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WFC3 UVIS Filters: Measured Throughput and Comparison to Specifications

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Abstract

We present the filter throughput at the center of each WFC3 UVIS filter as measured by the Jet Propulsion Laboratory team of J. Trauger, N. Raouf, B. Gordon and others. The filter performance is assessed relative to the WFC3 CEI specifications and to the requirements defined in the JPL requirements document (J. Trauger, 2000). Note: The intention of this study is to document the comparison between spec and as- built properties for future reference. Ultimately, the science goals determine the applicability of a specific filter. The WFC3 Science Oversight Committee has reviewed all the measured data, selected the flight candidates, and approved the filter deliveries. Spatial trends will be addressed in a future report.

1. Introduction

We present the filter throughput at the center of each WFC3 UVIS filter as measured by the Jet Propulsion Laboratory team of J. Trauger, N. Raouf, B. Gordon and several descriptive parameters calculated at the STScI. The intention of this study is to document the comparison between spec and as-built properties for future reference. Ultimately, the science goals determine the applicability of a specific filter. The WFC3 Science Oversight Committee has reviewed all the measured data, selected the flight candidates, and approved the filter deliveries.

The **structure of this ISR** is as follows: Section 2 presents the throughput data and derived parameters in the form of annotated plots and tables. Definitions of all relevant filter characterization parameters are provided. Section 3 compares the throughput measurements to the specifications. Section 4 describes the requirements and JPL measurements of wavefront, wedge, and focus shift. The document text closes with acknowledgements and references.

The Wide Field Camera 3 UVIS filter development program is complete, the flight filters are bonded into the filter wheel mechanisms and are awaiting ambient and thermal vac ground based calibration activities. The program has spanned 3 years starting with the scientific selection of wavelength ranges of interest followed by the filter definition and requirements phase, the vendor interface phase, receipt and measurement of the filter properties and the final selection of the flight candidates. The scientific selection process and interim results are documented in several ISRs (WFC3 ISRs 2000-07,08,09 and ISR 2002-10). The team responsible for the entire filter development program included the following:

- WFC3 Science Oversight Committee → recommended the selection of filters and chose the final flight candidates,
- JPL scientists → designed, purchased, and characterized the UVIS filters,
- Barr Associates, Inc and Omega Optical → manufactured the filters,
- Ball Aerospace → provided optical prescriptions and mounted the filters in the housings, and
- STScI/GSFC/Ball Aerospace → provided scientific studies and technical support.

This ISR documents the WFC3 UVIS filter throughput measurements, specifically those taken at the center of the filter. The filter characterization measurements are represented in the SPIE paper, "*Characterization of UV-visible Filters for the WFC3 of the Hubble Space Telescope*" (Raouf and Trauger, SPIE, Waikoloa August 2002).

2. Filter Throughput Data

The CEI requires 48 selectable spectral defining elements in the WFC3 UVIS channel as listed in the **CEI Table 4-6** (see Table 1 in this ISR columns 3 and 4). There are indeed 48 selectable spectral defining elements. Five of those elements are "QUAD" filters composed of 4 quadrants each having a unique filter. Also, a UV grism is included as one of the 48 spectral elements. Grism characteristics as well as Out-of-band-Blocking performance characteristics of the filter will be documented in future ISRs.

Testing procedures, scientific method, and error budget analyses are well established, well documented and consistent with the needs of the WFC3 program. The JPL Optical Filter Acceptance Test Matrix is outlined in Appendix B of the JPL Requirements Document (Trauger, 2001).

2.1 Annotations

Panels 1 through 11 display the measured throughput at the center of each UVIS filter as a function of wavelength. The requirements (referred to as 'spec') and several measured (as-built) and derived parameters are also labeled. Very wide and broad band data were provided by JPL in 10-Angstrom increments and medium and narrow band data in increments of 1 Angstrom.
The extra-wide, wide and medium band filter throughputs were measured at 25 locations on the filter and narrow band data were measured at 9 locations. Small spatial dependent trends in the throughput seen in a few filters will be discussed in a future ISR.

2. 1.1 Requirements Specifications: λ_{+50} , λ_{-50} , λ_{-90} , λ_{+90}

Spectral Performance
The spectral performance requirements are given in terms of the wavelengths at which the transmittance on either side of the passband equals a certain percentage of the peak and remains less than that value for all shortward and longward wavelengths. In each panel, a dotted rectangle outlines the specs for the FWHM defined at the wavelengths where the transmittance is 50% (λ_{-50} and λ_{+50}) or 90% (λ_{-90} and λ_{+90}) for wide/medium and narrow bands, respectively.
A subset of narrow bands were better described using the 50% points instead of the 90% points in the original specifications to the vendors. The 50% spec value is displayed as a dotted box whose width is the FWHM at 50% and height corresponds to the peak throughput of the filter.

The required peak throughput specification is shown using symbol (*--*). The peak throughput is defined as the absolute average transmittance between λ_{-90} and λ_{+90}.

Width

The width, drawn as a dotted line or dotted rectangle (FWHM) is defined as [λ_{-50} - λ_{+50}]. For narrow bands, the [λ_{-90} - λ_{+90}] width is a more descriptive and stringent requirement for a rectangular filter. The rectangle or line are centered on the central wavelength.

Central Wavelength

The central wavelength as specified in the JPL requirements is defined as the geometric mean $\sqrt{[\lambda_{-50} * \lambda_{+50}]}$. This mean is related to the average wavelength defined as the "geometric center of mass" of the filter.

2.1.2 As-Built Elements

Central Wavelength

In addition to the measured transmittance, several derived parameters are also included in the panels. Three descriptive "central wavelengths" are identified using vertical dash-dot-dash line: *pivot, average, and mean*. Together, these three centralized wavelengths provide information about the filter's symmetry in wavelength space as well as frequency (or energy) space. The *mean wavelength* (originally described in Schneider, Gunn and Hoessel Ap.J 264,337 and used to describe WFPC1 and WFCP2 filters) by indicates the "center of mass" in terms of frequency, i.e., it represents the wavelength halfway between the "frequency" mean of the filter and the wavelength mean (WFPC2 Instrument Handbook – Appendix B, System Throughput Section). The *average wavelength* is the center of mass with respect to the area in the wavelength domain and is most closely related to the geometric mean wavelength specified in the JPL requirements document. The *pivot wavelength* is the center of mass weighted by the inverse of the wavelength.

Widths

Two widths are denoted by horizontal dash-dot-dash lines with end brackets: 1) the full width half maximum of an equivalent Gaussian and 2) the rectangular width of the passband. These are labeled in the figures. The rectangular width is more suited for comparison with the FWHM specified in the requirements documents.

Spectral Performance Parameters

Knowledge of the technique used to manufacture a filter is always infused in the statement of the specifications to the vendors. Modeling of filter coatings and substrate thickness are used to realistically set the performance requirements. This is why the requirements specifications refer to different parameters depending on the type of filter being manufactured. As an example, for some of the wide band filters, one wavelength edge may be defined by the natural blocking of the color glass substrate used for that filter while the other edge may be sculpted by the type and thickness of the coating on the substrate. Hence the specs indicated the color glass label (e.g., UG11) rather than giving a shape for the throughput in wavelength. For most narrow bands, filter peak should be as flat and 'square' as possible. Therefore, the 90% wavelengths are more descriptive to the vendor than providing the 50% FWHM points.

The measured wavelengths at which the transmittances are 0.01 absolute, 50% of peak and 90% of peak are denoted on the panels by a large asterisk symbol. (∗). The wide and medium bands are best characterized by the elements (λ_{-50}, λ_{+50}) and (λ_{-01},λ_{+01}). Narrow bands are described using (λ_{-01},λ_{+01}) and either the 90% or 50% points. The values were calculated used a simple linear interpolation between the two closest points to the specified transmittance.

2.2 Table Descriptions

2.2.1 Requirements Specifications

Table 1 lists the filter performance requirements as stated in the Version D JPL Filter Specifications Document (J. Trauger, 2001). The central wavelength and FWHM from the JPL spec are reproduced in the "WFC3 Contract End Item Specifications" (WFC3 STE-66 Baselined May 31, 2002). Minor differences are highlighted in blue and purple shading. These shaded cells indicate estimated performance requirements only and were not part of the original specifications description. The long pass filters are best described by the wavelength of the 50% declineand the peak transmittance rather than the central wavelength or width. The column definitions are as follows:

Column 1: F number – number designation as stated in requirements document
Column 2: Filter Name
Column 3: Central Wavelength defined as the geometric mean wavelength $\sqrt{[\lambda_{-50} * \lambda_{+50}]}$.
Column 4: FWHM defined as $[\lambda_{-50} - \lambda_{+50}]$ or $[\lambda_{-90} - \lambda_{+90}]$. Non-blank cells for the 50% or 90% wavelengths indicate which type of FWHM is specified.
Columns 5 through 10: the wavelengths at which the transmittance is the specified percentage of the peak (λ_{-01} λ_{-50} λ_{-90} λ_{+90} λ_{+50} λ_{+90}). A blank cells indicates that the parameter was not used to assess performance.
Column 11: Out-of-band blocking– Below a certain wavelength the transmittance shall not exceed the specified value.
Column 12: Wavelength pertaining to the out-of-band blocking requirement.
Column 13: The minimum acceptable transmittance between the $[\lambda_{-90}, \lambda_{+90}]$ points.
Column 14: Filter Description.

2.2.2 Measurements

Table 2 contains calculated parameters for each filter. Wavelengths are given in Angstroms.
Columns 1 and 2: Filter name and sample number for the flight filter.
Column 3: Pivot Wavelength – center of mass of the filter weighted by the inverse wavelength according to the following: $\sqrt{[(\int T(\lambda)\lambda d\lambda)/\int (T(\lambda)d\lambda/\lambda)]}$ where T is the transmittance.
Column 4: Bandwidth: RMS bandwidth.
Column 5: Equivalent Gaussian FWHM (note - most filters are not Gaussian in shape).
Column 6: Peak λ - wavelength of the peak transmittance.
Column 7: Peak Transmittance.
Column 8: Average Wavelength – straightforward "center of mass" of the filter according to the following: $\int T(\lambda)\lambda d\lambda / \int T(\lambda)d\lambda$.
Column 9: Rectangular Width – area divided by the peak: $\int [T(\lambda)d\lambda / \max(T(\lambda))]$
Column 10: Mean (or *bar)* Wavelength – wavelength of the center of mass in frequency space according to the following: $\exp[(\int T(\lambda)\ln(\lambda)d\lambda/\lambda) / (\int T(\lambda)d\lambda/\lambda)]$.

2.2.3 Comparison: Spec to As-Built

Table 3 provides a comparison of the spec to the as-built performance characteristics of the filters. Note that the specifications in many cases were designed to push the limit of manufacturing capability, i.e., the specs were to be interpreted by the manufacturer as guidelines for the ultimate performance goals. *In these cases, the mutual understanding of best effort was shared by scientists and vendors.* The tolerances on the $[\lambda_{-90}, \lambda_{+90}]$ or the $[\lambda_{-50}, \lambda_{+50}]$ wavelengths are stated as $\pm$ 1 Angstrom for the narrow bands and $\pm$5 Angstroms for the wide band filters. The transmittances were measured in the lab in 10 Angstrom increments for the broad band and in 1 Angstrom increments for the narrow.
Column 1: Filter Name and ID

Columns 2 though 7: the wavelengths at which the measured transmittance is the specified percentage of the peak (λ_{-01} λ_{-50} λ_{-90} λ_{+90} λ_{+50} λ_{+90}). Blank cells indicate that the parameter was not used to assess performance.

Column 8: Central Wavelength as calculated in the JPL specs: $\sqrt{[\lambda_{-50} * \lambda_{+50}]}$ or $\sqrt{[\lambda_{-90} * \lambda_{+90}]}$. This wavelength is best compared to the "Average Wavelength" of Table 2.

Column 9: FWHM defined as $[\lambda_{-50} - \lambda_{+50}]$ or $[\lambda_{-90} - \lambda_{+90}]$

Column 10: Transmittance at 50% or 90% of peak.

Columns 11 through 16: The difference between the specified performance and the measured values at (λ_{-01} λ_{-50} λ_{-90} λ_{+90} λ_{+50} λ_{+90}) where applicable.

Column 17: The difference between the spec and as-built central wavelength. The central wavelength was calculated using the formula in the specifications (and most nearly approximates the average wavelength given in Table 2): $\sqrt{[\lambda_{-50} * \lambda_{+50}]}$ or $\sqrt{[\lambda_{-90} * \lambda_{+90}]}$ depending on the original specifications.

Column 18: The difference between the spec and as-built width.

Columns 19 and 20: Pass criteria and comments based solely on deduced CEI tolerances. Please see section 4.0 of this ISR for further explanations.

3. As-Built Throughput Conformance

The Contract End Item Specifications for the UVIS Filters are given in sections 4.4.5 of STE-66, version May 31, 2002. The requirement in <u>Section 4.4.5.1 CEI: Number of Spectral Elements</u> states that the channel should include 48 selectable spectral defining elements as listed in the CEI-Table 4-6 (see table 1 in this ISR columns 3 and 4) which includes a central wavelength and width. No tolerances on the values of the central wavelength and the width are specified in the CEI. The JPL Requirements are much more detailed and tolerances are stringent. However, all parties share the understanding that the vendor will perform a best effort at the manufacture of the filter with the stated tolerances. Ultimately, the Science Oversight Committee has determined whether a filter fits the particular science need. *As a compromise for the purposes of an overall performance verification, a tolerance has been adopted to identify those filters whose performance spec satisfy the needs of the science community but do not conform completely to the performance specifications*.

