INTEGRATED DIGITAL NUCLEAR DESIGN PROGRAMME

Integrated Nuclear Digital Environment

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Context

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Purpose → Help nuclear industry exploit benefits of Industry 4.0

Provide digital tools on an integrated platform → Reduce costs throughout the nuclear lifecycle

Provide digital tools on an integrated platform → Deliver cultural change across the industry

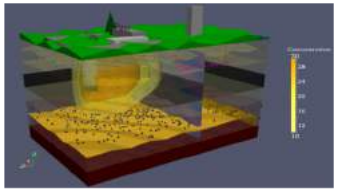
Design Standardisation:
Make UK the hub of the world's nuclear energy markets generating revenue & Sustain 30k jobs in the nuclear sector

Vision

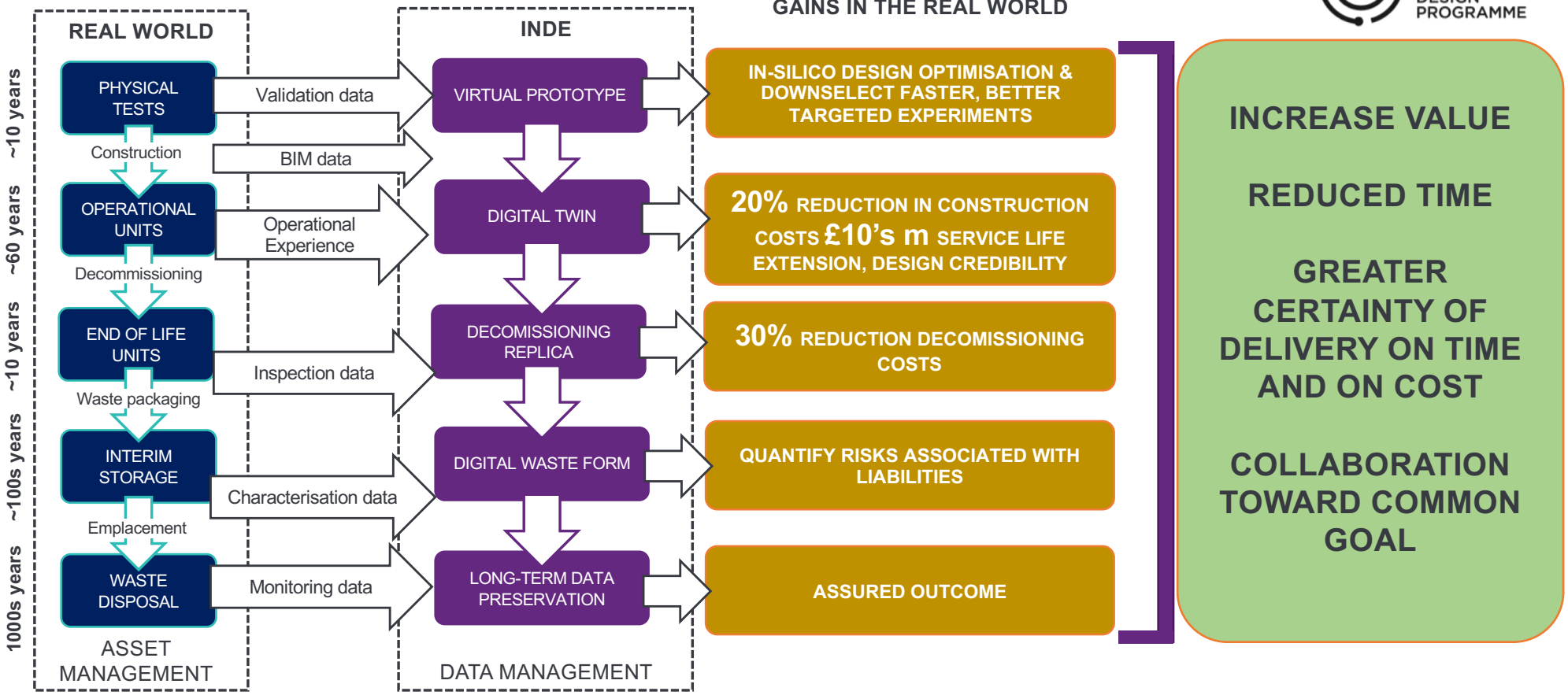
Nuclear engineering of the future, across the whole nuclear lifecycle:

