# Transfer of flap technology from laboratory to industrial application

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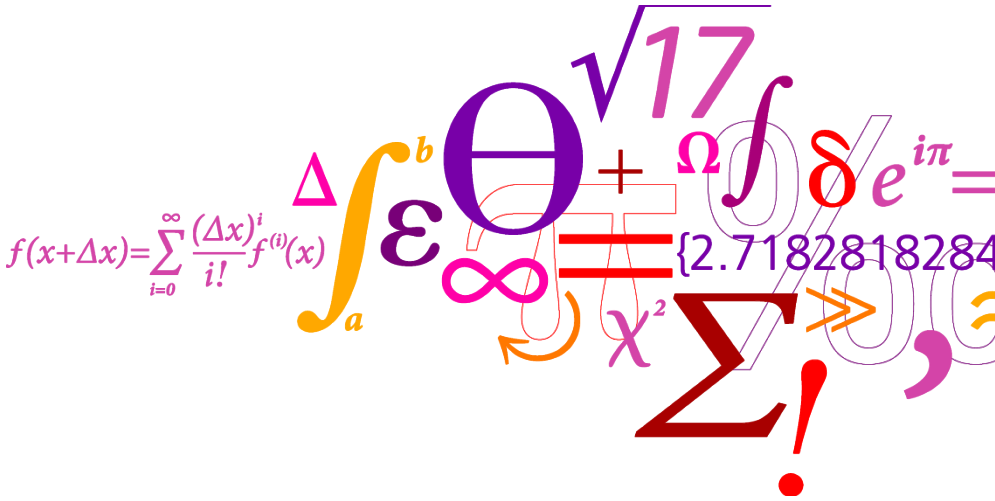


