

# Data Processing School :: Exercise 45

<b>Source directory</b>	/data/lofarschool/data/exercise 45
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## Context

This exercise will demonstrate how some simple Python commands can help visualize how a single polarization of the LOFAR low band antennae responds to electromagnetic radiation.

## Prerequisite

Basic python.

## Description

This exercise describes two functions you can use in this exercise to visualize the LOFAR LBA beam. The beam model is an analytic solution to how a single polarization of the LBA (e.g., “x”) sees electromagnetic radiation from the sky. This model only applies to a single polarization that is rotated 45 degrees relative to local north. For the x+y sensitivity, imagine rotating the sensitivity pattern of x by 90 degrees and adding it to the original pattern.

The exercise consists of two functions that can plot either one or a set of slices through the beam.

1. “show\_azimuth” requires as input the observing frequency and an azimuth value. It then plots a slice through the beam at that frequency and azimuth (from horizon to zenith). Azimuth=0deg is due north and increases to the east.
2. “show\_elevation” is the same, but plots a slice through the beam at a given elevation, starting from azimuth zero through 360 degrees.

Both functions can take one input value of azimuth or elevation. They can also take lists of multiple azimuths and elevations. A list in python is defined with square brackets, e.g., “[10., 50.]”.

## Files & Directories

The following files are found in the exercise directory:

1. `coordinates_mod.py` – A Python script the does coordinate conversion. Not used directly.
2. `exercise.py` – A Python script that defines a few functions for plotting the beam amplitude.
3. `inputs` – A directory for associated files and libraries. Not used directly.
4. `inputs_old` – An old inputs directory. Not used directly.
5. `lofar_beams.py` – A Python script that reads in the LOFAR LBA beam model. Not used directly in the exercise, but could be fun for experimentation.
6. `README.txt` – File that introduces the exercise and problems.

## Step-by-step instructions

Use these functions to answer the following questions.

1. Imagine a cell phone tower that is 50m tall and located 50km away to the east. How much will the x-dipole signal be reduced by the beam sensitivity at 30. and 80. MHz?
2. What is the elevation of the x-dipole half-power point for frequency = 30 MHz and azimuth = 0.,  $\pi/8$ ,  $\pi/4$ ,  $3\pi/8$ ,  $\pi/2$ ,  $\pi$ ?
3. How is the x-dipole beam pattern is symmetric in azimuth? How often does it repeat itself in a full 360 degrees? How often would the x+y dipole pattern repeat in 360 degrees?
4. Estimate the most that the x+y beam amplitude changes with azimuth at 30 and at 80 MHz?
5. At what frequency between 30-80 MHz does the x+y beam have the least structure (most smooth)?

## Example outputs

Here is are quick exapmles of how you can run the two functions:

```
# first, run python interactively and import the script.  
> ipython -pylab  
>>> import exercise
```

```
# this shows an azimuth slice through the beam at 30 MHz toward the east.  
>>> exercise.show_azimuth(30e6,90.)
```

```
# this shows three elevation slices through the beam at 80 MHz.  
>>> exercise.show_elevation(80e6,[10.,30.,50.] )
```

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