

# **Get to know our section**

# Microengineering



## **Robotics**



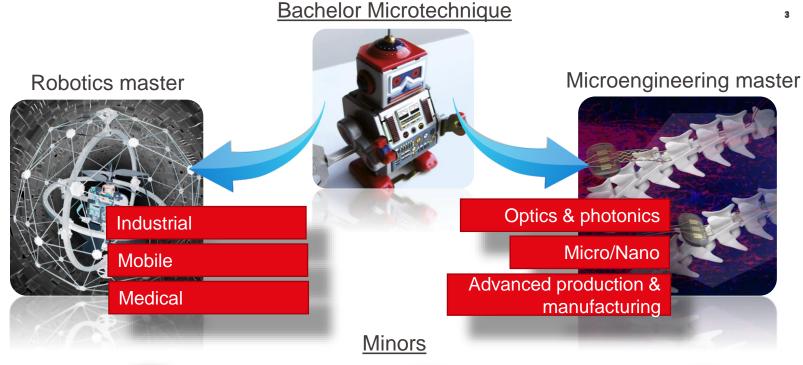
Faculté des Sciences et Techniques de l'Ingénieur (STI)





Faculté des Sciences et Techniques de l'Ingénieur (STI)



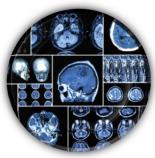




Biomedical Technologies



Imaging





#### **Admission criteria for other Bachelor degrees**

This Master's program is consecutive to a Bachelor's degree in Microengineering obtained at EPFL.

#### Non-EPFL degrees

Bachelor's degrees obtained in the same field but from another institution are eligible on the basis of an application dossier and must be accompanied by excellent academic records.

#### **EPFL** degrees

EPFL Bachelor's degrees in another related field of science and engineering are also subject to a dossier-based analysis and are eligible if they are accompanied by excellent academic records.

#### Prerequisites for all applications

In addition, excellent skills in at least two of the following three domains (computer science, electrical and electronic engineering or mechanical engineering) are required.

The acquisition of additional credits to fill any gaps may be required.

Please note that meeting all of these criteria is no guarantee of admission.





# What is Microengineering?



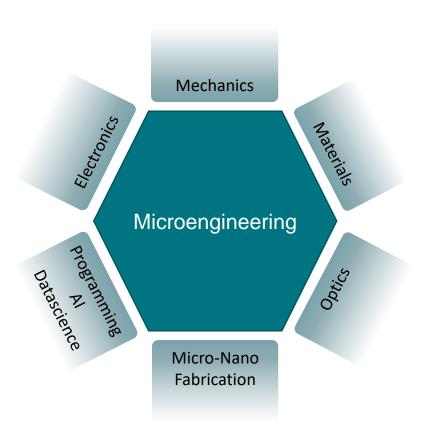
Microengineering is a branch of engineering that deals with the design and fabrication of very small structures and devices, typically on the scale of micrometers or smaller. It involves the use of microfabrication techniques to create complex systems and machines with dimensions that are often measured in microns.

Microengineering encompasses a wide range of applications, including micro-electronics, micro-electromechanical systems (MEMS), microfluidics, nanotechnology, and bioengineering. Some examples of microengineering products include microsensors, microactuators, micro-optics, microfluidic chips, and microelectronic devices.

Microengineering plays an increasingly important role in many fields, including medicine, electronics, materials science, and environmental monitoring. By creating devices that are small, efficient, and precise, microengineering is enabling new applications and advancing scientific understanding in a variety of areas.



# What is Microengineering?





# **Historical background**

Jaquet-Droz Automata (*La Chaux-de-Fonds* - 1768 et 1774)











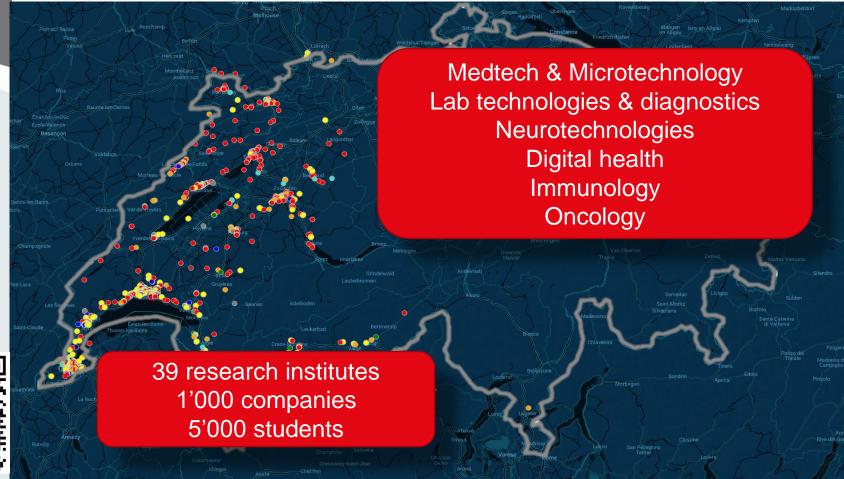
## **Watch Valley: Birthplace of Swiss Watchmaking**







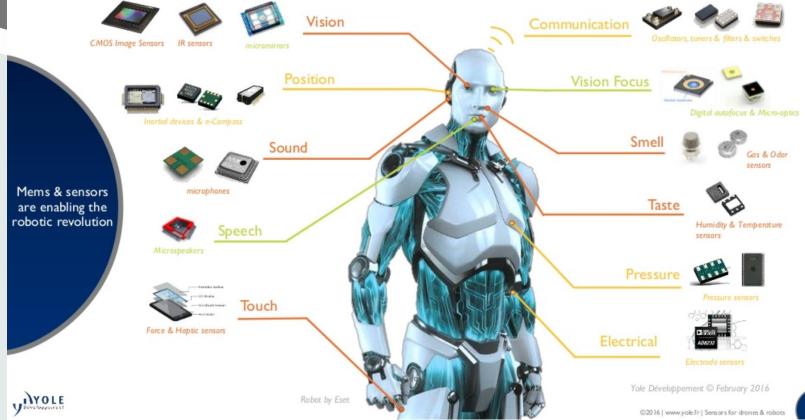
# **Building on history, The Swiss Health Valley**





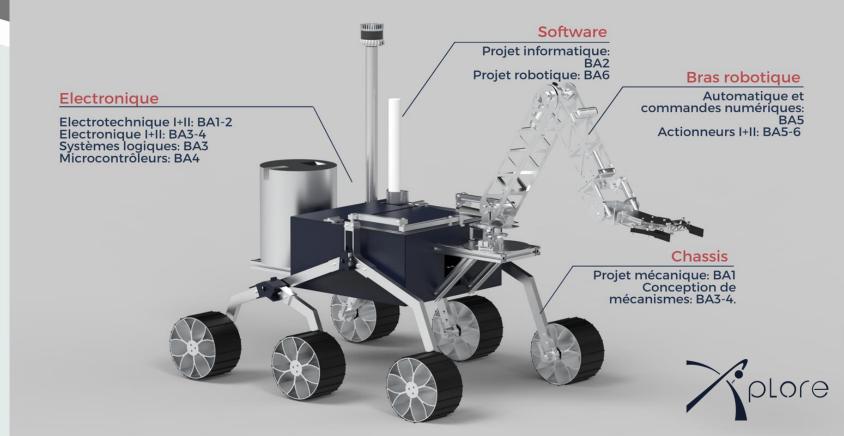


# **Robotics and Sensing**



# EPFL microtechnique microengineering section

## What is Microengineered onboard a Rover?





# Why go Small???

#### Size and Mass







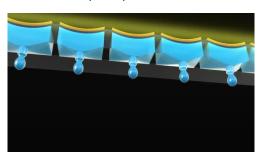
IMU on Saturn V (1960)



