



# EPFL-ETH Zürich Master Program in Nuclear Engineering

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*on behalf of*  
Andreas Pautz  
Professor

# Content

- Why nuclear engineering at EPFL / ETHZ / PSI
- A few words on the context
- Some details on the curriculum



# Master Program in Nuclear Engineering

- Since 2008

Two Federal universities...



... Two nuclear engineering professors



Annalisa Manera  
*Reactor technology*



Andreas Pautz  
*Reactor physics*

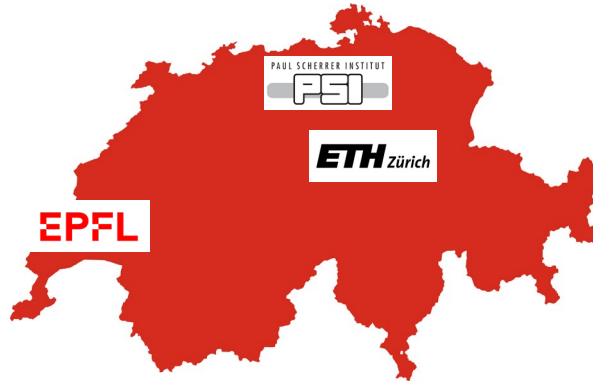
# ETHZ-EPFL MSc in Nuclear Engineering

- 1<sup>st</sup> joint MSc program between **ETHZ** and **EPFL**
  - Established in 2008, more than 200 graduates
  - Two-year program, 120 ECTS credits
  - Scientific support and research projects through cooperation with the **Paul Scherrer Institute**



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  - Two-year program, 120 ECTS credits
  - Scientific support and research projects through cooperation with the **Paul Scherrer Institute**
- 1<sup>st</sup> semester at EPFL, 2<sup>nd</sup> at ETHZ, 3<sup>rd</sup>-4<sup>th</sup> at PSI
  - Small program (~ 15 students/y, above 20 now!)
  - Makes extensive use of the **CROCUS** reactor



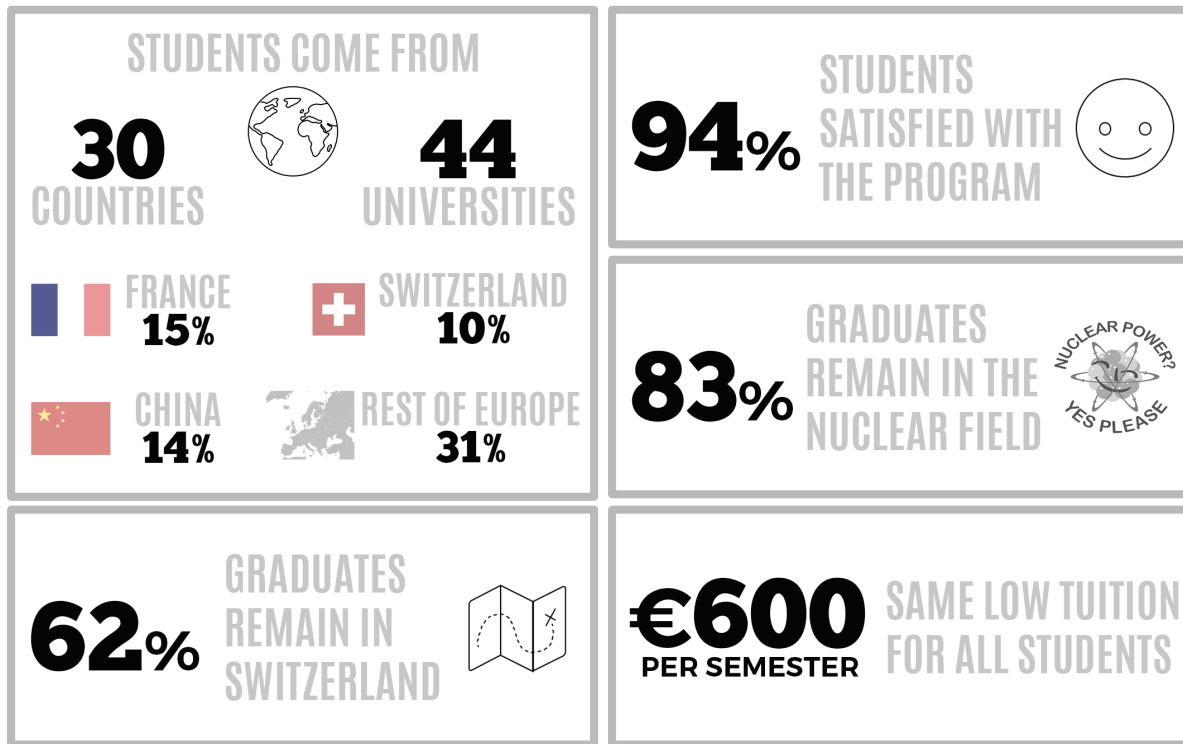
# Why nuclear engineering at EPFL / ETHZ / PSI?

