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Long Term Monitoring of GOME Diffuser Reflectivity and Dark Signal Analysis

Author: A. Dehn, Serco

Reviewed: R. Koopman APP/ADQ

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1. Introduction

The Global Ozone Monitoring Experiment (GOME) was launched on ERS-2 in April 1995 and has been continuously operational since then. It is a scanning nadir-viewing spectrometer, with its primary scientific objective being to retrieve total column ozone globally. A more detailed description of the instrument can be found in *[1]*. In common with previous instruments to measure total column ozone from space such as TOMS and SBUV, it measures the back-scattered radiance from the Earth's atmosphere and surface, and the solar irradiance which is viewed via a diffuser plate to provide a reference spectrum at comparable intensity. These diffuser plates have been found to be subject to degradation (see *[2]* for example) particularly when subject to shorter wavelength ultra-violet light, and efforts have been made to characterize this degradation for instruments such as SBUV/2, where the diffuser plate was exposed for a total of around 750 hours between 1979 and 1986. GOME has been designed with a cover for its diffuser plate in an attempt to minimise this degradation, with exposure usually being for a short time for one orbit each day to obtain a reference solar spectrum, and characterisation of any degradation is possible by means of the on-board Pt/Cr/Ne calibration lamp. In order to investigate the GOME diffuser degradation, and to see if the measures taken have reduced the effect, a first analysis was done in January 1997. The results and detailed description are presented in technical note *[9]*. Updates on the analysis were done for the time periods June 1995 to December 1997, June 1995 to December 1998, June 1995 to September 1999 and June 1995 to January 2000 (see technical notes *[10]*, *[11]*, *[12]*, *[13]*). This document provides the update on the degradation analysis, using the monthly calibration data from June 1995 until April 2000 following the same algorithms as in *[9]*.

2. Algorithm Descriptions

The detailed description of the algorithms used for the calculation of diffuser reflectivity and dark signal components can be found in *[9]*.

3. Results

3.1 Dark Current Analysis

The dark signal for GOME is defined as being comprised of two parts - a constant value of between 140 and 150 binary units (BU) which is the fixed pattern readout noise (FPRN) and a time dependent component of around 2 to 3 binary units per second which is the leakage current (LC).

Trends were calculated for both the FPRN and the LC, and for the noise on these measurements. The results are shown in Table 1 below and Figures 1 to 4.

Ch.	FPRN	Noise	LC	Noise
1	+0.14	-2.39	+13.6	+24
2	-0.04	+0.49	+13.8	+57
3	-0.03	-0.28	+13.5	+35
4	-0.03	-0.02	+ 20.5	+20

Table 1: GOME Dark Signal Trends;% per year

3.2 Diffuser Reflectivity

The diffuser reflectivity is calculated as the ratio of calibration lamp measurements and the lamp measurements via the diffuser. The result of the analysis for the diffuser reflectivity can be seen in Figure 5. The data are dark signal corrected.

4. Conclusions

Over a period of about 5 years, the following conclusions regarding trends in the GOME dark signal and diffuser reflectivity have been reached.

- No significant change is seen in the fixed pattern readout noise
- There is an increase of ~14% per year in leakage current for all detectors
- Leakage current measurements are becoming much noisier with time
- No significant change is seen in the diffuser reflectivity in any channel

This analysis is performed within the PCS about every half year to monitor GOME in orbit instrument performance.

5. References

[1]: GOME User's Manual SP-1182
ESA Publications Division September 1995.

[2]: Report of the International Ozone Trends Panel
WMO Report No. 18 Vol. 1, §2.3.6 1988.

[3]: ERGO Software User's Manual
DOR-GO-QA-SUM Issue 1.0 12/12/1995

[4]: ERGO Design Document
DOR-GO-QA-DD Issue 2.0 12/12/1995

[5]: GOME Data QA - Specification of Instrument Parameters - S. Slijkhuis
SRON-GOME-QA-TN01 Issue 2/A 30/06/1995.

[6]: ERGO Test Report of Final S/W Delivery Dec-1995 - S. Slijkhuis
SRON-GOME-QA-TN04 Issue 1 09/02/1996.

[7]: Remote Sounding of Atmospheres by J.T. Houghton, F.W. Taylor and C.D. Rodgers
Cambridge University Press 1st Edition 1986.

