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Wide Field Camera #3 Filter Selection Process - Part II- Compendium of Community Input

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ABSTRACT

This is the second part of a series documenting the WFC3 Filter Selection Process. For the sake of historical documentation, this series of reports presents a summary of the selection process and the final filter lists. Part I documents relevant studies of historical HST filter usage, Part II provides a brief synopsis of the WFC3 Filter Workshop during which the astronomical community responded to the solitication of their inputs. Parts III and IV present the IR and UVIS filter specifications and compare the suite of WFC3 filters to the those of ACS, NICMOS and WFPC2.

1.0 Introduction

Wide Field Camera #3 is a radial bay instrument slated to replace the WFPC2 during the final servicing mission to Hubble in late 2003. The WFC3 is a dual-channel instrument and its panchromatic capabilities make it unique among the HST pantheon of instruments. Besides the advances in technology that the WFC3 will bring to Hubble, there are other ways that WFC3 is unique among HST instruments: the instrument definition team as defined by all previous instrument-building philosophies has been replaced by a consortium of scientists and engineers at GSFC, STScI, Ball Aerospace, JPL, and other contractors. A Scientific Oversight Committee (SOC) provides scientific feedback to STScI and GSFC. It is composed of scientists from the astronomical community who are experts in the near UV, IR, ground-based and spaced-based observing, and who cover many relevant astronomical areas of interest. The role of the STScI WFC3 team is multi-faceted, providing both scientific input and operational experience to the project, supporting and facilitating the SOC in their endeavors, and carrying the information to the community.

The design of the instrument is a multi-bounded problem: budgets, technology limits, time limits, science-needs versus available resources, etc. Detailed reviews of these issues may be found at the GSFC WFC3 web site and in other WFC3 publications. Also, details of the WFC3 optical channels may be found in Part I of this series and also in the WFC3 "Science White Paper "(ed M. Stiavelli and R. O'Connell, 2000), and on the GSFC web-site (*http://wfc3.gsfc.nasa.gov*).

2. WFC3 Filter Workshop

Adopting the philosophy that the WFC3 is a community instrument, the main goal of the filter selection process is to address as many types of astronomical research as feasible. Three strategic initiatives have provided the information needed to arrive at a filter list for the WFC3:

1. a special **filter workshop** was held on July 14, 1999 at STScI where community astronomers were invited or volunteered to discuss their filter priorities with the SOC in several areas of astronomy;
2. GSFC, on its website, hosted a "**Discussion Board**" where astronomers who could not attend the meeting could still provide their opinions and priorities;
3. the SOC put out a **strawman filter list** (on the web site) prior to the workshop to encourage response from the community, i.e., laying the foundation of the filter priority and selection philosophy.

2.1 Workshop Agenda

The following is the agenda of the Filter Workshop. In addition to providing the list of speakers and talks, we also wish to emphasize the discussion sessions in the afternoon where the meeting participants constructed the preliminary filter lists.

I. Introduction and WFC3 Overview (J. MacKenty, STScI and R. O'Connell, SOC)

II. Science Needs:

Galaxy and Galactic: 9:00-10:30 Chair [Bob O'Connell, SOC Chair]

Nino Panagia: "Photometric Studies of Stars and Stellar Systems"
George Wallerstein: "Stromgren Photometry "
Jon Morse: "Narrowband Imaging of Shock-excited Environments"
Paul Scowen: "HST Narrow Band Science in HII Regions"
Pat Harrington: "Filters for Extracting the Physics of Emission Line Objects"
Ken Mighell: "Populations, Evolution, and Washington Photometry"
Alex Storrs: "Planetary Observations and Filter Choice"

Extra Galactic: 10:50-11:45 Chair [Jay Frogel, SOC]

Ben Dorman: "Stellar Populations in the UV with WFC3"
Alan Uomoto: "SDSS Filters"
Harry Ferguson: "Filters for Studying Galaxy Evolution"
Peter Garnevich: "High Redshift Supernovae"

Special Infrared - 11:45-12:30 Chair [Jay Frogel, SOC]

Marcia Rieke: "Optimum Choices for the Near IR Channel"
Pat McCarthy: "IR Grisms"

Special ACS Review: Z. Tsvetanov [ACS Filters]

III. Discussion Sessions

1. Broad Band, Medium [chairs J. Holtzman/R. Windhorst, SOC]
2. Narrow Band, Continuum [chair B. Balick, SOC]
3. Special Elements [chair John Trauger, SOC and UVIS Filters]

