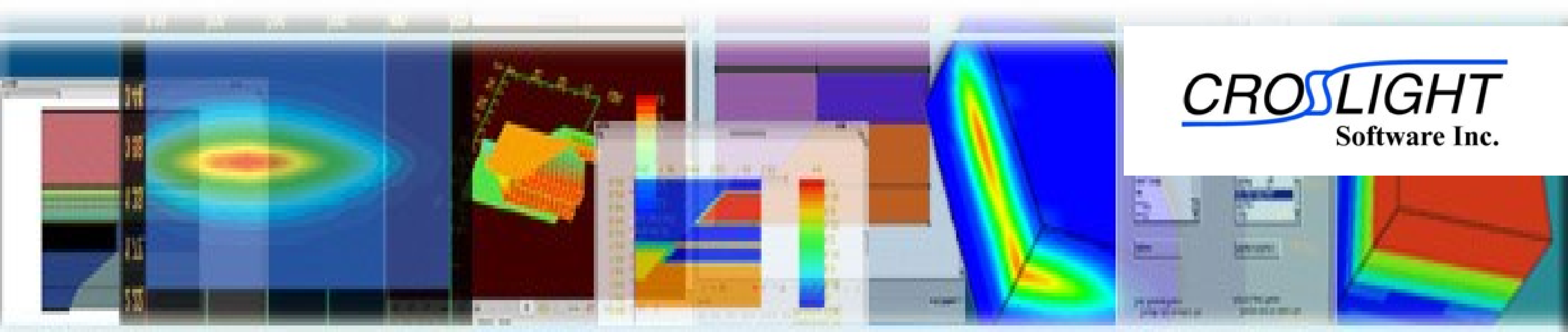

APSYS Simulation of hot Auger electron leakage in InGaN MQW LED

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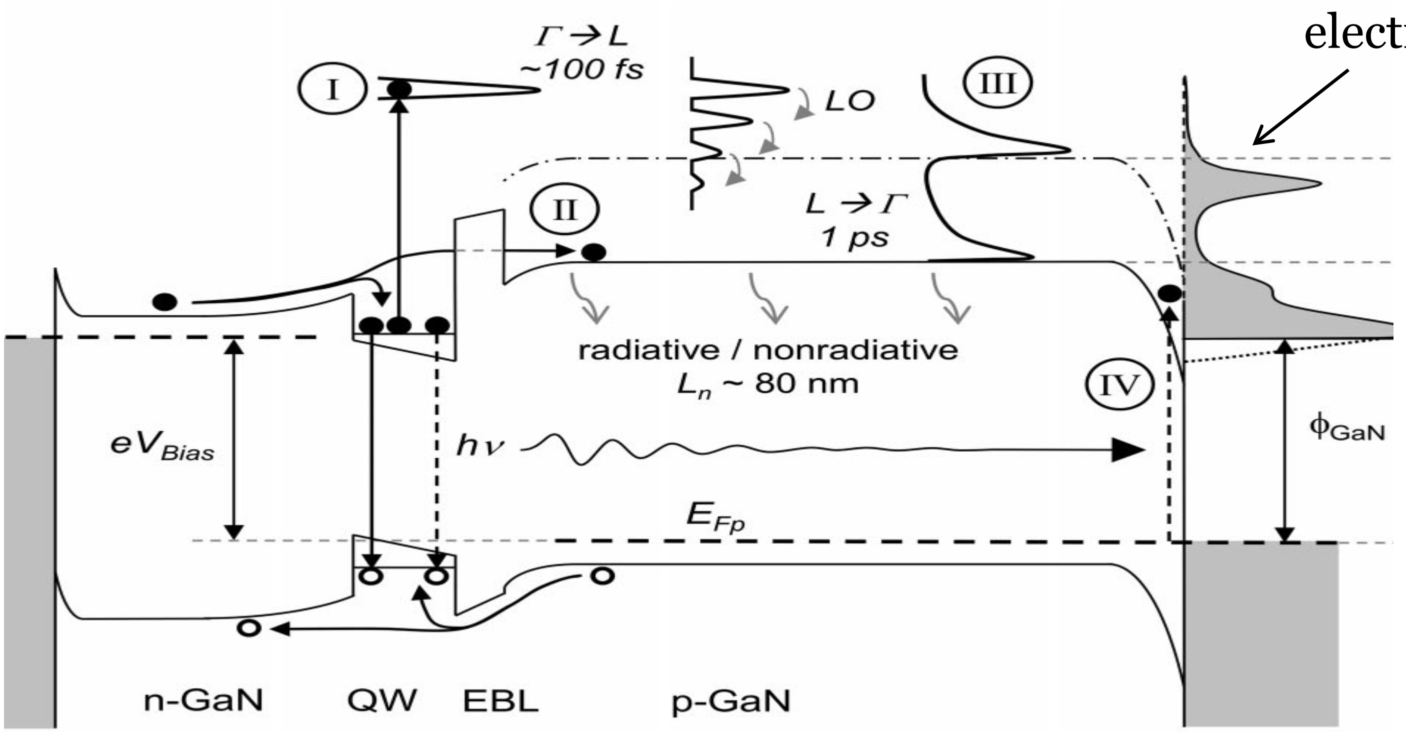
Introduction

