

## **WFIRST Coronagraph TAC Report on Milestone #7 Review**

September 16, 2016

A Webex review of Milestone #7 for the WFIRST coronagraph technology program was held on September 15, 2016. All five of the TAC members were able to participate in the review.

Milestone #7 deals with the low noise detector requirements for the WFIRST coronagraph. When the noise requirements were specified several years ago, it was not clear if electron-multiplying CCDs (EMCCDs) would be suitable for use on WFIRST, or if the photon-counting readout technique would be applicable. As a result of the error budget assigned to the detector at that time, the Milestone #7 performance requirements for the detector and the readout electronics were set to be a dark current less than 0.001 electrons/pixel/sec and a read noise less than 1 electron/pixel/frame. Due largely to the decision to employ both EMCCDs and photon counting threshold limits, both of these Milestone requirements have been handily met, even after exposure to radiation doses (multi-MEV protons) equivalent to over twice those expected during a six-year mission to and at L2. The measured dark current was 0.0007 electrons/pixel/sec, just below the requirement, and the measured read noise was  $1.7e-6$  electrons/pixel/frame, nearly six orders of magnitude lower than required. In addition, the team demonstrated an ability to further adjust gains to deal with any unanticipated degradations, such as aging. While actual testing was conducted using COTS readout electronics, the TAC felt the team's design summarized for readout electronics based on space-heritage components was sufficient at this time to support the milestone requirement for testing with space-like electronics. Clearly both requirements of Milestone #7 have been met and exceeded. The tests also examined and reported on a number of other measures of the noise associated with the EMCCD/photon counting approach, in both serial and parallel read-out mode, giving further support to the assertion that this approach should succeed.

Meeting this Milestone on schedule implies that the project is still on its way to finishing the WFIRST coronagraph Key Milestones on schedule. The TAC looks forward to learning about the progress made on the remaining two Key Milestones (#8 and #9), dealing with the OMC and PIAACMC coronagraph tests in the JPL HCIT, in both static and dynamic environments, the latter simulating the expected performance on a space telescope with pointing jitter.

We thank Ben Parvin, Rick Demers, Leon Harding, and other WFIRST/AFTA-C team members for their presentations and comments during the review.

**WFIRST Coronagraph TAC Members**

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