EPFL
mt
microtechnique
microengineering
section

Microtechnique

Robotique

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

EPFL
mt
microtechnique
microengineering
section

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

**Robotics
Master**

Bachelor Microtechnique

Robotics master

Microengineering master

Tomorrow:
18h15 -19h00
AAC 231

Industrial

Mobile

Medical
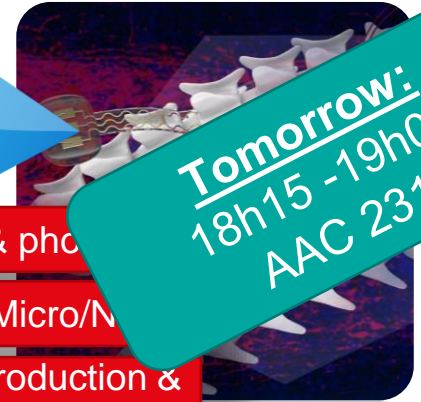
Optics & pho

Micro/N

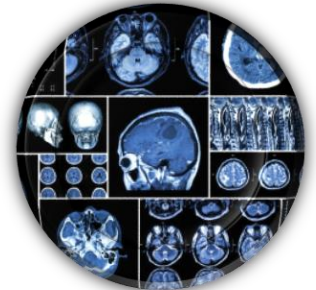Advanced production & manufacturing

Minors

Optics & Photonics

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.
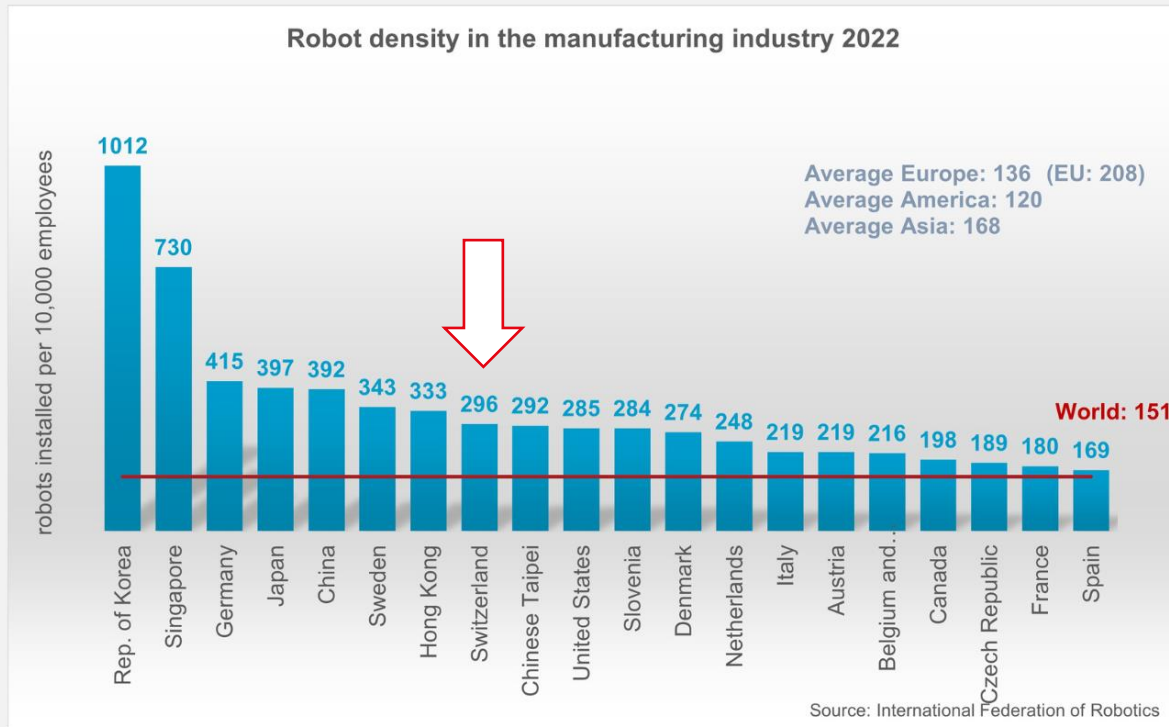
Robotics

La Suisse, un géant discret de la robotique

How Switzerland Became The Silicon Valley Of Robotics

Andrew Cave Contributor

Neue Zürcher Zeitung

Die Schweiz will sich als Drohnen-Mekka positionieren

Ce n'est pas un slogan marketing, c'est un fait: en robotique, la Suisse est championne du monde. «Si l'on prend le top 20 des labos dans le monde, pratiquement un quart sont en Suisse, alors que nous n'avons que huit millions d'habitants», confirme Aude Billard,
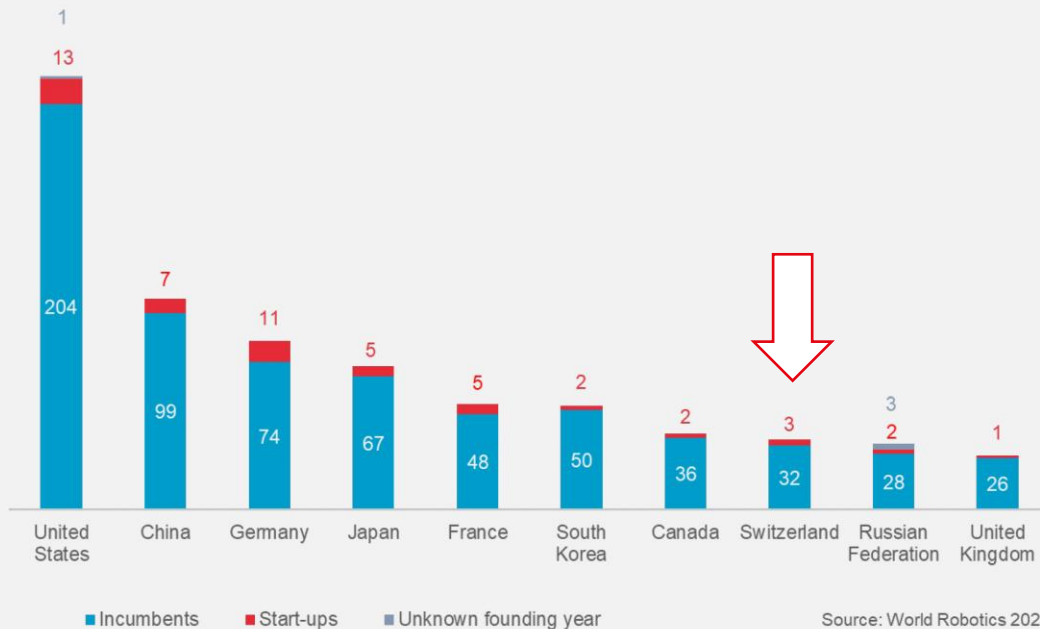
Switzerland in top 10 in automatisation

Top 10 in # of manufacturers of service robots

The United States is home of most service robot suppliers

Service robot manufacturers by country (top 10)
all applications

- Incumbents
- Start-ups
- Unknown founding year

Source: World Robotics 2023

Worldwide recognition

EduRank

27. **Federal Institute of Technology Lausanne**

🇨🇭 Switzerland | Lausanne

For Engineering

#4 in Europe

#1 in Switzerland

EPFL

6. **Federal Institute of Technology Lausanne**

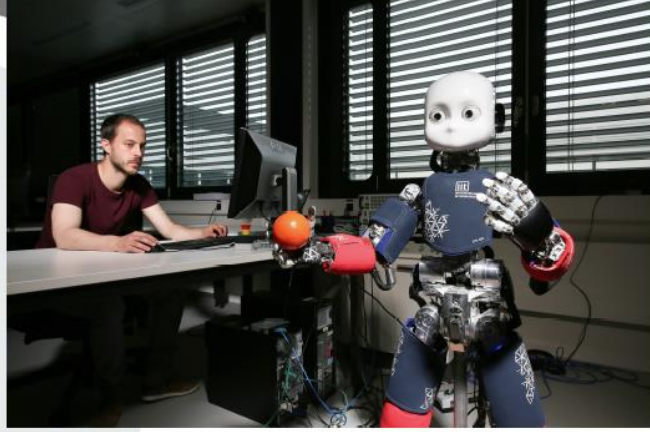🇨🇭 Switzerland | Lausanne

For Robotics

#1 in Europe

#1 in Switzerland

Enrollment   12,576

EPFL
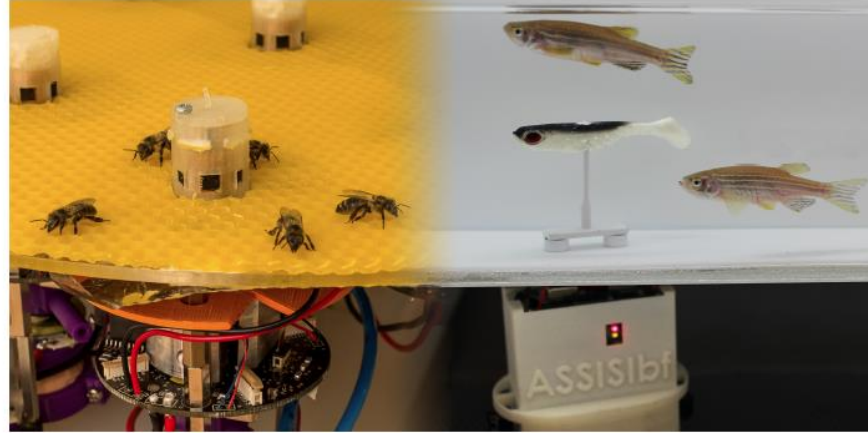
Robotics

Prof. Aude Billard

Prof. Dario Floreano

Prof. Auke Ijspeert

Prof. Silvestro Micera

Prof. Francesco Mondada

Diversité (écoles de provenance de nos candidats externes)

