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UCRL-51710

**ENERGETIC ELECTRONS IN THE INNER BELT IN 1968:
FITS TO LAWRENCE LIVERMORE LABORATORY'S
MAGNETIC ELECTRON SPECTROMETER DATA
OBTAINED ON OGO-5**

R. M. Buck

H. I. West, Jr.

December 2, 1974

Prepared for U.S. Atomic Energy Commission under contract No. W-7405-Eng-48

**LAWRENCE
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Printed in the United States of America
Available from
National Technical Information Service
U. S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151
Price: Printed Copy \$ ____*; Microfiche \$1.45

<u>*Pages</u>	<u>NTIS Selling Price</u>
1-50	\$4.00
51-150	\$5.45
151-325	\$7.60
326-500	\$10.60
501-1000	\$13.60

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Contents

Abstract	1
Introduction	1
Instrumentation	2
Data Fit Procedure	5
Appendix A. Details of Fitting Procedures	12
Appendix B. Fits to Inner-Belt Electron Fluxes	15
References	81

ENERGETIC ELECTRONS IN THE INNER BELT IN 1968: FITS TO LAWRENCE LIVERMORE LABORATORY'S MAGNETIC ELECTRON SPECTROMETER DATA OBTAINED ON OGO-5

Abstract

Pitch-angle data were obtained by the Lawrence Livermore Laboratory's magnetic electron spectrometer on OGO-5 during its traversals of the inner radiation belt March 1968 through January 1969. Data from the five

lowest-energy channels, 79-822 keV, were analyzed in terms of time decay J vs invariant latitude at constant L . This document contains the details of fitting the data at $L = 1.3, 1.35, 1.4, 1.5$, etc. to 2.4.

Introduction

Prior to the Starfish high-altitude nuclear detonation on July 9, 1962 our knowledge of the electron fluxes in the inner belt was rather incomplete. Most of our knowledge is contained in studies done by Pizzella *et al.*^{1,2} and Pizzella.³ Unfortunately, these data suffered from problems inherent to this early exploratory period; backgrounds from penetrating, high-energy protons made measurements of electrons inaccurate; calibrations were all too often performed after the fact; and a proper system of coordinates (B, L) had not been developed. The Starfish detonation of July 9, 1962 over Johnson Island injected large amounts of high-energy fission-decay electrons into the radiation belts. Because the decay mean-lives varied rapidly with location (from times on the order of a year in the inner belt to days for $L > 2.5$) the residual from the Starfish injection was confined largely to

the inner belt after 1962. Some of the early Starfish measurements were reported in the collected works introduced by Brown *et al.*⁴

Only one post Starfish experiment really ties the time variations together (1963-1968), the experiment of Beall *et al.*⁵ and Bostrom *et al.*⁶ on satellite 1963-38C. This experiment, consisting of solid-state detectors, provided thresholds at 0.28, 1.2, and 2.4 MeV. In Fig. 1, we show their data obtained for energies > 0.28 MeV.

The most complete prior study of the equatorial fluxes in the inner belt is that of the University of Minnesota group (Pfitzer, Kane, and Winkler),⁷⁻¹⁰ They made measurements on OGO's 1 and 3 covering the time period from September 1964 to December 1967. Their measurements were made with magnetic electron spectrometers (5 channels) covering the

Fig. 1. Inner-belt electrons >0.28 MeV obtained on satellite 1963-38C in the period 1963-1968, after Bostrom *et al.*⁶ The geometrical factor is 2.8×10^{-3} cm²-sr. These data provide a useful overview of the period covering our OGO-5 data and earlier times.

range from 50 to 4000 keV. They organized their data in terms of equatorial pitch angle since they had found that for a given L-shell ($L < 2.4$), the pitch-angle distribution was largely independent of energy. Once the equatorial pitch-angle distribution is obtained one can transform to the equator, and henceforth, talk only about the equatorial fluxes. We adopt this procedure in the present work. However, there are some finite energy-dependent effects, as we shall see.

We have obtained inner-belt data on the OGO-5 satellite covering the time period from launch, March 4, 1968, into early 1969. At launch, OGO-5 had a perigee of a few hundred kilometers. By May 1969, perigee had risen to an

equatorial L-shell of 2.5; hence, our coverage was largely limited to 1968. A fairly quiet period, in terms of inner-belt dynamics, existed up to the times of the major inner-belt injection during the magnetic storms of October 31 and November 1, which has allowed us to consider the electron decay (for $L < 2$) as exponential for this period. A mild storm occurred June 11 that caused injection effects for the higher-energy channels on the higher L-shells; this caused some minor complications in the analysis. The results of our studies and their comparison with other data, pre- and post-Starfish, are reported in detail by West and Buck.¹¹ It is the purpose of this report to document the details of the reduction of the OGO-5 data.

Instrumentation

The instrument is described in detail by West *et al.*¹² Briefly the instrument

consisted of two small magnetic electron spectrometers located on a boom on the

Table 1. Spectrometer characteristics.

Channel	Electron energy range (keV)	Geometry (cm ² -keV-sr)	Acceptance angle (deg) ^a
E ₁	79 ± 23	0.180	7.6
E ₂	158 ± 36	0.277	5.9
E ₃	265 ± 36	0.390	4.7
E ₄	479 ± 52	0.605	3.5
E ₅	822 ± 185	4.43	5.3
E ₆	1530 ± 260	8.57	4.1
E ₇	2820 ± 270	3.88	2.5

^aEffective full width at 50% acceptance in the scan plane.

OGO-5 spacecraft. The energy channels (E₁-E₇) are listed in Table 1 along with their respective geometrical factors. Backgrounds were very carefully evaluated and subtracted from the data. For channels E₃-E₇, individual background detectors were provided; the channels E₁-E₂, shared a common background detector. Typical electron-to-background ratios in the heart of the inner belt were 100/1, 100/1, 100/1, 40/1, 20/1, 2/1, and 1.2/1, respectively.

The experiment was scanned relative to the sun-earth stabilized spacecraft at 3°/sec through excursions of ±115° to obtain pitch-angle information. The experiment scanned so as to view directions perpendicular to the earth-satellite radius vector. An example of the scan-modulated fluxes is shown in Fig. 2. Data were obtained at accumulation times of 4.608, 0.576, and 0.072 sec depending upon the satellite bit rates in use - 1, 8, or 64 kbits/sec. Although the intrinsic resolution of the spectrometer

was less than 10°, the finite data accumulation times caused additional loss of resolution. At the longest accumulation times, the resolution was about 25°. The effect of the finite aperture was to lower the apparent j_⊥ values and raise the values for lower pitch angles (< 80°). In the interest of consistency, data acquired at higher bit rates were averaged to the lower rates (unfortunately the lower-bit-rate data formed too large a body of data to be ignored). Corrections* could have been applied to the data at a later time but the scatter of the data in the affected regions at high latitude did not warrant it.

The data were organized in terms of j_⊥ values vs λ₁, at constant L. The invariant latitude, λ₁, is related to the local magnetic field B by

*The procedure is first to fit the data as j_⊥-vs-λ on a given L-shell. Then, using the fit equation, transform to the local pitch-angle distribution. The resolution is then folded into the pitch-angle distribution and the reduction in j_⊥ gives a good measure of the error in the original j_⊥ measurement.

Fig. 2. Scan modulated E_5 and EB_5 fluxes obtained on a typical pass through the inner belt. The I's indicate the E_5 fluxes (4,6-sec averages) and the O's indicate EB_5 , the background. The pitch angle is given to the right of the plot and was determined using UCLA magnetometer data.

$$\frac{B}{B_0} = \frac{1}{\cos^6 \lambda_I} \sqrt{4 - 3 \cos^2 \lambda_I}.$$

where B_0 is the equatorial field on the local field line. As such, plotting in terms of $j_{\perp}$ -vs- λ_I is equivalent to j -vs- B or j -vs- B/B_0 , or to $j(\theta)$ -vs-equatorial pitch angle. We have chosen to use $j_{\perp}$ -vs- λ_I because of its immediate physical significance. The $j_{\perp}$ values were obtained by interpolating between the peaks in the scan-modulated fluxes such as those of Fig. 2.

