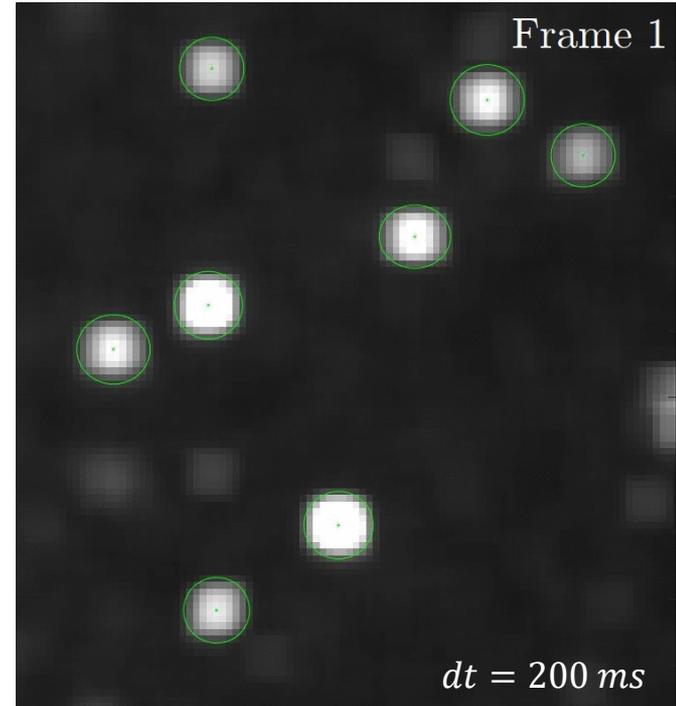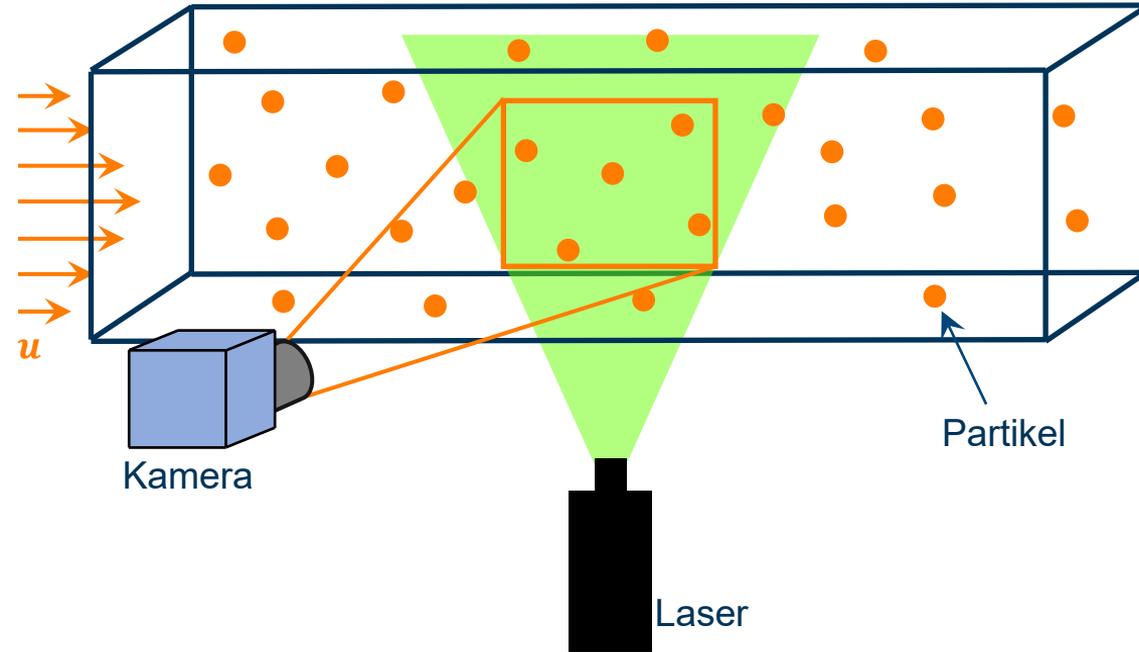# Particle tracking velocimetry using deep neural networks

Sebastian Sachs, Christian Cierpka

Institute of Thermodynamics and Fluid Mechanics
Technische Universität Ilmenau, Germany

sebastian.sachs@tu-ilmenau.de

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Datasets

particle tracking velocimetry (PTV)

