



Design and experimental investigation with particle image velocimetry of a minimum induced drag wing.

Masters' thesis presented by

Jonathan Toussaint

Academic year 2016-2017

Appendix : Images of PIV experiments

The following figures result from the PIV tests. Different C_L have been examined, at various distances x behind the trailing edge of both bell and elliptic wings. All those results were obtained at $Re_r \approx 10^5$. *Note : the images for the u component of the velocity vector fields are not showed, as the they are well approximated by the average velocity vector fields.*

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1 Bell wing

1.1 $C_L = 0.4$

1.1.1 Average velocity

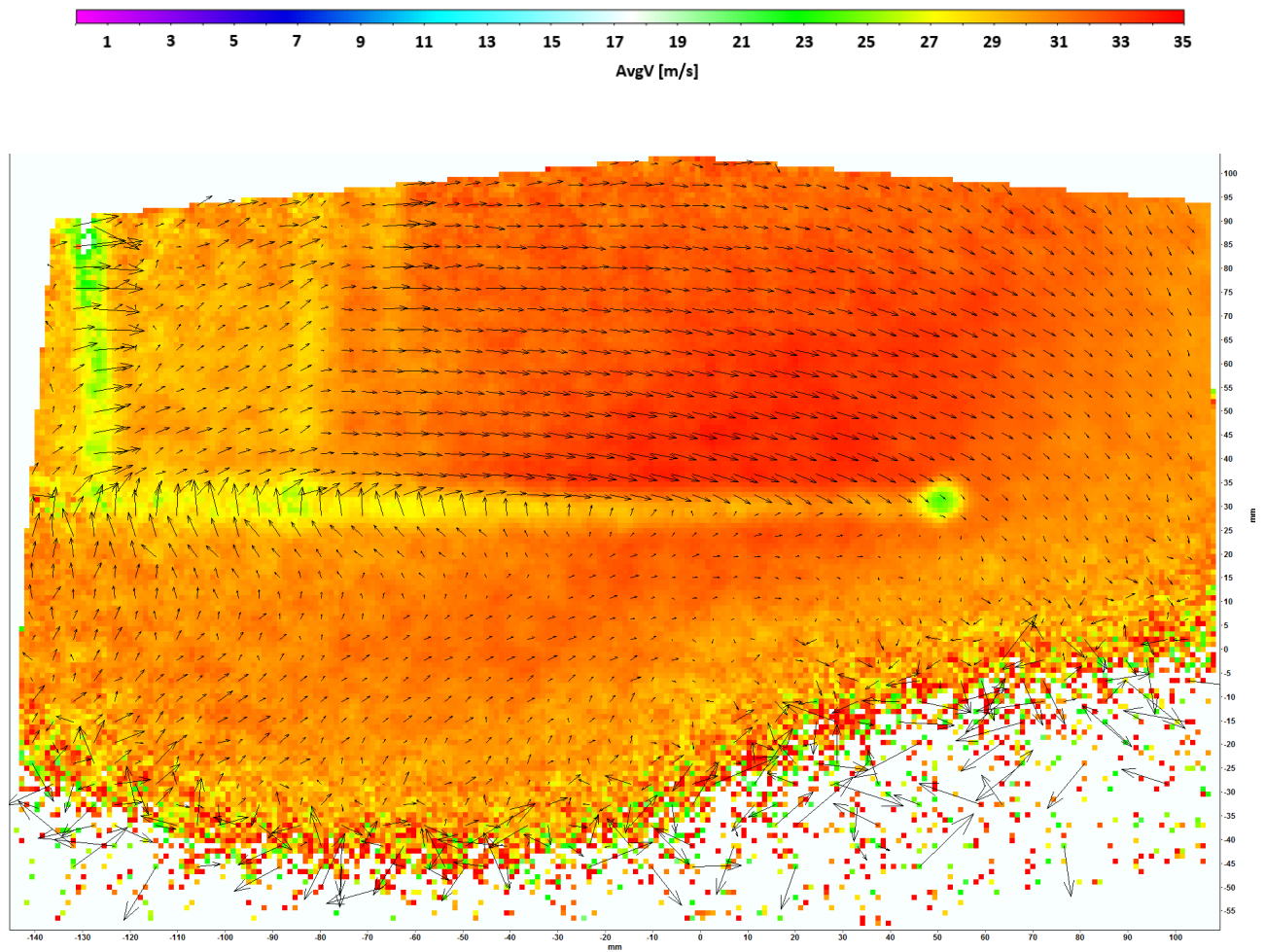


Figure 1.1: $C_L = 0.4$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

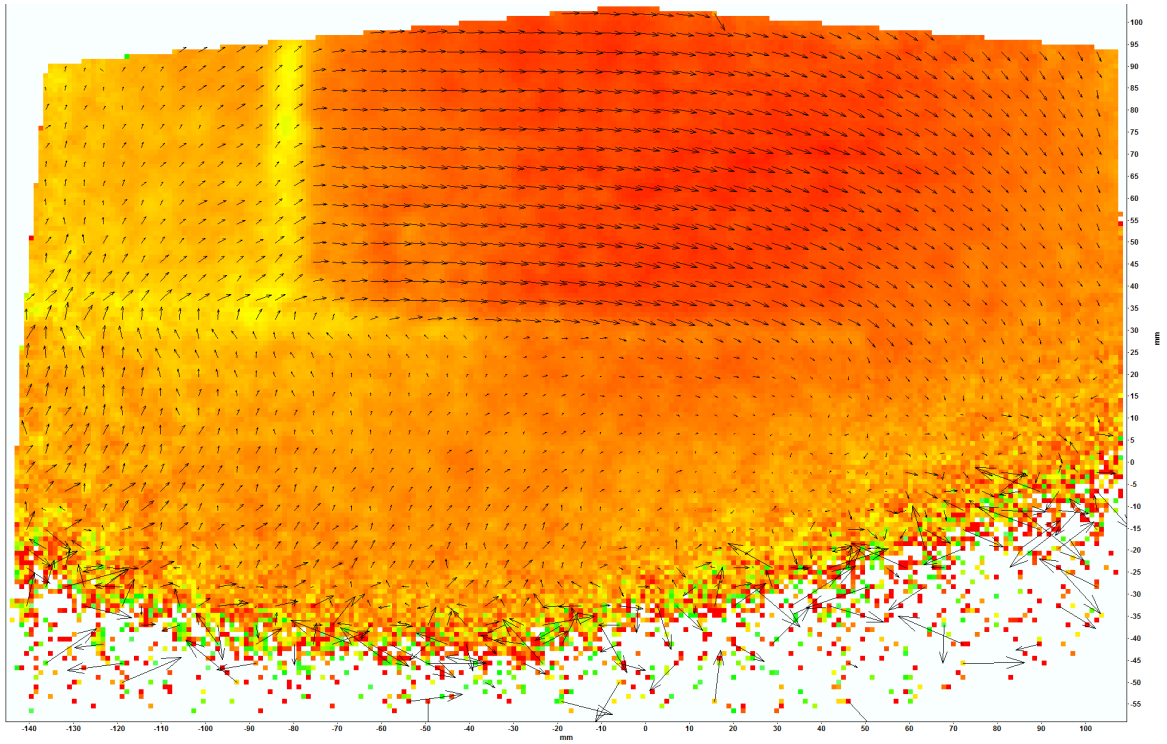
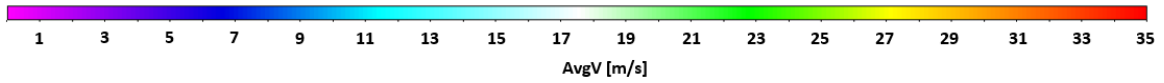


Figure 1.2: $C_L = 0.4$, $x = 50 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

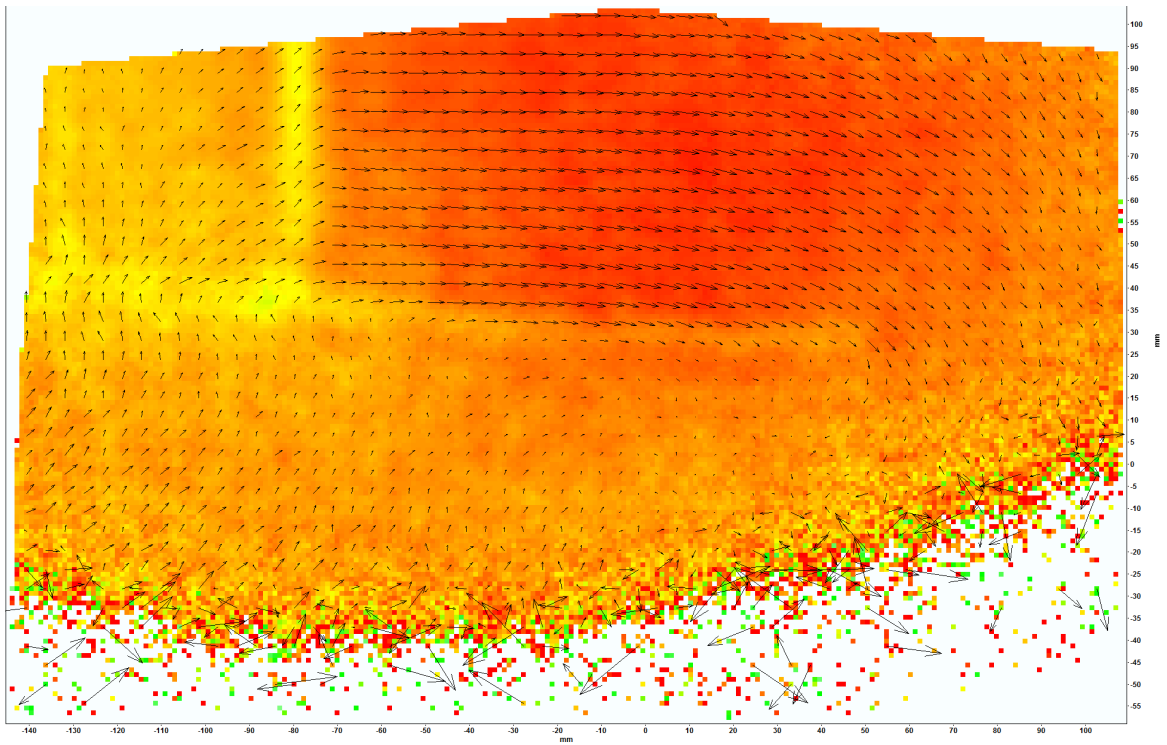


Figure 1.3: $C_L = 0.4$, $x = 100 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

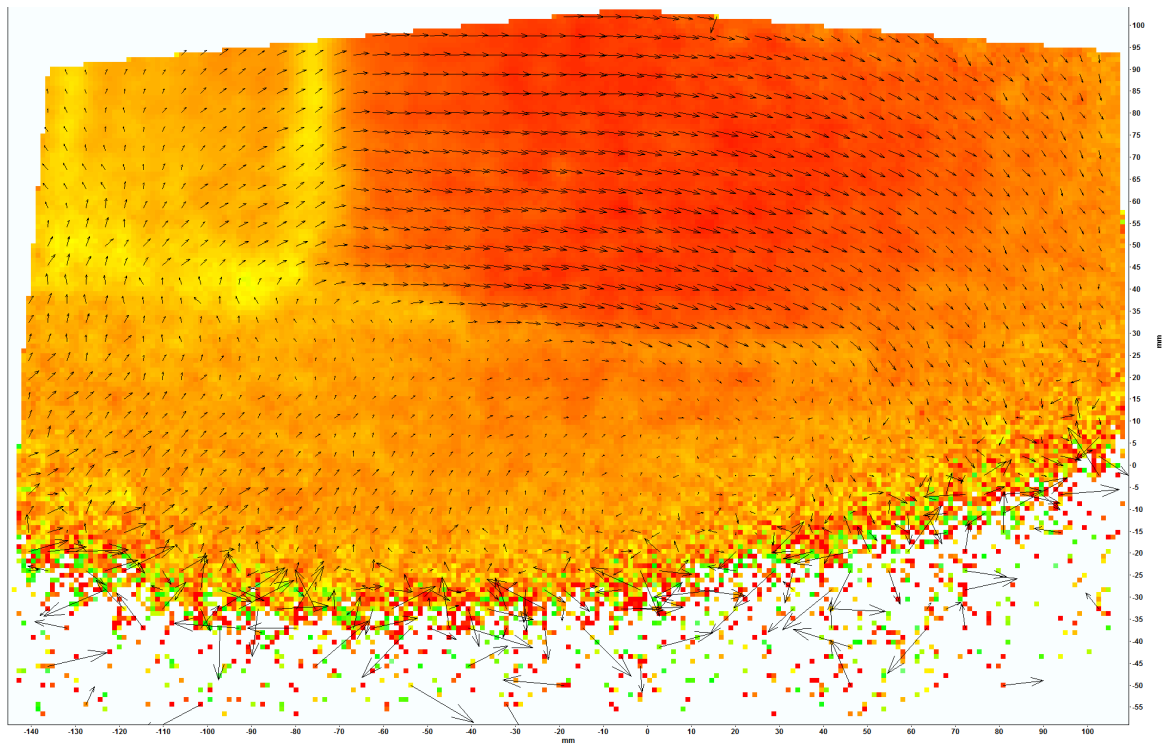
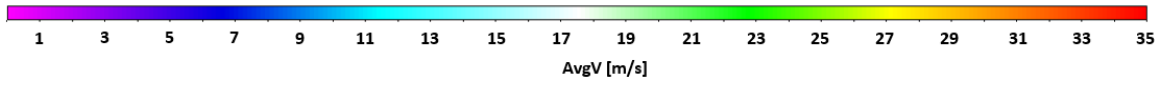


Figure 1.4: $C_L = 0.4$, $x = 200 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

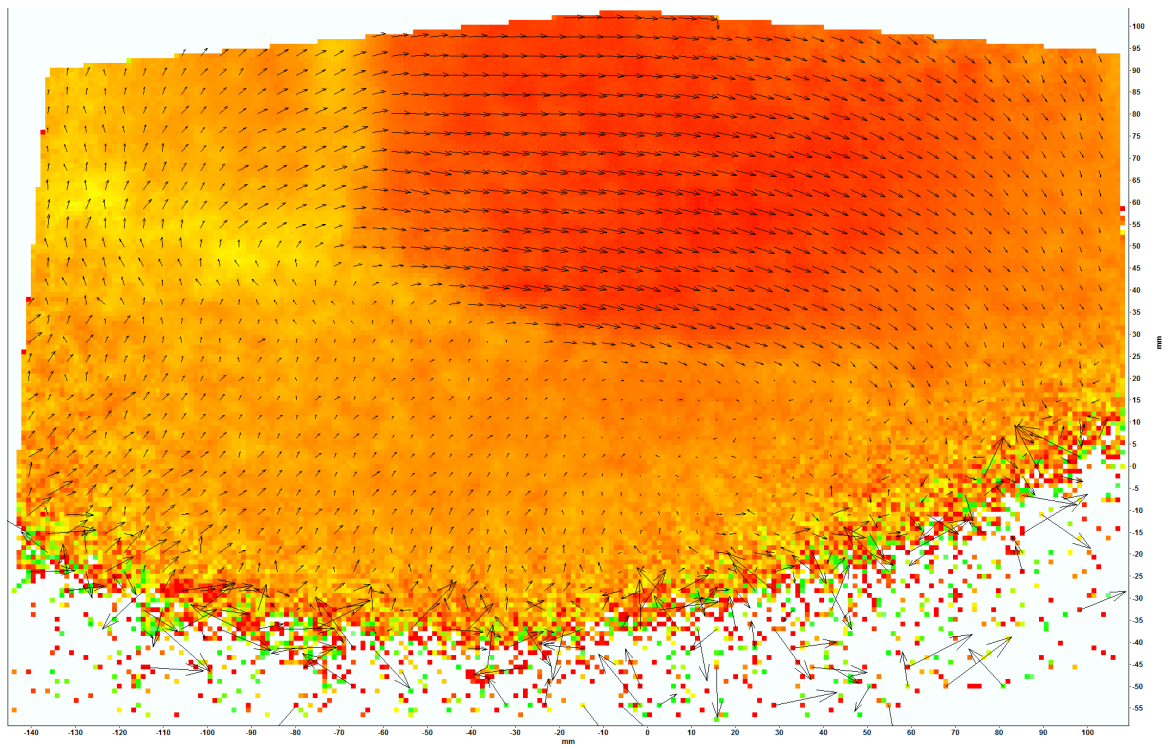


Figure 1.5: $C_L = 0.4$, $x = 350 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

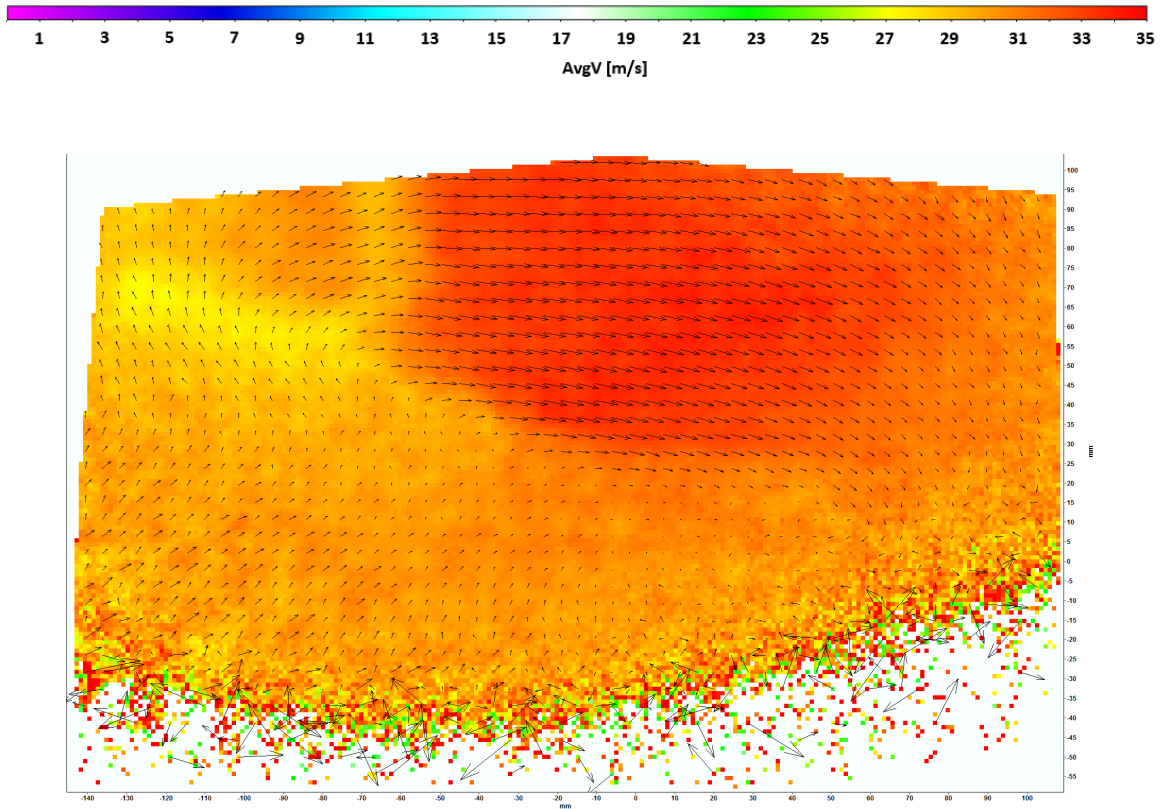


Figure 1.6: $C_L = 0.4$, $x = 450 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.1.2 v velocity component

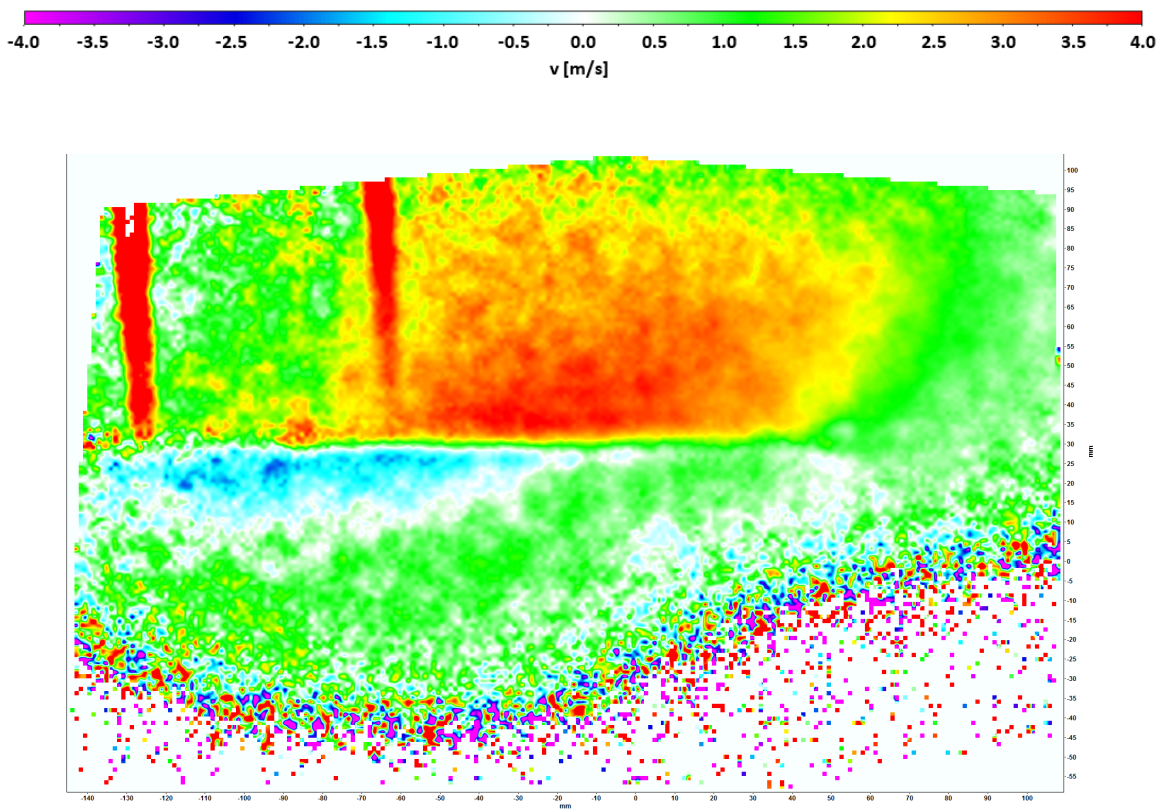


Figure 1.7: $C_L = 0.4$, $x = 10^{-3} [m]$ behind trailing edge, bell wing

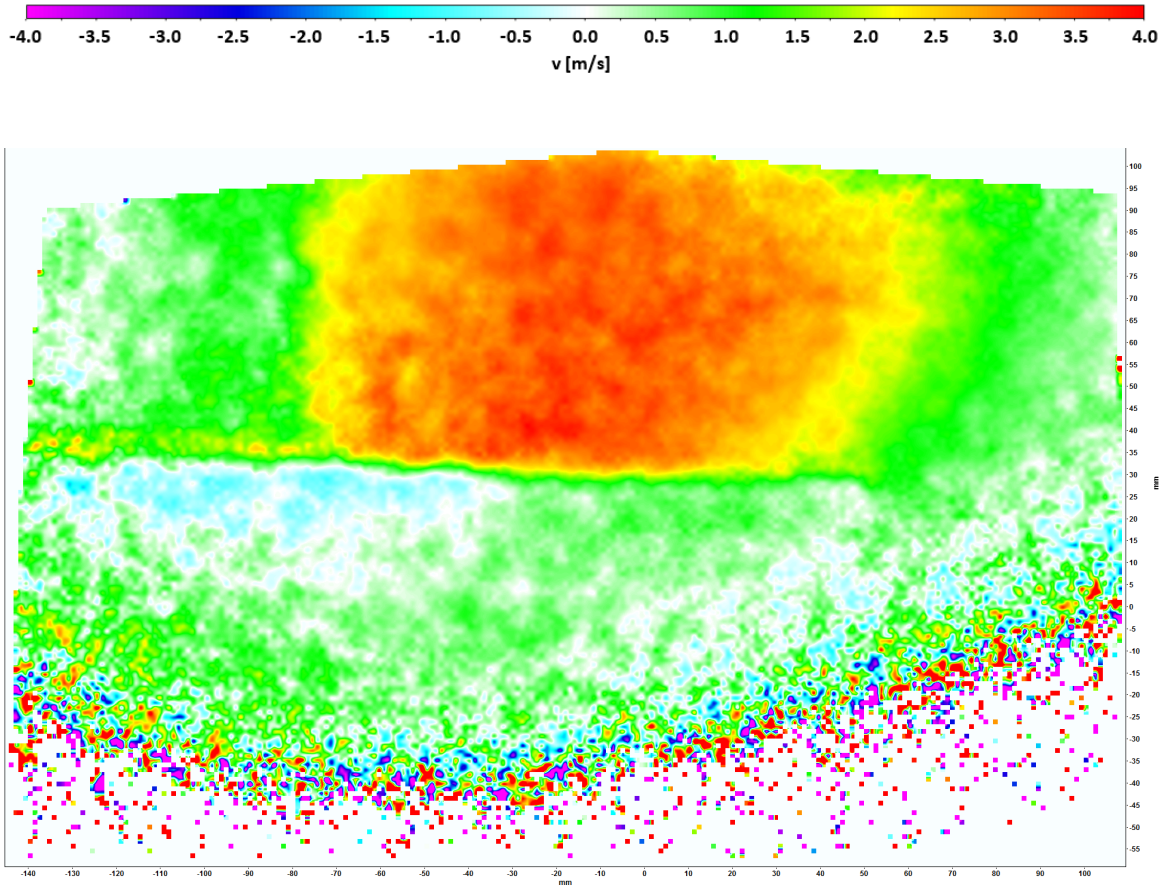


Figure 1.8: $C_L = 0.4$, $x = 50 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

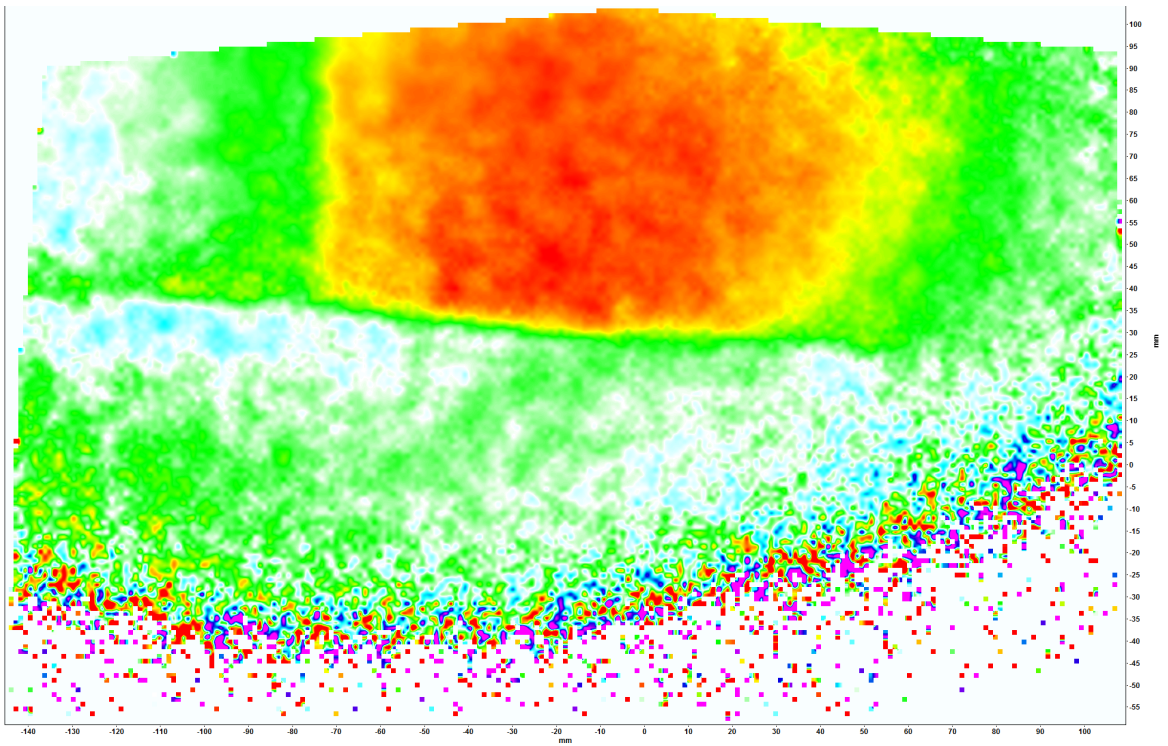


Figure 1.9: $C_L = 0.4$, $x = 100 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

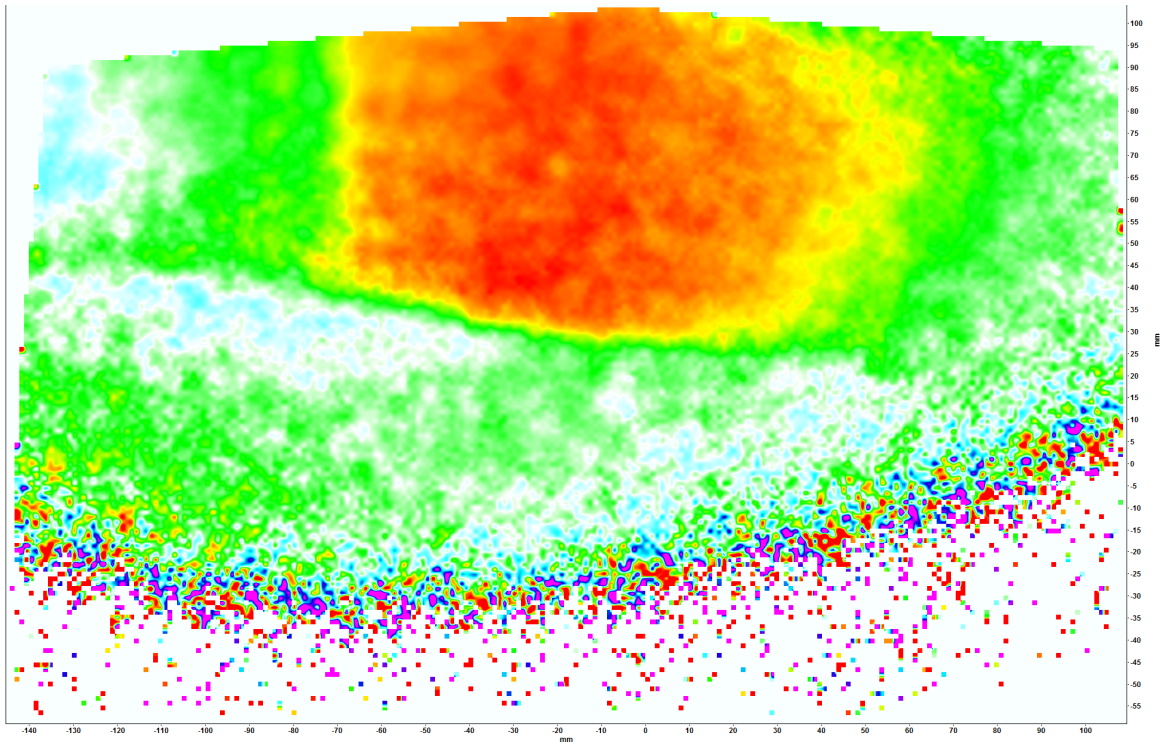
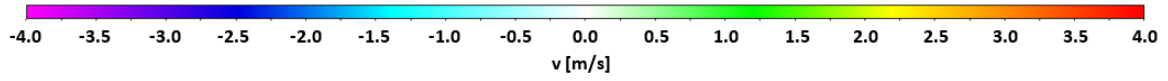


