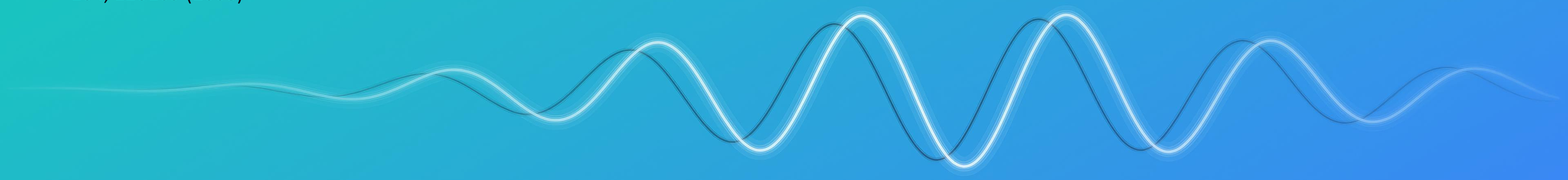
Phazic

VALIDATION REPORT

2026 · 07

Phazic reproduces OLED light-extraction physics

Figure-for-figure against Nowy & Brütting, J. Appl. Phys. 104, 104, 123109 (2008)



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THE REFERENCE

A classic OLED light-extraction analysis

Nowy & Brütting analyse a bottom-emitting Alq_3 OLED with a CPS point-dipole model and report where every photon goes across their across their Figures 4–7. Those are exactly what we set out to reproduce.

FIG. 4

Power-dissipation K(λ, k_x)

2-D map, split into four channels.

FIG. 5

TE / TM mode ID

Polarisation of guided & SPP modes.

FIG. 6

Cross-section at 525 nm

1-D cut at the emission maximum.

FIG. 7

Angular emission I(λ, θ)

Far-field s- and p-polarised.

CHANNELS

air / sub / WG / SPP

The four-channel loss budget.

OUR METHOD

S-matrix CPS dipole

Same physics, independent solver.

S. Nowy, B. C. Krummacher, J. Frischeisen, N. A. Reinke, W. Brütting · “Light extraction and optical loss mechanisms in organic light-emitting diodes” · J. Appl. Phys. 104, 123109 (2008)

THE DEVICE & METHOD

The bottom-emitting Alq_3 OLED, rebuilt in Phazic

Point dipole at the TPD/Alq_3 interface · isotropic · **q = 0.20** · Alq_3 PL as spectral weight · one **Run**.

Al cathode	100 nm
Ca	15 nm
Alq_3 emission layer ★	80 nm · emitter
TPD hole transport · dipole here	80 nm
PEDOT:PSS	30 nm
ITO anode	140 nm
Glass substrate · light exits ↓	out

RADIATIVE QE

0.20

PLQY q · isotropic dipole

PURCELL F

1.37

enhancement factor

DIRECT (AIR)

