Cy Westbrook's Portfolio

Full-stack engineer - analog to firmware; backend to frontend; idea to reality.

Rutgers Class of '27 ECE+CS

View the online version of this portfolio at https://westbrook.cy ↗

Resume | LinkedIn | GitHub | Email

This portfolio showcases my relevant engineering experience. Besides engineering, I've also done a lot of web development (much of it before vibe coding) and technical theater work. Check out my portfolios for those:

Web Portfolio (cy2.me) ↗

Tech Theater Timeline ↗

Updated Oct 2026

Rutgers Solar Car Team — team

Low Voltage System 3 (LV3) — subsystem

- LV3 Core — PCB, firmware
- LV3 Dash — PCB, firmware
- LV3 SwitchSense — PCB, firmware
- LV3 LVBPS — PCB, firmware
- LV3 HVBPS — PCB, firmware
- LV3 CAN — firmware component

Modular Battery System (MBS) — subsystem

- MBS 15P Module — PCB
- MBS 12S Smart Backplane — PCB
- MBS 14S Lite Backplane — PCB

Low Voltage System 2 (LV2) — subsystem

- LV2 Mainboard — PCB, firmware
- LV2 Dashboard — PCB, firmware

Rutgers Swarm Intelligence Lab — research lab

MagTile (original) — project, publication

- MagTile Actuator Tile — PCB

MagTile2 — project

- MagTile2 Master Tile — PCB, firmware
- MagTile2 Actuator Tile — PCB, firmware
- Actuator Tile Interconnect Board — PCB
- MagTile2 Manager — web app

Rutgers WINLAB — research lab

Aggelos Bletsas Lab — research lab

- LP Radio Sensor Hub — PCB, firmware

COSMOS Environmental Sensing Suite — project

Personal Projects

Development Tools — collection

- 100V Parallel Si FET Half-Bridge Module — PCB
- PCM186x Breakout — PCB

Theatrical Tools — collection

- dmxdude mini — PCB, firmware
- miq — web app

Wi-Fi Lighting Controls — project

- Wi-Fi Light Switch — PCB, firmware
- Wi-Fi Lighting Controller — PCB, firmware

Web Development — collection

Somerset County 4-H — nonprofit

Somerset County 4-H Fair App — project, web app

Rutgers Senior Design — team

Arcjet PPU — subsystem

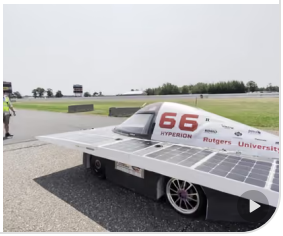
team

Rutgers Solar Car Team

Rutgers Solar Car builds solar-powered cars to race in the American Solar Challenge. I have served as the team's low-voltage electronics lead and project manager in the past, and I am currently the team's main electrical lead. The team was fairly new when I joined, having never built or raced a vehicle before. I began redesigning the team's electrical system in 2024 and built the entire system for our 2026 entry. The team raced on the track for the first time in its history in the summer of 2026 with our vehicle, in part thanks to my electrical system.



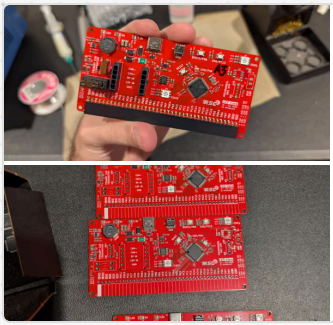




subsystem

Low Voltage System 3 (LV3)

LV3 is my second redesign of the vehicle's low voltage system, and is the system that raced on our 2026 entry. It consists of several modules sharing a core hardware and software architecture. All modules connect using a daisy-chained "main bus" carrying 12V and CAN, and a custom shared CAN bus library running on all boards abstracts data synchronization and communication failsafes into just a few lines of code.



PCB firmware

LV3 Core

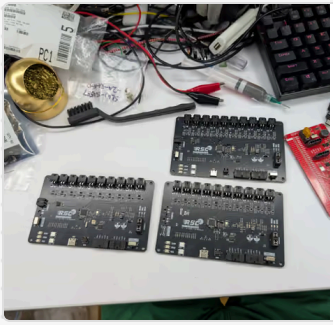
The first board I built for LV3, designed as a development board with all the shared architecture components present. These include a 5V buck converter supporting up to 24V in, an automotive mini blade fuse, dual parallel main bus connectors for daisy chaining, an STM32 microcontroller, dual CAN-FD capable CAN ports (one on the main bus connector, one on an auxiliary connector), two RGB status indicators (one handled by the CAN library, one handled by application code), 3 buttons, USB, and a Cortex Debug connector.



