ANL-7611

F. W. Thalgott

ANL-7611

Argonne National Laboratory

ANALYSIS OF COMPTON CONTINUUM MEASUREMENTS

by

R. Gold and I. K. Olson

The facilities of Argonne National Laboratory are owned by the United States Government. Under the terms of a contract (W-31-109-Eng-38) between the U. S. Atomic Energy Commission, Argonne Universities Association and The University of Chicago, the University employs the staff and operates the Laboratory in accordance with policies and programs formulated, approved and reviewed by the Association.

MEMBERS OF ARGONNE UNIVERSITIES ASSOCIATION

The University of Arizona
Carnegie-Mellon University
Case Western Reserve University
The University of Chicago
University of Cincinnati
Illinois Institute of Technology
University of Illinois
Indiana University
Iowa State University
The University of Iowa
Kansas State University
The University of Kansas
Loyola University
Marquette University
Michigan State University
The University of Michigan
University of Minnesota
University of Missouri
Northwestern University
University of Notre Dame
The Ohio State University
Ohio University
The Pennsylvania State University
Purdue University
Saint Louis University
Southern Illinois University
The University of Texas at Austin
Washington University
Wayne State University
The University of Wisconsin

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
Springfield, Virginia 22151
Price: Printed Copy $3.00; Microfiche $0.65

ANL-7611
Mathematics and
Computers

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue
Argonne, Illinois 60439

ANALYSIS OF COMPTON CONTINUUM MEASUREMENTS

by

R. Gold and I. K. Olson

Applied Physics Division

February 1970

TABLE OF CONTENTS

	Page
ABSTRACT	7
I. INTRODUCTION	7
II. COMPSCAT	9
III. FEND	17
IV. GABCO	20
V. DOSE	23
VI. COMPLOT	26
APPENDIXES:	
A. COMPSCAT Program Listing (IBM-360)	28
B. FEND Program Listing (IBM-360)	33
C. GABCO Program Listing (DDP-24)	39
D. DOSE Program Listing (IBM-360)	45
E. COMPLOT Program Listing (DDP-24)	51
F. Sample Measurement Data	54
REFERENCES	84

LIST OF FIGURES

No.	Title	Page
1.	Block-diagram Form of the Relationship among the Computer Programs COMPSCAT, FEND, GABCO, DOSE, and COMPLOT	8
2.	General Flow Chart for the COMPSCAT Program	12
3.	The Raw Data or W-vector Observed in the ATSR Depleted-uranium Snell Block (A = 0.0167 MeV)	13
4.	The Compton Continuum, $W_C(E)$, or the WADJ-vector for the Sample Measurement	14
5.	The Flow Chart of the Subroutine ITERAT	15
6.	The Flow Chart of the Subroutine BOUND	16
7.	The Initial Gamma Continuum for the Sample Measurement Obtained from the Treatment of the WADJ-vector in COMPSCAT	17
8.	The General Flow Chart for the FEND Program	18
9.	The Vectors WADJ, V, and WP = WADJ - V Obtained from FEND for the Sample Measurement	20
10.	The Corrected Gamma Continuum for the Sample Measurement Obtained from Processing the WP-vector in COMPSCAT	20
11.	The General Flow Chart for the GABCO Program	21
12.	Comparison between a Theoretical Response Calculated in GABCO and Experimental Data for ^{137}Cs (ε_0 = 1.29)	22
13.	Comparison between Theory (GABCO) and Experiment for ^{28}Al (ε_0 = 3.48)	22
14.	The Energy-dependent (diagonal) G-matrix or G(E) Function Obtained from GABCO Analysis of ^{65}Zn, ^{52}V, ^{28}Al, and ^{24}Na Response Data	23
15.	The General Flow Chart for the DOSE Code	25
16.	The Energy-dependent (diagonal) P-matrix or P(ε_0) Function Obtained from Monoenergetic Response Function Measurements with the Depicted Radioisotopes	25
17.	The General Flow Chart for the COMPLOT Code	27

LIST OF TABLES

No.	Title	Page
I.	Card Input for COMPSCAT	13
II.	Option Chart for COMPSCAT	17
III.	Card Input for FEND	18
IV.	Card Input for GABCO	21
V.	Card Input for DOSE	25
VI.	Card Input for COMPLOT	26

ANALYSIS OF COMPTON CONTINUUM MEASUREMENTS

by

R. Gold and I. K. Olson

ABSTRACT

Five computer programs: COMPSCAT, FEND, GABCO, DOSE, and COMPLOT, have been developed and used for the analysis and subsequent reduction of measured energy distributions of Compton recoil electrons to continuous gamma spectra. In addition to detailed descriptions of these computer programs, the relationship amongst these codes is stressed. The manner in which these programs function is illustrated by tracing a sample measurement through a complete cycle of the data-reduction process.

I. INTRODUCTION

The development of high-resolution (lithium-drifted) solid-state detectors for gamma-ray measurements is a significant experimental advance which has been widely applied in nuclear spectroscopy. Work with these detectors has focused on precise definition of nuclear energy levels by accurate gamma-ray-energy measurements (of the photopeak response). In such investigations, only a limited number of transitions can be successfully analyzed because of the dominance of the Compton response in these detectors. Hence, these detectors cannot be used in the same manner (i.e., as photopeak detectors) for measurement of continuous gamma-ray spectra.

Although the dominance of the Compton recoil continuum in these detectors is regarded as an unwanted and troublesome complication in nuclear (energy-level) spectroscopic studies, it is precisely this response which can be exploited for continuous gamma-ray spectroscopy.[1-3] Indeed, the Compton distribution and the continuous gamma-ray spectrum are directly related by a well-defined integral equation. Consequently, the continuous gamma-ray spectrum can be determined from an unfolding calculation[4] in terms of the measured electron-recoil spectrum.

Compton-continuum measurements have been carried out with solid-state silicon detectors. In these silicon detectors, the Compton response dominates by more than two orders of magnitude in the broad energy region from 100 keV up to a few MeV. Consequently, all other

photon-interaction modes can be neglected and the response kernel (or response matrix) can be calculated from first principles, provided that corrections have been introduced for effects of finite detector size. It is of interest, therefore, to compare the present treatment with the work of Silk and Wright,[5-7] who have independently recognized the merit of Compton-continuum measurements.

Five computer programs: COMPSCAT, FEND, GABCO, DOSE, and COMPLOT, have been developed for the analysis and reduction of electron-recoil spectra. The relationship among these programs is depicted in Fig. 1. The COMPSCAT program constructs the Compton response function (C-matrix) and uses iterative unfolding to obtain the gamma continuum from the experimental electron-recoil data. In addition, COMPSCAT provides the random error induced in the unfolded gamma spectrum. Under this option, an error matrix is constructed and iterative unfolding is again employed to obtain error estimates.

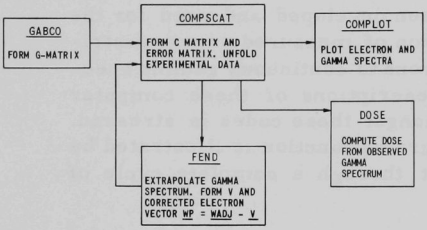

Fig. 1. Block-diagram Form of the Relationship among the Computer Programs COMPSCAT, FEND, GABCO, DOSE, and COMPLOT. ANL Neg. No. 113-3190 Rev. 1.

Correction of the gamma spectrum for the contribution due to gamma rays beyond the high-energy truncation point of the response matrix is carried out in the program FEND. The FEND program extrapolates the gamma continuum furnished by COMPSCAT into this high-energy region and thereby furnishes the corrected electron vector, WP, which can again be processed by COMPSCAT.

Program GABCO provides for correction of finite-size effects. Measurements of silicon detector response due to monoenergetic gamma rays are used in GABCO to form the G-matrix; a matrix which describes the effects of finite detector size. The G-matrix is used, in turn, in COMPSCAT to correct the observed recoil-electron spectrum for finite-size effects.

Program DOSE applies an additional finite-size correction, the P-matrix, to gamma spectra produced by COMPSCAT. The corrected gamma continuum is then used in DOSE to calculate the (infinite medium) physical dose.

It is essential that electron and gamma spectra be available for examination and comparison at crucial stages of the data-reduction process. These requirements are satisfied by the plotting program COMPLOT. The COMPLOT program uses output from COMPSCAT to plot the desired electron or gamma spectrum.

Sections II to VI contain detailed descriptions of the computer codes COMPSCAT, FEND, GABCO, DOSE, and COMPLOT, respectively. To further illustrate the manner in which these codes function, treatment of a sample measurement is followed through all programs, and results of the data treatment for this case are given. Actual listings of these five computer programs can be found in Appendixes A to E. Appendix F contains a listing of input and output data for the sample measurement.

II. COMPSCAT

The integral equation which relates the scalar photon flux, $\Phi(\varepsilon_0)$, to the Compton-electron continuum, $W_c(E)$, is given by[2,3]

$$W_c(E) = N_e \int \frac{d\sigma_c}{dE}(E, \varepsilon_0)\Phi(\varepsilon_0)\, d\varepsilon_0, \tag{1}$$

where $d\sigma_c/dE$ is the Compton-scattering cross section (per free electron), and N_e is the total number of electrons in the detector. The desired Compton cross section can be obtained directly from the Klein-Nishina formula in the form[8-10]

$$\frac{d\sigma_c}{dE}(E, \varepsilon_0) = \frac{\pi r_0^2}{(\varepsilon_0 - E)^2}\left\{\left(\frac{E}{\varepsilon_0^2}\right)^2 + 2\left(\frac{\varepsilon_0 - E}{\varepsilon_0}\right)^2 + \frac{\varepsilon_0 - E}{\varepsilon_0^3}\left[(E-1)^2 - 1\right]\right\}, \tag{2}$$

where $r_0 = e^2/mc^2$ is the classical electron radius, with e the electron charge, m the electron mass, and c the velocity of light in vacuum. In addition, the initial photon energy, ε_0, and the electron energy, E, in the final state are expressed in units of the electron rest mass: $mc^2 = 0.510976$ MeV.

In the numerical treatment of this type of integral equation,[4] it is customary to introduce the matrix approximation

$$\underline{W}_c = C\underline{\Phi}, \tag{3}$$

where $\underline{W}_c$ and $\underline{\Phi}$ are vector representations of the continuous electron and photon spectra, respectively. The Compton response matrix, C, is defined in terms of the response kernel in the usual manner as

$$C_{ij} = N_e \int_{(\varepsilon_0)_j}^{(\varepsilon_0)_{j+1}} \frac{d\sigma_c}{dE}(E_i, \varepsilon_0)\, d\varepsilon_0; \qquad i,j = 1,2\ldots m. \tag{4}$$

Using constraints imposed by the Compton-scattering process, one can obtain a particularly advantageous representation of the Compton response matrix C. More specifically, given a recoil electron of energy E,

the permissible range of initial photon energies is bounded from below by[8-10]

$$(\varepsilon_0)_C = (E/2)[1 + (1 + 2/E)^{1/2}]. \tag{5}$$

Thus, for this given recoil energy E, the response kernel, $d\sigma_C/dE$, must vanish for all $\varepsilon_0 \leq (\varepsilon_0)_C$. This condition can be used to obtain an (upper) triangular representation for the C matrix. The advantages which accrue from iterative unfolding of triangular-type response matrices are well established.[4]

Let A be the energy mesh spacing (in MeV units) used for the measurement of the electron-recoil distribution. Then, the mid-bin electron energy E_i, corresponding to the component $(W_C)_i$, is given by

$$E_i = A \cdot i/mc^2; \quad i = 1,2...m. \tag{6}$$

The lower and upper energy values bounding the ith bin are therefore

$$E_i^\ell = E_i - \frac{A}{2mc^2} \tag{7a}$$

and

$$E_i^u = E_i + \frac{A}{2mc^2}, \tag{7b}$$

respectively. This experimentally dictated mesh in E-space can be used in Eq. 5 to generate a corresponding decomposition of ε_0-space. One finds

$$(\varepsilon_0)_i = \frac{E_i}{2}\left[1 + \left(1 + \frac{2}{E_i}\right)^{1/2}\right], \tag{8a}$$

$$(\varepsilon_0)_i^\ell = \frac{E_i^\ell}{2}\left[1 + \left(1 + \frac{2}{E_i^\ell}\right)^{1/2}\right], \tag{8b}$$

and

$$(\varepsilon_0)_i^u = \frac{E_i^u}{2}\left[1 + \left(1 + \frac{2}{E_i^u}\right)^{1/2}\right]. \tag{8c}$$

For this specific decomposition of E-space and ε_0-space, the C matrix possesses the triangular form

$$C_{ij} = N_e \int_{(\varepsilon_0)_j^\ell}^{(\varepsilon_0)_j^u} \frac{d\sigma_c}{dE}(E_i, \varepsilon_0)\, d\varepsilon_0; \quad i \le j, \tag{9a}$$

and

$$C_{ij} = 0; \quad i > j. \tag{9b}$$

Pulse-Shape Discrimination (PSD) is used to reject defective events due to electrons that enter or leave the finite sensitive volume of the detector. Under PSD operation, finite size effects can be treated by introducing two diagonal correction matrices, G and P, into Eq. 3. This modification of Eq. 3 can be written in the form

$$\underline{W}_c = C\underline{\Phi}_p, \tag{10a}$$

where $\underline{W}_c$ is related to the raw electron spectral data $\underline{W}$ by

$$\underline{W} = G\underline{W}_c, \tag{10b}$$

and $\underline{\Phi}_p$ is the P-matrix modified gamma spectrum given by

$$\underline{\Phi}_p = P\underline{\Phi}. \tag{10c}$$

Further details on the origin and nature of the G and P matrices can be found in Sects. IV and V, respectively, as well as in Ref. 3.

COMPSCAT generates Compton response matrices as defined in Eqs. 4-9. The general flow chart for the COMPSCAT code is displayed in Fig. 2. Table I lists the card input, formats, and definitions of the variables and constants used in COMPSCAT.

After reading in the problem identification and input parameters, the G-matrix is formed with the fitted least-squares coefficients obtained from the GABCO code (see Sect. IV). The initial vector for the ITERAT subroutine is also formed at this point. Various types of input spectra can be used in COMPSCAT under the option KIND as indicated in Table I. Raw experimental data are treated under the KIND = 1 option. Figure 3 displays the raw data for the sample measurement. This electron spectrum was obtained in a low-power irradiation of the Argonne Thermal Source Reactor (ATSR) depleted-uranium Snell block.

The raw-data $\underline{W}$ are then adjusted to produce the Compton continuum, $W_c(E)$, which is designated by the $\underline{WADJ}$-vector in COMPSCAT. One has

$$(\underline{WADJ})_i = (F/G_{ii})(\underline{W})_i; \quad i = 1, 2 \ldots m, \tag{11a}$$

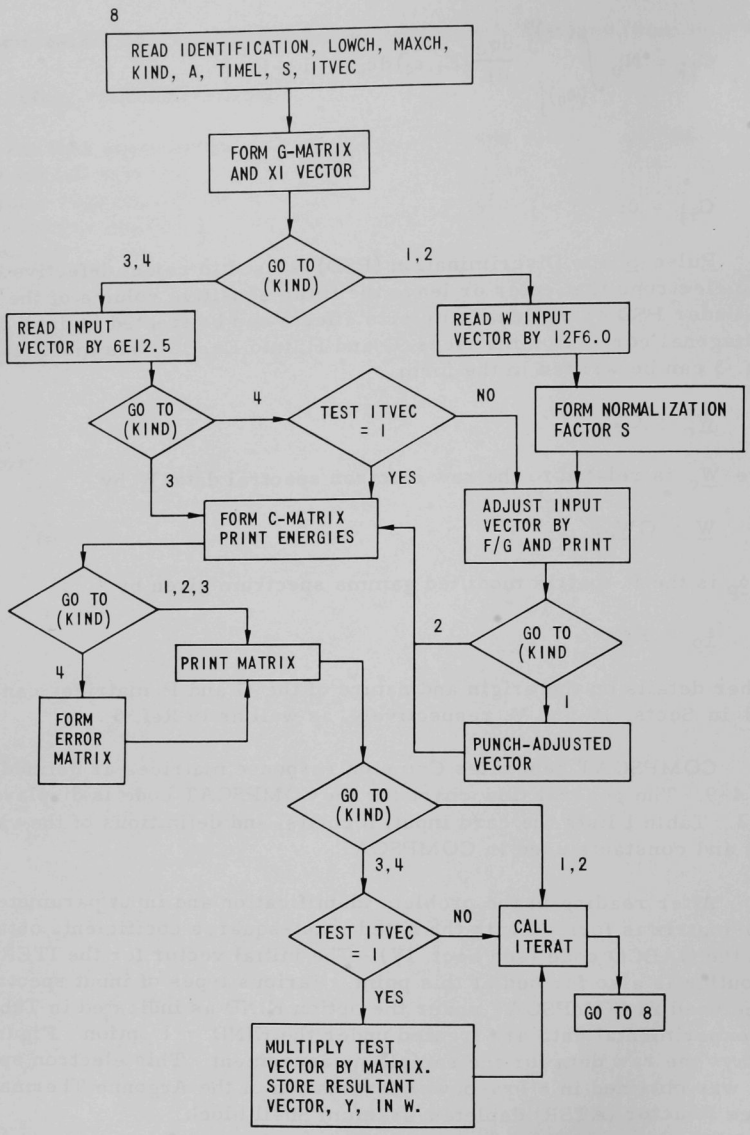

Fig. 2. General Flow Chart for the COMPSCAT Program. ANL Neg. No. 113-3193 Rev. 1.

TABLE I. Card Input for COMPSCAT

Card Type	Format	Description
(1)	2X17A4,A2	Problem identification. (Col. 3-Col. 72)
(2)	I3	LOWCH = Lowest channel used in array of experimental data.
	I3	MAXCH = Highest channel used (≤128).
	I3	KIND = 1, 2, 3, or 4 1 = Raw experimental data. Punch adjusted data. 2 = Same as 1 except no punchout of adjusted data. 3 = WP-vector input, or test vector. 4 = WADJ-vector input for error vector unfolding, or test vector.
	F9.2	A = MeV/channel (experimental mesh). (Col. 10-Col. 18)
	E12.5	TIMEL = Live time of the detector (in sec). (Col. 19-Col. 30)
	E12.5	S = Normalization factor. Input for error vector only. (Col. 31-Col. 42)
	I6	ITVEC = 1 if test vector is input for processing. (Col. 48)
(3)a	12F6.0	Raw data input. (KIND = 1 or 2.)
(3)b	6E12.5	WP-vector, WADJ-vector for error calculation, or test vector. (KIND = 3 or 4.)
(4)	4I6	ITER = Number of iterations to run. NOUT = Which multiple of iterations should be printed. NERR = Option used for calculating arresting criterion. 1 is used for KIND = 1 or 2. 2 is used for constant relative error. 3 is used for KIND = 3 or 4. NU = Number of iterations to be punched.
(5)	10I6	Not needed if NU = 0. Otherwise is (N1(I),I = 1,NU).
(6)	F12.0	ERROR. Used under NERR = 2 as the constant relative error factor. Not needed unless NERR = 2.
(7)	6F12.0	Used under KIND = 3, to input WADJ-vector for formation of arresting bound when WP-vector is unfolded.

NOTE: Card types 1 through 4 used on all problems. Problems may be stacked.

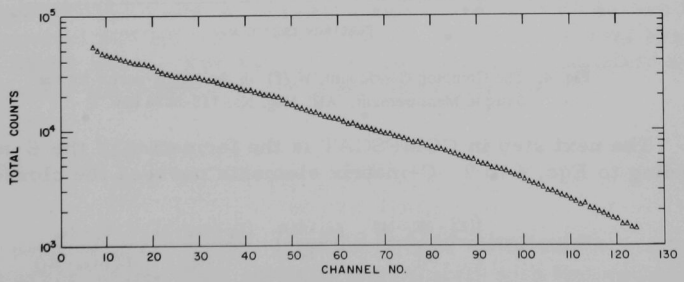

Fig. 3. The Raw Data or W-vector Observed in the ATSR Depleted-uranium Snell Block (A = 0.0167 MeV). ANL Neg. No. 113-2666.

where G_{ii} are the elements of the diagonal G-matrix and consequently provide the necessary correction for finite-size effects in the silicon detector.[3] The scalar F is introduced to provide WADJ with the proper units and normalization. Actually,

$$F = Smc^2/(AT), \tag{11b}$$

where T is the live time in seconds of the counting experiment and S is a normalization factor chosen to conserve the total number of observed electrons. The Compton continuum or WADJ-vector for the sample measurement is shown in Fig. 4, as produced from the COMPLOT program (see Sect. V). The W-vector, WADJ-vector, and diagonal G-matrix are printed out and the WADJ-vector is punched out for later use. An example of this printout is given in Appendix F for the sample measurement.

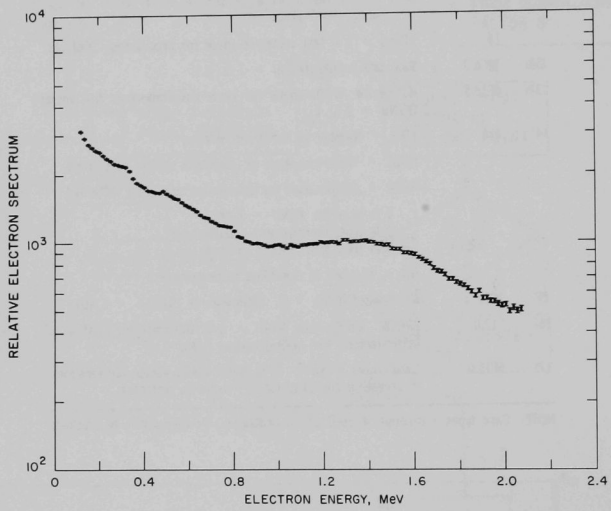

Fig. 4. The Compton Continuum, $W_c(E)$, or the WADJ-vector for the Sample Measurement. ANL Neg. No. 113-3034 Rev. 1.

The next step in COMPSCAT is the formation of the C-matrix according to Eqs. 4 to 9. C-matrix elements possess the closed form*

$$C_{ij} = N_e \pi r_0^2 \left\{ \frac{(E_i^2 - 2E_i - 4)}{E_i^3} \ln\left(\frac{\varepsilon_0 - E_i}{\varepsilon_0}\right) + \frac{(E_i - 2\varepsilon_0 - 2)}{2\varepsilon_0^2} + \frac{E_i - 2\varepsilon_0}{E_i^2 \varepsilon_0 (\varepsilon_0 - E_i)} - \frac{1}{3\varepsilon_0^3} - \frac{(2\varepsilon_0 + E_i + 2E_i\varepsilon_0)}{\varepsilon_0^2 E_i^2} \right\} \Bigg|_{(\varepsilon_0)_j^\ell}^{(\varepsilon_0)_j^u} . \tag{12}$$

*In the COMPSCAT code the constants N_e and $\pi r_0^2 = 2.49452 \times 10^{-25}$ cm^2 are denoted by TOTEL and PIROSQ, respectively.

The C-matrix is generated by rows from low energy to high energy and is stored for use by the ITERAT subroutine. Upper and lower corners of the C-matrix generated for the sample measurement (A = 0.0167 MeV) are displayed in Appendix F.

Iterative unfolding is performed in the subroutine ITERAT. This subroutine was obtained by modifying the general unfolding program ITERATE for the specific requirements of Compton recoil gamma-ray spectroscopy. A complete theoretical description of iterative unfolding together with the development and use of the ITERATE code has already been given.[4] Figure 5 displays the flow chart of subroutine ITERAT. The vector to be unfolded is stored in WNU and the iteration process is initialized. The residual vector

$$\underline{R}^{(n)} = \underline{WNU} - \underline{W}^{(n)} \qquad (13)$$

is used to form an arresting criterion for the iteration process. When the norm of the residual vector

$$N\left[\underline{R}^{(n)}\right] = \sum_{i=1}^{m} \left[W_i^{(n)} - WNU_i\right]^2 \qquad (14)$$

decreases below a prescribed bound, the iteration process is automatically terminated.

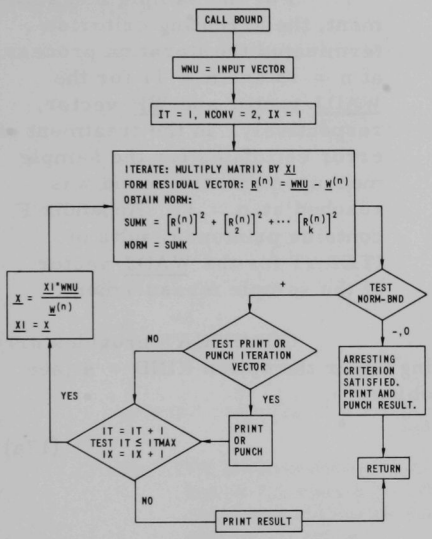

Fig. 5. The Flow Chart of the Subroutine ITERAT. ANL Neg. No. 113-3188.

Appropriate bounds for all vectors unfolded by ITERAT are formed in the subroutine BOUND, as shown in Fig. 6. Different vectors are treated under the NERR option. For NERR = 1, a 2σ-bound (two standard deviations) is generated for the WADJ-vector. In this case, one has

$$BND = 4F \sum_{i=1}^{m} \frac{(WADJ)_i}{G_{ii}} . \qquad (15)$$

Input of a relative error factor, ERROR, is used under NERR = 2 to provide a relative error bound. This option is used mainly with test vectors. Under NERR = 3, a 2σ-bound is formed for either the error matrix problem (KIND = 4) or for the corrected electron vector, $\underline{WP}$ (KIND = 3). The bound for the error matrix case is given by

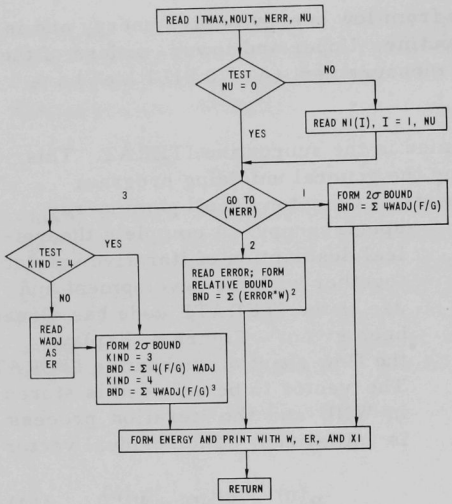

Fig. 6. The Flow Chart of the Subroutine BOUND. ANL Neg. No. 113-3192 Rev. 1.

$$\mathrm{BND} = 4F^3 \sum_{i=1}^{m} \frac{(\mathrm{WADJ})_i}{(G_{ii})^3}, \qquad (16)$$

whereas the bound for the $\underline{\mathrm{WP}}$-vector is identical with that of Eq. 15.

For the sample measurement, the arresting criterion terminated the iteration process at n = 13 and n = 11 for the $\underline{\mathrm{WADJ}}$-vector and $\underline{\mathrm{WP}}$-vector, respectively. In the treatment of error estimates for the sample measurement, the bound was reached at n = 11. Appendix F contains printout results of ITERAT for the $\underline{\mathrm{WADJ}}$-vector of the sample measurement.

COMPSCAT provides error estimates induced by iterative unfolding under the option KIND = 4 (see Fig. 2). The independent unfolding problem[11]

$$\underline{Y} = B\underline{S_\Phi}, \qquad (17a)$$

with

$$\underline{Y} = F \cdot G^{-1} \cdot \underline{\mathrm{WADJ}} \qquad (17b)$$

is generated, where the elements of $\underline{S_\Phi}$ are the variances of the corresponding components of the $\underline{\Phi}_p$ gamma spectrum and the elements B_{ij} of B are simply

$$B_{ij} = (C_{ij})^2; \quad i,j = 1,2...m. \qquad (17c)$$

The error-matrix problem is also treated by iterative unfolding in COMPSCAT as described above. As an example, the error estimates depicted in the initial gamma continuum of Fig. 7 were obtained from COMPSCAT with the WADJ-vector of the sample measurement. This spectrum was plotted directly by the COMPLOT code (see Sect. V).

A summary of the possible modes of data treatment available in COMPSCAT is presented in Table II. The specific form of data treatment depends upon the type of input spectrum (option KIND) and the arresting criterion employed (option NERR) for termination of the iterative unfolding process. For example, under KIND = 1, 2, or 4, the input spectrum is

transformed to a Compton continuum. Hence, the option KIND = 3 is available when this transformation is unnecessary, i.e., for either a test vector or a WP-vector (FEND output). In the NERR = 2 option, a constant relative error factor (ERROR) must be available from input to form the arresting bound. For NERR = 1 or 3, Poisson statistics are used to determine the appropriate bound for the given input spectrum.

A complete listing of the COMPSCAT program (IBM-360) is given in Appendix A.

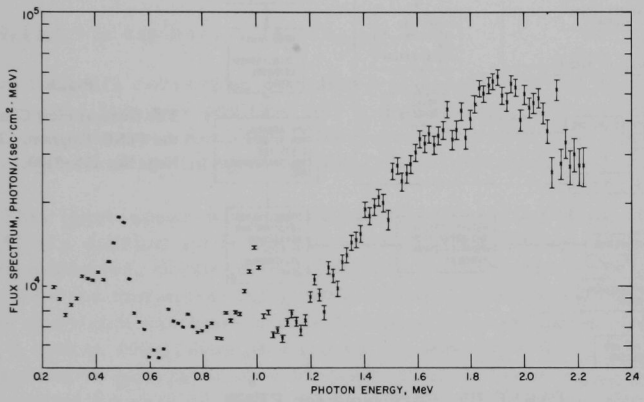

Fig. 7. The Initial Gamma Continuum for the Sample Measurement Obtained from the Treatment of the WADJ-vector in COMPSCAT. Depicted experimental error has also been obtained from the COMPSCAT code. ANL Neg. No. 116-127.

TABLE II. Option Chart for COMPSCAT

	NERR		
KIND	2	3	1
1	Relative error case	Does not apply	Raw data (WADJ punchout)
2	Relative error case	Does not apply	Raw data (No WADJ punchout)
3	Relative error case	WP-vector	Does not apply
4	Relative error case	Error vector	Does not apply

III. FEND

In Compton recoil gamma-ray spectroscopy, the Compton response matrix is necessarily of finite size and hence possesses a high-energy truncation point, ϵ_{max}. The gamma continuum normally extends into the region $\epsilon_0 > \epsilon_{max}$, and therefore high-energy gamma rays in this region will contribute to the observed electron continuum. Corrections for these

far-end effects are carried out in the program FEND. The general flow chart describing FEND can be found in Fig. 8. Card input requirements for FEND as well as the definitions of the various constants and variables used in FEND are described in Table III.

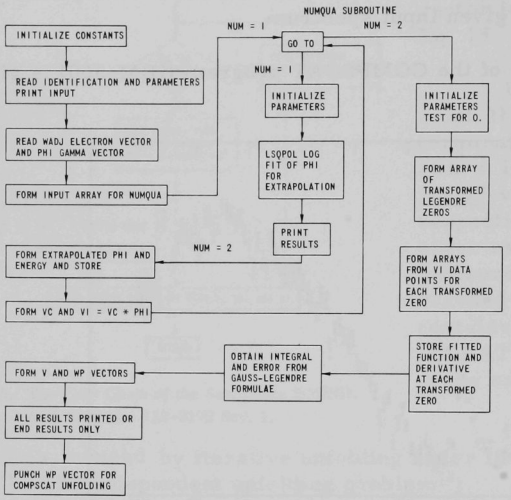

Fig. 8

The General Flow Chart for the FEND Program. ANL Neg. No. 113-3189.

TABLE III. Card Input for FEND

Card Type	Format	Description
(1)	18A4	Problem identification. Need a 1 in column 1 to start printout at top of page.
(2)	I3	LOWCH = Lowest channel of input vectors.
	I3	MAXCH = Highest channel of input vectors.
	I6	LOWFIT = Starting channel for extrapolation fit. (MAXCH-LOWFIT ≤ 24.)
	E12.3	AM = MeV/channel (experimental mesh).
	E12.3	TIMEL = Live time of detector (in sec).
	I1	NPRIN = 1 for printout of end results only. Otherwise complete printout occurs.
(3)	6E12.0	WADJ(J), J = LOWCH, MAXCH (electron vector).
(4)	6E12.0	PHI(J), J = LOWCH, MAXCH (initial gamma spectrum).

NOTE: Problems may be stacked.

Let the vector $\underline{V}$ denote the contribution due to high-energy gamma rays in the region $\epsilon_0 > \epsilon_{max}$. One has, from Eqs. 1 and 10,

$$V_i = V(E_i) = \int_{\epsilon_{max}}^{\infty} C(E_i, \epsilon_0)\Phi_p(\epsilon_0)\, d\epsilon_0; \quad i = 1,2...m. \tag{18}$$

To obtain estimates of the components $\{V_i\}$, the initial $\underline{\Phi}_p$ gamma continuum obtained with the WADJ-vector is extrapolated into the region $\epsilon_0 > \epsilon_{max}$, and this extrapolation is used in Eq. 18. This extrapolation utilizes the last fifteen to twenty points of the initial $\underline{\Phi}_p$ gamma continuum. A first-order least-squares fit of the logarithm of the initial gamma spectrum is actually used. Consequently, this extrapolation possesses the form

$$\Phi_p(\epsilon_0) = a \exp\{b\epsilon_0\}; \quad (\epsilon_0 > \epsilon_{max}). \tag{19}$$

It follows that this correction procedure is possible if and only if the least-squares coefficient a is positive and b is negative. The coefficient b must be negative to insure a monotonically decreasing spectrum that will guarantee convergence of the integral defining the components of $\underline{V}$ (viz., Eq. 18).

This least-squares extrapolation and the actual integration (required in Eq. 18) are carried out in the subroutine NUMQUA, as shown in Fig. 8. This subroutine was obtained by modifying the program NUMQUAD, a general code for numerical integration using Gauss-Legendre quadrature.[12] After the spectrum extrapolation is performed in NUMQUA under the NUM = 1 option, integration is carried out under the NUM = 2 option. The integrand is generated on a 61-point mesh between ϵ_{max} and an upper bound of roughly 20 MeV. The number of Legendre zeros used in the Gauss-Legendre quadrature is fixed at 15. Having formed the V-vector, the corrected electron spectrum

$$\underline{WP} = \underline{WADJ} - \underline{V} \tag{20}$$

is punched out for use in COMPSCAT.

Printout obtained from FEND with the sample measurement is given in Appendix F, and these results are also displayed in Fig. 9. The complete $\underline{WP}$-vector is not normally used in COMPSCAT, since beyond a certain (electron) energy the correction becomes too large to be reliable. The condition $(\underline{WP})_i \cong V_i$ can be used to define the termination point. For the sample measurement, this termination point occurs at $E \cong 1.9$ MeV (cf. Fig. 9).

Figure 10 presents the corrected gamma continuum and error estimates obtained by processing the (terminated) $\underline{WP}$-vector through COMPSCAT. This corrected spectrum differs from the original continuum (see Fig. 7) by at most a few percent. The corrected spectrum, as displayed in Fig. 10, is plotted directly by the COMPLOT code.

A complete listing of the FEND code (IBM-360) can be found in Appendix B.

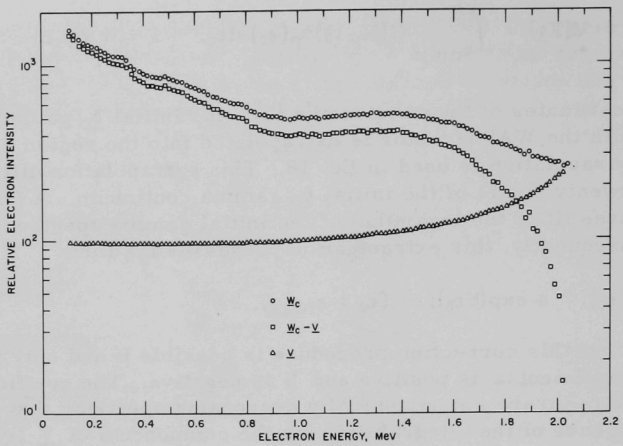

Fig. 9. The Vectors WADJ, V, and WP = WADJ - V Obtained from FEND for the Sample Measurement. ANL Neg. No. 113-2671.

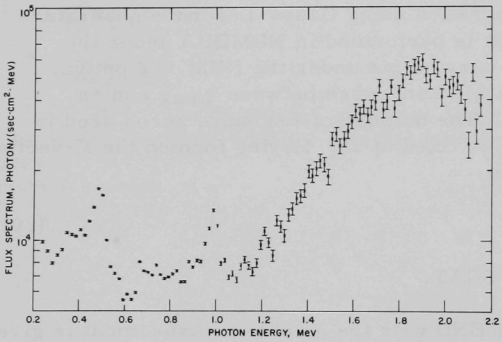

Fig. 10

The Corrected Gamma Continuum for the Sample Measurement Obtained from Processing the WP-vector in COMPSCAT. ANL Neg. No. 116-128.