Datasets

particle tracking
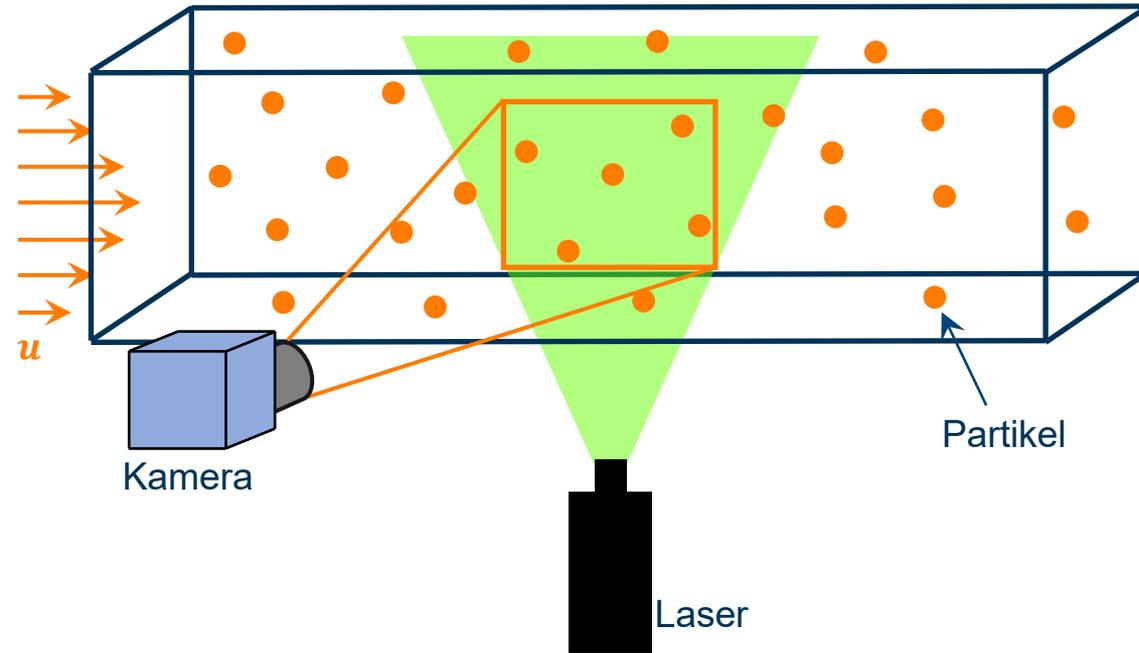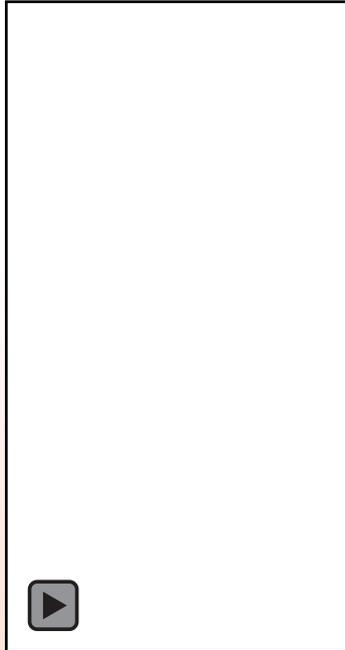
velocimetry (PTV)

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Datasets

particle tracking velocimetry (PTV)

u

Kamera

Partikel

Laser

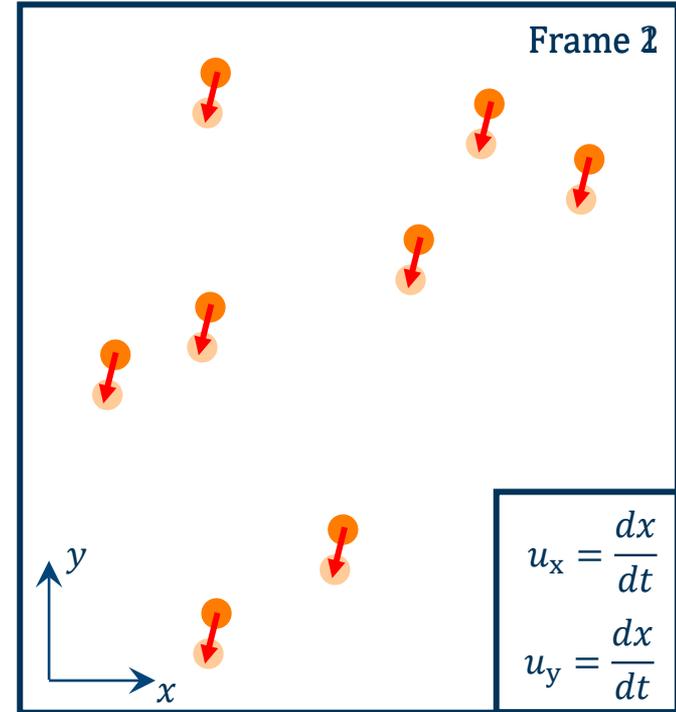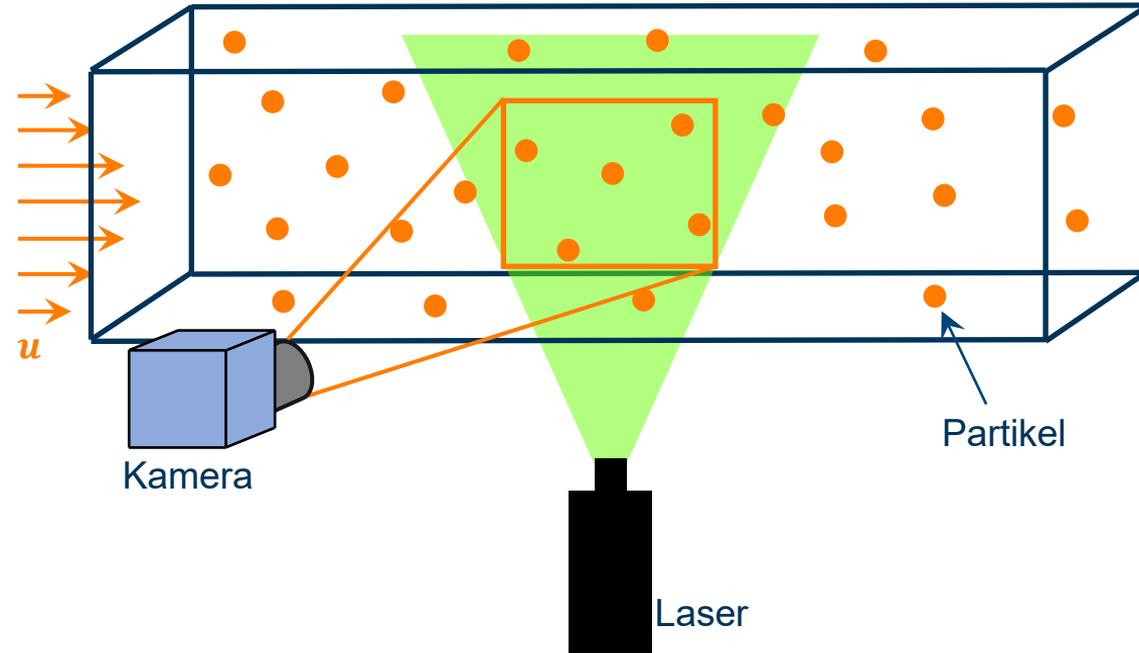TrackOpt

