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New RPC front-end electronics for hades

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Time of flight detectors are used for both particle identification and triggering. RPC detectors are becoming widely used because their excellent TOF capabilities and reduced cost. The new ESTRELA Resistive Plate Chamber (RPC) detector, which is currently being installed in the HADES detector at Darmstadt GSI, will contain 1000 RPC modules, covering a total active area of 8 m2. It has excellent TOF and good charge resolutions. Its Front-End electronics is based on a 8 layer Motherboard (MB) providing impedance
matched paths for the output signals of each of the eight 4-channel Daughterboards (DB) to the TDC.

Summary

HADES is a High Acceptance DiElecton Spectrometer currently installed at GSI Darmstadt (Germany), which has as main goal the detection of electron pairs produced in relativistic pion-nucleus and nucleus-nucleus collisions, with high invariant-mass resolution and high acceptance, to obtain information about the modification of the properties of vector mesons in nuclear matter, both normal and hot and compressed. HADES consists of several subdetectors providing triggering, and particle identification and discrimination capabilities. Among these subdetectors there is a TOF system, built of plastic scintillator rods read by photo-multiplier tubes at large angles and of Resistive Plate Chamber (RPC) detectors at low angles, where the particle rate is low enough. This new low angle ESTRELA detector, which has recently been approved, covers a polar angle between 18 and 85 deg. with 2pi azimuthal acceptance, and consists of a RPC wall containing 1000 double-sided readout detectors (2000 channels) distributed in 6 sectors, covering an active area of 8 squared-meters.

The Front-End electronics consists of 2 kind of boards: 4-channel daughter boards (DB) and 32-channel motherboards in which 8 DB are allocated. Accurate timing measurement are performed by adjustable threshold discriminators.

The charge of RPC signals are measured from the time-over-threshold of the integrated signals (with sliding reference threshold in the next upgrade) via a comparator with latch-enable, and are encoded as LVDS signals. Output signals contain information about both detection time and ionization charge. Time information is given by the rising edge of the output signal, which gives the detection time. Charge information is given by the width of the output pulse. The 6-layer DB boards provide a digital LVDS

output signal containing accurate time and charge information in a compact design, using a reduced number of commercially available and inexpensive components.

The MB is a 8-layer board providing voltage regulation. Stable thresholds for time-of-flight and time-over-threshold are set by DAC circuits daisy-chained on the motherboard and remotely programmable by Serial Peripheral Interface. A 3-stage circuit of summing operational amplifiers generates a multiplicity signal to be used for low level trigger purposes.

The motherboards are 8-layer PCBs, use the novel technique of plugged vias and are completely impedance matched to reduce signal reflections and distortions. Connectors have been carefully selected, and are high frequency, differential and impedance matched.

Measurements for both electronic pulses and gamma ray sources show, respectively, about 15 ps (for
pulses above 100 fC) and 40+-5 ps TOF resolutions values. Studies
of data with several channels firing simultaneously show levels of cross-talk below 1% for a threshold of 25 fC, and a worsening of the time resolution of 10 ps at most. Recent data for cosmic rays and secondaries from 1 GeV C-C collisions show efficiencies larger than 90% and a time resolution about 75 ps (including the detector response).

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