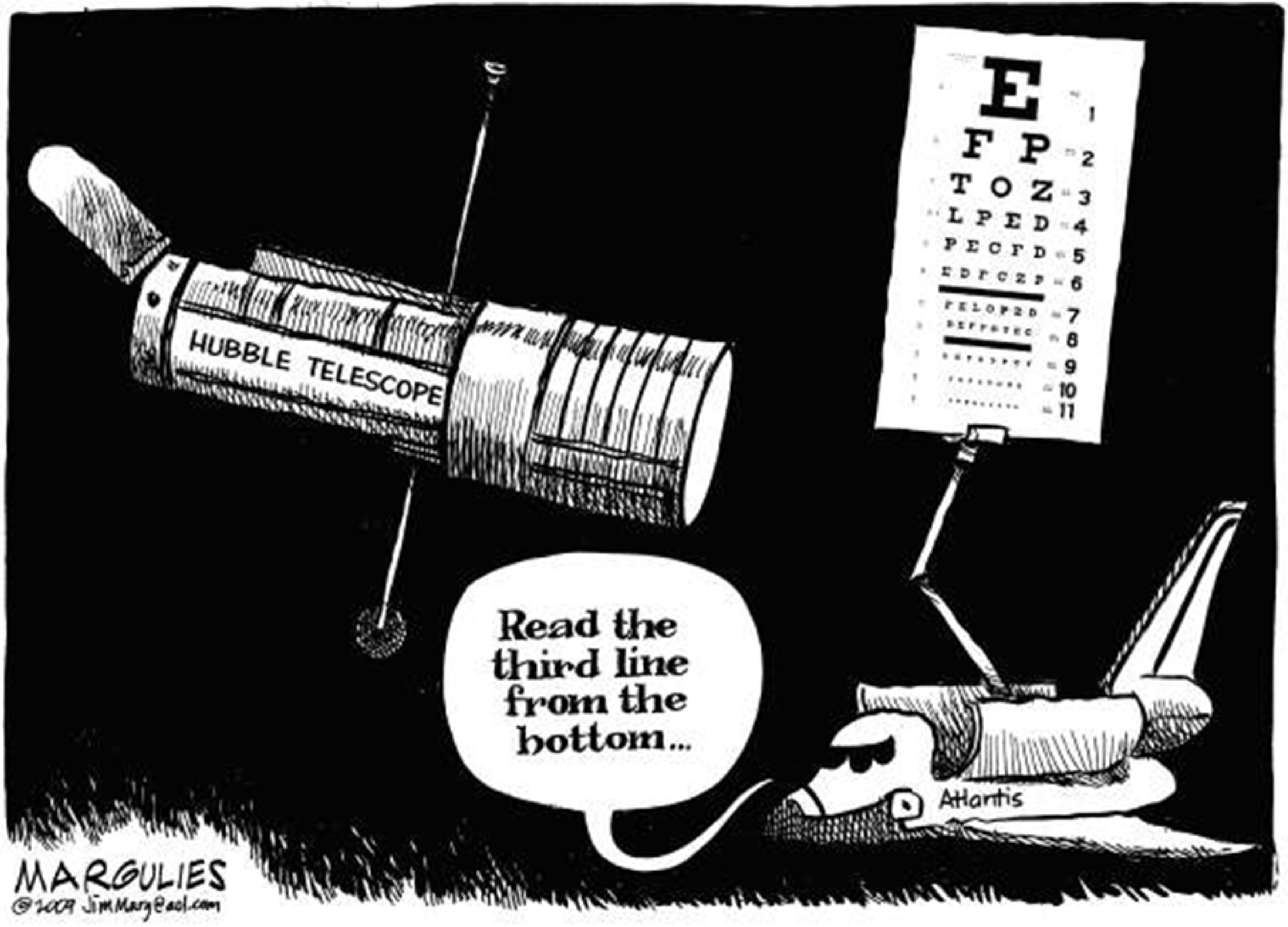
Fixing Hubble, The First Servicing Mission

