INL/MIS-23-73534-Revision-0

NDMAS: Data storage, visualization, analysis, delivery, and more

July 2023

Courtney Mariko Yang Hui Otani

Changing the World's Energy Future

Idaho National Laboratory

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NDMAS

Data storage, visualization, analysis, delivery, and more

DOE ART Gas-Cooled Reactor (GCR) Review Meeting
Virtual Meeting
July 25 – 27, 2023

ART
Advanced Reactor Technologies

Motivation

- As scientists, we have a responsibility and a desire to properly preserve our very expensive, publicly funded data
- DOE Public Access Plan
- Users might include:
  - Reactor vendor engineers
  - NRC
  - Researchers
  - Universities

NDMAS Data

- Advanced Reactor Technologies
  - Fuel Fabrication
  - Irradiation Monitoring (Fuel & Graphite – near real-time)
  - Post-Irradiation Examination (Fuel & Graphite)
  - Graphite Characterization
  - High Temperature Materials Mechanical Tests
  - Methods Validation Data
    - JAEA's High Temperature Test Reactor
    - Argonne National Laboratory's Natural convection Shutdown heat removal Test Facility (NSTF)
    - Oregon State University's High Temperature Test Facility (HTTF)
- Other program data
  - Advanced Test Reactor operations (near real-time)
  - Accident Tolerant Fuel
  - TMIST (near real-time)
  - High Performance Research Reactor
  - European Mini-plate Irradiation Experiment (EMPIRE)
  - Advanced Fuel Campaign

Nuclear Data Management and Analysis System (NDMAS)

- Provide a controlled and central repository and data management system for R&D data
- Provide qualification traceability to level required in support of design decisions and licensing
- Provide extensive statistical analysis and graphing capabilities
- Enable access-controlled web delivery of data, graphs, and analysis results to the research community
- Provide web-based collaboration capabilities to the research community
- Provide an adaptive system to meet individual program needs


ARE YOU SURE THIS IS HOW WE GET DATA INTO THE CLOUD?
IT

NDMAS Data Processing Model

Data Owner

Capture

- Programmed data capture from files
- Multiple checks on process integrity

Archive

- Original data file, codes, and completed QA forms are retained
- Stored on the servers

Storage

- Secure file storage using robust servers
- Data storage in relational database
- Version control of codes, documents, and source data

Qualification

- Meet NQA-1 data requirements
- Ensure data integrity from capture to delivery
- Process tracking of code & webpage changes

Delivery & Analysis

- SharePoint and SAS VA web interface
- Access controlled
- Data tables (downloadable)
- Graphical displays
- Advanced statistical analyses

