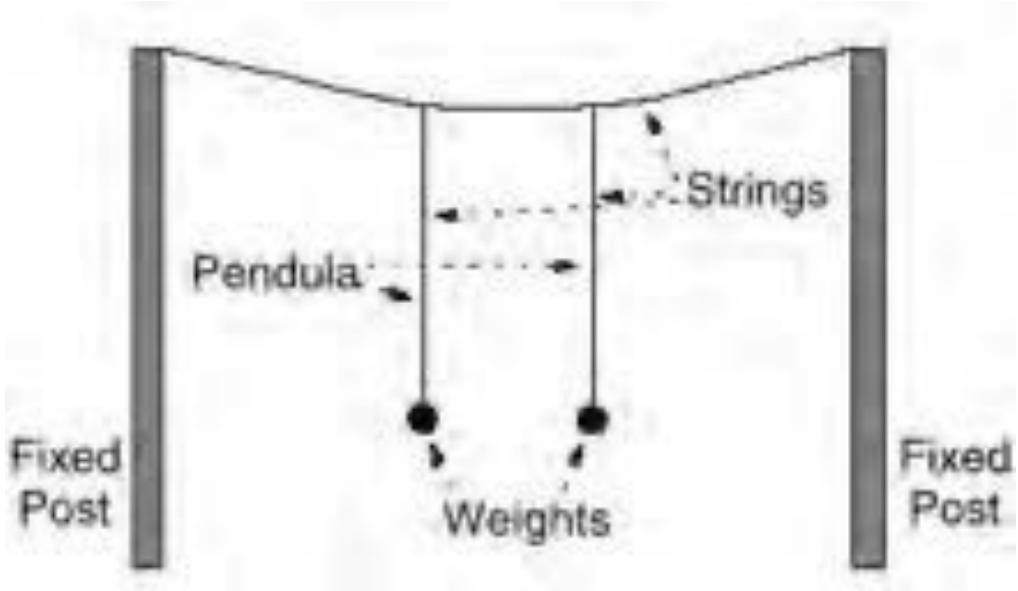
A – lab NEMS

Advanced NEMS Lab
Lab projects

- Sync – Systèmes couplés
- Pendule Double - Système chaotique
- Boîte d’isolation acoustique

École
polytechnique
fédérale
de Lausanne

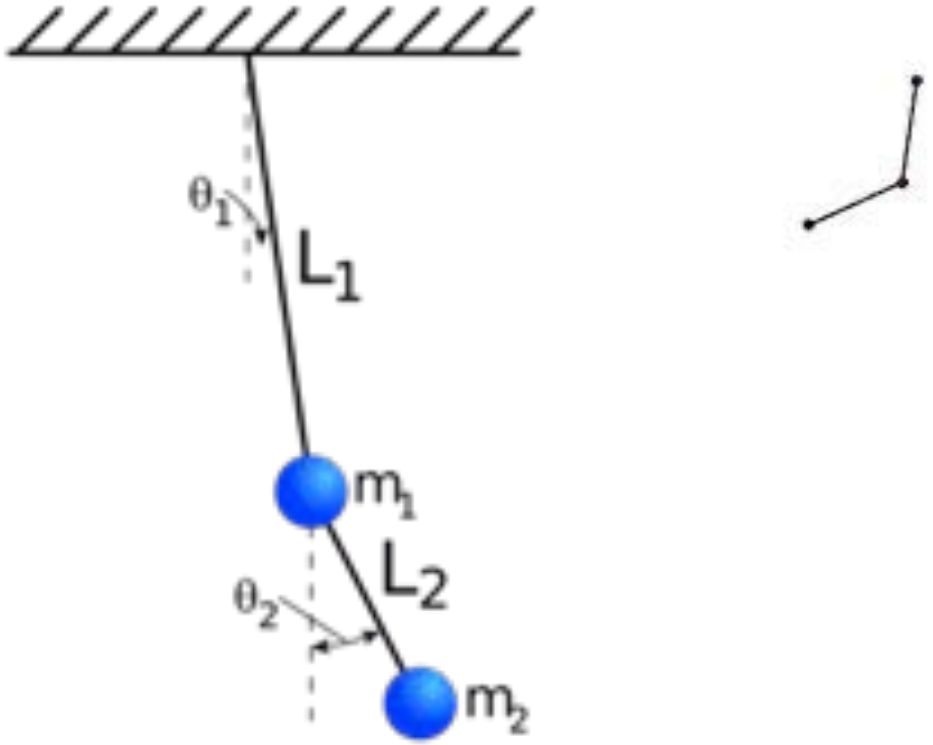
Projet 1 - Synchronisation



- Qu'est-ce qu'on va faire?
  - Design & Fabrication d'un système de résonateurs couplés
  - On mettra sur place la démonstration de synchronisation

1-2 Groupes – 3 personnes par groupe approx.

Projet 2 – Pendule Double (ou triple ☺)



- Qu'est-ce qu'on va faire?
  - Étude Analytique du système
  - App pour modéliser le système
  - Design & Fabrication d'un système physique
  - On mettra sur place la démonstration

1-2 Groupes – 3 personnes par groupe approx.

Projet 3 – Boîte d'isolation acoustique

- Qu'est-ce qu'on va faire?
  - Étude du design et des matériaux
  - Important – en gardant (peut-être un air flow)
  - Design & Fabrication de la boîte

1 Groupe – 3-4 personnes

For questions...



- Mercredi prochain
  - 15.12
  - Polydôme
  - 14-16h (série d'exos de Mec Vibra)

- By email:
  - Guillermo.Villanueva@epfl.ch

B – Egg drop challenge

The Egg Drop Challenge

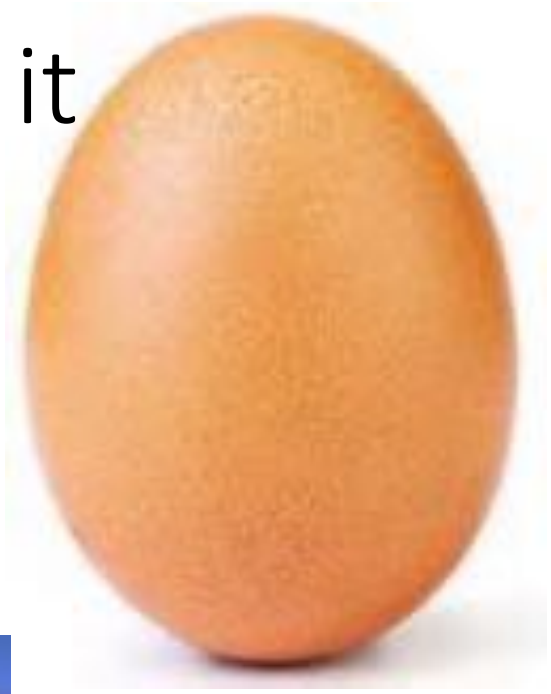
Tobias M. Schneider (ECPS)

Guillermo Villanueva (NEMS)

SpaceX Crew Dragon splashdown

Challenge: Protect sensitive ‘cargo’ on impact… using structures of minimal weight

Challenge: Protect an egg when dropping it



Task: Construct device protecting raw egg for maximum drop height
given specified constraints (weight, materials, active components,…..)

Examples:

The competition

- Given constraints (weight, ….)
- Find an optimal solution in groups of 3
  - Approach: dampers / ~~parachutes~~ …..
  - Material choices / structures
  - Back-of-the-envelope calculations / physical reasoning – when does the egg break?
  - Simulations
  - Experiments / Tests
- Competition:
  - Minimum weight of protective structure to survive a drop from BM 6th floor
- Constrains:
  - Lighter than XX grams (XX to be defined)

For questions...