4.63%

out-coupled to air

PLASMON / SPP

9.2%

Ca/Al cathode loss

ON-AXIS PEAK

540nm

angle-stable to ~60°

NON-RADIATIVE

74.2%

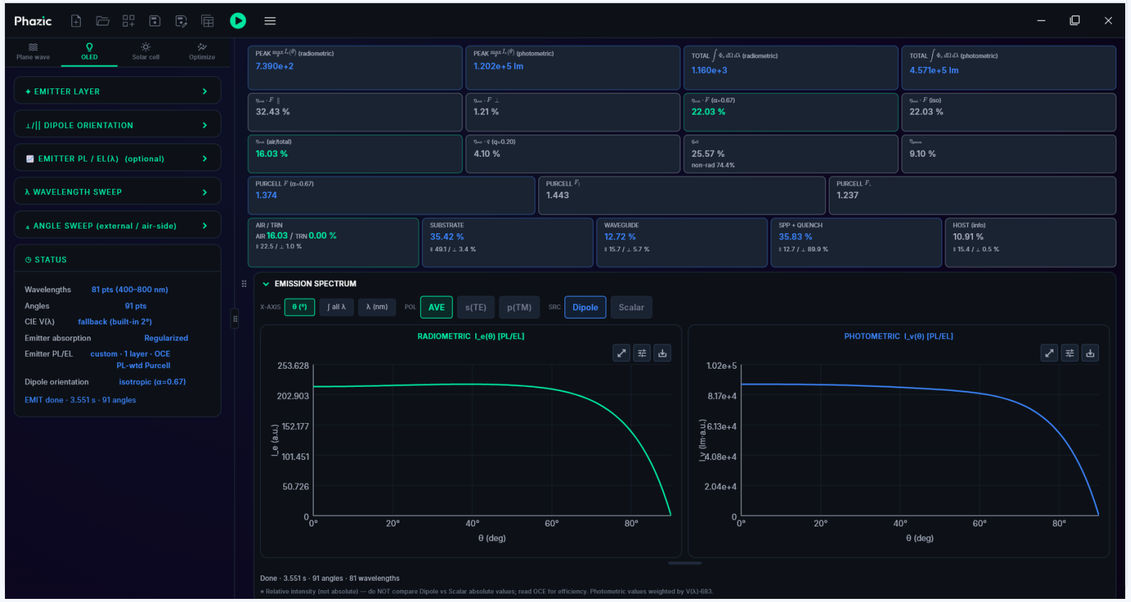
intrinsic (q-limited)

PHAZIC IN ACTION

One run returns the whole OLED picture

Efficiency cards (η_out·F / q_eff / Purcell), the air·substrate·waveguide·SPP decomposition and far-field I(θ) — plus the plane-wave R/T/A and CIE and CIE chromaticity of the same stack.

PHAZIC OLED tab — efficiency, channels & emission I(θ)



PHAZIC Plane-wave tab — R/T/A spectra & CIE color

THE CHANNELS AGREE

Phazic lands on the paper's loss budget, channel for channel

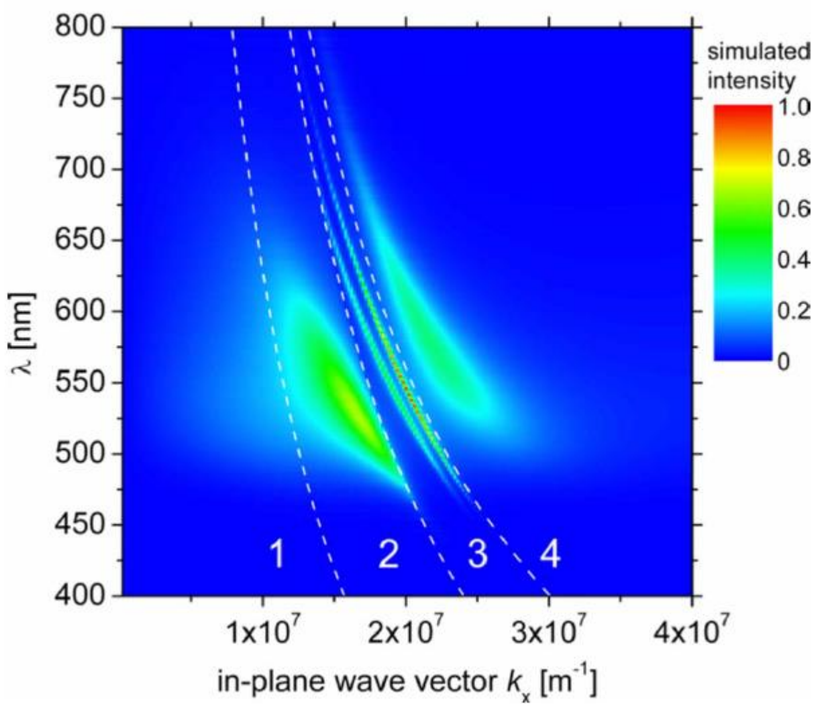
CHANNEL (OF TOTAL POWER)	PAPER	PHAZIC	Δ	AGREEMENT
Direct emission (air)	4.2	4.63	0.4	✓ <0.5%
Substrate (glass-trapped)	6.3	8.5	2.2	split convention
Waveguided modes	3.0	3.4	0.4	✓ <0.5%
Plasmon / SPP	9.5	9.2	0.3	✓ <0.5%
Absorption	3.3	~1.3*	—	bookkeeping*
Intrinsic non-radiative	73.6	74.2	0.6	✓ <1%

✓ Every headline number agrees to ~1–2%. Only the internal substrate/waveguide split differs — a channel-boundary convention. *Phazic folds metal absorption into SPP + quench, absorption into SPP + quench, so ~1.3% HOST + metal ≈ the paper's 3.3%.

