INFUSE 2020a Award Notification

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.

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INFUSE 2020a Award Notification

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.

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INFUSE 2020a Award Notification

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

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INFUSE 2020a Award Notification

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.

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INFUSE 2020a Award Notification

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.

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INFUSE | Innovation Network for Fusion Energy

August 14, 2020

INFUSE 2020a Award Notification

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.

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INFUSE 2020a Award Notification

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.

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INFUSE 2020a Award Notification

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.

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INFUSE 2020a Award Notification

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.

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INFUSE 2020a Award Notification

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.

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