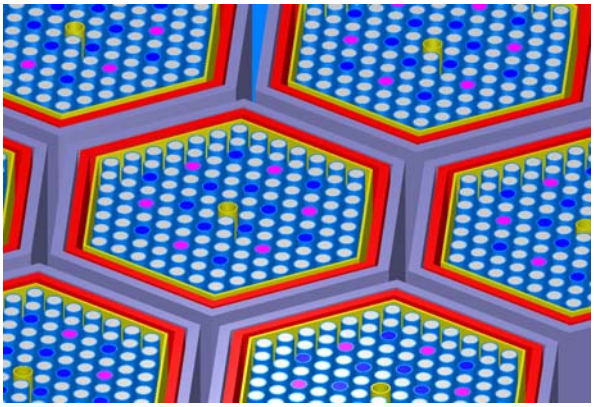
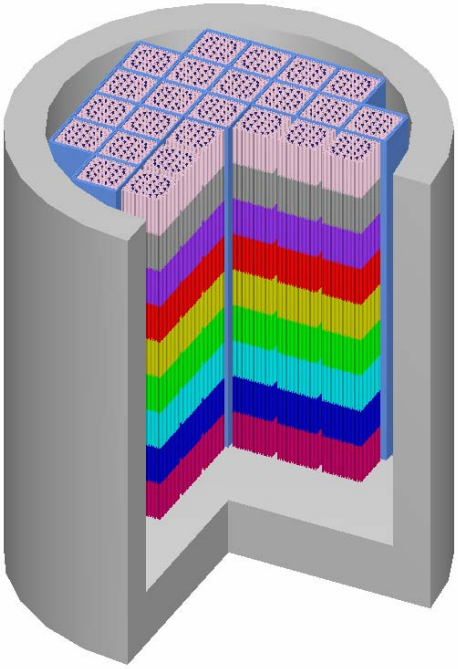
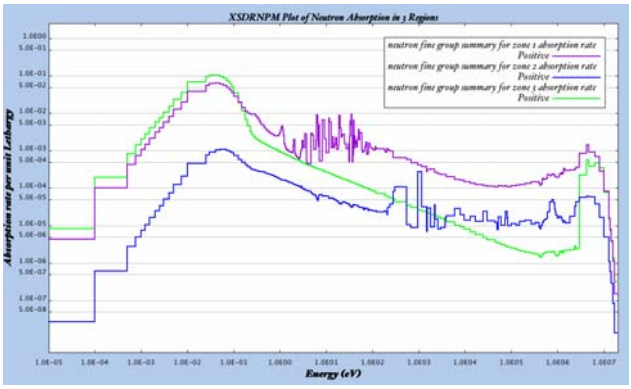
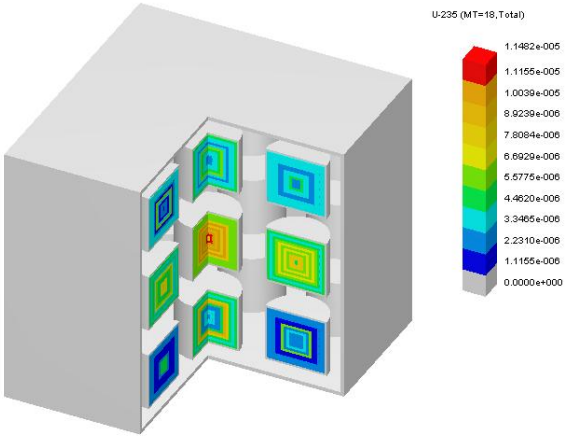




SCALE



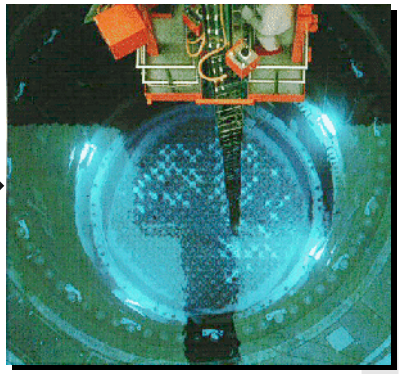


An Easy-to-Use Computer Software System for Nuclear Safety Analyses

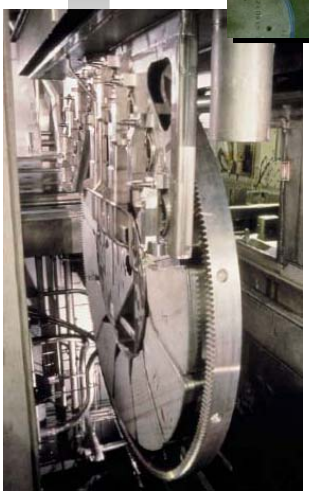
OAK RIDGE National Laboratory

Material processing and fabrication

Commercial and research reactors



SCALE is used worldwide (~30 nations) by regulators, vendors, utilities, cask designers, R&D labs, safeguard agencies

