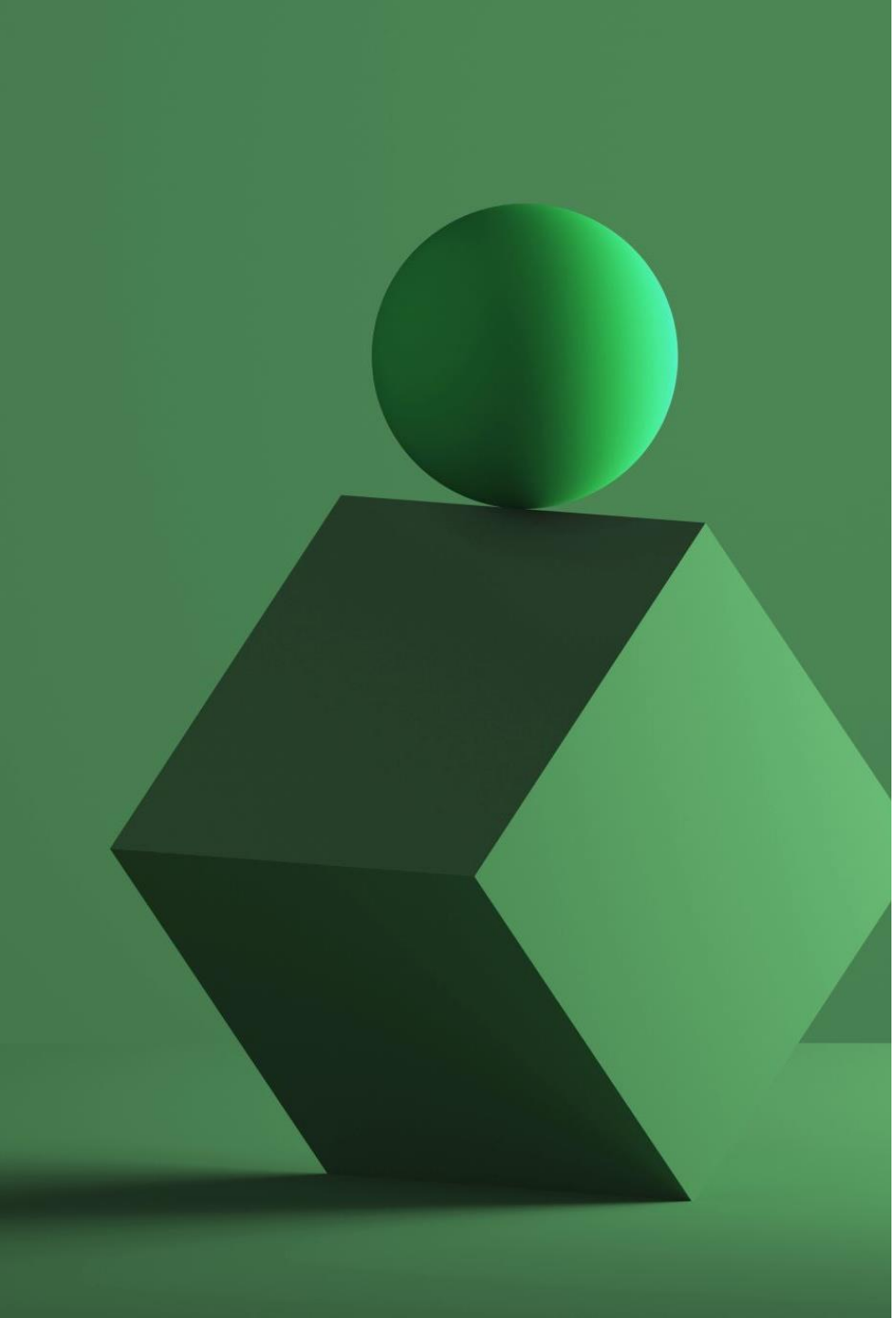
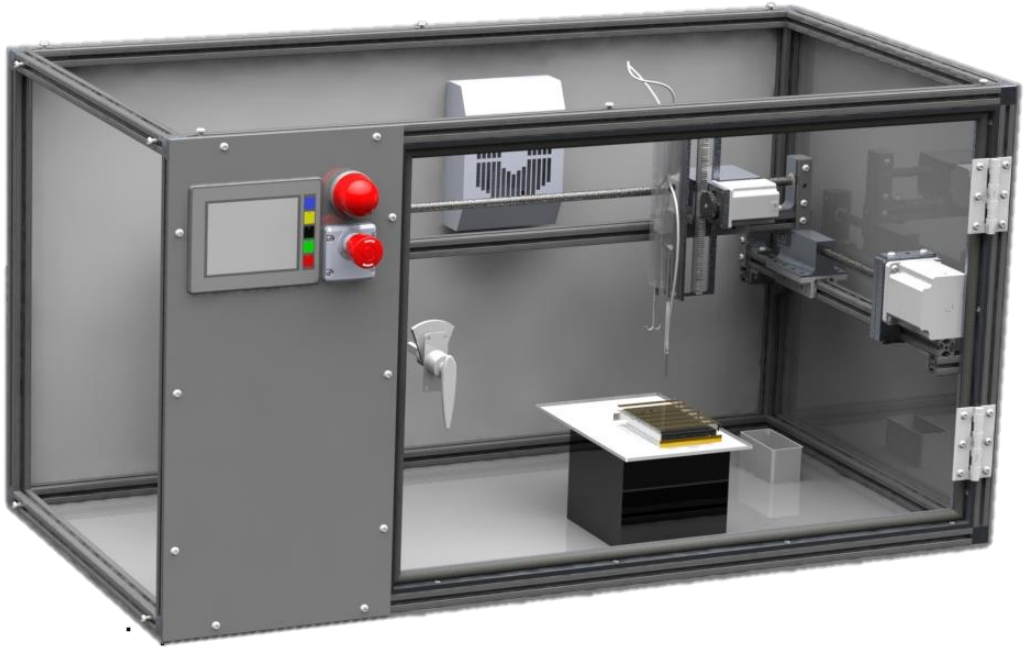


