

# Pressure Controlled Autonomous Reactor (P.C.A.R)

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## Abstract

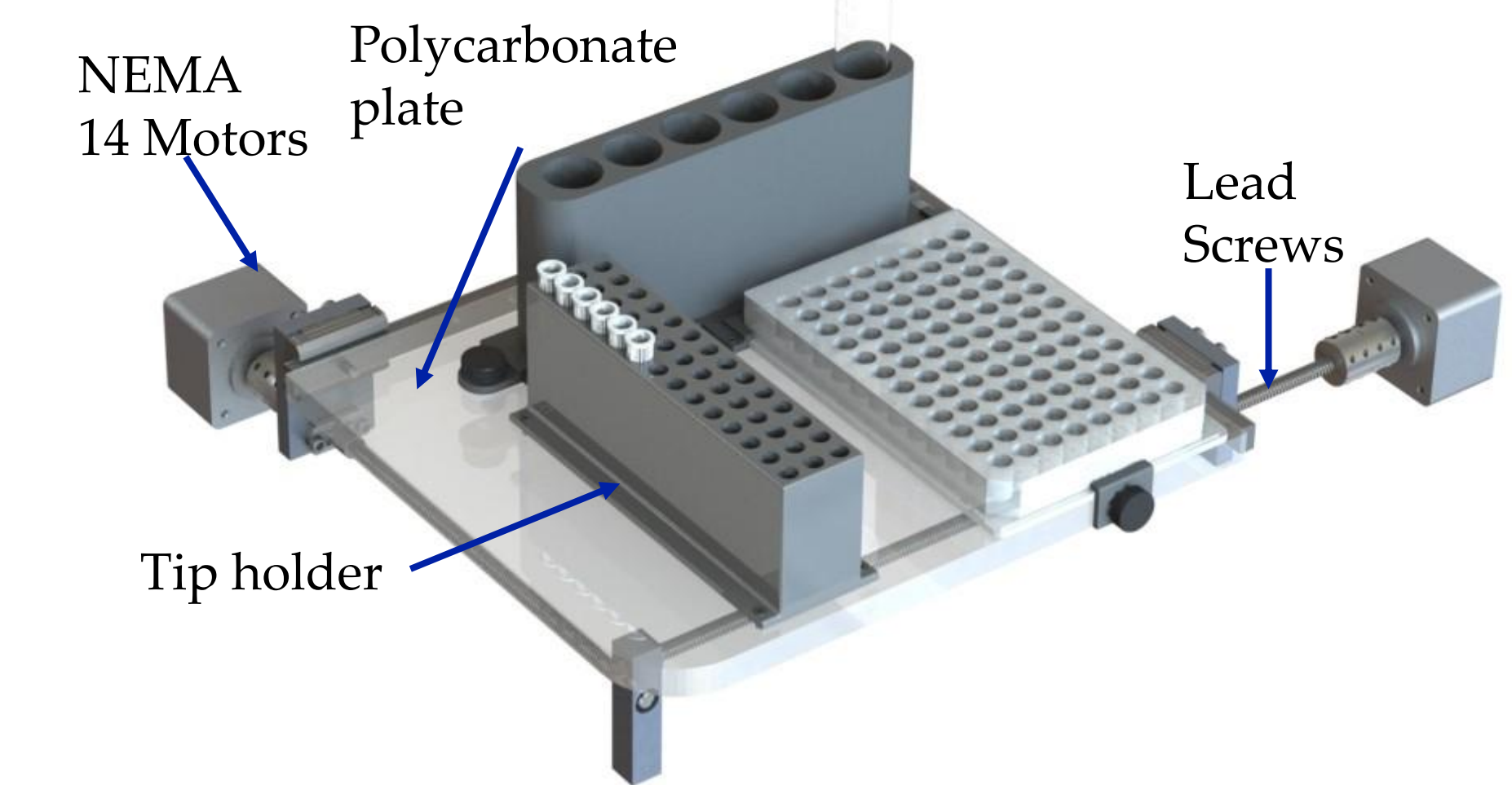
The pressure controlled autonomous reactor (P-CAR), is a micro-bioreactor capable of environmental extrema attempting to simulate extreme environments or extra-terrestrial atmospheric conditions. The P-CAR exceeds the customer's needs for the heating and cooling time as well as the temperature range. The P-CAR is also capable of producing a wide range of pressures between atmospheric pressure down to a near vacuum with 100% control over the proportion of gases within the chamber. Along with these capabilities, the other functions are designed specifically to survive the rugged conditions for a robust system. Some additional objectives that were heavily considered while designing the P-CAR were to make sure the design was small, simple, safe, and as cost effective as possible while making use of ordinary lab equipment such as a laptop to supplement its function. Key features of the design include a reversible heat pump that quickly heats and cools not only the entire environment, but also directly heats and cools the acrylic plate that holds the well plate. The same acrylic plate is actuated by lead screws, which double as the culture agitator motion as well as the transport method between necessary functions such as the liquid dispenser, heater, and ODFI. Additionally, a rotating ODFI arm allows for the synergy of seamless continuous measurement of any size well plate as well as the ability to rotate 90 degrees to perform measurements on the test tubes. The resulting prototype is an affordable automated micro bioreactor with unparalleled environmental testing capabilities.

