Strain dynamics for vortex ring mixing process\textsuperscript{1} YANN BOUREMEL, MICHAEL YIANNESKIS, ANDREA DUCCI, Kings College London — Simultaneous PIV-PLIF measurements were carried out to investigate the mixing occurring in a laminar vortex ring flow during the formation stage (Re=357-1072). In the first part of the work a control volume analysis was used to determine the variation in time of the scalar concentration mean, variance, and probability density function. In the second part the advection-diffusion differential equations of the scalar, $\xi$, and of its energy, $0.5 \xi^2$, were studied in depth to gain insight into the effect of the strain rate tensor, $\mathbf{S}$, on the local scalar concentration for increasing $Re$. The measurements were obtained with a high spatial resolution (12 $\mu$m for the PLIF) in order to resolve the scalar dissipative scales. Reliable estimates of the scalar dissipation rate ($\nabla \xi \cdot \nabla \xi$), and of the symmetric contraction term ($\nabla \xi \cdot \mathbf{S} \cdot \nabla \xi$), shown in equation 1, were obtained. $\nabla \xi \cdot \mathbf{S} \cdot \nabla \xi$ accounts for the reduction of scalar dissipation due to the straining component directed as the local scalar gradient (see Southerland et al.\textsuperscript{2})

Equation 1: \[
\left( \frac{\partial}{\partial t} + \bar{u} \cdot \nabla + \frac{1}{ReSc} \nabla^2 \right) \frac{1}{2} (\nabla \xi \cdot \nabla \xi) = - (\nabla \xi \cdot \mathbf{S} \cdot \nabla \xi) - \frac{1}{ReSc} \nabla (\nabla \xi) : \nabla (\nabla \xi)
\]

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