

SCALE Overview

6.3.3

ORNL is managed by UT-Battelle LLC for the US Department of Energy

SCALE

ORNL code system for nuclear modeling and simulation

- Initiated by the U.S. Nuclear Regulatory Commission (NRC) in the 1980s to provide confirmatory analysis capabilities for light-water reactor (LWR) criticality, transportation, and spent fuel applications
 - Current sponsors include DOE Nuclear Criticality Safety, DOE NNSA, and U.S. NRC
 - Over 7,000 user licenses for the v6.2 series (2016)
 - Over 20 international regulatory bodies use SCALE
 - More than 100 trainees/year, including courses at OECD/NEA and IAEA
 - New v6.3 series (2023) recently available from RSICC
 - V&V-ed non-LWR capability for TRISO particle-based systems, graphite moderation, and molten salt fueled reactors (MSRs)
 - Additional HALEU/HBU/ATF enhancements
 - Inclusion of the Shift Monte Carlo code
- **Leading-edge capabilities**
 - Criticality safety
 - Radiation shielding
 - Spent fuel inventory
 - Reactor physics/operation
 - Activation/Isotope production

Emerging capabilities in v7.0 for rapid non-LWR inventory generation, Mo99 production, and comprehensive uncertainty quantification.



SCALE v6.3
3D visualization of **Kairos “Hermes” prototype reactor to be built in Oak Ridge TN**
created by SCALE staff to support NRC’s review of construction permit.

