



Vision System for Grain Detection

Andrea Dunbar
Edge AI and Vision

CSEM at a Glance – Close to Industry

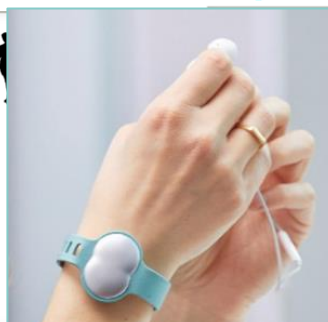
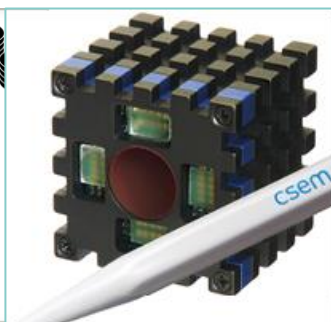
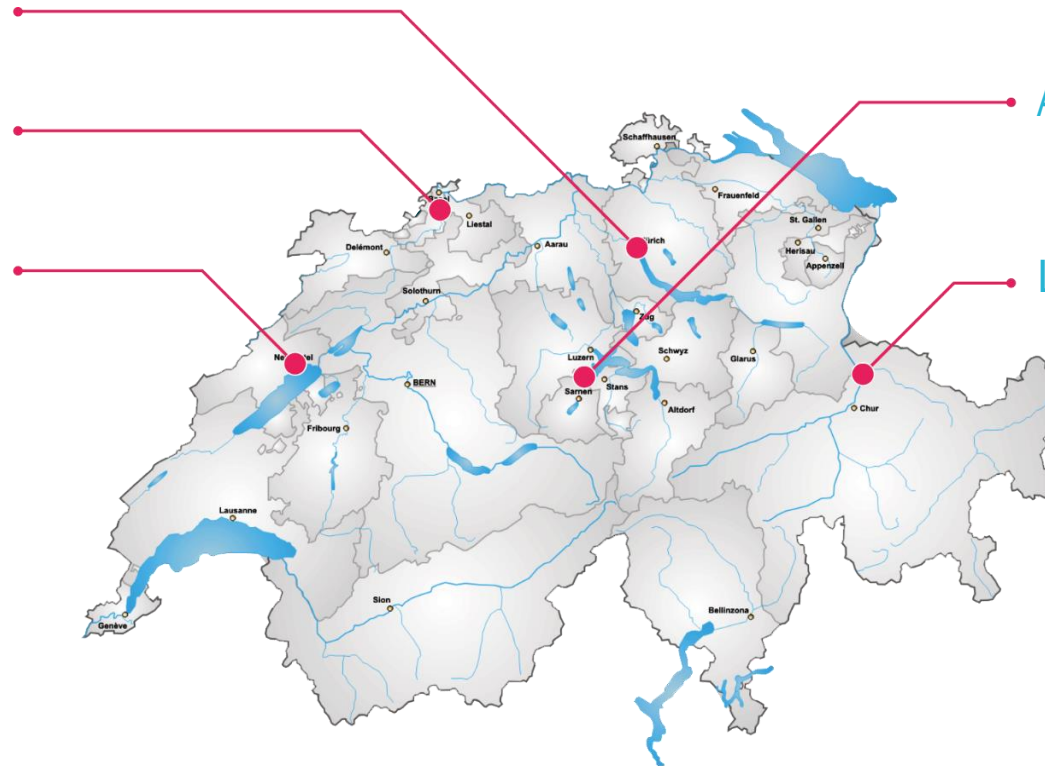
Zürich

Muttenz

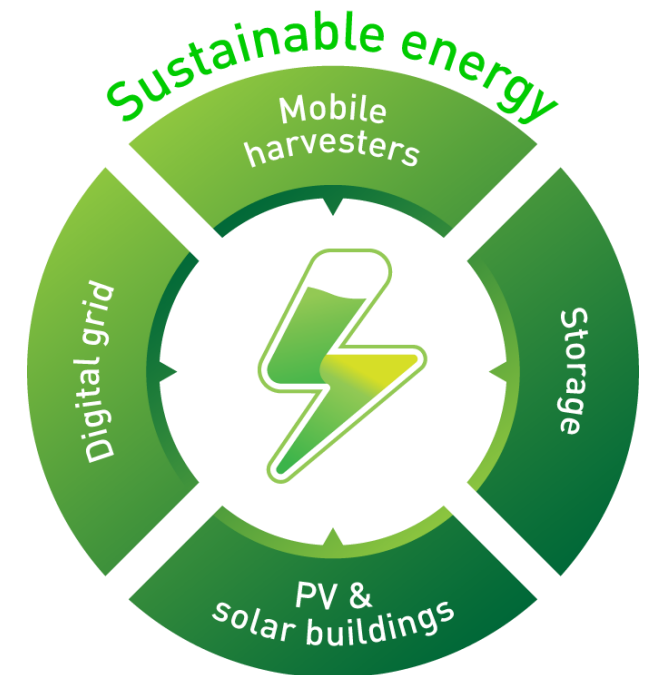
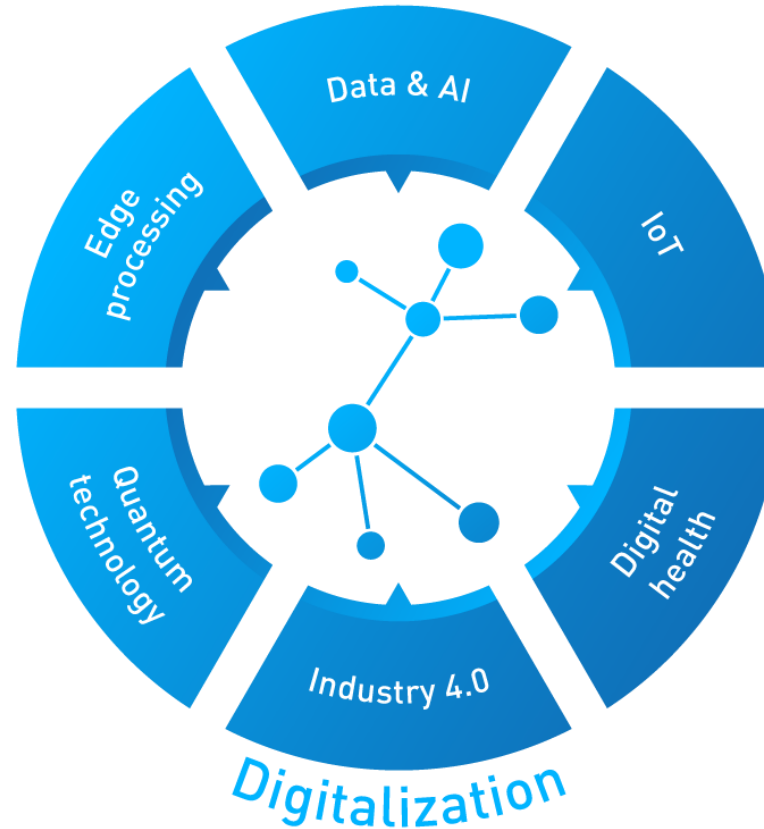
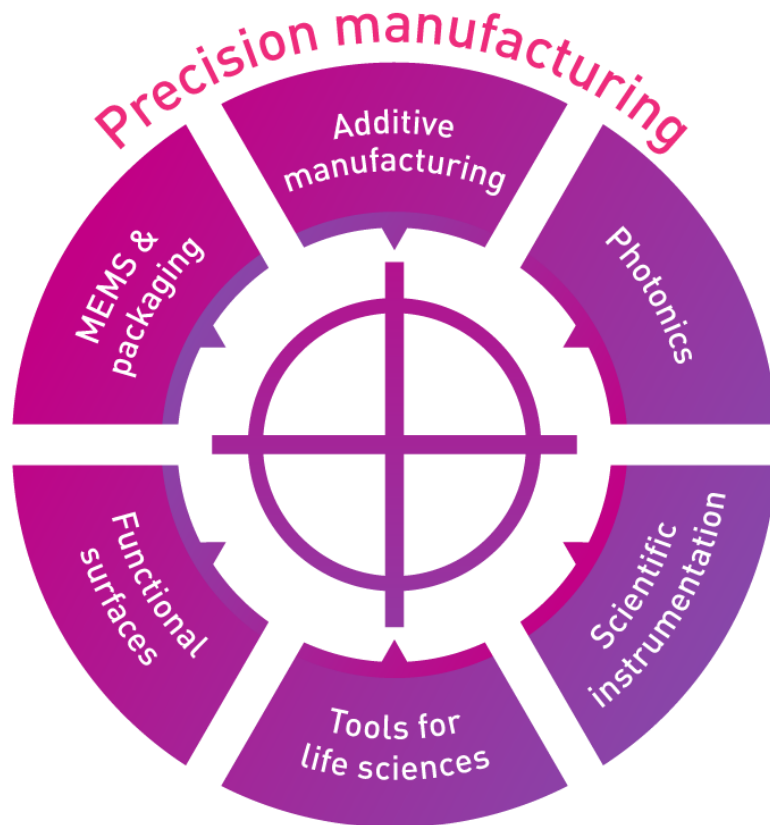
Neuchâtel

