An Approach for Correcting the Velocity Bias Error in One-Component Molecular Tagging Velocimetry: Theoretical Analysis[1]
AHMED NAGUIB, PATRICK HAMMER, SHAHRAM POUYA, MANOOCHEHR KOOCHESFAHANI, Michigan State University — One-component Molecular Tagging Velocimetry (1c-MTV) using line tagging has the advantage of providing velocity information with very high spatial resolution: at every pixel along the imaged line of tagged molecules. This renders the technique particularly suitable for near-wall, boundary-layer-resolved measurements. However, a non-negligible bias error could affect the measurements if the velocity component along the "tag line" is substantial relative to the measured component and/or when the time delay between image pairs is large. In this presentation, which is the first of a sequence of two talks, a theoretical analysis is detailed for expressing this bias error in a Taylor-series framework. The error estimate based on this analysis is validated using simple flows with known analytical solutions. Moreover, by truncating the Taylor-series expansion at a low order, it is possible to use the resulting form as basis for a practical method for linear, or higher-order, correction of the bias error. Experimental demonstration of the viability of the method will be presented in a follow-up talk.

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