[8]: Functional / Performance Test on GOME BBM - Olij, C. & Zoutman, A. E.
TPD-ERS-GO-MIR-11 Issue 2 1993

[9]: GOME Diffuser Reflectivity and Dark Signal Analysis - D. Pemberton
ERS2-GO-DDS-TN-001 Issue 1.0 1997

[10]: Long Term Monitoring of GOME Diffuser Reflectivity and Dark Signal Analysis- A. Dehn
ERS2-GO-DDS-TN-002 Issue 1.0 1998

[11]: Long Term Monitoring of GOME Diffuser Reflectivity and Dark Signal Analysis- A. Dehn
ERS2-GO-DDS-TN-003 Issue 1.0 22/03/1999

[12]: Long Term Monitoring of GOME Diffuser Reflectivity and Dark Signal Analysis- A. Dehn
ERS2-GO-DDS-TN-004 Issue 1.0 09/11/1999

Figures

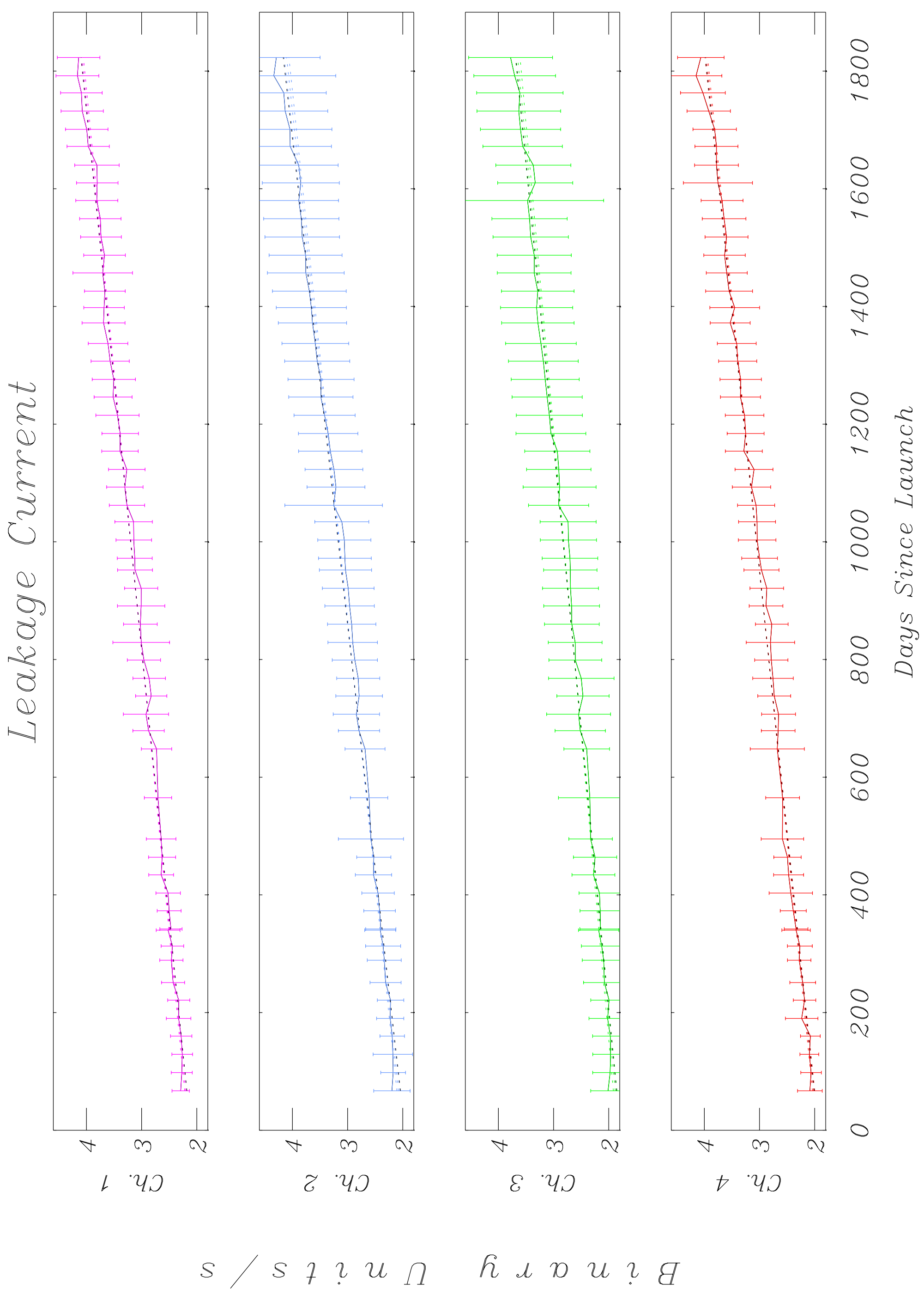

Figure 1: Leakage Current

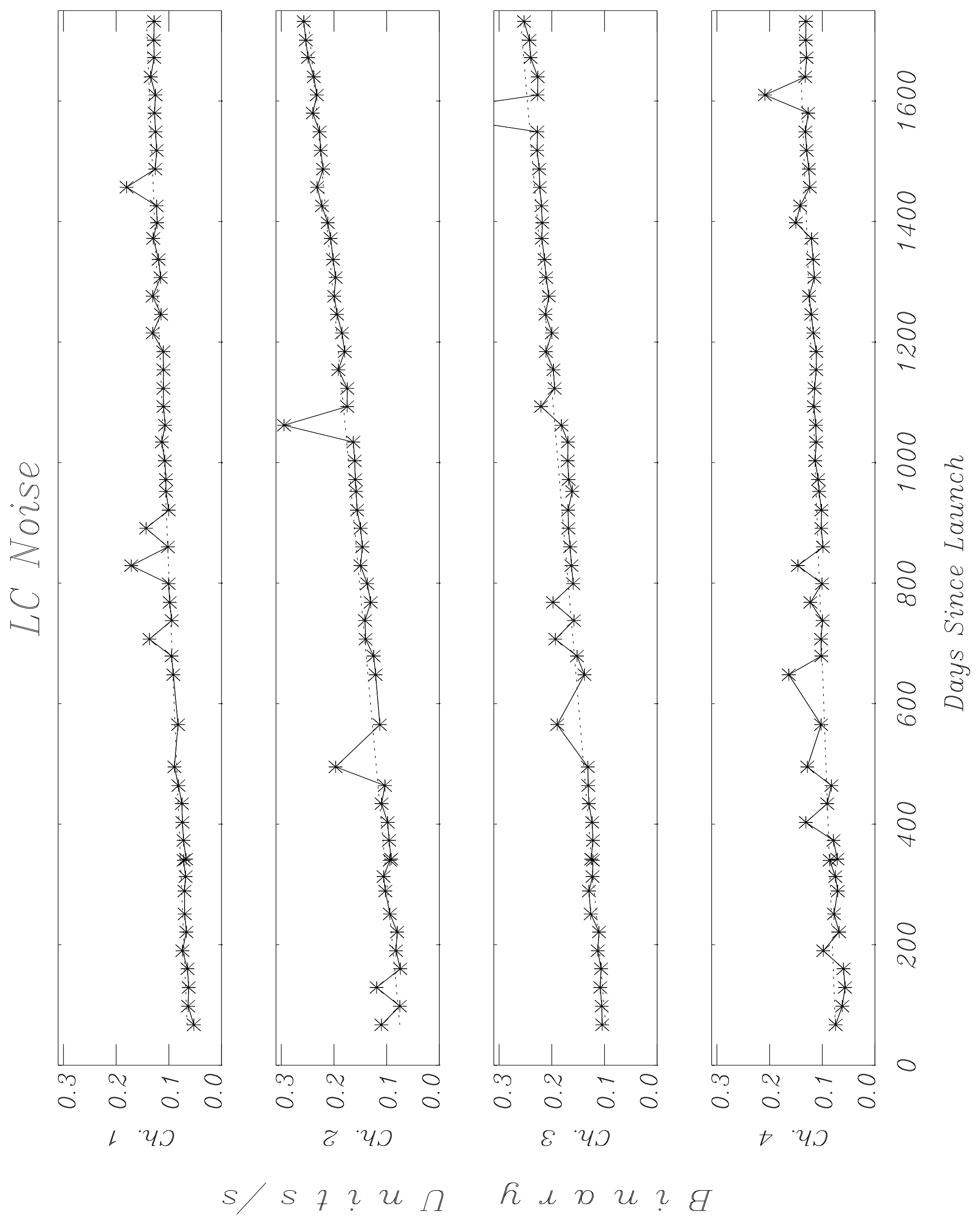

Figure 2: Leakage Current Noise

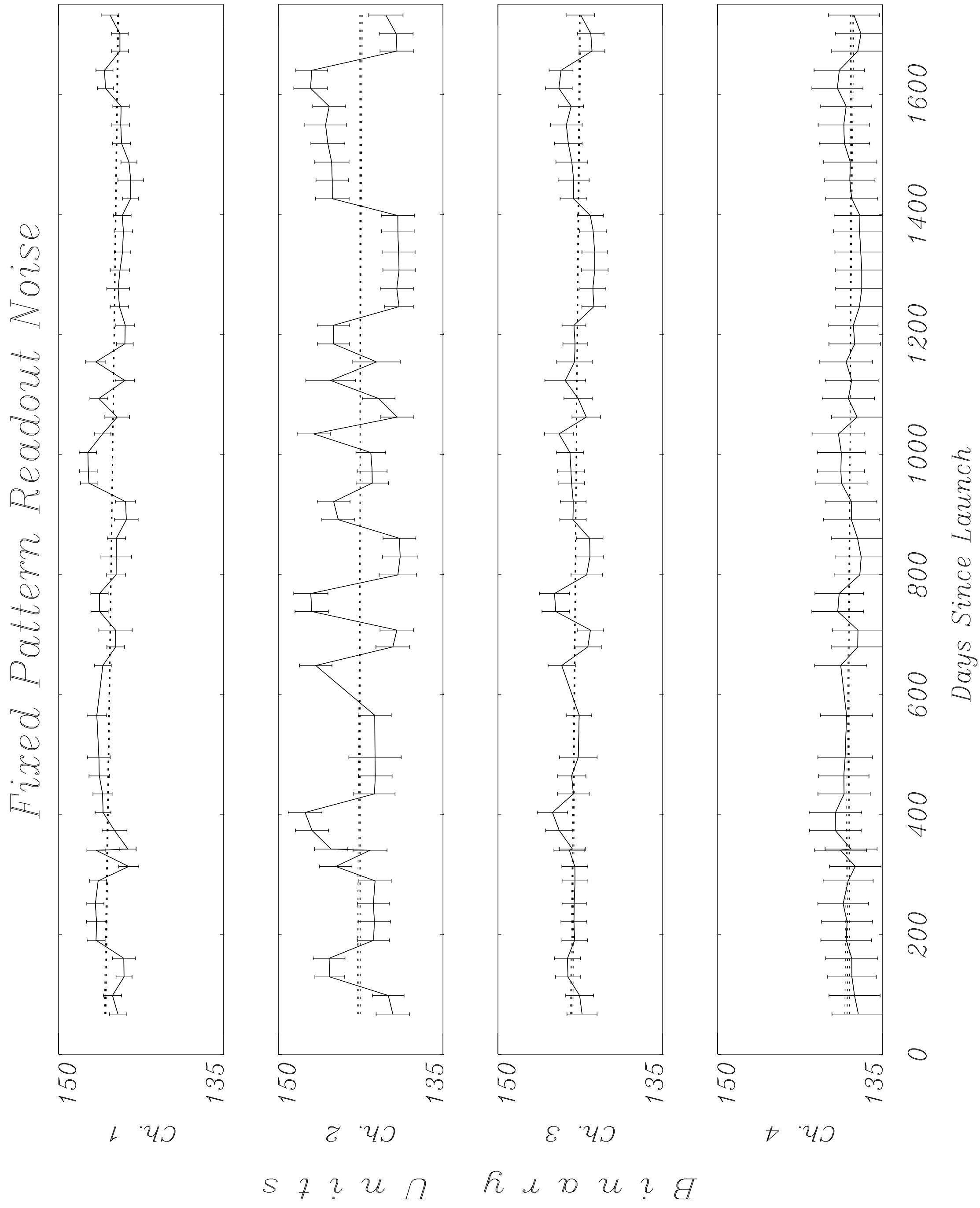

Figure 3: Fixed Pattern Readout Noise

