# PHYSICS 474/790B - Methods of Experimental Physics in particle physics

- Tuesday - Thursday 2:00 - 3:15 FW227
- office hours T-Th 1:30-2:00

This will be team taught by primarily

- Dave Hedin, FW224, hedin@niu.edu
- Mary Anne Cummings, FW230, macc@fnal.gov

This is mostly just one course. Undergrads enroll in PHYS 474 and grad students take PHYS 790B. 474 students will spend a few weeks in a lab working with particle detectors and so miss one of the examples.

- **Syllabus - Spring 2014**
- **G4beamline home page**
- g4bl_nicadd.txt Simple procedure for making a working version of g4beamline on the nicadd cluster.

## G4beamline example input files

- pCT.pdf documentation of the pCT geant4 simulation which doesn't use g4beamline. An example of why g4bl is much, much simpler to use.
- test.in g4beamline simple 1 muon input file. This makes g4beamline.root which if you rename to test_mu.root (which is on this web page) is the input for the test root macros g4bl_loop.C and g4bl_test.C below.

## ROOT example files

- graph0.C make a graph
- feynman.C make a Feyman diagram
- zh.C make another Feyman diagram
- g4bl_test.C fills histograms for ntuples in test.in.
- g4bl_loop.C loop over hits in test.in. Calls devX.h
- devX.h example of a function

On one can set up root by

- looking at Sergey's talk below

and then run by either

- root // run in graphics. I use EXCEED on my Windows machines
- root -b // run in non-graphics mode

- root g4beamline.root // run with input file

  once in root can do commands like

- TBrowser tb& - browser mode
- Draw.One("x","PDGid==13"); - draw all x leaves of branch One with a condition
- .L feynman.C - load macro
- feynman() - execute macro

## Lectures

- Intro to NICADD cluster Sergey Uzunyan's 1/14/2014 talk
- Intro to G4beamline Mary Anne Cummings' 1/14/2014 talk
- Intro to ROOT Mike Eads' 1/16/2014 talk plus scripts canvas.C , file_write.C , hist.C , simpleScript.C , file_read.C , graph.C
- Particles in Matter Mary Anne Cummings' 1/21/2014 talk

## Problems

- 1. Energy loss
-   Syllabus for PHYS 790B/474   --- Spring 2013  -- Version 0.5
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- Team taught: M.A. Cummings, M. Eads, D. Hedin, S. Martin and probably
-              others
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- Note the difference between 790B and 474 is that 474 will do
- some lab-oriented work (item II) while 790B will skip this in
- favor of an additional effort on (probably) LHC/ILC physics. This
- is the first time we have taught this class in this fashion.
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- Thdere is not an assigned textbook. We will use:
-   g4beamline users guide etc from
- www.muonsinternal.com/muons3/G4beamline
- CERN ROOT from root.cern.ch
- and MADGraph from madgraph.hep.uiuc.edu/index.html
- or madgraph.phys.ucl.ac.be/
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- The particle data group website at pdg.lbl.gov contains a wealth
- of information including being able to get PDG material sent to you.
- Testbooks like Particle Physics (Duncan Carlsmith) or Quarks&Leptons
- (Francis Halzen and Alan Martin)
- are also useful but we leave to you to pick your favorite.
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-               Methods of Experimental Physics
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-    This course will cover some basic techniques in experimental physics
- emphasizing the design and construction of research apparatus, and
- a little bit about data analysis. Some

- exposure to detectors themselves will be included for those in 474.
- Radiation safety will be discussed in terms of shielding.
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- I. Introduction to softwarre tools
- A. geant4 Monte carlo as operated by the g4beamline software suite
- (first 2 weeks)
- B. The CERN toolkit ROOT (first 2 weeks)
- C. MADGraph, a physics generator (midway through class)
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- II. Introduction to particle detection (laborat0ry based)
- A. overview of how particles are detected
- B. 474 only. use available detectors (scintillator or cherenkov based
- counters, drift tubes) to understand performance including varying
- operating voltages on electronic readout, response to different
- sources, use of TDC or ADC information when appropriate.
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- III. Excercises in designing detectors including backgrounds and efficiencies
- using the tools in part I. and the technolgies in part II.
- Will pick from these topics (or additional) based on the
- interests of others helping to teach this class. They are not
- in order.
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- A. shielding of gamma and neutron sources; radiation dose
- B. muon conversion to electrons in a nuclear field (Mu2E)
- C. measureing the muon magnetic moment (muon g-2) including
- understanding track reconstruction and momentum determination
- D. Rare kaon decays especially K+ --> pi++nu+nu (ORKA)
- E. neutrino detection
- F. searching for new physics at the LHC
- G. beam transport systems (MTA as an example)
- H. calorimeters for the ILC
- I. high intensity neutrino beams
- J. muon collider
- K. proton tomography detector (not the "tomography")
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- Grading - not yet really worked out
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- Excercises using the tools in I., II., and II. will be assigned.
- They will typically be assigned on Thursday and due the next week.
- Students should answer the questions but also include
- and "code", that is *.in, *.C, *.h or output histogram files use to arrive
- at the results.
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- We may have students (using in teams of 2) do an extended design of one
- item in III to present to the class. This needs to be determined.
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- possible grading
- excercises 70%
- extended design+presentation 30%
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- educational environment in collaboration with the Disability Resource
- Center (DRC). Any student requiring an academic accommodation due to a
- disability should let his or her faculty member know as soon as possible.
- Students who need academic accommodations based on the impact of a
- disability will be encouraged to contact the DRC if they have not done so
- already. The DRC is located on the 4th floor of the Health Services
- Building, and can be reached at 815-753-1303 (V) or drc@niu.edu.