FEKO and then use FEKO for design customization and optimization.

- ***Antenna placement studies with standard 3rd party antennas***. System engineers often buy standard antennas off the shelf, but have to confirm that these antennas will work in the environment where they will be deployed. FEKO models for such antennas are rarely readily available and engineers could use Antenna Magus to generate FEKO models that closely represent off-the-shelf antennas for use in antenna placement studies.

The typical work flow for the combined usage of these two tools is as follows:

1. Identify a suitable antenna within the Antenna Magus database.
2. Use Antenna Magus to quickly establish a first-order design of the antenna.
3. From within Antenna Magus, export a high quality, parametric model of the designed antenna to FEKO.
4. In FEKO, verify the performance of the antenna and make small adjustments as necessary, using the state-of-the-art, rigorous, full-wave solver of FEKO.
5. In FEKO, the antenna design can be further customised to satisfy specialised design criteria and incorporate additional features which are beyond the scope of Antenna Magus.
6. In FEKO, the antenna can be mounted onto a superstructure for antenna placement and coupling studies. Such a structure could for example be an imported CAD model of a ship or aircraft.

To illustrate this work flow, two examples will be considered, the first is the design of an enhanced-bandwidth helix antenna, and the second is a naval antenna placement study.

Customized Antenna Design Example

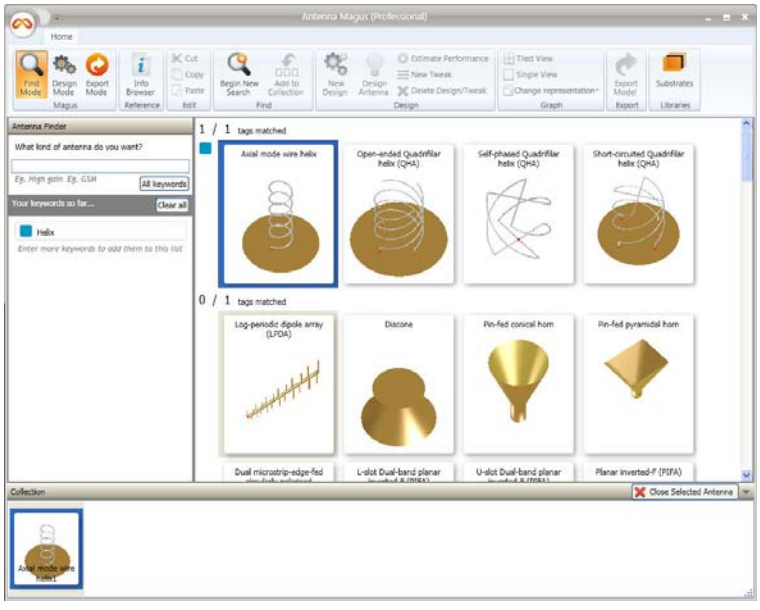
Antenna designers often start with a standard design, but have to customize the design to achieve better than typical performance. In this work requirement Antenna Magus can assist by creating the initial CADFEKO antenna model of the standard design. In doing so, it provides detailed knowledge of how to model such an antenna optimally in FEKO, allowing antenna designers to avoid the detail work of setting up appropriate computational models. Antenna designers can then focus on customizing the antenna by simply modifying the CADFEKO geometry that was exported from Antenna Magus.
The following example illustrates this workflow.

Design requirement

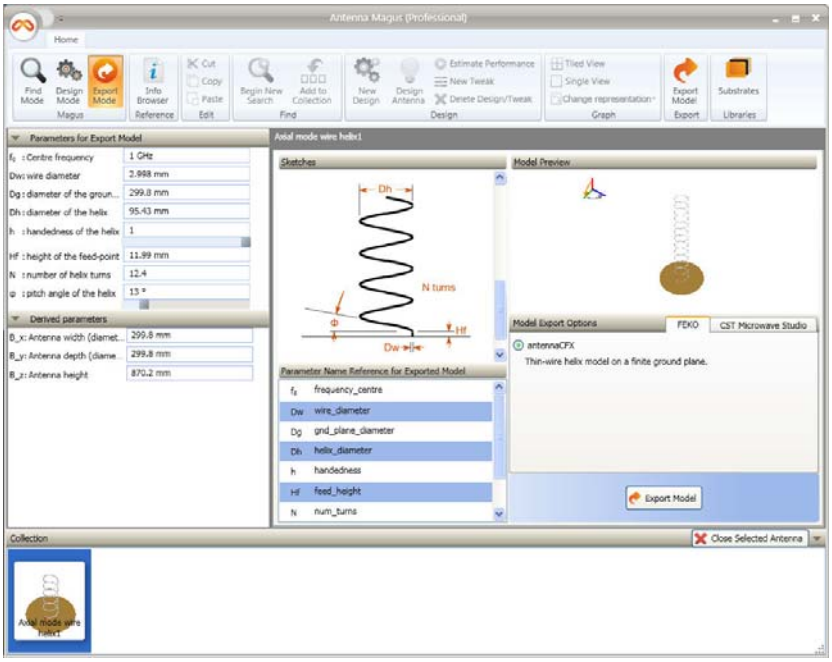
Design a helix antenna, maintaining gain bandwidth, but improving on VSWR and axial ratio bandwidth.