Jim Crocker, The Riccardo Giacconi Memorial Symposium

May29-30 ,2019


hubble
NASA
APOLOGIES to MR. MAGOO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HUBBLE TELESCOPE
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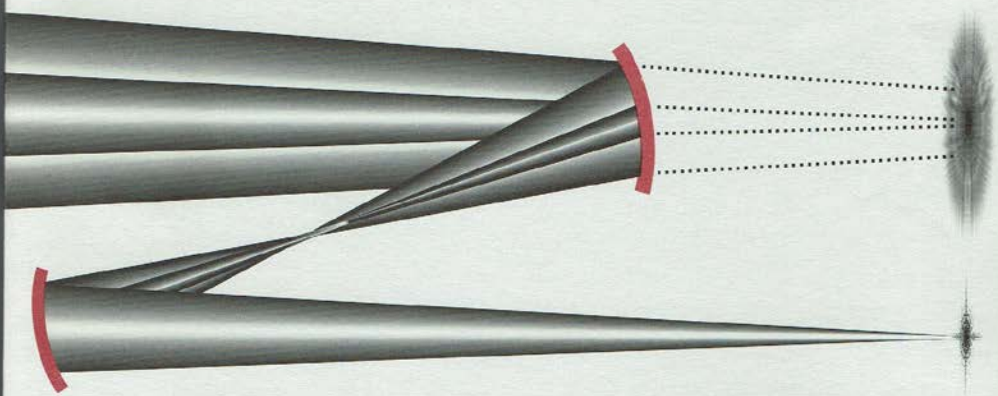
REPORT OF THE HST STRATEGY PANEL: A STRATEGY FOR RECOVERY

The Results of a Special Study
August–October 1990



EDITED BY R. A. BROWN AND H. C. FORD

PANEL MEMBERS

Robert Brown, *Co-Chairman*	Space Telescope Science Institute
