Hubble Ultra-Wide-Field Imager (HUFI)

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Hubble Space Telescope

Field of View

FOV Footprint at CCD FPA

4K x 4K CCD’s (3)

90 square arc minute FOV

X image (mm)

Y image (mm)
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Optical Schematic

M3 Mirror
Pupil
Filters, CCD
Shutter Location
CCD FPA
M2 Mirror
Radial “Pickle”
Pick Off Mirror (POM)

HST OTA
Geometric ray trace compared to two-pixel and four-pixel width scale-bars shows a well-corrected design.
Diffraction PSF encircled energy @ $\lambda=632.8$ nm for center field and 4 other field positions show that PSF is diffraction-limited and is uniform over full FOV.
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Instrument Layout

FGS Enclosure Side

Optical Bench

Strut

Point C
(Point B Opposite Side)

Radiator

CPL Saddle To AS Radiator
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Instrument Layout

M2

M2 Support

FGS Enclosure
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HUFI Design Features

• All-Reflective Design
  – Four surfaces – one flat, three powered

• Well-Corrected Aberrations
  – Wavefront error 0.0451 to 0.0523 waves rms at 632.8nm

• Flat Focal Surface
  – Requires three 4Kx4K CCD’s similar to ACS and WFC3 detectors

• Cooling Via HUFI External Radiator Plus Coupling To NCS Radiator

• Replaces FGS #3 Without Compromising Current Pointing Performance

• Does Not Interfere With Other Instruments
  – Amenable to parallel observing
  – Follow-up observations with WFC3, COS, ACS, STIS
HUFI Scientific Performance

- FOV – 90 arcmin$^2$ (8xACS, 16xWFPC2)
- Pixel Scale – 0.10 arcsec (same as WFPC2)
- Sensitivity – Comparable to ACS in I-band, 5x WFPC2 in I-band
- Discovery Efficiency – 8xACS, 80xWFPC2
- SNe Ia Discovery Rate - ~1 per day with follow-up
POTENTIAL OBSERVING STRATEGY

• 3-6 Month campaigns dedicated to high galactic latitude fields

• Deep exposures with WFC3, COS, ACS broken into multiple visits
  – HUFI parallel exposures for “free”

• SN detected in HUFI fields followed with other HST instruments
  – STIS spectra for redshifts and classifications up to z=1.2
  – WFC3 near-IR images and grism spectroscopy up to 1.7 microns
  – ACS higher resolution images for host galaxy morphology
Monte Carlo Constraints, Input Model: \((\Omega_M=0.3, w_x=-2/3)\)
Monte Carlo Constraints, Input Model: \((\Omega_m=0.3, w_x=-2/3)\)
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RETIREMENT OPTIONS FOR HST

- One Shuttle flight allocated to HST after Servicing Mission 4 in 2004
- Current baseline plan is to return HST to the ground in 2010
  - Exhibit in National Air & Space Museum
  - Requires partial disassembly and disposal of multiple pieces in orbit
    (e.g. solar arrays, external radiators, possibly instruments)
  - 5 EVA mission
  - Requires HST to be stable and commandable
  - Less than 50/50 chance that HST will function to 2010

- Alternative option
  - "Light" servicing mission in 2007 instead of 2010
  - Maximizes probability of zero downtime between HST and NGST
  - Attach propulsion module to HST for end-of-mission controlled re-entry
  - Provides possible opportunity for new instrument, e.g. HUFI
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9/10/01 HST Reliability Indicator from the Refined Aerospace Corporation Model

Probability of HST Science Operations vs. Time Since Last Servicing Mission
SUMMARY

- We’ve identified an instrument design which provides a major increase in FOV compared to prior HST cameras
- A systematic campaign should yield ~1 SNe per day with follow up provided by full suite of HST instruments
- Flight opportunity requires change in current baseline retirement plan for HST and willingness of Code S to support a new HST instrument
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Thermal Block Diagram

HUFI Radial SI

90 watts electronics to modified “door radiator” using HPs

“New” Radiator/Door

120 watts to NCS Radiator using HP/VCHP to carry heat from CEB and CCDs

NCS Radiator

Existing Inserts

40 watts to AS
Total estimated power requirement of 250 W

- HUFI Radial SI
- 60 watts From HST
- Diode Box Auxiliary Power Ports
- 190 watts from NCS Radiator auxiliary power supply
- NCS Radiator