- Mercredi prochain
  - 15.12
  - Polydôme
  - 14-16h (série d'exos de Mec Vibra)

- By email:
  - Guillermo.Villanueva@epfl.ch

C - UNFold

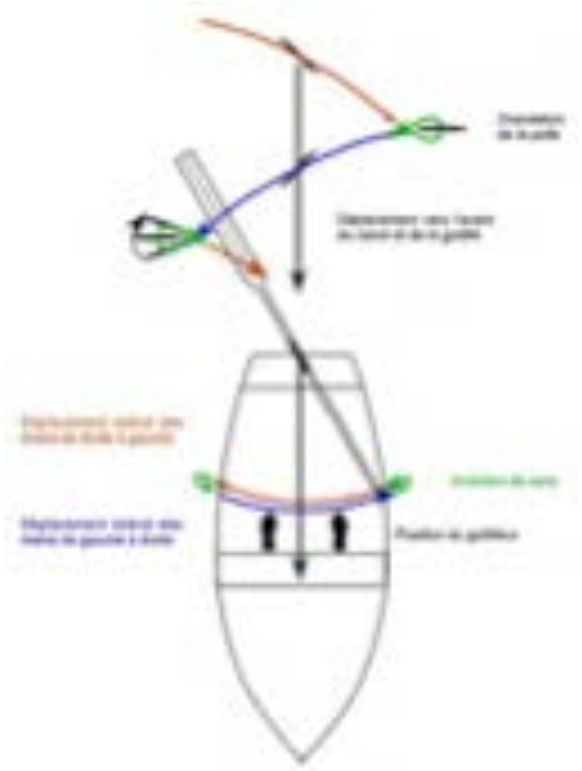
Projects at UNFOLD

L’art de la Godille

Exposition Iffic, 2018

France 3 Iroise
youtube.com/watch?v=C9yVqgCjqT4

L’art de la Godille



G. Roudaut, *L’art de la godille*

Godille à UNFoLD

Projects at UNFOLD

Gaétan Raynaud

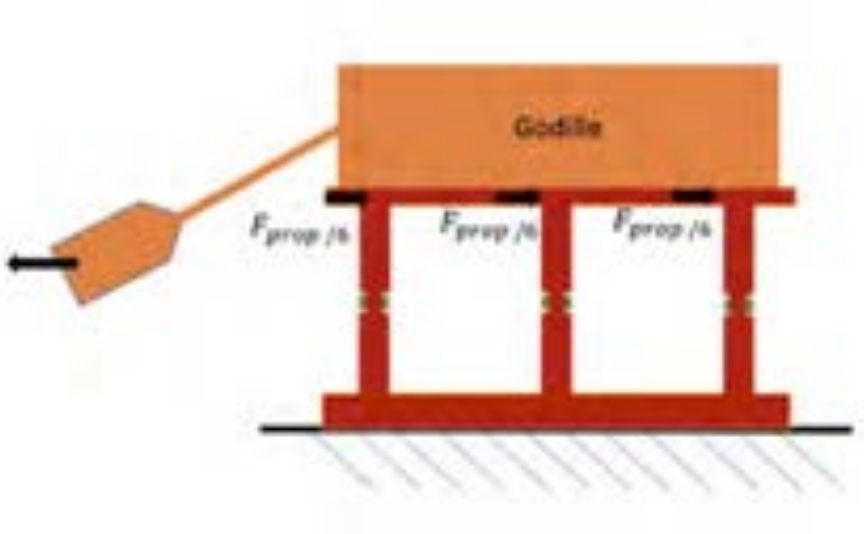
L'art de la Godille

Projet 1 : système de contrôle pour les 2 moteurs

- Limit switch et homing procedure
- Control independent en rotation et en pitch

Projet 2 : plateforme de mesure de forces

- Mesure de la poussée exercée par la Godille dans un basin
- Calibration et validation



D – Lab LA

Ingénierie simultanée 2022

Laboratoire d'automatique

christophe.salzmann@epfl.ch

Mini Segway challenge

Multi-years challenge

Year 1 : initial mechanical setup + stand up control

Year 2 : path following/tracking + communication

Year 3 : crowd control via camera tracking

Nbr etudiants: 16

Responsables:

Christophe Salzmann

Babyfoot fine control

Improve strategy and tricks

Programmed in LabVIEW !

Nbr etudiants: 2

Responsables: Christophe Salzmann

QUBE Extension(s)

- New support for remote experimentation (cameras, usb, power)
- New extensions for the QUBE
- Design hardware and related controllers

Nbr etudiants: 2
Responsables: Christophe Salzmann

Bouncing table(s) v1 -> v2

https://www.youtube.com/watch?v=IYyAMDYzJQM

- Build and control a bouncing table(s)
- Mechanical design
- Controller design
- Vision

Nbr etudiants: 2-4

Final project will bonce between two or more tables

Bouncing table(s) v2

https://www.youtube.com/watch?v=IYyAMDYzJQM

- Build and control a bouncing table(s)
- Mechanical design
- Controller design
- Vision

Nbr etudiants: 2-4

Final project will bonce between two or more tables

E - Biomobile

biomobile
(Re)designing materials and energy

Association biomobile

Présentation EPFL - Projets d'ingénierie simultanée

biomobile
(Re)designing materials and energy

Présentation

Mission:

Réalisation de véhicules maximisant le recours aux ressources renouvelables:

- Utilisation de matériaux végétaux pour la structure de la voiture (fibre de lin, époxy biosourcée, bois,…).
- Propulsion à l'aide de carburants issus de déchets organiques.

Participer à la formation d'étudiants par l'intermédiaire de projets multidisciplinaires, motivants et novateurs.

biomobile
(Re)designing materials and energy

Projet : Conception innovante des roues

L'objectif : A partir d'un cerclage réalisé en fibre de lin, concevoir les moyeux et un système d'accroche des rayons basé sur l'utilisation de fils.

- Etape 1: Etablir les cas de chargements et déterminer les efforts en jeux.
- Etape 2: Concevoir plusieurs solutions et établir le dossier de fabrication
- Etape 3: Tests mécaniques, analyses et choix de la solution

- Effectif: 2-3 étudiants

biomobile
(Re)designing materials and energy

Contact

Plus d'informations sur notre site :

www.biomobile.ch

Adresses de contact :

perraudin@biomobile.ch
coordination@biomobile.ch
022 546 24 56

F - Create

Service Robot Competition - RoboCup @Home

CREATE Lab

What is RoboCup @Home?

https://historyofai.files.wordpress.com/2014/04/home5.jpg

- Annual international competition
- Testing service robots in real life situations
  - Interact with humans (voice commands)
  - Navigation in a room
  - Manipulation of objects

About the project - Long term

Kickoff (Now) → Prototype robot (2022 Winter) → RoboCup Competition (2023) → Self sustaining student project (ongoing)

Similar to: Swiss solar boat, Xplore, etc...

About the project - next semester

- Develop the robot platform (fresh start)
- Initial testing of control/sensing
- Prototyping (software and hardware)

Hardware (mechatronics)	Voice recognition & behaviour tree	Computer vision	Manipulation

Manipulator Design	Mobile base design	Electronics Development	Control & sensor Development

Who we are looking for

Bachelor project

- Application of theoretical mechanical engineering to a real world problem
- Interest in developing robotic systems
- Want to learn and work on a technical integration project
- Potential interest in continuing this project after the next semester

General recruitment

- Someone keen to take a leadership position (next two years)

Contact kai.junge@epfl.ch

G – FlexLab challenge

Fabrics, Sewing, and Embroidery

SGM - Projet d'ingénierie simultanée 2021-2022

Design goal: You will be ideating, developing, prototyping and exploring an innovative technique, process, structure, application, or a research question that addresses an existing niche in sewn or embroidered fabrics.

