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STELLAR

Development of a Unique Concept Neutron Irradiation Facility

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16th March 2023

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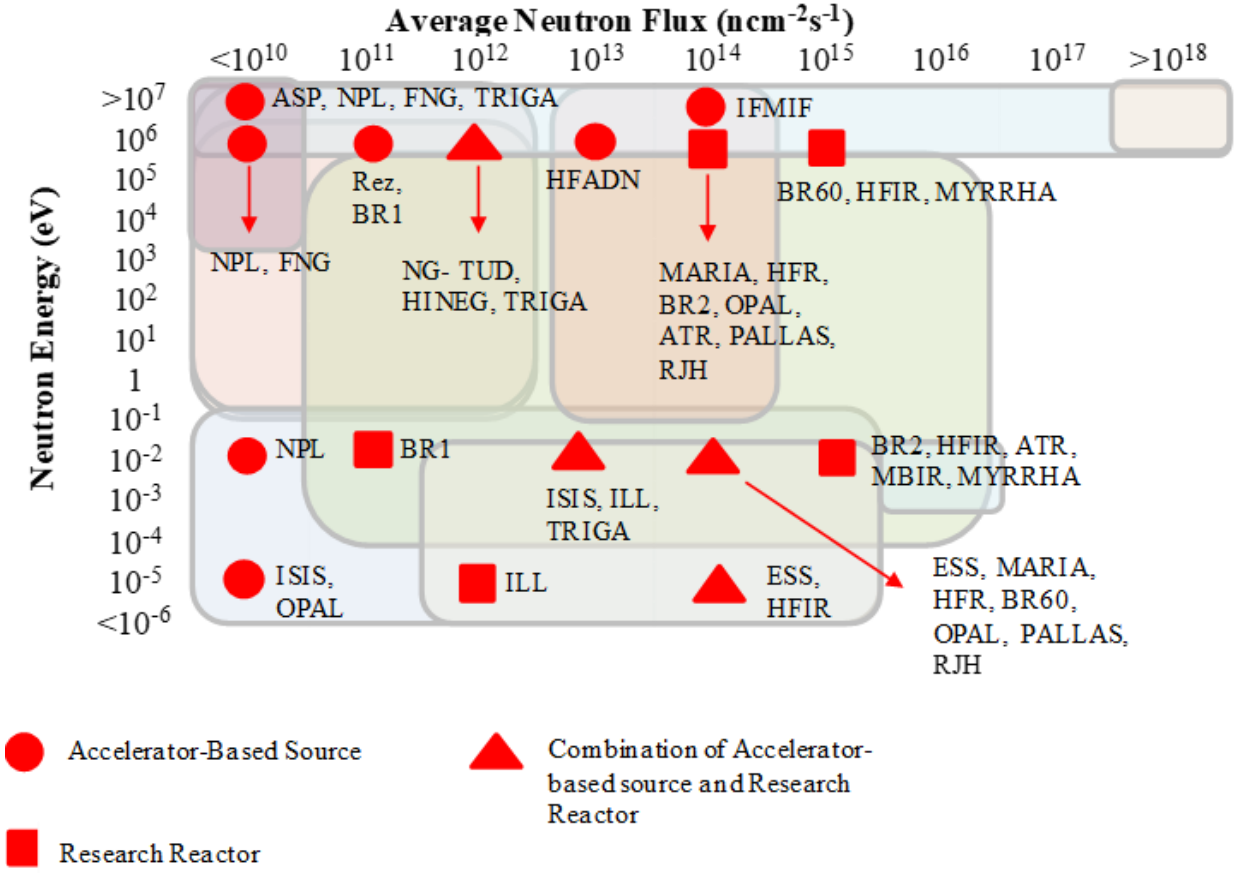
Introducing STELLAR

- What is STELLAR?
- Aims of the STELLAR Pilot Project
- Applications of STELLAR
- Expanding UK and International Capabilities
- Building Collaborations

What is STELLAR?

