SOURCES OF ABERRATIONS IN THE OPTICS FOR THE REMOTE STEERING ITER ECRH UPPER LAUNCHER

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Complex quasi-optical systems designed and developed for the ECRH Upper Launcher in ITER need to be treated with particular attention, since reflection on generic surfaces introduces aberration effects which strongly influence beam propagation even in free space.

From an optical point of view the system has to maintain sufficient steering capability and beam convergence in order to localize heating and current drive over a large range of plasma radii in ITER scenarios, limiting as much as possible the level of aberrations of the resulting beam. Principal sources of aberrations in the Remote Steering (RS) design of the ITER ECRH Upper-Port Launcher [1] are the combined double curvature mirrors employed (same set of mirrors used for different steering angles and different beam lines) and the relative orientation of such mirrors.

Effects of double curvature mirrors in specific configurations can bring a gain in narrowness of driven current profile, being only the curvature in the steering plane limited by the requirements of suitable steering range, while the curvature in the plane orthogonal to the steering plane can be optimized to keep low beam dimensions in this plane.

Moreover we find that a standard description with simply astigmatic beams is no more adequate in complex optical systems that include more than one reflecting mirrors with double curvature as encountered in the RS mm-wave system.

As a direct consequence of this setup general astigmatism emerges, whose effects must be included to describe with accuracy resulting beam propagation beam propagation towards the plasma. The main feature that characterizes these general astigmatic beams is that even in free space the orientation of the spot ellipse and phase ellipse of the resulting beam changes along the path of propagation.

Added to this, deformation effects on mirror reflecting profiles caused by thermal loads change the focal properties of the mirror, possibly leading to a resulting enhancements in beam divergence.

These aspects are thus reviewed and included in the present work, since analysis of the layouts recently developed shows the necessity of a detailed study of all these combined effects in the next optimization phase of the ECRH Upper Launcher design for ITER.

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References

[1] A.G.A. Verhoeven et al., Remote Steering Design of the ITER ECRH Upper-Port Launcher, This Conference.