Alternating Direction Implicit Method in 2D

This homework assignment concerns the implementation and usage of the ADI method. Your task is to implement it with the help of functions developed for the previous homework assignment.

Note: For simplicity, assume that the computational grid has equidistant spacings in both transverse dimensions.

Hint: The sources in exercise package EP111 can be perused for inspiration. Keep in mind, especially if you write in Matlab and use vector notations that incorrect access into various arrays is the most common source of problems during de-bugging.

Deliverables:

A) Implement your own ADI BPM solver to simulate beams propagating in vacuum.

B) Use a (two-dimensional!) Gaussian beam solution to demonstrate that your ADI-BPM works properly. Choose parameters as you deem fit, and plot the $y = 0$ trace through both the numerical and analytic solution thus demonstrating that they are close as they should be.

C) Optional: Implement an extension of the code for the white-noise based measurement of what is now numerical dispersion surface. We have looked in the class at how one can obtain the $k_y = 0$ trace of this surface. Use Fourier transform on the fly to obtain and store the data to visualize the dispersion for a fixed wave-vector direction: $\vec{k} = k[\cos\alpha, \sin\alpha]$.