- The UK has limited access to neutron irradiation sources
- Recognition that hands on neutron science is important to development of new technologies
- Aiming to identify flexible, low cost to deployment of suitable facilities



Sellafield

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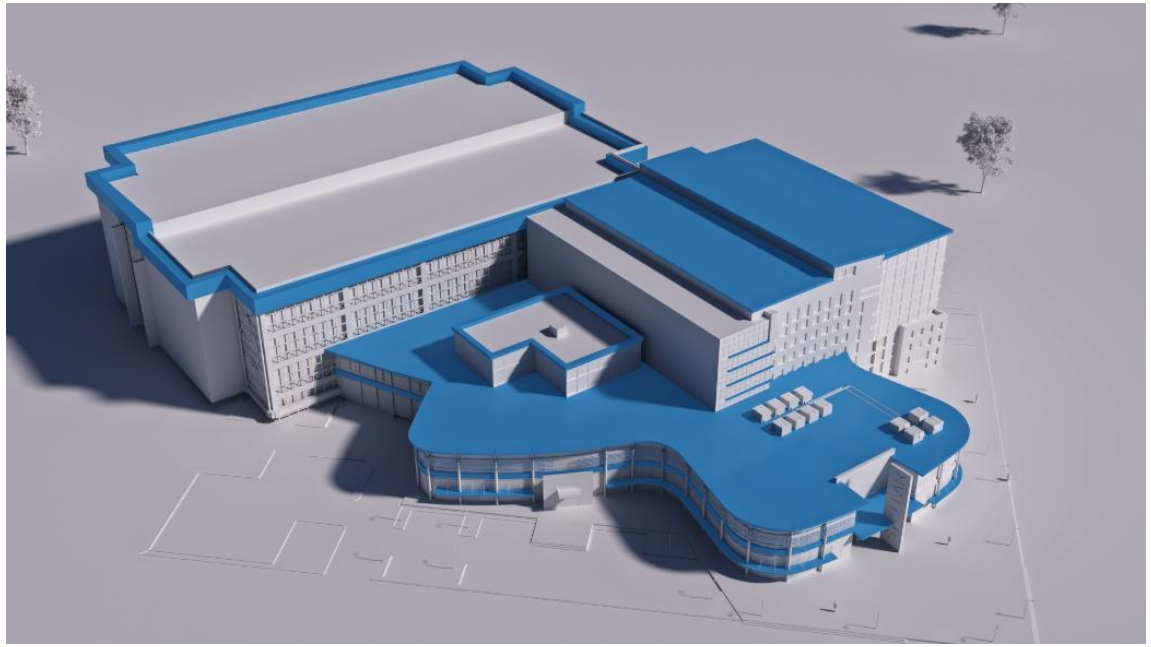
Expanding UK and International Capabilities

- HEIF already has significant reinforced concrete shielding (2-3 m thick) and space for an accelerator driven system.
- HEIF is located on a high security nuclear licensed site, in Central Laboratory, which has active facilities including gloveboxes, hot cells and import/export capabilities.
- NNL's Windscale Laboratory is also on Sellafield site, which has PIE capabilities, minimising transport requirements.
- Direct access to relevant skills and experience, infrastructure and materials on site.
- Expected cost and time savings in this choice of location.



What is STELLAR?

Fusion Research

- Global access to fusion relevant neutron sources is limited
- Data that will directly affect the design and development of commercial fusion needs improving
- UK programmes are currently limited to globally available facilities

Fission Research

- Fundamental science for material evolution under irradiation has limited mechanistic understanding
- Improving understanding could avoid the need for materials research reactor irradiations and improve computational modelling

