

## IGEM Grant Report

Progress (due Jan. 1)     Annual (due Jul. 31)     **Final (due Aug. 31)**

IGEM Grant # IGEM22-002    Principal Investigator: Owen McDougal

Submission Date 8/28/2024    Primary Institution: Boise State University

*Instructions: Complete each section of this report directly on this template. Completed reports must be 4 pages or less in 12 pt Arial font, excluding the expenditure report. Reports that do not follow these requirements will be returned for revision. Submit reports by the appropriate due date to [HERC@osbe.idaho.gov](mailto:HERC@osbe.idaho.gov)*

**Section 1:** Summary of project accomplishments for the reporting period and plans for the upcoming reporting period.

**Extramural Funding:** In year 3 of the IGEN HERC project, we proposed to construct Food and Dairy Innovation Center (FDIC) labs and submit 12 grants to generate \$1.5M in external funding. Our accomplishments associated with the lab construction and grant activity are as follows. Construction of the three and a half FDIC lab modules of 650 sq ft per lab for a total of more than 2,000 sq ft., began on October 25, 2023. The lab construction project was completed, and we moved into the new space on August 5, 2024. Our project team is currently managing 20 sponsored projects, for a total budget of \$21,952,792. Another four proposals have been awarded and contracts are in the process of being finalized. The budget for the four grants in-contract is \$15,631,478 (**Table 1**).

**Table 1.** Summary of FDIC extramural funding activity

External Funding / Grants & Funding	YR1 (\$500K)	\$	YR2 (\$1M)	\$	YR3 (\$1.5M)	\$
Grants Administered			15	\$4,579,541	23	\$37,584,270
Grants Awarded	5	\$668,541	8	\$2,437,351	19	\$21,952,792
Grants In-contract					4	\$15,631,478

**Personnel/Students:** In FY24, the FDIC team trained 17 graduate students, 23 undergraduate students, and employed 7 staff. In addition, we were able to place 4 students into internships, where two gained full time employment. Of the staff, two obtained different jobs following the end of this IGEN HERC grant, and another three have been funded by different grants.

**Publications:** Our team published 5 papers during FY2024 that included topics in pulsed electric field (PEF) applied to potato chips to reduce acrylamide formation, PEF technology to accelerate barley germination and improve malt extraction, chemometric software to rapidly identify and quantify dairy proteins in milk, radio-frequency wave-based bacterial biofilm detection in dairy processing facilities, and characterization of plant alkaloids that have therapeutic properties.

**Analytical work:** A milk transportation tube model and a commercial heat exchanger/pasteurizer model were studied using simulation, and it was observed that a 1  $\mu\text{m}$  thick

layer of biofilm in a milk filled pipe shifted the reflection coefficient from 0.229 GHz to 0.19 GHz. Further sensitivity analysis revealed the shift in frequency from 0.8 GHz to 1.2 GHz for a film thickness of 5  $\mu\text{m}$  to 10  $\mu\text{m}$  with the highest wave reflection (S11) peak of approximately -120 dB for a 6  $\mu\text{m}$  thick biofilm. For the case of the resonant cavity/heat exchanger, the same antenna approach was used to excite the modes in the heat exchanger with fins and filled with milk and biofilm. The simulated resonance frequency shifted from 1.52 to 1.54 GHz, for a film thickness varying from 1 to 10  $\mu\text{m}$ . A proposal to study the response experimentally will be resubmitted to USDA NIFA.

**Section 2:** High-level summary of budget expenditures for the period just completed. If budget is underspent at time of report, explain why and plans for expending funds.

The overall budget expenditures equate to 100% of the total funds having been spent on infrastructure, instrumentation, and equipment.

**Section 3:** Demonstration of economic development/impact, including the following as applicable: patents, copyrights, plant variety protection certificates received or pending; technology licenses signed, start-up businesses created, and industry involvement; private sector engagement; jobs created; external funding; any other pertinent information.

The FDIC has been exceedingly engaged with private sector companies as partners on external grants and as sponsors of funded projects. The companies that have contributed time, resources, and funds in FY24 include; Agropur, Glanbia Nutritionals, Daisy Brand, Jones & Company Flavorings, Valley Food Tec, Genesis Organics, Ingredion, Dairy West, Cinder Wines, Telaya Winery, Food Physics, Anheuser Busch, Mountain Malt, Southern Fabrication Works, J.R. Simplot Co., McClain Foods USA, Gibby Group, Top Onion USA, Amalgamated Sugar, Chobani, Brabender, National Dairy Council, Pacific Process, Agilent Technology, Idaho National Laboratory, and Schmidt Futures. These partnerships led to the continued employment of three postdoctoral researchers, two research technicians, and a program director. Of the 20 grant funded projects in 2024, 17 of them were with industry partners. The four additional grants that have been recommended for funding, all have industrial collaborators that contributed to the success of the proposals.