Alpnach

Landquart



Technologies in Focus at CSEM



“A custom intelligent vision system to detect the type of grain, measure the flow rate and morphology of grains going through a milling system.”

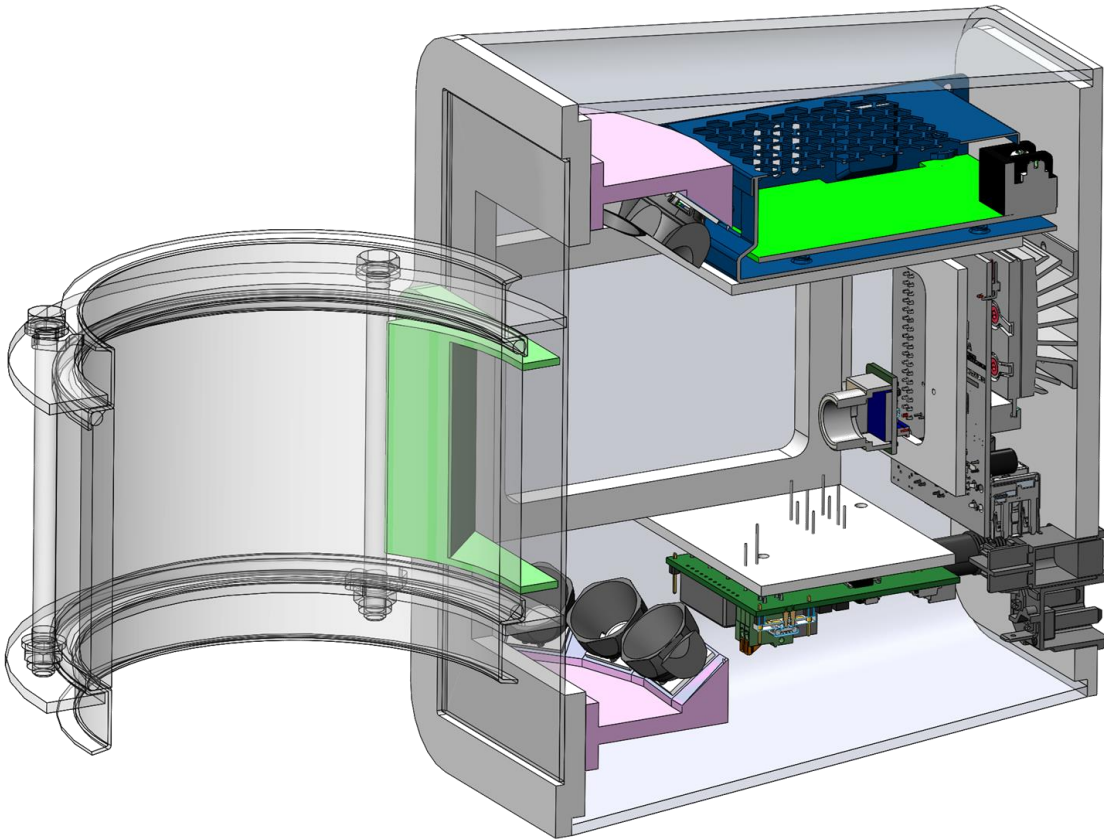
Challenges

- Rate of 1.5 m/s through a mill
- Measure flow rate <3% error
- Start data driven techniques such as morphology for quality detection