Up to 5 teams of up to 5 students. Open-ended project. Lab work will take place at new DLL.

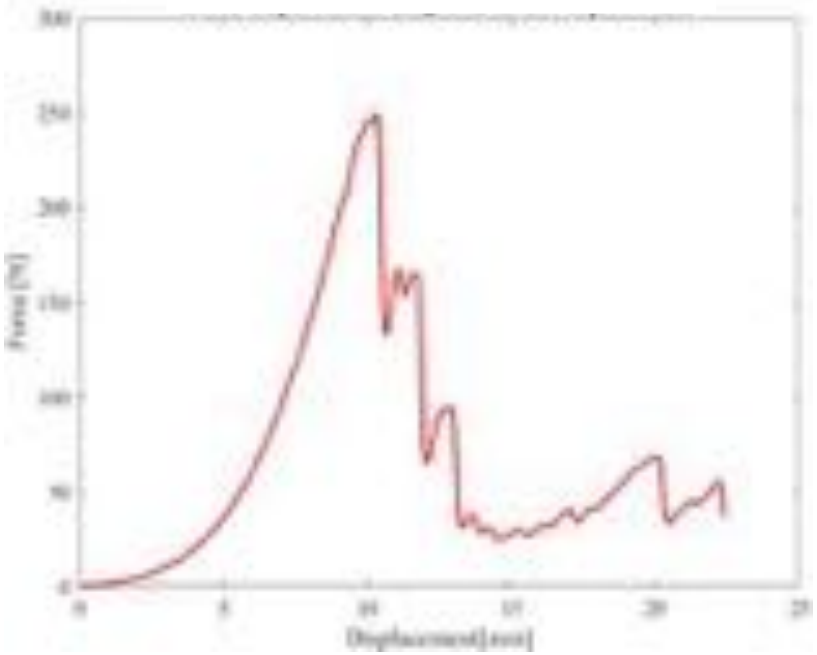
Flexible Structures Laboratory – IGM. Contact: pedro.reis@epfl.ch

Who cares?

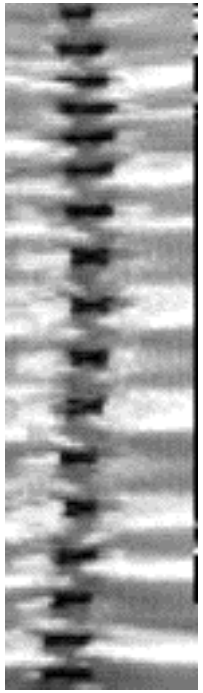
https://www.worldbank.org/

- The fashion industry uses 93 billion m^3/year of water; consumption needs of 5M people.
- ~ 20 % of wastewater worldwide comes from fabric dyeing and treatment.
- Of the total fiber input used for clothing, 87 % is incinerated or disposed of in a landfill.
- **The fashion industry is responsible for 10 % of annual global carbon emissions, more than all international flights and maritime shipping combined.**
- If demographic and lifestyle patterns continue as they are now, global consumption of apparel will rise from 62 million metric tons in 2019 to 102 million tons in 10 years.
- Every year a half a million tons of plastic microfibers are dumped into the ocean, the equivalent of 50 billion plastic bottles. The danger? Microfibers cannot be extracted from the water and they can spread throughout the food chain.

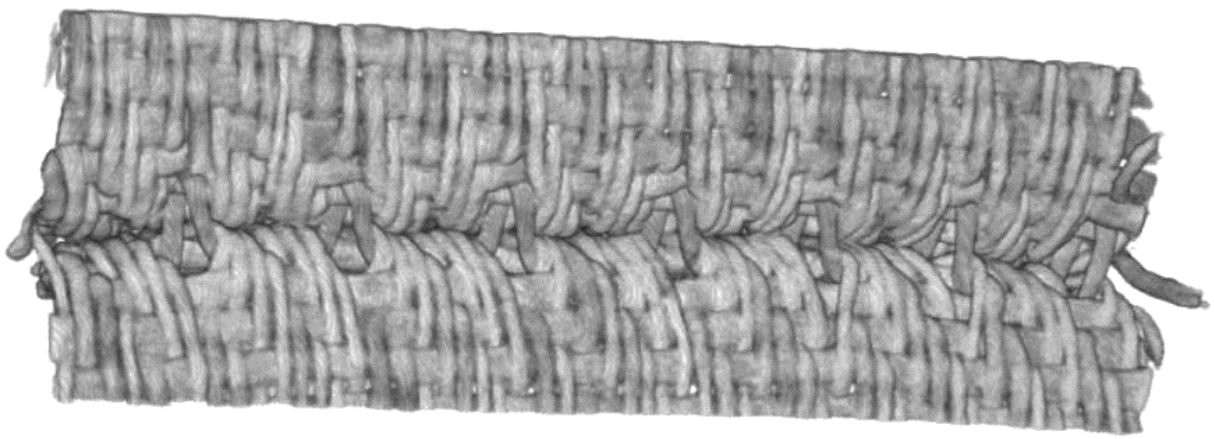
Mechanical testing



40k fps



Innovative imaging (X-ray µCT)



Smart fabrics

In collaboration with

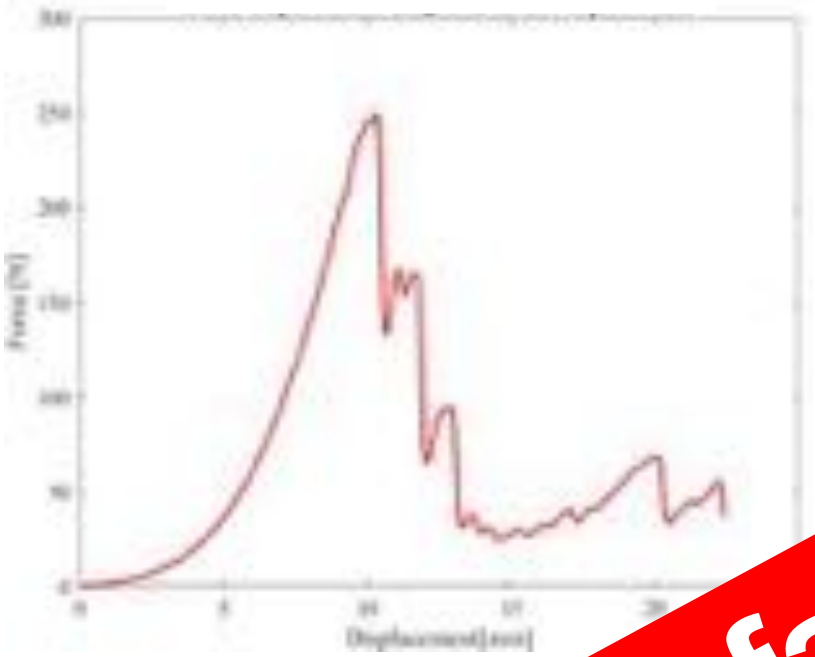
BERNINA

made to create

Amann Silver-tech conducting thread

https://www.youtube.com/watch?v=qiTmaCds2P4

Mechanical testing



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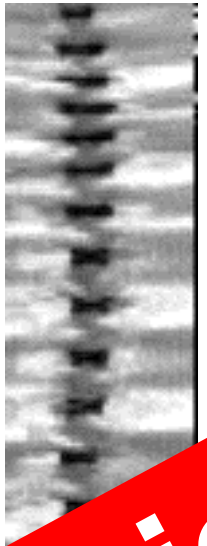


Innovative imaging (X

Anything fabrics-related is game for your design/research project

Smart fabrics

Amann Silver-tech conducting thread

https://www.youtube.com/watch?v=qiTmaCds2P4

H – Solar Boat


Swiss Solar Boat

Swiss Solar Boat

Projet d'ingénierie simultanée

Objectifs

Renforcer l’apprentissage

Partager une aventure humaine

Sensibiliser aux énergies vertes

Proposer un concept innovant

S’inscrire comme un challenger sérieux

Monaco Energy Boat Challenge

- Compétition entre étudiants et professionnels organisée par le Yacht Club de Monaco
- Participation à la catégorie solaire: un pilote, des panneaux solaires, un design libre
- Partage de connaissances
- Promotion de l'innovation vers des énergies propres

Résultats

- 2ème place
- Prix de l'écoconception

Et après ?