The orbital period of OGO-5 was about 2-1/2 days. However, an additional experiment shared our scan platform and at the behest of the experimenters the platform was configured, on alternate orbits inside $4 R_E$, into the "gyro mode"—the experiment looked forward into the plane of the orbit. Usually we ignored these data, since all too often the spectrometer was not measuring $j_{\perp}$ fluxes, and used only the scan data. This then gave us two data points per L-shell, one inbound and one outbound, every 5 days.

Data Fit Procedure

The mirror-point fluxes on each L-shell were approximated in a least-squares sense by a model which contained both time and space dependence. The model assumed that for a given electron energy,

- 1) The fluxes along an L-shell could be represented by a power series in λ_1 at any time;
- 2) The flux along an L-shell exhibited a simple exponential time decay over the time interval studied.

Because the data were collected over a period of time which was of the same order as the observed decay mean-lives of some belt electrons, it was necessary to include explicit time-dependence in the model.

The model used was

$$\hat{y} = \exp \left[-(t - t_0)/b_1 \right] \times b_2 \exp \left[\sum_j b_j \lambda_j^{2(j-2)} \right], \quad j = 3 \text{ to } 10, \quad (1)$$

where $\hat{y}$ = perpendicular electron flux at λ (particles/cm²-keV-sr-s),

t = time of year 1968 (days),

t_0 = initial time, taken as day 69,

λ = scaled invariant latitude, hereinafter called simply "latitude,"

$\lambda = \lambda_j/50^\circ$; λ_1 in degrees.

The b 's are coefficients which were determined by the least-squares process.

b_1 = mean-decay life (days) for the epoch day 69-293, 1968,

b_2 = flux amplitude at $t = t_0$, $\lambda = 0$.

$b_3 - b_{10}$ = latitude coefficients.

A fit was computed for each of the 5 channels over data from each of 13 L-shells. The backward elimination procedure

was used to determine the optimum number of coefficients in each case. First, a 10-coefficient fit was calculated and a test performed on each coefficient to determine whether it was significantly different from zero. The least significant coefficient was discarded, and the fit was recalculated using nine coefficients. This process was continued until the smallest set of coefficients remained that gave a good fit to the data. Details of the fitting procedures and fit statistics and an explanation of printout headings are given in Appendix A.

The simple exponential time-decay of the model is strictly appropriate only for particle populations maintained by steady-state sources and sinks. For time-varying conditions, b_1 represents an average exponential decay life-time for the epoch day 69-293, 1968. The lower L-shells ($L = 1.3-1.9$) were sufficiently quiet during this epoch for the complete model to be independently applied to all channels. It was not possible to determine both time and latitude coefficients concurrently for the higher energy channels (E2-E5) at the higher L-shells ($L = 2.0-2.4$) because of the disturbances caused by the October-November magnetic storms. Also, a mild storm ($Dst = -94\gamma$) occurring on day 163 caused major fluctuations in channels E3-E5, and lesser effects in E2. However, E1 showed essentially the same decay life-time after day 163 as before. The average decay lifetime for the higher energy channels were calculated by setting their latitude coefficients equal to the corresponding coefficients for Channel E1,

and allowing only b_1 and b_2 to be determined for each channel. This "fit over time only" procedure was successful since the shape of the $j_{\perp}$ -vs- $\lambda_{\perp}$ curve is not markedly energy dependent on these higher shells.

In Appendix B, we give plots of (1) the raw $j_{\perp}$ -vs- $\lambda_{\perp}$ data, (2) the $j_{\perp}$ -vs- $\lambda_{\perp}$ data fitted and time-transformed to day 69, (3) the fluxes transformed to the equator and plotted vs time, and (4) tables covering the fit statistics. The symbols used on the plots are:

- * = input data points accepted for fitting, days 69-293,
- / = input data points with $\lambda > \lambda_{\max}$ and not included in fit,
- 0 = input data points at high λ ,
- T = input data points for days greater than 293,
- = calculated fit points.

Note that for the higher L -shells the time-independent flux plot shows a fair degree of scatter of the time-transformed data about the calculated curve. This means that the simple exponential decay used in the E_1 -fit to determine the latitude coefficients is not adequate for the higher-energy channels on the higher

L -shells. The effect of this shows in the standard error of the b_1 and b_2 coefficients. However, the time-plot curve ($j_{\perp}$ equatorial vs days) is properly given subject only to the errors in determining the latitude coefficients in E_1 and the small differences that exist in the j -vs- $\lambda_{\perp}$ curves as a function of energy (like 10% errors). Note that in the time plots, the points plotted as 0's occasionally show a large scatter; by reference to the time-independent flux plots, the 0's can be identified as falling in the high-latitude skirts of the distribution and should be ignored.

To give an overview of the data fits we have overlaid the time-independent flux plots for each energy as given in Figs. 3 (a), (b), (c), (d), and (e) for energy channels E_1 through E_5 . In putting together the overlays, small artifacts resulting from limitation in the fitting were removed. The plots show the general consistency in the analysis procedure. Nevertheless, there are obvious (small) discrepancies in the region of the flux falloffs at high latitudes that symmetry tells us probably are not real. A more complete discussion of these results is given by West and Buck.¹¹

Fig. 3. Plots of j_1 -vs- λ_1 profiles time-transformed to day 69, 1968. These data provide a summation of the data plots given in Appendix B.

Fig. 3. Plots of j_1 -vs- λ_1 profiles time-transformed to day 69, 1968. These data provide a summation of the data plots given in Appendix B (continued).

Fig. 3. Plots of j_1 -vs- λ_1 profiles time-transformed to day 69, 1968. These data provide a summation of the data plots given in Appendix B (continued).

Fig. 3. Plots of j_1 -vs- λ_1 profiles time-transformed to day 69, 1968. These data provide a summation of the data plots given in Appendix B (continued).

Fig. 3. Plots of $j_{\perp}$ -vs- $\lambda_{\perp}$ profiles time-transformed to day 69, 1968. These data provide a summation of the data plots given in Appendix B (continued).

Appendix A.

Details of Fitting Procedures

The following terms are used in the description of the fit and the statistics. For an elementary treatment of the least-squares method, see Draper and Smith.¹³

y_i	=	perpendicular flux measured at time t_i , latitude λ_i .
Y_i	=	$\ln y_i$.
w_i	=	weight to be applied to point i .
$\hat{y}_i$	=	calculated flux from model.
$\hat{Y}$	=	$\ln \hat{y}$.
m	=	number of data points.
n	=	number of coefficients in model.
p	=	number of unknown coefficients in model ($\leq n$).
$\lambda_{\max}$	=	upper latitude limit of fit.

The nonlinear model [Eq. (1)] was linearized by taking the logarithm of both sides, yielding

$$\hat{Y} = -(t - t_0)/b_1 + b_2 + \sum_j b_j \lambda^{2(j-2)}, \quad j = 3, \dots$$

The unknown coefficients b_j were then determined by the usual least-squares criterion that $Q^2 \equiv \sum_{i=1}^m w_i (\hat{Y}_i - Y_i)^2$ be a minimum. In matrix terms, the set of equations to be solved is

$$\underline{Z} = \underline{X} \underline{B},$$

where

$$Z_i = \sqrt{w_i} (Y_i), \quad i = 1, 2, \dots, m,$$

$$X_{i1} = -\sqrt{w_i} (t_i - t_0), \quad i = 1, 2, \dots, m,$$

$$X_{i2} = \sqrt{w_i},$$

$$X_{ij} = \sqrt{w_i} \lambda_i^{2(j-2)}, \quad j = 3, 4, \dots, p,$$

$$B_1 = 1/b_1,$$

$$B_j = b_j \quad j = 2, 3, \dots, p.$$

Formally the solution is given by

$$\underline{B} = \underline{C} \underline{X}^T \underline{Z},$$

where $\underline{C} \equiv (\underline{X}^T \underline{X})^{-1}$ is the covariance matrix. Rather than finding $\underline{B}$ by first calculating $\underline{C}$, which involves the inversion of the ill-conditioned $(\underline{X}^T \underline{X})^{-1}$ matrix, we have used a more accurate routine (von Holdt¹⁴) which minimizes Q^2 by a sequence of Householder reflections.