IV. GABCO

A general formulation of spectral distortion due to finite detector size has already been given.[13] In Compton recoil gamma-ray spectroscopy, distortion of electron spectra due to effects of finite-size can be described by the matrix equation[3]

$$\underline{W} = G\underline{W}_c, \tag{21}$$

where $\underline{W}$ is the experimental data and $\underline{W}_c$ is the desired Compton continuum. The behavior of the G-matrix can be investigated with monoenergetic gamma rays from radioisotopic sources. For such

a case, the $\underline{W}_c$-vector is an elementary Compton continuum (obtained from Eq. 2) broadened by the Gaussian response of the silicon detector. The program GABCO (DDP-24) calculates Gaussian broadened Compton continua of this elementary type and compares these theoretical distributions with experimental results. The general flow chart describing GABCO is presented in Fig. 11, and Table IV contains a description of the card input, constants, and variables used in this code.

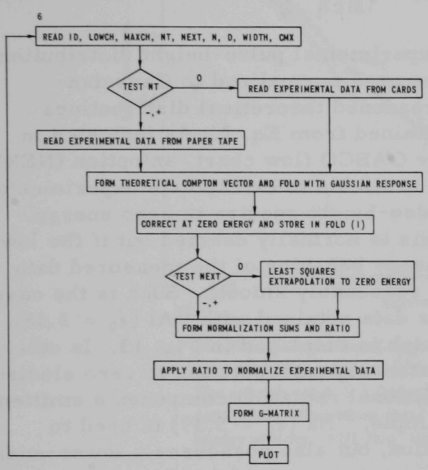

Fig. 11. The General Flow Chart for the GABCO Program. ANL Neg. No. 113-3186.

With a modest amount of cooling ($\cong$ -20°C) to reduce detector noise, it can be demonstrated that electronic pulse shape discrimination (PSD) effectively rejects wall-interaction events in lithium-drifted silicon detectors.[3] To this end, Fig. 12 compares a GABCO distribution with experimental data for ^{137}Cs (ε_0 = 1.29) obtained with PSD at -23°C. The demonstrated agreement between theory and experiment not only implies that wall events are properly rejected, it also reveals that G-matrix corrections need not be considered below a certain electron energy. Moreover, the fact that wall events are properly rejected also implies that the G-matrix is diagonal. Under these conditions, the G-matrix can be determined empirically with measurements from monoenergetic gamma-emitting radioisotopes.

TABLE IV. Card Input for GABCO

Card Type	Format	Description
(1)	X17A4,A3	Isotope identification.
(2)	I3	LOWCH = Lowest channel used.
	I3	MAXCH = Highest channel used.
	I3	NT = Data input option. 0 = card input; 1 = paper tape input (ASCII).
	I3	NEXT = Extrapolation option; 0 = extrapolation to zero; 1 = no extrapolation used.
	I3	N = Number of points used for fitted extrapolation coefficients. Blank if NEXT = 1.
	F9.3	D = MeV/channel (experimental mesh).
	F12.5	WIDTH = Experimental width (FWHM) in MeV units.
	F6.4	CMX = Maximum Compton electron recoil energy for the given radioisotope.
(3)a	12F6.0	Used when experimental data are on cards.
(3)b	F6.0,7F8.0	Used when experimental data are on paper tape.

NOTE: Problems may be stacked.

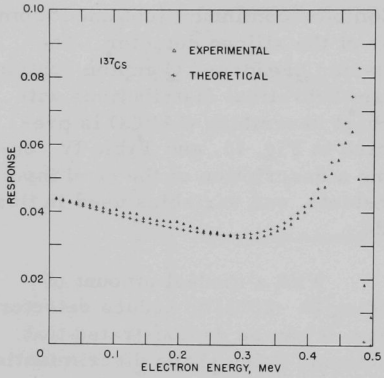

Fig. 12. Comparison between a Theoretical Response Calculated in GABCO and Experimental Data for ^{137}Cs (ε_0 = 1.29). ANL Neg. No. 113-2661.

Diagonal G-matrix elements are calculated in GABCO using the reduced diagonal form of Eq. 21. One has

$$G_{ii} = \frac{(\underline{W})_i}{(\underline{W}_c)_i}; \quad i = 1,2...m. \tag{22}$$

Experimental pulse-height distributions are area normalized to Gaussian-broadened theoretical distributions obtained from Eq. 2. As indicated in the GABCO flow chart, an option (NEXT) is available to extrapolate experimental pulse-height spectra to zero energy. This is normally carried out if the low-energy behavior of the measured data is reasonably smooth. Such is the case for data obtained with ^{28}Al (ε_0 = 3.48), which is displayed in Fig. 13. In other instances, extrapolation to zero electron energy may not be possible due to additional radiation components emitted from the given radionuclide. For example, ^{24}Na (ε_0 = 5.39) is used to obtain high-energy G-matrix information, but also possesses a lower-energy gamma transition (ε_0 = 2.68) which prevents meaningful extrapolation to zero energy.

The agreement between theory and experiment for ^{137}Cs (see Fig. 12) should be contrasted with the systematic deviation due to finite-size effects that is evident for ^{28}Al (see Fig. 13). For both these comparisons, theory and experiment have been normalized to equal area over the Compton continuum. Observation of this systematic deviation, which obviously grows with increasing energy, permits an evaluation of the diagonal G-matrix by application of Eq. 22.

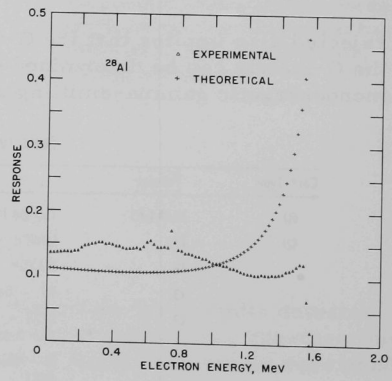

Fig. 13. Comparison between Theory (GABCO) and Experiment for ^{28}Al (ε_0 = 3.48). ANL Neg. No. 113-2657.

The diagonal G-matrix or the G(E) function obtained from GABCO analysis of ^{65}Zn, ^{52}V, ^{28}Al, and ^{24}Na data is shown in Fig. 14. The smooth curve is a fifth-order least-squares fit of this G-matrix data. For the present silicon detector, the low-energy boundary condition below which no finite-size correction is necessary for electron spectra, i.e., $G_{ii} \rightarrow 1$, occurs in the neighborhood of 500 keV.

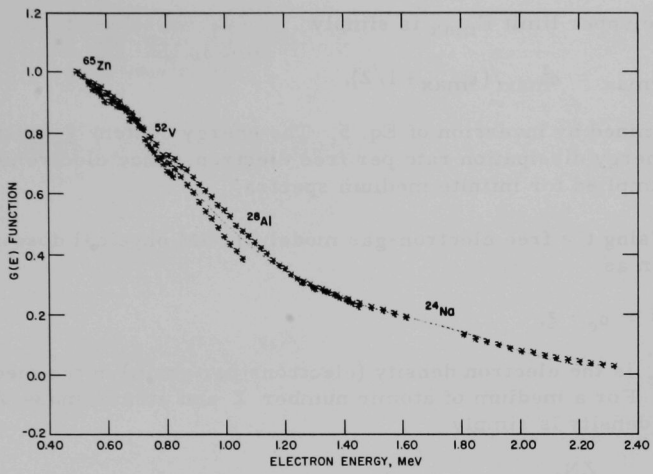

Fig. 14. The Energy-dependent (diagonal) G-matrix or G(E) Function Obtained from GABCO Analysis of ^{65}Zn, ^{52}V, ^{28}Al, and ^{24}Na Response Data. The smooth curve is a fifth-order least-squares polynomial fit of all data points. Data from these radioisotopes dominate in the designated energy regions. ANL Neg. No. 116-109.

Appendix C contains a complete listing of the GABCO code. Printout available from GABCO is illustrated with the ^{137}Cs measurements in Appendix F.

V. DOSE

The electron energy distribution,

$$W_{IM}(E) = \int_{\epsilon_{min}}^{\epsilon_{max}} \frac{d\sigma_c}{dE}(E, \epsilon_0)\Phi(\epsilon_0)\, d\epsilon_0, \tag{23}$$

represents the Infinite Medium (IM) electron-recoil spectrum per free electron due to gamma rays in the energy interval $[\epsilon_{min}, \epsilon_{max}]$. In the matrix approximation, the IM electron energy distribution is given by

$$\underline{W}_{IM} = N_e^{-1} C \underline{\Phi}. \tag{24}$$

The energy content (per unit time) in the IM electron spectrum, ξ, is therefore

$$\xi = \int_0^{E_{max}} E W_{IM}(E)\, dE, \tag{25}$$

where the upper limit E_{max} is simply

$$E_{max} = \epsilon_{max}^2/(\epsilon_{max} + 1/2), \tag{26}$$

as determined by inversion of Eq. 5. The energy content ξ must also be the IM energy dissipation rate per free electron, since electronic equilibrium is implied for infinite medium spectra.

Using the free electron-gas model, the IM physical dose rate D can be written as

$$D = \rho_e \cdot \xi, \tag{27}$$

where ρ_e is the electron density (electrons per gram) in the medium of interest. For a medium of atomic number Z and atomic mass A, the electron density is simply

$$\rho_e = \frac{ZN_a}{A}, \tag{28a}$$

where N_a is Avogadro's number. For low Z, the approximate form

$$\rho_e \cong \frac{N_a}{2}, \tag{28b}$$

can be used. Combining Eqs. 25 to 28, the IM dose rate due to gamma rays in the energy region $[\epsilon_{min}, \epsilon_{max}]$ is approximately

$$D \cong \frac{N_a}{2} \int_0^{E_{max}} E W_{IM}(E)\, dE. \tag{29}$$

The IM dose rate is computed in Program DOSE according to Eq. 29. The general flow chart describing DOSE is given in Fig. 15, and Table V presents the card input, constants, and variables used in this program. Since the output of COMPSCAT is the P-matrix modified gamma spectrum $\underline{\Phi}_p$, the transformation to the gamma continuum $\underline{\Phi}$ takes place in DOSE. Since P is a diagonal ϵ_0-space matrix, the solution of Eq. 10c is trivial. The P-matrix provides a finite-size correction which accounts for the deviation from total (integral) Compton cross section that is observed with PSD operation.[3]

Data for the P matrix can be obtained from the monoenergetic response function measurements and is illustrated in Fig. 16. The smooth curve is a second-order least-squares polynomial fit of the experimental data, which is used in DOSE to form the P-matrix. To use the response function determination of the P-matrix, experimental adjustment of the PSD system is always investigated with a monoenergetic ^{137}Cs source prior to

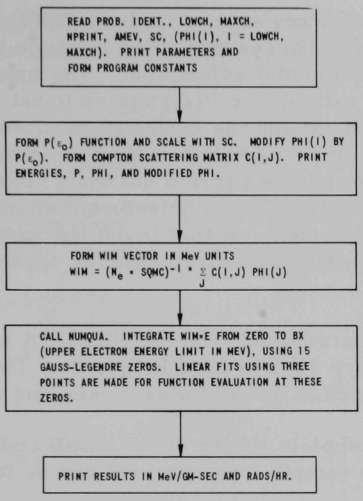

Fig. 15

The General Flow Chart for the DOSE Code. ANL Neg. No. 116-126.

TABLE V. Card Input for DOSE

Card Type	Format	Description
(1)	18A4	Problem identification.
(2)	I3	LOWCH = lowest channel used.
	I3	MAXCH = highest channel used.
	I6	NPRINT (1 gives complete printout, 0 prints end results only).
	E12.4	AMEV = MeV/channel.
	E12.4	SC = scale factor for $P(\varepsilon_0)$ function.
(3)	6E12.0	(W(I),I = LOWCH,MAXCH) is COMPSCAT output of PHI data.

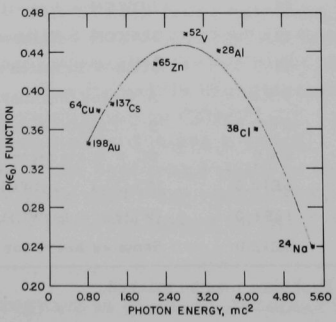

Fig. 16

The Energy-dependent (diagonal) P-matrix or $P(\varepsilon_0)$ Function Obtained from Monoenergetic Response Function Measurements with the Depicted Radioisotopes. The smooth curve is a second-order least-squares polynomial fit of all data points. ANL Neg. No. 116-112.

any given spectral measurement. Provision is made in DOSE for scaling the P-matrix to account for small changes that arise between the response function data and the actual experimental adjustment. The input scaling constant SC is formed from the ratio of the $P(\varepsilon_0)$ values found with ^{137}Cs in the specific experimental adjustment and the response function measurements, respectively. Since the entire P-matrix is scaled on the basis of ^{137}Cs data, this procedure should only be carried out when observed changes are small, i.e., for SC close to unity. This requirement can usually be met by proper adjustment of the PSD system. If this is not the case, then it is necessary to repeat response function measurements for applicable P-matrix data.

Integration in Eq. 29 is carried out with the NUMQUA subroutine in a manner similar to the procedure used in the FEND code. The calculated IM physical dose rate is expressed in units of MeV/g-sec and rad/hr.

Appendix D contains a complete listing of the DOSE code (IBM-360), and results of this code with the sample measurement can be found in Appendix F.

VI. COMPLOT

Plots of electron and gamma spectra at different stages of the data-reduction process can be obtained from the COMPLOT code. Table VI lists

TABLE VI. Card Input for COMPLOT

Card Type	Format	Description
(1)	I1	KIND option: 1, 2, or 3.
		1 = Gamma spectrum with raw data input for experimental error.
		2 = WADJ or WP electron vector with error treatment same as for KIND = 1.
		3 = Gamma spectrum with error matrix vector.
	I1	LIN option: 0 = semi-log; 1 = linear ordinate scale.
	17A4,A3	Spectrum identification.
(2)	I3	LOWCH = Lowest channel used.
	I3	MAXCH = Highest channel used.
	I3	ITER = Iteration number used. (Left blank with KIND = 2 option.)
	F9.4	A = MeV/channel (experimental mesh).
	F6.0	S = Length of plot in inches.
	F6.0	SC = Scale factor for $P(\varepsilon_0)$ function.
(3)	6E12.0	(FL(J),J = LOWCH, MAXCH). Input spectrum.
(4)a	12F6.0	(W(J),J = LOWCH, MAXCH). Error vector input for KIND = 1 and 2.
(4)b	6E12.0	Same as above for KIND = 3.

NOTE: Problems may be stacked.

the card input requirements for COMPLOT, and also defines the parameters and variables used in the program. The general flow chart for COMPLOT is given in Fig. 17.

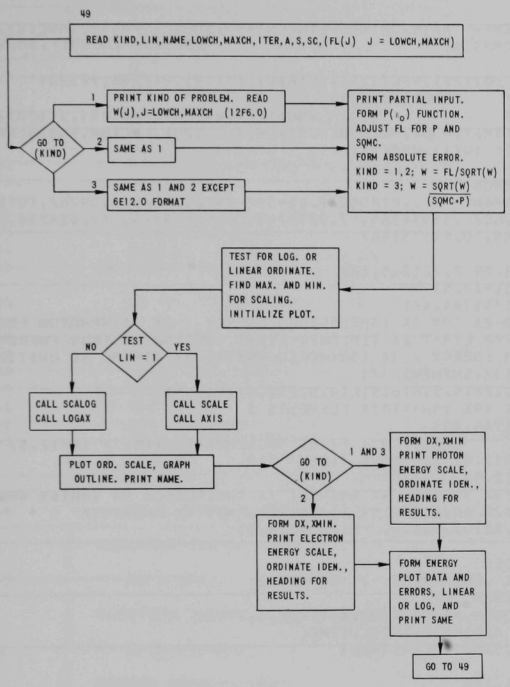

Fig. 17

The General Flow Chart for the COMPLOT Code. ANL Neg. No. 116-125.

COMPLOT uses punched output from either the COMPSCAT or FEND programs. Linear or semilogarithmic plots can be obtained using the input option, LIN. Graph length is governed by the input parameter S (in inches). Plots of the electron vectors WADJ and WP can be obtained under the KIND = 2 option. Unfolded gamma spectra from these two vectors can also be displayed by COMPLOT under the options KIND = 1 or KIND = 3. For KIND = 1, the experimental error is determined from raw data, whereas KIND = 3 uses experimental error determined from COMPSCAT treatment of the error-matrix problem. Under these options, the error to be plotted is computed within the COMPLOT program. The P-matrix transformation to obtain $\underline{\Phi}$ from COMPSCAT output is also performed in COMPLOT. This correction is identical to that already described in Program DOSE. In addition, gamma spectra are transformed from rest mass units to the more conventional MeV units by the COMPLOT code under the option KIND = 1 or 3. Figures 4, 7, and 10 are examples of plots furnished by the COMPLOT code.

A full listing of the COMPLOT program is given in Appendix E.

APPENDIX A

COMPSCAT Program Listing (IBM-360)

```
LEVEL 16 ( 1 JULY 68)              OS/360  FORTRAN H                DATE  70.118/03.55.48

        COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=57,SOURCE,FBCDIC,NOLIST,DECK,
                 C      PROGRAM COMPSCAT                          LOAD,MAP,NOEDIT,ID,NOXREF
                 C
ISN 0002                DIMENSION EO(128),VEC(128),GC(6),IDEN(18),E(128),Y(128)
ISN 0003                COMMON/Z1/    COMP(128,128)
ISN 0004                COMMON/Z2/                    WNU(128),W(128),ER(128),X(128),X1(128)
                       X ,NI(10),ITMAX,NOUT,NU,LOWCH,MAXCH,A,G(128),FACTOR,BND,NERR,KIND
ISN 0005                EQUIVALENCE (W(1),VEC(1))
                 C
ISN 0006                LOGICAL NPROB
ISN 0007                DATA NPROB/4H     /,PIROSQ/2.49452E-25/,SQMC/0.510976/,TOTEL/
                       X 7.0E+23/,GC/-.35934365, 7.9075295, -15.569776, 12.424238,
                       X -4.5243289, 0.62175146/
                 C
ISN 0008             10 FORMAT(3I3,F9.2,2E12.5,I6)
ISN 0009             13 FORMAT(2I3,F12.5)
ISN 0010             14 FORMAT(1H1/X17A4,A2)
ISN 0011             20 FORMAT(1H0 2X 1HN 2X 15HELECTRON ENERGY   2X  13HPHOTON ENERGY
                       X 2X 11HUPPER LIMIT 2X 11HLOWER LIMIT  4X 15HELECTRON ENERGY 3X
                       X 13HPHOTON ENERGY / 7X 13H(MC SQ UNITS) 3X 13H(MC SQ UNITS) 34X
                       X 5H(MEV) 13X 5H(MEV)  /)
ISN 0012             30 FORMAT(I4,1PE15.5,E16.5,E14.5,E13.5,2E17.5)
ISN 0013             40 FORMAT(1H1 19X 15HMATRIX ELEMENTS )
ISN 0014             50 FORMAT(2X17A4,A2)
ISN 0015             60 FORMAT(1H0    8HMEV/CH = F7.5, 5X 12HPI*R(0)**2 = 1PE12.5, 5X
                       X6HN(E) = E12.3/ 12HOLIVE TIME = E12.5,  5H SEC. )
ISN 0016             70 FORMAT(6E12.5)
ISN 0017             80 FORMAT(///3X 5HCHAN. 4X 5HINPUT 7X 8HELECTRON 9X 1HG16X 4HWADJ
                       X       / 12X 6HVECTOR 5X 11HENERGY, MEV 5X 6HMATRIX  )
ISN 0018             90 FORMAT(I7,E11.3,F14.5,  E16.5,E18.5)
                 C
ISN 0019              8 READ 50,IDEN
ISN 0020                IF(IDEN(1) .EQ. NPROB  )  GO TO 11
ISN 0022                PRINT 14,IDEN
ISN 0023                READ 10,LOWCH,MAXCH,KIND,A,TIMEL,S,ITVEC
ISN 0024                PRINT 60, A,PIROSQ,TOTEL,TIMEL
ISN 0025                FACTOR = .510976/(A*TIMEL)
                 C
ISN 0026                DO 444 I=1,128
ISN 0027                E(I) = A*I
                 C
                 C   TEST ELECTRON ENERGY .GT. 500 KEV FOR G FUNCTION VALUE.
                 C
ISN 0028                IF(E(I) .GT. 0.500 )  GO TO 19
ISN 0030                G(I) = 1.0
ISN 0031                GO TO 444
ISN 0032             19 G(I) = GC(1) + E(I)*(GC(2)+ E(I)*(GC(3)+ E(I)*(GC(4)+ E(I)*(GC(5)+
                       X E(I)*GC(6)))))
ISN 0033            444 X1(I) = 1.
                 C
                 C   KIND = 1, INITIAL VECTOR INPUT AND UNFOLDED IN ITERAT SUBROUTINE.
                 C              WADJ AND UNFOLDED WADJ ARE PUNCHED ON CARDS.  NERR = 1
                 C
                 C   KIND = 2, SAME AS ABOVE EXCEPT NO PUNCHOUT OF WADJ.
                 C
                 C   KIND = 3, WP(FEND OUTPUT) IS INPUT, UNFOLDED AND PUNCHED ON CARDS.
                 C              WADJ IS INPUT AS ER FOR ARRESTING CRITERION.  NERR = 3
                 C             (MAY BE USED FOR TEST VECTOR WHEN ITVEC = 1)
                 C
                 C   KIND = 4, WADJ IS INPUT FOR ERROR MATRIX AND ERROR VECTOR IS
                 C              UNFOLDED AND PUNCHED ON CARDS.  NERR = 3
                 C             (MAY BE USED FOR TEST VECTOR WHEN ITVEC = 1)
                 C
ISN 0034                GO TO (81,81,83,83),KIND
ISN 0035             83 READ 70, (VEC(I),I=LOWCH,MAXCH)
                 C
ISN 0036                GO TO (25,25,25,15),KIND
                 C
```

```
ISN 0037        81 READ 82, (VEC(I), I=LOWCH,MAXCH)
ISN 0038        82 FORMAT (12F6.0)
            C
ISN 0039        15 IF(ITVEC .EQ. 1)  GO TO 25
ISN 0041           IF(KIND .EQ. 4)  GO TO 33
            C
            C   NORMALIZATION RATIO FORMED.
            C
ISN 0043           SUM1 = 0.
ISN 0044           SUM2 = 0.
ISN 0045           DO 7 J=LOWCH,MAXCH
ISN 0046           SUM1 = SUM1 + VEC(J)
ISN 0047         7 SUM2 = SUM2 + VEC(J)/G(J)
ISN 0048           S = SUM1/SUM2
ISN 0049           PRINT 29, S
ISN 0050        29 FORMAT(23HONORMALIZATION FACTOR =  1PE12.6)
ISN 0051        33 PRINT 80
            C
ISN 0052           DO 16 J=LOWCH,MAXCH
ISN 0053           TEMP = VEC(J)
ISN 0054           VEC(J) = S*TEMP*FACTOR/G(J)
ISN 0055        16 PRINT 90,J,TEMP,E(J),G(J),VEC(J)
            C
ISN 0056           GO TO (17,25,25,25),KIND
            C
ISN 0057        17 PUNCH 50, IDEN
ISN 0058           PUNCH 13,LOWCH,MAXCH,A
ISN 0059           PUNCH 84, (VEC(I), I=LOWCH,MAXCH)
ISN 0060        84 FORMAT (6E12.5)
ISN 0061        25 PRINT 20
ISN 0062           AMC = A/SQMC
ISN 0063           PCON = PIROSQ*TOTEL
            C
            C   FORM COMPTON SCATTERING MATRIX
            C
ISN 0064           DO 1 J=LOWCH,MAXCH
            C
            C  ELECTRON ENERGY, MEV
            C
ISN 0065           EE = A*J
            C
            C  ELECTRON ENERGY, (MC SQ UNITS)
            C
ISN 0066           EP = EE/SQMC
            C
            C  PHOTON ENERGY, MEV
            C
ISN 0067           PHE = EE*0.5*(1.+SQRT (1.+2.*SQMC/EE))
            C
            C  PHOTON ENERGY, (MC SQ UNITS)
            C
ISN 0068           EO(J) = EP*0.5*(1.+ SQRT (1.+2./EP))
            C
ISN 0069           DO 4 I=LOWCH,MAXCH
            C
            C  ELECTRON ENERGY, (MC SQ UNITS)
            C
ISN 0070           EL = AMC*I
ISN 0071           EIX = EL*EL
ISN 0072           IF (I-J) 2,2,3
ISN 0073         3 COMP(I,J) = 0.0
ISN 0074           GO TO 4
            C
            C  FORM EIL AND EIU IN ELECTRON ENERGY (MC SQ UNITS)
            C
ISN 0075         2 EIL = EP - 0.5*AMC
ISN 0076           EIU = EIL + AMC
ISN 0077           EOL = EIL*0.5*(1. + SQRT ((EIL + 2.)/EIL))
            C
            C  FORM EOL AND EOU IN PHOTON ENERGY (MC SQ UNITS)
            C
ISN 0078           EOU = EIU*0.5*(1. + SQRT ((EIU + 2.)/EIU))
ISN 0079           EOX1 = EOU*EOU
ISN 0080           EOX2 = EOL*EOL
```

```
ISN 0081          DIFF1 = EOU - EL
ISN 0082          DIFF2 = EOL - EL
ISN 0083          EE1 = EL*EOU
ISN 0084          EE2 = EL*EOL
ISN 0085          ELECTI = (EIX - 2.*EL - 4.)/(EIX*EL)
ISN 0086          TUP =ALOG (DIFF1/EOU)*ELECTI+(EL-2.*EOU-2.)/(2.*EOX1)+(EL-2.*EOU)/
                 X(EIX*EOU*DIFF1)-1./(3.*EOX1*EOU)-(2.*EOU+EL+2.*EE1)/(EE1*EE1)
ISN 0087          TLOW=ALOG (DIFF2/EOL)*ELECTI+(EL-2.*EOL-2.)/(2.*EOX2)+(EL-2.*EOL)/
                 X(EIX*EOL*DIFF2)-1./(3.*EOX2*EOL)-(2.*EOL+EL+2.*EE2)/(EE2*EE2)
            C
ISN 0088          COMP(I,J) = PCON*(TUP - TLOW)
ISN 0089        4 CONTINUE
            C
ISN 0090          PRINT 30,J,EP,EO(J),EOU,EOL,EE,PHE
ISN 0091        1 CONTINUE
            C
            C  PRINT MATRIX ELEMENTS
            C
ISN 0092          GO TO (6,6,6,18),KIND
            C
ISN 0093       18 DO 12 I=LOWCH,MAXCH
ISN 0094          DO 12 J=LOWCH,MAXCH
ISN 0095       12 COMP(I,J) = COMP(I,J)*COMP(I,J)
            C
ISN 0096        6 PRINT 40
ISN 0097          L1 = MAXCH
ISN 0098          K1 = LOWCH
ISN 0099          K2 = LOWCH + 7
ISN 0100          IF(K2 - L1)200,200,100
ISN 0101      100 K2 = L1
ISN 0102      200 PRINT 300,   (I,I=K1,K2)
ISN 0103          PRINT 301,(EO(I),I=K1,K2)
ISN 0104      300 FORMAT(1H0 X3HI/J5X14,7I13)
ISN 0105      301 FORMAT( 1H F14.5,7F13.5)
ISN 0106          DO 400 I=LOWCH,MAXCH
ISN 0107      400 PRINT 500,   I,(COMP(I,J),J=K1,K2)
ISN 0108      500 FORMAT(I4,E14.5,7E13.5)
ISN 0109          IF(K2 - L1)600,9,9
ISN 0110      600 K1 = K1 + 8
ISN 0111          K2 = K2 + 8
ISN 0112          IF(K2 - L1)200,200,700
ISN 0113      700 K2 = L1
ISN 0114          GO TO 200
ISN 0115        9 IF(KIND .LT. 3)  GO TO 27
ISN 0117          IF(ITVEC .NE. 1)  GO TO 27
            C
            C  MATRIX MULTIPLICATION
            C
ISN 0119          DO 21 I=LOWCH,MAXCH
ISN 0120          Y(I) = 0.0
ISN 0121          DO 21 J=LOWCH,MAXCH
ISN 0122       21 Y(I) = Y(I) + COMP(I,J)*VEC(J)
ISN 0123          PRINT 31
ISN 0124       24 FORMAT(1H06(I6,E12.5) )
ISN 0125       31 FORMAT(33H1TEST VECTOR MULTIPLIED BY MATRIX )
            C
ISN 0126          INC =(MAXCH - LOWCH + 6)/6
ISN 0127          NX = 1
ISN 0128          DO 22 I=1,INC
ISN 0129          M = LOWCH + INC*5 + I - 1
ISN 0130          IF(M - MAXCH)28,28,23
ISN 0131       23 M = MAXCH - INC + NX
ISN 0132          NX = NX + 1
ISN 0133       28 L = LOWCH + I - 1
ISN 0134       22 PRINT 24, (J,Y(J),J=L,M,INC)
            C
ISN 0135          DO 26 K=LOWCH,MAXCH
ISN 0136       26 W(K) = Y(K)
            C
ISN 0137       27 CALL ITERAT
ISN 0138          GO TO 8
ISN 0139       11 CONTINUE
ISN 0140          RETURN
ISN 0141          END
```

```
LEVEL 16 ( 1 JULY 68)          OS/360  FORTRAN H                    DATE  69.282/17.58.25

        COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=57,SOURCE,EBCDIC,NOLIST,NODECK,
ISN 0002          SUBROUTINE ITERAT                                  LOAD,MAP,NOEDIT,ID,NOXREF
            C
ISN 0003          DIMENSION R(128),SUMN(128),VEC(128)
ISN 0004          COMMON/Z1/     COMP(128,128)
ISN 0005          COMMON/Z2/                    WNU(128),W(128),ER(128),X(128),X1(128)
                 X ,NI(10),ITMAX,NOLT,NL,LOWCH,MAXCH,A,G(128),FACTOR,BND,NERR,KIND
ISN 0006          EQUIVALENCE (W(1),VEC(1))
            C
ISN 0007          CALL BOUND
ISN 0008          DO 6 I=LOWCH,MAXCH
ISN 0009        6 WNU(I)=W(I)
            C
            C     BEGIN ITERATION PROCEEDURE
            C
ISN 0010        2 PRINT 18
ISN 0011       18 FORMAT(1H1)
ISN 0012          IX = 1
ISN 0013          IT=1
ISN 0014          NCONV=2
            C
ISN 0015       19 CONTINUE
            C
ISN 0016       22 SUM1=0.
ISN 0017          DO 24 I=LOWCH,MAXCH
ISN 0018          SUM=0.
ISN 0019          DO 23 J=LOWCH,MAXCH
ISN 0020       23 SUM = SUM + COMP(I,J)*X1(J)
ISN 0021          X(I)=X1(I)*WNU(I)/SUM
ISN 0022          W(I)=SUM
ISN 0023          R(I)=WNU(I)-W(I)
ISN 0024          SUM1=SUM1+R(I)**2
ISN 0025       24 SUMN(I)=SUM1
ISN 0026          IF(SUMN(MAXCH) - BND) 25,25,27
ISN 0027       25 PRINT 26, IT,BND,SUMN(MAXCH)
ISN 0028       26 FORMAT(1H0//5X15HARRESTING CRITERION SATISFIED ON ITERATION NUMBER
                 1 I6,//9X6HBOUND=1PE11.4, 3X 5HNORM= E11.4,          //26X1H1 9X1HX
                 211X6HWPRIME12X1HR13X4HNORM//)
ISN 0029          PUNCH 1003, (X1(I),I=LOWCH,MAXCH)
ISN 0030     1003 FORMAT(6E12.5)
ISN 0031          NCONV=1
ISN 0032          GO TO 30
ISN 0033       27 IF(IX .GT. NL)  GO TO 277
ISN 0035          IF(IT .NE. NI(IX))  GO TO 277
ISN 0037          PUNCH 1003, (X1(I),I=LOWCH,MAXCH)
ISN 0038          IX = IX + 1
ISN 0039      277 IF( MOD (IT,NOLT))34,28,34
            C
ISN 0040       28 PRINT 29, IT
ISN 0041       29 FORMAT(1H0//5X17HITERATION NUMBER I6,//26X1H1 9X1H X11X6HWPRIME12X1H
                 1R13X4HNORM//)
            C
ISN 0042       30 DO 31 I=LOWCH,MAXCH
ISN 0043       31 PRINT 32, I,X1(I),W(I),R(I),SUMN(I)
ISN 0044       32 FORMAT(I27,1P4E15.4)
            C
ISN 0045       33 GO TO(1,34),NCONV
ISN 0046       34 IT=IT+1
ISN 0047          IF(IT-ITMAX)35,35,37
ISN 0048       35 DO 36 I=LOWCH,MAXCH
ISN 0049       36 X1(I)=X(I)
ISN 0050          GO TO 19
ISN 0051       37 PRINT 38, ITMAX,BND,SUMN(MAXCH)
ISN 0052       38 FORMAT(1H0//5X40HARRESTING CRITERION NOT SATISFIED AFTER I6,2X11H1
                 1TERATIONS.//9X6HBOUND=1PE11.4, 3X 5HNORM= E11.4)
ISN 0053        1 RETURN
ISN 0054          END
```

```
LEVEL 16 ( 1 JULY 68)              OS/360  FORTRAN H                DATE  70.122/19.26.45

        COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=57,SOURCE,EBCDIC,NOLIST,DECK,
ISN 0002            SUBROUTINE BOUND                                LOAD,MAP,NOEDIT,ID,NOXREF
              C
ISN 0003            DIMENSION VEC(128)
ISN 0004            COMMON/Z1/    COMP(128,128)
ISN 0005            COMMON/Z2/                    WNU(128),W(128),ER(128),X(128),X1(128)
                   X ,N1(10),ITMAX,NOUT,NU,LOWCH,MAXCH,A,G(128),FACTOR,BND,NERR,KIND
ISN 0006            EQUIVALENCE (W(1),VEC(1))
              C
ISN 0007            READ 1,ITMAX,NOUT,NERR,NU
ISN 0008            IF(NU .EQ. 0)  GO TO 3
ISN 0010            READ 1,(N1(I),I=1,NU)
ISN 0011          1 FORMAT(12I6)
ISN 0012         10 FORMAT(6F12.0)
              C
ISN 0013          3 BND = 0.
ISN 0014            GO TO (71,70,60),NERR
              C
              C  WADJ IS READ IN AS ER FOR WP VECTOR
              C  UNFOLDED SPECTRUM ARRESTING CRITERION PATH.  (KIND=3)
              C  ERROR VECTOR ARRESTING CRITERION PATH.  (KIND=4)
              C
ISN 0015         60 IF(KIND .EQ. 4)  GO TO 2
ISN 0017          4 READ 10, (ER(I),I=LOWCH,MAXCH)
              C
ISN 0018          2 DO 100 I=LOWCH,MAXCH
ISN 0019            TEMP = FACTOR/G(I)
ISN 0020            IF(KIND .EQ. 4)  GO TO 99
ISN 0022            ERROR = ER(I)*TEMP
ISN 0023            ER(I) = SQRT(ERROR)
ISN 0024            BND = BND + ERROR*4.
ISN 0025            GO TO 100
ISN 0026         99 ER(I) = SQRT(W(I))*TEMP
ISN 0027            BND = BND + 4.*W(I)*TEMP*TEMP
ISN 0028        100 CONTINUE
ISN 0029            GO TO 90
              C
              C  USED FOR RELATIVE ERROR INPUT.
              C
ISN 0030         70 READ 10,ERROR
ISN 0031            DO 80 I=LOWCH,MAXCH
ISN 0032            ER(I) = ERROR*W(I)
ISN 0033         80 BND = BND + (ER(I))**2
ISN 0034            GO TO 90
              C
              C  RAW DATA ARRESTING CRITERION PATH
              C
ISN 0035         71 IF(KIND .EQ. 4)  GO TO 2
ISN 0037            IF(KIND .EQ. 3)  GO TO 4
ISN 0039            DO 72 I = LOWCH,MAXCH
ISN 0040            ER(I) = SQRT(FACTOR*W(I)/G(I))
ISN 0041         72 BND = BND + 4.*W(I)*FACTOR/G(I)
              C
ISN 0042         90 CONTINUE
ISN 0043            PRINT7,
ISN 0044          7 FORMAT(1H125X38HITERATIVE SOLUTION OF DETECTION SYSTEM//26X1HI4X
                   X 13HPHOTON ENERGY 4X8HW VECTOR 10X 5HERROR 6X9HX1 VECTOR /
                   X 31X 13H(MC SQ UNITS)  )
              C
ISN 0045            DO8I=LOWCH,MAXCH
ISN 0046            E = A*I
ISN 0047            ENERGY = (F/1.021952)*(1.+SQRT (1.+1.021952/E) )
ISN 0048          8 PRINT 9,I,ENERGY,W(I),ER(I),X1(I)
ISN 0049          9 FORMAT(I27,F15.5,1P3E15.4)
ISN 0050            RETURN
ISN 0051            END
```

