



Penn State Physics Undergraduate Program Better* Practices

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- Data
- Practices and results (mostly about majors, not intro courses)
- More information available online**

* ...than they used to be, anyway!

** <http://www.phys.psu.edu/~rick/SPINUP.html>



Penn State – some data points

- Supposedly the most applications of any US University
- University Park (main research campus)
 - 44,000 students (about 39,000 ugrads)
- Other smaller Penn State campuses (19 of them)
 - 33,500 students (almost all ugrads)
 - 1-3 faculty per science discipline at each campus
- “*One University, geographically dispersed*” is the mantra
- Students who do not start at UP typically take intro and GenEd courses for two years, then move to UP to complete their major – Astronomy/Astrophysics is an exception
- Has impact on format of many majors.
- Random fact: This coming Fall, 40% of incoming students at UP are out-of-state

Physics Department

more data points

- 42 faculty
 - Including two Deans
- 4 instructional staff
 - Teaching PHYS algebra-trig based intro courses and 'Conceptual Physics' class
 - Administering calculus-based intro courses
- ~ 55 postdocs
- ~ 120 graduate students at any one time
 - About 55 TA's and 65 RA's at any one time.
- 35-45 undergraduate majors per year
 - Including ~5-6 double majors
- 10-15 minors per year
 - From EE, Astro (a separate department!), Math, and 'rest of the universe'
- Moderate size undergraduate major in College of Science
 - On a log scale
- Moderate size student credit hour load
 - cf. Math and Chemistry

How many majors in each department?

At Spring 2009 (2010) graduation

- Forensic Science – 8 (16)
- Statistics – 9 (5)
- Astro – 10 (11)
- Chemistry – 29 (25)
- BMB – 32 (41)
- **Physics – 34 (28)**
- Pre-med – 36 (27)
- Math – 63 (65)
- Science (General Science major) – 84 (103)
- Biology – 133 (193)

A number of students take an extra summer or Fall to graduate



Physics Department – more data

- PSU Physics has jumped from 55th to 23rd best Physics program overall in the US
 - In span of 15 years
- Three subprograms in the top 13 in the country
 - Condensed matter, gravity/relativity and AMO
 - Two of the three subprograms did not exist at PSU 15 years ago
- Lesson? Programs can improve in dramatic and substantial ways with faculty (and University) support and commitment to excellence.

Intro courses - organization

- About 3300 students per semester
- **Five** large intro courses (plus conceptual PHYS)
 - **Three** semester calculus-based sequence
 - **Two** semester algebra-trig based sequence
 - Lectures (faculty), recitations and labs (TAs)
 - Reorganized twice in last decade (more collaborative learning components in smaller settings)
 - No SCALEUP
- Resource issues?
 - Largest class is PHYS 211 (mechanics) in Spring
 - 1200+ students, four large lectures (faculty) and 52 recitations/26 labs running from 8AM – 10PM (TA's), M-R



Intro courses - continued

- Faculty only do lecturing, office hours, and picking homework and test problems.
 - Instructors do all the behind-the-scenes administration.
- WebAssign used for homework
 - About 5-7 MG/S (mega grades per semester)
- Intro Course Staff (ICS) has active Physics Education Research (PER) journal club
 - Education proposals to NSF and elsewhere
 - Source of educational innovations in intro courses
 - Most important for institutional memory and continuity!

Major program

- Currently five options in the Physics major
 - General (most grad school bound students) 😊
 - Electronics (really an EE minor) 😊
 - Medical (medical physics or med school) 😊
 - Acoustics (to be discontinued – classes have died) 😞
 - Teaching (to be discontinued -- complicated) 😞!! 😞!!
 - Three more new options planned 😊
- Most students (80%) in the General Option
- About 1/3 of Physics undergraduates come from another PSU campus or another institution

Undergraduate advising

- Cradle-to-grave method, with single point of contact for all undergrad advising (since about 2001)

- *Motivated by 'Best Practice' Studies from AIP*
- *Visit to Rutgers for SPIN-UP was cause!*



Thanks Mohan
and SPIN-UP!

