

# Deep learning for the analysis of optical maps of CVD-grown TMDs

INSTITUT ZA FIZIKU

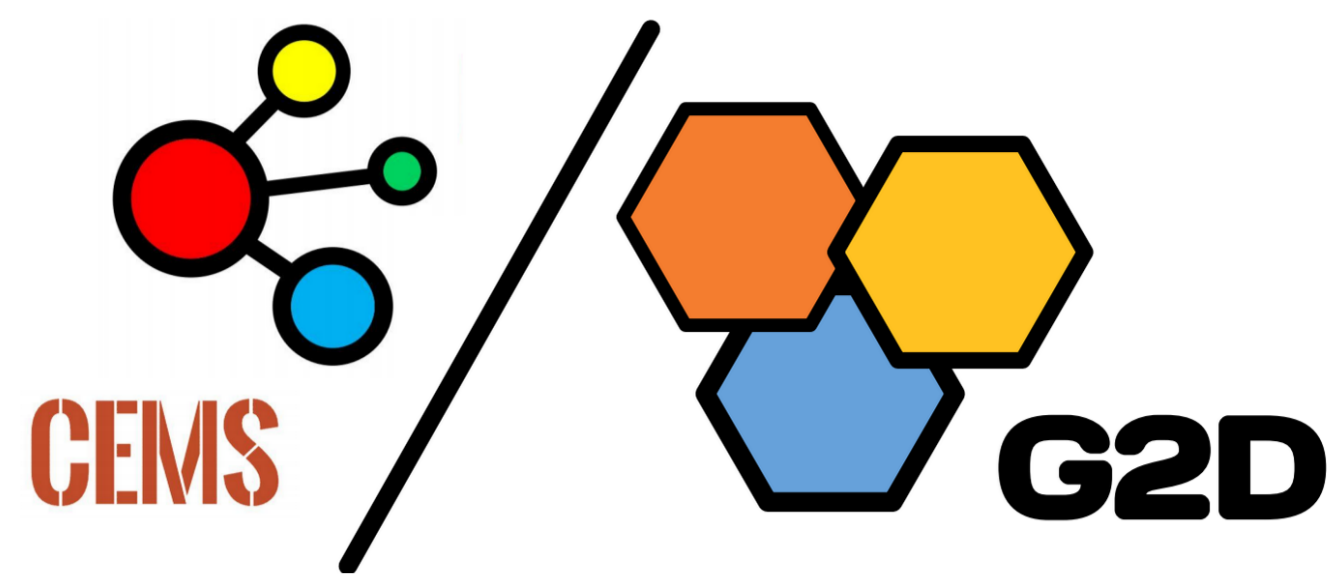
A. Supina<sup>1</sup>, A. Senkic<sup>1</sup>, A.L. Brkic<sup>1</sup>, M. Jaklin<sup>2</sup> and M. Kralj<sup>1</sup>

