Fontys
Hogescholen

Fontys
University of Applied Sciences

Presentation by:

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Fontys University of Applied Sciences

Fontys offices/locations

Technology region

1 Brainport Eindhoven
2 Technology region Aachen (lifesciences + telecom)
3 Micro-electronics & DSP Cluster Medical Sciences

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Rankings Region Eindhoven

- Authoritative national and international, technological, educational and R&D institutes
- Anchoring of top-class technology on a global level
- Eindhoven University of Technology: 10,000 students
- High Tech Campus (Philips): 5,000 employees, € 600.000.000 investment
- Fontys Hogescholen: well over 38,000 students receive training at one of the 6 Fontys' faculties. 4,000 of them in technical education
- 40% of total business R&D expenditure in the Netherlands is realized in the region Eindhoven-Venlo
- 14% of the total industrial labour costs is in R&D (national 3%)

University of Applied Sciences:

50 employees and 700 students

Courses:

- Engineering Physics : 230 students
- Applied Science : 470 students

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Just a few partners for Fontys Applied Physics

SABIC Innovative Plastics

sabic

JANSSEN PHARMACEUTICA

Johnson & Johnson PHARMACEUTICAL RESEARCH & DEVELOPMENT

PHILIPS sense and simplicity

Unlimited. DSM

Erasmus MC Universitair Medisch Centrum Rotterdam

Universiteit Maastricht

Universiteit Utrecht

Radboud University Nijmegen

UMC Utrecht

BÜHLER

Hycult biotech

ECN Energy research Centre of the Netherlands

Educational program and Comsol

1. Comsol has been introduced in 2007.
2. First year simulations with Comsol
   a) Mechanics, Convection and Currents+heating (Joule effect)
3. 2009 Introduction of Comsol in Laboratory experiments.
   1. Windtunnel.
   2. Convective heatflow around horizontal rod.
   3. Flow in system of tubes.
   4. Cooling Fins.
4. Next year solar devices, semi conductor physics.

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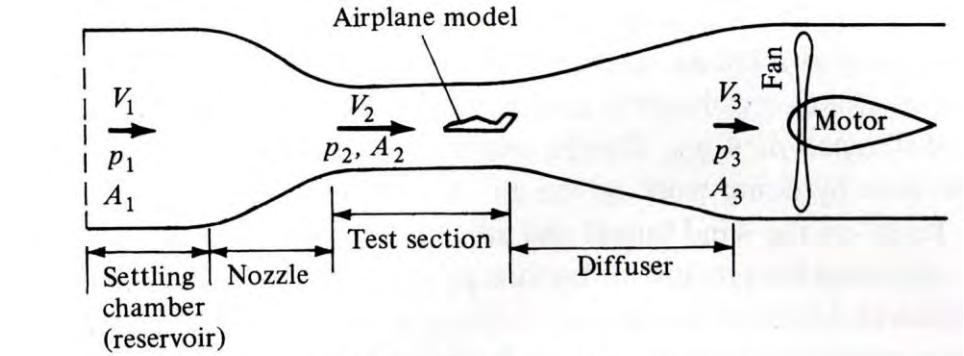
Main items in educational program.

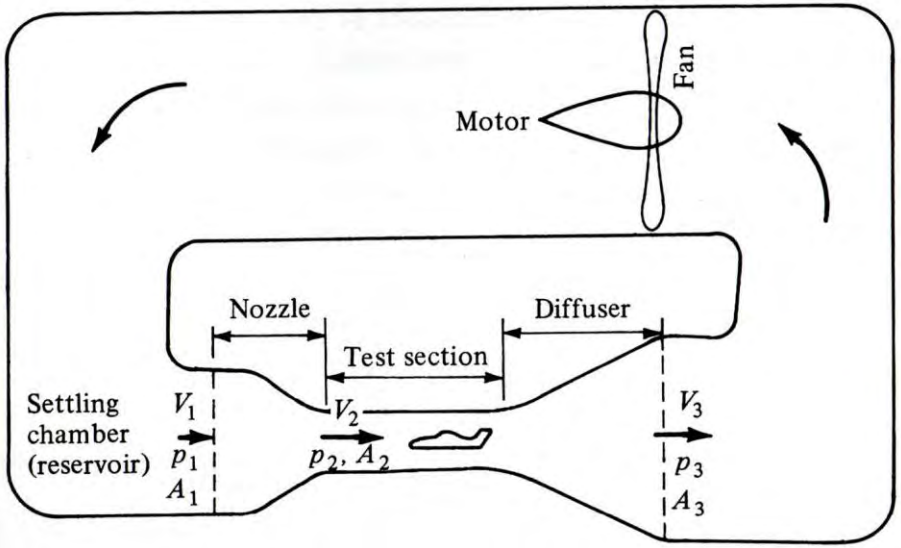
Emphasis in program on practical applications of Finite Element Methods.

- Some important coupling of physics.
- Symmetry of the problem.(CPU time)
- Mesh issues.(CPU time)
- Geometry and level of details.
- Parameter scans, such conductivity etc.
- Some solvers.

Design of windtunnel



(*a*) Open-circuit tunnel



(*b*) Closed-circuit tunnel

Design made by graduated student of the Delft University of Technology, department space and flight studies.