APPENDIX B

FEND Program Listing (IBM-360)

```
LEVEL 16 ( 1 JULY 68)              OS/360  FORTRAN H                    DATE  71.005/15.10.48

        COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=57,SOURCE,EBCDIC,NOLIST,NODECK,
                 C      PROGRAM FEND                                   LOAD,MAP,NOEDIT,ID,NOXREF
                 C
                 C       THIS PROGRAM HAS BEEN TRANSLATED FOR THE     360/50
                 C       WITH RELEASE 1-A OF THE MOD-50 TRANSDECK
                 C                                                              JDB
                 C   COMPTON SCATTERING PROGRAM...FAR END EFFECTS ADJUSTED VECTOR  R. GOLD
                 C   MARCH 1969          REVISED JULY 1969 FOR 3600CDC ADDING NUMQUA SUBR.
                 C   REVISION SEPT. 1969 FOR 360 IBM
ISN 0002             DIMENSION PHI(128),WP(128),V(128),PHIEO(70),WADJ(128),ER(128)
                    X ,IDEN(18)
ISN 0003             DOUBLE PRECISION FN1,FN2,FN,SL,A0,B0,ABAR
ISN 0004             COMMON/XY/FN(15),SL(15),FN1,FN2,ABAR,A0,B0,AX,BX,XI(70),VI(70),
                    X X(25),Y(25),ARG(15),ETA,NPTS,NUM,NEXT,MAXCH,LOWCH
ISN 0005             LOGICAL NPROB
ISN 0006             DATA NPROB /4H    /,PIROSQ/2.49452E-25/,SQMC/0.510976/,
                    X TOTEL /7.0E+23/
                 C
ISN 0007          10 FORMAT(2I3,I6,2E12.3,I1)
ISN 0008          40 FORMAT(18A4)
ISN 0009          60 FORMAT(1H0     8HMEV/CH = F8.5)
ISN 0010          70 FORMAT(6E12.5)
ISN 0011         107 FORMAT(13H0PI(RO)(RO) = 1PE12.5, 29X6HN(E) = E10.3, /12H0LIVE TIME
                    X = 0PF10.1,5H SEC. 8X 23H INTEGRATION CONSTANT = 1PE13.5)
                 C
                 C
ISN 0012           8 READ(3,40) IDEN
ISN 0013             IF (IDEN(1) .EQ. NPROB)  GO TO 20
                 C
ISN 0015          30 WRITE(4,40) IDEN
ISN 0016             READ(3,10) LOWCH,MAXCH,LOWFIT,AM,TIMEL,NPRIN
ISN 0017             WRITE(4,60) AM
ISN 0018             AMC = AM/SQMC
                 C
ISN 0019             CONST = PIROSQ*TOTEL
ISN 0020             WRITE(4,107) PIROSQ,TOTEL,TIMEL,CONST
ISN 0021             READ(3,70) (WADJ(J),J=LOWCH,MAXCH)
ISN 0022             READ(3,70) (PHI(J),J=LOWCH,MAXCH)
ISN 0023             K = 0
ISN 0024             DO 1 J=LOWFIT,MAXCH
ISN 0025             K = K + 1
ISN 0026             X(K) = AMC*0.5*J*(1.+SQRT(1.+2./(AMC*J)) )
ISN 0027           1 Y(K) = ALOG(PHI(J))
                 C
ISN 0028             NEXT = K
ISN 0029             NUM = 1
                 C
                 C   NUM USED FOR 2 CALLS TO NUMQUA SUBR., ONE FOR PHI EXTRAPOLATION
                 C         FIT, TWO FOR INTEGRATION OF PHI*C(EO,EI)
                 C
ISN 0030             CALL NUMQUA
ISN 0031             NUM = 2
ISN 0032             EIMAX = AMC*FLOAT(MAXCH)
                 C
                 C  PHI IS UNFOLDED EXPERIMENTAL SPECTRUM
                 C
ISN 0033             EOMAX = EIMAX *0.5*(1.+SQRT(1.+2./EIMAX))
                 C
                 C   FORM PHIEO FROM EOMAX TO ENDPT.
                 C
ISN 0034             AX = EOMAX - AMC*0.5
ISN 0035             ESTART = EOMAX
ISN 0036             ENDPT = (-20. - A0)/B0
ISN 0037             BX = ENDPT
ISN 0038             DEL = (ENDPT - ESTART)/60.
ISN 0039             I=0
ISN 0040         101 I=I+1
ISN 0041             PHIEO(I) =DEXP(A0 + B0*ESTART)
```

```
ISN 0043          XI(I) = ESTART
ISN 0044          ESTART = ESTART + DEL
ISN 0045          IF(ESTART - ENDPT)101,101,4
ISN 0046        4 NPTS = I
            C
            C  V VECTOR GENERATED FOR NUMERICAL INTEGRATION IN NUMQUA
            C  FORM V(I) FUNCTION.  INTEGRAND STORED AS VI(K)
            C
            C          EI CONTRIBUTION
            C
ISN 0047          NOPT = 1
ISN 0048          DO 103 J=LOWCH,MAXCH
ISN 0049          EI = AMC * FLOAT(J)
ISN 0050          IF(NPRIN .EQ. 1)  GO TO 110
ISN 0052          WRITE(4,111) EI
ISN 0053          WRITE(4,112)
ISN 0054      110 EIX = EI* EI
            C
            C          EO CONTRIBUTION
            C
ISN 0055          DO 102 K =1,NPTS
ISN 0056          EOV = XI(K)
ISN 0057          EOVSQ = EOV*EOV
ISN 0058          DIFF  = EOV - EI
ISN 0059          DOFF = DIFF*DIFF
ISN 0060          VC = 2./EOVSQ + EIX/(EOVSQ*EOVSQ*DOFF)+(EIX-2.*EI)/(EOVSQ*EOV*DIFF
                 X)
ISN 0061          VI(K) = VC*PHIEO(K)*CONST
ISN 0062          IF(NPRIN .EQ. 1)  GO TO 102
ISN 0064          WRITE(4,105) K,EOV,PHIEO(K),VC,VI(K)
ISN 0065      102 CONTINUE
            C
ISN 0066          IF(NPRIN .EQ. 0)  GO TO 2
ISN 0068          GO TO (15,2),NOPT
ISN 0069       15 WRITE(4,12) VI(1),NPTS,VI(NPTS),AX,BX
ISN 0070        2 CALL NUMQUA
ISN 0071          V(J) = ABAR
ISN 0072          ER(J) = ETA
ISN 0073          WP(J) = WADJ(J) - V(J)
            C
ISN 0074          IF(NPRIN .EQ. 1)  GO TO 6
ISN 0076          WRITE(4,9) AX,BX,ABAR,ETA,(I,ARG(I),FN(I),SL(I),I=1,15)
ISN 0077          WRITE(4,13) AX,FN1,BX,FN2

            C
ISN 0079        6 EE = AM*J
ISN 0080          EP = EE/0.510976
ISN 0081          EO = EP*0.5*(1. + SQRT(1.+2./EP) )
ISN 0082          PHE= EE*0.5*(1. + SQRT(1.+2./EP) )
ISN 0083          GO TO (3,5),NOPT
ISN 0084        3 NOPT = 2
ISN 0085          WRITE(4,55) J,EP,EO,EE,PHE,WADJ(J),WP(J),ABAR,ETA
ISN 0086          GO TO 103
            C
ISN 0087        5 WRITE(4,50) J,EP,EO,EE,PHE,WADJ(J),WP(J),ABAR,ETA
ISN 0088      103 CONTINUE
            C
ISN 0089          IF(NPRIN .EQ. 1)  GO TO 7
ISN 0091          WRITE(4,55)
ISN 0092          DO 11 J=LOWCH,MAXCH
ISN 0093          EE = AM*J
ISN 0094          EP = EE/0.510976
ISN 0095          EO = EP*0.5*(1. + SQRT(1.+2./EP) )
ISN 0096          PHE= EE*0.5*(1. + SQRT(1.+2./EP) )
ISN 0097       11 WRITE(4,50) J,EP,EO,EE,PHE,WADJ(J),WP(J),V(J),ER(J)
ISN 0098        7 PUNCH 70,(WP(K),K=LOWCH,MAXCH)
            C
ISN 0099        9 FORMAT(1H0/1H0////7X30HAPPROX. VALUE OF INTEGRAL FROM   F10.5,X
                 X 2HTO F10.5, /1H06X 2HIS 1PE13.5, 5H +/- E12.5, 6X 6H(N = 3
                 X 8H, M = 2)          /1H0 7X 1HL 6X 8HABSCISSA 7X 14HFUNCTION VALUE
                 X 8X 10HDERIVATIVE /(1H I8,1PE14.5,E21.5,E18.5) )
ISN 0100       12 FORMAT(/ 12H0   VI(1) = 1PE12.5,/7H0   VI( I2, 4H) = E12.5,/31H0
                 X INTEGRATION LIMITS FOR V =  0PF8.5, 1H, F9.5 )
ISN 0101       13 FORMAT(5HOFCN( F9.5,3H) = 1PE12.5,6X4HFCN(0PF11.5,3H) = 1PE12.5/)
```

```
ISN 0102          50 FORMAT(I4,F12.5,F14.5,2F12.5,1P3E17.5,E15.4)
ISN 0103          55 FORMAT(1H0 2X 1HN 4X 8HELECTRON 8X 6HPHOTON 5X 8HELECTRON 5X 6HPHO
                    XTON 8X 8HW-ADJ(N) 10X 5HWP(N) 13X 18HV(N)    +/-    ERROR / 9X 6HENE
                    XRGY 9X 6HENERGY 6X 6HENERGY 6X 6HENERGY / 6X 12H(MCSQ UNITS) 3X
                    X 12H(MCSQ UNITS) 4X 5H(MEV) 7X 5H(MEV) /(1H0 I3,F12.5,F14.5,2F12.5
                    X,1P3E17.5,E15.4 ) )
ISN 0104         105 FORMAT(1H I3,1PE17.4,2E16.4,E17.4)
ISN 0105         111 FORMAT(1H1/     18H0ELECTRON ENERGY =  F10.5)
ISN 0106         112 FORMAT(4H0  N 5X 13HPHOTON ENERGY 7X 6HPHI(N) 8X 10HPARTIAL VI 6X
                    X 12HVI INTEGRAND  )
                C
ISN 0107            GO TO 8
                C
ISN 0108          20 STOP
ISN 0109            RETURN
ISN 0110            END
```

```
LEVEL 16 ( 1 JULY 68)              OS/360  FORTRAN H                DATE  69.276/14.54.03

      COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=57,SOURCE,EBCDIC,NOLIST,NODECK,
ISN 0002            SUBROUTINE NUMQUA                          LOAD,MAP,NOEDIT,ID,NOXREF
                C  NUMERICAL INTEGRATION USING GAUSS-LEGENDRE QUADRATURE (15 ZEROS)
ISN 0003            DIMENSION B(2),RESID(25),A(2,2),IPIVOT(2),INDEX(2,2),STD(2),
                   X PIVOT(2),EVAL(25),C(25,2),CHAN(128),EXY(25),ZEWT(2,8)
                C
ISN 0004            DOUBLE PRECISION A,B,AMAX,SUM,PIVOT,DETERM,STD,C,A0,B0,FN1,FN2,FN,
                   X SL,ZEWT,ABAR
ISN 0005            COMMON/XY/FN(15),SL(15),FN1,FN2,ABAR,A0,B0,AX,BX,XI(70),VI(70),
                   X X(25),Y(25),ARG(15),ETA,NPTS,NUM,NEXT,MAXCH,LOWCH
ISN 0006            EQUIVALENCE (AMAX,T,SWAP),(IROW,JROW),(ICOLUM,JCOLUM)
                C
ISN 0007            DATA
                   X ZEWT(1,1) /0.987992518020485 /, ZEWT(2,1) /0.030753241996117  /,
                   X ZEWT(1,2) /0.937273392400706 /, ZEWT(2,2) /0.070366047488108  /,
                   X ZEWT(1,3) /0.848206583410427 /, ZEWT(2,3) /0.107159220467172  /,
                   X ZEWT(1,4) /0.724417731360170 /, ZEWT(2,4) /0.139570677926154  /,
                   X ZEWT(1,5) /0.570972172608539 /, ZEWT(2,5) /0.166269205816993  /,
                   X ZEWT(1,6) /0.394151347077563 /, ZEWT(2,6) /0.186161000015562  /,
                   X ZEWT(1,7) /0.201194093997435 /, ZEWT(2,7) /0.198431485327112  /,
                   X ZEWT(1,8) /0.000000000000000 /, ZEWT(2,8) /0.202578241925561  /
                C
                C  END ZERO AND WEIGHT DATA FOR 15 POINT CASE
                C
                C  AX = LOWER LIMIT OF INTEGRATION FORMED IN MAIN PROGRAM FROM MAXCH
                C  BX = UPPER LIMIT OF INTEGRATION FORMED IN MAIN PROG. FROM EXTRAP. FIT
                C
ISN 0008            GO TO (111,222),NUM
ISN 0009         111 N = NEXT
ISN 0010            NPTS = 1
ISN 0011            GO TO 446
                C
ISN 0012         222 XI1 = XI(1)
ISN 0013            XIN = XI(NPTS)
ISN 0014            YI1 = VI(1)
ISN 0015            YIN = VI(NPTS)
                C
ISN 0016            DO 18 J=1,NPTS
ISN 0017            IF(VI(J) .GT. 0.)   GO TO 18
ISN 0019            WRITE(4,35)
ISN 0020          35 FORMAT(28H VALUES ARE ZERO OR NEGATIVE  )
ISN 0021            RETURN
ISN 0022          18 CONTINUE
                C
ISN 0023            N = 3
                C
                C  FORM ABSCISSA VALUES FOR 15 GAUSS-LEGENDRE POLYNOMIAL ZEROS.
                C
ISN 0024            J = 15
                C
```

```
ISN 0025          DO 20 I=1,7
ISN 0026          ARG(I)=((AX - BX)*ZEWT(1,I) + AX + BX)*0.5
ISN 0027          ARG(J)=((BX - AX)*ZEWT(1,I) + AX + BX)*0.5
ISN 0028       20 J = J -1
            C
ISN 0029          ARG(J)=(AX + BX)*0.5
ISN 0030          JOG = 2
            C
            C  FORM SLOPES AND FUNCTIONS
            C
ISN 0031      446 DO 451 JS = 1,15
ISN 0032          GO TO (202,5),NUM
ISN 0033        5 TEST = ARG(JS)
ISN 0034          IF(TEST - XI(NPTS))202,202,51
            C
ISN 0035      202 DO 452 IB = 1,NPTS
ISN 0036          GO TO (95,24),NUM
ISN 0037       24 NTIME = 0
ISN 0038          IF(TEST - XI(IB))98,98,452
ISN 0039       98 IF(IB .LE. 2)  GO TO 16
ISN 0041          L = IB - JOG
ISN 0042       54 IF(L .LE. 0)  GO TO 16
ISN 0044          IF(L + N - NPTS - 1)60,60,59
ISN 0045       59 L = NPTS - N + 1
ISN 0046          GO TO 60
ISN 0047       16 L = 1
            C
ISN 0048       60 DO 99 K = 1,N
ISN 0049          X(K) = XI(L)
ISN 0050          Y(K) = ALOG(VI(L))
ISN 0051       99 L = L + 1
            C
            C  FIRST ARG
            C
ISN 0052          IF((L-1) .EQ. N)  GO TO 95
            C
            C  LAST ARG
            C
ISN 0054          IF(L .GT. NPTS)  GO TO 95
            C
            C  TEST FOR CLOSEST POINTS TO ARG
            C
ISN 0056          ILOW = L - N - 1
ISN 0057          TEST1 = TEST - XI(ILOW)
ISN 0058          TEST2 = TEST - X(1)
ISN 0059          TEST3 = X(N) - TEST
ISN 0060          TEST4 = XI(L) - TEST
ISN 0061          IF(TEST4 .GE. TEST2)  GO TO 97
ISN 0063          GO TO 452
ISN 0064       97 IF(TEST1 .GE. TEST3) GO TO 95
ISN 0066          NTIME = NTIME + 1
ISN 0067          L = IB - JOG - NTIME
ISN 0068          GO TO 54
            C
            C   LSQPOL CALCULATIONS
            C
ISN 0069       95 DO620 I =1,N
ISN 0070      620 C(I,1) = 1.0
ISN 0071          DO 50 J = 2,2
ISN 0072          DO 50 I = 1,N
ISN 0073       50 C(I,J) = C(I,J-1)*X(I)
ISN 0074          DO 150 I = 1,2
ISN 0075          B(I) = 0.0
ISN 0076          DO 100 J = 1,2
ISN 0077          A(I,J) = 0.0
ISN 0078          DO 100 K = 1,N
ISN 0079      100 A(I,J) = A(I,J) + C(K,I)*C(K,J)
ISN 0080          DO 150 K = 1,N
ISN 0081      150 B(I) = B(I) + C(K,I)*Y(K)
            C
            C  INITIALIZATION
            C
ISN 0082          DETERM=1.0
ISN 0083          DO 621 J = 1,2
```

```
ISN 0084        621 IPIVOT(J)=0
ISN 0085            DO 550 I=1,2
                C
                C  SEARCH FOR PIVOT ELEMENT
                C
ISN 0086            AMAX=0.0
ISN 0087            DO 605 J=1,2
ISN 0088            IF (IPIVOT(J)-1)660,605,660
ISN 0089        660 DO 600 K=1,2
ISN 0090            IF (IPIVOT(K)-1) 80,600,740
ISN 0091         80 IF(DABS (AMAX)-DABS(A(J,K))) 85,600,600
ISN 0092         85 IROW=J
ISN 0093            ICOLUM=K
ISN 0094            AMAX=A(J,K)
ISN 0095        600 CONTINUE
ISN 0096        605 CONTINUE
ISN 0097            IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
                C
                C  INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
                C
ISN 0098            IF (IROW-ICOLUM)  140, 260, 140
ISN 0099        140 DETERM=-DETERM
ISN 0100            DO 200 L=1,2
ISN 0101            SWAP=A(IROW,L)
ISN 0102            A(IROW,L)=A(ICOLUM,L)
ISN 0103        200 A(ICOLUM,L)=SWAP
ISN 0104            SWAP = B(IROW)
ISN 0105            B(IROW) = B(ICOLUM)
ISN 0106            B(ICOLUM) = SWAP
ISN 0107        260 INDEX(I,1)=IROW
ISN 0108            INDEX(I,2)=ICOLUM
ISN 0109            PIVOT(I)=A(ICOLUM,ICOLUM)
ISN 0110            DETERM=DETERM*PIVOT(I)
                C
                C  DIVIDE PIVOT ROW BY PIVOT ELEMENT
                C
ISN 0111            A(ICOLUM,ICOLUM)=1.0
ISN 0112            DO 350 L=1,2
ISN 0113        350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
ISN 0114            B(ICOLUM) = B(ICOLUM)/PIVOT(I)
                C
                C  REDUCE NON-PIVOT ROWS
                C
ISN 0115            DO 550 L1=1,2
ISN 0116            IF(L1-ICOLUM) 400,550,400
ISN 0117        400 T=A(L1,ICOLUM)
ISN 0118            A(L1,ICOLUM)=0.0
ISN 0119            DO 450 L=1,2
ISN 0120        450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
ISN 0121            B(L1) = B(L1) - B(ICOLUM)*T
ISN 0122        550 CONTINUE
                C
                C  INTERCHANGE COLUMNS
                C
ISN 0123            DO 710 I=1,2
ISN 0124            L = 3 - I
ISN 0125            IF (INDEX(L,1)-INDEX(L,2)) 630,710,630
ISN 0126        630 JROW=INDEX(L,1)
ISN 0127            JCOLUM=INDEX(L,2)
ISN 0128            DO 705 K=1,2
ISN 0129            SWAP=A(K,JROW)
ISN 0130            A(K,JROW)=A(K,JCOLUM)
ISN 0131            A(K,JCOLUM) = SWAP
ISN 0132        705 CONTINUE
ISN 0133        710 CONTINUE
ISN 0134        740 CONTINUE
                C
ISN 0135            IF(NUM .EQ. 2)  GO TO 51
ISN 0137            SUM = 0.0
ISN 0138            DO 205 I = 1,N
ISN 0139        203 RESID(I)=B(1)+X(I)*B(2) - Y(I)
ISN 0140        205 SUM = SUM+RESID(I)*RESID(I)
                C
                C   BACK TO MAIN PROGRAM
```

```
                C
ISN 0141              DEG=N-2
ISN 0142              DO 680 I=1,2
ISN 0143          680 STD(I) =DSQRT (SUM*A(I,I)/DEG)
                C
ISN 0144              DO 170 I=1,N
ISN 0145              CHAN(I) = MAXCH - N + I
ISN 0146              EVAL(I) = RESID(I) + Y(I)
ISN 0147          170 EXY(I) = EXP(Y(I))
                C
ISN 0148              WRITE(4,1234)   (B(I),STD(I),I=1,2)
ISN 0149              WRITE(4,6000) SUM
ISN 0150              WRITE(4,7000) (CHAN(I),X(I),EXY(I),Y(I),EVAL(I),RESID(I),I=1,N)
ISN 0151         1234 FORMAT(/1H0 9X11HCOEFFICIENT11X6HERROR /(1H 1P2E20.7) )
ISN 0152         6000 FORMAT(   40H0   WEIGHTED SUM OF SQUARED DEVIATIONS = 1PE13.5/ )
ISN 0153         7000 FORMAT(4X 5HCHAN. 5X 13HPHOTON ENERGY 7X 3HPHI 8X 7HLOG PHI 5X
                     X 10HEVALUATION 5X 8HRESIDUAL /15X 12H(MCSQ UNITS)/(0PF8.0,F16.6,
                     X 1PE17.5,0PF11.5,F13.5,1PE16.4) )
                C
ISN 0154              A0 = B(1)
ISN 0155              B0 = B(2)
ISN 0156              RETURN
ISN 0157          452 CONTINUE
                C
ISN 0158           51 IF(JS .GT. 1)  GO TO 1
ISN 0160              FN1 =DEXP(B(1) + AX*B(2))
ISN 0161            1 FN(JS) =DEXP(B(1) + TEST*B(2))
ISN 0162              SL(JS) = B(2)*FN(JS)
ISN 0163          451 CONTINUE
ISN 0164              FN2 =DEXP(B(1) + BX*B(2))
                C
                C        FORM INTEGRATION APPROXIMATION
                C
ISN 0165          445 J = 15
ISN 0166              ARG4 = (BX - AX)*0.5
ISN 0167              ABAR = 0.
                C
ISN 0168              DO 42 I = 1,7
ISN 0169              ABAR = ABAR + ZEWT(2,I)*(FN(I) + FN(J))
ISN 0170           42 J = J - 1
ISN 0171              ABAR = ABAR + ZEWT(2,8)*FN(J)
ISN 0172              ABAR = ABAR*ARG4
                C
                C  FORM ERROR BASED ON DERIVATIVES
                C
ISN 0173              ETA = 0.
ISN 0174              J = 16
                C
ISN 0175              DO 15 I=1,7
ISN 0176              J = J - 1
ISN 0177              GL = ZEWT(2,I)*ZEWT(1,I)
ISN 0178              ARGE = GL*(SL(J) - SL(I))
ISN 0179           15 ETA = ETA + ARGE
                C
ISN 0180              ETA = ETA*ARG4*ARG4
ISN 0181              ETA =(ARG4*(FN2 + FN1) -ABAR - ETA)/31.
                C
ISN 0182              RETURN
ISN 0183              END
```

APPENDIX C

GABCO Program Listing (DDP-24)

```
C
C  GABCO...GAUSSIAN BROADENED COMPTON SCATTERING MATRIX COLUMN, ELECTRON
C          ENERGY(MC SQ UNITS) DEPENDENCY.  AUGUST, 1969
C   G(I,I) VECTOR FORMED
C
      COMMON    COM(138),EXPER(138),FOLD(138),ID(18),XX(2),YY(2)
     X ,X(10),Y(10),B(5),A(5,5),IPIVOT(5),C(10,5),STD(5),PIVOT(5)
     X ,INDEX(5,2),EN(138),T,RESID,WIDTH,D,T1,AMC,EIL,EIU,EOU,EOL,EIX,
     X EL,EOX22,EI3  ,EE1,EE2,ELECTI,TUP,TLOW,CON2,SUM,ARG,TOY,TOZ,
     X SUMEXP,SUMTHE,DY,XI,RATIO,EI,G,E,XP,YP1,DA,YP2,DETERM,DBG,XMIN,
     X DX,YMIN,LOWCH,MAX,MAXCH,TU,TL,TWOEOU,TWOEOL,CMX,TOU,TOL,TOW,TOX
     X ,NT,FOLDI,EOX12,EOX1,EOX2,JK,IROW,ICOLUM,EE,EF
C
      EQUIVALENCE(IROW,JROW),(ICOLUM,JCOLUM),(AMAX,T,SWAP)
      EQUIVALENCE (B(1),B1),(B(2),B2),(B(3),B3),(B(4),B4),(B(5),B5)
C
      DOUBLE PRECISION TUP,TLOW,ELECTI,EL,EIX,EOX1,EOX2,EE1,EE2,EOU,EOL,
     X EOX22, EI3, TWOEOU,TWOEOL,TOU,TOL,TOW,TOX,TOY,TOZ,TU,TL,EOX12
C
   20 FORMAT(X 17A4,A3)
   21 FORMAT(5I3,F9.3,F12.5,F6.4)
   23 FORMAT(1H0/3X 1HN 2X 9HE. ENERGY 5X 6HG(N,N)  )
   30 FORMAT(6H0CHAN. 3X 8HELECTRON 4X 7HCOMPTON 6X 7HCOMPTON 6X  8HEXPE
     XRIM.      7X  8HEXPERIM.      / 10X 6HENERGY 4X 10HSCATTERING 3X 10H
     XSCATTERING 4X 8HSPECTRUM 7X 8HSPECTRUM / 11X 5H(MEV) 4X 9H(INITIAL
     X) 5X 8H(FOLDED) 5X 9H(EXTRAP.) 4X 12H(NORMALIZED) /)
   40 FORMAT(I4,0PF12.6,1PE14.5,E13.5,0PF11.0,1PE17.5)
   51 FORMAT(1H1/ X17A4,A3/   20H0WIDTH AT HALF-HT. = F9.6, 4H MEV 26X
     X 8H LOWCH =  I3/ 37X 31HPTS. USED FOR FITTED EXTRAPL. =  I2)
   60 FORMAT(12F6.0)
   61 FORMAT(F6.0,7F8.0)
   70 FORMAT(9H SPECTRUM)
   81 FORMAT(21H ELECTRON ENERGY, MEV)
   90 FORMAT(13H EXPERIMENTAL)
  101 FORMAT(20H THEORETICAL, FOLDED )
  130 FORMAT(13H0EXPER. SUM = 1PE13.6/13H THEOR. SUM = E13.6/
     X 15H NORM. FACTOR = E13.6)
 1234 FORMAT( 1H0 9X11HCOEFFICIENT11X6HERROR /(1H 1P2E20.7)  )
 6000 FORMAT(28H0SUM OF SQUARED DEVIATIONS = 1PE13.5/)
C
C  MAXCH = CHANNEL OF ISOTOPE GAMMA ENERGY AFTER CONVERSION TO ELECTRON
C          ENERGY.
C  M = NUMBER OF COEFFICIENTS USED IN EXTRAPOLATION FIT
C  NT = 0 FOR CARD INPUT OF EXPERIMENTAL SPECTRUM
C  NT = +,- FOR ASCII TAPE INPUT OF SAME
C  NORMCH IS LAST CHANNEL USED IN NORMALIZATION OF THEORY AND EXPERIMENT
C  CMX IS ELECTRON ENERGY IN MEV AT MAXCH
C  N IS NUMBER OF POINTS USED IN FIT FOR EXTRAPOLATION TO ZERO.
C  NEXT = 1 IF NO EXTRAPOLATION USED.
C  NEXT = 0 OTHERWISE
C
    6 READ(3,20) ID
      READ(3,21) LOWCH,MAXCH,NT,NEXT,N,D,WIDTH,CMX
      MAX = MAXCH + 10
      IF(NT)26,27,26
   27 READ(3,60) (EXPER(I),I=LOWCH,MAX)
      GO TO 28
```

```
   26 CALL ASCII
      READ(2,61) DA,(EXPER(I),I=1,127)
   28 WRITE(4,51) ID,WIDTH,LOWCH,N
      NORMCH = MAXCH - 3
C
C  FORM THEORETICAL VECTOR - COMPTON SCATTERING
C  FORM EIL AND EIU WITH ELECTRON ENERGY, MC SQUARED UNITS
C
      AMC = D/.510976
      EIL = CMX/.510976 - 0.5*AMC
      EIU = EIL + AMC
      EOU = EIU*0.5*(1. + SQRT ((EIU + 2.)/EIU))
      EOL = EIL*0.5*(1. + SQRT ((EIL + 2.)/EIL))
      EOX1 = EOU*EOU
      EOX2 = EOL*EOL
      TWOEOU = 2.*EOU
      TWOEOL = 2.*EOL
      TOW = 3.*EOX1*EOU
      TOX = 3.*EOX2*EOL
      EOX12 = EOX1 * EOX1
      EOX22 = EOX2 * EOX2
C
      DO 24 I=1,MAX
      EL = AMC*FLOAT(I)
      IF(I-MAXCH)10,10,34
   10 EIX = EL*EL
      EI3 =  EL*FL*FL
      TU = 1. - EL/EOU
      TL = 1. - EL/EOL
      TOU = EL - TWOEOU - 2.
      TOL = EL - TWOEOL - 2.
      EE1 = EIX*EOX1
      EE2 = EIX*EOX2
      TOY = EE1 - EI3*EOU
      TOZ = EE2 - EI3*EOL
      ELECTI = (EIX - 2.*EL - 4.)/EI3
      TUP = DLOG(TU)*ELECTI + TOU/EOX12 + (TOU+2.)/TOY - 1./TOW -
     X (TWOEOU*(1.+EL)*FL)/EE1
      TLOW= DLOG(TL)*ELECTI + TOL/EOX22 + (TOL+2.)/TOZ - 1./TOX -
     X (TWOEOL*(1.+EL)*EL)/EE2
      COM (I) = (TUP - TLOW)*0.1746164
      GO TO 24
   34 COM(I) = 0.0
   24 EN(I) = EL*0.510976
C
C  FOLD THEORETICAL VECTOR WITH GAUSSIAN FUNCTION
C
      CON2 = 2.772589*D*D/(WIDTH*WIDTH)
C
      DO 1 I=1,MAX
      SUM = 0.
C
      DO 2 J=1,MAX
      ARG = CON2*FLOAT((J-I)*(J-I))
      IF(ARG - 20.)3,3,2
    3 SUM = SUM + EXP(- ARG)*COM(J)
    2 CONTINUE
C
      FOLDI   = SUM*0.9394373
      IF(FOLDI)13,13,1
   13 NOR = I - 1
      GO TO 14
```

```
    1 FOLD(I) = FOLDI
C
   14 FOLD(1)=2.*FOLD(2) - FOLD(3)
      IF(NEXT)301,300,301
  301 JK = LOWCH
      GO TO 302
  300 JK = 1
C
C  EXTRAPOLATE EXPERIMENTAL SPECTRUM TO ZERO
C
      M = 2
      L = LOWCH + N - 1
      K = 0
      DO 15 I=LOWCH,L
      K = K + 1
      X(K) = I
   15 Y(K) = EXPER(I)
C
      GO TO 95
C
  501 L = LOWCH - 1
      DO 16 K=1,L
      XI = K
   16 EXPER(K) = B1 + XI*(B2 + XI*(B3 + XI*(B4 + XI*B5)))
C
C  NORMALIZE EXPERIMENTAL TO THEORY
C
  302 SUMEXP = 0.0
      SUMTHE = 0.0
      DO 4 K=JK,NORMCH
      SUMEXP = SUMEXP + EXPER(K)
    4 SUMTHE = SUMTHE + FOLD(K)
C
      RATIO = SUMTHE/SUMEXP
      WRITE(4,130) SUMEXP,SUMTHE,RATIO
      WRITE(4,30)
C
      YY(1) = 1.0E-10
      YY(2) = 1.0E+10
      DO 5 J=JK,NOR
      T1 = EXPER(J)
      EE = RATIO*T1
      EF = FOLD(J)
      YY(1) = AMAX1(YY(1),EF,EE)
      YY(2)= AMIN1(YY(2),EF,EE)
      WRITE(4,40) J,EN(J),COM(J),EF,T1,EE
    5 EXPER(J) = EE
C
      WRITE(4,23)
      DO 19 J=JK,NORMCH
      G = EXPER(J)/FOLD(J)
   19 WRITE(4,40) J,EN(J),G
C
      CALL PLOT(0.,0.,-3)
      XX(1) = EN(JK)
      XX(2) = EN(NOR)
      CALL SCALE(XX,2,10.,XMIN,DX)
C
C
      CALL SCALE(YY,2,10.,YMIN,DY)
      CALL AXIS(0.,0.,10.,90.,YMIN,DY,9)
```

```
      WRITE(9,70)
      CALL AXIS(0.,0.,10.,0.,XMIN,DX,-21)
      WRITE(9,81)
      CALL PLOT(10.,0.,3)
      CALL PLOT(10.,10.,2)
      CALL PLOT(0.,10.,1)
      CALL PLTX(32)
      CALL SETGRF(0.2,10.05,0.,0.1)
      WRITE(9,20) ID
      CALL SYMBOL(7.,9.5,0.,0.1,19,3)
      CALL SETGRF(7.2,9.5,0.,0.1)
      WRITE(9,90)
      CALL SYMBOL(7.,9.0,45.,0.1,26,3)
      CALL SETGRF(7.2,9.0,0.,.1)
      WRITE(9,101)
      CALL PLOT(0.,0.,3)
      PAUSE
      CALL PLTX(32)
C
      DO 8 K=JK,NOR
      XP = (EN(K) - XMIN)/DX
      YP1 = (EXPER(K) - YMIN)/DY
      YP2 = (FOLD(K) - YMIN)/DY
      CALL SYMBOL(XP,YP1,0.,.07,19,1)
    8 CALL SYMBOL(XP,YP2,45.,.07,26,1)
C
      CALL PLOT(12.,0.,3)
C
      GO TO 6
C
C   LSQPOL CALCULATIONS
C
   95 DO620 I =1,N
  620 C(I,1) = 1.0
      DO 50 J = 2,M
      DO 50 I = 1,N
   50 C(I,J) = C(I,J-1)*X(I)
      DO 150 I = 1,M
      B(I) = 0.0
      DO 100 J = 1,M
      A(I,J) = 0.0
      DO 100 K = 1,N
  100 A(I,J) = A(I,J) + C(K,I)*C(K,J)
      DO 150 K = 1,N
  150 B(I) = B(I) + C(K,I)*Y(K)
C
C   INITIALIZATION
C
      DETERM=1.0
      DO 621 J = 1,M
  621 IPIVOT(J)=0
      DO 550 I=1,M
C
C   SEARCH FOR PIVOT ELEMENT
C
      AMAX=0.0
      DO 605 J=1,M
      IF (IPIVOT(J)-1)660,605,660
  660 DO 600 K=1,M
      IF (IPIVOT(K)-1) 80,600,740
   80 IF (ABS (AMAX)-ABS (A(J,K))) 85,600,600
   85 IROW=J
```

```
      ICOLUM=K
      AMAX=A(J,K)
  600 CONTINUE
  605 CONTINUE
      IPIVOT(ICOLUM)=IPIVOT(ICOLUM) + 1
C
C  INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
C
      IF (IROW-ICOLUM)  140, 260, 140
  140 DETERM=-DETERM
      DO 200 L=1,M
      SWAP=A(IROW,L)
      A(IROW,L)=A(ICOLUM,L)
  200 A(ICOLUM,L)=SWAP
      SWAP = B(IROW)
      B(IROW) = B(ICOLUM)
      B(ICOLUM) = SWAP
  260 INDEX(I,1)=IROW
      INDEX(I,2)=ICOLUM
      PIVOT(I)=A(ICOLUM,ICOLUM)
      DETERM=DETERM*PIVOT(I)
C
C  DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
      A(ICOLUM,ICOLUM)=1.0
      DO 350 L=1,M
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
      B(ICOLUM) = B(ICOLUM)/PIVOT(I)
C
C  REDUCE NON-PIVOT ROWS
C
      DO 550 L1=1,M
      IF(L1-ICOLUM) 400,550,400
  400 T=A(L1,ICOLUM)
      A(L1,ICOLUM)=0.0
      DO 450 L=1,M
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
      B(L1) = B(L1) - B(ICOLUM)*T
  550 CONTINUE
C
C  INTERCHANGE COLUMNS
C
      DO 710 I=1,M
      L = M + 1 - I
      IF (INDEX(L,1)-INDEX(L,2)) 630,710,630
  630 JROW=INDEX(L,1)
      JCOLUM=INDEX(L,2)
      DO 705 K=1,M
      SWAP=A(K,JROW)
      A(K,JROW)=A(K,JCOLUM)
      A(K,JCOLUM) = SWAP
  705 CONTINUE
  710 CONTINUE
  740 CONTINUE
C
      SUM = 0.0
C
      IF(M-4)209,206,203
  209 IF(M-2)204,204,207
  204 B3 = 0.
  207 B4 = 0.
```

```
  206 B5 = 0.
  203 DO 205 I = 1,N
      XI = X(I)
      RESID = B1 + XI*(B2 + XI*(B3 + XI*(B4 + XI*B5))) - Y(I)
  205 SUM = SUM+RESID*RESID
C
C   BACK TO MAIN PROGRAM
C
      DEG = N - M
      DO 680 I=1,M
      T1 = ABS(A(I,I))
  680 STD(I) = SQRT(T1*SUM/DEG)
      WRITE(4,1234)   (B(I),STD(I),I=1,M)
      WRITE(4,6000) SUM
C
      GO TO 501
      END
*0
```

