

DR. DEEP PUNJ

Optical Engineer & Scientific Data Specialist | Optics, Python and Machine Learning

Lasers, OCT and microscopy · Python for instruments and images · SQL and machine learning · COMSOL and FDTD
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PROFILE

Optical engineer with a PhD in nano-optics and more than ten years of turning optical measurements into results people can trust. At Ghent University I design, build and maintain laser, OCT and microscopy platforms and write the Python code that controls the instruments, analyses the images and checks system performance over time. Earlier research at Institut Fresnel, KAUST, UC Irvine, IIT Madras and Leiden combined COMSOL and FDTD modelling, nanofabrication and single-molecule spectroscopy, and led to a first-author Nature Nanotechnology paper. Alongside my job I have built public projects in photonic simulation, machine learning on thermal-camera images, SQL-based predictive modelling and Power BI. I am looking for a role in optical engineering or scientific data science where the physics, the measurement and the data all matter.

CORE SKILLS

- Optical systems: pulsed and nanosecond lasers, OPO, beam alignment and delivery, OCT, confocal, STED and spinning-disk microscopy, FCS and single-molecule fluorescence, optical test setups; Zemax (basic).
- Modelling and fabrication: COMSOL Multiphysics, Lumerical FDTD, Python mode solving and Monte Carlo tolerance analysis, FIB nanofabrication, SEM, AFM, cleanroom methods.
- Programming and data: Python (NumPy, pandas, SciPy, Matplotlib, PyTest), SQL (PostgreSQL), MATLAB, instrument control, data acquisition, GUI development, signal and image analysis.
- Machine learning: scikit-learn (logistic regression, Random Forest, gradient boosting), feature engineering, grouped and time-based validation, leakage checks, SHAP, MLflow.
- Visualisation and tools: Streamlit, Power BI, Tableau, Git and GitHub, Jupyter, VS Code, PyCharm; learning PySpark and Databricks.
- Hardware: scientific cameras, photodetectors, single-photon counting, translation stages, laser and detector troubleshooting and maintenance.
- Languages: English (fluent), Hindi (native).

PROFESSIONAL EXPERIENCE

Optical Engineer / Researcher | Ghent University, Faculty of Pharmaceutical Sciences, Belgium Apr 2022 – present

- Designed and built from scratch an in vivo retinal photoporation setup that combines a Thorlabs OCT system with nanosecond lasers at 532 nm and 1064 nm. It is installed in the UZ Gent Animalarium Core facility.
- Rebuilt and extended a nanosecond OPO platform for photoporation, which delivers molecules into targeted cells; check its performance across wavelengths on a regular schedule and fix problems.
- Wrote Python programs for image analysis, camera and stage control, and routine quality checks of the laser systems, tracking their performance over time.
- Work with pharmaceutical scientists on cell and drug-delivery studies, turning their research questions into measurements and analysis.
- Co-planned the move of the microscopy labs to a new floor, recommissioning four setups (A1R confocal, STED, spinning disk, LumiPore); train PhD students and postdocs on them.
- Contribute to research papers and funding proposals; local IT administrator for the lab (PCs, group website, SharePoint).

Data Mining Intern | World Development Organization Nov 2021

- Wrote Python scrapers (requests, BeautifulSoup) to collect NGO funding data from several websites, then cleaned and merged it with pandas into one dataset.

Postdoctoral Researcher, Single-Molecule Optics | Leiden University, Netherlands (Orrit group) Jun 2019 – Apr 2022

- Combined wet-chemical synthesis, SEM characterization and COMSOL simulations of gold nanorod dimers with measurements of one- and two-photon single-molecule fluorescence enhancement.
- Mentored a PhD student on nonlinear excitation of single-molecule fluorescence, and supervised a B.Sc. thesis project.

Postdoctoral Researcher | IIT Madras · UC Irvine · KAUST 2015 – 2019

- IIT Madras (Aug 2018 – Mar 2019): plasmonics-assisted ptychography, a computational imaging method that reconstructs high-resolution images from a series of intensity measurements.
- UC Irvine (Apr 2017 – Mar 2018): fabricated plasmonic nanostructures with a nanorobot inside a scanning electron microscope and modelled gold nanoparticle assemblies in Lumerical FDTD.
- KAUST (Jun 2015 – Jun 2016): FIB nanofabrication on Quanta 3D and Helios systems, and design, fabrication and FDTD simulation of AFM probe shapes for near-field measurements.

