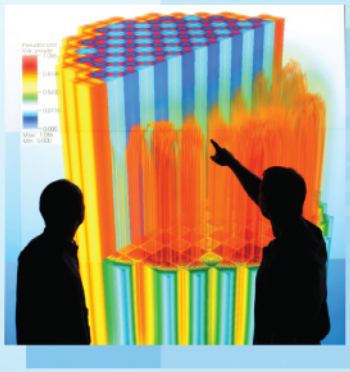
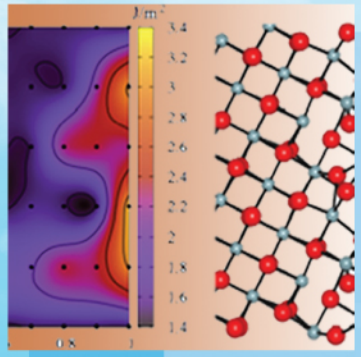
CASL-U-2013-0034-001

Power uprates
and plant life extension



Engineering design
and analysis

Science-enabling
high performance
computing



Fundamental science

Plant operational data

Consortium for Advanced Simulation of LWRs

Improving Reactor Performance

Rose Montgomery
The Tennessee Valley Authority

Mark Uhran
Oak Ridge National Laboratory

April 9, 2013

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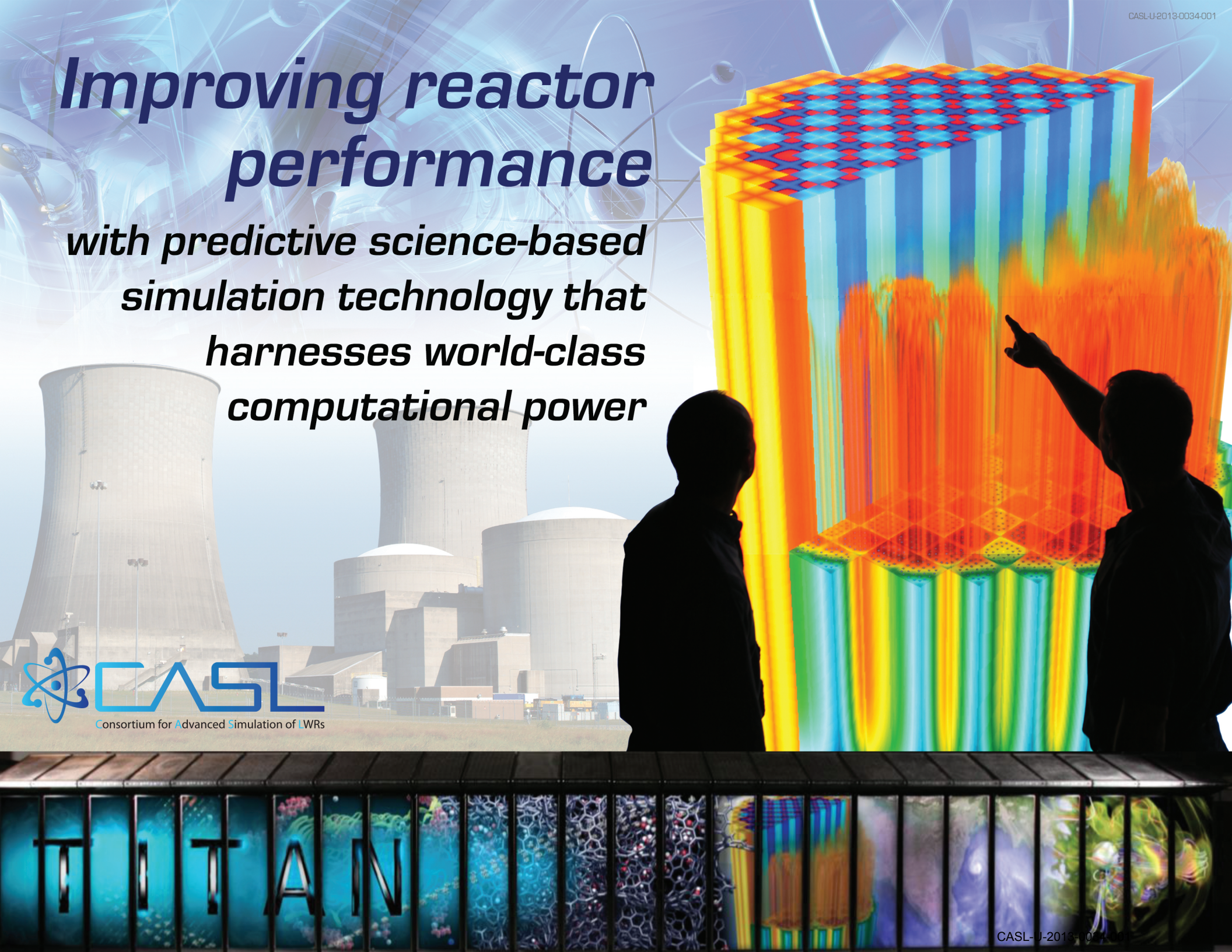
Improving reactor performance

with predictive science-based simulation technology that harnesses world-class computational power



