GEN IV International Forum℠
Expertise | Collaboration | Excellence

Performance Assessments for Fuels and Materials for Advanced Nuclear Reactors

Summary / Objectives:

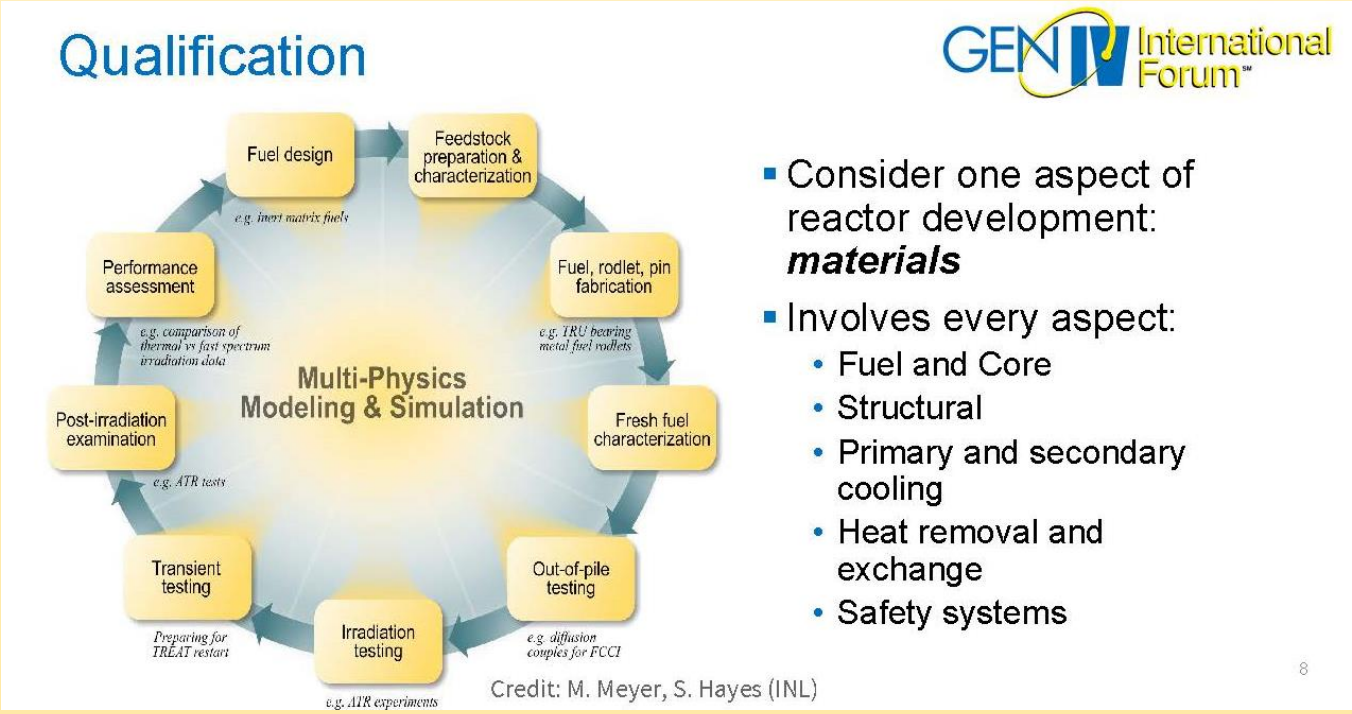
A host of novel fuel and material concepts are being investigated as part of the GenIV reactor development initiative. While many of these candidates are rooted in historical programs from previous reactor development campaigns, most of these concepts were never fully evaluated for long-term performance in non-LWR facilities. The performance data that is needed for candidate material **downselection, feasibility studies, and eventual qualification is, currently, very costly** in terms of monetary cost and human capital. The use of an **'all of the above' strategy for performance assessment** is needed to reduce the cost of ushering materials through the qualification process. In this presentation, we will discuss the efforts that are currently underway, and those planned for the near future, to advance many of these candidates from concept to deployment.