Holland Ford, *Co-Chairman*	Space Telescope Science Institute
Roger Angel	University of Arizona
Jacques Beckers	European Southern Observatory
Pierre Bely	Space Telescope Science Institute
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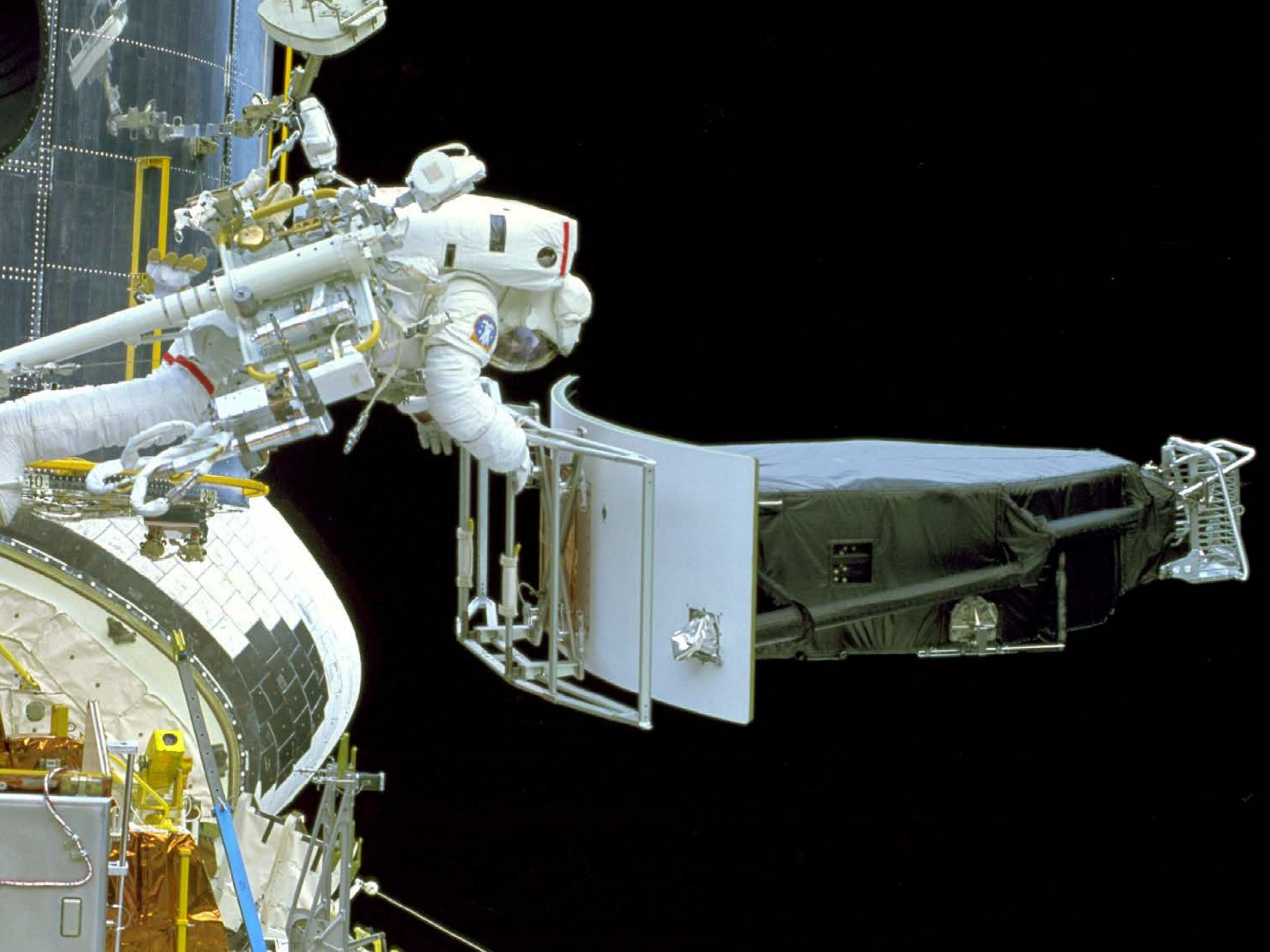
Bruce McCandless	Johnson Space Center/NASA (Ret.)
Francesco Paresce	Space Telescope Science Institute
Lyman Spitzer, Jr.	Princeton University
Raymond Wilson	European Southern Observatory

