Cumulative List of INFUSE Awards

INFUSE 2021b, November 22, 2021

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Magnetic Pumps for Molten Salt Fusion Devices

Abstract:

Commonwealth Fusion Systems (CFS) plans to complete construction of ARC, an affordable compact fusion power plant in the early 2030's. ARC will employ a novel liquid immersion blanket design that uses a molten lithium salt as both the tritium breeding material and the vacuum vessel coolant. FLiBe is currently the leading salt candidate due to its favorable heat transfer, neutronic, and tritium breeding properties. ARC will also require a FLiBe-compatible molten salt pump that can handle high temperatures and high pumping powers.

This program leverages Oak Ridge National Laboratory's (ORNL's) expertise in high-temperature, canned-rotor magnetic bearing pumps. This category of pump is well suited for service in ARC because it does not expose any internal seals or bearings to the molten salt. The ORNL and CFS team will identify modifications needed to adapt an existing ORNL salt pump design to meet ARC's requirements. The team will also experimentally test and evaluate the dielectric strength of insulation materials needed to reach ARC's power requirements. If successful, the program will accelerate CFS' molten salt pump roadmap for ARC.

Co. PI: Dr. Brandon Sorbom

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Laboratory: ORNL

Lab PI: Dr Alex Melin, melina@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2021b, November 22, 2021

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Neutron Ion Handshake for Fusion Materials

Abstract:

Commonwealth Fusion Systems plans to complete construction of ARC, an affordable compact fusion power plant in the early 2030's. ARC's vacuum vessel needs to withstand high temperatures, mechanical loadings, and intense neutron radiation fields. A testing program is required to enable the judicious selection of structural materials that can withstand radiation-induced degradation. However, such programs have been hampered by the lack of appropriate neutron sources, long program timelines and high costs.

This program leverages the unique *in situ* ion irradiation transient grating spectroscopy facility at Sandia National Laboratories and its state-of-the-art shared materials analytical facilities to establish an equivalency between ion irradiation and neutron irradiation testing of candidate materials. If successful, the program will simplify and accelerate ARC materials testing, enabling testing of fusion-relevant materials at speeds three orders of magnitude faster than is possible with neutron irradiation test reactors.

Co. PI: Dr. Brandon Sorbom

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Laboratory: SNL

Lab PI: Dr. Khalid Hattar, khattar@sandia.gov

Cumulative List of INFUSE Awards

INFUSE 2021b, November 22, 2021

Company: Energy Driven Technologies LLC., DUNS: 080060913

Title: High Heat Flux Exposure of PFC Candidate Fine-Grain Dispersion-Strengthened Tungsten Materials

Abstract:

Energy Driven Technologies (a.k.a. Editekk) is developing a plasma facing material for future burning-plasma magnetic thermonuclear fusion reactors. While tungsten is an attractive option due to its high melting temperature, good thermal conductivity, and high sputtering threshold, current monolithic tungsten suffers from brittleness and grain growth under heavy thermal loads. Editekk' s approach is to use advanced manufacturing to create fine-grain dispersion-strengthened tungsten to improve thermo-mechanical properties. To achieve this goal and offer a material solution, this project will subject candidate samples to prototypical high heat fluxes using an electron beam facility. These tests will demonstrate material performance under extreme thermal loading and check for damage, such as melting and crack formation, as well as microstructural changes, such as grain growth. Results of these tests will guide development of the manufacturing process and demonstrate feasibility of Editekk' s material design approach.

Co. PI: Mr. Zachariah Koyn

Co. e-mail: zkoyn@editekk.com

Laboratory: ORNL

Lab PI: Dr. Travis Gray, graytk@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2021b, November 22, 2021

Company: Energy Driven Technologies LLC., DUNS: 080060913

Title: Mechanical Characterization of PFC Candidate Fine-Grain Dispersion-Strengthened Tungsten Materials

Abstract:

Energy Driven Technologies (a.k.a. Editekk) is developing a plasma facing material for future burning-plasma magnetic thermonuclear fusion reactors. While tungsten is an attractive option due to its high melting temperature, good thermal conductivity, and high sputtering threshold. Current monolithic tungsten suffers from brittleness and grain growth under heavy thermal loads. Editekk's approach is to use advanced manufacturing to create fine-grain dispersion-strengthened tungsten to improve thermo-mechanical properties. To achieve this goal and offer a material solution, this project will test the high temperature mechanical properties of candidate materials including tensile strength, ductile-to-brittle transition temperature, flexural strength, thermal diffusivity, the ability to inhibit grain growth after prolonged exposure to high temperatures and how this exposure affects properties, such as hardness. Results of these tests will define mechanical properties, guide the development of the manufacturing process, and demonstrate feasibility of Editekk's material design approach.

