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Design of the high field side antenna of the new reflectometric system for plasma position estimate in RFXmod2

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In the framework of the ongoing refurbishment of the RFX-mod torus [1, 2], a new K-band (18-26 GHz) reflectometric system will be installed, consisting of 4 couples of transmitting/receiving antennas working in O-mode and X-mode wave propagation for RFP and Tokamak discharges, respectively. They will be placed within dedicated plasma accesses in the same poloidal section at 4 equispaced poloidal positions, two on the equatorial plane, High Field Side (HFS)/ Low Field Side (LFS), and two at the vertical top/bottom ports. This configuration was conceived to perform plasma position control experiments without using the magnetic measurement signals [3]. While the accesses in LFS, top and bottom positions will accommodate pyramidal antennas, the strict room constraints in the HFS position required the design of a different type of antenna together with a special routing of the feeding waveguide. The horn reflector (also named hoghorn) type was preferred which allows radiating (and receiving) a beam at a 90° direction with respect to the horn axis, which will be perpendicular to the equatorial plane. After fixing a work reference central frequency f=21 GHz (wavelenght λ=14 mm), a COMSOL Multiphysics model of the antenna was developed with the aim of comparing the radiative patterns of different versions and optimizing the antenna directivity. As a first step of the design process, the flare angles of a pyramidal horn antenna were chosen following a suboptimal approach due to the small available room. The paraboloidal reflecting surface was then added and 4 different shapes of the antenna aperture were designed and tested. The main difference was the presence and the shape of a protruding edge built on the aperture inner short side to minimize the radiation side lobes and to improve the antenna focusing. The analyses were run for frequencies in the 17-26 GHz interval. Total field and “far-field” maps of the electric field for the different antennae are presented and standard figure of merits are compared. The compatibility of the selected version sizes with the fully equipped section of the torus was also checked. In the next months the realization of a prototype by additive 3D printing technique is planned.

References

[1] S. Peruzzo et al., Fus. Eng. Des., Vol. 123, Pages 59-62 (2017).
[2] L.Marrelli et al., Nuclear Fusion 59 (2019) 076027 (14pp).
[3] G. De Masi et al., “Design of a new reflectometric system for real time plasma position control on the RFX-mod2 device”, ECPD, Lisbon (Portugal), 2019.