- Single contact responsible for
 - All student recruiting presentations (Open Houses, etc.)
 - Summer advising of entering students (so-called FTCAP)
 - First Year Seminar and Junior Careers course teaching
 - All academic and honors advising (about 140 advisees)
 - Career advising
 - SPS and COOP and Study Abroad advisor
 -
- **Not** a model used by any other PSU Science departments!

Assessment data on advising

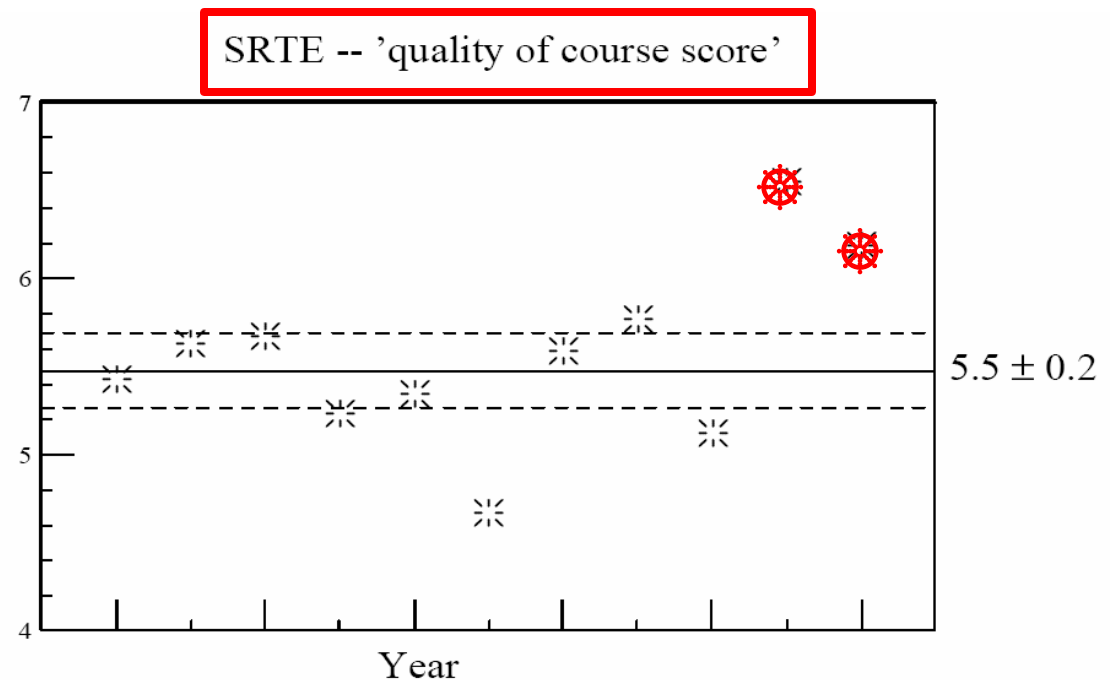
	N/A	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive
Academic advising	0	0	0	0	3%	97% (100%)
Career advising	15% (21%)	0	3%	12%	33% (29%)	36% (50%)

- Data taken from three years worth of ‘senior surveys’ (2008/2009 and 2010)
- Data had quick impact of format of PHYS 444 (‘junior careers’ course)
- PHYS 444
 - Two credit course – Spring of the junior year – all majors!
 - ‘Show and Tell’ format with visiting speakers (not just Physics profs)
 - Lots of homework (but not the math intensive kind)



PHYS 444 – ‘junior careers’ course

- Historically a fairly successful course already
- Spring 2009/2010 included far more ‘*careers*’ information
- Deemed even more useful in new format
- Example of assessment driven improvement



PHYS 444 – ‘Careers course’

- Speakers and homework designed to show the diversity of possible outcomes with a Physics degree

