

CURRENT POSITION Postdoctoral Research Associate
Massachusetts Institute of Technology
Plasma Science and Fusion Center
Cambridge, Massachusetts, 02139 USA

CONTACT INFORMATION *Mail:* MIT PSFC *Voice:* (518) 428-9014
175 Albany St., NW17-125 *Fax:* (617) 253-0627
Cambridge, MA 02139 *Email:* hbar@mit.edu

EDUCATION **Massachusetts Institute of Technology**, Cambridge, MA, USA
Sc.D., Nuclear Science and Engineering, February 2014
Thesis advisors, D.G. Whyte, R.C. Lanza, G. Wright
GPA: 4.5/5.0

S.M., Nuclear Science and Engineering, 2009
Thesis advisors, D. G. Whyte, B. Lipschultz

Cornell University, Ithaca, NY, USA
B.S., Applied and Engineering Physics, 2006

RESEARCH INTERESTS

- Accelerator based diagnostic techniques for materials analysis (hardware development, spectroscopy, beam optics and modeling)
- Fusion and fission reactor design (engineering and conceptual design studies)
- General design, engineering, and integration of scientific equipment

CURRENT RESEARCH PROJECTS

- Development of accelerator based diagnostic techniques for in-situ analysis of plasma facing components in magnetic fusion devices.
- Development of simulation tools for charged particle beams in complex fields (i.e. tokamak fields in toroidal geometry).
- Materials studies using ion beam analysis techniques.
- Hardware development for linear accelerators and beam optics.
- Design studies for fusion reactors/experiments
- Design study for ion beam facility for radiation-materials science.

ENGINEERING EXPERIENCE:

Prototyping: accelerator hardware, instrumentation, mechanical design, PCB design

Electrical Eng.: analog circuit design, PLC controls, DC/RF/pulsed power systems

Mechanical Eng.: structural/thermal analysis, FEA, pneumatics, vacuum systems

CAD Modeling: SolidWorks, AutoCAD, QCad, Eagle

Scientific Computing: Python, MATLAB, COMSOL

Neutron Transport Modeling: MCNP

Fabrication: machining, welding, brazing, electrical soldering, carpentry

RESEARCH EXPERIENCE

- **MIT: Plasma Science and Fusion Center**, Feb. 2014 - present
Postdoctoral Research Associate, Cambridge MA, Supervisor: Dennis Whyte
 - Continued development of accelerator-based in-situ materials diagnostics for the Alcator C-Mod tokamak.
- **MIT: Plasma Science and Fusion Center**, Sept. 2009 - Jan. 2014
Doctoral Research, Cambridge MA, Advisor: Dennis Whyte
 - Developed a novel RFQ accelerator based in-situ materials diagnostic integrated with Alcator C-Mod tokamak. This diagnostic injects a 0.9 MeV deuterium beam into the tokamak vacuum vessel, using the magnetic field coils to steer the beam for targeted ion beam analysis of plasma facing components.
 - Refurbished and upgraded a radio frequency quadrupole (RFQ) accelerator controls to enable remote operation in a radiation test-cell environment with high magnetic fields.
 - Contributed to design studies for compact, steady-state fusion devices and accelerator-based materials test facilities.
- **MIT: Plasma Science and Fusion Center**, Sept. 2006 - Aug. 2009
Masters of Science Research, Cambridge MA, Advisor: Dennis Whyte
 - Reconstructed and refurbished a 1.7MV tandem accelerator and beam lines for ion beam analysis (IBA) of materials.
 - Constructed a beamline for Rutherford backscattering spectroscopy and external proton beam induced X-Ray and gamma spectroscopy.
 - Performed a IBA study of net plasma erosion and poloidal transport of tungsten in the Alcator C-Mod divertor.