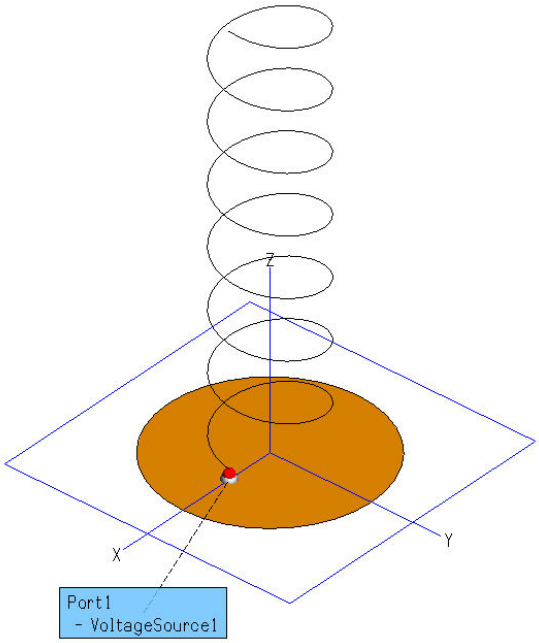
Work steps

Use the Antenna Magus keyword search capability to find a helix antenna. Select the appropriate antenna in the filtered list and click on the "export mode" button in the task ribbon. Fill in the appropriate geometry details for the basic helix model and export the FEKO model.



Keyword searchable collection of antennas

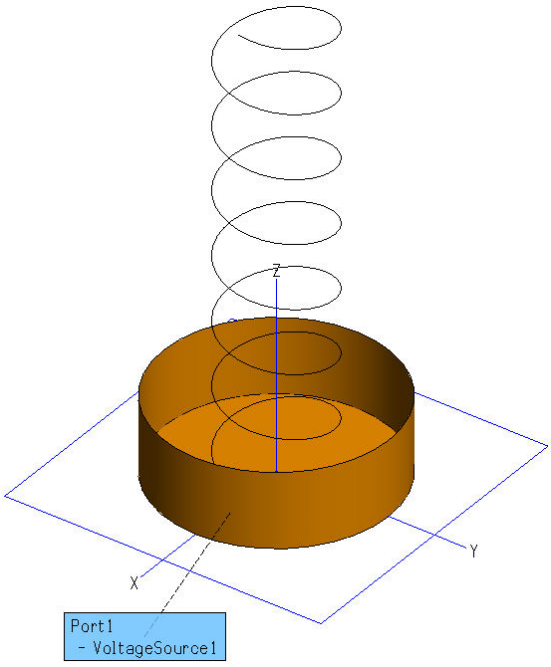




Export models to CADFEKO

Now that the CADFEKO model has been created, it is a simple task to create non-standard variants of the model, e.g.

- Loft the edge of the ground plane to form a small metal cupped ground plane around the helix base. This operation requires only an edge selection and loft operation.
- Taper the top few turns of the helix to end in a smaller radius. This operation requires only the modification of the creation method for the top part of the helix.
- Use both the lofted base and tapered helix modifications.

