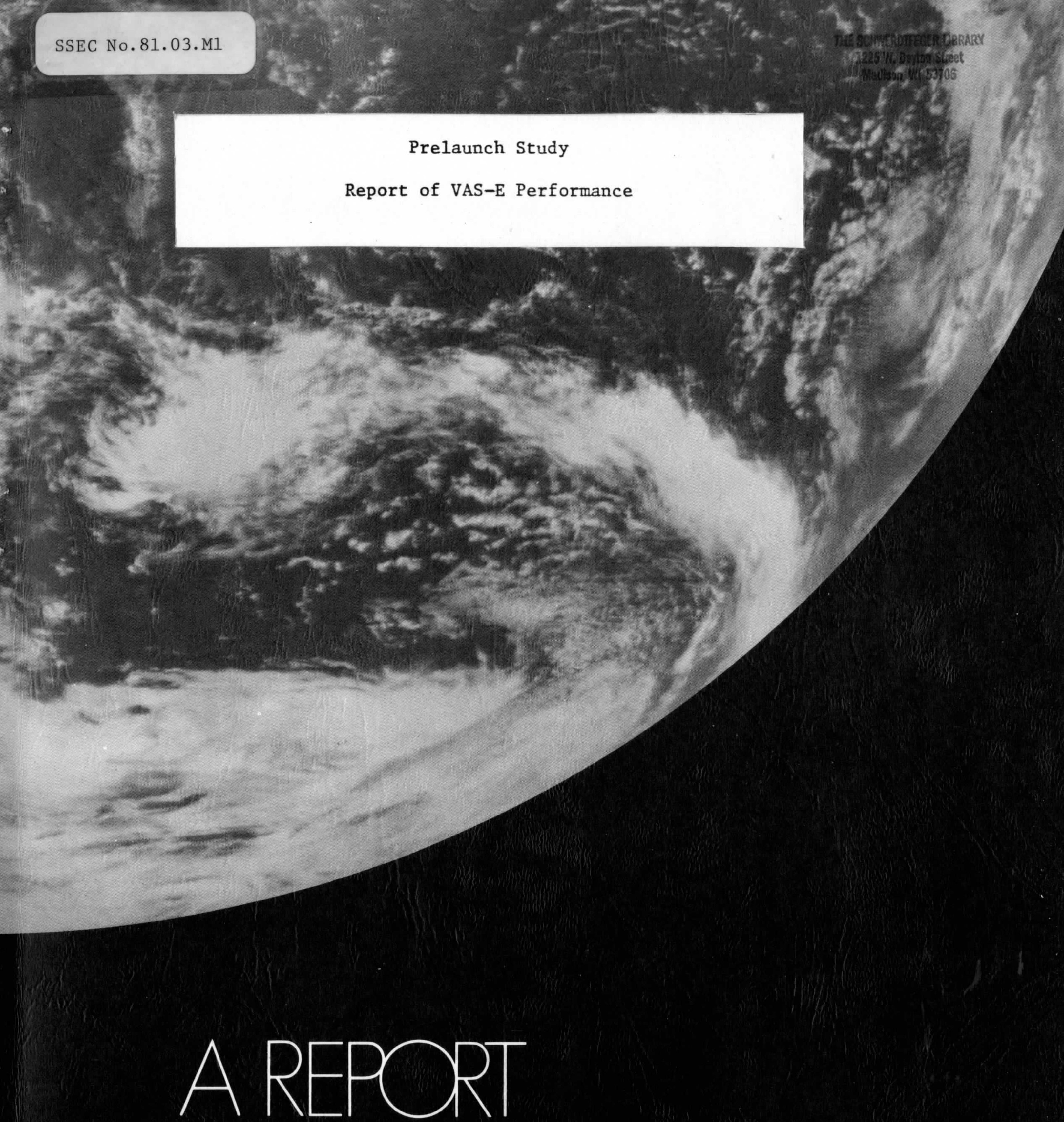
Prelaunch Study

Report of VAS-E Performance



A REPORT
from the space science and engineering center
the university of wisconsin-madison
madison, wisconsin

Prelaunch Study

Report of VAS-E Performance

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by

Paul Menzel

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The University of Wisconsin
Space Science and Engineering Center
1225 West Dayton Street
Madison, Wisconsin 53706

INTRODUCTION

GOES-E is the second in a series of three VAS instruments to be launched into geostationary orbit. It is scheduled for launch in March, 1981. The VAS instrument has been designed to enable timely imaging and sounding in and around short lived weather phenomena. During the VAS Demonstration with GOES-4, the accuracy and utility of the VAS data in depicting small but significant temporal variations in atmospheric temperature and moisture were successfully demonstrated. The VAS performance in the areas of radiometric calibration, noise reduction, and registration of different spectral bands was found to be within the guidelines set out in the Prelaunch Study Report of VAS-D Performance of September 1980.

