Sirepo – software framework for X-ray optics simulations

Maksim S. Rakitin

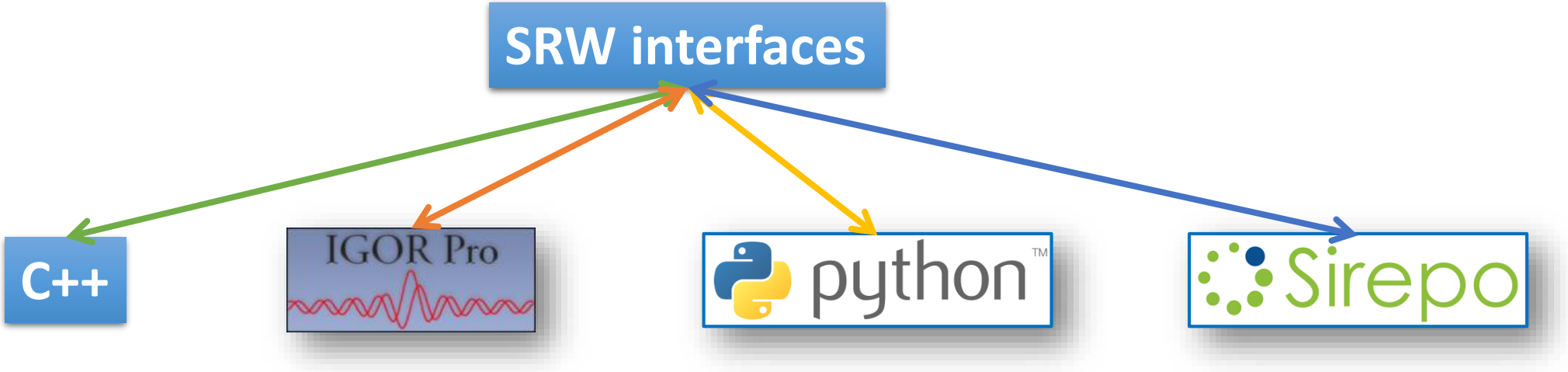
Research Associate

Photon Sciences (PS), NSLS-II, BNL

December 13, 2016

Introduction

- **Sirepo** – an open-source Python/JavaScript framework for cloud computing
- **SRW** (Synchrotron Radiation Workshop) – allows to simulate synchrotron radiation and wavefront propagation through beamline optics
- SRW is written in C++ and has several interfaces



Distribution & Servers

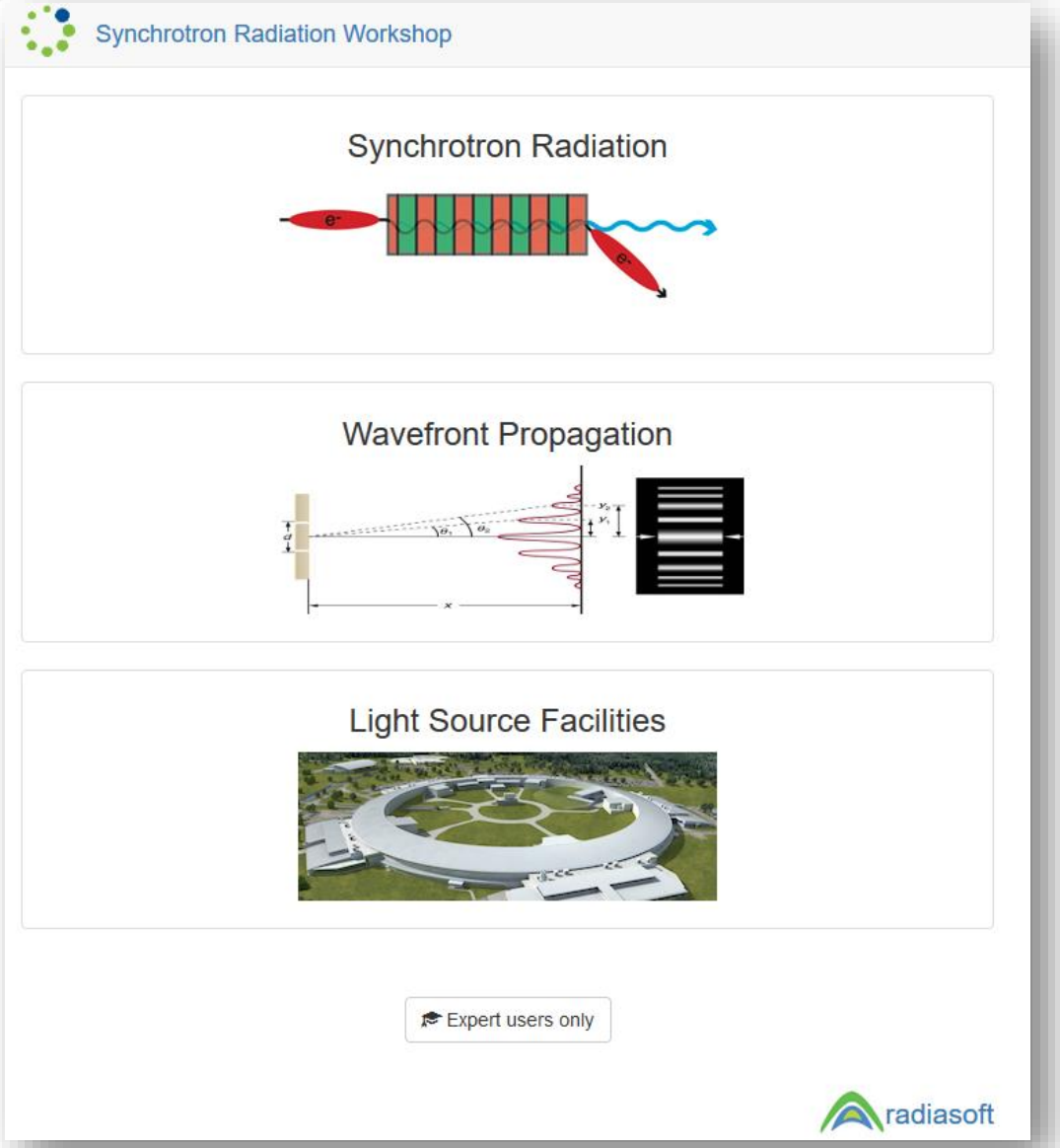
Distribution:

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

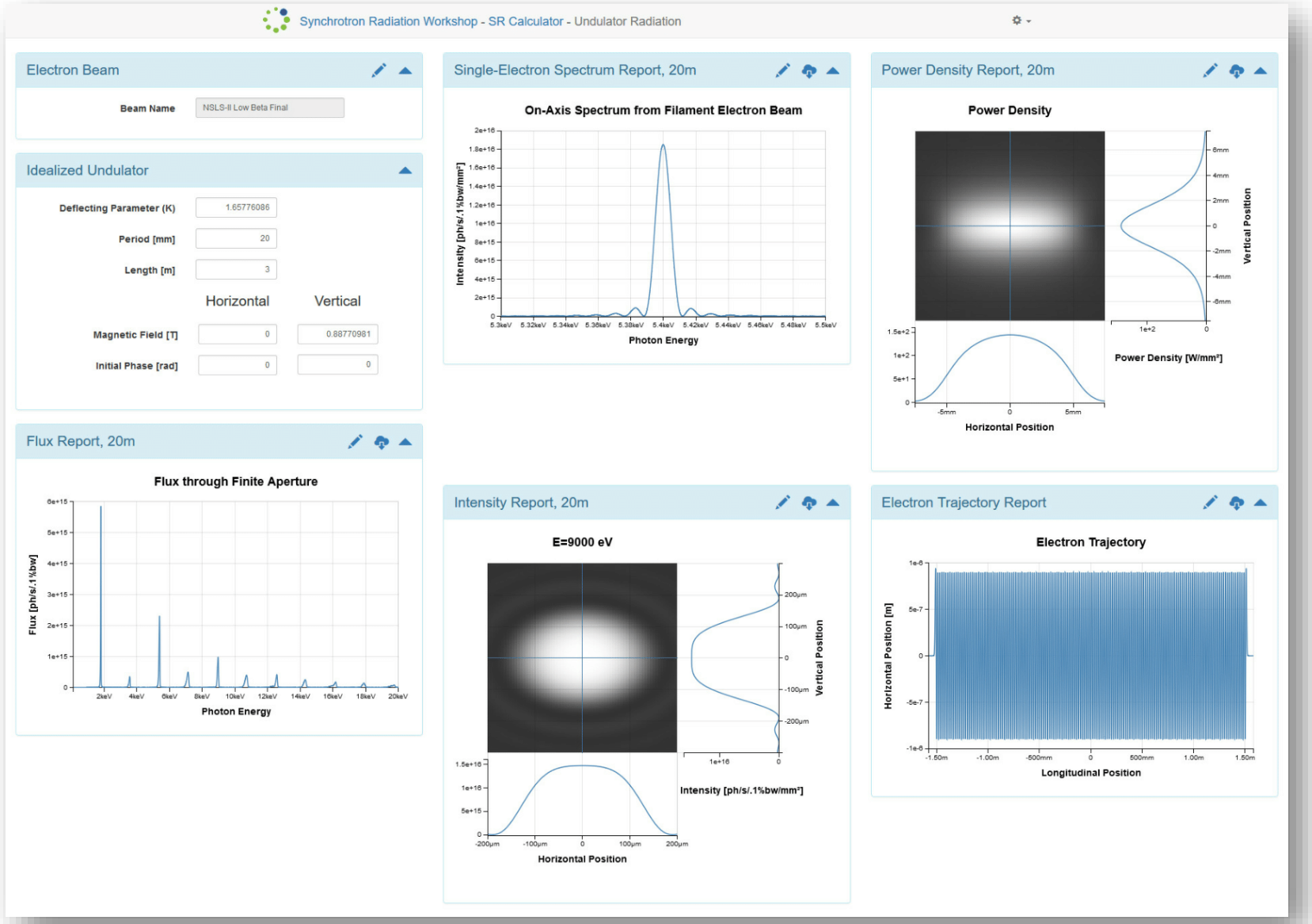
Servers:

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

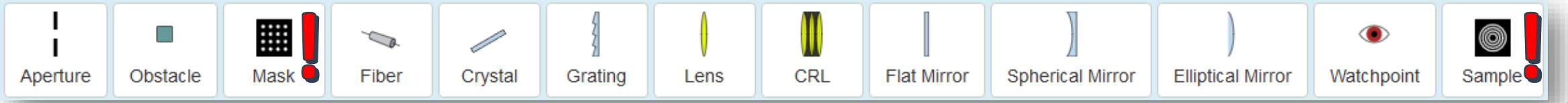
Landing page

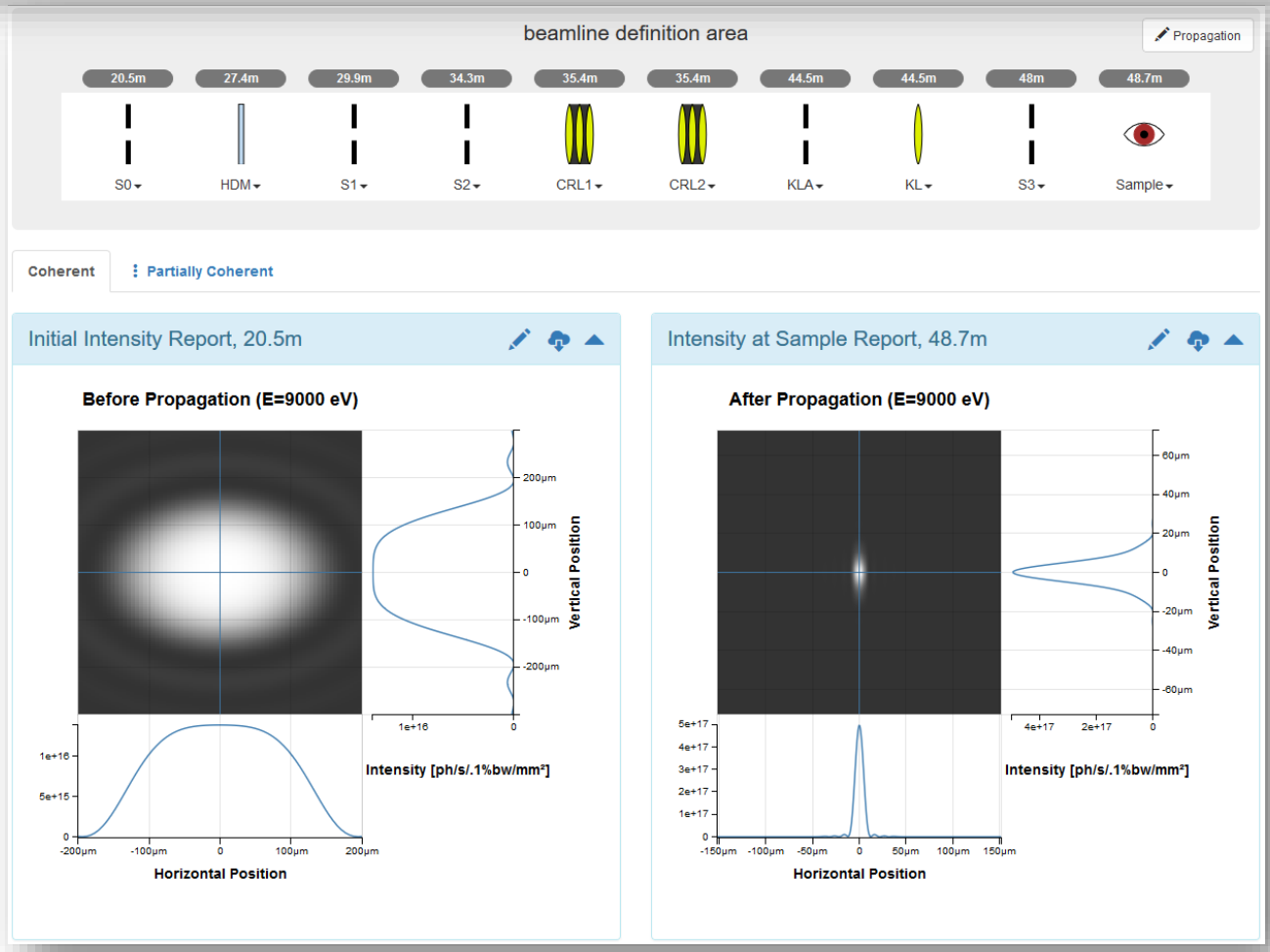


Source page

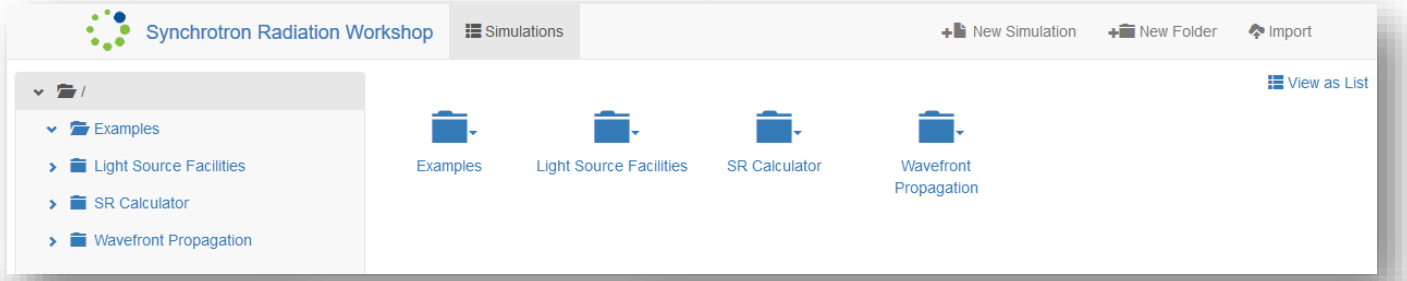

Synchrotron Radiation Workshop - SR Calculator - Undulator Radiation
Electron Beam
Beam Name
NSLS-II Low Beta Final
Idealized Undulator
Deflecting Parameter (K)
1.65776086
Period [mm]
20
Length [m]
3
Horizontal
Vertical
Magnetic Field [T]
0
0.88770981
Initial Phase [rad]
0
0
Flux Report, 20m
Flux through Finite Aperture
Flux [ph/s/.1%bw]
Photon Energy
Single-Electron Spectrum Report, 20m
On-Axis Spectrum from Filament Electron Beam
Intensity [ph/s/.1%bw/mm²]
Photon Energy
Intensity Report, 20m
E=9000 eV
Vertical Position
Intensity [ph/s/.1%bw/mm²]
Horizontal Position
Power Density Report, 20m
Power Density
Vertical Position
Power Density [W/mm²]
Horizontal Position
Electron Trajectory Report
Electron Trajectory
Horizontal Position [m]
Longitudinal Position

