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FIRST-TIME ANALYSIS OF COMPLETELY RESTORED DTREM INSTRUMENT DATA FROM APOLLO 14 AND 15. Marie J. McBride[1], David R. Williams[2], H. Kent Hills[3], and Niescja Turner[1], [1]Florida Institute of Technology, 150 W. University, Melbourne, FL 32901, mmcbride2009@my.fit.edu, neturner@fit.edu, [2]NSSDC, Code 690.1, Goddard Space Flight Center, Greenbelt, MD 20771, david.r.williams@nasa.gov, [3]ADNET Systems, Inc., NSSDC, Code 690.1, Goddard Space Flight Center, Greenbelt, MD 20771, howard.k.hills@nasa.gov.

Introduction: The Dust, Thermal and Radiation Engineering Measurement (DTREM) packages (figure 1) mounted on the central stations of the Apollo 11, 12, 14, and 15 ALSEPs (Apollo Lunar Surface Experiments Packages) measured the outputs of exposed solar cells and thermistors over time. The goal of the experiment, also commonly known as the dust detector, was to study the long-term effects of dust, radiation, and temperature at the lunar surface on solar cells. The monitors returned data for up to almost 8 years from the lunar surface. The original data from the instruments were never properly archived in full. There were only 38 reels of microfilm archived at the National Space Science Data Center (NSSDC). On the microfilm were images of computer printouts containing times as well as raw and calibrated data for only Apollo 14 and 15 (figure 2). This form of data is not ideal for analysis because of the large volume. The raw data for the DTREM are embedded in the ALSEP housekeeping (Word 33) telemetry stream, but these are only in the form of uncalibrated counts. As part of the lunar data restoration effort, we used the microfilm and raw telemetry to provide Apollo 14 and 15 DTREM data in a digital format for the first time.

We created a full digital DTREM data set from the information about the instrument that was preserved. Since the raw telemetry data were in a digital format the goal was to determine the calibrations and translations necessary to make the raw counts into a usable and accurate format. We were able to use the microfilm records as a “Rosetta Stone” to find the calibration procedure and as an accuracy check. As a result of this process the Apollo 14 and 15 DTREM now have fully calibrated digital data sets giving temperatures and solar cell outputs over time. The calibrations found have also been confirmed with the Apollo 14 and 15 instrument data.

The Apollo 11 DTREM was powered by solar cells and only operated for a few months as planned. The Apollo 12, 14, and 15 detectors operated for 5 to 7 years, returning data every 54 seconds, consisting of voltage outputs from the three solar cells and temperatures measured by the three thermistors. The immense size of the data set shows the need for the data to be in a digital format for full analysis. We have collected some of the necessary information on Apollo 11 and 12 but more is needed to complete the process and we are attempting to obtain the required information.

With the success of the Apollo 14 and 15 DTREM data restoration, a full analysis of the results is underway. Since the data sets are in a digital format, modern technologies can be used to complete an unprecedented in-depth analysis. Initial analysis has been completed and some preliminary conclusions can be drawn from the results. We can see the effects of the Earth-Moon orbital motion on the instrument by the sinusoidal trend in the collected data. Lunar eclipses can be identified by sharp dips in the data (figure 3). The Apollo 14 and 15 DTREMs each had three solar cells: one was a normal glass-covered cell, one was an equivalent cell without a glass covering, and one was a glass-covered cell that had been exposed to high-energy radiation on Earth pre-flight. The relatively large degradation experienced by the uncovered cell and the very small change in output of the pre-irradiated cell over time indicates that radiation is a major contributor to the degradation of unprotected solar cells. The small change in output of the pre-irradiated cell (and the very minor change in the normal covered cell) rules out any major changes due to deposition of dust on the solar cells.

One of the most evident features in the data set is the damage to the uncovered solar cell by the major August 1972 solar proton event (figure 3). Using the completed DTREM data sets with calibrated results combined with data sets from other ALSEP instruments that detected effects due to this particle event, we hope to better quantify the true effects of the solar proton event at the lunar surface.

In the future we will complete the archival process and release the data from the Apollo 14 and 15 DTREM through the Lunar Data Node of the Planetary Data System.