## Overview



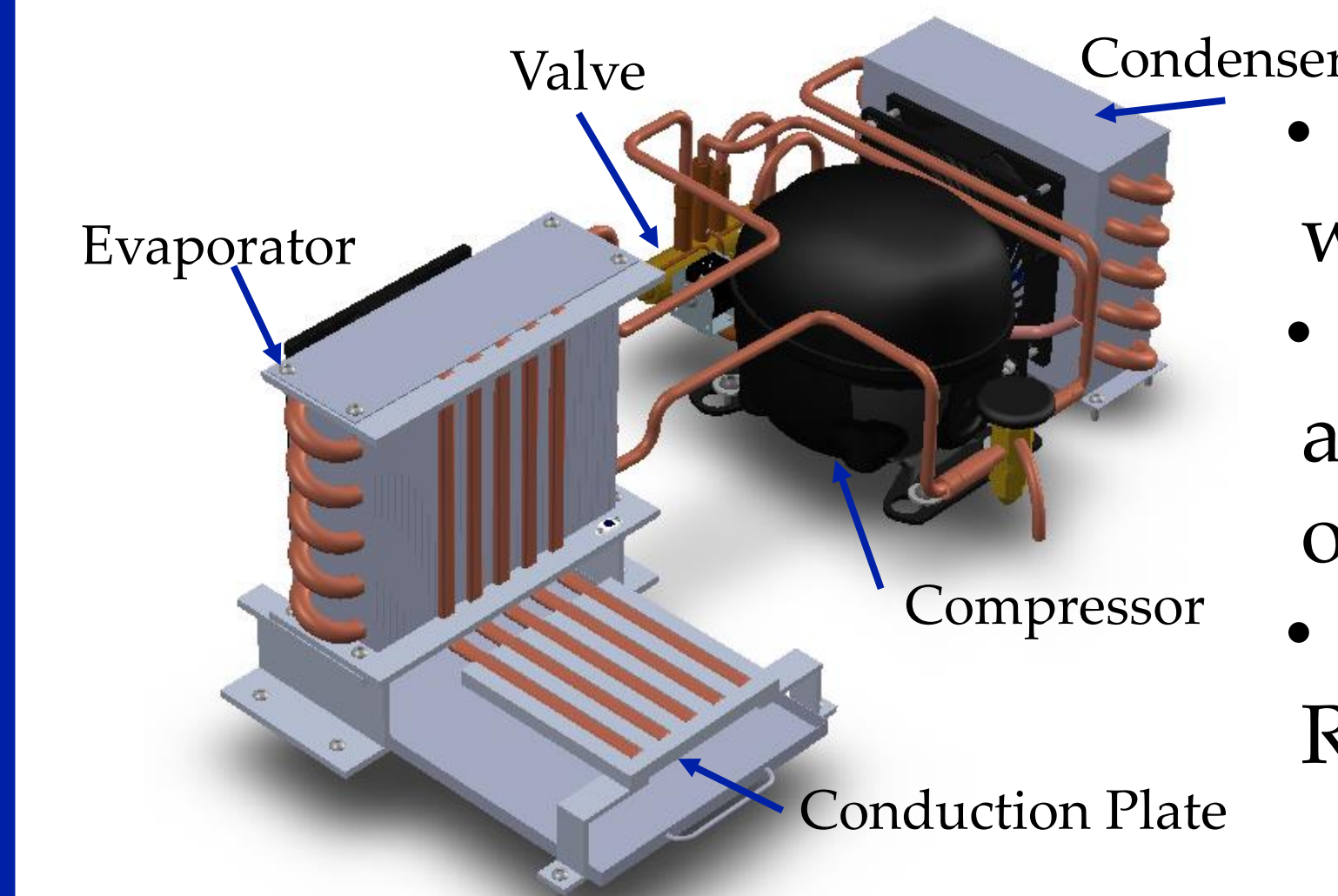
The prototype seeks to autonomously culture cells without lab technician interference while subjecting cultures to a variety of experimental variables. The bioreactor houses cultures in a sealed environment subjectable to gas injection, temperature variation, and low pressure. A lead screw system automatically carries samples to perform liquid dispensing, waste removal, OD/FI measurements, and culture shaking.