<sup>1</sup>Institute of Physics, Zagreb, Croatia

<sup>2</sup>Universidad de Santiago de Compostela, Spain

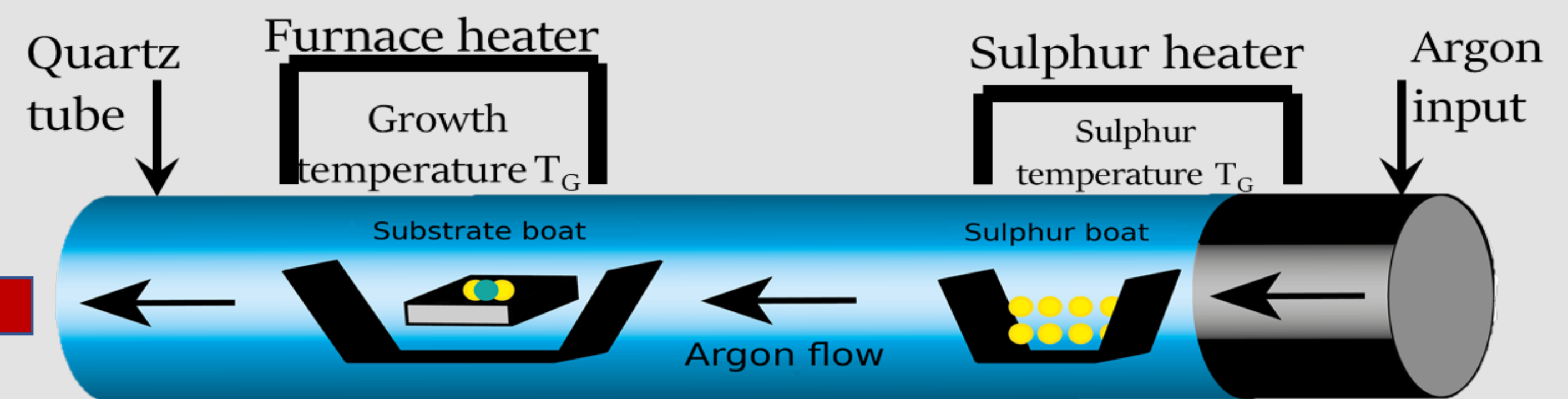
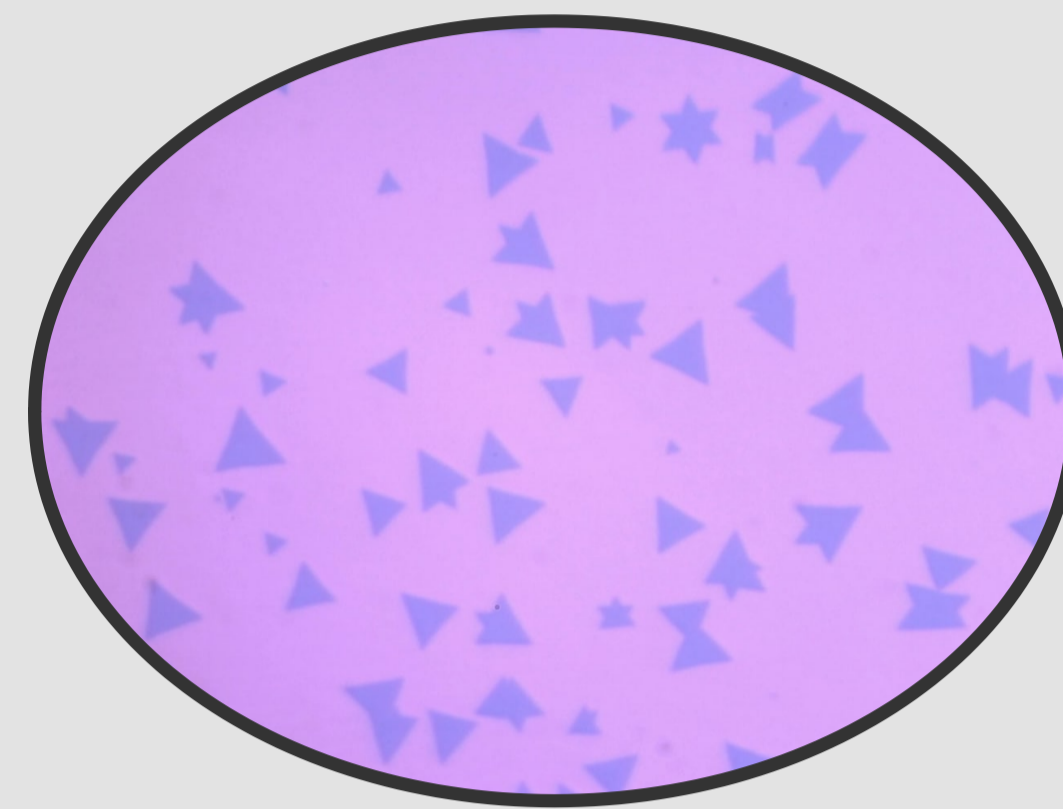
e-mail: asupina@ifs.hr

This work has been supported by ERDF Grant KK.01.1.1.01.0001



## Motivation

2D TMDs



Schematic illustration of CVD synthesis through which we obtain 2D TMDs (ex: MoS<sub>2</sub>)

