FINAL REPORT

ANALYSIS OF LEAM EXPERIMENT RESPONSE
TO CHARGED PARTICLES

BSR 4234

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SECTION 1

SUMMARY

The Lunar Ejecta and Meteorites Experiment (LEAM) was deployed on the moon on 12 December 1972. The objectives of the experiment were to measure the long-term variations in cosmic dust influx rates and the extent and nature of the lunar ejecta. While analyzing these characteristics in the data, it was discovered that a majority of the events could not be associated with hyper-velocity particle impacts of the type usually identified with cosmic dust, but could only be correlated with the lunar surface and local sun angle.

The possibility that charged particles could be incident on the sensors led the Principal Investigator (PI) to request that an analysis of the electronics be performed to determine if such signals could cause the large pulse height analysis (PHA) signals. These signals indicate the energy of the hyper-velocity particles in the normal mode of operation.

A qualitative analysis of the PHA circuit showed that an alternative mode of operation existed if the input signal were composed of pulses with pulse durations very long compared to the durations for which it was designed, by a factor of at least 40 to 1. This alternative mode would give large PHA outputs even though the actual input amplitudes were small. This revelation led to the examination of the sensor and its response to charged particles to determine the type of signals that could be expected.

A qualitative review of the sensor and application of basic electrostatic theory indicated that very slow particles, below the normal experiment operating range, could produce pulses of the time duration required to excite the PHA circuit's anomalous response.

A grossly simplified model of the sensor was developed on a computer to determine the range of particle characteristics to which the sensor would respond. This range was then compared with known or expected values for lunar dust particles and practical expectations for charge to mass ratios.

At the same time, the electronics was analyzed using a standard IBM analysis program, SCEPTRE.

The results of the sensor modeling and circuit analysis showed conclusively that charged particles moving at velocities below 1 kilometer per second would produce PHA responses of the type observed in the lunar data and in addition could cause double accumulator counts, another of the unusual events.

This finding was of such importance to the understanding of lunar surface dust transport that it was decided to continue the analysis to obtain more accurate data on particle mass, charge, and velocity. A theoretical calibration of the experiment response to charged particles was required to enable a complete analysis of the lunar data to be performed. In addition, a practical measurement of the response using the experiment qualification model was to be attempted to corroborate the analysis. A complete physical calibration was impractical.

The analysis was continued on two fronts. A simplified model of the electronics was developed because the SCEPTRE simulation was cumbersome and costly to use. In parallel with this, a refined model of the sensor was developed to remove the limitations of the simple model and provide greater accuracy.

The sensor film, collector grid, and suppressor grid were divided into 7,360 elements for computational purposes. Using basic electrostatic principles, the charge distributions on each plane were calculated for both the applied potentials and the charged particle. The 7,360 simultaneous equations that result from the mutual interactions between elements were solved iteratively. The program used a large area of computer memory and was slow to converge to a result. No complete results were obtained from this model because efforts were made to speed up the convergence and overall running time to save future costs.

Two other programs, which apply the sensor model results to the electronics and then analyze the results, were prepared and checked on simulated data. Program descriptions are given in the Appendix.

The conclusion from the analysis to date is that the LEAM experiment data contain significant information relative to mechanisms operating at the lunar surface. To fully understand and appreciate these mechanisms, the lunar events recorded by LEAM must be transposed into parameters of particle mass, velocity, and charge and their respective variations in space and time. To accomplish this, a calibration of the LEAM in response to charged particles must be completed.

This report recommends that the analysis be continued, in conjunction with work being performed by the Principal Investigator, to provide a comprehensive picture of the dust environment at the lunar surface. The results would be, in addition to characterization of the particles, that unique events would be characterized, allowing segmentation of the measurement range, and event types would be correlated with lunar cycles and temporal effects. Hypotheses on dust formation and transport would be refined and opportunities would be developed for understanding several unexplained phenomena observed on the lunar surface by astronauts and other experimenters.

A meeting was conducted on 20 July 1976 by the LEAM Principal Investigator with Dr. W. Quaide and M.J. Smith of NASA Headquarters to discuss the present LEAM program status and the importance of continuing both the analysis of the experiment response to charged particles and the lunar data analysis.

A summary of the LEAM study status and the proposed tasks for extended study of the charged particle phenomenon is included herein as Appendix B.

SECTION 2

INTRODUCTION

The study of the LEAM experiment's response to charged particles was initiated at the request of the Principal Investigator, when it was observed that data over a 2-year period showed an incidence of signals with outputs of 6 and 7 PHA counts, far greater than anticipated from data obtained on previous space flights. Particles of this energy would normally penetrate the front film and provide signals at the rear film, but this was not observed. There were numerous events which recorded impacts on two film strips or collector grid strips, or which recorded two accumulator counts for one event. These events could not be explained by the normal experiment response to hypervelocity particles. The average event rate of less than 10 particles per 3-hour period gave an extremely low probability of two particles being incident on the sensor at precisely the same time. The inhibit circuit, which was employed to prevent crosstalk between adjacent sensor elements, prevents noncoincident events from being recorded in the same time frame. This guarantees that PHA and accumulator data can be identified with the correct event. The majority of the events occurred around sunrise and sunset, but thermally induced signals were ruled out because the onset of the data occurred up to 60 hours before sunrise, when the experiment was thermally stable. Normal operation of the experiment was verified by the internal calibration signals, which were generated automatically every 15.5 hours.

The preliminary analysis was discussed in detail in a Bendix report, ASTIR/TM66, prepared 1 August 1975. The electronics analysis using SCEPTRE showed that for long input pulses to the PHA peak detector the diode in the forward path continued to conduct and maintain the input to the threshold detector. This, in turn, allowed the PHA counter to continue incrementing. In addition, if the pulse length and amplitude were above certain levels, a condition arose which caused double counting of the film accumulator. The accumulator increments whenever the PHA threshold detector is triggered. Double triggering was caused by the combination of pulse length, amplitude, and the circuit time constants. The circuit was designed for pulses of 2 microseconds maximum length, while the pulses giving the effects discussed above were over 80 microseconds in length.

To determine the type of signal to be expected from the sensor in response to charged particles, a very simple model of the sensor was developed which treated the sensor planes as solid conducting sheets rather than 95% transparent grids. The model permitted an increased understanding of the electrostatic principles involved and allowed determination, within an order of magnitude, of the ranges of particle parameters to which the sensor would respond.

The simple sensor results showed that the electrostatic forces involved were significant for particles of masses and charges in a range which could reasonably be expected to be present on the moon. Also, if the velocities were below 1 kilometer per second (km/sec), signal pulse lengths and amplitudes could be obtained from the film which would cause the PHA circuit to give the observed large values and double accumulator counting.

Thus, the simple sensor and SCEPTRE analysis showed that LEAM could respond to slowly moving charged particles and give data outputs similar to those observed on the moon. The simple model could not give accurate values for the mass and charge ranges measurable by the experiment because of its gross simplification of the electric fields. Also, it did not include any modeling of the film strips adjacent to the one being considered, which meant that multiple events and inhibits were ignored and PHA signal levels were generally too small.

To alleviate the limitations of the simple sensor and to provide an electronic model which would provide cost-effective results, a refined sensor model and a simple electronics model were developed. The refined sensor model included a true representation of the grid structures and the interactions between elements.

SECTION 3

METHOD OF ANALYSIS

3.1   REVIEW OF LEAM OPERATION

3.1.1   Sensor Operation

The sensor (Figure 3-1) normally operates upon impact of a particle that causes ionization of film material at the impact site. This ionization is collected at the film and collector grid. The negative potential of the film attracts the positive ions while the positive potential of the collector grid attracts the electrons. These actions cause small current flows in the film and collector grid circuits, which result in a positive voltage pulse to the film amplifier and a negative voltage pulse to the collector grid amplifier. The film and collector grid areas are divided into 1-inch strips, which allow for identification of the impact site.

A second film and grid assembly is situated behind the first and separated from it by 5 centimeters. The operation of this rear assembly is similar to that of the front assembly. An analysis of impact locations on the two films provides an indication of the direction of travel of the particle, while the time taken to traverse the intervening front and rear film space provides a measure of particle velocity.

3.1.2   Electronics Operation

The typical dual sensor logic is divided into two sections, the first rank or measurement section, and the rear rank, or buffer section. The measurement section includes identification pulse storage latches, accumulators,

3-1
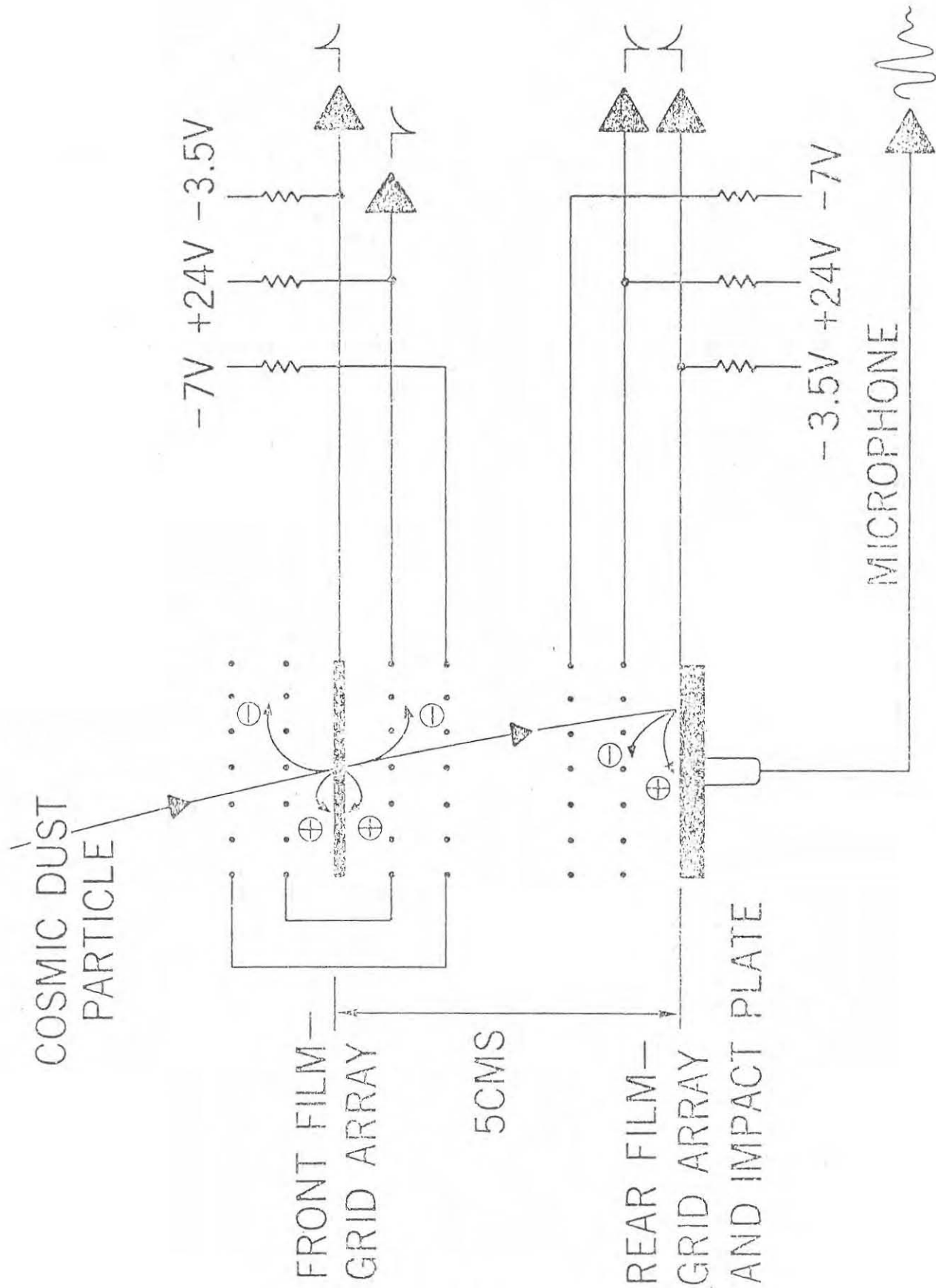
Figure 3-1 The Basic Sensor

PHA conversion counters, and TOF conversion counter. The rear rank is a parallel-in, serial-out shift register, which shifts data, upon demand, to the ALSEP central station in predetermined telemetry frames. The shift register is only cleared when new data are to be transferred into it and after the old data have been transmitted to ALSEP at least once. The new data are transferred from the front rank storage latches to the shift register, provided that the current frame is not one in which data are to be transferred to ALSEP. If the old data have been transferred to ALSEP once, the new data are retained in the front rank storage latches, thus allowing data from two events to be retained. Further hits in rapid succession would be evidenced by accumulator counts only. The time interval during which rapidly occurring events, which exceed the storage capability, would be lost varies between 2 milliseconds and 3 seconds, depending upon the position of the telemetry sequence in ALSEP. Data have not been observed which approach this event frequency.

The pertinent circuits for this analysis are those associated with the front film as shown in Figure 3-2, which shows the elements of one typical film channel. These are the circuits which were previously referred to as the front rank or measurement section. There are two distinct signal channels beyond the film amplifier: (1) the film strip identification channel, or film ID, and (2) the pulse height analysis, or PHA channel. Each is discussed separately.
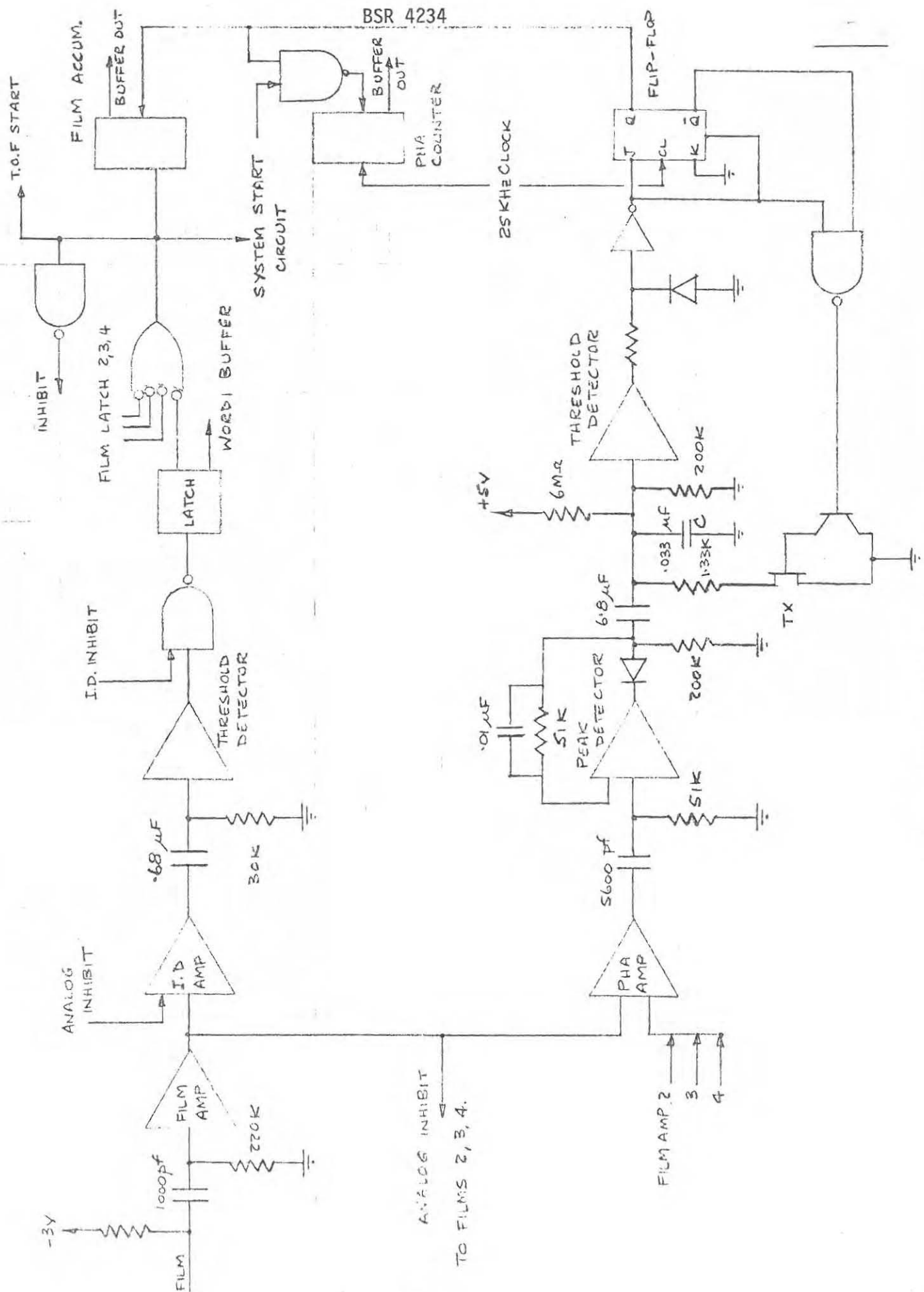
Figure 3-2 Typical Film Channel

3.1.2.1   Film Strip ID Channel

The common film amplifier provides the -3-volt film bias and a non-inverting gain of 3. The output is applied to the first amplifier of the ID channel, the PHA amplifier, and the analog inhibit inputs of the three other film channels.

The ID amplifier provides an inverting gain of 5.25 at its normal input and a gain of 0.49 at each of three noninverting inputs, which receive analog inhibit signals from the other film amplifiers. These inhibits cause the output of the ID amplifier to remain at or above 0 Vdc if one of more of the other films receive a coincident signal which is approximately 10 times greater than that on film 1. If film 1 has a signal equal to or greater than the other films, an output is applied to the threshold detector. The threshold detector is designed to apply a logic "1" to the following NAND gate if the input signal at the film amplifier exceeds 1 millivolt (mV). The NAND gate sets the following latch circuit, provided that the ID inhibit signal from the central electronics is also at logic "1", indicating that no other front film latch is set. The latch circuit provides the signal to the output, via a buffer, to indicate which film strip has been impacted.

When the ID latch is set, all the ID signals are inhibited for the four front film strips, which has the effect of negating crosstalk and makes the ID channels for the front film unresponsive until the measurement cycle for this hit is completed.

The OR function of all the film and collector latches and the microphone sample one-shot signal starts a measurement cycle. If a collector latch only is set during the 1-millisecond (msec) measurement period, a normal sequence occurs, except that the data transfers and clear are inhibited while the clear latch signal is generated. Thus, a collector signal alone will not be presented in the data output nor will existing data be changed.

When the system start occurs, a 1-millisecond gate signal is generated which has three functions:

1. Provide an enable to the front and rear PHA counters.

2. Provide a synthetic rear film signal to complete the time of flight sequence if the normal signal does not occur within 1 millisecond.

3. Prevent a premature measurement completion signal.

The film count accumulator measures PHA signal threshold crossings, providing that a film ID latch is set. The ID latches are inhibited for any further hits during a measurement cycle, but the accumulator circuit may give evidence of later hits. If a second hit occurs within the PHA pulse of the first, the PHA is augmented, but no direct evidence of the second hit survives. If the second hit is delayed sufficiently to create an independent PHA pulse, but lies still within the 1-msec measurement gate, it will cause further PHA counting and one additional increment to the film accumulator. If it occurs more than 1 msec after the first hit, but before transfer of data into the shift register, it will cause an increment of the accumulator only.

3.1.2.2 Film Signal Pulse Height Analysis

The signals from the four film amplifiers are summed by the PHA amplifier which, together with the film amplifier, gives a gain of -10 from film strip to PHA amplifier output. This output is passed to the Peak Detector circuit, which is a high-gain amplifier with a closed-loop gain of +1.0 for negative signals. The detector charges the capacitor C to the peak of the input signal. When the input signal is removed, the diode in the forward path prevents discharge of the capacitor C back through the amplifier.

When transistor TX is on, capacitor C discharges with a time constant that is designed to give a 240-microsec decay time. The voltage across the capacitor is sensed by the PHA threshold detector, which is a high-gain operational amplifier. When the voltage across capacitor C is more negative than -10 mV, the detector output is clamped at -0.6 V, the "0" level for the logic inverter of the following stage. When the voltage is more positive than -10 mV, a logic "1" (+2.5 V) is presented to the inverter input.

When the voltage on capacitor C is below threshold, the logic gates hold transistor TX on, which causes capacitor C to be in a short time constant mode. When threshold is achieved, transistor TX is turned off via the logic until the next 25-kHz clock pulse sets the flip-flop. When the flip-flop is set, transistor TX turns on (allowing capacitor C to discharge), the PHA counter is enabled, and the accumulator is incremented. When the capacitor discharges to below threshold level, the threshold detector causes the flip-flop to be reset and the PHA counter to be disabled. The length of the

pulse from the flip-flop, and thus the length of time the PHA counter is enabled, is proportional to the peak of the input pulse. Thus, the count recorded by the PHA counter is a measure of the pulse height.

The synchronization of the capacitor discharge with the 25-kHz clock reduces the quantizing error.

3.2 ANALYSIS OF PULSE HEIGHT ANALYSIS (PHA) CIRCUIT

The description of operation given in Section 3.1 applies to the type of particle for which the experiment was designed. That is, a noncharged, hypervelocity particle which would cause a pulse input to the electronics with the following characteristics:

Amplitude	1 to 200 mV peak
Rise Time	400 nanoseconds (nsec)
Fall Time	1,000 nsec
Width	600 nsec

The experiment was tested and qualified for this type of input under all conditions of lunar environment, and thus shown to meet the design requirements.

When considering the effects of charged particles upon the sensor, it was realized that, for slow particles, current pulses of much greater length than 2 microsec could be obtained. (The sensor dynamics are discussed in later sections.) The PHA circuit was then analyzed for the effects of long input pulses.

A qualitative review of the peak detector circuit shows that, for a short pulse, the capacitor C is charged to the peak of the input signal and the decay time of the charge on the capacitor is proportional to this peak value. The time constant in this mode is approximately 45 microsec, which was chosen to give the maximum count of 7 in 240 microsec. (The PHA output indicates at least 1 whenever a threshold is achieved.) When a long pulse occurs, the diode in the forward path is held in a conducting state, even while capacitor C is being discharged in what is normally called the short time constant mode. The effect of the conducting diode is that the signal is maintained at the amplifier output. The result at capacitor C is to effectively increase the time constant by 200 times, thereby maintaining the signal above threshold for a much longer time. The longest pulse which will not change the PHA value is theoretically 80 microsec, but the value depends upon the time relationship between the start of the pulse and the 25-kHz clock and could be less than 80 microsec.

In addition to the extended count for long pulses, a condition arises that causes double accumulator counts. If a pulse of sufficient amplitude and length occurs, the falling edge of the pulse causes the input to the peak detector to go hard positive, shutting off the diode. The capacitor C now discharges normally. The time constants ahead of the peak detector are such that its input returns to a negative value, which causes the diode to conduct again. If the capacitor C had previously discharged below threshold and the signal is large enough (negative) to exceed threshold again, an extra accumulator count is made and renewed PHA counting occurs.

The above analysis indicates that negative pulses can also give PHA thresholds.

The qualitative analysis was followed by a detailed quantitative analysis of the electronics and by laboratory tests on the experiment prototype.

3.2.1   Circuit Analysis

The circuit analysis was performed on the typical film channel of Figure 3-2 (from the film input to the input of the PHA threshold detector). The emphasis was placed on the peak detector portion of the film channel since this is the circuit which gives rise to extended counting and multiple accumulator counts. The remainder of the circuitry was simulated by passive networks and fixed gain terms.

A detailed simulation was performed using the SCEPTRE* computer program to give a thorough understanding of the circuit operation under all conditions. This knowledge was then used to develop a simple model of the circuits because the SCEPTRE program used an excessive amount of computer time for this component configuration. This long run time would make the task very expensive for the multiple computations we planned over the ranges of mass, charge, and velocity applicable to the problem.

3.2.1.1   SCEPTRE Simulation

The simulation program, SCEPTRE, was developed by IBM for the Air Force Weapons Laboratory at Kirtland Air Force Base, New Mexico. The program calculates initial conditions, and transient and steady-state responses for large networks.

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*Bowers, J.C. and Sedore, S.R., "SCEPTRE: A Computer Program for Circuit and System Analysis," Prentice-Hall, Inc. 1971.

The film and PHA amplifiers were simulated by a simple gain term and the transistor TX was assumed to be in the fully conducting state, i.e., ON; thus, the flip-flop and logic control of transistor TX were not simulated. The linear transistors were simulated in the nonlinear regions with the best data available. The peak detector circuit is shown in Figure 3-3.

A typical output from a run is shown in Figure 3-4. The output is the voltage across capacitor C, shown as positive because of the sign convention used in the simulation. The output is observed to return negative at 700 microsec, but on this occasion the amplitude was insufficient to cause further PHA or accumulator counting.

A summary of the data obtained from several simulations is shown in Table 3-1. All runs were made for 1-msec duration, which is the measurement sample time. The times quoted are the length of time the output pulse remained above 9 mV, which is the threshold level at the following detector circuit. The data show that PHA levels of 7 can be achieved with inputs of 30 mV and the multiple pulses do occur.

The simulation program provides information on all the intermediate points within the circuit. This information was used to identify critical components and, thus, enable us to devise a simple model of the circuits.

Computations were made on identical data inputs, using both SCEPTRE and the simple model to verify the latter's validity.

Figure 3-3   LEAM Peak Detector
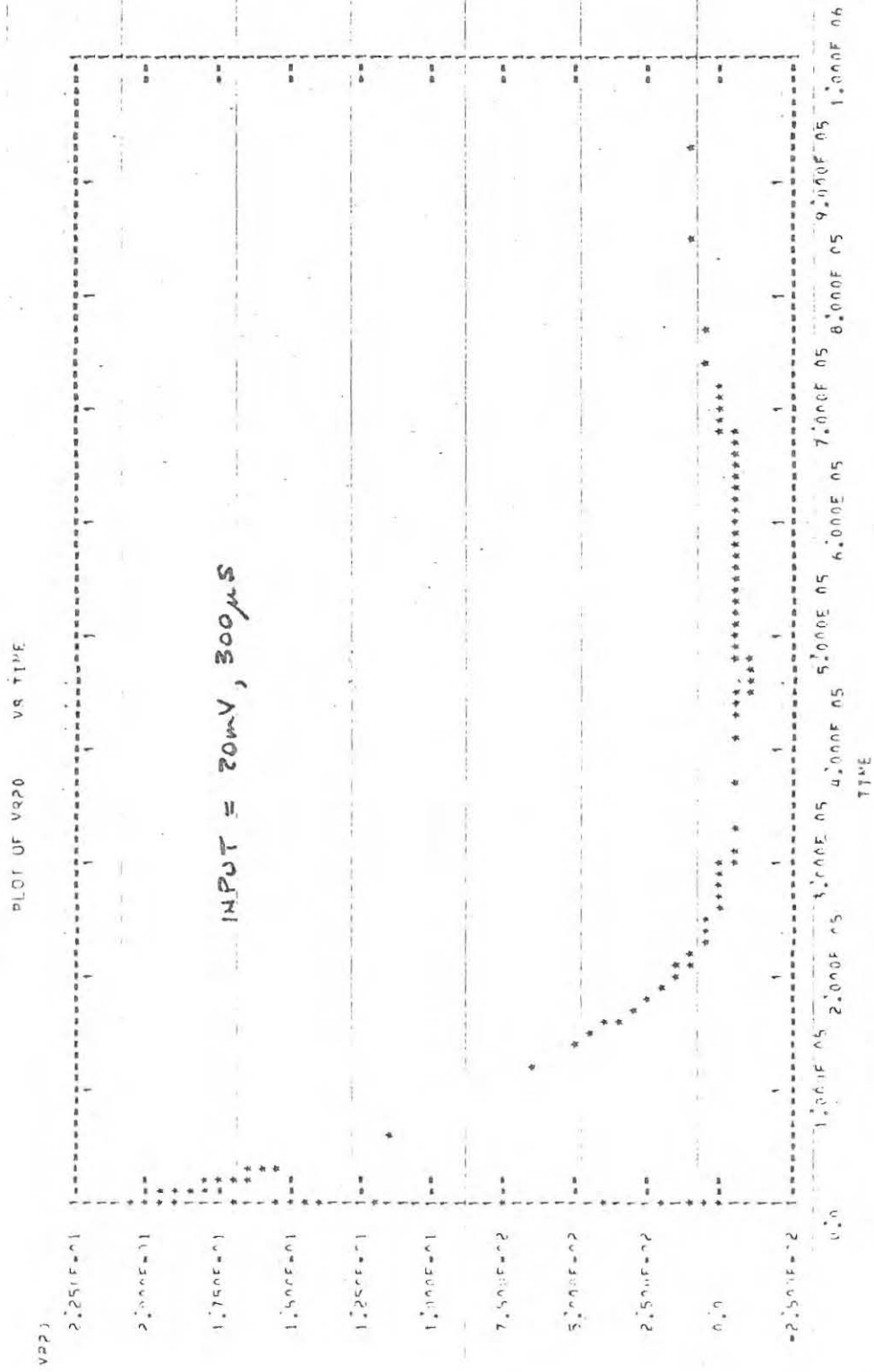
Figure 3-4 Typical SCEPTRE Output

Table 3-1

SCEPTRE Program Results

Input Amplitude	Output Pulse Length (microsec)	Comments
50-microsec Pulse		
50 mV	184	No subsequent pulses - All normal
100	211	
150	234	
100-microsec Pulse		
50 mV	213	No subsequent pulse
100	243	Returned above 9 mV at 730 microsec until 890 microsec
150	260	Returned above 9 mV at 670 microsec until 1.01 msec
200-microsec Pulse		
50 mV	248	Returned above 9 mV at 720 microsec
300-microsec Pulse		
10 mV	189.9	
20	219.6	
30	235.0	Returned above 9 mV at ≈ 780 microsec
40	245.6	Returned above 9 mV at ≈ 760 microsec
50	254.03	Returned above 9 mV at ≈ 746 microsec
		All longer than normal

3.2.1.2   Simplified Peak Detector Model

Analyzing the data from the SCEPTRE program identified the importance of the various components within the peak detector, thus allowing us to eliminate many of them without affecting the veracity of the result.

The obvious simplifications are to neglect the transistor internal capacitances as they are small and the associated time constants have no effect on the result. Next, the coupling capacitors in the forward and feedback paths are found to have no effect on the length of time the output remains above threshold or on the cause of the double accumulator counts.

When the input signal is negative, the circuit behaves as a simple amplifier with a gain of 1. When the signal is positive-going, the diode ceases to conduct, allowing capacitor C to discharge. Once the diode ceases to conduct, the feedback loop opens and a large back bias is applied due to the high open loop gain. The diode will not conduct again until a forward bias is applied from the combined effects of the capacitor discharge and input level. In the simplified model, Figure 3-5, the diode is replaced by a switch, which opens whenever the input increases positively faster than the rate at which the voltage across R12 increases. The rate of rise of the voltage across R12 is calculated for the switch-open conditions. (The switch closes when a forward bias is achieved.)

The input to the peak detector is an emitter follower with a parallel capacitor across its load. The effect of the capacitor is to restrict the rate at which the emitter can rise towards the +5-volt supply line. Consequently, the input transistor cuts off if this input signal rises positively

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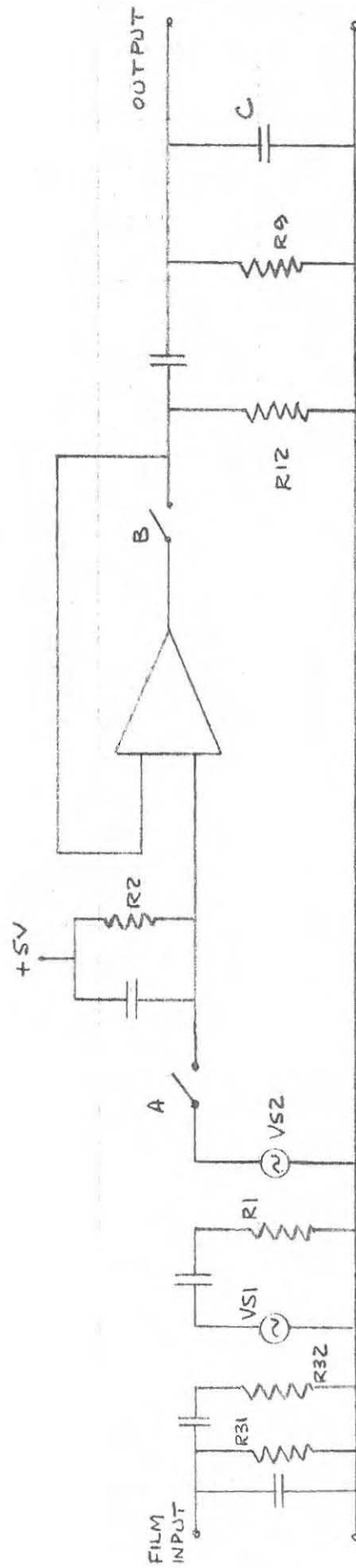
Figure 3-5   Simplified Peak Detector Model

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faster than the emitter load can follow. The emitter follower just described is replaced by a switch whose condition depends upon the direction and rate of change of the input signal.

The loading of the emitter follower upon the coupling circuit between the PHA amplifier and the peak detector is small, so the coupling circuit is treated as an independent element. The signal source VS2 for the peak detector is then the output of the coupling circuit. Similarly, the film amplifier loading of the coupling circuit between itself and the film is small, allowing these components to be treated independently. The signal source VS1 is -10 times the voltage across resistor R32 because the film and PHA amplifiers, together, give an inverting gain of 10.

The simple model, Figure 3-5, is thus comprised of a unity gain amplifier, two voltage sources, two switches, and 12 passive components. The model has four possible operating conditions:

1. Switches A and B closed.

2. Switch A open, switch B closed.

3. Switch A closed, switch B open.

4. Switches A and B open.

The input signal from the film is divided into many elemental ramp functions with known initial value, slope, and time duration. The response of the model to such a ramp is calculated (for all four conditions) using Laplace transform techniques. The correct response to be applied for any particular ramp element is determined by first deducing the state of switches A and B at the end of the time interval. For example, if the switches are

initially closed and a particular ramp input would cause switch B to be open at the end of this time interval, the true signal values at the various points in the model are calculated using the condition 3 equations. The time increments are chosen to be small enough that the errors incurred due to opening switch B slightly early are negligible.