- Master degree from two of **Europe's top schools**
- **Small program** (15-20 students/year) with intensive contact and close supervision by professors and teaching/research staff
- **Highly international** and intercultural experience
- **Good job prospects** with a long-term perspective in Switzerland (plant operation past 2040!), and worldwide
- Large needs in nuclear competence in **long-term operation, decommissioning, waste disposal**, but also in non-power generation areas
- Very close cooperation with **Swiss industrial partners**
- Exciting **research opportunities** at EPFL, ETHZ, and PSI, e.g. continuation with a PhD on new reactor types



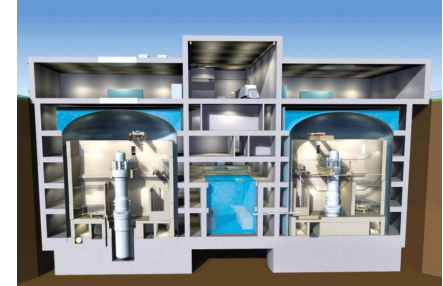
# ETHZ-EPFL MSc in Nuclear Engineering

- A survey was organized in 2017  
For more information visit [master-nuclear.ch](http://master-nuclear.ch)



# Context

- Switzerland
  - Long-term perspective: plant operation past 2040
- International
  - France: 71% in 2019, 50% target in the future
  - USA investing in nuclear power : 4 sites + extensions
  - Numerous operating plants and new-builts in Russia
  - China planning on 28 plants by 2020 plus 150 by 2035
- Low-carbon emissions
  - *Role for effective action to mitigate climate change*





# General scope

## Focus

- Fundamentals & technology of employing nuclear fission for a safe and sustainable energy supply

## Complement

- Nuclear techniques in medicine & industry, and also nuclear fusion
- Program restructured in 2018

## Integration into energy systems as a whole

- Nuclear + Renewables + Efficient energy use = Sustainability of energy supply

## Degree open to Bachelors in various disciplines

- Physics, Chemistry, Mechanical, Electric, etc., as per high level of interdisciplinarity needed



# Program features

## Degree awarded

- *Master of Science EPF-ETH in Nuclear Engineering*

## Combined implementation on semester basis

- 1<sup>st</sup> semester (autumn)      courses at Lausanne
- 2<sup>nd</sup> semester (spring)      courses at Zurich
- 3<sup>rd</sup> semester (autumn)      block courses at PSI
  - Internship during summer
- 4<sup>th</sup> semester (spring)      MSc thesis

## Flexibility and support granted

- Large spectrum of elective courses
- Tutor aided program: a professor to be identified by each student



# Program features

## 3<sup>rd</sup> semester

- Industrial internship
  - to be started around July
  - 3 months minimum
- “Block” courses & semester project at PSI
- Semester project selected during a PSI visit at the end of 2<sup>nd</sup> semester (typically around mid-May)

## 4<sup>th</sup> semester

- MSc thesis (30 ECTS), typically at PSI, EPFL or ETHZ
- 25 weeks of research
  - can be a continuation of your semester project theme
- Conditions
  - start of MSc thesis: at least 80 ECTS of courses
  - MSc degree: full 90 ECTS of courses + thesis completed



# Curriculum

	ECTS
▪ eleven compulsory courses	50
▪ Industrial internship <ul style="list-style-type: none"> <li>• conducted partly outside semesters</li> </ul>	8
▪ Semester project <ul style="list-style-type: none"> <li>• during 3<sup>rd</sup> semester, at PSI</li> </ul>	8
▪ Management or Humanities courses <ul style="list-style-type: none"> <li>• during 1<sup>st</sup> or 2<sup>nd</sup> semester</li> </ul>	min. 4
▪ Elective core courses	20
▪ Including “Free” elective courses	8



# Large facilities at PSI



Hot cells  
with manipulators

# Large facilities at PSI



## ARTIST

*Aerosol Trapping In a Steam Generator experiment*

International project to investigate aerosol and droplet retention in a model steam generator