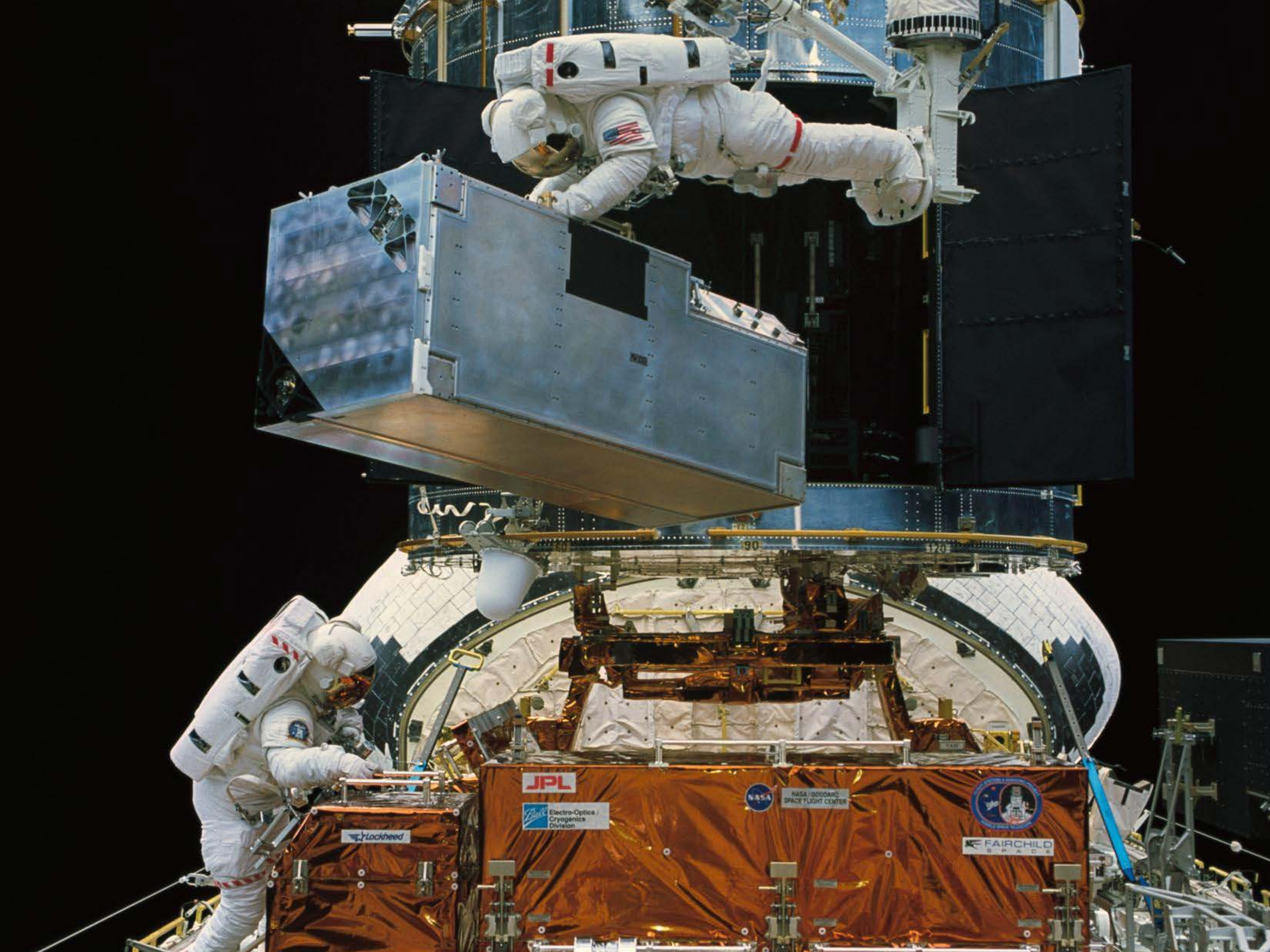
PANEL CHARTER

The Panel will identify and assess strategies for recovering HST capabilities degraded by spherical aberration. It will review the current state of the observatory, the Allen Board findings, the scientific potential of the ideal HST, and the tentative science program of the unimproved HST. It will develop a comprehensive framework for identifying possible improvements, including OTA-, instrument-, spacecraft-, and operations-level changes, and including hybrid combinations. Within this framework, the Panel will develop and debate the technical and scientific merits of particular improvements. On the basis of their findings, the Panel will formulate a set of recommendations and conclusions.

The Panel will cast its net widely, especially seeking the ideas and appropriate involvement from ST ScI staff. It is expected that the whole Institute will be informed regularly of the Panel's thinking and progress. As necessary in the course of its work, the Panel can request ST ScI support for short studies of specific technical or scientific issues that may arise. They may also request the support of outside experts including but not limited to NASA and NASA contractor personnel.

The Panel is appointed by and reports to the ST ScI Director, who will take the panel's findings to NASA.

