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Bendix Aerospace Systems Division

FINAL REPORT

ANALYSIS OF LEAM EXPERIMENT RESPONSE TO CHARGED PARTICLES

BSR 4234

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(NASA Contract No. NAS9-14751)

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Bendix Aerospace Systems Division

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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 hypervelocity 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 hypervelocity 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,

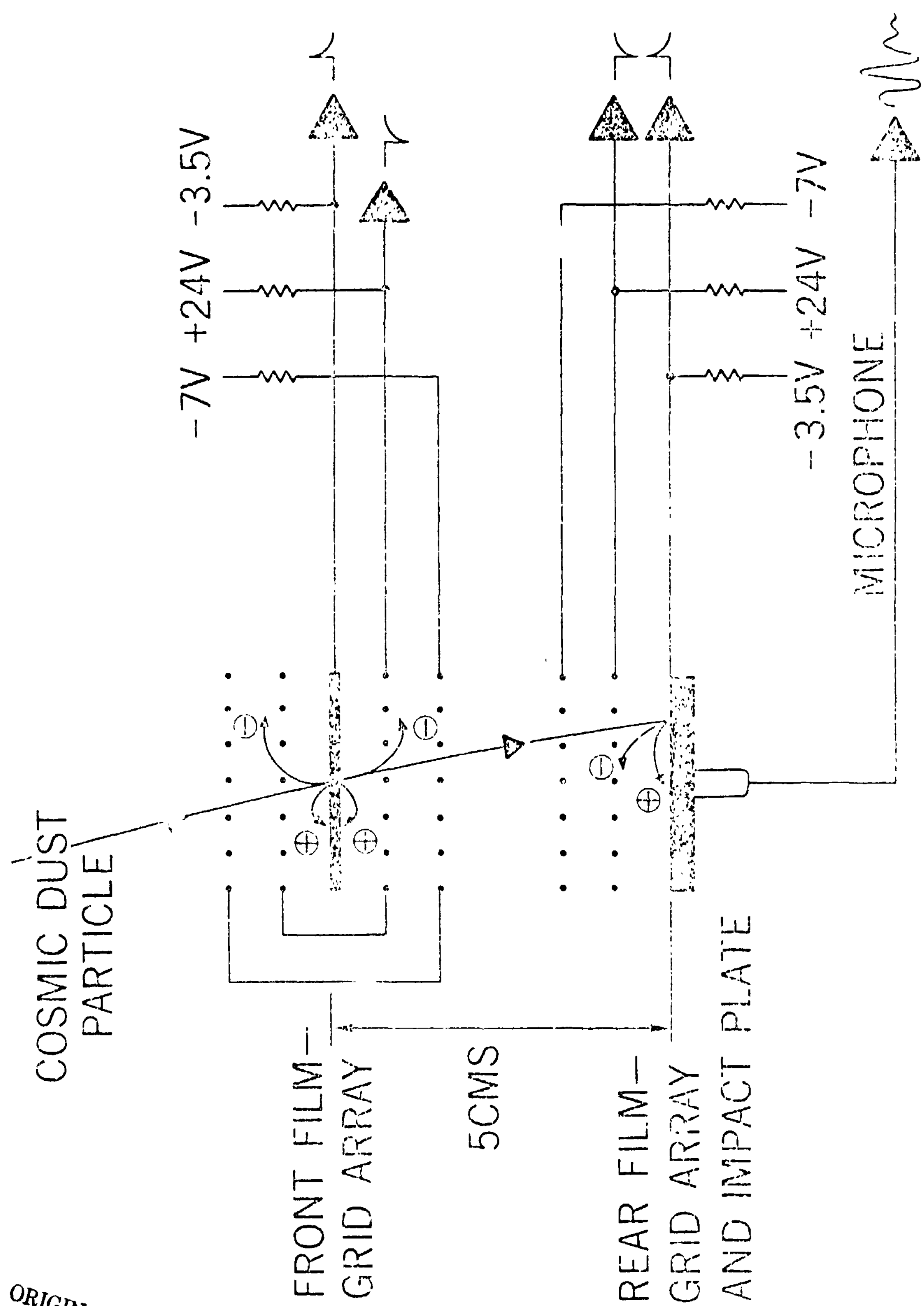

Figure 3-1 The Basic Sensor

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.

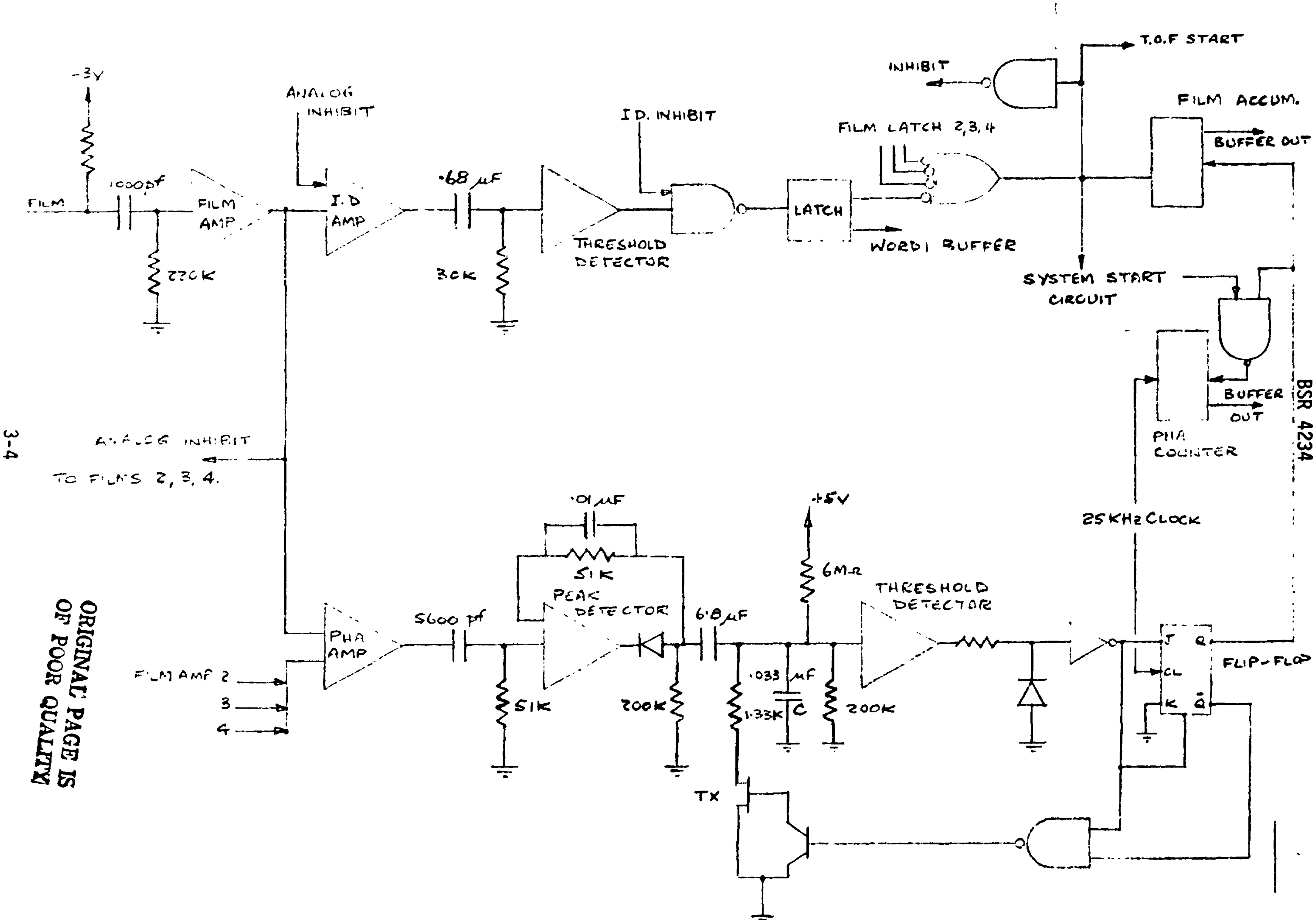

Figure 3-2 Typical Film Channel

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3.1.2.1 Film Strip ID Channel

The common film amplifier provides the -3-volt film bias and a noninverting 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.?.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 tc 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.