Fast

Accurate

Data Collection



IMX 296
1/2.9"
RGB/CMOS
1440 x 1080
pixel 60 FPS
Global Shutter

MIPI Jumper
25-15 lines

Jetson Nano
4-cores ARM
CPU
Maxwell GPU
128 CUDA cores

LED Array +
Reflectors
CBX1512
700 mA, 18 V

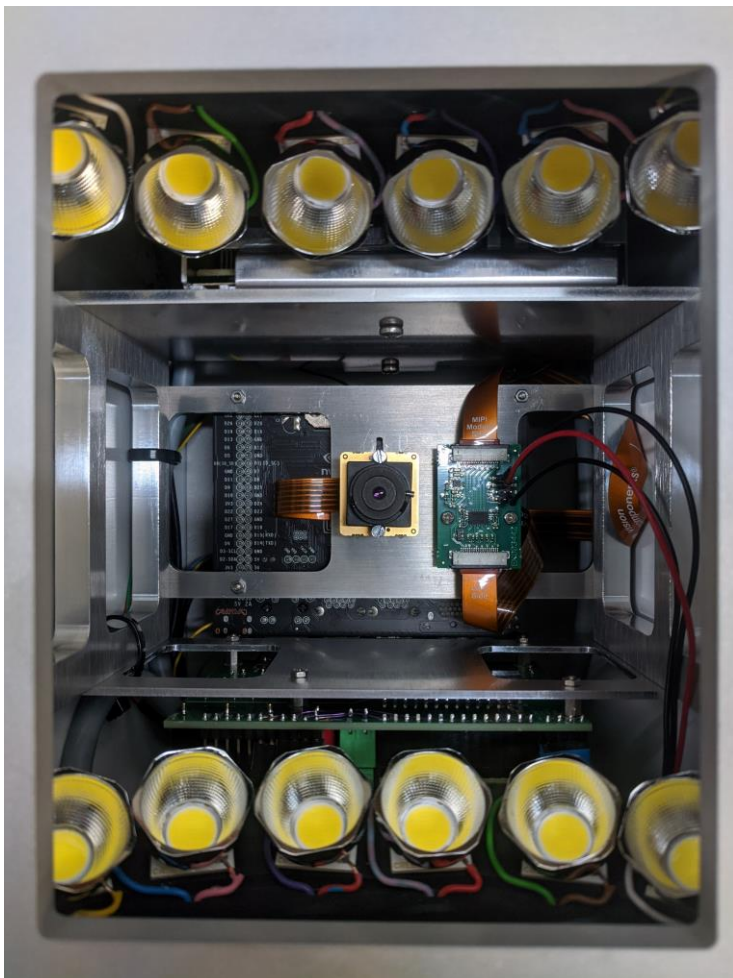
CSEM Custom
Driver

WiFi
Responsive web
GUI

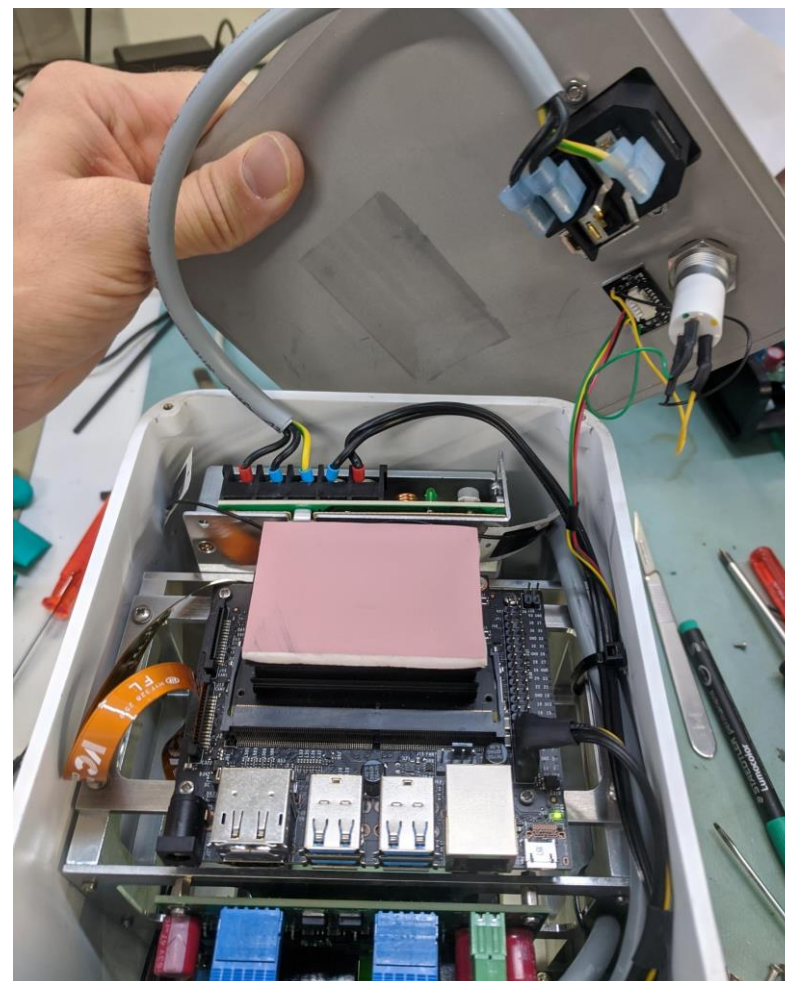
Camera

- 50 fps
- 8 ms exposure time
- 1.5 MP
- 8.5 mm focal length

