Department of Nuclear Science and Engineering

The faculty and students of the Department of Nuclear Science and Engineering (NSE) study low-energy nuclear reactions and radiation, their applications, and their consequences. The work of the department involves generating, controlling, and applying nuclear reactions and radiation for the benefit of society and the environment. The mission of the department is to help develop the next generation of leaders of the global nuclear enterprise and to provide technical leadership in energy and non-energy applications of nuclear science and technology. As a leading academic department in the field, NSE also has a responsibility to inform public debates on the wise and humane uses of nuclear science and technology.

Increasing global energy needs and rising concerns over climate change are bringing new attention to the role of nuclear energy around the world. The department's efforts will be central to the newly announced MIT Climate Change initiative; NSE faculty will be co-directors of three of the eight MIT Energy Initiative's Low-Carbon Energy Centers. In addition, the department studies many important non-energy applications of nuclear science and technology, with a particular recent focus on nuclear security. The department offers what is probably the widest spectrum of research and educational activities of any nuclear science department in the country. Faculty and students develop nuclear reactors for electricity generation as well as for other diverse uses, including waste management, fluid fuels production, and space propulsion. They work on demonstrating the scientific and technical feasibility of fusion power and on developing the underlying capabilities needed for this. They contribute to security by developing new ways to monitor nuclear materials and to detect nuclear threats. They apply nuclear technologies to the physical and life sciences in areas ranging from neutron interferometry to radiation modeling, magnetic resonance imaging, advanced nuclear detection, quantum information processing, and next-generation quantum-based detectors.

Faculty and Administration

Professor Jacopo Buongiorno became the director for the Center for Advanced Nuclear Energy Systems (CANES). He was named Nuclear Science and Engineering associate department head. He also received the TEPCO Chair of Nuclear Science and Engineering.

Professor Paola Cappellaro was promoted to the rank of associate professor with tenure.

Professor R. Scott Kemp was named a Norman C. Rasmussen Career Development Professor.

Professor Emilio Baglietto was named a Norman C. Rasmussen Career Development Professor.

Professor Dennis Whyte was appointed department head of Nuclear Science and Engineering.

He has been named the Hitachi American Professor of Engineering.

Professor Nuno Loureiro joined the NSE faculty this year.

Research Highlights

In 2015, CANES celebrated its 15th anniversary as an integral part of the MIT energy community and as a research hub that brings together industry, national laboratory, and leading international organizations to collaborate on pushing forward the understanding and design of advanced nuclear energy systems. As part of the celebration, a new CANES-MIT Low-Carbon Energy Center conference room, located in the late Professor Mujid Kazimi's former office, was dedicated in his honor. Founded in 2001 by Professor Mujid Kazimi, CANES has established itself as a leading research center at MIT and has produced more than 250 publications since its inception. Known as someone who built bridges across the Institute and international research community, Professor Kazimi provided the vision and groundwork for assembling the necessary collaborators, funding, and culture to establish CANES as a lasting center for excellence. In CANES, Professor Kazimi fostered an environment that was as much about studying the future of nuclear energy as training and enabling the future leaders in the field. Jacopo Buongiorno, TEPCO Professor of Nuclear Science and Engineering, has assumed the role of director of CANES.

Professors Jacopo Buongiorno and Dennis Whyte received a large grant from the Sloan Foundation to launch a new Future of Nuclear Energy study. Like the previous study in 2003, this will be a multidisciplinary effort, involving seven MIT faculty members from across the Institute as well as two Harvard University faculty members and two external consultants. The goal is to conduct an objective assessment of the opportunities and challenges affecting the ability of nuclear energy technologies in meeting US and global energy needs in a carbon-constrained world. The study will assess the prospects for innovative nuclear technologies, business models, and governance mechanisms to accelerate the transition to a lower-carbon energy system.

