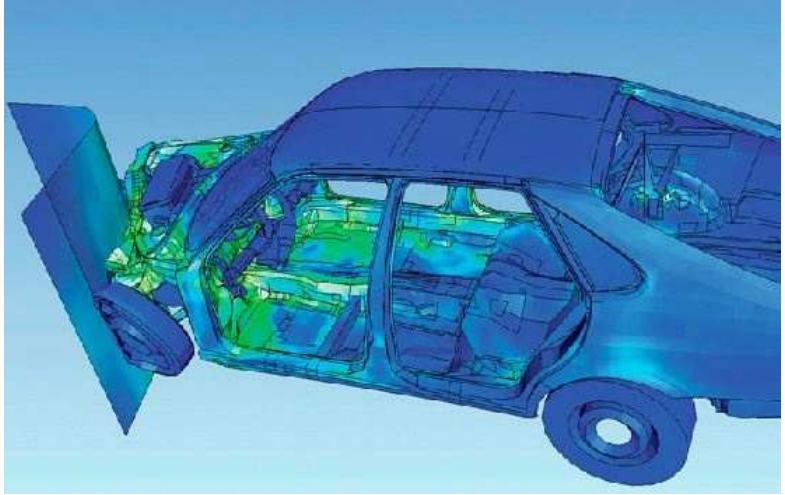


Solid and Fluid Mechanics

15 maart 2012

René Delfos - Coordinator Solids & Fluids

r.delfos@tudelft.nl **(015-27) -82963**

TU Delft

Delft University of Technology

Why study ‘Solid and Fluid Mechanics’?

- Some examples:
  - Rattleback
  - Golf ball
  - Euler’s Disc
  - Fingering ‘Saffman-Taylor instability’

Why study 'Solid and Fluid Mechanics'?

- How much (in my design)?

  (deformation, resonance frequency)

  -> <u>ME-PME</u> (Precision and Microsystems Engineering)

- How much? (in my design)

  (chemical conversion, power production)

  -> <u>ME-SPET</u> (Sustainable Process & Energy Technology)

- **Why** (and we still might use it in a design)?

  ('what is the underlying physics')

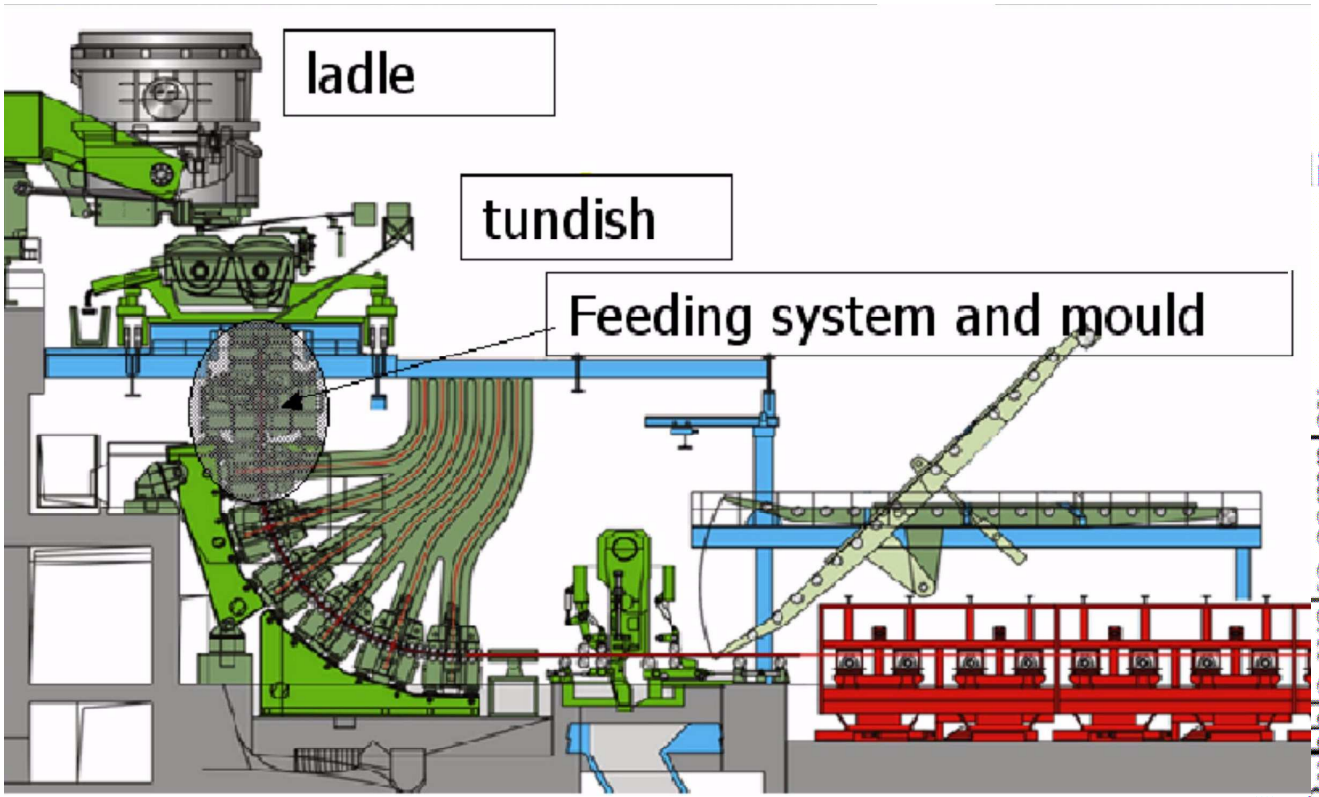
  -> **ME-SFM (Solid and Fluid Mechanics**

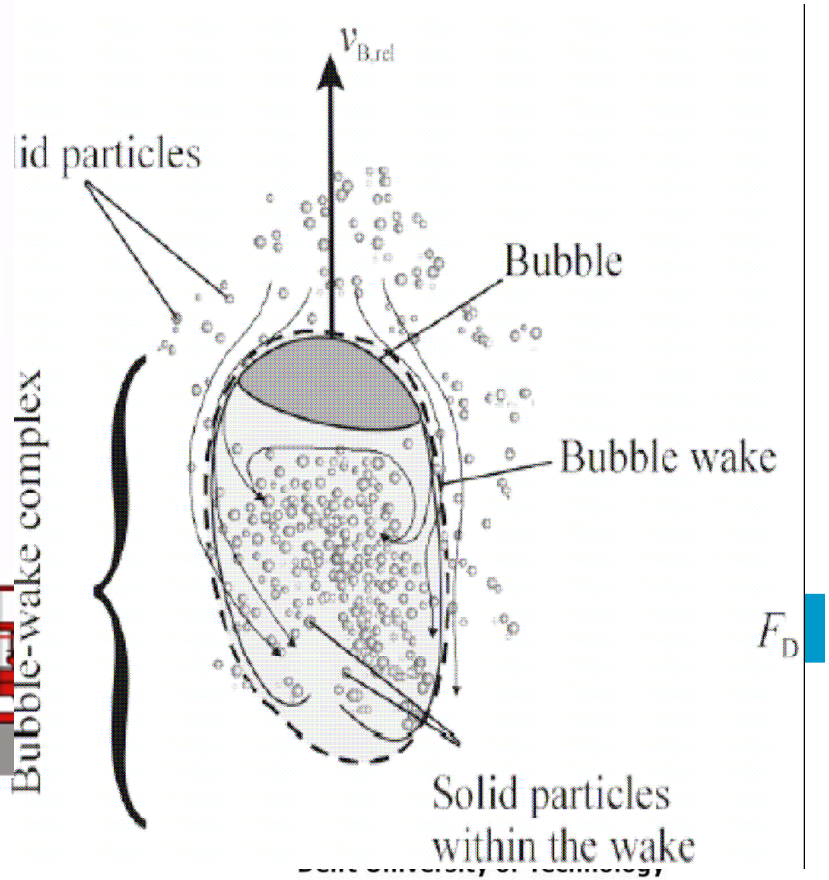
SFM is about the fundamentals of Mech. Eng.

