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A SILICON SURFACE BARRIER TELESCOPE FOR SOLAR PARTICLES IDENTIFICATION

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ABSTRACT

The calibration results of a laboratory model of a three silicon surface barrier detector telescope developed to identify energetic solar particles produced in solar flares and low energy cosmic rays in interplanetary space, by the ΔE-E method, are presented.

1. Introduction. During this last decade a number of experiment on board spacecrafts have been gathering information on the composition and energy of solar energetic particles and low energy cosmic rays. The most striking features to be extracted form the data are: a) Charge range $1 \le Z \le 28$ b) Energy range $\sim 1 \lesssim E \lesssim 50$ MeV/n c) Composition highly variable from event to event, with energy and even with time during a particular event. A detailed review has recently been published by J.P.Meyer (1985).

A International Solar-Terrestrial Physics programme is being studied by NASA, ESA and ISAS for the 90's, in which the European Space Agency is contributing with a multidisciplinary Solar-heliospheric observatory (e.g.SOHO) whose aims include the measurement of energetic particles in Interplanetary Space. The laboratory model of a detector telescope presented here is being realized as a first step towards our eventual participation in such programme.

2. Detector characteristics. The laboratory model of the heavy ion telescope has been designed to separate elements from $_2$He to $_{26}$Fe in the energy range of interest for solar energetic particles and C.R. anomalous component (Fig. 1). The telescope consists of three silicon solid state surface barrier detectors (D1, D2 and D3, Fig. 2) housed in a modular aluminium structure of cilindral symmetry which can easily be modified to hold different detector size and opening angles. The third detector (D3) is set in anticoincidence to reject particles which are not stopped in D2. TABLE I shows the main cha

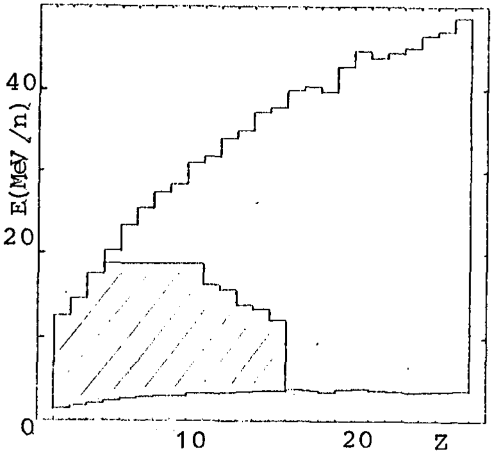


Fig. 1 Energy and charge ranges of the telescope.

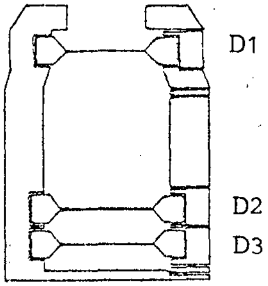
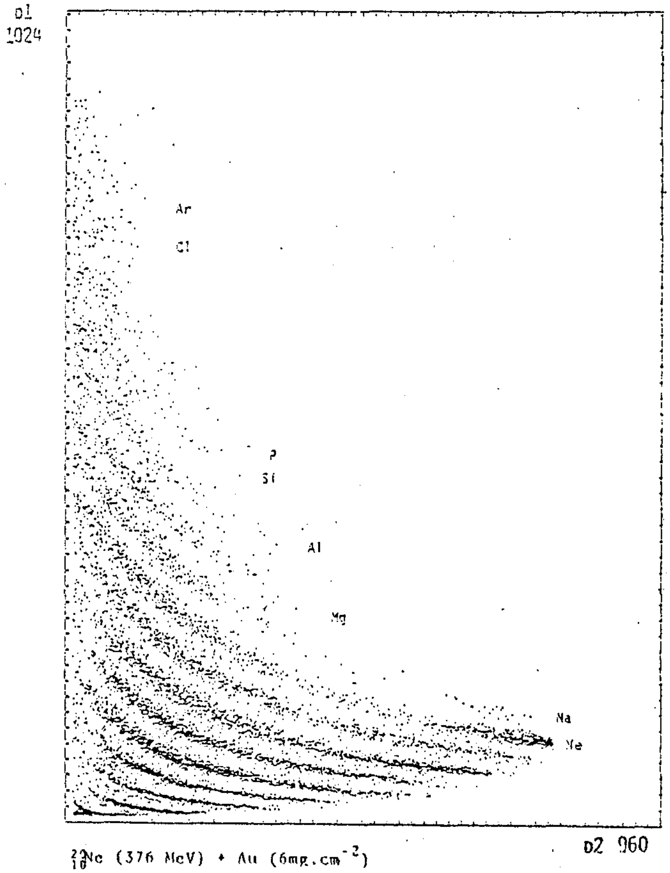


Fig. 2 Schematic cross section of the telescope.

TABLE I

Detector characteristics

	D1	D2	D3
Surface Area (cm^2)	3	4.5	4.5
Thickness (μm)	31	1014	470
Resistivity (KΩcm)	.408	12.5	6.7
Dead Layers (μg/cm^2)	40.0 Au 40.1 Al	40.1 Au 40.0 Al	40.3 Au 121.0 Al
Alpha Resolution (FWHM in KeV)	36.8	20.8	18.8



$^{20}_{10}$Ne (376 MeV) + Au (6mg.cm^{-2})

Fig. 3 D1 v.s. D2 matrix of raw data.

racteristics of the detector chosen. All detectors are ORTEC silicon surface barrier totally depleted. Alpha resolutions have been measured with an ^{241}Am source and include the contribution of noise from our electronic system. The geometrical factor of the model telescope has been G=0.4sr·cm^2.

