Safeguard Approach for Molten Salt Reactors

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Team Members

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Acknowledgments

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- Reynolds played an important role in helping with troubleshooting and understanding the software.
- The project also heavily utlized Reynold's dissertation as it aided with understanding the physics behind the software as well as how to use the software.

Sources

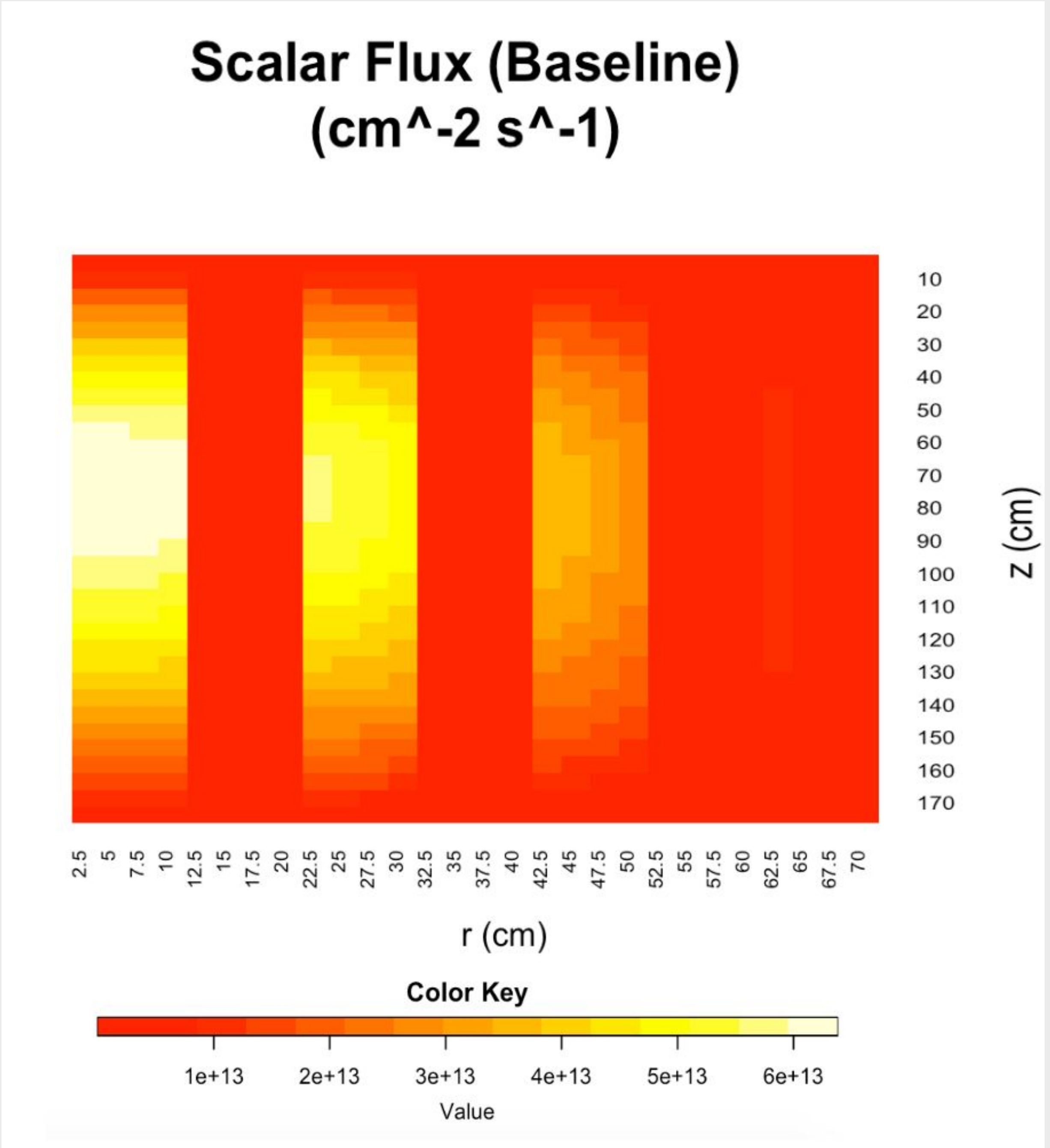
Reynolds, A. (2020). *A Multilevel Nonlinear Projective Method for Circulating Fuel Reactor Kinetics.* : Oregon State University.