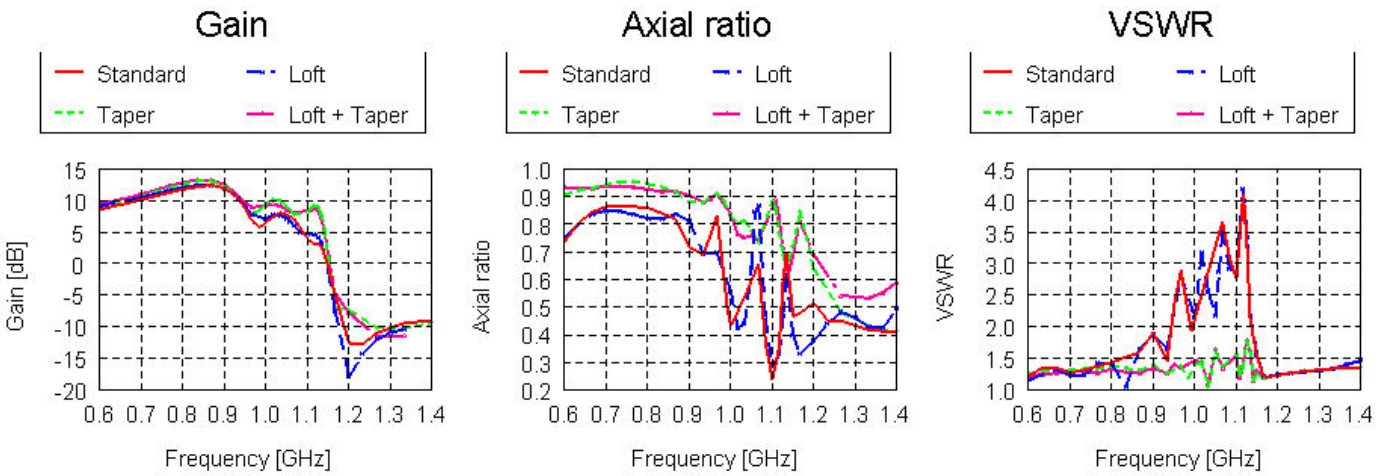


CADFEKO modified model with edge lofted

Note that no modification was made to the port and source setup of the original model. This was left as exported by Antenna Magus! Running these models for a frequency sweep of 600 MHz to 1.4 GHz is now a simple matter. Comparing the results show that:

- Far-field gain remains constant across the band of operation.
- Axial ratio of the tapered and loft & tapered models are better than for the standard helix model.
- VSWR of the tapered and loft & tapered models are better than for the standard helix model.

The design workflow, assisted by Antenna Magus, resulted in an exceptionally quick way to evaluate three options for non-standard modifications to a helix antenna.



Customized helix antenna performance simulated by FEKO

Operational Antenna Specification and Placement Example

System engineers are often presented with functional requirements for a communication system that has to operate in a challenging environment. The task of selecting an appropriate antenna topology and modelling it with FEKO might fall outside their field of expertise. Antenna Magus will help them to easily select, design and evaluate a suitable antenna model for system analysis in FEKO.

The following example illustrates a workflow that could result from using Antenna Magus and FEKO for such projects.

Requirement

The functional requirement for a communication antenna to be mounted on a naval ship is to create a wide-band VHF antenna for ship-ship communication links. From experience an engineer can write down the following design specifications:

- VHF wide-band requires a frequency span of 150 MHz to 350 MHz, centre frequency 250 MHz and bandwidth of 80% around the centre frequency.
- Wire antennas are preferable as such antennas present little wind resistance and require little maintenance in the challenging environment of operation at sea.
- Communication to the horizon is important and elevation pattern degradation is not a problem.
- The antenna will be mounted on the port-side lower yardarm of rear castle.

Work steps

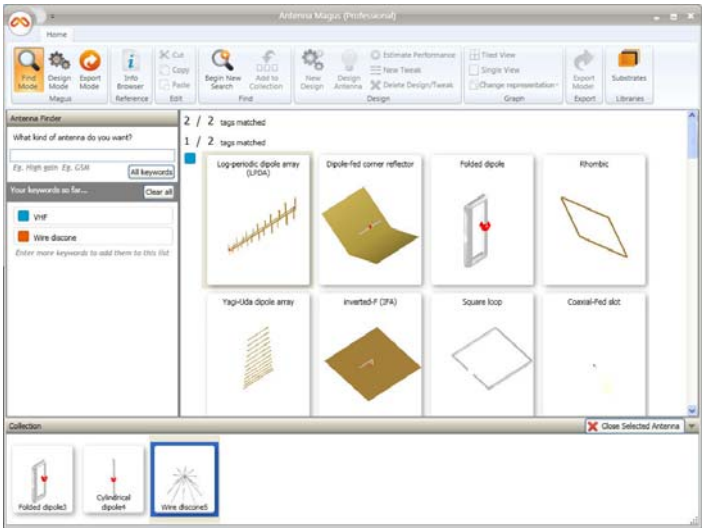
Select antenna topology in Antenna Magus*:*

- Using the ***find mode***, "VHF" is the first keyword that is entered. From the list of antennas that remains, a folded dipole and cylindrical dipole is added to the antenna collection as they look like typical horizontal communciation antennas.
- Discone antennas are often used in naval applications so "discone" is also entered as a keyword. One of the filter keyword suggestions from Antenna Magus is "Wire discone" which is selected and the wire discone antenna added to the collection that will be considered.