Figure 1.10: $C_L = 0.4$, $x = 200 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

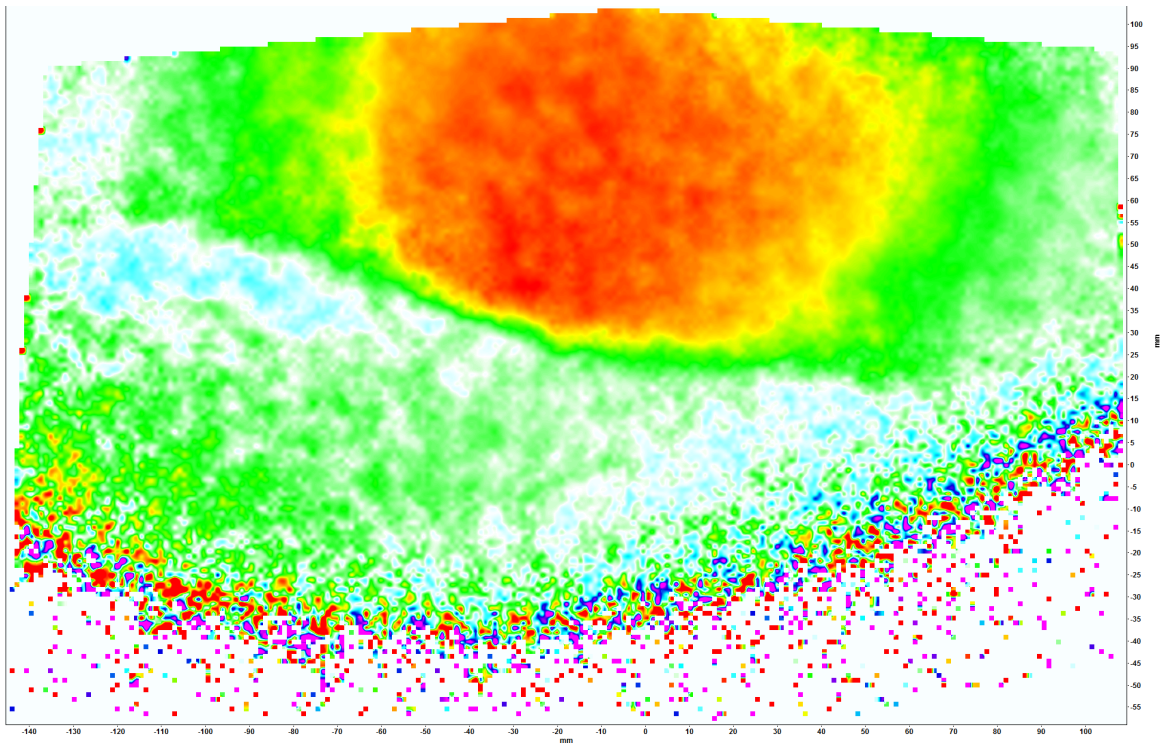


Figure 1.11: $C_L = 0.4$, $x = 350 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

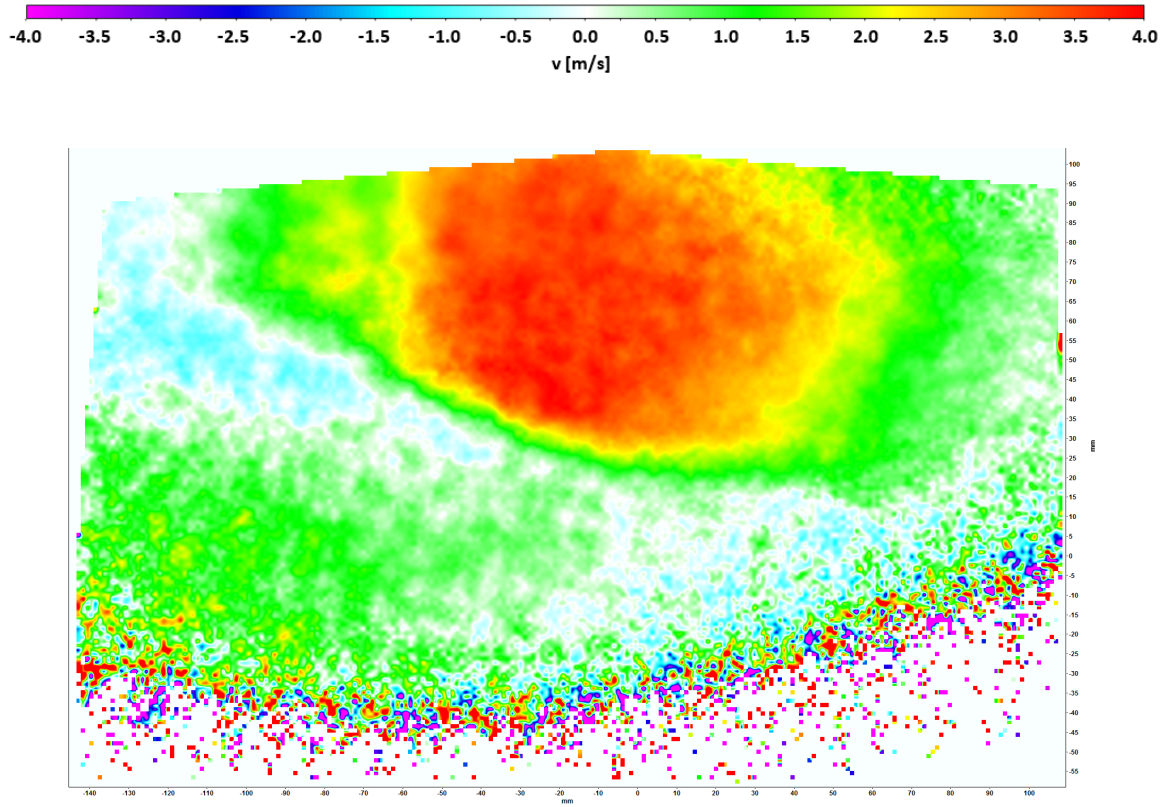


Figure 1.12: $C_L = 0.4$, $x = 450 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.1.3 w velocity component

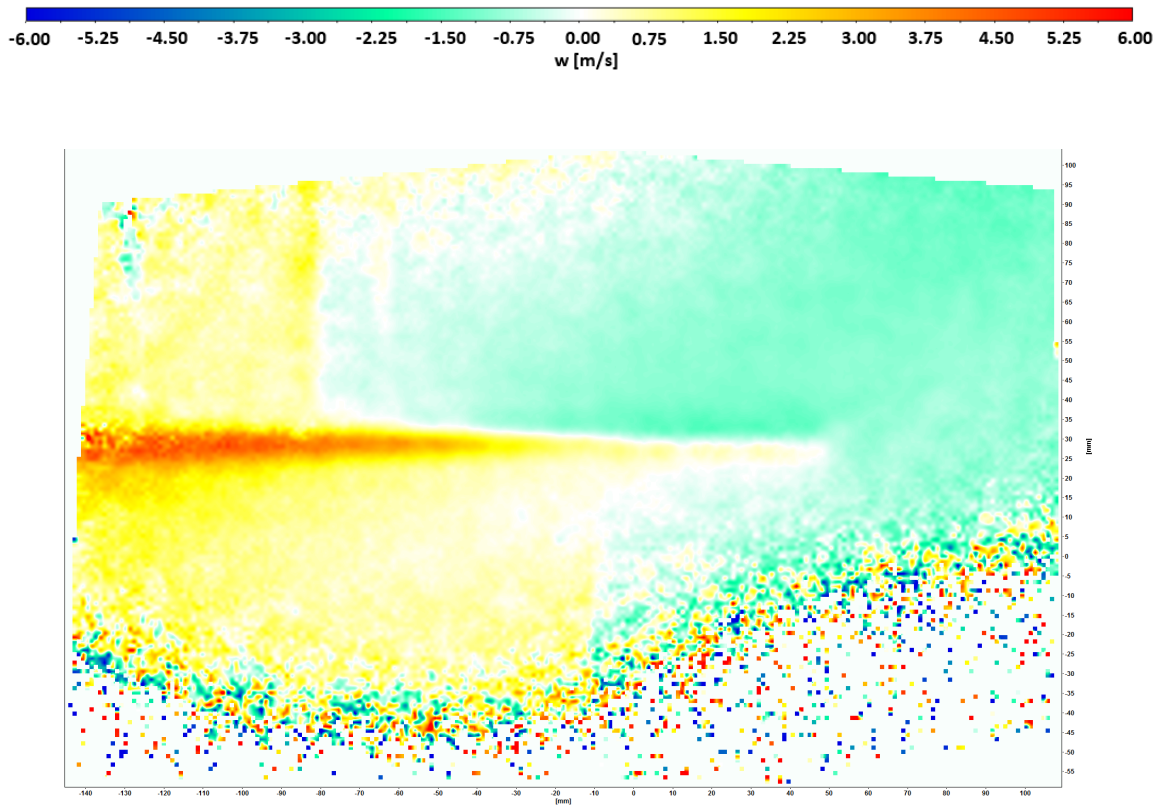


Figure 1.13: $C_L = 0.4$, $x = 10^{-3} [m]$ behind trailing edge, bell wing

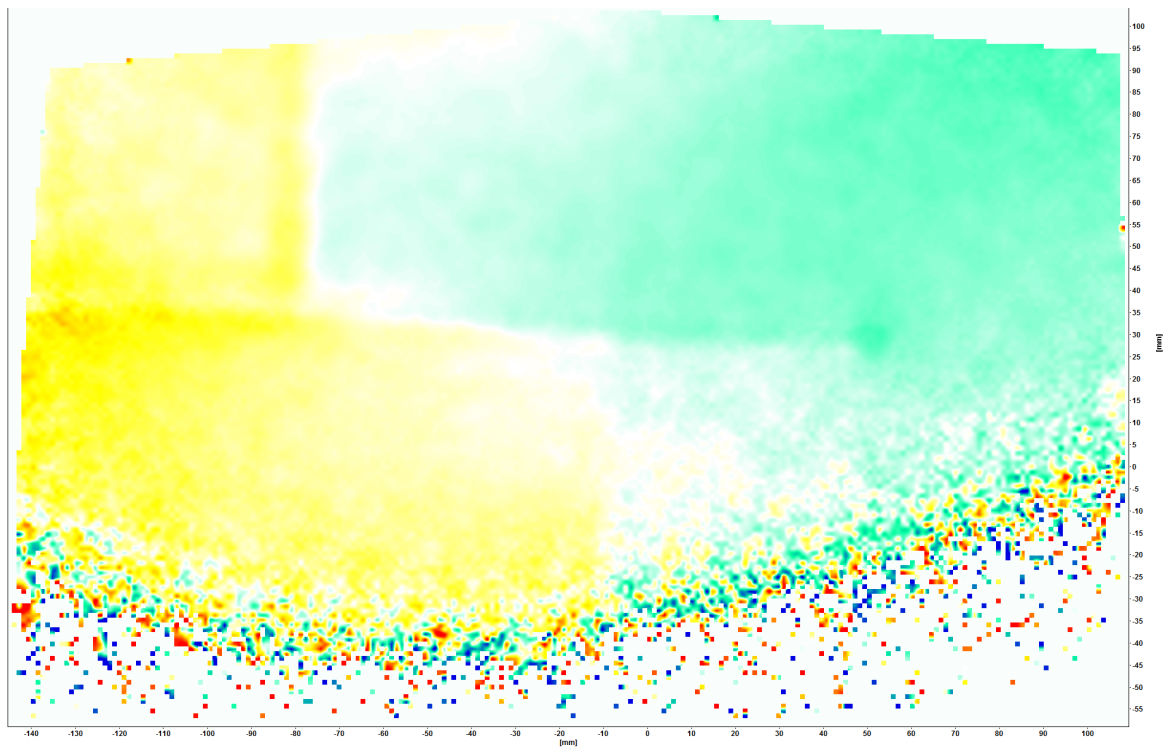
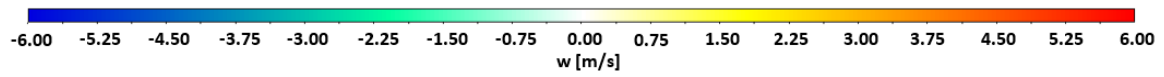


Figure 1.14: $C_L = 0.4$, $x = 50 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

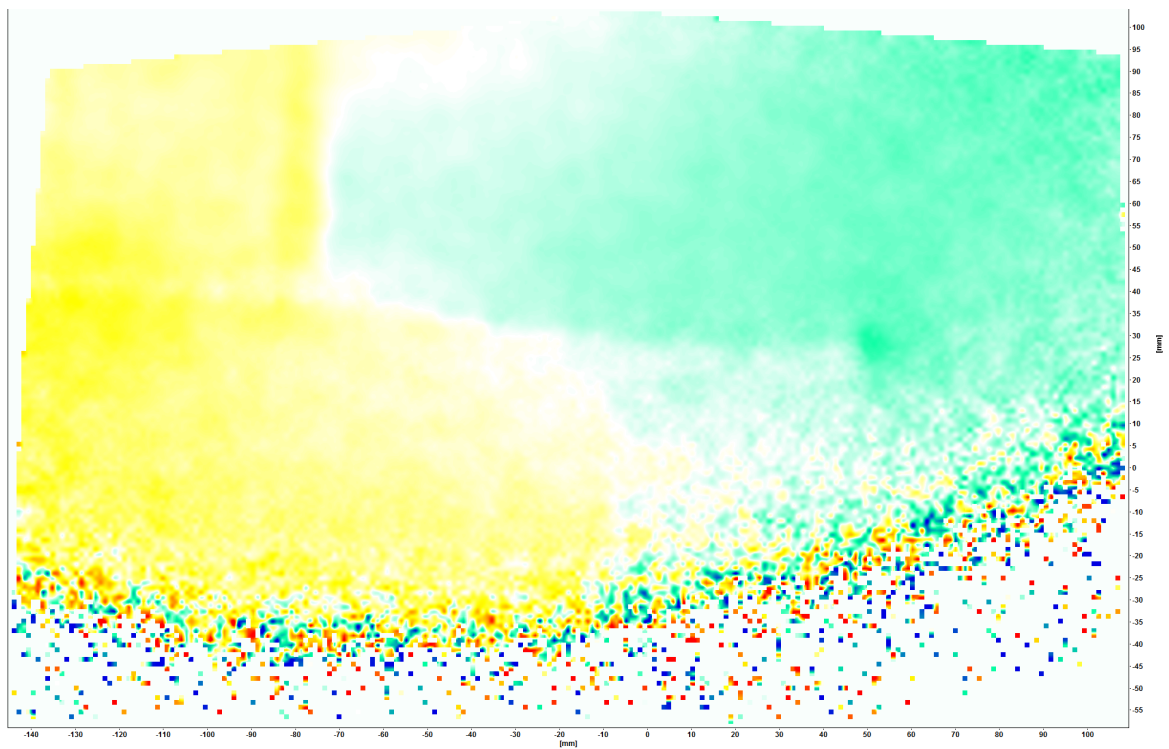


Figure 1.15: $C_L = 0.4$, $x = 100 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

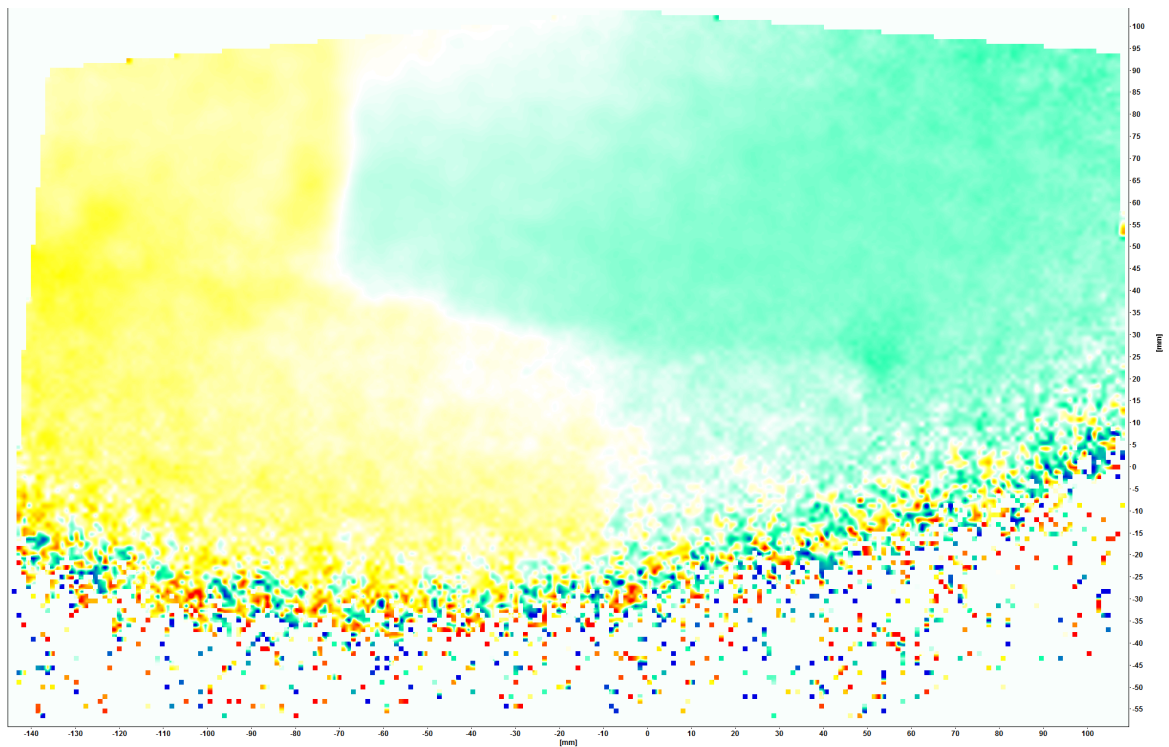
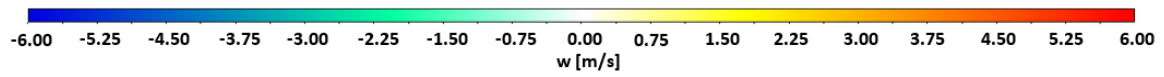


Figure 1.16: $C_L = 0.4$, $x = 200 \cdot 10^{-3} \text{ [m]}$ behind trailing egde, bell wing

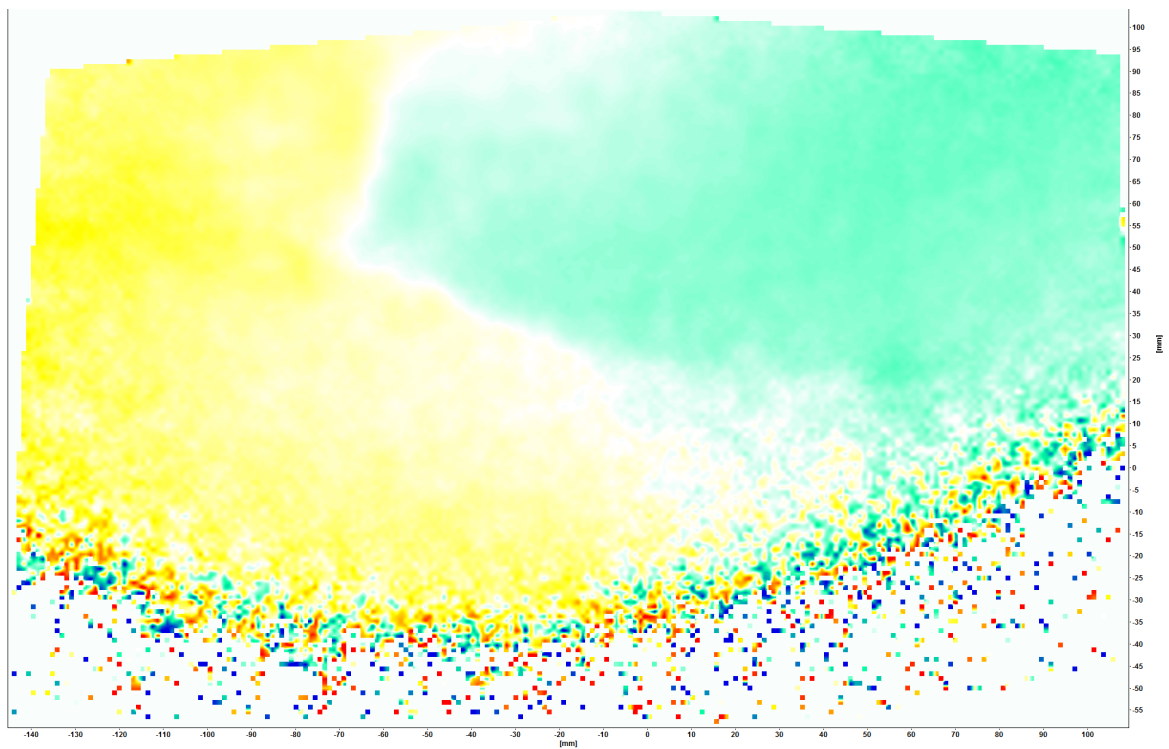
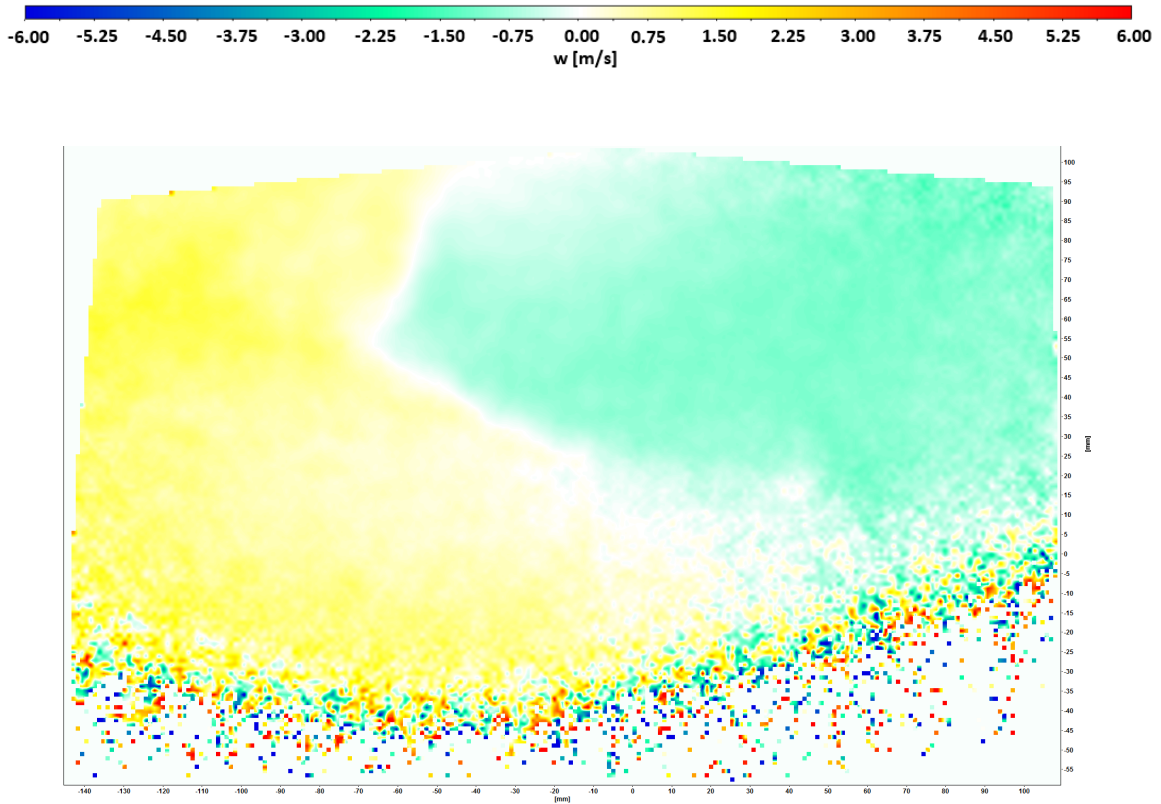
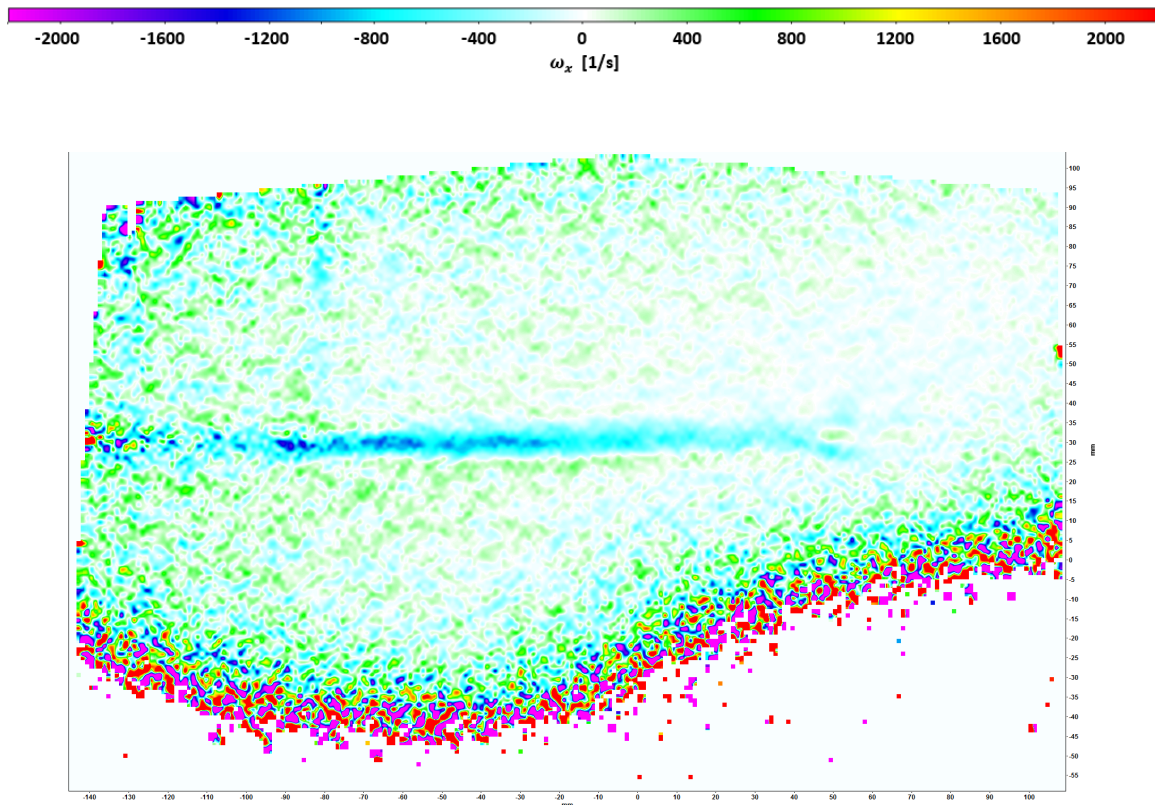


Figure 1.17: $C_L = 0.4$, $x = 350 \cdot 10^{-3} \text{ [m]}$ behind trailing egde, bell wing



1.1.4 Vorticity ω_x



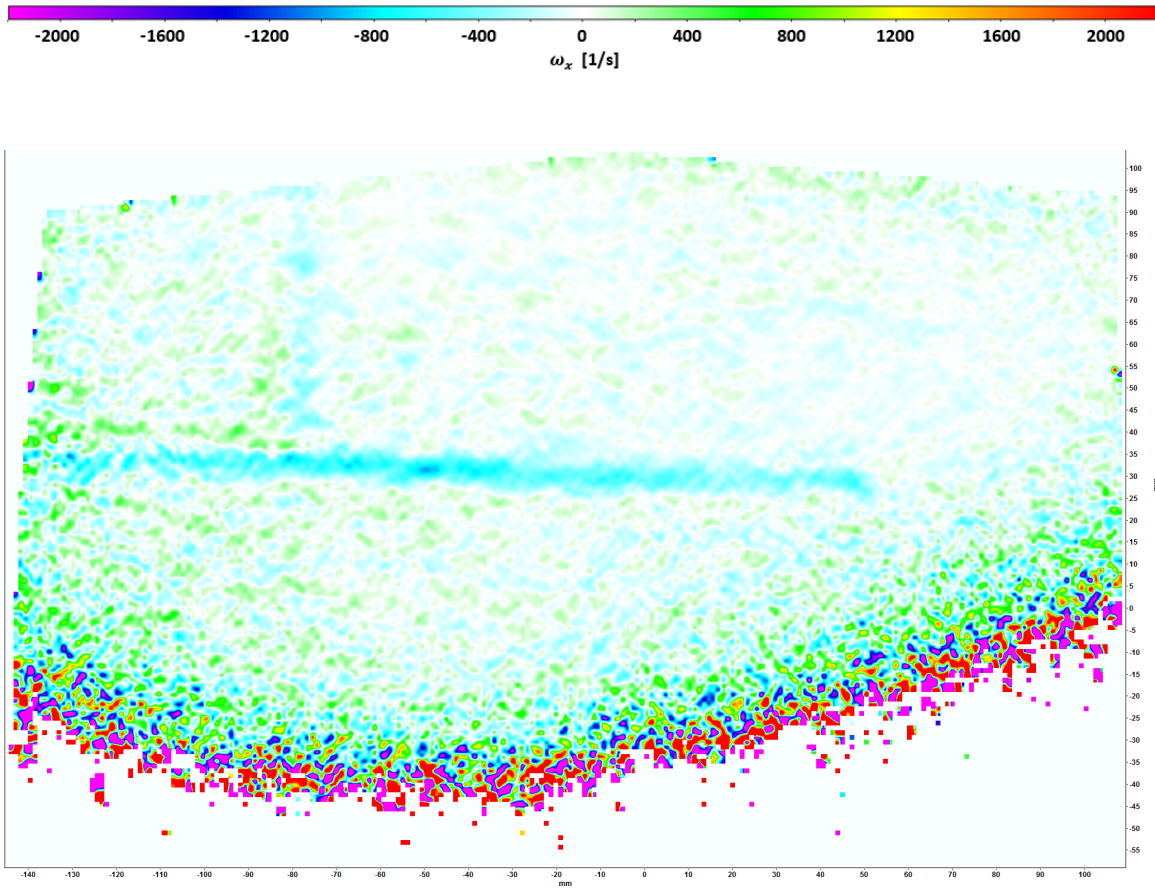


Figure 1.20: $C_L = 0.4$, $x = 50 \cdot 10^{-3} [m]$ behind trailing egde, bell wing