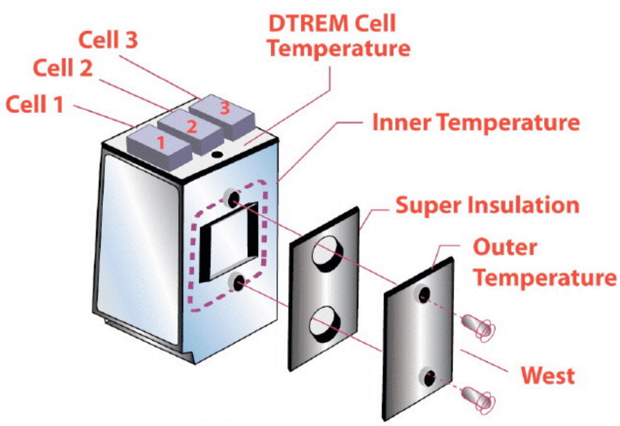
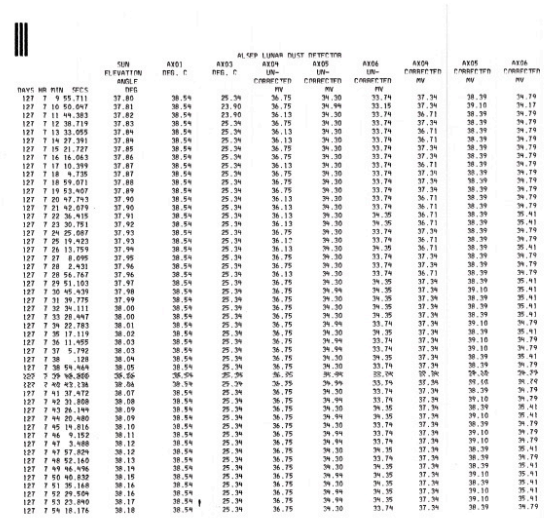


Figure 1: Diagram of the Dust, Thermal, and Radiation Engineering Monitor (DTREM).



ALSEP LUNAR DUST DETECTOR

DAYS	HR	MIN	SECS	SUN ELEVATION ANGLE DEG	AX01 DEG. C	AX03 DEG. C	AX04 UN-CORRECTED MV	AX05 UN-CORRECTED MV	AX06 UN-CORRECTED MV	AX04 CORRECTED MV	AX05 CORRECTED MV	AX06 CORRECTED MV
127	7	9	55.711	37.80	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	10	50.047	37.81	38.54	23.90	36.75	34.94	33.15	37.34	39.10	34.17
127	7	11	44.383	37.82	38.54	23.90	36.13	34.30	33.74	36.71	38.39	34.79
127	7	12	38.719	37.83	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	13	33.055	37.84	38.54	25.34	36.13	34.30	33.74	36.71	38.39	34.79
127	7	14	27.391	37.84	38.54	25.34	36.13	34.30	33.74	36.71	38.39	34.79
127	7	15	21.727	37.85	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	16	16.063	37.86	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	17	10.399	37.87	38.54	25.34	36.13	34.30	33.74	36.71	38.39	34.79
127	7	18	4.735	37.87	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	18	59.071	37.88	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	19	53.407	37.89	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	20	47.743	37.90	38.54	25.34	36.13	34.30	33.74	36.71	38.39	34.79
127	7	21	42.079	37.90	38.54	25.34	36.13	34.30	33.74	36.71	38.39	34.79
127	7	22	36.415	37.91	38.54	25.34	36.13	34.30	34.35	36.71	38.39	35.41
127	7	23	30.751	37.92	38.54	25.34	36.13	34.30	34.35	36.71	38.39	35.41
127	7	24	25.087	37.93	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	25	19.423	37.93	38.54	25.34	36.13	34.30	33.74	36.71	38.39	34.79
127	7	26	13.759	37.94	38.54	25.34	36.13	34.30	34.35	36.71	38.39	35.41
127	7	27	8.095	37.95	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	28	2.431	37.96	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	28	56.767	37.96	38.54	25.34	36.13	34.30	33.74	36.71	38.39	34.79
127	7	29	51.103	37.97	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	30	45.439	37.98	38.54	25.34	36.75	34.94	34.35	37.34	39.10	35.41
127	7	31	39.775	37.99	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	32	34.111	38.00	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	33	28.447	38.00	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	34	22.783	38.01	38.54	25.34	36.75	34.94	33.74	37.34	39.10	34.79
127	7	35	17.119	38.02	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	36	11.455	38.03	38.54	25.34	36.75	34.94	33.74	37.34	39.10	34.79
127	7	37	5.792	38.03	38.54	25.34	36.75	34.94	33.74	37.34	39.10	34.79
127	7	38	.128	38.04	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	38	54.464	38.05	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	39	48.800	[illegible]	38.54	25.34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
127	7	40	43.136	38.06	38.54	25.34	36.75	34.94	33.74	37.34	39.10	34.79
127	7	41	37.472	38.07	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	42	31.808	38.08	38.54	25.34	36.75	34.94	33.74	37.34	39.10	34.79
127	7	43	26.144	38.09	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	44	20.480	38.09	38.54	25.34	36.75	34.94	34.35	37.34	39.10	35.41
127	7	45	14.816	38.10	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	46	9.152	38.11	38.54	25.34	36.75	34.94	33.74	37.34	39.10	34.79
127	7	47	3.488	38.12	38.54	25.34	36.75	34.94	33.74	37.34	39.10	34.79
127	7	47	57.824	38.12	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	48	52.160	38.13	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79
127	7	49	46.496	38.14	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	50	40.832	38.15	38.54	25.34	36.75	34.94	34.35	37.34	39.10	35.41
127	7	51	35.168	38.16	38.54	25.34	36.75	34.30	34.35	37.34	38.39	35.41
127	7	52	29.504	38.16	38.54	25.34	36.75	34.94	34.35	37.34	39.10	35.41
127	7	53	23.840	38.17	38.54	25.34	36.75	34.94	34.35	37.34	39.10	35.41
127	7	54	18.176	38.18	38.54	25.34	36.75	34.30	33.74	37.34	38.39	34.79