The goal of the fluoride salt-cooled high-temperature reactor (FHR) project is to develop a reactor to provide zero-carbon electricity to meet variable electricity demand while the reactor itself operates at full capacity to minimize costs. Led by Principal Research Scientist Dr. Charles Forsberg, and sponsored by the US Department of Energy (DOE), the project received additional funding from the Chinese Academy of Sciences to address specific technical challenges associated with tritium management in the FHR. In the design, the FHR is coupled to an air-Brayton combined cycle plant that is similar to natural gas plants. The nuclear reactor, which operates in base-load mode, achieves a thermal efficiency of 42%, with a requirement for cooling water that is 40% less than that of a light water reactor (LWR); the thermal efficiency of auxiliary natural gas combustion exceeds 66% as a thermodynamic topping cycle, significantly above that of the most efficient stand-alone combined-cycle natural gas plants.

The computational reactor physics group, led by Professors Benoit Forget and Kord Smith, have pursued the development of high-fidelity open source software using both deterministic (OpenMOC) and stochastic (OpenMC) methods. Recent highlights in

OpenMOC include the development of a three-dimensional high-fidelity method that demonstrated for the first time suitable efficiency for use on realistic problems, and the ability to converge, in space and angle, LWR problems. The team has also developed a novel, random ray method-of-characteristics method that converges rapidly in angle and is highly parallelizable. Recent highlights in OpenMC include the development of a full energy range Doppler broadening capability for dealing with temperature feedback, coupling with fuel performance and fluids finite-element codes using functional expansion tallies, low-order acceleration techniques to improve convergence on large realistic nuclear reactor cores, and a new ability to predict the inter-cycle correlations caused by the power iteration in discrete particle systems.

Professor Buongiorno and Professor Strano (Chemical Engineering) started a new project sponsored by the US Navy on the development of ultra-low thermal conductivity diving-suit material for enhanced persistence in cold-water dives. Conventional wetsuits and drysuits are made of neoprene, an inexpensive rubber foam with a high density of approximately spherical pores with nitrogen gas. The project is investigating both replacing nitrogen with a lower thermal-conductivity gas (e.g., xenon), and changing the aspect ratio of the pores. It may be possible almost to triple the thermal resistance of standard neoprene, increasing the time before hypothermia occurs in cold water by severalfold. This technology will find broad application in the commercial sector, in industry, and in the scientific and national security communities. Wetsuits, drysuits, and other dive garments can be made out of the new material for surfers and triathletes, recreational divers and spear fishermen, oceanographers, shipyard workers, and Special Forces members (e.g., Navy SEALs).

Professors Jacopo Buongiorno, Neil Todreas, and Michael Golay have continued to make technical progress in the development of the offshore floating nuclear plant concept. In the past 12 months, the effort has focused on assessing major security threats to an offshore platform, such as an intentional collision of a large tanker, as well as flood hazards caused by internal and external events. The offshore floating nuclear plant concept continues to receive media and industrial attention.

Professor Buongiorno and Dr. Thomas McKrell have made progress in the project on suppression of nucleate boiling in annular flow. The flow loop was completed and the first data were generated, showing, for the first time, periodic fluctuations of the heat transfer coefficient in annular flow. This work is relevant to fast-transient conditions in both boiling water reactors and pressurized water reactors; it is sponsored by Knolls Atomic Power Laboratories.

Significant progress has been made in the project on numerical simulations of bubble growth in nucleate boiling. The focus is on the formation and evaporation of the so-called microlayer, a thin liquid film underneath a bubble growing at a heated wall that greatly affects the bubble growth time and ultimately the heat transfer coefficient in nucleate boiling. Current microlayer models are based on a steady state analysis of the liquid film; however, direct experimental observations of the microlayer suggest that its shape and thickness evolve significantly during the growth of the bubble. Realistic time-dependent microlayer evaporation models necessitate initialization of the microlayer profile underneath the bubble. This project is sponsored by Electricité de France and Commissariat a l'Energie Atomique, and features a collaboration with Professor Stephane Zaleski at Universite Pierre et Marie Curie in Paris.

Professor Buongiorno and Dr. Koroush Shirvan are leading a team of NSE faculty and research scientists, as well as participants from four other universities, in a new DOE-sponsored research program on accident-tolerant fuel for LWRs. The project is analyzing and testing experimentally the performance of several engineered coatings for the fuel cladding that will result in a drastic reduction of hydrogen generation during severe accidents, thus mitigating the consequences of Fukushima-like scenarios.

