

Advanced Camera for Surveys



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ACS

Design goals: I



- **Deep, survey imaging**

- Optimized for near-infrared imaging
- Wide field, sharper images
- Survey capabilities
 - imaging
 - low resolution spectroscopy
- **Discovery Efficiency = QE x Area**
= **10 x WFPC2**

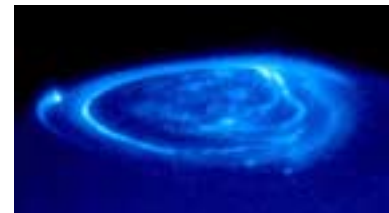


- **High resolution imaging**

- Optimized for near-UV (200 – 400 nm)
- High angular resolution images
- High contrast coronagraphic imaging

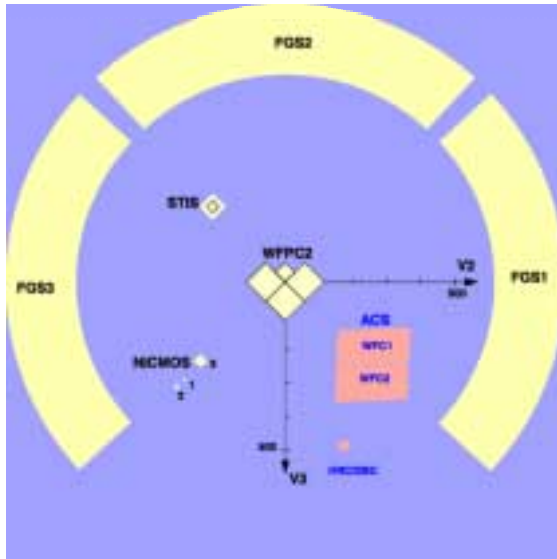
- **Far Ultraviolet Imaging**

- Solar Blind Imaging
- Low resolution spectroscopy

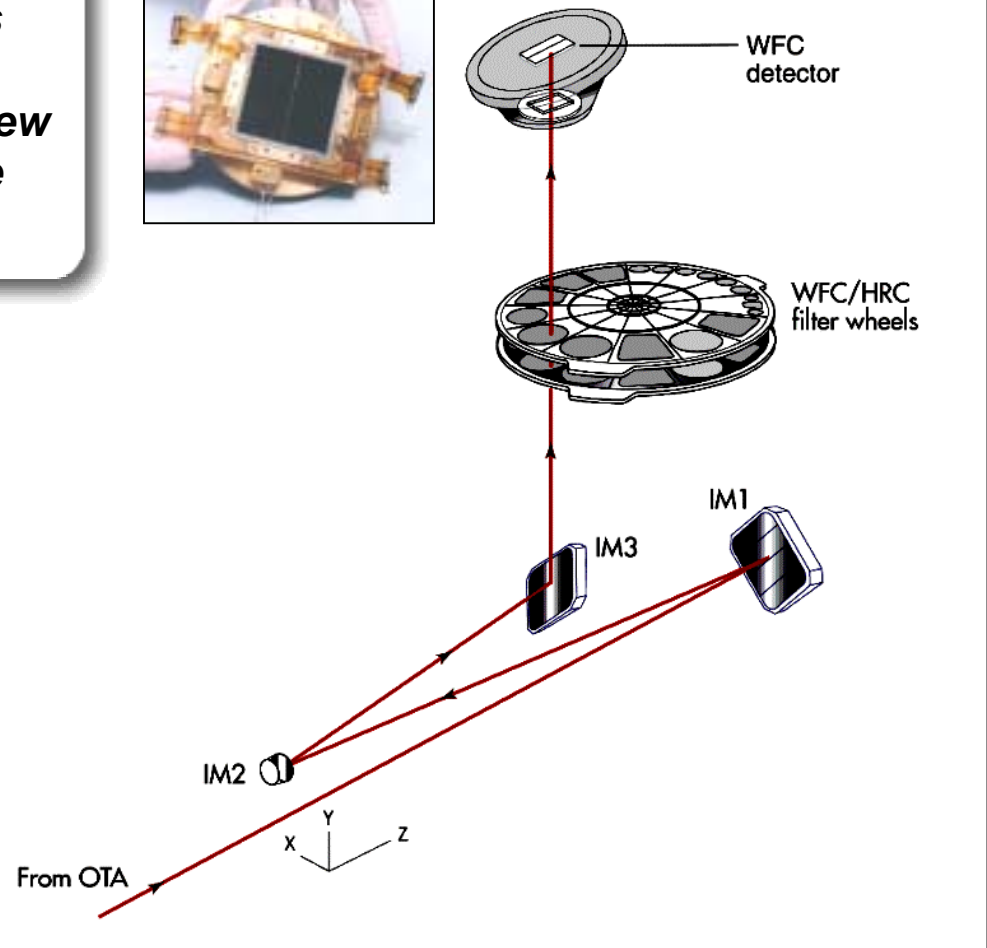
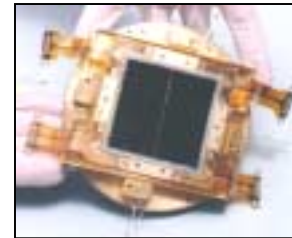