It was often desirable to adopt non-uniform weights to compensate for the natural fluctuations in counting rate as a function of latitude. In particular, a weighting function was devised which gave less weight to smaller fluxes, thus reducing the effects of the low level, more highly variable high-latitude fluxes on the fit at low latitude. The type of weighting is indicated on the plots in Appendix B.

KWT = 0, $w_i = 1$ (uniform weight),

$$= 2, \begin{cases} w_i = 1 + \log(y_i/y_{\max}) \left[\frac{1 - \text{WMIN}}{\text{WDEC}} \right], & y_{\max} \geq y_i \geq y_{\max} \times 10^{-\text{WDEC}} \\ w_i = \text{WMIN}, & y_i < y_{\max} \times 10^{-\text{WDEC}} \end{cases}$$

WMIN = minimum weight, $0 < \text{WMIN} \leq 1$.

WDEC = number of decades over which w_i decreases from 1 to WMIN.

The following terms are useful in interpreting the fit statistics:

DOF = statistical degrees of freedom,

DOF = $m - p$,

S^2 = mean square residual,

$$S^2 = \frac{1}{\text{DOF}} \sum_{i=1}^m (\hat{Y}_i - Y_i)^2.$$

A small S^2 denotes a good agreement between model and data.

R^2 = the square of the multiple correlation coefficient, $\times 100$. This is the percent of the total variation about the mean which is accounted for by the fit.

$$R^2 = \left[\sum_{i=1}^m (\hat{Y}_i - \bar{Y})^2 / \sum_{i=1}^m (Y_i - \bar{Y})^2 \right] \times 100.$$

The closer R^2 approaches 100% the better the fit.

$\hat{\sigma}_j$ = estimated standard error in coefficient b_j .

$$\hat{\sigma}_j = \sqrt{S^2 (\underline{X}^T \underline{X})^{-1}_{jj}}.$$

$t_j \equiv$ the ratio $b_j/\hat{\sigma}_j$, which follows a t-distribution with DOF degrees of freedom if b_j is not significantly different from zero. The coefficient with the smallest t_j was eliminated in each step of the backwards elimination process described earlier.

Appendix B.

Fits to Inner Belt-Electron Fluxes

For each L-value, a group of four plots is presented for each energy channel. These plots are:

- 1) Measured perpendicular fluxes $j_{\perp}(\lambda_i, t_i)$ vs invariant latitude λ .
- 2) Measured fluxes fitted and transformed in time to $t = t_0$ (day 69). The curve is the fitting function $\hat{y}(\lambda, t)$ [Eq. (1)] evaluated at $t = t_0$, versus λ . The data points are the measured fluxes transformed in time to $t = t_0$ according to

$$j_{\perp}(\lambda_i, t = t_0) = j_{\perp}(\lambda_i, t_i) e^{(t_i - t_0)/b_1}.$$

- 3) Equivalent equatorial fluxes vs time. The curve is $\hat{y}(\lambda, t)$ evaluated at $\lambda = 0$, vs t . The data points are the measured fluxes transformed in λ to the equator according to

$$j_{\perp}(\lambda = 0, t_i) = j_{\perp}(\lambda_i, t_i) \times \hat{y}(\lambda = 0, t_i) / \hat{y}(\lambda_i, t_i).$$

- 4) Fit coefficients and fit statistics.

L SHAZL = 1.30 DETECTOR E1 $t_0 = 69.0$

$$1 + \frac{1}{2} \frac{1}{t_0} \quad t_0 = 69.0$$

H N P DO α β γ δ ϵ ζ η θ ι κ λ μ ν ξ π ρ σ τ υ ϕ χ ψ ω

1 : 1.17050E+02 $\alpha = 2.0E+01$ $\beta = 1.1E+02$
 2 : 3.67697E+01 $\gamma = 2.0E+01$ $\delta = 1.1E+01$
 3 : 1.75087E+01 $\epsilon = 2.0E+01$ $\zeta = 1.1E+01$
 4 : 1.12958E+01 $\eta = 2.0E+01$ $\theta = 1.1E+01$
 5 : 5.24817E+00 $\iota = 2.0E+01$ $\kappa = 1.1E+01$
 6 : 2.59362E+00 $\lambda = 2.0E+01$ $\mu = 1.1E+01$

L. SHELL - 1.30 DETECTION E2 $\epsilon_2 = 88.0$

$\epsilon_1 = 1.5 \times 10^{-1}$ $\epsilon_2 = 1.5 \times 10^{-1}$

H 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 - 1.07178E+02 5.0E+01 2.5E+00
2 - 2.23339E+01 1.1E+00 8.0E+01
3 - 1.07020E+01 1.0E+00 1.0E+00
4 - 3.71400E+01 1.1E+00 1.0E+00
5 - 3.28761E+01 9.0E+00 1.0E+00
6 - 2.33167E+01 2.1E+00 2.0E+00

15-21

$$f_1 = \frac{1}{2} \left(1 + \frac{1}{2} \right) = \frac{3}{4}$$

M	N	B	DO	h ⁺	mg	S ⁺	R ⁺
16	6	6	10	f	26	0	308.02

	1	2	3	4
1	0.000191E+03	2 0.012-03	3 0.012-03	
2	0.000191E+03	1 0.012-03	6 0.012-03	
3	0.000191E+03	1 0.012-03	1 0.012-03	
4	0.000191E+03	1 0.012-03	1 0.012-03	
5	0.000191E+03	1 0.012-03	1 0.012-03	
6	0.000191E+03	1 0.012-03	1 0.012-03	
7	0.000191E+03	1 0.012-03	1 0.012-03

RUN 09-20797 10-10 FINAL COMPLETE LINEAR LAMBDA FIT DAYS
L SKEW = 1.30 DETECTOR E- $\lambda_0 = 69.0$

$$I = I_0 + \sum_{j=1}^N A_j \exp\left(-\frac{(t - t_j)^2}{\tau_j^2}\right)$$

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

L SWELL = 1.30 DETECTOR ES 1.4 69.0

$$\hat{p}_{j+1} = (1 - \frac{1}{2^j}) \hat{p}_j + \frac{1}{2^j} \hat{p}_{j+1}^*, \quad j=1, 2, \dots$$

m	n	p	DOF = m ² - n ²	$\chi^2_{0.05}$	χ^2	P
16	7	7	9	16.0	16.0	100.0

i	b_i	$\hat{b}_i$	$\hat{e}_i$
1	-2.99673E+02	5.374E+01	4.68E+03
2	3.393149E+02	1.052E+00	1.15E+02
6	-5.707910E+05	5.61E+04	9.29E+02
7	1.375825E+07	1.47E+06	9.50E+03
9	1.377624E+06	1.34E+05	1.02E+04
9	5.939536E+09	5.30E+07	1.1E+01
10	-9.230155E+08	7.90E+07	1.17E+01