A further complication of the model is that, for large signals, one or all of the film, PHA, or peak detector amplifiers can saturate. This condition is accounted for using the ramp technique, where the relevant amplifier output is treated as a ramp with zero slope.

3.2.1.3 Complete Film Channel Model

The remainder of the film channel of Figure 3-2 was modeled to simulate the correct LEAM response to the sensor signals.

The film and collector grid ID model accounts for the analog inhibit signals from the three sensor elements, at either the film or collector grid, respectively, which are not impacted by the particle. A charged particle, unlike an uncharged meteorite particle, can induce signals in adjacent sensor elements. This affects the charge/velocity characteristics of the particle required to achieve threshold, because the inhibit signal from one element effectively reduces the signal from an adjacent element. In addition, the timing of the element IDs relative to one another and between films and collector grids is modeled. The inhibit signals prevent multiple film IDs unless they occur within approximately 0.2 microsec of one another. This limitation also applies to the collector grids. When a film or collector

grid ID is received, the system starts a measurement sequence with the setting of a bracket one-shot which lasts for 1 msec. If a collector signal starts the sequence, a film ID must be received within this 1-msec period or no data transfer takes place. A film ID alone can cause the system to operate through its full measurement sequence.

When a film ID is indicated, the four film signals are summed and applied to the peak detector model. The output is recorded for PHA count and accumulator count. The accumulator counts PHA threshold crossings. The PHA count is limited to 7 in the LEAM, but in the model it is allowed to reach its full value of 26 if a long enough pulse occurs. This is done to obtain more information about the response.

3.2.2 Laboratory Tests

Measurements were made using the Prototype LEAM Experiment, the experiment test set, a variable pulse width generator, and a storage oscilloscope. The LEAM center support structure was removed from the outer housing and thermal bag, and the east sensor was removed from the center support structure. This dismantling was required to allow access to the microphone board upon which the PHA circuitry resides. The sensor circuitry was now without shielding, which meant that it was very susceptible to noise, making other than qualitative measurements difficult.

Pulse inputs were injected via the test set calibration adapter box, with the input pulse amplitude being measured directly on the film input test point.

Measurements were made on the A film channels 1 and 2, which gave identical results as follows:

Input		Output
Pulse Width (micro-seconds)	Pulse Amplitude (millivolts)	
2	4.5	PHA of 1 registered on test set lamps.
	6.5	PHA of 2 registered on test set lamps.
	28	At capacitor C: -250 mV peak pulse; rise time 1 microsec; fall time to -10 mV, 120 microsec. At flip-flop output: 4.5-volt logic pulse 120-microsec width.
100	30	First noticeable change at flip-flop output.
300	30	Output at flip-flop; logic pulse greater than 200-microsec width, starting at threshold crossing. Second pulse at 950 microsec from threshold, greater than 20-microsec width. Occassional multiple pulses occurred around 950 microsec from threshold.
2	-100	PHA threshold.
6	- 28	PHA threshold.
50	- 5	PHA threshold.
200	-1.5	PHA threshold.

In summary, the laboratory tests showed that long pulses give large PHA counts with the actual value depending upon pulse amplitude and duration. Multiple pulses can occur, which add to the PHA count if they occur during the 1-msec sample period, and increment the film hit accumulator, giving the appearance of multiple film hits. These tests also confirmed that negative pulses at the film input can give PHA and accumulator outputs.

3.3   REFINED SENSOR MODEL

A previous report, ASTIR/TM66, detailed the analysis which led to a simple model of the sensor. This simple model verified that the sensor can give valid responses to charged particles with certain mass, charge, and velocity characteristics. The model has several limitations which made it difficult or, in some cases, impossible to accurately predict the response to certain particle types, and also gave undetermined inaccuracies in the results.

3.3.1   Simple Model and Its Limitations

The simple model was based on an analysis that considered the grids and film to be infinite plane conducting sheets. This was modified at the grids by applying a simple cosine function to the forces on the particle to allow the force to go to zero in the grid planes.

The limitations of the simple model were:

1.   Solid electrodes were used instead of grids with 95% transparency. Thus, the grid signals and forces due to induced charges were overestimated.

2.   There was no interaction accounted for between the suppressor/collector space and the film/collector space. Thus, the film could not see the particle until it passed the collector grid.

3.   Induced charges were calculated by assuming the 1-inch by 4-inch strips were circles of equivalent area.

4. Only one film strip and collector grid strip were considered, whereas a particle will induce charges in all film strips and collector grid strips. This prevents considerations of multiple element events at the film or collector grids and gives inaccurate values for particle characteristics which can cause PHA thresholds.

5. The analysis only considered particle positions between the suppressor grid and film, with no account being taken of the forces on the particle outside the sensor. Thus, all calculations assume a particle emerging from the suppressor grid, on the film side, with a certain velocity. The true sensor measurement range is not calculated, as the suppressor, due to its potential, will accelerate positive particles and decelerate negative particles, while the image forces accelerate all particles.

To overcome the limitations of the simple model and thus obtain a more complete and accurate result, a different approach was utilized to refine the model.

3.3.2   Refined Model

The sensor is composed of three parallel planes, termed the film, collector grid, and suppressor grid. The film and collector grid planes are each divided into four 1-in. by 4-in. strips and each strip is composed of four 1-in. by 1-in. squares. Thus, each plane has 16 1-in. by 1-in. segments. The suppressor grid is formed by one plane divided into a similar set of 16 segments. One of the 1-in. by 1-in. square sections is shown in Figure 3-6.

EACH SENSOR HAS 4×4
ARRAY OF THESE 1" SQUARES.

SUPPRESSOR −1 VOLT

COLLECTOR +24 VOLT

FILM −3 VOLT

0.116"

0.266"

0.125"
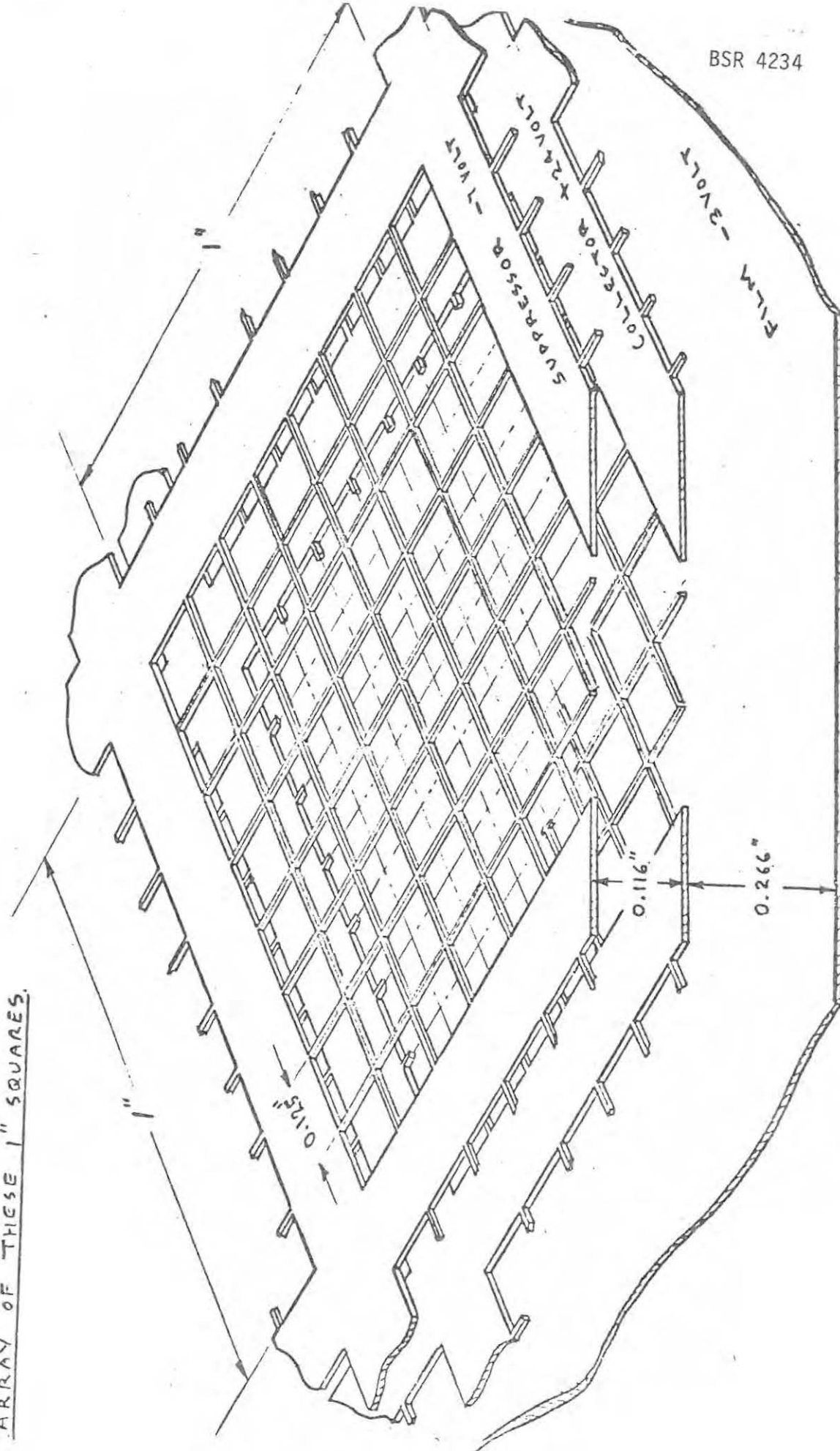
Figure 3-6 LEAM Grid and Film Structure

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The problem resolves itself into two areas, namely the charges induced in the sensor and the potential at the particle. The change in the induced charge as the particle position changes gives a measure of the current into the sensor electronics, while the difference in potential between successive particle positions gives a measure of the work done by the particle and, hence, enables calculation of the velocity profile along the path.

The charges on the sensor elements arise from two sources, the charges due to the applied potentials and the charges due to the particle. Both distributions are required to determine the potential at the particle, while only the latter is required to determine the current flow due to particle movements. The potential at the particle is thus seen to be from two sources, the applied potential charge and its own induced charge. This latter effect is similar to the image effects used on the simple model.

The task of modeling the sensor was complicated by several factors. The major problem was containing the model within a size that could be handled by the computer. The job is equivalent to solving nearly 8,000 simultaneous equations. It rapidly became obvious that a compromise had to be reached between accuracy and the number of elements into which the sensor films and grids could be divided. A secondary problem associated with the number of elements is that of devising a satisfactory bookkeeping scheme for keeping track of which element is influencing which. This task also is affected strongly by programming limitations of array dimension sizes and allowable DO loop nesting. The final model has 7,360 elements which between them have over 27 million interactions. Considerable effort was expended in accommodating these interactions within 132,701 influence coefficients. The use of

this reduced number of coefficients required careful bookkeeping and the formulation of generalized equations that expressed the relationships of the elements to the coefficients.

The coefficients could not all be retained in memory at the same time, so they were calculated and retained on magnetic tape and called upon when required. The most efficient method for operating the sensor model would be to have all the coefficients available at once, but as this was not possible, a compromise of using two sets of coefficients at a time was used to speed up the iterative process. The two largest coefficients take up 130,000 bytes of core.

The sensor physical shape precludes its being easily divided into uniformly sized elements. Allied to this is the task of calculating the interactions between the various elements. As the configurations and shapes are not found in standard text books, all the interactions for the potentials produced at one element by a charge on another were calculated from elementary electrostatic principles.

The film and grids are divided into 7,360 uniformly charged elements, which are 0.125 in. on a side. The charge distributions due to the particle and the applied potentials are calculated separately and superposed.

In either case, the charge on an element is adjusted so that the total potential, caused by its own charge and that due to all other element charges and the particle if considered, is equal to to the applied potential. The charge adjustment is made iteratively by changing the charge on each element to the newly determined value at each iteration. The applied potentials are set to zero for calculations of the charge due to the particle.

The iterations are continued until the changes in charge distribution at each step are less than a specified value, i.e., the calculation has converged to within an acceptable tolerance of the final value.

All calculations and results are in terms of a unit coulomb charge on the particle. The potential of each element due to all other elements of the sensor is calculated using a set of stored "influence coefficients." These coefficients are the values of potential at an element due to a unit charge at another element. To save computer time, they were calculated once using first principles of electrostatics and stored for future use. A similar set of coefficients is calculated for each particle position, but they are determined in real time for each new particle path.

A computer program was prepared to perform these calculations. Several options are made available which are selected by input variables or cards. The basic calculations are: (1) to calculate the charge distributions due to the applied potentials and store them on tape; these distributions are fixed and used often; (2) to calculate the charge distribution due to the particle; and (3) to calculate the potential at the particle due to (a) the applied potential charge distribution and (b) the particle image charge distribution. Items 2 and 3 are repeated for each position of the particle. The charges on each film strip and collector grid strip are summed to give the total charge on each element at each step. The data relative to a particular particle path are stored on tape for future use.

3.4   SYSTEM MODEL

To determine the response of the LEAM to a charged particle, the data obtained from the sensor model are used as an input to the electronics model. The sensor model output is the characteristics of a particular path through the sensor calculated using a particle of unit charge. The system model uses these data in conjunction with the parameters for the particular particle in question to derive the actual response to that particle. Thus, the profile of the current flow in each film and collector grid strip is determined versus time. The profile is then applied to the electronic model as discrete ramp inputs for each time interval.

A program was prepared to accomplish this which performs the following tasks:

1. Reads input cards to determine which of the following options to perform:

    a.   Selection of sensor, up, east or west and particle path.

    b.   Normal or shielded film on east sensor.

    c.   Positively or negatively charged particles.

    d.   Preselected or random mass and charge values.

    e.   Number of particles.

    f.   Particle velocities.

    g.   Whether output is to be plotted and, if so, the dimensions of the axes.

    h.   How many of the data points to list on output.

2. If a plot is desired, the plot program data are generated.

3. If random particle characteristics are desired, a random number generator is employed to derive mass and charge values.

4. Data relevant to selected particle path read from tape.

5. Calculates work done on particle between successive steps and calculates velocity at each step.

6. Calculates currents in films and collector grids from rate of change of charge.

7. Determines if film and collector grid IDs occur.

8. Calculates input signal to PHA circuit.

9. If a film ID occurs, the electronics model subroutine is called to calculate PHA and accumulator response to the signal calculated in step 8.

10. Results are listed or plotted as selected by input cards. All results are stored by sensor on tape for future analysis.

Thus, a single particle path can be analyzed for either positively or negatively charged particles at any number of velocities, charges, and masses. The stored data for any sensor and any path can then be analyzed by a second program, which is designed to select the particles by type of event or velocity and can either plot or list the resulting selection. The types of events that can be selected, either singly or in combination, are coincidence, noncoincidence, multiple accumulator, multiple film or collector grid adjacent or nonadjacent, on any of the sensors or shielded film.

The orientations of the film and collector grid strips within the LEAM experiment are identified in Figure 3-7. This information is supplied so that the analysis data can be readily compared with the lunar data.
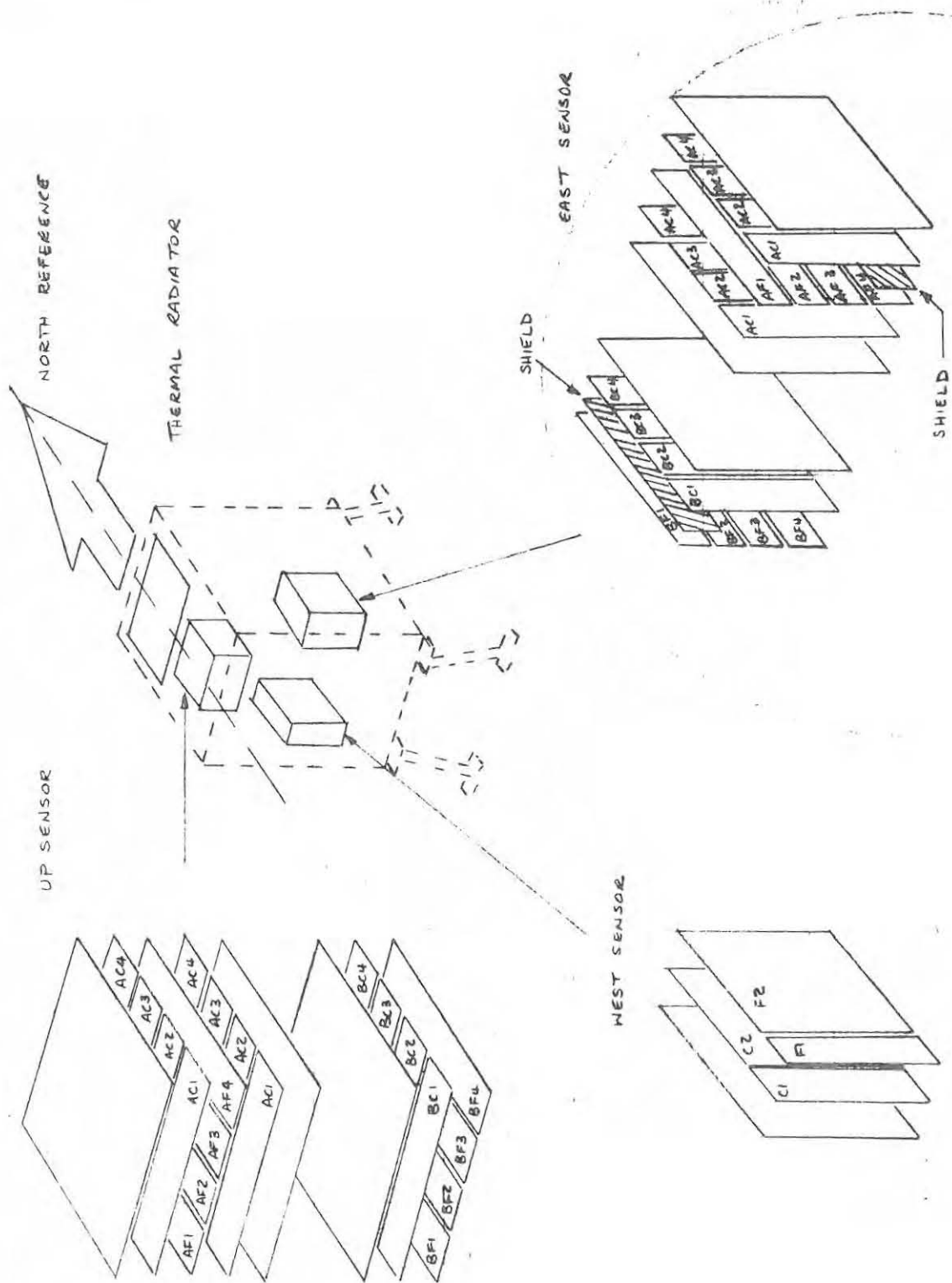
Figure 3-7 LEAM Sensor Orientations

SECTION 4

RESULTS AND IMPLICATIONS OF ANALYSIS

4.1   RESULTS

An accurate simplified representation of the electronics has been ach-
ieved in a computer model. This model simulates the inhibit circuits in addi-
tion to the PHA threshold circuit analyzed previously.

When the simplified electronics model was completed, it was checked
out with the simple sensor model. This combined model gave useful results
because it could be used with the random number generator to generate numer-
ous particles with differing mass and charge values and calculate the result-
ing responses very quickly compared with the SCEPTRE program.

The plots resulting from these runs are shown in Figures 4-1, 4-2, and
4-3. The PHA values and double accumulator events appear in bands which
differ in shape, depending upon the velocity of the particles. The separa-
tion of events into those with and without double accumulator counts will
permit a broad classification of the particles observed on the moon.

The intent with the refined sensor model was that at least one particle
path would be calculated and analyzed by the end of the contract period end-
ing on 31 July 1976.

We have achieved the following towards this goal. A program to calcu-
late the influence coefficients for the interactions between the 8512 sensor
elements was prepared, debugged, and 132,701 coefficients committed to
magnetic tape storage. The sensor program that utilizes these coefficients

VELOCITY (M/S) 1500

-LN Q

-LN M
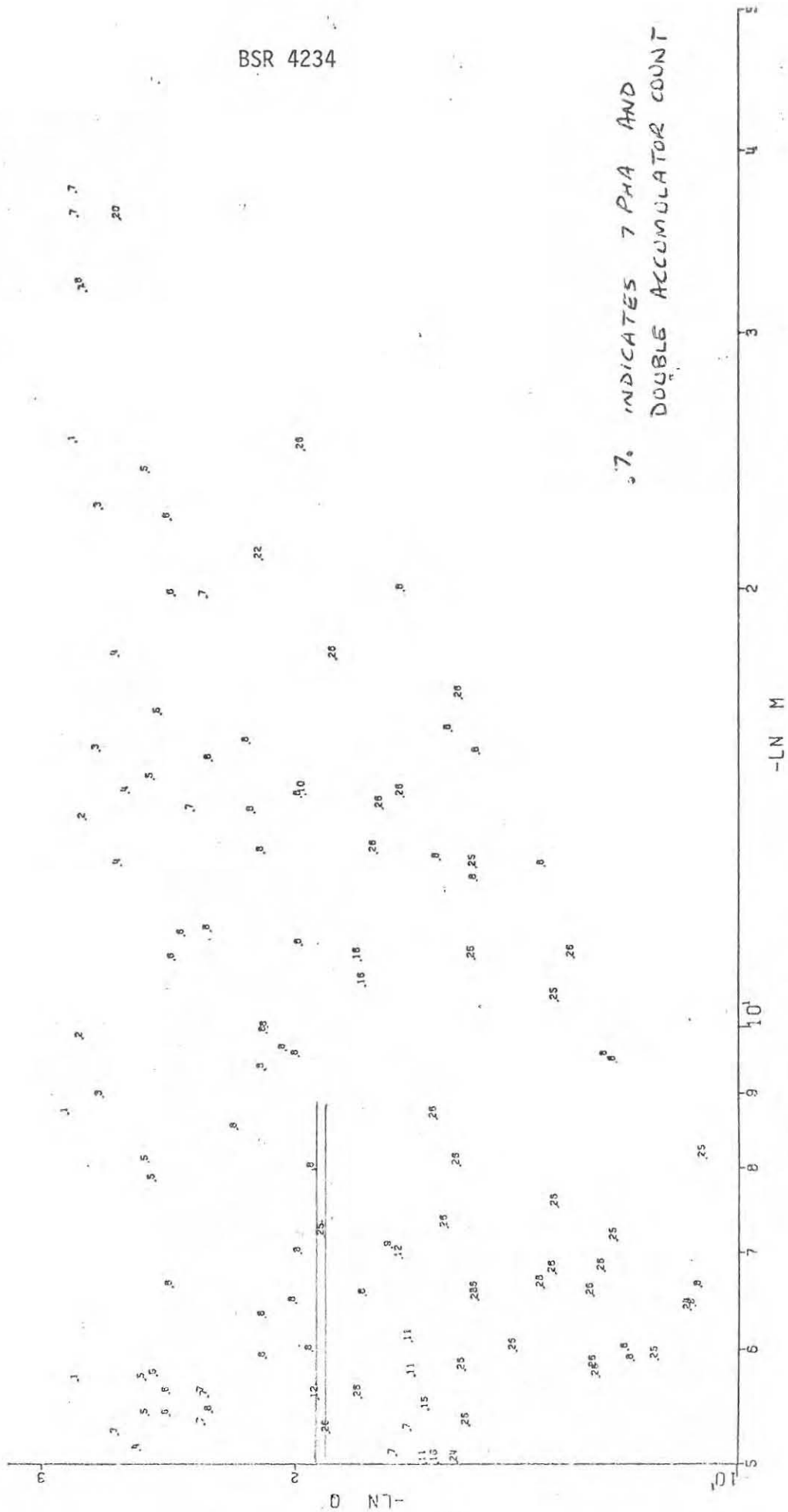
.7. INDICATES 7 PHĀ AND
DOUBLE ACCUMULATOR COUNT

Figure 4-1 Plot of PHĀ Counts vs. Charge (Q) and Mass (M)
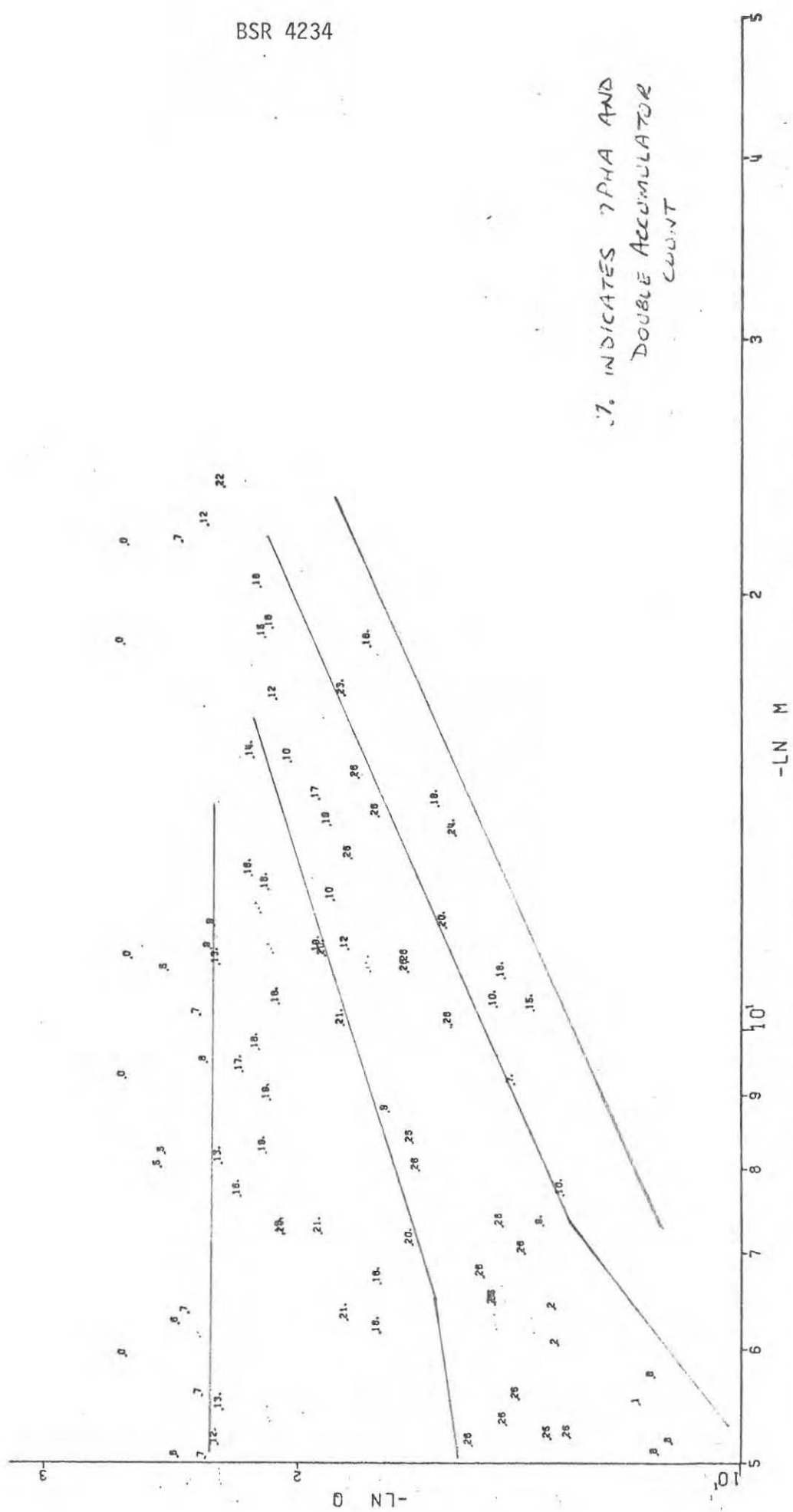
Figure 4-2 Plot of PHA Counts vs. Charge (Q) and Mass (M)
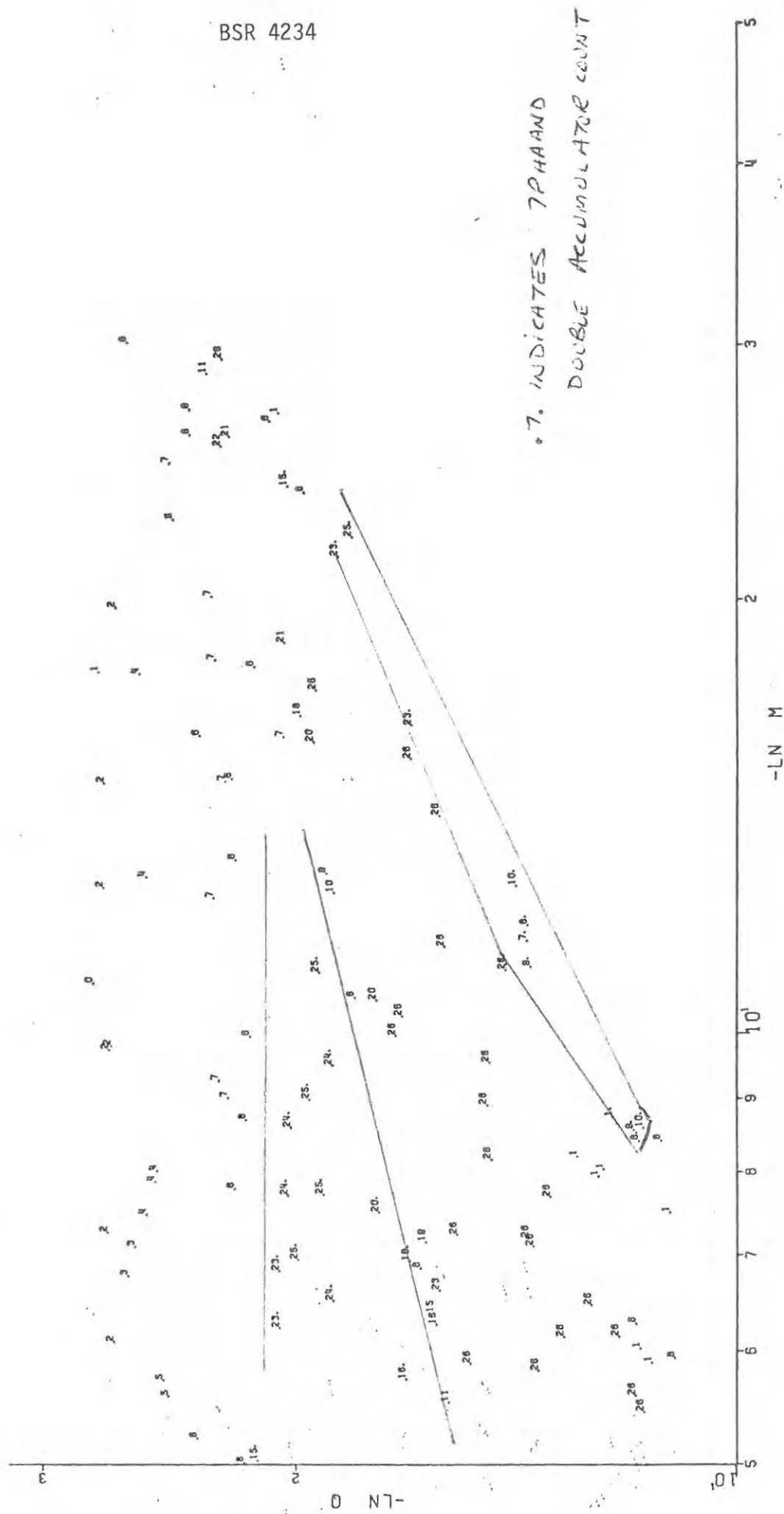
Figure 4-3 Plot of PHA vs. Charge (Q) and Mass (M)

has been written, debugged, and operated. The main part of this program is the iterative loop, which adjusts the element charges to the values needed to give the required potentials both in the case of the applied potential distribution and the distribution due to a particle. Several problems were encountered in the implementation of this iterative loop:

1. The most efficient method of implementation involves holding the 132,701 coefficients in core while performing the iterations, but this takes 530,804 bytes of memory, which is virtually the entire capability of the computer. Thus, a method was devised which required repeatedly reading the coefficients from tape in blocks.

2. The calculation of the potential contributions at each element due to all the other elements is the most time-consuming portion of the iterative loop. The initial implementation of this part took almost 30 minutes per iteration to run. Considerable effort was expended in reducing the running time until we achieved the present time of approximately 17 minutes, which was done by streamlining each of the 15 subsections of this part and then combining them where possible. The number of elements was reduced from 8,512 to the present number of 7,360 by considering the tops and undersides of the grids as single elements. This potentially impairs accuracy, but the difference is insignificant in our model. Finally, the whole part was formulated as a subroutine and compiled using the FORTRAN H compiler.

3. The present problem is ensuring rapid convergence of the iterative loop. When originally formulated, the loop was conditionally stable, depending upon the magnitude of the changes made in the elemental charges at each step. When stable, the convergence was extremely slow because of the small size of the changes in charge which were permissible. Although time consuming, the present program will provide the required data.

The remaining tasks to achieve the one particle path for one sensor, once convergence is achieved, are:

1. To perform one run of the program to determine the charge distribution due to the applied potentials.

2. To perform 10 runs of the program to determine the distributions due to the particle. It is assumed that 10 data points will be sufficient to allow a good interpolation for the intermediate data points.

3. To perform interpolation to obtain all other required data.

4. To run sensor and electronics model program.

4.2 IMPLICATIONS OF ANALYSIS

The analysis as performed to date indicates that nearly all types of events observed on LEAM can be explained and that classification by event type will allow more accurate identification of particle mass, charge, and velocity characteristics.

The hypotheses explaining the events are described below. When the model is made fully operational, the hypotheses will be verified.

The coincident film and collector grid events were shown by the simple model to be obtained by a positive particle, between the collector grid and film, traveling toward the film.

Noncoincident events can be achieved by a positive particle with a combination of mass, charge, and velocity that provides sufficient signal at the film but not at the collector grid. The collector grid is less sensitive to charged particles. Noncoincidence at the collector grid cannot be observed because the experiment requires a film ID to allow completion of a measurement sequence.

Multiple accumulator events have been observed with the simple model and are caused by the electronics response to long duration input signals.