Beamline page

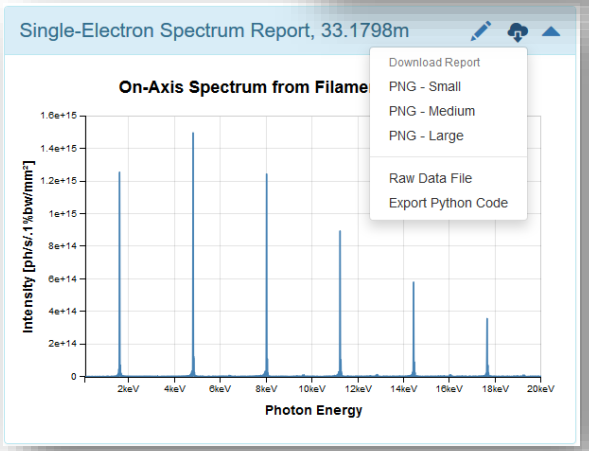


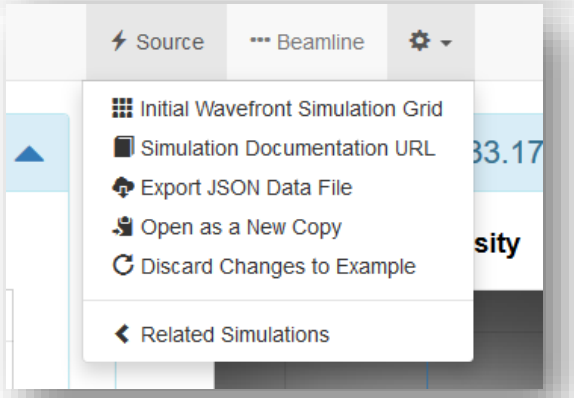


Data storage & exchange

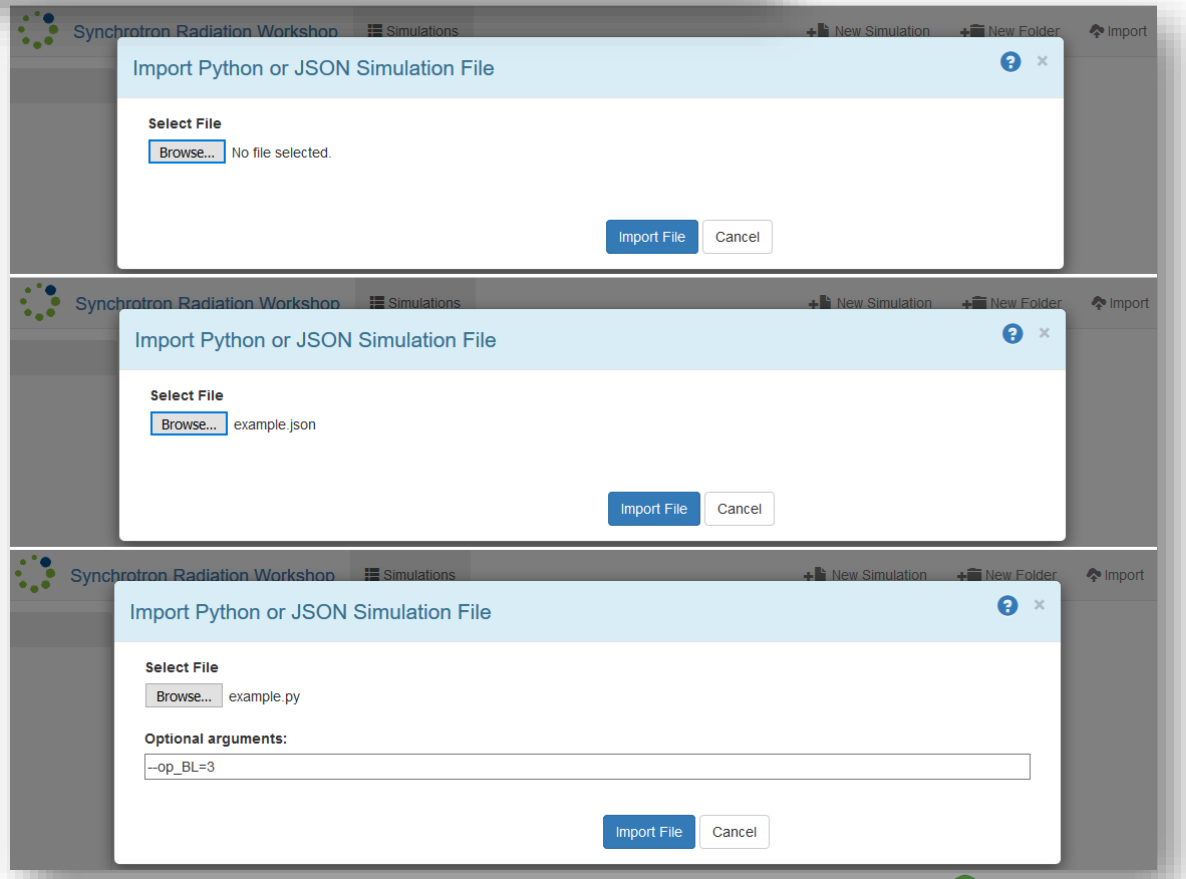


Export:

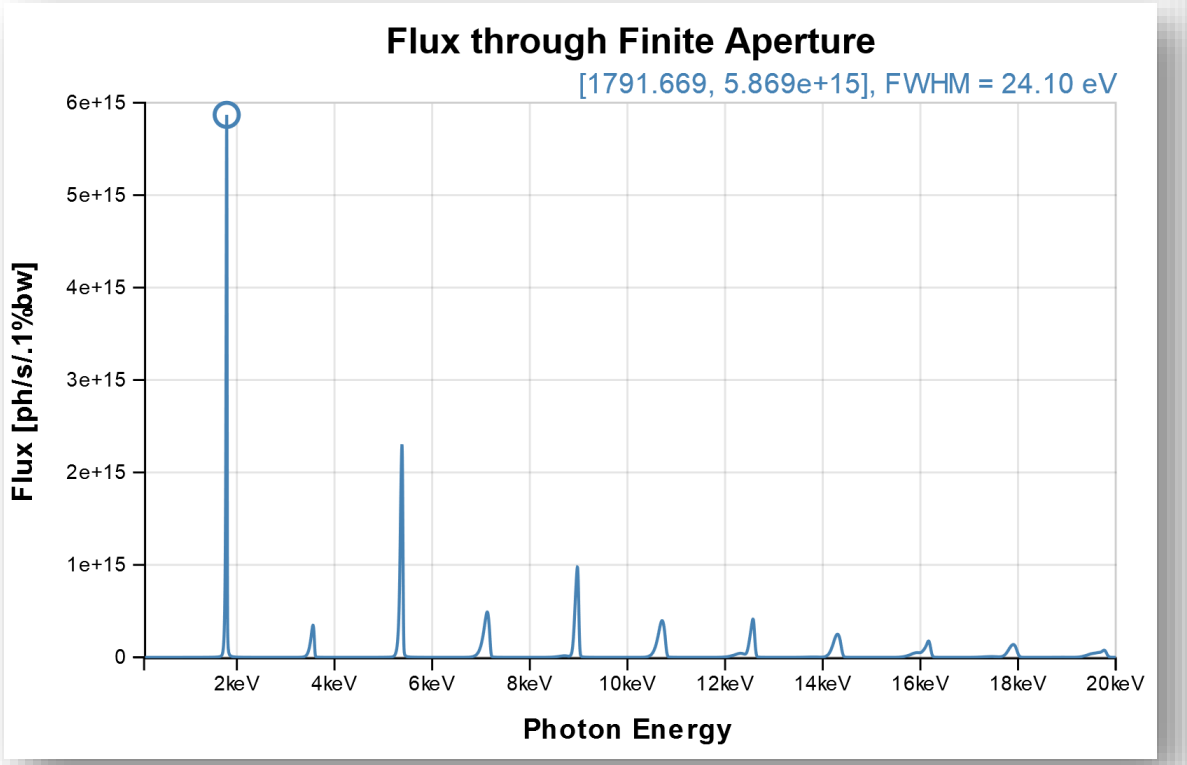


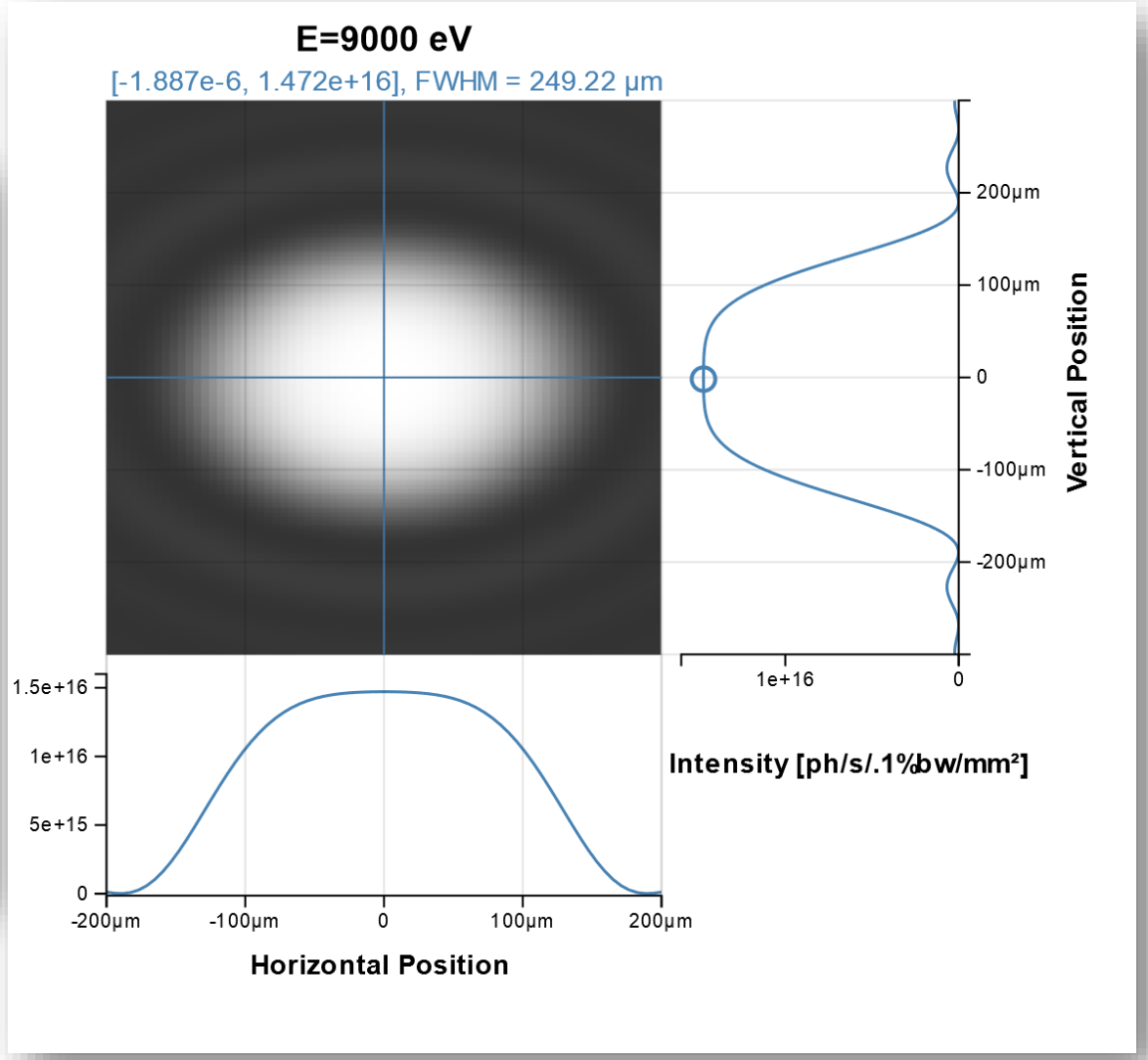


Import:

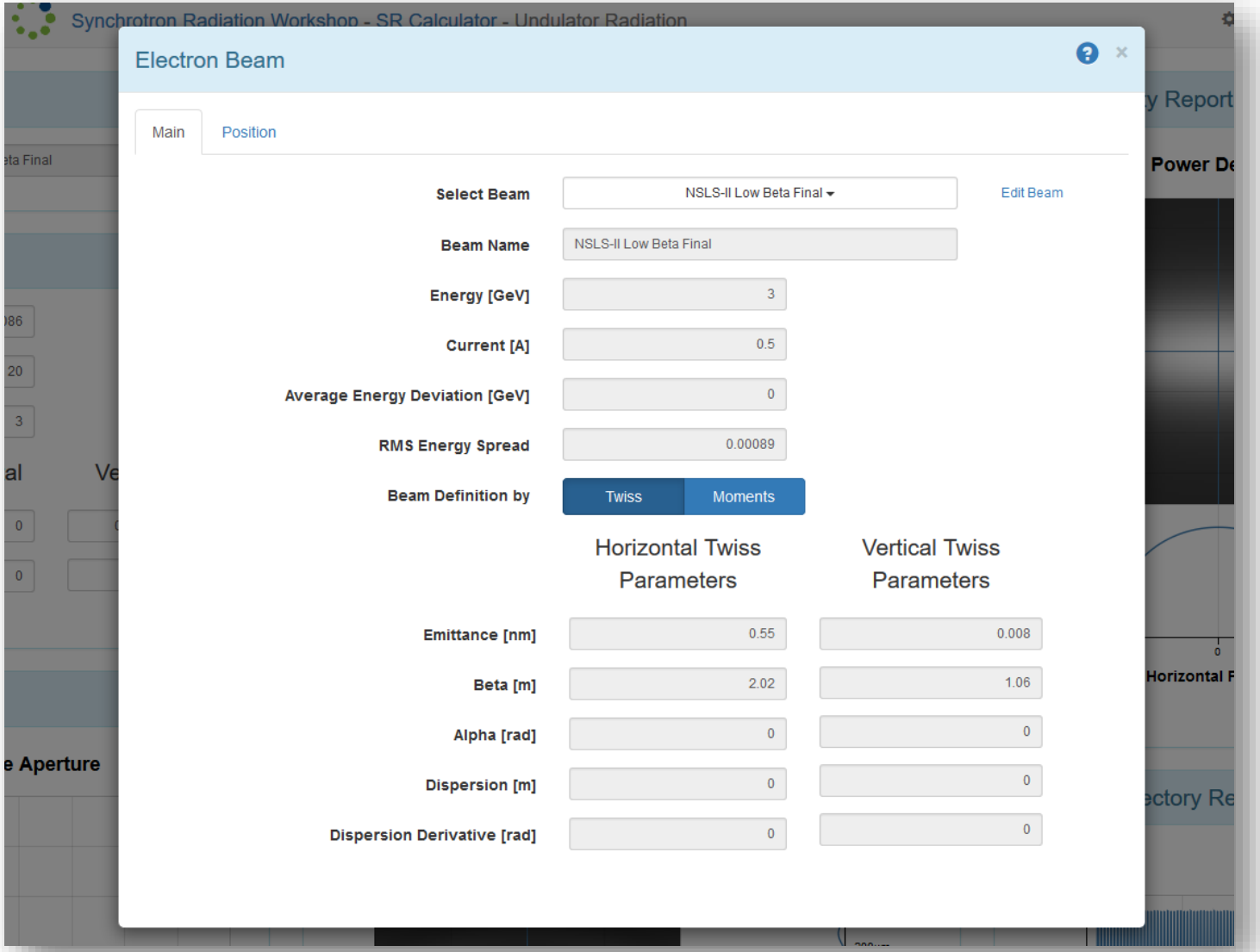


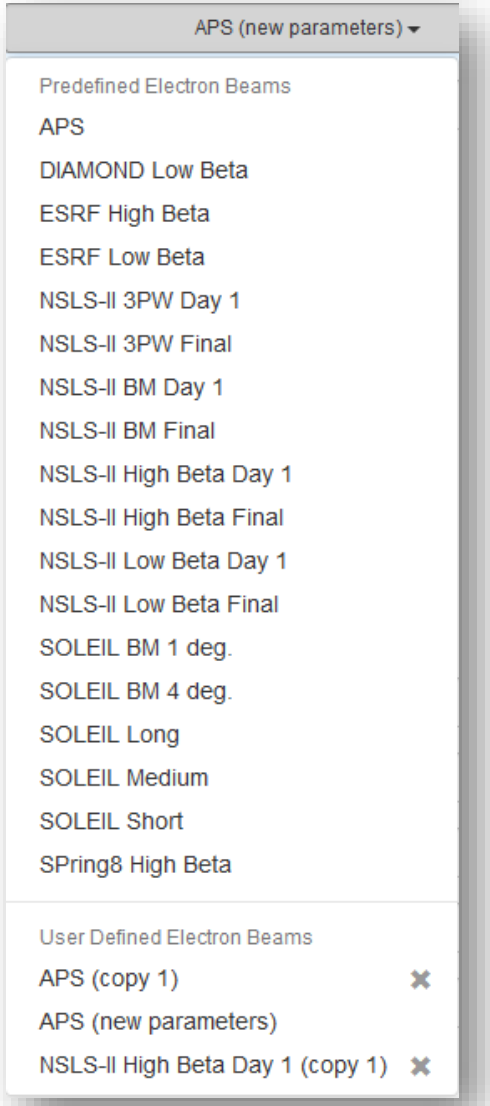
Interactive graphics





Closer to real world (electron beam)





Closer to real world (tab. undulator)

EARLY CAREER RESEARCHER SYMPOSIUM 2016 ECRS BROOKHAVEN NATIONAL LABORATORY

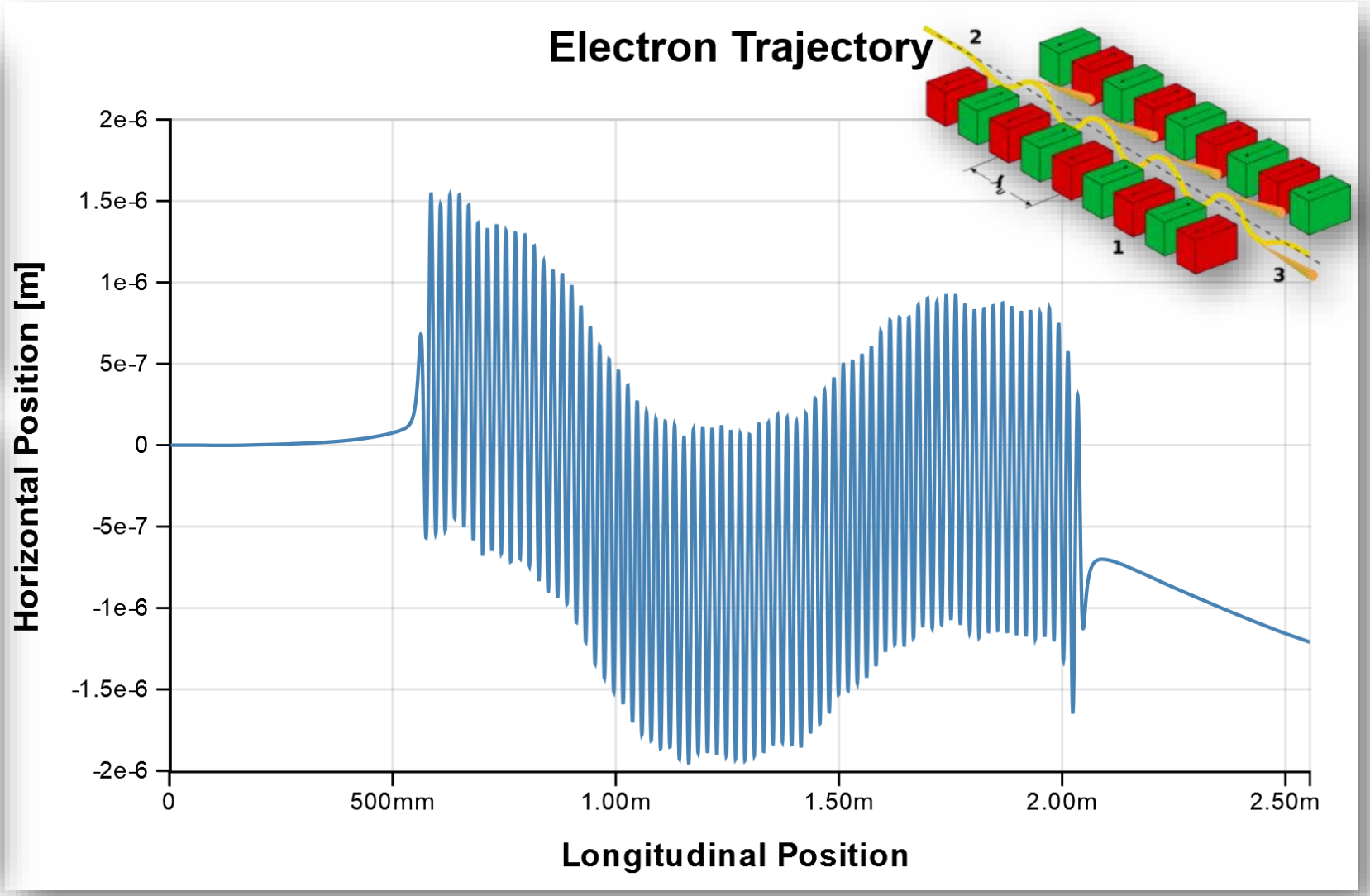
Undulator (Idealized or Tabulated)