- **Integrated simulation**
- **Trusted in-silico simulation**
- **Faster / (lower cost) Increased Value**
- **Easily auditable decisions**
- **Appropriate application of VR and AR**
- **Integrated smart systems**
- **Real-time monitoring and diagnosis**

End-to-end integration for the design licensing of future nuclear plant



Vision – Integrated Nuclear Digital Environment



Patterson EA, Taylor RJ & Bankhead M, A framework for an integrated nuclear digital environment, *Progress in Nuclear Energy*, 87:97-103, 2016

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Multiscale & Multiphysics Digital Twin

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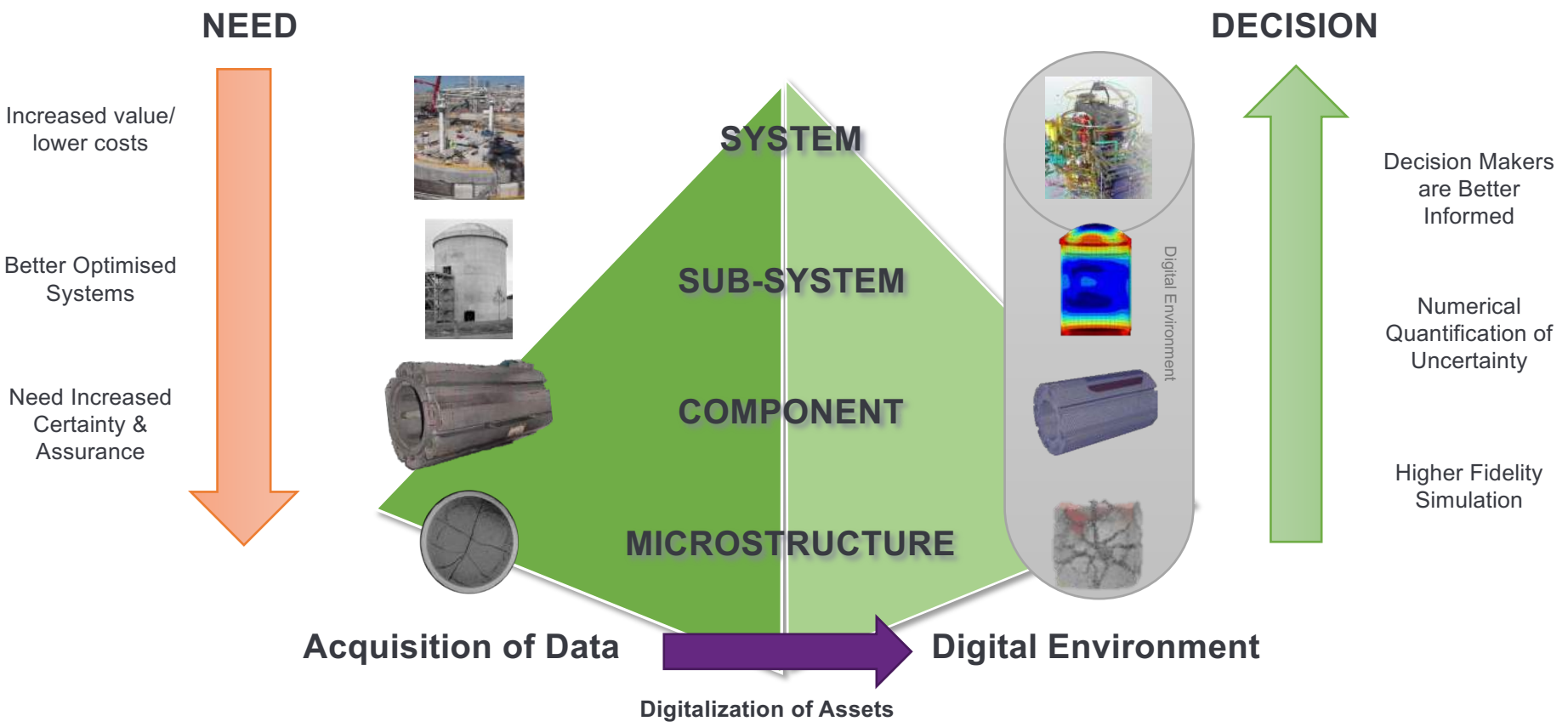
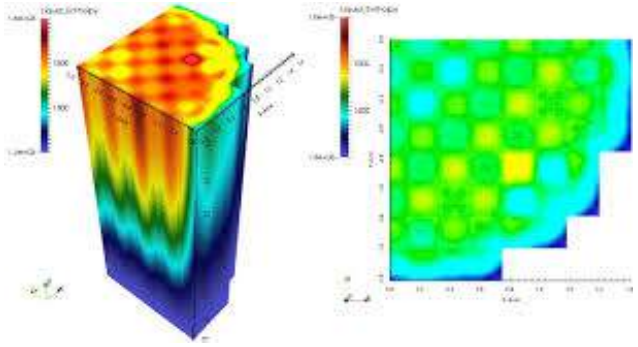
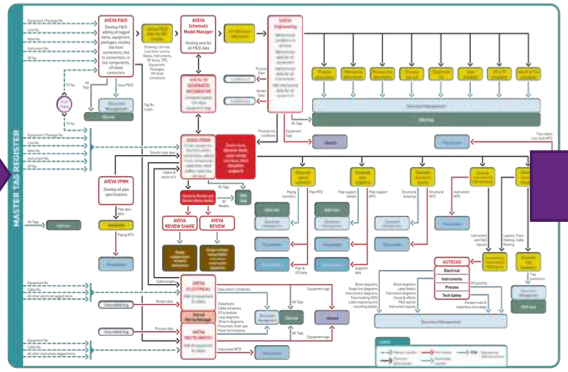


