Bench tests of PMTs and voltage dividers for counting applications at FAIR

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This contribution presents selected results from tests of Photomultipliers (PMT) and active voltage dividers (AVD) with a laser diode.

At FAIR, plastic scintillator counters will be used for beam intensity and beam loss measurements [1]. Furthermore, the Photonis company phased out the production of the XP2972 PMT, which is presently used in the beam diagnostic counters at GSI [2,3]. Commercially available PMTs from Hamamatsu and ET Enterprises were selected, based on photo-cathode area, gain, signal rise time and transit time spread. The gain variation and the maximum counting rate were determined for combinations of the selected PMTs and AVDs at various luminances. These parameters determine the scintillator thickness necessary for detection of an ion accelerated by SIS18/100, and the instantaneous beam intensity which can be measured by the counters.

Measurements and Results

Measurements were performed with the Hamamatsu R6427, ET Enterprises 9442B and Photonis XP2972 PMTs. They were biased by a Hamamatsu-H7415MOD, ET Enterprises E220BFN2-01 and an in-house developed active voltage divider.

The PMTs and AVDs were tested with a fast switched laser diode by PicoQuant (FSL500 with a LDH-S-C-405 laser head). This light source emits at wavelength of 405 nm, matching the 420 nm wavelength of maximum emission for a BC400 plastic scintillator.

The full active area of the tested PMTs was illuminated by light pulses of a fixed duration, of approximately 3 ns. Their intensity was varied by changing the FSL500 power setting and by neutral glass filters. The laser was triggered by a white noise generator. The trigger frequency was measured by a rate meter, while the PMT minimum anode amplitude and average anode charge were determined by a 50 Ohm terminated broadband oscilloscope.

The tested PMTs were illuminated by the same light intensity at different repetition rates. For each series of measurements the AVDs high voltages were adjusted in order to observe signals with similar amplitude at 10-100 Hz trigger rate. Data from three measurements are shown in Fig. 1. Before reaching the maximum counting rate for a given PMT-AVD combination the signal amplitude increases, due to the higher voltage drop between the last dynodes.

In the GSI AVD the last 6 dynode voltages are stabilized. The stabilization is done by a voltage follower based on the BSS125 SIPMOS transistor. In comparison, the Hamamatsu divider has 3 stabilized dynodes, while in the ET Enterprises divider all dynodes are stabilized. The measurements showed that the ET Enterprises and the GSI AVDs can withstand counting rates above 10 MHz. Further in-beam tests [4] favored the GSI-AVD, due to better performance at higher counting rates.

Measurements with different neutral glass filters showed more than 10 times larger gain variation for the Hamamatsu R6427 PMT, compared to the ET 9442B and XP2972 PMTs. Based on the tests described in this contribution and in Ref. [4], one can conclude that the optimum PMT-AVD combination for the future counters at FAIR and GSI is a Hamamatsu R6427 PMT powered by the GSI AVD.

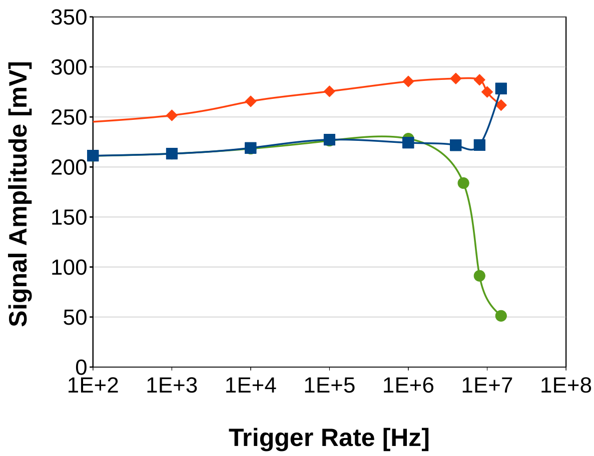

Figure 1: The solid curves follow the evolution of the signal amplitude of different PMT-AVD combinations as a function of the trigger rate. Blue-squares: Plots for the Hamamatsu R6427 PMT powered by GSI AVD. Orange-diamonds: ET 9442B PMT powered by E220BFN2-01. Green-circles: Hamamatsu R6427 PMT powered by Hamamatsu AVD.

References

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