PHARO Report
On Work Done 2003 August 12 – 17

- by -
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Introduction

Bruce Pirger arrived from Cornell on Tuesday, August 12, 2003 to help us work on the three problems and two upgrades identified in my email "PHARO" sent June 6, 2003. The three PHARO problems are:

1. Internal wheels (esp. Lyot) do not always move to the requested position
2. The array is not linear
3. Images taken in fast sequence show odd signal behavior, especially in the RESET/READ frames. This behavior diminishes as RESET frames are inserted between images

We did not have time to work on the upgrade items (shutter and AO/PHARO communication issues). Following is a report on the work done while Bruce was here.

Internal Wheels

The 4 PHARO wheels (slit, lyot, filter, grism) each include a magnet located at a unique position on the wheel. A magnetic field gradient sensor (GMR), located under each wheel, detects the magnet at the unique position. This position is defined as HOME. All other moves of the wheel are stepper moves relative to the HOME position.

We found that the Lyot GMR was intermittently sensing a second unique position (-55 steps from HOME). When this error occurs, all subsequent stepper moves end up -55 steps from the desired position resulting in a misplaced wheel that occults the image. We have seen evidence in the past that the other wheels experience the same error condition.

Tom Hayward has agreed to modify the PHARO control software:

- Add error checking to each HOME request. If the requested move does not match the result, then warn the observer about a possible error (with a popup window). At that time the observer may choose to investigate the beam by taking a pupil image.
- Move the wheel counter-clockwise during a HOME request to avoid the intermittent "second" GMR home position.
- Always move the wheel clockwise during stepper moves to reduce backlash in the assembly.

We will monitor wheel performance and will encourage observers to report any trouble.

Array Linearity and RESET Anomaly

When under power, PHARO continuously clocks through the HAWAII-1 array with RESET frames. When an exposure is requested, the current RESET frame is allowed to complete, then a RESET/READ frame is taken (all reads are non-destructive). Instead of stopping the clocking sequence, PHARO continues to clock through the array in multiples of the frame time until the desired exposure time is reached. At that time, a READ frame executes followed by the continuous RESET. The difference READ – RESET/READ is written to disk.

We have found that the amount of signal on the array directly influences the amount of signal in the RESET/READ frame. **Higher signal on the array results in *lower* counts in the RESET/READ frame (exactly opposite of a persistence condition).** If images are taken in a fast sequence (CYCLES), the problem is magnified. In the CYCLES case, a READ frame for one image is followed immediately by the next RESET/READ frame for the next image. When we insert a RESET frame between consecutive images, the problem is reduced. When we insert two or more RESET frames between images, the problem is reduced to its lowest form, but signal on the array still influences the RESET frame. The following table shows the mean output of 3 images taken consecutively in 3 different ways (CYCLE, 1 RESET between images, and 2 RESET between images). All image exposure times are 1.84 seconds; the input signal was increased.

	CYCLE (no RESET between)			**1 RESET between images**			**>= 2 RESET between images**		
Incoming Signal DN	**RESET READ**	**READ (signal)**	**DIFF**	**RESET READ**	**READ (signal)**	**DIFF**	**RESET READ**	**READ (signal)**	**DIFF**
12 (dark)	3595	3607	12	3600	3613	12	3603	3615	12
Image 2	3595	3607	12	3600	3613	12	3603	3616	12
Image 3	3595	3607	12	3600	3613	12	3603	3616	12
~5000	3596	8743	5146	3597	8754	5157	3597	8758	5160
Image 2	3393	8656	5262	3601	8760	5159	3597	8759	5161
Image 3	3402	8665	5263	3601	8760	5158	3597	8759	5161
~10000	3410	13605	10195	3413	13603	10190	3414	13600	10185
Image 2	2430	12782	10351	3467	13643	10175	3415	13599	10184
Image 3	2522	12863	10341	3468	13643	10175	3414	13599	10183
~45000	429	47351	46921	429	47371	46942	430	47357	46927
Image 2	49	46341	46292	490	47501	47011	430	47414	46984
Image 3	49	46355	46306	487	47522	47034	430	47400	46970

* All numbers are DN

Note that most of the instability resides in the RESET/READ frames, but the signal in the READ frame also changes slightly, especially in the CYCLE case (could the problem be related to reading pixels as opposed to the RESET of the array??).

Further, we have found that if the signal on the array is bright enough (~ 10,000) the RESET/READ signal drops low enough such that pixels start to get clipped. The array typically has 450 dead pixels (identical zero) in the RESET/READ frame of a dark image. The number of zero pixels in the RESET/READ frame goes up to 4000 when the array is subjected to 10,000 DN of signal. The number of zero pixels in the RESET/READ frame goes up to 970,000 when the array is subjected to 45,000 DN of signal.

Of course this behavior at least partially explains the non-linearity of the detector.

We verified that voltages to the detector were correct, and we tested changing Detbias and Output Bias Gate voltages. Bruce inspected his clocking sequence on an oscilloscope, verified that the clock sequence was behaving as expected, and tried several clocking variations. Nothing we did changed the RESET behavior.

If this problem cannot be fixed, then it can be reduced by inserting a full RESET frame between images during a cycle. We were able to reduce the frame read time from 1.840 seconds to 1.416. I have tested the faster frame read time. It is stable and noise parameters are identical so we will start to use the faster frame time immediately. With a reset frame between images in a cycle, the added overhead amounts to 0.568 seconds per image written to disk.

Comments, suggestions, and/or concerns are welcome.