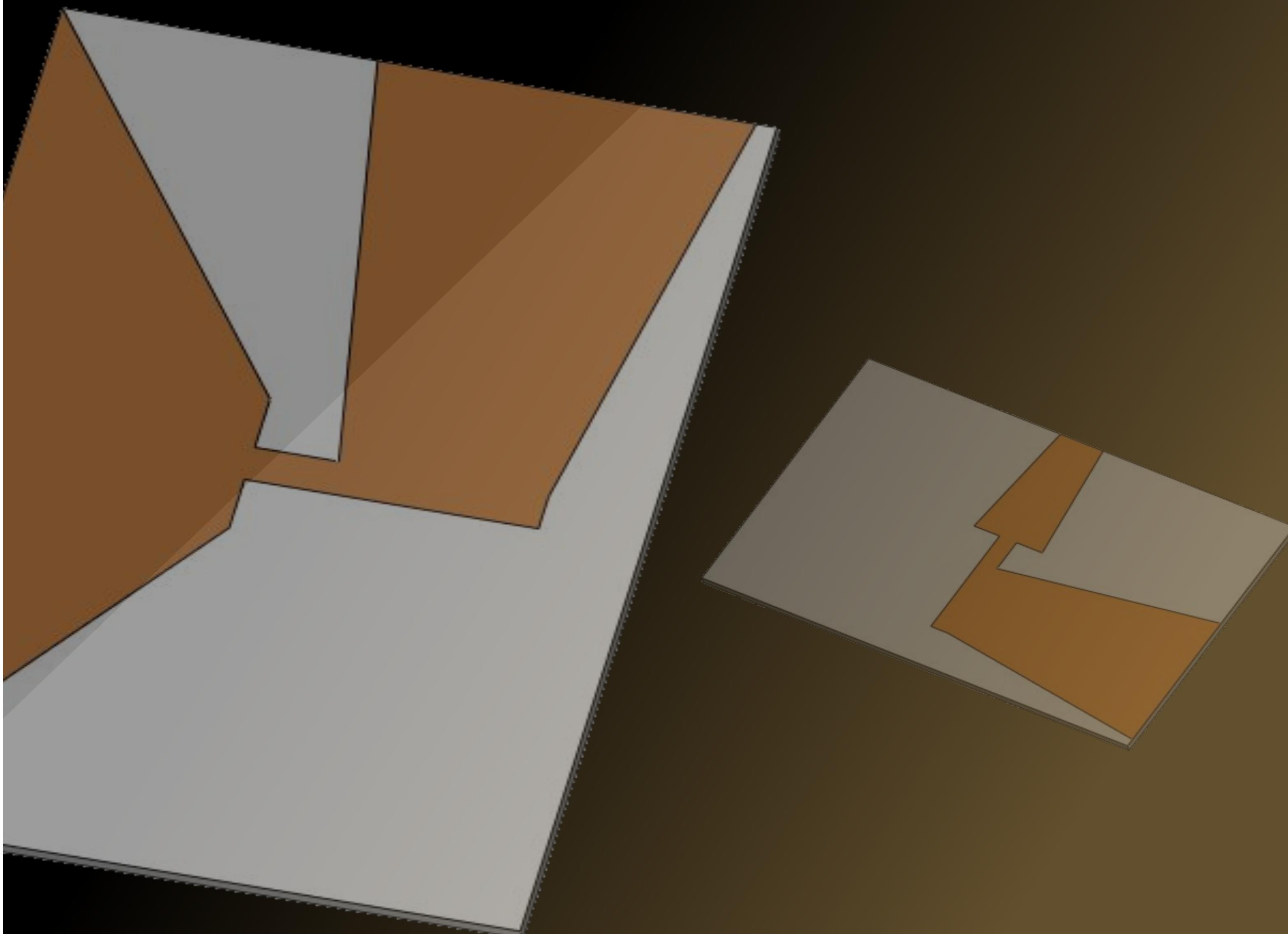
# Dipole Antenna



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# ANTENNA SIMULATION OF A DIPOLE ANTENNA

