



# DOE Microreactor Program

# Legacy Fuel Qualification Update

## Technology Maturation Panel

GAIN-EPRI-NEI Microreactor Program  
Workshop  
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# Background

## SFR metallic fuels data (Fuels Irradiation and Physics Database: FIPD)

### Content Highlights

#### IFR Operational Details

- Experiment objectives
- Pin design specs/measurements
- Loading configurations
- Reactor run details / power levels

#### Operating Conditions

- Thermal data
- Neutronics data
- Isotopic data

#### PIE Measurements

- Profilometry
- Gamma scans
- Neutron radiography
- Plenum gas details

#### Document Library

- Design descriptions
- Run reports
- Analysis of data
- Loading Diagrams
- Safety documents

### Fuel Characteristics

#### Fuel Composition

- U-xPu-10Zr (x = 0, 3, 8, 19, 22, 26, 28)
- U-xZr (x = 2, 6, 10)

#### Cladding Types

- 316SS, D9, HT9

#### Smeared Density

- 58 – 90%

#### Plenum/Fuel ratio

- 1 – 3

#### Fuel Diameter

- 0.168 – 0.313 in  
(0.427 – 0.795 cm)

### Pin Operating Conditions

#### Peak Linear Power

- 10 – 19 kW/ft  
(33 – 62 kW/m)