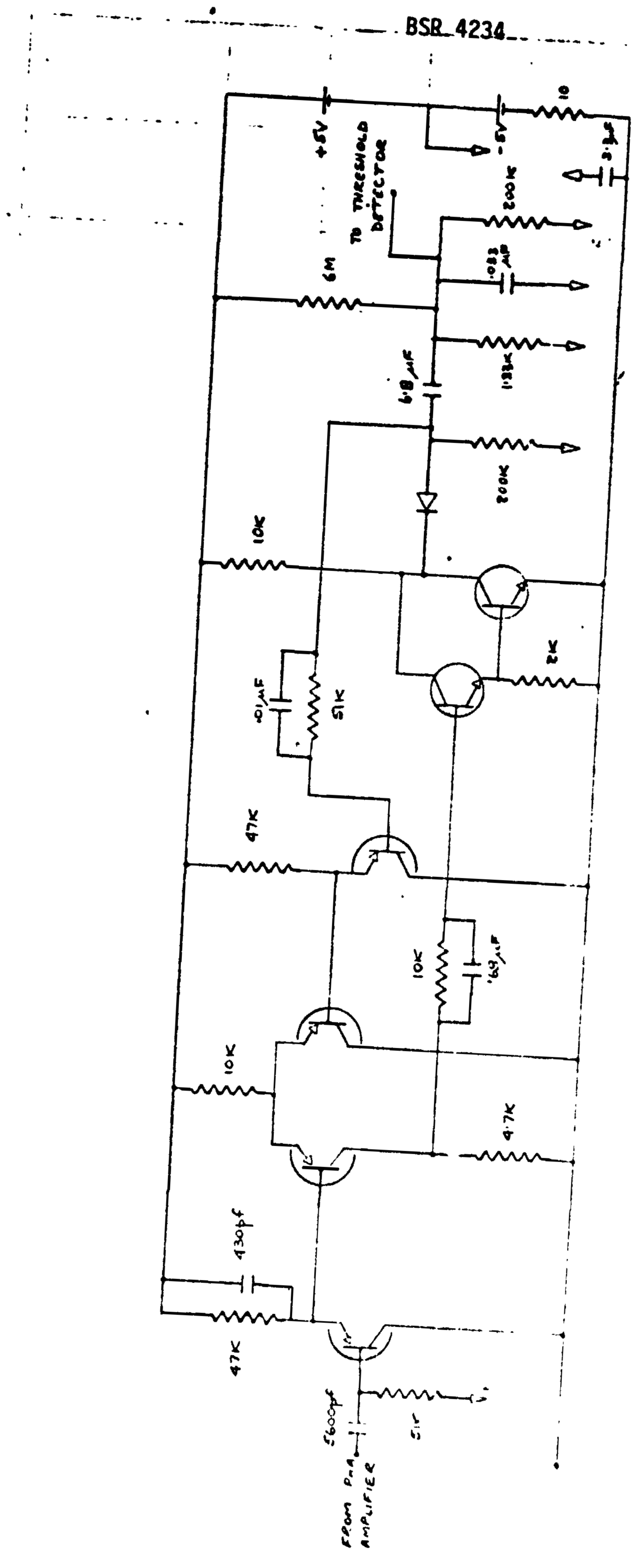

Figure 3-3 LEAM Peak Detector

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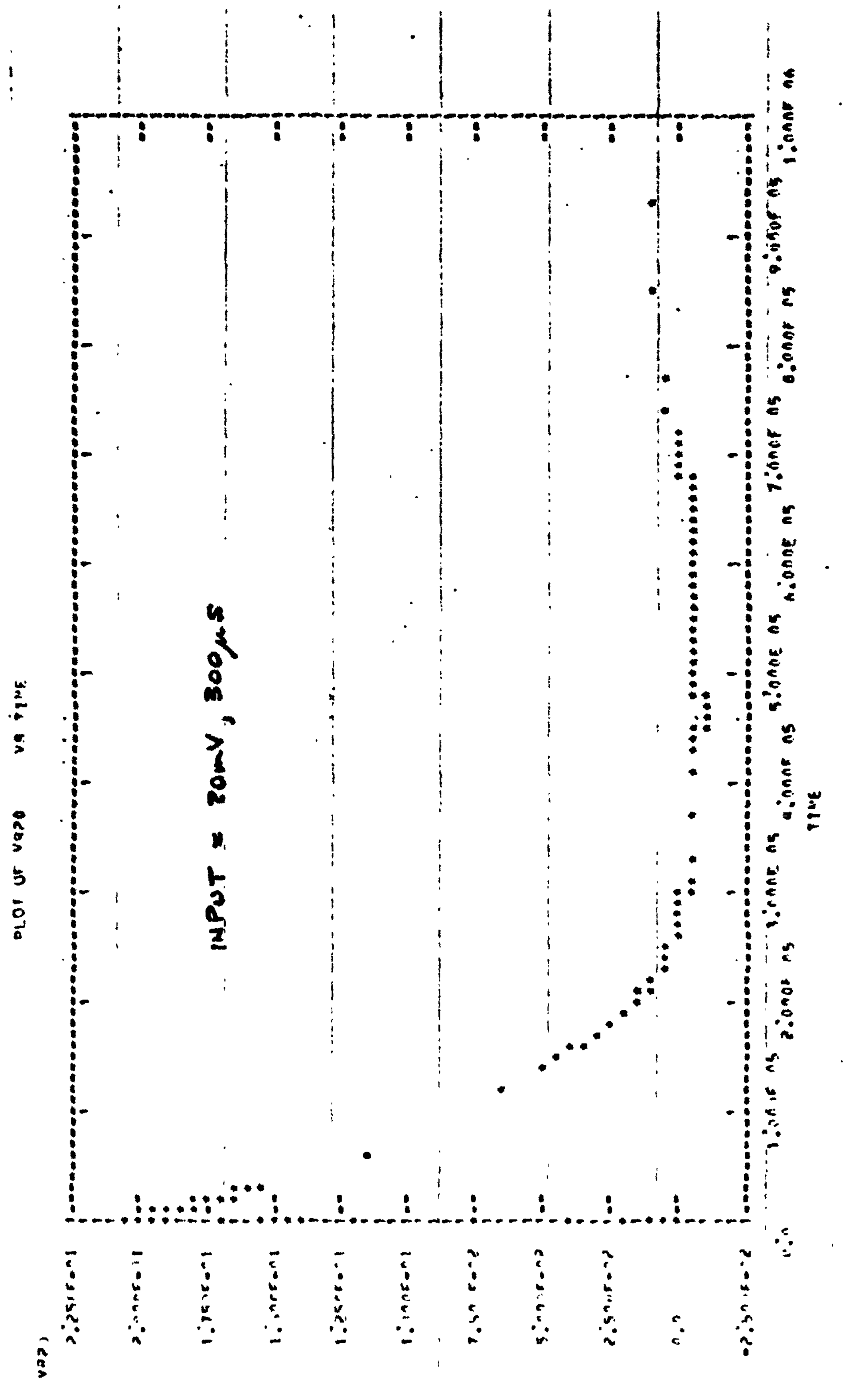


Figure 3-4 Typical SCEPTRE Output

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 $\approx$ 780 microsec
40	245.6	Returned above 9 mV at $\approx$ 760 microsec
50	254.03	Returned above 9 mV at $\approx$ 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

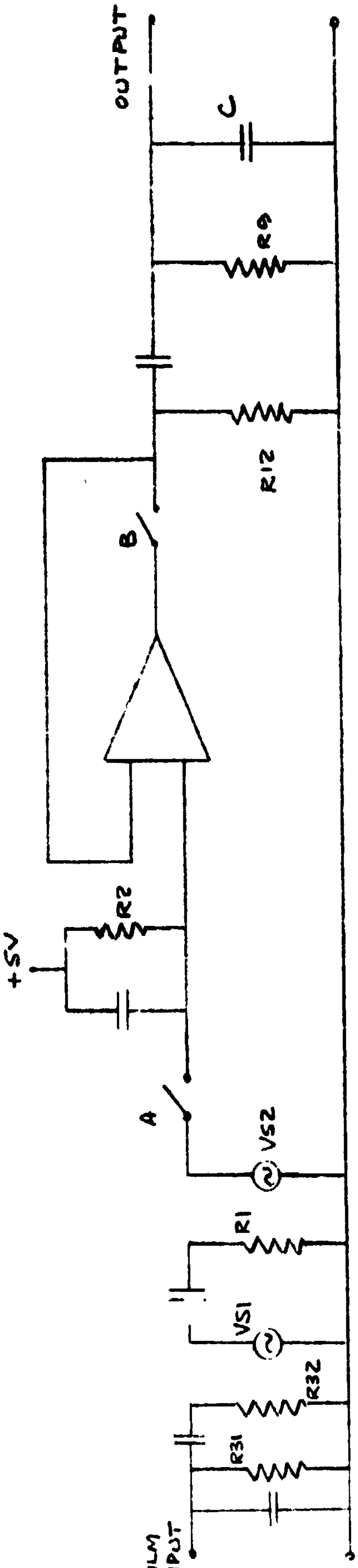


Figure 3-5 Simplified Peak Detector Model

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: Pulse Width (micro-seconds)	Input: Pulse Amplitude (millivolts)	Output
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.