Technische Universität München	Allemagne
Technische Universität Wien	Autriche
Université Catholique de Louvain	Belgique
McGill University, Montreal	Canada
University of British Columbia, Vancouver	Canada
University of Toronto	Canada
University of Waterloo	Canada
Shanghai Jiao Tong University	Chine
The Hong Kong University of Science and Technology	Chine
Tsinghua University, Beijing	Chine
Universitat Politècnica de Catalunya, Barcelona	Espagne
Cornell University, Ithaca	Etats-Unis
Harvard University, Cambridge	Etats-Unis
University of California, Santa Barbara	Etats-Unis
University of Illinois at Urbana-Champaign	Etats-Unis
Ecole Polytechnique, Palaiseau	France
National Technical University of Athens	Grèce
Indian Institute of Technology Delhi	Inde
Indian Institute of Technology Kanpur	Inde
Indian Institute of Technology Madras	Inde
Politecnico di Milano	Italie
Politecnico di Torino	Italie
Università degli Studi di Roma "La Sapienza"	Italie
Delft University of Technology	Pays-Bas
Imperial College London	Royaume-Uni
University of Edinburgh	Royaume-Uni
Nanyang Technological University	Singapour
National University of Singapore	Singapour
Bogazici University, Istanbul	Turquie

Alumni careers

Careers after EPFL's MA Program in Robotics

Alumni careers (graduated in 2020 and 2021)

|		
42matters	EPFL	Philip Morris
Aircall	ETHZ	Pilatus Aircraft Ltd
Alpine Intuition	Flyability	Pix4D
Alpine Intuition	Flybotix	Precitrame Machines SA
Anaglyph Ltd	Freshape	Qwestive
ANYBotics	GF Machining Solutions	Rolex
Bain & Company	Hamilton Medical	Scandit
Beaver Innovation	Harvard University	SCS - Supercomputing Systems AG
Biped AI	Imperial College	Selexis SA
BLUE ORIGIN	Koenigsegg Automotive AB	SHL Medical
Capgemini	Kudelski Group	Sonova Group
CERN	LAAS-CNRS	Spes Robotics
China Nanhu Academy of Electronics and Information Technology	Logitech	Strategy&
ClearSpace	Magnebotix AG	Swisscom
CORTEXIA	Meta	Technis
Credit Suisse	Metaphysiks Engineering SA	Tesla
Datwyler Group	Mikron	Typeless
Décovi SA	MOBBOT	Universidad del País Vasco
DragonBox Kahoot!	myBrain Technologies	Université Paris-Saclay
ei3	OHB SE	University of Oxford
Embedded Factory	Omnisense SA	USI Università della Svizzera italiana
	Open Web Technology	Wearin'

Quality

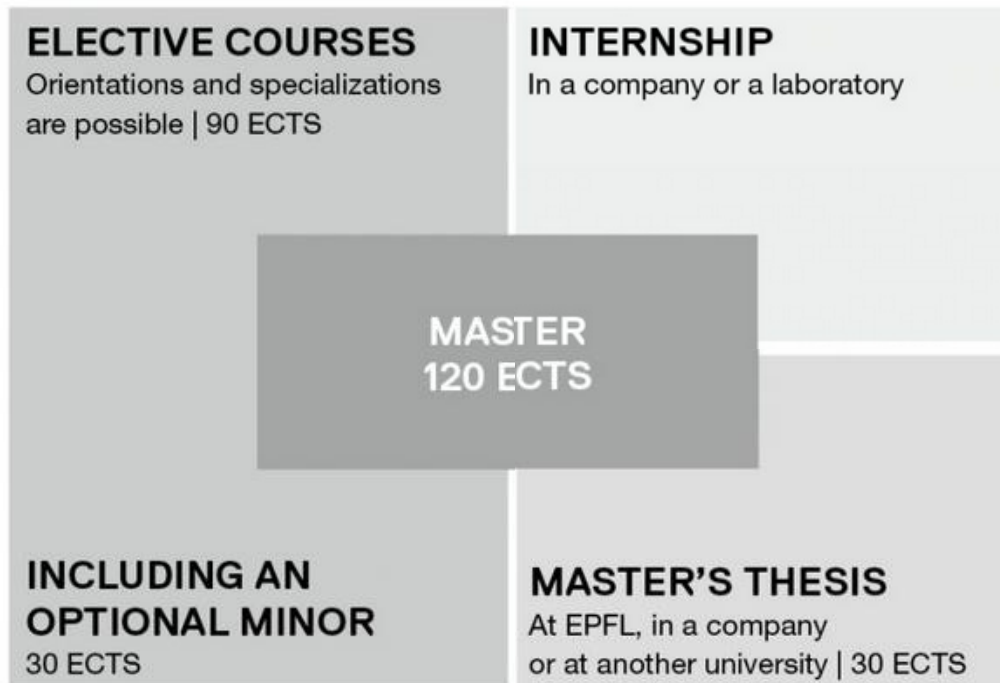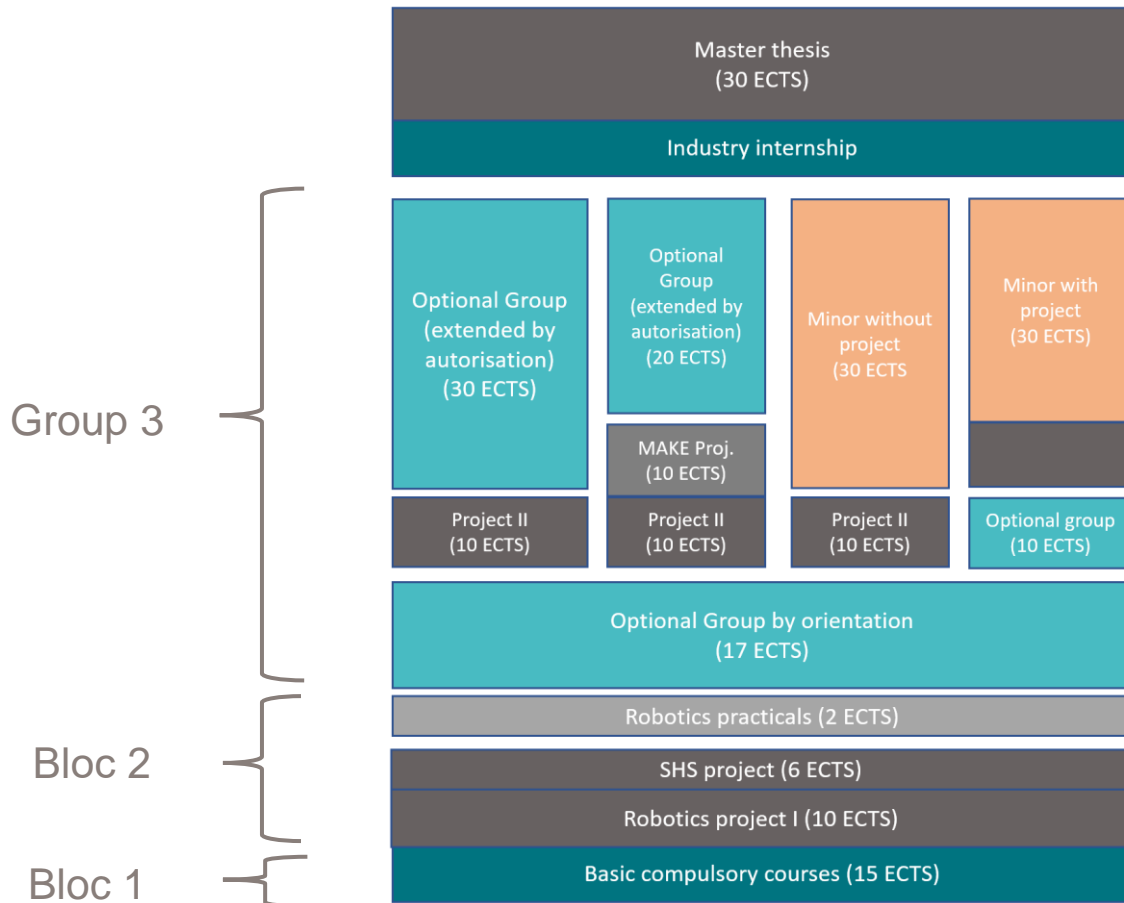## 3.1 GLOBAL ASSESSMENT OF THE MASTER IN ROBOTICS
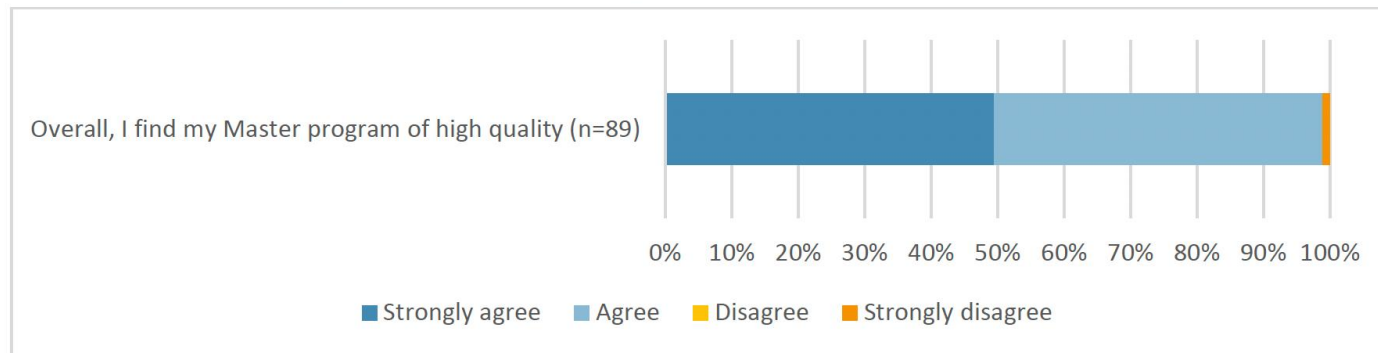
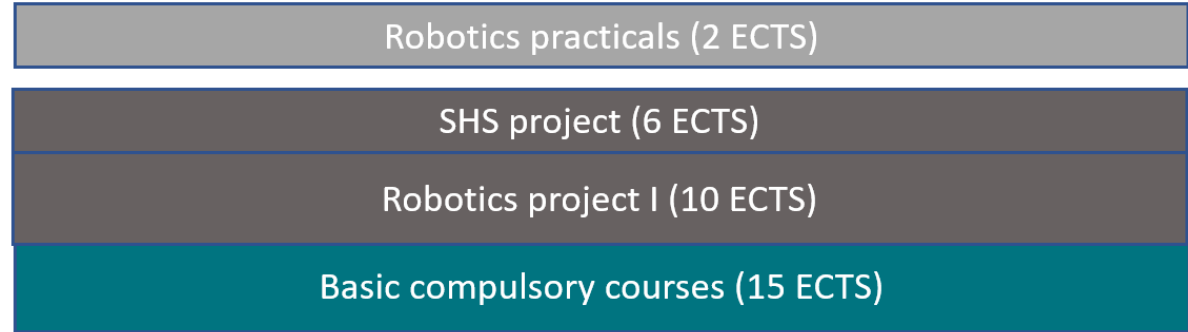*Figure 8. Respondents assessment of the Master*

