Queen Mary
University of London
Science and Engineering

Radiation Sensors (SPA 6309)

Lecture 1

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Module Introduction

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- Research Group: Particle Physics

What is this module about?

- The principles of detection of ionising radiation
  - Interaction of charged and neutral particles with matter
  - Gaseous sensors
  - Semiconductor sensors
  - Scintillators
- Sensor systems used in particle and nuclear physics
  - Calorimeters
  - Tracking detectors
  - Neutrino detectors

What is this module not about?

- The fundamentals of particle physics (for that see SPA6306)
  - IMPORTANT: I will not assume that you have taken SPA6306.
- History of radiation sensors
  - I will concentrate on fairly recent developments use examples from current (or planned) experiments in most cases.
- Sensors primarily used in optical imaging.

Module outline (1)

- Interaction of radiation with matter
  - “Heavy” particle interactions (e.g. proton, alpha)
  - “Light” particle interactions (e.g. the electron)
  - The photon
  - Radiation damage issues
- Sensors that use ionisation directly
  - Gaseous detectors
  - Semiconductors
  - Noble-gas liquids
- Sensors producing light
  - Scintillators
  - Cherenkov

Module outline (2)

- Calorimeters
  - Homogeneous
  - Sampling
- Tracking Detectors
  - Silicon strip
  - Resistive plate
  - Time-projection
- Dark matter, astroparticle and neutrino
  - Scintillators
  - Cherenkov
- Detector system walkthrough
  - The Compact Muon Solenoid at the Large Hadron Collider

Assessment & Feedback

The summative (provides marks as well as feedback) assessment is as follows:

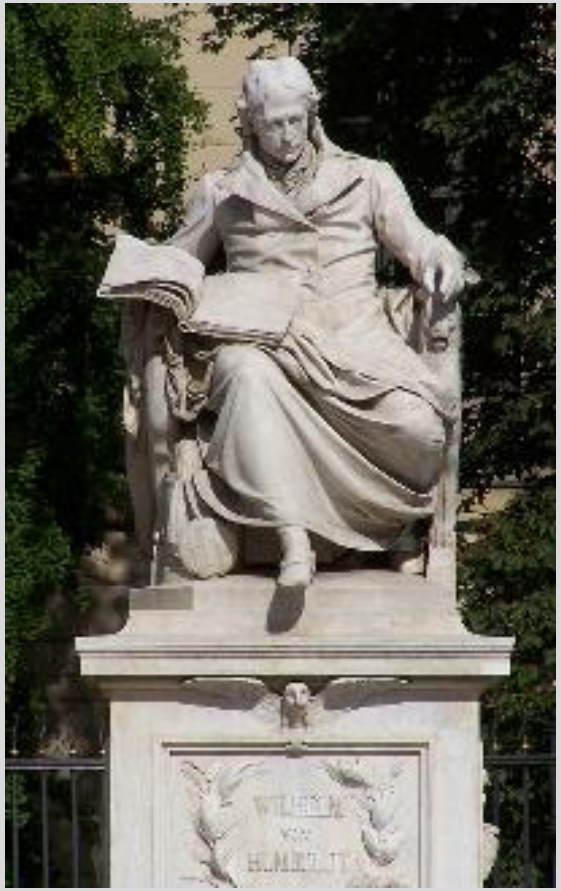
1. One hour class test in week 6, this will count towards 30% of the final mark.
2. An individual critical essay (deadline 14 April 2020) which will count for the remaining 70% .

Tutorial sessions starting in week 2. Questions which you should attempt before the tutorial will be normally available a week in advance. These will be formatively assessed within the tutorial session (they do not count towards the final module mark).

Philosophy

What are my aims?

- You gain an understanding of the key radiation sensor principles, including the interaction of particles with matter.
- You understand how the most important detector systems operate and what the current limits to performance are.
- You can estimate order-of-magnitude system parameters for typical applications.
- You can apply the above to critically analyse a significant experimental measurement of a fundamental particle property (for example mass).



Resources

The “recommended” text is by W R Leo, it is very good but even the 2nd edition is now over 25 years old.

The on-line “Particle Data Group” (PDG) reviews are up-to-date but are fairly condensed (see http://pdg.lbl.gov/)

These lectures will guide you, but I will give references to other resources as we go through where I think they will be useful.