L. SHELL = 1.35 DETECTOR E1 I₁ = 89.0

M	N	P	OCV	KNT	λ_{max}	S ²	R ²
25	-	7	18	r	28.0	1.56E-01	99%

i	y_i	$\hat{y}_i$	t_i
1	-2.1559872E+02	1.30E+02	1.59E+02
2	9.2208011E+04	1.71E+01	5.95E+01
3	-1.5998079E+01	1.10E+01	1.46E+01
5	3.0915641E+03	4.08E+03	9.54E+01
6	-6.3275034E+04	6.04E+04	1.31E+02
7	2.0090300E+09	2.02E+09	1.44E+02
8	-1.0723633E+09	3.02E+09	1.48E+02

L 9444 = 1.35 DETECTOR E2 $\epsilon_p = 69.0$

$$I = I_0 \left(1 - \frac{1}{2} \frac{I_0}{I_0 + I_1} \right) \frac{I_1}{I_0 + I_1} \approx 0.5 I_1$$

M 15 0 001 10 7 000 0 1 500-01 99.2

1 -1.01672E+02 0.22E+01 2.07E+03
2 0.2360947E+02 1.20E+00 6.17E+01
3 -1.59373E+02 3.83E+00 1.05E+00
4 1.047362E+02 7.3E+03 1.56E+00
5 -1.020113E+05 4.81E+04 0.75E+00
6 3.393277E+05 1.19E+05 0.63E+00
7 0.0668891E+05 0.57E+05 3.5E+00

L. SMALL - 125 DETECTOR ES 1, - 69 0

$$A = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \quad C = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$$

[illegible]

	a	b	c
1	3.76611E+02	3.7E+02	1.0E+02
2	5.112E+01	5.1E+01	6.0E+01
3	5.76060E+02	3.3E+02	2.7E+01
4	8.6106E+01	6.3E+01	4.6E+01
5	3.50675E+03	1.5E+03	3.0E+01
7	3.52735E+06	3.9E+06	3.3E+01
9	1.09935E+07	3.9E+07	3.7E+01
10	2.3381E+07	5.0E+07	4.1E+01

L SHELL = 1.25 DETECTOR EN $I_p = 99.0$

$$I_p = 99.0$$

22 5 5 10 2 10 0 5 100-07 99.0

1	2	3	4	5	6	7	8	9
1	1.62000E+00	2.00E+00	1.00E+00					
2	9.00000E+00	1.00E+00	9.00E+00					
3	1.00000E+00	1.00E+00	1.00E+00					
4	1.00000E+00	1.00E+00	1.00E+00					
5	1.00000E+00	1.00E+00	1.00E+00					
6	1.00000E+00	1.00E+00	1.00E+00					
7	1.00000E+00	1.00E+00	1.00E+00					
8	1.00000E+00	1.00E+00	1.00E+00					
9	1.00000E+00	1.00E+00	1.00E+00

L. SHELL - 1 35 DETECTOR 65 1.0 68.0

 

[illegible][illegible][illegible]

1. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a} \cdot \vec{b}$ 及 $|\vec{a}|$.
 2. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a} \times \vec{b}$.
 3. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a}$ 在 $\vec{b}$ 上的投影.
 4. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a}$ 与 $\vec{b}$ 的夹角.
 5. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a}$ 与 $\vec{b}$ 的叉积.
 6. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a}$ 与 $\vec{b}$ 的混合积.
 7. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a}$ 与 $\vec{b}$ 的标量积.
 8. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a}$ 与 $\vec{b}$ 的向量积.
 9. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a}$ 与 $\vec{b}$ 的混合积.
 10. 已知 $\vec{a} = (1, 2, 3)$, $\vec{b} = (2, 1, 1)$, 求 $\vec{a}$ 与 $\vec{b}$ 的标量积.

TIME

TIME

TIME

L. SHELL = 1.40 DETECTOR E3 1.4 69.0

1. 1.4 69.0 1.4 69.0

1. 1.4 69.0 1.4 69.0

1. 1.4 69.0 1.4 69.0
2. 1.4 69.0 1.4 69.0
3. 1.4 69.0 1.4 69.0
4. 1.4 69.0 1.4 69.0
5. 1.4 69.0 1.4 69.0
6. 1.4 69.0 1.4 69.0
7. 1.4 69.0 1.4 69.0
8. 1.4 69.0 1.4 69.0
9. 1.4 69.0 1.4 69.0
10. 1.4 69.0 1.4 69.0

1. 546.11 = 1.00 DETECTOR E = 1.00 00 0

1. 546.11 = 1.00 DETECTOR E = 1.00 00 0

1. 546.11 = 1.00 DETECTOR E = 1.00 00 0

1. 546.11 = 1.00 DETECTOR E = 1.00 00 0

1. SHELL = 1.50 DETECTOR E1 1.50 = 0.0

$$1.50 = 1.50 \times 1.50 = 2.25$$

1.50 = 1.50 \times 1.50 = 2.25

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50

6. SHEL = 1 50 DETECTOR 62 1, 1 50 0

 
1900	7	M	11	15	8	St. Louis, Mo.	St. Louis, Mo.

1	1	331.27	03	1	071.05	1	1
2	2	154.73	05	1	065.00	2	2
3	1	08.76	00	03	1.79	07	0
4	1	208.99	11	03	1.98	07	0
5	0	0	1	300.00	05	1	05
6	2	291.00	06	08	1.39	05	0
7	1	385.52	08	08	1.91	05	0

1. SPELL = 1.50 DETECTOR ES $I_A = 69.0$

$$f_{\alpha} = \frac{1}{2}(\delta_{\alpha} + i\epsilon_{\alpha})$$

N	N	P	DOB	KMT	FAIR	C ²	D ²
37	7	7	30	6	35	5.4	02

i	b	c	t
1	1.049-610E+03	3 76E+03	4 84E+03
2	1.686-23E+05	1 10E+00	1 17E+02
3	1 03+230E+00	3 95E+00	2 51E+01
5	1 3539763E+03	7 45E+02	1 82E+00
6	1 731775E+04	6 06E+03	1 94E+00
7	3.0723+10E+04	1 42E+02	2 17E+00
10	1 3771356E+05	6 48E+04	2 12E+00

L. SHELL = 1.50 DETECTOR E4 I₀ = 69.0

[illegible]

I	N	P	DO ₂ max ^a	τ_{max}	S ^b	R ^b	
16	0	0	29	c	35	c	1: 62C 0.3 97: 9

	μ	σ	t
1	2.07-0310E+03	2.04E+08	1.29E
2	2.253310E+04	1.44E+10	1.54E+01
5	0.6033363E+05	2.09E+03	4.15E+03
7	1.084007E+25	5.11E+04	1.61E+03
7	1.084007E+06	2.0E+05	2.4E+00
9	7.925703E+06	2.29E+16	1.5E+00
9	1.041811E+07	2.15E+05	3.5E+00
10	1.673071E+07	6.2E+06	1.0E+00

1.50ELL = 1.50 DETECTOR 65 1.50 65 0

1.50ELL = 1.50 DETECTOR 65 1.50 65 0

1.50ELL = 1.50 DETECTOR 65 1.50 65 0

L-SHELL = 1.50 DETECTOR E1 $\lambda_p = 69.0$

11-12 1 11-12 11-12 11-12

H A P DO λ_{p1} λ_{p2} λ_{p3} λ_{p4} λ_{p5} λ_{p6} λ_{p7} λ_{p8} λ_{p9} λ_{p10} λ_{p11} λ_{p12} λ_{p13} λ_{p14} λ_{p15} λ_{p16} λ_{p17} λ_{p18} λ_{p19} λ_{p20} λ_{p21} λ_{p22} λ_{p23} λ_{p24} λ_{p25} λ_{p26} λ_{p27} λ_{p28} λ_{p29} λ_{p30} λ_{p31} λ_{p32} λ_{p33} λ_{p34} λ_{p35} λ_{p36} λ_{p37} λ_{p38} λ_{p39} λ_{p40} λ_{p41} λ_{p42} λ_{p43} λ_{p44} λ_{p45} λ_{p46} λ_{p47} λ_{p48} λ_{p49} λ_{p50} λ_{p51} λ_{p52} λ_{p53} λ_{p54} λ_{p55} λ_{p56} λ_{p57} λ_{p58} λ_{p59} λ_{p60} λ_{p61} λ_{p62} λ_{p63} λ_{p64} λ_{p65} λ_{p66} λ_{p67} λ_{p68} λ_{p69} λ_{p70} λ_{p71} λ_{p72} λ_{p73} λ_{p74} λ_{p75} λ_{p76} λ_{p77} λ_{p78} λ_{p79} λ_{p80} λ_{p81} λ_{p82} λ_{p83} λ_{p84} λ_{p85} λ_{p86} λ_{p87} λ_{p88} λ_{p89} λ_{p90} λ_{p91} λ_{p92} λ_{p93} λ_{p94} λ_{p95} λ_{p96} λ_{p97} λ_{p98} λ_{p99} λ_{p100}

