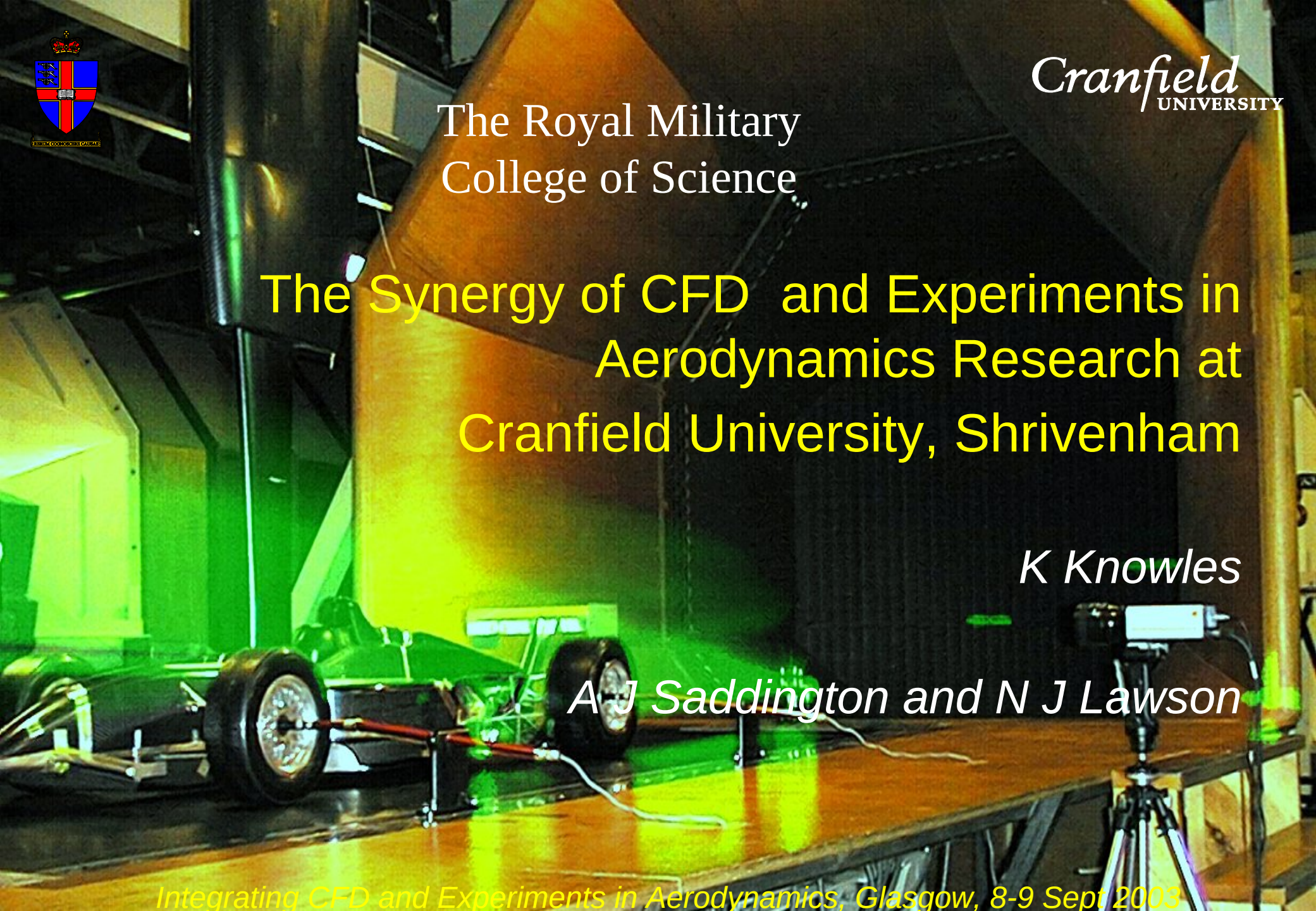

The Royal Military College of Science

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The Synergy of CFD and Experiments in Aerodynamics Research at Cranfield University, Shrivenham

K Knowles

A J Saddington and N J Lawson

Integrating CFD and Experiments in Aerodynamics, Glasgow, 8-9 Sept 2003

Overview

- Jet aerodynamics
- Transonic cavity flows
- Racing car wheel flows

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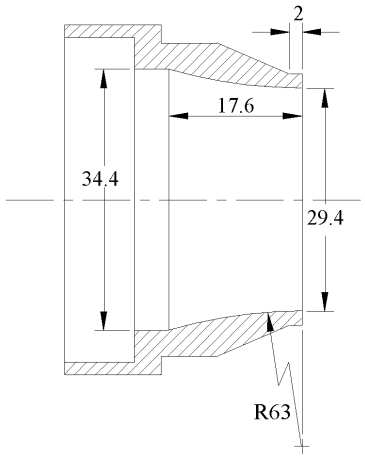
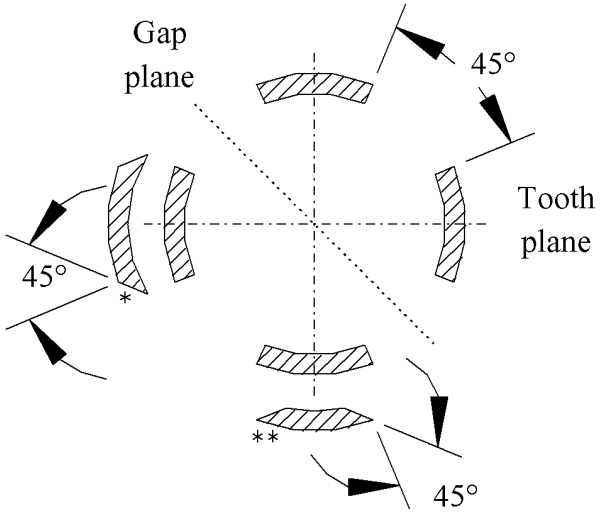
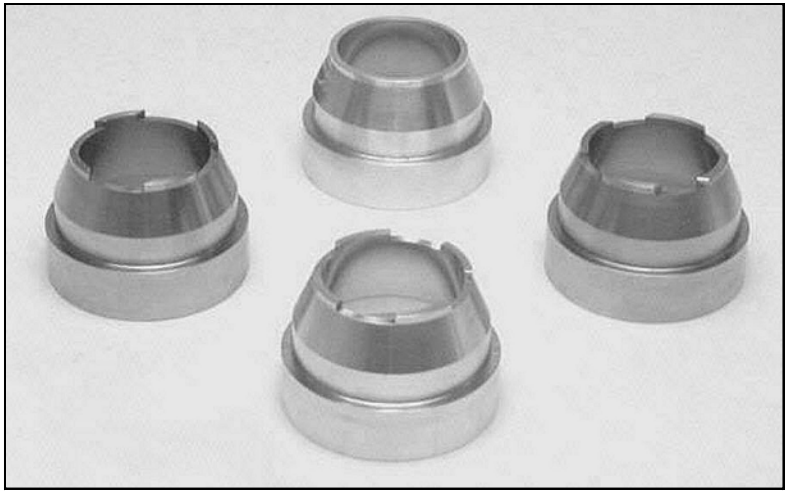
High-speed jet research







