

EXPERIMENTAL & NUMERICAL INVESTIGATION OF MIXING OF TWO GAS STREAMS

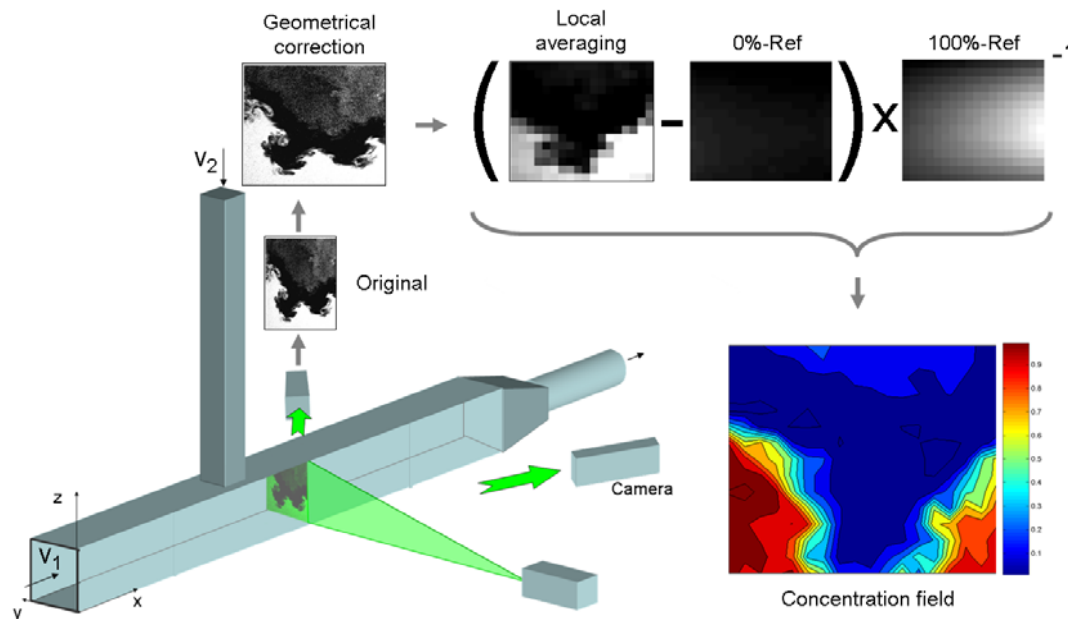
- Thesis Presentation - Kristian Mark Ingvorsen



Supervisors:
Knud Erik Meyer – DTU
Niels Finderup Nielsen - FLS Airtech

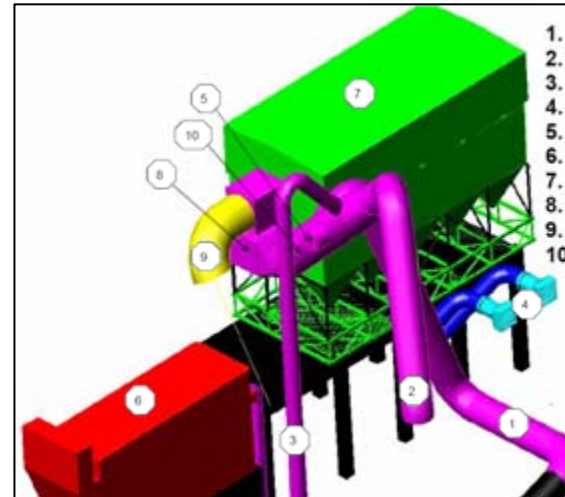


Section for Fluid Mechanics
Department of Mechanical Engineering
Technical University of Denmark