Recent direct measurement of electron leakage triggered by QW Auger recombination. PRL 110, 177406 (2013)

Hot Auger electrons



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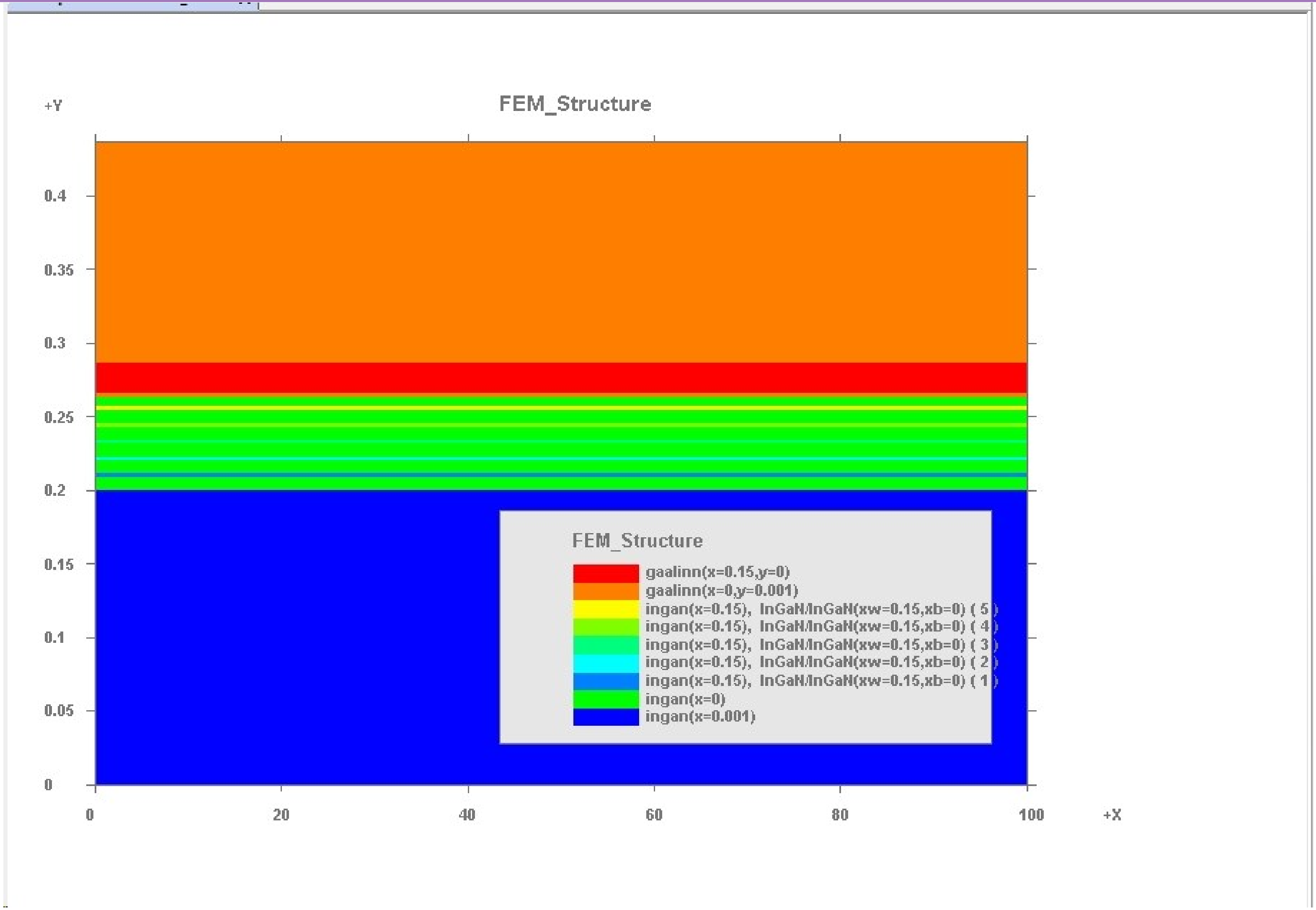
APSYS models related to efficiency droop

