MPPC readout of plastic scintillators*

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MPPC, a Multi-Pixel Photon Counter [1], belongs to the family of the silicon photomultipliers similar and competitive in many respects to the standard photomultiplier tubes. The main advantage of these fast light sensors, apart from a small size and relatively low biasing voltage, is their insensitivity to magnetic fields. This was the main reason to test them as light readout devices for prototypes of the Trigger Array designed for the SAMURAI experiments at RIKEN [2]. The Trigger Array has to provide fast (100-150 ns) trigger and veto signals for the SPiRIT TPC chamber placed inside the 0.5 T magnetic field of the SAMURAI magnet. The veto signal has to be generated for heavy ($Z>20$) fragments passing through the TPC, enabling a quick closure of the gating grid in that case. Thus, the array has to provide in addition a possibility of charge discrimination. A schematic setup of the beam test is presented in Fig. 1.

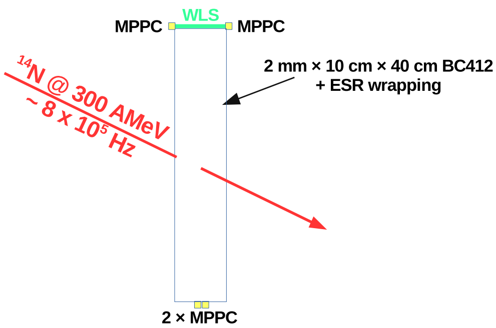

Figure 1: Schematic beam test setup.

During the S333 beam test, the 300 MeV/nucleon nitrogen ions were passing through the 2 mm thick BC412 plastic scintillator wrapped with a highly reflective ESR foil. The signals were read out in two ways: using the two 1×1 mm^2 MPPCs with 10000 pixels attached directly to one side of the scintillator and using the wave length shifting, WLS, fiber (BCF92) read out from both ends by the same type of MPPCs on the other side. The current pulses were amplified with custom designed fast preamplifiers [3] and digitized using the 500 MHz, V1730 digitizer.

Fig. 2 shows a sample wave-form for three nitrogen projectiles coming close in time. On average, the WLS fiber introduces about 2-3 ns delay as compared to the direct readout. The direct readout provides about 1 ns better time resolution (about 15 ns FWHM) and about 0.5 ns faster rise time (about 4.6 ns between 10-90% of the amplitude).

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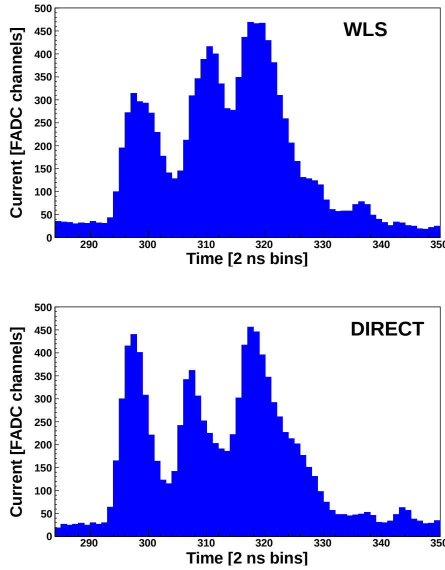

Figure 2: Pulse shapes for three neighboring projectiles readout using the WLS and direct methods with the 500 MHz digitizer.

The WLS readout has been tested because, in the first place, it should assure a better position independence of the amplitude. First tests also showed a slightly better amplitude resolution and a higher light collection, about 40% more as compared to the direct readout. The estimated charge resolution around Z=7 amounts to about 1.6 units of atomic number Z. Since the TPC measurements do not allow for very high beam intensity measurements anyway, a slightly better timing performance of the direct readout was found not to play a decisive role in selecting the final readout method. The final design of the Trigger Array assumes the WLS readout which assures a better position independence of the pulse amplitude, a fast rough charge determination of the passing through ion, and the on-line monitoring of the amplitude deterioration due to the radiation damage of the plastic scintillator. The usage of our custom designed [3] high stability and temperature compensated power supplies for the MPPCs is an additional advantage.

References

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