Front view



Top view

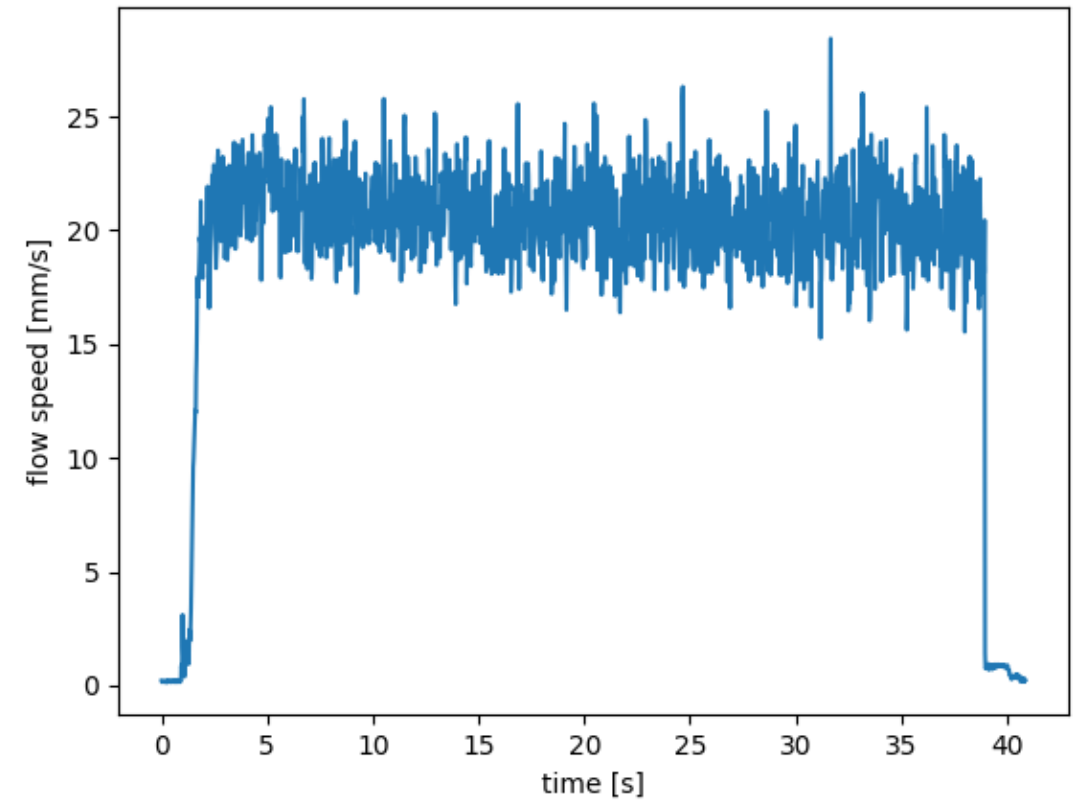


First Trial

2021
embedded
vision
summit



Algorithms: Flow Speed



Algorithms: Mass Flow

$$\text{Mass flow [kg/s]} = \text{flow speed [m/s]} * \text{cross section [m}^2\text{]} * \text{density [kg/m}^3\text{]}$$



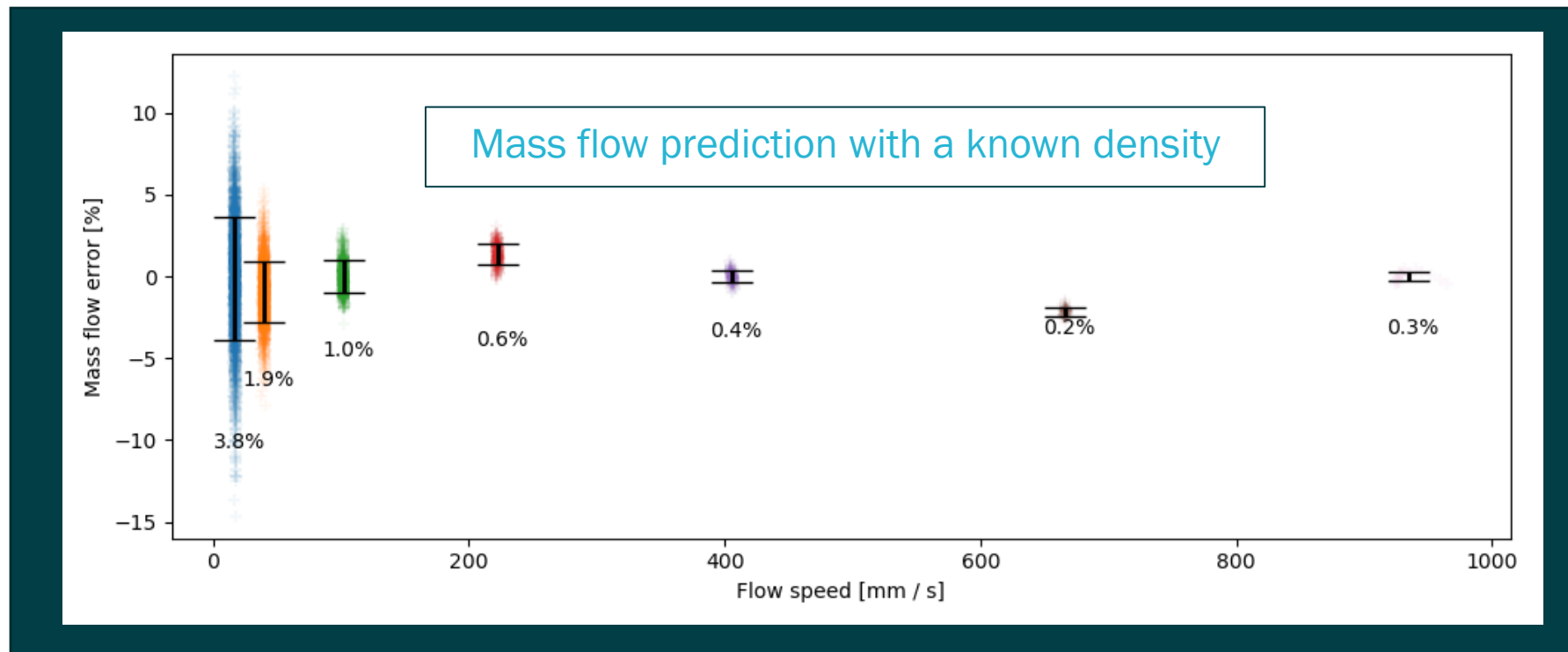
Camera



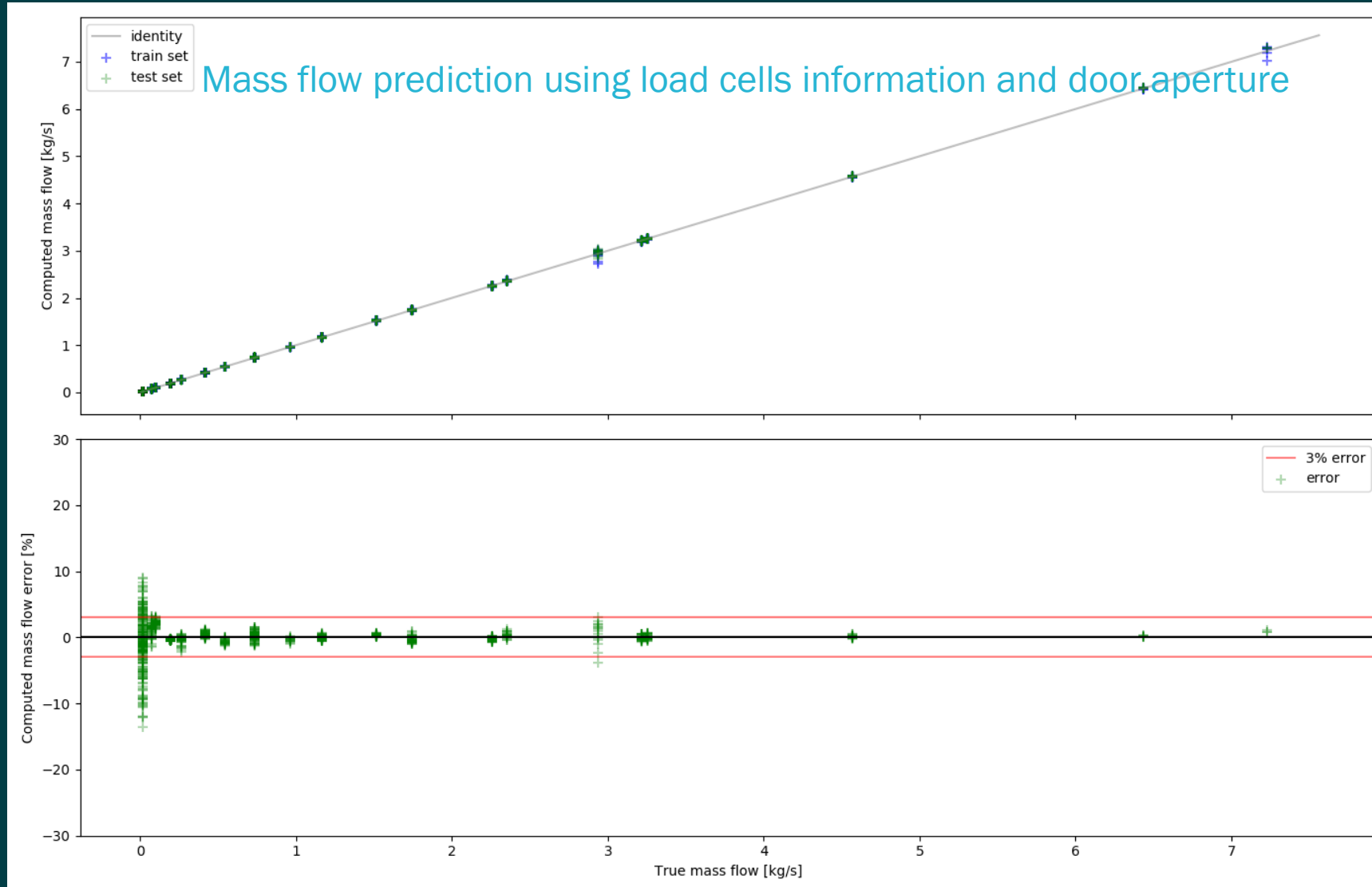
Constant
(from tube diameter)