Blue: FLiBe coolant
Red: Fuel pebble
Black: Moderator pebble

Primary sponsors of SCALE

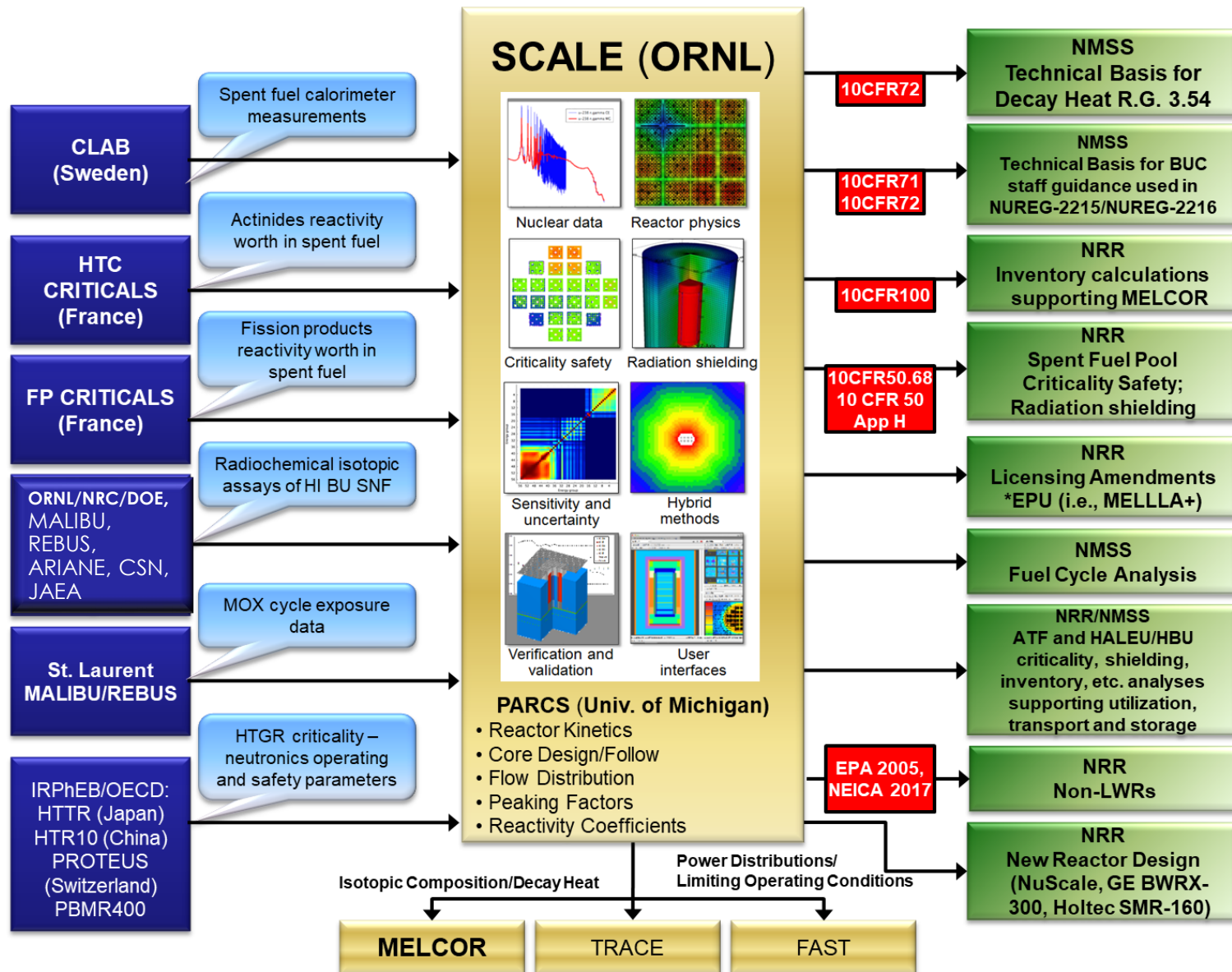
- U.S. NRC

- Confirmatory analysis of licensee calculations (RES and NMSS)
- Currently focused on preparedness
 - LWRs: HALEU/HBU/ATF
 - non-LWRs: Severe accident

- DOE Nuclear Criticality Safety Program (NCSP)

- Monte Carlo criticality safety (KENO and Shift)
- Sensitivity and uncertainty analysis
- Participation in criticality safety working groups

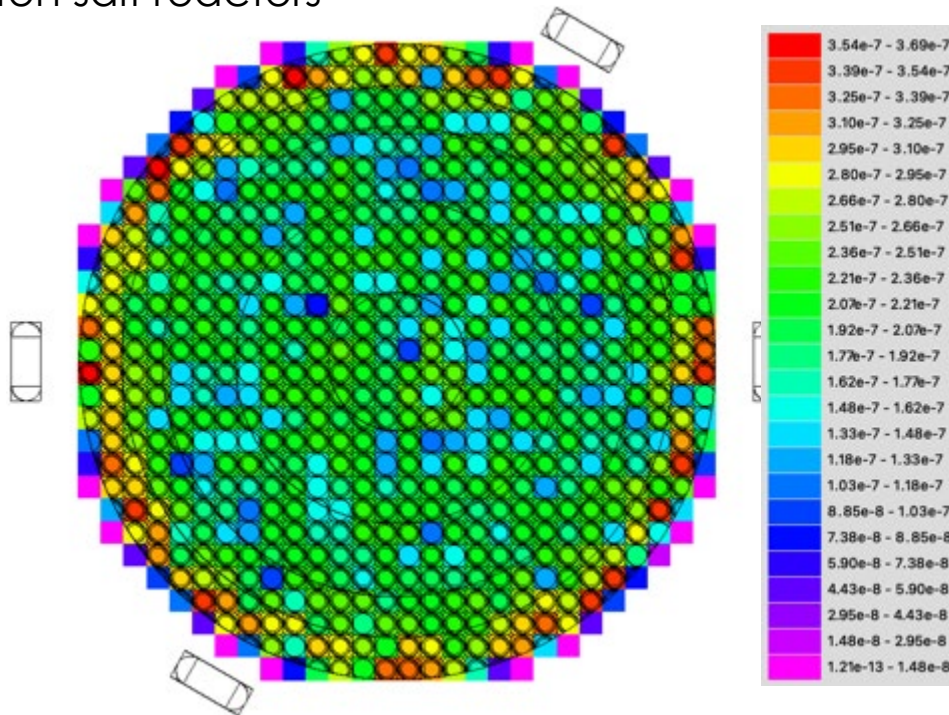
NRC confirmatory analysis with SCALE



What is unique/useful about SCALE ? (part 1 of 2)

