FalconXn: Mapping Buffer Specification

The FalconXn (n=1, 4 or 8) currently supports two high-speed data acquisition modes: MCA mapping mode (or gated acquisition mode) and list mode; multiSCA mode may be added at a future time. For MCA mapping mode, one full spectrum for each active channel is generated for each pulse on the GATE input. The list mode output, based largely upon the output available from the MAIA detector, can incorporate a wide variety of data into the output data stream: event energies (with or without time stamps), gate states, encoder values, as well as general time stamps. In order to provide a high level of backwards compatibility with existing applications for XIA spectrometers, we process the mapping data into formats consistent with those used for high speed mapping on our DXP-Mercury and DXP-xMAP processors.

In mapping mode, the DXP processors use two completely separate memory buffers; this enables the system to take data into one buffer while the other buffer is read out by the host computer. The size of each buffer is 2MB, organized as 1Mword by 16 bits. For the FalconXn, we will use the same sort of ping-pong buffer scheme; however, the output buffers are built in computer memory, and do not have the same size constraints.

For all timing modes, the buffer starts out with a buffer header, containing general information about the data contained in the memory block. For all timing modes involving sequential pixels, there is also a pixel header block, typically containing statistics information (used to make pileup corrections on a pixel by pixel basis).

The format of the data contained in the buffers is described in detail in the following sections.

Buffer Header

For all timing applications that use the dual buffers, the buffer header will have a fixed, 256-word length (the word size is 16 bits in this mode). The contents of the header are defined below:

Word Number	Contents
0	Tag Word 0: 0x55AA
1	Tag Word 1: 0xAA55
2	Buffer Header Size (=256)
3	Mapping Mode: 1: Full Spectrum 2: Reserved 3: List Mode

Word Number	Contents
4	Run Number
5 to 6	Sequential Buffer Number (low word first)
7	BufferID (0:A, 1:B)
8	Number of Pixels in buffer
9 to 10	Starting Pixel Number (low word first)
11	Module Serial Number?/Module #
12	Detector Channel
13	Detector Element (not implemented)
14 to 19	Reserved (set to 0)
20	Channel Size (number of words)
21 to 23	Reserved (set to 0)
24	Buffer errors: Buffer overrun 0: No error >0: Number of extra pixels combined with last pixel in buffer Not implemented
25 to 255	Reserved (set to 0)

Pixel Data Block

For all mapping modes based upon pixels, the data block for each pixel will start with a pixel header, followed by the data collected for the pixel. The header can differ in size for different mapping applications; in general, the header contains the statistics data required to make pileup corrections on a pixel-by-pixel basis (live time, real time, input triggers, and output events). The full data blocks are described below for the various mapping modes.

Mapping Mode 1: Full Spectrum Mapping

The pixel header for full spectrum mapping mode is described below; due to the constraint in the DXP-Mercury that the spectra sizes are a multiple of 256 and must start on an even multiple of 256, the size of the pixel header is 256 words in this mode to maintain cross-compatibility.

The data block for full spectrum mapping mode contains the spectrum. The length of the spectrum is constrained to be a power of two, with a minimum of 256 and a maximum of 8192. The format for the entire pixel block is described in the table below; please note that the pixel header definition is designed to be consistent with the xMAP, which requires room for three additional channels.4

Word Number	Contents
0	Tag Word 0: 0x33CC
1	Tag Word 1: 0xCC33
2	Pixel Header Size (=256)
3	Mapping Mode (=1)
4 to 5	Pixel Number (low word first) In the case of a mapping error where one pixel record combines data from several pixels, this is the number of the last pixel recorded.
6 to 7	Total Pixel Block size in words (including header, low word first)
8	Spectrum Size K
9 to 31	Reserved (set to 0)

Word Number	Contents
32 to 39	Statistics: Realtime (2 words, low word first, 320 ns per tick) Livetime (2 words, 320 ns ticks) Triggers (2 words) Output events (2 words) Note: when converting FalconX list mode data into mapping mode buffers, the statistics from the FalconX are converted to xMAP-style statistics. The statistics offered by the FalconXn are output events, Triggers, icr and ocr. Define xMAP statistics in terms of these values: Realtime = output events/ocr Livetime = Triggers/icr Triggers = pulsesAccepted + pulsesRejected Output events = pulsesAccepted
40 to 71 (assuming a double is 64 bits)	Reserved for Channel Statistics, SI$_{TORO}$ format, if needed (currently set to 0) Elapsed Time (double) Samples Detected (total clock ticks) (u64) Samples Erased (Clock ticks) (u64) Total Accepted Events (64) Total Rejected Events (64) Input Count Rate (double) Output Count Rate (double) Dead Time % (double)
72 to 254	Reserved (set to 0)
255	Product Type (Not implemented)
256 to (256 + 2*K − 1)	Channel Spectrum (2 words/bin)

Mapping Mode 2: Reserved

This mode is used for Multiple SCA mapping on the xMAP.

Mapping Mode 3: List Mode Mapping

The pixel header for list mode mapping is described below; there is no constraint on the data alignment in the buffer, so the header length is shorter than the 256 words required for full spectrum mapping.

For the data block in list mode, each word contains data for a single event. The events are stored in the order they are processed, and so the data are not separated according to channel. The channel number information is embedded into the upper two bits of the data word itself; the lower 14 bits are sued to store energy information (typically MCA channel number); for the case of the Mercury, the upper two bits will always be zero.

The format for the entire pixel block in list mode is described in the table below.

(to be added)