- **Wide Field Channel (WFC)**

- Silver mirror coatings
- Optimized for I band
- 202" x 202" field of view
- 0.05"/pixel plate scale
- 380 nm - 1050 nm



Post Sm3B: HST Focal Plane

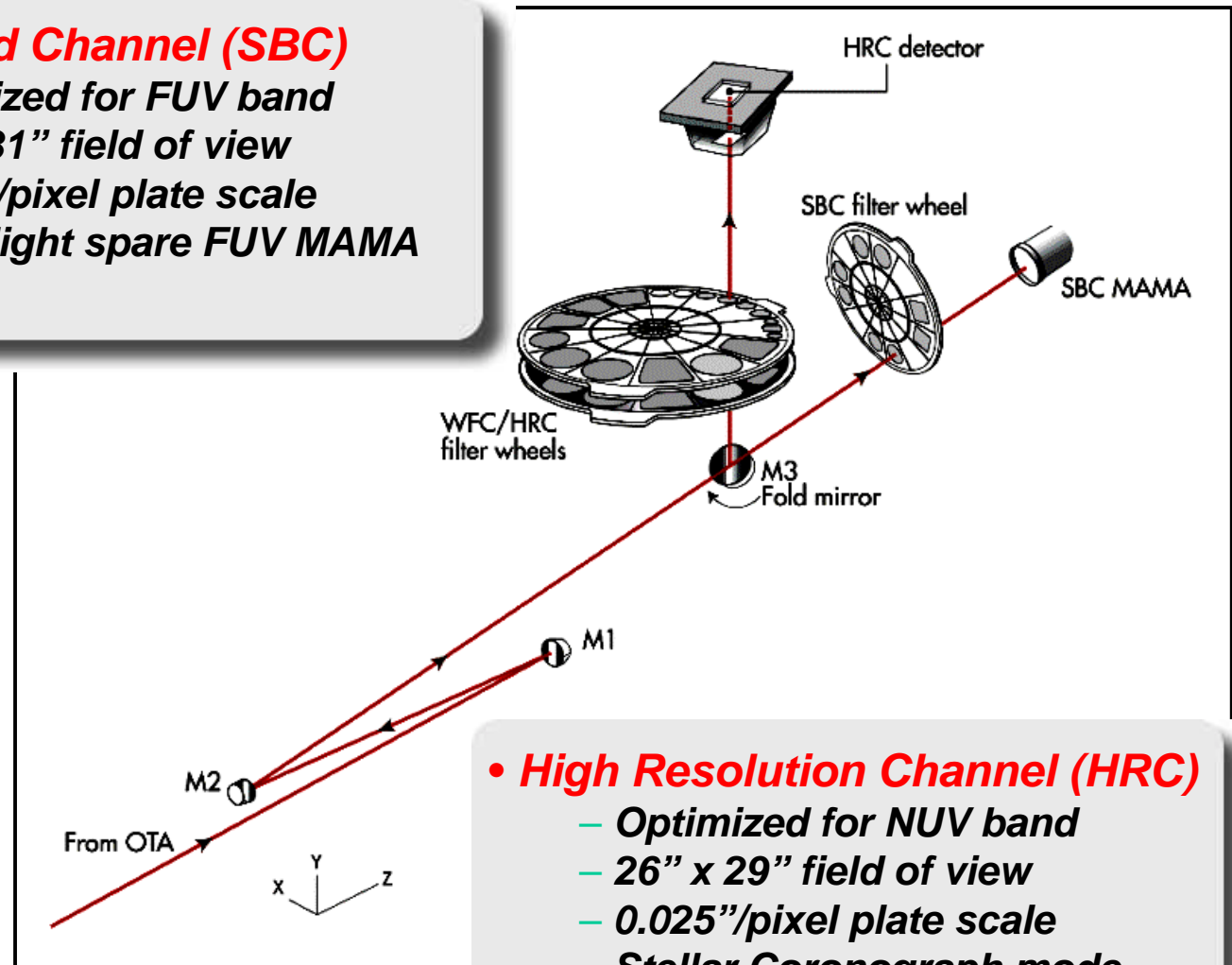


HRC/SBC Optical Designs



- **Solar Blind Channel (SBC)**

- Optimized for FUV band
- 35" x 31" field of view
- 0.032"/pixel plate scale
- STIS flight spare FUV MAMA