Co. PI: Mr. Zachariah Koyn

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Laboratory: ORNL

Lab PI: Dr. Lauren Garrison, garrisonlm@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2021b, November 22, 2021

Company: General Atomics, DUNS: 067638957

Title: In-Field Performance Testing of a Novel HTS CICC for Practical and Cost-Effective Fusion Magnet Systems

Abstract:

High temperature superconducting (HTS) magnets could significantly enhance the performance 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 (STF) coil at a scale typical of a compact tokamak fusion device. GA's design of the STF coil uses a unique configuration of Conductor-on-Round-Core (CORC®) HTS cables in a Cable-In-Conduit-Conductor (CICC). The CICC concept is novel approach to have an internally cooled conductor with large current capacity. The use of CORC® compared to the stacked and/or twisted tape cables enable a round geometry and isotropic properties which are favorable attributes in terms of fabrication as well as tokamak operation. Thus, the CORC-based CICC design offers a simplified and cost-effective solution to large-scale HTS magnets. Under this project, GA is fabricating a 4 m long test article of the CORC®-based CICC that will be tested under high-applied currents and high magnetic field conditions at the DCC017 dipole system at Brookhaven National Laboratory. The parametric evaluation of the test article that includes the tight radius bend will retire key manufacturing risks by demonstrating the integrity of CORC® cable inside the copper stabilizer and welded SS conduit. If successful, the project will demonstrate the technical feasibility of full-scale HTS fusion magnets and provide a path towards compact high-density plasma fusion machines.

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Laboratory: BNL

Lab PI: Dr. Ramesh Gupta, gupta@bnl.gov

Cumulative List of INFUSE Awards

INFUSE 2021b, November 22, 2021

Company: Magneto-Inertial Fusion Technologies, Inc. (MIFTI), DUNS: 078640171

Title: Thermonuclear fusion verification of Staged Z-pinch fusion on a 0.5 MA LTD pulsed power generator

Abstract:

Magneto-Inertial Fusion Technologies, Inc. (MIFTI) is developing a fusion concept based on the oldest fusion idea, the Z-pinch, and refines it by surrounding the fusion fuel with a high atomic number cylindrical plasma shell. This so-called Staged Z-Pinch concept was recently successfully tested on the one million ampere pulsed power generator Zebra where krypton plasma shell compressed a deuterium target producing ten billion thermonuclear neutrons. MIFTI is about to start experiments on a five hundred thousand ampere pulsed power generator utilizing Linear Transformer Driver (LTD) technology which has more efficient energy coupling to the plasma load. We propose to use neutron diagnostics developed by the Lawrence Livermore National Laboratory to accurately measure the neutron yield on this machine. Monte-Carlo code simulations will clarify the neutron scattering properties of the LTD device and facility and will inform the interpretation of the neutron time of flight measurements along multiple sightlines, which are essential for establishing the thermonuclear neutron origin.

Co. PI: Dr. Emil Ruskov

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Laboratory: LLNL

Lab PI: Dr. Drew Higginson, higginson2@llnl.gov

Cumulative List of INFUSE Awards

INFUSE 2021b, November 22, 2021

Company: Renaissance Americas Inc., DUNS: 117506666

Title: Artificially intelligent optimization of alpha particle transport in stellarators

Abstract:

Stellarator optimization requires rapid evaluation of physical properties associated with the magnetic equilibrium. However, certain optimization targets such as alpha losses are computationally costly to evaluate. With experts in machine learning from the Princeton Plasma Physics Laboratory (PPPL) we will:
1) generate an open-source dataset of burning stellarator equilibria,
2) efficiently evaluate alpha losses from such equilibria, and
3) generate machine-learned proxies for those metrics.
These proxies will aid Renaissance and the whole stellarator community in designing future reactors.

Co. PI: Dr. Christopher Berg Smiet

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Laboratory: PPPL

Lab PI: Dr R. Michael Churchill, rchurchi@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2021b, November 22, 2021

Company: Silver-Fir Software, Inc, DUNS: 117147222

Title: Extension of MCNP® Mesh Based Weight Windows to Support Unstructured Mesh Topologies

Abstract:

In this project, the capabilities of the MCNP Monte Carlo code will be extended by Los Alamos National Laboratory to support weight windows defined on unstructured mesh topologies. As a cost-share contribution, Silver Fir Software will extend the capabilities of Attila4MC to support the new MCNP unstructured mesh weight window format.

Co. PI: Dr. Eugeny Sosnovsky

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Laboratory: LANL

Lab PI: Dr. Joel A. Kulesza, jkulesza@lanl.gov

Cumulative List of INFUSE Awards

INFUSE 2021a, June 14, 2021

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.

Co. PI: Dr. Matthew Reinke

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Laboratory: PPPL

Lab PI: Dr Nathaniel Ferraro, nferraro@pppl.gov

INFUSE | Innovation Network for Fusion Energy

Cumulative List of INFUSE Awards

INFUSE 2021a, June 14, 2021

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.

Co. PI: Dr. Brandon Sorbom

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Laboratory: SRNL

Lab PI: Dr. Brenda Garcia-Diaz, Brenda.Garcia-Diaz@srnl.doe.gov

Cumulative List of INFUSE Awards

INFUSE 2021a, June 14, 2021

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.

