

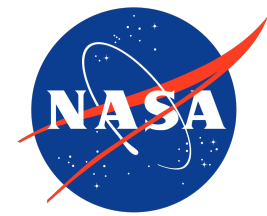
AI-assisted monitoring of coal particles within droplets in a coal monoethylene glycol slurry spray

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1 Motivation and measurement principle



Figure 1: RGB PTA (3 × 1024 × 1024).

Continuous light scattering signals from slurry droplets form Particle-Tensor-AI (PTA) representations for CNN classification of coal mass concentration and mean particle size.

Four detectors collect scattered light at different angles. Fixed time windows retain signals from droplet ensembles without triggering. In RGB tensors, each color channel represents one selected detector.

1 Detection

Four detectors collect scattered light at different angles

2 PTA

Fixed time windows without triggering; RGB tensor 3 × 1024 × 1024

3 CNN

TensorFlow/Keras, 3 × 256 × 256 tensors, 8 bit

4 Classification

Coal mass concentration C_m and mean particle size

2 Experimental setup

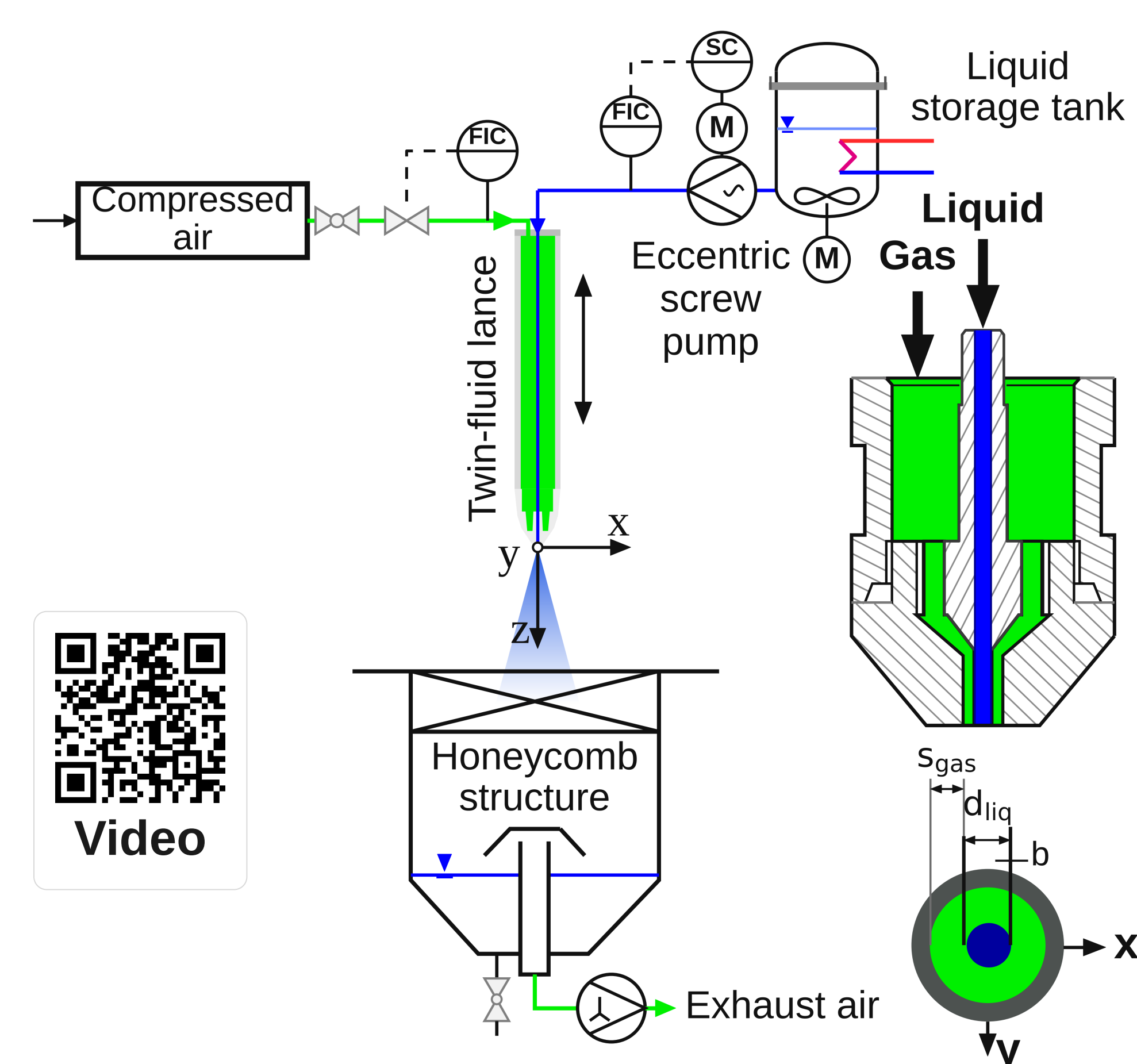
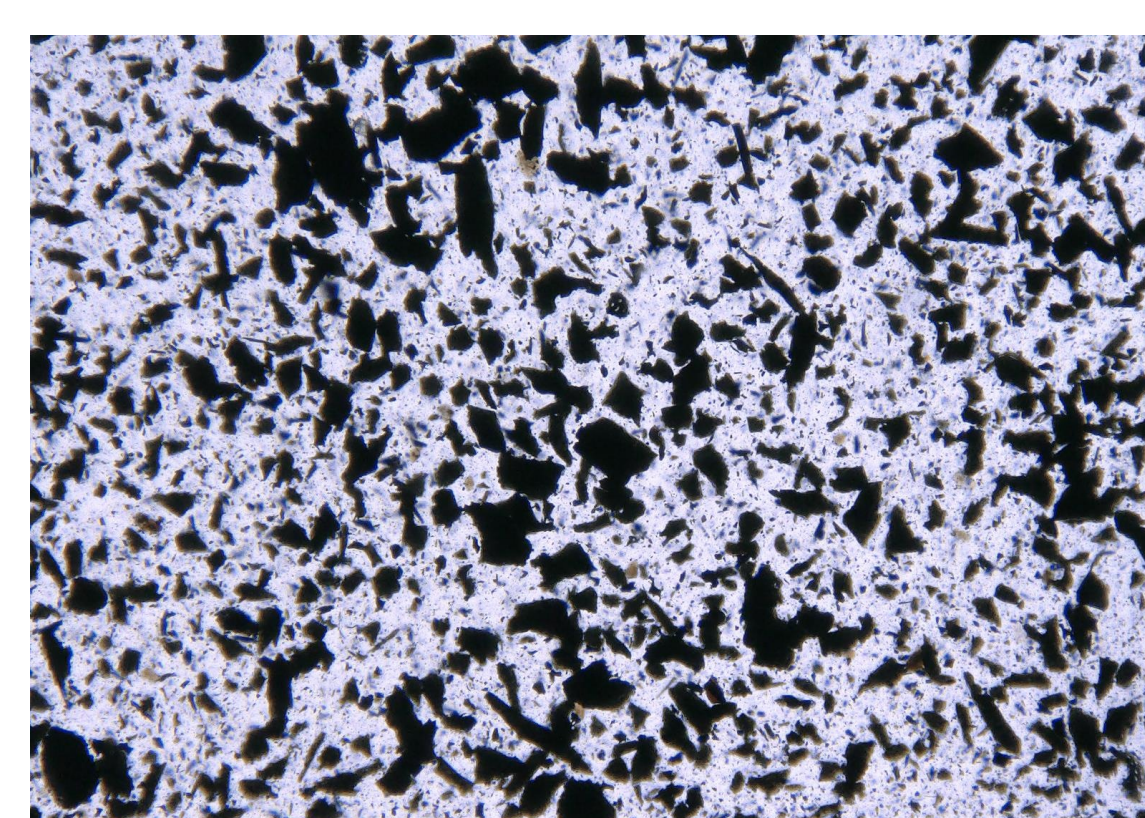
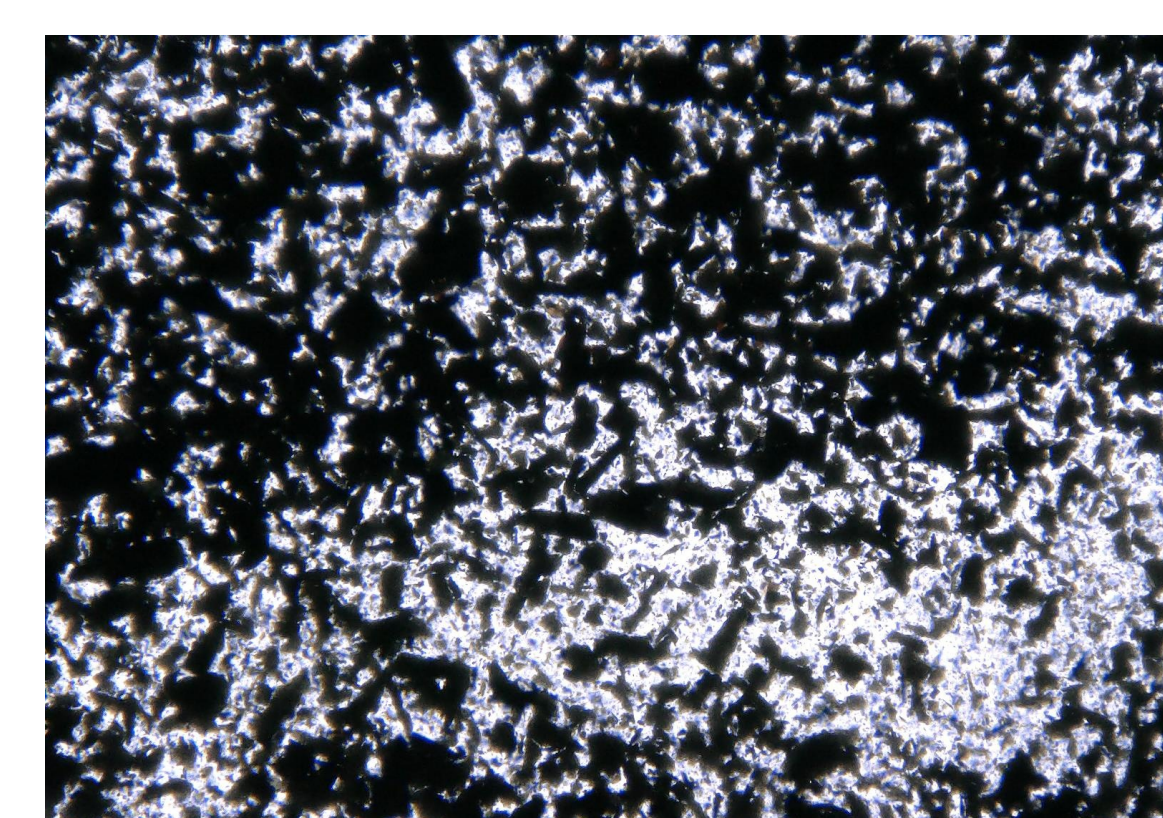