#### Speed



40'000 droplets per second



#### **Energy consumption**





# **Worldwide recognition of our programs**









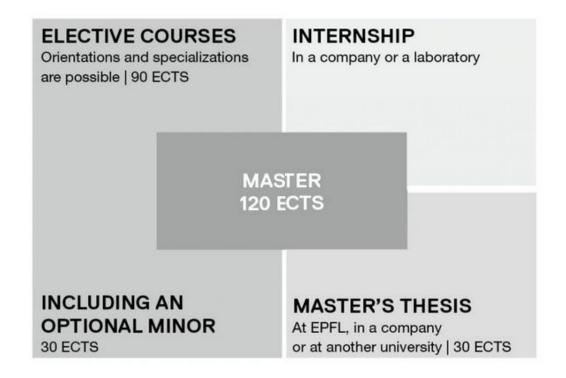








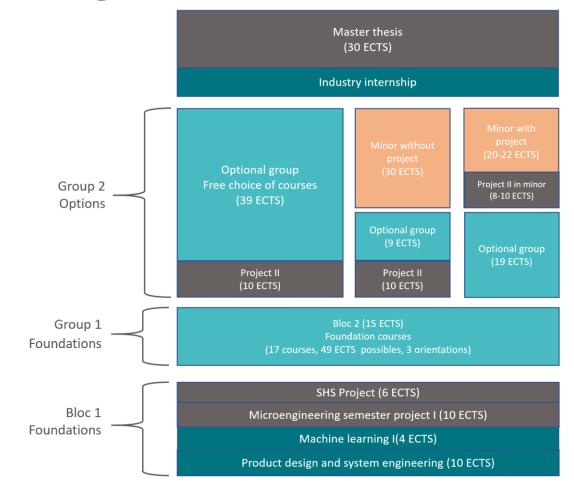
# **Master program structure**



https://www.epfl.ch/education/master/study-programs-structure/



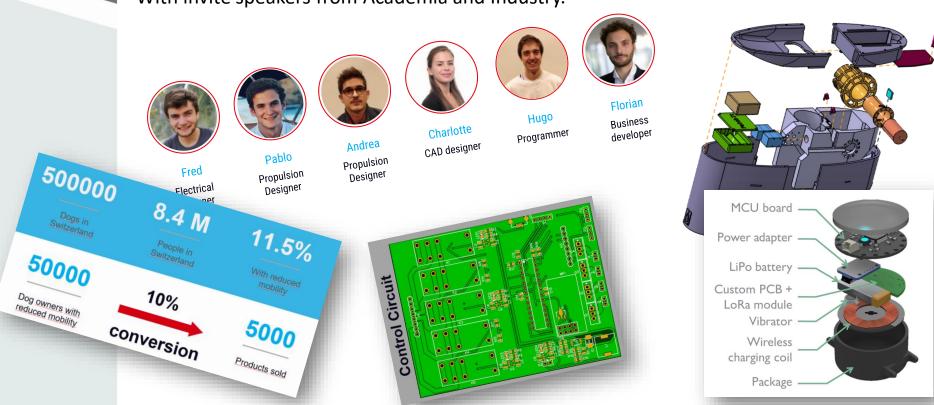
## **Master Program structure**





# **Products Design and Systems Engineering**

Foundational course in the first semester letting groups of students create their own product from concept to prototype, including a first marketing plan. With invite speakers from Academia and Industry.





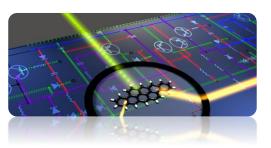
# **Orientations – Microengineering Master**

Orientations are meant as **guidelines** to help students choose their courses

A
Optics and Photonics

Micro ans Nanosystems

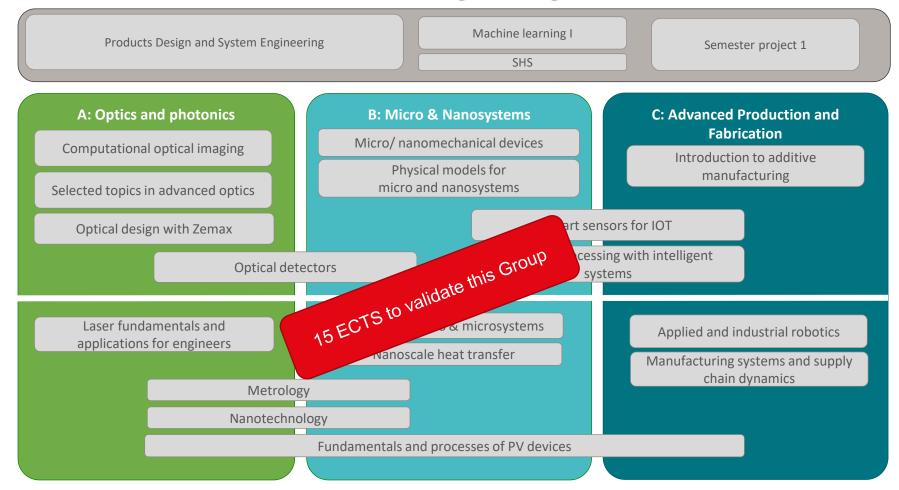
Advanced and Production and Fabrication







#### **Master Microengineering**



### **Orientations - Master Microengineering**

Model predictive control

Advanced control systems

Fall

. .

