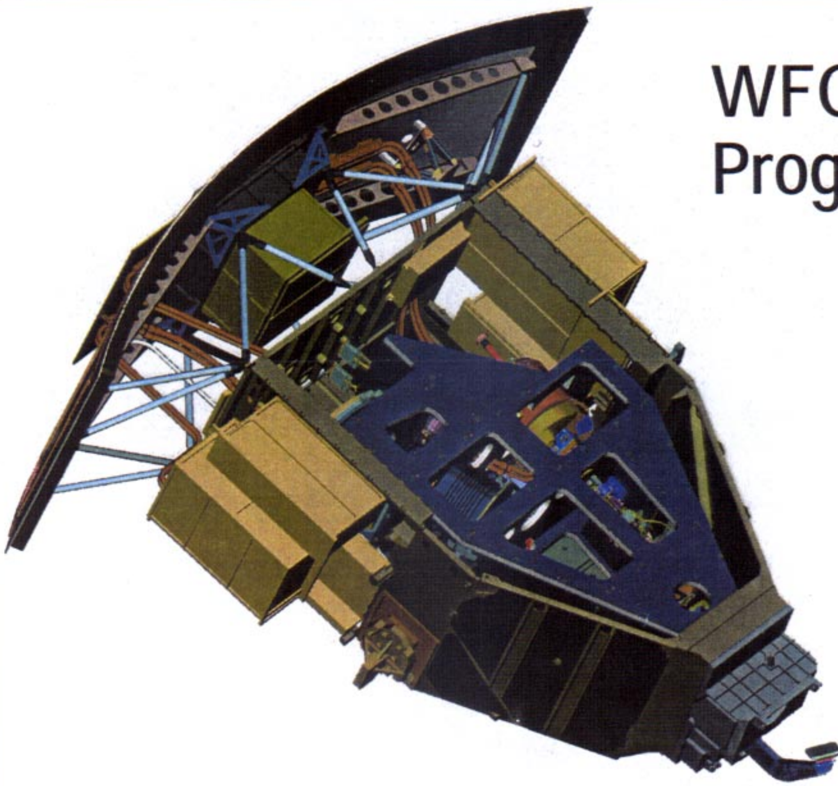


WFC3 Program Briefing

for the

Origins Subcommittee

June 13, 2000

What is WFC3?

- WFC3 is a high performance facility instrument developed on behalf of the HST user community.
  - Ensures continued world-class HST imaging science to end of mission.
    - By 2010 WFPC2, STIS and ACS will be 17, 13 and 9 years old, respectively.
  - Funded with re-programmed HST research funds (UPN 459).
  - No GTO team, no GTO observing time, no GTO funding (saves >$20M).
  - Scientific Oversight Committee (SOC) chartered by Code S.
  - “Badgeless” development team, led by the HST Project.
  - Makes extensive use of returned flight equipment, spares, designs, and expertise from other HST instruments.

What is WFC3?
(cont)

- WFC3 will be the first "panchromatic" camera on HST
  - Two channels cover near-UV to near-IR without cryogen.
  - UVIS CCD channel backs up ACS while providing a unique wide-field, near-UV capability.
    - Expected on-orbit radiation damage reduces CCD performance with time.
    - WF/PC 2 and STIS are already severely affected by radiation damage.
  - IR HgCdTe channel replaces the out-of-focus NICMOS Camera 3.
    - Improved field of view, resolution, and sensitivity.
    - Optimized wavelength range for HST.
    - Provides unique capabilities not possible from the ground or from current space missions.