#### Peak Burnup

- 0.5 – 20 at%

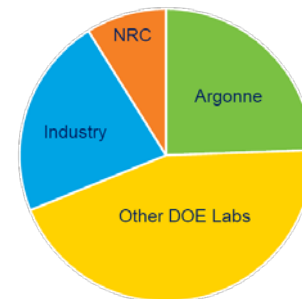
#### Peak Fuel Temp

- 630 – 800 °C

#### Peak Clad Temp

- 490 – 660 °C

### FIPD Users

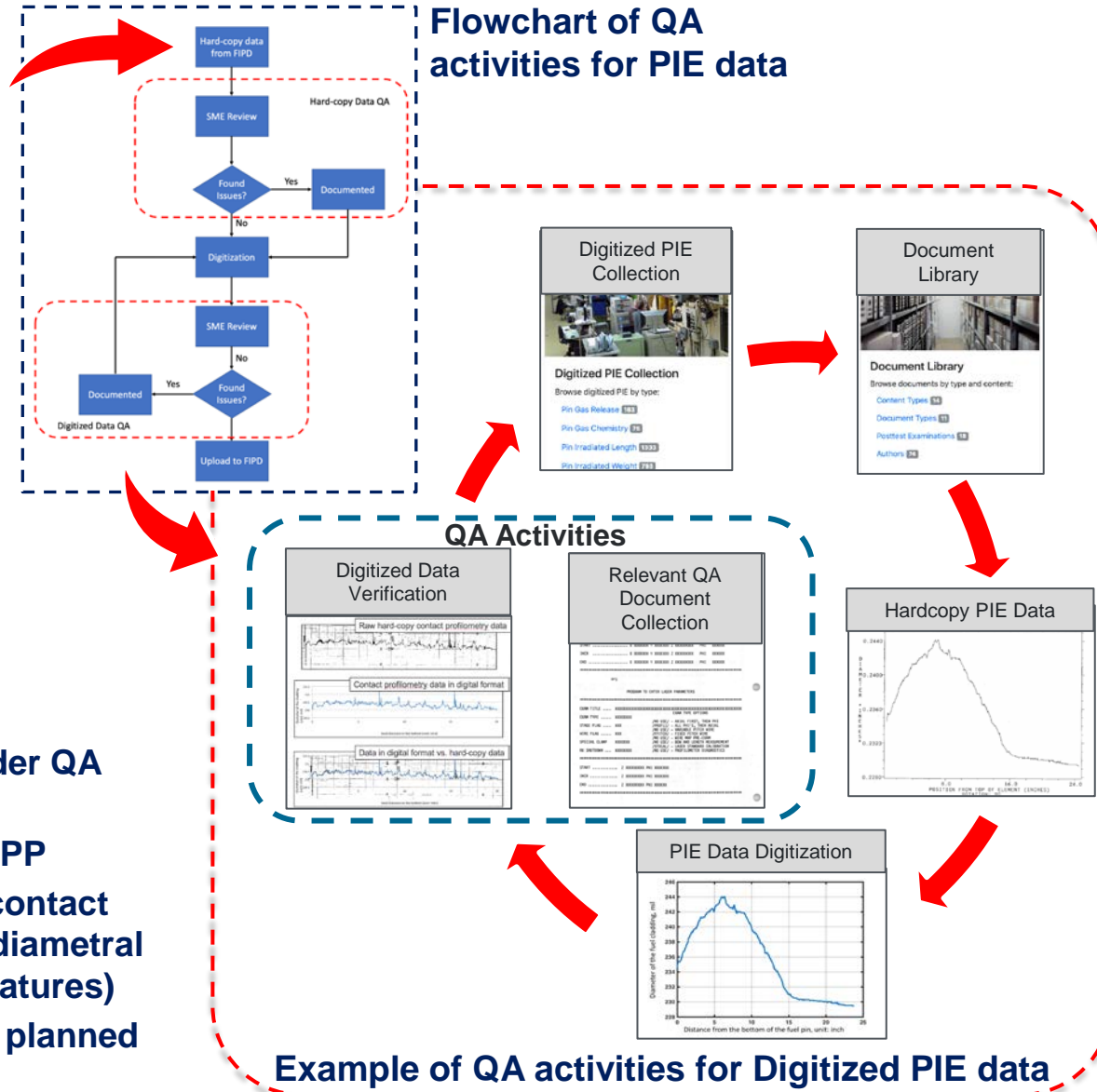


# PIE Data and QA Activities

## Massive PIE data in FIPD under QA

Type of Data	Description
Bow measurements	Pin bow measurements
Fission gas analysis data	Pin fission gas analysis data
Fission gas chemistry data	Pin fission gas chemistry data
Fuel redistribution	Pin fuel redistribution results
Gamma scans	Pin isotopic/gross gamma scans
Laser profilometry	Pin laser profilometry traces, taken as multiple angles
Length Measurements	Pin length measurements
Metallography data	Pin metallography data
Neutron radiography	Pin neutron radiographs
Contact Profilometry	Pin contact profilometry traces
S/A disassembly photos and/or information	Subassembly disassembly photos / information
S/A profilometry data	Subassembly profilometry data / traces
S/A radiography	Subassembly radiographs
Strain data	Pin strain data
Swelling data	Pin swelling data
Visual exam photos/data	Pin / Subassembly visual examination photos / data
Weight data	Pin weight data
Other HFEF data	Other HFEF results

