Operation of Cyberstar Scintillation Detector

Donald A. Walko
MHATT-CAT, APS, Argonne National Laboratory, Argonne, IL 60439
d-walko@anl.gov

November 26, 2002, revised February 25, 2003

General Description

The Oxford Cyberstar X1000 scintillator detector ("Cyberstar") is advertised as a high-countrate detector, ideal for use at a synchrotron beamline. It consists of a scintillator head (the standard scintillator is NaI with Tl) and a NIM module pulse processor [high-voltage (HV) supply, shaping amplifier, and single-channel analyzer (SCA)]. Its settings can be controlled locally with the dials and switches on the front panel of the NIM unit, or remotely via RS232 protocol (via a program running on a Windows PC or via an EPICS screen.

An LED display shows the HV setting [250 V (when the HV dial is turned all the way down) to 1250 V], which is adjustable with a potentiometer. The gain of the shaping amplifier is adjustable between 0 and 100%, and the peaking time can be selected to be 0.3, 0.5, 1, or 3 μs. The lower level and upper level/window thresholds are adjustable between 50 meV and 10 V. The four-position "mode" switch determines how the SCA window is set: In Normal mode, the upper and lower levels are separately adjustable. In Integral mode, the upper level is disabled. In Asymmetric mode, the upper level adjusts the window 0 to 1 V above the lower level. In Symmetric mode, the upper level adjusts the window +0.5 V above and -0.5 V below the lower level.

There are four BNC outputs on the front of the NIM unit. "Signal Out" is the shaped unipolar pulse, which can be connected to an oscilloscope, MCA or external SCA. "Window Out" is the TTL pulse which is produced when the shaped pulse satisfies the SCA settings. The "Lower Level" and "Upper Level" TTL outputs include pulses outside of the SCA window, and may be useful in some applications.

Deadtime

Researchers at CMC-CAT [1] have demonstrated that a Cyberstar offers improved count rate capabilities compared to a BICRON detector. Specifically, the Cyberstar operated well up to 350k cps using a deadtime correction of about 1 μs (deadtime corrections become significant above $\sim$50k cps) using the 0.3 μs peaking time setting with 8.0-keV x rays. Longer shaping times will improve the energy resolution but degrade the count-rate performance;

higher energy x rays may also lower the maximum usable count rate. The CMC group fit the measured count rate N_0 to the "true" count rate N_T (measured with an ion chamber) via the form [2]

$$N_0 = \frac{N_T}{1 + N_T \tau}, \tag{1}$$

where τ was found to be 1.006(4) μs.

Typical Settings

Here are a few guidelines on the settings of the pulse processor. Table 1 shows settings which are appropriate for a number of x-ray energies (although you should always doublecheck that they are collecting all the pulses you want). These settings were found by pointing the Cyberstar detector downstream and measuring x-rays which were backscattered by air. The upper level was set to discriminate against pile-up peaks as well as the third harmonic, and the lower level was set to discriminate against low-level noise. The gain was set low enough such that the top of the third harmonic peak would not be clipped; if you are not concerned about harmonic contamination then you could easily raise the gain (and, thus, the lower and upper levels). For all these cases, the settings of **HV = 900 V**, **normal mode**, and **peaking time = 0.3 μs** were used.

X-ray Energy (keV)	Gain (%)	Lower Level (V)	Upper Level (V)
8	30	1.5	4.0
10	20	1.2	3.2
12	15	1.5	3.5
13	15	1.5	4.0
15	12	1.0	3.0
25	12	1.8	4.0
54	10	3.5	7.5

Table 1: Suggested Cyberstar settings with HV = 900 V, normal mode.

References

[1] T. Gog, C. Venkataraman, and D.M. Casa, CMC NewsBlip 01-02-01; `www.cmc.aps.anl.gov/techniques/notes/Szin_1/NB010201Szintillators.html`

[2] L.H. Schwartz and J.B. Cohen, *Diffraction from Materials*, Academic Press, NY (1977).