Wide Band

Taking into account the measurement increment of 10 Angstroms, the JPL performance spec of +/- 5 Angstroms, an assumed measurement error and an adjustment factor to take into account the "best effort", the tolerances on the FWHM and central wavelengths as defined by the JPL spec document will be assigned as +/- 12 Angstroms. The central wavelength as defined as $\sqrt{[\lambda_{-50} * \lambda_{+50}]}$ or $\sqrt{[\lambda_{-90} * \lambda_{+90}]}$ will be assigned as tolerance of +/- 7 Angstroms The final two columns in Table 3 indicate the filters that "passed" this criteria and pass/fail comments. The UV filters are unique, very difficult to manufacture, and were understood to be best-effort candidates. The long pass filters with larger tolerances on the cut-on or cut-off wavelengths also pass the criteria. **Note that filters not satisfying the "mathematical" representation of the tolerances still satisfied the science requirements.**

Narrow Band

The measurement increment is 1 Angstrom, the JPL performance spec is +/- 1 Angstrom, and adjusting for the "best effort" criteria the tolerances are +/- 3 Angstroms on the central wavelength and +/-5 Angstroms on the FWHM. The final two columns in Table 3 indicate the filters that "passed" the "CEI" criteria along with comments. **Note that filters not satisfying the "mathematical" representation of the tolerances still satisfied the science requirements.**

4. Types of Elements, Image Displacement and Transmitted Wavefront

The Contract End Item Specifications for the UVIS Filter elements given in sections 4.4.5 of STE-66, also include the image quality, parfocality condition, wedge, types of elements and their location in the optical train.

4.1 Section 4.4.5.2 CEI: Types of Spectral Elements

The CEI states that provision must be made to accommodate filters, polarizers, grisms, etc and the optical design must place the filters in the un-aberrated beam. The spectral element suite includes filters and a grism and these are mounted in the Selectable Optical Filter Assembly (SOFA) located in the un-aberrated beam (optical prescriptions provided by Ball Aerospace).

4.2 Section 4.4.5.4 CEI: Performance of Spectral Elements - Image Quality, Parfocality, Wedge

Additional performance requirements state that a mounted filter must not displace the image by more than 50% of a pixel size or degrade image quality by more than 0.02 waves at 633 nm of transmitted wavefront. This requirement guarantees positional and performance consistency between measurements obtained with different filters.

The JPL Requirements details the focus shift, wedge, and transmitted wave front. The focus shift of each filter must equal the focus shift of a 5.500mm thick plano/plano fused silica substrate at wavelengths 6330 Angstroms (refractive index 1.457) plus the shift of two fused silica CCD windows (refractive indices 8.382 and 2.540 respectively). The focus shift equation insures the parfocality of the filters. The allowable wedge is specified as 0.0006 inches wedge across a 2.256-inch aperture (i.e., 2 fringes at 6328 Angstroms).

The results of the JPL and vendor measurements of the focus shift, transmitted wavefront, and wedge are given in Tables 2, 3, and 4 respectively in Raouf and Trauger, 2002. The information in these tables are reproduced here for ease of reference.

4.2.2 Transmitted Wavefront Measurements

Table 4 contains the wedge measurements and measured transmitted wavefront as measured by Trauger and Raouf. Each individual substrate wedge was measured prior to the filter manufacturing process. The wavefront accuracy for laminated filters refer to the complete filter and are specified as ½ wave peak to valley over the entire clear aperture of the filter and 1/15 wave peak-to-valley over a 10 mm diameter circle. For single substrate filters, the wavefront accuracy is specified as ¼ wave peak-to-valley over the clear aperture and 1/30 wave in the 10 mm diameter circle. The accuracy is defined as a fraction of a wave at 6330 Angstroms.

Columns 1 and 2: Filter Name and ID.
Column 3: Transmitted Wavefront peak-to-valley over the full clear aperture.
Column 4: Transmitted Wavefront rms over 10mm aperture.
Column 5: Substrate Wedge in inches.

4.2.3 Focus Shift Measurements

Table 5 lists the specification, measured focus shift, tolerance and delta. For those filters measured at JPL, only 4 filters exceed the tolerance and these too are acceptable with respect to the science requirements.

Column 1and 2: Filter Name and ID

Column 3: The spec in mm for the focus shift.
Column 4: The tolerance for each filter in mm.
Column 5: The measured focus shift in mm.

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Trauger, J. T. 2001, WFC3 UVIS Filter Specifications, JPL – Version D, Nov 2001.

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Table 1: UVIS Filter Performance Specifications from Version D JPL Spec or CEI.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
JPL Ver.D 11/01 Fnumber	Fname	Lam0 CEI * Table 4-6	FWHM CEI * Table 4-6	lam-01	lam-50	lam-90	lam+90	lam+50	lam+01	OUT-BAND max T	OUT-BAND at lam	Min T	Description
UVIS-1	F218W	2175.0	300		2025			2325		1.E-03	2750	0.20	ISM feature
UVIS-2	F225W	2250.0	500		2000			2500		1.E-03	2750	0.20	UV Wide
UVIS 3	F275W	2750.0	500		2500			3000		1.E-03	3250	0.20	UV Wide
UVIS 4	F336W	3375.0	550	*UG11	3100	*UG11	3610	3650	3725	1.E-04	4000	0.45	U, Stromgren u
UVIS 5	F390W	3900.0	1000		3400			4400		1.E-04	5000	0.55	Washington C
UVIS 6	F438W	4320.0	695	3915	3970	4040	4595	4665	4755	1.E-04	5300	0.65	WFPC2 B
UVIS 7	F555W	5217.0	1620	4220	4470	*GG455	*BG38	6090	7150	1.E-04	8000	0.90	WFPC2 V
UVIS 8	F606W	5956.0	2340	4590	4785	4925	7020	7125	7340	1.E-04	8500	0.90	WFPC2 Wide V
UVIS 9	F814W	8353.0	2555	6865	7060	7235	9295	9615	10225	1.E-03	11000	0.95	WFPC2 Wide I
UVIS 10	F475W	4750.0	1520	3915	4000	4442	5465	5520	5630	5.E-05	6500	0.90	SDSS g
UVIS 11	F625W	6250.0	1550	5390	5500	5555	6980	7050	7190	5.E-05	8000	0.90	SDSS r
UVIS 12	F775W	7760.0	1470	6890	7030	7100	8415	8500	8670	5.E-05	9500	0.90	SDSS i
UVIS 13	F850L	8320.0	2000	*RG830	8320	*RG830	-	-	-	-	-	0.95	SDSS z
UVIS-14	F350L	3500.0	7000	*GG375	3500	*GG375	-	-	-		-	0.95	Long Pass
UVIS-15	F300X	2775.0	1850		1800			3650		1.E-04	4300	0.50	Long Pass
UVIS 16	F475X	3800.0	2200		3800			6000		1.E-04	8000	0.80	Long Pass
UVIS 17	F600L	6000.0	4000	*RG610	6000	*RG610	-	-	-	-	-	0.95	Long Pass
UVIS 18	F390M	3900.0	200		3800			4000		5.E-05	4600	0.70	Long Pass
UVIS 19	F410M	4105.0	190	3930	4010	4040	4170	4200	4300	5.E-05	4800	0.75	Stromgren v
UVIS 20	F467M	4675.0	230	4475	4560	4590	4755	4790	4890	5.E-05	5300	0.80	Stromgren b
UVIS 21	F547M	5475.0	710	[5007]	5120	5235	5710	5830	6000	5.E-05	6800	0.80	Stromgren y
UVIS 22	F621M	6212.0	640		5900			6540		5.E-05	7300	0.85	11%
UVIS 23	F689M	6886.0	710		6540			7250		5.E-05	8000	0.85	11%
UVIS 24	F763M	7630.0	780		7250			8030		5.E-05	8800	0.85	11%
UVIS 25	F845M	8454.0	870		8030			8900		5.E-05	9600	0.85	11%
UVIS 26	F280N	2798.0	42		2777			2819		1.E-04	4000	0.20	MgII 2795/2802?
UVIS 27	F343N	3426.0	228	3198		3312	3540		3654	1.E-06	4000	0.50	[NeV] 3426
UVIS 28	F373N	3732.0	38	3694		3713	3751		3770	1.E-06	4100	0.50	[OII] 3726/29
UVIS 29	F395N	3950.0	61	3890		3920	3981		4011	1.E-06	4500	0.60	CaII H&K
UVIS 30	F469N	4686.0	32	4654		4670	4702		4718	1.E-06	5100	0.65	HeII 4686
UVIS 31	F487N	4867.0	45	4823		4845	4890		4912	1.E-06	5400	0.65	H-b 4861
UVIS 32	F502N	5013.0	47	4967		4990	5037		5060	1.E-06	5500	0.70	[OIII] 5007
UVIS 33	F588N	5886.0	60	5826		5856	5916		5946	1.E-06	6200	0.80	HeI 5876
UVIS 34	F631N	6306.0	54	6252		6279	6333		[6352]	1.E-06	6900	0.80	[OI] 6300
UVIS 35	F645N	6455.0	82	6374	6414			6496	6537	1.E-06	7000	0.85	Continuum
UVIS 36	F656N	6563.0	14	[6553]		6556	6570		[6576]	1.E-06	7000	0.80	H-a 6563
UVIS 37	F658N	6585.0	20	[6570]		6576	6596		6606	1.E-06	7000	0.80	[NII] 6583
UVIS 38	F665N	6654.0	94	[6559]		6607	6701		[6749]	1.E-06	7100	0.80	z (Ha +[NII])
UVIS 39	F673N	6731.0	77	[6689]		6694	6771		6820	1.E-06	7200	0.80	[SII] 6717, 31
UVIS 40	F680N	6902.0	288	[6670]		6756	7044		[7135]	1.E-06	7500	0.80	z (Ha +[NII])
UVIS 41	F953N	9532.0	64	9468		9500	9564		9596	5.E-06	9800	0.80	[SIII] 9532
UVIS 42a	F437N	4368.0	26	4341		4356	4382		4397	1.E-06	4000	0.10	[OIII]4353
UVIS 42b	F232N	2326.0	36		2308			2344		1.E-04	4000	0.15	CII] 2326
UVIS 42c	F243N	2425.0	36		2407			2443		1.E-04	4000	0.20	[NeIV] 2425
UVIS 42d	F378N	3780.0	80	3702		3740	3820		3860	1.E-06	4100	0.60	z ([OII] 3727)
UVIS 43a	F387N	3869.0	26	3843		3856	3882		3895	5.E-06	4400	0.50	[NeIII] 3869
UVIS 43b	F422M	4220.0	108	4116	4166			4274	4326	5.E-06	4800	0.50	continuum
UVIS 43c	F436N	4364.0	30	4333		4348	4378		4393	1.E-06	4900	0.50	[OIII] 4363
UVIS 43d	F492N	4924.0	78	4841		4880	4968		5007	1.E-06	5400	0.60	z (H-b)
UVIS 44a	F508N	5081.0	112	4969		5025	5137		5193	1.E-06	5500	0.70	z ([OIII] 5007)
UVIS 44b	F575N	5755.0	12	5737		5749	5761		5773	1.E-06	6100	0.70	[NII] 5755
UVIS 44c	F672N	6716.0	14	6703		6710	6724		[6731]	1.E-06	6900	0.70	[SII] 6717
UVIS 44d	F674N	6731.0	14	[6717]		6724	6738		6745	1.E-06	6900	0.70	[SII] 6731
UVIS 45a	F889N	8890.0	89		8845			8935		5.E-06	9300	0.80	25/km-agt
UVIS 45b	F906N	9060.0	91		9015			9105		5.E-06	9400	0.80	2.5/km-agt
UVIS 45c	F924N	9240.0	92		9194			9286		5.E-06	9600	0.80	0.25/km-agt
UVIS 45d	F937N	9370.0	94		9323			9417		5.E-06	9800	0.80	0.025/km-agt
UVIS 46a	F619N	6194.0	62		6163			6225		1.E-06	6700	0.80	CH4 6194
UVIS 46b	F634N	6340.0	63		6308			6372		1.E-06		0.75	6194 cont.+
UVIS 46c	F727N	7270.0	73		7234			7306		1.E-06	7700	0.80	CH4 7270
UVIS 46d	F750N	7504.0	75		7466			7542		1.E-06	7900	0.80	7270 cont.
UVIS 47	G200	2775.0	1850		1800			3650			4300	0.50	UV prism
UVIS 48	F657N	6573.0	94	6479		6526	6620		6667	1.E-06	7000	0.80	Wide Ha+[NIII]

KEY * CEI spec (exception see shaded cells); [ ] special or difficult requirements
UG, RG, GG colored glass types (bandpass defined by glass substrate)
(light blue shading) estimated, not specified as requirement
(purple shading) value provided for long pass only for perspective.

