Sirepo – an open-source cloud-based software interface for X-ray source and optics simulations

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Outline

- Overview of Sirepo:
  - Sirepo & SRW
  - Distribution of Sirepo
  - Source page
  - Beamline page
  - Selected features

- Demonstration of Sirepo

Sirepo & SRW

- **SRW (Synchrotron Radiation Workshop)** – allows to simulate synchrotron radiation and wavefront propagation through beamline optics

- SRW is written in C++ and has several interfaces

- **Sirepo** – an open-source Python/JavaScript interface for cloud computing, developed in collaboration with RadiaSoft LLC within SBIR project
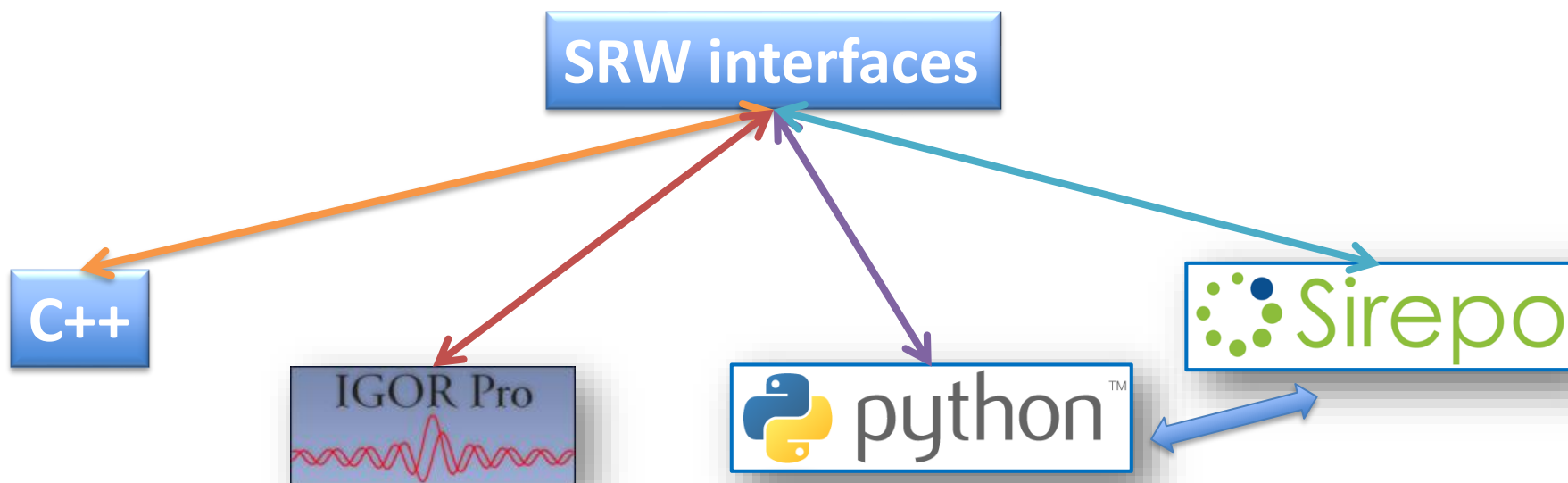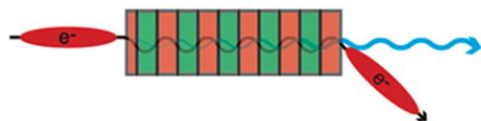

Concept of "Virtual Beamline"
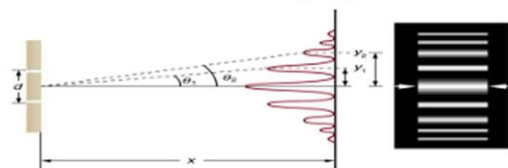
Distribution of Sirepo

