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Battery Intelligence

6th Annual Knowledge Foundation: Next-Generation Energy
Storage 2016

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Data-driven battery product development: Turn battery
performance into a competitive advantage.

Tal Sholklafter, PhD
CEO and Co-Founder

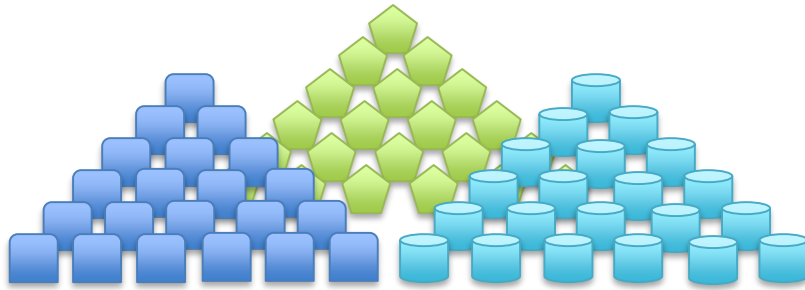
Batteries are the bottleneck in nearly every application



- Slow product development
- Incremental improvement
- Resource intensive to test and develop
- Not enough time to test thoroughly for each application
- Unreliable in operation

Engineering battery products is a data problem, but most battery data goes under-analyzed

