Research Overview for Prospective Students

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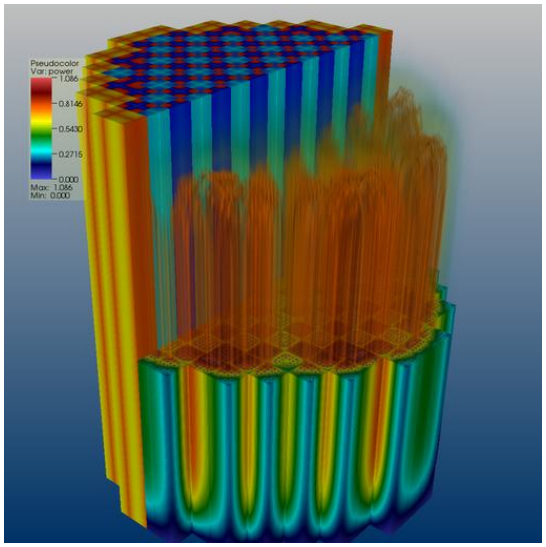
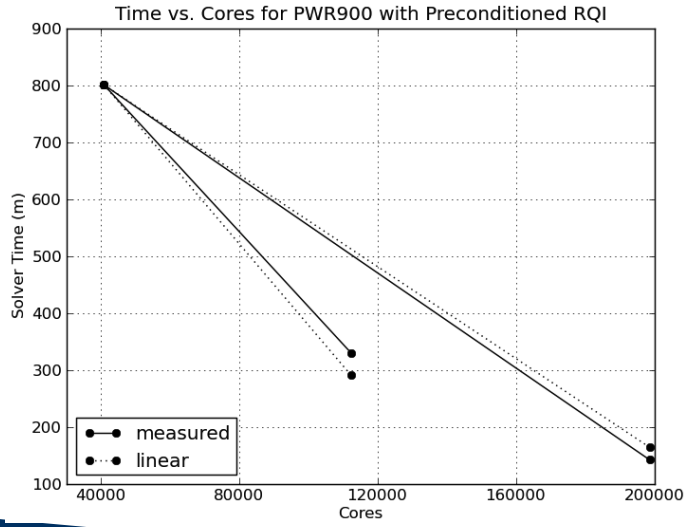
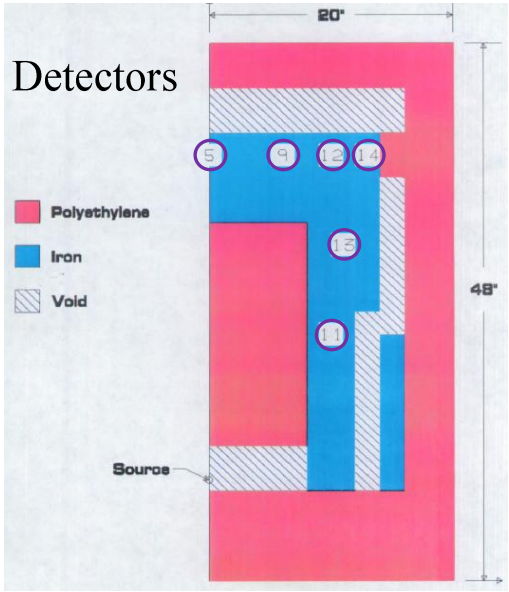
What exactly do you do?

$$[\hat{\Omega}\cdot\nabla+\Sigma(\vec{r},E)]\psi(\vec{r},\hat{\Omega},E)=$$
$$\int dE'\int d\hat{\Omega}'\,\Sigma_s(\vec{r},E'\rightarrow E,\hat{\Omega}'\cdot\hat{\Omega})\psi(\vec{r},\hat{\Omega}',E')$$
$$+\frac{\chi(E)}{k}\int dE'\,\nu\Sigma_f(\vec{r},E')\int d\hat{\Omega}'\,\psi(\vec{r},\hat{\Omega}',E')$$







How do you do it?

- Deterministic methods require discretization of phase space
  - discretize more finely to improve solution quality
  - use advanced solvers to converge solution more quickly
- Monte Carlo (MC) treats phase space continuously
  - accuracy depends on number of particles simulated
  - often requires variance reduction (VR)
- Hybrid methods: create MC VR parameters using deterministic solutions

Algorithms + Architecture

Applied Math Informed by Physics

Example: use adjoint relationship:

$$\int\int q^{+}(r,E)\phi(r,E)drdE = \int\int q(r,E)\phi^{+}(r,E)drdE$$

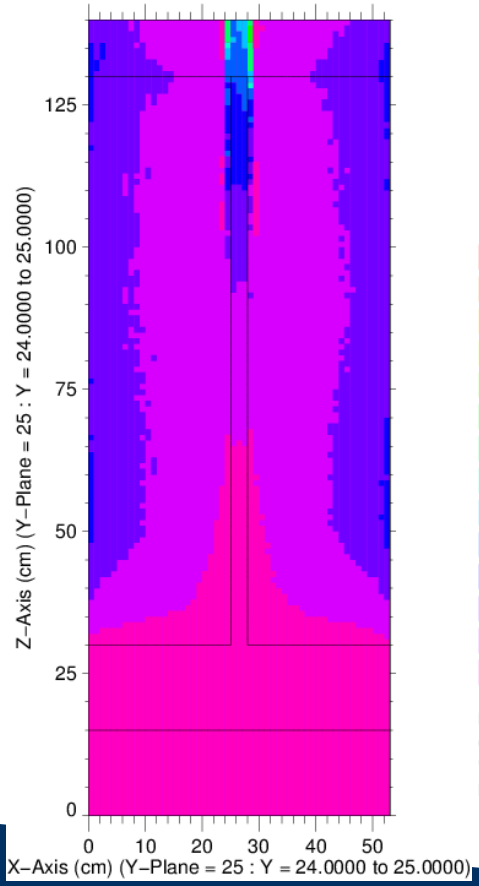
$$\boxed{q^{+}(r,E) = f(r,E)}$$

$$R = \int_{E}\int_{V_f} f(r,E)\phi(r,E)drdE \quad \longrightarrow \quad R = \int_{E}\int_{V_S} q(r,E)\phi^{+}(r,E)drdE$$