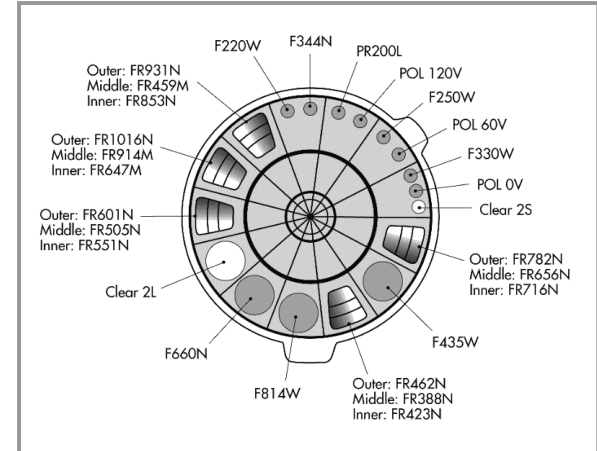
- **High Resolution Channel (HRC)**

- Optimized for NUV band
- 26" x 29" field of view
- 0.025"/pixel plate scale
- Stellar Coronagraph mode

WFC/HRC Filter Wheel 2



#	Filter Name	Filter Description	Camera
1	CLEAR3	Clear	WFC
2	F660N	[NII]	WFC/HRC
3	F814W	Johnson I	WFC/HRC
4	FR427N	Oil Ramp	WFC/HRC
5	F435W	Johnson B	WFC/HRC
6	FR722N	H α Ramp	WFC/HRC
7	CLEAR4	Clear	HRC
8	POL0V	Visible Polarizer 0 $^{\circ}$	WFC/HRC
9	F330W	HRC u	HRC
10	POL60V	Visible Polarizer 60 $^{\circ}$	WFC/HRC
11	F250W	Near-UV filter	HRC
12	POL120V	Visible Polarizer 120 $^{\circ}$	WFC/HRC
13	G200L	HRC Prism	HRC
14	F344N	NeV	HRC
15	F220M	Near-UV filter	HRC
16	FR914N	IR Ramp	WFC/HRC
17	FR715M	Broad Ramp	WFC/HRC
18	FR555N	OIII Ramp	WFC/HRC

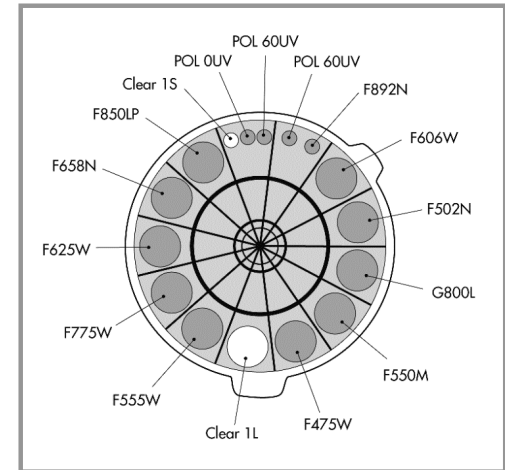


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WFC/HRC Filter Wheel 1



#	Filter Name	Filter Description	Camera
1	CLEAR1	Clear	WFC
2	F555W	Johnson V	WFC/HRC
3	F775W	SDSS i	WFC/HRC
4	F625W	SDSS r	WFC/HRC
5	F658N	H α	WFC/HRC
6	F850LP	SDSS z	WFC/HRC
7	CLEAR2	Clear	HRC
8	POL0UV	UV Polarizer 0 $^{\circ}$	HRC
9	POL60UV	UV Polarizer 60 $^{\circ}$	HRC
10	POL120UV	UV Polarizer 120 $^{\circ}$	HRC
11	F892N	Methane	WFC/HRC
12	F606W	Broad V	WFC/HRC
13	F502N	[OIII]	WFC/HRC
14	G800L	Grism	WFC/HRC
15	F550M	Narrow V	WFC/HRC
16	F475W	SDSS g	WFC/HRC

