FORMALITIES

Eric Prebys, FNAL

Goals of this course

- I hope this course will provide you with…
  - a rigorous foundation of the underlying physics of particle accelerators,
    - Fairly sophisticated understanding of their operations.
    - The background to pursue more advanced studies on your own (or in further classes).
  - a quantitative overview of the state of the art, as well as current and future challenges.
  - familiarity with enabling and related technologies:
    - Magnets
    - RF
    - Instrumentation
    - etc.

Course Personnel

- Instructor: Eric Prebys, FNAL
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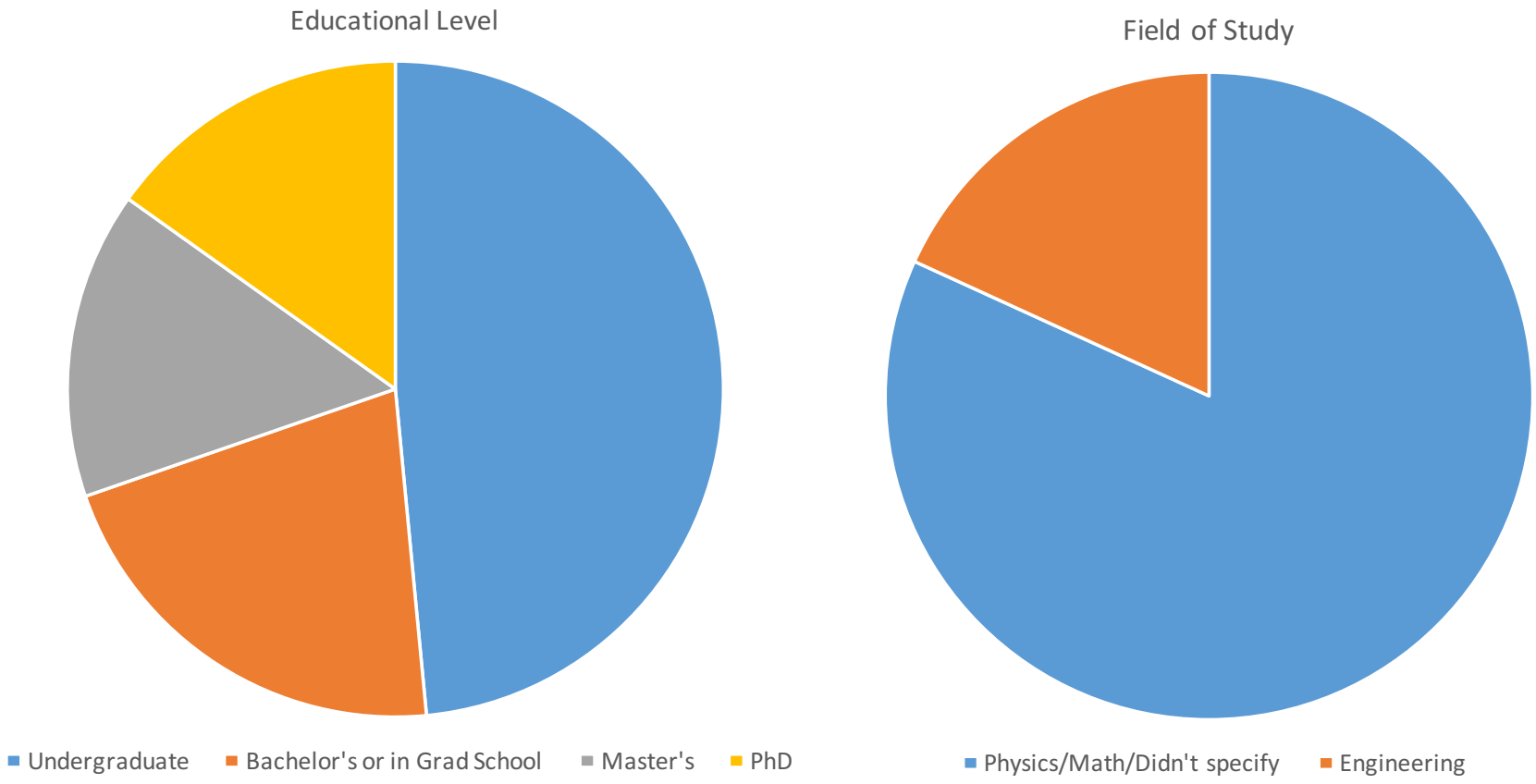
  - 630-336-1893
- Lab Instructor: Elvin Harms, FNAL
  - harms@fnal.gov
- TA: Brian Beaudoin, University of Maryland
  - beaudoin@umd.edu
- Grader: Bryant Garcia, Stanford
  - bryantg@stanford.edu

