



Queen Mary

University of London

Science and Engineering

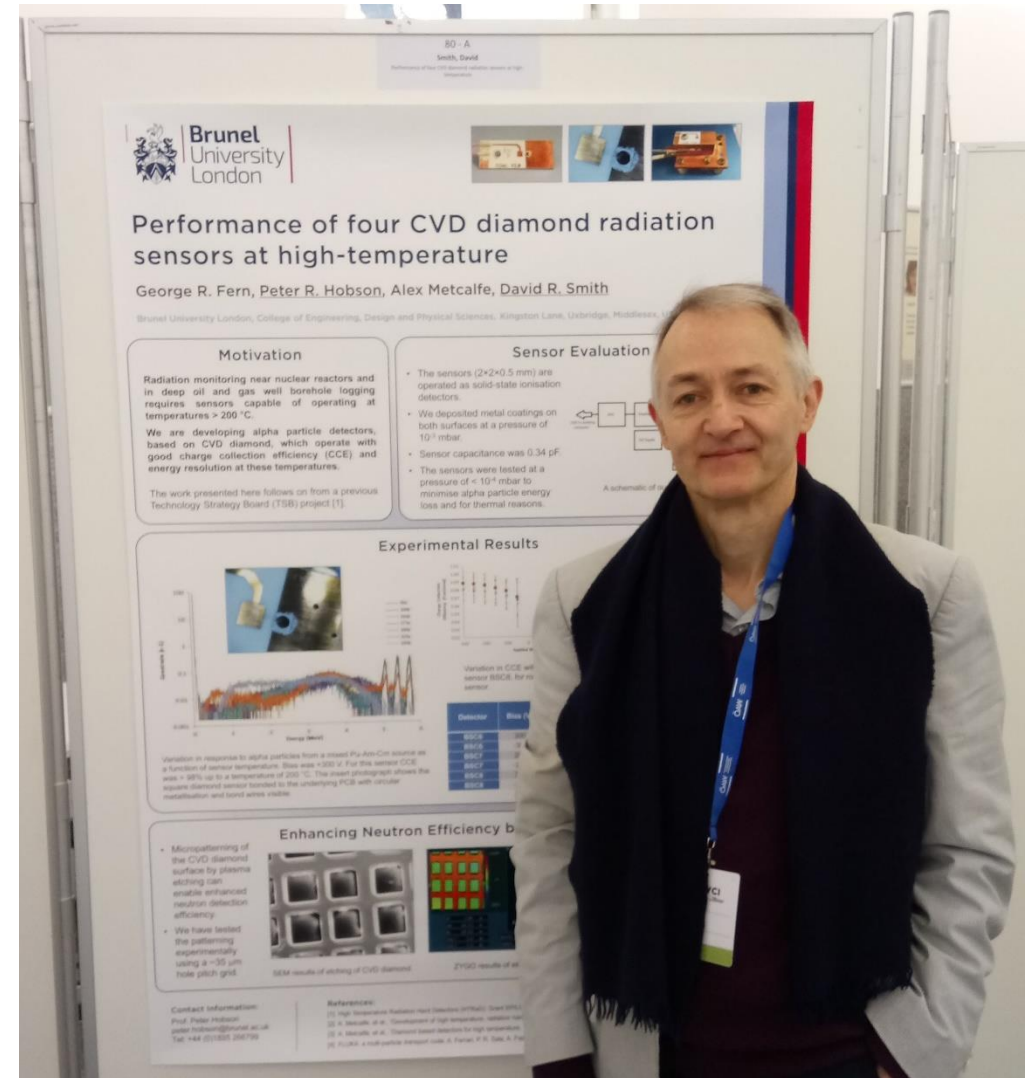
Radiation Sensors (SPA 6309)

Lecture 1

Module Introduction

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- Role: Head of School
- 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).



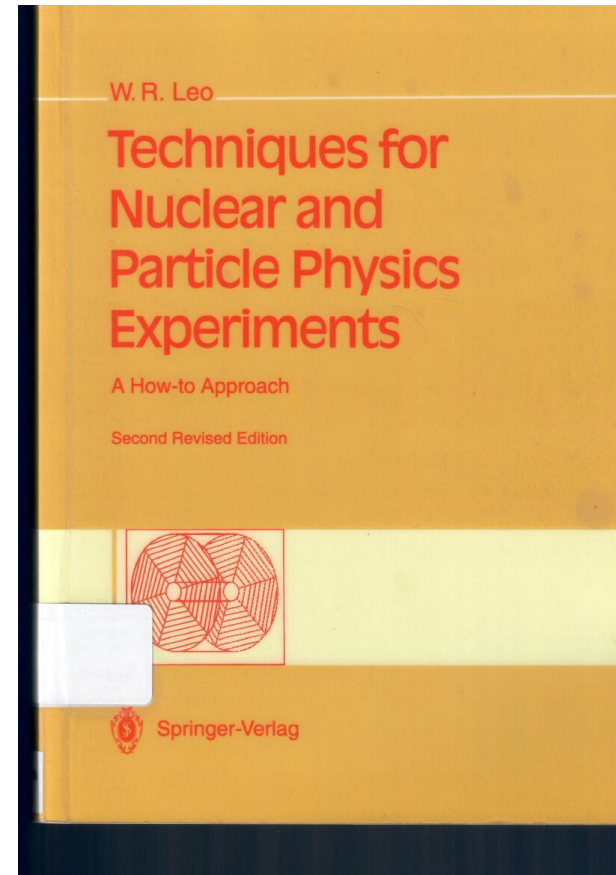
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Resources

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.



The image is a screenshot of the Particle Data Group (PDG) website. At the top, there is a blue header with the PDG logo and navigation links: 'About PDG', 'PDG Authors', 'PDG Citation', 'News', and 'Contact Us'. Below the header, a green banner announces 'Dec. 6, 2019: Updated 2019 reviews now available'. The main heading is 'The Review of Particle Physics (2019)' with a subtitle 'M. Tanabashi et al. (Particle Data Group), Phys. Rev. D 98, 030001 (2018) and 2019 update.'. There are several blue buttons for navigation: 'pdgLive - Interactive Listings', 'Summary Tables', 'Reviews, Tables, Plots', 'Particle Listings', and a search bar. Below these are green and grey buttons for 'ORDER: Book & Booklet' and 'DOWNLOAD: Book, Booklet, more'. A table lists 'Previous Editions (& Errata) 1957-2018' and 'Physical Constants'. Below that, there are links for 'Errata in current edition', 'Figures in reviews (2018)', and 'Mirror Sites'. A section titled 'PDG Outreach' includes links for 'Particle Adventure & Apps', 'CPEP Charts', and 'History book'. Another section, 'Non-PDG Resources', has dropdown menus for 'HEP Papers', 'Databases & Info', and 'Institutions & People'. At the bottom, there is a 'Funded by:' section with text about funding from US DOE, CERN, MEXT (Japan), and INFN (Italy). The footer contains copyright information: 'All pages © 2019 Regents of the University of California. See LBNL disclaimers.'