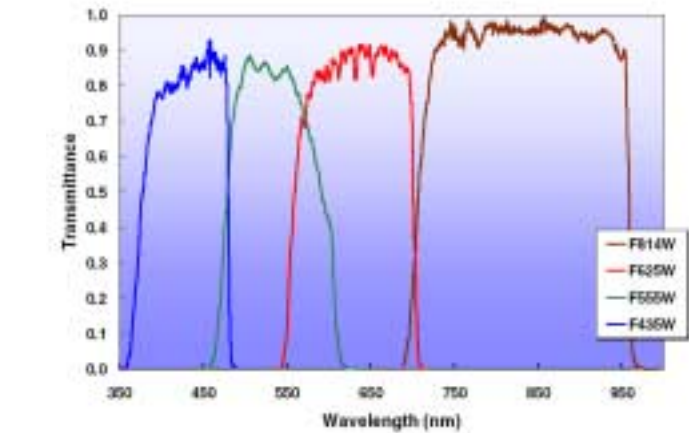
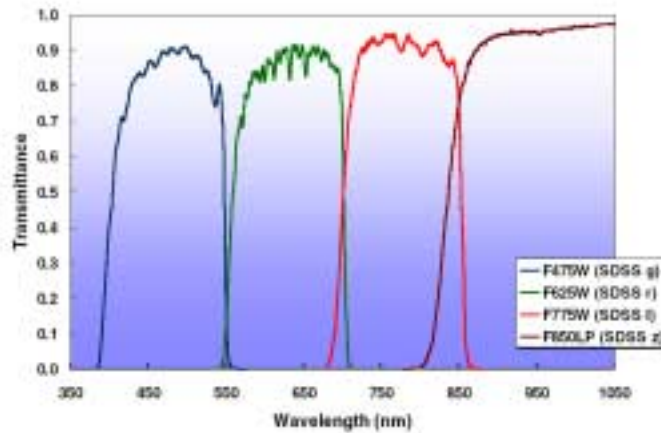


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WFC/HRC Filters: Broadband

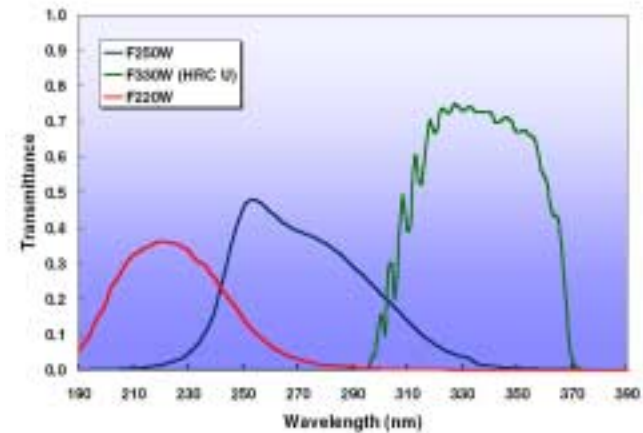
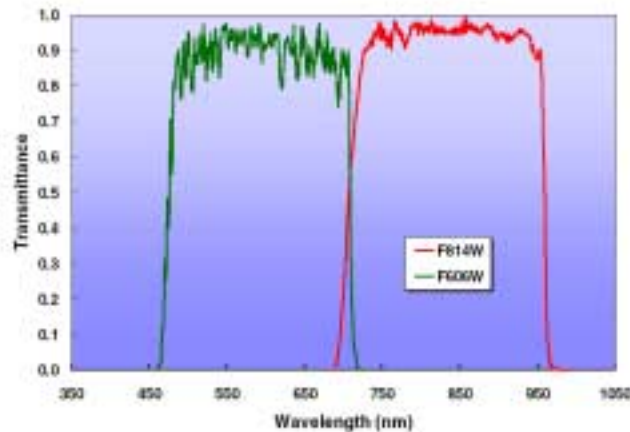


