IGEM Grant Report

☐ Progress (due January 1) ☐ Annual (due July 31) ✕ Final (due August 31)

IGEM Grant # **IGEM26-002** Principal Investigator **Ken Cornell, Ph.D.**

Name/Full Title of Project [*Proof of Concept Project*]:
Improving Idaho Seed Crops with Cold Atmospheric Pressure Plasma (CAP) Technology

Submission Date **8/31/2026** Primary Institution **Boise State University**

Section 1: Provide a short one paragraph summary describing the project and its goals

This project focuses on the development of a cold atmospheric-pressure plasma (CAP) array for use in seed processing. The goals of this project are to: **(1)** engineer a 10cm x 10cm array device and deploy on a conveyor or gravity separator to treat seeds and surfaces during processing, and **(2)** determine CAP treatment parameters that eliminate 90-99% of pathogens from seeds and surfaces. The goals of this project have largely been accomplished, although device engineering continues to be optimized to improve performance and deployment.

Section 2: Summary of project accomplishments and future plans.

During the one year grant period (7/1/25-6/30/26) the following was accomplished:

1. *Plasma array was fabricated with gas recovery manifold to scavenge ionized products [**milestone A**]. Incorporation of a blower fan to direct recirculated plasma effluent back into the plasma array increased ozone concentration by more than 2-fold. **Future plans**: To address heating issues, improvements to the cooling system will be incorporated into the gas scavenger manifold system.*
2. *Operating conditions determined for uniformity [**milestone A**]. Operating conditions included: 2.7 kVrms (21.5 kHz), 255 mA rms, 130 lpm Air, 10 kΩ ground side resistors. **Future plans**: Prolonged operation using air led to heating and non-uniformity issues. To address these issues, prototypes were developed with changes to ballast resistors and incorporation of capacitors to improve device uniformity. Additional operating parameters (duty cycle), recirculation gas flow rate, and active cooling are being examined to improve operation.*
3. *Prototype device consisting of two 10 x 10 arrays was deployed on a conveyor belt [**milestone B**]. This prototype consisted of two 10 x 10 cm arrays operating on a single driver power supply. **Future plans**: Continue to expand the number of 10 x 10 cm arrays that can be powered by one driver and deployed to cover larger surface areas.*
4. *One manuscript published [**milestone C**]. Bhattacharya R, Islam S, Miller D, Brown D, Akhtar N, Pearlman M, Hay R, Cornell KA, Browning J. Fabrication and characterization of a 10 x 10 cm cold atmospheric pressure plasma array. IEEE Trans Plasma Sci IEEE Nucl Plasma Sci Soc. 2026 Feb; 54(2): 496-502. Doi: 10.1109/tps.2025.3646554.**Future plans**: Several manuscripts describing device improvements are planned for submission in the next year to meet milestone F.*
5. *Device shown to kill 91-94% of the plant pathogen Ps. syringae on surfaces [**milestone D**]. **Future plans**: expand studies on the types of seeds and plant/foodborne pathogens (to meet milestone D), (2) demonstrate device activity while on a conveyor belt (milestone E), and (3) submit 2nd manuscript for publication (milestone F). Characterize reactive oxygen species produced as a function of duty cycle, power consumption, and effluent gas recirculation.*

Section 3: Summary of budget expenditures

*Expense Summary (7/1/25-6/30/26): Expensed Budget: **$120,930.45** (94.6% of $127,800 budget) Encumbered budget: **$6,451.52** (5.0%) Remaining unspent budget: **$418.03** (0.33%)*
The total budget is underspent by <1% for a variety of reasons: changes in salary expenditures, a capital expense for a power supply, and university changes in student costs.

Section 4: Economic development/impact.

