

Measurement of arrival time of particles in extensive air showers using TDC32

S. K. Gupta · J. Christiansen · Y. Hayashi ·
A. Jain · P. K. Mohanty · K. C. Ravindran ·
B. Satyanarayana

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Abstract Arrival time of particles in an extensive air shower (EAS) is a key physical parameter to determine its direction. EAS direction is useful for studies of anisotropy and composition of cosmic rays, and search for multi-TeV γ -rays sources. Accurate timing may be used to search exotic phenomena such as production of new particles at extremely high energies available during early stages of development of EAS and also for detecting sub-relativistic hadrons in EAS. Time to digital converters (TDCs) are used to perform this task. Traditional TDCs operate in the START-STOP mode with limited dynamic range and single-hit capability. With the advent of high luminosity collider LHC, need for TDCs with large dynamic range, multi-hit capability and TRIGGERED mode of operation became necessary. A 32 channel TDC was designed for the GRAPES-3 experiment on a CAMAC platform around TDC32, an ASIC developed by micro-electronics group at CERN, Geneva. Four modules were operated in the GRAPES-3 experiment. Here, we present details of the circuit design and their performance over several years. The multi-hit feature of this device was used to study the time structure of particles in the EAS on time scale of $\sim 1 \mu\text{s}$. The distribution of time intervals in the

S. K. Gupta · A. Jain · P. K. Mohanty · K. C. Ravindran · B. Satyanarayana
Tata Institute of Fundamental Research, Mumbai 400 005, India

S. K. Gupta (✉) · A. Jain · P. K. Mohanty · K. C. Ravindran · B. Satyanarayana
GRAPES-3 Experiment, Cosmic Ray Laboratory, Ooty 643 001, India
e-mail: gupta@grapes.tifr.res.in

J. Christiansen
Microelectronics Group, CERN, Geneva 23, Switzerland

Y. Hayashi
Faculty of Science, Osaka City University, Osaka 558-8585, Japan