Effect of Phase Slippage and Higher Order Beam Modes in a 340GHz Focal Plane Array Optics

Axel.Murk*, Mark Whale, Matthias Renker
University of Bern, Institute for Applied Physics, CH-3012 Bern, Switzerland
* Contact: murk@iap.uninbe.ch

***Abstract*— Focal plane arrays (FPA) are an efficient way to improve the the mapping speed and integration time of single dish observations in radio astronomy and microwave remote sensing. An example is the multi-beam limb sounder STEAMR (Stratosphere-Troposphere Exchange and Climate Monitor Radiometer), which is currently being developed under the lead of the Swedish Space Corporation for the next ESA Earth Explorer Core Mission PREMIER. The instrument consists of a linear array of fourteen 313-355 GHz receivers, which will provide simultaneous observations of the Earth's atmospheric limb at different tangent heights. The STEAMR optics consists of a Ritchey-Chrétien telescope and astigmatic transfer optics which generates the desired elliptical beam profiles with a 2:1 aspect ratio. While these first reflectors M1 to M6 are shared by all fourteen beams of the instrument, the signals are split in the FPA optics by means of a polarizing wire grid and two facet reflector assemblies which are matched to the corrugated feed horns of the receivers. In order to meet the scientific goals of the PREMIER mission it is essential to achieve a high beam efficiency, low sidelobes, high pointing stability and frequency independent performance for each of the fourteen channels.**

The overall optical design of STEAMR is described in Whale et al., EuCAP 2011. In this paper, we will focus on the design trade-offs of its focal plane array optics, and in particular on the effect of phase slippage and higher order beam modes on the system performance. The facets of this focal plane array are tightly packed and maintain a relatively high level of truncation in comparison to typical millimetre-wave reflector optics. Specific attention is paid to maximizing the throughput for the array optics. We present results of higher order Gaussian Beam Mode analysis and GRASP Physical Optics simulations for different geometries with both standard and optimized multi-moded corrugated feed horns.