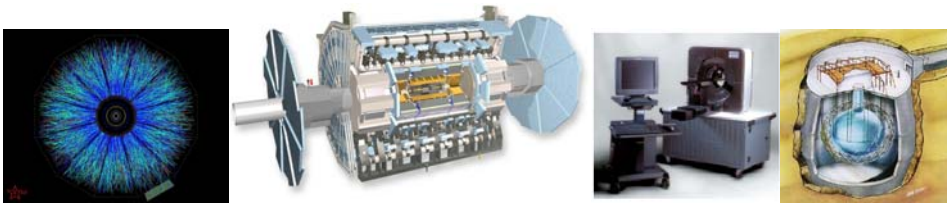

Physics 531: Radiation Detection Techniques

September-December, 2017

Prof. Douglas Bryman

J.B. Warren Chair

Department of Physics and Astronomy

UBC

http://rarek.triumf.ca/doug/detector_course

This course is aimed at graduate students (and advanced undergraduates) interested in radiation detectors used in experimental particle, nuclear and medical physics, and other applications such as space physics and condensed matter (e.g. MuSR). It will cover the basics of the interactions with matter of charged particles, gamma rays, and neutrons and the methods used to detect these particles. Scintillators, (inorganic crystals, plastics, fibers), optical sensors (phototubes, APDs, MPPCs, etc.), solid state detectors and devices (e.g. Si strips and pixels, Ge diodes), gas and liquid tracking detectors (e.g. MWPCs, TPCs, GEMs, Micro-megas, liquid argon and xenon detectors), calorimeters, Cerenkov and transition radiation detectors are among the topics to be addressed. Applications in high energy, nuclear, and medical physics (e.g. SPECT, PET) will be emphasized. Students will prepare reports and present seminars on topics of interest in their research and on advanced detector developments.

Tentative List of Topics

1. Charged Particle Interactions with matter
    - Kinematics and Scattering
    - Energy loss
    - Bremsstrahlung
    - Ionization
    - Multiple Coulomb scattering
    - Cerenkov radiation
    - Transition radiation
2. Photon Interactions with matter
    - Photoelectric effect
    - Compton Scattering
    - Pair Production
    - Attenuation/absorption
3. Drift and diffusion in gases
4. Ionization detectors
5. Proportional chambers
    - Proportional gain
    - Energy resolution
    - Penning effect and Fano factor
    - Geiger mode, streamer mode
6. MWPC,GEM,Micromegas,Micropattern Gas Detectors
7. Drift Chambers, TPCs
8. Scintillators and photo-sensors
    - Inorganic scintillators and crystals
    - Plastic scintillators
    - Scintillating fibers
    - Cryogenic noble liquids
    - PMT’s and other photo sensors
9. Solid state detectors
10. Calorimetry
11. Particle ID
12. Tracking
13. Neutron Detection
14. Neutrino Detection
15. Dark Matter Detection
16. Applications
    - Detectors for Particle and Nuclear Physics
    - Detectors in Medical Physics
    - Other Applications

There will not be an official text. The following references may be useful.

References:

- C. Grupen (1996) Particle Detectors (Cambridge University Press)
- K. Kleinnkecht (1998) Detectors of part. radiation (C. U. P.)
- R. Fernow (1989) Intro. to Exp. Part. Phys. (C. U. P.)
- C. Leroy, G. Rancoita (2009), Principles of Interactions of Matter and Detection. (World Scientific)
- G. Knoll, Radiation Detection and Measurement, 3rd Edition, 2000
- W. R. Leo, Techniques for Nuclear and Particle Physics Experiments, 2nd edition (Springer), 1994
- R.S. Gilmore, Single particle detection and measurement, (Taylor&Francis), 1992
- W. Blum, L. Rolandi, Particle Detection with Drift Chambers, (Springer), 1994
- D. M. Ritson (1961) Tech. of HEP
- T. Ferbel Exp. Tech. HEP (1991W.S.)
- F. Sauli (1992) Instr. in HEP (W.S.)
- Ereditano (1991) Calorimetry in HEP (W.S.)
- S. Sze (1981) Physics of Semi-conductors (Wiley)

Literature and Lectures on particle detectors

- Particle Data Book
  http://pdg.lbl.gov/2013/reviews/rpp2013-rev-passage-particles-matter.pdf
- DESY Lectures
  http://www.desy.de/~garutti/LECTURES/ParticleDetectorSS12/Lectures_SS2012.htm
- Fermilab EDIT School Lectures
  http://detectors.fnal.gov/EDIT2012/lectures.html
- Helmuth Spieler Lectures/Tutorials 2012
  http://www-physics.lbl.gov/~spieler/
  Semiconductor Detector Systems (Oxford University Press, 2005; 2nd printing 2006).
- Proceedings of detector conferences (e.g. Vienna VCI, Elba, IEEE)