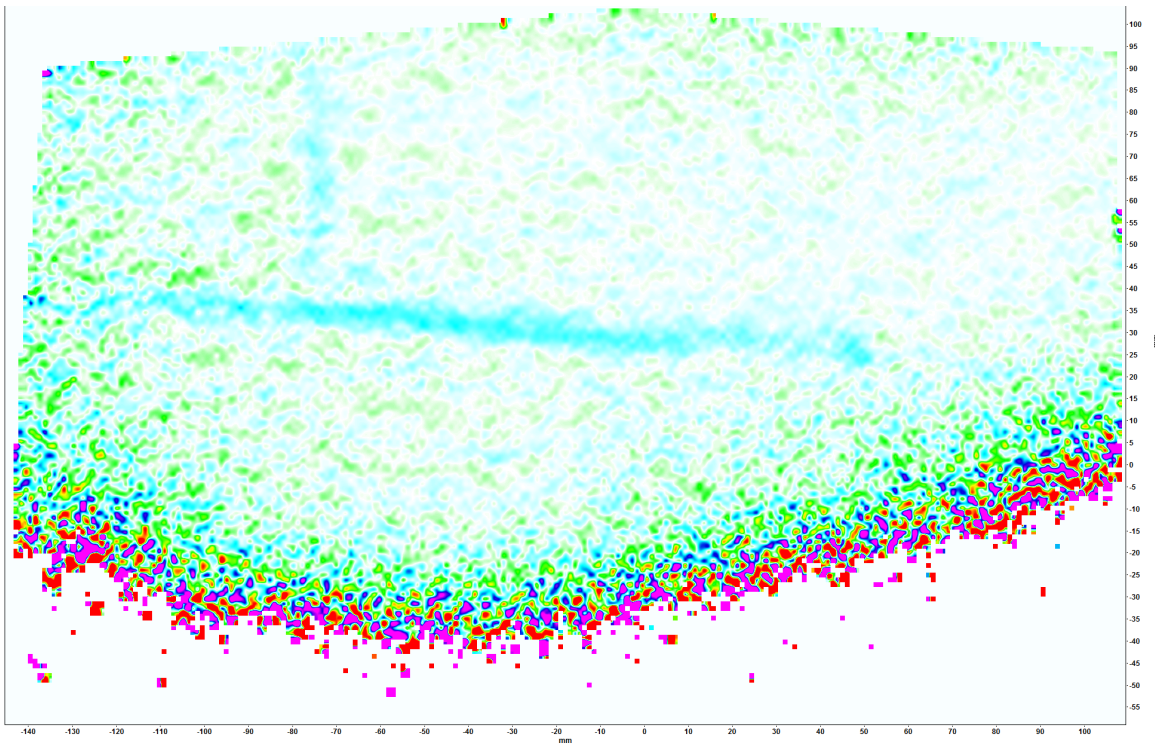


Figure 1.21: $C_L = 0.4$, $x = 100 \cdot 10^{-3} [m]$ behind trailing egde, bell wing

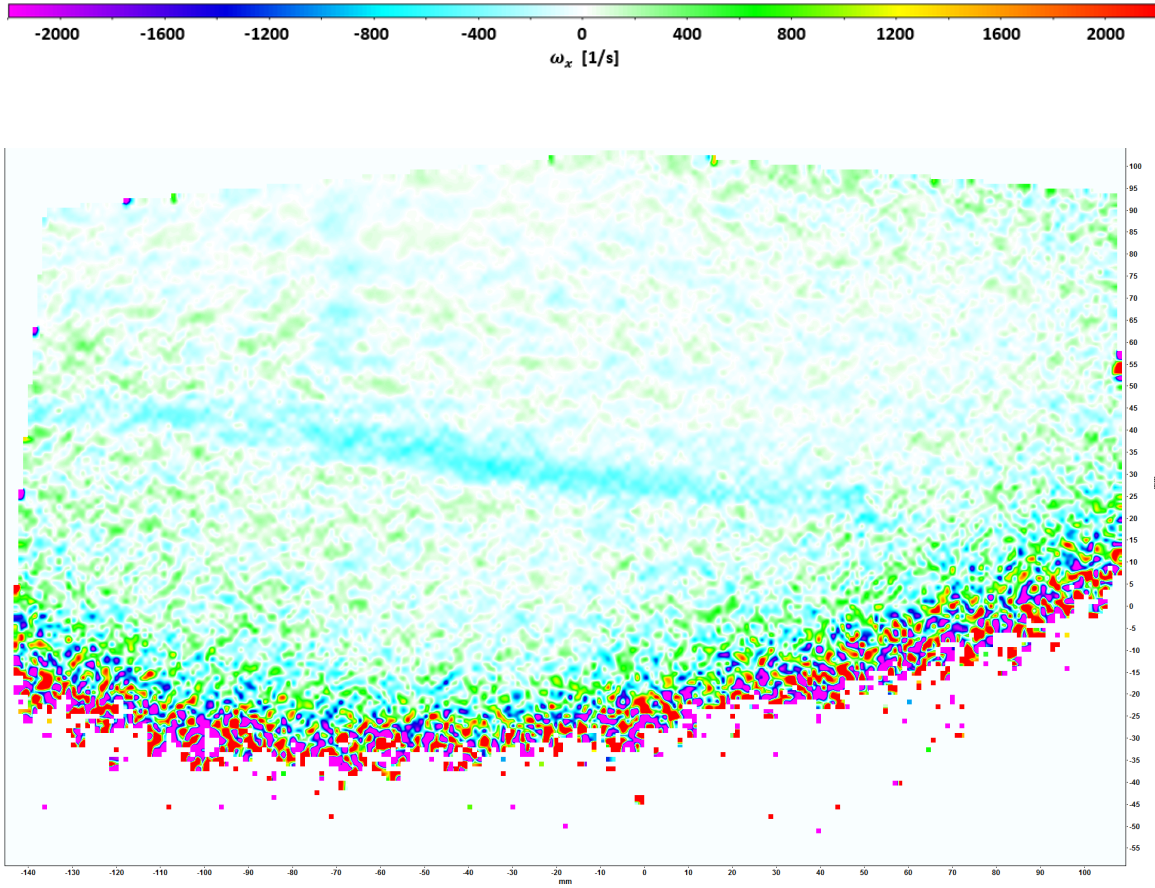


Figure 1.22: $C_L = 0.4$, $x = 200 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

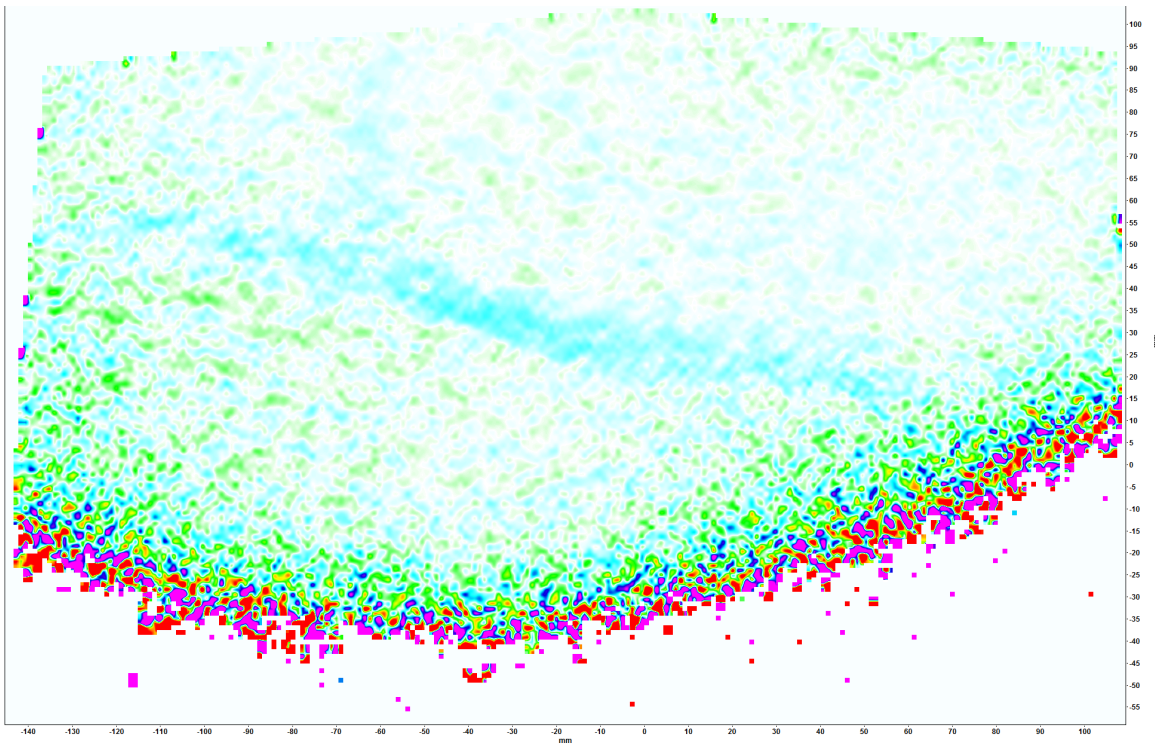


Figure 1.23: $C_L = 0.4$, $x = 350 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

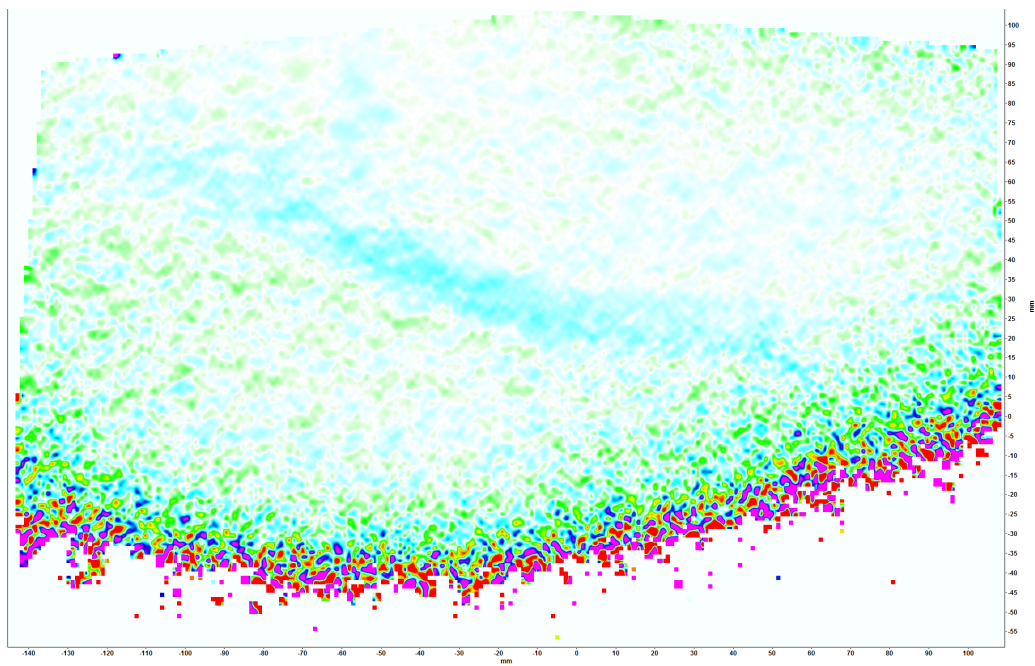
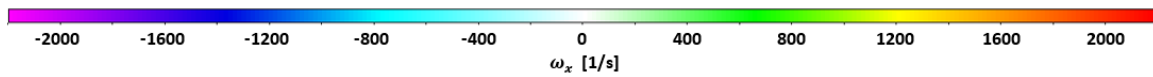


Figure 1.24: $C_L = 0.4$, $x = 450 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.2 $C_L = -0.1$

1.2.1 Average velocity

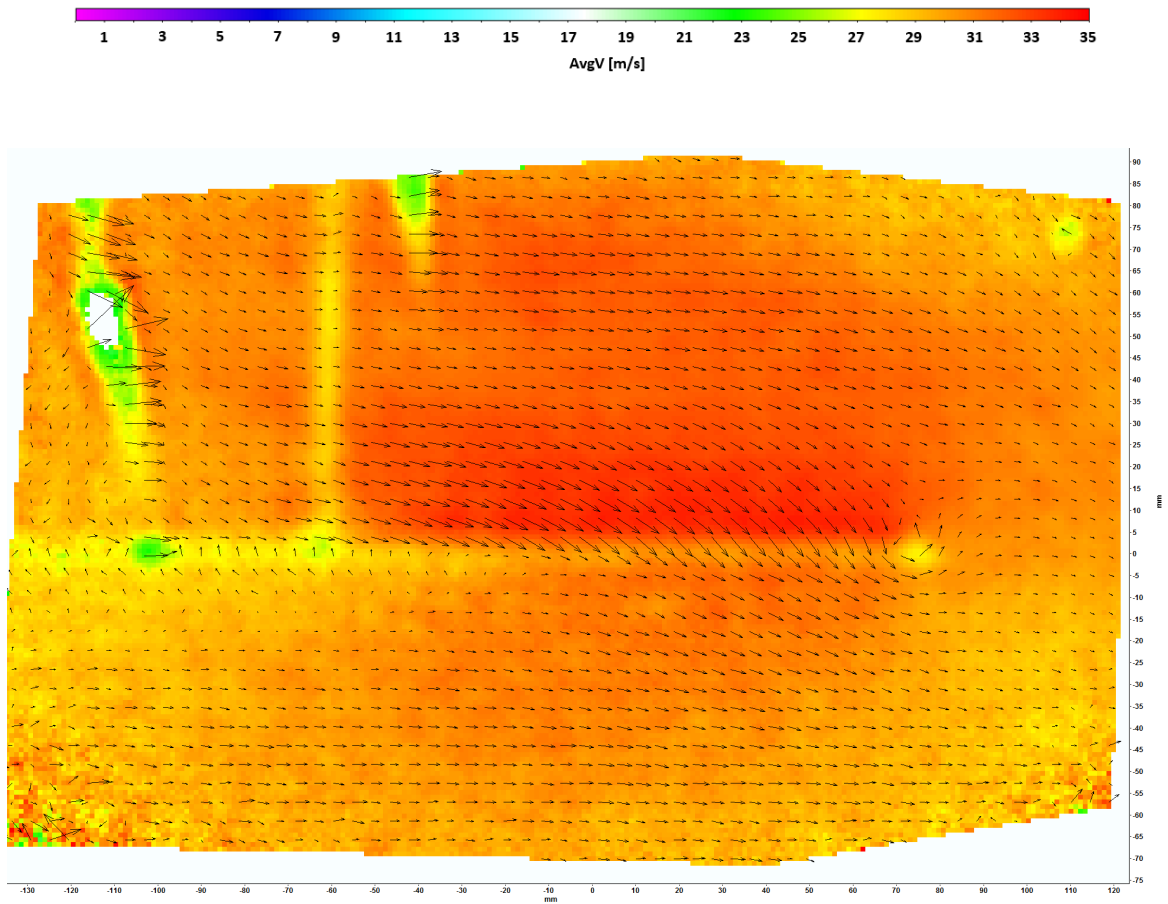


Figure 1.25: $C_L = -0.1$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

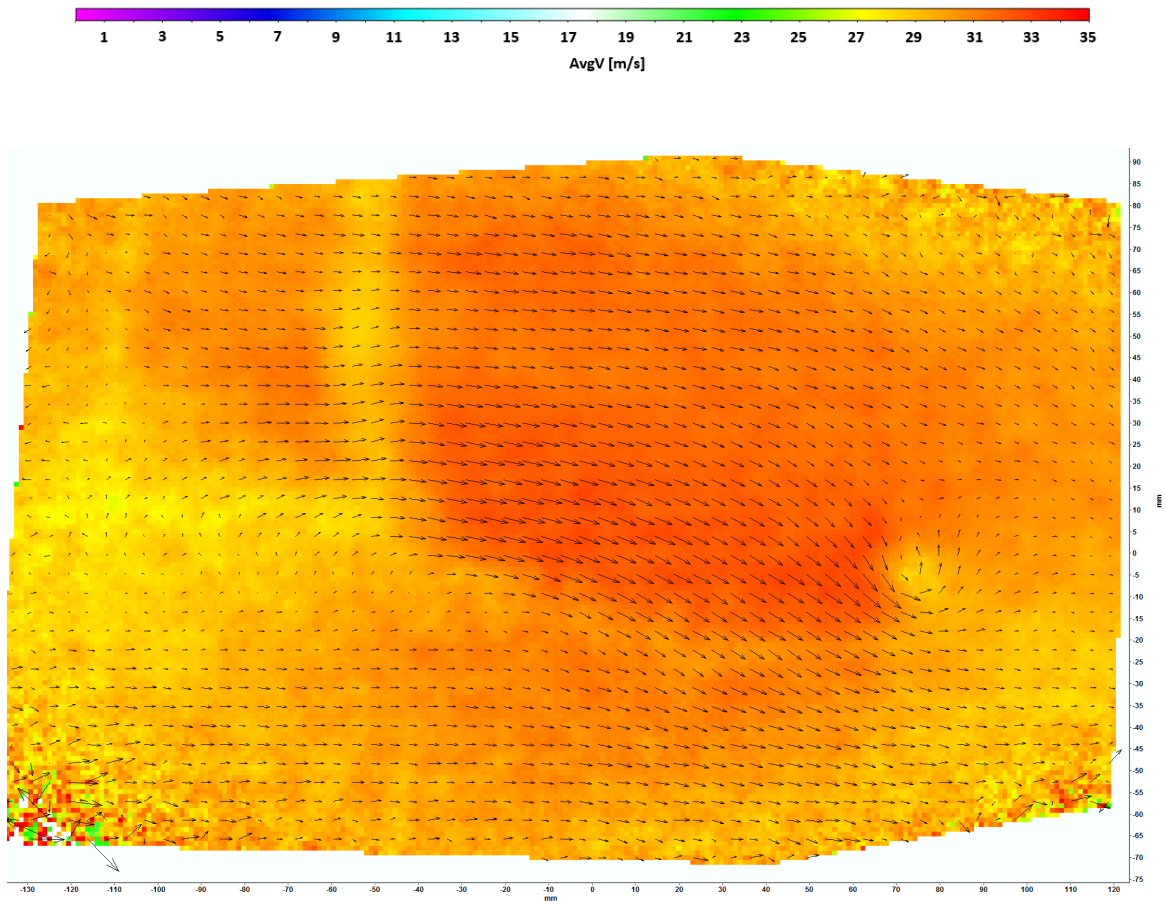


Figure 1.26: $C_L = -0.1$, $x = 350 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

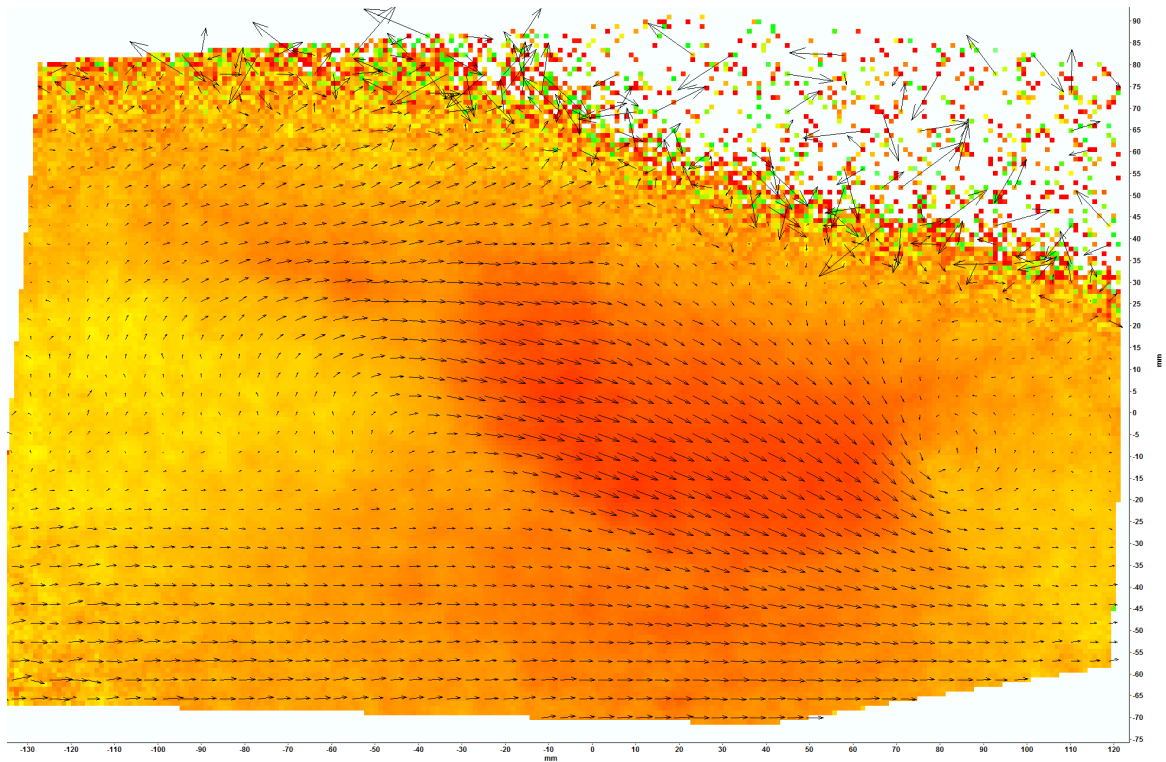


Figure 1.27: $C_L = -0.1$, $x = 700 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.2.2 v velocity component

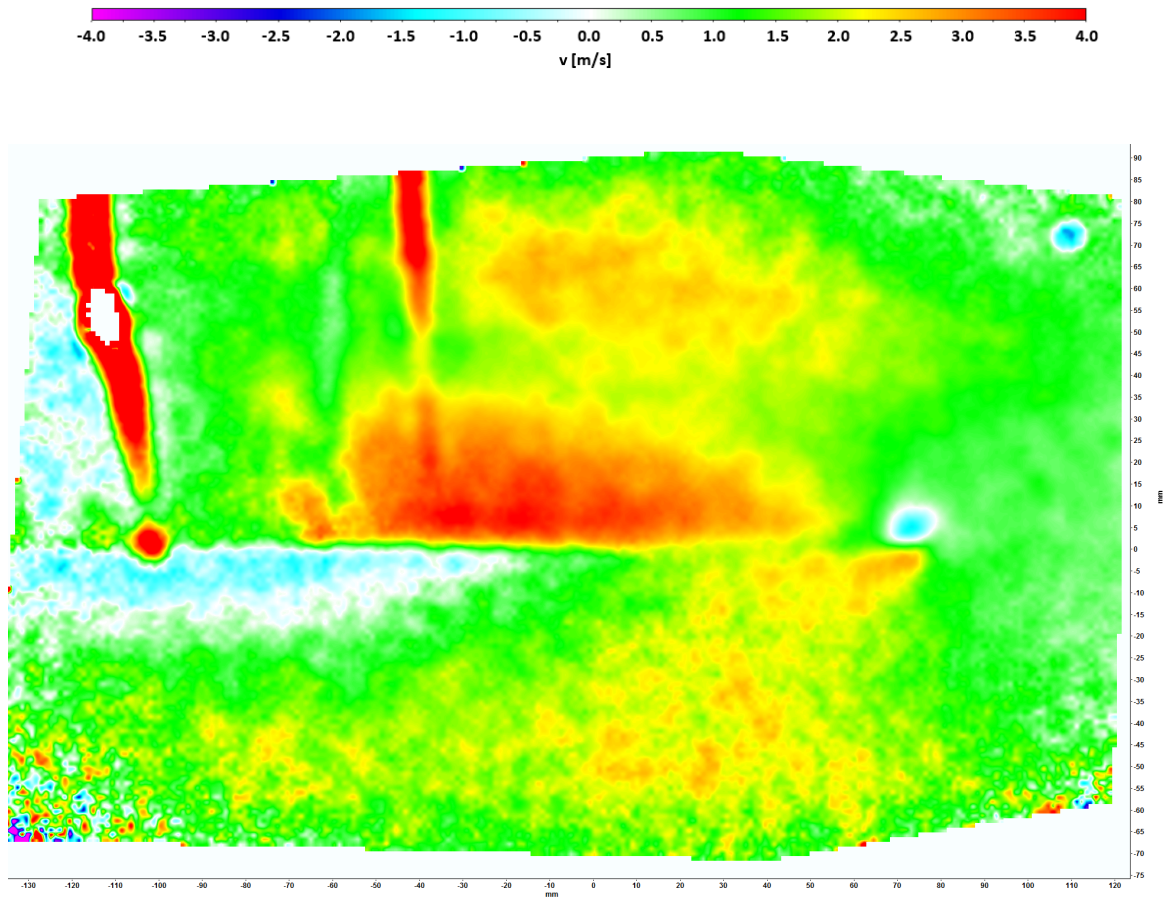


Figure 1.28: $C_L = -0.1$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

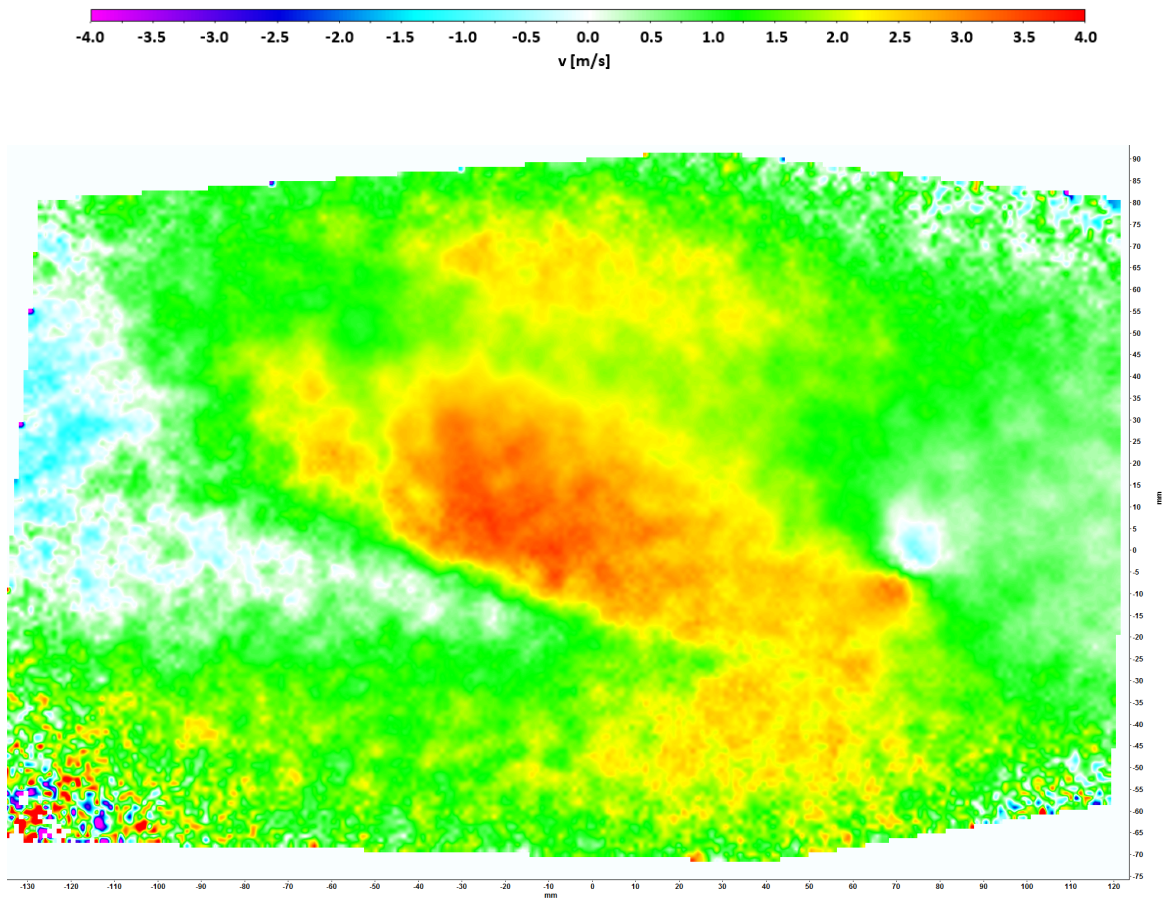


Figure 1.29: $C_L = -0.1$, $x = 350 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

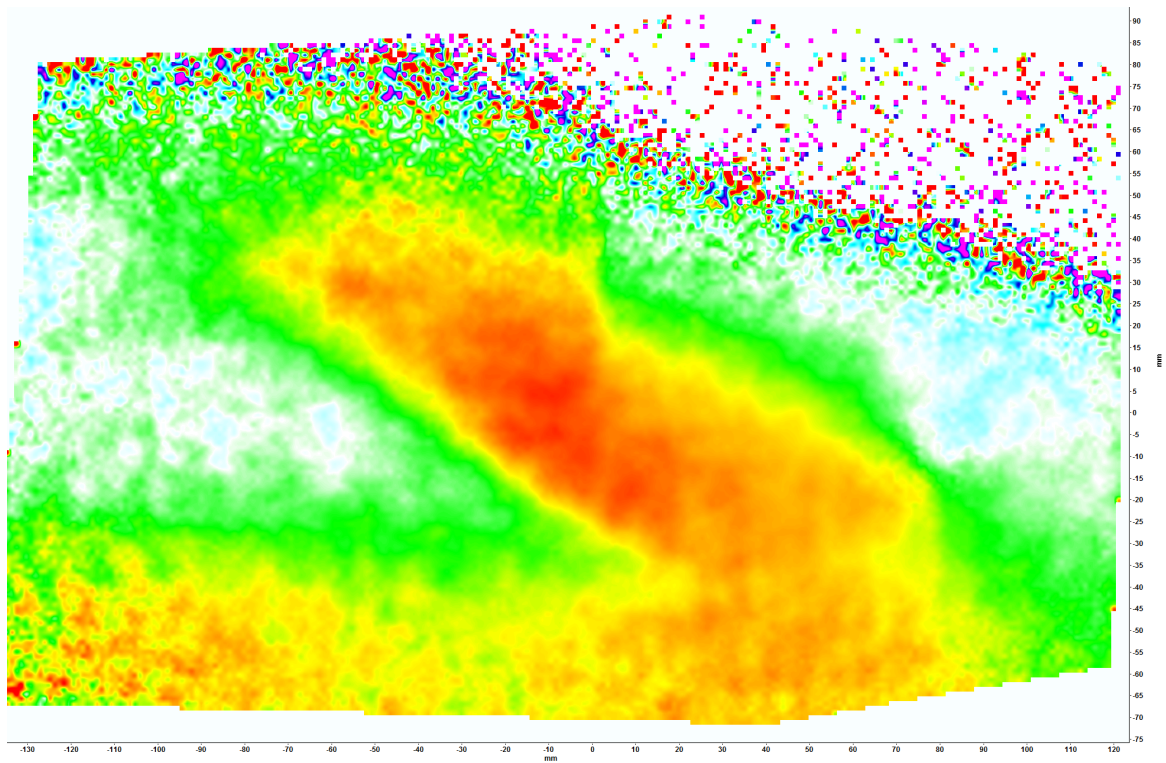


Figure 1.30: $C_L = -0.1$, $x = 700 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

