# Answers to Common Questions about the DXP-4C

**Q: How is the DXP-4C able to count twice as fast as an amplifier/SCA when it does multi-channel analysis?**

A. This depends on three factors. First, the filtering is digital, so when a peak value is captured, no further digitization time is required. Second, the digital filter produces nearly ideal trapezoids which terminate cleanly, as compared to analog filters which have extended tails. This allows digitally filtered pulses to come closer together without piling up, which increases the throughput. See Figs. 1a and 1b below. Third, even an SCA introduces dead time because its window test must wait to see if a pulse crossing the lower level stays within the window without crossing the upper level. See Fig. 1c. This inspection time adds to the system overall dead time. The DXP does all of its testing in a fast channel before the slow channel peak arrives. The peak can then be captured and transferred to the output buffers in only 1 clock cycle (50 ns) which doesn't add to the deadtime, being less than the peaking time.

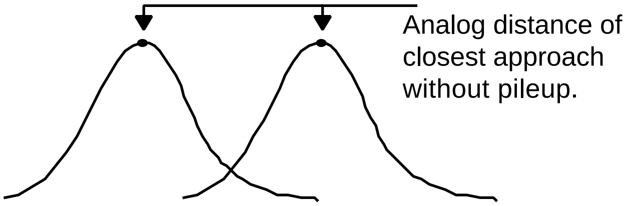

Figure 1a:

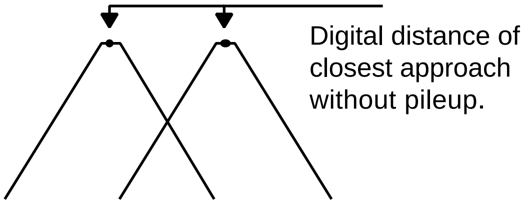

Figure 1b:

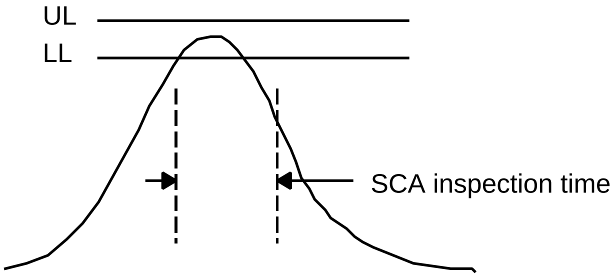

Figure 1c

**Q: Will the DXP-4C work with my existing detector?**

A: Probably. The DXP-4C works with most common preamplifiers of either polarity. To date we have operated successfully with detectors from EG&G Ortec, Canberra, Kevex, and detectors in several firms' specialty analysis equipment.

**Q: How do I supply my preamp reset pulse to the DXP-4C?**

A: You don't have to. The DXP detects resets automatically. It normally looks for x-ray steps in the preamp output. When it detects a very large "negative" step, it understands that a preamp reset has occurred and suspends collection for a preset time (which is set as a parameter) to allow the preamp to recover.

**Q: I have a VME system and the DXP-4C is a CAMAC module. How can I use it?**

A: The DXP-4C was produced in CAMAC format because, among other things, the VME environment is a digital environment and not quiet enough for the DXP's very low noise analog front end. For multi-element detector arrays we recommend the following approach: consider the detector electronics to be a "black box" which you can control from VME. This is implemented by acquiring: 1) a CAMAC mini-crate (about $3000; 2) a CAMAC crate controller that interfaces to VME (about $2000); 3) as many DXP-4C cards as your detector needs (3.25 for a 13 element detector, about $29,000); and, 4) a Preamp Distribution Module (about $1,100) to supply preamp power from the CAMAC crate to minimize ground loops. This whole system is then placed in the hutch, very close to the detector array, and controlled from your VME system. This has a distinct performance advantage as well, since the short preamplifier cables will eliminate the noise pickup that would result if they were strung to amplifiers outside the hutch. Here, only noise resistant digital signals are shipped outside the hutch.

**Q: How do I integrate the DXP-4C into my existing data collection system?**

A: You have several options. 1) We have written C-code drivers which will simplify controlling the DXP from your present software. The DXP has both an on-board computer and digital signal processor which require downloaded code and operating parameters, so this approach will have the longest learning curve, but will give you the most complete control in the end. You can consider such opportunities as automating your data collection, implementing data quality inspection, etc.. 2) XIA has moderately complete LabView® software developed for downloading operating code, setting parameters and collecting spectra. If you are already using LabView®, which runs on PCs, Macs, and Suns, this is a very fast way to get started. 3) We are presently working with the creator of SPEC® to integrate DXP support within that program. 4) We are also working with a few researchers who are planning to integrated DXP support into their existing programs and have indicated that they might be willing either to share their software or allow XIA to distribute it.

