

## 4.3 SHUTTER TIMES

### 4.3.1 NAC FM SHUTTER TIMES

*As reported in Reference 4.3.1-1*

**Reference 4.3.1-1 - ISS DFM 387-MS-96-623, "Component Level Calibration Report for the ISS NAC Flight Shutter", M. Schwochert, December 9, 1996**

**Reference 4.3.1-2 - "Test Procedure for the Cassini ISS Shutter Performance Verification & Component Calibration Tests", M. Schwochert, 27 September 1994**

The component calibration for the ISS NAC Flight shutter was performed from 9/20/95 to 9/21/95 in JPL building 168 room 107 per Reference 4.3.1-2. These test were performed using a test fixture containing five photo-diode/photo-transistor pairs spread evenly across the clear aperture of the shutter. The photo-sensor pairs were used to measure the exposure time of five locations, spaced 5.6 mm apart, across the shutter aperture. One hundred measurements were made for each photo-sensor pair for commanded exposures of 5, 25 and 100 ms at temperatures of 25, 0 and -10 °C. Table 4.3.1-1 shows the average of the 100 exposures for the three commanded exposures at the three temperatures. The averages in Table 4.3.1-1 were calculated by taking the mean of the five photo-sensor measurements, for each exposure, and averaging these mean values for all 100 exposures. The uncertainties shown for each average exposure are the standard deviation of the 100 mean exposure values. Table 4.3.1-2 shows the shutter exposure time offsets which are the difference between the commanded exposure time and the average exposure time.

The three attached graphs show the shutter shading characteristics at the three test temperatures. Shading is defined as the non-uniformity of the exposure across the aperture. What is shown on the graphs are the average shading values at each of the five photo-sensor locations. The shading values are the difference between the measured exposure time for each of the five photo-sensor locations and the mean of all five. Also shown on the graphs is a line representing the optical clear aperture of the Wide Angle Camera (WAC) at the shutter mechanical aperture. For the NAC the two outside photo-sensors were well outside of the clear aperture. With the way that the shutter is oriented in the camera, CCD column 1024 is illuminated first. So when looking at the graphs the left side of the plot is the illumination of CCD column 1024 and the right side is the illumination of CCD column 1.

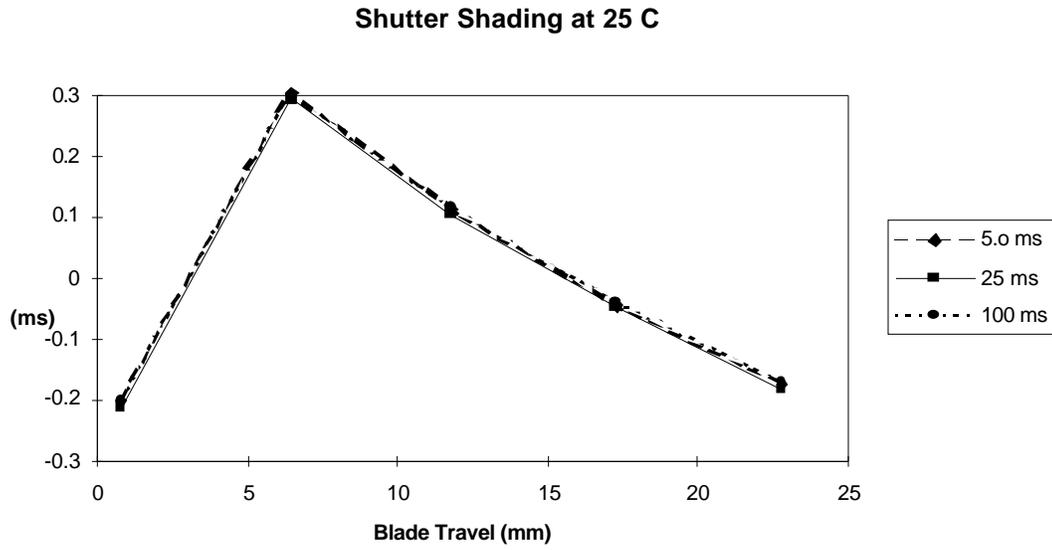
As can be seen from the data, the shutter did not meet the exposure control requirements of the average exposure being within  $\pm 1.0$  ms of the commanded exposure. There were five cases where the offset values were greater than 1.0 ms, the worst being 1.65 ms for the 25 ms exposure at -10 C. This can be accommodated by adding a 1.0 ms offset, via software, to the NAC exposure times. The standard deviation or uncertainty was met by being less than 0.1 ms. In addition there was no observed shutter bounce. Also, the data sheets and raw data are available in Reference 4.3.1-1. The raw data has been electronically archived (see Appendix E). This test data was taken while performing the tests specified in Reference 4.3.1-2.

