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CHEMICALS

Seeq

Emily Cole,
Sr. Scientist

VERDAGY

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Leveraging Seeq to Build an Internal Data Analysis Platform with No User Learning Curve

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VERDAGY

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Verdagy Focus & What I Do

Verdagy - clean hydrogen via electrolysis

- Hard to abate industries such as chemicals, refining, and steel
- 10M tonnes of hydrogen are produced yearly in the US
- Switching to clean hydrogen would mitigate 245 to 366 million tonnes of greenhouse gas emissions in the US annually

Senior Scientist

- Lead Applied Research Team: the bridge between lab tests and pilot / commercial scale technology demonstration
- 15+ years in climate tech
- BS in ChemE; MS in EnvE

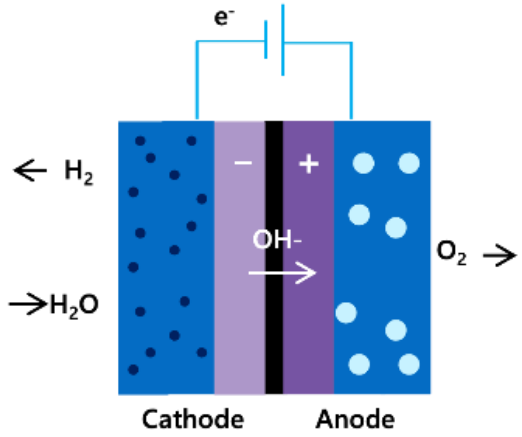
Throughline: making data accessible to support informed decision-making for any scale and application