Co. PI: Dr. Zbigniew Piec

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Laboratory: LBNL

Lab PI: Dr. Xiaorong Wang, xrwang@lbl.gov

Cumulative List of INFUSE Awards

INFUSE 2021a, June 14, 2021

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.

Co. PI: Dr. Setthivoine You

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Laboratory: LANL

Lab PI: Dr. Hui Li, hli@lanl.gov

Cumulative List of INFUSE Awards

INFUSE 2021a, June 14, 2021

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.

Co. PI: Dr. Alexey Svyatkovskiy

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Laboratory: PPPL

Lab PI: Dr. William Tang, tang@pppl.gov

INFUSE | Innovation Network for Fusion Energy

Cumulative List of INFUSE Awards

INFUSE 2021a, June 14, 2021

Company: Renaissance Americas Inc., DUNS: 117506666

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

Abstract:

Solutions of Lithium and its hydrides are expected to exhibit isotopic effects that could facilitate the extraction of LiT (alone or lumped with LiD) from liquid walls and blankets. As a preliminary test of this new concept, we propose to measure the phase-diagram of Li-LiH,D and analytically infer from it the behavior of Li-LiD,T.

Co. PI: Dr. Francesco Volpe

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Laboratory: SRNL

Lab PI: Dr James Klein, james.klein@srnl.doe.gov

Cumulative List of INFUSE Awards

INFUSE 2021a, June 14, 2021

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.

Co. PI: Dr. Sean Dettrick

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Laboratory: PPPL

Lab PI: Dr Elena Belova, ebelova@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2021a, June 14, 2021

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.

Co. PI: Dr. Deepak Gupta

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Laboratory: LANL

Lab PI: Dr. Glen Wurden, wurden@lanl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Time-Dependent Boundary Modeling to Inform Design of SPARC Diagnostic and Actuators

Abstract:

In order to inform near-term design and enable future advanced control, CFS is looking to obtain modeling of the time-dependent boundary plasma behavior it can expect in SPARC. This will be used to test plasma response to various actuator designs provided by CFS and as inputs to synthetic diagnostic modeling to inform design decisions. This activity requires laboratory assistance because of the complexity of performing boundary plasma simulation that can accurately capture plasma, neutrals and their dynamic, self-consistent behavior. This is not a present capability of CFS or a capability that is commercially available, but is one that DOE maintains and improves as part of its Fusion Energy Sciences mission.

Co. PI: Dr. Alex Creely

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Laboratory: ORNL

Lab PI: Dr. Jeremy Lore, lorejd@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: General Fusion Corp., DUNS: 117111477

Title: Ion Temperature Diagnostic Improvement

Abstract:

This project is to improve General Fusion's ion temperature diagnostic for fusion plasmas. An accurate, time- and spatially-resolved measurement of ion temperature will enable experimental confirmation of fusion reaction rates.

Co. PI: Dr. Akbar Rohollahi

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Laboratory: ORNL

Lab PI: Dr. Theodore Biewer, biewertm@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: Princeton Fusion Systems, LLC, DUNS: 0020074970

Title: Magnetic Field Vector Measurements Using Doppler-Free Saturation Spectroscopy

Abstract:

A non-perturbative diagnostic will be deployed to measure the topology of the equilibrium magnetic field in the PFRC-2 device at PPPL. The diagnostic implements Doppler-free saturation spectroscopy to obtain a 2D high-resolution, spatially resolved, measurement of the H_α spectral line profile.

Co. PI: Dr. Charles Swanson

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Laboratory: PPPL

Lab PI: Dr. Samuel Cohen, scohen@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: Magneto Inertial Fusion Technologies, Inc, DUNS: 065262557

Title: Staged Z-pinch modeling with HYDRA and CHICAGO codes

Abstract:

The Staged Z-pinch (SZP) fusion concept is a magneto-inertial compression scheme where small amounts of fusion fuel (pure deuterium gas, or a mixture of deuterium and tritium gas) are brought to fusion relevant conditions by passing multi-million amperes strong current through a cylindrical shell of high atomic number material. Modeling with the MACH2 code suggests that net fusion energy gain can be achieved when currents in the 10 million amperes range compress a 50%-50% mixture of deuterium and tritium gas. In this project various SZP configurations will be explored with the HYDRA and CHICAGO codes through collaboration with the Lawrence Livermore National Laboratory. HYDRA is a radiation-magnetohydrodynamic code, similar to MACH2, while CHICAGO is a particle-in-cell code which is suitable for a more realistic treatment of the alpha particle heating. Of particular interest are models for high current machines. The ultimate project goal is to provide independent confirmation of net fusion energy gain from the Staged Z-pinch.

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Laboratory: LLNL

Lab PI: Dr. Drew Higginson, higginson2@llnl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: Renaissance Americas, Inc, DUNS: 065262557

Title: Innovative Joints for High-Temperature Superconducting Tapes

Abstract:

The ability to segment HTS coils for tokamaks and stellarators is very attractive but requires joints of ultra-low resistance, well below 1 nOhm. These could be enabled by ultra-thin In-Ag solder (at BNL) between ad-hoc HTS splices (from U. Houston).