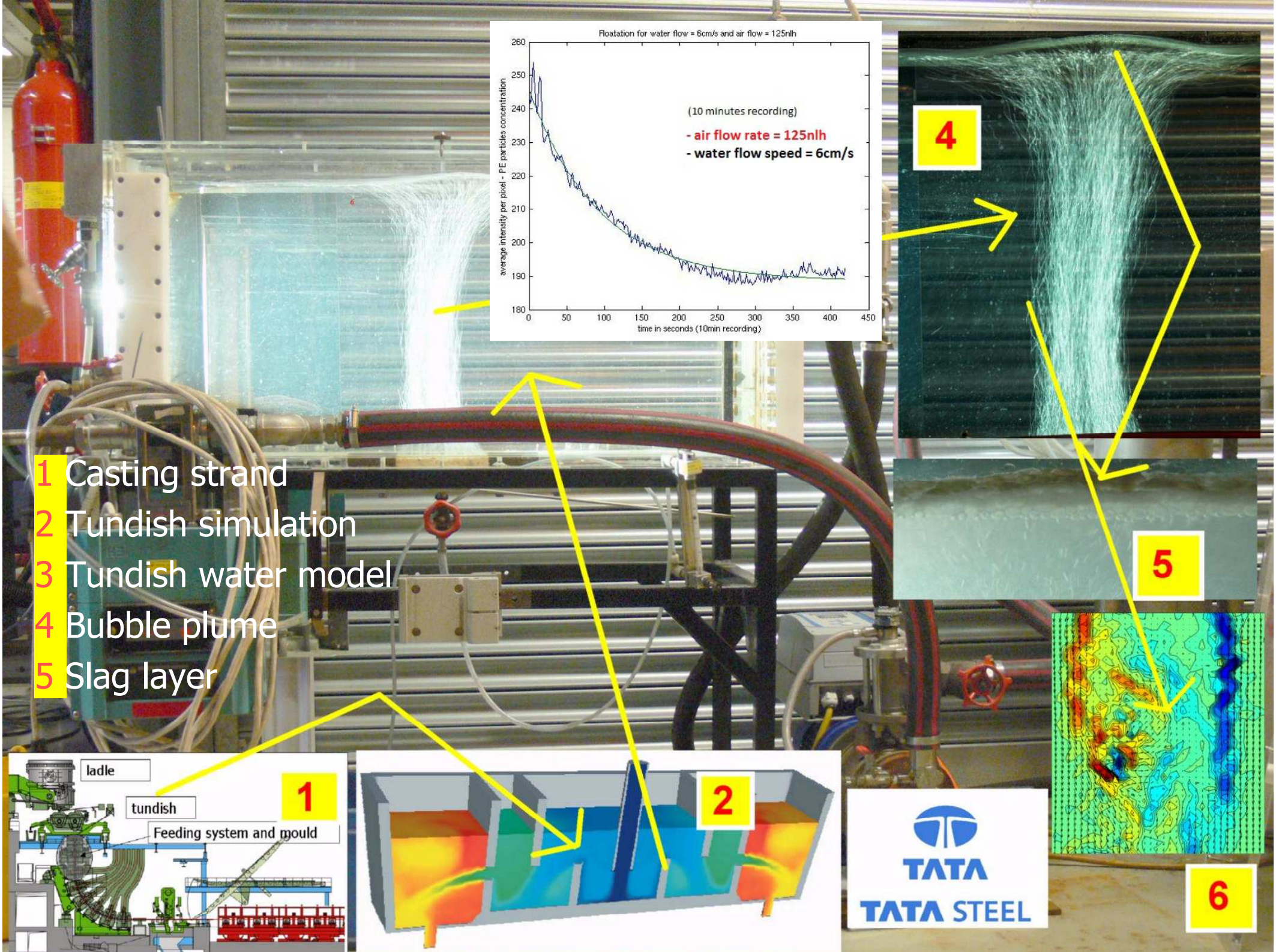
Multi-phase flow: flotation

- Can we improve steel quality (i.e., remove solids from liquid steel) using rising gas bubbles?

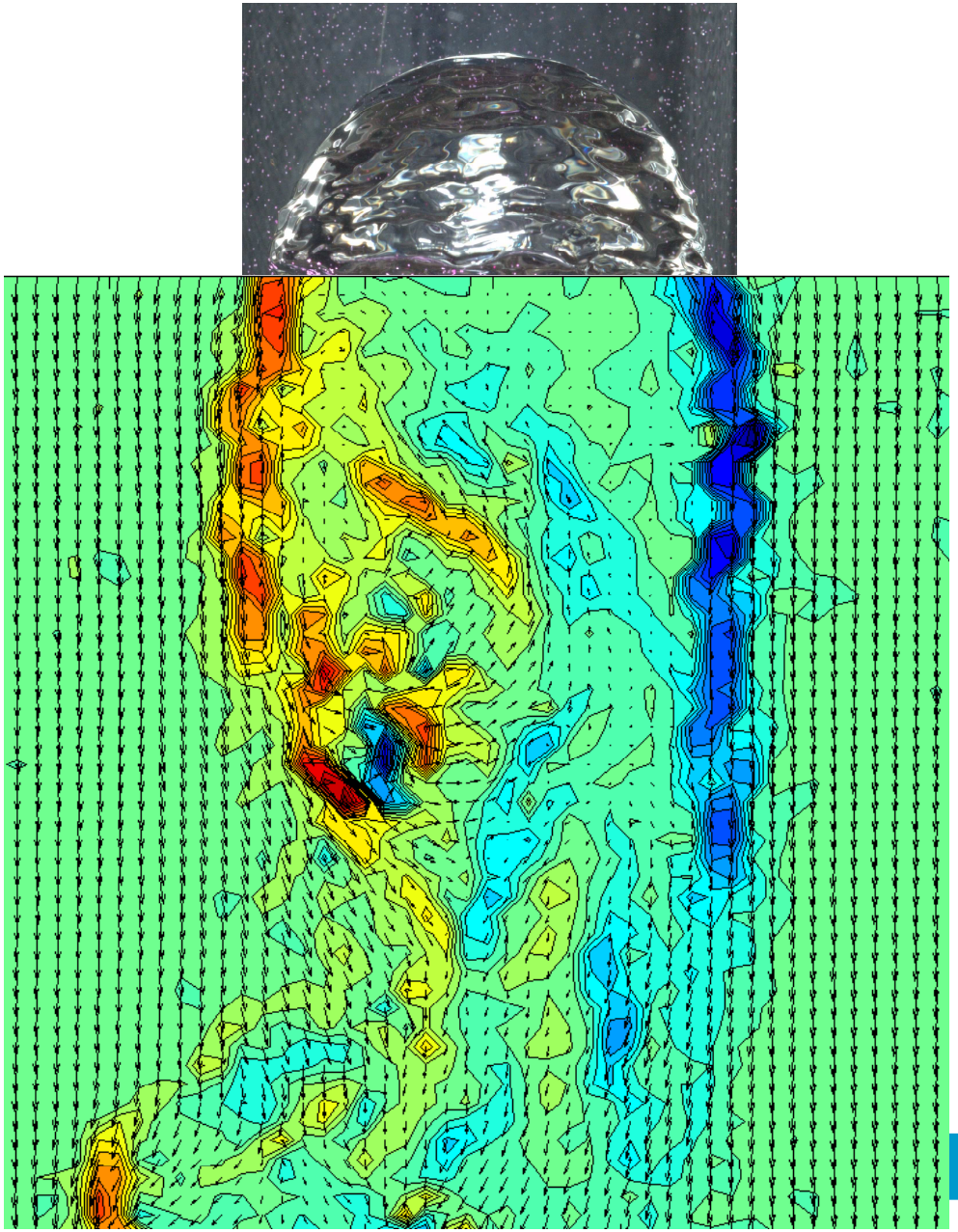
->Q: Wake or surface 'capture'?

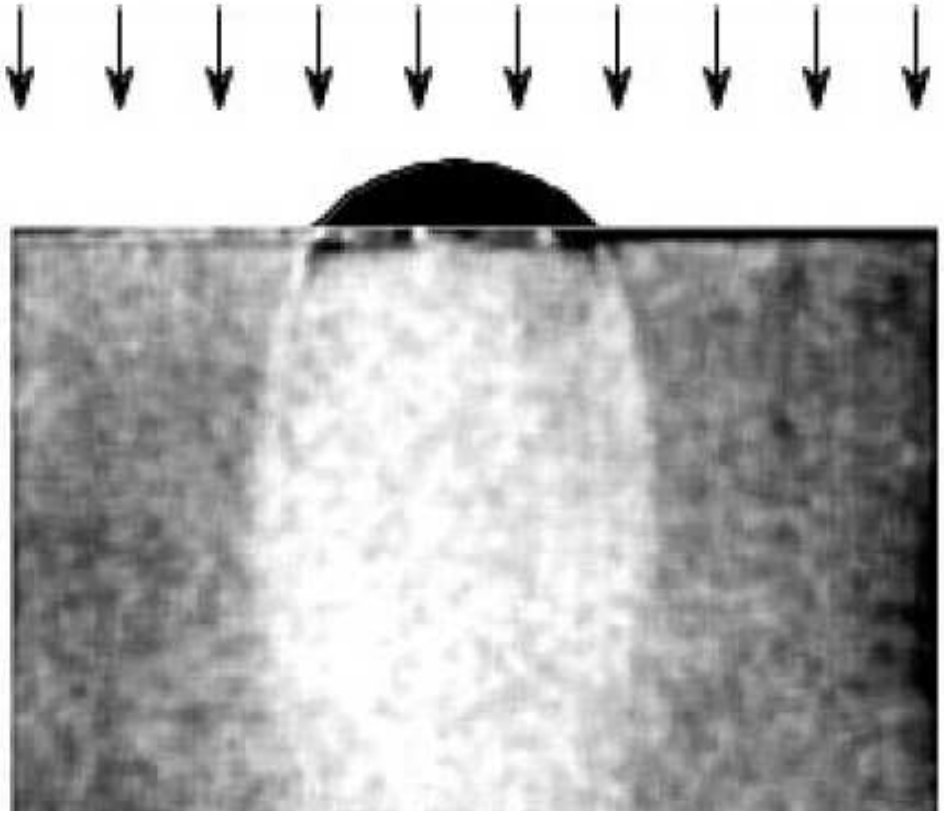


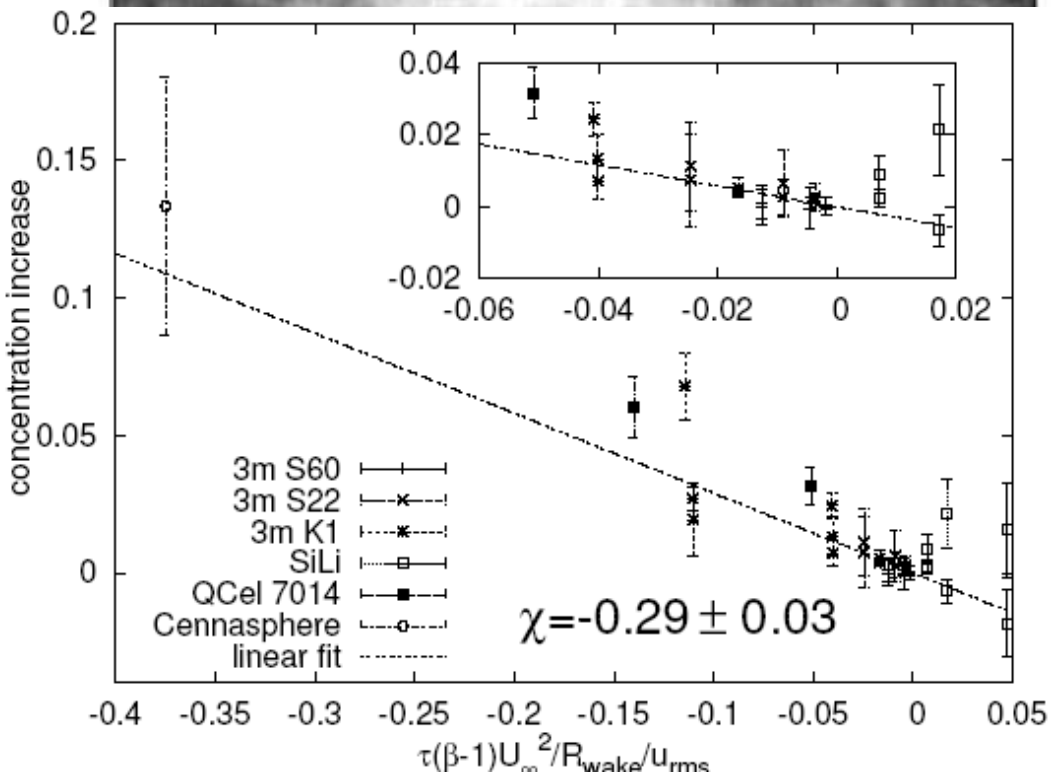



Floatation for water flow = 6cm/s and air flow = 125nlh
average intensity per pixel - PE particles concentration
time in seconds (10min recording)
(10 minutes recording)
- air flow rate = 125nlh
- water flow speed = 6cm/s
4
5
6
1 Casting strand
2 Tundish simulation
3 Tundish water model
4 Bubble plume
5 Slag layer
ladle
tundish
Feeding system and mould
1
2
TATA
TATA STEEL