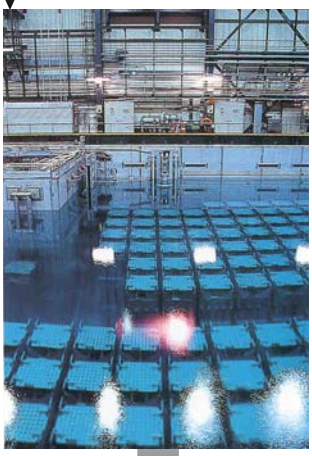


Recycling

SCALE is a modular code system that uses automated sequences to provide:

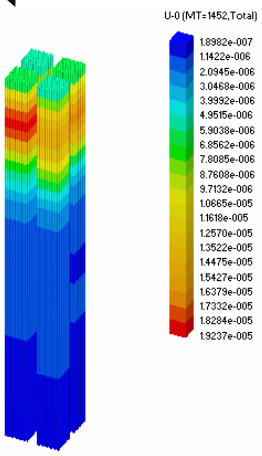
- Cross-section processing
- Reactor physics
- Criticality safety
- Radiation shielding
- Spent fuel and HLW characterization
- Advanced 3-D visualization and automated user interface

Storage



Transport

Disposal



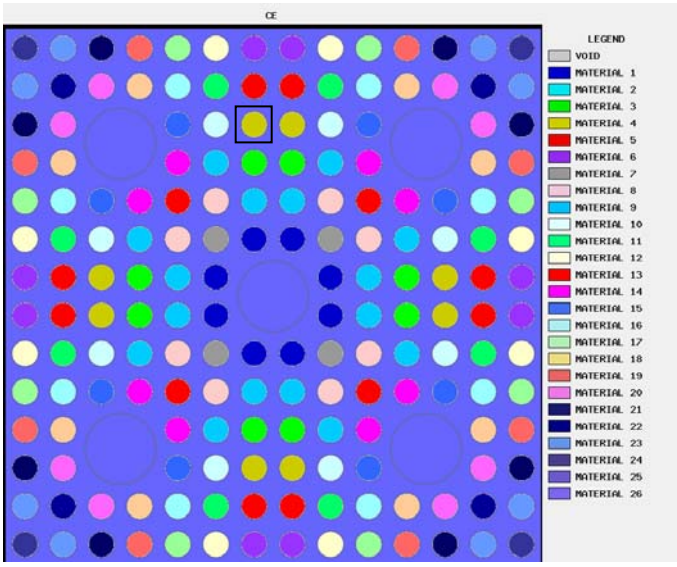
3-D Visualization

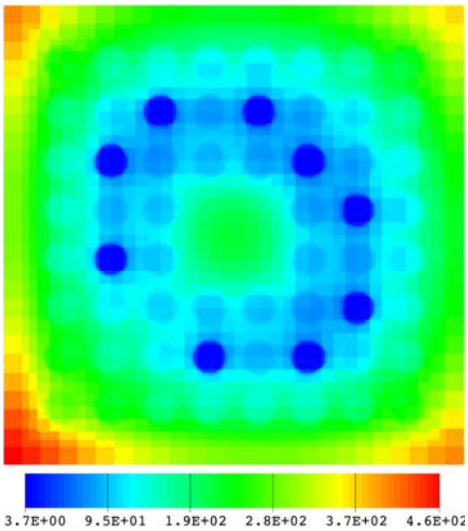
SCALE is a complete package

- Unix, Windows, Linux platforms
- ENDF/B-V and –VI data (multigroup and continuous-energy)
- Manual w/ searchable index on CD
- V&V benchmark suites on SCALE website
- Configuration management
- QA surveillance and auditing
- Cosponsored by U.S. NRC & DOE

www.ornl.gov/sci/scale

Key SCALE Modules





KENO	**3-D Monte Carlo k_{eff} calculation**
MORSE	**3-D Monte Carlo shielding**
NEWT	**2-D flex-mesh discrete ordinates**
XSDRN	**1-D discrete ordinates**
CENTRM	**1-D continuous energy transport**
ORIGEN	**isotopic depletion and decay**
BONAMI	**Resonance processing of**
NITAWL	**multigroup cross sections**

