

CASE STUDY · PHYSICS-BASED CELL DESIGN · eVTOL

Simulation-led cell design.

Better cells, fewer builds, faster.

Conventional experiment-led design relies on slow, costly trial-and-error build loops. Ionworks transforms cell development with a simulation-led approach. A validated physics-based model maps the full design space and optimizes electrodes for complex eVTOL missions virtually, so Avrion builds only the top candidates.

+21%

Specific energy, measured

High-power landing design vs. the baseline cell, measured on built cells

5 months

Faster per design program

Two build loops instead of four, once the chemistry is parameterized

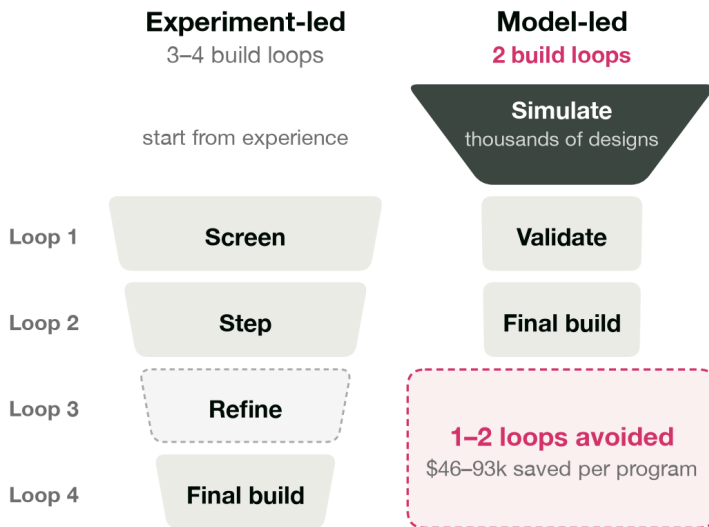
\$930k¹

Saved Annually

\$93k saved on every program, alongside unlocked throughput

BUILD · TEST · LEARN

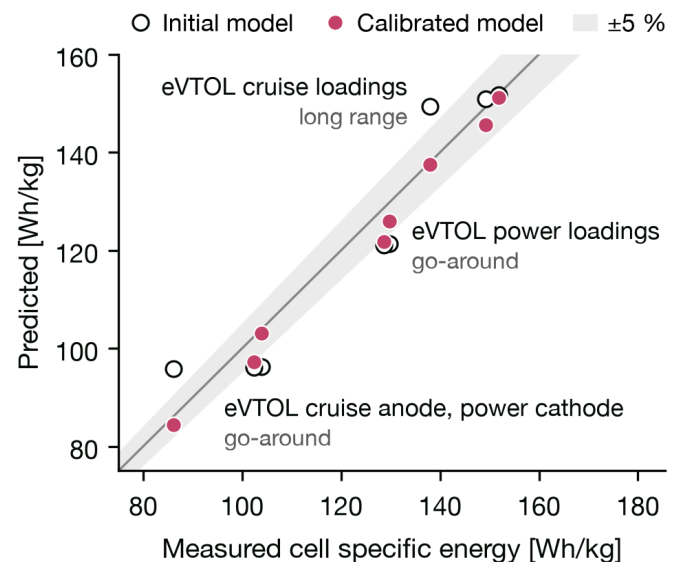
Iterate faster, building better cells



Test data recalibrates the physics model after each loop, reducing the number of candidates needing to be built.

SIMULATED · LONG-RANGE eVTOL MISSION

Predict energy density within 5%



Bars span each build's cells; band ±5%. Mean absolute error of 5.2% (initial model) and 2.4% (calibrated model) across all builds.

01

Characterize

A few baseline cells, tested in half- and full-cell format, are enough to build the model.

02

Optimize

Ionworks screened 5,800 designs (17,400 cells if built in triplicate). Virtually, the search can grow far beyond any build plan.

03

Build and iterate

Avrion Battery Labs built 19 designs to validate the methodology. Complex programs loop, each time building on what the last round learned.

