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## Comparison of a Fast Avalanche Photodiode with a NaI Detector

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Beamline(s): X18A

**Introduction:** We have built a fast detector using a reach-through avalanche photodiode (APD) for use in X-ray scattering experiments up to 20 KeV that has the same energy resolution as the traditional NaI detector and can easily count to rates in excess of 10 MHz.

**Materials:** The detector system is comprised of two components. The first is a detector head, which has the same diameter housing as the commonly used Bicron NaI detector, and houses a 5 X 5 mm reach-through avalanche photodiode and multi-staged high speed amplifier [1]. The second component of the system is an electronics package that supplies the bias voltages for the detector head and a switch selectable constant fraction discriminator (CFD)[2] or a fast single channel analyzer (SCA). The objective of the design was to provide a package that non-specialists could easily apply in situations where the NaI detector was seriously limiting the experiment.

**Results:** In order to exercise the detectors over a large dynamic range, each detector was mounted in turn on the 2-theta arm of the X18A diffractometer and scanned near zero angle to measure the air scatter from a synchrotron x-ray beam. Counting rates for a standard NaI detector and an APD detector are shown in figures 1 and 2 for no attenuation, 0.1mm and 0.25mm of Aluminum attenuators. The maximum rate before the NaI detector saturates was approximately 10KHz (although, with shorter shaping times 100kHz can be achieved) compared to the APD detector that showed no signs of saturation to at least 2MHz. The theoretical maximum count rate at NSLS is dominated by the source bunch structure. The x-ray ring provides light pulses at a 50MHz rate and one might expect that rates approaching this would lead to some events recording two photons from a single bunch (i.e. pulse pileup).

**Conclusions:** We have provided a good alternative detector system to the time honored NaI - photomultiplier detector. This detector is advantageous to use for high count-rate and time resolved experiments[3] at modern X-ray facilities. The system has been designed to be simple and reliable to operate, and can handle as high a rate as can reasonably be used at NSLS in single pulse counting experiments.

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### References:

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2. M.D. Cable, et.al., "A low jitter, low cost, time-of-flight circuit", *IEEE Trans. on Nucl. Sci.*, **35**, No.1, Feb. 1988.
3. A. Q. Baron, "Detectors for nuclear resonant scattering experiments", *Hyperfine Interactions*, **125** (2000) 29-42.

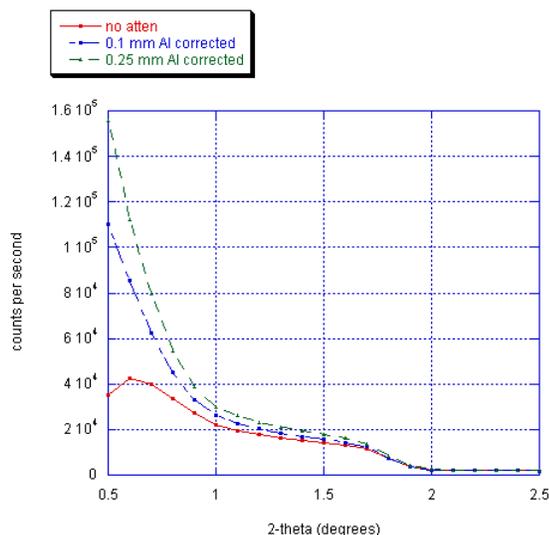


Figure 1. Count rate vs. angle for NaI detector

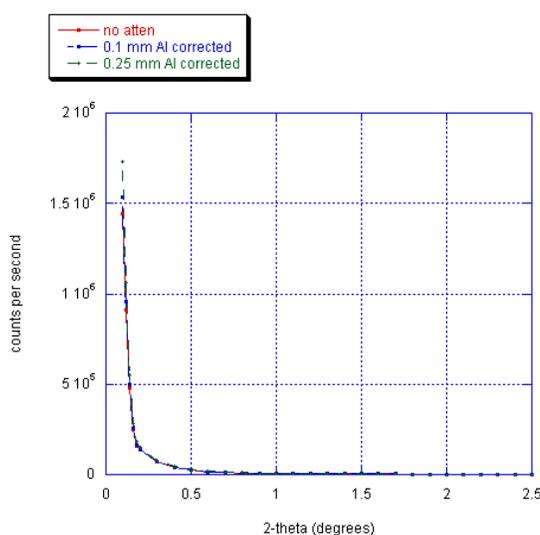


Figure 2. Count rate vs. angle for APD detector