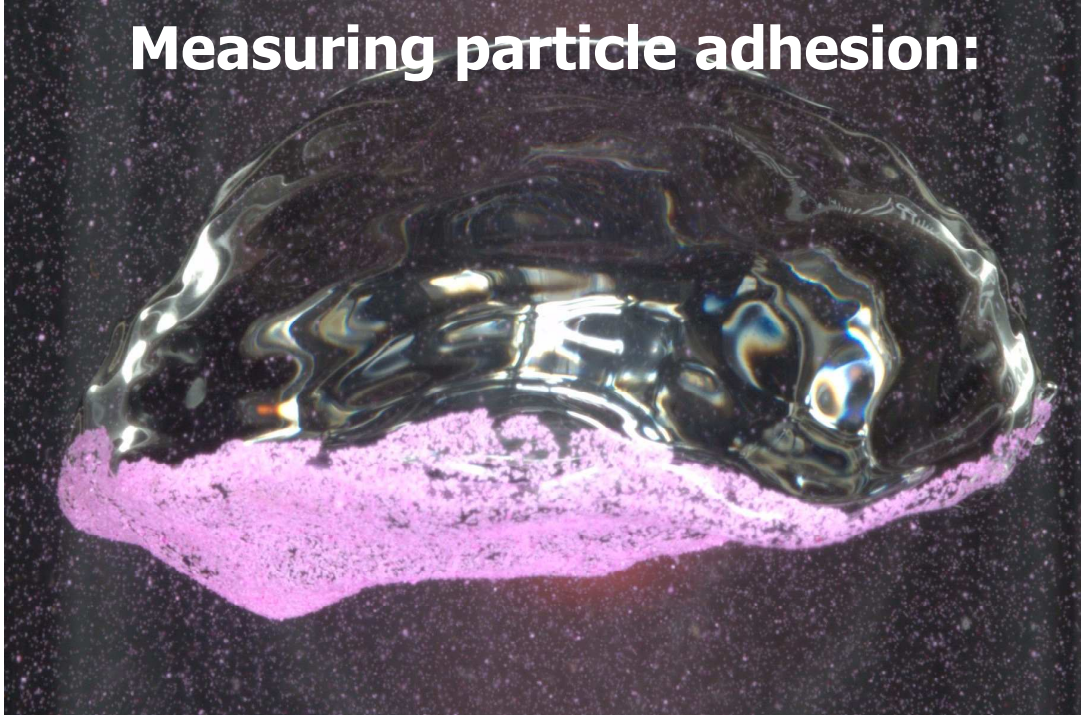
Measuring the flow field &

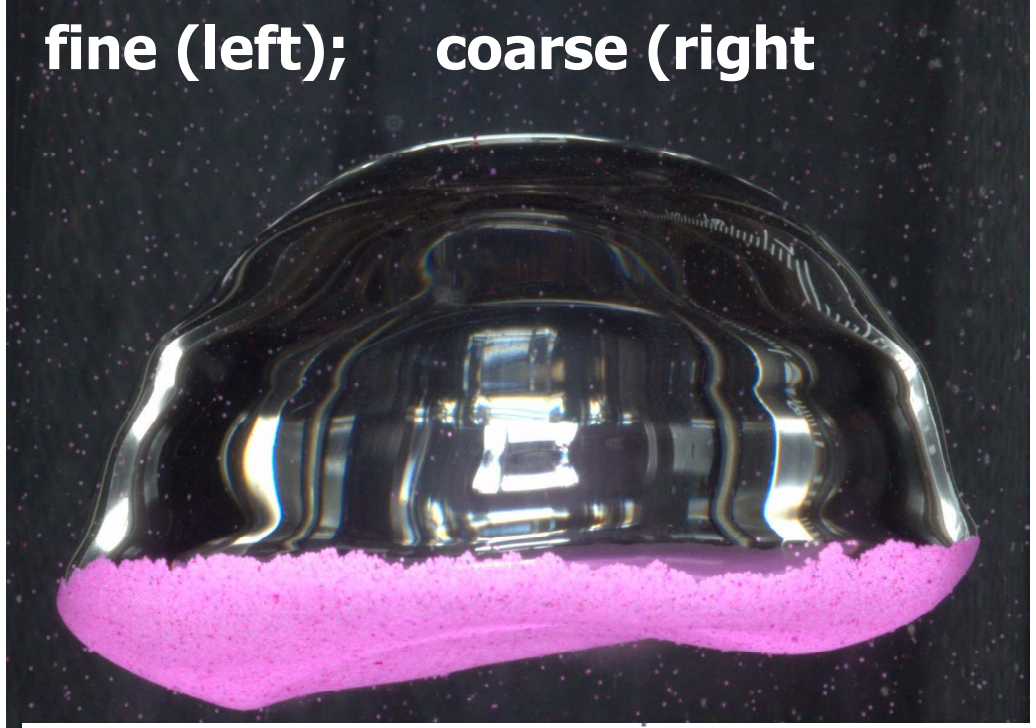


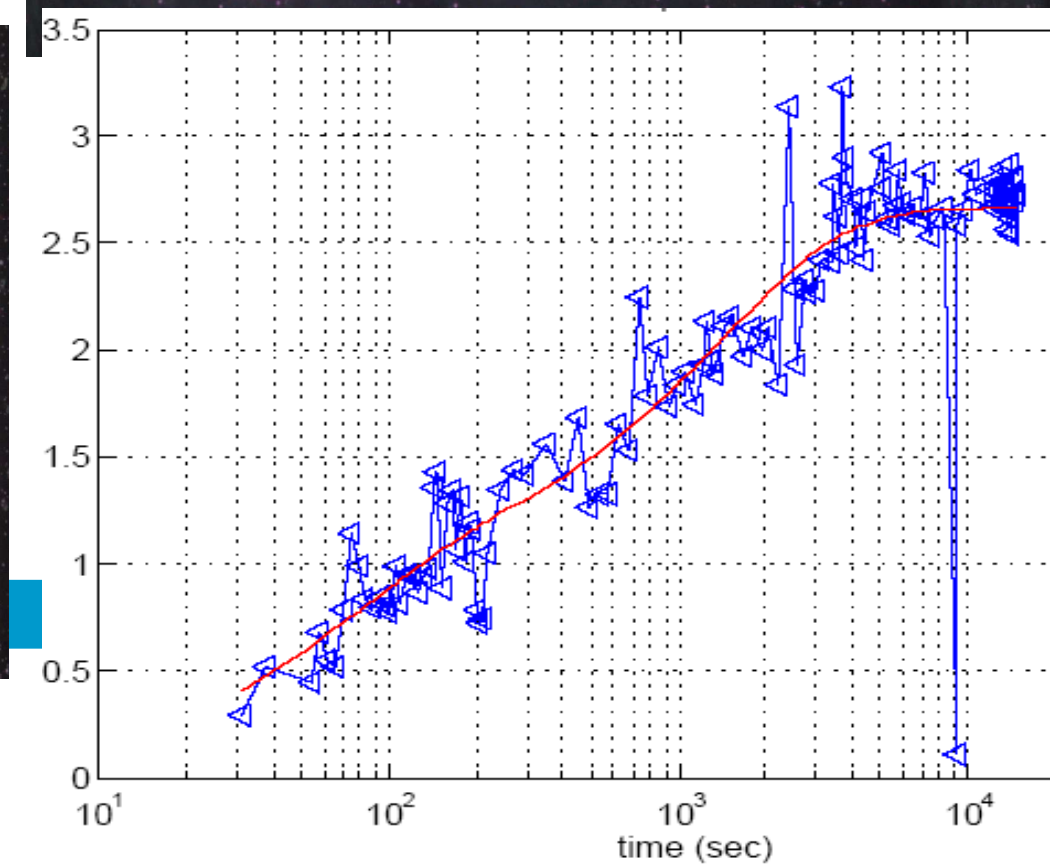




Measuring particle adhesion: fine (left); coarse (right







Program layout

Courses (1st year)

- Obligatory SFM: ~ 28 ECTS
- Obligatory specialisation: ~ 12 ECTS
- Elective: 20 ECTS or more
- Total ~ 60 ECTS

Projects (2nd year)

- Internship 15 ECTS
- MSc project 45 ECTS

  of which 10 ECTS literature study

  with oral presentation.
- Possibility to combine internship and MSc project.
- For instance:

  Internship in Industry

  -> MSc project at University

  or vice versa

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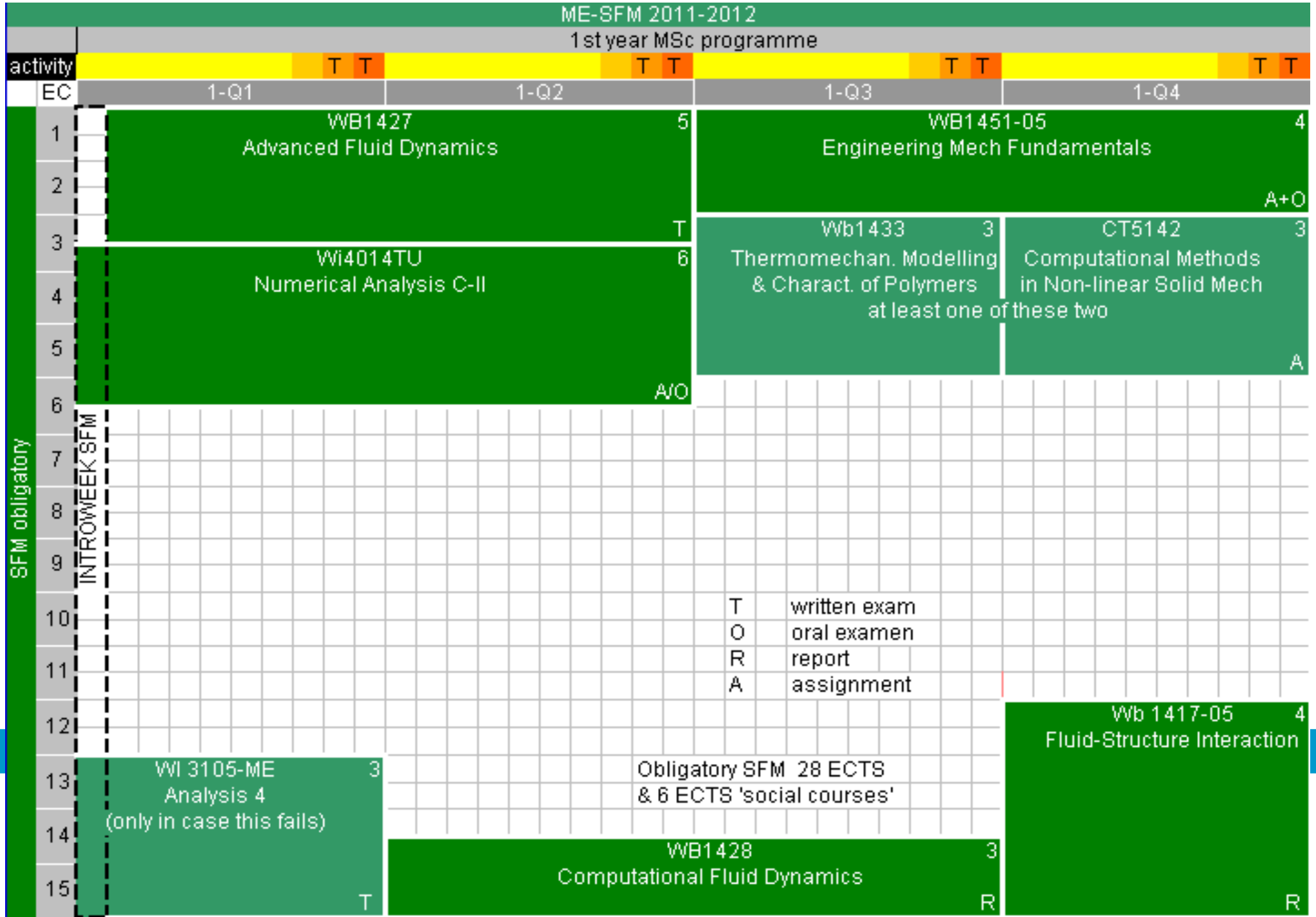
Modulekaart = vakkenverdeling



Specialisations

FLUID MECHANICS

part of P&E (Process & Energy Technology) dept.

- **Fluid Mechanics**
  Westerweel, Boersma, (Ooms, Eckhardt), Delfos

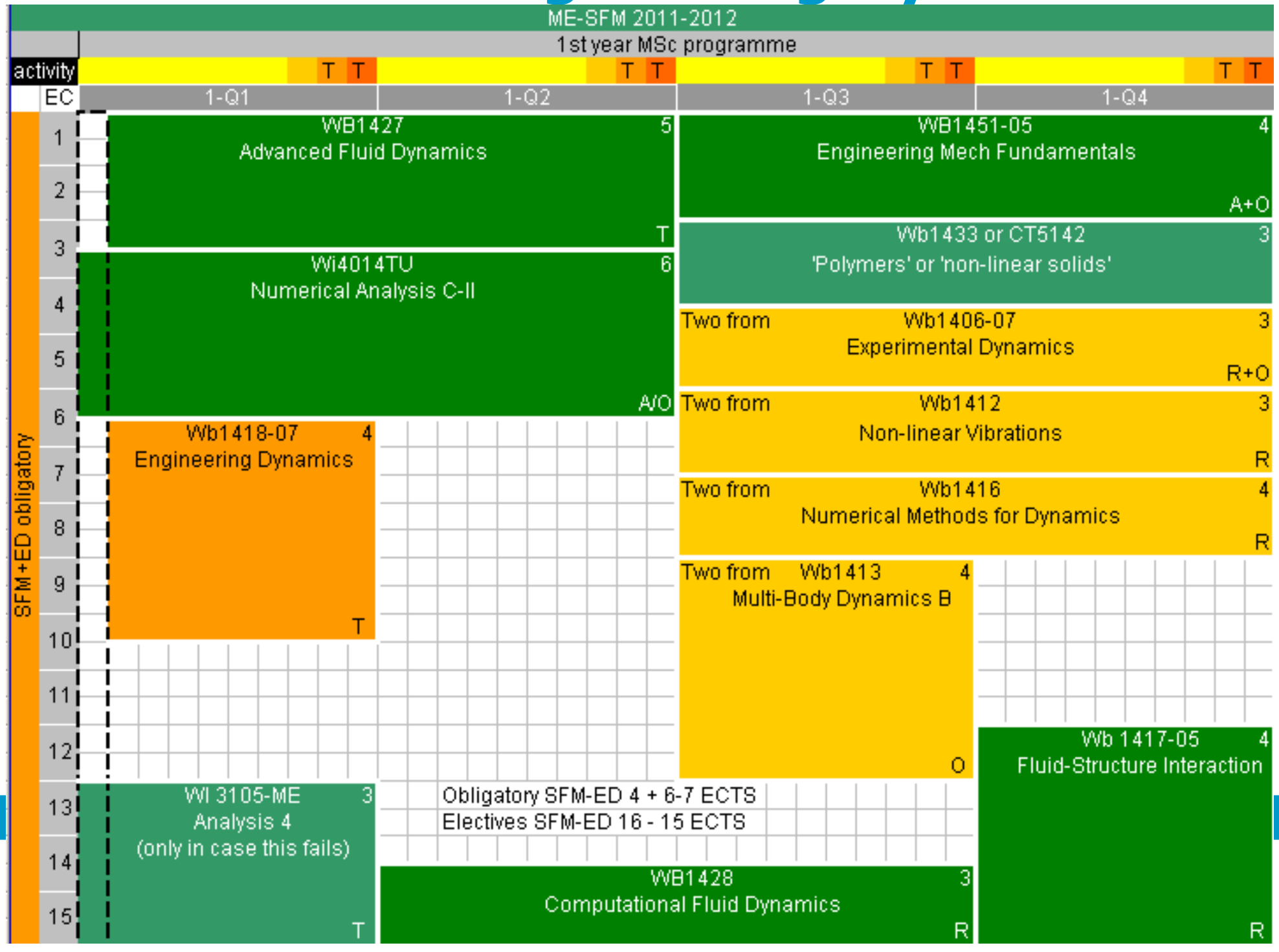
ENGINEERING MECHANICS

part of PME (Precision and Microsystems Engineering) dept.

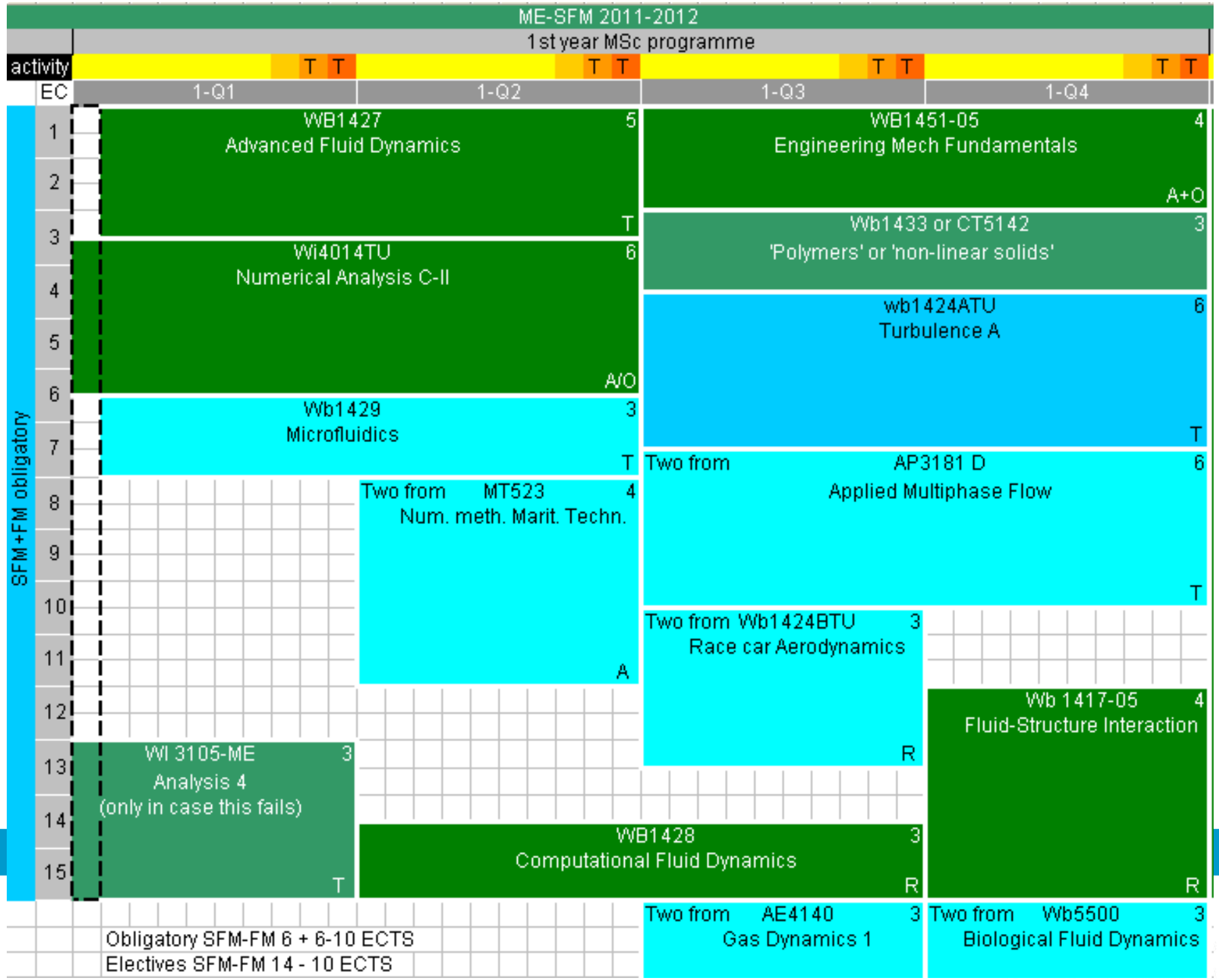
- **Engineering Dynamics**
  Rixen, (van Woerkom, Schwab)

