Physics and Engineering at Bethel University

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Welcome to a Great Tradition

Physics and engineering at Bethel have a tradition of excellence which has led to a strong national reputation. Recently, *Physics Today* cited us as one of the few "great" physics departments for undergraduates in the U. S.[1] We have excellent and flexible educational programs, great opportunities for students to get laboratory experience, outstanding alumni, and highly qualified faculty members who are committed to their students.

In our program, physics and engineering students start out with a very similar course load and are advised by the Physics Department faculty. Students studying in either field are equally welcome in our local chapter of the Society of Physics Students and the Sigma Pi Sigma honorary society. Many students choose to double major in physics and a particular engineering field. Such cohesiveness builds a sense of unity among the students and faculty that gives us a family-like atmosphere.

This brochure is designed to provide a great deal of detail about our department and all of its activities. We invite you to flip through it and read those sections that provide the information you need.

1 Physics and Engineering Programs

1.1 Engineering: Dual-Degree

No matter what field of engineering a student chooses, more than half of the courses taken will be the same. All students take physics, math, chemistry, and computer science, in addition to the general education requirements. For this reason, at major universities these courses have enormous numbers of students in each class. It is also true that no small private school is large enough to provide the resources necessary for good majors in all the various engineering fields. In response to this situation, Bethel offers a dual-degree program (sometimes called "3–2"). Students spend three years at a small school taking all of the necessary basics and then transfer to a university to spend two years working on the specialty courses in areas such as aeronautical, chemical, civil, mechanical, or electrical engineering. After five years the student graduates with two degrees: one from the engineering school and a B.A. from the smaller school. Since the average engineering major at any school takes at least five years to graduate, the "3–2" provides twice as many degrees, and all the advantages of small class sizes, in the same amount of time.

Bethel students can complete their dual-degree at most engineering schools, but we also have official relationships with two excellent institutions: the University of Minnesota in the Twin Cities and Case Western Reserve in Cleveland, Ohio. The majority of our students choose the U. of Minnesota, and we have a close relationship with their Institute of Technology. Typically, 12 to 15 of our students are at "IT" at any given time; some choose to continue living in Bethel Residence Halls. To date, virtually all students prepared at Bethel have done well academically upon transferring to the school of their choice.

In our experience, dual-degree graduates have had great success in obtaining job offers. Employers really do appreciate students who have received the *broader education* inherent in a B.A. degree. A big part of any engineer's success lies in his or her ability to communicate results to other engineers and the public. Liberal arts classes train people to communicate well both orally and in writing—skills which often receive only minimal attention in the standard engineering curriculum. In addition, the broad course load offered at Bethel will provide more intensive work in mathematics and the sciences than the typical engineering major

[1] Hilborn and Howes, "Why Many Undergraduate Physics Programs Are Good but Few Are Great," *Physics Today*, Sept. 2003, pp. 38–44.

receives. Such training can have a very positive long term impact on an engineer's potential, both in the ability to adapt to a changing technical environment, and as a leader or manager of other engineers.

Because the curriculum for the first three years is the same, many dual-degree students at Bethel take advantage of this time to learn more about themselves and their interests before being forced to decide on a particular area of engineering. Sometimes students decide to work a little bit harder and achieve their Bethel B.A. with a *major in physics* to go with the engineering degree. This combination is particularly strong in the job market. It is even more advantageous for those anticipating future graduate work in engineering research, since research efforts often build on the broader perspective of an undergraduate science major.

1.2 Graduate Engineering

An increasingly popular option with our students is to obtain a *major in physics or applied physics* and then to pursue a graduate degree in fields such as biomedical, civil, electrical, mechanical, industrial, or aerospace engineering. Normally this means four years at Bethel followed by two years in graduate school, resulting in the nickname "4-2." At the end of six years, the student will have both a B.S. from Bethel and an M.S. from the graduate school of his or her choice. This approach is particularly appealing to the talented student who desires a career more involved with the research end of the engineering spectrum. Typically, our students get full financial support during their graduate work in the form of research or teaching assistantships, tuition wavers, or even fellowships. A few have finished their masters degree in considerably less than two years and some have gone on for Ph.D.s. One example is Dr. Keith Stein, who got his Ph.D. at the University of Minnesota in aerospace engineering and is now a faculty member in Bethel's Physics Department.

Many of our students choose to do graduate work at the nearby University of Minnesota, one of the best engineering schools in the country. The 'U' has been so pleased with our students that their Institute of Technology has prepared a brochure specifically designed to attract our students to both the "3-2" and the "4-2" programs. Of course, graduate work can, and is, done at many other fine schools. Please check the list on page 5.

1.3 Physics Major

Bethel offers both B.A. and B.S. degrees in physics. The B.S. is an intensive program designed to prepare the student for graduate school or research employment. The B.A. requires fewer courses so that the student may develop a more individualized approach to their education. This flexibility often results in a double major with mathematics, computer science, engineering (via the dual-degree program), or the humanities (e.g., music or philosophy) or the opportunity for a variety of minors.