Vision - Joining the Dots…….





Integrated Reactor Simulation

- Nucleonics
- Thermal Hydraulics
- Structural

Data Centric Engineering

- Mechanical
- Civil
- Instrumentation & Control

Digital Twin

- BIM Level 3 compliant
- 4D Construction planning
- E-working

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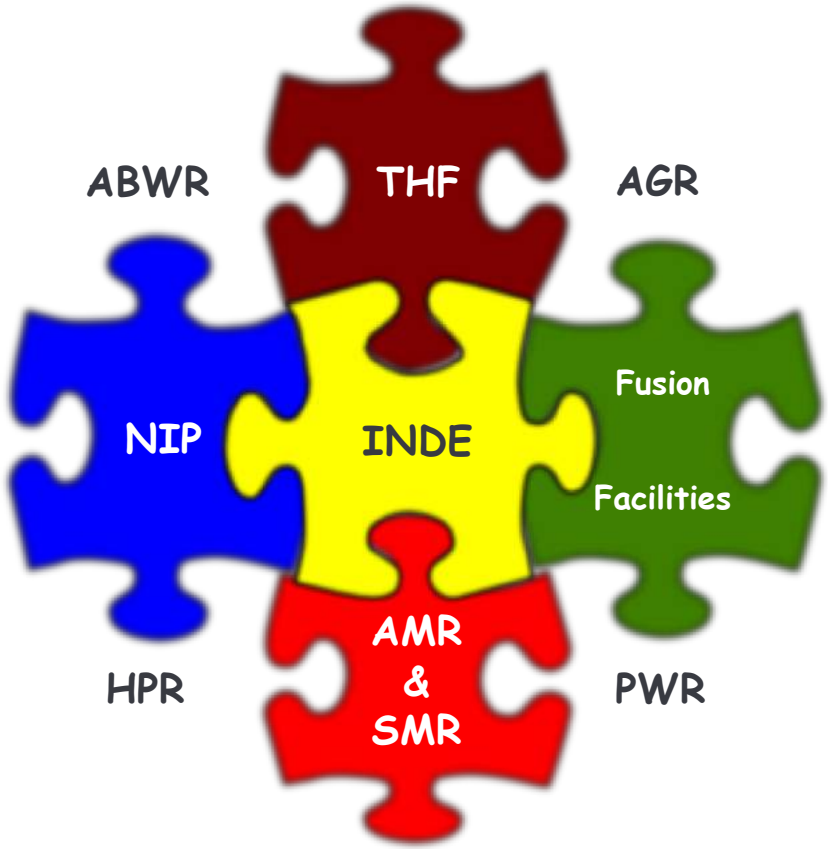
the nuclear institute

Digital Special Interest Group

Innovate UK Knowledge Transfer Network

Digital Built Britain

Vision – Programme Integration



INDE can be the Master Data Configuration environment for all programmes and could be the digital environment for the:

- **North Wales Thermal Hydraulic Facility**
- **UKAEA Fusion Facilities (FTF & H3AT)**
- **AMR Programme**
- **SMR Programme**
- **R&D under the Nuclear Innovation Programme**