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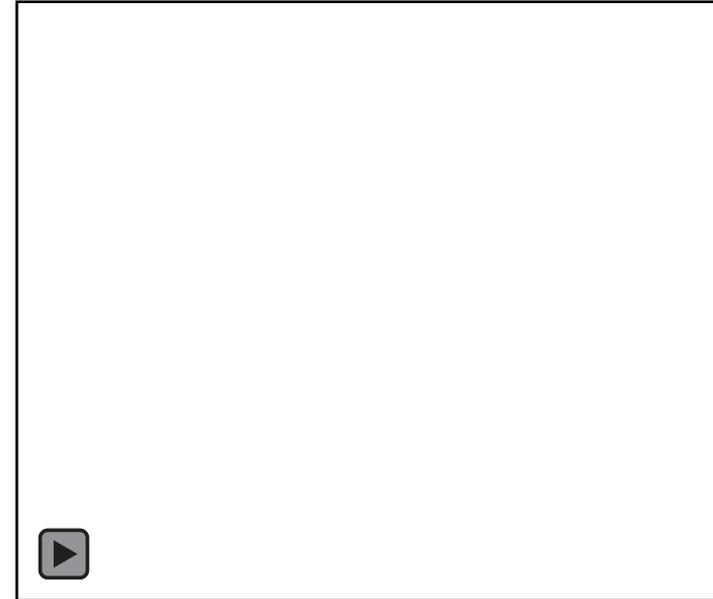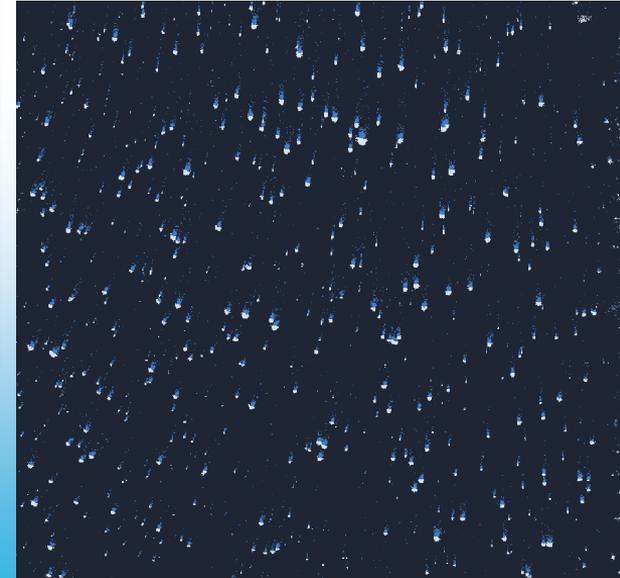
th
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Datasets

particle tracking
velocimetry (PTV)

astigmatism particle tracking
velocimetry (APTV)

event-based vision

(EBV)

