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Lab in Tube Interdisciplinary Semester Project

Micro catheter equipped with temperature and flow sensing

Spring 2022 EPFL

Prof. Stéphanie P. Lacour

EPFL-STI LSBI

Dr. Yves Leterrier

EPFL-STI LPAC
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Dr. Massimo Mariello

EPFL-STI LPAC

Dr. Haotian Chen



Welcome!

- **Team 1** (mentor Massimo Mariello)
 - David Niederhauser (MT)
 - Kateryn Leon (GM)
 - Elise Joulain (SV)

- **Team 2** (mentor Haotian Chen)
 - Clément Albert (MT)
 - Monika Stasytyte (SV)
 - Pierre-Jean Martin (MT)

- **Team 3** (mentor Yves Leterrier)
 - Ahmed Eman (SV)
 - Desire'E Maula' (SV)
 - Philippine Milward (MT)

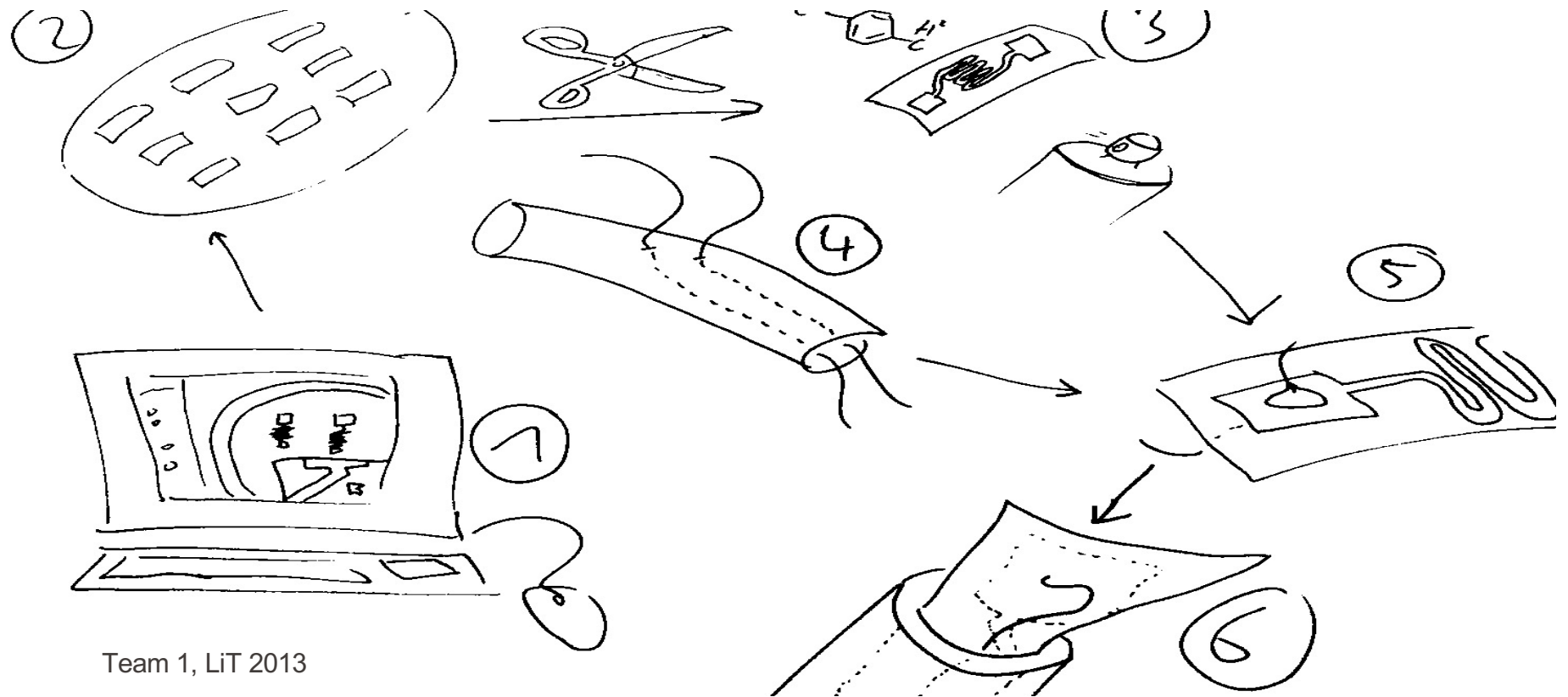
■ Scientific objective

- Propose and develop **your technological solution** for a “smart” catheter, i.e. a millimeter-sized tube with built-in temperature and flow sensing