PCB firmware

LV3 Dash

A redesigned version of the LV2 dashboard, built around the same display panel and overall shape but with new internals and a capacitive touch panel. Features an STM32 H7 with more RAM to allow full double-buffering, an internal DC-DC converter so it can run straight off the car's main bus, internal SD card slot and I2S interface, and redesigned layout that exposes USB, debug headers, buttons and LEDs, and a steering wheel d-pad connector on the bottom edge. The redesigned layout allows it to be thinner and more structurally rigid than LV2 Dashboard thanks to low-profile components, SMD-mount connectors, and integration of the FR-4 PCB as a structural element in the mechanical design.



PCB firmware

LV3 SwitchSense

A general purpose control board with 10 multipurpose 4-pin connectors that can each sense one input and drive one output at up to 3A, switched on the low side, for connecting to illuminated switches, exterior lights, mechanical limit switches (e.g. brake pedal), open-drain controller outputs, relays/contactors, fans, and more. Also features a secondary software-isolated CAN interface for connecting to third-party modules like the motor controller and proxying their CAN data to the main bus safely. 3 of these boards are used on the vehicle.

PCB firmware

LV3 LVBPS

The vehicle's low-voltage battery protection system, which handles overvoltage, undervoltage, overcurrent, and overtemperature conditions for the low-voltage battery, as well as managing charging from the DC-DC converter and also precharging the LV main bus when the car is turned on to prevent current surges and detect short circuits. Reports granular fault codes on the main bus. An LV main bus cable was damaged during work on the car at the 2026 competition causing a short circuit, and the smart precharge feature detected this when the car was next turned on, preventing catastrophic failure.

PCB firmware

LV3 HVBPS

The vehicle's high-voltage battery protection system, responsible for making the "final decision" on whether to close the contactors in the main battery enclosure and reporting battery information such as cell voltages, pack current, and temperature. Reports granular fault codes on the main bus. Uses an Orion BMS2 as the AFE for cell taps, current sensing, and temperature sensing. Also manages the hardware E-stop chain which can interrupt the main contactors without any software involved, and controls enclosure fans/lights.

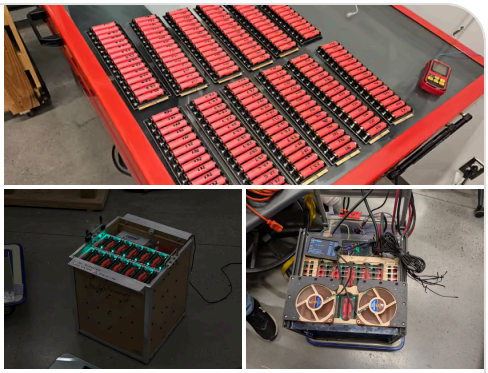
firmware component

LV3 CAN

subsystem

Modular Battery System (MBS)

The Modular Battery System is a PCB-based electrical interconnect system used to construct the vehicle's battery pack. Modularity comes from individual modules being easily removable from the pack, and from cells being easily removable from modules, with no spot-welding involved. The PCB nature also allows cell taps to be integrated and cleanly bundled in a single connector, with no messy wires. This system was used to construct the pack for the 2025 and 2026 entry.





PCB

MBS 15P Module

PCB battery module holding 15 18650 lithium-ion cells in clip holders connected in parallel, capable of 150A total output. A connector on the top allows for a management card to be added on to monitor the module voltage and individual cell temperatures, and enable automatic passive balancing, without the need for a BMS or for the module to even be installed in the pack.



PCB

MBS 12S Smart Backplane

Backplane designed to accommodate 12 MBS modules, connected in series. Each module connection carries the full pack current in addition to an SPI connection for an onboard STM32 to interface with the management cards on the MBS modules, to collect voltage/temperature data and command automatic balancing. Cell taps are also exposed directly on the end of the backplane, allowing for a clean and simple connection to a BMS if the on-module management cards are not implemented. Two of these 12S backplanes were used to build the 24S pack used on the vehicle, but a conventional BMS was used rather than using the smart features due to time constraints.