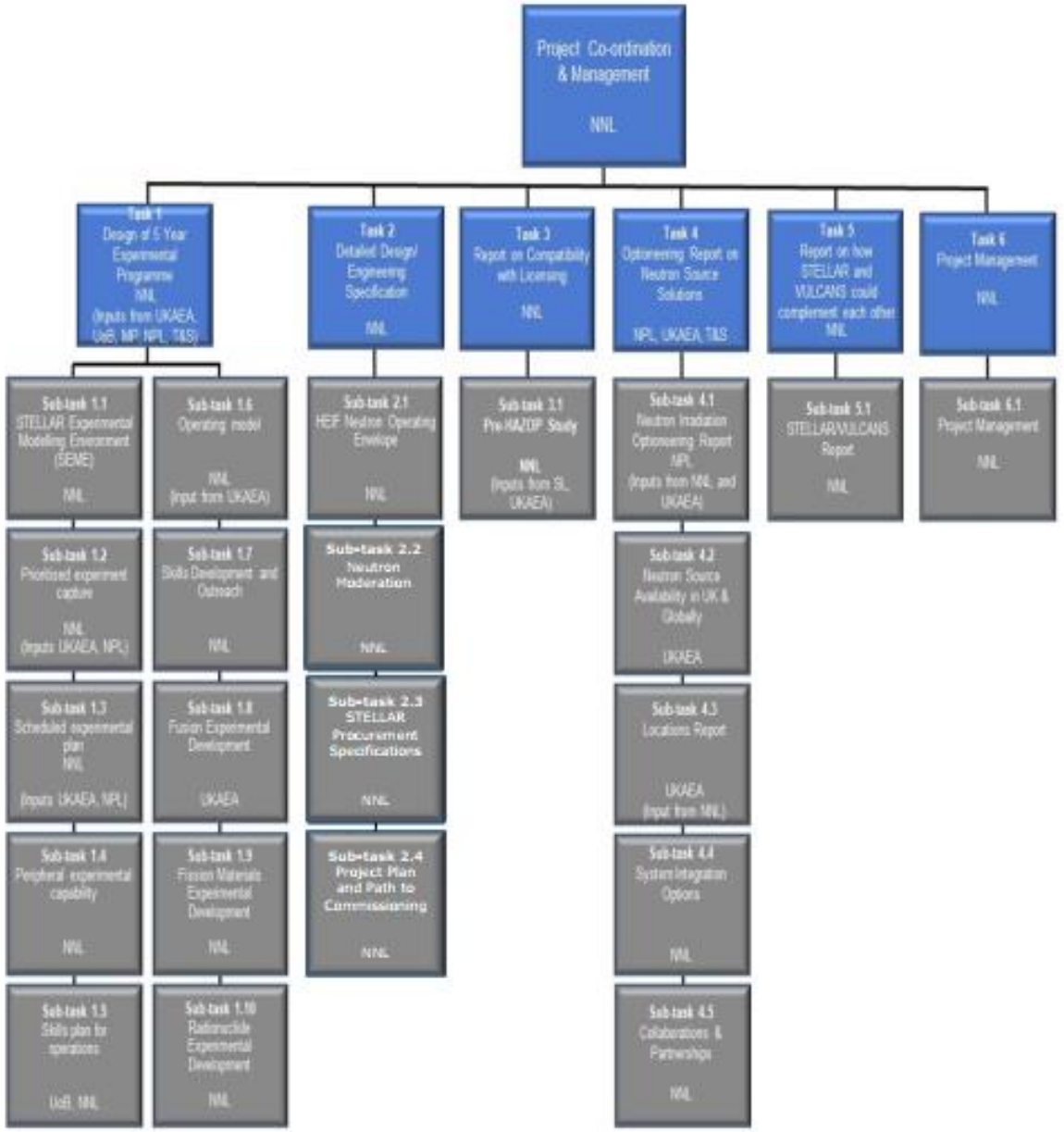
Medical Radionuclides

- Medical radionuclides are important for both diagnostic and therapeutic needs
- Global supply is constrained, and limited range of nuclides
- Opportunity to identify novel production routes, and generate more targeted radionuclides

Aims of the STELLAR Pilot Project

- Build first iteration of a **five-year experimental programme** with increasing confidence in the viability and value of proposed experiments covering **fusion, advanced fission and medical radionuclide requirements**
- Develop a facility specification that takes account of experimental needs and aims to promote **unique aspects of a STELLAR facility** that make it complementary to alternative neutron sources
- Begin **development of the tools and capability** (including a digital twin and specialist personnel) that would support users of the facility
- Identify a suitable **operating model for the facility**, including commercial and access considerations
- **Identify key hazard implications** of a proposed facility based on the input experimental requirements
- **Review technology and location options** for the STELLAR system and make a recommendation on approach based on initial proposed experiment types
- **Develop industry, academic and international links** that will strengthen STELLAR business case and deliver a network of future users

