

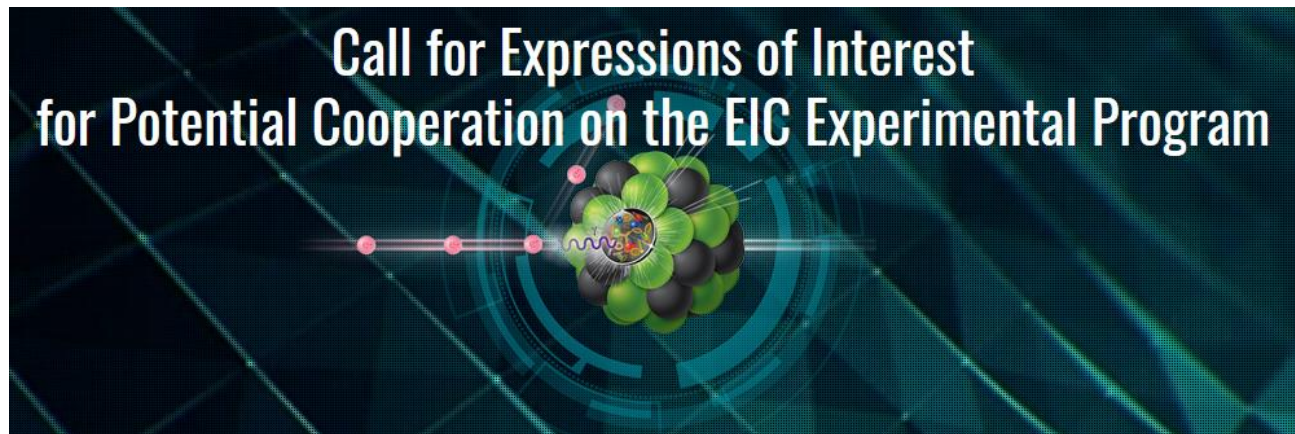
The Sirepo framework – a case study in scientific cloud computing

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Software Needs – requirements

- The relevant time scale is decades
 - design → commissioning → operations → upgrades
- This imposes severe requirements on software developers
 - Reproducibility
 - simulations from the design phase must be reproducible 10 or 20 years later
 - Sustainability
 - with limited resources, sustainability & efficiency must be emphasized
 - Training & education
 - students must be recruited to join the field (software & computation)
 - new contributors (e.g. software users) must be trained efficiently
 - Cloud computing
 - in the covid-19 era, a cloud computing approach should be emphasized

Software Needs – technologies & techniques

- Software containerization
 - Docker → Shifter (at NERSC) & other HPC container technologies
- Cloud computing
 - The browser becomes the ubiquitous scientific UI
 - web browsers have become powerful just-in-time compilers
 - open source JavaScript libraries facilitate success (viz, cross-platform, ...)
 - Server-side development is complex
 - capable developers are not easy to recruit and retain

Meeting Needs – what can your group contribute?

- Software Engineering
 - cloud computing
 - distributed computing
 - browser-based GUIs
- Physics & Data Science
 - computational physics
 - parallel computing
 - machine learning
 - particle accelerators
 - plasma devices
 - control systems
- Science writing & product management

Rob Nagler



Paul Moeller



Evan Carlin



Mike Keilman



David Bruhwiler



Nathan Cook



Jon Edelen



Stephen Webb



Boaz Nash



Stephen Coleman



Chris Hall



Callie Federer



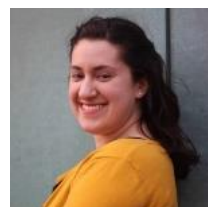
Xi Tan



Ilya Pogorelov



Remy Poore



Paula Messamer



The Sirepo framework – a case study

- To date, funded work has emphasized particle accelerator technology
 - parallel simulation and design of accelerators
 - multiple codes; similar UI for each; developing interoperability
 - magnet design; synchrotron radiation & X-ray optics
 - in development / soon to appear
 - 3D MHD plasma simulations; ML toolbox; control system algorithm design
- In most cases, we are supporting community codes
 - Containerization & UI development do not impact the physics development team
- RadiaSoft is committed to an open source business model
 - containers freely distributed via <https://hub.docker.com/u/radiasoft>
 - software is openly developed via <https://github.com/radiasoft>

D.L. Bruhwiler *et al.*, “Knowledge Exchange Within the Particle Accelerator Community via Cloud Computing,” in *IPAC* (2019) ; <https://accelconf.web.cern.ch/ipac2019/papers/thpmp046.pdf>

M.S. Rakitin *et al.*, “Sirepo: an open-source cloud-based software interface for X-ray source and optics simulations,” *Journal of Synchrotron Radiation* **25**, 1877 (2018); <https://doi.org/10.1107/S1600577518010986>





M.S. Rakitin *et al.*, “Introduction of the Sirepo-Bluesky interface and its application to the optimization problems,” *Advances in Computational Methods for X-Ray Optics*, *Proc. of SPIE* **11493**, 1149311 (2020).









