

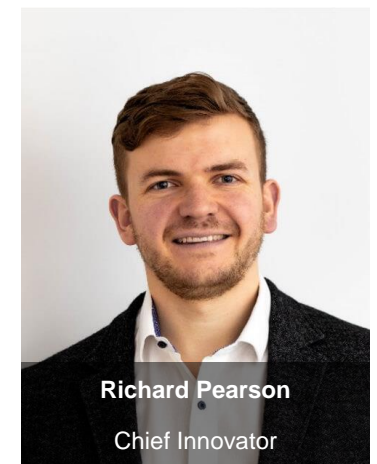
Kyoto FUSIONEERING

Powering Tomorrow's World

Dr. Richard Pearson, Chief Innovator

41st FPA Meeting, Thursday December 17, 2020

- Founded in **2019** in **Kyoto, Japan**, as a spin-out from **Kyoto University**
- **Japan's first fusion start-up!**
- **Investment & grants:**
 - **Kyoto-iCAP** (University tech spin-out investment branch)
 - **Japanese government** (Ministry of Economy, Trade & Industry)
 - **Private Japanese investors** (undisclosed)
- Member of **Fusion Industry Association**
- Currently recruiting a team of **world-class fusionneers** for our mission!



For fusion to be a **transformative energy technology**, reactors must be designed to be **high performance, cost-effective & easy to manufacture**.

Key reactor technologies – principally relating to the **fuel cycle & power generation** – have a direct impact on commercial viability of fusion energy.

Kyoto Fusion Engineering will **design, build, and test commercially-relevant reactor technology solutions** for the fusion industry (such technologies are required by **all** D-T fusion efforts).

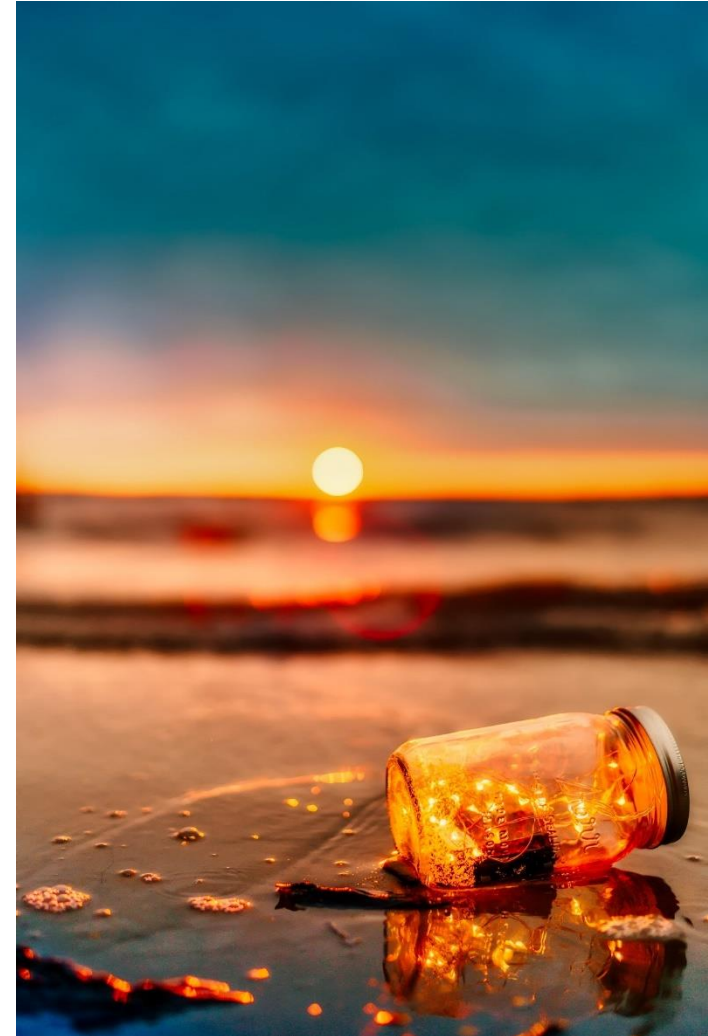


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Levi Strauss & Co.



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Manufactured durable clothing (jeans) for miners in the Gold Rush, rather than focusing on the *moon-shot* of the gold itself.

SpaceX



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Founded to develop **advanced & low-cost** rocket technology, to *provide a service* to the public and private space transportation sector.



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Leading manufacturer of **advanced**
& **reliable** jet engine *technology for*
aerospace companies

(including via its “TotalCare” service
model)

Rolls Royce



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Will not develop a fusion reactor, and will instead focus on the **engineering & technologies required for overall industry success** ...