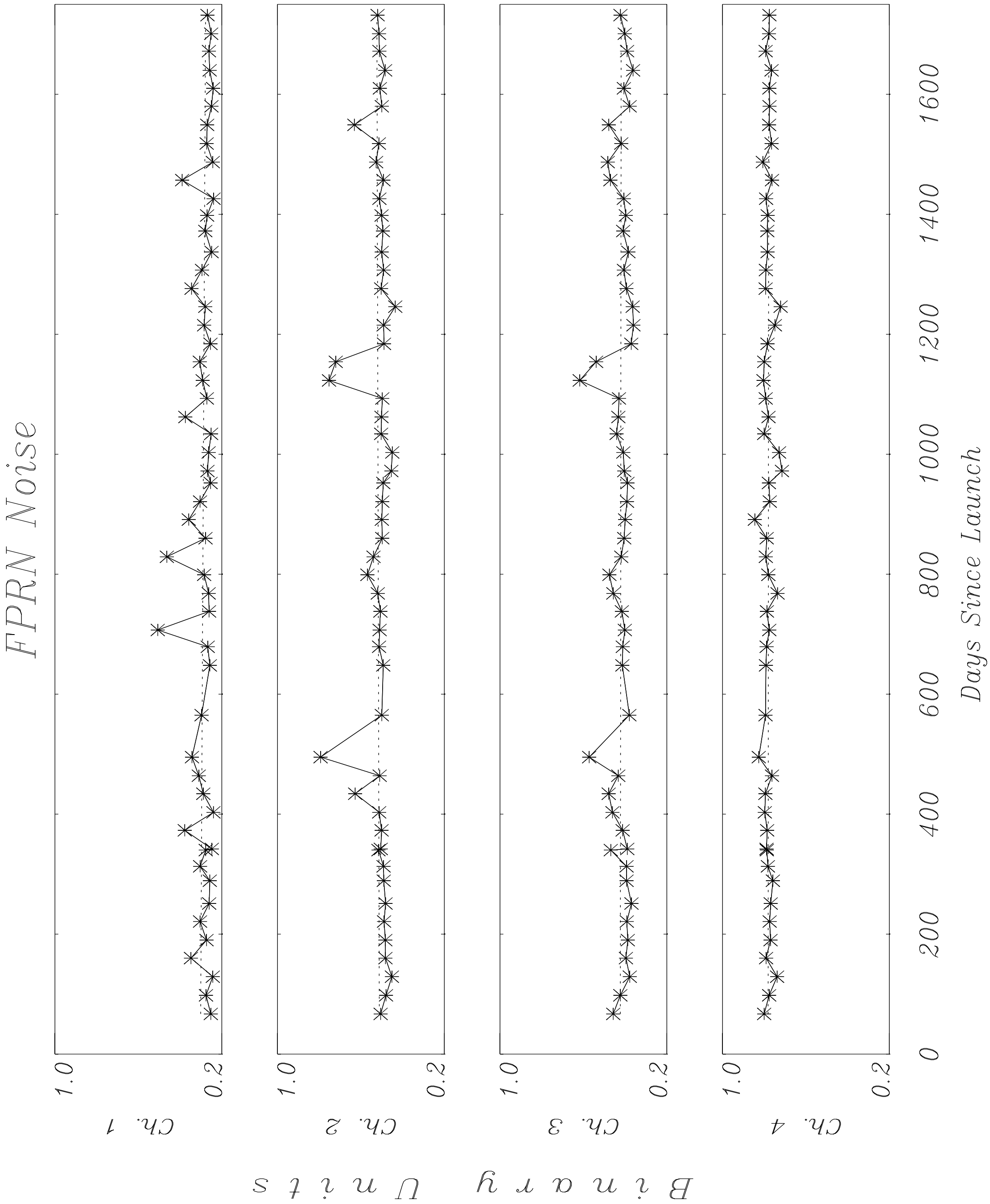

Figure 4: FPRN Noise

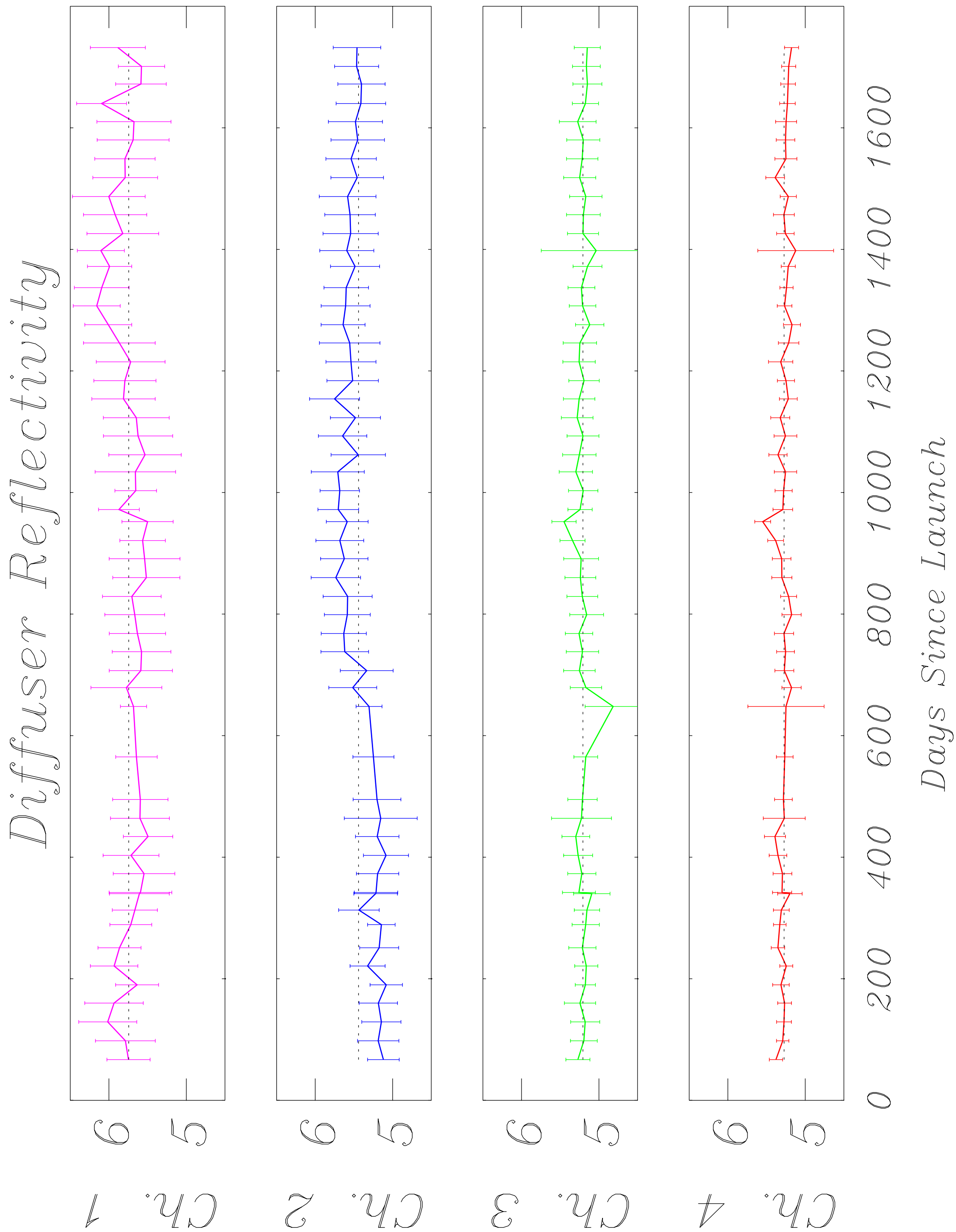

Figure 5: Diffuser Reflectivity (to be multiplied by 10^{-4})

Appendix A

Monthly Calibration Data Sets

Calibration Sequence	Date	Days From Launch	Orbits (No.)
1	27 June 1995	67	965 - 967; 969 (4)
2	28 July 1995	98	1410 - 1413 (4)
3	28 August 1995	129	1854 - 1857 (4)
4	28 September 1995	160	2298 - 2301 (4)
5	28 October 1995	190	2726 - 2730 (5)
