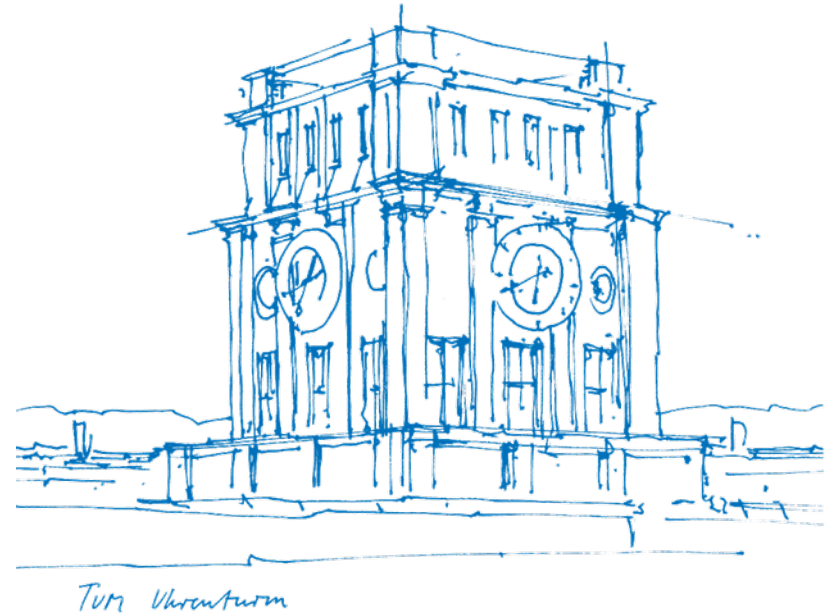


Deep Learning Methods for Reynolds-Averaged Navier-Stokes Simulations of Airfoil Flows

Julian Hohenadel
Technical University of Munich
Chair of Computer Graphics and Visualization
Munich, 11. May 2020



Introduction

TODO

Background – RANS

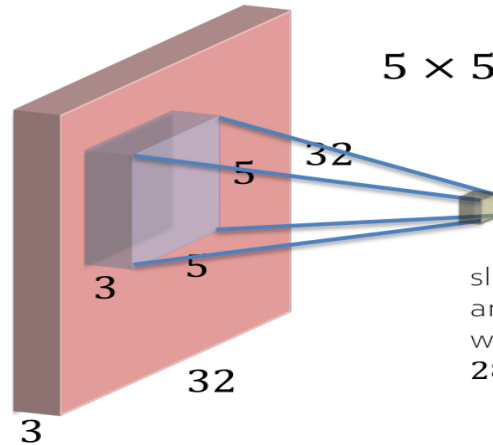
TODO

Background – RANS

TODO

Background – Convolutions

$32 \times 32 \times 3$ image

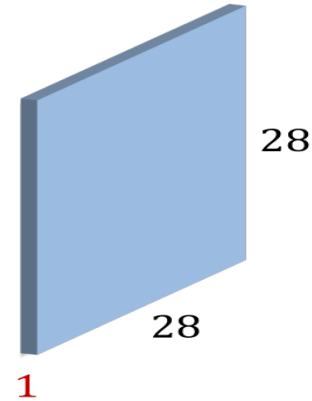


$5 \times 5 \times 3$ filter



slide over all spatial locations x_i
and compute all output z_i
w/o padding, there are
 28×28 locations

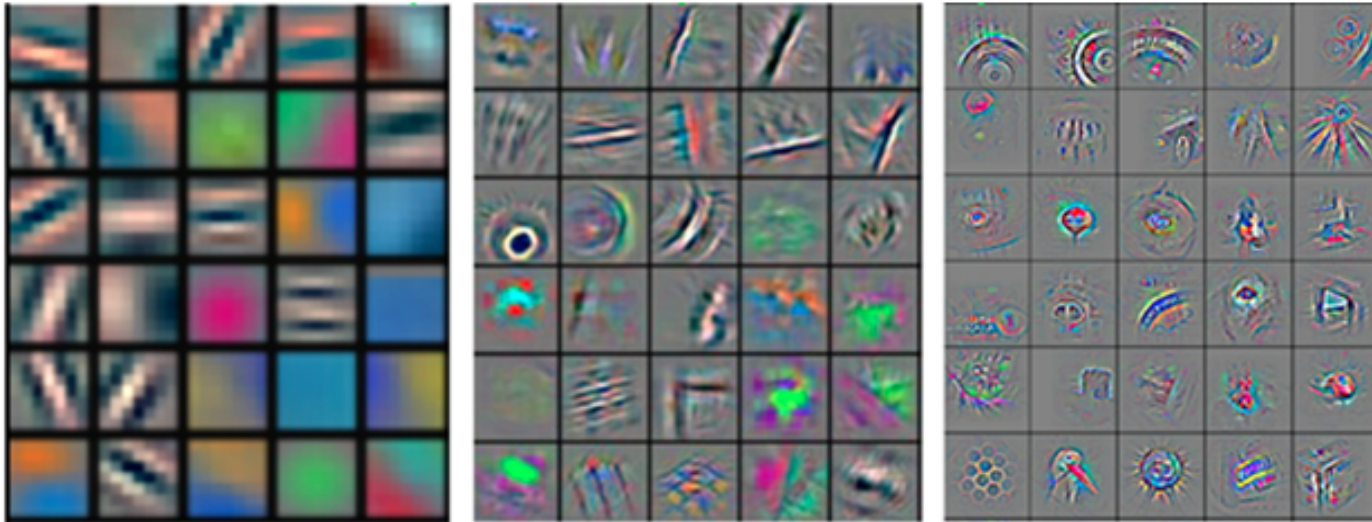
activation map
(also feature map)