Almost all respondents are satisfied with the Master. 49,5% strongly agreed and 49.5% agreed that they find the Master programme of high quality.

Master program structure

ELECTIVE COURSES
Orientations and specializations are possible | 90 ECTS

INTERNSHIP
In a company or a laboratory

MASTER
120 ECTS

INCLUDING AN OPTIONAL MINOR
30 ECTS

MASTER'S THESIS
At EPFL, in a company or at another university | 30 ECTS

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

Master Program structure

Structure
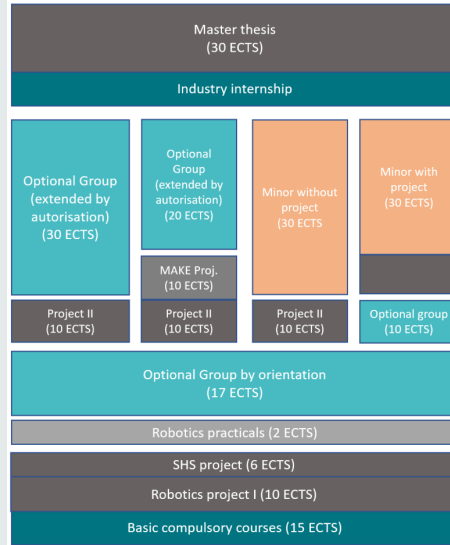
Master Robotics

Bloc 1

| Basics of mobile robotics | Basics of robotics for manipulations | Machine learning I | Model predictive control |

Bloc 2

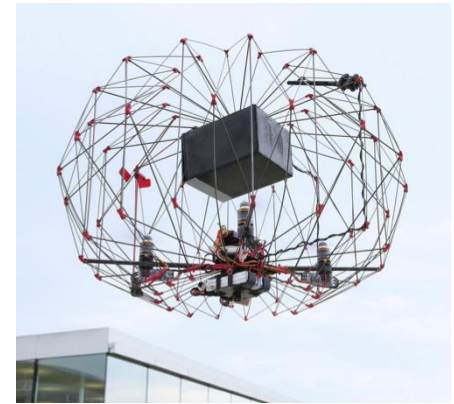| Robotics practicals | Robotics project I | SHS intro & project |

Orientations

17 optional credits chosen among the optional courses of the chosen orientation, then free choice in robotics options.
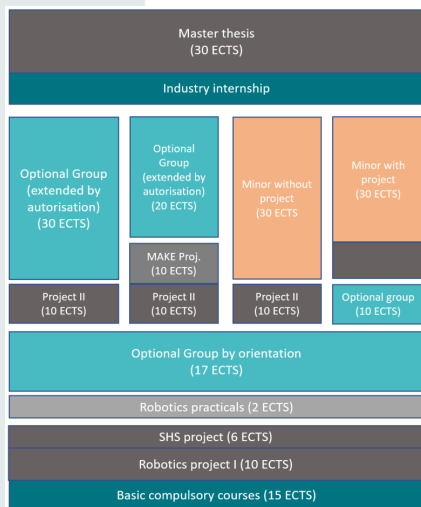

Industrial Robotics

Medical Robotics

Mobile robotics

Orientations

Students must choose 17 ECTS of optional courses in one of these three orientations:

A Industrial robotics
B Medical robotics
C Mobile robotics

Groupe à options
Grand choix de cours
(17 ECTS)

Optional courses and orientation	A	B	C	59
Advanced control systems	A	B	C	3
Advanced machine learning	A	B	C	4
Advanced MEMS & microsystems			C	3
Advanced satellite positionning			C	4
Analyse de produits et systèmes	A			2
Analysis and modeling of locomotion		B	C	4
Biomaterials		B		4
Commande embarquée de moteurs	A			2
Computational motor control		B	C	4
Computer vision	A	B	C	4
Conception mécanique intégrée	A			3
Continuous improvement of manufacturing systems	A			4
Controlling behavior in animal and robots		B	C	4
Deep learning	A	B	C	4
Distributed intelligent systems			C	5
Embedded systems	A	B	C	4
Evolutionary robotics			C	3
Flexible bioelectronics		B		4
Flying robots			C	4
Fundamentals of computer aided manufacturing	A			5
Fundamentals of neuroengineering			C	4
Haptic human robot interfaces	A			3
How technology shapes the workplace of the future	A	B	C	3
Image analysis and pattern recognition		B	C	4
Image processing I		B		3
Image processing II		B		3
Industrial automation	A			3
Industry dynamics, models & trends	A			4
Intelligent agents	A		C	6
Interdisciplinary project				10
				4
				3
				2
				5
				3
				4
				3
				3
				4
				2
				5
Production management	A			
Real-time embedded systems	A	B	C	4
Robotique industrielle et appliquée	A			2
Sensorimotor neuroprosthetics		B		4
Sensor orientation			C	4
Sensors in medical instrumentation		B		3
Signal processing for functional brain imaging		B		3
System identification	A	B	C	3
Systèmes mécatroniques	A	B	C	5

Master in Robotics - Orientations

Options group : Fall

A: Industrial robotics

- Commande embarqués moteurs
- Production management
- Image processing I

- Applied data analysis
- Commande non-linéaire
- Systems programming for systems on a chip

B: Medical robotics

- Basics of Bioinstrumentation
- Neural interfaces
- Neural signals and signal processing

- Machine learning programming
- Managment de projet et analyse du risque
- Mechanical product design and development

C: Mobile robotics

- Multivariable control
- Intelligent agents
- Legged robots
- Networked control systems

- Principles of finance

Options group : Spring

A: Industrial robotics

- Analyse de produits et systèmes
- Applied and industrial robotics
- Industrial automation
- Optimal decision making
- Haptic human robot interfaces
- Image processing II
- Continuouse improvement of manufacturing systems

- Advanced control systems
- *Machine learning II (pas en 2026)*
- Computer vision
- Convex optimization

B: Medical robotics

- Numerical methods in biomechanics
- Introduction to bioengineering
- Sensors in medical instrumentation

- Advanced mecanisms for extreme environments
- Controlling behavior of animals and robots
- Computational motor control

- *Deep learning for optical imaging*
- Machine learning programming
- Micro/nanorobotics
- Embedded systems design

C: Mobile robotics

- Deep learning for autonomouse vehicles
- Advanced MEMS and microsystems
- Deep learning
- Lifecycle performance of products systems
- Sensor orientation
- Advanced Satellite positioning
- *Learning and adaptive control for robots (pas en 2026)*
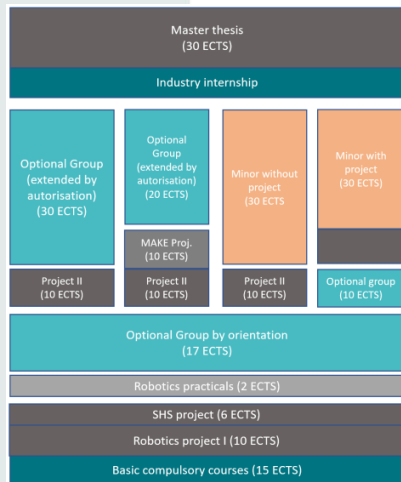- Aerial robotics
- Evolutionary robotics
- Distributed intelligent systems