## Description

Dipoles have several applications in RF industry. One of the problems with dipole antennas, is the balanced nature of the dipoles which makes it difficult to feed them with an unbalanced coaxial line. Many people have had success in feeding a dipole directly with a coaxial cable feed rather than a ladder-line. However, coax is not symmetrical and thus not a balanced feeder. It is unbalanced, because the outer shield is connected to earth potential at the other end. When a balanced antenna such as a dipole is fed with an unbalanced feeder, common mode currents can cause the coax line to radiate in addition to the antenna itself, and the radiation pattern may be asymmetrically distorted. Normally a separated media called BALUN is used to feed the dipole properly. In the following printed dipole antenna, the BALUN is integrated with the antenna using a tapered line to enable the user to connect the coaxial line directly to the antenna. The operating frequency of the antenna is 2.4 GHz. The butterfly shape technique is used to increase the bandwidth of the antenna.

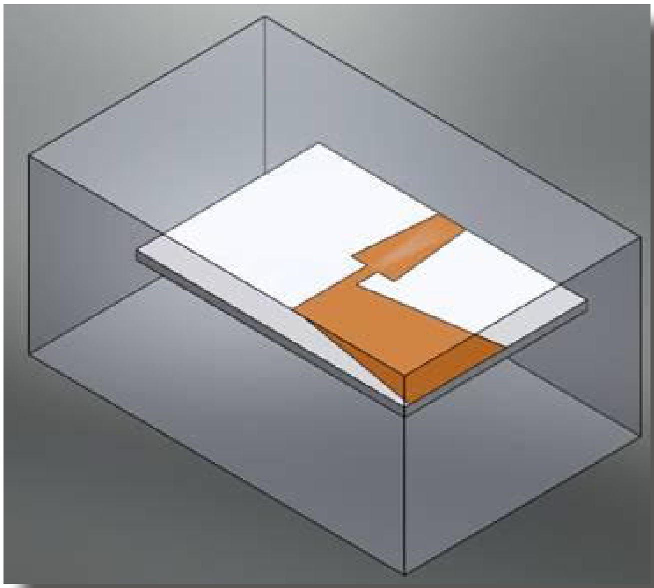


**Figure 1: Helical antenna model (3D SolidWorks view)**

## Simulation

To simulate the behavior of this dipole antenna (radiation patterns and antenna parameters like gain, directivity...), we create an Antenna study, and specify the relevant frequency range at which the antenna operates (in our case 21 frequencies uniformly distributed from 1.8 GHz to 3.8 GHz).

In an antenna simulation, radiation boundaries which are simulate an anechoic chamber have to be assigned to the radiation surfaces, perfectly surfaces of an air box. Antenna studies of HFWorks afford multiple choices and options to plot and to adjust the outputted results according to the user's need. They also offer the exploitation of electrical parameters calculated in Scattering parameters simulations (insertion, return losses...etc).

## Solids and Materials

The antenna is built of a Duroid 5880 substrate and two Perfect Electric Conductor surfaces orthogonal to the port face.

| Nbr. | Part Name | Material Name | Permittivity Type | Permeability Type | Conductivity Type |
|---|---|---|---|---|---|
| 1 | Air^Dipole-2-Body 1 (Cavity1) | Air | Lossy Isotropic | Lossy Isotropic | Isotropic |
| 2 | Substrate-1-Body 1 (Split Line18) | Duroid 5880 | Lossy Isotropic | Lossy Isotropic | Isotropic |

## Boundary conditions

The port is applied to the lateral faces of both substrate (the side of the upper face of the PEC) and the air box. This way, the simulation considers the electric field's distribution in the air and the radiation boundaries would give more convenient results.