## Shaker and Transporter



- 2 Stepper motor driven lead screws move well-plate platform in 2 dimensions
- Holds well plate, test tubes, liquid handling disposable tips, and liquid solutions

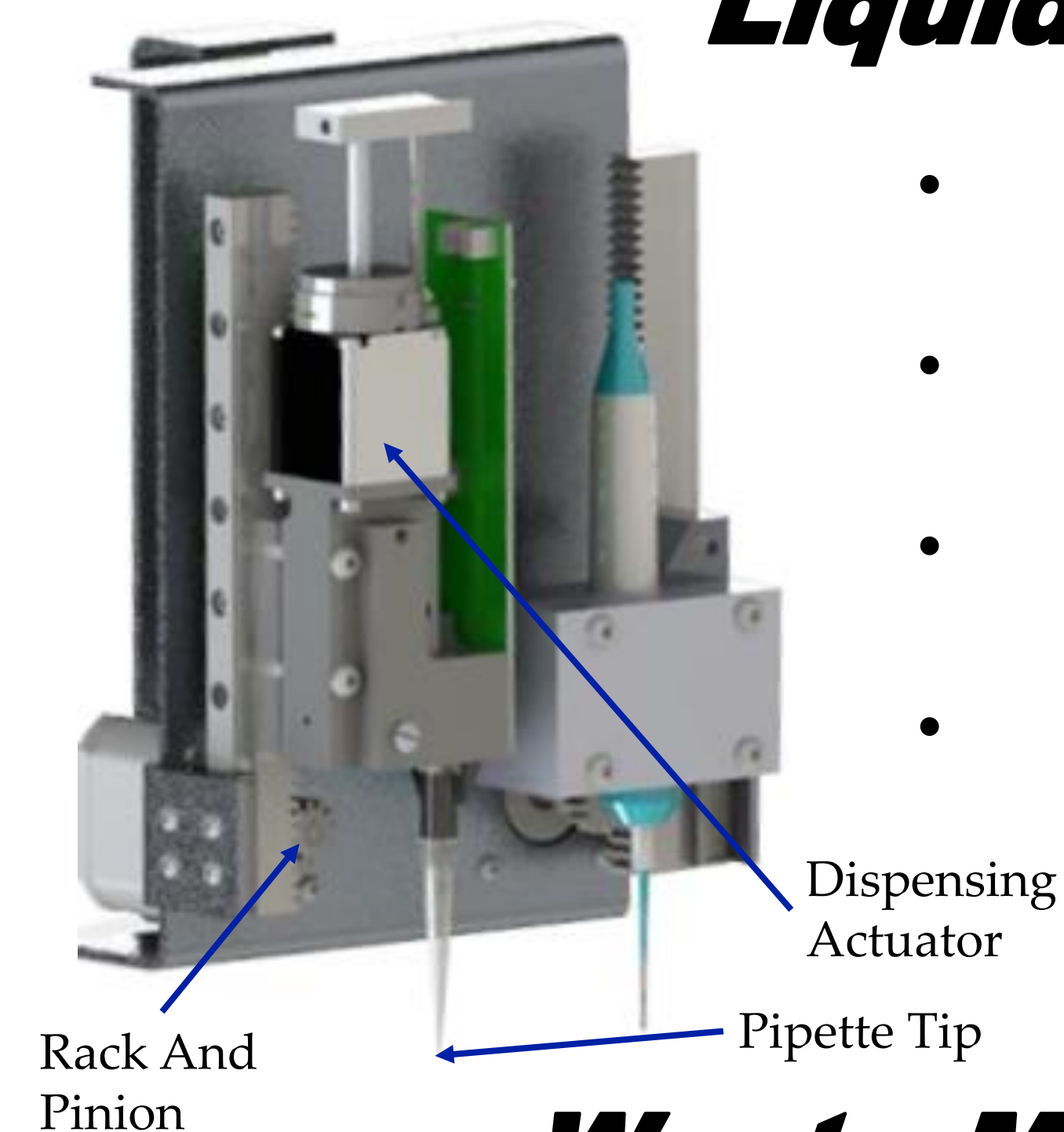
## Heating and Cooling



- Reversible heat pump with internal evaporator
- Conduction plate attached to evaporator outlet
- Operating Temperature Range between 70°C to -10°C