VERDAGY

Verdagy: Over a Decade of Electrolyzer Development

2014

2021



Lab

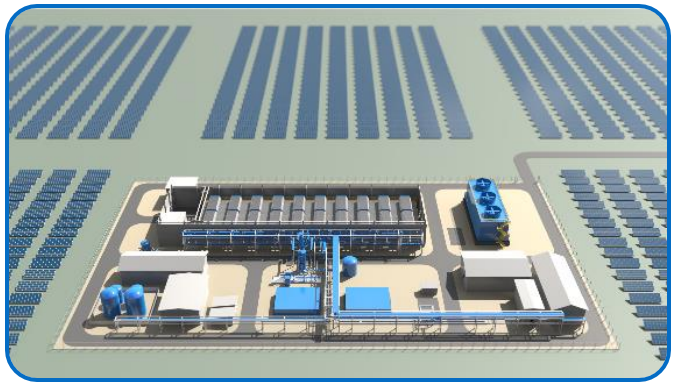
2 MW Commercial Pilot

20 MW Unit

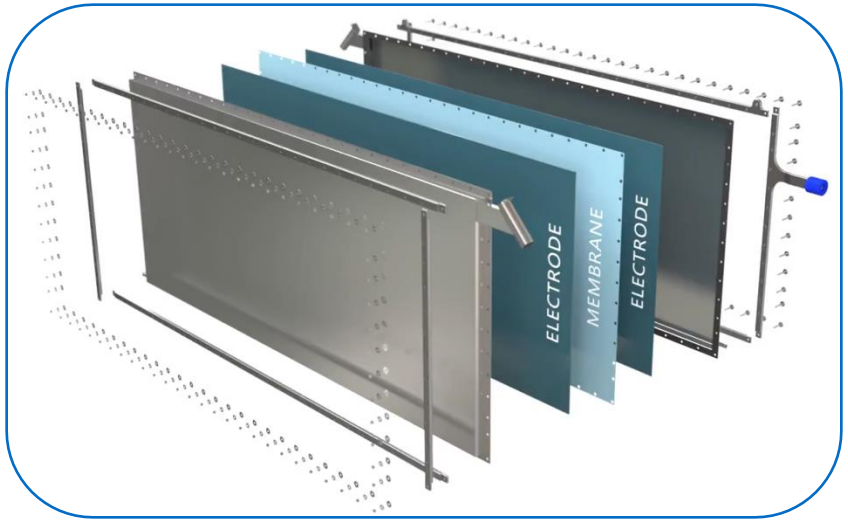
500 kW Commercial Cells

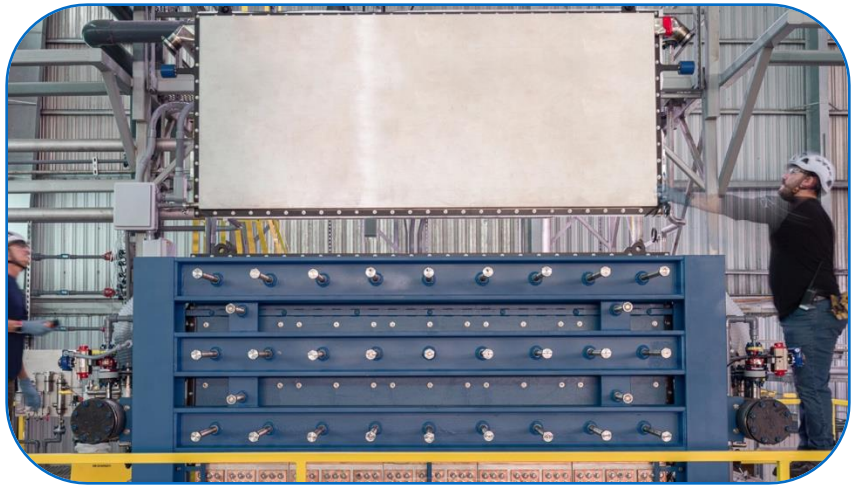
Gigafactory

Large Scale Deployment



Verdagy: Daily Lab ⇌ Commercial Activities





Deploying Seeq at Verdagy (lab scale too!)

- **Problems**:
  - Data are generated faster than it can be tagged, filtered, and summarized for accurate company-wide communication
  - Technical team members all enjoy data analysis… We require uniform analyses and KPI calculations across multiple users

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- **Strategy**:

Real-time data + ***Operator-updated databases*** → ***Algorithms*** / ***Visualizations*** → ***Real-time KPI-generation*** + ***Fast, data-driven decision making***

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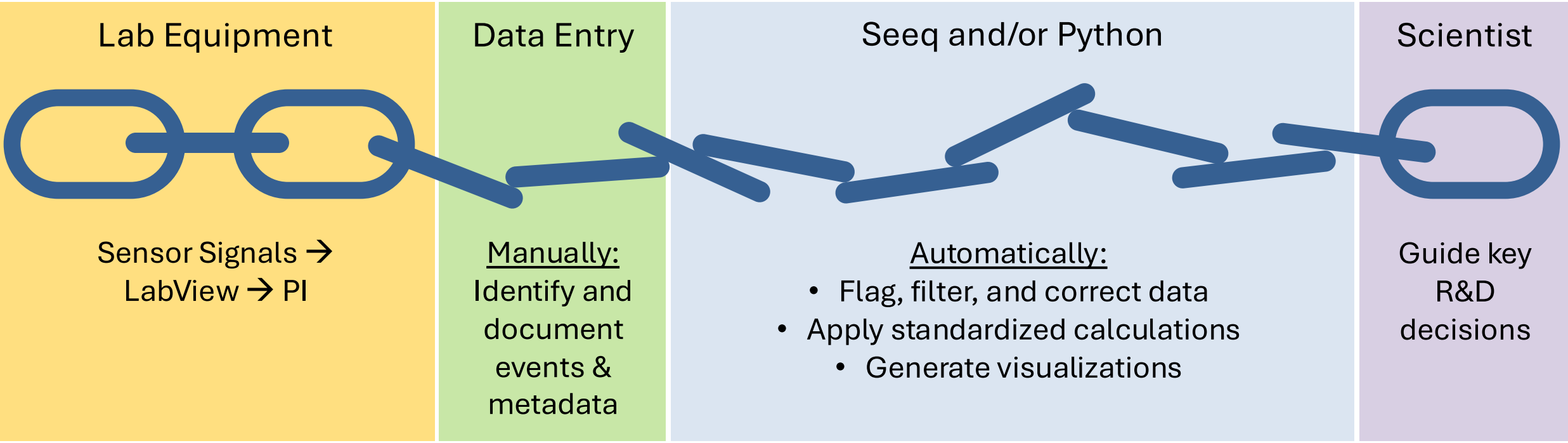
Lab Data Generation → Interpretation Chain