PhD Researcher, Nano-Optics | Aix-Marseille Université, Institut Fresnel (CNRS), France Mar 2012 – Feb 2015

- Developed the plasmonic antenna-in-box platform, which makes single-molecule detection possible at micromolar concentrations; modelled it with FDTD and measured it with fluorescence correlation spectroscopy (FCS).

SELECTED PROJECTS (code and case studies: punjdeep.com)

- **Photonic Coupling and Assembly Tolerance** (Python, NumPy, Monte Carlo; github.com/deeppunj/sipho-coupler-study). Scalar finite-difference mode solver for a SiN edge coupler at 1550 nm, checked against an exact slab solution, linking taper-tip width to fibre-coupling loss, alignment tolerance and simulated assembly yield. Best modelled loss 0.43 dB at a 250 nm tip; simulation only.
- **Laser Weld Defect Inspection** (Python, scikit-learn, SHAP, Streamlit; github.com/deeppunj/laser-defect-inspection-ml). Physics-based features from 16,362 thermal-camera frames of 97 welds, Random Forest with weld-grouped nested cross-validation (ROC AUC 0.974 ± 0.007) and SHAP explanations.
- **Healthcare Risk Prioritisation** (PostgreSQL, scikit-learn, MLflow; github.com/deeppunj/patient-finding-synthea). SQL cohorts and leakage-free features from synthetic Synthea records; trained on 2019–2023 and tested on 2024–2025, the top 10% of ranked snapshots held 37 of 75 future kidney-disease diagnoses.
- **FDA Drug Shortages Analytics** (Power BI, Power Query, DAX; github.com/deeppunj/powerbi_fda_drug_shortages). Dashboard of 1,582 openFDA shortage records by therapeutic category, manufacturer and duration, with DAX measures that keep listings and distinct drugs apart.

EDUCATION

PhD, Nano-Optics | Aix-Marseille Université, Institut Fresnel, France 2012 – 2015

Integrated M.Sc., Photonics | Cochin University of Science and Technology, India 2006 – 2011

TEACHING AND SUPERVISION

- Specialist Microscopy course (annual), Ghent University, 2022 – 2026; Physical Experiment 1, Leiden University (2020); Europhotonics Master lab course in single-molecule spectroscopy, Aix-Marseille Université (2013, 2014).
- Day-to-day mentoring of a PhD student at Leiden University (joint papers in ACS Photonics and Nano Letters); supervised a B.Sc. thesis and a pre-PhD research project.

SELECTED PUBLICATIONS

- D. Punj, M. Mivelle, S. B. Moparthi, T. S. van Zanten, H. Rigneault, N. F. van Hulst, M. F. Garcia-Parajo, J. Wenger, "A plasmonic 'antenna-in-box' platform for enhanced single-molecule analysis at micromolar concentrations", *Nature Nanotechnology* 8, 512 (2013). First author.
- D. Punj, R. Regmi, A. Devilez, R. Plauchu, S. B. Moparthi, B. Stout, N. Bonod, H. Rigneault, J. Wenger, "Self-assembled nanoparticle dimer antennas for plasmonic-enhanced single-molecule fluorescence detection at micromolar concentrations", *ACS Photonics* 2, 1099 (2015). First author.
- D. Punj, J. de Torres, H. Rigneault, J. Wenger, "Gold nanoparticles for enhanced single molecule fluorescence analysis at micromolar concentration", *Optics Express* 21, 27338 (2013). First author.
- X. Lu, D. Punj, M. Orrit, "Two-photon-excited single-molecule fluorescence enhanced by gold nanorod dimers", *Nano Letters* 22, 4215 (2022).
- M. D. Baaske, N. Asgari, D. Punj, M. Orrit, "Nanosecond time scale transient optoplasmonic detection of single proteins", *Science Advances* 8, eabl5576 (2022).
- Further papers in ACS Nano, ACS Photonics, J. Phys. Chem. C and WIREs Nanomedicine; Google Scholar: h-index 13, 1,096 citations.

TRAINING AND CERTIFICATIONS

- Google Data Analytics Professional Certificate (SQL, R, Tableau, data cleaning)
- Python for Data Science, AI and Development, IBM (Coursera, 2021)
- First Order Optical System Design, University of Colorado Boulder (Coursera, 2021)
- MATLAB 2018 Essential Training and Tableau Essential Training (LinkedIn Learning, 2021)