Gestion de projet
Fiabilisation,
Optimisation
Etude de projet
Conception
Production

Swiss Solar Boat

Projet 1 : Mesure d’altitude

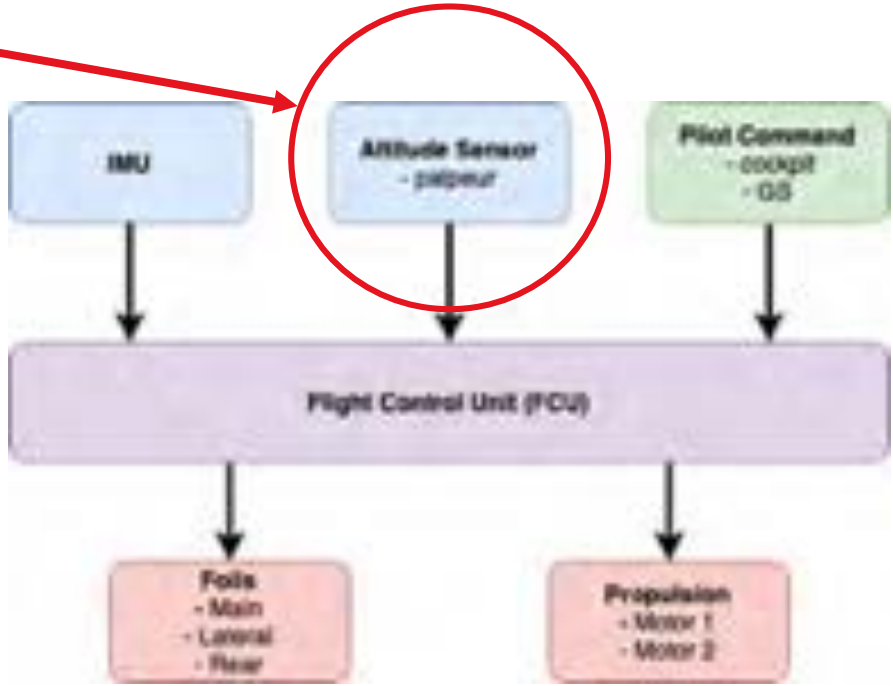
Projet 1 : Mesure d’altitude

Control du bateau :

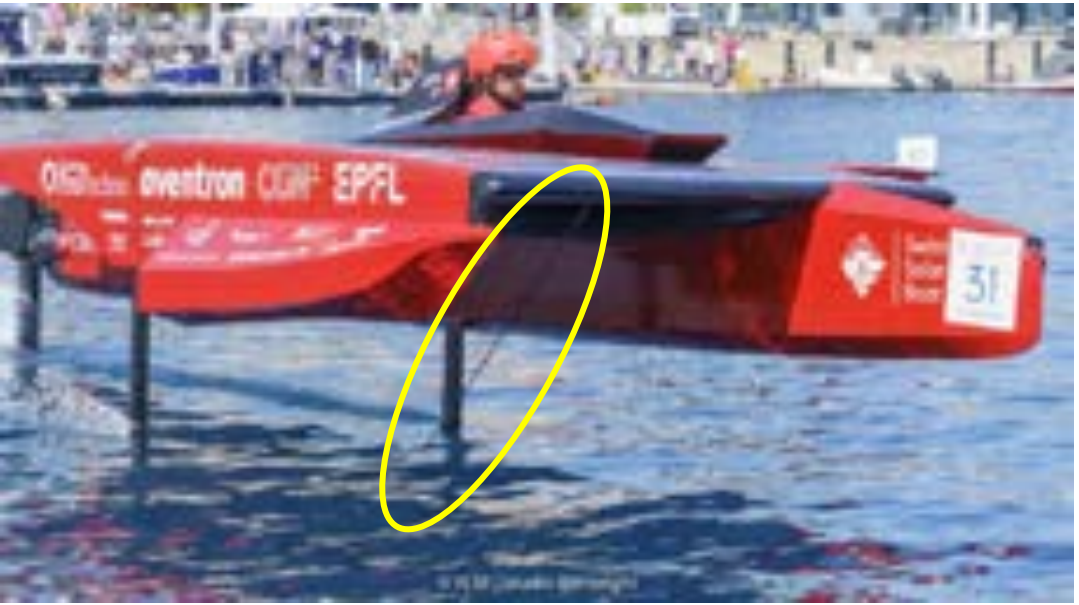
- FCU:
  - Board STM32 nucleo
  - Code C/Cpp
  - Programmable à distance (Raspi/USB)
  - Cerveau du bateau

- PIDs controllers
  - Altitude
  - Roll
  - Pitch

- Modèle Numérique du bateau
  - Code Matlab
  - Simuler le comportement du bateau



Projet 1 : Mesure d’altitude



- Actuellement : Palpeur mécanique
- Atout : Fonctionnel et simple
- Désavantage : Sensible aux rebonds, pas très robuste.

Projet 1 : Mesure d’altitude

Objectif du projet :

- Etudier les différentes pistes possibles : capteur Ultrason, Radar, Lidar, Caméra…
- Regarder comment l’implémentation peut se faire en partenariat avec d’autres projets
- Rendre le système robuste : aux marches arrières, aux éclaboussures
- Travailler avec l’objectif de l’efficience et l’écoconception (réduire la consommation et le poid)

Swiss Solar Boat

Projet 2 : Production du CUS

Projet 2 : Production du CUS

Composite Upper Structure

Projet 2 : Production du CUS

- Production de la lower part en fibre de carbone : usinage des moules, préparation des fibres, mise en places des fibres
- Upper part en fibre de lin
- Etanchéité à gérer
- Production doit commencer le plus tôt possible (début février)

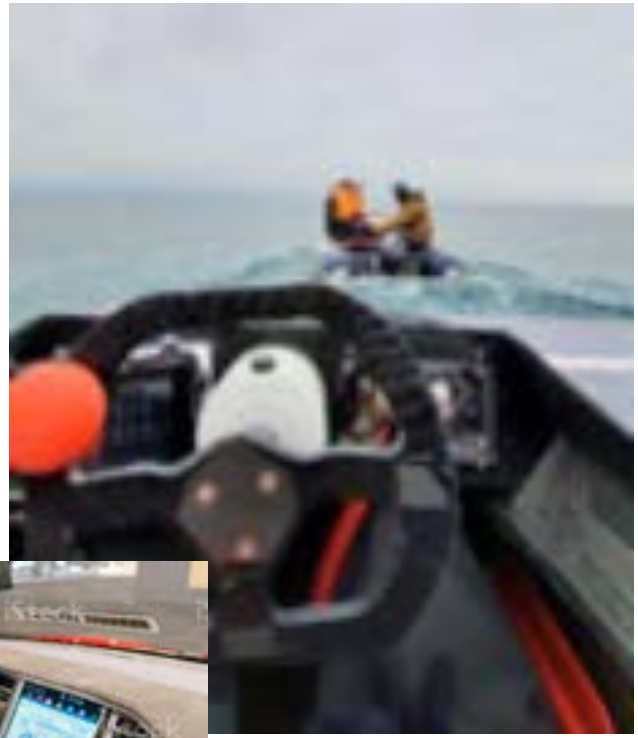
Swiss Solar Boat

Projet 3 : Interaction Pilote bateau

Projet 3 : Interaction Pilote bateau

Objectif du projet

- Améliorer le cockpit actuel : design épuré,
- Refaire volant
- Manche à balais pour les virages
- Ajouter écran type “tesla”
  (code Javascript)