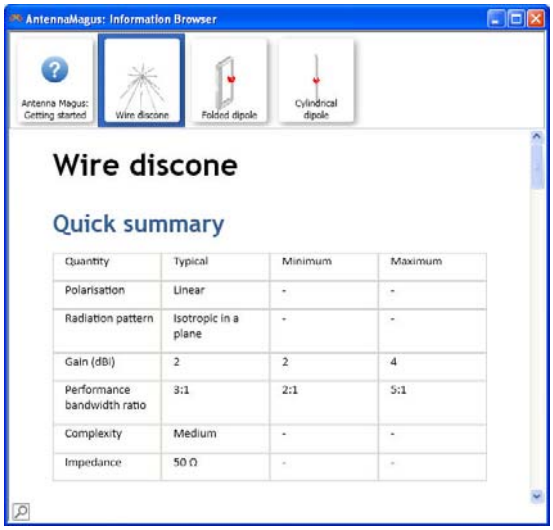
- Antenna Magus's ***information browser*** provides a quick summary of the expected performance characteristics of the antennas in the collection. Based on the performance bandwidth ratio, it is easy to discard the cylindrical dipole (12%) and folded dipole (25%), while selecting the wire discone (3:1) as the only viable option.

Design antenna, estimate performance, iterate in Antenna Magus.

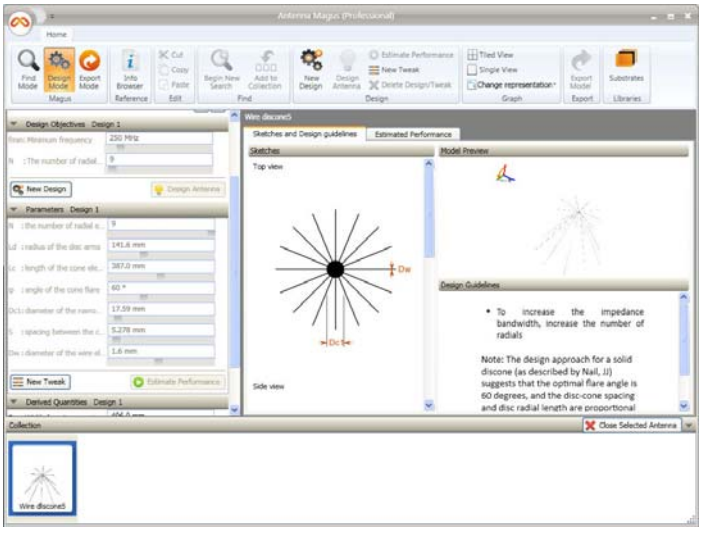
- Using the ***design mode***, the first design is made for a 250 MHz centre frequency with 9 radial elements and the ***performance estimated***. Antenna Magus is used to estimate performance to find out that the initial design does not meet the required frequency band specifications (S11 < -10dB for 250 MHz to 640 MHz).
- A second antenna is designed with a new centre frequency of 150 MHz and 9 radial elements. The estimated performance for this design predicts a satisfactory impedance bandwith (S11 < -10dB for 150 MHz to 380 MHz).