Week	Date	Assignment
1	W Jan 13	No Homework Due
2	W Jan 20	HW1 -- Initial student survey
3	W Jan 27	HW2 – High school physics content test (LST*)
4	W Feb 03	HW3 – Dimensional analysis problems (LST*)
5	W Feb 10	HW4 – Nobel prizes and everyday life – The role of Physics in society
6	W Feb 17	HW5 – Faculty publication search
7	W Feb 24	HW6 – US Patent office search
8	W Mar 03	HW7 – General GRE exam (LST*)
-----	W Mar 10	SPRING BREAK – No Homework Due – Have Fun!
9	W Mar 17	HW8 – Lecture Review (science writing format)
10	W Mar 24	HW9 – Twitter versions of fundamental physics laws
11	W Mar 31	HW10 – Fantasy resume
12	W Apr 07	HW11 – On-line grad school and career resource web page
13	W Apr 14	HW12 – Undergraduate Physics major content test (LST*)
14	W Apr 21	HW13 – Lecture review (reaction paper format)
15	W Apr 28	HW14 – Final student survey
-----	W May 05	FINAL EXAMS – No Homework Due

Some homeworks are ‘secret’
assessment exercises:
General GRE, Praxis and
Major Field Tests

Speaker schedule for PHYS 444 – Spring 2010

Date	Speaker	Title
M Jan 11	Prof. R. Robinett (PSU, PHYS)	Introduction to the course
W Jan 13	Prof. R. Robinett (PSU, PHYS)	Careers I
M Jan 18	NO CLASS	Martin Luther King Holiday
W Jan 20	Prof. Ying Liu (PSU, PHYS)	Superconductivity and graphene
M Jan 25	Prof. R. Robinett (PSU, PHYS)	Careers II
W Jan 27	Prof. R. Robinett (PSU, PHYS)	Dimensional analysis in Physics
M Feb 01	Prof. David Weiss (PSU, PHYS)	Experiments with optical lattices and cold atoms
W Feb 03	Dr. Nikolas Podraza (PSU, EE)	Optical characterization of materials using ellipsometry
M Feb 08	Prof. R. Robinett (PSU, PHYS)	Careers III
W Feb 10	Prof. Jorge Sofo (PSU, PHYS)	Computational materials science
M Feb 15	Prof. Nitin Samarth (PSU, PHYS)	Spintronics
W Feb 17	Dr. Suzanne Lemieux (PSU, SSRI)	MRI Physics as a career
M Feb 22	Prof. Reka Albert (PSU, PHYS)	Physics of Networks
W Feb 24	Prof. R. Robinett (PSU, PHYS)	Introduction to Mathematica: Symbolic programming
M Mar 01	PHYS 444 students (Various artists)	Stories about undergrad research and other activities
W Mar 03	Prof. Sam Finn (PSU, PHYS)	Gravitational wave physics at LIGO and LISA
M Mar 08	NO CLASS	SPRING BREAK
W Mar 10	NO CLASS	SPRING BREAK
M Mar 15	Prof. Doug Cowen (PSU, PHYS)	Particle astrophysics with the Icecube detector
W Mar 17	Prof. Stephane Coutu (PSU, PHYS)	Ballooning in Antarctica
M Mar 22	Prof. Alexey Kozhevnikov (PSU, PHYS)	Computational neuroscience
W Mar 24	Prof. R. A. Kimel (PSU, Materials Science)	Graduate study in materials science
M Mar 29	PSU Physics graduate students	Life as a grad student in Physics
W Mar 31	Prof. Anna Stasto (PSU, PHYS)	Physics at the LHC
M Apr 05	Prof. Martin Bojowald (PSU, PHYS)	Quantum cosmology
W Apr 07	Dr. Benjamin Campbell (EOC) (BS in Physics from PSU, 2002)	Laser physics at the Electro-Optics Center (EOC)
M Apr 12	Prof. G. Kelly and Prof. S. McDonald (PSU, College of Ed)	High school physics teacher preparation strategies
W Apr 14	Dr. Kate Spillane (UPenn)	Medical Physics and the UPenn Medical Masters program
M Apr 19	Prof. Margaret Slattery (PSU, BIOE)	Bioengineering programs (ugrad and grad)
W Apr 21	Dr. Andrew Bazarko (Schlumberger Corp)	Using Physics at an oil company
M Apr 26	HELD IN S5 OSMOND LAB PSU Physics majors – graduating seniors HELD IN S5 OSMOND LAB	HELD IN S5 OSMOND LAB What I’ve learned from my time at PSU in Physics HELD IN S5 OSMOND LAB
W Apr 28	Prof. R. Robinett (PSU, PHYS)	Course wrap-up