4. Summary and Other Issues [chair J. Holtzman, SOC]

2.2 Abstracts/Summaries

In this section, informal abstracts or brief summaries of the talks are documented. Note that if abstracts were not available, s*ummaries compiled by WFC3 Science Integrated Product Team (IPT)* members are included for completeness. To see figures and actual presentations, please refer to the STScI WFC3 web site at *http://www.stsci.edu/instruments/wfc3/wfc3-filter_workshop.html.*

1. Title: Stellar Populations in the Ultraviolet with WFC3
Speaker: Ben Dorman (Raytheon ITSS-NASA/GSFC)

ABSTRACT: The precise study of both resolved and integrated stellar populations at ultraviolet wavelengths promises to allow accurate assessment of the integrated from galaxies at significant (z > 1) redshifts. For Galactic globular clusters, UV colour-magnitude diagrams can be used to measure stellar populations of interest, in particular the blue stragglers and advanced evolutionary stages (Horizontal-branch and later), without significant crowding problems as seen in the visual. The hot populations of local group systems may be also be accurately measured. An important new application possible with WFC3 arises as the UV also strongly differentiates against metallicity. This can be used to obtain an accurate record of the history of Galactic halo metallicity enrichment.

Integrated light from old stellar populations is dominated by the main-sequence turnoff with potential contamination from hot HB stars. Two colour UV diagrams can be used to gain information concerning the age-metallicity "degeneracy" problem since the turnoff is sensitive to both. The UV spectral range in populations dominated by cool stars has three significant wavelength ranges which may have differential behavior with population parameters: lambda <~ 250 nm, lambda < 250nm, lambda < 290, lambda >~ 290nm. Requirements for these projects are:

a) most importantly, strong red rejection longward of ~ 320nm,
b) filters with peak response in each of the above mentioned regimes.

2. Title: Filters For Studying Galaxy Evolution
Speaker: Harry Ferguson (STScI)

ABSTRACT: For most studies of distant galaxies, the choice of filter is a delicate trade-off of throughput and bandwidth. I will provide examples of specific applications that illustrate the criteria that should enter in to the filter selection for both narrow and broadband filters.

SUMMARY NOTES:

- filters for detections: very broad f300x, f475x, f800x
- filters for morphological structure: SLOAN or WFPC2
- UV filter at 2500A for deep field work
- Lyman-break galaxies - wavelengths 2280,2735,3650A
- Medium-band filters for field galaxies
- Red-leak suppression critical.
- Redshifted SLOAN filters
- Grism for emission line searches
- Rounded Overlapping filter shapes are preferable to sharp non overlapping filters - transformations are easier (Young 1994 A&A288,687).

3. Title: High Redshift Supernovae
Speaker: Peter Garnevich (Center for Astrophysics)

SUMMARY NOTES:
For low redshift supernovae, a filter is needed at about 4000A. To observe supernovae at z=0.9-1.3, a high QE IR channel is needed with filters at 1 micron with widths from 20-30%. The best case to support this filter is an observation set of LP850 with NICMOS F110M.

4. Title: Beyond Pretty Pictures- Key Filters for Extracting the Physics of Emission Line Objects.
Speaker: Pat Harrington (Univ. of Maryland)
ABSTRACT: The wealth of new and unexpected morphological detail seen with the high spatial resolution of the WFPC2 in planetary nebulae and other emission line nebulae have revolutionized our ideas of these objects. Narrow-band filters were key to revealing this fine structure. But a proper set of filters is even more important in understanding the physical processes which shape these structures. To achieve such an understanding, we must be able to map such parameters as temperature on the same 0.1 arcsec scale. Such programs are just getting under way as they necessarily lag the morphological studies; it important that the WFC3 have a filter set that is well chosen for such analysis. Ratios of narrow-band images are ideal for such work. We discuss the most important filters, and the requirements which image-ratio studies place on them, such as out-of-band rejection and the need for filters to subtract the continuum background.

SUMMARY NOTES:
Filters for studying various processes:

- basic morphology: H-alpha, H-beta (reddening); H-alpha leak <1%
- basic ionization structure: HeI 5876A, HeII 4686A
- advanced ionization structure: OI]6300A at H^0/H^+
- physical conditions from ratios OIII and OIII/OII.
- density in low ionization regions [NII]6584A is strong line for shocks, [SII], [CII];
- higher ionization regions [OIII]5007A (strongest), [NeIII]3869A,[SII]9532A;
- highest ionization [NeV]3426A.