## Flowchart of QA activities for PIE data

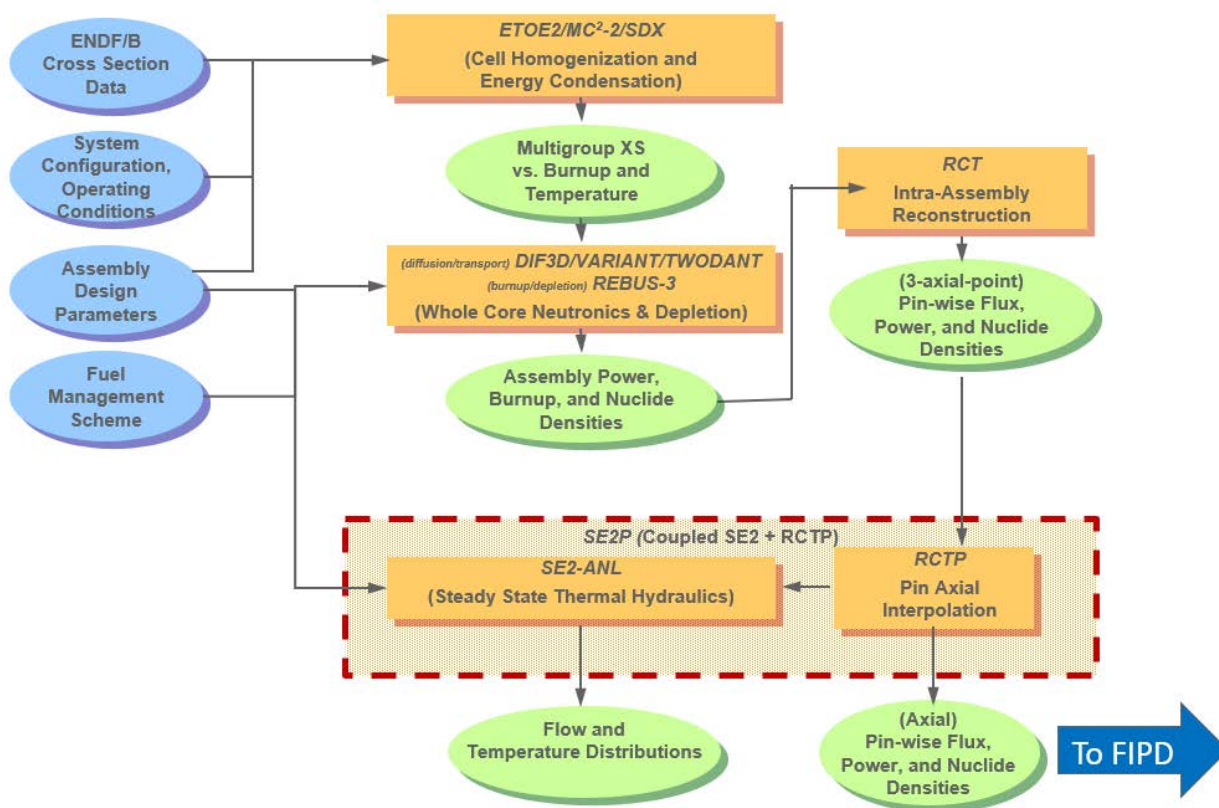


- More than 18 types of PIE data are under QA
- The QA activities were performed by implementing the ANL QAPP and SQAPP
- The focus in FY20 is QA activities on contact and laser profilometry data (cladding diametral strain in different burnups and temperatures)
- Major part of important PIE data QA is planned for completion in FY21

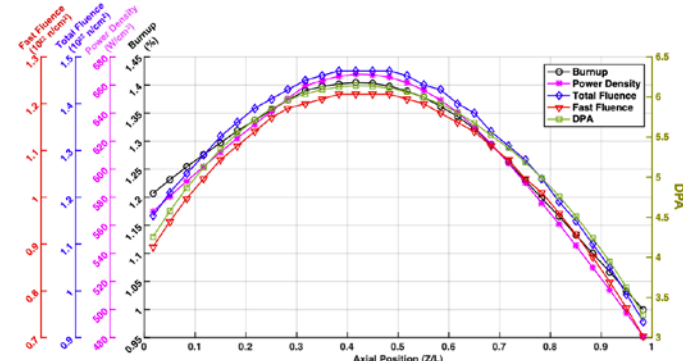
## Example of QA activities for Digitized PIE data

# Calculated Operating Data

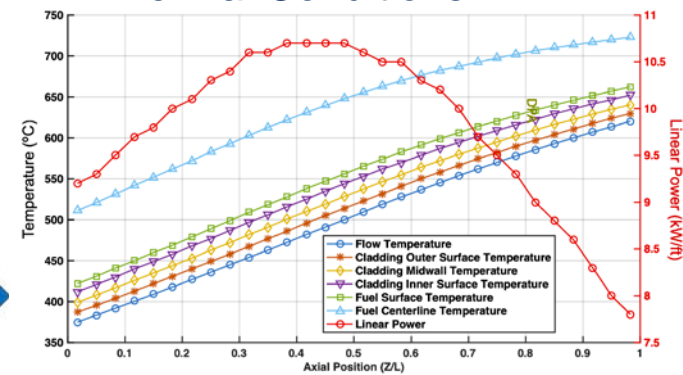
Operating conditions calculated using a collection of codes



## Neutronics Data



## Thermal Conditions



Operating data is provided as axial profiles, calculated per pin for each run, for all pins in FIPD

X447/DP14/148B

- Thermal Data: Linear Power, Temperature (Coolant, Cladding OD/MW/ID, Fuel OD/centerline)
- Neutronics Data – Burnup, Fluence (Fast, Total), Power density, DPA
- Isotopic Data – U, Pu, Actinides, Fission products

