Event Building with ANEMONE an EUDET-type Beam Telescope

Rasmus Partzsch

University of Bonn

Introduction

The development and research of particle detection devices is an important aspect of particle physics experiments. Technical requirements on the detectors depend on the specific experiment and range from high radiation tolerance over minimal power consumption to precise spatial resolution.

The spatial resolution is characterized in test beam campaigns. In those, the device under test (DUT) is placed in a particle beam originating from an accelerator, with beam energies up to hundreds of GeV. A beam telescope is used in addition to the DUT. The telescope comprises multiple detectors with a high spatial resolution and identifies reference particle tracks. Facilitating such telescope, for example the hit efficiency of a DUT is measured.

An EUDET-type Beam Telescope

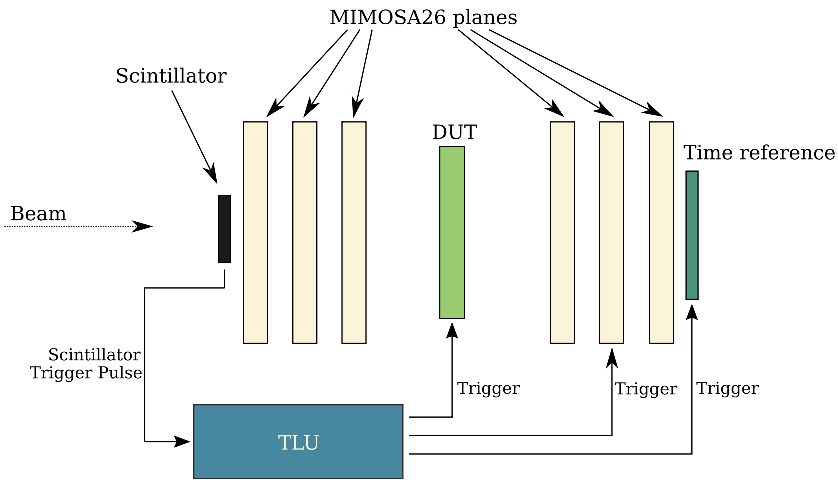

Figure 1: Triggering setup of the ANEMONE telescope.

A standardized test beam telescope was build within the scope of the EUDET project. The EUDET project was coordinated by DESY with the goal to improve the detector development infrastructure. University of Bonn obtained such a EUDET-type beam telescope with the name ANEMONE. It comprises six MIMOSA26 semiconductor pixel detector planes with 576 x 1152 (18.4 µm pitch) square pixels. The DUT is situated in the center of the telescope (see Fig. **??**). Due to the long readout time (115.2 µs) of the MIMOSA26 planes, an additional time reference detector (ITkPix) with fine time stamping capabilities (25 ns) is used in ANEMONE. The ITkPix, was developed for the ATLAS inner tracker upgrade, with 400 x 384 (50 µm pitch) square pixels. The combination of high spatial resolution MIMOSA26 planes and fine ITkPix time stamping capabilities, allows the accurate temporal and spatial measurement of each particle track. Utilizing the setup, the intersection point of individual beam particles with the DUT is precisely determined.

Scintillators indicate the passing of a particle through the telescope and create trigger signals. These signals are processed by a trigger logic unit (AIDA-TLU) and synchronous distributed to all detectors. The AIDA-TLU, was designed by the AIDA-2020 project and offers flexible communication protocols for different device readouts and telescope setups. AIDA-2020 continuous the EUDET project in advancement of detector development infrastructure. A new custom Python based control software for the AIDA-TLU has been developed and tested at different test beam campaigns.

Event Building with an EUDET-type Beam Telescope

There are different operating modes to synchronize individual detector hits to valid particle tracks, traversing the whole telescope setup. This operating mode corresponds to a communication protocol of the TLU with the device. In the ANEMONE telescope DAQ system, the hits of each device are combined using an event number, produced from the TLU trigger signal. After the TLU issues a trigger to an individual detector, the DAQ of the device reads the current trigger number from the TLU. This trigger number is distributed synchronously to all participating readout systems and a specific event can be build (EUDET handshake mode).

The EUDET handshake mode requires a definite hit to trigger assignment also within the readout system of an individual detector. As some devices stream their data continuously to the readout system, trigger based event building is difficult, because the assignment of trigger to hit data is ambiguous. A solution is time-based event building. The AIDA-TLU can distribute a global clock to all devices, to realize a synchronous time stamp between the detectors. Each device stores all hit information with a tagged time stamp in the readout system. The TLU records the time stamp of each trigger, and time based event building can be realized. As the AIDA-TLU already supports the time based operating mode (AIDA mode), the readout system of the individual devices needs to be adjusted to work on a global clock and synchronous time stamp. Early studies using two detectors (TJ-Monopix2) in AIDA mode could be demonstrated. A further transition towards time based event building for the ANEMONE telescope would increase usability and flexibility of different detector prototypes.