The physics major is a good starting place for a large number of different careers in industry, or it can be an excellent springboard for graduate work. Some four-year graduates have gone directly to work for companies like 3M, Medtronic, Accenture, United Technologies Inc., Honeywell, St. Paul Companies, Logic Product Development, Amoco, Cray Research, Dynamark, and Aerospace Corp. Besides all the students who have gone on to graduate school in engineering, we have had some go on in medicine, computer science, and even forestry. Some decide to continue in physics, receiving Ph.D.s from universities such as Princeton, MIT, and Minnesota. Many have later obtained prestigious post-doctoral positions with JILA (Joint Institute for Laboratory Astrophysics), NIST, Caltech, IBM, Haverford College, and an NSF International Research Fellowship at the University of Wales. Some of our alumni have gone on to become physics professors at schools like the University of Toronto and Calvin College.

1.4 Applied Physics Major

Applied Physics is an exciting and innovative new major that was added to Bethel's curriculum early in 2002. Our goal is to produce graduates equipped for high-technology employment, interdisciplinary research, and graduate education in applied science and engineering. Physics is the foundation for virtually all technology. Our technologically-based society must have an adequate supply of workers who understand physics, and equally important, know how to use their knowledge.

The B.S. degree in applied physics is built on a solid physics core with additional emphasis in the use of computers (as modeling and laboratory tools), applied optics, engineering techniques, and fluids. This broader version of the traditional physics degree is designed to provide the tools and experiences that are

especially valuable for direct entry into industry after graduation. The fundamentals and techniques learned also provide an excellent foundation for graduate work in engineering.

The Bethel University Physics Department has a long and excellent tradition of preparing students for careers in both engineering and physics. The Applied Physics major builds directly on this success, serving as a transition from the more foundational fields of physics to the applied problems in industry. It will give physics majors the knowledge, skills, and experiences that are in great demand in high-tech industry. Graduates will not merely be technically oriented, but will have the breadth of learning and the people skills that are best developed in a liberal arts setting.

2 Departmental Research

The faculty in the physics department are involved in a significant amount of applied research, and because we have no graduate students, our undergraduates almost always play a significant role. Our work has been supported by grants and loans from NASA, 3M, Los Alamos National Laboratory, the National Science Foundation, the United States Air Force, the McKnight Foundation, the Blandin Foundation, Calspan Corp., Simulation Technologies Inc., Rice University, the American Physical Society, and the Council on Independent Colleges. Dozens of students have been positively impacted by this chance to work directly with faculty members doing publishable physics and engineering research. Since 2003, we have published or presented 60 papers with 20 student co-authors.

Our research laboratories are particularly well-equipped in the areas of modern optics and laser physics. During 2006, Bethel invested heavily in a new Advanced Optics Lab that houses custom built, frequency tunable lasers. We are also in the process of developing a fluid dynamics lab to support both the applied physics major and many aspects of the engineering research that occurs at Bethel.

Not only are there research opportunities at Bethel, but we also place students in external research environments. We probably average about ten students at a time working for 3M, Medtronic, Honeywell, Logic, or other high-tech companies in the Twin Cities. In addition, there have been six students who worked at Los Alamos National Laboratory for a summer or a semester (or both), one student who spent a summer at the National Institute of Standards and Technology (NIST), two others were among a handful of students in the U. S. chosen to receive a summer fellowship at CERN (Switzerland), and others who have spent summers at Argonne National Lab. Most were supported financially by prestigious SERS awards from the U. S. Department of Energy.

3 Teaching Assistantships

The teaching assistantship program in our department has proven to be particularly valuable for the students involved in it. After their first year, nearly all successful students are given the opportunity to work as TAs. They are paid for a few hours a week to assist with labs, run help sessions, and assist in grading. At no time do they actually run a class, but their involvement provides additional help for other students while affording an excellent opportunity for the TA to review important concepts and develop leadership skills.

All TAs get keys to one or more of our labs and are usually able to find an extra desk in a quiet corner which makes very serviceable "office space." These upper-division students find our labs an inviting place to study and collaborate with other physics and engineering students. Such activities help to develop a healthy camaraderie among our students.

4 Summer Internships

Our students are strongly encouraged to get experience during the summer months. Usually we hire a couple of students as research assistants at Bethel, but many students do internships elsewhere. Since the summer of '02, more than 80 physics and engineering majors have been employed at about three dozen research sites throughout the country. The internships were at a wide range of companies, government agencies, and universities—including such prestigious organizations as CERN (Switzerland), MIT, Medtronic, Purdue University, NIST (National Inst. of Standards and Technology), Honeywell, Argonne National Lab, Michigan State Univ., 3M, Cornell U., Delta Industrial, NASA Goddard, Excel Energy, and Columbia University. Many of these internships were national awards funded by the National Science Foundation or NASA.

Students are often promised permanent employment after the completion of their degree, but all profit immensely from the opportunity to gain valuable work experience using their Bethel education.

5 Physics and Engineering Scholarships

In addition to the financial aid and scholarship opportunities that are available through Bethel, the physics department offers scholarships to promising students regardless of financial need.