PCB

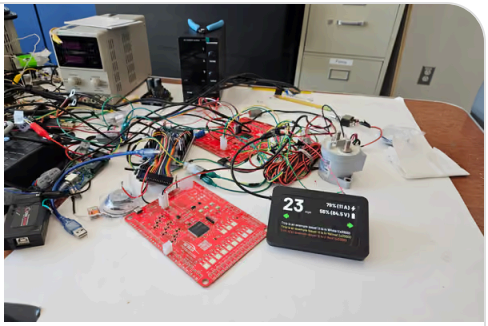
MBS 14S Lite Backplane

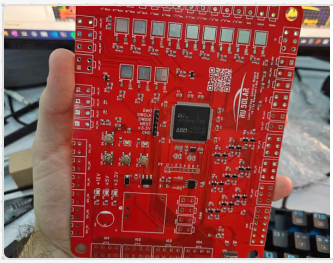
An expanded version of the 12S Smart Backplane accommodating 14 modules in series, with the smart features excluded to simplify the design and allow it to use a 2-layer PCB rather than a 4-layer PCB. Two of these 14S backplanes are planned to be used for an expanded 28S pack for the 2027 entry.

subsystem

Low Voltage System 2 (LV2)

LV2 was my initial redesign of the vehicle's low voltage system, including 2 PCBs which I designed my freshman year. They were used briefly during some tests, but were replaced by LV3 starting in 2025 in preparation for the 2026 entry.





PCB firmware

LV2 Mainboard

STM32-based central control board to replace the existing, mostly analog central control board the team had been using previously. Connects to all lights, switches, and contactors, and has I/O ports with GPIO, CAN, and UART to communicate with the BMS, solar charge controllers, and co-designed RSC LV2 Dashboard.



PCB firmware

LV2 Dashboard

STM32-based 4.3-inch dashboard display I designed alongside the RSC LV2 Mainboard. Onboard display backlight driver and STM32 LTDC peripheral allow using ubiquitous 40-pin parallel RGB displays, such as the particular sunlight-readable display panel used here. Runs LVGL and receives data from the central control board over CAN.

research lab

Rutgers Swarm Intelligence Lab

The Rutgers Swarm Intelligence Lab is run by Dr. Daniel Burbano Lombana, an electrical and computer engineering professor at Rutgers University. I have worked as a research assistant for the lab since 2023, developing hardware and software platforms for our research. The lab is exploring swarm behaviors in animals and how they can be applied in robotics, and studying the interactions between animals and robots, also known as ethorobotics.

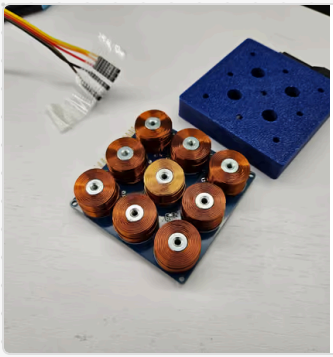
project publication

MagTile (original)

IEEE paper ↗

When studying animal-robot interactions with smaller animals like zebrafish, creating robots that are small enough and can also move on their own is often impractical, so a larger "puppetry" system is used to actuate the agent through magnets or hidden attachments. These systems are often limited to just one agent, which limits their value for swarm behavioral research. MagTile presents a different approach — using a grid of electromagnets to pull multiple magnetic zebrafish replicas near the bottom of a tank, allowing multi-agent experiments with some live and some robotic zebrafish to be conducted. The original version of MagTile was published in IEEE Transactions on Control Systems Technology (ieeexplore.ieee.org/document/11400697) and led to the development of MagTile2.