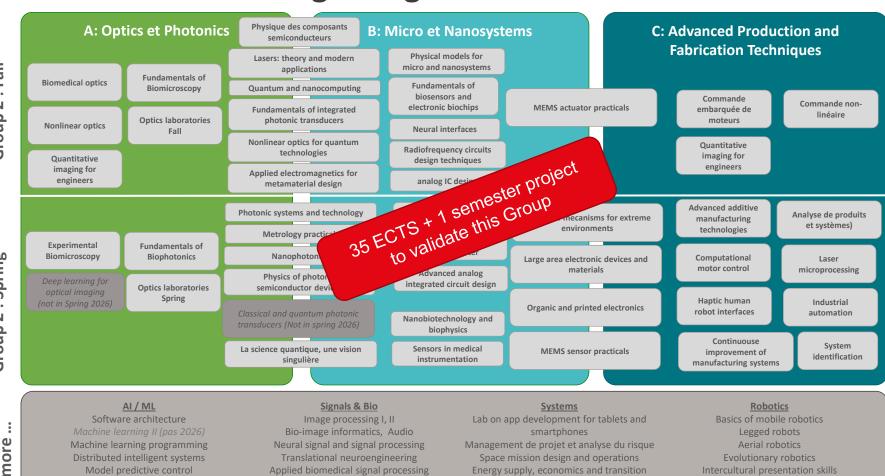
2

Group

Spring

2

Group



Energy supply, economics and transition

Intercultural presentation skills

Computational photography

Applied biomedical signal processing

Introduction to Bioengineering

Neuroscience foundations



Marking & security



Smart fabric printing

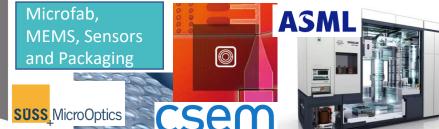






communications







47/

Example of **Industry Players** Micro & **Nanosystems** 

Sensors, Wireless and IOT







Watchmaking











Advanced manufacturing





\* Readily3D

Example of Industry players

Advanced production and
fabrication techniques







Supply chain







**ETEL** 







Materials processing





**Industrial robotics** 

## Master internship evaluations

Company evaluation of over 400 students







## Microengineering Alumni





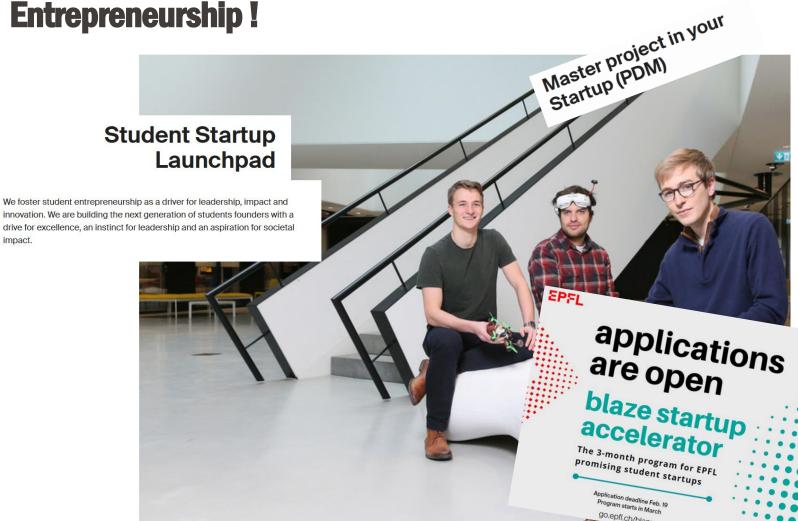








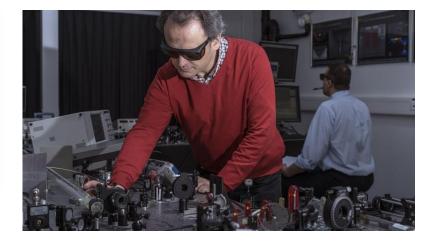
## **Entrepreneurship!**





## **Research - IEM to host your projects**





IEM covers the following major technical fields:

- Electronic Circuits and Devices
- Micro-manufacturing and Micro- and Nano-technologies
- Robotics
- IoT, Computer & Communication Engineering
- · Optics, Photonics and wave engineering
- Machine learning, Information Science and Systems
- Power and Energy

#### Research in IEM:

- 37 Full Professors / Associate Professors / Tenure-Track Assistant Professors
- 1 SNSF-funded Professor
- 13 Adjunct Professors
- 11 Senior Scientists
- 1 Member of the US National Academy of Engineering
- 1 Member of the American Academy of Arts & Sciences
- 1 Member of the Academia Europaea
- 2 Members of Swiss Academy of Engineering Sciences
- 25 ERC grants: 12 Advanced, 6 Consolidator and 7 Starting grants since 2008



## One Institute on 3 campuses



#### Geneva - Campus Biotech

- · Bio- and neuroengineering (Wyss center)
- · Human Brain Project
- · Center for neuroprosthetics

#### **Neuchâtel** - Microcity

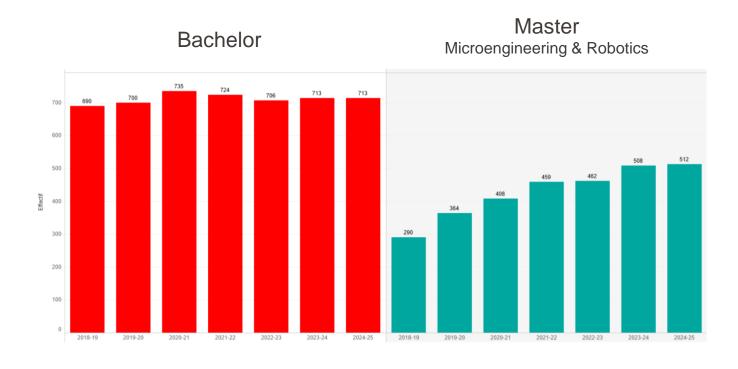
· Microengineering and nanotechnologies

- 420 staff
- 9 chairs
- 3880 m<sup>2</sup>
- 230 staff
- 11 chairs
- 8035 m<sup>2</sup>





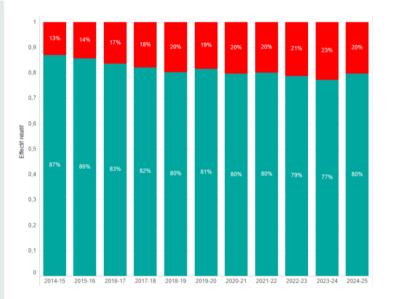
# Successful curricula (>1200 students)



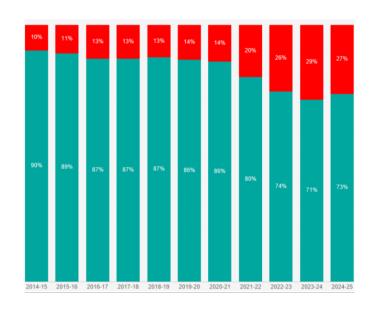


## **Gender balance**

#### Bachelor

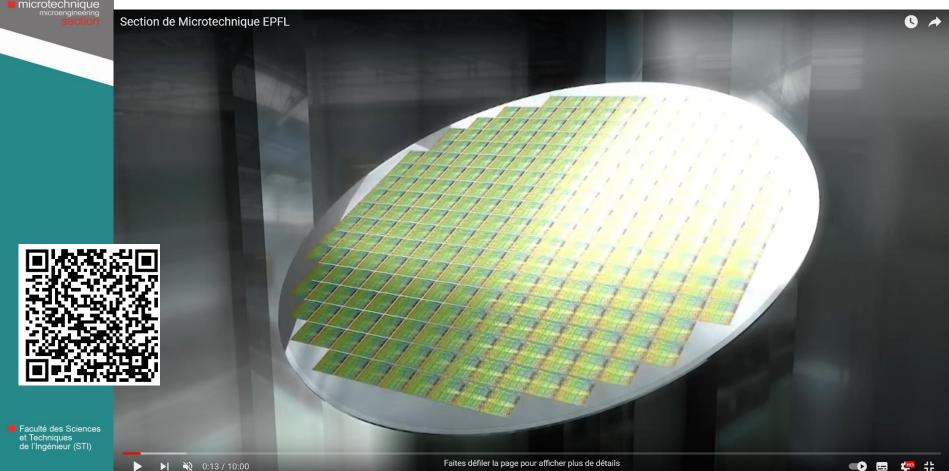


#### Microengineering Master





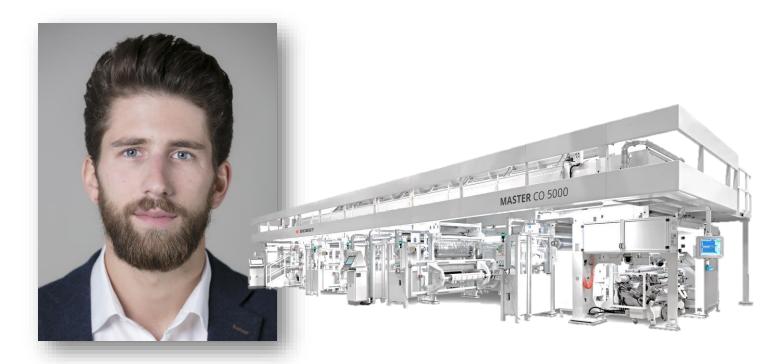
## **Movie to learn more ...**





## **Alumni Testimonies**





Léonard Badet Head of Group Technology – Bobst Master Microtechnique terminé en 2017