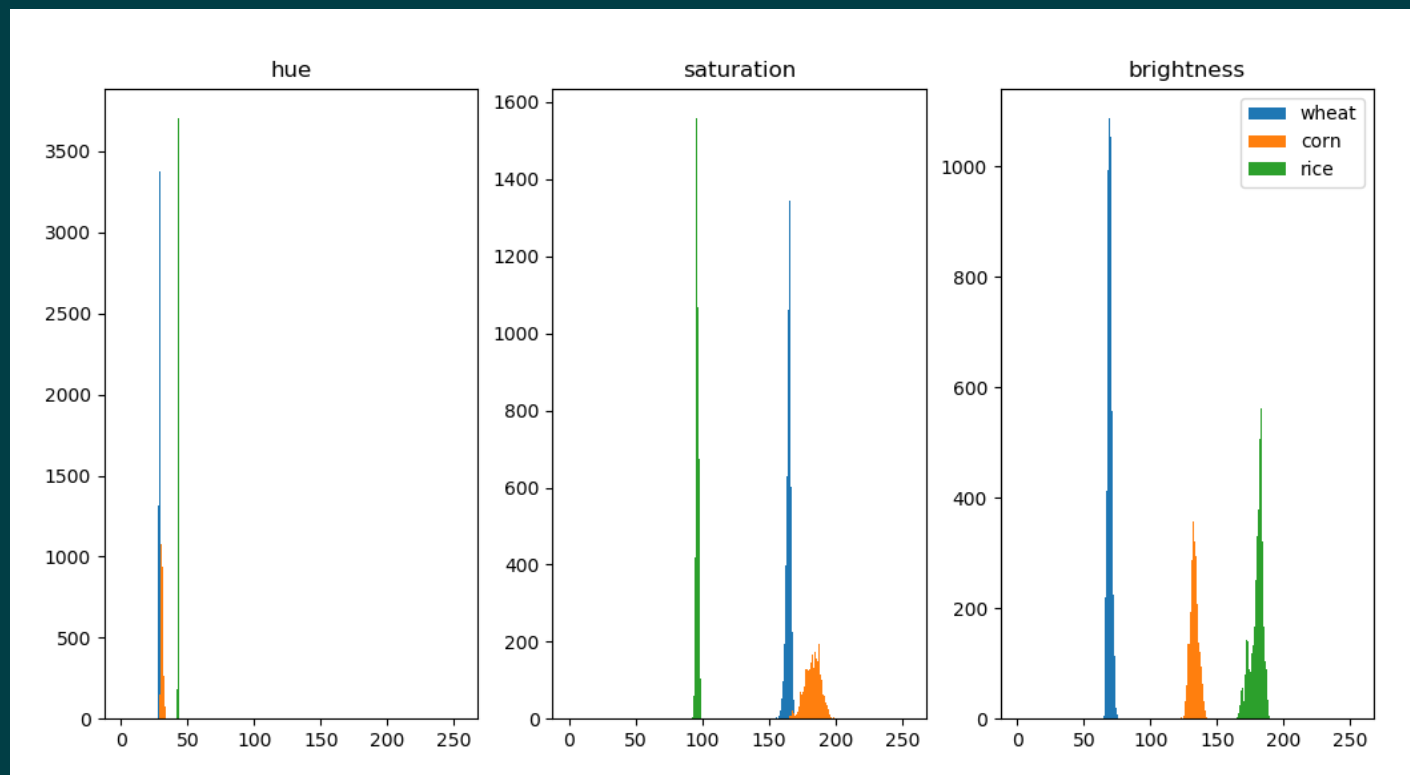
From load cells
OR
Constant



Algorithms: Mass Flow

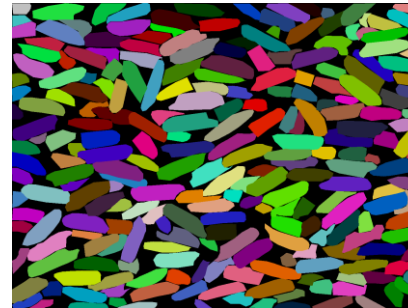


Algorithms: Grain Type Detection

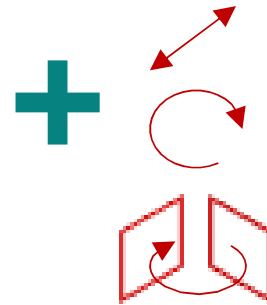
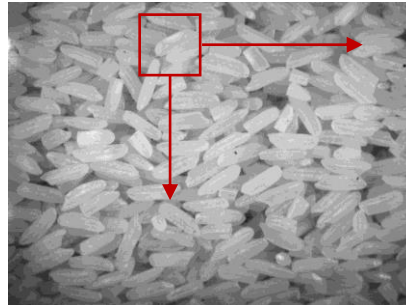


Algorithms: Grain Segmentation

Weakly supervised: only one annotated image (for rice)