- **Structural Optimization and Computational Mechanics**
  van Keulen, (Zhang), Goosen

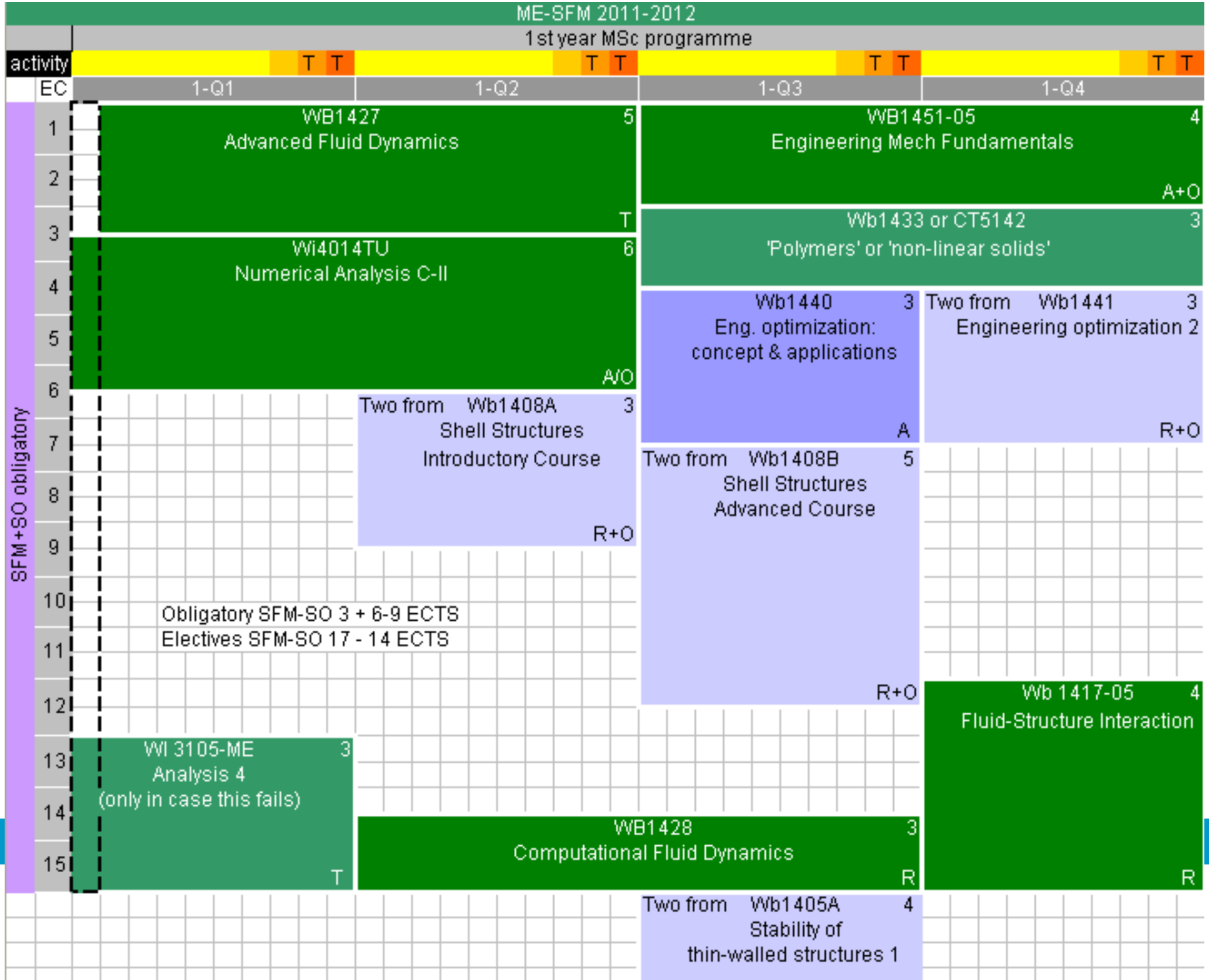
Modulekaart Engineering Dynamics



Modulekaart Fluid Mechanics



Structural Optimization and Computational Mechanics



Internship (stage) 15 EC (niet voor ex-HBO!)

Internship can be done abroad:

Recent in California-Davis, ETH (Zürich), Osaka, NTNU, DLR (Göttingen), Numeca (Brussels)…

But more local is possible as well;

Recent in TUDelft, Teijin, Heerema…

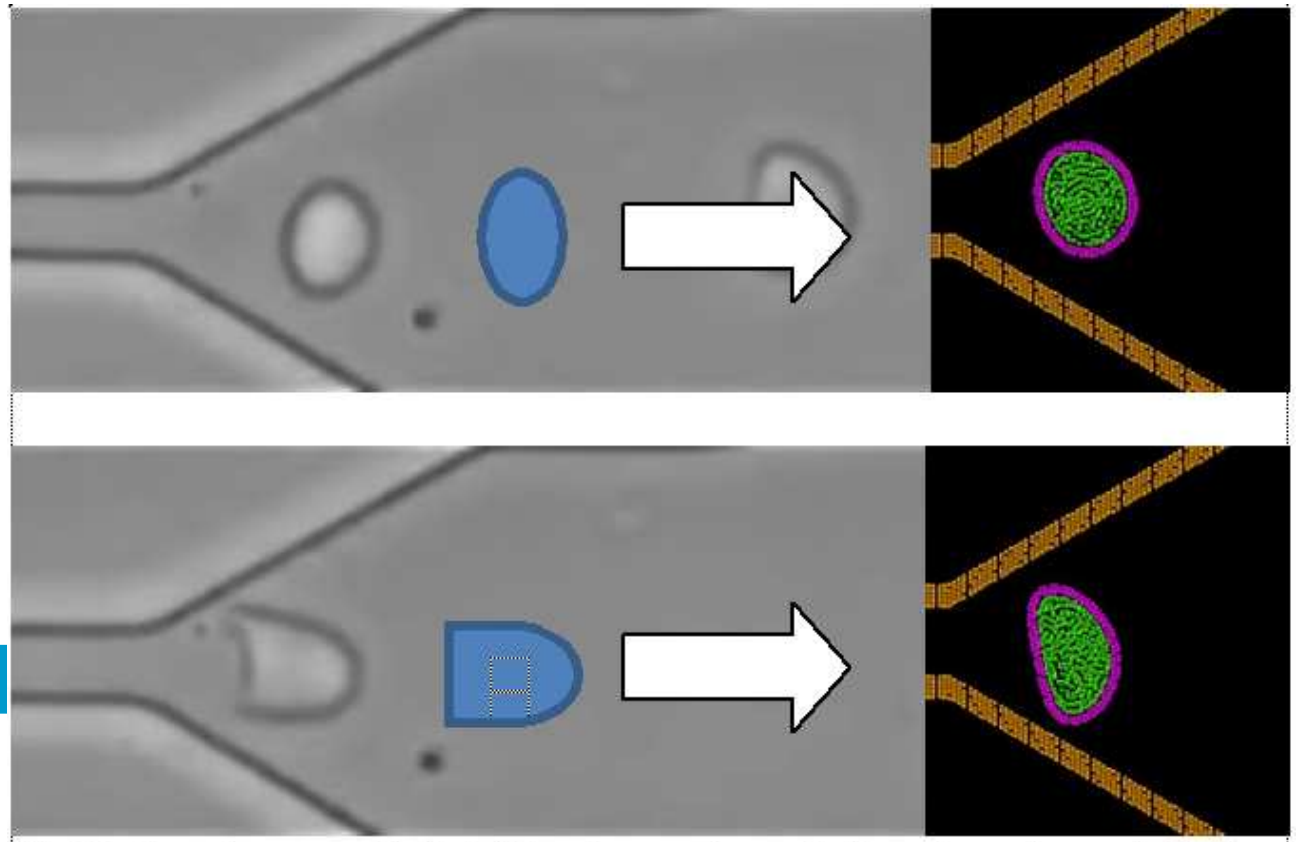
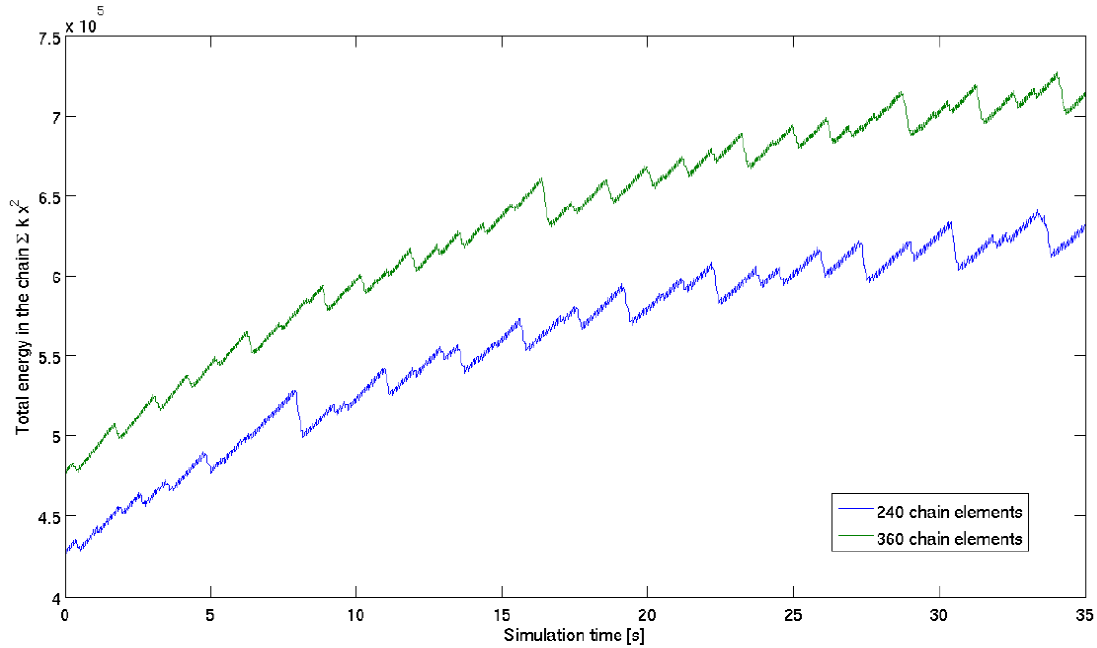
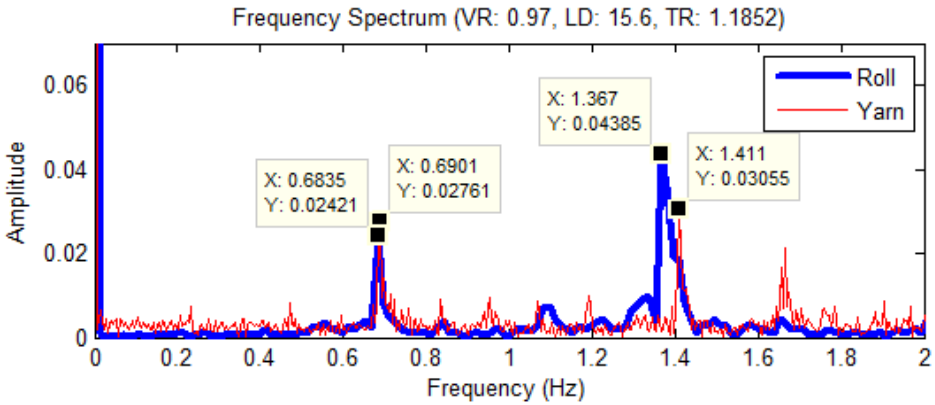