Research Scientist Dr. Shirvan continued his study on a novel reduced-moderation boiling water reactor concept by focusing on its fuel performance in collaboration with Professor Ballinger. He has also made progress in an investigation of high-density fuel, uranium nitride, to increase the power output of the AP1000 nuclear reactor. The use of uranium nitride allows the fabrication of lower than 5% enriched fuel, given current core reload design constraints. In another investigation, with the use of recent data obtained from Canadian CANDU reactors and a research reactor in Europe, the behavior of thoria-plutonia, thoria-urania, and urania–beryllium oxide fuels were more accurately captured. Support for these activities was provided by private industry (Hitachi, Exxon Mobil, and Lockheed Martin). Dr. Shirvan is also the executive director of the accident-tolerant fuel integrated research project.

Professors Michael Driscoll (Emeritus) and Emilio Baglietto, together with Dr. Thomas McKrell and several students, including visiting students from France and the UK, are in the final stages of their evaluation of using deep boreholes for disposal of spent fuel from TerraPower's innovative fast reactor design. A solution to the challenges posed by its high peak and average decay power has been developed, supported by laboratory studies, using cast zinc alloy to fill voids inside the fuel assembly and inside its disposal canister. Meanwhile, development of the deep borehole approach has achieved enhanced prominence in DOE plans for nuclear waste disposal, partly because of NSE's past collaboration with Sandia National Laboratories on two completed projects.

Professors Neil Todreas (Emeritus) and Emilio Baglietto have continued the development of a methodology to assess uncertainties in the measurement of key operating nuclear plant parameters critical to maintaining reactor safety and meeting environmental regulations. The methodology development draws from insights being developed in the conduct of a series of five case studies of uncertainty sources and their magnitude for a series of relevant individual measurements. This research is sponsored by Electricité de France in collaboration with the Electric Power Research Institute (EPRI).

Professor Ballinger's group, in partnership with Professor Alex Slocum (Mechanical Engineering), finished the development of a model for corrosion fatigue of naval submarine propulsion shafting. The model has resulted in an alteration of the design specifications for the next-generation ballistic missile class submarine to extend the inspection interval for the propulsion shaft. Ballinger's group has also succeeded in the use of mechanical testing in pure heavy water at light water reactor conditions, as a means to detect the migration and location of hydrogen in materials, using deuterium as a surrogate. This new technique has never been used in water at high temperature and pressure. His group has also succeeded in using a combination of alternating current potential drop techniques, with autoclave testing, to detect precursors to cracking in pipeline materials used for the oil, gas, and power generation industries.

Professor Emilio Baglietto's group made considerable advances in delivering a pioneering capability for predicting critical heat flux using a first principles–based, three-dimensional approach. The work is largely sponsored by the Consortium for Advanced Simulation of Light Water Reactors. The novel approach is also driving a larger international community to push experimental capabilities to validate this new approach.

Professor Emilio Baglietto's team has delivered an innovative hybrid turbulence model capable of locally controlling the level of resolution on the basis of the turbulence characteristics. This new family of models is the enabling technology to extend the use of computational fluid dynamics to complete reactor systems and safety analysis transients.

Professor Baglietto won an Nuclear Energy University Programs award, in collaboration with the University of Wisconsin–Madison, Virginia Commonwealth University, and Argonne National Laboratory, to develop high-fidelity data, improve computational fluid dynamic calculations for liquid sodium, and advance existing simulation methods to support critical design and safety analysis.

Professor Ju Li's group is developing nanocomposite materials with metallic matrix (aluminum, zirconium, magnesium, copper) and one-dimensional nanowires and nanotubes and two-dimensional graphene dispersions that have shown superior radiation resistance and mechanical properties. The Li group also led the development and applications of IM3D, a parallel Monte Carlo software for efficient simulations of primary radiation damage with the ability to describe arbitrary three-dimensional geometries and microstructures, replacing the one-dimensional code.

Combining modeling with electron microscopy, Ju Li's group has investigated radiation effects on mechanical properties and hydrogen effects on materials corrosion. Under the theme of elastic strain engineering, Professor Li's group has participated in the development of niobium-based superconductors that show improved critical temperature.

Professor Li's group has also developed scalable syntheses of novel cathode (Li_2O/Li_2O_2/LiO_2) materials for next-generation lithium-ion batteries.