IN A SENCE, COMPLEMENTARY TO ACS & NICMOS

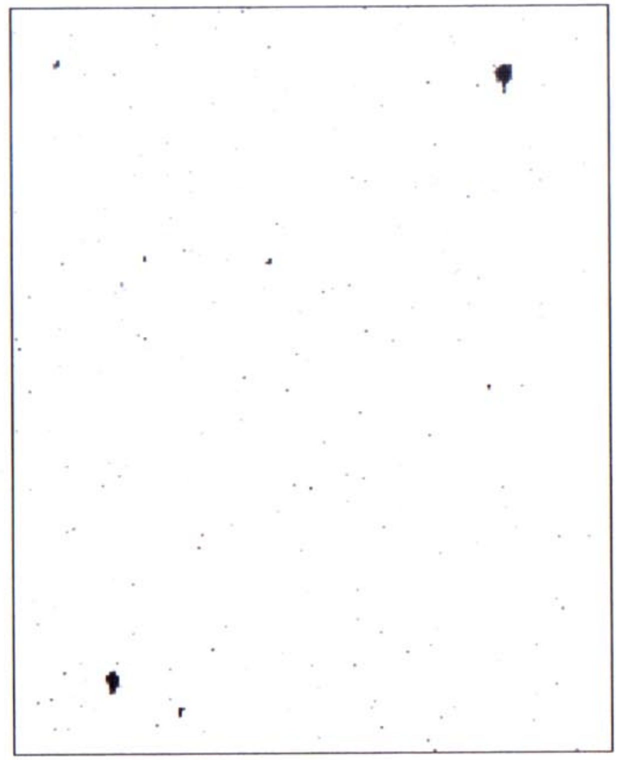
BUT

Scientific Mandate

- Backup imaging capability for HST.
  - Ensure an imaging capability through 2010 (lifetime).
  - Address on-orbit CCD degradation issues (photometry).
  - Radial bay operation not thermally constrained (efficiency).
- Provide a wide field and wide spectral range imaging capability.
  - Utilize as close as possible the full field-of-view offered by the HST radial instrument configuration.
  - Prime spectral region of 200 to 300 nm in the near-UV, and 1000 to 1600 nm in the near-IR.

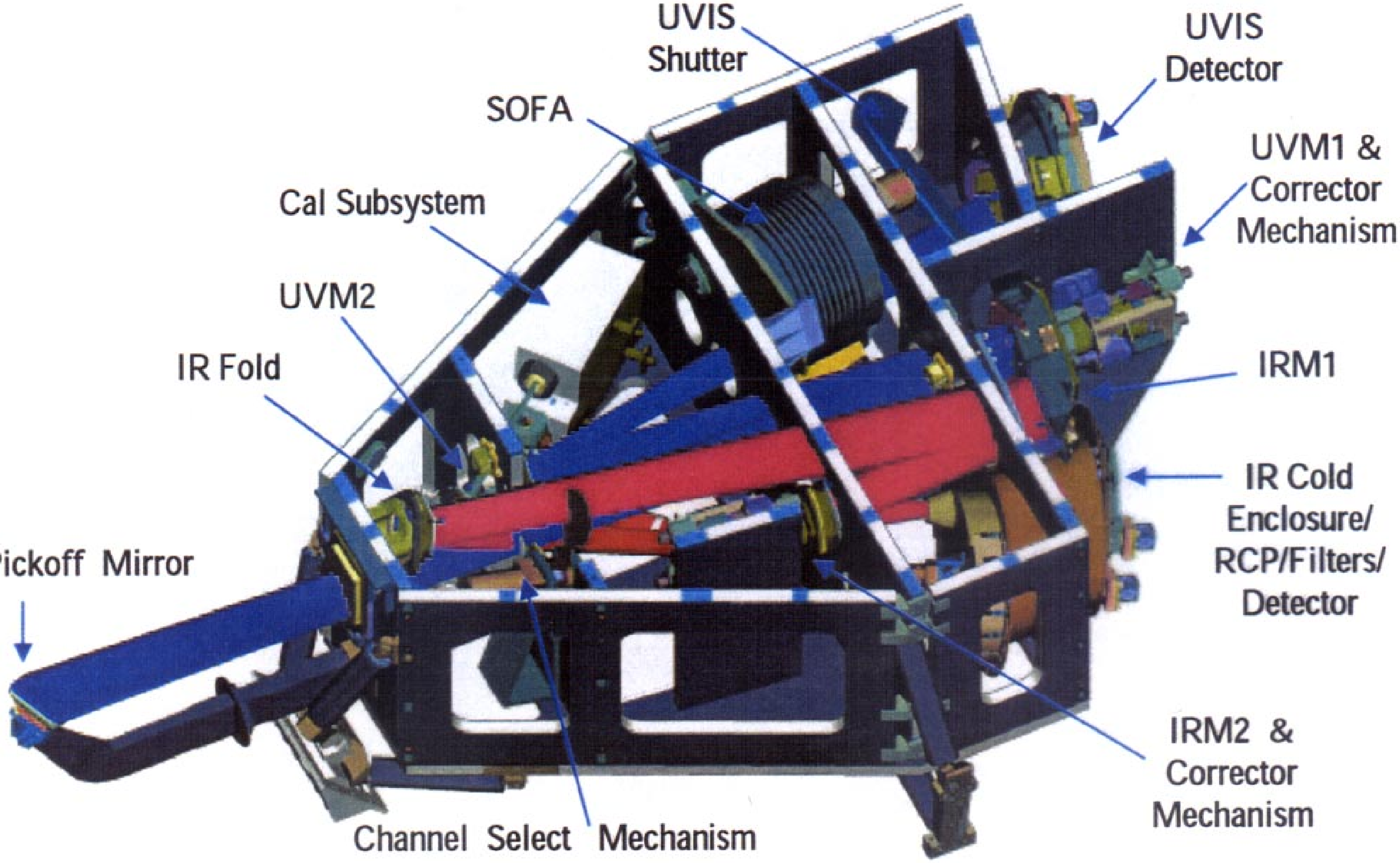
On-Orbit CCDs are a Limited-Life Component

