



Presentation from:

INFUSE 2024 Workshop
Princeton, New Jersey, U.S.A.



Kyoto Fusioneering Ltd.

Tokyo & Kyoto, Japan • Reading, England, UK • Seattle, Washington, U.S.A.

URL: [FUSION for the FUTURE | KYOTOFUSIONEERING](https://www.kyotofusioneering.com)

Kyoto Fusioneering America: FY2023 INFUSE Project Awards

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Kyoto Fusioneering America was awarded three INFUSE projects in FY2023, which are set to begin in 2024. The three projects are detailed, all of which are related to the breeding blanket and tritium technology area.

The first project is with Princeton Plasma Physics Laboratory (PPPL) and is titled "A Multiphysics Simulation of Magnetohydrodynamic (MHD) Li-Pb Flow in a Blanket." The second project is with Oak Ridge National Laboratory (ORNL) and is titled "Evaluating Lithium-Lead (Li-Pb) Mixtures for Fusion Energy Blanket Systems: Exploring the Impact of Composition and Temperature." The third project is with Savannah River National Laboratory (SRNL) and is titled "Evaluating Lithium Compatibility for Electrode Materials Used in an Electrolysis-Based Tritium Extraction Process."

Details of the project scope, and how each project addresses a specific fusion science and technology gap, are provided, with specific emphasis to their relevance to the U.S. Bold Decadal Vision.

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**Kyoto Fusion Engineering America:
FY2023 INFUSE Project Awards**

R. PEARSON, C. DORN, B. UPPAL, and
the Kyoto Fusion Engineering Team

INFUSE 2024 Workshop
Princeton Plasma Physics Laboratory
Princeton, New Jersey, U.S.A.

February 27-28, 2024



**INFUSE 2024
Workshop**

FUSION for
the **FUTURE.**

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Introduction to KF/ KFA (1)



- **Presenter Personal Background**
 - Background
 - Education & Thesis
 - Co-Founder of KF
 - Roles: Chief Innovator & UK Director

- **About Kyoto Fusion Engineering (KF)**
 - Founded in October 2019
 - KF America established in 2022
 - Venture Capital (VC) Funding: ~\$90M (JPY ¥ equivalent)
 - Locations: Japan, UK, and U.S.
 - Company Size: 120+ (including part-time and contractors)
 - Currently Hiring in all Locations



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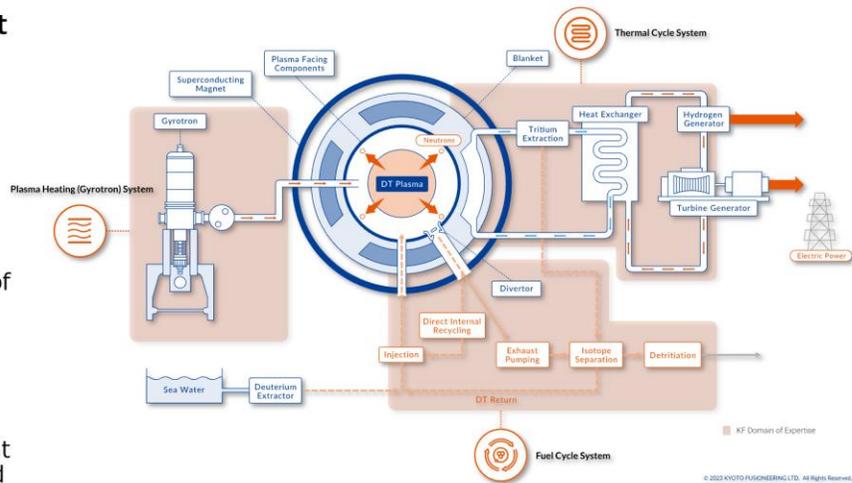
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Introduction to KF/ KFA (2)



- **KF Mission Statement**
 - To accelerate the development of high performance, commercially viable reactor technologies associated with plasma heating, thermal cycle, and fuel cycle to support the rapid expansion of the budding fusion industry.

- **KF Business Model**
 - Focused on *critical path* technologies that enable an accelerated path to commercial fusion



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KFA & US Strategic Fit



- **U.S. Bold Decadal Vision**
 - Pushed by Climate Change and a changing world
 - Announced on 15 March 2022
 - Purpose: accelerate fusion development
 - Goal: build a prototype Fusion Power Plant (FPP) in 10-15 years
- **Public-Private Partnerships**
 - US Department of Energy
 - Milestone-Based Program
 - INFUSE Partnership Grants
 - Workshops on Fusion Fuel Cycle and Blankets (EPRI, May-2023) and Materials (EPRI, Nov-2023)
 - Symposium on Fusion Energy 2023; steered by KF
 - Satellite Session, Jun-2023, titled “Next Steps to Global Fusion Partnerships”



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INFUSE | Innovation Network for Fusion Energy



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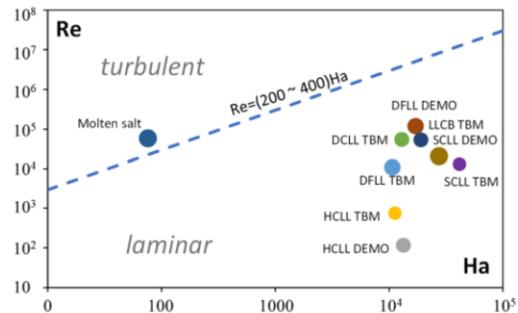
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INFUSE FY2023: Princeton Plasma Physics Lab (PPPL)



- **A Multiphysics Simulation of MHD Li-Pb Flow in a Blanket**
 - Why: Liquid-metal breeders hold great promise for fusion blankets, but a key challenge is the interaction with magnetic field (MHD impacting flow). Currently, no current commercial software is available for accurate modelling.
 - What: Create software to bridge gaps in modeling capabilities for fusion relevance.
 - How: Adapt a state-of-the-art existing finite-element modeling system (ANSYS) to simulate critical blanket-relevant conditions.
- **RFA (Request for Assistance) Highlights**
 - PPPL uniquely qualified for this project, based on recent advances/achievements and expertise available (Dr. Andrei Khodak).
 - KF’s commercial blanket development will benefit (SCYLLA®: Self-Cooled Lithium-Lead).