1.2.3 w velocity component

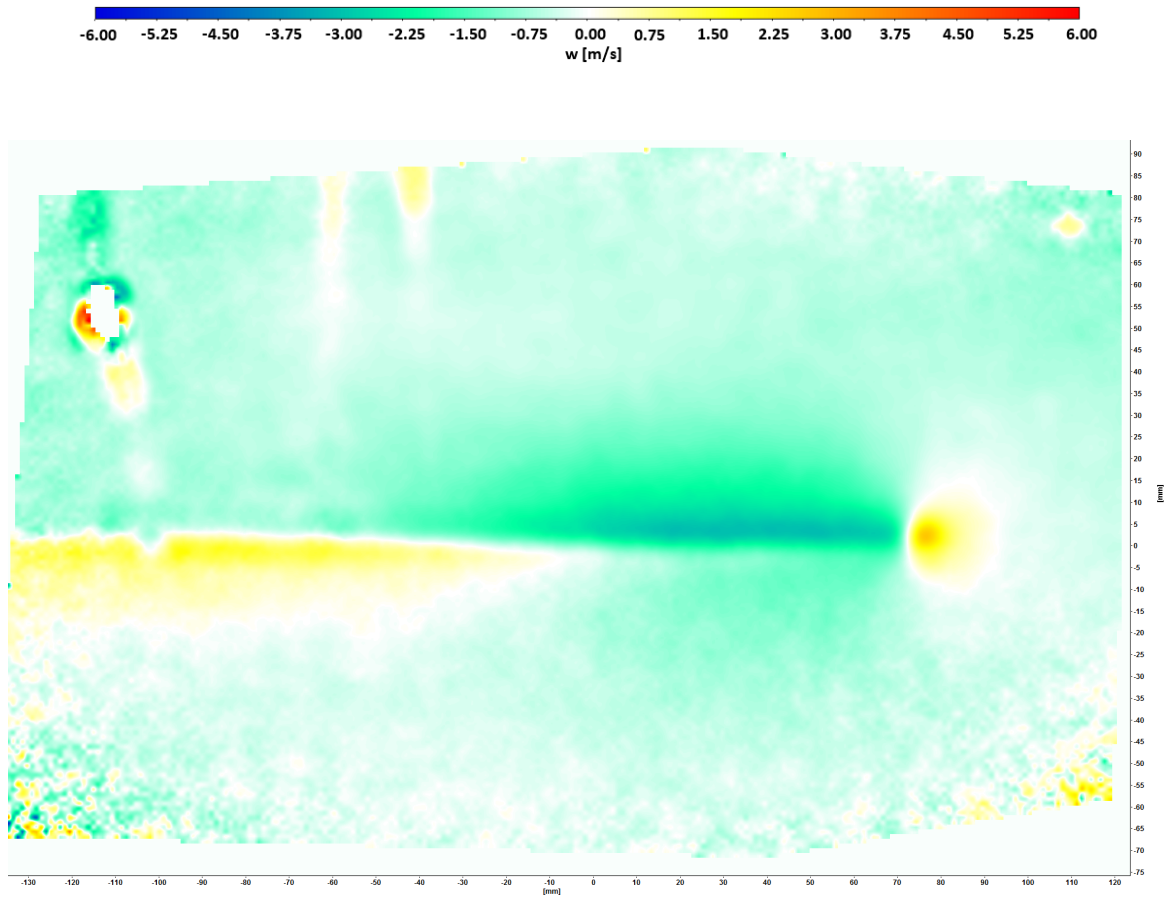


Figure 1.31: $C_L = -0.1$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

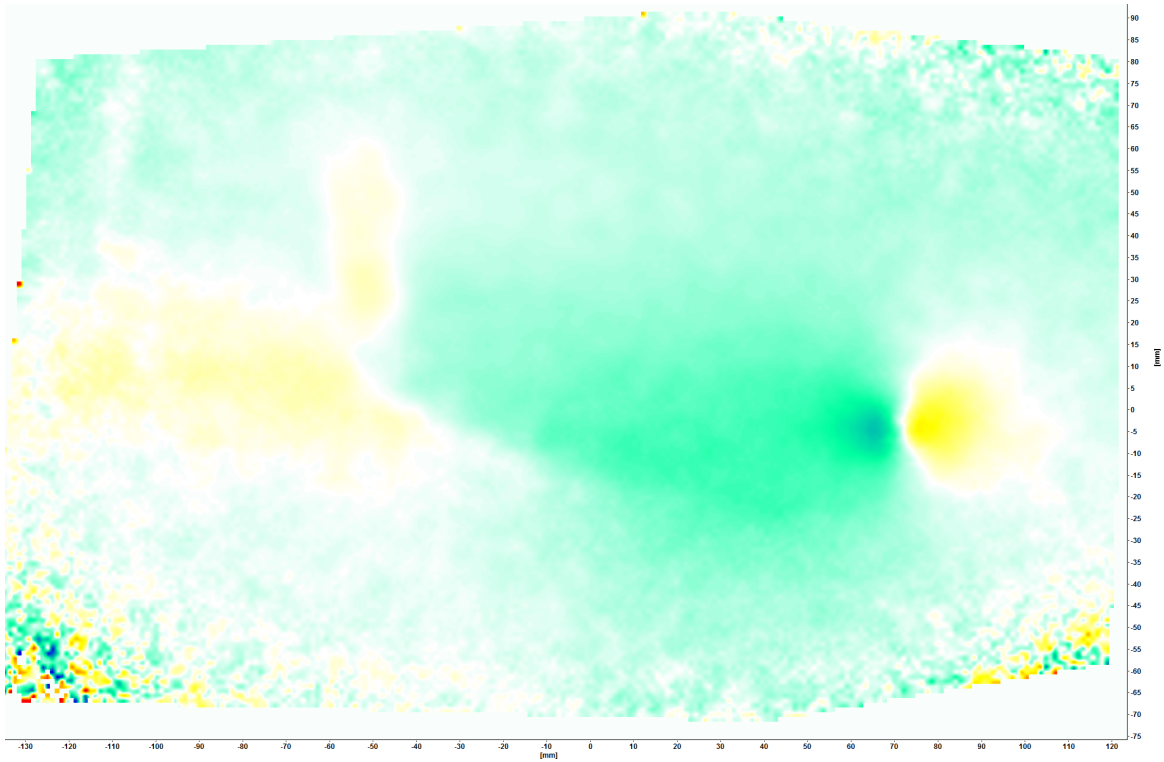
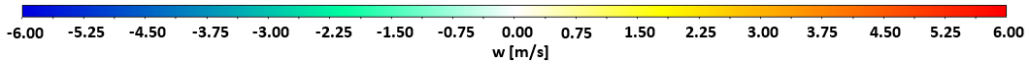


Figure 1.32: $C_L = -0.1$, $x = 350 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

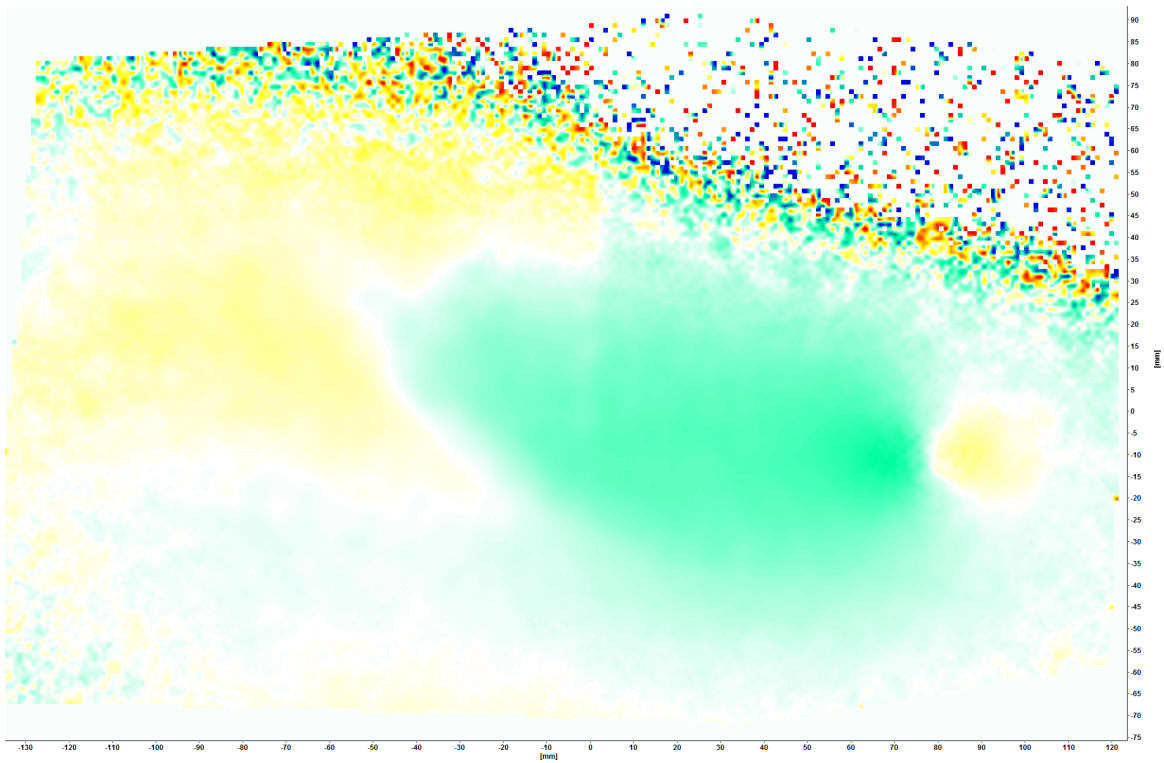


Figure 1.33: $C_L = -0.1$, $x = 700 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

1.2.4 Vorticity ω_x

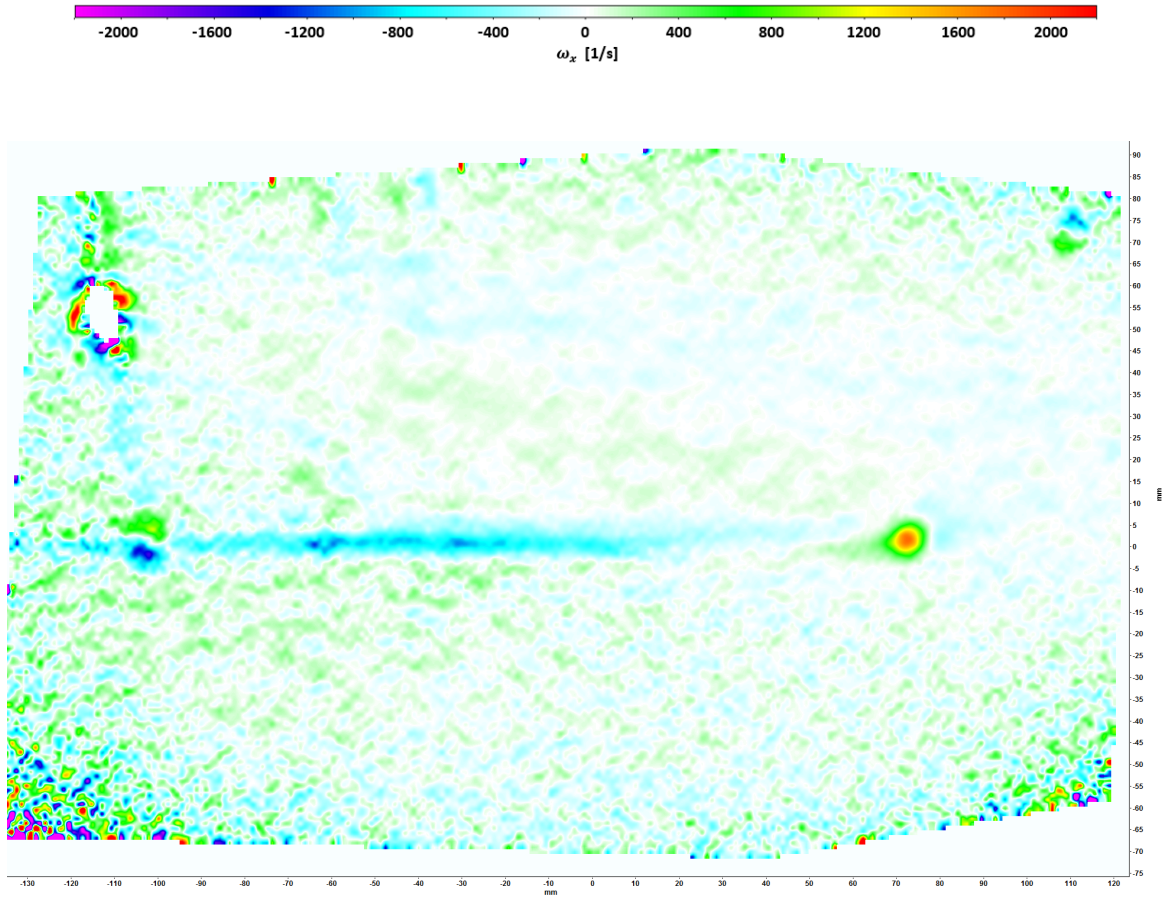


Figure 1.34: $C_L = -0.1$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

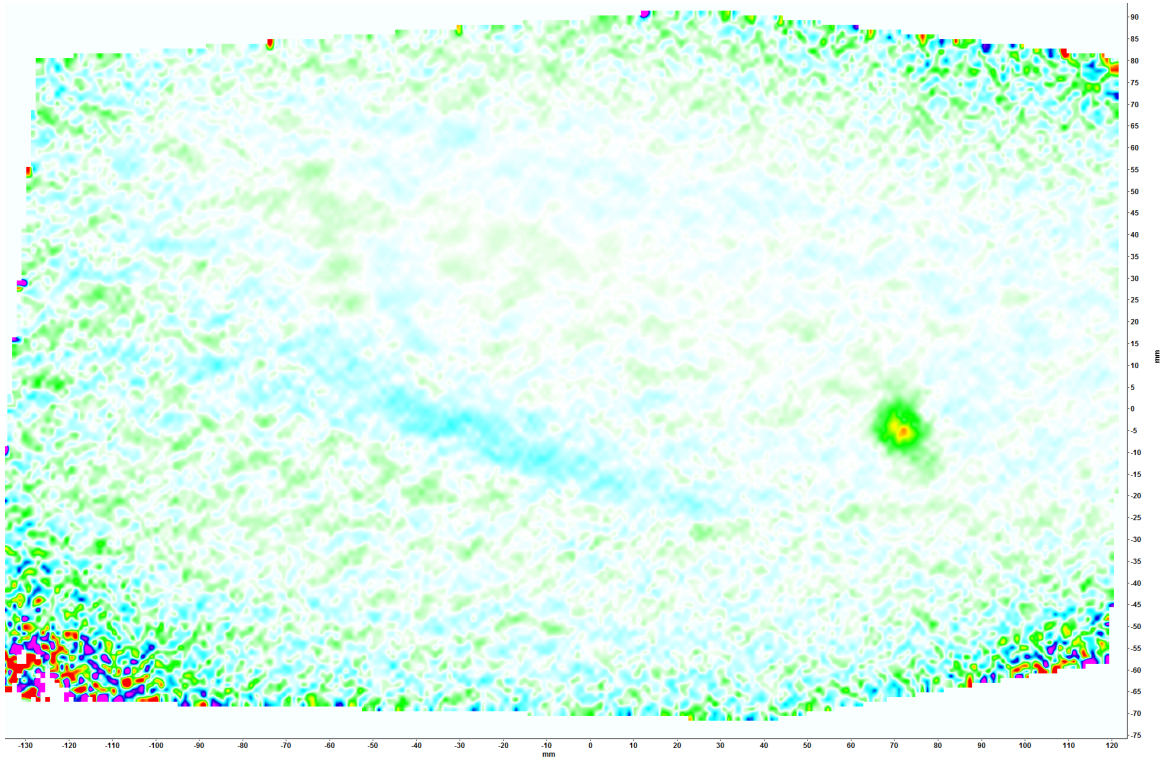
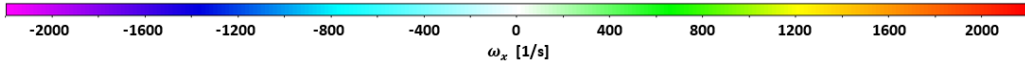


Figure 1.35: $C_L = -0.1$, $x = 350 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

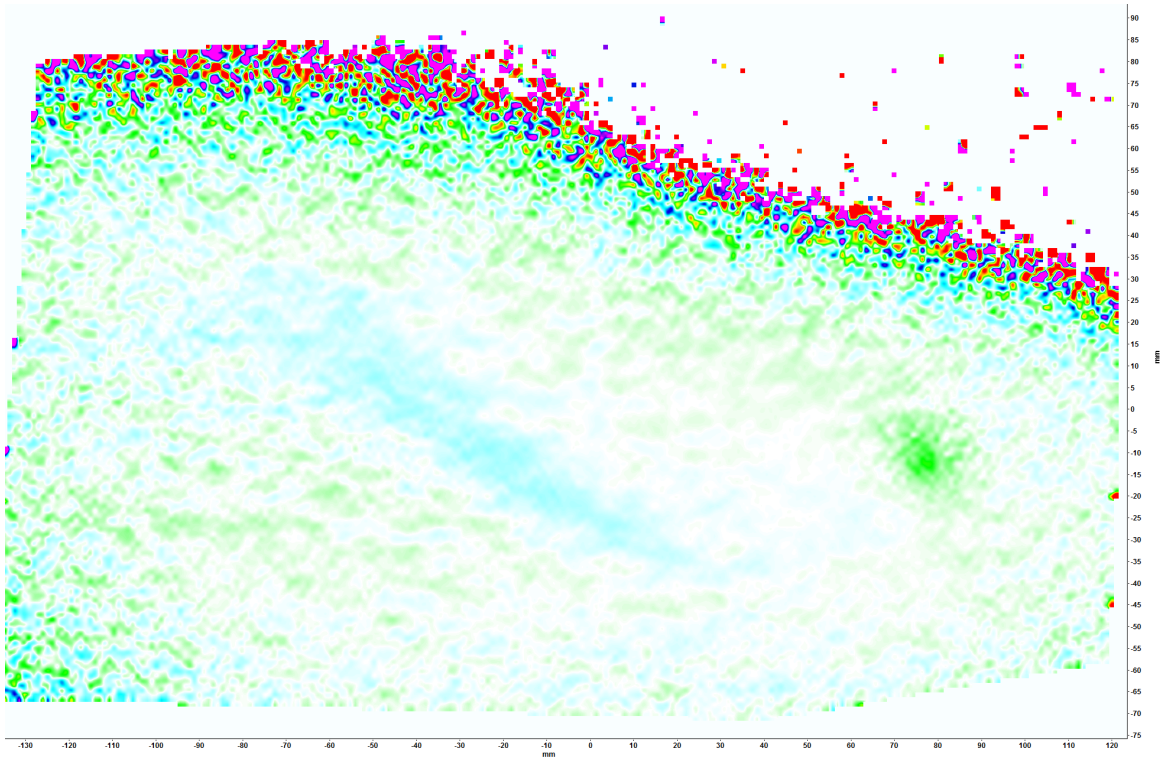


Figure 1.36: $C_L = -0.1$, $x = 700 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.3 $C_L = 0.1$

1.3.1 Average velocity

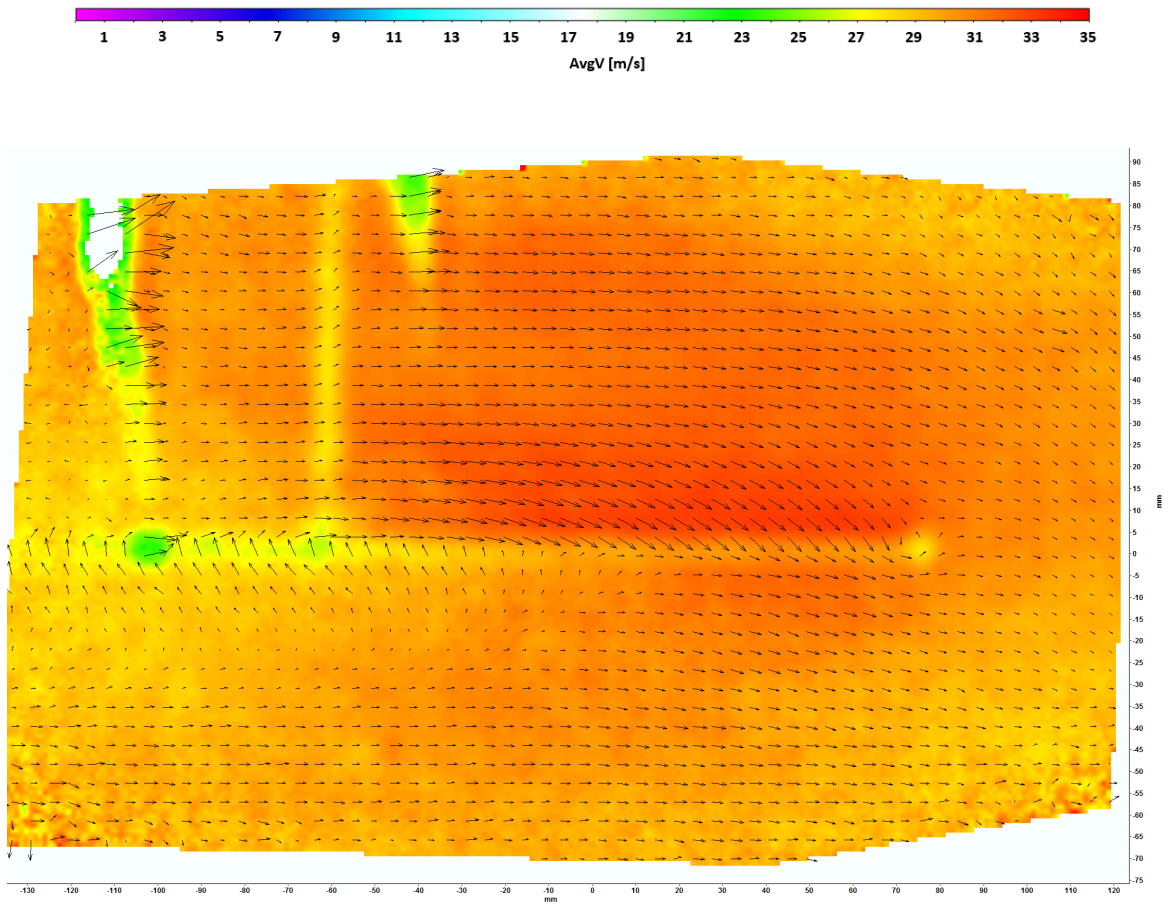


Figure 1.37: $C_L = 0.1$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

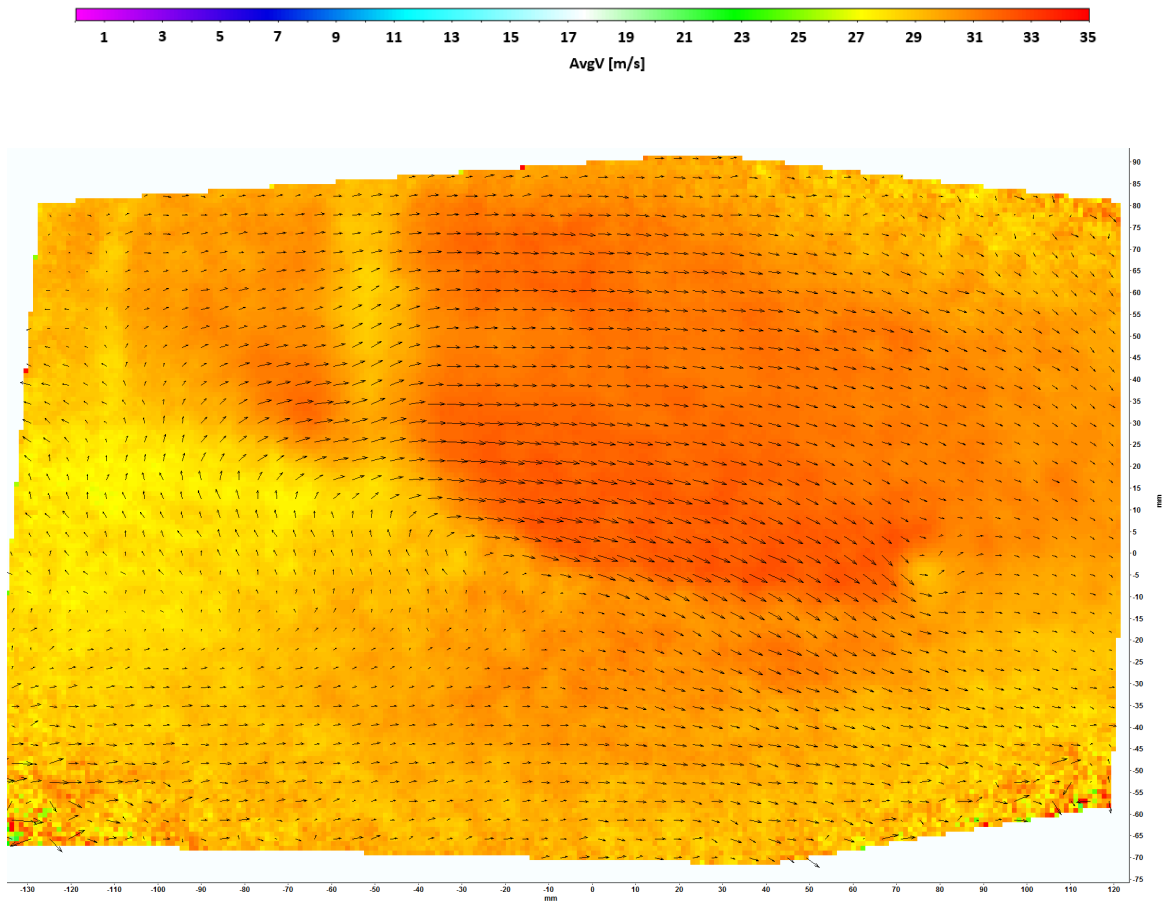


Figure 1.38: $C_L = 0.1$, $x = 350 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

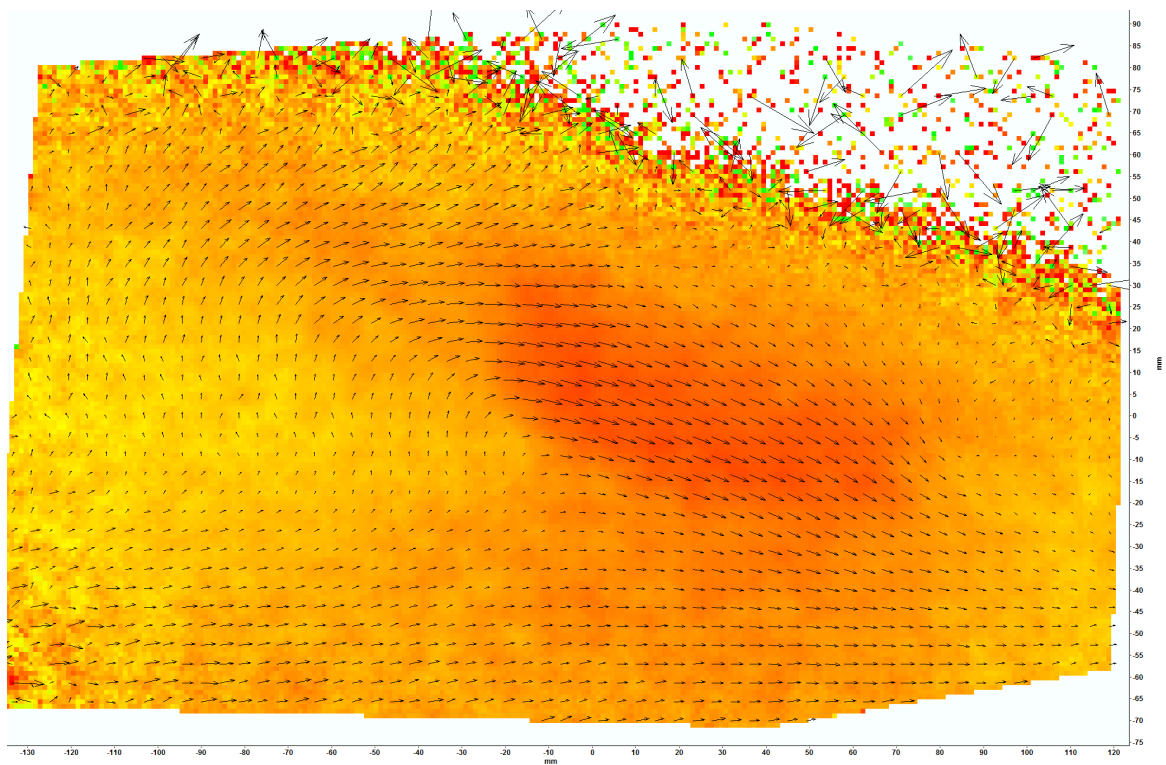


Figure 1.39: $C_L = 0.1$, $x = 700 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.3.2 v velocity component

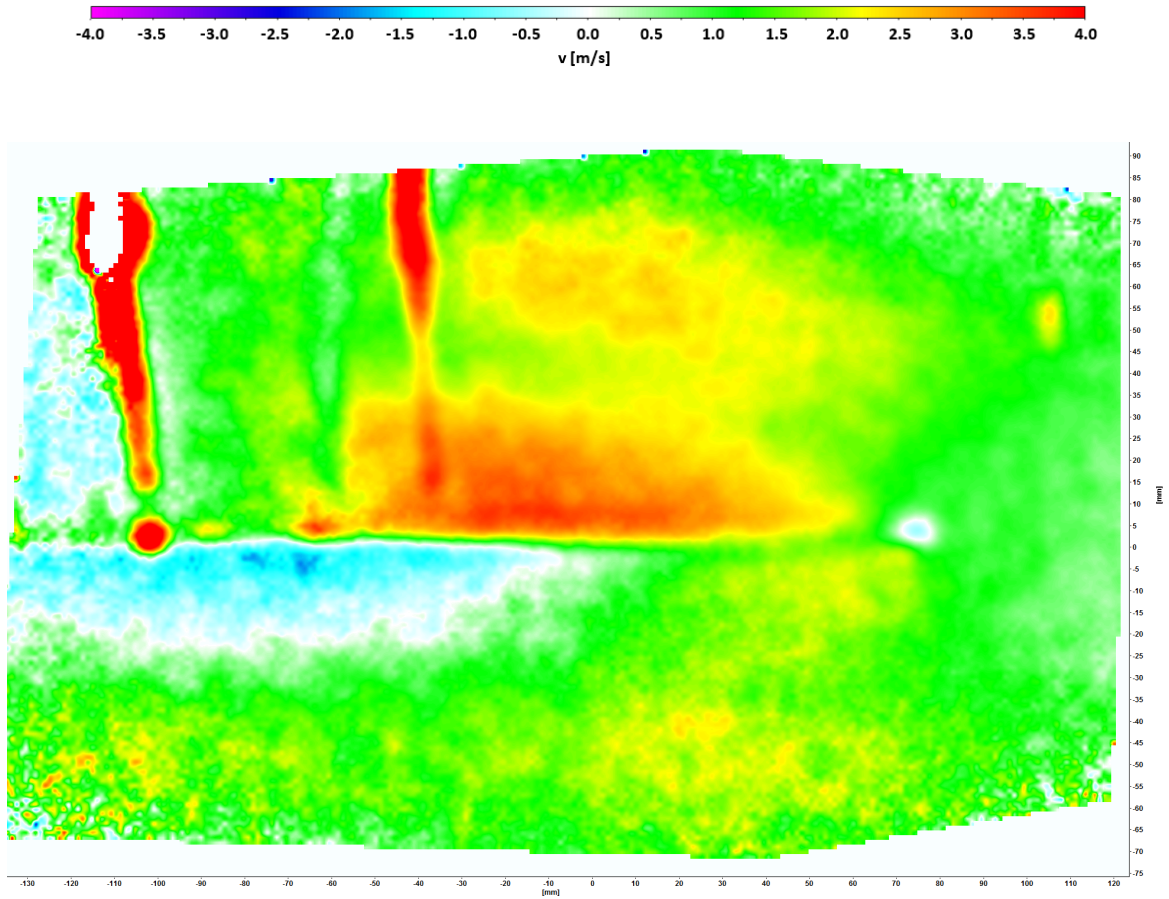


Figure 1.40: $C_L = 0.1$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

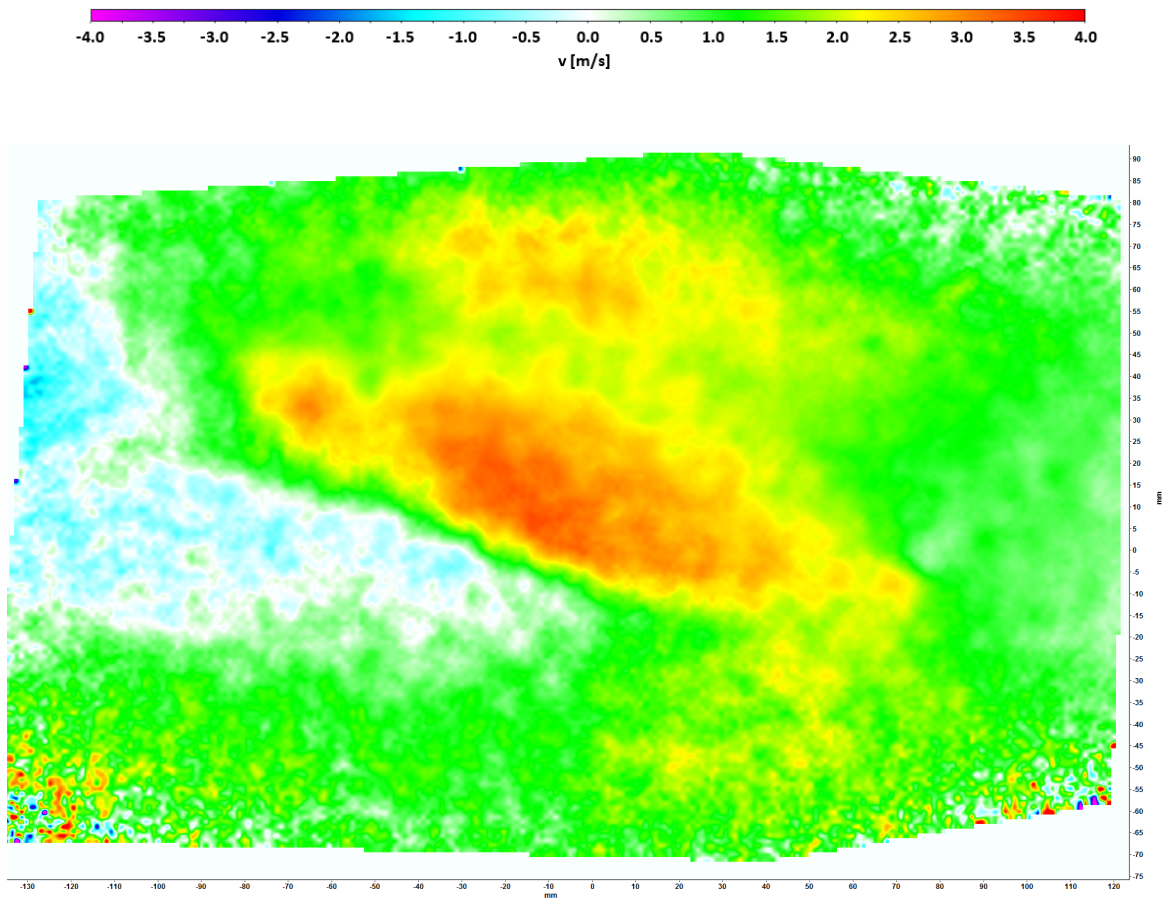


Figure 1.41: $C_L = 0.1$, $x = 350 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

