Supporting Information

A Magnetic field sensor based on OLED / organic photodetector stack

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Electric & magnetic field characterization of the OLEDs

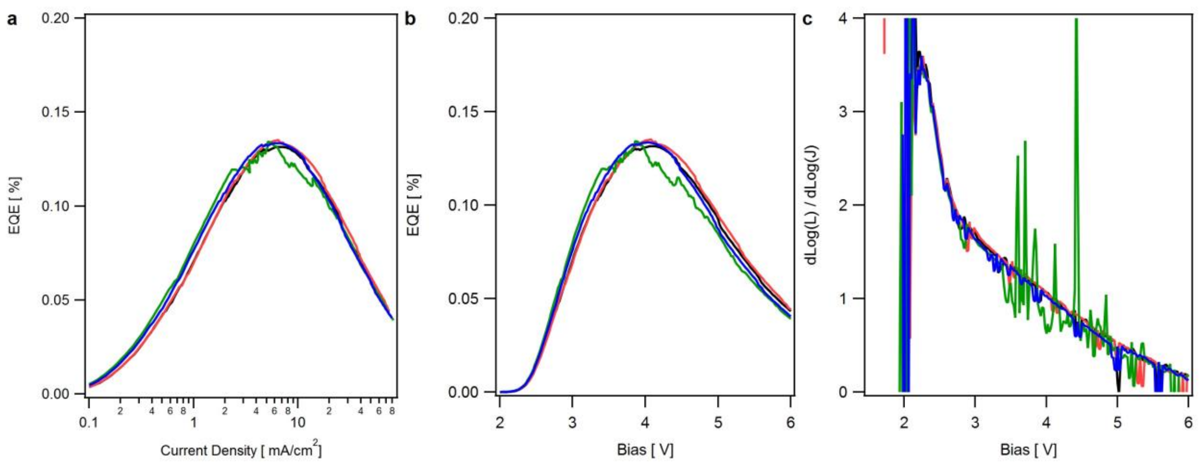

Figure S1 - EQE dependence of devices reported in the main manuscript as function of current density (a) and applied bias (b). Shown in (c) is the exponent of $L \sim J^n$.

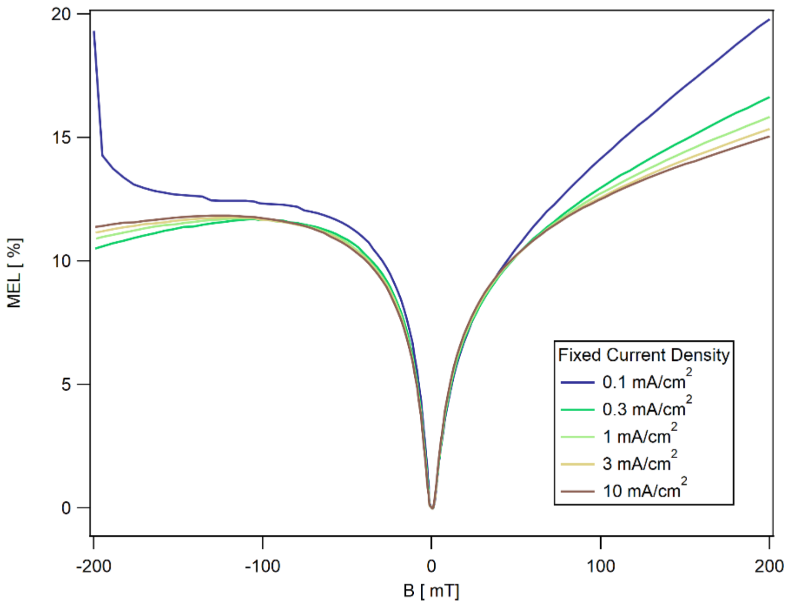

Figure S2 - MEL-response for a reference OLED on glass at constant current density