Taken from I2DL WS19/20 (TUM)

Background – Convolutions

Low-Level Features, Mid-Level Features, High-Level Features: each filter captures different characteristics



Taken from <https://arxiv.org/pdf/1311.2901.pdf>

Pre-processing

TODO

Pre-processing – Evaluation

TODO

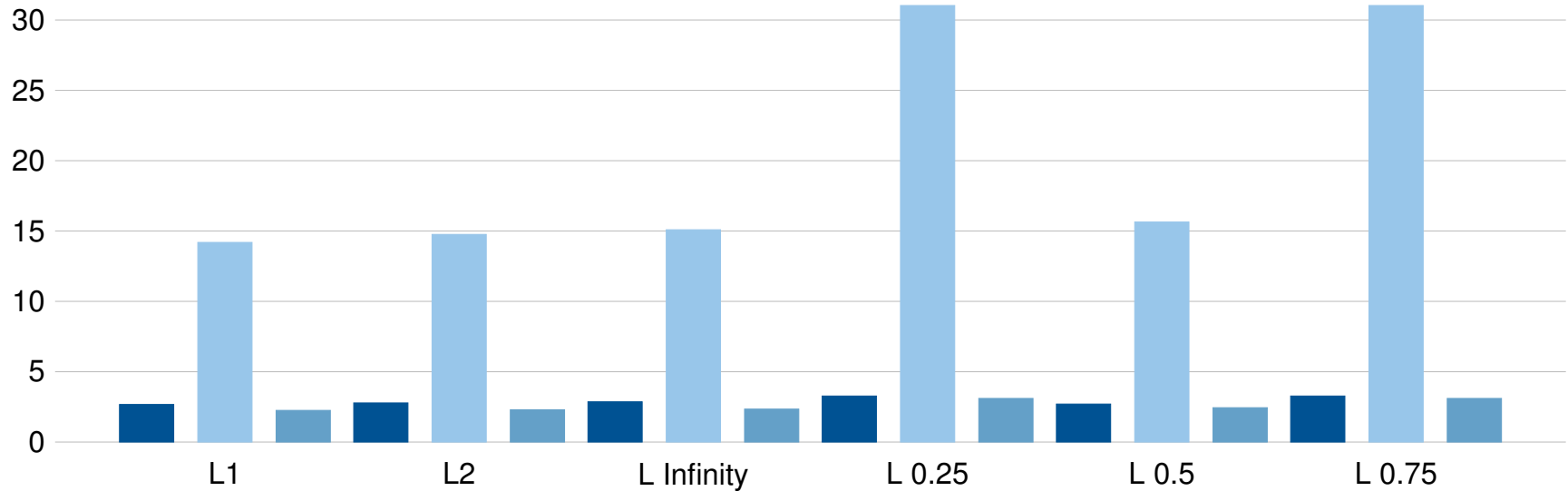
Pre-processing – Evaluation

TODO

Pre-processing – Evaluation

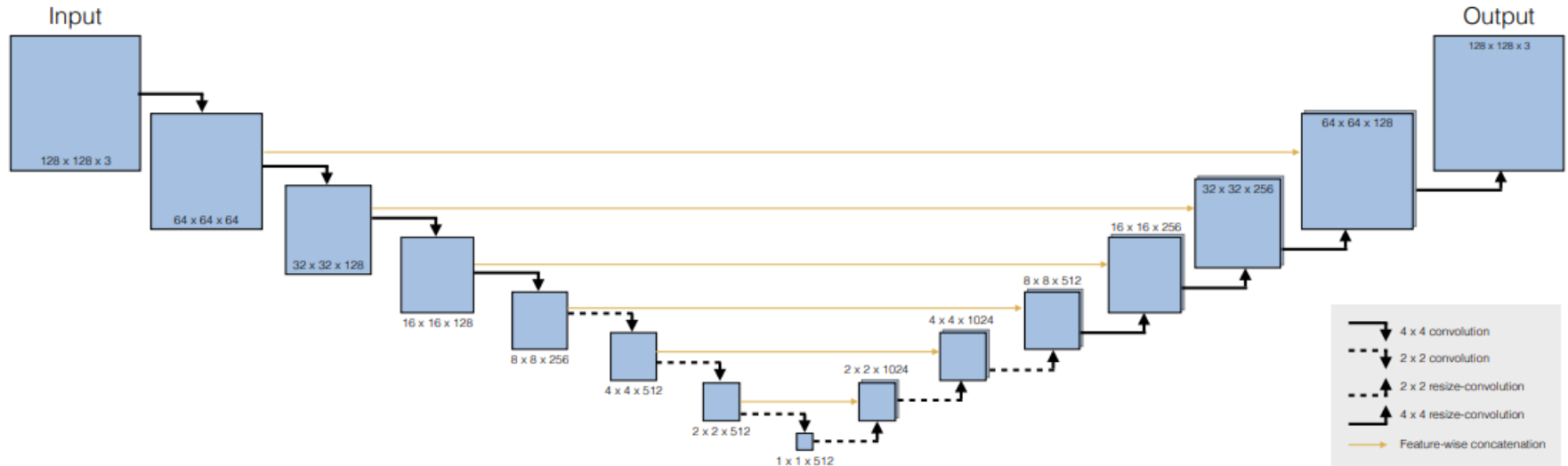
Vector norms used in pre-processing comparison wrt. error, L2 default (in %)