The Gruez physics endowment provides a scholarship worth at least $1400 to the best physics or engineering student in each of the Sophomore, Junior, and Senior classes. In addition, typically $7000 of scholarships are provided yearly by NASA's MN Space Grant Consortium. For the most promising incoming students intending to major in physics or engineering, the Carlsen Physics Faculty Scholarship and the Edgar G. Johnson Memorial Scholarships provide a total of $13,000 in scholarships each year.

6 Significant Equipment Acquisitions Since 2005

- New Advanced Optics Lab — 650 sq. ft. with computers, sink, and closed-loop cooler.
- Three new research quality optics tables — valued at between $10k to $15k each, these tables are air cushioned and low vibration. Two of them are 5'× 12'. The new tables bring our total to six research quality optics tables, a highly unusual number for an undergraduate physics department.
- Geola G2J pulsed holography laser — 2 J per pulse at 529 nm, valued at over $60,000.
- Two frequency tunable IR lasers — custom made and donated by NIST.
- Coherent argon-ion laser — donated by TSI, St. Paul, MN.
- Miscellaneous Support Equipment — Lock-in amplifiers, Kepco power supplies, digital oscilloscopes, temperature controllers, etc., to equip the new Advanced Optics Lab.
- External Cavity Tunable Diode System — Extremely small bandwidth laser systems (632–637 nm) ideal for telecommunications, laser spectroscopy, coherence studies, and metrology applications. Uses computer control and LabVIEW operation.
- Broadband Phase Modulator — allows stabilization and tuning during interferometric measurements.
- Spectra-Physics 35 mW Holography Laser, a Coherent Radiation 35 mW holography laser, and two stabilized, single-frequency interferometry lasers.
- Two Canon GL1 Camcorders with Professional L Series Fluorite Lens — Combined with computer editing capability, this system is used for real-time Stroboscopic Interferometric Holography.
- Mach 3 Supersonic Shock Tunnel custom built with two dynamic piezoelectric transducers for pressure and shock speed measurements and microsecond event triggering capability.
- Flow Visualization Water Tunnel — low-turbulent flow with a recirculating, high-speed pump and a dye injection system. This system is a key part of the development of the new Fluids Lab.
- Meade LX200 10-inch diameter Schmidt-Cassegrain telescope and an assortment of eyepieces.
- Tel-Atomic CWS-1250 NMR/ESR spectrometer and PASCO Educational Spectrophotometer system for Modern Physics teaching lab.

7 Alumni Success

One very important method of evaluating a program is to examine what its alumni are doing. We are justifiably proud of our physics and engineering graduates. Many have been accepted into some of the finest graduate programs in the country, and in a wide variety of fields. The accompanying table illustrates this point. *Virtually all of these students received full financial support* in the form of fellowships, teaching assistantships, or research assistantships.