## **Alumni Testimonies**

EPFL Switchtube





Damien Wittwer
Business Unit Manager Associate
Master Microtechnique terminé en 2010



https://tube.switch.ch/videos/J6tEwLlxYr



## **Alumni Testimonies**

EPFL Switchtube





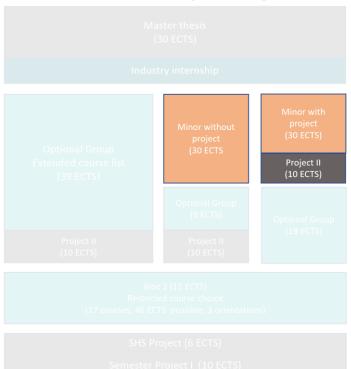
Adrien Briod Founder and CTO Master Microtechnique terminé en 2009 Thèse doctorat EPFL 2013





## **Minors**

#### Microenginering



#### **Robotics**





# Minors (optional)

The student informs the section of his choice of minor and selects it in the course-registration screen on IS-Academia, no later than the beginning of the 2nd semester of his Master's studies.

A minor is successfully completed when **30 credits at minimum have been gained** among the approved subjects. Each subject must be successfully completed on it own merits: there is no possible compensation between the subjects. These 30 credits add to the total of your optional group and for the **90 ECTS** of course credits of you Master program.

Rules and procedures:

https://www.epfl.ch/education/studies/en/rules-and-procedures/minors/



# **Recommended and possible Minors**

Administrated and recommended by the section

	y		Y	Microengineering	Robotics
Mineurs / Minors	Туре	Section	Contact		
Data and internet of things	Interdiscipl.	EL	Atienza D.	r	С
Energie / Energy	Interdiscipl.	GM	Maréchal F.	г	Г
Imaging	Interdiscipl.	MT	Sage Daniel	r	r
Ingénierie pour la durabilité / Engineering for sustainability	Interdiscipl.	SIE	Gilliéron P.Y., Leterrier	r	г
Management, technologie et entrepreneuriat / Technology management and entrepreneurship	Interdiscipl.	MTE	de Rassenfosse G.	r	С
Neuro-X	Discipl.	NX	Hummel F, Micera S.	r	г
Photonique / Photonics	Interdiscipl.	MT	Martin O.	r	г
Physique des systèmes vivants / Physics of living systems	Interdiscipl.	SV	Persat A.	r	r
Science et ingénierie quantiques / Quantum science and engineering	Discipl.	SIQ	Macris N. et Klinke H.	r	г
Technologies biomédicales / Biomedical technologies	Interdiscipl.	MT	Guiducci C.	r	г
Technologies spatiales / Spacial technologies	Interdiscipl.	EL	Kneib JP.	r	r
Science et ingénierie computationnelles / Computational science and engineering	Discipl.	MA	Pouchon O.	r	С
Informatique / Computer science	Discipl.	IN	Hazboun E.	С	г
Architecture	Discipl.	AR	Kochnitzky Palluel L.	С	С
Computational Biology	Interdiscipl.	IN	Salathé M.	С	С
Biotechnologie / Biotechnology	Interdiscipl.	CGC	Pick H.	С	С
Chimie et génie chimique / Chemistry and chemical engineering	Discipl.	CGC	Marendaz JL.	С	С
Cyber security	Discipl.	IN	Hazboun E.	С	С
Data science	Discipl.	SC	Hazboun E.	С	С
Design intégré, architecture et durabilité / Integrated Design, Architecture and Sustainability (IDE/	AsInterdiscipl.	AR	Andersen M., Rey E.	С	С
Territoires en transformation et climat / Territories in transformation and climate (TTC)	Interdiscipl.	AR	Joost St.	С	С
Génie civil / Civil engineering	Discipl.	GC	Turberg P.	С	С
Génie électrique et électronique / Electrical and electronic engineering	Discipl.	EL	Gay-Balmaz Ph.	С	С
Génie mécanique / Mechanical engineering	Discipl.	GM	Prenleloup A.	С	С
Humanités digitales, médias et société	Interdiscipl.	DH	Collins Kathleen	С	С
Ingénierie des systèmes / Systems Engineering	Interdiscipl.	MTE	Weber Th.	С	С
Ingénierie des sciences du vivant / Life sciences engineering	Discipl.	SV	Bezler B.	С	С
Ingénierie financière / Financial engineering	Discipl.	IF	Malamud S.	С	С
Mathématiques / Mathematics	Discipl.	MA	Pouchon O.	С	С
Physique / Physics	Discipl.	PH	Mari D.	С	С
Science et génie des matériaux / Materials science and engineering	Discipl.	MX	Marselli B.	С	С
Sciences et ingénierie de l'environnement / Environmental sciences and engineering	Discipl.	SIE	Gilliéron PY	С	С
Statistique / Statistics	Discipl.	MA	Mhalla L.	С	С
Systèmes de communication / Communication systems	Discipl.	SC	Hazboun E.	С	С

recommanded in the study plans

c choice of the courses with the advice of the initiating section and the person in charge of the minor



#### Minors offered in the Microengineering section

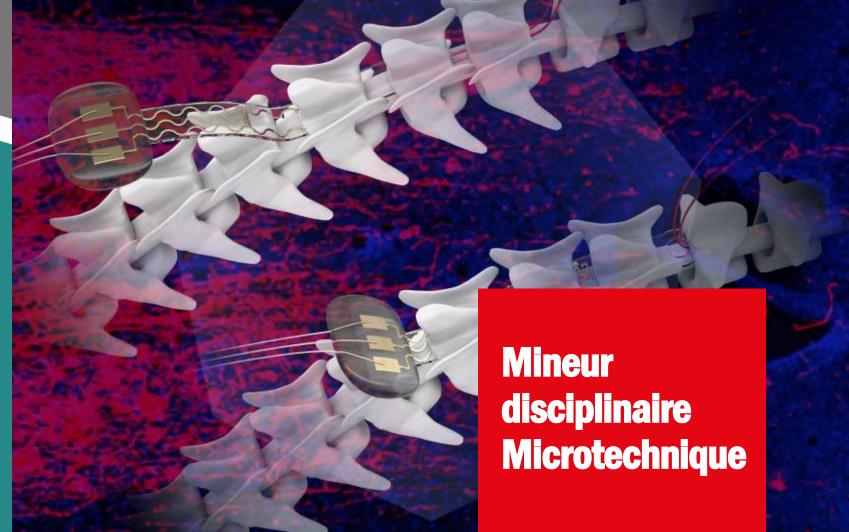






https://sti.epfl.ch/wp-content/uploads/2023/02/Mineur-Technologies-Biomedicales.pdf https://sti.epfl.ch/wp-content/uploads/2023/02/Prsentation\_Mineur-Photonique.pdf https://imaging.epfl.ch/minor-in-imaging/