Meet the Presenter:

Dr. Daniel LaBrier is an Assistant Professor of Nuclear Engineering at Idaho State University. He earned his doctorate in nuclear science and engineering from ISU in 2013, with an **emphasis in irradiated materials characterization**. His research focuses on characterizing nuclear-grade materials that are exposed to extreme environments and nuclear reactor safety projects, including investigation of corrosion and erosion of structural materials relevant to LWR and advanced (SFR, MSR, HTR) systems. His research interests include **development and qualification of fuels and materials for advanced reactor concepts**, investigating thermal hydraulic effects on material performance, and used fuel recycling techniques. In the recent past, Dr. LaBrier has contributed to projects related to chemical effects testing for Generic Safety Issue (GSI)-191, **materials testing capability** development for the TREAT reactor restart, and design of advanced reactor testing systems. After serving as a post-doctoral fellow at the University of New Mexico and as a research professor at Oregon State University, Dr. LaBrier returned to ISU in March 2019 and maintains residence as a researcher at the Center for Advanced Energy Studies (CAES) in Idaho Falls, ID.

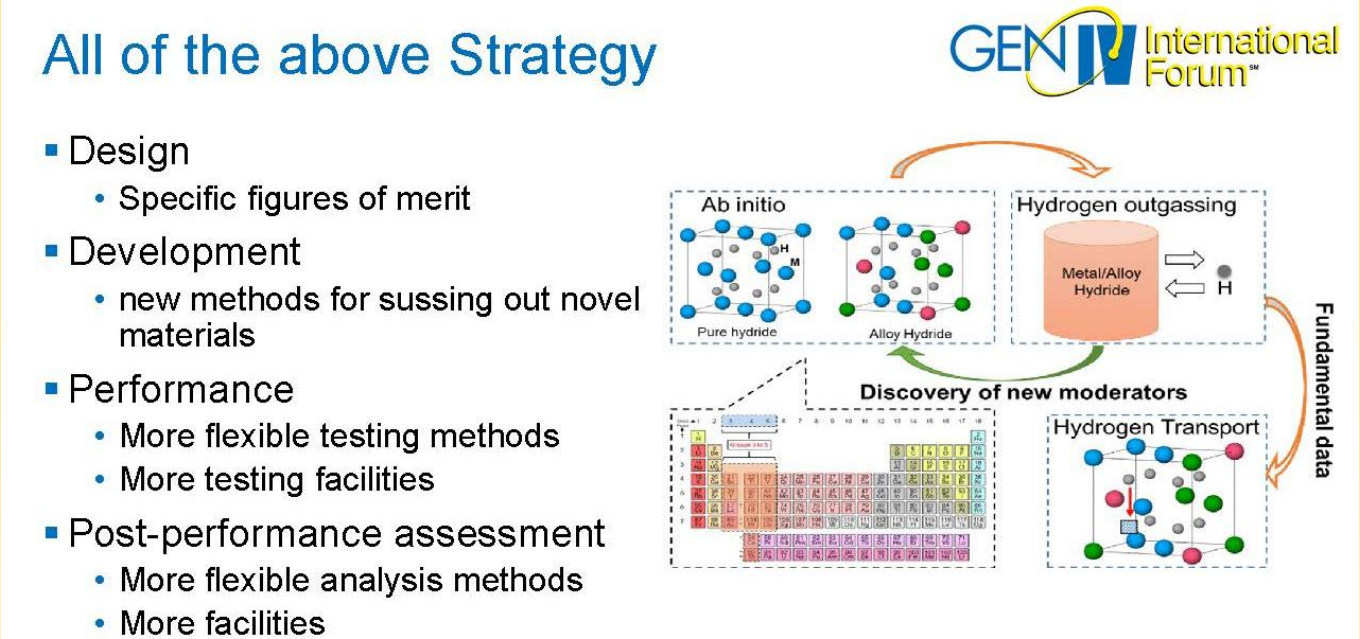
Impetus for 'all of the above' strategy

Qualification of fuels and materials for the construction and deployment of advanced nuclear reactors is a costly process. The qualification of a new fuel concept requires typically 20 years' worth of work, including **the acquisition of data necessary to narrow down candidate fuels and performance evaluation**. In order to introduce advanced nuclear reactors, we need to find a way to **streamline the process from the design to qualification**.