BETHEL PHYSICS AND ENGINEERING GRADUATE SCHOOL PLACEMENTS

	NAME	YEAR	GRADUATE SCHOOL	FIELD
1.	Sarah Anderson [A]	08	U of Michigan	Physics
2.	Eric Bostrum	08	U of Minnesota	Medical School
3.	Matt Freeland [A]	08	U of Minnesota	Aerospace Eng.
4.	Tim Johnson	08	U of Minnesota	Electrical Eng.
5.	Randy Johnson	08	North Dakota State U	Atmospheric Science
6.	Cory Lindh [A]	08	MIT	Civil Eng.
7.	Jonathan Sass	08	Harvard	MBA/technical
8.	Chris Scheeval [A]	08	U of Minnesota	Civil Eng.
9.	Michael Slotman [A]	08	U of Minnesota	Mechanical Eng.
10.	Laura Steen	08	Purdue University	Aerospace Eng.
11.	Matt Seaberg [A]	07	U of Colorado	Physics
12.	Gus Olson	07	U of Illinois	Physics
13.	Ben Todt	07	Montana State Univ.	Physics
14.	Eric Leigh	07	Marquette Univ.	Philosophy
15.	Carl Schreck*	06	Yale	Physics
16.	Nathan Lemke* [A]	06	U of Colorado	Optical Sciences & Eng.
17.	Aaron Montello* [A]	06	Ohio State	Mechanical Eng.
18.	Nick Johnson [B]	06	U of New Mexico	Optical Sciences
19.	Jared Sturdy* [A]	06	U of California	Physics
20.	Marissa Sauter	06	St. Catherine	Library Science
21.	Erik Dahlman	05	U of Minnesota	Physics
22.	Reed Weber* [A]	05	U of New Mexico	Optics
23.	David Rowley	05	U of Minnesota	Mechanical Eng.
24.	Ken Meyer	05	Rose Hulman Inst. of Technology	Optical Eng.
25.	Tom Kuehn	05	U of Minnesota	Mechanical Eng.
26.	Robert (Putty) Putman* [A]	04	U of Illinois	Physics
27.	Tim Reynolds	04	U of Minnesota	Material Science
28.	Ben Pulford* [A]	04	U of New Mexico	Optics
29.	Ben Montello*	04	Ohio State	Mechanical Eng.
30.	Dawn Schafer*	04	Colorado School of Mines	Physics
31.	Steve Gardeen*	04	U of Minnesota	Physics
32.	Dave Parent	04	Arizona State	Physics Ed
33.	Steve Anderson*	04	U of Michigan	Nuclear Eng.
34.	Luke Granlund* [A]	03	Michigan State Univ.	Physics
35.	Matt Borg*	03	Purdue Univ.	Aerospace Eng.
36.	Nate Lindquist*	03	U of Minnesota	Electrical Eng.
37.	Randy Kleinman, Ph.D.	03	U of Illinois	Theoretical/Applied Mechanics
38.	Rob Grodahl	03	U of Minnesota	Electrical Eng.
39.	Aaron Rendahl, Ph.D. [A]	03	U of Minnesota	Statistics
40.	Katie Toop	03	Loughborough Univ. (England)	Environmental Management
41.	Dan Krzmarzick [A]	02	U of Minnesota	Civil/Structual Eng.
42.	Nathan Sunquist	02	U of Minnesota	Mechanical Eng.
43.	Noah Bock	02	Rose-Hulman Inst. of Technology	Optics
44.	Tom McElmurry, Ph.D. [A]	01	U of Illinois	Physics
45.	Kathryn Zurek, Ph.D.	01	U of Washington	Physics
46.	Sarah Boswell, Ph.D.	01	U of Wisconsin	Medical Physics
47.	Jesse Geroy	01	U of Minnesota	Mechanical Eng.
48.	Lance Lohstreter	01	U of Minnesota	Physics
49.	Seth Hulst	01	U of Minnesota	Electrical Eng.
50.	Amy Herman, Ph.D. [A]	01	U of Minnesota	Epidemiology
51.	Matt Lang, Ph.D.	00	U of Arizona	Optical Science
52.	Andrew Bunger, Ph.D. [A]	00	U of Minnesota	Geological Eng.
53.	Candice Bacon, Ph.D.	99	U of Rochester	Physics
54.	Jim Belich, Ph.D.	99	U of Minnesota	Physics
55.	Jodi Hansberger Hansen	99	U of Sioux Falls	Education
56.	Chris Tebow, Ph.D.	98	U of Arizona	Optical Science
57.	Pete Engblom	98	U of Minnesota	Mechanical Eng.
58.	Matt Richter	98	G. Washington U/NASA	Aerospace Eng.
59.	Dan Sykora, Ph.D.	98	U of Rochester	Optical Science
60.	Colin Marsh	97	U of Minnesota	Physics
61.	Adam Dickson	96	U of Minnesota	Electrical Eng.
62.	Ryan Lahm	96	U of Minnesota	Biomedical Eng.
63.	Alain Swanson	96	U of Minnesota	Computer Science
64.	Jonathan Dinsmore	96	Mankato State U	Physics
65.	Bradley Johnson, Ph.D.	96	U of Minnesota	Physics

[A] University Fellow [B] NSF Grad Fellow *Ph.D. Candidate

8 Faculty Biographies

Brian P. Beecken, Professor of Physics and Department Chair

Dr. Beecken received his M.S. and Ph.D. in physics from the University of Minnesota and then spent two years on the technical staff at Texas Instruments. His research interests center primarily on optical detectors, including work on infrared detector limitations at Arnold Engineering Development Center in Tennessee and photon counters, IR cameras, and a dual-band IR spectrometer at the Air Force Research Lab in New Mexico. At NASA's Jet Propulsion Laboratory (JPL), he created and verified statistical models for noise in focal plane arrays, and modeled the transport of charge in dielectrics on spacecraft. His analysis assisted in the development of a test facility at Eglin Air Force Base, and he has collaborated on computer models with both JPL and NASA's Langley Research Center. Dr. Beecken received the 1999 Bethel Excellence in Scholarship Award. His research has been externally supported by five NASA fellowships, two grants from the Air Force Office of Scientific Research, one grant from Calspan Corp., one NASA grant, four AFOSR fellowships, and four American Society for Engineering Education fellowships.

Thomas R. Greenlee, Professor of Physics

Dr. Greenlee received his M.S. and Ph.D. degrees in physics from the California Institute of Technology. His thesis was in experimental atomic spectroscopy applied to the determination of the solar abundance of manganese. He has had grants from 3M for laser interferometry to measure roughness of surfaces and temperatures of gases. Dr. Greenlee was awarded two fellowships in temperature measurement by infrared pyrometry at NASA–Lewis Research Center. His other professional interests are computational physics, chaos theory, and connections between science and Christianity. He is an Associate Director of NASA's Minnesota Space Grant Consortium and served three years on the Editorial Board of *Physics Resource Letters* of the *American Journal of Physics* and six years as secretary of the Minnesota Area Association of Physics Teachers. Dr. Greenlee has made three trips to Mongolia at the invitation of a Mongolian college and the supervisor of teacher training for one of the provinces of Mongolia and has given three presentations at Wuhan University in China on relativity, quantum mechanics, and possible implications for Christianity. He also speaks locally on the connections between science and Christianity.