L1 normalization achieves the best error rates (pressure, velocity, combined: 14.19%, 2.251%, 2.646% – L2: 14.76%, 2.291%, 2.780%)



Architecture

U-Net derivative proposed in the paper:



Taken from <https://arxiv.org/pdf/1810.08217.pdf>

Architecture

Convolutional blocks:

TODO

Architecture – Evaluation

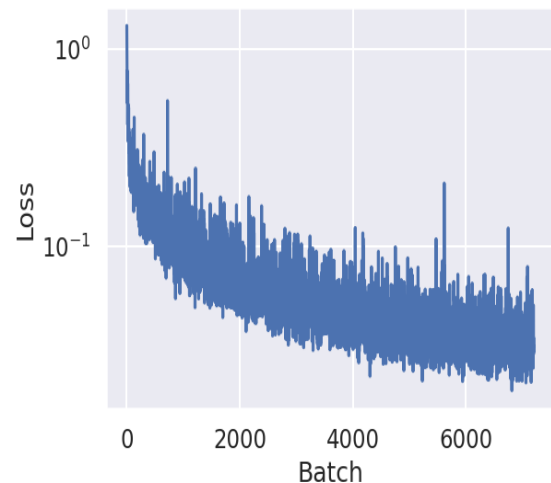
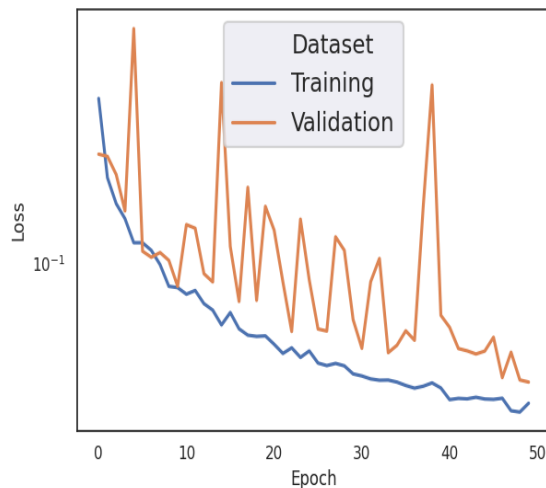
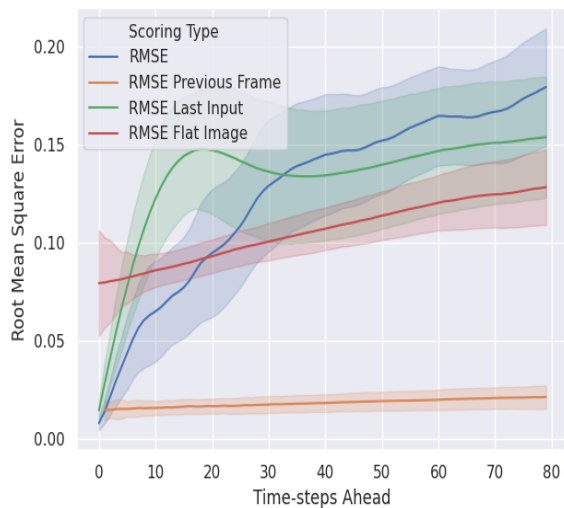
TODO