End User

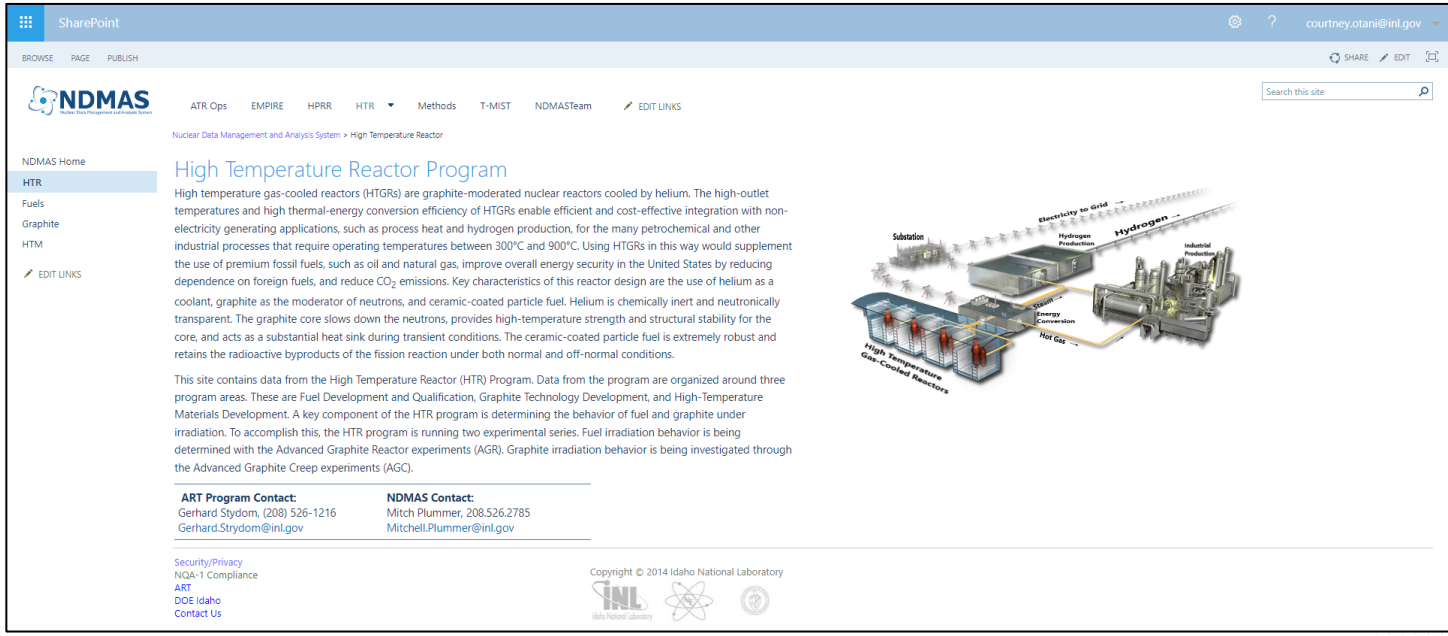
Data Storage
NDMAS 2.0 Database

- Data that need to be readily accessible for analysis and dissemination are stored in the database
- Structured Query Language relational database
  - Uses Microsoft SQL Server technology
  - Database structure (schema) is customized for each project
  - Efficient and customizable visualization and reporting
- Access
  - Access to database structure controlled to NDMAS team only
  - Access to data within database controlled with approved authentication
- Quality
  - Conforms to INL Information Management standards
  - Operates within framework of NQA-1 2008 / NQA-1a-2009 Addenda

Reference: SDD-228 Rev. 1, “NDMAS 2.0 Database,” March, 2015.

Web Delivery

- Uses SharePoint with SAS VA to deliver experimental results to the program community over the Internet
  - Downloadable data tables
  - Graphs
  - Analysis results
- Full access control
  - In INL's DMZ
  - Role-based
    - Sites
    - Subsites
  - Row-level data security



Fuel Fabrication

SharePoint

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BROWSE PAGE PUBLISH

NDMAS
Nuclear Data Management and Analysis System

ATR Ops EMPIRE HPRR HTR Methods T-MIST NDMASTeam EDIT LINKS

Nuclear Data Management and Analysis System > High Temperature Reactor > Fuel Development and Qualification > Fuel Fabrication

- NDMAS Home
- HTR
- Fuels
- **Fuel Fabrication**
  - AGR-1 Fabrication
  - AGR-2 Fabrication
  - AGR-3/4 Fabrication
  - AGR-5/6/7 Fabrication
- Fuel Irradiation
- Fuel Post-Irradiation Examination
- AGR Compact Summary

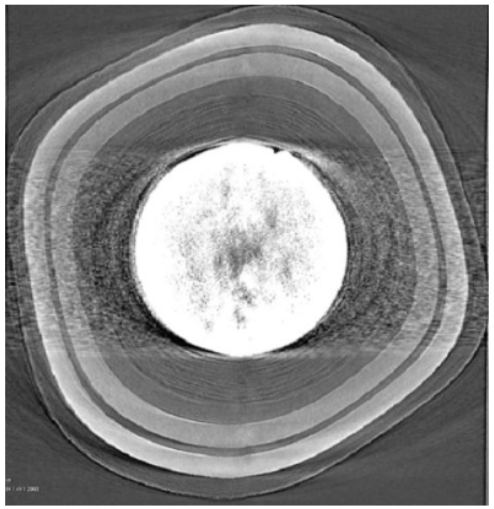
Fuel Fabrication

The Fuel Fabrication project develops and qualifies fuel fabrication processes that can serve as the foundation for fabrication of commercial-scale, coated-particle fuel for HTGRs. The fabrication process developed within the VHTR TDO/AGR fuel program begins with UCO or UO2 kernels formed by the internal gelation process in which droplets of uranium-containing chemical broth are formed into gel spheres in a fluid medium. The resulting gel spheres are then dried and sintered into hard ceramic spheres yielding kernels of a controlled and consistent size and chemistry.