– Sloan Digital Sky Survey: *g, r, i, z*



– WFPC2 filter set: *B, V, R & I*

– Deep Imaging: *F606W & F814W*

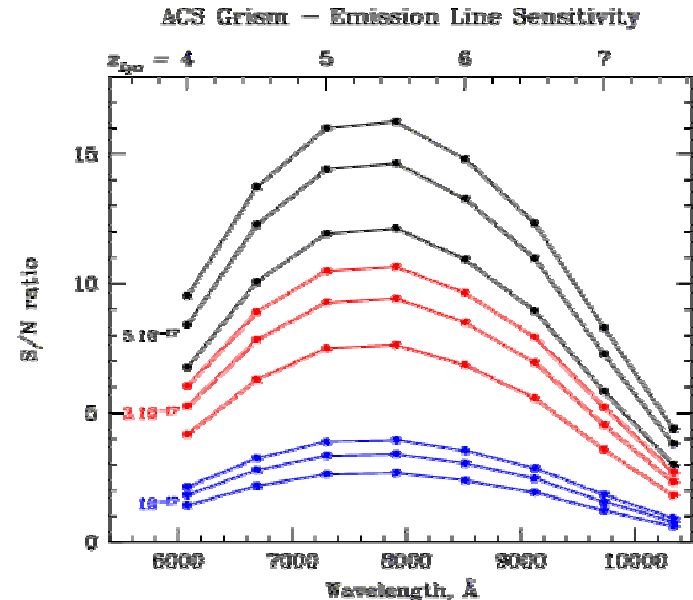
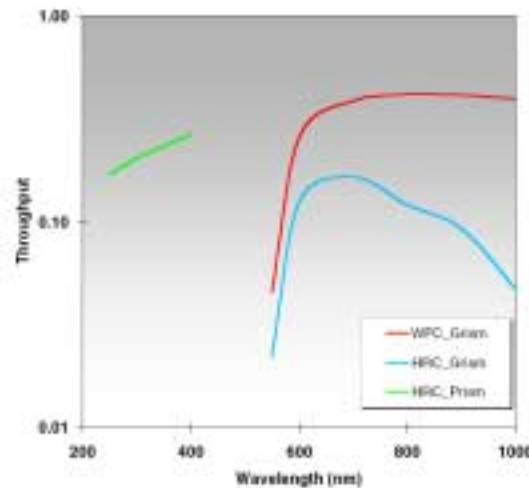
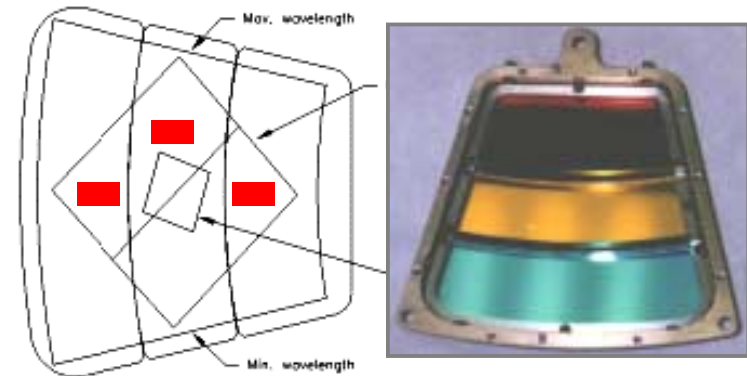