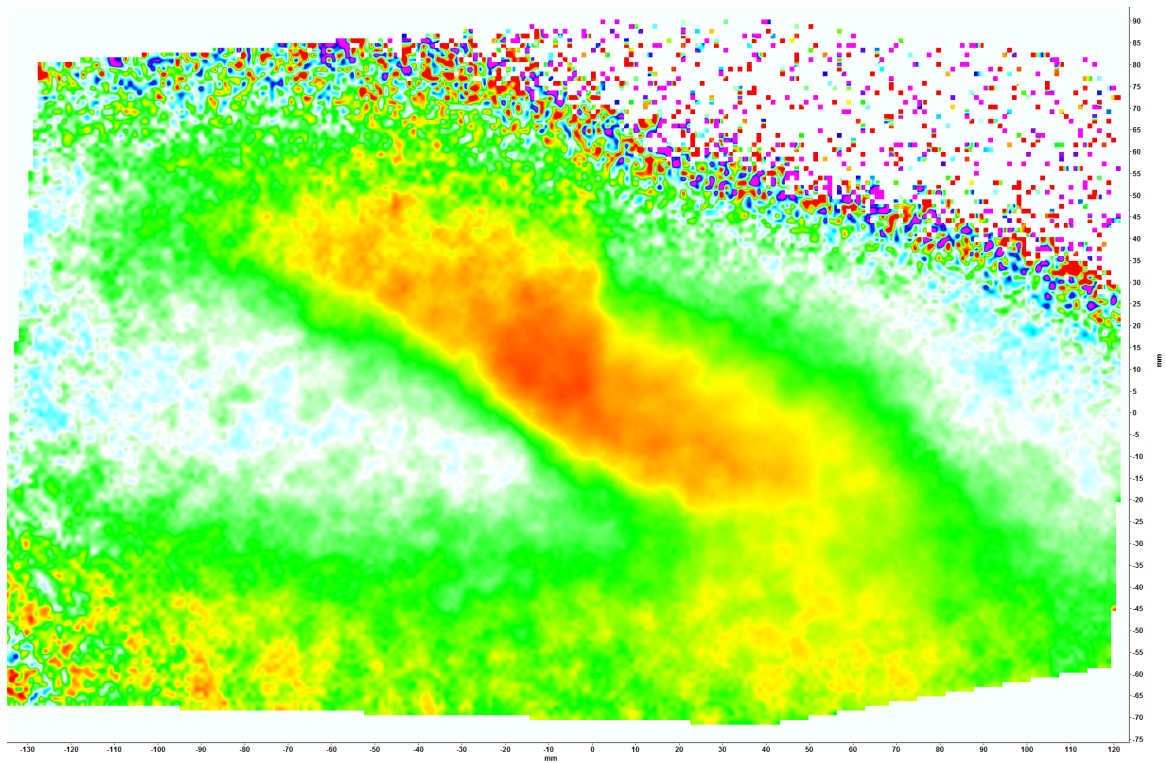


Figure 1.42: $C_L = 0.1$, $x = 700 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.3.3 w velocity component

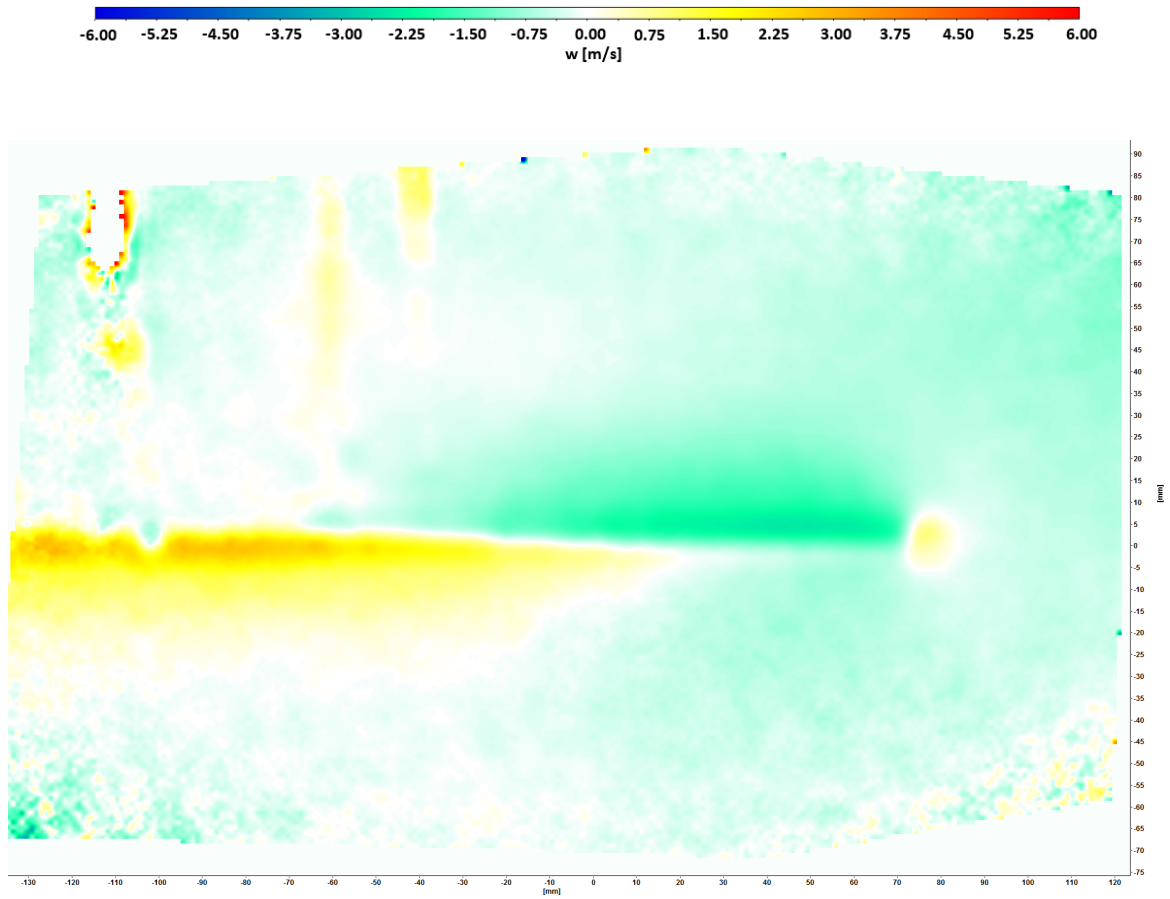


Figure 1.43: $C_L = 0.1$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

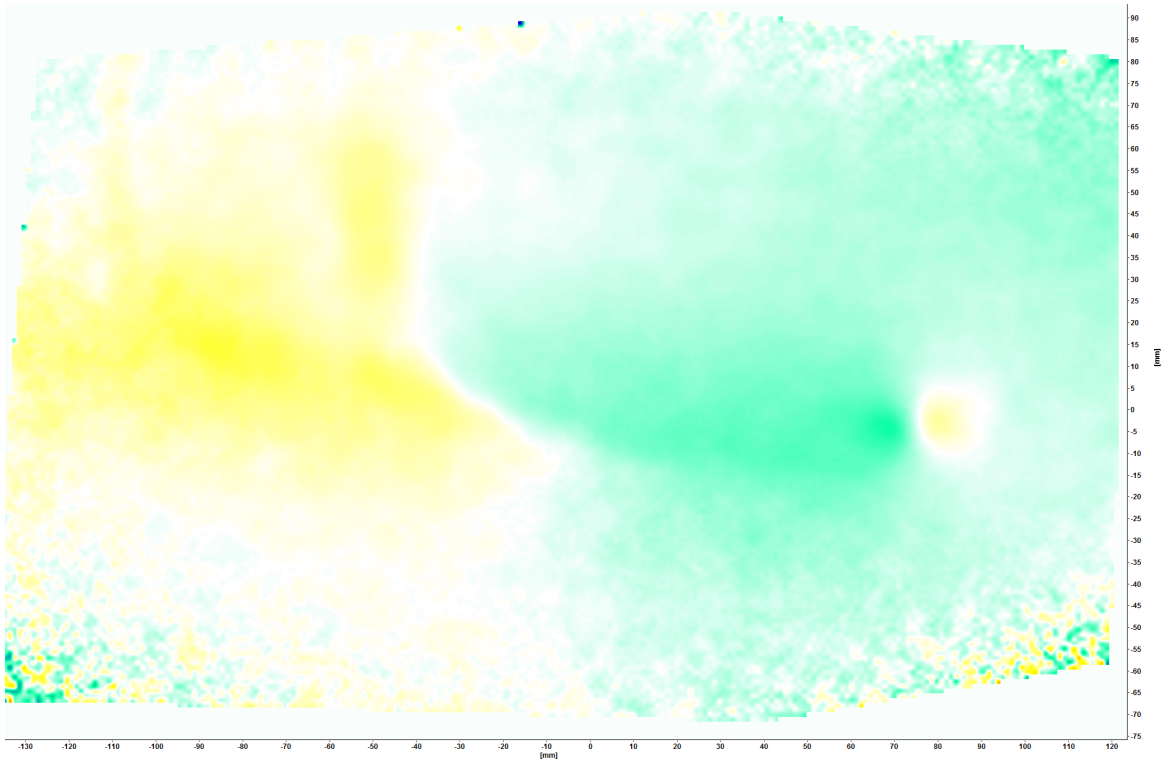
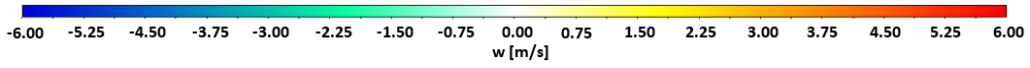


Figure 1.44: $C_L = 0.1$, $x = 350 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

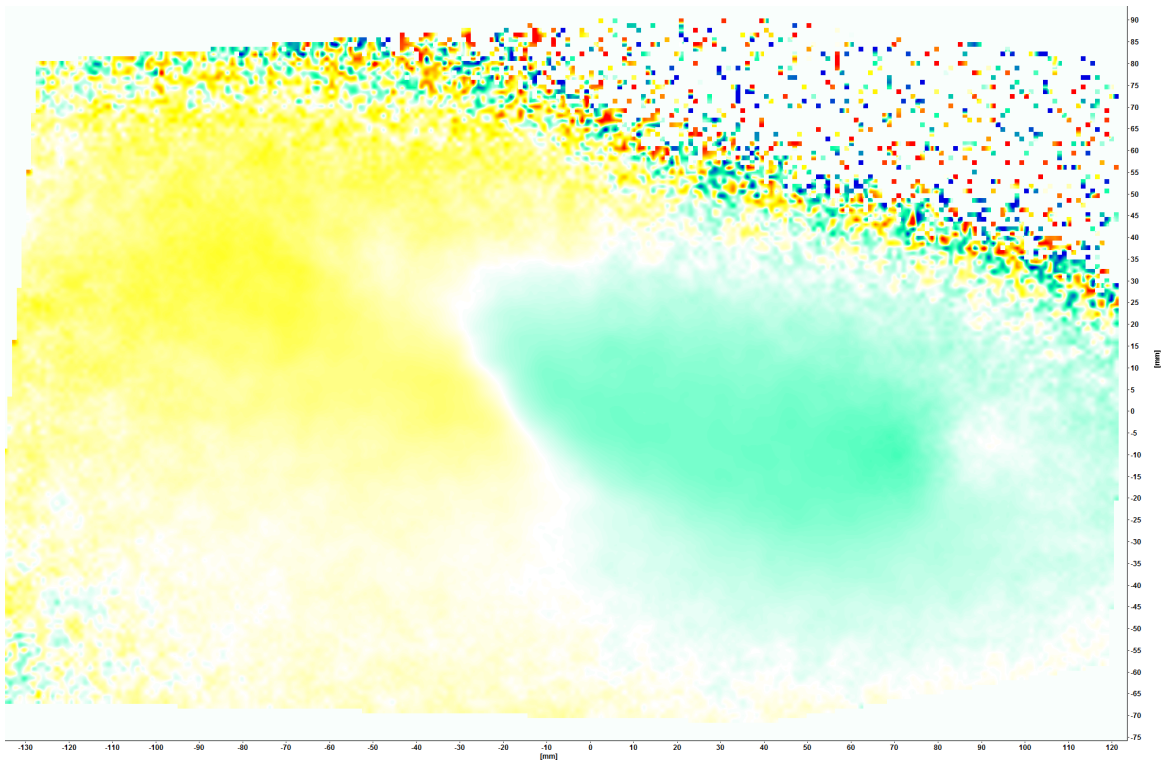


Figure 1.45: $C_L = 0.1$, $x = 700 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.3.4 Vorticity ω_x

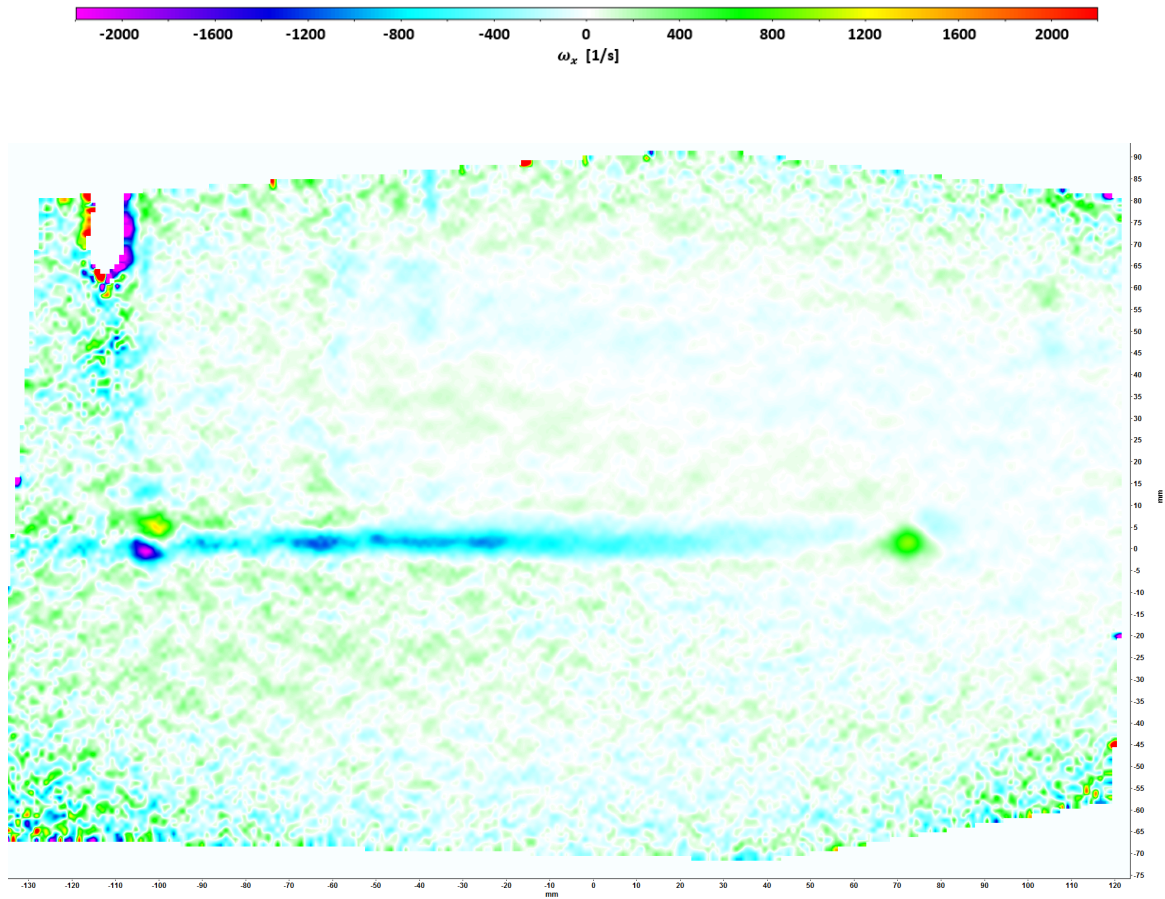


Figure 1.46: $C_L = 0.1$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

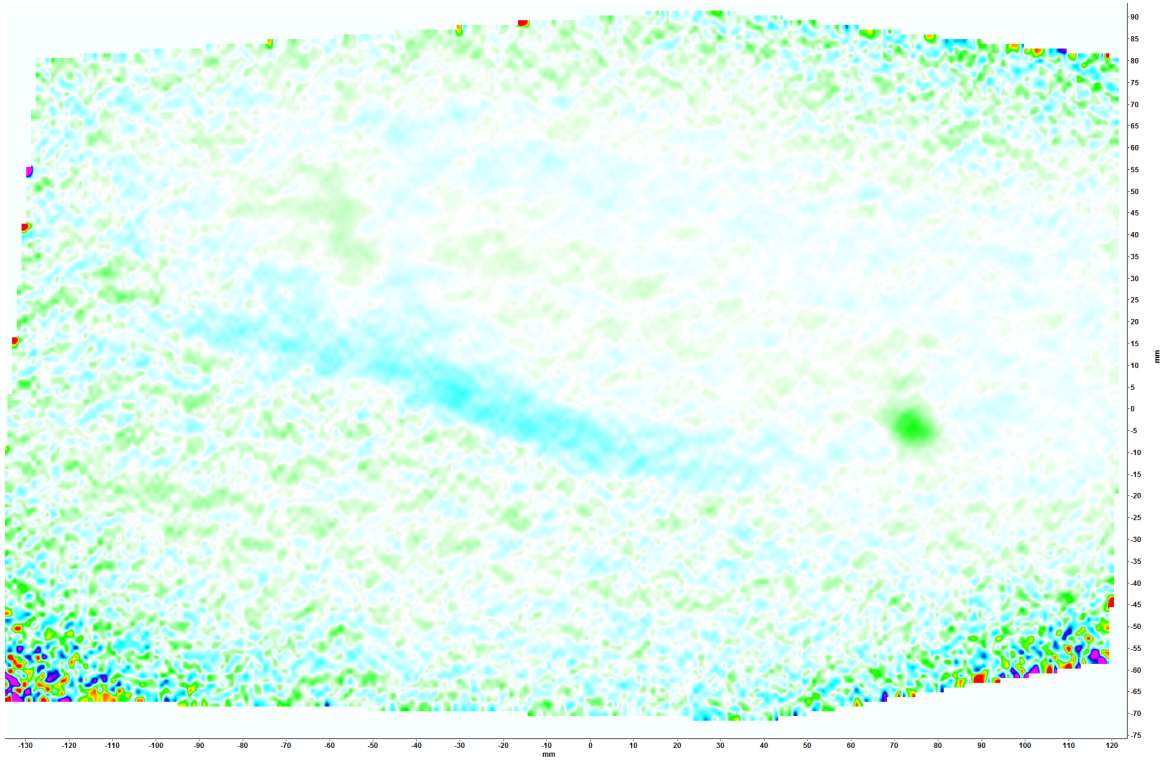
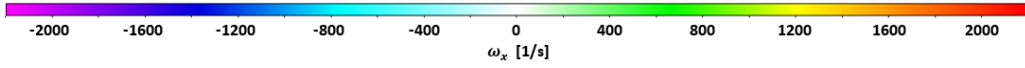


Figure 1.47: $C_L = 0.1$, $x = 350 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

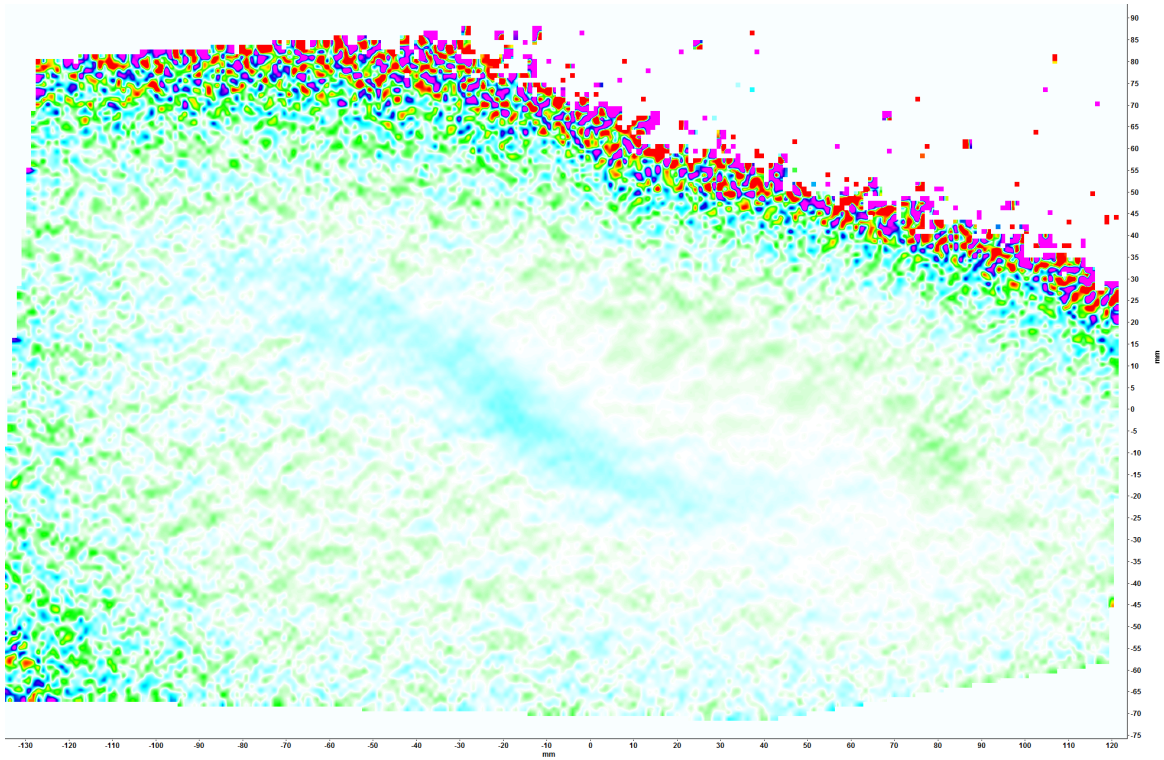


Figure 1.48: $C_L = 0.1$, $x = 700 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

1.4 $C_L = 0.6$

1.4.1 Average velocity

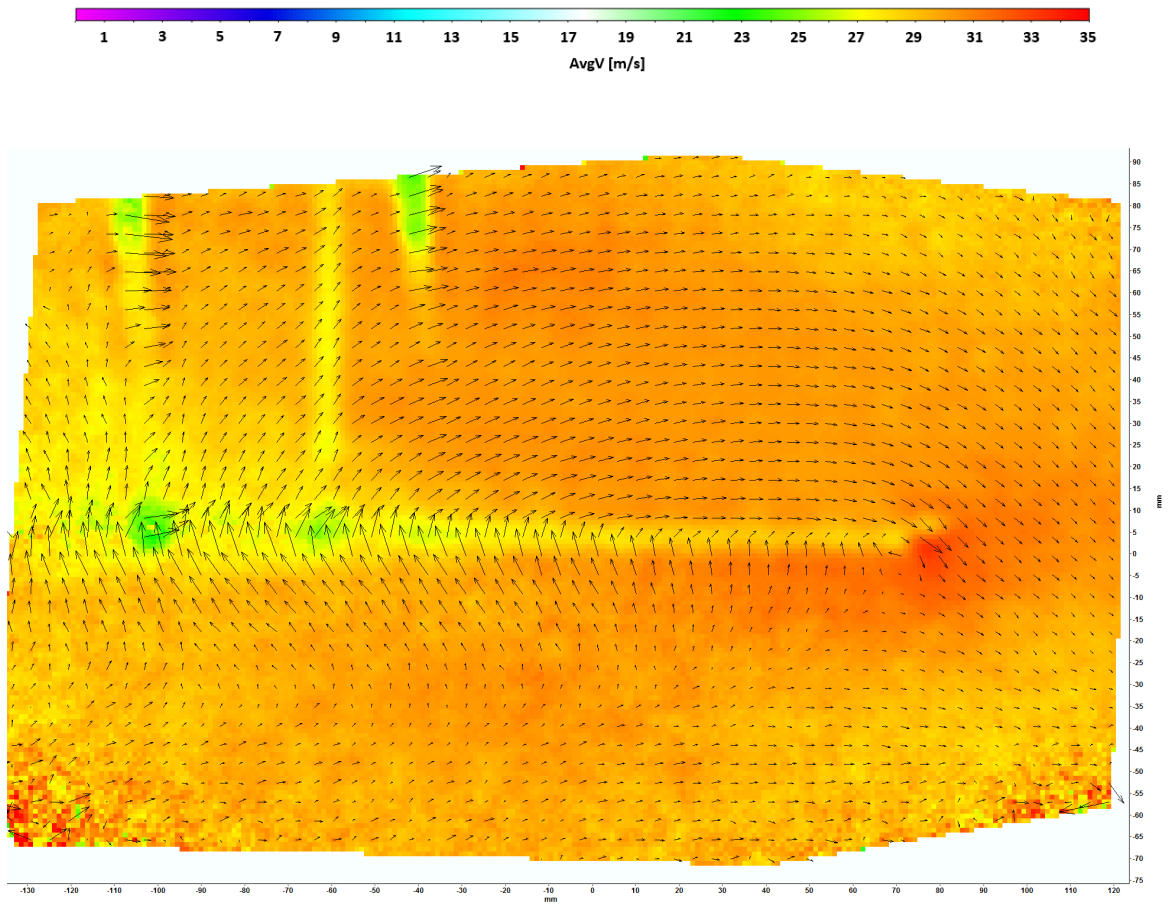


Figure 1.49: $C_L = 0.6$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

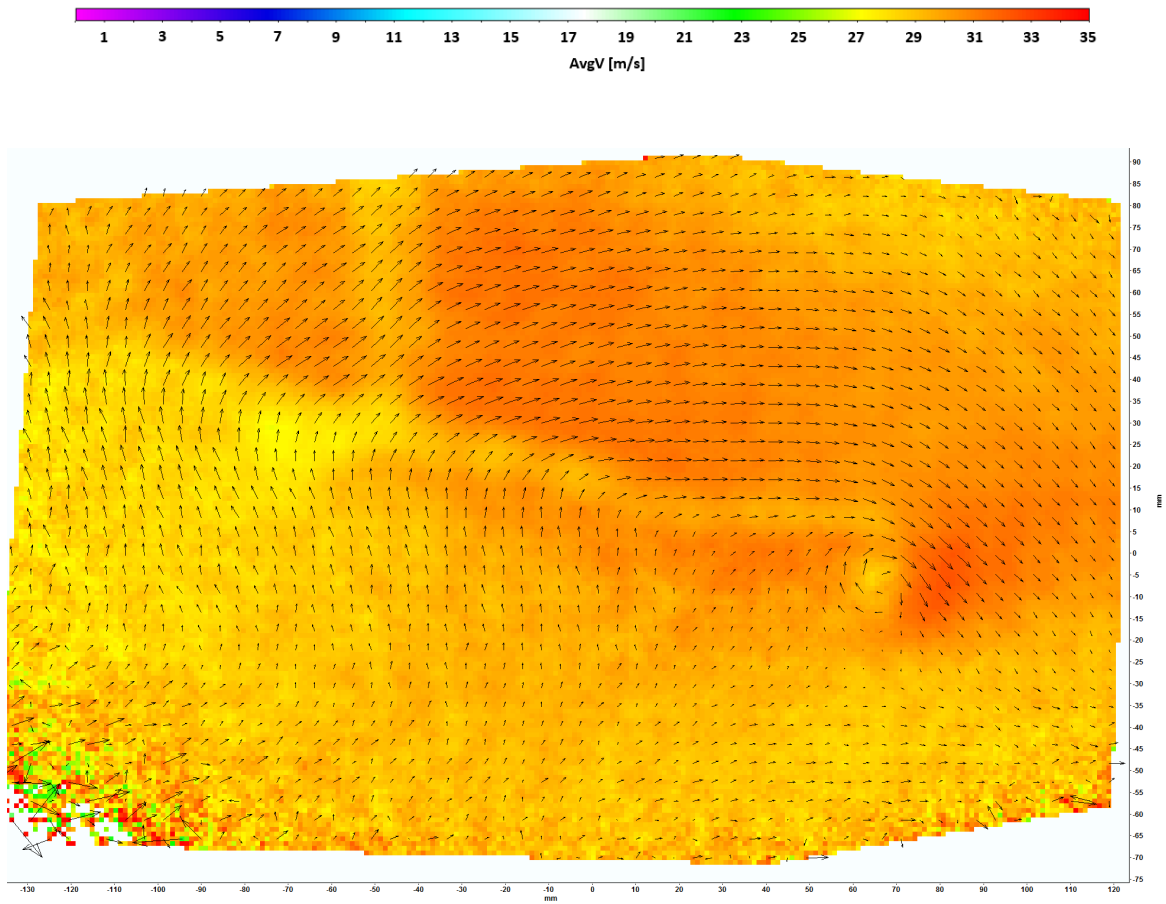


Figure 1.50: $C_L = 0.6$, $x = 350 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

