Feasibility Assessment of Bolometry as Impurity Transport Study Tool for the Stellarator W7-X

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At the stellarator W7-X, on the long run eleven bolometers in total are foreseen to be installed to monitor the plasma radiation from different poloidal directions at different toroidal positions in order to capture the 3D features of the plasma radiation originating from the edge region. One of the two initially installed nearly perpendicular systems is equipped with a double detector array, with one array covered by Be-filters to filter out the lower-energy contributions with wavelengths >1.5nm. This bolometer array is dedicated to measuring the core radiation contributed by heavy intrinsic impurities from plasma facing materials like iron, or others injected for diagnostic purposes. It consists of 32 sight-lines in total and covers the entire plasma at the triangular cross-section with a reasonable spatial resolution. A response time of 3-5ms is sufficiently fast to resolve core impurity transport processes on a time scale of interest. Thus, this bolometer can potentially be used to study the impurity transport processes in the core. A feasibility study is presented based on the impurity transport code STRAHL with Fe as a representative impurity. It is assumed that the impurity transport in the core is governed by convective and diffusive processes with spatially varying convective velocity $v$ and diffusion coefficient $D$. For a given background plasma and assumed values for $v$ and $D$, Fe atoms are started as neutrals from the plasma edge and STRAHL predicts the temporal evolution of the radial density distributions of the different ionization stages of Fe during the propagation process. The local emissivity is calculated using the ADAS database, which is filtered and then integrated along the real sight-lines to simulate the synthetic bolometer signals. The correlation between the temporal evolution of the forward calculated signals and the choices of $v$ and $D$ will be studied and demonstrated. Unknown transport coefficients to be investigated in impurity injection experiments can be deduced by fitting the calculated signals to the measured ones. The feasibility and reliability of this method is presented for both $v$ and $D$ varied over a reasonable range.