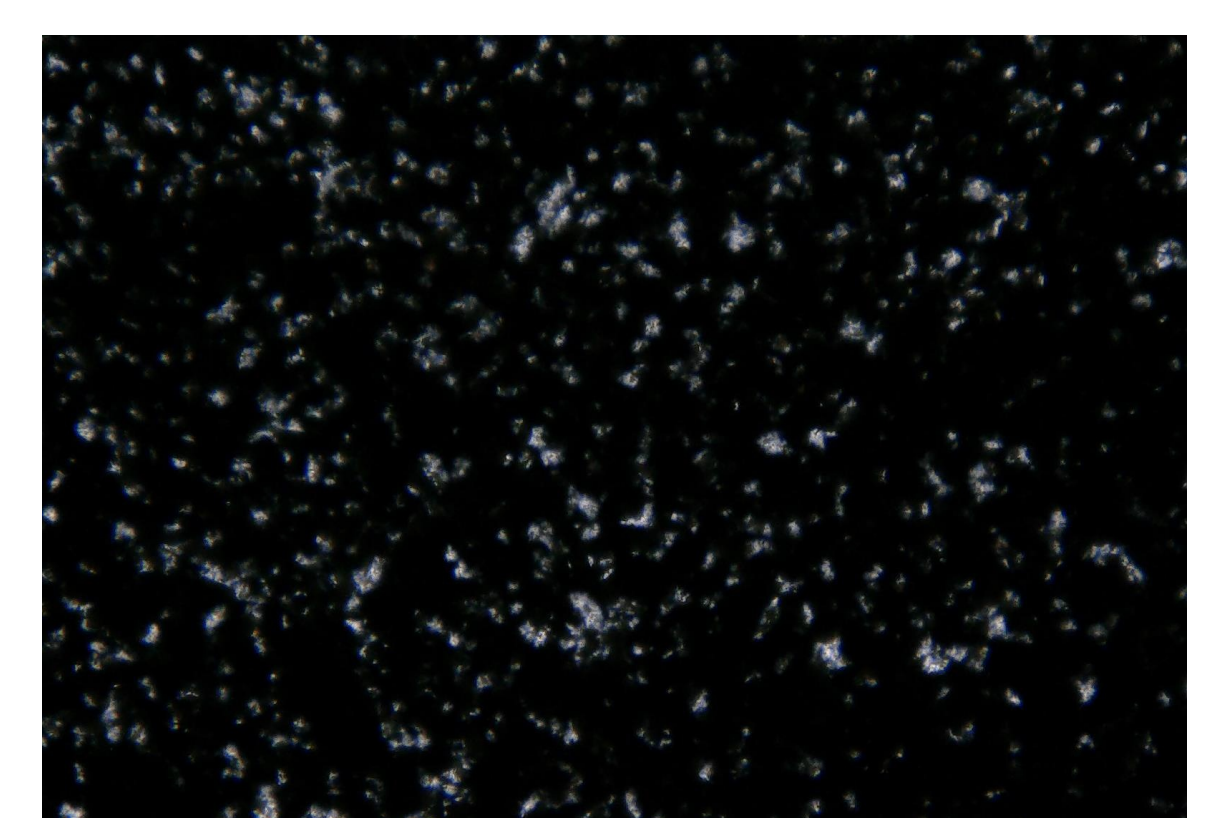
Figure 2: Atmospheric spray test rig (ATMO) with the twin-fluid nozzle.