Swiss Solar Boat

Projet 4 : Production vertical latéral

Projet 4 : Production vertical latéral

Projet 4 : Production vertical latéral

Objectif du projet

- Produire le vertical latéral en fibre de carbone
- Conçu par les étudiants en master de SSB
- Renforcé par rapport aux verticaux en alu
- Commencer la production au plus tôt (Janvier/Février)

Swiss Solar Boat

Projet 5 : Production des foils

Projet 5 : Production des foils

Projet 5 : Production des foils

Objectif du projet

- Production des foils V2, V3
- Priorité foil latéral
- Designé par les étudiants en master de SSB

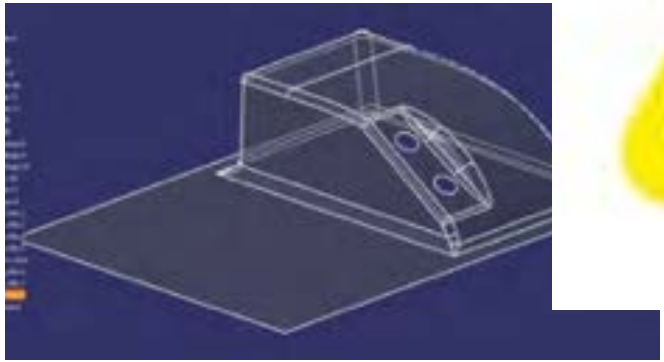
- Commencer la production au plus tôt (Janvier/Février)

Swiss Solar Boat

Projet 6 : Production de boîtes ultra légères, rack MPPT et capot latéral

Projet 6 : Production des foils

- Production de boîte ultra légère par vacuum forming
- par l’expérience acquise, design V2 du capot latéral
- Design du rack MPPT et production de celui-ci



Bonus

Thank you !

I – Duck road trip

Duck Road Trip

Laboratoire d'Automatique

Dependable Control and Decision group

Prof. Giancarlo Ferrari Trecate

Clara Galimberti
Muhammad Zakwan
Mahrokh Ghoddousiboroujeni
Baiwei Guo
Jean-Sébastien Brouillon
Andrea Martin
Liang Xu
Luca Furieri

Duck Road Trip

Objective: Design control algorithms to drive self-driving car around the DuckieTown

Check: https://www.duckietown.org/

Duck Road Trip

EPFL

Learning outcomes:

Group of 4 students

- Teamwork
- Coding in Python & understanding existing platform (DuckieTown)
- Implementing control algorithms for tracking, and collision avoidance
- Road and object detection from images

If interested, don't hesitate to contact us:

Clara Galimberti – clara.galimberti@epfl.ch
Muhammad Zakwan – muhammad.zakwan@epfl.ch
Mahrokh Ghoddousiboroujeni – mahrokh.ghoddousiboroujeni@epfl.ch
Jean-Sébastien Brouillon – jean-sebastien.brouillon@epfl.ch
Baiwei Guo – baiwei.guo@epfl.ch
Andrea Martin – andrea.martin@epfl.ch

J – lab LBO

Shoulder Project

Pezhman Eghbali, Laboratory of Biomechanical Orthopedics (EPFL)
Patrick Götti, Service of Orthopedics (CHUV)

- Failure rate of shoulder arthroplasty is mainly associated with mechanical causes
- Preoperative scanner images can be used to build finite element modeling (FEM) to estimate mechanical variables
- Tasks: Use Python coding to automate FEM (Abaqus) from scanner images (with existing triangular mesh)

Skills:

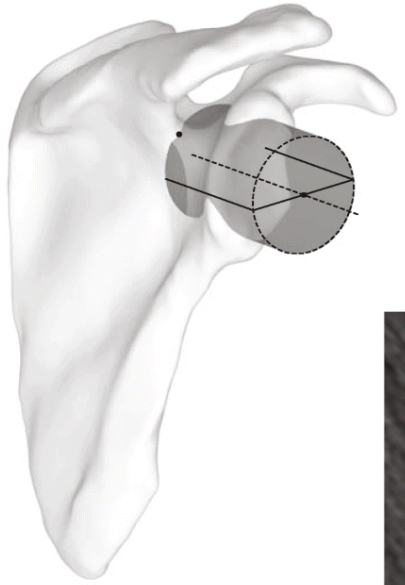
- FE modelling with Abaqus
- Python Coding

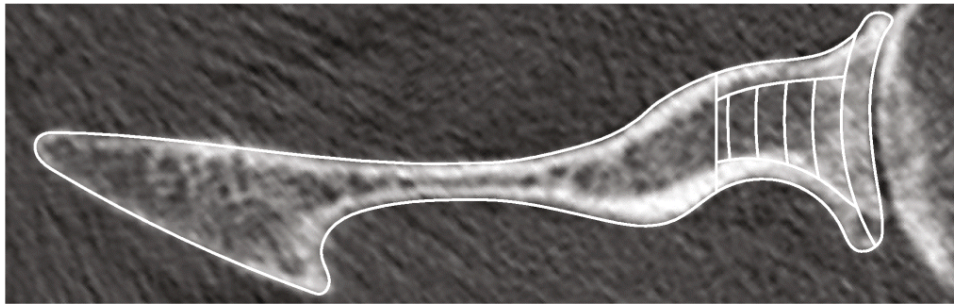
https://www.drgordongroh.com/

- Bone mineral density (BMD) is associated to bone strength, and several shoulder pathologies (osteoporosis, fracture risk, osteoarthritis)
- BMD can be measured in the glenoid bone and proximal humerus from preoperative scanner images
- Tasks: Detect the cortical and trabecular bone regions in the scanner images using image processing and python coding

Skills:

❖ Python Coding





S. Mariaux et al, BMC Musculoskeletal Disorders, 2021

K – Rocket team

PROJECT PROPOSAL

Title:	**Design of a small scale supersonic wind tunnel**	Prepared by: Bouwakdh Taha
Project:	2022 EPFL Rocket Team, project Wildhorn	Checked by: William Cottier
Filename:	2022_WH_FD_SP_004_SUPERSONIC_WINDTUNNELI	
Supervisor:	Pr. Noca	
		Responsible signature

PROJECT DESCRIPTION

The aim of this project is to build a small experimental setup to study flow in the supersonic regime and test imperfections on the rocket body.

The work should focus on designing and building a small scale setup using supersonic air jets produced by pumps to generate the flow and schlieren photography to visualize it and record it for further analysis.