Transfer

TODO

Transfer

RMSE with variance, validation loss and batch loss on Bigger Tub environment:

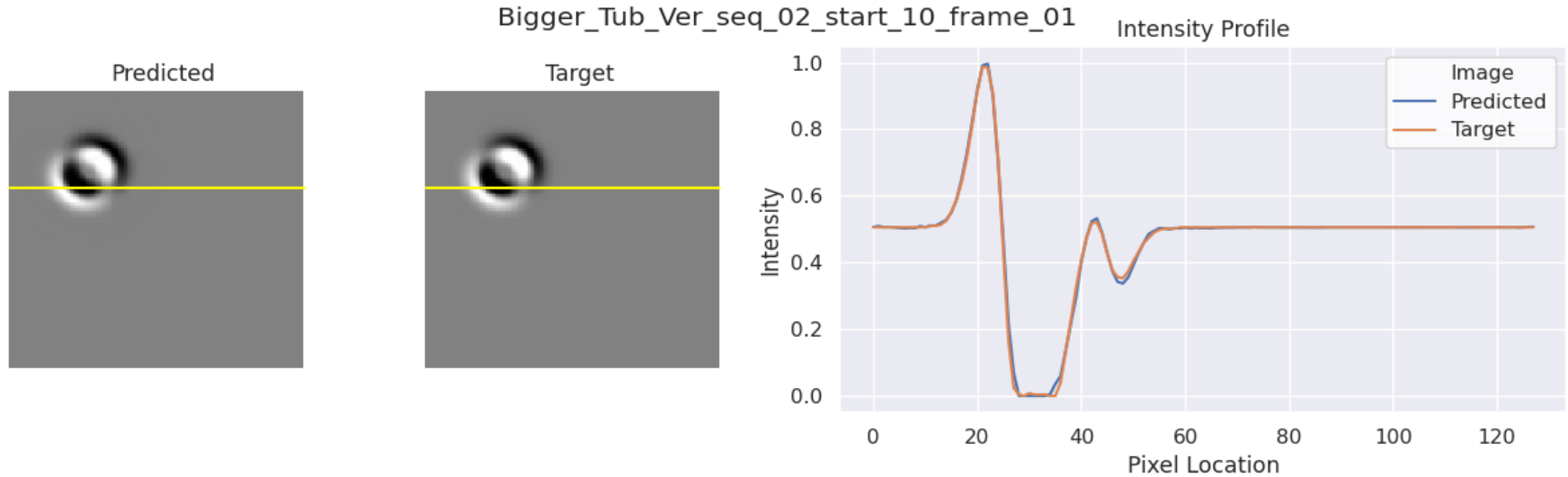


All plots in Transfer were made with https://github.com/stathius/wave_propagation