Multiple adjacent film events are caused by a positive particle having a combination of mass, charge, and velocity that give a sufficiently large signal to achieve threshold on two or more films at once. The same mechanism would be expected to result in multiple collector grid events, but conceivably it could give only a single one if the signal level were in the right range.

Multiple nonadjacent film events are of the type where films 1 and 3 recorded an ID threshold but film 2 did not. This phenomenon can be explained by a negatively charged particle traveling toward the film strip that does not record an ID threshold, e.g., film 2. It will be remembered that the film circuit requires a positive current to produce an ID, which, in the case of a positive particle, was achieved by an induced negative

charge in the film. This charge was produced by a flow of electrons to the film, equivalent to a positive conventional current flow into the amplifier. In the case of a negative particle, a positive induced charge occurs in the film and, thus, a negative current flows to the amplifier. This current will not produce an ID, as observed by film 2. Consider now films 1 and 3. If the particle has appropriate charge and velocity characteristics, it will induce sizable positive charges and, thus, negative current flows in them also. As the particle approaches the plane of the film, its influence on films 1 and 3 will decrease, falling eventually to zero at the film. Note that this is not the case with film 2 whose charge increases until impact. Thus, the charges at films 1 and 3 reach a peak positive value somewhere before the film and then decrease to zero at impact. When the charge starts to fall to zero, there is an electron flow to the film to replace the positive charge; this flow is again the positive conventional current flow into the amplifier. Therefore, if the magnitudes are correct, sufficient current can flow to produce an ID in films 1 and 3.

Shielded film events are explained by the fact that the thin dielectric virtually has no effect on the particle induced charge in the film except to restrict the approach of the particle to it. Thus, the induced signals will be identical to the unshielded films for particles in similar positions.

The following observed cases in the lunar data are less easy to explain and require assumptions which cannot yet be proven:

1. Multiple film, nonadjacent, events with no collector ID.

2. Multiple collector, adjacent and nonadjacent, with single film ID.

3. Multiple film and multiple collector, both nonadjacent.

Analyzing these cases requires further knowledge of the effects of the particle on the film when it is in electrode spaces other than the collector grid/film space. If the particle can truly induce a signal of threshold amplitude in the film when it is in these areas, then the remaining cases can probably be explained.

The detailed study of the sensor and electronics has led to a better overall understanding of the instrument responses and has indicated areas that affect the LEAM data but which must be left to future analysis.

Our analysis considers only particles traveling perpendicularly to the film. Obviously, particles are likely to be traveling in all directions. Particles traveling at the speeds considered here would probably describe curved paths in the proximity of the sensor elements, and this has not been considered. The implication is that particles, outside the field of view for hypervelocity particles, could be electrostatically deflected into the instrument if they have appropriate energy and charge characteristics.

The verification that the LEAM experiment is measuring charged dust particles as well as hypervelocity cosmic dust particles could lead to an understanding of phenomena observed by astronauts and other experimenters. Observations in this category include several instances of solar light scattering over the terminator regions reported by the Apollo crews in lunar orbit,

transient lunar events being investigated by experimenters on a worldwide

basis, and indications at the Apollo 17 site that a substantial amount of

lunar surface material has been added over the past 1 to 2 million years.*

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*Abstracts of Papers Submitted to the Seventh Lunar Science Conference,
March 15-19, 1976.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

There are several conclusions which can be drawn from instrument analysis alone, without reference to the lunar data.

The sensor definitely responds to charged particles that have certain ranges of mass, charge, and velocity. The physical dimensions and applied potentials of the sensor are such that charged particles incident upon it are affected dynamically and some particle selection takes place. Charged particles can be attracted into the sensor, thereby increasing its effective field of view. In theory, negative particles will cause sensor responses.

The electronics does not differentiate between signals from hypervelocity particles and charged particles, but the circuits are sensitive to pulse shape. The pulses from hypervelocity particles, for which the experiment was designed, are well defined, both from theory and gun measurements. They are known to be of short duration, whereas the sensor analysis has shown that long pulses, several hundred microseconds in length, can be produced. The electronics analysis has shown that several characteristic responses to long pulses can explain certain peculiarities in the LEAM lunar data, namely large PHA counts and double accumulator counts. Negative pulses will also give PHA thresholds.

When comparisons are made between the analyses and the lunar data, it can be concluded that different particle types are producing the observed events. Some of the events are probably due to particles within a small portion of the total response range, while some are certainly produced by negative particles.

The overall conclusion is that the combined theoretical analysis of the electronics and sensor together with the Principal Investigator's analysis of LEAM lunar data can provide a comprehensive picture of the dust environment at the lunar surface. Therefore, it is recommended that the sensor analysis be completed in order to allow a thorough analysis and understanding of the LEAM lunar data. The achievements to be expected from further study are:

1.   Total ranges of mass, charge, and velocity of particles being measured by the LEAM instrument.

2.   Characterization of particles producing unique events, thus sub-dividing total measurement range into identifiable segments.

3.   Correlation of particle types identified in 1 and 2 with lunar cycles and temporal effects.

4.   Knowledge gained above will allow refinement of hypotheses on dust sources and transport.

5.   Application of results to analysis of other lunar surface phenomena observed by astronauts and other experimenters.

6.   Application of results to Pioneer experiment data, allowing additional information to be obtained on deep space particles.

In accordance with NASA policy, the LEAM experiment data and supporting documentation will be archived to make it available for future use by investigators anywhere in the world. This report and the results of the Qualification model tests constitute essential supporting documentation invaluable to future users of the LEAM experiment data. The bulk of the experiment data is incomprehensible without a detailed knowledge of its response to charged particles.

Thus, without this knowledge, the data cannot be applied to investigations of other lunar surface phenomena. Future users of the data could apply the results herein to a continued analysis resulting in a comprehensive calibration of the instrument, which would include particles incident anywhere on all three sensors.

A more practical and cost-effective approach would be to require the Principal Investigator and the Bendix Project Engineer for the LEAM experiment to continue the analysis using the extensive knowledge and understanding which they have acquired over the past three years. The result would be a set of data and documentation with far greater application to other areas of scientific research into lunar phenomena than is presently practicable.

APPENDIX A

COMPUTER PROGRAM DESCRIPTIONS

The computer programs required for a complete theoretical analysis of the LEAM experiment are described in the following sections. Flow charts and listings are included for information purposes.

The programs complement each other to achieve the final results. The numbers given are from the program numbering system for computer data sets, used by the Bendix Corporation Data Center.

Program P5072CHG computes the path data using subroutines PLEINF and POTCON. The outputs, which are stored on tape, are utilized by P5072SGF to determine the experiment response to particular particles. The subroutine used is LES, which itself uses subroutines COND1, COND2, COND3, and CVOLT. Finally, the PHA and accumulator count data for the various particles are analyzed or sorted by P5072INT.

All programs were written in FORTRAN IV for the IBM-370 system. The plotting routines are those used by the Cal Comp plotting system.

A.1 PROGRAM P5072CHG TO DETERMINE SENSOR CHARACTERISTICS TO CHARGED PARTICLES

A.1.1 Summary

The program calculates

1. Charge distribution on the film, collector grid, and suppressor grid due to (a) applied potentials and (b) charged particle. These distributions are calculated separately and the one for applied potentials is committed to tape for future use. Those

due to the particle are calculated for particle positions, which are selected by input card.

2. Total charges on each film and grid strip for each particle position. Thus, knowing the particle speed, the current in the film and collector grid circuits may be determined. (This calculation is performed in program P5072SGF).

3. Potential at the particle due to both the applied potentials and the particle image charge. This allows calculation of the work done on the particle along the path.

The program stores position, potentials, and charges on tape so that all parameters for one path are stored for future use.

A.1.2   Description

The calculations center upon determining the charge distributions on the films, collector grids, and suppressor grid. The distributions on one grid are affected by the distributions on all other films and grids and vice versa. Thus, to determine the actual distribution is an iterative process which adjusts the individual charge distributions until the calculated potential at any element, grid or film matches the applied potentials. When the charge distribution due to the particle is determined, the applied potentials are set to zero.

The films and grids are divided into uniformly charged square elements of 3.175×10^{-3} meter on a side. The total number of elements used is 7,360. The interactions between elements are determined in a subroutine POTCON using

influence coefficients, which have been previously calculated and stored on tape. An influence coefficient is the value of potential at one element due to a unit charge at another element.

The resulting charge distribution is used in two ways. The first sums the elemental charges on each film and collector grid to give the total charge on the respective sensor element at that time. This is done in the particle case only and gives the charge due to the particle at each chosen position relative to the sensor. The rate of change of charge, caused by particle movement, determines the sensor output current. The second use for the charge distributions is to calculate the potential at the particle caused by both the applied potential charge distribution and the distribution due to the particle itself. The latter gives rise to the method of images used for calculations involving infinite planes. The change in potential along the path through the sensor determines the work done on the particle and thus the change in its energy.

The program has two basic modes of operation:

1. To calculate the charge distribution due to the applied potentials and commit the values to tape.

2. To calculate the required parameters of potential at the particle and total charge on each film and collector grid strip, for each selected particle position.

Other operational options, which are variations and combinations of the above two modes, are available and will be discussed later.

A.1.2.1   Mode 1

The mode is selected by guide parameter G1 = 1 on the second input card, and guide parameter G2 is set to zero. The initial elemental charges are set to half the values estimated for uniformly charged surfaces at the potentials of the film, collector grid, and suppressor, and the elemental potentials are set to zero. Next, the elemental potentials due to all other charges are calculated using the initial charge values and the influence co-efficients, which are read from tape. The difference between the potential at an element and the applied potential is due to the element's own charge and form factor. The charge, thus calculated, is compared with the original charge to determine the charge value for the next iteration.

The comparison includes a check to ensure that the calculated value does not lie outside the limits prescribed on an input card. If it is outside the limits, the elemental values are scaled to give the limit value for the total charge. The charge value for the next iteration is determined by taking a frac-tion of the difference between the calculated and original values and adding it to the original value. The fraction is selected on the input card, together with the number of iterations allowed and the maximum percentage difference desired between successive charge values on any element. The maximum percen-tage difference determines the accuracy of the resulting distribution.

When the program transfers out of the loop, the calculated charge distributions are recorded on tape for future use. The transfer occurs when either the iterations allowed are completed or the desired accuracy is achieved.

A.1.2.2   Mode 2

This mode is selected by guide parameters G1 and G2 being set to 3.0 and 1.0, respectively.

In this mode, the first step is to calculate the influence co-efficients between the particle and the elements of the films and grids and vice versa. These coefficients, designated P--Q, are the values of potential at an element for a unit charge at the particle and vice versa. The coefficients are calculated for every particle position that is selected by an input card. Subroutine PLEINF is used in the calculation. The charges on the films and grids and the potential at the particle are calculated as follows,

1. The charge distribution due to the particle is calculated iteratively in an identical manner to that for the applied potentials, except that the applied potentials are set to zero and the initial element potentials are set to the values attributable to the particle (the values of the influence coefficients, P--Q). The potential contributions at each element due to all other elements are accumulated with the P--Q value to give the total potential at each element. This value is compared with the applied potential (now zero) as before, and the new elemental charge is determined using the same factor. The same criteria are applied as in Mode 1 to determine when sufficient iterations have been performed.

2. The potential at the particle due to the applied potentials is computed from the influence coefficients (P--Q) and the charge distribution stored on tape in Mode 1.

3. The potential at the particle due to the charge it induces in the films and grids is computed from the influence coefficients (P--Q) and the charge distribution calculated for the particle alone.

4. The total charge on each film and collector grid strip is calculated by summing the respective elemental charges for each strip.

When all the potentials and charges have been computed for a particular position, the values are committed to tape as part of a data set which is compiled for each path through the sensor.

The program then reads the next input card for a new particle position. At each position, the program automatically alternates between the loop that reads the applied potential charges from tape and the loop that iterates to a new charge distribution due to the particle charge.

A.1.2.3 Other Options

Options are selected by input parameters G1 and G2:

1. When G1 = 2.0, the program calculates the potential at points selected by input cards, in addition to computing and committing to tape the charge values of Mode 1.

2. When G1 = 3.0, the program calculates the potentials of the previous option using the charge values recorded on the tape.

3.   When G1 = 5.0, the charge values recorded on tape in Mode 1
are read in and used as the initial values for the first step
of the iteration loop. This allows further refinement of the
charge values without repeating the previous steps.

4.   When G2 = 1.0 and G1 = 0.0, the potentials at the particle
due to the particle induced charges and the total film and
collector grid strip charges due to the particle are calculated.
The potential due to the applied potentials is not calculated.
This mode has limited use on its own and, if called for, should
have a dummy card for the JCL card defining FT25F001 to prevent
erroneous data being stored on a data tape.

A.1.2.4   P5072SIC Program to Calculate Influence Coefficients

The program to calculate the influence coefficients P5072SIC is used
once, and the results are stored on magnetic tape. This program calculates
the coefficients from first principles, based on the physical geometry of the
elements. The interactions occur many times due to the repetitive nature of
the physical geometry, but any particular interaction is calculated only once.
Each interaction is referenced by an index number so that the correct coef-
ficient can be recalled from tape in program P5072CHG. This program, P5072SIC,
determines the correct index number for the particular coordinates of the
elements under consideration, then calculates the coefficient using subroutine
INFLCF.

All coefficients are stored on tape VOL SER NOS T53344 using the following data set names:

ASD.P067.   CFWW

CFMSFW

CFTUFW

CFEDGW

CFPFIW

CFFMFM

CFTUFM

CFEDFM

CFISFM

CFTUTU

CFISIS

CFEDED

CFEDIS

CFEDTU

ASD.P067.   CFTUIS

A JCL card is required for each data set.

A.1.3   Method of Use

Four input cards are required if full use of the program is to be made, including calculations involving particle position. This applies to every condition of G1 and G2 except G1 = 1.0 and G2 = 0.0. In this instance, the fourth card may be omitted.

Card 1 controls the iterative process of determining the charge distributions.

The inputs required, all format code F7.4, are:

Columns 1-7; FACTOR, which determines the fraction of old and new charge values which are to be used for the value in the next iteration.

Columns 8-14; PERCEN, specifies the maximum percentage difference between new and old charge values required before exiting the iteration loop.

Columns 9-21; CYCLES, specifies the maximum number of iterative cycles allowed before exiting the loop.

Card 2 defines the guide numbers G1 and G2 (Format, 2F3.1).

G1 = 0.0 Does nothing with regard to applied potentials.

G1 = 1.0 Charges due to applied potentials are computed and written to tape.

G1 = 2.0 Same as G1 = 1.0 and also computes the potential at specified point(s) from card 4.

G1 = 3.0 Reads charge distribution due to applied potentials from tape and computes the potential at specified point(s) from card 4.

G1 = 5.0 Refines charges due to applied potentials. (From Tape).

G2 = 0.0 Does nothing with regard to particle.

G2 = 1.0 Computes charge distribution due to particle. Computes image potential at position of particle and total charges on grid and film strips due to particle.

Note: If G1 = 2.0 or 3.0 and/or G2 = 1.0, cards giving XP, YP and ZP must be present, where XP, YP and ZP are the coordinates of the particle relative to the center of the film.

Card 3 defines the maximum and minimum charge values for each sensor plane

during the iteration process. These values limit the excursions of

the charge values to prevent divergence. (Format 6E11.4).

Card 4 defines the particle path position, the distance of the particle from

the film and the total number of points (NPTS) to be calculated (par-

ticle positions). ZP is the distance of the particle from the film

in meters. XP and YP are the distances from the center of the film

plane, in meters, as shown below,

AC1 AF1	AC2	AC3	AC4
AF2		XP	
AF3		YP	
AF4			

A card of this type is required for every particle position or position

for which potential due to applied potentials is required. (Format

3E11.4, I3). XP and YP must have the same respective values on each

card for each path, i.e., on a particular path only ZP changes.

Tapes are required for storage of the charges due to applied potentials

and for the path data which includes potentials and total charges.

If the charge distribution due to applied charges is held on tape and further refinement of the values is desired, i.e., a smaller value of PERCEN, then G1 should be given the value of 5.0. The existing values will be read from tape and further iterations performed until the new accuracy is achieved.

Some WRITE statements, that are not shown on the flow chart which follows, are included for diagnostic purposes. These print out some of the terminal point numbers so that the position in the program can be determined and also the potential and charge of selected elements in each plane are printed prior to executing terminal points 3508 or 3509.

A.1.4   Flow Charts and Program Listings

A flow chart of the program is given in Figure A-1.

Program listings for P5072CHG, P5072SIC, and subroutines POTCON, PLEINF, and INFLCF follow on pages A-13 through A-53.