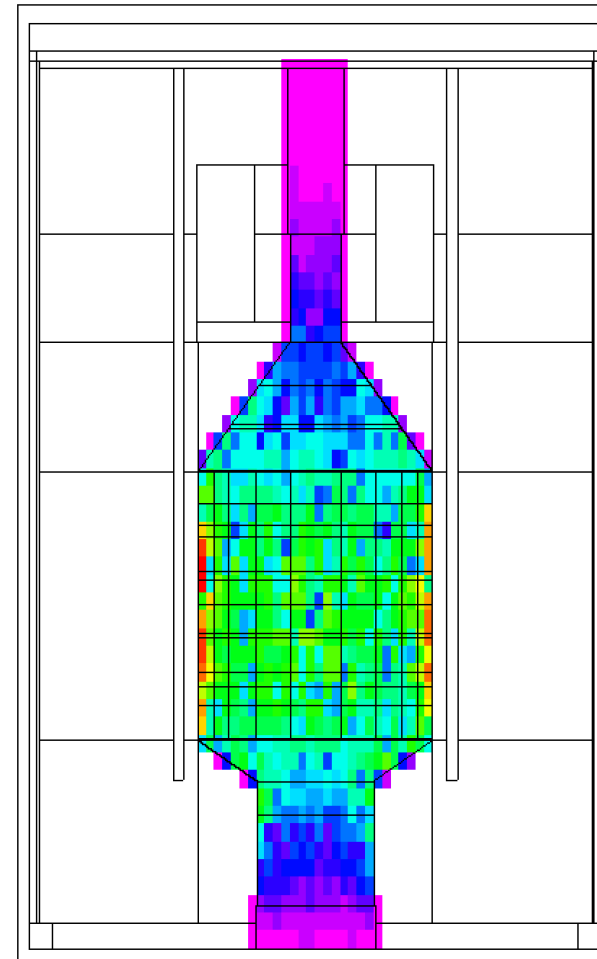
- Modernized graphical user interface and visualization options
- Fast and accurate methods for advanced reactor analyses
 - Efficient methods to model TRISO fuel forms used in small modular reactors and microreactors
 - Accurate methods for liquid fuel systems like molten salt reactors

Fission rate
(radial)