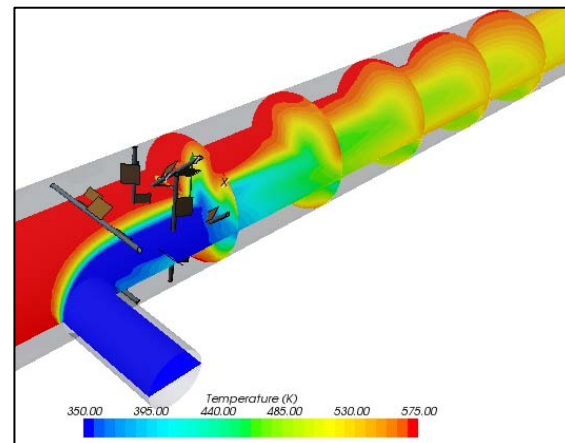


Intro

- Background
 - Turbulent single phase mixing used in many industrial processes
 - With and without static mixers
 - Need for experimental data to support CFD
- Main objectives
 - Obtain experimental data for CFD validation
 - Evaluate CFD predictions



Complex ducting with mixing of 3 gas streams before filter

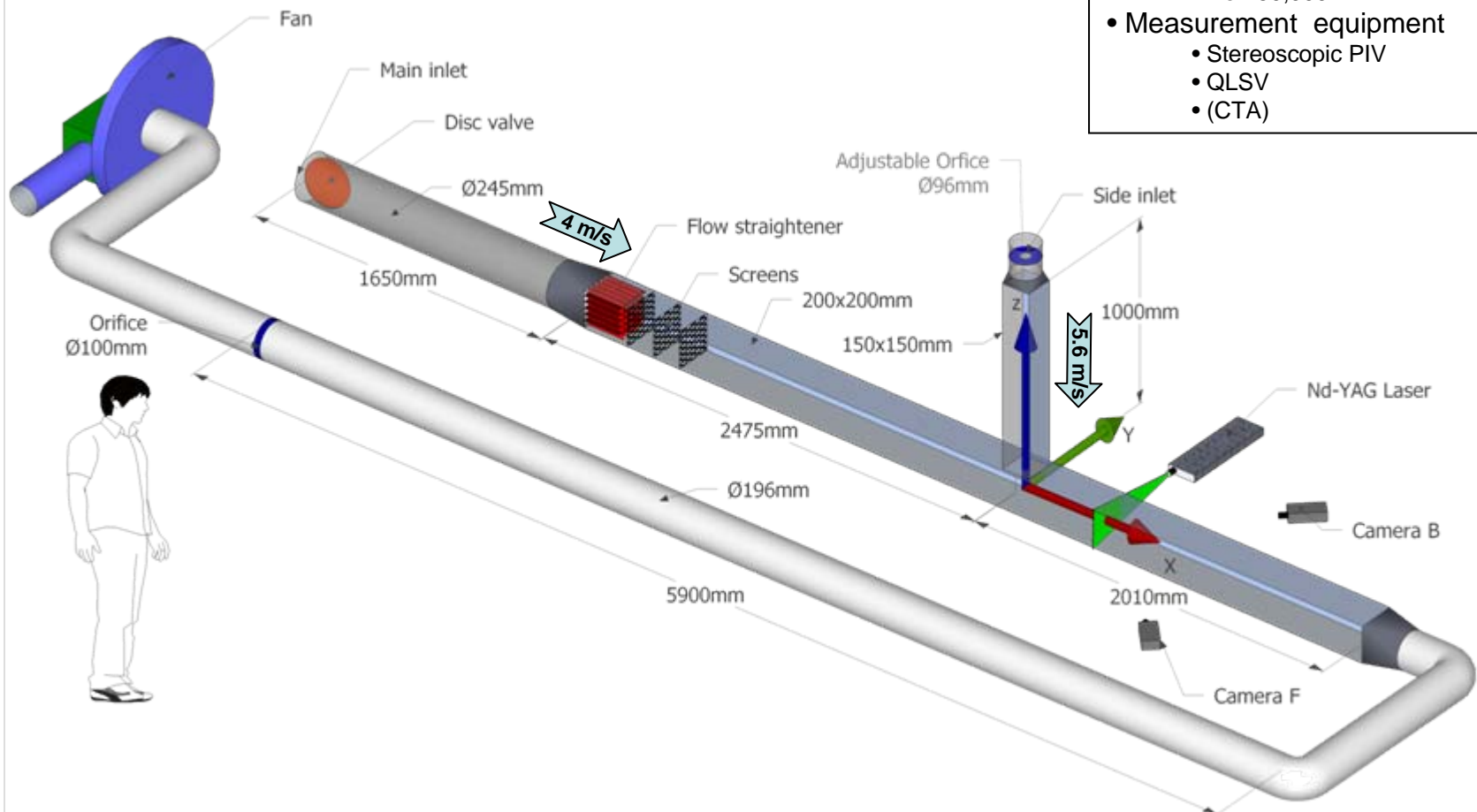


CFD simulation of mixing of hot and cold gas streams with inserted static mixer

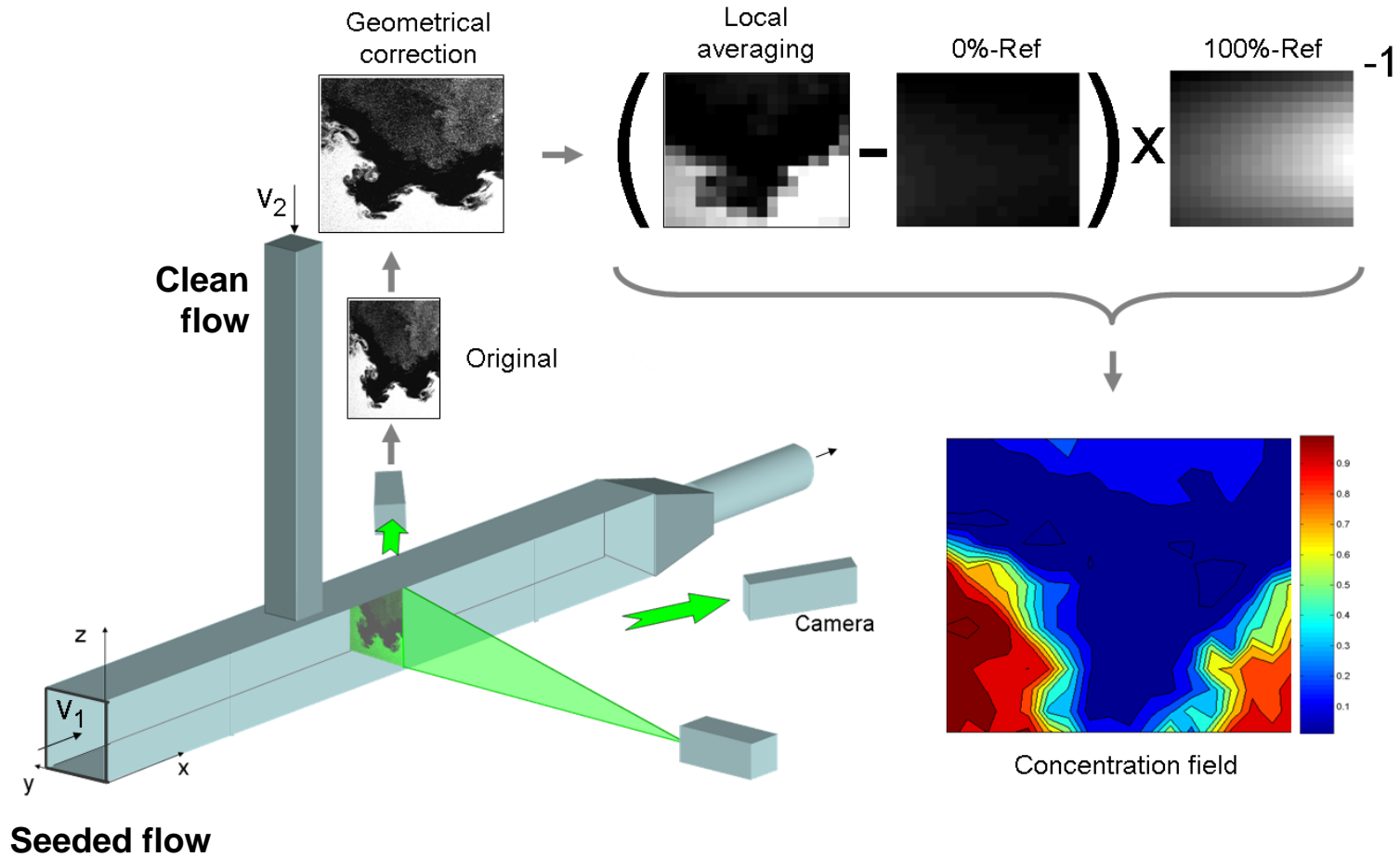
Experimental methods (1)