Turbid-o-STAT

SEMI-AUTONOMOUS
MICROBIOREACTOR

Inventors

1. Dylan Atterbury
2. Alexa Dimovski
3. Peter DiNapoli
4. Bertholt Flock
5. Ryan Gleason
6. Andrew Miller
7. Joseph Prueger



Panels hidden for visual effect

Partners

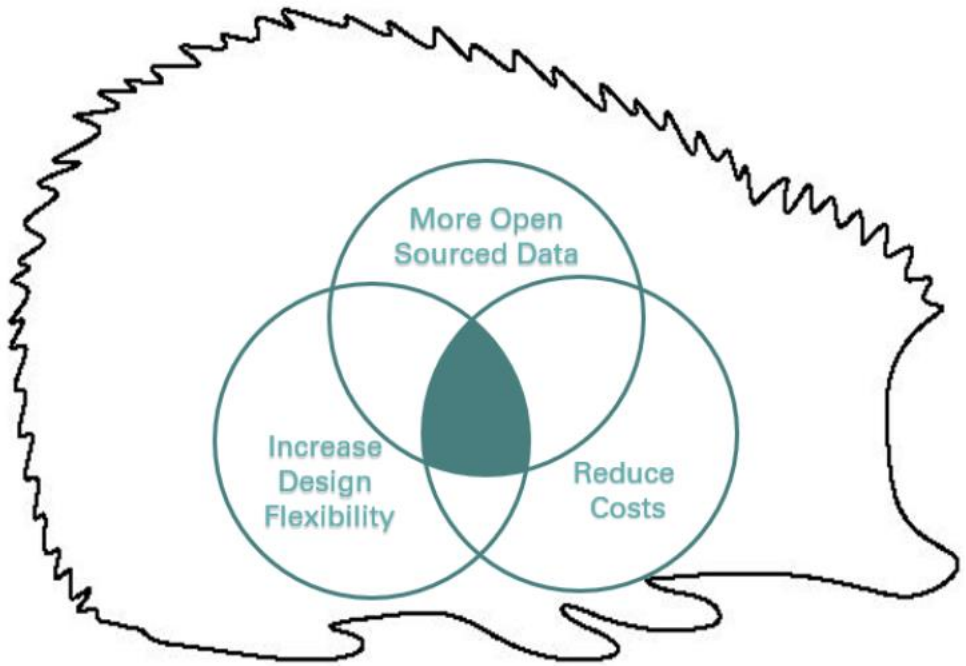
NG NORTHROP GRUMMAN

Cummins

UF BIO FOUNDRY

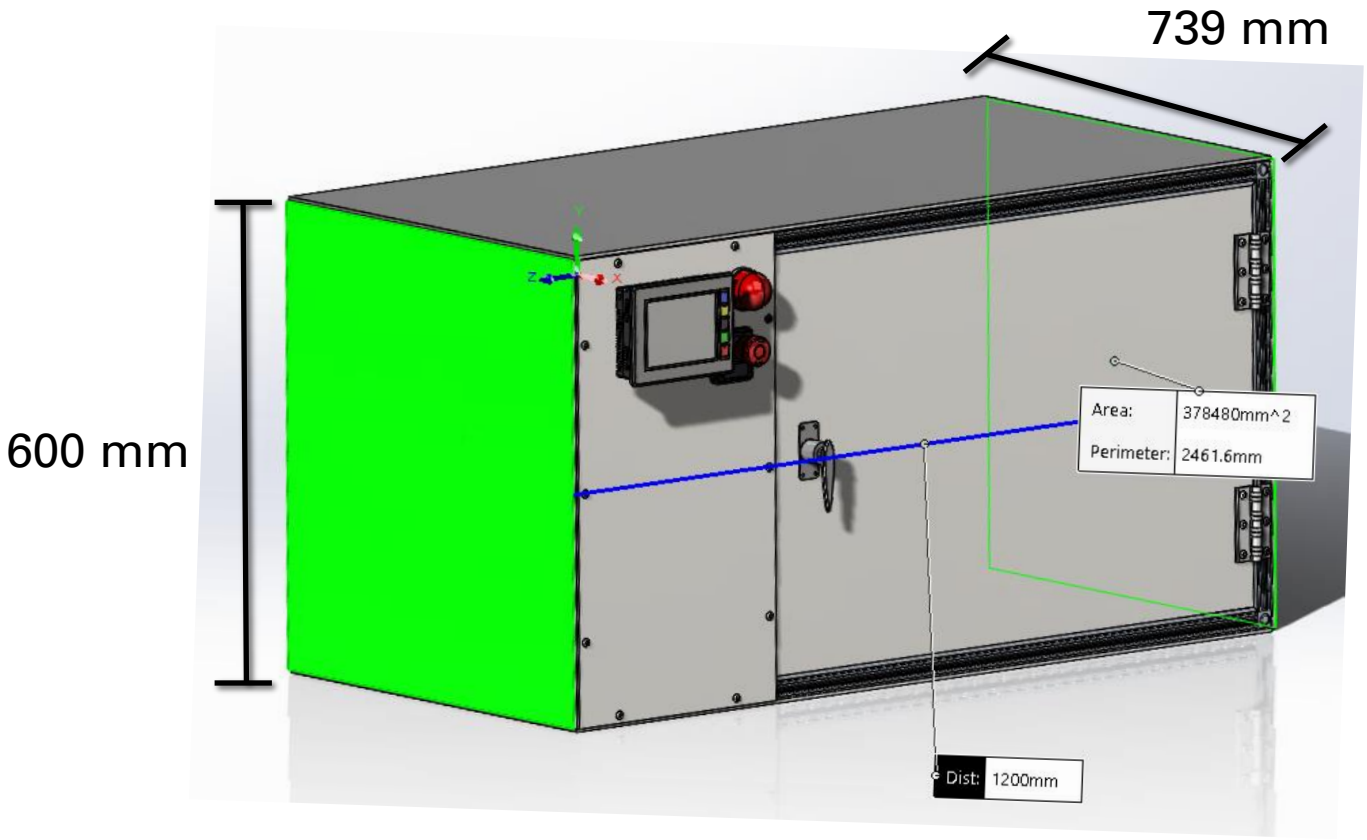
Hedgehog Concept

- **More Open-Sourced Data**: Design enables more experimentation through efficient benchtop
- **Increase Design Flexibility**: Modular design with re-attachable fixtures to enable future iterations
- **Reduce Costs**: OTS parts used in conjunction with custom-made parts enable cost reduction