Co. PI: Dr. Francesco Volpe

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Laboratory: BNL

Lab PI: Dr. Bill Sampson, wsampson@bnl.gov

INFUSE | Innovation Network for Fusion Energy

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: TAE Technologies, DUNS: 065262557

Title: Measurement of Magnetic Field using Doppler-Free Saturation Spectroscopy (DFSS) in C-2W FRC plasma

Abstract:

In TAE Technologies' fusion approach, which requires high population of confined fast ions, Field Reversed Configuration (FRC) plasma provides an advantage due its unique magnetic field profile. In the experiment, measurement of internal magnetic field profile is important to verify the presence of the FRC and to estimate/simulate the orbit of confined fast ions. Doppler-Free Saturation Spectroscopy (DFSS) is capable of measuring Zeeman and Stark splitting with a resolution nearly three orders of magnitude when compared to conventional OES capabilities, and hence serve as excellent non-perturbative diagnostic to measure a low magnetic field.

A feasibility study conducted by ORNL in collaboration with TAE Technologies has shown that measurements of magnetic fields with an error of ± 5 Gauss may be possible to obtain in C-2W FRC plasma. In this proposal, ORNL will temporarily deploy their mobile Doppler Free Saturation Spectroscopy (DFSS) diagnostic system on TAE's C-2W FRC plasma device. ORNL will also help with the operation and data analysis of DFSS system on C-2W. The main goals of this collaboration are:

1) Validate that adequate signal-to-noise ratio (SNR) as well as temporal and spatial resolution can be achieved with DFSS in C-2W plasma.
2) Demonstrate the capability of DFSS to non-intrusively measure low magnetic fields and its direction in the core of the FRC plasma.
3) Experimentally assess the presence of a reversed magnetic field configuration inside the C-2W plasma.

Co. PI: Dr. Deepak Gupta

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Laboratory: ORNL

Lab PI: Dr. Elijah Martin, martineh@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: TAE Technologies, DUNS: 065262557

Title: Feasibility Study of High-Flux FRC Formation via Spheromak Merging for C-2W Experiments

Abstract:

This project on MRX at PPPL will allow us to assess the feasibility of new spheromak-merging high magnetic-flux FRC formation technique for C-2W NBI experiment at TAE that could further advance C-2W performance to achieve higher energy density regime.

Co. PI: Dr. Hiroshi Gota

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Laboratory: PPPL

Lab PI: Dr. Masaaki Yamada, myamada@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: Tokamak Energy, Inc., DUNS: 117135313

Title: XGC1 predictions of Scrape of Layer width in present and future high field spherical tokamaks

Abstract:

This project aims to calculate the Scrape-Off-Layer width and the heat power deposition of present and future high field spherical tokamak reactors using the global gyrokinetic code XGC1 developed at PPPL.

Co. PI: Dr. Michelle Romanelli

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Laboratory: PPPL

Lab PI: Dr. Choonseok Chang, cschang@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: Tokamak Energy, Inc., DUNS: 117135313

Title: Fabrication and characterization of transition metal hydrides for radiation shielding in tokamak devices

Abstract:

Metal hydrides are identified as key radiation shielding materials to protect components in tokamak reactors. This project will investigate the fabrication and characterization of metal hydrides manufactured by the powder metallurgy process.

Co. PI: Dr. Thomas Davis

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Laboratory: LANL

Lab PI: Dr. Caitlin Taylor, caitlin@lanl.gov

Cumulative List of INFUSE Awards

INFUSE 2020b, November 25, 2020

Company: Type One Energy Group, Inc., DUNS: 117135313

Title: Characterization and Qualification of JK2LB Alloy for Additive Manufacturing of Fusion Components

Abstract:

JK2LB is a nuclear alloy providing fast clearance for fusion components. The project provides initial characterization & qualification of JK2LB for additive manufacturing (AM). The ORNL High Flux Isotope Reactor will irradiate AM-JK2LB specimens followed by tensile & microstructural analysis.

Co. PI: Mr. Randall Volberg

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Laboratory: ORNL

Lab PI: Dr Yutai Katoh, katohy@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2020a, August 14, 2020

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Baselining a Tritium Accountancy and Safety Case for a Molten Salt Liquid Immersion Fusion Blanket

Abstract:

The ARC reactor concept is a leading commercial fusion plant concept, featuring a simplified reactor design and decreased costs

The switch to high temperature superconducting (HTS) magnets further enables innovation in the reactor's blanket. Since the power density may be too high for solid ceramic breeders, and the high magnetic field may create unacceptably large pressure drops in liquid metal breeders, the molten salt FLiBe ($2LiF+BeF_2$) has been proposed as a tritium breeder, multiplier, and coolant for ARC.

Any economically and environmentally viable fusion reactor must minimize onsite tritium inventories and environmental releases (to $\lesssim$ 0.1 g tritium released annually) and successfully mitigate release of tritium and activation products during off-normal events or accidents. While tritium transport and accident analyses are routinely performed by Idaho National Laboratory for Fusion Energy Systems Studies (FESS) designs such as ARIES and FNSF, no comparable analyses have ever been performed for ARC or another design using FLiBe. We propose to leverage the expertise of INL researchers and the MELCOR/TMAP code developed there to perform these analyses for ARC, in order to characterize its tritium transport and safety behavior.