Table 2: Parameters Calculated from Measured JPL Transmittance Data

1	2	3	4	5	6	7	8	9	10
Name	Name/file	Pivot Lambda	Bndwidth	FWHM	Lambda Tpeak	Peak T	Avg Lambda	Rect Width	Mean Lambda
		(A)	(rms)	(gauss)	(A)		(A)	(A)	(A)
F218W	u_F218W_305_trns.tab	2219.0	124.9	294.2	2139.9	0.36	2222.8	319.0	2204.8
F225W	u_F225W_302_trns.tab	2284.3	178.1	419.4	2150.2	0.32	2291.7	445.1	2256.1
F275W	u_F275W_304_trns.tab	2742.4	199.3	469.4	2579.7	0.36	2749.8	547.5	2713.3
F300X	u_F300X_301_trns.tab	2819.6	316.5	745.2	2639.8	0.45	2838.6	824.5	2747.4
F336W	u_F336W_302_trns.tab	3361.1	160.2	377.3	3350.4	0.75	3364.9	526.5	3345.8
F350L	u_F350LP_306_trns.tab	6812.0	2073.1	4881.9	5730.2	0.98	7185.0	7480.4	5447.6
F390M	u_F390M_301_trns.tab	3893.8	65.1	153.4	3890.0	0.88	3894.3	204.6	3891.5
F390W	u_F390W_301_trns.tab	3904.6	286.8	675.5	3880.3	0.96	3915.2	909.8	3862.4
F410M	u_F410M_304_trns.tab	4111.6	63.4	149.3	4104.8	0.66	4112.1	200.9	4109.7
F422M	u_F422M_301_trns.tab	4217.7	37.6	88.6	4182.0	0.69	4217.9	111.0	4217.1
F438W	u_F438W_302_trns.tab	4318.7	197.8	465.8	4510.0	0.84	4323.2	634.6	4300.5
F467M	u_F467M_307_trns.tab	4690.2	73.5	173.0	4714.3	0.82	4690.7	236.7	4687.9
F475W	u_F475W_301_trns.tab	4760.6	423.6	997.5	4889.5	0.92	4779.6	1370.1	4684.9
F475X	u_F475X_302_trns.tab	4917.1	667.4	1571.6	5150.4	0.94	4964.6	2127.0	4732.9
F547M	u_F547M_305_trns.tab	5447.0	206.3	485.9	5287.3	0.88	5451.0	652.8	5431.3
F555W	u_F555W_202_trns.tab	5309.8	520.6	1226.0	5160.5	0.95	5336.6	1581.7	5206.6
F600L	u_F600LP_002_trns.tab	8402.2	1389.7	3272.4	8931.1	1.00	8522.4	4815.9	7933.6
F606W	u_F606W_001_trns.tab	5932.3	663.4	1562.2	6080.0	0.96	5970.1	2155.2	5782.6
F621M	u_F621M_303_trns.tab	6212.0	190.6	448.9	6349.7	0.94	6214.9	613.1	6200.3
F625W	u_F625W_301_trns.tab	6254.0	455.6	1072.8	5799.6	0.95	6270.7	1494.9	6187.4
F689M	u_F689M_302_trns.tab	6886.0	208.3	490.6	7130.8	0.94	6889.2	685.1	6873.3
F763M	u_F763M_302_trns.tab	7636.3	230.8	543.6	7540.3	0.97	7639.8	770.3	7622.3
F775W	u_F775W_301_trns.tab	7733.6	432.0	1017.4	8110.9	0.85	7745.7	1462.0	7685.2
F814W	u_F814W_301_trns.tab	8304.7	733.3	1726.7	7640.7	0.97	8337.5	2490.3	8174.4
F845M	u_F845M_303_trns.tab	8468.9	261.5	615.8	8360.0	0.96	8472.8	879.3	8452.8
F850L	u_F850LP_203_trns.tab	9756.4	713.6	1680.4	1000.0	0.96	9782.6	2403.0	9652.5
F232N	u_F232N_302_trns.tab	2326.9	11.4	26.9	2332.5	0.12	2327.0	31.7	2326.8
F243N	u_F243N_302_trns.tab	2420.6	11.5	27.1	2420.1	0.15	2420.6	35.0	2420.5
F280N	u_F280N_301_trns.tab	2796.1	13.4	31.5	2794.9	0.21	2796.2	40.7	2796.0
F343N	u_F343N_301_trns.tab	3438.0	87.4	205.8	3317.9	0.78	3439.1	261.3	3433.5
F373N	u_F373N_302_trns.tab	3729.6	15.3	36.0	3724.1	0.78	3729.6	49.6	3729.5
F378N	u_F378N_302_trns.tab	3790.9	31.6	74.5	3823.5	0.83	3791.1	101.0	3790.4
F387N	u_F387N_301_trns.tab	3873.0	10.4	24.5	3865.8	0.72	3873.0	33.5	3872.9
F395N	u_F395N_302_trns.tab	3953.7	25.7	60.4	3939.6	0.86	3953.8	84.5	3953.3
F436N	u_F436N_301_trns.tab	4366.7	13.4	31.6	4364.5	0.67	4366.7	43.3	4366.6
F437N	u_F437N_302_trns.tab	4370.6	9.4	22.1	4363.2	0.70	4370.6	29.9	4370.6
F469N	u_F469N_301_trns.tab	4687.5	15.1	35.7	4682.3	0.69	4687.5	49.6	4687.4
F487N	u_F487N_302_trns.tab	4870.7	18.5	43.6	4880.9	0.85	4870.7	60.4	4870.5
F492N	u_F492N_301_trns.tab	4932.1	33.9	79.8	4924.0	0.85	4932.2	113.4	4931.6
F502N	u_F502N_301_trns.tab	5009.0	20.4	48.0	5031.9	0.87	5009.1	65.3	5008.8
F508N	u_F508N_301_trns.tab	5089.7	39.3	92.5	5076.3	0.87	5089.9	130.7	5089.1
F575N	u_F575N_301_trns.tab	5755.9	5.7	13.5	5757.7	0.78	5755.9	18.4	5755.9
F588N	u_F588N_302_trns.tab	5882.2	22.1	52.1	5900.9	0.88	5882.2	72.0	5882.0
F619N	u_F619N_301_trns.tab	6197.5	19.7	46.4	6193.6	0.89	6197.5	61.0	6197.3
F631N	u_F631N_301_trns.tab	6303.0	18.3	43.2	6323.2	0.86	6303.1	58.3	6302.9
F634N	u_F634N_301_trns.tab	6347.5	21.2	49.8	6352.1	0.88	6347.5	64.1	6347.4
F645N	u_F645N_301_trns.tab	6451.6	27.2	64.0	6440.4	0.86	6451.7	84.2	6451.5
F656N	u_F656N_302_trns.tab	6561.1	5.4	12.8	6557.1	0.86	6561.1	17.7	6561.1
F657N	u_F657N_301_trns.tab	6565.1	39.2	92.4	6553.8	0.90	6565.2	121.3	6564.6
F658N	u_F658N_303_trns.tab	6587.2	6.9	16.2	6586.2	0.79	6587.2	22.1	6587.2
F665N	u_F665N_301_trns.tab	6654.4	40.7	95.9	6620.0	0.90	6654.5	132.2	6653.9
F672N	u_F672N_301_trns.tab	6716.1	6.0	14.0	6713.4	0.89	6716.1	19.4	6716.1
F673N	u_F673N_302_trns.tab	6764.5	36.7	86.4	6756.7	0.91	6764.6	117.9	6764.1
F674N	u_F674N_301_trns.tab	6729.5	5.6	13.3	6730.2	0.68	6729.5	17.6	6729.5
F680N	u_F680N_302_trns.tab	6878.6	111.5	262.6	6889.8	0.95	6879.5	370.3	6875.0
F727N	u_F727N_301_trns.tab	7274.7	21.3	50.1	7277.6	0.89	7274.7	63.9	7274.6
F750N	u_F750N_301_trns.tab	7500.6	23.0	54.1	7498.2	0.85	7500.6	70.5	7500.5
F889N	u_F889N_303_trns.tab	8891.8	30.5	71.8	8907.6	0.90	8891.9	95.2	8891.6
F906N	u_F906N_303_trns.tab	9056.7	34.2	80.6	9083.9	0.92	9056.8	96.5	9056.5
F924N	u_F924N_303_trns.tab	9246.3	30.5	71.7	9244.9	0.94	9246.3	91.3	9246.0
F937N	u_F937N_303_trns.tab	9371.1	31.7	74.6	9377.2	0.91	9371.2	92.8	9370.9
F953N	u_F953N_306_trns.tab	9529.7	30.8	72.6	9496.0	0.90	9529.8	95.7	9529.5

Table 3: Performance Parameters for UVIS Filters – Spec and As-Built

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Name	MEAS Lambda (A)	MEAS Lambda (A)	MEAS Lambda (A)	MEAS Lambda (A)	MEAS Lambda (A)	MEAS Lambda (A)	MEAS Central Lambda (A)	MEAS FWHM (spec def) (A)	MEAS T at 50% or 90% Tpk	DELTA: MEAS-SPEC Lambda (A)	DELTA: MEAS-SPEC Lambda (A)	DELTA: MEAS-SPEC Lambda (A)	DELTA: MEAS-SPEC Lambda (A)	DELTA: MEAS-SPEC Lambda (A)	DELTA: MEAS-SPEC Lambda (A)	DELTA: MEAS-SPEC Cent Lam	DELTA: MEAS-SPEC FWHM	CEI	Comments
	1%	50%	90%	90%	50%	1%				1%	50%	90%	90%	50%	1%	(A)	(A)	Pass	
F218W	1952.2	2054.0			2361.0	2594.0	2202.1	306.9	0.2		29.0			35.9		32.3	6.9	x	Best effort criteria only
F225W	1930.8	2038.0			2513.3	2759.0	2263.2	475.4	0.2		38.0			13.3		27.1	-24.6	x	Best effort criteria only
F275W	2277.8	2464.4			3054.4	3202.8	2743.6	590.0	0.2		-35.6			54.4		5.0	90.0	x	Best effort criteria only
F300X	2216.6	2350.8			3178.2	3829.4		827.4	0.2									x	Best effort criteria only
F336W	3017.5	3092.7			3646.5	3702.7	3358.2	553.8	0.4		-7.3			-3.5	-22.3	-5.6	3.8	x	within tol.
F350L		3355.3							0.5		-144.7					-144.7		x	Long Pass cut on only
F390M	3722.8	3792.6			4003.1	4050.8	3896.4	210.5	0.4		-7.4			3.1		-2.3	10.5	x	within tol.
F390W	3253.6	3447.9			4400.9	4468.0	3895.4	953.0	0.5		47.9			0.9		27.6	-47.0		
F410M	3955.4	4011.5			4210.2	4279.7	4109.6	198.7	0.3	25.3	1.5			10.2	-20.3	5.7	8.7	x	within tol.
F422M	4119.4	4162.3			4275.6	4319.4	4218.6	113.3	0.3	3.4	-3.7			1.6	-6.6	-1.1	5.3	x	within tol.
F438W	3894.0	3981.0			4657.8	4708.0	4306.2	676.8	0.4	-21.0	11.0			-7.2	-47.0	2.7	-18.2		
F467M	4526.6	4566.9			4813.6	4861.3	4688.7	246.7	0.4	51.6	6.9			23.6	-28.7	15.1	16.7		
F475W	3941.5	4018.8			5507.7	5580.8	4704.7	1488.9	0.5	26.5	18.8			-12.3	-49.2	5.8	-31.1		
F475X	3729.8	3804.2			6003.8	6926.7	4779.1		0.5		4.2			3.8		4.2	-0.4	x	Long Pass cut on only
F547M	5040.4	5106.3			5820.3	5906.4	5451.6	714.0	0.4	0.0	-13.7			-9.7	-93.6	-11.8	4.0		
F555W	4379.9	4469.4			6064.5	7061.8	5206.2	1595.1	0.5	159.9	-0.6			-25.5	-88.2	-11.3	-24.9		
F600L	0.0	6074.7							0.5		74.7					74.7		x	Long Pass cut on only
F606W	4703.7	4784.6			7129.5	7223.7	5840.5	2345.0	0.5	113.7	-0.4			4.5	-116.3	1.6	5.0	x	within tol.
F621M	5800.8	5890.5			6541.3	6606.9	6207.4	650.8	0.5	0.0	-9.5			1.3	0.0	-4.4	10.8	x	within tol.
F625W	5413.2	5486.7			7062.1	7139.8	6224.8	1575.4	0.5	23.2	-13.3			12.1	-50.2	-2.2	25.3		
F689M	6449.9	6530.4			7238.9	7325.3	6875.5	708.6	0.5	0.0	-9.6			-11.1	0.0	-10.3	-1.4		
F763M	7165.5	7243.3			8041.9	8093.3	7632.2	798.6	0.5	0.0	-6.7			11.9	0.0	2.1	18.6		
F775W	6875.4	7000.2			8486.2	8582.4	7707.5	1486.0	0.4	-14.6	-29.8			-13.8	-87.6	-22.7	16.0		
F814W	6977.7	7061.8			9605.1	9733.6	8235.9	2543.3	0.5	112.7	1.8			-9.9	-491.4	-3.2	-11.7	x	within tol.
F845M	7898.8	8026.8			8913.5	9026.5	8458.5	886.7	0.5		-3.2			13.5		4.7	16.7		
F850L		8545.7							0.5		225.7					225.7		x	Long Pass cut on only