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

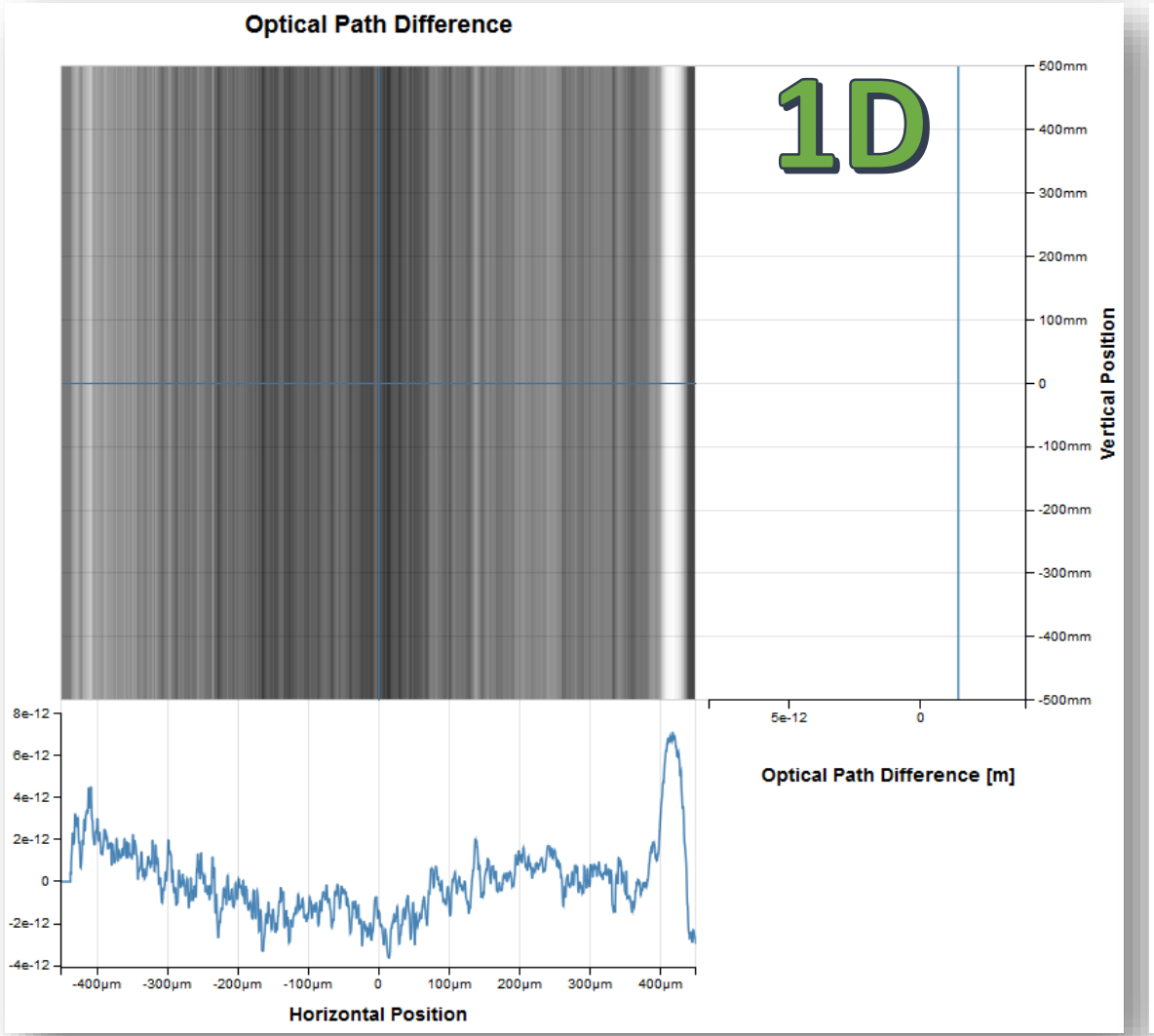
Deflecting Parameter (K)	1.65776086
Period [mm]	20
Length [m]	3
Longitudinal Central Position [m]	0

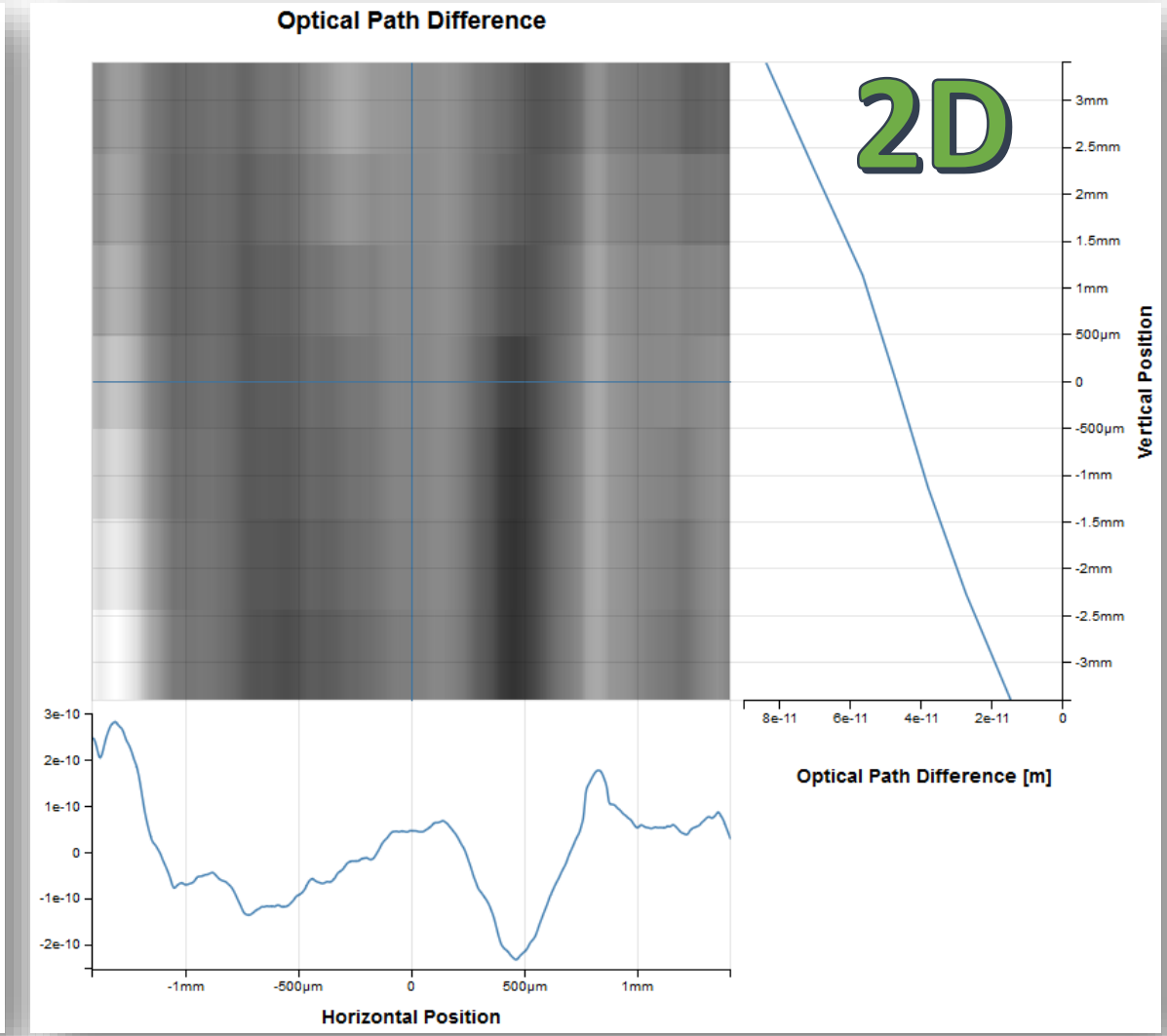
	Horizontal	Vertical
Magnetic Field [T]	0	0.88770981
Initial Phase [rad]	0	0
Symmetry	Symmetrical	Anti-symmetri