Internship opportunities for students in FY24 are shown in **Table 2** along with an overview of internships and jobs for students since the FDIC was first funded. The YR3 partners are Daisy Brand, Food Physics, Carollo Engineering, National Renewable Energy Laboratory (NREL), Idaho National Laboratory (INL), and the BSU FDIC.

**Table 2.** Summary of internships and jobs for students who have worked with the FDIC.

Internships/Jobs	YR1 (2-4)	YR2 (5-10)	YR3 (10-20)
Internships	6	5	5
Jobs	2	0	3

**Section 4:** Number of faculty and student participants as a result of funding, and brief description of student efforts.

**Table 3** provides a summary of student, staff, and faculty participation in the FDIC. The students work with the FDIC faculty in independent research through Vertically Integrated Project (VIP) courses in Food Systems and Plasma Medicine and Agriculture. The staff are postdoctoral researchers and research technicians working with FDIC faculty. The faculty are FDIC team members and the expanded network of professors that collaborate on extramural grant activity or industry engagement through FDIC-sponsored projects.

**Table 3.** Summary of participant engagement with the FDIC.

FDIC Student Training	YR1 (3-5)	YR2 (5-10)	YR3 (5-10)
Undergraduate Students	25	40	23
Graduate Students	6	11	17
Staff	6	6	7
Faculty	5	16	12

**Table 4** provides a summary of students, their degree program, and a brief description of their project activity associated with the FDIC. The student academic program has been provided to demonstrate the interdisciplinary nature of work happening in the FDIC.

**Table 4.** Brief description of student effort associated with the FDIC.

Student (Graduate*)	Title/Position	Project/Topic
Mark Skinner*	MSMSE PhD	PEF in potato chip processing
Alyssa Hendricks	CHEM BS	PEF in potato chip processing
Taurus Rimkus	CHEM BS	PEF in potato chip processing
Rianat Lukman*	CHEM MS	Dairy protein analysis by NIR and HPLC
Matt Lorentz*	CHEM MS	PEF treatment of grapes to make wine better
Kylie Johnson*	CHEM MS	Separations Technologies that Enable Production and Use of High-Value Biomass Streams from Agricultural and Food Processing Wastes
Alder Escobar	CHEM BS	PEF treatment of grapes to make wine better
Mia Rheede*	BMOL PhD	Bioactive ingredient degradation in ready-to-mix drinks and protein bars
Amber Hawley*	CHEM BS/MS	PEF treatment of grapes to make wine better; PEF algae
Morgan Fong*	CHEM BS/MS	PEF in potato chip processing; Dairy byproduct utilization
Anna Shuey*	BMOL PhD	Investigating Bioactive Alkaloids in Kratom
Jordan Hoover	BIOL BS	Investigating Bioactive Alkaloids in Kratom
Delaney Odell	CHEM BS	Investigating Bioactive Alkaloids in Kratom
Christopher Orizaba	CHEM BS	Investigating Bioactive Alkaloids in Kratom
McKenzi Riggs	CHEM BS	Investigating Bioactive Alkaloids in Kratom
Gracie Garringer	CHEM BS	Cold atmospheric-pressure plasma array for inactivation of plant pathogens
Sarah Knowlton	CHEM BS	Gas mix impact on ROS generation by cold atmospheric-pressure plasma discharge
Mason Feerar	BIOL BS	Cold atm.-pressure plasma array for inactivation of plant pathogens
Jocelyn Stephens	CHEM BS	Use of cold atmospheric-pressure plasma array for inactivation of plant pathogens
Krystal Sosa*	BMOL PhD	Use of cold atmospheric-pressure plasma array for inactivation of plant pathogens
Kaden Falkner	CHEM BS	Use of cold atmospheric-pressure plasma array for inactivation of plant pathogens
Hassan Mohammed	CHEM BS	Use of cold atmospheric-pressure plasma array for inactivation of plant pathogens
Sumona Islam*	ECE MS	Use of cold atmospheric-pressure plasma array for inactivation of plant pathogens
Gretchen Kunz*	BMOL PhD	Use of cold atmospheric-pressure plasma array for inactivation of plant pathogens
Matthew Ostapovich	BIOL BS	Use of cold atmospheric-pressure plasma array for inactivation of plant pathogens
Stephanie Rood*	BIOL MS	Gas mix impact on ROS generation by cold atmospheric-pressure plasma discharge
Konnor Sullie	BIOL BS	Cold atmospheric-pressure plasma devices for inactivation of foodborne pathogens
Dalton Miller*	CHEM MS	Biofilm experiments in Medicine; Gas mix impact on ROS generation by cold atmospheric-pressure plasma discharge; Cold atmospheric-pressure plasma inactivation of bacterial biofilms in porcine wound models
Cale Thorton*	CHEM MS	In cell NMR, analysis of metabolites
Joseph Collins*	BMOL PhD	Whey protein isolation, structure evaluation and degradation monitoring
Madison Dirks*	BMOL PhD	GMP bioactivity assessment
Elizabeth Ryan*	BMOL PhD	PEF to improve whey protein spray dry efficiency and powder quality
Habeeb Babatunde*	CS PhD	Chemometric software development for real time monitoring of casein protein throughout a processing facility