Student self-assessment of skills

How do you rate yourself In the following areas	No competency	Not confident	Somewhat confident	Fairly confident	Very confident
Problem solving skills	0%	0%	6%	29% (29%)	65% (71%)
Basic Physics knowledge	0%	0%	6%	50% (64%)	44% (36%)
Basic math knowledge	0%	0%	3% (7%)	35% (43%)	62% (50%)
Programming and general Computer skills	0% (7%)	23% (14%)	21% (43%)	38% (21%)	18% (14%)
Experimental skills	0%	9% (14%)	35% (50%)	38% (29%)	18% (7%)
Oral presentation skills	0%	0% (14%)	20% (29%)	65% (36%)	15% (21%)
Writing skills (scientific, technical, otherwise)	0%	0%	15% (29%)	59% (29%)	26% (42%)
Scientific presentation skills (i.e. PowerPoint, etc.)	0%	0%	9% (36%)	65% (50%)	26% (14%)

- Three years worth of senior survey data (2008/2009 and 2010)
- Has led to proposals for programming across all options
- And possible computational physics option



Research areas represented by PSU Physics faculty

- Atomic and (laser-based) optical physics.
- Condensed matter, low-temperature, surface physics, and novel superconductors.
- Mesoscopic physics, magnetic materials, and nanomaterials
- Condensed matter theory and computer simulations of materials.
- Elementary particle experiment (at national labs)
- Theoretical particle physics, including string theory and mathematical physics
- Experimental particle astrophysics
- Gravity (theoretical and computational, quantum gravity)
- Acoustics
- Biophysics, networks, neuroscience

Underlining means that undergraduates have participated in research with faculty in these areas.

Student successes related to early ugrad research opportunities

- Schreyer Honors College awards
 - At Spring medals ceremony, 3 major awards per year
 - 1997-2009
 - 8 Physics, 3 A&A (Physics) awards (two of them in 2004!)
- Goldwater Scholarships
 - 2000-2009
 - 6 Physics, 3 A&A (Physics) awards (two of them in 2005/2007)
- Other national awards (last 5 years)
 - NSF (3), NDSEG (2), NPSC (1), Marshall (1), Cambridge-NIH (2), etc. (just 'Physics first' majors)
 - Three AAPM Summer Fellows (2007-2009) (medical physics)
- Early research experience(s) help students be highly competitive
 - 10-12 Summer research slots saved for PSU Physics majors



Undergraduate program committee

- Inert for years -- ‘Re-activated’ to respond to need for assessment
- Met regularly (bi-weekly) this year – will continue next year
- **Several proposals ready and more upcoming**
 - Benchmarking against 25 other US Physics department
 - Input from assessment, student feedback, etc.
 - ☐ Kill some old options within major (Acoustics, Teaching)
 - ☐ Add new ones
 - ☐ Computational physics
 - ☐ Nanotechnology
 - ☐ Material science
 - ☐ Add more credits to an important core class (PHYS 400, junior E&M)
 - ☐ Revamp Physics minor (make it more flexible/useful/responsive)
- Next year the committee will focus on assessment of **intro** courses
 - Explicit learning objectives
 - Metrics of assessing learning

How do PSU Physics undergraduates (and others) use their degrees?