PCB

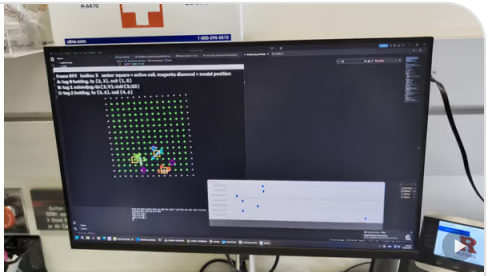
MagTile Actuator Tile

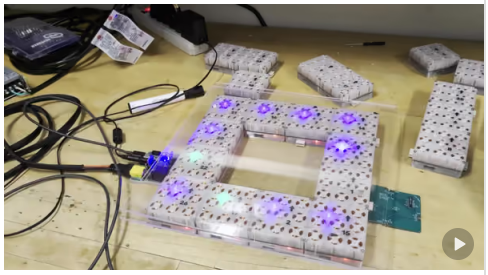
A 3×3 tile of electromagnets with connectors on all 4 sides so that multiple can be connected to form a large continuous grid. The electromagnet grid is used to pull zebrafish replicas along the bottom of a fish tank to simulate swimming patterns and study interactions with live fish. Uses PCA9685 I2C PWM controllers connected to MOSFETs to drive electromagnets. An Arduino connected to a PC via serial/USB is used to issue commands to tiles over I2C. Tiles run at 15V and can drive coils at up to 1.5A, with 60W total system power across all tiles. Designed for the Rutgers Swarm Intelligence Lab as a 2024 summer project.

project

MagTile2

The original MagTile system was developed in a hurry as a proof of concept, but when it proved that the method could work, the lab asked me to develop an improved, more thoroughly designed system. MagTile2 shares the same layout and electromagnet coils as the original MagTile, but completely overhauls the power system, jumping to a 48V architecture and individual constant current regulators for each electromagnet, capable of driving them at up to 4.5A for short bursts, and capable of over 200W of total system power across all tiles. Each tile has a dedicated MCU, and the I2C bus is replaced with CAN-FD to allow for faster, more robust control and detailed telemetry data. A "Master Tile" is added to manage power safety and facilitate platform control from a PC over USB. We hope to publish a methods paper describing and characterizing this system soon.

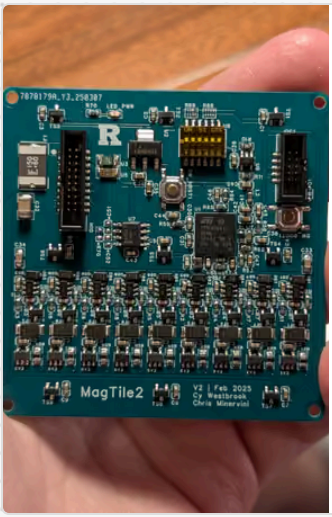




PCB firmware

MagTile2 Master Tile

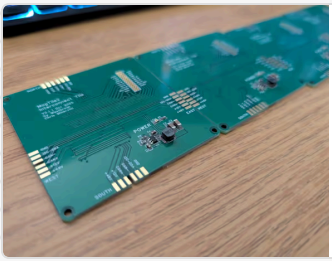
Power safety and USB interface board for the MagTile2 system. Accepts 48V drive supply and 12V control supply inputs, ensures voltage/current are within allowable thresholds, and precharges/arms the 48V bus when commanded to do so by the PC. The USB interface presents a composite device to the PC, including a virtual serial port device for controlling the platform from Python, MATLAB, or other environment supporting serial communication, and a vendor-defined WebUSB device which communicates with MagTile2 Manager. MagTile2 manager is a browser-based program that interactively displays all telemetry and granular fault data from the Master Tile and Actuator Tiles to the user during operation and standby including displaying the detected grid shape reconstruction, and allows arming, setting setpoints, and initiating the self-test procedure.



PCB firmware

MagTile2 Actuator Tile

9-channel constant-current regulator board embedded in each MagTile2 tile, based on the STM32G473, commanded over CAN-FD, for driving the tile's 3×3 grid of electromagnets. Accepts 48V in from the main system bus, runs individual digital constant-current control loops for each electromagnet, and reports telemetry and granular fault data over CAN. The control loop exploits high input voltage and MOSFET pulse rating to support driving electromagnets at up to 4.5 amps despite using SOT-23 MOSFETs rated for only 3A continuous, and estimates the resistance of each electromagnet based on control loop parameters to monitor rapid temperature rise caused by 80W of power developed in the electromagnet when driven at 4.5A. Multiple hardware and software safety systems protect the tile from damage and user error, and of the 234 power stages built, zero have failed to date, including during development and hours of experimental runs. An automated self-test enables easy qualification during assembly. Serial ports on each side of the tile allow it to identify its neighbors to automatically reconstruct the grid shape in software on the Master Tile.



