Florian Effenberg, PhD

- **Email**: f.effenberg@princeton.edu
- **Work Address 1**: General Atomics, 3550 General Atomics Ct, San Diego, CA 92121
- **Work Address 2**: Princeton Plasma Physics Laboratory, 100 Stellarator Road, Princeton, NJ, 08540
- **ORCiD**: 0000-0002-4846-4598

Professional summary

Dynamic and results-oriented Nuclear Engineer and Physicist with a Ph.D. from the University of Wisconsin - Madison, specializing in cutting-edge plasma physics research. Demonstrates a proven track record in leading innovative experiments and theoretical analyses in fusion energy, with significant contributions to the field of divertor and edge plasma physics. Offers extensive experience in computational modeling, experimental analysis, plasma-material interactions, and the study of novel materials and techniques for fusion reactors. Recognized for collaborative leadership in international research projects and a commitment to advancing the global scientific community's understanding of fusion as a clean and sustainable energy source.

Education

- **Doctor of Philosophy**, Nuclear Engineering & Engineering Physics, University of Wisconsin – Madison, 2018
- **Master of Science**, Physics (‘Diplom Physiker’), Carl von Ossietzky University of Oldenburg, Germany 2012

Research experience

- **Staff Research Scientist**, Princeton Plasma Physics Laboratory, since April 2022
  - Spearheaded the ITPA task 'DSOL-48: In-situ coating with solid boron injection to mitigate risk for Q=10’ introducing this in-situ coating techniques on ITER to enhance plasma performance for the Q=10 objective
  - Appointed Deputy Leader for the 'FPP Wall Candidate Materials Thrust 2024-25', overseeing the evaluation and execution of fusion materials experiments critical to fusion reactor longevity and performance
  - Contributed strategic insights on run-time allocation and scientific priorities as an integral member of the DIII-D Research Council for FY24, influencing key research directions and resource distribution
  - Orchestrated and directed groundbreaking impurity injection experiments at the DIII-D tokamak, uncovering the effects of mixed low-mid Z impurities on divertor power exhaust and tungsten erosion, contributing valuable insights to the field of plasma-material interactions.
  - Enhanced reactor wall conditioning techniques by supporting multiple experiments in Wide Pedestal Quiescent H-mode, alongside pioneering efforts to increase the effective charge using carbon material injection
  - Facilitated collaborative problem-solving and innovation as the lead discussion facilitator at the US-ITER research program planning workshop in 2022, shaping the research program and US contributions to ITER

- **Postdoc Research Associate**, Princeton Plasma Physics Laboratory, 2019 - 2022
  - Led pivotal impurity granule injection experiments at the DIII-D tokamak, investigating SiC formation on plasma-facing components, and presented results at the PSI conference in 2022
  - Integrated the Dust Injection Simulator with EMC3-EIRENE, enhancing the modeling of low Z powder transport and plasma-material interactions
  - Analyzed low-Z powder and N2 gas injection data, revealing improved core-edge compatibility and divertor efficiency, leading to an invited talk and a Nuclear Fusion paper
  - Proposed and took the first step for the development of a plasma spray unit for in-vessel wall coating, drawing on research in plasma-material interactions for fusion reactor wall solutions
  - Simulated real-time wall conditioning with boron powder injection, presenting findings on 3D effects on transport and plasma-material interactions at PSI 2020
  - Contributed to advanced material research and modeling, enhancing the PPPL-DIII-D collaboration with co-authored publications
  - Provided stellarator edge and divertor physics expertise to international collaborators, resulting in co-authored papers

- **Postdoc Research Associate,** University of Wisconsin – Madison, IPP Greifswald, Germany, 2018 – 2019
  - Active participant in Task Force II 'Plasma Edge and Divertor Physics', focusing on the analysis of radiative edge cooling and detachment control via impurity gas seeding experiments at Wendelstein 7-X
  - Conducted comprehensive analyses of W7-X experimental data with impurity gas seeding, culminating in a well-received presentation at the IAEA Fusion Energy Conference 2018

- Collaborated with IPP and Auburn University to model novel counter-streaming island scrape-off layer flows, leveraging first-time coherence imaging spectroscopy measurements at Wendelstein 7-X, contributing to a co-authored article in Nuclear Fusion