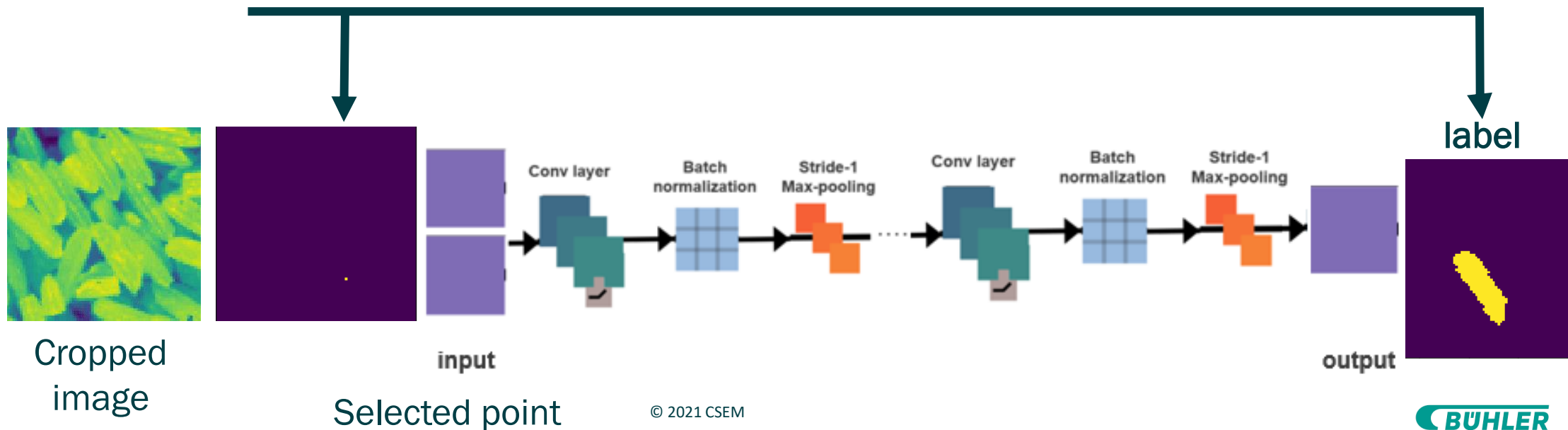
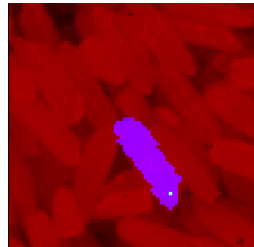
Cropping and data augmentation:



➡ Infinite number
of learning
samples

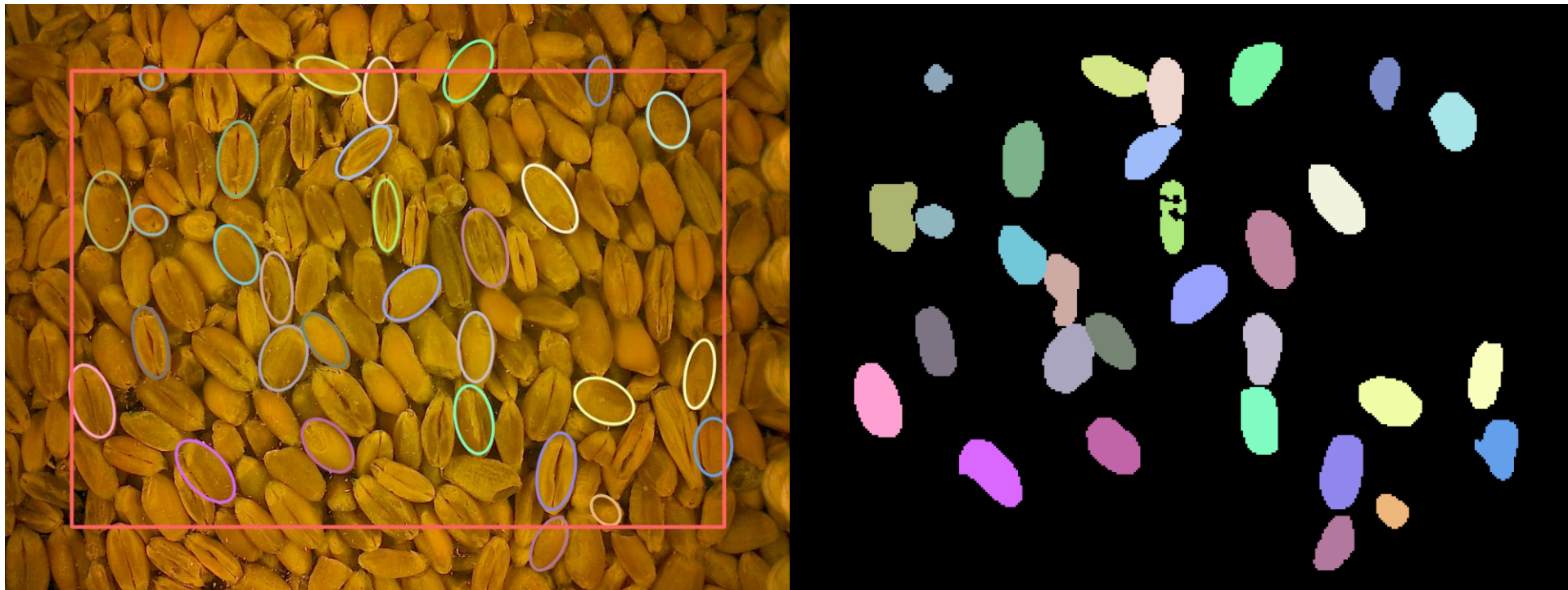
- Flow speed
- Mass flow
- Grain type detection
- **Grain segmentation**
- Shape measurement