- Polarization charge induced well/barrier potential distortion.
- Cold carrier leakage over barriers and EBL, using default drift-diffusion and thermionic emission models.
- Hot-carrier induced non-local transport. Quantum well escape or capture, and barrier-to-barrier fly-over. Sequential or collective non-local hot carrier transport.
- Collective non-local hot Auger carrier leakage from above well to p-contact via thermionic emission (Auger-thermionic model).
- Collective non-local direct escape of confined carriers from well to p-contact with Auger recombination rate (Auger-direct model).
- Collective non-local emission of above-barrier hot carriers to p-contact with Auger rate (Auger-indirect model).

Demo example: InGaN/GaN MQW LED with EBL



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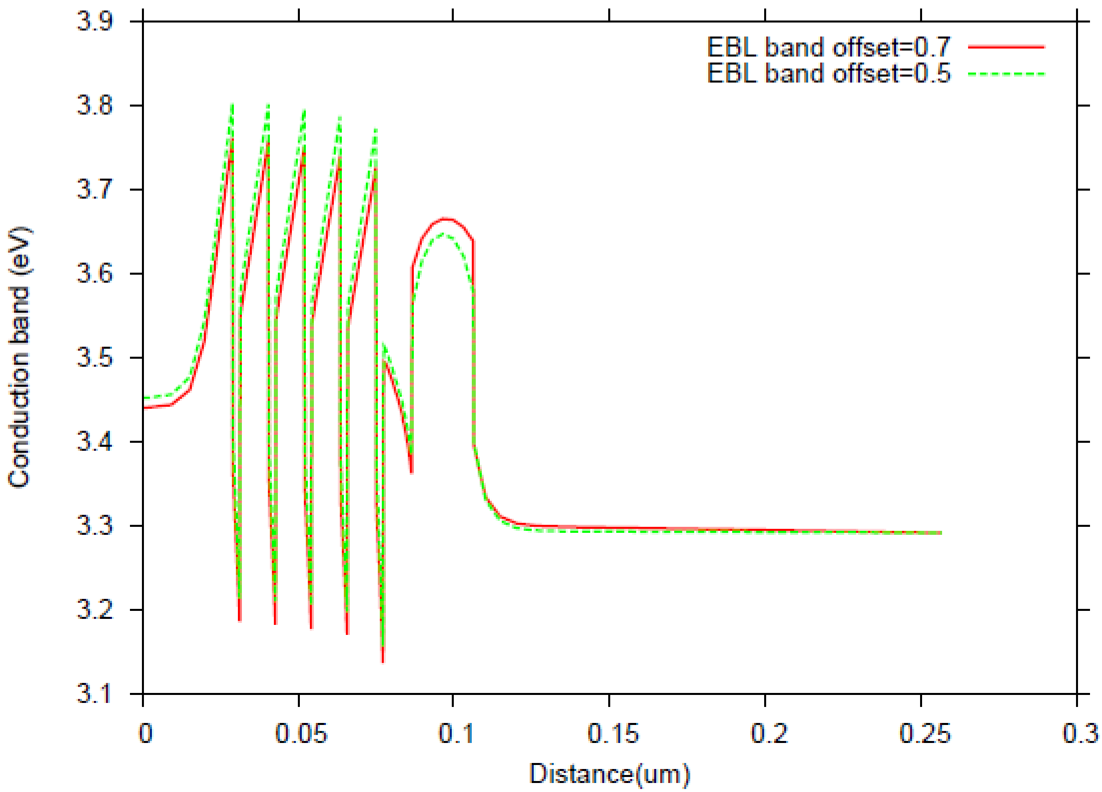
Conduction band for different EBL band offsets