- Image analysis and pattern recognition
- Organic and printed electronics
- Translational neuroengineering

- Reinforcement learning
- Software architecture
- Systèmes mécatroniques
- System identification

Orientation courses examples

| 2021-2022	ROBOTICS - Options		
Code	Matières	Enseignants	Crédits
MICRO-502	Aerial robotics	Floreano	3
MICRO-515	Evolutionary robotics	Floreano	3
MICRO-570	Advanced machine learning	Billard	4
EE-559	Deep learning	Fleuret	4
MICRO-514	Flexible bioelectronics	Lacour S.	4
EE-451	Image analysis and pattern recognition	Thiran J.-P.	4
MICRO-462	Learning and adaptative control for robots	Billard	4
MICRO-455	Applied machine learning	Billard	4
MICRO-553	Haptic human robot interfaces	Bouri	3
MICRO-401	Machine learning programming	Billard	2
BIOENG-404	Analysis and modelling of locomotion	Aminian/Ijspeert/Courtine	4
BIOENG-456	Controlling behavior in animals and robots	Ramdya	4
CIVIL-459	Deep learning for autonomous vehicles	Alexandre Alahi	6
ENG-466	Distributed intelligent systems	Martinoli	5
CS-487	Industrial automation	Tournier/Sommer	3
MICRO-507	Legged robots	Ijspeert	3
ENV-548	Sensor orientation	Skaloud	4
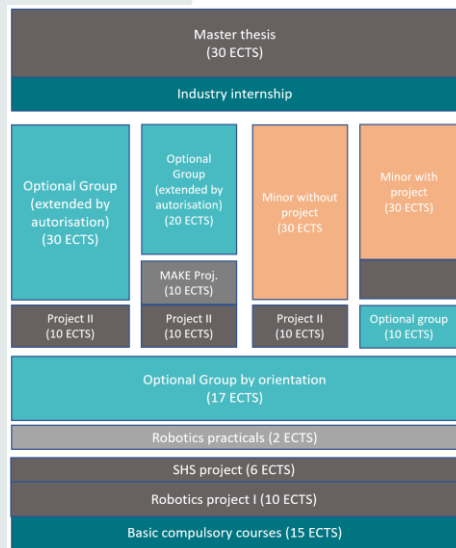
Free options

Entrepreneurship !

Student Startup Launchpad

We foster student entrepreneurship as a driver for leadership, impact and innovation. We are building the next generation of students founders with a drive for excellence, an instinct for leadership and an aspiration for societal impact.

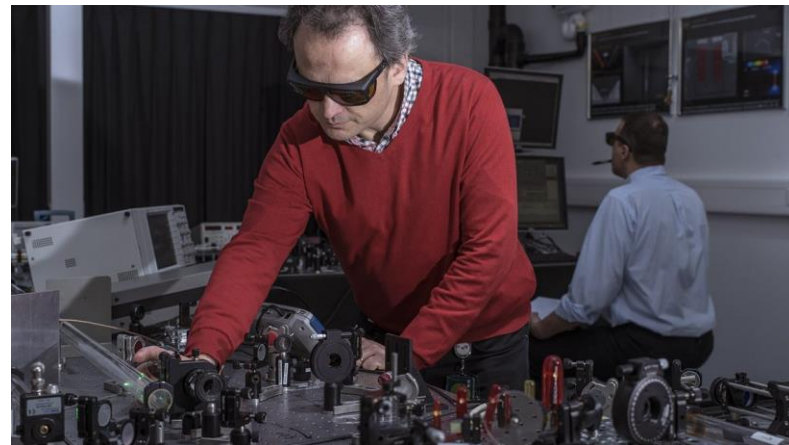Master project in your Startup (PDM)
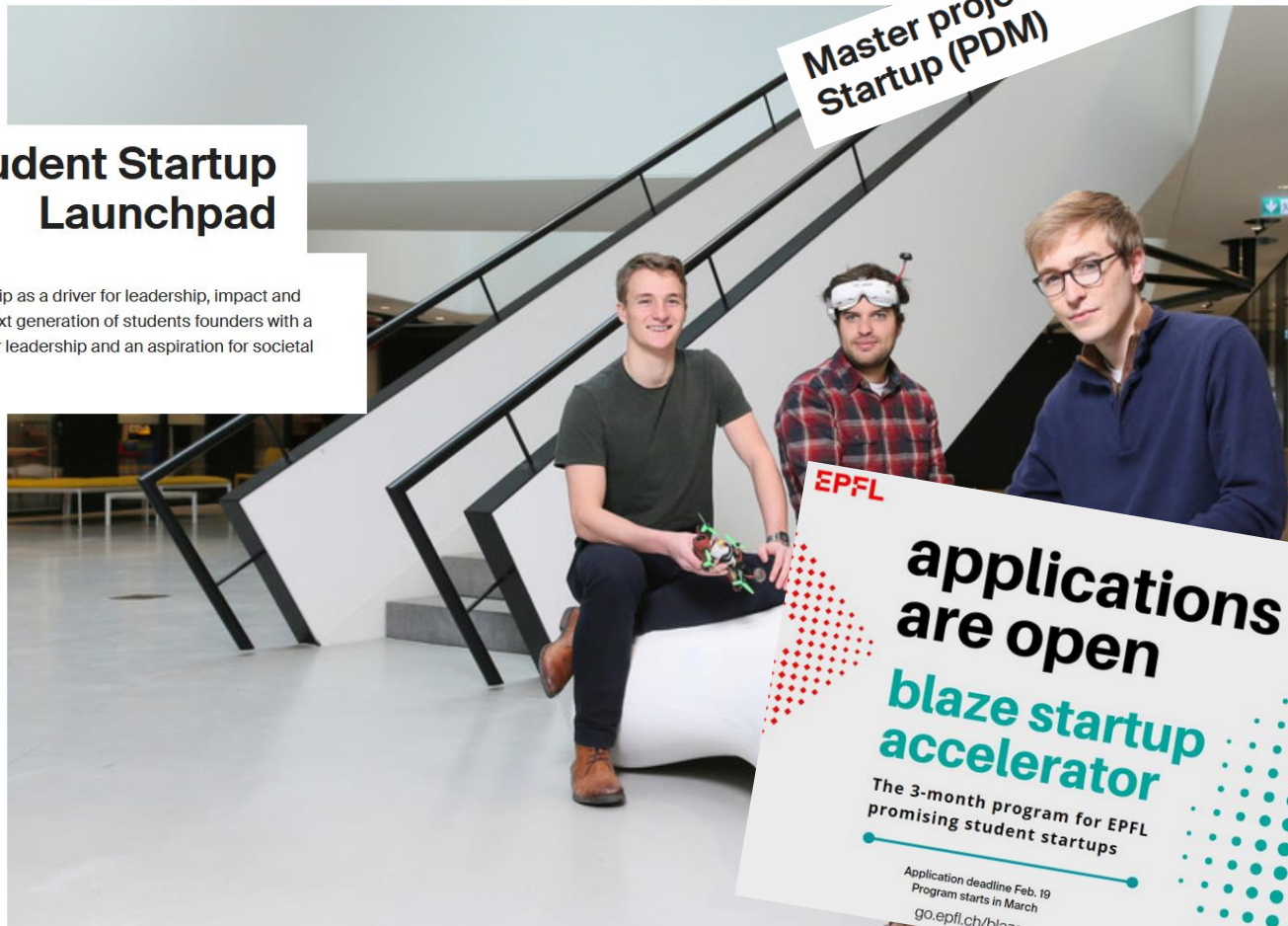
EPFL

applications are open

blaze startup accelerator

The 3-month program for EPFL promising student startups

Application deadline Feb. 19
Program starts in March

go.epfl.ch/bla...