Pilot Project



Applications of STELLAR

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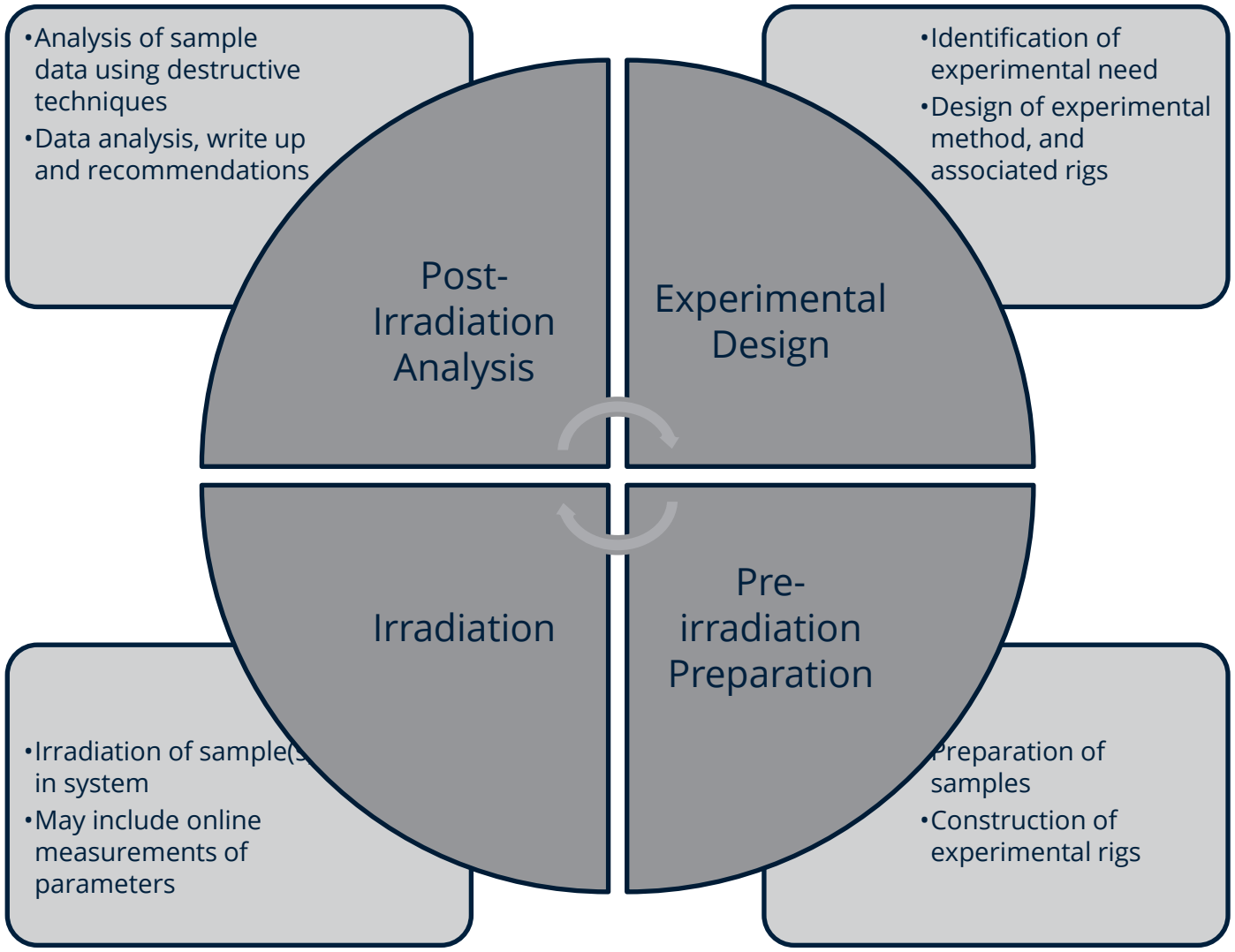
Experiment	Ranking
Cross section measurements of fusion nuclear reactor materials	1
Transmutation benchmarks	2
Tritium benchmarks	3
Shielding benchmarks	4
Gas production measurements	5
Graphite analysis	6
Medical radionuclide production route development	7
Measurement of key nuclear reactions for fission, fusion, and astrophysics applications	8
Cross section measurements for fission nuclear reactor materials	9
Waste transmutation	10
Gen IV nuclear reactor materials	11
Hydrogen rich material analysis	12
Xenon impregnated fuel irradiation	13