3. Accelerator calibration. Absolute calibration of the telescope was performed in the VICKSI (Van-de-Graaff-Isochron-Cyclotron-Kombination fur Schwere Ionen) accelerator of the Hahn-Meitner-Institut (Berlin,F.R.G.). Two shifts, with beams of ^{20}Ne of 230 and 376 MeV, and ^{197}Au targets of 210 μg.cm^{-2} and 6 mg·cm^{-2} and ^{12}C target of 50 μg·cm^{-2}, were used. The scattered and fragmented ions were detected by the telescope placed at 20 cm from the targets and at θ = 25° (gold targets) and θ = 15° (carbon target) with respect to the beam direction. The angular acceptance of the telescope was about 0.3°. The data were split by a data distributer and collected simultaneously by our ADC's interfaced to a HP 9825 minicomputer and the da

ta adquisition system of the Institute, in order to check the reliability of our system.

4. Results. The resolution of D1 and D2 detectors for ^{20}Ne of 230 MeV elastically scattered in a 210 $\mu g \cdot cm^{-2}$ ^{197}Au target were measured to be 1.7 MeV and 1.9 MeV FWHM which correspond to 7.6% and 0.9% respectivily. Fig. 3 shows a D1 v.s. D2 energy-loss matrix of raw data from ^{20}Ne (E=376MeV) + ^{197}Au (6mg$\cdot cm^{-2}$) which gives and idea of the charge resolution of the detector system in low gain mode.

The charge spectra, over the whole charge and energy ranges produced (shade area in Fig. 1), have been obtained using a particle identifier algorithm described by Seamster et al. (2). This algorithm is based on integrating Bragg curves using the Bethe-Bloch equation and assuming

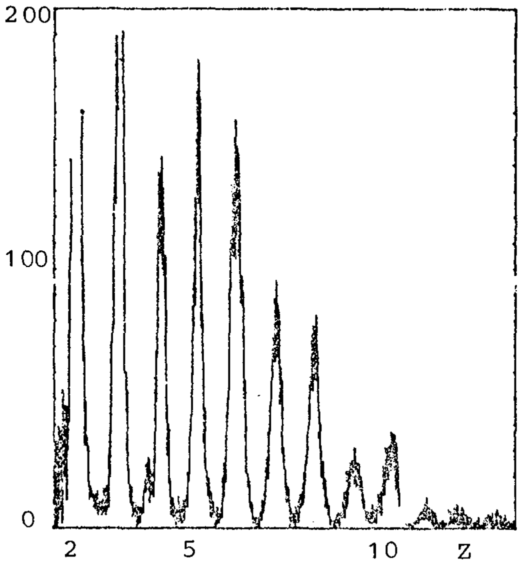


Fig. 4 Charge spectrum from de data of Fig. 3.

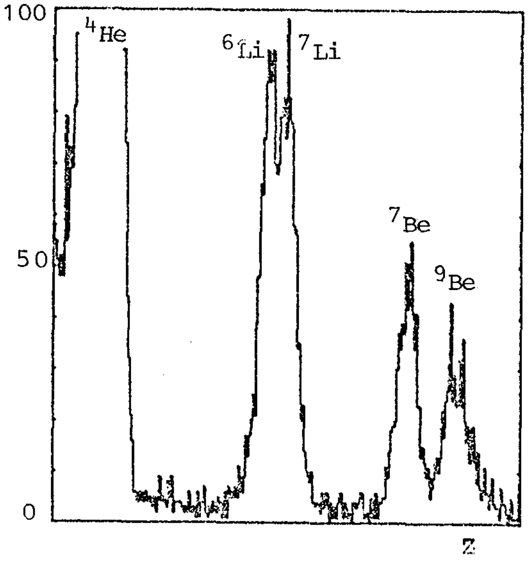


Fig. 5 Charge spectrum of ^{20}Ne (376MeV)+^{12}C(50μg cm^{-2}) in high gain mode.

M(amu)=2Z. For each event, by an iterative calculation, a particle identification parameter PI=$(1/2\ MZ^2)^{1/3}$ has been obtained. Fig. 4 shows the charge spectrum obtained from the data of Fig. 3. In Fig. 5 the low charge spectrum of the reaction products of ^{20}Ne (376 MeV) + ^{12}C(50 $\mu g \cdot cm^{-2}$) in high gain mode, is shown. No corrections have been performed on the data. The bias voltages were in creased 25% for detectors D1 and D3 and 50% for detector D2 above the depletion voltages, in order to reduce the contribution of plasma recombination to pulse hight defect.

5. Conclusions. From the results shown in Fig. 4 and 5 three conclusions can be made: a) The detector system described and tested is capable of good charge resolution from He to Al

although beyond Ne the statistic is very poor b) In the high gain mode, isotopic resolution has been acheived for ^{6}Li/^{7}Li and ^{7}Be/^{9}Be c) The much higher yield of ^{4}He over ^{3}He and of ^{9}Be over ^{10}Be in this type of nuclear reactions prevent from obtaining experimental evidence of those isotopes, although we believe that, at least ^{3}He/^{4}He, can be resolved under other more favorable conditions (i.e. solar ^{3}He-rich events).

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