

Evidence for a build-in remnant field in symmetrically contacted MAPbBr₃ X-ray detectors

Supplementary Material

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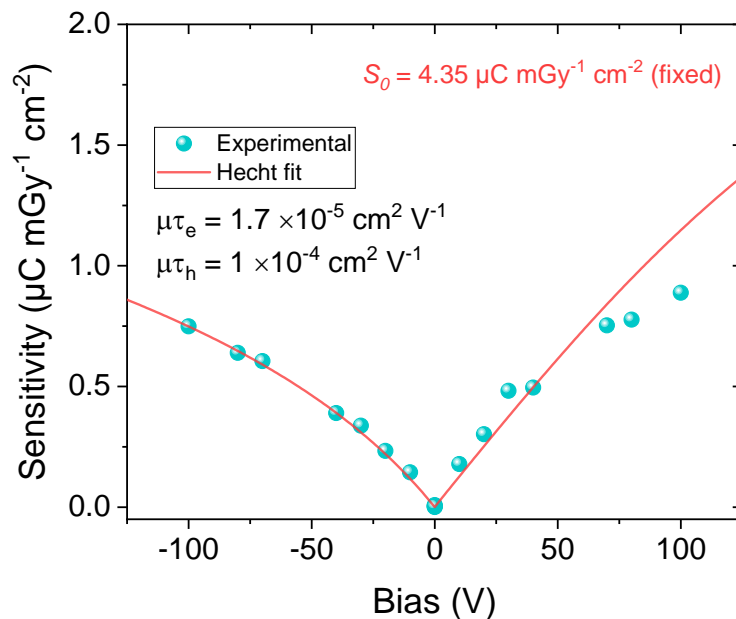


Fig. S1. Sensitivity-voltage plot of a MAPbBr₃ device and the best two-carriers Hecht fit with S_0 calculated using the electron-hole pair creation energy W -value from [1], measured for CsPbBr₃. There are a few examples of W -values being experimentally determined in the literature; this has been done for CsPbBr₃ [1] and MAPbI₃ [2], but to the best of our knowledge never for MAPbBr₃. While the W -value for CsPbBr₃ seems to deviate from the “classical” Klein’s rule ($W = 14/5 \cdot E_g + 0.5$), it does apply for MAPbI₃. At this point, it is unknown whether Klein’s rule applies to MAPbBr₃.

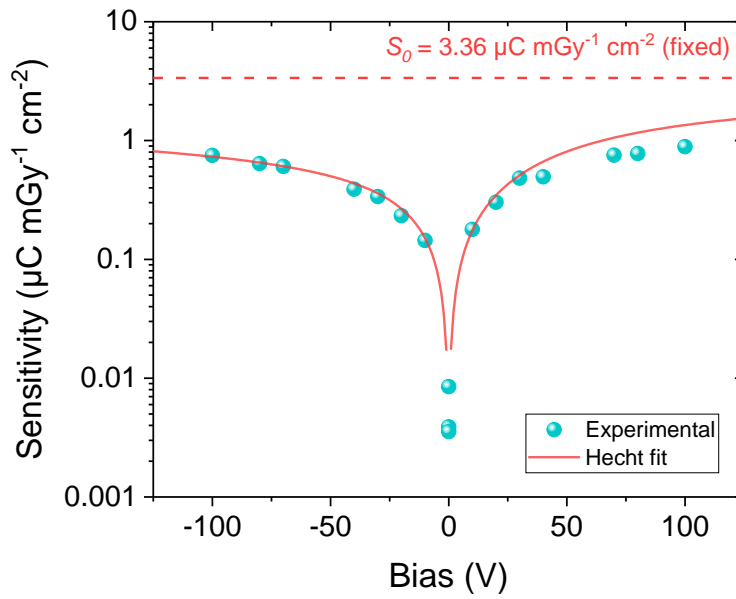


Fig. S2. Sensitivity-voltage plot of a MAPbBr₃ device and the best two-carriers Hecht fit with S_0 set as the total charge generated in the device (see Fig. 1b in the main text). The graph is displayed in semi-log scale.