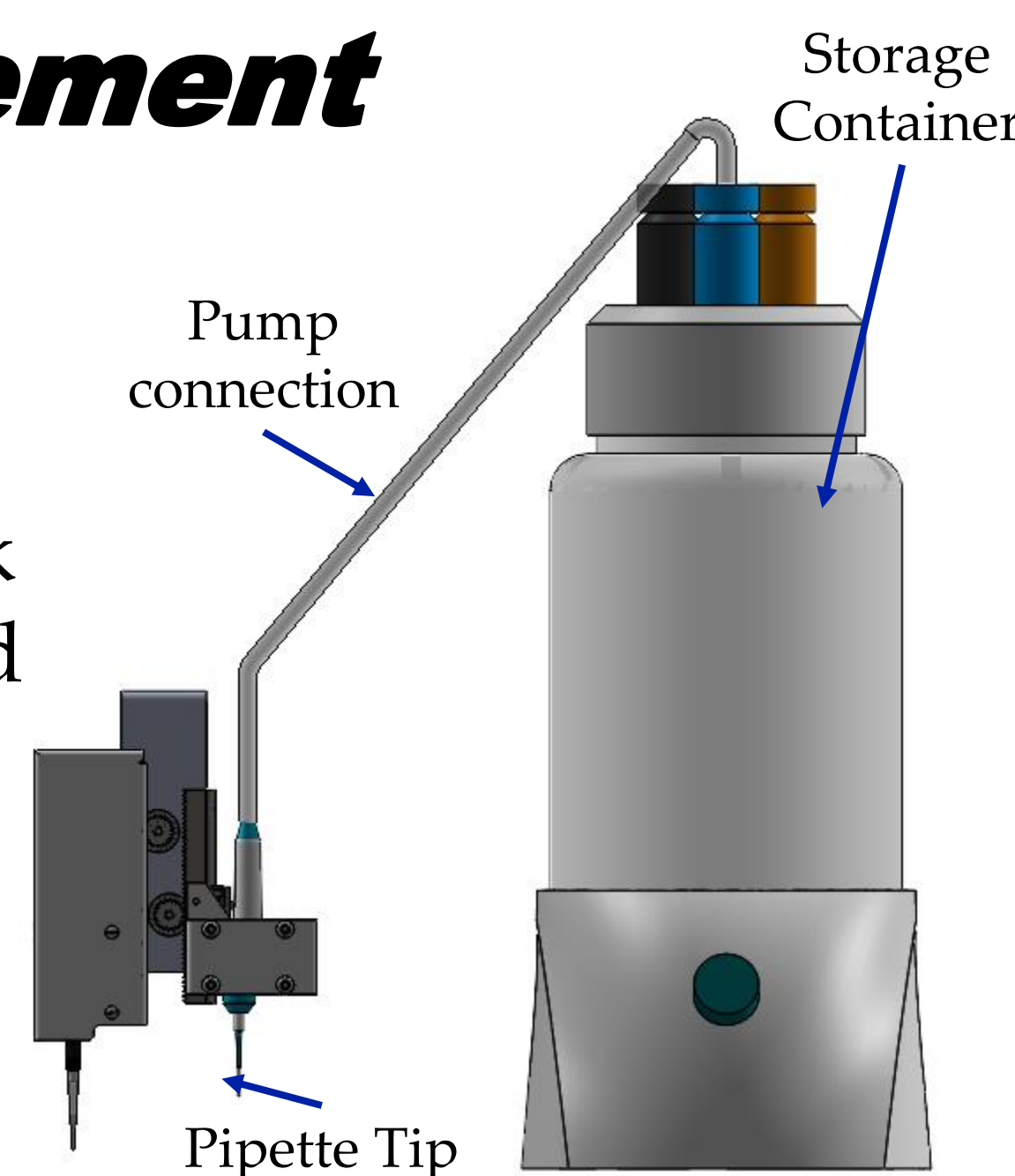
## Liquid Handling

- Air Z Continental off-the-shelf automatic pipette system
- Rack and pinion for lowering to deposit into well or tube
- Disposable Pipette tips for sterile experimentation
- 0.025  $\mu\text{L}$  volume resolution with 1  $\mu\text{L/s}$  to 3000  $\mu\text{L/s}$  flow rate