New WFPC2

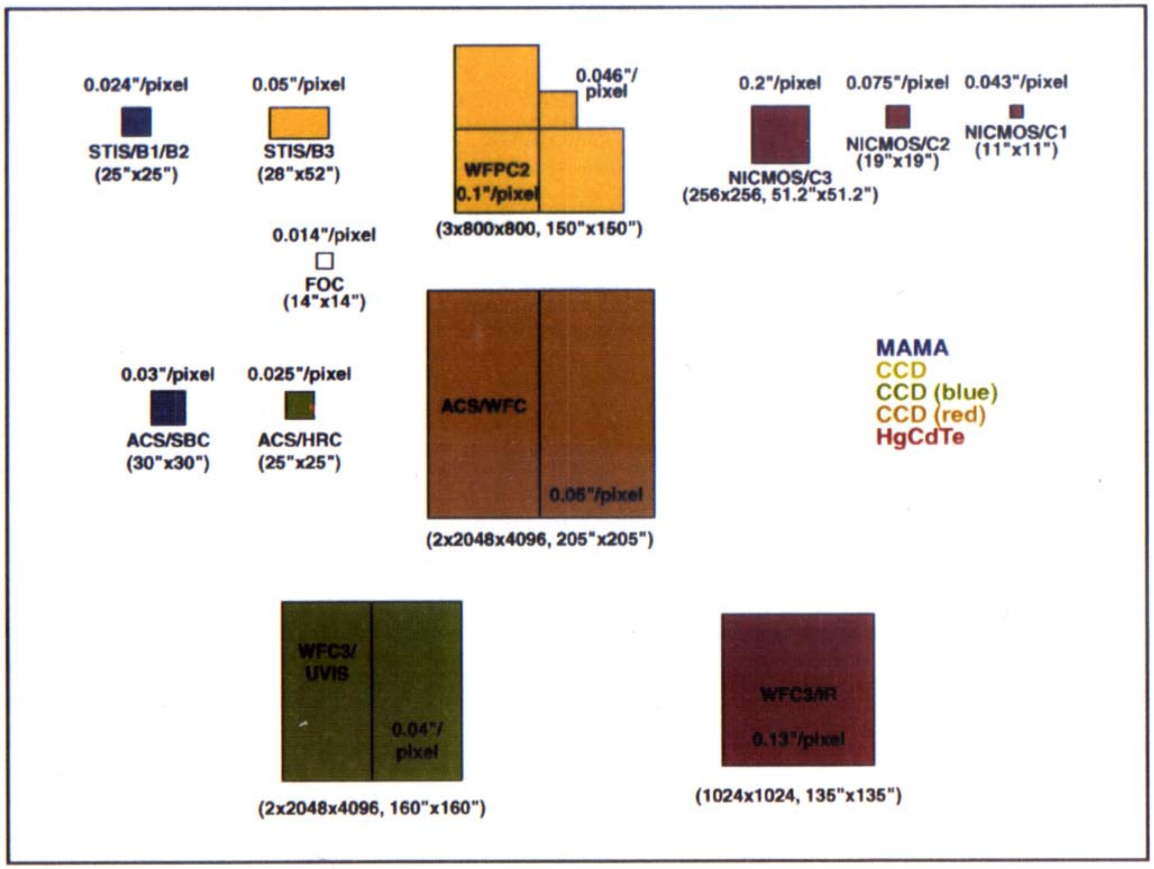


2008 WFPC2 Simulation

Optical Layout In The Optical Bench



HST Imaging FOV



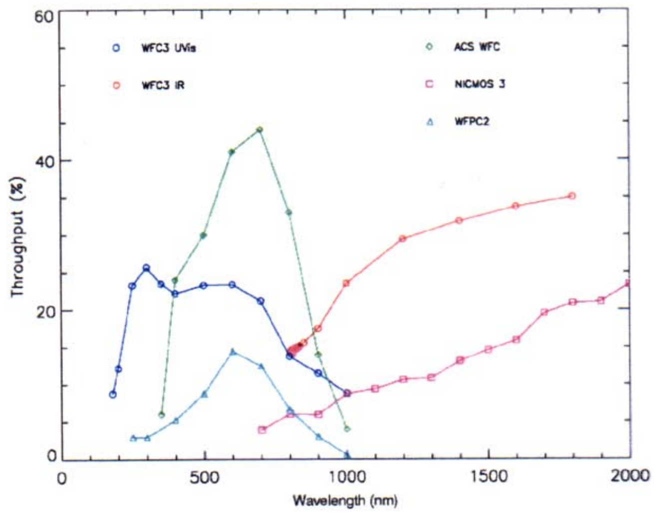


Figure 4. Comparison of the throughput of various HST imaging instruments. WFC3 has the highest throughput of all wide-field imagers both in the UV and in the near-IR.

WFC3's infrared channel will provide an important bridge spanning NICMOS and NGST. This can be achieved because WFC3/IR does not rely on expendable cryogens and thus is able to operate until the end of the HST mission. WFC3/IR will also become a workhorse for identifying objects of scientific interest for further study with NGST, SIRTF, and the large ground-based telescopes. Furthermore, WFC3/IR's good spatial sampling (0.13 arcsec per pixel versus 0.2 arcsec per pixel for NIC3) and larger field of view (135 arcsec vs 51 arcsec for NIC3) will provide an increased discovery efficiency of a factor of 15 in the 9000-17000 Å wavelength region compared to NICMOS (with the NICMOS Cooling System - NCS.)