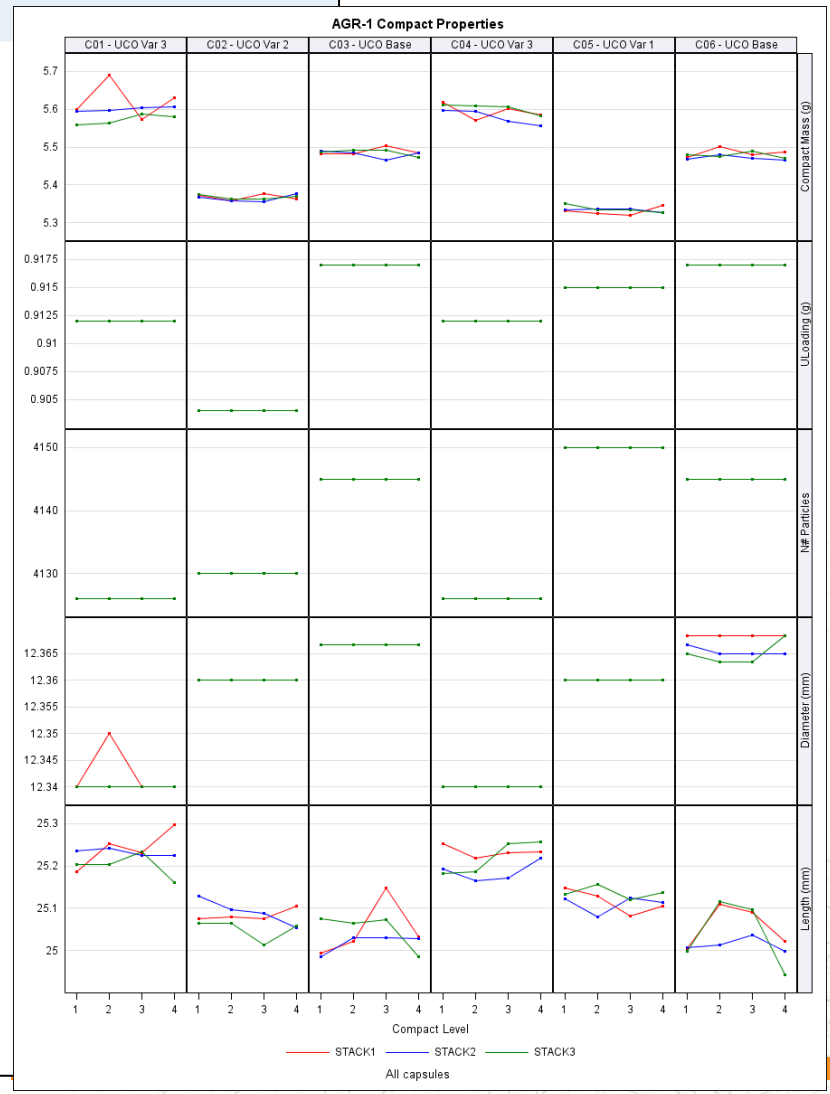
Fuel kernels are coated using a fluidized-bed chemical vapor deposition process. The coatings include a low-density carbon layer (buffer layer), a high-density inner pyrolytic carbon (IPyC) layer, a silicon carbide (SiC) layer, and a high-density outer pyrolytic carbon (OPyC) layer. These coatings are designed to work together to make each fuel particle a mini pressure vessel that will maintain its integrity and retain fission products during normal reactor operation and potential accident conditions. The finished coated particle is a small (~1 mm diameter) carbon and ceramic sphere that is stable to temperatures well beyond 1,600°C.

Fuel particles are embedded in a thermosetting matrix consisting of phenolic resin mixed with graphite powder and molded into right-circular cylinders. Each cylinder is called a compact. A compact contains from 1,800 to 4,200 particles depending on the uranium loading per kernel and the desired total uranium content per compact. Each AGR capsule contains only one fuel variant.