**Q: How do I estimate the throughput that I can expect with the DXP-4C?**

A: Throughput can be estimated fairly accurately using the extending deadtime formula relating the output counting rate (OCR) to the input counting rate (ICR):

$$\mathrm{OCR} = \mathrm{ICR}\,\exp(-\,\mathrm{ICR}\;\tau_d), \qquad (1)$$

where, for the DXP-4C, the deadtime $\tau_d$ is very nearly twice the peaking time $\tau_p$. From Fig. 2 in the brochure estimate the peaking time you need to achieve acceptable energy resolution, double it, and substitute into Eqn. 1. For example, for 210 eV, choose a 2 μs peaking time, which gives 4 μs for $\tau_d$. From Eqn. 1, maximum throughput will then occur when ICR $\tau_d$ is unity, or the ICR is 250 Kcps. The maximum ICR will then be 1/e of this value or about 92 Kcps. This number scales inversely with $\tau_p$, so at 1 μs peaking, the maximum would be 184 Kcps, etc.

## Q: What about pileup?

A: Because the DXP-4C implements both fast channel and slow channel pileup inspection tests, instead of the usual, single, slow channel test, its pileup rejection is excellent, as shown in Fig. 4 of the brochure, which was taken at 230 Kcps, illuminating a Cu target at a synchrotron. Because the synchrotron is a pulsed source, many of the pair peaks are real, that is, come from pairs of x-rays arriving in the same light flash. The region between the singles and pairs reflects the improvement in pileup, being over 3 orders of magnitude down form the peak of the $K_\beta$. At this same rate, measurements using good analog spectroscopy amplifiers typically show a pileup background at about the $5x10^3$ level. The DXP's performance is therefore about 2 orders of magnitude better.

## Q: How do I do deadtime corrections using the DXP-4C?

The DXP-4C reports the following numbers: the spectrum of output counts, their sum (OCR counts) the number of input counts its fast channel detected (ICR counts), and its total livetime, as measured by its internal system clock. This allows throughput curves to be measured for a given set of filter parameters, as shown in Fig. 3 in the brochure. Note that both the OCR and ICR can be described by curves of the form of Eqn. 1 above. This is because there is also pileup in the fast channel, an issue which is often overlooked. A throughput curve measurement is typically run by sequentially stepping up the x-rays' intensity and then fitting to the ICR and OCR values to obtain the fast and slow channel dead times.

Given these deadtimes, obtaining accurate answers then proceeds according to the following recipe. First, for each experimental point, correct the ICR, OCR and all channel counts for the time the DXP-4C was really "live". This means, for example, that times when the preamplifier was resetting are not counted as part of the collection time. Second, numerically invert Eqn. 1 in its ICR form to obtain the "true" value $ICR_T$ of the ICR. Third, form the scaling constant $K = ICR_T/OCR$, which is the inverse of the ratio between the total number of counts that actually were detected and the number that were actually binned into the spectrum. Fourth: multiply each channel value in the spectrum by K to rescale the spectrum so that it contains $ICR_T$ counts rather than OCR counts. The spectrum has now been corrected for all deadtime effects. We have found experimentally that this can typically be done to better than 0.5% over a very wide range of input count rates (ex. from 0 to 120 Kcps using 4 μs peaking time).

## Q: How does the DXP-4T do timing, and what can it be used for?

A: Because the DXP is digitally based, it can tell what time it is, using its system clock. The DXP-4T basically has two operating modes. In the first it acts like a multichannel scaler: if an x-ray satisfies an SCA window test, then it is binned according to the time that has passed since a SYNC pulse in a repetitive experiment. Thus if a laser initiates some phenomenon, and this can be done repetitively, the DXP could be used to collect fluorescent counts as a function of time after the laser pulse, allowing time resolved EXAFS, for example. Since the system clock is 20 MHz, time resolution to the microsecond level is possible.

In its second mode, the DXP-4T can be set up to collect multiple internal spectra and the SYNC pulse used to cause data collection to cycle sequentially between them. In a simple example, two spectra could be used to collect data from above and below the superconducting transition temperature in a high TC sample. This can be called “Phase Locked” EXAFS and can be effectively employed to reduce noise in EXAFS measurements in the same way a Phase Locked Amplifier is used to reduce noise in voltage measurements, effectively eliminating noise from environmental sources at frequencies lower than the phase switching frequency.

**Q: Could you summarize the DXP-4C’s advantages?**

A: The first advantage is high throughput at low cost. The DXP-4C can essentially give you the performance of twice as many detector elements at much less than the cost of a traditional amplifier plus SCA system. The speed advantage is even larger when comparing to traditional amplifier plus MCA systems. The second advantage is that it then also gives a full MCA analysis for each detector element. The third advantage is that it occupies much less space than traditional approaches. The fourth is that all functions are computer controlled, allowing both spectrometer tuning and data collection functions to be fully computer automated. This also means that data quality verification tests can also be implemented. Fifth, because of its excellent pileup rejection, the DXP-4C gives very clean spectra in situations where there are many spectral lines. Sixth, because it also reports the number of input counts it detects, the DXP-4C allows very accurate dead time corrections to be made.