Phase 1 Progress – Highlights

Objective	Delivered
Develop engagement plan	Maximised engagement and understood state-of-the-art
Industry requirements capture	Clarified end-user requirements
Develop test cases to prove concept	Real life AGR and PWR test cases
Develop INDE framework architecture	Sufficient to prove the concept
Integrate simulation codes into INDE	Simulation codes support test cases but also integrated for future use
Prove INDE concept via test cases	Demonstrated code coupling and seamless data sharing across five organisations
Provide HPC linkage	Successful demonstration of HPC linkage for test cases
Develop Safety and Security roadmap	Covers IP concerns, data and info security and policy/guidance
Develop Commercialisation roadmap	To be completed

Phase 1 Progress – Engagement

Capturing requirements and industry perspective

- 15/07/2017 in Knutsford
- 02/08/2017 in Birchwood
- 25/09/2017 in Daresbury
- 14/09/2018 in Birchwood

Updating on progress and continued feedback

- 03/05/2018 in London
- 27/09/2018 in Liverpool

Specific integration sessions

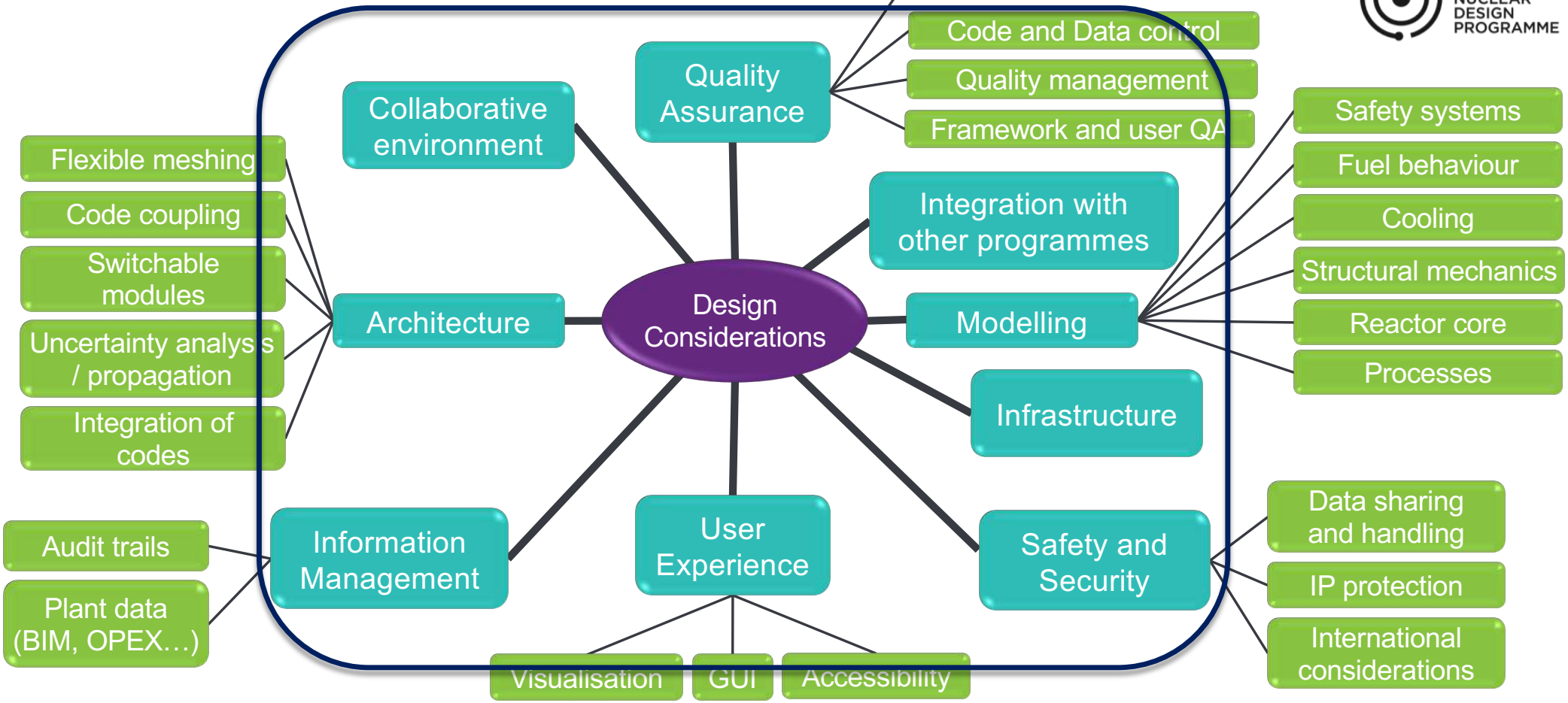
- 11/04/2018 in Warrington
- 30/05/2018 in Birchwood
- 26/07/2018 in Culham
- 08/08/2018 in Gloucester
- 24/09/2018 in Rotherham
- 12/11/2018 in Bangor

