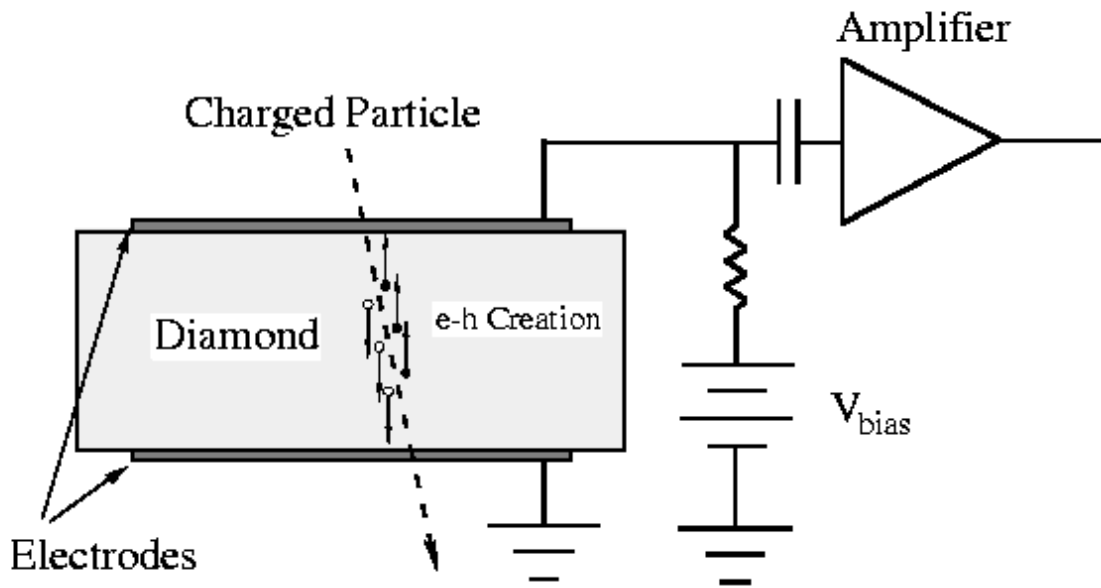


PHY2405

Experimental Methods in High Energy Physics

January 2024



First meeting for this course will be Monday  
January 8<sup>th</sup> at 1pm in MP912

For further information contact the instructors:  
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# Course Information for PHY2405 (January 2024)

## Course Overview

The course will cover the following topics:

1. Accelerators
2. Underground/low background facilities
3. Interaction of charged particles with matter
4. Charged particle tracking detectors
  - a. Gas chambers
  - b. Solid State Trackers
5. Bolometers and Scintillators
  - a. Particle identification
6. Calorimeters in HEP experiments
7. Digital signal processing and noise reduction
8. HEP triggering and data acquisition

## Textbook

There is no formal textbook but access to Fernow, Leo, Ferbel, Green or Perkins may be useful. I will try to follow the first couple of chapters of Edwards and Syphers in my discussion of particle accelerators

Much of what we will talk about is also summarized in the **Review of Particle Properties**. You can order a copy online (if you don't already have one) at [pdg.lbl.gov](http://pdg.lbl.gov) or you can access the content electronically from there. You are welcome to borrow one of our 'older versions' (they come out every two years and none of the material we'll be discussing in class has changed in the last 2-4 years...) for the duration of the course.

## Grades

4 problem sets worth **60% of the final mark**

One on accelerators (due at the end of January)

One on low background laboratories and particle interactions  
(due in Feb)

One on tracking detectors (due mid March)

One on dark matter detection and noise reduction (due at the end  
of March)

A report on an existing or planned particle experiment or accelerator. Students will make a short (15-20 minute) in-class presentation of their report during the last week of classes, worth **20% of the grade in the course**. With the feedback from their presentation they will prepare a 10 page (+figures and references ... so maybe 15 pages all together) written report that will be worth **20% of the final grade in the course**. The term paper will be due April 5, 2024. Your part of this course will be done before the start of the spring examination period.

Possible topics:

1. The CMS detector (or some subsystem there-of). We'll be using the ATLAS experiment and it's detector systems as examples throughout the term, so they will be off-limits for your project.
2. The LHCb experiment
3. The BELLE-II experiment
4. The ILD or SiD for the linear collider
5. The HyperK experiment
6. The IceCube experiment
7. Solid-state detector based dark matter search experiments (SuperCDMS@SNOLAB will be used as examples in the lectures, so if you choose that, you'll need to go significantly deeper than what we covered)
8. DEAP, Darkside, LZ, XENON dark matter search experiments (a tank of cold liquid)
9. nEXO, SNO+, CUORE, double-beta decay search experiments
10. CEvNS experiments at reactors or other neutrino sources
11. Possible new accelerator projects: FCC (ee, hh), CEPC, CLIC)

When choosing a topic you should keep in mind the main goal of this presentation/paper: We are hoping that you will apply what you've learned about the various detector/accelerator topics in the course to a critical exploration of the current/future project. So you should

look for things that will allow you to extend and deepen your understanding of the concepts discussed in the course (and present them to the other members of the class)

In your presentation and report you should consider the following aspects:

- Overall design and reasons behind the design choices
- New technology and other innovations being proposed or implemented
- Performance or expected performance gains relative to current experiments (or accelerators)

The detailed weekly plan for the course can be found at:

<https://www.physics.utoronto.ca/~phy2405/>

lecture notes will be posted there along with problem set questions and other course materials as the term goes on