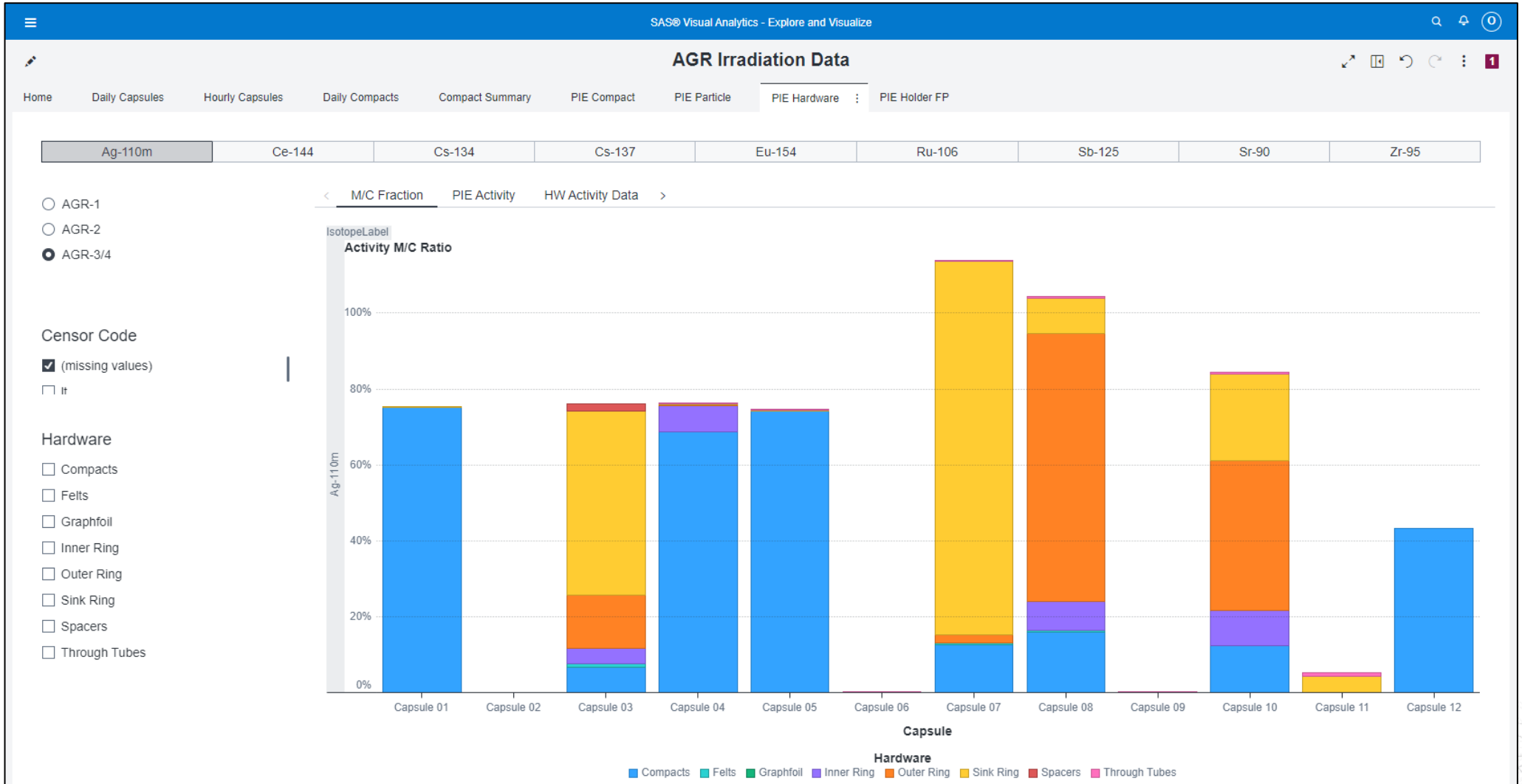
Data were received as PDF files on a CD and were manually transferred into an EXCEL spreadsheet. The data were then read into SAS datasets from the EXCEL spreadsheet. The referential integrity of the data was evaluated to make sure that all components, component attributes, response variables, and response values were properly linked. The SAS datasets were then transferred to the NDMAS SQL database for permanent storage. Data were then pulled from the SQL database and compared to the SAS dataset used to populate the database using a SAS procedure (PROC-COMPARE), verifying that the data in the SQL database are the same as the data in the SAS datasets. Finally, the data in the SQL database output were compared to the original data in the data packages by an independent person. For fabrication data, the delivered hard copy data packages are served as the quality record showing whether the predefined design specifications were met or have been accepted as is. Because all laboratories providing data are either NQA-1 compliant or were assessed to have QA programs that were equivalent to NQA-1.