Table 2 : Discovery efficiency of selected HST imaging. The 3000 and 6000 Å performance is normalized to that of WFPC2/PC, that at 16000 Å to NICMOS/Camera 2. The values for WFC3 are based on the baseline performance. Achieving the goal performance for WFC3 would double its discovery efficiency.

Instrument	Discovery Efficiency		
	@ 3000 Å	@ 6000 Å	@ 16000 Å
WFPC2/PC	1	1	N/A
WFPC2/WF	14	14	N/A
ACS/HRC	5.5	1.0	N/A
ACS/WFC	N/A	110	N/A
NICMOS/CAM2	N/A	N/A	1
NICMOS/CAM3	N/A	N/A	7.2
WFC3/UVIS	**180**	**36**	**N/A**
WFC3/IR	**N/A**	**N/A**	**105**

13x 8x 15x

WFC3 Key Scientific Features

	UVIS	IR	
Format	2 x 2K x 4K	1K x 1K	pixels
Field Size	160 x 160	135 x 135	arcsec
Pixel Size	39	130	mas
Spectral Range	200 to 1000	850 to 1700	nm
Dark Current	< 0.003	< 0.4	e-/pix/sec
Readout Noise	< 4	< 15	e-/pix/ readout
Operating Temp	-90	-120	°C

