

*Assignment 4*  
*Date handout: 19/12/2023*  
*Name: Elisabeth and Joshua*  
*Deadline: 12/01/2024*

## **Assignment 4: 1D beamforming of real experimental data**

Study sections 8.1 and 8.2 of the lecture notes on Aircraft Noise and Emissions, Introduction to Aircraft Noise. Study the background slides on this assignment as provided on Brightspace.

Hand in a concise report, documenting and discussing the results and outcomes of the questions below. Add to the report a listing of the program used.

Load the data as provided on Brightspace for this assignment. These contain 1 second of data for 128 hydrophones (underwater microphones). **Please realize that the sound speed underwater is 1500 m/s so this value should be used throughout this assignment number 4.** The sample frequency is 6000 Hz. The spacing between the microphones is 2 m.

1. What is the highest frequency at which you can do beamforming at a steering angle of  $0^\circ$  without having grating lobes?
2. What is the highest frequency at which you can do beamforming at a steering angle of  $90^\circ$  without having grating lobes?
3. Beamform the data and produce the 2D plot of the result versus steering angle and frequency. See for example outputs the last slide of the background material provided on brightspace for this assignment.
4. Interpret the result by plotting the expected grating lobe positions on the beamform plot.
5. Interpret the result by plotting the expected beam width (frequency dependent) on the beamform plot (for the real targets).
6. Indicate the useable area of the beamform plot for the general cases, i.e., where the aim is to localize the direction from which a **narrow band signal** originates. Also make use of your answers at questions 1 and 2 of this assignment.