– Near-UV: *F220W, F250W, F330W*

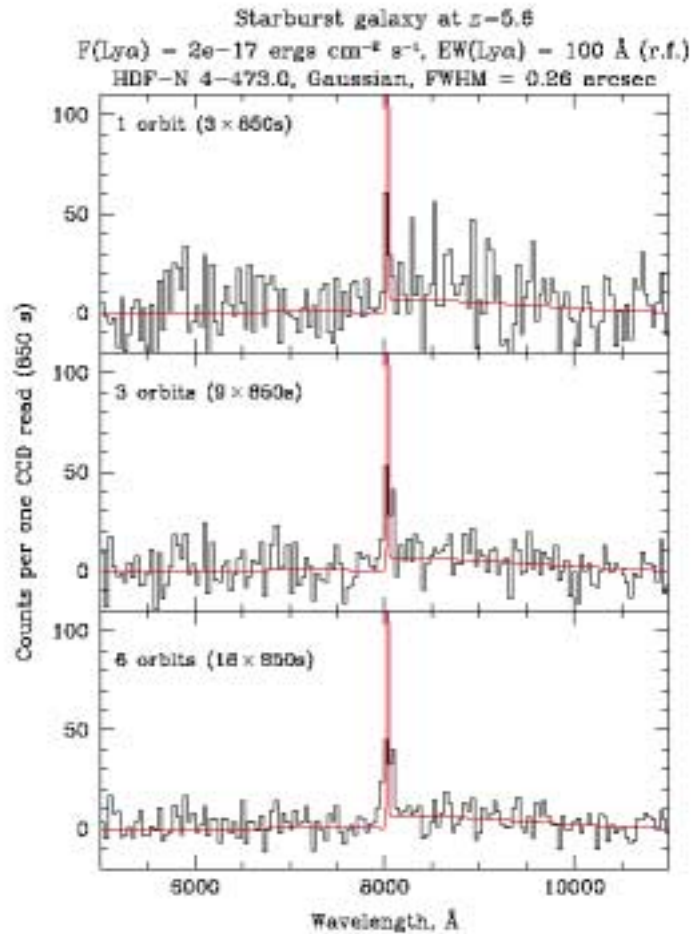
WFC/HRC Filters: Narrowband



- **Narrowband**
 - WFC: H α , [OIII]
 - HRC: NeV, CH₄
- Ramp filters: ~40"x70" FOV
 - $\Delta\lambda$ 2%: 371-1061 nm
- **R~100 Grism/Prisms**
 - **ST-ECF will support ACS grism/prisms**

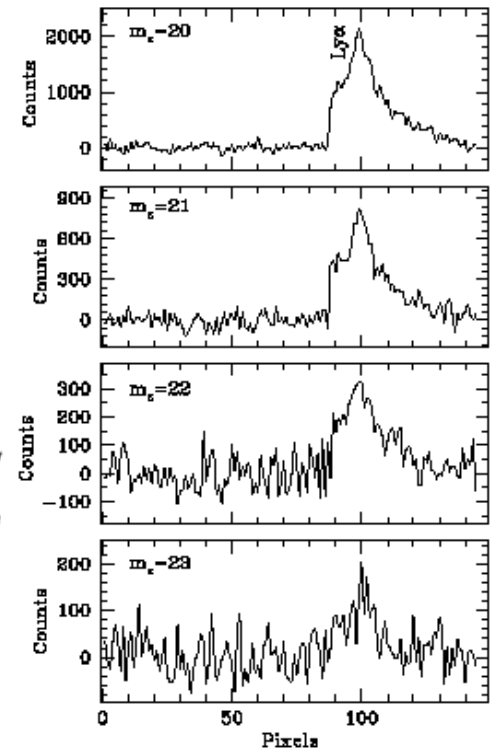


Exposure time = 2500 s
 Object size = 0.15 arcsec
 Read-out-noise = 4.5 e-
 Background = Zodiacal light: low, average, high



Tsvetanov, ACS-IDT

Figure 7. SLIM spectra of the QSO at $z=6.5$, 20, 21, 22 and 23. The units are counts and pixels from the object x-position in the direct image. The exposure time is 1000 sec. The background has not been subtracted. The Ly α is the only line detectable in the spectra, whose resolution is 40 Å/pix.



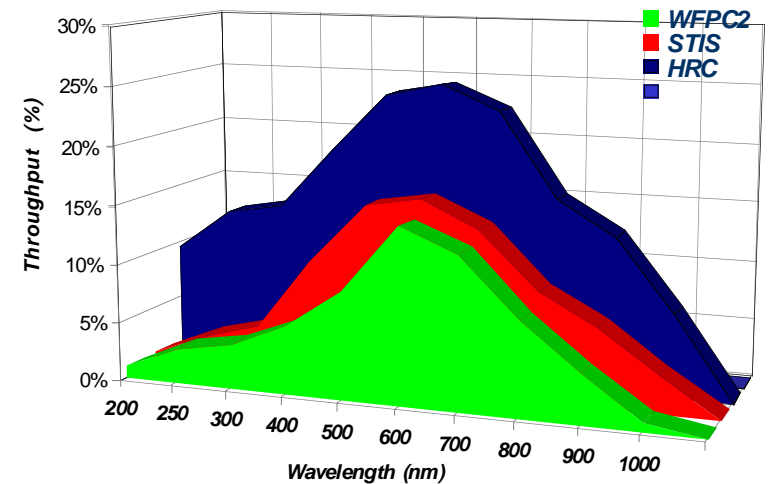
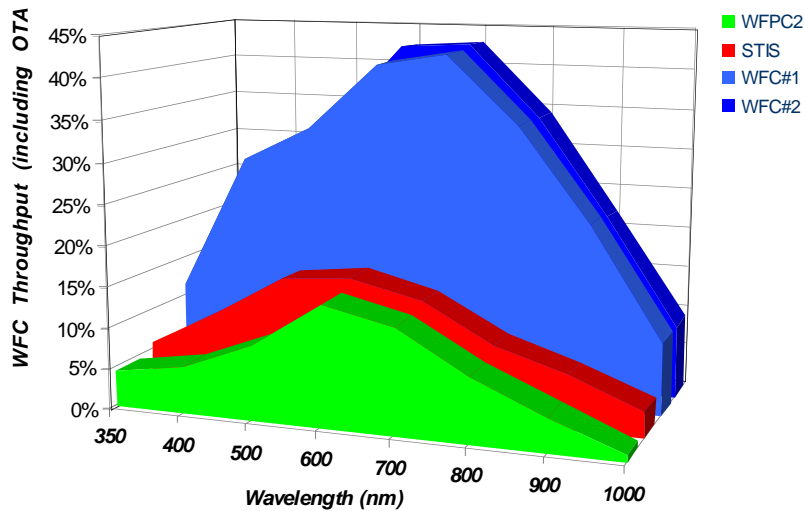
Pirzcal et al. ST-ECF