-90 -120 °C

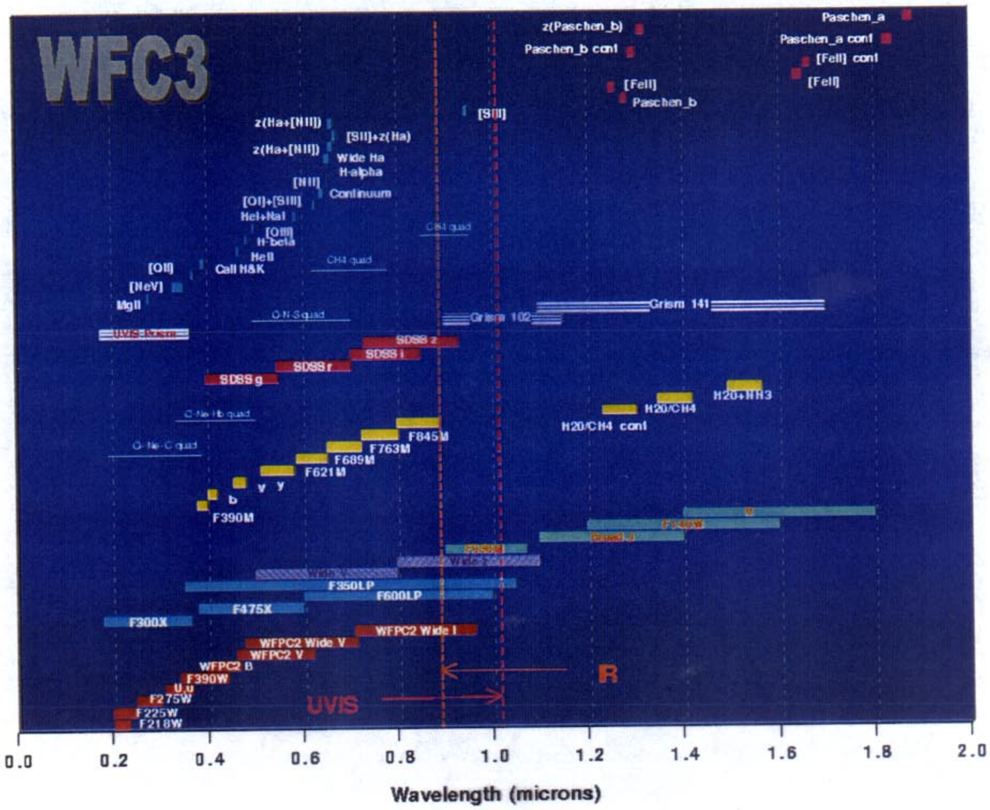


Figure 3: A schematic representation of the WFC3 filter set. The dashed vertical line marked "UVIS" indicates the UVIS channel long-wavelength sensitivity limit. The dashed vertical line marked "IR" indicates the IR channel short-wavelength sensitivity limit.

To compare the performance of HST cameras (apart from angular resolution), a useful index originally introduced by the ACS IDT is the "discovery efficiency," which is defined as the field of view multiplied by the throughput. In Tables 1 and 2 we tabulate the main characteristics and the predicted discovery efficiency of WFC3 compared to other HST instruments.

By using large-format CCD's, both WFC3/UVIS and ACS/WFC produce wide fields with spatial sampling of 0.040 and 0.050 arcsec respectively. These pixel sizes are comparable to that of the WFPC2 Planetary Camera (PC) channel (0.046 arcsec per pixel). However, WFC3 covers 20 times more field area than does WFPC2/PC and 25% more than WFPC2/WF. The WFC3/UVIS design offers a combination of excellent near-UV response and a large field of view (160 arcsec), giving it a discovery efficiency 12 times higher than any prior HST instrument at 3000 Å and 30 times higher than ACS/HRC. This effectively opens up for HST investigation a large new discovery space in the near-UV region.

