opentrons

Building the AI-Native Lab

How AI is transforming laboratories today, and laying the foundation for autonomous experimentation

Learn why the Opentrons Flex is built for the future of intelligent lab automation

A new era of scientific discovery

Experiments once bottlenecked by manual execution, protocol complexity, and fragmented workflows are rapidly becoming streamlined, scalable, and radically more intuitive.

At the center of this shift is OpentronsAI, a tool designed to translate scientific intent into executable, automated lab workflows. It turns experimental ideas into ready-to-run protocols today. While forming the foundation of a broader ecosystem that will perceive and respond to outcomes, and learn from data, paving the way toward fully autonomous, closed-loop laboratories.

The future of science is being shaped by AI, automation, and scalability.

With OpentronsAI, scientists can:

01

Use **natural language** prompts to generate protocols

02

Optimize and iterate within a conversational interface

03

Use the Opentrons App to **simulate** and **visualize** each step of your protocol

04

Reduce friction and fully automate every step: from idea to data

Try OpentronsAI

Automation and AI is where the field is going overall. You need real experience with liquid handling automation because that's what the entire industry will expect you to be able to do. The table stakes for doing anything relevant are familiarity with the cloud, with pipelines, with liquid handling automation and AI.

Dr. Peter McCaffrey, MD, MS, FCAP
VP, Chief AI + Digital Officer at UTMB

Why automation and AI now?

Across the sciences, three forces are colliding into a permanent shift:

Data is exploding

Experiments generate more data than ever, and the only sustainable way forward is automation.

Technology is advancing

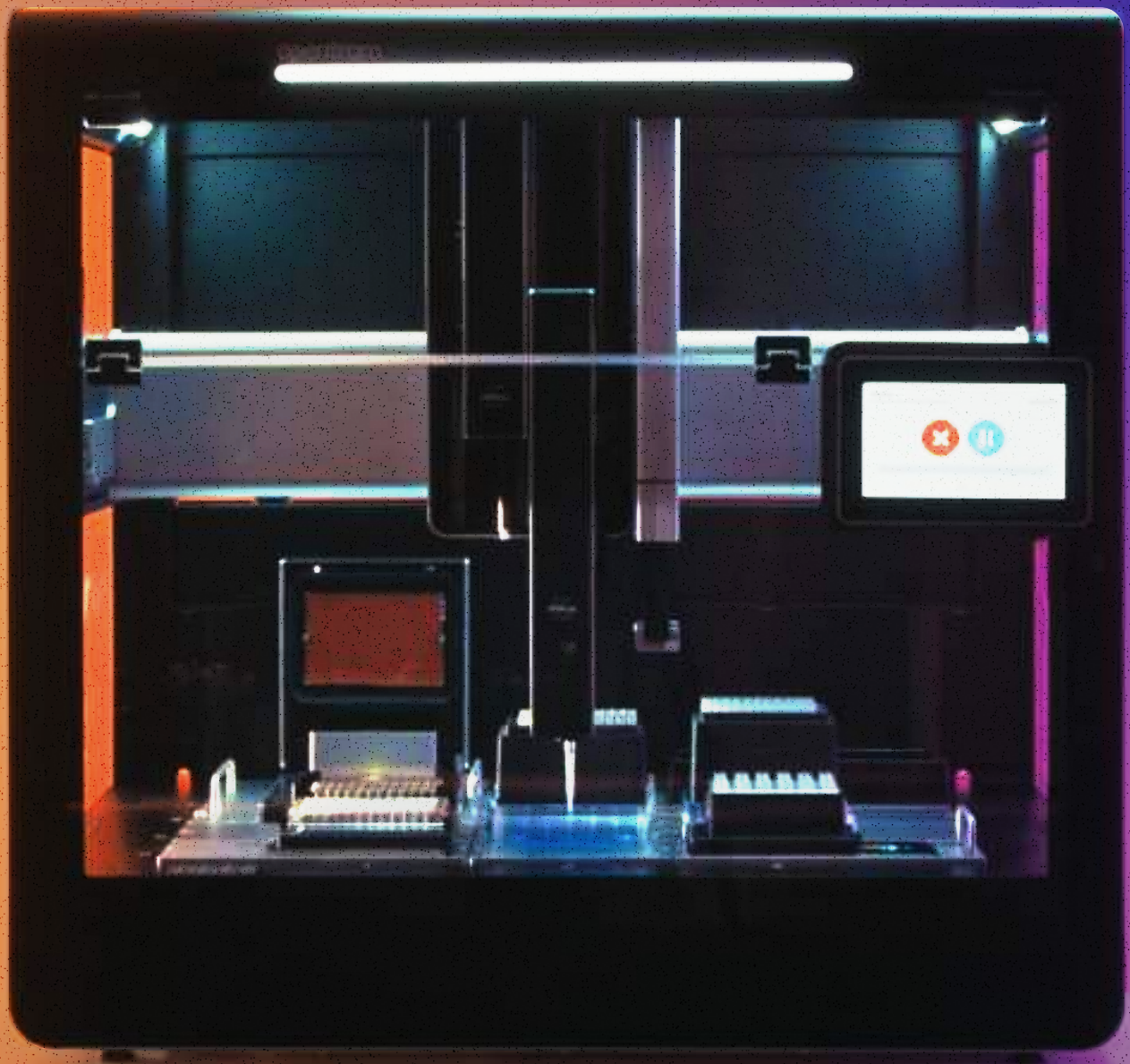
Automation experience is now a career requirement, but traditional systems remain expensive and hard to learn.

