Space Taper: A Spatially Tapered Phased Array Antenna for Future Space Communications

Nehir Berk Onat, EEMCS faculty

The current progress of the project is listed as follows:

- In conventional array designs, idealized elements are considered during the synthesis process, which neglects an important electromagnetic effect, mutual coupling. Estimating this effect becomes more important in aperiodic arrays due to the layout irregularity. Thus, a new deep learning methodology is currently being studied to predict the active element patterns with respect to the position of an element.
- The realization of the feeding network for the circularly-clustered array prototype is one of the important challenges of this project. Several simulations are required to find an optimum design. An MSc student was selected to do his extra project to support us on this challenge for the next three months.
- An element design has been developed for the initial array prototype. The element design is currently being improved.

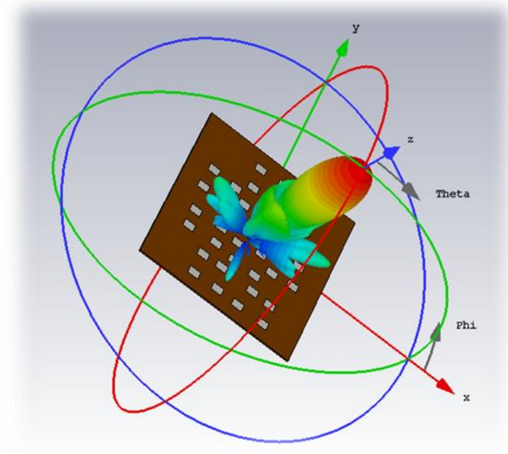


Figure 1: 36-element aperture coupled microstrip patch circularly-clustered array

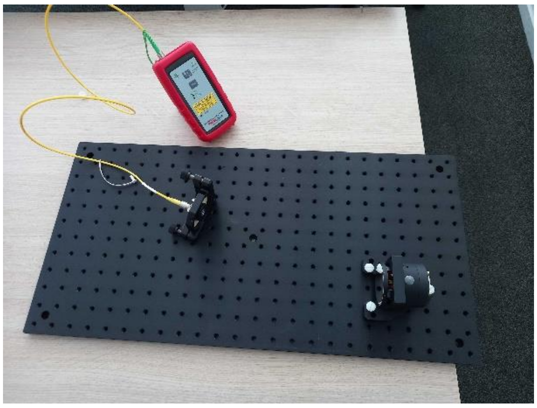
Free Space Optical Communications Testbed

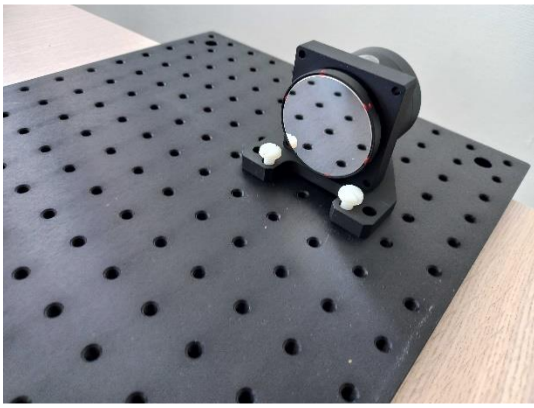
Joshua Spaander, AE faculty

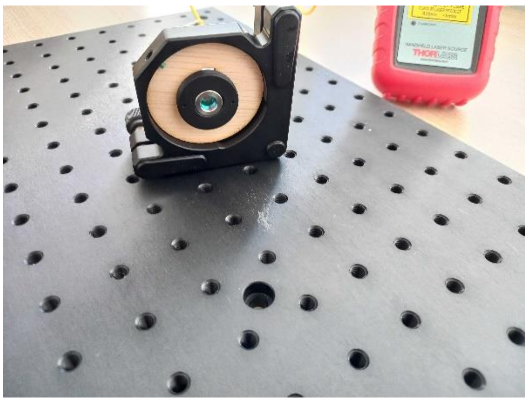
After consultation with experts a plan was drawn up to build the setup. Experimentation with phase 1 of the FSOC testbed has started. We have purchased lenses, optical breadboards and mirrors to guide light. A breadboard format was chosen which is both portable and standardized for a large variety of optical components. This should allow the testbed to facilitate a very diverse set of experiments in the lab and in the field.

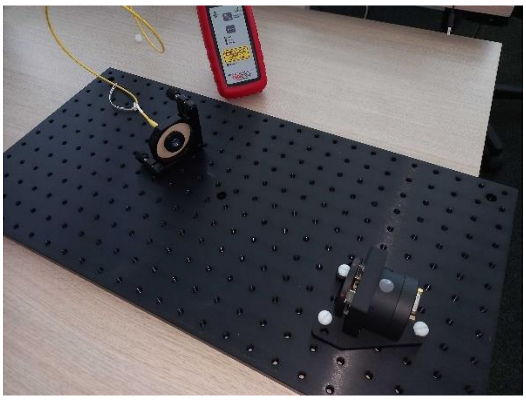
Furthermore, the optical components selected are the largest standard optics we could find, 2" in diameter! This is to accommodate large beams. The benefit of using larger beams is that they diverge less and can hence travel longer distances. It would allow the FSOC testbed to be used over a large range of distances to test new steering solutions and measure atmospheric effects.