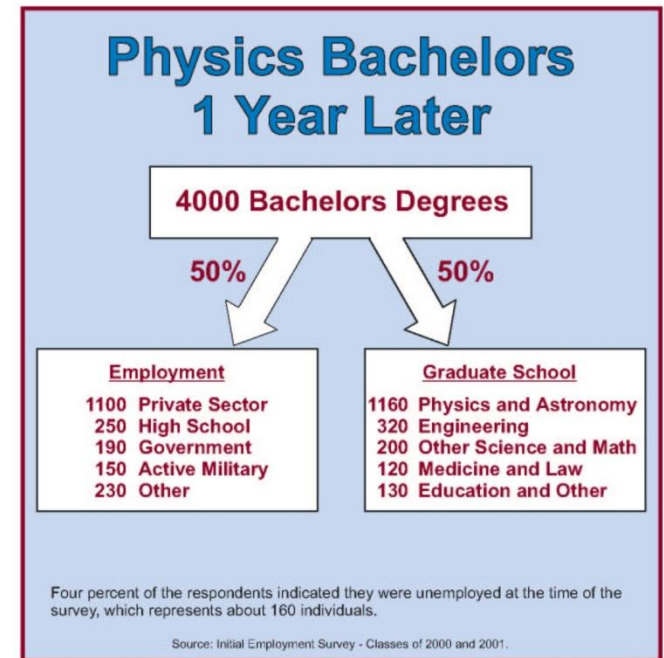
- Fraction going to graduate and professional school typically higher than national norms. Recent seniors have gone to grad programs at:
 - Harvard, Princeton, Stanford, Chicago, Cornell, Cambridge, MIT, Berkeley, ...
- Industrial employers:
 - IBM, RF Microdevices, Sprint, Bettis, EPIC Systems...(recent INTEL Innovation award winner).
- Government (or related) agencies:
 - JHU/APL, NRL (Naval Research Lab), ARL, EOC, Applied Hydroacoustics, SAIC, NSA, Naval Surface Warfare Center, US Patent Office, NAVSEA, CIA...
- Teaching (public and private high school)

This type of information is shared with students at regular intervals!

PHYSICS TRENDS

Contact: Patrick J. Mulvey
pmulvey@aip.org

Winter 2004



AMERICAN
INSTITUTE
OF PHYSICS

Statistical Research Center
www.aip.org/statistics

The rule of 4th's
 $\frac{1}{4} : \frac{1}{4} : \frac{1}{4} : \frac{1}{4}$

Career information 'outcomes' web pages

Profiles of former Penn State University Physics majors

The former PSU Physics majors linked below have provided feedback on a variety of topics related to their current careers, how their Physics degree helps them, and advice for prospective and current Physics majors. (These former student all responded to a survey asking [these questions](#).) The name (graduation year) and brief description of their current job title is given below. (Note: Information collected during the Fall 2009 semester.)

1. [David Atlee \(2005\)](#) -- Graduate student in Astronomy at Ohio State
2. [Brian Bahn \(2004\)](#) -- High school Physics teacher
3. [Rachel Barry \(2004\)](#) -- High school Physics and General Science teacher
4. [Chris Bernotavicius \(2007\)](#) -- Naval officer (and M. S. in Mathematics)
5. [Nick Bevins \(2007\)](#) -- Graduate student in medical physics at UW Madison
6. [Mark Bolden \(2006\)](#) -- Air Force (civilian) scientist -- Associate Physics at Air Force Maui Optical Services
7. [Michael Bowne \(2007\)](#) -- Physicist at FRABA (sensor technology company)
8. [Chris Burgy \(2007\)](#) -- Navy (civilian) scientist
9. [Marshall Calhoun \(2008\)](#) -- Scientist at Advanced Research Systems (cryogenics)
10. [Benjamin Campbell \(2002\)](#) -- Laser Physicist at the Electro-Optics Center
11. [James Dalessio \(2006\)](#) -- Graduate student (in Astrophysics) at U Delaware
12. [Rachel Dicht \(2004\)](#) -- Physicist at Naval Research Lab



Marshall Calhoun (2008) -- Scientist at Advanced Research Systems (cryogenics)

I started out as a freshman with the intent to graduate with a bachelors in physics, and that was what I went through and did. A large portion of the students that started out in this degree with me, stayed with it the whole time.