Our design is small.

Should fit on a table, in lab.

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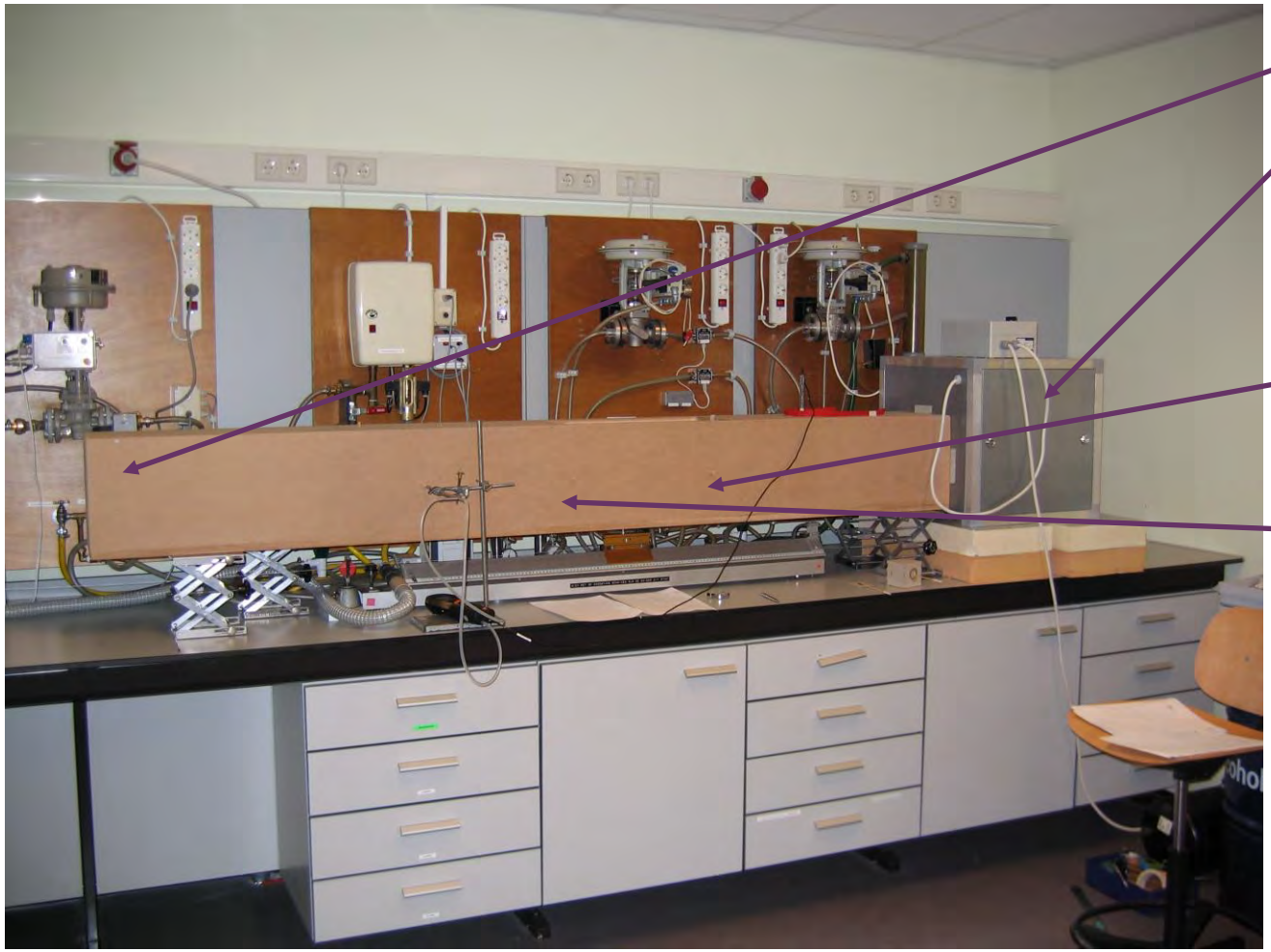
Scope of project, for students

1. Study the tunnel design and measuring equipment.
2. Perform measurements and check results with theory.
3. Use Comsol and compare results from CFD with theory and experiment.
   - Study the setup in Comsol.
   - Apply symmetry when possible.
   - Optimize mesh
   - Take DOF into account.

Windtunnel setup



Air inlet

Ventilator

Inner

dimensions 0.25x0.25 m^2

Length 2.5 m

Basic theory

Use single phase turbulent flow in Comsol.

