CONTINUOUS READOUT CAPABILITY

The CCD and IR controllers now support a continuous readout mode wherein a single start exposure command initiates the readout of a specified (and possibly very large) number of frames that are then written to the host image buffer without any further intervention by the host computer. Normally the host computer image buffer size is large enough that it can contain many frames, so in continuous readout mode the frames are written sequentially to the image buffer until it is full. When it is full the timing board sends the Initialize Image Address = 'IIA' command to the PCI interface board instructing it to set its current PCI address to the base address so subsequent frames will be written to the beginning of the buffer, overwriting the ones that had been written earlier. This is a classical single circular buffer. While the frames are being written the host computer interrogates the PCI interface board to determine the number of frames that have been transferred, using this information to move the pixel data out of the image buffer at the end of each frame's transfer and before they're overwritten on the next pass. An important detail is that the PCI board writes each new frame to the next address that is a multiple of 1024, because the PCI board writes data in bursts of 512 pixels (1024 16-bit bytes) that cannot cross 16-bit address boundaries. Voodoo can do one of two things with the pixel data, one where the frames are coadded into a single 32-bit precision image and the second where many frames are written to disk in FITS format files whose sizes are the same as the host computer's image buffer.

Continuous readout is currently supported only for the faster 250 Mhz fiber optic data link, that is for ARC-22 timing boards and ARC-64 or ARC-65 interface boards. DSP firmware that supports continuous readout mode must reside in both the PCI board and the controller's timing board. The PCI code can be supplied to users for downloading to their DSP or writing to their EEPROM and example code for IR and CCD controllers will be supplied. New revision PALs will be distributed on request.

Sun Systems require a Rev. 5.1 PAL U19 for the PCI board, which has only recently been released. This is required because byte swapping of image data is needed in Sun's implementation of the PCI bus interface, and it needs to be done in hardware rather than software to keep up with the maximum 12.5 Mpix/sec controller data transfer rate. This is not required for Windows or Linux machines, that is for PCs, because they do not require byte swapping at all. In non-continuous readout, Voodoo performs the byte swapping in software after the image has been written to host memory, but in continous readout mode this is not possible since the data flow cannot be interrupted.

Continuous readout mode is selected by sending two commands to the timing board. The Frames-Per-Buffer (FPB) command allows the timing board to send the 'IIA' command to the PCI board at the correct time and Set Number of Frames (SNC, or set number of coadds) determines the total number of frames that will be sent until another SEX command is issued. The number of frames can be any 24-bit number. Continuous readout mode can be de-selected by issuing the SNC = 1 command. It is well suited to being used with synchonized readout wherein an exposure will only start when an external SYNC pulse is asserted true. The number of frames to be read can be set much

larger than the anticipated need, and the continuous readout sequence can be stopped by issuing an abort exposure command.

Controllers that support the continous readout mode can have one of their controller configuration bits set so Voodoo can ascertain that the capability is supported. The bit number for continous readout is #20, its mask is 0x100000, and it is indentified as 'CONT_RD' in the DSP timing board code in the "timhdr.asm" and "tim.asm" files. The controller code for implementing this is located in the START_EXPOSURE area of the "timCCDmisc.asm" file and at the end of the RDCCD area in the "tim.asm" file.

Voodoo's Coaddition Sequence

The shutter status and exposure time are set in the normal fashion. Start exposure is issued and Voodoo then enters a loop, which exits when Voodoo's total frame counter reaches the number of frames set by the SNC command. Voodoo polls the PCI board for its frame counter. When the PCI board's frame counter is greater than Voodoo's then a complete frame has been written to the image buffer, so voodoo reads the frame just written by the PCI board, and adds it to the 32-bit coadded image that is accumulating in a separate buffer.

Voodoo's Write-To-Disk Sequence

The shutter and exposure time are set in the normal fashion. Start exposure is issued and Voodoo then enters a loop, which exits when Voodoo's total frame counter reaches the number of frames set by the SNC command. If the number of frames is greater than one then the timing board recognizes that it is in continuous readout mode and transfers the indicated number of frames, as well as the 'IIA' command to the PCI board every FPB frames. Voodoo polls the PCI board for its frame counter and writes the images to disk ¼ of an image buffer at a time. Each FITS file contains one image buffer's worth of frames, except for the last file written which may contain fewer images.

Device Driver Commands

The PCI board frame count can be read by sending the following I/O control command (unix/linux: ioctl, win2k: DeviceIOControl) to the device driver:

```
ASTROPCI_GET_FRAMES_READ = 0x5
```

In turn, the device driver sends the following vector (HCVR) command to the PCI board:

```
READ_NUMBER_OF_FRAMES_READ = 0x807D
```

The command syntax is a follows.

FPB – Frames Per Buffer
This tells the Timing board how many image frames will fit into the current image buffer. Voodoo automatically calculates this value.

Usage: `0x000203 <'FPB'> <arg1>`
- `arg1 is the number of frames-per-buffer`

SNC – Set Number Of Frames
This tells the Timing board how many image frames to continuously send.

Usage: `0x000103 <'SNC'> <arg1>`
- `arg1 is the number of frames to be sent by the controller:`
    `arg1 = 1 Single readout`
        `>= 2 Continuous readout`

SBS – Set Byte Swapping
This instructs the PCI board whether or not to byte swap the image data before writing it to the host computer image buffer. This mode is only set once at Voodoo startup and is for Sun Systems only.

Usage: `0x000203 <'SBS'> <arg1>`
- `arg1 turns hardware byte swapping on/off`
    `arg1 = 0 No hardware byte swapping`
        `= 1 Yes hardware byte swapping`