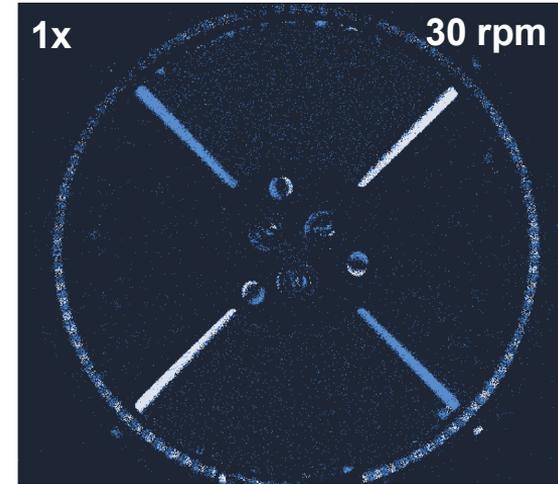sebastian.sachs@tu-ilmenau.de

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Event-based vision

frame-based

event-based

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Event-based vision

frame-based

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Event-based vision

frame-based

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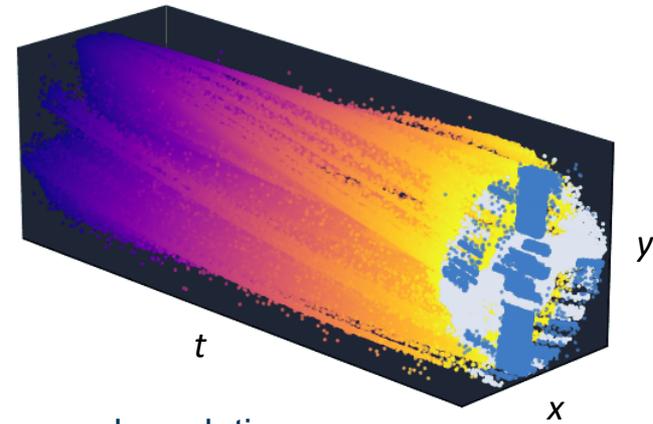sebastian.sachs@tu-ilmenau.de
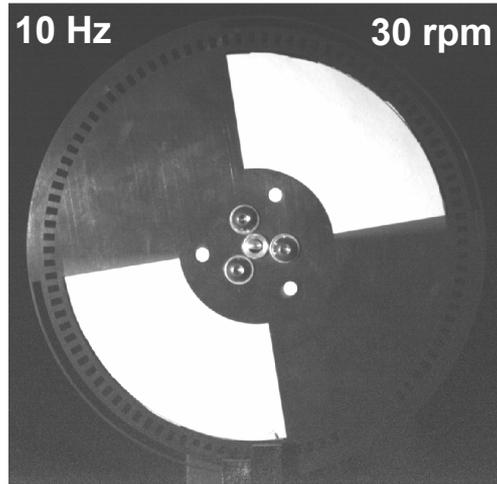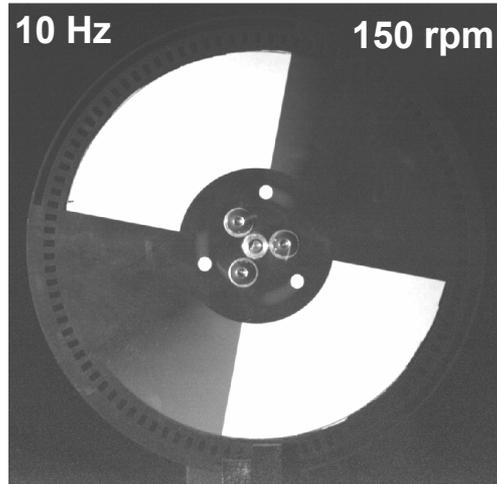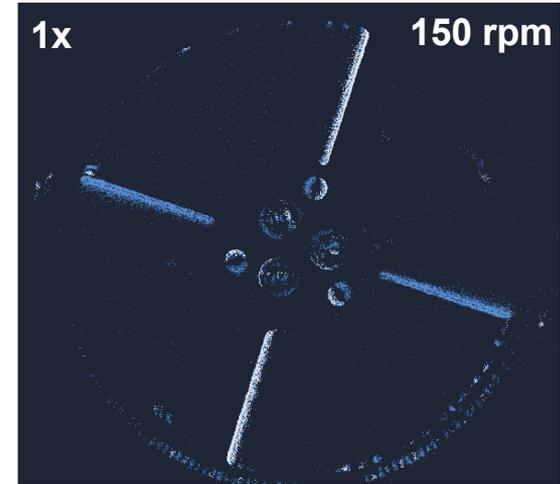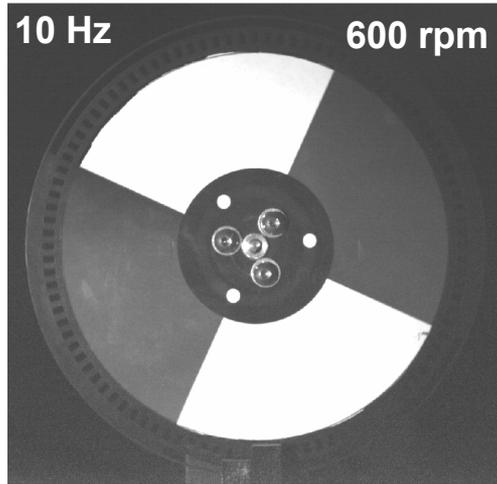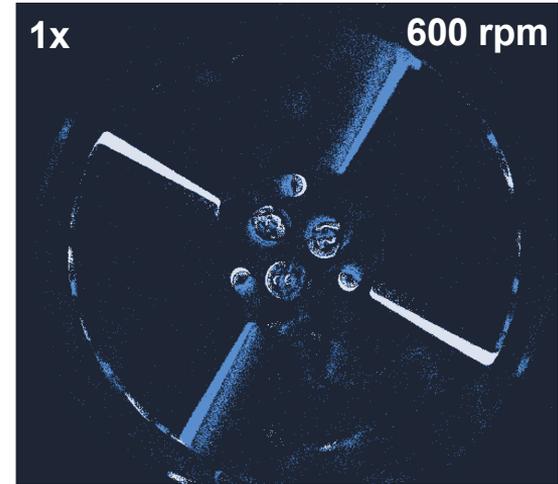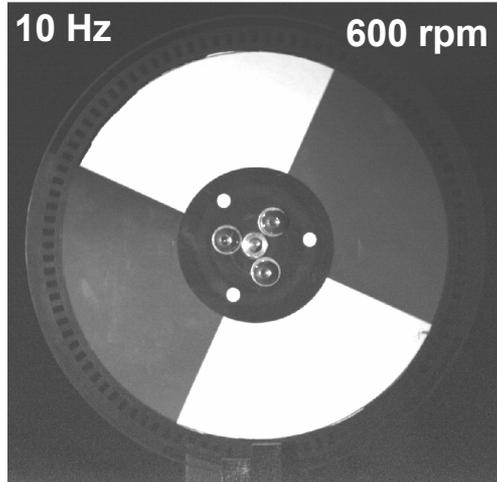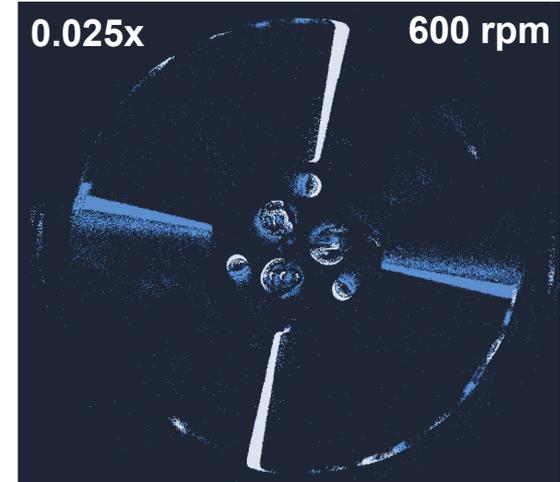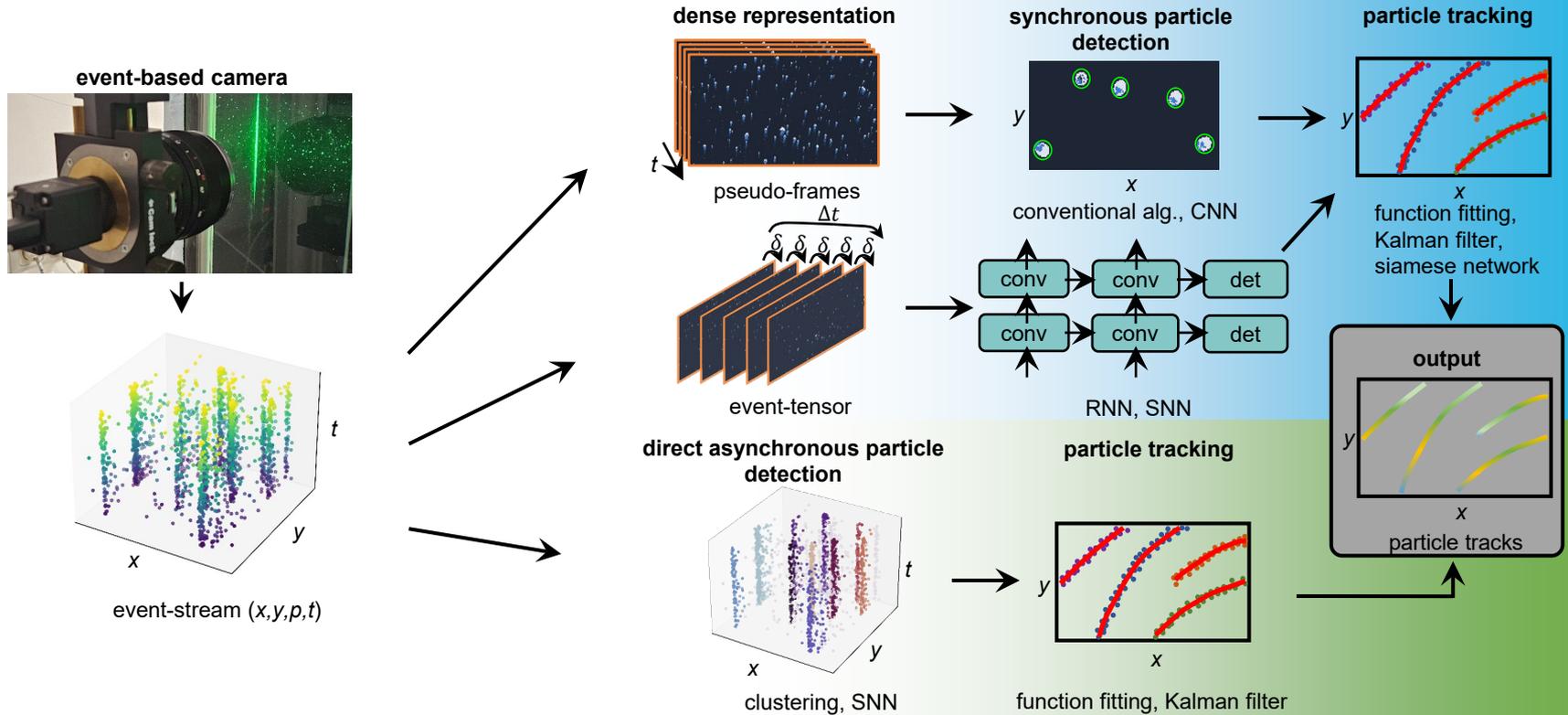
Event-based vision