This study is a sequel to that study; the VAS-D report should be read first so that the VAS-E results make sense. No attempt will be made here to reiterate the theoretical basis for the many calculations; only results where VAS-E differs from VAS-D will be presented.

I. VAS-E RADIOMETRIC CALIBRATION

The data from the VAS-E Calibration and Acceptance Test of April 1980 were analyzed in the manner described in the Prelaunch Study Report of VAS-D Performance. The ray trace determination of the calibration coefficients (see Table I.1) were adjusted after performing an analysis of covariance on the vacuum test data. Table I.2 shows those results.

With the coefficients determined from the ray tracing, the absolute and relative errors for the 28 test gradients for band 8 were calculated to be $-.43\pm.76$ ergs/etc. (or $-.25\pm.45$°C). Improved results were obtained by changing C_{BF} and C_{SMS} using an analysis of covariance; the new absolute and relative errors were $-1.26\pm.48$ ergs/etc. (or $-.74\pm.28$°C). The rather large absolute error was further reduced by incorporating the detector nonlinearity explicitly into the analysis. Using the band 8 nonlinearity of $c/b = .005$ where the radiance is a quadratic function of detector response voltage $N = a + bV + cV^2$, the absolute and relative errors were found to be $-.57\pm.44$ ergs/etc. (or $-.34\pm.26$°C). Band 8 is the only band where the detector nonlinearity had any noticeable effect on the analysis of covariance; the remaining bands had negligible nonlinearities by comparison.

The uncertainty of the effective external blackbody radiance determination was found to be .15 ergs/etc., .10 ergs/etc., and .05 ergs/etc. for summer, winter, and equinox respectively.

Comparing the VAS-E calibration to the VAS-D calibration, one finds that the VAS-E absolute errors are significantly lower for all bands and the VAS-E relative errors are comparable for all bands.

Table I.1 VAS-E Radiometric Calibration Algorithm Coefficients determined from Ray Tracing

1	SM	Secondary Mirror	.041 ± .014
2	PM	Primary Mirror	.032 ± .011
3	θM	Scan Mirror	.031 ± .010
4	BF	Baffle Forward	.176 ± .015
5	SC	Shutter Cavity	-.031 ± .016
6	PMM	Primary Mirror Mask	.060 ± .016
7	SMS	Secondary Mirror Shield	.213 ± .017
8	BA	Baffle Aft	.095 ± .008

Table I.2 VAS-E Calibration Coefficients determined from test data

Band	C_{BF}	C_{SMS}	abs. error (in ergs/etc.)	rel. error
1	.161 $\pm$ .053	.114 $\pm$ .019	.17	.68
2	.118	.134	-.17	.50
3	.119	.130	-.13	.50
4	.134	.124	-.20	.55
5	.123	.151	-.37	.49
6	.103	.131	-.04	.02
7	.142	.167	-.27	.44
8	.125	.200	-.57	.44
9	.169	.189	.02	.25
10	.150	.194	-.06	.19
11	.103	.184	-.03	.02
12	.143	.197	-.01	.01

II. VAS-E DETECTOR NOISE REDUCTION ANALYSIS

Raw data from the test of April 1980 was analyzed to estimate the autocovariance function and the spin budget. Figures II.1 and II.2 show the plots of $C(\tau)$ and σ_M^2/σ^2 for large HgCdTe band 8 data (11.2 micron) and large InSb band 12 data (3.9 micron). These curves are in good agreement with the theoretical curves calculated in the VAS-D Prelaunch Study Report.

The spin budget for the large detectors is shown in Table II.1. Data to determine spin budgets for the small detectors was inaccessible.

The VAS-E spin budget is roughly half the VAS-D spin budget; the VAS-E detector responsivity is much improved. With a spin budget of 47 (to assure good signal to noise in all detectors), the sounding rate at the subsatellite point is roughly 54.1 Km/min without visible data and 50.2 Km/min with visible data.