■ Requirements

- The Lab in Tube system will reliably monitor:
 - Fluid temperature in the physiological range ($35 - 45\text{ °C} \pm 0.1\text{ °C}$)
 - Flow in the 10-100 mL/sec range.
- The sensor readout should be displayed in real time (Labview interface)
- The device(s) must fit tubes of 10 and 5mm diameter (bonus for 2mm $\varnothing$)

LiT seen from past students



Project steps

1. Design and manufacturing of the thin film sensors
2. Design and manufacturing of the sensors electronic interface
1. Integration
2. Evaluation, adjustment, validation
3. Report and presentation

Design and manufacturing of the thin film sensors

- Type of sensors

- Temperature sensors

- Metallic thermistance

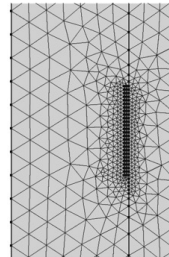
- $R(T) \approx R_0 (1 + \alpha (T - T_0))$

- Flow measurement

- Several circuit design based on a single and/or 2 devices (heat and measure)

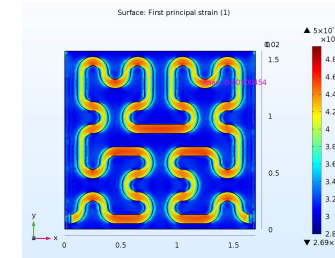
Design and manufacturing of the thin film sensors

