A BI-DIRECTIONAL CHARGED PARTICLE TELESCOPE TO OBSERVE FLUX, ENERGY SPECTRUM AND ANGULAR DISTRIBUTION OF RELATIVISTIC AND NON-RELATIVISTIC PARTICLES

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1. INTRODUCTION

A Charged Particle Telescope[1] (CPT) was designed, fabricated and calibrated to make the following observations[2,3]:

(i) Discrimination between various singly charged particles e.g. electrons, muons and protons, in about 5-100 MeV energy range.
(ii) Measurement of the flux and the energy of the charged particles incident on telescope from two opposite directions and stopping in the Telescope, thus obtaining flux and energy spectrum of downward and upward moving charged particles.
(iii) Measurement of broad angular distribution of selected particles as a function of azimuthal angle.

This telescope can be used to study low energy electron, muon and proton energy spectra. The experiment was flown in a high altitude balloon from Hyderabad, India, in December 1984. This same equipment is also useful in ground level electron, muon spectrum study.

2. EXPERIMENT

The Charged Particle Telescope contains a stack of Plastic Scintillators, inorganic scintillator and Cerenkov detectors. The telescope is described below.

The total energy detector consisted of a 1" thick NaI(Tl) crystal of 3" diameter. The total energy of particles was observed for those stopping in the crystal. Pulse height analysis was done for stopping as well as for penetrating particles. To distinguish various singly charged particles, dE/dX vs E technique has been used, aided by a Lucite (plastic) Cerenkov detector. The capability of charged particle separation by telescope is demonstrated by dE/dx vs. E graph with quick look data shown in Fig. 1. From Fig. 1, it is clear that various charged particles will produce different energy losses in a thin dE/dx detector for a given residual energy E, measured by Total energy detector. Those electrons which stop in total energy detector[4] are all relativistic while the stopping muons and protons are non-relativistic. Therefore, a velocity threshold Cerenkov detector will produce output for a stopping electrons only and other stopping particles will thus be separated. Combination of these two techniques results in an effective separation of electrons, muons and protons in selected energy interval of 5-30 MeV.

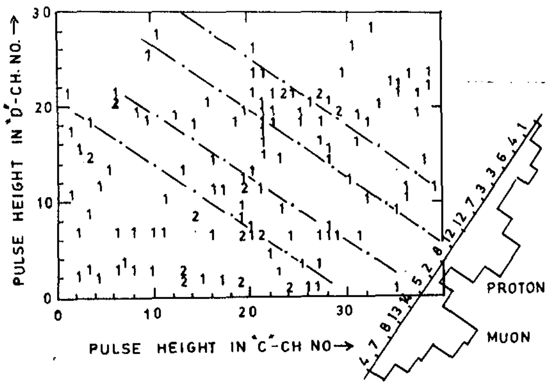


FIG.1

The up and down moving particles are distinguished using upper and lower dE/dx counters as anticoincidence detectors for upward and downward particles respectively.

3. ENERGY CALIBRATION

The energy calibration of various detectors of CPT was done using ground level Cosmic Ray Muons and radioactive Gamma Ray sources (Cs^{137}, Co^{60}). These sources were used for NaI(Tl) detector energy calibration. Beta particle source Sr^{90} was used for dE/dx detector testing, energy calibration and monitoring. A 8 MeV monoenergetic electron beam from microtron was used for various detector calibrations and for determining efficiency of Cerenkov

