WaveDAQ: an highly integrated trigger and data acquisition system

Marco Francesconi, Luca Galli, Ueli Hartmann, Manuel Meucci, Fabio Morsani, Donato Nicolò, Stefan Ritt, Elmar Schmidt.

a - Istituto Nazionale di Fisica Nucleare sezione di Pisa
b - Università degli studi di Pisa
c - Paul Scherrer Institut

d - Istituto Nazionale di Fisica Nucleare sezione di Roma

WaveDAQ system

The WaveDAQ (WDAQ) is a compact and highly integrated trigger and data acquisition system scalable from 16 to about 10000 channels. It consists of 4 specific boards hosted in a dedicated backplane. One crate has 16 digitising boards, called WaveDREAM (WDB) used to receive 16 inputs to be digitised by the Domino Ring Sampler chip (DRS) with sampling speed in the range of 1-5 Giga Sample Per Second and in parallel at 80 MHz for trigger processing. Any WDB has a dedicated serial connection [1] to the two higher level boards, 5.12 Gbit/s to the trigger processor (TCB) and up to 1.28 Gbit/s to the data read out board (DCB). A DCB has a 10Gbit/s ethernet link to the offline storage.

The trigger, synchronisation and busy flags are distributed on the backplane together with a low jitter (<10 ps) and low skew clock (trigger bus). If the number of channels exceeds 256, a trigger dedicated crate is used to collect the data from lower level crates, and a synchronisation board (Ancillary) is used for the trigger bus distribution.

WaveDREAM

It is a compact 16-channel TDAQ system. The 16 inputs provide GHz bandwidth and programmable amplification in the range 0.5-100 with an selectable pole zero cancelation circuit, suited for timing applications. An onboard power supply can be used to power SiPM arrays up to 240 V. Fast discriminators are used for triggering and also for online time reconstruction with resolution of 400ps.

System demonstrator

It consists of 4 digitising crates, 1024 channels, accompanied by a trigger and synchronisation crate (the top most in picture). It was used to read out a scintillation time of flight detector [2], part of a LHe calorimeter plus auxiliary channels (LED and laser synchronisation pulses). The data and trigger bus distribution worked as expected. At the end of this year the DCB will be commissioned (so far the WDBs are read out individually) being the last step towards the final system production.

The Trigger Concentrator

It collects data from the WDBs to be processed on an FPGA. As a consequence, the reconstruction is fully flexible to any experimental needs. It can handle up to 64 trigger algorithms in parallel with individual pre-scaling factors. When a trigger crate is needed, a TCB is programmed to collect the data from the front panel and transmit them (after processing) to the backplane.

Application to MEG II

MEG II @ Paul Scherrer Institut (PSI) aims at measuring the branching ratio of the $\mu \rightarrow e\gamma$ decay with a sensitivity of $6 \times 10^{-14}$ [3]. The experiment is equipped with a drift chamber [4] to measure the positron track and a scintillation device for its time of flight; a liquid Xenon detector [5] for the photon characterisation. The WaveDAQ will read out the whole detector, ~8000 channels from SiPMs, PMTs and the amplified pulses from tracker anode wires. A complex trigger reconstruction mainly based on the photon energy discrimination, but also positron-photon relative timing and direction, will reduce event rate from the target by almost 7 order of magnitudes to about 10Hz. The positron time of flight detector is installed and commissioned at PSI with WDAQ, we measured a time resolution of about 30 ps.

Application to FOOT

FOOT (Fragmentation Of Target) aims at identifying the fragments produced by accelerated ion beams on a hydrogen-enriched target [6]. The measurement of their time of flight from the production target to the $\Delta E-\text{TOF}$ detector and their $\text{dE}/\text{dx}$ are mandatory for particle identification. WDAQ is adopted for trigger and readout of the FOOT scintillation devices (~80 channels) up to 1 kHz of DAQ rate. The time resolution of a $\Delta E-\text{TOF}$ prototype irradiated with ions was measured in the range of 20-150 ps (depending on the ion energy deposit).

Bibliography

[1] M. Francesconi poster at this conference
[5] K. Satoru poster at this conference
[6] E. Ciarrocchi poster at this conference

Contact: luca.galli@pi.infn.it