Faculté des Sciences et Techniques de l'Ingénieur (STI)



## Courseplan (1)

Groupe "Mineur"				30			
Cours obligate	oire du mineur en Microtechnique						
MICRO-406	Products design & systems engineering	Bellouard/Charbon	MT	10		Α	
Fundamentals							
MICRO-534	Advanced MEMS & microsystems	Briand	MT	3			Р
MICRO-565	Fundamentals & processes for photovoltaic devices	Ballif	MT	3			Р
ME-413	Introduction to additive manufacturing	Boillat + Boillat/Brugger/Moser	GM	3		Α	
MICRO-426	Laser fundamentals and applications for engine (pas donné en 2024-25)	Moser	MT	3	<u> </u>		Р
MICRO-428	Metrology	Bruschini/Charbon/Fantner	MT	3			Р
MICRO-530	Nanotechnology	Boero/Brugger	MT	3			Р
MICRO-312	Physique des composants semiconducteurs	Besse	MT	3		A	
MICRO-498	Projet microtechnique I	Divers enseignants	MT	10		Α	Р
	1	:	1	•		•	



## Courseplan (2)

Optics & photo	nics		†		<u> </u>		
	Ingénierie optique (pour MT)	Martin + Achouri/Santschi	MT	3		Δ	
MICRO-420	Selected topics in advanced optics	Martin O.	MT	3		Α	
MICRO-523	Optical detectors	Bruschini	MT	3		Α	
MICRO-573	Deep learning for optical imaging Pas Donné au printemps 2026	Psaltis	MT	3		·············	Р
MICRO-471	Fundamentals of integrated photonic components	Benea-Chelmus	MT	4	20	Δ	
MICRO-471	Lasers: theory and modern applications	Kippenberg/Moser Ch.	MT	4	£20	Δ	
MICRO-429	Metrology practicals	Bruschini/Charbon/Fantner	MT	2	<b></b>	······	D
MICRO-516	Nanophotonics	ladanza/Moselund + Moselund	MT	3	ļ		
PHYS-501		Roke	PH	<u>, , , , , , , , , , , , , , , , , , , </u>	<b>!</b>		P
MICRO-424	Nonlinear optics Optics laboratories (autumn)	Pu	MT	4	ļ	^	Г
MICRO-424		Pu	MT	3	<b> </b>	A	n
	Optics laboratories (spring)	{-i		3		ļ	F
MICRO-421	Computational optical imaging	Psaltis	MT MT	3			Р
MICRO-517	Optical design with ZEMAX	Pu	IVII	3	ļ	Α	
	<u>:</u>	<u>i</u>	<u>.i</u>	<u> </u>	L	<u> </u>	
Micro/Nano	The All Control of the Control of th				:		
ME-426	Micro/Nanomechanical devices	Villanueva	GM	4	ļ	A	
EE-594	Smart sensors for IoT Donnée en 25-26 ?	Ionescu/Paun + Ionescu	<u>EL</u>	3	<b>!</b>	Α	
EE-517	Bio-nano-chip design	Саггага	EL	4	ļ	Α	
MICRO-372	Mécanismes avancés pour environnements extrêmes	Cosandier	MT	3	<b> </b>		Р
MICRO-501	MEMS Actuator practicals	Bertsch/Boero/Brugger	MT	3	ļ	Α	
MICRO-503	MEMS sensors practicals	Bertsch/Boero/Brugger	MT	3	<b> </b>	<u> </u>	Р
MICRO-505	Organic and printed electronics	Briand/Subramanian	MT	2	ļ		Р
EE-536	Physical models for micro and nanosystems	Kis	EL	2	ļ	Α	
ME-469	Nano-scale heat transfer	Tagliabue	MT	4	ļ	į	Р
	<u> </u>	<u> </u>	<u> </u>	<u> </u>	ļ	<u> </u>	
	dvanced manufacturing	····	.į	ļ	ļ	ļ	
MICRO-457	Materials processing with intelligent systems	Hoffmann/Shevchik	MT	3	<b></b>	Α	
MICRO-448	Manufacturing systems and supply chain dynamics	Filliger/Gallay	MT	3	ļ		P
MICRO-451	Applied and industrial robotics	Bouri	MT	2	ļ		Р
MICRO-413	Advanced additive manufacturing technologies	Brugger J./Pu	MT	4	Į		P
MICRO-443	Analyse de produits et systèmes	Kejik	MT	2			Р
MICRO-510	Commande embarquée de moteurs	Koechli+Hodder/Koechli/Perriard	MT	3	į	A	
ME-523	Commande non linéaire	Müllhaupt	GM	3		A	
CS-432	Computational motor control	ljspeert	IC	4	į	<u> </u>	Р
ME-498	Continuous improvement of manufacturing systems	Kaboli	GM	5	<u> </u>		Р
MICRO-553	Haptic human robot interfaces	Bouri/Shokur	MT	4			Р
MICRO-566	Large-area electronics: devices and materials	Ballif/Haug/Würsch	MT	3			Р
MICRO-520	Laser microprocessing	Hoffmann	MT	2			Р
ME-421	System identification	Karimi	GM	3			Р



#### Welcome!



Olivier Martin Responsable Mineur Photonique



Daniel Sage Responsable Mineur Imaging



Carlotta Guiducci Responsable Mineur Technologies biomédicales



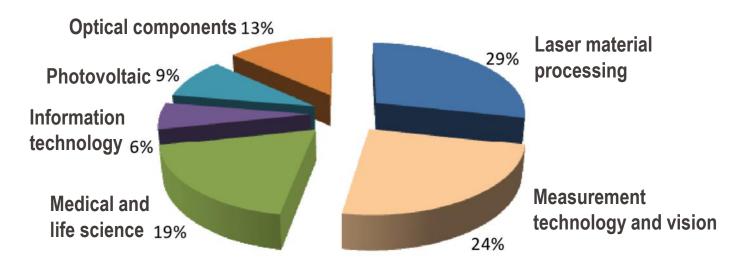


Faculté des Sciences et Techniques de l'Ingénieur (STI)



### **Photonics and industry**

- One of the five key enabling technologies identified by the European Commission
- € 447 billion world market, growing at a rate of 6.2%
- CHF >4 billions Swiss photonics industry, ~ 100 companies,
  - >10'000 highly skilled collaborators:



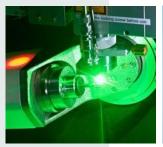


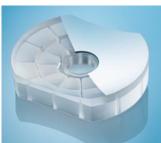


### Photonics in Switzerland – e.g. Optical components

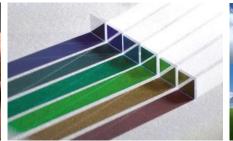
- CHF 400 Mio turnover
- Some large companies and many Small & Medium Enterprises:

ABB, Alpes Laser, ams-OSRAM, Axetris, Balzers Optics, Lumentum Ultrafast Lasers, Escatec, Exalos, Feinwerkoptik Zünd, Fiberoptic, FISBA, Fischer Connectors, Heptagon/AMS, id Quantique, IMT Masken und Teilungen, Industrial Laser Electronics and Engineering, Insolight, Leica, Leister, LESS, Logitech, Mikrop, Omnisens, Onefive, OVD-Kinegram, Silitec Fibers, Sinar, Rainbow Photonics, Schott Suisse, Spectros, Suss Microoptics, SwissOptic, Thin Film Physics, Time-Bandwidth Products, Victor Kyburz, Volpi, Vectronix WZW Optic, Xenlux, Zünd Precision Optics... ... and many, many more!