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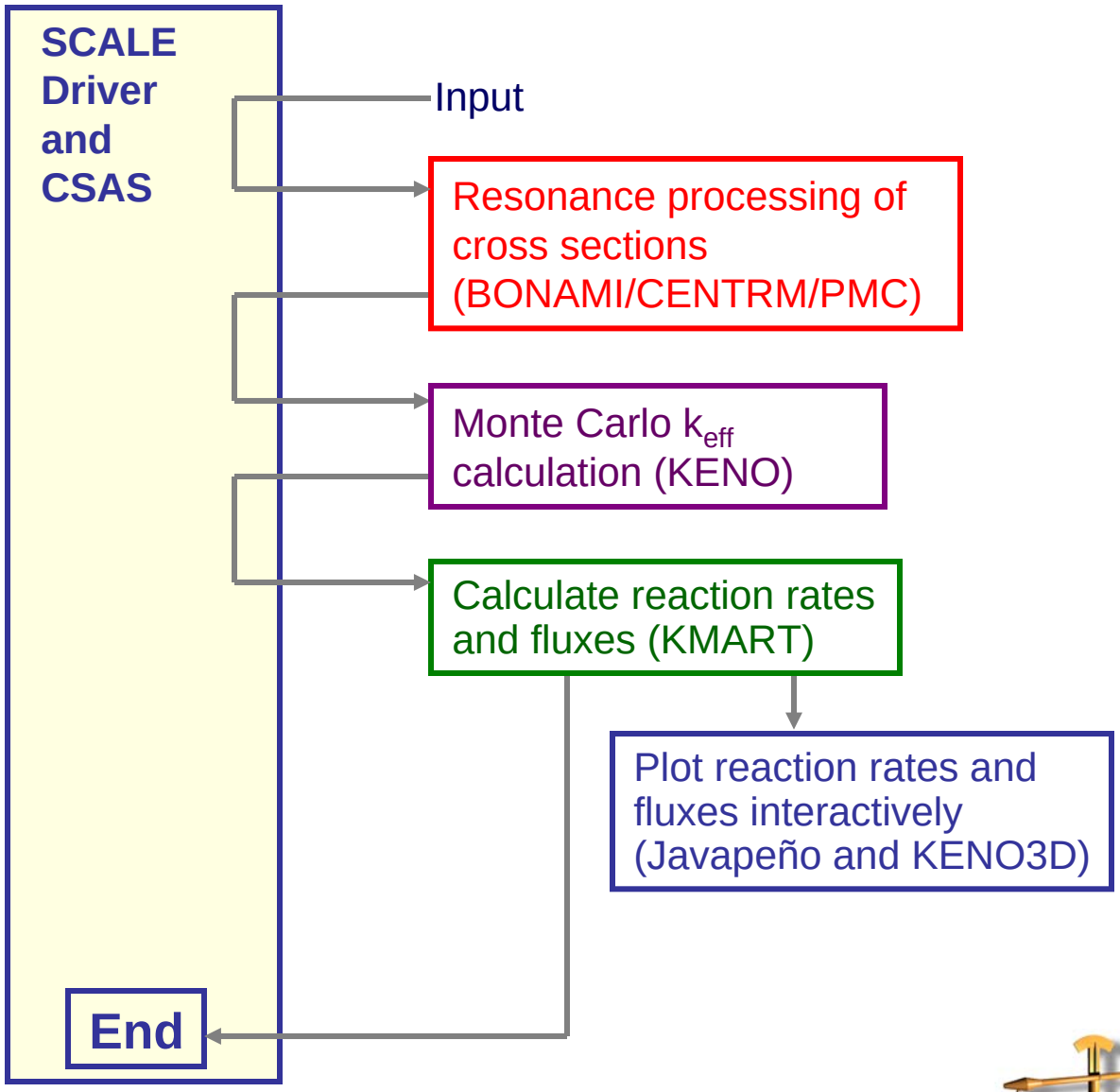
Modules Integrated into Automated Sequences Make SCALE Easy to Use