- **Bendability**
- **Layout**
- **Fabrication**

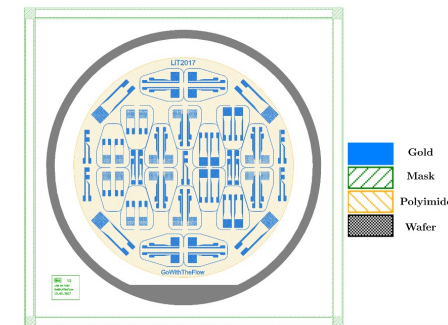


Finite Element Simulation

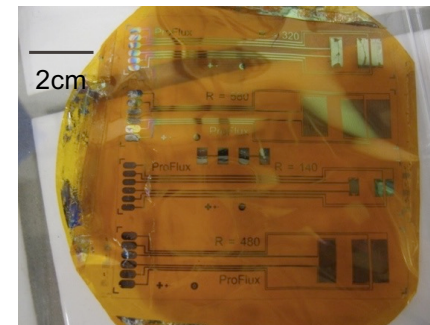
Temperature profiles



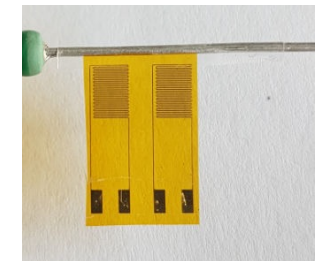
Strain profiles



Mask CAD design

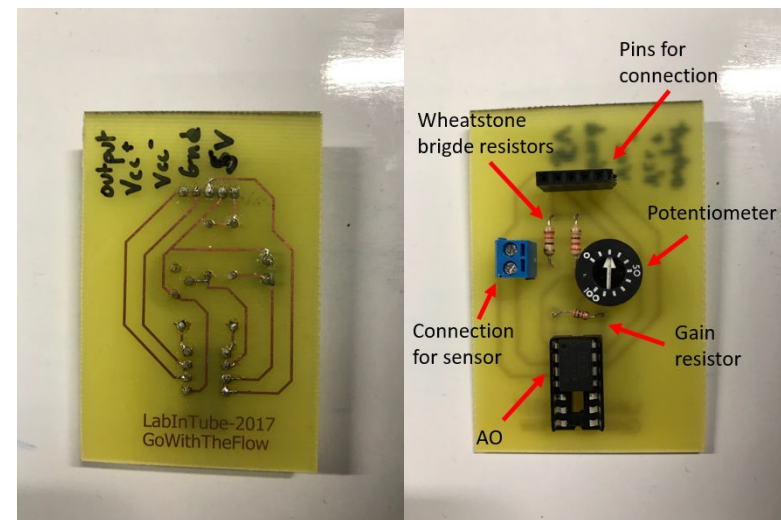
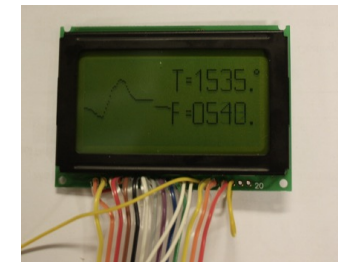
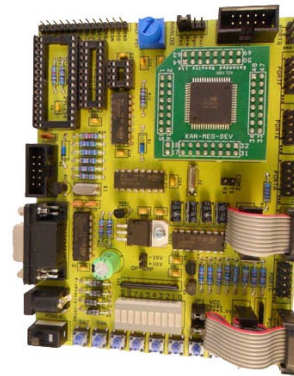
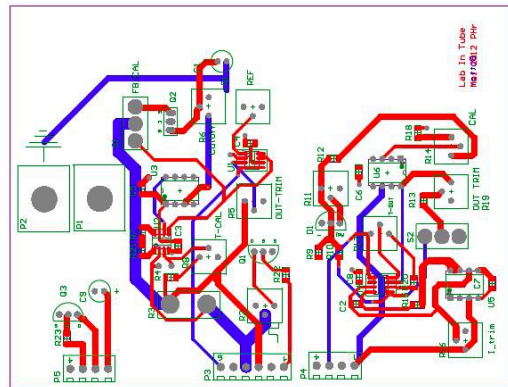
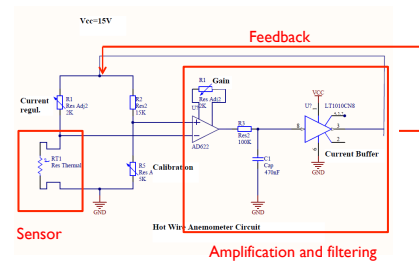


