VICE – qualification of lithium ceramic breeders

T. P. Davis[1,2] A. Hills[1], P Charlesworth[1], R Ghent[1], D. Martinez de Luca[1], G. C. Blackett[1], A. Morrison[1], G Anderson[1], M Anderton[1]

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LIBRTI- Lithium Breeding Tritium Innovation

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VICE is funded by UKAEA's LIBRTI programme:

UK Atomic Energy Authority

> LIBRTI's over-arching mission is to **design, build and operate a world leading facility in the UK for the testing of tritium breeding in power plant relevant fusion fuel breeders, to accelerate the delivery of sustainable fusion energy**.

FUSION FUTURES

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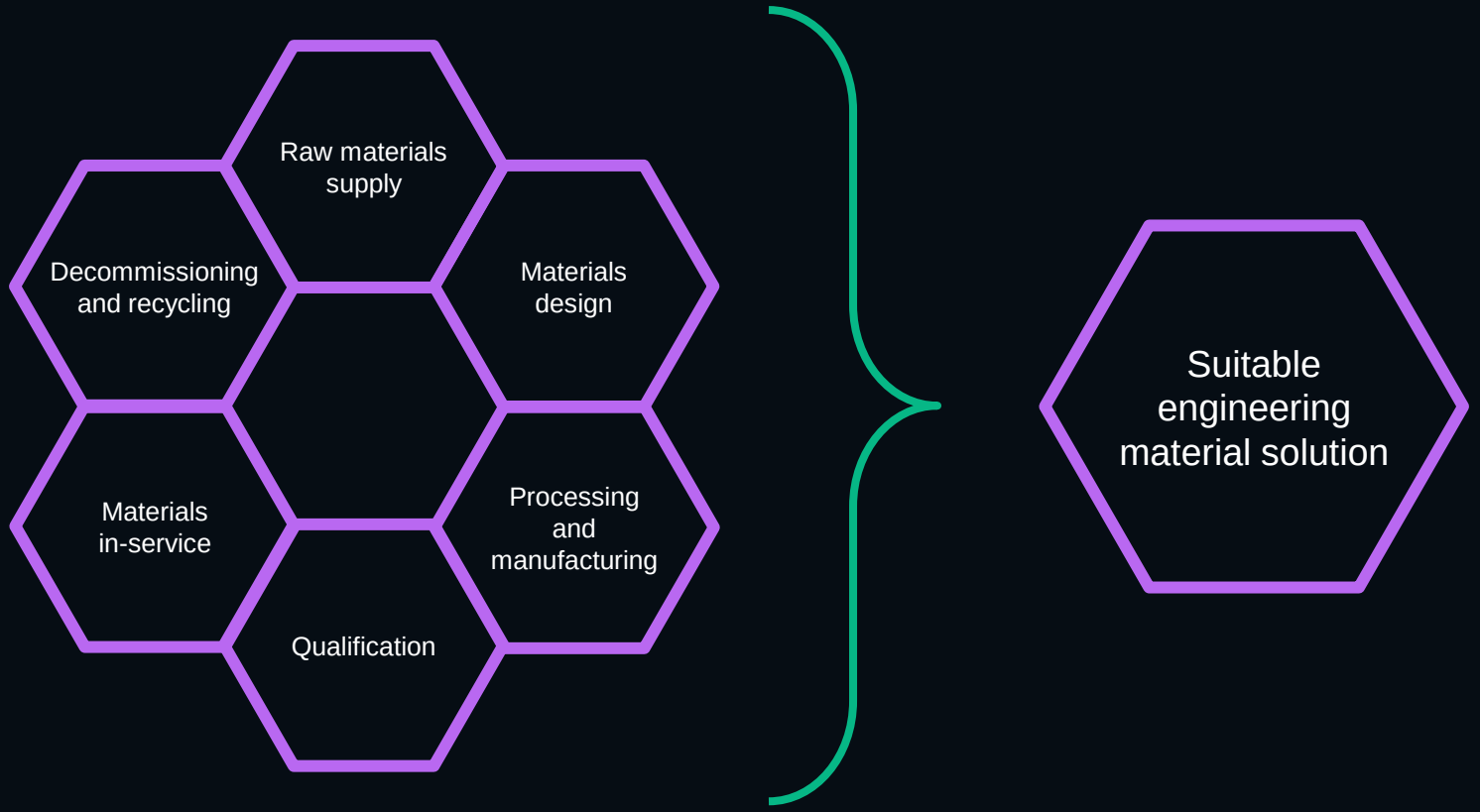
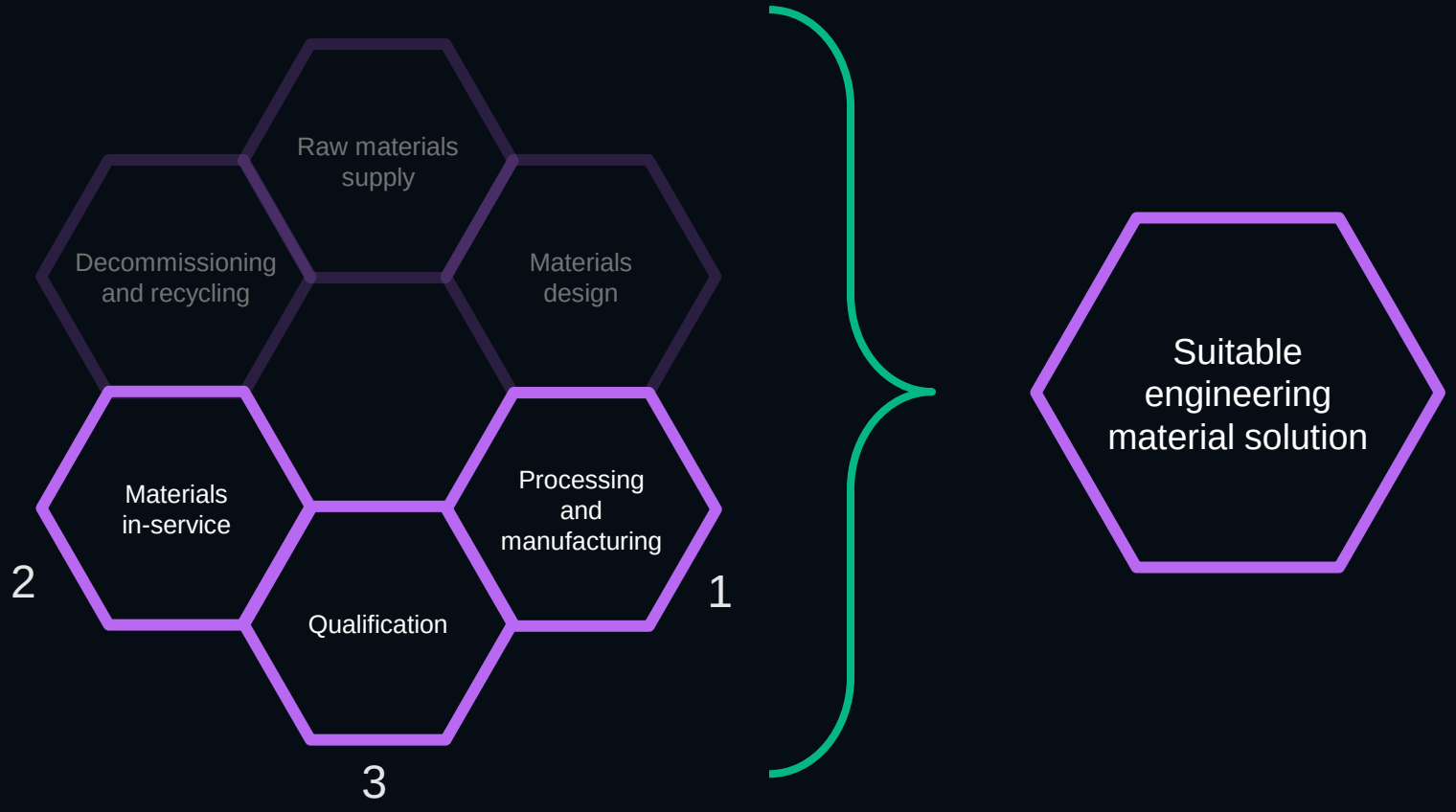
Tritium breeding