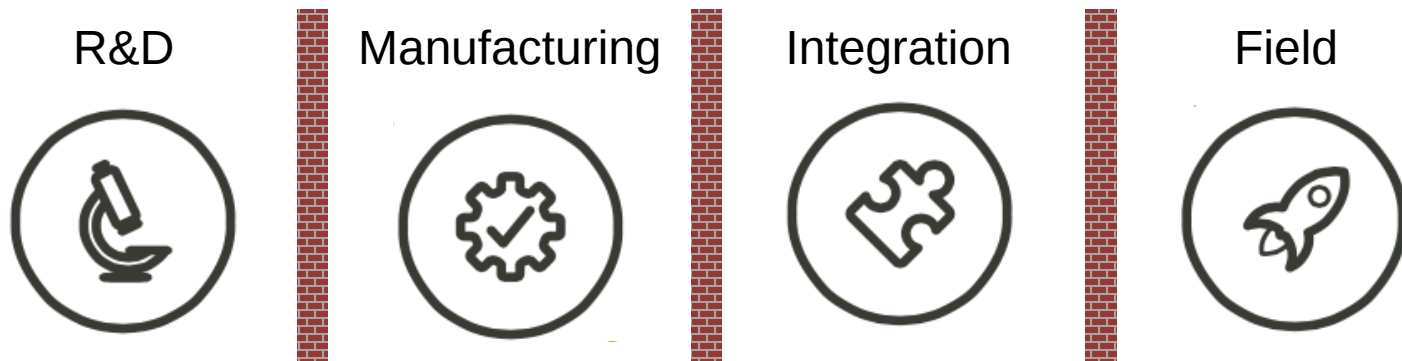
Too many files, too many formats



Lousy analysis tools



Data isn't shared across the industry value chain

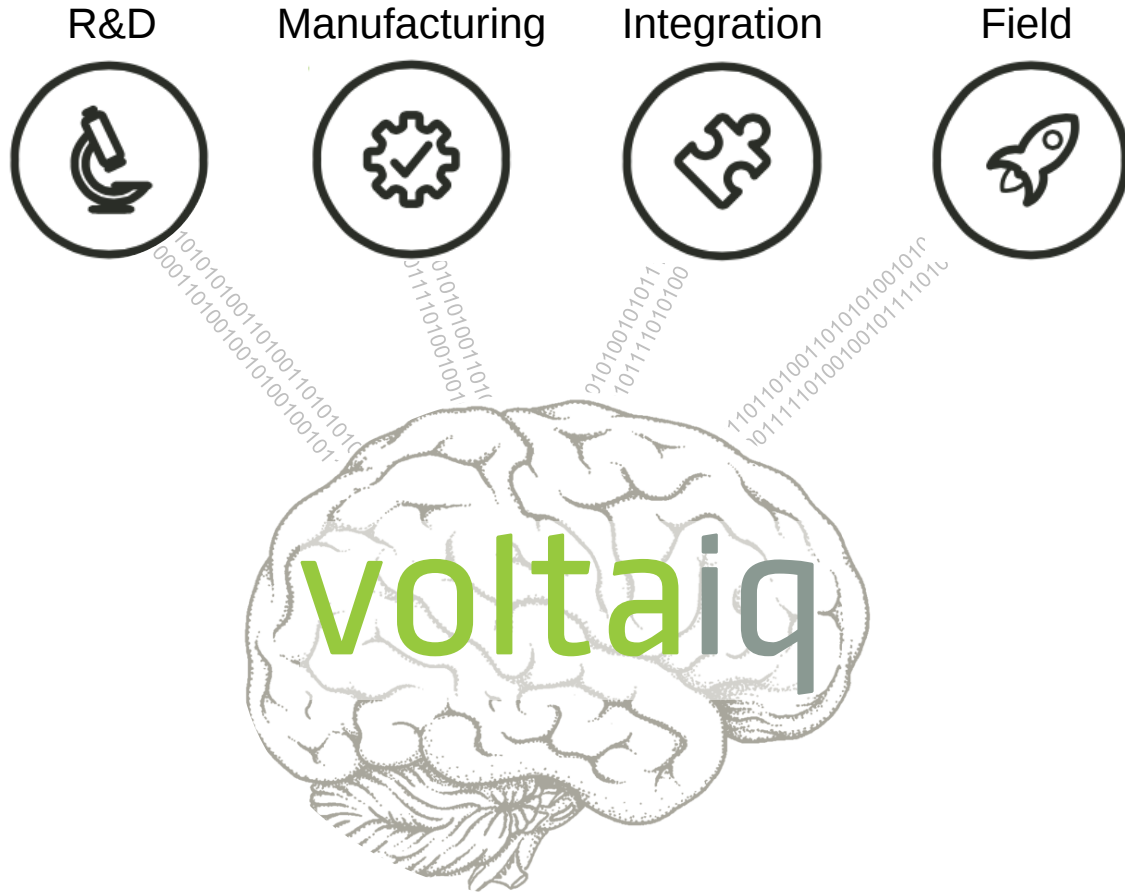


Inefficiencies in data management and analysis are slowing development

- Slow manual analysis:
 - Engineers spend hours per day doing basic analysis, relying on outdated desktop software, inadequate spreadsheet-based processes, and expensive custom IT systems.
- Sluggish development cycles:
 - Time is wasted waiting for tests to complete, analysis to be run.
- Lost insight:
 - Organizations repeat up to 40% of their experiments with resulting increased costs and longer development times.*

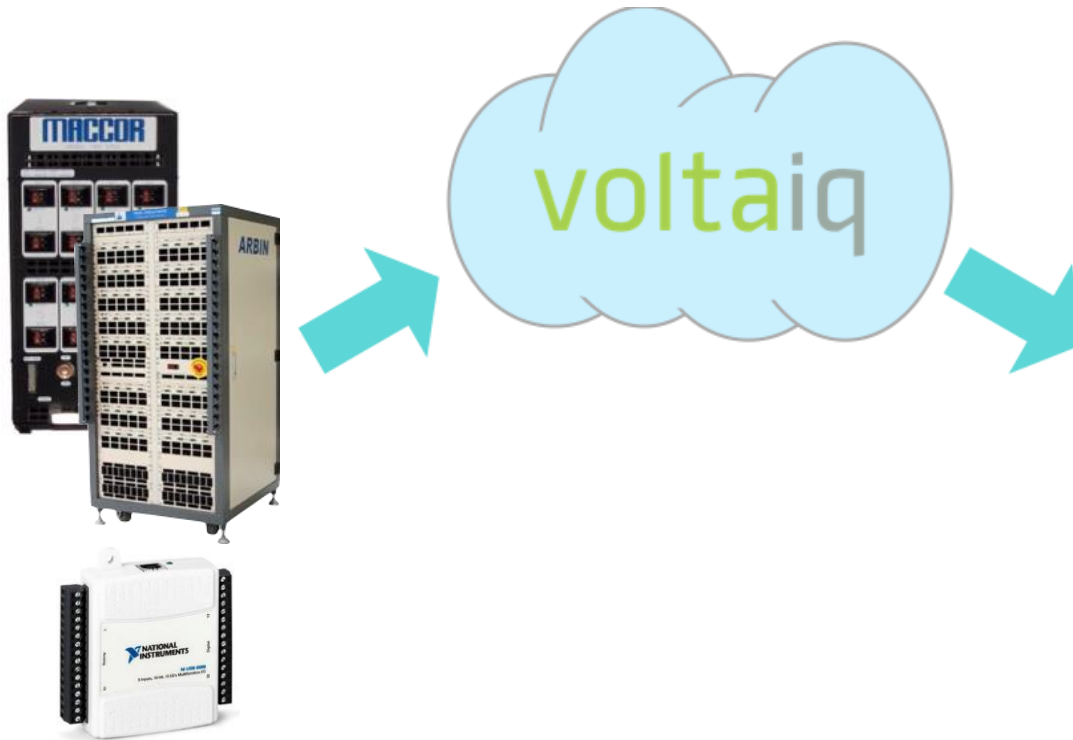


Voltaiq is the enterprise platform for data-driven battery product development and optimization

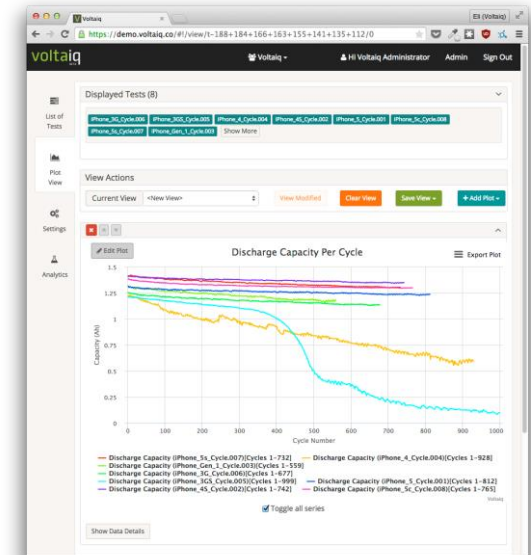


- Get products to market faster using fewer resources
- Ship with confidence, ensuring safety and reliability in the field
- Turn battery performance into a competitive advantage