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Nuclear Energy

CASL
Consortium for Advanced Simulation of LWRs

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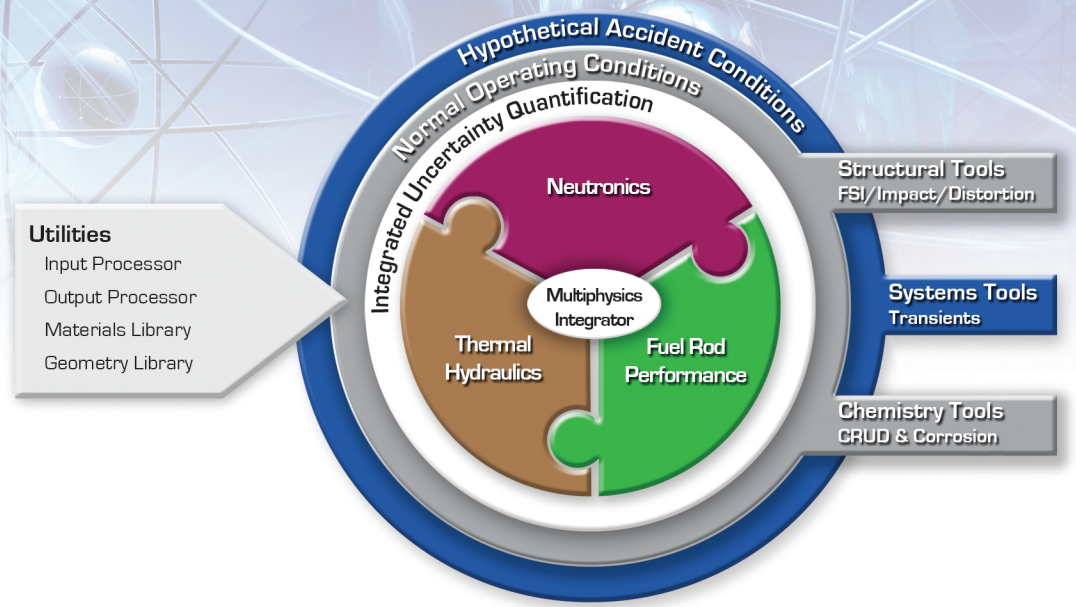
Value of Predictive Simulations

High fidelity predictive simulation of challenging nuclear reactor conditions is a key strategic objective for CASL, and represents a technology step change to support today's nuclear energy industry. Implementation of CASL's technology is expected to accelerate future advances in the development of this cleaner energy source. CASL will address, through new insights afforded by its advanced modeling & simulation technology, key nuclear energy industry challenges to furthering power uprates, higher fuel burnup, and lifetime extension, while providing higher confidence in enhanced nuclear safety.

CASL's fully-coupled, three dimensional, multi-scale physics environment is being designed to track the operational and safety performance of tens of thousands of fuel rods in a reactor core each cycle. This translates to trillions of degrees of freedom on the engineering scale and thousands of supporting micro- or meso-scale effects. CASL's vision is to predict, with confidence, the performance of nuclear reactors through comprehensive, science-based modeling and simulation technology that is deployed and applied broadly throughout the nuclear energy industry to enhance safety, reliability, and economics.



Component models for thermal hydraulics, radiation transport, and fuel performance are being coupled in CASL's Virtual Environment for Reactor Applications (VERA) to form an integrated "reactor-aware" simulation capability addressing the design, operational and safety challenges of commercial light water reactors.

Progress in Motion

- CASL has established a multi-physics integrator that provides a basis for closely coupling multiple simulation applications to address feedback effects that are not currently reflected in the industry analytical approach.
- Several simulation applications, including those for advanced radiation transport, thermal-hydraulics, and CRUD deposition have been coupled using the multiphysics integrator, and alpha testing is underway.
- R&D continues on additional advanced simulation applications addressing fuel rod performance, fluid-structure interaction, and structural mechanics and will be integrated to CASL's Virtual Environment for Reactor Applications (VERA).
- An initial release of VERA to CASL core partners has been completed through ORNL's Radiation Safety Information Computational Center, and update releases will follow as capabilities are increased.
- CASL has also established a baseline industry coupled physics capability that directly demonstrated the increased fidelity of the coupled approach and provided a direct industry comparison point.
- Initial applications of VERA to operational PWR core scenarios with conditions relevant to corrosion buildup have also demonstrated that CASL's newly established multi-physics simulation capabilities exceed the fidelity of the current industry physics modeling approach.

A partnership with unparalleled collective institutional knowledge, nuclear science and engineering talent, computational science leadership, and a record of LWR design and regulatory accomplishments!

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