APPENDIX D

DOSE Program Listing (IBM-360)

```
LEVEL 16 ( 1 JULY 68)                    OS/360  FORTRAN H                    DATE  70.133/12.39.21

        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SOURCE,EBCDIC,NOLIST,DECK,
                 C      PROGRAM DOSE                                  LOAD,MAP,NOEDIT,ID,NOXREF
ISN 0002                DIMENSION W(128),COMP(128,128),IDEN(18)
ISN 0003                COMMON/XY/FN(15),SL(15),FN1,FN2,ABAR,BX,ARG(15),WIM(128),AMEV,
                       X ETA,NPRINT,MAXCH,LOWCH
                 C
ISN 0004                DOUBLE PRECISION FN,SL,FN1,FN2,ABAR
ISN 0005                LOGICAL NPROB
ISN 0006                DATA NPROB/4H    /,Q1,Q2,Q3/0.2443038,0.1517175,-.02842462/,
                       X TOTEL/7.0E+23/,SQMC/0.510976/,PIROSQ/2.49452E-25/
                 C
ISN 0007              10 FORMAT(18A4)
ISN 0008              20 FORMAT(1H1/X 18A4)
ISN 0009              30 FORMAT(2I3,I6,2E12.4)
ISN 0010              40 FORMAT(15H0   MEV/CHAN. = F9.6, 9X24HSCALE FACTOR FOR P(E0) = F9.5
                        X//10H0   N(E) = 1PE14.1,9X26HELECTRON REST MASS UNITS = 0PF9.6 //
                        X /6HOCHAN. 4X 8HELECTRON 6X 8HELECTRON 8X 6HPHOTON 8X 6HPHOTON 7X
                        X 5HP(E0) 11X 5HINPUT 7X 7HPHI(E0)
                        X    / 12X 6HENERGY 8X 6HENERGY 8X 6HENERGY 8X 6HENERGY 21X 7HPHI(E
                        X0) 8X 6H/P(E0) 8X 4H EOU   8X 4H EOL   / 13X 5H(MEV) 7X 6H(MC SQ
                        X 10X 5H(MEV) 8X 6H(MC SQ 6X 6H(MC SQ 10X 6H(MC SQ
                        X                    /25X 6HUNITS) 23X 6HUNITS) 6X 6HUNITS) 10X6HUNITS) )
ISN 0011              50 FORMAT(I5,1PE13.3,8E14.3)
ISN 0012              80 FORMAT(6E12.0)
                 C
ISN 0013               8 READ 10,IDEN
ISN 0014                IF(IDEN(1).EQ. NPROB) GO TO 11
ISN 0016                READ 30,LOWCH,MAXCH,NPRINT,AMEV,SC
ISN 0017                READ 80,(W(I),I=LOWCH,MAXCH)
                 C
                 C    NPRINT = 1 FOR COMPLETE PRINTOUT
                 C    NPRINT = 0 FOR END RESULTS ONLY
                 C    SC = SCALE FACTOR FOR P(E0) FUNCTION
                 C    W(I) = COMPSCAT UNFOLDED WP VECTOR
                 C
ISN 0018                PRINT 20,IDEN
ISN 0019                PRINT 40,AMEV,SC,TOTEL,SQMC
                 C
ISN 0020                AMC = AMEV/SQMC
ISN 0021                PCON = PIROSQ*TOTEL
                 C
                 C    FORM COMPTON SCATTERING MATRIX
                 C
ISN 0022                DO 5 J=LOWCH,MAXCH
                 C
                 C   ELECTRON ENERGY, MEV
                 C
ISN 0023                EI = AMEV*J
                 C
                 C   ELECTRON ENERGY, (MC SQ UNITS)
                 C
ISN 0024                EP = EI/SQMC
                 C
                 C   PHOTON ENERGY, MEV
                 C
ISN 0025                PHE = EI*0.5*(1.+SQRT (1.+2.*SQMC/EI))
                 C
                 C   PHOTON ENERGY, (MC SQ UNITS)
                 C
ISN 0026                EOJ   = EP*0.5*(1.+ SQRT (1.+2./EP))
ISN 0027                P = SC*(Q1 +Q2*EOJ +Q3*EOJ*EOJ)
ISN 0028                WJ=W(J)/P
                 C
ISN 0029                DO 4 I=LOWCH,MAXCH
                 C
                 C   ELECTRON ENERGY, (MC SQ UNITS)
                 C
```

```
ISN 0030          EL = AMC*T
ISN 0031          EIX = EL*EL
ISN 0032          IF (T-J) 2,2,3
ISN 0033        3 COMP(I,J) = 0.0
ISN 0034          GO TO 4
            C
            C  FORM EIL AND EIU IN ELECTRON ENERGY (MC SQ UNITS)
            C
ISN 0035        2 EIL = EP - 0.5*AMC
ISN 0036          EIU = EIL + AMC
ISN 0037          EOL = EIL*0.5*(1. + SQRT ((EIL + 2.)/EIL))
            C
            C  FORM EOL AND EOU IN PHOTON ENERGY (MC SQ UNITS)
            C
ISN 0038          EOU = EIU*0.5*(1. + SQRT ((EIU + 2.)/EIU))
ISN 0039          EOX1 = EOU*EOU
ISN 0040          EOX2 = EOL*EOL
ISN 0041          DIFF1 = EOU - EL
ISN 0042          DIFF2 = EOL - EL
ISN 0043          EE1 = EL*EOU
ISN 0044          EE2 = EL*EOL
ISN 0045          ELECTI = (EIX - 2.*EL - 4.)/(EIX*EL)
ISN 0046          TUP =ALOG (DIFF1/EOU)*ELECTI+(EL-2.*EOU-2.)/(2.*EOX1)+(EL-2.*EOU)/
                 X(EIX*EOU*DIFF1)-1./(3.*EOX1*EOU)-(2.*EOU+EL+2.*EE1)/(EE1*EE1)
ISN 0047          TLOW=ALOG (DIFF2/EOL)*ELECTI+(EL-2.*EOL-2.)/(2.*EOX2)+(EL-2.*EOL)/
                 X(EIX*EOL*DIFF2)-1./(3.*EOX2*EOL)-(2.*EOL+EL+2.*EE2)/(EE2*EE2)
            C
ISN 0048          COMP(I,J) = PCON*(TUP - TLOW)
ISN 0049        4 CONTINUE
            C
ISN 0050          PRINT 50,J,EI,EP,PHE,EOJ,P,W(J),WJ,EOU,EOL
ISN 0051          W(J) = WJ
ISN 0052        5 CONTINUE
            C
ISN 0053          BX = AMEV*MAXCH
            C
ISN 0054          DO 13 I=LOWCH,MAXCH
ISN 0055          SUM = 0.
ISN 0056          DO 12 J=LOWCH,MAXCH
ISN 0057       12 SUM = SUM + COMP(I,J)*W(J)
ISN 0058       13 WIM(I) = SUM/(TOTEL*SQMC)
            C
ISN 0059          CALL NUMQUA
            C
ISN 0060          CONST1 = 0.5*6.02252E+23
ISN 0061          CONST2 = CONST1 * 5.7672E-5
ISN 0062          RE    = ETA/ABAR
ISN 0063          DOSE1= ABAR* CONST1
ISN 0064          DOSE2 = ABAR*CONST2
ISN 0065          ERROR1 = DOSE1*RE
ISN 0066          ERROR2 = DOSE2*RE
            C
ISN 0067          PRINT 9, BX,ABAR,ETA,(I,ARG(I),FN(I),SL(I),I=1,15)
ISN 0068          PRINT 60,DOSE1,ERROR1,DOSE2,ERROR2
            C
ISN 0069        9 FORMAT(1H17X39HAPPROX. VALUE OF INTEGRAL FROM ZERO TO F10.5, 4X
                 X 6H(N = 3,7H,M = 2)// 7X 2HIS 1PE13.5, 5H +/- E12.5, /
                 X                                          // 8X 1HL 6X 8HABSCISSA 7X
                 X 14HFUNCTION VALUE 8X 10HDERIVATIVE /(1H I8,1PE14.5,E21.5,E18.5))
ISN 0070       60 FORMAT(1H0 7X 6HDOSE = 1PE13.5,5H +/- E12.5, 13H MEV/GM.-SEC. //
                 X 14X E13.5, 5H +/- E12.5, 9H RADS/HR.)
ISN 0071          GO TO 8
ISN 0072       11 STOP
ISN 0073          END
```

```
LEVEL 16 ( 1 JULY 68)              OS/360  FORTRAN H                    DATE  70.138/12.30.10

        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SOURCE,EBCDIC,NOLIST,DECK,
ISN 0002            SUBROUTINE NUMQUA                                LOAD,MAP,NOEDIT,ID,NOXREF
            C   NUMERICAL INTEGRATION USING GAUSS-LEGENDRE QUADRATURE (15 ZEROS)
ISN 0003            DIMENSION A(2,2),B(2),PIVOT(2),C(25,2),ZEWT(2,8),
                   X IPIVOT(2),INDEX(2,2),EVAL(25),NDEX(25),DI(128),XI(128),X(25),
                   X Y(25)
            C
ISN 0004            COMMON/XY/FN(15),SL(15),FN1,FN2,ABAR,BX,ARG(15),WIM(128),AMEV,
                   X ETA,NPRINT,MAXCH,LOWCH
            C
ISN 0005            DOUBLE PRECISION FN,SL,FN1,FN2,ABAR,A,B,AMAX,PIVOT,DETERM,C,ZEWT
                   X ,T,SWAP
ISN 0006            EQUIVALENCE (AMAX,T,SWAP),(IROW,JROW),(ICOLUM,JCOLUM)
            C
ISN 0007            DATA
                   X ZEWT(1,1) /0.987992518020485 /, ZEWT(2,1) /0.030753241996117  /,
                   X ZEWT(1,2) /0.937273392400706 /, ZEWT(2,2) /0.070366047488108  /,
                   X ZEWT(1,3) /0.848206583410427 /, ZEWT(2,3) /0.107159220467172  /,
                   X ZEWT(1,4) /0.724417731360170 /, ZEWT(2,4) /0.139570677926154  /,
                   X ZEWT(1,5) /0.570972172608539 /, ZEWT(2,5) /0.166269205816993  /,
                   X ZEWT(1,6) /0.394151347077563 /, ZEWT(2,6) /0.186161000015562  /,
                   X ZEWT(1,7) /0.201194093997435 /, ZEWT(2,7) /0.198431485327112  /,
                   X ZEWT(1,8) /0.000000000000000 /, ZEWT(2,8) /0.202578241925561  /
            C
            C   END ZERO AND WEIGHT DATA FOR 15 POINT CASE
            C
            C   BX = UPPER LIMIT OF INTEGRATION FOR WIM*E
            C
            C
ISN 0008            N=3
            C
ISN 0009            XI(1) = 0.0
ISN 0010            DI(1) = 0.0
ISN 0011            IF(LOWCH .GE. 2)  GO TO 5
ISN 0013            PRINT 6
ISN 0014          6 FORMAT( 25H0FIRST POINT MUST BE ZERO  )
ISN 0015            ABAR = 0.
ISN 0016            ETA = 0.
ISN 0017            RETURN
ISN 0018          5 WIM(LOWCH-1) = 0.
ISN 0019            K = 1
            C
ISN 0020            DO 2 J=LOWCH,MAXCH
ISN 0021            K = K + 1
ISN 0022            XI(K) = AMEV*J
ISN 0023            DI(K) = WIM(J)*AMEV*J
ISN 0024          2 CONTINUE
ISN 0025            NPTS = K
            C
ISN 0026            PRINT 999, (K,XI(K),WIM(LOWCH-2+K),DI(K),K=1,NPTS)
ISN 0027        999 FORMAT(7H1 INDEX 4X 8HELECTRON 5X 24H(PHI(EO)/P(EO))*C(EI,EO)
                   X 8X 7HWIM(EI) / 13X 6HENERGY 11X 13H/(N(EI)*SQMC) 15X 3H*EI
                   X / 14X 5H(MEV) 12X 9H= WIM(EI) /(I6,1PE13.3,4X E18.5,6X E17.5) )
            C
            C   FORM ABSCISSA VALUES FOR 15 GAUSS-LEGENDRE POLYNOMIAL ZEROS.
            C
ISN 0028            J=15
ISN 0029            DO 20 K=1,7
ISN 0030            ARG(K) =(-BX*ZEWT(1,K)+ BX)*0.5
ISN 0031            ARG(J) =(BX* ZEWT(1,K)+ BX)*0.5
ISN 0032         20 J=J-1
ISN 0033            ARG(J)= BX*0.5
            C
            C
            C   FORM SLOPES AND FUNCTIONS
            C
ISN 0034            DO 451 JS = 1,15
ISN 0035            TEST = ARG(JS)
ISN 0036            IF(TEST - XI(NPTS))202,202,51
            C
ISN 0037        202 DO 452 IB = 1,NPTS
ISN 0038            NTIMF = 0
```

```
ISN 0039          IF(TEST - XI(IB))98,98,452
ISN 0040       98 IF(IB .LE. 2)  GO TO 16
ISN 0042          L = IB - 2
ISN 0043       54 IF(L .LE. 0)  GO TO 16
ISN 0045          IF(L + N - NPTS - 1)60,60,59
ISN 0046       59 L = NPTS - N + 1
ISN 0047          GO TO 60
ISN 0048       16 L = 1
            C
ISN 0049       60 DO 99 K = 1,N
ISN 0050          X(K) = XI(L)
ISN 0051          Y(K) = DI(L)
ISN 0052       99 L = L + 1
            C
            C  FIRST ARG
            C
ISN 0053          IF((I-1) .EQ. N)   GO TO 95
            C
            C  LAST ARG
            C
ISN 0055          IF(L .GT. NPTS)  GO TO 95
            C
            C  TEST FOR CLOSEST POINTS TO ARG
            C
ISN 0057          ILOW = L - N - 1
ISN 0058          TEST1 = TEST - XI(ILOW)
ISN 0059          TEST2 = TEST - X(1)
ISN 0060          TEST3 = X(N) - TEST
ISN 0061          TEST4 = XI(L) - TEST
ISN 0062          IF(TEST4 .GE. TEST2)  GO TO 97
ISN 0064          GO TO 452
ISN 0065       97 IF(TEST1 .GE. TEST3) GO TO 95
ISN 0067          NTIME = NTIME + 1
ISN 0068          L = IB - NTIME - 2
ISN 0069          GO TO 54
            C
            C   LSQPOL CALCULATIONS
            C
ISN 0070       95 DO620 I =1,N
ISN 0071      620 C(I,1) = 1.0
ISN 0072          DO 50 J = 2,2
ISN 0073          DO 50 I = 1,N
ISN 0074       50 C(I,J) = C(I,J-1)*X(I)
ISN 0075          DO 150 I = 1,2
ISN 0076          B(I) = 0.0
ISN 0077          DO 100 J = 1,2
ISN 0078          A(I,J) = 0.0
ISN 0079          DO 100 K = 1,N
ISN 0080      100 A(I,J) = A(I,J) + C(K,I)*C(K,J)
ISN 0081          DO 150 K = 1,N
ISN 0082      150 B(I) = B(I) + C(K,I)*Y(K)
            C
            C  INITIALIZATION
            C
ISN 0083          DETERM=1.0
ISN 0084          DO 621 J = 1,2
ISN 0085      621 IPIVOT(J)=0
ISN 0086          DO 550 I=1,2
            C
            C  SEARCH FOR PIVOT ELEMENT
            C
ISN 0087          AMAX=0.0
ISN 0088          DO 605 J=1,2
ISN 0089          IF (IPIVOT(J)-1)660,605,660
ISN 0090      660 DO 600 K=1,2
ISN 0091          IF (IPIVOT(K)-1) 80,600,740
ISN 0092       80 IF(DABS (AMAX)-DABS(A(J,K))) 85,600,600
ISN 0093       85 IROW=J
ISN 0094          ICOLUM=K
ISN 0095          AMAX=A(J,K)
ISN 0096      600 CONTINUE
ISN 0097      605 CONTINUE
ISN 0098          IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
            C
```

```
                C  INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
                C
ISN 0099              IF (IROW-ICOLUM)  140, 260, 140
ISN 0100          140 DETERM=-DETERM
ISN 0101              DO 200 L=1,2
ISN 0102              SWAP=A(IROW,L)
ISN 0103              A(IROW,L)=A(ICOLUM,L)
ISN 0104          200 A(ICOLUM,L)=SWAP
ISN 0105              SWAP = B(IROW)
ISN 0106              B(IROW) = B(ICOLUM)
ISN 0107              B(ICOLUM) = SWAP
ISN 0108          260 INDEX(I,1)=IROW
ISN 0109              INDEX(I,2)=ICOLUM
ISN 0110              PIVOT(I)=A(ICOLUM,ICOLUM)
ISN 0111              DETERM=DETERM*PIVOT(I)
                C
                C  DIVIDE PIVOT ROW BY PIVOT ELEMENT
                C
ISN 0112              A(ICOLUM,ICOLUM)=1.0
ISN 0113              DO 350 L=1,2
ISN 0114          350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
ISN 0115              B(ICOLUM) = B(ICOLUM)/PIVOT(I)
                C
                C  REDUCE NON-PIVOT ROWS
                C
ISN 0116              DO 550 L1=1,2
ISN 0117              IF(L1-ICOLUM) 400,550,400
ISN 0118          400 T=A(L1,ICOLUM)
ISN 0119              A(L1,ICOLUM)=0.0
ISN 0120              DO 450 L=1,2
ISN 0121          450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
ISN 0122              B(L1) = B(L1) - B(ICOLUM)*T
ISN 0123          550 CONTINUE
                C
                C  INTERCHANGE COLUMNS
                C
ISN 0124              DO 710 I=1,2
ISN 0125              L = 3 - I
ISN 0126              IF (INDEX(L,1)-INDEX(L,2)) 630,710,630
ISN 0127          630 JROW=INDEX(L,1)
ISN 0128              JCOLUM=INDEX(L,2)
ISN 0129              DO 705 K=1,2
ISN 0130              SWAP=A(K,JROW)
ISN 0131              A(K,JROW)=A(K,JCOLUM)
ISN 0132              A(K,JCOLUM) = SWAP
ISN 0133          705 CONTINUE
ISN 0134          710 CONTINUE
ISN 0135          740 CONTINUE
                C
ISN 0136              IF(NPRINT .EQ. 0)  GO TO 51
                C
                C  PRINT RESULTS
                C
ISN 0138              IF(IB - N)3,4,4
ISN 0139            3 IB = N
ISN 0140            4 DO 170 I=1,N
ISN 0141              NDEX(I) = LOWCH + IB - 5 + I
ISN 0142          170 EVAL(I) = B(1) + X(I)*B(2)
                C
ISN 0143              PRINT   1234, B(1),B(2)
ISN 0144              PRINT 7000
ISN 0145              PRINT   7001, (NDEX(I),X(I),Y(I),EVAL(I),I=1,N)
ISN 0146         1234 FORMAT(///18HOLEAST SQUARES FIT //
                     X 6X 3HA =     1PE16.7, /6X 3HB = E16.7)
ISN 0147         7000 FORMAT(/6HOCHAN. 6X 8HELECTRON 9X 5HWIM*E  8X
                     X 10HEVALUATION / 11X 11HENERGY, MEV 6X 6HVECTOR )
ISN 0148         7001 FORMAT(I5,0PF15.5,1PE16.4,E18.4)
                C
ISN 0149              GO TO 51
                C
ISN 0150          452 CONTINUE
                C
ISN 0151           51 IF(JS .GT. 1)  GO TO 1
```

```
ISN 0153          FN1 = B(1)
ISN 0154        1 FN(JS) = B(1) + TEST*B(2)
ISN 0155          SL(JS) = B(2)
ISN 0156      451 CONTINUE
ISN 0157          FN2 = B(1) + BX*B(2)
            C
            C       FORM INTEGRATION APPROXIMATION
            C
ISN 0158      445 J = 15
            C
ISN 0159          ARG4 = BX*0.5
ISN 0160          ABAR = 0.
            C
ISN 0161          DO 42 I = 1,7
ISN 0162          ABAR = ABAR + ZEWT(2,I)*(FN(I) + FN(J))
ISN 0163       42 J = J - 1
ISN 0164          ABAR = ABAR + ZEWT(2,8)*FN(J)
ISN 0165          ABAR = ABAR*ARG4
            C
            C  FORM ERROR BASED ON DERIVATIVES
            C
ISN 0166          ETA = 0.
ISN 0167          J = 16
            C
ISN 0168          DO 15 I=1,7
ISN 0169          J = J - 1
ISN 0170          GL = ZEWT(2,I)*ZEWT(1,I)
ISN 0171          ARGE = GL*(SL(J) - SL(I))
ISN 0172       15 ETA = ETA + ARGE
            C
ISN 0173          ETA = ETA*ARG4*ARG4
ISN 0174          ETA =(ARG4*(FN2 + FN1) -ABAR - ETA)/31.
            C
ISN 0175          RETURN
ISN 0176          END
```

APPENDIX E

COMPLOT Program Listing (DDP-24)

```
C
C   COMPLOT PROGRAM
C     JAN. 1969 REVISION          MODIFIED VERSION AUG. 1969
C   APRIL 1970 VERSION USES P FUNCTION AND SCALE FACTOR FOR P
C   KIND = 1 FOR PHOTON ENERGY(MEV) SCALE WITH COMPSCAT OUTPUT (FL) AND
C            RAW DATA (W).  FL IS UNFOLDED.
C   KIND = 2 FOR ELECTRON ENERGY SCALE WITH COMPSCAT OR FEND OUTPUT (FL)
C            RAW DATA(W).  FL IS NOT UNFOLDED.
C   KIND = 3 FOR PHOTON ENERGY(MEV) SCALE, COMPSCAT OUTPUT (FL AND W)
C            W IS MATRIX ITERATED ERROR.  (BOTH UNFOLDED)
C
C   LIN = 0 FOR LOG SCALE (ORDINATE)
C   LIN = 1 FOR LINEAR SCALE (ORDINATE)
C    SC (SCALE FACTOR FOR P(E0) FUNCTION) = (CIN/COUT)EXP/(CIN/COUT)RESP
C
      COMMON FL(128),W(128),NAME(18),YY(2),E(2)
      DATA Q1,Q2,Q3/0.2443038,0.1517175,-.02842462/,SQMC/.518976/
C
    1 FORMAT (3I3,F9.4,2F6.0)
    4 FORMAT (6E12.0)
    6 FORMAT(12F6.0)
   32 FORMAT(2I1,17A4,A3)
  203 FORMAT(/25H0ERROR VECTOR IS ADJUSTED )
  208 FORMAT(8X 48HKIND = 1, FL = ITERATED OUTPUT AND W = RAW DATA.)
  209 FORMAT(8X 52HKIND = 2, FL = COMPSCAT OR FEND OUTPUT, W = RAW DATA)
  210 FORMAT(8X 39HKIND = 3, FL AND W ARE ITERATED OUTPUT. )
  212 FORMAT(8H0LOWCH = I3,2X 8HMAXCH = I3,2X 8HMEV/CH = F8.5, 2X
     X 17H MEV/MC SQ UNIT = F9.6/3X 24HSCALE FACTOR FOR PKEDT =  F9.6;/
     X 15H0INPUT SPECTRUM /(6E12.4) )
  300 FORMAT(1H1/X 17A4,A3)
C
   49 READ(3,32) KIND,LIN,NAME
      READ(3,1) LOWCH,MAXCH,ITER,A,S,SC
      READ (3,4) (FL(J),J=LOWCH,MAXCH)
      WRITE(4,300) NAME
      GO TO (205,206,207),KIND
  205 WRITE(4,208)
      READ (3,6) (W(J),J=LOWCH,MAXCH)
      GO TO 211
  206 WRITE(4,209)
      READ (3,6) (W(J),J=LOWCH,MAXCH)
      GO TO 211
  207 WRITE(4,210)
      READ (3,4) (W(J),J=LOWCH,MAXCH)
  211 WRITE(4,212) LOWCH,MAXCH,A,SQMC,SC,(FL(J),J=LOWCH,MAXCH)
C
C   FORM ABSOLUTE ERROR FOR RAW DATA AND ERROR VECTOR.  BOTH ARE W
C   ADJUST FLUX WITH P FUNCTION AND CONVERT FROM MC SQ UNITS.
C
      NONO = 1
      TEMP = A/SQMC
      DO 2 J=LOWCH,MAXCH
      CH = J
      EOJ =  TEMP*CH*0.5*(1.+SQRT(1.+2./(TEMP*CH)) )
      P = (Q1+Q2*EOJ+Q3*EOJ*EOJ)*SC
      FLUX = FL(J)/(SQMC*P)
      GO TO (14,14,16),KIND
```

```
   14 W(J) = FLUX/SQRT(W(J))
      GO TO 21
   16 W(J) = SQRT(W(J))/(SQMC*P)
   21 IF(W(J)-FLUX )2,22,22
   22 W(J) = FLUX*0.95
      NONO = 2
    2 FL(J) = FLUX
      GO TO (17,202),NONO
  202 WRITE(4,203)
C
   17 YY(1) = 1.E-20
      YY(2) = 1.E+20
      DO 10 J=LOWCH,MAXCH
      FLJ = FL(J)
      SIGMA = W(J)
      TEMP1 = FLJ - SIGMA
      TEMP2 = FLJ + SIGMA
      IF(LIN .EQ. 1)  GO TO 11
      TEMP1 = ALOG10(FLJ - SIGMA)
      TEMP2 = ALOG10(FLJ + SIGMA)
   11 YY(1) = AMAX1(YY(1),TEMP2)
   10 YY(2) = AMIN1(YY(2),TEMP1)
C
      CALL PLOT (0.,0.,-3)
      IF(LIN .EQ. 1)  GO TO 12
      CALL SCALOG(YY,2,10.,IMAX,NDEC,YMIN,DY)
      CALL LOGAX(0.,0.,45,10.,90.,IMAX,NDEC,.1)
      GO TO 101
   12 CALL SCALE (YY,2,10.,YMIN,DY)
      CALL AXIS (0.,0.,10.,90.,YMIN,DY,46)
  101 CALL PLOT (S, 0., 3)
      CALL PLOT (S, 10., 2)


      CALL PLOT (0.,10.,1)
      CALL PLOT (0.,10.,3)
C
      IF(KIND - 2) 103,15,103
   15 WRITE(9,18)
   18 FORMAT(14X 17HADJUSTED SPECTRUM 15X )
      CALL SETGRF (.2,10.05,0.,.11)
      WRITE(9,19) NAME
   19 FORMAT(3X 17A4,A3 )
      E(1) = A*FLOAT(LOWCH)
      E(2) = A*FLOAT(MAXCH)
      CALL SCALE(E,2,S,XMIN,DX)
      CALL AXIS(0.,0.,S,0.,XMIN,DX,-21)
      WRITE(9,8)
    8 FORMAT(21H ELECTRON ENERGY, MEV )
      WRITE(4,221)
  221 FORMAT(5H0   N 6X 9H ELECTRON 7X 8HSPECTRUM 9X 5HSIGMA  /12X
     X 6HENERGY /13X 5H(MEV) )
      GO TO 9
C
  103 WRITE (9,5)
    5 FORMAT (46H PHOTON FLUX SPECTRUM (PHOTON/(SEC*CM*CM*MEV)) )
      E(1) = FLOAT(LOWCH)*A*.5*(1.+SQRT(1.+2.*SQMC/(FLOAT(LOWCH)*A)))
      E(2) = FLOAT(MAXCH)*A*.5*(1.+SQRT(1.+2.*SQMC/(FLOAT(MAXCH)*A)))
      CALL SCALE (E,2,S,XMIN,DX)
      CALL AXIS (0.,0., S, 0.,XMIN,DX,-20)
```

```
      WRITE (9,7)
    7 FORMAT (20H PHOTON ENERGY (MEV))
      CALL SETGRF (.2,10.05,0.,.12)
      WRITE (9,20) NAME,ITER
   20 FORMAT (17H UNFOLDED RESULTS 4X 17A4,A3,2X 5HITER= I2)
      WRITE(4,220)
  220 FORMAT(4H0  N 8X 6HPHOTON 8X 8HSPECTRUM 7X 5HSIGMA  / 12X
     X 6HENERGY /13X 5H(MEV) )
C
    9 CALL PLOT(0.,0.,3)
      PAUSE
C
      DO 55 J=LOWCH,MAXCH
      FLJ = FL(J)
      DELTA = W(J)
      IF(KIND .NE. 2)  GO TO 26
      EOM = (A*FLOAT(J) - XMIN)/DX
      WRITE(4,225) J,EOM,FLJ,DELTA
  225 FORMAT(1H I4,F15.5,1P2E15.5)
      GO TO 3
C
   26 AJ = FLOAT(J)*A
      EOM =  AJ*.5*(1.+SQRT(1.+2.*SQMC/AJ))
      WRITE(4,200) J,EOM,FLJ, DELTA
  200 FORMAT(1H I3,1PE14.4,E16.4,E14.4)
      EOM = (EOM - XMIN)/DX
    3 IF(LIN .EQ. 0)  GO TO 56
      FLUX = (FLJ - YMIN)/DY
      DELTA = DELTA/DY
      CALL SYMBOL(EOM,FLUX-DELTA,0.,.1,33,3)
      CALL SYMBOL(EOM,FLUX,0.,.05,26,1)
      CALL SYMBOL(EOM,FLUX+DELTA,180.,.1,33,2)
      GO TO 55
C
   56 FLUU = (ALOG10(FLJ    - DELTA) - YMIN)/DY
      FLUX = (ALOG10(FLJ    ) - YMIN)/DY
      FLUV = (ALOG10(FLJ    + DELTA) - YMIN)/DY
      CALL SYMBOL(EOM,FLUU,0.,.1,33,3)
      CALL SYMBOL(EOM,FLUX,0.,.05,26,1)
      CALL SYMBOL(EOM,FLUV,180.,.1,33,2)
   55 CONTINUE
C
      CALL PLOT (S+2.,0.,3)
      GO TO 49
      END
*0
```

APPENDIX F

Sample Measurement Data

1. COMPSCAT Program Input (KIND = 2, NERR = 1)

```
10/9/69 ATSR, 37 WATT, SNELL BLOCK, UNFOLD RAW DATA
 7124  2  .01671    1031.70
53668 49957 46988 45558 44195 43495 41949 40627 39767 38508 38146 37702
37310 35846 33243 31708 30976 30341 29327 29165 28709 29630 29192 28319
27749 27130 26823 25981 25297 24750 24230 23690 22839 22266 22100 21364
20890 20263 19994 19634 19279 18282 17018 16519 15730 15292 14727 14448
14075 13545 13043 12742 12556 12302 11754 11251 11275 10842 10406 10292
10021  9798  9508  9252  9121  8780  8557  8341  8040  7705  7758  7528
 7193  7018  6851  6692  6535  6287  6120  5864  5718  5552  5446  5126
 5004  4907  4637  4563  4455  4337  4143  4002  3845  3694  3490  3343
 3266  3127  2936  2894  2761  2672  2585  2462  2344  2201  2263  2056
 2016  1907  1851  1759  1681  1646  1491  1493  1396  1369
   20    20     1
```

2. COMPSCAT Program Input (KIND = 4, NERR = 3)

```
10/9/69  ATSR, 37 WATT, SNELL BLOCK,  UNFOLD ERROR VECTOR
 7124  4  .01671    1031.70     0.5819268
0.92567E 03 0.86166E 03 0.81045E 03 0.78578E 03 0.76228E 03 0.75020E 03
0.72354E 03 0.70073E 03 0.68590E 03 0.65419E 03 0.65794E 03 0.65028E 03
0.54352E 03 0.61827E 03 0.57338E 03 0.54690E 03 0.53427E 03 0.52332E 03
0.50583E 03 0.50304E 03 0.49517E 03 0.49381E 03 0.50350E 03 0.49282E 03
0.48673E 03 0.48042E 03 0.48025E 03 0.47100E 03 0.46497E 03 0.46183E 03
0.45957E 03 0.45725E 03 0.44910E 03 0.44652E 03 0.45244E 03 0.44693E 03
0.44698E 03 0.44383E 03 0.44869E 03 0.45178E 03 0.45519E 03 0.44323E 03
0.42394E 03 0.42310E 03 0.41447E 03 0.41474E 03 0.41133E 03 0.41576E 03
0.41747E 03 0.41424E 03 0.41142E 03 0.41467E 03 0.42166E 03 0.42641E 03
0.42091E 03 0.41558E 03 0.42995E 03 0.42681E 03 0.42287E 03 0.43169E 03
0.43377E 03 0.43759E 03 0.43800E 03 0.43949E 03 0.44561E 03 0.44298E 03
0.44465E 03 0.44619E 03 0.44253E 03 0.43613E 03 0.45135E 03 0.44991E 03
0.44135E 03 0.44183E 03 0.44231E 03 0.44281E 03 0.44294E 03 0.43629E 03
0.43460E 03 0.42593E 03 0.42465E 03 0.42143E 03 0.42240E 03 0.40615E 03
0.40496E 03 0.40558E 03 0.39143E 03 0.39343E 03 0.39242E 03 0.39039E 03
0.38125E 03 0.37667E 03 0.37046E 03 0.35439E 03 0.35287E 03 0.34678E 03
0.34796E 03 0.34258E 03 0.33119E 03 0.33664E 03 0.33191E 03 0.33216E 03
0.33310E 03 0.32956E 03 0.32668E 03 0.32014E 03 0.34442E 03 0.32829E 03
0.33873E 03 0.33825E 03 0.34775E 03 0.35119E 03 0.35803E 03 0.37528E 03
0.36536E 03 0.39468E 03 0.39961E 03 0.42584E 03
   20    20     3
```

3. COMPSCAT Program Input (KIND = 3, NERR = 3)

```
10/9/69 ATSR,37 WATT, SNELL BLOCK, UNFOLD WP VECTOR
 7119  3  .01671    1031.70
0.89724E 03 0.83327E 03 0.78209E 03 0.75746E 03 0.73399E 03 0.72194E 03
0.69531E 03 0.67253E 03 0.65772E 03 0.63604E 03 0.62981E 03 0.62218E 03
0.61544E 03 0.59021E 03 0.54534E 03 0.51888E 03 0.50626E 03 0.49533E 03
0.47785E 03 0.47508E 03 0.46722E 03 0.46586E 03 0.47556E 03 0.46489E 03
0.45880E 03 0.45249E 03 0.45232E 03 0.44307E 03 0.43703E 03 0.43389E 03
0.43162E 03 0.42929E 03 0.42113E 03 0.41853E 03 0.42443E 03 0.41890E 03
```

0.41893E 03	0.41575E 03	0.42058E 03	0.42364E 03	0.42702E 03	0.41502E 03
0.39569E 03	0.39480E 03	0.38613E 03	0.38634E 03	0.38288E 03	0.38725E 03
0.38890E 03	0.38560E 03	0.38271E 03	0.38588E 03	0.39299E 03	0.39745E 03
0.39186E 03	0.38644E 03	0.40071E 03	0.39746E 03	0.39341E 03	0.40211E 03
0.40406E 03	0.40775E 03	0.40802E 03	0.40936E 03	0.41532E 03	0.41253E 03
0.41402E 03	0.41538E 03	0.41153E 03	0.40493E 03	0.41994E 03	0.41827E 03
0.40947E 03	0.40971E 03	0.40992E 03	0.41015E 03	0.40999E 03	0.40303E 03
0.40101E 03	0.39200E 03	0.39036E 03	0.38676E 03	0.38732E 03	0.37064E 03
0.36900E 03	0.36914E 03	0.35448E 03	0.35594E 03	0.35435E 03	0.35171E 03
0.34192E 03	0.33664E 03	0.32969E 03	0.32282E 03	0.31045E 03	0.30344E 03
0.30363E 03	0.29719E 03	0.28465E 03	0.28886E 03	0.28258E 03	0.28156E 03
0.28089E 03	0.27559E 03	0.27077E 03	0.26208E 03	0.28398E 03	0.26519E 03
0.27264E 03	0.26878E 03	0.27443E 03	0.27344E 03	0.27515E 03	
20	20	3			
0.92567E 03	0.86166E 03	0.81045E 03	0.78578E 03	0.76228E 03	0.75020E 03
0.72354E 03	0.70073E 03	0.68590E 03	0.66419E 03	0.65794E 03	0.65028E 03
0.54352E 03	0.61827E 03	0.57338E 03	0.54690E 03	0.53427E 03	0.52332E 03
0.50583E 03	0.50304E 03	0.49517E 03	0.49381E 03	0.50350E 03	0.49282E 03
0.48673E 03	0.48042E 03	0.48025E 03	0.47100E 03	0.46497E 03	0.46183E 03
0.45957E 03	0.45725E 03	0.44910E 03	0.44652E 03	0.45244E 03	0.44693E 03
0.44698E 03	0.44383E 03	0.44869E 03	0.45178E 03	0.45519E 03	0.44323E 03
0.42394E 03	0.42310E 03	0.41447E 03	0.41474E 03	0.41133E 03	0.41576E 03
0.41747E 03	0.41424E 03	0.41142E 03	0.41467E 03	0.42166E 03	0.42641E 03
0.42091E 03	0.41558E 03	0.42995E 03	0.42681E 03	0.42287E 03	0.43169E 03
0.43377E 03	0.43759E 03	0.43800E 03	0.43949E 03	0.44661E 03	0.44298E 03
0.44465E 03	0.44619E 03	0.44253E 03	0.43613E 03	0.45135E 03	0.44991E 03
0.44135E 03	0.44183E 03	0.44231E 03	0.44281E 03	0.44294E 03	0.43629E 03
0.43460E 03	0.42593E 03	0.42465E 03	0.42143E 03	0.42240E 03	0.40615E 03
0.40496E 03	0.40558E 03	0.39143E 03	0.39343E 03	0.39242E 03	0.39039E 03
0.38125E 03	0.37667E 03	0.37046E 03	0.35439E 03	0.35287E 03	0.34678E 03
0.34796E 03	0.34258E 03	0.33119E 03	0.33664E 03	0.33171E 03	0.33216E 03
0.33310E 03	0.32956E 03	0.32668E 03	0.32014E 03	0.34442E 03	0.32829E 03
0.33873E 03	0.33825E 03	0.34775E 03	0.35119E 03	0.35803E 03	0.37528E 03

4. Compton Response Matrix (Upper Corner)

MATRIX ELEMENTS

I/J	7	8	9	10	11	12	13	14
	0.47161	0.51541	0.55803	0.59968	0.64053	0.68068	0.72025	0.75931
7	0.88726E-01	0.47938E-01	0.32104E-01	0.24872E-01	0.21020E-01	0.18587E-01	0.16853E-01	0.15486E-01
8	0.0	0.73525E-01	0.42047E-01	0.28712E-01	0.22317E-01	0.18771E-01	0.16565E-01	0.15014E-01
9	0.0	0.0	0.62500E-01	0.37369E-01	0.26016E-01	0.20276E-01	0.17026E-01	0.14995E-01
10	0.0	0.0	0.0	0.54125E-01	0.33614E-01	0.23796E-01	0.18616E-01	0.15632E-01
11	0.0	0.0	0.0	0.0	0.47627E-01	0.30521E-01	0.21931E-01	0.17255E-01
12	0.0	0.0	0.0	0.0	0.0	0.42420E-01	0.27921E-01	0.20354E-01
13	0.0	0.0	0.0	0.0	0.0	0.0	0.38181E-01	0.25717E-01
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.34670E-01
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

5. Compton Response Matrix (Lower Corner)

I/J	117	118	119	120	121	122	123	124
	4.27378	4.30694	4.33989	4.37295	4.40600	4.43904	4.47208	4.50511
115	0.25186E-02	0.22958E-02	0.21074E-02	0.19465E-02	0.18076E-02	0.16867E-02	0.15809E-02	0.14874E-02
116	0.27615E-02	0.24978E-02	0.22775E-02	0.20912E-02	0.19319E-02	0.17943E-02	0.16748E-02	0.15698E-02
117	0.30541E-02	0.27381E-02	0.24775E-02	0.22596E-02	0.20751E-02	0.19173E-02	0.17814E-02	0.16628E-02
118	0.0	0.30273E-02	0.27151E-02	0.24574E-02	0.22419E-02	0.20592E-02	0.19034E-02	0.17685E-02
119	0.0	0.0	0.30010E-02	0.26924E-02	0.24377E-02	0.22243E-02	0.20439E-02	0.18893E-02
120	0.0	0.0	0.0	0.29751E-02	0.26701E-02	0.24181E-02	0.22074E-02	0.20287E-02
121	0.0	0.0	0.0	0.0	0.29496E-02	0.26481E-02	0.23992E-02	0.21905E-02
122	0.0	0.0	0.0	0.0	0.0	0.29245E-02	0.26267E-02	0.23804E-02
123	0.0	0.0	0.0	0.0	0.0	0.0	0.29001E-02	0.26056E-02
124	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.28760E-02

6. COMPSCAT Printout (KIND = 1, NERR = 1)

10/9/69 ATSR, 37 WATT, SNELL BLOCK, UNFOLD RAW DATA

MEV/CH =0.01671 PI*R(0)**2 = 2.49452E-25 N(E) = 7.000E 23

LIVE TIME = 1.03170E 03 SEC.