Product Dimensions

Overall Footprint
Length: 1.20 m
Width: .739 m
Height: .600 m



Product Dimensions Benchtop Scale

Fluid Dispensing and Disposal

Customer needs considered when selecting the design for this subsystem were:

- #15 – Nonporous and nonreactive materials
- #25 – Automated fluid addition and subtraction
- #33 – Dispensing rate
- #34 – Dispensing accuracy and precision
- #35 – Waste disposal

The Turbid-o-STAT fluid dispensing and disposal subsystem:

- Mounted along gantry-style track system for 3-dimensional movement
- Two nozzle fluid addition and subtraction
- Separate nozzle for waste disposal
- Fluid dispensing and disposal promoted via peristaltic pumps for accuracy and precision
- In communication with the controller subsystem for autonomous control

The proposed fluid dispensing and disposal subsystem concept satisfies all necessary customer needs.

Gas Dispensing and Disposal

Customer needs considered when selecting the design for this subsystem were:

- #5 – Factor of safety
- #26 – Ability to capture effluent gases
- #27 – Gas addition and regulation

The Turbid-o-STAT gas dispensing and disposal subsystem:

- Utilizes pinch valves in conjunction with the controller subsystem to accurately provide a regulated gaseous environment
- Ability to provide all 5 requested gases to individual tray/tube chamber
- Incorporates vacuum and compressor for safe gas disposal

The proposed gas dispensing and disposal subsystem concept satisfies all necessary customer needs.

Optical

Customer needs considered when selecting the design for this subsystem were:

- #2 – Electrical power source
- #5 – Factor of safety
- #19 – Culture condition
- #28 – OD and FI readings
- #29 – FI reading capability
- #30 – Light intensity

The Turbid-o-STAT optical subsystem:

- Light sensor mounted along gantry-style track system for 3-dimensional movement and ability to measure all necessary test trials
- Necessary light strips mounted beneath conical tubes and culture trays
- In communication with the controller subsystem for automated closed-loop control

The proposed optical subsystem concept satisfies all necessary customer needs.

Controller

Customer needs considered when selecting the design for this subsystem were:

- #5 – Factor of safety
- #6 – System failure indication
- #8 – Safety limit shut-off
- #9 – Warning indication visibility
- #13 – Programmability
- #14 – User Interface
- #19 – Closed loop control of culture conditions

The Turbid-o-STAT controller subsystem:

- Incorporates user interface for user control and system programmability
- Has manual shut-off button and autonomous safety-limit shut-off
- Provides adequate warning indication visibility
- Communicates with all necessary subsystems to promote autonomous control

The proposed controller subsystem concept satisfies all necessary customer needs.

Temperature Control

Customer needs considered when selecting the design for this subsystem were:

- #2 – Electrical power source
- #5 – Factor of safety
- #15 – Nonporous and nonreactive materials
- #20 – Culture temperature capability
- #24 – Uniform heat distribution

The Turbid-o-STAT temperature control subsystem:

- Uses heat strips along the interior chamber walls to promote uniform heat distribution for conical tubes and culture trays
- Utilizes ambient cooler if lower temperatures are required
- Communicates with the controller subsystem for autonomous temperature control
- Controller subsystem allows the temperature of each chamber to be manipulated separately

The proposed temperature control subsystem concept satisfies all necessary customer needs.

Shaking and Trays

Customer needs considered when selecting the design for this subsystem were:

- #2 – Electrical power source
- #5 – Factor of safety
- #18 – Incubation time
- #21 – Microbe culture capability
- #22 – Culture plate housing
- #23 – Conical tube housing
- #31 – Shaking patterns
- #32 – Independent conditions for each plate/tube

The Turbid-o-STAT shaking and trays subsystem:

- Separate housing chambers accommodation for conical tubes and culture trays
- Housing chamber works in conjunction with the temperature control, fluid dispensing and disposal, and optical subsystems
- Shaking mechanism allows for all three required movement patterns

The proposed shaking and trays subsystem concept satisfies all necessary customer needs.

Housing Unit

Customer needs considered when selecting the design for this subsystem were:

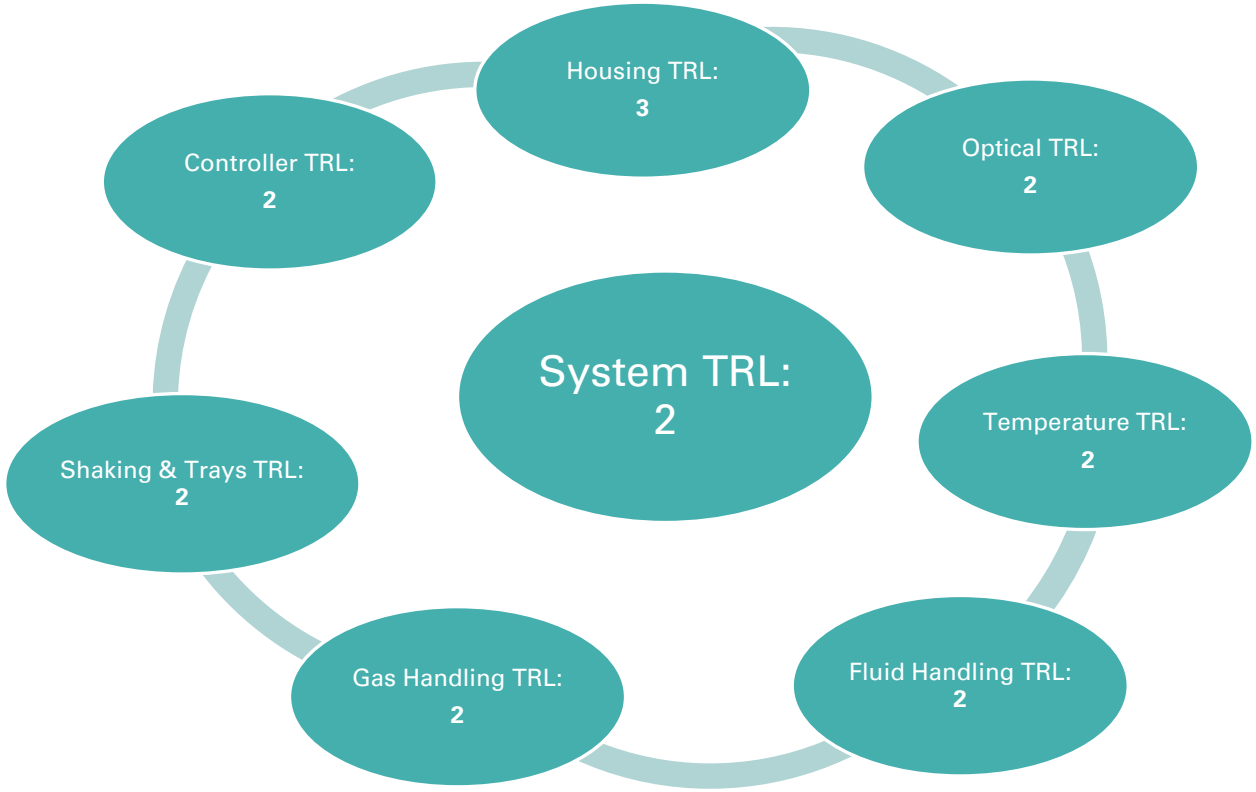
- #1 – System dimensions
- #3 – Accessibility
- #4 – Assembly/disassembly time
- #7 – Emergency shut-offs
- #10 – Operational lifetime
- #11 – Total cost
- #12 – No external features or supports
- #16 – BSL-2 lab safety requirements
- #17 – Exterior surface temperature

