INFUSE 2021a Award Notification

Company: Air Squared, Inc., DUNS: 824841027

Title: Design, test, and evaluation of a scroll roughing vacuum pump with filter and Vespel tip seals for tritium handling

Abstract:

Development of a novel scroll pump that meets the strict containment levels of D/T experimental campaigns aiming to replace both the scroll and metal bellows pumps with a single scroll pump utilizing Vespel tip seals to demonstrate improved reliability, discharge pressure, and reduced costs.

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Lab PI: Mr. Charles Smith III, smithcd1@ornl.gov

INFUSE 2021a Award Notification

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Informing Layout and Performance Requirements for SPARC Massive Gas Injection

Abstract:

Commonwealth Fusion Systems (CFS) is designing a compact tokamak called SPARC and is evaluating massive gas injection (MGI) as its primary means of plasma disruption mitigation technique. Present conservative scoping has enabled a preliminary design of the MGI system. However, physics-based modeling can help CFS inform an optimized layout, which can either reduce the cost of MGI system by reducing the number of gas injectors or provide supporting evidence that present scoping estimates are correct.

This program leverages the 3D magneto-hydrodynamic modeling expertise at Princeton Plasma Physics Laboratory (PPPL), which is maintained through the development and use of the M3D-C1 code. CFS and PPPL will develop a gas source model representative of SPARC MGI's system. PPPL would then use M3D-C1 to simulate unmitigated SPARC disruptions, to develop a baseline response, and then simulate mitigated disruptions representing a variety of MGI system configurations. The specific output of this program will reduce risks associated with disruptions on SPARC, make SPARC's disruption mitigation system more cost-effective, a benefit that will carry to commercial fusion devices. The methodology developed by this program is expected to have wide benefits, independent of the design details, and have potential applications to other future power-producing fusion device concepts.

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INFUSE 2021a Award Notification

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Active Redox Control of Molten Salts for Fusion Blankets

Abstract:

Commonwealth Fusion Systems is investigating FLiBe molten salt as a novel blanket material for its fusion tokamak. However, FLiBe is known to cause significant degradation to structural materials via impurity-driven corrosion. The use of FLiBe for commercial fusion applications will require the application of corrosion mitigation strategies, including monitoring impurities and salt chemistry, controlling impurity levels, and ensuring protection of salt-facing structural materials.

This program leverages the expertise in electrochemical and corrosion engineering at Savannah River National Laboratory to monitor corrosion caused by FLiBe in real time, and to enable local control of corrosion rates by adjusting impurity concentrations in the FLiBe. Electrochemical reference electrodes will be used to detect the presence of hydrogen isotopes and of corrosion products. An active redox control system that maintains stable redox conditions in response to real-time sensor output will be demonstrated.

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INFUSE 2021a Award Notification

Company: General Atomics, DUNS: 067638957

Title: Performance Testing of Low-Resistance Demountable HTS Joints for Large Segmented Magnets

Abstract:

High temperature superconducting (HTS) magnets could significantly enhance the performance characteristics of fusion devices and are recognized as one of the four first-tier transformative enabling capabilities to efficiently advance fusion technology. General Atomics (GA) is actively evaluating the technical feasibility of large-scale HTS fusion magnets. One of the focus areas at GA is the demonstration of an HTS-based segmented toroidal field (TF) coil at a scale representative of a compact tokamak fusion device. Practical configurations of magnet coils for future fusion devices, such as TF coils, will require demountable, high current, low-resistance joints. A method for reliably constructing such joints is essential for the application of HTS to fusion magnet systems, as the ability to remove a quadrant of the TF coils permits access to the machine's internals and simpler exchange of components. The goal of the present project is to significantly advance the current state-of-the-art HTS conductor and joint technology beyond tabletop experimentation. Under this project, GA will design and fabricate test articles of the HTS joints and perform basic testing for superconductivity at a temperature of 77 Kelvin. The detailed testing at a temperature of 4.5 Kelvin will be conducted at Lawrence Berkeley National Laboratory's (LBNL) unique facilities ideally suited to the testing of superconducting joints under high magnetic fields and high transport currents. LBNL also has expertise in the instrumentation of such test samples, which is crucial to ensure the viability of the results. The project will provide important joint performance data for the development and demonstration of the HTS demountable joint technology that is novel, generic, scalable, and parallelizable, thus promising dramatic simplification and cost reduction for any fusion concept benefiting from demountable HTS coils. The program will demonstrate the technical feasibility of demountable HTS magnets and provide a path towards compact high-density plasma fusion machines.

