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ON THE ACCURACY OF SCALAR DISSIPATION MEASUREMENTS BY LASER RAYLEIGH SCATERING.

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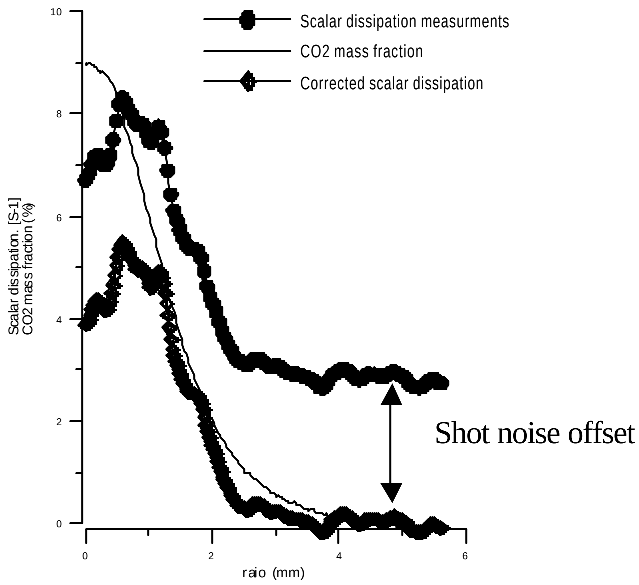
ABSTRACT

A new sensor for high spatial resolution scalar dissipation measurements is presented together with a dedicated signal analysis, which enables the compensation for systematic uncertainty inherent to the diagnostics technique. The sensor is based in Laser induced Rayleigh Scattering (LRS), from a pulsed laser, in a coaxial CO_2-air jet The light is collected by a linear array sensor, allowing for instantaneous line measurements of the CO_2 mass fraction. The main sources of uncertainty are the shot noise caused by photon statistics and Mie scattering from particles in the flow. Improvements in signal quality were achieved by increasing laser intensity, carefully designing the acquisition electronics, and developing data processing strategies.

The analysis performed, showed that the shot noise of a LRS measurement induces a systematic error which gives rise to an offset in the dissipation measurements. An expression to evaluate the scalar dissipation offset, as a function of the shot noise variance, was derived. The results obtained are illustrated in the figure below, which represent the effect of the LRS shot noise correction in the raw scalar dissipation measurements obtained.

The negligible scalar dissipation obtained for regions where CO_2 concentration vanishes, contributes to validate the methodology developed and, as a consequence, this experimental technique can be considered as an accurate scalar



dissipation diagnostics for complex multi-fluid turbulent shear flows.