Criticality Safety Analysis Sequence (CSAS) Example



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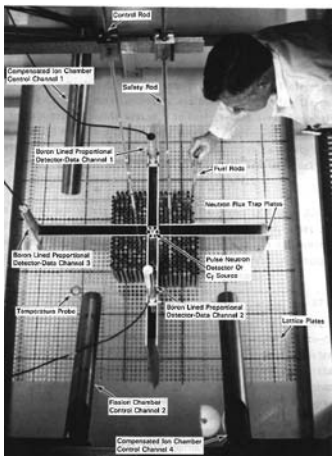
SCALE Is Widely Used and Accepted

- Accepted by both U.S. domestic and international technical communities
  - Regulatory agencies
  - R&D labs
  - Government contractors
  - Fuel enrichment/fabrications facilities
  - Utilities/Vendors
  - Cask designers
- SCALE training courses in U.S., Europe, Japan, and Latin America
  - Over 700 attendees (1/3 foreign nationals from 30 nations) in public courses since 1993
  - Hundreds of attendees in private courses at sponsor sites
- SCALE Newsletter issued twice per year
  - Over 800 members in SCALE e-mail news group

Verification & Validation

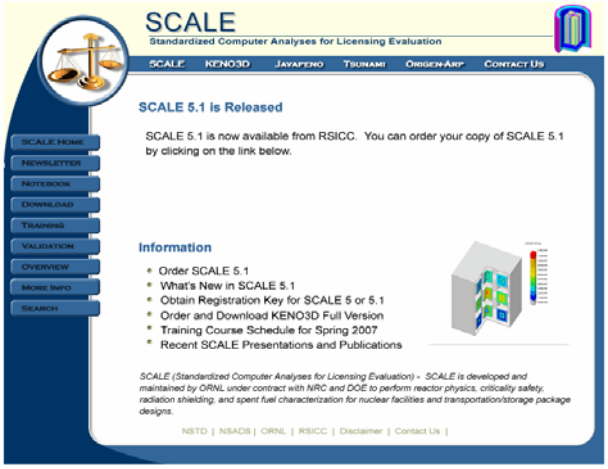
- Criticality safety
  - High-enriched homogeneous ^{235}U
    - Fast, thermal, and intermediate spectra
  - Low-enriched homogeneous ^{235}U
  - LWR and MOX lattices
  - ^{239}Pu
  - ^{233}U
- Radiation shielding
  - Spent fuel casks
- Spent fuel characterization
  - PWR, BWR and MOX assemblies
- Decay heat
  - PWR and BWR assemblies



Training and Tech Support

- **Training courses**
  ORNL and on-site

- **SCALE Web Site**
  (www.ornl.gov/sci/scale)
  - SCALE Newsletter
  - Validation reports
  - Download updates
  - Training course info

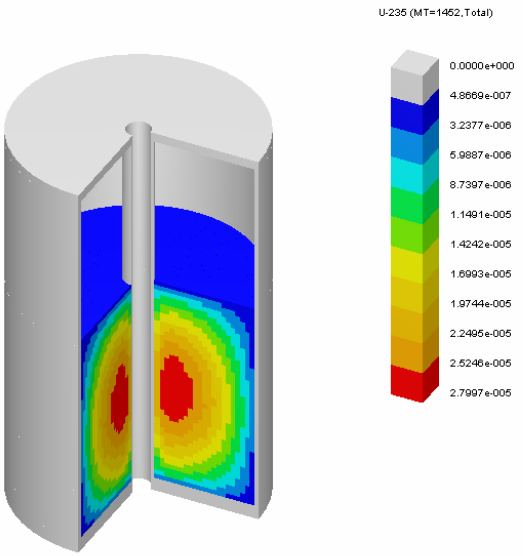


- **User help**
  via e-mail
  (scalehelp@ornl.gov)