***1.** Two patent disclosures filed:*
   a. *Large Atmospheric Pressure Plasma Array (P15236US00 / BSU-316)*
   b. *Methods for Driving a Large Atmospheric Pressure Plasma Array (P15714US00_BSU 354)*

***2.** Industry/Private sector engagement: The PI (Cornell) presented the project during the 2025*

Futurama Idaho-Eastern Oregon Seed Association (IEOSA) conference. The PI and coPIs discussed the project with representatives from Crookham Seeds, Illinois Heritage Seeds, West Coast Co., the Idaho Dept. of Agriculture, and NOMADX.

3. *The PI/coPIs submitted five grant applications to support CAP development: 1) IWRRI (declined), 2) USDA NIFA (declined), 3) NSF TTP-T (pending), 4) USDA SAS (pending), 5) ISDA (awarded).*

Section 5: Number of faculty & student participants, and brief description of student efforts.

Faculty: **4** (Cornell, Browning, Pearlman, Hay); # Graduate Students: **3;** # Undergraduates: **27**

Table 1. Brief description of student effort on project

Graduate Students:	**Title/Position**	**Project/Topic**
1. Krystal Sosa	BMOL Ph.D. (2026)	Antiviral activity of plasma surface treatment
2. Travis Hudok	CHEM M.S. (2026)	Plasma surface inactivation of human microbial pathogens
3. Stephanie Rood	BMOL Ph.D. (current)	Plasma inactivation of plant pathogens, plant germination
Undergraduate Students	**Title/Position**	**Project/Topic**
1. Daniel Bowden	Biology BS 2025, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
2. Coleman Boyd	Engineering, summer intern	Construction and testing of 10 x 10 cm CAP array
3. Neil Benavente	Chemistry, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
4. Kahlen Carpenter	Chemistry	Plasma inactivation of plant pathogens, plant germination
5. Hayden Cleere	Biology, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
6. Leo Delannoy	Business, entrepreneur program	Market analysis of seed industry and cost of contamination
7. Laney Dew	Chemistry, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
8. Teodoro Giannotta	Biology, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
9. Razmira Hamidovic	Chemistry BS 2026, summer intern	Antiviral activity of plasma surface treatment
10. Catherina Htoo	Chemistry, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
11. Lilah Johnson	Chemistry	CAP ROS production
12. Rin Komma	Chemistry, summer intern	CAP ROS production
13. Gavin Liberty	Chemistry, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
14. Jared Loffer	Biology, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
15. Hassan Mohamed	Chemistry BS 2026, summer intern	Plasma inactivation of plant pathogens, plant germination
16. Delaney Ott	Chemistry	CAP ROS production
17. Natalie Perez	Health Science, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
18. Saxon Putnam	Business, entrepreneur program	Market analysis of seed industry and cost of contamination
19. Luke Rodriguez	Health Science	Plasma inactivation of plant pathogens, CAP ROS production
20. Briana Rojas	Health Science, summer intern	Plasma inactivation of plant pathogens, plant germination
21. Tessa Sprague	Chemistry BS 2026, summer intern	Antiviral activity of plasma surface treatment
22. Mason Swafford	Business, entrepreneur program	Market analysis of seed industry and cost of contamination
23. Madero Tassi	Engineering, summer intern	Construction and testing of 10 x 10 cm CAP array
24. Daniel Titus	Engineering, summer intern	Construction and testing of 10 x 10 cm CAP array
25. Greta Tschider	Chemistry BS 2026, summer intern	Plasma inactivation of plant pathogens, plant germination
26. Marlon Villatoro	Chemistry, summer intern	Plasma inactivation of plant pathogens, CAP ROS production
27. Hanna Wallin	Chemistry	Plasma inactivation of plant pathogens, CAP ROS production

27 undergraduates worked in teams under the guidance of the PI, coPIs, senior personnel (Hay), and graduate students on a variety of projects including: 1) device assembly & testing, 2) analysis of device production reactive oxygen species (ROS), 3) CAP inactivation of plant/animal pathogens (virus, bacteria, fungi) on surfaces & crop seeds, 4) CAP effect on seed germination, and 5) a market analysis of the benefit of CAP for the seed industry. Two graduate students (Sosa, Hudok) successfully defended their dissertations, and a 3rd (Rood) advanced to candidacy. Students presented their work more than 30 times at >12 scientific venues. Only 6 students received direct support from the IGEM-HERC grant, the remainder of the students received college credit and/or were supported by a variety of summer internship programs (SARE, INBRE, COBRE, One Refugee, Ralph Jones, SURF, etc.)

