Nuclear radiation detection and measurement: Basics, Principles and Applications

Prof. Dr. Abdallah Lyoussi
CEA/DES/IRESNE
CEA Cadarache Research Center, France

Abstract

Instrumentation and measurement methods in nuclear environments are key aspects that contribute to the quality of scientific and technological programs in the fields of physics, energy, nuclear fuel cycle, safeguards and radioactive waste management. Furthermore, measurements relying on nuclear physics now play an important role in various fields of application such as biology, medicine and environment.

For nuclear physics and technology side, nuclear power and/or experimental/research reactors are widely used around the world for various purposes, such as energy production, irradiation of material or fuel samples for present and future power reactors, safety studies, assessment of neutronic parameters (such as neutron absorption cross sections or reaction rates), production of artificial radio-elements, etc.

The lecture will focus on nuclear radiation detection and measurement. It will start from the physical principles by presenting the basics, performances and limitations of the main nuclear radiation detectors used in the frame of nuclear measurement and monitoring needs such as:

- Gaseous detectors (fission chambers, proportional counters, GM),
- Scintillators and semi-conductors with neutron convertor materials/layers
- Self-Powered Neutron Detectors (SPND)
- Activation detectors/Dosimeters

The course will first give reminders about the interactions of radiations with matter that are involved in ray detection.
Some example of applications dealing with nuclear non-destructive measurements will be presented.
Furthermore, second lectures will deal with the radiation instrumentation and measurement for nuclear fission and more specifically for nuclear reactor uses and applications. Examples, performances and challenges as well as some recommendations will be given.