Figure A-1 P5072CHG Program Calculates Charge Distributions in Films and Grids

P5072CHG

```
C       CARD(S) GIVING VALUES OF G1 & G2 MUST ALWAYS BE PRESENT
C
C       G1=0.0 DOES NOTHING WITH REGARD TO APPLIED POTENTIALS
C       G1=1.0 CHARGES DUE TO APPLIED POTENTIALS COMPUTED AND WRITTEN TO TAPE
C       G1=2.0 SAME AS G1=1.0 & ALSO COMPUTES POTENTIAL AT SPECIFIED POINT(S)
C       G1=3.0 READS CHARGE DISTRIBUTION DUE TO APPLIED POTENTIALS FROM TAPE AND
C              COMPUTES POTENTIAL AT SPECIFIED POINT(S)
C       G1=5.0 REFINES CHARGES DUE TO APPLIED POTENTIALS. (FROM TAPE )
C       G2=0.0 DOES NOTHING WITH REGARD TO PARTICLE
C       G2=1.0 COMPUTES CHARGE DISTRIBUTION DUE TO PARTICLE. . COMPUTES IMAGE
C              POTENTIAL AT POSITION OF PARTICLE.COMPUTES TOTAL CHARGES ON
C              GRID AND FILM STRIPS DUE TO PARTICLE.
C
C         NOTE   IF G1=2.0 OR 3.0 AND/OR G2=1.0 CARDS GIVING XP,YP AND ZP MUST BE
C                PRESENT
C
C         NOTE    CARDS GIVING VALUES OF FACTOR,PERCEN AND CYCLES MUST ALWAYS BE
C                PRESENT
C       IN THE FOLLOWING ARRAYS THE PREFIX G INDICATES THE TOTAL CHARGE ON AN
C       ELEMENT,THE PREFIX P THE TOTAL POTENTIAL AT AN ELEMENT DUE TO ALL OTHER
C       CHARGES AND THE PREFIX P WITH SUFFIX Q THE POTENTIAL AT AN ELEMENT DUE TO
C       THE CHARGE ON THE PARTICLE ALONE.THE P--Q NUMBERS ARE ALSO THE INFLUENCE
C       COEFFICIENTS FOR THE EFFECT OF THE ELEMENT CHARGES UPON THE  POTENTIAL
C       AT THE PARTICLE.
        DIMENSION PWQ(2,2,4,4,7,8),PTUQ(3,2,4,4,2,8),PEDQ(2,2,4,4,2,8)
        DIMENSION PISQ(3,4,4,2,2),PFMSQ(4,4,8,8)
        DIMENSION CHG(3),SCALE(3),QMAX(3),QMIN(3)
        DIMENSION BLANK(8)
        COMMON     GFMS(4,4,8,8),PFMS(4,4,8,8)
        COMMON     PW(2,2,4,4,7,8),GW(2,2,4,4,7,8)
        COMMON     GED(2,2,4,4,2,8),PED(2,2,4,4,2,8)
        COMMON     GTU(3,2,4,4,2,8),PTU(3,2,4,4,2,8)
        COMMON     GIS(3,4,4,2,2),PIS(3,4,4,2,2)
        DATA BLANK/8*0.0/
C
C       THE ABOVE 15 ARRAYS REQUIRE 25536 WORDS (I.E. 102144 BYTES)
C       3500 TO 3514 PROVIDE ROUTING THROUGH THE PROGRAM BLOCKS
        READ(5,3500)FACTOR,PERCEN,CYCLES
 3500   FORMAT(3F7.4)
        WRITE(6,8000)FACTOR,PERCEN,CYCLES
 8000   FORMAT(5X,'FACTOR = ',F7.4,'    PERCEN = ',F7.4,'   CYCLES = ',F7.4)
        PERCEN=0.01*PERCEN
        READ(5,3501)G1,G2
 3501   FORMAT(2F3.1)
        WRITE(6,8001)G1,G2
 8001   FORMAT(5X,'G1,G2 = ',2(F4.2,2X))
        READ(5,8020)QMAX,QMIN
 8020   FORMAT(6E11.4)
        WRITE(6,8021)QMAX,QMIN
 8021   FORMAT(5X,'QMAX = ',3(E11.4,5X)/5X,'QMIN = ',3(E11.4,5X))
        IF(G2.GT.0.5)LINE=1
        IF(G1.GT.0.5)LINE=0
        JUMP=0
        INUM=0
        IF(G1.GT.4)GO TO 3504
        IF(G1.LT.1.5.AND.G2.LT.0.5)GO TO 3504
```

```
 3502 READ(5,3503,END=3514)XP,YP,ZP,NPTS
 3503 FORMAT(3E11.4,I3)
      WRITE(6,8002)XP,YP,ZP
 8002 FORMAT(5X,'XP,YP,ZP = ',3(E11.4,3X))
      IF(INUM.GT.1)GO TO 5999
      WRITE(25)XP,YP,NPTS,BLANK
      INUM=INUM+1
      GO TO 5999
C        COMPUTES POTENTIALS/INFL. COEFFS DUE TO PARTICLE ANDRETURNS TO 3504
 3504 WRITE(6,8003)
 8003 FORMAT(5X,'3504')
      IF(G1.LT.2.5.OR.LINE.EQ.1)GO TO 2019
      IF(JUMP.EQ.1)GO TO 2050
      READ(9)GW,GTU,GED,GIS,GFMS
      REWIND 9
      JUMP=1
      IF(G1.GT.4)GO TO 3505
      GO TO 2050
C        GOES TO 2019 ZOROS ALL CHARGES & RETURNS TO 3505 OR GOES TO 2050 &
C        COMPUTES POTENTIAL AT PARTICLE POSITION RETURNING TO 3511
 3505 COUNT=0.0
      WRITE(6,8004)
 8004 FORMAT(5X,'3505')
 3508 IF(LINE.EQ.1)GO TO 3506
      V1=-7.0
      V2=24.0
      V3=-3.0
      GO TO 1999
 3506 V1=0.0
      V2=0.0
      V3=0.0
      GO TO 2010
C        GOES TO 1999 & SETS P-- TO ZERO, OR GOES TO 2010 & SETS P-- = P--Q IN BOTH
C        CASES RETURNING TO 3507
 3507 WRITE(6,8005)
 8005 FORMAT(5X,'3507')
      IF(COUNT.LT.0.5.AND.LINE.EQ.1)GO TO 4999
      GO TO 4499
C        GOES TO ITERATION BLOCK BUT BYPASSES COMPUTATION OF POTENTIAL
C        CONTRIBUTIONS DUE TO ELEMENTS ON FIRST PASS. RETURNS TO 3508 FOR FURTHER
C        ITERATION OR TO 3509 WHEN ITERATION COMPLETED. ALL CHARGES NOW COMPUTED
 3509 WRITE(6,8006)
 8006 FORMAT(5X,'3509')
      IF(G1.GT.4)GO TO 8050
      IF(G1.GT.2.5.OR.LINE.EQ.1)GO TO 3510
 8050 WRITE(9)GW,GTU,GED,GIS,GFMS
      REWIND 9
      IF(G1.GT.4)GO TO 3514
      IF(G1.LT.1.5.AND.G2.LT.0.5)GO TO 3514
      JUMP=1
 3510 GO TO 2050
C        COMPUTES POTENTIAL AT PARTICLE, RETURNING TO 3511
 3511 IF(LINE.EQ.0)GO TO 3515
      PAR=SUM
      WRITE(6,3517)PAR
 3517 FORMAT(5X,'PAR = ',E11.4)
      GO TO 3516
 3515 APP=SUM
      WRITE(6,3518)APP
 3518 FORMAT(5X,'APP = ',E11.4)
 3516 IF(LINE.EQ.0)GO TO 3513
      GO TO 2100
C        COMPUTES CHARGES ON FILM AND GRID STRIP AND RETURNS TO 3512
 3512 WRITE(6,3519)AF1,AF2,AF3,AF4,AC1,AC2,AC3,AC4
 3519 FORMAT(5X,'FILM CHARGE = ',4(2X,F11.4)//4X,'GRID CHARGE = ',4(2X,E
     211.4))
```

```
          WRITE(25)ZP, APP, PAR, AC1, AC2, AC3, AC4, AF1, AF2, AF3, AF4
   3513 IF(LINE. EQ. 0. AND. G2. GT. 0. 5)L=1
        IF(LINE. EQ. 1. AND. G1. GT. 1. 5)L=0
        IF(LINE. EQ. 1. AND. G1. LT. 1. 5)L=1
        IF(LINE. EQ. 0. AND. G2. LT. 0. 5)L=0
        LINE=L
        IF(G1. GT. 1. 5)G1=3. 0
        IF(LINE. EQ. 1. AND. G1. GT. 2. 5)GO TO 3504
        GO TO 3502
C       THIS BLOCK SETS ALL POTENTIAL CONTRIBUTIONS FROM ELEMENTS TO ZERO
C
   1999 DO 2007 K=1, 4
        DO 2006 L=1, 4
        DO 2005 M=1, 8
        DO 2004 N=1, 8
        PFMS(K, L, M, N)=0. 0
        IF(M. GT. 7)GO TO 2004
        DO 2003 I=1, 3
        IF(M. GT. 2. OR. N. GT. 2)GO TO 2000
        PIS(I, K, L, M, N)=0. 0
   2000 DO 2002 J=1, 2
        IF(M. GT. 2)GO TO 2001
        PTU(I, J, K, L, M, N)=0. 0
   2001 IF(I. GT. 2)GO TO 2002
        PN(I, J, K, L, M, N)=0. 0
        IF(M. GT. 2)GO TO 2002
        PED(I, J, K, L, M, N)=0. 0
   2002 CONTINUE
   2003 CONTINUE
   2004 CONTINUE
   2005 CONTINUE
   2006 CONTINUE
   2007 CONTINUE
        GO TO 3507
C       THIS BLOCK SETS ALL ELEMENT CHARGES TO ZERO
C
   2019 JUMP=0
        IF(LINE. EQ. 0)GO TO 9000
        IF(INUM. GT. 1)GO TO 3505
        FYLM=0. 0
        GRYD=0. 0
        SUPG=0. 0
        GO TO 9020
   9000 FYLM=-2. 0E-13
        GRYD=3. 0E-13
        SUPG=-2. 0E-13
   9020 DO 2027 K=1, 4
        DO 2026 L=1, 4
        DO 2025 M=1, 8
        DO 2024 N=1, 8
        GFMS(K, L, M, N)=FYLM
        IF(M. GT. 7)GO TO 2024
        IF(M. GT. 2. OR. N. GT. 2)GO TO 2020
        GIS(1, K, L, M, N)=SUPG
        GIS(2, K, L, M, N)=GRYD
        GIS(3, K, L, M, N)=FYLM
   2020 DO 2022 J=1, 2
        GN(1, J, K, L, M, N)=SUPG
        GN(2, J, K, L, M, N)=GRYD
        IF(M. GT. 2)GO TO 2022
        GTU(1, J, K, L, M, N)=SUPG
        GTU(2, J, K, L, M, N)=GRYD
        GTU(3, J, K, L, M, N)=FYLM
        GED(1, J, K, L, M, N)=SUPG
        GED(2, J, K, L, M, N)=GRYD
   2022 CONTINUE
```

```
2024 CONTINUE
2025 CONTINUE
2026 CONTINUE
2027 CONTINUE
     GO TO 3505
C       THIS BLOCK SETS POTL. CONTRIBUTIONS P-- EQUAL TO CORRESPONDING P--0
C
2010 DO 2018 K=1,4
     DO 2017 L=1,4
     DO 2016 M=1,8
     DO 2015 N=1,8
     PFMS(K,L,M,N)=PFMSQ(K,L,M,N)
     IF(M.GT.7)GO TO 2015
     DO 2014 I=1,3
     IF(M.GT.2.OR.N.GT.2)GO TO 2011
     PIS(I,K,L,M,N)=PISQ(I,K,L,M,N)
2011 DO 2013 J=1,2
     IF(M.GT.2)GO TO 2012
     PTU(I,J,K,L,M,N)=PTUQ(I,J,K,L,M,N)
2012 IF(I.GT.2)GO TO 2013
     PW(I,J,K,L,M,N)=PWQ(I,J,K,L,M,N)
     IF(M.GT.2)GO TO 2013
     PED(I,J,K,L,M,N)=PEDQ(I,J,K,L,M,N)
2013 CONTINUE
2014 CONTINUE
2015 CONTINUE
2016 CONTINUE
2017 CONTINUE
2018 CONTINUE
     GO TO 3507
C       THIS BLOCK COMPUTES POTENTIAL AT PARTICLE
C
2050 SUM=0.0
     DO 2058 K=1,4
     DO 2057 L=1,4
     DO 2056 M=1,8
     DO 2055 N=1,8
     SUM=SUM+PFMSQ(K,L,M,N)*GFMS(K,L,M,N)
     IF(M.GT.7)GO TO 2055
     DO 2054 I=1,3
     IF(M.GT.2.OR.N.GT.2)GO TO 2051
     SUM=SUM+PISQ(I,K,L,M,N)*GIS(I,K,L,M,N)
2051 DO 2053 J=1,2
     IF(M.GT.2)GO TO 2052
     SUM=SUM+PTUQ(I,J,K,L,M,N)*GTU(I,J,K,L,M,N)
2052 IF(I.GT.2)GO TO 2053
     SUM=SUM+PWQ(I,J,K,L,M,N)*GW(I,J,K,L,M,N)
     IF(M.GT.2)GO TO 2053
     SUM=SUM+PEDQ(I,J,K,L,M,N)*GED(I,J,K,L,M,N)
2053 CONTINUE
2054 CONTINUE
2055 CONTINUE
2056 CONTINUE
2057 CONTINUE
2058 CONTINUE
     GO TO 3511
C
C       THIS BLOCK COMPUTES CHARGES ON GRID AND FILM STRIPS
C
2100 AC1=0.0
     AC2=0.0
     AC3=0.0
     AC4=0.0
     AF1=0.0
     AF2=0.0
     AF3=0.0
```

```
         AF4=0.0
         DO 2105 KL=1,4
         DO 2104 M=1,8
         DO 2103 N=1,8
         AF1=AF1+GFMS(KL,1,M,N)
         AF2=AF2+GFMS(KL,2,M,N)
         AF3=AF3+GFMS(KL,3,M,N)
         AF4=AF4+GFMS(KL,4,M,N)
         IF(M.GT.7)GO TO 2103
         IF(M.GT.2.OR.N.GT.2)GO TO 2101
         AF1=AF1+GIS(3,KL,1,M,N)
         AF2=AF2+GIS(3,KL,2,M,N)
         AF3=AF3+GIS(3,KL,3,M,N)
         AF4=AF4+GIS(3,KL,4,M,N)
         AC1=AC1+GIS(2,1,KL,M,N)
         AC2=AC2+GIS(2,2,KL,M,N)
         AC3=AC3+GIS(2,3,KL,M,N)
         AC4=AC4+GIS(2,4,KL,M,N)
    2101 IF(M.GT.2)GO TO 2102
         AF1=AF1+GTU(3,1,KL,1,M,N)+GTU(3,2,1,KL,M,N)
         AF2=AF2+GTU(3,1,KL,2,M,N)+GTU(3,2,2,KL,M,N)
         AF3=AF3+GTU(3,1,KL,3,M,N)+GTU(3,2,3,KL,M,N)
         AF4=AF4+GTU(3,1,KL,4,M,N)+GTU(3,2,4,KL,M,N)
         AC1=AC1+GTU(2,1,1,KL,M,N)+GTU(2,2,KL,1,M,N)
         AC2=AC2+GTU(2,1,2,KL,M,N)+GTU(2,2,KL,2,M,N)
         AC3=AC3+GTU(2,1,3,KL,M,N)+GTU(2,2,KL,3,M,N)
         AC4=AC4+GTU(2,1,4,KL,M,N)+GTU(2,2,KL,4,M,N)
    2102 AC1=AC1+GW(2,1,1,KL,M,N)+GW(2,2,KL,1,M,N)
         AC2=AC2+GW(2,1,2,KL,M,N)+GW(2,2,KL,2,M,N)
         AC3=AC3+GW(2,1,3,KL,M,N)+GW(2,2,KL,3,M,N)
         AC4=AC4+GW(2,1,4,KL,M,N)+GW(2,2,KL,4,M,N)
         IF(M.GT.2)GO TO 2103
         AC1=AC1+GED(2,1,1,KL,M,N)+GED(2,2,KL,1,M,N)
         AC2=AC2+GED(2,1,2,KL,M,N)+GED(2,2,KL,2,M,N)
         AC3=AC3+GED(2,1,3,KL,M,N)+GED(2,2,KL,3,M,N)
         AC4=AC4+GED(2,1,4,KL,M,N)+GED(2,2,KL,4,M,N)
    2103 CONTINUE
    2104 CONTINUE
    2105 CONTINUE
         GO TO 3512
    4499 CALL POTCON
C
C        COMPUTE CHARGE ON EACH ELEMENT DUE TO APPLIED POTENTIAL ANDPOTENTIAL
C        CONTRIBUTIONS FROM ALL OTHER ELEMENTS AND PARTICLE.NOTE THAT IF PARTICLE
C        IS PRESENT THEN ALL APPLIED POTENTIALS ARE ZERO.
    4999 CHG(1)=0.0
         CHG(2)=0.0
         CHG(3)=0.0
         DO 2518 K=1,4
         DO 2517 L=1,4
         DO 2516 M=1,8
         DO 2515 N=1,8
         CHG(3)=CHG(3)+(V-PFMS(K,L,M,N))*0.11853E-12
         IF(M.GT.7)GO TO 2515
         V=V1
         DO 2514 I=1,3
         IF(I.EQ.2)V=V2
         IF(I.EQ.3)V=V3
         IF(M.GT.2.OR.N.GT.2)GO TO 2511
         CHG(I)=CHG(I)+(V-PIS(I,K,L,M,N))*0.7111799E-13
    2511 DO 2513 J=1,2
         IF(M.GT.2)GO TO 2512
         CHG(I)=CHG(I)+(V-PTU(I,J,K,L,M,N))*0.9322102E-13
    2512 IF(I.GT.2)GO TO 2513
         CHG(I)=CHG(I)+(V-PW(I,J,K,L,M,N))*0.5140147E-13
         IF(M.GT.2)GO TO 2513
```

```
        CHG(I)=CHG(I)+(V-PED(I,J,K,L,M,N))*0.4137133E-13
2513 CONTINUE
2514 CONTINUE
2515 CONTINUE
2516 CONTINUE
2517 CONTINUE
2518 CONTINUE
     DO 2530 I=1,3
     SCALE(I)=1.0
     IF(CHG(I).GT.QMAX(I))SCALE(I)=QMAX(I)/CHG(I)
     IF(CHG(I).LT.QMIN(I))SCALE(I)=QMIN(I)/CHG(I)
2530 CONTINUE
C
C    START WIRES
C
     CRIT=0.0
     V=V1
     DO 5005 I=1,2
     IF(I.EQ.2)V=V2
     DO 5004 J=1,2
     DO 5003 K=1,4
     DO 5002 L=1,4
     DO 5001 M=1,7
     DO 5000 N=1,8
     TEMP1=(V-PW(I,J,K,L,M,N))*0.5140147E-13
     TEMP1=TEMP1*SCALE(I)
     TEMP2=TEMP1*FACTOR+GW(I,J,K,L,M,N)*(1-FACTOR)
     TEMP3=PERCEN*GW(I,J,K,L,M,N)
     TEMP4=TEMP1-GW(I,J,K,L,M,N)
     TEMP3=ABS(TEMP3)
     TEMP4=ABS(TEMP4)
     IF(TEMP4.GT.TEMP3)CRIT=1.00
     GW(I,J,K,L,M,N)=TEMP2
5000 CONTINUE
5001 CONTINUE
5002 CONTINUE
5003 CONTINUE
5004 CONTINUE
5005 CONTINUE
C
C    END WIRES. START GRID EDGES
C
     V=V1
     DO 5011 I=1,2
     IF(I.EQ.2)V=V2
     DO 5010 J=1,2
     DO 5009 K=1,4
     DO 5008 L=1,4
     DO 5007 M=1,2
     DO 5006 N=1,8
     TEMP1=(V-PED(I,J,K,L,M,N))*0.4137133E-13
     TEMP1=TEMP1*SCALE(I)
     TEMP2=TEMP1*FACTOR+GED(I,J,K,L,M,N)*(1-FACTOR)
     TEMP3=PERCEN*GED(I,J,K,L,M,N)
     TEMP4=TEMP1-GED(I,J,K,L,M,N)
     TEMP3=ABS(TEMP3)
     TEMP4=ABS(TEMP4)
     IF(TEMP4.GT.TEMP3)CRIT=1.0
     GED(I,J,K,L,M,N)=TEMP2
5006 CONTINUE
5007 CONTINUE
5008 CONTINUE
5009 CONTINUE
5010 CONTINUE
5011 CONTINUE
C    END GRID EDGES. START MAIN GRID/FILM T & U
```

```
C
        V=V1
        DO 5017 I=1,3
        IF(I.EQ.2)V=V2
        IF(I.EQ.3)V=V3
        DO 5016 J=1,2
        DO 5015 K=1,4
        DO 5014 L=1,4
        DO 5013 M=1,2
        DO 5012 N=1,8
        TEMP1=(V-PTU(I,J,K,L,M,N))*0.9322102E-13
        TEMP1=TEMP1*SCALE(I)
        TEMP2=TEMP1*FACTOR+GTU(I,J,K,L,M,N)*(1-FACTOR)
        TEMP3=PERCEN*GTU(I,J,K,L,M,N)
        TEMP4=TEMP1-GTU(I,J,K,L,M,N)
        TEMP3=ABS(TEMP3)
        TEMP4=ABS(TEMP4)
        IF(TEMP4.GT.TEMP3)CRIT=1.0
        GTU(I,J,K,L,M,N)=TEMP2
 5012 CONTINUE
 5013 CONTINUE
 5014 CONTINUE
 5015 CONTINUE
 5016 CONTINUE
 5017 CONTINUE
C
C       END MAIN GRID/FILM T & U. START INTERSECTION SQUARES
C
        V=V1
        DO 5022 I=1,3
        IF(I.EQ.2)V=V2
        IF(I.EQ.3)V=V3
        DO 5021 K=1,4
        DO 5020 L=1,4
        DO 5019 M=1,2
        DO 5018 N=1,2
        TEMP1=(V-PIS(I,K,L,M,N))*0.7111799E-13
        TEMP1=TEMP1*SCALE(I)
        TEMP2=TEMP1*FACTOR+GIS(I,K,L,M,N)*(1-FACTOR)
        TEMP3=PERCEN*GIS(I,K,L,M,N)
        TEMP4=TEMP1-GIS(I,K,L,M,N)
        TEMP3=ABS(TEMP3)
        TEMP4=ABS(TEMP4)
        IF(TEMP4.GT.TEMP3)CRIT=1.00
        GIS(I,K,L,M,N)=TEMP2
 5018 CONTINUE
 5019 CONTINUE
 5020 CONTINUE
 5021 CONTINUE
 5022 CONTINUE
C
C       END INTERSECTION SQUARES. START FILM MAIN SQUARES
C
        V=V3
        DO 5026 K=1,4
        DO 5025 L=1,4
        DO 5024 M=1,8
        DO 5023 N=1,8
        TEMP1=(V-PFMS(K,L,M,N))*0.11853E-12
        TEMP1=TEMP1*SCALE(3)
        TEMP2=TEMP1*FACTOR+GFMS(K,L,M,N)*(1-FACTOR)
        TEMP3=PERCEN*GFMS(K,L,M,N)
        TEMP4=TEMP1-GFMS(K,L,M,N)
        TEMP3=ABS(TEMP3)
        TEMP4=ABS(TEMP4)
        IF(TEMP4.GT.TEMP3)CRIT=1.00
```

```
             GFMS(K, L, M, N)=TEMP2
        5023 CONTINUE
        5024 CONTINUE
        5025 CONTINUE
        5026 CONTINUE
             WRITE(6, 8100)(PIS(I, 2, 2, 2, 2), GIS(I, 2, 2, 2, 2), I=1, 3)
        8100 FORMAT(3(5X, 'PIS = ', E11. 4, 5X, 'GIS = ', E11. 4/))
             WRITE(6, 8101)(PTU(I, 2, 2, 2, 2, 8), GTU(I, 2, 2, 2, 2, 8), I=1, 3)
        8101 FORMAT(3(5X, 'PTU = ', E11. 4, 5X, 'GTU = ', E11. 4/))
             WRITE(6, 8102)(PED(I, 2, 2, 2, 2, 8), GED(I, 2, 2, 2, 2, 8), I=1, 2)
        8102 FORMAT(2(5X, 'PED = ', E11. 4, 5X, 'GED = ', E11. 4/))
             WRITE(6, 8103)(PW(I, 2, 2, 2, 7, 8), GW(I, 2, 2, 2, 7, 8), I=1, 2)
        8103 FORMAT(2(5X, 'PW = ', E11. 4, 5X, 'GW = ', E11. 4/))
             WRITE(6, 8104)PFMS(2, 2, 4, 4), GFMS(2, 2, 4, 4)
        8104 FORMAT(5X, 'PFMS = ', E11. 4, 5X, 'GFMS = ', E11. 4/)
      C
      C      END FILM MAIN SQUARES
      C      COMPUTATION OF NEW CHARGE DISTRIBUTION COMPLETED
      C      IF CRIT IS NOT ZERO THEN CHANGE OF CHARGE ON AT LEAST ONE ELEMENT
      C      EXCEEDED SPECIFIED PERCENTAGES. IF CRIT IS ZERO THEN ITERATION HAS
      C      REACHED REQUIRED ACCURACY
      C
             COUNT=COUNT+1
             IF(COUNT. LT. CYCLES-0. 1. AND. CRIT. GT. 0. 5)GO TO 3508
      C
      C      CONDITIONAL RETURN TO START OF ITERATION PROCESS
      C
      C      WHEN ITERATION COMPLETED AND/OR PERMITTED NUMBER OF CYCLES REACHED
      C      COMPUTE POTENTIAL AT POSITION OF PARTICLE DUE TO APPLIED POTENTIALS
      C      AND PARTICLE IMAGE CHARGES
             GO TO 3509
      C      COMPUTE POTENTIAL AT ELEMENTS DUE TO ONE COULOMB AT PARTICLE
      C
      C      START PARTICLE ON WIRES
      C
        5999 Z=ZP-0. 0097028
             DO 6007 I=1, 2
             IF(I. EQ. 2)Z=ZP-0. 0067564
             DO 6006 J=1, 2
             DO 6005 K=1, 4
             DO 6004 L=1, 4
             DO 6003 M=1, 7
             DO 6002 N=1, 8
             IF(J. EQ. 2)GO TO 6000
             A=0. 0
             B=0. 003175
             X=0. 02921*K+0. 003175*M-0. 085725-XP
             Y=0. 02921*L+0. 003175*N-0. 087313-YP
             GO TO 6001
        6000 A=0. 003175
             B=0. 0
             X=0. 02921*L+0. 003175*N-0. 087313-XP
             Y=0. 02921*K+0. 003175*M-0. 085725-YP
        6001 CALL PLFINF(X, Y, Z, A, B, POTL)
             PWQ(I, J, K, L, M, N)=POTL
        6002 CONTINUE
        6003 CONTINUE
        6004 CONTINUE
        6005 CONTINUE
        6006 CONTINUE
        6007 CONTINUE
      C
      C      END PARTICLE ON WIRES
      C
      C      START PARTICLE ON GRID EDGES
      C
```

```
              DO 6015 I=1,2
              IF(I.EQ.2)Z=ZP-0.0067564
              DO 6014 J=1,2
              DO 6013 K=1,4
              DO 6012 L=1,4
              DO 6011 M=1,2
              DO 6010 N=1,8
              IF(J.EQ.2)GO TO 6008
              A=0.0
              B=0.003175
              X=0.02921*K+0.0254*M-0.111125-XP
              Y=0.02921*L+0.003175*N-0.087313-YP
              GO TO 6009
        6008  A=0.003175
              B=0.0
              X=0.02921*L+0.003175*N-0.087313-XP
              Y=0.02921*K+0.0254*M-0.111125-YP
        6009  CALL PLEINF(X,Y,Z,A,B,POTL)
              PEDQ(I,J,K,L,M,N)=POTL
        6010  CONTINUE
        6011  CONTINUE
        6012  CONTINUE
        6013  CONTINUE
        6014  CONTINUE
        6015  CONTINUE
   C
   C          END PARTICLE ON GRID EDGES
   C
   C          START PARTICLE ON MAIN GRID/FILM T & U
   C
              Z=ZP-0.0097028
              DO 6023 I=1,3
              IF(I.EQ.2)Z=ZP-0.0067564
              IF(I.EQ.3)Z=ZP
              DO 6022 J=1,2
              DO 6021 K=1,4
              DO 6020 L=1,4
              DO 6019 M=1,2
              DO 6018 N=1,8
              IF(J.EQ.2)GO TO 6016
              A=0.001905
              B=0.003175
              X=0.02921*K+0.027305*M-0.1139825-XP
              Y=0.02921*L+0.003175*N-0.0873125-YP
              GO TO 6017
        6016  A=0.003175
              B=0.001905
              X=0.02921*L+0.003175*N-0.0873125-XP
              Y=0.02921*K+0.027305*M-0.1139825-YP
        6017  CALL PLEINF(X,Y,Z,A,B,POTL)
              PTUQ(I,J,K,L,M,N)=POTL
        6018  CONTINUE
        6019  CONTINUE
        6020  CONTINUE
        6021  CONTINUE
        6022  CONTINUE
        6023  CONTINUE
   C
   C          END PARTICLE ON MAIN GRID/FILM T & U
   C
   C          START PARTICLE ON GRID/FILM INTERSECTION SQUARES
   C
              Z=ZP-0.0097028
              DO 6028 I=1,3
              IF(I.EQ.2)Z=ZP-0.0067564
```

```
            IF(I.EQ.3)Z=ZP
            DO 6027 K=1,4
            DO 6026 L=1,4
            DO 6025 M=1,2
            DO 6024 N=1,2
            A=0.001905
            B=0.001905
           ·X=0.02921*K+0.027305*M-0.1139825-XP
            Y=0.02921*L+0.027305*N-0.1139825-YP
            CALL PLEINF(X,Y,Z,A,B,POTL)
            PISQ(I,K,L,M,N)=POTL
      6024 CONTINUE
      6025 CONTINUE
      6026 CONTINUE
      6027 CONTINUE
      6028 CONTINUE
C
C          END PARTICLE ON GRID/FILM INTERSECTION SQUARES
C
C          START PARTICLE ON FILM MAIN SQUARES ELEMENTS
            Z=ZP
            DO 6032 K=1,4
            DO 6031 L=1,4
            DO 6030 M=1,8
            DO 6029 N=1,8
            A=0.003175
            B=0.003175
            X=0.02921*K+0.003175*M-0.0873125-XP
            Y=0.02921*L+0.003175*N-0.0873125-YP
            CALL PLEINF(X,Y,Z,A,B,POTL)
            PFMSQ(K,L,M,N)=POTL
      6029 CONTINUE
      6030 CONTINUE
      6031 CONTINUE
      6032 CONTINUE
C
C          END PARTICLE ON FILM MAIN SQUARES ELEMENTS
C
C          ALL POTENTIALS DUE TO CHARGE ON PARTICLE COMPLETED. NOTE THAT PWQ, PEDQ,
C          PTUQ, PISQ  & PFMSQ ARE ALSO THE INFLUENCE COEFFICIENTS FOR COMPUTING
C          POTENTIAL AT PARTICLE DUE TO CHARGE DISTRIBUTION ON ELECTRODES
C
            GO TO 3504
      3514 CONTINUE
            END
```

```
      SUBROUTINE POTCON
      DIMENSION CFWW(9678),CFMSFW(5194),CFTUFW(21364),CFEDGW(10682)
      DIMENSION CFPFIW(10976),CFFMFM(2809),CFTUFM(8904),CFEDFM(5936)
      DIMENSION CFISFM(9408),CFTUTU(18595),CFISIS(605),CFEDED(7438)
      DIMENSION CFEDIS(3136),CFEDTU(15512),CFTUIS(2464)
      COMMON    GFMS(4,4,8,8),PFMS(4,4,8,8)
      COMMON    PW(2,2,4,4,7,8),GW(2,2,4,4,7,8)
      COMMON    GED(2,2,4,4,2,8),PED(2,2,4,4,2,8)
      COMMON    GTU(3,2,4,4,2,8),PTU(3,2,4,4,2,8)
      COMMON    GIS(3,4,4,2,2),PIS(3,4,4,2,2)
      EQUIVALENCE(CFTUFW(1),CFTUTU(1),CFTUFM(1),CFPFIW(1),CFWW(1),CFISIS
     2(1),CFMSFW(1),CFFMFM(1),CFISFM(1),CFEDIS(1),CFEDTU(1),CFTUIS(1)),(
     3CFEDGW(1),CFEDFM(1),CFEDED(1))
C
C     START INTERSECTION SQUARES ON INTERSECTION SQUARES
C
      READ(20)CFISIS
      DO 4648 LL=1,4
      DO 4647 NN=1,2
      IMP1=3*LL+NN
      DO 4646 MM=1,2
      DO 4645 KK=1,4
      IMP2=3*KK+MM
      DO 4644 M=1,2
      IND2=M-IMP2
      DO 4643 K=1,4
      IND2=IND2+3
      IND3=IABS(IND2)
      IND4=-IMP1
      DO 4642 L=1,4
      IND4=IND4+3
      IND6=11*IABS(IND4+1)
      IND7=11*IABS(IND4+2)
      INX1=IND6+IND3
      INX2=IND7+IND3
      DO 4641 II=1,3
      TEMP13=0.0
      DO 4640 I=1,3
      IF(I.EQ.II)GO TO 4637
      IF(I.EQ.3.OR.II.EQ.3)GO TO 4638
      IND1=243
      GO TO 4639
 4637 IND1=1
      GO TO 4639
 4638 IF(I+II.EQ.4)IND1=364
      IF(I+II.EQ.5)IND1=485
 4639 INDEX1=INX1+IND1
      INDEX2=INX2+IND1
      TEMP13=TEMP13+CFISIS(INDEX1)*GIS(I,K,L,M,1)+CFISIS(INDEX2)*GIS(I,K
     2,L,M,2)
 4640 CONTINUE
      PIS(II,KK,LL,MM,NN)=PIS(II,KK,LL,MM,NN)+TEMP13
 4641 CONTINUE
 4642 CONTINUE
 4643 CONTINUE
 4644 CONTINUE
 4645 CONTINUE
 4646 CONTINUE
 4647 CONTINUE
 4648 CONTINUE
C
C     END INTERSECTION SQUARES ON INTERSECTION SQUARES
C
```

```
C
C       START WIRES ON WIRES
C
        REWIND 20
        READ(10)CFWW
        DO 4516 NN=1,8
        DO 4515 LL=1,4
        IND1=15*LL+NN
        TEMP5=14*LL+NN-0.5
        DO 4514 MM=1,7
        DO 4513 KK=1,4
        IND2=13*KK+MM
        TEMP6=14*KK+MM+0.5
        HOLD1=0.0
        HOLD2=0.0
        HOLD3=0.0
        HOLD4=0.0
        TEMP17=IND2-TEMP5
        DO 4512 N=1,8
        IND3=N-IND1
        TEMP7=N-TEMP6
        DO 4511 L=1,4
        IND3=IND3+15
        IND5=46*IABS(IND3)+1
        TEMP7=TEMP7+14
        TEMP1=ABS(TEMP7)+0.7
        IND7=INT(TEMP1)+4876
        DO 4510 M=1,7
        IND4=M-IND2
        DO 4509 K=1,4
        IND4=IND4+13
        INDEX1=IABS(IND4)+IND5
        TEMP8=IND4+TEMP17+K
        TEMP8=ABS(TEMP8)-0.3
        IND8=49*INT(TEMP8)
        INDEX3=IND7+IND8
        INDEX2=INDEX1+2438
        INDEX4=INDEX3+2401
        TEMP12=CFWW(INDEX1)
        TEMP9=CFWW(INDEX2)
        TEMP13=CFWW(INDEX3)
        TEMP10=CFWW(INDEX4)
        TEMP21=GW(1,1,K,L,M,N)
        TEMP22=GW(1,2,K,L,M,N)
        TEMP23=GW(2,1,K,L,M,N)
        TEMP24=GW(2,2,K,L,M,N)
        HOLD1=HOLD1+TEMP9*TEMP23+TEMP12*TEMP21+TEMP10*TEMP24+TEMP13*TEMP22
        HOLD2=HOLD2+TEMP9*TEMP21+TEMP12*TEMP23+TEMP10*TEMP22+TEMP13*TEMP24
        HOLD3=HOLD3+TEMP9*TEMP24+TEMP12*TEMP22+TEMP10*TEMP23+TEMP13*TEMP21
        HOLD4=HOLD4+TEMP9*TEMP22+TEMP12*TEMP24+TEMP10*TEMP21+TEMP13*TEMP23
 4509   CONTINUE
 4510   CONTINUE
 4511   CONTINUE
 4512   CONTINUE
        PW(1,1,KK,LL,MM,NN)=PW(1,1,KK,LL,MM,NN)+HOLD1
        PW(2,1,KK,LL,MM,NN)=PW(2,1,KK,LL,MM,NN)+HOLD2
        PW(1,2,KK,LL,MM,NN)=PW(1,2,KK,LL,MM,NN)+HOLD3
        PW(2,2,KK,LL,MM,NN)=PW(2,2,KK,LL,MM,NN)+HOLD4
 4513   CONTINUE
 4514   CONTINUE
 4515   CONTINUE
 4516   CONTINUE
C
C       WIRES ON WIRES FINISHED
C
C       START FILM MAIN SQUARE ON WIRES AND VICE VERSA
```

```
C
      REWIND 10
      READ(11)CFMSFW
      DO 4531 NN=1,8
      DO 4530 LL=1,4
      IND6=15*LL+NN
      DO 4529 MM=1,7
      DO 4528 KK=1,4
      TEMP1=14*KK+MM+0.5
      DO 4527 JJ=1,2
      TEMP12=GW(1,JJ,KK,LL,MM,NN)
      TEMP14=GW(2,JJ,KK,LL,MM,NN)
      TEMP13=0.0
      TEMP16=0.0
      IF(JJ.EQ.2)GO TO 4521
      TEMP4=-TEMP1
      DO 4520 K=1,4
      TEMP4=14+TEMP4
      DO 4519 M=1,8
      TEMP2=TEMP4+M
      TEMP2=ABS(TEMP2)+0.7
      IND2=INT(TEMP2)
      IND3=-IND6
      DO 4518 L=1,4
      IND3=IND3+15
      DO 4517 N=1,8
      IND4=IND3+N
      INDEX1=49*IABS(IND4)+IND2
      INDEX2=INDEX1+2597
      TEMP3=CFMSFW(INDEX1)
      TEMP5=CFMSFW(INDEX2)
      TEMP13=TEMP13+GFMS(K,L,M,N)*TEMP3
      TEMP16=TEMP16+GFMS(K,L,M,N)*TEMP5
      PFMS(K,L,M,N)=PFMS(K,L,M,N)+TEMP3*TEMP12+TEMP5*TEMP14
 4517 CONTINUE
 4518 CONTINUE
 4519 CONTINUE
 4520 CONTINUE
      GO TO 4526
 4521 TEMP4=-TEMP1
      DO 4525 L=1,4
      TEMP4=TEMP4+14
      DO 4524 N=1,8
      TEMP2=TEMP4+N
      TEMP2=ABS(TEMP2)+0.7
      IND2=INT(TEMP2)
      IND3=-IND6
      DO 4523 K=1,4
      IND3=IND3+15
      DO 4522 M=1,8
      IND4=IND3+M
      INDEX1=49*IABS(IND4)+IND2
      INDEX2=INDEX1+2597
      TEMP3=CFMSFW(INDEX1)
      TEMP5=CFMSFW(INDEX2)
      TEMP13=TEMP13+GFMS(K,L,M,N)*TEMP3
      TEMP16=TEMP16+GFMS(K,L,M,N)*TEMP5
      PFMS(K,L,M,N)=PFMS(K,L,M,N)+TEMP3*TEMP12+TEMP5*TEMP14
 4522 CONTINUE
 4523 CONTINUE
 4524 CONTINUE
 4525 CONTINUE
 4526 PW(1,JJ,KK,LL,MM,NN)=PW(1,JJ,KK,LL,MM,NN)+TEMP13
      PW(2,JJ,KK,LL,MM,NN)=PW(2,JJ,KK,LL,MM,NN)+TEMP16
 4527 CONTINUE
 4528 CONTINUE
```

```
 4529 CONTINUE
 4530 CONTINUE
 4531 CONTINUE
C
C       END FILM MAIN SQUARES ON WIRES AND VICE VERSA
C
C       START GRID/FILM MAIN T & U ON WIRES AND VICE VERSA
C
C
C       START PLATE EDGES ON WIRES AND VICE VERSA
C
        REWIND 11
        READ(12)CFTUFW
        REWIND 12
        READ(13)CFEDGW
        REWIND 13
        DO 4548 NN=1,8
        DO 4547 LL=1,4
        IND1=15*LL+NN
        TEMP1=16*LL+2*NN-7.5
        DO 4546 MM=1,7
        DO 4545 KK=1,4
        TEMP2=14*KK+2*MM-6.5
        TEMP3=14*KK+MM+0.5
        TEMP13=GW(1,1,KK,LL,MM,NN)
        TEMP14=GW(1,2,KK,LL,MM,NN)
        TEMP18=GW(2,1,KK,LL,MM,NN)
        TEMP19=GW(2,2,KK,LL,MM,NN)
        TEMP12=0.0
        TEMP15=0.0
        TEMP16=0.0
        TEMP17=0.0
        HOD1=0.0
        HOD2=0.0
        HOD3=0.0
        HOD4=0.0
        DO 4544 N=1,8
        IND2=N-IND1
        TEMP4=N-TEMP3
        DO 4543 L=1,4
        IND2=IND2+15
        IND3=49*IABS(IND2)
        TEMP4=TEMP4+14
        TEMP5=ABS(TEMP4)
        IND4=INT(TEMP5+0.7)
        DO 4542 M=1,2
        TEMP6=M-TEMP2
        TEMP7=M-TEMP1
        DO 4541 K=1,4
        TEMP6=TEMP6+14
        TEMP7=TEMP7+16
        TEMP8=ABS(TEMP7)-0.3
        IND8=49*INT(TEMP8)
        TEMP9=ABS(TEMP6)+0.7
        IND9=INT(TEMP9)
        INX1=IND3+IND9
        INX2=IND8+IND4
 7000 INDEX1=INX1
        INDEX2=INX2+10388
        INDEX3=INX1+2597
        INDEX4=INX2+13132
        INDEX5=INX2+5194
        INDEX6=INX2+7938
        TEMP36=CFEDGW(INDEX1)
        TEMP37=CFEDGW(INDEX5)
        TEMP38=CFEDGW(INDEX3)
```

```
        TEMP39=CFEDGW(INDEX6)
        TEMP30=GED(1,1,K,L,M,N)
        TEMP31=GED(1,2,K,L,M,N)
        TEMP32=GED(2,1,K,L,M,N)
        TEMP33=GED(2,2,K,L,M,N)
        HOD1=HOD1+TEMP36*TEMP30+TEMP37*TEMP31+TEMP38*TEMP32+TEMP39*TEMP33
        HOD2=HOD2+TEMP36*TEMP31+TEMP37*TEMP30+TEMP38*TEMP33+TEMP39*TEMP32
        HOD3=HOD3+TEMP36*TEMP32+TEMP37*TEMP33+TEMP38*TEMP30+TEMP39*TEMP31
        HOD4=HOD4+TEMP36*TEMP33+TEMP37*TEMP32+TEMP38*TEMP31+TEMP39*TEMP30
        PED(1,1,K,L,M,N)=PED(1,1,K,L,M,N)+TEMP36*TEMP13+TEMP37*TEMP14+TEMP
     238*TEMP18+TEMP39*TEMP19
        PED(1,2,K,L,M,N)=PED(1,2,K,L,M,N)+TEMP36*TEMP14+TEMP37*TEMP13+TEMP
     338*TEMP19+TEMP39*TEMP18
        PED(2,1,K,L,M,N)=PED(2,1,K,L,M,N)+TEMP36*TEMP18+TEMP37*TEMP19+TEMP
     438*TEMP13+TEMP39*TEMP14
        PED(2,2,K,L,M,N)=PED(2,2,K,L,M,N)+TEMP36*TEMP19+TEMP37*TEMP18+TEMP
     538*TEMP14+TEMP39*TEMP13
        DO 4539 I=1,3
        IF(I.EQ.2)GO TO 7010
        IF(I.EQ.3)GO TO 7020
        GO TO 7030
 7010   INDEX1=INX1+2597
        INDEX2=INX2+13132
        INDEX3=INX1
        INDEX4=INX2+10388
        GO TO 7030
 7020   INDEX1=INX1+5194
        INDEX2=INX2+15876
        INDEX3=INX1+7791
        INDEX4=INX2+18620
 7030   TEMP20=CFTUFW(INDEX3)
        TEMP21=CFTUFW(INDEX4)
        TEMP10=CFTUFW(INDEX1)
        TEMP11=CFTUFW(INDEX2)
        TEMP22=GTU(I,1,K,L,M,N)
        TEMP23=GTU(I,2,K,L,M,N)
        TEMP12=TEMP12+TEMP10*TEMP22+TEMP11*TEMP23
        TEMP15=TEMP15+TEMP10*TEMP23+TEMP11*TEMP22
        TEMP16=TEMP16+TEMP20*TEMP22+TEMP21*TEMP23
        TEMP17=TEMP17+TEMP20*TEMP23+TEMP21*TEMP22
        PTU(I,1,K,L,M,N)=PTU(I,1,K,L,M,N)+TEMP10*TEMP13+TEMP11*TEMP14+TEMP
     220*TEMP18+TEMP21*TEMP19
        PTU(I,2,K,L,M,N)=PTU(I,2,K,L,M,N)+TEMP11*TEMP13+TEMP10*TEMP14+TEMP
     321*TEMP18+TEMP20*TEMP19
 4539 CONTINUE
 4541 CONTINUE
 4542 CONTINUE
 4543 CONTINUE
 4544 CONTINUE
        PW(1,1,KK,LL,MM,NN)=PW(1,1,KK,LL,MM,NN)+TEMP12+HOD1
        PW(1,2,KK,LL,MM,NN)=PW(1,2,KK,LL,MM,NN)+TEMP15+HOD2
        PW(2,1,KK,LL,MM,NN)=PW(2,1,KK,LL,MM,NN)+TEMP16+HOD3
        PW(2,2,KK,LL,MM,NN)=PW(2,2,KK,LL,MM,NN)+TEMP17+HOD4
 4545 CONTINUE
 4546 CONTINUE
 4547 CONTINUE
 4548 CONTINUE
C
C       END GRID/FILM T & U ON WIRES AND VICE VERSA
C
C       END PLATE EDGES ON WIRES AND VICE VERSA
C
C       START PLATE/FILM INTERSECTION ON WIRES AND VICEVERSA
C
        READ(14)CFPFIW
        DO 4575 NN=1,8
```

```
              DO 4574 LL=1,4
              TEMP1=16*LL+2*NN-7.5
              DO 4573 MM=1,7
              DO 4572 KK=1,4
              TEMP2=14*KK+2*MM-6.5
              TEMP11=GW(1,1,KK,LL,MM,NN)
              TEMP12=GW(1,2,KK,LL,MM,NN)
              TEMP13=GW(2,1,KK,LL,MM,NN)
              TEMP14=GW(2,2,KK,LL,MM,NN)
              TEMP15=0.0
              TEMP16=0.0
              TEMP17=0.0
              TEMP18=0.0
              DO 4571 M=1,2
              TEMP3=M-TEMP2
              DO 4570 K=1,4
              TEMP3=TEMP3+14
              TEMP4=ABS(TEMP3)+0.7
              IND4=INT(TEMP4)
              DO 4569 N=1,2
              TEMP5=N-TEMP1
              DO 4568 L=1,4
              TEMP5=TEMP5+16
              TEMP6=ABS(TEMP5)-0.3
              IND6=49*INT(TEMP6)
              INX=IND4+IND6
              DO 4567 I=1,3
              IF(I.EQ.1)GO TO 4566
              IF(I.EQ.2)GO TO 4576
              IF(I.EQ.3)GO TO 4577
  4566        INDEX1=INX
              INDEX2=INX+2744
              GO TO 7040
  4576        INDEX1=INX+2744
              INDEX2=INX
              GO TO 7040
  4577        INDEX1=INX+5488
              INDEX2=INX+8232
  7040        TEMP7=CFPFIW(INDEX1)
              TEMP8=CFPFIW(INDEX2)
              TEMP15=TEMP15+GIS(I,K,L,M,N)*TEMP7
              TEMP16=TEMP16+GIS(I,L,K,N,M)*TEMP7
              TEMP17=TEMP17+GIS(I,K,L,M,N)*TEMP8
              TEMP18=TEMP18+GIS(I,L,K,N,M)*TEMP8
              PIS(I,K,L,M,N)=PIS(I,K,L,M,N)+TEMP7*TEMP11+TEMP8*TEMP13
              PIS(I,L,K,N,M)=PIS(I,L,K,N,M)+TEMP7*TEMP12+TEMP8*TEMP14
  4567 CONTINUE
  4568 CONTINUE
  4569 CONTINUE
  4570 CONTINUE
  4571 CONTINUE
              PW(1,1,KK,LL,MM,NN)=PW(1,1,KK,LL,MM,NN)+TEMP15
              PW(1,2,KK,LL,MM,NN)=PW(1,2,KK,LL,MM,NN)+TEMP16
              PW(2,1,KK,LL,MM,NN)=PW(2,1,KK,LL,MM,NN)+TEMP17
              PW(2,2,KK,LL,MM,NN)=PW(2,2,KK,LL,MM,NN)+TEMP18
  4572 CONTINUE
  4573 CONTINUE
  4574 CONTINUE
  4575 CONTINUE
C
C     END PLATE/FILM INTERSECTION ON WIRES AND VICE VERSA
C
C     START FILM MAIN SQUARE ON FILM MAIN SQUARE
C
              REWIND 14
              READ(15)CFFNFM
```

```
            DO 4585 KK=1,4
            DO 4584 MM=1,8
            IND1=15*KK+MM
            DO 4583 LL=1,4
            DO 4582 NN=1,8
            IND2=15*LL+NN
            TEMP13=0.0
            DO 4581 M=1,8
            IND3=M-IND1
            DO 4580 K=1,4
            IND3=IND3+15
            IND4=IABS(IND3)+1
            DO 4579 N=1,8
            IND5=N-IND2
            DO 4578 L=1,4
            IND5=IND5+15
            INDEX=53*IABS(IND5)+IND4
            TEMP1=CFFMFM(INDEX)*GFMS(K,L,M,N)
            TEMP13=TEMP13+TEMP1
 4578 CONTINUE
 4579 CONTINUE
 4580 CONTINUE
 4581 CONTINUE
            PFMS(KK,LL,MM,NN)=PFMS(KK,LL,MM,NN)+TEMP13
 4582 CONTINUE
 4583 CONTINUE
 4584 CONTINUE
 4585 CONTINUE
C
C
C       END FILM MAIN SQUARE ON FILM MAIN SQUARE
C
C       START GRID/FILM MAIN T & U ON FILM MAIN SQUARE AND VICE VERSA
C
C
C       START GRID EDGES ON FILM MAIN SQUARE ELEMENTS AND VICE VERSA
C
            REWIND 15
            READ(16)CFTUFM
            REWIND 16
            READ(17)CFEDFM
            REWIND 17
            DO 4596 KK=1,4
            DO 4595 MM=1,8
            TEMP1=16*KK+2*MM-7.5
            DO 4594 LL=1,4
            DO 4593 NN=1,8
            IND1=15*LL+NN
            TEMP12=0.0
            TEMP13=GFMS(KK,LL,MM,NN)
            TEMP14=0.0
            TEMP15=GFMS(LL,KK,NN,MM)
            DO 4592 N=1,8
            IND2=N-IND1
            DO 4591 L=1,4
            IND2=IND2+15
            IND3=54*IABS(IND2)
            DO 4590 M=1,2
            TEMP2=M-TEMP1
            DO 4589 K=1,4
            TEMP2=TEMP2+16
            TEMP3=ABS(TEMP2)+0.7
            IND4=INT(TEMP3)
            INX=IND3+IND4
            INDEX1=INX
            INDEX2=INX+2968
            INDEX3=INX+5936
```

```
             TEMP4=CFTUFM(INDEX2)
             TEMP6=CFEDFM(INDEX1)
             TEMP7=CFEDFM(INDEX2)
             TEMP12=TEMP12+TEMP6*GED(1,1,K,L,M,N)+TEMP7*GED(2,1,K,L,M,N)
             TEMP14=TEMP14+TEMP6*GED(1,2,K,L,M,N)+TEMP7*GED(2,2,K,L,M,N)
             PED(1,1,K,L,M,N)=PED(1,1,K,L,M,N)+TEMP6*TEMP13
             PED(2,1,K,L,M,N)=PED(2,1,K,L,M,N)+TEMP7*TEMP13
             PED(1,2,K,L,M,N)=PED(1,2,K,L,M,N)+TEMP6*TEMP15
             PED(2,2,K,L,M,N)=PED(2,2,K,L,M,N)+TEMP7*TEMP15
             DO 4588 I=1,3
             IF(I.EQ.2)TEMP4=CFTUFM(INDEX3)
             IF(I.EQ.3)TEMP4=CFTUFM(INDEX1)
             TEMP16=GTU(I,1,K,L,M,N)
             TEMP17=GTU(I,2,K,L,M,N)
             TEMP12=TEMP12+TEMP4*TEMP16
             TEMP14=TEMP14+TEMP4*TEMP17
             PTU(I,1,K,L,M,N)=PTU(I,1,K,L,M,N)+TEMP4*TEMP13
             PTU(I,2,K,L,M,N)=PTU(I,2,K,L,M,N)+TEMP4*TEMP15
        4588 CONTINUE
        4589 CONTINUE
        4590 CONTINUE
        4591 CONTINUE
        4592 CONTINUE
             PFMS(KK,LL,MM,NN)=PFMS(KK,LL,MM,NN)+TEMP12
             PFMS(LL,KK,NN,MM)=PFMS(LL,KK,NN,MM)+TEMP14
        4593 CONTINUE
        4594 CONTINUE
        4595 CONTINUE
        4596 CONTINUE
      C
      C     END GRID/FILM MAIN T & U ON FILM MAIN SQUARE AND VICE VERSA
      C
      C     END GRID EDGES ON FILM MAIN SQUARE ELEMENTS AND VICE VERSA
      C
      C     START INTERSECTION SQUARES ON FILM MAIN SQUARE ELEMENTS AND VICE VERSA
      C
             READ(18)CFISFM
             DO 4616 KK=1,4
             TEMP1=16*KK-7.5
             DO 4615 MM=1,8
             TEMP1=TEMP1+2
             DO 4614 LL=1,4
             TEMP2=16*LL-7.5
             DO 4613 NN=1,8
             TEMP2=TEMP2+2
             TEMP13=0.0
             TEMP12=GFMS(KK,LL,MM,NN)
             DO 4612 M=1,2
             TEMP3=M-TEMP1
             DO 4611 K=1,4
             TEMP3=TEMP3+16
             TEMP4=ABS(TEMP3)+0.7
             IND4=INT(TEMP4)
             DO 4610 N=1,2
             TEMP5=N-TEMP2
             DO 4609 L=1,4
             TEMP5=TEMP5+16
             TEMP6=ABS(TEMP5)-0.3
             IND6=56*INT(TEMP6)
             INDEX1=IND4+IND6
             INDEX2=INDEX1+3136
             INDEX3=INDEX1+6272
             TEMP31=CFISFM(INDEX1)
             TEMP32=CFISFM(INDEX2)
             TEMP33=CFISFM(INDEX3)
             TEMP13=TEMP13+TEMP31*GIS(3,K,L,M,N)+TEMP32*(GIS(1,K,L,M,N))+TEMP33
```

```
      3*GIS(2,K,L,M,N)
       PIS(1,K,L,M,N)=PIS(1,K,L,M,N)+TEMP32*TEMP12
       PIS(2,K,L,M,N)=PIS(2,K,L,M,N)+TEMP33*TEMP12
       PIS(3,K,L,M,N)=PIS(3,K,L,M,N)+TEMP31*TEMP12
 4609 CONTINUE
 4610 CONTINUE
 4611 CONTINUE
 4612 CONTINUE
       PFMS(KK,LL,MM,NN)=PFMS(KK,LL,MM,NN)+TEMP13
 4613 CONTINUE
 4614 CONTINUE
 4615 CONTINUE
 4616 CONTINUE
C
C
C     END INTERSECTION SQUARES ON FILM MAIN SQUARES AND VICE VERSA
C
C     START PLATE/FILM T & U ON PLATE/FILM T & U
C
C
C
C     START GRID EDGES ON GRID EDGES
C
       REWIND 18
       READ(19)CFTUTU
       REWIND 19
       READ(21)CFEDED
       REWIND 21
       DO 4636 MM=1,2
       TEMP1=-(MM+7.5)
       DO 4635 KK=1,4
       TEMP1=TEMP1+16
       IND1=3*KK+MM
       DO 4634 NN=1,8
       TEMP2=2*NN-7.5
       DO 4633 LL=1,4
       TEMP2=TEMP2+16
       IND2=15*LL+NN
       TEMP13=0.0
       TEMP23=0.0
       TEMP33=0.0
       TEMP43=0.0
       DO 4632 M=1,2
       TEMP3=M-TEMP2
       IND3=M-IND1
       DO 4631 K=1,4
       TEMP3=TEMP3+16
       TEMP4=ABS(TEMP3)-0.3
       IND10=56*INT(TEMP4)+2915
       IND3=IND3+2
       IND4=IABS(IND3)+1
       DO 4630 N=1,8
       TEMP5=-(TEMP1+2*N)
       IND5=N-IND2
       DO 4629 L=1,4
       TEMP5=TEMP5+16
       TEMP6=ABS(TEMP5)+0.7
       IND6=INT(TEMP6)
       IND5=IND5+15
       IND7=11*IABS(IND5)
       IND8=IND4+IND7
       IND9=IND6+IND10
       INDEX1=IND8
       INDEX2=IND9+1166
       INDEX3=INDEX1+583
       INDEX4=INDEX2+3136
       TEMP7=GED(1,1,K,L,M,N)
       TEMP8=GED(1,2,K,L,M,N)
```

```
      TEMP9=GED(2,1,K,L,M,N)
      TEMP10=GED(2,2,K,L,M,N)
      TEX1=CFEDED(INDEX1)
      TEX2=CFEDED(INDEX2)
      TEX3=CFEDED(INDEX3)
      TEX4=CFEDED(INDEX4)
      TEMP13=TEMP13+TEX1*TEMP7+TEX2*TEMP8+TEX3*TEMP9+TEX4*TEMP10
      TEMP23=TEMP23+TEX1*TEMP8+TEX2*TEMP7+TEX3*TEMP10+TEX4*TEMP9
      TEMP33=TEMP33+TEX1*TEMP9+TEX2*TEMP10+TEX3*TEMP7+TEX4*TEMP8
      TEMP43=TEMP43+TEX1*TEMP10+TEX2*TEMP9+TEX3*TEMP8+TEX4*TEMP7
      DO 4628 II=1,3
      TEMP53=0.0
      TEMP14=0.0
      DO 4627 I=1,3
      IF(I.EQ.II)GO TO 4617
      IF(I.EQ.3.OR.II.EQ.3)GO TO 4618
      III=2
      GO TO 4619
 4617 III=0
      GO TO 4619
 4618 IF(I+II.EQ.4)III=3
      IF(I+II.EQ.5)III=4
 4619 INDEX1=IND8+583*III
      INDEX2=IND9+3136*III
      TEMP53=TEMP53+CFTUTU(INDEX1)*GTU(I,1,K,L,M,N)+CFTUTU(INDEX2)*GTU(I
     2,2,K,L,M,N)
      TEMP14=TEMP14+CFTUTU(INDEX2)*GTU(I,1,K,L,M,N)+CFTUTU(INDEX1)*GTU(I
     3,2,K,L,M,N)
 4627 CONTINUE
      PTU(II,1,KK,LL,MM,NN)=PTU(II,1,KK,LL,MM,NN)+TEMP53
      PTU(II,2,KK,LL,MM,NN)=PTU(II,2,KK,LL,MM,NN)+TEMP14
 4628 CONTINUE
 4629 CONTINUE
 4630 CONTINUE
 4631 CONTINUE
 4632 CONTINUE
      PED(1,1,KK,LL,MM,NN)=PED(1,1,KK,LL,MM,NN)+TEMP13
      PED(1,2,KK,LL,MM,NN)=PED(1,2,KK,LL,MM,NN)+TEMP23
      PED(2,1,KK,LL,MM,NN)=PED(2,1,KK,LL,MM,NN)+TEMP33
      PED(2,2,KK,LL,MM,NN)=PED(2,2,KK,LL,MM,NN)+TEMP43
 4633 CONTINUE
 4634 CONTINUE
 4635 CONTINUE
 4636 CONTINUE
C
C     END PLATE/FILM T & U ON PLATE/FILM T & U
C
C     END GRID EDGES ON GRID EDGES
C
C     START EDGES ON INTERSECTION SQUARES AND VICE VERSA
C
      READ(22)CFEDIS
      DO 4684 LL=1,4
      DO 4683 NN=1,2
      TEMP1=NN-16*LL+7.5
      TEMP2=1.5-4*LL-2*NN
      DO 4682 KK=1,4
      DO 4681 MM=1,2
      TEMP3=1.5-4*KK-2*MM
      TEMP4=MM-16*KK+7.5
      TEMP12=GIS(1,KK,LL,MM,NN)
      TEMP34=GIS(2,KK,LL,MM,NN)
      TEMP5=GIS(3,KK,LL,MM,NN)
      TPIS12=0.0
      TPIS34=0.0
      TPIS5=0.0
```

```
        TEMP6=TEMP1
        DO 4680 N=1,8
        TEMP6=TEMP6-2
        TEMP4=TEMP4-2
        TEMP7=TEMP2
        TEMP8=TEMP3
        DO 4679 K=1,4
        TEMP7=TEMP7+4
        TEMP8=TEMP8+4
        DO 4678 L=1,4
        TEMP9=TEMP6+16*L
        TEMP10=TEMP4+16*L
        TEMP9=ABS(TEMP9)-0.3
        IND1=14*INT(TEMP9)
        TEMP10=ABS(TEMP10)-0.3
        IND2=14*INT(TEMP10)
        DO 4677 M=1,2
        TEMP11=TEMP7+M
        TEMP14=TEMP8+M
        TEMP11=ABS(TEMP11)+0.7
        IND3=INT(TEMP11)
        TEMP14=ABS(TEMP14)+0.7
        IND4=INT(TEMP14)
        INDEX1=IND1+IND4
        INDEX2=INDEX1+784
        INDEX3=IND2+IND3
        INDEX4=INDEX3+784
        INDEX5=INDEX1+1568
        INDEX6=INDEX1+2352
        INDEX7=INDEX3+1568
        INDEX8=INDEX3+2352
        TEX1=CFEDIS(INDEX1)
        TEX2=CFEDIS(INDEX2)
        TEX3=CFEDIS(INDEX3)
        TEX4=CFEDIS(INDEX4)
        TEX5=CFEDIS(INDEX5)
        TEX6=CFEDIS(INDEX6)
        TEX7=CFEDIS(INDEX7)
        TEX8=CFEDIS(INDEX8)
        TGED1=GED(1,1,K,L,M,N)
        TGED2=GED(2,1,K,L,M,N)
        TGED3=GED(1,2,K,L,M,N)
        TGED4=GED(2,2,K,L,M,N)
        TPIS12=TPIS12+TEX1*TGED1+TEX2*TGED2+TEX3*TGED3+TEX4*TGED4
        TPIS34=TPIS34+TEX2*TGED1+TEX1*TGED2+TEX4*TGED3+TEX3*TGED4
        TPIS5=TPIS5+TEX5*TGED1+TEX6*TGED2+TEX7*TGED3+TEX8*TGED4
        PED(1,1,K,L,M,N)=PED(1,1,K,L,M,N)+TEX1*TEMP12+TEX2*TEMP34+TEX5*TEM
       2P5
        PED(2,1,K,L,M,N)=PED(2,1,K,L,M,N)+TEX2*TEMP12+TEX1*TEMP34+TEX6*TEM
       3P5
        PED(1,2,K,L,M,N)=PED(1,2,K,L,M,N)+TEX3*TEMP12+TEX4*TEMP34+TEX7*TEM
       4P5
        PED(2,2,K,L,M,N)=PED(2,2,K,L,M,N)+TEX4*TEMP12+TEX3*TEMP34+TEX8*TEM
       5P5
 4677 CONTINUE
 4678 CONTINUE
 4679 CONTINUE
 4680 CONTINUE
        PIS(1,KK,LL,MM,NN)=PIS(1,KK,LL,MM,NN)+TPIS12
        PIS(2,KK,LL,MM,NN)=PIS(2,KK,LL,MM,NN)+TPIS34
        PIS(3,KK,LL,MM,NN)=PIS(3,KK,LL,MM,NN)+TPIS5
 4681 CONTINUE
 4682 CONTINUE
 4683 CONTINUE
 4684 CONTINUE
C
```

```
C        END EDGES ON INTERSECTION SQUARES AND VICE VERSA
C
C        START EDGES ON MAIN GRID/FILM T & U AND VICE VERSA
C
         REWIND 22
         READ(23)CFEDTU
         DO 4703 LL=1,4
         TEMP1=7.5-16*LL
         DO 4702 NN=1,8
         IND1=-(15*LL+NN)
         TEMP2=TEMP1-2*NN
         DO 4701 MM=1,2
         TEMP3=MM+7.5
         TEMP4=1.5-2*MM
         DO 4700 KK=1,4
         TEMP3=TEMP3-16
         TEMP4=TEMP4-4
         DO 4699 N=1,8
         IND2=IND1+N
         TEMP5=TEMP3-2*N
         DO 4698 L=1,4
         IND2=IND2+15
         TEMP5=TEMP5+16
         IND3=14*IABS(IND2)
         TEMP6=ABS(TEMP5)+0.7
         IND6=INT(TEMP6)+2968
         DO 4697 M=1,2
         TEMP7=TEMP2+M
         TEMP8=TEMP4+M
         DO 4696 K=1,4
         TEMP7=TEMP7+16
         TEMP8=TEMP8+4
         TEMP9=ABS(TEMP7)-0.3
         IND9=56*INT(TEMP9)
         TEMP10=ABS(TEMP8)+0.7
         IND10=INT(TEMP10)
         INDEX1=IND3+IND10
         INDEX2=INDEX1+742
         INDEX3=INDEX1+1484
         INDEX4=INDEX1+2226
         INDEX5=IND6+IND9
         INDEX6=INDEX5+3136
         INDEX7=INDEX5+6272
         INDEX8=INDEX5+9408
         TEX1=CFEDTU(INDEX1)
         TEX2=CFEDTU(INDEX2)
         TEX3=CFEDTU(INDEX3)
         TEX4=CFEDTU(INDEX4)
         TEX5=CFEDTU(INDEX5)
         TEX6=CFEDTU(INDEX6)
         TEX7=CFEDTU(INDEX7)
         TEX8=CFEDTU(INDEX8)
         DO 4695 II=1,3
         TEMP12=GTU(II,1,KK,LL,MM,NN)
         TEMP13=0.0
         TEMP14=GTU(II,2,KK,LL,MM,NN)
         TEMP15=0.0
         DO 4694 I=1,2
         IF(I.EQ.2)GO TO 4689
         IF(II.EQ.2)GO TO 4685
         IF(II.EQ.3)GO TO 4686
         TEMP13=TEMP13+TEX1*GED(I,1,K,L,M,N)+TEX5*GED(I,2,K,L,M,N)
         TEMP15=TEMP15+TEX5*GED(I,1,K,L,M,N)+TEX1*GED(I,2,K,L,M,N)
         PED(I,1,K,L,M,N)=PED(I,1,K,L,M,N)+TEX1*TEMP12+TEX5*TEMP14
         PED(I,2,K,L,M,N)=PED(I,2,K,L,M,N)+TEX5*TEMP12+TEX1*TEMP14
         GO TO 4694
```

```
4685 TEMP13=TEMP13+TEX2*GED(I,1,K,L,M,N)+TEX6*GED(I,2,K,L,M,N)
     TEMP15=TEMP15+TEX6*GED(I,1,K,L,M,N)+TEX2*GED(I,2,K,L,M,N)
     PED(I,1,K,L,M,N)=PED(I,1,K,L,M,N)+TEX2*TEMP12+TEX6*TEMP14
     PED(I,2,K,L,M,N)=PED(I,2,K,L,M,N)+TEX6*TEMP12+TEX2*TEMP14
     GO TO 4694
4686 TEMP13=TEMP13+TEX3*GED(I,1,K,L,M,N)+TEX7*GED(I,2,K,L,M,N)
     TEMP15=TEMP15+TEX7*GED(I,1,K,L,M,N)+TEX3*GED(I,2,K,L,M,N)
     PED(I,1,K,L,M,N)=PED(I,1,K,L,M,N)+TEX3*TEMP12+TEX7*TEMP14
     PED(I,2,K,L,M,N)=PED(I,2,K,L,M,N)+TEX7*TEMP12+TEX3*TEMP14
     GO TO 4694
4689 IF(II.EQ.1)GO TO 4690
     IF(II.EQ.3)GO TO 4691
     TEMP13=TEMP13+TEX1*GED(I,1,K,L,M,N)+TEX5*GED(I,2,K,L,M,N)
     TEMP15=TEMP15+TEX5*GED(I,1,K,L,M,N)+TEX1*GED(I,2,K,L,M,N)
     PED(I,1,K,L,M,N)=PED(J,1,K,L,M,N)+TEX1*TEMP12+TEX5*TEMP14
     PED(I,2,K,L,M,N)=PED(I,2,K,L,M,N)+TEX5*TEMP12+TEX1*TEMP14
     GO TO 4694
4690 TEMP13=TEMP13+TEX2*GED(I,1,K,L,M,N)+TEX6*GED(I,2,K,L,M,N)
     TEMP15=TEMP15+TEX6*GED(I,1,K,L,M,N)+TEX2*GED(I,2,K,L,M,N)
     PED(I,1,K,L,M,N)=PED(I,1,K,L,M,N)+TEX2*TEMP12+TEX6*TEMP14
     PED(I,2,K,L,M,N)=PED(I,2,K,L,M,N)+TEX6*TEMP12+TEX2*TEMP14
     GO TO 4694
4691 TEMP13=TEMP13+TEX4*GED(I,1,K,L,M,N)+TEX8*GED(I,2,K,L,M,N)
     TEMP15=TEMP15+TEX8*GED(I,1,K,L,M,N)+TEX4*GED(I,2,K,L,M,N)
     PED(I,1,K,L,M,N)=PED(I,1,K,L,M,N)+TEX4*TEMP12+TEX8*TEMP14
     PED(I,2,K,L,M,N)=PED(I,2,K,L,M,N)+TEX8*TEMP12+TEX4*TEMP14
4694 CONTINUE
     PTU(II,1,KK,LL,MM,NN)=PTU(II,1,KK,LL,MM,NN)+TEMP13
     PTU(II,2,KK,LL,MM,NN)=PTU(II,2,KK,LL,MM,NN)+TEMP15
4695 CONTINUE
4696 CONTINUE
4697 CONTINUE
4698 CONTINUE
4699 CONTINUE
4700 CONTINUE
4701 CONTINUE
4702 CONTINUE
4703 CONTINUE
C
C
C     END EDGES ON MAIN GRID/FILM T & U AND VICE VERSA
C
C     START MAIN GRID/FILM T & 1 ON INTERSECTION SQUARES AND VICE VERSA
C
     REWIND 23
     READ(24)CFTUIS
     DO 4721 LL=1,4
     TEMP1=7.5-16*LL
     DO 4720 NN=1,2
     TEMP2=TEMP1+NN
     IND1=-(3*LL+NN)
     DO 4719 KK=1,4
     TEMP3=7.5-16*KK
     DO 4718 MM=1,2
     TEMP4=MM+TEMP3
     IND2=-(3*KK+MM)
     DO 4717 N=1,8
     TEMP5=TEMP2-2*N
     TEMP6=TEMP4-2*N
     DO 4716 L=1,4
     TEMP5=TEMP5+16
     TEMP6=TEMP6+16
     TEMP7=ABS(TEMP5)-0.3
     IND7=11*INT(TEMP7)+1
     TEMP8=ABS(TEMP6)-0.3
     IND8=11*INT(TEMP8)+1
     DO 4715 M=1,2
```

```
        IND3=IND1+M
        IND4=IND2+M
        DO 4714 K=1,4
        IND3=IND3+3
        IND4=IND4+3
        IND5=IABS(IND3)
        IND6=IABS(IND4)
        IND9=IND6+IND7
        IND10=IND5+IND8
        DO 4713 II=1,3
        TEMP12=GIS(II,KK,LL,MM,NN)
        TEMP13=0.0
        DO 4712 I=1,3
        IF(I.EQ.3.OR.II.EQ.3)GO TO 4704
        IND11=616
        IF(I.EQ.II)IND11=0
        GO TO 4705
4704    IND11=1848
        IF(I.EQ.II)IND11=0
        IF(I+II.EQ.4)IND11=1232
4705    INDEX1=IND9+IND11
        INDEX2=IND10+IND11
        TEX1=CFTUIS(INDEX1)
        TEX2=CFTUIS(INDEX2)
        TEMP13=TEMP13+TEX1*GTU(I,1,K,L,M,N)+TEX2*GTU(I,2,K,L,M,N)
        PTU(I,1,K,L,M,N)=PTU(I,1,K,L,M,N)+TEX1*TEMP12
        PTU(I,2,K,L,M,N)=PTU(I,2,K,L,M,N)+TEX2*TEMP12
4712    CONTINUE
        PIS(II,KK,LL,MM,NN)=PIS(II,KK,LL,MM,NN)+TEMP13
4713    CONTINUE
4714    CONTINUE
4715    CONTINUE
4716    CONTINUE
4717    CONTINUE
4718    CONTINUE
4719    CONTINUE
4720    CONTINUE
4721    CONTINUE
C
C       END MAIN GRID/FILM T & U ON INTERSECTION SQUARES AND VICE VERSA
C
        REWIND 24
        RETURN
        END
```

```
      SUBROUTINE PLEINF(X, Y, Z, A, B, POTL)
      TEMP2=X*X+Y*Y+Z*Z
      IF(TEMP2.GT.0.16E-3)GO TO 6002
      IMAX=10
      JMAX=10
      SUM=0
      IF(A.LT.0.1E-2)IMAX=1
      IF(B.LT.0.1E-2)JMAX=1
      TEMP1=Y+0.55*B
      TEMP3=X+0.55*A
      TEMP5=TEMP3-0.1*A*I
      DO 6001 I=1,IMAX
      DO 6000 J=1,JMAX
      TEMP6=TEMP1-0.1*B*J
      TEMP7=TEMP6*TEMP6+TEMP5*TEMP5+Z*Z
      R=SQRT(TEMP7)
      SUM=SUM+1/R
6000  CONTINUE
6001  CONTINUE
      POTL=(SUM*0.89877E10)/(IMAX*JMAX)
      GO TO 6003
6002  TEMP2=SQRT(TEMP2)
      POTL=0.89877E10/TEMP2
6003  RETURN
      END
```

```
FC    P5072SIC
C
C
C
C     PROGRAM TO CALCULATE LEAM EXPERIMENT SENSOR INFLUENCE COEFFICIENTS
C
C
C

      DIMENSION CFWW(9678),CFMSFW(5194),CFTUFW(21364),CFEDGW(10682)
      DIMENSION CFPFIW(10976),CFFMFM(2809),CFTUFM(8904),CFEDFM(5936)
      DIMENSION CFISFM(9408),CFTUTU(18595),CFISIS(605),CFEDED(7438)
      DIMENSION CFEDIS(3136),CFEDTU(15512),CFTUIS(2464)
      EQUIVALENCE (CFWW(1),CFMSFW(1),CFTUFW(1),CFEDGW(1),CFPFIW(1),CFFMF
     2M(1),CFTUFM(1),CFEDFM(1),CFISFM(1),CFTUTU(1),CFISIS(1),CFEDED(1),C
     3FEDIS(1),CFEDTU(1),CFTUIS(1))
      DO 2005 K=1,4
         T1=0.0
         IF(K.NE.1)T1=1
         TEMP1=0.02921*K-0.051435
         IND1=13*K-3515
         MM1N=1
         IF(K.EQ.1)MM1N=7
         DO 2004 M=MM1N,13
            T2=T1
            IF(M.NE.7)T2=1
            X=TEMP1+0.003175*M
            IND2=IND1+M
            DO 2003 L=1,4
               T3=T2
               IF(L.NE.1)T3=1
               TEMP2=0.02921*L-0.05461
               IND3=690*L+IND2
               NM1N=1
               IF(L.EQ.1)NM1N=8
               DO 2002 N=NM1N,15
                  T4=T3
                  IF(N.NE.8)T4=1
                  Y=TEMP2+0.003175*N
                  IND4=IND3+46*N
                  DO 2001 I=1,2
                     Z=0.0029464*(I-1)
                     INDEX=IND4+2438*I
                     IF(T4+I.LT.1.5)GO TO 2000
                     CALL INFLCF(X,Y,Z,0.0,0.003175,0.003175,0.0,COEFF)
                     CFWW(INDEX)=COEFF
                     GO TO 2001
2000                 CFWW(INDEX)=0.0
2001              CONTINUE
2002           CONTINUE
2003        CONTINUE
2004     CONTINUE
2005  CONTINUE
C
C     WIRE ON WIRE WITH J=JJ COMPLETED.  NUMBER OF COEFFS = 4876
C
C     START NEXT ON WIRE ON WIRE WITH J NOT EQUAL TO JJ
C
      DO 2010 L=1,4
         TEMP1=0.02921*L-0.0530225
         IND1=1376+14*L
         NM1N=1
         IF(L.EQ.1)NM1N=8
         DO 2009 N=NM1N,14
            X=TEMP1+0.003175*N
            IND2=IND1+N
            DO 2008 K=1,4
               TEMP2=0.02921*K-0.0530225
               IND3=686*K+IND2
               MM1N=1
```