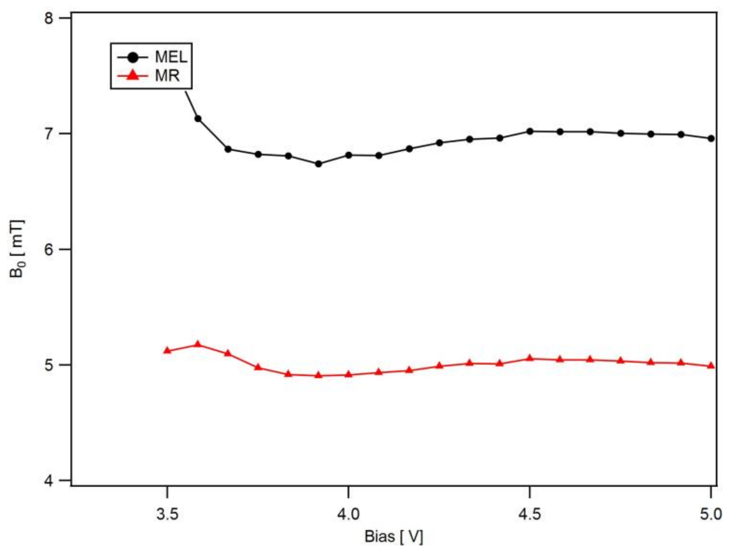

Figure S3 - Extracted characteristic field from MEL and MR to a non-Lorentzian line shape as described in the manuscript.

Electric & magnetic field characterization of OLEDs using a P3HT:PCBM OPD

<u>No magnetic field</u>

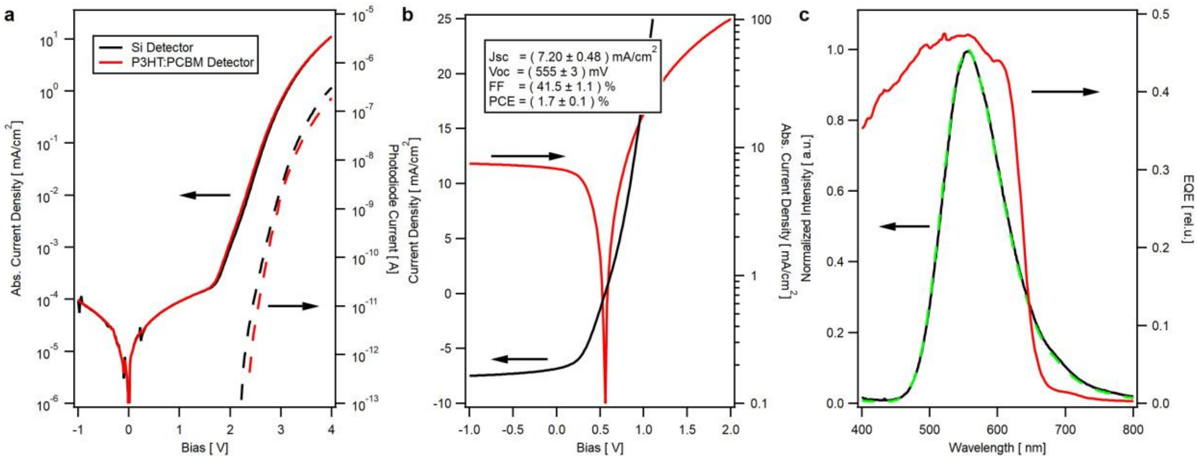

Figure S4 – Current density-Voltage-Luminescence, J-V-L, characteristics of a ITO/PEDOT/m-MTDATA (20nm) / m-MTDATA:3TPYMB 1:1 (40nm) /3TPYMB (5nm) /Al OLED (a). Shown are the Photodetector current for a Si-Detector as well as P3HT:PCBM OPD. Shown in b) is are the J-V-characteristics of the P3HT:PCBM OPD (ITO/PEDOT/P3HT:PCBM 1:1/Al) under illumination of a white light LED with 100mW/m^2. The electroluminescence spectra of the OLED in and without external magnetic field and 3V applied bias are shown in c). Also shown in c) is the EQE of the P3HT:PCBM OPD.