Unfortunately, I never really did any of the undergraduate research while I was at Penn State. I was a TA for Phys 214 for two semesters where I worked in the lab portion with one of the graduate students. It was really nice to go through that information again as I picked up little key details and I had a better appreciation of what was being shown than the first time that I went through it. I also worked for the ITS in the computer labs. It was an easy job where they essentially pay you to work on your homework.

After Penn State I joined the work force. I was lucky enough to have a job lined up before I graduated. My boss actually contacted me along with other physics majors that I was graduating with. I responded back to his call and I told him that I was going to come see him as spring break was coming up. He agreed and I was offered the job the week after spring break. I am still currently working for Advanced Research Systems, where we design and manufacture Laboratory Cryogenic Equipment. We deal primarily with universities and national labs where people are researching properties of different materials. The customers that I deal with typically have a background in Physics, Chemistry, Electrical Engineering, or Material Science. It is nice to have an idea of what they are doing and how their research can benefit.

Having the background in physics allows me to understand what they are trying to accomplish and how we can try to help them out. It helps to be able to "speak the lingo" a bit.

I would get involved in undergraduate research. It would allow you to see a lot equipment in use and give you a better feel for the type of research that is being conducted and how it can benefit society.

About 65 of them in total

Other trivia

- About 85-90% of majors do have some kind of experiential 'out of class' learning before graduation
 - Ugrad research, REUs (PSU or elsewhere, sometimes overseas!)
 - COOP, Study Abroad, internships, TAing, jobs on campus/elsewhere
 - PSU Science COOP Student of the Year 3 times since 2000
 - One National COOP Student winner (2004)
- **Very** active SPS (Society of Physics Students) chapter
 - Several national financial awards – tons of outreach
 - Recognition of last years President with national research award
 - Third oldest $\Sigma\Pi\Sigma$ chapter in country (honor society for Physics)
- Undergraduate lounge space set aside for their use (historical)
 - Deemed a definite 'Best Practice' by AIP
 - Computers, comfy chairs, fridges, etc.
 - Shared with grad students – only occasional friction



Want more details?

Penn State Physics Department Undergraduate Information

R. Robinett (Associate Department Head)

For June 4-6 SPIN-UP meeting

Email me (rick@phys.psu.edu or rq9@psu.edu) with questions.

- Physics Department web pages
 - [PSU Physics undergraduate web page](#)
 - [PSU Society of Physics Students \(SPS\) Chapter](#)
 - [Profiles of recent PSU Physics undergraduates and their early careers.](#)
 - [Descriptions of some of the Summer 2009 research and internship opportunities pursued by PSU Physics majors](#)
 - [Same as above, but for Summer 2008 students](#)
- Physics First Year Seminar (FYS) information
 - Penn State has FYS requirement of all majors
 - Many College of Science departments (including Physics) offer a one-credit seminar, restricted to prospective majors, in the Fall of the first year. More info below.
 - [First Year Seminar \(FYS\) syllabus](#)
 - [FYS speaker list](#)
 - [FYS final assessment](#)
- PHYS 444 (junior careers course) information
 - Offered in Spring of junior year, 2 credits -- See organization and speaker list below.
 - [PHYS 444 syllabus](#)
 - [PHYS 444 speaker schedule](#)
 - [Career talks in PHYS 444](#)
- Random handouts and presentations
 - [Physics Undergraduate Handbook](#)
 - Available on-line at Physics Department web site.
 - [Spring 2010 version of Senior survey](#)
 - Valuable source of information over the last three years. Used as part of ongoing assessment program.
 - [Overall assessment plans for Physics department](#)
 - Mandated by PSU as part of ongoing Middle States accreditation process.
 - [Course assessment plans](#)
 - [Slides from typical Open House type presentation for prospective Physics majors and their families](#)
 - [Suggested semester by semester schedules for ALL Penn State majors](#)

www.phys.psu.edu/~rick/SPINUP.html