- **Research Assistant**, University of Wisconsin – Madison, 2014 – 2018
  - Led pioneering impurity seeding experiments for the W7-X stellarator's island divertor campaigns as a session leader, achieving stable radiative power exhaust with Ne and N2 seeding
  - Developed models to assess magnetic configuration effects on divertor heat fluxes using 3D HINT equilibrium fields, corroborating findings with IR camera experimental data
  - Investigated SOL heat and particle transport, focusing on the impact of magnetic resonances on fueling and pump-out in various W7-X configurations, resulting in several authored and co-authored papers

- **Research Assistant**, Forschungszentrum Juelich GmbH, Germany, 2012 – 2014
  - Conducted critical calculations of heat fluxes on W7-X startup limiters, leading to significant redesigns of limiter and magnetic field configurations to enhance component safety
  - Developed models for helium and carbon transport in W7-X, contributing to the optimization of helium beam diagnostics and divertor impurity spectroscopy systems

- **Student Research Assistant**, Semiconductor Physics (GRECO), University of Oldenburg, Germany, 2010 – 2012
  - Enhanced the modulated photoluminescence spectroscopy experimental setup and developed Matlab analysis scripts for improved data analysis
  - Conducted characterization of crystalline-silicon wafers with amorphous-silicon passivation using advanced spectroscopic techniques

Selected papers

- F. Effenberg et al, 'In-situ coating of silicon-rich films on tokamak plasma-facing components with real-time Si material injection', Nucl. Fusion 63 106004, 2023
- F. Effenberg et al, 'Divertor dissipation with low-Z powders in DIII-D high confinement plasmas', Nucl. Fusion 62 106015, 2022
- F. Effenberg et al, '3D modeling of boron transport in DIII-D L-mode wall conditioning experiments', Nuclear Materials and Energy 26, 100900, 2021
- F. Effenberg et al, 'First demonstration of radiative power exhaust with impurity seeding in the island divertor at Wendelstein 7-X', Nuclear Fusion 59 10, 106020, 2019
- F Effenberg et al 'Investigation of 3D effects on heat fluxes in performance-optimized island divertor configurations at Wendelstein 7-X', Nuclear Materials and Energy 18, 262-267, 2019
- **Shortlisted for the 2020 Nuclear Fusion Award:** F. Effenberg et al, 'Numerical investigation of plasma edge transport and limiter heat fluxes in Wendelstein 7-X startup plasmas with EMC3-EIRENE', Nucl. Fusion 57 036021, 2017
- K. Schmid, F. Effenberg et al, 'Integrated modeling: Coupling of surface evolution and plasma-impurity transport', Nuclear Materials and Energy, Volume 25, 100821, 2020
- H. Niemann, M.W. Jakubowski, F. Effenberg et al, 'Features of near and far scrape-off layer heat fluxes on the Wendelstein 7-X inboard limiters', Nucl. Fusion 60 016014, 2020
- V. Perseo, F. Effenberg et al, 'Direct measurements of counter-streaming flows in a low-shear stellarator magnetic island topology', Nucl. Fusion 59 124003, 2019
- T. Barbui, F. Effenberg et al, 'Radiative edge cooling experiments in Wendelstein 7-X start-up limiter campaign', Nucl. Fusion 59 076008, 2019
- **Editors-pick:** L. Stephey, A. Bader, F. Effenberg et al, 'Impact of magnetic islands in the plasma edge on particle fueling and exhaust in the HSX and W7-X stellarators', Physics of Plasmas 25, 062501 (2018)
- H. Frerichs, F. Effenberg et al, 'Reconstruction of recycling flux from synthetic camera images, evaluated for the Wendelstein 7-X startup limiter', Nucl. Fusion 57 126022, 2017

Selected talks and posters

- **Contributed talk**: F. Effenberg et al, 'In situ growth and replenishment of PFC coatings with real-time material injection for enhanced steady-state plasma operation', contributed talk, The IEEE Symposium on Fusion Engineering, (SOFE 2023), July 9–13, 2023; UK Atomic Energy Authority; Oxford, UK
- **Contributed talk**: F. Effenberg et al, 'EMC3-EIRENE modeling of toroidally-localized material injections and its effect on plasma-material interactions', 19th International Conference on Plasma-Facing Materials and Components

