AFCP
Advanced Fuel Cycle Programme

Nuclear Data for Advanced Fuel Cycles

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Outline

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- About Advanced Fuel Cycle Programme
- Introducing nuclear data
- Nuclear data for Advanced Technology Fuel (ATF)
- Developing tools for an advanced fuel cycle (FISPIN11)
- Nuclear data for advanced reactors

About AFCP

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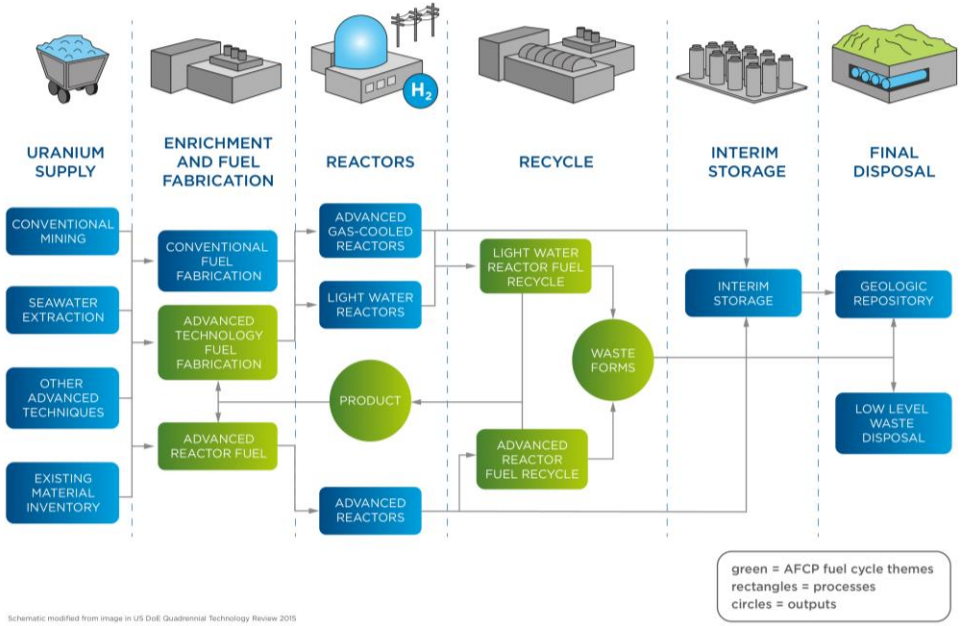
- £46m investment by UK Government into nuclear science and technology
- Supporting research across the fuel cycle, including enabling capabilities
- Involvement of over 90 organisations across the UK including universities and businesses
- Capability and capacity building



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Nuclear data for beginners

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- Computational modelling is dependent on data that describes the physical parameters of nuclides
- Tens of thousands of measurements have been made experimentally throughout the years
- Processed through the nuclear data lifecycle and international collaborative projects to build libraries:
  - **JEFF-3.3**
  - **ENDF/B-VIII.0**
  - **TENDL-2019**

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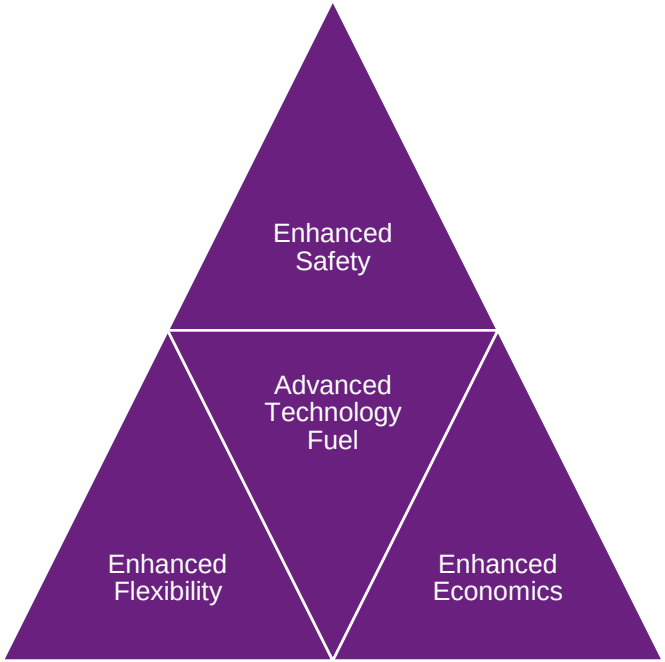
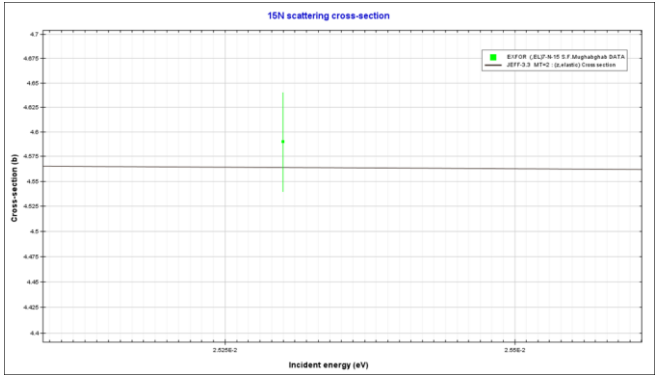
Drivers for ATF

