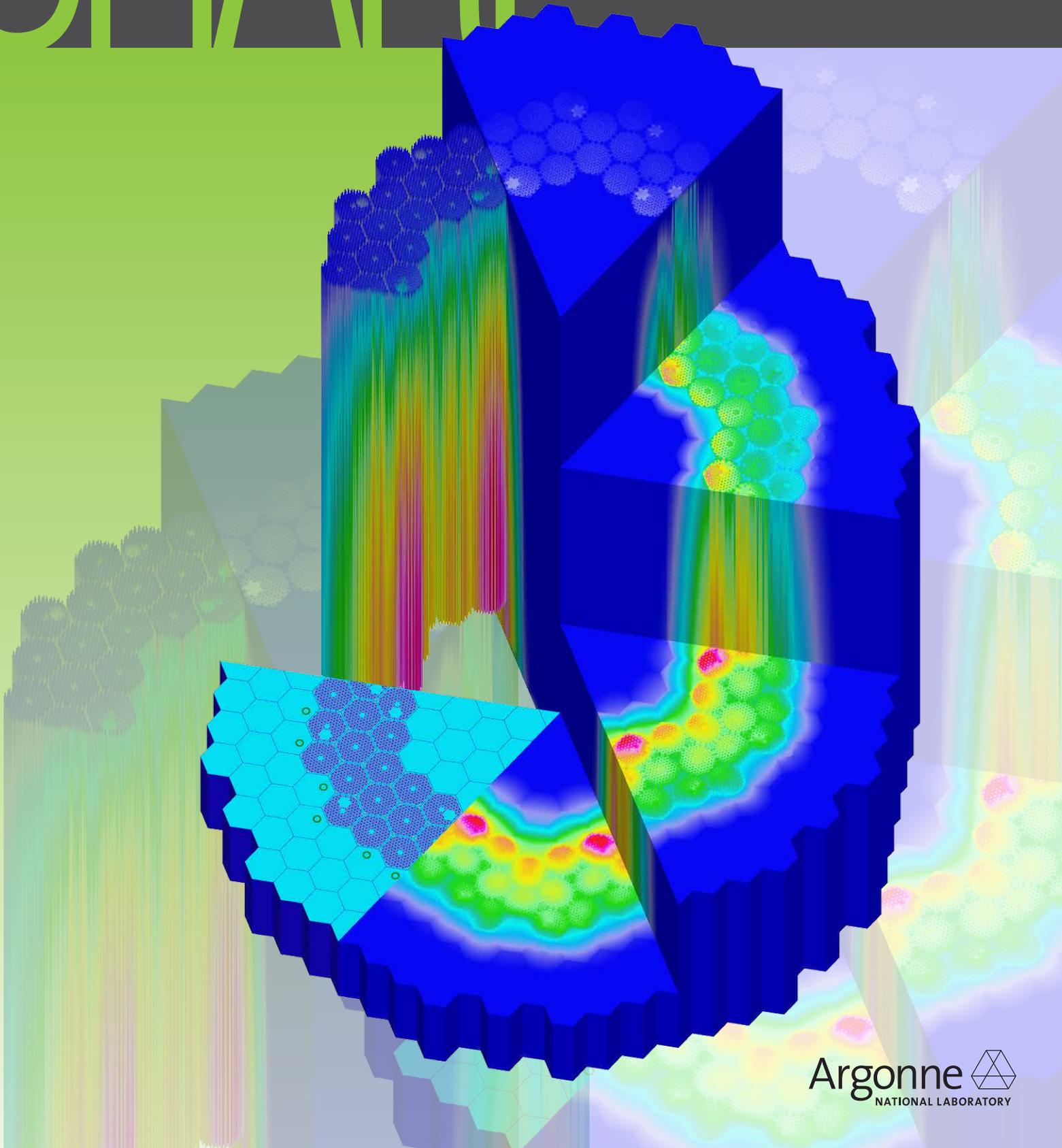


SHARP

Argonne National Laboratory's

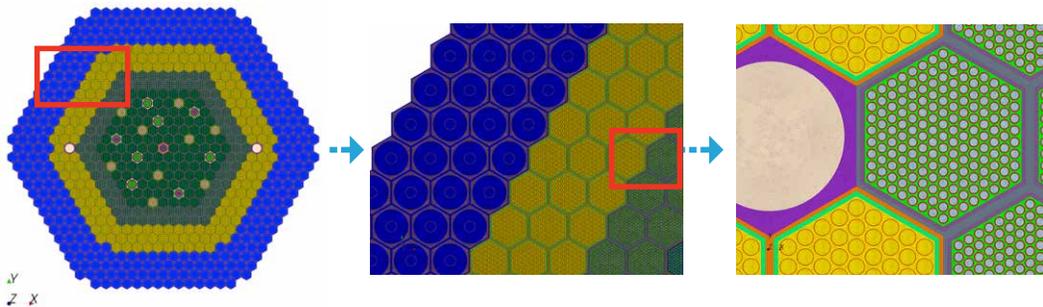
Advanced Reactor
Core Analysis and
Component Design
Toolkit



SHARP applies modern, high-performance computing to improve accuracy, allowing reduced conservatism

It helps understand and reduce the uncertainties in conventional

A flexible, mission-agile toolbox for construction of advanced



◀ A significant challenge in reactor core design and analysis is creating a computational mesh that accurately describes the complex reactor geometry. SHARP's MeshKit module can generate reactor core geometries and meshes systematically.

Introducing the SHARP Suite

The U.S. Department of Energy's Nuclear Energy Advanced Modeling and Simulation (NEAMS) Program aims at development of high-fidelity computational methods to support deployment of safe, secure, sustainable and economical nuclear power technologies. The goal of the NEAMS Program Reactor Product Line is to simulate key phenomena involved in reactor core design and analysis by employing mechanistic models to replace empiricism and correlations embedded in conventional codes. Following multi-year efforts for development of coupled neutronics, computational fluid dynamics (CFD) and computational structural mechanics (CSM) analysis capabilities, the NEAMS Reactor Product Line released the SHARP multi-physics toolkit in March 2016.

SHARP is a suite of computational framework components and physics modules that include heterogeneous neutron transport in exact geometries, three-dimensional thermal-fluid analysis and finite element structural mechanics analysis capabilities. With the SHARP ToolKit, users can construct

