

PROJECT IDEA SUBMISSION – RESEARCH

LABORATORY INFORMATION

Name: Purdue University Boiling and Two-Phase Flow Laboratory

Date: 10/12/2024

LABORATORY'S LIAISON CONTACT INFORMATION

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PROJECT NAME

Fusion reactor thermal management - Project B

GENERAL PROJECT DESCRIPTION

Modern fusion reactors are based on the 'tokamak' concept of magnetic containment where the plasma is confined in a donut-shaped vacuum vessel. A mixture of Deuterium and Tritium, both hydrogen isotopes, is heated to over 150 million °C to form a hot plasma. A combination of strong magnetic fields that are produced by superconducting coils that surround the vessel and an electrical current through the plasma keeps the plasma away from the walls.

The fusion reactor "blanket" consists of several hundred modules that cover the inner walls of the fusion enclosure. Each of these modules has a first wall that directly faces the plasma and removes the plasma heat load. Overall, the blanket is one of the most critical and technologically challenging components of the fusion reactor, given its exposure to extreme heat and radiation. The proposed project will be focused on design of the thermal blanket.

The proposed work will be pursued by two design teams: Project Team A and Project Team B.

Important: This project requires U.S. citizenship.

WHAT IS THE MECHANICAL ENGINEERING PROBLEM (APPARATUS) YOU ARE WANTING SOLVED (BUILT)?

The team will be tasked with assisting in the development of blanket design with focus on use of CAD and CNC machining of multiple interconnecting cooling modules.

WHY IS THIS PROBLEM (APPARATUS) WORTH SOLVING (BUILDING)? (Value Proposition)

Recent efforts worldwide have already demonstrated the viability of fusion reactors as a source of limitless clean energy. The proposed project will aid in developing solutions for one of the most challenging components of fusion reactors: the reactor blanket.

WHAT ARE THE MOST IMPORTANT FUNCTIONAL REQUIREMENTS AND SPECIFICATIONS FOR THIS PROJECT?

Req. 1: Conduct an extensive review of available blanket module designs

Req. 2: Develop details for internal cooling passages

Req. 3: Using CAD and finite element analysis software, and with assistance of Project A team, provide detailed design of improved module

Req. 4: Using CNC machining, construct multiple modules, addressing module meshing requirements

Req. 5: Coordinate with Project A team on developing cooling system, including fluid couplers, pump and external heat exchanger.

WHAT DO YOU ANTICIPATE THE STUDENTS DESIGNING, ANALYZING, BUILDING/PROTOTYPING AND TESTING? BE AS SPECIFIC AS POSSIBLE.

Design: cooling modules, external cooling system

Analyze: cooling performance, structural integrity of modules

Build: cooling modules, external cooling system

Test: cooling modules, external cooling system

WHAT IS YOUR BEST ESTIMATE OF THE COST OF THE HARDWARE, COMPONENTS, MATERIALS, ... OF THE PROPOSED PROTOTYPE?

Total \$: hardware, component, and material costs will have a budget of about \$1,000 to be provided to the team.

HOW MUCH TIME AND EFFORT WOULD YOU EXPECT TO SPEND ON THIS PROJECT IF YOU WERE DOING IT INTERNALLY?

About 9 hours per week as instructor for one division of ME463.

DO YOU BELIEVE THE PROJECT CAN BE COMPLETED WITH EXISTING TECHNOLOGY, IF NOT, ELABORATE ON NEEDED DEVELOPMENTS?

Prof. Mudawar has developed multiple cooling module designs over the past 40 years. Available expertise will ensure successful attainment of the project’s objectives.

CONCERNS OR OTHER RELATED INFORMATION ASSOCIATED TO THE PROPOSED PROJECT?

Any Concerns: U.S. citizenship requirement.

ATTACH ANY APPROPRIATE SKETCHES, DRAWINGS, STANDARDS, DATA, PHOTOS, ... USEFUL IN JUDGING APPROPRIATENESS AND SCOPE OF PROPOSED PROJECT.

Details be provided after the team selection.

ARE YOU WORKING WITH ME SENIORS WHO YOU WOULD LIKE ON THIS PROPOSED PROJECT? YES/NO (If YES, provided what information you can.)

| NAME | PHONE | EMAIL |
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Save this filled out .docx with the following naming nomenclature: “RESEARCH_ *project name* – *student point of contact full name*.docx” where the *italic strings* get replaced with appropriate actual text strings.

If you have any questions concerning a proposed project or completing this form please contact Professor Greg Jensen.

To submit a project for consideration, please return attached as a PDF (preferred) this form and any attachments to:

C. Greg Jensen, PhD

Director of Senior Design
 Professor of Engineering Practice
 School of Mechanical Engineering, Room 2195
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ME463 Senior Design Project

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