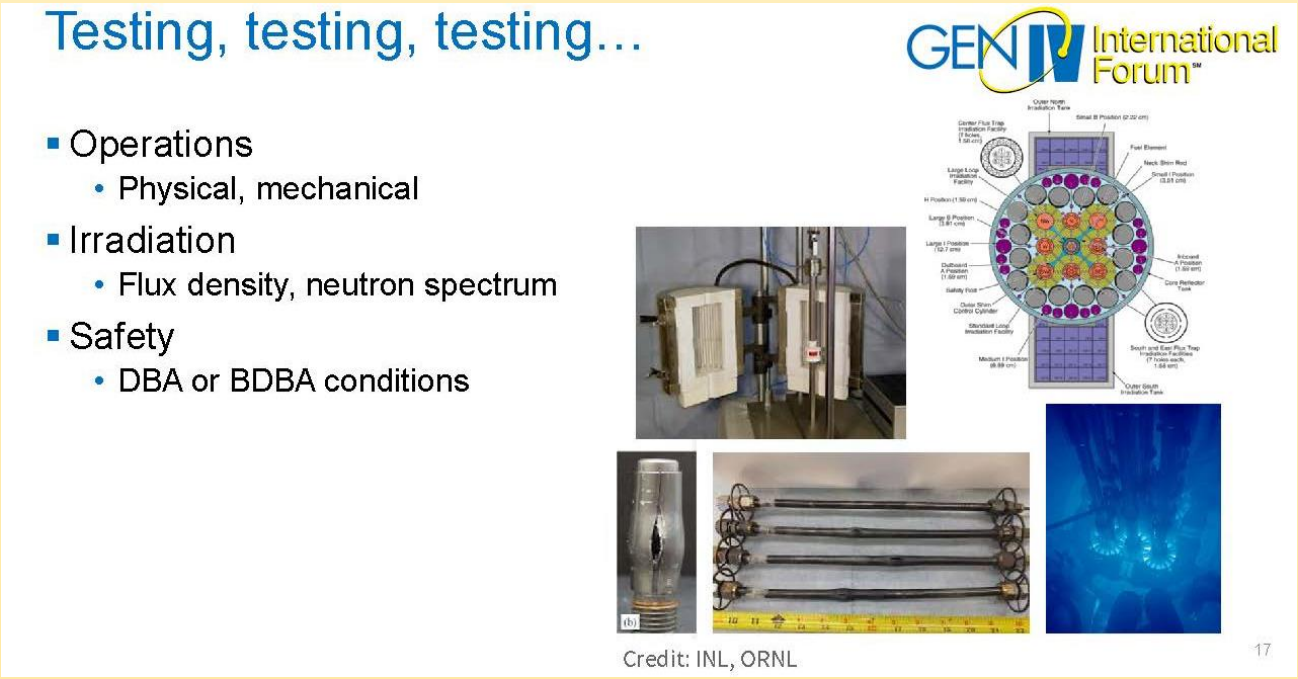
What exactly does 'All of the above' strategy mean ?

It means an innovative thinking to pursue more flexible testing and assessment methods for the reduction of the cost required for material qualification. Specific examples include **the introduction of the metrics that are not for nuclear applications but can be used for nuclear design, and the evaluation of material properties through modeling and simulation of atomic-level microstructures**.