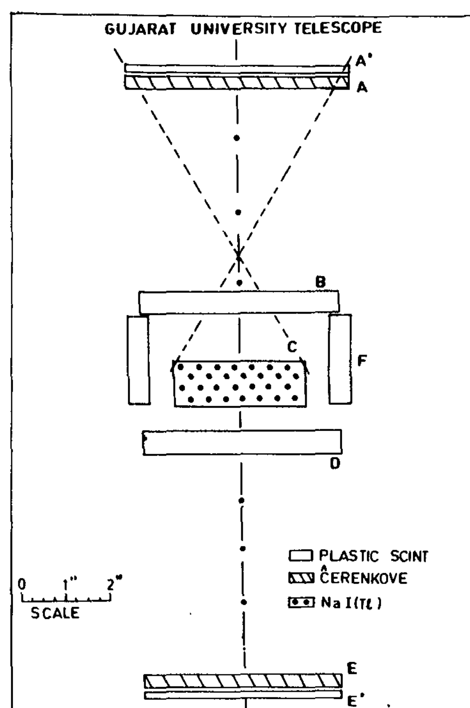
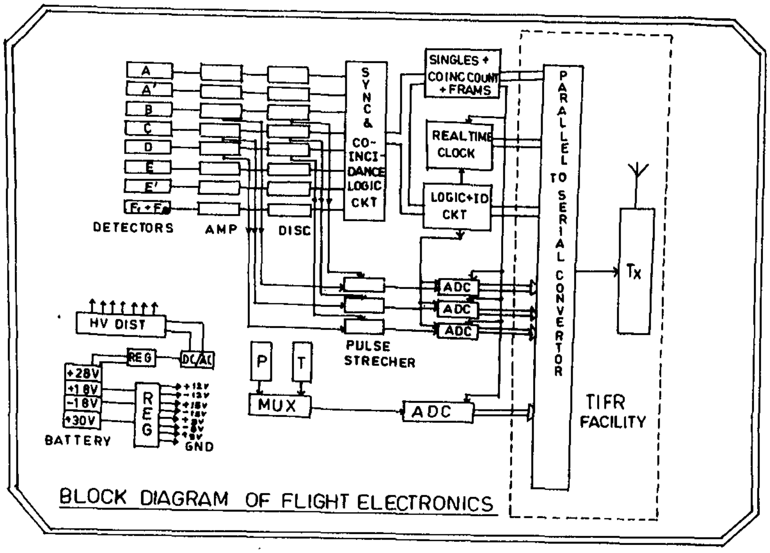


FIG 2

detector.

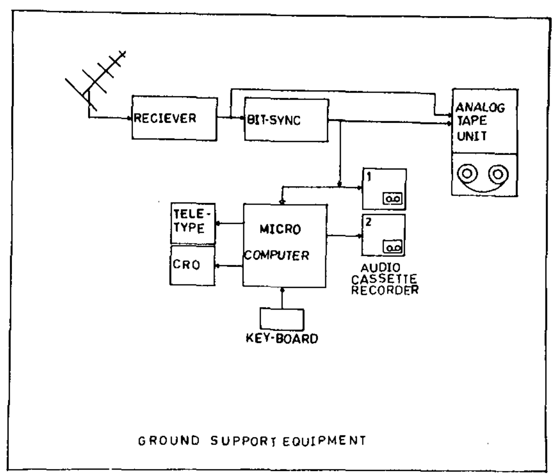


BLOCK DIAGRAM OF FLIGHT ELECTRONICS

FIG3

4. TELESCOPE HARDWARE

The Schematics of CPT is shown in Fig.2. The geometry of the telescope is defined by 1/8" thick plastic scintillator A' and 1" thick NaI(Tl) detector C. Geometrical factor of the telescope is 13 cm^2 Ster. Detector A is a Lucite Cerenkov detector, used as velocity threshold discriminator for various stopping particles. The detector B is 1/2" thick plastic scintillator, working as energy loss (dE/dx) detector. Lower detector D is another 1/2" thick plastic scintillator working as anticoincidence detector for downward moving particles. Detectors E and E' are complementary to A and A', creating another telescope for upward particles, with B acting as the anticoincidence detector, D as dE/dx detector. Fig.3 is a block diagram of the Electronic Support sub-system. The Ground Support System is shown in Fig.4. It consists of a microcomputer and a teletype unit. The microcomputer receives clock and data from Bit-synchroniser and analyses the incoming data in real time. The desired information from quick look system can be printed out on teletype on getting a command from keyboard. Telescope assembly can be rotated around its horizontal axis to study angular distribution.



GROUND SUPPORT EQUIPMENT

FIG 4

The experiment was tested for several weeks before the flight for various detector characteristics, gain shifts, singles and coincidence count rates, high voltages, discriminator levels etc.

5. BALLOON FLIGHT

On 8th December 1984, this experiment was flown in a high altitude balloon in early morning hours (5.23 a.m. IST) from Hyderabad, India. Balloon ascended to an altitude of 37 km (4 mb) and floated for four hours. Experiment was cut down by telecommand at 12.00 noon and was picked up in a reasonably good shape. Post flight checkout runs indicate experimental condition to be good. Data analysis and results are presented in SH session[5,6].

6. ACKNOWLEDGEMENT

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