Microsensors on polyimide foil

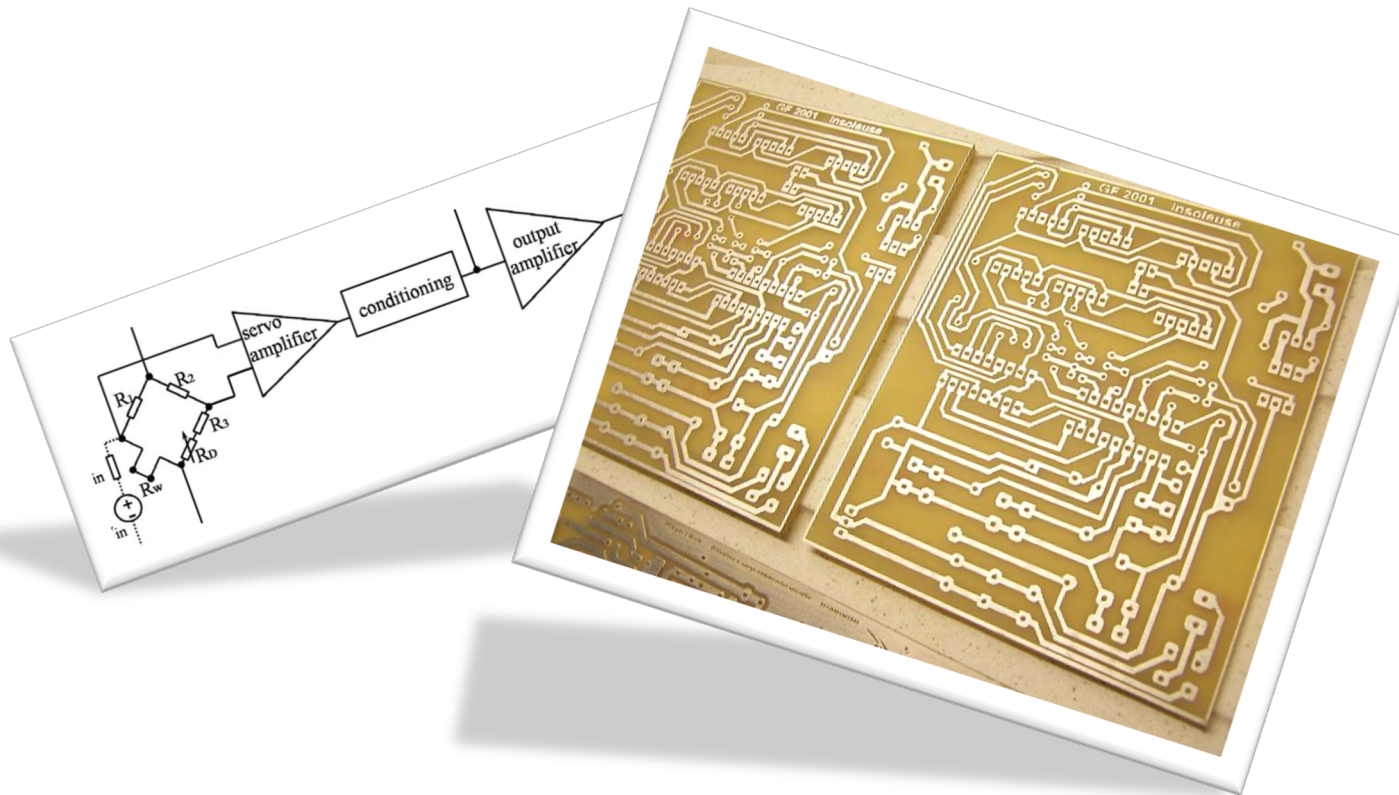


EPFL **Design and manufacturing
of the electronic interface**

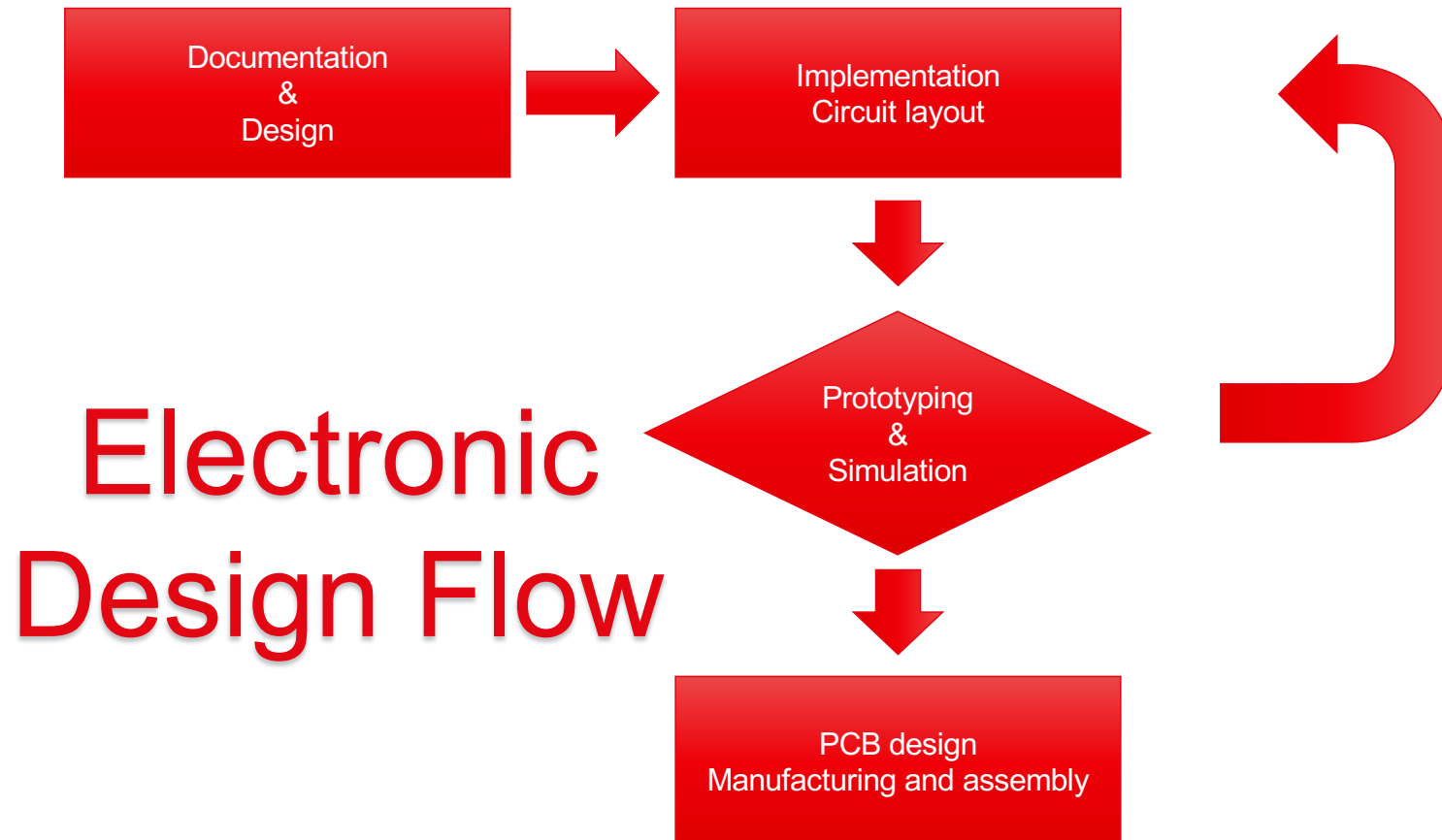
Analog & digital circuits



LiT : Electronique



