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# DOCTORAL RESEARCH POSITIONS

## Advanced Control of Nuclear-Fusion Plasmas

The Lehigh University (LU) Plasma Control Laboratory within the Department of Mechanical Engineering and Mechanics is seeking to fill several PhD positions, which are fully funded (tuition + stipend) by the Office of Fusion Science at the US Department of Energy. These positions lie at the boundary of Nuclear Fusion, Control Systems, Machine Learning, Applied Mathematics, and Computational Methods. The PhD candidates should have background in one or more of these research areas and should ideally have an undergraduate or preferably a Masters degree in engineering, physics or applied math. Solid analytical skills, as well as programming/coding abilities, are also required for these positions.

Controlled fusion is a very challenging technology, but a fusion power reactor would produce no air pollution or greenhouse gases, only short-term/low-level radioactive waste, no risk of nuclear accident or generation of weapon materials, and there exists a nearly infinite supply of fuel. As more of the fundamental physics problems are solved, the fusion community is moving beyond the realm of physics research toward the production of fusion energy. As a result, the need for solutions to many engineering problems has become critical, including the development of *control strategies* to guarantee safe, robust, reliable, high-performance operation while providing stable plasma confinement.

“Providing energy from fusion” has indeed been identified by the U.S. National Academy of Engineering (NAE) as one of the 14 Grand Challenges for Engineering in the 21st century [1]. Following the recommendations arising from studies charged by the U.S. DOE to the National Academies of Sciences, Engineering, and Medicine in 2019 [2] and 2021 [3], and to the Fusion Energy Sciences Advisory Committee in 2020 [4], the US has started moving aggressively toward the deployment of fusion energy, which could power modern society while mitigating climate change. The ultimate goal is for the US to produce net electricity in a Fusion Pilot Plant (FPP) by 2035-2040 in order to make an impact on the transition to a low-carbon emission electrical system by 2050. The current administration has recently held a “White House Fusion Summit” as the first step towards the development of a bold decadal strategy to accelerate the realization of commercial fusion [5]. It is definitely an exciting time for nuclear fusion as shown by recent physics and engineering breakthroughs, the increasing support by governments around the world, and, more importantly, the growing investment by the private sector in a nascent nuclear-fusion industry.

Besides providing an education across the areas mentioned above and unique research opportunities, these positions also provide the possibility of carrying out experimental work at large fusion facilities in the US (DIII-D tokamak in San Diego, California; NSTX-U tokamak in Princeton, New Jersey) and abroad (EAST tokamak in Hefei, China; KSTAR tokamak in Daejeon, South Korea; ITER tokamak in Saint-Paul-lès-Durance, France). Both short-term and long-term stays at these facilities are usually part of the PhD program within the LU Plasma Control Group.

Due to the interdisciplinary nature of these positions, former members of the Plasma Control Laboratory continue their careers in a variety of disciplines, including nuclear fusion (General Atomics, Princeton Plasma Physics Laboratory), nuclear fission (Shanghai Institute of Applied Physics), controls (General Electric, Corning Inc., Ingersoll Rand, Agilent Technologies, Lockheed Martin), robotics (Zhejiang University, Shenzhen Institute of Advanced Technology, General Dynamics Robotic Systems, U.S. Army), and high-performance computing (Oak Ridge National Laboratory).

These PhD positions are available immediately. Admission is possible both in the Spring and in the Fall. Students starting their PhD programs in the Fall usually join the laboratory in the Summer. Candidates interested in being part of this educational and research opportunity are encouraged to send by e-mail their Curricula Vitae to Prof. Eugenio Schuster at schuster@lehigh.edu.

For more than 150 years, Lehigh University has combined outstanding academic and learning opportunities with leadership in fostering innovative research. The institution is among the nation's most selective, highly ranked private research universities. Lehigh's four colleges provide graduate and undergraduate education to approximately 7,000 students. Located in Bethlehem, Pennsylvania, Lehigh is 80 miles west of New York City and 50 miles north of Philadelphia, providing an accessible and convenient location that offers an appealing mix of urban and rural lifestyles. The Lehigh Valley International Airport is just six miles from campus. Lehigh Valley cities and towns are regularly listed as among the best places to live in the country. Lehigh's MEM Department is consistently ranked among the best in the country. Lehigh University offers an inspiring academic environment, excellent education, state-of-the-art research and computer facilities, very competitive economic conditions (tuitions, stipend, housing, health insurance) for graduate students, and great career opportunities after graduation. More information can be found at https://www1.lehigh.edu/academics/graduate-studies

The LU Plasma Control Group, directed by Prof. Eugenio Schuster and co-directed by Prof. Tariq Rafiq, conducts research at the boundary of theory-based modeling, predictive simulation, and plasma control. Group members combine backgrounds in plasma physics, applied mathematics, computational methods, machine learning, and controls. They work closely with colleagues at experimental facilities to integrate the fields of nuclear fusion, physics-based modeling, and model-based control. Present collaborations include the DIII-D tokamak (San Diego, CA, USA), the NSTX-U tokamak (Princeton, NJ, USA), the KSTAR tokamak (Daejeon, South Korea), the EAST tokamak (Hefei, China), and the ITER tokamak (St. Paul-lez-Durance, France). More information can be found at https://www6.lehigh.edu/~eus204/lab/PCL.php

[1] National Academy of Engineering. NAE grand challenges for engineering. [Online]. Available: http://www.engineeringchallenges.org/challenges/fusion.aspx
[2] National Academies of Science, Engineering and Medicine. A strategic plan for u.s. burning plasma research. [Online]. Available: https://www.nationalacademies.org/our-work/a-strategic-plan-for-us-burning-plasma-research
[3] National Academies of Science, Engineering and Medicine. Bringing fusion to the u.s. grid. [Online]. Available: https://www.nationalacademies.org/our-work/key-goals-and-innovations-needed-for-a-us-fusion-pilot-plant
[4] Fusion Energy Sciences Advisory Committee. Powering the future: Fusion & plasmas. [Online]. Available: https://usfusionandplasmas.org/
[5] The U.S. White House: Biden Administration. Fact sheet: Developing a bold vision for commercial fusion energy. [Online]. Available: https://www.whitehouse.gov/ostp/news-updates/2022/03/15/fact-sheet-developing-a-bold-vision-for-commercial-fusion-energy/