

Symmetric and Asymmetric Lamb waves- an example of a COMSOL app

When to use an app

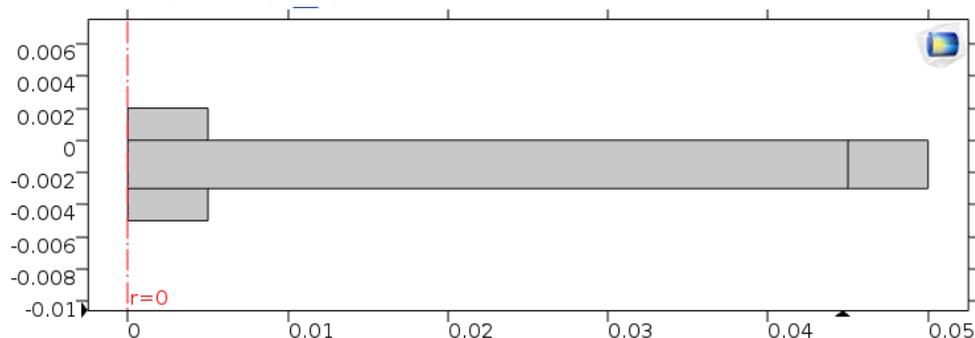
The advantages of using an app are discussed in detail at <https://www.comsol.com/comsol-server>. Briefly- apps are useful when simulations of a well-defined type need to be run by non-expert users. In this example, the app allows a user to explore the phenomena of Lamb wave generation by piezoelectric patches.

Lamb waves and piezoelectric patches

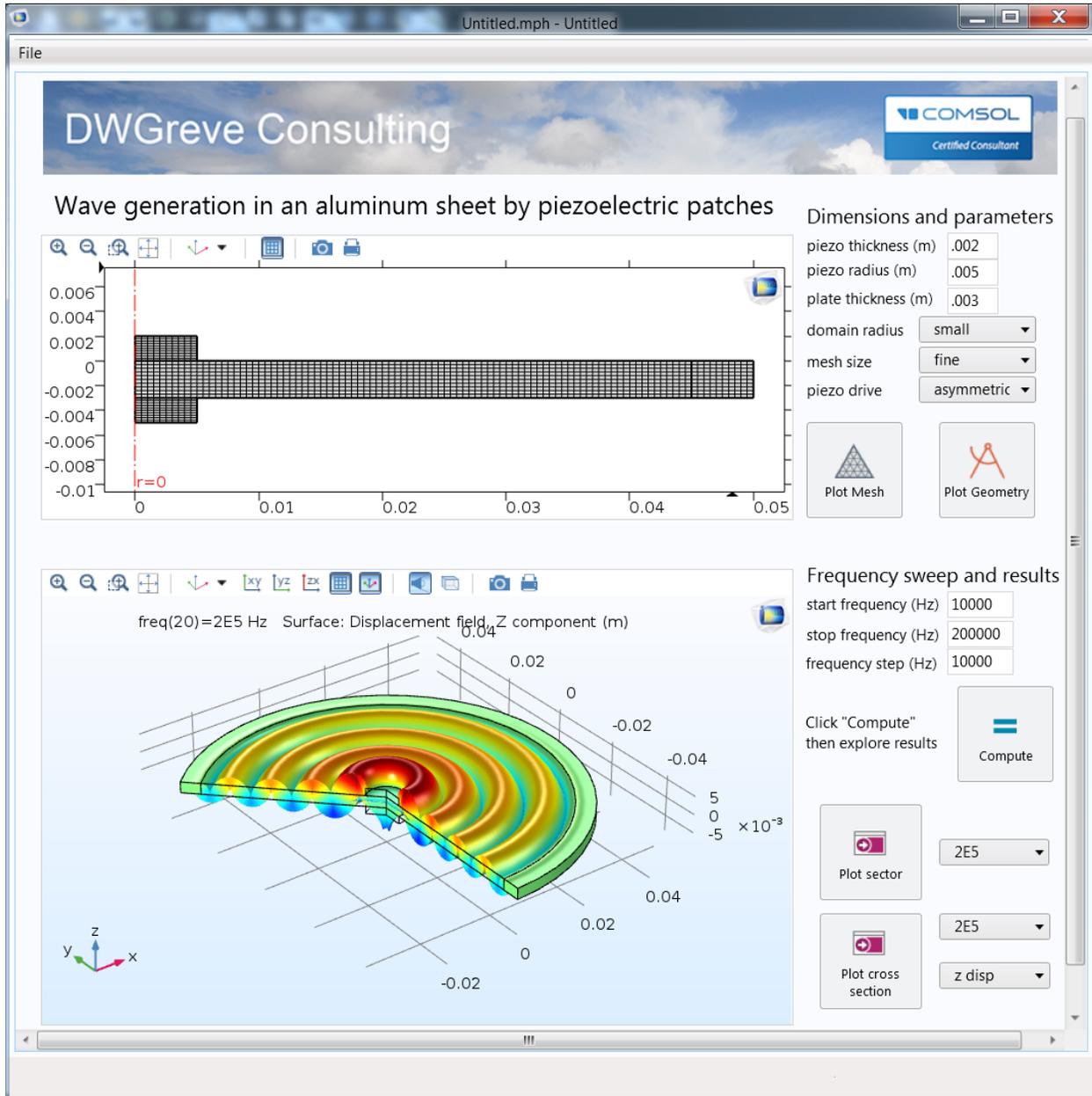
Lamb waves are wave modes that are generated in a plate when the product of plate thickness and frequency ($f \cdot d$) is small. When the product $f \cdot d$ is less than about 2 MHz · mm there are only two wave modes. One of these modes has displacements symmetric with respect to the plate centerline (designated S0) and the other has asymmetric displacements (A0). When $f \cdot d$ becomes higher, additional modes become possible (S1, S2, ...).