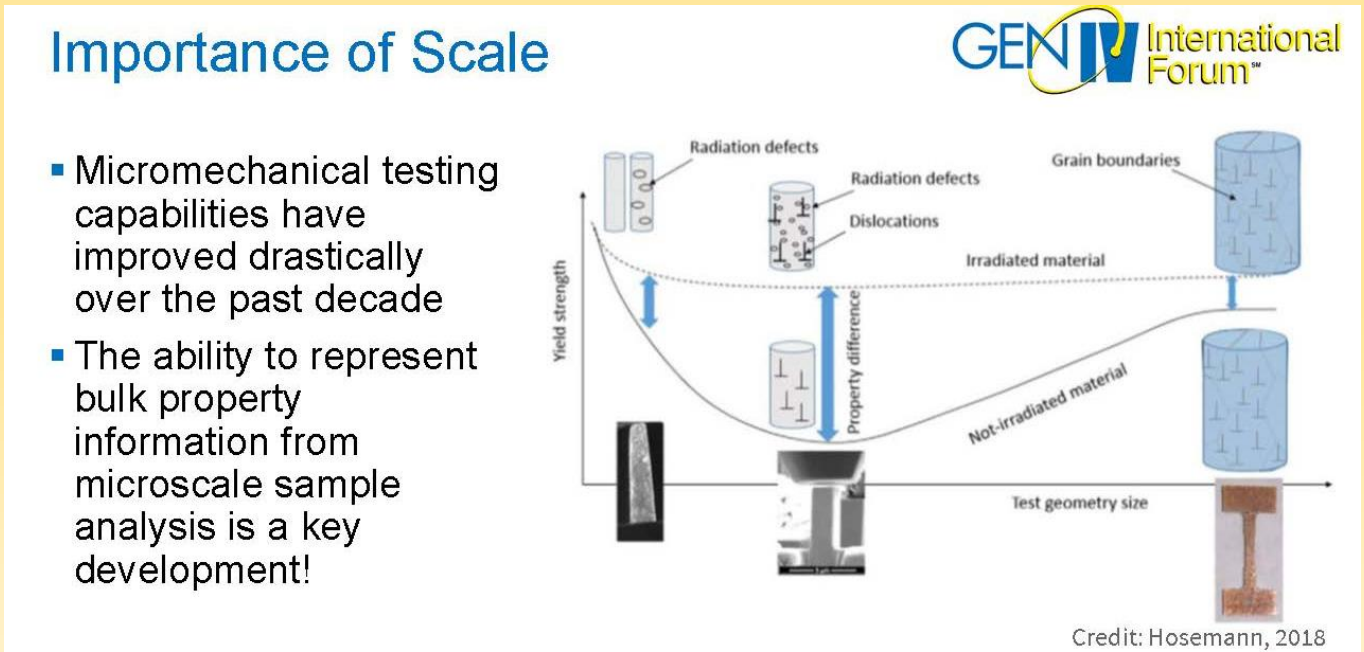
Response to the test need for the qualification

While modeling and simulation are very useful, well-vetted experimental data is crucial to the qualification process. The data vary widely depending on the type of reactor system, and the development of technologies and systems required for safety tests is a major challenge. Therefore, in addition to the utilization of existing test reactors, it is important to develop and **utilize all types of irradiation facilities including ion sources and accelerator systems, as well as material testing equipment that can be operated in university and industrial laboratories.**



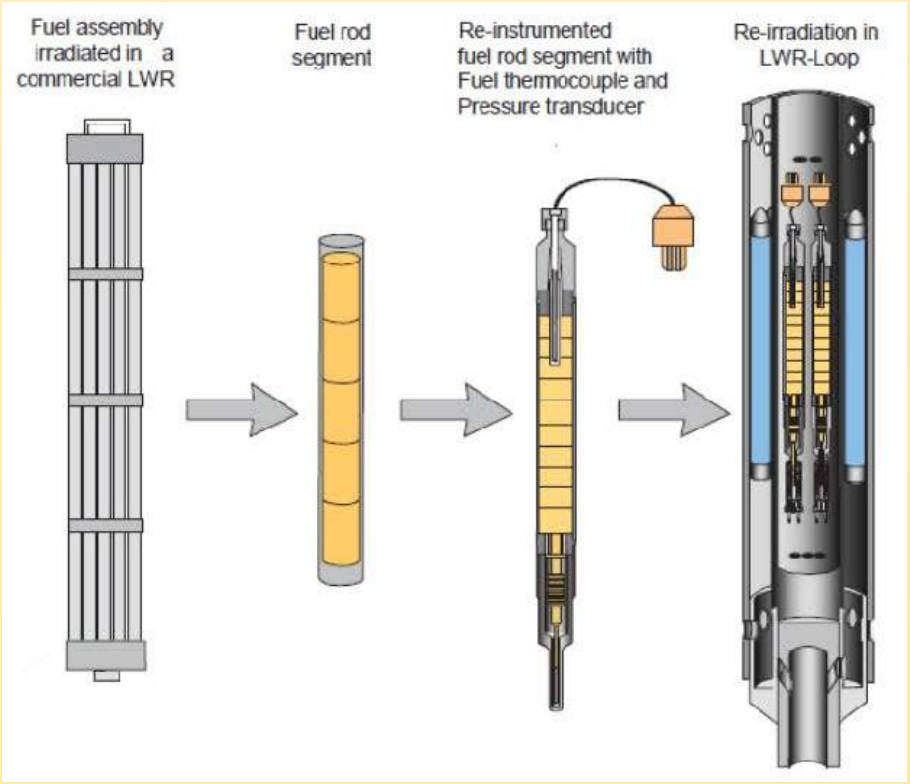
Progress in how to collect data and apply it to material qualification