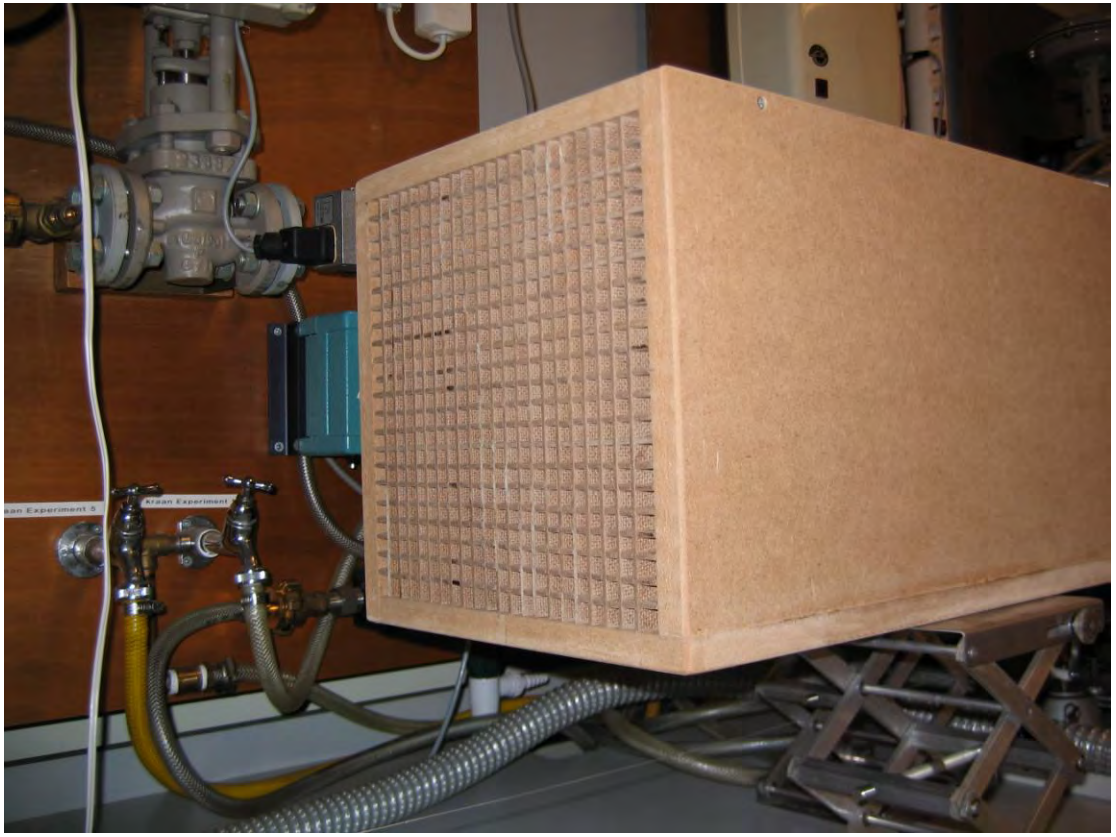
$$\mathrm{Re} = \frac{\rho \cdot V \cdot D_h}{\mu}$$

$$F_D = C_D \cdot \frac{1}{2} \cdot \rho \cdot V^2 \cdot A$$

It looks simpel, but!!!!!

To apply your skills for the first time on such issues causes quite some turbulence!

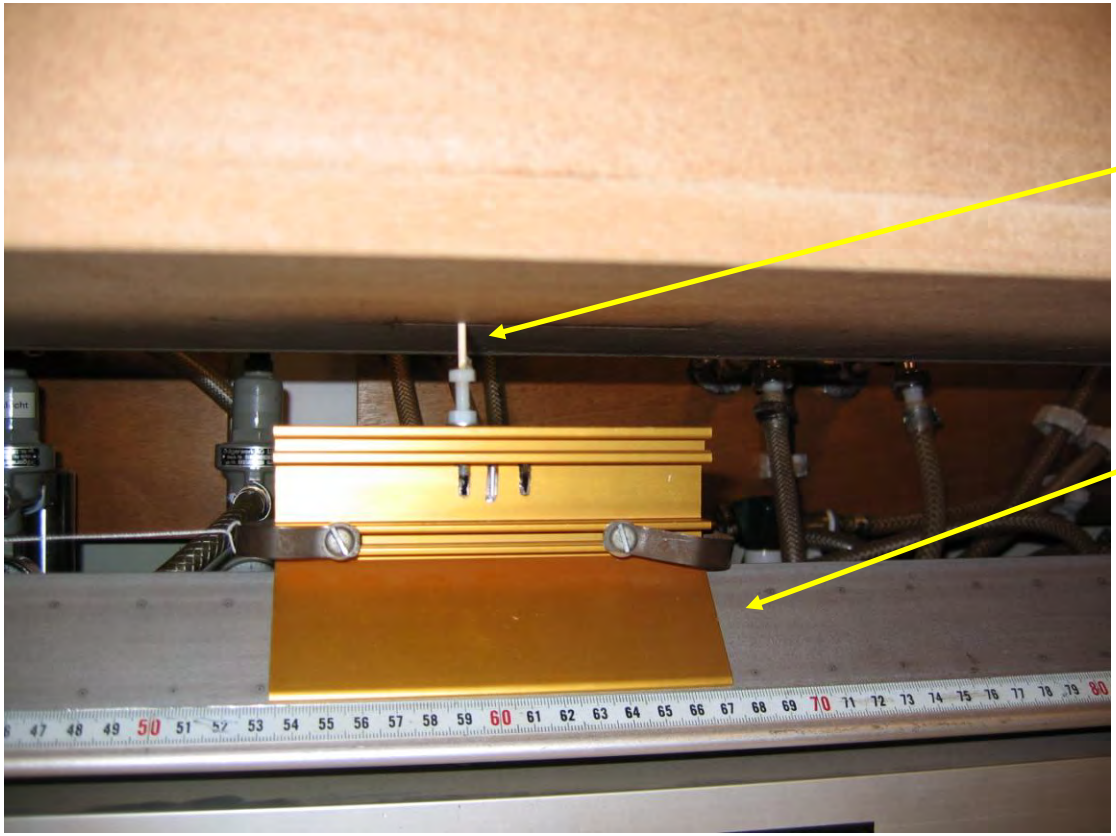
Inlet



Inlet.

