Vakhtang Chulukhadze 22' and Mathias Hansen 22'
Supervised by Marvin Doyley

In medical ultrasound, arrays of piezoelectric transducers are used to image biological tissue. Synthesizing images from ultrasound waves that are reflected back to the transducers from the boundary of various media often utilize beamforming algorithms which help increase the quality of the constructed image in a variety of ways. Currently, the most widespread algorithm is known as Delay-And-Sum (DAS). It offers low computational complexity and is considered a conventional beamforming algorithm as its operation is mostly independent of the data received. However, medical Ultrasound imaging also uses adaptive beamforming methods which utilize the received data to increase the accuracy of the process at the cost of computational complexity.

Mathias Hansen (left) and Vakhtang Chulukhadze (right)

Throughout the summer of 2021, Vakhtang (Vato) Chulukhadze and Mathias Hansen, worked on developing a Minimum Variance Distortionless Beamformer (MVDR) for the Parametric Imaging Research Laboratory using robustness techniques like sub-array averaging and diagonal coefficient loading. The minimum variance algorithm offers a substantial increase to image resolution over DAS, increasing the main lobe of the system's directionality pattern, and reducing the side-lobes in gain. To improve on the increased computation times of the minimum variance algorithm, the approach was to explore and implement parallel programming on GPUs using Nvidia's CUDA parallel computing platform.

As a result of this process, the students were able to deliver results on an image of a bright Cyst; the difference between the DAS algorithm and the MVDR algorithm can be viewed with the naked eye in figure 1.

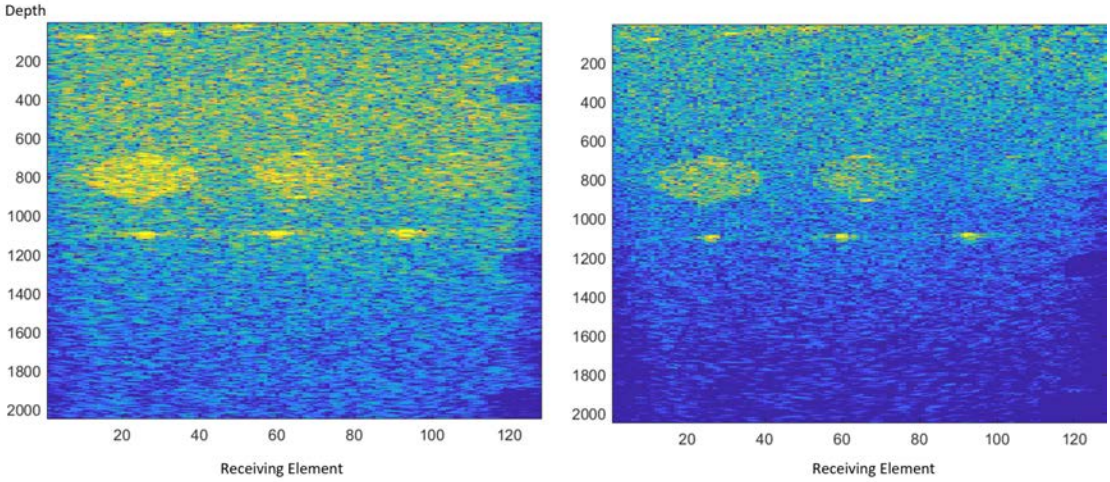

Figure 1 The DAS algorithm (first) and the MVDR algorithm beamforming the same data