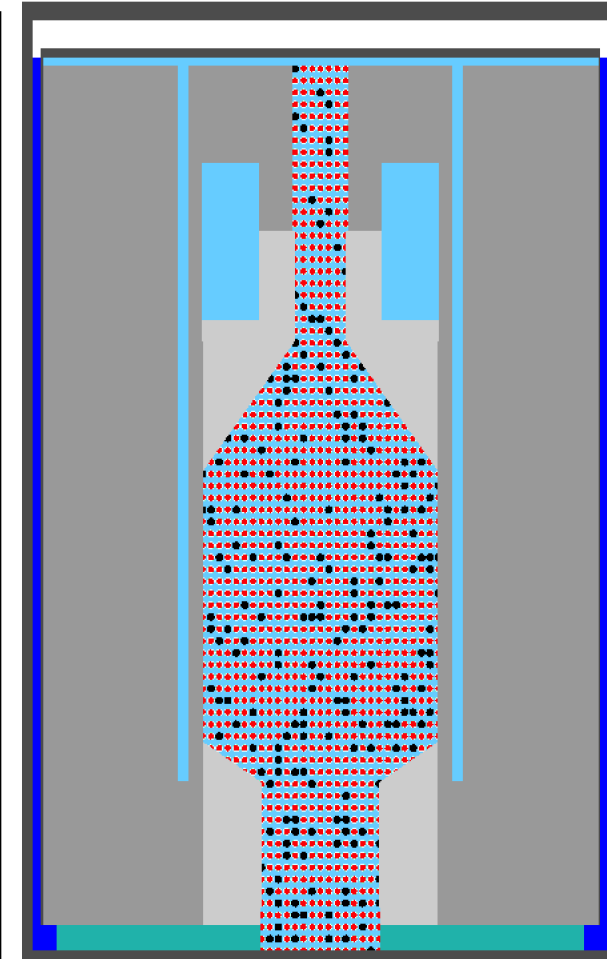


Kairos Hermes Prototype Reactor Analysis

Fission rate (side)