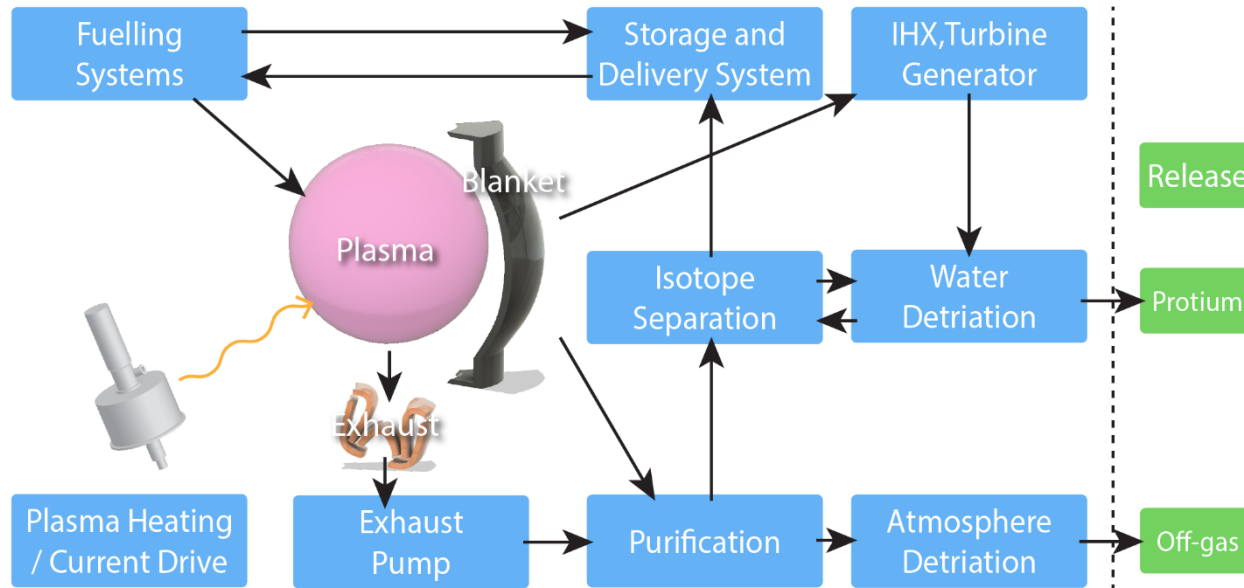
... like *Levi Strauss & Co.*

Will develop the **most advanced and lowest cost solutions**, to enable fusion developers to commercialise on an **accelerated timescale** ...

... like *SpaceX*

Aim to become a **world leader** in fusion reactor engineering, **providing high-quality components for the industry** ...

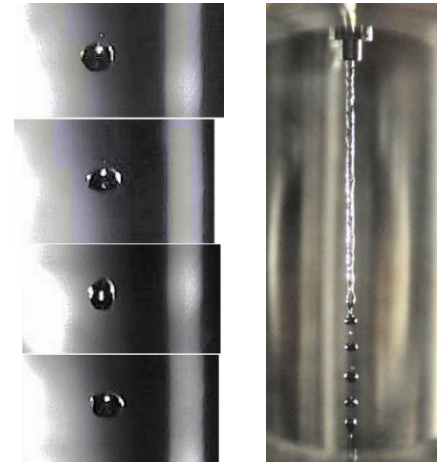
... like *Rolls Royce*



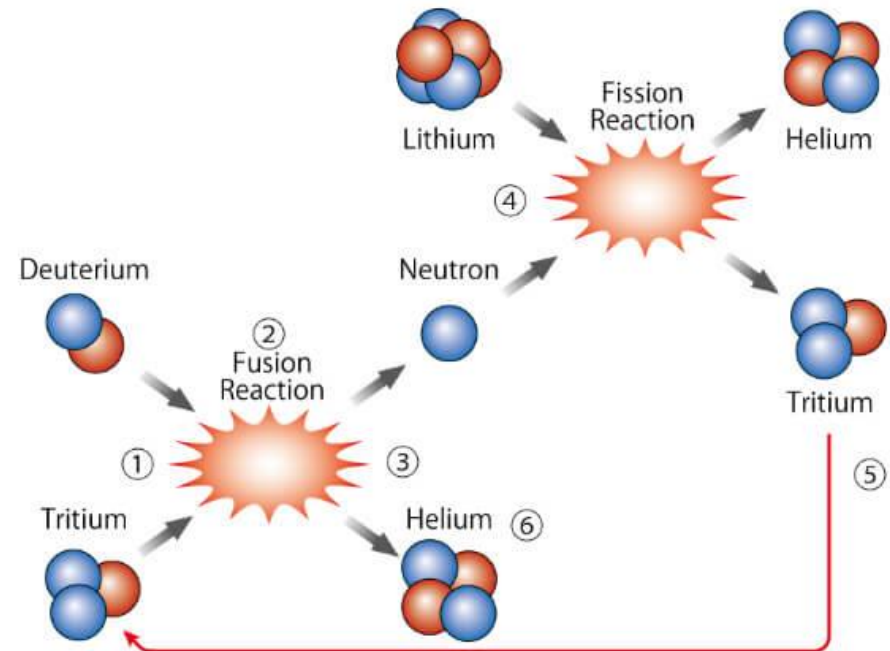
Overlaps with requirements for INFUSE and ARPA-E (particularly GAMOW) in the USA, and STEP in the UK, as well as FESAC recommendations