Small square pipes realize a homogeneous flow in the tunnel

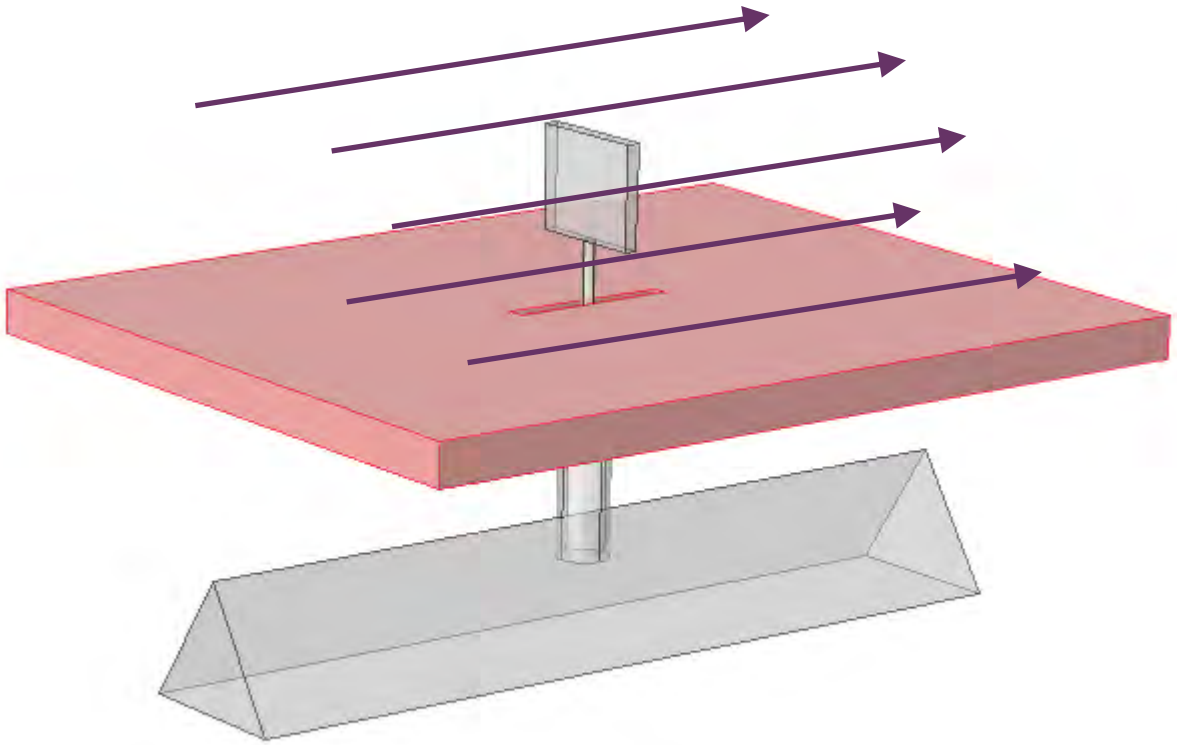
” Frictionless” air rail



Mounting for plates and disks

Air rail

