Performance of the New Readout Frontend for the HADES RICH ◇

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Currently the HADES data acquisition system is upgraded to cope with a sustained trigger rate of 20 kHz for events with charged particle multiplicities $M \simeq 200$. In this context the GASSIPLEX based photon detector readout of the RICH is replaced by new frontend cards utilizing the low noise amplifier chip APV25S1 [1]. The chip, developed for Si - detectors in LHC experiments, offers 128 analog input channels with 192 cell analogue pipeline. By selecting particular, non standard operation parameters [2], the effective signal peaking time can be adjusted to $\tau_{RC} \simeq 200\,\text{ns}$ such that the readout of gaseous detectors becomes feasible. For the photosensitive multiwire proportional chamber (MWPC) of the RICH signals from $6 \cdot 4712 = 28272$ cathode pads have to be processed. Digitization and zero suppression is performed by an FPGA controlled 12 bit ADC Module (40 MHz). The data stream is read out by the HADES TRB net [3] via an optical link with 2 Gbit/s full duplex data transfer capability.

We have compared the response of the new APV and the old GASSIPLEX ($\tau_{RC} \simeq 1000\,\text{ns}$) readout to MWPC pad signals induced by single photo electrons from the conversion of VUV photons on the CsI pad cathode. The detector module with CaF_2 window was irradiated by photons ($\lambda = 170\,\text{nm}$) from a Xenon excimer light source and operated with CH_4 at atmospheric pressure and anode voltages between 2150 V and 2500 V. The recorded pulse height distributions (see Fig. 1) exhibit the exponential decrease typical for avalanches induced by single electrons. From the mean charge values A_0 and the known gas gain we extract a sensitivity $S = (77 \pm 5)\,e^-/\text{ch}$. Noise distributions were obtained from pedestal amplitude measurements (see inlet of Fig. 2) and yield $\sigma = 840\,e^-$ for the APV frontend.

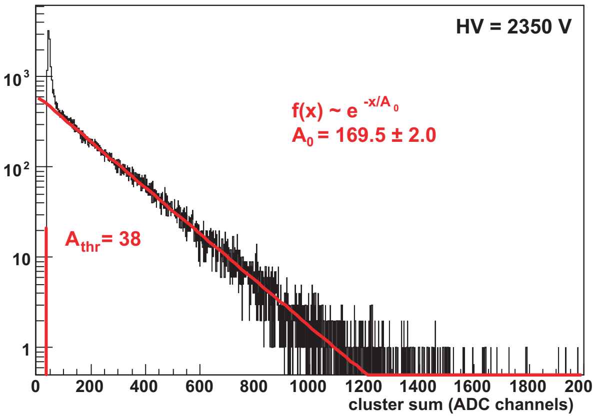

Fig. 1: Summed pulse height distribution of pad clusters measured in a CsI - MWPC with the APV25S1 frontend for single photon triggers.

Single electron detection efficiencies $\epsilon_{det} = e^{-\frac{A_{thr}}{A_0}}$ extracted from fits of the pulse height distributions are plotted for various MWPC anode voltages in Fig. 2. The achieved efficiencies are similar to those measured with the GASSIPLEX, inspite of the smaller signal fraction seen by the APV chip, and reach $\epsilon_{det} \simeq 90\%$ at nominal voltage.

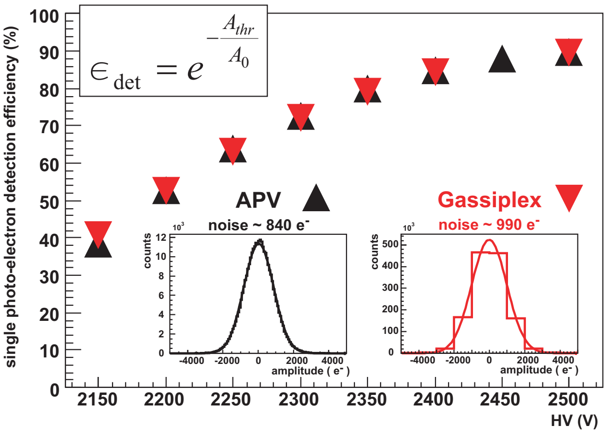

Fig. 2: Electron detection efficiencies and noise distributions (inlet) measured with the RICH photon detector module.

We have also irradiated the MWPC with α particles from an ^{241}Am source to check the APV response for very high charge injection as it occurs for heavily ionizing particles (HIPs) (see also [4]). In HADES experiments such HIPS find their way to the RICH MWPC and create typically 200 - 1000 primary e^- inside the gas volume. These signals strongly affect the baseline of all APV channels depending on the hit position. A pedestal subtraction suppresses the small signals from photo electrons in a very large area. Our solution to this problem is to leave the odd APV channels unconnected (NC). Performing an event by event pedestal measurement of the NC pads recovers the baseline (see Fig. 3) for each signal channel and hence restores single electron sensitivity.

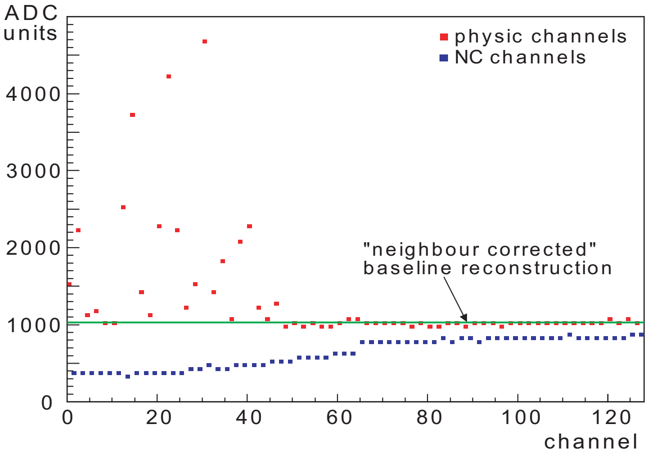

Fig. 3: APV response to HIPs. Pedestal correction using NC odd channels (blue) restores the baseline (green) for signal channels (red).

References

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