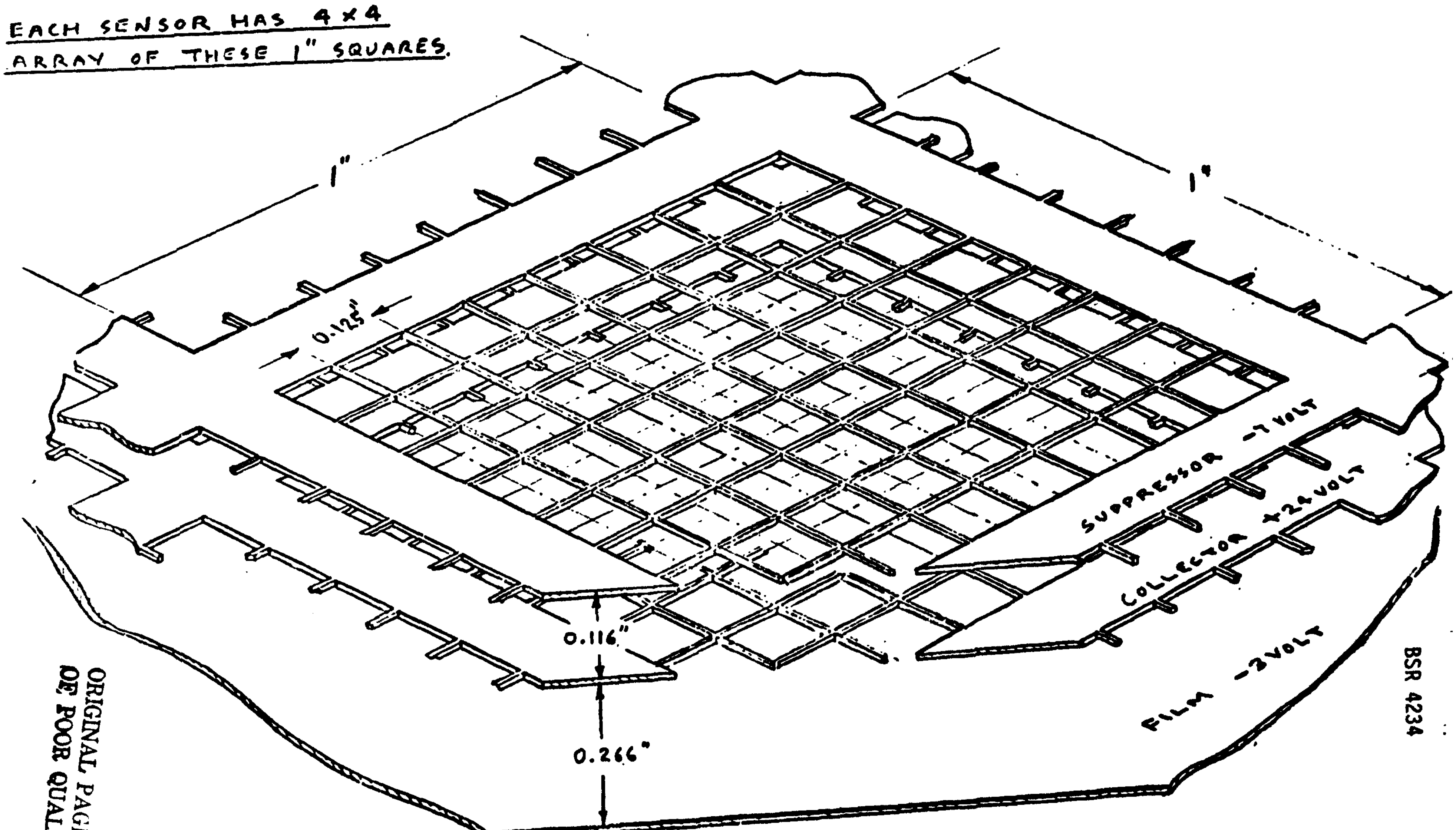


Figure 3-6 LEAM Grid and Film Structure

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 require 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 non-adjacent, 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.

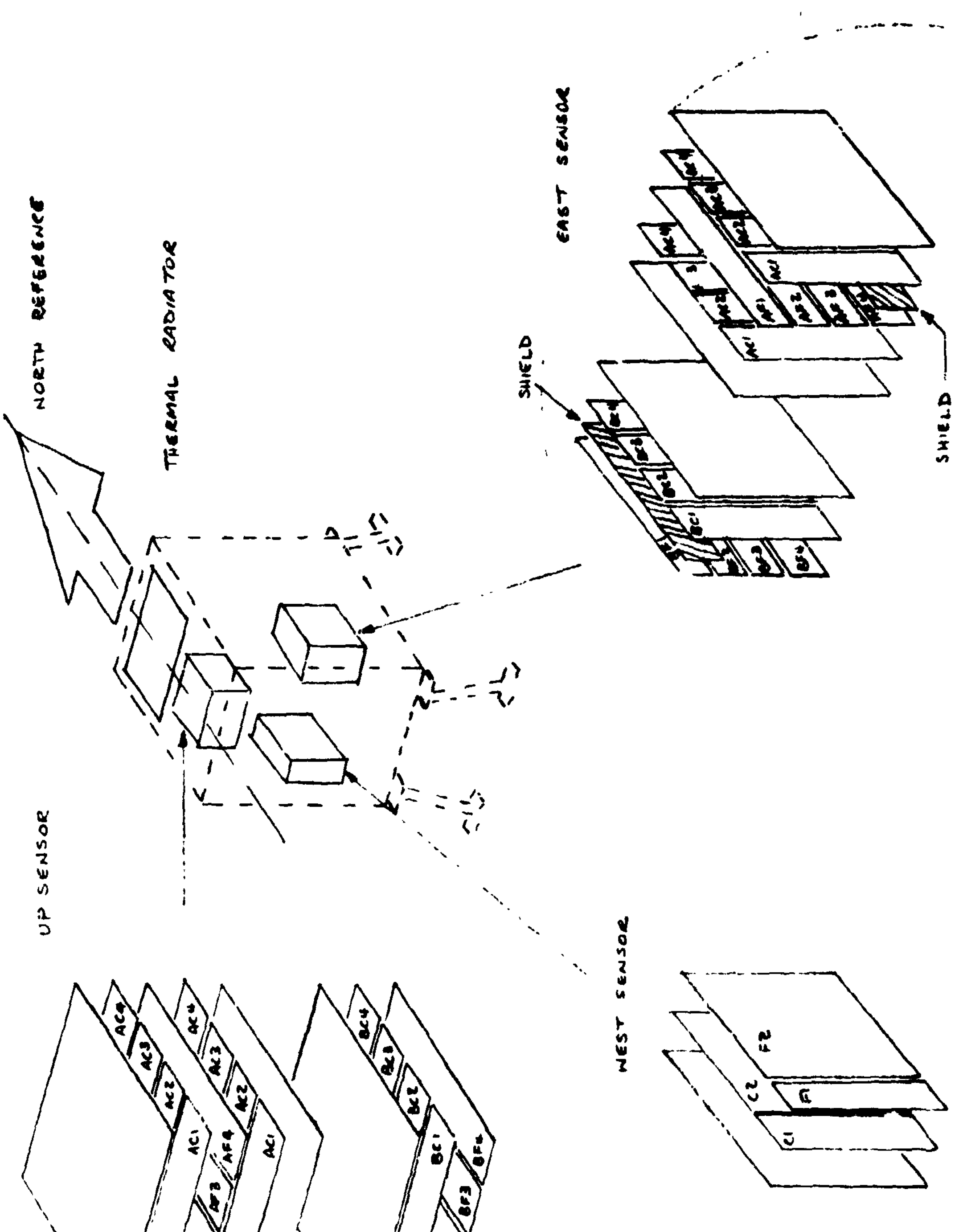


Figure 3-7 LEAM Sensor Orientations

SECTION 4
RESULTS AND IMPLICATIONS OF ANALYSIS

4.1 RESULTS

An accurate simplified representation of the electronics has been achieved in a computer model. This model simulates the inhibit circuits in addition 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 numerous particles with differing mass and charge values and calculate the resulting 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 separation 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 ending on 31 July 1976.