6	28 November 1995	221	3171 - 3174 (4)
7	28 December 1995	251	3600 - 3604 (5)
8	04 February 1996	289	4144 - 4148 (5)
9	28 Februrary 1996	313	4488 - 4491 (4)
10	13 March 1996	327	4684; 4687 (2)
11	26 March 1996	340	4874 - 4878 (5)
12	28 March 1996	342	4902; 4904 - 4906 (4)
13	28 April 1996	373	5347 - 5350 (4)
14	28 May 1996	403	5776 - 5780 (5)
15	28 June 1996	434	6220; 6221; 6223 (3)
16	28 July 1996	464	6649; 6650 (2)
17	28 August 1996	495	7092 - 7096 (5)
18	28 September 1996	526	7536 - 7540 (5)
19	06 November 1996	565	8094 - 8098 (5)
20	28 January 1997	648	9282 - 9286 (5)
21	28 Februrary 1997	679	9726 - 9730 (5)
22	28 March 1997	707	10129 - 10132 (4)
23	28 April 1997	738	10570 - 10574 (5)
24	28 May 1997	768	11000 - 11004 (5)
25	28 June 1997	799	11444 - 11448 (5)
26	28 July 1997	829	11874 - 11877 (4)
27	28 August 1997	860	12318 - 12322 (5)

