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PMT Application Notes for Current Amplifiers

Note 1, Setup:

A PMT is first of all a photon counter that produces small charge spikes at the output for every photo-electron generated by the photocathode. So the output signal of a PMT is a stream of small charge peaks. Increasing the light inensity on the PMT will result in **more** peaks but the peak **height** will stay more or less constant. If you connect such a PMT directly to a 50 Ohm scope you will hardly see the individual peaks because they are about the same height as the noise of the scope.

If you connect such a PMT to a slow amplifier (or to a 1 MOhm scope) it will average across the peaks and give you an analog output voltage which will increase with increasing light intensity because **more peaks** produce a higher **average** signal.

If you use a fast amplifier like our HCA-200M behind the PMT it will amplify the peaks without averaging them because the amplifier rise time is short enough to resolve every single peak. As a result the output signal of such a PMT-amplifier combination is a stream of larger peaks. Increasing the light intensity will increase the **number** of peaks **but not the height** of the peaks.

Our experience with PMTs is that the HCA-200M-20K-C has often too much gain so that the stream of peaks at the PMT output will saturate the amplifier input. The HCA-400M-5K-C is often better suited.

Once you know how the user calculated the 200 nA you will be in a better position to recommend a specific amplifier.

Note 2, Linearity Issues:

1. Please make sure the oscilloscope has a high input impedance of e.g. 1 MOhm. The DLPCA-200 is NOT intended for a 50 Ohm load which could result in non-linearities.

2. The H6780 PMT has a pretty strong output ripple of a few mV due to the HV power supply which is built in. The DLPCA-200 will see and amplify this ripple. This ripple could have a negative impact on the accuracy and stability of the measurement. Averaging a few times with the oscilloscope should help to minimize this ripple.

3. The PMT output signals are usually very short (ns) but high spikes (a PMT basically is a photon counter producing short charge pulses for every detected photon). These spikes will be averaged by the much slower amplifier generating an output signal in the mV to V range with µs rise time. When using a PMT with a high gain current amplifier (10^6 V/A gain in this case) the first stage of the amplifier can sometimes be overloaded by the spikes even if the amplifier will average out the spike character of the PMT output signals and even if the averaged signal is in the right range (like nA in this case). Therefore it is sometimes necessary to add a filter between the PMT and the amplifier to avoid overload by the short spikes and to increase linearity. Please find attached a design for such a filter (one C parallel to the PMT output followed by a series R towards the DLPCA-200). This should help to optimize the linearity of the setup. It will have only a minor impact on the bandwidth of the system. If the measurements are relatively slow (a few kHz) increasing R to values around 100 kOhm will further increase the linearity.

Note 3, Low Noise Cable

CAB-LN1