Transfer

Wave propagation prediction

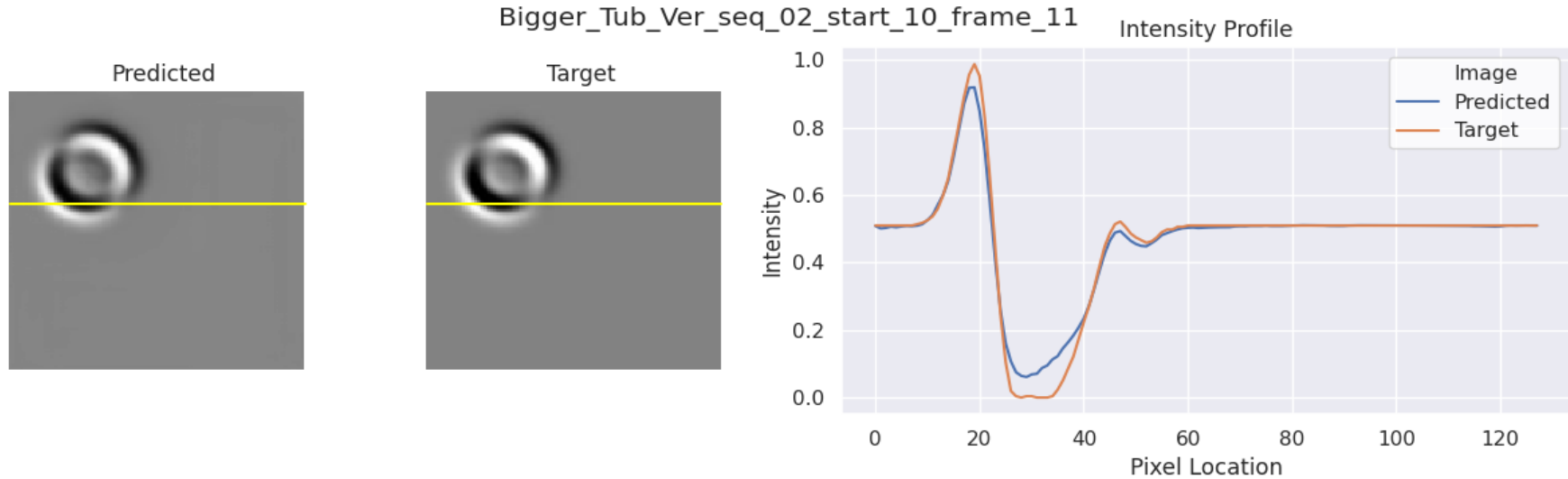
Intensity profile on scanline – Frame 1



Transfer

Wave propagation prediction

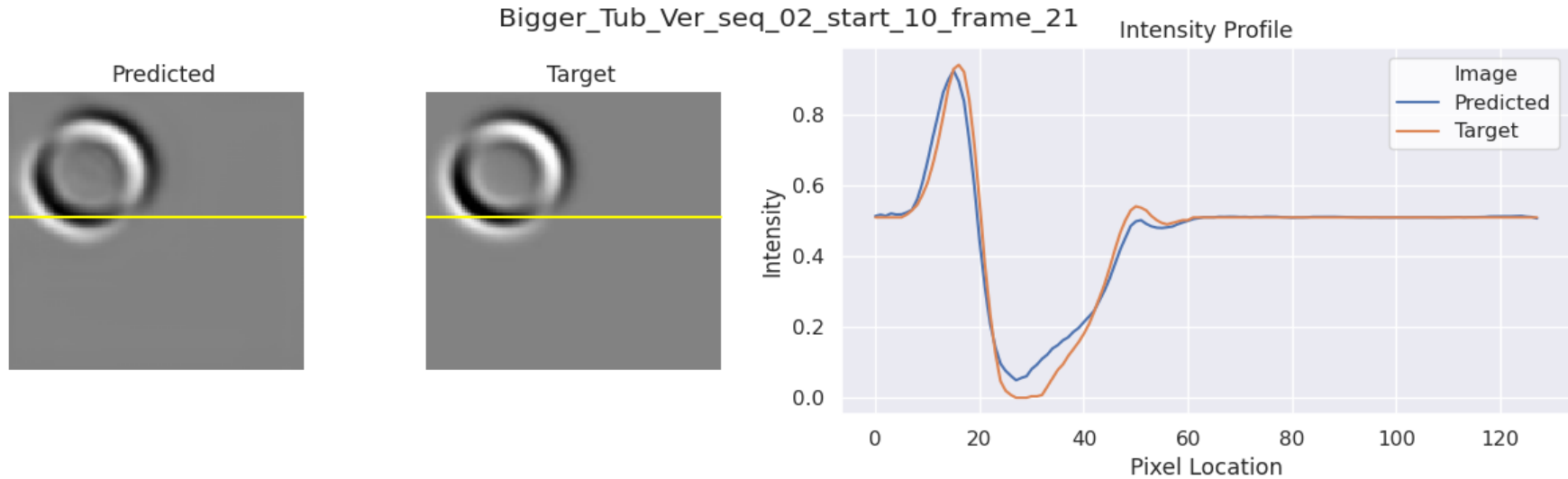
Intensity profile on scanline – Frame 11



Transfer

Wave propagation prediction

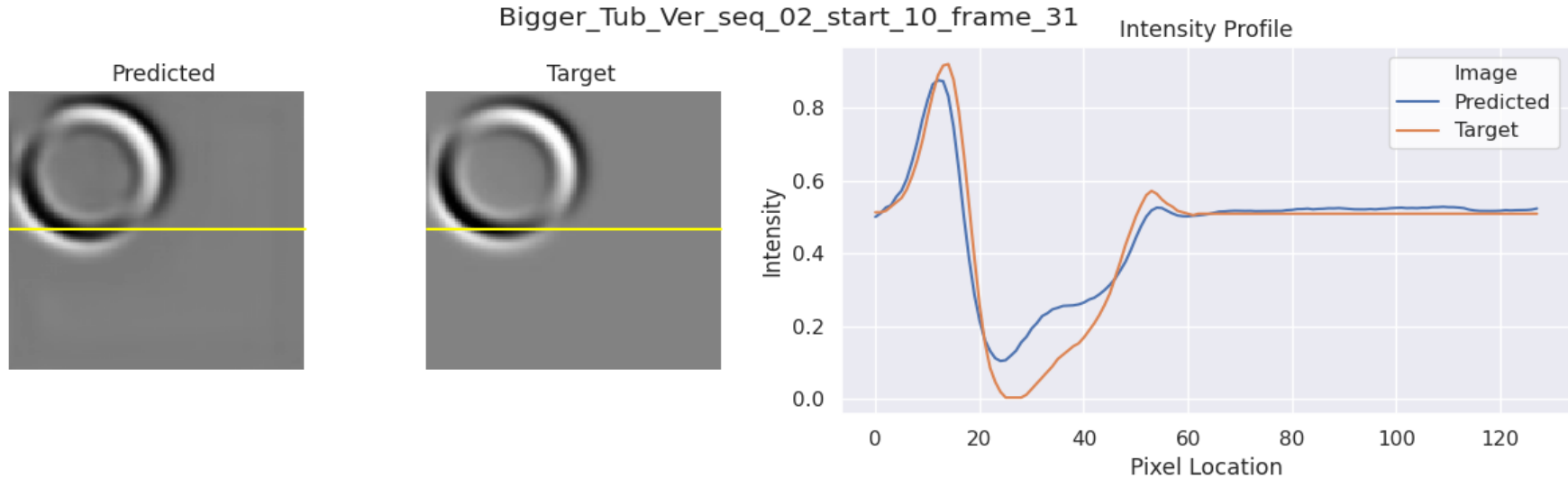
Intensity profile on scanline – Frame 21