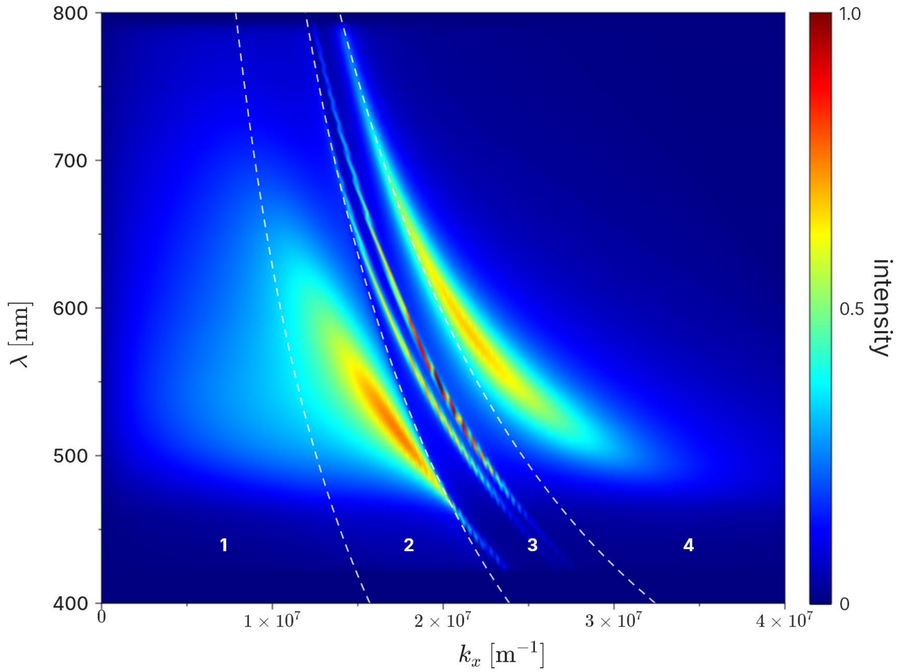
FIGURE 4

Where the light goes — K(λ, k_x)

PAPER Fig. 4 — power-dissipation spectrum



PHAZIC K(λ, k_x), 4 channels

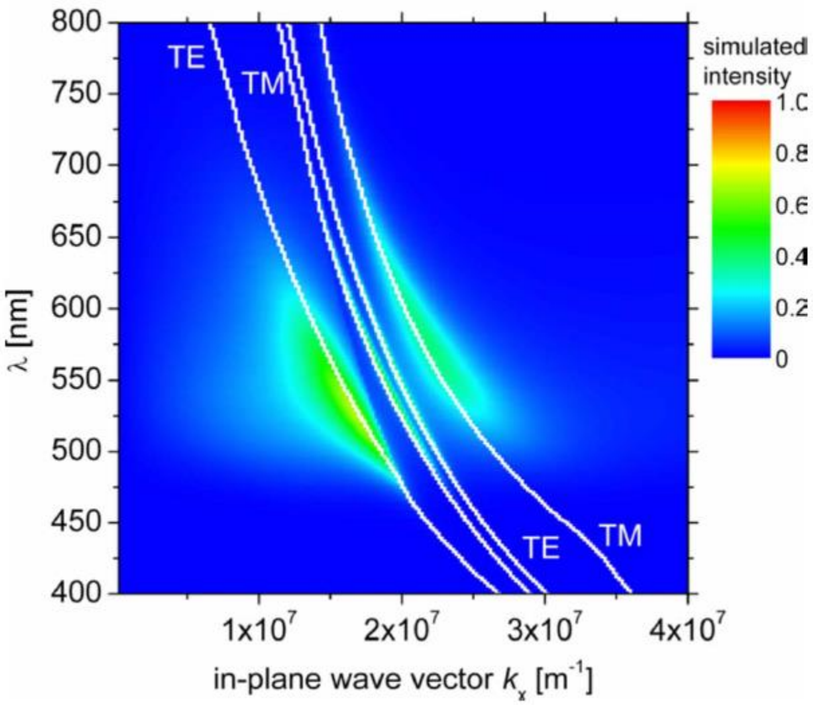


✓ The substrate lobe near 530 nm, the sharp waveguide streaks and the SPP band curving to higher k_x all reproduce the paper.