Table 3:Continuation: Performance Parameters: Spec and As-Built

1 Name	2 MEAS Lambda (A)	3 MEAS Lambda (A)	4 MEAS Lambda (A)	5 MEAS Lambda (A)	6 MEAS Lambda (A)	7 MEAS Lambda (A)	8 MEAS Central Lambda (A)	9 MEAS FWHM (spec def) (A)	10 MEAS T at 50% or 90% Tpk	11 DELTA: MEAS-SPEC Lambda (A)	12 DELTA: MEAS-SPEC Lambda (A)	13 DELTA: MEAS-SPEC Lambda (A)	14 DELTA: MEAS-SPEC Lambda (A)	15 DELTA: MEAS-SPEC Lambda (A)	16 DELTA: MEAS-SPEC Lambda (A)	17 DELTA: MEAS-SPEC Cent Lam	18 DELTA: MEAS-SPEC FWHM	19 *CEI*	20 Comments
	1%	50%	90%	90%	50%	1%				1%	50%	90%	90%	50%	1%	(A)	(A)	*Pass*	
F232N	2302.8	2310.3			2342.5	2350.3	2326.3	32.2	0.1		2.3			-1.5		-3.8	0.4	x	Best effort criteria only
F243N	2395.9	2403.0			2437.7	2445.1	2420.3	34.8	0.1		-4.0			-5.3		-1.2	-4.7	x	Best effort criteria only
F280N	2766.3	2776.4			2815.9	2826.6	2796.1	39.5	0.1		-0.7			-3.1		-2.5	-1.9	x	Best effort criteria only
F343N	3192.3		3308.4	3448.4		3640.0	3377.7	140.0	0.7	-5.7		-3.6	-91.6		-14.0	-88.0	46.4		double peak
F373N	3693.6		3708.6	3747.8		3769.1	3728.1	39.2	0.7	-0.4		-4.4	-3.2		-0.9	1.2	3.8	x	within tol.
F378N	3724.1		3743.4	3832.6		3869.4	3787.8	89.2	0.8	22.1		3.4	12.6		9.4	9.2	-8.0		
F387N	3849.6		3860.0	3883.1		3896.7	3871.5	23.1	0.7	6.6		4.0	1.1		1.7	-2.9	-2.5	x	within tol.
F395N	3894.5		3916.5	3989.4		4016.1	3952.8	72.9	0.8	4.5		-3.5	8.4		5.1	11.9	-2.4		
F436N	4334.8		4348.7	4384.4		4399.7	4366.5	35.7	0.6	1.8		0.7	6.4		6.6	5.7	-3.5		
F437N	4348.5		4358.4	4383.0		4392.3	4370.7	24.6	0.6	7.5		2.4	1.0		-4.7	-1.4	-1.7	x	within tol.
F469N	4653.9		4666.7	4703.9		4721.6	4685.3	37.2	0.6	-0.1		-3.3	1.9		3.6	5.2	0.7	x	within tol.
F487N	4827.4		4844.8	4893.3		4916.4	4869.0	48.4	0.8	4.4		-0.2	3.3		4.4	3.4	-1.5	x	within tol.
F492N	4858.6		4880.4	4981.4		5010.5	4930.6	101.0	0.8	17.6		0.4	13.4		3.5	23.0	-6.8		
F502N	4962.9		4979.4	5037.3		5057.2	5008.3	57.8	0.8	-4.1		-10.6	0.3		-2.8	10.8	5.2		
F508N	5002.7		5030.9	5148.8		5178.7	5089.5	117.9	0.8	33.6		5.9	11.8		-14.3	5.9	-8.8		
F575N	5741.4		5749.8	5762.7		5769.8	5756.3	12.9	0.7	4.4		0.8	1.7		-3.2	0.9	-1.3	x	within tol.
F588N	5829.7		5851.9	5911.6		5936.5	5881.7	59.7	0.8	3.7		-4.1	-4.4		-9.5	-0.3	4.2		
F619N	6146.5	6166.3			6227.9	6251.5	6197.1	61.6	0.4		3.3			2.9		-0.4	3.1	x	within tol.
F631N	6262.9		6285.0	6328.0		6345.2	6306.5	43.1	0.8	10.9		6.0	-5.0		-6.8	-10.9	-0.5		double peak
F634N	6293.1	6313.6			6379.9	6404.8	6346.7	66.2	0.4		5.6			7.9		3.2	6.7		
F645N	6393.8	6409.5			6494.5	6515.4	6451.9	85.0	0.4	19.8	-4.5			-1.5	-21.6	3.0	-3.0	x	within tol.
F656N	6548.5		6554.1	6568.0		6573.7	6561.0	13.9	0.8	-4.5		-1.9	-2.0		-2.3	-0.1	2.0	x	Best Effort - narrow
F657N	6475.0		6509.3	6605.6		6671.3	6557.3	96.3	0.8	-4.0		-16.7	-14.4		4.3	2.3	15.6		
F658N	6571.4		6578.0	6591.7		6602.8	6584.8	13.7	0.7	1.4		2.0	-4.3		-3.2	-20.0	1.2	x	within tol.
F665N	6552.0		6602.5	6711.5		6753.2	6656.8	109.0	0.8	-7.1		-4.5	10.5		4.2	15.0	-2.9		
F672N	6701.3		6708.6	6723.5		6730.5	6716.0	14.9	0.8	-1.7		-1.4	-0.5		-0.5	0.9	1.0	x	within tol.
F673N	6680.1		6709.2	6809.7		6857.7	6759.3	100.5	0.8	-8.9		15.2	38.7		37.7	23.5	-26.9		
F674N	6716.1		6724.5	6734.5		6742.8	6729.5	10.0	0.6	-0.9		0.5	-3.5		-2.2	-4.0	1.5	x	within tol.
F680N	6628.7		6714.3	7037.8		7144.4	6874.1	323.6	0.9	-113.3		-41.7	-6.2		91.4	35.6	24.4		
F727N	7216.9	7242.2			7306.9	7334.2	7274.5	64.8	0.5		8.1			0.9		-8.2	4.6		
F750N	7436.2	7466.1			7534.9	7566.8	7500.4	68.8	0.4		0.1			-7.1		-6.2	-3.5		
F889N	8792.5	8844.5			8938.3	8997.7	8891.3	93.7	0.5		-0.5			3.3		4.7	1.4	x	within tol.
F906N	8945.1	9010.6			9104.6	9162.3	9057.5	94.0	0.5		-4.4			-0.4		3.0	-2.4	x	within tol.
F924N	9127.0	9201.7			9291.0	9345.0	9246.2	89.2	0.5		7.7			5.0		-2.8	6.3		
F937N	9230.1	9324.9			9416.8	9480.8	9370.7	91.9	0.5		1.9			-0.3		-2.1	0.8	x	within tol.
F953N	9456.1		9488.0	9572.6		9622.3	9530.2	84.6	0.8	-11.9		-12.0	8.6		26.3	20.6	1.7		

KEY

(yellow) long pass filters hence most descriptors not applicable

(cyan) double peaked narrow band

Measured: used measured throughput at center of filter

Accurac) Wide Bands measured in 10A increments (values good to 1A)

Narrow bands measured in 1 A increments (values good to 0.1A)

Table 4: Measured Transmitted Wavefront and Wedge from Raouf and Trauger (2002)

1	2	3	4	5
Fnumber	**Fname**	**Transmitted* Wave p-v (full ap)**	**Transmitted* rms (10mm ap)**	**Wedge (inches)* (SPEC 0.0006in)**
UVIS 1	**F218W**	*0.146*		*0.0006*
UVIS 2	**F225W**	*0.192*		0.0009
UVIS 3	**F275W**	*0.500*		*0.0006*
UVIS 4	**F336W**	*0.500*		*0.0006*
UVIS 5	**F390W**	0.280	0.012	0.00166
UVIS 6	**F438W**	0.282	0.026	0.00103
UVIS 7	**F555W**	0.215	0.016	0.00131
UVIS 8	**F606W**	0.222	0.019	0.00057
UVIS 9	**F814W**	0.165	0.027	0.00077
UVIS 10	**F475W**	0.176	0.021	0.00022
UVIS 11	**F625W**	0.199	0.019	0.00088
UVIS 12	**F775W**	0.189	0.018	0.00257
UVIS 13	**F850L**	0.173	0.019	0.00161
UVIS 14	**F350L**	0.147	0.009	0.00075
UVIS 15	**F300X**	*0.170*		*0.0006*
UVIS 16	**F475X**	0.342	0.023	0.00045
UVIS 17	**F600L**	0.298	0.026	0.00043
UVIS 18	**F390M**	0.234	0.017	0.00064
UVIS 19	**F410M**	0.210	0.013	0.00213
UVIS 20	**F467M**	0.330	0.015	0.00099
UVIS 21	**F547M**	0.250	0.013	0.00026
UVIS 22	**F621M**	0.190	0.023	0.00015
UVIS 23	**F689M**	0.176	0.021	0.00049
UVIS 24	**F763M**	0.281	0.026	0.00018
UVIS 25	**F845M**	0.258	0.025	0.0002
UVIS 26	**F280N**	0.481		*0.0006*
UVIS 27	**F343N**	0.343		0.00016
UVIS 28	**F373N**	0.429		*0.0006*
UVIS 29	**F395N**	0.019	0.017	0.00047
UVIS 30	**F469N**	0.340	0.035	0.00044
UVIS 31	**F487N**	0.237	0.021	0.00011
UVIS 32	**F502N**	0.173	0.022	0.00024
UVIS 33	**F588N**	0.195	0.019	0.00014

***KEY: Wavefront Accuracy Spec is 0.02 waves at 6330 Angstroms.**
See text for explanation of numbers: Laminated vs single substrate
Wedge Spec for individual substrates to be < 0.0006-in across 57.3mm ap.

1	2	3	4	5
Fnumber	**Fname**	**Transmitted* Wave p-v (full ap)**	**Transmitted* rms (10mm ap)**	**Wedge (inches)* (SPEC 0.0006in)**
UVIS 34	**F631N**	0.153	0.018	0.00119
UVIS 35	**F645N**	0.126	0.016	0.00092
UVIS 36	**F656N**	0.360	0.027	0.00093
UVIS 37	**F658N**	0.260	0.016	0.00031
UVIS 38	**F665N**	0.200	0.03	0.00063
UVIS 39	**F673N**	0.120	0.02	0.00064
UVIS 40	**F680N**	0.200	0.025	0.00048
UVIS 41	**F953N**	0.151	0.022	0.00022
UVIS 42a	**F437N**	*0.500*		*0.0006*
UVIS 42b	**F232N**	*0.500*		*0.0006*
UVIS 42c	**F243N**	*0.500*		*0.0006*
UVIS 42d	**F378N**	*0.500*		*0.0006*
UVIS 43a	**F387N**	*0.500*		*0.0006*
UVIS 43b	**F422M**	0.140	0.02	*0.0006*
UVIS 43c	**F436N**	0.210	0.031	*0.0006*
UVIS 43d	**F492N**	0.240	0.021	*0.0006*
UVIS 44a	**F508N**	0.220	0.019	*0.0006*
UVIS 44b	**F575N**	0.270	0.025	*0.0006*
UVIS 44c	**F672N**	0.200	0.026	*0.0006*
UVIS 44d	**F674N**	0.170	0.022	*0.0006*
UVIS 45a	**F889N**	0.260	0.03	*0.0006*
UVIS 45b	**F906N**	0.310	0.033	*0.0006*
UVIS 45c	**F924N**	0.160	0.042	*0.0006*
UVIS 45d	**F937N**	0.130	0.041	*0.0006*
UVIS 46a	**F619N**	0.170	0.016	*0.0006*
UVIS 46b	**F634N**	0.240	0.033	*0.0006*
UVIS 46c	**F727N**	0.210	0.024	*0.0006*
UVIS 46d	**F750N**	0.350	0.041	*0.0006*
UVIS 47	**g280**			
UVIS 48	**F657N**	0.210	0.02	*0.0006*

***KEY: Wavefront Accuracy Spec is 0.02 waves at 6330 Angstroms.**
See text for explanation of numbers: Laminated vs single substrate
Wedge Spec for individual substrates to be < 0.0006-in across 57.3mm ap.

Numbers in Italics supplied by vendor and not measured at JPL

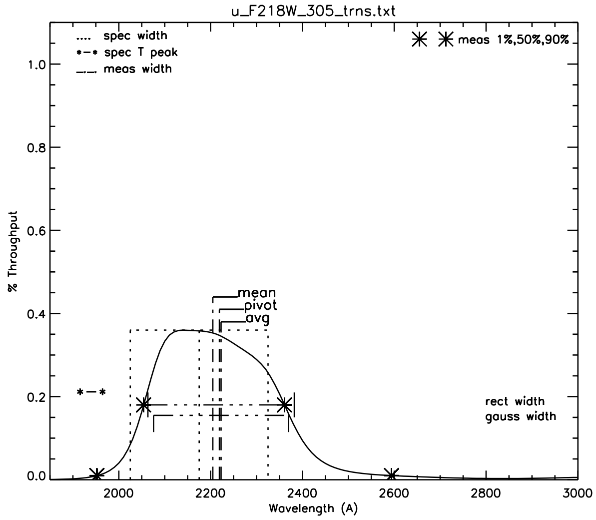
Table 5: Focus Shift Specification and Measurements from Raouf and Trauger (2002)

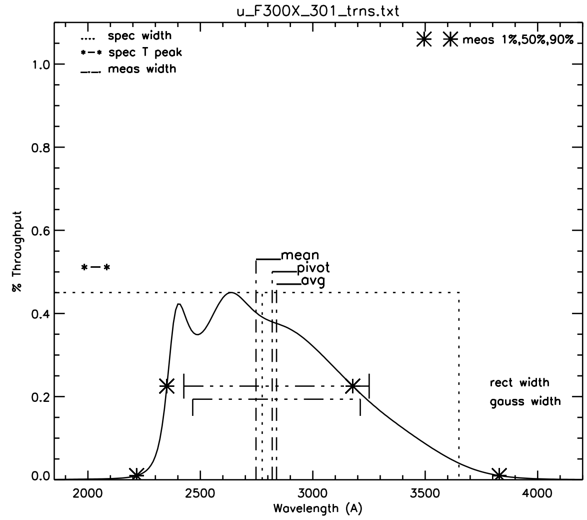
1	2	3	4	5	6
Fnumber	**Fname**	**SPEC (mm) Focus Shift**	**MEAS (mm) Focus Shift**	**Tolerance +/- (mm)**	**Delta (mm)**
UVIS 1	**F218W**	1.366	*1.366*	0.035	
UVIS 2	**F225W**	1.395	*1.395*	0.034	
UVIS 3	**F275W**	1.530	*1.530*	0.033	
UVIS 4	**F336W**	1.612	*1.612*	0.032	
UVIS 5	**F390W**	1.652	1.633	0.032	-0.019
UVIS 6	**F438W**	1.677	1.718	0.032	0.041
UVIS 7	**F555W**	1.711	1.678	0.031	-0.033
UVIS 8	**F606W**	1.721	1.754	0.031	0.033
UVIS 9	**F814W**	1.745	1.754	0.031	0.009
UVIS 10	**F475W**	1.690	1.647	0.032	-0.043
UVIS 11	**F625W**	1.724	1.756	0.031	0.032
UVIS 12	**F775W**	1.742	1.796	0.031	0.054
UVIS 13	**F850L**	1.748	1.727	0.031	-0.021
UVIS 14	**F350L**	1.624	1.639	0.032	0.015
UVIS 15	**F300X**	1.570	*1.570*	0.033	
UVIS 16	**F475X**	1.690	1.691	0.032	0.001
UVIS 17	**F600L**	1.720	1.686	0.031	-0.034
UVIS 18	**F390M**	1.652	*1.652*	0.032	
UVIS 19	**F410M**	1.662	*1.663*	0.032	
UVIS 20	**F467M**	1.688	1.706	0.032	0.018
UVIS 21	**F547M**	1.710	1.743	0.032	0.033
UVIS 22	**F621M**	1.723	1.775	0.031	0.052
UVIS 23	**F689M**	1.733	1.758	0.031	0.025
UVIS 24	**F763M**	1.741	1.765	0.031	0.024
UVIS 25	**F845M**	1.748	1.782	0.031	0.034
UVIS 26	**F280N**	1.539	*1.539*	0.033	
UVIS 27	**F343N**	1.618	*1.618*	0.032	
UVIS 28	**F373N**	1.642	*1.642*	0.032	
UVIS 29	**F395N**	1.655	*1.655*	0.031	
UVIS 30	**F469N**	1.688	1.716	0.031	0.028
UVIS 31	**F487N**	1.694	1.742	0.033	0.048
UVIS 32	**F502N**	1.699	1.723	0.032	0.024
UVIS 33	**F588N**	1.718	1.769	0.032	0.051
UVIS 48	**F657N**	1.699	1.699	0.032	