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

EPFL

iem

■ institute of electrical and micro engineering

Geneva - Campus Biotech
- Bio- and neuroengineering (Wyss center)
- Human Brain Project
- Center for neuroprosthetics

- 420 staff
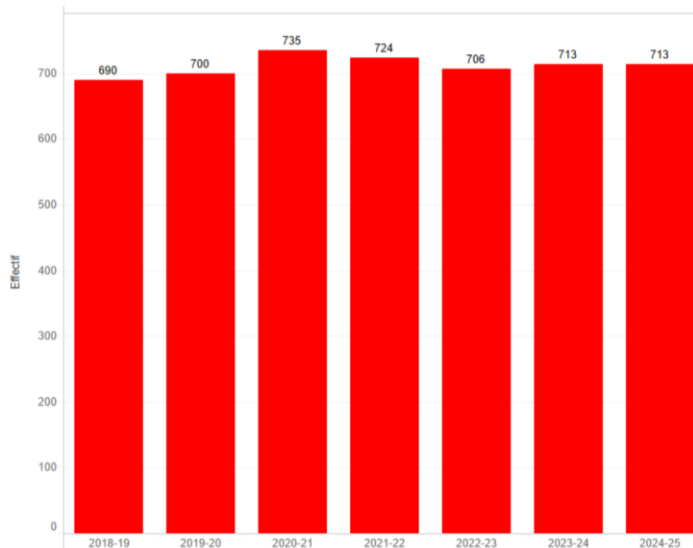- 9 chairs
- 3880 m^2

Neuchâtel - Microcity
- Microengineering and nanotechnologies
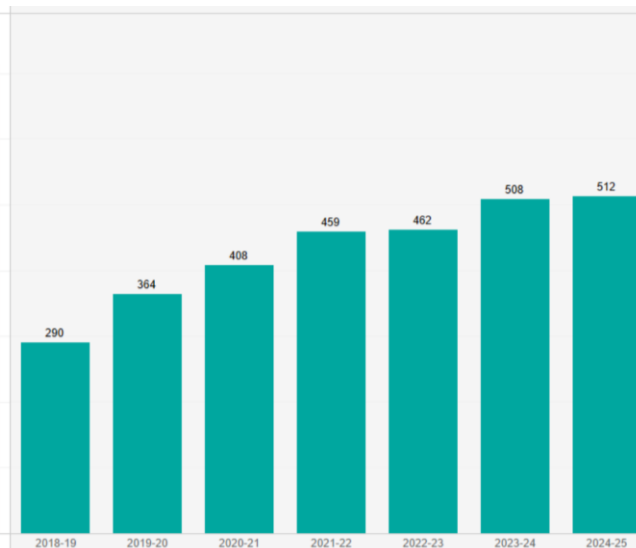
- 230 staff
- 11 chairs
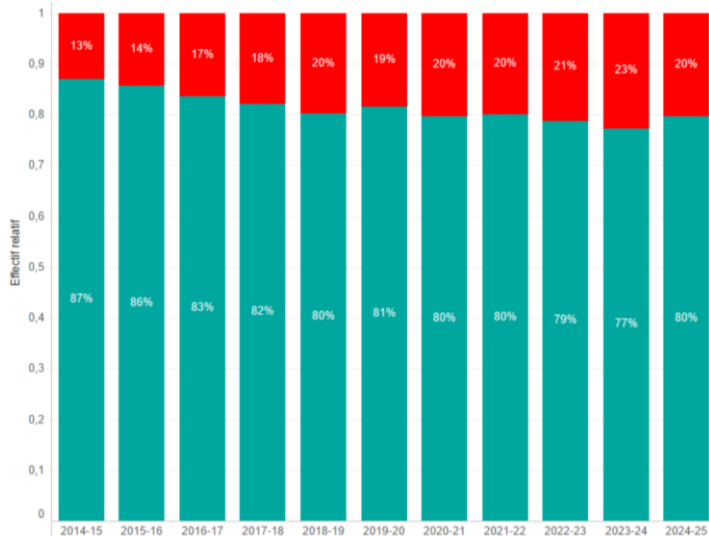- 8035 m^2

Successful curricula (>1200 students)

Bachelor

Master
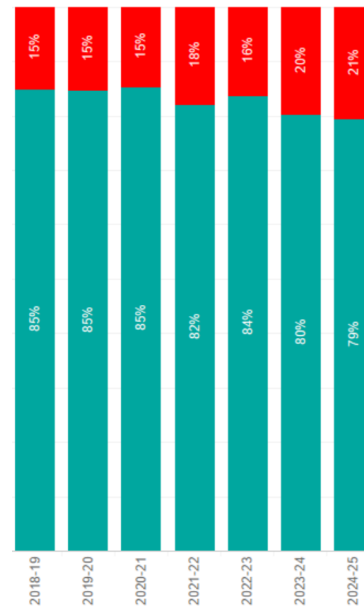Microengineering & Robotics

Gender balance

Bachelor

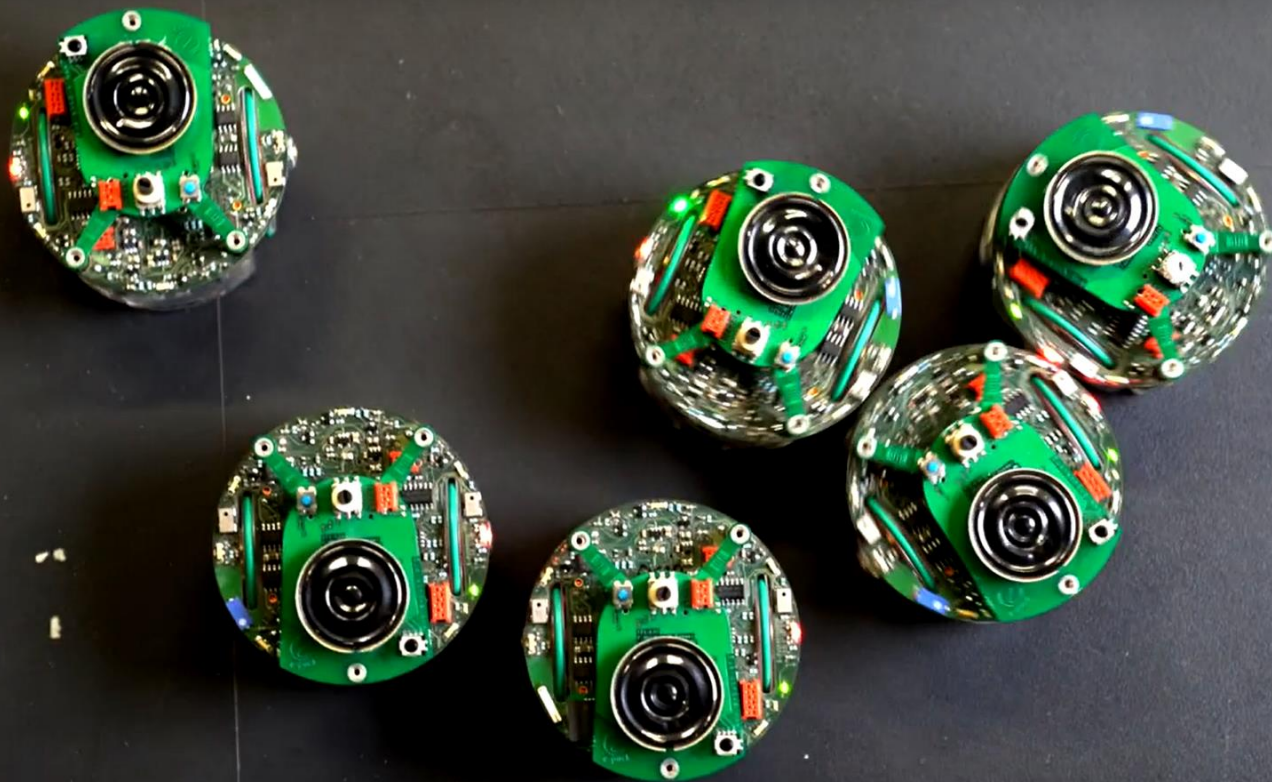## Robotics Master

Short Movie to learn more

Student Testimony

Sébastien de Rivaz
about the Robotics Master

Student Testimony

Arwen Blanche Giraud
about the Robotics Master
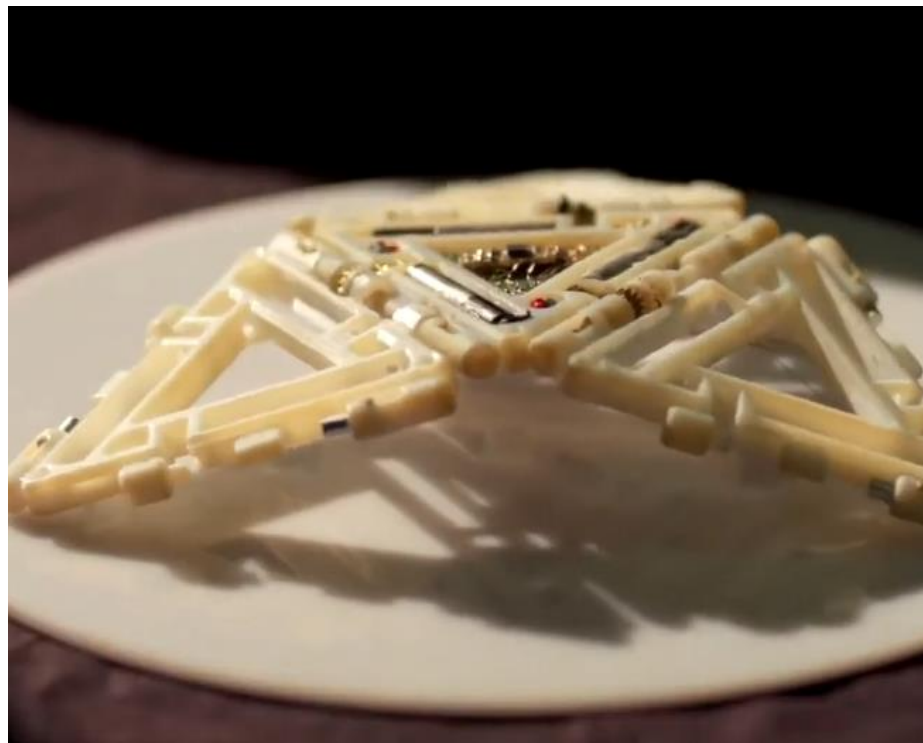
Alumni Testimonies