Feasible. But what is the practicality for power plant relevant engineered systems?

VICE Validation in ceramics experiments



VICE Validation in ceramics experiments



1. Manufacture and Characterisation of Lithium Ceramic
2. Irradiate Lithium Ceramic Samples to Create Tritium
3. Extract and Measure Tritium Produced

Integrate

Manufacturing and Characterisation of Lithium Ceramics

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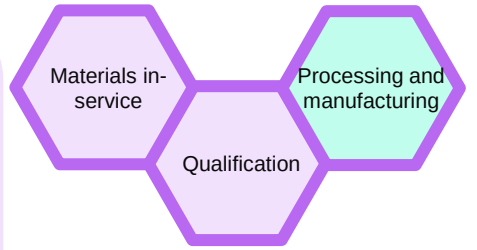

Lithium ceramic – what are the primary choices?

Li_2O	Li_4SO_4	Li_2TiO_3
• High lithium density • Hygroscopic nature requires handling management	• Well studied breeder material • Potential high temperature stability issues	• Readily available COTS material • Good stability at temperature

Powder morphology – what matters?

- Size
- Sphericity
- Porosity

Control regime – What are our tools?

- Milling fineness
- Binder ratio
- Conglomeration route

Research Objective:
Meeting a specification and being repeatable, and scalable…

Irradiation of lithium ceramics

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Neutrons – how do you get “the right neutrons”?

Quantity:

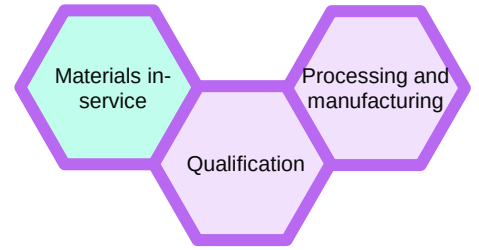
Lower energy spectrum enhance T production in 6-Li, but no high energy 7-Li reactions

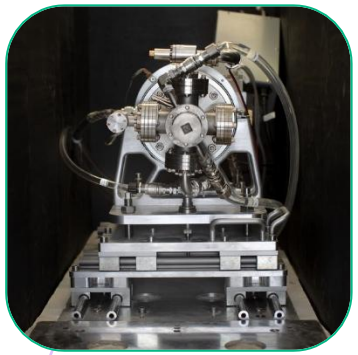
Higher flux

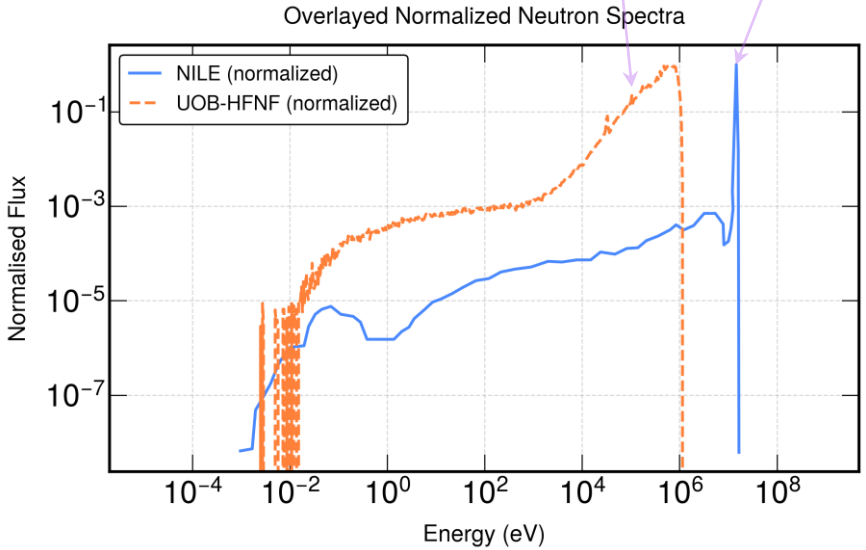
Energy:

Correct spectrum for reaction cross-sections

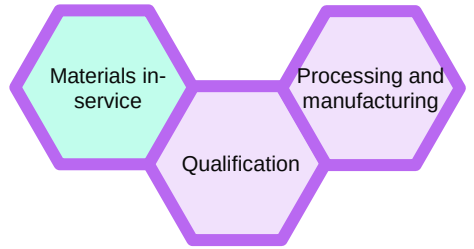
Lower flux





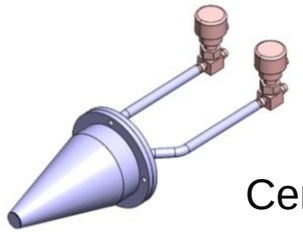


Irradiation of lithium ceramics

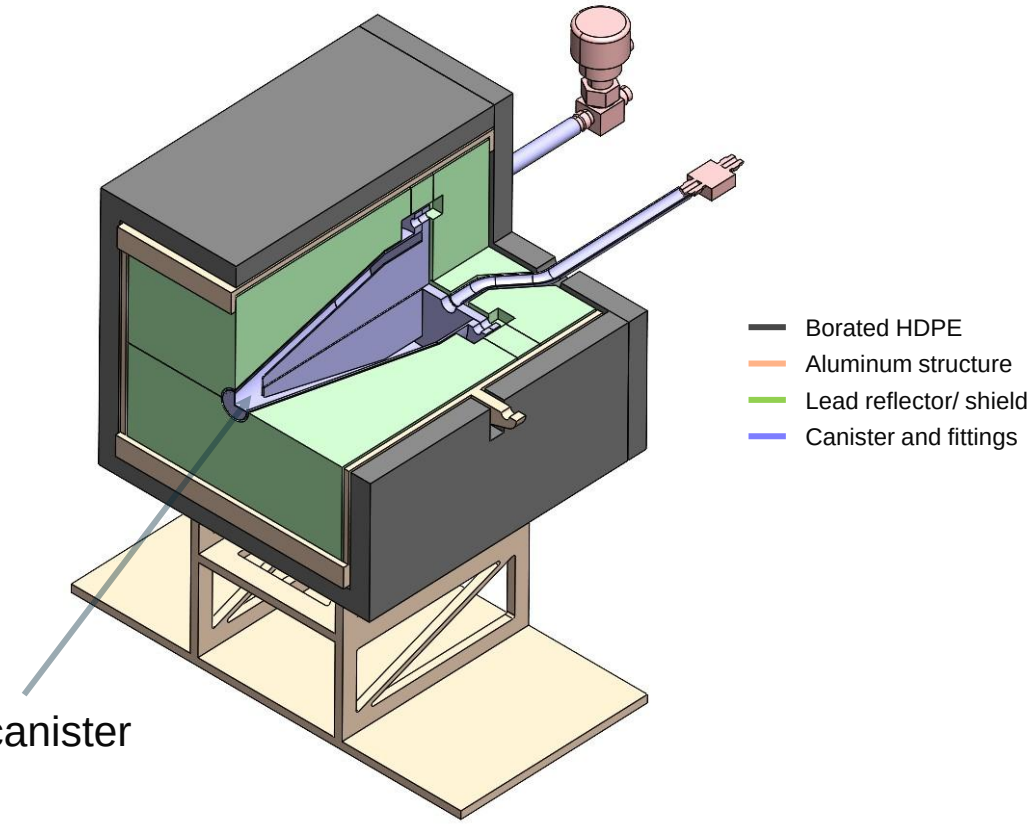


Whichever neutron approach is selected it is important to make the best use of the neutrons available

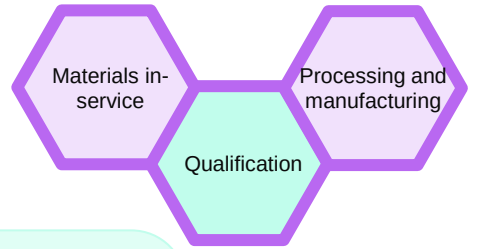
Beam spread	High scattering cross-section in titanium	Minimise parasitic absorption
• Conical irradiation capsule configuration	• Lead reflector	• Use credible early use blanket structural materials • Produce detectable tritium with minimum irradiation time.



Ceramics in canister



Extract and measure tritium produced



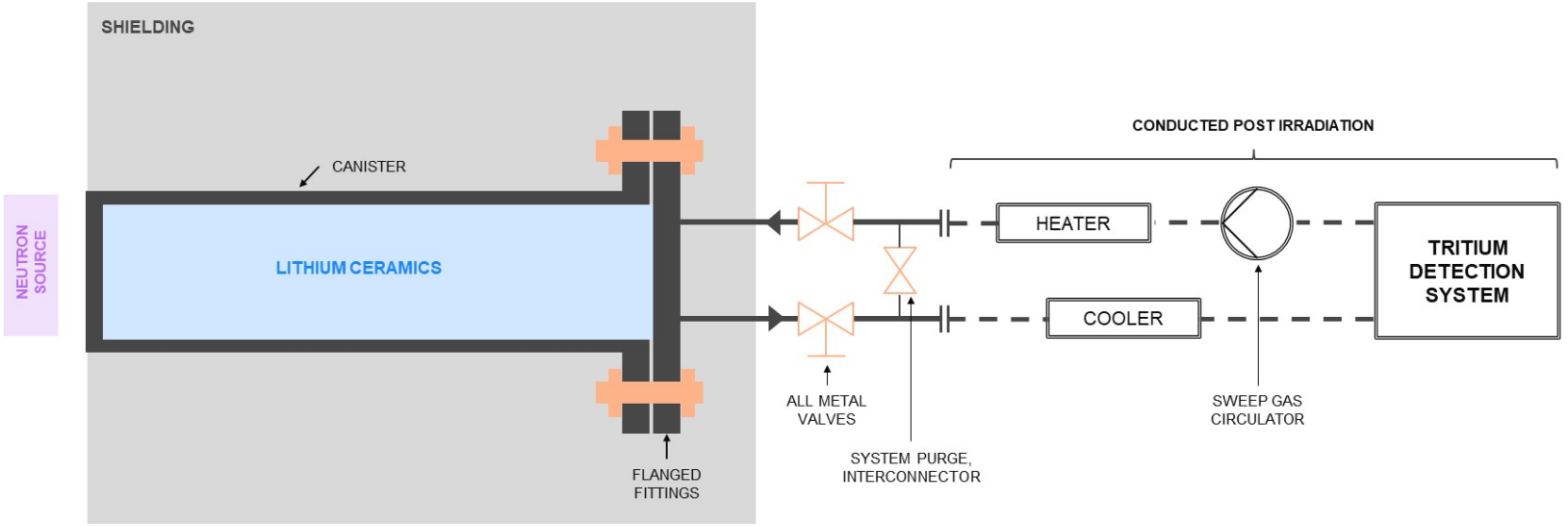
In a real fusion device ceramic blanket, the ceramic is expected to remain in place and tritium will be removed by a flowing “sweep gas”.