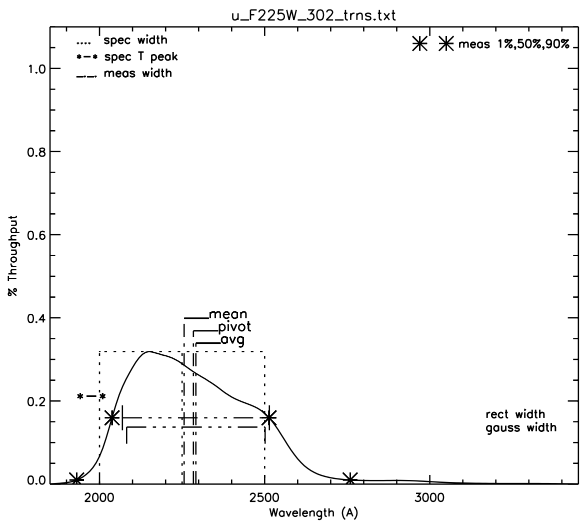
1	2	3	4	5	6
Fnumber	**Fname**	**SPEC (mm) Focus Shift**	**MEAS (mm) Focus Shift**	**Tolerance +/- (mm)**	**Delta (mm)**
UVIS 34	**F631N**	1.725	1.754	0.032	0.029
UVIS 35	**F645N**	1.727	1.783	0.032	0.056
UVIS 36	**F656N**	1.728	1.689	0.032	-0.039
UVIS 37	**F658N**	1.729	1.697	0.031	-0.032
UVIS 38	**F665N**	1.729	1.788	0.031	0.059
UVIS 39	**F673N**	1.720	1.778	0.031	0.058
UVIS 40	**F680N**	1.731	*1.731*	0.031	
UVIS 41	**F953N**	1.731	1.752	0.031	0.021
UVIS 42a	**F437N**	1.211	*1.211*	0.036	
UVIS 42b	**F232N**	1.421	*1.421*	0.034	
UVIS 42c	**F243N**	1.455	*1.454*	0.034	
UVIS 42d	**F378N**	1.645	*1.645*	0.032	
UVIS 43a	**F387N**	1.651	*1.651*	0.032	
UVIS 43b	**F422M**	1.670	*1.670*	0.032	
UVIS 43c	**F436N**	1.676	*1.676*	0.032	
UVIS 43d	**F492N**	1.696	*1.696*	0.032	
UVIS 44a	**F508N**	1.700	*1.700*	0.032	
UVIS 44b	**F575N**	1.715	*1.715*	0.031	
UVIS 44c	**F672N**	1.730	*1.730*	0.031	
UVIS 44d	**F674N**	1.731	*1.731*	0.031	
UVIS 45a	**F889N**	1.752	*1.752*	0.031	
UVIS 45b	**F906N**	1.753	*1.753*	0.031	
UVIS 45c	**F924N**	1.754	*1.754*	0.031	
UVIS 45d	**F937N**	1.755	*1.755*	0.031	
UVIS 46a	**F619N**	1.723	*1.723*	0.031	
UVIS 46b	**F634N**	1.725	*1.725*	0.031	
UVIS 46c	**F727N**	1.737	*1.737*	0.031	
UVIS 46d	**F750N**	1.740	*1.740*	0.031	
UVIS 47	**g280**	1.539	*1.539*	0.033	
UVIS 48	**F657N**	1.699	1.699	0.032	

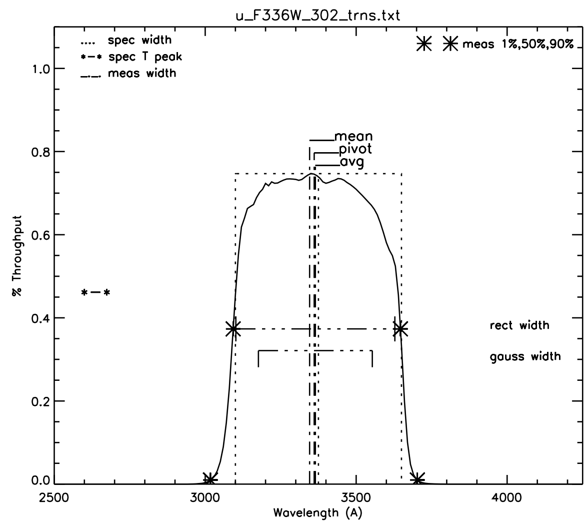
Numbers in italics supplied by vendor (and not measured at JPL)

