**TWO-DIMENSIONAL POSITION-SENSING PVDF DUST DETECTOR FOR MEASUREMENT OF DUST PARTICLE TRAJECTORY;*** J.A. Simpson and A.J. Tuzzolino, Laboratory for Astrophysics and Space Research, Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637, USA

In earlier reports (1,2) we described our development of polyvinylidene fluoride (PVDF) dust detectors having the capability for:

a) particle mass and velocity determination using thin PVDF sensors spaced a given distance apart - i.e., by time-of-flight, and;

b) impact position determination - i.e., x,y coordinates of impact, as illustrated in FIG. 1

By combining these developments, we have designed space instrumentation capable of determining the mass, velocity and trajectory of an incident dust particle (2). In particular, for applications requiring high accuracy in trajectory determination (~ 1° trajectory error), we have described a dust-particle trajectory telescope using PVDF x,y detectors which will have this capability if the x,y detectors can determine the x,y impact coordinates to within ± ~2mm in x and y (2).

During our earlier studies of the dust response characteristics of a PVDF x,y detector carried out at the Heidelberg dust accelerator (3) the accuracy with which the x,y detector could determine the x,y coordinates of particle impact was not determined. To obtain this information, we developed a scheme for measuring the x,y determining capabilities of a PVDF x,y detector which does not require accelerated dust particles. This scheme makes use of a pulsed light source to simulate dust particle impacts. Using this optical scheme, we showed that PVDF x,y detectors should have the capability for particle impact position measurement with an error of ~1-2mm in x and y (2). However, the validity of these results for high velocity dust particle impacts had yet to be established.

To verify that the position errors determined by the optical scheme would also apply to impacting dust particles, a recent calibration of PVDF x,y detectors was carried out at the Munich dust accelerator facility using the arrangement shown in FIG. 2. FIG. 3 shows the signals from the D1 and D2 x,y detectors resulting from an accelerated glass particle of mass $m_o = 1 \times 10^{-6}$g incident on D1 with velocity $v_o = 2.74$ km/s. The particle penetrates D1 and emerges with a reduced velocity $v_1 = 2.41$ km/s and then impacts and penetrates through D2. Penetration of the particle through D1 and D2 was verified by microscope location of the penetration holes in D1 and D2. A comparison of the particle impact coordinates calculated from the detector signals with those measured geometrically (listed in FIG. 3) verifies the x,y errors determined by the optical scheme. Our Munich results show that PVDF x,y detectors can measure impact coordinates for high velocity dust particles with an error ~1-2mm in x and y and thus, when used in a telescope, can provide highly accurate trajectory information (2).

REFERENCES

(1) Simpson, J.A., Rabinowitz, D. and Tuzzolino, A.J. (1989), Nucl. Instr. and Meth. A279, 611-624.
(2) Simpson, J.A. and Tuzzolino A.J. (1989), Nucl. Instr. and Meth. A279, 625-639.
(3) Simpson, J.A. (1986), invited paper presented at Workshop on the Multicomet Mission, NASA/Goddard Space Flight Center, September 17, 1986, EFI Preprint No. 86-81.

*This research supported in part by NASA Grant No. NAG W-1757.

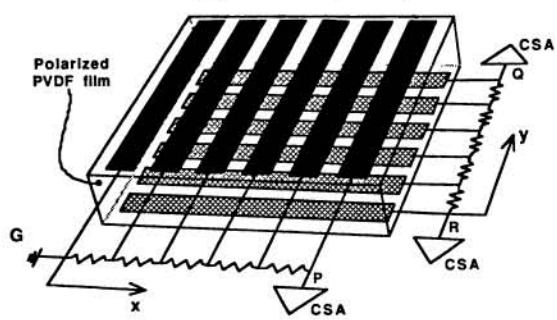


**FIG. 1:** Schematic diagram of a two-dimensional position-sensing PVDF dust detector (x,y detector). Evaporated aluminum strips on the front and back surfaces of the PVDF film are connected to external resistor networks as shown. Upon dust particle impact, current pulses are generated and passed to charge sensitive preamplifiers (CSA) located at P,Q,R. The CSA signals are passed to shaping amplifiers which yield output pulses having amplitudes P,Q,R. The x-coordinate of impact is determined from the ratio P/(Q+R) and the y-coordinate from the ratio Q/(Q+R).