## PANDA

Thermal-hydraulics facility for safety investigations of light water reactors



# The CROCUS reactor at EPFL

## Reactor type

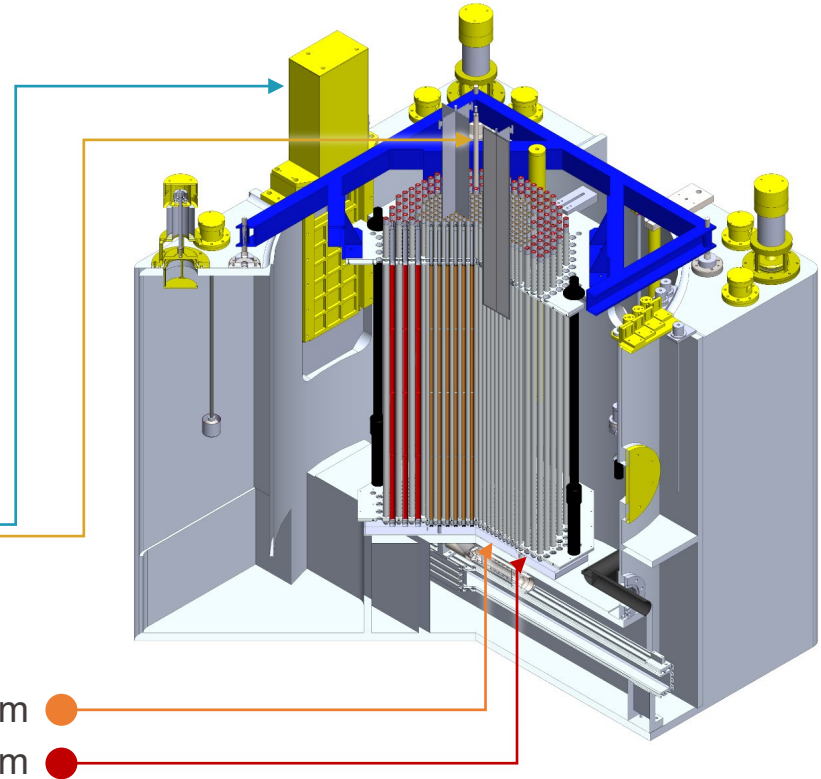
- LWR with partially submerged core
- Room T (controlled) and atmospheric P
- Forced water flow ( $160 \text{ l}\cdot\text{min}^{-1}$ )

## Operation

- 100 W (zero-power reactor)
- i.e. maximum  $2.5 \times 10^9 \text{ cm}^{-2}\cdot\text{s}^{-1}$
- Control:  $\text{B}_4\text{C}$  rods and spillway

## Core

- $\varnothing 60 \text{ cm}/100 \text{ cm}$ , 2-zone
- Inner: 336  $\text{UO}_2$  1.806 wt% 1.837 cm
- Outer: 176  $\text{U}_{\text{met}}$  0.947 wt% 2.917 cm







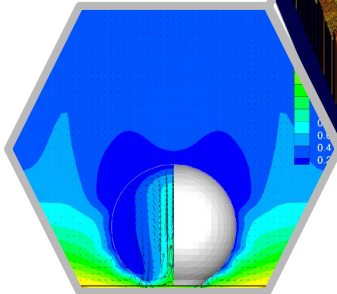
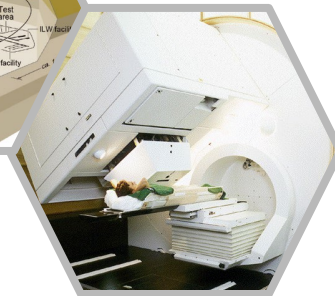
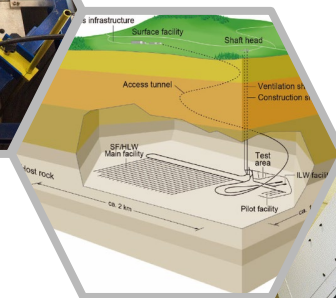
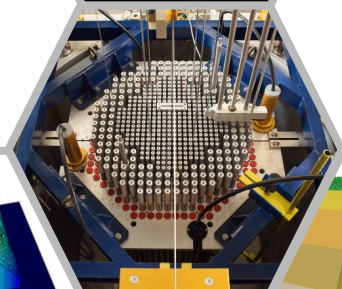
# In few words...

