DETERMINATION OF THE PELLETS PARAMETERS BY IMAGE PROCESSING METHODS

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§ See the Appendix of F. Romanelli et al., Fusion Energy Conference 2008 (Proc. 22nd Int. FEC Geneva, 2008) IAEA, (2008).

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Injection of solid, cryogenic hydrogen isotope pellets in tokamaks is used for particle fuelling as well as for ELM control. The efficiency depends on technical control variables such as pellet size, velocity, frequency and poloidal launch position. Recently developed image processing methods [1-2] were improved and adapted in order to evaluate some of these key parameters.

The optical flow (OF) method was adapted for the determination of the ice extrusion velocity based on the image sequences provided by a CCD camera viewing the ice at the exit of the nozzles of the extrusion cryostat [3]. Implementations of linear/nonlinear OF approaches, which combines the advantages of local methods (robust under noise) and global techniques (which yield dense flow fields), were analyzed. Fast pattern recognition based on segmentation of binarized images was developed in order to narrow the region of interest where OF is calculated. Further computing time reduction was obtained by optimizing the parameters of the multi-resolution coarse-to-fine procedure used in order to be able to work with large displacements between consecutive frames. The total image processing time is 10s/frame allowing the analysis of large amount of video data. A representative result is presented in Fig. 1. OF was used also to determine the velocity of the pellets during ablation in the plasma, based on image sequences provided by the JET wide angle view fast visible camera [4]. OF is able to provide fully automatic results for JET cameras images which can be affected by discontinuous movement, reshaping of image objects and low gray-level in-depth resolution.

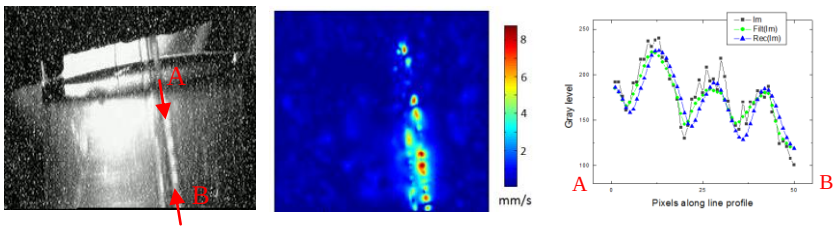

Figure 1 – Image of extruded deuterium ice in case of JET pulse #76379 (left), OF velocity field (middle) and line profiles through the image and its reconstruction

The reconstruction of pellet volume was performed using images provided by another CCD camera, coupled to a set of optical barriers used for pellet velocity measurement. This camera was installed on a diagnostic chamber located at the injector exit of the JET high frequency pellet injector [3], providing images about the flying pellet. A Bayesian statistical analysis was applied, calculating the probability distribution function (PDF) of the pellet volume based on three measured parameters of the pellet shadow: area, smallest dimension, largest dimension. The only assumption made in the algorithm is the presumed cylindrical shape of the pellets. The advantage of the method is that beside the pellet volume its error bars can also be estimated. The method was applied for the first time for JET data. Results concerning the pellet volume reconstruction for JET pulses will be presented. Reconstructed pellet volume can be used for deriving injector's optimized operational conditions.

[1] T. Craciunescu et al., J. Nucl. Mater. (2010) doi:10.1016/j.nucmat.2010.03.005.
[2] T. Szepesi et al., Rev. Sci. Instrum., 79 (2008) 033501.
[3] A. Geraud et al., Fus. Eng. Des. 82 (2007) 2183–2188.
[4] J.A. Alonso et al., J. Nucl. Mater., 390-391(2009)797.