$C_m = 5\%$



$C_m = 10\%$



$C_m = 20\%$

200 μm

Figure 3: Suspension images at $C_m = 5\%$, 10% and 20% (same magnification).

A twin-fluid nozzle atomized coal in monoethylene glycol (Fig. 2). The TSTOF instrument recorded the light scattering signals on the nozzle axis.

Coal mass concentration C_m	5%, 10%, 20%
Mean coal particle size SMD_p	4.0, 9.4, 18.7 μm
Atomizing air flow $\dot{V}$	7.5 m ³ /h
Slurry mass flow $\dot{M}$	12.56 kg/h
Measurement position	Nozzle axis, 120 mm downstream

3 AI classification and results

TensorFlow/Keras CNNs classified coal mass concentration and mean particle size using 3 × 256 × 256 tensors with 8-bit resolution. The study tested 168 configurations with different detector combinations, downsampling factors and RGB or grayscale encoding.

Longer time windows improved classification. At downsampling factor 1, RGB generally outperformed grayscale. Mass concentration was more reliably classified than mean particle size.

At downsampling factor 16, the prediction probability for C_m was 94.7–99.9% for all 14 detector combinations.

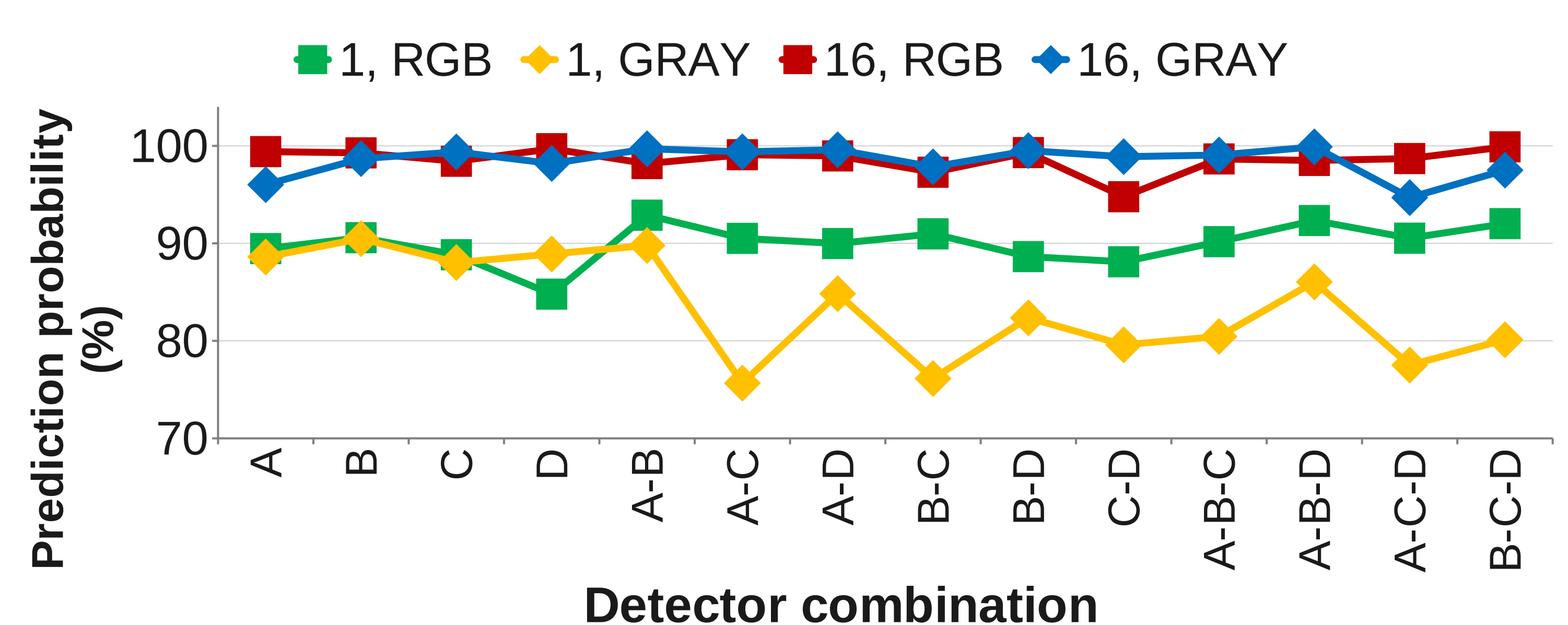


Figure 4: Prediction probability of the C_m classification by detector combination. 1 and 16: downsampling factors; RGB/GRAY: tensor encoding.

Conclusion and outlook

PTA-based CNNs classified coal mass concentration in monoethylene glycol sprays. Longer time windows improved results. Particle-size classification was less reliable. Further work will optimize the models and test other sprays.