**SWISS\*PHOTONICS** 



#### **Context for the Minor in Photonics**

- Photonics is widespread at EPFL: Physics, Chemistry, Microengineering,
   Electrical Engineering, Bioengineering, Architecture...
- Very successful Doctoral Program in Photonics
- Large photonics faculty body in the Microengineering Section, where photonics is one of the focuses
- The minor in photonics bundles these competencies to propose a high level photonics degree

### **Objectives**

- Educate students in the science of optics and photonics
- Prepare the students for their future in industry or academia
- Propose a balanced study plan between theory and practical work



## **EPFL** Courseplan

CODE	MATIERES	ENSEIGNANTSsous réserve de	RET DECOU	FREDITSECTS	NBRE PLACES	PERIODE DES COURS	
						AUT	PRI
Groupe "Mi				30			
	atoire du mineur en Photonique						
MICRO-488	Project in photonics	Divers enseignants		10		Α	Р
Bases en pr	notonique pour étudiants n'ayant aucune formation en photonique						
MICRO-321(a	Ingénierie optique (pour MT)	Martin + Achouri/Santschi	MT	6		Α	
Foundations	s of photonics						
MICRO-471	Fundamentals of integrated photonic components (pas donné en 2024-25)	Benea-Chelmus	MT	4	20	Α	
MICRO-426	Laser fundamentals and applications for engineers	Moser	MT	3			Р
MICRO-422	Lasers: theory and modern applications	Moser Ch./Kippenberg + Moser	MT	4		Α	
PHYS-501	Nonlinear optics	Roke	MT	4		A	Р
PHYS-470	Nonlinear optics for quantum technologies	Galland	PH	4		A	Р
MICRO-423	Optics laboratories (spring)	Psaltis/Pu	MT	3			Р
MICRO-424	Optics laboratories (autumn)	Psaltis/Pu	MT	3		Α	
EE-440	Photonic systems and technology	Brès	EL	4			Р
PHYS-434	Physics of photonic semiconductor devices	Grandjean	PH	4			Р
PHYS-453	Quantum electrodynamics and quantum optics	Kippenberg	PH	6		Α	
PHYS-454	Quantum optics and quantum information	Brantut	PH	6			Р
PHYS-425	Quantum physics III	Yazyev	PH	6		Α	
MICRO-420	Selected topics in advanced optics	Martin O.	MT	3		Α	
PHYS-433	Semiconductor physics and light-matter interaction	Butté	PH	4		Α	
MICRO-410	Classical and quantum photonic transducers	Benea-Chelmus	MT	3			Р
Applied pho							
MICRO-565	Fundamentals & processes for photovoltaic devices	Ballif	MT	3			Р
BIO-443	Fundamentals of biophotonics	Radenovic	SV	3			Р
MICRO-511	Image processing I	Unser/Van de Ville	MT	3		Α	
MICRO-512	Image processing II	Liebling/Sage/Unser/Van de Vill	MT	3			Р
MICRO-421	Imaging optics Computational Optical Imaging	Psaltis	MT	3			Р
MICRO-520	Laser microprocessing	Hoffmann	MT	2			Р
MICRO-331	Microfabrication technologies	Brugger/Gijs/Lacour	MT	4		Α	
MICRO-516	Nanophotonics	ladanza/Moselund + Moselund	MT	3			Р
MICRO-517	Optical Design with ZEMAX	Pu	MT	3		Α	
MICRO-523	Optical detectors	Besse Bruschini	MT	3		Α	
MICRO-505	Organic and printed electronics	Briand/Subramanian	MT	2			Р
Biomedical	photonics						
	Biomedical optics	Wagnières	SV	3		Α	
MICRO-561	Biomicroscopy I	Altug	MT	3		A	
MICRO-562	Biomicroscopy II	Altug + Seitz A.	MT	4			Р
CH-448	Photomedicine	Wagnières	CGC	2 3			P

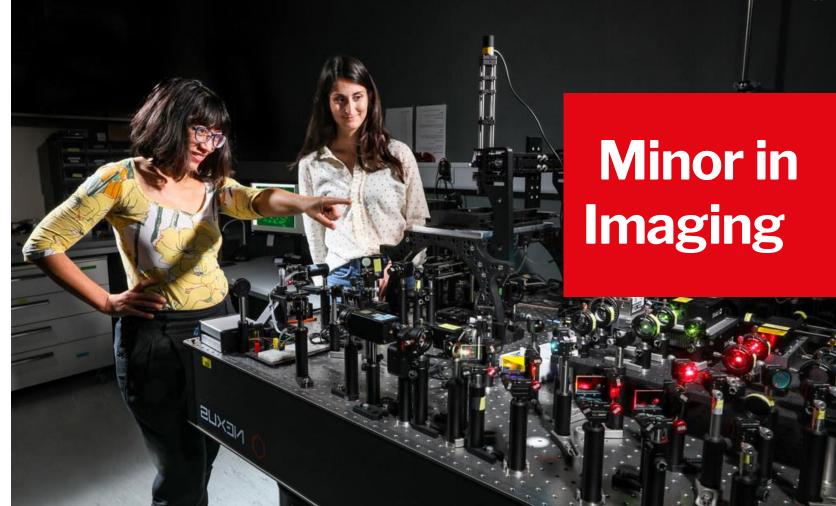


#### **Further information**

please do not hesitate to contact me olivier.martin@epfl.ch

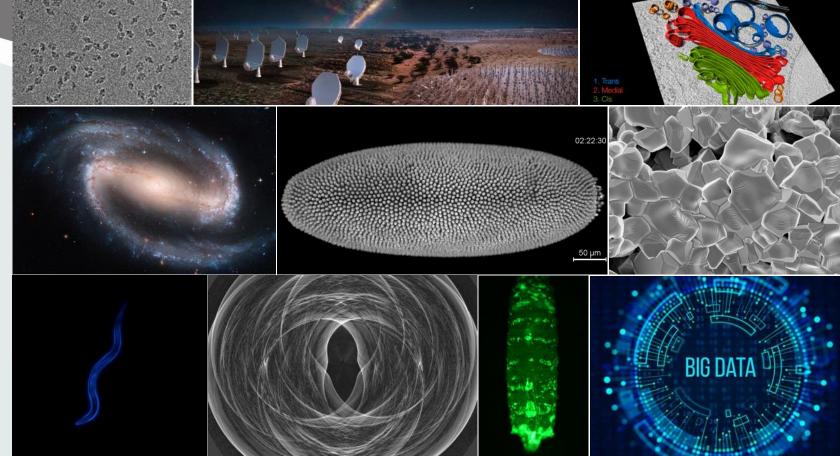
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#### **EPFL**



 École polytechnique fédérale de Lausanne

## An explosion of (very large) images





### Context



Rich but scattered imaging curriculum



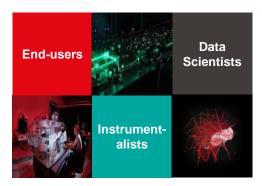
EPFL: unique concentration of academic strengths



