# Absolute Method to Certify Quantum Yields of Photon Upconversion via Triplet-Triplet Annihilation

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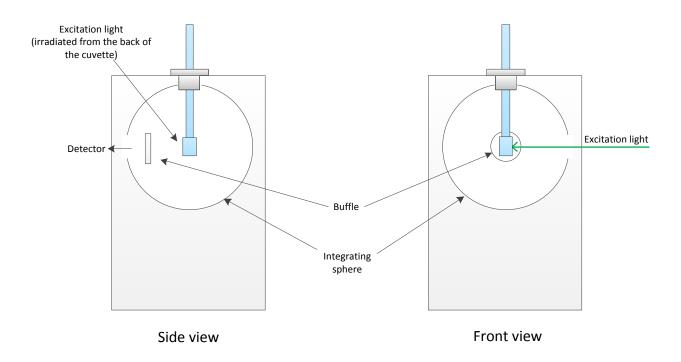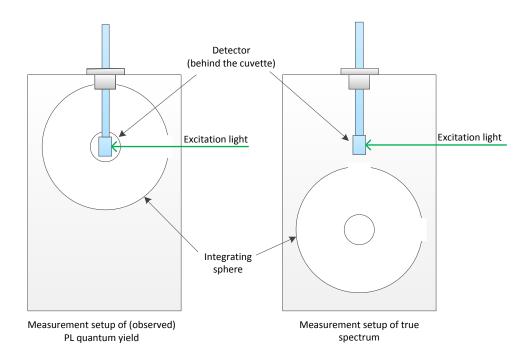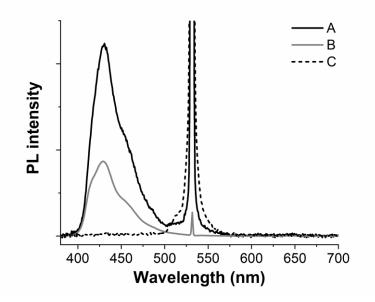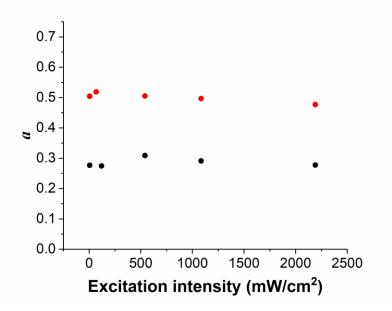
**Figure S1.** Schematic illustration of absolute quantum yield measurement setup.
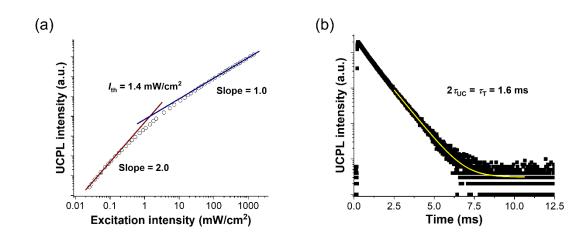


**Figure S2.** Schematic illustration of the absolute quantum yield measurement setup with mechanically removable integrating sphere for Experiment (A) (left) and Experiment (B) (right).
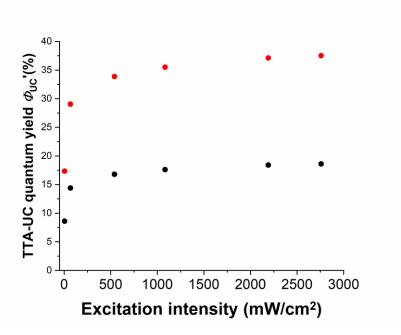
**Figure S3.** Photoluminescence (PL) spectra of PtOEP (100 μM) and DPA (10 mM) in deaerated THF in Experiment (A), (B) and (C) normalized to identical exposure time without a short-pass filter ($\lambda_{ex}$ = 532 nm, $I_{ex}$ = 5.7 mW/cm$^2$). The TTA-UC emission intensity in Experiment (C) was much smaller than those in Experiment (A) and (B). Note that the TTA-UC emission intensity in Experiment (A) is larger than the one in Experiment (B), but this trend becomes opposite when the emission intensity is scaled based on the PtOEP phosphorescence (Figure 2c, 2d).
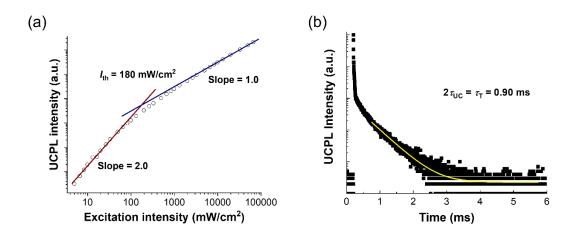


**Figure S4.** Reabsorption probability $a$ of PtOEP (100 μM) and DPA (10 mM) in deaerated THF with sample volume of 1×4×7 mm$^3$ (black) and 1×10×35 mm$^3$ (red) as a function of excitation intensity.

**Figure S5.** (a) TTA-UC emission intensity of a PtOEP-DPA THF solution ([PtOEP] = 100 μM, [DPA] = 10 mM) as a function of excitation intensity. (b) TTA-UC emission decay of the PtOEP-DPA THF solution upon pulsed excitation at 531 nm ($\lambda_{em}$ = 430 nm, [PtOEP] = 100 μM, [DPA] = 10 mM). The fitting curve was obtained by the known relationship of $I_{UC}(t) \propto$ exp($-t/\tau_{UC}$) = exp($-2t/\tau_T$), where $\tau_{UC}$ and $\tau_T$ are lifetimes of TTA-UC emission and emitter triplet, respectively.



**Figure S6.** Absolute TTA-UC quantum yield $\Phi_{UC}$' of PtOEP (100 μM) and DPA (10 mM) in deaerated THF without (black) and with (red) the reabsorption correction (sample volume =

$1{\times}10{\times}35$ mm$^3$).



**Figure S7.** (a) TTA-UC emission intensity of a PtTPBP-TTBP THF solution ([PtTPBP] = 100 μM, [TTBP] = 10 mM) as a function of excitation intensity. (b) TTA-UC emission decay of the PtTPBP-TTBP THF solution upon pulsed excitation at 630 nm ($\lambda_{em}$ = 485 nm, [PtTPBP] = 100 μM, [TTBP] = 10 mM). The fitting curve was obtained by the known relationship of $I_{UC}(t) \propto$ exp($-t/\tau_{UC}$) = exp($-2t/\tau_T$), where $\tau_{UC}$ and $\tau_T$ are lifetimes of TTA-UC emission and emitter triplet, respectively.