**Inhomogeneous distribution of island shapes and properties** with respect to lateral position on the growth substrate

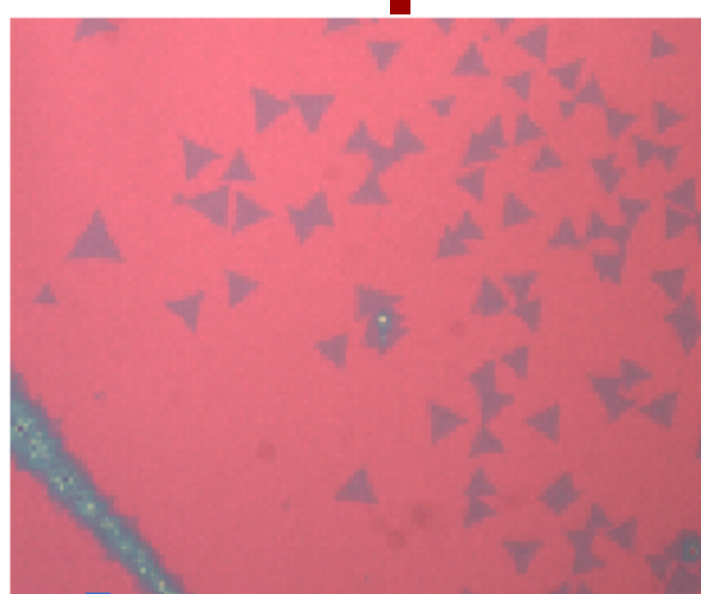
## Methodology

**Low-cost optical microscope upgrade** consisting of an x-y motorized stage, microcontroller and camera for image acquisition