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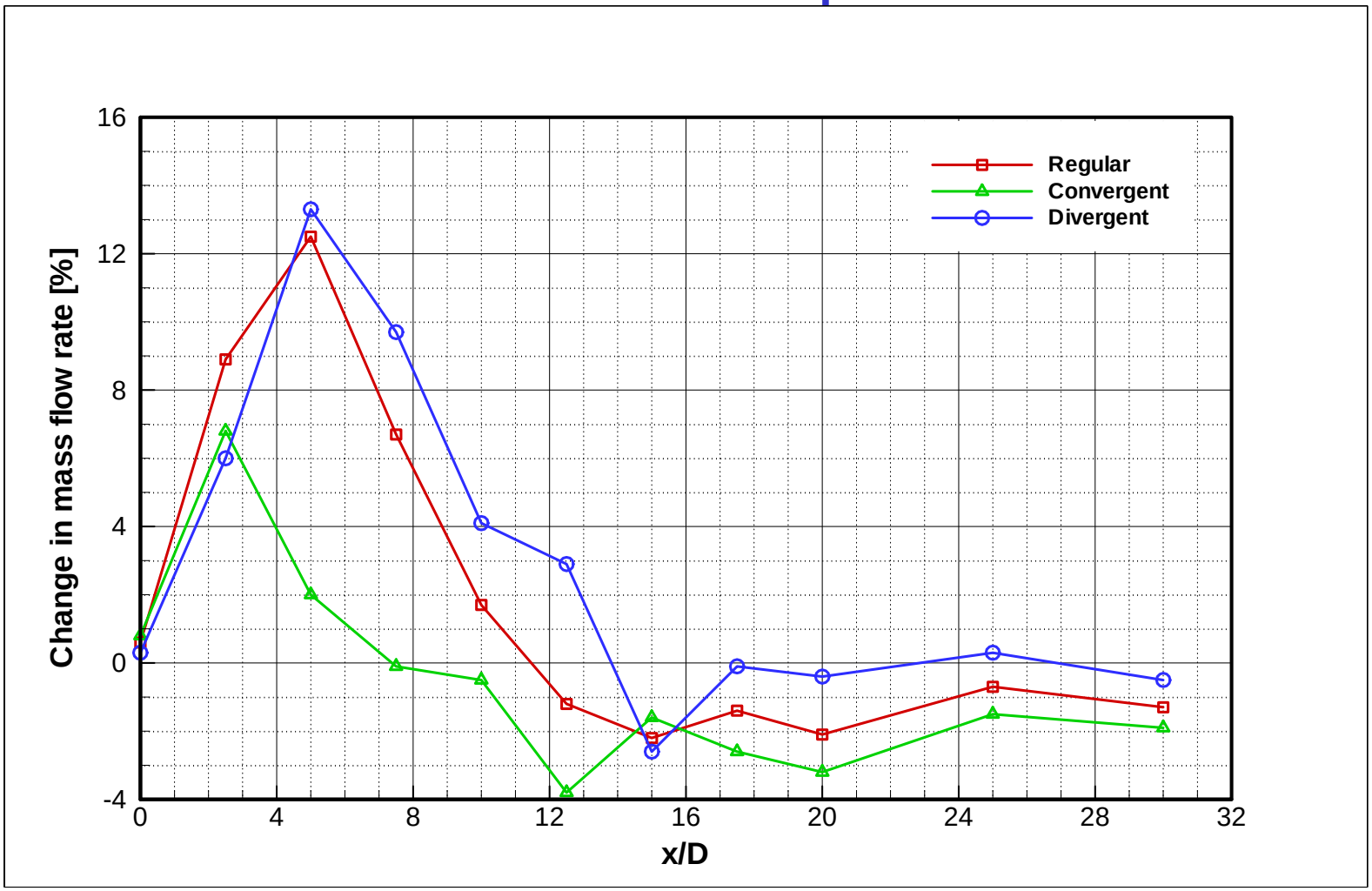
CFD-predicted nozzle mass flow rates vs streamwise position



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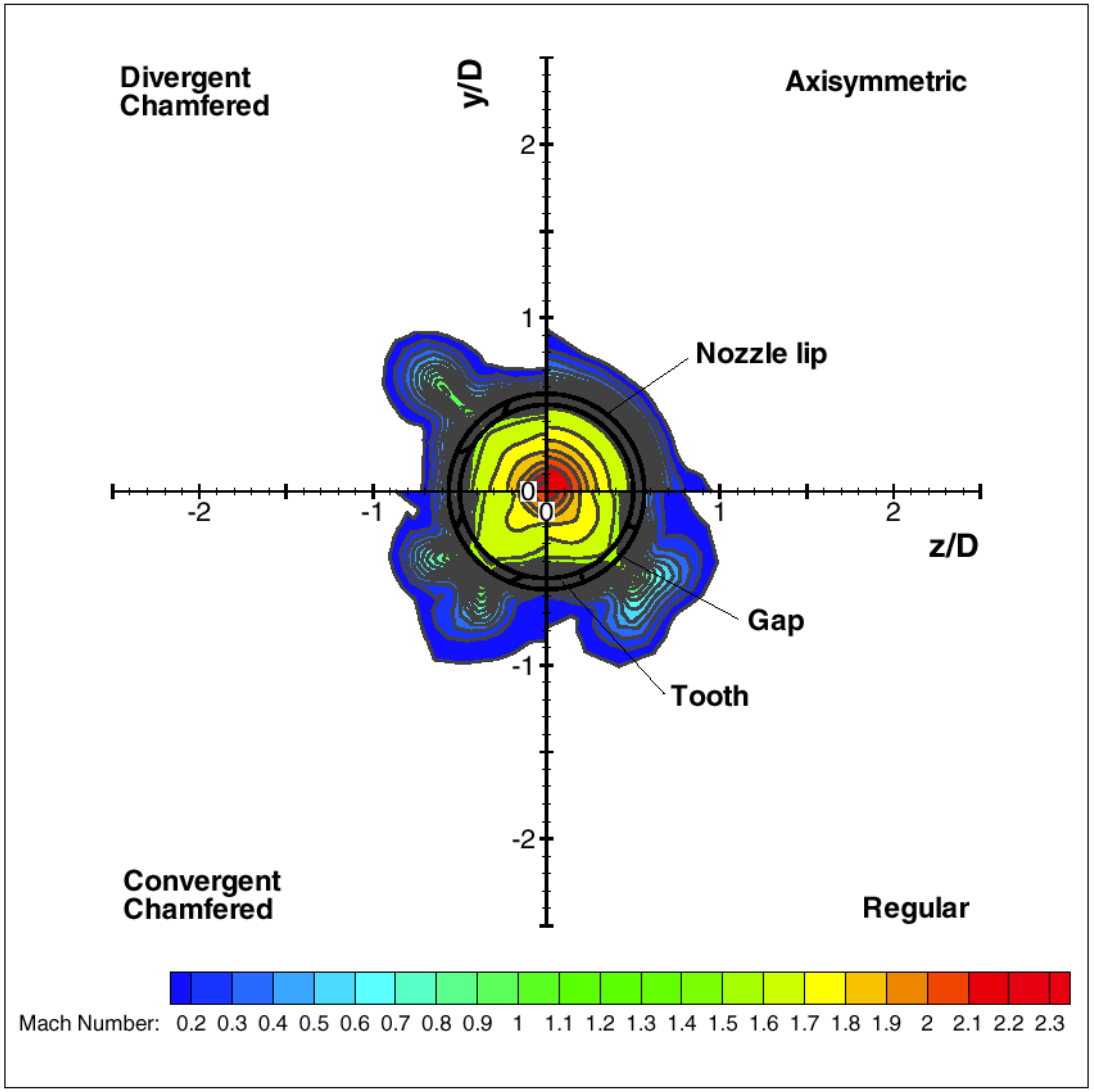
Mach no contours x/D=2.5



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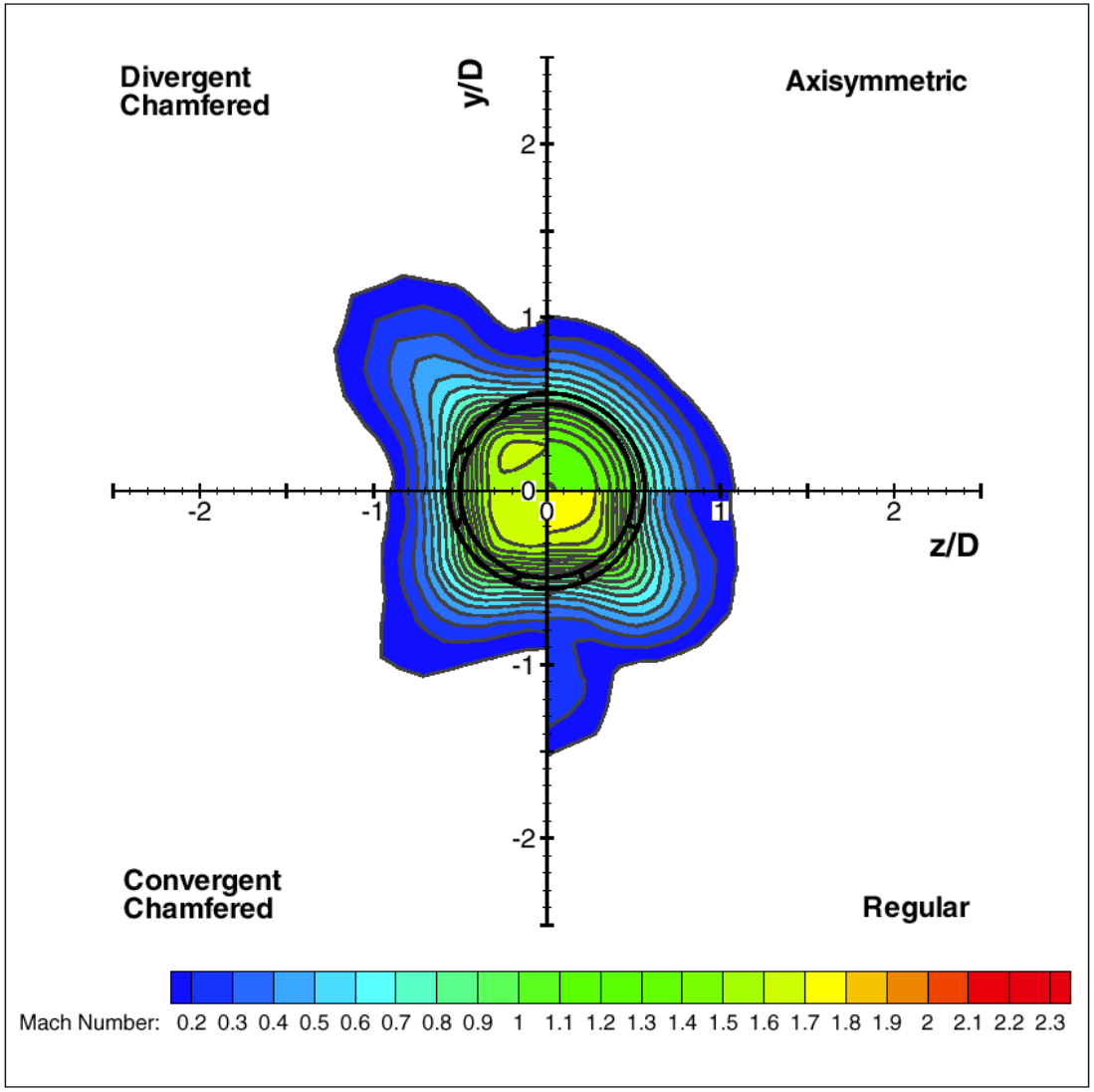
Mach no contours x/D=5