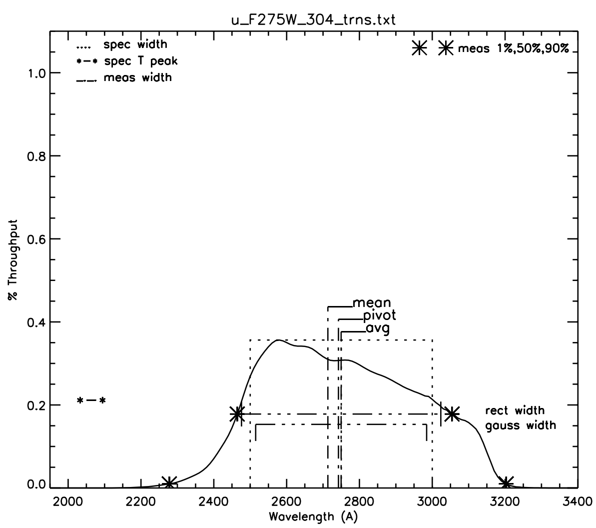
Panel 1: Wide and Medium Filters

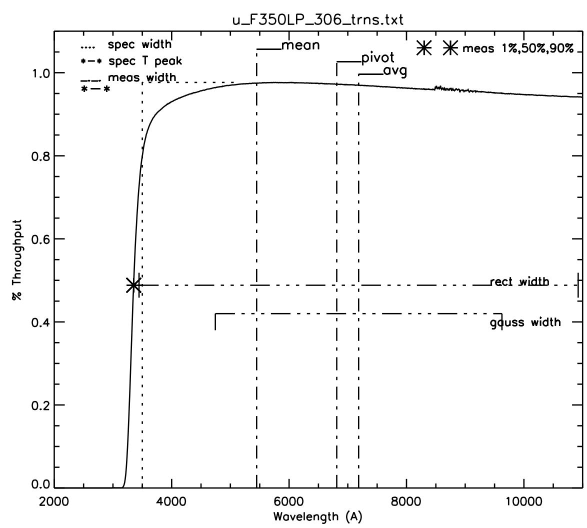




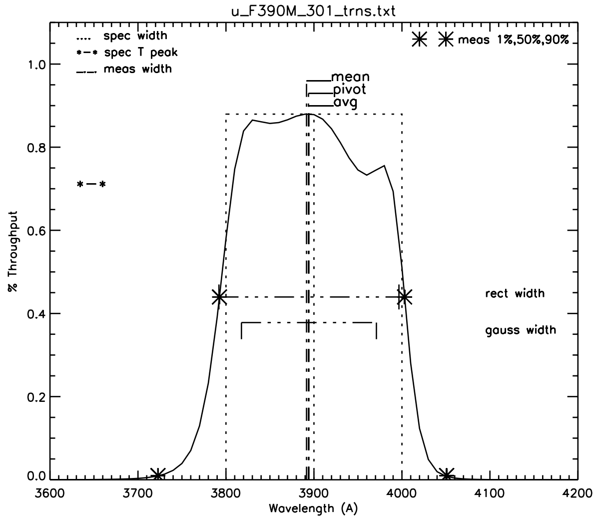


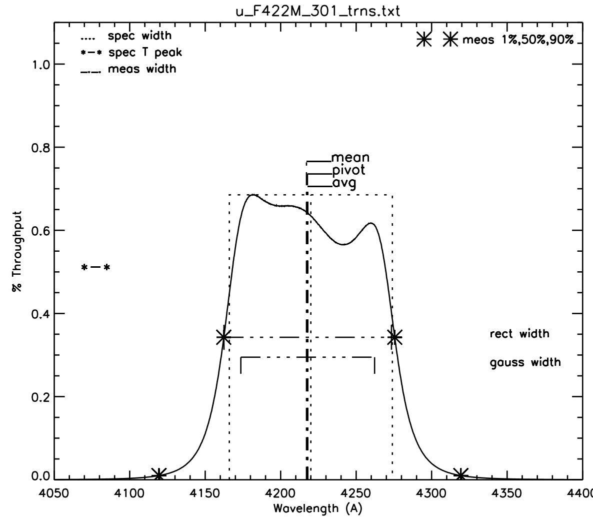


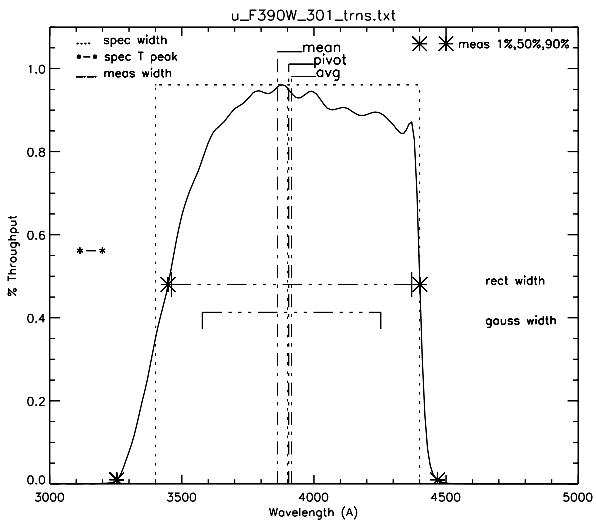


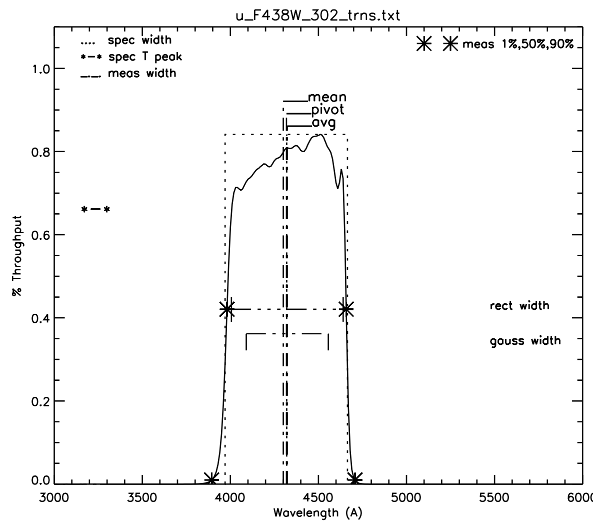


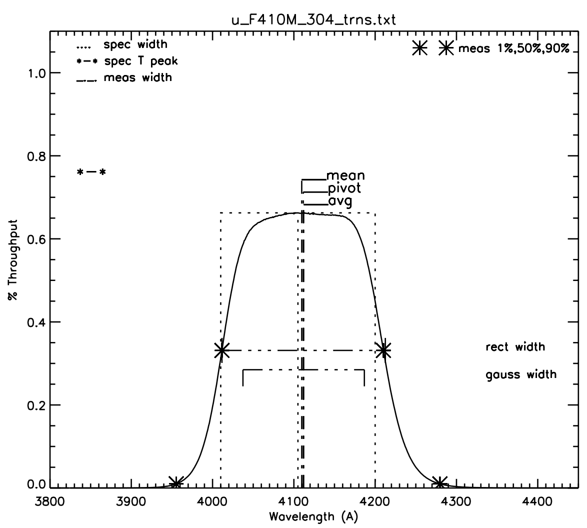
Panel 2: Wide and Medium Filters

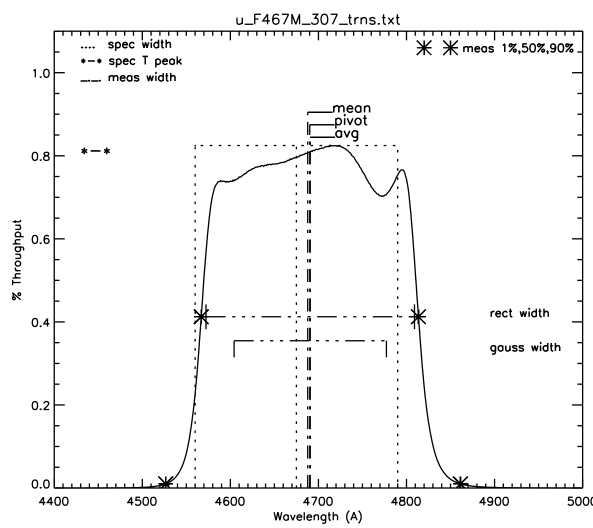




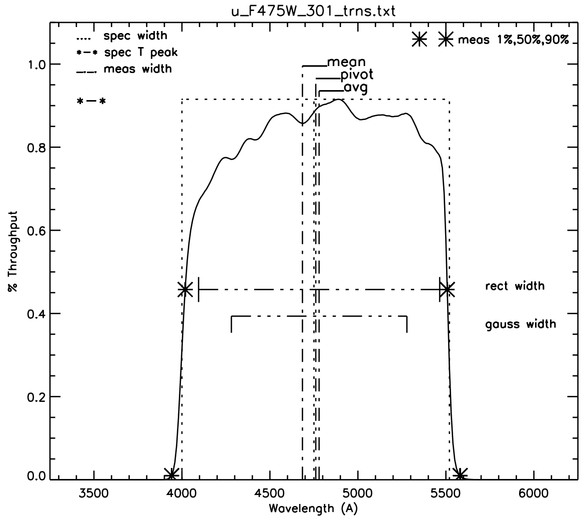


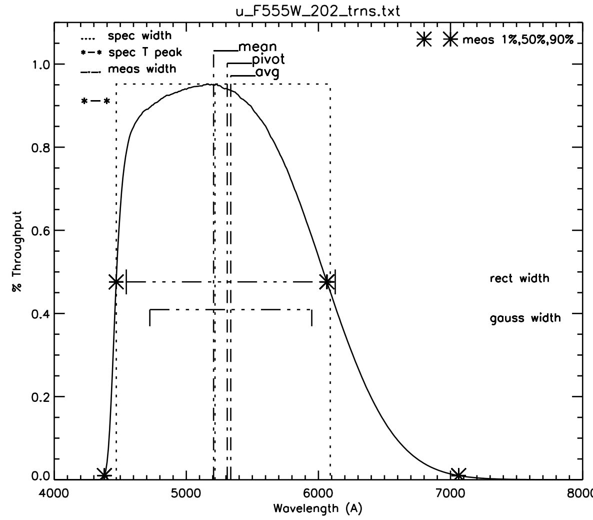


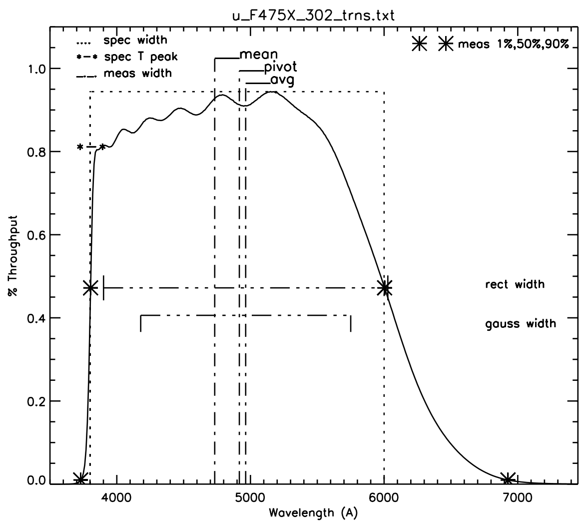


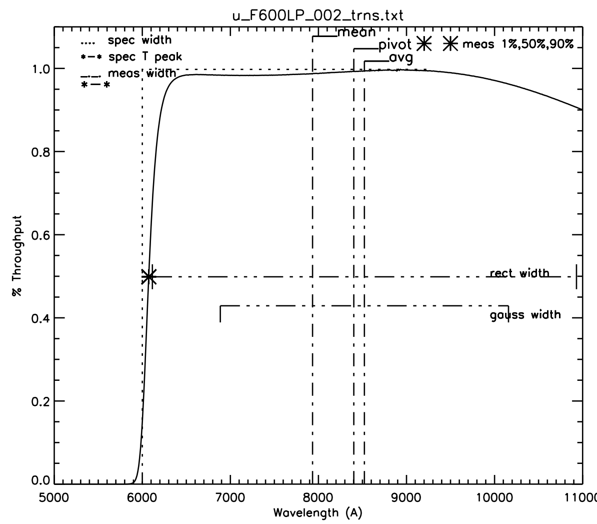


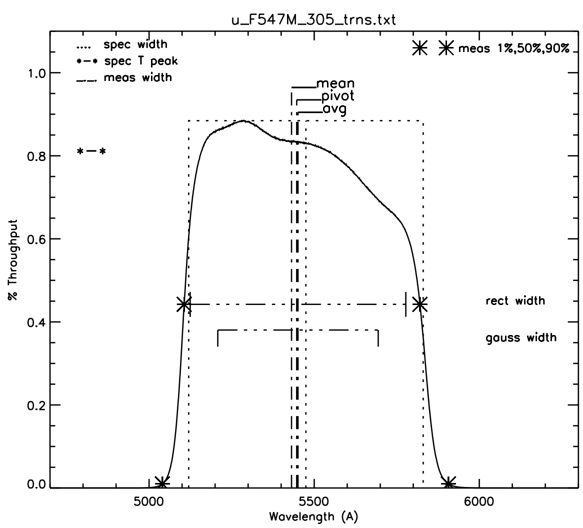
Panel 3: Wide and Medium Filters

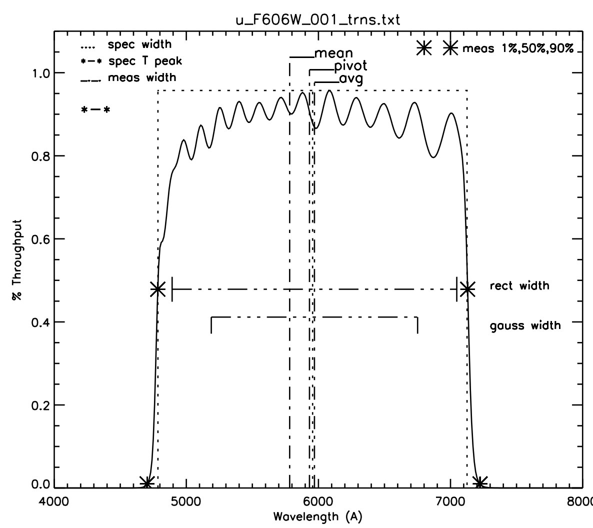




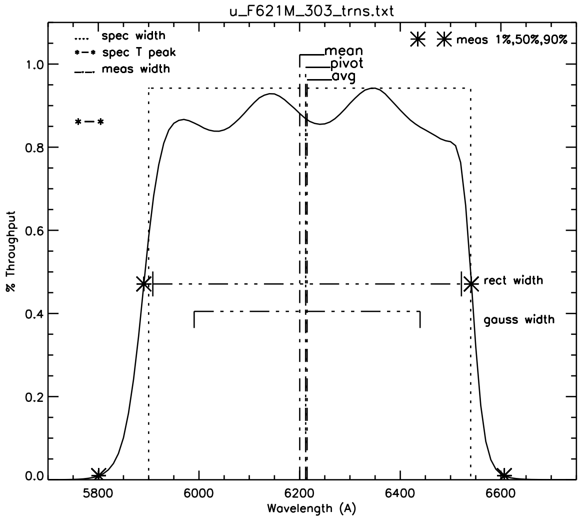


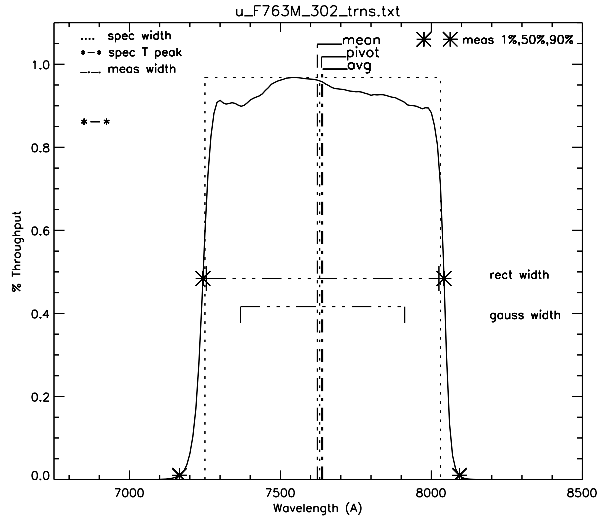