We can excite either symmetric or asymmetric modes only by applying forces that are symmetric or asymmetric about the centerline. One way to do this is to bond piezoelectric patches that are excited with the appropriate voltages. In this example app wave generation by two PZT-4 patches is modeled. The effectiveness of wave generation depends on the size of the piezoelectric patch compared to the wavelength of the mode. This leads to minima and maxima in the wave generation as a function of excitation frequency.

The simulation is performed using cylindrical symmetry in the geometry below. Two patches are located on top and on the bottom of the aluminum plate. An outer ring is defined as a perfectly matched layer; that is, it absorbs almost all waves arriving at the outer edge, simulating emission into an infinite domain.

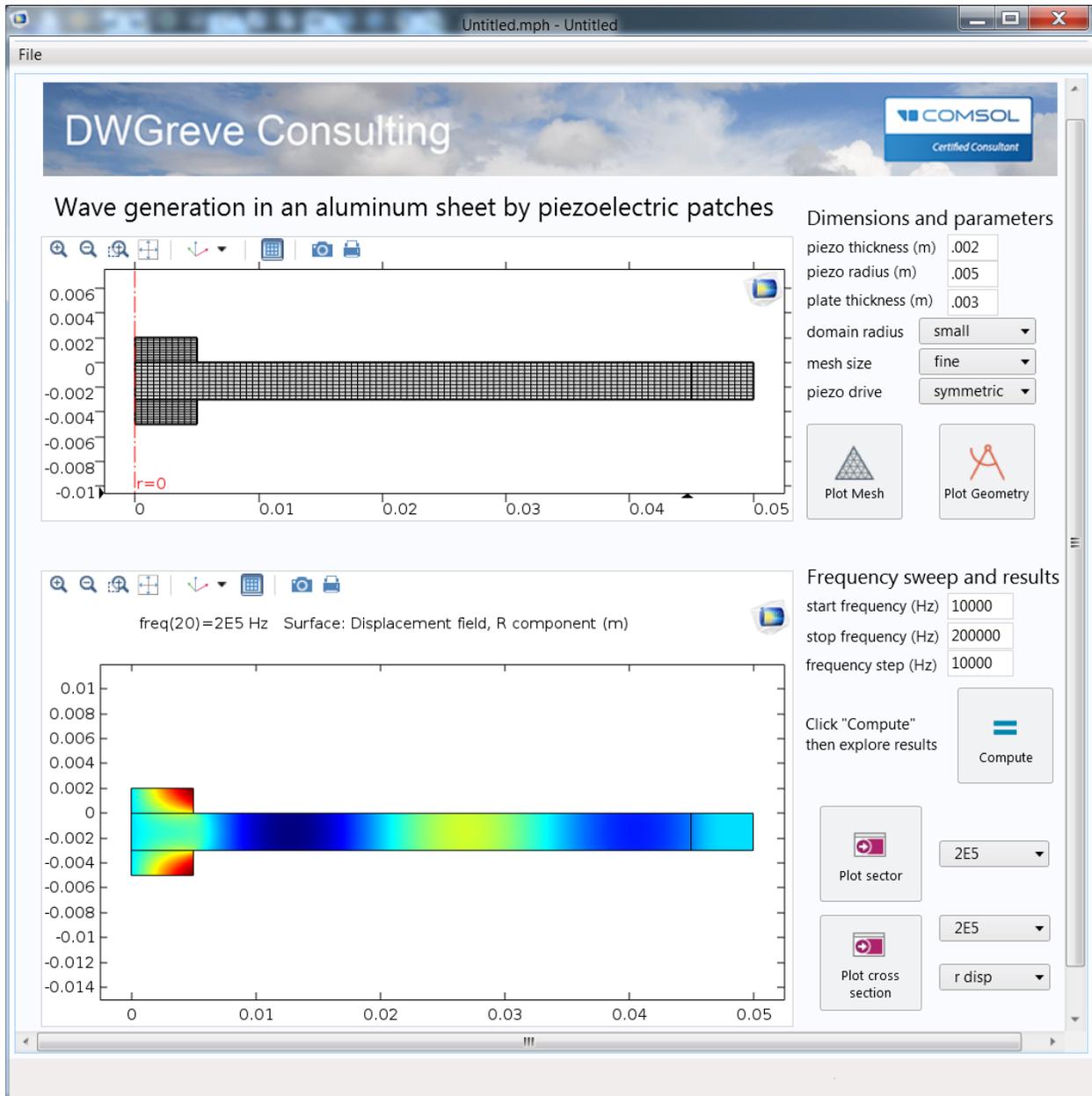


Various parameters can be change by the user, including thickness and radius of the piezoelectric patch and plate thickness. Symmetric or asymmetric drive can be selected and the mesh size and domain radius can be changed. Smaller mesh size and larger domain radius require more computation time. The simulation is performed over a selectable range of frequencies. After the simulation is completed (by selecting *compute*) The results can be plotted in various ways. The figure below shows a sector plot of the z (axial) component of the displacement along with the deformed shape. Because asymmetric excitation was selected, an A0 wave is generated.



The next figures show plots of the r and z displacements for symmetric excitation at the same frequency. This excites the S_0 wave which has a higher phase velocity and thus a longer wavelength.

r displacement



z displacement