# Controllable rubber trailing edge flap (CRTEF) designs

## development of the technology

# The Controllable Rubber Trailing Edge Flap CRTEF development

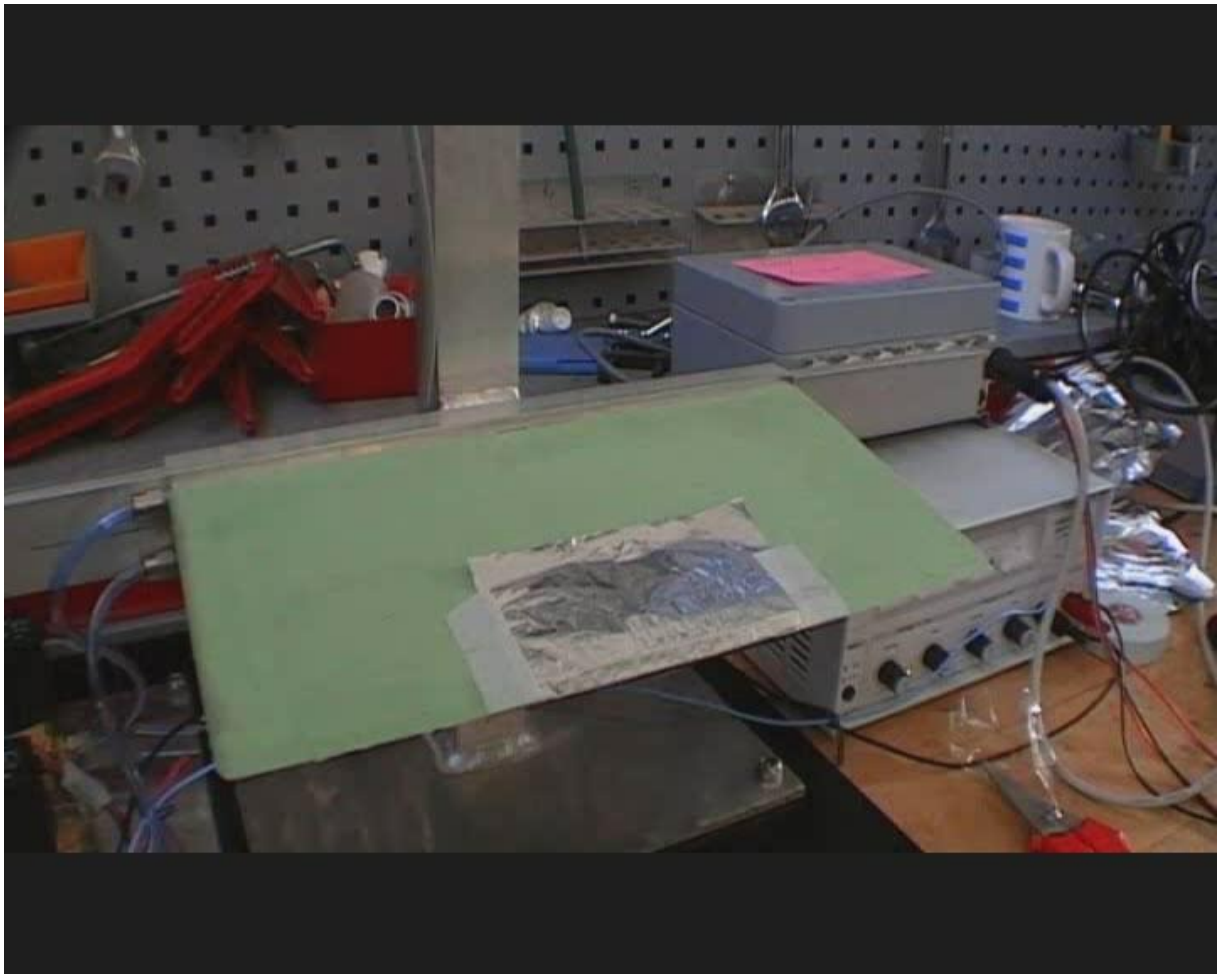
**Development work** started in 2006

**Main objective:** Develop a robust, simple controllable trailing edge flap

**The CRTEF design:**

"A flap in an elastic material with a number of reinforced voids that can be pressurized giving a deflection of the flap"

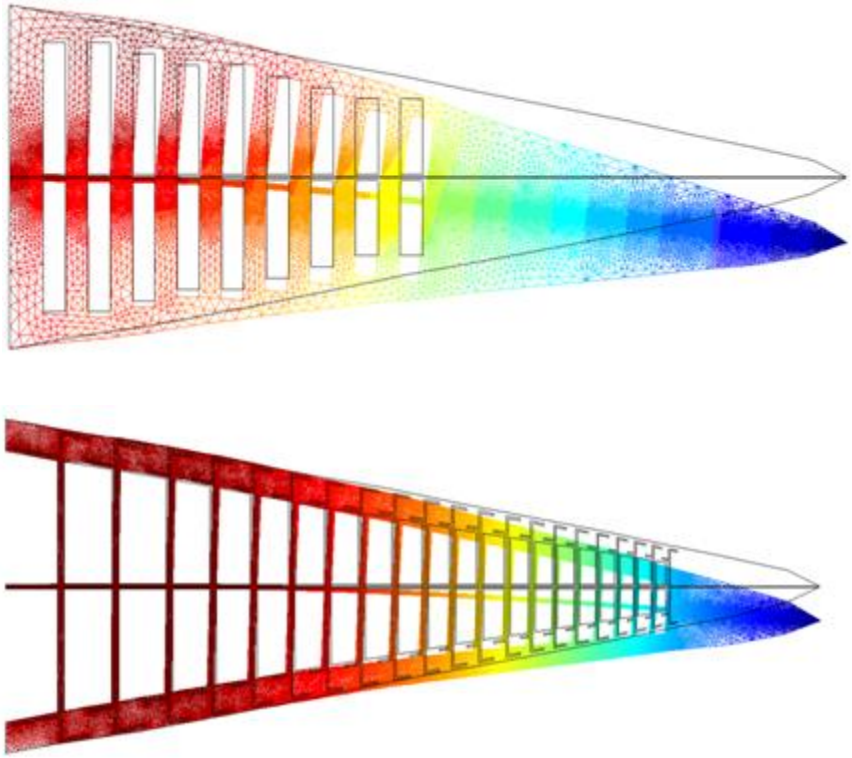
# The Controllable Rubber Trailing Edge Flap CRTEF – test of prototype in 2008