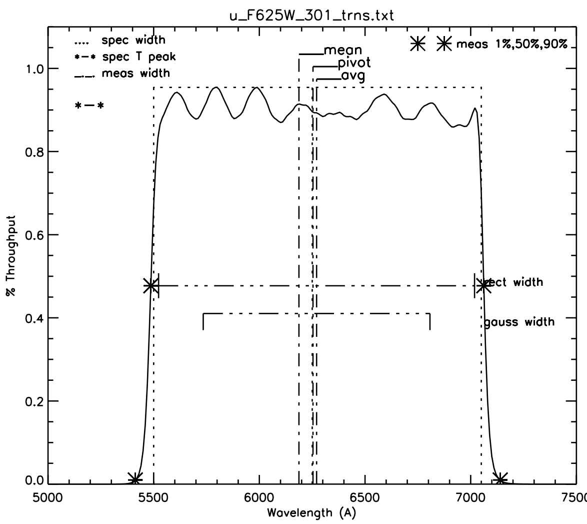


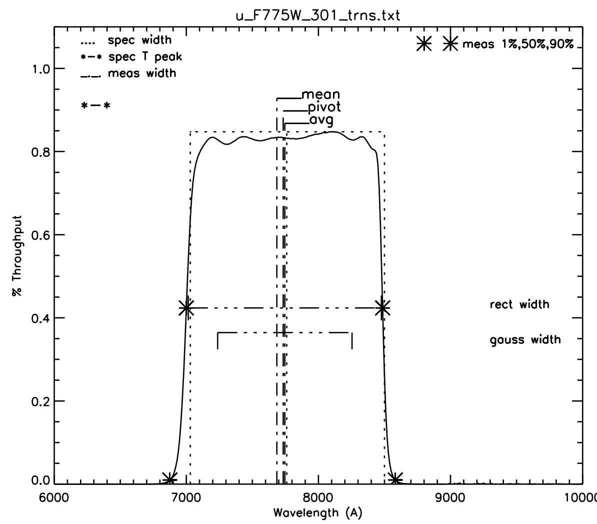


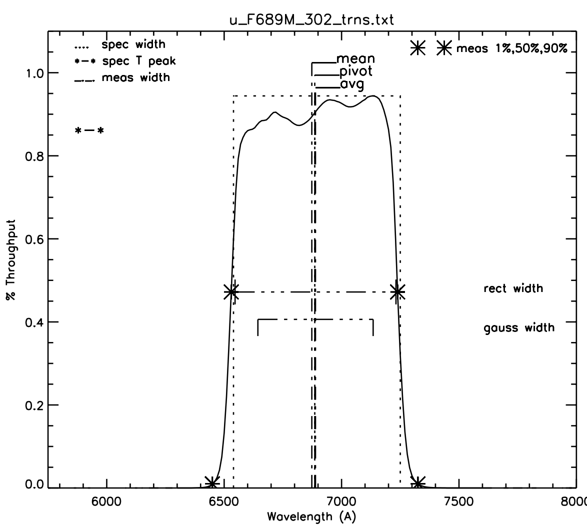
Panel 4: Wide and Medium Filters

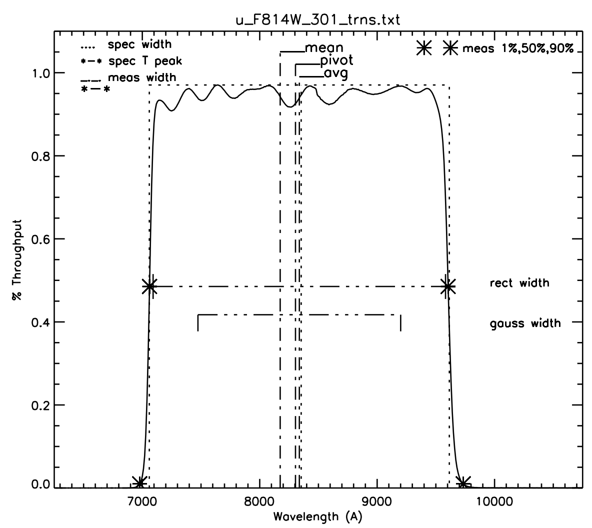




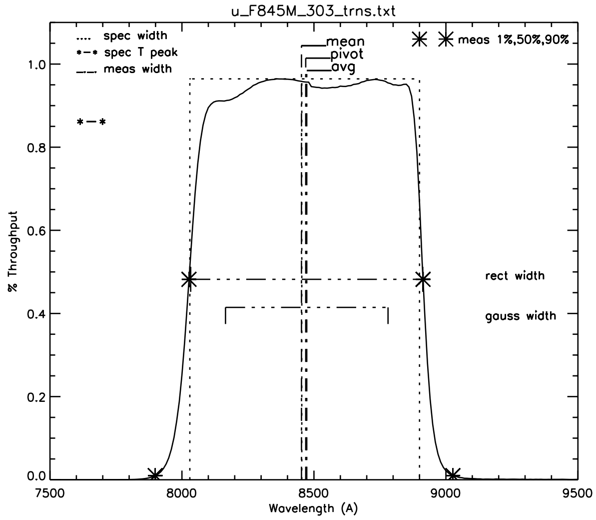


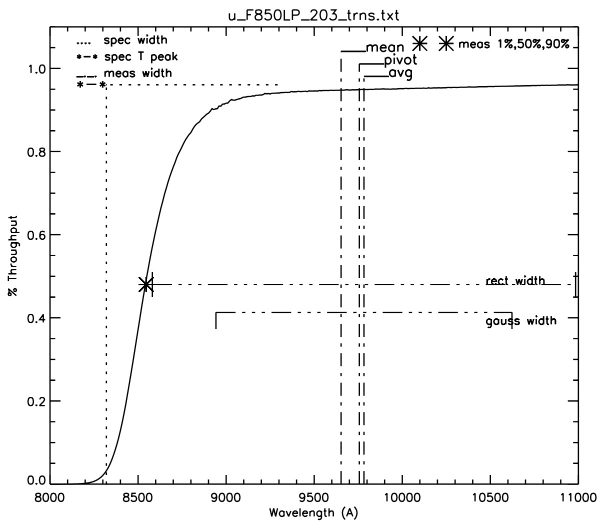




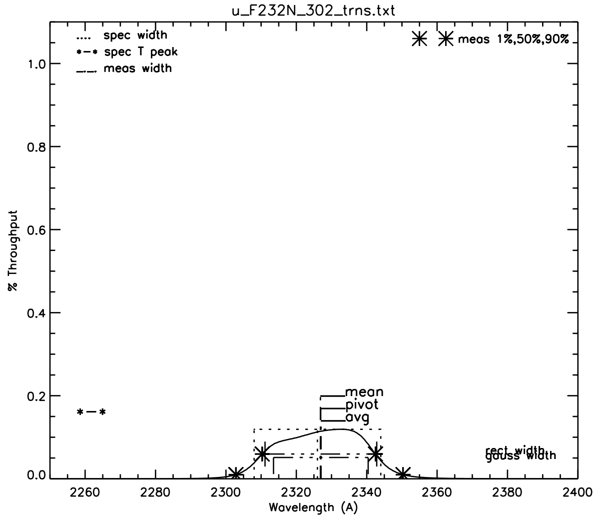


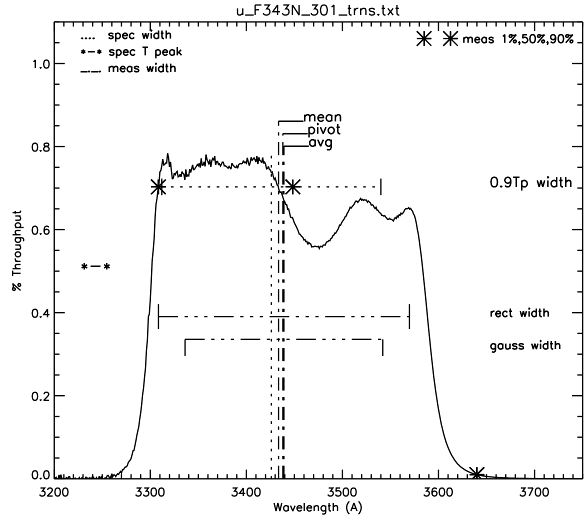
Panel 5: Wide and Medium Filters

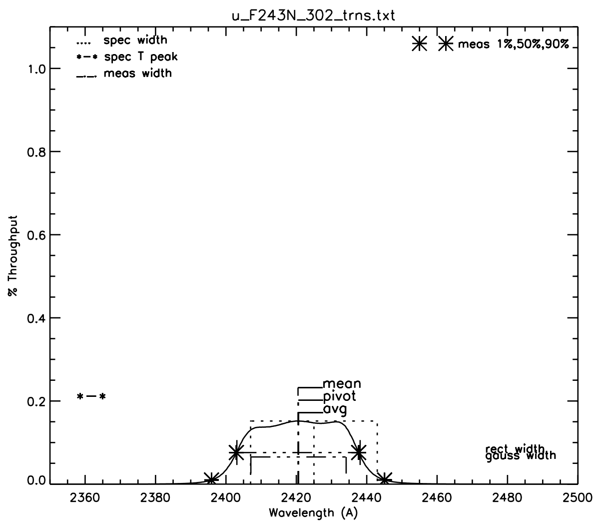


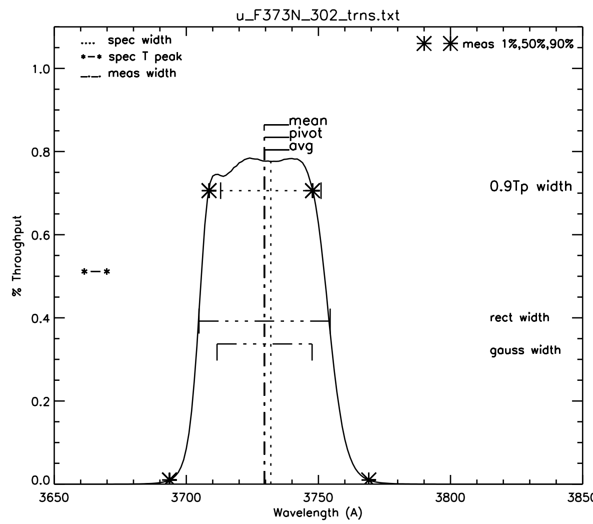


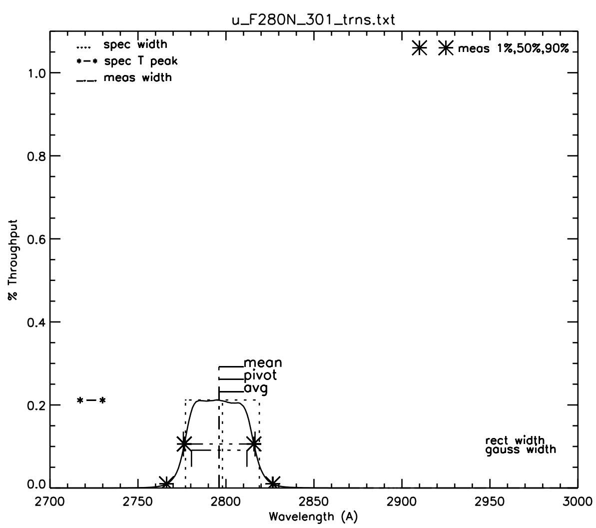
Panel 6: Narrow Band Filters

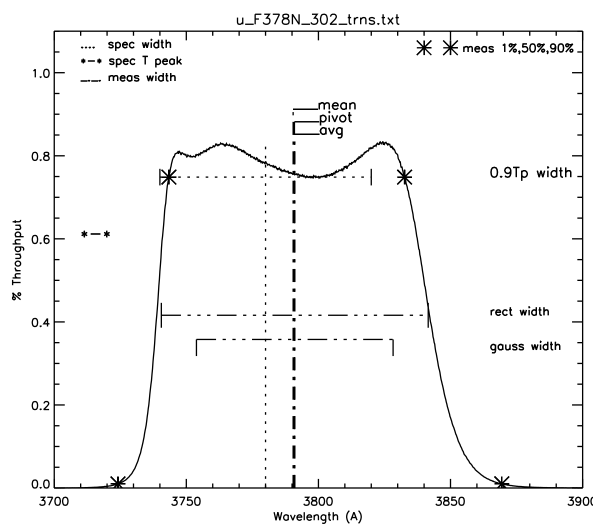




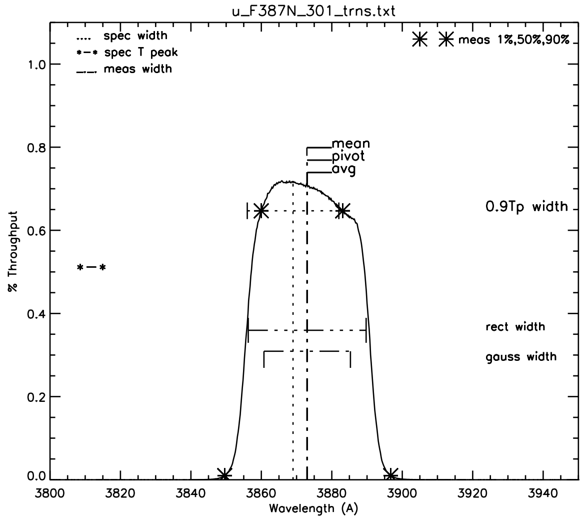


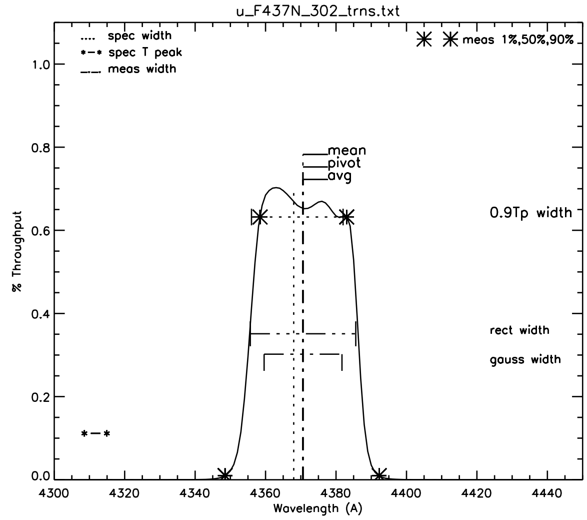


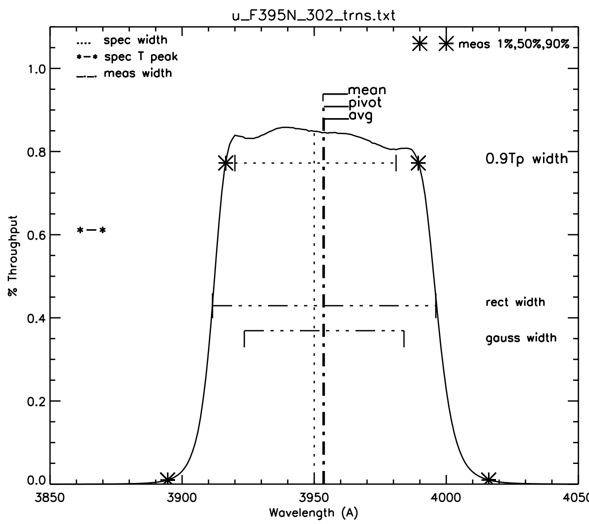


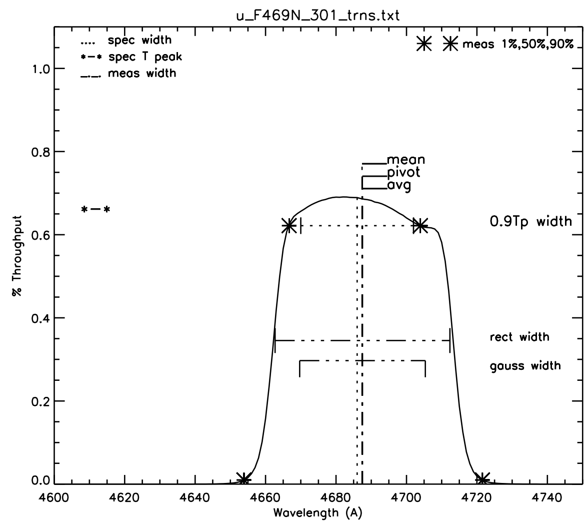