Tomographic cross-section of a particle with extra outer layers

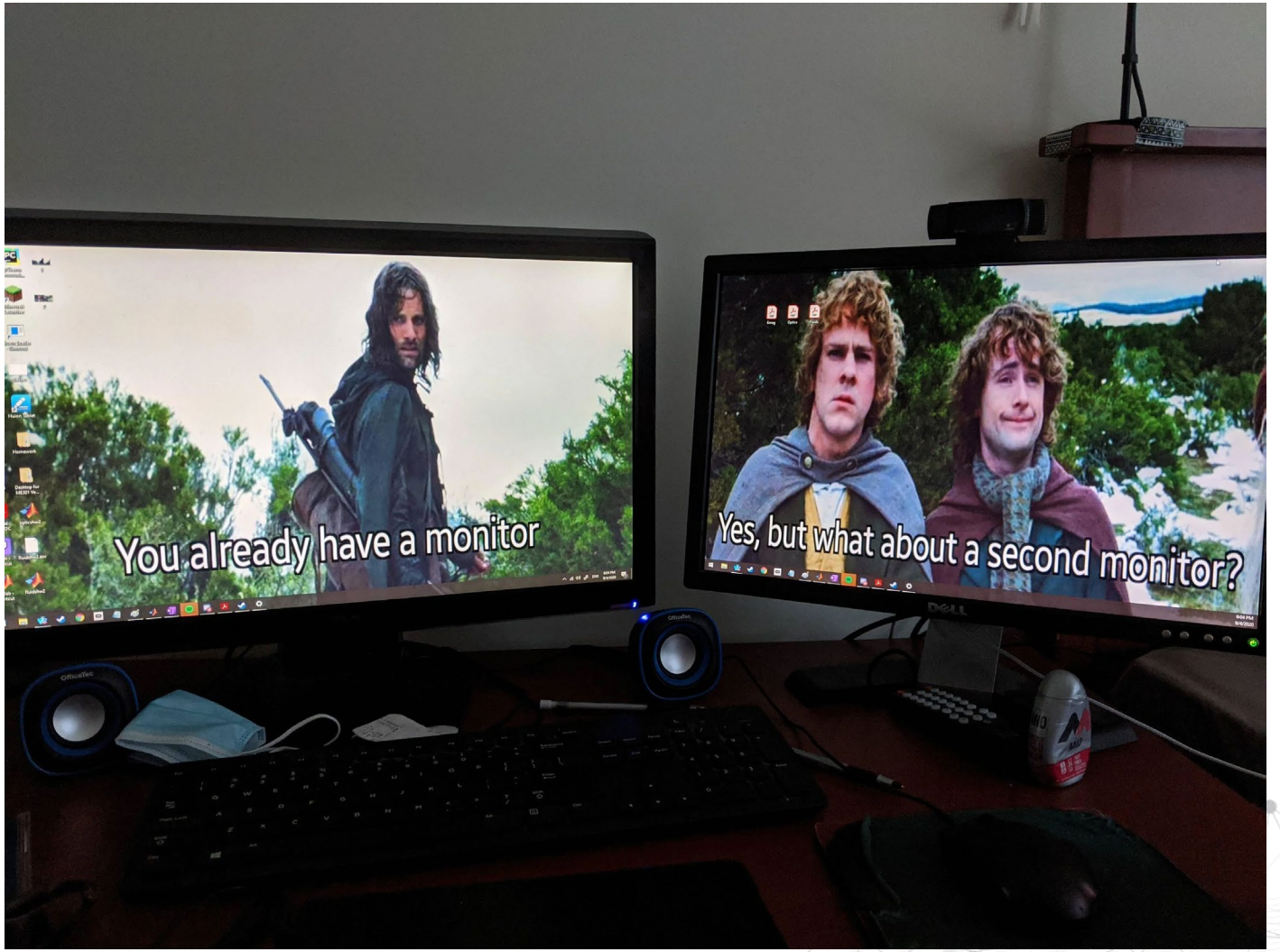


PIE

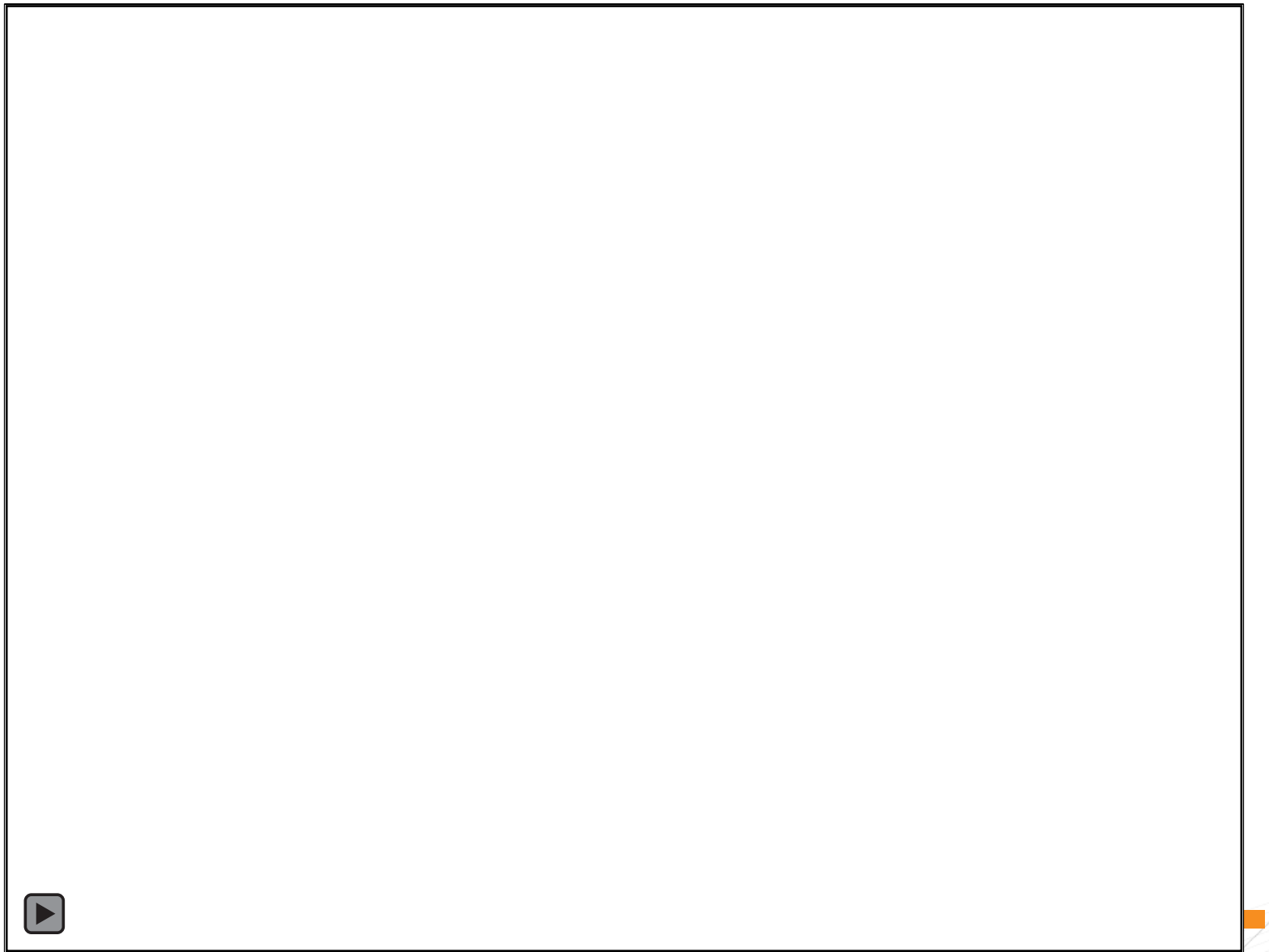

SAS® Visual Analytics - Explore and Visualize
AGR Irradiation Data
Home
Daily Capsules
Hourly Capsules
Daily Compacts
Compact Summary
PIE Compact
PIE Particle
PIE Hardware
PIE Holder FP
Ag-110m
Ce-144
Cs-134
Cs-137
Eu-154
Ru-106
Sb-125
Sr-90
Zr-95
AGR-1
AGR-2
AGR-3/4
M/C Fraction
PIE Activity
HW Activity Data
IsotopeLabel
Activity M/C Ratio
Censor Code
(missing values)
Hardware
Compacts
Felts
Graphfoil
Inner Ring
Outer Ring
Sink Ring
Spacers
Through Tubes
100%
80%
60%
40%
20%
0%
Ag-110m
Capsule 01
Capsule 02
Capsule 03
Capsule 04
Capsule 05
Capsule 06
Capsule 07
Capsule 08
Capsule 09
Capsule 10
Capsule 11
Capsule 12
Capsule
Hardware
Compacts
Felts
Graphfoil
Inner Ring
Outer Ring
Sink Ring
Spacers
Through Tubes