Table 1: Characteristics of selected HST Imaging Instruments

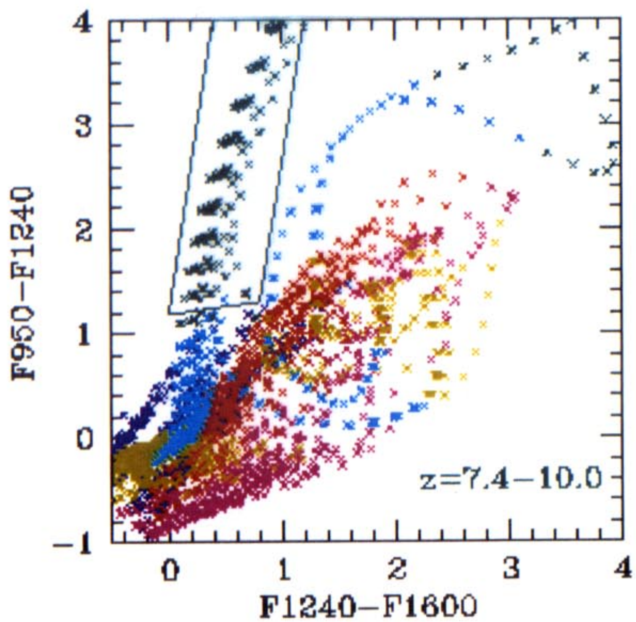
Instrument	Wavelength Range (Å)	Pixel Size (arcsec)	FOV ($arcsec^2$)
WFPC2/PC	1200-10500	0.046	35 x 35
WFPC2/WF	1200-10500	0.100	3x 75 x 75
ACS/HRC	2000-10500	0.026	26 x 26
ACS/WFC	3500-10500	0.050	205 x 205
STIS/CCD	2000-10500	0.050	51 x 51
NICMOS/CAM2	8000-25000	0.076	19 x 19
NICMOS/CAM3	8000-25000	0.200	51 x 51
WFC3/UVIS	**2000-10500**	**0.040**	**160 x 160**
WFC3/IR	**8000-17000+**	**0.130**	**135 x 135**

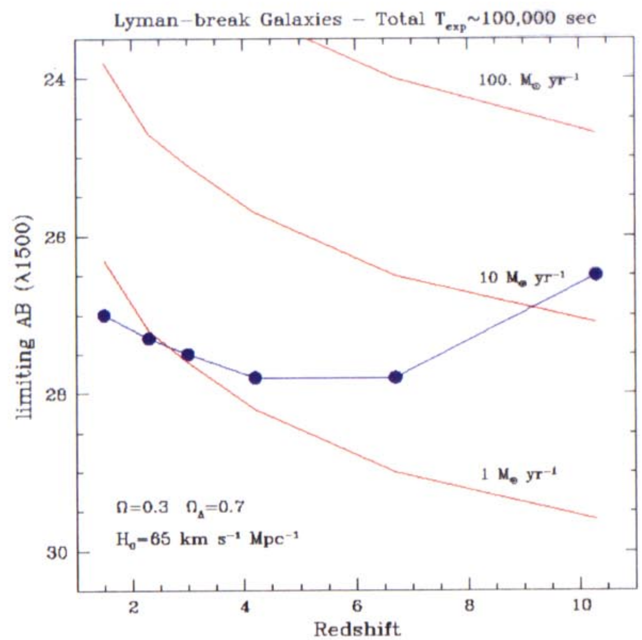
Both the Wide Field and Planetary Camera 1 (WF/PC) and WFPC2 had relatively poor response at wavelengths below 3500 Å. Below 2500 Å, the low UV response exacerbated the problem of red leaks (i.e. unwanted long-wavelength photons) in the UV filters. STIS has much improved UV response, good resolution, and much reduced red-leak problem thanks to its Multi-Anode Microchannel Array (MAMA) detectors, but its imaging fields of view are very small (25 arcsec) and are not well matched to large, extended targets such as globular clusters, nearby galaxies, or distant clusters of galaxies. ACS/HRC (using a CCD) and ACS/SBC (using a MAMA detector) offer good response, but again over only small fields (26 arcsec and 30 arcsec, respectively). ACS/WFC has a large field of view but no sensitivity below 3500 Å (see Figure 4.)

WFC3 achieves its good near-UV performance by using aluminum mirrors coated with MgF2 and special blue-optimized antireflection coatings on its CCD detectors. HST is the only NASA-approved large-aperture mission with good UV performance. While NGST will provide higher sensitivity than any HST camera for wavelengths longwards of 6000 Å, its performance below 6000 Å is still not well defined and it is very likely that it will not perform at all shortwards of 4000 Å. In order to balance UV and IR capabilities it is important to have the best UV performance that can be provided for a reasonable cost.

High Z Galaxies

(Stiavelli, Giavalisco, Carollo)





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