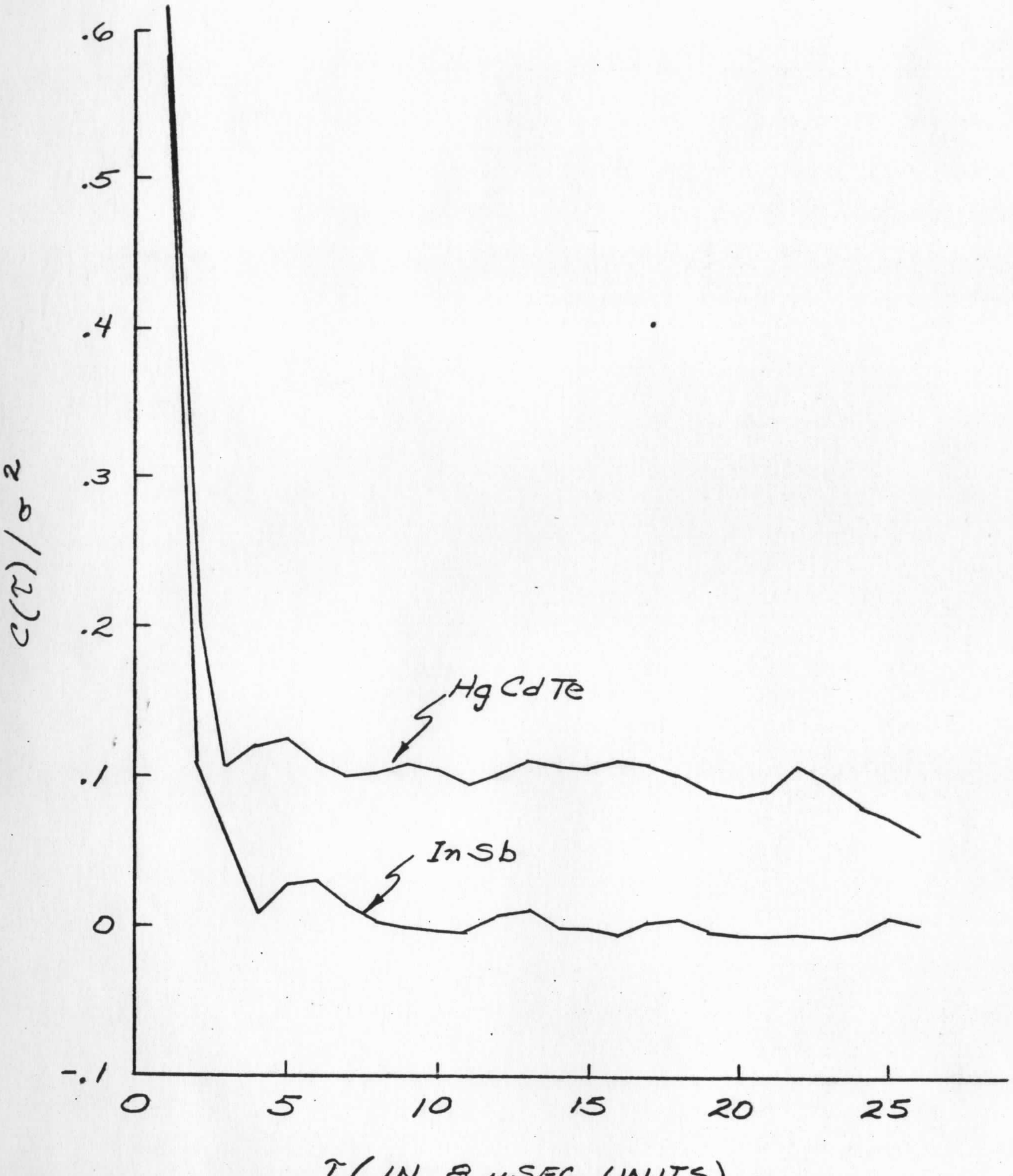

FIGURE II.1 VAS-E AUTOCOVARIANCE OF NOISE $c(\tau)/\sigma^2$ AS A FUNCTION OF SAMPLING INTERVAL τ EVALUATED FROM CALIBRATION ACCEPTANCE TEST DATA