Professor Michael Short's group has made considerable theoretical and experimental gains in both of its two main research thrusts: fouling and radiation damage. In the area of fouling, the group has discovered that the key to fouling resistance should reside in calculating the van der Waals forces between fouling particles and heat transfer surfaces. A custom hyperbaric atomic force microscope is under construction to confirm the lack of adhesion force at nuclear reactor and geothermal conditions. This work is funded entirely by a group of industrial sponsors, including Westinghouse, EPRI, Statoil ASA, and KETEP, a Korean industrial consortium. In the area of radiation damage, two major gains have been made: the construction of a transient grating spectroscopy facility, in concert with Keith Nelson's group in Chemistry, and the discovery of a measurable unit of radiation damage. Transient grating spectroscopy rapidly reveals multiple thermoelastic material properties, and Short's group is building an in situ beamline to investigate these changes during irradiation in Professor Dennis Whyte's proton accelerator. Such "beam-on" material properties have never been measured before, and are expected to differ significantly from ex situ properties. The measurable unit of radiation damage is based on measurement and prediction of stored energy caused by radiation damage, locked in the complex defect populations that irradiation creates. Molecular dynamics simulations show a universal scaling law, relating the material, its irradiation temperature, and irradiation energy to a single power law. Experimental verification is under way.

Professor Anne White's research focuses on the study of turbulent transport in fusion plasmas, with the goal of controlling the transport and improving the performance of tokamaks. Her group develops diagnostics, conducts experiments, and leads validation projects using advanced turbulence simulation codes at four major tokamaks (NSTX-U, Alcator C-Mod, DIII-D, and ASDEX Upgrade). At the NSTX-U tokamak at Princeton's Plasma Physics Laboratory, students are using the high-k scattering diagnostic to measure electron-scale density fluctuations directly and compare the measured turbulence with theory and simulation. Professor White collaborates with Dr. John Rice of MIT's Plasma Science and Fusion Center on development of a new diagnostic for measurement of ion temperature and plasma rotation profiles. At MIT's Alcator C-Mod tokamak and at DIII-D, students are tracking the propagation of electron temperature heat pulses to measure plasma thermal diffusivity. At DIII-D, Professor White also collaborates on the development of new diagnostics to enable the study of impurity particle transport, an effort led by PSFC scientist Dr. Nathan Howard. At the ASDEX Upgrade at the Max Planck Institute for Plasma Physics in Garching, Germany, Professor White's group has installed new instruments to enable measurement of electron temperature fluctuations and correlations between density and temperature fluctuations; the first successful data was collected in 2015. Across all the tokamak projects, Professor White's group is expanding diagnostic development work to enable further particle and momentum transport experiments, as well as investigations of nondiffusive transport, in fusion plasmas.

Professor White has supervised several Undergraduate Research Opportunities Program (UROP) projects involving studies of both core and edge turbulence on Alcator C-Mod and the development of small, tabletop plasma devices such as fusors—electrostatic inertial confinement devices—for use in classroom teaching at MIT.

Professor Ian Hutchinson's group investigates the basic physics of plasma flow past obstacles, using their particle in cell codes and analytic theory. The disruption of plasma wakes in simulations by nonlinear growth of electron holes has led to renewed interest in these free-standing, self-sustaining phenomena. Satellites in a range of different space plasma environments have recently observed electron holes. Professor Hutchinson has developed a theoretical understanding of the kinematics of electron holes that enables one to apply momentum conservation to predict how their velocity changes. This theory shows that interactions with moving ions are crucially important in determining hole velocity, and that electron holes cannot normally overtake ion streams. This fact explains how holes can be trapped between multiple ion streams in a wake, as well as a number of other electron hole acceleration phenomena.

Professor Nuno Loureiro joined MIT in January 2016. His research expertise is in the theory and computation of nonlinear plasma dynamics, with applications to laboratory, space, and astrophysical plasmas. One of his leading interests is magnetic reconnection—the phenomenon that empowers solar flares, magnetospheric substorms, and several instabilities in magnetically confined fusion devices. Professor Loureiro's recent work on this topic has focused on the problem of reconnection onset, and the theoretical interpretation of the data from a novel reconnection experiment hosted at Imperial College London.