Calibration Sequence	Date	Days From Launch	Orbits (No.)
28	28 September 1997	891	12760 - 12764 (5)
29	28 October 1997	921	13190 - 13194 (5)
30	28 November 1997	952	13634 - 13638 (5)
31	28 December 1997	972	14064 - 14068 (5)
32	28 January 1998	1003	14508 - 14512 (5)
33	28 Februrary 1998	1034	14950 - 14954 (5)
34	28 March 1998	1062	15352 - 15356 (5)
35	28 April 1998	1093	15796 - 15800 (5)
36	28 May 1998	1123	16224 - 16228 (5)
37	28 June 1998	1154	16668 - 16672 (5)
38	28 July 1998	1184	17098 - 17102 (5)
39	28 August 1998	1215	17542 - 17546 (5)
40	28 September 1998	1246	17986 - 17990 (5)
41	28 October 1998	1276	18416 - 18420 (5)
42	28 November 1998	1307	18858 - 18862 (5)
43	28 December 1998	1337	19288 - 19292 (5)
44	02 February 1999	1372	19804 - 19808 (5)
45	28 February 1999	1398	20176 - 20180 (5)
46	28 March 1999	1426	20576 - 20580 (5)
47	28 April 1999	1457	21020 - 21024 (5)
48	28 May 1999	1487	21450 - 21454 (5)
49	28 June 1999	1518	21894 - 21898 (5)
50	28 July 1999	1549	22322 - 22336 (5)
51	28 August 1999	1580	22768 - 22770 (3)
52	28 September 1999	1610	23210 - 23214 (5)
53	28 October 1999	1640	23640 - 23644 (5)
54	29 November 1999	1672	24098 - 24102 (5)
55	28 December 1999	1701	24512 - 24516 (5)
56	28 January 2000	1732	24956 - 24960 (5)

Appendix B

Lamp Lines Used For Diffuser Calibration

Channel 1				Channel 2		
Line Number	Wavelength / nm	Pixel Number		Line Number	Wavelength / nm	Pixel Number
1	244.08	313.79		1	321.91	275.71
2	248.79	353.41		2	332.47	368.00
3	262.88	475.23		3	337.92	415.96
4	266.02	503.16		4	352.15	542.43
5	273.48	569.93		5	369.53	698.64
6	281.03	638.76		6	372.82	728.42
7	283.11	657.69		7	390.99	893.48
8	293.06	749.28		8	392.03	903.05
9	299.88	812.66				
10	304.35	854.03				
11	306.56	874.64				

Channel 3				Channel 4		
Line Number	Wavelength / nm	Pixel Number		Line Number	Wavelength / nm	Pixel Number
1	425.55	145.6		1	588.35	44.42
2	427.60	155.2		2	594.65	72.22
3	429.09	162.2		3	597.72	85.92
4	437.25	200.6		4	603.17	109.43
5	460.20	309.8		5	607.60	130.53
6	492.36	464.5		6	609.79	140.45
7	503.92	520.3		7	613.01	155.21
8	540.21	694.7		8	616.53	171.30

Channel 3				Channel 4		
Line Number	Wavelength / nm	Pixel Number		Line Number	Wavelength / nm	Pixel Number
9	556.43	772.0		9	621.90	196.02
10	574.99	859.4		10	626.82	218.84
11	576.60	866.8		11	630.65	236.66
12	580.61	885.5		12	638.47	273.25
13	582.18	892.7		13	653.47	344.13
14	588.35	921.3		14	660.08	375.64
15	594.65	950.4		15	668.01	413.61
16	597.72	964.1		16	693.14	534.83
17	603.17	988.6		17	717.59	653.62
18	607.60	1008.5		18	724.72	688.28
				19	744.09	782.40
				20	749.09	806.62
				21	753.79	829.28