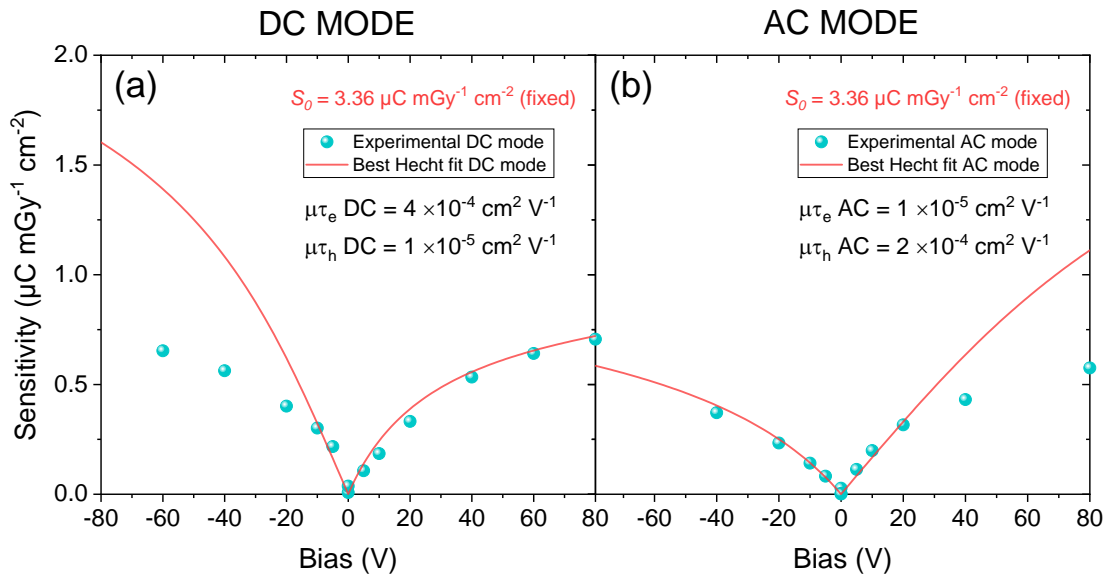


Fig. S3. Sensitivity-voltage plots of a MAPbBr₃ device and the two corresponding best two-carriers Hecht fits. In experiment (a), we applied increasingly constant bias sweep (bias = 0, 5, 10...V) (DC mode); in experiment (b), we added depolarization time inbetween each bias (bias = 0, 5, 0, 10, 0... V) (AC mode). The device was depolarized by physically shorting the two terminals for 5 min at lower bias and up to 10 min at higher bias (>20V). These depolarization times were chosen to ensure that the dark current had recovered most of its level before the next measurement step was started.