## Meshing

Meshing the signal's path helps the solver refine its precision on the eddy parts, and take their forms into account.

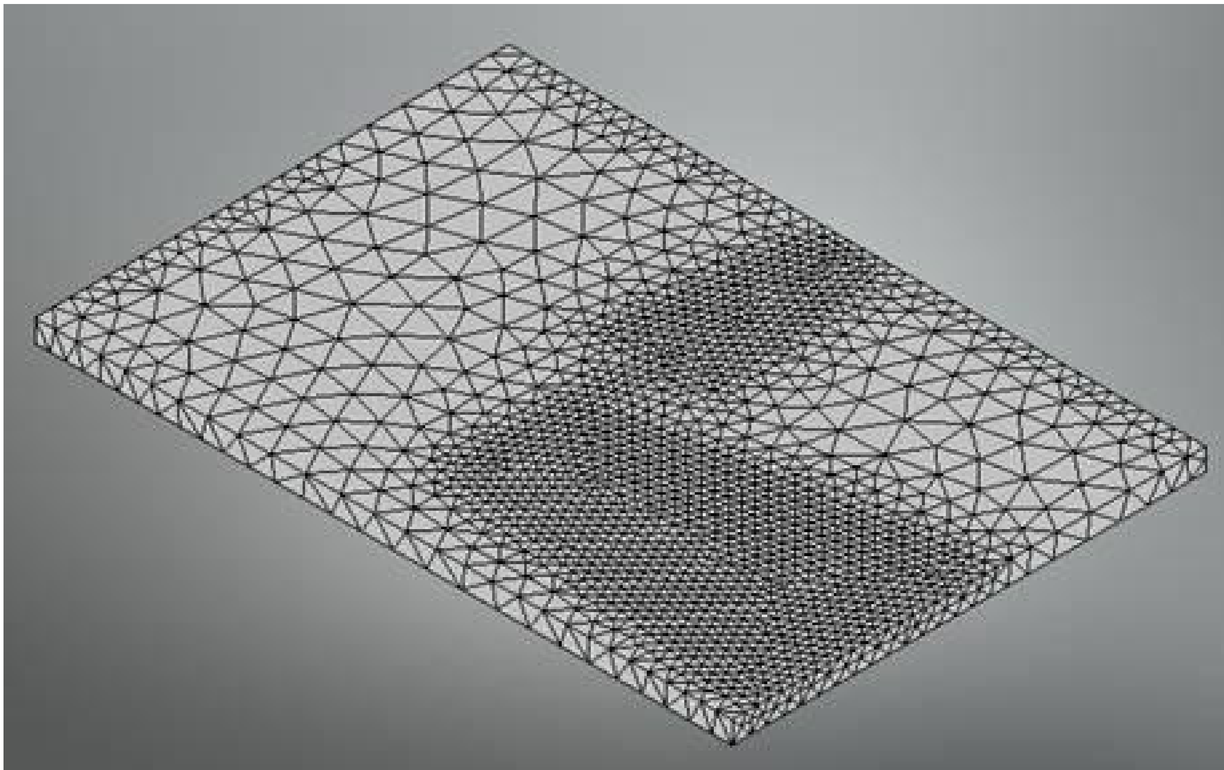


FIGURE 2: MESH OF THE DIPOLE ANTENNA

## Results

Various 3D and 2D plots are available to exploit. As we are dealing with an antenna simulation, plotting the radiation diagram sounds like an intuitive task. The following figure shows the radiation pattern of the considered antenna:

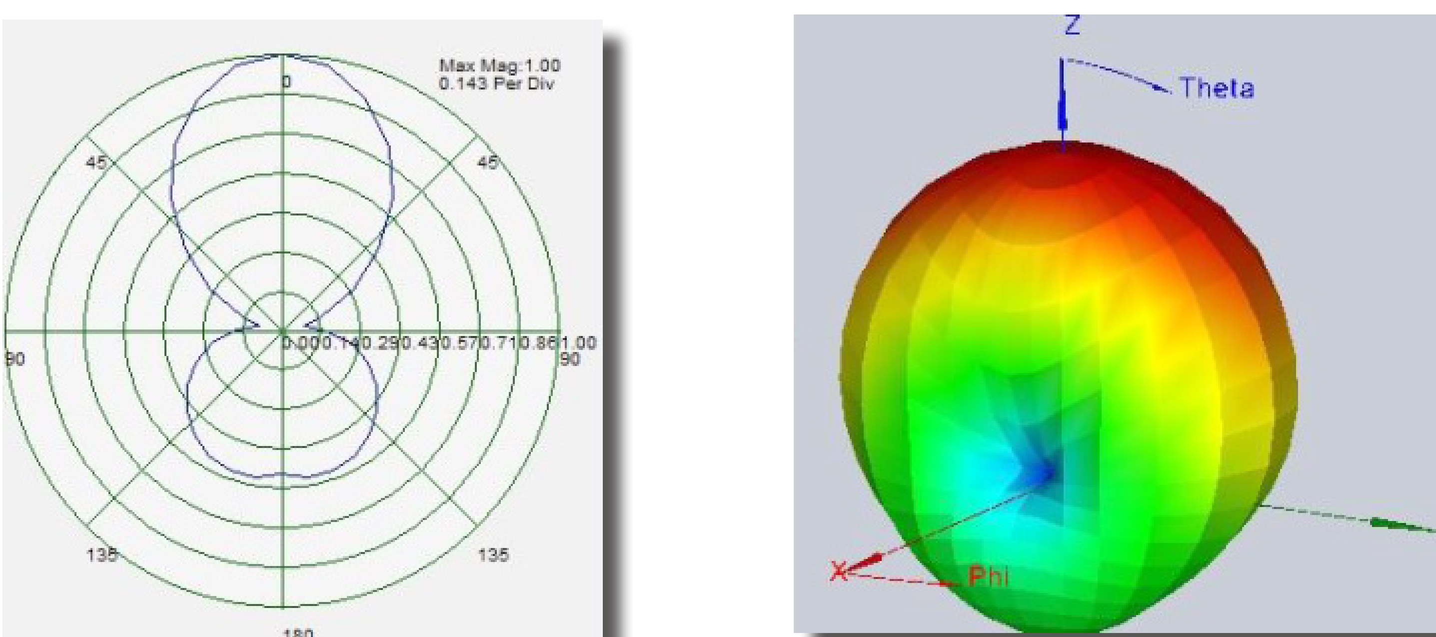



Figure 3: 2D and 3D radiation patterns of a dipole antenna

This figure shows conformal views (2D and 3D) of the variation of the power radiation pattern of the antenna in terms of the Theta angle. The 2D radiation plot shows the maximum of power radiated at the considered frequency; the angle corresponding to that radiation is obvious within the figure through the use of equipotential concentric circles spaced by 0.14 dB in this case. HF-Works automatically computes the maximum radiated intensity's properties (Theta, Phi, power, Directivity, Gain, Effective Angle, Radiation efficiency..) As mentioned within the beginning of this report, HFWorks computes scattering parameters within antenna studies as well; this is mostly relevant to antennas' matching optimization tasks. In this example, the antenna is best matched at 2.3 GHz:

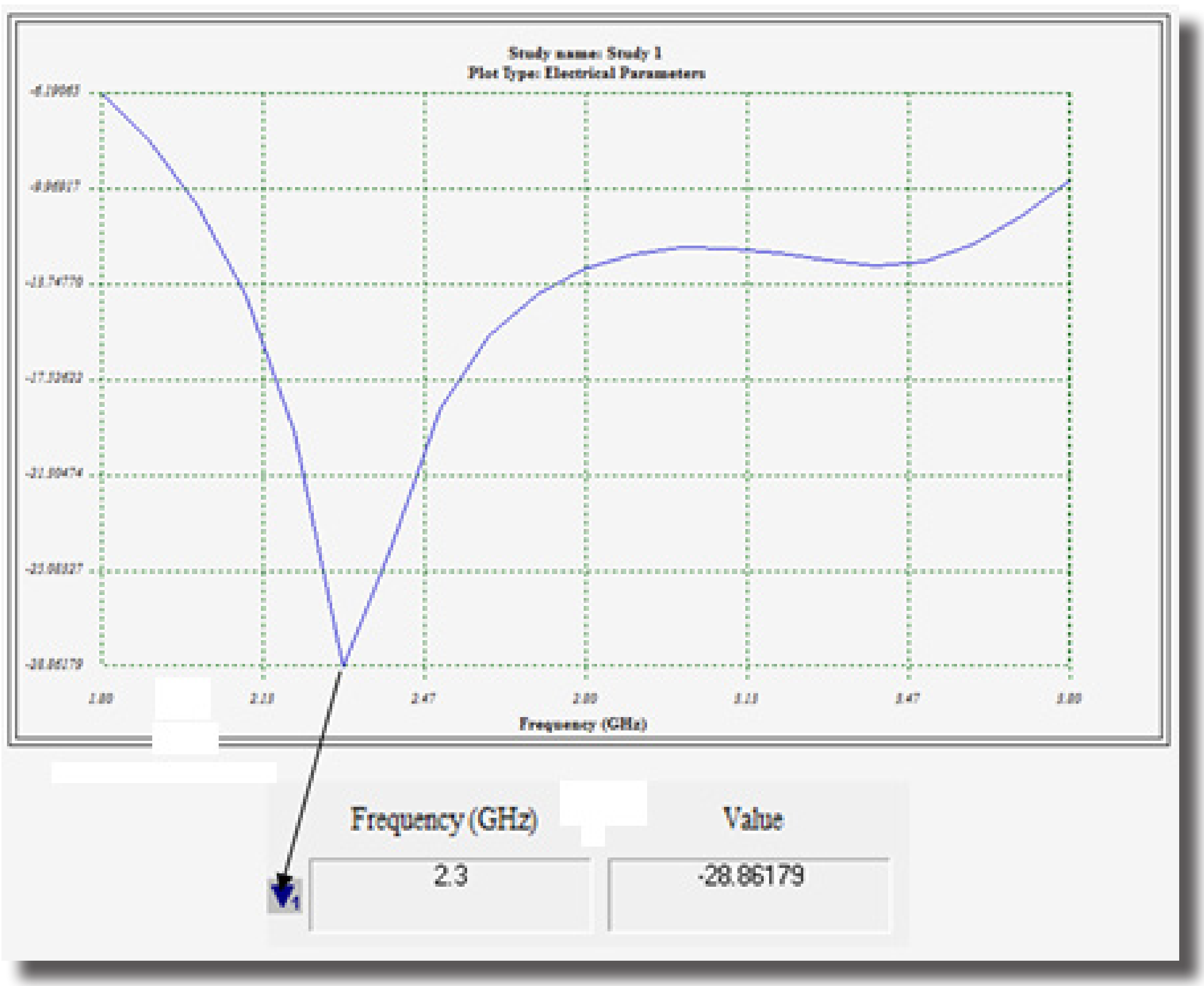



**Figure 4: Variations of reflection coefficient at the antenna's port**

The polar plots of the antenna parameters cover a wide range of parameters: radiated electric field, radiation intensity, directivity, gain pattern, axial ratio... etc. We can simulate, plot and animate the electric field distribution on the antenna wire. This is a plot of the electric field in its vector format at 2.3 GHz:

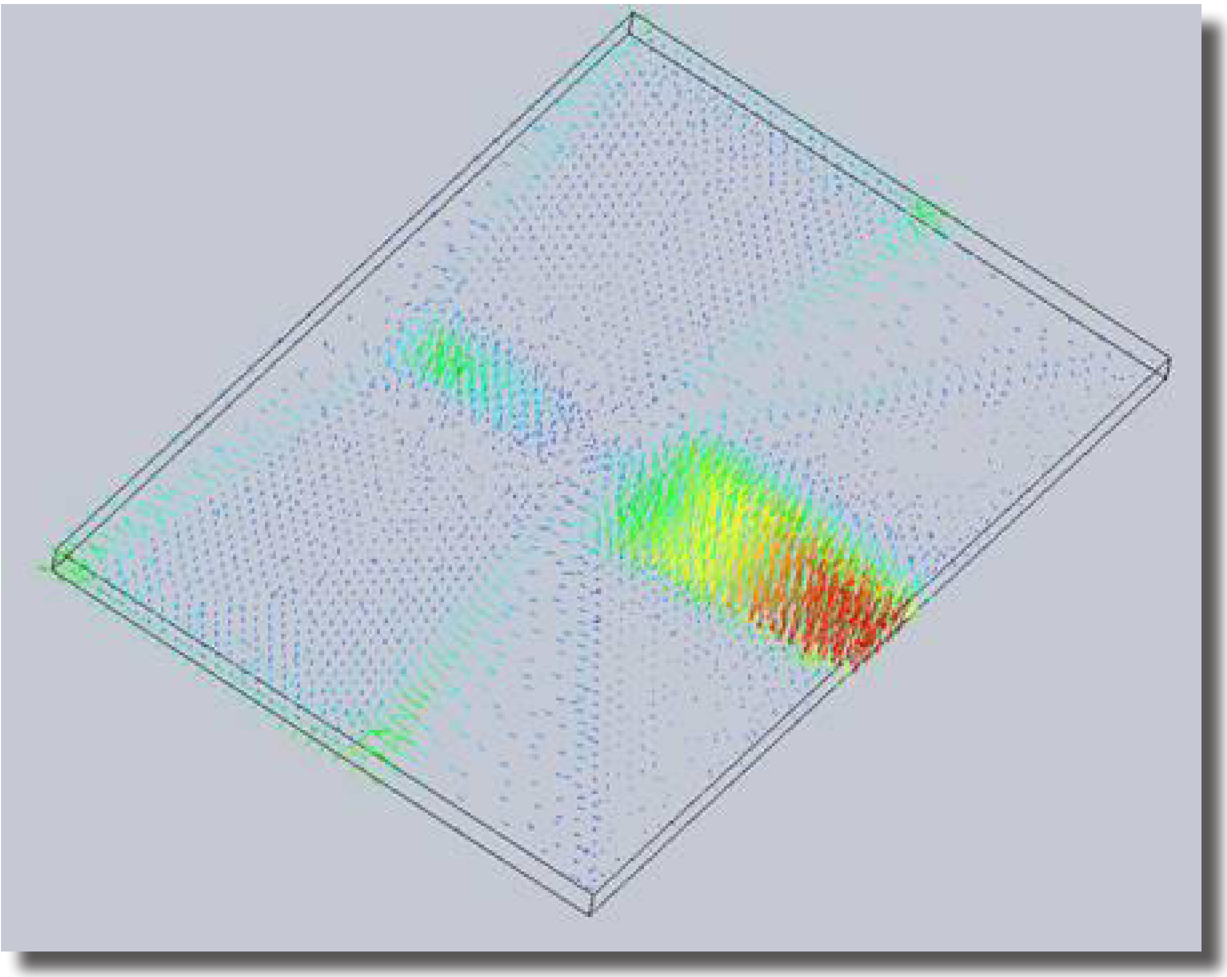
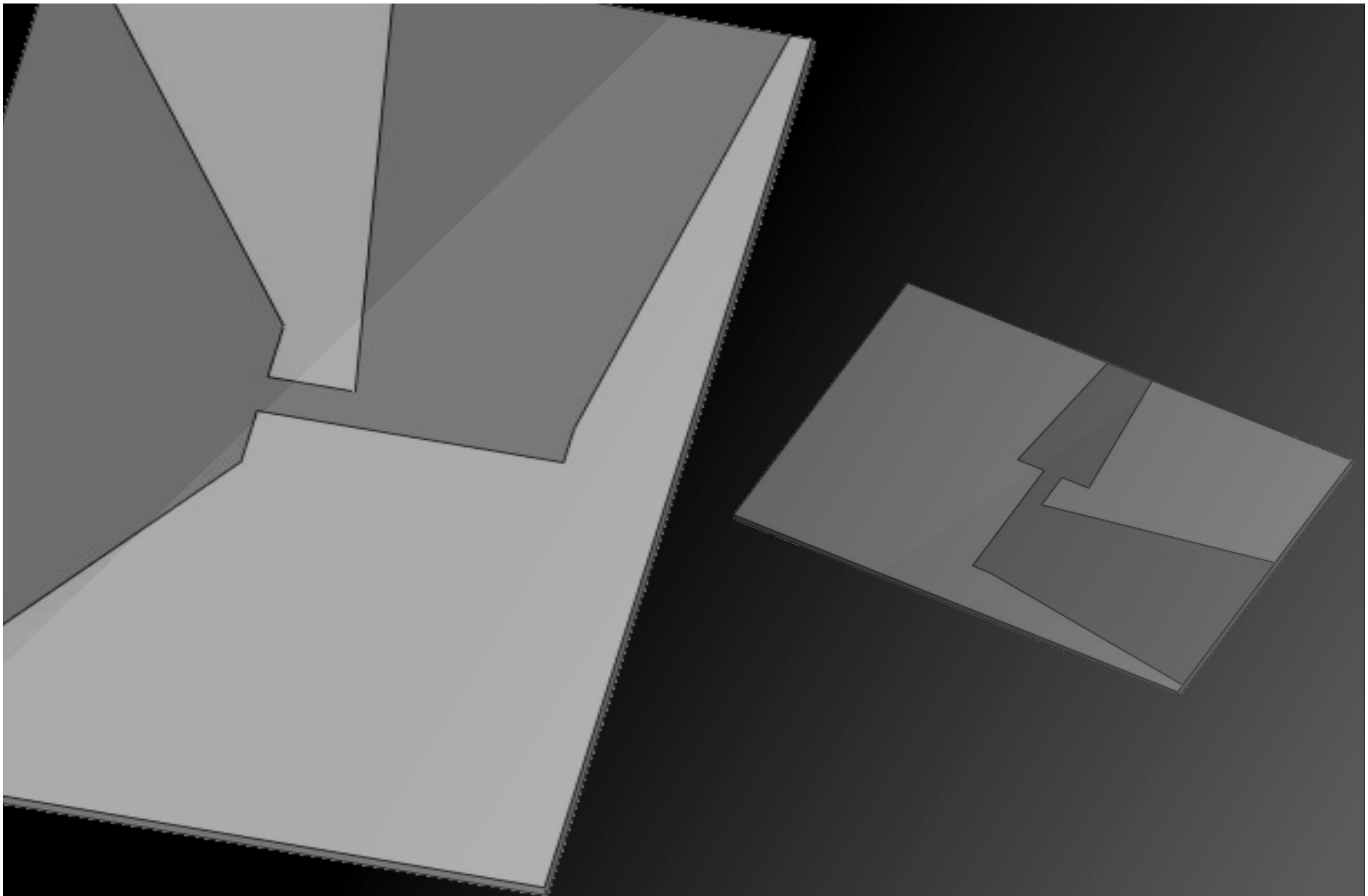


**Figure 5: Electric field vector distribution**



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