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

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/

Minors

Microenginering

Master thesis (30 ECTS)		
Industry internship		

Optional Group Extended course list (39 ECTS)

Minor without project (30 ECTS

Minor with project (30 ECTS)

Project II (10 ECTS)

Optional Group (9 ECTS)

Optional Group (19 ECTS)

Project II (10 ECTS)

Project II (10 ECTS)

Bloc 2 (15 ECTS) Restricted course choice (17 courses, 46 ECTS possible, 3 orientations)

SHS Project (6 ECTS)

Semester Project I (10 ECTS)

Product design and system engineering (10 ECTS)

Robotics

Master thesis (30 ECTS)		
Industry internship		

Optional Group Extended course list (30 ECTS)

Optional Group Extended course list (20 ECTS)

Minor without project (30 ECTS

Minor with project (30 ECTS)

Interdisc. Proj. (10 ECTS)

Project II (10 ECTS)

Project II (10 ECTS)

Project II (10 ECTS)

Optional group (10 ECTS)

Optional Group by orientation (17 ECTS)

Robotics practicals (2 ECTS)

SHS project (6 ECTS)

Robotics project I (10 ECTS)

Basic compulsory courses (15 ECTS)

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

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

r 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
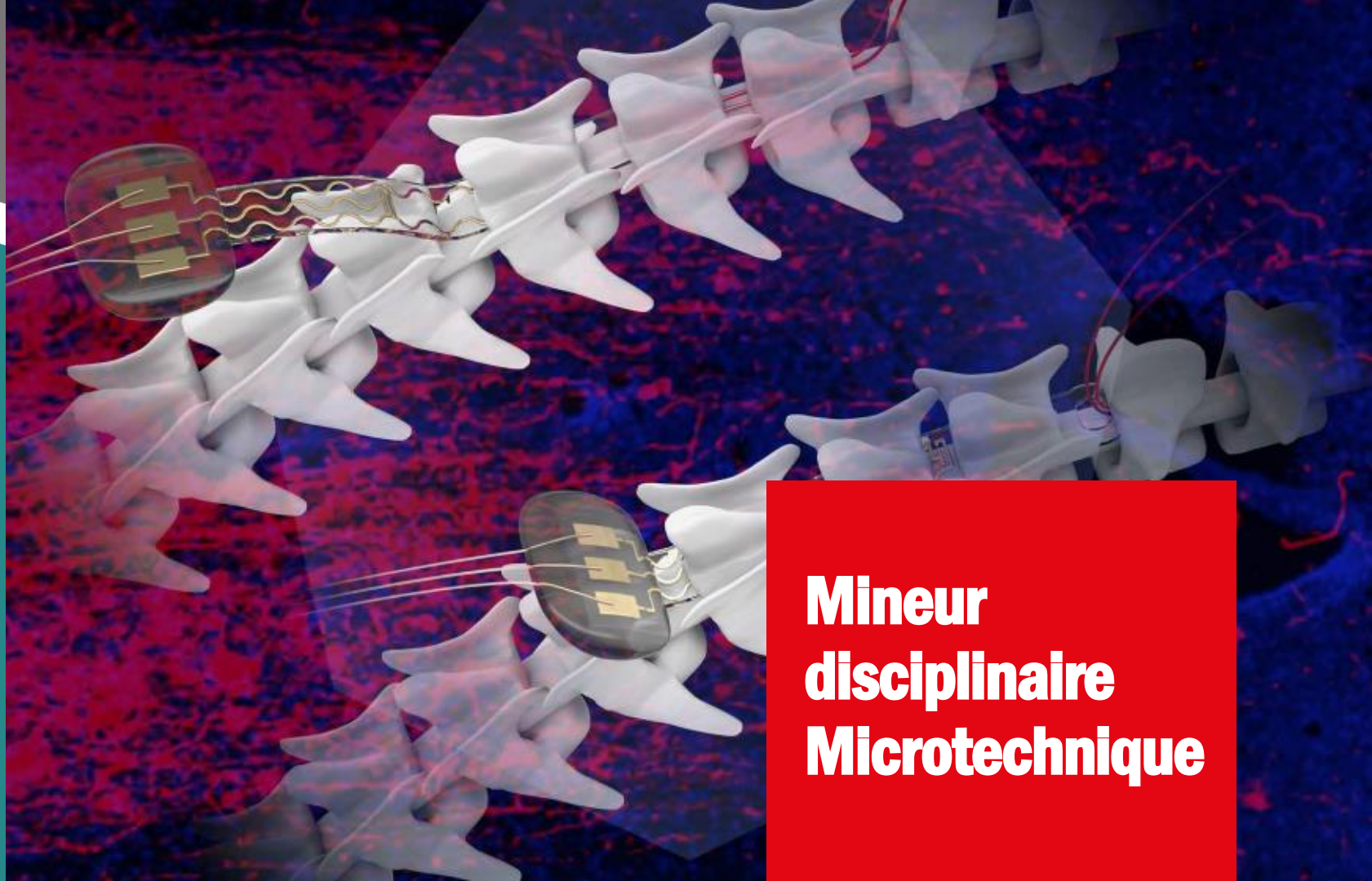
Mineur disciplinaire Microtechnique

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

Courseplan (2)

Optics & photonics						
MICRO-321(a)	Ingénierie optique (pour MT)	Martin + Achouri/Santschi	MT	**3**		A
MICRO-420	Selected topics in advanced optics	Martin O.	MT	3		A
MICRO-523	Optical detectors	Bruschini	MT	3		A
MICRO-573	Deep learning for optical imaging _Pas Donné au printemps 2026_	Psaltis	MT	3		P
MICRO-471	Fundamentals of integrated photonic components	Benea-Chelmus	MT	4	20	A
MICRO-422	Lasers: theory and modern applications	Kippenberg/Moser Ch.	MT	4		A
MICRO-429	Metrology practicals	Bruschini/Charbon/Fantner	MT	2		P
MICRO-516	Nanophotonics	Iadanza/Moselund + Moselund	MT	3		P
PHYS-501	Nonlinear optics	Roke	PH	4		P
MICRO-424	Optics laboratories (autumn)	Pu	MT	3		A
MICRO-423	Optics laboratories (spring)	Pu	MT	3		P
MICRO-421	Computational optical imaging	Psaltis	MT	3		P
MICRO-517	Optical design with ZEMAX	Pu	MT	3		A
Micro/Nano						
ME-426	Micro/Nanomechanical devices	Villanueva	GM	4		A
EE-594	Smart sensors for IoT _Donnée en 25-26 ?_	Ionescu/Paun + Ionescu	EL	3		A
EE-517	Bio-nano-chip design	Carrara	EL	4		A
MICRO-372	Mécanismes avancés pour environnements extrêmes	Cosandier	MT	3		P
MICRO-501	MEMS Actuator practicals	Bertsch/Boero/Brugger	MT	3		A
MICRO-503	MEMS sensors practicals	Bertsch/Boero/Brugger	MT	3		P
MICRO-505	Organic and printed electronics	Briand/Subramanian	MT	2		P
EE-536	Physical models for micro and nanosystems	Kis	EL	2		A
ME-469	Nano-scale heat transfer	Tagliabue	MT	4		P
Production & advanced manufacturing						
MICRO-457	Materials processing with intelligent systems	Hoffmann/Shevchik	MT	3		A
MICRO-448	Manufacturing systems and supply chain dynamics	Filliger/Gallay	MT	3		P
MICRO-451	Applied and industrial robotics	Bouri	MT	2		P
MICRO-413	Advanced additive manufacturing technologies	Brugger J./Pu	MT	4		P
MICRO-443	Analyse de produits et systèmes	Kejik	MT	2		P
MICRO-510	Commande embarquée de moteurs	Koechli+Hodder/Koechli/Perriard	MT	3		A
ME-523	Commande non linéaire	Müllhaupt	GM	3		A
CS-432	Computational motor control	Ijspeert	IC	4		P
ME-498	Continuous improvement of manufacturing systems	Kaboli	GM	5		P
MICRO-553	Haptic human robot interfaces	Bouri/Shokur	MT	4		P
MICRO-566	Large-area electronics: devices and materials	Ballif/Haug/Würsch	MT	3		P
MICRO-520	Laser microprocessing	Hoffmann	MT	2		P
ME-421	System identification	Karimi	GM	3		P

Welcome !

