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Circular TTFD array design for omnidirectional FoV

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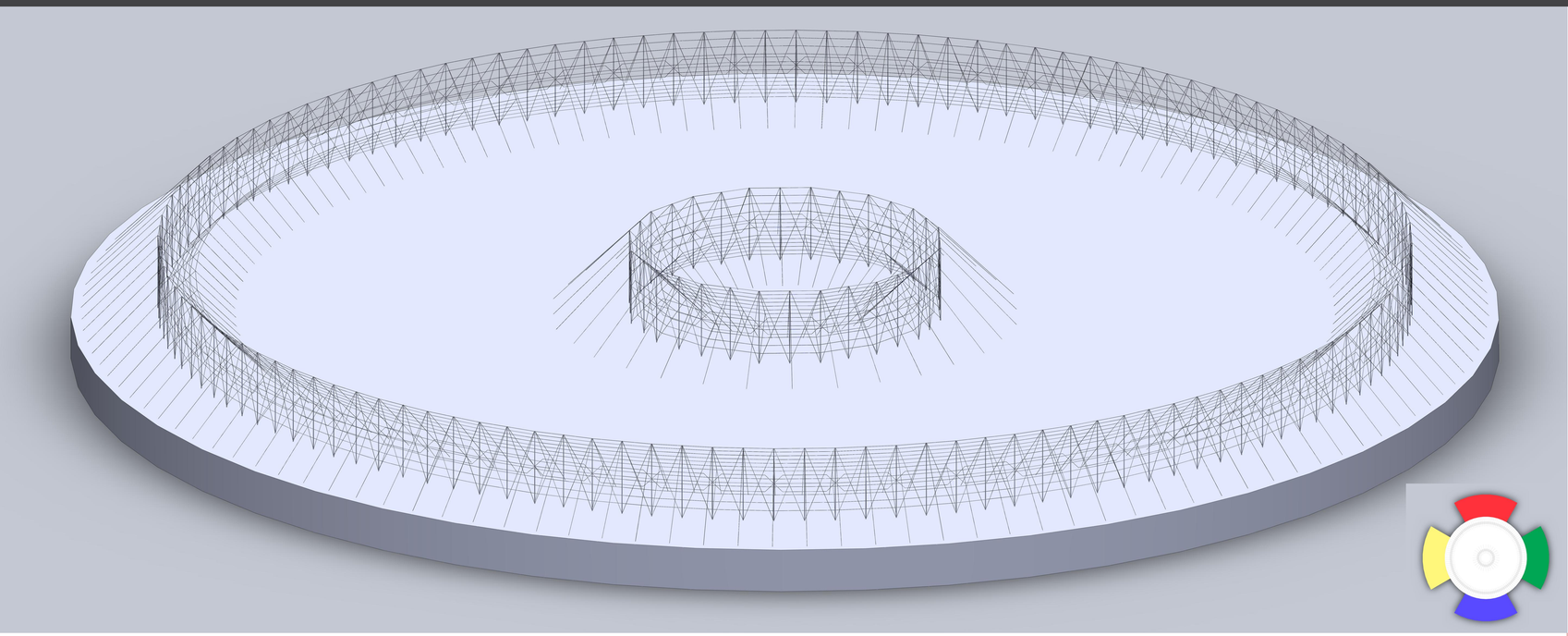

Figure 1: Artists impression of a circular TTFD array. 64 element outer array, 16 element interferometer array. Total diameter 300m. Inset: multiple simultaneous beams.

INTRODUCTION

Existing SuperDARN RADARs typically have a Field of View (FoV) of approximately 52°. Recently postulated designs, such as the Twin Terminated Folded Dipole work by Dieter Andre, Ray Greenwald, Edhem Custovic and Mick Parsons, have shown that a much wider FoV is possible with different antenna designs, up to around 100°. [1],[2],[3]

We propose a 64-transciever circular array with 14 metre spacing between elements, which makes for a roughly 300 metre diameter array. With an array of this size, we can select an arc of 16 transmitters in any given direction, with similar gain to a 16-element linear array (see Figures 2a and 2b).