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Battery cycler and
external data streams



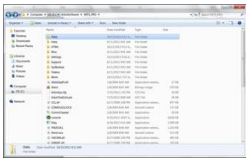
Quickly find, visualize
and analyze your data

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Voltaiq gets battery powered products to market faster using fewer resources

Typical workflow for data analysis

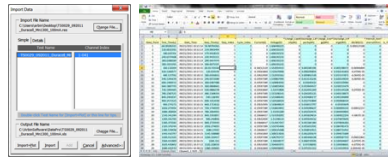
Find the files you need, from among thousands



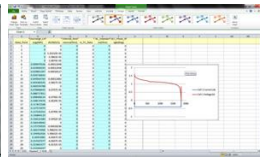
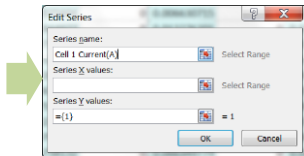
Transfer files to flash drive



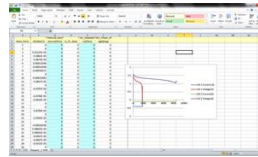
Import the first data file into Excel



Plot the relevant data series, one by one



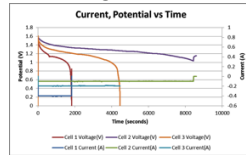
Repeat file import and plotting for each additional test



Modify plot options for each plot



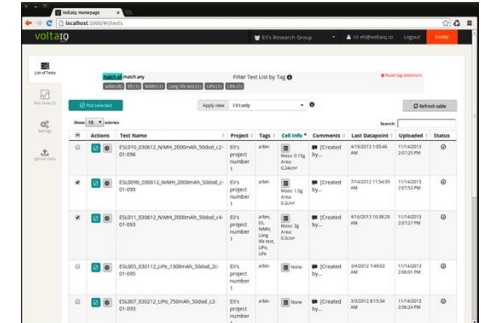
Export plot for presentation or emailing to colleagues



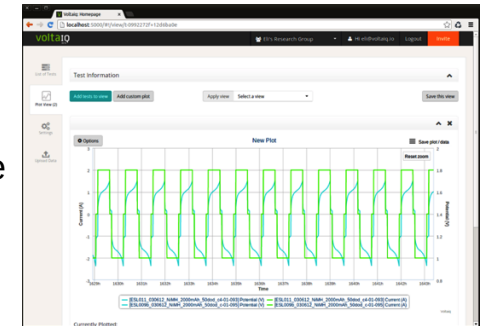
Repeat for each type of plot

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Select tests to compare



View plots in browser, share by URL



Save 5-20 hours per engineer, per week (\$25k - \$100k per engineer annually) and dramatically improve the pace of development and asset utilization

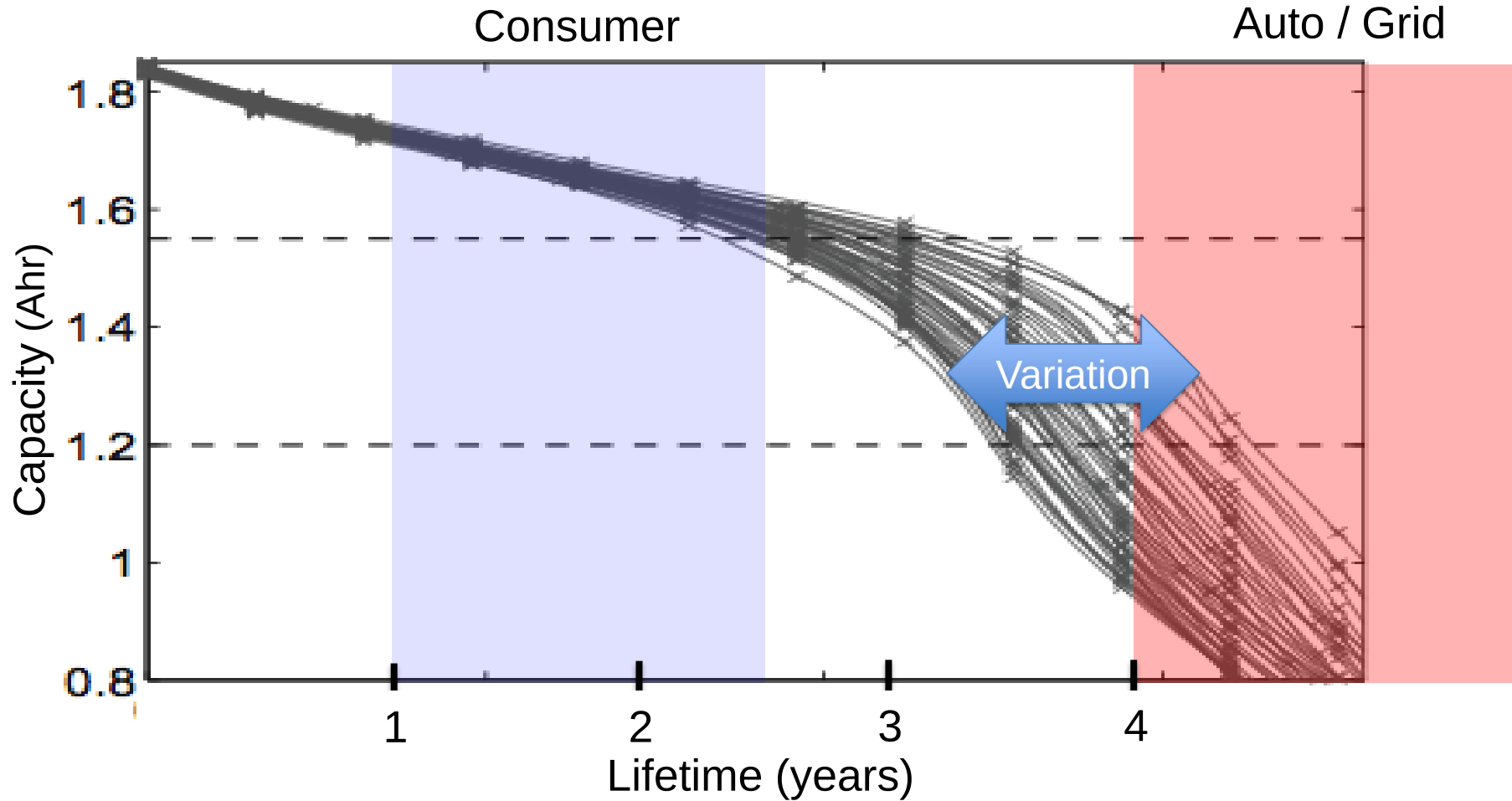
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The battery life challenge.



