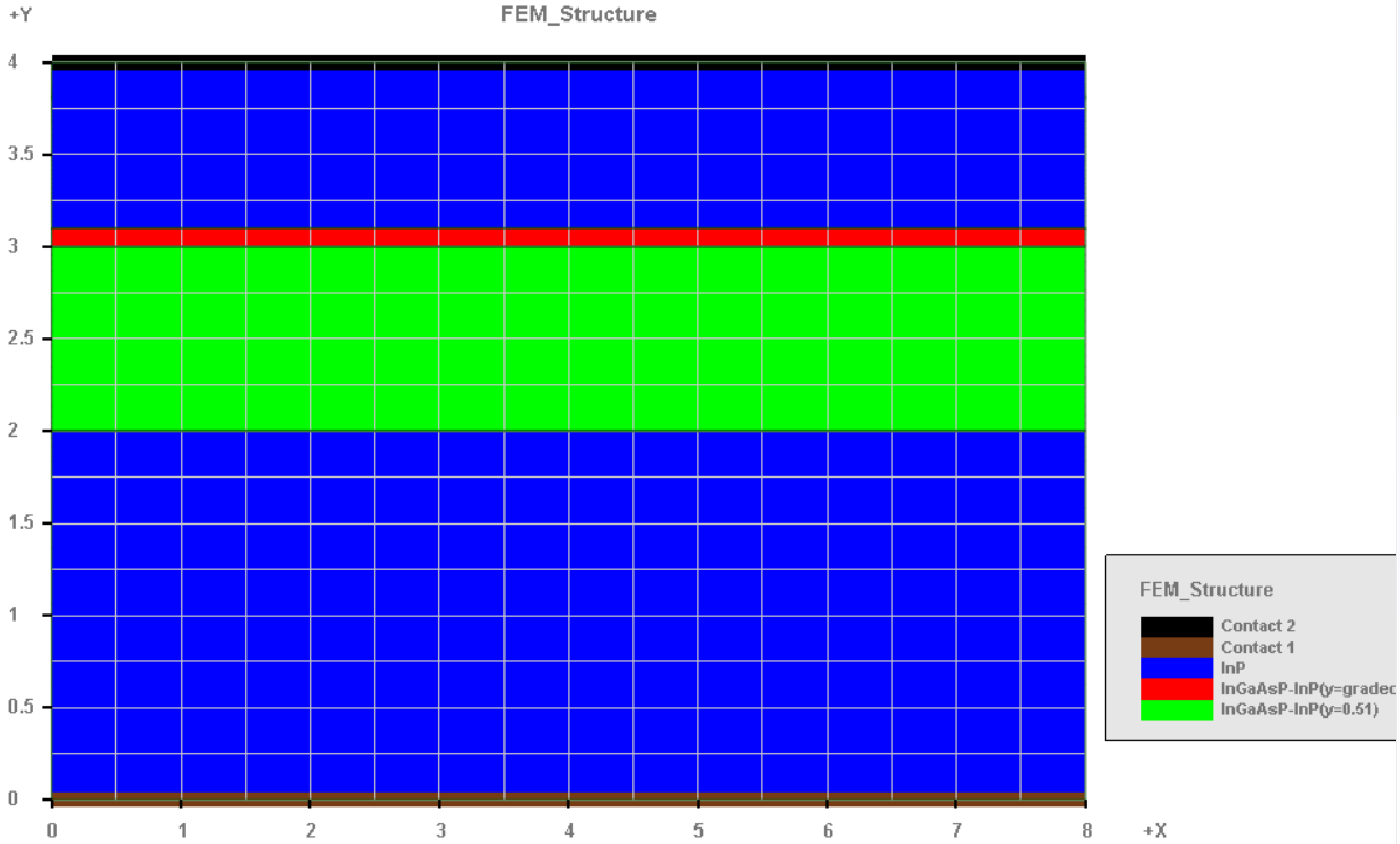
Crosslight APSYS Simulation of APD Afterpulse Effects