5. Title: IR GRISMS
Speaker: Pat McCarthy (Carnegie Obs, Pasadena and WFC3 SOC member)

SUMMARY NOTES:
An IR grism allows observations out to z=4 (might have to deal with overlapping spectrum). The recommended grisms are:

- J-band at 0.9-1.3 microns R=300 per pix
- H-band at 1.3-1.8 microns R=300
- Hi-Resolution band at 1.4-1.6 microns R=800

Note: [redder version of G096, shorter version of G141 and a grism at z=1-1.5 at 1.4 microns.]

6. Populations, Evolution, and Washington Photometry
Speaker: Ken Mighell (NOAO)

ABSTRACT: Analysis of WFC3 observations of Local Group stellar populations in star clusters will be greatly simplified if the filter set includes filters designed since the Johnson-Cousins BVRI and Washington C because the community understands the interpretation of data in these filters and stellar evolution models are not available for unique HST filters.
The [original] strawman list surprisingly does not contain the WFPC2 F555W or any other filter which would transform well to V without color terms. T. has been shown that using F606W color magnitude diagrams is problematical. User community support is quite strong.
Geisler and Sarajedini (1999 AJ 117, 308) have recently shown that observations of Population II red giants with the Washington C system (C-T1) color have 3 times the metallicity sensitivity in comparison with the standard (V-I) color. The T1 filter is frequently [and successfully] replaced with the R filter. Usage of the R and Washington C

filters may well suffice for precise metallicity determination. However, unambiguous interpretation of stellar ages within the complex populations in the Local Group has suffered from the degeneracy of red giant branch colors. The Washington C filter can break the degeneracy by combining (C-R) and (C-I). The strawman F380W should be replaced with a Washington C filter with a higher peak throughput.

7. Title: Narrowband Imaging Diagnostics of Shock-excited Environments
Speaker: Jon A. Morse (University of Colorado)

ABSTRACT: HST studies of shock structures in the interstellar medium have led to new insights into many astrophysical phenomena that harbor supersonic flows, from protostellar jets, to nebulae surrounding Luminous Blue Variables, to supernova remnants. High spatial resolution images from WFPC, WFPC2, FOC, and STIS in the light of various emission lines have been combined to allow the first detailed tests of radiative shock models. Narrowband images of nebular objects are also among the most stunning from HST, and have engendered significant public interest. I will discuss important emission-line diagnostics of shock-excited environments that can be observed with WFC3 through narrowband filters. Future WFC3 studies will make use of the improved throughput (especially at blue and NUV wavelengths), larger field of view, and smaller pixel size compared to WFPC and WFPC2.

SUMMARY NOTES:
Ionization Structure:

- need access to wide range of ionization stages in ionized environments to measure ionization parameter, structure and cooling distance in post shock regions, degree of completeness in radiative shocks. Example SNR N132D].
- HST Resolves bow-shock Mach disk structures in Jets (H alpha isolated from neighboring NII).

Proper Motions: HST resolution allows us to track gaseous motions over short time scales, e.g., multi-epoch images of protostellar jets to test models of hydrodynamic flow, transverse kinematics can be combined with LOS kinematics to deduce 3-D flow geometries.

Electron Densities and Temperatures [equations on web]: Densities from H recombination and forbidden line fluxes (e.g., [OII]5007), densities from ratio [SII]6717/6731

Temperatures from line ratio maps (7000-35000K) [OIII]4959,5007/[OII]4363, [NII]6548,6583/[NII]5755

Elemental Abundances - origin of heavy elements and nucleosynthesis; Wide range of elements H, He, C, N, O, Ne, Mg, Si, S, Ar, Ca, Fe, and molecular.

NIR Filters: Stellar Jets from [FeII]1.644 microns and other tracers. Off-band continuum filters desirable to eliminate dust scattered light.

8. Title: Photometric Studies of Stars and Stellar Systems
Speaker: Nino Panagia (STScI)

ABSTRACT: I will review the quantities that characterize a stellar spectrum, focusing mostly on the continuum. On this basis, I will discuss criteria to select and define photometric bands suited for the identification of the surface parameters of a star, i.e. effective temperature, angular radius and, possibly, gravity. Some applications to the case of young populations and the identification of special types of stars will be presented and discussed. Finally, I will extend these considerations to the study of more distant stellar systems, in which blending of several stars into one apparent stellar image is a problem.

SUMMARY NOTES:
1) For each star, measure in at least 3 bands with high signal and separation between bands to be long enough to measure the flux gradient accurately and short enough to make all observations near the peak of the stellar flux curve, and to retain comparable angular resolution in all bands;
2) Have filters just shortward and just longward of the Balmer discontinuity;
3) maximize width but minimize overlap; filter group that allows photometric measurements for all stars.
4) A possible list of central wavelengths:
1100,1600,2250,3150(300w),4450(f450w),6300(f606w),8900(f814w),12600,17800.