- Flow rig

- Flow
 - Isothermal
 - $Re = 50,000$
- Measurement equipment
 - Stereoscopic PIV
 - QLSV
 - (CTA)



Experimental methods (2)

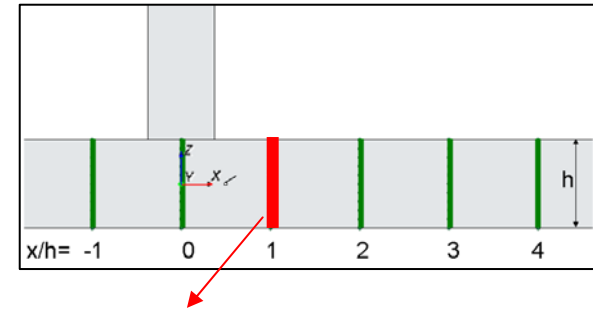


Results

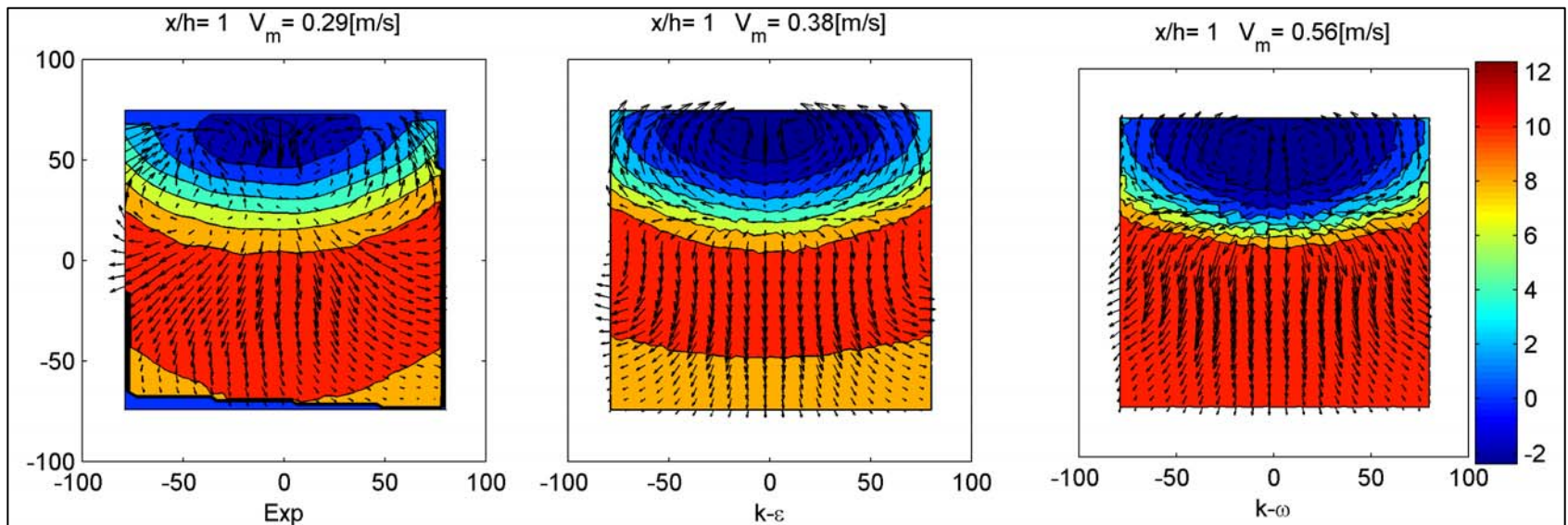
- Empty ducts

Mixing in a T-junction (1)

- velocity and turbulence