- **General Atomics: Fusion Diagnostics Division**, June 2006 - Sept. 2006
Internship, San Diego CA, Supervisor: Rejean Boivin
 - Designed and built a test setup for measuring the time response of fast thermocouples used for heat flux measurement on plasma facing components in the DIII-D tokamak.
- **Sandia National Laboratories**, June 2005 - Sept. 2005
Internship, Albuquerque NM, Advisor Dr. John Maenchen
 - Fabricated and assembled components for the upgraded Radiographic Integrated Test Stand (RITS) accelerator.
 - Designed and built a calibration system for B-dot current sensors used in RITS.
- **Cornell Laboratory for Plasma Studies**, Sept. 2004 - April 2006
Undergraduate Research, Ithaca NY, Advisor: Prof. Bruce Kusse
 - Developed an electroplating technique for fabricating modulated-diameter wires for for pulsed plasma experiments with X-ray radiography and Z-pinch applications.
- **Cornell High Energy Synchrotron Source**, Sept. 2003 - Sept 2004
Undergraduate Research, Ithaca NY, Advisor: Dr. Ernest Fontes
 - Fabricated and tested stepper motor control units for x-ray optics.
 - Created a video based x-ray beam imaging system for x-ray optics.
 - Built hardware and instrumentation for various beamline end-station applications.
- **U. Albany Institute for Materials/Albany Nanotech**, June 2003 - Sept. 2003
Undergraduate Research, SUNY Albany, Advisor: Dr James Castracane
 - Characterized and simulated micro-fabricated diffraction gratings.
- **U. Albany Institute for Materials/Albany Nanotech**, June 2001 - August 2002
Internship, Albany NY, Advisor: Dr James Castracane.
 - Designed and built a complete setup for packaging, actuating, testing micro fluidic devices.

TEACHING EXPERIENCE AT MIT

- Graduate Resident Tutor: Mentoring and advising undergraduate students. 2007 - 2013
- Assistant lab instructor: 22.071 - Electronics, Signals, and Circuits: Feb. - March 2011
- Teaching assistant: 22.63 - Eng. Principles for Fusion Reactors: Sept. - Dec. 2012

PUBLICATIONS

1. Hartwig, Z.S., **H. S. Barnard**, R. C. Lanza, B. N. Sorbom, P. W. Stahle, and D. G. Whyte, "An accelerator based diagnostic for plasma-material interactions science on magnetic fusion devices." submitted to *Review of Scientific Instruments* (2013)
2. Olynyk, G. M., Z. S. Hartwig, D. G. Whyte, **H. S. Barnard**, P. T. Bonoli, L. Bromberg, M. L. Garrett, C. B. Haakonsen, R. T. Mumgaard, and Y. A. Podpaly. "Vulcan: A steady-state tokamak for reactor-relevant plasma-material interaction science." *Fusion Engineering and Design* (2012).
3. **Barnard, H. S.**, Z. S. Hartwig, G. M. Olynyk, and J. E. Payne. "Assessing the feasibility of a high-temperature, helium-cooled vacuum vessel and first wall for the Vulcan tokamak conceptual design." *Fusion Engineering and Design* (2012).
4. Whyte, D. G., G. M. Olynyk, **H. S. Barnard**, P. T. Bonoli, L. Bromberg, M. L. Garrett, C. B. Haakonsen, Z. S. Hartwig, R. T. Mumgaard, and Y. A. Podpaly. "Reactor similarity for plasma-material interactions in scaled-down tokamaks as the basis for the Vulcan conceptual design." *Fusion Engineering and Design* (2012).
5. Lipschultz, B., J. W. Coenen, **H. S. Barnard**, N. T. Howard, M. L. Reinke, D. G. Whyte, and G. M. Wright. "Divertor tungsten tile melting and its effect on core plasma performance." *Nuclear Fusion* 52, no. 12 (2012): 123002.
6. Podpaly, Y. A., J. E. Rice, P. Beiersdorfer, M. L. Reinke, J. Clementson, and **H. S. Barnard**. "Tungsten measurement on Alcator C-Mod and EBIT for future fusion reactors" Special Issue on the 10th International Colloquium on Atomic Spectra and Oscillator Strengths for Astrophysical and Laboratory Plasmas." *Canadian Journal of Physics* 89, no. 5 (2011): 591-597.
7. **Barnard, H. S.**, B. Lipschultz, and D. G. Whyte. "A study of tungsten migration in the Alcator C-Mod divertor." *Journal of Nuclear Materials* 415, no. 1 (2011): S301-S304.
8. Wright, G. M., **H. S. Barnard**, Z. S. Hartwig, P. W. Stahle, R. M. Sullivan, K. B. Woller, and D. G. Whyte. "Plasma-Surface Interaction Research At The Cambridge Laboratory Of Accelerator Studies Of Surfaces." In *AIP Conference Proceedings*, vol. 1336, p. 626. 2011.
9. **Barnard, H. S.**, "External proton beam analysis of plasma facing materials for magnetic confinement fusion applications." S.M. Thesis, Massachusetts Institute of Technology, 2009.