Longer warranties have created new challenges



T. Baumhofer et. Al. / Journal of Power Sources 247 (2014) 332-338

Getting more from your raw data: Capacity isn't enough

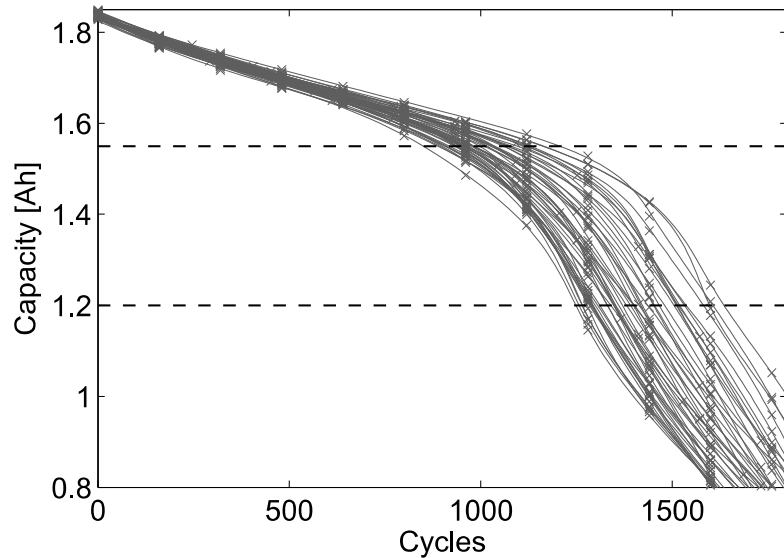


Fig. 6. Different aging trends from 48 equal cells under same aging conditions and profiles.

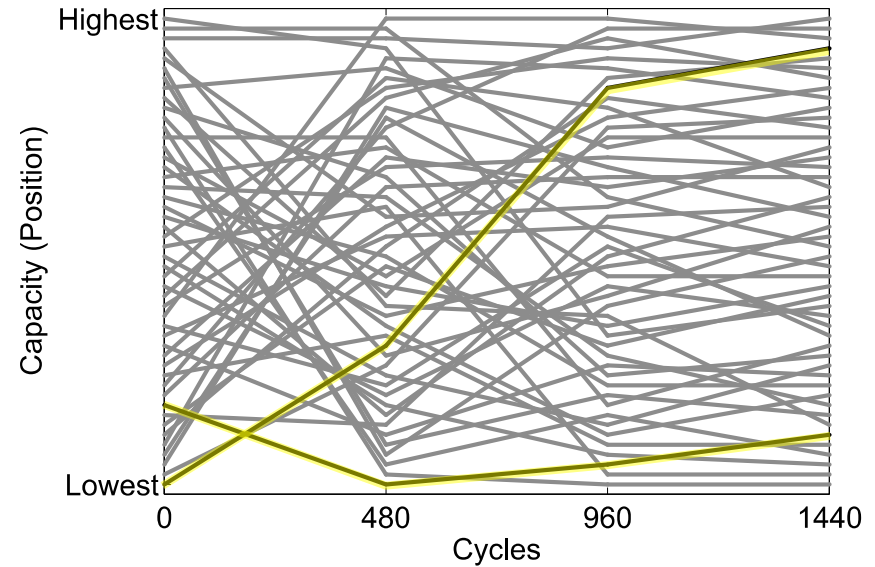


Fig. 7. Development of the position of the 48 cells within the sorted capacity at four cycle lifetimes.