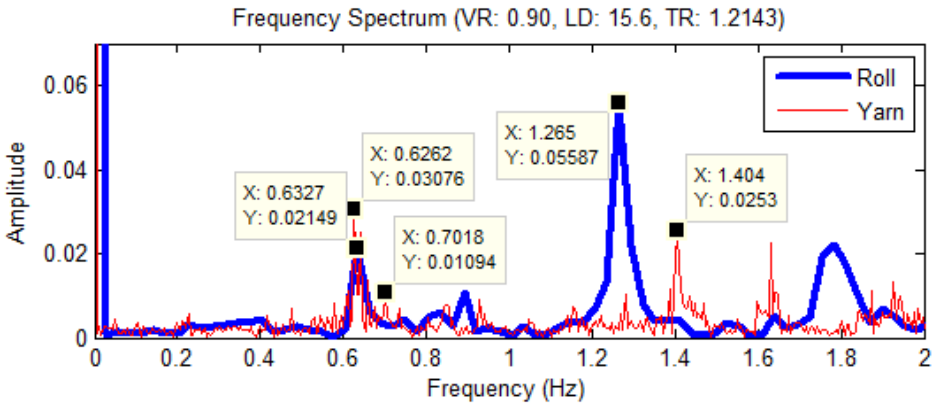
Fig.16 Top shows a cell that takes longer through the micro channel. Bottom shows a cell that goes quickly.

Internship (2)

Teijin (production of Aramid-fibe

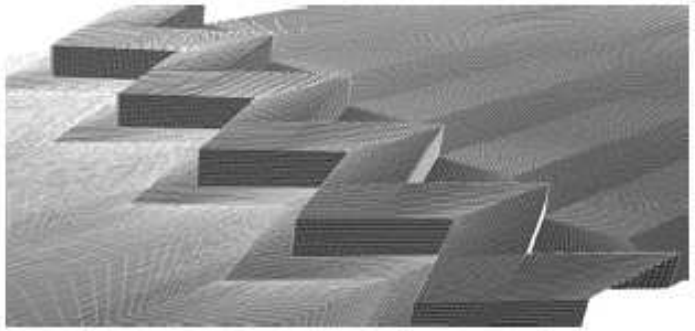


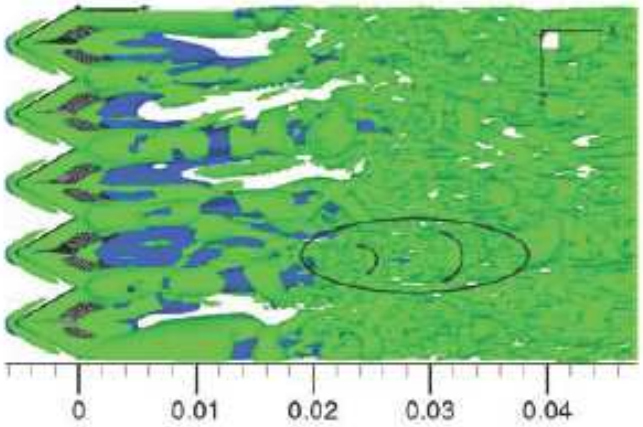


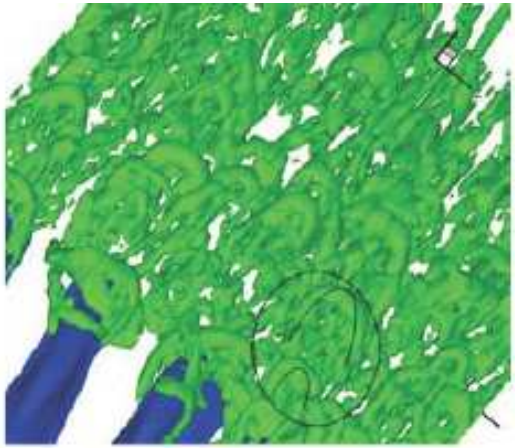


Master-thesis project 45 EC

Can be done in a company, usually in ‘your laboratory’.

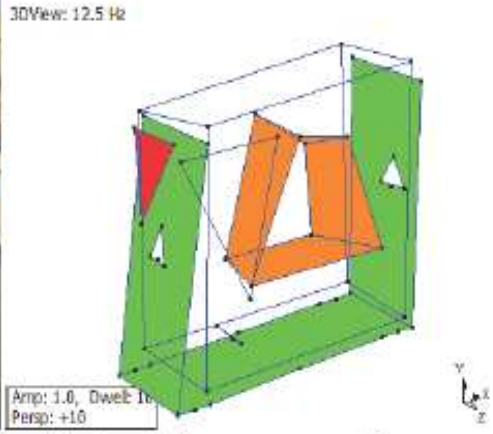






Prediction of turbulent transition through ‘trip wires’ using flow simulation.

Prediction of CT-scanner floor stability



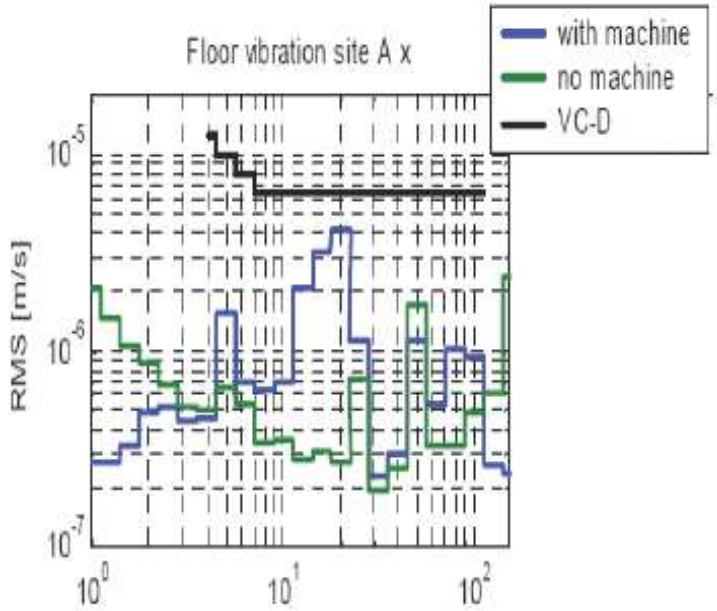


Figure 1 Philips CT system with performance dependent on floor properties

The next step in your career:

- Industry (R&D):
  - Philips, Shell, Tata (Corus), Akzo-Nobel, DSM, ASML …
  - Canon-OCE, Bronkhorst, NXP, BMW …
  - GTI's: TNO, MARIN, NLR, …

  - Process technology, chemical industry, metal industry, energy technology, aeronautics,
    dredging industry, automotive industry, wind energy, climate control, food & health, meteorology, …

- University (obtaining a Ph.D.): some 50% of SFM-students!
  - 'Education in research'. Later on, R&D or University

FLUID MECHANICS

Fluid Mechanics Section

- 2 full-time prof: J. Westerweel, BJ. Boersma
- 2 part-time prof: G. Ooms, B. Eckhardt

- 5 U(H)D: R. Delfos, M. Pourquié,
  C. Poelma, WP. Breugem, Gerrit Elsinga

- 1 post-doc, 12-14 Ph.D. students.