The Turbid-o-STAT fluid housing unit subsystem:

- Houses and accommodates all other subsystems
- Housing supports provide the necessary structure and stability to the system without external supports
- Sealed door ensures no gas from the testing environment escapes and provides proper user access
- Ensures system complies with all BSL-2 lab safety requirements

The proposed housing unit subsystem concept satisfies all necessary customer needs.

Technology Readiness Levels (TRLs)



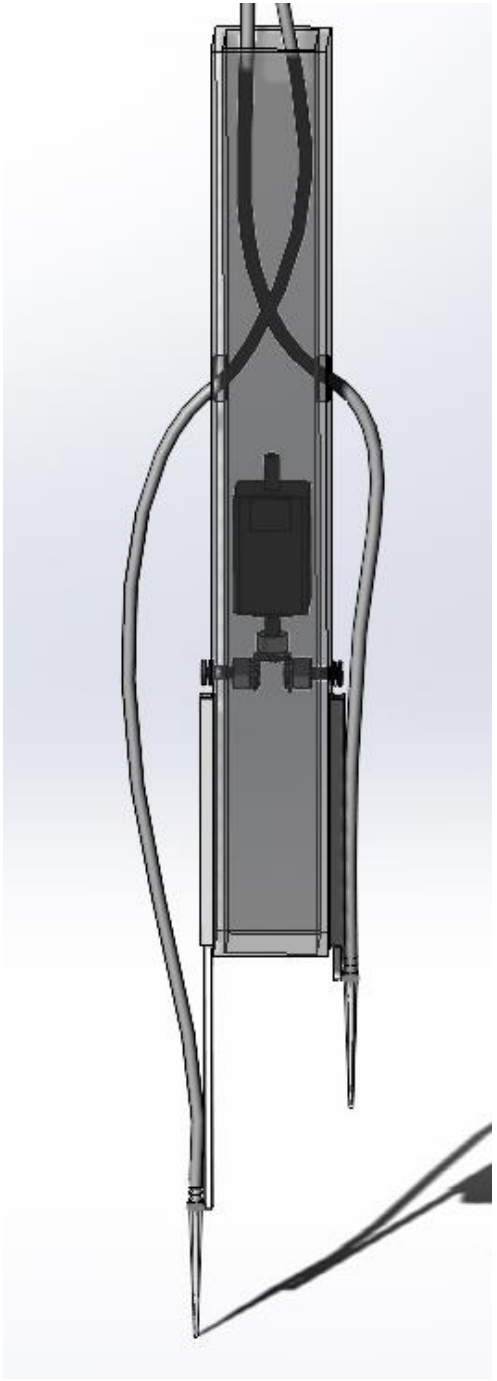