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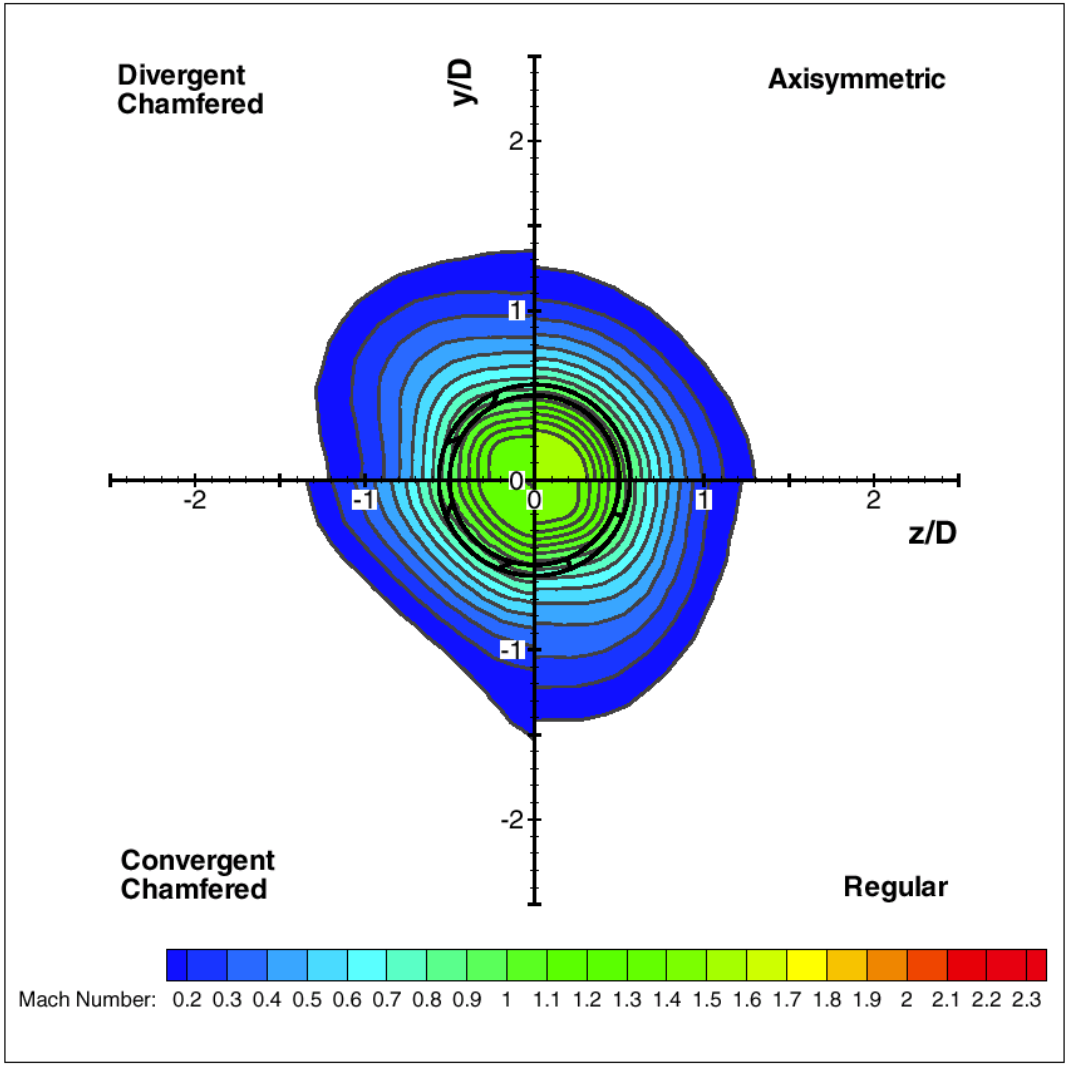
Mach no contours x/D=7.5



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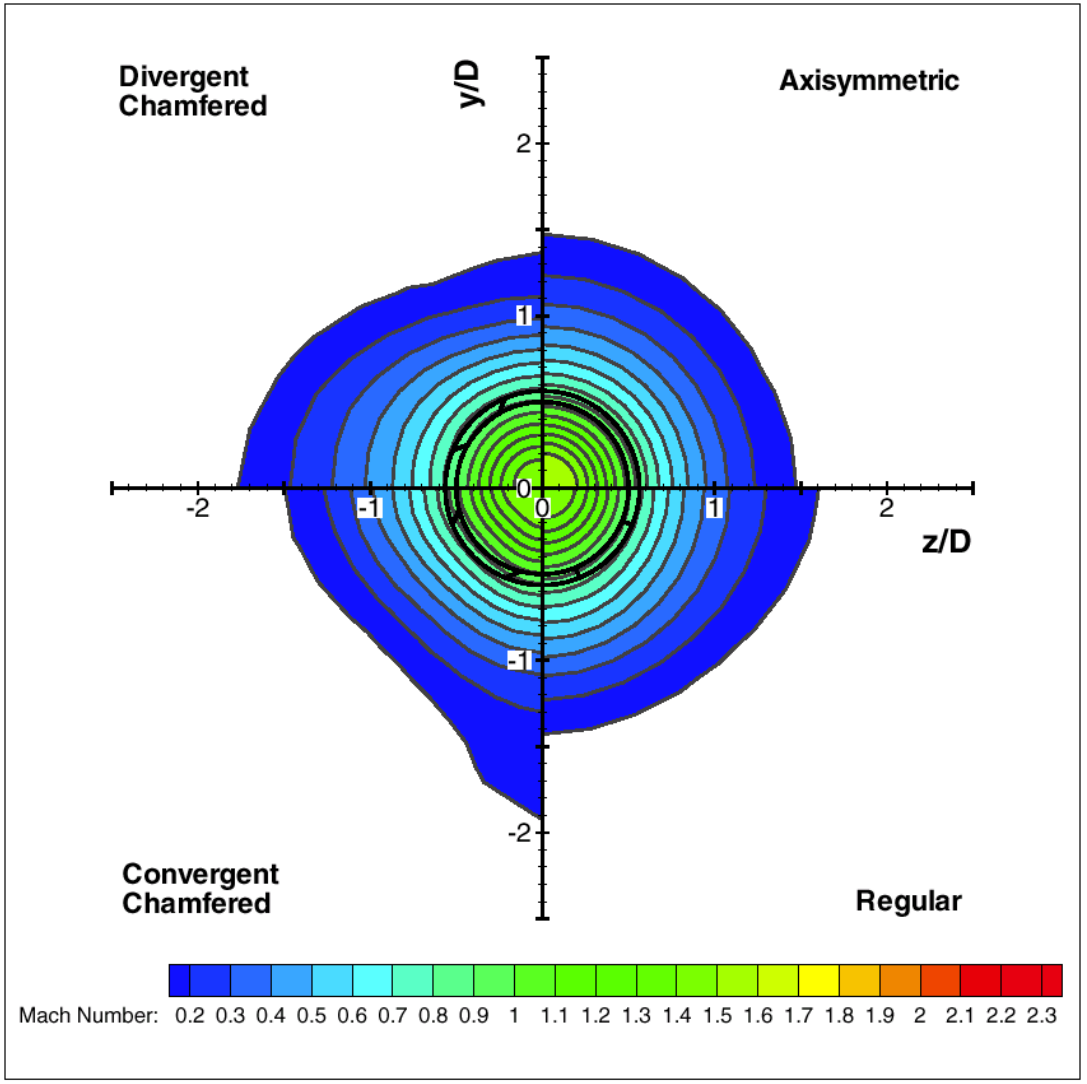
Mach no contours x/D=10



