Open Research Awards 2026

Overall runner-up prize

José Carlos Do Amaral Rocha (Physics and Astronomy)

PLMCtrl: accelerating adoption of high-speed light modulators through open-source software

Introduction to the case study

Controlling laser beam shape underpins modern photonics, from microscopy to quantum optics. Spatial Light Modulators (SLMs) are programmable optical elements that enable this control by reshaping light. Current SLMs are efficient but slow to switch patterns, limiting applications that demand rapid beam updates, such as adaptive optics and steering microscopic particles at high speed. The Texas Instruments Phase-only Light Modulator (PLM) represents a step change: combining high efficiency, megapixel resolution, and switching speeds far beyond conventional devices. However, no suitable open-source control software existed for it. PLMCtrl addressed this gap, making the PLM immediately accessible to the wider research community.

Detail the practices you have used to support openness/reproducibility

PLMCtrl was developed from the outset with open research principles in mind. The full library is publicly available on GitHub under an MIT licence [1], ensuring any researcher can freely adapt and build on the work. It was designed to support a wide range of programming languages, meaning experimentalists without a systems-programming background can immediately integrate it into their existing workflows.

A preprint was deposited on arXiv [2] prior to peer review, with the work subsequently published open-access in *Optics Express* [3]. It has already received 34 citations in little over two years, alongside a substantial volume of correspondence from researchers at laboratories worldwide.

To support reproducibility, a dataset containing the raw data required to reproduce all figures in the main paper was deposited in the University of Exeter's ORE repository [4].

A detailed GitHub Wiki covers getting started, full API documentation, compilation instructions, device configuration, and main issues we encountered.

PLMCtrl underpins subsequent work published open-access in *Nature Communications* [5], which has accumulated 13 citations since its publication in January 2026, demonstrating immediate community engagement. A preprint [6] and supporting dataset [7] were again made openly available.

Outline any barriers or challenges you encountered, and how they were handled

The primary challenge was engineering the library to be lightweight and performant across different hardware, while remaining usable from a wide range of programming languages.

Achieving reliable hologram display rates required careful optimisation and extensive experimental validation. Ensuring portability across languages added further complexity, particularly in maintaining a simple and consistent library interface (API).

Even before its public release, use within the group exposed edge cases such as unexpected hardware combinations, driver behaviours, and usage patterns. Addressing these issues improved the robustness and reliability of the software across a broader range of experimental setups.

What benefits have you identified from your case?

PLMCtrl removes a significant technical barrier for groups wishing to adopt next-generation light modulation technology.

It serves as a reliable, ready-to-use starting point for researchers when using this new generation device. This is particularly valuable for applications that demand rapid beam updates, a growing need in modern photonics, where the performance gap between the PLM and conventional SLMs is most consequential.

Groups working with the PLM no longer need to develop control software from scratch, or adapt existing options that were created for older generation devices, effort that is duplicated across the community and diverts focus from scientific questions.

How do you plan to continue this case moving forward?

Development is continuing with a focus on supporting the Near-Infrared PLM variant, which is seeing growing adoption in microscopy and telecommunications research.

The project will continue maintaining the repository, addressing user issues, and refining documentation.

Conclusions

PLMCtrl demonstrates how open-source software enables adoption of emerging experimental technologies while improving reproducibility and accessibility. By making both implementation and documentation openly available, it supports a broader research community and reduces duplication of effort. This work highlights the value of open research in delivering practical, reusable tools.

Links to any materials/resources relevant to the case

[1] PLMCtrl GitHub repository - https://github.com/structuredlightlab/plmctrl

[2] arXiv preprint (arXiv:2409.01289) - https://arxiv.org/abs/2409.01289

[3] Optics Express paper - https://doi.org/10.1364/OE.541857

[4] Optics Express supporting dataset (ORE) - https://doi.org/10.24378/exe.5386

[5] Nature Communications paper - https://doi.org/10.1038/s41467-025-66798-2

[6] arXiv preprint (arXiv:2501.14129) - https://arxiv.org/abs/2501.14129

[7] Nature Communications supporting dataset (ORE) - https://doi.org/10.24378/exe.30479279