<u>Magnetic field response of the OPD</u>

Shown in **Figure S5** is the change in the P3HT:PCBM OPDs current density under dark conditions relative to the 0 mT case as well as the change in photocurrent under illumination with 555 nm. A small MC change with field on the order of 0.5% is observable in the OPD under dark conditions. The line profile is of Lorentzian like shape. The photocurrent dependence seems to be rather constant and is below 5%.

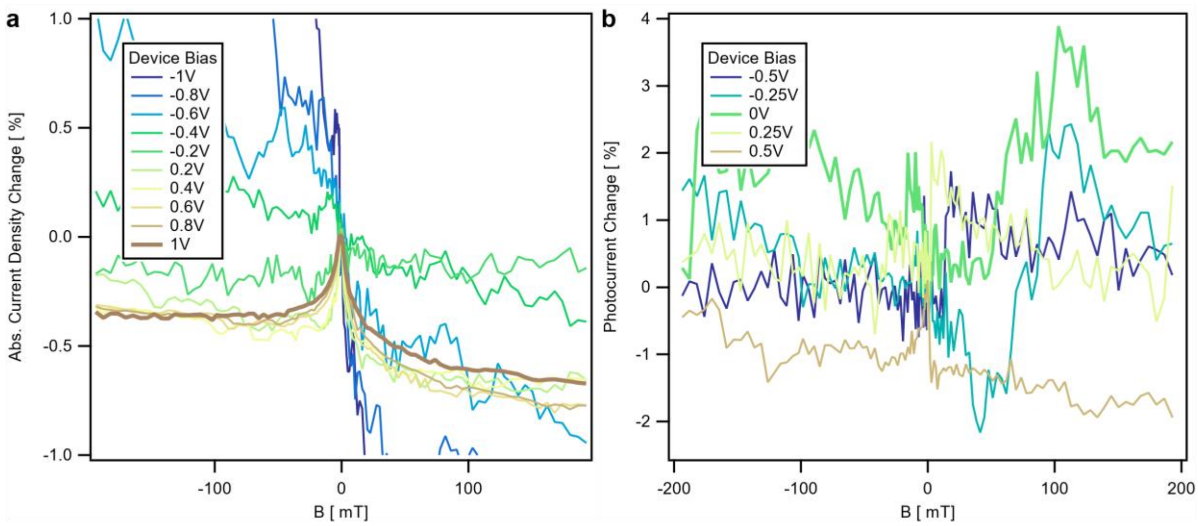

Figure S5 – Current density change at fixed device bias in the dark (a) and photocurrent change under monochromatic illumination of 555 nm (b) of a P3HT:PCBM photodetector. The data was referenced to the 0 mT value in the form Change in % = (I(B)/I(0) – 1) * 100.