Transfer

Wave propagation prediction

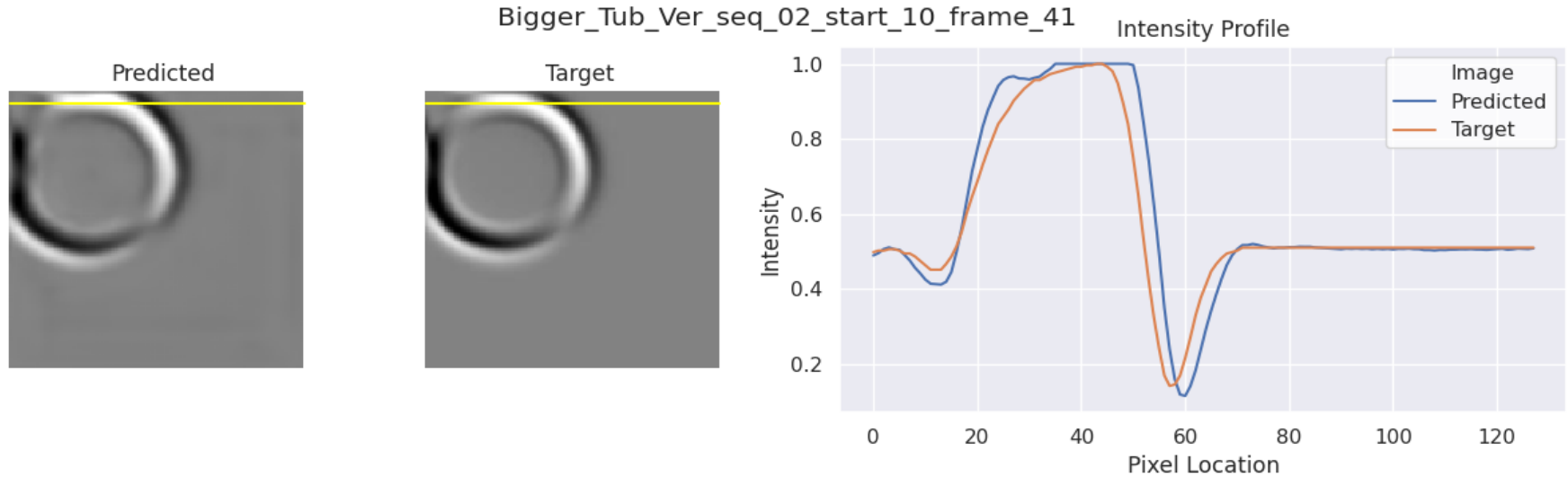
Intensity profile on scanline – Frame 31



