A blob tracking algorithm for the study of turbulence-flow interaction

G. Hornung¹, S. Hoste¹, G. Verdoolaege¹,², Ph. Ghendrih³, Y. Sarazin³, J.-M. Noterdaeme¹,⁴

¹Department of Applied Physics, Ghent University, Ghent, Belgium
²Association “EURATOM – Belgian State”, LPP ERM-KMS, Brussels, Belgium
³CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France
⁴Max-Planck-Institut für Plasmaphysik, EURATOM-Assoziation, D-85748 Garching, Germany

Mean flows attract a growing interest as they can suppress the plasma turbulence and are thus believed to play a crucial role in the transition to improved confinement regimes. The complex relation between turbulence and flows occurs basically in two steps [1]. First, roughly symmetric turbulent structures, often called blobs, are deformed through their propagation across the flow. Following the tilting and stretching of the blobs, the Reynolds stress transfers energy from the ambient turbulence to the flow, leading to a reduction of the fluctuation level. In the second step, the blobs split and recover their symmetry. The Reynolds stress energy transfer becomes less efficient and the fluctuation level rises again.

Given the continuous blob deformation during the stretching and splitting processes, a careful description of the evolution of the blob shape can yield useful information on the turbulence-flow interaction. A non-rigid object tracking algorithm has therefore been developed to characterize the blobs individually. The algorithm is based on a probabilistic approach and provides a description of the blobs in terms of size, location, velocity and shape.

Extending previous work [2,3], the algorithm is able to track blobs with arbitrary shapes and keeps record of the merging and splitting processes. The algorithm is applied to simulated turbulence data obtained with the TOKAMAK-2D code [4]. The relation between blob size and velocity is investigated and tested against analytical models. By adding external bias in the code, mean flows are generated and their impact on the turbulence is investigated. Special attention is paid to the blob deformation rate.