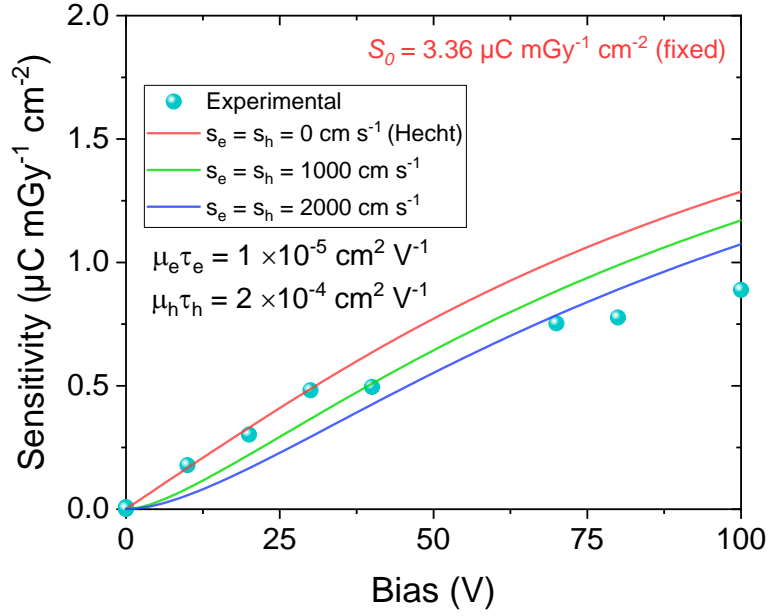


Fig. S4. Experimental sensitivity-voltage of a MAPbBr₃ device (blue dots), and computed S-V (colored lines) using the Many equation $\eta(x, V) = \frac{\mu_e \tau_e (V - V_i)}{L^2} \left[1 - e^{-\frac{L(L-x)}{\mu_e \tau_e (V - V_i)}} \right] \frac{1}{1 + \frac{L s_e}{\mu_e V}} + \frac{\mu_h \tau_h V}{L^2} \left[1 - e^{-\frac{xL}{\mu_h \tau_h (V - V_i)}} \right] \frac{1}{1 + \frac{L s_h}{\mu_h V}}$ with s_e and s_h the surface recombination rate of electrons and holes respectively, μ_e and μ_h the mobility-lifetime products of electrons and holes respectively. We set $\mu_e = 40 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ and $\mu_h = 20 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ as for our Laser Time-of-Flight results.[3] Length L of the device is 2 mm. The Many equation does not fit the experimental S-V because it does not have the typical "s-shape" that occurs at high recombination rates, and because the S-V computed with Many still has to plateau to $S_0 = 3.36 \text{ } \mu\text{C mGy}^{-1} \text{ cm}^{-2}$ at infinite voltage, which is precisely not the case in our experimental data.

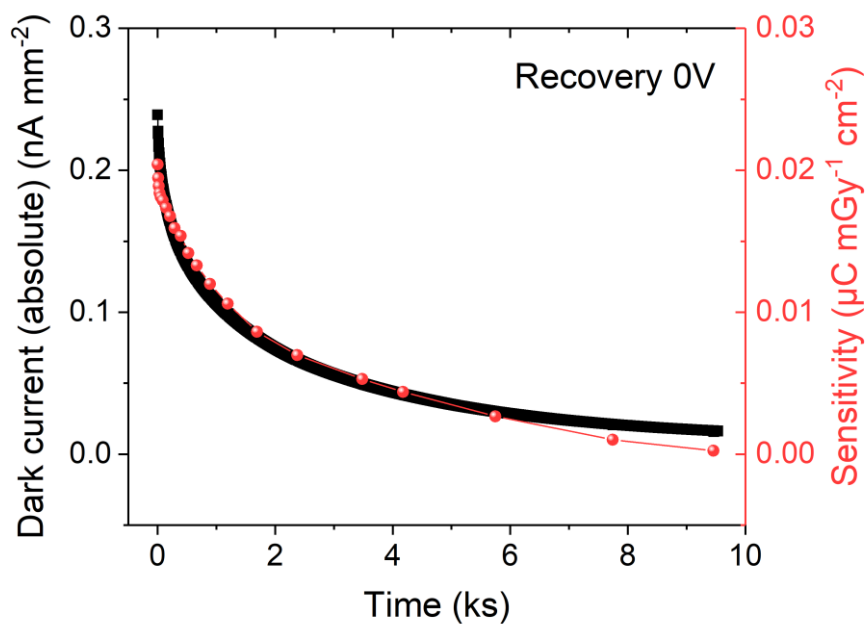


Fig. S5. Dark current (black dots) and sensitivity (red dots) as function of time. The device was previously biased at 10V. Dark current is negative and is plotted here in absolute unit.