Minimal correlation between capacity early and late in the life cycle

Need to probe deeper into the data

Identify signatures of primary degradation mechanisms

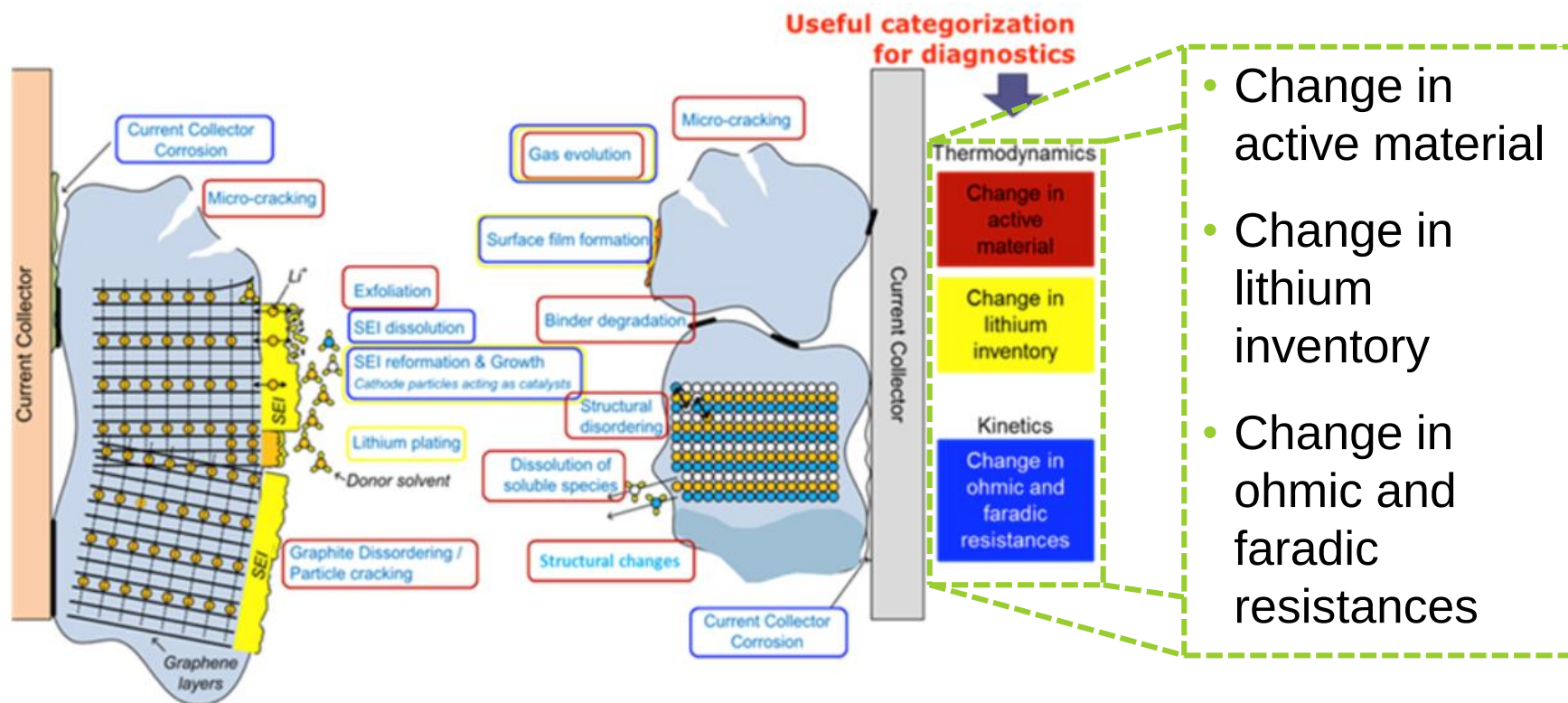
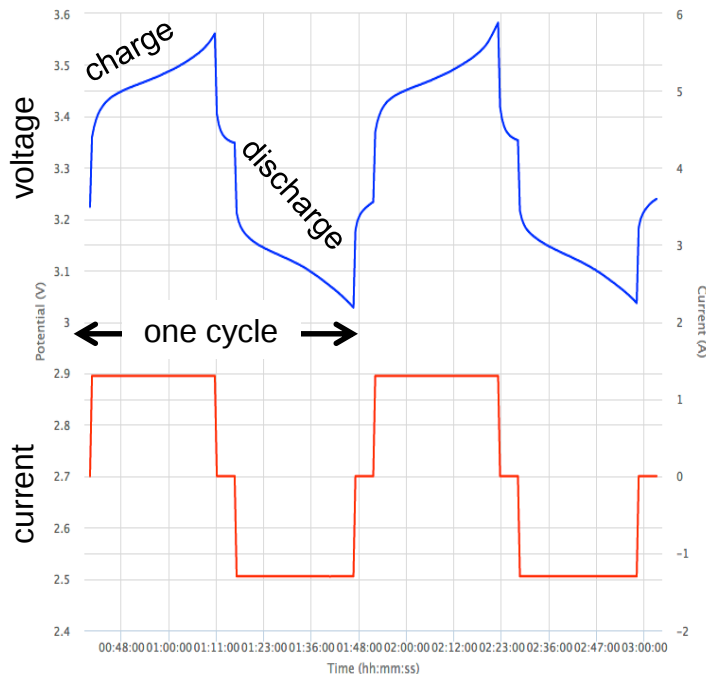


Fig. 1 Schematic of possible degradation processes in a Li-ion battery. Adapted with permission from [1].

