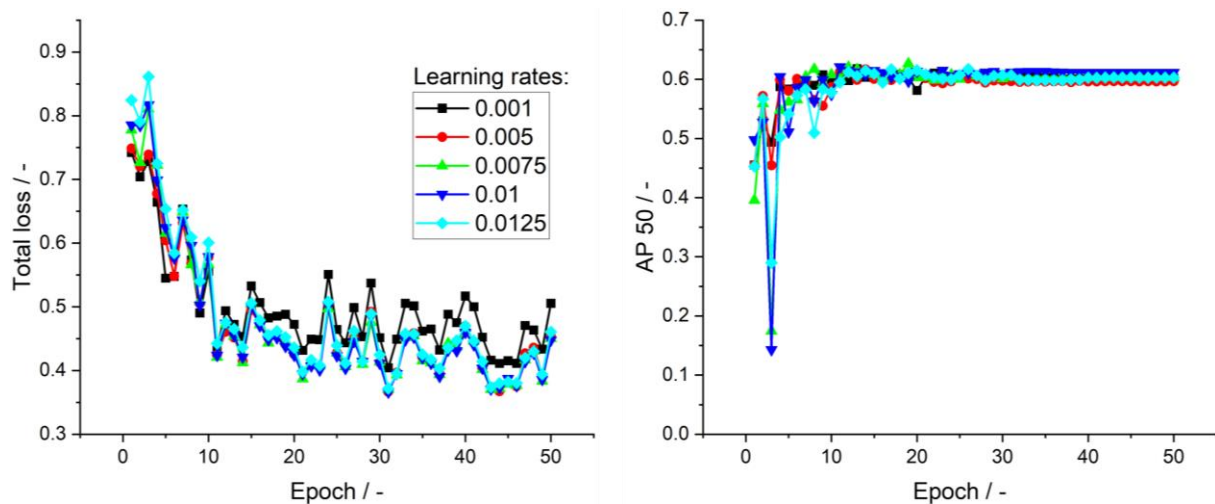


## Supplementary material

### S1. Sensitivity of the results to the learning rate

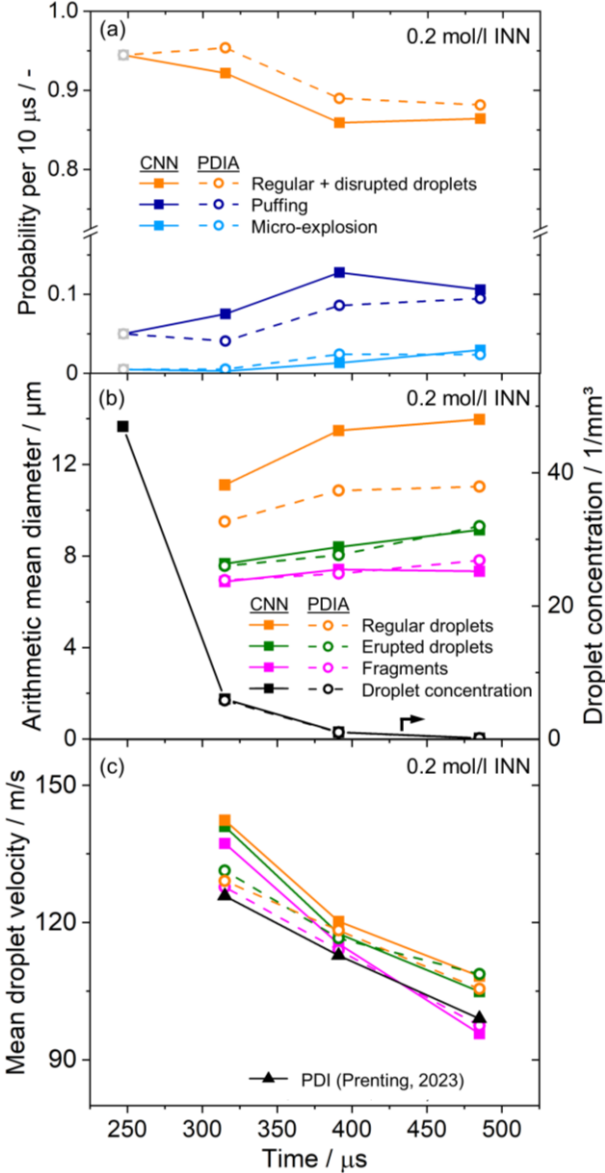
Figure S1 shows loss and precision (average precision at 50% IoU -  $AP_{50}$ ) of Mask R-CNN (a similar outcome was found for Faster R-CNN) versus 50 training epochs and a variation of the learning rate. All other hyperparameters were kept constant with the values stated in Table 1. The order of training and validation images was fixed throughout the epochs. The results show that loss and precision are relatively insensitive to the learning rate and approach an asymptote after  $\sim 10$  epochs. The learning rate we chose for our networks (0.01) reaches one of the lowest losses and highest precisions. Differences in loss and precision are minor within the learning-rate range from 0.001 to 0.015. However, it can be seen (for this configuration) that larger learning rates cause oscillation in the precision within the first epochs but after many epochs reach a low loss and high precision. Large oscillations also at later epochs might occur without a learning-rate scheduler. A learning rate above 0.013 leads to losses diverging towards infinity and stopping training. Learning rates below 0.001 were not found to improve the results and necessitate longer training. To estimate optimal hyperparameters (not just for a specific configuration), optimization methods such as grid search or bayesian optimization could be used, but are beyond the scope of this work. We added this discussion and the Figure as supplementary information.



**Fig. S1** Total loss and precision versus the number of training epochs for a variation of learning rates.

**S2. Disruption probability, diameter, velocity, and concentration versus the mean droplet residence time**

Figure S2 shows the disruption probabilities, mean droplet diameters, mean droplet velocities, and droplet concentrations from CNNs and PDIA as a function of the mean droplet residence time in the spray flame and with 0.2 mol/l INN.



**Fig. S2** (a) Probability per 10  $\mu\text{s}$  for finding regular + disrupted droplets, puffing, or micro-explosion versus the mean droplet residence time. (b, c) Mean diameter and mean velocity of regular droplets, erupted droplets, and fragments as well as total droplet concentration versus the mean droplet residence time.