Don't forget to answer the specific questions in the prompt! Sometimes it is helpful to copy the Statement of Purpose prompt into your document so you can easily refer back to it and make sure your own Personal Statement is on track.

MIT Statement of Objectives

Please give your reasons for wishing to do graduate work in the field you have chosen. Prepare your statement of objectives and goals in whatever form clearly presents your views. Include as far as you can, your particular interests, be they experimental, theoretical, or issue-oriented, and show how your background and MIT's programs support these interests. The statement could be much like a proposal for graduate studies, in the more specific context of your professional objectives. You should set forth the issues and problems you wish to address. Explain your longer-term professional goals. The Admissions Committee will welcome any factors you wish to bring to its attention concerning your academic and work experience to date.

Brief opening story to demonstrate commitment to, and excitement about, experimental physics

"You've got fifteen minutes to get your data before we have to seal the reactor off and prepare for tomorrow's run," the engineer informed us. Our team had spent the past two years repairing, upgrading, and finally installing a particle accelerator on Alcator C-Mod, MIT's fusion reactor. The last month and a half of the summer had been a blur, working 12 to 16 hours a day, seven days a week, to finish the installation and take data for our grant renewal proposal, which was due the next day. We had painstakingly installed and tested dozens of individual systems, but we hadn't had time to test the entire accelerator as a unit and would have to hope we had put everything together correctly the first time. We slowly brought all of the main systems online. "Eighty percent, ninety percent, accelerator at full power; we are measuring a beam current!" With our beam operational, we convinced the engineers to give us one more hour on the reactor and were able to collect our data. Utilizing a combination of hard work, physics education, and engineering skills to implement a unique diagnostic and add new knowledge to the scientific community has been one of my proudest accomplishments and has reinforced my desire to be a contributing member of the fusion community.

Dives into the technical details of the project described above. Concrete actions and skills developed.

Explanation of why current research is important.

As a master's candidate at MIT, I have been part of the AGNOSTIC project for Alcator C-Mod. AGNOSTIC is a novel fusion diagnostic, allowing in-situ ion beam analysis of Alcator's plasma facing surfaces to better understand the interaction between fusion plasma and surrounding material surfaces. Repairing, upgrading, and installing AGNOSTIC's radio-frequency quadrupole (RFQ) particle accelerator on Alcator has allowed me to use and hone the skills I learned as a double major in electrical engineering and engineering physics, such as circuit design and fabrication, soldering, basic machining, CAD modeling, and vacuum system construction. In addition to hardware work on the RFQ, I also designed and built the experimental beamlines used to validate the diagnostic technique in the lab, assisted with detector setup and calibration, and operated the particle accelerator during some of our data collection runs. Presently I am in the process of repairing another particle accelerator, DANTE (Deuterium Accelerator-based Neutron-producing Tandem Experiment), which I will use to measure the angular distribution of the B11(d,p+g)B12 reaction cross section at low deuteron energies. As well as filling a gap in the published cross-section data, this knowledge will allow the AGNOSTIC group to quantitatively measure the evolution and transport of low-Z isotopes on the plasma facing tiles of Alcator's inner wall.

More explanation of research background as well as science outreach.

In addition to my experimental work with accelerators, last year I had the opportunity to take 22.63, the fusion engineering design course. During this course, I used MCNP, a Monte-Carlo particle transport code, to design an all-liquid molten salt blanket for our compact, high field fusion reactor concept design. Building on previous work, I continued the development of a C++ "shell" for MCNP to automate the production of MCNP runs. This reduced the time required to set up multiple iterations of reactor geometry to be simulated and allowed our group to sweep a wide parameter space of reactor configurations. Recently, I was the first author of our group's liquid blanket design poster at APS, and I am coordinating a group of students from the design course on publishing our reactor concept in the journal Fusion Engineering Design. I strongly believe in the importance of making science accessible to the public, and to that end I have presented our reactor design at both the MIT and Harvard Energy Night events.

Shows that the applicant has done their homework about the school's research strengths and curriculum.

Addresses question in prompt about the applicant's particular interests and how MIT programs support those interests

I believe that my research interests align with the Department of Nuclear Science and Engineering's new expanded core and research thrusts and that NSE would be the ideal place to continue my studies. If I was selected to be a PhD candidate in NSE, I would continue my work with particle accelerators and radiation detectors for use in analyzing and characterizing plasma facing materials in the extreme environment of a tokamak—specifically fusion fuel retention in those materials. The DANTE facility would be an ideal place to continue this work, as its deuterium beam would induce high-Q reactions with the retained deuterium fuel, producing charged particles and neutrons with energies in the MeV range. The high-energy charged particle reactants could be measured in the lab using Nuclear Reaction Analysis (NRA) and used to determine the depth and concentration profiles for the retained fuel in the plasma facing surfaces.

In addition to this ex-situ analysis of plasma facing materials, I would like to develop a system to collect the neutron energy spectra from deuteron-induced reactions. Historically, ion beam analysis of materials via nuclear reactions has favored charged particles due to the relative difficulty of obtaining neutron energy spectra, but developing a system to reliably measure high-energy neutron spectra in a tokamak environment would allow in-situ diagnostics (such as AGNOSTIC) to characterize fuel retention in a tokamak without physically removing tiles. In addition to utilizing the newest developments in detector technology, I will use my neutronics modeling experience to simulate the complicated neutron environment inside of the tokamak and assist in the design of the diagnostic. The DOE has specifically mentioned plasma-wall interactions and materials as one of its "research charges" to the US fusion community. Fuel retention is an important research topic within this area, and the ability to perform in-situ fuel retention analysis would greatly reduce the time in between measurements as well as giving shot-to-shot data. Tritium retention will be an important safety issue for ITER, and the ability to track the retention of tritium throughout ITER's run campaign would make AGNOSTIC a valuable tool for the future device.

Acknowledges concerns about funding and briefly illustrates possible solutions

Addresses question about long-term professional goals, and ties in how an education at MIT could help achieve these.

Ideally, I hope to develop the neutron spectroscopy diagnostic to study fuel retention in Alcator C-Mod. However, if Alcator does not receive funding for the coming year I hope to keep developing the neutron spectroscopy diagnostic technique using the DANTE facility at MIT and set up a collaboration with another tokamak experiment. After completing my PhD, I would like to be active in the fusion technology community, whether it is in academia or private industry. While fusion power is admittedly a long-range goal, I think that it could solve many of the world's energy problems in the future and is a worthwhile pursuit. The study of fusion energy looks to be one of the most challenging and potentially rewarding research problems of the 21st century. I believe that the department of Nuclear Science and Engineering at MIT would be the ideal environment for me to continue my studies and would provide me with the tools to be a valuable and contributing member of the fusion community.

Wrap things up and re-iterate good fit between student and school.

Thank you for taking the time to read my application, and I look forward to hearing from you.