Sirepo is an open framework for cloud computing


<https://github.com/radiasoft/sirepo>

https://github.com/radiasoft/sirepo 110% ...






Pull requests Issues Marketplace Explore

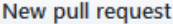
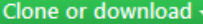
 **radiasoft** / **sirepo**  Unwatch 20  Star 35  Fork 20


 Code  Issues 406  Pull requests 3  Projects 0  Wiki  Security  Insights  Settings






Sirepo is a framework for scientific cloud computing. Try it out! <https://sirepo.com> 

[Manage topics](#)

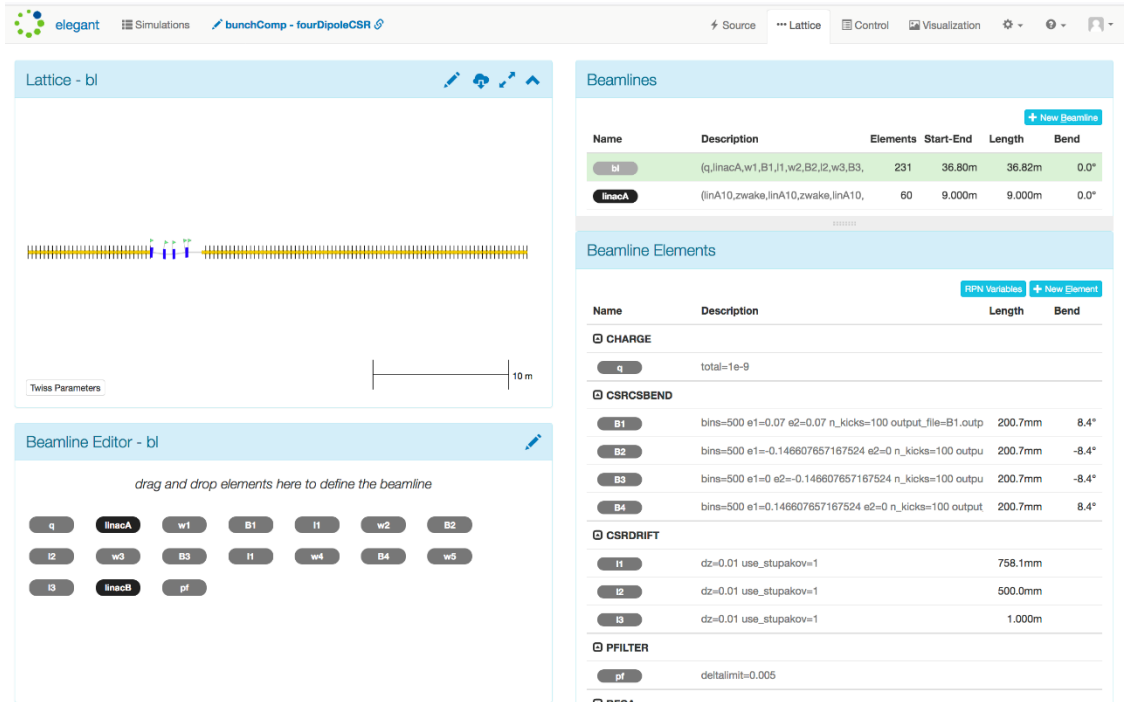
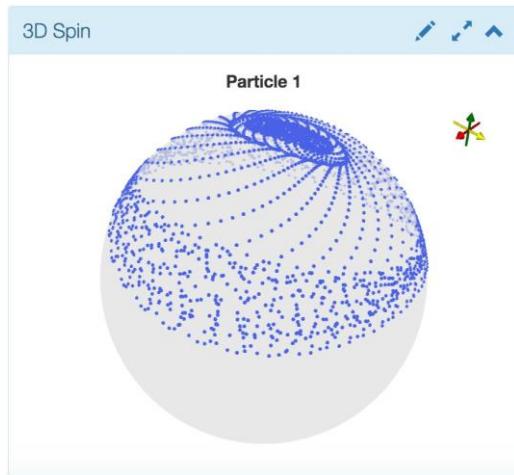
 4,105 commits  30 branches  0 releases  11 contributors  Apache-2.0