Key Design Features

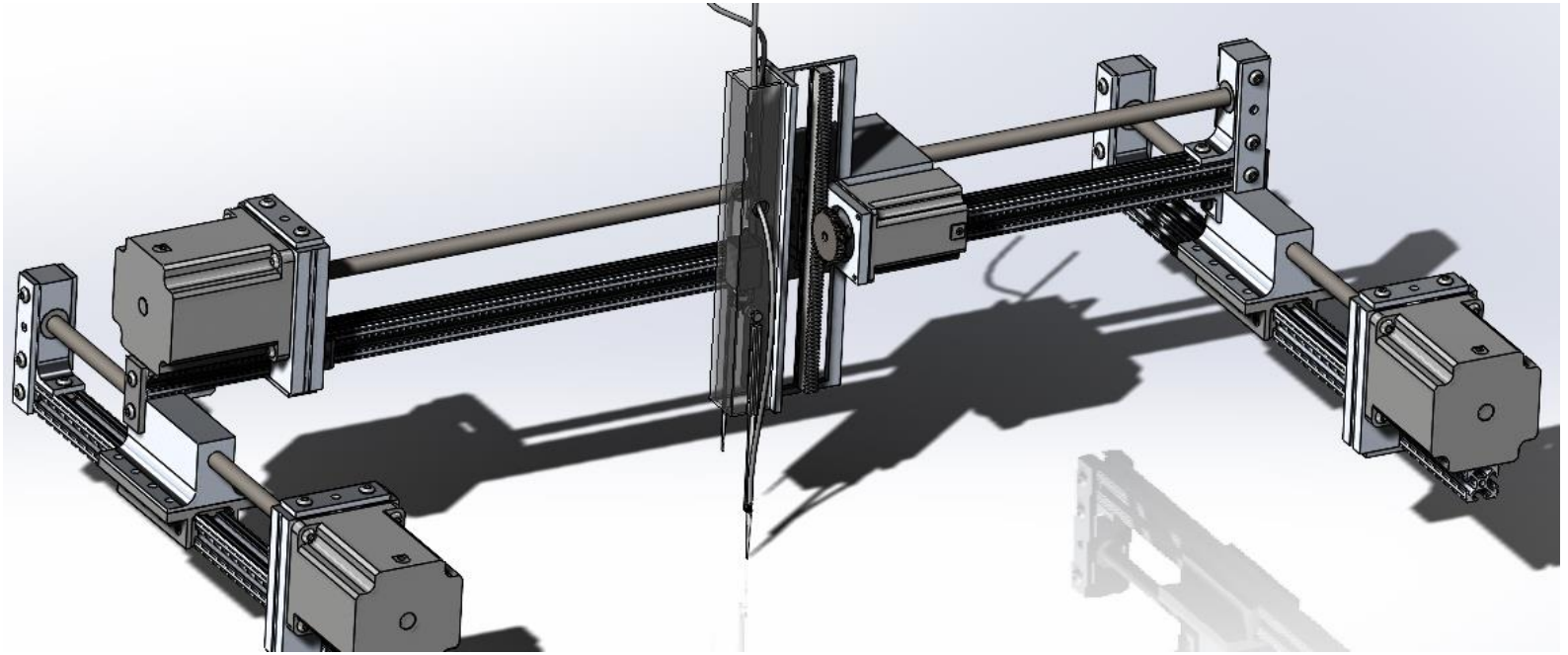
Fluid Handler

- Robust two nozzle design
- X-Y-Z gantry assisted motion
- Enhanced z-directional movement through rack and pinion
- Autonomous fluid addition and subtraction (hook-container)

Shaking & Trays

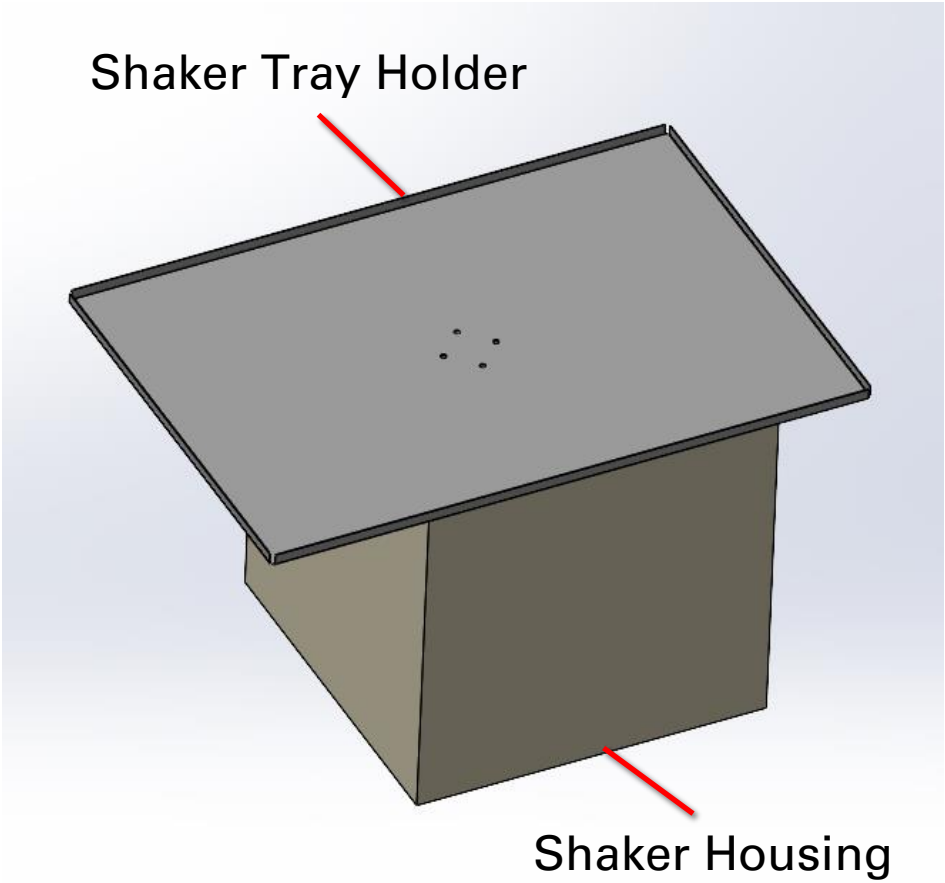
- Dual purpose tray & tube containers, includes uniform heating sleeves and optical density LEDs
- Shaker capable of Linear, Orbital, and Double Orbital Patterns
- Shaker interior system filed for IP