Synchrotron Radiation Workshop

Synchrotron Radiation
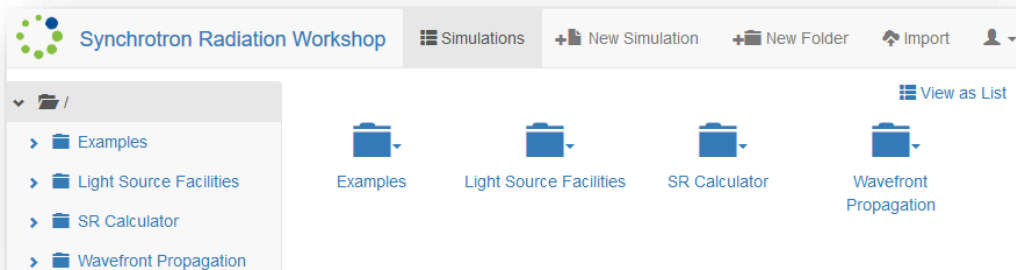
Wavefront Propagation

Light Source Facilities

Distribution:
- **Source code:**
  - https://github.com/ochubar/SRW
  - https://github.com/radiasoft/sirepo
- **Docker containers:**
  https://hub.docker.com/r/radiasoft/sirepo/tags/
- **Vagrant boxes:**
  https://atlas.hashicorp.com/radiasoft/boxes/sirepo

Servers:
https://beta.sirepo.com/light – globally available
https://expdev.nsls2.bnl.gov/light – behind BNL firewall
http://nsls2expdev1.bnl.gov/light – behind BNL firewall

Expert users only

Synchrotron Radiation Workshop ☰ Simulations + New Simulation + New Folder ⬆ Import

▾ ▸ /

☰ View as List

▸ 📁 Examples
▸ 📁 Light Source Facilities
▸ 📁 SR Calculator
▸ 📁 Wavefront Propagation

Examples   Light Source Facilities   SR Calculator   Wavefront Propagation

U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY | National Synchrotron Light Source II

Source page

Source page: definition of the beam

Source page: definition of the source

Undulator (Idealized or Tabulated) ▲

Type of Undulator	[Idealized] [**Tabulated**]
Magnetic Gap [mm]	6.72
Magnet Arrays Shift [mm]	0
Longitudinal Central Position [m]	1.305
Magnetic Data File	magnetic_measurements.zip ▾ ☁

Idealized Undulator ▲

Deflecting Parameter (K)	1.65776086
Period [mm]	20
Length [m]	3
Longitudinal Central Position [m]	0