1 1 0000000000 0 0000000000 0 0000000000
2 1 0000000000 0 0000000000 0 0000000000
3 1 0000000000 0 0000000000 0 0000000000
4 1 0000000000 0 0000000000 0 0000000000
5 1 0000000000 0 0000000000 0 0000000000
6 1 0000000000 0 0000000000 0 0000000000
7 1 0000000000 0 0000000000 0 0000000000
8 1 0000000000 0 0000000000 0 0000000000
9 1 0000000000 0 0000000000 0 0000000000
 

L SHEL = 1.80 DETECTOR 12 69.0

11-11-68 21:12

53 11-11-68 21:12 12 69.0

1 0.01578+20 1.01578+20
2 2.870000+20 1.01578+20
3 1.01578+20 1.01578+20
4 0.738000+20 1.01578+20
5 0.000000+20 1.01578+20
6 0.738000+20 1.01578+20

L SHELL = 1.80 DETECTOR EN $t_0 = 69.0$

$$P(t) = \frac{1}{\sigma} \sqrt{\frac{2\pi}{\sigma^2}} e^{-\frac{(t-t_0)^2}{2\sigma^2}}$$

H N P OR KAT t_{max} σ^2 σ
50 0 0 0 0 37 0 2.80E-07 99.7

i	B	F
1	3.725493E+02	1.1E+01
2	2.665950E+02	1.0E+00
3	1.205793E+03	0.75E+02
4	6.700441E+04	1.66E+04
5	6.616876E+05	1.2E+05
6	1.960348E+06	4.4E+05
7	5.211844E+06	1.62E+06
8	2.314704E+06	5.30E+05

L-SHELL = 1.70 DETECTOR E1 $L_0 = 69.0$

 

L-SHELL = 1.70 DETECTOR $\epsilon_p = 89.0$

$$J = \frac{1}{2} \left(\frac{1}{\epsilon_p} + \frac{1}{\epsilon_p} \right) \left(\frac{1}{\epsilon_p} + \frac{1}{\epsilon_p} \right)$$

M H P DO ϵ_p ϵ_p ϵ_p
 65 6 6 90 30 0 8 5 0 99 0

1 5 0.000000E+00 1.0E+00 0.0E+00
 2 3 0.000000E+00 1.0E+00 0.0E+00
 3 5 0.000000E+00 1.0E+00 0.0E+00
 4 7 0.000000E+00 1.0E+00 0.0E+00
 5 9 0.000000E+00 1.0E+00 0.0E+00
 6 1 0.000000E+00 1.0E+00 0.0E+00
 7 3 0.000000E+00 1.0E+00 0.0E+00
 8 5 0.000000E+00 1.0E+00 0.0E+00
 9 7 0.000000E+00 1.0E+00 0.0E+00

L SHELL = 1.70 DETECTOR ES $\epsilon_p = 89.0$

$$I = I_0 \cdot e^{-\mu \cdot L} \cdot e^{-\mu \cdot d} \cdot e^{-\mu \cdot R} \cdot e^{-\mu \cdot S} \cdot e^{-\mu \cdot T} \cdot e^{-\mu \cdot U} \cdot e^{-\mu \cdot V} \cdot e^{-\mu \cdot W} \cdot e^{-\mu \cdot X} \cdot e^{-\mu \cdot Y} \cdot e^{-\mu \cdot Z}$$

H N P DO KAT μ_{max} μ^2 μ^3
63 8 8 55 7 38 0 1.5E-02 93.9

1 4 2400000E+02 5.1E+01 8.22E+02
2 1.137360E+05 1.0E+00 2.05E+02
3 1.000000E+05 1.0E+00 7.00E+01
4 2.430000E+05 7.21E+01 3.17E+02
5 1.420000E+05 6.88E+00 7.08E+01
6 3.750000E+05 1.63E+02 2.30E+02
7 3.360000E+05 2.63E+02 2.01E+02
8 2.660000E+05 1.60E+02 1.79E+02

L. SHELL + 1 TO DETECTOR EN $t_{d0} = 69.0$

$$t_{d0} = \frac{1}{\rho} \left(\frac{1}{\rho} + \frac{1}{\rho} \right) \quad t_{d0} = \frac{1}{\rho} \left(\frac{1}{\rho} + \frac{1}{\rho} \right)$$

H A P DO $t_{d0} = 69.0$ $t_{d0} = 69.0$

63 8 8 55 2 33 2 2 548-07 99 7

1 2 0958561-02 2 171-02 154-02
2 2 0958561-02 2 171-02 154-02
3 2 0958561-02 2 171-02 154-02
4 2 0958561-02 2 171-02 154-02
5 2 0958561-02 2 171-02 154-02
6 2 0958561-02 2 171-02 154-02
7 2 0958561-02 2 171-02 154-02
8 2 0958561-02 2 171-02 154-02
9 2 0958561-02 2 171-02 154-02

L SHELL = 1 TO DETECTOR 85 $t_0 = 89.0$

$$N(t) = N_0 e^{-\lambda t} + N_{\text{bg}}$$

67 7 1 55 10 0 3 24 0 99 5

i	h	p	pc	pc	pc	pc	pc	pc	
1	3	15	99	12	+27	-18	+21	7.4E+00	
2	1	10	14	32	+25	-27	+00	-1.1E+00	
3	1	19	10	47	+52	-2	+02	+01	-7.4E+00
4	5	10	99	14	+29	-2	+10	+10	7.4E+00
5	10	75	20	32	+35	-7	+00	+03	6.8E+00
6	2	80	10	32	+04	-1	+00	+04	6.7E+00
7	2	80	10	32	+04	-1	+00	+04	6.7E+00

L SHELL = 1.80 DETECTOR C1 $\epsilon_p = 89.0$

$$A_{11} = A_{12} = A_{21} = A_{22} = 1.0$$

H A P DO KUL ϵ_{max} ϵ^P ϵ^E
70 8 8 62 38 0 5 47 02 89.5

1 4.569557E+02 1.02E+04 1.59E+03
2 1.087999E+02 1.11E+03 878E+02
3 1.507791E+02 8.86E+01 371E+02
4 1.576788E+03 8.93E+02 771E+02
5 1.156189E+03 7.90E+01 661E+02
6 1.188959E+04 8.03E+03 692E+02
7 1.108691E+04 8.14E+04 771E+02
10 3.353610E+04 1.91E+04 1.77E+02