Skills in high demand by industry and academia



Strategical context



Interdisciplinary field par excellence



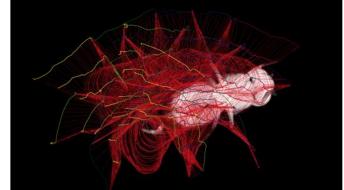
Massive demand for deep-learning



### **Pedagogical Concept**

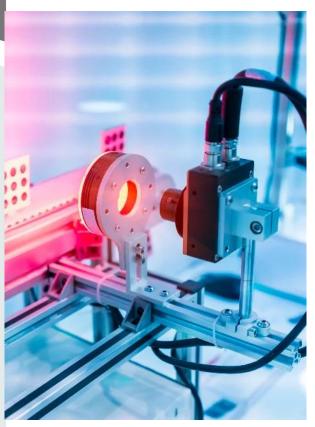
- Train students with a wide, transversal set of imaging skills.
- Bring greater visibility/coherency to the large offer of imaging-related classes at EPFL.
- Holistic program: From acquisition (optics, physics, sensors, etc.) to computation (image analysis, ML, computer vision, etc)
- Mostly application-agnostic.







### Interest from (Swiss) Industry



- Interdisciplinary imaging skills are in increasing demand from the Swiss industry and the academic world.
- Unanimously-positive feedback from contacted Swiss-based companies.
  - Nestlé, Mikron, Rolex, Siemens, NanoLive, etc.
- Wealth of job offers in imaging from major companies with offices in CH.
  - Apple CH, Novartis, Roche, Swatch, Google CH, Sony, etc.



### **Center for Imaging**





#### **Core Pillars**

- 1. Promotion of interdisciplinary collaborations in imaging
- 2. Support in image analysis
- **3. Common solutions** for image handling and processing
- 4. Training of students and users



imaging.epfl.ch



### **In Summary**

https://imaging.epfl.ch/minor-in-imaging/



Open to all EPFL Master students

- Holistic program
- instrumentation to computation
- theoretical and practical aspects
- ~25 courses (~90ECTS)
- Mandatory student project
- Strong interest from industry and academia

#### **Courses**

7

**EPFL** Fundamentals/Theory The Minor in Imaging **Application Fields:** Application Agnostic Computational Image Processing I Metrology Optics Biomedical, Life Sciences Imaging MICRO-428 3 S MICRO-421 3 MICRO-511 3 F Civil Engineering Biomicroscopy Fundamentals of Computational Image Processing II Earth Observation Biophotonics Photography MICRO-561 4 F BIO-443 3 S MICRO-512 3 S CS-413 6 S Neural Signals and Signal Image Analysis and Pattern Recognition Electron Microscopy Fundamentals of Computer Vision Adv. Methods Biomedical Imaging Processing PHYS-438 NX-421 CS-442 3 S EE-541 4 S 6 S Instrumentations Computation Optics **Data Science** Sensing and Spatial Visual Intellig. Machine Biomicroscopy Image Processing for Bioimage Informatics Modelling for Earth Obs. Farth Ohs. and Minds ENV-540 CS-503 6 S Quantitative Imaging for Deep Learning for Optical Optical Detectors Engineers Imaging MICRO-523 3 F MICRO-518 3 F MICRO-573 3 S MRI Practicals Metrology Lab in Signal and Image Preclinical imaging Practicals Processing PHYS-473 3 MICRO-429 EE-490 4 S Coordination Organization Dr. Daniel Sage Applied Labs/Practice **EPFL Center for Imaging** daniel.sage@epfl.ch Microengineering Section Info: imaging.epfl.ch/education



### EPFL Courseplan

CODE	MATIERES		ENSEIGNANTSsous réserve de	RET DECOU	REDITSECTS	NBRE PLACES	PERIODE DES COURS	
						AUT	PRI	
Groupe "Mir	neur"				30			
	atoire du mineur en Imagerie							
MICRO-489	Project in Imaging		Divers enseignants		8		Α	Р
	, reject in maging						,	•
Bases en ima	agerie							
MATH-xxx	Mathematics of imaging	(dès 2024-2025)	Unser/Simeoni/Guizar		3		Α	
	Autres cours							
	Instrumentation and Optics							
MSE-450	Electron microscopy: advanced method	ls	Alexander	MX	3			Р
BIO-443	Fundamentals of biophotonics		Radenovic	SV	3			Р
MICRO-421	Computational Optical Imaging		Psaltis	MT	3			Р
MICRO-428	Metrology		Bruschini/Charbon/Fantner	MT	3			Р
MICRO-429	Metrology practicals		Bruschini/Charbon/Fantner	MT	2			Р
MICRO-523	Optical detectors		Bruschini	MT	3		Α	
	Image Processing and Analysis							
CS-413	Computational photography		Süsstrunk	IN	6			Р
CS-442	Computer vision		Fua	IN	6			Р
MICRO-573	Deep learning for optical imaging		Psaltis	MT	3			Р
EE-451	Image analysis and pattern recognition		Bozorgtabar/Thiran	EL	4			Р
MICRO-511	Image processing I		Unser/Van de Ville	MT	3		Α	
MICRO-512	Image processing II		Liebling/Sage/Unser/Van de Ville	MT	3			Р
EE-490(f)	Lab in signal and image processing		Thiran	EL	4			Р
COM-514	Mathematical foundations of signal prod	essing	Fageot/Simeoni	SC	6		Α	
CS-503	Visual intelligence : machines and mind	S	Zamir	IN	6			Р
	Application-Specific Courses							
BIO-410	Bioimage informatics		Sage/Seitz	SV	4			Р
MICRO-561	Biomicroscopy I		Altug	MT	3		Α	
MICRO-562	Biomicroscopy II		Altug/Seitz	MT	4			Р
PHYS-438	Fundamentals of biomedical imaging		Gruetter	PH	4			Р
ENV-540	Image processing for Earth observation		Tuia	SIE	4		Α	
NX-421	Neural signals and signal processing		Micera/Van De Ville	NX	6		Α	
CIVIL-510	Quantitative imaging for engineers		Andò	GC	3		Α	
ENV-408	Sensing and spatial modeling for earth	observation	Berne/Skaloud/Tuia	SIE	5			Р
PHYS-XXX	MRI Practicals on CIBM preclinical ima	ging systems	Cudalbu / Lanz	PH	3		А	



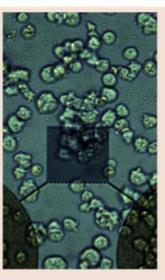


Faculté des Sciences et Techniques de l'Ingénieur (STI)



SCHOOL OF ENGINEERING

#### MINOR IN BIOMEDICAL TECHNOLOGY



The Minor in Biomedical Engineering complements the engineering programmes offered at EPFL, providing additional skills in the field of biomedical sciences and technologies.

The programme includes courses giving a general basis in biomedical sciences as well as a broad choice of engineering-related courses with special emphasis on applications in biomedical engineering.

