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Mr. J. J. Madden, Code 724
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Dear Jerry:

Enclosed please find a brief description of the Charged Particle Measurements Experiment (CPME) for the Project Development Plan (PDP) for AIMP H and J. I hope that it meets your requirements.

If there are any questions, please call me or Roy Cashion at 776-7100, ext. 2719 or 2757.

Sincerely yours,

S. M. Krimigis

SMK:mhh
Enclosure

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The Charged Particle Measurements Experiment (CPME) on AIMP H and J

I. INTRODUCTION

The main objective of the Charged Particle Measurements Experiment (CPME) is to measure protons, alpha particles, electrons, and X-rays in a wide energy interval, primarily designed to study radiations of solar origin, but with sufficient dynamic range and resolution to measure cosmic ray and magnetospheric tail particles. The experimental data will be used to study angular distributions, energy spectra, propagation characteristics, and absolute intensities of particles emitted from the sun, as well as those streaming along the magnetospheric tail away from the earth. Further, observations of the 2-10Å solar X-ray flux will be continued, so that data spanning the period from July 1966 (Explorer 33) through the next solar maximum may be obtained.

II. INSTRUMENT DESCRIPTION

The main detector assembly consists of a set of three solid state detectors placed inside a plastic scintillator cup. In addition to the above assembly, five thin window GM tubes have been included in order to extend measurements of electrons down to approximately 15 kev. The combined set of detectors makes it possible to separately identify and count protons and electrons in the following energy intervals. See Table I. The half angle of the conical collimator as defined by the coincidence-anticoincidence properties of the detector is nominally 22.5°. The GM tubes also have a half angle of 22.5°.

Each detector assembly will use the following constituent detectors (designation of component detectors being as listed in Table I):

D_1: Surface barrier, totally depleted silicon detector.

Area	= $2.0\ cm^2$, circular
Thickness	= 40 microns

D_2: Surface barrier, totally depleted silicon detector.

Area	= $2.0\ cm^2$, circular
Thickness	= 1000 microns

D_3: Lithium-drifted silicon detector.

Area	= $2.0\ cm^2$, circular
Thickness	= 3000 microns

D_4: Plastic scintillator.

Outside Diameter	= 3.5 cm
Inside Diameter	= 2.5 cm
Height	= 7.0 cm

GM-1	LND 705 Halogen-quenched GM tube
GM-2A, GM-2B, GM-2C	6213 EON GM tube
GM-3	LND-D1887 pancake type GM tube with 1.5 mg/cm^2 mica window and 13 mg/cm^2 of beryllium foil. Area $\simeq$ 1 cm^2.
A-PS	Anticoincidence plastic scintillator enclosing GM-1, GM-2A, and GM-3.

A. Proton-Electron Telescope

Detector D_1 is used to provide an anticoincidence pulse so that electrons can be separately identified and pulse-height analyzed by detector D_2. In addition, detector D_1 provides several differential proton and alpha particle channels, as well as an ion channel ($Z > 2$).

Detector D_2 is used, in conjunction with D_1 and D_3, for particle identification and energy measurements of protons, electrons and alpha particles. The discrimination levels have been chosen so that the resulting energy channels are identical for both protons and alpha particles on the basis of energy/nucleon (see Table I).

Detector D_3 is used to pulse-height analyze particles which penetrate D_2 and also those that penetrate D_3 as well but are stopped in the 2 cm of tungsten which is located behind D_3.

Detector D_4 is a plastic scintillator which provides an anticoincidence pulse for all particles which do not enter the detector system through the conical collimator, including secondaries created in the body of the spacecraft from incident primaries. We note that the scintillation plastic has a decay constant of $\sim 3 \times 10^{-9}$ seconds so that efficient operation at very high ($\sim 10^6$ c/sec) counting rates will be possible.

We note that the 2 cm of tungsten is used to stop protons of $E < 170$ Mev from reaching the anticoincidence scintillator and thus extends effectively the energy of particles that can be measured by the three solid state detectors. The counting rate of the anticoincidence scintillator is monitored and provides a high counting rate (~ 30 c/sec) for studying small fluctuations in the cosmic ray intensity.

B. GM Tube Assembly

1. GM-1 is a LND 705 Halogen-quenched GM tube whose window thickness is 0.3 mg/cm^2. This particular detector has not been flown before from this Laboratory and its reliability is presently being evaluated. The GM tube will be imbedded in an anticoincidence plastic scintillator so that only particles coming through the window and stopping within the volume of the detector will be counted. Thus the background counting rate due to cosmic rays will be eliminated and only low energy electrons ($E_e > 15$ kev) and protons ($E_p \geq 250$ kev) will be counted. Since the flux of

low energy protons will be measured from the PET detector, the flux of low energy electrons will be measured.

2. GM-2A, 2B, and 2C are 6213 Anton GM tubes looking at three different directions. The properties of these tubes is well known and their reliability well established. GM-2A will also be imbedded in the anticoincidence plastic scintillator and its background counting rate due to cosmic rays will thus be reduced. Its particle threshold is $E_e \geq 45$ kev and $E_p \geqslant 750$ kev. Both GM-2A and GM-1 will count solar X-rays when their cone of view intercepts the sun. Thus some rough spectral information on solar X-rays in the region $2 \leq \lambda \leq 10$ Å will be obtained.