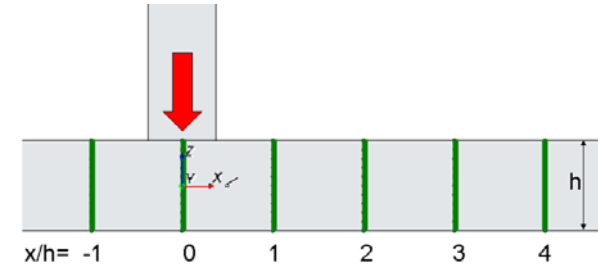
Example of 3D time averaged vector fields. Experimental and CFD



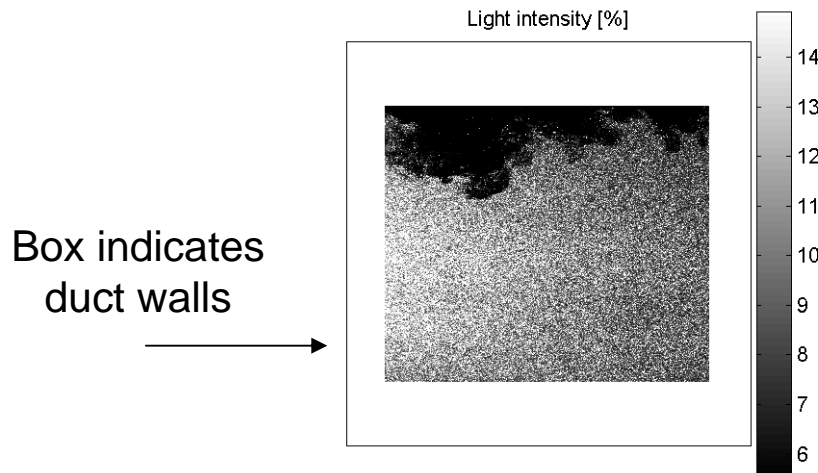
Mixing in a T-junction (2)

- Instantaneous concentration

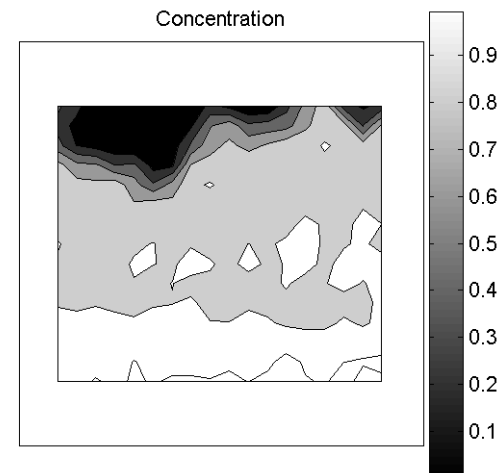
- Sample rate 4 Hz
- Animation frame rate same as sample rate