Co. PI: Dr. Brandon Sorbom

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Laboratory: INL

Lab PI: Dr. Paul Humrickhouse, Paul.Humrickhouse@inl.gov

Cumulative List of INFUSE Awards

INFUSE 2020a, August 14, 2020

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: SPARC 3D Field Physics and Support of the Non-Axisymmetric Coil Assessment

Abstract:

The Ideal Perturbed Equilibrium Code (IPEC) code developed and maintained by Princeton Plasma Physics Laboratory Scientists Jong-Kyu Park and Nikolas Logan has revolutionized the physical understanding of plasma sensitivity to error fields and is the centerstone of this proposal. IPEC will be used to assess the types of error fields that the plasma is most susceptible to in the various plasma conditions expected during SPARC plasma current ramp-up, the steady equilibrium phase, and the plasma current ramp-down. Knowledge of the dominant error fields then allows the evaluation of a set of error field correction coils where the metric is the overlap of the applied correction field with the dominant spectrum.

Co. PI: Dr. Alex Creely

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Laboratory: PPPL transferred to LLNL

Lab PI: Dr. Nikolas Logan, logan35@llnl.gov

INFUSE Innovation Network for Fusion Energy

Cumulative List of INFUSE Awards

INFUSE 2020a, August 14, 2020

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Advanced Manufacturing Workflows for Tokamak Internal Components

Abstract:

CFS is currently designing a commercial fusion reactor called ARC, whose key innovation is the use of high-field HTS magnets. These allow for reduced plant size and cost. In addition, they allow for resistive, demountable superconducting joints that give ready access to interior components, dramatically improving RAMI. In order to fully realize benefits of demountability, the following challenges must be addressed:

- A rapid/inexpensive fabrication method must be developed to keep costs down of replacing the internal components
- The fabrication method must be able to support the construction of large (several meter scale) components

In addition, early fusion energy devices will have a learning curve and there will likely be design changes to internal components. This may require expensive re-tooling unless we have an adaptable/reconfigurable fabrication method. Additive manufacturing (AM) is a potential solution to the above challenges and opens up the rapid, low cost fabrication of large components with novel materials. The metal Big Area Additive Manufacturing team developed GMAW-based (gas-metal-arc-welding) capability at ORNL from the ground up. Our overall objective is to design a workflow for the design and manufacture of an AM internal component in a fusion device. This workflow will be tested and driven by the production of an actual subscale divertor module of an ARC vacuum vessel

Co. PI: Dr. Brandon Sorbom

Co. POC: brandon@cfs.energy

Laboratory: ORNL

Lab PI: Dr. Andrzej Nycz, nycza@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2020a, August 14, 2020 [RESCINDED]

Company: Gamma Alloys, Inc., DUNS: 830224049

Title: Tungsten Engineered Feed Stock for PFCs

Abstract:

Gamma would seek to work with Oak Ridge National Lab for reasons as follows. ORNL has extensive knowledge in process modeling, process control, in-situ and ex-situ characterization of a wide range of high temperature materials fabricated via additively manufacturing. This includes fabrication of refractory materials such as Tungsten and Molybdenum. While ORNL has exhibited success in printing these systems, the process window range is relatively small. Besides porosity, which can largely be controlled via the energy density, the major technical challenge is in suppressing the formation of intergranular cracks along columnar grains generating during printing. Prior research has shown that powders decorated with small particles can induce the nucleation of equiaxed grains during solidification. By manipulating the solidification dynamics, it may be possible to eliminate columnar grains and therefore minimize cracking. Furthermore, as traditional processing of refractory materials is incredibly difficult, processing via additive manufacturing offers a novel opportunity to surpass the current manufacturing bottleneck and deploy these materials into industrial use. Currently, Gamma is in the early stages of a, AM Aluminum CRADA with ORNL focusing on similar development for Aluminum engineered feedstock. Lastly ORNL is our ideal choice as there is an internal need for Tungsten & Tungsten alloy parts & printing.

Co. PI: Mr. Micah Peabody

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Laboratory: ORNL

Lab PI: Dr. Peeyush Nandwana, nandwanap@ornl.gov

INFUSE 2020a, August 14, 2020

Company: General Fusion Corp., DUNS: 117111477

Title: Advanced Stability Analysis for Magnetized Target Fusion

Abstract:

This project seeks to apply advanced computational stability analyses to model equilibrium states representing the Fusion Demonstration Plant (FDP) device General Fusion is designing. The FDP is a Magnetized Target Fusion concept that strongly compresses a toroidal plasma inside of a liquid Lithium blanket. In particular, building on encouraging initial analyses, the effect of plasma rotation on the stability will be studied using the Resistive DCON and MARS-F codes under development at Princeton Plasma Physics Laboratory. The results will help to inform General Fusion on the stable operation of their design, and the project will pave the way for more advanced analyses such as the influence the energetic particles driven from fusion reactions would have on the stability.