Comparison of conduction band showing polarization charge induced potential distortion for different EBL band offsets

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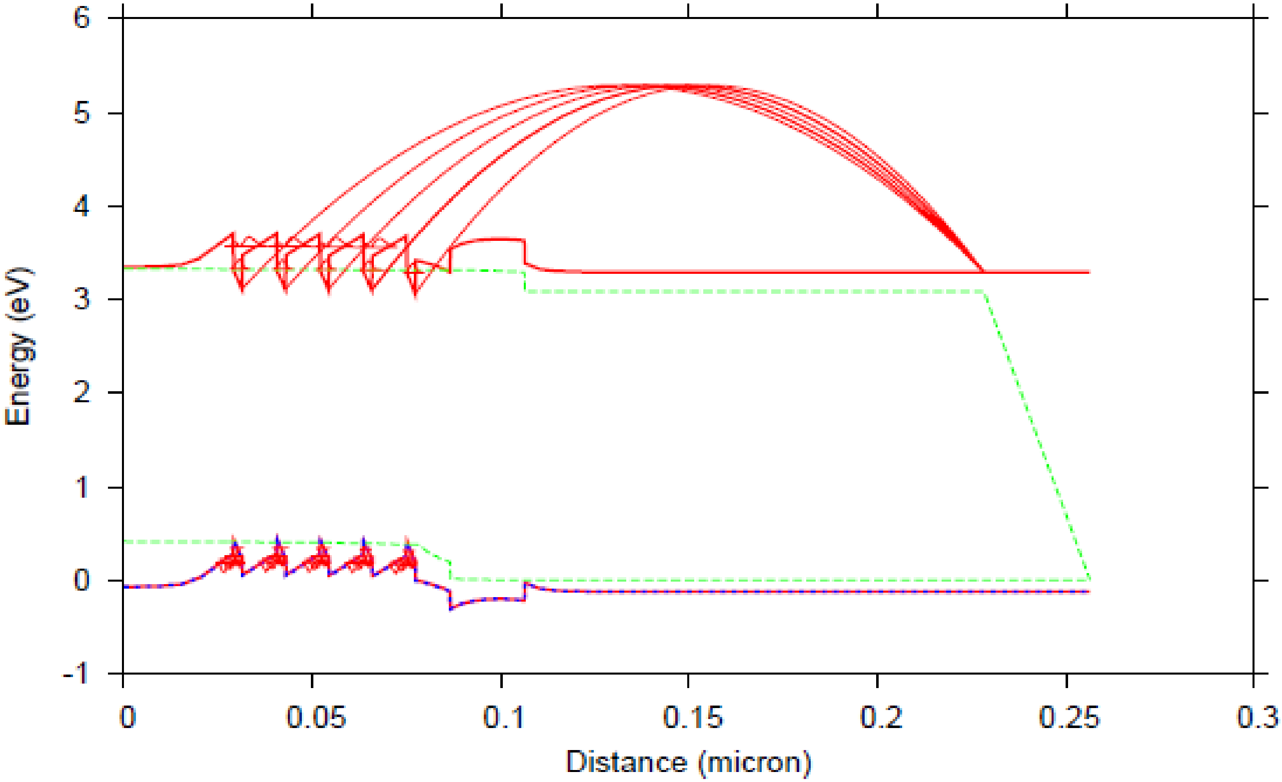
Hot carrier non-local transport



Band diagram indicating collective hot carrier non-local transport mesh connections through the MQW system. Superimposed on default drift-diffusion/thermionic solution.