May 2026

Simulated Structure

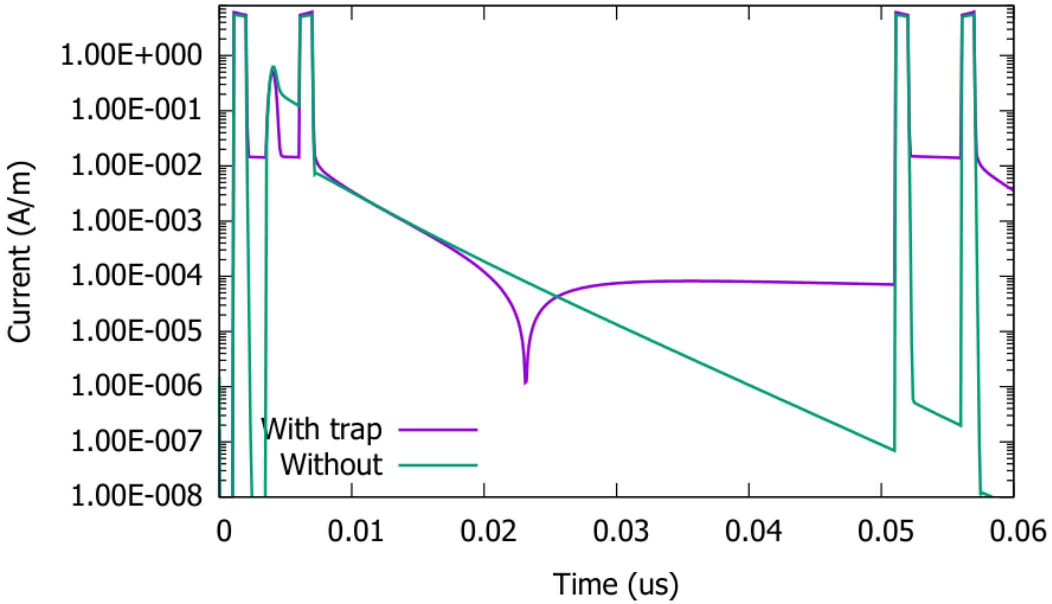


Crosslight APSYS Simulation of Multi-Gated APD Afterpulsing

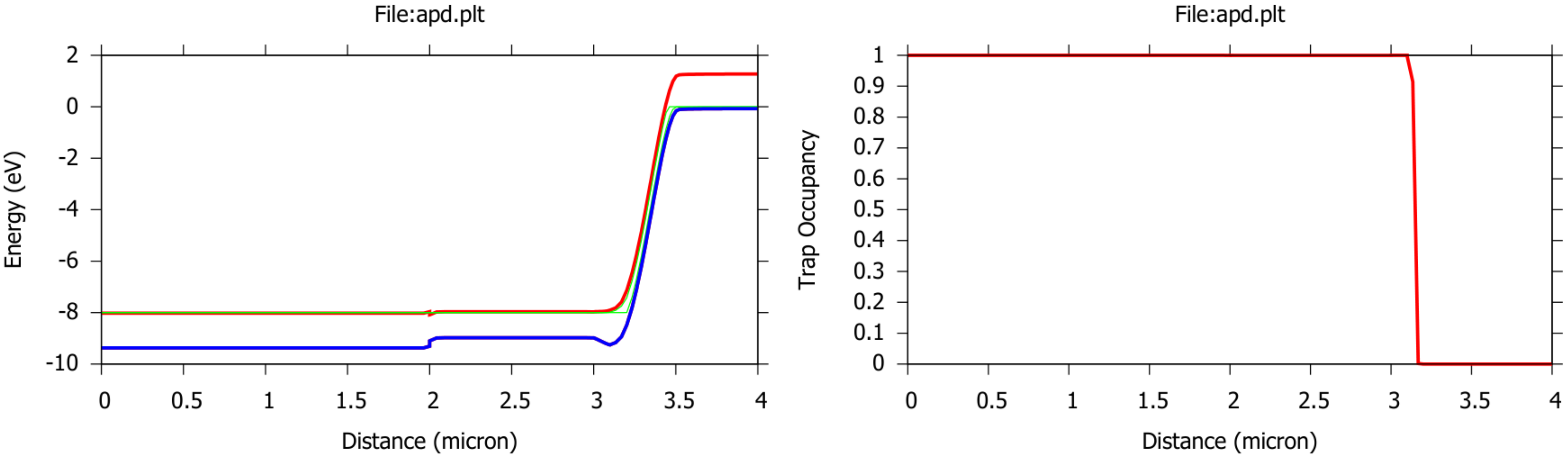
- Transient APSYS TCAD simulation for gated APD operation
- Trap-assisted afterpulse mechanism modeled using deep-level defects
- Comparison between trap-rich and trap-free APD structures
- Demonstration of delayed avalanche response during later gate cycles