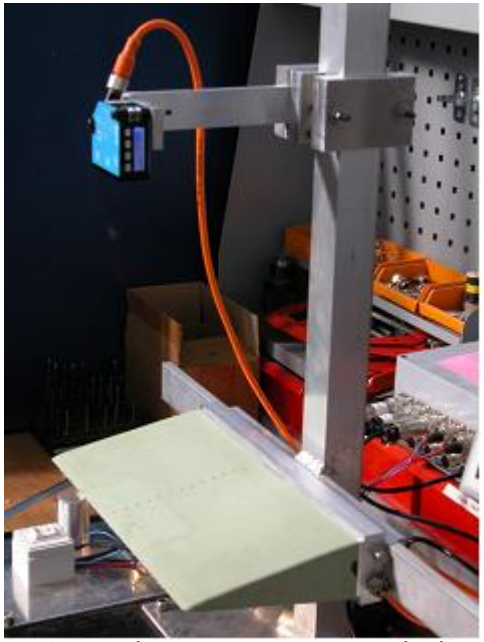


# The CRTEF development

## - early work (2008)

**Comsol 2D analyses**





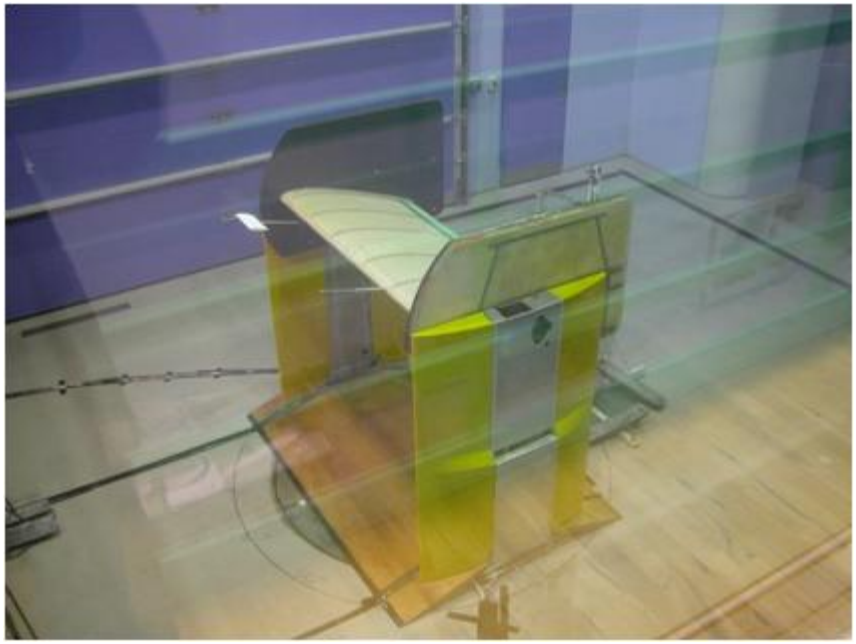
# Some milestones in the CRTEF development

- in **2007** a 1m long prototype rubber trailing edge flap was tested – problems with its robustness
- in autumm **2008** promissing results with a 30 cm prototype with chordwise voids
- December **2009** wind tunnel testing of 2m long flap section

# Wind tunnel experiment Dec. 2009

airfoil section + flap during instrumentation

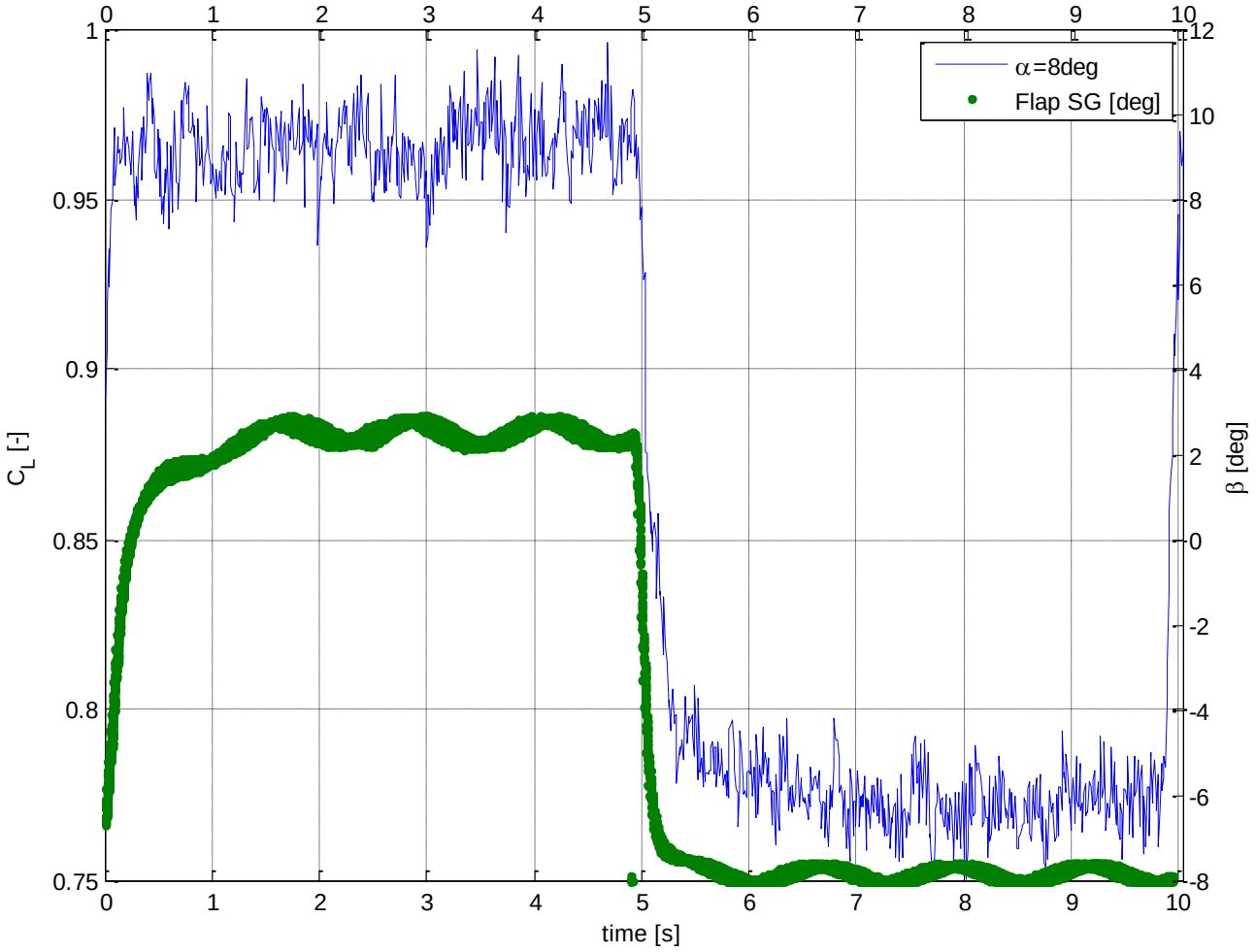
the 2m airfoil section with the flap in the VELUX wind tunnel, December 2009