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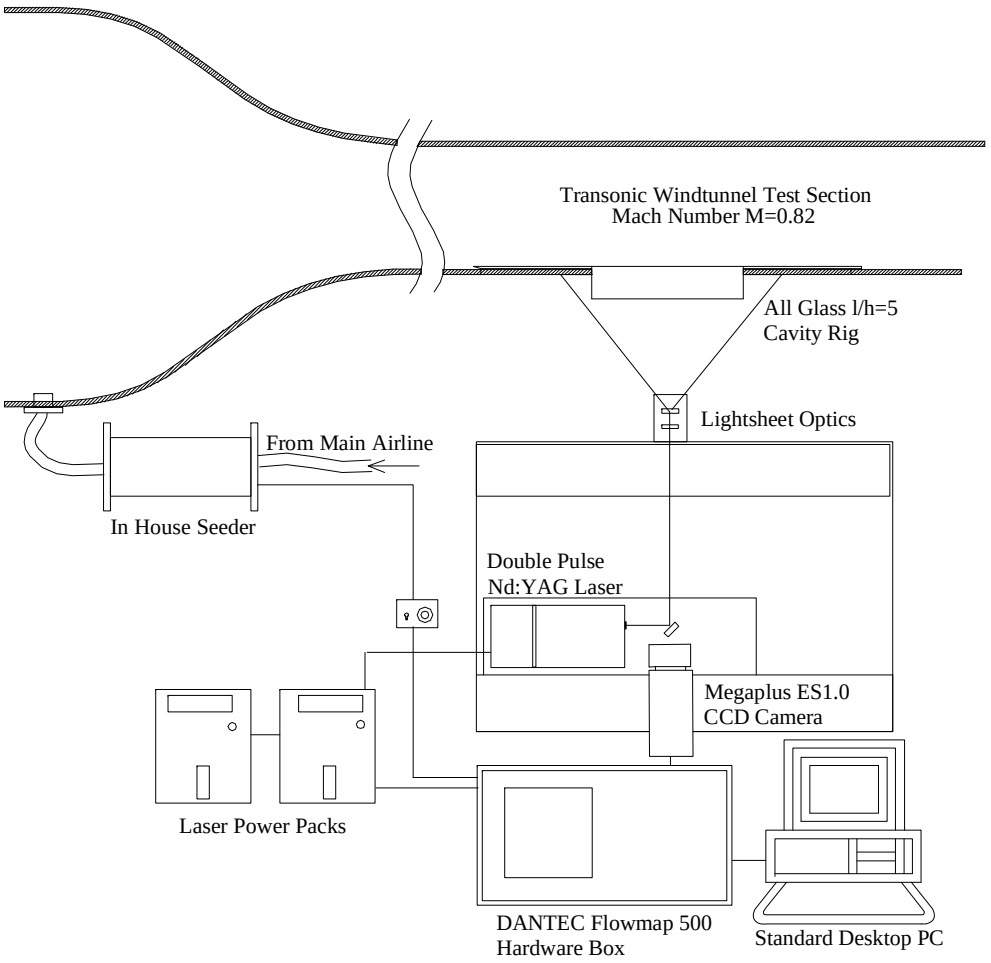
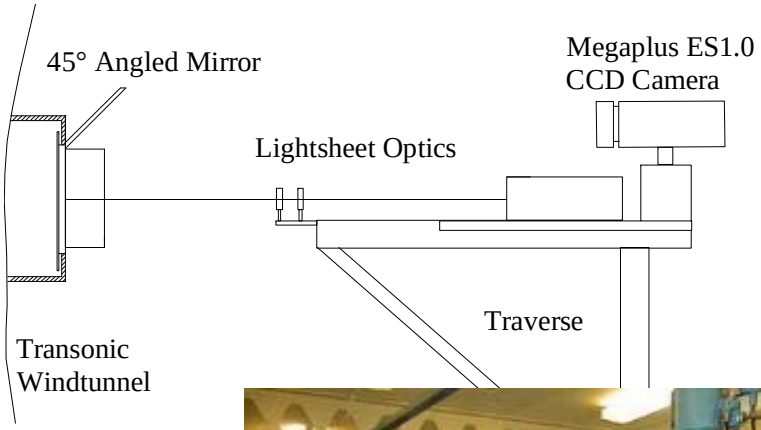
Transonic cavity flow





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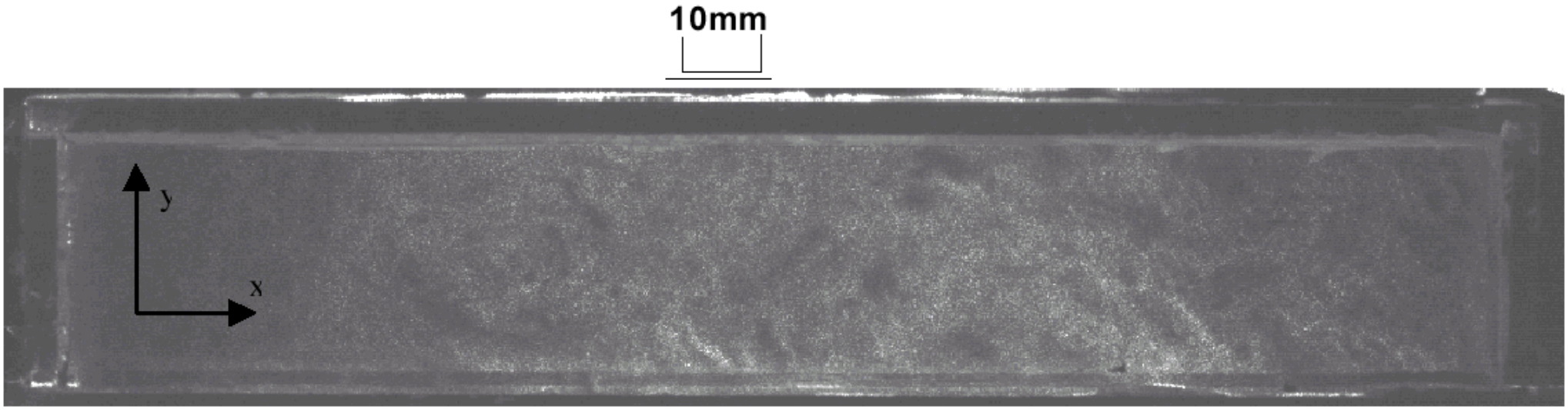
Instantaneous PIV image



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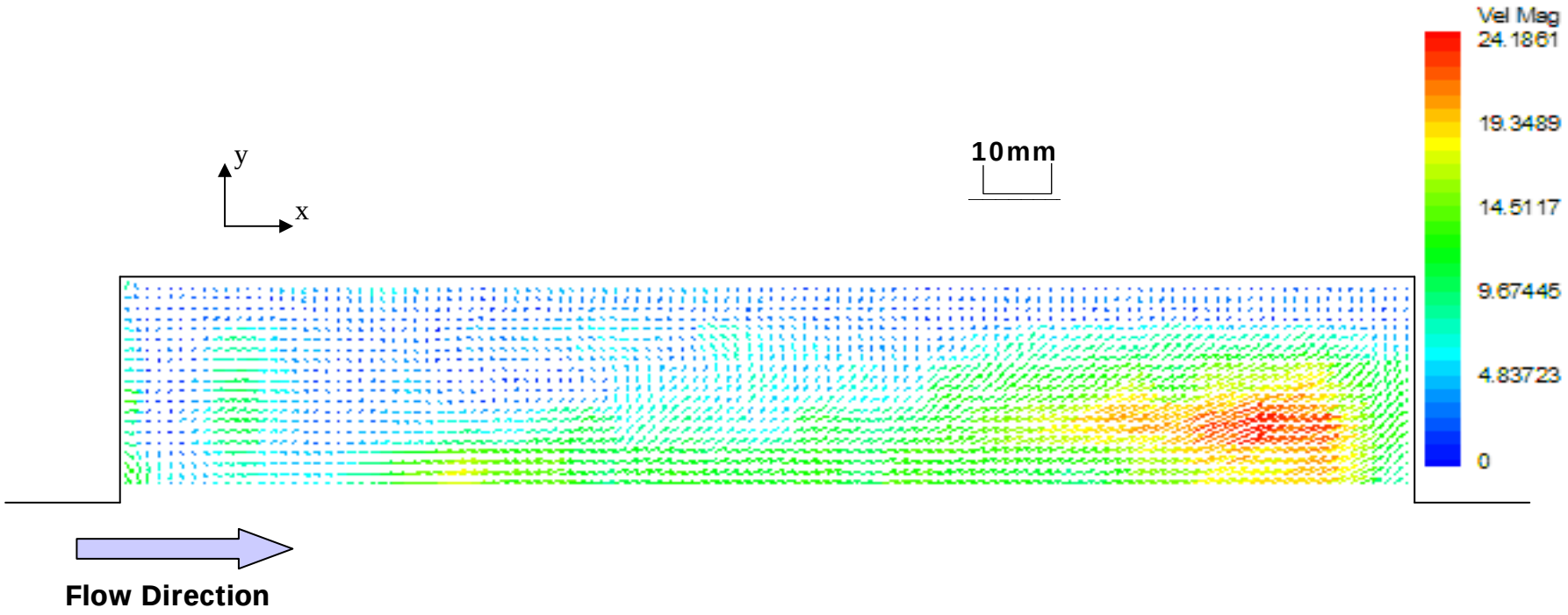
Insight softare processed PIV data