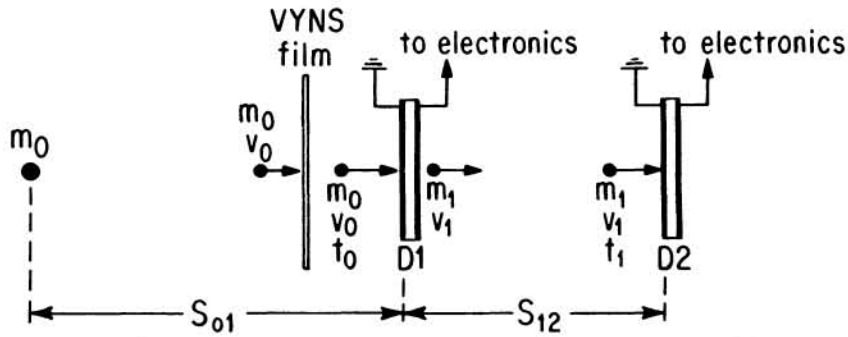


**FIG. 2:** Schematic arrangement for x,y detector telescope measurements during the Munich runs. D1 and D2 were 6μm thick PVDF x,y detectors having 58 aluminum strips on the front surface and 58 aluminum strips on the back surface. Strip width = 1.0mm; width of region between strips = 0.32mm; sensitive area = 64 $cm^2$; total resistance of resistor chain (57 resistors) = 170 ohms for each surface. An accelerated glass particle having mass $m_o$ and velocity $v_o$ travels a distance $S_{01}$ and impacts an ultra-thin (~700 Å) film (VYNS) located close to D1. The particle penetrates the VYNS film and impacts D1 at time $t_o$ after the accelerator trigger pulse. The particle penetrates D1 and exits D1 with mass $m_1$ and velocity $v_1$ and impacts D2, separated from D1 by a distance $S_{12}$, at a later time $t_1$. Particle mass $m_o$ is obtained by microscope examination of the impact hole in the VYNS film and $v_o$ and $v_1$ are obtained from $t_o$, $t_1$, $S_{01}$ and $S_{12}$.

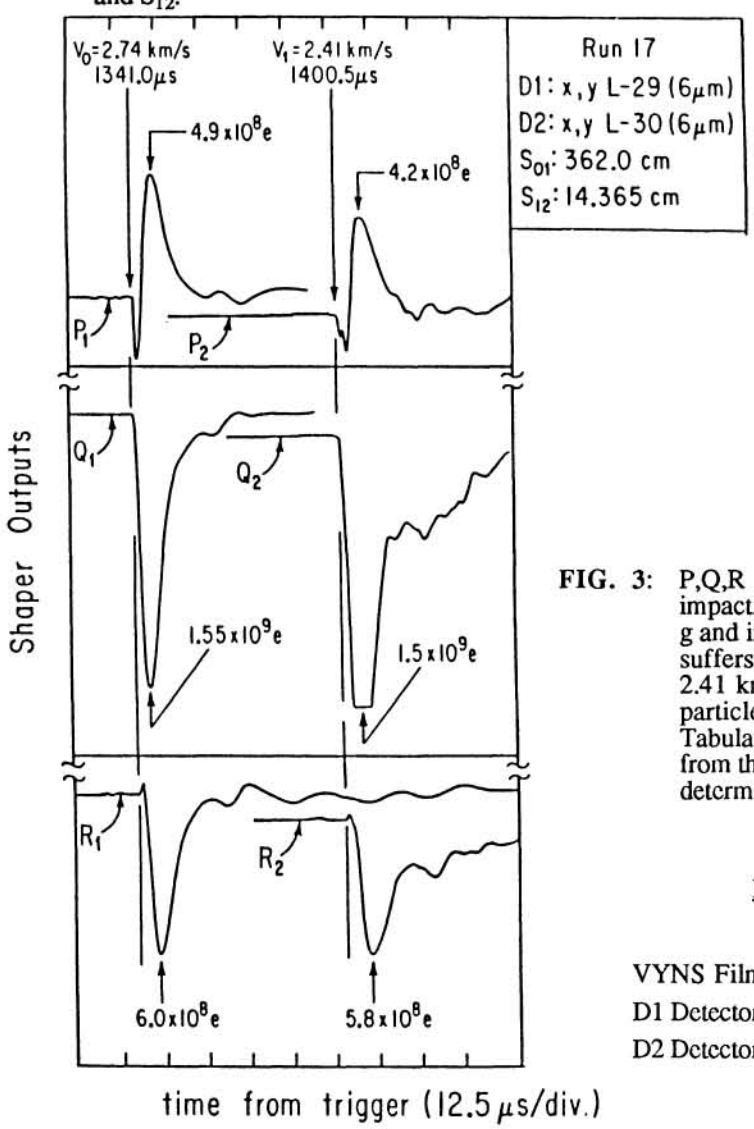


**FIG. 3:** P,Q,R signals from D1 and D2 resulting from an impacting glass particle having mass $m_o = 1 \times 10^{-6}$ g and incident velocity $v_o$ = 2.74 km/s. The particle suffers a velocity loss upon D1 penetration ($v_1$ = 2.41 km/s) but does not fragment ($m_1 = m_o$). The particle then impacts and penetrates through D2. Tabulated are particle impact coordinates calculated from the x,y detector signals and impact coordinates determined geometrically, as follows:

| | Impact Coordinates Located Geometrically | | Impact Coordinates Calculated from Detector Signals | |
|---|---|---|---|---|
| | x(cm) | y (cm) | x(cm) | y(cm) |
| VYNS Film | 2.35 | 6.25 | - | - |
| D1 Detector | 2.35 | 6.25 | 2.44 | 6.15 |
| D2 Detector | 2.20 | 6.30 | 2.24 | 6.15 |