Flask ANGULARJS RabbitMQ docker VAGRANT

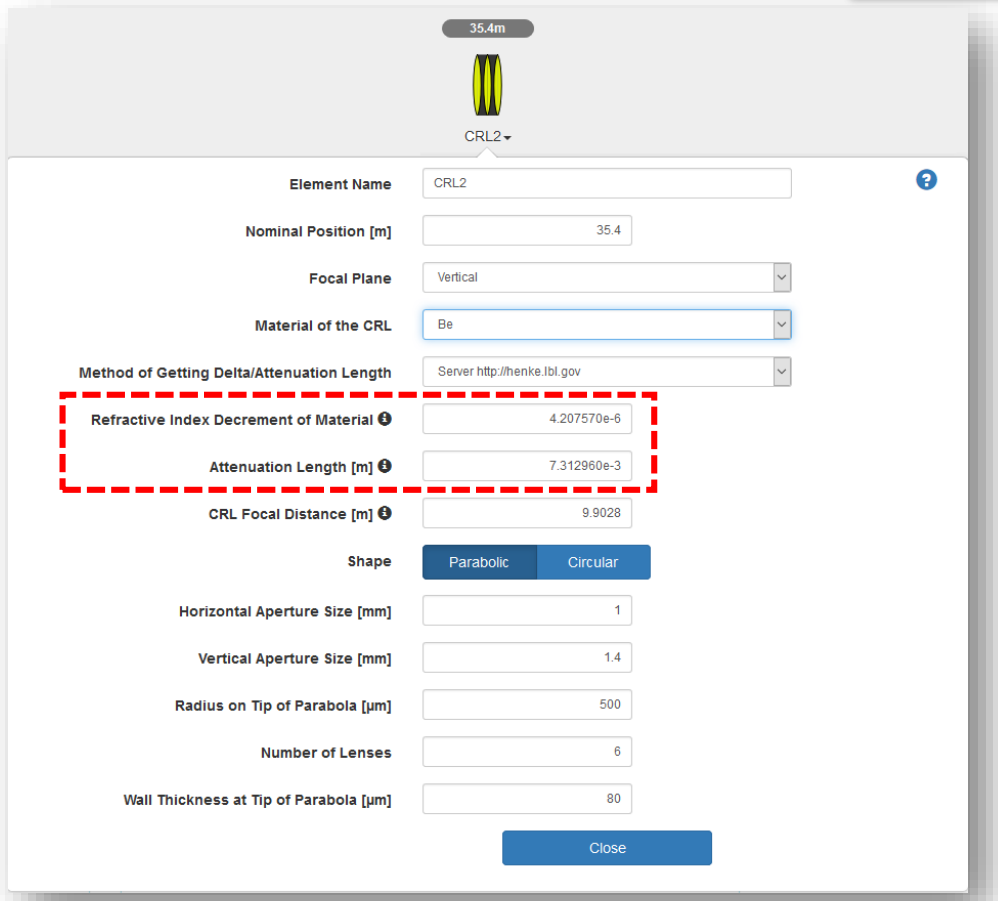
Closer to real world (mirror profiles)

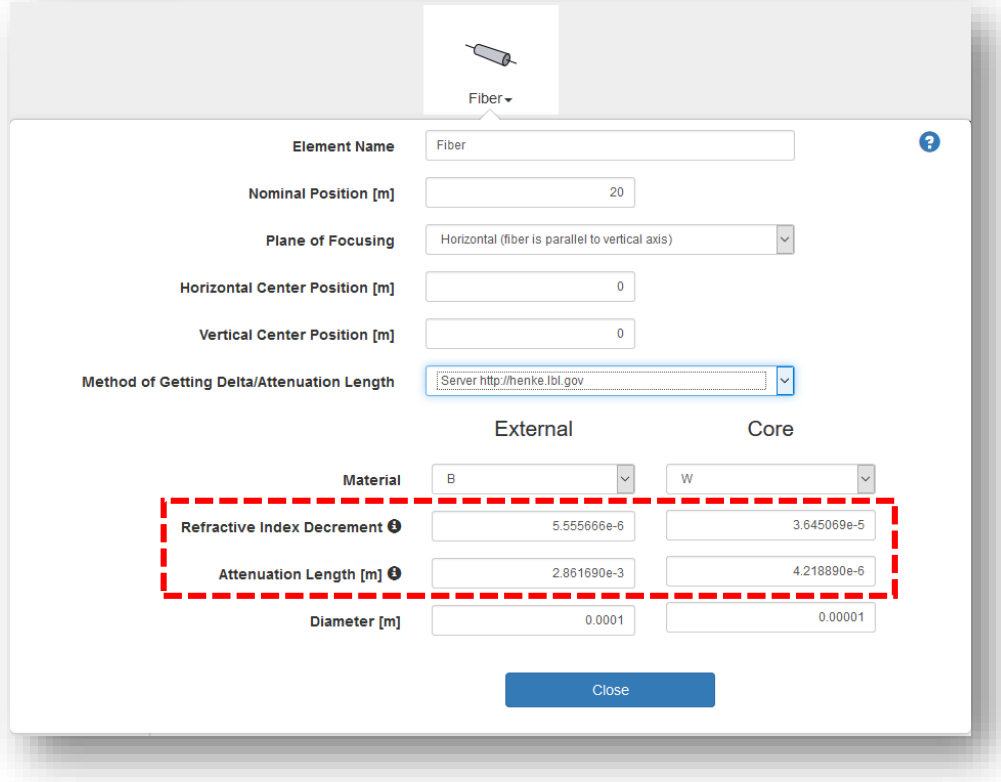




Closer to real world (delta, atten. len.)

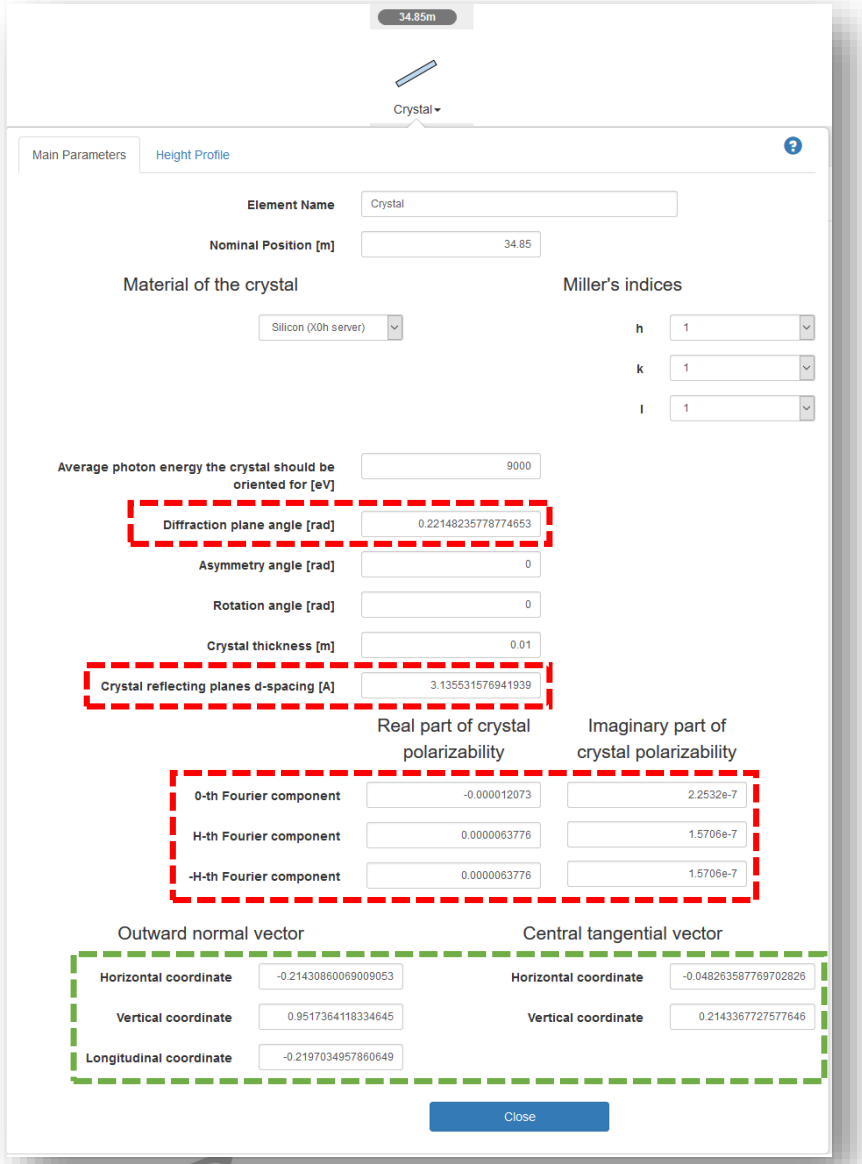
Data is dynamically queried from http://henke.lbl.gov/optical_constants/