Applications of STELLAR



Applications of STELLAR – Nuclear Data

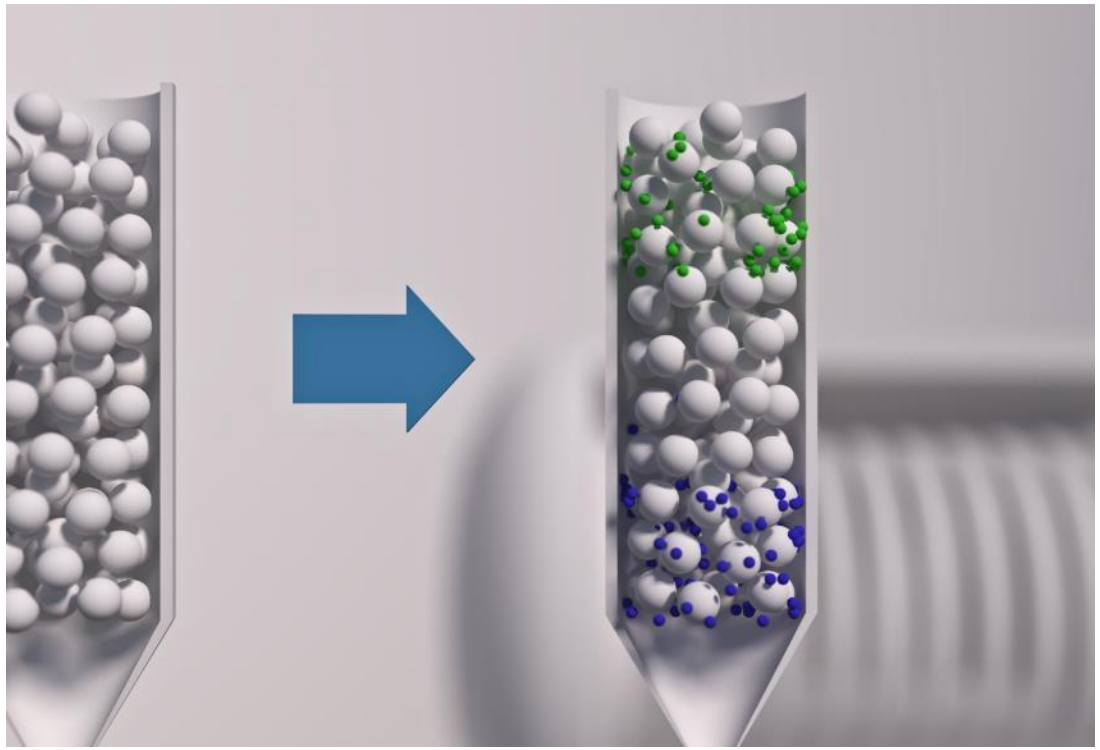
- Accurate and reliable nuclear data is required to underpin simulations and models for both fission and fusion research
- New data could fill in gaps to underpin modelling of novel fuels and materials.
- From measurements of nuclear cross-sections, decay heat, transmutation and gas production.
- Currently, the UK does not have easy access to high energy neutrons relevant to fusion or advanced fission reactors.
- An accessible and flexible high energy neutron accelerator system would address this.

Applications of STELLAR – Materials Research

- **Building a better understanding of mechanistic evolution of materials will improve performance of computer codes for future reactor development**
- **Limited irradiations under load (ie. heat, stress) could provide important information to demonstrate theories**
- **Multiple irradiations of one sample reduce experimental uncertainties**
- **New reactor concepts benefit from improved materials understanding**

Applications of STELLAR – Medical Radionuclides

- UK has unique access to a large variety of “waste” routes
- Leading expertise in chemical separations, including from advanced reprocessing
- Identification of applications for waste materials improves viability of future reprocessing
- Existing data to underpin these routes is often limited
- STELLAR could be used to identify and demonstrate production routes from hard to handle materials