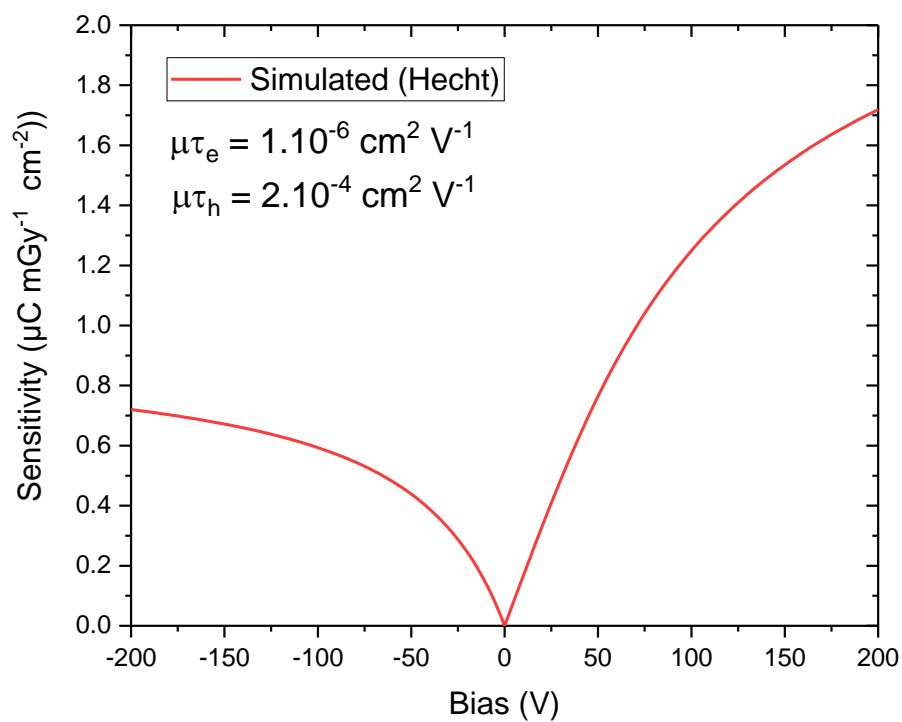


Fig. S6. Simulation of the sensitivity of a MAPbBr₃ planar device under RQA5 X-rays with 2-mm thickness and asymmetric charge transport properties.

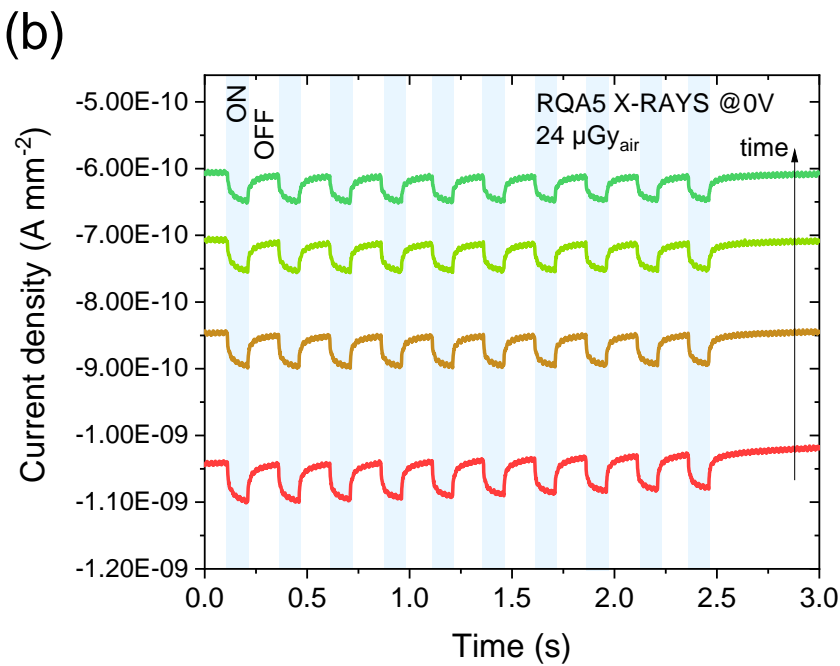
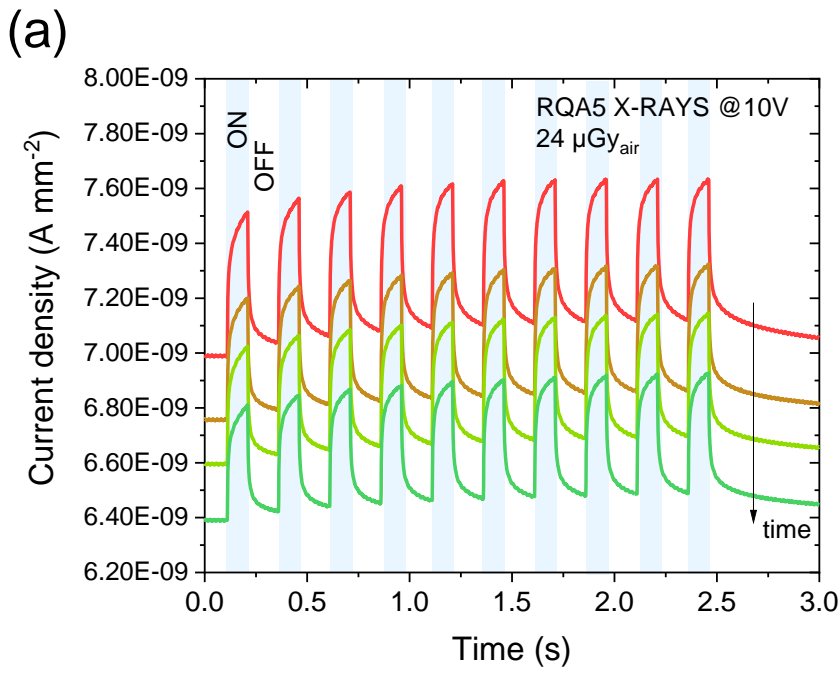


Fig. S7. Current density under X-rays measurements obtained for a 2-mm thick Cr/MAPbBr₃/Cr device at (a) 10V and (b) 0V right after removing the 10V bias. Each line corresponds to a single current-time acquisition. Each acquisition consists of 10 subsequent X-ray pulses with 100 ms duration and 100 mA tube current ($24 \mu\text{Gy}_{\text{air}}$ per pulse). Each acquisitions displayed here were separated by ~ 1 min delay.