KFA PI: Bibake Uppal



Reynolds (Re) and Hartman (Ha) numbers for various types of liquid-metal blanket. The dashed line separates the laminar from the turbulent flow region. Source: ([Zikanov et al., 2021](#))

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INFUSE FY2023: Oak Ridge National Lab (ORNL)



KFA PI: Chris Dorn

Temperature	90Pb-10Li	83Pb-17Li
600°C	SiC	SiC, TZM
800°C	SiC	<i>SiC, SiC*</i> TZM
1000°C	SiC	<i>SiC, SiC*</i> TZM

80Pb-20Li	70Pb-30Li	60Pb-40Li
SiC	SiC	SiC, TZM
SiC	SiC	<i>SiC, SiC*</i> TZM
SiC	SiC	<i>SiC, SiC*</i> TZM, Mo

Corrosion test experimental conditions generated from the combination of temperature and composition independently varied. The table contains the specimen coupons to be tested at each combination. Phase 1 experiments are italicized. Asterisks indicate experiments that will be performed inside a SiC capsule rather than the standard capsule (Mo).

Evaluating Li-Pb Mixtures for Fusion Energy Blanket Systems: Exploring the Impact of Composition & Temperature

- **Why:** Li-Pb liquid-metal breeders have been typically studied in 83Pb-17Li (+ 84.3Pb-15.7Li) composition, but not explored to optimize tritium breeding ratio (TBR) at higher temperatures relevant to advanced blankets.
- **What:** Design and execute experiments to test corrosion potential and behavior at a range of Li-Pb compositions & temperatures.
- **How:** Conduct static corrosion experiments using SiC composites, TZM, and Mo.

RFA Highlights

- ORNL has over 70 years experience in conducting similar compatibility R&D.
- KF has relevant experience with SiC_f/SiC composites and knowledge of Li-Pb mixtures.

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INFUSE FY2023: Savannah River National Lab (SRNL)

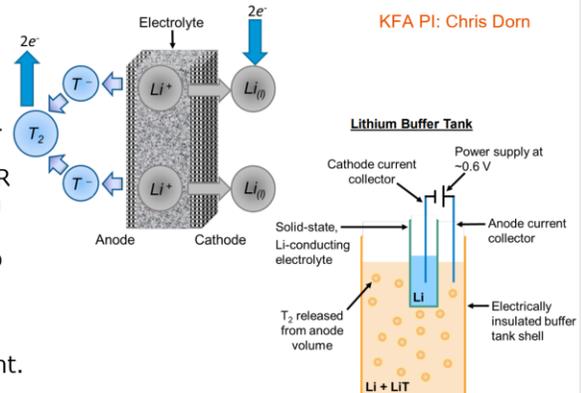


Evaluating Li Compatibility for Electrode Materials Used in an Electrolysis-Based Tritium Extraction Process

- **Why:** Liquid-Li holds great promise as a fusion-breeder blanket material, and for other applications, thanks to its potential for high TBR and attractive properties, but tritium extraction is challenging.
- **What:** Use the Direct LiT Electrolysis Process to extract tritium (T) from liquid Li.
- **How:** Characterize electrolyte mechanical properties, determining electrode and process parameters to progress design and development.

RFA Highlights

- SRNL has unmatched expertise for this project, based on achievements, including a US Patent, on the technology for LiT Electrolysis.
- KF's UNITY (UNique Integrated Testing Facility) will incorporate results for liquid-Li related R&D.



KFA PI: Chris Dorn

Electrochemical cells and methods are described that can be used for recovery of tritium directly from a molten Li metal solution without the need for a separation or concentration step prior to the electrolytic recovery process. Source: (García-Díaz et al., 2022)

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Summary & Conclusion



- **Global Fusion Community (Industry) is changing**
 - New US role is underpinned by the Bold Decadal Vision and driven by private investment.
 - Private fusion companies are trying to accelerate the timeline.
 - Government-funded labs and universities have a critical role to play.
- **Collaboration & Partnerships**
 - Public-Private Partnerships (PPPs) are emerging as the dominant model for accelerated fusion development.
 - INFUSE Program is a key element in the US DOE fusion strategy and a great opportunity for commercial fusion companies to tap into the vast resources of the national labs and universities.
 - Successful RFAs propose projects of scientific relevance, for which a lab or university is well positioned to handle, but which will ultimately result in commercial impact.
 - KF, working through KF America (KFA), demonstrates that international/global companies can also participate in programs like INFUSE and take advantage of the platform to expand their presence in the rapidly evolving US fusion industry.
 - This is evidenced through KFA being awarded 3 INFUSE projects so far, with PPPL, ORNL & SRNL.

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ありがとうございます
(Thank You Very Much!)

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