In this work we demonstrate cinematographic (up to 50 kHz) imaging of the scalar field in a co-flowing transitional jet \((Re_D = 1,750)\) using planar laser-induced fluorescence imaging of toluene seeded into the jet where the illumination source for the excitation was provided by a continuous wave 266 nm laser. Owing to the large fluorescence quantum yield of toluene, short integration on the order of microseconds are possible, enabling to effectively freeze the flow motion, while providing acceptable SNR levels. SNR up to 50 were obtained in the current study, with typical SNR on order of 30 at gating times of 5 μs.

Figure 1 shows a time-sequence of the mixture fraction in the near field of the transitional jet and shows the evolution of the late stages of transition from a laminar jet to a turbulent one. The sequence was acquired at 50 kHz (gating 5 μs), and every tenth frame is shown for clarity.

In the second part of the study, the imaging device used in the PLIF work was characterized. In particular, the high-speed CMOS imaging sensor (without the intensifier) was investigated for its response, linearity and noise characteristics under different imaging conditions (framing rates, exposure times, irradiance levels). An example of the linearity profile and SNR is shown in Fig. 2 for different configurations.

The results of the imaging sensor characterization indicates that the response of the sensor is sufficiently linear, but the internal dark-noise calibration can introduce negative offsets (on the order of 25 counts, which correspond to about 5 photo-electrons) that might alter the low-level photon-counts and hence the accuracy of low-light quantitative PLIF studies. Assessment of the SNR shows that for photo-electrons less than 10% of the full-well, read-out noise dominates, but the shot-noise limit is quickly approached for larger values, with maximum SNR on the order of 150 – 200.

In terms of linearity and noise characteristics, it seems that the available instrumentation performs superiorly than similar systems that had been evaluated in past work. This suggests that the current state-of-the-art of high-speed imaging systems is quickly improving, and give promise to high-quality high-speed imaging devices for accurate quantitative measurements in a near future.

**Fig. 1** Time-series showing the temporal evolution of the co-flowing transitional jet \((Re_D = 1,750)\). Imaging was carried out at 50 kHz with a gating time of 5 μs. Time separation between frames 0.2 ms (i.e., every tenth frame is shown).

**Fig. 2** (a) Measure gray scale value \(S_p\) as a function of photo-electrons at constant framing rate (50 kHz) and exposure time (5, 10, and 15 μs) at nine points \(p\) selected over the sensor area along with expected linear relation (solid lines), and (b) corresponding SNR with model (solid lines).