Overview of setup in tunnel

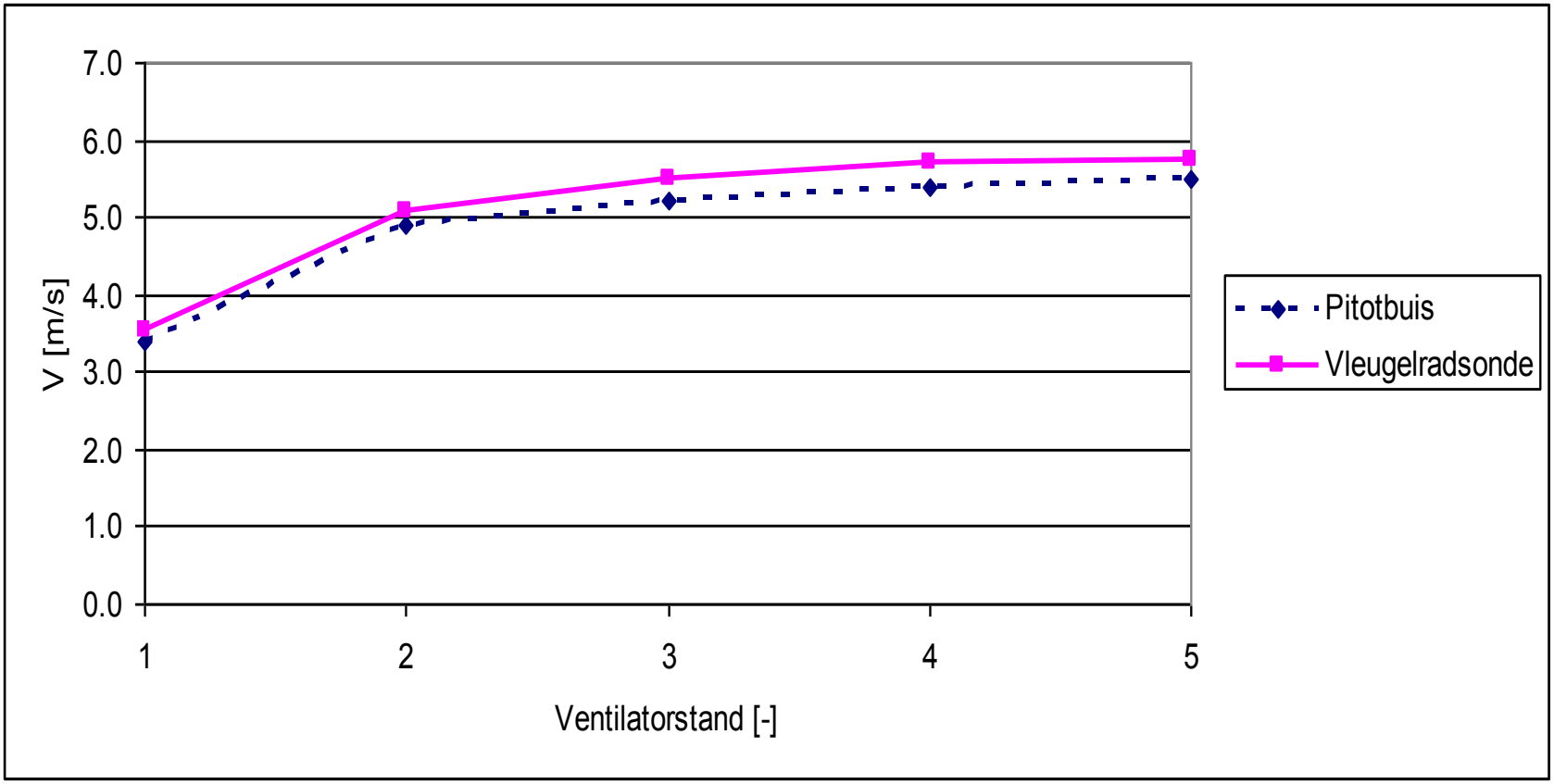


ıare plate in tunnel

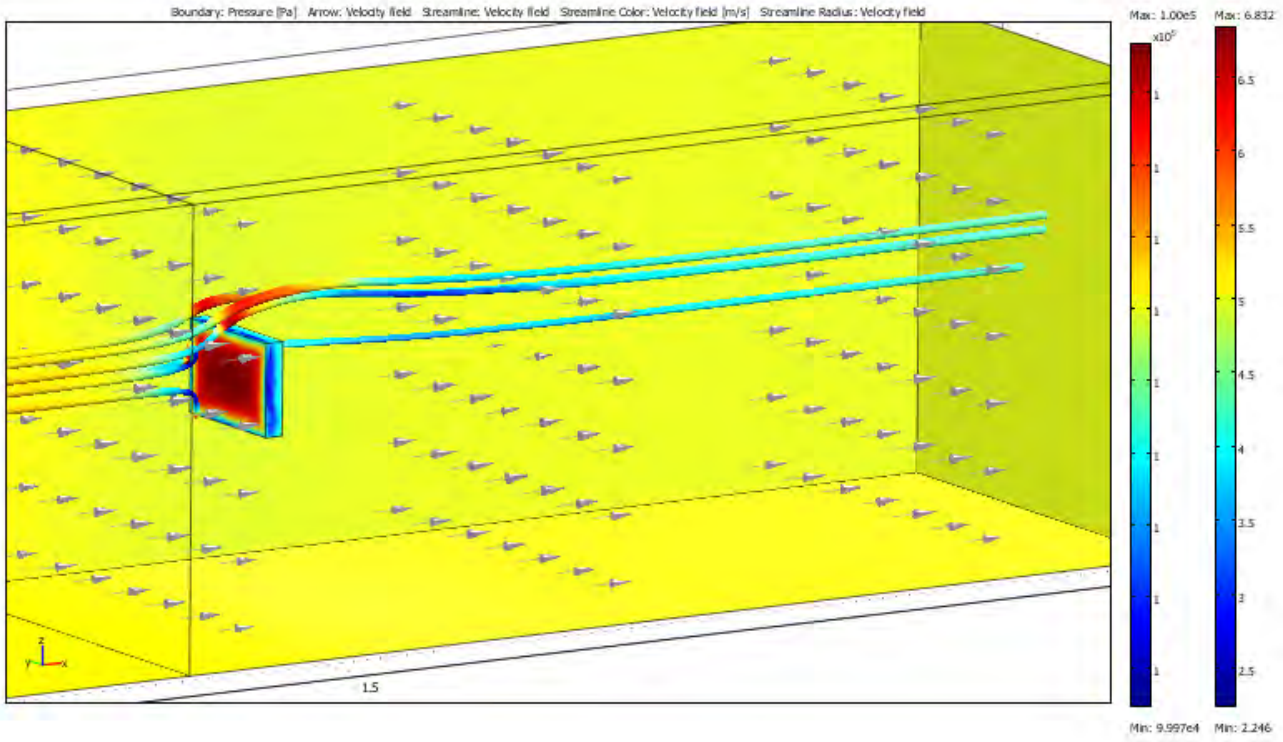
setup on frictionless

air rail.