Principle of Multi-Gated APD Afterpulse Measurement

- APD is periodically gated above avalanche breakdown voltage.
- Laser pulse is injected during the first gate window.
- Avalanche carriers become trapped in deep defect states.
- Trapped carriers are released during subsequent gates.
- Released carriers retrigger avalanche current (afterpulsing).

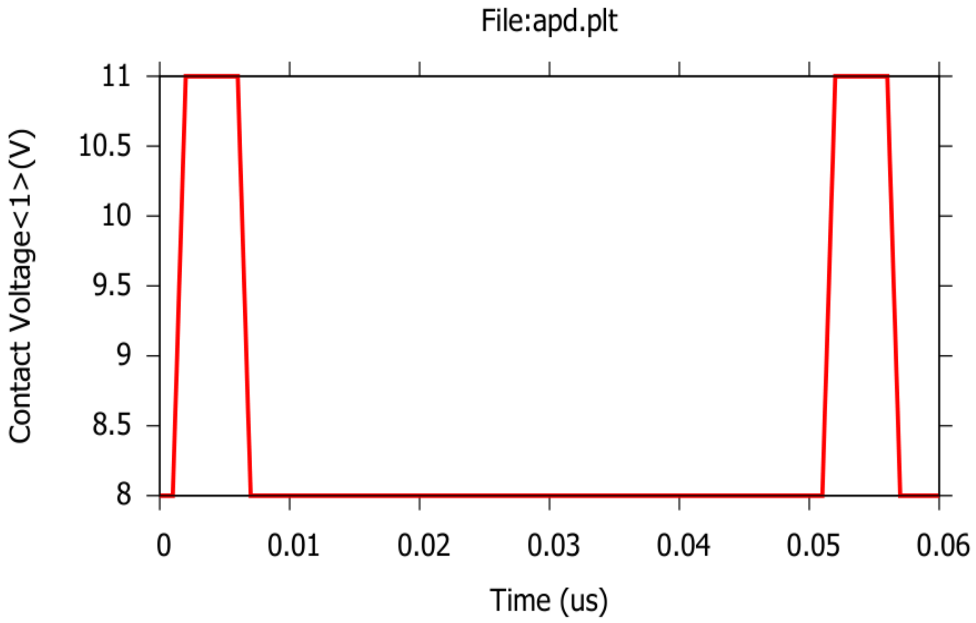


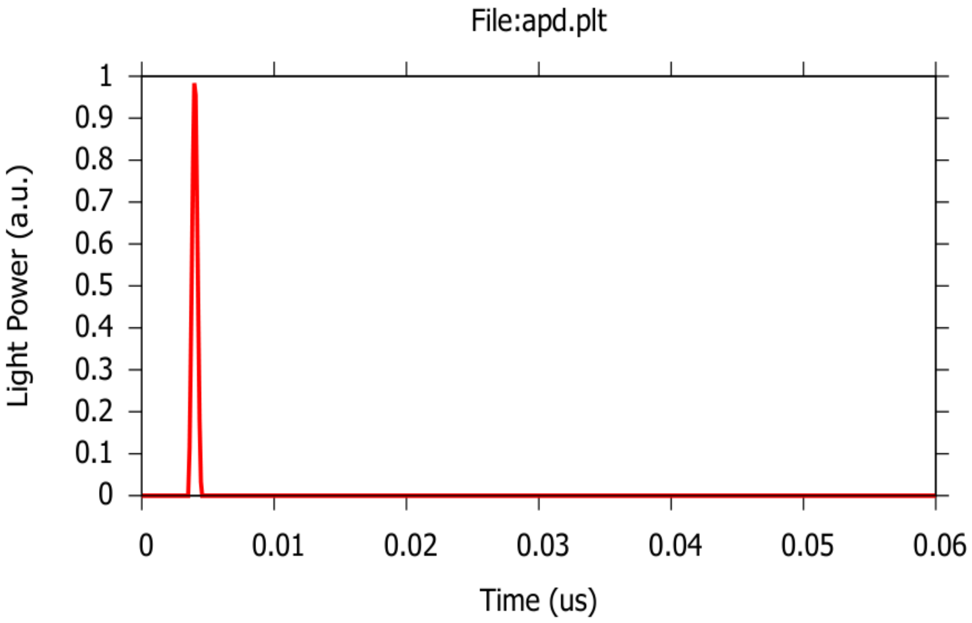
APD Structure and Trap Distribution



Energy band profile and trap occupancy distribution used in APSYS transient simulation.