WFC/HRC Performance



WFC	98242MABR10-01 (A-B)	98242MABR10-02 (C-D)
Pixel size	15 μm x 15 μm	15 μm x 15 μm
Chip pixel format	2048 x 4096	2048 x 4096
Full well	77000 e ⁻	77000 e ⁻
Dark current at -79°C	6.2 e ⁻ /pix/hr	7.0 e ⁻ /pix/hr
Quantum Efficiency		
400 nm	65%	66%
500 nm	68%	70%
600 nm	74%	76%
700 nm	74%	75%
800 nm	62%	60%
900 nm	37%	36%
950 nm	24%	23%
1000 nm	13%	12%
A-D read noise	4.9 e ⁻	5.3 e ⁻
B-C read noise	4.9 e ⁻	5.0 e ⁻

HRC	71611xd01-01
Pixel size	21 μm x 21 μm
Pixel format	1024 x 1024
Full well	159,000 e ⁻
Dark current at -82°C	9.5 e ⁻ /pix/hr
Quantum Efficiency	
250 nm	35%
300 nm	36%
350 nm	39%
400 nm	47%
500 nm	59%
600 nm	63%
700 nm	62%
800 nm	50%
900 nm	35%
1000 nm	14%
Read Noise (A-B)	4.1 e ⁻ , 4.1 e ⁻
Read Noise (C-D)	4.1 e ⁻ , 4.4 e ⁻



- Limiting AB magnitudes (extended sources)
 - S/N=10, Aperture = 0.2 Sq arcsecs, 2 x 1200 sec images

	WFPC2		WFC	HRC
F450W	25.78	F435W	26.61	26.02
F555W	26.25	F555W	26.62	25.89
F606W	26.55	F606W	27.20	26.54
F814W	25.81	F814W	26.77	25.79

- Limiting AB magnitudes (point sources)
 - S/N=10, 2 x 1200 sec images
 - Apertures: WFC 5x5 pixels, HRC 9x9 pixels, WFPC2 5x5 pixels

	WFPC2		WFC	HRC
F450W	25.23	F435W	26.77	26.41
F555W	25.53	F555W	26.65	26.22
F606W	25.74	F606W	27.10	26.77
F814W	25.05	F814W	26.65	26.05

- **Template Observation: WFPC2 Hubble Deep Field South**
 - Limiting AB magnitudes, S/N=10, Aperture = 0.2 arcsec²

	Limiting AB Magnitude	Exposure Time (secs)	Number Readouts
HDFS_F450W	27.7	101800	51
HDFS_F606W	28.3	97200	49
HDFS_F814W	27.7	112200	56

- **Case 1) HDFS limiting magnitudes**

	WFC	HRC
F435W_Texp_HDFS	23663.1	41016.9
F606W_Texp_HDFS	38310.8	46994.6
F814W_Texp_HDFS	29650.6	93437.5

*Nreads =20

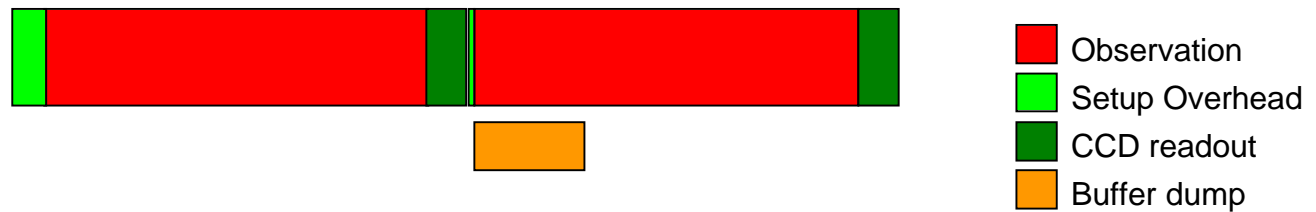
- **ACS can do HDFS in a third to a quarter of the time**
- **Case 2) Expose for Texp~100000 secs (Nreads=50)**