input



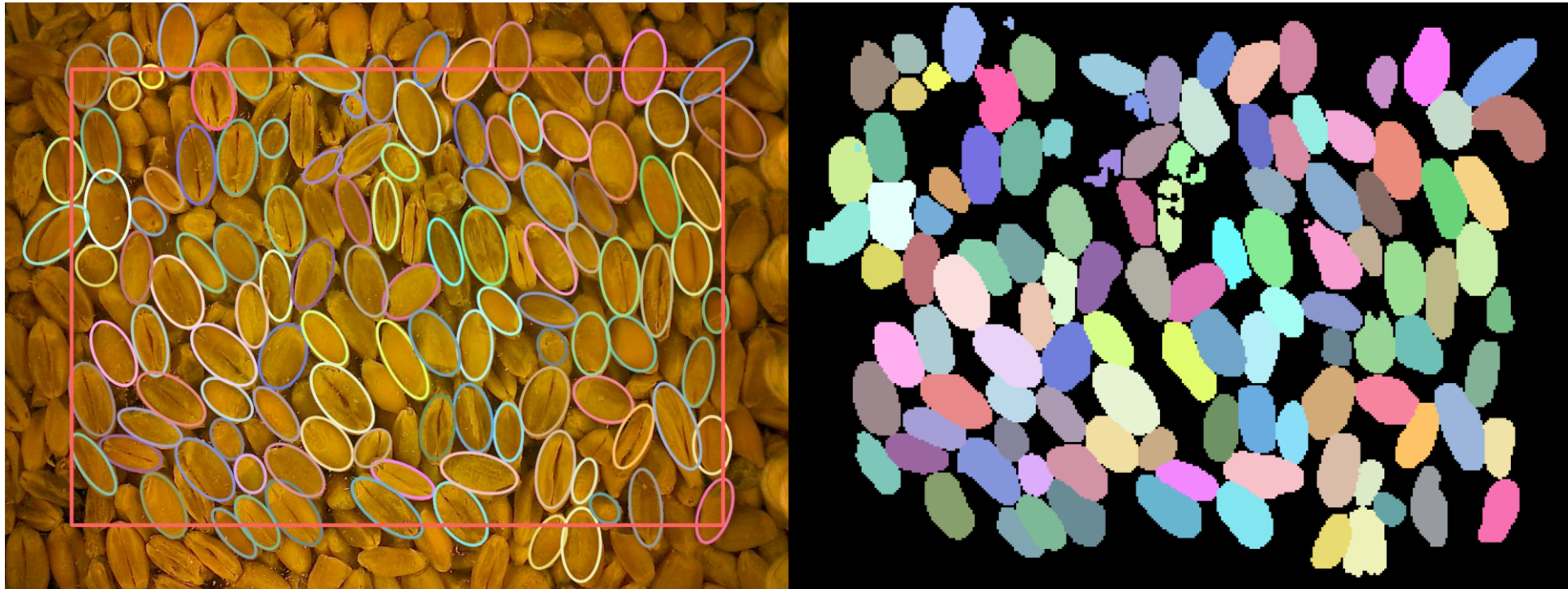
Algorithms: Grain Segmentation

Wheat: 1 iteration, 30 valid grains



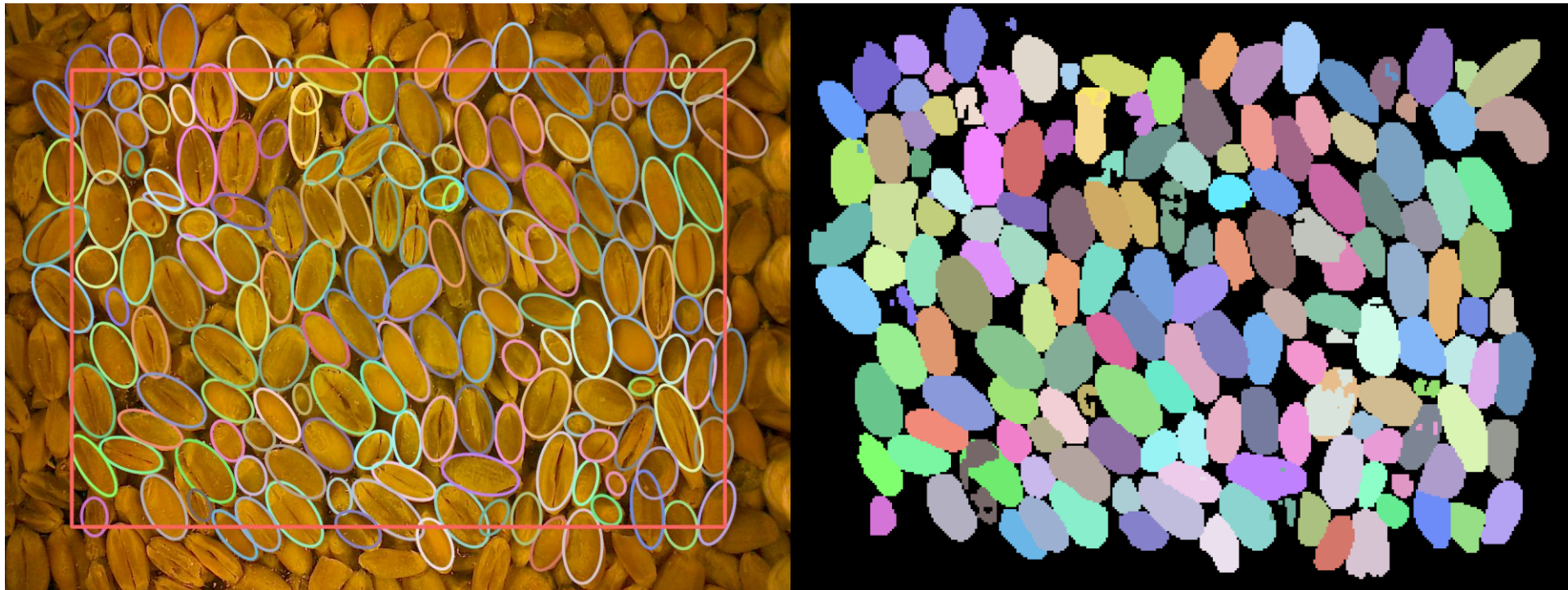
Algorithms: Grain Segmentation

Wheat: 3 iterations, 85 valid grains



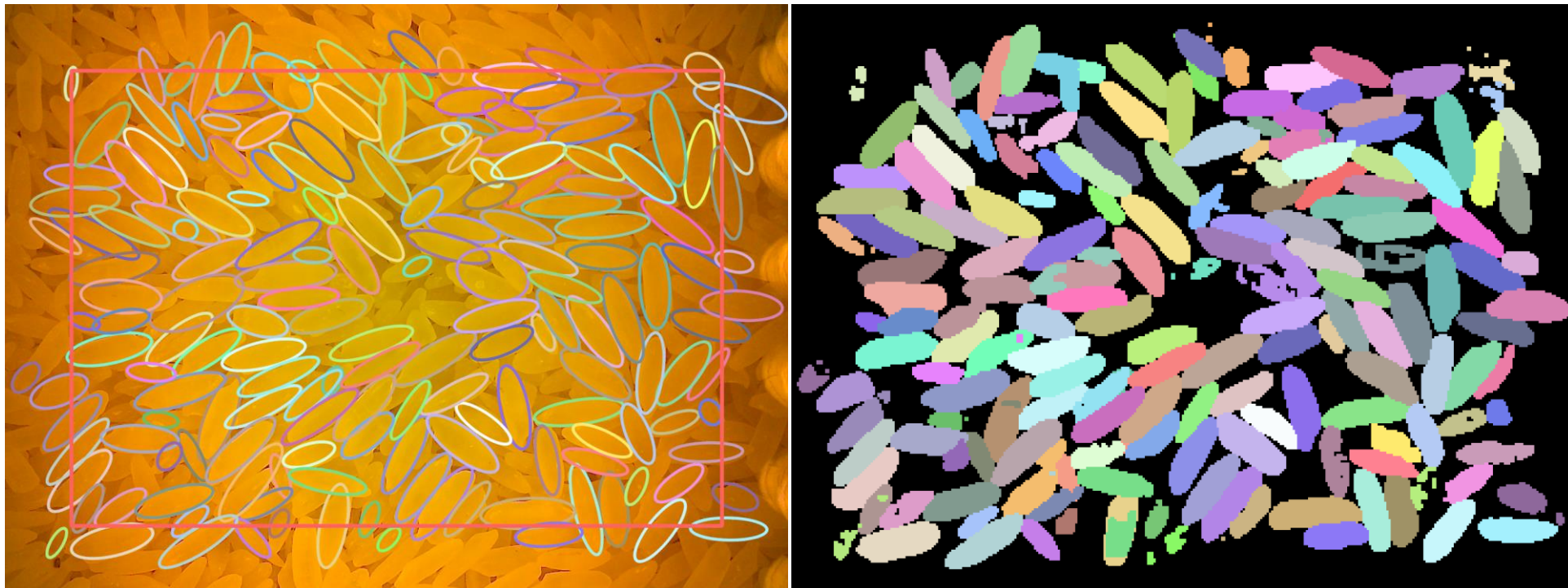
Algorithms: Grain Segmentation

Wheat : 8 iterations, 158 valid grains



Algorithms: Grain Segmentation

Rice, 12 iterations, 173 valid grains

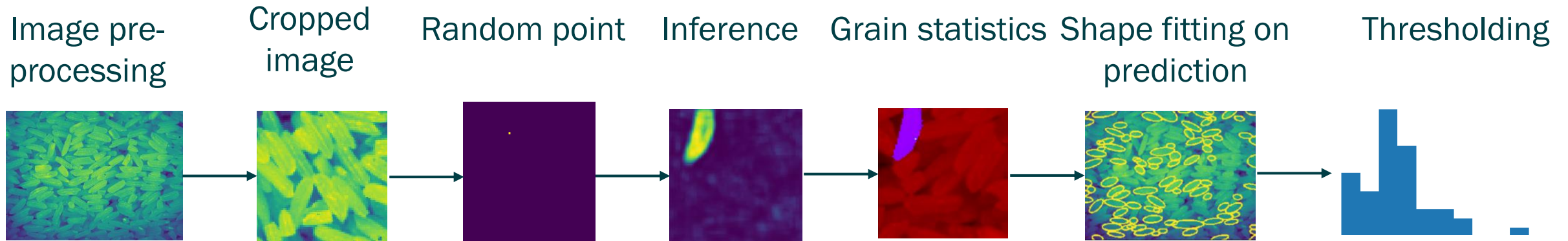


Algorithms: Grain Segmentation

Corn : 3 iterations, 33 valid grains



Algorithms: Shape Morphology



Final Installation

csem ● Camera ● Speed ● Shape | Grain type: wheat

Camera feed



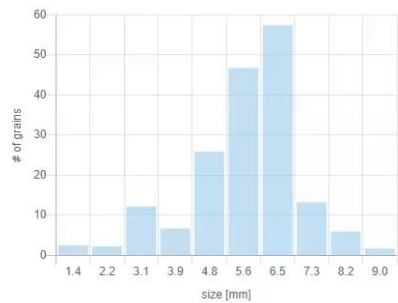
Segmentation result



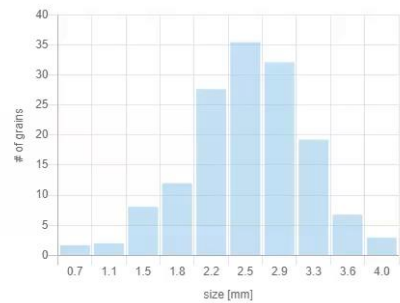