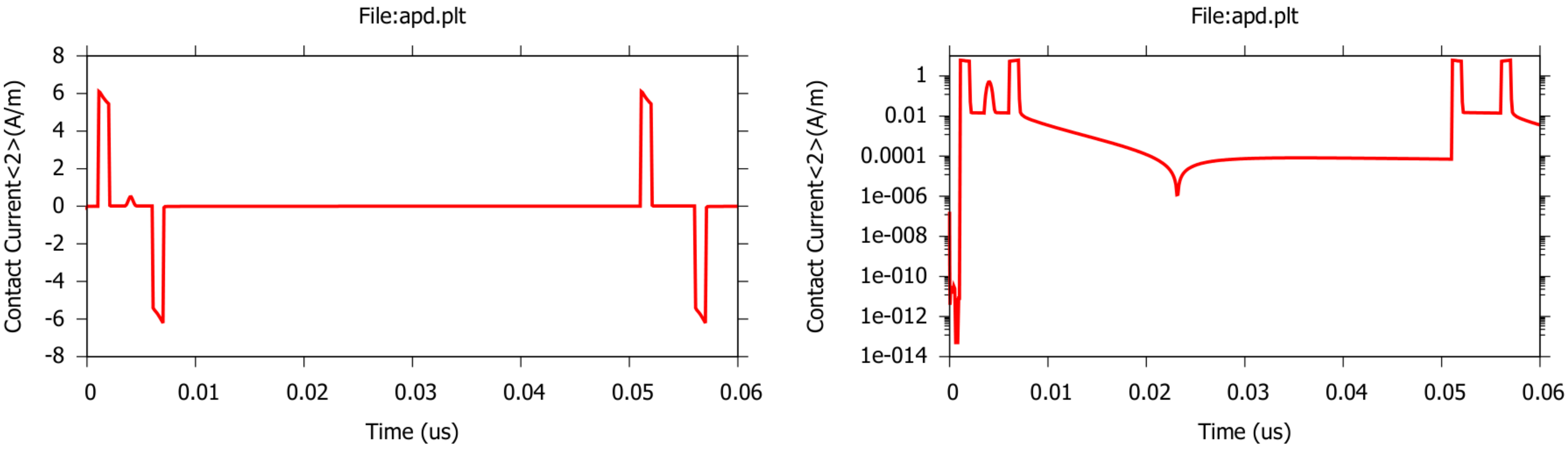
Gate Pulse and Optical Excitation





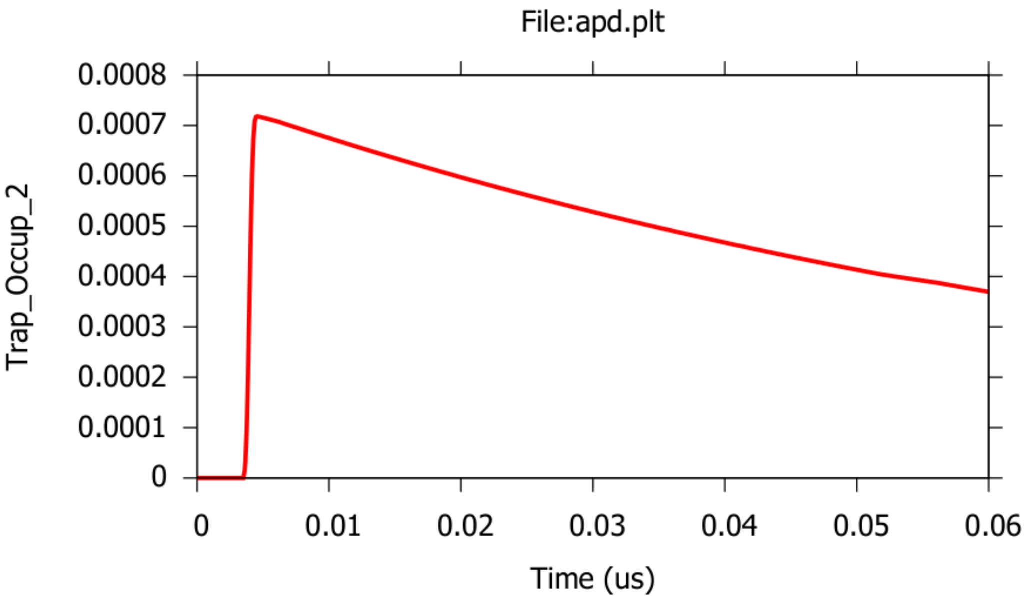
- Voltage gating periodically biases APD above breakdown.
- Optical pulse synchronized with the initial gate.