Workflows are becoming more complex

From multi-step molecular biology to automated proteomics, the technical demands have increased dramatically.

OpentronsAI removes these barriers by giving scientists an accessible, intuitive, and capable automation co-scientist.

The Opentrons ecosystem



Opentrons has always had a clear mission: make lab automation accessible with ease of use, open-source technology, and price point. Our systems are modular so your automation works more like your science does.

Write

Define your Opentrons robot, pipettes, modular hardware, the labware and reagents you already use, and input protocol steps using natural language.

Optimize

Optimize your protocol to adhere to the instructions of your specific reagent kit, reduce time spent on manual steps, save money and materials, and even reduce plastic waste.

Simulate & Visualize

Instantly inspect protocols created with OpentronsAI, simply by dragging them into the app and clicking “Visualize”.

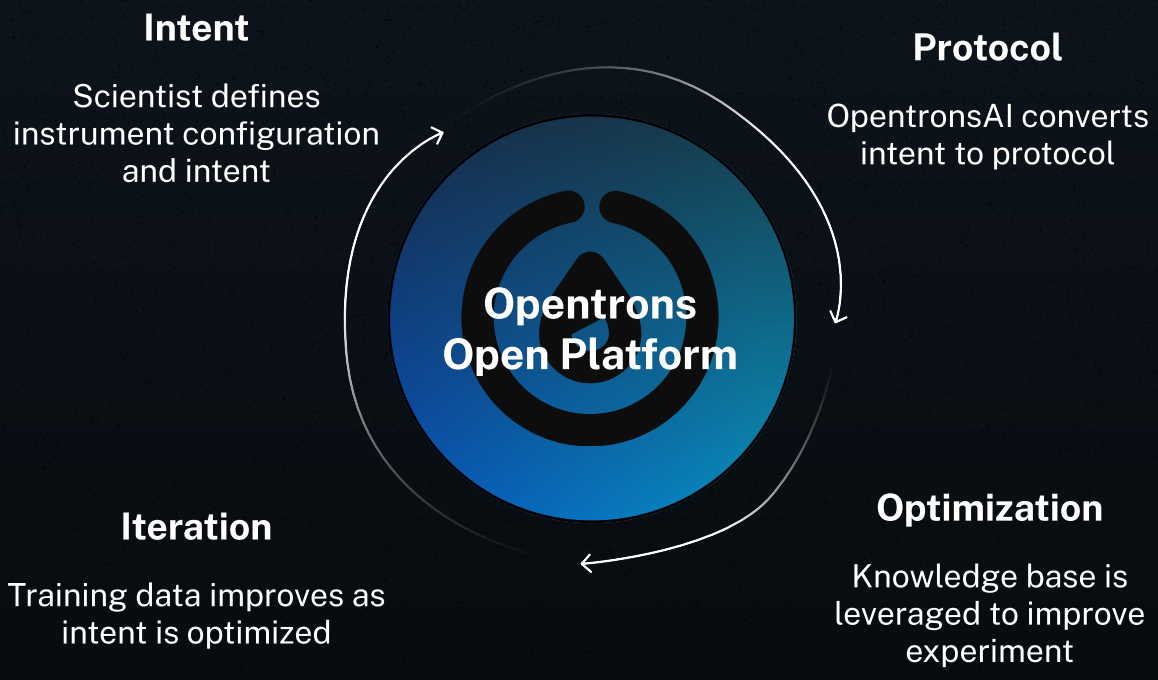
Run

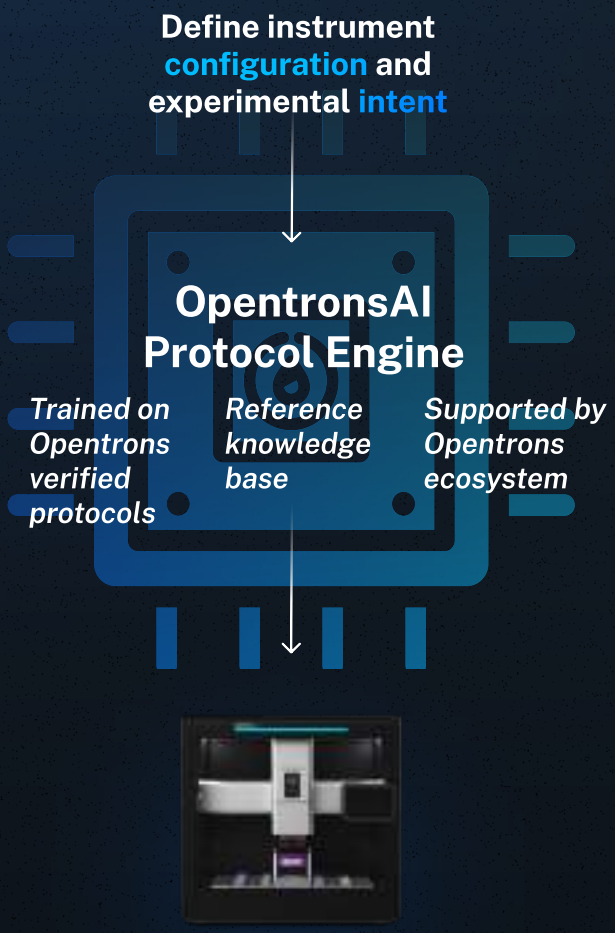
Upload to your Opentrons Flex and add labware and liquids to your deck. Then, just tap run on the touchscreen and let Flex do the rest.

Try OpentronsAI

What is OpentronsAI?

OpentronsAI turns experiment ideas into automated protocols, accelerating concept-to-execution





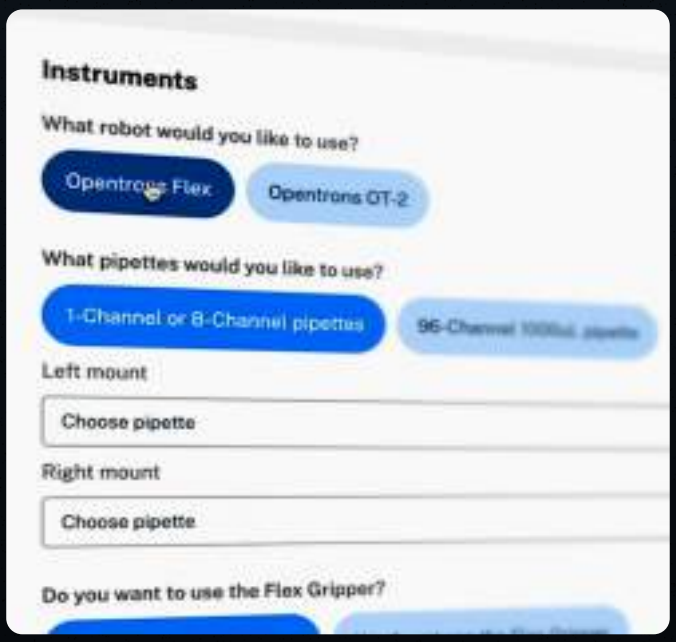
Trained on specific, verified, automation data, it's built specifically for designing protocols, simulating to check for errors and constraints, and optimization — all inside a single chat-based interface.