models that integrate the governing physics to evaluate a nuclear reactor's performance. Alternatively, SHARP users may construct highly detailed component models using high-fidelity methods to reduce the reliance on low-resolution engineering models. SHARP harnesses the power of commercial-scale computing platforms of today while pursuing the development of highly scalable algorithms to take advantage of supercomputers available at the national laboratories.

SHARP builds upon the experience gained in Argonne's established history of both developing novel reactor physics methods and applying the tools to support advanced reactor design and safety analysis. As the next-generation suite of computational tools, SHARP aims to enable developers to pursue bold design choices without the constraints imposed by conventional system analysis tools. It also aims to support making the safety case for new reactor concepts by adding an additional level of scientific rigor to quantitative analysis.

Ongoing validation and verification efforts provide confidence in SHARP's predictive analytical capabilities to represent the actual reactor performance reliability and with a much greater level of detail than that is achievable with conventional tools and methods. Trustworthy predictions from SHARP can then supplement the experimental database—which may be sparse for innovative reactor concepts—to inform and calibrate the faster running, but more approximate models available in the conventional tools. Relying on high-fidelity, science-based methods that do not require calibration tied to a specific reactor application, SHARP is largely technology-neutral and can be applied to virtually any type of reactor.

Computing techniques to nuclear reactor modeling to provide conservative margins and improved safety assurance.