Professor Loureiro has initiated a project to understand the behavior of energetic particles in high-magnetic-field fusion devices, as are being proposed at the Plasma Science and Fusion Center. He continues development of the massively parallel computer code Viriato, which is designed to investigate turbulence in weakly collisional, strongly magnetized plasmas.

Professors R. Scott Kemp and Areg Danagoulian developed a method for verifying the authenticity of nuclear warheads that are accounted for under international treaties, which has been an open technical problem for almost five decades. The proposed method uses physically encrypted isotopic tomography. The measure is specific enough that it cannot be fooled by any credible hoax object; at the same time, it protects all sensitive information about the design of the warhead from reaching the inspector in a provably secure way that relies on physics rather than electronics. If rendered into a practical system, the technique should facilitate the cooperative dismantling of thousands of surplus nuclear weapons currently stored in the United States and Russia. The method was published in the *Proceedings of the National Academy of Sciences*.

Professors R. Scott Kemp and Michael Short initiated a new project on ultrasensitive measurements of alpha damage to metals that could be useful in reconstructing the historical operation of uranium enrichment facilities. Such a technique, if demonstrated in ongoing research, would allow the international community to verify national claims about the amounts of materials suited for nuclear weapons that they produced and ensure that all previously produced material has been accounted for.

Professor Kemp and A. Taylor Baldwin, who holds an SM degree from NSE, completed the technical portion of a collaborative research project with Professor Barry Posen and Dr. Jim Walsh of the MIT Security Studies Program that seeks to evaluate the proliferation risks of novel types of laser-based isotope separation. The initial results suggest that the laser method remains technically complex compared with the traditional gas centrifuge method. Although any new capability to separate uranium isotopes presents some additional risk, the laser method might be less capable of being rapidly repurposed from peaceful to non-peaceful uses because of the complex shape of the separation cascade.

Professor Paola Cappellaro's Quantum Engineering Group has devised several strategies to improve quantum sensors using spin defects in diamond. Nanoscale magnetic resonance imaging enabled by quantum sensors is a promising path toward the outstanding goal of determining the structure of single biomolecules at room temperature. The first technique developed, quantum interpolation, can improve the frequency resolution of these quantum sensors far beyond the limitations set by the experimental controlling apparatus. The method was demonstrated over two orders of magnitude resolution gains and applications of the work to high-resolution nanoscale magnetic resonance imaging is being discussed. A second technique addresses the problem of sensing slowly varying magnetic fields, a task particularly relevant to many real-world scenarios. Professor Cappellaro's group devised a nuclear spin-mediated technique that allows interrogation times up to the much longer T2 coherence time. The method relies on frequency up-conversion of the direct current (DC) field by the hyperfine coupled ancilla, allowing quantum lock-in detection. This provides a valuable tool for vector DC magnetometry at the nanoscale.

Professor Cappellaro's group introduced a "quantum radar" technique for nanoscale magnetic resonance imaging that reveals nuclear spins in otherwise blind spots of the quantum spin probe. The quantum radar will enable precise reconstruction of the spatial position of nuclear spins in proteins and biomolecules.

Professor Yildiz's research group focuses on laying the scientific groundwork and proof-of-principle material systems for the next generation of high-efficiency devices for energy conversion and information processing, based on solid state ionic-electronic materials. The scientific insights derived from her research affect the design of novel surface and interface chemistries for efficient and durable solid oxide fuel and electrolysis cells, redox-based memristive information storage and logic, efficient and durable thermo/electrochemical splitting of water and carbon dioxide, high-energy-density and high-power-density solid-state batteries, and corrosion-resistant films in a wide range of extreme environments, such as in nuclear energy generation, concentrated solar energy, and oil exploration. In the past year, a key development in her group has been the development of oxide catalyst surfaces that are more durable and more active than the state-of-the-art in the field of fuel cells.

During this year, the continuing study on the phase behavior and dynamics of supercooled confined water by Professor Sow-Hsin Chen and his group, supported by DOE, led to the finding of the phase diagram of liquid-to-liquid transition. Professor Chen and his group also are involved in an innovative, collaborative study with his colleagues at the University of Florence on an environmentally friendlier ("green") cement; this study is also supported by DOE. In addition to the use of neutron-scattering facilities at the National Institute for Standards and Technology Center for Neutron Research, they conducted research in collaboration with the National Synchrotron Radiation Research Center in Hsinchu, Taiwan.