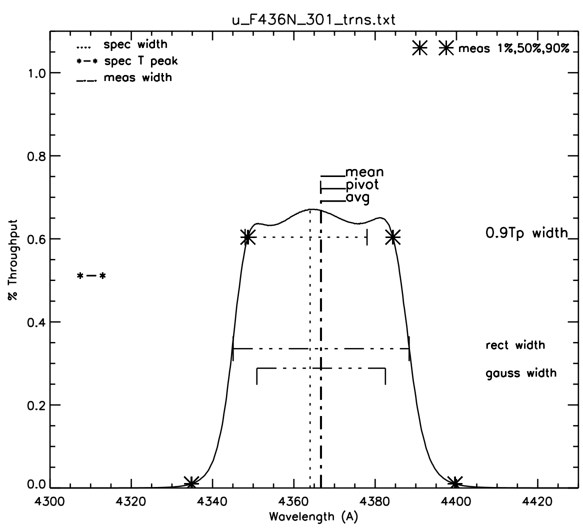
Panel 7: Narrow Band Filters

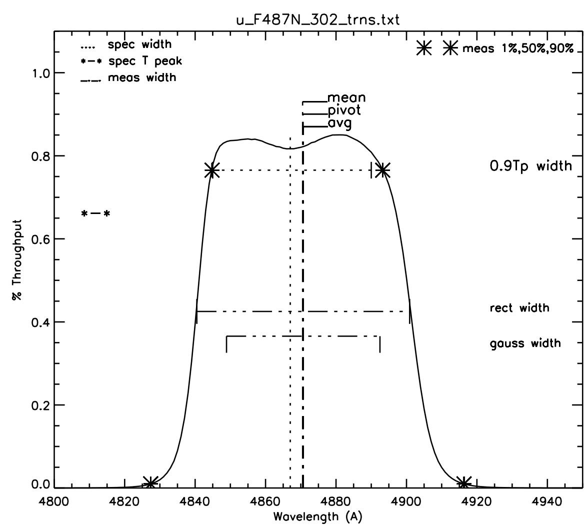




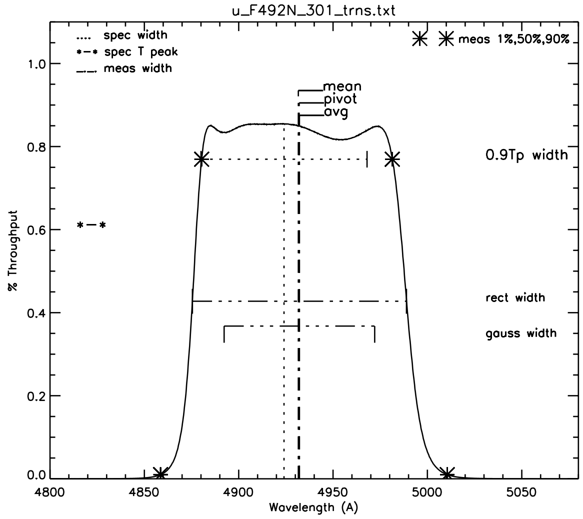


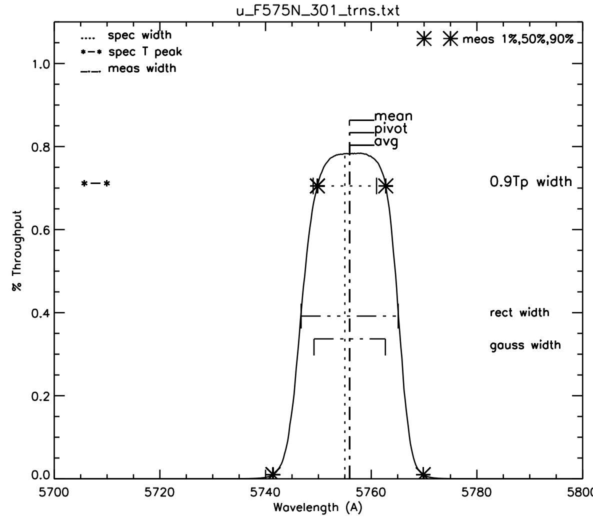


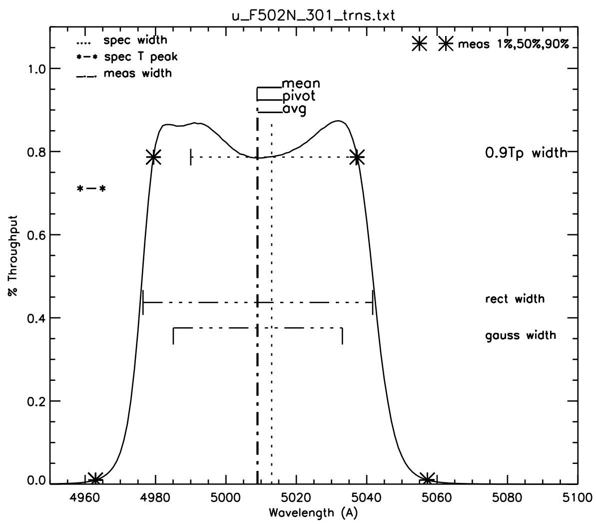


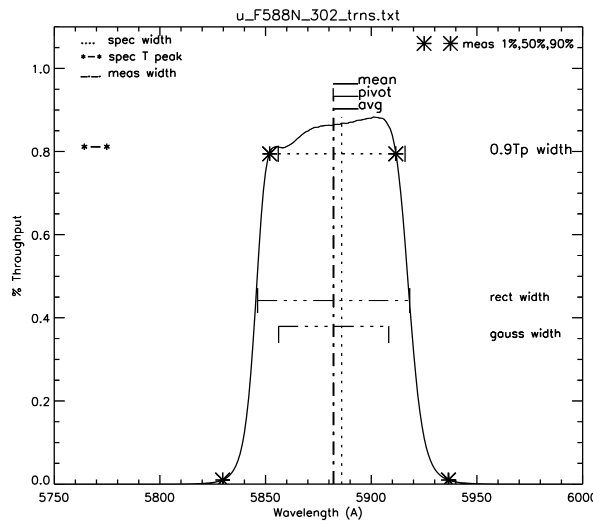


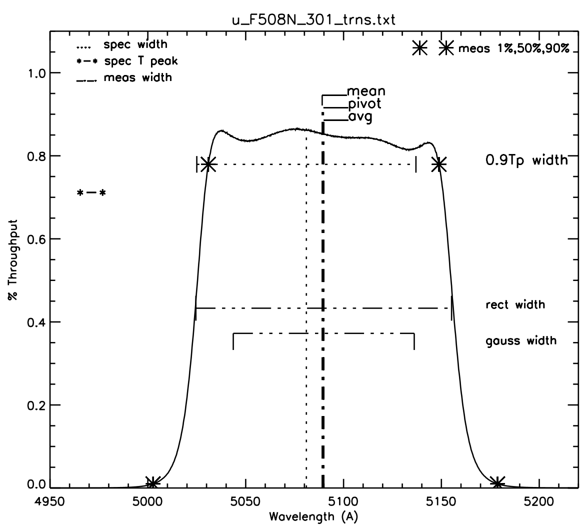
Panel 8: Narrow Band Filters

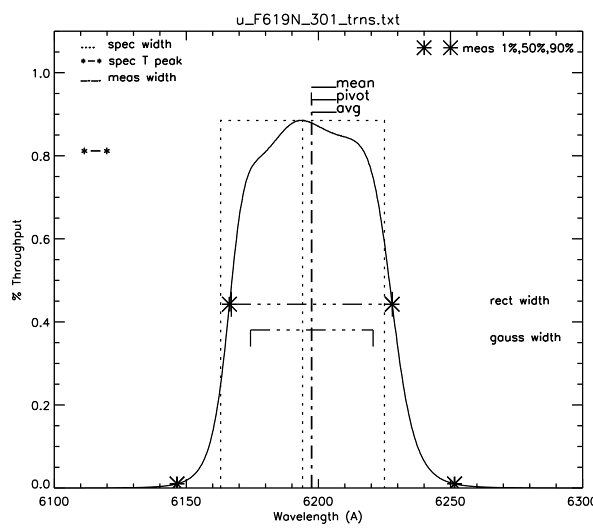




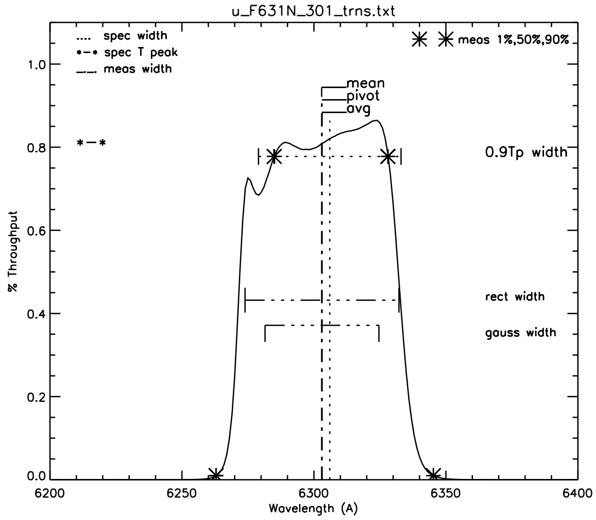


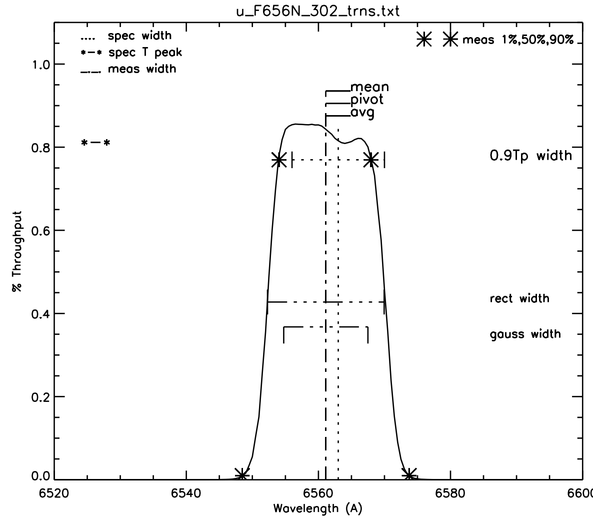


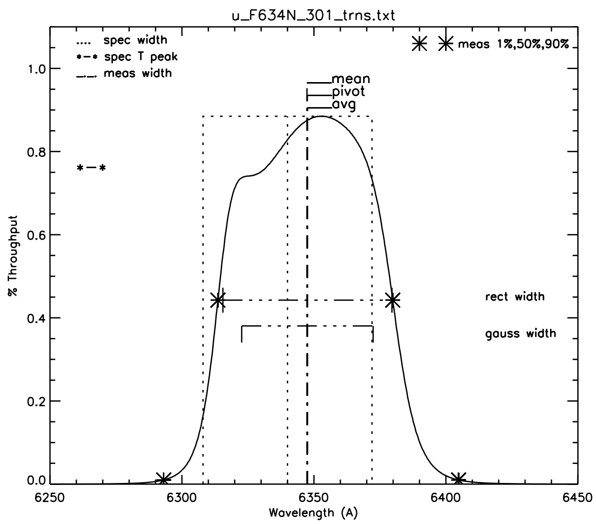


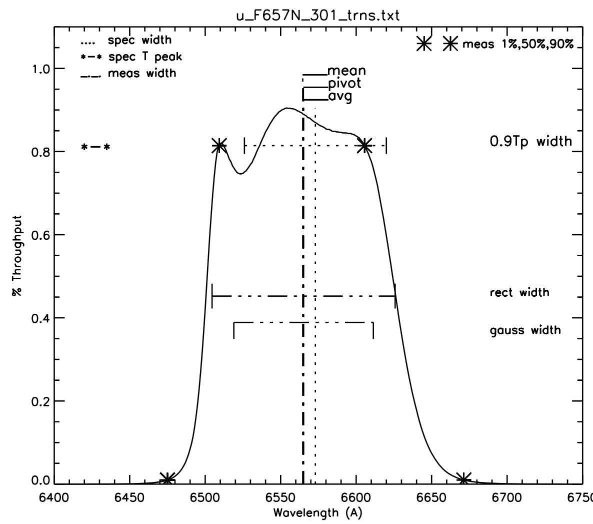


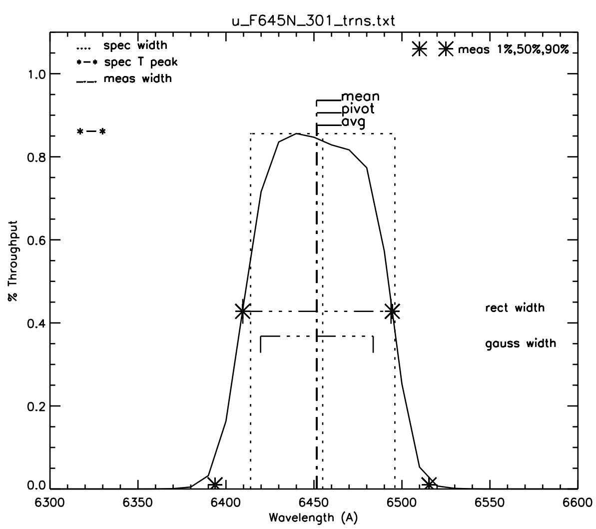
Panel 9: Narrow Band Filters

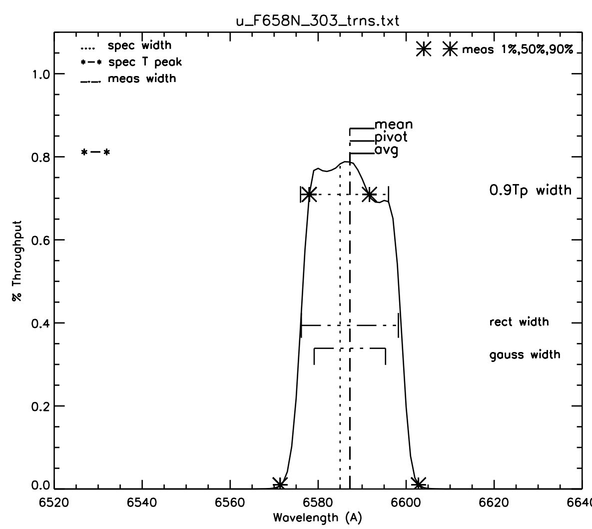




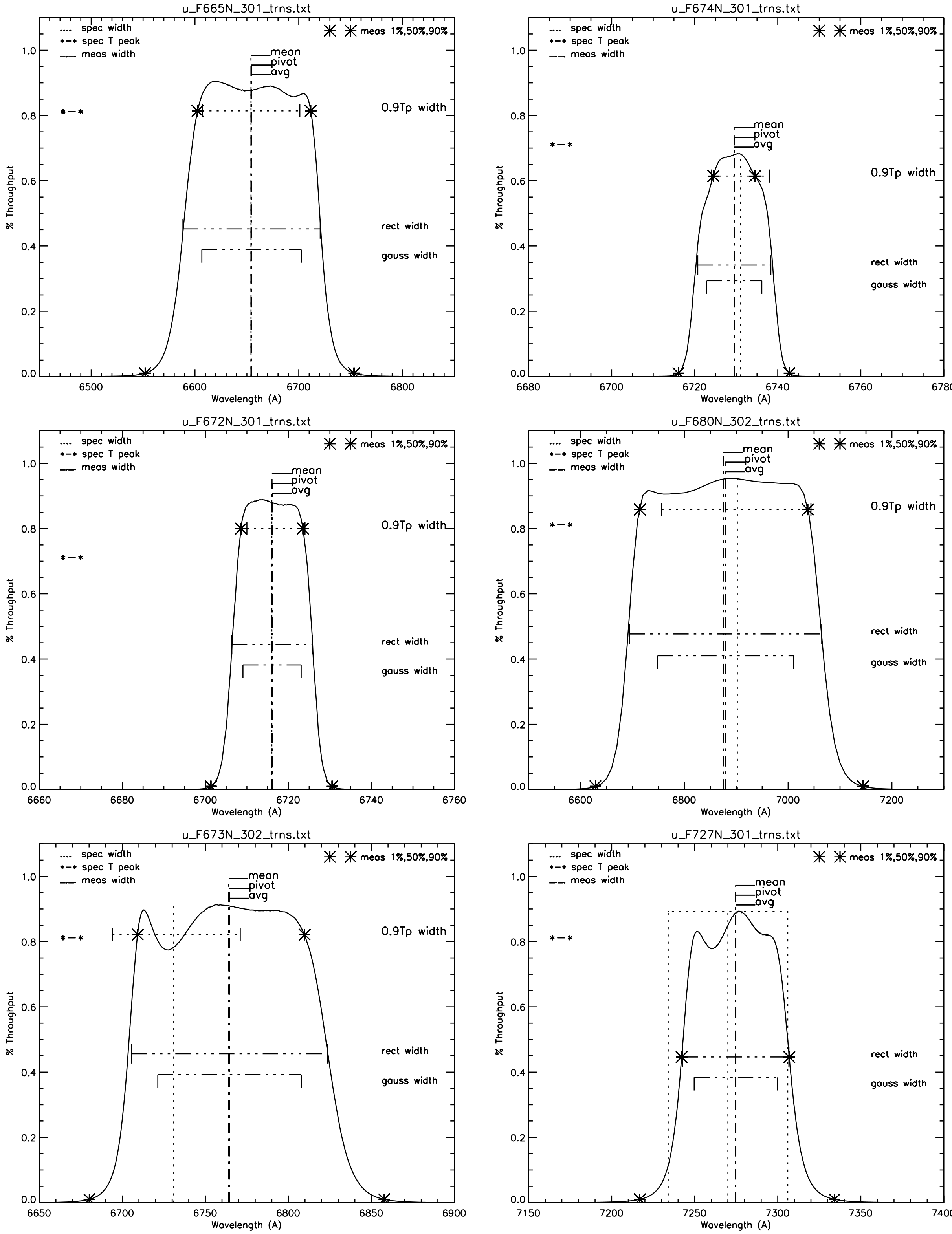








Panel 10: Narrow Band Filters



Panel 11: Narrow Band Filters