# Wide Scan-Range PAF Telescope for Massive-MIMO 5G Base-Stations

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With the emergence of the mobile fifth generation (5G), additional challenges are introduced for the radio access antennas at the base stations that operate at mm-waves [1], [2]. The base station antenna is then required to deliver high effective isotropic radiated power (EIRP) to compensate for the high path loss at mm-wave frequencies. Furthermore, the massive Multiple Input-Multiple-Output (MIMO) concept is aimed to be applied to increase the overall system capacity. For these reasons, assuming traditional phased arrays, the number of antenna elements is expected to be large, which will lead to high power consumption and the need for active cooling. The phased array fed (PAF) reflector antenna concept was proposed as a solution in [2] aiming at utilizing the reflector's high gain to produce high EIRP. That can be achieved by utilizing a small number of active elements in the focal plane thanks to the reflector antenna's focusing properties. Moreover, multibeam generation and steering is provided by exciting different antenna elements in the reflectors focal plane. This way, high EIRP can be generated while reducing the power consumption.

A base station cell sector of 150 m radius and ±30˚ scan range is chosen as a use case for our designed PAF reflector. The antenna operates at 28.5 GHz, and a gain of 36 dBi is set as a design goal based on link budget calculations. The wide scan range toroidal PAF reflector antenna in [3] was chosen as a reference design. The reflector surface is obtained by rotating a parabolic curve around a tilted axis leading to flat performance over the entire scan range when moving the feed along the focal arc. The scanning performance is demonstrated in Figure 1 where the reflector is fed with gaussian feeds from different points on the focal arc. Due to the antenna down-tilt in typical base station scenarios, the reflector's geometry is tuned to provide an adequate cell coverage. Furthermore, the reflector's size is limited to be in the order of the size of the currently existing base station antennas. The resulting reflector is presented in Figure 2. An array of patch antennas is then used as the focal plane array (FPA) model to feed the reflector. Having the reflector geometry and the FPA model the antenna system is simulated in different user scenarios and its performance is then demonstrated in terms of gain, EIRP, and number of active antenna elements per transmission. At the symposium, the designed PAF reflector will be presented along with relevant simulation results of the past and ongoing research.

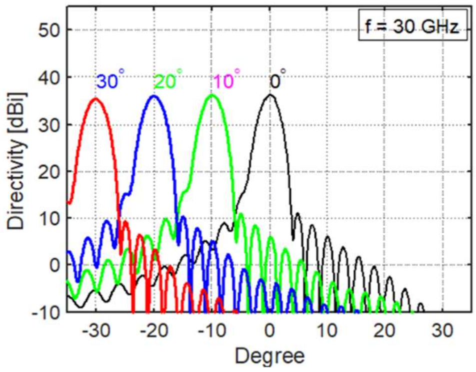


**Figure 1** Torus reflector scan performance.

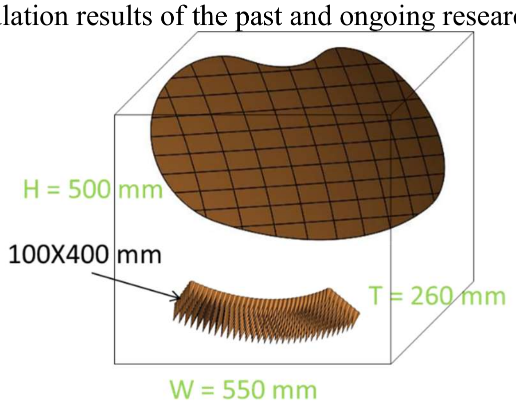


**Figure 2** Torus reflector antenna system.

[1] U. Johannsen, T.A.H. Bressner, A.A.H.M. Elsakka, R. Maaskant, M. Ivashina, and A.B. Smolders, "PAF telescope technology for 5G base-stations", in PAF reflector workshop, Sydney, Australia, p. 51, Nov. 2017.

[2] A. Elsakka, T.A.H. Bressner, A.J. van den Biggelaar, A. Al-Rawi, U. Johannsen, M.V. Ivashina, and A.B. Smolders, "On the Use of Focal-Plane Arrays in mm-Wave 5G Base Stations", in Proc. EuCap, London, UK, April 2018.

[3] O.A. Iupikov, M.V. Ivashina, N. Skou, C. Cappellin, K. Pontoppidan, and C.G.M. van't Klooster, "Multibeam Focal Plane Arrays with Digital Beamforming for High Precision Space-Borne Ocean Remote Sensing", IEEE Transactions on Antennas and Propagation*, vol.* 66, no. 2, p. 737--749, 2018.