Some warnings right up front

- This course is intended to cover in two very intense weeks the material that would be in a *full semester* university course
  - That's the mandate; there's nothing I can do about it
- Students have a pretty broad range of backgrounds, so some will struggle more than others.
- If you get behind, you will never catch up!
  - Ask questions
  - Attend help sessions
  - Work together
- This is my first time teaching the Fundamentals course*, and if I go off track, we all will never catch up
  - I appreciate feedback and constructive criticism

*taught the graduate course a few times

Class Demographics

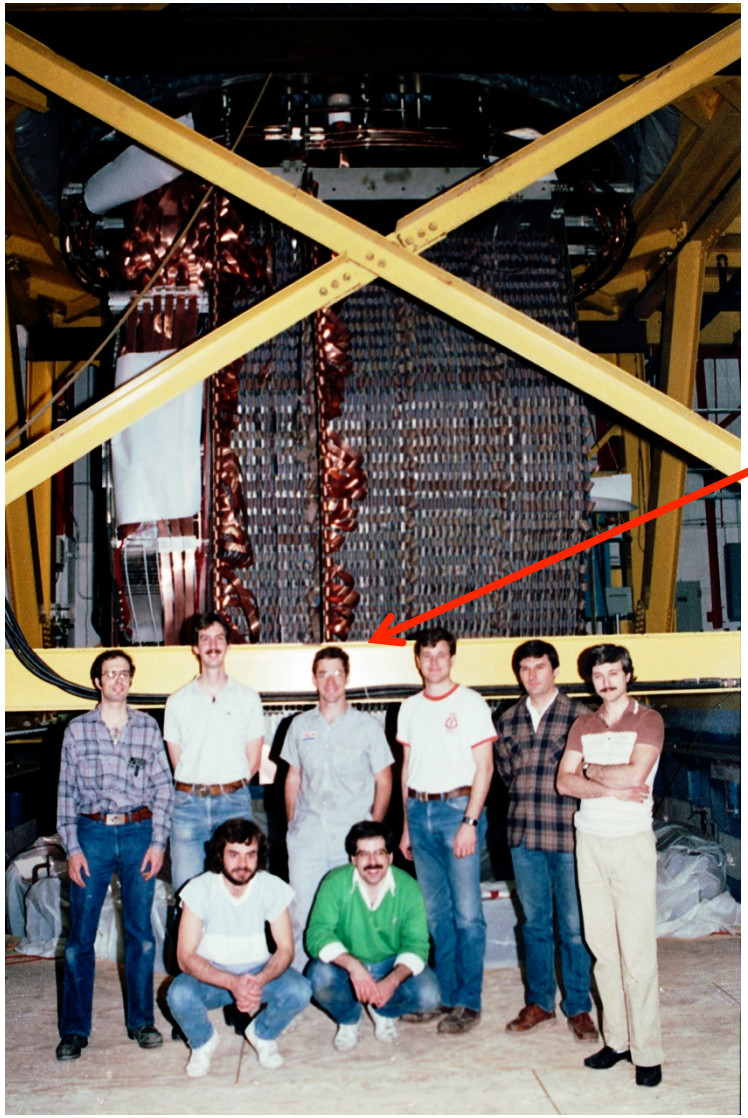


My Background

- 1984: BS in Engineering Physics, University of Arizona
  - Got a job in an HEP group after being fired from a gas station.
- 1984-1990: Grad Student, University of Rochester
  - PhD topic: Direct Photon Production in Hadronic Interactions
- 1990-1992: CERN Fellow, CERN
  - Studied e+e- reactions on the OPAL Experiment at LEP
- 1992-2001: RA and Assistant Professor, Princeton U.
  - GEM Experiment at the Superconducting Super Collider 😢
  - Belle CP Violation Experiment at KEK, Japan
  - Nonlinear QED in E-144 Experiment at SLAC
- 2001-Present: Scientist, Fermilab
  - Past:
    - MiniBooNE short baseline neutrino oscillation experiment
    - Proton Source Department Head
    - Director of LHC Accelerator Research Program (LARP)
    - Director of Joint University-Laboratory PhD Program
  - Present:
    - Mu2e rare muon conversion experiment
    - Integrable Optics Test Accelerator (IOTA) proton injection
    - Program director for Lee Teng Undergraduate Internship
    - Occasional Instructor at USPAS