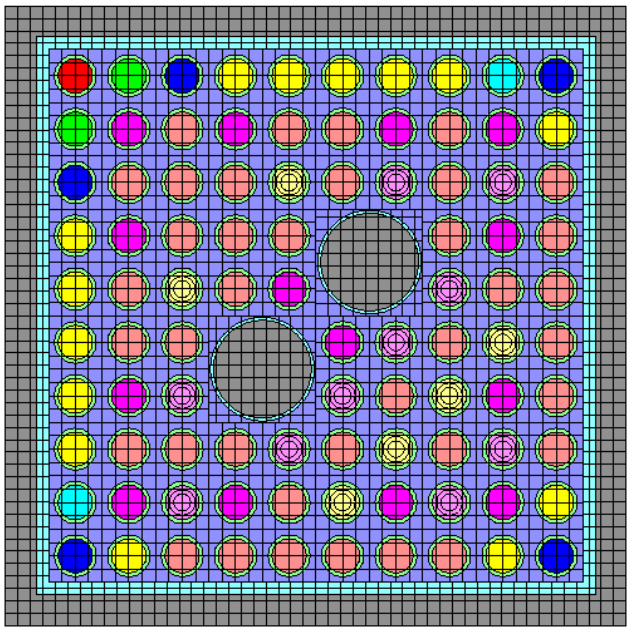
www.ornl.gov/sci/scale

Model Visualization

- Interactive 3-D visualization
  - Cut, rotate, slice
  - Display results overlaid on geometry

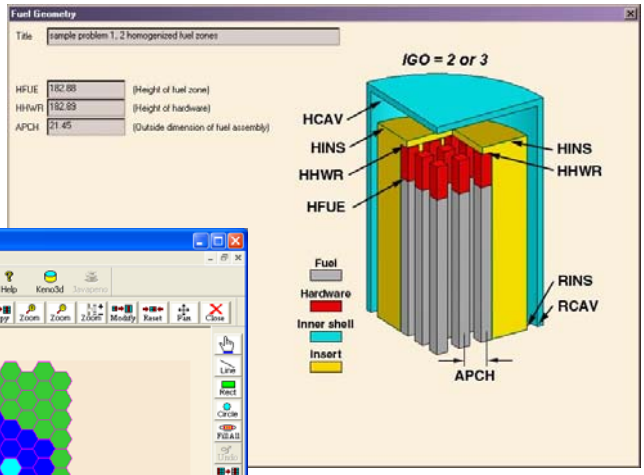


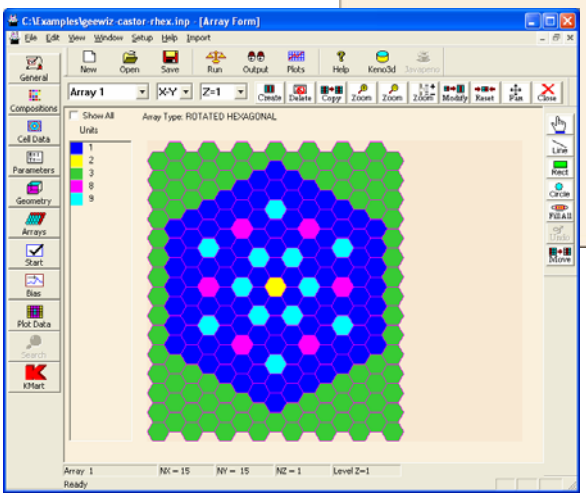
- 2-D Color Graphics
  - High resolution 2-D slices of geometry