Current cross-section



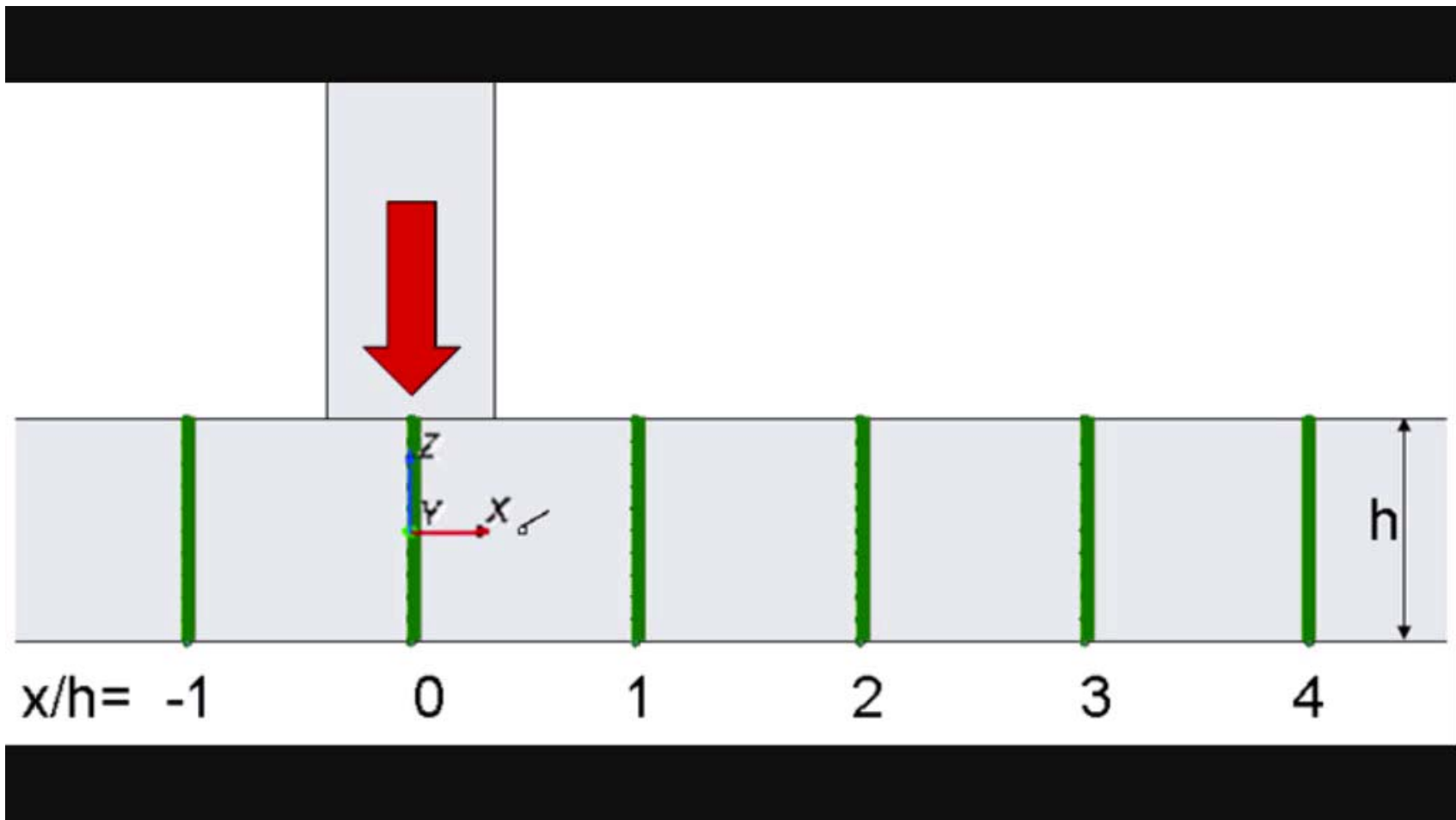
Left: Geometrically corrected particle image



Right: Corresponding concentration field

Mixing in a T-junction (2)

