Position and dynamics of the edge visible radiating belt at Wendelstein 7-X

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A ten channel overview video diagnostic system was installed and commissioned at Wendelstein 7-X (W7-X) optimised stellarator. In the first operation phase OP1.1, seven channels were equipped with EDICAMs, 1.3 Mpixel CMOS cameras (400 fps at full frame, up to 50 kfps at 64x64 pixel), observing the visible radiation emitted by the plasma. In vast majority of the cases, visible radiation is found in a narrow layer around the plasma edge, where the conditions are favourable for visible light emission (excitation of atomic and molecular species C, H, O at suitable values for temperature and density). Since W7-X is a stellarator, the plasma is not toroidal-symmetric, and hence the observed edge radiation detected by the tangentially viewing cameras is the superposition of light intensities coming from a flux surface with a shape depending on the toroidal position. The resulting radiation pattern does not resemble the shape of the flux surface at any toroidal position; therefore a straightforward conversion to plasma size is not possible. Additionally, it is also not trivial to deduce the width of the radiating layer.

Instead, forward modelling is used to derive phantoms, i.e. synthetic radiation images, produced by projecting the 3D coordinates of a flux surface in various toroidal positions observed by the camera view onto the 2D plane of the camera sensor, and “summing up” the light intensity – assumed to be homogenous – along each camera pixel (equivalent to a line-of-sight in the machine reference frame). Taking more than one flux surfaces at several effective minor radii (r_eff), the width of the radiating layer can be determined. The evolution of the width and position of the radiating layer will be presented in this contribution, with a special emphasis on the relation of the position to temperature and density profiles.