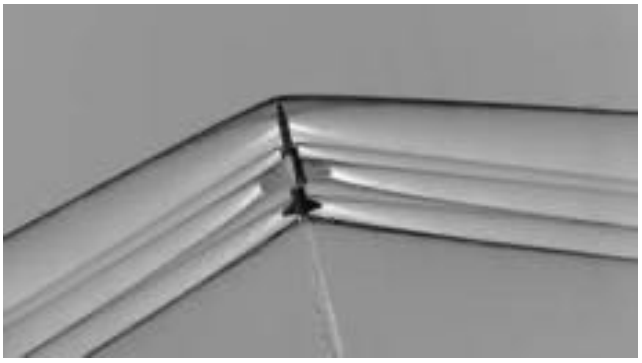


FIGURE 1: Schlieren image displays the shock wave of a supersonic jet (*Credits: NASA Photo*)

Skills needed (or that you are willing to learn)**:**

- Physics: optics.
- Fluid dynamics
- Manufacturing
- Sensors

Contact:

taha.bouwakdh@epfl.ch

kevin.marangi@epfl.ch

supervisor@epfl.ch

Number of students: 3

L – Racing team

Design and Optimization of an in-wheel powertrain system

VD/Powertrain

09/12/2021

EPFL RACING TEAM

Design and Optimization of an in-wheel powertrain system

EPFL RACING TEAM

Function:

- Provide a link between the suspension, the steering, the braking and the tyre
- Transmit engine torque to the wheels

In-wheel Motor - First Design

Objectives:

- Reduce weight as much as possible
- Reduce size to accommodate for the new 10 inch rims
- Gear box life time of ~100 hours
- Sizing wheel-assembly from steering and suspension needs

Design and Optimization of an in-wheel powertrain system

EPFL RACING TEAM

Project divided into 2 simultaneous parts:

- Gear box Design & opti
- Mechanical Integration

1) Gear Box:

- Literature study of the system (gear ratio, gear calculation)
- First iteration
- Implementation on software KissSys (with carrier, shaft, bearings)
- Validation of the design thanks to kissSys
- Continue iterations to get the optimal gear box (trade off between lifetime and efficiency)

Compound Planetary Gear-Box - First Design

Design and Optimization of an in-wheel powertrain system

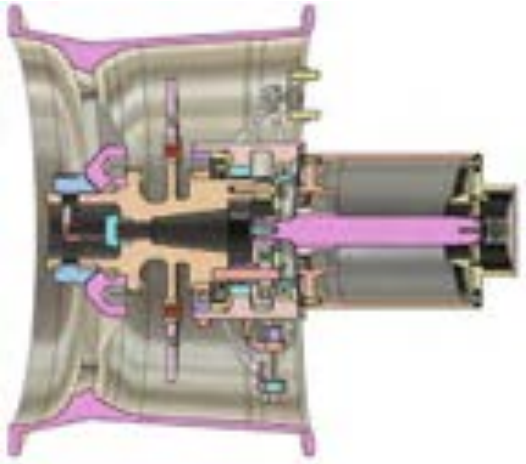
EPFL RACING TEAM

Project divided into 2 simultaneous parts:

- Gear box Design & opti
- Mechanical Integration

2) Mechanical integration

- Direct integration of gear box:
  - carrier, shaft, planet bearings
- Hard work on lubrication and oil sealing
- Design of wheel hub and upright (metal 3D printing?)
- Choice of hub's bearing



Cross section view of an *in-wheel motor* wheel assembly

Design and Optimization of an in-wheel powertrain system

EPFL RACING TEAM

Objective of the project for the end of the semester :

- full design ready to implement in september 2022
- List of materials to be purchased
- cost prediction

→ Need 3 people for this project

Associated tasks :

- literature study
- comparison of various solutions
- CAD/FEM
- Gears simulation on software KissSys
- topology optimization

Project Presentation
Aerodynamics - Rear Wing Design

09/12/2021

EPFL RACING TEAM

Rear Wing Design

Function:

- Provide Downforce to the car

Objectives:

- Optimize the Lift/Drag ratio
- Make it as light as possible
- Design handy fixations

Mercury's Rear Wing

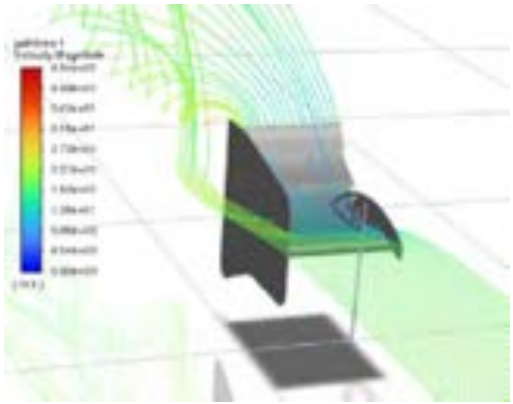
Rear Wing Design

Objective of the project for the end of the semester :

- Full design of the new wing and Endplates
- Determination of optimal composite layup
- Full design of the fixations

Associated tasks :

- literature study of the system
- comparison of various solutions
- CAD
- CFD simulations
- FEM simulations



Project Presentation
Aerodynamics - Front Wing Design

09/12/2021

EPFL RACING TEAM

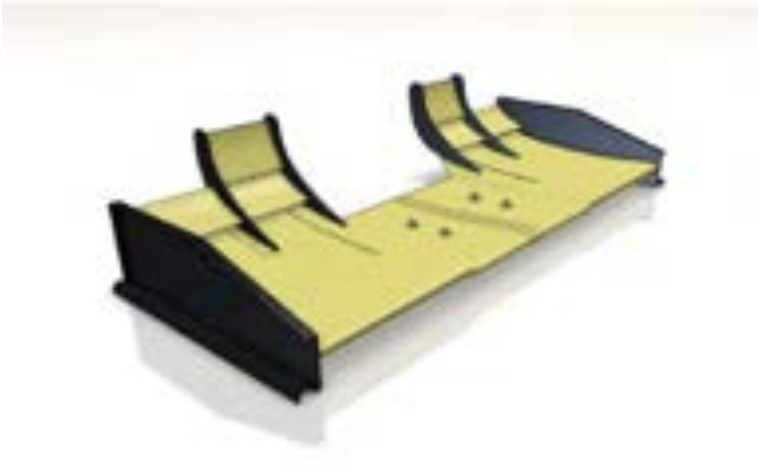
Front Wing Design

Function:

- Provide Downforce to the car

Objectives:

- Optimize the Lift/Drag ratio
- Make it as light as possible
- Design handy fixations



Mercury's Front Wing

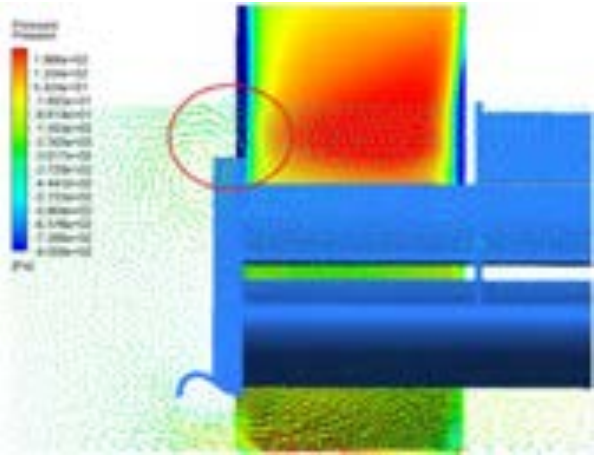
Front Wing Design

Objective of the project for the end of the semester :

- Full design of the new wing and Endplates
- Determination of optimal composite layup
- Full design of the fixations

Associated tasks :

- literature study of the system
- comparison of various solutions
- CAD
- CFD simulations
- FEM simulations



Suspension Design adapted for in-wheel motor

VD

09/12/2021

EPFL RACING TEAM

Suspension Design adapted for in-wheel motors

Function:

- Create the optimal link between the chassis on the track

Objectives:

- Geometry adapted to in-wheel motors
- Determine all optimal suspension parameters:
  - Springs coefficient
  - Damping coefficient
  - Suspension linking points on chassis and wheel assembly
- Make a new front anti-roll bar adapted to the geometry