Chad Hoyt, Assistant Professor of Physics

Dr. Hoyt started at Bethel in August, 2006. He received his doctorate with distinction in optical science from the University of New Mexico in 2003. His dissertation comprised some of the first observations of laser cooling in solids, for which he was awarded a $10,000 prize by the Optical Society of America and New Focus, Inc. He earned an award for outstanding laboratory mentorship of undergraduates in PURSUE, a NASA-funded program that encourages under-represented people in science. After completing his Ph.D., Dr. Hoyt won a post-doctoral fellowship from the National Research Council (part of the National Academies) to carry out research at the National Institute of Standards and Technology in Boulder, CO. Together with his team, he performed groundbreaking experiments on a new optical atomic clock based on laser-cooled and -trapped ytterbium atoms. Dr. Hoyt has been or currently is a referee for five different international physics journals. His research interests include atomic, molecular and optical physics. Bethel just completed construction of a new lab facility so he may continue his research with undergraduates.

Richard W. Peterson, Professor of Physics

Dr. Peterson received his Ph.D. in physics at Michigan State University and had a postdoctoral position in optical plasma diagnostics at Los Alamos National Laboratory. At Bethel, he has worked with students in developing new methods of performing fast laser and holographic measurements. He often teaches Applied Optics at 3M Center in St. Paul and has served as principal investigator in a 3M and Imation project to perfect optical quality control techniques for magnetic media surfaces—and was co-inventor for two patents. Dr. Peterson was awarded the national 1998 American Physical Society's (APS) Prize for best research at an undergraduate school in the U.S. and was elected a Fellow of the APS in 2005. During 2005–06 he served as national President of the American Association of Physics Teachers (AAPT). He served six years as Secretary of AAPT and received the AAPT Award for Distinguished Service. He enjoys the development of new apparatus for teaching physics (six prizes in national competitions), and he loves to share these

demonstrations with young and old. Dr. Peterson has received the Bethel Excellence in Teaching Award. In 2006, he was chosen as the first-ever Bethel University Professor—the highest award given to a Bethel faculty member.

Keith R. Stein, Professor of Physics

Dr. Stein is a graduate of the Bethel Physics department. After receiving his M.S. in Aerospace Engineering at the University of Minnesota, he accepted a position at the U.S. Army Soldier Systems Center in Massachusetts where his research focused on computational modeling of parachute fluid-structure interactions. As an Army researcher, he was awarded the Department of the Army Research and Development Award in 1994 and received his Ph.D. in Aerospace Engineering at the University of Minnesota in 1999. He spent the 2000-2001 academic year at Rice University as a visiting scholar and continued as an active member of the Team for Advanced Flow Simulation and Modeling (T*AFSM) until Fall 2006. Since joining the Bethel University physics department in 2001, Dr. Stein has continued to be actively involved in research in the area of computational modeling of parachutes and large displacement fluid-structure interactions. Current research activities include collaboration with the University of Minnesota department of Aerospace Engineering and Mechanics on simulations of Mars Science Laboratory (MSL) parachute system dynamics. Dr. Stein currently serves on the advisory board of the International Journal for Numerical Methods in Fluids (Wiley). Dr. Stein won the 2006 Bethel Excellence in Scholarship Award.

9 Departmental Accomplishments

Department Size and Productivity

Our graduating classes of physics majors usually rank among the largest of the undergraduate physics programs in the U.S. (according to American Institute of Physics statistics). Our productivity in research is clearly evident by the number of formal papers that have been produced. As you look through the following lists, pay particular attention to the number of students that were involved and who now have scientific papers to their credit.

Selected Papers Published Since 2005

1. K. R. Stein (prof), R. W. Peterson (prof), J. Houlton (student), J. Knapp (student), B. Peplinski (student), C. Scheevel (student), and D. Swenson (student), "Resonating with Students in the Undergraduate Physics Laboratory: Comprehending Acoustic Vibrations," Proceedings of 2008 COMSOL Conference, Boston, MA.
2. Paul D. LeVan, B. P. Beecken (prof), and Cory W. Lindh (student), "Dualband Infrared Imaging Spectrometer—Observations of the Moon," *Proceedings of SPIE* **7055A**, (2008).
3. Z. W. Barber, J. E. Stalnaker, N. D. Lemke (alum), N. Poli, C. W. Oates, T. M. Fortier, S. Diddams (alum), L. Hollberg, C. W. Hoyt (prof), A. V. Taichenachev, and V. I. Yudin, "Optical Lattice Induced Light Shifts in an Yb Atomic Clock," *Physical Review Letters* **100**, 103002 (2008).
4. R. W. Peterson (prof), "Science Under Stress in the 20th Cent. — Lessons from the Case of Early Nuclear Physics," chapter in volume edited by M. Stewart, Peking University Press, accepted for pub.
5. B. P. Beecken (prof), Paul D. LeVan, Cory W. Lindh (student), and Randall S. Johnson (student), "Progress on characterization of a dualband IR imaging spectrometer," *Proceedings of SPIE* **6940**, (2008).
6. S. Sathe, R. Benney, R. Charles, E. Doucette, J. Miletti, M. Senga, K. Stein (prof), and T.E. Tezduyar, "Fluid-structure interaction modeling of complex parachute designs with the space-time finite element techniques," *Computers and Fluids*, **36**(2007) 127-135.
7. B. P. Beecken (prof), Paul D. LeVan and Benjamin Todt (student), "Demonstration of a dual-band IR imaging spectrometer," *Proceedings of SPIE* **6660**, (2007) 666004-1.
8. R. W. Peterson (prof), Distinguished Service Citations published for A. Erzberger, R. Beichner, J. Mallinckrodt, D. Rice, P. Stokstad, D. Vernier, and C. Vernier; Melba Newell Phillips Citation to Clifford Swartz. *The Physics Teacher*, **45**, April 2007.
9. R. W. Peterson (prof), "Lighting the Fire - The Advanced Laboratory Experience," Interactions, **2**, March/April, 2007, pp. 16–20.