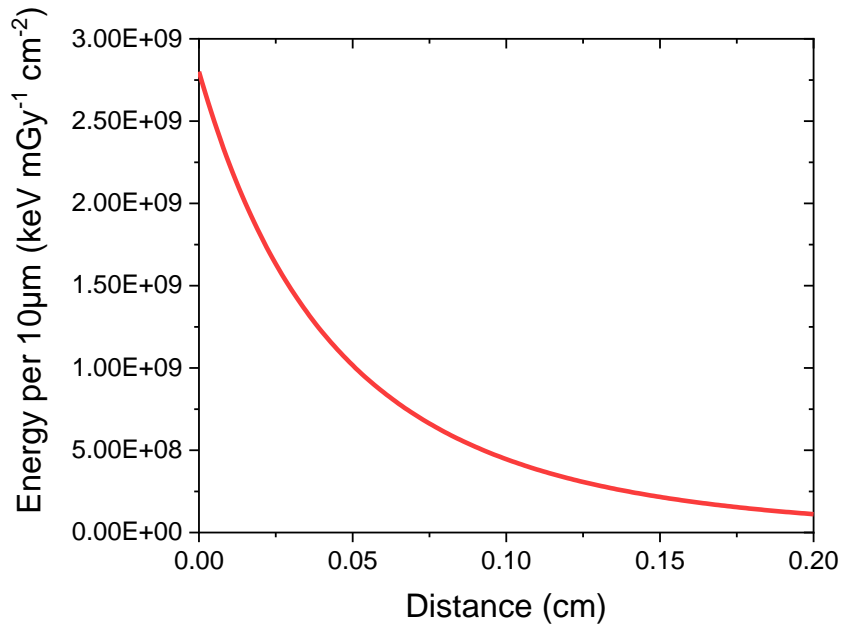


Fig. S8. Energy deposited by the X-rays in a 2-mm thick MAPbBr₃ perovskite crystal. Computed for a RQA5 X-ray spectrum.

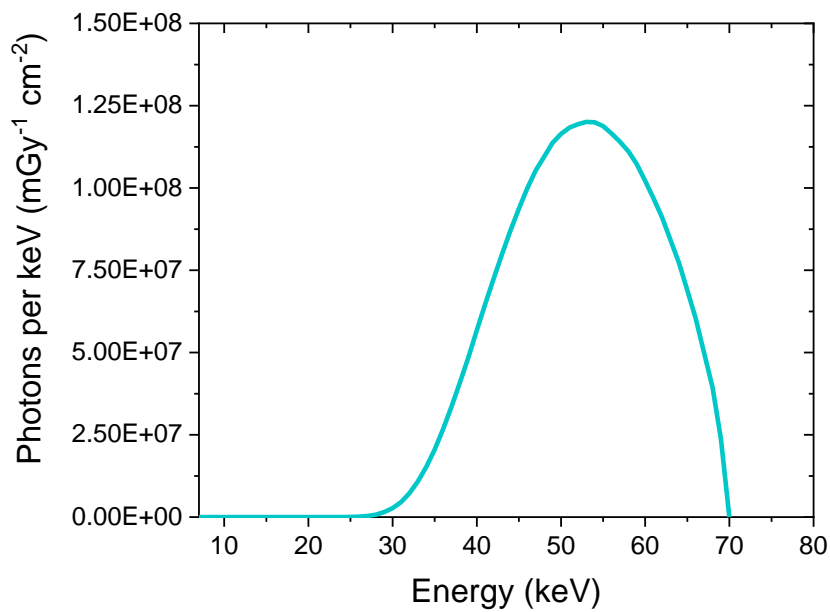


Fig. S9. Number of incident X-ray photons for a RQA5 X-ray spectrum (70 kV, 0.8 mm Be, 23.5 mm Al). Simulated with the SpekCalc software.[4]–[6]

References

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