## Focus

- Neutronics
- Thermohydraulics
- Nuclear Material Science
- Nuclear Safety
- Waste Management
- Radiation Protection
- ...and more

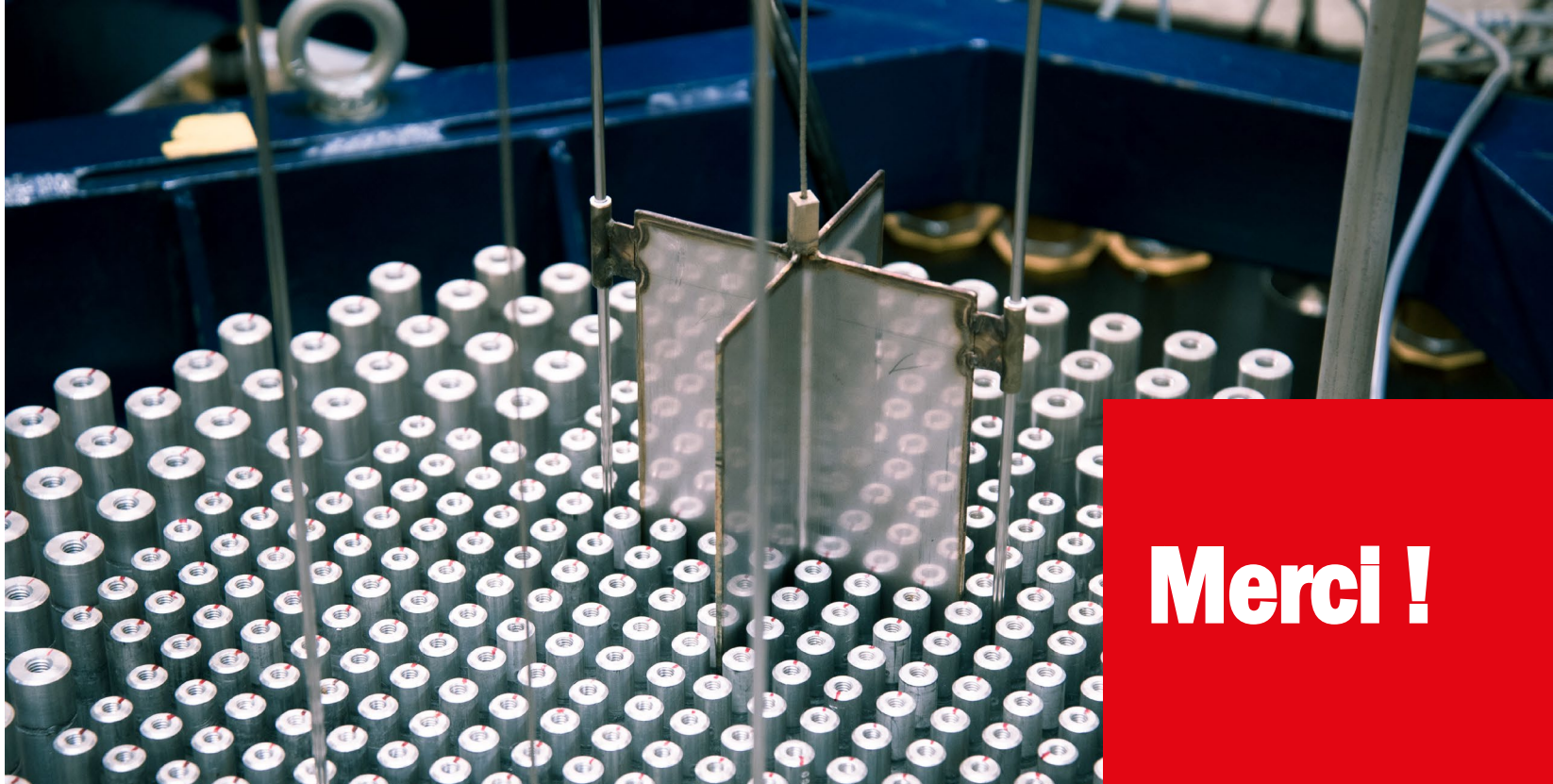
## Unique world-class facilities

- CROCUS reactor (EPFL)
- Swiss Light Source synchrotron
- Hot Lab facility (PSI)
- Proton therapy center (PSI)
- Numerous thermal-hydraulics experimental facilities (ETHZ, PSI)



## Included

- Three-month industrial internship
- Research project
- Master thesis



**Merci !**

For more information:  
<https://www.epfl.ch/schools/sb/sph/en/master/master-in-nuclear-engineering/>  
<http://www.master-nuclear.ethz.ch/>

or

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