ATR Experiment Monitoring Capabilities

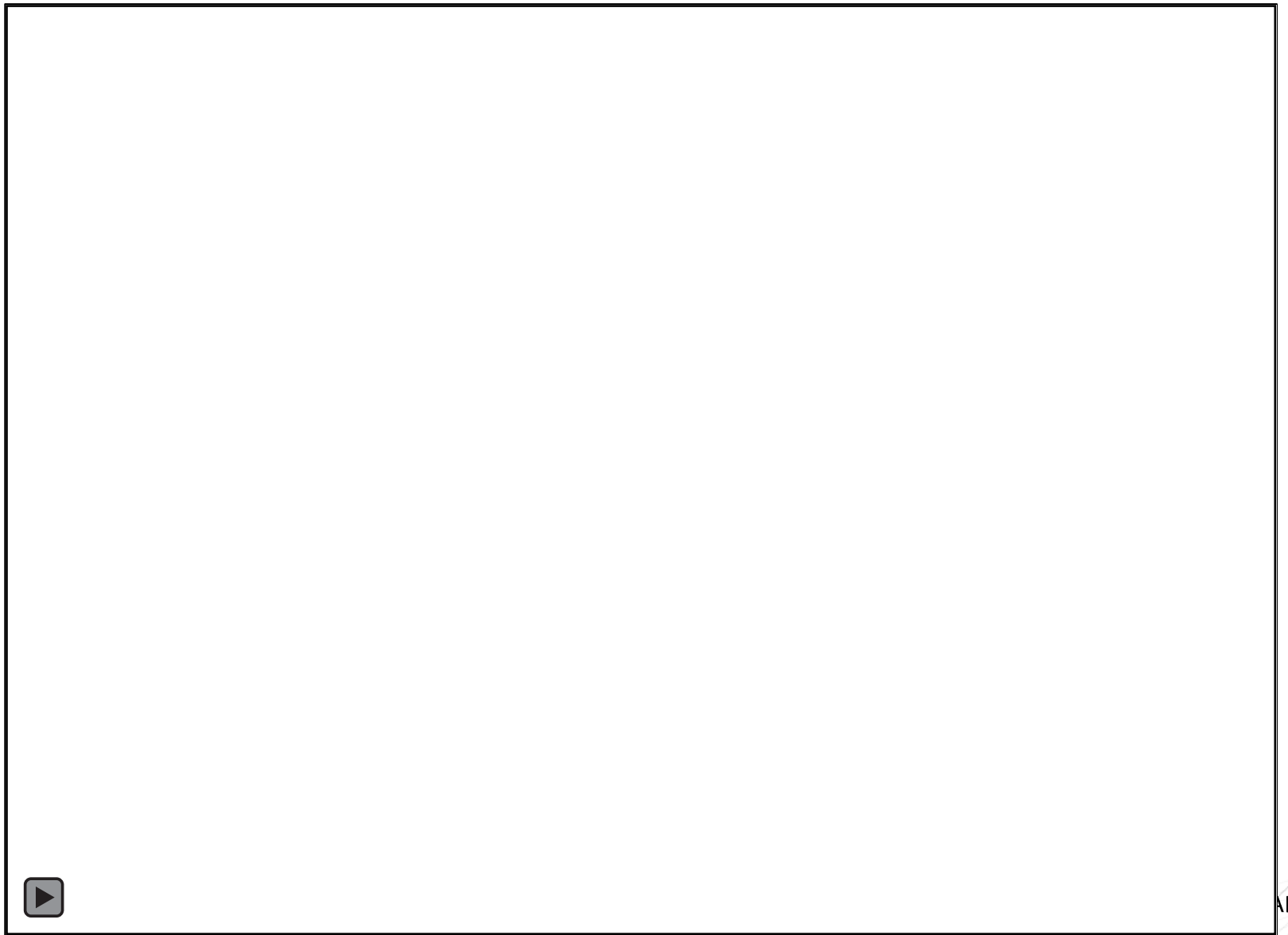
- Reactor power and experiment monitoring data that are delivered several times a day
- Data are processed and pushed to the database immediately
- Data and plots are updated in SAS at least once a day
- Researchers can view most recent plots or download data
- Excel files for data from completed experiments have been generated and stored in SharePoint libraries for easy access