- Transient simulation tracks avalanche current and trap occupancy.

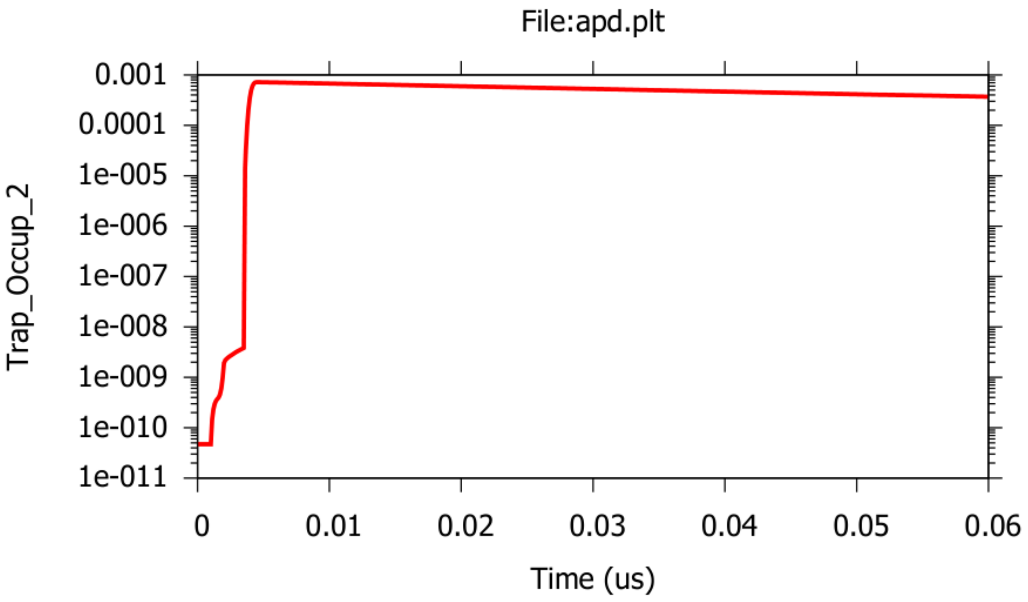
Transient Avalanche Current



Linear and logarithmic current plots reveal delayed avalanche activity caused by trap emission.