Average flow in Tunnel at different ventilation settings.



Students approach, neglecting symmetry



First disappointments arise!

Why does it take so long.

How to use mesh settings.

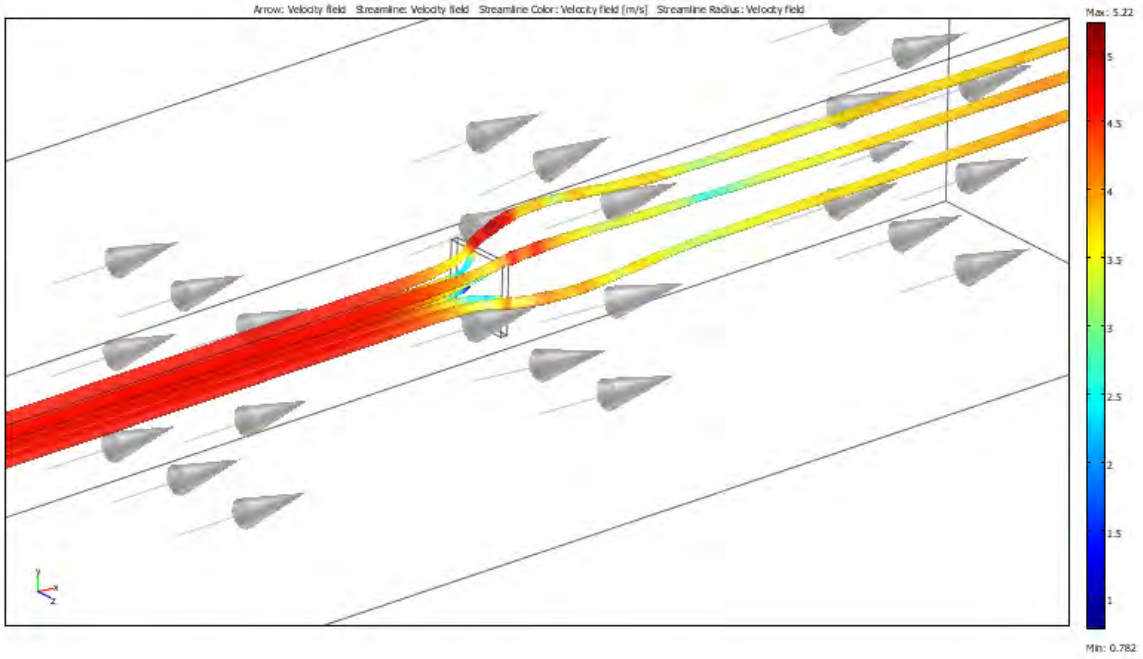
What do you measure and how to extract the information you want!

Emphasis on how to approach problems by means of FEM.

