ETHZ-EPFL Master Program in Nuclear Engineering

Vincent Lamirand on behalf of Andreas Pautz 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

Annalisa Manera
Reactor technology

Andreas Pautz
Reactor physics
1st joint MSc program between ETHZ and EPFL
- Established in 2008, more than 110 graduates
- Two-year program, 120 ECTS credits
- Scientific support and research projects through cooperation with the Paul Scherrer Institute
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1st semester at EPFL, 2nd at ETHZ, 3rd-4th at PSI
  • Small program (~10-15 students/y)
  • 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 (10-15 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 2016
For more information visit 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 restructuring 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
- 1st semester (autumn) courses at Lausanne
- 2nd semester (spring) courses at Zurich
- 3rd semester (autumn) block courses at PSI
  - Internship during summer
- 4th semester (spring) MSc thesis

Flexibility and support granted
- Large spectrum of elective courses
- Tutor aided program: a professor to be identified by each student
3rd semester

- Industrial internship
  - to be started around July
  - 3 months minimum
  → Start applications no later than January 2020!

- “Block” courses & semester project at PSI

- Semester project selected during a PSI visit at the end of 2nd semester (typically around 20th of May)

4th semester

- MSc thesis (30 ECTS), typically at PSI

- 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

- (Only) seven compulsory courses 28
- 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 42
- “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 2.5×10⁹ cm².s⁻¹
- Control: B₄C rods and spillway

Core
- ø60 cm/100 cm, 2-zone
- Inner: 336 UO₂ 1.806 wt% 1.837 cm
- Outer: 176 Uₘₑᵗ 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

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

Included
- Three-month industrial internship
- Research project
- Master thesis
Merci !

For more information:
http://master.epfl.ch/nuclearengineering
http://www.master-nuclear.ethz.ch/
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