Electric & magnetic field characterization of OPD/OLED layer stack

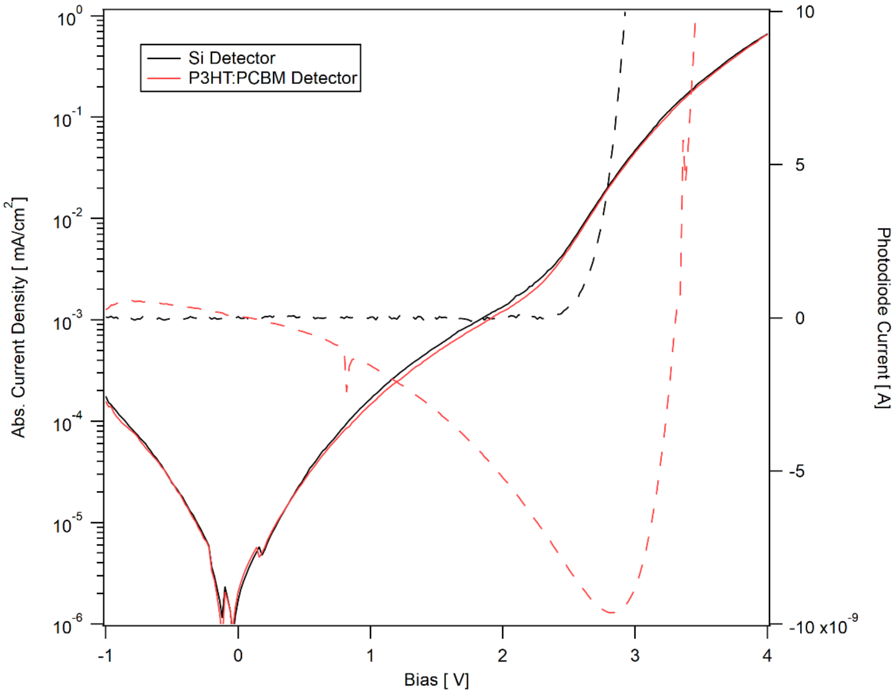

Figure S6 – J-V-L-characteristics of the OPD/OLED layer stack. Same data as shown in Error! Reference source not found. **except that the detector current (right axis) is on a linear scale and focused on the small signal region. The OPD signal was multiplied by -1 in order to make it comparable to the Si-detector.**

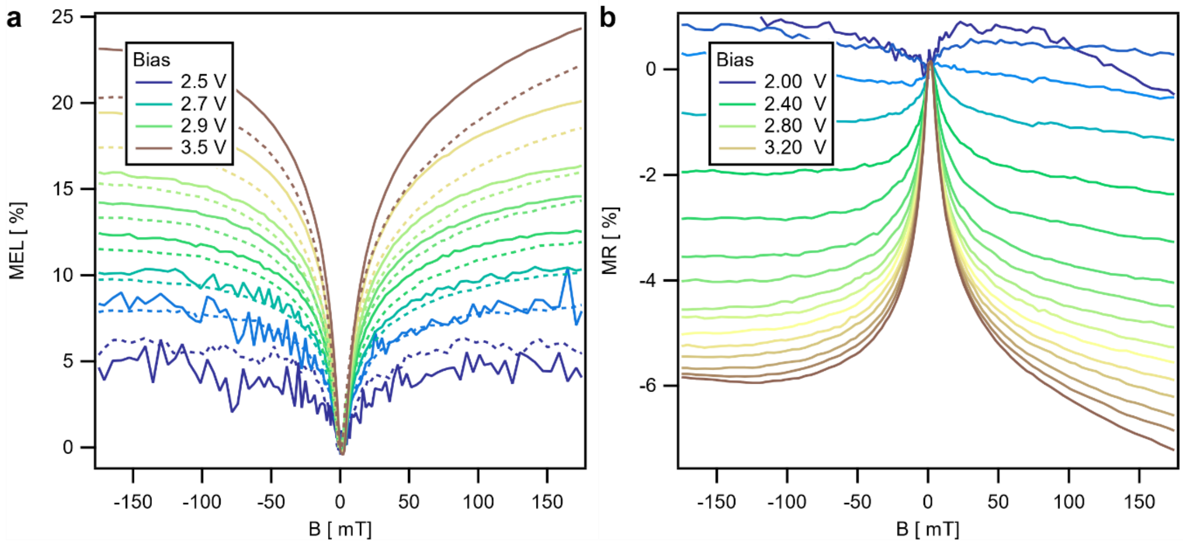

Figure S7 – Magneto-electroluminescence, MEL, change of the OLED (a) measured with a Si-detector (solid lines) and OPD (broken lines). Shown in (b) is the magneto-resistance change, MR, of the OLED.