- Time averaged flow field from 70 instantaneous image pairs captured at 15Hz
- Hart algorithm used to correlate particle displacements between images
- Data suffers from poor signal to noise ratio especially near to cavity walls

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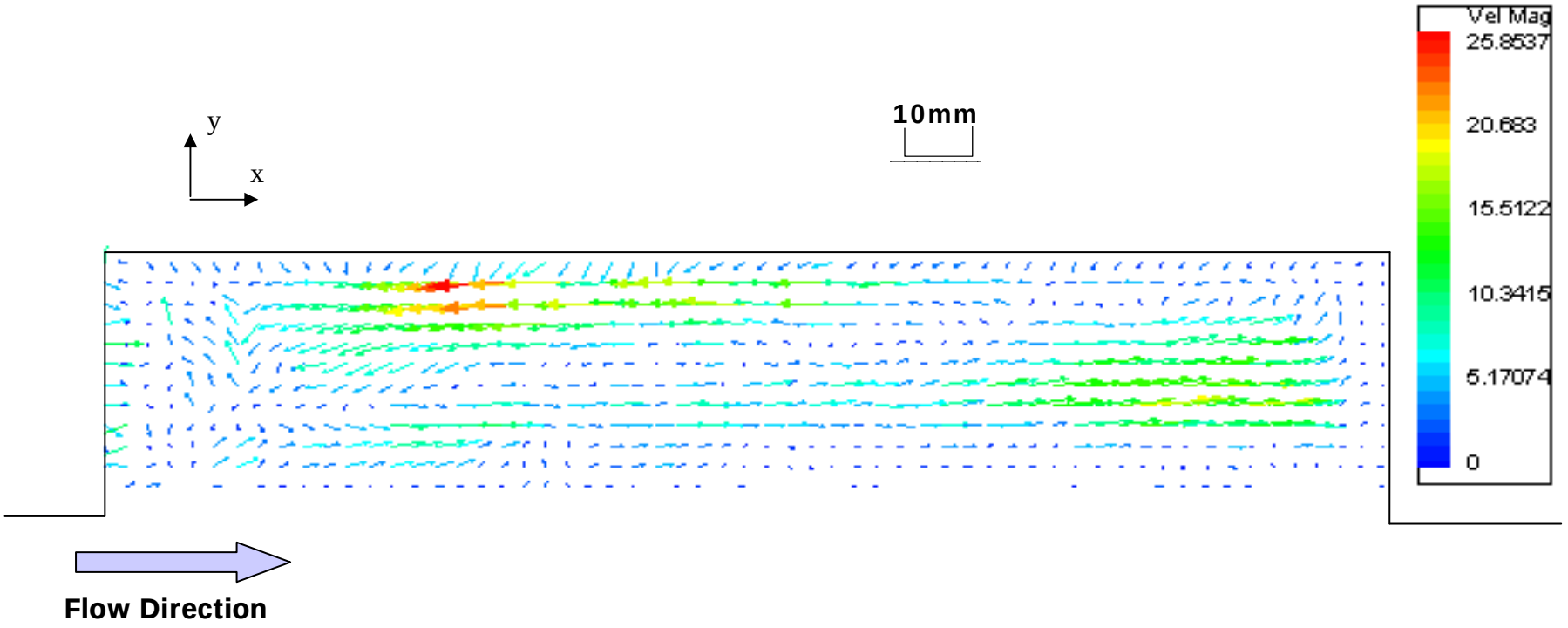
In-house code processed PIV data



- In house developed correlation algorithm proposed by Meinhart *et al* [2000]
- Correlation peak averaging technique rather than flow field averaging technique
- Technique offers greatly increased signal to noise ratio

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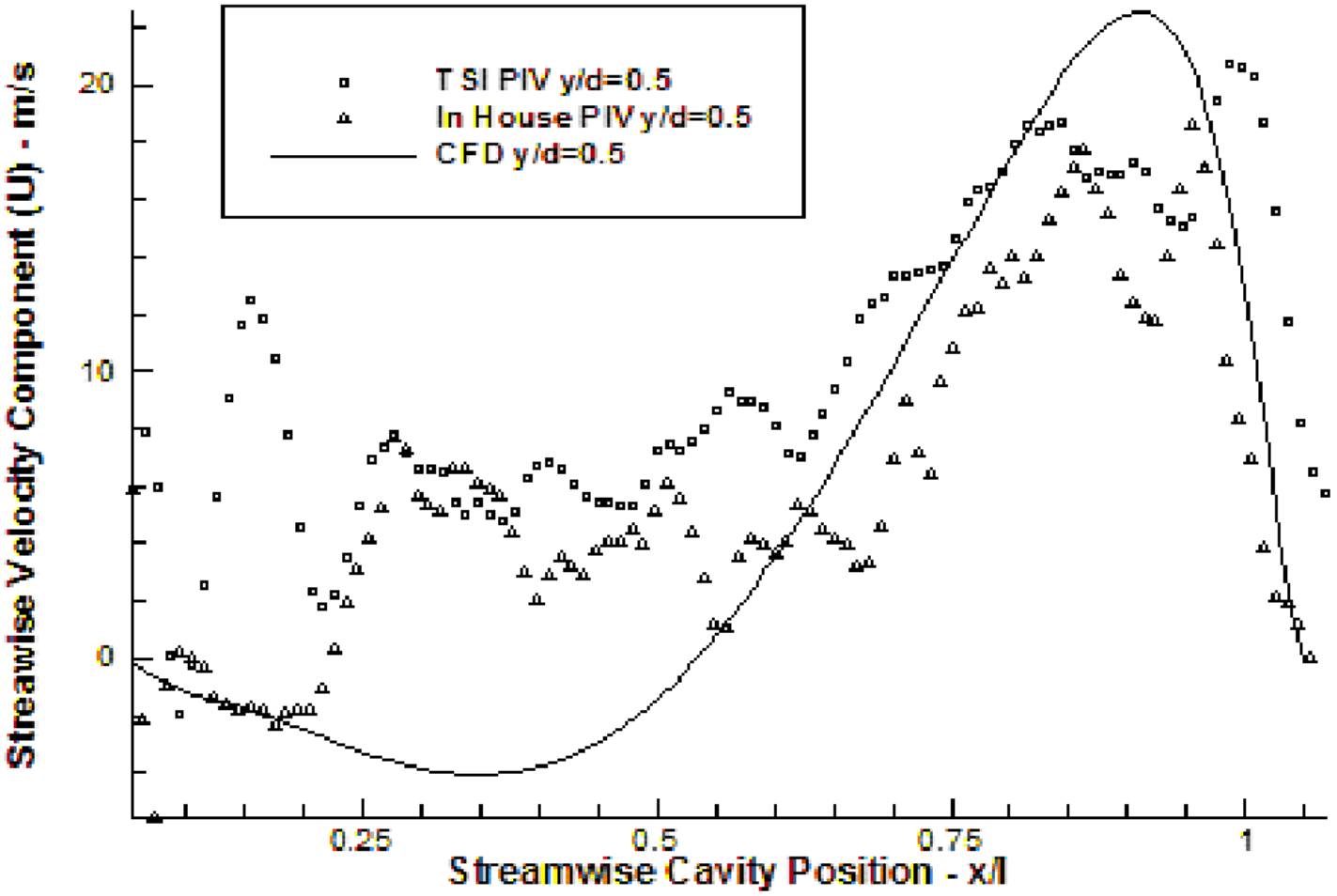
Streamwise velocity profiles