Professor Dennis Whyte and his doctoral students have begun to study the details of radiation damage in high-temperature superconductor tapes, which are currently being thought of for use in compact, robust fusion reactors. This study is using both the MIT reactor and high-energy protons to illuminate the underlying damage mechanisms and methods to mitigate degradations in the high-temperature superconductors' performance.

Education

A total of 111 students pursued graduate degrees from NSE in academic year 2016. Fifty-three percent of these students worked in fission energy, 17% in fusion and plasma physics, and 30% in other nuclear science and technology applications, including materials, nuclear technology management and policy, nuclear security, and quantum engineering. The department awarded 14 SM degrees and 13 PhD degrees. Twenty-two students entered the graduate program in fall 2015.

A total of 39 students were enrolled in the undergraduate program during the past year, including 14 sophomores, 15 juniors, eight seniors, and two fifth-year students. Eight students completed the requirements for the bachelor's degree in NSE during academic year 2016.

This year, the department continued to provide communication support to its students through the NSE Communication Lab, a peer coaching program launched in 2014 to help students and postdoctoral associates with their writing, speaking, and visual design needs. NSE Communication Lab manager Marina Dang hired and trained five NSE graduate students to become Communication Fellows; these were to provide field-specific feedback in one-on-one coaching sessions, design and run scientific communication workshops, and help to innovate within the department. The NSE Communication Lab also collaborated with instructors from eight NSE undergraduate and graduate courses to help strengthen the communication aspect of the curriculum. Since September 2015, the NSE Communication Fellows have held 156 coaching appointments with 77 visitors, or 47% of the department's members. Most NSE Communication Lab visitors were repeat users. In its 2015 report, the Corporation Visiting Committee for NSE noted that "the outstanding success of the NSE Communication Lab as a peer-to-peer resource for students was very clear."

This June marked the 50th session of the MIT Nuclear Plant Safety Course; this is the longest-running professional summer session course offered by MIT. It was co-directed by Professors Neil E. Todreas and Benoit Forget. From its inception in 1966, the course has played an important role in the professional development of hundreds of attendees from throughout the world by serving as an up-to-date exposition of ongoing developments in nuclear power plant safety. The lecturers come from industry, government, and academia and are among the most knowledgeable experts in nuclear technology. They are closely associated with current reactor safety or fuel facility safety issues as well as strategies for future plant operations and designs.

As part of a collaboration between MIT, Idaho State University, Texas A&M, and the University of Ontario's Institute of Technology, Dr. Richard Lanza helped to develop a workshop course for health physics students. The course, given at MIT in September 2015, was sponsored by DOE's National Nuclear Security Administration and was attended by 15 graduate students from the participating universities.

Professor Baglietto (22.06 Engineering of Nuclear Systems) was nominated for two important awards: the Everett Moore Baker Award for Excellence in Undergraduate Teaching (this is the only teaching award at MIT whose recipient is determined by undergraduates), and the 2016 Teaching with Digital Technology Award.

Faculty Awards, Honors, and Activities

Professor Emilio Baglietto is serving as the general chair of the Computational Fluid Dynamics for Nuclear Reactor Safety Applications (CFD4NRS-6) Conference, which will be held at MIT on September 13–15, 2016. The Organization for Economic Co-operation and Development and the International Atomic Energy Agency are the conference sponsors.

Professor Ronald Ballinger received the Creative Advising Activity Award, which is given by MIT's Office of Undergraduate Advising and Academic Programming.

Professor Paola Cappellaro became associate editor of the journal *Quantum Information Processing*.

Professor Sow-Hsin Chen was awarded the Guinier Prize in recognition of his lifetime achievements, which include major breakthroughs and contributions to the field of small-angle neutron scattering, at the Small Angle Scattering 2015 meeting in Berlin, Germany. Professor Chen was celebrated with a Special Workshop on Frontiers for Soft Condensed Matters at MIT. At the end of June 2016, the National Tsing Hua University in Hsinchu, Taiwan, held the fourth Sow-Hsin Chen Lectureship on Neutron Science and Technology, which is named in honor of Professor Chen.