9. Title: Optimum Choices for the Near-Infrared Channel
Speaker: Marcia Rieke (Univ. of Arizona Steward Observatory)

ABSTRACT: Based on both NICMOS and groundbased experience, the optimum filter set for the IR channel will be discussed. Calibration issues and photometric accuracy will be considered as well as scientific needs ranging from detection of Solar System ices to emission lines in extragalactic objects.

SUMMARY NOTES:
1. *Suggested Infrared Complement*:
Narrowband: F108N,F113N: HeI 1.083 microns
F128N, F130N: Paschen Beta 1.282 microns

F131N: Redshifted Paschen Beta
F164N, F167N: [FeII] 1.644 microns
F187N,F190N: Paschen alpha 1.875 microns

Broadband:

filter	λ_c	FWHM(micr)	R	Comments
F110M	1.1	0.20	5.5	
F124W	1.24	0.23	5.4	J
F125M	1.25	0.10	12.5	Brown Dwarf /CH4
F145M	1.45	0.19	07.6	H20,Brown Dwarf

Broad cont:

filter	λ_c	FWHM(micr)	R	Comments
F158M	1.58	0.10	15.8	Brown Dwarf
F160W	1.59	0.40	4.0	H and Grism filter
F165M	1.65	0.10	16.5	Ice
F172M	1.72	0.07	24.6	Brown Dwarf
F180M	1.80	0.07	25.7	Ice

2. NICMOS most used filters include F160W, F110W

3. Photometric Issues: Very broad filters should be avoided because: 1) color corrections make accurate photometric transformations difficult if $R < 4$; 2) Flat fielding is compromised for broad filters because of color-dependent terms in the FF response; and 3) Background over 0.9-1.9 microns has a minimum at 1.6 microns so broadening a filter's response may not necessarily improve S/N.

10. Title: HST Narrow-Band Science in HII regions
Speaker: Paul Scowen (Arizona State Univ)

ABSTRACT: Over the past 5 years the study of HII regions has enjoyed a Renaissance due almost entirely to the remarkable spatial resolution afforded by the WFPC-2 on HST using its complement of narrow band filters. Observations using these facilities have allowed us access, for the first time, to the spatial scales critical to successful modeling of the physics and dynamics of the ionization fronts in these objects. Such modelling has yielded a new picture of how these objects evolve. Another important part of this new view is the erosionary effect of photo evaporation and the implications it has for uncovering protostellar and protoplanetary systems, and in addition the effect it might have on secondary star formation. The importance of access to narrow-band filters at Space Telescope resolutions will be emphasized.

SUMMARY NOTES: The author reviewed typical targets in HII regions (protostellar objects, Ionization front shocks, bubbles, chaotic structure.

- ACS has only a couple of narrowband filters;
- ground-based cameras do not have the resolution;
- STIS has sensitivity but a limited set of filters;
- Enough filters need to be chosen to sample the range of ionization conditions in HII regions and the ISM;
- Line-free filters are needed for accurate continuum subtraction;
- Some filters are needed to remove contaminating flux e.g., [NII] from Halpha.

11. Title: Planetary Observations and Filter Choice
Speaker: Alex Storrs, STScI

ABSTRACT: Observations of solar system objects have some special considerations. I will review the different major types of planetary observations that have been made with WF/PC and WFPC2 and that may be made with WFC3, and the types of filters that have been used and that may be used in the future.

SUMMARY by author:
1. The F1042M filter has been very useful for defining the width of the 1 micron silicate feature,when used in connection with the F953N and other filters shortward of the feature. While the IR arm of WFC3 may well be more sensitive than the CCD in this region, there may be some time constraints on shifting from one to the other. For a time variable object (say, a rotating planet) the time lost may prevent a good comparison between filters. Also, wouldn't it be good to be able to directly compare the performance of the two sides of WFC3?
2. In looking at the long wavelength end of the mineral reflectivity spectrum, there are areas around 1.25 microns and 1.05 microns which would best be defined by medium band filters (say, 0.1 microns wide) and the intervening inflections at 1.125 microns and 1.400 microns could be investigated with medium- or narrowband filters at those wavelengths. This set would allow the refinement of the orthopyroxene/clinopyroxene and feldspar content of the surfaces studied.
3. Lacking an LRF, a grism would be very useful on small sources. There has not been a whole lot about the NICMOS grism in the news primarily because the software to reduce the data has only recently (like last week) become available. A grism will necessarily give you coverage across telluric absorptions, which has already been discussed (see P. Eisen hardt's posting) as a place of strength for WFC3. WFC3 will look at atmospheres, surfaces and aurorae and Io (torus).

