Supplementary Material

1 CHANGES OF THE LND CONFIGURATION

Tab.S1 lists the changes to the LND configuration which were made on the 3rd, 4th, 5th, and 9th lunar day (counted from the landing of Chang'E 4). An unforeseen sudden drop in temperature caused mechanical stresses in detectors A, H, I, and J which unfortunately resulted in an increased noise level of these detectors. This necessitated changes 1 - 3 presented below. Furthermore, we updated the onboard software to improve the response to the highest-energy stopping protons as is discussed in bullet 4 beneath. Point 5 below discusses how the LND firmware accumulates data into DPS boxes. Because these had to be defined before LND could be fully calibrated, they are not placed optimally for heavy ions.

Table S1. L1 threshold Changes history of LND (upper) and other configuration changes (bottom).

<table>
<tr><th>Lunar day</th><th>A2H</th><th>H2</th><th>I1H</th><th>I2H</th><th>J1</th></tr>
<tr><td>3rd</td><td>200 keV</td><td>42 keV</td><td>96 keV</td><td>300 keV</td><td>128 keV</td></tr>
<tr><td>4th</td><td>400 keV</td><td></td><td></td><td></td><td></td></tr>
<tr><td>9th</td><td></td><td>300 keV</td><td></td><td></td><td></td></tr>
<tr><td>5th</td><td colspan="2">Disable A2 in L3 logics:
LET and charged particles</td><td colspan="3">Raise L3 threshold of detector I
from 50 keV to 400 keV</td></tr>
</table>

1. The stress-induced increase in the noise level of the affected detector segments were partially compensated by adjusting the thresholds of the affected segments, as shown in Tab. S1.
2. We disabled the A2 channel in the L3 logic of LET and stopping particles to further reduce the impact of the increased noise on the LET spectra. LND triggers on the B detector which is also used for determining the LET spectrum. If the signal in detector A is also above threshold, then the appropriate LET channel is augmented. Thus the increased noise in A2 resulted in a corrupted LET spectrum which was fixed by disabling the A2 channel in the L3 logic. Disabling A2 in the level-3 logic dramatically changed the geometry factors and path length of LET spectra. An updated version of Table 4 in (Wimmer-Schweingruber et al., 2020) regarding the parameter of various LET spectra is given in Tab. S2
3. In the fifth lunar day we uploaded commands to raise the threshold of detector I in L3 trigger logic from 50 keV to 400 keV. The data products of penetrating particle were changed mostly as shown in panel (b) of Fig. 2, since we filtered many minimum ionizing protons that deposited

	Det.	# bins	$\langle L \rangle$ [μm]	$\hat{L}$[μm]	var(L) [μm]	g [mm^{2}sr]
1	$A \cdot B \cdot C \cdot I$	64	523	523	54	33
2	$\bar{A} \cdot B \cdot I \cdot J$	64	615	588	14896	2098
3	$A \cdot B \cdot I \cdot J$	8×64	511	513	1178	79
4	$2 \cup 3 \approx B \cdot J$	64	611	584	14774	2177
5	$1 \cup 3 \approx A \cdot B$	64	514	515	881	112

Table S2. Properties of the various LET spectra after disabling A2 in LND. This is thus an updated version of Table 4 in Wimmer-Schweingruber et al. (2020)

energy less than 400 keV in detector I. These missing particles mainly populate in the left half of penetrating panels of Xmas plots in DPS box H12 and H10. Luckily the detector response of the albedo particles, which are also in the left half, did not change as its energy deposition in the front detectors are much higher than the level 3 threshold of detector I.

4. Protons stopping in the I detector deposit different energy in it than our initial simulations had predicted. This means that the H9 DPS box is not correctly placed and therefore only has a reduced geometry factor compared to the analytical value of 0.275 $\mathrm{cm^2 sr}$. The correct value is given in Tab. S3.
5. Because of an error in the calculation of the locations of the DPS boxes for heavy ions they do not reflect the real positions of heavy ions in the Xmas plot. Thus, the DPS heavy ions should not be used for analysis. Also, because of the very low fluxes of heavy ions, the better time resolution of the DPS boxes of heavy ions is not needed and the data provided by the Xmas plot (at 1 hour time resolution) is more than adequate. The positions of the DPS boxes have not been corrected.

Those changes in the LND configuration were successful in salvaging the primary data products of LND. The quality of LND's data continues to be excellent thanks to the redundant design of LND.