Figure 2: Sample of the computer output saved to microfilm and archived at NSSDC.

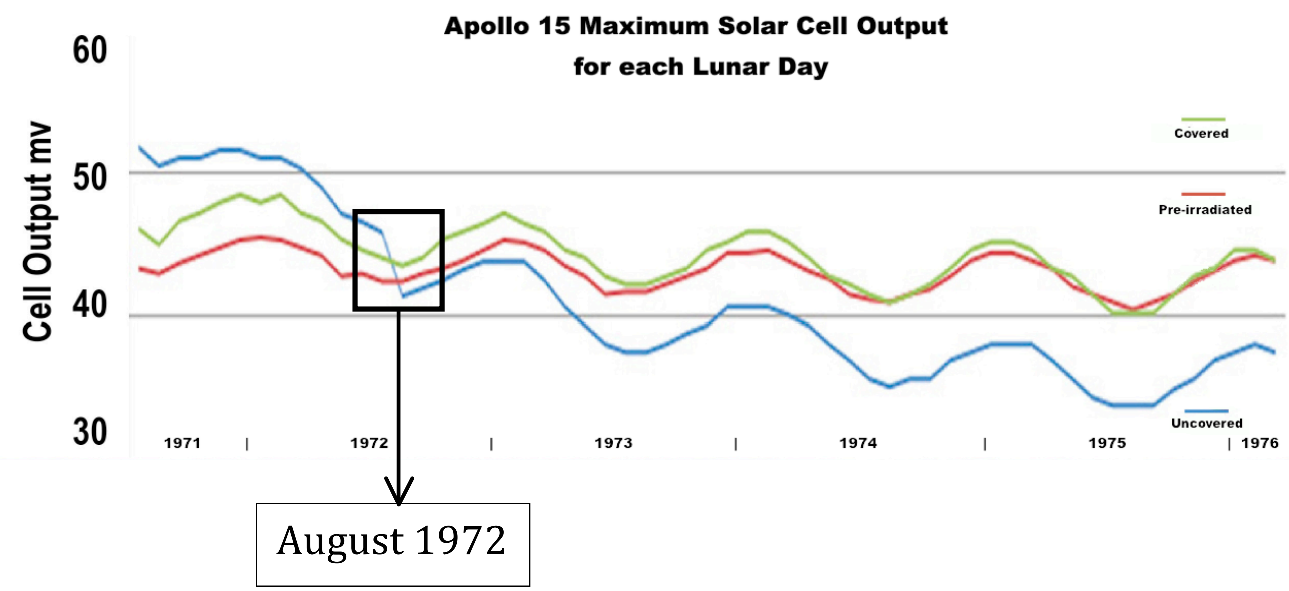


Figure 3: The three lines represent the three solar cells on the Apollo 15 DTREM. All data points represent lunar noon of a lunation. The damage to the uncovered cell by the solar proton event is highlighted