International collaboration

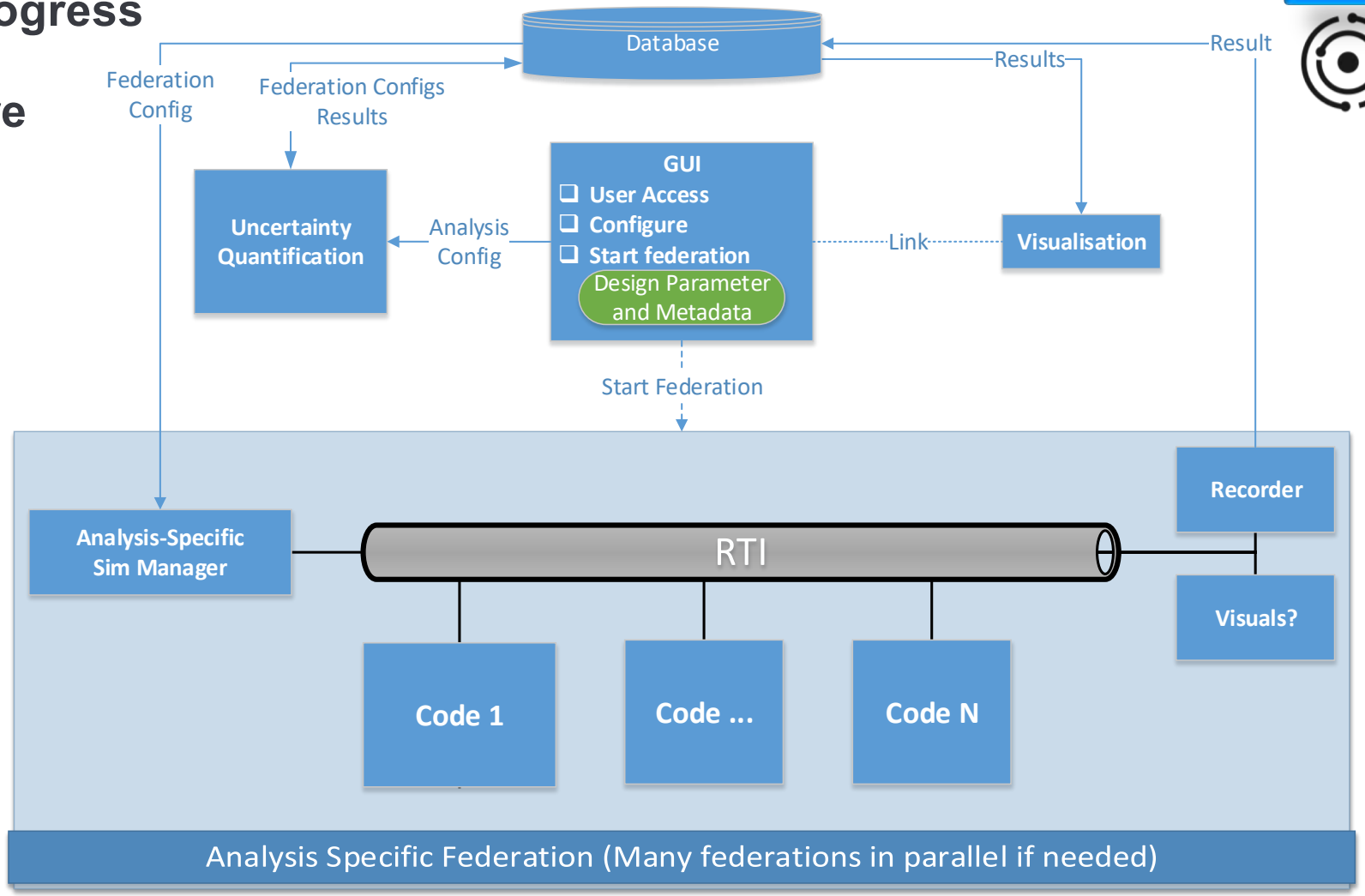
- 05/02/19 – 07/02/19 in Daresbury with ORNL/CASL
- 02/02/18 in Daresbury with ORNL