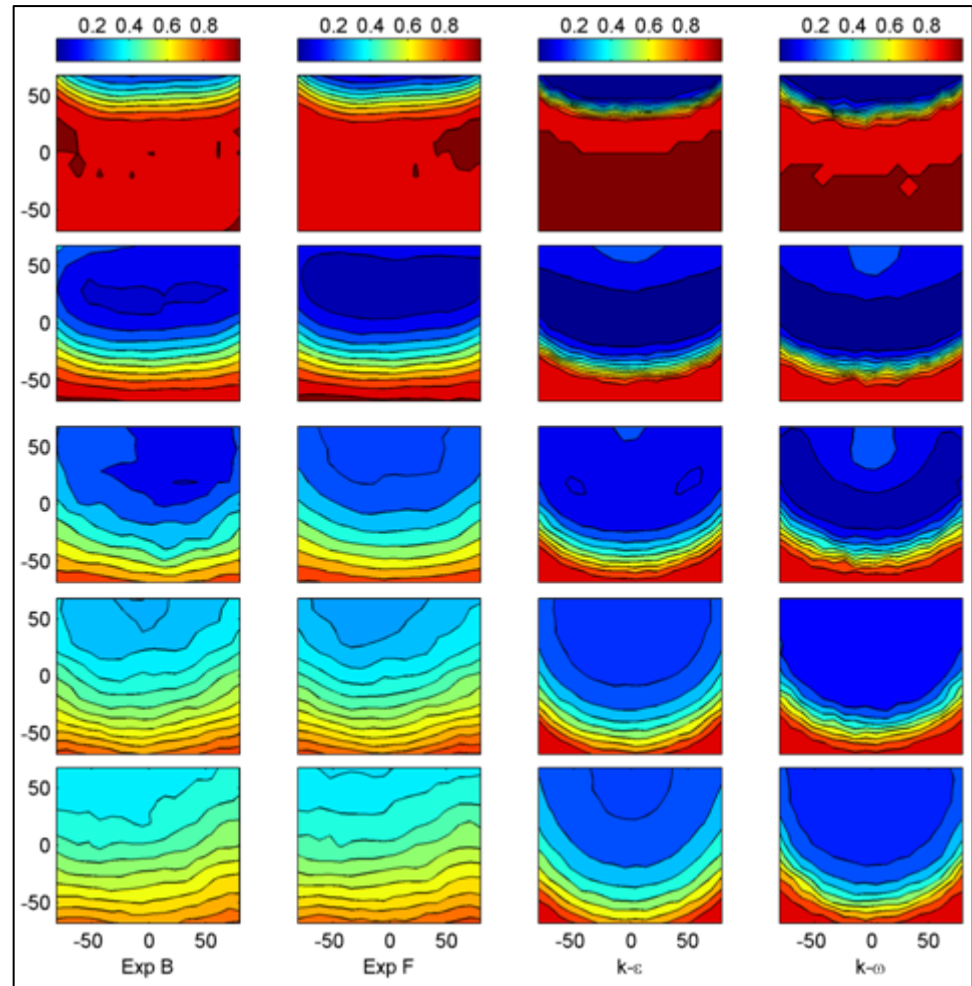
- Instantaneous concentration



Mixing in a T-junction (3)

- Time avg. concentration

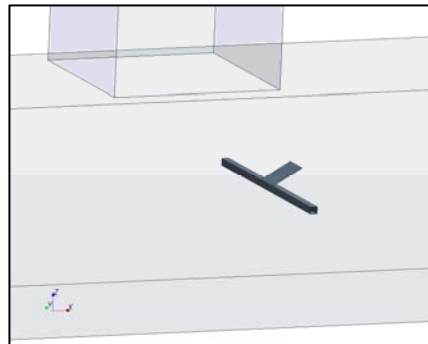
- Time avg. concentration fields
- Exp. Vs CFD.
 - Correct tendencies under estimation of level of mixing