	WFC	HRC
F435W	28.60	28.18
F555W	28.43	27.95
F606W	28.83	28.44
F814W	28.38	27.74

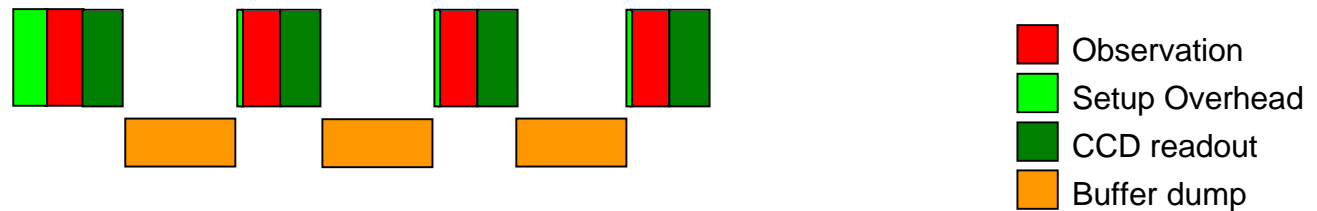


- Primary overhead driver is onboard memory
 - **34 Mb of CS buffer memory (drives buffer management)**
 - WFC images (2068 x 4164) requires 33 Mb
 - HRC images require (1068 x 1044) 2.1 Mb
- WFC
 - (texp > 340 secs)
 - observation overhead: 240 secs
 - subsequent observations: 150 secs
 - (texp < 340 sec)
 - include 340 secs for buffer dump
 - *short WFC exposures incur overhead penalty*
- HRC
 - observation overhead: 150 secs
 - subsequent observations: 60 secs
 - identical exposures (CRSPLIT or Patterns)
 - 16 observations before buffer dump

— CRSPLIT exposures of 1200 secs



— Example: 3 CRSPLIT exposures of 120 secs



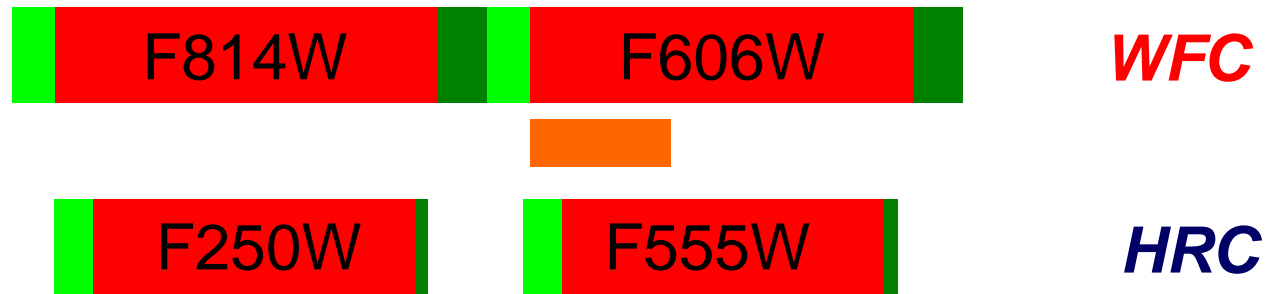
- Auto-Parallels: internal parallel WFC and HRC exposures
 - Constraints
 - no filter choice
 - exposure time limited by
 - primary exposure time
 - $t_{exp} > \sim 500$ secs
 - buffer management constraints
 - Auto-Parallels are inserted automatically

WFC Filter (Primary)	HRC Filter (Secondary)
F475W	F850LP
F658N	F550M
G800L	F625W
F502N	F775W
F606W	F555W
F850LP	G800L
F550M	F502N
F625W	F606W
F775W	F892N
F660N	F330W
F814W	F250W
F435W	F220W

HRC Filter (Primary)	WFC Filter (Secondary)
F892N	F775W
F606W	F625W
F502N	F550M
G800L	F850LP
F555W	F606W
F775W	F502N
F625W	G800L
F550M	F658N
F850LP	F475W
F330W	F660N
F250W	F814W
F220W	F435W



(1) WFC Primary: 2 x 1000 sec



(2) HRC Primary: 2 x 1200 sec