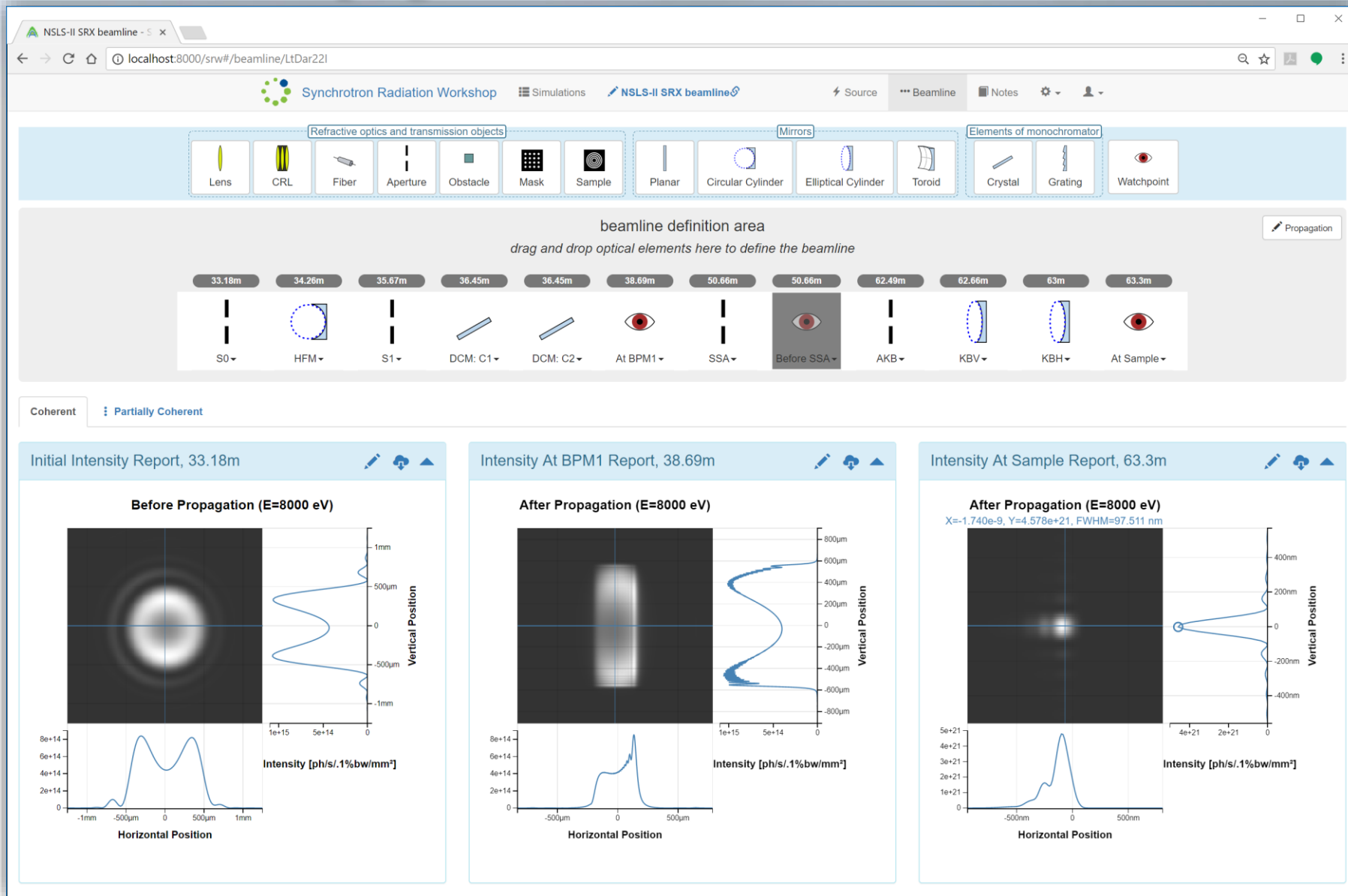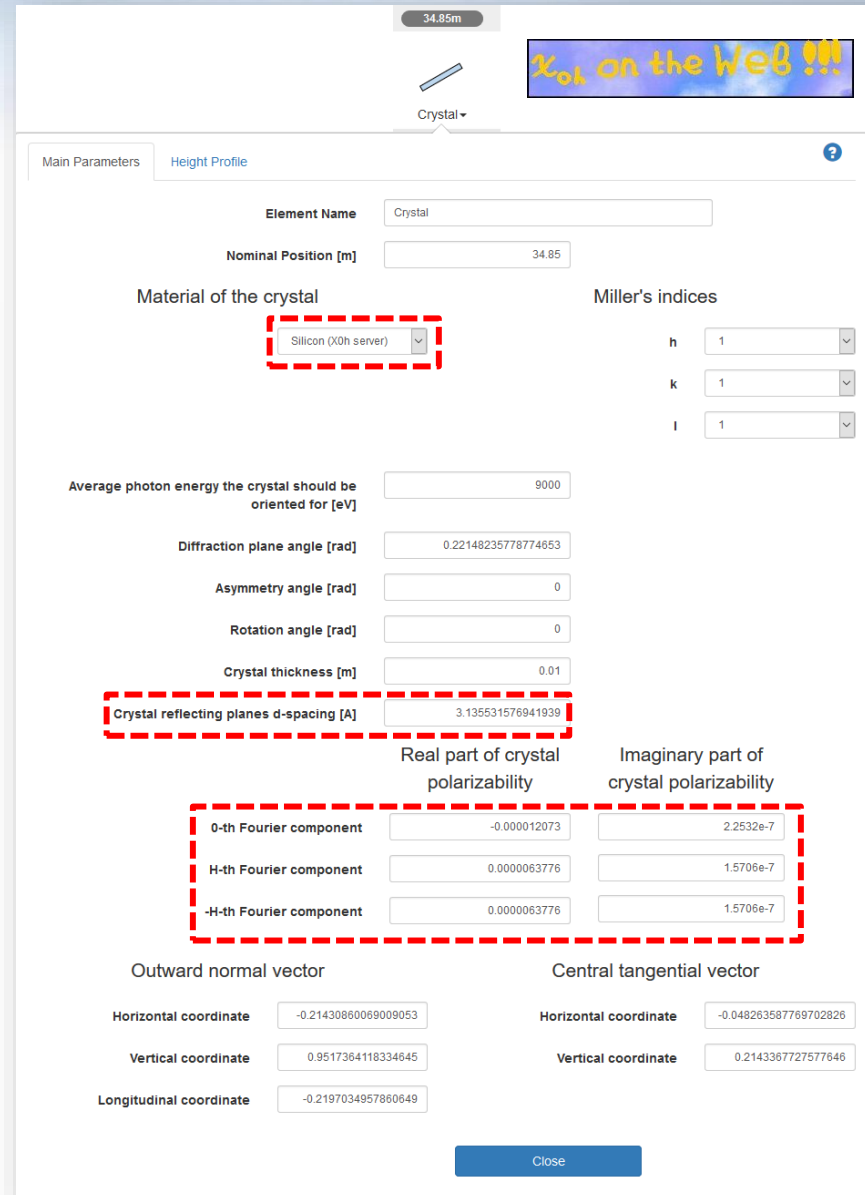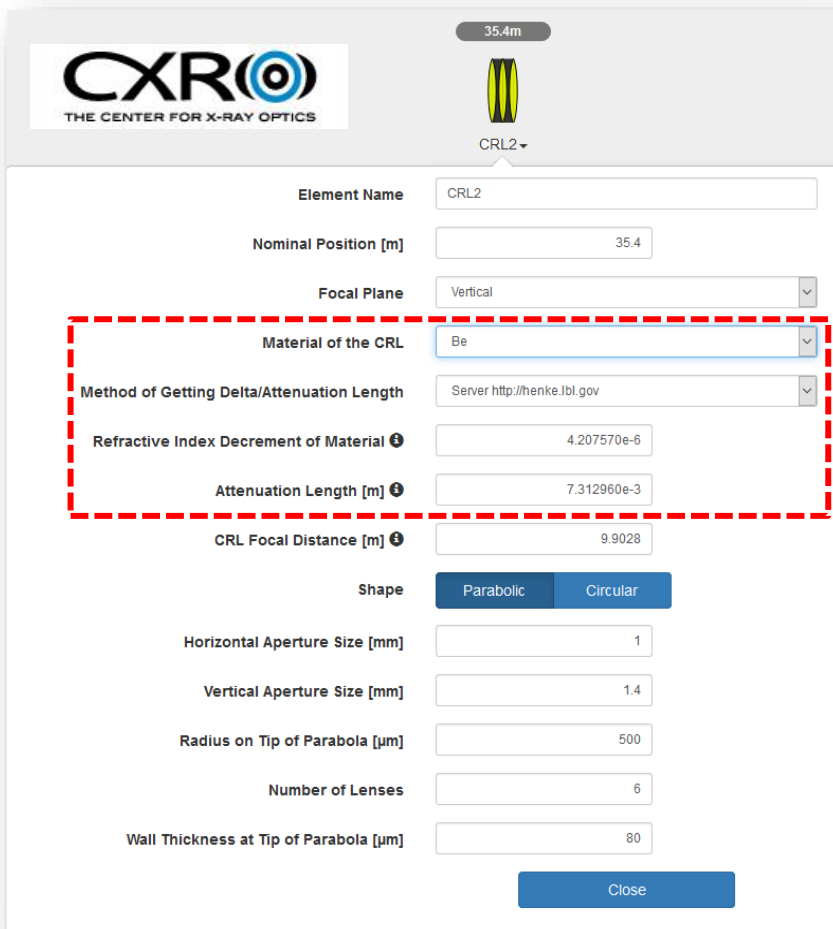|	Horizontal	Vertical
Magnetic Field [T]	0	0.88770981
Initial Phase [rad]	0	0
Symmetry	Symmetrical	Anti-symmetri
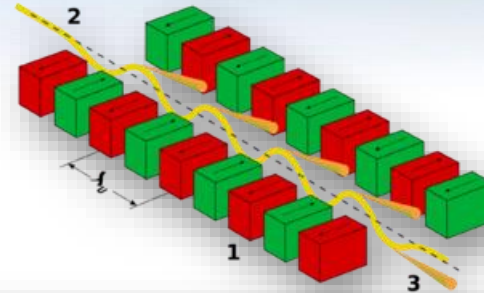
Electron Trajectory Report ✎ ☁ ▲