https://www.digitalnucleardesign.com/

Phase 1 Progress Design Considerations



Phase 1 Progress Framework Architecture



Phase 1 Progress – Proof of Concept

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Integrator

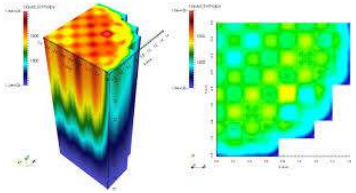
ROLLS ROYCE

Faster & more reliable → Lower Cost solutions

Higher fidelity simulation → Innovation

Evidence for decision making → Lower cost regulation

Sharing software whilst protecting IP → Collaborating to reduce costs



Hartree Centre

HPC

Information & Data Exchange Software Framework

VIRTUAL ENGINEERING CENTRE

UNIVERSITY OF LIVERPOOL

wood.

WIMS, MCBEND

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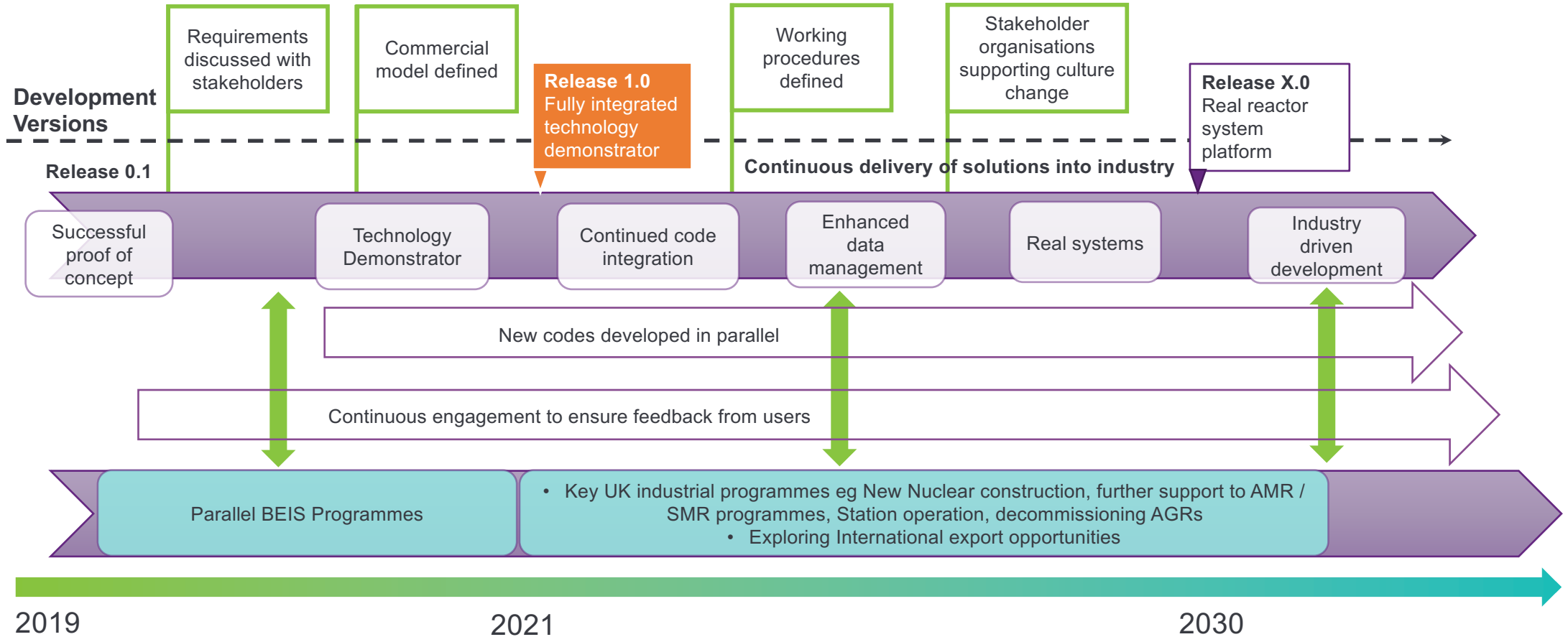
Roadmap – now to 2030



Conclusion

- Vision is ambitious and aims to bring cross-sector learning
- INDE would
  i. lower costs across the whole nuclear lifecycle
  ii. facilitate lower cost of regulation
  iii. support increased innovation and facilitate cultural change
  iv. align to Industry 4.0
- Our approach targets early industrial uptake
- Phase 1 has delivered a proven concept and defined the key factors for subsequent phases

Acknowledgements

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