12. Title: ACS Filters
Speaker: Z. Tsvetanov, ACS-JHU

ABSTRACT: Advanced Camera for Surveys (ACS) is a third generation HST instrument and is currently scheduled to replace FOC during SM3b at the end of 2000. ACS is equipped with a large selection of spectral elements to support a wide variety of astronomical programs. In this presentation I will present the scientific requirements determining the astronomical choices and technical specifications as well as the predicted performance.

SUMMARY NOTES:
ACS will provide a gain in HST imaging capability over current instruments with a discovery efficiency factor of 10 (area x throughput). The science drivers for the selection of ACS filters included:
1) survey of high redshift galaxy clusters and their surroundings to map dark matter distribution.
2) Narrowband imaging of inner regions of environs of active galaxies (QSOs and AGNs) and strongly starbursting galaxies.
3) Coronographic surveys of nearby stars for protoplanetary disks, brown dwarf companions, and planets.

13. Title: SDSS Filters
Speaker: Alan Uomoto (Johns Hopkins Univ)

SUMMARY NOTES: The Sloan Digital Sky Survey will soon contain more photometry than all other photometric systems combined. Much of the sky will be surveyed to 23rd magnitude. The SDSS filters are used on ACS and therefore, in its role as backup to ACS, the WFC3 should carry the SDSS filters onboard.

14. Title: The use of Stromgren photometry to Derive Metallicties and Ages in Globular Clusters and Local Group Galaxies
Speaker: George Wallerstein (Univ of Washington)

ABSTRACT: The Stromgren system consists of 4 filters: y,b,v, and u whose effective wavelengths are 5470A, 4670A, 4110A, and 3500A respectively with passbands of 180 to 300 A (half-width. The color b-y is sensitive to temperature but not metallicity (because of comparable line blanketing in b-y). The v-b color is very sensitive to metallicity for F and G stars. As an example of the usefulness of the Stromgren system we have analysed stars at the main sequence turnoff of Omega Centauri using the m index [(v-b)-(b-y)] to estimate the metallicity of individual stars with an uncertainty of about +/- 0.2 in [Fe/H].

We have observed a field north of the core of the most massive globular cluster in our Galaxy, Omega Centauri, with Stromgren vby filters. We looked for a correlation of age and metallicity in a region that avoids the dense core and the inhomogeneous foreground dust emission shown by the IRAS satellite. By dividing the stars into three groups with [-2.2<[Fe/H]<-1.6, -1.6<[Fe/H]<-1.2, and -1.2<[Fe/H]<-0.5 we investigated the connection between age and metallicity. When we plotted a color-magnitude diagram for each metallicity group with the isochrones of VandenBerg et al (1998) superimposed, we found that the most likely age for the most metal-poor group is 14 Gyr. The group with intermediate metallicity has a likely age of 12 Gyr, and the most metal-rich group has an age near 10 Gyr. This clear correlation of metallicity with age shows that Omega Centauri has enriched itself over a time-scale of roughly 4 Gyr. Apparently star formation ceased approximately 10 Gyr ago as type Ia supernovae and stellar winds dispersed the interstellar matter. It is remarkable that ejecta from stellar winds failed to disperse the interstellar matter at an earlier time, but were captured by the cluster instead. Possibly Omega Cen was once a small galaxy in which all the activity occurred before it was captured by our Galaxy. Our observations reached magnitude 20 with a 0.9-m telescope. With HST we could reach mag. 25 thereby covering almost all systems in the Local Group and the dense cores of Galactic globular clusters. [Figures showing the passbands and our C-M diagrams may be found on the web.]

3. WFC3 Filter Discussion Board

In addition to information presented in these talks, we document some highlights placed on the Filter Discussion Board prior to the Filter Workshop:

B. Woodgate, GSFC: WFC3 should have clear filters to provide a mode with maximum light gathering (faintest galaxies, Gamma ray bursts, protoplanetary disks, gravitational lens). Proved extremely useful on STIS and WFC3 will have a large field and higher sensitivity.

P. Eisenhardt - repeat F110w and F160w because of the large archive of existing data, however have filters which better match ground-based J and H; include an open filter 0.9-1.9 microns to provide very deep images like STIS; tune some filters to just the atmospheric bishoprics bands - what we cannot get from the ground.