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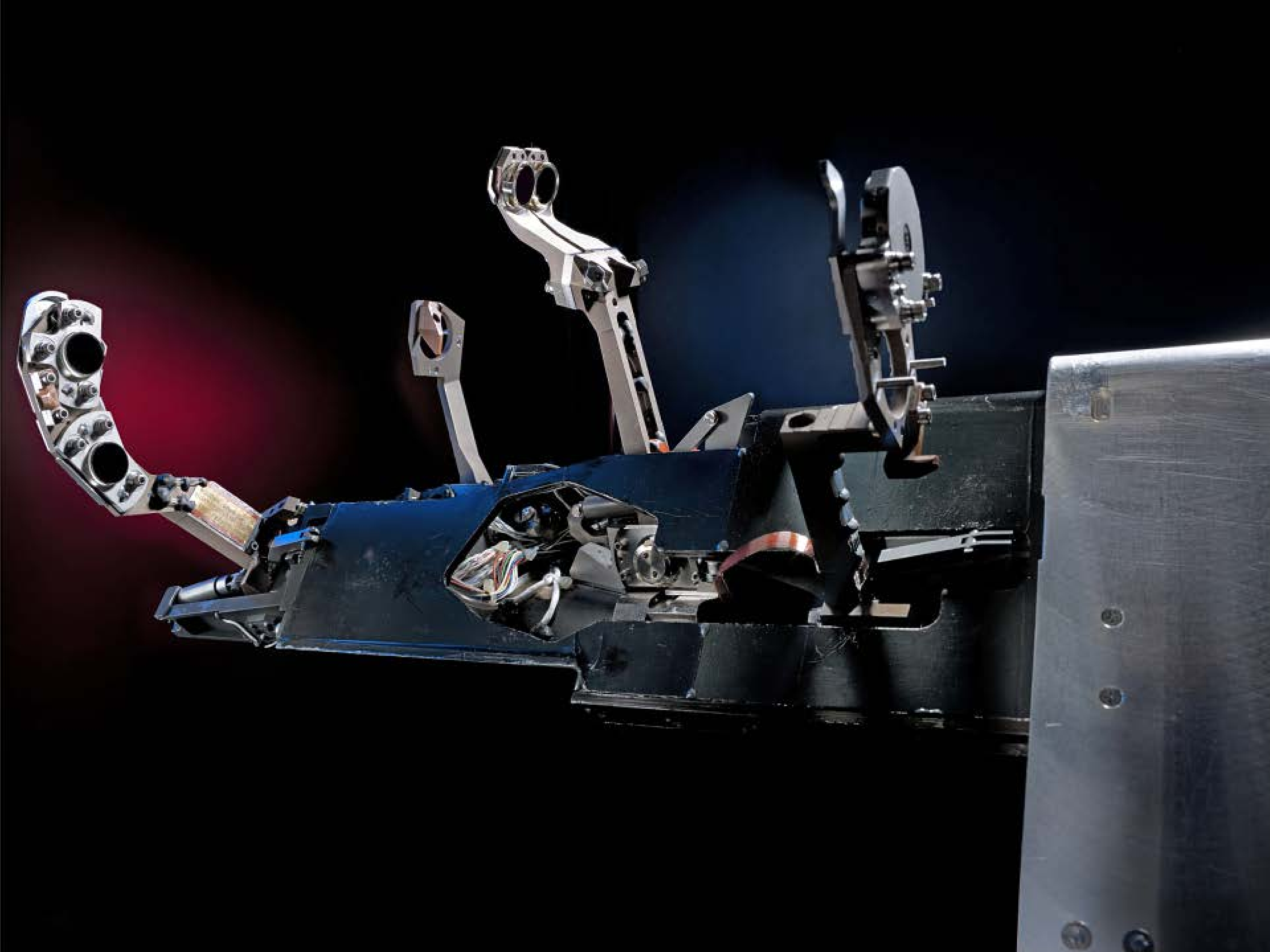

Optical design of the Advanced Camera for Surveys, a third generation HST axial science instrument

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ABSTRACT

The Advanced Camera for Surveys (ACS), designed to be installed in 1999 during the third servicing mission of the Hubble Space Telescope (HST), is a high performance axial bay camera.

The design provides three wide-band cameras plus coronagraphic capability. The cameras cover the spectral region from 115 nm to 170 nm and from 200 nm to 1000 nm. They are the very wide Field of View (FOV) (200 by 204 arc sec) Wide Field Channel (WFC) camera, the wide FOV (26 by 29 arc sec) High Resolution Channel (HRC) camera, the wide FOV (26 by 29 arc sec) Solar Blind Channel (SBC) ultraviolet, and the coronagraph which uses the HRC CCD. Numerous filters are provided for each of the three cameras using only three filter wheels, two of which are shared by the WFC and HRC. The optical design uses heritage from Space Telescope Imaging Spectrograph (STIS), a second generation HST instrument. To achieve full wavelength coverage the designs are all-reflective. The FOV of the two-mirror STIS design is extended for the WFC by use of a reflective Schmidt-like plate as a third mirror. The filters are placed in the corrected converging beam and are OPD-matched to maintain focus. Protected silver reflective coatings are used on the WFC mirrors to maximize throughput and minimize polarization sensitivity.

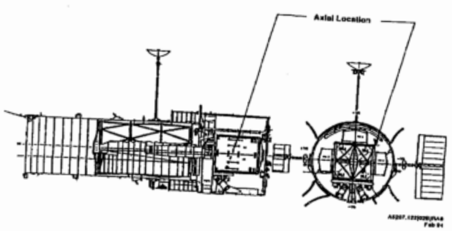
The paper will described the optical design and compare predicted performance with measured performance. The use of error budgets during the design process will also be discussed.

Key Words: (< 5) aberration correction, extending field of view, optical system design, HST instruments

1. OVERVIEW OF THE ADVANCED CAMERA FOR SURVEYS (ACS)

The Advanced Camera for Surveys, designed to be installed in 1999 during the third servicing mission of the HST, is a high performance axial bay camera. It will be installed in the axial HST slot currently occupied by the Faint Object Camera (FOC) as illustrated in **Figure 1**.