- Yearly 8-10 M.Sc. students (in SFM, SPET, AP)

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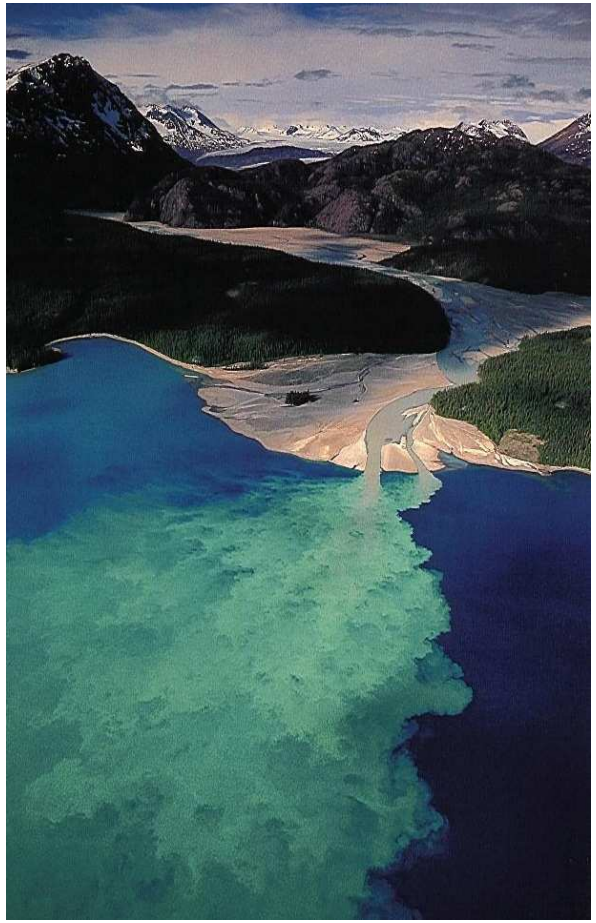

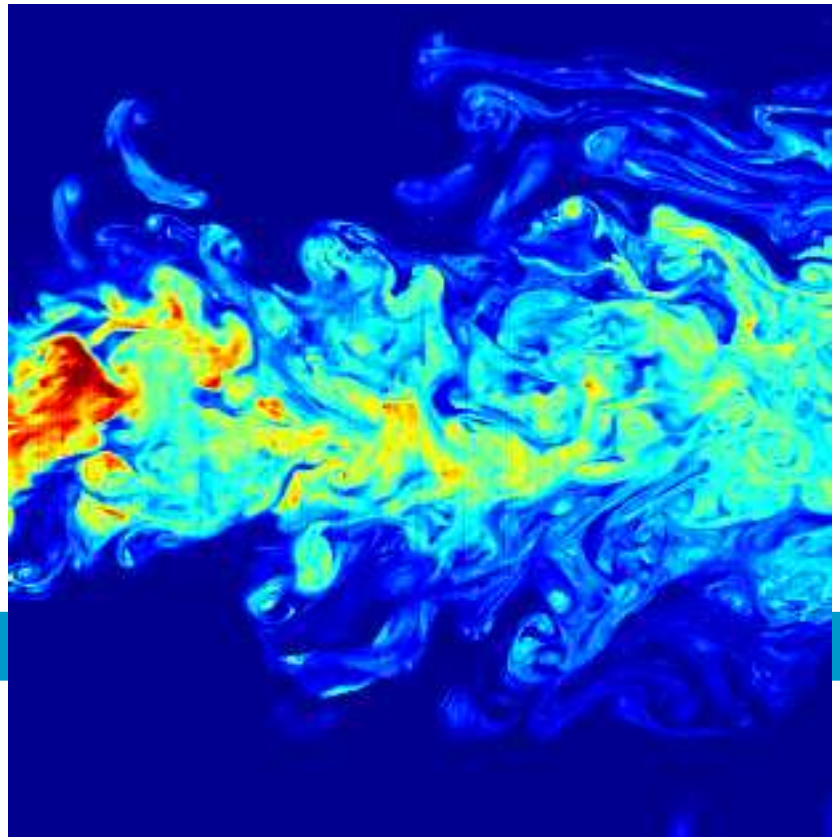

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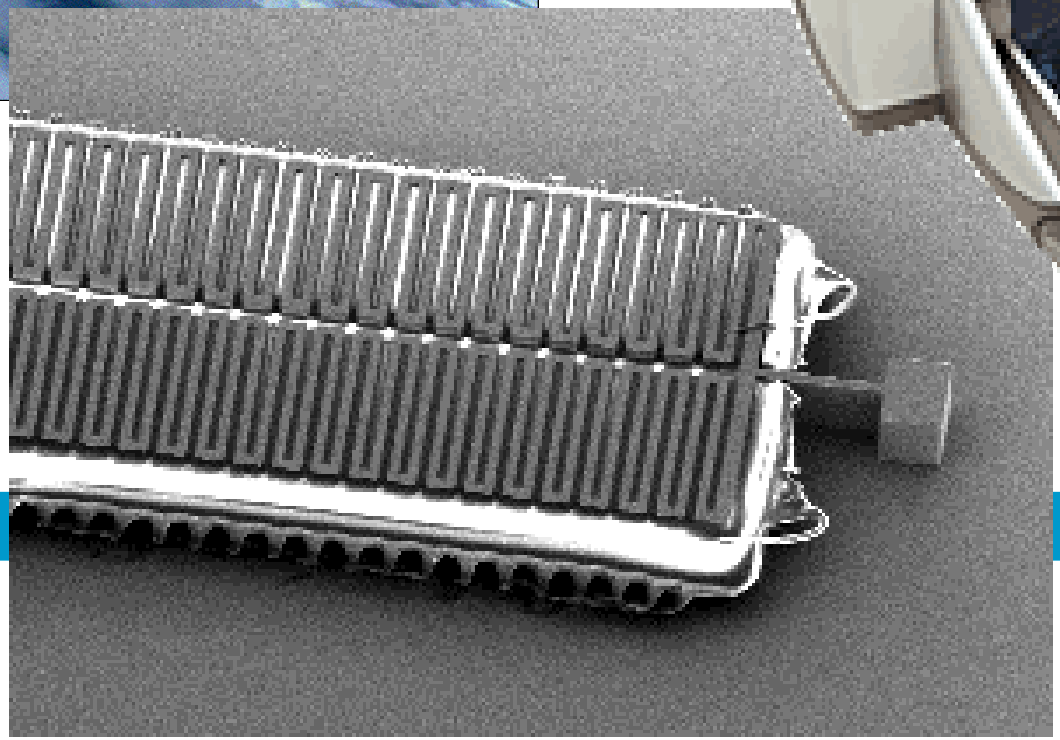
SOLID MECHANICS

Engineering Mechanics



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Engineering Mechanics Groups

- Engineering Dynamics
  (Rixen, v. Woerkom, Schwab…)



- Structural Optimization & Computational Mechanics
  (van Keulen, Goossen, Langelaar…)



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Research Focus
Engineering Dynamics

Focus:
- Multifield
- Multibody
- Dynamics & Statics

Application Fields:
- Microsystems
- Mechatronics

Aspects:
- Fundamentals
- Numerical Methods
- Experimental Techniques

But also:
- Aerospace
- Biomechanics
- Sports
- Automotive

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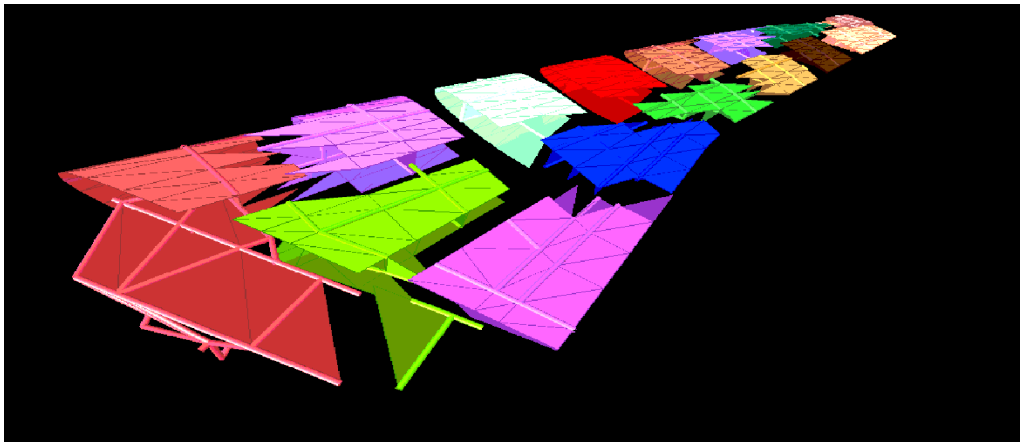
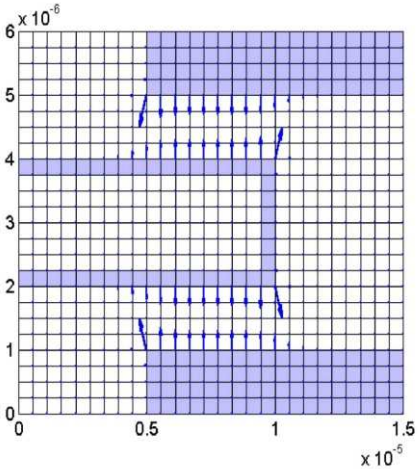
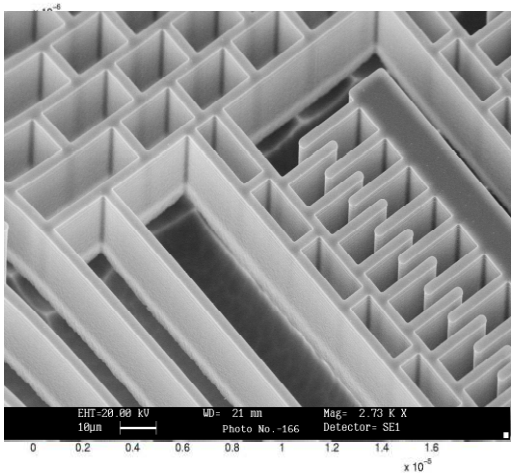
Examples
Engineering Dynamics