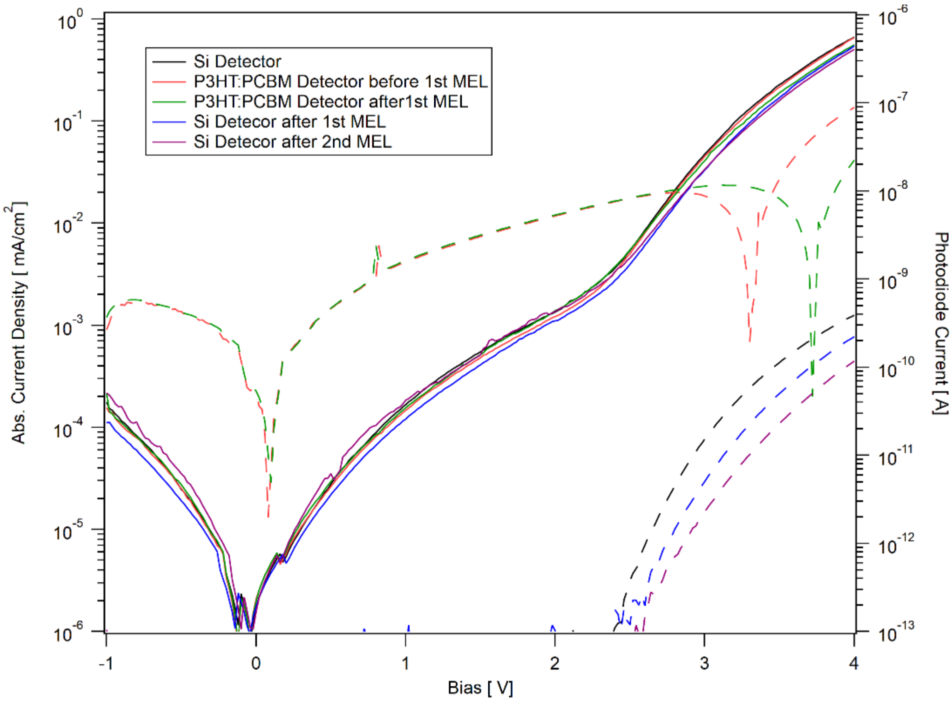

Figure S8 – J-V-L-characteristics of the OPD/OLED layer stack upon multiple measurements. The order of the measurements are Si-detector reference, OPD detector reference of the initial device. Measurement of the OPD MEL map shown in Error! Reference source not found.**, Measurement J-V-L with OPD, J-V-L with Si-detector, Si MEL map shown in** Error! Reference source not found.**, Measurement J-V-L Si-detector.**

Note on MEL data

Shown in **Figure S9** are the MEL data calculated directly from the raw current of the OPD as well as after a background correction that accounts for a changing coupling between the OPD and OLED with bias and field. The raw data shows bias regions with negative and positive response can be observed. The change in sign agrees with the change between region (I) and (II) in the J-V-L response, 3.7 V being the sign change in the slightly degraded device. Then more importantly, the observable response near that turn-over is several times larger than the MEL as observed by the external detector. Here a response of -200 % and 200 % were observed below and above the sign change. This extraordinary large response is due to an artefact and the way the MEL is calculated. Per definition MEL(B) = $L_D(B)/L_D(0)$ -1, however this is commonly approximated via the detector current $I_D(B)/I_D(0)$ -1, which is not limited to the up- or downside for detector currents approaching 0. The enhanced MEL response thus is due to a balancing of the coupling of the OPD to the OLED and the corresponding background “dark” current and the luminescent current. After subtracting the “dark” current, here estimated by a linear fit for constant field in the bias range <2.5V, from the detector data the corrected MEL can be calculated which shows identical behavior to the unbiased Si-detector data. The extracted background data is similar in its field dependence and order of magnitude to the MR-response of the TADF layer and the estimated current coupled into the OPD, respectively. The MR of the OLED is on the order 2-3% depending on bias condition, which roughly matches the change in OPD current coupled into the device (2%). Note that the current density in the OLED increases with field (decreasing MR) the current in the OPD due to coupling decreases with magnetic field.