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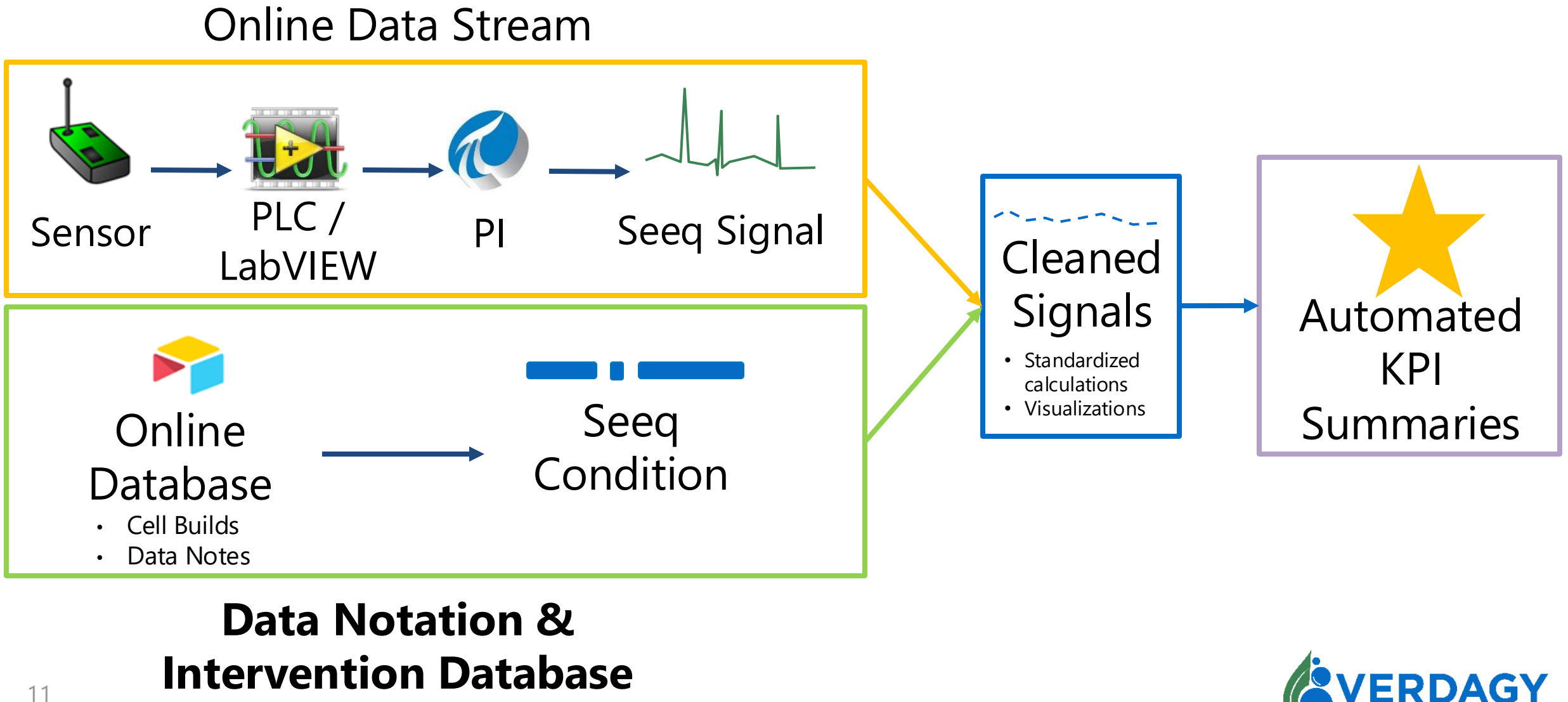
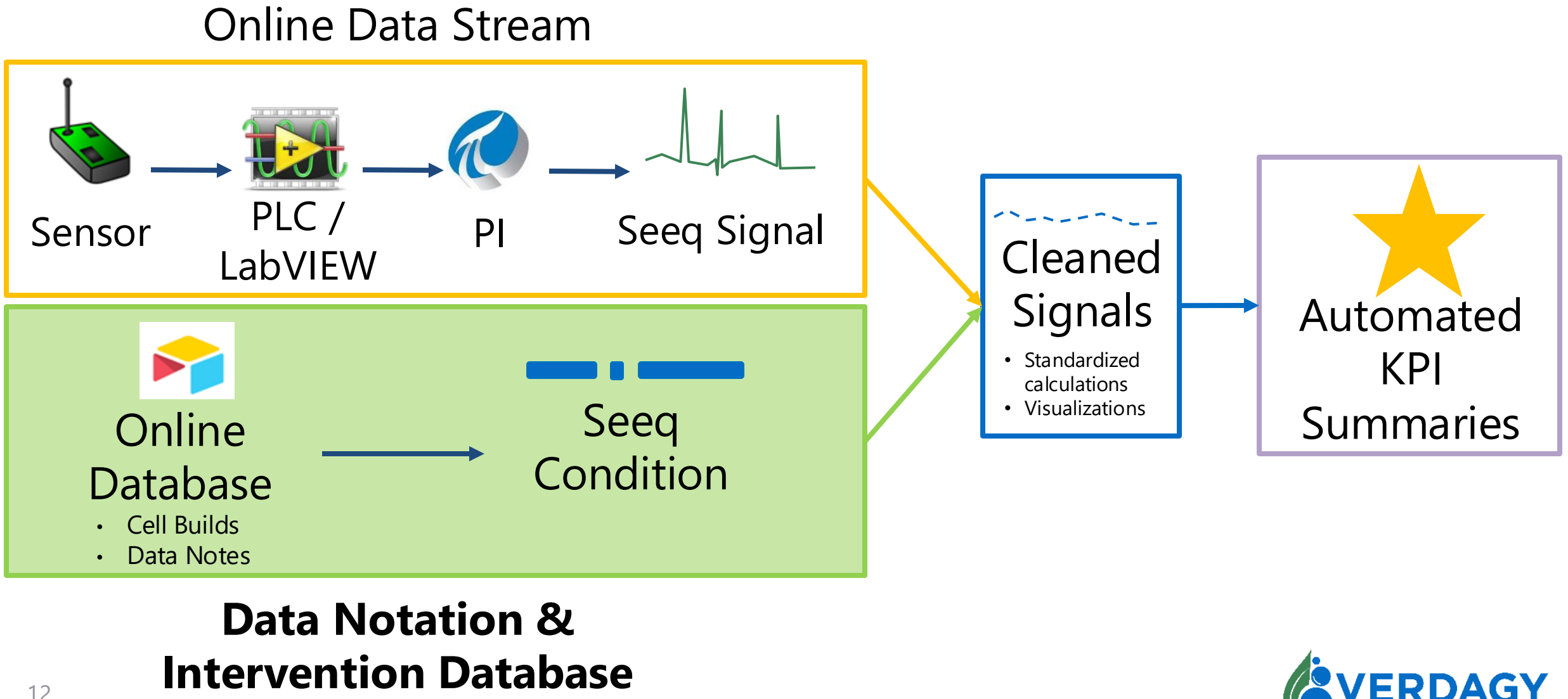
VERDAGY

