PHY811

PARTICLE PHYSICS EXPERIMENT - STUDY OF COSMIC RAYS

The purpose of the graduate particle physics experiment is to study the soft component of cosmic radiation at sea level, which is mainly composed of muons. The study proceeds through the measurement of the cosmic ray flux and the muon decay and capture rates in a heavy material (lead). It is anticipated that students taking the course will cover the theoretical part from the notes and the extended bibliography on the subject provided by the tutor. Simultaneously they will familiarise themselves with some of the methodology and techniques widely used today in particle physics research (detectors, electronics for signal manipulation and extraction, data acquisition and processing and presentation of the results).

COURSE CONTENTS

Practical Training

Training in the usage of a digital oscilloscope and digital function generator for the study of detector signals and adjustment of coincidence circuits.

1. Cosmic Radiation

Sources of cosmic radiation, primary and secondary interactions, soft and hard component, composition and energy spectrum of cosmic rays at sea level, Greisen-Zatsepin-Kuzmin energy limit.

2. Scintillation Counters

Scintillation counters and parameters describing their operation, energy loss mechanism, mechanisms of scintillation production in organic and inorganic materials, wave-guides and wavelength shifters, photomultipliers, signal production, cathode and dynode properties, extraction of the current intensity and operational voltage of scintillation counters.

3. Electronic Manipulation of the Signals

Electronic protocols, manipulation and amplification of signals coming from a scintillation counter, threshold discriminators and their adjustments, signal converters and multipliers, time delay, frequency counters, signal prescaling, selection of the threshold voltage and signal width for an array of scintillation counters.

4. Coincidence Signals coming from Cosmic Radiation

Frequency of signals in scintillation counters, rate of cosmic rays, veto counters, coincidences, logic functions, random coincidences due to noise, decay and capture rate of muons as a function of the time delay with respect to the detection of their reaction products.

5. Comparison to the Predicted Values

Calculation of the expected cosmic ray flux going through the solid angle of the detector geometry, mean life of the decay process of positive muons, mean life of the capture process of negative muons.