# Wind tunnel experiment  Dec. 2009

two different inflow sensors

# Lift changes integrated from pressure measurements



# March 2011

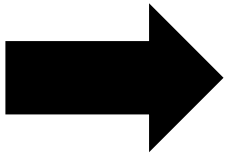
A three years research and development project **INDUFLAP** with participation of three **industrial partners** was initiated

# The INDUFLAP project

Start of project

Prototype CRTEF tested in laboratory

Project



End of project

Prototype ready for test on MW turbine

**Participants:**

DTU Elektro

DTU AED

DTU Fiberlab

**Industrial partners**

Rehau A/S (flap manufacturing)

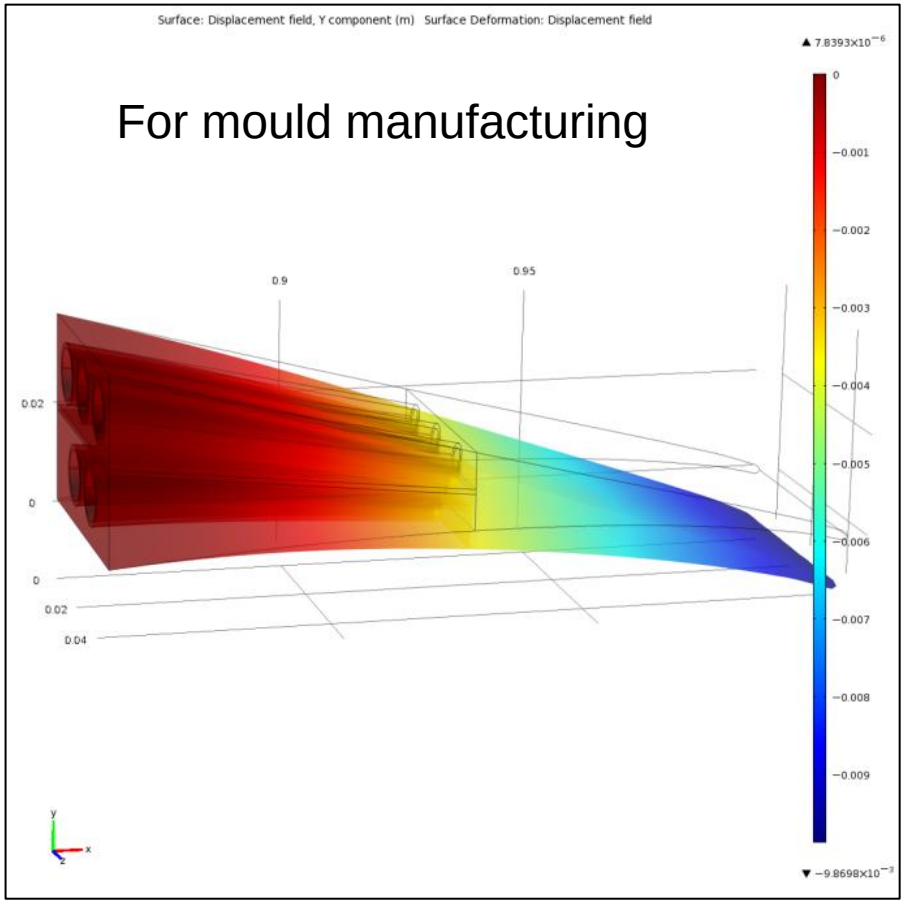
Hydratech Industries Wind Power (pneumatic power supply/control)