10. Paul D. LeVan, John P. Hartke, Eustace L. Dereniak, and Brian P. Beecken (prof), "Extending hyperspectral capabilities with dualband Infrared Focal Plane Arrays," *Proceedings of SPIE* **3479**, 64790W110 (2007).
11. T E. Tezduyar, S. Sathe, and K. Stein (prof), "Solution Techniques for the Fully-Discretized Equations in Computation of Fluid-Structure Interactions with the Space–Time Formulations," *Computer Methods in Applied Mechanics and Engineering*, **195** (2006) 5743-5753.
12. G. Olson (student), R. Peterson (prof), B. Pulford (student), M. Seaberg (student), K. Stein (prof), C. Stelter (student), and R. Weber (student), "The role of shock waves in expansion tube accelerators," cover illustration for *American Journal of Physics*, December 2006, **74** (12), p. 1071.
13. R. W. Peterson (prof), "Citations for 2006 Millikan Award and Klopsteg Memorial Awards," *American J. of Physics*, **74**, Dec. 2006, p. 1047.
14. R. W. Peterson (prof), "Reflections on a 'Different' Year," *AAPT Announcer*, **36**, Spring 2006.
15. Z. W. Barber, C. W. Hoyt (prof), C. W. Oates, L. Hollberg, A. V. Taichenachev, and V. I. Yudin, "Direct excitation of the forbidden clock transition in neutral ^{174}Yb atoms confined to an optical lattice," *Physical Review Letters*, **96** 083002 (2006).
16. A. V. Taichenachev, V. I. Yudin, C. W. Oates, C. W. Hoyt (prof), Z. W. Barber, and L. Hollberg, "Magnetic field-induced spectroscopy of forbidden optical transitions with application to lattice-based optical atomic clocks," *Physical Review Letters*, **96** 083001 (2006).
17. C. W. Hoyt (prof), Z. W. Barber, C. W. Oates, and L. Hollberg, "An optical lattice clock based on neutral Yb," *Proceedings of the XX International Conference on Atomic Physics*, Innsbruck, Austria, 2006.
18. C. W. Hoyt (prof), Z. W. Barber, C. W. Oates, A. V. Taichenachev, V. I. Yudin, and L. Hollberg, "Observation of 20 Hz-wide optical clock spectra in even isotope Yb atoms confined to an optical lattice," *Proceedings of the Conference on Lasers and Electro-Optics* (CLEO, Long Beach, CA, 2006).
19. C. W. Hoyt (prof), Z. W. Barber, C. W. Oates, A. V. Taichenachev, V. I. Yudin, and L. Hollberg, "Spectroscopy of neutral ytterbium in a one-dimensional optical lattice," *Proceedings of the 20th European Frequency and Time Forum* (PTB, Braunschweig, Germany, 2006).
20. R. W. Peterson (prof), "On Wanting to be a Hilton: Advanced Labs and AAPT," *Announcer*, **35**, Fall 2005.
21. K. R. Stein (prof), T.E. Tezduyar, S. Sathe and M. Senga, "Simulation of Parachute Descent and Maneuvers," Proceedings of the 5th International Conference on Computation of Shell and Spatial Structures, Salzburg, Austria, (2005).
22. C. W. Hoyt (prof), Z. W. Barber, C. W. Oates, T. M. Fortier, S. A. Diddams (alum), and L. Hollberg, "Observation and absolute frequency measurements of the $^1S_0 - ^3P_0$ optical clock transition in neutral ytterbium," *Physical Review Letters* **95**, 083003 (2005).
23. R. W. Peterson (prof), "Still a 'Band of Myopic Brothers?'," *AAPT Announcer*, **35**, Summer 2005.
24. L. Hollberg, C. W. Oates, G. Wilpers, C. W. Hoyt (prof), Z. W. Barber, S. A. Diddams (alum), W. H. Oskay, and J. C. Bergquist, "Optical frequency/wavelength references," *J. of Physics B: Atomic, Molecular, and Optical Physics* **38** S469 (2005).
25. K. R. Stein (prof), T.E. Tezduyar, S. Sathe and M. Senga, "Challenges and solutions in parachute modeling," Proceedings of the 5th International Conference on Computation of Shell and Spatial Structures, Salzburg, Austria, (2005).
26. R. W. Peterson (prof), "A Cloud of Witnesses," *AAPT Announcer*, **35**, Spring 2005.
27. R. Charles, M. Accorsi, S. Morton, R. Tomaro, K. Stein (prof), S. Sathe, and T. Tezduyar, "Overview of the Airdrop Systems Modeling Project within the Collaborative Simulation and Test (CST) Common High Performance Computing Software Support Initiative (CHSSI) Portfolio," Proceedings of the 18th AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar, Munich, Germany (2005).
28. R. W. Peterson (prof), "Exaggerated Rumors of Death," *AAPT Announcer*, **35**, Winter 2005.
29. T.E. Tezduyar, S. Sathe, M. Senga and K. Stein, "Space-Time Techniques for Finite Element Computation of Fluid-Structure Interactions with Membranes," Proceedings of the 5th International Conference on Computation of Shell and Spatial Structures, Salzburg, Austria, (2005).
30. R. W. Peterson (prof), "Primal Inquiry: Making Stuff Work," Guest Editorial, *The Physics Teacher*, vol. 43, February, 2005.
31. A. Sameh, S. Sathe, K. Stein (prof) and T.E. Tezduyar, "Preconditioning Linear Systems of the Navier-Stokes Equations," Proceedings of the 5th International Conference on Computation of Shell and Spatial Structures, Salzburg, Austria, (2005).