NORMALIZATION FACTOR =5.819268E-01

CHAN.	INPUT VECTOR	ELECTRON ENERGY, MEV	G MATRIX	WADJ
7	0.537E 05	0.11697	0.10000E 01	0.92567E 03
8	0.500E 05	0.13368	0.10000E 01	0.86166E 03
9	0.470E 05	0.15039	0.10000E 01	0.81045E 03
10	0.456E 05	0.16710	0.10000E 01	0.78578E 03
11	0.442E 05	0.18381	0.10000E 01	0.76228E 03
12	0.435E 05	0.20052	0.10000E 01	0.75020E 03
13	0.419E 05	0.21723	0.10000E 01	0.72354E 03
14	0.406E 05	0.23394	0.10000E 01	0.70073E 03
15	0.398E 05	0.25065	0.10000E 01	0.68590E 03
16	0.385E 05	0.26736	0.10000E 01	0.66419E 03
17	0.381E 05	0.28407	0.10000E 01	0.65794E 03
18	0.377E 05	0.30078	0.10000E 01	0.65028E 03
19	0.373E 05	0.31749	0.10000E 01	0.64352E 03
20	0.358E 05	0.33420	0.10000E 01	0.61827E 03
21	0.332E 05	0.35091	0.10000E 01	0.57338E 03
22	0.317E 05	0.36762	0.10000E 01	0.54690E 03
23	0.310E 05	0.38433	0.10000E 01	0.53427E 03
24	0.303E 05	0.40104	0.10000E 01	0.52332E 03
25	0.293E 05	0.41775	0.10000E 01	0.50583E 03
26	0.292E 05	0.43446	0.10000E 01	0.50304E 03
27	0.287E 05	0.45117	0.10000E 01	0.49517E 03
28	0.286E 05	0.46788	0.10000E 01	0.49381E 03
29	0.292E 05	0.48459	0.10000E 01	0.50350E 03
30	0.283E 05	0.50130	0.99112E 00	0.49282E 03
31	0.277E 05	0.51801	0.98332E 00	0.48673E 03
32	0.271E 05	0.53472	0.97402E 00	0.48042E 03
33	0.268E 05	0.55143	0.96335E 00	0.48025E 03
34	0.260E 05	0.56814	0.95143E 00	0.47100E 03
35	0.253E 05	0.58485	0.93839E 00	0.46497E 03
36	0.248E 05	0.60156	0.92433E 00	0.46183E 03
37	0.242E 05	0.61827	0.90937E 00	0.45957E 03
38	0.237E 05	0.63498	0.89361E 00	0.45725E 03
39	0.228E 05	0.65169	0.87715E 00	0.44910E 03
40	0.223E 05	0.66840	0.86008E 00	0.44652E 03
41	0.221E 05	0.68511	0.84250E 00	0.45244E 03
42	0.214E 05	0.70182	0.82448E 00	0.44693E 03
43	0.209E 05	0.71853	0.80610E 00	0.44698E 03
44	0.203E 05	0.73524	0.78745E 00	0.44383E 03
45	0.200E 05	0.75195	0.76859E 00	0.44869E 03
46	0.196E 05	0.76866	0.74959E 00	0.45178E 03
47	0.193E 05	0.78537	0.73052E 00	0.45519E 03
48	0.183E 05	0.80208	0.71143E 00	0.44323E 03
49	0.170E 05	0.81879	0.69238E 00	0.42394E 03
50	0.165E 05	0.83550	0.67342E 00	0.42310E 03

51	0.157E 05	0.85221	0.65460E 00	0.41447E 03
52	0.153E 05	0.86892	0.63596E 00	0.41474E 03
53	0.147E 05	0.88563	0.61754E 00	0.41133E 03
54	0.144E 05	0.90234	0.59938E 00	0.41576E 03
55	0.141E 05	0.91905	0.58152E 00	0.41747E 03
56	0.135E 05	0.93576	0.56399E 00	0.41424E 03
57	0.130E 05	0.95247	0.54681E 00	0.41142E 03
58	0.127E 05	0.96918	0.53000E 00	0.41467E 03
59	0.126E 05	0.98589	0.51360E 00	0.42166E 03
60	0.123E 05	1.00260	0.49761E 00	0.42641E 03
61	0.118E 05	1.01931	0.48206E 00	0.42091E 03
62	0.113E 05	1.03602	0.46696E 00	0.41558E 03
63	0.113E 05	1.05273	0.45231E 00	0.42995E 03
64	0.108E 05	1.06944	0.43814E 00	0.42681E 03
65	0.104E 05	1.08615	0.42443E 00	0.42287E 03
66	0.103E 05	1.10286	0.41121E 00	0.43169E 03
67	0.100E 05	1.11957	0.39846E 00	0.43377E 03
68	0.980E 04	1.13628	0.38620E 00	0.43759E 03
69	0.951E 04	1.15299	0.37441E 00	0.43800E 03
70	0.925E 04	1.16970	0.36310E 00	0.43949E 03
71	0.912E 04	1.18641	0.35225E 00	0.44661E 03
72	0.878E 04	1.20312	0.34186E 00	0.44298E 03
73	0.856E 04	1.21983	0.33193E 00	0.44465E 03
74	0.834E 04	1.23654	0.32243E 00	0.44619E 03
75	0.804E 04	1.25325	0.31337E 00	0.44253E 03
76	0.771E 04	1.26996	0.30472E 00	0.43613E 03
77	0.776E 04	1.28667	0.29646E 00	0.45135E 03
78	0.753E 04	1.30338	0.28860E 00	0.44991E 03
79	0.719E 04	1.32009	0.28110E 00	0.44135E 03
80	0.702E 04	1.33680	0.27396E 00	0.44183E 03
81	0.685E 04	1.35351	0.26716E 00	0.44231E 03
82	0.669E 04	1.37022	0.26066E 00	0.44281E 03
83	0.654E 04	1.38693	0.25447E 00	0.44294E 03
84	0.629E 04	1.40364	0.24855E 00	0.43629E 03
85	0.612E 04	1.42035	0.24289E 00	0.43460E 03
86	0.586E 04	1.43706	0.23746E 00	0.42593E 03
87	0.572E 04	1.45377	0.23225E 00	0.42465E 03
88	0.555E 04	1.47048	0.22723E 00	0.42143E 03
89	0.545E 04	1.48719	0.22238E 00	0.42240E 03
90	0.513E 04	1.50390	0.21769E 00	0.40615E 03
91	0.500E 04	1.52061	0.21313E 00	0.40496E 03
92	0.491E 04	1.53732	0.20868E 00	0.40558E 03
93	0.464E 04	1.55403	0.20432E 00	0.39143E 03
94	0.456E 04	1.57074	0.20004E 00	0.39343E 03
95	0.446E 04	1.58745	0.19581E 00	0.39242E 03
96	0.434E 04	1.60416	0.19162E 00	0.39039E 03
97	0.414E 04	1.62087	0.18743E 00	0.38125E 03
98	0.400E 04	1.63758	0.18325E 00	0.37667E 03
99	0.385E 04	1.65429	0.17906E 00	0.37046E 03
100	0.369E 04	1.67100	0.17485E 00	0.36439E 03
101	0.349E 04	1.68771	0.17059E 00	0.35287E 03
102	0.334E 04	1.70442	0.16627E 00	0.34678E 03
103	0.327E 04	1.72113	0.16189E 00	0.34796E 03
104	0.313E 04	1.73784	0.15744E 00	0.34258E 03
105	0.294E 04	1.75455	0.15291E 00	0.33119E 03
106	0.289E 04	1.77126	0.14828E 00	0.33664E 03
107	0.276E 04	1.78797	0.14357E 00	0.33171E 03
108	0.267E 04	1.80468	0.13875E 00	0.33216E 03

109	0.259E 04	1.82139	0.13385E 00	0.33310E 03
110	0.246E 04	1.83810	0.12885E 00	0.32956E 03
111	0.234E 04	1.85481	0.12376E 00	0.32668E 03
112	0.220E 04	1.87152	0.11858E 00	0.32014E 03
113	0.226E 04	1.88823	0.11333E 00	0.34442E 03
114	0.206E 04	1.90494	0.10802E 00	0.32829E 03
115	0.202E 04	1.92165	0.10265E 00	0.33873E 03
116	0.191E 04	1.93836	0.97242E-01	0.33825E 03
117	0.185E 04	1.95507	0.91807E-01	0.34775E 03
118	0.176E 04	1.97178	0.86389E-01	0.35119E 03
119	0.168E 04	1.98849	0.80982E-01	0.35803E 03
120	0.165E 04	2.00520	0.75651E-01	0.37528E 03
121	0.149E 04	2.02191	0.70387E-01	0.36536E 03
122	0.149E 04	2.03862	0.65246E-01	0.39468E 03
123	0.140E 04	2.05533	0.60254E-01	0.39961E 03
124	0.137E 04	2.07204	0.55449E-01	0.42584E 03

N	ELECTRON ENERGY (MC SQ UNITS)	PHOTON ENERGY (MC SQ UNITS)	UPPER LIMIT	LOWER LIMIT	ELECTRON ENERGY (MEV)	PHOTON ENERGY (MEV)
7	2.28915E-01	4.71610E-01	4.93674E-01	4.49178E-01	1.16970E-01	2.40981E-01
8	2.61617E-01	5.15411E-01	5.36854E-01	4.93674E-01	1.33680E-01	2.63363E-01
9	2.94319E-01	5.58031E-01	5.78967E-01	5.36854E-01	1.50390E-01	2.85140E-01
10	3.27021E-01	5.99683E-01	6.20197E-01	5.78967E-01	1.67100E-01	3.06423E-01
11	3.59723E-01	6.40526E-01	6.60684E-01	6.20197E-01	1.83810E-01	3.27293E-01
12	3.92425E-01	6.80684E-01	7.00536E-01	6.60684E-01	2.00520E-01	3.47813E-01
13	4.25128E-01	7.20252E-01	7.39839E-01	7.00536E-01	2.17230E-01	3.68031E-01
14	4.57830E-01	7.59308E-01	7.78664E-01	7.39839E-01	2.33940E-01	3.87988E-01
15	4.90532E-01	7.97915E-01	8.17067E-01	7.78664E-01	2.50650E-01	4.07715E-01
16	5.23234E-01	8.36125E-01	8.55096E-01	8.17067E-01	2.67360E-01	4.27240E-01
17	5.55936E-01	8.73983E-01	8.92791E-01	8.55096E-01	2.84070E-01	4.46584E-01
18	5.88638E-01	9.11524E-01	9.30186E-01	8.92791E-01	3.00780E-01	4.65767E-01
19	6.21340E-01	9.48781E-01	9.67311E-01	9.30186E-01	3.17490E-01	4.84804E-01
20	6.54042E-01	9.85780E-01	1.00419E 00	9.67311E-01	3.34200E-01	5.03710E-01
21	6.86745E-01	1.02254E 00	1.04085E 00	1.00419E 00	3.50910E-01	5.22496E-01
22	7.19447E-01	1.05910E 00	1.07730E 00	1.04085E 00	3.67620E-01	5.41173E-01
23	7.52149E-01	1.09545E 00	1.11356E 00	1.07730E 00	3.84330E-01	5.59750E-01
24	7.84851E-01	1.13163E 00	1.14965E 00	1.11356E 00	4.01040E-01	5.78236E-01
25	8.17553E-01	1.16764E 00	1.18559E 00	1.14965E 00	4.17750E-01	5.96636E-01
26	8.50255E-01	1.20350E 00	1.22137E 00	1.18559E 00	4.34460E-01	6.14958E-01
27	8.82957E-01	1.23921E 00	1.25702E 00	1.22137E 00	4.51170E-01	6.33208E-01
28	9.15659E-01	1.27480E 00	1.29254E 00	1.25702E 00	4.67880E-01	6.51391E-01
29	9.48362E-01	1.31026E 00	1.32795E 00	1.29254E 00	4.84590E-01	6.69511E-01
30	9.81064E-01	1.34561E 00	1.36324E 00	1.32795E 00	5.01300E-01	6.87572E-01
31	1.01377E 00	1.38085E 00	1.39843E 00	1.36324E 00	5.18010E-01	7.05579E-01
32	1.04647E 00	1.41599E 00	1.43352E 00	1.39843E 00	5.34720E-01	7.23535E-01
33	1.07917E 00	1.45103E 00	1.46852E 00	1.43352E 00	5.51430E-01	7.41442E-01
34	1.11187E 00	1.48599E 00	1.50344E 00	1.46852E 00	5.68140E-01	7.59305E-01
35	1.14457E 00	1.52086E 00	1.53827E 00	1.50344E 00	5.84850E-01	7.77125E-01
36	1.17728E 00	1.55566E 00	1.57303E 00	1.53827E 00	6.01560E-01	7.94905E-01
37	1.20998E 00	1.59038E 00	1.60772E 00	1.57303E 00	6.18270E-01	8.12647E-01
38	1.24268E 00	1.62503E 00	1.64233E 00	1.60772E 00	6.34980E-01	8.30354E-01
39	1.27538E 00	1.65962E 00	1.67689E 00	1.64233E 00	6.51690E-01	8.48027E-01
40	1.30808E 00	1.69414E 00	1.71138E 00	1.67689E 00	6.68400E-01	8.65667E-01
41	1.34079E 00	1.72861E 00	1.74582E 00	1.71138E 00	6.85110E-01	8.83277E-01
42	1.37349E 00	1.76302E 00	1.78020E 00	1.74582E 00	7.01820E-01	9.00859E-01
43	1.40619E 00	1.79737E 00	1.81453E 00	1.78020E 00	7.18530E-01	9.18413E-01
44	1.43889E 00	1.83167E 00	1.84881E 00	1.81453E 00	7.35240E-01	9.35941E-01
45	1.47159E 00	1.86593E 00	1.88304E 00	1.84881E 00	7.51950E-01	9.53444E-01
46	1.50430E 00	1.90014E 00	1.91722E 00	1.88304E 00	7.68660E-01	9.70924E-01
47	1.53700E 00	1.93430E 00	1.95136E 00	1.91722E 00	7.85370E-01	9.88381E-01
48	1.56970E 00	1.96842E 00	1.98547E 00	1.95136E 00	8.02080E-01	1.00582E 00
49	1.60240E 00	2.00250E 00	2.01953E 00	1.98547E 00	8.18790E-01	1.02323E 00
50	1.63511E 00	2.03654E 00	2.05355E 00	2.01953E 00	8.35500E-01	1.04063E 00
51	1.66781E 00	2.07055E 00	2.08754E 00	2.05355E 00	8.52210E-01	1.05800E 00
52	1.70051E 00	2.10452E 00	2.12149E 00	2.08754E 00	8.68920E-01	1.07536E 00
53	1.73321E 00	2.13846E 00	2.15541E 00	2.12149E 00	8.85630E-01	1.09270E 00
54	1.76591E 00	2.17236E 00	2.18930E 00	2.15541E 00	9.02340E-01	1.11003E 00
55	1.79862E 00	2.20624E 00	2.22316E 00	2.18930E 00	9.19050E-01	1.12733E 00
56	1.83132E 00	2.24008E 00	2.25699E 00	2.22316E 00	9.35760E-01	1.14463E 00
57	1.86402E 00	2.27389E 00	2.29079E 00	2.25699E 00	9.52470E-01	1.16191E 00
58	1.89672E 00	2.30768E 00	2.32456E 00	2.29079E 00	9.69180E-01	1.17917E 00

59	1.92942E 00	2.34144F 00	2.35831E 00	2.32456E 00	9.85890F-01	1.19642E 00
60	1.96213E 00	2.37517F 00	2.39203E 00	2.35831E 00	1.00260F 00	1.21366E 00
61	1.99483E 00	2.40888F 00	2.42573E 00	2.39203E 00	1.01931F 00	1.23088E 00
62	2.02753F 00	2.44257E 00	2.45940E 00	2.42573E 00	1.03602E 00	1.24809F 00
63	2.06023F 00	2.47623F 00	2.49305E 00	2.45940E 00	1.05273E 00	1.26530E 00
64	2.09294E 00	2.50987E 00	2.52669E 00	2.49306E 00	1.06944F 00	1.28249E 00
65	2.12564E 00	2.54349E 00	2.56029E 00	2.52668E 00	1.08615E 00	1.29966E 00
66	2.15834E 00	2.57709F 00	2.59388E 00	2.56029F 00	1.10286F 00	1.31683E 00
67	2.19104E 00	2.61067F 00	2.62745E 00	2.59389E 00	1.11957E 00	1.33399E 00
68	2.22374E 00	2.64423E 00	2.66100E 00	2.62745F 00	1.13628E 00	1.35114E 00
69	2.25644E 00	2.67777E 00	2.69453E 00	2.66100E 00	1.15299E 00	1.36828E 00
70	2.28915E 00	2.71129E 00	2.72805E 00	2.69453F 00	1.16970E 00	1.38541E 00
71	2.32185E 00	2.74480F 00	2.76155E 00	2.72805E 00	1.18641E 00	1.40253E 00
72	2.35455E 00	2.77829E 00	2.79503E 00	2.76155E 00	1.20312E 00	1.41964E 00
73	2.38725F 00	2.81176F 00	2.82849E 00	2.79503F 00	1.21983E 00	1.43674F 00
74	2.41996E 00	2.84522E 00	2.86194F 00	2.82849E 00	1.23654E 00	1.45384E 00
75	2.45266E 00	2.87866E 00	2.89538F 00	2.86194E 00	1.25325E 00	1.47093E 00
76	2.48536E 00	2.91209E 00	2.92880E 00	2.89538E 00	1.26996E 00	1.48801E 00
77	2.51806E 00	2.94550E 00	2.96220E 00	2.92880E 00	1.28667E 00	1.50508E 00
78	2.55076F 00	2.97890E 00	2.99559E 00	2.96220F 00	1.30338F 00	1.52215E 00
79	2.58347F 00	3.01229E 00	3.02897E 00	2.99559F 00	1.32009E 00	1.53921F 00
80	2.61617F 00	3.04566E 00	3.06234E 00	3.02897F 00	1.33680F 00	1.55626E 00
81	2.64887E 00	3.07902E 00	3.09569E 00	3.06234F 00	1.35351E 00	1.57330E 00
82	2.68157F 00	3.11236F 00	3.12903E 00	3.09569F 00	1.37022E 00	1.59034E 00
83	2.71428E 00	3.14570F 00	3.16236E 00	3.12903E 00	1.38693E 00	1.60738F 00
84	2.74698F 00	3.17902F 00	3.19568F 00	3.16236E 00	1.40364E 00	1.62440E 00
85	2.77968E 00	3.21233F 00	3.22898F 00	3.19568E 00	1.42035F 00	1.64143F 00
86	2.81238E 00	3.24563F 00	3.26228E 00	3.22898E 00	1.43706E 00	1.65844E 00
87	2.84508F 00	3.27893E 00	3.29557E 00	3.26228E 00	1.45377E 00	1.67545F 00
88	2.87778F 00	3.31221F 00	3.32884F 00	3.29557E 00	1.47048E 00	1.69246E 00
89	2.91049E 00	3.34547F 00	3.36210F 00	3.32884E 00	1.48719E 00	1.70946F 00
90	2.94319E 00	3.37873E 00	3.39536F 00	3.36211S 00	1.50390E 00	1.72645F 00
91	2.97589E 00	3.41198F 00	3.42860F 00	3.39536E 00	1.52061E 00	1.74344F 00
92	3.00859F 00	3.44522E 00	3.46184F 00	3.42860E 00	1.53732E 00	1.76043F 00
93	3.04130E 00	3.47846E 00	3.49507E 00	3.46184E 00	1.55403E 00	1.77741E 00
94	3.07400E 00	3.51168E 00	3.52829E 00	3.49507E 00	1.57074E 00	1.79438E 00
95	3.10670E 00	3.54489E 00	3.56149E 00	3.52829E 00	1.58745F 00	1.81135E 00
96	3.13940E 00	3.57810F 00	3.59470E 00	3.56149E 00	1.60416E 00	1.82832E 00
97	3.17210E 00	3.61129E 00	3.62789E 00	3.59470E 00	1.62087E 00	1.84529E 00
98	3.20481E 00	3.64448E 00	3.66107E 00	3.62789E 00	1.63758E 00	1.86224E 00
99	3.23751E 00	3.67766F 00	3.69425E 00	3.66107E 00	1.65429E 00	1.87920E 00
100	3.27021E 00	3.71084F 00	3.72742E 00	3.69425E 00	1.67100E 00	1.89615E 00
101	3.30291E 00	3.74401F 00	3.76058E 00	3.72742E 00	1.68771E 00	1.91310E 00
102	3.33561E 00	3.77716E 00	3.79374F 00	3.76058E 00	1.70442E 00	1.93004E 00
103	3.36832E 00	3.81031E 00	3.82689F 00	3.79374E 00	1.72113E 00	1.94698E 00
104	3.40102E 00	3.84346E 00	3.86003E 00	3.82689E 00	1.73784E 00	1.96392F 00
105	3.43372E 00	3.87660F 00	3.89316E 00	3.86003E 00	1.75455E 00	1.98085E 00
106	3.46642E 00	3.90973E 00	3.92629E 00	3.89316E 00	1.77126E 00	1.99778E 00
107	3.49913E 00	3.94285E 00	3.95941E 00	3.92629E 00	1.78797E 00	2.01470E 00
108	3.53183E 00	3.97597F 00	3.99253E 00	3.95941E 00	1.80468E 00	2.03163E 00
109	3.56453E 00	4.00908E 00	4.02564E 00	3.99253E 00	1.82139E 00	2.04855E 00
110	3.59723E 00	4.04219F 00	4.05874E 00	4.02564E 00	1.83810E 00	2.06546E 00
111	3.62994E 00	4.07529F 00	4.09184E 00	4.05874E 00	1.85481E 00	2.08238F 00
112	3.66264E 00	4.10838F 00	4.12493E 00	4.09184E 00	1.87152E 00	2.09929E 00
113	3.69534E 00	4.14147F 00	4.15801E 00	4.12493E 00	1.88823E 00	2.11619F 00
114	3.72804E 00	4.17456F 00	4.19110E 00	4.15802E 00	1.90494E 00	2.13310E 00
115	3.76074E 00	4.20763E 00	4.22417E 00	4.19110E 00	1.92165E 00	2.15000E 00
116	3.79344E 00	4.24071E 00	4.25724E 00	4.22417E 00	1.93836F 00	2.16690E 00
117	3.82615E 00	4.27378E 00	4.29031F 00	4.25724E 00	1.95507E 00	2.18380E 00
118	3.85885E 00	4.30684E 00	4.32337E 00	4.29031E 00	1.97178E 00	2.20069E 00
119	3.89155F 00	4.33989E 00	4.35642E 00	4.32337F 00	1.98849E 00	2.21758E 00
120	3.92425E 00	4.37295F 00	4.38947E 00	4.35642E 00	2.00520F 00	2.23447E 00
121	3.95696E 00	4.40600F 00	4.42252F 00	4.38947E 00	2.02191F 00	2.25136E 00
122	3.98966F 00	4.43904F 00	4.45555E 00	4.42252E 00	2.03862E 00	2.26824E 00
123	4.02236E 00	4.47208E 00	4.48859E 00	4.45556E 00	2.05533E 00	2.28512F 00
124	4.05506E 00	4.50511E 00	4.52163E 00	4.48859F 00	2.07204F 00	2.30200E 00

7. ITERAT Subroutine Input (KIND = 1, NERR = 1)

Iterative Solution of Detection System

I	PHOTON ENERGY (MC SQ UNITS)	W VECTOR	ERROR	X1 VECTOR
7	0.47161	9.2567E 02	5.2380E 00	1.0000E 00
8	0.51541	8.6166E 02	5.0536E 00	1.0000E 00
9	0.55803	8.1045E 02	4.9012E 00	1.0000E 00
10	0.59968	7.8578E 02	4.8260E 00	1.0000E 00
11	0.64053	7.6228E 02	4.7533E 00	1.0000E 00
12	0.68068	7.5020E 02	4.7155E 00	1.0000E 00
13	0.72025	7.2354E 02	4.6309E 00	1.0000E 00
14	0.75931	7.0073E 02	4.5573E 00	1.0000E 00
15	0.79792	6.8590E 02	4.5089E 00	1.0000E 00
16	0.83613	6.6419E 02	4.4369E 00	1.0000E 00
17	0.87398	6.5794E 02	4.4160E 00	1.0000E 00
18	0.91152	6.5028E 02	4.3902E 00	1.0000E 00
19	0.94878	6.4352E 02	4.3673E 00	1.0000E 00
20	0.98578	6.1827E 02	4.2808E 00	1.0000E 00
21	1.02254	5.7338E 02	4.1224E 00	1.0000E 00
22	1.05910	5.4690E 02	4.0261E 00	1.0000E 00
23	1.09545	5.3427E 02	3.9794E 00	1.0000E 00
24	1.13163	5.2332E 02	3.9384E 00	1.0000E 00
25	1.16764	5.0583E 02	3.8720E 00	1.0000E 00
26	1.20350	5.0304E 02	3.8613E 00	1.0000E 00
27	1.23921	4.9517E 02	3.8310E 00	1.0000E 00
28	1.27480	4.9381E 02	3.8257E 00	1.0000E 00
29	1.31026	5.0350E 02	3.8631E 00	1.0000E 00
30	1.34561	4.9282E 02	3.8390E 00	1.0000E 00
31	1.38085	4.8673E 02	3.8303E 00	1.0000E 00
32	1.41599	4.8042E 02	3.8235E 00	1.0000E 00
33	1.45103	4.8025E 02	3.8439E 00	1.0000E 00
34	1.48599	4.7100E 02	3.8305E 00	1.0000E 00
35	1.52086	4.6497E 02	3.8323E 00	1.0000E 00
36	1.55566	4.6183E 02	3.8483E 00	1.0000E 00
37	1.59038	4.5957E 02	3.8703E 00	1.0000E 00
38	1.62504	4.5725E 02	3.8944E 00	1.0000E 00
39	1.65962	4.4910E 02	3.8955E 00	1.0000E 00
40	1.69414	4.4652E 02	3.9227E 00	1.0000E 00
41	1.72861	4.5244E 02	3.9896E 00	1.0000E 00
42	1.76302	4.4693E 02	4.0084E 00	1.0000E 00
43	1.79737	4.4698E 02	4.0540E 00	1.0000E 00
44	1.83167	4.4383E 02	4.0873E 00	1.0000E 00
45	1.86593	4.4869E 02	4.1597E 00	1.0000E 00
46	1.90014	4.5178E 02	4.2265E 00	1.0000E 00
47	1.93430	4.5519E 02	4.2975E 00	1.0000E 00
48	1.96842	4.4323E 02	4.2972E 00	1.0000E 00
49	2.00250	4.2394E 02	4.2601E 00	1.0000E 00
50	2.03655	4.2310E 02	4.3153E 00	1.0000E 00
51	2.07055	4.1447E 02	4.3321E 00	1.0000E 00
52	2.10452	4.1474E 02	4.3965E 00	1.0000E 00
53	2.13846	4.1133E 02	4.4432E 00	1.0000E 00

54	2.17236	4.1576E 02	4.5342E 00	1.0000E 00
55	2.20624	4.1747E 02	4.6128E 00	1.0000E 00
56	2.24008	4.1424E 02	4.6658E 00	1.0000E 00
57	2.27389	4.1142E 02	4.7224E 00	1.0000E 00
58	2.30768	4.1467E 02	4.8155E 00	1.0000E 00
59	2.34144	4.2166E 02	4.9330E 00	1.0000E 00
60	2.37517	4.2641E 02	5.0397E 00	1.0000E 00
61	2.40888	4.2091E 02	5.0872E 00	1.0000E 00
62	2.44257	4.1558E 02	5.1360E 00	1.0000E 00
63	2.47623	4.2995E 02	5.3079E 00	1.0000E 00
64	2.50987	4.2681E 02	5.3734E 00	1.0000E 00
65	2.54349	4.2287E 02	5.4342E 00	1.0000E 00
66	2.57709	4.3169E 02	5.5782E 00	1.0000E 00
67	2.61067	4.3377E 02	5.6803E 00	1.0000E 00
68	2.64423	4.3759E 02	5.7951E 00	1.0000E 00
69	2.67777	4.3800E 02	5.8884E 00	1.0000E 00
70	2.71130	4.3949E 02	5.9896E 00	1.0000E 00
71	2.74480	4.4661E 02	6.1302E 00	1.0000E 00
72	2.77829	4.4298E 02	6.1973E 00	1.0000E 00
73	2.81177	4.4465E 02	6.3012E 00	1.0000E 00
74	2.84522	4.4619E 02	6.4044E 00	1.0000E 00
75	2.87866	4.4253E 02	6.4696E 00	1.0000E 00
76	2.91209	4.3613E 02	6.5132E 00	1.0000E 00
77	2.94550	4.5135E 02	6.7175E 00	1.0000E 00
78	2.97890	4.4991E 02	6.7975E 00	1.0000E 00
79	3.01229	4.4135E 02	6.8217E 00	1.0000E 00
80	3.04566	4.4183E 02	6.9138E 00	1.0000E 00
81	3.07902	4.4231E 02	7.0051E 00	1.0000E 00
82	3.11236	4.4281E 02	7.0958E 00	1.0000E 00
83	3.14570	4.4294E 02	7.1828E 00	1.0000E 00
84	3.17902	4.3629E 02	7.2131E 00	1.0000E 00
85	3.21233	4.3460E 02	7.2825E 00	1.0000E 00
86	3.24564	4.2593E 02	7.2914E 00	1.0000E 00
87	3.27893	4.2465E 02	7.3617E 00	1.0000E 00
88	3.31221	4.2143E 02	7.4142E 00	1.0000E 00
89	3.34548	4.2240E 02	7.5032E 00	1.0000E 00
90	3.37873	4.0615E 02	7.4364E 00	1.0000E 00
91	3.41198	4.0496E 02	7.5045E 00	1.0000E 00
92	3.44522	4.0558E 02	7.5898E 00	1.0000E 00
93	3.47846	3.9143E 02	7.5353E 00	1.0000E 00
94	3.51168	3.9343E 02	7.6351E 00	1.0000E 00
95	3.54489	3.9242E 02	7.7071E 00	1.0000E 00
96	3.57810	3.9039E 02	7.7708E 00	1.0000E 00
97	3.61130	3.8125E 02	7.7647E 00	1.0000E 00
98	3.64448	3.7667E 02	7.8053E 00	1.0000E 00
99	3.67766	3.7046E 02	7.8308E 00	1.0000E 00
100	3.71084	3.6439E 02	7.8593E 00	1.0000E 00
101	3.74401	3.5287E 02	7.8301E 00	1.0000E 00
102	3.77716	3.4678E 02	7.8623E 00	1.0000E 00
103	3.81032	3.4796E 02	7.9816E 00	1.0000E 00
104	3.84346	3.4258E 02	8.0309E 00	1.0000E 00
105	3.87660	3.3119E 02	8.0123E 00	1.0000E 00
106	3.90973	3.3664E 02	8.2032E 00	1.0000E 00
107	3.94285	3.3171E 02	8.2754E 00	1.0000E 00

108	3.97597	3.3216E 02	8.4236E 00	1.0000E 00
109	4.00908	3.3310E 02	8.5884E 00	1.0000E 00
110	4.04219	3.2956E 02	8.7069E 00	1.0000E 00
111	4.07529	3.2668E 02	8.8454E 00	1.0000E 00
112	4.10838	3.2014E 02	8.9453E 00	1.0000E 00
113	4.14147	3.4442E 02	9.4911E 00	1.0000E 00
114	4.17456	3.2829E 02	9.4911E 00	1.0000E 00
115	4.20763	3.3873E 02	9.8895E 00	1.0000E 00
116	4.24071	3.3825E 02	1.0154E 01	1.0000E 00
117	4.27378	3.4775E 02	1.0596E 01	1.0000E 00
118	4.30684	3.5119E 02	1.0977E 01	1.0000E 00
119	4.33990	3.5803E 02	1.1447E 01	1.0000E 00
120	4.37295	3.7528E 02	1.2126E 01	1.0000E 00
121	4.40600	3.6536E 02	1.2404E 01	1.0000E 00
122	4.43904	3.9468E 02	1.3390E 01	1.0000E 00
123	4.47208	3.9961E 02	1.4020E 01	1.0000E 00
124	4.50511	4.2584E 02	1.5087E 01	1.0000E 00

