# DISSIPATION ELEMENT ANALYSIS VIA HIGH-SPEED RAYLEIGH SCATTERING IN A TURBULENT JET FLOW

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**Fluid:** Turbulent round jet flow
**Visualization method(s):** High-speed Rayleigh scattering
**Other keywords:** Scalar turbulence, dissipation elements

**ABSTRACT**: Based on the extreme points of turbulent scalar fields, i.e. points of vanishing scalar gradient, Wang and Peters [1] developed the theory of dissipation elements. Starting from every grid point, trajectories along the ascending and descending gradient directions can be calculated, which inevitably end in extreme points. All points that share the same two ending points define a finite volume called dissipation element, which is parameterized by its linear length l between and the scalar difference $\Delta\theta$ at the extreme points. Based on this theory, space filling and non-arbitrary elements are identified, which allow the reconstruction of statistical properties of the field as a whole in terms of conditional statistics within the elements, see Fig. 1 (left). In the present study, a turbulent round propane jet discharging from a nozzle with diameter d=12mm into surrounding $CO_2$ has been chosen as the core of the experimental set-up. The free shear flow, i.e. the mixture fraction of propane and $CO_2$, is visualized via Rayleigh scattering of a diode pumped double cavity Nd:YLF laser at the molecules. The laser emits light at a wavelength of 527nm, has a pulse energy of 2x22.5mJ at 1kHz. As we need a three-dimensional test section, see for instance [2] for a discussion of different approaches, in which dissipation elements can be identified, a laser sheet is formed by a concave and a convex spherical as well as one cylindrical lens to illuminate a two-dimensional plane perpendicular to the jet axis. The resulting signal is recorded with a high speed CMOS camera. To protect the propane jet from exterior influences such as dust particles, a mild co-flow of $CO_2$ discharges from a surrounding tube with a diameter of 150mm and a length of 450mm providing a uniform velocity profile. In a next step, the recorded time series of the planar test section at a fixed downstream position is transformed into a spatial signal based on Taylor's hypothesis, so that we finally obtain a frozen three-dimensional volume of the mixture fraction. The latter can be post-processed using the same algorithms as for the DNS and yield a good agreement of the statistical properties of dissipation elements on the one hand and allow their visualization on the other hand, see Fig. 1 (right).

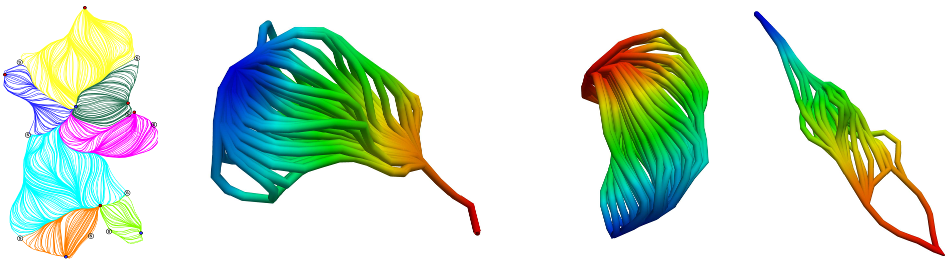

Fig. 1 Schematic illustration of three-dimensional dissipation elements (left) and exemplary dissipation elements obtained from Rayleigh scattering (right).

### References

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