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```
            IF(K. EQ. 1)MM1N=8
            DO 2007 M=MM1N, 14
              Y=TEMP2+0. 003175*M
              IND4=IND3+49*M
              DO 2006 I=1, 2
                Z=0. 0029464*(I-1)
                INDEX=IND4+2401*I
                CALL INFLCF(X, Y, Z, 0. 0, 0. 003175, 0. 0, 0. 003175, COEFF)
                CFWW(INDEX)=COEFF
 2006         CONTINUE
 2007       CONTINUE
 2008     CONTINUE
 2009   CONTINUE
 2010 CONTINUE
      WRITE(6, 3100)
      WRITE(6, 3000)(CFWW(I), I=3, 9678, 129)
      WRITE(12) CFWW
      END FILE 12
C
C
C     ALL WIRE ON WIRE INFLUENCE COEFFS, CFWW(   ), COMPLETED. TOTAL NUMBER = 9678
C
C     START NEXT ON FILM MAIN SQUARE ON WIRE CFMCSW(   ), GRID 1, FIRST, GRID 2.
C
      DO 2015 K=1, 4
        TEMP1=0. 02921*K-0. 0530225
        IND1=14*K-3745
        MM1N=1
        IF(K. EQ. 1)MM1N=8
        DO 2014 M=MM1N, 14
          X=TEMP1+0. 003175*M
          IND2=IND1+M
          DO 2013 L=1, 4
            TEMP2=0. 02921*L-0. 05461
            IND3=IND2+735*L
            NM1N=1
            IF(L. EQ. 1)NM1N=8
            DO 2012 N=NM1N, 15
              Y=TEMP2+0. 003175*N
              IND4=IND3+49*N
              DO 2011 I=1, 2
                Z=0. 0126492-0. 0029464*I
                INDEX=IND4+2597*I
                CALL INFLCF(X, Y, Z, 0. 0, 0. 003175, 0. 003175, 0. 003175, COEFF)
                CFMSFW(INDEX)=COEFF
 2011         CONTINUE
 2012       CONTINUE
 2013     CONTINUE
 2014   CONTINUE
 2015 CONTINUE
      WRITE(6, 3100)
      WRITE(6, 3000)(CFMSFW(I), I=2, 5194, 59)
      WRITE(12) CFMSFW
      END FILE 12
C
C
C     ALL MAIN SQUARE FILM ON WIRES COMPLETED. TOTAL NUMBER = 5194
C
C     START NEXT ON GRID SUPPORT STRUCTURE, TOP AND UNDERSIDES AND EQUIVALENT
C     FILM ELEMENTS, ON WIRES CFTUFW(   ). CASE J=JJ FIRST
C
      DO 2021 K=1, 4
        TEMP1=0. 02921*K-0. 0574675
        TEMP2=14*K-7. 5
        DO 2020 MM=1, 7
          TEMP3=TEMP1-0. 003175*MM
          TEMP4=TEMP2-2*MM
          MMAX=2
```

```
            IF(K.EQ.1)MMAX=1
            DO 2019 M=1,MMAX
               X=TEMP3+0.027305*M
               TEMP5=TEMP4+M
               TEMP5=ABS(TEMP5)+0.7
               IND1=INT(TEMP5)-3724
               DO 2018 L=1,4
                  TEMP5=0.02921*L-0.05461
                  IND2=IND1+735*L
                  NMIN=1
                  IF(L.EQ.1)NMIN=8
                  DO 2017 N=NMIN,15
                     Y=TEMP5+0.003175*N
                     IND3=IND2+49*N
                     DO 2016 I=1,4
                        Z=0.0
                        IF(I.EQ.2)Z=0.0029464
                        IF(I.EQ.3)Z=0.0097028
                        IF(I.EQ.4)Z=0.0067564
                        INDEX=IND3+2597*I
                        CALL INFLCF(X,Y,Z,0.0,0.003175,0.003175,0.001905,COEFF)
                        CFTUFW(INDEX)=COEFF
2016                 CONTINUE
2017              CONTINUE
2018           CONTINUE
2019        CONTINUE
2020     CONTINUE
2021  CONTINUE
C
C     GRID SUPPORT STRUCTURE, TOP AND UNDERSIDES, AND EQUIVALENT FILM ELEMENTS ON
C     WIRES WITH J=JJ,COMPLETED. CFTUFW( ). TOTAL NUMBER =10388
C
C     START NEXT ON CFTUFW( )FOR J NOT EQUAL TO JJ
C
      DO 2027 L=1,4
         TEMP1=0.02921*L-0.0530225
         IND1=14*L+7598
         NMIN=1
         IF(L.EQ.1)NMIN=8
         DO 2026 N=NMIN,14
            X=TEMP1+0.003175*N
            IND2=IND1+N
            DO 2025 K=1,4
               TEMP2=0.02921*K-0.05588
               TEMP3=16*K-8.5
               MMAX=2
               IF(K.EQ.1)MMAX=1
               DO 2024 M=1,MMAX
                  TEMP4=TEMP2+0.027305*M
                  TEMP5=TEMP3+M
                  DO 2023 NN=1,8
                     Y=TEMP4-0.003175*NN
                     TEMP6=TEMP5-2*NN
                     TEMP6=49*ABS(TEMP6)+0.7
                     IND3=IND2+INT(TEMP6)
                     DO 2022 I=1,4
                        Z=0.0
                        IF(I.EQ.2)Z=0.0029464
                        IF(I.EQ.3)Z=0.0097028
                        IF(I.EQ.4)Z=0.0067564
                        INDEX=IND3+2744*I
                        CALL INFLCF(X,Y,Z,0.0,0.003175,0.001905,0.003175,COEFF)
                        CFTUFW(INDEX)=COEFF
2022                 CONTINUE
2023              CONTINUE
2024           CONTINUE
```