Co. PI: Dr. Aaron Froese

Co. POC: aaron.froese@generalfusion.com

Laboratory: PPPL

Lab PI: Dr. Zhirui Wang, zwang@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2020a, August 14, 2020

Company: Solid Material Solutions, LLC, DUNS: 0020074970

Title: Low Temperature Testing of New Lower Cost Magnum-NX HTS Cable for Fusion

Abstract:

This program will directly measure the electrical current carrying properties of a new type of lower cost, more robust and quench resistant high temperature superconducting tape cable, thereby providing vital information for designing and developing fusion reactor coils and assessing their utility. The test cables will be produced by Solid Material Solutions, LLC and testing will be completed by staff at Brookhaven National Laboratory.

Co. PI: Dr. Alexander Otto

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Laboratory: BNL

Lab PI: Dr. Ramesh Gupta, gupta@bnl.gov

INFUSE 2020a, August 14, 2020

Company: TAE Technologies, DUNS: 065262557

Title: Development of phased-array HHFW antenna and load-resilient matching network for the C-2W FRC plasma device

Abstract:

This proposal is to develop the optimized design of a high power capable phased-array HHFW antenna and a load-resilient matching network for the C-2W FRC plasma device. The antenna will be designed to allow arbitrary phasing of currents on the radiating elements in order to maximize heating efficiency. It will be necessary to minimize RF/edge plasma interactions with design features to be considered including low-Z insulating limiters and the reduction to the greatest possible extent of surface currents on the antenna enclosure. The matching network design will incorporate a passive load-resilience feature, which will allow the antenna to operate with arbitrary current phasing between elements, even for low levels of antenna coupling for which impedance matching of all elements would otherwise not be possible.

Co. PI: Dr. Xiaokang Yang

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Laboratory: ORNL

Lab PI: Dr. Richard Goulding, gouldingrh@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2020a, August 14, 2020

Company: Tokamak Energy, Inc., DUNS: 117135313

Title: Investigating microstability characteristics of next step tokamaks across a range of aspect ratios

Abstract:

This project will investigate the microstability characteristics of next step tokamaks across arrange of aspect ratios. A systems code followed by a 1.5D transport code will be used to produce plasma equilibria and kinetic profiles that satisfy a set of high-level criteria across a range of aspect ratios. Linear gyrokinetic simulations will then be used to characterise the strength and thresholds of micro-instabilities to identify which configurations are most likely to project to high confinement. The results from this project are expected to provide assistance to Tokamak Energy by providing valuable insight to the design of the Company's next step device, ST-F1, and by informing the research programme on Tokamak Energy's high field spherical tokamak, ST40.

Co. PI: Dr. Steven McNamara

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Laboratory: PPPL

Lab PI: Dr. Walter Guttenfelder, wgutten@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2020a, August 14, 2020

Company: Tokamak Energy, Inc., DUNS: 117135313

Title: Development of an RF Antenna to start-up and sustain a fusion plasma in a spherical tokamak

Abstract:

The central solenoid is an intrinsic part of all present-day tokamaks and most spherical tokamaks (ST). The use of a conventional solenoid in an ST-based fusion reactor may be impossible. Solenoid-free plasma start-up and steady state operation is therefore an area of extensive worldwide research activity.

Tokamak Energy's ST40 has a toroidal magnetic field of 3T which allows testing of reactor relevant RF based plasma start-up, current ramp-up and sustainment methods with commercially available MW range RF power sources. Electron Bernstein wave (EBW) based plasma start-up and plasma current drive are in the research programme of ST40. Efficient EBW excitation in the plasma requires RF power to be launched as an X-mode from the high field side (HFS) of the machine. HFS RF launching was always technically difficult in tokamaks but it is even more challenging in STs because of very limited space at the centre of the torus. However, it is strategically important to develop a technology for HFS RF launching in the STs.

Oak Ridge National Laboratory (ORNL) will perform a conceptual design of an ST compatible HFS launching system to enable investigation of a reactor scale plasma start-up, current ramp-up and sustainment of spherical tokamak plasms, The ultimate aim will be to demonstrate steady-state EBW operation and eventually to use EBW as a main method of plasma current generation in an ST reactor.

Co. PI: Dr. Vladimir Shevchenko

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Laboratory: ORNL

Lab PI: Dr. Tim Bigelow, bigelowts@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2020a, August 14, 2020

Company: Tokamak Energy, Inc., DUNS: 117135313

Title: Conceptual design of a tritium pellet injector for the ST40 spherical tokamak

Abstract:

ORNL has a long track record of pellet injection technology development. For the application of pellet fueling on ST40, a previous design by ORNL of a flexible pipe-gun type injector named "pellet injector in a suitcase" would likely be an ideal technology to use as it has already been proven on several fusion devices and can be built and integrated into ST40 for relatively modest cost. The application of this system for ST40 would require some changes to make it tritium compatible and provide the necessary isolation of tritium containing components. The implementation of the injector for tritium use is of research interest to ORNL who have yet to deploy an injection system for use with tritium. The present proposal is to determine the pellet sizes to be utilized on ST40 and to modify the design for these sizes and for tritium compatibility.