Section 6: Long-term sustainability plan. Long-term project sustainability is dependent on continued pursuit of extramural grant funding. The PI and coPIs are actively pursuing external grants to continue the development of the plasma array device for industrial applications. In 2026, 1 grant (ISDA) was obtained to expand the array of plant pathogen testing. Two additional grants submitted to the NSF TTP-T and USDA SAS programs are pending review. Additional USDA NIFA, NSF ECLIPSE, and NIH applications are planned for Fall 2026 and Spring 2027. The PI and coPIs continue to work with the BSU Office of Technology Transfer to pursue patent protection of intellectual property, and licensing opportunities for the technology.

Section 7: Expenditure Report – see attached.

IGEM-HERC Improving Idaho Seed Crops with Cold Atmospheric Pressure Plasma

Section7: Expenditure Report

Part I. FINANCIAL REPORT Summary

Award:	4003031	**Start Date:**	7/1/2025
Project:	2000003546	**End Date:**	6/30/2026

Projected Budget	Budget	Expended	Encumbered	Remaining
Salary	$ 79,620.00	$ 62,038.52	$ 3,582.73	$ 13,998.75
Fringe	$ 19,075.00	$ 14,149.03	$ 2,868.79	$ 2,057.18
Other Expense	$ 17,220.00	$ 27,799.65		$ (10,579.65)
Travel				
Capital		$ 5,757.25		$ (5,757.25)
Student Costs	$ 11,885.00	$ 11,186.00		$ 699.00
Total	127,800.00	120,930.45	6,451.52	418.03

FINANCIAL REPORT

Award:	4003031	**Start Date:**	7/1/2025
Project:	2000003546	**End Date:**	6/30/2026

Projected Budget	Budget	Expended	Budget Adjustments	Encumbered	Remaining
Salary	$ 79,620.00	$ (62,038.52)	$ (13,998.75)	$ 3,582.73	$ -
Fringe	$ 19,075.00	$ (14,149.03)	$ (2,057.18)	$ 2,868.79	$ -
Other Expense	$ 17,220.00	$ (27,799.65)	$ 10,997.68		$ 418.03
Travel					$ -
Capital		$ (5,757.25)	$ 5,757.25		$ -
Student Costs	$ 11,885.00	$ (11,186.00)	$ (699.00)		$ -
Total	127,800.00	(120,930.45)	-	6,451.52	418.03

Part 2. Written Summary of Budget Expenditures

The initial proposed budget included $79,620 in salary and $19,075 in fringe for the PI, coPI, senior personnel, and graduate student salary. Adjustments to salary/fringe were made to accommodate 1) changes in work load for Drs. Pearlman and Hay to complete new designs for the 10 cm x 10 cm plasma array and driver systems; 2) changes in Ph.D. student salary due to fellowship support, and 3) incorporation of part-time temporary salary support for two graduate students and 3 undergraduate students to complete experiments to meet grant goals. Overall, the salary/fringe expenditures decreased by approximately $16,000. This budget ($13,996.75 + $2,057.18) and $699 from student costs was reallocated to “Other Expenses” ($10,997.68) to cover increased supply costs to create new device prototypes, and to “Capital” ($5,757.25) to cover an unexpected need to purchase a new power supply to drive the operation of two devices when assembled on the conveyor belt. Finally, the budget shows $6,451 in encumbered salary and fringe costs that reflect summer effort for the PI (from June) that is still being reconciled in the payroll system.

Overall, the award was underspent by $418.03, which equates to approximately 0.33% of the total award.