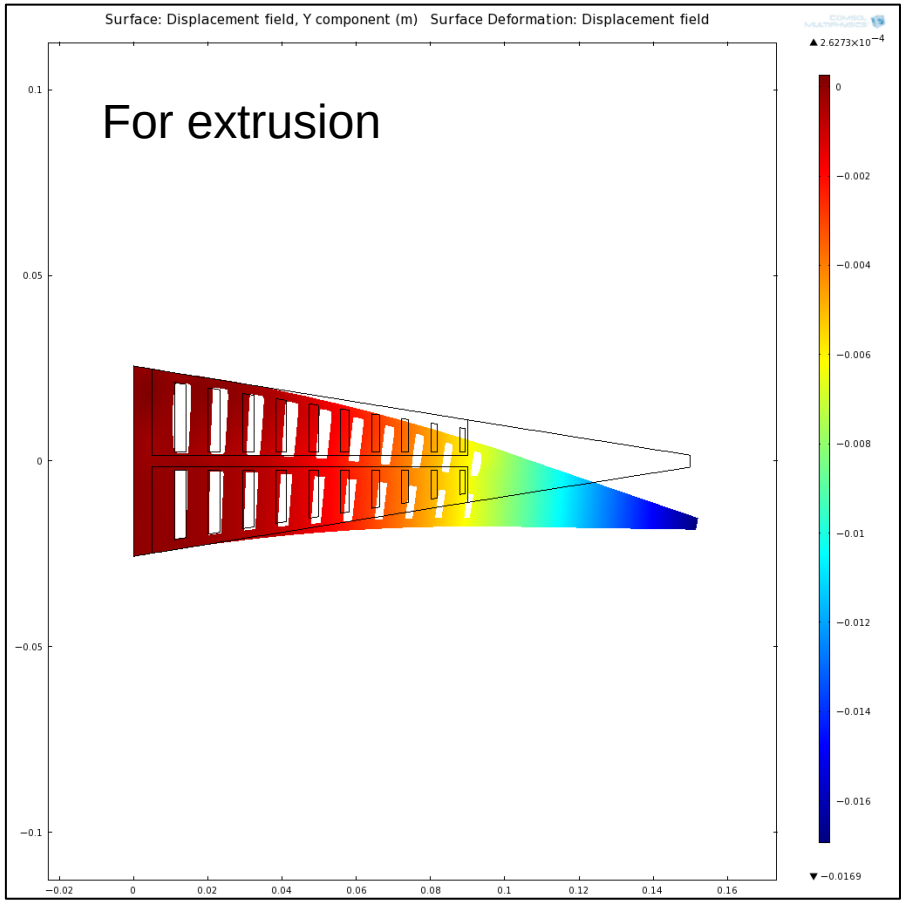
Dansk Gummi Industri A/S (flap manufacturing)

# Project activities/investigations

- new designs (void arrangement, reinforcement, manufacturing process)
- determine the best materials/develop new materials
- performance (deflection, time constants)
- robustness, fatigue, lightning
- manufacturing of 30 cm and 2 m prototypes
- integration of flap system into the blade
- pneumatic supply
- control system for flap and integration with pitch
- testing of 2 m sections  in outdoor rotating rig
- preliminary sketch of system for MW turbine blade

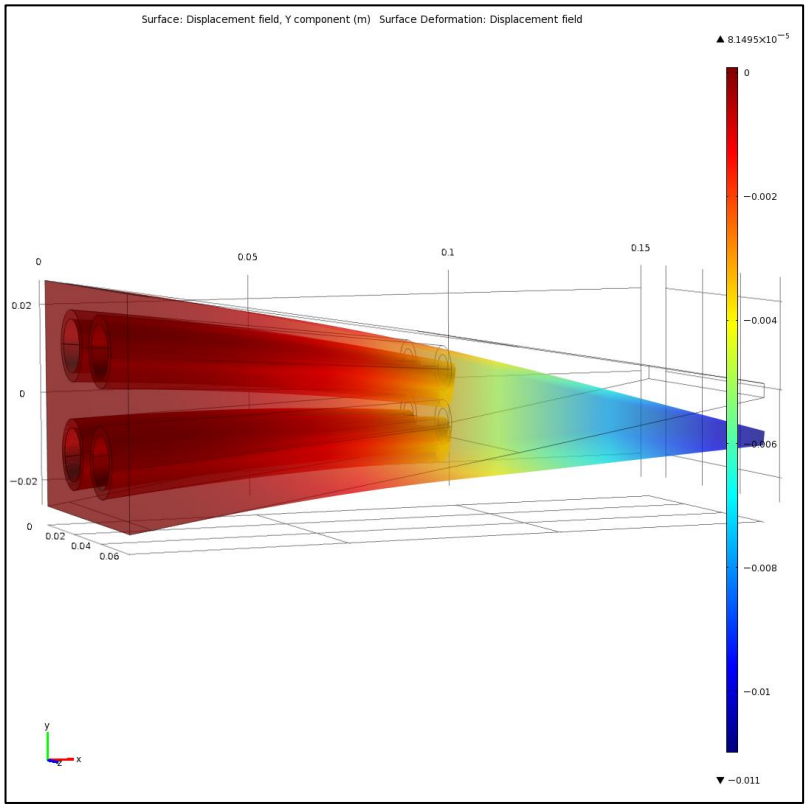
# Two basic different types: chordwise or spanwise voids