We have achieved the following towards this goal. A program to calculate 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

BSR 4234

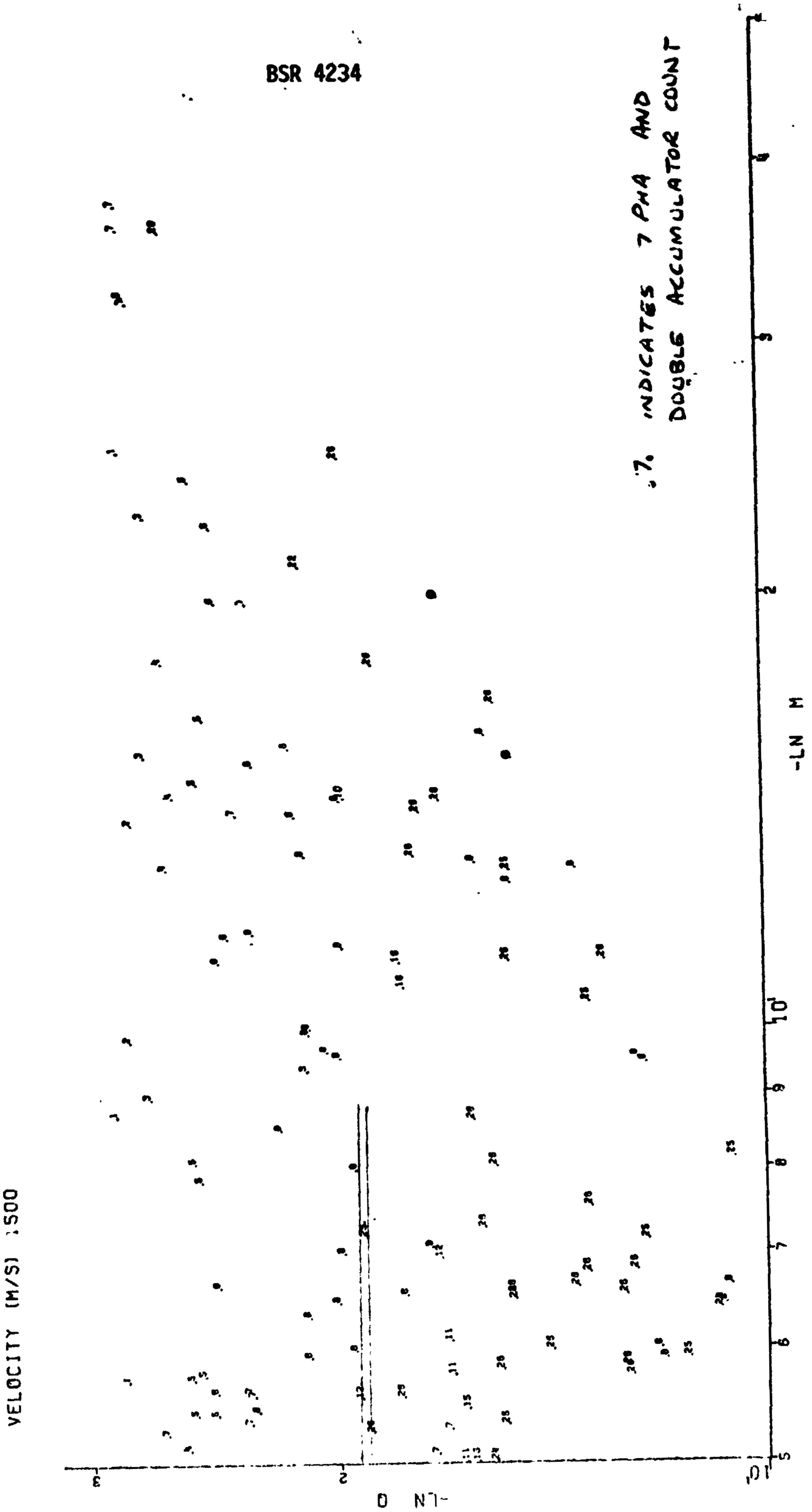


Figure 4-1 Plot of PHA Counts vs. Charge (Q) and Mass (M)

ORIGINAL PAGE IS
OF POOR QUALITY

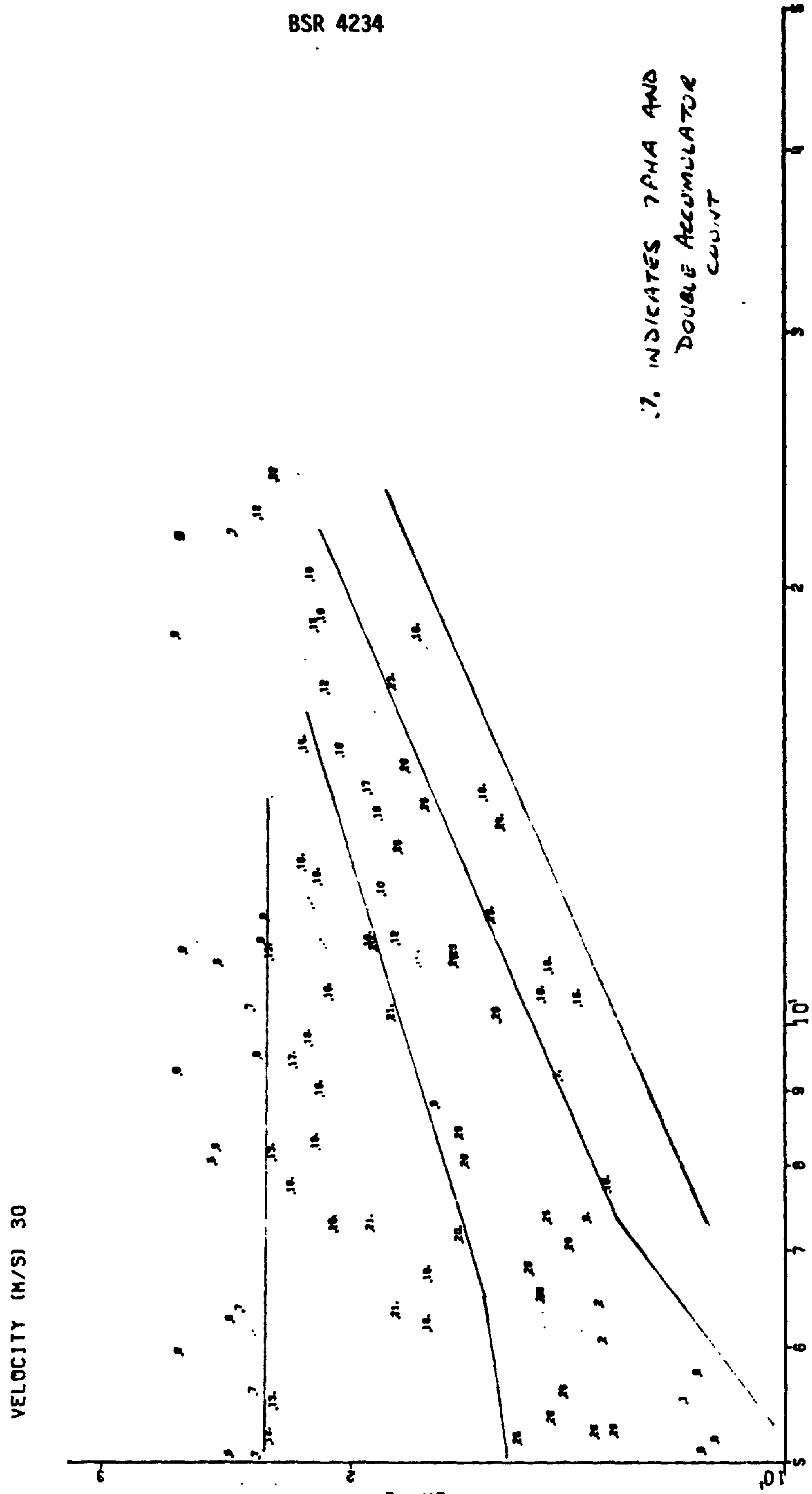


Figure 4-2 Plot of PHA Counts vs. Charge (Q) and Mass (M)

