COVER PAGE

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ACCOMPLISHMENTS

- **Major goals and objectives of this project**

1. Student Recruitment, Mentorship, and Internships: Recruit, mentor and support graduate students from Tennessee State University (TSU) for summer internships at Oakridge National Laboratory (ORNL) in their first year of selection and guide them to private fusion industry internships in their second year of selection. The students are guided by their ORNL research mentors and the TSU faculty in career preparation, course selection, and graduate school selection towards a career in fusion.
2. Curriculum Development: Develop, review, organize and deploy course modules for existing courses incorporating topics relevant to fusion. Guided by feedback from industry and ORNL collaborators, these course modules are designed to complement existing curricular by introducing students to the latest advancements in fusion research, presented in plain language. By bringing cutting-edge research into the classroom, these lectures will inspire students by showcasing the real-world impacts of fusion technology
3. Faculty development: Promote faculty technical development in nuclear fusion through summer internships in fusion-related research to support curriculum development.
4. Sustainability through Fusion Innovation Bootcamp (FIB): The FIB will offer undergraduate and graduate students the opportunity to collaborate in teams to develop innovative solutions to real-world fusion challenges. Lessons from the Nuclear Innovation Bootcamp will be utilized to ensure the success of FIB, leveraging insights to enhance the structure and effectiveness of the bootcamp. In FY27, as a conclusion to this RENEW project, a fusion engineering and technology workshop will be established for members of the community to share best practices and curricular developments. It is expected that the FIB will be self-sustaining after the completion of this project.

- **What was accomplished towards these goals?**

1. Student Recruitment: The student recruitment was kickstarted in November 2024 under an existing FES-RENEW grant at TSU with the help of an introductory seminar at TSU by our collaborator, Dr. Yuqiao (Joy) Fan, where she gave an overview of fusion energy technology. In particular, she introduced helium cooling for the first wall of the fusion blanket. TSU student, Brandon Partee who had interned in ORNL in Summer 2024 shared his experience with the attendees. The seminar was attended by 23 graduate students. Following the seminar, slides and information regarding the internship was sent out to all attendees as well as other graduate students from the college of engineering at TSU. 14 applications were received from graduate students at TSU, and 12 of them were shortlisted for review by Dr. Parthasarathy, TSU PI, based on GPA, research experience, technical skills and contributions to student chapters. The shortlisted resumes were provided to the ORNL research mentors who selected two candidates for interviews. Dr. Parthasarathy guided the selected candidates in preparation for their interviews. The selected candidates, Vailet Magidanga (civil engineering graduate student) and Oluwaseyi Amisu (mechanical engineering graduate student) successfully completed their 10-week internships at ORNL by August 2025 on the topics “Computational Fluid Dynamics (CFD) and Magnetohydrodynamics (MHD) Simulations for Modeling PbLi Flow in Fusion Blanket Geometries” and “Design and Thermomechanical Modeling of Functionally Graded First Wall of a Fusion Reactor”, respectively. The internships were deemed successful. Vailet is continuing her research work at TSU alongside her master’s research. Oluwaseyi has started a PhD at the University of Tennessee, Knoxville in the Bredesen Center under the Energy Science and Engineering program. Both trainees received mentorship regarding graduate study options, career preparation, and coursework priorities from their ORNL mentors, Yuqiao Fan and Sunday Aduloju, respectively. Vailet has been able to come up with a career plan through discussions with Parthasarathy and Fan. She will have her 2026 summer internship at one of participating private company partners.
2. Curriculum Development: Course modules were developed for three courses in TSU in the departments of Civil and Mechanical Engineering: (a) Structural design of nuclear containment structures for the course CVEN 3420 (Parthasarathy): Reinforced Concrete Design under the department of Civil Engineering, (b Mechanics of materials for plasma facing components (PFCs) of nuclear fusion reactors for the course ENGR 2130: Mechanics of materials, and (c) Selection of materials for nuclear fusion reactors for the course MEEN 3100 (Habibi): Materials Processing. The implementation of the course modulus in the lectures is underway and they have been received positively. Briefly, the course module for CVEN 3420 covered the analysis and design of dome shaped reinforced concrete nuclear containment structures. The content was integrated into the introductory lectures and into a design project that was based on the ITER tokamak complex. In addition to the design of conventional forms such as beams, slabs and columns, the students also learnt the design and analysis of domes. They are applying their knowledge on a simplified design of the diagnostics building as part of their term project for this course. In the course ENGR 2130 (Parthasarathy), the students will learn about material models for Tungsten, specifically focusing on the ductile-to-brittle transition, which is a crucial aspect of design for plasma facing components of fusion reactors. In the course MEEN 3100 (Habibi), the students are learning advanced manufacturing and materials for nuclear fusion reactor components, as well as mechatronics control systems, diagnostics and control systems which are applicable to fusion reactor operation and maintenance.
3. Faculty Development for curriculum development: TSU PI Parthasarathy participated in a 10-week intensive summer research at ORNL through the visiting faculty program (VFP) directly funded by the Department of Energy (DOE), on mechanics of Tungsten in plasma facing components of nuclear fusion reactors. This provided him with the required