Branch: master  Create new file Upload files Find File 

 **moellep** fix #1885 redirect from login URL is already logged in as a non-guest... Latest commit d0a2538 28 minutes ago

 container-conf	New landing pages: merged from beta3 branch	4 months ago
 docs	docs/.gitignore and improved README	3 years ago
 etc	Fix #1820 NavController_test commented out	last month
 misc	expunge.sh	2 years ago
 sirepo	fix #1885 redirect from login URL is already logged in as a non-guest...	28 minutes ago

Sirepo is a free scientific gateway



- Many supported Codes

- shared JavaScript UIs
- shared containerization technology

- The power of Sirepo for users

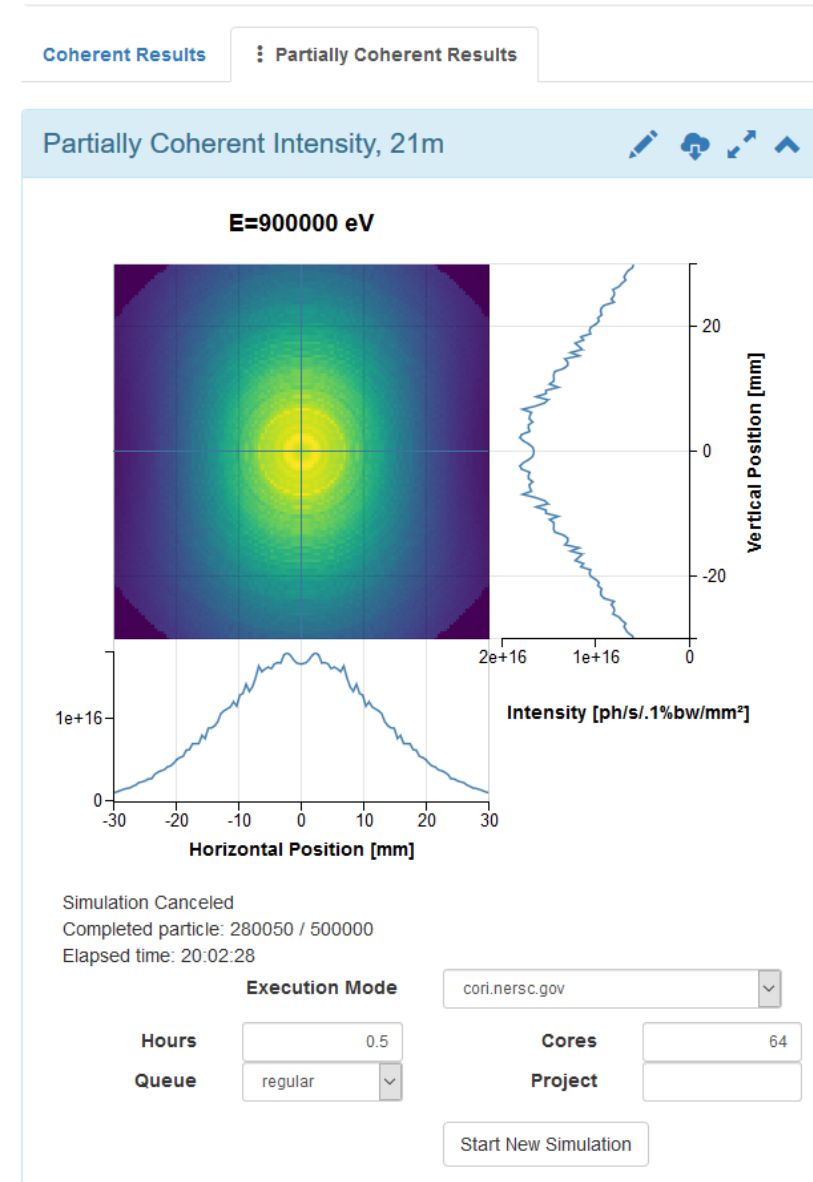
- Ease of use: nothing to install, build, or maintain
- Instantaneous collaboration: share your work with a single link
- Archive and save simulations: resume work a year later with zero start-up time
- The GUI is not a trap: export files for command-line execution