for Fusion Applications, (PFMC-19), May 22–26, 2023; Bonn, Germany

- **Poster**: F. Effenberg et al, 'In-situ growth of silicon-rich layers with Si granule injection in DIII-D H-mode plasmas', poster, 25nd International Conference on Plasma Surface Interactions 2022, June 13–17, 2022; Jeju, Korea
- **Invited talk**: F. Effenberg et al, 'Mitigation of plasma-material interactions with low-Z powders in DIII-D H-mode discharges', 63rd Annual Meeting of the APS Division of Plasma Physics, November 8–12, 2021; Pittsburgh, PA
- **Poster**: F. Effenberg et al**,** 'Enhanced radiative divertor power exhaust through injection of low-Z powders in DIII-D', 28th IAEA Fusion Energy Conference (FEC 2020), 10–15 May 2021
- **Contributed talk:** F. Effenberg et al**,** Divertor Power Exhaust with Impurity Powders in DIII-D, APS Division of Plasma Physics Meeting, PO06.006, 2020
- **Poster:** F Effenberg et al, 'Analysis of 3D effects on SOL transport in DIII-D impurity powder dropper experiments', 24th International Conference on Plasma Surface Interaction in Fusion Devices, 2021
- **Contributed talk:** F. Effenberg, et al, 'Radiative Power Exhaust in the Island Divertor and Access to Controlled Detachment with Impurity Seeding', 22nd International Stellarator and Heliotron Workshop 2019 (ISHW 2019)
- **Contributed talk:** F. Effenberg et al, 'Power Exhaust Control by Impurity Seeding in the Island Divertor at Wendelstein 7-X', 27th IAEA Fusion Energy Conference (FEC 2018), 22-27 Oct 2018, Ahmedabad, India

More research: https://scholar.google.com/citations?user=c4DMC78AAAAJ&hl=en

Teaching experience

- **Student Teaching Assistant**, Institute of Physics, University of Oldenburg, Germany, 2008 – 2011
  - Tutored and assisted in the teaching of Mathematical Methods for Engineering Physics I+II, Theoretical Electrodynamics, Physics IV: Thermodynamics and Statistics, Physics for Chemists & Environmental Scientists, Computational Theoretical Physics

Academic service

- **Vice Chair**, American Nuclear Society San Diego Section since FY23
- **Editorial Board Member**, Journal of Nuclear Engineering 2021-2022
- **Reviewer for scientific journals** since 2017
  - reviewed 56+ manuscripts Nuclear Fusion, Plasma Physics & Controlled Fusion, Physics of Plasmas, Nuclear Materials & Energy, Journal of Physics Communications, Physics Scripta, Materials; Institute of Physics trusted reviewer 2020

Honors and awards

- **PPPL SPOT Award** 2023
- **Outstanding reviewer** 2018 Plasma Physics and Controlled Fusion
- **James D. Callen Fellowship** for Excellence in Plasma Theory, University of Wisconsin, Madison, 2017
- **Student Poster Award** at the International Sherwood Fusion Theory Conference, Madison, 2016

Skills and training

- **APS Career Mentoring Fellows Program 2023-2024**, participated in the program's training sessions and engaged with students at the APS-DPP 2023 meeting to help them with their career decisions
- **Participated in DIII-D's mentorship pilot program 2023**, participated in the program and proposed enhancements
- **SPIN: Strategic Program for Innovation at National Labs 2023**, engaged in sessions led by the University of Chicago's Polsky Center, culminating in presenting an innovative proposal aimed at enhancing National Labs' efficiency by creating more opportunities for staff innovation, and shared insights from national lab surveys with PPPL leadership to address innovation barriers.
- **PPPL Energy I-Corps Lite Pioneer Cohort Winter 2021**, learned and applied entrepreneurial thinking to foster public-private partnerships between PPPL and industry in a project dedicated to reactor wall coating
- **2nd Computational Physics School for Fusion Research**, MIT, Cambridge, MA, Aug 30 - Sep 3, 2021
- **Wharton Princeton Entrepreneurship Executive Education Program** (June 17, 2021)
- **Tech Transfer Webinars and Workshops to Expand Entrepreneurial Skills** by L. Schoppe, Fuentek LLC, 2021
- **Linkedin Learning:** Diversity and Inclusion in a Global Enterprise, Unconscious Bias, The Six Biases of Decision

Making, Strategic Thinking, Project Management Simplified

- **PPPL training:** Lithium Safety, Hydrogen Gas Safety, Respiratory Protection Training, Laser Safety Rules, Nanomaterials Worker Safety Training, Radiation Safety, Cyber Security Awareness
- **DIII-D training:** DIII-D Pit Indoctrination, D3D-Specific Radiation Training, General Radiation Training
- **Computer skills:** High-Performance Computing, Matlab, Fortran, Python, C/C++, Linux, Latex
- **Languages:** English (fluent), German (native), French (basic), Spanish (basic)