COMMANDED SHUTTER TIME		5.0 ms	25.0 ms	100.0 ms
Measure Average Exposure @	-10° C	3.979 ± 0.020 ms	23.349 ± 0.021 ms	98.984 ± 0.014 ms
Measure Average Exposure @	0° C	4.020 ± 0.026 ms	23.484 ± 0.023 ms	99.032 ± 0.019 ms
Measure Average Exposure @	+25° C	4.096 ± 0.021 ms	23.507 ± 0.014 ms	99.088 ± 0.019 ms

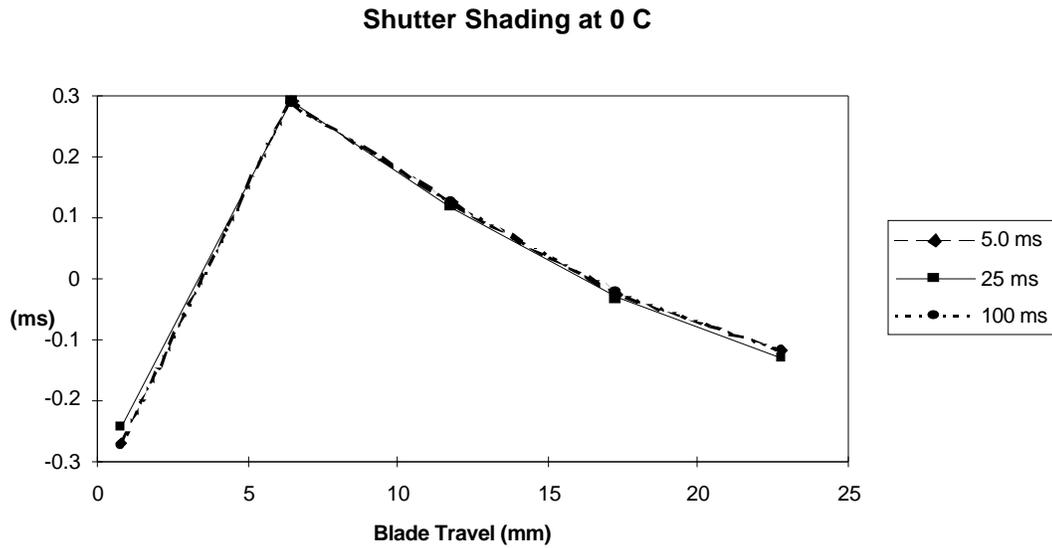
**Table 4.3.1-1 - ISS NAC Component Level Average Shutter Exposure Times**

COMMANDED SHUTTER TIME		5.0 ms	25.0 ms	100.0 ms
Measure Average Exposure Offset @	-10° C	1.021	1.651	1.016
Measure Average Exposure Offset @	0° C	0.980	1.516	0.968
Measure Average Exposure Offset @	+25° C	0.904	1.493	0.912

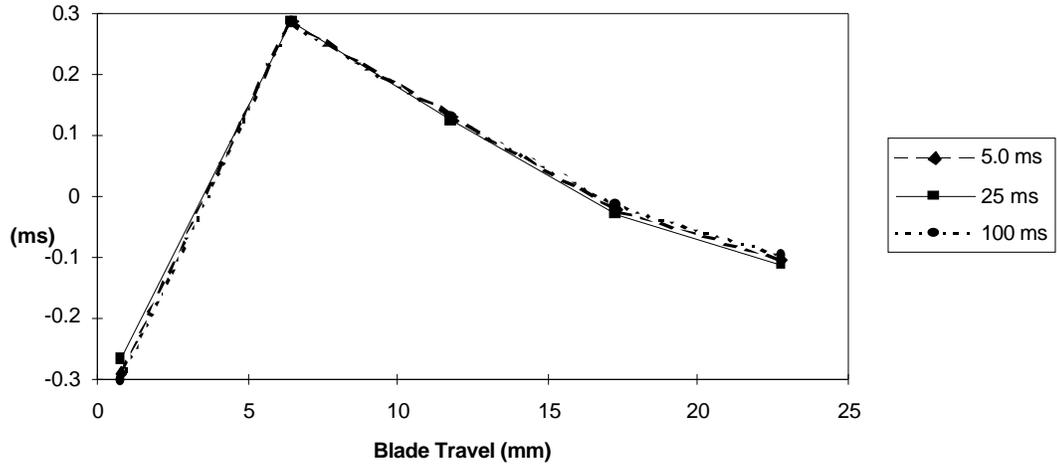
**Table 4.3.1-2 - ISS NAC Component Level Shutter Exposure Time Offsets**



**Figure 4.3.1-1 - NAC Component Level Shutter Shading @ 25°C**



**Figure 4.3.1-2 - NAC Component Level Shutter Shading @ 0°C**

**Shutter Shading at -10 C****Figure 4.3.1-3 - NAC Component Level Shutter Shading @ -10°C**