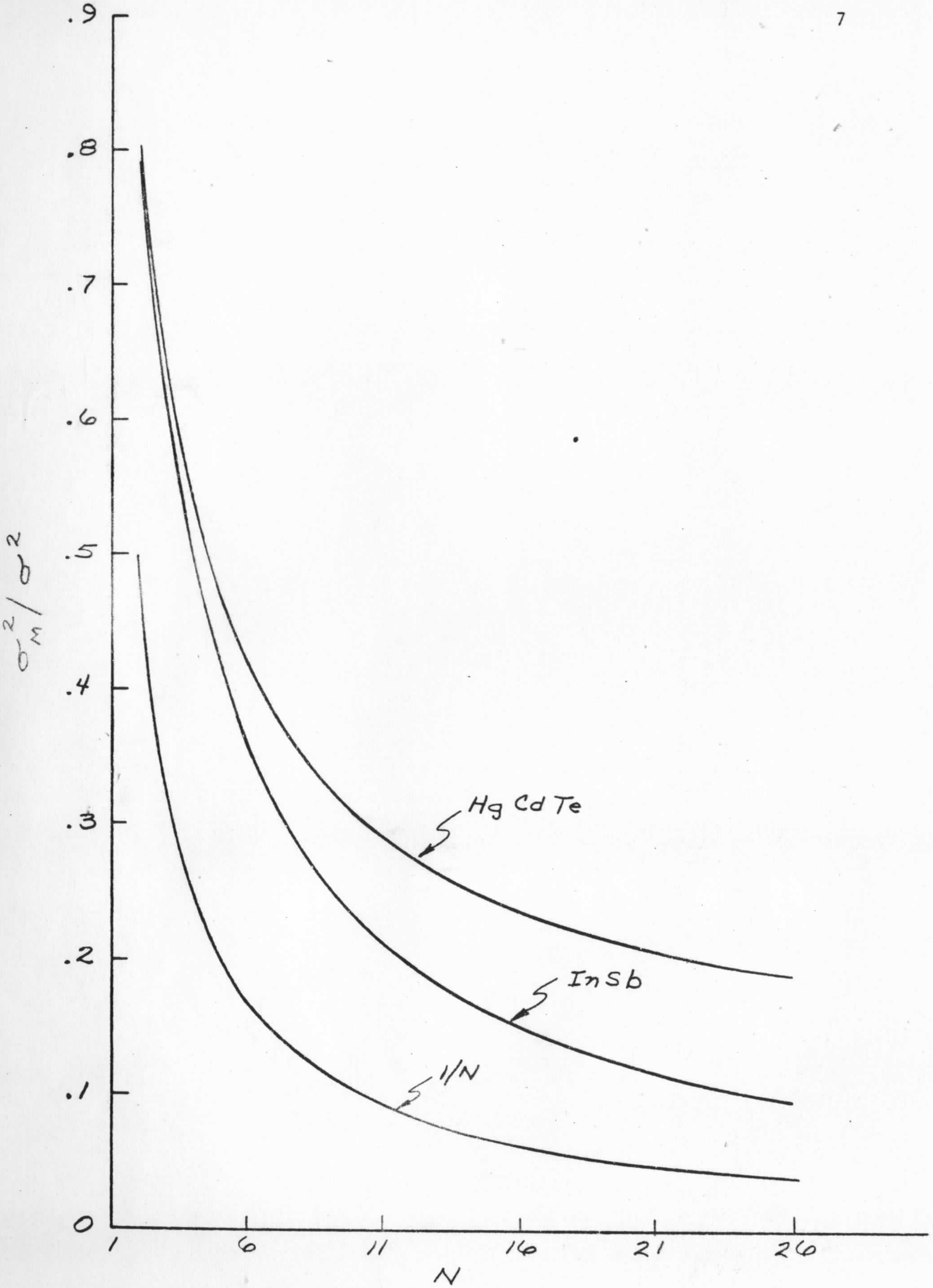

FIGURE II.2 σ_M^2/σ^2 AS A FUNCTION OF THE NUMBER OF SAMPLES N EVALUATED FROM CALIBRATION ACCEPTANCE TEST DATA

Table II.1 VAS-E Large Detector Spin Budget

Band	σ	I	σ_M	σ_{Req}	SB
1U†	2.74	12.28*	.22	.25	1
1L	3.00	11.18	.27	.25	2
2U	1.36	2.37	.57	.25	6
2L	1.52	2.32	.65	.25	7
3U	1.02	2.34	.44	.25	4
3L	1.11	2.30	.48	.25	4
4U	.94	2.34	.40	.25	3
4L	.99	2.30	.43	.25	3
5U	.76	2.34	.33	.25	2
5L	.84	2.36	.36	.25	2
6U	.028	2.28	.012	.004	9
6L	.025	2.36	.010	.004	7
7U	.64	2.41	.27	.25	2
7L	.70	2.36	.30	.25	2
8U	.10	2.31	.04	.25	1
8L	.10	2.18	.04	.25	1
9U	.65	2.37	.28	.15	4
9L	.68	2.31	.29	.15	4
10U	.14	2.31	.06	.10	1
10L	.15	2.30	.07	.10	1
11U	.029	2.29	.013	.004	11
11L	.026	2.38	.011	.004	8
12U	.009	2.26	.004	.004	1
12L	.008	2.36	.003	.004	1
Total U					45
Total L					42

*Improvement factor for band 1 is evaluated for samples from 150x150km^2; for all other bands it is evaluated for samples from 30x30km^2.

†U indicates upper, L indicates lower

III. Misregistration Effects

The analysis for VAS-D also holds true for VAS-E. Peak registration errors of 7% of a large detector field of view are expected which allow clear column radiance retrievals for resolutions as small as 60 x 60 km^2.