Alternative readout using APDs

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NPS Readout

 The NPS default readout is with PMT. However, it has been shown that PMTs have a high sensitivity to magnetic fields. (1998) Cavallari







Some alternative readout otions with APDs

- Suitable for high luminosity and enviroments with strong magnetic fields
 Work with lower High Voltage (400V compared with 1.5kV required for PMT operation)
 - Have a lower sensitive area and a higher temperature dependence. (2014) Navatni, R. Et al

Initial test with preamplifier from Giessen University (Collaboration with R. Novothy, S. Diehl)









10x10mm²





(2014) R.W. Novotny and Panda Collaboration

Results from initial tests

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We got a signal in the order of microseconds when we expect a signal in the order of nanoseconds. Pick-up noises and the need of shielding.

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Modified setup incliding shielding (Collaboration with Celentano. A. Mann, H.)



- APD Amplifier
- APD
- PbWO4 Crystal
- LED



PMT vs APD

In order to get the Light Yield measurement. We still need to isolate the single electron peak from the pedestal.



Outlook

- Replacing the source: From LED to a Sodium-22 source in order to study how does the ADC spectrum change. Having a better reference to compare both of the ADC spectra.
- $\cdot\,$ Anechoic chamber
- Study temperature dependance (2014)
- $\cdot\,$ Obtain a LY measurement from the APD







APD signals: If the intensity is not enough



APD Signals: Sufficient high intensity



Do we really see SEP? - Further studies are required.

Crystal peak - dependence on the intensity of the input light source LED

Fitting the crystal peak into a Gaussian distribution we get a linear response:



Crystal Peak

The brighter the light we get more photoelectrons generated as a response from the APD.

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Ongoing work



Get the signal out of the PMT using the same crystal and the same source (LED)

Outlook



- Replacing the source: From LED to a Sodium-22 source in order to study how does the ADC spectrum change. Having a better reference to compare both of the ADC spectra.
- Anechoic chamber which simulates a quiet open-space, which is useful when exterior influences would otherwise give false results. (In collaboration with VSL Miguel Penafiel, Ian Pegg)
- Study temperature dependance (2014) Novotny.
- \cdot Obtain a LY measurement from the APD

References

- (2014) R.W. Novotny and Panda Collaboration. Photosensors: Large Area Avalanche Photo Diodes (LAAPD)
- (2016) C. Woody, EIC R&D Committee Meeting PWO Crystal Readout with SIPMs.
- (1998) Francesca Cavallari. Progress on Avalanche Photodiodes as photon detectors for PbWO4 crystals in the CMS
- (2009) D. Renker. E Lorents. Advances in solid state photon detectors.