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DEMO divertor tiles temperature assessment from IR measurements

R. B. Gomes[1], W. Biel[2], A. Krimmer[2], R. Dux[3], T. Pütterich[3] and M. Siccinio [3,4]

1) Instituto de Plasmas e Fusão Nuclear, IST, Universidade de Lisboa, Portugal

E-mail : gomes@ipfn.ist.utl.pt

2) Institut für Energie und Klimaforschung, Forschungszentrum Jülich GmbH, Germany

3) Max-Planck-Institut für Plasmaphysik, Garching bei München, Germany

4) EUROfusion Power Plant Physics and Technology (PPPT) department, Garching, Germany

A Divertor Parallel Observation system diagnostic is being developed to monitor DEMO divertor and X-point. Although this is primarily thought to evaluate the divertor detachment state by performing Stark spectroscopy of Balmer and/or Paschen series in the 0.35 μm wavelength region [1], the choice of used optics materials is made to allow for high transmittances up to 5 μm wavelength. This option has the benefit to allow for measurements in the visible (divertor erosion and impurity content) and in the IR regions were tungsten tiles emissivity is used to assess surfaces temperatures.

The lower limit for temperature detection range of DEMO divertor tiles has been established around 800 ºK. In this paper we evaluate the most suitable wavelength range to achieve that value with adequate accuracy. Since continuum radiation sources from the plasma compete with tungsten emissivity, a comparison of both contributions is performed. A model has been produced, using ZEMAX© optical design software, for the integration of diagnostic components' into DEMO port based diagnostic systems. The CAD version for this model provides the relevant Line Of Sight (LOS) geometry which is used to evaluate the line integrated Bremsstrahlung contribution with Gaunt factor from Sutherland [2] and for one characteristic plasma equilibrium. The obtained data is compared to tungsten emissivity for a wide range of wavelengths (0.3 to 5 μm) and temperatures (800 to 2800 ºK).

The analysis of the obtained results points to the conclusion that most accurate measurements should be achieved within the 3 to 4 μm wavelength range where tungsten emissivity (at 800ºK) overcomes Bremsstrahlung by at least one order of magnitude.

References

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