4.2.3 POLARIZED FILTERS

4.2.3.1 TEST METHOD

Due to the light beam of the Cary being highly polarized (changes polarization characteristics when running a spectral scan), there are noted gaps in the transmission data, with discontinuities running into the tens of percent. To minimize the impact of this effect, spectral scans were taken with the reference polarizer at 4 different angles. At each reference angle, spectral data was taken for the 2 different test cases listed below. The test data would then be averaged with the goal to reduce the discontinuities to within a few percent. This polarizer filter transmission test approach was used previously for WFPCII.

	Reference Polarizer Angular Position	Polarizer Under Test Angular Position
Test Case 1A :	X (baseline)	
Test Case 1B :	X	X
Test Case 2A :	X (baseline)	
Test Case 2B :	X	X + 90 °

The test cases were ran for the following values of X :

X = 0 °, 45 °, 90 °, and 135 °

Other test criteria are listed below :

1) The Reference Polarizer and the Polarizer Under Test were of the same type, that is, either both visible or both IR.

2) Care was taken to ensure that the planes of the Reference Polarizer and the Polarizer Under Test were parallel to each other, as to not introduce additional factors into the test data.

3) Positioning the angle of the polarizers was “eyeballed” due to the fact there were no staging devices available at the time of the test to be used with the Cary.

4) Additional data was also obtained for Test Cases 3-5 :

	Reference Polarizer Angular Position	Polarizer Under Test Angular Position
Test Case 3 :	n/a	X
Test Case 4 :	n/a	X + 60 °
Test Case 5 :	n/a	X + 120 °

5) Measurements were to be made from 300-1100 nm @ 1 nm increments.

6) Measurement resolution to 0.001 was needed on the crossed-filter measurements.

4.2.3.2 DATA CORRECTION

As documented in Reference 4.2.3.2-1

Reference 4.2.3.2-1 - Cassini ISS Calibration : Polarizer Transmission Correction, R. West, September 23, 1997

Because the polarizer transmission measurements (visible and infrared) were made by using two polarizers in combination, a correction needs to be made to the transmission data reported by Dan Preston (and, presumably also for any data from Barr Associates). We want to derive $T_{//}$ and T , the transmission coefficients of the filter for light polarized parallel and perpendicular to the polarizing axis of the filter. Dan provided files of the transmissions measured parallel and perpendicular to a reference polarizer in the beam. I will call these $M_{//}$ and M . These depend on wavelength, and this dependency will be implicit throughout this discussion.

By averaging the measurements at four orientations, Dan provided a good approximation to what would be measured if the incident beam were unpolarized. For an unpolarized beam, half the incident flux (denoted by I) is polarized parallel to the polarization axis of the filter, and half is polarized perpendicular to that direction. After passing through the reference polarizer (same material as the polarizer we are measuring), the amount of flux will be $0.5IT_{//} + 0.5IT$. After passing through a second polarizer whose polarization axis is parallel to the test polarizer, the emerging measured flux will be $0.5I\,T_{//}T_{//} + 0.5I\,T\,T$. Similarly, for a second polarizer oriented perpendicular to the polarizer axis of the test polarizer, the measured flux will be $0.5I\,T_{//}T + 0.5I\,T\,T_{//}$. The measured transmissions are the ratios of these to the flux from the test polarizer alone. Thus,

$$M_{//} = \frac{T_{//}T_{//} + T\,T}{T_{//} + T}$$

and

$$M = \frac{2\quad T_{//}T}{T_{//} + T}$$

These imply

$$T_{//} = 1/2\,(M_{//} + M \;+\mathrm{sqrt}\,[(M_{//} + M)(M_{//} - M)]\;)$$

$$T = 1/2\,M\;(M_{//} + M)\,/\,T_{//}$$

4.2.3.3 POLARIZER FILTER FLIGHT DATA

The flight polarizer filters for the NAC and WAC are listed below :

NAC	WAC
IRP0 (123-1)	IRP0 (216-1)
P0 (120-4)	IRP90 (217-1)
P60 (121-2)	
P120 (122-1)	

Table 4.2.3.3-1 - NAC AND WAC FLIGHT POLARIZER FILTERS AND SERIAL #'S

Data was taken on spare flight filters: spare WAC filters 216-2 (reference) and 217-2 (test) for the IR polarizer data, and spare NAC filters 120-3 (reference) and 121-3 (test) for the visible polarizer data. It should be noted that the data for each type of filter (IR or visible) is applicable to all filters of the same type (each individual filter ,of like type, was made out of the same material as the others).

The graphs of the corrected parallel and crossed transmission for the polarized filters are shown in Figure 4.2.3.3-1 through Figure 4.2.3.3-4. The data is electronically archived (reference Appendix E). From the graphs, it can be seen that the polarizer filters meet their parallel and cross transmission requirements shown below :

	IR POLARIZERS	**VISIBLE POLARIZERS**
Minimum Parallel Transmission Factor	0.85 , 700 - 1100 nm	0.2 , 300 - 1100 nm
Maximum Cross Transmission Factor	0.001, 700 - 1100 nm	n/a

Table 4.2.3.3-2 - POLARIZER FILTER TRANSMISSION AND CROSS-TRANSMISSION REQUIREMENTS

Figure 4.2.3.3-1 - Visible Polarizer Parallel Transmission Graph

Figure 4.2.3.3-2 - Visible Polarizer Crossed Transmission Graph

Figure 4.2.3.3-3 - Polarizer Parallel Transmission Graph

Figure 4.2.3.3-4 - IR Polarizer Crossed Transmission Graph