Co. PI: Mr. David Wilson

Co. POC: david.wilson@tokamakenergy.co.uk

Laboratory: ORNL

Lab PI: Dr Larry Baylor, baylorlr@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: Advanced Conductor Technologies, DUNS: 969353734

Title: Development of a modeling toolbox for CORC® cable performance evaluation

Abstract:

Advanced Conductor Technologies and SuperPower Inc. request Lawrence Berkeley National Laboratory (LBNL) to develop a simulative tool that would create a deeper understanding of current distribution between tapes in CORC® cables for fusion magnet in the presence of common performance variations within REBCO tapes when operating at high magnetic fields. Such tool, which would be developed under the "Enabling technologies including new and improved magnets" topic area, would allow tailoring the design of CORC® cables for fusion magnets based on actual REBCO tape performance variations to ensure their optimum operation and prevent conductor burnout during a magnet quench. The model should be based on actual REBCO tape performance, with emphasis on variations in high-field REBCO tape performance due to variations in chemistry and processing conditions, and other key parameters such as contact resistance between REBCO tapes in CORC® cables.

Co. PI: Dr. Danko Van der Laan

Co. POC: danko@advancedconductor.com

Laboratory: LBNL

Lab PI: Dr. Steven Gourlay, sagourlay@lbl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Superconducting Cable Quench Detection

Abstract:

This proposal will enable Commonwealth Fusion Systems (CFS) to pursue its cable development program by using the 10-T Brookhaven National Laboratory (BNL) dipole magnet, DCC017. CFS and BNL will work together on cable design and construction, cable instrumentation, design and construction of a cable test fixture, quench testing at 4 K temperatures, and quench data analysis.

Co. PI: Dr. Brandon Sorbom

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Laboratory: BNL

Lab PI: Dr. Ramesh Gupta, gupta@bnl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Divertor Component Testing

Abstract:

Power exhaust is an immense challenge in tokamaks. Commonwealth Fusion Systems (CFS), in collaboration with MIT and others, is designing and building a compact, high-field tokamak for the demonstration of net fusion energy, called SPARC. A successful SPARC divertor will require very carefully engineered and qualified divertor tiles and cassettes to handle the cyclic thermal loading. Testing of materials and components under relevant heat flux conditions is a necessary step for developing a robust and reliable power exhaust system. Here we propose to use the high-heat flux testing expertise maintained by ORNL, used in support of NSTX-U, to demonstrate the thermal performance of tungsten-coated graphitic foam targets, to help CFS and its collaborators assess the performance of base materials and divertor mockups under SPARC-like divertor heat flux conditions.

Co. PI: Dr. Dan Brunner

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Laboratory: ORNL

Lab PI: Dr. Travis Gray, tkgray@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: Commonwealth Fusion Systems, DUNS: 117005109

Title: Divertor Plasma Simulations

Abstract:

Power exhaust is an immense and unsolved challenge in tokamaks. The intensity of the boundary plasma in present experiments falls far short of the conditions expected in net-energy tokamaks. This proposal will allow CFS to use the unique UEDGE plasma neutral simulation code to simulate boundary plasmas under conditions relevant to its net-energy tokamak device, called SPARC.

Co. PI: Dr. Dan Brunner

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Laboratory: LLNL

Lab PI: Dr. Maxim Umansky, umansky1@llnl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: Commonwealth Fusion Systems., DUNS: 117005109

Title: Alpha Particle Diagnostics Simulation

Abstract:

Measuring and understanding the physics of transport of fast ions is an important part of the missions of TFTR, JET, ITER and SPARC, because it affects both plasma performance (MHD stability and plasma heating) and survival of the first wall. A well-designed diagnostic set will be required to study the transport and loss of energetic ions from both classical (ripple) and MHD-driven mechanisms. Careful simulations of the expected properties of the energetic ion populations must first be carried out to optimally design, and position the diagnostics that are required to adequately test the transport models. The work proposed here aims to lay out the requirements for alpha-particle diagnostics, especially lost alphas, by predicting how these particles are expected to behave under conditions relevant to SPARC, CFS' break-even tokamak. We propose to use two sets of code developed and maintained by the Princeton Plasma Physics Laboratory to perform calculations of fast-ion losses in SPARC arising from toroidal field (TF) ripple and magnetohydrodynamic effects.

Co. PI: Dr. Steve Scott

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Laboratory: PPPL

Lab PI: Dr. Gerrit Kramer and Dr. Mario Podesta, mpodesta@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019 [RESCINDED]

Company: HelicitySpace, DUNS: 117087016

Title: Development of a High-Current Solid-State Switch for Magneto-Inertial Fusion

Abstract:

Magneto-inertial fusion attempts to satisfy the Lawson criterion in short pulses of the order of plasma energy confinement times. The power systems for this class of fusion concepts generally require large (> 1 MA) level currents delivered very rapidly. Delivering electricity to the grid will then require high frequency pulses (~ 1 Hz). There is therefore a strong need for switches capable of satisfying these requirements. The project proposes to develop power stacks capable of scaling up to these requirements based on light-activated thyristors that promise to provide more compact, robust and scalable switches for magneto-inertial fusion concepts.