32. T.E. Tezduyar, S. Sathe, R. Keedy and K. Stein (prof), "Space-Time Finite Element Techniques for Computation of Fluid-Structure Interactions," Extended Abstracts of 11th International Conference on Fracture, Turin, Italy, (2005).
33. R. W. Peterson (prof), B. N. Pulford (student), and K. R. Stein (prof), "The Ping-Pong Cannon: A Closer Look," cover illustration for *The Physics Teacher*, Vol 43, January 2005, pp. 22–25.
34. K. R. Stein (prof), T. Tezduyar, S. Sathe, R. Benney, and R. Charles, "Fluid-Structure Interaction Modeling of Parachute Soft-Landing Dynamics," *International Journal for Numerical Methods in Fluids*, **47** (2005) 619–631.

Selected Papers Presented Since 2007

1. K. R. Stein (prof), R. W. Peterson (prof), J. Houlton (student), J. Knapp (student), B. Peplinski (student), C. Scheevel (student), and D. Swenson (student), "Resonating with Students in the Undergraduate Physics Laboratory: Comprehending Acoustic Vibrations," 2008 COMSOL Conference, Boston, MA.
2. Paul D. LeVan, B. P. Beecken (prof), and Cory Lindh (student), "Dualband Infrared Imaging Spectrometer—Observations of the Moon," Infrared Detectors and Focal Plane Arrays X, SPIE Optics+Photonics, San Diego, CA, August 10, 2008.
3. R. W. Peterson (prof), "The Case for Interactive Demonstrations in the Physics Classroom, Seoul National University, Seoul, Korea, June 27, 2008.
4. R. W. Peterson (prof), "Advanced Labs Today: How They're Changing... and Getting Better," Invited talk, AAPT/APS Conference for US physics chairs, American Center of Physics, College Park, MD, June 8, 2008.
5. C. W. Lindh (student), "Demonstration of Remote Temperature Determination with a Novel Dualband IR Imaging Spectrometer," Minnesota Science Academy, Bethel University, April 2008. (Best session paper award)
6. S. Anderson (student) and C. W. Hoyt (prof), "A low-cost wavelength meter with picometer-level accuracy," Minnesota Area section of the American Association of Physics Teachers, Macalester College, St. Paul, MN, April 2008. (Best student paper award)
7. L. Steen (student) and K. Stein (prof), "Finite Element Studies of a Supersonic Disk-Gap-Band Parachute," Minnesota section of American Association of Physics Teachers, Macalester College, St. Paul, MN, April 2008.
8. R. W. Peterson (prof), "Favorite Lecture Demonstrations with Optics and Acoustics," International Conference on Developments in Optics and Communication, University of Latvia, Riga, April 25, 2008.
9. B. P. Beecken (prof), Paul D. LeVan, Cory W. Lindh (student), and Randall S. Johnson (student), "Progress on characterization of a dualband IR imaging spectrometer" Infrared Technology and Applications XXXIV, SPIE Defense+Security, Orlando, FL, March 18, 2008.
10. P. Weavers (student) and C. W. Hoyt (prof), "Towards stabilization of a 637 nm laser diode to molecular iodine," 5th Annual Minnesota Private Scholars at the Capitol, St. Paul, Minnesota (2008).
11. R. W. Peterson (prof), "On the Joys, Sustenance, and Human Enticement of Science," Cultural Life Lecture Series, Roberts Wesleyan College, Rochester, NY, January 31, 2008.
12. R. W. Peterson (prof), "Advanced Lab Experiences that Impact Lives Faculty and Student Perspectives" George Arfken Scholar Lecturer, APS/AAPT meeting, Miami University, Oxford, OH, October 19, 2007.
13. R. W. Peterson (prof), "Demonstration and optical diagnostics of the mysterious ping-pong cannon," invited paper, MN Optical Society of America Meeting, University of St. Thomas, St. Paul, MN, September 20, 2007.
14. B. P. Beecken (prof), Paul D. LeVan, and Benjamin Todt (student), "Demonstration of a dual-band IR imaging spectrometer," Infrared Detectors and Focal Plane Arrays IX, SPIE Optics+Photonics, San Diego, CA, Aug. 27, 2007.
15. Z. W. Barber, C. W. Hoyt (prof), J. E. Stalnaker, N. Lemke (alum), C. W. Oates, T. M. Fortier, S. Diddams (alum), and L. Hollberg, "Lattice-based optical clock using an even isotope of Yb," (Invited Paper) Time and Frequency Metrology, SPIE Optics+Photonics, San Diego, CA, August 2007.
16. R. W. Peterson (prof), "Lighting Fires in Advanced labs," invited paper, AAPT National Meeting, Greensboro, NC, Aug 1, 2007.
17. K. Stein (prof), "Computational Methods in Applied Physics at Bethel University," poster paper at the American Association of Physics Teachers Conference on Computational Physics for Upper Level Courses, Davidson College, NC July 27-28, 2007.
18. R. W. Peterson (prof), "Measurements and simulations of the ping-pong cannon," 30-min invited paper, NCS-AAPT, NC, March 3, 2007.
19. R. W. Peterson (prof), "Sins of Attitude and Omission in Teaching Physics," Invited banquet presentation, NCS-AAPT, Greensboro, NC, March 2, 2007.
20. B. D. Todt (student) and B. P. Beecken(prof), "Solar IR Spectrographic Images," 4th Annual Minnesota Private Scholars at the Capitol, St. Paul, Minnesota (2007).