J. Hutchings: put in a plug for ramp filters - filters tunable for studying randomly redshifted objects.

T. Von Hippel: Much of my research with WFPC2 has been with the F555W and F814W filters. F606W transforms poorly to the Johnson V band. I have used WFPC2 to observe open clusters, white dwarfs, and globular clusters. Leaving out the F555W filter would be a mistake for comparisons with past WFPC2 data and comparisons with a large body of ground-based data.

P. Stetson: The actual WFPC2 throughput of F555W and F814W filters should be duplicated for the sake of the Key Project Studies

JP. Linde: Galactic Evolution & importance of uvby Standard Photometry - a unique set of filters for determination of high quality metallicities for individual stars. Data from ubvy photometry provide high accuracy (Me/H) data and ages for individual stars much fainter than possible with spectroscopy of a resolution necessary for corresponding accuracy. From wide band photometry, no really reliable data on (Me/H) can be obtained
We envision a continuation of our studies of WFPC2 galactic evolution studies in other galaxies in the vicinity of the Galaxy. Given a reasonable sensitivity of the detector of the WFC3 (around 90 %), we can, without problems, reach a number of such galaxies with the HST, the WFC3 and uvby photometry. Suitable candidate galaxies are, with the corresponding limiting magnitudes for (Me/H) to an accuracy of 0.2 dex are Sculptor, Draco, Ursa Minor, Fornax, LeoII, LeoI.

Stolovy: It is crucial that continuum filters for narrowbands are chosen to match each spectral line filter.

T. Armandroff: Reproduce ground-based BV and I systems as closely as possible. (simple transformations with the smallest possible color terms. It is EXTREMELY IMPORTANT to be able to place the photometry on the ground-based system in order to be able to compare with existing photometry of comparison objects and stellar isochrones. The most important filters for such work, in my opinion, are B, V & I (Kron-Cousins).
S. Pascarelle: I'd like to suggest that a series of medium-band (delta z~5%) filters be included with the IR filter set. As Esther Hu mentioned, the narrow-band WFPC2 filters were not well suited for searching for very high redshift emission-line objects, but medium-band filters have proven quite useful (Pascarelle et al., 1998, AJ, 116, 2659). As Peter Eisenhardt points out, it would be most useful to place these medium-band filters in wavelength regions inaccessible to ground-based telescopes due to strong night sky emission. I also support the idea of including an "open" filter in the R filter set (0.9-1.9um) - the scientific returns would be numerous.

A. Storrs: I too would like to put in a plug for the ramp filters. These can be used in planetary observations for which the frequency of use would be too low to justify a dedicated filter. LRFs have been used in the past for monitoring Mars, for distinguishing silicate mineralogies there and on other rocky bodies, for atmospheric studies (esp. across terrestrial absorption bands), and for icy surfaces (ozone comes to mind). These would be especially useful if they could be put in or near a focal plane, preferably after correction for spherical aberration.

E. Hu: I'd like to follow up on Sam Pascarelle's comments on the issue of red filter selection, which is arguably the area which requires the most rethinking in the light of both very recent scientific discoveries (e.g., methane brown dwarfs, and new varieties of lowmass stars from IR surveys; very high redshift (z>5) galaxies; Kuiper Belt Objects and other outer Solar System bodies; etc.) and new instrumentation capabilities (IR detector side). For these programs a combination of medium bandpass filters spanning the far red wavelengths (from ~9000 Ang onwards) are important, and can be selected along with the J1, J2 filters to provide good general color discriminants, while also covering spectral diagnostic features (e.g., Alex Storrs' suggestion for 1.05 micron silicate feature in a medium bandpass filter). One can also include a filter placed in a region which inaccessible or difficult to study from the ground due to a combination of strong night sky emission and telluric absorption (following Peter Eisenhardt's suggestion). This would be an effective combination for a variety of programs. I would also favor a very broad JH filter.

J. Trauger: on suggestions for Planetary and Brown-Dwarf Study: Here is a strawman filter proposal for the atmospheres of giant planets and brown
dwarfs -- a set of three quad filters as follows --
(1) UVIS CH4 abs/cntm pairs   619, 619(+/-), 893, 935 nm
(2) UVIS CH4 narrowband   889, 904, 922, 937 nm (FWHM < 0.01*center wave).
(3) NIR CH4 abs/cntm pairs   1080, 1130, 1580, 1710 nm
This selection of planetary science passbands is offered for further discussion by the HST user community. It has been distilled from an informal email survey distributed in May 1999 to a number of planetary scientists who are past users of HST data. There were various opinions on the choice of continuum wavelength companion for the 1.71 micron filter, here we have taken Karkoschka's advice and selected 1.58 microns. The suggested broadband filters are already accounted in the WFC3 set of photometry filters in the UV and NIR.

