Contribution ID: **115** Type: **Poster**

Optimisation of the Front-End Electronics of Drift Tube Chambers for High-Rate Operation

Wednesday 24 September 2014 16:49 (1 minute)

We report on the high-rate optimisation of a new Amplifier/Shaper/Discriminator (ASD) chip for the ATLAS Monitored Drift Tube (MDT) chambers, which have to sustain an unprecedented radiation background during LHC operation. The design of a new ASD chip is inevitable to provide enough chips for future upgrades of the MDT chamber front-end electronics and desirable to optimise the shaping properties. This is necessary to fully exploit the improvements of new small diameter drift tube chambers (sMDT), which have been developed for high rate operation.

Summary

We report on the development and high-rate optimisation of a new Amplifier/Shaper/Discriminator (ASD) chip for the ATLAS Monitored Drift Tube (MDT) chambers. The MDT chambers account for the vast majority of precision tracking chambers in the muon spectrometer of the ATLAS experiment at the Large Hadron Collider (LHC), where they have to sustain an unprecedented radiation background of photons and neutrons in the energy range around 1 MeV. With the upgrade of the LHC to the High Luminosity LHC (HL-LHC), which implies an increase of the radiation background by a factor five, both the MDTs and the front-end electronics will exceed their rate capabilities. Therefore, new detectors, so-called sMDT chambers, with reduced tube diameter have been developed. These chambers are fully compatible with the MDT chambers in terms of read-out and services. The improved rate-capability of the sMDT chambers can, however, not be fully exploited with the present MDT front-end electronics due to limitations in the analog signal processing.

The predominant performance loss of sMDT chambers at high rates is due to dead time effects, which limit the efficiency of the detectors, hence we aim for a short dead time. A natural limit for a reasonable dead time is given by the typical pulse length which corresponds to the maximum electron drift time of approximately 185 ns in the sMDTs. With a dead time of 185 ns, the sMDTs could be operated with an efficiency of >80 % up to counting rates of 1 MHz/tube and >70 % at 2 MHz/tube. The present ASD chip used for both MDT and sMDT chambers allows a minimum dead time setting of approximately 220 ns, which is, however, not reached in reality due to the bipolar shaping scheme in use. Bipolar shaping has the advantage of baseline stability at high rates and is very robust in operation, but it introduces an undershoot of the baseline at the end of each pulse which effectively increases the dead time because the detector efficiency and resolution are strongly degraded for hits falling in this undershoot. Measurements have shown that the effective dead time due to the undershoot is approximately 350 ns, which limits the efficiency significantly compared to the targeted dead time of around 185 ns.

Measurements with the front-end chip developed for the ATLAS TRT on an sMDT chamber have been performed in the Gamma Irradiation Facility (GIF) at CERN. The TRT front-end chip (ASDBLR) has an active baseline restorer, but its amplification and peaking time are not optimal for the sMDT pulses. It has been demonstrated by these measurements and by simulation, that an active baseline restorer as used in the ATLAS TRT front-end chip can improve the efficiency of sMDT chambers significantly. First measurement results with a prototype implemented as a discrete circuit are available and drive the further design of the new ASD chip. The TRT-ASDBLR read-out electronics has been kindly made available by the University of Pennsylvania.

Author: SCHWEGLER, Philipp (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)

Co-authors: FINK, David (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut)); KROHA, Hubert (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); FRAS, Markus (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); KORTNER, Oliver (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); RICHTER, Robert (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); NOWAK, Sebastian (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); OTT, Sebastian (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); ABOVYAN, Sergey (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut)); DANIELYAN, Varuzhan (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut)); ZHAO, Yazhou (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut))

Presenter: SCHWEGLER, Philipp (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)

Session Classification: Second Poster Session

Track Classification: Systems