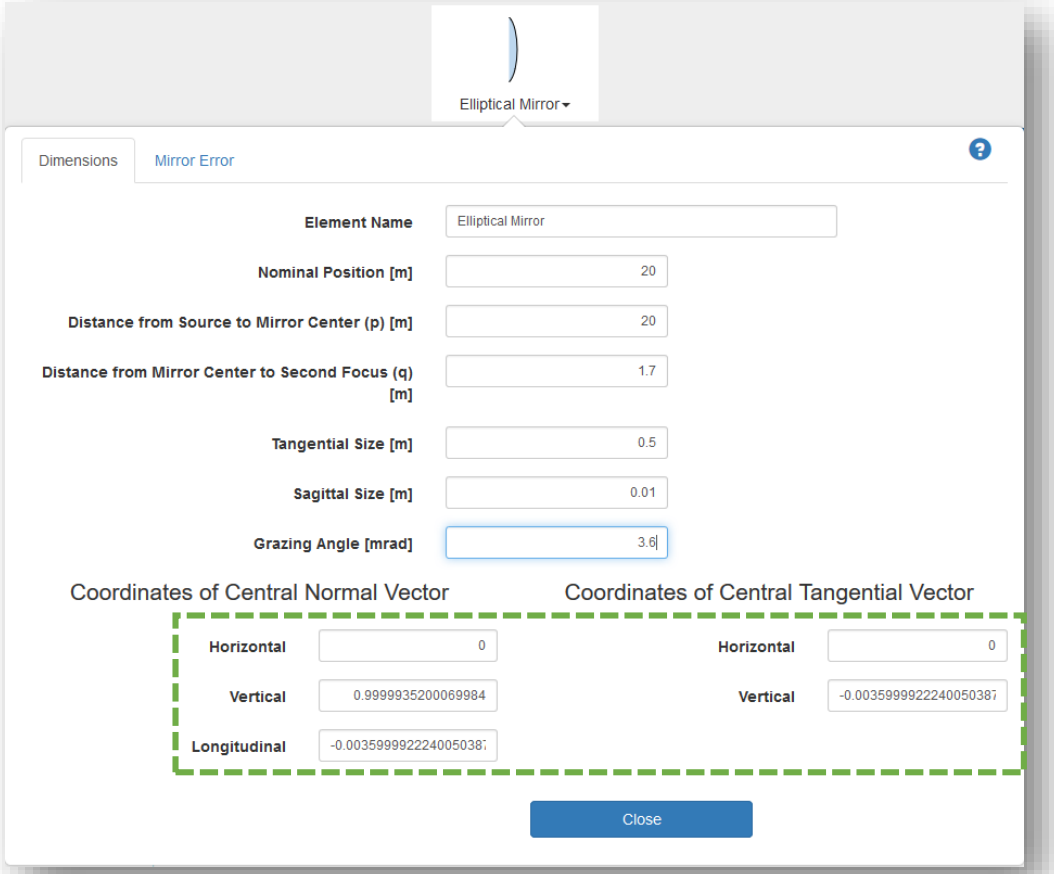




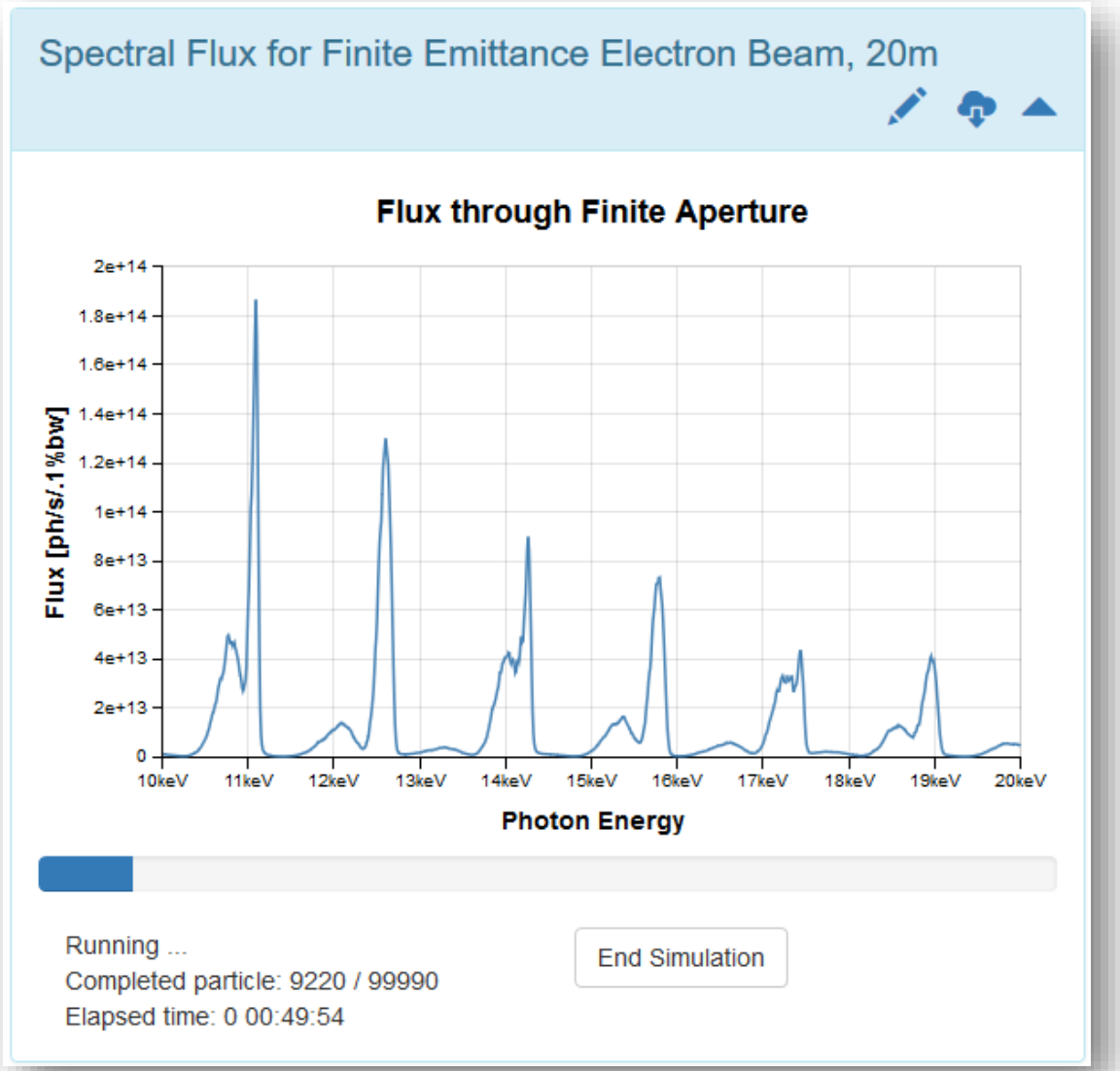
Closer to real world (crystal data)

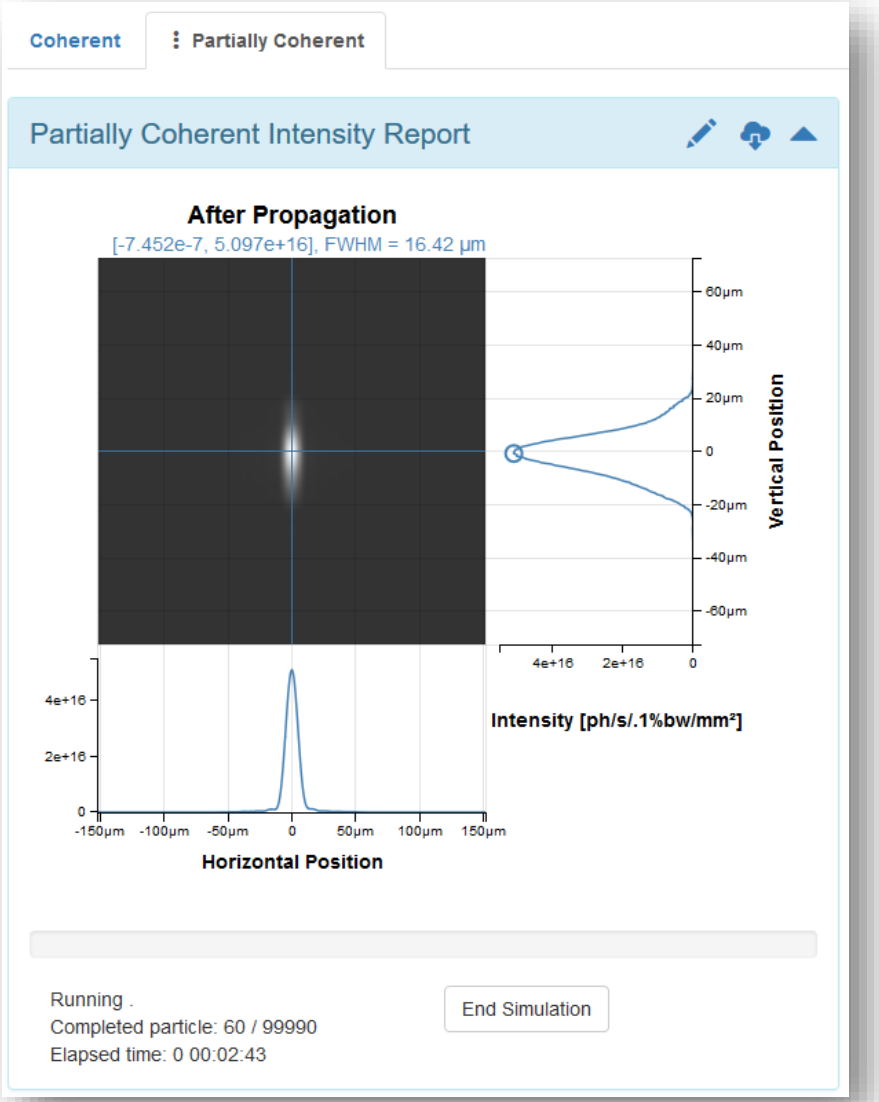
Data is dynamically queried from http://x-server.gmca.aps.anl.gov/x0h.html