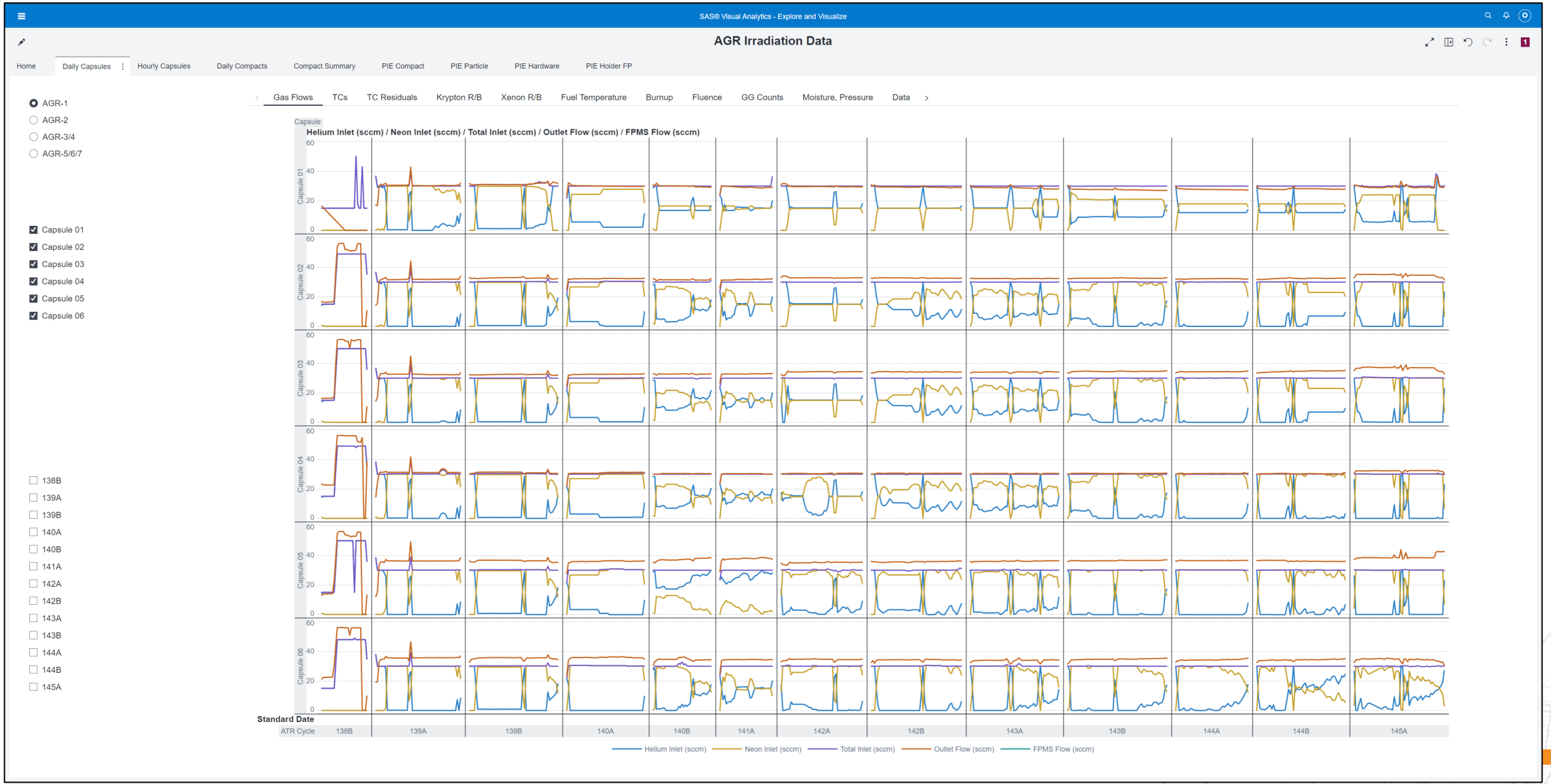
ATR Operations



Advanced Gas Reactor Irradiation Monitoring



Advanced Gas Reactor Irradiation Monitoring



Documents

- All controlled documents are stored in EDMS
- SharePoint libraries can be used to store and organize important documents that need to be more accessible
  - As a file (pdf or word document)
  - As a link to OSTI or EDMS (only accessible within the firewall)
- Term Sets can be used to categorize documents if desired
- Custom search applications can be developed as needed
- All documents included would have to have a full LRS release
- Currently we only have select reports stored in SharePoint

Example: Fuel Irradiation Web Page

Data Qualification and Analysis Documents

The reports listed below are not record copies and may not represent the most recent version. The INL Electronic Document Management System (EDMS) should be used to provide the record copy of the document. The ECARs listed below have a direct link to EDMS. Unfortunately, these links will not work for users outside the INL firewall. External users who wish to obtain a copy of a document stored in EDMS should contact Courtney Otani, 208-526-1228.

Name	Document ID
Experiment : AGR-1 (9)	
AGR-1 Thermocouple Data Analysis	INL/EXT-12-24761
AGR-1 Final As-Run Report Rev3	INL/EXT-10-18097
AGR-1 JMOCUP As-Run Daily Depletion Calculation	ECAR-958
AGR-1 Daily As-Run Thermal Analysis	ECAR-968
Release-to-Birth Ratios for AGR-1 Operating Cycles 138B through 145A	ECAR-907
AGR-1 Data Qualification Report	INL/EXT-10-17943
Uncertainty Quantification of Calculated Temperatures for the AGR-1 Experiment	INL/EXT-12-25169
AGR-1 Irradiation Experiment Test Plan Rev 3	INL/EXT-05-00593
AGR-1 Test Specification Rev1	EDF-4731
Experiment : AGR-2 (8)	
Experiment : AGR-3/4 (10)	
Experiment : AGR-5/6/7 (8)	

Working and Interfacing with NDMAS

- Working with NDMAS
  - Meet to discuss needs
  - NDMAS team members become members of your team
  - Database or tables are set up
  - Delivery is set up
  - Iterative process
  - Set up for next data set or stream will utilize established work
- New users
  - Request account by sending email to ndmas-webadmin@inl.gov
  - Need an INL POC to verify their need to access data
  - A restricted party screening is run
  - International employees require a security plan
  - They will be added to one or more SharePoint (and SAS if needed) security groups based on the data they need to access

Process for Completed Experiments

- As experiments close out, convert most data downloads to downloadable Excel files
- At end of project
  - Records retention 25 years past end of the project
  - Archive raw data files and the database to EDMS
  - As long as possible with minimal intervention:
    - Maintain the database
    - Maintain the web site
    - Add new users

FY 23 Accomplishments and Look Ahead

- All milestones completed on time
  - March- Presentation to HTR TWG
  - June- Updated thermal model for AGR-5/6/7 to analyze shifting holder position
  - July- Revised dimensional change analysis report with AGR-5/6/7 data
- New major project set up
  - Gen IV Materials Handbook learning and transition to INL initiated in tight collaboration with Oak Ridge
  - Primary execution to begin in FY 24
- Improving delivery system
  - Updating delivery system to increase capabilities
  - Training with vendor to maximize use of tool
- Formalizing access process for AGR data
  - Updating so DOE and AGR program access requirements are met