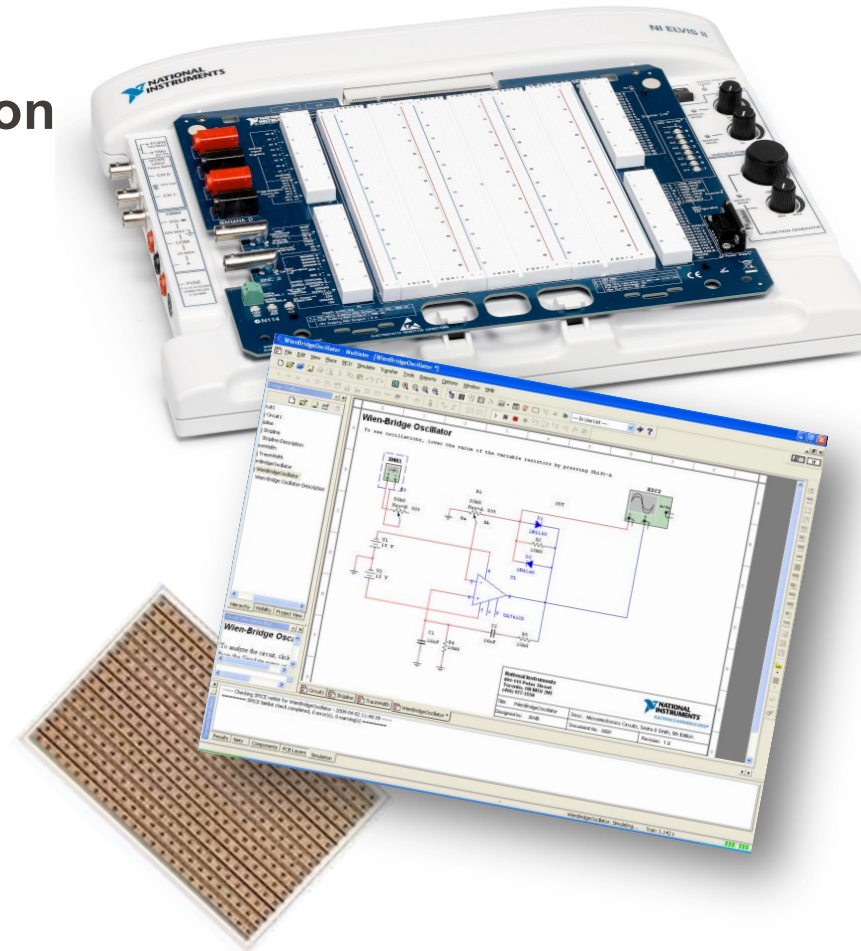
LiT : Electronique



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Prototyping & Simulation

- Test board: NI ELVIS II+
- Hirschman test boards
- Lab instrumentation
- Veroboard...
- Circuit simulation: NI Multisim



