EPFL-ETH Zürich
Master Program in Nuclear Engineering

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on behalf of
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Professor

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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

ETH Zurich

Annalisa Manera
Reactor technology

EPF Lausanne

Andreas Pautz
Reactor physics
1st 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
ETHZ-EPFL MSc in Nuclear Engineering

- 1st 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

- 1st semester at EPFL, 2nd at ETHZ, 3rd-4th 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
- A survey was organized in 2017
  For more information visit master-nuclear.ch

<table>
<thead>
<tr>
<th>STUDENTS COME FROM</th>
<th>30 COUNTRIES</th>
<th>44 UNIVERSITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRANCE</td>
<td>15%</td>
<td></td>
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<tr>
<td>SWITZERLAND</td>
<td>10%</td>
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<tr>
<td>CHINA</td>
<td>14%</td>
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</tr>
<tr>
<td>REST OF EUROPE</td>
<td>31%</td>
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| STUDENTS SATISFIED WITH THE PROGRAM | 94% |

| GRADUATES REMAIN IN THE NUCLEAR FIELD | 83% |

| GRADUATES REMAIN IN SWITZERLAND | 62% |

| SAME LOW TUITION FOR ALL STUDENTS | €600 PER SEMESTER |
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-builds 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\textsuperscript{st} semester (autumn) courses at Lausanne
- 2\textsuperscript{nd} semester (spring) courses at Zurich
- 3\textsuperscript{rd} semester (autumn) block courses at PSI
  - Internship during summer
- 4\textsuperscript{th} 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

3rd 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 2nd semester (typically around mid-May)

4th 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

- eleven compulsory courses 50
- Industrial internship 8
  - conducted partly outside semesters
- Semester project 8
  - during 3rd semester, at PSI
- Management or Humanities courses min. 4
  - during 1st or 2nd semester
- 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 l.min\(^{-1}\))

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

Core
- \(\varnothing 60\) cm/100 cm, 2-zone
- Inner: 336 U\(_{O_2}\) 1.806 wt% 1.837 cm
- Outer: 176 U\(_{met}\) 0.947 wt% 2.917 cm
Investigation of power fluctuations induced by fuel vibration

- Current experimental program in CROCUS for measuring noise induced by fuel oscillation
  - Device designed for selection of up to 18 Umet rods, ±2.5 mm radial, 2 Hz
- First oscillation experimental campaign in September 2018
  - within the framework of the CORTEX H2020 project
  - Up to 18 rods, ±0.5 to 2 mm, 0.1 to 2 Hz
  - 11 and 15 detectors in pulse and current modes, and instrumentations from three partners (TUD, ISTec and EPFL)

- Second oscillation campaign on-going: 15 detectors
- Static campaign by the end of the year
  - 16 to 18 rods at ±1.5 mm and 1 Hz

CROCUS and COLIBRI, view on the platform COLIBRI: fuel rods displacement experiments
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
For more information:
http://www.master-nuclear.ethz.ch/
or
Valerie.Schaererbusinger@epfl.ch / Andreas.Pautz@epfl.ch

Merci !