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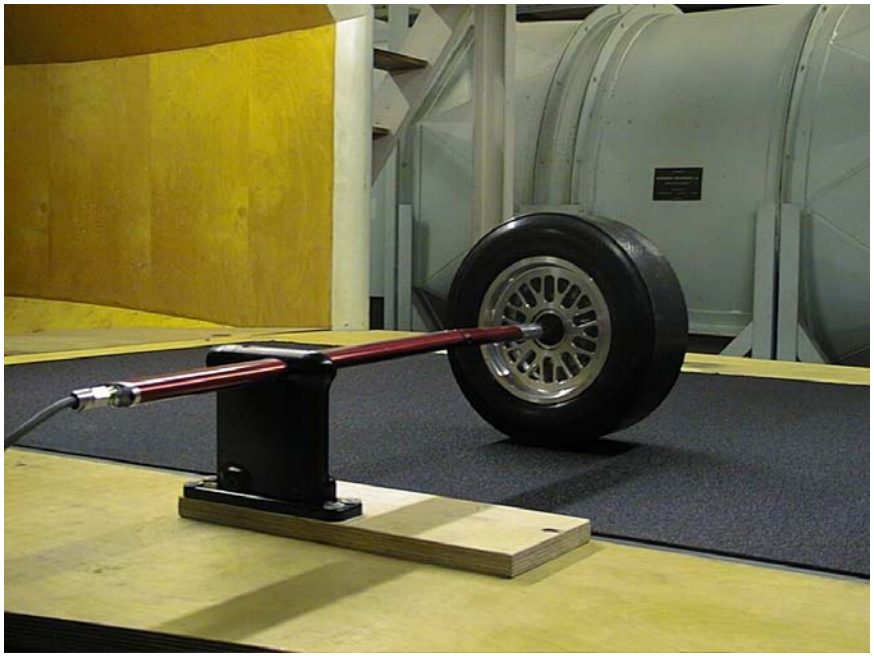
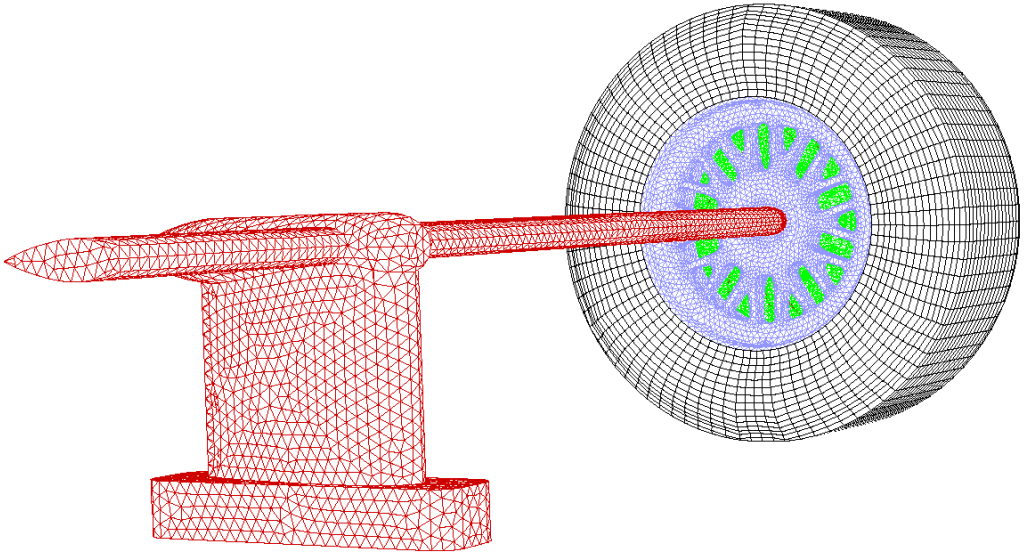
Open-wheeled racing cars





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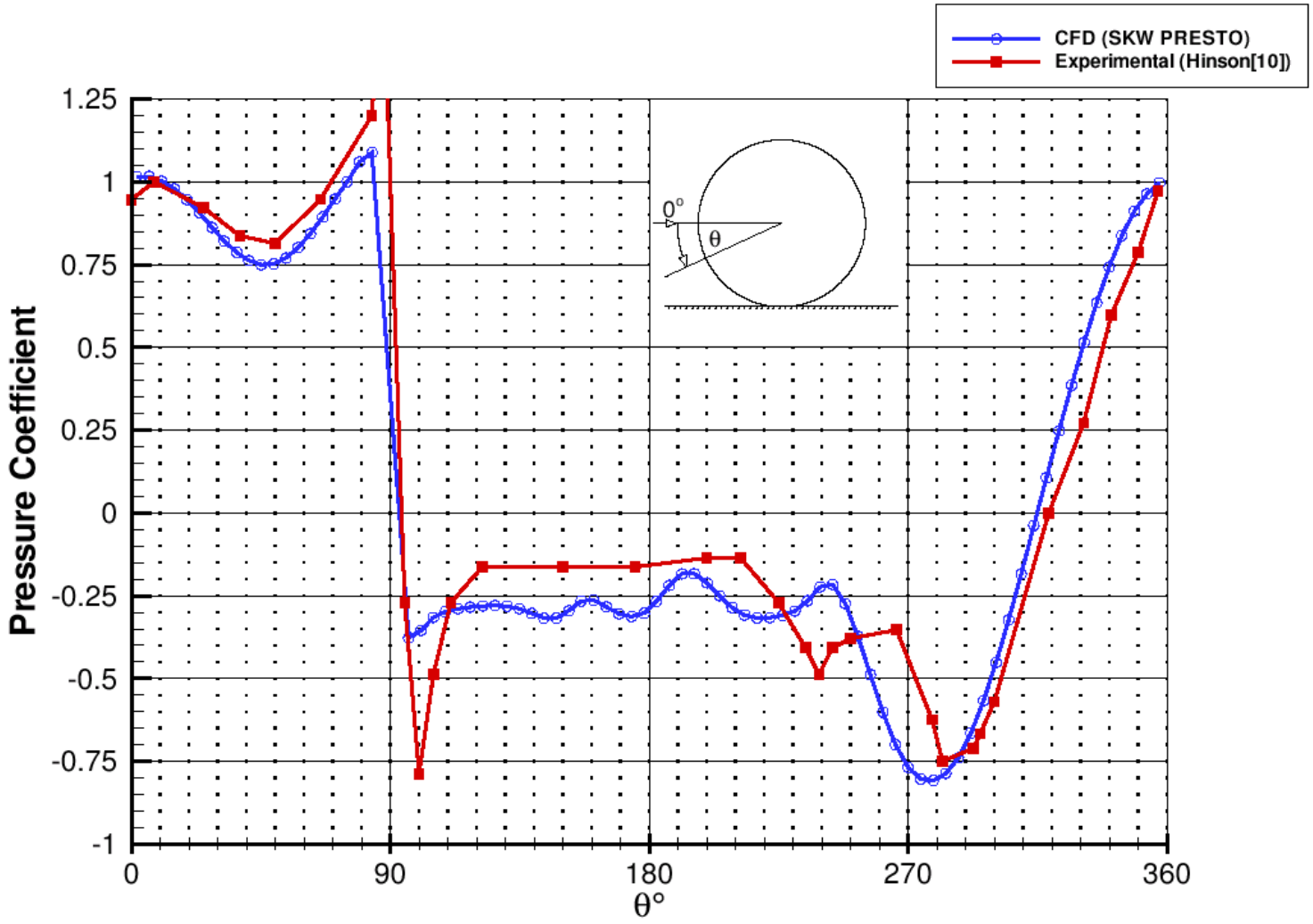
Centreline pressure distribution