L SHELL = 1.00 DETECTOR EE $\gamma_p = 69.0$

$$I_{p,0} = I_{p,1} + I_{p,2} + I_{p,3} + I_{p,4} + I_{p,5} + I_{p,6} + I_{p,7} + I_{p,8} + I_{p,9} + I_{p,10} + I_{p,11} + I_{p,12} + I_{p,13} + I_{p,14} + I_{p,15} + I_{p,16} + I_{p,17} + I_{p,18} + I_{p,19} + I_{p,20} + I_{p,21} + I_{p,22} + I_{p,23} + I_{p,24} + I_{p,25} + I_{p,26} + I_{p,27} + I_{p,28} + I_{p,29} + I_{p,30} + I_{p,31} + I_{p,32} + I_{p,33} + I_{p,34} + I_{p,35} + I_{p,36} + I_{p,37} + I_{p,38} + I_{p,39} + I_{p,40} + I_{p,41} + I_{p,42} + I_{p,43} + I_{p,44} + I_{p,45} + I_{p,46} + I_{p,47} + I_{p,48} + I_{p,49} + I_{p,50} + I_{p,51} + I_{p,52} + I_{p,53} + I_{p,54} + I_{p,55} + I_{p,56} + I_{p,57} + I_{p,58} + I_{p,59} + I_{p,60} + I_{p,61} + I_{p,62} + I_{p,63} + I_{p,64} + I_{p,65} + I_{p,66} + I_{p,67} + I_{p,68} + I_{p,69} + I_{p,70} + I_{p,71} + I_{p,72} + I_{p,73} + I_{p,74} + I_{p,75} + I_{p,76} + I_{p,77} + I_{p,78} + I_{p,79} + I_{p,80} + I_{p,81} + I_{p,82} + I_{p,83} + I_{p,84} + I_{p,85} + I_{p,86} + I_{p,87} + I_{p,88} + I_{p,89} + I_{p,90} + I_{p,91} + I_{p,92} + I_{p,93} + I_{p,94} + I_{p,95} + I_{p,96} + I_{p,97} + I_{p,98} + I_{p,99}$$

TO U B EP γ 10.0 2.00E+02 99.0

1 5.30715E+02 6.20E+01 1.31E+00
2 3.20000E+02 1.00E+00 2.50E+02
3 3.50000E+03 3.10E+02 7.00E+00
4 3.00000E+04 6.00E+03 6.50E+00
5 6.00000E+05 2.00E+04 6.30E+00
6 6.67761E+05 7.51E+04 6.21E+03
7 7.11111E+05 1.11E+05 6.20E+03
8 3.30000E+05 6.30E+04 6.20E+03

L SHELL = 1.80 DETECTOR E3 $t_0 = 69.0$

$$A = \frac{1 - t_0^2}{t_0^2} \quad Z_1 = \frac{2t_0}{1 - t_0^2} \quad Z_2 = \frac{2t_0}{1 - t_0^2}$$

M N → DO NOT t_{max} S^2 A^2
70 0 0 62 30 0 1.86E-07 99.6

1 3.4373950E+02 3.21E-01 1.07E-01
2 1.3588000E+05 1.00E+00 6.50E+01
3 -2.0177000E+15 0.00E+00 7.70E+00
4 2.5014670E+04 4.29E+03 6.60E+00
5 -1.0039900E+09 4.15E+04 6.50E+00
6 4.4429700E+09 6.94E+04 6.50E+00
7 0.0050000E+05 5.10E+04 6.50E+00
8 0.0050000E+05 5.10E+04 6.50E+00

L. SHELL = 1.00 DETECTOR EN $t_0 = 69.0$

$$I_1 = I_2 \cdot \frac{1 - \frac{1}{2} \frac{L}{L_0}}{1 - \frac{1}{2} \frac{L}{L_0} \cdot \frac{1}{2} \frac{L}{L_0}}$$

H N P DOH L_0 L_1 L_2 L_3 L_4 L_5 L_6 L_7

1 1.000000E+00 1.15E+01 1.00E+01
2 2.000000E+00 1.25E+01 1.00E+01
3 3.000000E+00 1.35E+01 1.00E+01
4 4.000000E+00 1.45E+01 1.00E+01
5 5.000000E+00 1.55E+01 1.00E+01
6 6.000000E+00 1.65E+01 1.00E+01
7 7.000000E+00 1.75E+01 1.00E+01
8 8.000000E+00 1.85E+01 1.00E+01
9 9.000000E+00 1.95E+01 1.00E+01
10 1.000000E+01 2.05E+01 1.00E+01

L-SHELL = 1.80 DETECTOR 5 $t_{\text{eff}} = 69.0$

$$\frac{1}{\sigma^2} = \frac{1}{\sigma^2} + \frac{1}{\sigma^2} \quad \frac{2\sigma^2}{\sigma^2} = \frac{2\sigma^2}{\sigma^2}$$

M	N	P	DOF	RMSE	χ^2_{red}	S^2	σ^2
70	9	8	52	38.0	0.12-02	99.1	
1	2	51	4958	0.02	2.57E-01	9.7E+00	
2	8	45	4973	0.02	1.07E-03	9.8E+00	
5	12	3321	7500	0.03	4.22E+02	6.16E+00	
6	3	3661	7332	0.04	6.27E+03	9.7E+00	
7	1	8397	2986	0.05	3.80E+04	5.17E+00	
8	5	3831	8918	0.05	1.00E+05	9.05E+00	
9	6	3800	8976	0.05	1.24E+05	6.17E+00	
10	3	3602	8718	0.05	7.09E+04	9.21E+00

L SHELL = 1.80 DETECTOR E1 $\lambda_p = 89.0$

$$f = \frac{1}{2} \left(\frac{1}{\lambda_p} + \frac{1}{\lambda_s} \right) \quad \lambda_s = 89.0$$

H H P (DE) λ_{max} λ_{min} λ_{avg} λ_{std}

1	0.0095164E+02	0.74E+01	0.11E+01	0.11E+01
2	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00
3	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00
4	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00
5	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00
6	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00
7	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00
8	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00
9	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00
10	0.0000000E+00	0.00E+00	0.00E+00	0.00E+00

L SHELL = 1.90 DETECTOR E3 I₀ = 65.0

$$\sum_{j=1}^n (1 - \frac{1}{2^j})^2 \leq \sum_{j=1}^n \frac{1}{2^j} = 1, \quad \text{for } n \geq 1.$$

M	N	P	DO	KM ²	Area	S ²	R ²
70	7	7	65	6	18.0	3.62	99.4

	1	2	3	4
1	2.0429	0.233+02	3.051+21	9.33E+00
2	1.2129	-0.000+05	1.03E+01	1.44E+02
3	-6.45E-03	0.000+00	0.50E+01	7.52E+02
7	2.01E-03	-7E+03	1.33E+03	1.52E+05
8	-1.331051	3E+04	8.10E+03	1.8E+02
9	3.01287E	0E+00	1.67E+03	1.40E+02
10	-2.32E-03	33E+04	1.16E+04	2.00E+00

L SHELL = 1.00 DETECTOR EN = 1.00 69.0

$$J_1 = \frac{1}{2} \left(\frac{1}{L_1} + \frac{1}{L_2} \right) \ln \frac{1}{L_1} \ln \frac{1}{L_2}$$

M = 10 B = 9 P = 0.00 A = 1.00 L = 1.00 S = 1.00 D = 1.00

1 1.5079010E+02 9.00E+03 1.60E+01
2 1.7755070E+02 1.1E+00 1.4E+01
3 1.9009010E+02 1.40E+02 1.1E+01
4 2.0009010E+02 2.10E+03 1.0E+01
5 2.0509010E+02 1.00E+02 1.0E+01
6 2.0809010E+02 8.00E+02 1.1E+01
7 2.1009010E+02 1.00E+02 1.0E+01
8 2.1109010E+02 2.0E+03 1.0E+01
9 2.1209010E+02 1.0E+02 1.0E+01
10 2.1309010E+02 1.0E+02 1.0E+01

L SHELL = 2.55 DETECTOR E1 $\epsilon_0 = 60.0$

FIT OVER TIME ONLY

$$E_1 = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) \epsilon_0 \left(\frac{1}{2} + \frac{1}{2} \right) \dots$$

N M P DO MAX ϵ_0 S² R²
60 8 2 67 0 11.0 6.25E-02 22.0

1 4.90357E+02 1.10E+00 4.90E+02
2 4.77917E+05 1.05E+00 2.25E+02
3 1.00799E+02 0. 0.
4 0.0712992E+02 0. 0.
5 -2.05107E+02 0. 0.
6 3.07039E+03 0. 0.
7 -1.000351E+03 0. 0.
8 -0.000000E+00 0. 0.