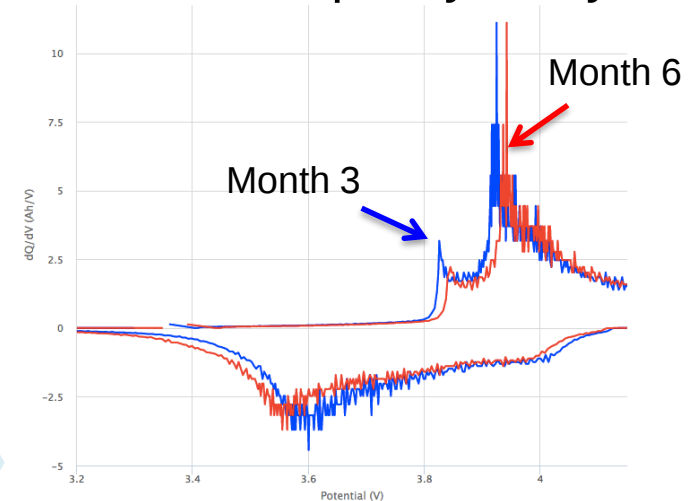
Dig deeper and extract key diagnostic information from raw time series data

From raw time-series current and voltage...

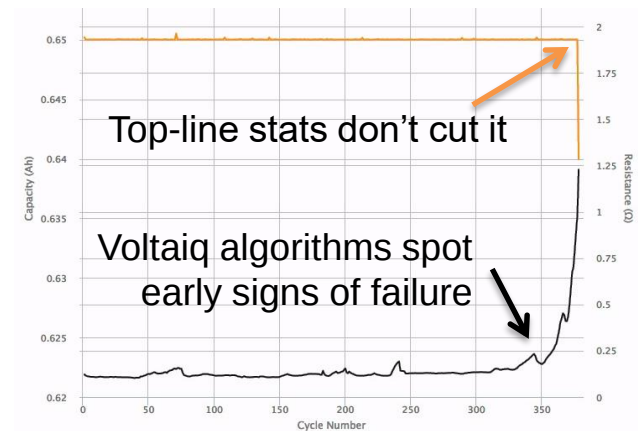


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proprietary
analytics