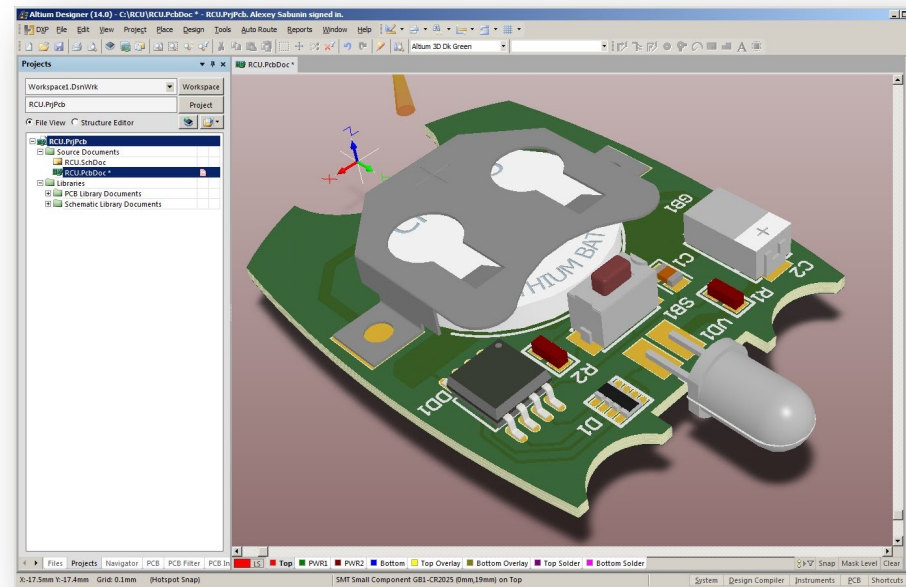
LiT : Electronique

PCB Design

PCB design software:
Altium Designer

- Layout
- Simulation
- FPGA programming
- PCB layout

Information link:
<http://wiki.epfl.ch/altium-designer>



LiT : Electronique

EPFL Atelier de Circuits Imprimés
<https://www.epfl.ch/schools/sti/ateliers/aci/>

Options:

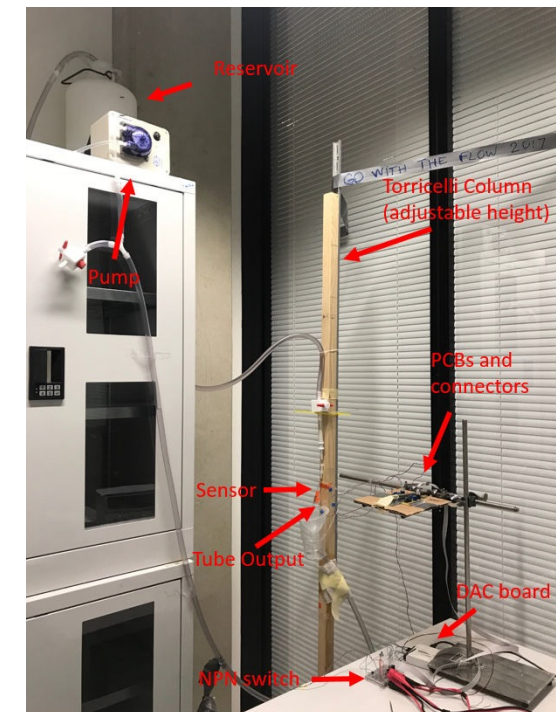
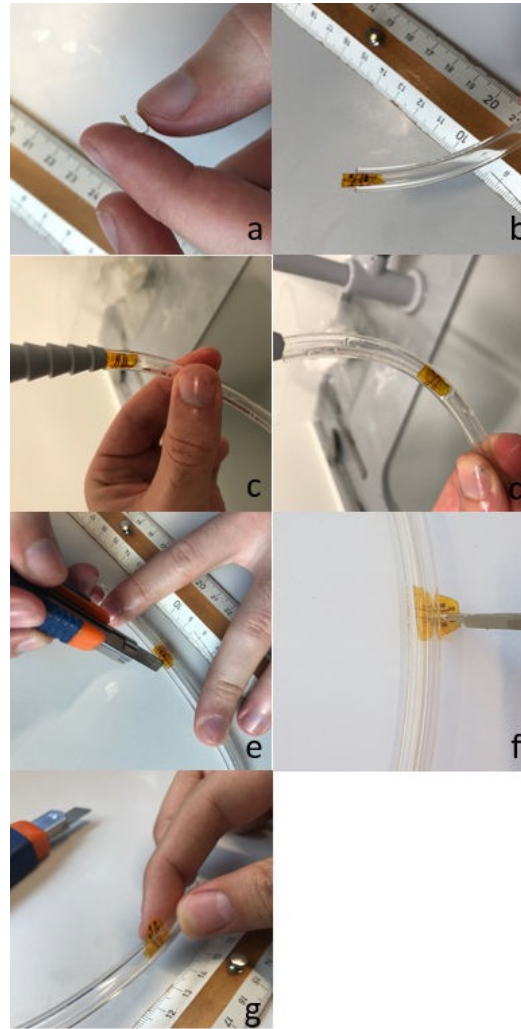
- DIY PCB – introductory class then autonomous work
- PCB design then manufacturing by the workshop staff:
 - Cost: 100 CHF flat fee; leadtime: 10 days