Figure 1
HST Interface



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MgF_2 coating on M3 is optimized for maximum reflectivity at wavelengths greater than 200 nm. The aberrated beam coronagraph uses the HRC optical path.

We have oriented the respective FOVs parallel to each other, but offset in the -V3 HST coordinate system direction as shown in **Figure 4**. The serial register(s) of both WFC and HRC CCDs are parallel to the V2 axis. The dispersion of the prism and grism is parallel to the serial register allowing the full spectrum to be shifted out with a parallel transfer.

Figure 4
ACS FOVs Optimize the Survey Operational Efficiency of HST

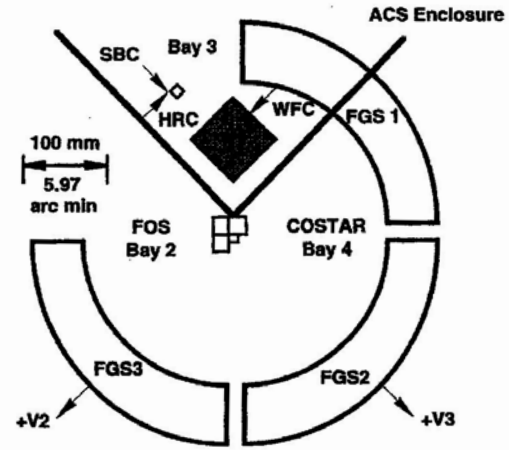

