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# SHADOW4: Advanced Ray-Tracing for the Design and Simulation of X-Ray Optical Systems

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"SHADOW" is a ray-tracing program originally developed by Franco Cerrina, widely adopted for the simulation of synchrotron radiation beamlines. Over more than four decades and across three generations of synchrotron sources, SHADOW has played a key role in the design and upgrade of numerous beamlines.

This work presents a comprehensive overhaul of SHADOW, resulting in the development of SHADOW4: a modern, object-oriented implementation written entirely in Python. The core package, shadow4, is integrated into the OASYS environment, providing a performant, intuitive, and workflow-based graphical interface.

Several application examples in X-ray optics are presented, including systems employing mirrors, multilayers, and crystals. In addition, the architecture of the software and its main dependencies are briefly described.

SHADOW4 is built upon modern, standard software engineering principles, facilitating collaboration and contributions from a broader community of developers. This foundation supports the creation of new features, tutorials, and documentation. Thanks to Python's cross-platform compatibility, SHADOW4 can be seamlessly deployed on Windows, macOS, and Linux systems.

Using the OASYS interface, SHADOW4 scripts are automatically generated, offering users a high degree of customization and control over their simulations. Advanced functionalities such as parameter scans and the development of digital twins enable integration with AI-driven workflows and optimization tools.

This project is presented with a dual aim: to engage potential users who can benefit from SHADOW4's powerful simulation capabilities, and to invite contributors to extend the platform by developing tools tailored to their specific applications. Such contributions have the potential to enrich the ecosystem and benefit the broader scientific community.

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