Differential capacity analysis

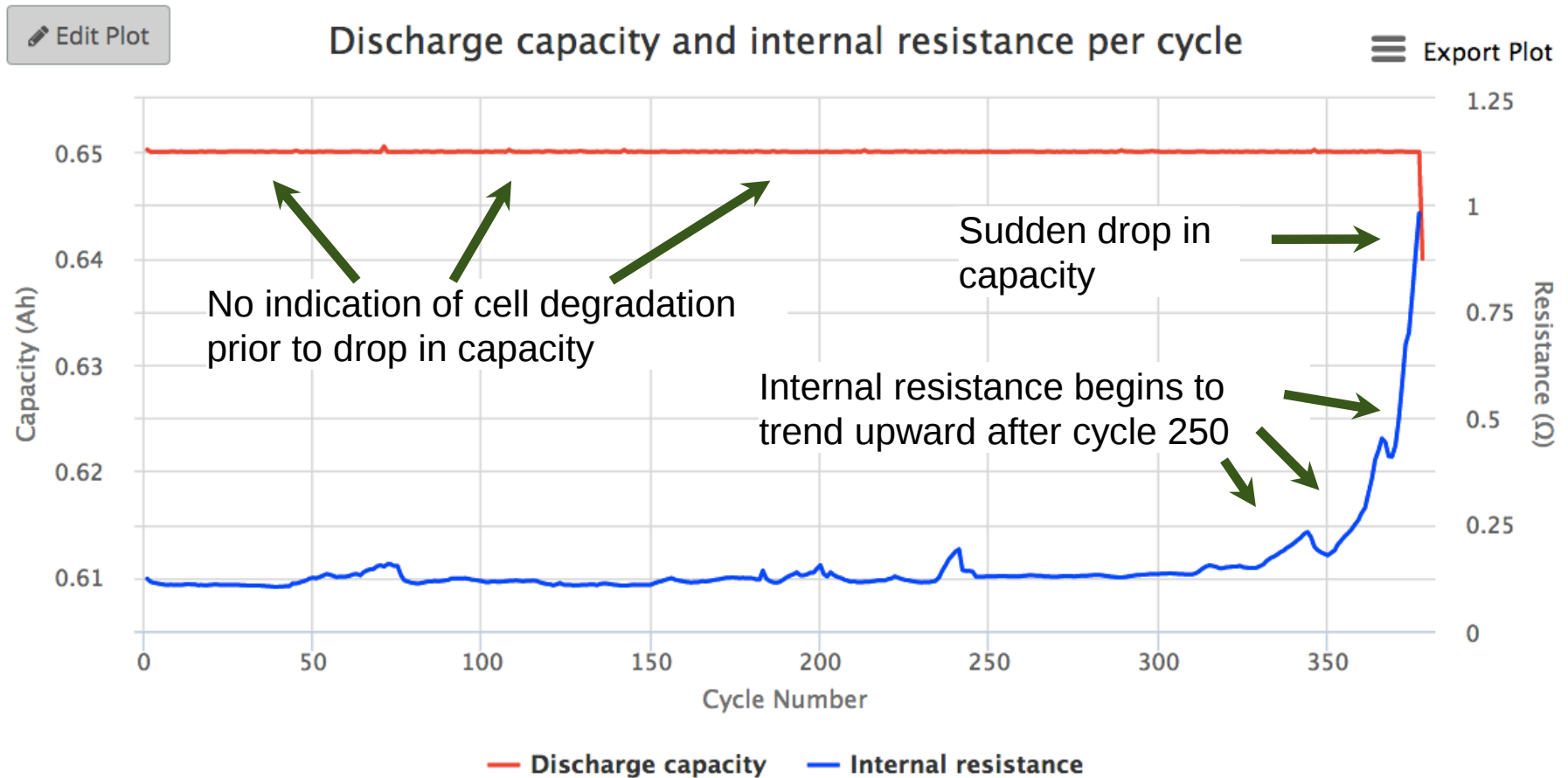


Predict failure



Predictive analytics built in

Use Voltaiq to spot degradation sooner

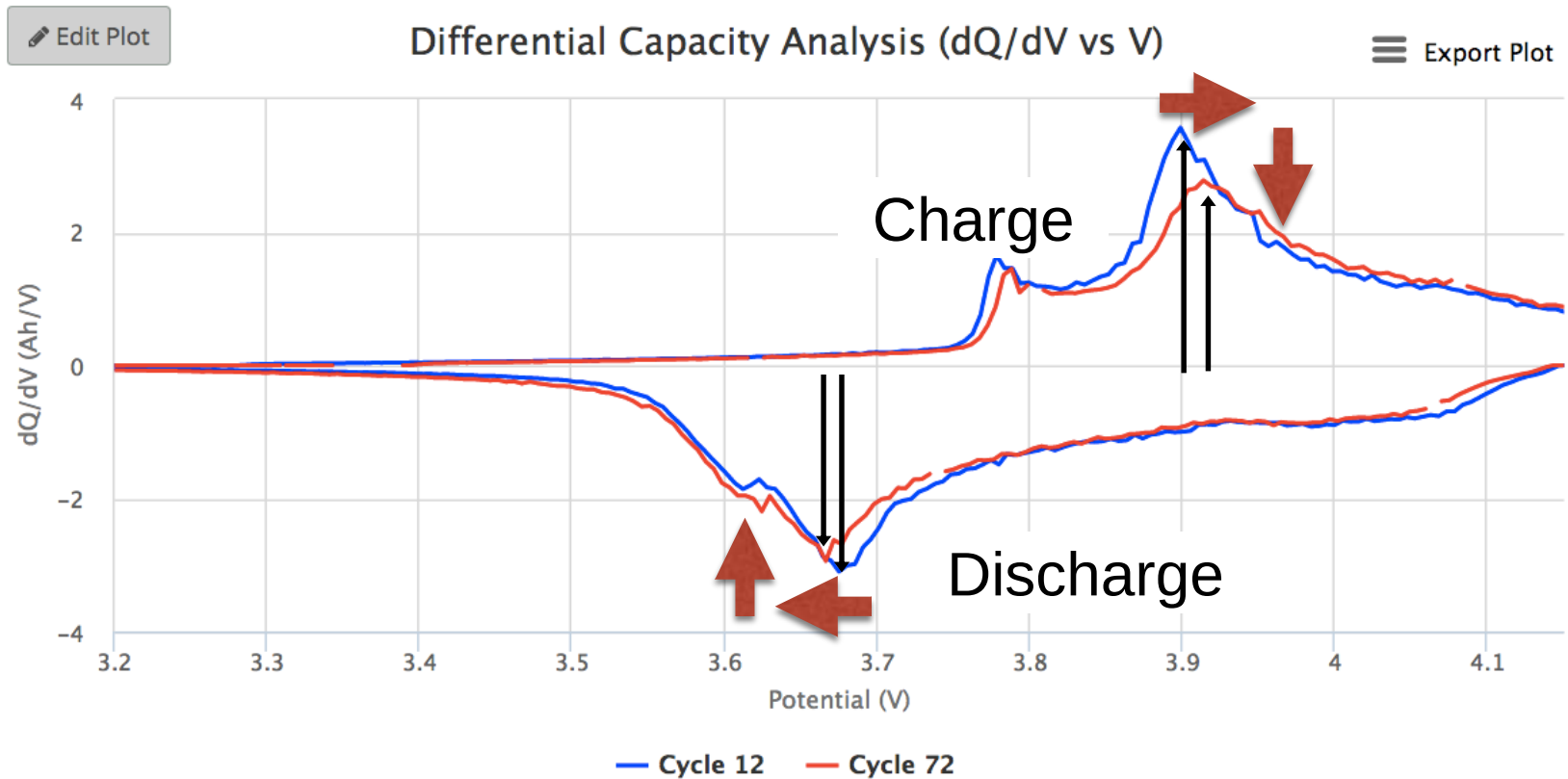


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Predictive analytics enhanced