Students have the opportunity to carry out a research project (semester project, 8 ECTS) in one of the laboratories participating in the programme. This Minor can be taken in addition to one of the following programmes:

- Mechanical Engineering
- Microengineering
- Materials Science and Engineering
- Electrical and Electronics Engineering
- Chemistry and Chemical Engineering
- Physics
- Life Sciences
- Civil Engineering

The 30 ECTS credits of the minor are added to the 90 ECTS of the Master (including the 30 ECTS of the Master's thesis) and duly mentioned in the Diploma Supplement.



# **Switzerland Medtech environment**

Top 10 Swiss medtech employers ranked by number of employees (data 2021)

No.	Company	Core activities in Switzerland	Headquarters	Number of employees in Switzerland
1	Jabil	Orthopaedics	USA	2,865
2	Roche Diagnostics	In vitro diagnostics	СН	2,800
3	J&J Medical	Orthopaedics, traumatology, wound treatment	USA	1,600
4	Hamilton <sup>1</sup>	Ventilators, in vitro diagnostics, laboratory automation	СН	1,540
5	Straumann	Dentistry	СН	1,460
6	Sonova <sup>2</sup>	Hearing aid technology	СН	1,445
7	Ypsomed <sup>2</sup>	Injection systems (drug delivery) and diabetes management	СН	1,356
8	Biotronik	Cardiology	GER	1,350
9	Zimmer Biomet	Orthopaedics, traumatology	USA	1,100
10	B. Braun	Wound treatment, hospital equipment and disposables	GER	1,100

#### + thousands of SME and start-up

https://www.startup.ch/medtech-startups

https://www.swissbiotech.org/category/services-medical-devices-technologies/

https://www.swiss-medtech.ch



Orthopaedics and traumatology



Dentistry



Ophthalmology



Surgical instruments and technology



General disposables



In vitro diagnostics and laboratory supplies



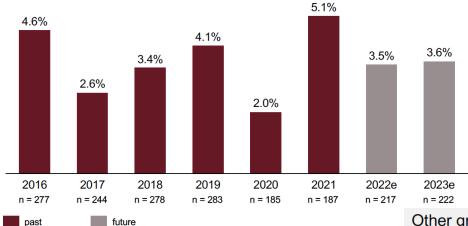
Rehabilitation, prosthetics, orthotics and everyday aids



Drug delivery systems and diabetes management



# **Employment trends in Medtech**



Source: SMTI 2022

4'500 news jobs beween 2020 and 2022

Other growth rates for comparison:

- Total number of jobs in Switzerland: +1.4% (2021)
- Number of jobs in the Swiss pharmaceutical industry: +2.2% (2021)



# **Top trends in medical technologies**

#### **Product innovation**

Smart devices

Smart design and engineering, wearables, hearables, implantables, etc.

Materials innovation

Improved properties: durability, biocompatibility, surfaces, malleability, etc.

Substitution technology

New sensors for continuous non-invasive and invasive measurement of body data, etc.

Data acquisition

Internet of things, sensorisation, integration with evaluation software, etc.

6 Individualisation

Individualised prostheses and implants, electronic tablets, etc.

#### **Diagnostics**

Service automation Remote monitoring, automatic ordering of replacement parts, etc.

Patient data processing

Big data analysis and processing, cyber security, artificial intelligence (AI), pattern recognition in unstructured data. etc.

Personalised medicine

Precision medicine adapted to genome, patientspecific implants, etc.

Augmented reality / virtual reality

Viewing internal body structures, visualisation of complex data, simulation of interventions, surgery planning incl. risk management, etc.

5 Human-machine interfaces

Intuitive handling, speech recognition, brain-computer interfaces, etc.

#### Therapy/Treatment

1	Automation and robotisation	Robots to support surgical, hospital, and nursing staff, etc.
2	Decision-making autonomy of physicians	Automation of interpretation and decision-making based on diagnostic values, etc.

#### Health care

Patient behaviour: prevention vs treatment	Integration of preventive health care into everyday life, etc.
Patient's need for information	Need for information on diseases, healthy living, all forms of treatment and sources, etc.
3 Telemedicine	Overcoming spatial or temporal distance for diagnostics and therapy, etc.
4 Branding	Brand awareness, etc.



### **Adapted offer and requisites**

The program includes **courses** (22 ECTS minimum, <u>all optional</u>) of basis in biomedical sciences as well as a broad choice of engineering-related courses with emphasis on applications in biomedical engineering.

A semester project (8 ECTS, mandatory) related to biomedical technology in included in the Minor.

#### For non-SV students (STI, SB...)

A core group of courses of biomedical basis is strongly recommended:

PHYS-301	Biophysics : physics of the cell
BIO-105	Cellular biology and biochemistry for engineers
BIO-377	Physiologie par systèmes
MICRO-568	Seminar in physiology and instrumentation

This Minor allows to aquire various fundamentals in many areas of biological and medical sciences

#### For SV students

SV students will have the opportunity to deepen their engineering knowledge in their domain of interest leveraging the offered courses in the Minor curriculum and possibly select other courses from other engineering programs (up to 10 ECTS, upon agreement of the Minor coordinator



#### Courseplan

CODE	MATIERES
Groupe "Mine	
	pire du mineur en Technologies biomédicales
MICRO-563	Project in biomedical technologies
Bases bioméd	icales 1)
PHYS-301	Biophysics : physics of the cell
BIO-105	Cellular biology and biochemistry for engineers
BIO-377	Physiologie par systèmes
MICRO-568	Seminar in physiology and instrumentation
Autres cours	
PHYS-XXX	MRI Practicals on CIBM preclinical imaging systems
NX-XXX	Regulatory, quality and Clinical affairs
EE-518	Analog circuits for biochip
EE-512	Applied biomedical signal processing
EE-519	Bioelectronics and biomedical microelectronics
BIO-410	Bioimage informatics
BIOENG-421	Basics in bioinstrumentation
NX-465	Computational neurosciences: neuronal dynamics
ME-481	Biomechanics of the cardiovascular system
ME-482	Biomechanics of the musculoskeletal system
BIOENG-445	Biomedical optics
MICRO-561	Biomicroscopy I
MICRO-562	Biomicroscopy II
EE-517	Bio-nano-chip design
PHYS-302	Biophysics : physics of biological systems
PHYS-438	Fundamentals of biomedical imaging
BIO-443	Fundamentals of biophotonics
EE-515	Fundamentals of biosensors and electronic biochips
MICRO-321(a)	Ingénierie optique (pour MT)
MICRO-390	Light, liquids and interfaces
ME-480	Mechanobiology: how mechanics regulate life
MICRO-331	Microfabrication technologies
CH-413	Nanobiotechnology
NX-422	Neural interfaces
NX-421	Neural signals and signal processing
BIO-482	Neuroscience: cellular and circuit mechanisms
BIO-491	New tools & research strategies in personalized health
ME-484	Numerical methods in biomechanics
EE-511	Sensors in medical instrumentation
NX-423	Translational neuroengineering

#### Science & technology domains related to Medtech

- Proteomics
- Genetics and sequencing
- In vitro models
- In vitro diagnostics
- Neuroengineering
- Sensors and instrumentations
- Reabilitation and prosthetics
- Imaging and Biomedicla signals treatment
- Digital diagnostics, data interpretation tools
- Biomaterial, Tissue engineering
- Biomechanics
- Surgical instruments and robotics
- Microsystems for sample processing and analysis (Biomems, lab-on-a-chip)
- •



## We wish you a successful completion of your Bachelor and to find the right Master!





# **Download the presentation**