PCB

Actuator Tile Interconnect Board

Sits below the main actuator tile board in each MagTile2 tile, connected through a mezzanine connector. Facilitates passing power and data to neighboring tiles and features a buck regulator to create a clean 5V supply for each tile's control electronics, generated from the 15V gate drive and control rail provided by the Master Tile.

web app

MagTile2 Manager

research lab

Rutgers WINLAB

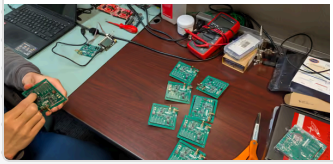
The Wireless Information Networks Laboratory (WINLAB) studies and develops technology for Radio Access Networks (RANs) such as cellular networks, as well as adjacent technology such as sensor networks, radar, source localization, and more. It is also home to the ORBIT indoor radio testbed and the primary developer of the COSMOS outdoor radio testbed network in New York City.

research lab

Aggelos Bletsas Lab

Aggelos Bletsas's Lab is currently focused on low-power sensor networks and source localization, with a focus on using backscatter radio methods to achieve these. I worked in his lab for the 2026 WINLAB summer internship.





PCB firmware

LP Radio Sensor Hub

Multipurpose ultra-low-power radio board with 915 MHz active radio transceiver and backscatter radio capabilities based on a Silicon Labs Series 2 RF SoC. Features rechargeable battery, solar panel power input, temperature and humidity sensor, and multipurpose peripheral ports providing power and supporting analog/digital I/O that can be fully powered down to save energy in duty-cycled applications. Meant to be used as a wireless distributed agricultural sensing node or a remote-configurable backscatter reflector for backscatter radio research.

project

COSMOS Environmental Sensing Suite

The COSMOS testbed is fairly new, and is still partially under development. As an outdoor testbed, environmental factors will affect experiment performance, and the testbed has only limited capabilities to measure these. I am currently designing an environmental sensing suite which will be mounted on COSMOS nodes in NYC to record environmental factors such as temperature, humidity, particulate matter, light level, noise and more.

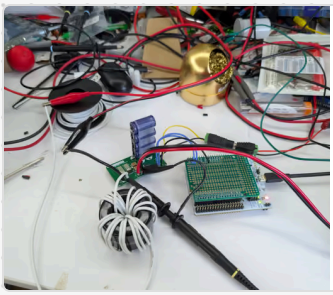
Personal Projects

I spend most of my free time working on personal projects to help develop skills and design blocks that I can use for other projects.

collection

Development Tools

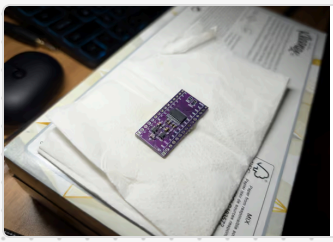
Boards designed to evaluate specific components/designs before integrating them into a larger system.



PCB

100V Parallel Si FET Half-Bridge Module

MOSFET half-bridge module designed for up to 150V and 10A featuring up to three parallel MOSFET pairs for reduced conduction loss, 3.5A TI gate driver with per-FET charge/discharge rate control resistors, and hybrid MLCC/electrolytic DC link capacitance. Meant to be used as a building block for developing switching power systems operating at up to 100V (after safety margin) such as power converters, motor inverters, switching audio amplifiers, and more.



PCB

PCM186x Breakout

Breakout board for developing applications around the TI PCM186x ADC, featuring separate analog/digital LDOs and analog/digital layout isolation for a low audio noise floor.

collection

Theatrical Tools

I used to do a lot of technical theater work at my high school and community theater, and more recently Rutgers theater clubs, so I have developed some custom hardware projects for theatrical applications.



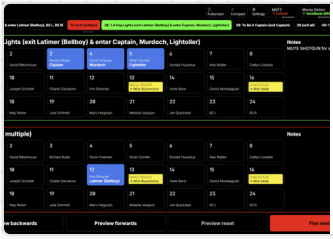




PCB firmware

dmxdude mini

Wi-Fi/DMX/WS2812 multitool. Uses an ESP32-S3 as the main microcontroller running MicroPython and an STM32C0 to offload time-critical DMX communication. Primary use case is as a DMX to WS2812 converter that can run custom effects written in Python (stored on the SD card) with Wi-Fi remote management, but can also be used as a USB-DMX adapter, wireless DMX bridge, USB-WS2812 adapter, wireless ArtNet node, and any other combination thereof.