expertise to design a course module for the ENGR 2130 Mechanics of Materials course on the ductile-to-brittle transition in Tunsgten fusion reactors. As part of the VFP research, TSU PI Parthasarathy developed traction separation laws for specific grain boundaries in Tungsten to use in a multi-scale hierarchical model being developed at ORNL.

4. Fusion Innovation Bootcamp (FIB): TSU PI Parthasarathy worked closely with ORNL PI Yuqiao Fan and ORNL collaborator Arnold Lumsdaine to come up with an action plan for the FIB to be hosted by TSU from June 15 to June 26, 2026. The first week of the FIB will involve technical training in nuclear fusion, market gaps in fusion, product development and branding, etc. followed by team formation. The second week will involve training in ideation, entrepreneurship, business startup, public speaking, followed by regulations training, venture financing and personalized mentorship. Students will also be working on their startup plans and final presentation in the week. The following tasks have been partially completed in preparation of the FIB: (a) reservation of residence hall rooms on TSU campus for all attendees of FIB, (b) identification of potential experts in the following areas: Public Speaking, Product & branding, Cutting-edge technologies, Venture Financing, Presentation skills, Fusion energy market, Creativity/Innovation, Starting a business. A new residence hall on TSU campus equipped with several computer labs, a state-of-the-art conference room with excellent acoustics and capable of seating 100 people has been reserved for the FIB. The hall, equipped with comfortable lobbies, will be an ideal venue for the participating students to have substantial engagement and informal discussions with private industry personnel and other experts throughout the day including evenings. The FIB will be modeled after the Nuclear Innovation Bootcamp (NIB) but will have adjustments to cater to the different education and technical demographics of the participants. Whereas the NIB participants come from backgrounds expected to have a background either in fusion or in finance/entrepreneurship, the FIB participants will instead be preparing themselves in these areas only at the time of preparing their applications. The participants will thus be selected based on their application statements, which will provide insight into their motivation levels. Supply chain management and financial statement analysis will be critical teaching points to the selected students in addition to entrepreneurship/leadership in the first week. Supply chain management expert, Dr. Xiaoming Li, from the TSU College of Business, has been recruited to teach his area of expertise in the first/second weeks of the FIB. The Vanderbilt University Fusion Group will also be approached as trainers in the first week of the FIB. Other shortlisted experts who will be contacted in the month of November include:

a. Mr. James Williams, TSU Alumnus- Entrepreneur-Structural Engineer: He will be involved in teaching ideation and provide his life experience on starting up a business.

b. Dr. Steve Krahn from Vanderbilt University, Professor of Practice in Nuclear Environmental Engineering: He will potentially be involved in both week one and two in lecturing and mentoring. He is the advisor to the Vanderbilt University Fusion Group.

c. Dr. Chungxin Fan, Professor of Business Administration at TSU: He will potentially be involved in week two to provide mentorship regarding the startup fusion company.

d. Community Organization Support Groups in Nashville: including Conexion Americas, Launch TN, SCORE, Nashville Business Incubation Center, Tennessee Small Business Development Center

PRODUCTS

The products shown below include only Publications with a 'Published' status and Intellectual Properties with a 'Granted' status. Products with other statuses are not included in this report. The Revision Type indicates whether a product is New (newly added), Updated (existing product modified), or No Change (existing product reported without modifications) during the current budget period. Note that 'Updated' statuses may appear more frequently as products progress through the publishing process. All products listed have been reported for the current project period of this award.

PUBLICATIONS

There are no publications to report.

INTELLECTUAL PROPERTIES

There are no intellectual properties to report.

PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS

The table below only contains participants who have identified an affiliation with the Awardee Institution. Participants from any associated subawards may not be included in this count.

PARTICIPANTS DETAIL

Project Role	Number of People	Total Person Months Worked
Co-Investigator	1	1
Principal Investigator/Project Director	1	4
Total Responses	**2**	**5**

PARTNERS DETAIL

Partner: Oakridge National Laboratory, Oakridge, TN, USA
Partner: Tennessee Technological University, Cookeville, TN, USA
Partner: University of Tennessee Knoxville, Knoxville, TN, USA

IMPACT

- What was the impact on the development of the principal discipline(s) of the project?

  The project has contributed substantially to the workforce development in nuclear fusion. One of the 2025 summer interns from TSU is currently pursuing a PhD with involvement of fusion related topics such as neutron irradiation. The other intern will be doing a 2026 summer internship with one of the private fusion company partners.
  The project has introduced nuclear fusion as a topic to the TSU community at large through the college of engineering. The three new course modules introduced at TSU have spurred interest in fusion among the Civil and Mechanical Engineering student bodies. 14 applications were received for the 2025 summer internships, and we expect to receive at least twice this number this year. The two 2025 summer interns have spread the word about their internship experiences among the student body. Prior to the commencement of this project, knowledge of nuclear fusion as a potential career field was almost non-existent among the student body on the TSU campus. The situation has been significantly changed with the help of the summer internships and the course modules. Several TSU students have also signed up to volunteer for the 2026 Fusion Innovation Bootcamp, as an opportunity to meet with fusion researchers from ORNL and from private industry.
  The faculty summer research on ductile-to-brittle transition of Tungsten in plasma facing components of fusion reactors provided relevant traction-separation laws for use in grain scale models as part of a multi-scale modeling effort at ORNL dealing with machine learning informed multi-scale simulation of plasma-facing materials, which aims at addressing the embrittlement of Tungsten under the combined action of thermal loads and neutron flux inside a fusion reactor.
- What was the impact on other disciplines?

  The project had a substantial impact on the civil and mechanical engineering education at TSU College of Engineering. The course module on design of containment structures for nuclear reactors introduced the topic of nuclear energy to civil engineering students, who are largely uninformed about this field. Through the course module, civil engineering students, particularly those with interest in pursuing structural engineering in the future, became aware of opportunities in the nuclear sector. Similarly, mechanical engineering students, through the course module on advanced manufacturing for fusion reactors, became aware of career opportunities in the nuclear sector.
- What was the impact on physical, institutional, and information resources that form infrastructure?

  The project has substantially enhanced the available computational and experimental facilities to TSU through Oakridge National Laboratory (ORNL). One 2025 TSU summer intern has been running the COMSOL Multiphysics simulation software package through computational resources provided by ORNL. The PI has improved his research network through ORNL and linked other faculty members at TSU to ORNL through this opportunity. In addition, there are plans for future research to be performed on the ORNL supercomputer cluster, such as Frontier. Through seminars and site visits, this project also exposed the TSU students and faculty to the vast number of user facilities available at ORNL and University of Tennessee, Knoxville (UTK) such as the spallation neutron source, small angle neutron scattering, and others, which could be utilized for further research.
- What was the impact on technology transfer?
  - Describe ways in which the project made an impact, or is likely to make an impact, on commercial technology or public use.
  - Include transfer of results to entities in government or industry, instances where the research has led to the initiation of a start-up company, and adoption of new practices.

Since this project is currently focused on workforce development and education through curriculum development, currently it does not have a substantial impact on technology transfer. However, with the completion of the Fusion Innovation Bootcamp (FIB), which is focused on entrepreneurship and innovation in fusion, it is possible that the work done could lay the synergistic collaborative foundation for a future start-up company.

- What was the impact on society beyond science and technology?

The project has opened opportunities in nuclear fusion to a diverse student body, providing an influx of fresh talent to the fusion industry, while also broadening the employment scope for a significant section of the society. After the FIB, the project is expected to further educate the public about the scope of nuclear energy and the opportunities available in nuclear fusion.

- What was the impact on the development of human resources?

The project has already had a substantial impact on human resource development through its efforts on workforce development. As stated in the earlier response, the project has provided the fusion sector with two promising engineering students from TSU and exposed several others to fusion engineering.

- What percentage of the award's budget was spent in foreign country(ies)?

  None of the award's budget was spent in foreign countries.