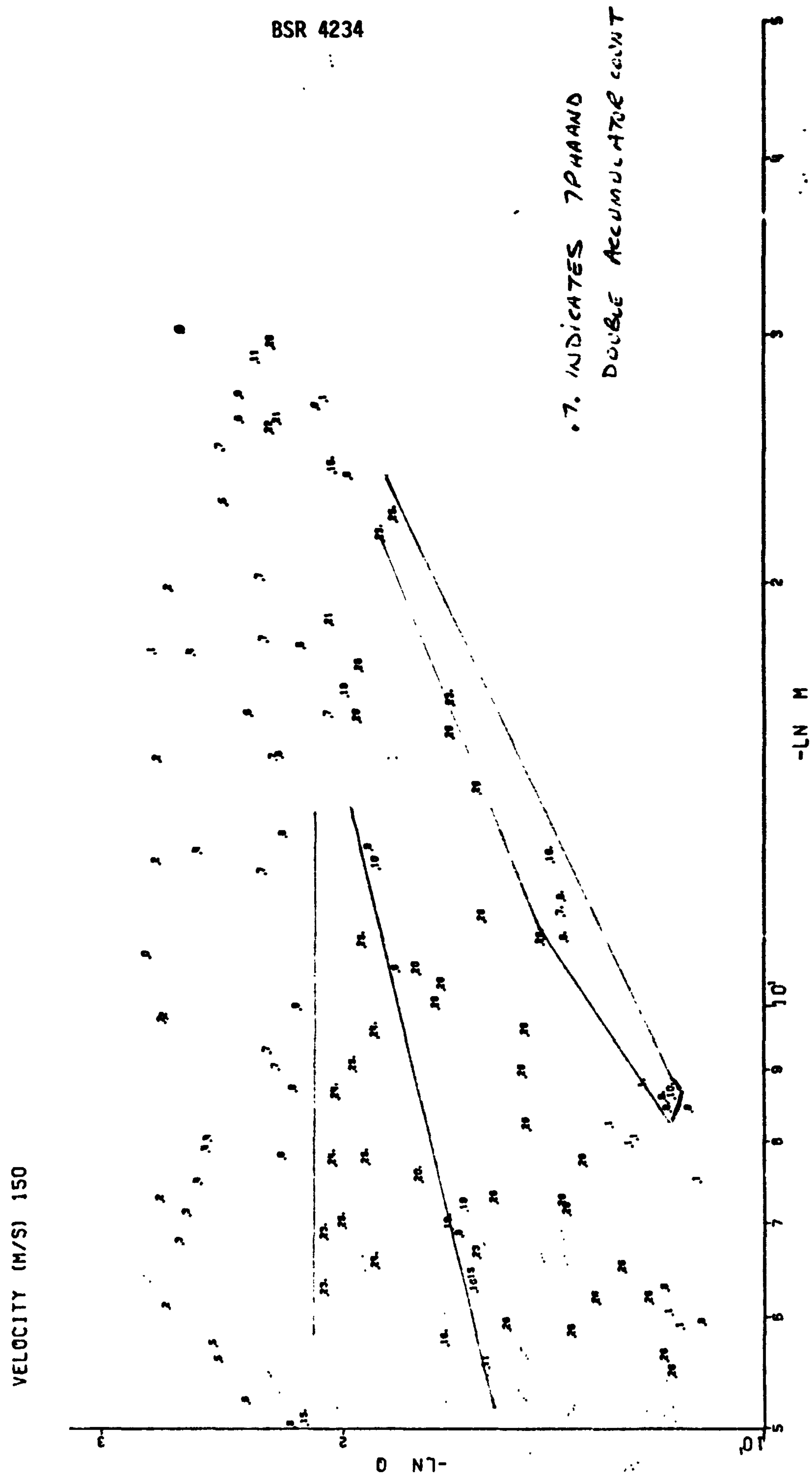


Figure 4-3 Plot of PHA vs. Charge (Q) and Mass (M)

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.*

*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 subdividing 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 PLFING 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 coefficients, 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 fraction 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 percentage 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 coefficients 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 par ˈ⌐le 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 coefficient 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).

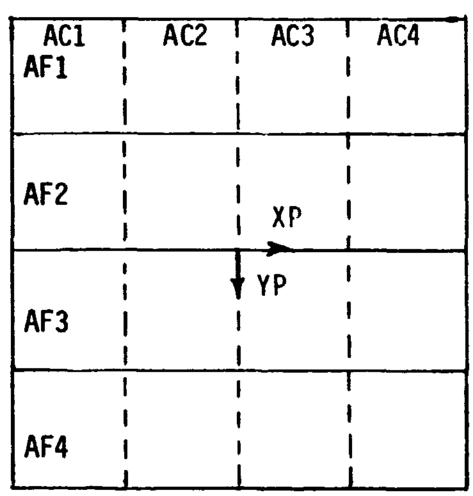
G2 = 0.0 Does nothing with regard to particle.

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 (particle 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,



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.

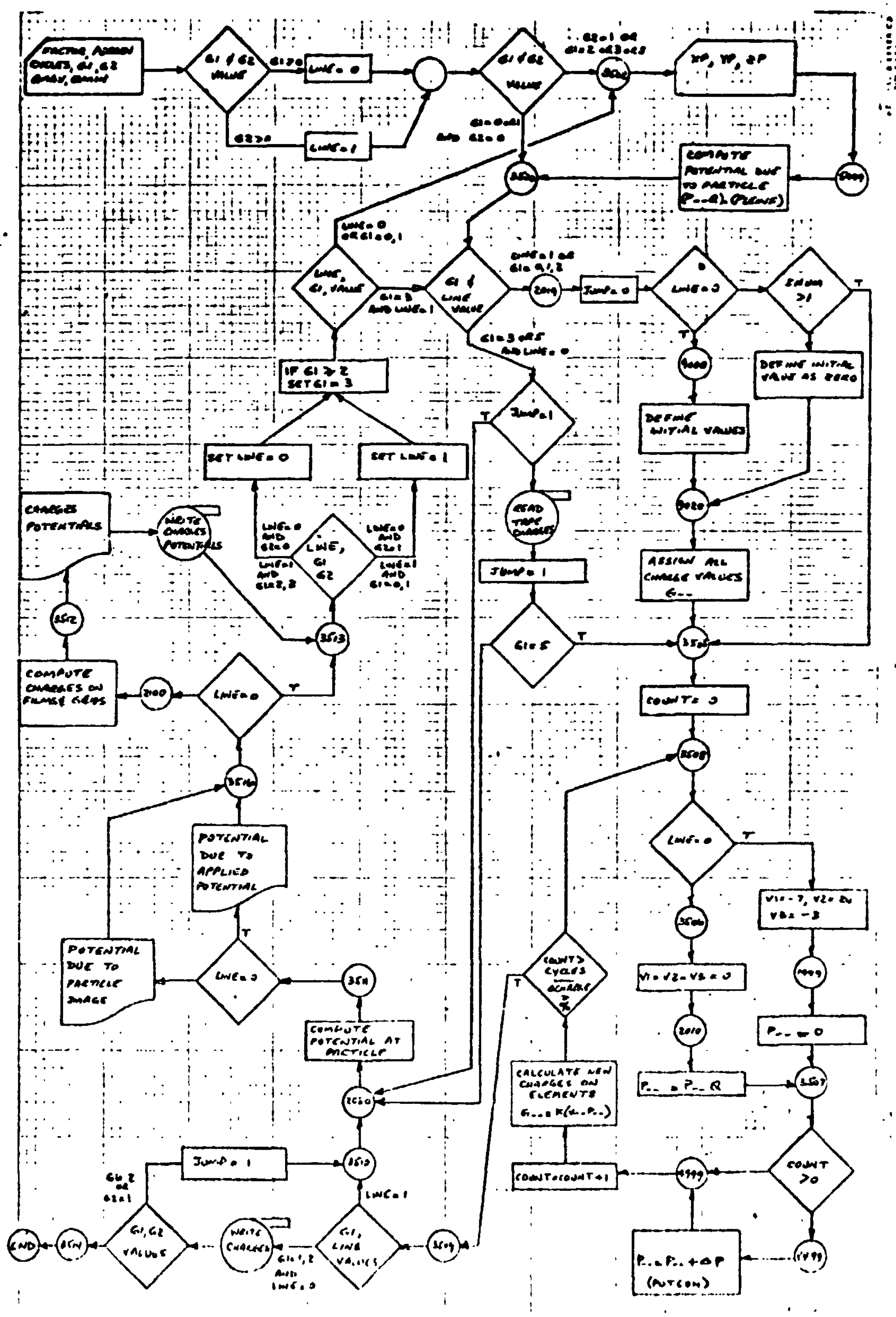


Figure A-1 P5072CHG Program Calculates Charge Distributions in Films and Grids

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
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 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 = ',F11.4)
      GO TO 3516
 3515 APP=SUM
      WRITE(6,3518)APP
 3518 FORMAT(5X,'APP = ',F11.4)
 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))
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      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
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 2024 CONTINUE
 2025 CONTINUE
 2026 CONTINUE
 2027 CONTINUE
      GO TO 3505
C     THIS BLOCK SETS POTL. CONTRIBUTIONS P-- EQUAL TO CORRESPONDING P--Q
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 CHARGE 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
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      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))*0.11853F-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 25J.
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      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
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      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
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      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)
      PNQ(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
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      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(4,4,6,8)
      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
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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
```

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 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  LATE 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+10288
      INDEX3=INX1+2597
      INDEX4=INX2+13132
      INDEX5=INX2+5194
      INDEX6=INX2+7938
      TEMP36=CFEDGN(INDEX1)
      TEMP37=CFEDGN(INDEX5)
      TEMP38=CFEDGN(INDEX3)
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      TEMP39=CFEDGN(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=CFTUFN(INDEX3)
      TEMP21=CFTUFN(INDEX4)
      TEMP10=CFTUFN(INDEX1)
      TEMP11=CFTUFN(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)CFPFIN
      DO 4575 NN=1,8
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      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     FND PLATE/FILM INTERSECTION ON WIRES AND VICE VERSA
C
C     START FILM MAIN SQUARE ON FILM MAIN SQUARE
C
      REWIND 14
      READ(15) FFMFM
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      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=CFMFM(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     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=56*IABS(IND2)
      DO 4590 M=1,8
      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+[illegible]3
      INDEX3=INX+[illegible]6
```

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      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)=[illegible](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 VERS
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)-[illegible]
      IND6=56+INT([illegible]
      INDEX1=IND4+IND[illegible]
      INDEX2=INDEX1+[illegible]
      INDEX3=INDEX1+[illegible]
      TEMP21=CFISFM(INDEX1)
      TEMP22=CFISFM(INDEX2)
      TEMP23=CFISFM(INDEX3)
      TEMP12=TEMP12+TEMP21*GIS([illegible],M,N)+TEMP22*GIS(1,K,L,M,N))+TEMP23
```