frame-based
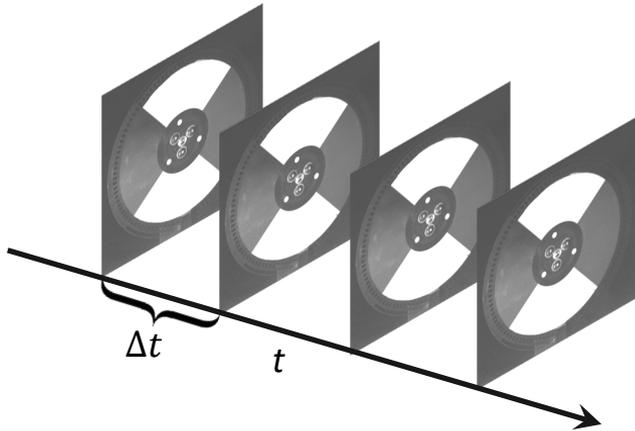
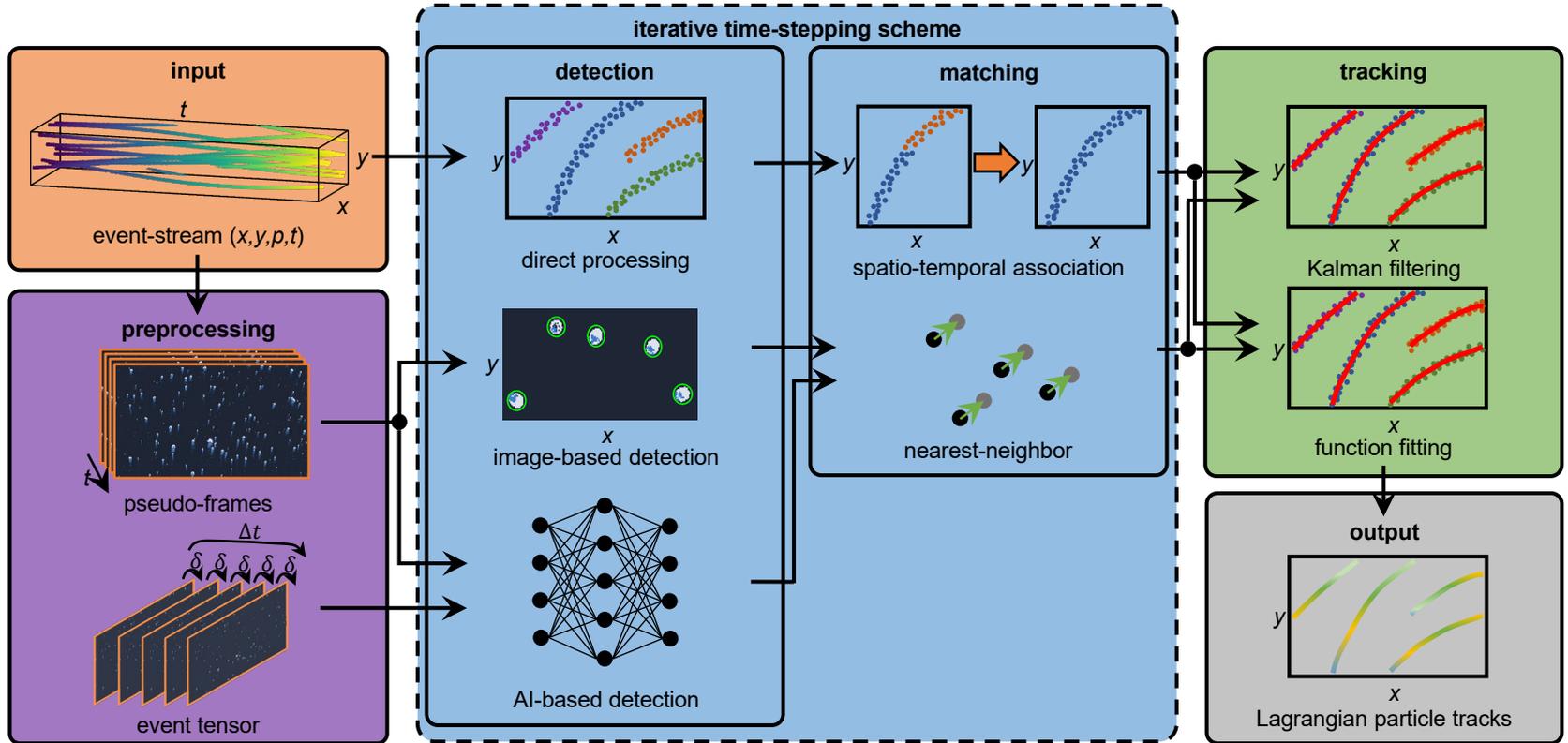**event-based**

- fixed frame rate

- dense data

- rather expensive

- ➤ high temporal resolution

- ➤ asynchronous, spatiotemporally sparse event-stream

- ➤ high dynamic range

- ➤ cost- and energy efficient

sebastian.sachs@tu-ilmenau.de

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Data processing

event-based camera

event-stream (*x,y,p,t*)

dense representation

pseudo-frames

Δt

event-tensor

synchronous particle detection

conventional alg., CNN

conv → conv → det
conv → conv → det

RNN, SNN

particle tracking

function fitting,
Kalman filter,
siamese network

output

particle tracks

direct asynchronous particle detection

clustering, SNN

particle tracking

function fitting, Kalman filter

sebastian.sachs@tu-ilmenau.de

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Framework STELLA

sebastian.sachs@tu-ilmenau.de

Framework STELLA

GitHub!