Outsourcing the PCB manufacturing:

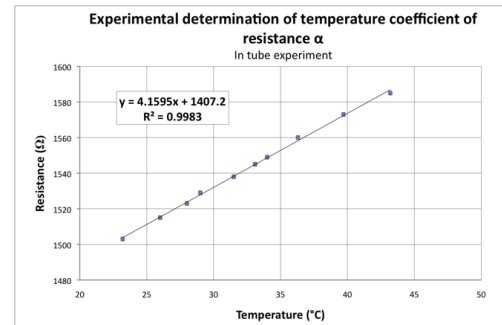
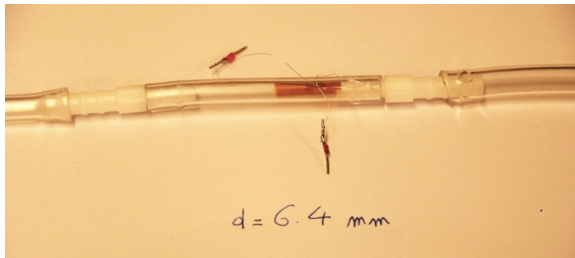
- <http://www.eurocircuits.com/>
- Be careful with costs and delays
 - e.g. rapid manufacturing => 2x to 3x std costs

Integration

- Sensor – PCB wiring
- Labview interface
- “Fluidic” interface

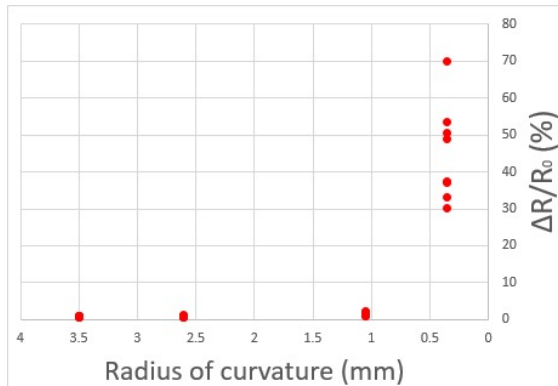


Evaluation, adjustment, validation

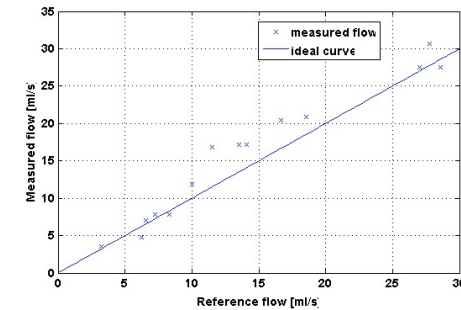


Temperature measurement in a tube

Bending the microsensors



Flow measurement in a tube



Logistics - where

- **Dedicated lab space**

- Room MED 3 1715
- 24h/24h, 7/7

- **Design, integration and evaluation**

- PC, electronics, microscope, etc.
- 1 tool box per team
- Access to DLL workshops