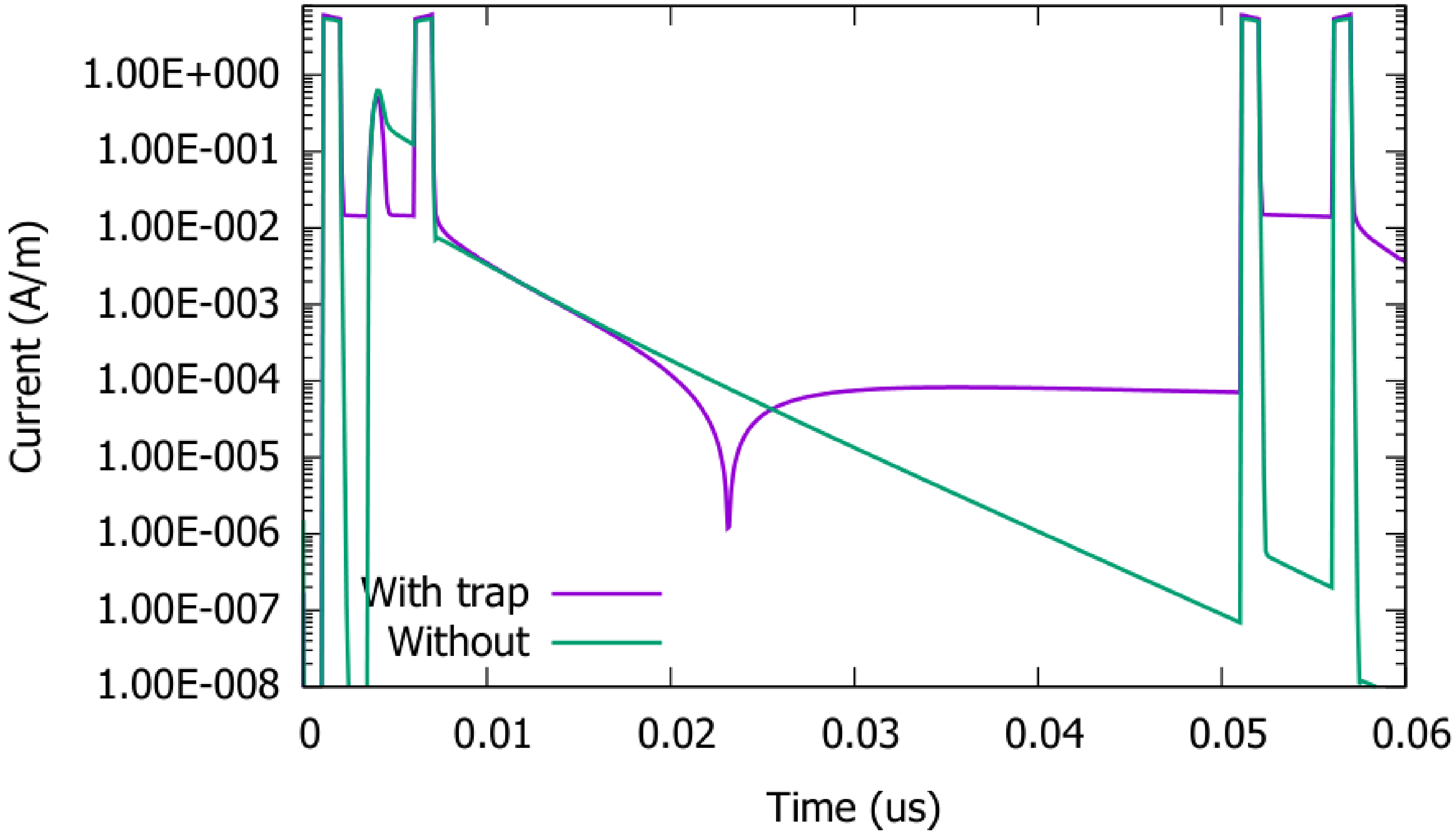
Trap Occupancy Dynamics





Trap occupancy rapidly increases during avalanche injection and decays slowly over time.

Comparison: With Trap vs Without Trap



- Trap-rich structure shows persistent avalanche current during later gates.
- Trap-free reference decays rapidly after optical excitation.
- Simulation verifies deep-level traps as the origin of afterpulsing.

Conclusions

- APSYS successfully reproduces gated APD afterpulse behavior.
- Trap-assisted carrier emission explains delayed avalanche events.
- Simulation framework enables trap parameter extraction and APD optimization.
- Methodology can be extended to SPAD and single-photon detector design.

Thank You