Arresting Criterion Satisfied on Iteration Number 13

BOUND = 2.1328E 04 NORM = 1.8417E 04

I	X	WPRIME	R	NORM
7	1.0117E 03	9.2154E 02	4.1221E 00	1.6991E 01
8	9.2945E 02	8.5945E 02	2.2092E 00	2.1872E 01
9	8.2507E 02	8.1524E 02	-4.7896E 00	4.4812E 01
10	9.1470E 02	7.8786E 02	-2.0767E 00	4.9124E 01
11	9.8100E 02	7.6333E 02	-1.0520E 00	5.0231E 01
12	1.1970E 03	7.4272E 02	7.4861E 00	1.0627E 02
13	1.1898E 03	7.1611E 02	7.4290E 00	1.6146E 02
14	1.1866E 03	6.9406E 02	6.6743E 00	2.0601E 02
15	1.2887E 03	6.7627E 02	9.6328E 00	2.9880E 02
16	1.2202E 03	6.5852E 02	5.6704E 00	3.3095E 02
17	1.4422E 03	6.4670E 02	1.1238E 01	4.5724E 02
18	1.7071E 03	6.3148E 02	1.8802E 01	8.1074E 02
19	2.1430E 03	6.1073E 02	3.2789E 01	1.8858E 03
20	2.0657E 03	5.7774E 02	4.0537E 01	3.5290E 03
21	1.2930E 03	5.4410E 02	2.9274E 01	4.3860E 03
22	9.7588E 02	5.2702E 02	1.9882E 01	4.7813E 03
23	9.1493E 02	5.1674E 02	1.7536E 01	5.0888E 03
24	8.6731E 02	5.0800E 02	1.5317E 01	5.3234E 03
25	6.9089E 02	5.0034E 02	5.4912E 00	5.3536E 03
26	7.3893E 02	4.9653E 02	6.5129E 00	5.3960E 03
27	6.9843E 02	4.9259E 02	2.5786E 00	5.4026E 03
28	7.5635E 02	4.9018E 02	3.6292E 00	5.4158E 03
29	1.0670E 03	4.8782E 02	1.5688E 01	5.6619E 03
30	9.6961E 02	4.8098E 02	1.1844E 01	5.8022E 03
31	9.5917E 02	4.7592E 02	1.0817E 01	5.9192E 03
32	9.3458E 02	4.7133E 02	9.0908E 00	6.0018E 03
33	1.0495E 03	4.6745E 02	1.2800E 01	6.1657E 03
34	9.4988E 02	4.6228E 02	8.7163E 00	6.2417E 03
35	9.1098E 02	4.5864E 02	6.3271E 00	6.2817E 03
36	9.2882E 02	4.5583E 02	6.0037E 00	6.3177E 03

37	9.6439E 02	4.5320E 02	6.3667E 00	6.3583E 03
38	9.9900E 02	4.5052E 02	6.7346E 00	6.4036E 03
39	8.8550E 02	4.4776E 02	1.3359E 00	6.4054E 03
40	8.8788E 02	4.4667E 02	-1.5283E-01	6.4054E 03
41	1.1077E 03	4.4616E 02	6.2788E 00	6.4448E 03
42	1.0429E 03	4.4386E 02	3.0703E 00	6.4543E 03
43	1.1216E 03	4.4265E 02	4.3330E 00	6.4730E 03
44	1.1105E 03	4.4116E 02	2.6765E 00	6.4802E 03
45	1.3516E 03	4.4031E 02	8.3816E 00	6.5504E 03
46	1.6041E 03	4.3770E 02	1.4075E 01	6.7486E 03
47	1.9695E 03	4.3297E 02	2.2221E 01	7.2423E 03
48	1.6688E 03	4.2476E 02	1.8472E 01	7.5836E 03
49	1.1080E 03	4.1867E 02	5.2700E 00	7.6113E 03
50	1.1484E 03	4.1721E 02	5.8848E 00	7.6459E 03
51	9.5267E 02	4.1558E 02	-1.1094E 00	7.6472E 03
52	9.9077E 02	4.1577E 02	-1.0283E 00	7.6482E 03
53	9.2428E 02	4.1600E 02	-4.6768E 00	7.6701E 03
54	1.0663E 03	4.1716E 02	-1.3982E 00	7.6721E 03
55	1.1473E 03	4.1766E 02	-1.9800E-01	7.6721E 03
56	1.0735E 03	4.1793E 02	-3.6948E 00	7.6857E 03
57	1.0005E 03	4.1913E 02	-7.7078E 00	7.7452E 03
58	1.0939E 03	4.2135E 02	-6.6814E 00	7.7898E 03
59	1.3322E 03	4.2352E 02	-1.8525E 00	7.7932E 03
60	1.5447E 03	4.2459E 02	1.8184E 00	7.7965E 03
61	1.3599E 03	4.2464E 02	-3.7307E 00	7.8104E 03
62	1.1707E 03	4.2633E 02	-1.0749E 01	7.9260E 03
63	1.7154E 03	4.2988E 02	6.9824E-02	7.9260E 03
64	1.6025E 03	4.3057E 02	-3.7561E 00	7.9401E 03
65	1.4361E 03	4.3247E 02	-9.5979E 00	8.0322E 03
66	1.7972E 03	4.3608E 02	-4.3867E 00	8.0515E 03
67	1.9056E 03	4.3826E 02	-4.4897E 00	8.0716E 03
68	2.1218E 03	4.4046E 02	-2.8748E 00	8.0799E 03
69	2.1747E 03	4.4206E 02	-4.0540E 00	8.0963E 03
70	2.2877E 03	4.4401E 02	-4.5154E 00	8.1167E 03
71	2.8055E 03	4.4604E 02	5.7520E-01	8.1170E 03
72	2.6624E 03	4.4578E 02	-2.8054E 00	8.1249E 03
73	2.8659E 03	4.4686E 02	-2.2109E 00	8.1298E 03
74	3.1023E 03	4.4745E 02	-1.2600E 00	8.1314E 03
75	2.9542E 03	4.4733E 02	-4.7981E 00	8.1544E 03
76	2.5645E 03	4.4857E 02	-1.2436E 01	8.3090E 03
77	3.8548E 03	4.5268E 02	-1.3237E 00	8.3108E 03
78	4.0362E 03	4.5100E 02	-1.0906E 00	8.3120E 03
79	3.5197E 03	4.4880E 02	-7.4482E 00	8.3674E 03
80	3.7620E 03	4.4967E 02	-7.8398E 00	8.4289E 03
81	4.0692E 03	4.5009E 02	-7.7759E 00	8.4894E 03
82	4.4806E 03	4.4969E 02	-6.8806E 00	8.5367E 03
83	5.0061E 03	4.4792E 02	-4.9785E 00	8.5615E 03
84	4.7991E 03	4.4410E 02	-7.8083E 00	8.6224E 03
85	5.1835E 03	4.4158E 02	-6.9807E 00	8.6712E 03
86	4.7126E 03	4.3766E 02	-1.1729E 01	8.8087E 03
87	5.0904E 03	4.3627E 02	-1.1612E 01	8.9436E 03
88	5.3196E 03	4.3369E 02	-1.2259E 01	9.0939E 03
89	6.3379E 03	4.3053E 02	-8.1384E 00	9.1601E 03
90	4.8833E 03	4.2312E 02	-1.6973E 01	9.4482E 03

91	5.2849E 03	4.2218E 02	-1.7221E 01	9.7447E 03
92	6.1692E 03	4.2011E 02	-1.4539E 01	9.9561E 03
93	4.8690E 03	4.1469E 02	-2.3256E 01	1.0497E 04
94	5.7273E 03	4.1511E 02	-2.1673E 01	1.0967E 04
95	6.4618E 03	4.1271E 02	-2.0295E 01	1.1379E 04
96	7.3566E 03	4.0780E 02	-1.7413E 01	1.1682E 04
97	7.0304E 03	3.9947E 02	-1.8216E 01	1.2014E 04
98	7.5048E 03	3.9245E 02	-1.5779E 01	1.2263E 04
99	7.7216E 03	3.8357E 02	-1.3103E 01	1.2434E 04
100	7.9529E 03	3.7366E 02	-9.2715E 00	1.2520E 04
101	6.7831E 03	3.6253E 02	-9.6633E 00	1.2614E 04
102	6.3781E 03	3.5559E 02	-8.8083E 00	1.2691E 04
103	7.4249E 03	3.5020E 02	-2.2310E 00	1.2696E 04
104	7.1662E 03	3.4084E 02	1.7407E 00	1.2699E 04
105	5.3932E 03	3.3212E 02	-9.3140E-01	1.2700E 04
106	6.6552E 03	3.2983E 02	6.8120E 00	1.2746E 04
107	5.9377E 03	3.2313E 02	8.5762E 00	1.2820E 04
108	6.1048E 03	3.1898E 02	1.3184E 01	1.2994E 04
109	6.3383E 03	3.1431E 02	1.8792E 01	1.3347E 04
110	5.5619E 03	3.0884E 02	2.0725E 01	1.3776E 04
111	4.7426E 03	3.0608E 02	2.0604E 01	1.4201E 04
112	3.3390E 03	3.0646E 02	1.3679E 01	1.4388E 04
113	6.6222E 03	3.1238E 02	3.2040E 01	1.5415E 04
114	3.5264E 03	3.0788E 02	2.0410E 01	1.5831E 04
115	4.1643E 03	3.1428E 02	2.4445E 01	1.6429E 04
116	3.3868E 03	3.1975E 02	1.8495E 01	1.6771E 04
117	3.7272E 03	3.2918E 02	1.8575E 01	1.7116E 04
118	3.3564E 03	3.3926E 02	1.1934E 01	1.7258E 04
119	3.3344E 03	3.5269E 02	5.3413E 00	1.7287E 04
120	4.7069E 03	3.6889E 02	6.3921E 00	1.7328E 04
121	3.1072E 03	3.8387E 02	-1.8509E 01	1.7670E 04
122	7.2126E 03	4.0779E 02	-1.3104E 01	1.7842E 04
123	1.3032E 04	4.2360E 02	-2.3989E 01	1.8417E 04
124	1.4807E 05	4.2584E 02	0.0	1.8417E 04

8. Error Matrix (Upper Corner)

MATRIX ELEMENTS

I/J	7	8	9	10	11	12	13	14
	0.47161	0.51541	0.55803	0.59968	0.64053	0.68068	0.72025	0.75931
7	0.78722E-02	0.22581E-02	0.10307E-02	0.61864E-03	0.44183E-03	0.34548E-03	0.26401E-03	0.23581E-03
8	0.0	0.54059E-02	0.17680E-02	0.82438E-03	0.49806E-03	0.35235E-03	0.27439E-03	0.22542E-03
9	0.0	0.0	0.39062E-02	0.13564E-02	0.67681E-03	0.41113E-03	0.28588E-03	0.22466E-03
10	0.0	0.0	0.0	0.29295E-02	0.11299E-02	0.56625E-03	0.34657E-03	0.24437E-03
11	0.0	0.0	0.0	0.0	0.22683E-02	0.93154E-03	0.48057E-03	0.29773E-03
12	0.0	0.0	0.0	0.0	0.0	0.17995E-02	0.77956E-03	0.41427E-03
13	0.0	0.0	0.0	0.0	0.0	0.0	0.14578E-02	0.66137E-03
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12020E-02
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

9. COMPSCAT Printout (KIND = 4, NERR = 3)

10/9/69 ATSR, 37 WATT, SNELL BLOCK, UNFOLD ERROR VECTOR

MEV/CH =0.01671 PI*R(0)**2 = 2.49452E-25 N(E) = 7.000E 23

LIVE TIME = 1.03170F 03 SEC.

CHAN.	INPUT VECTOR	ELECTRON ENERGY, MEV	G MATRIX	WADJ
7	0.926E 03	0.11697	0.10000E 01	0.15966E 02
8	0.862E 03	0.13368	0.10000E 01	0.14862E 02
9	0.810E 03	0.15039	0.10000E 01	0.13979E 02
10	0.786E 03	0.16710	0.10000E 01	0.13553E 02
11	0.762E 03	0.18381	0.10000E 01	0.13148E 02
12	0.750E 03	0.20052	0.10000E 01	0.12939E 02
13	0.724E 03	0.21723	0.10000E 01	0.12480E 02
14	0.701E 03	0.23394	0.10000E 01	0.12086E 02
15	0.686E 03	0.25065	0.10000E 01	0.11830E 02
16	0.664E 03	0.26736	0.10000E 01	0.11456E 02
17	0.658E 03	0.28407	0.10000E 01	0.11348E 02
18	0.650E 03	0.30078	0.10000E 01	0.11216E 02
19	0.644E 03	0.31749	0.10000E 01	0.11099E 02
20	0.618E 03	0.33420	0.10000E 01	0.10664E 02
21	0.573E 03	0.35091	0.10000E 01	0.98897E 01
22	0.547E 03	0.36762	0.10000E 01	0.94329E 01
23	0.534E 03	0.38433	0.10000E 01	0.92151E 01
24	0.523E 03	0.40104	0.10000E 01	0.90262E 01
25	0.506E 03	0.41775	0.10000E 01	0.87246E 01
26	0.503E 03	0.43446	0.10000E 01	0.86764E 01
27	0.495E 03	0.45117	0.10000E 01	0.85407E 01
28	0.494E 03	0.46788	0.10000E 01	0.85172E 01
29	0.504E 03	0.48459	0.10000E 01	0.86844E 01
30	0.493E 03	0.50130	0.99112E 00	0.85763E 01
31	0.487E 03	0.51801	0.98332E 00	0.85375E 01
32	0.480E 03	0.53472	0.97402E 00	0.85073E 01
33	0.480E 03	0.55143	0.96335E 00	0.85985E 01
34	0.471E 03	0.56814	0.95143E 00	0.85385E 01
35	0.465E 03	0.58485	0.93839E 00	0.85464E 01
36	0.462E 03	0.60156	0.92433E 00	0.86177E 01
37	0.460E 03	0.61827	0.90937E 00	0.87166E 01
38	0.457E 03	0.63498	0.89361E 00	0.88256E 01
39	0.449E 03	0.65169	0.87715E 00	0.88309E 01
40	0.447E 03	0.66840	0.86008E 00	0.89545E 01
41	0.452E 03	0.68511	0.84250E 00	0.92626E 01
42	0.447E 03	0.70182	0.82448E 00	0.93498E 01
43	0.447E 03	0.71853	0.80610E 00	0.95640E 01
44	0.444E 03	0.73524	0.78745E 00	0.97215E 01
45	0.449E 03	0.75195	0.76859E 00	0.10069E 02
46	0.452E 03	0.76866	0.74959E 00	0.10395E 02
47	0.455E 03	0.78537	0.73052E 00	0.10747E 02
48	0.443E 03	0.80208	0.71143E 00	0.10746E 02

49	0.424E 03	0.81879	0.69238E 00	0.10561E 02
50	0.423E 03	0.83550	0.67342E 00	0.10837E 02
51	0.414E 03	0.85221	0.65460E 00	0.10921E 02
52	0.415E 03	0.86892	0.63596E 00	0.11248E 02
53	0.411E 03	0.88563	0.61754E 00	0.11489E 02
54	0.416E 03	0.90234	0.59938E 00	0.11964E 02
55	0.417E 03	0.91905	0.58152E 00	0.12382E 02
56	0.414E 03	0.93576	0.56399E 00	0.12668E 02
57	0.411E 03	0.95247	0.54681E 00	0.12977E 02
58	0.415E 03	0.96918	0.53000E 00	0.13495E 02
59	0.422E 03	0.98589	0.51360E 00	0.14160E 02
60	0.426E 03	1.00260	0.49761E 00	0.14780E 02
61	0.421E 03	1.01931	0.48206E 00	0.15060E 02
62	0.416E 03	1.03602	0.46696E 00	0.15350E 02
63	0.430E 03	1.05273	0.45231E 00	0.16395E 02
64	0.427E 03	1.06944	0.43814E 00	0.16802E 02
65	0.423E 03	1.08615	0.42443E 00	0.17184E 02
66	0.432E 03	1.10286	0.41121E 00	0.18107E 02
67	0.434E 03	1.11957	0.39846E 00	0.18776E 02
68	0.438E 03	1.13628	0.38620E 00	0.19543E 02
69	0.438E 03	1.15299	0.37441E 00	0.20177E 02
70	0.439E 03	1.16970	0.36310E 00	0.20877E 02
71	0.447E 03	1.18641	0.35225E 00	0.21868E 02
72	0.443E 03	1.20312	0.34186E 00	0.22350E 02
73	0.445E 03	1.21983	0.33193E 00	0.23105E 02
74	0.446E 03	1.23654	0.32243E 00	0.23868E 02
75	0.443E 03	1.25325	0.31337E 00	0.24357E 02
76	0.436E 03	1.26996	0.30472E 00	0.24687E 02
77	0.451E 03	1.28667	0.29646E 00	0.26259E 02
78	0.450E 03	1.30338	0.28860E 00	0.26889E 02
79	0.441E 03	1.32009	0.28110E 00	0.27080E 02
80	0.442E 03	1.33680	0.27396E 00	0.27816E 02
81	0.442E 03	1.35351	0.26716E 00	0.28556E 02
82	0.443E 03	1.37022	0.26066E 00	0.29301E 02
83	0.443E 03	1.38693	0.25447E 00	0.30023E 02
84	0.436E 03	1.40364	0.24855E 00	0.30277E 02
85	0.435E 03	1.42035	0.24289E 00	0.30862E 02
86	0.426E 03	1.43706	0.23746E 00	0.30938E 02
87	0.425E 03	1.45377	0.23225E 00	0.31537E 02
88	0.421E 03	1.47048	0.22723E 00	0.31989E 02
89	0.422E 03	1.48719	0.22238E 00	0.32762E 02
90	0.406E 03	1.50390	0.21769E 00	0.32180E 02
91	0.405E 03	1.52061	0.21313E 00	0.32773E 02
92	0.406E 03	1.53732	0.20868E 00	0.33522E 02
93	0.391E 03	1.55403	0.20432E 00	0.33042E 02
94	0.393E 03	1.57074	0.20004E 00	0.33923E 02
95	0.392E 03	1.58745	0.19581E 00	0.34566E 02
96	0.390E 03	1.60416	0.19162E 00	0.35140E 02
97	0.381E 03	1.62087	0.18743E 00	0.35084E 02
98	0.377E 03	1.63758	0.18325E 00	0.35452E 02
99	0.370E 03	1.65429	0.17906E 00	0.35684E 02
100	0.364E 03	1.67100	0.17485E 00	0.35945E 02
101	0.353E 03	1.68771	0.17059E 00	0.35678E 02
102	0.347E 03	1.70442	0.16627E 00	0.35972E 02

103	0.348E 03	1.72113	0.16189E 00	0.37072E 02
104	0.343E 03	1.73784	0.15744E 00	0.37532E 02
105	0.331E 03	1.75455	0.15291E 00	0.37359E 02
106	0.337E 03	1.77126	0.14828E 00	0.39159E 02
107	0.332E 03	1.78797	0.14357E 00	0.39852E 02
108	0.332E 03	1.80468	0.13875E 00	0.41291E 02
109	0.333E 03	1.82139	0.13385E 00	0.42923E 02
110	0.330E 03	1.83810	0.12885E 00	0.44115E 02
111	0.327E 03	1.85481	0.12376E 00	0.45530E 02
112	0.320E 03	1.87152	0.11858E 00	0.46565E 02
113	0.344E 03	1.88823	0.11333E 00	0.52420E 02
114	0.328E 03	1.90494	0.10802E 00	0.52420E 02
115	0.339E 03	1.92165	0.10265E 00	0.56913E 02
116	0.338E 03	1.93836	0.97242E-01	0.59996E 02
117	0.348E 03	1.95507	0.91807E-01	0.65332E 02
118	0.351E 03	1.97178	0.86389E-01	0.70117E 02
119	0.358E 03	1.98849	0.80982E-01	0.76255E 02
120	0.375E 03	2.00520	0.75651E-01	0.85562E 02
121	0.365E 03	2.02191	0.70387E-01	0.89530E 02
122	0.395E 03	2.03862	0.65246E-01	0.10434E 03
123	0.400E 03	2.05533	0.60254E-01	0.11439E 03
124	0.426E 03	2.07204	0.55449E-01	0.13246E 03

10. ITERAT Subroutine Input (KIND = 4, NERR = 3)

Iterative Solution of Detection System

I	PHOTON ENERGY (MC SQ UNITS)	W VECTOR	ERROR	X1 VECTOR
7	0.47161	1.5966E 01	1.1843E-01	1.0000E 00
8	0.51541	1.4862E 01	1.1426E-01	1.0000E 00
9	0.55803	1.3979E 01	1.1082E-01	1.0000E 00
10	0.59968	1.3553E 01	1.0912E-01	1.0000E 00
11	0.64053	1.3148E 01	1.0747E-01	1.0000E 00
12	0.68068	1.2939E 01	1.0662E-01	1.0000E 00
13	0.72025	1.2480E 01	1.0471E-01	1.0000E 00
14	0.75931	1.2086E 01	1.0304E-01	1.0000E 00
15	0.79792	1.1830E 01	1.0195E-01	1.0000E 00
16	0.83613	1.1456E 01	1.0032E-01	1.0000E 00
17	0.87398	1.1348E 01	9.9847E-02	1.0000E 00
18	0.91152	1.1216E 01	9.9264E-02	1.0000E 00
19	0.94878	1.1099E 01	9.8746E-02	1.0000E 00
20	0.98578	1.0664E 01	9.6790E-02	1.0000E 00
21	1.02254	9.8897E 00	9.3210E-02	1.0000E 00
22	1.05910	9.4329E 00	9.1032E-02	1.0000E 00
23	1.09545	9.2151E 00	8.9975E-02	1.0000E 00
24	1.13163	9.0262E 00	8.9048E-02	1.0000E 00
25	1.16764	8.7246E 00	8.7547E-02	1.0000E 00
26	1.20350	8.6764E 00	8.7305E-02	1.0000E 00
27	1.23921	8.5407E 00	8.6620E-02	1.0000E 00
28	1.27480	8.5172E 00	8.6501E-02	1.0000E 00
29	1.31026	8.6844E 00	8.7345E-02	1.0000E 00
30	1.34561	8.5763E 00	8.7577E-02	1.0000E 00

31	1.38085	8.5375E 00	8.8073E-02	1.0000E 00
32	1.41599	8.5073E 00	8.8756E-02	1.0000E 00
33	1.45103	8.5985E 00	9.0219E-02	1.0000E 00
34	1.48599	8.5385E 00	9.1030E-02	1.0000E 00
35	1.52086	8.5464E 00	9.2338E-02	1.0000E 00
36	1.55566	8.6177E 00	9.4132E-02	1.0000E 00
37	1.59038	8.7166E 00	9.6228E-02	1.0000E 00
38	1.62504	8.8256E 00	9.8535E-02	1.0000E 00
39	1.65962	8.8309E 00	1.0042E-01	1.0000E 00
40	1.69414	8.9545E 00	1.0312E-01	1.0000E 00
41	1.72861	9.2626E 00	1.0707E-01	1.0000E 00
42	1.76302	9.3498E 00	1.0992E-01	1.0000E 00
43	1.79737	9.5640E 00	1.1371E-01	1.0000E 00
44	1.83167	9.7215E 00	1.1736E-01	1.0000E 00
45	1.86593	1.0069E 01	1.2237E-01	1.0000E 00
46	1.90014	1.0395E 01	1.2749E-01	1.0000E 00
47	1.93430	1.0747E 01	1.3301E-01	1.0000E 00
48	1.96842	1.0746E 01	1.3657E-01	1.0000E 00
49	2.00250	1.0561E 01	1.3912E-01	1.0000E 00
50	2.03655	1.0837E 01	1.4489E-01	1.0000E 00
51	2.07055	1.0921E 01	1.4963E-01	1.0000E 00
52	2.10452	1.1248E 01	1.5631E-01	1.0000E 00
53	2.13846	1.1489E 01	1.6268E-01	1.0000E 00
54	2.17236	1.1964E 01	1.7104E-01	1.0000E 00
55	2.20624	1.2382E 01	1.7935E-01	1.0000E 00
56	2.24008	1.2668E 01	1.8705E-01	1.0000E 00
57	2.27389	1.2977E 01	1.9527E-01	1.0000E 00
58	2.30768	1.3495E 01	2.0544E-01	1.0000E 00
59	2.34144	1.4160E 01	2.1716E-01	1.0000E 00
60	2.37517	1.4780E 01	2.2899E-01	1.0000E 00
61	2.40888	1.5060E 01	2.3861E-01	1.0000E 00
62	2.44257	1.5350E 01	2.4869E-01	1.0000E 00
63	2.47623	1.6395E 01	2.6533E-01	1.0000E 00
64	2.50987	1.6802E 01	2.7730E-01	1.0000E 00
65	2.54349	1.7184E 01	2.8949E-01	1.0000E 00
66	2.57709	1.8107E 01	3.0671E-01	1.0000E 00
67	2.61067	1.8776E 01	3.2232E-01	1.0000E 00
68	2.64423	1.9543E 01	3.3928E-01	1.0000E 00
69	2.67777	2.0177E 01	3.5559E-01	1.0000E 00
70	2.71130	2.0877E 01	3.7298E-01	1.0000E 00
71	2.74480	2.1868E 01	3.9348E-01	1.0000E 00
72	2.77829	2.2350E 01	4.0988E-01	1.0000E 00
73	2.81177	2.3105E 01	4.2923E-01	1.0000E 00
74	2.84522	2.3868E 01	4.4910E-01	1.0000E 00
75	2.87866	2.4357E 01	4.6680E-01	1.0000E 00
76	2.91209	2.4687E 01	4.8329E-01	1.0000E 00
77	2.94550	2.6259E 01	5.1232E-01	1.0000E 00
78	2.97890	2.6889E 01	5.3255E-01	1.0000E 00
79	3.01229	2.7080E 01	5.4869E-01	1.0000E 00
80	3.04566	2.7816E 01	5.7059E-01	1.0000E 00
81	3.07902	2.8556E 01	5.9286E-01	1.0000E 00
82	3.11236	2.9301E 01	6.1550E-01	1.0000E 00
83	3.14570	3.0023E 01	6.3820E-01	1.0000E 00
84	3.17902	3.0277E 01	6.5617E-01	1.0000E 00

85	3.21233	3.0862E 01	6.7793E-01	1.0000E 00
86	3.24564	3.0938E 01	6.9426E-01	1.0000E 00
87	3.27893	3.1537E 01	7.1669E-01	1.0000E 00
88	3.31221	3.1989E 01	7.3775E-01	1.0000E 00
89	3.34548	3.2762E 01	7.6288E-01	1.0000E 00
90	3.37873	3.2180E 01	7.7238E-01	1.0000E 00
91	3.41198	3.2773E 01	7.9613E-01	1.0000E 00
92	3.44522	3.3522E 01	8.2234E-01	1.0000E 00
93	3.47846	3.3042E 01	8.3385E-01	1.0000E 00
94	3.51168	3.3923E 01	8.6297E-01	1.0000E 00
95	3.54489	3.4566E 01	8.8994E-01	1.0000E 00
96	3.57810	3.5140E 01	9.1694E-01	1.0000E 00
97	3.61130	3.5084E 01	9.3667E-01	1.0000E 00
98	3.64448	3.5452E 01	9.6303E-01	1.0000E 00
99	3.67766	3.5684E 01	9.8879E-01	1.0000E 00
100	3.71084	3.5945E 01	1.0163E 00	1.0000E 00
101	3.74401	3.5678E 01	1.0378E 00	1.0000E 00
102	3.77716	3.5972E 01	1.0691E 00	1.0000E 00
103	3.81032	3.7072E 01	1.1147E 00	1.0000E 00
104	3.84346	3.7532E 01	1.1534E 00	1.0000E 00
105	3.87660	3.7359E 01	1.1848E 00	1.0000E 00
106	3.90973	3.9159E 01	1.2509E 00	1.0000E 00
107	3.94285	3.9852E 01	1.3033E 00	1.0000E 00
108	3.97597	4.1291E 01	1.3727E 00	1.0000E 00
109	4.00908	4.2923E 01	1.4508E 00	1.0000E 00
110	4.04219	4.4115E 01	1.5278E 00	1.0000E 00
111	4.07529	4.5530E 01	1.6160E 00	1.0000E 00
112	4.10838	4.6565E 01	1.7056E 00	1.0000E 00
113	4.14147	5.2420E 01	1.8936E 00	1.0000E 00
114	4.17456	5.2420E 01	1.9867E 00	1.0000E 00
115	4.20763	5.6913E 01	2.1782E 00	1.0000E 00
116	4.24071	5.9996E 01	2.3609E 00	1.0000E 00
117	4.27378	6.5332E 01	2.6095E 00	1.0000E 00
118	4.30684	7.0117E 01	2.8729E 00	1.0000E 00
119	4.33990	7.6255E 01	3.1961E 00	1.0000E 00
120	4.37295	8.5562E 01	3.6241E 00	1.0000E 00
121	4.40600	8.9530E 01	3.9844E 00	1.0000E 00
122	4.43904	1.0434E 02	4.6402E 00	1.0000E 00
123	4.47208	1.1439E 02	5.2611E 00	1.0000E 00
124	4.50511	1.3246E 02	6.1521E 00	1.0000E 00

Arresting Criterion Satisfied on Iteration Number 11

BOUND = 7.9015E 02 NORM = 7.7811E 02

I	X	WPRIME	R	NORM
7	1.3212E 02	1.5399E 01	5.6683E-01	3.2129E-01
8	1.2129E 02	1.4761E 01	1.0044E-01	3.3138E-01
9	1.0643E 02	1.4404E 01	-4.2521E-01	5.1218E-01
10	1.1782E 02	1.4163E 01	-6.0939E-01	8.8353E-01
11	1.2322E 02	1.3986E 01	-8.3773E-01	1.5853E 00
12	1.4069E 02	1.3874E 01	-9.3442E-01	2.4585E 00

13	1.3310E 02	1.3701E 01	-1.2218E 00	3.9511E 00
14	1.2680E 02	1.3565E 01	-1.4790E 00	6.1385E 00
15	1.3035E 02	1.3458E 01	-1.6272E 00	8.7862E 00
16	1.1681E 02	1.3386E 01	-1.9300E 00	1.2511E 01
17	1.2958E 02	1.3313E 01	-1.9651E 00	1.6373E 01
18	1.3941E 02	1.3244E 01	-2.0284E 00	2.0487E 01
19	1.5148E 02	1.3172E 01	-2.0725E 00	2.4782E 01
20	1.2326E 02	1.3088E 01	-2.4245E 00	3.0660E 01
21	6.9677E 01	1.3016E 01	-3.1265E 00	4.0435E 01
22	5.0438E 01	1.2972E 01	-3.5395E 00	5.2964E 01
23	4.5660E 01	1.2934E 01	-3.7190E 00	6.6794E 01
24	4.1799E 01	1.2911E 01	-3.8848E 00	8.1886E 01
25	3.3362E 01	1.2885E 01	-4.1601E 00	9.9193E 01
26	3.4955E 01	1.2862E 01	-4.1855E 00	1.1671E 02
27	3.2798E 01	1.2846E 01	-4.3052E 00	1.3525E 02
28	3.4759E 01	1.2833E 01	-4.3156E 00	1.5387E 02
29	4.5506E 01	1.2830E 01	-4.1453E 00	1.7105E 02
30	4.3542E 01	1.2818E 01	-4.2414E 00	1.8904E 02
31	4.4588E 01	1.2818E 01	-4.2803E 00	2.0736E 02
32	4.5869E 01	1.2820E 01	-4.3125E 00	2.2596E 02
33	5.4047E 01	1.2825E 01	-4.2267E 00	2.4383E 02
34	5.3182E 01	1.2834E 01	-4.2958E 00	2.6228E 02
35	5.6159E 01	1.2850E 01	-4.3039E 00	2.8080E 02
36	6.3446E 01	1.2871E 01	-4.2528E 00	2.9889E 02
37	7.3461E 01	1.2897E 01	-4.1801E 00	3.1636E 02
38	8.5508E 01	1.2927E 01	-4.1018E 00	3.3319E 02
39	8.7976E 01	1.2964E 01	-4.1328E 00	3.5027E 02
40	1.0244E 02	1.3007E 01	-4.0526E 00	3.6669E 02
41	1.4435E 02	1.3060E 01	-3.7974E 00	3.8111E 02
42	1.5901E 02	1.3118E 01	-3.7686E 00	3.9531E 02
43	1.9844E 02	1.3185E 01	-3.6207E 00	4.0842E 02
44	2.3126E 02	1.3259E 01	-3.5376E 00	4.2094E 02
45	3.2255E 02	1.3343E 01	-3.2744E 00	4.3166E 02
46	4.3433E 02	1.3437E 01	-3.0412E 00	4.4091E 02
47	5.9383E 02	1.3532E 01	-2.7843E 00	4.4866E 02
48	5.8216E 02	1.3631E 01	-2.8848E 00	4.5698E 02
49	4.7571E 02	1.3743E 01	-3.1820E 00	4.6711E 02
50	5.8577E 02	1.3880E 01	-3.0432E 00	4.7637E 02
51	5.9855E 02	1.4030E 01	-3.1090E 00	4.8603E 02
52	7.4900E 02	1.4202E 01	-2.9539E 00	4.9476E 02
53	8.5514E 02	1.4391E 01	-2.9029E 00	5.0319E 02
54	1.1705E 03	1.4604E 01	-2.6399E 00	5.1016E 02
55	1.4996E 03	1.4832E 01	-2.4500E 00	5.1616E 02
56	1.7016E 03	1.5079E 01	-2.4106E 00	5.2197E 02
57	1.9288E 03	1.5356E 01	-2.3787E 00	5.2763E 02
58	2.5010E 03	1.5669E 01	-2.1740E 00	5.3235E 02
59	3.5219E 03	1.6009E 01	-1.8485E 00	5.3577E 02
60	4.7034E 03	1.6360E 01	-1.5797E 00	5.3827E 02
61	4.9553E 03	1.6718E 01	-1.6581E 00	5.4101E 02
62	5.1296E 03	1.7131E 01	-1.7809E 00	5.4419E 02
63	8.2626E 03	1.7618E 01	-1.2227E 00	5.4568E 02
64	9.0084E 03	1.8063E 01	-1.2612E 00	5.4727E 02
65	9.4624E 03	1.8567E 01	-1.3830E 00	5.4918E 02
66	1.3070E 04	1.9158E 01	-1.0514E 00	5.5029E 02
67	1.5564E 04	1.9736E 01	-9.5950E-01	5.5121E 02
68	1.9176E 04	2.0343E 01	-8.0020E-01	5.5185E 02

69	2.1896E 04	2.0953E 01	-7.7615E-01	5.5245E 02
70	2.5395E 04	2.1606E 01	-7.2916E-01	5.5298E 02
71	3.3227E 04	2.2292E 01	-4.2419E-01	5.5316E 02
72	3.4994E 04	2.2878E 01	-5.2808E-01	5.5344E 02
73	4.0693E 04	2.3549E 01	-4.4363E-01	5.5364E 02
74	4.7339E 04	2.4206E 01	-3.3772E-01	5.5375E 02
75	4.9375E 04	2.4822E 01	-4.6439E-01	5.5397E 02
76	4.7350E 04	2.5535E 01	-8.4830E-01	5.5469E 02
77	7.0587E 04	2.6499E 01	-2.4030E-01	5.5475E 02
78	7.8535E 04	2.7059E 01	-1.7039E-01	5.5477E 02
79	7.4989E 04	2.7559E 01	-4.7894E-01	5.5500E 02
80	8.3780E 04	2.8305E 01	-4.8859E-01	5.5524E 02
81	9.4103E 04	2.9035E 01	-4.7939E-01	5.5547E 02
82	1.0691E 05	2.9720E 01	-4.1922E-01	5.5565E 02
83	1.2277E 05	3.0300E 01	-2.7707E-01	5.5572E 02
84	1.2455E 05	3.0687E 01	-4.1002E-01	5.5589E 02
85	1.3866E 05	3.1179E 01	-3.1679E-01	5.5599E 02
86	1.3403E 05	3.1520E 01	-5.8252E-01	5.5633E 02
87	1.4794E 05	3.2104E 01	-5.6665E-01	5.5665E 02
88	1.5881E 05	3.2583E 01	-5.9386E-01	5.5701E 02
89	1.8985E 05	3.3011E 01	-2.4979E-01	5.5707E 02
90	1.5999E 05	3.2958E 01	-7.7786E-01	5.5767E 02
91	1.7520E 05	3.3562E 01	-7.8922E-01	5.5830E 02
92	2.0426E 05	3.4070E 01	-5.4758E-01	5.5860E 02
93	1.7339E 05	3.4198E 01	-1.1556E 00	5.5993E 02
94	2.0074E 05	3.5008E 01	-1.0852E 00	5.6111E 02
95	2.2486E 05	3.5575E 01	-1.0083E 00	5.6213E 02
96	2.5399E 05	3.5920E 01	-7.7972E-01	5.6273E 02
97	2.4909E 05	3.5917E 01	-8.3279E-01	5.6343E 02
98	2.6661E 05	3.6081E 01	-6.2851E-01	5.6382E 02
99	2.7707E 05	3.6067E 01	-3.8295E-01	5.6397E 02
100	2.8840E 05	3.5953E 01	-7.8583E-03	5.6397E 02
101	2.5742E 05	3.5693E 01	-1.4816E-02	5.6397E 02
102	2.4811E 05	3.5915E 01	5.7053E-02	5.6397E 02
103	2.8481E 05	3.6376E 01	6.9609E-01	5.6446E 02
104	2.8094E 05	3.6424E 01	1.1080E 00	5.6568E 02
105	2.2573E 05	3.6562E 01	7.9663E-01	5.6632E 02
106	2.7259E 05	3.7546E 01	1.6133E 00	5.6892E 02
107	2.5232E 05	3.8089E 01	1.7623E 00	5.7203E 02
108	2.6338E 05	3.9035E 01	2.2566E 00	5.7712E 02
109	2.7801E 05	4.0026E 01	2.8970E 00	5.8551E 02
110	2.5654E 05	4.1025E 01	3.0898E 00	5.9506E 02
111	2.3275E 05	4.2487E 01	3.0430E 00	6.0432E 02
112	1.8103E 05	4.4534E 01	2.0303E 00	6.0844E 02
113	3.3440E 05	4.7648E 01	4.7723E 00	6.3121E 02
114	2.0859E 05	4.9502E 01	2.9177E 00	6.3973E 02
115	2.5474E 05	5.3264E 01	3.6497E 00	6.5305E 02
116	2.3046E 05	5.7279E 01	2.7172E 00	6.6043E 02
117	2.7040E 05	6.2477E 01	2.8558E 00	6.6859E 02
118	2.7089E 05	6.8419E 01	1.6980E 00	6.7147E 02
119	2.9763E 05	7.5819E 01	4.3552E-01	6.7166E 02
120	4.4120E 05	8.4844E 01	7.1753E-01	6.7217E 02
121	3.5350E 05	9.4784E 01	-5.2534E 00	6.9977E 02
122	8.1453E 05	1.0868E 02	-4.3469E 00	7.1867E 02
123	1.5901E 06	1.2210E 02	-7.7102E 00	7.7811E 02
124	1.6015E 07	1.3246E 02	1.5259E-05	7.7811E 02