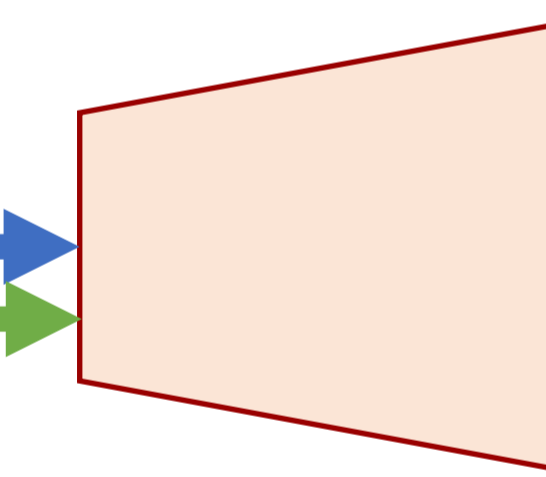


High magnification optical image maps

Real MoS<sub>2</sub> samples

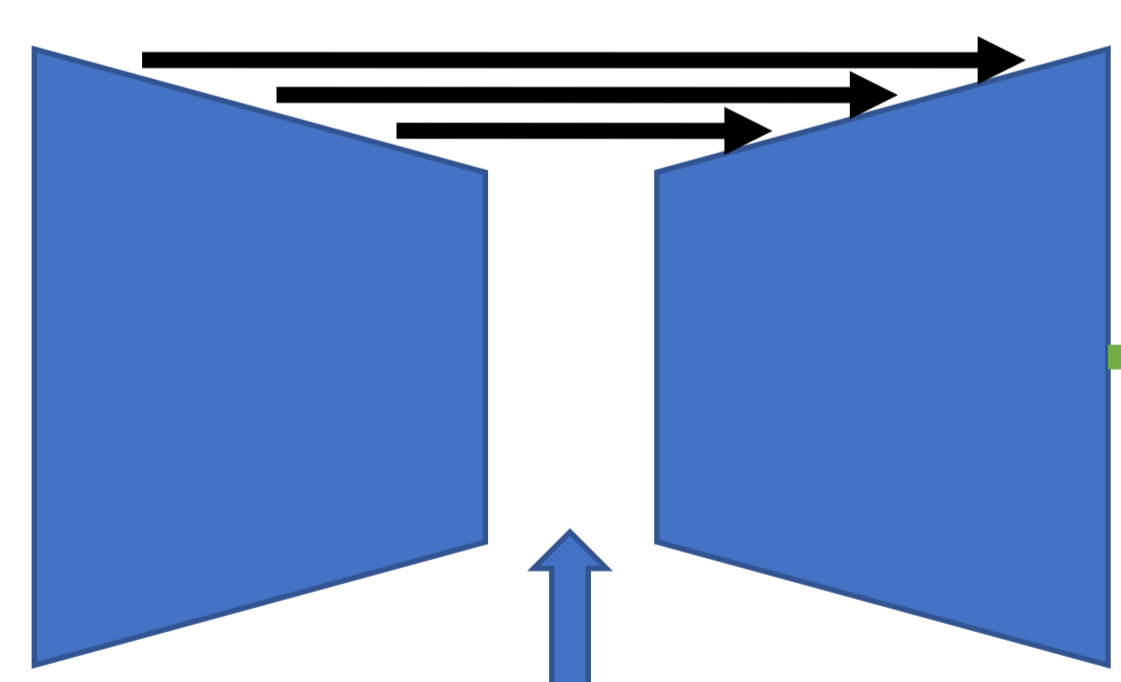


DISCRIMINATOR



Real / Generated sample?