L SHELL = 2.00 DETECTOR E2 $E_2 = 88.0$

FIX EVERY TIME ONLY

$$E_2 = \frac{11 \cdot 12 \cdot 13}{2 \cdot 3 \cdot 4} \cdot \frac{E_1}{E_2} \cdot \frac{1}{1 + 1.2 \cdot 10^{-4}}$$

P N P DOO AMT E_2 E_1 E_2

66 5 2 57 2 -1.0 7.624-02 19 6

1 - 0.733000E+02 1 0.0E+00 1 0.0E+00
2 5 0.703000E+02 1 0.0E+00 2 0.0E+00
3 1 1.977000E+02 0 0 0
4 6 0.712000E+02 0 0 0
5 2 0.9100750E+03 0 0 0
6 3 0.712000E+03 0 0 0
7 1 6.953518E+03 0 0 0
8 1 6.953518E+03 0 0 0
10 0 2.00E+03 0 0 0

L SHELL = 2.00 DETECTOR C₀ L₀ = 69.0

FIT OVER TIME ONLY

$$J = \frac{1 - \exp(-\lambda_0 L^*)}{\lambda_0 L^*} \quad \lambda_0 = 1.1 \times 10^{-10} \quad \lambda_0 = 1.1 \times 10^{-10}$$

N	H	P	DP	RMF	L ₀	S ²	R ²
69	8	2	67	0	41.0	1.95E-01	10.4

I	A ₀	A ₁	A ₂	A ₃
1	3.257788E+02	0.41E+01	3.09E+03	
2	3.106891E+05	1.10E+06	1.98E+07	
3	1.107789E+02	0.	0	
4	0.071099E+02	0.	0	
5	2.051078E+02	0.	0	
6	3.070998E+03	0.	0	
7	1.000351E+03	0.	0	
8	-0.260495E+02	0.	0

L (SHELL) = 2.00 DETECTOR 4N $t_0 = 00.0$

FIT OVER TIME ONE Y

$$f_{\text{fit}} = \frac{10^{-L/t_1}}{t_1} \quad \frac{E}{t_1} = \frac{211.21}{1.123, 4, \dots}$$

H N P DD OUT t_{exp} E^2 P^2
60 0 2 07 0 41.0 5.78E+02 77.2

i	B	E^2	1
1	1.5084811E+03	9.09E+02	1.51E+01
2	8.9522779E+03	1.00E+03	1.00E+02
3	1.1679802E+02	0.	0.
5	8.8711889E+04	0.	0.
6	2.8810878E+03	0.	0.
7	3.3703359E+03	0.	0.
8	1.8953510E+03	0.	0.
10	6.4904957E+02	0.	0.

L-SHELL = 2.00 DETECTOR ES $\mu_0 = 69.6$

FIT OVER TIME ONLY

$$J = \sum_{i=1}^N \frac{1}{2} \left(\frac{1}{\mu_i} + \frac{1}{\mu_i^2} \right) \quad \text{for } i=1, 2, \dots, N$$

M N P DO OUT μ_{max} μ^* μ^*
69 6 2 67 0 41.0 1.20E-01 69.0

i	μ_i	$\frac{1}{2} \left(\frac{1}{\mu_i} + \frac{1}{\mu_i^2} \right)$	$\frac{1}{\mu_i}$	$\frac{1}{\mu_i^2}$
1	1.396315E+02	1.20E-01	1.00E-01	1.00E-01
2	1.310210E+02	1.00E-01	1.00E-01	1.00E-01
3	1.007000E+02	0	0	0
4	8.671299E+01	0	0	0
5	7.091007E+01	0	0	0
6	5.970399E+01	0	0	0
7	5.000000E+01	0	0	0
8	4.000000E+01	0	0	0
9	3.000000E+01	0	0	0
10	2.000000E+01	0	0	0

L=2.10 DETECTOR E1 $\lambda_p = 69.0$

FIT OVER TIME ONLY

$$y = \frac{1}{1 + e^{-x}}$$

11 5 2 69 0 40.3 3.21E 30 27 9

1 4 6.84E+02 7 1E+01 0 5E+02
2 5 1.02E+05 1 5E+00 5 5E+00
3 2 2.94E+02 0 0
4 2 2.74E+02 0 0
5 2 7.93E+02 0 0
6 1 1.93E+02 0 0
7 5 5.10E+02 0 0
8 1 1.70E+02 0 0
9 1 1.05E+02 0 0
10 1 1.07E+02 0 0

L (WELL) = 2.10 DETECTOR EF $t_{\text{eff}} = 69.0$

FIT OVER TIME ONLY

$$J_1 = \frac{1}{2} \left(1 - \frac{1}{2} \right) \left(\frac{1}{2} \right)^{L_1} \left(\frac{1}{2} \right)^{DAYS}$$

M	N	P	DO	CHI2	χ^2_{red}	χ^2	R^2
71	9	2	69	0	42	5	50E-02

i	B_i	χ^2	R^2
1	4.16318E-02	0	37E-01
2	3.55968E-05	0	21E-02
3	2.219E-02E-02	0	0
4	2.74379E-03	0	0
5	1.01993E-04	0	0
6	1.01993E-04	0	0
7	5.34107E-04	0	0
8	1.02678E-05	0	0
9	1.02678E-05	0	0
10	1.02678E-05	0	0

L-SHELL = 2.10 DETECTOR E3 $t_0 = 60.6$

FIT OVER TIME ONLY

$$J = \frac{1}{1 + \frac{1}{2} \left(\frac{A - A_0}{\Delta A} \right)^2} \quad \text{IN } A \quad \Delta A = 2.1$$

H N P DOX KAT t_{max} S^2 R^2
71 9 2 69 C 40.3 1.63E-01 22.2

1 3.0151875E+02 6 70E+01 4 1E+00
2 1.0309602E+03 1 10E+00 1 1E+00
3 2.0000000E+04 0 0
4 2.7000000E+03 0 0
5 2.7000000E+03 0 0
6 1.0000000E+01 0 0
7 5.0000000E+01 0 0
8 1.0000000E+01 0 0
9 1.0000000E+01 0 0
10 1.0000000E+01 0 0

L. SHELL = 2.10 DETECTOR CH. 1.0 00.0

FIT OVER TIME ONLY

$$y = 11.137x - 15.47$$

71 0 2 60 0 12 5 1.13E-01 1.1 5

i	x	y	1
1	1.000000E+02	1.13E+01	0.12E+00
2	5.583512E+01	1.00E+00	0.90E+00
3	2.000000E+00	0	0
4	2.000000E+00	0	0
5	2.000000E+00	0	0
6	2.000000E+00	0	0
7	2.000000E+00	0	0
8	1.200000E+00	0	0
9	1.000000E+00	0	0
10	1.000000E+00	0	0

L SHELL = 2.10 DETECTOR ES $t_0 = 89.8$

FIT OVER TIME ONLY

$211-21$
 $11-12/15$ $11-12/15$

H H P DO KMT μ_{fit} σ^2 μ^2
 11 8 2 66 0 -2.5 2.00E-01 55.1

1 1 30183.7E+02 1 48E-01 9.22E-03
 2 5 299508E+01 1 11E+00 3.87E-01
 3 12 2494008E+00 1 0 0
 4 2 16375.1E+03 1 0 0
 5 1 6197387E+04 0 0 0
 6 5 9.59E+0755E+04 0 0 0
 7 1 0567623E+05 0 0 0
 8 1 0876055E+05 0 0 0
 10 14 4078664E+04 0 0 0

L. SHELL = P 20 DETECTOR E1 $t_0 = 09.0$
 P11 OVER TIME ONLY

	N	n	P	DD	sd	std	S
68	5	2	68	2	42.0	1.1E-02	
1	5	2	68	2	42.0	1.1E-02	
2	4	2	68	2	42.0	1.1E-02	
3	4	2	68	2	42.0	1.1E-02	
4	3	2	68	2	42.0	1.1E-02	
5	3	2	68	2	42.0	1.1E-02

L-SHELL = 2.20 DETECTOR ID 100000

FIT OVER TIME ONLY

2...2...