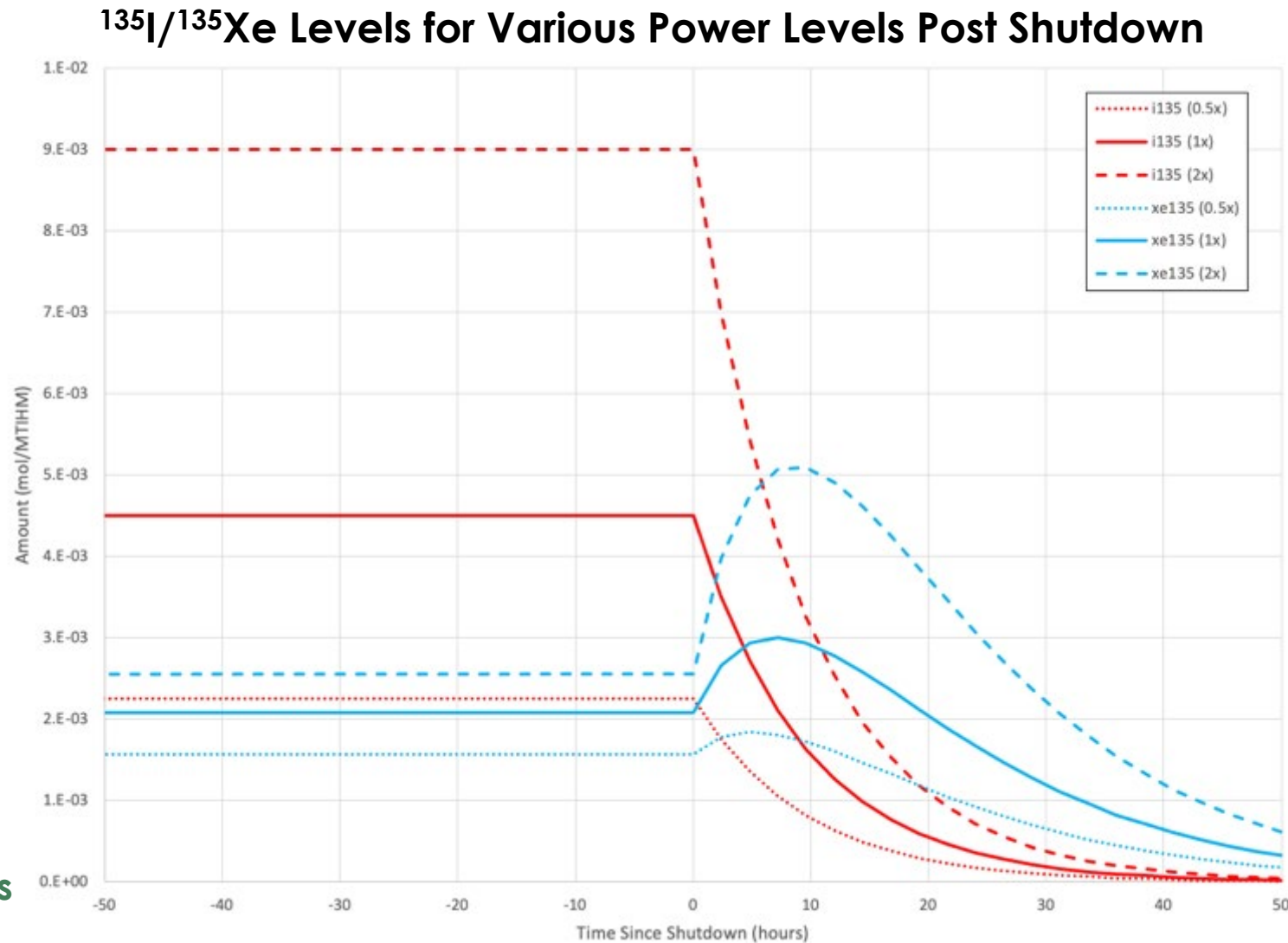


Geometry (side)



What is unique/useful about SCALE? (part 2 of 2)

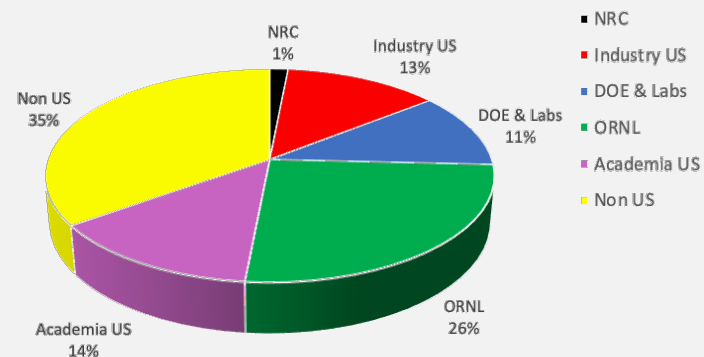
- Methods for modeling the entire fuel cycle
 - From 3D Monte Carlo transport methods to 1D deterministic transport
 - Insights in minutes of runtime: xenon feedback, fast/thermal spectra
 - ORIGEN activation, depletion, decay calculations (run in seconds—instant feedback)
 - Integrated uncertainty quantification and parametric studies
 - Tools for understanding impacts of nuclear data gaps
- Archives of publicly available models, reports, and journal papers for users
 - <https://code.ornl.gov/scale/analysis>
 - <https://www.ornl.gov/scale/references>



SCALE benefits from a wide user base

- Over 11k users and 18k licenses issued
- Used by over 20 regulatory bodies
- Two 4-week training blocks per year for select training subjects
- Annual users' group workshop for discussion, showcasing efforts, tutorials, and SCALE team updates
- SCALE helpline exists to support users
 - scalehelp@ornl.gov
 - Request access to SCALE Users' Group google forum via [scalehelp](https://www.ornl.gov/scale/help)
- Large collection of learning resources from training, primers, and workshops
 - <https://www.ornl.gov/scale/learning>

2025 Annual SCALE Users' Group Workshop Recap 132 attendees from 20 countries



- **12 Tutorials** offered
- **13 Model contest entries**
- **Other sessions:** Invited talks, open mic, upcoming feature preview, SCALE team highlights

Slides available at:

<https://www.ornl.gov/content/scale-users-group-annual-workshop>

Next Users' Group Workshop: June 8th-12th, 2026



SCALE 6.3 series (2023–?)