Design and Optimization of an in-wheel powertrain system

EPFL RACING TEAM

Objective of the project for the end of the semester :

- full design ready to implement in september 2022
- List of materials to be purchased
- cost prediction
- Hard work on final report : engineer approach, useful for next generation in Racing Team

→ Need 3 people for this project

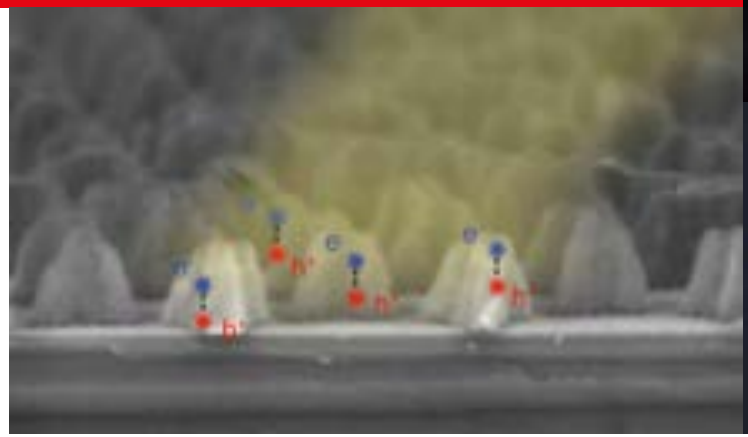
Associated tasks :

- literature study
- comparison of various solutions
- Hard work on suspension & Vehicle Dynamics Theory
- Suspension simulation on software OptimumKinematics
- CAD/FEM
- Matlab codes

K – Lab LNET

https://lnet.epfl.ch

1. Design a miniature controlled humidity chamber for Hydrovoltaic device
2. Design of a thermal stage for thermally tunable metasurfaces
3. a) Build an experimental setup for free convection in array of parallel plate chnannels. b)Demonstrating different boiling regime

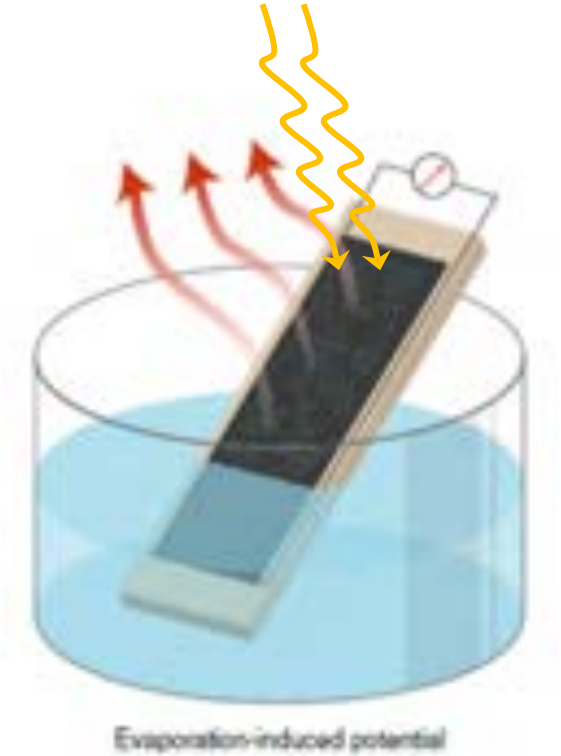


Prof. Giulia Tagliabue

3 Groups with 3-4 students each

École polytechnique fédérale de Lausanne

1. Miniature controlled humidity chamber for hydrovoltaic device

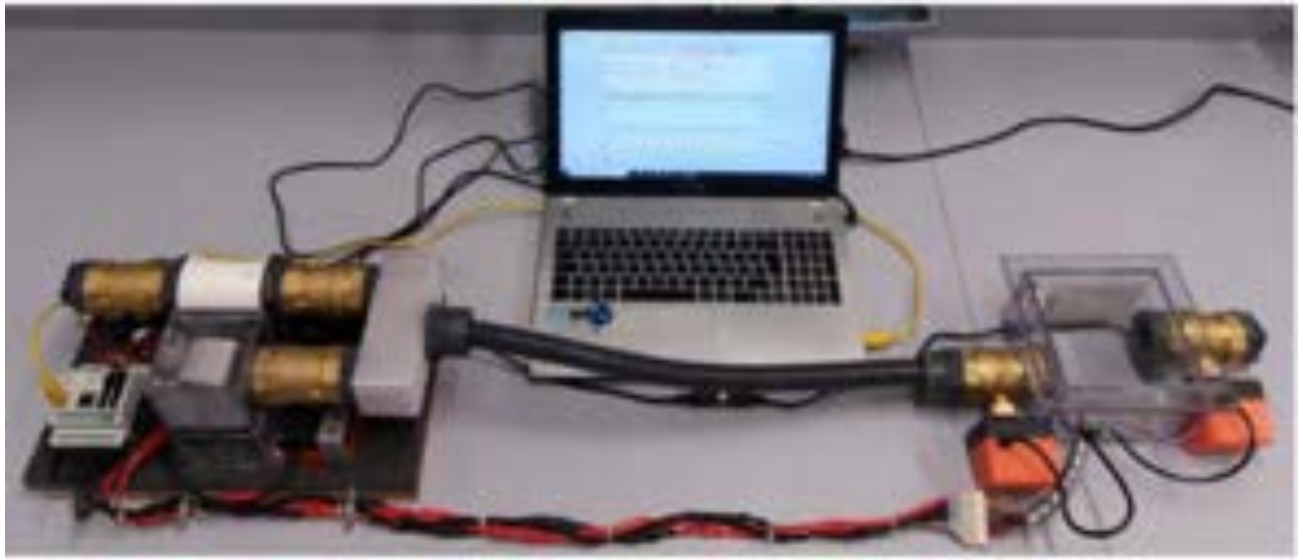


Environmental parameters

- ❑ Relative humidity
- ❑ Temperature
- ❑ Evaporation rate
- ❑ …

Devices' efficiency and output power

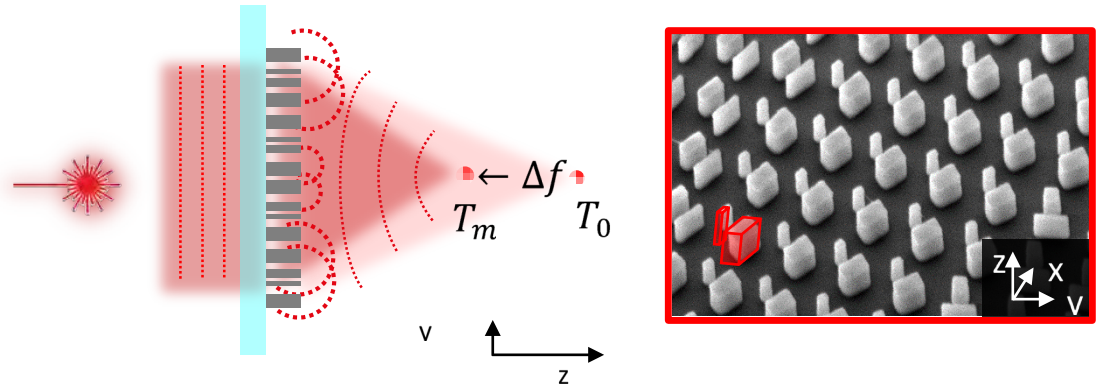
Current humidity chamber **15cm X 15cm X 10cm**



The main objectives of the project

1. Miniaturize the chamber, such that it can be used under a Microscope
2. Improve the dehumidification system
3. Controlling the temperature uniformly inside the miniature chamber

2. Design of a thermal stage for thermally tunable metasurfaces



2D arrangements of meta-atoms with sub-wavelength spacing to precisely control and manipulate the properties of a light beam.