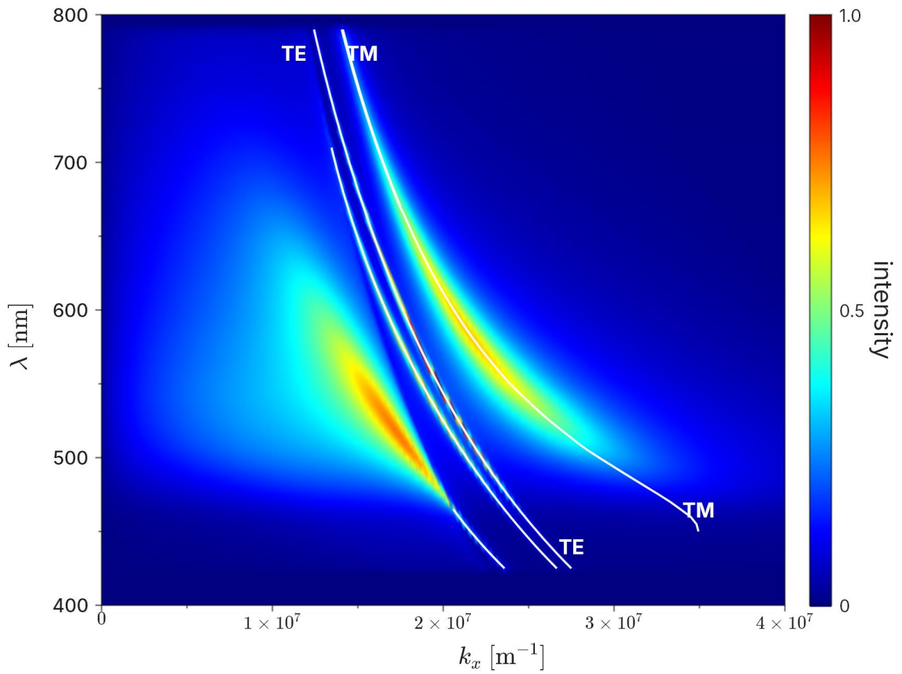
FIGURE 5

Polarisation of the guided / SPP modes

PAPER **Fig. 5 — TE / TM mode identification**



PHAZIC **TE / TM dispersion overlaid**

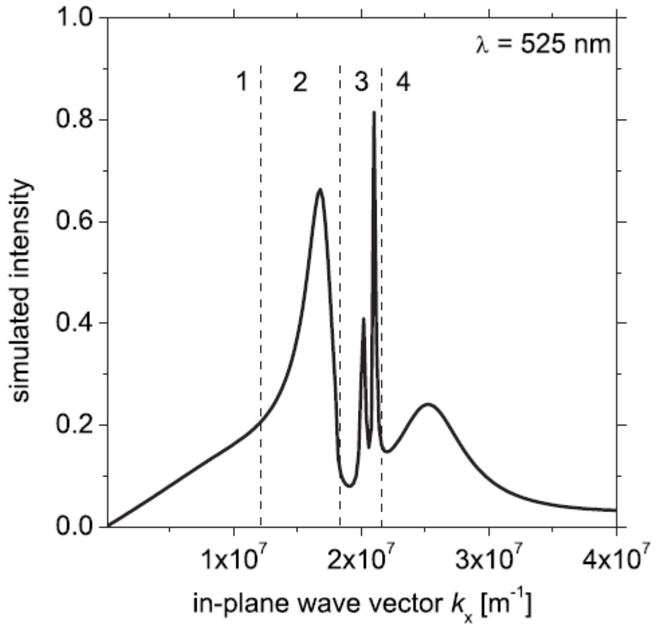


✓ Phazic finds the TE/TM guided poles and the TM-only surface-plasmon branch — matching the paper's assignment automatically.