Bob West suggests a Cassini-style dual-passband continuum filter for the 619 nm band. The 619(+/-) filter simultaneously transmits the continuum wavelengths on both sides of the 619 absorption feature, while blocking the 619 absorption band itself. Since it is likely there will be space for up to two UVIS and one NIR filter for methane/planetary science, the list was reduced to 12 passbands distributed into three quad filters, each quad element covering an FOV larger than Jupiter.

Multiple filter elements, four to each (quad) filter, each provide about 70 arcsecond square fields of view in the UVIS camera, and somewhat smaller (TBD) FOVs in the NIR camera. HST pointing offsets would be used to select among the four filter elements, as is done for the WFPC2 quads. Rapid absorption/continuum exposure pairs could be facilitated via filter selection, rather than telescope pointing, by placing each CH4 and its corresponding continuum passband in the same quad position on two different filters. Rapid subframe readouts of just one quadrant of the CCD can also be used to help keep the absorption/continuum pairs close together in time.

B. Balick - list of high and medium priority narrow band filters:

2326 F233N CII], - reject SiII]2335 if possible
2425 F243N [NeIV],
2798 F280N MgII,
3078-3099 F309N OH(0,0) series
3426 F343N [NeV],
3726+3729F373N [OII] 3727 - nearby faint contaminating lines
                    F375N [OII] redshifted - perhaps covered by medium filter?
3869 F387N [NeIII] - must reject H-epsilon and HeI lines
                    F390N CN?, from WFPC2,
                    F390N off CaII - perhaps covered by medium filter?
3945 F393N CaII,
4340 F434N H-gamma
4363 F437N [OIII] (must reject H-gamma)
                      - must be used with F502N
4471 F447N HeI
4572 F457N [Mg I]
4686 F469N HeII,
4740 F474N [NeIV] (I added this to your list)
4861 F487N H-beta,
5007 F502N [OIII],
5199 F520N [NI]5198+5200
5303 F530N [Fe XIV],
5755 F575N [NII] - must be used with F658N
5876+5892 F588N HeI/NaI,
6300 F631N [OI],
6563 F656N H-alpha,
6584 F658N [NII],
6678 F668N HeI
6717+6731 F673N [SII],
6717 F673AN [SII] - must be used with but reject 6731
6731 F673BN [SII] - must be used with but reject 6717
7005 F701N [ArV],
7135 F714N [ArIII],
7387 F739N [NiII],

7412 F741N [NiII],
9850 F985N [CI]
Methane quad (543N, 619N, 727N, 893N),
UV Narrow quad (376N, 384N, 392N, 399N)
Unprioritized list of IR Narrowbands:

10320 F1032N [SII] - sum of [SII] 10284, 10317, 10336, 10370
probes S+ in very dusty regions;

10830 F1083N HeI

12400 F1240N H_2 12260+12327+12380+12416+12418+12470
mini forest of medium bright H_2 lines
- must reject [FeII]12567

12818 F1282N Paschen-beta - not necessary of P-alpha is included

12567 F1257N FeII line; same upper state as 1.644 micron line
Good for extinction and for HH objects.

16436 F1644N [FeII] Traces high density shocks at modest
Excellent tracer of inner jets.

17470 F1748N H2 1-0 S(7)

18751 F1875N Paschen-alpha - use to probe H+ in very dusty regions

4. WFC3 FILTERS

Using their own expertise, inputs from the filter workshop and the Discussion Board, and several additional discussions, the SOC with help from the IPT prepared a list of filters that they recommend for inclusion into the WFC3. These are listed in the following table and discussed in more detail in Lupie and Boucarut, 2000 (ISR WFC3-2000-008, Part III).