Jamison Rawley		Food Systems (VIP)
Braydn Fielding	CHEM BS	Food Systems (VIP)
Logan Mallory	BIOL BS	Food Systems (VIP)
Logan Maynaugh		Food Systems (VIP)
Ajay Atkinson	CHEM BS	Food Systems (VIP)
Tessa Sprague	CHEM BS	Plasma Science (VIP)
Maggie Shirazi	BIOL BS	Plasma Science (VIP)

**Table 5** provides a summary of publications and patents associated with the FDIC activity. In FY24, we proposed to publish 5-10 papers/patents and have published 5 papers and one provisional patent.

**Table 5.** Summary of publication and patent activity associated with the FDIC.

Patents & Publications	YR1 (6)	YR2 (10)	YR3 (5-10)
Publications	6	4	5
Patents	0	0	1

**Section 5 :** Updated details and/or progress on the long-term sustainability plan for the project and description of future plans for project continuation or expansion.

The long-term sustainability plan for the FDIC will be dependent on grant support and industry engagement. Our team will continue to submit proposals under topics of advanced manufacturing or center programs that build capabilities for support staff and academic programs to leverage sustainable operations along with the CHIPS and Science Act, Schmidt Foundation Virtual Institute for Feedstocks of the Future, and the Department of Energy Cross-Sector Technologies. We will adopt (1) a recharge center model to include infrastructure for industry to supplement financing for the center, (2) industry funds “facility use agreement” for their people to come in to use the center equipment, and/or (3) industry directly funds research. We will incentivize start-up companies to utilize FDIC facilities to develop IP to promote economic development.

A grant proposal titled “Detection of Bacteria Biofilm at Dairy Processing Facilities using Radio Frequency Waves” on biofilm detection using RF method was submitted to USDA NIFA. The total cost of the proposed project was \$298,056. Most of the comments were positive. The proposal was rejected for further improvement. Based on the comments of the reviewers, the proposal is being updated and will be resubmitted. Simulation results were published in Intern. Conf. on Plasma Science 2023 (Detection of Biofilm Formation at Dairy Facilities Using Microwave," 2023 IEEE ICOPS, Santa Fe, NM, USA, 2023, pp. 1-1) and in a journal paper (“Simulation of a Radio-Frequency Wave Based Bacterial Biofilm Detection Method in Dairy Processing Facilities”, Appl. Sci. 2024, 14(11), 4342).

**Section 6:** Expenditure Report – Attach an expenditure report as a separate document showing expenses toward the original budget submitted for this project. The expenditure report does not count toward the page limit. A written summary of budget expenditures should be provided in section 2 of this report.

## FINANCIAL REPORT

**Award:** 3742016      **Start Date:** 7/1/2023  
**Project:** 2000002890      **End Date:** 6/30/2024

<b>Project Budget</b>	<b><u>Budget</u></b>	<b><u>Expended</u></b>	<b><u>Encumbered</u></b>	<b><u>Remaining</u></b>
Salary	\$181,948.58	\$181,948.58		\$0.00
Fringe	\$63,278.03	\$63,278.03		\$0.00
Other Expense	\$68,820.09	\$68,820.09		\$0.00
Travel	\$7,061.09	\$7,061.09		\$0.00
Capital	\$378,892.21	\$378,892.21		\$0.00
Student Costs				\$0.00
<b>Total</b>	<b><u>\$700,000.00</u></b>	<b><u>\$700,000.00</u></b>	<b><u>\$0.00</u></b>	<b><u>\$0.00</u></b>