Compaq, 4 CPU's

4 Gb memory

Full 3D setup

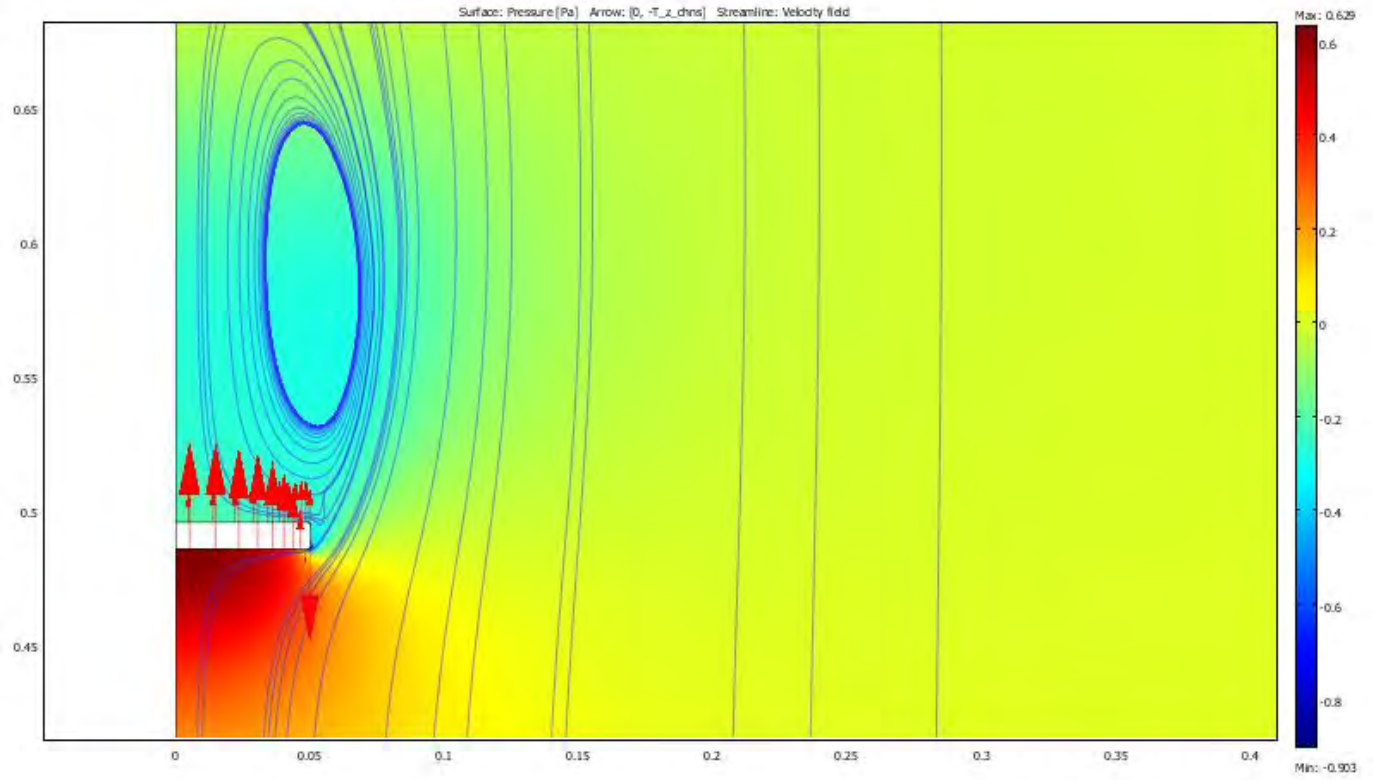


Full 3D simultion

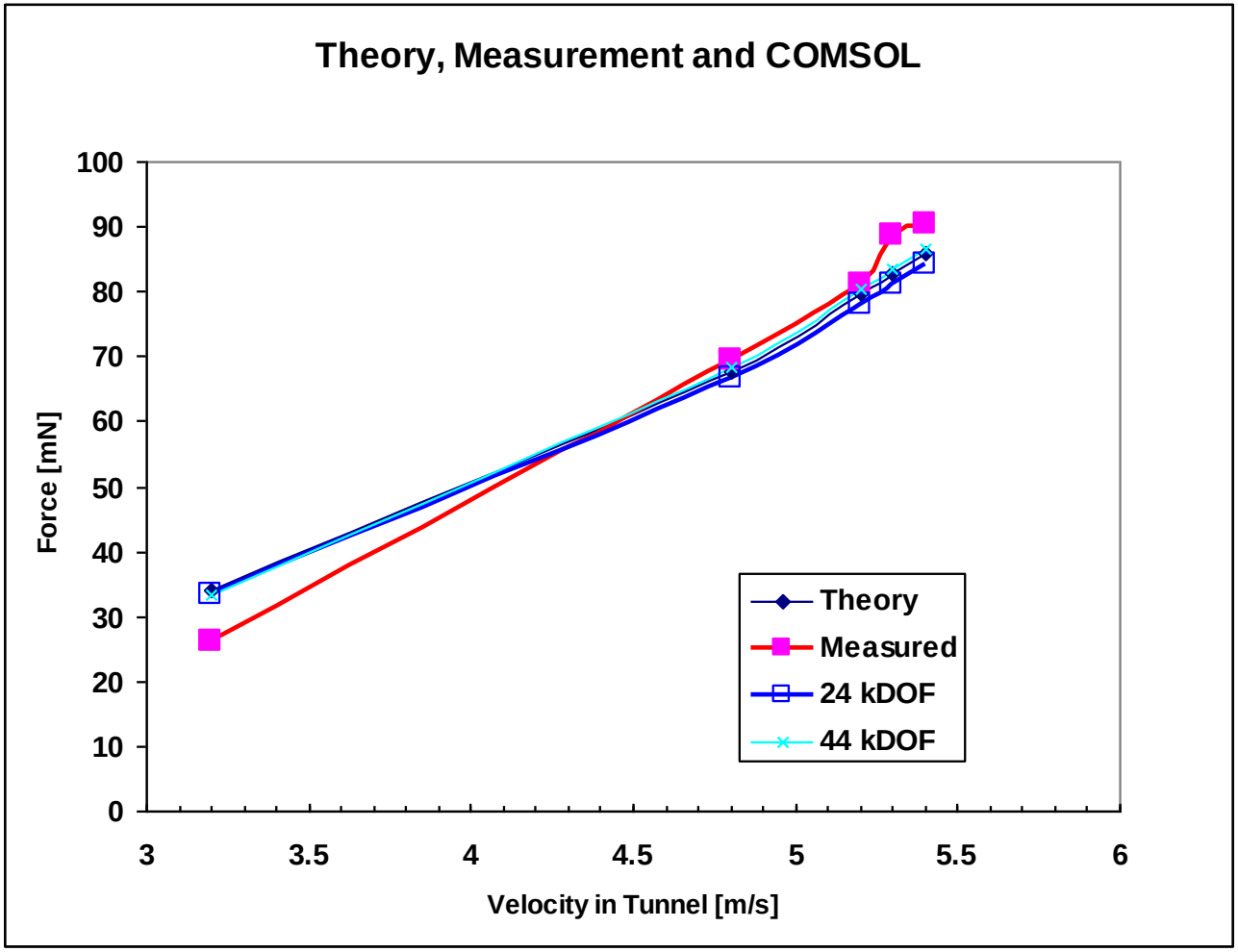
CPU intensive

Memory intensive

Axisymmetric study of a disk



Comparison measurements, theory and COMSOL

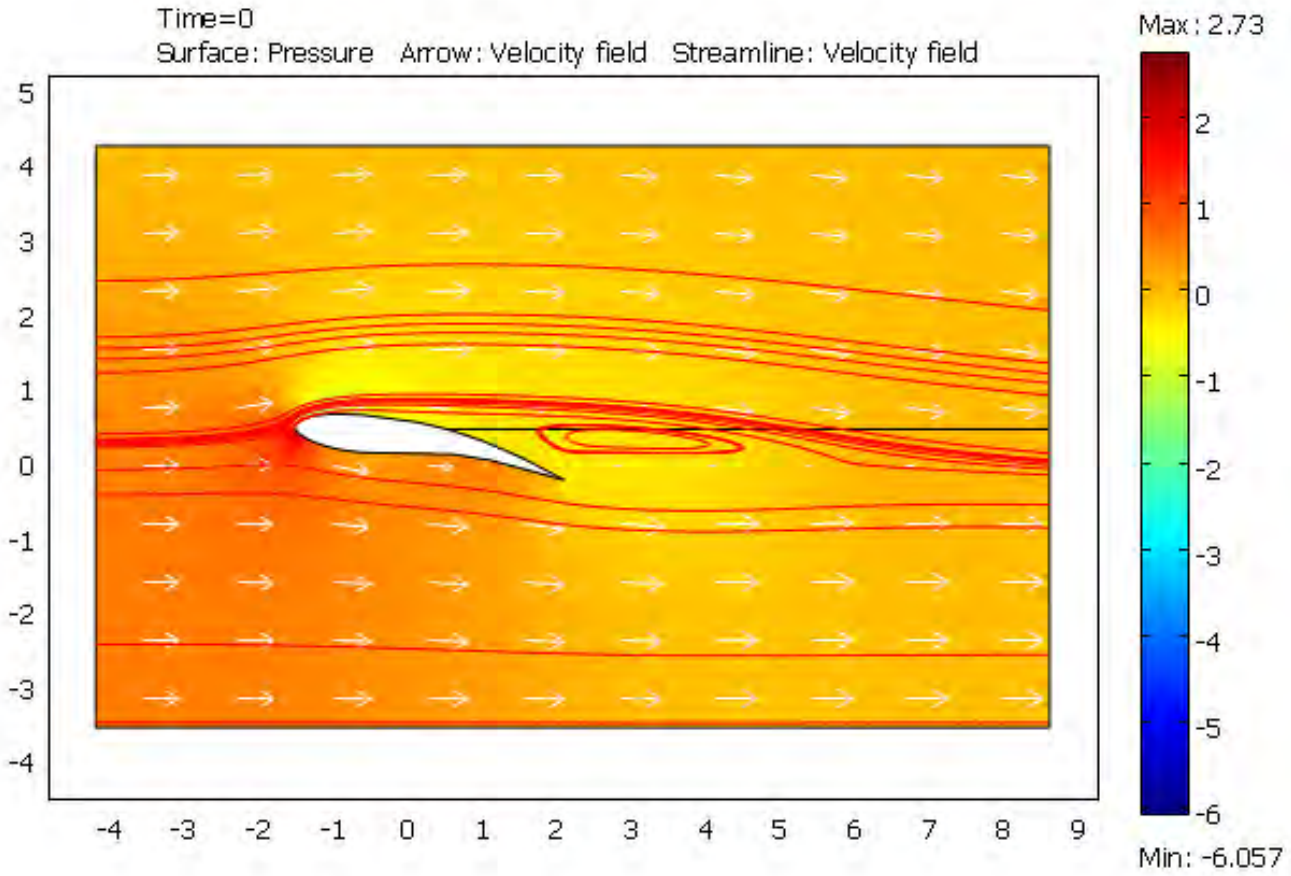


The simulations are close to the measured values.

Some deviations occur at the lowest and highest velocity values. Due to design of the simple windtunnel.

Students are forced to analyze all deviations seen.

Wing in air stream.



Pressure profile

Angle of air stream increases during time.

Time dependant simulation.

The future of COMSOL at Fontys

- **Comsol** will be implemented in **chemical** engineering.
- **Comsol** will be implemented also for the course **fluid** dynamics. Book used Fundamentals of Thermal Fluid Sciences, Cengel, Turner and Cimbala, 3rd edition.
- Excercises in **Book** will be used during the course to implement Comsol further in the educational system.

- Comsol will become an **essential** part in the study of applied physics.

- In december a general presentation will be given for all the **universities of applied physics** in the Netherlands how we have implemented COMSOL.

Internships or trainees

- Students are well equipped to do an internship abroad.
- When possible they use Comsol for parts of their work.
- If you need students for work or projects in combination with COMSOL please contact me.

- Thank you for your attention!