1...1... 2...2... 3...3...

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

L SHELL = 2.20 DETECTOR E3
FIT OVER TIME ONLY

$$Y = Y_0 + Y_1 X_1 + Y_2 X_2 + Y_3 X_3 + Y_4 X_4 + Y_5 X_5 + Y_6 X_6 + Y_7 X_7 + Y_8 X_8 + Y_9 X_9$$

M N P DO MIN² S² D²
68 5 2 66 -2.0 1.00 0.176 0

1 5.273555E+02 6 10E-11 1.00E+02
2 6.094101E+04 10E-11 1.00E+02
3 1.706711E+00 0 0
4 3.300737E+01 0 0
5 0.000000E+00 0 0

L SHELL = 2.00 DETECTOR EN $t_0 = 60.0$

FIT OVER TIME ONLY

$$I_1 = \frac{1}{2} I_0 \quad I_2 = \frac{1}{2} I_0 \quad I_3 = \frac{1}{2} I_0$$

H N P DO VMT μ_{max} S^2 μ^2
60 5 2 86 0 -2.0 3.3AC-01 19.7

1 2.281106E+00 0 0.0E+00 0 0.0E+00
2 1.927309E+03 1 -1.0E+00 0 0.0E+00
3 -1.788717E+00 0 0 0
4 3.507373E+01 0 0 0
5 8.98095E-01 0 0 0

C. SMELL = 2.29 DETECTOR E5 I₀ = 69.0

FIT OVER TIME ONLY

217-21

N	H	P	DO	KH	T _{max}	S ²	R ²
68	5	2	66	0	42.0	4.65E-01	23.6

60	5	2	66	0	42.0	4.65E-01	21.8
----	---	---	----	---	------	----------	------

i	b _i	a _i	t
1	1.7178277E+02	3.80E+01	4.02E+02
2	1.2261453E+01	1.17E+20	1.57E+01
3	-4.7867175E+00	0	0.
8	3.9281373E+01	0.	0.
9	-6.8898743E+01	0.	0

2	1.2261450E+01	1	17E+20	1.57E+01
3	3.267126E+00	0		2

8 3 928737X*01 0.

9 -6 00307474-01 0.

L SHELL = 2.30 DETECTOR CI $\epsilon_p = 88.0$

FIT OVER TIME ONLY

$$I_{\text{fit}} = I_0 + I_1 \cdot \frac{1 - e^{-\lambda t}}{\lambda}$$

N N P DO shift λ_{fit} χ^2 ρ^2

71 7 2 60 2 +5.0 5.24E-07 29.5

i	λ_i	I_{0i}	I_{1i}	χ^2_i	ρ^2_i
1	4.4708340E+02	0.54E+01	5.24E+00		
2	3.7980000E+05	1.25E+00	2.54E+02		
3	5.5801200E+01	0.	0.		
4	5.0383431E+02	0.	0.		
5	7.1802000E+02	0.	0.		
6	5.7951200E+02	0.	0.		
7	4.5110000E+02	0.	0.

L SHELL = 2.30 DETECTOR ES $L_p = 68.0$

FIT OVER TIME ONLY

$$J = \frac{1}{1 + \frac{L}{L_p}} \left(\frac{1}{1 + \frac{L}{L_p}} \right)^{1/2}$$

M N P QP RM σ_{RM} σ^2 μ^2

7 7 2 69 0 45.0 2.57E-01 15.4

1 2.0095901E+02 6.00E+01 3.35E+00
2 3.55287187E+04 1.12E+00 5.44E+01
3 5.6511219E+01 0 0
4 2.0303881E+02 0 0
5 7.8827048E+02 0 0
6 9.795180E+02 0 0
7 4.4118205E+02 0 0

FILE OVER TIME ONLY

$$\hat{g}_n = (1 - \frac{1}{n})^k, \quad \hat{g}_n = \frac{k!}{(k-1)!} \cdot \frac{(k-1)!}{(k-2)!} \cdots \frac{1!}{0!} = k!$$

M	N	P	DOF	Kurt	χ^2_{MS}	S^2	P^2
71	7	2	89	0	45.0	7.63E-01	0.8

β	β_1	β_2	β_3
1	2.3811057E+02	9.22E+01	2.59E+00
2	7.7477670E+02	1.21E+00	3.45E+01
4	-8.6601239E+01	0.	0.
5	3.0363831E+02	0.	0.
7	7.8262959E+02	0.	0.
8	9.7991291E+02	0.	0.
9	-4.6116959E+02	0.	0.

L SHELL = 2.30 DETECTOR IS $I_0 = 69.0$

FIT OVER TIME ONLY

$$I = I_0 e^{-\lambda t} + I_1 e^{-\lambda_1 t} + I_2 e^{-\lambda_2 t}$$

N	N	P	DN	TIME	I_0	I_1	I_2
71	7	2	69	0	45.0	1.7E+02	0.5

I	B	C	D	E
1	7.89E+03	1E+02	1.2E+03	6.13E+01
2	2.21E+04	1E+02	1.2E+03	3.4E+02
3	-5.00E+03	1E+01	0	0
4	3.00E+03	1E+02	0	0
5	-1.00E+04	1E+02	0	0
6	9.79E+03	1E+02	0	0
7	-4.01E+03	1E+02	0	0

L SHELL = 2.40 DETECTOR E1 $t_0 = 89.0$

FIT OVER TIME ONLY

$$J_1 = \frac{1}{2} \left(\frac{J_1}{J_0} \right)^{1/2} \ln \left(\frac{J_1}{J_0} \right) + \frac{1}{2} \ln \left(\frac{J_1}{J_0} \right)$$

N	N	P	OD	HALF	t_{max}	S^2	χ^2
10	5	2	50	0	-9.0	3.00E+02	19.8

1	2	3	4	5	6	7	8	9	10
1	1.000000E+00	0.33E+01	6.70E+01						
2	2.000000E+00	1.00E+00	2.00E+00						
3	3.000000E+00	0.00	0.00						
4	4.000000E+00	0.00	0.00						
5	5.000000E+00	0.00	0.00						
6	6.000000E+00	0.00	0.00						
7	7.000000E+00	0.00	0.00						
8	8.000000E+00	0.00	0.00						
9	9.000000E+00	0.00	0.00						
10	1.000000E+01	0.00	0.00

L SHELL = 2.ND DETECTOR 85 1.0 80.0

FIT OVER TIME ONLY

$$L_2 = 1.0 L_1 + 0.0 \quad R^2 = 0.99$$

TO 8 2 80 1.0 0.0 1.0 0.0 0.0 0.0

1 3.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 2 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 3 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 4 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 5 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 6 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 7 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 8 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 9 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0
 10 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0

L=2, N=0 DETECTOR IS $J_1 = 49.0$

FIT OVER TIME ONLY

$J_1 = 1.11 \times 10^{-1}$ $J_2 = 1.11 \times 10^{-1}$

$J_1 = 1.11 \times 10^{-1}$ $J_2 = 1.11 \times 10^{-1}$

 

L SWELL - P 40 DETECTOR 19 1, 4 04 3

919 OVER TIME 2007

[illegible]

	 

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