11. ITERAT Subroutine Input (KIND = 3, NERR = 3)

Iterative Solution of Detection System

I	PHOTON ENERGY (MC SQ UNITS)	W VECTOR	ERROR.	X1 VECTOR
7	0.47161	8.9724E 02	5.2380E 00	1.0000E 00
8	0.51541	8.3327E 02	5.0536E 00	1.0000E 00
9	0.55803	7.8209E 02	4.9012E 00	1.0000E 00
10	0.59968	7.5746E 02	4.8260E 00	1.0000E 00
11	0.64053	7.3399E 02	4.7533E 00	1.0000E 00
12	0.68068	7.2194E 02	4.7155E 00	1.0000E 00
13	0.72025	6.9531E 02	4.6309E 00	1.0000E 00
14	0.75931	6.7253E 02	4.5573E 00	1.0000E 00
15	0.79792	6.5772E 02	4.5088E 00	1.0000E 00
16	0.83613	6.3604E 02	4.4369E 00	1.0000E 00
17	0.87398	6.2981E 02	4.4160E 00	1.0000E 00
18	0.91152	6.2218E 02	4.3902E 00	1.0000E 00
19	0.94878	6.1544E 02	4.3673E 00	1.0000E 00
20	0.98578	5.9021E 02	4.2808E 00	1.0000E 00
21	1.02254	5.4534E 02	4.1225E 00	1.0000E 00
22	1.05910	5.1888E 02	4.0261E 00	1.0000E 00
23	1.09545	5.0626E 02	3.9794E 00	1.0000E 00
24	1.13163	4.9533E 02	3.9384E 00	1.0000E 00
25	1.16764	4.7785E 02	3.8720E 00	1.0000E 00
26	1.20350	4.7508E 02	3.8613E 00	1.0000E 00
27	1.23921	4.6722E 02	3.8310E 00	1.0000E 00
28	1.27480	4.6586E 02	3.8257E 00	1.0000E 00
29	1.31026	4.7556E 02	3.8631E 00	1.0000E 00
30	1.34561	4.6489E 02	3.8390E 00	1.0000E 00
31	1.38085	4.5880E 02	3.8303E 00	1.0000E 00
32	1.41599	4.5249E 02	3.8235E 00	1.0000E 00
33	1.45103	4.5232E 02	3.8440E 00	1.0000E 00
34	1.48599	4.4307E 02	3.8305E 00	1.0000E 00
35	1.52086	4.3703E 02	3.8323E 00	1.0000E 00
36	1.55566	4.3389E 02	3.8482E 00	1.0000E 00
37	1.59038	4.3162E 02	3.8703E 00	1.0000E 00
38	1.62504	4.2929E 02	3.8944E 00	1.0000E 00
39	1.65962	4.2113E 02	3.8956E 00	1.0000E 00
40	1.69414	4.1853E 02	3.9227E 00	1.0000E 00
41	1.72861	4.2443E 02	3.9896E 00	1.0000E 00
42	1.76302	4.1890E 02	4.0084E 00	1.0000E 00
43	1.79737	4.1893E 02	4.0540E 00	1.0000E 00
44	1.83167	4.1575E 02	4.0873E 00	1.0000E 00
45	1.86593	4.2058E 02	4.1597E 00	1.0000E 00
46	1.90014	4.2364E 02	4.2266E 00	1.0000E 00
47	1.93430	4.2702E 02	4.2975E 00	1.0000E 00
48	1.96842	4.1502E 02	4.2972E 00	1.0000E 00
49	2.00250	3.9569E 02	4.2601E 00	1.0000E 00
50	2.03655	3.9480E 02	4.3153E 00	1.0000E 00
51	2.07055	3.8613E 02	4.3321E 00	1.0000E 00
52	2.10452	3.8634E 02	4.3965E 00	1.0000E 00
53	2.13846	3.8288E 02	4.4432E 00	1.0000E 00

54	2.17236	3.8725E 02	4.5342E 00	1.0000E 00
55	2.20624	3.8890E 02	4.6128E 00	1.0000E 00
56	2.24008	3.8560E 02	4.6658E 00	1.0000E 00
57	2.27389	3.8271E 02	4.7224E 00	1.0000E 00
58	2.30768	3.8588E 02	4.8156E 00	1.0000E 00
59	2.34144	3.9279E 02	4.9329E 00	1.0000E 00
60	2.37517	3.9745E 02	5.0397E 00	1.0000E 00
61	2.40888	3.9186E 02	5.0872E 00	1.0000E 00
62	2.44257	3.8644E 02	5.1360E 00	1.0000E 00
63	2.47623	4.0071E 02	5.3079E 00	1.0000E 00
64	2.50987	3.9746E 02	5.3734E 00	1.0000E 00
65	2.54349	3.9341E 02	5.4342E 00	1.0000E 00
66	2.57709	4.0211E 02	5.5781E 00	1.0000E 00
67	2.61067	4.0406E 02	5.6803E 00	1.0000E 00
68	2.64423	4.0775E 02	5.7951E 00	1.0000E 00
69	2.67777	4.0802E 02	5.8884E 00	1.0000E 00
70	2.71130	4.0936E 02	5.9896E 00	1.0000E 00
71	2.74480	4.1632E 02	6.1302E 00	1.0000E 00
72	2.77829	4.1253E 02	6.1973E 00	1.0000E 00
73	2.81177	4.1402E 02	6.3012E 00	1.0000E 00
74	2.84522	4.1538E 02	6.4044E 00	1.0000E 00
75	2.87866	4.1153E 02	6.4696E 00	1.0000E 00
76	2.91209	4.0493E 02	6.5132E 00	1.0000E 00
77	2.94550	4.1994E 02	6.7175E 00	1.0000E 00
78	2.97890	4.1827E 02	6.7975E 00	1.0000E 00
79	3.01229	4.0947E 02	6.8217E 00	1.0000E 00
80	3.04566	4.0971E 02	6.9138E 00	1.0000E 00
81	3.07902	4.0992E 02	7.0051E 00	1.0000E 00
82	3.11236	4.1015E 02	7.0958E 00	1.0000E 00
83	3.14570	4.0999E 02	7.1827E 00	1.0000E 00
84	3.17902	4.0303E 02	7.2131E 00	1.0000E 00
85	3.21233	4.0101E 02	7.2825E 00	1.0000E 00
86	3.24564	3.9200E 02	7.2914E 00	1.0000E 00
87	3.27893	3.9036E 02	7.3617E 00	1.0000E 00
88	3.31221	3.8676E 02	7.4142E 00	1.0000E 00
89	3.34548	3.8732E 02	7.5032E 00	1.0000E 00
90	3.37873	3.7064E 02	7.4364E 00	1.0000E 00
91	3.41198	3.6900E 02	7.5045E 00	1.0000E 00
92	3.44522	3.6914E 02	7.5898E 00	1.0000E 00
93	3.47846	3.5448E 02	7.5353E 00	1.0000E 00
94	3.51168	3.5594E 02	7.6350E 00	1.0000E 00
95	3.54489	3.5435E 02	7.7071E 00	1.0000E 00
96	3.57810	3.5171E 02	7.7708E 00	1.0000E 00
97	3.61130	3.4192E 02	7.7646E 00	1.0000E 00
98	3.64448	3.3664E 02	7.8053E 00	1.0000E 00
99	3.67766	3.2969E 02	7.8308E 00	1.0000E 00
100	3.71084	3.2282E 02	7.8593E 00	1.0000E 00
101	3.74401	3.1045E 02	7.8301E 00	1.0000E 00
102	3.77716	3.0344E 02	7.8623E 00	1.0000E 00
103	3.81032	3.0363E 02	7.9816E 00	1.0000E 00
104	3.84346	2.9719E 02	8.0309E 00	1.0000E 00
105	3.87660	2.8465E 02	8.0124E 00	1.0000E 00
106	3.90973	2.8886E 02	8.2032E 00	1.0000E 00
107	3.94285	2.8258E 02	8.2754E 00	1.0000E 00
108	3.97597	2.8156E 02	8.4236E 00	1.0000E 00
109	4.00908	2.8089E 02	8.5884E 00	1.0000E 00

110	4.04219	2.7559E 02	8.7068E 00	1.0000E 00
111	4.07529	2.7077E 02	8.8453E 00	1.0000E 00
112	4.10838	2.6208E 02	8.9453E 00	1.0000E 00
113	4.14147	2.8398E 02	9.4911E 00	1.0000E 00
114	4.17456	2.6519E 02	9.4911E 00	1.0000E 00
115	4.20763	2.7264E 02	9.8895E 00	1.0000E 00
116	4.24071	2.6878E 02	1.0154E 01	1.0000E 00
117	4.27378	2.7443E 02	1.0596E 01	1.0000E 00
118	4.30684	2.7344E 02	1.0977E 01	1.0000E 00
119	4.33990	2.7515E 02	1.1447E 01	1.0000E 00

Arresting Criterion Satisfied on Iteration Number 11

BOUND = 1.7710E 04 NORM = 1.6660E 04

I	X	WPRIME	R	NORM
7	1.0042E 03	8.8780E 02	9.4412E 00	8.9136E 01
8	9.2897E 02	8.2657E 02	6.7029E 00	1.3406E 02
9	8.3816E 02	7.8287E 02	-7.8394E-01	1.3468E 02
10	9.2134E 02	7.5518E 02	2.2810E 00	1.3988E 02
11	9.8660E 02	7.3021E 02	3.7793E 00	1.5416E 02
12	1.1849E 03	7.0874E 02	1.3199E 01	3.2838E 02
13	1.1764E 03	6.8249E 02	1.2822E 01	4.9279E 02
14	1.1744E 03	6.6054E 02	1.1992E 01	6.3660E 02
15	1.2658E 03	6.4256E 02	1.5162E 01	8.6648E 02
16	1.2112E 03	6.2461E 02	1.1432E 01	9.9716E 02
17	1.4093E 03	6.1200E 02	1.7807E 01	1.3143E 03
18	1.6366E 03	5.9621E 02	2.5973E 01	1.9888E 03
19	1.9858E 03	5.7563E 02	3.9810E 01	3.5737E 03
20	1.8826E 03	5.4514E 02	4.5070E 01	5.6049E 03
21	1.2169E 03	5.1512E 02	3.0219E 01	6.5181E 03
22	9.4348E 02	4.9939E 02	1.9491E 01	6.8981E 03
23	8.8983E 02	4.8970E 02	1.6565E 01	7.1724E 03
24	8.4999E 02	4.8135E 02	1.3983E 01	7.3680E 03
25	6.9651E 02	4.7401E 02	3.8430E 00	7.3827E 03
26	7.4292E 02	4.7014E 02	4.9412E 00	7.4072E 03
27	7.1013E 02	4.6617E 02	1.0486E 00	7.4083E 03
28	7.6649E 02	4.6358E 02	2.2815E 00	7.4135E 03
29	1.0459E 03	4.6095E 02	1.4606E 01	7.6268E 03
30	9.6108E 02	4.5446E 02	1.0432E 01	7.7356E 03
31	9.5429E 02	4.4951E 02	9.2932E 00	7.8220E 03
32	9.3461E 02	4.4504E 02	7.4482E 00	7.8774E 03
33	1.0390E 03	4.4120E 02	1.1121E 01	8.0011E 03
34	9.5230E 02	4.3625E 02	6.8179E 00	8.0476E 03
35	9.2018E 02	4.3267E 02	4.3572E 00	8.0666E 03
36	9.3951E 02	4.2986E 02	4.0276E 00	8.0828E 03
37	9.7491E 02	4.2723E 02	4.3918E 00	8.1021E 03
38	1.0094E 03	4.2454E 02	4.7485E 00	8.1246E 03
39	9.0962E 02	4.2182E 02	-6.8750E-01	8.1251E 03
40	9.1588E 02	4.2062E 02	-2.0923E 00	8.1295E 03
41	1.1207E 03	4.1995E 02	4.4836E 00	8.1496E 03
42	1.0659E 03	4.1761E 02	1.2864E 00	8.1512E 03
43	1.1424E 03	4.1627E 02	2.6594E 00	8.1583E 03
44	1.1365E 03	4.1467E 02	1.0771E 00	8.1595E 03

45	1.3600E 03	4.1364E 02	6.9380E 00	8.2076E 03
46	1.5881E 03	4.1099E 02	1.2652E 01	8.3677E 03
47	1.9055E 03	4.0645E 02	2.0573E 01	8.7909E 03
48	1.6365E 03	3.9890E 02	1.6124E 01	9.0509E 03
49	1.1327E 03	3.9329E 02	2.3984E 00	9.0567E 03
50	1.1725E 03	3.9188E 02	2.9170E 00	9.0652E 03
51	9.9447E 02	3.9033E 02	-4.2041E 00	9.0828E 03
52	1.0341E 03	3.9048E 02	-4.1421E 00	9.1000E 03
53	9.7599E 02	3.9068E 02	-7.8047E 00	9.1609E 03
54	1.1144E 03	3.9177E 02	-4.5186E 00	9.1813E 03
55	1.1952E 03	3.9223E 02	-3.3320E 00	9.1924E 03
56	1.1305E 03	3.9248E 02	-6.8835E 00	9.2398E 03
57	1.0666E 03	3.9361E 02	-1.0899E 01	9.3586E 03
58	1.1620E 03	3.9572E 02	-9.8372E 00	9.4554E 03
59	1.3942E 03	3.9776E 02	-4.9736E 00	9.4801E 03
60	1.5987E 03	3.9878E 02	-1.3308E 00	9.4819E 03
61	1.4315E 03	3.9884E 02	-6.9841E 00	9.5306E 03
62	1.2586E 03	4.0045E 02	-1.4007E 01	9.7268E 03
63	1.7849E 03	4.0382E 02	-3.1062E 00	9.7365E 03
64	1.6860E 03	4.0448E 02	-7.0200E 00	9.7858E 03
65	1.5371E 03	4.0628E 02	-1.2867E 01	9.9513E 03
66	1.8926E 03	4.0969E 02	-7.5818E 00	1.0009E 04
67	2.0067E 03	4.1171E 02	-7.6533E 00	1.0067E 04
68	2.2232E 03	4.1375E 02	-6.0005E 00	1.0103E 04
69	2.2856E 03	4.1518E 02	-7.1641E 00	1.0155E 04
70	2.4058E 03	4.1695E 02	-7.5901E 00	1.0212E 04
71	2.9059E 03	4.1875E 02	-2.4324E 00	1.0218E 04
72	2.7848E 03	4.1839E 02	-5.8630E 00	1.0253E 04
73	2.9906E 03	4.1927E 02	-5.2458E 00	1.0280E 04
74	3.2276E 03	4.1965E 02	-4.2729E 00	1.0298E 04
75	3.1034E 03	4.1935E 02	-7.8213E 00	1.0360E 04
76	2.7499E 03	4.2031E 02	-1.5380E 01	1.0596E 04
77	3.9996E 03	4.2396E 02	-4.0168E 00	1.0612E 04
78	4.1834E 03	4.2202E 02	-3.7520E 00	1.0626E 04
79	3.7104E 03	4.1958E 02	-1.0111E 01	1.0729E 04
80	3.9644E 03	4.2002E 02	-1.0307E 01	1.0835E 04
81	4.2801E 03	4.1993E 02	-1.0013E 01	1.0935E 04
82	4.6940E 03	4.1900E 02	-8.8547E 00	1.1013E 04
83	5.2087E 03	4.1669E 02	-6.7004E 00	1.1058E 04
84	5.0248E 03	4.1237E 02	-9.3430E 00	1.1146E 04
85	5.4044E 03	4.0925E 02	-8.2444E 00	1.1214E 04
86	4.9673E 03	4.0475E 02	-1.2753E 01	1.1376E 04
87	5.3501E 03	4.0261E 02	-1.2254E 01	1.1526E 04
88	5.5861E 03	3.9926E 02	-1.2505E 01	1.1683E 04
89	6.5671E 03	3.9528E 02	-7.9624E 00	1.1746E 04
90	5.1659E 03	3.8719E 02	-1.6553E 01	1.2020E 04
91	5.5733E 03	3.8534E 02	-1.6335E 01	1.2287E 04
92	6.4415E 03	3.8228E 02	-1.3143E 01	1.2460E 04
93	5.1789E 03	3.7592E 02	-2.1435E 01	1.2919E 04
94	6.0405E 03	3.7520E 02	-1.9261E 01	1.3290E 04
95	6.7678E 03	3.7161E 02	-1.7259E 01	1.3588E 04
96	7.6329E 03	3.6547E 02	-1.3764E 01	1.3777E 04
97	7.2989E 03	3.5598E 02	-1.4056E 01	1.3975E 04
98	7.7435E 03	3.4777E 02	-1.1126E 01	1.4099E 04
99	7.9285E 03	3.3775E 02	-8.0627E 00	1.4164E 04
100	8.1188E 03	3.2680E 02	-3.9795E 00	1.4180E 04

101	6.9516E 03	3.1474E 02	-4.2869E 00	1.4198E 04
102	6.5340E 03	3.0682E 02	-3.3784E 00	1.4209E 04
103	7.5289E 03	3.0047E 02	3.1553E 00	1.4219E 04
104	7.2466E 03	2.9034E 02	6.8481E 00	1.4266E 04
105	5.4801E 03	2.8093E 02	3.7217E 00	1.4280E 04
106	6.6840E 03	2.7795E 02	1.0908E 01	1.4399E 04
107	5.9492E 03	2.7081E 02	1.1772E 01	1.4538E 04
108	6.0773E 03	2.6634E 02	1.5215E 01	1.4769E 04
109	6.2752E 03	2.6162E 02	1.9270E 01	1.5141E 04
110	5.5021E 03	2.5636E 02	1.9231E 01	1.5510E 04
111	4.6901E 03	2.5404E 02	1.6729E 01	1.5790E 04
112	3.3001E 03	2.5513E 02	6.9542E 00	1.5839E 04
113	6.6689E 03	2.6210E 02	2.1884E 01	1.6318E 04
114	3.7140E 03	2.5887E 02	6.3181E 00	1.6357E 04
115	4.7510E 03	2.6671E 02	5.9338E 00	1.6393E 04
116	4.5283E 03	2.7308E 02	-4.2969E 00	1.6411E 04
117	6.8375E 03	2.8248E 02	-8.0493E 00	1.6476E 04
118	1.2579E 04	2.8702E 02	-1.3578E 01	1.6660E 04
119	9.1687E 04	2.7515E 02	2.4414E-04	1.6660E 04

12. FEND Program Input (COMPSCAT Punchout)

```
  10/9/69 ATSR, 37 WATT, SNELL BLOCK, UNFOLDED RAW DATA
 7119   106        .01671   1031.70    1
0.92567E 03 0.86166E 03 0.81045E 03 0.78578E 03 0.76228E 03 0.75020E 03
0.72354E 03 0.70073E 03 0.68590E 03 0.66419E 03 0.65794E 03 0.65028E 03
0.64352E 03 0.61827E 03 0.57338E 03 0.54690E 03 0.53427E 03 0.52332E 03
0.50583E 03 0.50304E 03 0.49517E 03 0.49381E 03 0.50350E 03 0.49282E 03
0.48673E 03 0.48042E 03 0.48025E 03 0.47100E 03 0.46497E 03 0.46183E 03
0.45957E 03 0.45725E 03 0.44910E 03 0.44652E 03 0.45244E 03 0.44693E 03
0.44698E 03 0.44383E 03 0.44869E 03 0.45178E 03 0.45519E 03 0.44323E 03
0.42394E 03 0.42310E 03 0.41447E 03 0.41474E 03 0.41133E 03 0.41576E 03
0.41747E 03 0.41424E 03 0.41142E 03 0.41467E 03 0.42166E 03 0.42641E 03
0.42091E 03 0.41558E 03 0.42995E 03 0.42681E 03 0.42287E 03 0.43169E 03
0.43377E 03 0.43759E 03 0.43800E 03 0.43949E 03 0.44561E 03 0.44298E 03
0.44465E 03 0.44619E 03 0.44253E 03 0.43613E 03 0.45135E 03 0.44991E 03
0.44135E 03 0.44183E 03 0.44231E 03 0.44281E 03 0.44294E 03 0.43629E 03
0.43460E 03 0.42593E 03 0.42465E 03 0.42143E 03 0.42240E 03 0.40615E 03
0.40496E 03 0.40558E 03 0.39143E 03 0.39343E 03 0.39242E 03 0.39039E 03
0.38125E 03 0.37667E 03 0.37046E 03 0.36439E 03 0.35287E 03 0.34678E 03
0.34796E 03 0.34258E 03 0.33119E 03 0.33664E 03 0.33171E 03 0.33216E 03
0.33310E 03 0.32956E 03 0.32668E 03 0.32014E 03 0.34442E 03 0.32829E 03
0.33873E 03 0.33825E 03 0.34775E 03 0.35119E 03 0.35803E 03 0.37528E 03
0.10117E 04 0.92945E 03 0.82507E 03 0.91470E 03 0.98100E 03 0.11970E 04
0.11898E 04 0.11866E 04 0.12887E 04 0.12202E 04 0.14422E 04 0.17071E 04
0.21430E 04 0.20657E 04 0.12930E 04 0.97588E 03 0.91493E 03 0.86731E 03
0.69089E 03 0.73893E 03 0.69843E 03 0.75635E 03 0.10670E 04 0.96961E 03
0.95917E 03 0.93458E 03 0.10495E 04 0.94988E 03 0.91098E 03 0.92882E 03
0.96439E 03 0.99900E 03 0.88550E 03 0.88788E 03 0.11097E 04 0.10429E 04
0.11216E 04 0.11105E 04 0.13516E 04 0.15041E 04 0.19695E 04 0.16688E 04
0.11080E 04 0.11484E 04 0.95267E 03 0.99077E 03 0.92498E 03 0.10663E 04
0.11473E 04 0.10735E 04 0.10005E 04 0.10939E 04 0.13392E 04 0.15447E 04
0.13599E 04 0.11707E 04 0.17154E 04 0.15025E 04 0.14361E 04 0.17972E 04
0.19056E 04 0.21218E 04 0.21747E 04 0.22877E 04 0.28055E 04 0.26624E 04
0.28659E 04 0.31023E 04 0.29542E 04 0.25645E 04 0.38548E 04 0.40362E 04
0.35197E 04 0.37620E 04 0.40692E 04 0.44806E 04 0.50061E 04 0.47991E 04
0.51835E 04 0.47126E 04 0.50904E 04 0.53196E 04 0.63379E 04 0.48833E 04
0.52849E 04 0.61692E 04 0.48690E 04 0.57273E 04 0.64618E 04 0.73566E 04
0.70304E 04 0.75048E 04 0.77216E 04 0.79529E 04 0.67881E 04 0.63781E 04
0.74249E 04 0.71662E 04 0.53932E 04 0.65552E 04 0.59397E 04 0.61048E 04
0.53383E 04 0.55619E 04 0.47426E 04 0.33390E 04 0.66222E 04 0.35264E 04
0.41643E 04 0.33868E 04 0.37272E 04 0.33564E 04 0.33344E 04 0.47069E 04
```

13. FEND Printout

10/9/69 ATSR, 37 WATT, SNELL BLOCK, UNFOLDED RAW DATA

MEV/CH = 0.01571

PI(RO)(RO) = 2.49452E-25 N(E) = 7.000E 23

LIVE TIME = 1031.70 SEC. INTEGRATION CONSTANT = 1.74616E-01

COEFFICIENT	ERROR
1.54826920 01	1.41253100 00
-1.70932110 00	3.42262390-01

WEIGHTED SUM OF SQUARED DEVIATIONS = 3.50204D-01

CHAN.	PHOTON ENERGY (MCSQ UNITS)	PHI	LOG PHI	EVALUATION	RESIDUAL
106.	3.909729	6.65520E 03	8.80315	8.79971	-3.4444E-03
107.	3.942854	5.93770E 03	8.68908	8.74309	5.4011E-02
108.	3.975972	6.10480E 03	8.71683	8.68648	-3.0351E-02
109.	4.009084	6.33830E 03	8.75437	8.62988	-1.2449E-01
110.	4.042192	5.56190E 03	8.62370	8.57329	-5.0407E-02
111.	4.075292	4.74260E 03	8.46434	8.51671	5.2370E-02
112.	4.108384	3.33900E 03	8.11343	8.46014	3.4672E-01
113.	4.141475	6.62220E 03	8.79818	8.40358	-3.9460E-01
114.	4.174559	3.52640E 03	8.16803	8.34703	1.7900E-01
115.	4.207635	4.16430E 03	8.33430	8.29049	-4.3810E-02
116.	4.240708	3.38680E 03	8.12764	8.23396	1.0632E-01
117.	4.273775	3.72720E 03	8.22341	8.17744	-4.5975E-02
118.	4.306838	3.35640E 03	8.11862	8.12092	2.2981E-03
119.	4.339895	3.33440E 03	8.11205	8.06442	-4.7631E-02

VI(1) = 5.82856E 01

VI(61) = 1.67002E-12

INTEGRATION LIMITS FOR V = 4.32354, 20.75835

N	ELECTRON ENERGY (MCSQ UNITS)	PHOTON ENERGY (MCSQ UNITS)	ELECTRON ENERGY (MEV)	PHOTON ENERGY (MEV)	W-ADJ(N)	WP(N)	V(N)	+/- ERROR
7	0.22891	0.47161	0.11697	0.24098	9.25670E 02	8.97245E 02	2.84251D 01	-3.9769E-02
8	0.26152	0.51541	0.13368	0.26336	8.61660E 02	8.33270E 02	2.83902D 01	-3.9569E-02
9	0.29432	0.55803	0.15039	0.28514	8.10450E 02	7.82094E 02	2.83564D 01	-3.9376E-02
10	0.32702	0.59968	0.16710	0.30642	7.85780E 02	7.57456E 02	2.83236D 01	-3.9188E-02
11	0.35972	0.64053	0.18381	0.32729	7.62280E 02	7.33988E 02	2.82919D 01	-3.8998E-02
12	0.39243	0.68068	0.20052	0.34781	7.50200E 02	7.21939E 02	2.82612D 01	-3.8812E-02
13	0.42513	0.72025	0.21723	0.36803	7.23540E 02	6.95308E 02	2.82317D 01	-3.8643E-02
14	0.45783	0.75931	0.23394	0.38799	7.00730E 02	6.72527E 02	2.82033D 01	-3.8469E-02
15	0.49053	0.79791	0.25065	0.40772	6.85900E 02	6.57724E 02	2.81762D 01	-3.8306E-02
16	0.52323	0.83613	0.26736	0.42724	6.64190E 02	6.36040E 02	2.81502D 01	-3.8158E-02
17	0.55594	0.87398	0.28407	0.44658	6.57940E 02	6.29814E 02	2.81254D 01	-3.7991E-02
18	0.58854	0.91152	0.30078	0.46577	6.50280E 02	6.22173E 02	2.81020D 01	-3.7853E-02
19	0.62134	0.94878	0.31749	0.48480	6.43520E 02	6.15440E 02	2.80798D 01	-3.7720E-02
20	0.65404	0.98578	0.33420	0.50371	6.18270E 02	5.90211E 02	2.80590D 01	-3.7589E-02
21	0.68674	1.02254	0.35091	0.52250	5.73380E 02	5.45340E 02	2.80396D 01	-3.7466E-02
22	0.71945	1.05910	0.36762	0.54117	5.46900E 02	5.18878E 02	2.80215D 01	-3.7347E-02
23	0.75215	1.09545	0.38433	0.55975	5.34270E 02	5.06265E 02	2.80049D 01	-3.7232E-02
24	0.78485	1.13163	0.40104	0.57824	5.23320E 02	4.95330E 02	2.79899D 01	-3.7141E-02
25	0.81755	1.16764	0.41775	0.59664	5.05830E 02	4.77854E 02	2.79763D 01	-3.7060E-02
26	0.85026	1.20350	0.43446	0.61496	5.03040E 02	4.75075E 02	2.79643D 01	-3.6984E-02
27	0.88296	1.23921	0.45117	0.63321	4.95170E 02	4.67216E 02	2.79540D 01	-3.6916E-02
28	0.91566	1.27480	0.46788	0.65139	4.93810E 02	4.65865E 02	2.79453D 01	-3.6861E-02
29	0.94836	1.31026	0.48459	0.66951	5.03500E 02	4.75562E 02	2.79383D 01	-3.6833E-02
30	0.98106	1.34561	0.50130	0.68757	4.92820E 02	4.64887E 02	2.79331D 01	-3.6798E-02
31	1.01377	1.38085	0.51801	0.70558	4.86730E 02	4.58800E 02	2.79297D 01	-3.6785E-02
32	1.04647	1.41599	0.53472	0.72354	4.80420E 02	4.52492E 02	2.79281D 01	-3.6783E-02
33	1.07917	1.45103	0.55143	0.74144	4.80250E 02	4.52321E 02	2.79285D 01	-3.6805E-02
34	1.11187	1.48599	0.56814	0.75931	4.71000E 02	4.43069E 02	2.79309D 01	-3.6835E-02
35	1.14457	1.52086	0.58485	0.77713	4.64970E 02	4.37035E 02	2.79353D 01	-3.6894E-02
36	1.17728	1.55566	0.60156	0.79491	4.61830E 02	4.33888E 02	2.79418D 01	-3.6963E-02
37	1.20998	1.59038	0.61827	0.81265	4.59570E 02	4.31619E 02	2.79505D 01	-3.7048E-02
38	1.24268	1.62503	0.63498	0.83035	4.57250E 02	4.29288E 02	2.79615D 01	-3.7163E-02
39	1.27538	1.65962	0.65169	0.84803	4.49100E 02	4.21125E 02	2.79747D 01	-3.7290E-02
40	1.30808	1.69414	0.66840	0.86567	4.46520E 02	4.18529E 02	2.79903D 01	-3.7450E-02
41	1.34079	1.72861	0.68511	0.88328	4.52440E 02	4.24431E 02	2.80084D 01	-3.7619E-02
42	1.37349	1.76302	0.70182	0.90086	4.46930E 02	4.18901E 02	2.80291D 01	-3.7824E-02
43	1.40619	1.79737	0.71853	0.91841	4.46980E 02	4.18927E 02	2.80523D 01	-3.8065E-02
44	1.43889	1.83167	0.73524	0.93594	4.43830E 02	4.15751E 02	2.80783D 01	-3.8320E-02
45	1.47159	1.86593	0.75195	0.95344	4.48690E 02	4.20583E 02	2.81071D 01	-3.8615E-02
46	1.50430	1.90014	0.76866	0.97092	4.51780E 02	4.23641E 02	2.81388D 01	-3.8941E-02
47	1.53700	1.93430	0.78537	0.98838	4.55190E 02	4.27016E 02	2.81736D 01	-3.9292E-02
48	1.56970	1.96842	0.80208	1.00582	4.43230E 02	4.15019E 02	2.82114D 01	-3.9695E-02
49	1.60240	2.00250	0.81879	1.02323	4.23940E 02	3.95687E 02	2.82525D 01	-4.0129E-02
50	1.63511	2.03654	0.83550	1.04063	4.23100E 02	3.94803E 02	2.82969D 01	-4.0605E-02
51	1.66781	2.07055	0.85221	1.05800	4.14470E 02	3.86125E 02	2.83447D 01	-4.1125E-02
52	1.70051	2.10452	0.86892	1.07536	4.14740E 02	3.86344E 02	2.83962D 01	-4.1688E-02
53	1.73321	2.13846	0.88563	1.09270	4.11330E 02	3.82878E 02	2.84514D 01	-4.2303E-02
54	1.76591	2.17236	0.90234	1.11003	4.15760E 02	3.87249E 02	2.85104D 01	-4.2977E-02
55	1.79862	2.20624	0.91905	1.12733	4.17470E 02	3.88896E 02	2.85735D 01	-4.3702E-02
56	1.83132	2.24008	0.93576	1.14463	4.14240E 02	3.85599E 02	2.86407D 01	-4.4485E-02
57	1.86402	2.27389	0.95247	1.16191	4.11420E 02	3.82708E 02	2.87123D 01	-4.5317E-02
58	1.89672	2.30768	0.96918	1.17917	4.14670E 02	3.85881E 02	2.87884D 01	-4.6234E-02

59	1.92942	2.34144	0.98589	1.19642	4.21660E 02	3.92791E 02	2.88692D 01	-4.7218E-02
60	1.96213	2.37517	1.00260	1.21366	4.26410E 02	3.97455E 02	2.89549D 01	-4.8278E-02
61	1.99483	2.40888	1.01931	1.23088	4.20910E 02	3.91864E 02	2.90457D 01	-4.9414E-02
62	2.02753	2.44257	1.03602	1.24809	4.15580E 02	3.86438E 02	2.91418D 01	-5.0641E-02
63	2.06023	2.47623	1.05273	1.26530	4.29950E 02	4.00707E 02	2.92434D 01	-5.1952E-02
64	2.09294	2.50987	1.06944	1.28249	4.26810E 02	3.97459E 02	2.93508D 01	-5.3364E-02
65	2.12564	2.54349	1.08615	1.29966	4.22870E 02	3.93406E 02	2.94643D 01	-5.4878E-02
66	2.15834	2.57709	1.10286	1.31683	4.31690E 02	4.02106E 02	2.95840D 01	-5.6503E-02
67	2.19104	2.61067	1.11957	1.33399	4.33770E 02	4.04059E 02	2.97104D 01	-5.8253E-02
68	2.22374	2.64423	1.13628	1.35114	4.37590E 02	4.07746E 02	2.98436D 01	-6.0125E-02
69	2.25644	2.67777	1.15299	1.36828	4.38000E 02	4.08016E 02	2.99841D 01	-6.2127E-02
70	2.28915	2.71129	1.16970	1.38541	4.39490E 02	4.09358E 02	3.01321D 01	-6.4274E-02
71	2.32185	2.74480	1.18641	1.40253	4.46610E 02	4.16322E 02	3.02881D 01	-6.6588E-02
72	2.35455	2.77829	1.20312	1.41964	4.42980E 02	4.12527E 02	3.04524D 01	-6.9053E-02
73	2.38725	2.81176	1.21983	1.43674	4.44650E 02	4.14024E 02	3.06255D 01	-7.1696E-02
74	2.41996	2.84522	1.23654	1.45384	4.46190E 02	4.15382E 02	3.08078D 01	-7.4540E-02
75	2.45266	2.87866	1.25325	1.47093	4.42530E 02	4.11530E 02	3.09997D 01	-7.7583E-02
76	2.48536	2.91209	1.26996	1.48801	4.36130E 02	4.04928E 02	3.12019D 01	-8.0835E-02
77	2.51806	2.94550	1.28667	1.50508	4.51350E 02	4.19935E 02	3.14147D 01	-8.4342E-02
78	2.55076	2.97890	1.30338	1.52215	4.49910E 02	4.18271E 02	3.16390D 01	-8.8079E-02
79	2.58347	3.01229	1.32009	1.53921	4.41350E 02	4.09475E 02	3.18751D 01	-9.2104E-02
80	2.61617	3.04566	1.33680	1.55626	4.41830E 02	4.09706E 02	3.21240D 01	-9.6420E-02
81	2.64887	3.07902	1.35351	1.57330	4.42310E 02	4.09924E 02	3.23862D 01	-1.0105E-01
82	2.68157	3.11236	1.37022	1.59034	4.42810E 02	4.10147E 02	3.26627D 01	-1.0602E-01
83	2.71428	3.14570	1.38693	1.60738	4.42940E 02	4.09986E 02	3.29542D 01	-1.1136E-01
84	2.74698	3.17902	1.40364	1.62440	4.36290E 02	4.03028E 02	3.32616D 01	-1.1710E-01
85	2.77968	3.21233	1.42035	1.64143	4.34600E 02	4.01014E 02	3.35861D 01	-1.2326E-01
86	2.81238	3.24563	1.43706	1.65844	4.25930E 02	3.92001E 02	3.39287D 01	-1.2990E-01
87	2.84508	3.27893	1.45377	1.67545	4.24650E 02	3.90359E 02	3.42905D 01	-1.3704E-01
88	2.87778	3.31221	1.47048	1.69246	4.21430E 02	3.86757E 02	3.46730D 01	-1.4473E-01
89	2.91049	3.34547	1.48719	1.70946	4.22400E 02	3.87322E 02	3.50775D 01	-1.5301E-01
90	2.94319	3.37873	1.50390	1.72645	4.06150E 02	3.70644E 02	3.55096D 01	-1.6194E-01
91	2.97589	3.41198	1.52061	1.74344	4.04960E 02	3.69001E 02	3.59590D 01	-1.7158E-01
92	3.00859	3.44522	1.53732	1.76043	4.05580E 02	3.69140E 02	3.64396D 01	-1.8199E-01
93	3.04130	3.47846	1.55403	1.77741	3.91430E 02	3.54480E 02	3.69496D 01	-1.9325E-01
94	3.07400	3.51168	1.57074	1.79438	3.93430E 02	3.55939E 02	3.74911D 01	-2.0542E-01
95	3.10670	3.54489	1.58745	1.81135	3.92420E 02	3.54353E 02	3.80668D 01	-2.1860E-01
96	3.13940	3.57810	1.60416	1.82832	3.90390E 02	3.51710E 02	3.86795D 01	-2.3287E-01
97	3.17210	3.61129	1.62087	1.84529	3.81250E 02	3.41917E 02	3.93323D 01	-2.4838E-01
98	3.20481	3.64448	1.63758	1.86224	3.76670E 02	3.36641E 02	4.00288D 01	-2.6520E-01
99	3.23751	3.67766	1.65429	1.87920	3.70460E 02	3.29687E 02	4.07730D 01	-2.8350E-01
100	3.27021	3.71084	1.67100	1.89615	3.64390E 02	3.22820E 02	4.15694D 01	-3.0342E-01
101	3.30291	3.74401	1.68771	1.91310	3.52870E 02	3.10947E 02	4.24229D 01	-3.2512E-01
102	3.33561	3.77716	1.70442	1.93004	3.46780E 02	3.03440E 02	4.33394D 01	-3.4881E-01
103	3.36832	3.81031	1.72113	1.94698	3.47960E 02	3.03635E 02	4.43254D 01	-3.7469E-01
104	3.40102	3.84346	1.73784	1.96392	3.42580E 02	2.97191E 02	4.53883D 01	-4.0303E-01
105	3.43372	3.87660	1.75455	1.98085	3.31190E 02	2.84653E 02	4.65367D 01	-4.3409E-01
106	3.46642	3.90973	1.77126	1.99778	3.36640E 02	2.88859E 02	4.77806D 01	-4.6817E-01
107	3.49913	3.94285	1.78797	2.01470	3.31710E 02	2.82578E 02	4.91316D 01	-5.0566E-01
108	3.53183	3.97597	1.80468	2.03163	3.32160E 02	2.81557E 02	5.06030D 01	-5.4684E-01
109	3.56453	4.00908	1.82139	2.04855	3.33100E 02	2.80889E 02	5.22108D 01	-5.9242E-01
110	3.59723	4.04219	1.83810	2.06546	3.29560E 02	2.75586E 02	5.39739D 01	-6.4273E-01
111	3.62994	4.07529	1.85481	2.08238	3.26680E 02	2.70765E 02	5.59147D 01	-6.9852E-01
112	3.66264	4.10838	1.87152	2.09929	3.20140E 02	2.62080E 02	5.80602D 01	-7.6038E-01
113	3.69534	4.14147	1.88823	2.11619	3.44420E 02	2.83975E 02	6.04434D 01	-8.2920E-01
114	3.72804	4.17456	1.90494	2.13310	3.28290E 02	2.65185E 02	6.31045D 01	-9.0578E-01
115	3.76074	4.20763	1.92165	2.15000	3.38730E 02	2.72636E 02	6.60935D 01	-9.9141E-01
116	3.79344	4.24071	1.93836	2.16690	3.38250E 02	2.68777E 02	6.94734D 01	-1.0870E 00
117	3.82615	4.27378	1.95507	2.18380	3.47750E 02	2.74426E 02	7.33241D 01	-1.1944E 00
118	3.85885	4.30684	1.97178	2.20069	3.51190E 02	2.73441E 02	7.77489D 01	-1.3149E 00
119	3.89155	4.33989	1.98849	2.21758	3.58030E 02	2.75146E 02	8.28842D 01	-1.4505E 00