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Datasets

synthetic

- 142 clips of 2 s (1000 fps)
- variation in magnitude, pattern, particles
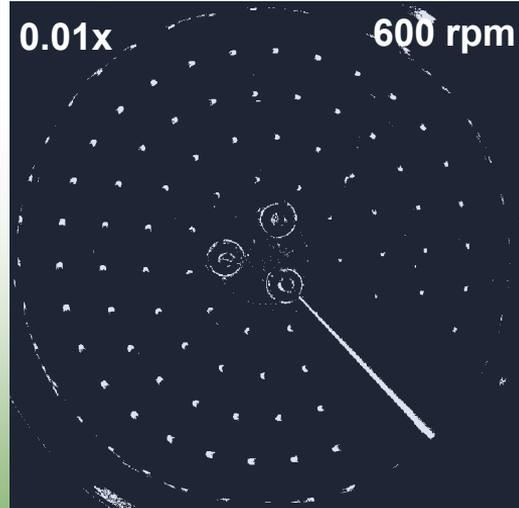- split: 70/10/20 in train/val/test

synth. particle images

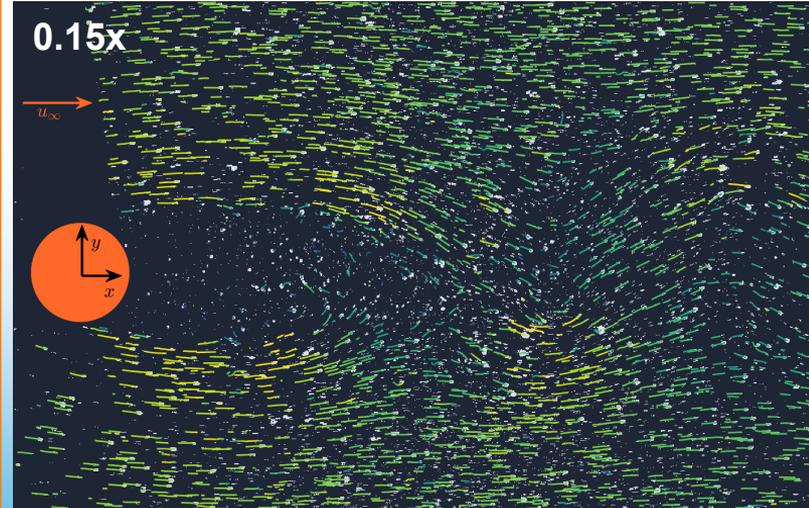converted to event-stream using ESIM [1]
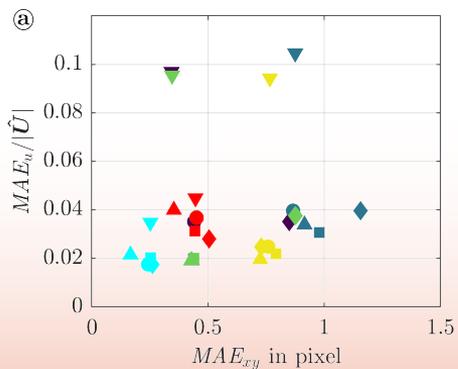
Datasets

synthetic

experimental (I)

experimental (II)

Datasets

synthetic
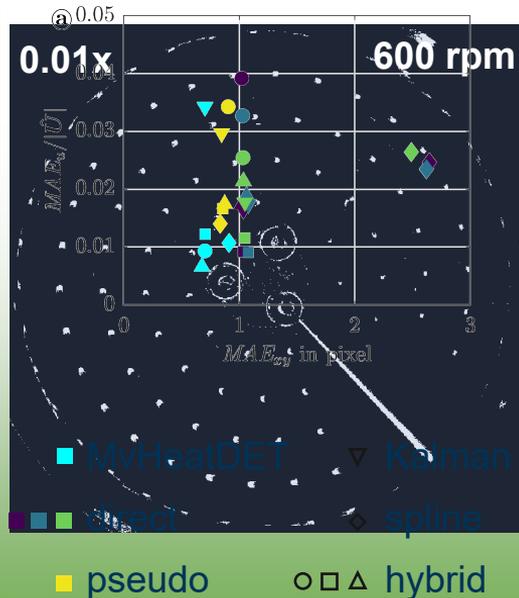
experimental (I)

experimental (II)

Datasets

particle tracking velocimetry (PTV)

astigmatism particle tracking velocimetry (APTV)

event-based vision (EBV)