Instead of needing to know Python, calibration protocols, or deck constraints, you can use the prompt generation guide and natural language to generate a protocol.

Using the "visualize" tool in the Opentrons App, you can verify and simulate your protocol before you run, seeing a detailed view of every step via an interactive deck map, list view, and well view.

With the optimization feature, you can compare different iterations of the protocol run to see which version streamlines the amount of steps, money, and consumables.

Connecting scientific knowledge and intent to execution



Optimize for:

- Streamlined steps
- Lowest reagent cost
- Fewest pieces of plastic

OpentronsAI workflow

01

Describe your experiment

Use natural language to describe your workflow, upload an existing protocol to edit, or use our prompt creation guide to input your hardware, labware, and liquids.

02

Generate protocol code

OpentronsAI outputs executable protocol scripts in seconds.

03

Optimize your protocol

Upload PDF documents directly from your reagent kits to better tailor your protocol to your specific chemistry.

Further optimize to save time, precious reagents, and money.

04

Analyze protocol options

Compare multiple generated protocols, explain the rationale behind each approach, and lay out the tradeoffs.

OpentronsAI unlocks new use cases and higher throughput assays with visualization and editing

Try OpentronsAI

05

Simulate and visualize in the Opentrons App

See every step, whether your protocol has 10 steps or 10,000 steps, via a list view, deck view, or zoom in to the well view to verify with millimeter and microliter precision.

06

Execute on Flex

Send the protocol directly to your Flex robot and run.

07

Continue to iterate and optimize

OpentronsAI can refine, tune, and adjust parameters across iterations.

Protocol Simulation & Visualization

See every step in the sidebar

Use deck view for a summary of what's happening on your robot

Never run out of tips. See exactly how many have been used at any point

Zoom in to well view to see details with millimeter and milliliter precision

This was the very first time a non-organic intelligence was able to plan, design, and execute these complex chemical reactions.

Gabe Gomes

Assistant Professor, Chemical Engineering, Chemistry at Carnegie Mellon University

Autonomous experimentation

Science at the speed of thought

In December 2023, Gabe Gomes' team at Carnegie Mellon University published one of the first papers demonstrating an AI co-scientist planning, designing and executing an experiment. The team's work emerged from emerged from a practical constraint rather than a theoretical ambition: Gomes needed to run experiments at high throughput, but traditional automation systems were expensive and were impossible to customize to the level he needed to accomplish this type of autonomous experimentation system.

Instead of scaling down his research questions, Gomes scaled his tools. The Opentrons robotic system was significantly less expensive than closed, enterprise-grade systems and offered something more important than price: an open hardware and software system. That openness allowed him to build custom Python-based control systems, tightly integrating experiment design, execution, and analysis into a single autonomous loop.

This approach reframes automation from a labor-saving tool into an autonomous researcher able to generate protocols, run experiments, and iterate on results with minimal human intervention. The value wasn't speed, but scale through less expensive, more programmable experimentation with fewer human bottlenecks.

By lowering these barriers, Opentrons' open ecosystem makes this kind of frontier research more accessible to all scientists.

A glimpse into the future

OpentronsAI is helping labs transition from manual science to fully orchestrated discovery.

If automation is the engine, and AI is the driver, then OpentronsAI is the first step toward the self-driving laboratory.

OpentronsAI marks the beginning of a new era in scientific automation, one where:

Experiments can be designed with natural language

Protocols are safer and less expensive to run

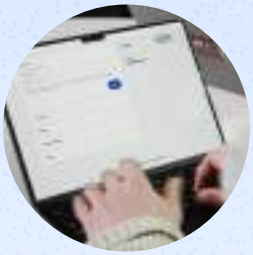
Workflows are more reproducible and scalable

Spend more time discovering, not debugging

Try OpentronsAI

Building infrastructure to enable an autonomous lab

Redefining how science is done with an ecosystem primed for the AI-era.



Intent and orchestration

Large language models (LLM): Open source API and largest protocol training set enables **Generative AI based experimental design with OpentronsAI**

Perception and cognition

Vision language models (VLM): Camera vision on Flex will enable **real time** perception and feedback.

Intelligence and action

Vision language action models (VLA): Opentrons accelerates Physical AI enabled lab automation with **open source datasets** anchored in real lab execution.

Clear adoption by the scientific community with over 400 publications on Opentrons + AI