Transfer

Wave propagation prediction

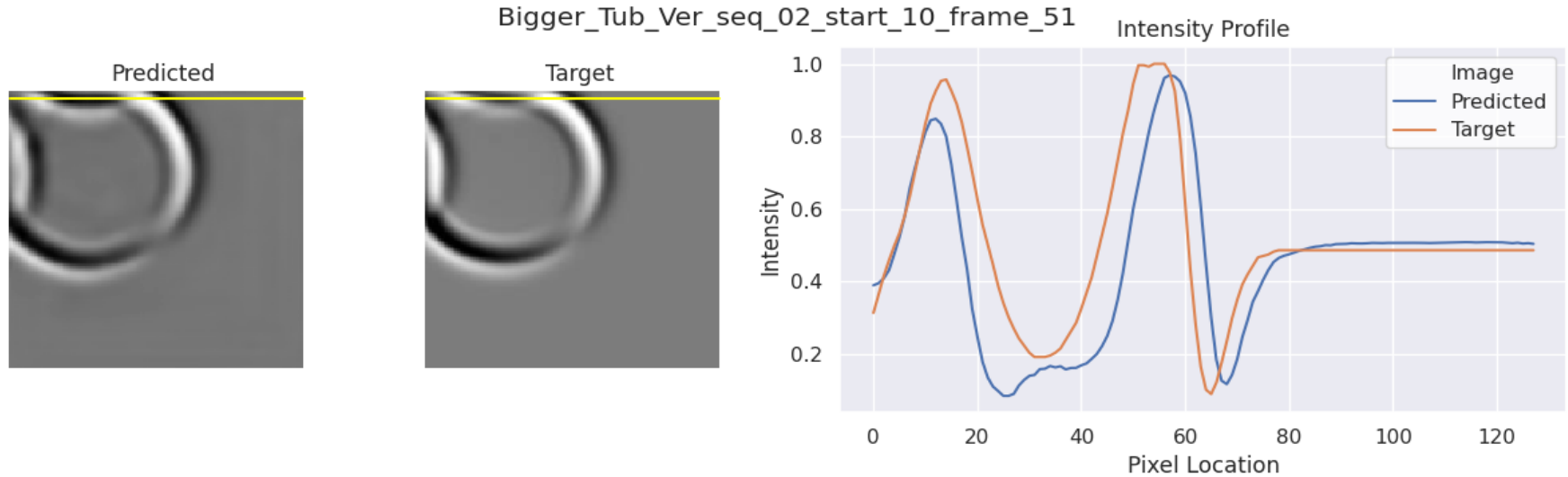
Intensity profile on scanline – Frame 41



Transfer

Wave propagation prediction

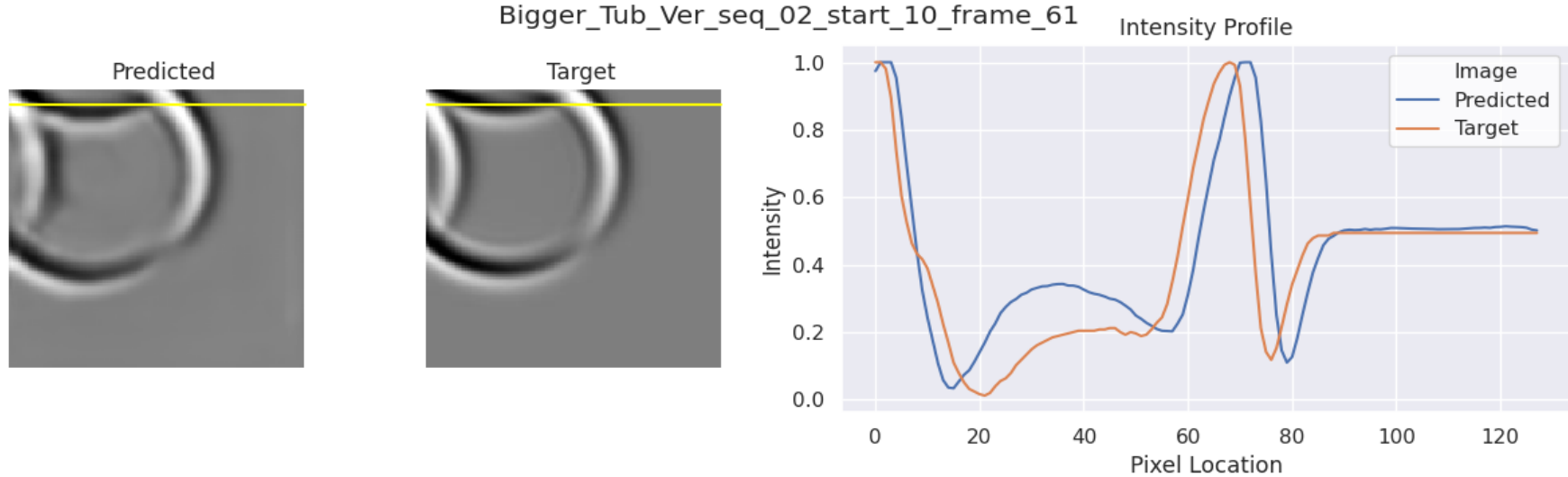
Intensity profile on scanline – Frame 51