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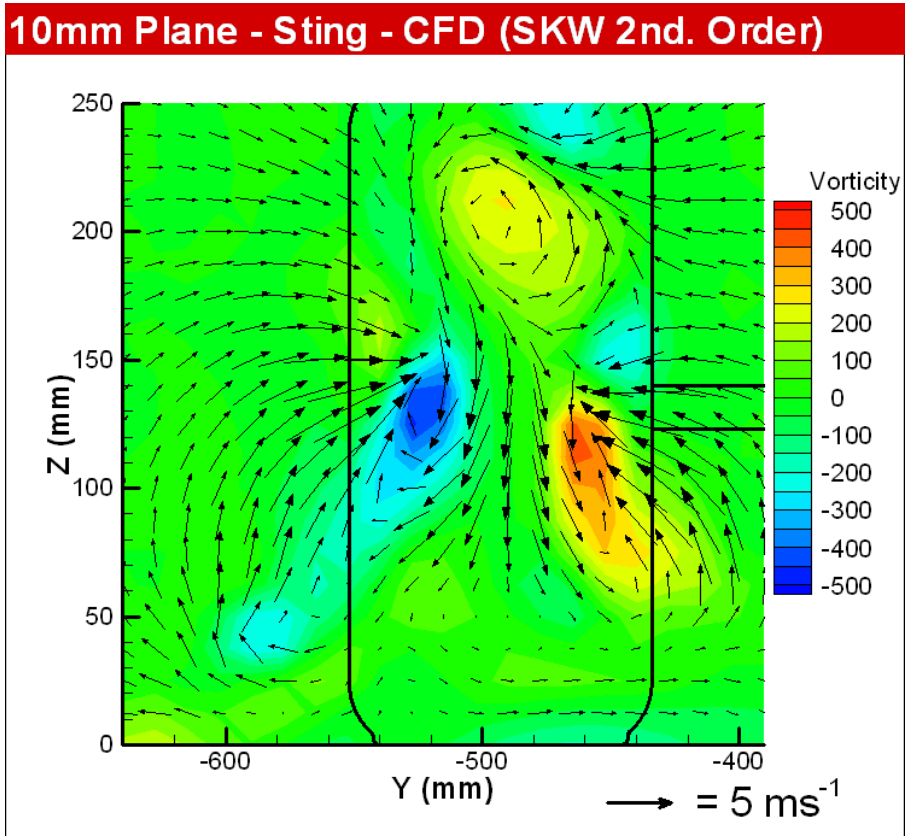
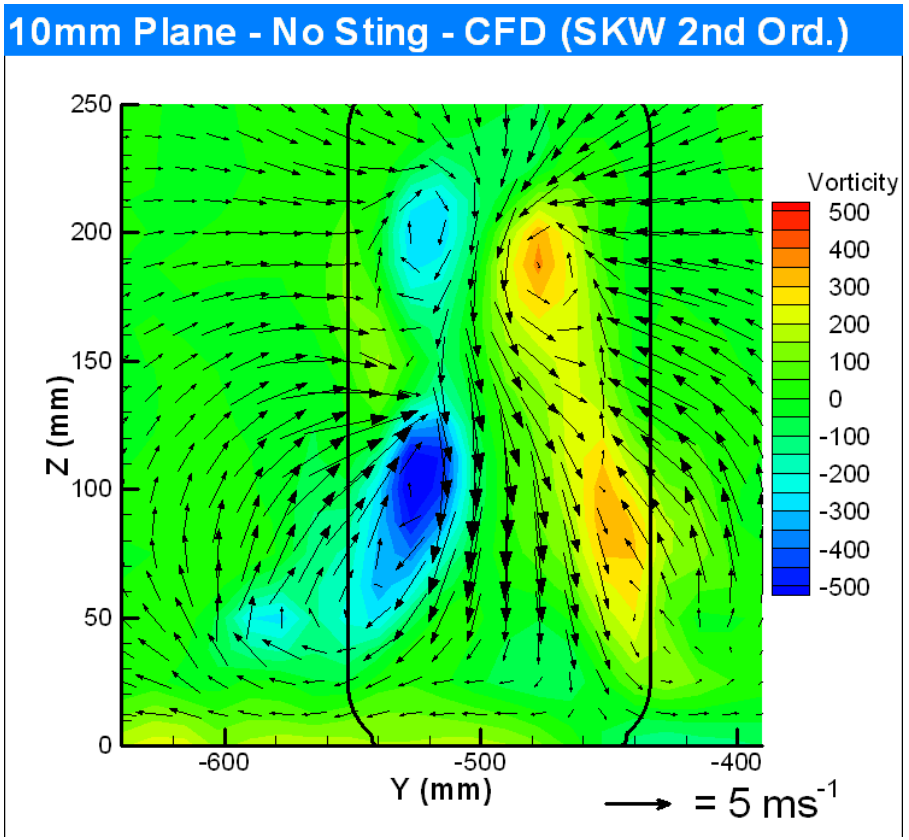
Sting vs no-sting (10mm)





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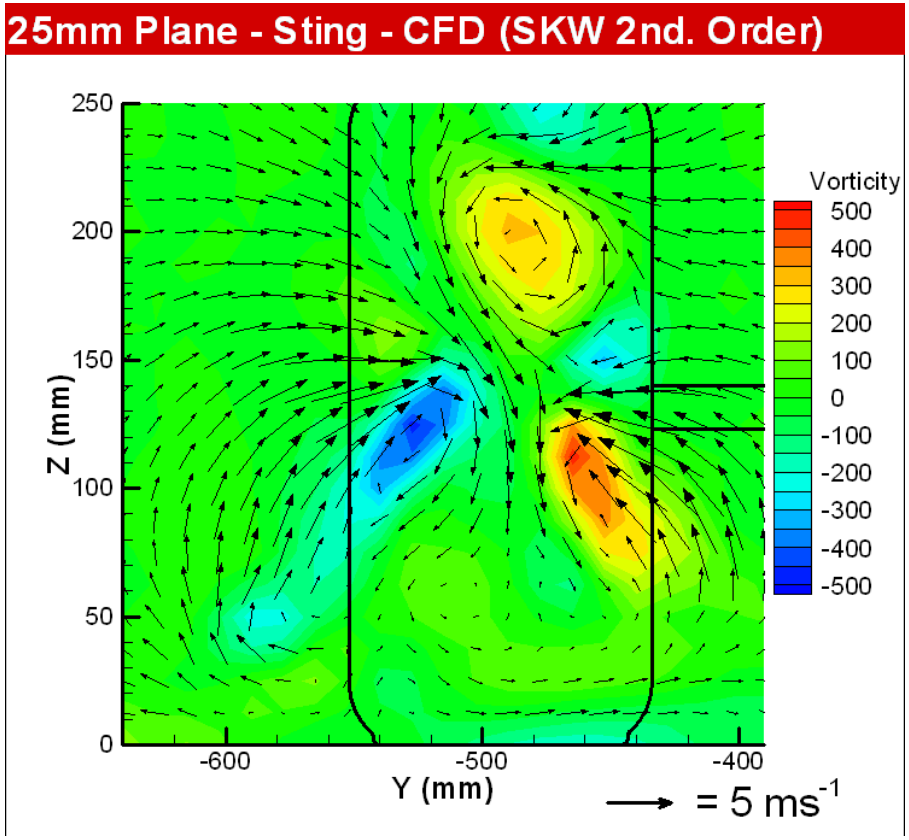
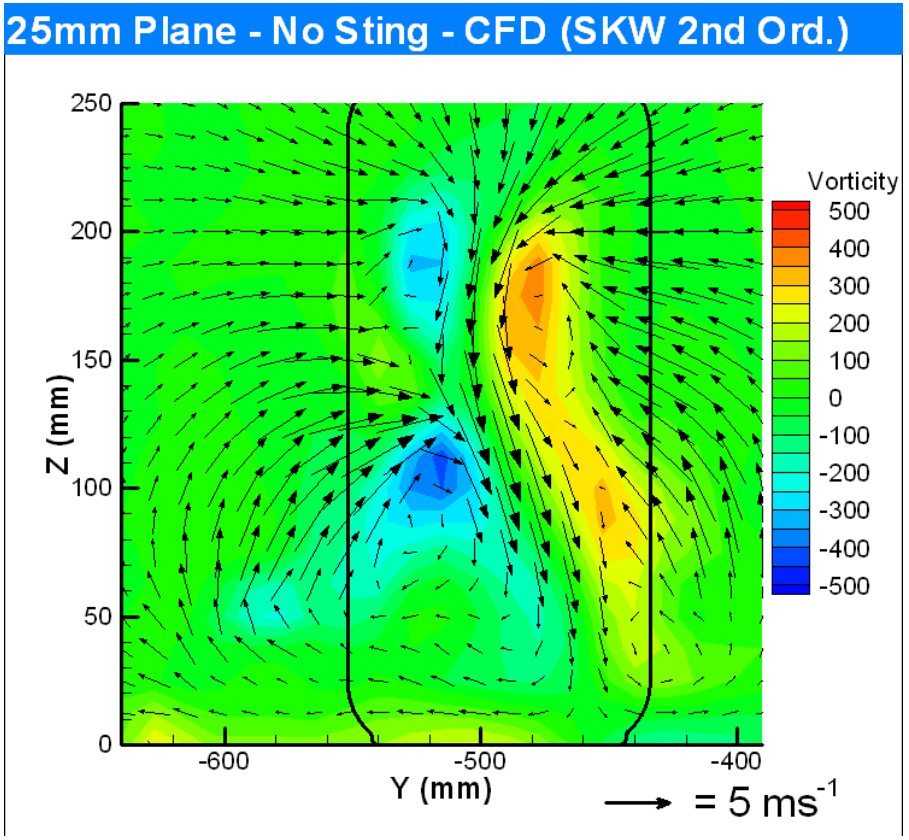
Sting vs no-sting (25mm)