<https://sirepo.com>

Sirepo enables single-click supercomputing

- Example: partially-coherent X-ray optics

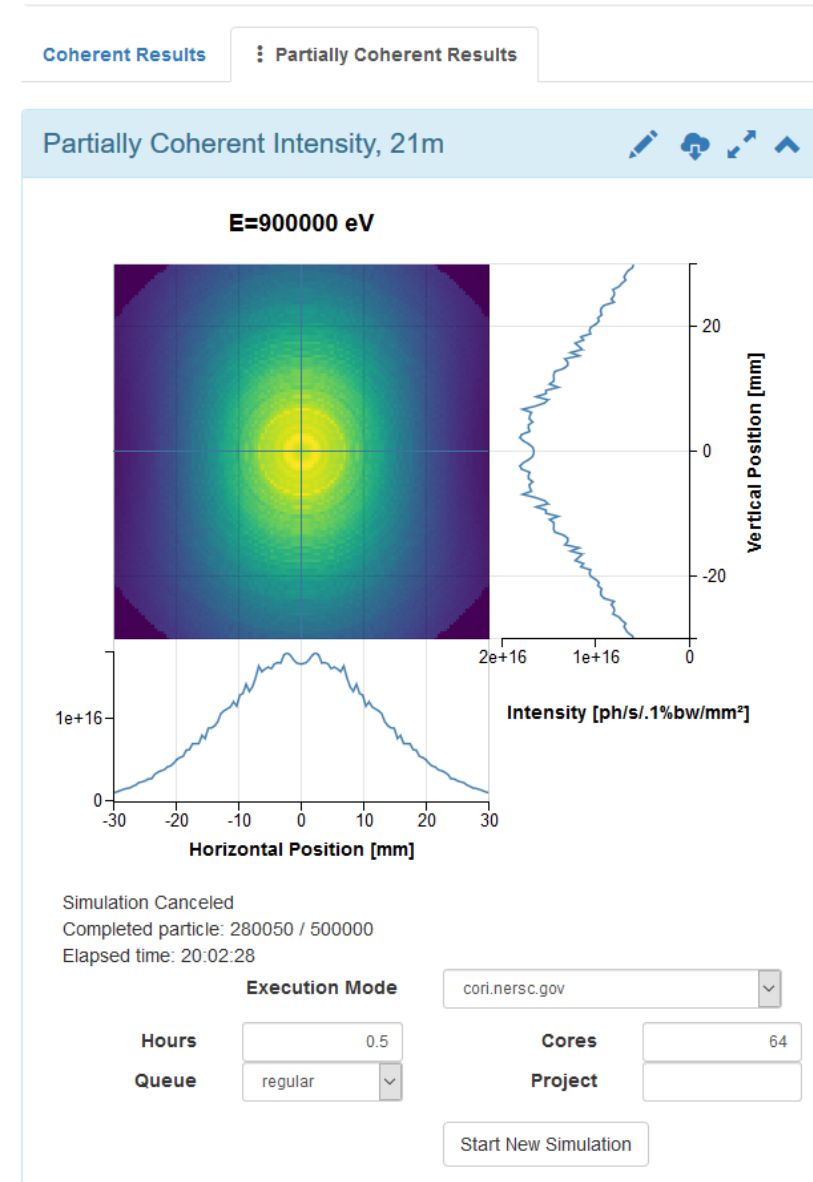
- user must enter login credentials
 - supports 2-factor authentication
- Docker containers on Sirepo servers
Shifter containers used at NERSC
- not all codes are supported yet



Sirepo enables single-click supercomputing

- Example: partially-coherent X-ray optics

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RadiaSoft also supports a JupyterHub gateway

https://jupyter.radiasoft.org

```
[42]: plt.figure(figsize=(15,2))
plt.subplot(1,2,1)
plt.hist(settings_array[:,0],bins=100)
plt.xlabel('Phase (deg)')
plt.ylabel('Counts')

plt.subplot(1,2,2)
plt.hist(settings_array[:,3]/(10**6),bins=100)
plt.xlabel('Amplitude (MV)')
plt.ylabel('Counts')
plt.show()
```

Plot longitudinal phase space data at the end of the beamline. The settings changed by errors are displayed in a table.

- Jupyter notebooks provide an HPC sandbox
 - all the Sirepo codes are pre-installed, together with standard ML tools
 - export all files with a valid Python script from Sirepo → they run on Jupyter
 - work from the command line or from a notebook; use your own workflow
- Our Jupyter server is actively used by RadiaSoft & the community
 - like Sirepo, it is used in every session of the US Particle Accelerator School