- **Microfabrication at the FCBG NMP**

- B3.2
- Introduction cleanroom training then autonomous access

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Microfabrication

- Valentina Paggi
- Laurine Kolly
- Yash Vyza
- Haotian Chen

- Anthony Guillet (NMP)
- Jeremy Laedermann (NMP)

Materials Science / Testing

- Cédric Meinen
- Jean-Baptiste Leran

- Kangling Wu
- Massimo Mariello
- Emilio Lavado

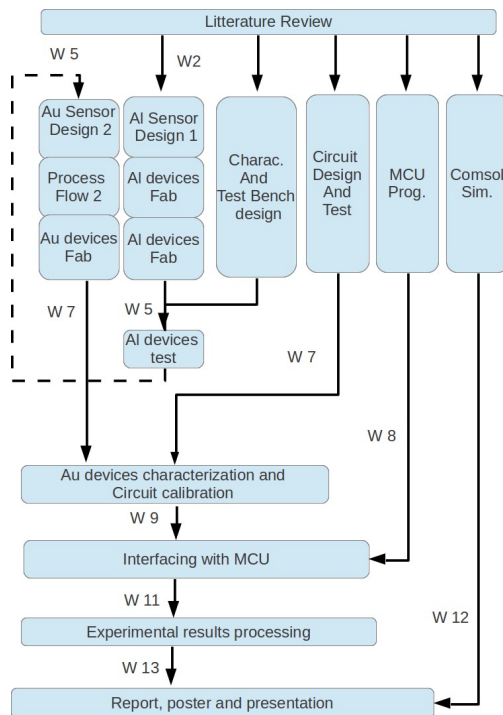
Project management

- **Work as a team**
 - Define roles and objectives for each member
 - Prepare a timeline to make sure tasks are completed smoothly

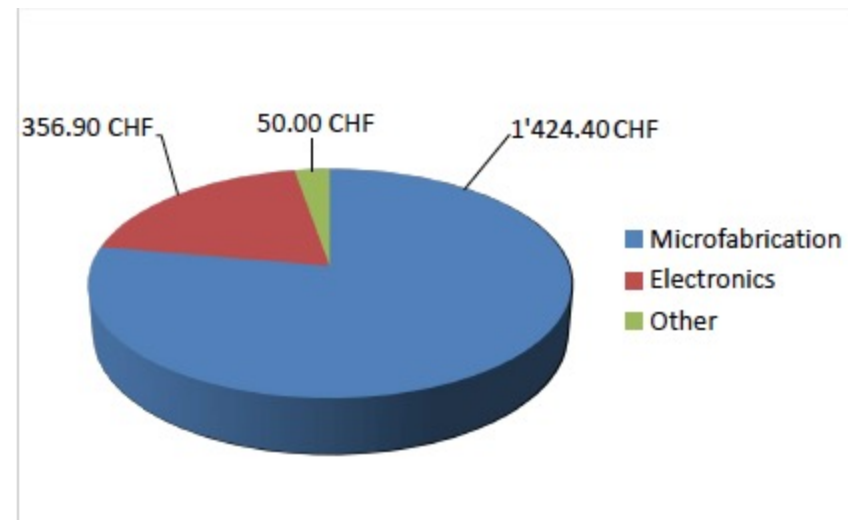
- **“Virtual budget” of 2,000CHF**
 - Manage the budget wisely to be able to complete the project

Project Management

Planning



Budget management



Project assessment

- Each student will receive an individual grade and the number of credits assigned by their own section
- First report: **mid-march 2022** to mentors
- Mid-semester presentation: week of **March 28 or April 3, 2022**
- Final report: **June 11, 2022** to mentors
- Presentations and demos: **week of June 13, 2022** (tbc)

Grading

- **Final grade based on:**

- Final report and presentation
- Demonstrator/prototype
- Project management and innovation

- **Grading criteria:**

- 40% final report
- 20% final presentation
- 20% demonstrator/prototype
- 10% project management
- 10% creativity and innovation

MicroEthics Workshop

- How to work efficiently in a team

By Siara ISAAC

EPFL MAKE committee

- To register : <https://bookwhen.com/etudiants>
- 17 March, 14h15-17h
- or 23 March, 16h15-19h
- or 28 March, 17h15-20h