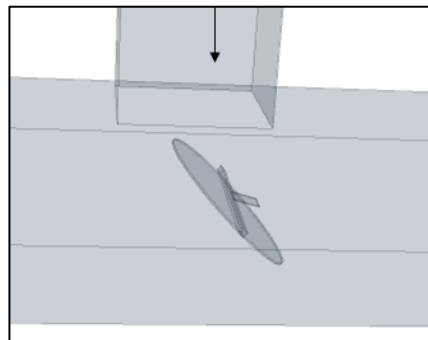
Mixing in a T-junction (4)

- Mixing with and without static mixers

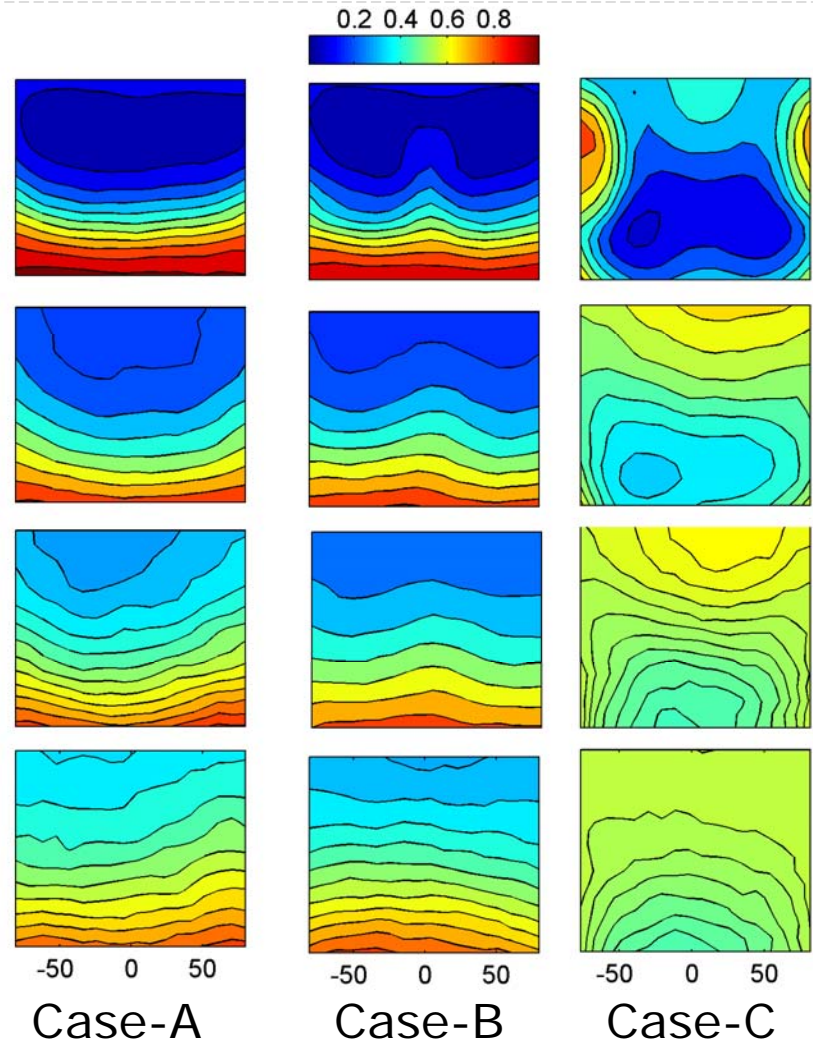
Case-A:
Empty ducts



Case-B:
Small blade



Case-C:
Large disc



Conclusions

- QLSV technique
 - High quality data
 - Well suited for CFD validation
- Mixing in T-junction
 - Fair predictions on mean velocities
 - Inaccurate but conservative predictions on mixing
- CFD evaluation
 - RANS based simulations applicable in cases where time averaged mixing is of interest
- Static mixer design
 - Focus on large scale structures for convective diffusion
 - Incorporate flow structures created by duct geometry

Questions