```
2025      CONTINUE
2026     CONTINUE
2027 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFTUFW(I),I=4,21364,9)
      WRITE(12) CFTUFW
      END FILE 12
C
C     ALL CFTUFW(  ) COMPLETED.  NUMBER IN THIS BLOCK = 10976.  TOTAL = 21364
C
C     START NEXT ON PLATE EDGES ON WIRES WITH J=JJ.  CFEDGW(  )
C
      DO 2033 K=1,4
        TEMP1=0.02921*K-0.05461
        TEMP2=14*K-7.5
        DO 2032 MM=1,7
          TEMP3=TEMP1-0.003175*MM
          TEMP4=TEMP2-2*MM
          MMAX=2
          IF(K.EQ.1)MMAX=1
          DO 2031 M=1,MMAX
            X=TEMP3+0.0254*M
            TEMP5=TEMP4+M
            TEMP5=ABS(TEMP5)+0.7
            IND1=INT(TEMP5)-3724
            DO 2030 L=1,4
              TEMP5=0.02921*L-0.05461
              IND2=IND1+735*L
              NMIN=1
              IF(L.EQ.1)NMIN=8
              DO 2029 N=NMIN,15
                Y=TEMP5+0.003175*N
                IND3=IND2+49*N
                DO 2028 I=1,2
                  Z=0.0029464*(I-1)
                  INDEX=IND3+2597*I
                  CALL INFLCF(X,Y,Z,0.0,0.003175,0.003175,0.0,COEFF)
                  CFEDGW(INDEX)=COEFF
2028            CONTINUE
2029          CONTINUE
2030        CONTINUE
2031      CONTINUE
2032    CONTINUE
2033 CONTINUE
C
C     PLATE EDGES ON WIRES WITH J=JJ COMPLETED.NUMBER OF COEFFS = 5194
C
C     START NEXT ON PLATE EDGES ON WIRES WITH J NOT EQUAL TO JJ.  CFEDGW(5195 ON)
C
      DO 2039 L=1,4
        TEMP1=0.02921*L-0.0530225
        TEMP2=14*L-21.5
        NMIN=1
        IF(L.EQ.1)NMIN=8
        DO 2038 N=NMIN,14
          X=TEMP1+0.003175*N
          TEMP3=TEMP2+N
          TEMP3=ABS(TEMP3)+2426.2
          DO 2037 K=1,4
            TEMP8=0.02921*K-0.0530225
            TEMP4=14*K-8.5
            DO 2036 NN=1,8
              TEMP5=TEMP8-0.003175*NN
              TEMP6=TEMP4-2*NN
              MMAX=2
              IF(K.EQ.1)MMAX=1
```

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```
                DO 2035 N=1, MMAX
                   Y=TEMP5+0.0254*M
                   TEMP7=TEMP6+M
                   TEMP7=49*ABS(TEMP7)+TEMP3
                   IND1=INT(TEMP7)
                   DO 2034 I=1,2
                      Z=0.0029464*(I-1)
                      INDEX=IND1+2744*I
                      CALL INFLCF(X,Y,Z,0.0,0.003175,0.0,0.003175,COEFF)
                      CFEDGW(INDEX)=COEFF
2034                CONTINUE
2035             CONTINUE
2036          CONTINUE
2037       CONTINUE
2038    CONTINUE
2039 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFEDGW(I),I=2,10682,89)
      WRITE(12) CFEDGW
      END FILE 12
C
C
C     ALL PLATE EDGES ON WIRES COMPLETED. TOTAL OF CFEDGW(  ) IS 10682
C
C     START NEXT ON PLATE/FILM INTERSECTION SQUARES ON WIRES. CFPFIW( )
C
      DO 2046 K=1,4
         TEMP1=0.02921*K-0.0574675
         TEMP2=14*K-7.5
         MMAX=2
         IF(K.EQ.1)MMAX=1
         DO 2045 M=1,MMAX
            TEMP3=TEMP1+0.027305*M
            TEMP4=TEMP2+M
            DO 2044 MM=1,7
               X=TEMP3-0.003175*MM
               TEMP5=TEMP4-2*MM
               TEMP5=ABS(TEMP5)
               DO 2043 L=1,4
                  TEMP6=0.02921*L-0.05588
                  TEMP7=16*L-8.5
                  NMAX=2
                  IF(L.EQ.1)NMAX=1
                  DO 2042 N=1,NMAX
                     TEMP8=TEMP6+0.027305*N
                     TEMP9=TEMP7+N
                     DO 2041 NN=1,8
                        Y=TEMP8-0.003175*NN
                        TEMP10=TEMP9-2*NN
                        TEMP10=49*ABS(TEMP10)+TEMP5+0.2
                        IND1=INT(TEMP10)-2768
                        DO 2040 I=1,4
                           Z=0.0
                           IF(I.EQ.2)Z=0.0029464
                           IF(I.EQ.3)Z=0.0097028
                           IF(I.EQ.4)Z=0.0067564
                           INDEX=IND1+2744*I
                        CALL INFLCF(X,Y,Z,0.0,0.003175,0.001905,0.001905,COEFF)
                           CFPFIW(INDEX)=COEFF
2040                    CONTINUE
2041                 CONTINUE
2042              CONTINUE
2043           CONTINUE
2044        CONTINUE
2045     CONTINUE
2046  CONTINUE
      WRITE(6,3100)
```

```
       WRITE(6,3000)(CFPFIW(I),I=11,10976,129)
       WRITE(12) CFPFIW
       END FILE 12
C
C
C      ALL PLATE/FILM INTERSECTIONS ON WIRES COMPLETED. TOTAL OF CFPFIW( )=10976
C
C      ALL CONTRIBUTIONS TO WIRES HAVE BEEN COMPLETED. NUMBER OF COEFFS = 57894
C
C      START NEXT ON CONTRIBUTIONS TO FILM MAIN SQARE ELEMENTS. NOTE THAT CONTRIBU
C      TIONS FROM WIRES ARE THE SAME AS FILM ELEMENTS TO WIRES
C
C      START OF FILM MAIN SQUARE ON FILM MAIN SQUARE  ' CFFMFM( )
C
       DO 2051 K=1,4
         T1=0.0
         IF(K.NE.1)T1=1
         TEMP1=0.02921*K-0.05461
         IND1=15*K-1241
         MMIN=1
         IF(K.EQ.1)MMIN=8
         DO 2050 M=MMIN,15
           T2=T1
           IF(M.NE.8)T2=1
           X=TEMP1+0.003175*M
           IND2=IND1+M
           DO 2049 L=1,4
             T3=T2
             IF(L.NE.1)T3=1
             TEMP2=0.02921*L-0.05461
             IND3=IND2+795*L
             NMIN=1
             IF(L.EQ.1)NMIN=8
             DO 2048 N=NMIN,15
               T4=T3
               IF(N.NE.8)T4=1
               Y=TEMP2+0.003175*N
               INDEX=IND3+53*N
               IF(T4.LT.0.5)GO TO 2047
               TEMP3=0.003175
               CALL INFLCF(X,Y,0.0,TEMP3,TEMP3,TEMP3,TEMP3,COEFF)
               CFFMFM(INDEX)=COEFF
               GO TO 2048
 2047          CFFMFM(INDEX)=0.0
 2048        CONTINUE
 2049      CONTINUE
 2050    CONTINUE
 2051  CONTINUE
       WRITE(6,3100)
       WRITE(6,3000)(CFFMFM(I),I=1,2809,39)
       WRITE(12) CFFMFM
       END FILE 12
C
C
C      FILM MAIN SQUARE ON FILM MAIN SQUARE COMPLETED. TOTAL CFFMFM( ) = 2809
C
C      START NEXT ON GRID SUPPORT STRUCTURE, TOP AND UNDERSIDES, AND EQUIVALENT
C      FILM ELEMENTS ON FILM MAIN SQUARE  ELEMENTS. CFTUFM( )
C
       DO 2057 K=1,4
         TEMP1=0.02921*K-0.05588
         TEMP2=16*K-9.5
         MMAX=2
         IF(K.EQ.1)MMAX=1
         DO 2056 M=1,MMAX
           TEMP3=TEMP1+0.027305*M
           TEMP4=TEMP2+M
           DO 2055 MM=1,8
```

```
                  X=TEMP3-0.003175*MM
                  TEMP5=TEMP4-2*MM
                  TEMP5=ABS(TEMP5)+0.7
                  IND1=INT(TEMP5)-4256
                  DO 2054 L=1,4
                     TEMP5=0.02921*L-0.05461
                     IND2=IND1+840*L
                     NMIN=1
                     IF(L.EQ.1)NMIN=8
                     DO 2053 N=NMIN,15
                        Y=TEMP5+0.003175*N
                        IND3=IND2+56*N
                        DO 2052 I=1,3
                           Z=0.0
                           IF(I.EQ.2)Z=0.0097028
                           IF(I.EQ.3)Z=0.0067564
                           INDEX=IND3+2968*I
                           TEMP6=0.003175
                           CALL INFLCF(X,Y,Z,TEMP6,TEMP6,TEMP6,0.001905,COEFF)
                           CFTUFM(INDEX)=COEFF
  2052                   CONTINUE
  2053                CONTINUE
  2054             CONTINUE
  2055          CONTINUE
  2056       CONTINUE
  2057    CONTINUE
          WRITE(6,3100)
          WRITE(6,3000)(CFTUFM(I),I=4,8904,89)
          WRITE(12) CFTUFM
          END FILE 12
C
C
C         GRID SUPPORT STRUCTURE, TOP AND UNDERSIDES AND EQUIVALENT FILM ELEMENTS ON
C         FILM MAIN SQUARE ELEMENTS COMPLETED. TOTAL CFTUFM(  ) = 8904
C
C         START NEXT GRID EDGES ON FILM MAIN SQUARE ELEMENTS. CFEDFM(  )
C
          DO 2063 K=1,4
             TEMP1=0.02921*K-0.0530225
             TEMP2=16*K-8.5
             MMAX=2
             IF(K.EQ.1)MMAX=1
             DO 2062 M=1,MMAX
                TEMP3=TEMP1+0.0254*M
                TEMP4=TEMP2+M
                DO 2061 MM=1,8
                   X=TEMP3-0.003175*MM
                   TEMP5=TEMP4-2*MM
                   TEMP5=ABS(TEMP5)+0.7
                   IND1=INT(TEMP5)-4256
                   DO 2060 L=1,4
                      TEMP5=0.02921*L-0.05461
                      IND2=IND1+840*L
                      NMIN=1
                      IF(L.EQ.1)NMIN=8
                      DO 2059 N=NMIN,15
                         Y=TEMP5+0.003175*N
                         IND3=IND2+56*N
                         DO 2058 I=1,2
                            Z=0.0097028
                            IF(I.EQ.2)Z=0.0067564
                            INDEX=IND3+2968*I
                            TEMP6=0.003175
                            CALL INFLCF(X,Y,Z,TEMP6,TEMP6,TEMP6,0.0,COEFF)
                            CFEDFM(INDEX)=COEFF
  2058                      CONTINUE
  2059                   CONTINUE
```

```
2060        CONTINUE
2061       CONTINUE
2062      CONTINUE
2063 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFEDFM(I),I=11,5936,79)
      WRITE(12) CFEDFM
      END FILE 12
C
C     GRID EDGES ON FILM MAIN SQUARE ELEMENTS COMPLETED. TOTAL CFEDFM(  )=5936
C
C      START NEXT INTERSECTION SQUARES ON FILM MAIN SQUARE ELEMENTS. CFISFM(   )
C
      DO 2070 K=1,4
        TEMP1=0.02921*K-0.05588
        TEMP2=16*K-8.5
        MMAX=2
        IF(K.EQ.1)NMAX=1
        DO 2069 M=1,MMAX
          TEMP3=TEMP1+0.027305*M
          TEMP4=TEMP2+M
          DO 2068 MM=1,8
            X=TEMP3-0.003175*MM
            TEMP5=TEMP4-2*MM
            TEMP5=ABS(TEMP5)+0.7
            IND1=INT(TEMP5)
            DO 2067 L=1,4
              TEMP5=0.02921*L-0.05588
              TEMP6=16*L-8.5
              NMAX=2
              IF(L.EQ.1)NMAX=1
              DO 2066 N=1,NMAX
                TEMP7=TEMP5+0.027305*N
                TEMP8=TEMP6+N
                DO 2065 NN=1,8
                  Y=TEMP7-0.003175*NN
                  TEMP9=TEMP8-2*NN
                  TEMP9=ABS(TEMP9)-0.3
                  IND2=IND1+56*INT(TEMP9)
                  DO 2064 I=1,3
                    Z=0.0
                    IF(I.EQ.2)Z=0.0097028
                    IF(I.EQ.3)Z=0.0067564
                    INDEX=IND2+3136*(I-1)
                    TEMP9=0.003175
                    TEMP10=0.001905
                    CALL INFLCF(X,Y,Z,TEMP9,TEMP9,TEMP10,TEMP10,COEFF)
                    CFISFM(INDEX)=COEFF
2064              CONTINUE
2065            CONTINUE
2066          CONTINUE
2067        CONTINUE
2068      CONTINUE
2069    CONTINUE
2070 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFISFM(I),I=8,9408,47)
      WRITE(12) CFISFM
      END FILE 12
C
C     INTERSECTION SQUARES ON FILM MAIN SQUARES COMPLETED. TOTAL CFISFM(  )=9408
C
C     START NEXT ON PLATE/FILM T AND U ON PLATE/FILM T AND U. CFTUTU(  )FOR J=JJ
C
      DO 2076 K=1,4
        TL=0.0
```

```
          IF(K.NE.1)T1=1
          TEMP1=0.02921*K-0.08382
          IND1=3*K-840
          MMIN=1
          IF(K.EQ.1)MMIN=2
          DO 2075 M=MMIN,3
            T2=T1
            IF(M.NE.2)T2=1
            X=TEMP1+0.027305*M
            IND2=IND1+M
            DO 2074 L=1,4
              T3=T2
              IF(L.NE.1)T3=1
              TEMP2=0.02921*L-0.05461
              IND3=IND2+165*L
              NMIN=1
              IF(L.EQ.1)NMIN=8
              DO 2073 N=NMIN,15
                T4=T3
                IF(N.NE.8)T4=1
                Y=TEMP2+0.003175*N
                IND4=IND3+11*N
                DO 2072 I=1,5
                  Z=0.0
                  IF(I.EQ.2)Z=0.0001524
                  IF(I.EQ.3)Z=0.0029464
                  IF(I.EQ.4)Z=0.0097028
                  IF(I.EQ.5)Z=0.0067564
                  INDEX=IND4+583*I
                  IF(T4+I.LT.1.5)GO TO 2071
                  TEMP3=0.001905
                  TEMP4=0.003175
                  CALL INFLCF(X,Y,Z,TEMP3,TEMP4,TEMP4,TEMP3,COEFF)
                  CFTUTU(INDEX)=COEFF
                  GO TO 2072
2071              CFTUTU(INDEX)=0.0
2072          CONTINUE
2073        CONTINUE
2074      CONTINUE
2075    CONTINUE
2076 CONTINUE
C
C     ALL J=JJ PLATE/FILM T AND U ON PLATE/FILM T AND U COMPLETED.NUMBER = 2915
C
C
C     START NEXT ON SAME FOR J NOT EQUAL TO JJ. CFTUTU( )
C
      DO 2083 L=1,4
        TEMP1=0.02921*L-0.00254
        TEMP2=16*L-8.5
        MMMAX=2
        IF(L.EQ.1)MMMAX=1
        DO 2082 MM=1,MMMAX
          TEMP3=TEMP1-0.027305*MM
          TEMP4=TEMP2+MM
          DO 2081 N=1,8
            X=TEMP3+0.003175*N
            TEMP5=TEMP4-2*N
            TEMP5=ABS(TEMP5)+0.7
            IND1=INT(TEMP5)-221
            DO 2080 K=1,4
              TEMP5=0.02921*K-0.05588
              TEMP6=16*K-8.5
              MMAX=2
              IF(K.EQ.1)MMAX=1
              DO 2079 M=1,MMAX
```

```
                        TEMP7=TEMP5+0.027305*M
                        TEMP8=TEMP6+M
                        DO 2078 NN=1,8
                          Y=TEMP7-0.003175*NN
                          TEMP9=TEMP8-2*NN
                          TEMP9=ABS(TEMP9)-0.3
                          IND2=IND1+56*INT(TEMP9)
                          DO 2077 I=1,5
                            Z=0.0
                            IF(I.EQ.2)Z=0.0001524
                            IF(I.EQ.3)Z=0.0029464
                            IF(I.EQ.4)Z=0.0097028
                            IF(I.EQ.5)Z=0.0067564
                            INDEX=IND2+3136*I
                            TEMP9=0.001905
                            TEMP10=0.003175
                            CALL INFLCF(X,Y,Z,TEMP9,TEMP10,TEMP9,TEMP10,COEFF)
                            CFTUTU(INDEX)=COEFF
2077                      CONTINUE
2078                    CONTINUE
2079                  CONTINUE
2080                CONTINUE
2081              CONTINUE
2082            CONTINUE
2083 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFTUTU(I),I=3,18595,83)
      WRITE(12) CFTUTU
      END FILE 12
C
C     ALL PLATE/FILM T AND U ON PLATE/FILM T AND U COMPLETED.FOR J NOT EQUAL TO
C     JJ NUMBER IS 15680. WITH 2915 FOR J=JJ TOTAL CFTUTU( ) =18595
C
C     START NEXT ON INTERSECTION SQUARES ON INTERSECTION SQUARES. CFISIS( )
C
      DO 2089 K=1,4
        T1=0.0
        IF(K.NE.1)T1=1
        TEMP1=0.02921*K-0.08382
        IND1=3*K-180
        MMIN=1
        IF(K.EQ.1)MMIN=2
        DO 2088 M=MMIN,3
          T2=T1
          IF(M.NE.2)T2=1
          X=TEMP1+0.027305*M
          IND2=IND1+M
          DO 2087 L=1,4
            T3=T2
            IF(L.NE.1)T3=1
            TEMP2=0.02921*L-0.08382
            IND3=IND2+33*L
            NMIN=1
            IF(L.EQ.1)NMIN=2
            DO 2086 N=NMIN,3
              T4=T3
              IF(N.NE.2)T4=1
              Y=TEMP2+0.027305*N
              IND4=IND3+11*N
              DO 2085 I=1,5
                Z=0.0
                IF(I.EQ.2)Z=0.0001524
                IF(I.EQ.3)Z=0.0029464
                IF(I.EQ.4)Z=0.0097028
                IF(I.EQ.5)Z=0.0067564
                INDEX=IND4+121*I
```

```
                  IF(T4+I.LT.1.5)GO TO 2084
                  TEMP3=0.001905
                  CALL INFLCF(X,Y,Z,TEMP3,TEMP3,TEMP3,TEMP3,COEFF)
                  CFISIS(INDEX)=COEFF
                  GO TO 2085
 2084             CFISIS(INDEX)=0.0
 2085          CONTINUE
 2086        CONTINUE
 2087      CONTINUE
 2088    CONTINUE
 2089 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFISIS(I),I=5,605,12)
      WRITE(12) CFISIS
      END FILE 12
C
C
C    INTERSECTION SQUARES ONINTERSECTION SQUARES COMPLETED. TOTAL CFISIS( )=605
C
C    START NEXT ON GRID EDGES ON GRID EDGES. CFEDED( ). J=JJ FIRST
C
      DO 2095 K=1,4
        T1=0.0
        IF(K.NE.1)T1=1
        TEMP1=0.02921*K-0.08001
        IND1=3*K-840
        MMIN=1
        IF(K.EQ.1)MMIN=2
        DO 2094 M=MMIN,3
          T2=T1
          IF(M.NE.2)T2=1
          X=TEMP1+0.0254*M
          IND2=IND1+M
          DO 2093 L=1,4
            T3=T2
            IF(L.NE.1)T3=1
            TEMP2=0.02921*L-0.05461
            IND3=IND2+165*L
            NMIN=1
            IF(L.EQ.1)NMIN=8
            DO 2092 N=NMIN,15
              T4=T3
              IF(N.NE.8)T4=1
              Y=TEMP2+0.003175*N
              IND4=IND3+11*N
              DO 2091 I=1,2
                Z=0.0
                IF(I.EQ.2)Z=0.0029464
                INDEX=IND4+583*I
                IF(T4+I.LT.1.5)GO TO 2090
                CALL INFLCF(X,Y,Z,0.0,0.003175,0.003175,0.0,COEFF)
                CFEDED(INDEX)=COEFF
                GO TO 2091
 2090           CFEDED(INDEX)=0.0
 2091         CONTINUE
 2092       CONTINUE
 2093     CONTINUE
 2094   CONTINUE
 2095 CONTINUE
C
C    GRID EDGES ON GRID EDGES, CFEDED( ), WITH J=JJ COMPLETED. NUMBER= 1166
C
C    START NEXT ON GRID EDGES ON GRID EDGES WITH J NOT EQUAL TO JJ
C
      DO 3002 L=1,4
        TEMP1=0.02921*L-0.0053975
        TEMP2=16*L-8.5
```

```
            MMMAX=2
            IF(L.EQ.1)MMMAX=1
            DO 3001 MM=1,MMMAX
              TEMP3=TEMP1-0.0254*MM
              TEMP4=TEMP2+MM
              DO 2100 N=1,8
                X=TEMP3+0.003175*N
                TEMP5=TEMP4-2*N
                TEMP5=ABS(TEMP5)+0.7
                IND1=INT(TEMP5)-1970
                DO 2099 K=1,4
                  TEMP5=0.02921*K-0.0530225
                  TEMP6=16*K-8.5
                  MMAX=2
                  IF(K.EQ.1)MMAX=1
                  DO 2098 M=1,MMAX
                    TEMP7=TEMP5+0.0254*M
                    TEMP8=TEMP6+M
                    DO 2097 NN=1,8
                      Y=TEMP7-0.003175*NN
                      TEMP9=TEMP8-2*NN
                      TEMP9=ABS(TEMP9)-0.3
                      IND2=IND1+56*INT(TEMP9)
                      DO 2096 I=1,2
                        Z=0.0
                        IF(I.EQ.2)Z=0.0029464
                        INDEX=IND2+3136*I
                        CALL INFLCF(X,Y,Z,0.0,0.003175,0.0,0.003175,COEFF)
                        CFEDED(INDEX)=COEFF
2096                  CONTINUE
2097                CONTINUE
2098              CONTINUE
2099            CONTINUE
2100          CONTINUE
3001        CONTINUE
3002 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFEDED(I),I=2,7438,52)
      WRITE(12) CFEDED
      END FILE 12
C
C     ALL EDGES ON EDGES COMPLETED, TOTAL = 1166+6272=7438



C
C     START NEXT ON EDGES ON INTERSECTION SQUARES. CFEDIS(  )
C
      DO 3009 K=1,4
        TEMP1=0.02921*K-0.0263525
        TEMP2=4*K-2.5
        MMAX=2
        IF(K.EQ.1)MMAX=1
        DO 3008 M=1,MMAX
          TEMP3=TEMP1+0.0254*M
          TEMP4=TEMP2+M
          DO 3007 MM=1,2
            X=TEMP3-0.027305*MM
            TEMP5=TEMP4-2*MM
            TEMP5=ABS(TEMP5)+0.7
            IND1=INT(TEMP5)-784
            DO 3006 L=1,4
              TEMP5=0.02921*L-0.00254
              TEMP6=16*L-8.5
```

```
                    NNMAX=2
                    IF(L. EQ. 1)NNMAX=1
                    DO 3005 NN=1, NNMAX
                      TEMP7=TEMP5-0. 027305*NN
                      TEMP8=TEMP6+NN
                      DO 3004 N=1, 8
                        Y=TEMP7+0. 003175*N
                        TEMP9=TEMP8-2*N
                        TEMP9=ABS(TEMP9)-0. 3
                        IND2=IND1+14*INT(TEMP9)
                        DO 3003 I=1, 4
                          Z=0. 0000762
                          IF(I. EQ. 2)Z=0. 0029464
                          IF(I. EQ. 3)Z=0. 0097028
                          IF(I. EQ. 4)Z=0. 0067564
                          INDEX=IND2+784*I
                          TEMP9=0. 001905
                          CALL INFLCF(X, Y, Z, TEMP9, TEMP9, 0. 003175, 0. 0, COEFF)
                          CFEDIS(INDEX)=COEFF
3003                    CONTINUE
3004                  CONTINUE
3005                CONTINUE
3006              CONTINUE
3007          CONTINUE
3008      CONTINUE
3009 CONTINUE
      WRITE(6, 3100)
      WRITE(6, 3000)(CFEDIS(I), I=4, 3136, 87)
      WRITE(12) CFEDIS
      END FILE 12
C
C
C     EDGES ON INTERSECTION SQUARES COMPLETED. TOTAL CFEDIS( ) =3136
C
C
C     START NEXT ON EDGES ON SUPPORT STRUCTURE/FILM T & U CFEDTU(   )
C     FOR J=JJ
C
      DO 3015 K=1, 4
        TEMP1=0. 02921*K-0. 0263525
        TEMP2=4*K-2. 5
        MMAX=2
        IF(K. EQ. 1)MMAX=1
        DO 3014 M=1, MMAX
          TEMP3=TEMP1+0. 0254*M
          TEMP4=TEMP2+M
          DO 3013 MM=1, 2
            X=TEMP3-0. 027305*MM
            TEMP5=TEMP4-2*MM
            TEMP5=ABS(TEMP5)+0. 7
            IND1=INT(TEMP5)-1064
            DO 3012 L=1, 4
              TEMP5=0. 02921*L-0. 05461
              IND2=IND1+210*L
              NMIN=1
              IF(L. EQ. 1)NMIN=8
              DO 3011 N=NMIN, 15
                Y=TEMP5+0. 003175*N
                IND3=IND2+14*N
                DO 3010 I=1, 4
                  Z=0. 0000762
                  IF(I. EQ. 2)Z=0. 0029464
                  IF(I. EQ. 3)Z=0. 0097028
                  IF(I. EQ. 4)Z=0. 0067564
                  INDEX=IND3+742*I
                  TEMP6=0. 003175
                  CALL INFLCF(X, Y, Z, 0. 001905, TEMP6, TEMP6, 0. 0, COEFF)
```

```
                       CFEDTU(INDEX)=COEFF
     3010              CONTINUE
     3011             CONTINUE
     3012           CONTINUE
     3013         CONTINUE
     3014     CONTINUE
     3015 CONTINUE
C
C      EDGES ON SUPPORT STRUCTURE/FILM T & U FOR J=JJ COMPLETED. NUMBER = 2968
C
C      START NEXT ON SAME FOR J NOT EQUAL TO JJ. CFEDTU(2969 ON )
C
       DO 3022 L=1,4
         TEMP1=0.02921*L-0.00254
         TEMP2=16*L-8.5
         MMMAX=2
         IF(L.EQ.1)MMMAX=1
         DO 3021 MM=1,MMMAX
           TEMP3=TEMP1-0.027305*MM
           TEMP4=TEMP2+MM
           DO 3020 N=1,8
             X=TEMP3+0.003175*N
             TEMP5=TEMP4-2*N
             TEMP5=ABS(TEMP5)+0.7
             IND1=INT(TEMP5)-168
             DO 3019 K=1,4
               TEMP5=0.02921*K-0.0530225
               TEMP6=16*K-8.5
               MMAX=2
               IF(K.EQ.1)MMAX=1
               DO 3018 M=1,MMAX
                 TEMP7=TEMP5+0.0254*M
                 TEMP8=TEMP6+M
                 DO 3017 NN=1,8
                   Y=TEMP7-0.003175*NN
                   TEMP9=TEMP8-2*NN
                   TEMP9=ABS(TEMP9)-0.3
                   IND2=IND1+56*INT(TEMP9)
                   DO 3016 I=1,4
                     Z=0.0000762
                     IF(I.EQ.2)Z=0.0029464
                     IF(I.EQ.3)Z=0.0097028
                     IF(I.EQ.4)Z=0.0067564
                     INDEX=IND2+3136*I
                     TEMP9=0.003175
                     CALL INFLCF(X,Y,Z,0.001905,TEMP9,0.0,TEMP9,COEFF)
                     CFEDTU(INDEX)=COEFF
     3016              CONTINUE
     3017             CONTINUE
     3018            CONTINUE
     3019          CONTINUE
     3020        CONTINUE
     3021     CONTINUE
     3022 CONTINUE
       WRITE(6,3100)
       WRITE(6,3000)(CFEDTU(I),I=2,15512,235)
       WRITE(12) CFEDTU
       END FILE 12
C
C      ALL EDGES ON SUPPORT STRUCTURE/FILM T AND U COMPLETED. TOTAL CFEDTU()=15512
C
C      START NEXT ON SUPPORT STRUCTURE/FILM T AND U ON INTERSECTION SQUARES.
C      CFTUIS( )
C
       DO 3028 K=1,4
         TEMP1=0.02921*K-0.03382
```

```
          IND1=3*K-620
          MMIN=1
          IF(K.EQ.1)MMIN=2
          DO 3027 M=MMIN,3
            X=TEMP1+0.027305*M
            IND2=IND1+M
            DO 3026 L=1,4
              TEMP2=0.02921*L-0.00254
              TEMP3=16*L-8.5
              NNMAX=2
              IF(L.EQ.1)NNMAX=1
              DO 3025 NN=1,NNMAX
                TEMP4=TEMP2-0.027305*NN
                TEMP5=TEMP3+NN
                DO 3024 N=1,8
                  Y=TEMP4+0.003175*N
                  TEMP6=TEMP5-2*N
                  TEMP6=ABS(TEMP6)-0.3
                  IND3=IND2+11*INT(TEMP6)
                  DO 3023 I=1,4
                    Z=0.0
                    IF(I.EQ.2)Z=0.0029464
                    IF(I.EQ.3)Z=0.0097028
                    IF(I.EQ.4)Z=0.0067564
                    INDEX=IND3+616*I
                    TEMP7=0.001905
                    CALL INFLCF(X,Y,Z,TEMP7,TEMP7,0.003175,TEMP7,COEFF)
                    CFTUIS(INDEX)=COEFF
3023              CONTINUE
3024            CONTINUE
3025          CONTINUE
3026        CONTINUE
3027      CONTINUE
3028 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFTUIS(I),I=4,2464,41)
      WRITE(12) CFTUIS
      END FILE 12
C
C     AL  SUPPORT STRUCTURE/FILM T AND U ON INTERSECTION SQUARES.COMPLETED.
C     TOTAL CFTUIS(  )=2464
C
C     ALL INFLUENCE COEFFICIENTS CALCULATED.TOTAL NUMBER=132701
3000 FORMAT(11(2X,E10.3))
3100 FORMAT('0','NEW DATA SET'/)
      END
```

```
      SUBROUTINE INFLCF(X,Y,Z,A,B,S,T,COEFF)
      TEMP2=Z*Z
      TEMP1=X*X+Y*Y+TEMP2
      IF(TEMP1.GT.0.16E-3)GO TO 1004
      IMAX=10
      JMAX=10
      KMAX=10
      SUM=0.0
      IF(A.LT.0.1E-2)IMAX=1
      IF(B.LT.0.1E-2)JMAX=1
      IF(T.LT.0.1E-2)KMAX=1
      TEMP8=T
      TEMP9=0.0
      IF(S.GT.0.1E-2)GO TO 1000
      TEMP8=0.0
      TEMP9=T
      KMAX=1
1000  TEMP1=Y+0.55*B-0.5*S
      TEMP3=X+0.55*A-0.55*TEMP8+0.5*TEMP9
      DO 1003 K=1,KMAX
        TEMP4=TEMP3+0.1*K*TEMP8
        DO 1002 I=1,IMAX
          TEMP5=(TEMP4-0.1*A*I)
          DO 1001 J=1,JMAX
            TEMP6=TEMP1-0.1*B*J
            TEMP7=TEMP6*TEMP6+TEMP5*TEMP5+TEMP2
            R1=SQRT(TEMP7)
            TEMP6=TEMP6+S
            TEMP7=TEMP5-TEMP9
            TEMP7=TEMP7*TEMP7+TEMP6*TEMP6+TEMP2
            R2=SQRT(TEMP7)
            TEMP7=S+TEMP9
            TEMP6=(R1+R2+TEMP7)/(R1+R2-TEMP7)
            SUM=SUM+ALOG(TEMP6)
1001      CONTINUE
1002    CONTINUE
1003  CONTINUE
      TEMP8=S
      IF(S.LT.0.1E-2)TEMP8=T
      COEFF=(SUM*0.89877E10)/(TEMP8*IMAX*JMAX*KMAX)
      GO TO 1005
1004  TEMP1=SQRT(TEMP1)
      COEFF=0.89877E10/TEMP1
1005  RETURN
      END
```

A.2 PROGRAM P5072SGF TO DETERMINE SENSOR SIGNALS DUE TO CHARGED PARTICLES AND RESULTING ELECTRONICS RESPONSE

A.2.1 Summary

This program uses the particle path characteristics calculated by program P5072CHG to generate sensor signals for selected particles and then determines the response of the electronics to these signals. The particle parameters of mass and charge are selected either by input card or by a random number generator. The output from the electronics model is stored on tape for future analysis and may be plotted, if desired, by selecting the proper code on an input card.

A.2.2 Description

A.2.2.1 Determination of Velocity

The starting velocity is one of the parameters supplied by input card. The new velocity of the particle at the end of each incremental step is determined from the new particle energy and the particle mass, using the relationship that energy equals half the product of mass and velocity squared. The new energy is determined by subtracting from the starting energy the work done in traversing the step distance. The work done is calculated from the potentials. Program P5072CHG provides two potentials at each step. One is the potential due to the applied potentials EPOT(J) and the other is the potential, per unit charge, due to the particle charge CPOT(J). The work done between two points is equivalent to the product of the potential difference between the points and the charge. Thus, the work done is determined from

Q*EPOT(J) + Q*Q*CPOT(J) calculated for the two steps, J and (J-1). The time taken for the step is determined from the average velocity over the step and its distance.

A.2.2.2   Determination of Grid and Film Currents

The currents are equivalent to the time rate of change of charge. Program P5072CHG provides the total charge on each film and collector grid element at each step. The current is found from the difference in charge at the beginning and end of the step, divided by the time interval, calculated above.

A.2.2.3   Film and Grid ID Thresholds

The two systems are identical except for signal polarity, so only the grid ID will be described. The input to the linear amplifier after the input circuit is calculated for each collector grid strip using the ramp function response equations arrived at by Laplace transform. The input to a threshold detector is the sum of the amplified signal from the impacted film plus the factored inputs from the other films applied as analog inhibit signals.

The time to reach threshold is determined by performing a linear interpolation between the present and most recent steps. Thresholds at other collector grids are only permitted if they occur within 0.2 microsec of the first ID.

The time of the first ID, either film or grid, is used as the start time for the PHA measurement in the electronics subroutine LES.

A.2.2.4   PHA Amplifier Signals

The inputs to the four film amplifiers are summed to be used as inputs for subroutine LES. To save computing time, data points are not accumulated until the input reaches one-tenth of the input threshold level.

A.2.2.5   Program Flow

The first input card is read to retrieve the parameters which select the various options. The number of particles to be analyzed, the velocity of the particles, the mass and charge, if random numbers are not used, the number of the input data set for path data, and the number of the output data set and codes for printout selections are retrieved from this card. The second card gives plot axes dimension information.

The first step is to define the physical stopping point within the sensor as either the film or east sensor shield followed by the initialization and setup of the CalComp plotter. This setup can be bypassed if no plotting is desired. Next, the particle path data are read in from tape as the potentials and charges at each particle position, plus a header record which defines the impact position on the sensor relative to the center and the total number of data points.