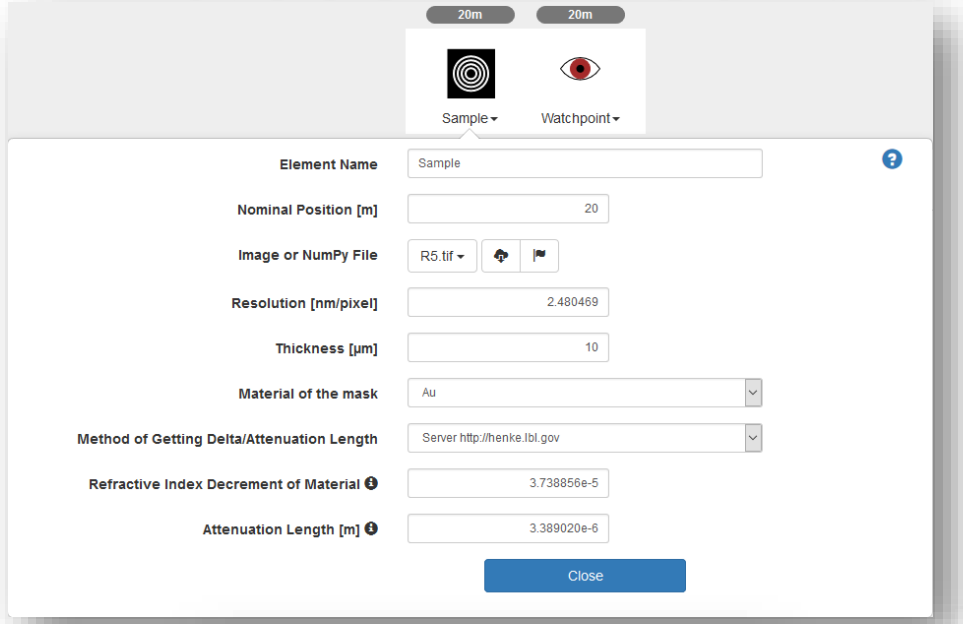


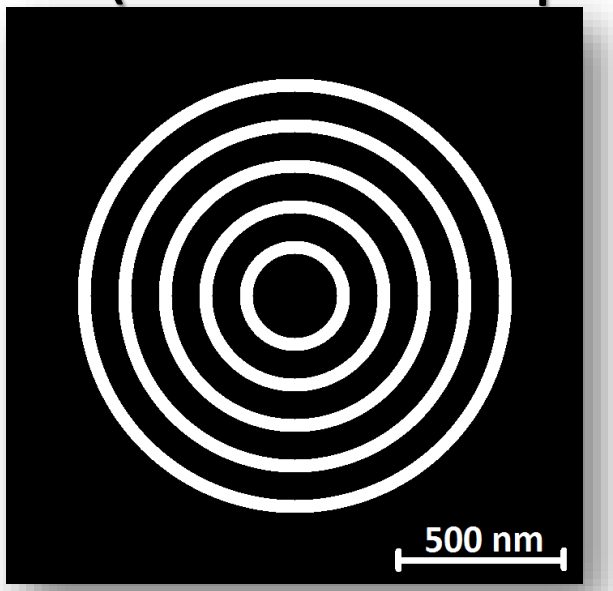
Closer to real world (multi-electrons)

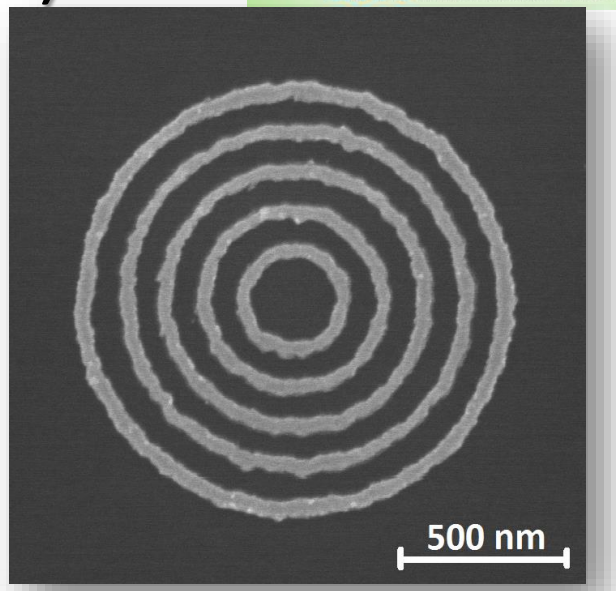


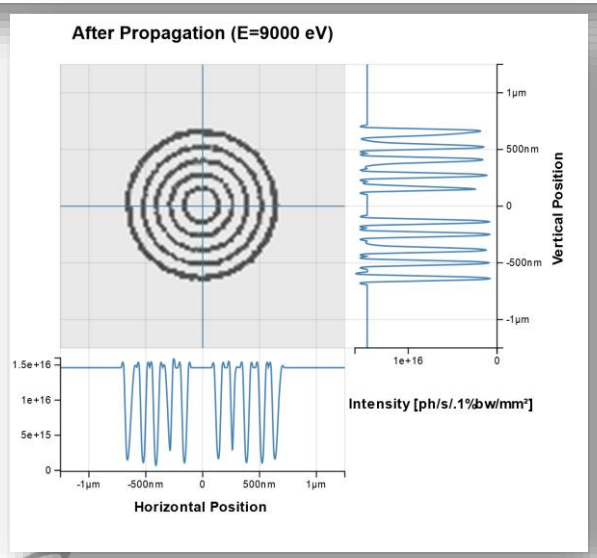


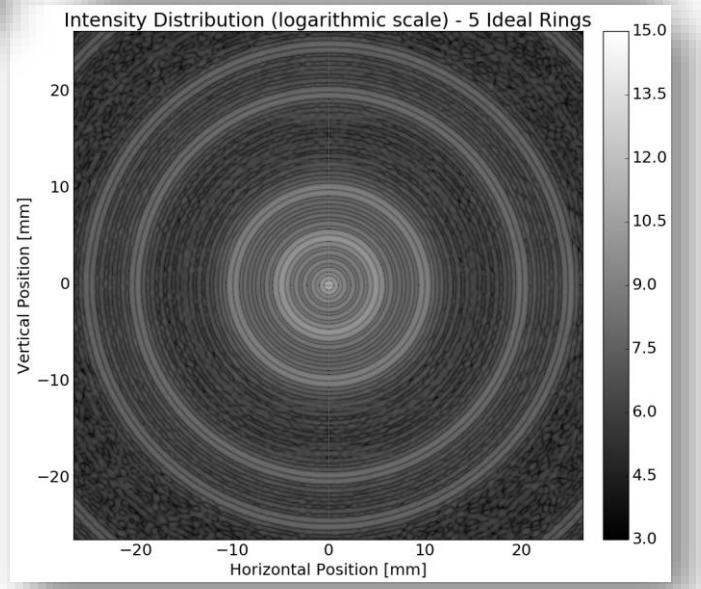
Closer to real world (real samples)

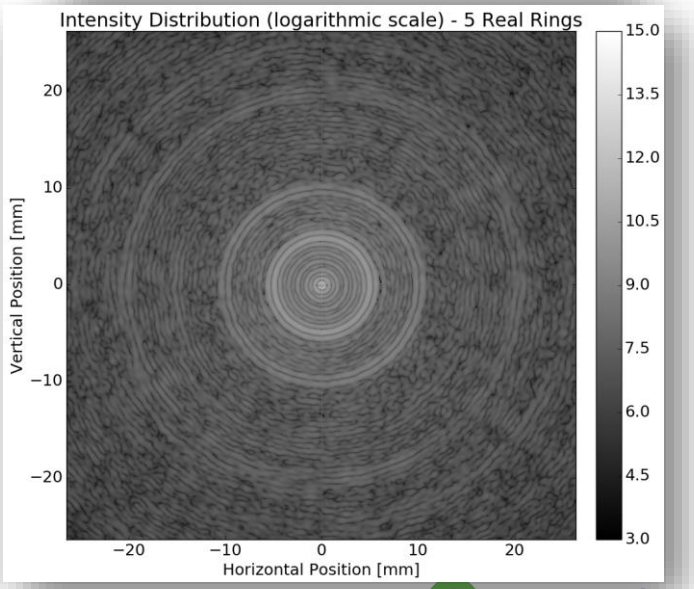












New virtual beamlines

- NSLS-II CHX beamline (idealized and tabulated undulator)
- NSLS-II SMI beamline (low div. and normal div. modes)
- NSLS-II FMX beamline
- NSLS-II ESM beamline
- LCLS SXR beamline
- …

Usage & contributions

Sirepo and SRW are used at the light source facilities around the world:

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

Interested? Try out today:
https://beta.sirepo.com/light

Want to contribute? Fork on Github:
https://github.com/radiasoft/sirepo

Acknowledgements

- My supervisor Dr. Oleg Chubar (Tchoubar) (NSLS-II, BNL)
- Collaborators from RadiaSoft LLC:
  - David Bruhwiler
  - Rob Nagler
  - Paul Moeller
- Mikhail Zhernenkov (NSLS-II, BNL)
- Julien Lhermitte (CFN, BNL)
- Many other people who assisted and helped me.
- This work is supported in part by the US DOE Office of Science, Office of Basic Energy Sciences under SBIR awards DE-SC0006284 and DE-SC0011237.


Thank
You
Dank u wel
Merci
Grazie mille
Gracias
Arigato
Mahalo
Juspaxar
Spasibo
Efcharisto
Salamat
Toda raba
Cám ơn
Dhanyawaad
Köszi
Shukria
Kamsahamnida
Biyan
Shukuria
Dankon
Pidamayado
Tusen takk
Terima kasih
Tashakkur
bolzïn
suksama
Maake
gozaimashita
atu
Tingki
Komapsumnida
Paldies
Mehrbani
Ekhmet
Tesekkurler
Yaqhanyelay
Obrigado
Dankscheen
Khawp khun
Doh je
Dhanyabaad
Yuspagrasunki