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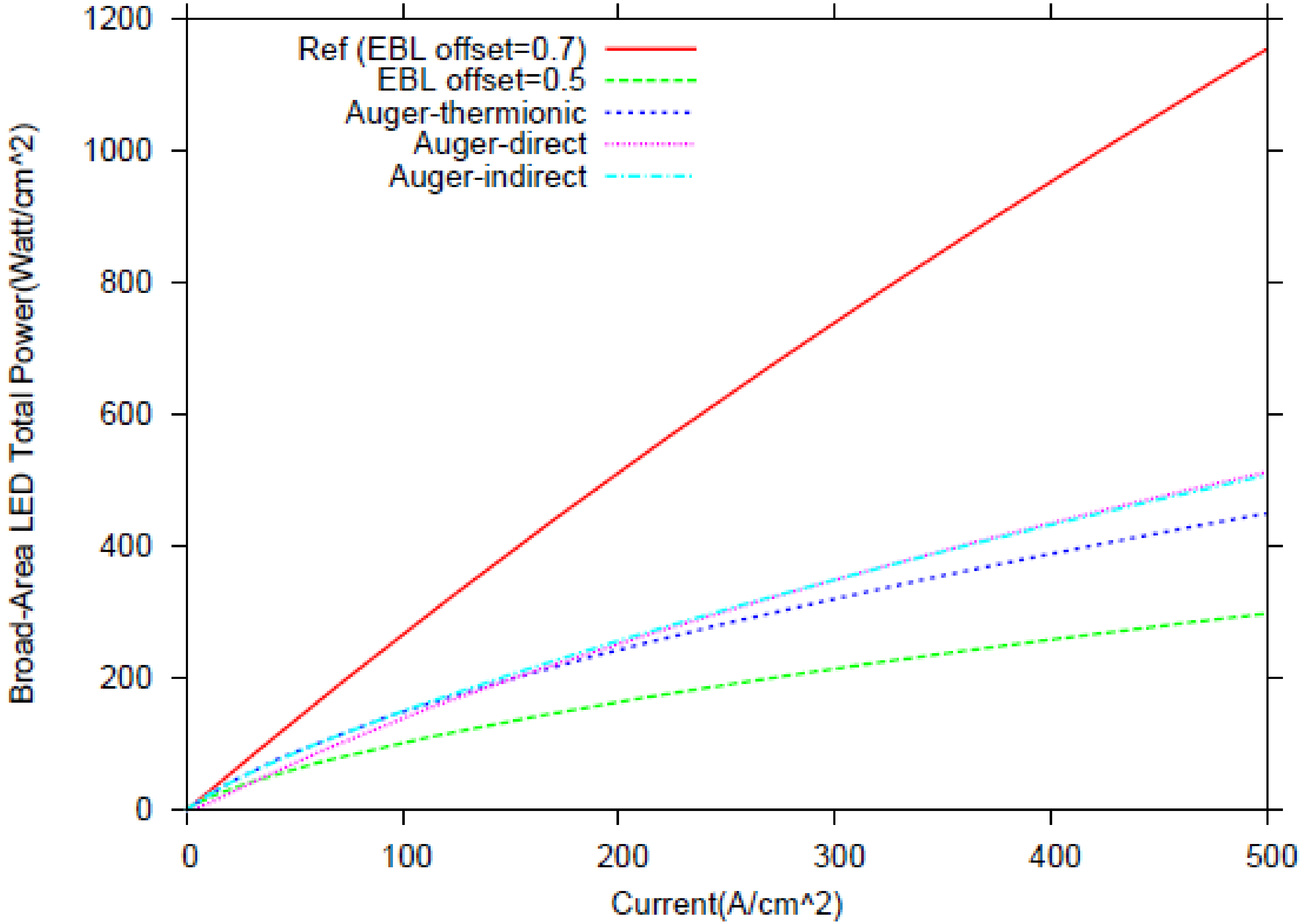
Comparison of LED emission power