WFC3 UVIS

#	Fname	description	lambda (A)	fwhm (A)
UVIS-1	F218W	ISM feature	2175	300
UVIS-2	F225W		2250	500
UVIS 3	F275W		2750	500
UVIS 4	F336W	U, Stromgren u	3375	550
UVIS 5	F390W	Washington C	3900	1000
UVIS 6	F438W	WFPC2 B	4320	695
UVIS 7	F555W	WFPC2 V	5410	1605
UVIS 8	F606W	WFPC2 Wide V	5956	2340
UVIS 9	F814W	WFPC2 Wide I	8353	2555
UVIS 10	F475W	SDSS g	4750	1520
UVIS 11	F625W	SDSS r	6250	1550
UVIS 12	F775W	SDSS i	7760	1470
UVIS 13	F850LP	SDSS z	8320	2000
UVIS-14	F350LP	very broad *	3500	7000
UVIS-15	F300X	very broad *	2775	1850
UVIS 16	F475X	very broad *	3800	2200
UVIS 17	F600LP	very broad *	6000	4000
UVIS 18	F390M		3900	200
UVIS 19	F410M	Stromgren v	4105	190
UVIS 20	F467M	Stromgren b	4675	230
UVIS 21	F547M	Stromgren y	5475	710
UVIS 22	F621M	11% fil	6212	640
UVIS 23	F689M	11% fil	6886	710
UVIS 24	F763M	11% fil	7630	780
UVIS 25	F845M	11% fil	8454	870
UVIS 26	F280N	MgII 2795/2802	2798	42
UVIS 27	F343N	[NeV] 3426	3426	228
UVIS 28	F373N	[OII] 3726/29	3732	38
UVIS 29	F395N	CaII H&K	3950	61
UVIS 30	F469N	HeII 4686	4686	32
UVIS 31	F487N	H-b 4861	4867	45
UVIS 32	F502N	[OIII] 5007	5013	47
UVIS 33	F588N	HeI 5876+NaI	5886	60
UVIS 34	F631N	[OI] 6300+[SIII]	6306	54
UVIS 35	F645N	Continuum	6455	82
UVIS 36	F656N	H-a 6563	6563	14
UVIS 37	F658N	[NII] 6583	6585	20
UVIS 38	F665N	z (Ha +[NII])	6654	94
UVIS 39	F673N	[SII] 6717, 31	6731	77
UVIS 40	F680N	z (Ha +[NII])	6902	288
UVIS 41	F953N	[SIII] 9532	9532	64
quads				
UVIS 42a	F191N	CIII] 1909	1909	30
UVIS 42b	F232N	CII] 2326	2326	36
UVIS 42c	F243N	[NeIV] 2425	2425	36
UVIS 42d	F378N	z ([OII] 3727)	3780	80
UVIS 43a	F387N	[NeIII] 3869	3869	26
UVIS 43b	F422M	continuum	4220	108
UVIS 43c	F437N	[OIII] 4363	4364	30
UVIS 43d	F492N	z (H-b)	4924	78
UVIS 44a	F508N	z ([OIII] 5007)	5081	112
UVIS 44b	F575N	[NII] 5755	5755	12
UVIS 44c	F672N	[SII] 6717	6716	14
UVIS 44d	F674N	[SII] 6731	6731	14
UVIS 45a	CH4A-a	25/km-agt	8890	89
UVIS 45b	CH4A-b	2.5/km-agt	9060	91
UVIS 45c	CH4A-c	0.25/km-agt	9240	92
UVIS 45d	CH4A-d	0.025/km-agt	9370	94
UVIS 46a	CH4B-a	CH4 6194	6194	62
UVIS 46b	CH4B-b	6194 cont.+	6340	63
UVIS 46c	CH4B-c	CH4 7270	7270	73
UVIS 46d	CH4B-d	7270 cont.	7504	75
UVIS 47	P200	UV prism	2775	1850
UVIS 48	F657N	Wide Ha+[NIII]	6573	94

WFC3 IR

Fname	description	lambda (microns)	fwhm (microns)
F160W	Broad H and Red Grism Ref	1.5450	0.2900
F125W	Broad J	1.2500	0.3000
G141	"Red" Low Resolution Grism	(1.4100)	(0.6000)
F127M	Water/CH_4 continuum	1.2700	0.0700
F139M	Water/CH_4 line	1.3850	0.0700
G102	"Blue" High Resolution Grating	(1.0250)	(0.2500)
F098M	"Blue" Filter, Blue Grism Ref	0.9850	0.1700
F164N	[FeII]	1.6463	0.0165
F167N	[FeII] continuum	1.6677	0.0167
F153M	H_20 and NH_3	1.5300	0.0700
F128N	Paschen Beta	1.2839	0.0128
F130N	Paschen Beta continuum	1.3006	0.0130
F126N	[FeII]	1.2590	0.0126
F132N	Paschen Beta (redshifted)	1.3200	0.0132
F105W	Wide "z"	1.0450	0.3100
F140W	Wide Band spanning J-H bounda	1.4000	0.4000

Note: ( ) parenthesis indicates exact specs are still in work.

Table: WFC3 IR and UVIS Filters

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