2 UPDATED RESPONSE FUNCTIONS FOR PROTONS

Figure 3 (a) shows the geometry factors for the different DPS channels. The lower and upper limits in energy of the proton DPS boxes are fairly sharp for stopping particles (DPS boxes H1 - H9), but are not as clearly delineated for penetrating particles, as is to be expected. In other words, the geometry factors are not purely geometric quantities, but energy dependent response functions. We give the updated boundaries at the 50%-level (a kind of FWHM) in the second column of Tab. S3. For the lowest energy bin (H1), we used the 10%-level for the lower boundary, for H10 we used the 10% boundary for the upper limit.

Because of the sometimes broad energy response (e.g., for H10 or H11) variations of the primary particle spectrum will result in different counts rates in these DPS channels even if the total number of particles remains the same. The count rate is determined by integrating the product of the geometry factor and the primary particle spectrum. This results in a small, but in some cases non-negligible variation of the geometry factor. This is shown in columns three and four of Tab. S3 for a logarithmically flat (power-law exponent $\gamma = -1$) and the solar-minimum 24/25 CREME96 model. The calculation was performed as shown in eq. S1,

$$\bar{G} = \frac{\int_0^{inf} f(E)\, g\, \mathrm{d}E}{\int_{E_{min}}^{E_{max}} f(E)\, \mathrm{d}E}, \tag{S1}$$

where $f(E)$ is the input spectrum and the g are the (energy-dependent) geometry factors as shown in Fig. 3 (a).

Fig. 2 (a) shows that the proton DPS boxes are contaminated (primarily) by heavier ions. We account for this by a fixed correction factor for each DPS channel which is given in columns 5 and 6 for the CREME96 and BON14 models (again computed for solar minimum 24/25). These corrections can be substantial for some channels, as can be seen in the table.

The last column of Tab. S3 gives the numerical values of the LND data points shown in Fig. 5 together with their uncertainties.

Table S3. Weighted geometry factors and energy bins of primary and albedo protons, correction factors caused by other particles for CREME96 and BON14 case, and the averaged GCR and albedo proton fluxes.

Name	Energy(MeV)	GF(cm^2sr) (γ = -1)	GF(cm^2sr) (CREME)	Correction (CREME)	Correction (BON14)	GCR Flux (cm^2 sr s Mev)$^{-1}$
H1	9.18, 10.73	0.29	0.30	0.95	0.87	$4.66 \pm 0.28 \times 10^{-5}$
H2	10.73, 12.90	0.28	0.31	0.97	0.94	$3.96 \pm 0.21 \times 10^{-5}$
H3	12.90, 15.96	0.29	0.32	0.96	0.94	$4.22 \pm 0.18 \times 10^{-5}$
H4	15.96, 18.65	0.27	0.27	0.98	0.97	$4.90 \pm 0.23 \times 10^{-5}$
H5.	18.65, 21.17	0.26	0.28	0.97	0.96	$5.29 \pm 0.24 \times 10^{-5}$
H6.	21.17, 29.73	0.27	0.28	0.96	0.96	$7.60 \pm 0.15 \times 10^{-5}$
H7	29.73, 31.50	0.28	0.27	0.98	0.97	$8.38 \pm 0.37 \times 10^{-5}$
H8	31.50, 33.36	0.25	0.29	0.82	0.78	$7.96 \pm 0.34 \times 10^{-5}$
H9	33.17, 34.14	0.17	0.20	0.79	0.76	$9.13 \pm 0.61 \times 10^{-5}$
H10	139.2, 368.4	0.11	0.095	0.98	0.98	$4.74 \pm 0.01 \times 10^{-4}$
H11	42.3, 139.2	0.28	0.30	0.36	0.35	$1.98 \pm 0.01 \times 10^{-4}$
H14	34.94, 41.76	0.28	0.35	0.75	0.72	$1.54 \pm 0.02 \times 10^{-4}$
Albedo	64.7, 76.7	0.18	-	-	-	$1.12 \pm 0.09 \times 10^{-4}$

REFERENCES

Wimmer-Schweingruber, R. F., Yu, J., Böttcher, S. I., Zhang, S., Burmeister, S., Lohf, H., et al. (2020). The Lunar Lander Neutron and Dosimetry (LND) Experiment on Chang'E 4. Space Science Reviews 216, 104. doi:10.1007/s11214-020-00725-3