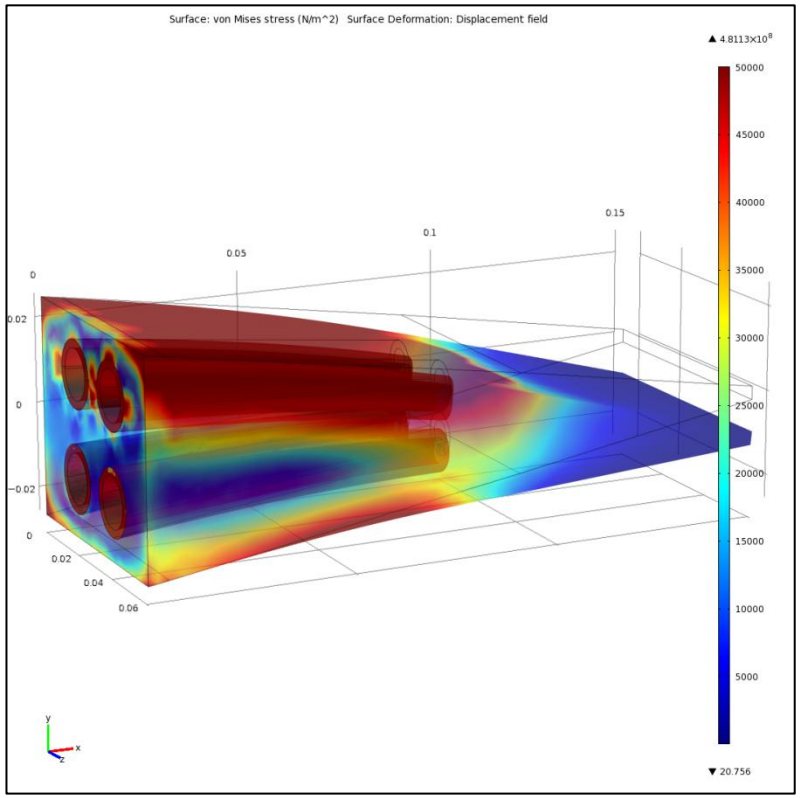



# Example of COMSOL simulations on a new prototype with chordwise voids

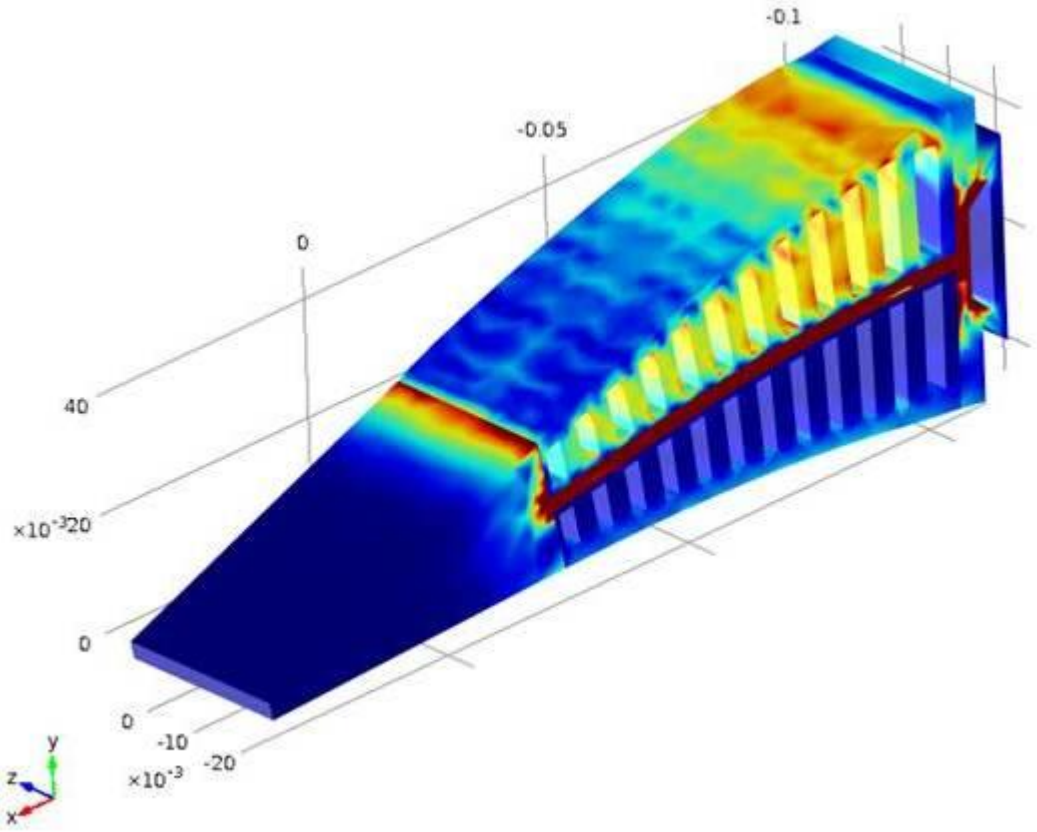
Contour plot of deflection