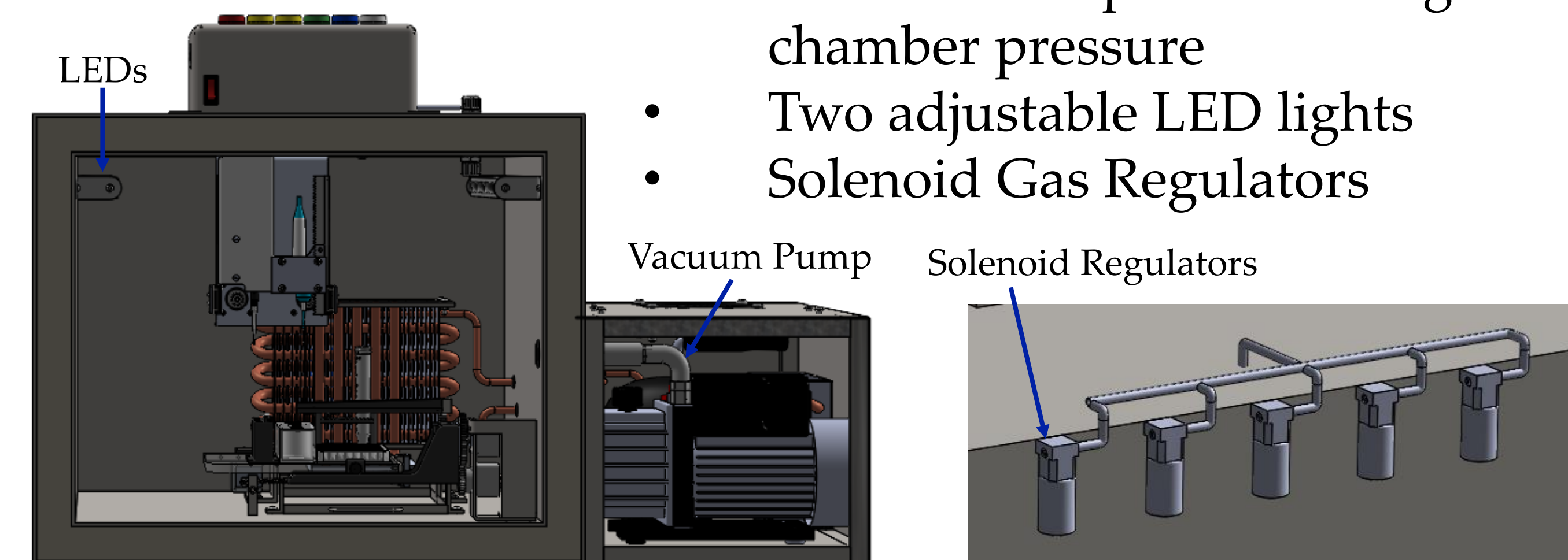
## Waste Management

- Integra Vacusafe off-the-shelf automatic pump removal system
- Pipette lowers to well and waste is pumped out to external holding tank
- Tank can be removed and autoclaved
- Piepette Housed in same rack and pinion actuator as liquid handler