3. GM-3 is a 1 cm^2 area pancake-type, Halogen-quenched GM tube with a 1.5 mg/cm^2 mica window, and a 13 mg/cm^2 beryllium foil (LND-type D 1887). This counter will also be imbedded in the anti-coincidence scintillator in order to reduce its background counting rate due to cosmic rays. This detector will serve to count protons and electrons in the energy ranges $E_p > 2.8$ Mev and $E_e \geq 120$ kev, respectively. An additional and equally important function of this detector will be to map out the galactic X-ray sources. Because of its large area and low background it is estimated that one may get statistically significant variations of the individual X-ray sources with a time resolution of 1-5 minutes.

4. The A-PS (anticoincidence plastic scintillator) consists of a scintillator slab with approximate dimensions of 5 cm x 5.5 cm x 6 cm, into which detectors GM-1, GM-2A, and GM-3 will be imbedded. Because of its large surface area the anticoincidence counting rate could be as high as 10^5 c/sec in an intense solar proton event, consequently blocking the outputs of the GM tubes. Hence the scintillator slab will be encased in a brass shield of minimum thickness 0.42 cm (range of 50 Mev protons) and the whole unit placed inside the main box such that additional incidental shielding will be obtained. The additional weight to the experiment due to the scintillator and the brass shield is estimated at $\sim$ 250 gm.

III. INFLIGHT CALIBRATION SYSTEM

A. Inflight Calibrator

The CPME contains an in-flight calibration system which checks the electronics in all channels. The test signals are generated from a segmented ramp and chopper which are fed to the test inputs of the charge-sensitive preamps. The system resolution is 1 to 3% of the nominal discriminator settings. The signal level for each channel is adjusted by attenuators at each input and the coincidence system is disabled during the calibration sequence.

B. Housekeeping and Noise Monitor

The CPME has been assigned two analogue performance parameters (APP) and the experiment contains a multi-channel commutator for analogue functions. Three of these are a voltage, temperature, and signal ground. The remaining functions are the noise levels on the output of each amplifier. This provides an important check on the performance of each detector. In orbit, of course, the measurement is valid only during periods of low counting rate. However, the combination of the in-flight calibrator and noise monitor will permit a fairly complete test of experiment performance during ground check-out with no external connection to the package.

IV. CPME INTERFACE SUMMARY

Size:	Module Height of 5 inches plus GM detector extending 1-1/2 inches on outboard face.
Weight:	7.0 pounds.
Power:	2.0 Watts.
Outputs:	Four (4) each sectored outputs. Nineteen (19) each spin-averaged outputs. Two (2) Analog Performance Parameters (APP).
Inputs:	Sync pulses - a_2, a_3, and a_4. Calibrate - C35 at 46.6 hour rate.
Commands:	Two (2) each (in addition to power on/off).

TABLE 1*

Detector Designation	Detector Type	Particle Type	Channel Designation	Energy Interval	Geometric Factor cm^2 sr	Dynamic Range $(cm^2 \text{ sec sr})^{-1}$
PET (Proton-Electron Telescope)	Solid State Detectors and anticoincidence plastic scintillators	Electrons	E4	$0.2 \le E_e \le 2.5$ Mev	0.956	$0 - 10^6$
			E5	$0.4 \le E_e \le 2.5$	0.956	
			E6	$0.7 \le E_e \le 2.5$	0.956	
		Protons	P1	$0.3 \le E_p \le 0{,}5$ Mev	2.5	
			P2	$0.5 \le E_p \le 0.9$	2.5	
			P3	$0.9 \le E_p \le 1.9$	2.5	
			P4	$1.9 \le E_p \le 3.9$	0.956	
			P5	$3.9 \le E_p \le 8.0$	0.956	
			P6	$8.0 \le E_p \le 14.0$	0.956	
			P7	$14.0 \le E_p \le 30$	0.956	
			P8	$30 \le E_p \le 50$	0.956	
			P9	$50 \le E_p \le 100$	0.956	
			P10	$100 \le E_p \le 170$	0.956	
			P11	$170 \le E_p \le 500$	0.956	
		Alphas	A1	$2.0 \le E_\alpha \le 3.6$ Mev	0.956	
			A2	$3.6 \le E_\alpha \le 7$	0.956	
			A3	$7 \le E_\alpha \le 17$	0.956	
			A4	$17 \le E_\alpha \le 32$	0.956	
			A5	$32 \le E_\alpha \le 60$	0.956	
			A6	$60 \le E_\alpha \le 120$	0.956	
			A7	$120 \le E_\alpha \le 200$	0.956	
		Integral Protons and Alphas	M	$E > 50$ Mev/Nucleon ($9\ cm^2$)		
		Particles with $Z > 2$	Z	$E > 8$ Mev	2.5	
GM-1	LND-GM Tube	Electrons	E1	$E_e > 15$ keV	0.02	$10 - 10^8$
		Protons		$E_p > 250$ keV	0.02	"
		X-Rays		$2 < \lambda < 10\text{Å}$		
GM-2A, GM-2B GM-2C	213 GM Tube (3)	Electrons	E2A, E2B, E2C	$E_e > 45$ keV	0.03	"
		Protons		$E_p > 500$ keV	0.03	"
		X-Rays		$2 < \lambda < 10\text{Å}$		
GM-3	LND-D1887 GM Tube (foil)	Electrons	E3	$E_e > 120$ keV	0.03	"
		Protons		$E_p > 2800$ keV	0.03	"
		X-Rays		$2 < \lambda < 10\text{Å}$		