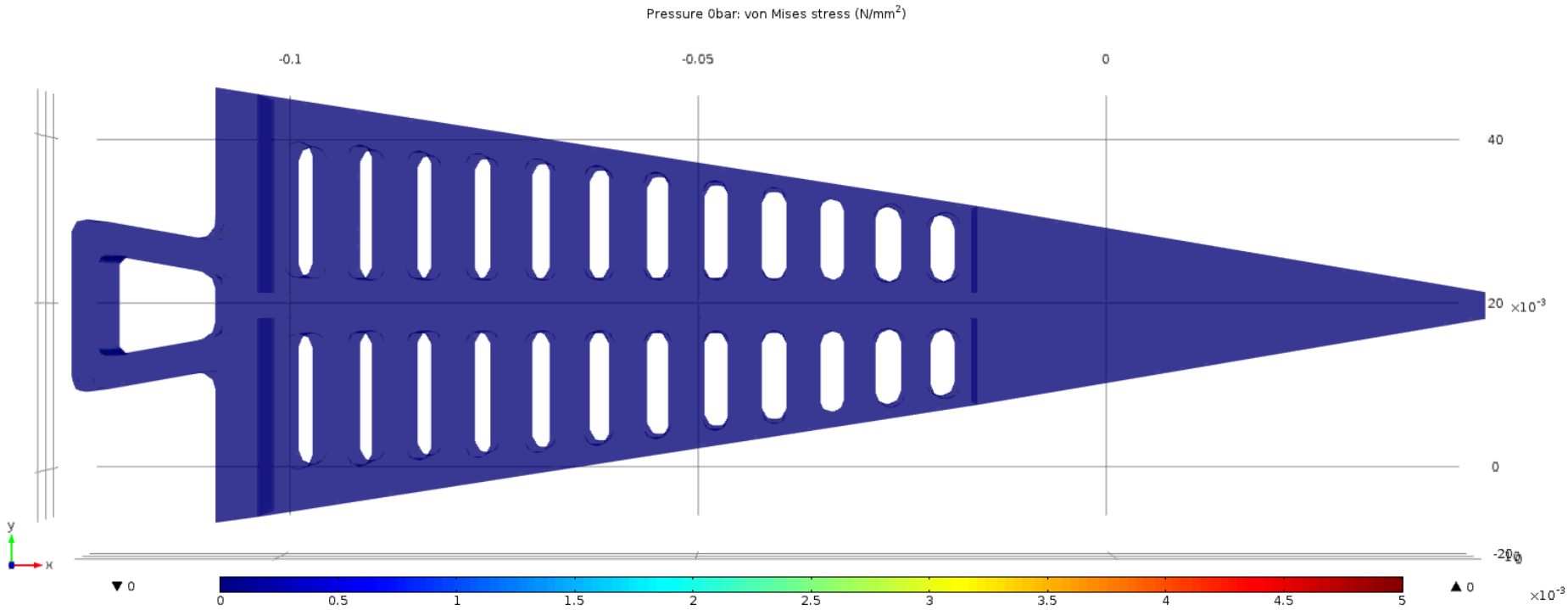

Contour plot of stress



# Design to be tested in the spring/summer 2013



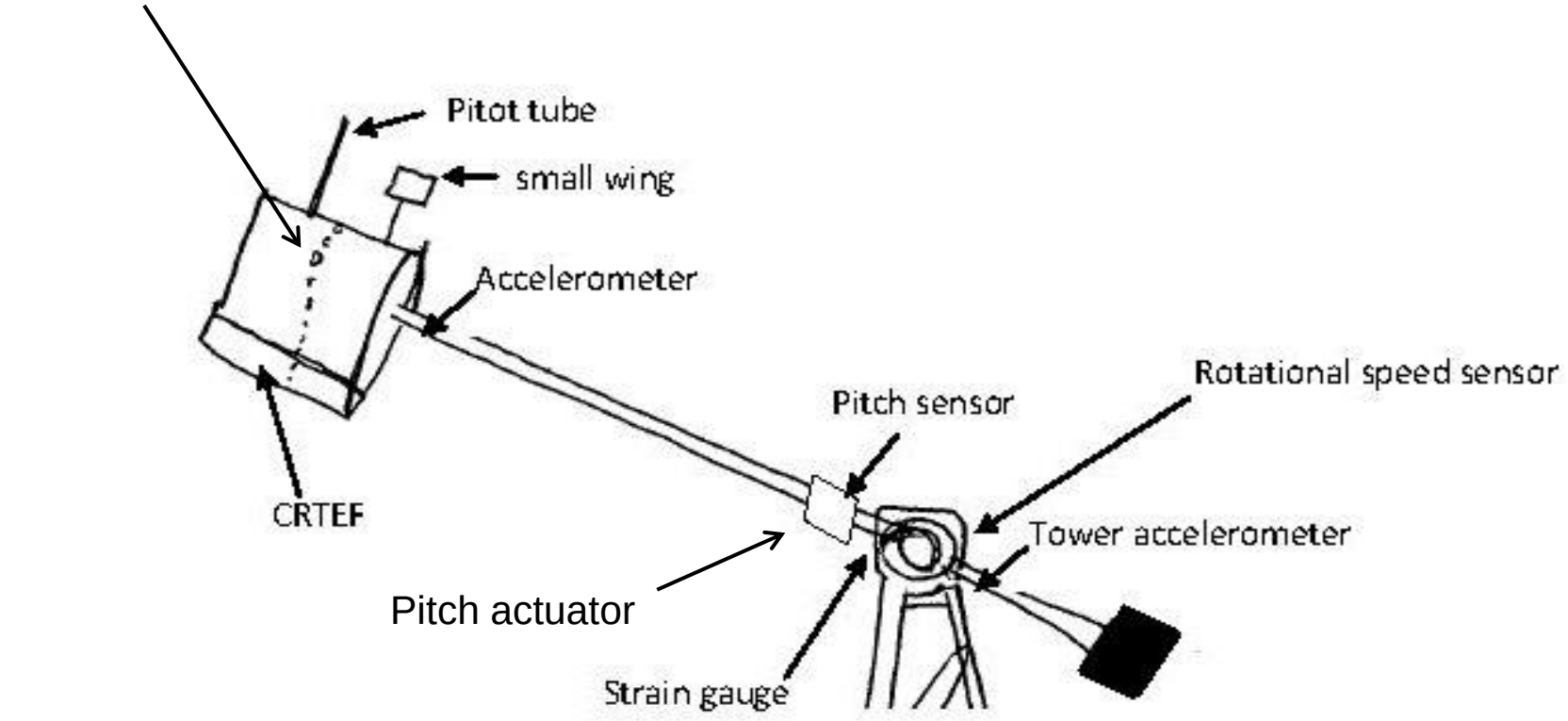
# Example of COMSOL simulation of stress contours