Co. PI: Dr. Setthivoine You

Co. POC: setthivoine.you@helicityspace.com

Laboratory: PPPL

Lab PI: Mr. Clement Bovet, cbovet@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: HelicitySpace, DUNS: 117087016

Title: Simulation of Plectoneme Formation

Abstract:

Plectonemes are non-axisymmetric Taylor states recently discovered in the SSX and MOCHI experiments. These experiments have observed remarkable stability and long lifetimes, without close-fitting walls in some cases, despite their non-axisymmetric nature. The Helicity Drive is an innovative fusion energy concept that exploits these properties together with magnetic reconnection heating and passive magnetic compression to achieve triple products sufficient for net energy gain. The company has detailed physics calculations that estimate the scaling of plasma parameters and triple product with input parameters based on prior laboratory experience. This project proposes to perform high-performance 3D MHD numerical simulations of the formation process of plectonemes to improve the understanding of the SSX and MOCHI results, and help enable predictive capabilities for the Helicity Drive concept.

Co. PI: Dr. Setthivoine You

Co. POC: setthivoine.you@helicityspace.com

Laboratory: LANL

Lab PI: Dr. Hui Li, hli@lanl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: Hyperjet Fusion Corp., DUNS: 080736078

Title: 3D MHD Simulations Support for PJMIF

Abstract:

We are looking for help from the national labs in conducting credible 3D MHD simulations of our proposed target formation approach, assessing relevant merging conditions of the compact toroids that can be created in the near term and to assess the magnetic topology and plasma properties that can be obtained. These simulations are challenging because they require the study of a complicated magnetic topology in 3D, varying over a wide range of physical length scales as the compact toroids converge and stagnate, and have proved well beyond the capabilities of codes we have been able to access in the commercial space.

Co. PI: Dr. Franklin Witherspoon

Co. POC: witherspoon@hyperjetfusion.com

Laboratory: LANL

Lab PI: Dr. Glen Wurden and/or Dr. Samuel Langendorf, samuel.langendorf@lanl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: TAE Technologies, Inc., DUNS: 065262557

Title: Simulations of Global Stability in the C-2W Device

Abstract:

TAE Technologies, Inc, proposes to use the HYM 3D particle-in-cell code developed at PPPL to study the synergistic effects of neutral beam injection and end biasing on the global stability of FRC plasmas in conditions relevant to the C-2W experimental device and the planned next-step device, Copernicus.

Co. PI: Dr. Sean Dettrick

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Laboratory: PPPL

Lab PI: Dr Elena Belova, ebelova@pppl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: TAE Technologies, Inc., DUNS: 065262557

Title: Doppler-Free Saturation Spectroscopy (DFSS) for Magnetic and Electric Field Measurements in an FRC plasma

Abstract:

The proposal will examine the feasibility of implementing Doppler Free Saturation Spectroscopy (DFSS) to measure the magnetic and electric fields profiles in the Field Reversed Configuration (FRC) plasma of TAE's C-2W device. There are two primary objectives,

1) An error analysis will be conducted to determine the minimum magnetic and electric field that can be determined by DFSS, and measurement uncertainty as a function of magnetic and electric field magnitude and direction. Potential sources of systematic error will be identified using C-2W plasma parameters.
2) Recommend preliminary design for the DFSS system based on C-2W machine parameters, accessibility, and the desired spatial and temporal resolution.

Co. PI: Dr. Deepak Gupta

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Laboratory: ORNL

Lab PI: Dr. Elijah Martin, martineh@ornl.gov

Cumulative List of INFUSE Awards

INFUSE 2019b, September 23, 2019

Company: TAE Technologies, Inc., DUNS: 065262557

Title: Developing high harmonic fast wave (HHFW) as an enabling electron heating actuator for an FRC plasma

Abstract:

The main task of this project is to perform HHFW simulations in FRC plasma by using Petra-M code and the 4-strap antenna geometry implemented in LArge Plasma Device (LAPD) under different plasma conditions, for example, at (1) the different phasing between straps, (2) the different external magnetic field (thus different RF frequency), and (3) the different antenna radial position. Furthermore, due to compact and limited space near the midplane of C-2W, the impact of the different number of antenna straps will be also explored in order to improve the antenna design and its performance. A study of high power enabling HHFW antenna design will be considered using the HHFW engineering and simulation tools developed at PPPL.

A possible verification activity with the experimental data (RF wave magnetic fields at both the near and far field measured by B-dot magnetic probes) for the HHFW phased-array (4-strap) antenna in LAPD will be also considered.

Co. PI: Dr. Xiaokang Yang

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Laboratory: PPPL

Lab PI: Dr. Nicola Bertelli, nbertell@pppl.gov