Parallel testing of a large number of subdivided samples and reassembling of the collected data is one of the useful methods to reduce the cost of testing. A method to investigate bulk properties, which are important for material qualification, from microstructural analysis is also being developed.



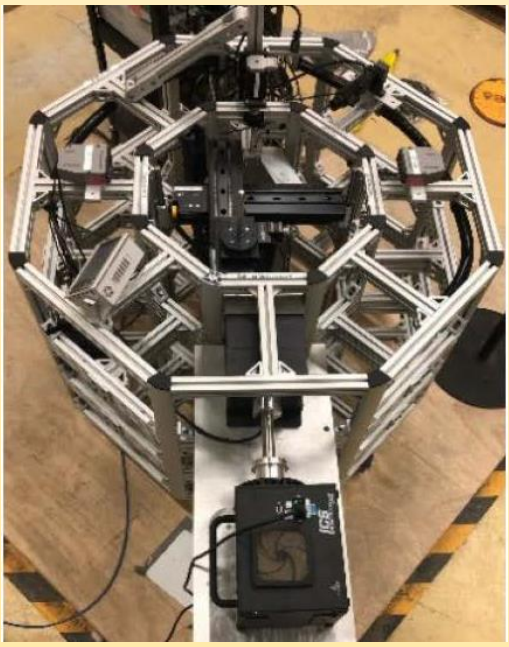
Reimagination of techniques

In order to efficiently obtain the data necessary for material qualification, various innovations need to be taken, such as constructing arrangement that allows as much information as possible to be obtained without repeating specific test processes.



Multiple test campaigns at Halden facility

(Irradiated fuel can be reloaded, re-irradiated, removed, and re-evaluated.)

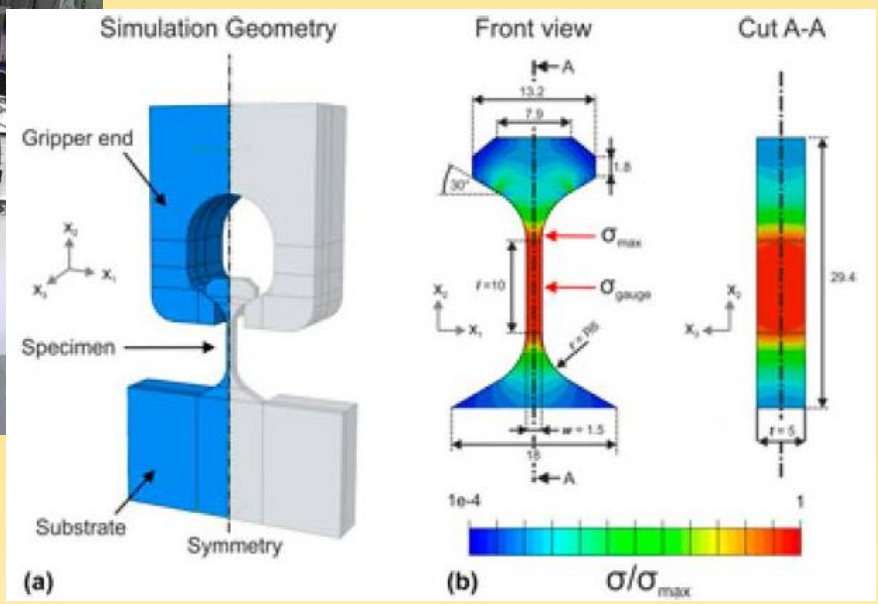


Multiple PIE

(A material sample is placed in the center of the device and can be inspected with multiple measurement tools around it.)

Robotics to improve efficiency

(Robot can move samples from one measurement device to the next and collect multiple data.)



FIB technology to create more samples

(It is possible to cut out small inspection samples from each one of fuel particles.)