Lastly, to eliminate vibrations and jitter, we are experimenting with a Fast Steering Mirror (FSM) shown here:









Hundred colours of galaxies validating ultra-wideband sub-mm spectroscopy

Matus Rybak, EEMCS faculty

In the first phase of this project, we are focusing on setting up the computing resources and the data-processing pipelines. We started by ordering a powerful computer to process and store data from DESHIMA. Now we are waiting for it to make it through the clogged supply chains to our office.

The computer is on its way, but how will we process the data? With Liam Ligthart (BSc Applied Physics), we have investigated a noise-removal algorithm SPLITTER on an extensive set of simulated observations. These simulations took over 20,000 CPU hours to create.

We find that SPLITTER indeed significantly improves the extraction of emission lines, including fainter lines that might be otherwise lost in the noise. An algorithm that can find weak signals makes a difference between detecting a galaxy and not!

Yet there are still challenges to overcome: SPLITTER tends to overestimate broadband continuum signals. We are working on understanding the cause of this problem before the actual data start coming in.

Advanced Background Subtraction for Terabyte-Sized METIS/ELT Imaging
Time SeriesThrough GPU-Accelerated and Memory-Constrained Algorithms

Roger Moens, 3ME faculty

In the search of planet-forming zones, the METIS instrument at the European Extremely Large Telescope (ELT) has the ability to detect faint signatures among noisy measurements. However, traditional chop-nod techniques for reducing thermal background are not practical due to the weight of this multi-ton telescope. While METIS has a dedicated chopper, the ELT might not be able to match the nodding requirements to reduce chop residuals (see Figure 1). Therefore, we proposed a novel matrix-based model to capture spatio-temporal properties of these residuals, to separate them, and ultimately to reduce the thermal background. Besides model development, we are empirically testing our methodology on existing VISIR/VLT data, a METIS predecessor. The next steps in our project consist of (1) defining quality metrics, (2) comparing to chop-nod methods, and (3) settling on the final model and estimation method. These will then be further optimized for handling terabyte-sized METIS/ELT imaging time series through GPU-acceleration.

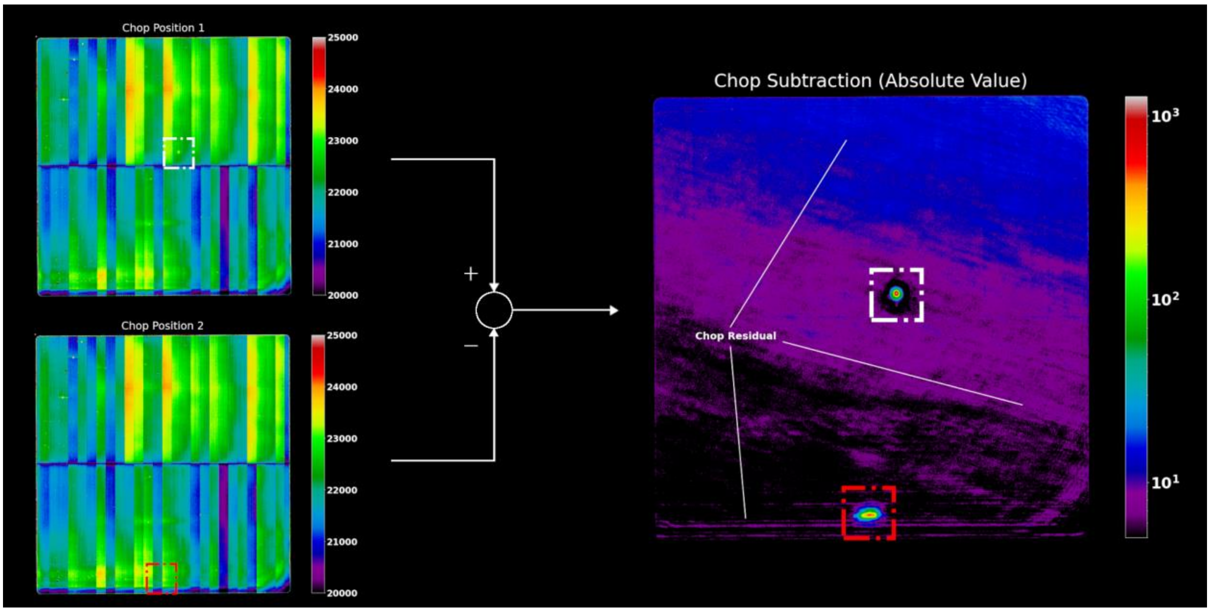


Figure 1: Chop residual example of the subtraction of two chop positions (left images) to reduce the thermal background for VISIR/VLT data. On the right image a “background” gradient is observed, which is part of the chop residuals. It can be seen that the object of interest (in white and red boxes) are faint in comparison to the background in both chop positions on the left, and are readily detectable in the subtracted image on the right