- Major 6.3 features developed in 2016–2021 include

1. HALEU/HBU/ATF material properties
2. Additional uncertainty propagation capability
3. Code speedups through method improvements (e.g., 5-fold speedup in Polaris)
4. ENDF/B-VII.1 and ENDF/B-VIII.0 nuclear data
5. Nuclide inventory sensitivity to nuclear data
6. Molten salt-fueled reactor modeling capability

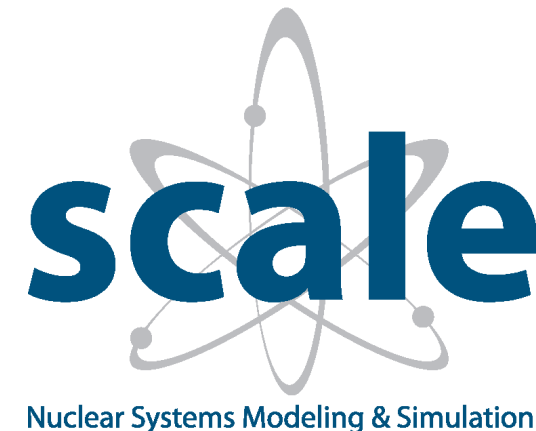
7. Shift high-performance Monte Carlo integration
8. Modernization of nuclear data and results storage formats
9. Manual ported to new format to enable online website
<https://scale-manual.ornl.gov>

• Next SCALE 7.0 (≥ 2027)

- SCALE 6.3 will have maintenance releases with bug fixes, 6.3.1, 6.3.2 etc.
- SCALE 7.0 initially in closed beta—open beta will require a license agreement

SCALE vision

- To be the leader in generating reliable reference solutions for challenging problems
 - Accuracy first, speed second
 - Always consider uncertainty
 - Ease-of-use is important and requires constant evolution and communication with users
 - Publish models, results, and scripts—achieve true reproducibility and transparency
- Provide comprehensive assessment of nuclear data quality through validation across
 - Criticality safety
 - Radiation shielding
 - Spent fuel inventory and decay heat
 - Reactor physics/operation
 - Isotope production



SCALE team

Leadership

Director

Will Wieselquist

Production Coordinator

Rob Lefebvre

User Support Coordinator

Germina Procop

Logistics Coordinator

Sandra Poarch

Advisors

Matt Jessee

NEAMS Reactor Physics Lead

Tara Pandya

Section Head, Nuclear Applications, Methods, and Data

ORNL/NRC Projects Office

NRC Program Manager

Bruce Bevard

NRC Business Ops

Lindsey Aloisi

ORNL/NCSP Management

NCSP Execution Manager

Doug Bowen

ORNL Site Manager

Alex Lang

Product Owners

AMPX Jordan McDonnell

CSAS Kursat Bekar

DATA Jesse Brown

FULCRUM Rob Lefebvre

MAVRIC Cihangir Celik

OMNIBUS Seth Johnson

ORIGAMI Steve Skutnik

ORIGEN B.K. Jeon

POLARIS Matt Jessee

SAMPLER Ugur Mertuyrek

STDCOMP Rob Lefebvre*

TITAN Tarek Ghaddar

TRITON Rike Bostelmann

TSUNAMI Jordan McDonnell*

VADER Lisa Fassino

XSPROC Kang Seog Kim

*Interim owner

Development/Testing/Analysis

Iyad Al-Qasir Travis Greene Douglas Peplow

Arzu Alpan Will Gurecky Marco Pigni

Goran Arbanas Steven Hamilton Germina Procop

Mehdi Asgari Donny Hartanto Georgeta

Jin Whan Bae Andrew Radulescu

John Batson, III Holcomb Kemal Ramic

Kursat Bekar Jianwei Hu Yves Robert

Elliot Biondo BK Jeon Kat Royston

Rike Bostelmann Seth Johnson Jose S. Perez

Jesse Brown Kang Seog Kim Alex Shaw

Cihangir Celik Alex Lang Steve Skutnik

Chris Chapman Brandon Langley Ben Taylor

Eva Davidson Rob Lefebvre Ben Coalson

Greg Davidson BJ Marshall Doro Wiarda

Mathieu Dupont Jordan Will Wieselquist

Rabab Elzohery McDonnell Blake Wilkerson

Tom Evans Ugur Mertuyrek

Lisa Fassino Walid Metwally

Tarek Ghaddar Tara Pandya

Questions?