Temperature control in capsule:

External heating of the capsule

Temperature profile in capsule:

Heating through sweep gas allows testing to understand



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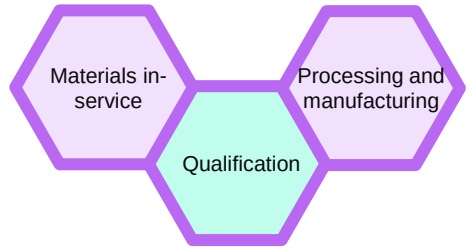
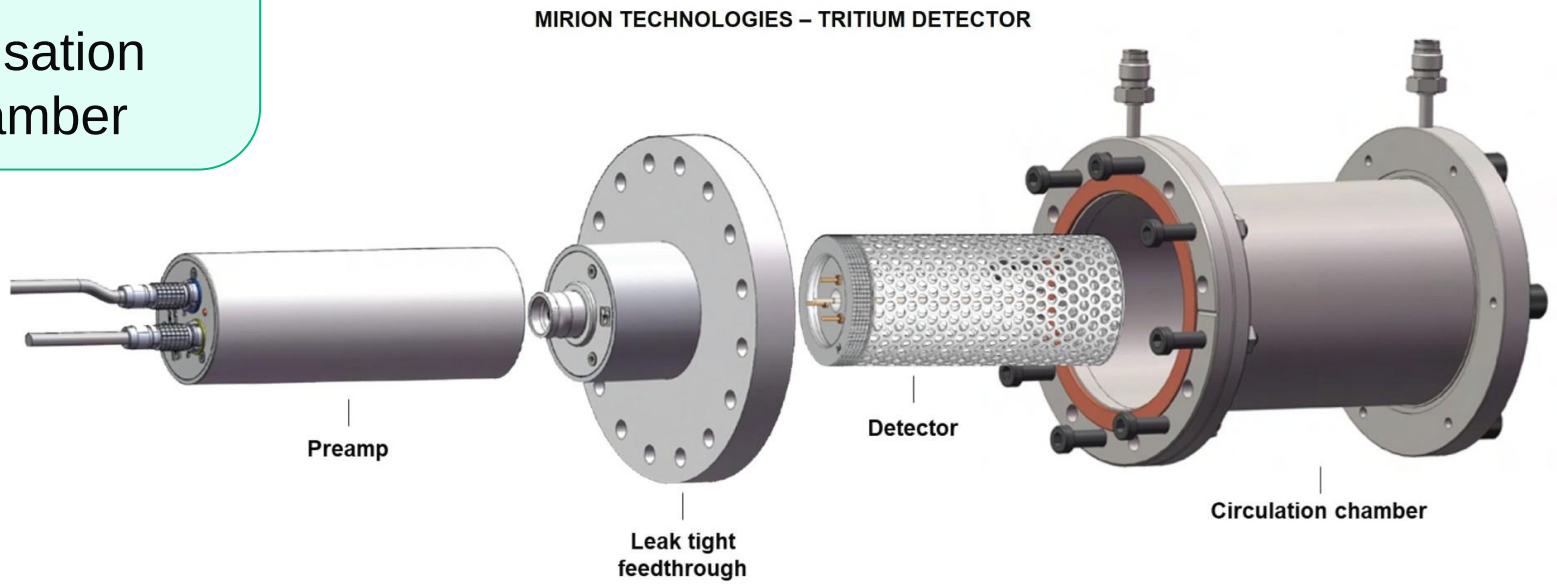


Actual detection of tritium – what is the best approach?

Very weak β emitter

Incorporate in a liquid	Incorporate in a gas
scintillation counter	ionisation chamber



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25/06/2025

R-1506