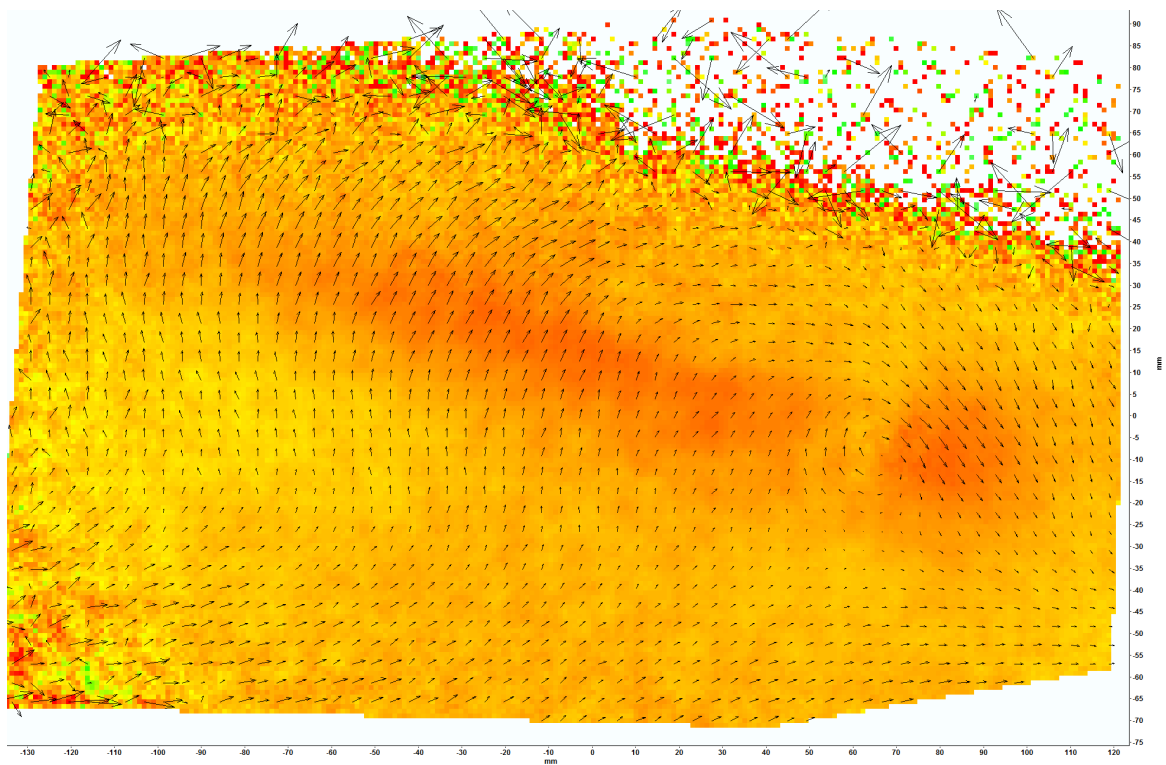


Figure 1.51: $C_L = 0.6$, $x = 700 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

1.4.2 v velocity component

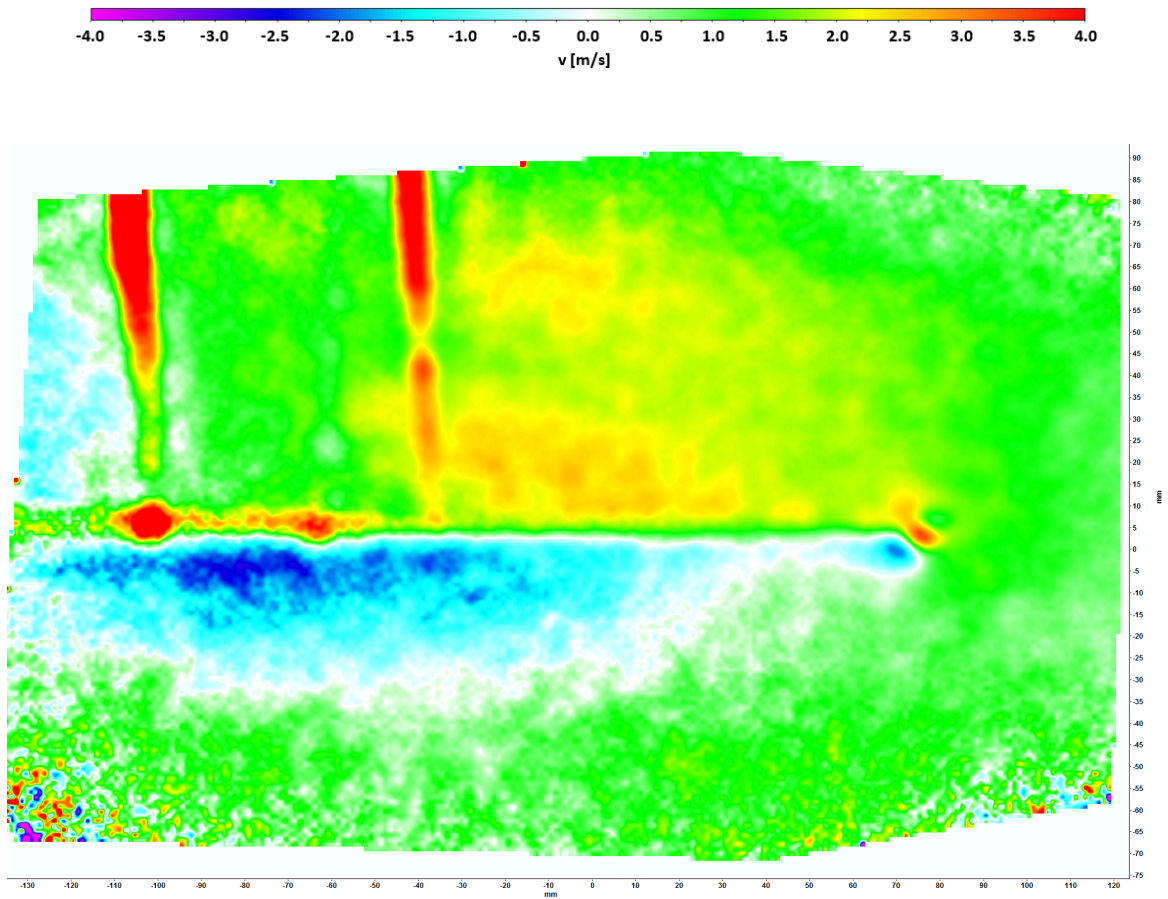


Figure 1.52: $C_L = 0.6$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

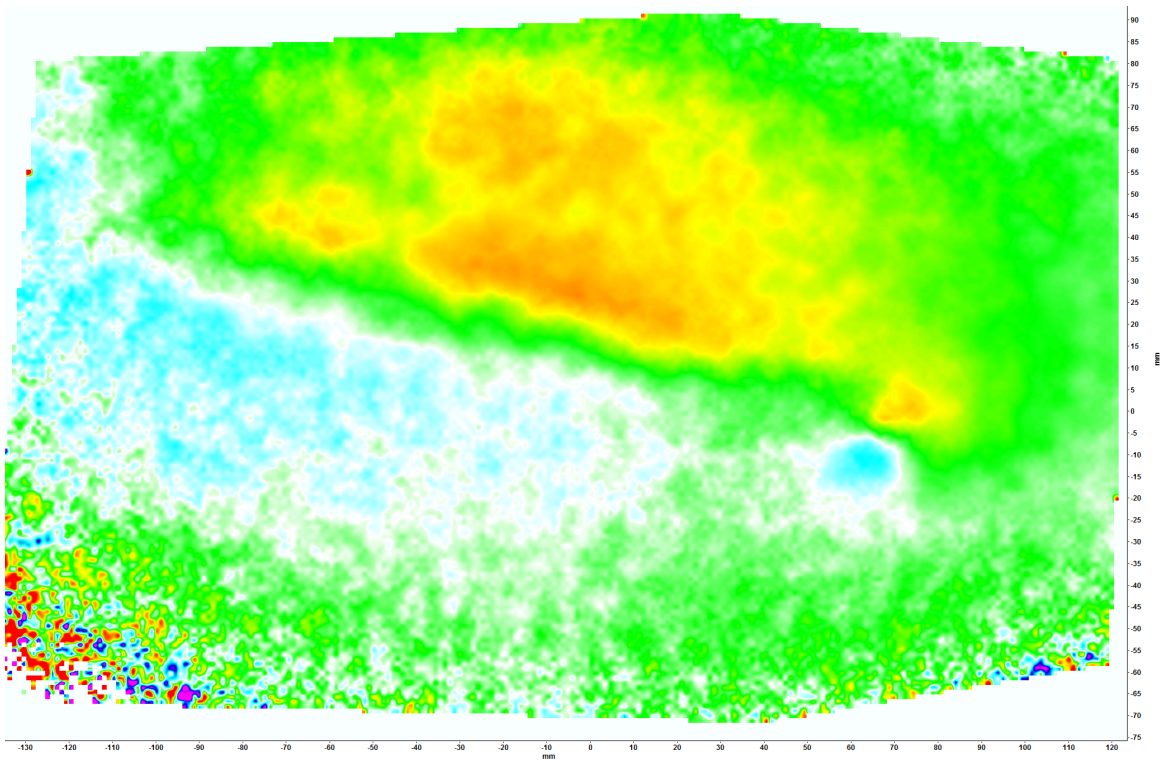
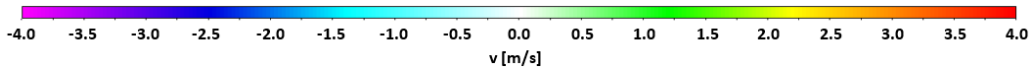


Figure 1.53: $C_L = 0.6$, $x = 350 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

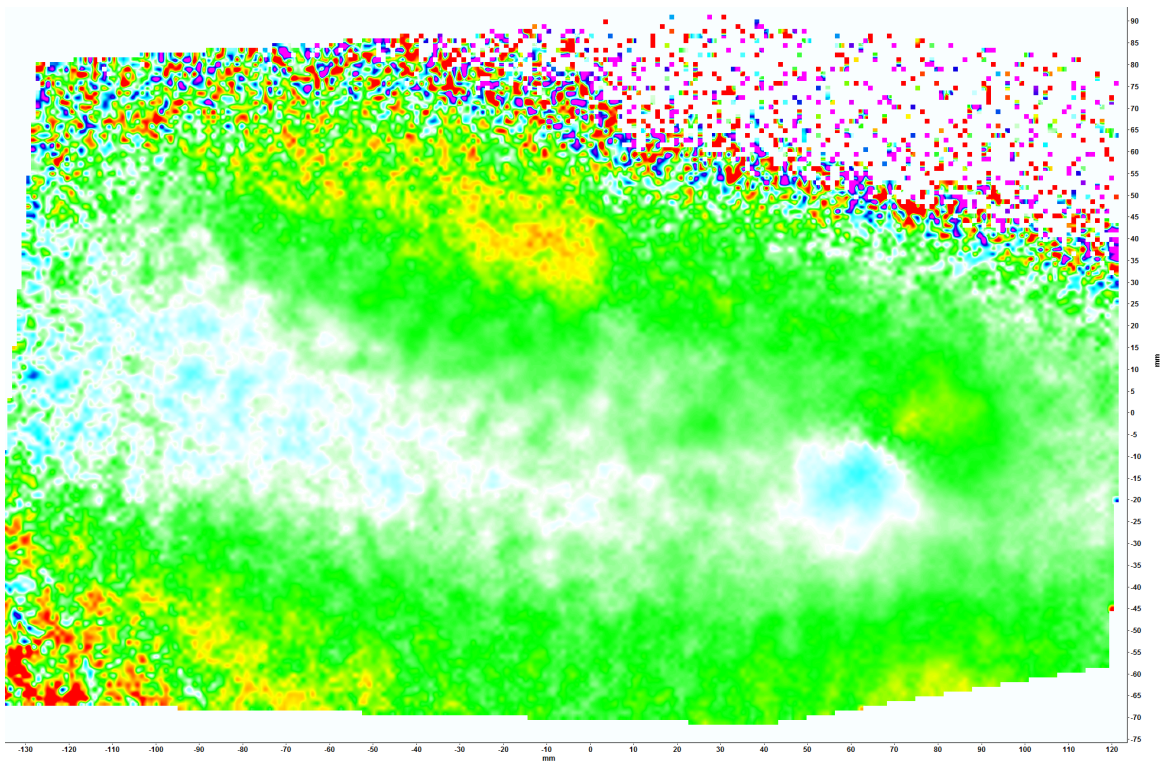


Figure 1.54: $C_L = 0.6$, $x = 700 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

1.4.3 w velocity component

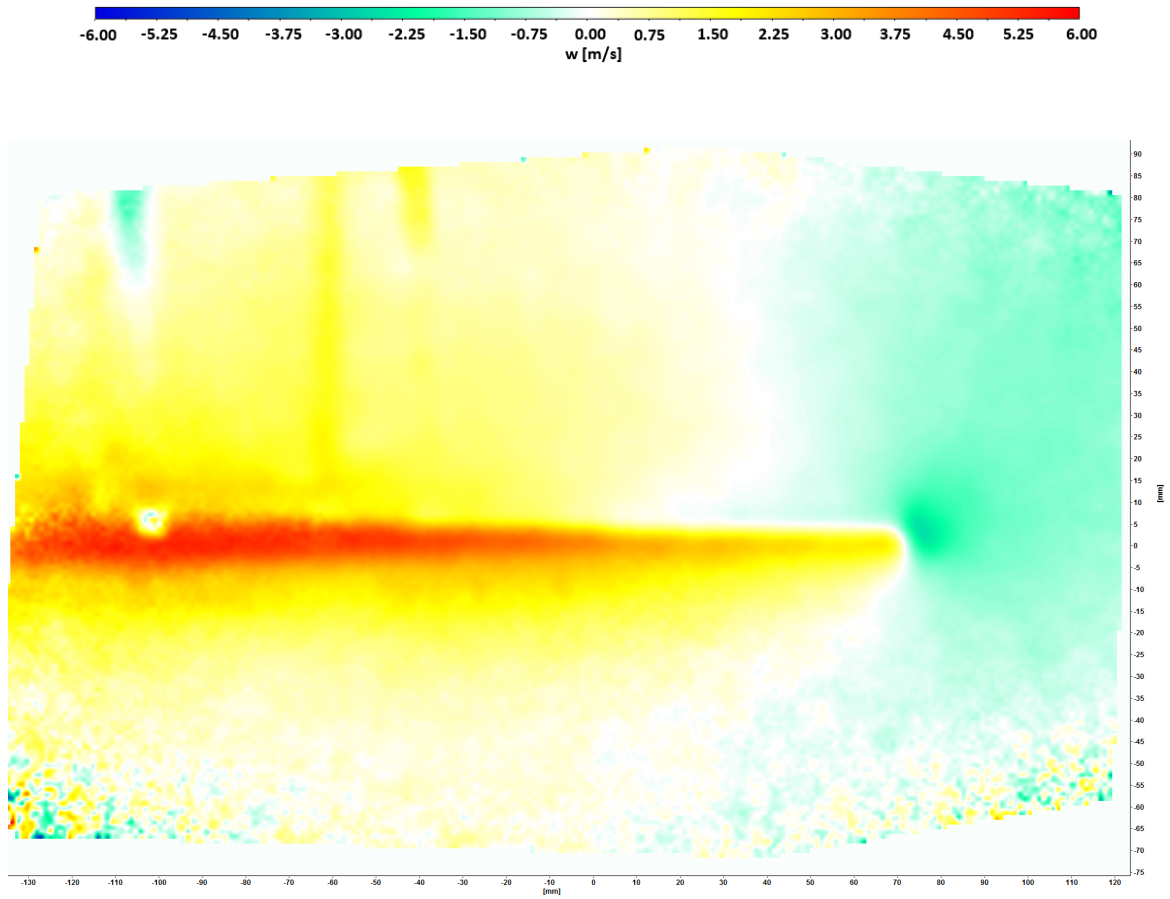


Figure 1.55: $C_L = 0.6$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

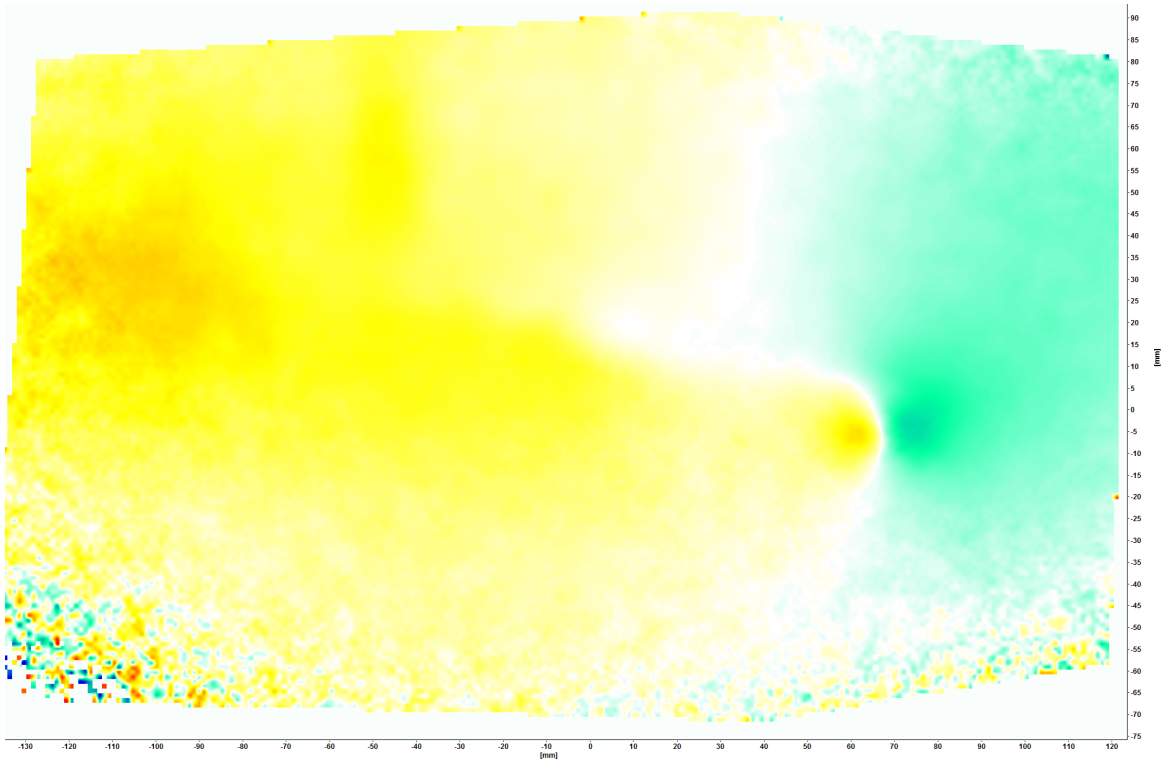
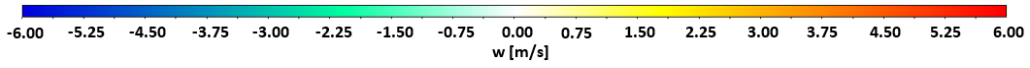


Figure 1.56: $C_L = 0.6$, $x = 350 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

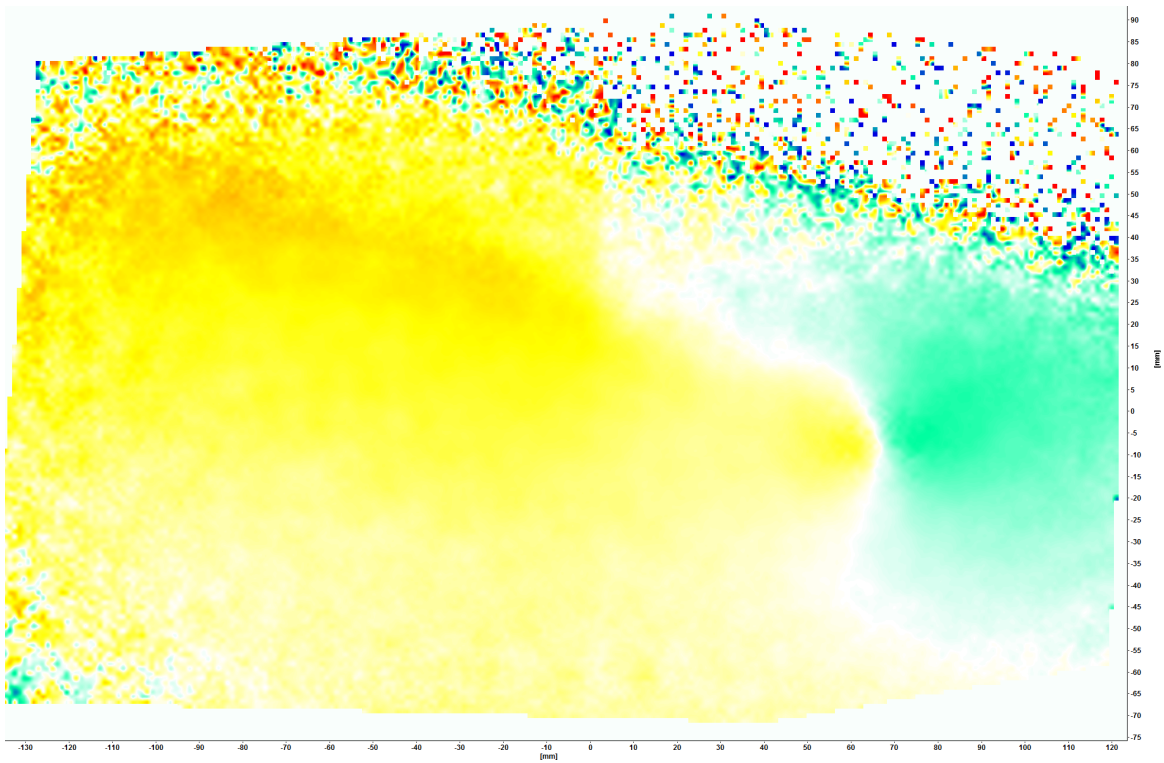


Figure 1.57: $C_L = 0.6$, $x = 700 \cdot 10^{-3} \text{ [m]}$ behind trailing edge, bell wing

1.4.4 Vorticity ω_x

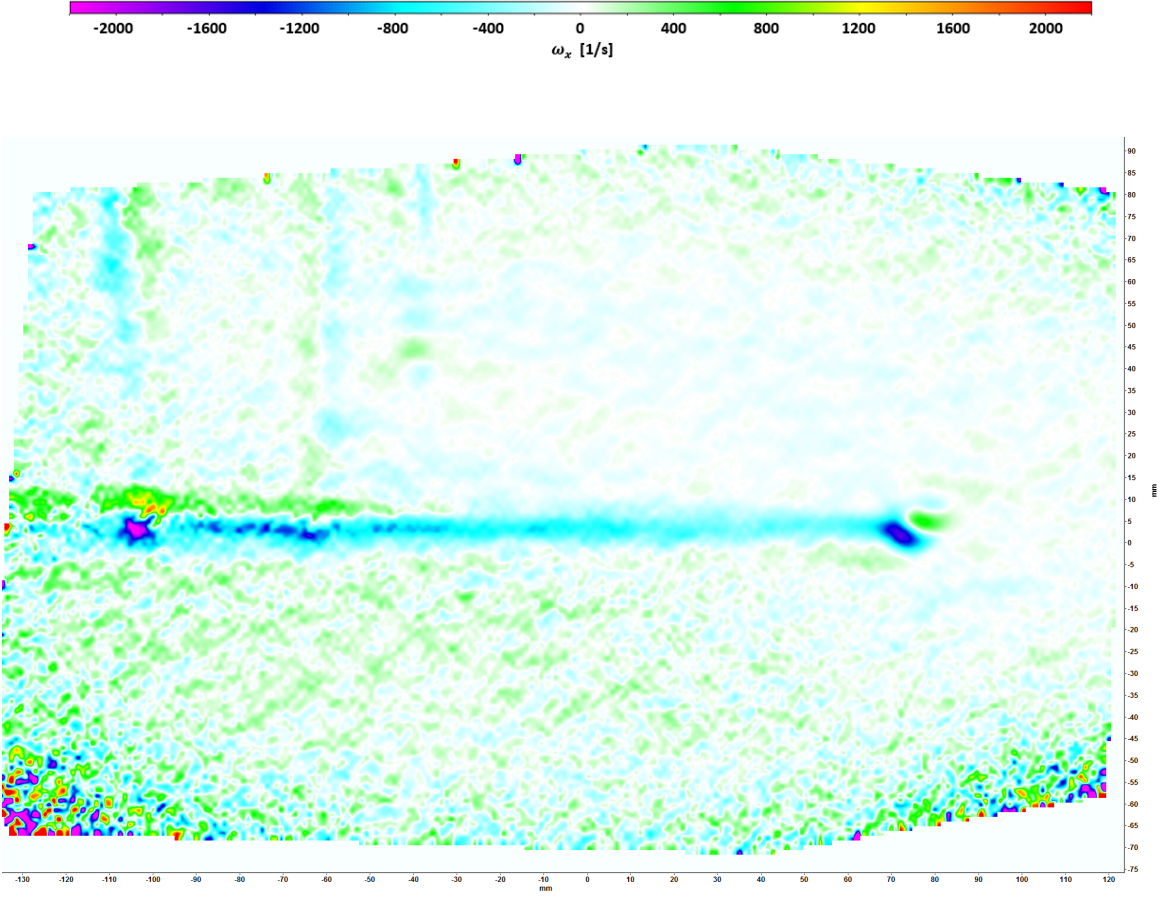


Figure 1.58: $C_L = 0.6$, $x = 10^{-3}$ [m] behind trailing edge, bell wing

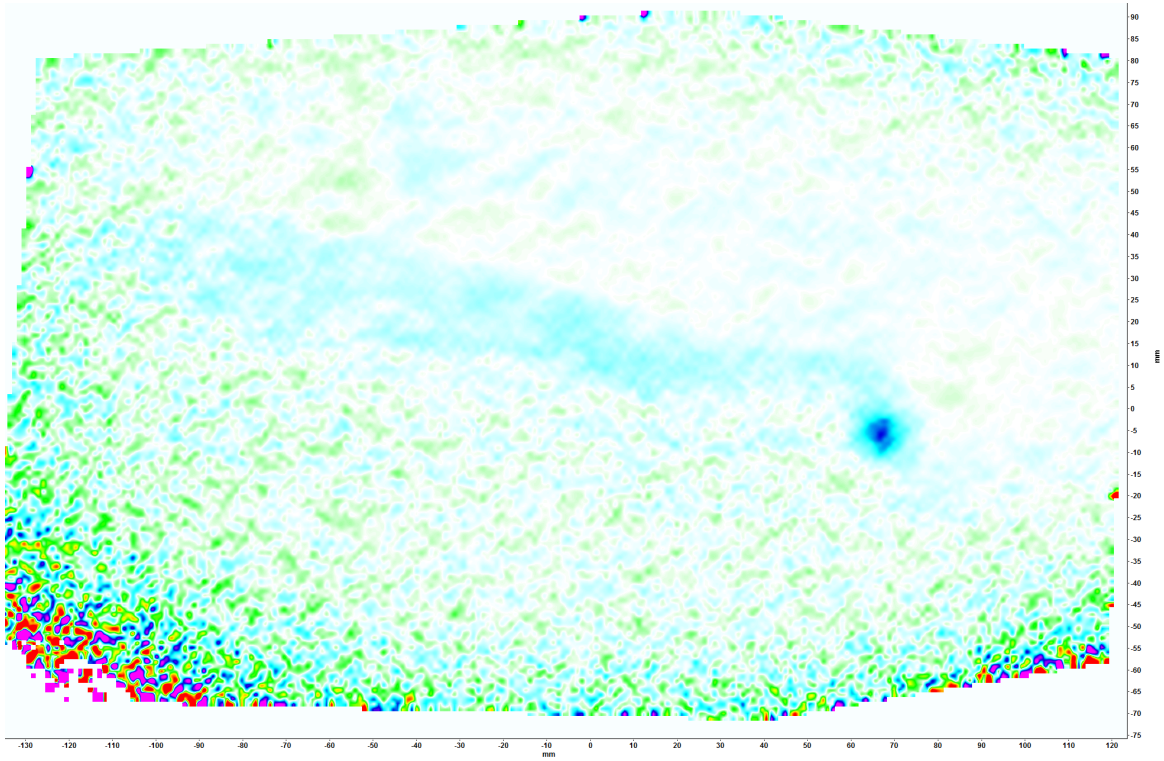
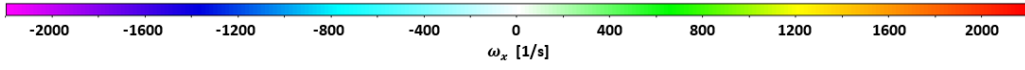


Figure 1.59: $C_L = 0.6$, $x = 350 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

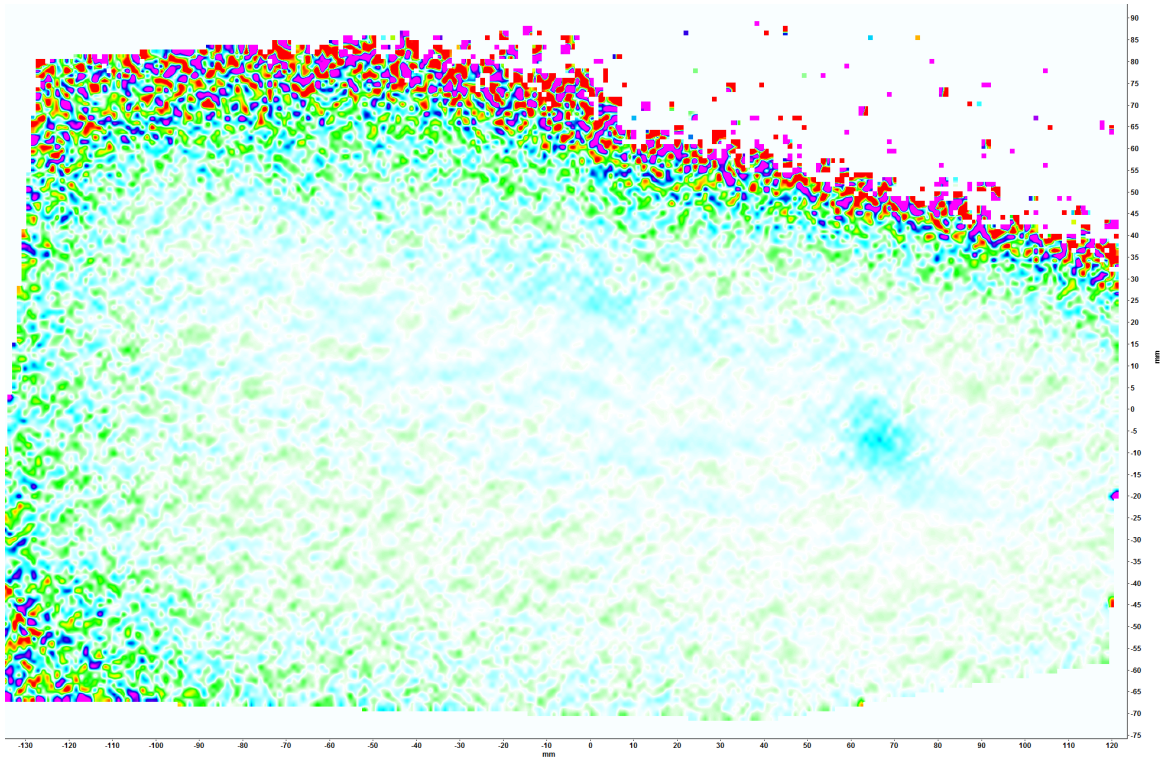


Figure 1.60: $C_L = 0.6$, $x = 700 \cdot 10^{-3} [m]$ behind trailing edge, bell wing