National Awards and Recognition

- Selected as one of 21 "thriving" physics departments (of 780) by Nat'l Task Force on Undergrad Physics
- Heuer Award for Outstanding Achievement in Science Education, Council of Independent Colleges
- Chosen Fellow of the American Physical Society, Prof. Peterson
- Continuing Member of NASA's Space Grant College Consortium - Prof. Greenlee, Assoc. Director

Since 2005

- Nationally elected to the Executive Board of Advanced Laboratories in Physics Assoc. - Prof. Peterson
- National Science Foundation 2008 Summer Internship, U of Colorado - David Carlson, '09
- Mayo Clinic, Dept. of Physiology & Biomedical Engineering, Internship - Paul Weavers, '09
- National Science Foundation 2008 Summer Internship, Montana State U - Andrew Rice, '09
- Internship at NIST (National Institute of Standards & Technology) - Tommy Hofer, '09
- Break Through Collaborative Teaching Internship - Andrew Dirks, '08
- Fellowship from the American Society for Engineering Education for 2008 - Prof. Beecken
- 2007 Nobel Travel Award, Swedish Council of America - Matt Seaberg, '07
- 2007 AFCEA General John Wickham Scholarship - Justin Knapp, '09
- Society of Physics Students, 2007 Top National Leadership Award - Sarah Anderson, '08
- National Science Foundation 2007 Summer Internship, MIT - Cory Lindh, '08
- National Science Foundation 2007 Summer Internship, U of Colorado - Sarah Anderson, '08
- National Science Foundation 2007 Summer Internship, Cornell U. - Nathan Friez, '08
- National Science Foundation 2007 Summer Internship, U of Michagin - Randy Johnson, '08
- National Science Foundation 2007 Summer Internship, Cornell U. - Tim Johnson, '08
- National Science Foundation 2007 Summer Internship, Michigan State U - Michael Slotman, '08
- National Science Foundation 2007 Summer Internship, Prudue U. - Laura Steen, '08
- Fellowship from the American Society for Engineering Education for 2007 - Prof. Beecken
- Cover illustration, *American Journal of Physics* (world's most widely distributed physics j.), Dec '06
- President of the American Association of Physics Teachers, 05–06, Prof. Richard Peterson
- 2006–07 NASA Space Scholar Award - Laura Steen, '08
- 2006 NASA Summer Undergraduate Research Fellowship, Caltech - Matt Seaberg, '07
- 2006 Internship at the University of Amsterdam - Carl Schreck, '06
- 2006 Space Scholar, Air Force Research Lab, New Mexico - Jared Sturdy, '06
- National Science Foundation 2006 Summer Internship, Texas A & M - Gus Olson, '07
- U.S. Air Force Office of Scientific Research Faculty Fellowship for 2006 - Prof. Beecken
- 2005 Internship at CERN, Geneva, Switzerland - Jared Sturdy, '06
- 2005 National Institute of Standards and Technology (NIST) Fellowship - Nathan Lemke, '06
- National Science Foundation 2005 Summer Internship, Texas A & M - Carl Schreck, '06
- Co-author on a 2005 Patent Application by 3M - Aaron Montello, '06
- Society of Physics Students, 2005 National Leadership Scholarship - Michelle Haglund, '06