



Phased array receiver tile with microwave photonic beamforming

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Microwave photonic technologies have a broadband performance and a relatively large bandwidth distance product characteristic when compared to existing analog electronic technologies, which makes them attractive for application in radio astronomy systems.

Since several years, the use of analog optical signal transport technology has been a viable solution for transporting signals from telescope antennas to a central signal processor [1]. Thanks to advances in the production of optical communication components, low cost, long distance RF over fiber technology is commercially available nowadays, enabling e.g. an antenna remoting architecture for the LFAA telescope of the SKA [2].

Although microwave photonic signal processing like photonic beamforming could in principle be attractive for use in radio telescopes as well, this technology is currently not sufficiently mature to play a proper role in present day operational radio telescopes. For investigating the status and capabilities of integrated microwave photonic technology, a four channel photonic beamformer IC is applied in a phased tile. The performance of this photonic phased array tile is currently being tested at ASTRON. The integrated photonic beamformer is fabricated as a Silicon Photonics IC by IBM Research Zurich. In the photonic beamformer ring resonators [3] are used to generate a true time delay in the 0.5 to 1.5 GHz frequency band. For testing the photonic beamforming, the photonic technology is applied in ASTRON's Low Noise Tile (LNT) [4], in which four external modulated optical analog links are used for the transfer of the signals from four LNT antennas to the photonic beamformer IC. During the presentation the design of the photonic phased array tile will be explained and the first experimental results will be provided.

1. See: <http://www.ncra.tifr.res.in/ncra/gmrt/gmrt-users/low-frequency-radio-astronomy/ch22.pdf>

2. See: www.skatelescope.org/lfaa/

3. Meijerink, A., Roeloffzen, C.G.H., Meijerink, R., Zhuang, L., Marpaung, D.A.I., Bentum, M.J., Burla, M., Verpoorte, J., Jorna, P., Huizinga, A. and van Etten, W.C. "Novel ring resonator-based integrated photonic beamformer for broadband phased array receive antennas - part 1: design and performance analysis", *Journal of Lightwave Technology*, 28, 2010, pp. 3-18

4. E. Woestenburg, R.H. Witvers, M. Ruiters, P. Benthem, "Improved sensitivity of a low noise aperture array tile for the SKA", *International Conference on Electromagnetics in Advanced Applications (ICEAA)*, 2014, doi: 10.1109/ICEAA.2014.6903844