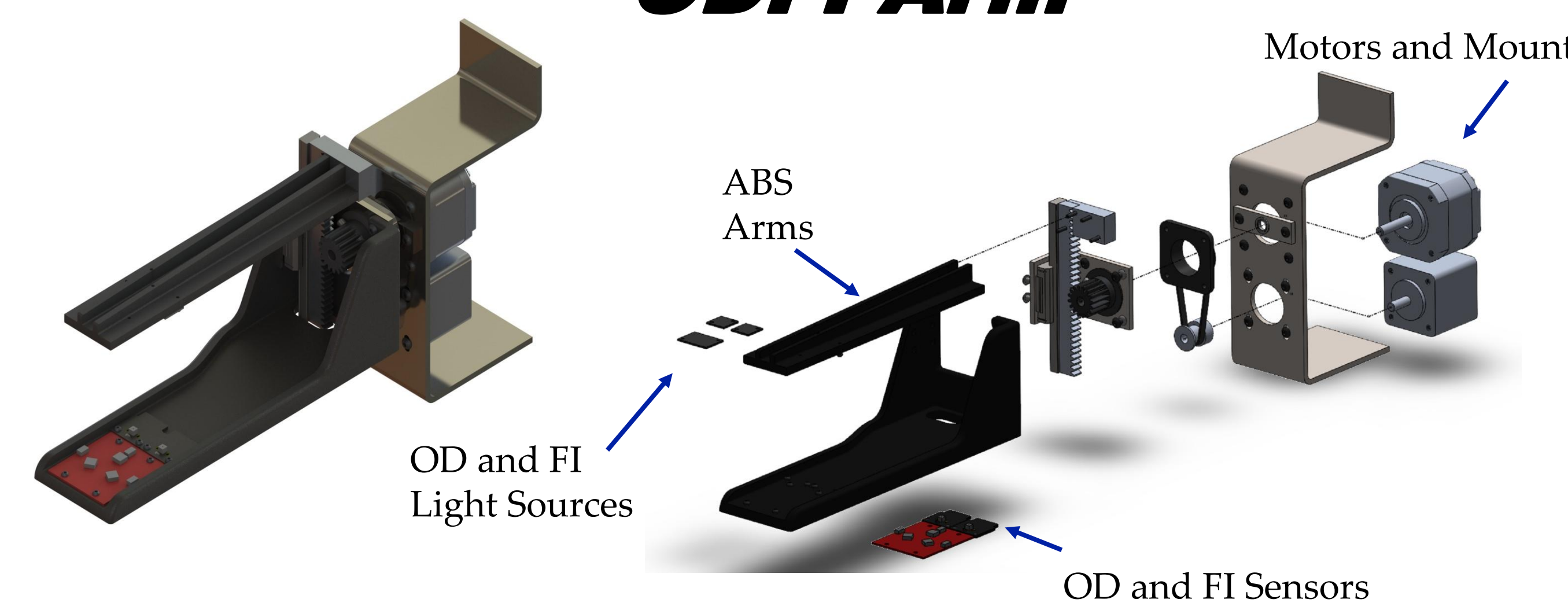


## Environmental Regulation

- Vacuum Pump for reducing chamber pressure
- Two adjustable LED lights
- Solenoid Gas Regulators

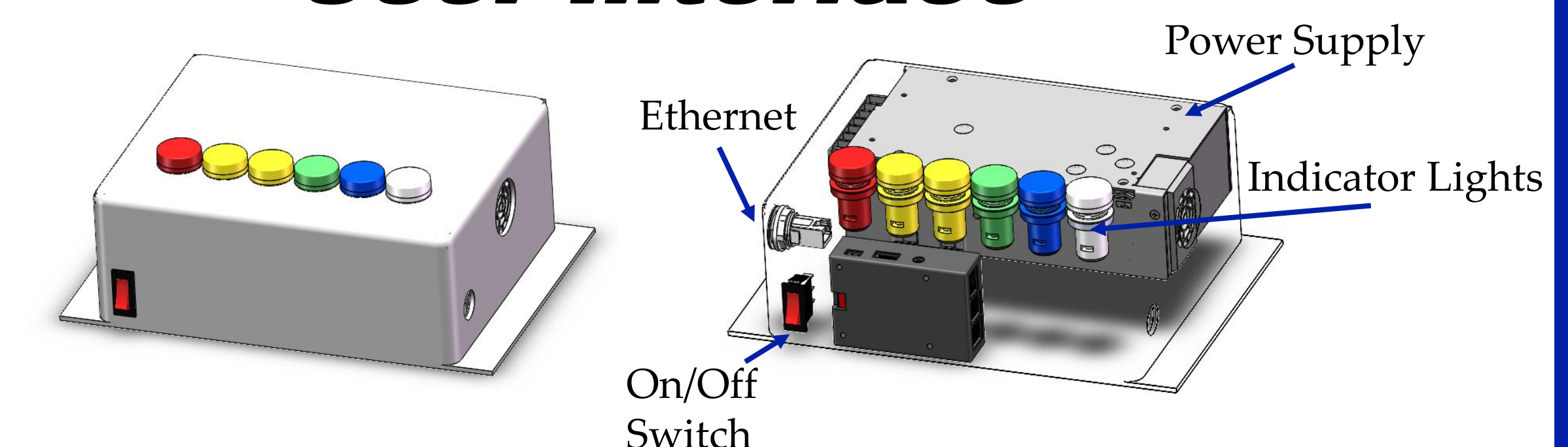


## ODFI Arm



- Rotating ABS arms accommodate all well-plate sizes and conical tubes with sensors and light sources on opposing arms to read through the samples.
- SparkFun SEN-15050 and AS7262 6-channel Spectral Sensor

## User Interface



- Attached to top of structure, houses Raspberry Pi, power supply, on/off switch, and indicator lights
- Outputs to a GUI on a PC via an ethernet connection

## Cost Overview

Expense	Cost (\$)
OTS Parts	\$6650.59
Modified OTS parts	\$303.95
Materials	\$1168.17
Manufacturing and Assembly	\$405.32
Energy	\$10.07
<b>Total</b>	<b>\$8,528.03</b>

# Customer Needs Mapping