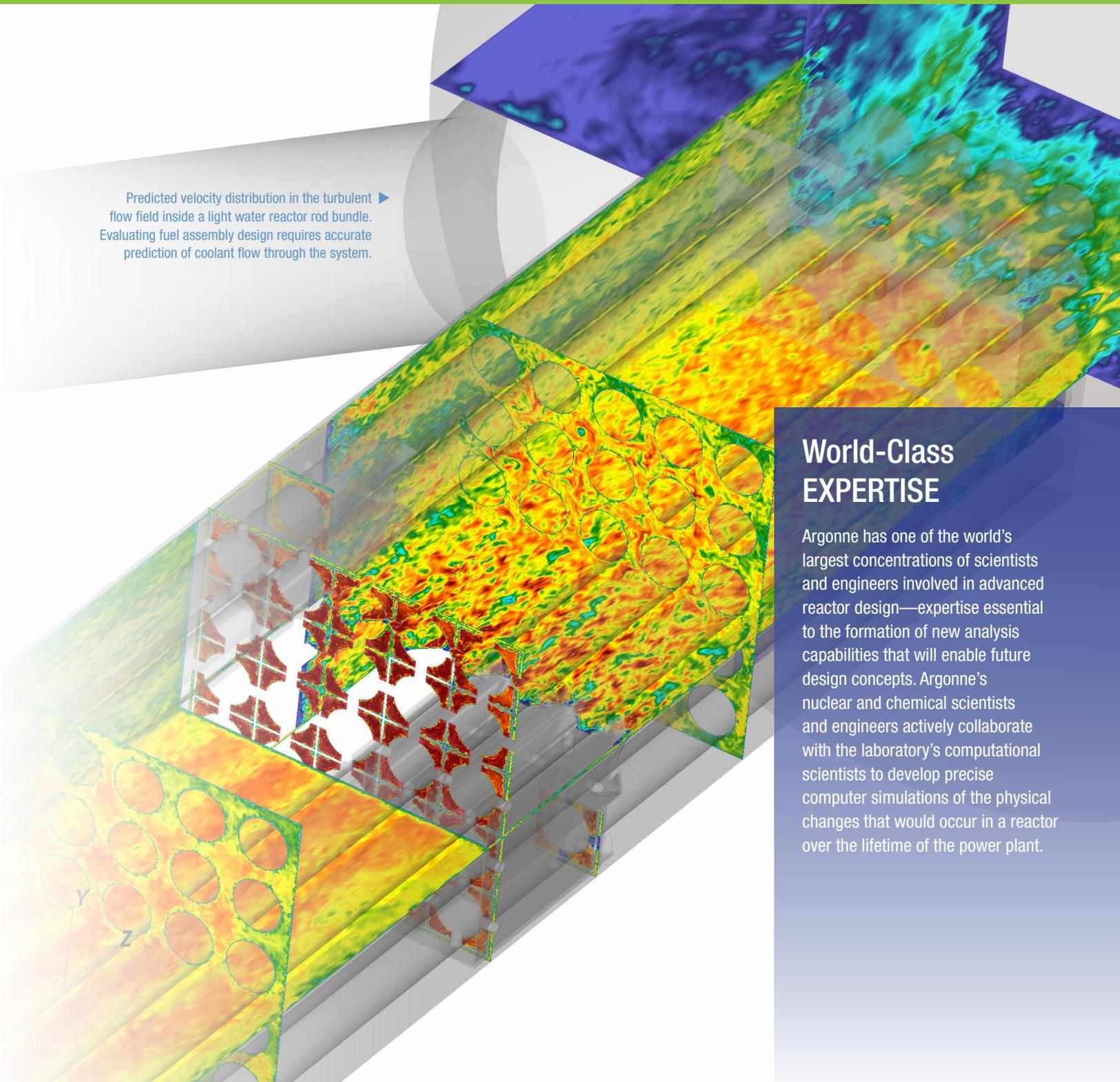
Advanced computational models.