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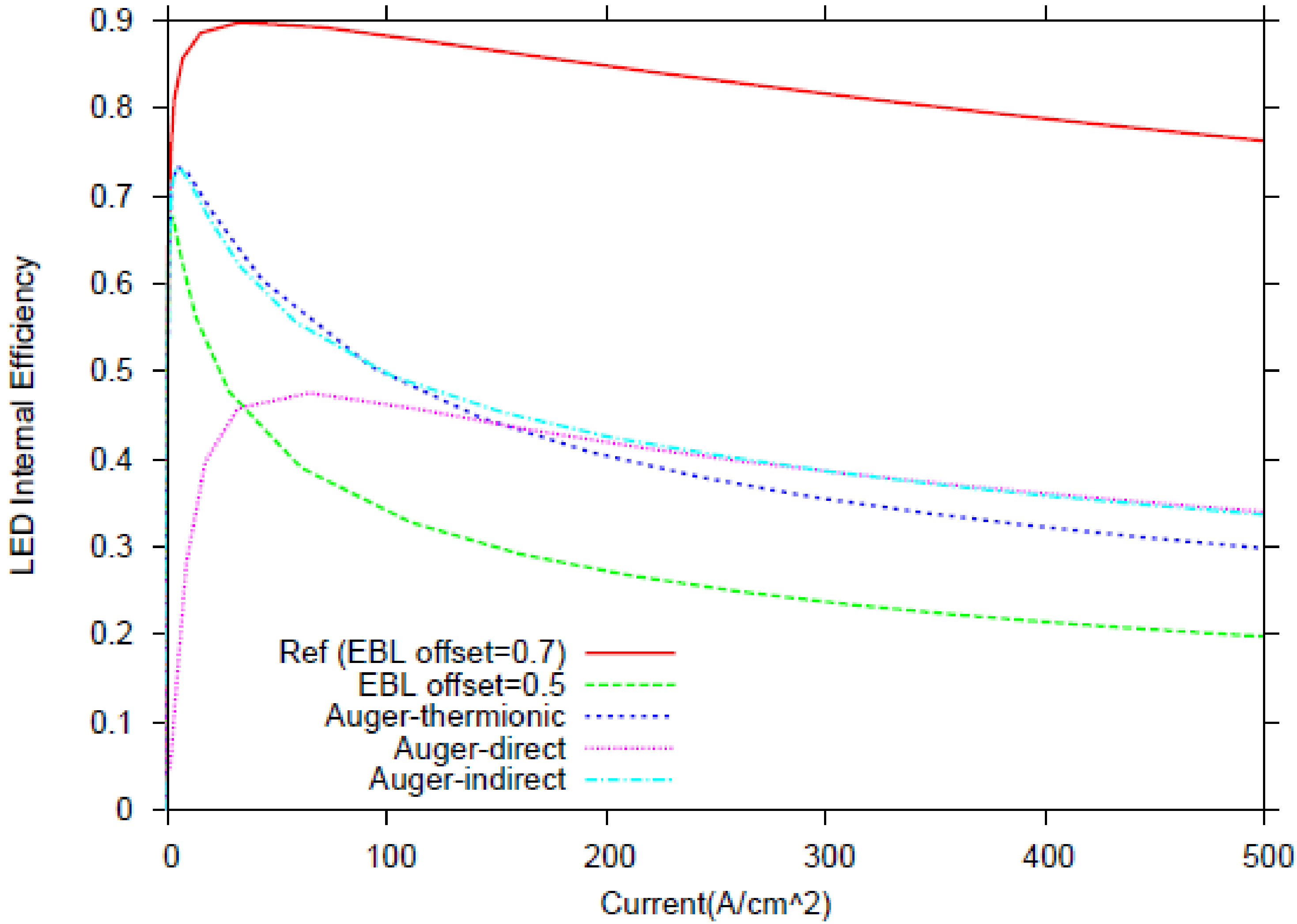
Comparison of LED IQE



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Summary

- Many effects can cause LED droop.
- APSYS may simulate and study various possible droop causes in LED, including hot Auger carrier leakage.
- Non-local quantum well transport model is an effective means of treating hot carriers within the drift-diffusion based simulator.
- Based on IQE tendency, both Auger-thermionic and Auger-indirect models can fit measurement.

