

Apollo 17 Lunar Ejecta and Meteorites Experiment (LEAM)

Microphone Pulse Height Analyzer (PHA) levels

The microphone PHA data values (DJ-8, DJ-19, and DJ-30) are 3 bit numbers ranging from 0 to 7. According to Berg et al. (1973), the microphone can be triggered by momenta as low as 2×10^5 dyne-sec.

For the Pioneer 8 and 9 Cosmic Dust Detectors, the threshold values are given in figure 1 below from Berg et al. (2017).

C. ACTIVE MIKE P.H.A

BINARY COUNT	-25°C	+25°C	+70°C
1	51 μV	55 μV	59 μV
2	132	123	140
3	345	325	392
4	920	825	900
5	2.43 MV	2.25 MV	2.3 MV
6	6.6	6.05	6.0
7	19.0	16.1	16.0

Figure 1 – Otto Berg, notebook 2, p. 42, Pioneer 8 and 9 Cosmic Dust Detector microphone PHA levels

If the detectors are identical, a value of 55 microvolts corresponds to the minimum momentum of 2×10^5 dyne-sec. The magnitude of the signal from the microphone has been considered to be proportional to the particle momentum (Final Engineering Report, 1970, p.2-5). Therefore, the particle momentum, p , can be determined from the signal magnitude, s , by

$$P = s (2 \times 10^5 \text{ dyne-sec} / 55 \text{ mV}) = s (3.6 \times 10^{-7} \text{ dyne-sec/mV})$$

However, note that the detectors may not be identical, and, from the Final Engineering Report (1970, p. 2-6): “Microphone signals generated from hyper velocity particles impacting on the microphone plate are not always exactly proportional to mass times velocity. These variations may be attributed to the variation of accommodation coefficient due to variation of particle diameter, density, or configuration. For the purposes of design and calibration it has been assumed that microphone signals are proportional to particle momentum.”

If we assume we can accept the $P = s (3.6 \times 10^{-7} \text{ dyne-sec/mV})$ relationship, we get the following ranges of momenta for the PHA recorded on the microphones:

PHA	Threshold (millivolts)	Momentum Range (10^{-5} dyne-sec)
1	0.055	2 – 4.4
2	0.123	4.4 – 11.7
3	0.325	11.7 – 29.7
4	0.825	29.7 – 81.0
5	2.25	81.0 - 218
6	6.05	218 - 580
7	16.1	580 -

References

Berg, O.E., F.F. Richardson, and H. Burton, Apollo 17 Preliminary Science Report, Chapter 16, NASA SP-330, NASA, Washington, D.C., 1973.

Berg, O.E. and D.R. Williams, "Pioneer 8 and 9 Cosmic Dust Detector Calibration Notebook Bundle", NASA Planetary Data System, ID: urn:nasa:pds:pioneer89cdd, 2017. Digital reproduction of two hand-written laboratory notebooks, #1 and #2, of calibration analyses for the Pioneer 8 and 9 Cosmic Dust Detectors (CDD). These results aided Berg's calibration effort for the Apollo 17 Lunar Ejecta And Meteorite Experiment (LEAM) detector which was identical to the Pioneer CDDs.

Final Engineering Report for Cosmic Dust Detector Model ML 309-1 and Cosmic Dust Detector Ground Support Equipment Model ML 310-1, prepared for NASA/Goddard, Technical Staff, Time-Zero Corporation, NASA CR-110703, 1970. (Available from NASA Technical Reports Service Registered website, <https://ntrsreg.nasa.gov> for NASA-registered users.)