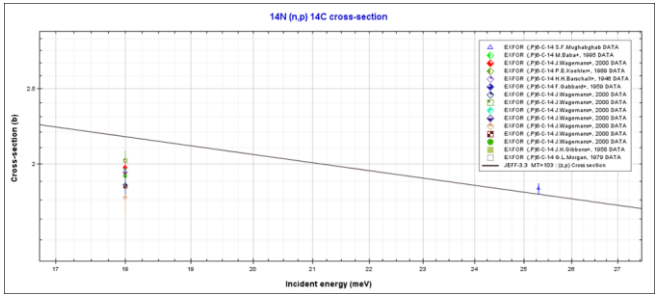
- ATF – ‘Accident Tolerant Fuel’ borne out of the Fukushima Daichii Accident
- Initial focus on safety, however UK research programmes aligned with Westinghouse have moved to recognise what would drive operators to adopt ATF
- Fuel needs to be attractive to reactor operators, so production routes and total cost need to be comparable with UOx
- Lends itself to fuels that can reach higher burnup to account for higher cost



Review of the Data

- No criticality or reactor benchmarks that allow the current nuclear data to be verified for nitride fuels in thermal reactors
- The nitrogen scattering cross-sections for 14N and 15N in the thermal range have little justification
- The 14N (n,p) cross-section measurements differ by about 5% and this is the major source of neutron absorption in nitrogen, reducing the confidence in existing basic nuclear data.
- The 14N capture cross-section differ by 7% but is a small component to the total neutron absorption.
- **Current data would not be suitable for fuel qualification under the UK regime**





Criticality Benchmarks

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- Review of data available in ICSBEP and open literature has failed to reveal any criticality benchmarks for nitride fuels in thermal reactors
- Some useful benchmarks have been identified in the expected fuel route (uranyl nitrates)
- Additional useful operating experience is noted with fast reactors
- Other identified UN studies also highlight the same paucity of data as a limitation

Assessing Sensitivity

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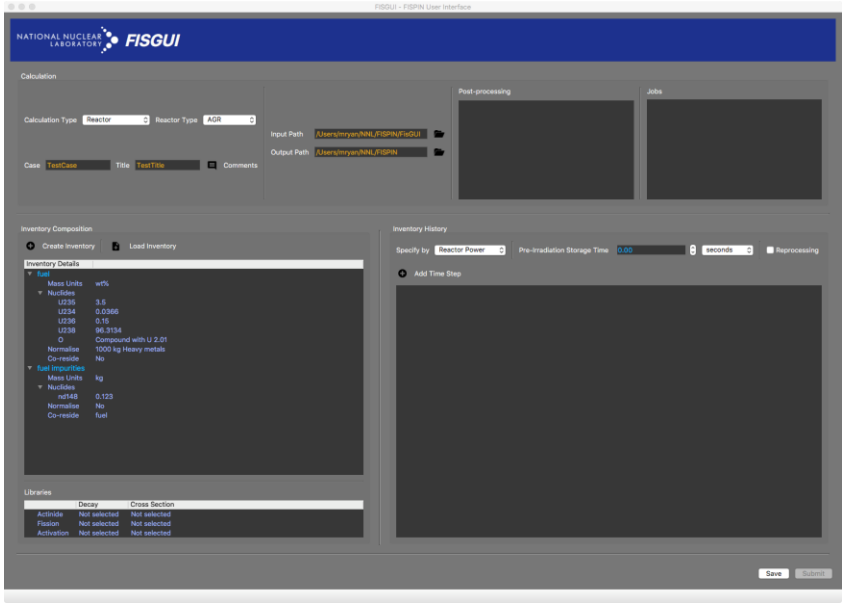
- Following initial review, currently in the process of developing sensitivity models to define measurement requirements

MCNP	WIMS
• Provides assessment of sensitivity using Monte-Carlo code • Allows adjustment of continuous cross-sections in nuclear data libraries to investigate sensitivities	• Deterministic code which is currently default neutronics code for UK applications • Aim to demonstrate if there are additional sensitivities that are exposed in the deterministic method

FISPIN Uncertainty Handling

- FISPIN is the UK spent fuel inventory code
- It's performance is well understood for existing fuels and reactors, however inventory calculations for advanced systems may introduce greater uncertainties
- To start testing this, under AFCP we've been developing FISPIN's uncertainty handling capability, making use of the embedded uncertainty information in nuclear data, to assess the resultant uncertainties in the inventory
- Need to understand the impact now, to focus improvements



Advanced Reactors

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- AFCP is focused on developing capability and knowledge on **fuel** development for advanced reactors
- Key reactors of interest in the UK are **High Temperature Gas Reactors** and **Liquid Metal Fast Reactors**
- Integrated programme means our Nuclear Data activities are spread across the range of projects to support future requirements

U236 fission fragment measurements

- Improving the correction to the angular distribution for fission of U236

Solid state inverse kinematics

- Improved (n,alpha) measurements on the bulk fuel component

Prompt gamma measurements @ n_ToF

- Improving prompt gamma measurements for U235, Pu239

Fast reactor cladding

- Providing early assessment of potential nuclear data implications from suggested cladding materials

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Conclusions

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"Programme elements such as Nuclear Data and Nuclear Physics relevant to the sector are vital enabling capabilities without which the UK nuclear sector cannot function"

External Review of the Advanced Fuel Cycle Programme by Dame Sue Ion and Mike Tynan

This work was funded under the £46m Advanced Fuel Cycle Programme as part of the Department for Business, Energy and Industrial Strategy's (BEIS) £505m Energy Innovation Programme.

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Any questions?

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