Olivier Martin
Responsable
Mineur Photonique

Daniel Sage
Responsable
Mineur Imaging

Carlotta Guiducci
Responsable
Mineur Technologies biomédicales

Mineur en Photonique

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:

Optical components 13%

Photovoltaic 9%

Information technology 6%

Medical and life science 19%

Laser material processing 29%

Measurement technology and vision 24%

SWISS PHOTONICS
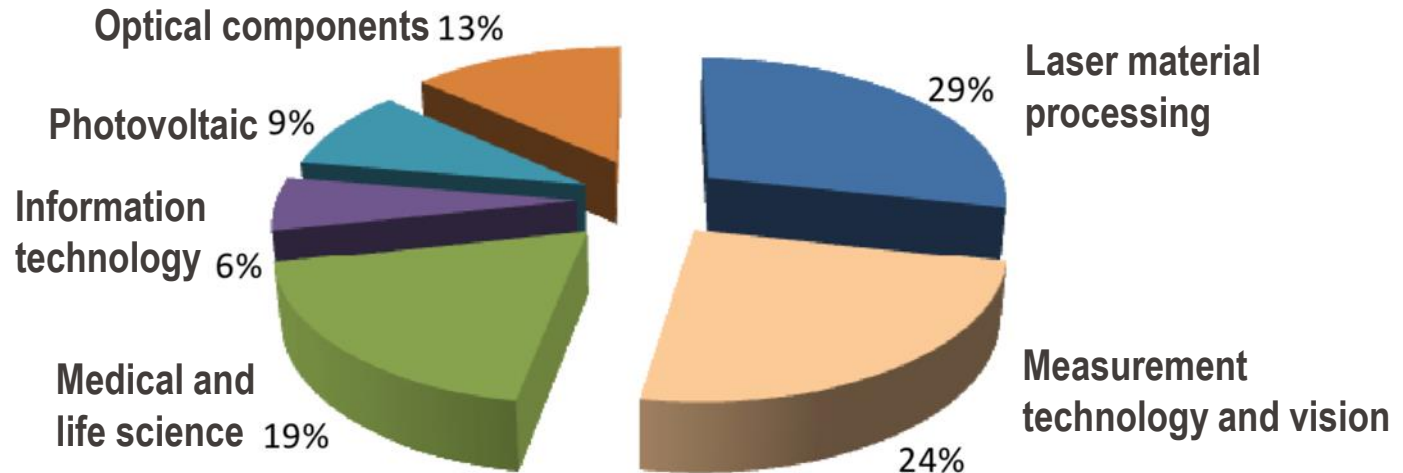
Photonics in Switzerland – e.g. Optical components

- 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 !
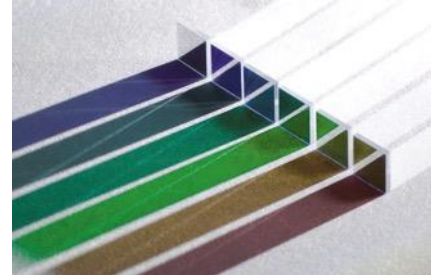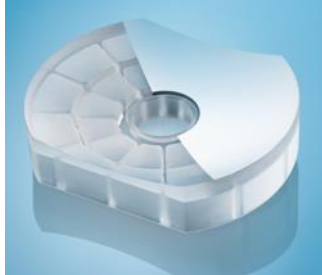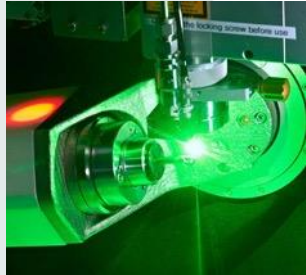
SWISS PHOTONICS

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

Courseplan

CODE	MATIERES	ENSEIGNANTS sous réserve de	RET DECOUR	CREDITS ECTS	NBRE PLACES	PERIODE DES COURS	
						AUT	PRI
Groupe "Mineur"				**30**			
Projet obligatoire du mineur en Photonique							
MICRO-488	Project in photonics	Divers enseignants	--	**10**		A	P
Bases en photonique pour étudiants n'ayant aucune formation en photonique							
MICRO-321(a)	Ingénierie optique (pour MT)	Martin + Achouri/Santschi	MT	6		A	
Foundations of photonics							
MICRO-471	Fundamentals of integrated photonic components (pas donné en 2024-25)	Benea-Chelmus	MT	4	20	A	
MICRO-426	Laser fundamentals and applications for engineers	Moser	MT	3			P
MICRO-422	Lasers: theory and modern applications	Moser Ch./Kippenberg + Moser	MT	4		A	
PHYS-501	Nonlinear optics	Roke	MT	4		A	P
PHYS-470	Nonlinear optics for quantum technologies	Galland	PH	4		A	P
MICRO-423	Optics laboratories (spring)	Psaltis/Pu	MT	3			P
MICRO-424	Optics laboratories (autumn)	Psaltis/Pu	MT	3		A	
EE-440	Photonic systems and technology	Brès	EL	4			P
PHYS-434	Physics of photonic semiconductor devices	Grandjean	PH	4			P
PHYS-453	Quantum electrodynamics and quantum optics	Kippenberg	PH	6		A	
PHYS-454	Quantum optics and quantum information	Brantut	PH	6			P
PHYS-425	Quantum physics III	Yazyev	PH	6		A	
MICRO-420	Selected topics in advanced optics	Martin O.	MT	3		A	
PHYS-433	Semiconductor physics and light-matter interaction	Butté	PH	4		A	
MICRO-410	Classical and quantum photonic transducers	Benea-Chelmus	MT	3			P
Applied photonics							
MICRO-565	Fundamentals & processes for photovoltaic devices	Ballif	MT	3			P
BIO-443	Fundamentals of biophotonics	Radenovic	SV	3			P
MICRO-511	Image processing I	Unser/Van de Ville	MT	3		A	
MICRO-512	Image processing II	Liebling/Sage/Unser/Van de Ville	MT	3			P
MICRO-421	~~Imaging optics~~ Computational Optical Imaging	Psaltis	MT	3			P
MICRO-520	Laser microprocessing	Hoffmann	MT	2			P
MICRO-331	Microfabrication technologies	Brugger/Gijs/Lacour	MT	4		A	
MICRO-516	Nanophotonics	Iadanza/Moselund + Moselund	MT	3			P
MICRO-517	Optical Design with ZEMAX	Pu	MT	3		A	
MICRO-523	Optical detectors	~~Besse~~ Bruschini	MT	3		A	
MICRO-505	Organic and printed electronics	Briand/Subramanian	MT	2			P
Biomedical photonics							
BIOENG-445	Biomedical optics	Wagnières	SV	3		A	
MICRO-561	Biomicroscopy I	Altug	MT	3		A	
MICRO-562	Biomicroscopy II	Altug + Seitz A.	MT	4			P
CH-448	Photomedicine	Wagnières	CGC	~~2~~ 3			P

Further information

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

... and don't forget, the photon makes life fun and colorful!!

Minor in Imaging

An explosion of (very large) images
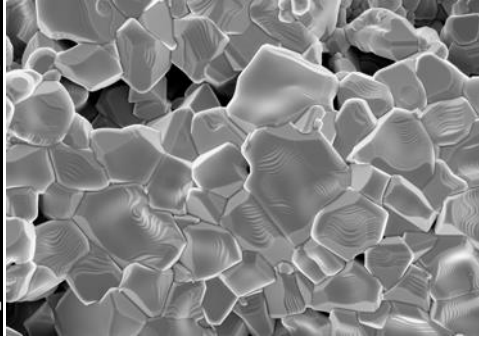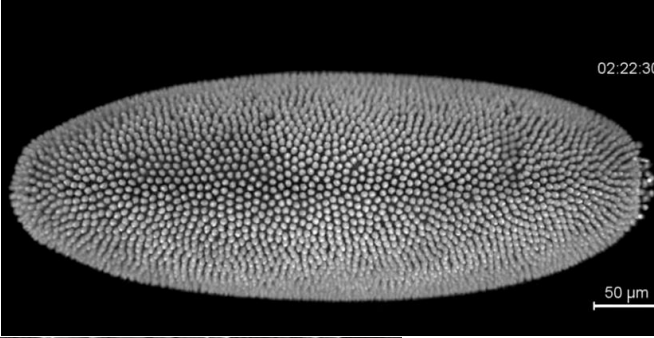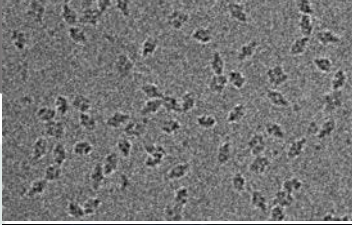
Context

Rich but scattered imaging curriculum

Skills in high demand by industry and academia

End-users

Data Scientists

Instrument-alists
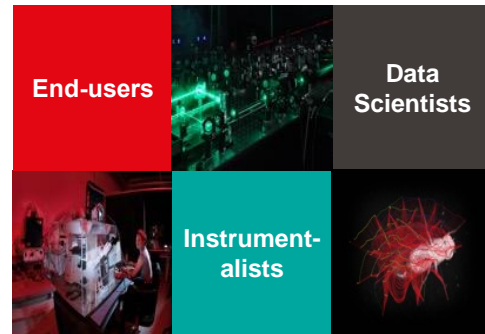
Interdisciplinary field *par excellence*