Flow speed



Grain shape: major axis



Grain shape: minor axis



Recorded data

shapes_20210511_171004.csv



speed_20210511_171005.csv



Conclusions Intelligent Vision System

- High speed (low latency), privacy & low power
- Data driven technique only when needed
- Reduced labelling a genuine help
- Concrete return as first step to further digitalization know-how

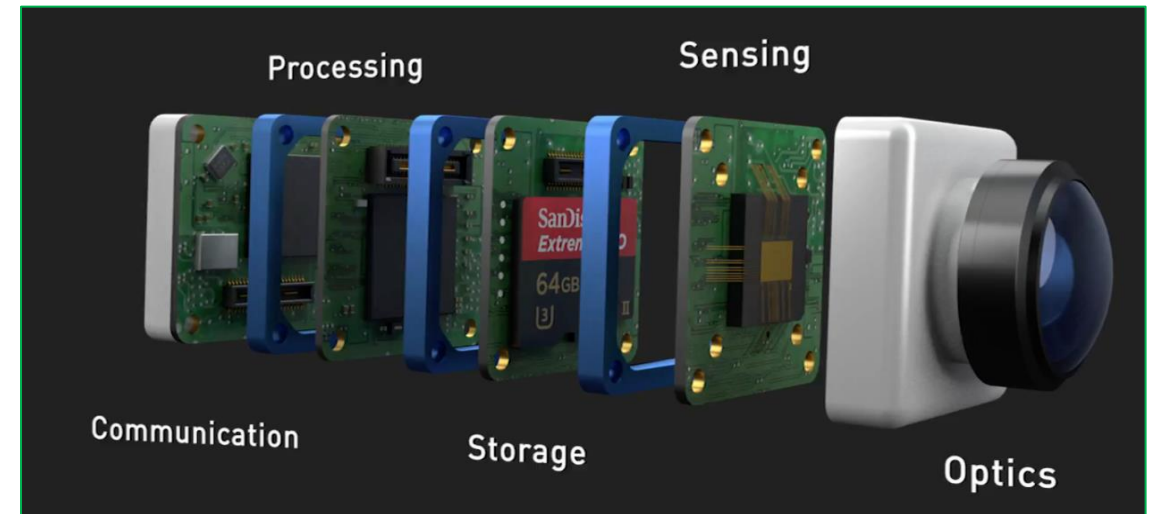
We make Intelligent Vision Systems at the Edge

Thanks to: Nicolas Cantale, Pedram Pad,
Sébastien Blanc, Clément Kundig

Andrea Dunbar
EDGE AI & Vision
Andrea.dunbar@csem.ch
+41 32 720 5069

CSEM website
<https://www.csem.ch/vision>

Bühler website
<https://digital.buhlergroup.com/>



Photon In.....Information Out: PI.....IO