Electron Trajectory
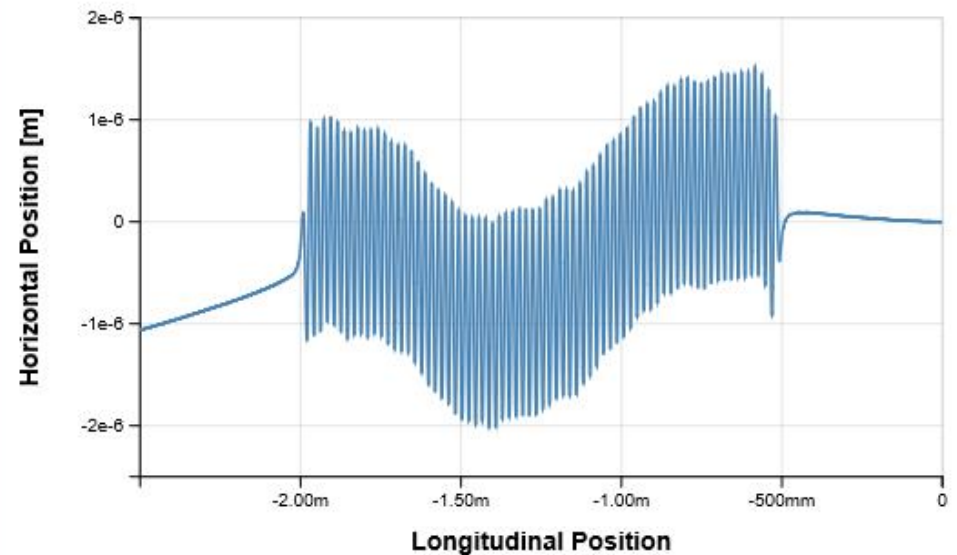
Beamline page

Dynamic access to external databases

Data is dynamically queried from:
- http://henke.lbl.gov/optical_constants/
- http://x-server.gmca.aps.anl.gov/xoh.html