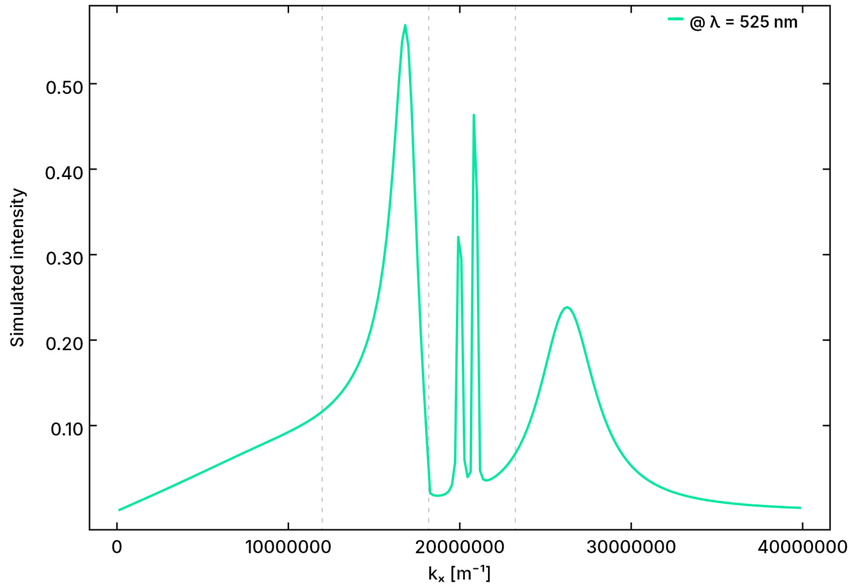
FIGURE 6

1-D cross-section at λ = 525 nm

PAPER Fig. 6 — cross-section at 525 nm



PHAZIC cross-section at 525 nm

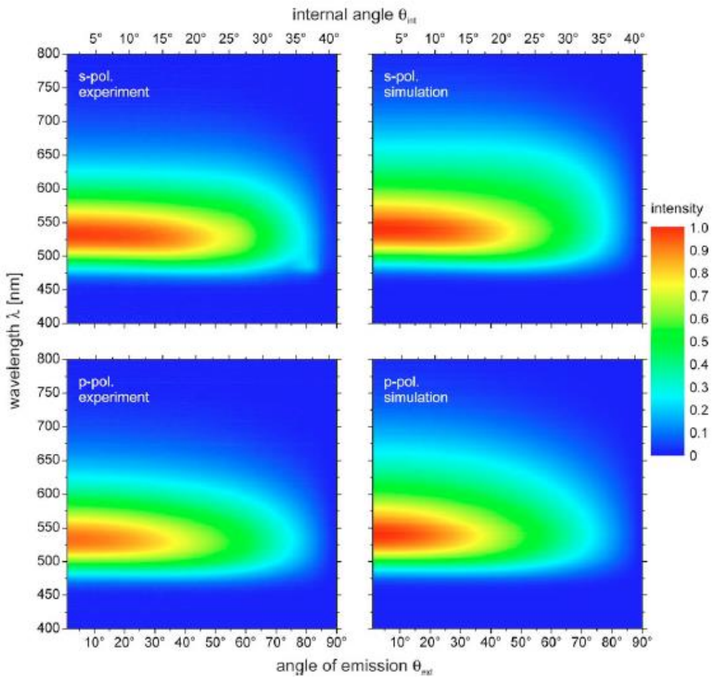


✓ Peak positions and relative heights match — substrate lobe, the two waveguide spikes and the SPP peak at ~2.6×10^{7} m^{-1}.