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Building Collaborations

- Operating STELLAR in the future will require an expansion of current UK neutron irradiation skills
- On the obverse, STELLAR will promote improved UK skills around neutron irradiation, nuclear physics, nuclear data, materials development and chemistry
- Building up skills with international partnerships and collaborations in the near term, can ensure improved value from STELLAR in the future

Pilot Project Recommendations
Outputs of STELLAR Pilot Project

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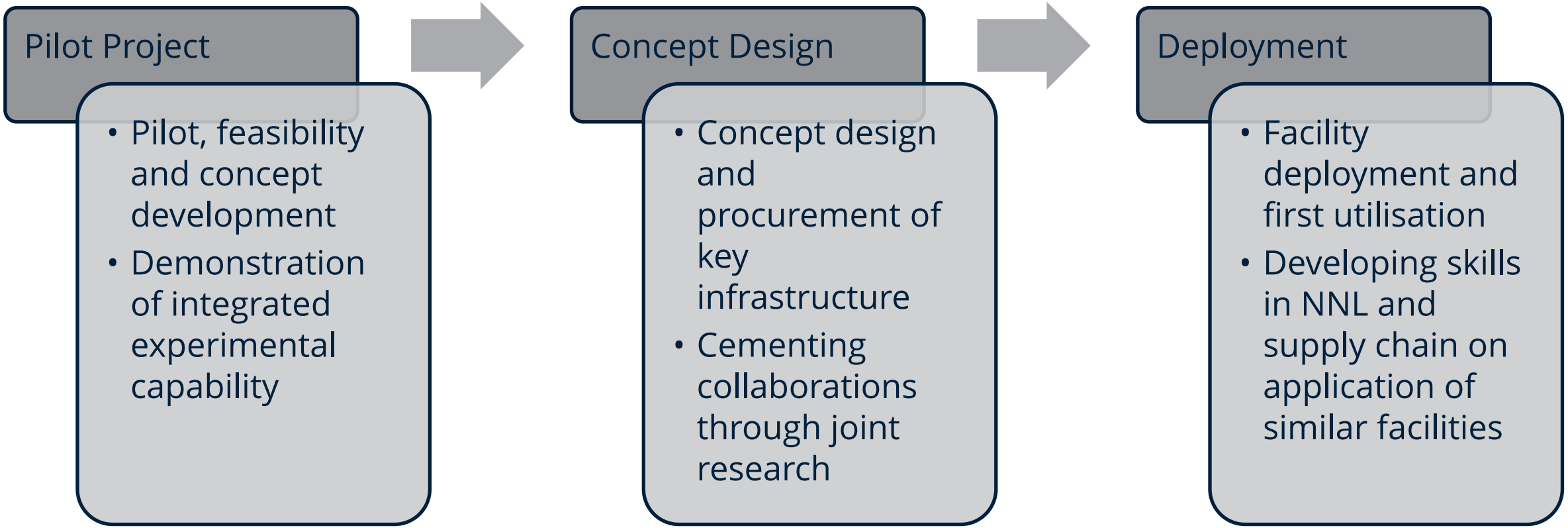
1. **Additional work is required to develop the engineering concepts for identified technologies that could be deployed in support of STELLAR. Existing feasibility studies delivered by the relevant technology manufacturers should be extended to de-risk future deployment.**
2. **Outputs of the engineering development should be used to refine forecast costings and provide better underpinning for a future business case.**
3. **Work to build external links and interest should be continued to grow the pool of interested users for a future facility.**
4. **Development of national and international collaborations should be continued to progress the build up of key neutron physics skills.**
5. **Prioritisation of the application priorities for STELLAR should be driven by a future funding source. When a clear funding route is available, a formal optioneering step should be included to down select the technology and deployment approach optionality that is currently available in the project.**

Current proposed follow on work for STELLAR focuses on the items highlighted in blue.

Next Steps


Pilot Project
• Pilot, feasibility and concept development
• Demonstration of integrated experimental capability
Concept Design
• Concept design and procurement of key infrastructure
• Cementing collaborations through joint research
Deployment
• Facility deployment and first utilisation
• Developing skills in NNL and supply chain on application of similar facilities

Thank you

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