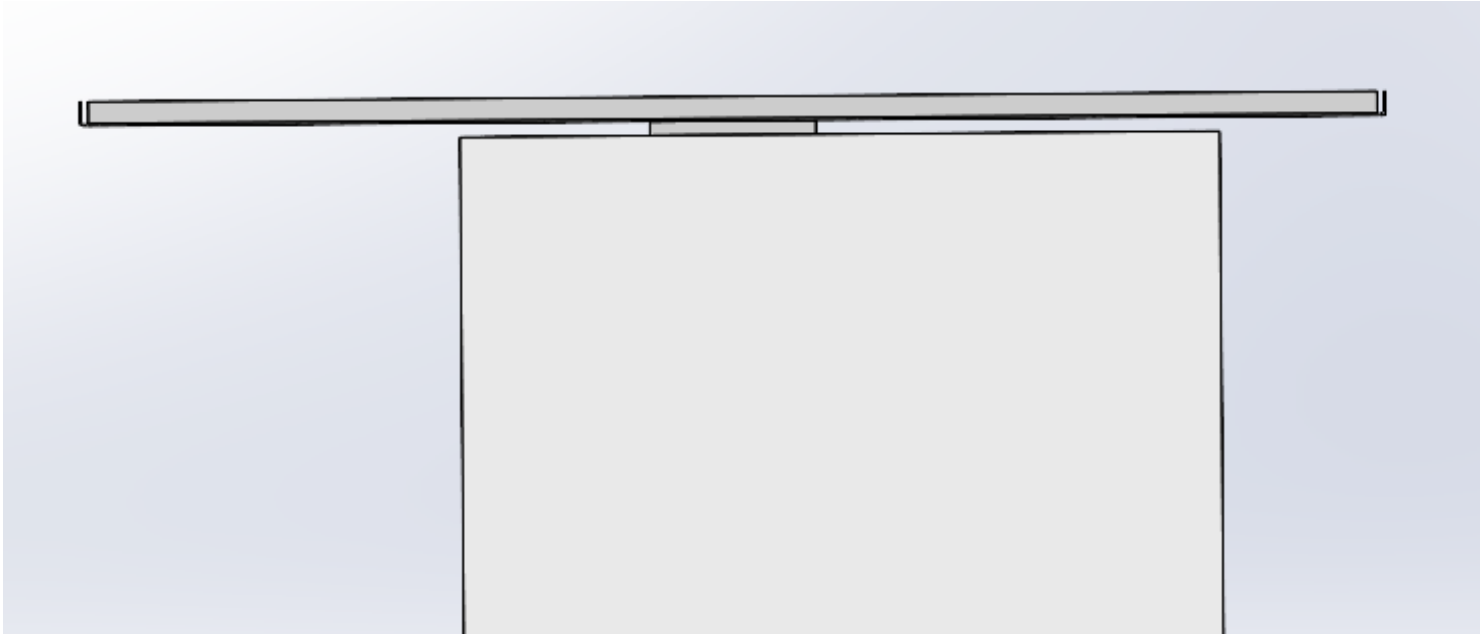




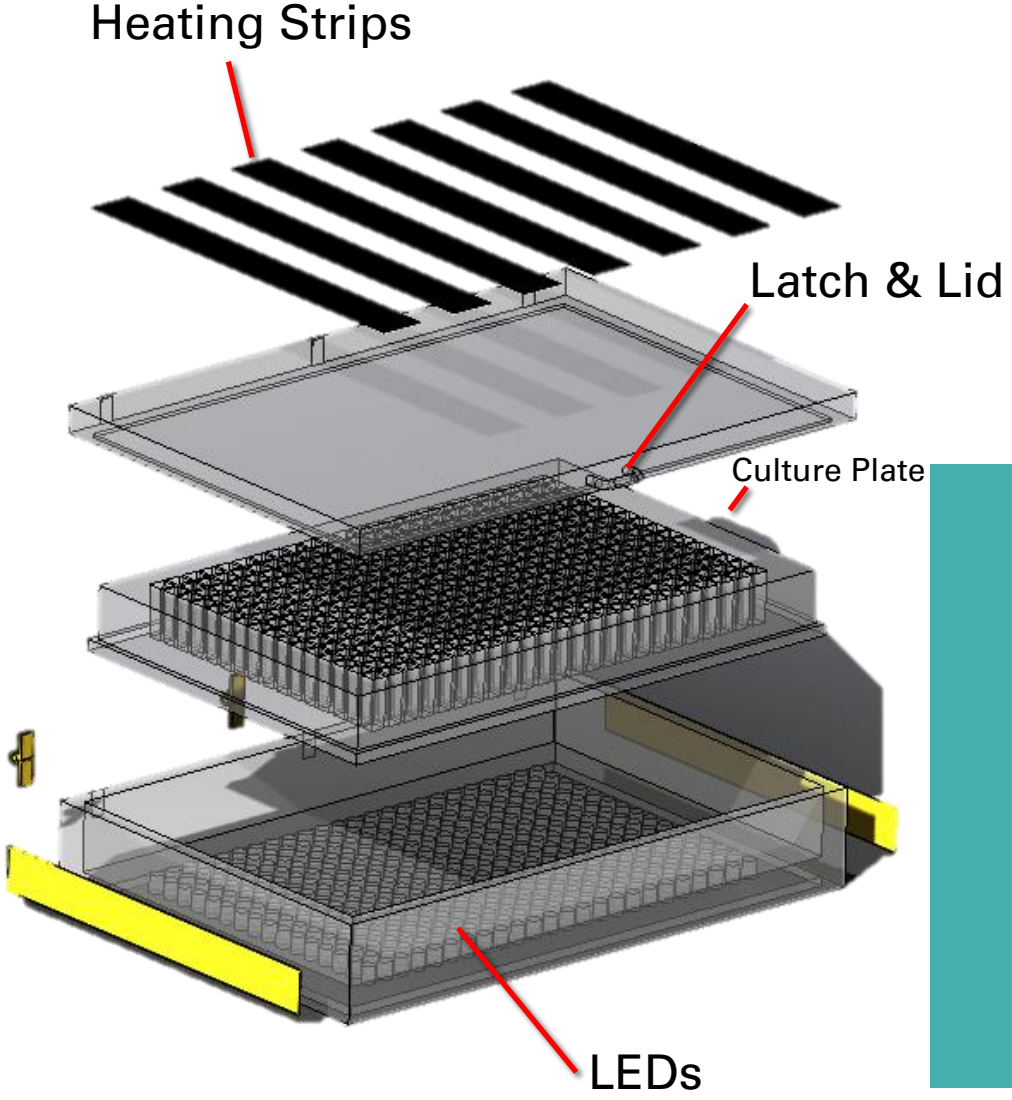
CAD Views of Fluid Handler

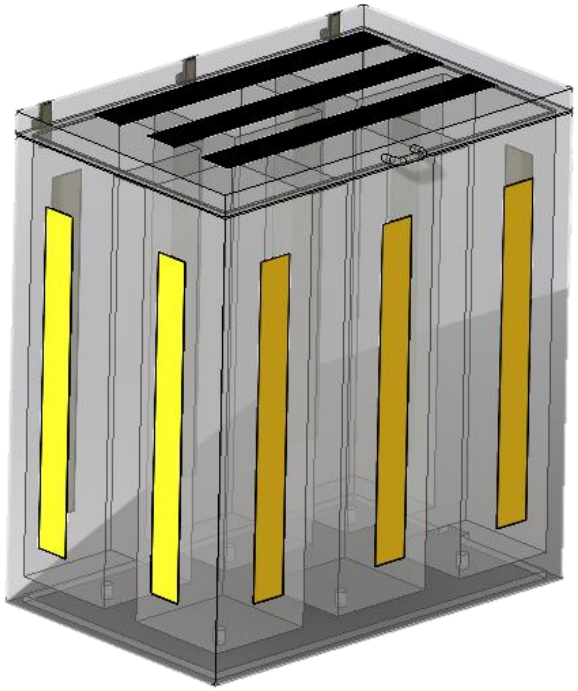
Shaker animations available after PowerPoint Presentation