Create an importance map augmented by info about physics:

$$q^{\dagger}(\mathbf{r},E) = \left(\frac{\phi_{res(\sigma_0)}(\mathbf{r},E)}{\phi_{dilute(\sigma_0)}(\mathbf{r},E)}\right)^{M} q^{\dagger}_{FWC}, \qquad imp(\mathbf{r},E) = \frac{\phi^{\dagger}_{ResFact}(\mathbf{r},E)}{R(\mathbf{r},E)}$$

Driven By Application

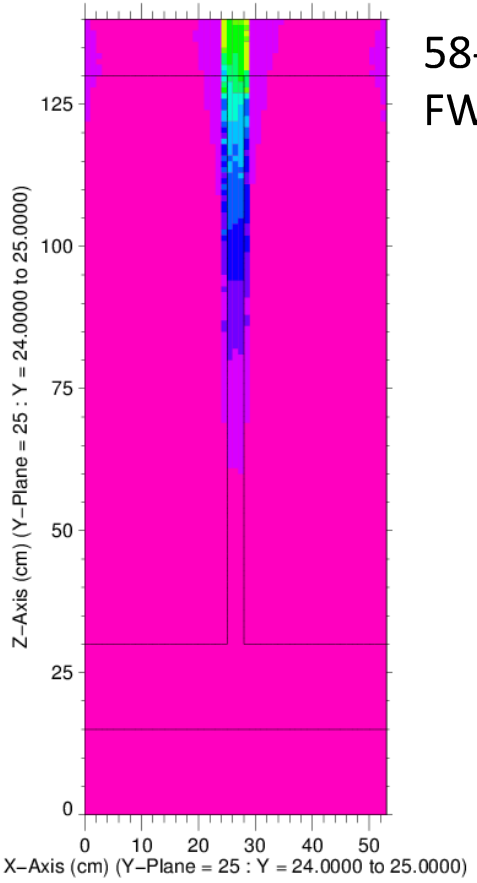


M = 1.0

Color Map Legend

Range	% of Cells
0.350	0.00
0.300	0.00
0.250	0.00
0.200	0.00
0.170	0.00
0.150	0.04
0.130	0.13
0.110	0.03
0.0900	0.16
0.0700	0.58
0.0500	2.02
0.0300	24.33
0.01000	43.68
	29.03

Minimum Value: 0.00101992
Cell–Wtd Avg: 0.0211355
Vol–Wtd Avg: 0.0211355
Maximum Value: 0.154631



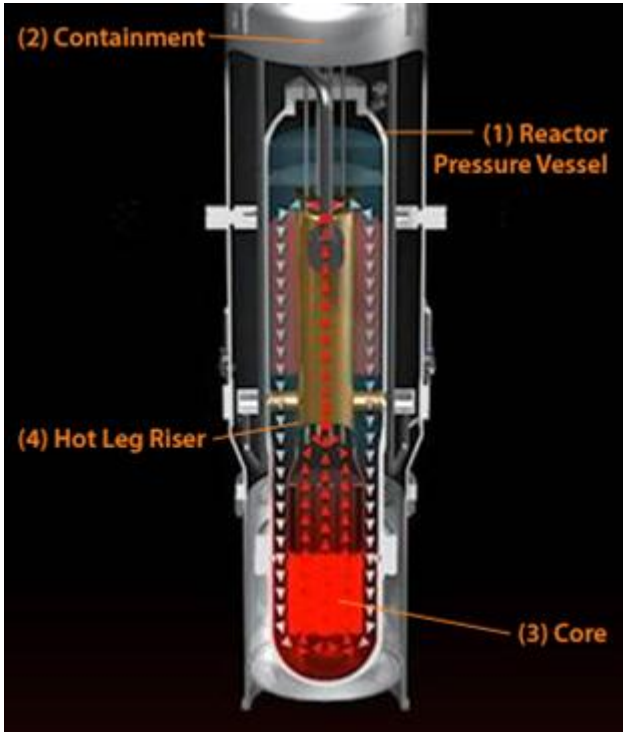
58-grp
FW-CADIS

Color Map Legend

Range	% of Cells
0.35	0.00
0.30	0.00
0.25	0.00
0.20	0.16
0.17	0.08
0.15	0.32
0.13	0.24
0.11	0.24
0.090	0.42
0.070	0.59
0.050	0.73
0.030	0.93
0.0100	4.43
	91.85

Minimum Value: 0.000902912
Cell–Wtd Avg: 0.00834701
Vol–Wtd Avg: 0.00834701
Maximum Value: 0.243378

Example Projects



$$\mathbf{L}\psi = \mathbf{MS}\phi + Q$$

$$\phi = \mathbf{D}\psi$$