If random particles are to be selected, the first mass and charge values are calculated. The random number generator scales the values developed so that they fall within a range specified by the axes dimension information given on the second input card. All random numbers generated are used to save computing time over the method which uses all numbers for deriving masses and charges and then rejects those which do not fit the problem. The

variables are initialized, and the particle position at which measurable sig-
nals can be detected is then determined for use as the starting point for the
remaining calculations. The steps start at 10 meters from the sensor and step
in rapidly until either the signal reaches one-tenth of the threshold of a
collector grid or film circuit or a point 0.4 centimeter from the suppressor
grid is reached. This is done to give a starting point for the potential
measurements and the calculations of work done on the particle, since absolute
potentials are measured relative to infinity or a point of zero potential.

The sensor currents at this position are written out if the selection
code demands them, followed by the calculations of work done and the magnitude
of the remaining particle energy. Providing that the remaining energy is posi-
tive, the new velocity and the time increment are determined, followed by a
calculation of the new film and collector grid currents.

The film and collector grid threshold ID status is then determined
together with the value of the PHA amplifier input signal.

This sequence is continued until all particle positions have been
analyzed or the remaining energy reaches zero, indicating that the sensor
forces have stopped the particle.

When the sequence is complete and if a film ID has occurred alone,
before a collector ID or less than 1 msec after a collector grid ID, the data
are passed to subroutine LES, which calculates the electronics response.

The results of the electronics analysis, namely the PHA, film and
collector grid ID and accumulator counts, together with the particle charge,
mass, and velocity are stored for future analysis and, if required, the points
are plotted.

The program then returns to the start to read the next selection.

A.2.2.6   Subroutine LES

Section 3.2.1.2 describes the operation of the simple model of the electronics. The modeling is accomplished in subroutine LES.

The program uses the data points passed to it by dummy arguments and similarly returns values for the PHA count and accumulator count.

The output signal from the sensor is a pulse whose length and amplitude are determined from the path characteristics and particle characteristics in the MAIN program of P5072SGF. The signal is in the form of discrete amplitudes at discrete times. This subroutine treats the signal as a series of ramp functions by developing straight-line equations for the signal between adjacent values.

The program then evaluates the slope of the ramps to determine the status of the two switches. The result of this evaluation determines which of three subroutines will be used to calculate the value of the output signal. The subroutines called are COND 1, COND 2, and COND 3, which calculate the responses using predetermined equations that were arrived at by using the Laplace transform technique. A fourth subroutine, CVOLT, is used to calculate the voltages across the capacitors at the end of each step, as these are required as initial conditions for the next ramp function.

A.2.3   Method of Use

All references to Job Control Cards (JCL) are for the IBM-370 system.

Operation of the program requires a minimum of two input cards, plus one data tape produced by P5072CHG giving particle path data for the path and sensor to be analyzed. The minimum input allows, on the one path, either: (1) analysis of one particle with its mass, charge, and velocity selected by input card, or (2) analysis of any number of randomly selected particles, all at one selected velocity, up to a maximum of 999 particles. The results will be printed and optionally plotted. If more than one particle is desired in (1), different random numbers in (2), or different velocities or different paths are desired, then additional sets of cards must be added with the new codes and the appropriate path data sets must be available on tape.

The information required on the cards is as follows:

Card 1

Column	Requirements
1-3	A number from 1 to 999, format I3, representing the number of particles to be generated. If discrete particles are selected, the value should be 001.
4-6	A number, format I3, which determines the rate at which the element charge values will be written out, e.g., if the value is 5, every 5th step will be printed out during analysis.
7-13	A number representing the particle/s initial velocity, Format F7.2.
14-23	Not used.
24-29	An odd number used to start the random number generator, Format I6.

Card 1 (Cont.)

Column	Requirements
30-32	The number of the particle, e.g., 5, for the 5th particle of the total set of random particles generated for which the charge data are desired. If zero, all particle data will be selected on the basis of the number in columns 4 through 6.
33-42	The particle charge, format E10.4. If random numbers are selected, this value may be blank.
43-52	The particle mass, format E10.4. If random numbers are selected, this value may be blank.
53-55	A number which if greater than 10 will cause random particles to be produced and a plot of the results generated. If greater than 1 but less than 10, random particles will be generated. If less than 1, discrete values must be put in columns 33 through 52.
56-58	The input data set number which matches the JCL card, e.g., FT12F001.
59-61	The output data set number. 22 and 25 must be used for shielded film data sets.

Card 2

Card 2 provides information required by the CalComp plotter to set up the axes and by the random number generator to set up mass and charge values. The axes charge and mass information is developed as follows, with references being made to the following figure.
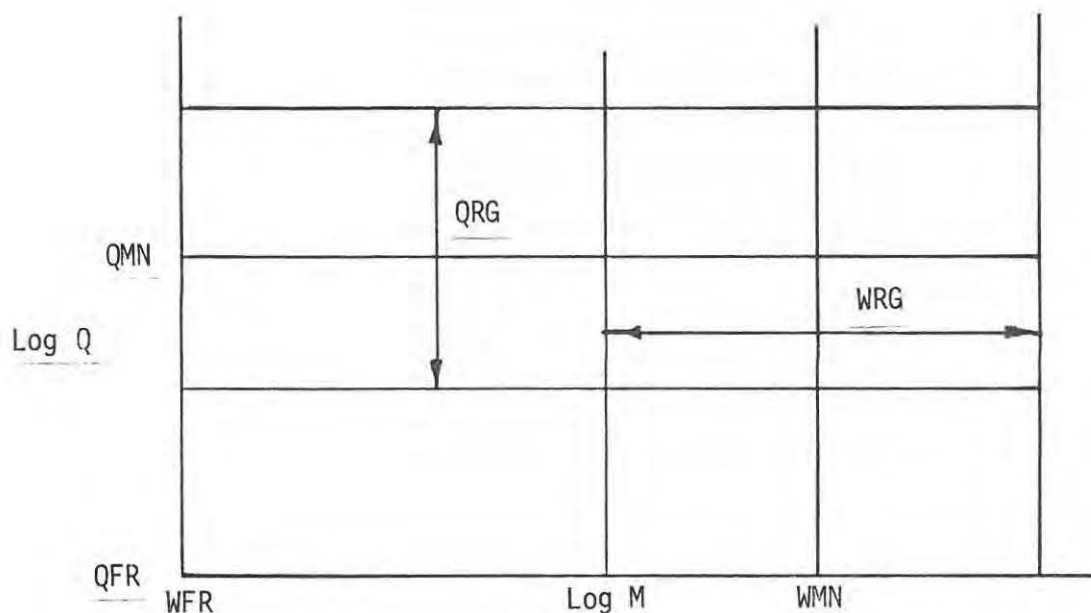
Consider the charge values: because of the range of values, the logar-ithm of the charge is plotted on a log scale. The distance along the y-axis is given by QCON*log (log Q) where QCON is a constant and Q is the charge.

The random number generator develops numbers between 0 and 1.0. The value of 0.5 is subtracted to give a range of -0.5 to +0.5, which is then multiplied by QRG, the desired range of log Q values. We now have the cor-rect range centered about the origin. The mean value of the desired range, QMN, in inches from the origin, is added to the generated value to place the range in the required area. The value obtained (y) is the position along the log Q axis, in inches, of the desired log Q.

Therefore, scale value = exp (y/QCON).

To obtain log Q, we now multiply by the scale factor, QFR, then

$$Q = \exp (\log Q).$$

An identical procedure is followed for the mass M.

The values required by Card 2 are:

Column	Requirement
1-4	QRG, range in inches of required log Q values on the plot (Format F4.2).
5-8	QMN, mid-point of range in inches from origin (Format F4.2).
9-16	QFR, scale factor (value of log Q axis at origin), ignore any minus sign (Format E8.2).
17-26	QCON, axis constant for size of axes to be plotted (Format F10.8), i.e., axis length for one cycle in inches (CYC) = QCON* ln 10.
27-30	WRG
31-34	WMN
35-42	WFR
43-52	WCON

All the same as the equivalent log Q definitions, for log M.

53-56	AXLEQ length of the log Q-axis in inches (Format F4.2).
57-60	AXLEM length of the log M axis in inches (Format F4.2).

If a plot is not required, a card must be submitted but it may be blank.

A.2.4   Flow Charts and Program Listings

A flow chart for program P5072SGF is shown in Figure A-2.

Program listings are provided for program P5072SGF and subroutines LES, COND1, COND2, COND3, and CVOLT on pages A-67 through A-77.
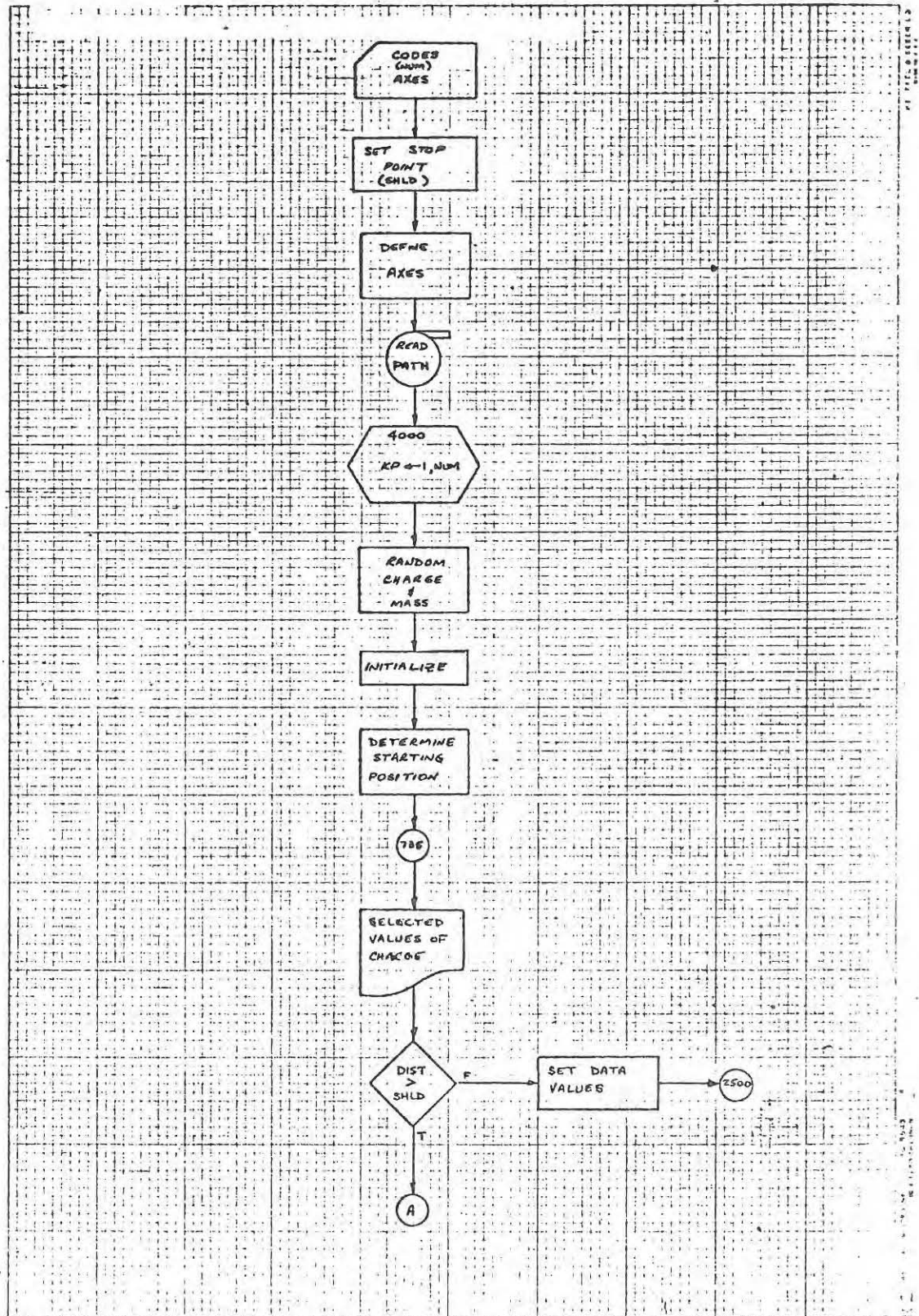
Figure A-2   P5072SGF Combined Sensor and Electronics
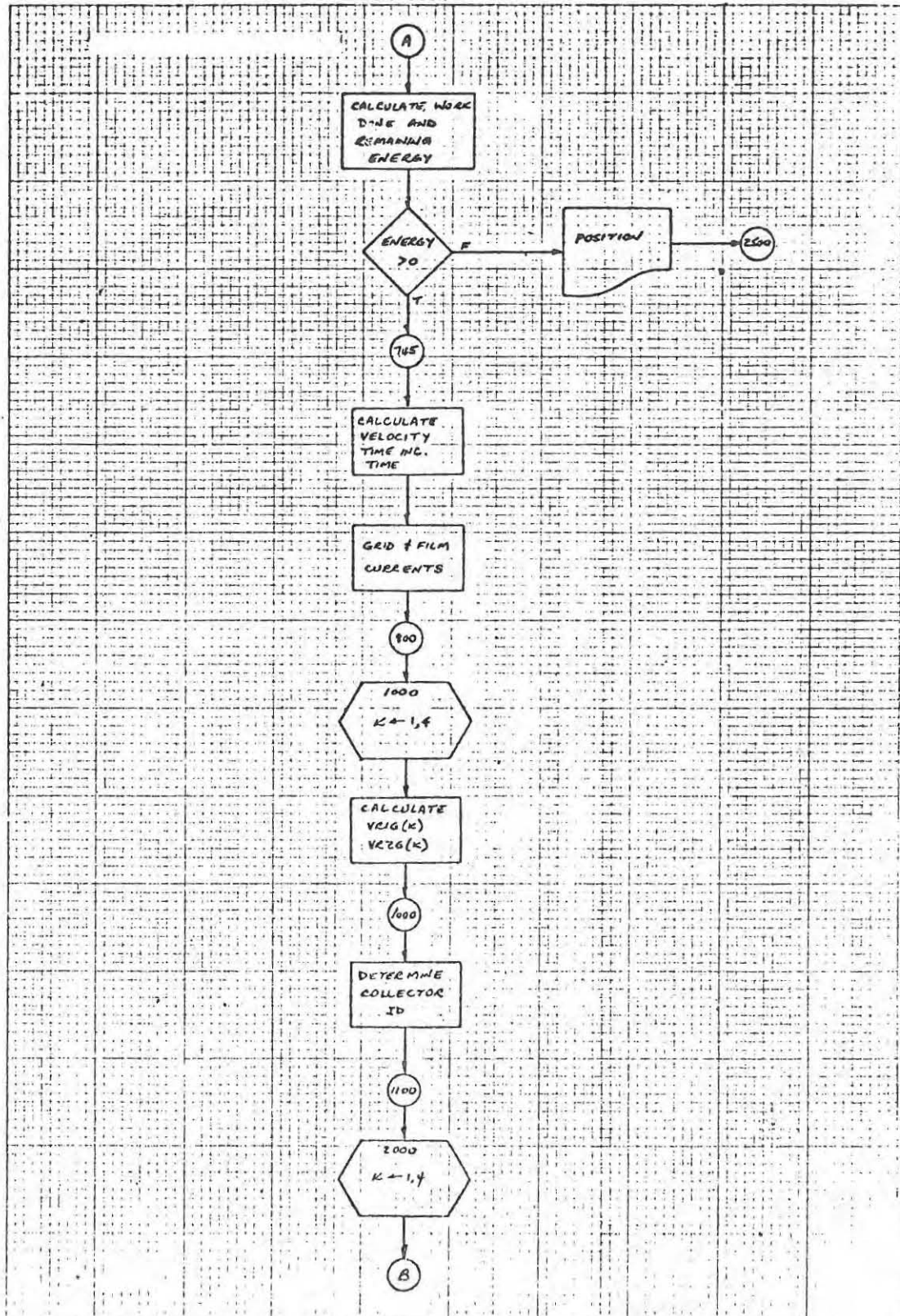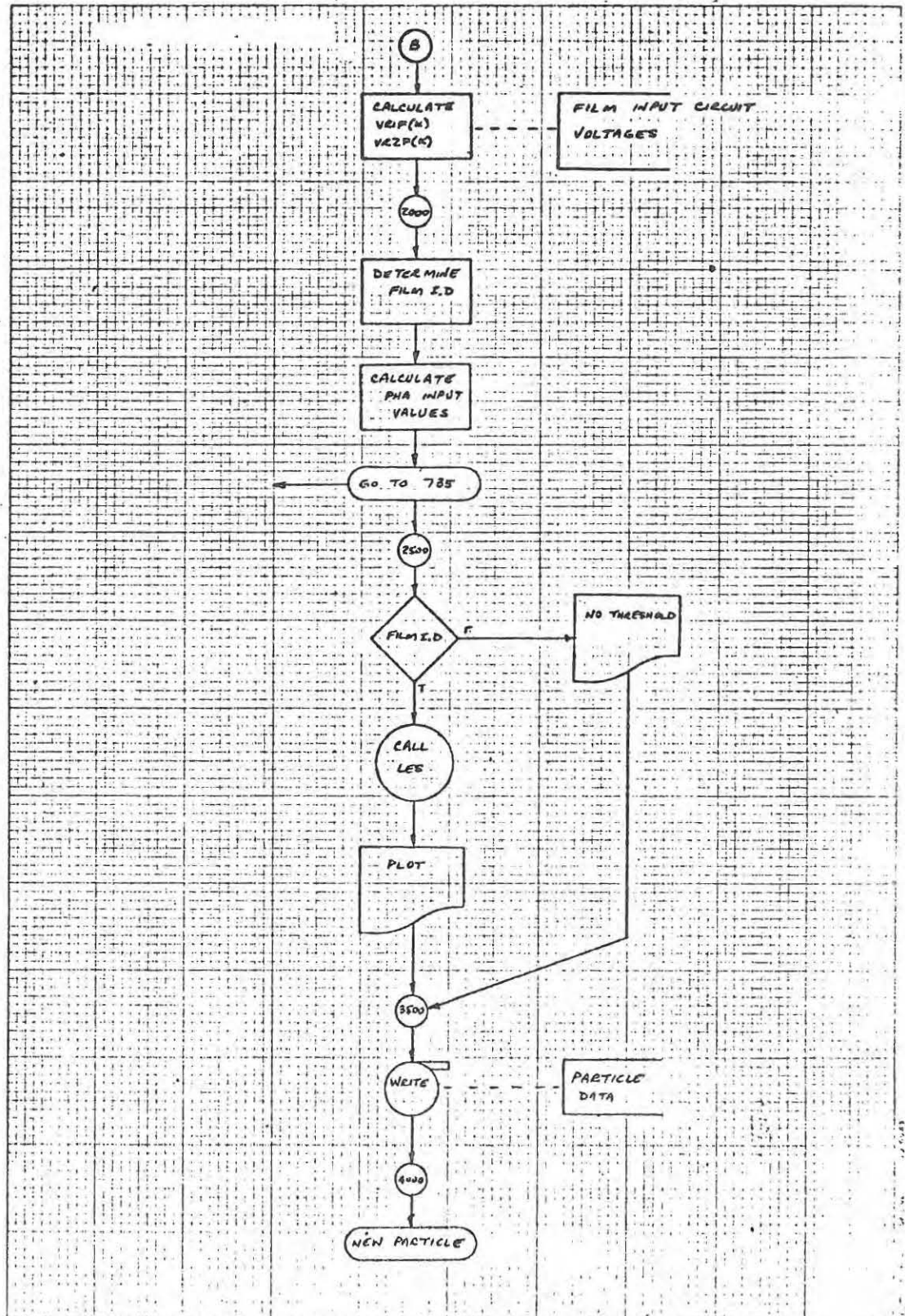
Figure A-2 (Cont.)
A-65

Figure A-2 (Cont.)