Transfer

Wave propagation prediction

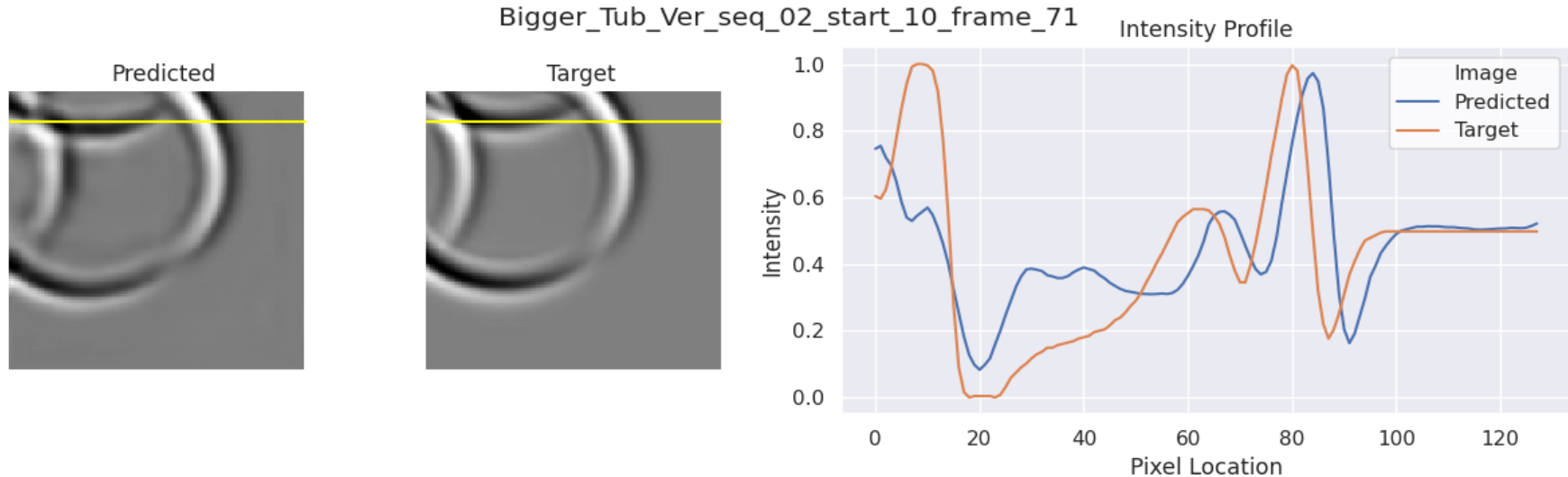
Intensity profile on scanline – Frame 61



Transfer

Wave propagation prediction

Intensity profile on scanline – Frame 71

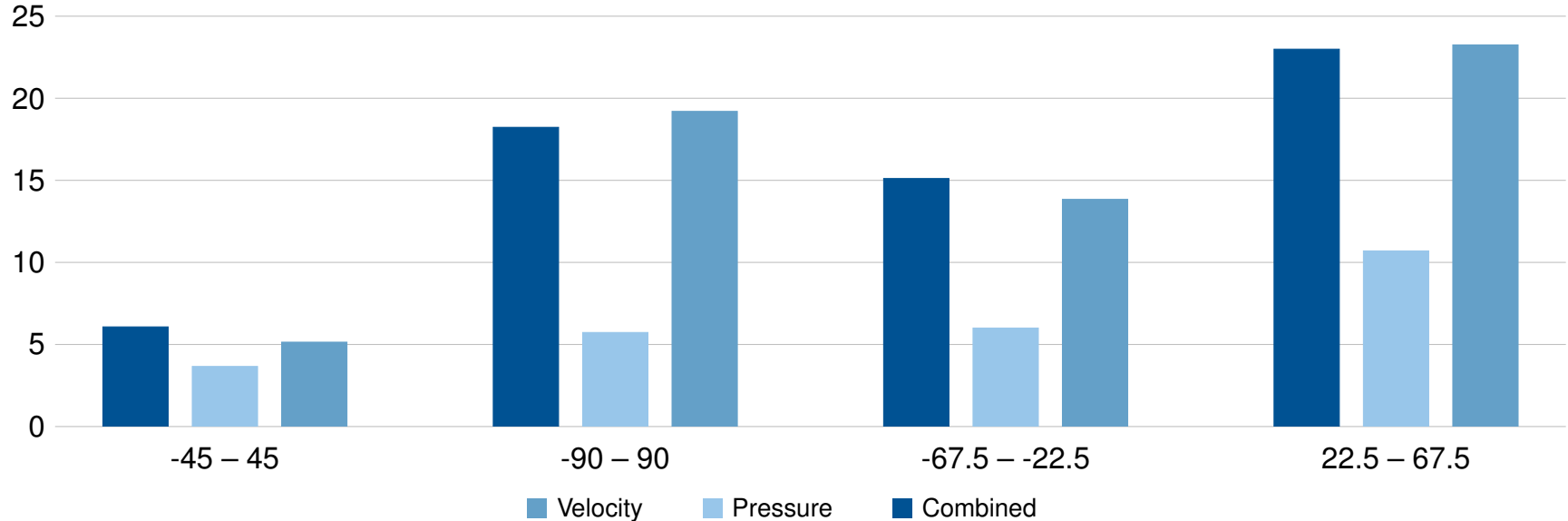


Generalization

TODO

Generalization

Error percentage of different angle of attack intervals wrt. ground truth $[-22.5, 22.5]$



Discussion

TODO

Summary

TODO

Backup slides

TODO