Background

Metasurfaces are used to produce flat versions of traditional optics with tunability.

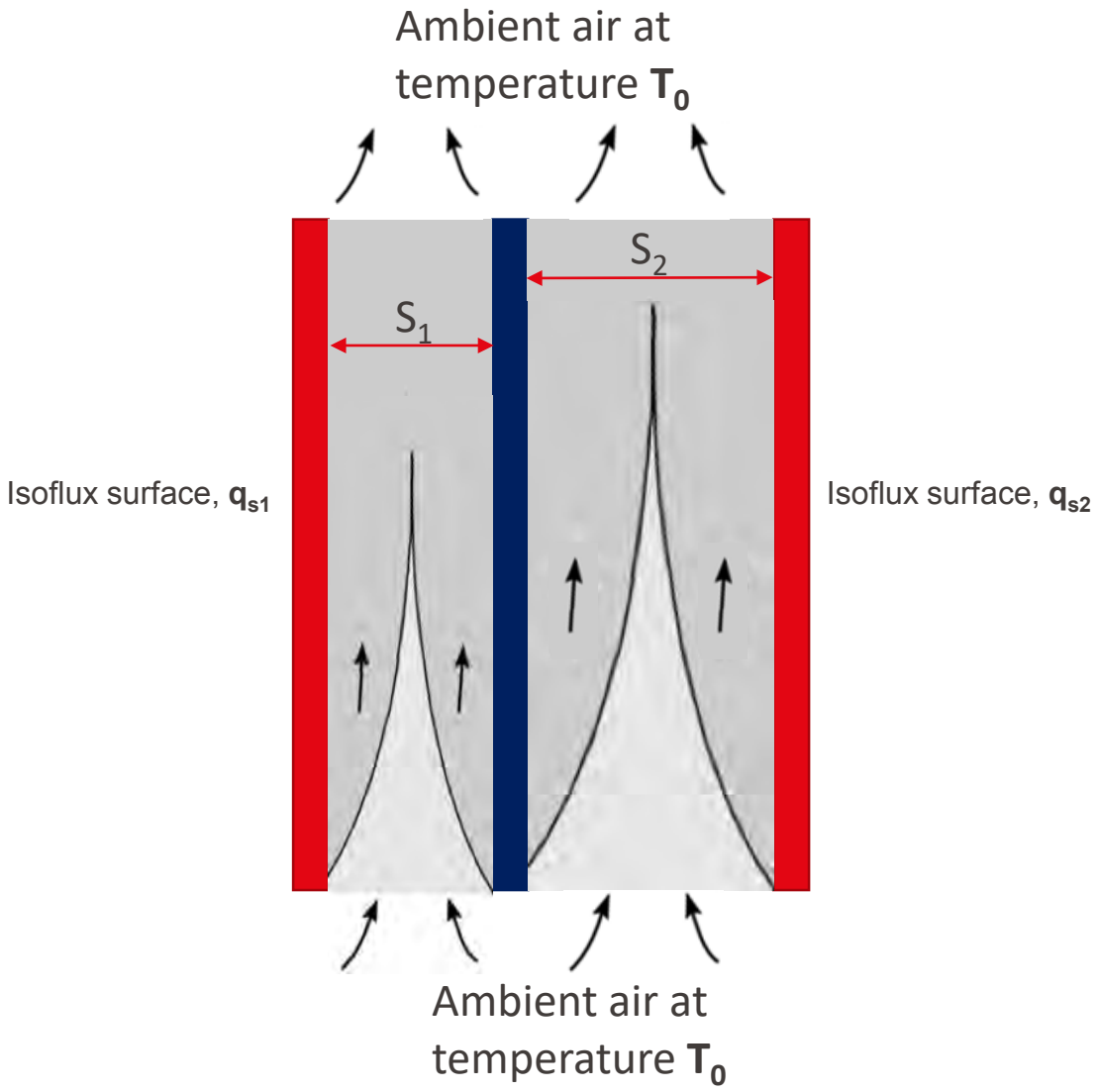
The aim of this project is to design and fabricate a thermal stage to test thermally tunable metasurfaces.

The main objectives of the project

Design of a thermal stage with the following properties:

1. Capable of reaching high temperature **(>200 °C)**
2. Temperature feedback
3. Adjustable mounting system for the optics/metasurfaces
4. Optically transparent

3.a. Bulid an experimental setup for free convection in array of parallel plate channels



Background

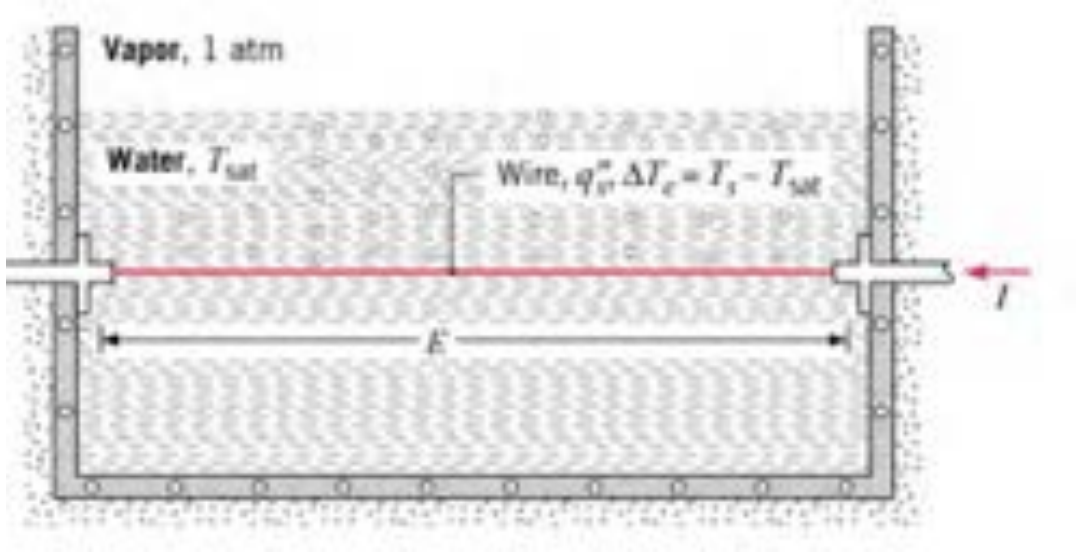
The theory will be covered by Prof. Tagliabue in the heat transfer course next semester.

The heat transfer rates can be altered by adjusting the spacing(S_1,S_2) between the plates or ratio of length and spacing.

The main objectives of the project

1. Do the structure and thermal design of the setup.
2. Obtain the correlation for heat transfer coefficient in two-plate configuration.
3. Repeating part 1 in three-plate configuration (with and without heat flux).
4. Optimal spacing that maximizes the heat transfer rate.
5. Is vertical plates best in every scenarios?

3.b Demonstrating different boiling regime



Nukiyama's power controlled heating setup for demonstrating the boiling curve

Background

By controlling current under a voltage difference, heat flux was supplied and temperature was determined by the change in resistance of the wire. By having a wide range of heat flux different boiling regime can be visualized.

The main objectives of the project

1. Build a similar setup as Nukiyams's to show all the boiling regime in the boiling curve
2. Study the change in boiling curve at different pressures
3. Effect of ambient environment, such as having a pure vapor chamber instead of air.

Thank you!

Feel free to contact for more information about the project.

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