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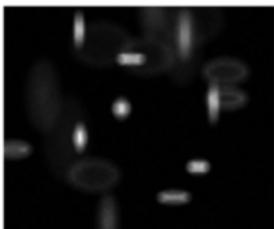**TECHNISCHE UNIVERSITÄT ILMENAU**
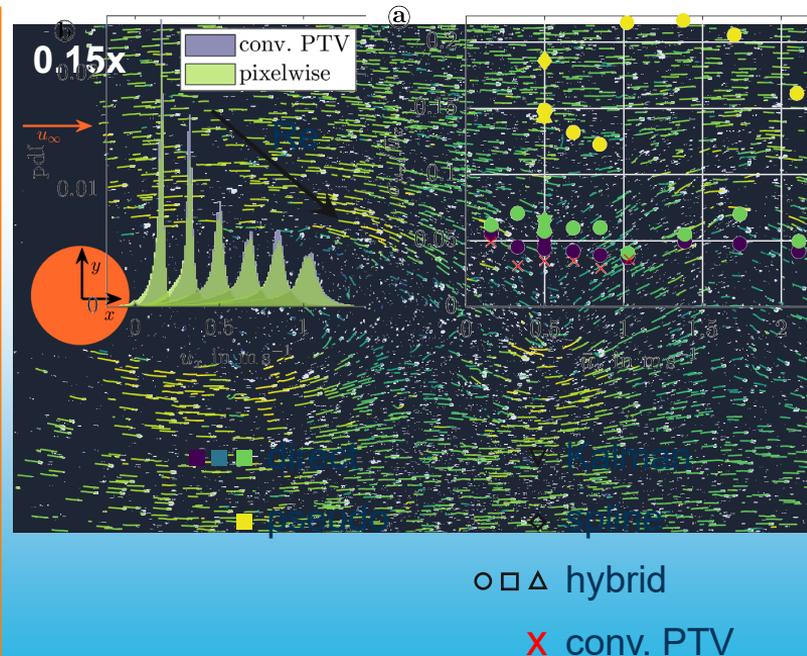
Defocus Challenge

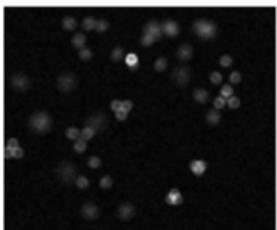## Mutli-flavor datasets
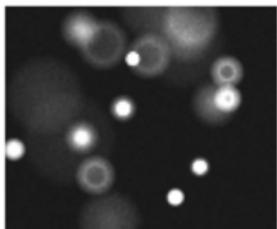
Defocusing

Astigmatism

3-Pinholes
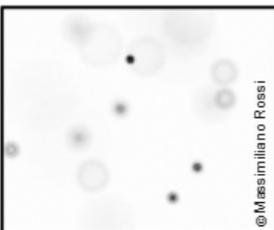
Shadowgraphy

@Maassimiliano Rossi

Chip-in-the-Box (ChiB)

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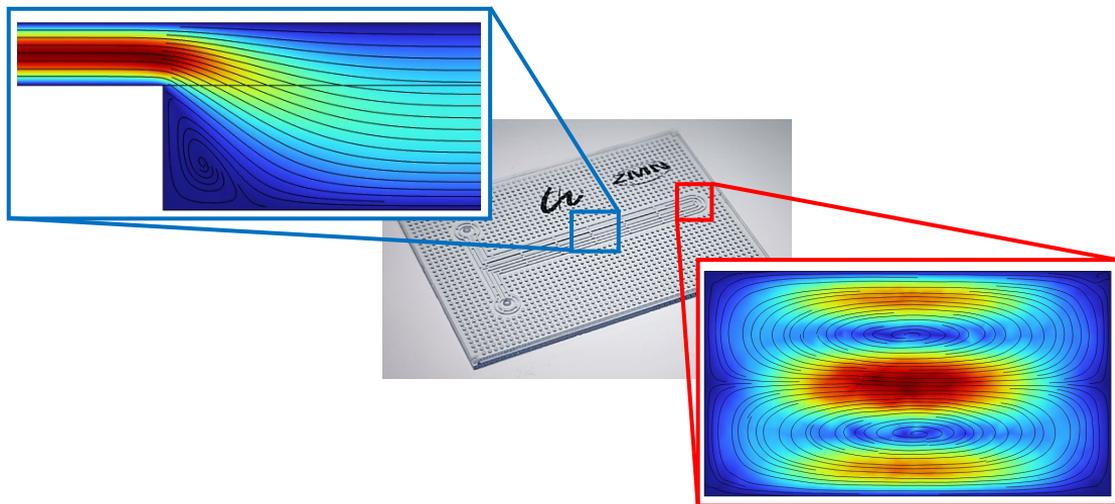
Conclusion

➢ collected synthetic and experimental **datasets** of multiple flavors

➢ developed modular **framework** for particle tracking using event-based cameras

➢ **presented** at „ISPIV2025" and „Fachtagung Experimentelle Strömungsmechanik"

➢ **journal publication** submitted

➢ initiated **Defocus Challenge**

Outlook:

➢ working on applying trained networks to experimental data

➢ tailored neural network architecture in strong collaboration with Prof. Margret Keuper

sebastian.sachs@tu-ilmenau.de

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