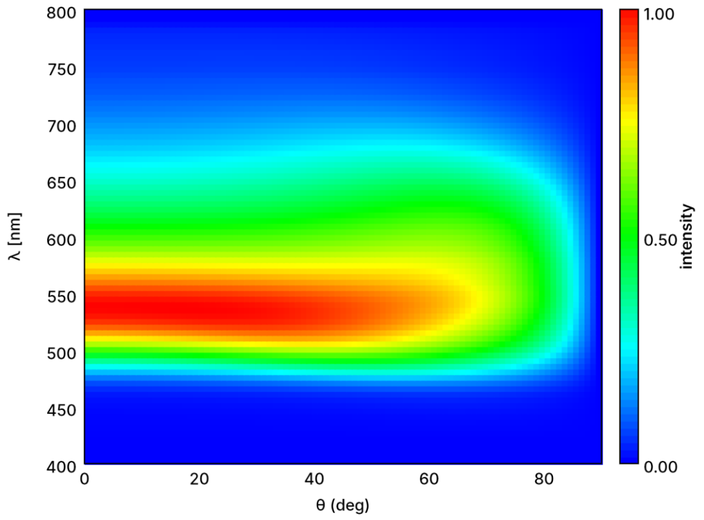
FIGURE 7

Angular emission spectrum I(λ, θ)

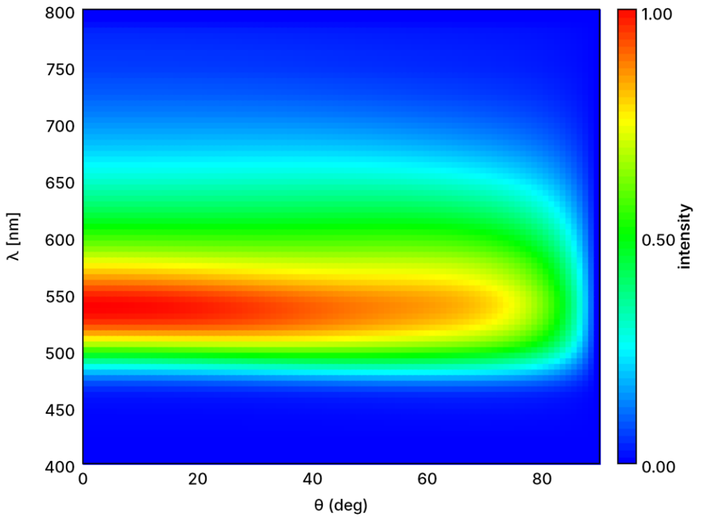
PAPER Fig. 7 — s/p, exp vs sim



PHAZIC s-pol I(λ, θ)



PHAZIC p-pol I(λ, θ)



✓ The on-axis 540 nm maximum, the mild angle broadening and the s-vs-p difference reproduce the paper's simulation panels.

OBJECTIVE ANALYSIS

Why Phazic and the paper differ — and by how little

Every headline number agrees to ~1–2%. The residual gaps come from data provenance and bookkeeping conventions — not the physics engine, which is the same CPS dipole method the paper uses.

Refractive indices (n, k)

Paper uses private ellipsometry; Phazic uses public measured curves + Cauchy endpoints. The metal n,k sets the SPP band — shifts of ~1–2%.

Absorption accounting

Paper reports a separate 3.3% channel; Phazic itemises HOST ~1.3% and folds metal-ohmic loss into SPP + quench. Together they match.

Channel boundaries

The trapped-light split by in-plane k uses different thresholds — internal split differs ±2–3%, but total trapped and total escaped match to ~1%.

Emitter optical loss

Phazic sets organic k = 0 (Alq_3 transparent above ~470 nm); the non-radiative loss lives in q = 0.20 — preventing double-counting.

Purcell factor F

Phazic F ≈ 1.37; the paper's 73.6% non-rad implies F ≈ 1.44. The small difference gives 4.6% vs 4.2% direct emission.

Fig. 7 — exp vs sim

The paper's Fig. 7 includes measured spectra; Phazic outputs only the simulation. It matches the paper's simulation panels.

✓ Feeding Phazic the paper's exact per-layer n(λ), k(λ) would close the remaining ~1% gap. The model itself already reproduces the paper.

THE VERDICT

Independent solver, same OLED physics.

1 - 2%

every channel of the loss budget agrees.

4 figures

matched in shape, mode positions & polarisation.

1 run

CPS dipole — channels, modes & far-field together.

Ref: Nowy & Brütting · J. Appl. Phys. 104, 123109 (2008)