```
     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     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    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+3
      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=13*IABS(IND5)
      IND8=IND4+IND7
      IND9=IND6+IND10
      INDEX1=IND8
      INDEX2=IND9+1166
      INDEX3=INDEX1+583
      INDEX4=INDEX2+316
      TEMP7=GFD(1,1,K,L,M,N)
      TEMP8=GFD(1,2,K,L,M,N)
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      TEMP9=GET (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,
      DO 4681 MM=1,
      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
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```
      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
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```
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(I.EQ.1)GO TO 4690
     IF(I.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(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
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    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)
       TU(I,1,K,L,M,N)=PTU(I,1,K,L,M,N)+TEX1*TEMP12
       TU(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 2
      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      PROGRAM TO CALCULATE LEAM EXPERIMENT SENSOR INFLUENCE COEFFICIENTS
C
C
C

       DIMENSION CFWW(9678),CFMSFW(5194),CFTUFW(21364),CFEDGW(10682)
       DIMENSION CFPFIN(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
         NMIN=1
         IF(L.EQ.1)NMIN=8
         DO 2009 N=NMIN,14
           X=TEMP1+0.003175*N
           IND2=IND1+N
           DO 2008 K=1,4
             TEMP2=0.02921*K-0.0530225
             IND3=686*K+IND2
             NM1N=1
```

```
      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    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)
               CFMSFN(INDEX)=COEFF
2011         CONTINUE
2012       CONTINUE
2013     CONTINUE
2014   CONTINUE
2015 CONTINUE
     WRITE(6,3100)
     WRITE(6,3000)(CFMSFN(I),I=2,5194,59)
     WRITE(12) CFMSFW
     END FILE 12
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
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          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=0.0029454
                  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,COMPLE ED.  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
```

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 2025       CONTINUE
 2026     CONTINUE
 2027 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFTUFW(I),I=4,21364,59)
      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=0.029464*(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
            TEMP6=0.02921*K-0.0530225
            TEMP7=14*K-8.5
            DO 2036 NN=1,8
              TEMP8=TEMP6-0.003175*NN
              TEMP9=TEMP7-2*NN
              MMAX=2
              IF(K.EQ.1)MMAX=1
```

```
            DO 2035 M=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     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)
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      WRITE(6,3000)(CFPFIW(I),I=11,10976,129)
      WRITE(12) CFPFIW
      END FILE 12
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    ,894
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-0.05451
        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     FILM MAIN SQUARE ON FILM MAIN SQUARE COM   TED. 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-8.5
        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
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          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     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
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 2060        CONTINUE
 2061      CONTINUE
 2062    CONTINUE
 2063 CONTINUE
      WRITE(6,3100)
      WRITE(6,3000)(CFEDFM(I),I=11,5936,/9)
      WRITE(12) CFEDFM
      END FILE 12
C
C     GRID EDGES ON FILM MAIN SQUARE ELEMENTS COMPLETED. TOTAL CFEDFM(   )=5936
C
C      STAR  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)MMAX=1
        DO 2069 M=1,MMAX
          TEMP3=TEMP1+0.0273o5*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
                    INDFX=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
        T1=0.0
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      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
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                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      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=TEMP3-0.02705*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     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)
```

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```
                  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   CONTINUF
 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-0.00382
```

```
      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=TEMP[illegible]NN
            DO 3024 N=1,8
              Y=TEMP[illegible]+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    ALL 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
```

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```
      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
```

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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 signals 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 positive, 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

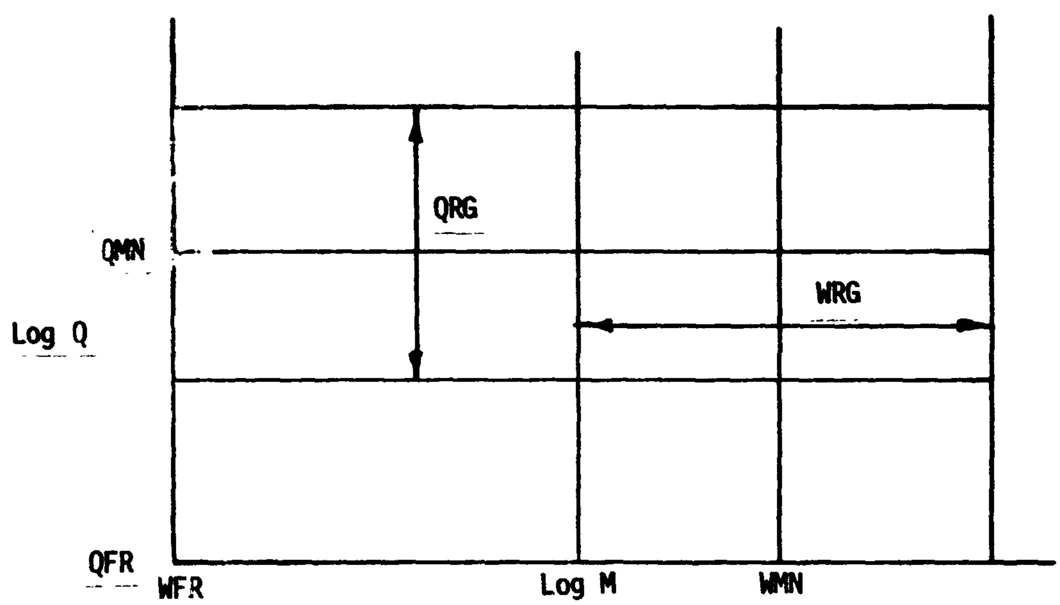
Column	Requirements
1-3	A number from 1 to 999, format I3, representing the number of particles to be generated. If discrete particles are selected, the value should be 001.
4-6	A number, format I3, which determines the rate at which the element charge values will be written out, e.g., if the value is 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 logarithm 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 correct 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
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).

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

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.