Professor Michael Golay was a member of the Committee on Lessons Learned from the Fukushima Nuclear Accident of the National Academies of Sciences, Engineering, and Medicine. The work of the committee included a published report, *Study on Lessons Learned from the Fukushima Accident for Improving Safety and Security of U.S. Nuclear Plants: Phase 2.* Professor Golay presented "A Strategy for Global Climate Change Mitigation" at the 21st International Conference & Exhibition: "Nuclear Fuel Cycle for a Low-Carbon Future," Global 2015 Conference, Paris, France.

Professor R. Scott Kemp was the recipient of a 2016 Sloan Research Fellowship in physics. He was also invited to join the JASON advisory group—an independent group of elite scientists that advises the US government.

Professor Nuno Loureiro received the American Physical Society's Thomas H. Stix Award for Outstanding Early Career Contributions to Plasma Physics Research.

Professor Michael Short won the 2016 Earll S. Murman Award for Excellence in Undergraduate Advising.

Professor Kord Smith was the recipient of the Eugene Wigner award given by the Reactor Physics division of the American Nuclear Society.

Professor Anne White serves on the Faculty Task Force on International Engagement and continues to serve on the MIT Faculty Policy Committee. She also participated this year in the "Life after Tenure" Program organized by the Provost. She is presently a member of the Executive Committees for the American Physical Society Division of Plasma Physics and the US-European Union Transport Task Force. She also chairs the local organizing committee for the International Sherwood Fusion Theory Conference (MIT is hosting the conference in spring 2017).

Professor Emeritus Sidney Yip presented a Distinguished Lecture on Materials Theory and Simulation at the Swiss Federal Institute of Technology in Lausanne on August 31, 2015. He was a member of the Visiting Committee of the Department of Nuclear Engineering and Radiological Sciences at the University of Michigan. Professor Yip's textbook, *Nuclear Radiation Interactions,* has gone into a second printing in a soft-cover edition.

Student Awards and Activities

Jake Hecla received the Outstanding UROP Award for his outstanding contributions to an NSE research project by a junior or senior.

Will Boyd, Derek Gaston, Geoff Gunow, Sterling Harper, Lulu Li, Sam Shaner, and John Tramm received the Outstanding Student Service Awards in recognition of exceptional service to the department.

Jimmy Rojas Herrera received the Roy Axford Award for academic excellence by a senior in NSE.

Karia Dibert and Logan Abel received Outstanding UROP awards for outstanding contributions by a freshman or sophomore on an NSE project.

Akira Sone and Adam Kuang both received the Outstanding Teaching Assistant Award for exceptional contributions as a teaching assistant..

Guany Su received the Manson Benedict Award for excellence in academic performance and professional promise by a graduate student.

Sean Lowder received the Irving Kaplan Award for excellent academic achievement by a junior in NSE.

Will Boyd received the American Nuclear Society's Outstanding Grader Award, presented by the student chapter of the American Nuclear Society.

Carolyn Coyle won the Young Professional Author Award and was one of eight winners of the Best Paper Award at the American Nuclear Society's International Topical Meeting on Nuclear Reactor Thermal Hydraulics for her paper, "Synthesis of CRUD and its Effects on Pool and Subcooled Flow Boiling."

Alex Creely received a National Defense Science and Engineering Graduate fellowship.

Cody Dennett was awarded the National Nuclear Security Administration's Stewardship Science Graduate Fellowship (one of seven national recipients).

Patrick Everett won the Ernest Cravalho Award for Outstanding Performance in Thermal Fluids Engineering.

Geoffrey Gunow won the award for Outstanding Graduate Resident Advisor.

Silvia Espinso-Gutiez was awarded the Student Poster Prize by the Plasma Physics and Controlled Fusion, the European Physical Society, and the International Union of Pure and Applied Physics at the 2015 European Physics Society Plasma Physics conference and the Award for Excellent Graduate Student Presentation at the 2016 International Sherwood Fusion Theory Conference. The prizes were given for her research presentation, "Theoretical Explanation for Strong Poloidal Impurity Asymmetry in Tokamak Pedestals."

Dennis G. Whyte
Department Head
Hitachi American Professor of Engineering