Currently available data in FIPD is based on legacy calculations

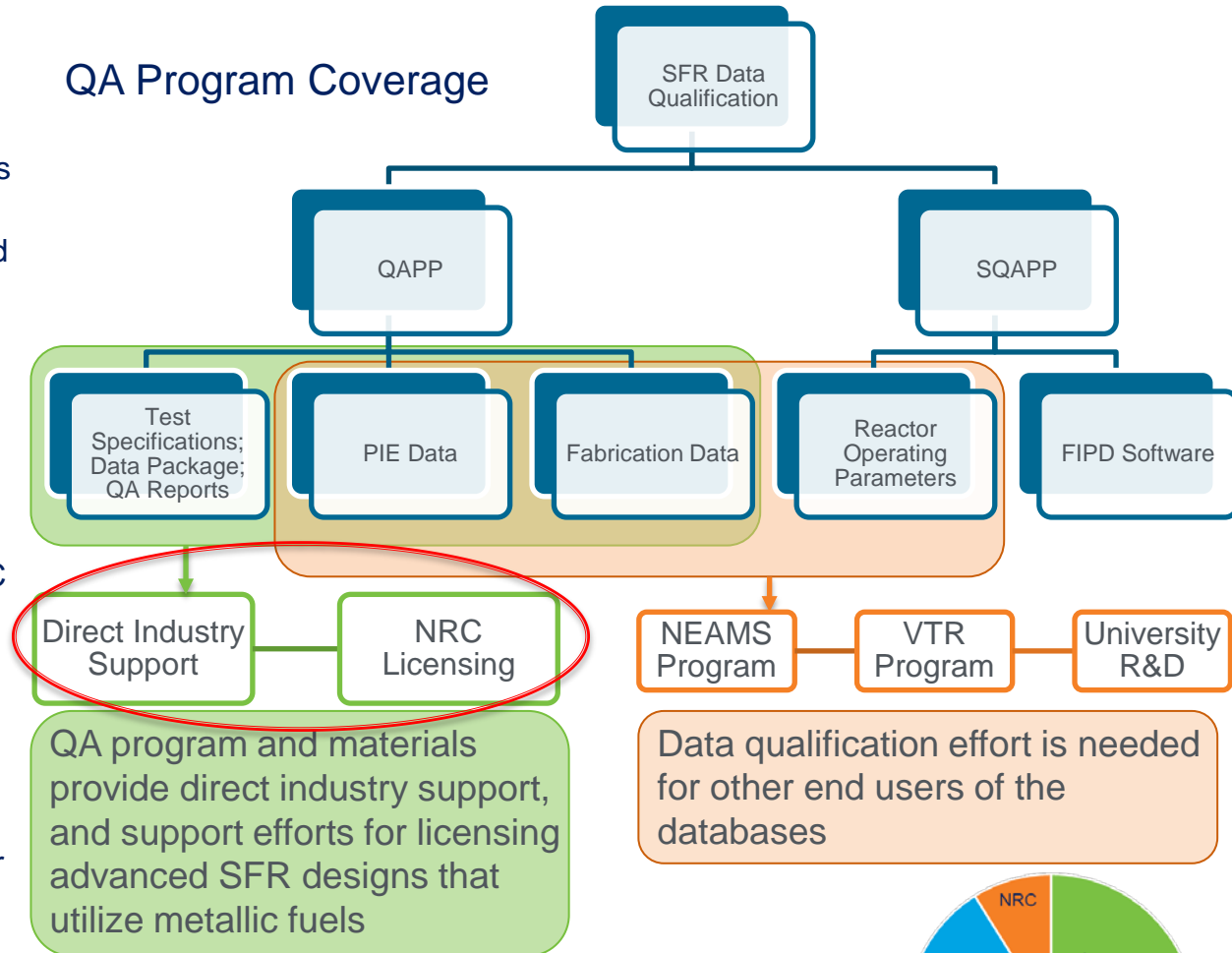
QA efforts underway to review input and data files for issues, regenerate results, and correct any inconsistencies

# Quality Assurance and End Users

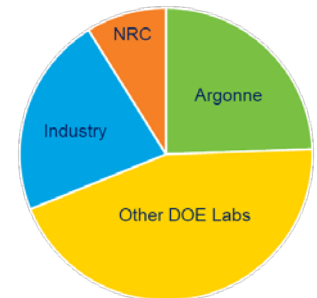
## Key FY20 QA Accomplishments:

- NRC approval of the QAPP
- Support of Oklo licensing activities
- Continued QA of digitized PIE materials
  - Specifications of the contact profilometry data were developed
  - Contact profilometry data: 154 pins (4 experiments) QA'd (many other completed FY19)
  - Laser profilometry data: 480 datasets in 11 pins of X441 went through QA
  - Gamma scan data: 285 datasets in 22 pins of X423C went through QA
- QA of reactor operating parameters
  - Completed regeneration of all RCT input data from records, regeneration of SE2P results
  - Comparison of legacy and regenerated operating parameter data ongoing

## QA Program Coverage



## FIPD Users



# Future work plans and priorities

- Industry licensing support (SFR working group/NRC communication)
  - Metallic fuel based designs (Oklo, TerraPower, ...)
- QA of Test Specifications, Data Package, Fabrications, and QA Records
  - Pin profilometry specification (2020, INL requested); Radiography data (2020-2021); Gas release data QA document (2021)
- Validation of PIE Data
  - Complete reviewing contact and laser profilometry data (2020-2021)
  - Other PIE data: gas release data, fuel swelling (2020-2022)
- QA of Reactor Operating Parameters
  - Review and correction of calculated operating parameters; QA review of associated software packages
  - Documentation of calculation procedures and data sources
- QA of FIPD Software
  - Develop test suite and automated testing system to verify prescribed functionality
  - Documentation of FIPD functions and procedures



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