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INFUSE 2021a Award Notification

Company: HelicitySpace., DUNS: 117087016

Title: Simulation of the Helicity Drive Magneto-Inertial Fusion Concept

Abstract:

The Helicity Drive is a new, compact magneto-inertial fusion concept with a unique fusion output scalability that could simplify the challenge of achieving net fusion gain in short pulses. The concept exploits magnetic reconnection-heating of merging plectonemic plasmas with peristaltic magnetic compression to increase the fusion triple product. The project proposes to perform magnetohydrodynamic simulations with select kinetic simulations to investigate the plasma physics behind the concept. Our Request for Assistance is therefore complementary to our existing, separately funded, experimental effort to build a new proof-of-concept device in collaboration with academia and national laboratories. Together, the proposed simulation effort is critical to the company's ambition of building a robust development program for our new magneto-inertial fusion concept.

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INFUSE 2021a Award Notification

Company: Microsoft Corporation, DUNS: 081466849

Title: Improving Plasma Control Capabilities in Magnetically-Confined Tokamak Systems with Transformer Neural Networks

Abstract:

The ongoing AI revolution in fundamental science offers multifarious new opportunities for application and further development of cutting-edge machine learning algorithms used in Microsoft products. In particular, the advanced AI-enabled deep learning disruption prediction capability developed at PPPL is being actively targeted in current R&D efforts at DOE's Princeton Plasma Physics Laboratory (PPPL) for implementation into plasma control capabilities in magnetically-confined tokamak experiments. This objective represents a great candidate for the proposed implementation of Microsoft's approach based on transformer neural networks to improve forward temporal projection algorithms that accurately predict dangerous disruption events encountered in thermonuclear tokamak plasmas which can in turn lead to important beneficial advances in real-time plasma control in advanced tokamak systems, including ITER.

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INFUSE 2021a Award Notification

Company: Renaissance Americas Inc., DUNS: 117506666

Title: Phase Diagram of Li-LiH,D,(T) Mixtures and Implications for Tritium Retention and Extraction

Abstract:

Tritium extraction from Lithium based liquid walls or blankets will require the extraction of LiT (alone or lumped with LiD). To assist and guide the design of new extraction techniques, as well as optimize existing ones, we propose to measure with unprecedented accuracy the phase-diagram of Li-LiH,D and analytically infer from it the behavior of Li-LiD,T.

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June 14, 2021

INFUSE 2021a Award Notification

Company: TAE Technologies, Inc, DUNS: 065262557

Title: Extending Operational Boundaries in the Advanced FRC

Abstract:

The 3D hybrid Particle-In-Cell code HYM will be used at PPPL to simulate the stability properties of realistic plasma equilibrium states in Advanced Field Reversed Configuration (FRC) plasmas. The study will include the effects of the large fast ion population that is present in Advanced FRC plasmas due to the use of neutral beam injection (NBI). On the C-2W experiment at TAE Technologies, Inc, it is found empirically that the fast ion contribution has a strong stabilizing effect, allowing a high temperature FRC plasma to be confined with parameters that would not be accessible to conventional FRCs, which are lacking NBI. Using the HYM code, initial value simulations will be performed to identify the mechanism behind the stabilization effects of the NBI. In particular, the effect of the fast ion population on mode growth rate, non-linear saturation, and possible mode coupling will be studied. Simulation results will be used to interpret C-2W results by detailed comparison of numerical and experimental phenomena. Simulations will also be used to explore the use of other external actuators for mitigation of instabilities. The resulting improved theoretical understanding of operational boundaries will be later used to make critical decisions in the conceptual design of a next-step Advanced FRC device that is currently being planned at TAE. In this public-private partnership, scientific contributions from the Department of Energy will directly accelerate progress toward the development of fusion energy in the private sector.

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INFUSE 2021a Award Notification

Company: TAE Technologies, Inc., DUNS: 065262557

Title: X-ray Diagnostic for C-2W FRC Plasma

Abstract:

TAE Technologies (TAE) is committed to develop and distribute safe, cost-effective commercial fusion energy with the cleanest environmental profile. TAE's fusion approach relies on the advanced beam-driven Field-Reversed Configuration (FRC) plasma. One of the critical advantages of the advanced beam-driven FRC is its capability to suppress MHD modes and extend the stability boundary. To investigate the impact of fast ions on these phenomena, TAE recognizes the need to augment its diagnostic capability that can quantify MHD mode activities in the FRC core with sufficient time and spatial resolution. Understanding and extension of stability boundary will have a direct impact on the design and operation of TAE's next milestone device, Copernicus.

To measure the MHD mode activities in TAE's FRC core plasma, Los Alamos National Laboratory (LANL) will provide two 7-detector high-frequency x-ray diagnostic systems. TAE will work with LANL to install the diagnostics on the C-2W (aka Norman) FRC plasma device. After validating an adequate signal-to-noise ratio and frequency response in the x-ray signal for the MHD study, dedicated experiments and data analysis campaigns will be conducted to understand and extend the stability boundaries for beam-driven FRC plasmas. The data with two 7-detector (five filters, one open, and one blind) system will also help determine a rough energy spectrum of the x-ray emission. In addition, the physics and technical requirements for a 2D solid-state x-ray imaging diagnostic for TAE's FRC plasma devices will be identified and specified to further extend the capabilities for measuring the core MHD activities.

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