This configuration opens the door to many new operational modes, in particular, the ability to send beams in various directions simultaneously. It provides for uniform beam-forming across the entire horizon, whereas a linear array will have significantly worse beam at its' extent.

Several simultaneous beams allow for multiple operational campaigns at any given time. This will provide additional discretionary options. In addition to normal SuperDARN modes, a circular array could spend time observing Sea State, or other as-yet unconsidered modes.

PROJECTED RESULTS

The two graphs below show calculated azimuth gain plots for circular and linear arrays, with 10MHz on the left, and 14MHz on the right.

It is apparent that there isn't significant degradation of the output signal, and that sidelobes will be less prevalent with the circular array. Also consider that a circular array has no need for extended beam aiming, as one can simply choose a different arc of antennas in order to move the beam. This means that beam-forming can be consistent across the horizon.

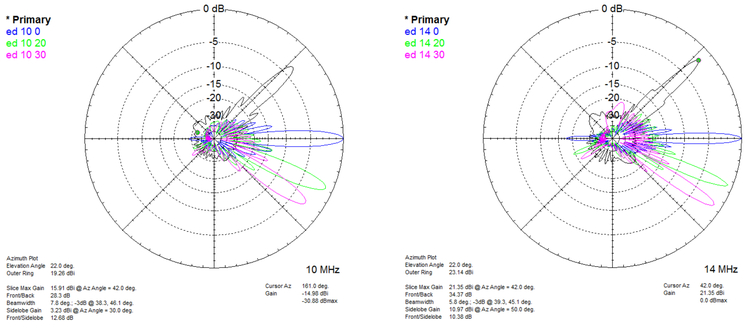

Figure 2: a) Plot of 10MHz TTFD performance b) Plot of 14MHz TTFD performance
The **black** trace is the projected circular array, **Blue**, green and pink is the a linear array aimed at 0, 20, and 30°.

IMPLEMENTATION

A complex array shape like this requires a much more complex phasing algorithm for beamforming than has been possible in the past. TIGER-3's FPGA based transceiver is more than able to handle these new challenges. Additional complexities come in the form of timesharing the transceivers for the multiple simultaneous beams.

A complete 80 transceiver array has a projected hardware component cost of less than $US 1,000,000, not including time or site works.

Much of the ongoing work for TIGER-3 will be applicable toward this project.

CONCLUSION & WORK TO COME

Looking toward the future, complex array geometries allow for a wider range of RADAR operations and enable more research to be conducted, with lower site overheads and greater flexibility in operational campaigns. This project may be of interest to other research bodies within Australia and overseas.

- Further modelling is required to determine the effects of a spread-butterfly design, which would halve the number of poles require (see Figure 3).
- Funding applications will be made in 2012 for a Newcastle, Australia site.

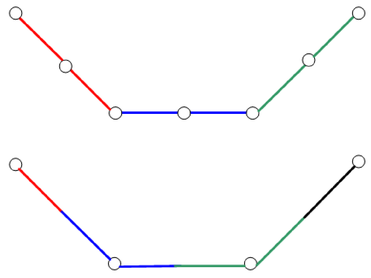

Figure 3: top) Conventional TTFD circular array.
bottom) Spread-butterfly TTFD circular array.
Circles denote poles, and coloured lines active elements.

REFERENCES

[1] Andre D., Greenwald R., Marshall W., "A new antenna for SuperDARN", SuperDARN workshop 2003

[2] Custovic, E., Devlin, J., Whittington, J., Console, A., "Three-wire Twin Terminated Folded Dipole array for SuperDARN Radars", Proceedings of 12th Australian Symposium on Antennas, pp 33-34, Sydney, Australia, 16 - 17 Feb. 2011

[3] Custovic, E., and Console, A. "TTFD Array Variations for TIGER 3",International SuperDARN Conference Proceedings, Hermanus, South Africa, June 2010