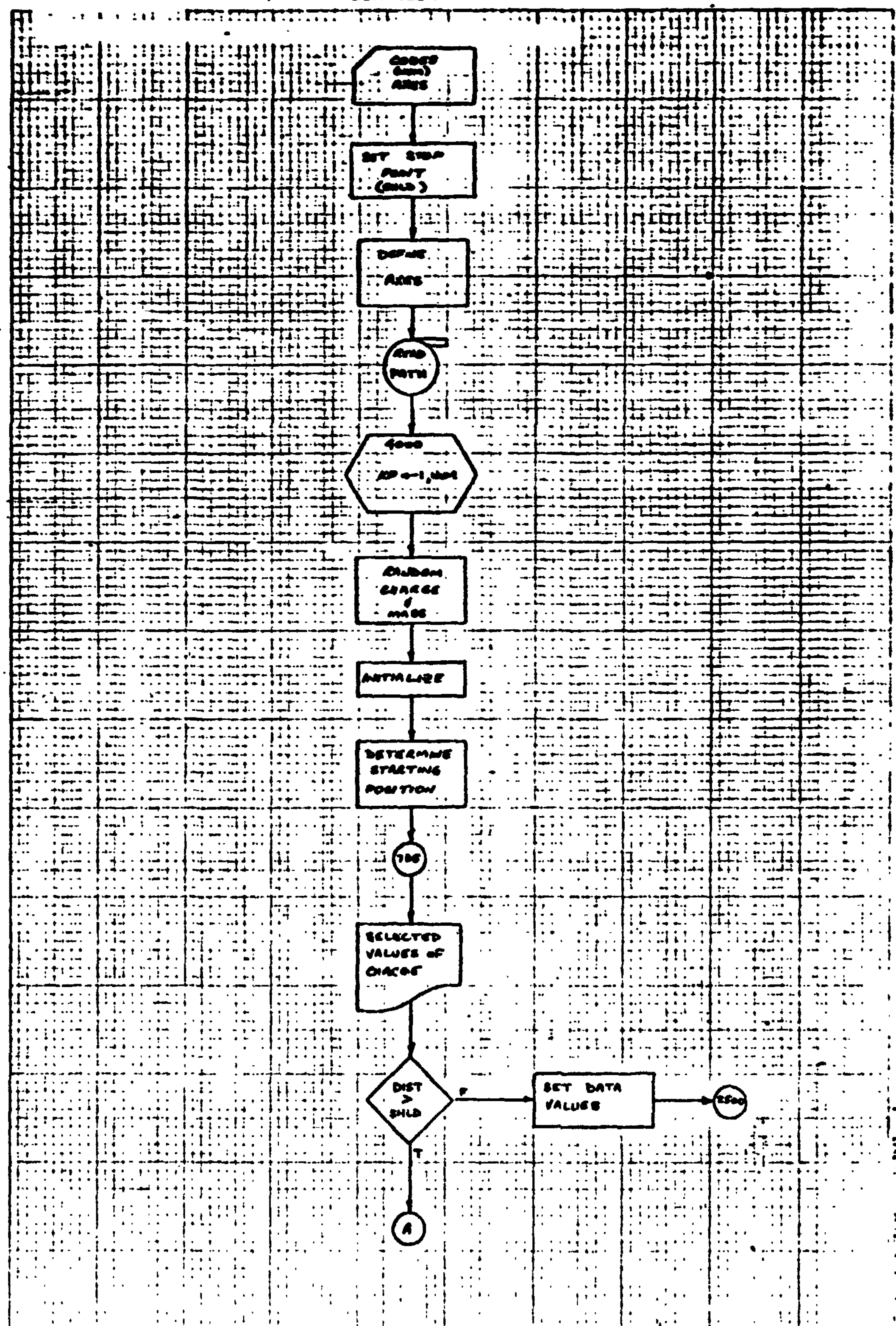


Figure A-2 P5072SGF Combined Sensor and Electronics

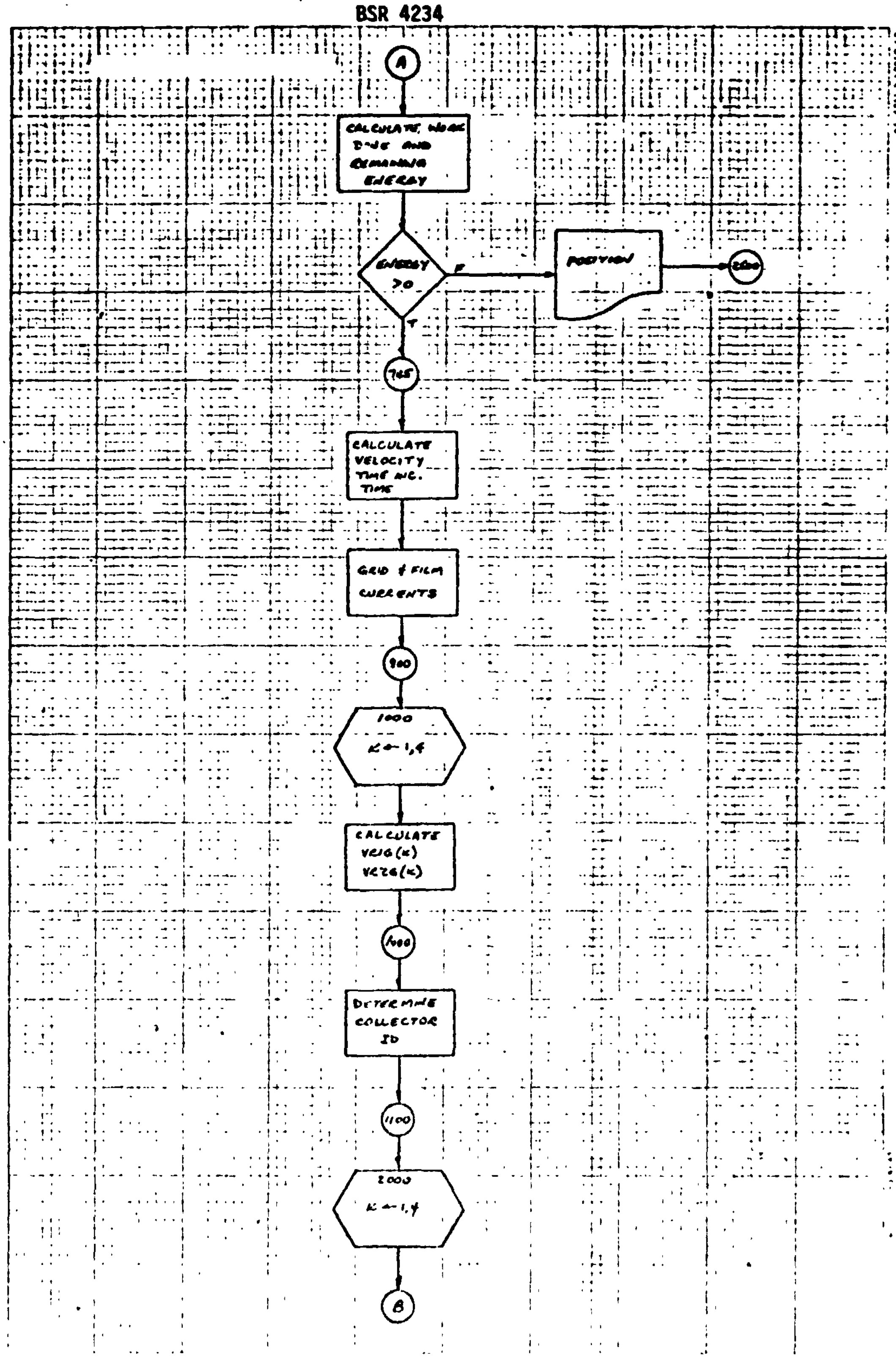


Figure A-2 (Cont.)

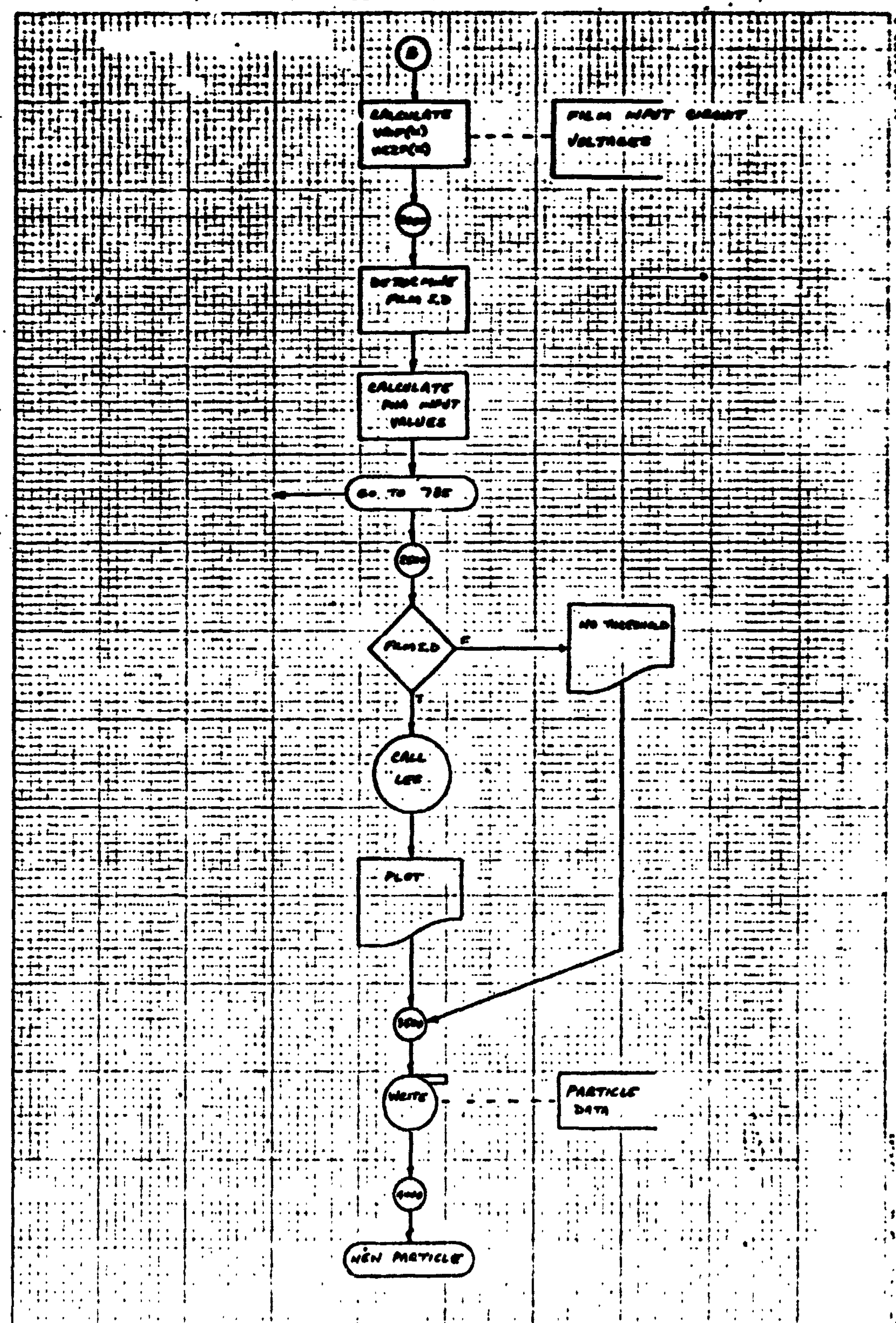


Figure A-2 (Cont.)

