UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Electronic Experimentation

2021-3-E3001Q071

Aims

Basic knowledge of the use of microcontrollers for the management of the link between the analog world and the digital world. Introduction to the analog manipulation of signals generated by particle detectors: amplification and signal shaping. Construction of a complete acquisition chain: the detector signal is amplified, suitably shaped, then transformed into a sequence of numbers that can be mathematically analyzed by the microcontroller system.

Contents

The course aims to introduce the student to the world of physics experiments by introducing the main ingredients of a measurement chain with a particle detector: analog signal amplifiers and shapers, use of converters from the analog world to the digital world and vice versa and use of microcontrollers for the management of the 2 analog and digital worlds. A practical application will be the construction of a measurement chain for one of the most current detectors, the so called SiPM, or Silicon Photomultiplier. A detector capable of producing a measurable electrical signal in response even to a single incident photon. It will be studied the electrical signal generated in the detector to be converted into a sequence of numbers that will be analyzed mathematically with a chain completely built in the laboratory.

Detailed program

This will be the first year for this course and, in the second half of the year, we may still be in a pandemic emergency. However, the basic idea is to analyse and build a detector acquisition reading. Clearly, all the issues will not be dealt with in-depth, also because the educational offer of the degree course includes specific courses.

More explicitly. We will start by considering the detector of interest, a SiPM, a silicon photomultiplier, in our case. The next step will be how to deal with the amplification of the signal produced and its shaping, to be able to optimize what will be the so-called signal-to-noise ratio, also dealing with non-ideal situations in the presence of environmental disturbances, learning to use the appropriate expedients. The output signal from this analog chain will be a voltage that must be converted into a string of numbers to be studied and interpreted mathematically by means of specific software tools. In current physics experiments it is important to know how to deal with, or understand, how to convert analog signals into digital signals and vice versa and also to learn how to manage the synchronization of what happens, especially when many detectors have to be managed simultaneously, as in a CT scan, for example. For this reason we will learn to use the so called Analogue to Digital, ADC, and Digital to Analog converters, DAC and, above all, microcontrollers, the intelligent heart of the system. The microcontrollers that we will learn to use are 32-bit ARM series, one of the most widespread in the industry.

The course is for everyone and aims to be preparatory to any address the student wants to undertake later.

Here a short presentation.

More information will be available at the following web page:

http://pessina.mib.infn.it

Prerequisites

Notions on classical Physics: Electricity and Magnetism

Teaching form

Standard mode:

Every experience is introduced by a lesson, 6 cfu, 72 h.

"Covid" mode:

The experiences may not all be fully enjoyable. Some procedures will be modified. For example, experience carried out by the teacher in the laboratory, with analysis of the acquired data carried out remotely.

Textbook and teaching resource

Slides (available on the web page http://pessina.mib.infn.it), development sw, instrumentations.

Semester

Second semester

Assessment method

Standard mode:

Discussion of the report about the laboratory experiences.

Covid mode:

Like the standard but with google meet chat and jamboard virtual board, unless platform changes.

Office hours

Anytime, upon notice: claudio.gotti@mib.infn.it, pessina@mib.infn.it