P5072SGF

```
C
C
C   NF IS DATA SET REF. NUMBER FOR PARTICLE PATH DATA
C   NDOUT IS DATA SET REF. NUMBER FOR OUTPUT DATA SETS AS FOLLOWS
C          POSITIVE CHARGE : UP & EAST NORMAL PATH    20
C                            WEST SENSOR              21
C                            EAST SHIELDED FILM       22
C          NEGATIVE CHARGE : UP & EAST NORMAL PATH    23
C                            WEST SENSOR              24
C                            EAST SHIELDED FILM       25
C   NOTE : REF. NOS. 22 & 25 MUST BE USED FOR  SHIELDED FILM DATA SETS
C
C
        DIMENSION DATA(2,1000),IBUF(1000),BLANK(8),CC(4,500),CF(4,500)
        DIMENSION IG(4),IFM(4),C1G(4),C2G(4),C1F(4),C2F(4),VCG(4),VCF(4)
        DIMENSION VIDG(4),TIMF(4),TIMG(4),VR1F(4),VR2F(7),VR1G(4),VR2G(7)
        DIMENSION VIDF(4),CPOT(500),EPOT(500),DIST(500)
```

```
         REAL M
         INTEGER OUT
  600 READ(5, 6000, END=5000)NUM, OUT, VEL, QMAX, IX, IPNUM, Q, M, KODE, NF, NDOUT
         READ(5, 6010)QRG, QMN, QFR, QCON, WRG, WMN, WFR, WCON, AXLEQ, AXLEM
         WRITE(6, 6020)QRG, QMN, QFR, QCON, WRG, WMN, WFR, WCON, AXLEQ, AXLEM
         SHLD=0. 0
         IF(NDOUT. EQ. 22)SHLD=5. 4864E-3
         IF(NDOUT. EQ. 25)SHLD=5. 4864E-3
         IF(KODE. LT. 10)GO TO 603
C    DEFINE PLOT AXES & TITLE
         CALL PLOTS(IBUF, 1000, 0)
         CALL PLOT(1. 0, 1. 0, -3)
         CYC=2. 30259*WCON
         DTV=1/CYC
         CALL LGAXIS(0. 0, 0. 0, 6H-LN    M, -6, AXLEM, 0. 0, WFR, DTV)
         CYC=2. 30259*QCON
         DTV=1/CYC
         CALL LGAXIS(0. 0, 0. 0, 6H-LN    Q, 6, AXLEQ, 90. , QFR, DTV)
         YAX=AXLEQ+0. 5
         CALL SYMBOL(0. 5, YAX, . 14, 15HVELOCITY (M/S) , 0. 0, 15)
         CALL NUMBER(999. , 999. , . 14, VEL, 0. 0, -1)
C    FINISH AXES DEFINITION
C
C PARTICLE PATH  CHARACTERISTICS
  603 REWIND NF
         READ(NF)X, Y, NPTS, BLANK
         WRITE(6, 6030)VEL, X, Y, NPTS, IX, NF, NDOUT
         DO 605 K=1, NPTS
         READ(NF)DIST(K), EPOT(K), CPOT(K), (CC(L, K), L=1, 4), (CF(L, K), L=1, 4)
  605 CONTINUE
  609 DO 4000 KP=1, NUM
         WRITE(6, 6035)KP
         IF(KODE. LT. 1)GO TO 625
  610 IY=IX*65539
         IF(IY)615, 616, 616
  615 IY=IY+2147483647+1
  616 YFL=IY
         YFL=YFL*. 4656613E-09
         IX=IY
         YFL=YFL-0. 5
         RANDQ=YFL*QRG+QMN
         QSV=EXP(RANDQ/QCON)
         QVAL=QSV*(-QFR)
         Q=EXP(QVAL)
  618 IY=IX*65539
         IF(IY)619, 620, 620
  619 IY=IY+2147483647+1
  620 YFL=IY
         YFL=YFL*. 4656613E-09
         IX=IY
         YFL=YFL-0. 5
         RANDM=YFL*WRG+WMN
         NSV=EXP(RANDM/WCON)
         NVAL=NSV*(-WFR)
         M=EXP(NVAL)
C INITIALIZATION
  625 TIME=0. 0
         NDT=0
         ND=1
         NFID=0
         NGID=0
         NDGT=999
         NDFT=999
         VEL1=VFL
         LP=0
         DO 700 I=1, 4
```

```
        IFM(I)=0
        IG(I)=0
        C1G(I)=0.0
        C1F(I)=0.0
        VCG(I)=0.0
        VCF(I)=0.0
        VIDG(I)=0.0
        VIDF(I)=0.0
        C2G(I)=0.0
        C2F(I)=0.0
  700 CONTINUE
        ENRGY=0.5*M*VEL*VEL
C DETERMINE  STARTING CONDITIONS
        DO 726 J=2,12
        IF(DIST(J).LE.1.369E-2)GO TO 730
        JJ=J
        TINC=(DIST(J-1)-DIST(J))/VEL
        DO 725 K=1,4
        C2G(K)=Q*(CC(K,J)-CC(K,J-1))/TINC
        C1G(K)=C2G(K)
        C2F(K)=Q*(CF(K,J)-CF(K,J-1))/TINC
        C1F(K)=C2F(K)
        IF(C2G(K).LT.-0.4E-9.OR.C2F(K).GT.0.4E-9)GO TO 730
  725 CONTINUE
  726 CONTINUE
  730 POT1 =Q*EPOT(JJ-1)+Q*Q*CPOT(JJ-1)
  735 J=JJ+ND
        LP=LP+1
        IF(IPNUM.EQ.0)GO TO 736
        IF(KP.NE.IPNUM)GO TO 738
  736 IF(LP.LT.OUT)GO TO 738
  737 LP=0
        WRITE(6,6040)C2G,C2F,TIME,DIST(J-1)
  738 IF(DIST(J).GT.SHLD)GO TO 739
        DATA(1,J)=TIME
        DATA(2,J)=0.0
        GO TO 2500
  739 ND=ND+1
        POT2 =Q*EPOT(J)+Q*Q*CPOT(J)
        WORK=POT2-POT1
        REM=ENRGY-WORK
        IF(REM.GT.0.0)GO TO 745
  740 IF(DIST(J).GE..67564E-2)GO TO 741
        WRITE(6,6050)J
        GO TO 2500
  741 IF(DIST(J).GE..97028E-2)GO TO 742
        WRITE(6,6060)J
        GO TO 2500
  742 WRITE(6,6070)J
        GO TO 2500
  745 VEL2=SQRT(2*REM/M)
        AVEL=(VEL1+VEL2)/2
        TINC=(DIST(J-1)-DIST(J))/AVEL
        TIME=TIME+TINC
        VEL1=VEL2
C CALCULATE NEW GRID AND FILM CURRENTS
        DO 800 K=1,4
        C2G(K)=Q*(CC(K,J)-CC(K,J-1))/TINC
        C2F(K)=Q*(CF(K,J)-CF(K,J-1))/TINC
  800 CONTINUE
C   COLLECTOR GRID ID
        DO 1000 K=1,4
        SLP=(C2G(K)-C1G(K))/TINC
        SUM1=0.5*EXP(-2.272727273E3*TINC)*(2.2E5*C1G(K)+VCG(K))
        SUM2=(1-EXP(-2.272727273E3*TINC))*(2.2E5*C1G(K)-48.4*SLP)
        SUM3=2.2E5*SLP*TINC
```

```
      VR1G(K)=SUM1+SUM2+SUM3
      SUM4=0.5*EXP(-2.272727273E3*TINC)*(2.2E5*C1G(K)-VCG(K))
      SUM5=SLP*48.4*(1-EXP(-2.272727273E3*TINC))
      VR2G(K)=SUM4+SUM5
      C1G(K)=C2G(K)
      VCG(K)=VR1G(K)-VR2G(K)
1000  CONTINUE
      IF(ND.LE.NDGT+1)GO TO 1010
      IF(TIME.GT.TIMG(1)+2E-7)GO TO 1100
1010  IF(NGID.EQ.4)GO TO 1100
      VR2G(5)=VR2G(1)
      VR2G(6)=VR2G(2)
      VR2G(7)=VR2G(3)
      DO 1100 K=1,4
      IF(IG(K).EQ.1)GO TO 1100
      VID=15.75*VR2G(K)-1.47*(VR2G(K+1)+VR2G(K+2)+VR2G(K+3))
      IF(VID.LE.-.12E-1)GO TO 1050
      VIDG(K)=VID
      GO TO 1100
1050  IF(NGID.GT.0)GO TO 1060
      NDGT=ND
      IG(K)=1
      NGID=1
      TIMG(1)=(.12E-1-VIDG(K))*TINC/(VID-VIDG(K))
      TIMG(1)=TIMG(1)+TIME-TINC
      IF(NFID.GT.0)GO TO 1100
      TIMID=TIMG(1)
      GO TO 1100
1060  NGID=NGID+1
      TIMG(NGID)=(.12E-1-VIDG(K))*TINC/(VID-VIDG(K))
      TIMG(NGID)=TIMG(NGID)+TIME-TINC
      IF(TIMG(NGID)-TIMG(1).LT.2E-7)IG(K)=1
1100  CONTINUE
C  FILM  ID
      DO 2000 K=1,4
      SLP=(C2F(K)-C1F(K))/TINC
      SUM1=0.5*EXP(-2.272727273E3*TINC)*(2.2E5*C1F(K)+VCF(K))
      SUM2=(1-EXP(-2.272727273E3*TINC))*(2.2E5*C1F(K)-48.4*SLP)
      SUM3=2.2E5*SLP*TINC
      VR1F(K)=SUM1+SUM2+SUM3
      SUM4=0.5*EXP(-2.272727273E3*TINC)*(2.2E5*C1F(K)-VCF(K))
      SUM5=SLP*48.4*(1-EXP(-2.272727273E3*TINC))
      VR2F(K)=SUM4+SUM5
      C1F(K)=C2F(K)
      VCF(K)=VR1F(K)-VR2F(K)
2000  CONTINUE
      IF(ND.LE.NDFT+1)GO TO 2010
      IF(TIME.GT.TIMF(1)+2E-7)GO TO 2100
2010  IF(NFID.EQ.4)GO TO 2100
      VR2F(5)=VR2F(1)
      VR2F(6)=VR2F(2)
      VR2F(7)=VR2F(3)
      DO 2100 K=1,4
      IF(IFM(K).EQ.1)GO TO 2100
      VID=-15.75*VR2F(K)+1.47*(VR2F(K+1)+VR2F(K+2)+VR2F(K+3))
      IF(VID.LE.-.12E-1)GO TO 2050
      VIDF(I)=VID
      GO TO 2100
2050  IF(NFID.GT.0)GO TO 2060
      NDFT=ND
      IFM(K)=1
      NFID=1
      TIMF(1)=(.12E-1-VIDF(K))*TINC/(VID-VIDF(K))
      TIMF(1)=TIMF(1)+TIME-TINC
      IF(NGID.GT.0)GO TO 2100
      TIMID=TIMF(1)
```

```
              GO TO 2100
  2060 NFID=NFID+1
       TIMF(NFID)=(.12E-1-VIDF(K))*TINC/(VID-VIDF(K))
       TIMF(NFID)=TIMF(NFID)+TIME-TINC
       IF(TIMF(NFID)-TIMF(1).LT.2E-7)IFM(K)=1
  2100 CONTINUE
C CALCULATE  PHA  VALUES
       SVR1F=VR1F(1)+VR1F(2)+VR1F(3)+VR1F(4)
       IF(NDT.GT.1)GO TO 2150
       IF(SVR1F.LT..1E-3)GO TO 735
       DATA(1,1)=TIME-TINC
       DATA(2,1)=0.0
       DATA(1,2)=TIME
       DATA(2,2)=SVR1F
       NDT=2
       GO TO 735
  2150 NDT=NDT+1
       DATA(1,NDT)=TIME
       DATA(2,NDT)=SVR1F
       GO TO 735
  2500 IF(NFID.EQ.0)GO TO 2700
       IF(NGID.EQ.0)GO TO 2510
       IF(TIMG(1)+.1E-2.LT.TIMF(1))GO TO 2700
  2510 ETIME=TIMID+.1E-2
  3000 CALL LES(DATA,NDT,ETIME,OUT,KP,IPNUM,NPHA,NACC)
       IF(KODE.LT.10)GO TO 3500
C   PREPARE TO PLOT PHA VALUE
       PHA=NPHA
C   PLOT VALUE
       CALL SYMBOL (RANDM,RANDQ,.01,75,0.0,-1)
       CALL NUMBER(999.,999.,.07,PHA,0.0,-1)
       IF(NACC.LT.2)GO TO 3500
       CALL SYMBOL(999.,999.,.03,125,0.0,-1)
       GO TO 3500
  2700 WRITE(6,7000)
  3500 AQ=ABS(Q)
       AQL=ALOG(AQ)
       AML=ALOG(M)
       IGTOT=IG(1)+IG(2)*2+IG(3)*4+IG(4)*8
       IFTOT=IFM(1)+IFM(2)*2+IFM(3)*4+IFM(4)*8
       WRITE(NDOUT)VEL,Q,M,IGTOT,IFTOT,NPHA,NACC
       WRITE(6,6080)Q,M,IG,IFM
       WRITE(6,7010)AQL,AML
  4000 CONTINUE
       IF(KODE.LT.10)GO TO 4500
       CALL SYMBOL(20.,0.0,.14,11,0.0,-1)
       CALL SYMBOL(20.,10.,.14,11,0.0,-2)
       CALL PLOT(22.,-1.,-3)
  4500 GO TO 600
  5000 CONTINUE
       IF(KODE.LT.10)GO TO 5100
       CALL PLOT(0.,0.,999)
  5100 CONTINUE
  6000 FORMAT(2I3,F7.2,E10.4,I6,I3,2E10.4,3I3)
  6010 FORMAT(2(2F4.2,E8.2,F10.8),2F4.2)
  6020 FORMAT(1X,2(2F5.2,E8.2,F11.8),2F5.2)
  6030 FORMAT(5X,'VELOCITY = ',E10.4,2X,'X ORD = ',F8.3,2X,'Y ORD = ',F8.
      23//4X,'NO. OF STEPS = ',I4,2X,'RANDU = ',I6,2X,'PATH DATA SET = ',
      3I3,'OUTPUT DATA SET = ',I3)
  6035 FORMAT('0','PARTICLE NUMBER ',I3//)
  6040 FORMAT(5X,'CURRENT: GRID1 = ',E8.2,4X,'GRID2 = ',E8.2,4X,'GRID3 =',
      2,F8.2,4X,'GRID4 = ',E8.2//13X,'FILM1 = ',E8.2,4X,'FILM2 = ',E8.2,4
      3X,'FILM3 = ',E8.2,4X,'FILM4 = ',E8.2,4X,'TIME = ',E9.3,4X,'DIST =
      4',E9.3)
  6050 FORMAT(5X,'PARTICLE STOPS BEFORE FILM AT STEP',2X,I3//)
  6060 FORMAT(5X,'PARTICLE STOPS BEFORE GRID AT STEP',2X,I3//)
       STOPS BEFORE SUPPRESSOR AT STEP',2X,I3//)
  6080 FORMAT(5X,'CHARGE = ',E9.3,' MASS = ',E9.3,' GRID ID = ',4I2,' FIL
      5M ID = ',4I2//)
  7000 FORMAT(4X,' SIGNAL BELOW THRESHOLD '//)
  7010 FORMAT(5X,'LOG Q = ',E9.3,5X,'LOG M = ',E9.3//)
```

```
      SUBROUTINE LES (DATA, ND, ETIME, OUT, K, IPNUM, NPHA, NACC)
C
C     REVISED  15 DEC 1975
C
      DIMENSION DATA(2,1000)
      COMMON VCI, VC1, VC4, VC5, VC8, TC1, TC2, TC3, TC4, TC5, TC6, VAL1, VAL2, X, SLP
      INTEGER SWAB, OUT
      VR1=0.0
      VR2=0.0
      VR32=0.0
      VR3=0.0
      VR12=0.0
      VR9=0.0
      SWAB=4
      IVR9=2
      NACC=0
      VCI=0.0
      VC1=0.0
      VC4=0.0
      VC5=0.0
      VC8=0.0
      TC1=.4545454545E4
      TC2=.350140056E4
      TC3=.4948045522E5
      TC4=.1052867643E3
      TC5=.2195226115E5
      TC6=.73021894
      J=0
      NPHA=0
      TIME=DATA(1, ND)
      KOUNT=ND
      L=ND+1
      DO 2020 I=L, 1000
      IF(TIME. GE. ETIME)GO TO 2025
      TIME=TIME+2E-6
      KOUNT=KOUNT+1
      DATA(1, I)=TIME
 2020 CONTINUE
 2025 L=ND+1
      IF(KOUNT. LT. L)GO TO 2030
      DO 2030 I=L, KOUNT
      DATA(2, I)=0.0
 2030 CONTINUE
      IF(K. NE. IPNUM)GO TO 2080
      IF(OUT. GT. 500)GO TO 2080
      WRITE(6, 3100)
 2080 INC=2
 3100 IF(INC. EQ. KOUNT+1)GO TO 2800
      T2=DATA(1, INC)
      T1=DATA(1, INC-1)
      VAL1=DATA(2, INC-1)
      VAL2=DATA(2, INC)
      INC=INC+1
C
C     CALCULATE INPUT SLOPE (SLP)
C
      Y=VAL2-VAL1
      X=T2-T1
      SLP=Y/X
      IF(SLP. LT. 0.0)GO TO 2160
C
```

```
C   CALCULATE CONDITION 1 VALUES
C
 2150 CALL COND1 (VR32, VR1, VR2, VR9, VR12)
      CALL CVOLT (VR32, VR1, VR2, VR9, VR12)
      KOND=1
      GO TO 2600
C
C    POSITIVE SLOPE - CALCULATE SWITCH STATUS
C
 2160 VR202=VR2
      VR112=VR12
      VR132=VR32
      CALL COND1 (VR132, VR101, VR102, VR109, VR112)
      CALL COND2(VR202, B, C)
      RVR1=VR101-VR1
      RVR2=VR202-VR2
      IF(RVR1, LE, RVR2)GO TO 2170
      SWAB=SWAB-1
      GO TO 2180
 2170 VR2=VR1
 2180 GO TO (2181, 2181, 2184, 2186), SWAB
 2181 STOP 181
 2184 IF(VR12, EQ, 0, 0)GO TO 2390
      VR202=VR2
      CALL COND2 (VR202, VR209, VR212)
      CALL COND3 (VR309, VR312)
      RVR2=VR202-VR2
      RVR12=VR312-VR12
      IF(RVR2, GT, RVR12)GO TO 2390
      GO TO 2200
 2186 IF(VR12, EQ, 0, 0)GO TO 2290
      VR112=VR12
      VR132=VR32
      CALL COND1 (VR132, VR101, VR102, VR109, VR112)
      CALL COND3 (VR309, VR312)
      RVR2=VR102-VR2
      RVR12=VR312-VR12
      IF(RVR2, GT, RVR12)GO TO 2290
      GO TO 2150
C
C   CALCULATE VALUES UNDER CONDITION 2
C
 2200 CALL COND2 (VR2, VR9, VR12)
      CALL COND1 (VR32, VR1, A, B, C)
      CALL CVOLT (VR32, VR1, VR2, VR9, VR12)
      KOND=2
      GO TO 2600
 2250 IF(INC, EQ, KOUNT+1)GO TO 2800
      T2=DATA(1, INC)
      T1=DATA(1, INC-1)
      VAL1=DATA(2, INC-1)
      VAL2=DATA(2, INC)
      INC=INC+1
      Y=VAL2-VAL1
      X=T2-T1
      SLP=Y/X
      VR202=VR2
      VR112=VR12
      VR132=VR32
      CALL COND1 (VR132, VR101, VR102, VR109, VR112)
      CALL COND2(VR202, A, B)
      IF(VR101, LE, VR202) SWAB=SWAB+1
      GO TO 2180
C
C   CALCULATE VALUES UNDER CONDITION 3
C
```

```
2290  SWAB=SWAB-2
2300  CALL COND1(VR32, VR1, VR2, A, B)
      CALL COND3(VR9, VR12)
      CALL CVOLT (VR32, VR1, VR2, VR9, VR12)
      KOND=3
      GO TO 2600
2350  IF(INC. EQ. KOUNT+1)GO TO 2800
      T1=DATA(1, INC-1)
      T2=DATA(1, INC)
      VAL1=DATA(2, INC-1)
      VAL2=DATA(2, INC)
      INC=INC+1
      Y=VAL2-VAL1
      X=T2-T1
      SLP=Y/X
      IF(SLP. GE. 0. 0)GO TO 2370
      VR202=VR2
      VR112=VR12
      VR132=VR32
      CALL COND1 (VR132, VR101, VR102, VR109, VR112)
      CALL COND2(VR202, B, C)
      RVR1=VR101-VR1
      RVR2=VR202-VR2
      IF(RVR1. LE. RVR2)GO TO 2360
      SWAB=SWAB-1
      GO TO 2370
2360  VR2=VR1
      VR132=VR32
2370  GO TO (2380, 2375, 2380, 2375), SWAB
2375  CALL COND1 (VR132, VR101, VR102, VR109, VR112)
      CALL COND3(A, VR312)
      IF(VR101. LE. VR312) GO TO 2378
      GO TO 2300
2378  SWAB=SWAB+2
      GO TO 2150
2380  VR202=VR2
      CALL COND2(VR202, A, B)
      CALL COND3(A, VR312)
      IF(VR202. LE. VR312)GO TO 2385
      GO TO 2400
2385  SWAB=SWAB+2
      GO TO 2200
2390  SWAB=SWAB-2
C
C   CALCULATE VALUES UNDER CONDITION 4
C
2400  CALL COND1(VR32, VR1, A, B, C)
      CALL COND2(VR2, A, B)
      CALL COND3(VR9, VR12)
      CALL CVOLT (VR32, VR1, VR2, VR9, VR12)
      KOND=4
      GO TO 2600
2450  IF(INC. EQ. KOUNT+1)GO TO 2800
      T1=DATA(1, INC-1)
      T2=DATA(1, INC)
      VAL1=DATA(2, INC-1)
      VAL2=DATA(2, INC)
      INC=INC+1
      Y=VAL2-VAL1
      X=T2-T1
      SLP=Y/X
      VR202=VR2
      VR112=VR12
      VR132=VR32
      CALL COND1 (VR132, VR101, VR102, VR109, VR112)
      CALL COND2(VR202, A, B)
```

```
         CALL COND3(A, VR312)
         IF(VR101. LE. VR202)GO TO 2500
         IF(VR202. LE. VR312)GO TO 2475
         GO TO 2400
  2475 SWAB=SWAB+2
         GO TO 2200
  2500 SWAB=SWAB+1
         IF(VR101. LE. VR312)GO TO 2550
         GO TO 2300
  2550 SWAB=SWAB+2
         GO TO 2150
  2600 IF(IPNUM. EQ. 0)GO TO 2601
         IF(K. NE. IPNUM)GO TO 2603
  2601 IF(J-OUT)2603, 2602, 2602
  2602 J=0
         WRITE(6, 3000)T2, VR32, VR1, VR2, VR12, VR9, SWAB
         GO TO 2605
  2603 J=J+1
  2605 IF(VR9. LE. -. 1E-01)GO TO 2620
         GO TO (2610, 2750), IVR9
  2610 PT2=T2
         IVR9=2
         TPHA=PT2-PT1
         NUM=TPHA/. 4E-04
         NPHA=NPHA+NUM
         GO TO 2750
  2620 TIMID=ETIME-. 1E-2
         IF(T2. LT. TIMID)GO TO 2750
         GO TO (2630, 2640), IVR9
  2630 IF(INC. LT. KOUNT+1)GO TO 2750
         PT2=T2
         TPHA=PT2-PT1
         NUM=TPHA/. 4E-04
         NPHA=NPHA+NUM
         GO TO 2800
  2640 PT1=T2
         IVR9=1
         IF(NACC. EQ. 0)NPHA=1
         NACC=NACC+1
  2750 GO TO (2100, 2250, 2350, 2450), KOND
  2800 CONTINUE
         WRITE(6, 3700)NPHA, NACC
  3000 FORMAT(7X, 6(E12. 6, 6X), 5X, I2)
  3100 FORMAT(11X, 'TIME', 14X, 'VR32', 14X, 'VR1', 16X, 'VR2', 14X, 'VR12', 14X, 'V
      2R9', 12X, 'SWITCH A/B'//)
  3700 FORMAT('0', 5X, 'PHA = ', I3, 10X, 'ACCUMULATOR COUNT = ', I3)
         RETURN
```

```fortran
      SUBROUTINE COND1(VR32, VR1, VR2, VR9, VR12)
C
C   REVISED 26 SEPT 1975
C
      COMMON VCI, VC1, VC4, VC5, VC8, TC1, TC2, TC3, TC4, TC5, TC6, VAL1, VAL2, X, SLP
      REAL MR12, MR32
      INTEGER VS1AB, VS2AB
      VS1A=-10*VR32
      VR32=(VAL1-VCI)*EXP(-TC1*X)+SLP*(1-EXP(-TC1*X))/TC1
      VS1B=-10*VR32
      VS1AB=1
      IF(ABS(VS1A).LT.5.0)GO TO 200
      VS1A=SIGN(5.0, VS1A)
      VS1AB=VS1AB+1
  200 IF(ABS(VS1B).LT.5.0)GO TO 400
      VS1B=SIGN(5.0, VS1B)
      VS1AB=VS1AB+2
  400 GO TO (500,600,600,600),VS1AB
  500 VR1=.95780487E-2*(VCI-VAL1)*(TC1*EXP(-TC1*X)-TC2*EXP(-TC2*X))-.957
     180487E-2*SLP*(EXP(-TC2*X)-EXP(-TC1*X))-VC1*EXP(-TC2*X)
      VR2=VR1
      IF(VR2.LT.-5.0)VR2=-5.0
      IF(VR2.GT.5.0)VR2=5.0
      VS2A=VR12
      VR12=VR2
      VS2B=VR12
      VS2AB=1
      IF(ABS(VS2A).LT.5.0)GO TO 530
      VS2A=SIGN(5.0, VS2A)
      VS2AB=VS2AB+1
  530 IF(ABS(VS2B).LT.5.0)GO TO 550
      VS2B=SIGN(5.0, VS2B)
      VS2AB=VS2AB+2
  550 GO TO (560,570,570,570),VS2AB
  560 VR9=(VC8*3.3E-8-VC4*6.8E-6)*EXP(-TC4*X)/6.833E-6+0.99517*(10*(VCI-
     2VAL1)*(4.456893965*EXP(-TC1*X)-3.457629098*EXP(-TC2*X)+7.35133E-4*
     3EXP(-TC4*X))-10*SLP*(.980166724E-03*(1-EXP(-TC1*X))-.9874988704E-
     403*(1-EXP(-TC2*X))+.69821980586E-05*(1-EXP(-TC4*X)))-VC1*(3.5014005
     56*EXP(-TC2*X)-.1052867643*EXP(-TC4*X))/3.396113796)
      GO TO 900
  570 MR12=(VS2B-VS2A)/X
      SUM1=(VC8*3.3E-8-VC4*6.8E-6+VS2A*6.8E-6)*EXP(-TC4*X)/6.833E-6
      SUM2=9.452E-3*MR12*(1-EXP(-TC4*X))
      VR9=SUM1+SUM2
      GO TO 900
  600 MR32=(VS1B-VS1A)/X
      VR1=(VS1A-VC1)*EXP(-TC2*X)+MR32*(1-EXP(-TC2*X))/TC2
      VR2=VR1
      IF(VR2.LT.-5.0)VR2=-5.0
      IF(VR2.GT.5.0)VR2=5.0
      VS2A=VR12
      VR12=VR2
      VS2B=VR12
      VS2AB=1
      IF(ABS(VS2A).LT.5.0)GO TO 630
      VS2A=SIGN(5.0, VS2A)
      VS2AB=VS2AB+1
  630 IF(ABS(VS2B).LT.5.0)GO TO 650
      VS2B=SIGN(5.0, VS2B)
      VS2AB=VS2AB+2
  650 GO TO (660,570,570,570),VS2AB
```

```
      660 SUM3=1. 463486024E5*(3. 3E-8*VC8-6. 8E-6*VC4)*EXP(-TC4*X)
          SUM4=2. 930321408E-04*(VS1A-VC1)*(TC2*EXP(-TC2*X)-TC4*EXP(-TC4*X))
          SUM5=2. 930321408E-04*MR32*(EXP(-TC4*X)-EXP(-TC2*X))
          VR9=SUM3+SUM4+SUM5
          GO TO 900
      900 CONTINUE
          RETURN
          END
          SUBROUTINE COND2(VR2,VR9,VR12)
C
C   REVISED 26 SEPT 1975
C
          COMMON VCI,VC1,VC4,VC5,VC8,TC1,TC2,TC3,TC4,TC5,TC6,VAL1,VAL2,X,SLP
          REAL MR12,MR32
          INTEGER VS2AB
          VR2=5*(1-EXP(-TC3*X))+VR2*EXP(-TC3*X)
          IF(VR2. LT. -5. 0)VR2=-5. 0
          IF(VR2. GT. 5. 0)VR2=5. 0
      150 GO TO (200,300,300,300),VS2AB
      200 VR9=(VC8*3. 3E-8-VC4*6. 8E-6)*EXP(-TC4*X)/6. 833E-6-0. 99517*(VR2*(TC4
         1*EXP(-TC4*X)-TC3*EXP(-TC3*X))/4. 937516846E4+5. 010661914*(EXP(-TC3*
         2X)-EXP(-TC4*X)))
          GO TO 900
      300 MR12=(VS2B-VS2A)/X
          SUM1=(VC8*3. 3E-8-VC4*6. 8E-6+VS2A*6. 8E-6)*EXP(-TC4*X)/6. 833E-6
          SUM2=9. 452E-3*MR12*(1-EXP(-TC4*X))
          VR9=SUM1+SUM2
      900 CONTINUE
          RETURN
          END
          SUBROUTINE COND3(VR9,VR12)
          COMMON VCI,VC1,VC4,VC5,VC8,TC1,TC2,TC3,TC4,TC5,TC6,VAL1,VAL2,X,SLP
          SUMA=(TC5*EXP(-TC5*X)-TC6*EXP(-TC6*X))/2. 195153128E4
          SUMB=(EXP(-TC6*X)-EXP(-TC5*X))/2. 195153128E4
          VR12=(VC4+VC8)*SUMA+. 2186074122E5*VC4*SUMB
          VR9=VC8*SUMA+2. 228163993E7*(VC8*3. 3E-8-VC4*6. 8E-6)*SUMB
          RETURN
          END
          SUBROUTINE CVOLT(VR32,VR1,VR2,VR9,VR12)
C
C   REVISED 24 SEPT 1975
C
          COMMON VCI,VC1,VC4,VC5,VC8,TC1,TC2,TC3,TC4,TC5,TC6,VAL1,VAL2,X
          VCI=VAL2-VR32
          VS1B=-10*VR32
          IF(VS1B. LT. -5. 0)VS1B=-5. 0
          IF(VS1B. GT. 5. 0)VS1B=5. 0
          VC1=VS1B-VR1
          VC5=VR2
          VC4=VR12-VR9
          VC8=VR9
          RETURN
          END
```

A.3 P5072INT DATA SELECTION PROGRAM

A.3.1 Summary

The sensor and electronics model programs produce sets of data for particles on particular paths. These data sets include all types of events in random order for a particular sensor and path. The data selection program was prepared to allow selection of all particles giving a particular response or combination of responses. The range of particles obtained can then be correlated with the lunar data for that response or combination of responses, thereby giving important data for the formation of hypotheses regarding particle sources and transport theory.

The program selects the responses to be analyzed by referencing a code inserted on an input card. The output can be selected as either a printed listing or a CalComp plot.

A.3.2 Description

The type and number of selections are read from a data card. This card defines the type of event to be selected, the velocity of the particles of interest, whether or not the data are to be plotted, the data set reference number of the data to be analyzed, and the number of data sets to be recorded per list/plot.

If a list is desired, the headings are written out; if a plot is required, a card is read which defines the size of the axes and scales. The data required by the plotting routine to set up the axes and titles are then produced.

The data set to be analyzed is read from tape a record at a time, and each record is analyzed for conformance with the characteristics selected on the input card and either plotted, listed, or rejected. When all records from that data set are analyzed, a check is instituted to determine if more than one event type is to be plotted or listed on the one output medium or whether more analyses are to be performed.

The selections available are as follows.

The variable KIND, of dimension 8, selects the options by setting a 1 in the respective array member corresponding to the item number below:

1. All PHA events listed or plotted.

2. Coincident film and collector grid events.

3. Film only events.

4. Multiple accumulator events.

5. Multiple, adjacent, film events.

6. Multiple, adjacent, grid events.

7. Multiple, nonadjacent, film events.

8. Multiple, nonadjacent, grid events.

The desired sensor and the east sensor shielded film are selected by data set reference number. Particular velocities or all velocities are selected by the velocity parameter on the input cards. If all velocities are required, VEL is set to zero. The plotted output symbol is related to IK, which indicates the selection code. IK is a combination of the codes listed in KIND, i.e., 1 to 8 for single plots or 24, say, for coincident, multiple accumulator events.

A.3.3   Method of Use

Three input data cards are required if a plot of the data is requested; if a printed list is requested, the third card must be omitted.

The first card data requirements are:

Column   Requirement

1-8   KIND; Place 1 in the positions corresponding to the desired options.

9-15   VEL: the velocity of the desired selections. If all velocities are required, leave columns blank (Format F7.2).

16   LOP: Insert a 1 if a plot is desired, otherwise leave blank.

17-18   IDSR: Input data set reference number (Format I2); from JCL card.

19-22   IK: Code indicating type of selection for titles and plot symbols, e.g., 1 through 8 for single selections or 24 for coincident multiple accumulator, etc. (Format I4).

23-24   NDSPP: Number of data sets to be recorded/plotted. If more than one data set or selection is to be recorded on the same list or plot, another card identical to card 1 is required with columns 23 and 24 blank.

The second card requires an alpha-numeric title in the first 28 columns. This title is used in both the plotted and printed outputs.

The third card is identical to card two in program P5072SGF. A data tape is required which carries the results from program P5072SGF.

The program will repeat for each additional set of cards.

A.3.4   Flow Charts and Program Listings

A flow chart of the program is shown in Figure A-3 and a program listing is provided on pages A-83 through A-84.
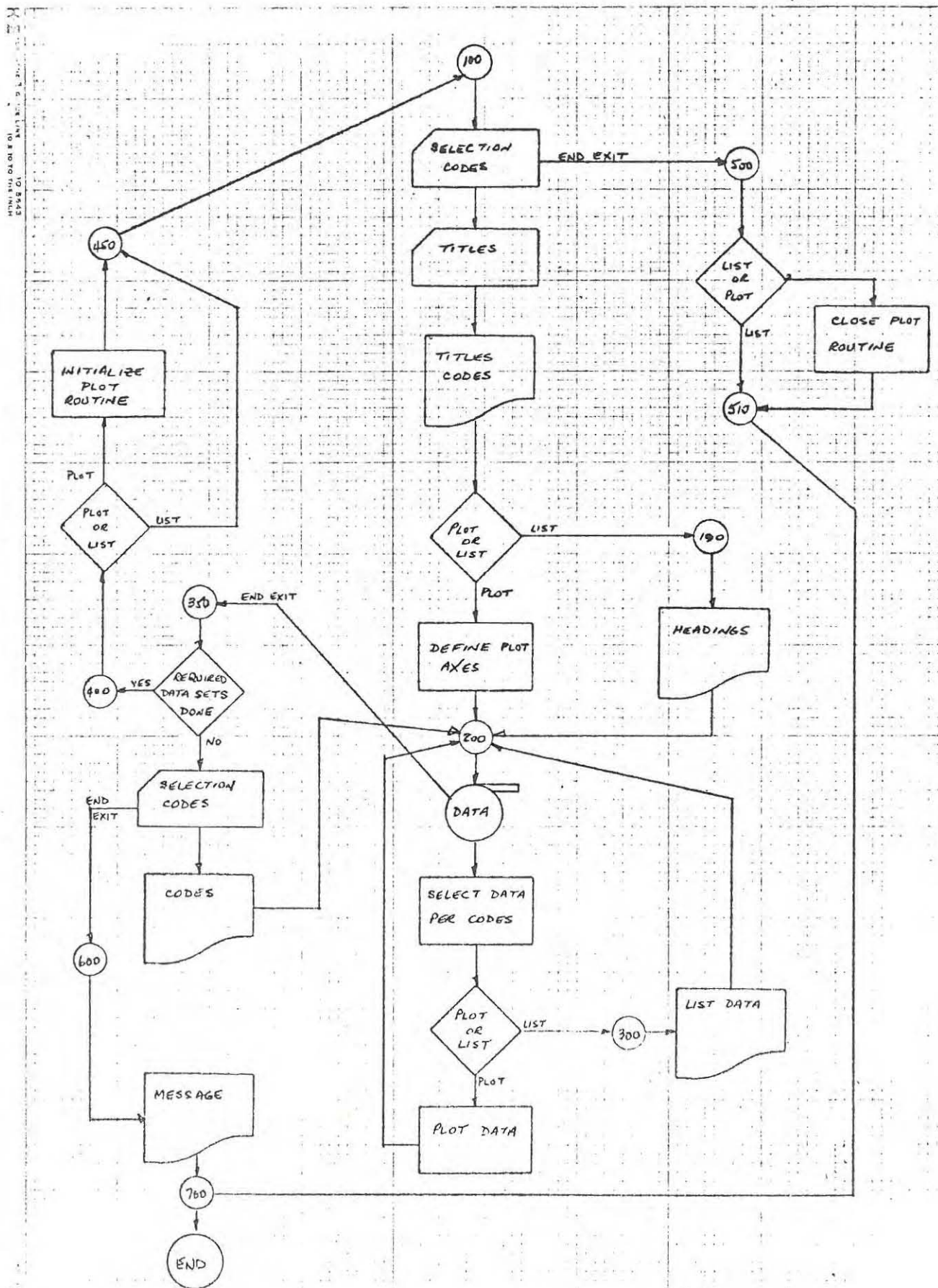
Figure A-3 P5072INT Data Selection

P5027INT

F

```
      DIMENSION TITLE(7),KIND(8)
      REAL M
100   READ(5,110,END=500)KIND,VEL,LOP,IDSR,IK,NDSPP
110   FORMAT(8I1,F7.2,I1,I2,I4,I2)
      READ(5,120)TITLE
      WRITE(6,121)TITLE
120   FORMAT(7A4)
121   FORMAT(2X,7A4)
      WRITE(6,370)IDSR,VEL,IK,NDSPP
      J=0
      IF(LOP.EQ.0)GO TO 190
C   DEFINE PLOT AXES AND TITLES
      READ(5,130)QRG,QMN,QFR,QCON,WRG,WMN,WFR,WCON,AXLEQ,AXLEM
130   FORMAT(2(2F4.2,E8.2,F10.8),2F4.2)
      WRITE(6,180)QRG,QMN,QFR,QCON,WRG,WMN,WFR,WCON,AXLEQ,AXLEM
180   FORMAT(30X,2(2F4.2,E8.2,F10.8),2F4.2)
      CALL PLOTS(IBUF,1000,0)
      CALL PLOT(1.0,1.0,-3)
      CYC=2.30259*WCON
      DTV=1/CYC
      CALL LGAXIS(0.0,0.0,5H-LN M,-5,AXLEM,0.0,WFR,DTV)
      CYC=2.30259*QCON
      DTV=1/CYC
      CALL LGAXIS(0.0,0.0,5H-LN Q,5,AXLEQ,90.,QFR,DTV)
      YAX=AXLEQ+0.5
      CALL SYMBOL(0.5,YAX,.14,15HVELOCITY (M/S) ,0.0,15)
      IF(VEL.EQ.0.0)GO TO 115
      CALL NUMBER(999.,999.,.14,VEL,0.0,-1)
      GO TO 125
115   CALL SYMBOL(999.,999.,.14,5H ALL ,0.0,5)
125   CALL SYMBOL(999.,999.,.14,20H   DATA SELECT CODE ,0.0,20)
      YK=IK
      CALL NUMBER(999.,999.,.14,YK,0.0,-1)
      YAX=YAX-0.25
      CALL SYMBOL(0.5,YAX,.14,TITLE,0.0,28)
      GO TO 200
190   WRITE(6,140)
140   FORMAT(22X,'VELOCITY',11X,'CHARGE',12X,'MASS',10X,'GRID ID',7X,'FI
     2LM ID',8X,' PHA',8X,' ACC'//)
C   SELECT DATA REQUIRED BY INPUT CODES
200   READ(IDSR,END=350)$VEL,Q,M,IGTOT,IFTOT,NPHA,NACC
      IF(VEL.EQ.0.0)GO TO 210
      IF($VEL.NE.VEL)GO TO 200
210   IF(KIND(1).EQ.1)GO TO 280
      IF(KIND(2).EQ.0)GO TO 220
      IF(IGTOT.EQ.0)GO TO 200
220   IF(KIND(3).EQ.0)GO TO 230
      IF(IGTOT.GT.0)GO TO 200
230   IF(KIND(4).EQ.0)GO TO 240
      IF(NACC.LT.2)GO TO 200
240   IF(KIND(5).EQ.0)GO TO 250
      IF(IFTOT.EQ.3)GO TO 250
      IF(IFTOT.EQ.6)GO TO 250
      IF(IFTOT.EQ.7)GO TO 250
      IF(IFTOT.EQ.12)GO TO 250
      IF(IFTOT.EQ.14)GO TO 250
      IF(IFTOT.EQ.15)GO TO 250
      GO TO 260
250   IF(KIND(6).EQ.0)GO TO 260
      IF(IGTOT.EQ.3)GO TO 260
```

```
          IF(IGTOT.EQ.6)GO TO 260
          IF(IGTOT.EQ.7)GO TO 260
          IF(IGTOT.EQ.12)GO TO 260
          IF(IGTOT.EQ.14)GO TO 260
          IF(IGTOT.EQ.15)GO TO 260
          GO TO 200
      260 IF(KIND(7).EQ.0)GO TO 270
          IF(IFTOT.EQ.5)GO TO 270
          IF(IFTOT.EQ.9)GO TO 270
          IF(IFTOT.EQ.10)GO TO 270
          GO TO 200
      270 IF(KIND(8).EQ.0)GO TO 280
          IF(IGTOT.EQ.5)GO TO 280
          IF(IGTOT.EQ.9)GO TO 280
          IF(IGTOT.EQ.10)GO TO 280
          GO TO 200
      280 CONTINUE
          IF(LOP.EQ.0)GO TO 300
C    PREPARE TO PLOT  PHA DATA
          PHA=NPHA
          QVAL=ALOG(Q)
          QSV=QVAL/(-QFR)
          RAND=ALOG(QSV)
          RANDQ=RAND*QCON
          WVAL=ALOG(M)
          WSV=WVAL/(-WFR)
          RAND=ALOG(WSV)
          RANDM=RAND*WCON
C    PLOT PHA DATA
          INTEQ=IK
          IF(IK.GT.8)INTEQ=0
          CALL SYMBOL(RANDM,RANDQ,.04,INTEQ,0.0,-1)
          CALL NUMBER(999.,999.,.07,PHA,0.0,-1)
          GO TO 200
C    LIST DATA
      300 WRITE(6,160)*VEL,Q,M,IGTOT,IFTOT,NPHA,NACC
      160 FORMAT(21X,3(E10.4,8X),I4,10X,I4,11X,I3,9X,I3)
          GO TO 200
      350 REWIND IDSR
          J=J+1
          IF(J.EQ.NDSPP)GO TO 400
          READ(5,110,END=600)KIND,VEL,LOP,IDSR,IK
          WRITE(6,370)IDSR,VEL,IK
          GO TO 200
      370 FORMAT(5X,'DATA SET = ',I3,5X,'VEL = ',F7.2,5X,'SELECTION = ',2I4)
      400 CONTINUE
          IF(LOP.EQ.0)GO TO 450
          CALL SYMBOL(20.,0.0,.14,11,0.0,-1)
          CALL SYMBOL(20.,10.,.14,11,0.0,-2)
          CALL PLOT(22.,-1,-3)
      450 GO TO 100
      500 CONTINUE
          IF(LOP.EQ.0)GO TO 510
          CALL PLOT(0.,0.,999)
      510 CONTINUE
          GO TO 700
      600 WRITE(6,170)
      170 FORMAT(21X,'INSUFFICIENT DATA CARDS')
      700 CONTINUE
          END
```

APPENDIX B

SUMMARY STATUS AND
PROPOSED TASKS

LEAM CHARGED PARTICLE ANALYSIS RESULTS TO DATE

- CONFIRMED EXPERIMENT RESPONSE TO CHARGED DUST PARTICLES

- IDENTIFIED OPERATIONAL CHARACTERISTICS CAUSING OBSERVED DATA

- COMPLETED SIMPLIFIED ELECTRONICS MODEL FOR EASY RESPONSE EVALUATION

- COMPLETED DETAILED SENSOR MODEL FOR ANALYSIS OF PARTICLE RESPONSE UP AND EAST SENSORS ONLY (SHOULD BE OPTIMIZED FOR COST EFFECTIVENESS)

- COMPLETED PROGRAMS FOR ANALYSIS OF PARTICLE DATA

- IDENTIFIED PRELIMINARY BOUNDARIES FOR PARTICLE MASS CHARGE AND VELOCITY

ANALYSIS OBJECTIVES TO COMPLETE

- CHARACTERIZE PARTICLES RELATIVE TO OBSERVED RESPONSES

- EXPLAIN DIFFERENT EVENTS IN TERMS OF MASS, CHARGE AND VELOCITY

- CORRELATE ANALYTICAL CHARACTERISTICS WITH LUNAR AND TEMPORAL EFFECTS

- SUPPORT CALIBRATION TEST PROGRAM (CONCORDIA)

- CORRELATE TESTS OF QUAL. MODEL CHARGED PARTICLE RESPONSE WITH ANALYSIS

- PREPARE HYPOTHESES ON MATERIAL TYPES AND METHODS OF TRANSPORT

- APPLY RESULTS TO ANALYSIS OF OTHER LUNAR SURFACE PHENOMENA

- ANALYZE COSMIC PARTICLES AND EJECTA

P/E - P/I TASK REQUIREMENTS

BENDIX PROJECT ENGINEER

- SUPPORT QUAL MODEL CHARGED PARTICLE RESPONSE TESTS

- OBTAIN CHARACTERISTICS FOR ONE PARTICLE PATH THROUGH SENSOR

- CHARACTERIZE PARTICLE TYPES FOR OBSERVED RESPONSES

- EXPLAIN DIFFERENT EVENT TYPES IN TERMS OF MASS, CHARGE, VELOCITY

- ANALYZE WEST SENSOR

- INTERPRETATION OF LUNAR DATA RELATIVE TO HARDWARE PERFOMANCE

- ASSIST P.I. WITH CORRELATION OF ANALYSIS RESULTS WITH LUNAR DATA

PRINCIPAL INVESTIGATOR

- PERFORM QUAL MODEL TESTS

- ANALYZE LEAM DATA FOR TEMPORAL EFFECTS AND STATISTICALLY SIGNIFICANT PATTERNS

- CORRELATE ANALYTICAL CHARACTERISTICS WITH LUNAR CYCLES AND TEMPORAL EFFECTS

- PREPARE HYPOTHESES ON MATERIAL TYPES, SOURCES AND TRANSPORT MECHANISMS

- EVALUATE APPLICATION OF RESULTS TO OTHER LUNAR SURFACE PHENOMENA

- ANALYZE COSMIC PARTICLES AND EJECTA

- SUPPORT LUNAR SURFACE OPERATIONS

SCHEDULE

Issued On:		
Updated On:		

Title EXTENDED ANALYSIS PLAN

	1976					1977											
Line	Item		A	S	O	N	D	J	F	M	A	M	J	J	A	S	O
1	QUAL MODEL TESTS	PI/PE															
2																	
3	ANALYZE RESULTS & REPORT	PI/PE															
4																	
5	COMPLETE ONE SENSOR PATH	PE															
6																	
7	CHARACTERIZE PARTICLES	PE															
8																	
9	PREPARE HYPOTHESES	PI															
10																	
11	PREPARE INTERIM REPORT	PI/PE															
12																	
13	ANALYZE WEST SENSOR	PE															
14																	
15	CHARACTERIZE PARTICLES	PE															
16																	
17	CORRELATE WITH LUNAR DATA	PI/PE															
18																	
19	REFINE HYPOTHESES	PI															
20																	
21	ANALYZE COSMIC PARTICLES & EJECTA	PI															
22																	
23	PREPARE FINAL REPORT	PI/PE															
24																	
25																	
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Remarks

Prog Cont

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