CAD Views of Shaker

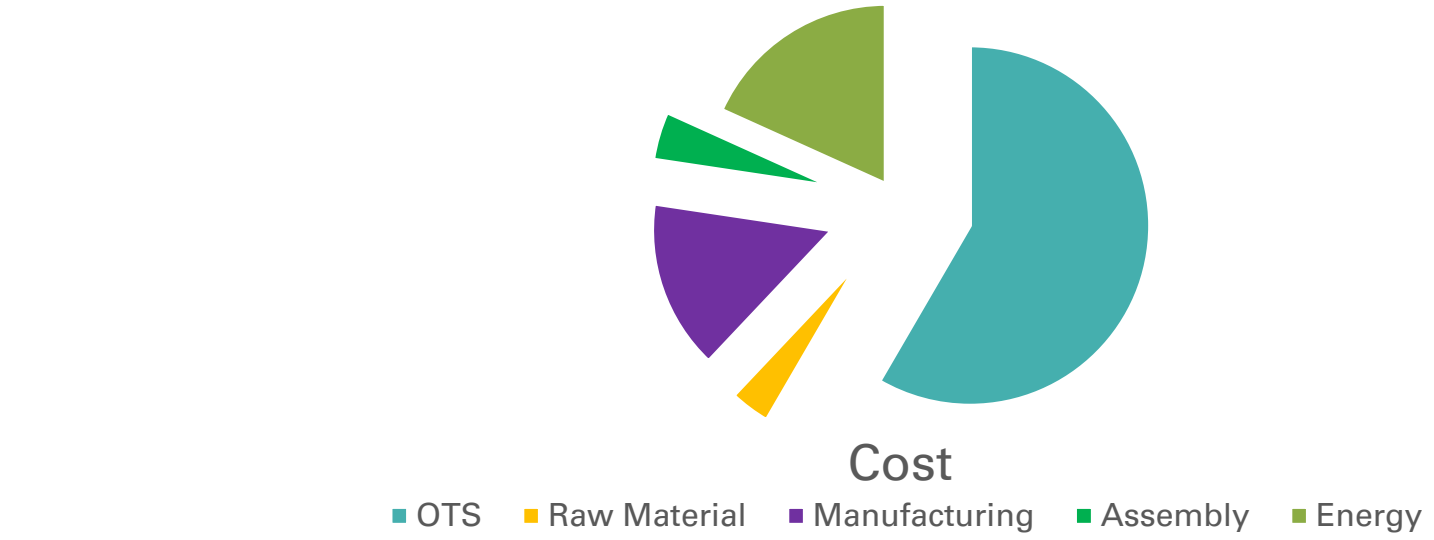




CAD Views of Trays

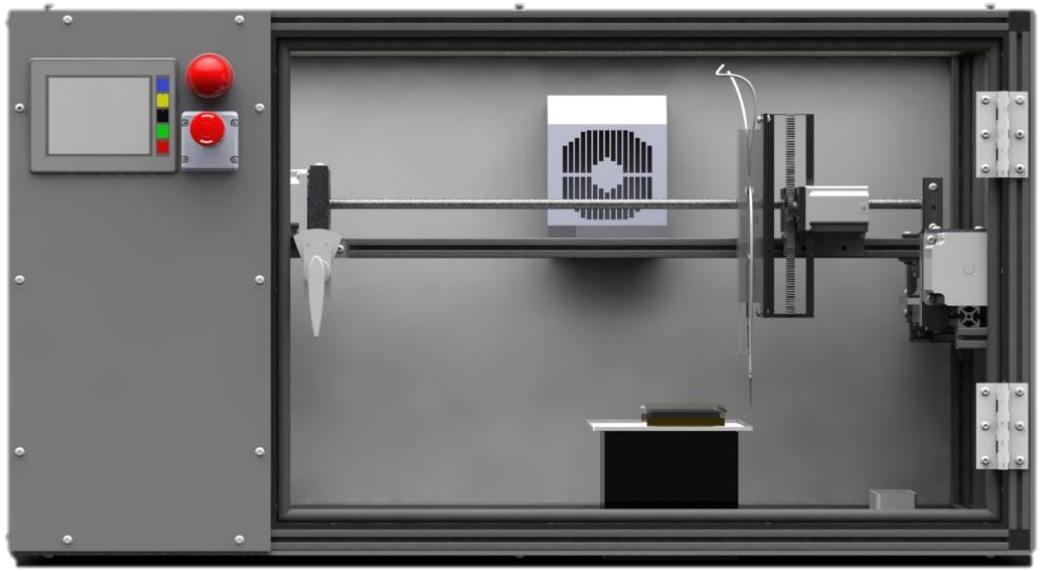
Turbid-o-STAT Cost

OTS Cost	Raw Material Cost	Manufacturing and MFG Cost	Assembly Cost	Energy Cost	Total Cost
$5,877.81	$22.66	$103.10	$24.39	$181.44	$6209.40