1: Ten programs per year, three design parameters per program, two build rounds saved per program

Ionworks **Booth 2531**

Avrion Battery Labs **Booth 5703**

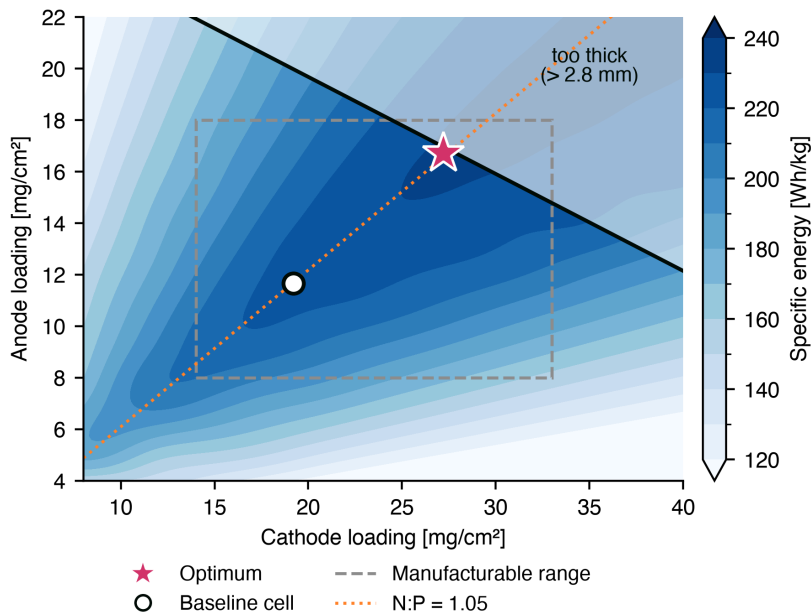
THE TECHNICAL DETAIL

A few cells in.

A 5,800-design DOE out.

A Doyle–Fuller–Newman (DFN) model, built with the Ionworks pipeline from a couple of baseline 1 Ah pouch-cell designs, maps the full electrode design space for a long-range eVTOL mission: take off, cruise as far as the cell allows, land.

THE DESIGN SPACE · LONG-RANGE eVTOL MISSION



The whole design space, not just a few builds

Every contour point on the landscape represents a full DFN simulation of the mission and recharge: specific energy across cathode and anode loading.

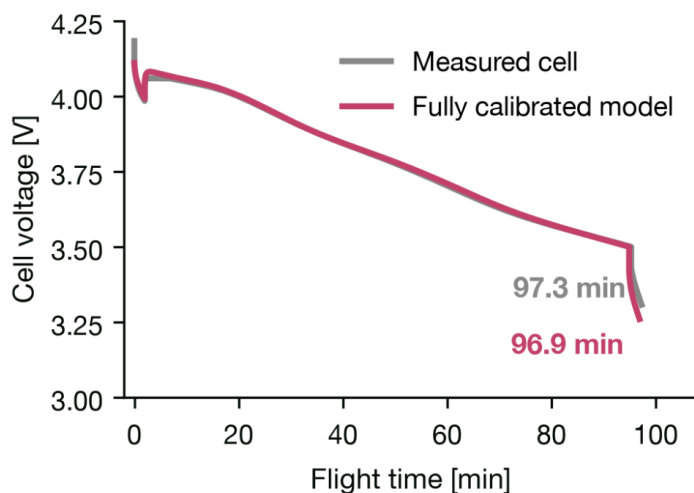
Heavier electrodes store more energy until the 2.8 mm thickness limit cuts them off, so the best long-range eVTOL design sits where that limit meets the N:P floor.

Rather than sweeping a fixed DOE grid, an optimizer searches the electrode loadings and press densities at once and heads straight for the best design.

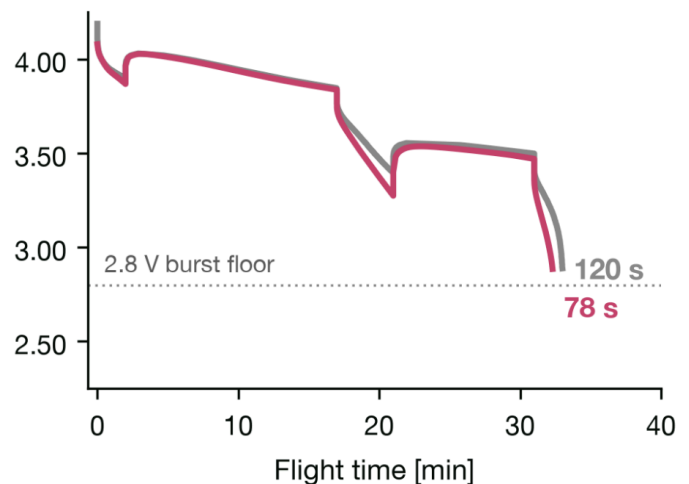
Because the search runs virtually, it covers far more of the design space than any build plan. Each build loop starts closer to the optimum, so fewer loops are needed: better cells, sooner, for less.

THE VALIDATION · TIME-SERIES PREDICTION

Long range: within 0.4 min



Go-around: final burst within 42 s



Best cell of each mission's best build against the fully calibrated model. Voltage RMSE 12 mV (long range), 65 mV (go-around).