- **Exhaust systems** (including for non-magnetic confinement reactors)
- **Tritium fuel cycle** (tritium systems)
- **Blankets** for tritium breeding & power extraction
- **Balance of Plant** systems & plant design
- High-power, high-frequency **gyrotrons** (for magnetic confinement reactors)
- **Commercialisation** studies (including for non-electricity applications)
- **Economic & safety** assessments

- Kyoto Fusion Engineering (KF) is **leveraging expertise** from decades of R&D at **Kyoto University** (*Konishi lab*) and the wider **Japanese fusion community**
- KF is **transferring these capabilities** for **commercial scale-up**, including:
 - **Liquid lithium-lead test loop** (*demonstrating **heat extraction**; **tritium extraction** [vacuum sieve]; **materials compatibility***).
 - **Materials testing** in fusion-relevant environment
 - Advanced **SiCf/SiC composite** development & manufacture
 - **Gyrotron** development
 - Commissioned small-scale **FLiBe test loop**
 - **Tritium systems** design
 - Advanced **power plant modelling**
- Existing **collaborations** with **academia** & **industry**, but seeking further partnerships (incl. under U.S. **INFUSE** & **ARPA-E**).



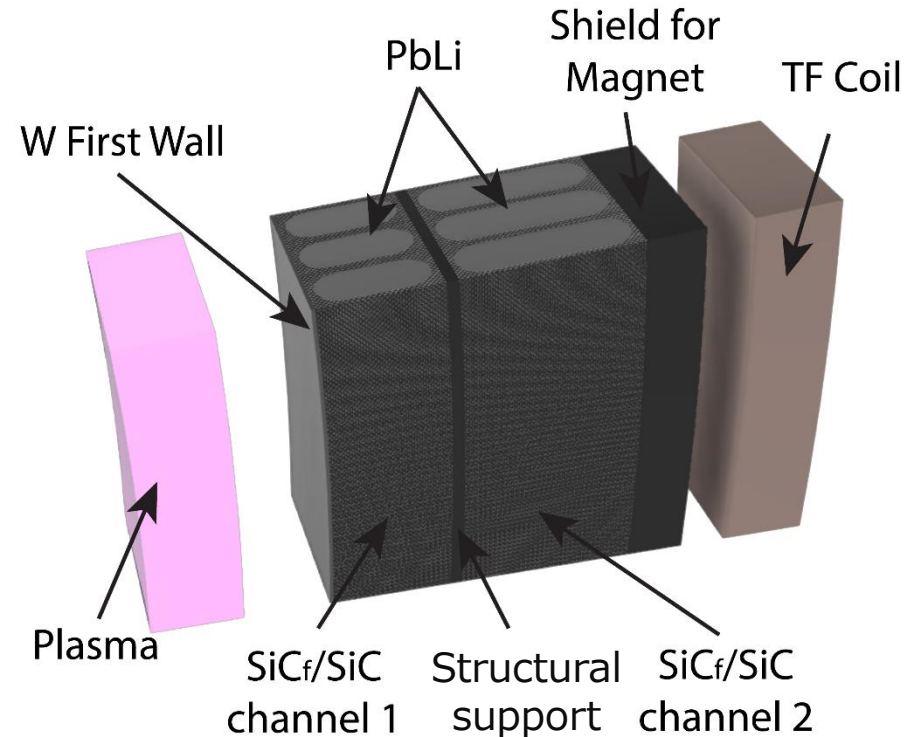
- The blanket is **the** key component in a commercial fusion plant, essential for:
 - **Tritium self-sufficiency**
 - **Power generation**
- Strong driver on commercial viability, dictating: **performance, cost, lifetime, waste** etc.
- Developing a functional blanket cannot be **“left until later”** – and it **cannot be done in one step!!**
- Focus has not been on developing an **advanced blanket**, i.e. one that allows fusion to **fulfil its potential as a transformative energy technology**