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)
```

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```
      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,WCCN,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
      WSV=EXP(RANDM/WCON)
      WVAL=WSV*(-WFR)
      M=EXP(WVAL)
C INITIALIZATION
  625 TIME=0.0
      NP1=0
      NP=1
      NFID=0
      NGID=0
      NDGT=999
      NDFT=999
      VFL1=VFL
      LP=0
      DO 700 I=1,4
```

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```
      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..57028E-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(K)=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(IFID)+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 2"'0
      IF(TIMG(1)+.1E-2.LT.  iMF(1))GO TO 2700
 2510 ETIME=TIM1D+.1E-2
 3000 CALL LES(DATA,NDT,ETIME,OUT,KP,TPNUM,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.
     33//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 = ',F8.2,4X,'GRID2 = ',E8.2,4X,'GRID3 ='
     2,F8.2,4X,'GRID4 = ',E8.2//15X,'FILM1 = ',E8.2,4X,'FILM2 = ',E8.2,4
     3X,'FILM3 = ',E8.2,4X,'FILM4 = ',F8.2,4X,'TIME = ',F9.3,4X,'DIST =
     4',F9.3)
 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 = ',F9.3,' MASS = ',E9.3,  G                 12, FIL
     5M ID = ',4I2/)
 7000 FORMAT(4X,' SIGNAL BELOW THRESHOLD '/)
 7010 FORMAT(5X,'LOG Q =  ',F9.3 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=.35014005 6E4
      TC3=.4948045522E5
      TC4=.1052867643E3
      TC5=.2195226 15E5
      TC6=.73021894
      J=6
      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
 2100 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
```

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```
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 [illegible]
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 (2380,2375,2390,2375),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
```

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```
      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*(.9805166724E-03*(1-EXP(-TC1*X))-.9874988704E-
     403*(1-EXP(-TC2*X))+.6982198058E-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+.2180074122E5*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
```

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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.

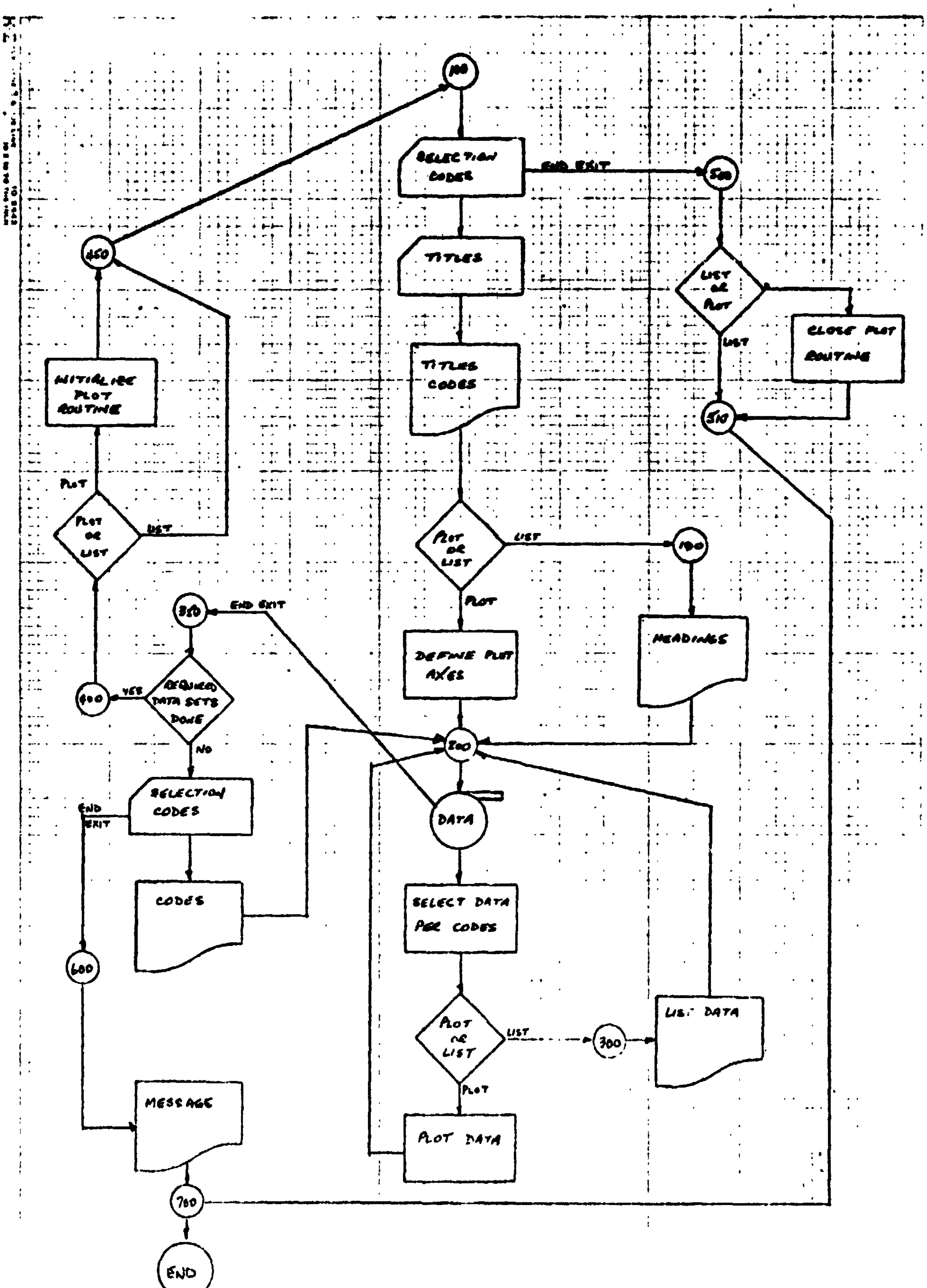

Figure A-3 P5072INT Data Selection

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',13X,'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
  21  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 200
  250 IF(KIND(6).EQ.0)GO TO 260
      IF(IGTOT.EQ.2)GO TO 260
```

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```
      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)WVEL,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
```

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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

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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

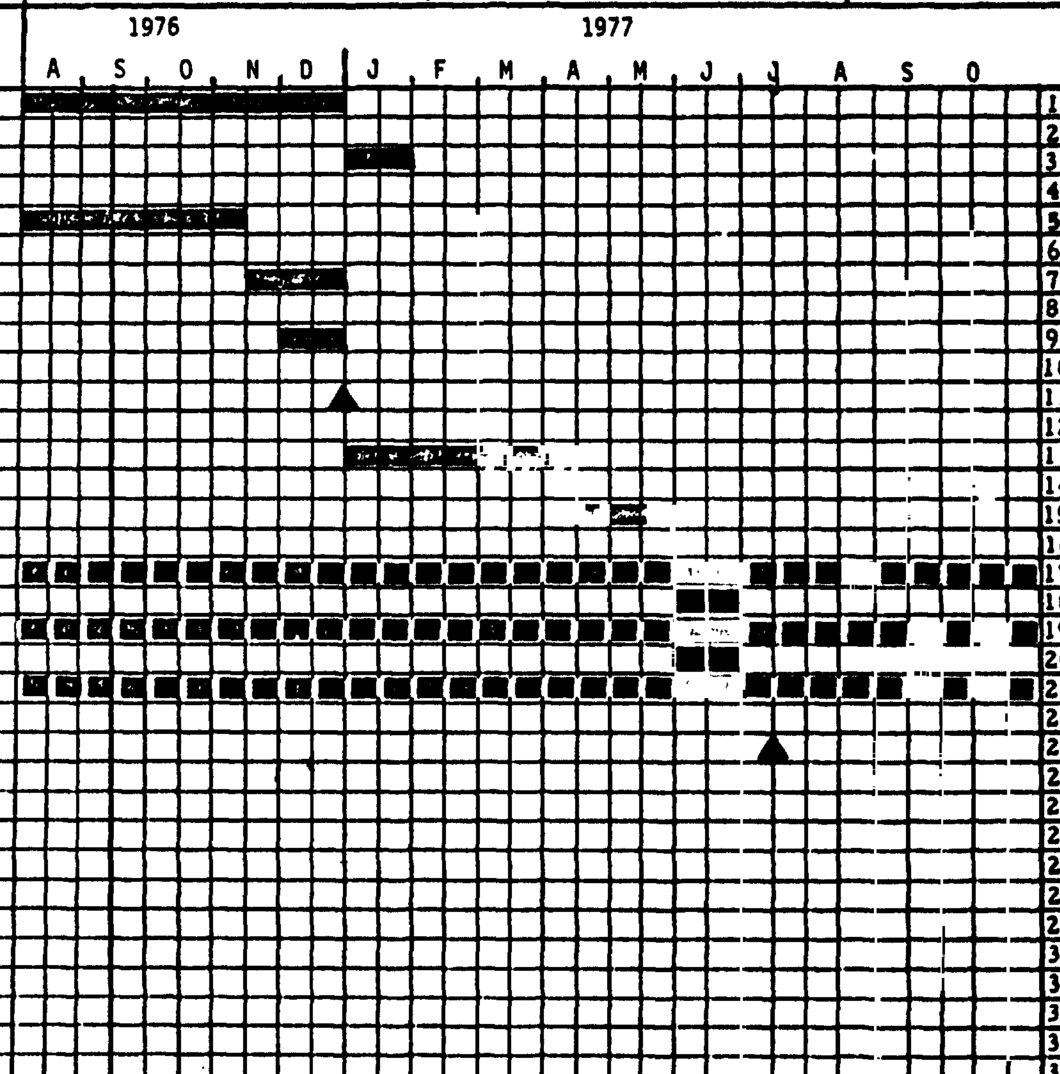
SCHEDULE

Title: EXTENDED ANALYSIS PLAN

Issued On:

Updated On:

Line	Item	
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		
26		
27		
28		
29		
30		
31		
32		
33		
34		



Remarks

Prog Cont

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