SUPPLEMENTARY INFORMATION
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Power conversion efficiency exceeding the Shockley–Queisser limit in a ferroelectric insulator

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I. LOCAL SCREENING-INDUCED BAND BENDING

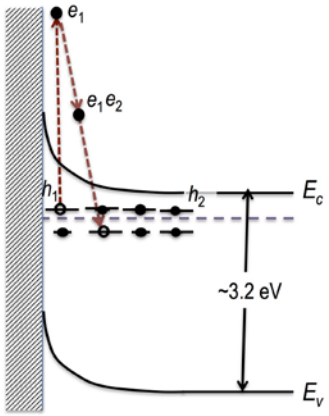

FIG. S1: Schematic illustration depicting pair production as described in the main text.

II. PHOTO-HALL MEASUREMENT GEOMETRY

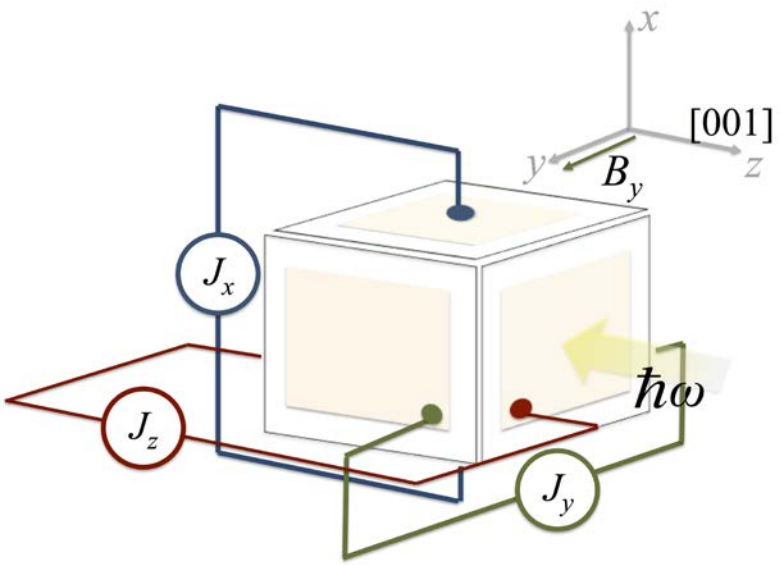

FIG. S2: Experimental geometry illustrating the photo-Hall measurement.

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III. COMPARISON WITH A PIEZOELECTRIC: THE BPVE AND ABSENCE OF ENHANCEMENT IN GALLIUM PHOSPHIDE (100)

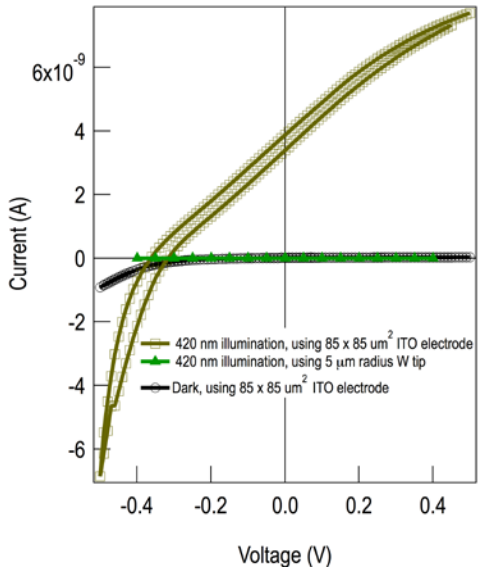

FIG. S3: Current-voltage response of GaP(100) crystal under linearly polarized illumination using planar and tip electrodes, and dark current.

For piezoelectric and non ferroelectric single crystal GaP(100) we collected the photoresponse under planar ITO electrodes and also under the tip using the same experimental configuration as for $BaTiO_3$ using linearly polarized illumination of wavelength $\lambda = 420$ nm, and alternately, 620 nm, directed along [100]. Plotted below are the photocurrent-voltage traces on linear (Fig. S3) and log (Fig. S4) current scales, along with the dark response in each case. For a planar electrode (85×85 μm^2 in area) piezoelectric single-crystal GaP shows the usual BPVE in accordance with previous work [1].

Under 420 and 620 nm illumination using this planar electrode we measure short-circuit currents of 14.6 $\times 10^{-9}$ A and 2 $\times 10^{-9}$A, respectively, whereas for the tip (under identical illumination conditions) we measure a short-circuit current of 6×10^{-15} A, values that are $\approx 10^5$-10^6 smaller. For the planar electrode this corresponds to a current density at 420 nm of $J_{sc,planar} = 14.6 \times 10^{-9}$ A / 7.2×10^{-5} cm^2 $= 2 \times 10^{-4}$A/cm^2. However the current density for the tip electrode $J_{sc,tip}$ (here assuming, *e.g.*, the same value of l_0 as that for $BaTiO_3$) is

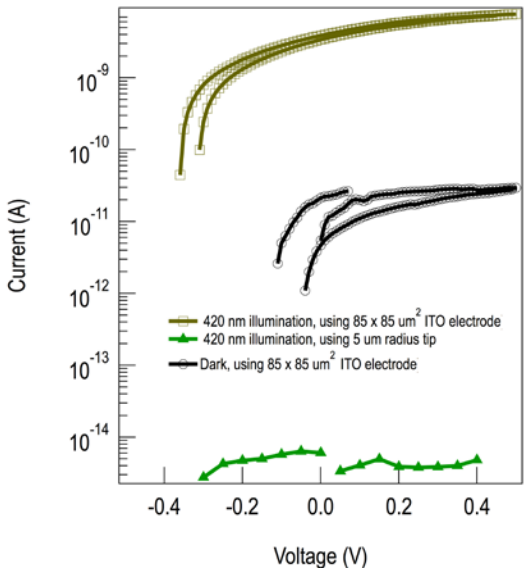

FIG. S4: Log current-voltage response of GaP(100) crystal under linearly polarized illumination using planar and tip electrodes, and dark current.

6×10^{-15} A / 1×10^{-10} cm^2 = 6×10^{-5}A/cm^2, *i.e.*, $J_{sc,planar}$ is of the same order as $J_{sc,tip}$: no enhancement is observed in the *piezoelectric* non-centrosymmetric crystal. This result proves that our experimental observations are explained by a combination of the BPVE and strong screening in the pin regime as observed in the ferroelectric $BaTiO_3$, only the BPVE and no tip enhancement in the non-centrosymmetric piezoelectric and non-ferroelectric GaP(100) under polarized light, and no BPVE or tip enhancement in the centrosymmetric paraelectric $SrTiO_3$.

[1] Astafiev, S. B., Fridkin, V. M., and Lazarev, V. G. The influence of the magnetic field on the linear bulk photovoltaic current in piezoelectric semiconductor GaP. *Ferroelectrics* **80**, 251 (1988).