Find appropriate antennas



Information browser



Design mode

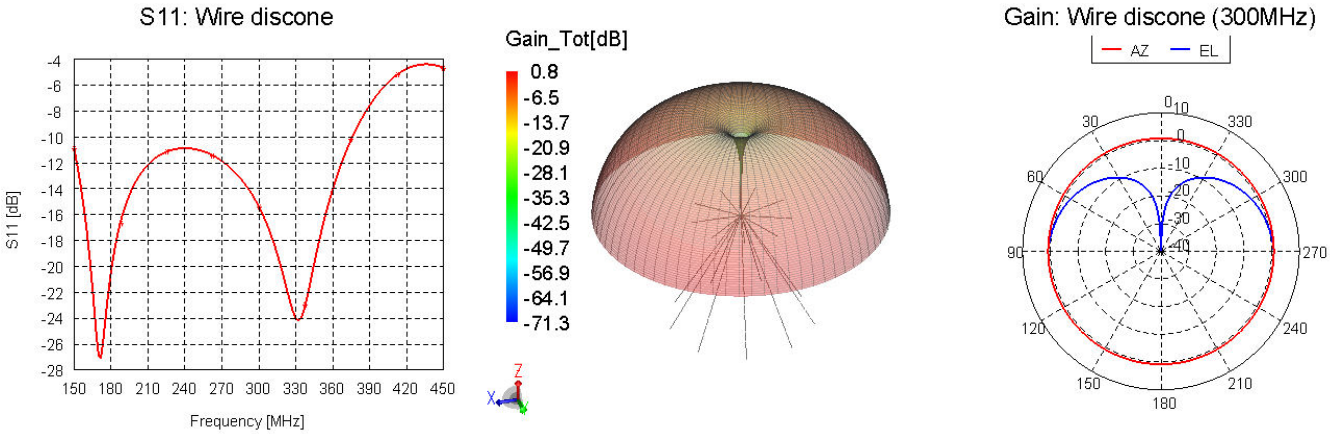
Performance estimation

Export model to FEKO from Antenna Magus

The second design is easily exported for FEKO using the Antenna Magus ***export mode***.

Confirm antenna performance with FEKO

The Antenna Magus model is easily modified in FEKO to simulate across the frequency range of interest, the model meshed and simulated without any problems. These steps confirm that the stand-alone wire discone antenna easily satisfy the required performance criteria for both impedance bandwidth and radiation pattern.