Observe degradation directly using features extracted from time-series data



*Peak position indicates internal resistance; peak height indicates electrode capacity

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Voltaiq uncovers actionable insights hidden in raw battery performance data

The screenshot displays the Voltaiq web application interface. The top navigation bar includes the Voltaiq logo, user information (Hi Tal Sholklafter), and a Sign Out button. Below the navigation bar, there are buttons for 'Plot Selected', 'Analyze Selected', 'Edit Cell Info', 'Add Tests to Project', 'Tag Selected', and 'Comment Selected'. The main content area features a 'List of Tests' sidebar on the left and a central table of test results. The table has columns for Actions, Test Name, Tags, Comments, Project, Cell Info, Cycles, Start Time, and Last Updated. The table displays 10 rows of test data, including test names like 'TS096TenergyStandardCycle-01-006' and 'TS103Tenergy05C02C42to34-01-012', along with their respective cycles, start times, and last updated dates.

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https://demo.voltaiq.co/#/tests

Plot Selected Analyze Selected

Edit Cell Info Add Tests to Project Tag Selected Comment Selected

List of Tests

Projects Filter by Projects Tags Enter tags... Clear Selections All Tags

Search Refresh Table 0 Selected Clear All Displaying 25 of 250

Actions	Test Name	Tags	Comments	Project	Cell Info	Cycles	Start Time	Last Updated
	TS096TenergyStandardCycle-01-006	3	1	Tenergy Study		564	2015.08.03 09:12:39	2016.02.14 10:57:36
	TS103Tenergy05C02C42to34-01-012	4	1	Tenergy Study		537	2015.08.19 15:07:07	2016.02.14 10:56:56
	TS106Tenergy05C02C42to34-01-001	2	1	Tenergy Study		430	2015.09.21 08:34:35	2016.02.14 10:56:55
	TS105Tenergy05C02C42to34-01-024	3	1	Tenergy Study		531	2015.08.19 15:10:30	2016.02.14 10:56:55
	TS099TenergyStandardCycle-01-016	3	1	Tenergy Study		570	2015.08.03 09:18:31	2016.02.14 10:56:16
	TS087TenergyStandardCycleNoCV-01-018	3	1	Tenergy Study		918	2015.07.07 12:31:20	2016.02.14 10:56:16
	TS001_Arbin_LG_HG2_cycle-01-022	3	1	Arbin New Cyclers		135	2016.01.20 11:42:50	2016.02.14 10:56:16
	TS104Tenergy05C02C42to34-01-013	3	1	Tenergy Study		556	2015.08.19 15:09:56	2016.02.14 10:56:16
	TS003_Arbin_LG_HG2_cycle-01-017	3	1	Arbin New Cyclers		125	2016.01.22 10:05:51	2016.02.14 10:56:15

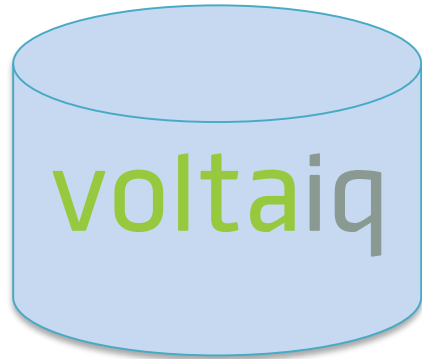
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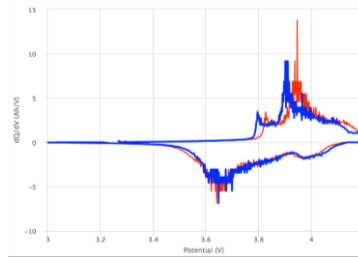
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Voltaiq machine learning models

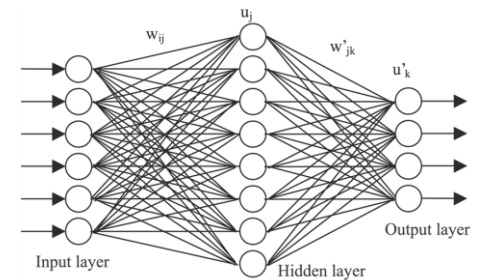
Massive battery
performance database



Proprietary analytics



Machine learning



- Predict failure without testing to end-of-life
- Optimize device operation
- Minimize product risks

Get your products to market faster and cheaper with Voltaiq

- Complete projects significantly faster (10x or more) by leveraging existing research and IP, and automating routine data gathering and analysis
- Uncover hidden knowledge by quickly aggregating and processing massive volumes of data from different operating units
- Enable collaboration across employees, partners, departments and throughout the organization
- Improve decision making with better, faster results through real-time, interactive reporting
- Reduce total cost of ownership (TCO) through a common and consistent approach to IT services

Thank you!

Tal Sholklapper, PhD
CEO and Co-Founder
E: tal@voltaiq.com
O: 646-586-3062
M: 415-742-1055

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