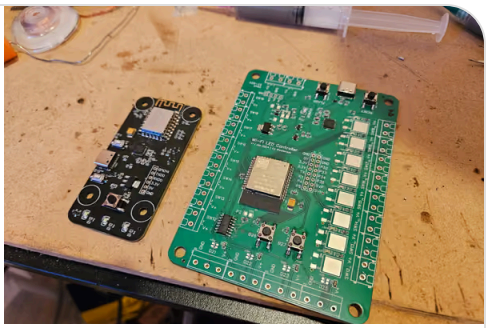
web app

miq

project

Wi-Fi Lighting Controls

When I was 12, I decided to illuminate my room using LED strips that could be controlled over the network using a Raspberry Pi, and later a NodeMCU. When I learned PCB design, I decided to create some boards to make the setup cleaner.

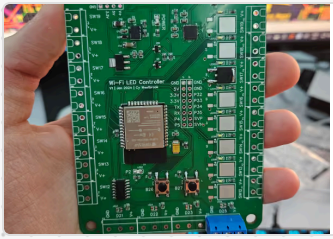




PCB firmware

Wi-Fi Light Switch

One of my first PCB designs. Arduino-programmable, wall-mountable, illuminated, ESP8266-based IoT button meant to be used as a light switch for networked lights. I currently use two of them in my bedroom synced over MQTT, one on the wall by the door and the other on my bedside table.



PCB firmware

Wi-Fi Lighting Controller

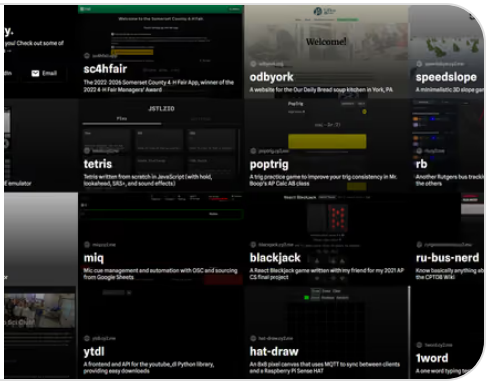
Versatile ESP32-based lighting controller with 8 PWM outputs paralleled on either side and 4 powered WS2812 outputs. An onboard DC-DC converter allows the board to be powered off the lighting power supply, up to 48V. Meant to run Tasmota or be programmed using Arduino.

collection

Web Development

cy2.me ↗

When I was in high school, before AI "vibe coding" completely took over web development, I designed several web sites, apps, and games. Starting in college, I focus more on hardware/firmware, but still do web development sometimes. Some notable web projects are mentioned in this portfolio, but the rest you can find on my web portfolio: cy2.me.



nonprofit

Somerset County 4-H

4-H is a national youth development organization where kids can create and join clubs for everything from agriculture to robotics. I started and ran the Computer Club in my local chapter. Each 4-H chapter has a summer fair where clubs show off what they work on and host activities for the community.





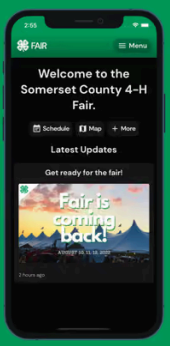


project web app

Somerset County 4-H Fair App

sc4hfair.app ↗

In 2020, a member I met in my Computer Club and I began developing a web-based companion app for my county's 4-H fair, including features like a schedule, interactive map, scavenger hunt, push notifications, and more. Through clever selection of serverless hosting, databasing, and content management tools, the app runs without any recurring fees besides the domain name. The fair was cancelled for two years due to COVID-19, so the app debuted at the 2022 fair. Every year since, we have gone back to update the data for each summer's fair, including capturing an aerial photo of the fair the day before which gets georeferenced and overlaid on top of a satellite/road map in the map feature. See the app live at sc4hfair.app.



team

Rutgers Senior Design

I am working with a multidisciplinary group for my Rutgers Senior Design project, including mechanical, aerospace, and electrical engineers. We are developing a 500W-class arcjet thruster for research purposes, under Dr. Steven Berg, a mechanical and aerospace engineering professor.

subsystem

Arcjet PPU

Arcjet thrusters require a Power Processing Unit (PPU) to provide constant-current regulation for the arc, which has a negative differential resistance. They also require a high voltage ignition system to ionize the arc region before the lower voltage, higher current, sustained arc can form. Our PPU will feature both of these capabilities, be fully digitally controlled, and support control and telemetry through standard lab instrument protocols so that it can be easily integrated into experiments.