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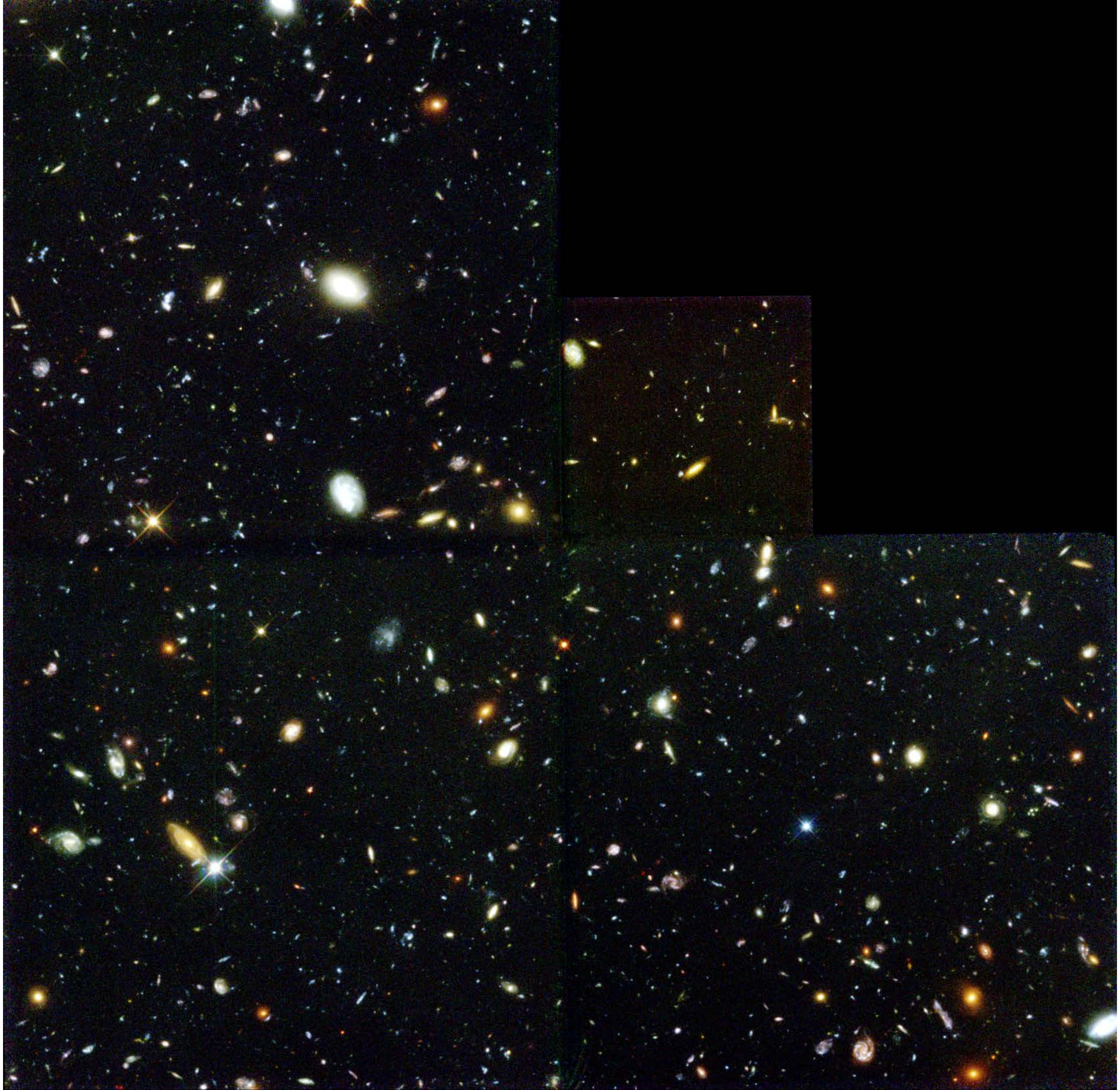
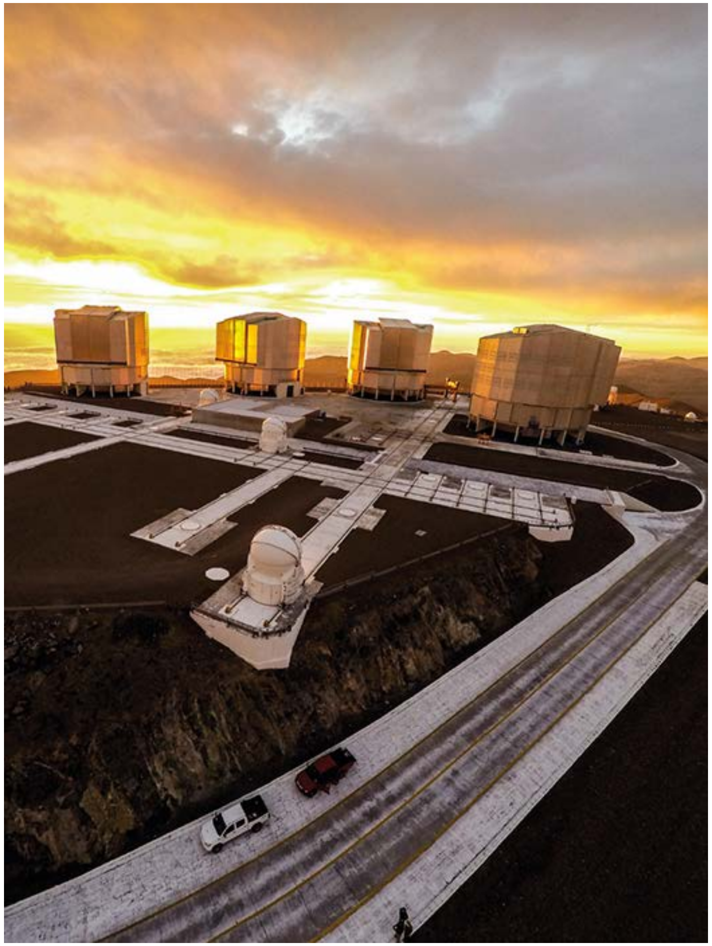
Table 1 summarizes the top level performance of the ACS and compares the performance to the specification given in the Contract End Item (CEI) specification. We predict that maximum sensitivity to linear polarization will be less than 1 % (WFC) and less than 4.3 % (HRC). We predict that the encircled energy within a 0.25 arc second diameter circle at the image will be greater than 79.4 % (WFC) and greater than 81.6 % (HRC), both exceeding the specification of greater than 75 % and nearly exceeding the goal of greater than 80 %. In all cases the image is well corrected and uniform over the FOV.