Experimental HEP

Accelerator Physics (mostly)



Fermilab E-706 Rochester Group
~1987

Me

"Buck's River Road Exxon"

General Plan

- I'm going to spend today on the basics, as well as a fairly qualitative overview of everything we're *going* to learn
  - This will hopefully level the playing field in terms of previous experience and exposure to the concepts
- I'm planning to give an in depth treatment of
  - Transverse motion
    - Strong focuusing
    - Lattice functions
  - Longitudinal motion
    - Acceleration
    - Synchrotron motion
- More qualitative treatment of general topics in the field
  - Will mix up the two, to give your brains a rest.

A note on text

- I chose Edwards and Syphers "An Introduction to the Physics or High Energy Accelerators" as the primary course text because
  - It's the book I learned from
  - I find the mathematical level appropriate to a broad range of students.
  - It was written by Fermilab people, so it uses conventions that I'm familiar with.
  - It's the same book I use for the graduate course, but we'll cover much less of it, and at a less rigorous level.
  - I won't stick to the order of the book. In particular, like most people who use it, I'll switch the order of Chapter 2 (longitudinal motion) and 3 (transverse motion)

Other references

- Edmund Wilson, “Particle Accelerators”
  - A bit lower level than E&S. Often used for this course.
  - Concise reference on a number of major topics
  - Available in paperback (important if you are paying)
- Klaus Wille “The Physics of Particle Accelerators”
  - Same comments
- Welmut Wiedemann, “Particle Accelerator Physics”
  - Probably the most complete and thorough book around (originally two volumes)
  - Scope very large and mathematical level *very* high, even for the graduate course.
- Fermilab “Accelerator Concepts” (“Rookie Book”)
  - http://tinyurl.com/FNAL-concepts
  - Particularly chapters II-IV

Tentative Schedule

- Lecture: 9-12
  - Will lecture in the afternoon a bit today.
- Lunch: 12-1:30
- Labs: 1:30-5:00
- Problem sessions: 7-??
- Homework every day except Friday and next Thursday, to be turned in the next day.
  - Students are encouraged to work together on homework
- In-class exam next Friday.
- As lectures, homework, and other material are ready, they will be put at:
  - http://home.fnal.gov/~prebys/misc/uspas_2016/

Course Schedule (*very* approximate)

Time	Day				
	Mon. (6/13)	Tues. (6/14)	Wed. (6/15)	Thu. (6/16)	Fri. (6/17)
9:00 AM	**Lecture:** - Formalities - Introduction - Basics	**Lecture:** - Transverse Motion 1	**Lecture** - Transverse Motion 2	**Lecture**: - Lattice Imperfections and corrections - Insertions	**Guest Lecture** (Brian Beaudoin)
10:00 AM					
11:00 AM					
12:00 AM	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
1:00 PM	**Lecture** (cont'd)	**Lab**	**Lab**	**Lab**	**Lab**
2:00 PM					
3:00 PM	**Lab Introduction**				
4:00 PM					

Time	Day				
	Mon. (6/20)	Tues. (6/21)	Wed. (6/22)	Thu. (6/23)	Fri. (6/24)
9:00 AM	**Lecture** - Longitudinal Motion 1	**Lecture** - Longitudinal Motion 2	**Lecture** - Collective effects - Instability - Colliders and Luminoity	**Lecture** - Special topics - Requests	**In-class final exam**
10:00 AM					
11:00 AM					
12:00 AM	**Lunch**	**Lunch**	**Lunch**	**Lunch**	End
1:00 PM	**Lab**	**Lab**	**Lab**	**Lab**	
2:00 PM					
3:00 PM					
4:00 PM					

Lecture Style

- All the details of my lectures will be in my PowerPoint slides, which I will copy and hand out (they'll also be available online).
  - This is first time I'm teaching this course, so there *will* be mistakes in the slides, which I'll correct in the online version if and when we catch them.
- I will often write on the board simply as a way to pace myself (otherwise, I find I go way too fast). Sometimes this will involve simply copying what's on the slides.
- I'll also work through a lot of problems and examples that aren't in the slides, so that's where you'll want to take notes. I'll copy and distribute any I think are particularly valuable, but don't count on it.
- I used to think that if people didn't ask questions, it's because they understood everything I was saying. Now I know the opposite is true, so if I don't get any questions, I'll keep slowing down until I do.