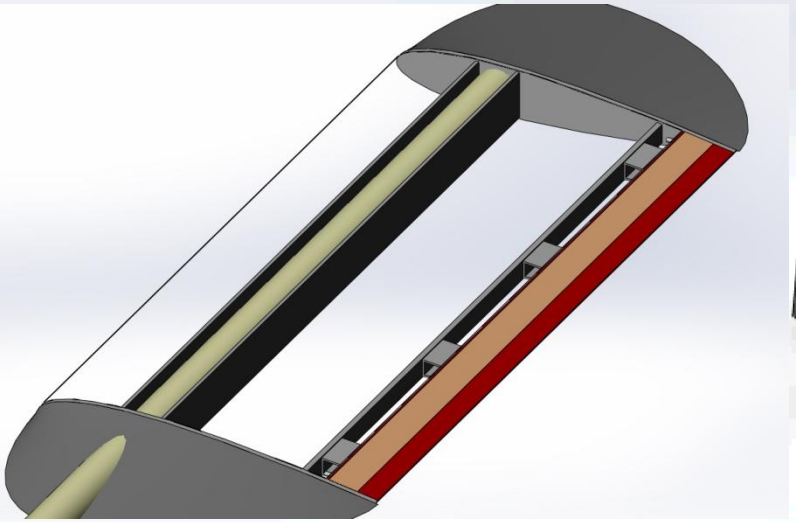
# A novel rotating test rig based on a 100 kW turbine platform

# Flaps to be tested on a rotating outdoor test rig

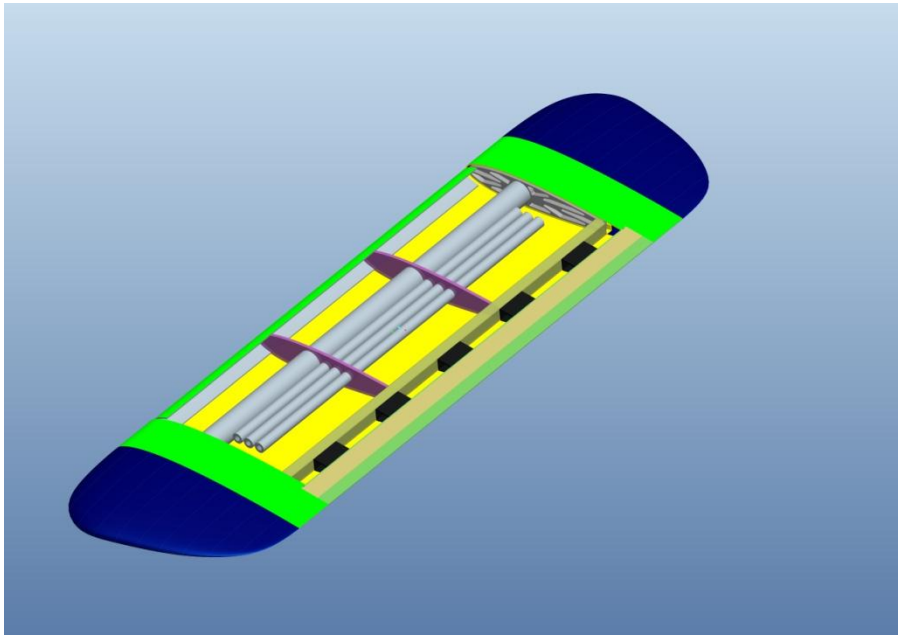
Test rig based on a 100 kW turbine.
Rotation of a 10m long tube with an airfoil section of about 2x1m



# The rotating outdoor test rig based on a 100kW turbine platform



# Design and manufacturing of 2m wing section with a 15% flap



# Outlook

- tests of flap system and control procedures on the rotating rig in spring/summer 2013
- fatigue tests of flap system in laboratory autumn 2013
- late 2013 evaluation of the flap system for a full scale turbine

# Acknowledgement

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- Rehau
- Hydratech Industries Wind Power
- Dansk Gummi Industri
- DTU (Elektro, Fiberlab, AED)


Thank you for
your attention
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