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Research Focus
Structural Optimization & Computational Mechanics

Focus:
- Multifield
- Multilevel
- Statics & Dynamics

Aspects:
- Fundamentals
- Numerical Methods
- Optimization and Design
- Experimental Validation

Application Fields:
- Micro-devices and Micro-systems

But also:
- Aerospace
- Biomechanics
- Maritime

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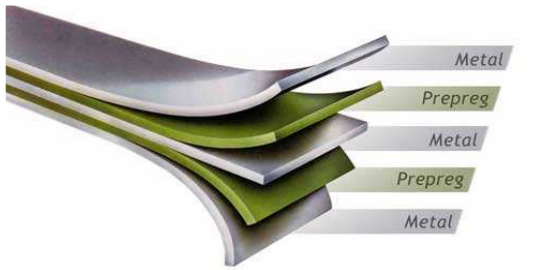
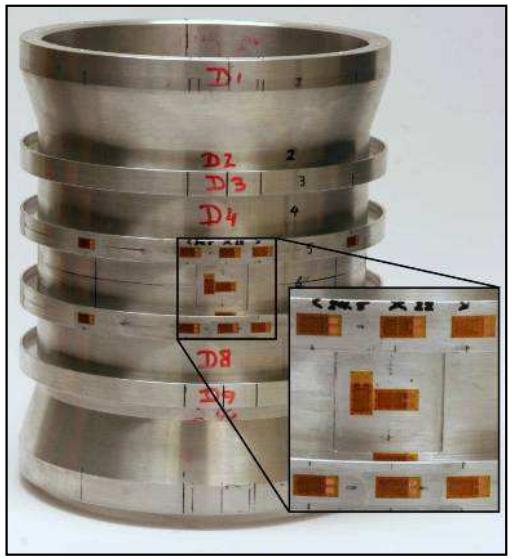
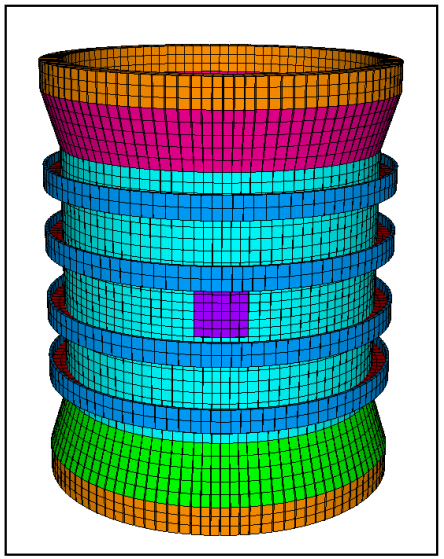
Examples
Structural Optimization & Computational Mechanics







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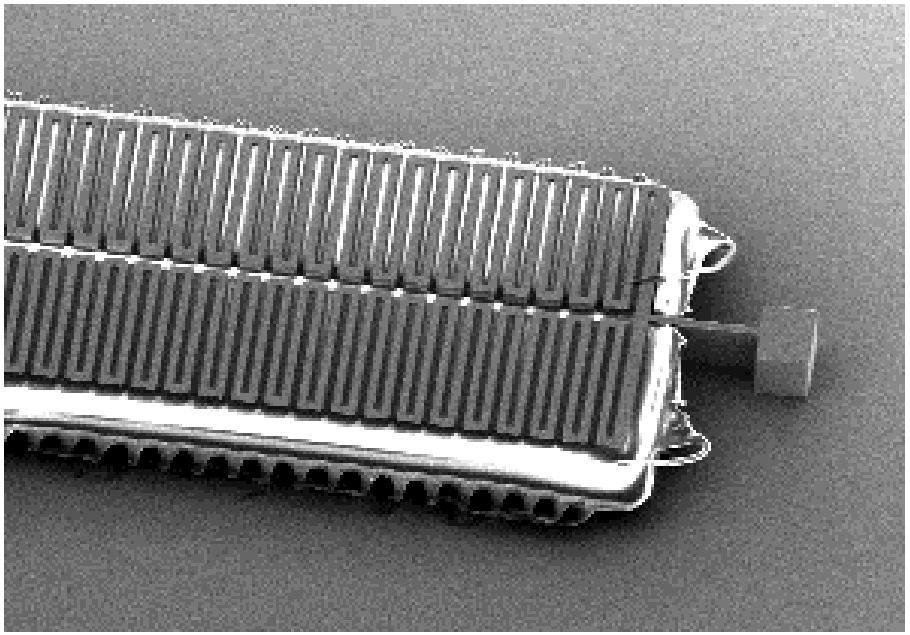
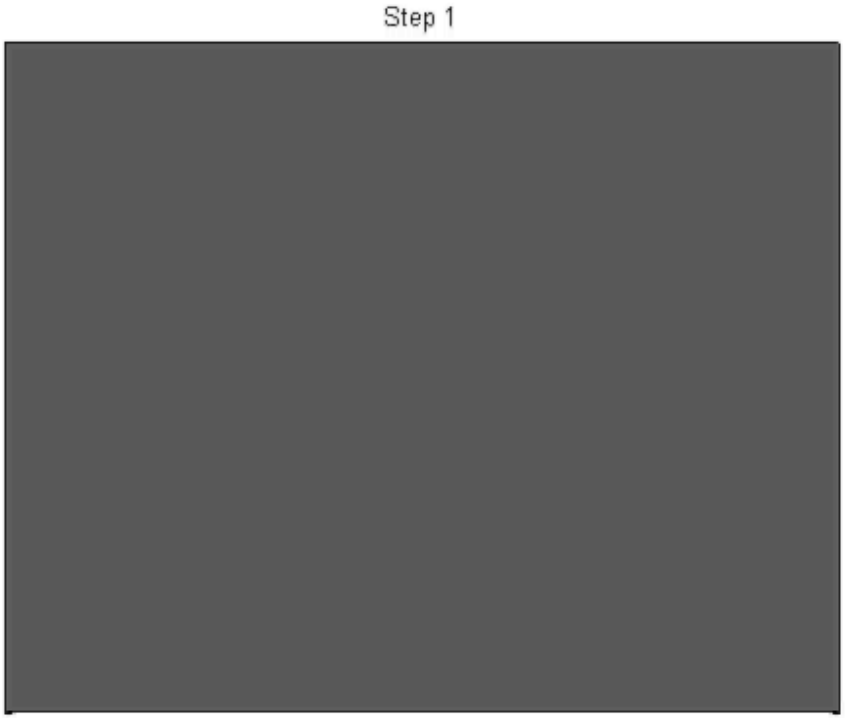
Examples
Structural Optimization & Computational Mechanics





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Examples of Collaboration

- Infineon
- NXP
- Philips (research)
- ASML
- Dutch Space
- ESA
- AOES
- Bronkhorst High Tech
- Aquamarijn
- OCE
- Univ. of Leeds
- Imtek
- Airbus
- Bosch
- BMW
- Univ. of Stuttgart
- Univ. of Florida
- Technion
- Chalmers

(slightly) different interests?

SOLID MECHANICS

- Join the presentation next week of
  Precision and Microsystems Engineering (PME)
  (or contact dr.ir. Jan Neve, PME-coordinator)

FLUID MECHANICS

- You maybe joined the presentation last week of
  Sustainable Processes and Energy Technology (SPET)
  (or contact dr.ir. Joop ter Horst, SPET-coordinator)

Or just pass by with questions...

CAREER OPPORTUNITIES

- as a participant in the excellence track, you will be in contact with several academic fields and in the spotlight of various industries
- due to your knowledge of fluid and solid mechanics, you will be highly qualified for both industry and technological institutes

INDUSTRIAL, ECONOMICAL & SOCIETAL IMPACT

- energy (wind energy, climate control, batteries, combustion, mechanics in fusion reactors, …)
- environment (dispersion in urban areas, flow generated noise, acoustic shielding, ...)
- health & bio (lab-on-a-chip, injury mechanics, bio-mimetics, …)
- modern engineering products and materials (flexible and stretchable electronics, intelligent cooling, new printing technology, advanced smart- and super-materials, ...)
- transport in fluids and solids (granular flow, enhanced oil and gas recovery, …)

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TU/e Technische Universiteit Eindhoven University of Technology

UNIVERSITY OF TWENTE.

3TU.

Questions?

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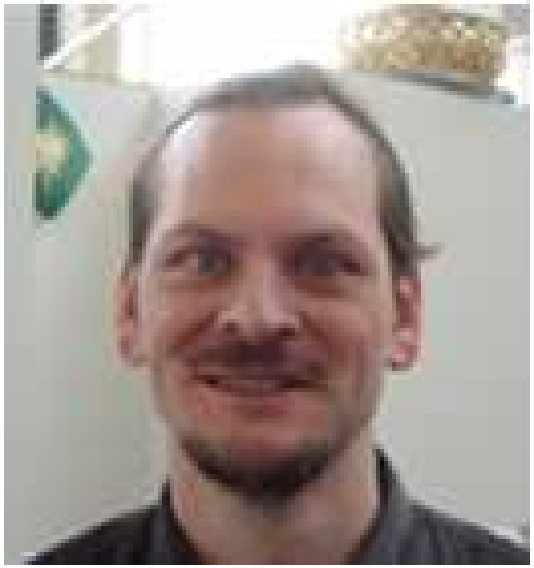
phone 82963 r.delfos@tudelft.nl
EM: Hans Goosen Room 4B-1-25
phone 82963 j.f.l.goosen@tudelft.nl



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