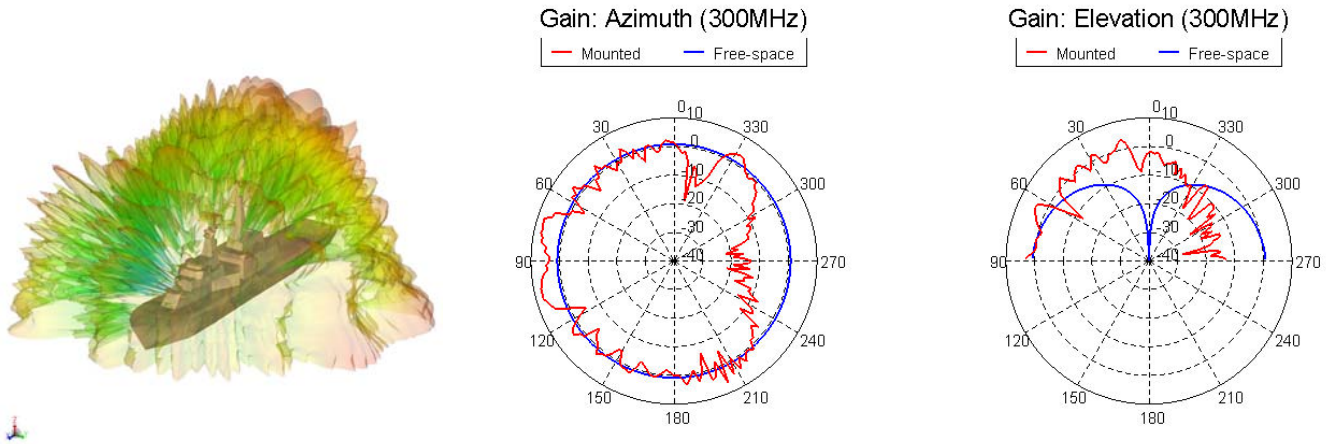


Accurate free-space performance analysis and design confirmation in FEKO

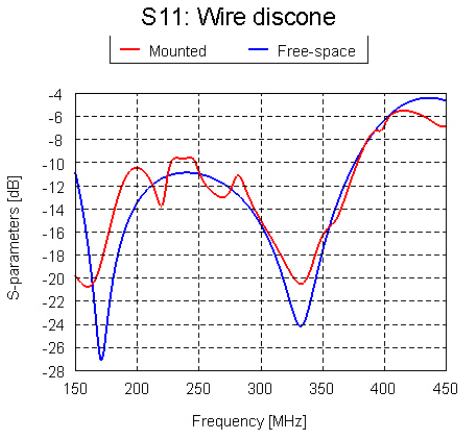
Antenna placement study with FEKO

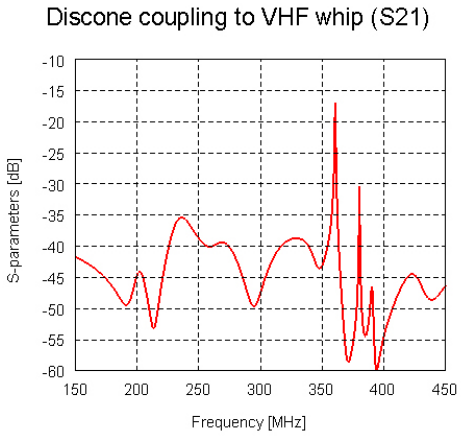
Confirm impedance bandwidth, radiation pattern, coupling from VHF whip on rear deck.

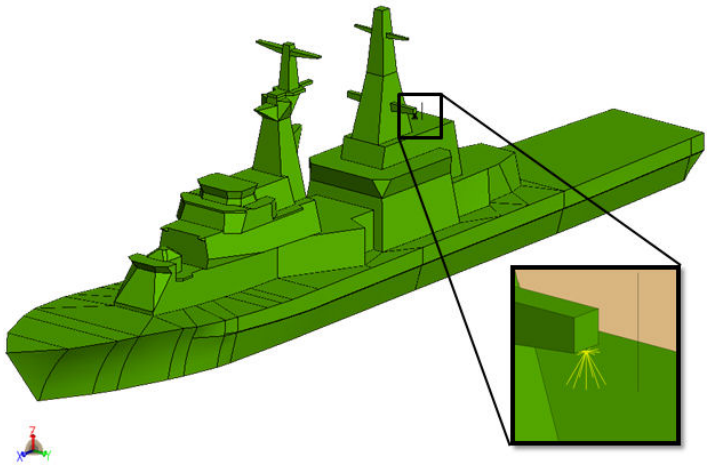
- The FEKO model that was exported by Antenna Magus is easily imported into FEKO (import only the geometry, ports are preserved with this option) and translated to the appropriate position just below the port side yardarm where it will be mounted.
- Mounted wire discone antenna performance simulations are set up in FEKO to evaluate 300 MHz radiation patterns. These simulation results are easily compared to the results for the standalone wire discone antenna.
- Antenna isolation between the wire discone antenna and the existing VHF whip antenna on the ship is also considered. S-parameters are computed to determine how much energy will couple between the wire discone antenna and the VHF whip antenna.

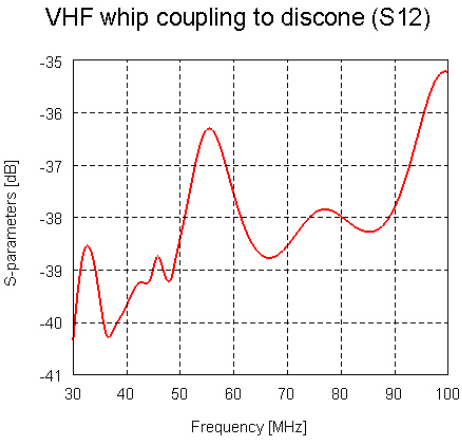


Far-field gain analysis of the designed antenna in its operating environment with FEKO









Mounting the designed antenna in FEKO and estimating cross-coupling between sources of radiation

Concluding remarks

- Antenna Magus assisted in confirming that knowledge of the general naval use of discone antennas was useful and also to help evaluate other possible solutions. Using Antenna Magus implicitly provides the certainty that a wide range of antennas were considered.
- In free-space the antenna impedance bandwidth specification is easily realised and confirmed by using the CADFEKO model that was exported by Antenna Magus.
- The far-field radiation gain patterns show a definite null in the direction of the main mast that the yardarm with the wire discone antenna is mounted on. System design either need to incorporate a second wire discone antenna on the far side of the mast to fill in this null, or need to move the wire discone antenna to a different, less obstructed position.
- Very little energy is coupled into the wire discone antenna from the VHF whip antenna on the rear deck of the ship. Communication via the wire discone antenna is thus possible even while the VHF whip antenna is transmitting in its band of operation.

For more information on FEKO and Antenna Magus, please visit:

- The FEKO website: www.feko.info
- The Antenna Magus area in the FEKO website: www.feko.info/antennamagus