2 Elliptical wing

2.1 $C_L = 0.4$

2.1.1 Average velocity

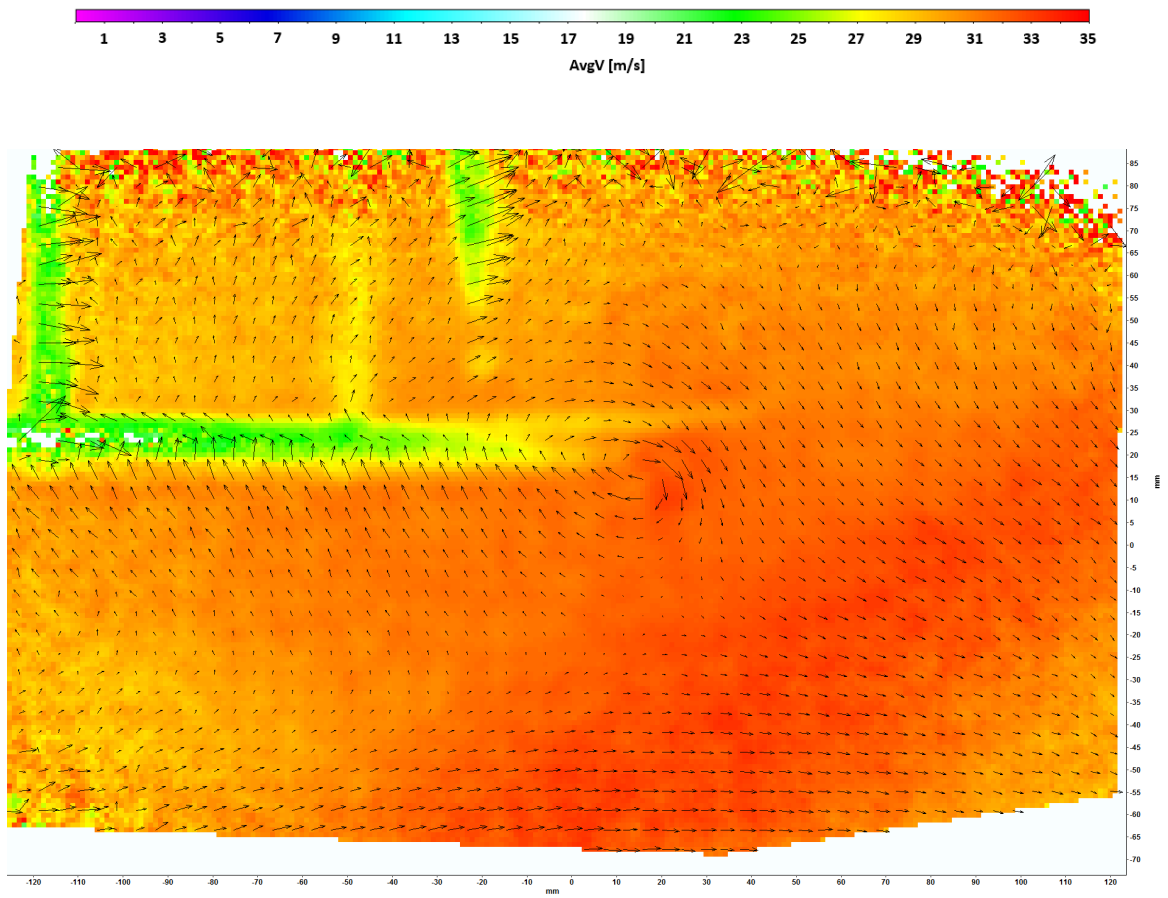


Figure 2.1: $C_L = 0.4$, $x = 10^{-3}$ [m] from trailing edge, elliptical wing

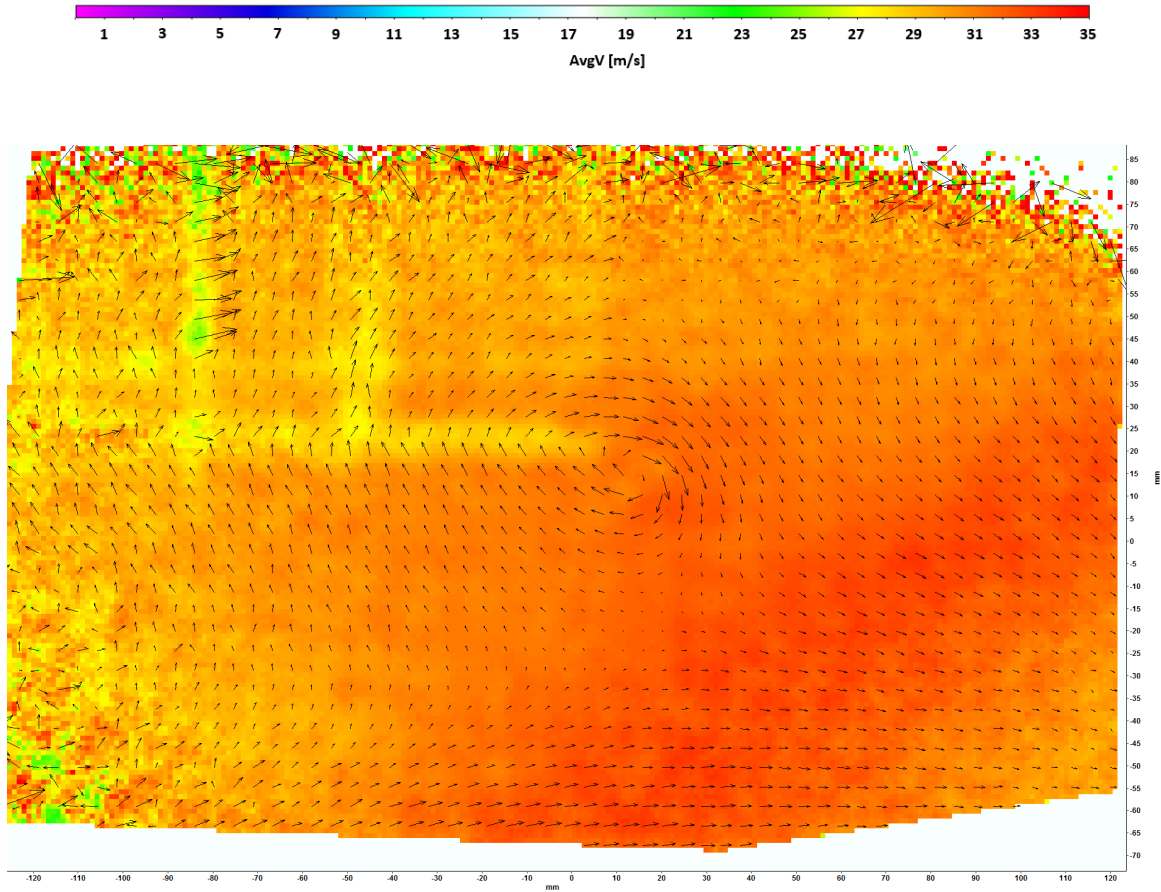


Figure 2.2: $C_L = 0.4$, $x = 50 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

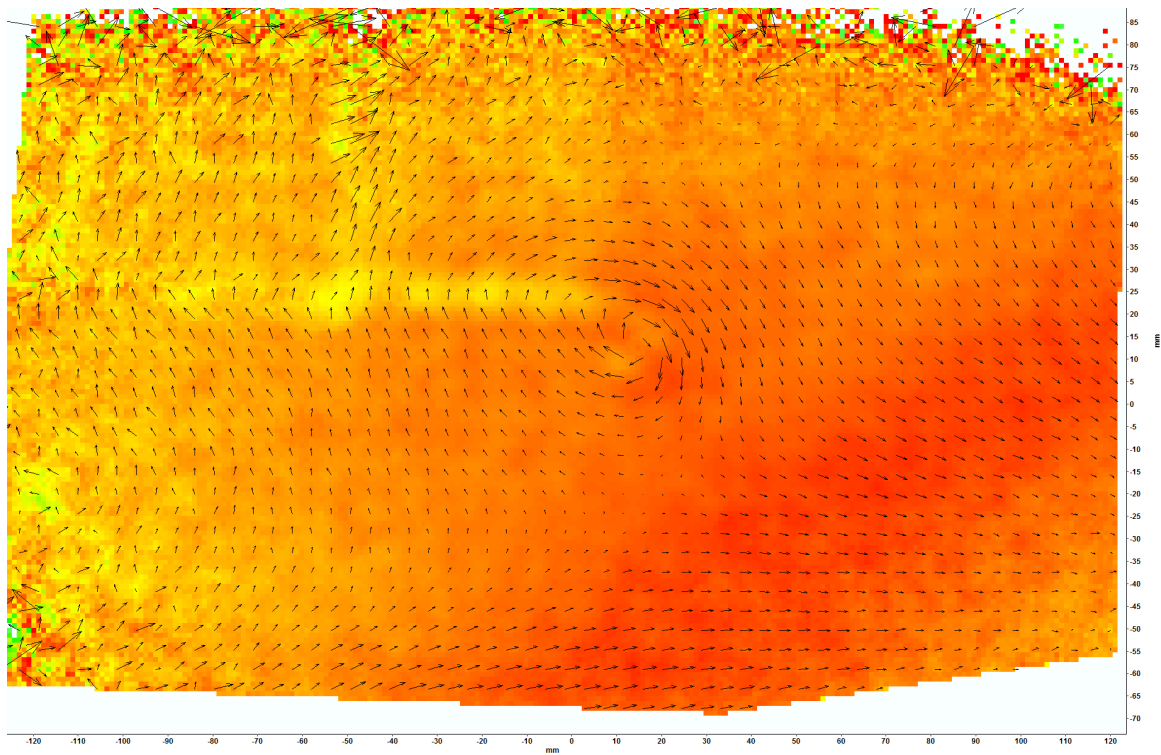


Figure 2.3: $C_L = 0.4$, $x = 100 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

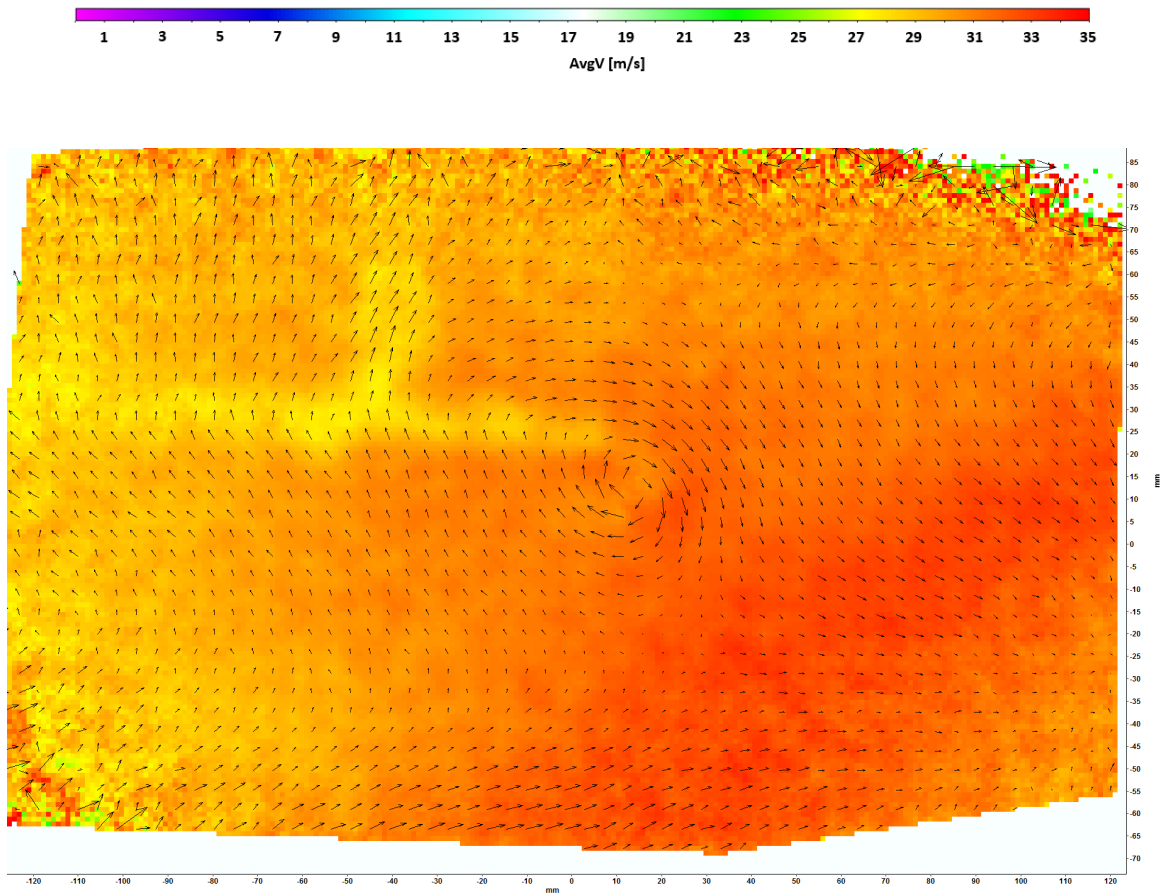


Figure 2.4: $C_L = 0.4$, $x = 200 \cdot 10^{-3} \text{ m}$ from trailing edge, elliptical wing

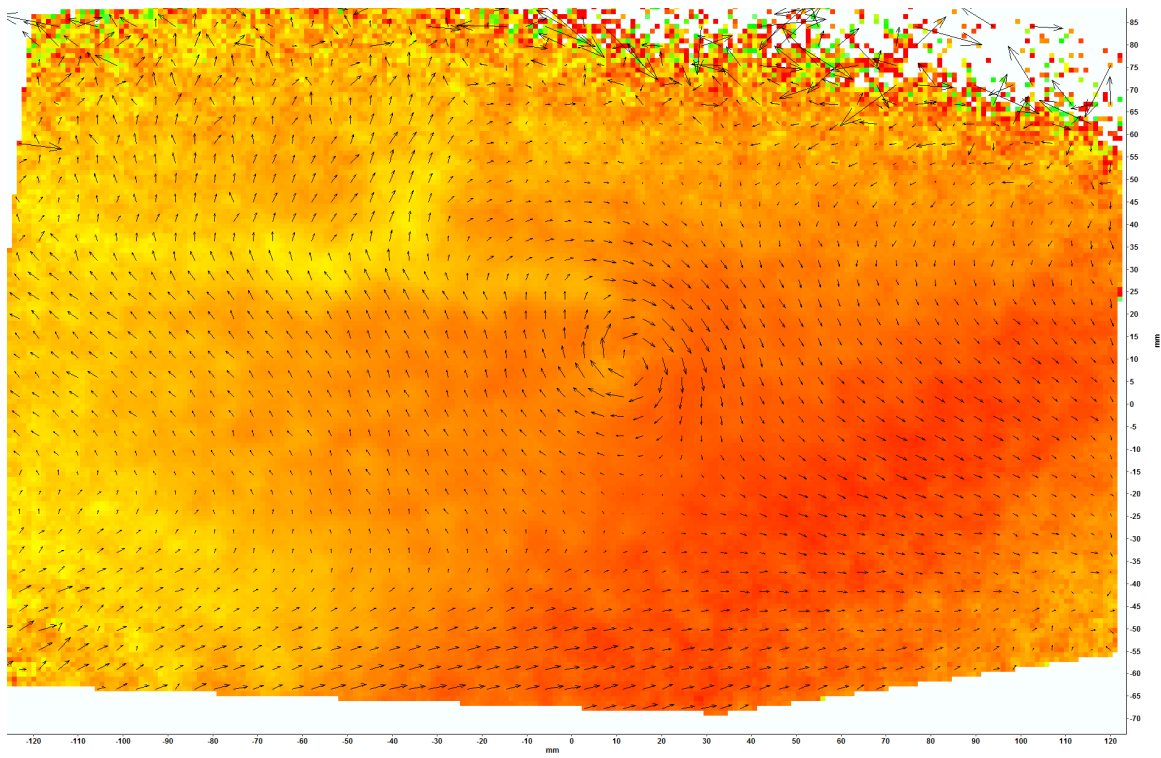


Figure 2.5: $C_L = 0.4$, $x = 350 \cdot 10^{-3} \text{ m}$ from trailing edge, elliptical wing

2.1.2 v velocity component

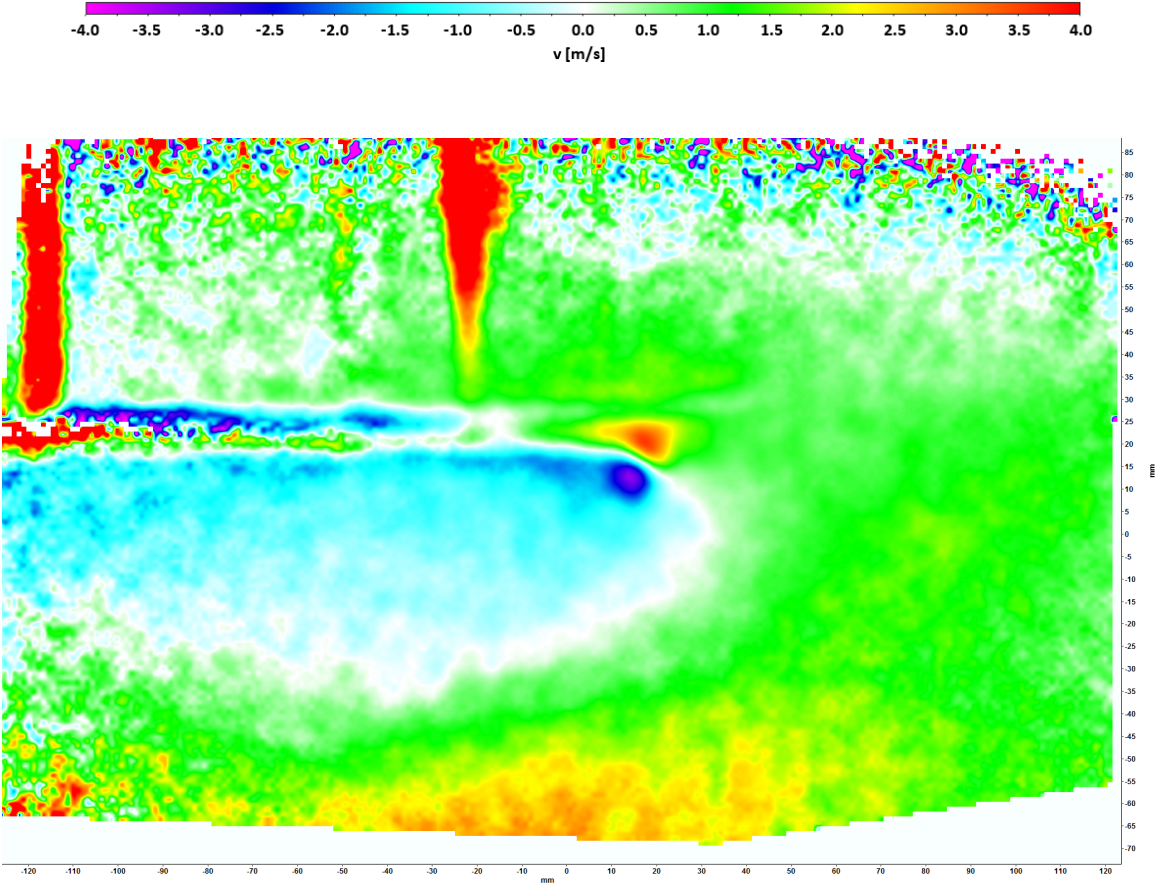


Figure 2.6: $C_L = 0.4$, $x = 10^{-3}$ [m] from trailing edge, elliptical wing

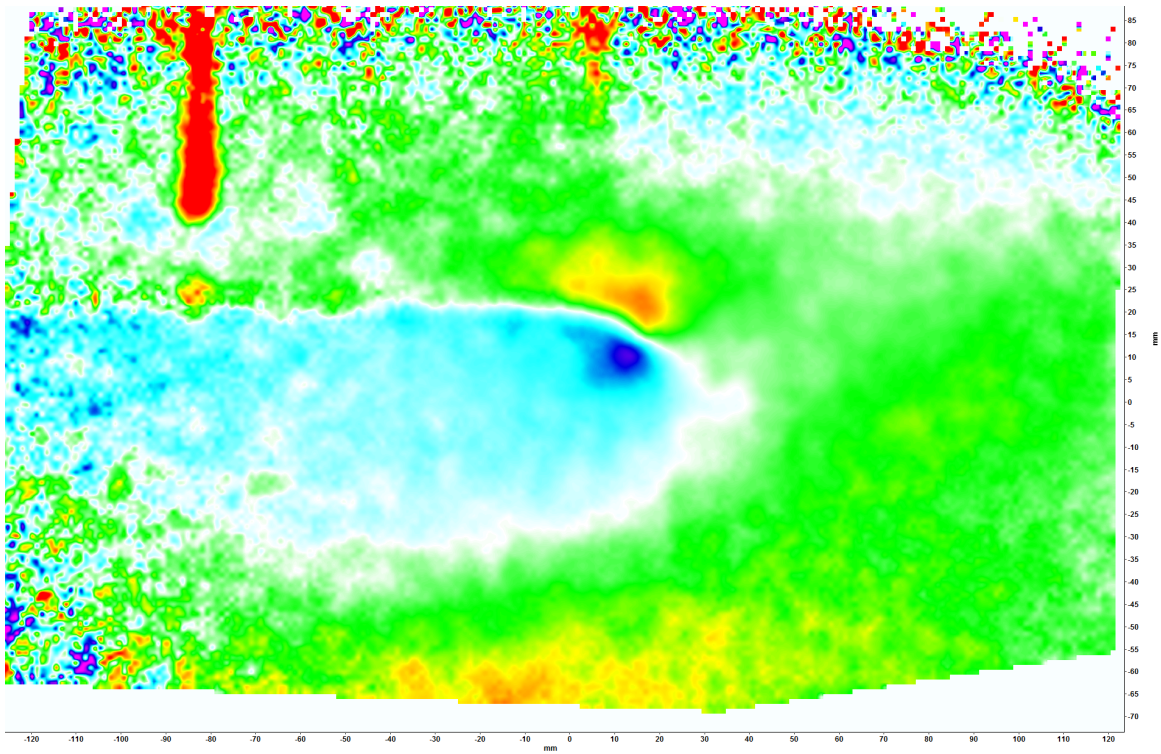
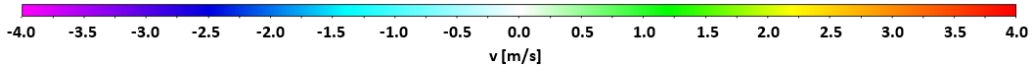


Figure 2.7: $C_L = 0.4$, $x = 50 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

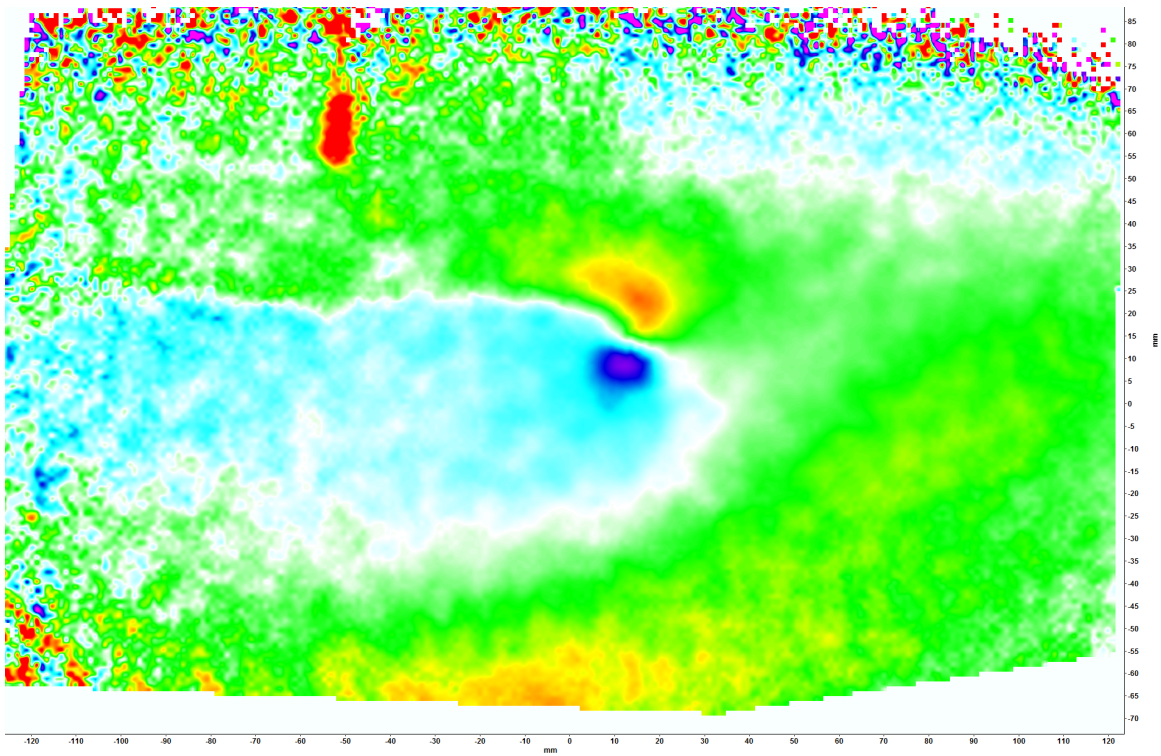


Figure 2.8: $C_L = 0.4$, $x = 100 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

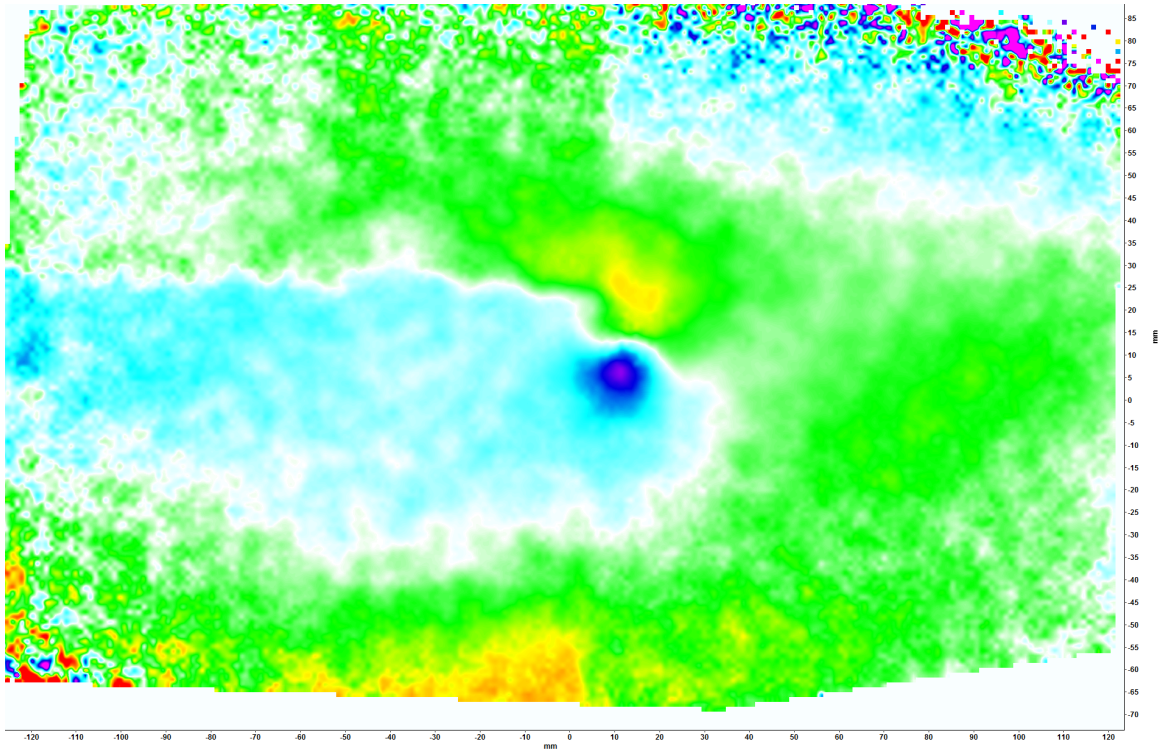
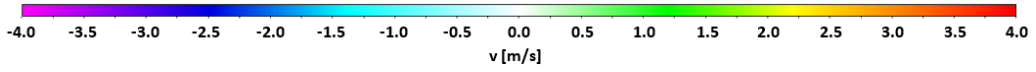


Figure 2.9: $C_L = 0.4$, $x = 200 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

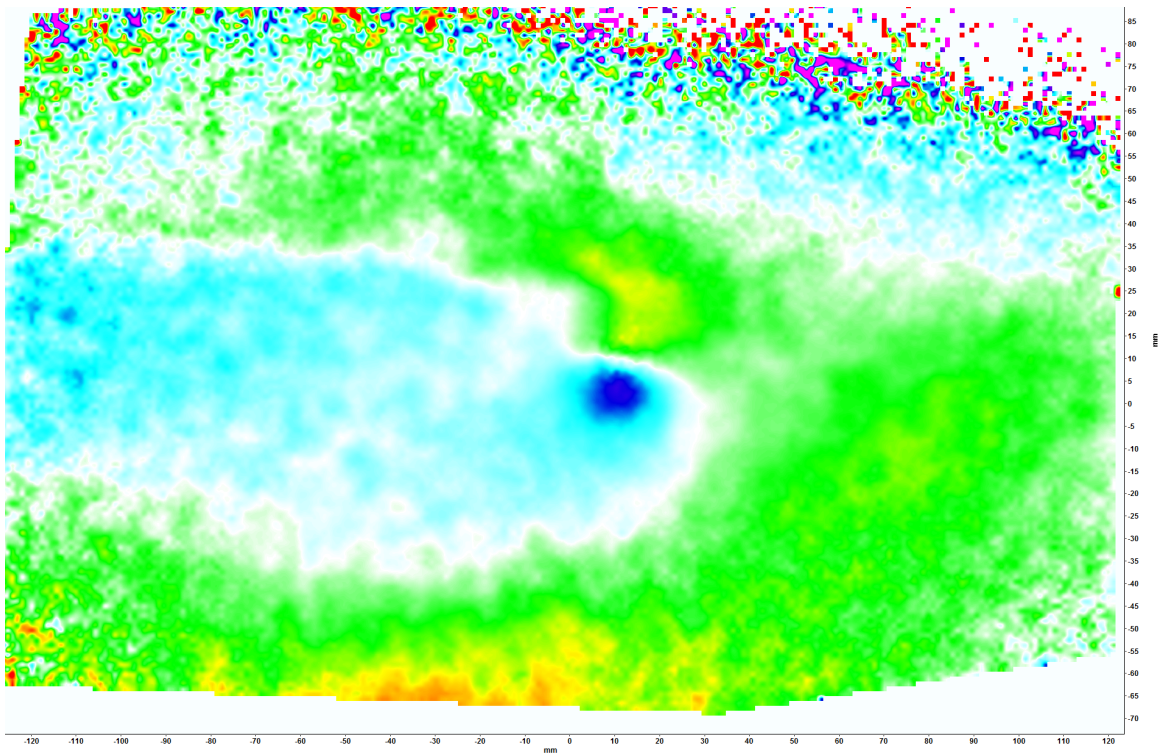


Figure 2.10: $C_L = 0.4$, $x = 350 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

