EZNEC Antenna Design Example
Using EZNEC to design a compact 23 cm band Yagi array
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On the home EZNEC screen, enter the frequency: 1296 MHz, an appropriate file name, and click on the title “23cm5el Clean” to name the antenna design.

Next, click on the Wires tab to enter a set of wires as shown on the following page. The antenna will need a source.

A number of features are available on the left side of the screen, and exploration is encouraged. After a few designs have been simulated, it is usually appropriate to copy, rename, and modify an existing design rather than starting from scratch.
The Wires table pops up when the Wires tab is clicked on the home page. Enter a diameter for the wires, and enter wires using coordinates for endpoints. A sketch helps at this point. Error messages will pop up if wire ends are inside each other, which can be corrected either by using smaller diameter wire or shifting position. Note that yagi elements have odd numbers of segments. That provides a center segment and even number of segments between the center segment and wire ends. In this example, wires 2 through 5 are a folded dipole.

A drawing of the antenna appears in the View window. This provides a quick visual check that the dimensions entered into the wires table result in the expected configuration.

Note that it is generally easier to copy, move, and modify new elements after a few have been entered, using the commands in the Edit line on top of the Wires page.

When the antenna view appears as expected, press the FFplot (Far Field Plot) button on the home page.
NEC calculates the currents in all the wires, and then Far Field plots in either azimuth, elevation, or 3D. Inspect the current magnitude graphics on the antenna view. In this example, the currents in the folded dipole appear smaller than the current in the first director to the right, but each wire in the folded dipole only carries half the current. It is instructive to shift frequency and watch how currents change in the elements.

Controls on the left of the screen allow close-up views of the currents, for example, in the folded dipole driven element.
Far Field antenna patterns are calculated from the currents in the antenna view. Select either azimuth—in the plane of the yagi elements, or elevation—normal to the element plane.

One concept from array theory is that the antenna pattern is the product of the individual element patterns and the array pattern. The individual elements of a yagi array are dipoles, which have a zero in the Far Field pattern off the ends. The zeros are clearly seen in the azimuth pattern above. Dipoles also have an element pattern in the azimuth plane, resulting in a narrower total antenna pattern, compared with the elevation pattern shown on the next page. Note that Azimuth, Elevation, or 3D is selected on the home page before clicking FFplot.
The text box below the pattern includes several bits of useful information. Outer ring gain is normalized to 0 dB, and gain at the outer ring is listed in the text, to hundredths of a dB.

It is easy to be lured into the game, playing with wire lengths and spacings to obtain a few more hundredths of a dB gain, but real antenna designers use the last few tenths of a dB to optimize bandwidth, source impedance, sidelobe and backlobe levels. BUT playing the game is how we become familiar with antennas and the simulator, so it is an important activity.
It is often worth sacrificing a few tenths of a dB in simulated forward gain for a cleaner pattern, wider bandwidth, or a source impedance near 50 ohms.

The source data page below indicates that the impedance at the folded dipole feedpoint is about 72 ohms. This design started by scaling a 5 element yagi for 2m wavelength, and dividing all element lengths and spacings by 9. Elements were then scaled to smaller size wire, and a Far Field pattern run for a quick look at the scaled design. It was not bad at 1950 MHz, so the elements were shortened by another 3% and rounded to convenient dimension.

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EZNEC+ ver. 5.0

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---------- SOURCE DATA ----------

Frequency = 1296 MHz

Source 1
Voltage = 71.88 V at -0.3 deg.
Current = 1 A at 0.0 deg.
Impedance = 71.88 - j 0.3762 ohms
Power = 71.88 watts
SWR (50 ohm system) = 1.438 (75 ohm system) = 1.044
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This design represents about one hour of work in the simulator by a skilled designer, familiar with the tool. A few more hours work might result in reduced back and sidelobes, and a source impedance closer to 50 ohms. At that point it is important to build and measure the actual antenna, as that will reveal some constraints and opportunities that aren’t obvious in the model.