Python API for data access, **JS** for GUI

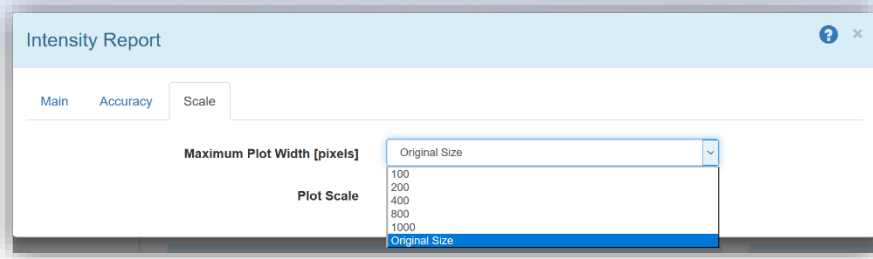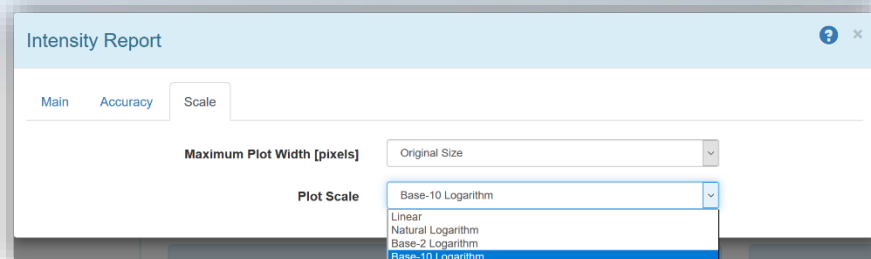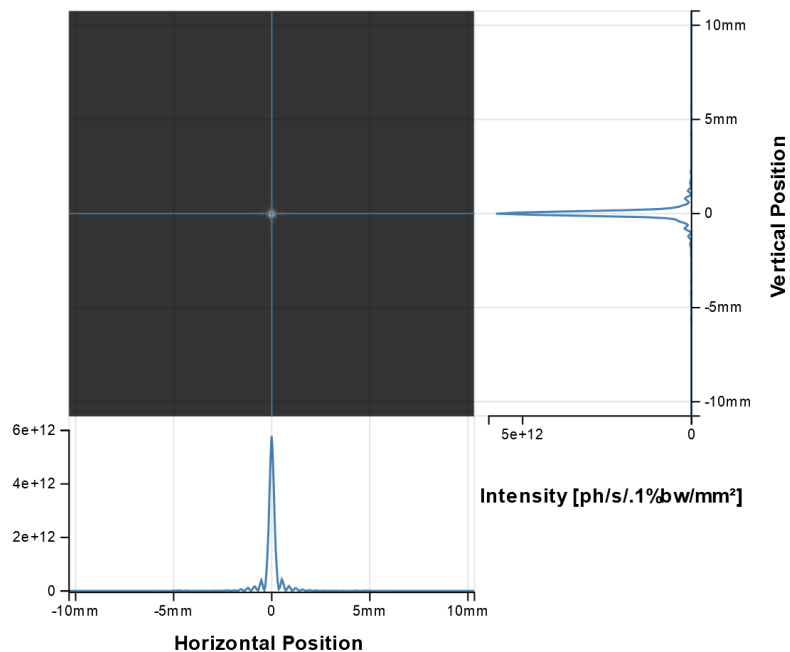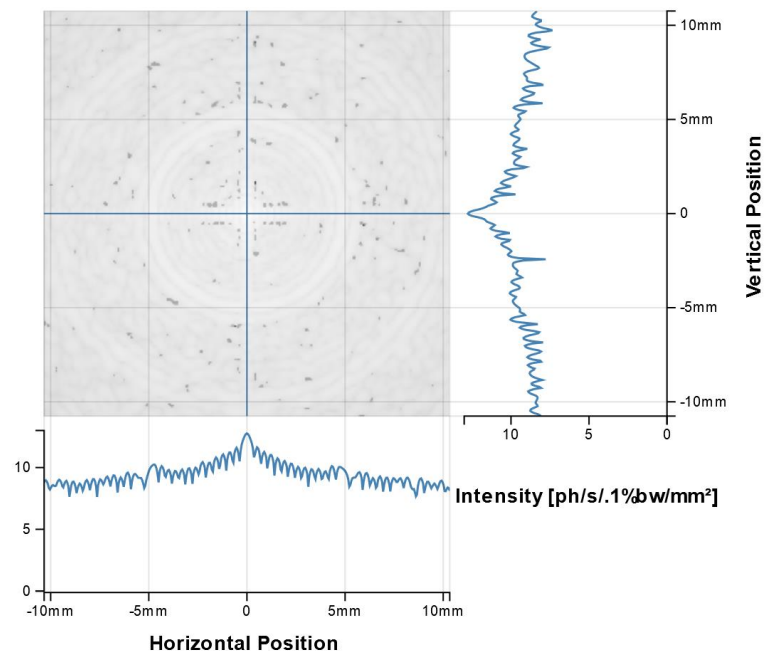# Intensity image resizing and scaling

Image resizing option implemented in Sirepo and SRW using SciPy to optimize amount of data transferred from server to client

Selection of scales (linear & logarithmic) implemented in Sirepo and SRW using NumPy to allow better insight into the resulted intensity