2.1.3 w velocity component

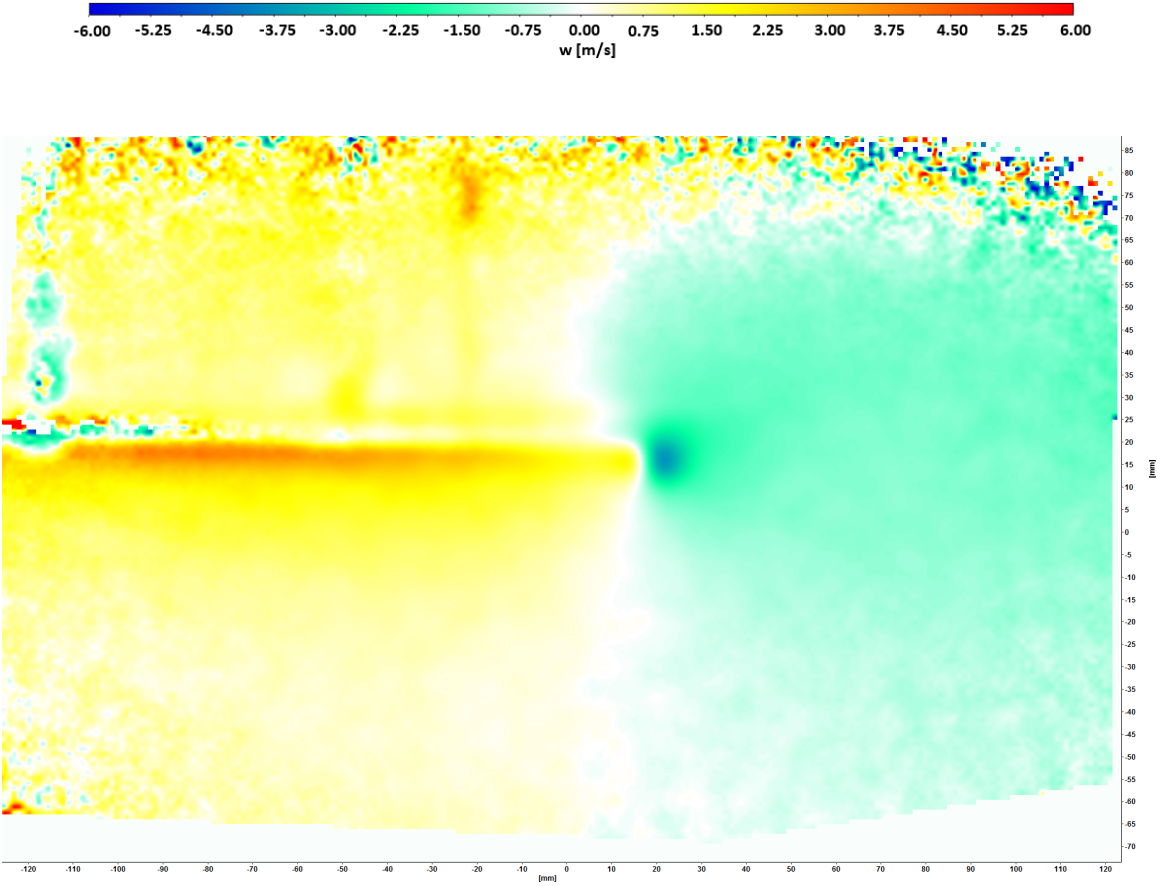


Figure 2.11: $C_L = 0.4$, $x = 10^{-3}$ [m] from trailing edge, elliptical wing

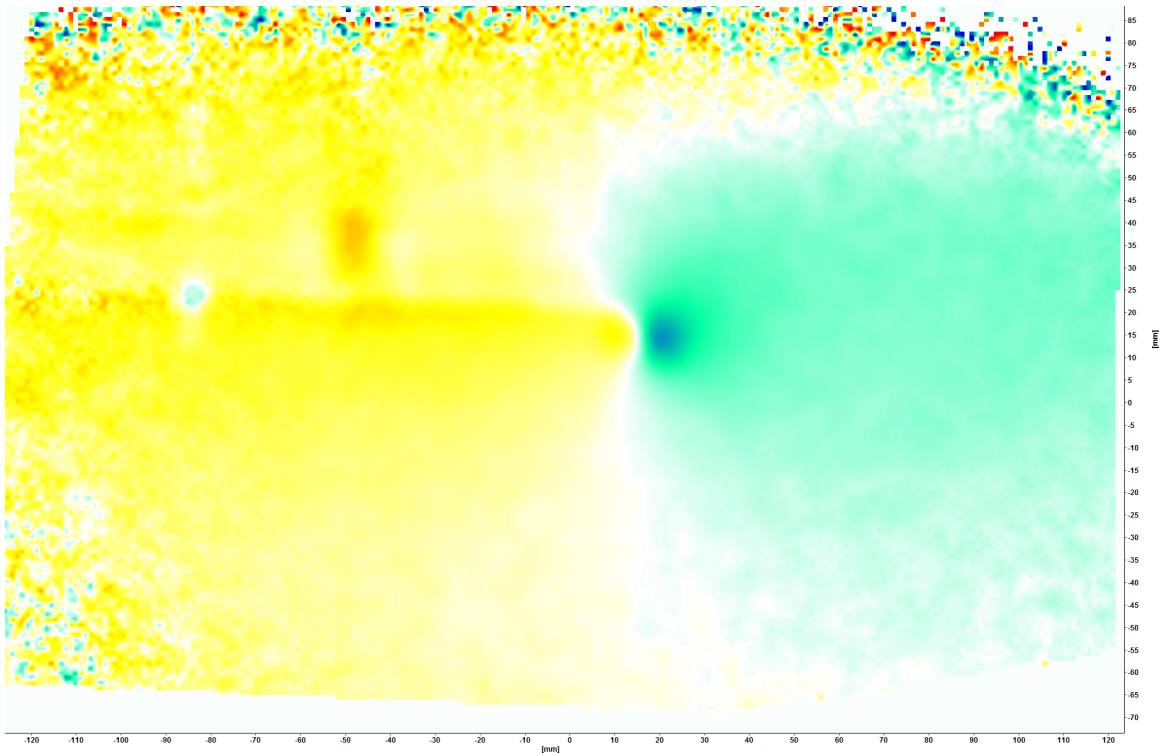
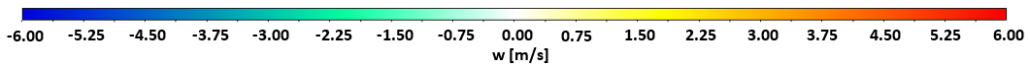


Figure 2.12: $C_L = 0.4$, $x = 50 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

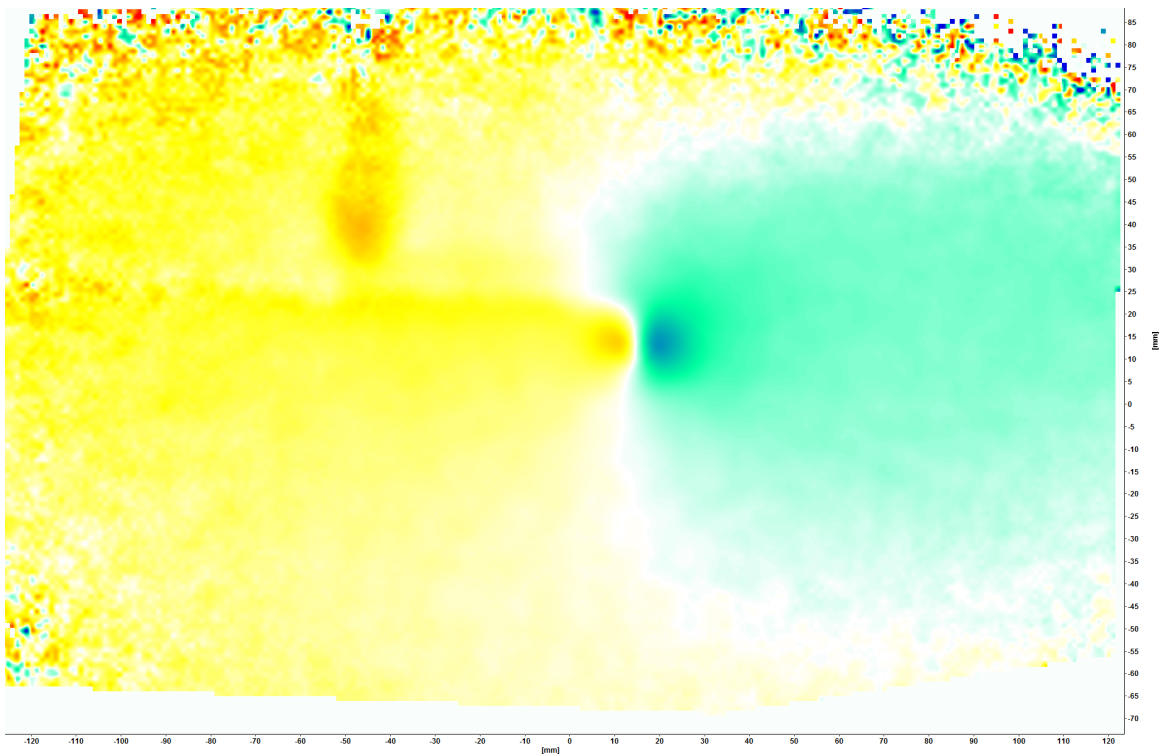


Figure 2.13: $C_L = 0.4$, $x = 100 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

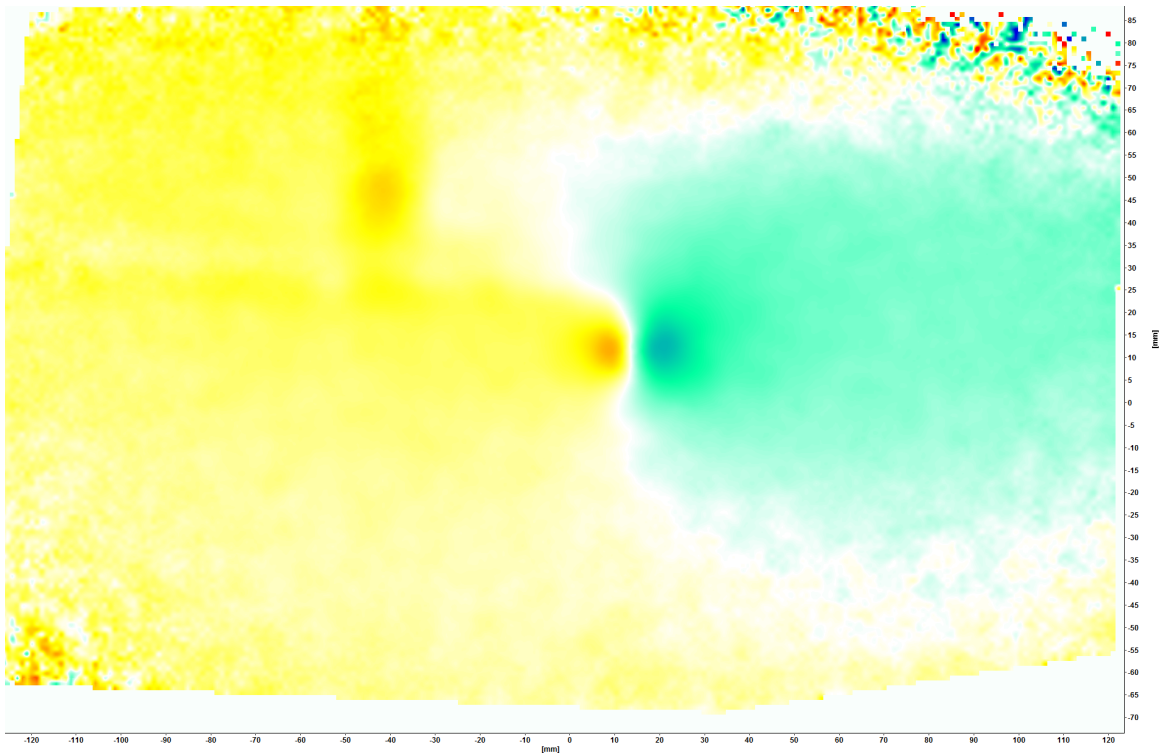
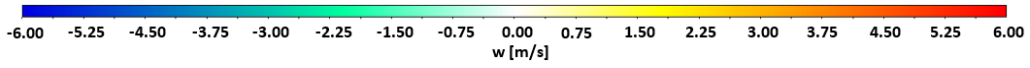


Figure 2.14: $C_L = 0.4$, $x = 200 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

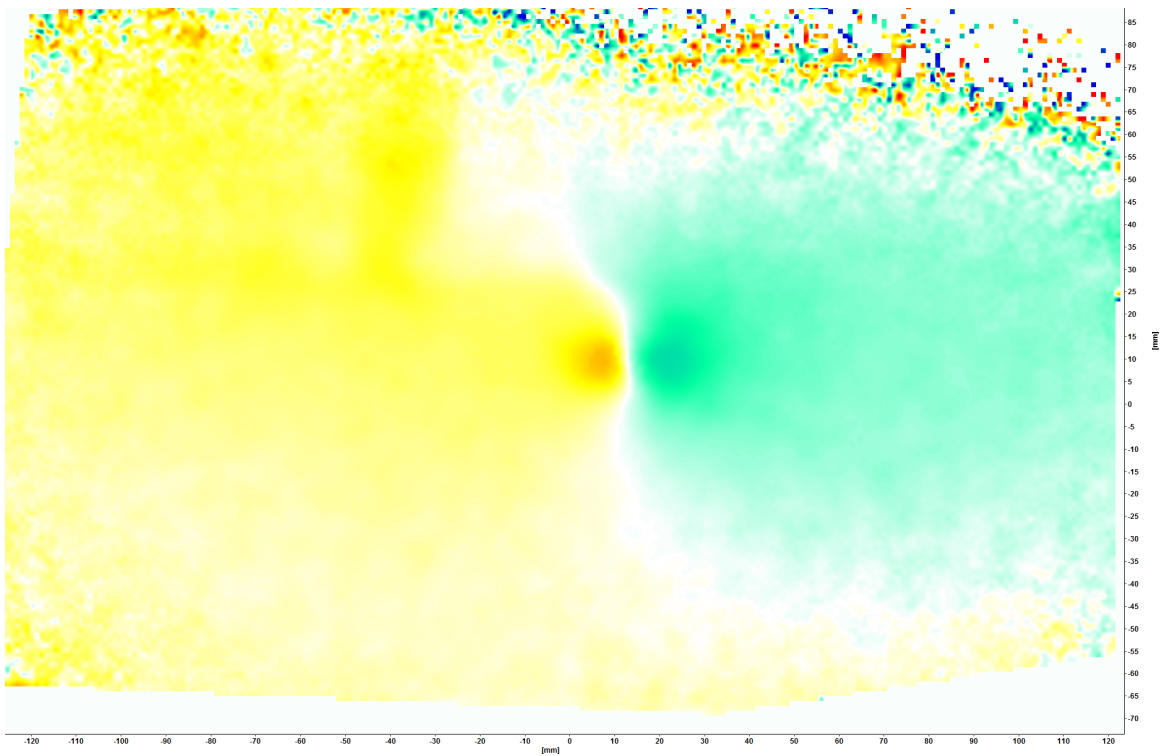


Figure 2.15: $C_L = 0.4$, $x = 350 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

2.1.4 Vorticity ω_x

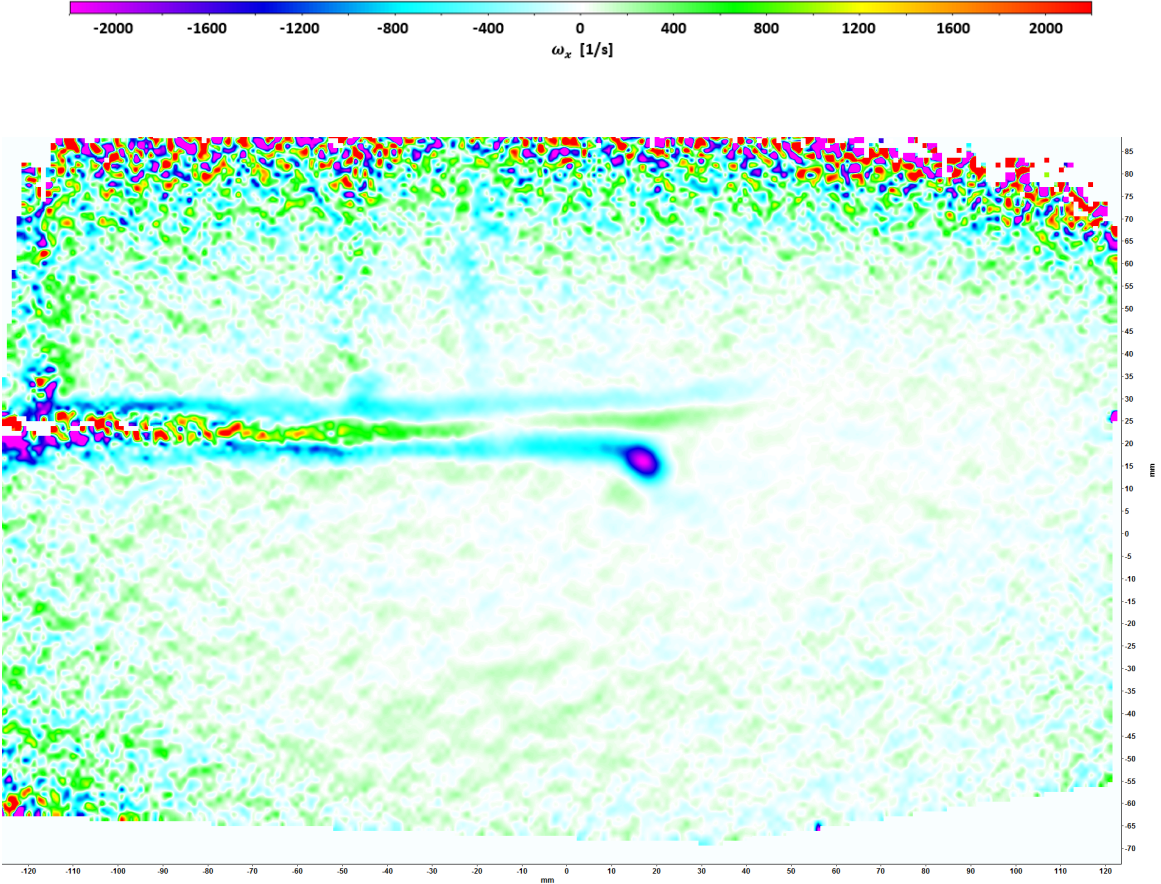


Figure 2.16: $C_L = 0.4$, $x = 10^{-3}$ [m] from trailing edge, elliptical wing

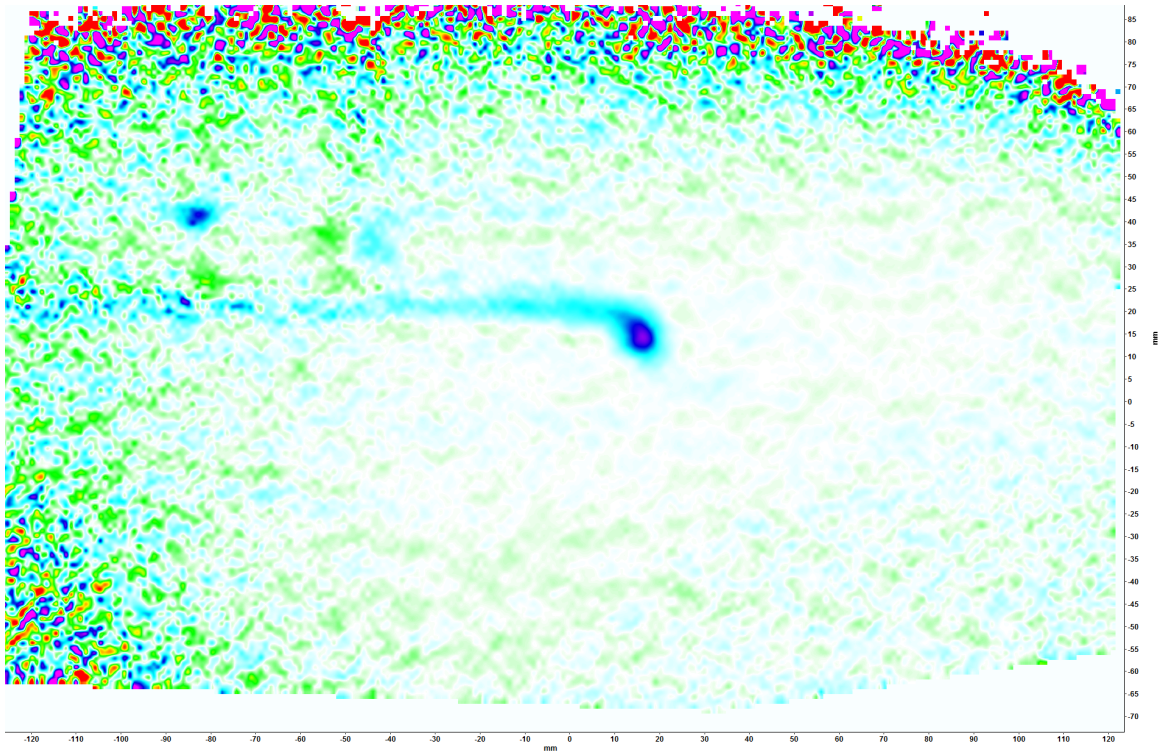
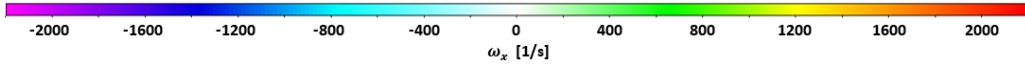


Figure 2.17: $C_L = 0.4$, $x = 50 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

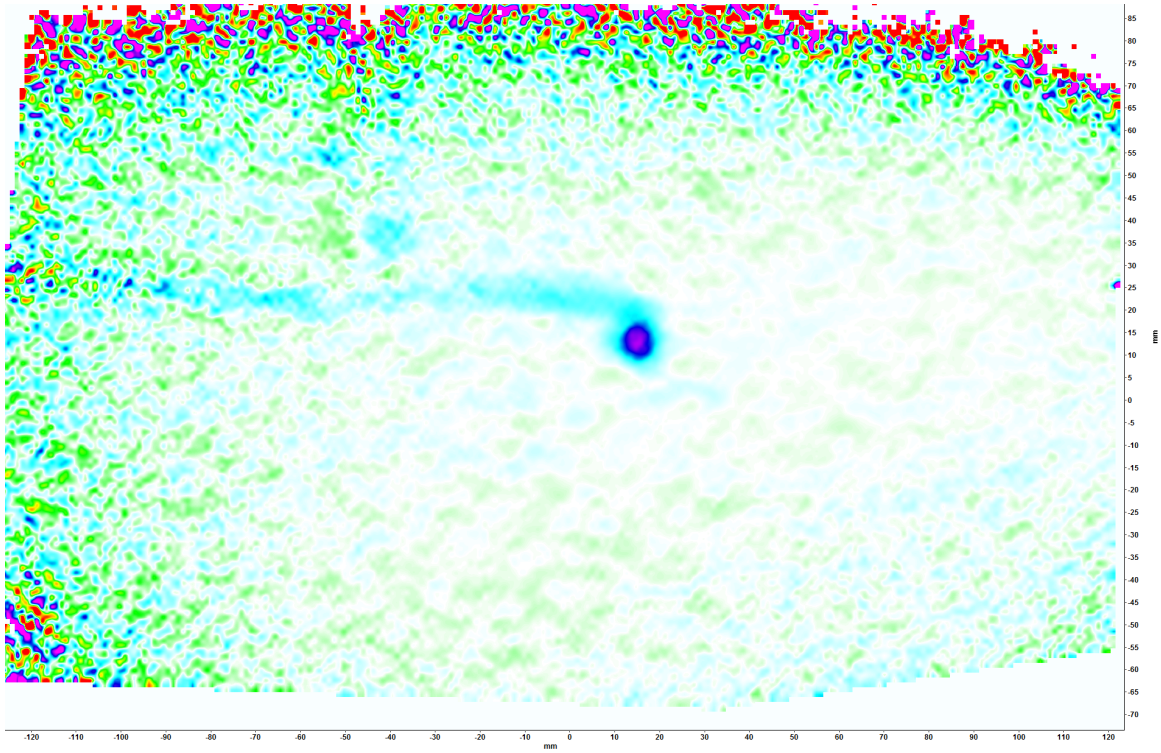


Figure 2.18: $C_L = 0.4$, $x = 100 \cdot 10^{-3} [m]$ from trailing edge, elliptical wing

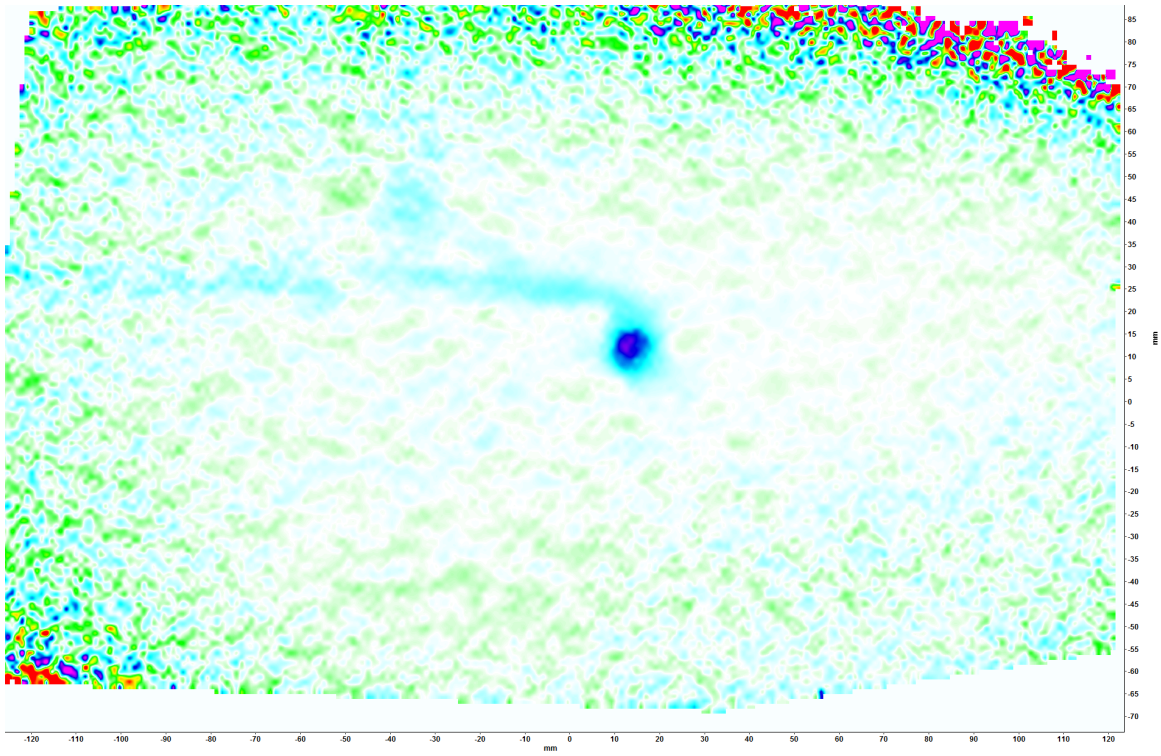
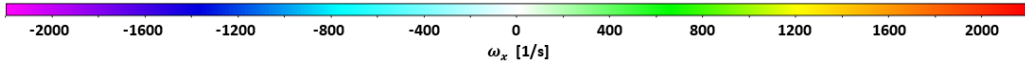


Figure 2.19: $C_L = 0.4$, $x = 200 \cdot 10^{-3} \text{ [m]}$ from trailing edge, elliptical wing

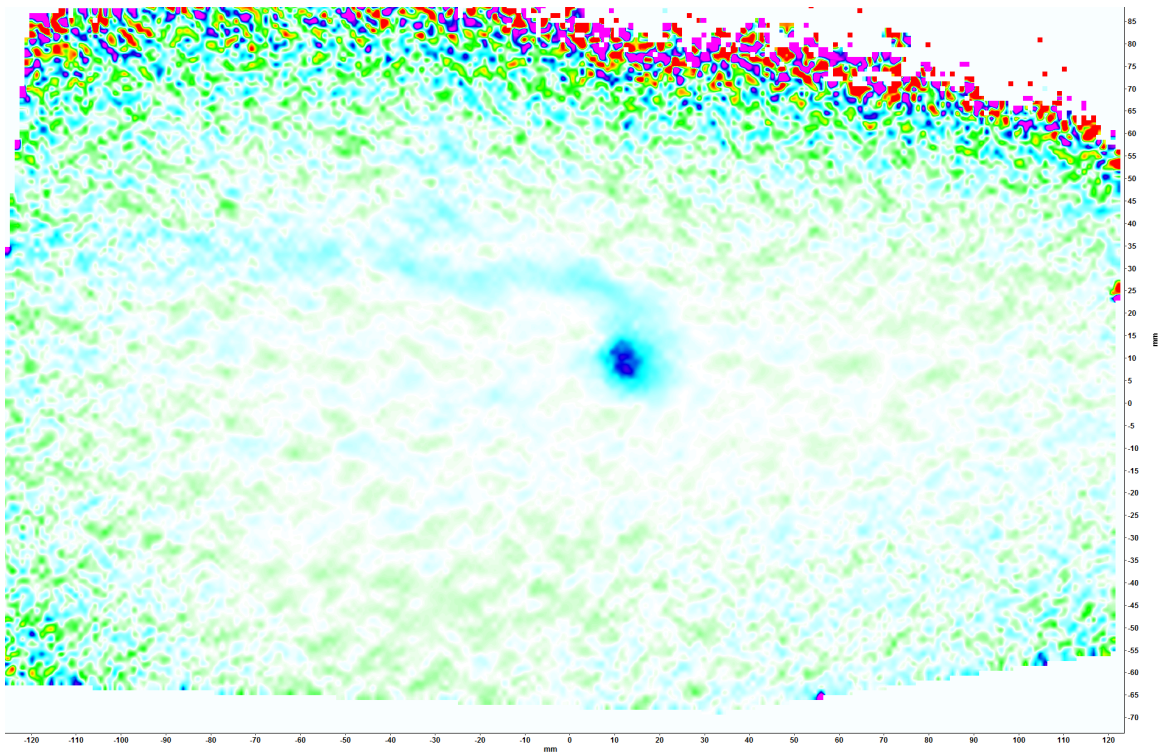


Figure 2.20: $C_L = 0.4$, $x = 350 \cdot 10^{-3} \text{ [m]}$ from trailing edge, elliptical wing