

2026.9 | A First Research Attempt: RCE OPDs and Device Simulation

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1: Learning

- **Continued literature study:** I expanded my reading of near-infrared and shortwave-infrared OPDs, including broadband polymer devices, resonance-enhanced structures, traps and dark-current noise, and detectivity limits. I continued extracting data and preparing summaries to connect device performance with its physical explanation.
- **An initial RCE project:** Building on the resonant-cavity-enhanced (RCE) OPD literature, I began exploring whether changes to device structure could improve performance. One question was whether an embedded electrode could shorten carrier-collection distances while preserving the optical benefit of the cavity.
- **Simulation training:** I used finite-difference time-domain (FDTD) simulation to investigate optical behavior and began working with CHARGE for electrical modeling. Learning to use these tools exposed me to the practical difficulty of connecting an optical design with a carrier-transport model.

2: Highlights

- I moved from reproducing published plots toward examining a structural idea of my own. The RCE project gave me an initial experience of a research cycle: use the literature to motivate a question, build a model, explore modifications, and assess whether the results support the intended improvement.
- The structural modifications I tried did not deliver the expected improvement. This negative result became an important part of my training: I had to reconsider the idea and examine the trade-offs, rather than treat a plausible physical argument as sufficient evidence of better device performance.
- FDTD and the initial CHARGE work helped me distinguish optical questions from electrical ones. Field distributions and absorption can inform where light is absorbed, while electrical modeling is needed to examine carrier transport and collection. Progress in one part does not by itself establish improvement in the complete detector.
- I broadened my literature-data workflow by digitizing figures, checking reported values against extracted data, and recording the conditions behind performance metrics. Work on dark-current and noise papers strengthened my attention to the difference between detectivity estimated from shot noise and detectivity based on measured noise.

3: Insights & Takeaways

- The main outcome of the RCE attempt was methodological learning. A device modification must be evaluated across optical absorption, carrier collection, and loss mechanisms; improving a single feature may introduce a cost elsewhere.
- A negative result is useful when I can explain what was tested, what the model actually supports, and what information is still missing. This attempt taught me to revise an idea in response to evidence and to keep the strength of my conclusions consistent with the maturity of the model.
- Literature reading became more purposeful once I had a concrete project. Questions about cavity fields, electrode placement, dark current, and collection helped guide what I looked for in papers and which parameters I needed for modeling.
- I also learned that producing more plots or organizing more files is not sufficient on its own. The value of a research workflow lies in making a physical argument easier to test, inspect, and communicate.

4: Challenges & Open Questions

- The FDTD and CHARGE work was an early research attempt. Electrical-model setup and the connection between optical generation and carrier collection still required further development and checking.
- I needed to distinguish a limitation of the proposed structure from a limitation of the modeling assumptions or parameter choices. The unsuccessful trial did not justify a universal conclusion about every related design.
- I still needed more experience in presenting a complete argument: the motivation, comparison baseline, method, result, limitations, and the next test that would resolve an uncertainty.

5: Following Plan

- Consolidate the RCE attempt into a clear report, including the original hypothesis, the modifications tested, the negative result, and the remaining modeling questions.
- Strengthen the optical and electrical baselines before interpreting further structural changes, and connect simulation predictions with experimentally measurable quantities.
- Continue targeted literature reading and choose the next investigation around a specific unresolved question, with a defined comparison and criterion for success.