14. COMPLOT Program Input (COMPSCAT Punchout)

```
3  ATSR, SL-5, UNFOLDED WP VECTOR AND ERROR VECTOR, IT, 11
  7115 11   0.01671 13.   .64885
 0.10042E 04 0.92897E 03 0.83816E 03 0.92184E 03 0.98660E 03 0.11849E 04
 0.11764E 04 0.11744E 04 0.12658E 04 0.12112E 04 0.14093E 04 0.16366E 04
 0.19858E 04 0.18826E 04 0.12169E 04 0.94348E 03 0.88983E 03 0.84999E 03
 0.69651E 03 0.74292E 03 0.71013E 03 0.76649E 03 0.10459E 04 0.96108E 03
 0.95429E 03 0.93461E 03 0.10390E 04 0.95230E 03 0.92018E 03 0.93951E 03
 0.97491E 03 0.10094E 04 0.90962E 03 0.91588E 03 0.11207E 04 0.10659E 04
 0.11424E 04 0.11365E 04 0.13600E 04 0.15881E 04 0.19055E 04 0.16365E 04
 0.11327E 04 0.11725E 04 0.99447E 03 0.10341E 04 0.97599E 03 0.11144E 04
 0.11952E 04 0.11305E 04 0.10666E 04 0.11620E 04 0.13942E 04 0.15987E 04
 0.14315E 04 0.12586E 04 0.17849E 04 0.16860E 04 0.15371E 04 0.18926E 04
 0.20067E 04 0.22232E 04 0.22856E 04 0.24058E 04 0.29059E 04 0.27848E 04
 0.29906E 04 0.32276E 04 0.31034E 04 0.27499E 04 0.39996E 04 0.41834E 04
 0.37104E 04 0.39644E 04 0.42801E 04 0.46940E 04 0.52087E 04 0.50248E 04
 0.54044E 04 0.49673E 04 0.53501E 04 0.55861E 04 0.65571E 04 0.51659E 04
 0.55733E 04 0.64415E 04 0.51789E 04 0.60405E 04 0.67578E 04 0.76329E 04
 0.72989E 04 0.77435E 04 0.79285E 04 0.81188E 04 0.69516E 04 0.65340E 04
 0.75289E 04 0.72466E 04 0.54801E 04 0.66840E 04 0.59492E 04 0.60773E 04
```

0.62752E 04	0.55021E 04	0.46901E 04	0.33001E 04	0.66689E 04	0.37140E 04
0.47510E 04	0.45283E 04	0.68375E 04	0.12579E 05	0.91687E 05	
0.13212E 03	0.12129E 03	0.10643E 03	0.11782E 03	0.12322E 03	0.14069E 03
0.13310E 03	0.12680E 03	0.13035E 03	0.11681E 03	0.12988E 03	0.13941E 03
0.15148E 03	0.12326E 03	0.69677E 02	0.50438E 02	0.45560E 02	0.41799E 02
0.33362E 02	0.34955E 02	0.32798E 02	0.34759E 02	0.45506E 02	0.43542E 02
0.44588E 02	0.45869E 02	0.54047E 02	0.53182E 02	0.56159E 02	0.63446E 02
0.73461E 02	0.85508E 02	0.87976E 02	0.10244E 03	0.14435E 03	0.15901E 03
0.19844E 03	0.23126E 03	0.32255E 03	0.43433E 03	0.59383E 03	0.58216E 03
0.47571E 03	0.58577E 03	0.59855E 03	0.74900E 03	0.85514E 03	0.11705E 04
0.14996E 04	0.17016E 04	0.19288E 04	0.25010E 04	0.35219E 04	0.47084E 04
0.49553E 04	0.51296E 04	0.82626E 04	0.90084E 04	0.94624E 04	0.13070E 05
0.15564E 05	0.19176E 05	0.21896E 05	0.25395E 05	0.33227E 05	0.34994E 05
0.40693E 05	0.47339E 05	0.49375E 05	0.47350E 05	0.70587E 05	0.78535E 05
0.74989E 05	0.83780E 05	0.94103E 05	0.10691E 06	0.12277E 06	0.12455E 06
0.13866E 06	0.13403E 06	0.14794E 06	0.15881E 06	0.18985E 06	0.15999E 06
0.17520E 06	0.20426E 06	0.17339E 06	0.20074E 06	0.22486E 06	0.25399E 06
0.24909E 06	0.26661E 06	0.27707E 06	0.28840E 06	0.25742E 06	0.24811E 06
0.28481E 06	0.28094E 06	0.22573E 06	0.27259E 06	0.25232E 06	0.26338E 06
0.27801E 06	0.25654E 06	0.23275E 06	0.18103E 06	0.33440E 06	0.20859E 06
0.25474E 06	0.23046E 06	0.27040E 06	0.27089E 06	0.29763E 06	0.44120E 06

15. DOSE Printout

ATSR, 37 WATT, SNELL BLOCK, UNFOLDED WP VECTOR, ITER. 11

MEV/CHAN. = 0.016710 SCALE FACTOR FOR P(E0) = 0.64885

N(E) = 7.0E 23 ELECTRON REST MASS UNITS = 0.510976

CHAN.	ELECTRON ENERGY (MEV)	ELECTRON ENERGY (MC SQ UNITS)	PHOTON ENERGY (MEV)	PHOTON ENERGY (MC SQ UNITS)	P(E0) (MC SQ UNITS)	INPUT PHI(E0) (MC SQ UNITS)	PHI(E0) /P(E0)	EOU	EOL
7	1.170E-01	2.289E-01	2.410E-01	4.716E-01	2.008E-01	1.004E 03	5.000E 03	4.937E-01	4.492E-01
8	1.337E-01	2.616E-01	2.634E-01	5.154E-01	2.044E-01	9.290E 02	4.546E 03	5.369E-01	4.937E-01
9	1.504E-01	2.943E-01	2.851E-01	5.580E-01	2.077E-01	8.382F 02	4.035E 03	5.790E-01	5.369E-01
10	1.671E-01	3.270E-01	3.064E-01	5.997E-01	2.109E-01	9.218E 02	4.371F 03	6.202E-01	5.790E-01
11	1.838E-01	3.597E-01	3.273E-01	6.405E-01	2.140E-01	9.866E 02	4.610E 03	6.607E-01	6.202E-01
12	2.005E-01	3.924E-01	3.478E-01	6.807E-01	2.170E-01	1.185E 03	5.461E 03	7.005E-01	6.607E-01
13	2.172E-01	4.251E-01	3.680E-01	7.203E-01	2.199E-01	1.176F 03	5.351E 03	7.398E-01	7.005E-01
14	2.339E-01	4.578E-01	3.880E-01	7.593E-01	2.226E-01	1.174E 03	5.275E 03	7.787E-01	7.398E-01
15	2.506E-01	4.905F-01	4.077E-01	7.979E-01	2.253E-01	1.266E 03	5.618F 03	8.171E-01	7.787E-01
16	2.674E-01	5.232E-01	4.272E-01	8.361E-01	2.279E-01	1.211E 03	5.314F 03	8.551E-01	8.171E-01
17	2.841E-01	5.559F-01	4.466E-01	8.740E-01	2.305E-01	1.409E 03	6.115E 03	8.928E-01	8.551E-01
18	3.008E-01	5.886E-01	4.658E-01	9.115E-01	2.329E-01	1.637E 03	7.026E 03	9.302E-01	8.928E-01
19	3.175E-01	6.213F-01	4.848E-01	9.488E-01	2.353E-01	1.986E 03	8.439E 03	9.673E-01	9.302E-01
20	3.342E-01	6.540E-01	5.037E-01	9.858E-01	2.376E-01	1.883E 03	7.922E 03	1.004E 00	9.673E-01
21	3.509E-01	6.867E-01	5.225E-01	1.023F 00	2.399E-01	1.217E 03	5.073F 03	1.041E 00	1.004E 00
22	3.676E-01	7.194E-01	5.412E-01	1.059E 00	2.421E-01	9.435E 02	3.897E 03	1.077E 00	1.041E 00
23	3.843E-01	7.521E-01	5.598E-01	1.095E 00	2.442E-01	8.898E 02	3.644E 03	1.114E 00	1.077E 00
24	4.010E-01	7.849E-01	5.782E-01	1.132E 00	2.463E-01	8.500E 02	3.451E 03	1.150E 00	1.114E 00
25	4.177E-01	8.176E-01	5.966E-01	1.168E 00	2.483E-01	6.965E 02	2.805E 03	1.186E 00	1.150E 00
26	4.345E-01	8.503E-01	6.150E-01	1.203E 00	2.503E-01	7.429E 02	2.968E 03	1.221E 00	1.186E 00
27	4.512E-01	8.830E-01	6.332E-01	1.239E 00	2.522E-01	7.101E 02	2.816E 03	1.257E 00	1.221E 00
28	4.679E-01	9.157E-01	6.514E-01	1.275E 00	2.540E-01	7.665E 02	3.017E 03	1.293E 00	1.257E 00
29	4.846E-01	9.484E-01	6.695E-01	1.310E 00	2.558E-01	1.046E 03	4.088E 03	1.328E 00	1.293E 00
30	5.013E-01	9.811F-01	6.876E-01	1.346E 00	2.576E-01	9.611E 02	3.731E 03	1.363E 00	1.328E 00
31	5.180E-01	1.014E 00	7.056E-01	1.381E 00	2.593E-01	9.543E 02	3.680E 03	1.398E 00	1.363E 00
32	5.347E-01	1.046F 00	7.235E-01	1.416E 00	2.609E-01	9.346E 02	3.582E 03	1.434E 00	1.398E 00
33	5.514E-01	1.079E 00	7.414E-01	1.451E 00	2.625E-01	1.039E 03	3.958E 03	1.469E 00	1.434E 00
34	5.681E-01	1.112F 00	7.593E-01	1.486E 00	2.641E-01	9.523E 02	3.606E 03	1.503E 00	1.469E 00
35	5.848E-01	1.145F 00	7.771E-01	1.521E 00	2.656E-01	9.202E 02	3.465E 03	1.538E 00	1.503E 00
36	6.016E-01	1.177E 00	7.949E-01	1.556E 00	2.670E-01	9.395E 02	3.518E 03	1.573E 00	1.538E 00
37	6.183E-01	1.210E 00	8.126E-01	1.590E 00	2.684E-01	9.749E 02	3.632E 03	1.608E 00	1.573E 00
38	6.350E-01	1.243E 00	8.304E-01	1.625E 00	2.698E-01	1.009E 03	3.742E 03	1.642E 00	1.608E 00
39	6.517E-01	1.275E 00	8.480E-01	1.660E 00	2.711E-01	9.096E 02	3.355E 03	1.677E 00	1.642E 00
40	6.684E-01	1.308E 00	8.657E-01	1.694E 00	2.724E-01	9.159E 02	3.363E 03	1.711E 00	1.677E 00
41	6.851E-01	1.341E 00	8.833E-01	1.729E 00	2.736E-01	1.121E 03	4.097E 03	1.746E 00	1.711E 00
42	7.018E-01	1.373E 00	9.009E-01	1.763E 00	2.747E-01	1.066E 03	3.880E 03	1.780E 00	1.746E 00
43	7.185E-01	1.406E 00	9.184E-01	1.797E 00	2.759E-01	1.142E 03	4.141E 03	1.815E 00	1.780E 00
44	7.352E-01	1.439E 00	9.359E-01	1.832E 00	2.770E-01	1.137E 03	4.104E 03	1.849E 00	1.815E 00
45	7.519E-01	1.472E 00	9.534E-01	1.866E 00	2.780E-01	1.360E 03	4.892E 03	1.883E 00	1.849E 00
46	7.687E-01	1.504E 00	9.709E-01	1.900E 00	2.790E-01	1.588E 03	5.693E 03	1.917E 00	1.883E 00
47	7.854E-01	1.537E 00	9.884E-01	1.934E 00	2.799E-01	1.906E 03	6.807E 03	1.951E 00	1.917E 00
48	8.021E-01	1.570E 00	1.006E 00	1.968E 00	2.808E-01	1.637E 03	5.827E 03	1.985F 00	1.951E 00
49	8.188E-01	1.602E 00	1.023E 00	2.003E 00	2.817E-01	1.133E 03	4.021E 03	2.020E 00	1.985E 00
50	8.355E-01	1.635E 00	1.041E 00	2.037E 00	2.825E-01	1.173E 03	4.150E 03	2.054E 00	2.020E 00
51	8.522E-01	1.668E 00	1.058E 00	2.071E 00	2.833E-01	9.945E 02	3.511E 03	2.088E 00	2.054E 00
52	8.689E-01	1.701E 00	1.075E 00	2.105E 00	2.840E-01	1.034E 03	3.641E 03	2.121E 00	2.088E 00

53	8.856E-01	1.733E 00	1.093E 00	2.138E 00	2.847E-01	9.760E 02	3.428F 03	2.155E 00	2.121E 00
54	9.023E-01	1.766E 00	1.110E 00	2.172E 00	2.853E-01	1.114E 03	3.906E 03	2.189E 00	2.155E 00
55	9.190E-01	1.799E 00	1.127E 00	2.206E 00	2.859E-01	1.195E 03	4.180E 03	2.223E 00	2.189E 00
56	9.358E-01	1.831E 00	1.145E 00	2.240E 00	2.865E-01	1.131E 03	3.946E 03	2.257E 00	2.223E 00
57	9.525E-01	1.864E 00	1.162E 00	2.274E 00	2.870E-01	1.067E 03	3.716E 03	2.291E 00	2.257E 00
58	9.692E-01	1.897E 00	1.179E 00	2.308E 00	2.875E-01	1.162E 03	4.042E 03	2.325E 00	2.291E 00
59	9.859E-01	1.929E 00	1.196E 00	2.341E 00	2.879E-01	1.394E 03	4.843E 03	2.358E 00	2.325E 00
60	1.003E 00	1.962E 00	1.214E 00	2.375E 00	2.883E-01	1.599E 03	5.546E 03	2.392E 00	2.358E 00
61	1.019E 00	1.995E 00	1.231E 00	2.409E 00	2.886E-01	1.432E 03	4.960E 03	2.426E 00	2.392E 00
62	1.036E 00	2.028F 00	1.248E 00	2.443E 00	2.889E-01	1.259E 03	4.356E 03	2.459E 00	2.426E 00
63	1.053E 00	2.060E 00	1.265E 00	2.476E 00	2.892E-01	1.785E 03	6.172E 03	2.493E 00	2.459E 00
64	1.069E 00	2.093E 00	1.282E 00	2.510E 00	2.894E-01	1.686E 03	5.826E 03	2.527E 00	2.493E 00
65	1.086E 00	2.126E 00	1.300E 00	2.543E 00	2.896E-01	1.537E 03	5.308E 03	2.560E 00	2.527E 00
66	1.103E 00	2.158E 00	1.317E 00	2.577E 00	2.897E-01	1.893E 03	6.532E 03	2.594E 00	2.560E 00
67	1.120E 00	2.191E 00	1.334E 00	2.611E 00	2.898E-01	2.007E 03	6.924E 03	2.627E 00	2.594E 00
68	1.136E 00	2.224E 00	1.351E 00	2.644E 00	2.899E-01	2.223E 03	7.670E 03	2.661E 00	2.627E 00
69	1.153E 00	2.256E 00	1.368E 00	2.678E 00	2.899E-01	2.286E 03	7.885E 03	2.695E 00	2.661E 00
70	1.170E 00	2.289E 00	1.385E 00	2.711E 00	2.898E-01	2.406E 03	8.300E 03	2.728E 00	2.695E 00
71	1.186E 00	2.322E 00	1.403E 00	2.745E 00	2.898E-01	2.906E 03	1.003E 04	2.762E 00	2.728E 00
72	1.203E 00	2.355E 00	1.420E 00	2.778E 00	2.897E-01	2.785E 03	9.614E 03	2.795E 00	2.762E 00
73	1.220E 00	2.387E 00	1.437E 00	2.812E 00	2.895E-01	2.991E 03	1.033E 04	2.828E 00	2.795E 00
74	1.237E 00	2.420E 00	1.454E 00	2.845E 00	2.893E-01	3.228E 03	1.116E 04	2.862E 00	2.828E 00
75	1.253E 00	2.453E 00	1.471E 00	2.879E 00	2.891E-01	3.103E 03	1.074E 04	2.895E 00	2.862E 00
76	1.270E 00	2.485E 00	1.488E 00	2.912E 00	2.888E-01	2.750E 03	9.522E 03	2.929E 00	2.895E 00
77	1.287E 00	2.518E 00	1.505E 00	2.946E 00	2.885E-01	4.000E 03	1.387E 04	2.962E 00	2.929E 00
78	1.303E 00	2.551E 00	1.522E 00	2.979E 00	2.881E-01	4.183E 03	1.452E 04	2.996E 00	2.962E 00
79	1.320E 00	2.583E 00	1.539E 00	3.012E 00	2.877E-01	3.710E 03	1.290E 04	3.029E 00	2.996E 00
80	1.337E 00	2.616E 00	1.556E 00	3.046E 00	2.873E-01	3.964E 03	1.380E 04	3.062E 00	3.029E 00
81	1.354E 00	2.649E 00	1.573E 00	3.079E 00	2.868E-01	4.280E 03	1.493E 04	3.096E 00	3.062E 00
82	1.370E 00	2.682E 00	1.590E 00	3.112E 00	2.862E-01	4.694E 03	1.640E 04	3.129E 00	3.096E 00
83	1.387E 00	2.714E 00	1.607E 00	3.146E 00	2.857E-01	5.209E 03	1.823E 04	3.162E 00	3.129E 00
84	1.404E 00	2.747E 00	1.624E 00	3.179E 00	2.851E-01	5.025E 03	1.763E 04	3.196E 00	3.162E 00
85	1.420E 00	2.780E 00	1.641E 00	3.212E 00	2.844E-01	5.404E 03	1.900E 04	3.229E 00	3.196E 00
86	1.437E 00	2.812E 00	1.658E 00	3.246E 00	2.837E-01	4.967E 03	1.751E 04	3.262E 00	3.229E 00
87	1.454E 00	2.845E 00	1.675E 00	3.279E 00	2.830E-01	5.350F 03	1.890E 04	3.296E 00	3.262E 00
88	1.470E 00	2.878E 00	1.692E 00	3.312E 00	2.822E-01	5.586E 03	1.979E 04	3.329E 00	3.296E 00
89	1.487E 00	2.910E 00	1.709E 00	3.345E 00	2.814E-01	6.567E 03	2.333E 04	3.362E 00	3.329E 00
90	1.504E 00	2.943E 00	1.726E 00	3.379E 00	2.806E-01	5.166E 03	1.841E 04	3.395E 00	3.362E 00
91	1.521E 00	2.976E 00	1.743E 00	3.412E 00	2.797E-01	5.573E 03	1.993E 04	3.429E 00	3.395E 00
92	1.537E 00	3.009E 00	1.760E 00	3.445E 00	2.788E-01	6.442E 03	2.311E 04	3.462E 00	3.429E 00
93	1.554E 00	3.041E 00	1.777E 00	3.478E 00	2.778E-01	5.179E 03	1.864E 04	3.495E 00	3.462E 00
94	1.571E 00	3.074E 00	1.794E 00	3.512E 00	2.768E-01	6.041E 03	2.182E 04	3.528E 00	3.495E 00
95	1.587E 00	3.107E 00	1.811E 00	3.545E 00	2.757E-01	6.768E 03	2.455E 04	3.561E 00	3.528E 00
96	1.604E 00	3.139E 00	1.828E 00	3.578E 00	2.746E-01	7.633E 03	2.779E 04	3.595E 00	3.561E 00
97	1.621E 00	3.172F 00	1.845E 00	3.611E 00	2.735E-01	7.299E 03	2.669E 04	3.628E 00	3.595E 00
98	1.638E 00	3.205E 00	1.862E 00	3.644E 00	2.723E-01	7.744E 03	2.844E 04	3.661E 00	3.628E 00
99	1.654E 00	3.238E 00	1.879E 00	3.678E 00	2.711E-01	7.929E 03	2.925E 04	3.694E 00	3.661E 00
100	1.671E 00	3.270E 00	1.896E 00	3.711E 00	2.698E-01	8.119E 03	3.009E 04	3.727E 00	3.694E 00
101	1.688E 00	3.303E 00	1.913E 00	3.744E 00	2.686E-01	6.952E 03	2.589E 04	3.761E 00	3.727E 00
102	1.704E 00	3.336E 00	1.930E 00	3.777E 00	2.672E-01	6.534E 03	2.445E 04	3.794E 00	3.761E 00
103	1.721E 00	3.368E 00	1.947E 00	3.810E 00	2.658E-01	7.529E 03	2.832E 04	3.827E 00	3.794E 00
104	1.738E 00	3.401E 00	1.964E 00	3.843E 00	2.644E-01	7.247E 03	2.741E 04	3.860E 00	3.827E 00
105	1.755E 00	3.434E 00	1.981E 00	3.877E 00	2.630E-01	5.480E 03	2.084E 04	3.893E 00	3.860E 00
106	1.771E 00	3.466E 00	1.998E 00	3.910E 00	2.615E-01	6.684E 03	2.556E 04	3.926E 00	3.893E 00
107	1.788E 00	3.499E 00	2.015E 00	3.943E 00	2.599E-01	5.949E 03	2.289E 04	3.959E 00	3.926E 00
108	1.805E 00	3.532E 00	2.032E 00	3.976E 00	2.584E-01	6.077E 03	2.352E 04	3.993E 00	3.959E 00
109	1.821E 00	3.565E 00	2.049E 00	4.009E 00	2.567E-01	6.275E 03	2.444E 04	4.026E 00	3.993E 00
110	1.838E 00	3.597E 00	2.065E 00	4.042E 00	2.551E-01	5.502E 03	2.157E 04	4.059E 00	4.026E 00
111	1.855E 00	3.630E 00	2.082E 00	4.075E 00	2.534E-01	4.690E 03	1.851E 04	4.092E 00	4.059E 00
112	1.872E 00	3.663E 00	2.099E 00	4.108E 00	2.517E-01	3.300E 03	1.311E 04	4.125E 00	4.092E 00
113	1.888E 00	3.695E 00	2.116E 00	4.141E 00	2.499E-01	6.669E 03	2.669E 04	4.158E 00	4.125E 00
114	1.905E 00	3.728E 00	2.133E 00	4.175E 00	2.481E-01	3.714E 03	1.497E 04	4.191E 00	4.158E 00
115	1.922E 00	3.761E 00	2.150E 00	4.208E 00	2.462E-01	4.751E 03	1.930E 04	4.224E 00	4.191E 00
116	1.938E 00	3.793E 00	2.167E 00	4.241E 00	2.443E-01	4.528E 03	1.854E 04	4.257E 00	4.224E 00
117	1.955E 00	3.826E 00	2.184E 00	4.274E 00	2.424E-01	6.838E 03	2.821E 04	4.290E 00	4.257E 00
118	1.972E 00	3.859E 00	2.201E 00	4.307E 00	2.404E-01	1.258E 04	5.233E 04	4.323E 00	4.290E 00

INDEX	ELECTRON ENERGY (MEV)	(PHI(EO)/P(EO))*C(EI,EO) /(N(EI)*SQMC) = WIM(EI)	WIM(EI) *EI
1	0.0	0.0	0.0
2	1.170E-01	9.61774E-21	1.12499E-21
3	1.337E-01	8.77876E-21	1.17354E-21
4	1.504E-01	8.18368E-21	1.23074E-21
5	1.671E-01	7.81365E-21	1.30566E-21
6	1.838E-01	7.48297E-21	1.37544E-21
7	2.005E-01	7.20187E-21	1.44412E-21
8	2.172E-01	6.86001E-21	1.49020E-21
9	2.339E-01	6.57821E-21	1.53891E-21
10	2.506E-01	6.34910E-21	1.59140E-21
11	2.674E-01	6.12176E-21	1.63671E-21
12	2.841E-01	5.96266E-21	1.69381E-21
13	3.008E-01	5.76759E-21	1.73477E-21
14	3.175E-01	5.51780E-21	1.75184E-21

15	3.342E-01	5.15359E-21	1.72233E-21
16	3.509E-01	4.79843E-21	1.68382E-21
17	3.676E-01	4.61384E-21	1.69614E-21
18	3.843E-01	4.50008E-21	1.72951E-21
19	4.010E-01	4.40289E-21	1.76573E-21
20	4.177E-01	4.31821E-21	1.80393E-21
21	4.345E-01	4.27301E-21	1.85645E-21
22	4.512E-01	4.22661E-21	1.90692E-21
23	4.679E-01	4.19573E-21	1.96310E-21
24	4.846E-01	4.16489E-21	2.01826E-21
25	5.013E-01	4.09167E-21	2.05115E-21
26	5.180E-01	4.03585E-21	2.09061E-21
27	5.347E-01	3.98531E-21	2.13102E-21
28	5.514E-01	3.94210E-21	2.17379E-21
29	5.681E-01	3.88717E-21	2.20846E-21
30	5.848E-01	3.84722E-21	2.25005E-21
31	6.016E-01	3.81547E-21	2.29523E-21
32	6.183E-01	3.78566E-21	2.34056E-21
33	6.350E-01	3.75564E-21	2.38476E-21
34	6.517E-01	3.72523E-21	2.42769E-21
35	6.684E-01	3.71069E-21	2.48022E-21
36	6.851E-01	3.70147E-21	2.53591E-21
37	7.018E-01	3.67557E-21	2.57959E-21
38	7.185E-01	3.65979E-21	2.62967E-21
39	7.352E-01	3.64151E-21	2.67738E-21
40	7.519E-01	3.62907E-21	2.72888E-21
41	7.687E-01	3.60034E-21	2.76743E-21
42	7.854E-01	3.55301E-21	2.79043E-21
43	8.021E-01	3.47581E-21	2.78788E-21
44	8.188E-01	3.41818E-21	2.79877E-21
45	8.355E-01	3.40243E-21	2.84273E-21
46	8.522E-01	3.38538E-21	2.88505E-21
47	8.689E-01	3.38512E-21	2.94140E-21
48	8.856E-01	3.38542E-21	2.99823E-21
49	9.023E-01	3.39428E-21	3.06279E-21
50	9.190E-01	3.39720E-21	3.12219E-21
51	9.358E-01	3.39797E-21	3.17968E-21
52	9.525E-01	3.40735E-21	3.24540E-21
53	9.692E-01	3.42630E-21	3.32070E-21
54	9.859E-01	3.44463E-21	3.39603E-21
55	1.003E 00	3.45287E-21	3.46185E-21
56	1.019E 00	3.45193E-21	3.51859E-21
57	1.036E 00	3.46594E-21	3.59077E-21
58	1.053E 00	3.49709E-21	3.68149E-21
59	1.069E 00	3.50200E-21	3.74518E-21
60	1.086E 00	3.51791E-21	3.82097E-21
61	1.103E 00	3.54940E-21	3.91449E-21
62	1.120E 00	3.56749E-21	3.99405E-21
63	1.136E 00	3.58565E-21	4.07430E-21
64	1.153E 00	3.59811E-21	4.14858E-21
65	1.170E 00	3.61363E-21	4.22686E-21
66	1.186E 00	3.62950E-21	4.30607E-21
67	1.203E 00	3.62447E-21	4.36067E-21
68	1.220E 00	3.63130E-21	4.42957E-21

69	1.237E 00	3.63338E-21	4.49282E-21
70	1.253E 00	3.62873E-21	4.54770E-21
71	1.270E 00	3.63614E-21	4.61776E-21
72	1.287E 00	3.66945E-21	4.72137E-21
73	1.303E 00	3.64853E-21	4.75541E-21
74	1.320E 00	3.62249E-21	4.78201E-21
75	1.337E 00	3.62419E-21	4.84481E-21
76	1.354E 00	3.62059E-21	4.90050E-21
77	1.370E 00	3.60843E-21	4.94434E-21
78	1.387E 00	3.58239E-21	4.96852E-21
79	1.404E 00	3.53628E-21	4.96366E-21
80	1.420E 00	3.50142E-21	4.97324E-21
81	1.437E 00	3.45240E-21	4.96130E-21
82	1.454E 00	3.42604E-21	4.98067E-21
83	1.470E 00	3.38703E-21	4.98056E-21
84	1.487E 00	3.34092E-21	4.96858E-21
85	1.504E 00	3.25312E-21	4.89236E-21
86	1.521E 00	3.22631E-21	4.90595E-21
87	1.537E 00	3.18656E-21	4.89876E-21
88	1.554E 00	3.11233E-21	4.83665E-21
89	1.571E 00	3.09358E-21	4.85920E-21
90	1.587E 00	3.04434E-21	4.83273E-21
91	1.604E 00	2.96762E-21	4.76054E-21
92	1.621E 00	2.85470E-21	4.62709E-21
93	1.638E 00	2.75261E-21	4.50761E-21
94	1.654E 00	2.62953E-21	4.35000E-21
95	1.671E 00	2.49382E-21	4.16716E-21
96	1.688E 00	2.34342E-21	3.95501E-21
97	1.704E 00	2.23257E-21	3.80523E-21
98	1.721E 00	2.13440E-21	3.67358E-21
99	1.738E 00	1.99220E-21	3.46213E-21
100	1.755E 00	1.85274E-21	3.25072E-21
101	1.771E 00	1.77622E-21	3.14614E-21
102	1.788E 00	1.64929E-21	2.94888E-21
103	1.805E 00	1.54422E-21	2.78682E-21
104	1.821E 00	1.42851E-21	2.60187E-21
105	1.838E 00	1.29787E-21	2.38561E-21
106	1.855E 00	1.18879E-21	2.20499E-21
107	1.872E 00	1.10492E-21	2.06788E-21
108	1.888E 00	1.07196E-21	2.02411E-21
109	1.905E 00	9.07779E-22	1.72926E-21
110	1.922E 00	8.46585E-22	1.62684E-21
111	1.938E 00	7.42906E-22	1.44002E-21
112	1.955E 00	6.41457E-22	1.25409E-21
113	1.972E 00	4.42883E-22	8.73268E-22

APPROX. VALUE OF INTEGRAL FROM ZERO TO 1.97178 (N = 3,M = 2)

IS 5.84249D-21 +/- -4.61326E-25

L	ABSCISSA	FUNCTION VALUE	DERIVATIVE
1	1.18380E-02	1.14469D-22	9.08786D-21
2	6.18415E-02	5.68893D-22	9.08786D-21
3	1.49651E-01	1.23373D-21	3.95322D-21
4	2.71694E-01	1.65392D-21	3.06439D-21
5	4.22974E-01	1.82289D-21	2.71453D-21
6	5.97300E-01	2.28374D-21	2.70840D-21
7	7.87534E-01	2.78324D-21	6.11718D-22
8	9.85889E-01	3.39286D-21	4.22340D-21
9	1.18424E 00	4.28920D-21	4.00401D-21
10	1.37448E 00	4.94645D-21	2.03535D-21
11	1.54880E 00	4.87105D-21	-1.18349D-21
12	1.70008E 00	3.84778D-21	-8.42097D-21
13	1.82213E 00	2.58257D-21	-1.20049D-20
14	1.90994E 00	1.73400D-21	-1.18876D-20
15	1.95994E 00	1.10653D-21	-1.69586D-20

DOSE = 1.75933E 03 +/- -1.38917E-01 MEV/GM.-SEC.

1.01464E-01 +/- -8.01164E-06 RADS/HR.

REFERENCES

1. R. Gold, *Compton Continuum Measurements for Continuous Gamma-ray Spectroscopy*, Bull. Am. Phys. Soc. *13*, 1405 (1968).
2. R. Gold, "Compton Recoil Continuum Measurements for In-core Gamma-ray Spectroscopy," in *Reactor Physics Division Annual Report--July 1, 1967 to June 30, 1968*, ANL-7410, pp. 373-377 (Jan 1969).
3. R. Gold, *Compton-recoil Gamma-ray Spectroscopy*, Nucl. Instr. Methods *84*, 173-194 (1970).
4. R. Gold, *An Iterative Unfolding Method for Response Matrices*, ANL-6984 (Dec 1964).
5. M. G. Silk and S. B. Wright, *The Determination of the Energy Spectrum of Gamma Radiation Near the Core Center of GLEEP*, AERE-M1981 (1967).
6. M. G. Silk, *Iterative Unfolding of Compton Spectra*, AERE-5653 (1968).
7. M. G. Silk, *The Energy Spectrum of the Gamma Radiation in the Daphne Core*, J. Nucl. Energy *23*, 308 (1969).
8. W. Heitler, *The Quantum Theory of Radiation*, Oxford University Press, London (1954).
9. R. D. Evans, "Compton Effect," in *Handbuch der Physik*, Springer, Berlin (1958), Vol. XXXIV, pp. 218-297.
10. A. T. Nelms, *Graphs of the Compton Energy-Angle Relationship and the Klein-Nishina Formula from 10 keV to 500 MeV*, NBS Circular 542 (1953).
11. R. Gold and E. F. Bennett, *Error Estimates for Iterative Unfolding*, J. Comp. Phys. *3*, 167 (1968).
12. I. K. Olson and R. Gold, "NUMQUAD--A Program for Numerical Integration of Experimental Data Using Gauss-Legendre Quadrature," in *Reactor Physics Division Annual Report, July 1, 1968 to June 30, 1969*, ANL-7610, p. 537 (Jan 1970).
13. R. Gold and E. F. Bennett, *Effects of Finite Size in 4π-Recoil Proportional Counters*, Nucl. Instr. Methods *63*, 285 (1968).

ARGONNE NATIONAL LAB WEST
3 4444 00011306 8

B