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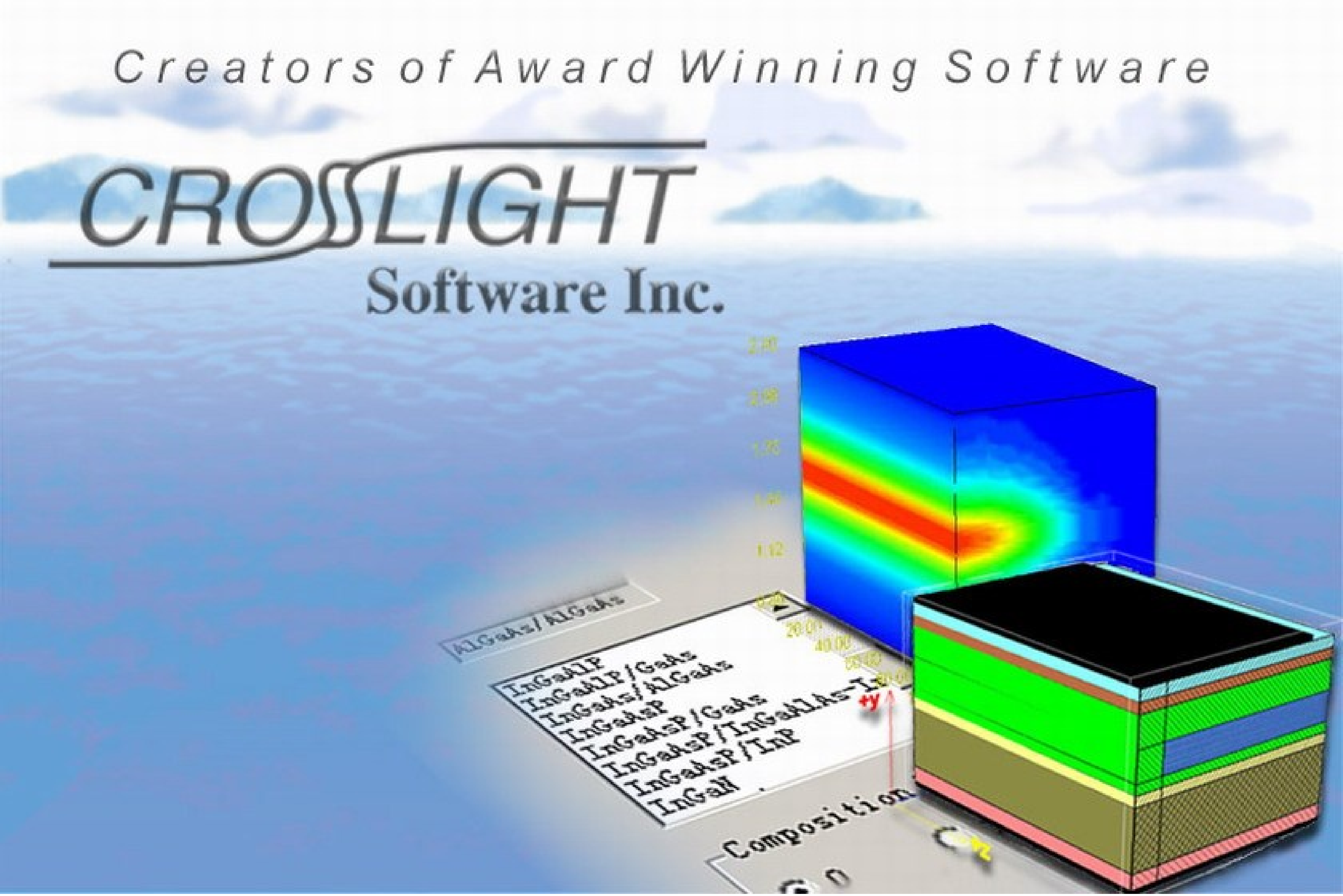

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