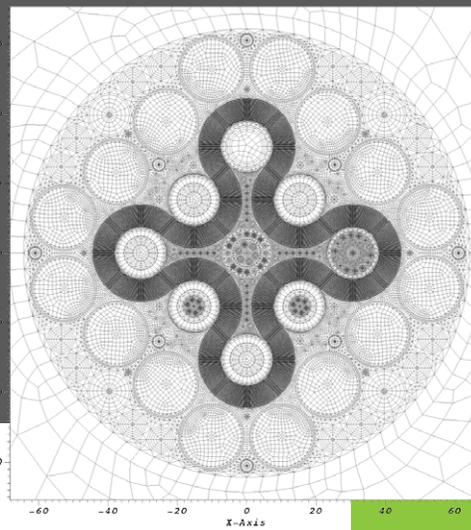
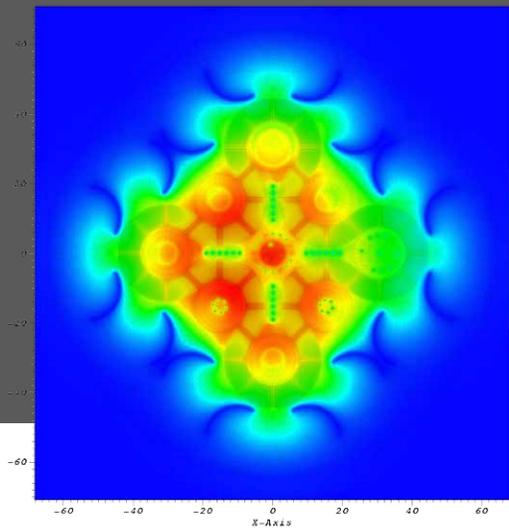
Simulating reactor models on high-performance computing platforms.

Predicted velocity distribution in the turbulent flow field inside a light water reactor rod bundle. Evaluating fuel assembly design requires accurate prediction of coolant flow through the system.

World-Class EXPERTISE

Argonne has one of the world's largest concentrations of scientists and engineers involved in advanced reactor design—expertise essential to the formation of new analysis capabilities that will enable future design concepts. Argonne's nuclear and chemical scientists and engineers actively collaborate with the laboratory's computational scientists to develop precise computer simulations of the physical changes that would occur in a reactor over the lifetime of the power plant.





◀ Predicted distribution of neutrons of a certain energy range in the complex geometry of an advanced test reactor. Evaluating reactor design performance depends on accurately predicting the multi-physics phenomena that involve neutronics, thermalhydraulics and thermo-structural mechanics.

How SHARP Adds Value

- ▶ Enables users to evaluate the impact of design decisions on performance and safety of nuclear reactors or their components
- ▶ Constructs highly detailed component models using science-based high-fidelity methods—which rely on few or no engineering approximations—to optimize designs for safety and performance
- ▶ Provides heterogeneous neutron transport in exact geometries, three-dimensional thermal fluid analysis and finite element structural mechanics analysis capabilities

Contact:

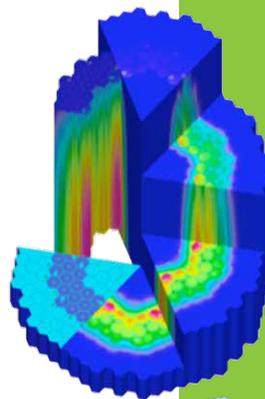
Emily Shemon, Ph.D.
 Nuclear Engineering Division
 Argonne National Laboratory
 eshemon@anl.gov

The SHARP simulation suite development team, led by Argonne National Laboratory, includes other leading national laboratories and research universities. SHARP is developed under the auspices of the U.S. Department of Energy, Office of Nuclear Energy, Nuclear Energy Advanced Modeling and Simulation Program (NEAMS).

Seventy years of leadership in nuclear science and technology

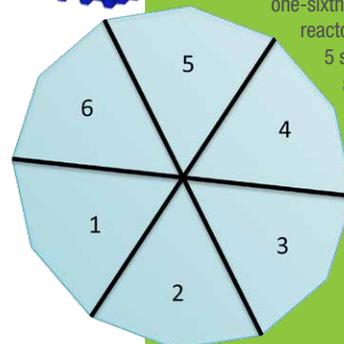
Argonne developed and/or built experiments, research reactors or prototypes of nearly every kind of commercial nuclear reactor in the world today, as well as many research and training reactors. An overview of this history can be found at

www.ne.anl.gov/About/ANL-Reactors.shtml



On the cover

The SHARP toolset accurately predicts temperature distributions of a very high-temperature reactor from a simulation of one-sixth of a VHTR core. Wedge 1 shows the reactor core geometry. Wedges 2 through 5 show temperature distributions across all core materials at different axial heights. Wedge 6 shows temperature distributions in the cylindrical fuel compacts.



Argonne National Laboratory is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.