Simulation of scattering experiments
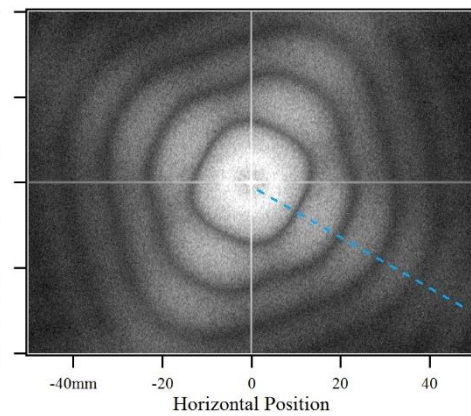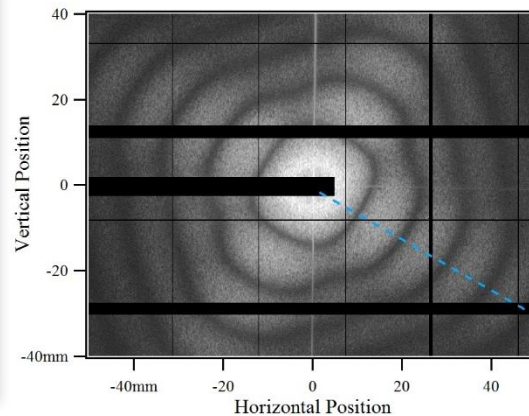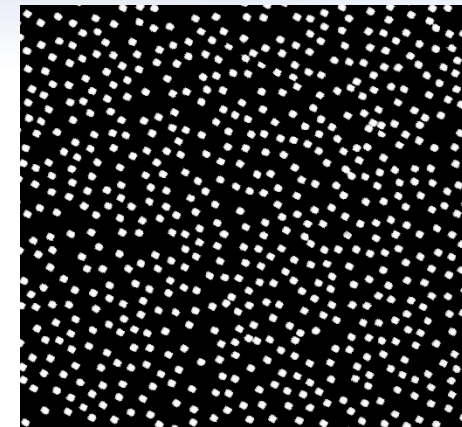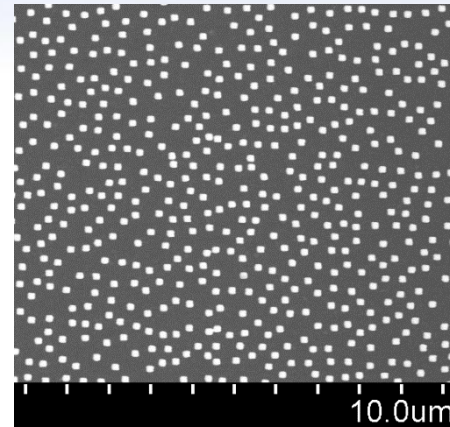

SRW and Sirepo extension:
Sample scattering simulation using microscopy imaging:
Python/NumPy/SciPy/Pillow image processing library

Chubar, *et al.* Proc. SPIE (2017), 10.1117/12.2274481
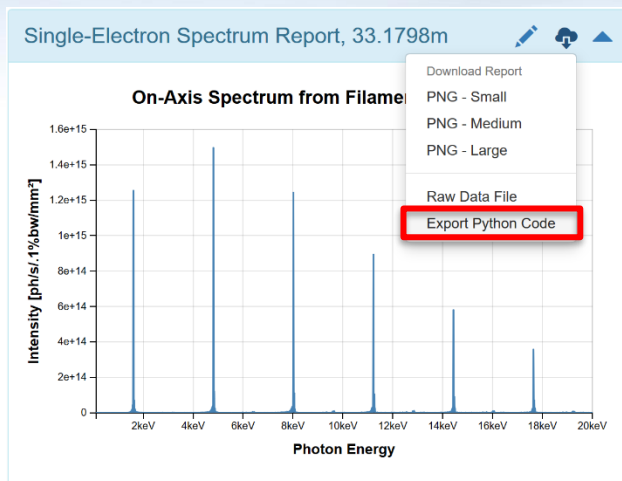
Data storage & exchange

Export:
- Python script
- JSON file
- Zip-archive
- Self-extracting simulation

Import:
- Python script
- JSON
- Zip-archive

Demonstration of Sirepo

https://expdev.nsls2.bnl.gov/light

Summary:

- A new user-friendly web-interface Sirepo for portable reproducible SRW simulations developed in collaboration with RadiaSoft LLC and deployed at NSLS-II

- Virtual beamlines implemented: NSLS-II CHX, SMI, SRX, HXN, FMX, ESM, and LCLS-SXR

- All commonly used optical elements for "Virtual Beamline" are available

- Dynamic access to X-ray optics material properties from community databases helps obtain optical constants for particular photon energy and material in one click

- Advanced import-export features allow for easier exchange of simulations between colleagues and collaborators

- Demonstration at SPIE'17: https://www.spiedigitallibrary.org/conference-proceedings-of-spie/10388/2274031/Sirepo--a-web-based-interface-for-physical-optics-simulations/10.1117/12.2274031.full?SSO=1

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