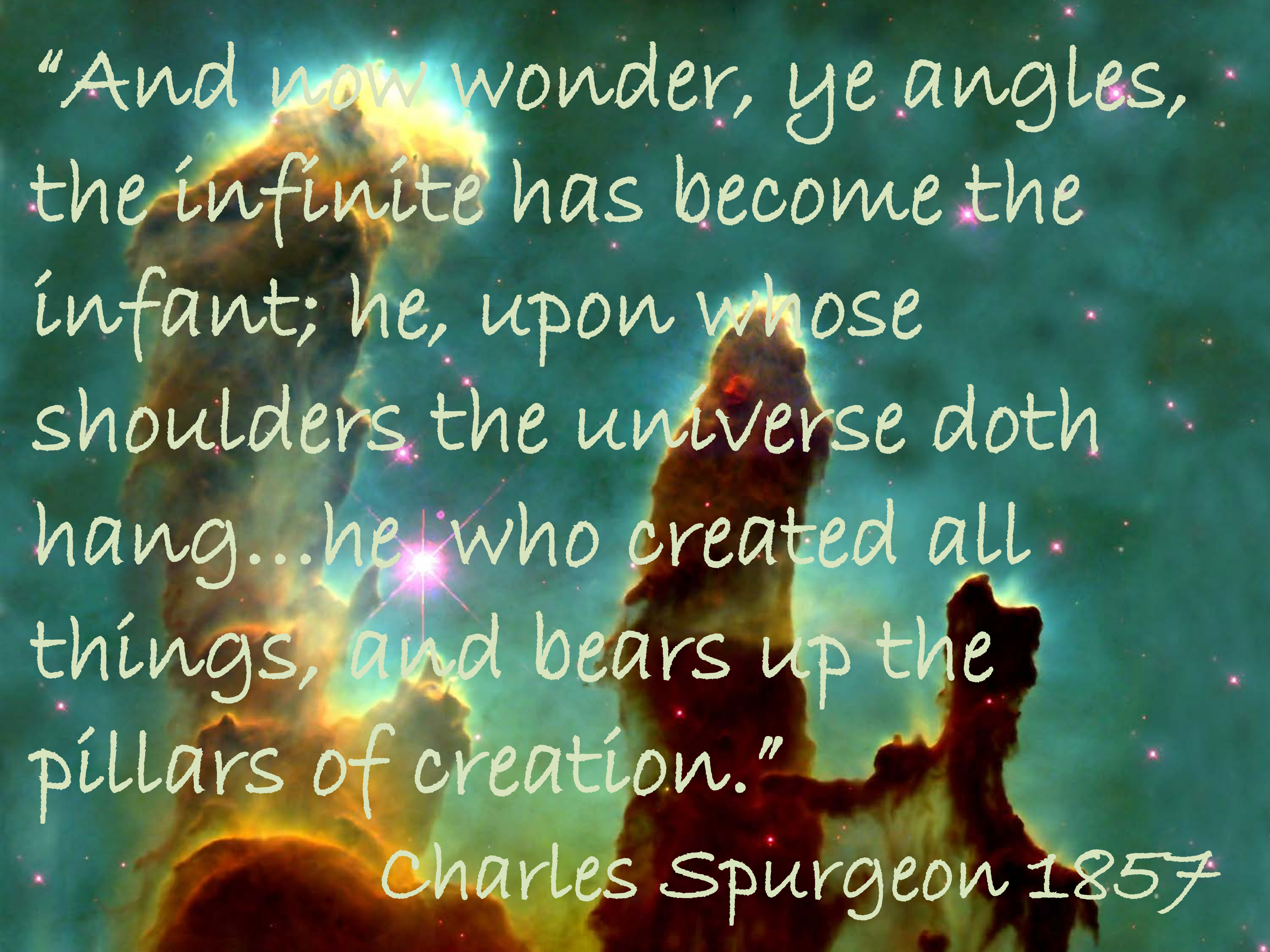
Table 1
CEI Part II Details Performance Summary

Table 4-1
Induced Polarization

Channel	Maximum Induced Polarization	Predicted
WFC	2 percent over 500-1000nm(1 percent goal)	≤ 1.0%
HRC	6.5 percent over 220-1000nm (5 percent goal)	< 4.3%






"And now wonder, ye angles, the infinite has become the infant; he, upon whose shoulders the universe doth hang…he, who created all things, and bears up the pillars of creation."
Charles Spurgeon 1857