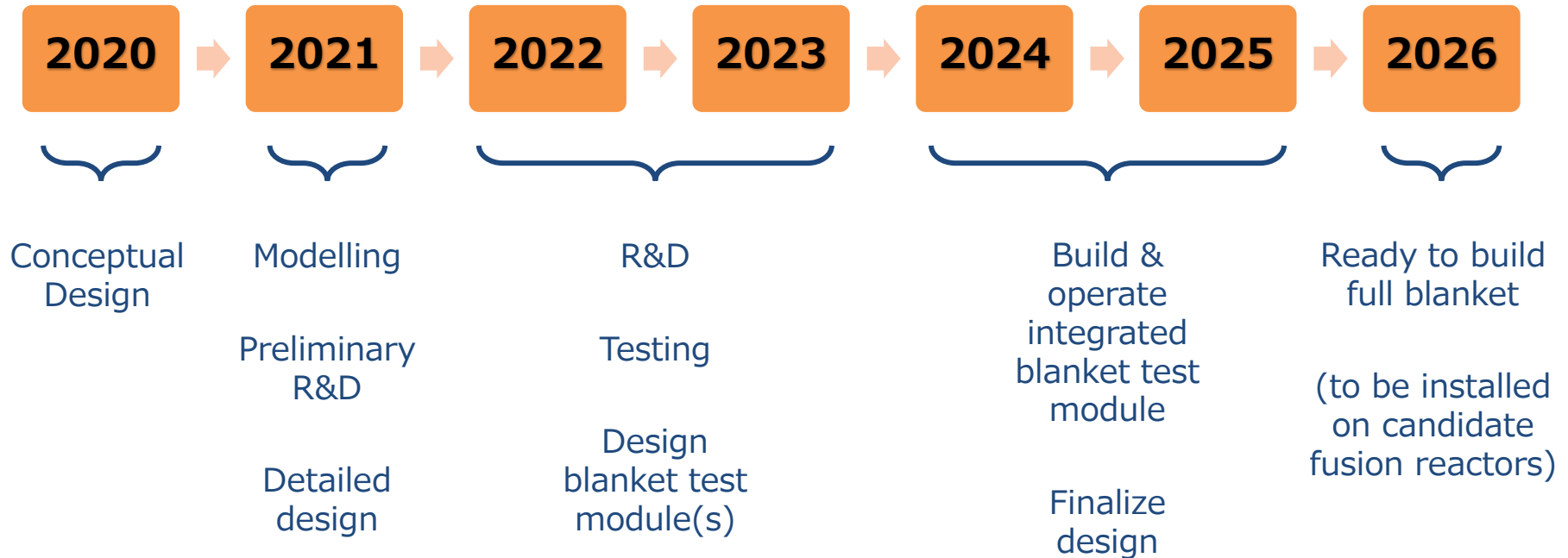
SCYLLA©: Advanced self-cooled blanket

SCYLLA© is the optimal commercial concept:

- **Lithium-lead** eutectic for **tritium & heat extraction**
- Advanced Japanese **SiCf/SiC composite** structure
- **LiPb-SiCf/SiC combination** allows **ultra-high temperature** operation ($\sim 1000^{\circ}\text{C}$)
- **High thermodynamic efficiency** & potential for **non-electricity applications** (e.g. H_2)
- **High local Tritium Breeding Ratio (TBR)**
- **Simple & manufacturable** configuration
- **Long lifetime (self-healing)**
- **Simple maintenance**
- **Intrinsic safety** (no pressurised media)



Kyoto Fusion Engineering's SCYLLA© (Self-Cooled "Yuryo" Lithium-Lead Advanced) blanket concept



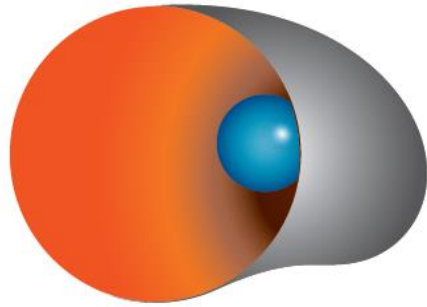
KF will be ready for low-rate production from 2027

“Everything is theoretically impossible, until it is done.”

- Robert A. Heinlein, “The Rolling Stones”, 1952

Also see:

- Pearson, R. J., et al. *Technology Roadmapping for mission-led agile hardware development: a case study of a commercial fusion energy start-up*. Technological Forecasting and Social Change 158 (2020): 120064.
- Nuttall, W. J., et al. *Commercialising Fusion Energy: How Small Businesses Are Transforming Big Science*. Institute of Physics Publishing (2020).



Kyoto FUSIONEERING

Thank you!

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