4B2/2007G093

# Statistical Properties of Observed X-ray Intensities Affected by Counting Loss

Takashi IDA*, Akihisa OYA, Hisashi HIBINO
CRL, Nagoya Inst. Tech., Asahigaoka, Tajimi, Gifu 507-0071, Japan

## Introduction

Observed X-ray intensity measured by a counting method is always affected by counting loss caused by finite response time of sensors and electronic circuits in detection systems. We have proposed an intermediately extended deadtime model to be used in analysis and correction of counting loss for real counting systems [1].

In this study, we have investigated the statistical properties of a counting system of the diffractometer on the beamline BL-4B2, simply by repeated measurements based on the Chipman's foil method, varying the X-ray intensities introduced to a detector. A mathematical formula to predict the statistical variance is examined by comparing with the experimental data.

## Experimental

Intensity of x-ray beam introduced to a counting system of the diffractometer was varied by rotating a 0.5 mm-width slit attached to the Θ-axis of the goniometer stepwise to obtain 67 data points. Twenty-time measurements for 0.5 s period, inserting and removing an attenuator, were repeated 10 times at each data point.

## Results

A typical result of repeated measurements at fixed intensity is shown in Fig. 1. Since periodical change of intensities of X-ray signal has been observed, segmented lines are fitted to the observed data, and the residuals are identified as the statistical variation of observed intensity. Figure 2 plots the average and variance of the unattenuated intensities versus the average of attenuated intensities.

The errors in the estimated variance of the unattenuated intensities $\Delta v$ have been calculated by

$$\Delta v = n^{-1/2}\left[\left\langle (y-y_{calc})^4\right\rangle - \left\langle (y-y_{calc})^2\right\rangle^2\right]^{1/2}, \qquad (1)$$

where $y$ is the measured intensity, $n$ the number of data, $y_{calc}$ the value of fitted lines, and $\langle y \rangle$ means the average of $y$.

The observed relation between the average values of attenuated and unattenuated intensities was fitted by using an intermediately extended deadtime model, which gives the optimized values of deadtime $\tau$ = 1.0649(3) μs and degree of extension $\rho$=0.8689(6). The curve calculated from the following equation are also drawn in Fig. 2.

$$v_{calc} = \frac{rT}{(1+r\tau_1)^3}\exp(-r'\tau_2)\left[1-2r'\tau_2\exp(-r'\tau_2)\right] \qquad (2)$$

$$r' = \frac{r}{1+r\tau_1},\ \tau_1 = \tau - \tau_2,\ \tau_2 = \rho^{1/2}\tau$$

where $r$ is the true pulse rate and $T$ the measurement period. It is suggested that the observed variance is slightly enhanced from the value calculated from eq. (2) , because of time-dependent change of the source x-ray beam intensity, which could not thoroughly be subtracted.

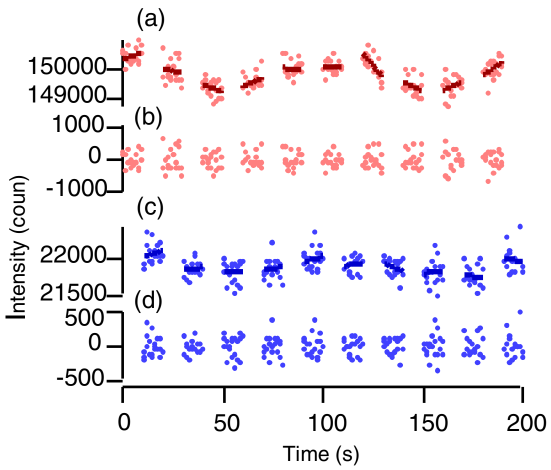


Fig. 1 (a) Intensities measued without an attenuator and (c) intensities measured with an attenuator. (b) and (d) show the residuals from the optimized segmented lines.

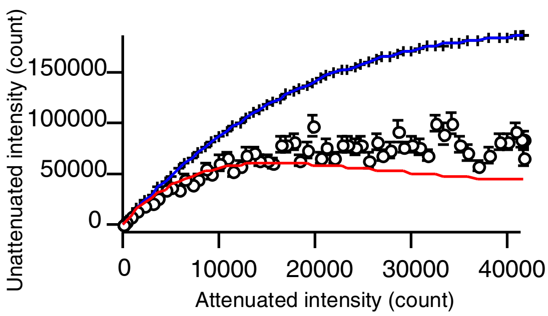


Fig. 2 Average (crosses) and variance (circles) of observed intensities. Blue and red lines show the calculated curve.

## References

[1] T. Ida et al., J. Appl. Cryst. 38, 426 (2005).

* ida.takashi@nitech.ac.jp