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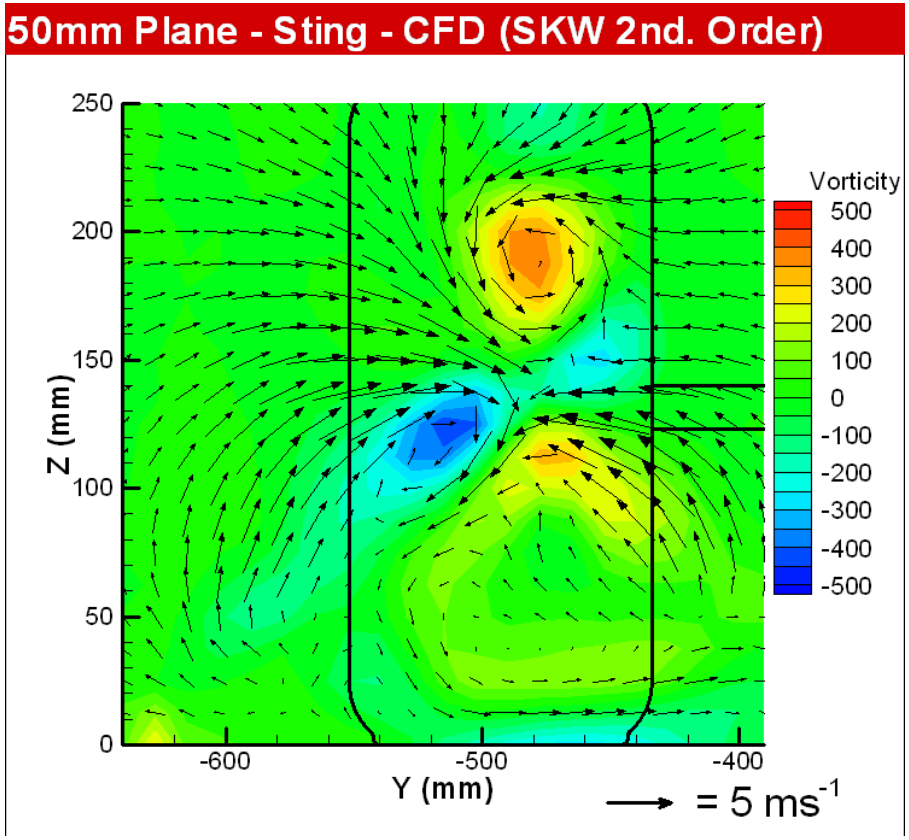
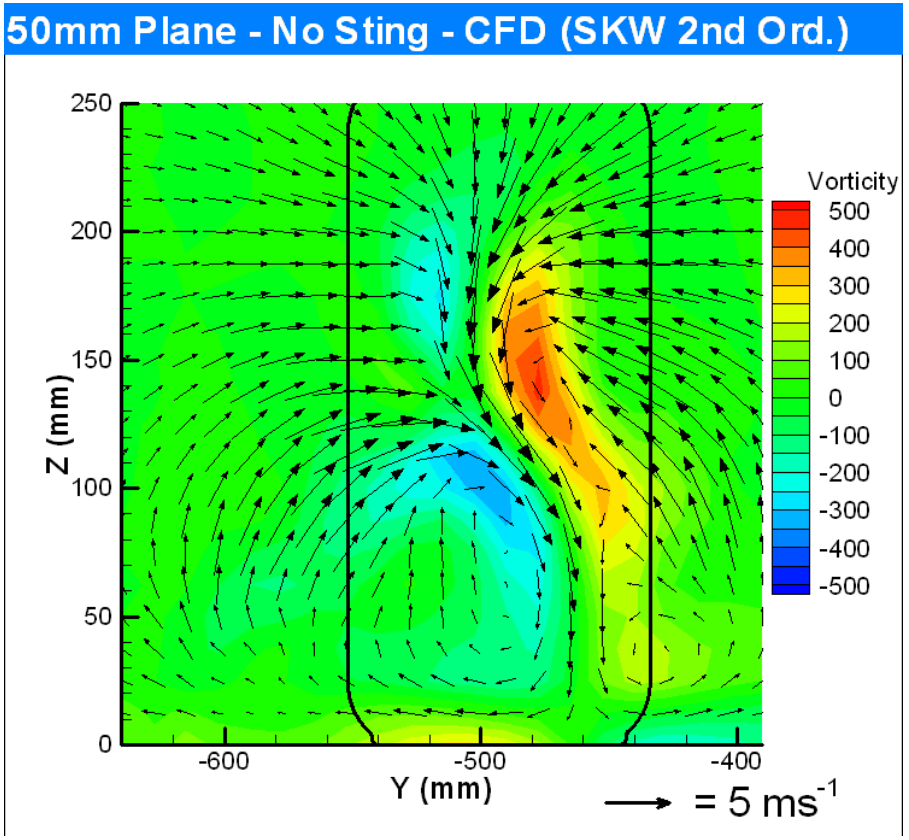
Sting vs no-sting (50mm)





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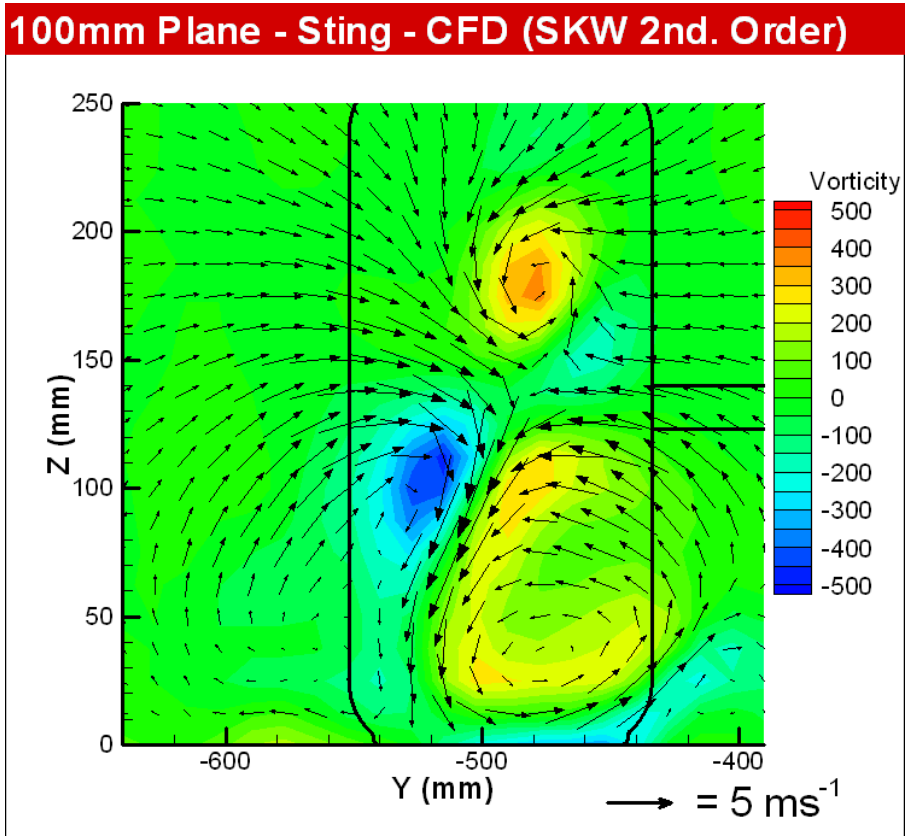
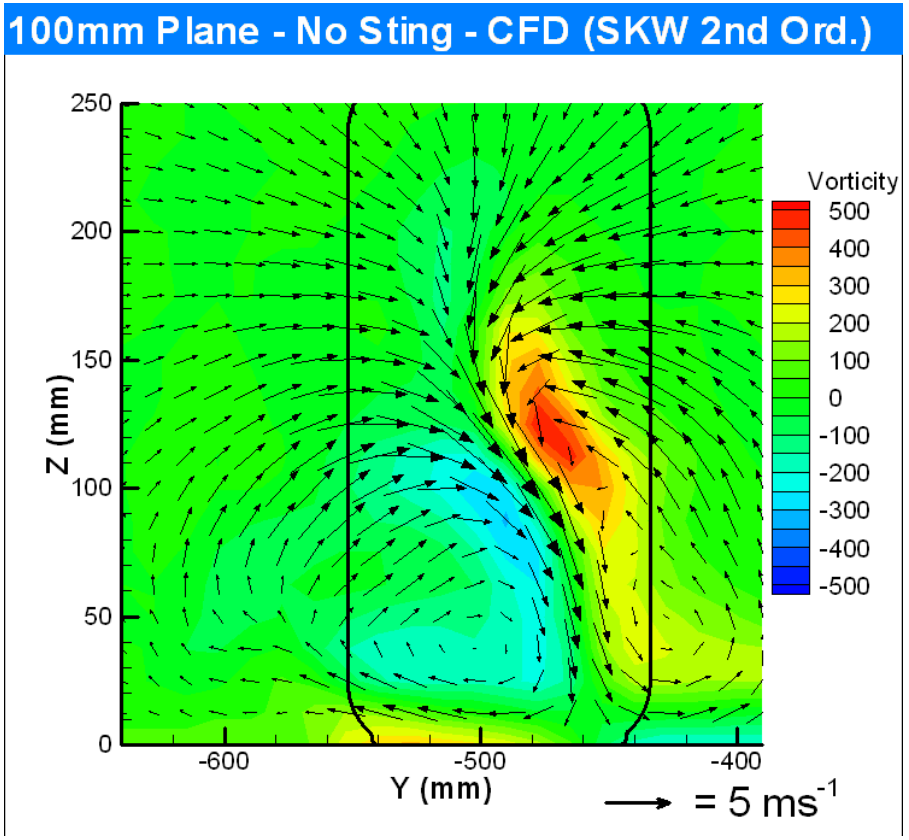
Sting vs no-sting (100mm)





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Conclusions

- The combined use of CFD and experiment has been shown to give enhanced insight into a wide range of aerodynamic flows, including:
  - high-speed turbulent jet flows
  - transonic cavity flows
  - open-wheeled racing car aerodynamics.
- Traditionally, experiments have been used to inform CFD development.
- Increasingly, CFD can inform experimental set-ups.