EPFL: unique concentration of academic strengths

DRAFT
EPFL 2021–2024 Plan Stratégique

Strategical context

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.**
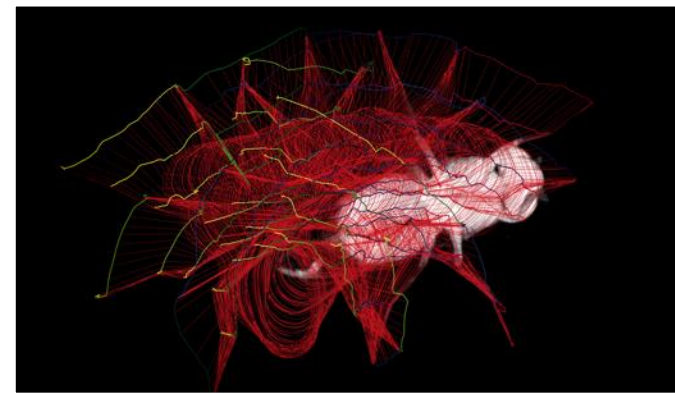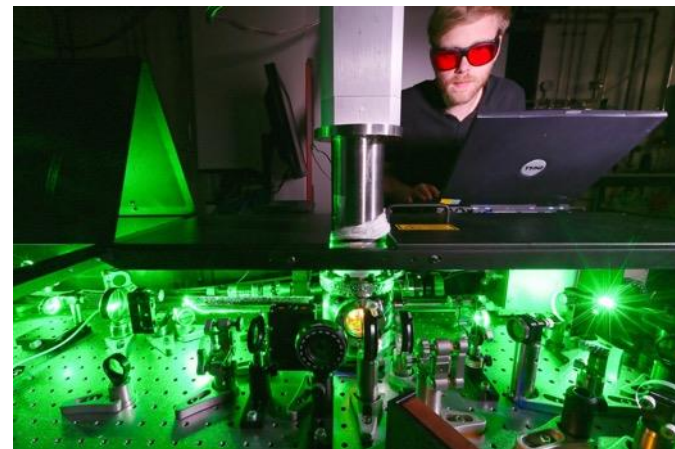
Interest from (Swiss) Industry
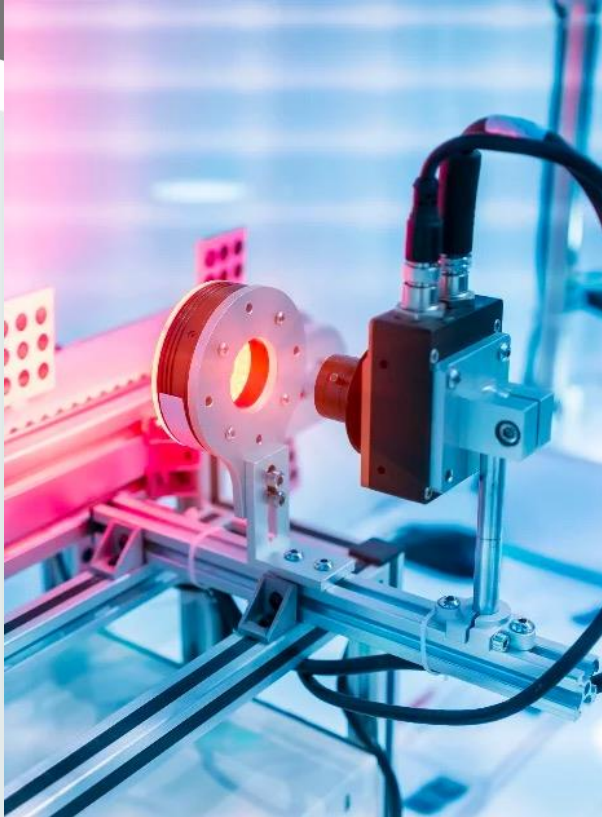
- Interdisciplinary imaging skills are in **increasing demand** from the Swiss industry and the academic world.

- **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
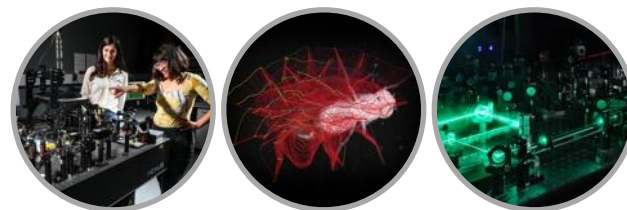
imaging.epfl.ch

In Summary

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

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

Open to all EPFL Master students

The Minor in Imaging

Fundamentals/Theory

Instrumentations Optics ← → Computation Data Science

Applied Labs/Practice

Application Fields:
- Application Agnostic
- Biomedical, Life Sciences
- Civil Engineering
- Earth Observation

Course	Code	Credits	Sem
Metrology	MICRO-428	3	S
Computational Optics Imaging	MICRO-421	3	S
Image Processing I	MICRO-511	3	F
Biomicroscopy I	MICRO-561	4	F
Fundamentals of Biophotonics	BIO-443	3	S
Image Processing II	MICRO-512	3	S
Computational Photography	CS-413	6	S
Electron Microscopy Adv. Methods	MSE-450	3	S
Fundamentals of Biomedical Imaging	PHYS-438	4	S
Neural Signals and Signal Processing	NX-421	6	F
Image Analysis and Pattern Recognition	EE-541	4	S
Computer Vision	CS-442	6	S
Biomicroscopy II	MICRO-562	4	S
Sensing and Spatial Modelling for Earth Obs.	ENV-408	5	S
Image Processing for Earth Obs.	ENV-540	4	F
Bioimage Informatics	BIO-410	4	S
Visual Intellig. Machine and Minds	CS-503	6	S
Optical Detectors	MICRO-523	3	S
Quantitative Imaging for Engineers	MICRO-518	3	F
Deep Learning for Optical Imaging	MICRO-573	3	S
Metrology Practicals	MICRO-429	3	S
MRI Practicals Preclinical imaging	PHYS-473	3	F
Lab in Signal and Image Processing	EE-490	4	S

Coordination
Dr. Daniel Sage
daniel.sage@epfl.ch

Organization
EPFL Center for Imaging
Microengineering Section

Info: imaging.epfl.ch/education

Courseplan

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

EPFL
mt
microtechnique
microengineering
section

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

Mineur en Technologies Biomédicales

SCHOOL OF ENGINEERING

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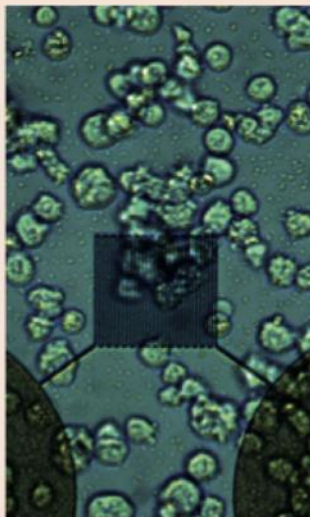
The Minor in Biomedical Engineering complements the engineering programmes offered at EPFL, providing additional skills in the field of biomedical sciences and technologies.

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	CH	2,800
3	J&J Medical	Orthopaedics, traumatology, wound treatment	USA	1,600
4	Hamilton[1]	Ventilators, in vitro diagnostics, laboratory automation	CH	1,540
5	Straumann	Dentistry	CH	1,460
6	Sonova[2]	Hearing aid technology	CH	1,445
7	Ypsomed[2]	Injection systems (drug delivery) and diabetes management	CH	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

4.6% (2016), 2.6% (2017), 3.4% (2018), 4.1% (2019), 2.0% (2020), 5.1% (2021), 3.5% (2022e), 3.6% (2023e)

2016	2017	2018	2019	2020	2021	2022e	2023e
n = 277	n = 244	n = 278	n = 283	n = 185	n = 187	n = 217	n = 222

■ past   ■ future
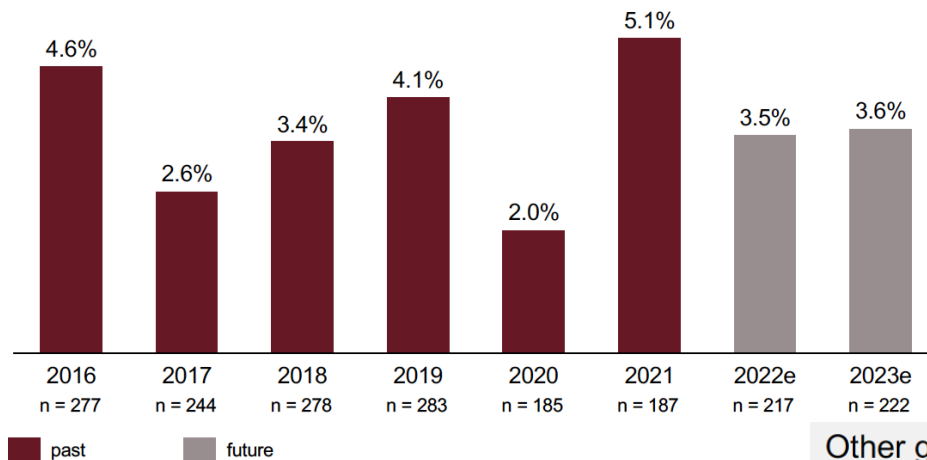
Source: SMTI 2022

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

1 **Smart devices** — Smart design and engineering, wearables, hearables, implantables, etc.

2 **Materials innovation** — Improved properties: durability, biocompatibility, surfaces, malleability, etc.

3 **Substitution technology** — New sensors for continuous non-invasive and invasive measurement of body data, etc.

4 **Data acquisition** — Internet of things, sensorisation, integration with evaluation software, etc.

5 **Individualisation** — Individualised prostheses and implants, electronic tablets, etc.

Diagnostics

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

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

3 **Personalised medicine** — Precision medicine adapted to genome, patient-specific implants, etc.

4 **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

1 **Patient behaviour: prevention vs treatment** — Integration of preventive health care into everyday life, etc.

2 **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, <u>mandatory</u>) related to biomedical technology in included in the Minor.

For non-SV students (STI, SB…)
A core group of courses of biomedical basis is <u>strongly recommended</u>:

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 "Mineur"	
Projet obligatoire du mineur en Technologies biomédicales	
MICRO-563	Project in biomedical technologies
Bases biomédicales 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