Sirepo — software framework for X-ray sources and optics simulations

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Objectives

Sirepo allows to perform scientific simulations in a cloud:

- Convenient and installation-free access to physical optics and accelerator codes (SRW, Elegant, WARP, *etc.*)
- Simulation of X-ray sources (undulators, damping wigglers, *etc.*)
- Simulation of wavefront propagation through optical system of X-ray beamlines
- Sharing the simulations with colleagues and collaborators

Introduction

Sirepo — a browser-based GUI and framework for X-ray optics simulations, built on top of Synchrotron Radiation Workshop (SRW).

SRW — a physical optics computer code, allowing simulation of entire experimental beamlines using the concept of a "Virtual Beamline" with the accurate treatment of the synchrotron radiation propagation through the X-ray optical system [1, 2, 3].

Links

Use:

- beta.sirepo.com/light (publicly available)
- expdev.nsls2.bnl.gov/light (behind NSLS-II firewall)
- nsls2expdev1.bnl.gov:8000/light (behind NSLS-II firewall)

Download (open source):

- github.com/radiasoft/sirepo
- github.com/ochubar/SRW
- hub.docker.com/r/radiasoft
- atlas.hashicorp.com/radiasoft

Users

- NSLS-II, LCLS, APS, ALS in the US
- ELETTRA in Italy
- European XFEL in Germany
- ESRF and SOLEIL in France
- PSI in Switzerland
- Diamond Light Source in UK
- LNLS in Brazil

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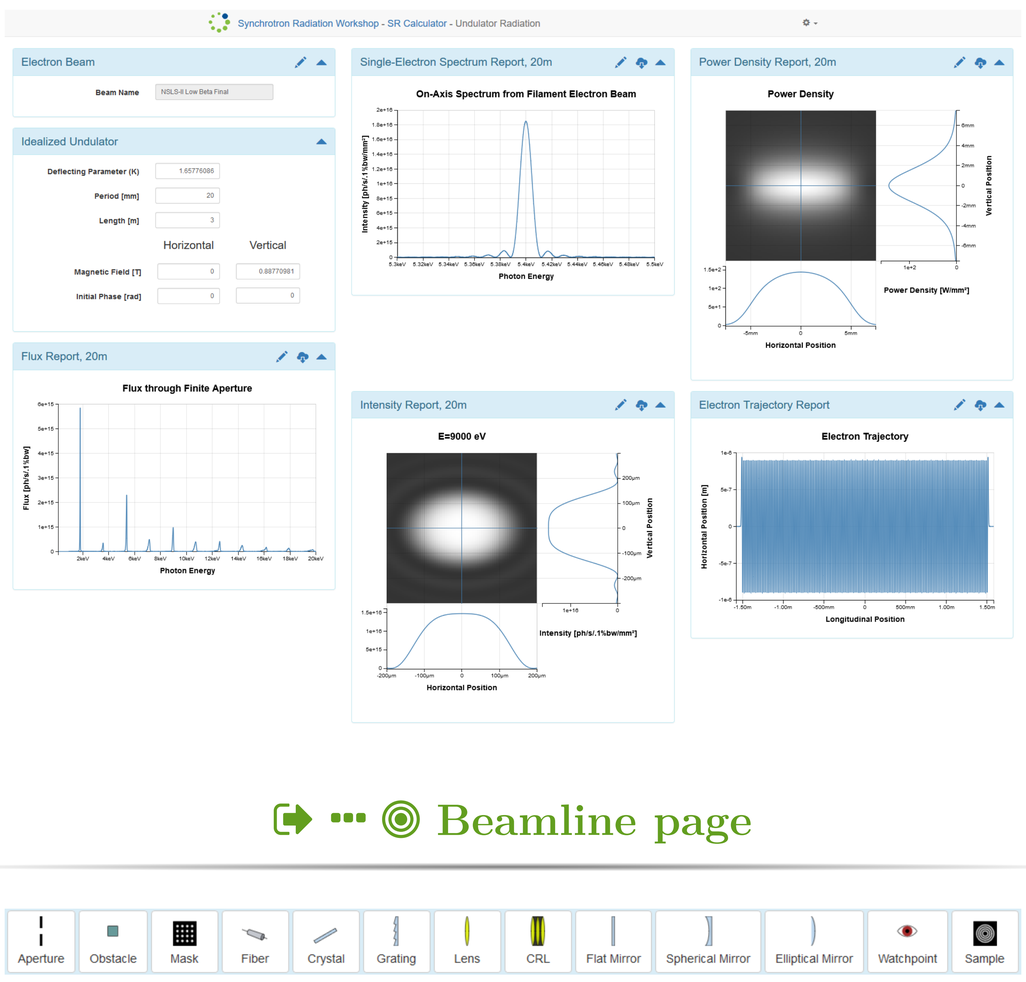
Server technologies

- **Python** — widely used high-level programming language for general-purpose programming
- **Flask** — lightweight framework for web development with Python based on Werkzeug WSGI toolkit
- **Nginx** — industry standard HTTP server and a reverse proxy
- **JSON (JavaScript Object Notation)** — a lightweight data-interchange format
- **Celery and RabbitMQ** — asynchronous job queue and cluster management
- **Open MPI/mpi4py** — technology used to run scientific codes in parallel across a cluster of computational nodes on a network

Client

- **HTML5** — markup language used for structuring and presenting web content
- **CSS3** — style sheet language used for describing the presentation of a document written in a markup language
- **Bootstrap** — HTML, CSS and JavaScript framework for developing cross-platform web applications
- **AngularJS** — structural framework for dynamic web apps
- **D3.js** — JavaScript graphics library which is used to generate interactive plots in the browser. D3 supports large datasets and dynamic behaviors for interaction and animation.

Source page



Beamline page

Conclusion

Sirepo — a browser-based open-source framework for X-ray optics simulations. Sirepo is interfaced with a number of leading codes in the fields of X-ray source and optics simulations (SRW and Shadow3) and particle accelerators (Elegant, Hellweg and Warp). Sirepo for SRW contains predefined textbook examples as well as simulations of the wavefront propagation through the real beamlines at NSLS-II. On the Source page users can optimize the source of the synchrotron radiation. On the Beamline page one can construct a "virtual" beamline emulating layout of a real experimental beamline. Sirepo is empowered with the interactive widgets and dynamically accessed data from the community databases for X-ray optics [4, 5]. Simulation of experimental samples is implemented in Sirepo & SRW.

References

[1] O. Chubar and P. Elleaume. Accurate and efficient computation of synchrotron radiation in the near field region. *Conf. Proc.*, C980622:1177–1179, 1998.

[2] Oleg Chubar, Pascal Elleaume, Serguei Kuznetsov, and Anatoly A. Snigirev. Physical optics computer code optimized for synchrotron radiation. *Proc. SPIE*, 4769:145–151, 2002.

[3] O. Chubar, A. Fluerasu, L. Berman, K. Kaznatcheev, and L. Wiegart. Wavefront propagation simulations for beamlines and experiments with "synchrotron radiation workshop". *Journal of Physics: Conference Series*, 425(16):162001, 2013.

[4] http://x-server.gmca.aps.anl.gov/x0h.html.

[5] http://henke.lbl.gov/optical_constants/.

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