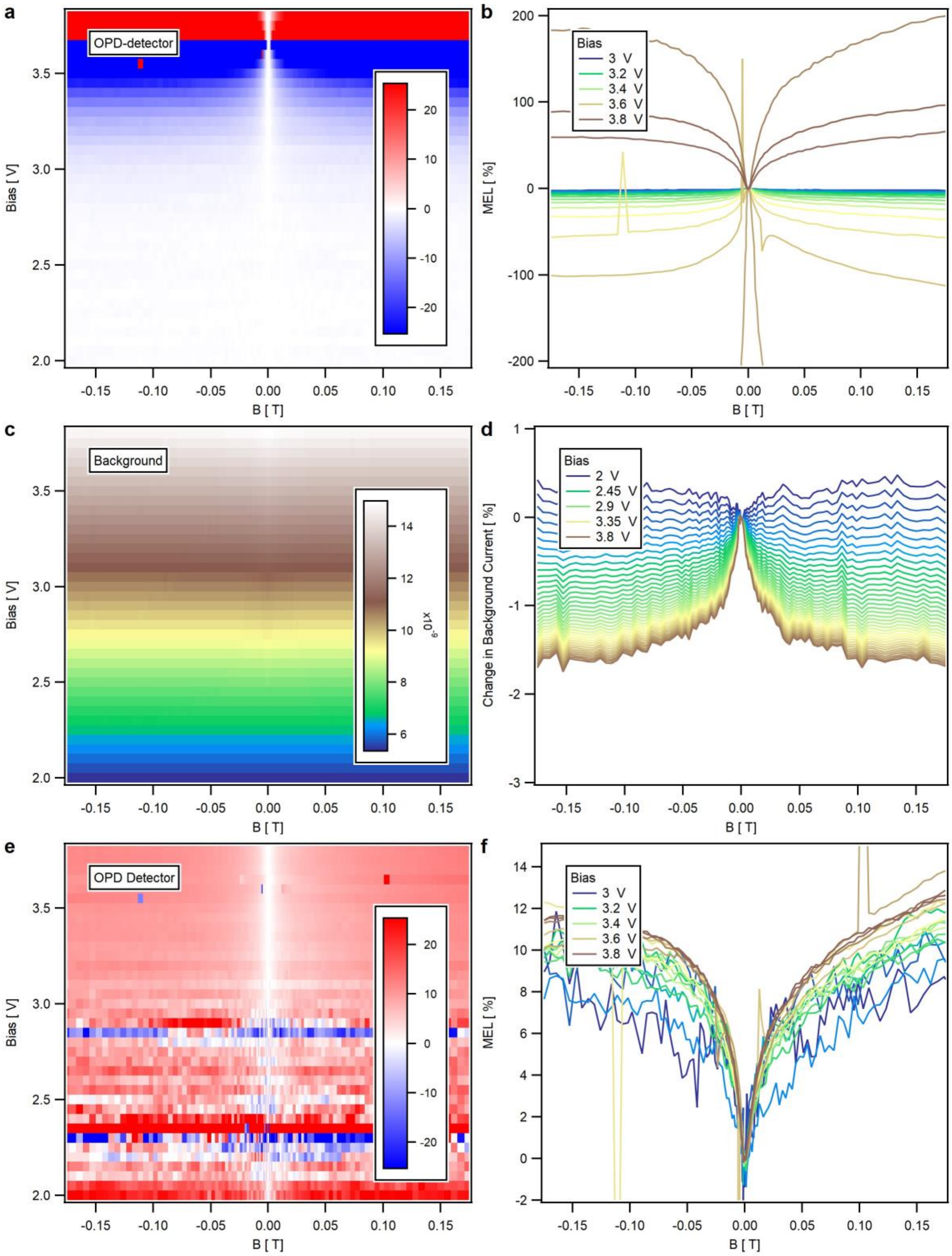

Figure S9 – False Color plot of the MEL calculated from the raw OPD data (a), the current coupled into the OPD as function of bias and field as extracted from a linear fit of the OPD current data (c) and corrected MEL data (e). Also shown are extracted line profiles at constant bias (b,d,f) for each of the false color plots. The current in (c) was estimated by a linear fit of the raw OPD current data to a linear dependence in the bias regime < 2.5V and extrapolated over the whole measurement range. Using this current the current contribution from the OLED luminescence can be extracted from the raw data.