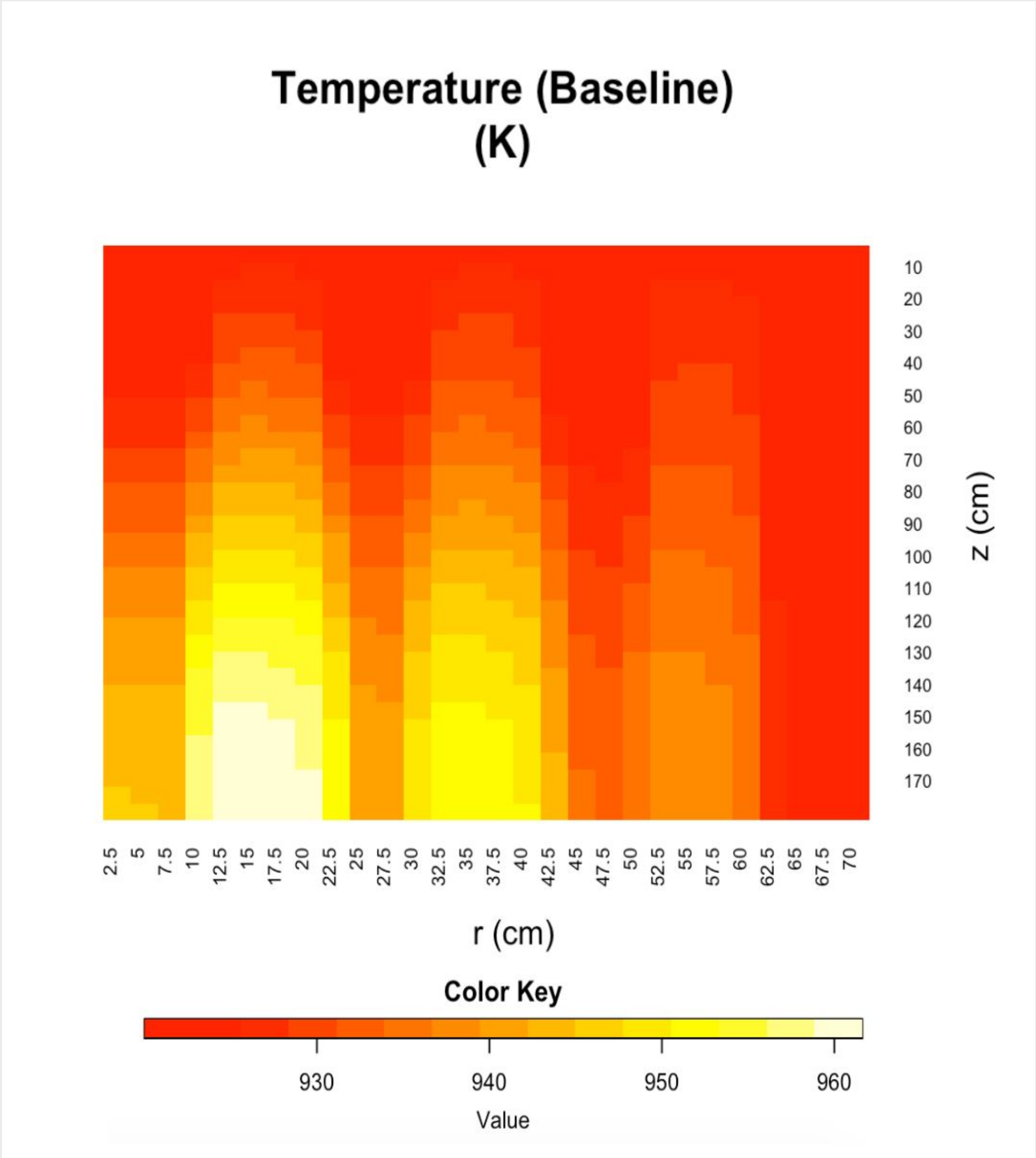
IAEA. (2020, August 24). *Spotlight on Innovation: Molten Salt Reactors for a Sustainable Clean Energy Transition*. IAEA.

Video- **The Molten-Salt Reactor Experiment**

Full List of project Referencse Here

Oregon State University





Simulations

- Simulations were ran using a heterogeneous core model with these input specifications for the baseline simulation. These specifications were slightly modified to create simulation conditions with varying levels of fuel salt volume.
- Graphite Moderators' radius was altered by increments of 5 cm .
- This decreases the volume of the total fuel channel which represents the action of fuel salt diversion from the reactor
- Simulations used a steady state solving method, which resulted in decreasing Keff values in each simulation due to the decreasing value in fuel.
- Temperatures and Scalar Fluxes (fasest neutron group) were calculated

Results

- Keff decreases as the amount of fuel volume decreases
- There is no notable trend for average scalar flux across the reactor that would be able to detected by monitors.
- There is a slight trend in average temperature across the reactor, but differences between the simulations are not large enough to be able to be detected by monitoring systems.
- Monitoring Systems may not be effective as a safeguard approach due to the non detectible changes in scalar flux, and temperature.
- May have to rely on more human-powered safeguard approaches, such as human surveillance and personnel checks when work is done on the reactor.

Background

- Circulating Fuel Reactors (CFR) are a type of nuclear reactor that circulate their fuel as a fluid. This is in contrast to Solid Fuel Reactors (SFR), where the fuel is stationary.
- Molten Salt Reactors (MSR) are CFRs which use a molten salt mixture as their fuel. Only two CFRs have ever been built – both MSRs. The last one was the Molten Salt Reactor Experiment (MSRE), over 50 years ago!
- A typical CFR uses a cylindrical geometry, with the liquid fuel flowing vertically along the axis of the cylinder. This fuel flows in multiple channels in the reactor. There are also channels of moderator material. The nuclear fuel creates the neutron flux which gives the reactor its power. The moderator slows down the neutrons to speeds that allow for more nuclear reactions and more neutron flux. There is also control material, which can absorb excess neutrons and prevent the flux from getting too large.
- MSRs and CFRs are getting renewed attention lately. This is due to several advantages they have over SFRs: efficiency, economics, safety, and reliability, to name a few.

Molten Salt Reactor Experiment- Outside View

Molten Salt Reactor Experiement- Top/Inside View