GENERATOR

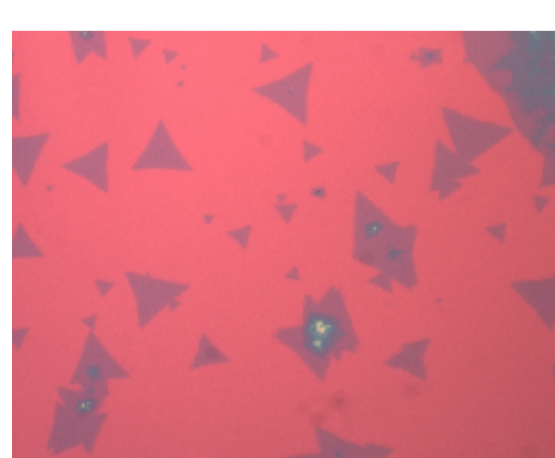


Random noise

OUTPUT Generated MoS<sub>2</sub> samples



Simulated MoS<sub>2</sub> islands using Monte Carlo Simulation

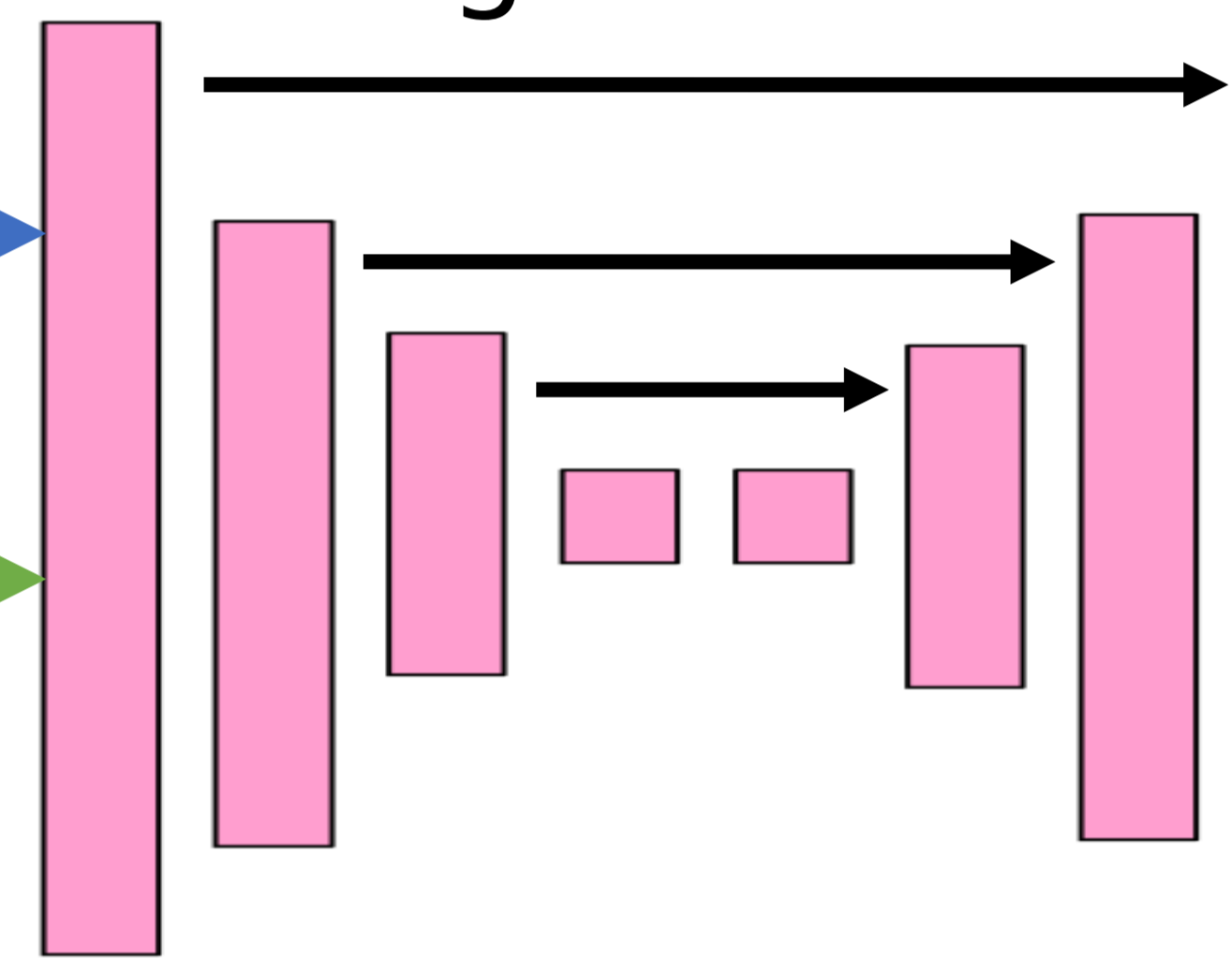


Real MoS<sub>2</sub> samples

YOTO

Localize and assess the size of islands using a YOLO-like architecture

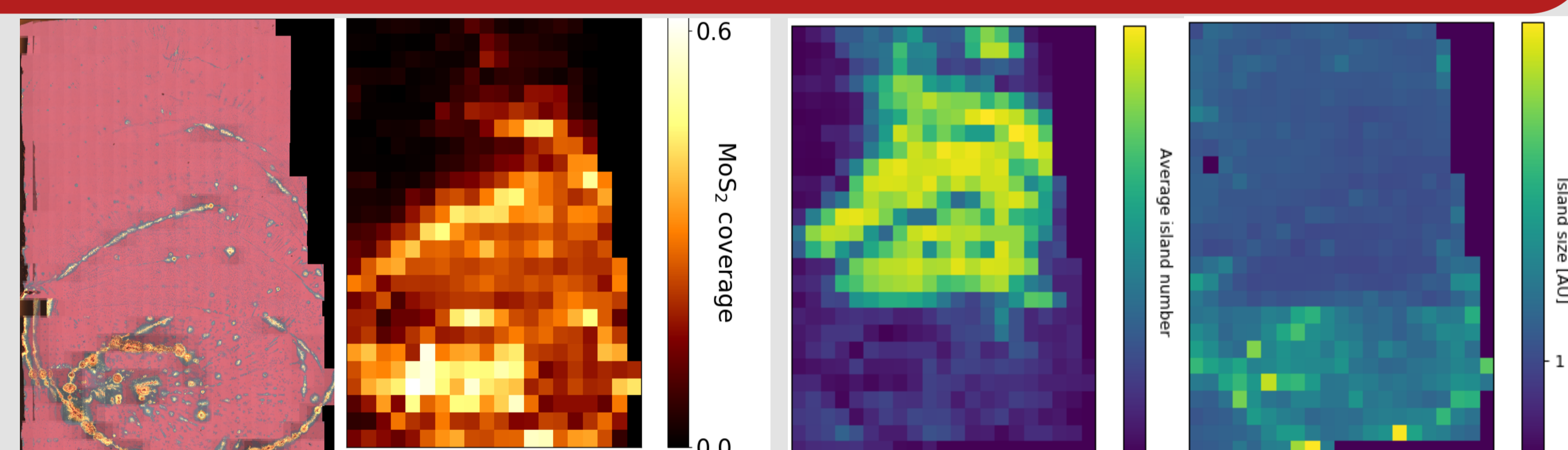
U-Net with adversarial augmentation



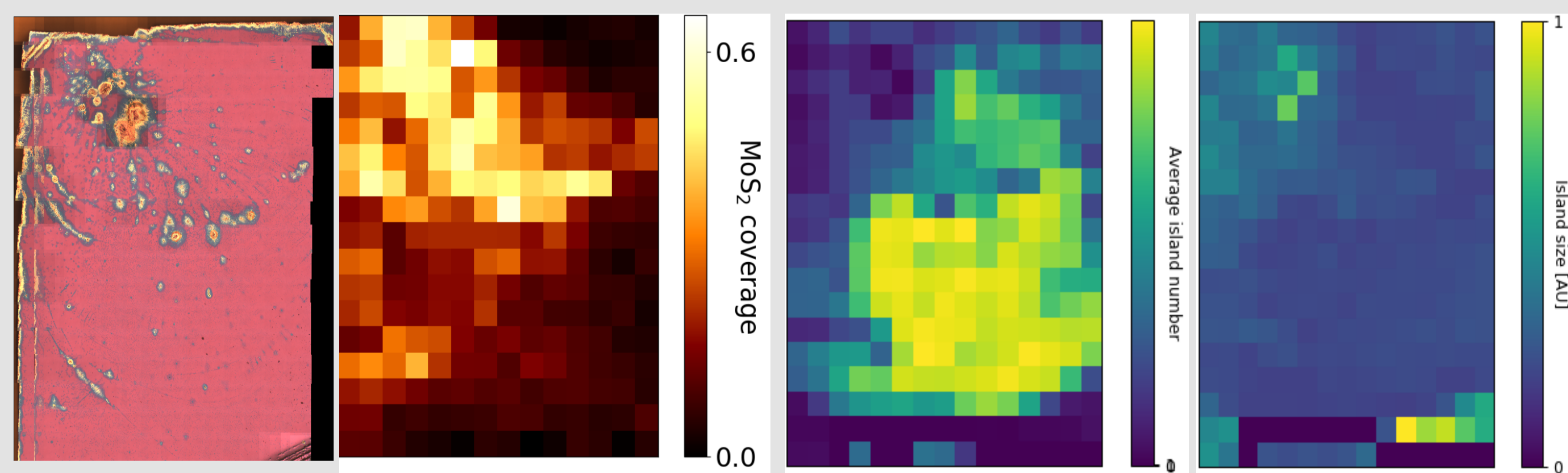
Segmentation of material from the substrate area



## Results



Extraction of material coverage distribution from U-Net segmentation. Lateral distribution of island density and island size for each grown sample



## REFERENCES

- [1] D. Dumcenco, D. Ovchinnikov, K. Marinov, et al, ACS Nano. 9, 4611–4620 (2015).
- [2] B. Han, Y. Lin, Y. Yang, et al., Advanced Materials. 32, 2000953 (2020).
- [3] O. Ronneberger, P. Fischer, T. Brox, arXiv:1505.04597 [Cs]. (2015).
- [4] J. Redmon, S. Divvala, R. Girshick, A. Farhadi, arXiv:1506.02640 [cs.CV], (2016).
- [5] Bajo, J., Optical characterization of transition metal dichalcogenides for synthesis parameters improvements, Master's thesis, University of Zagreb, Faculty of Science, Zagreb, 2020.