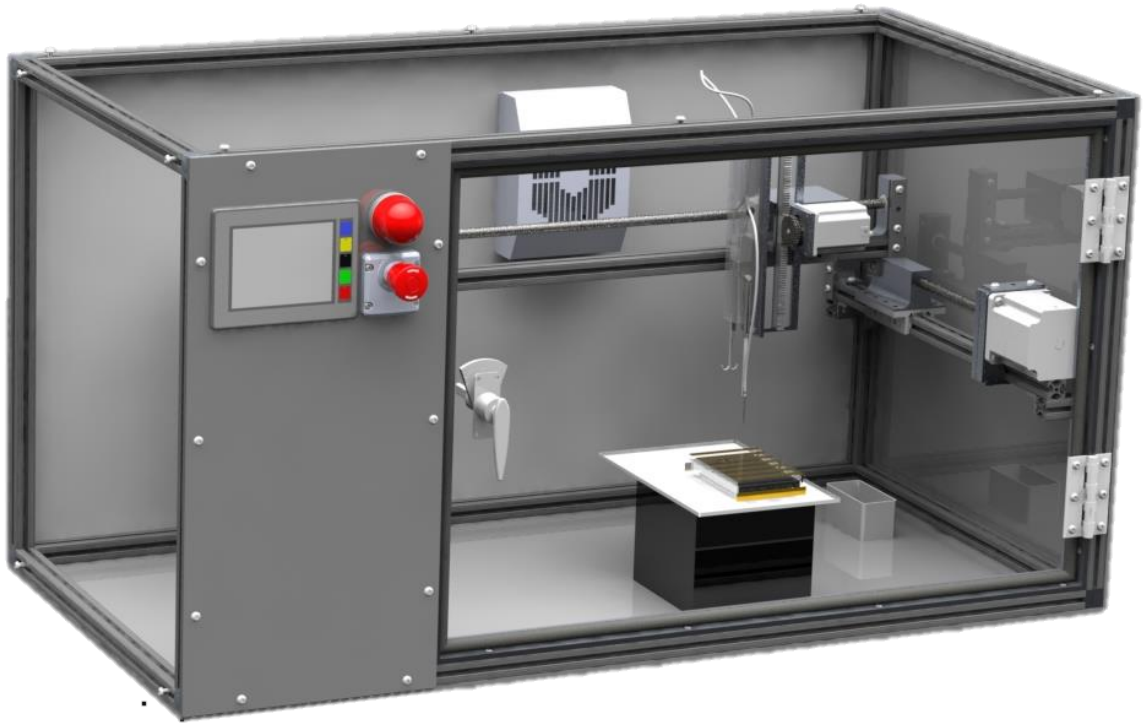
Why Prototype Turbid-o-STAT?

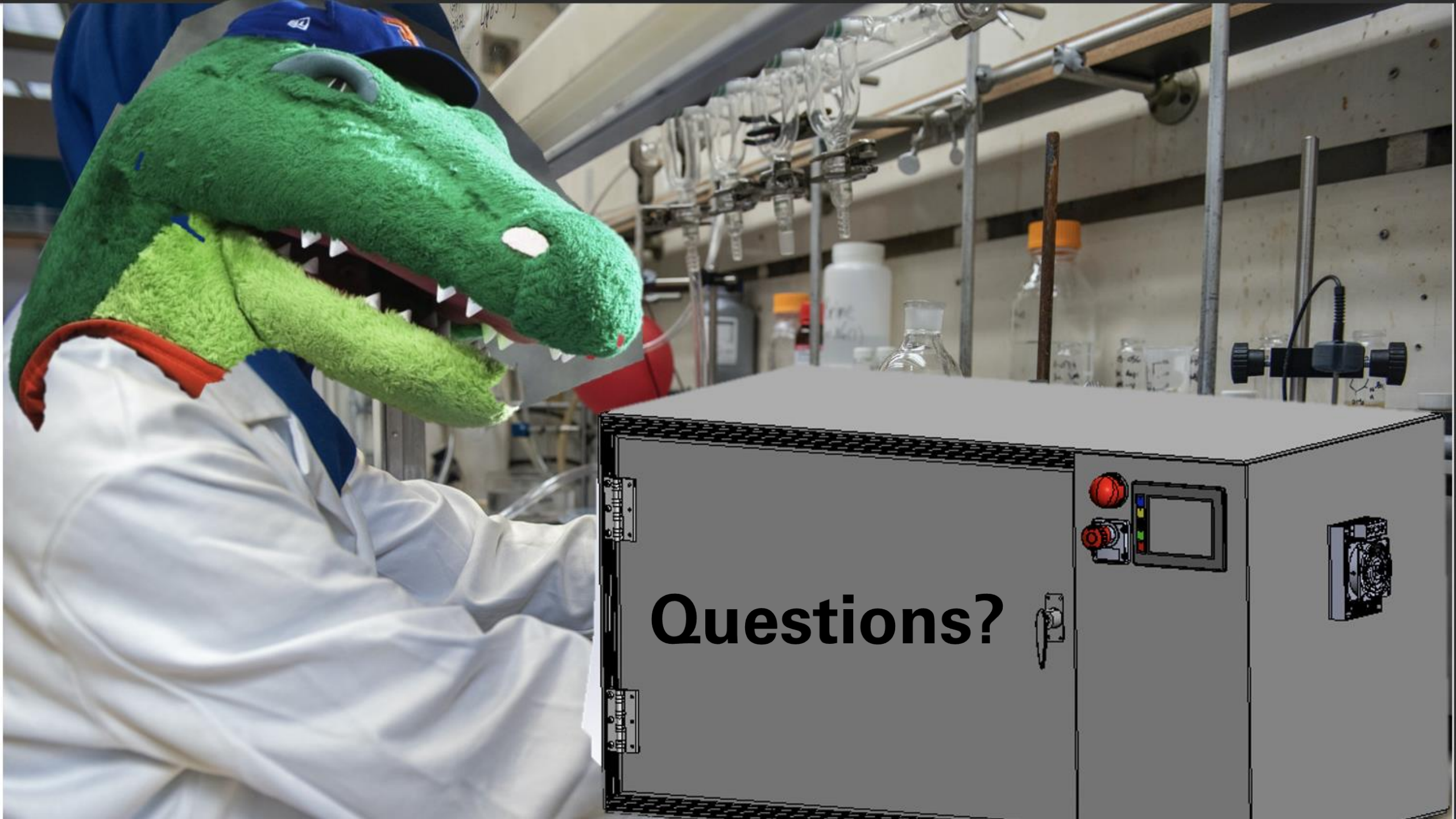
- Modular design through use of 80/20 with moveable and accessible features
- Total system cost underneath required $10,000 limit
- Autonomous fluid addition and subtraction without robotic arm
- Who wouldn’t want to prototype the Turbid-o-STAT based on this render?



Wrap Up: Turbid-o-STAT

Thank You for Joining Our Presentatio n




Questions?