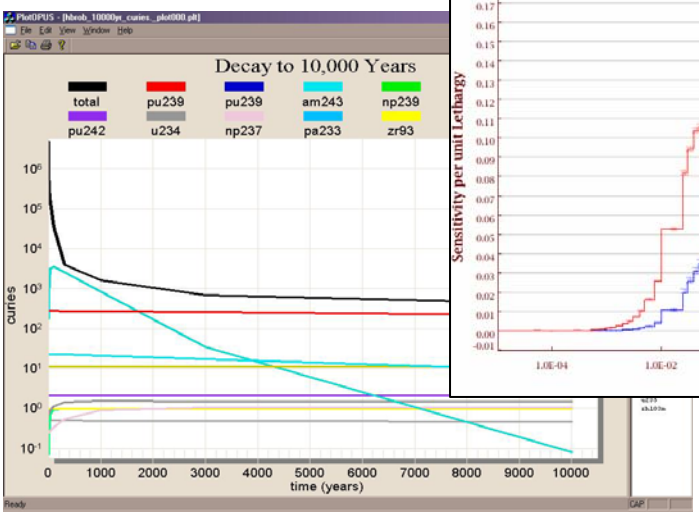
Pre- and Post-processors

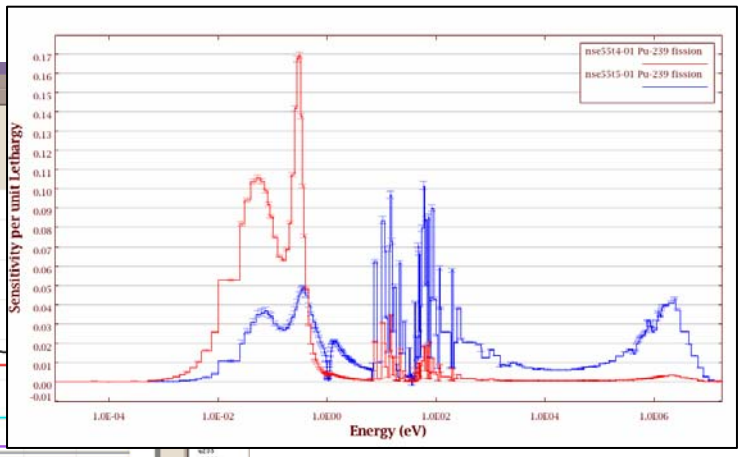
- Graphical user interfaces





- Plot calculated results





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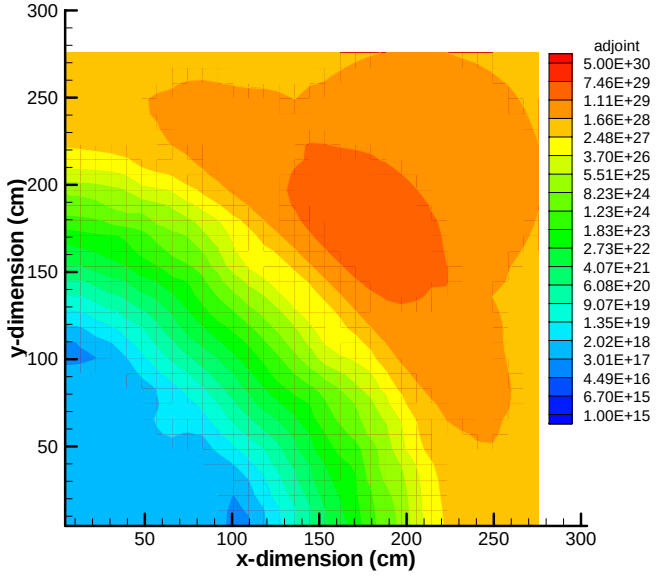
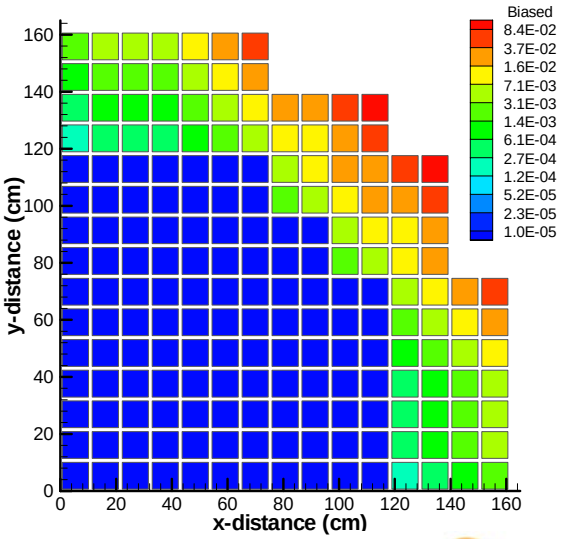
New Developments

- Sensitivity/Uncertainty (1-D / 3-D)
  - Produce sensitivity coefficients
  - Identify parameters / regions of importance
  - Establish similarity of benchmark experiments
  - Provide estimate of bias and uncertainty
- 2-D flexible mesh lattice physics
- 3-D Monte Carlo depletion
  - Coupled with ORIGEN-S depletion/decay code
- New radiation shielding methods
  - Monte Carlo with 3-D automated variance reduction





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NSTD The Nuclear Science and Technology Division

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