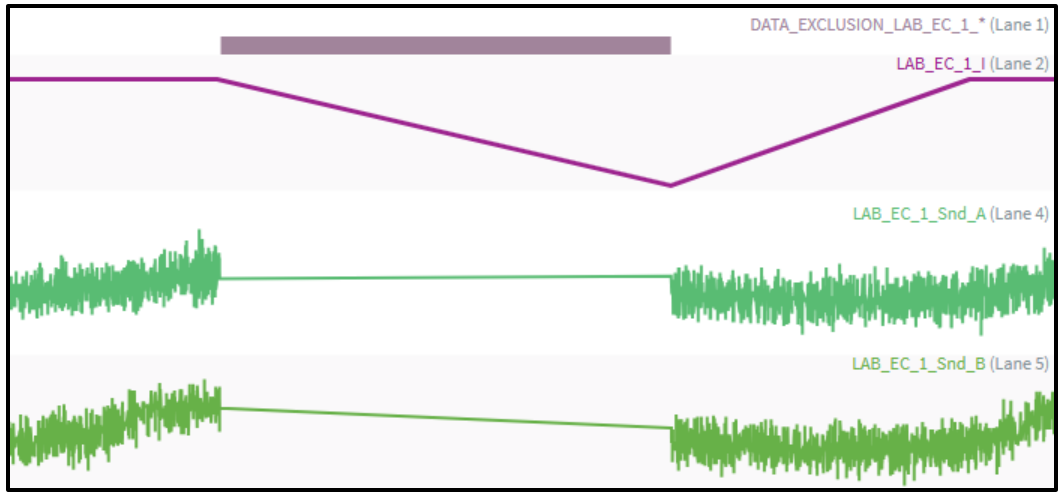
Data Pipeline for Lab and Plant Systems



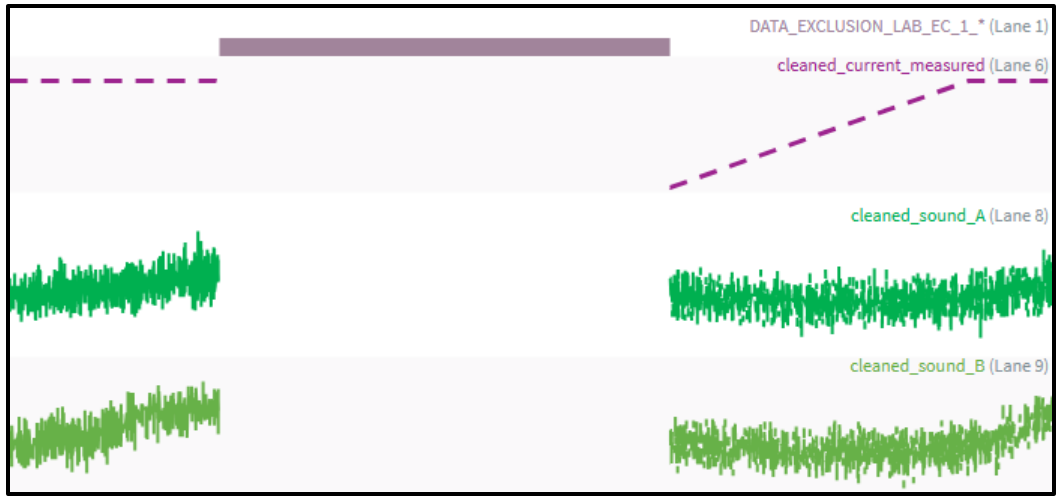
Data Pipeline for Lab and Plant Systems



Notation & Intervention Database: Example 1



Communication loss between sensors and data logger; interpolation *does not* reflect real process phenomena



Sensor signal that more *accurately* reflects process phenomena

Notation
(capsules only)

Component ID Info

Event Notes

Start/End Times

Seeq imports the database and creates capsules

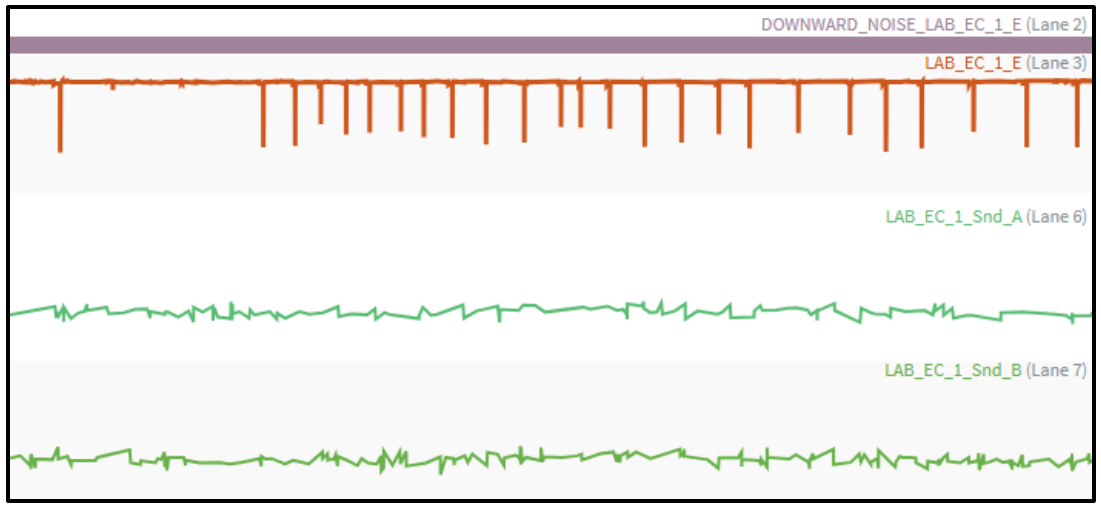
\+ Optional Intervention

Failing Sensors

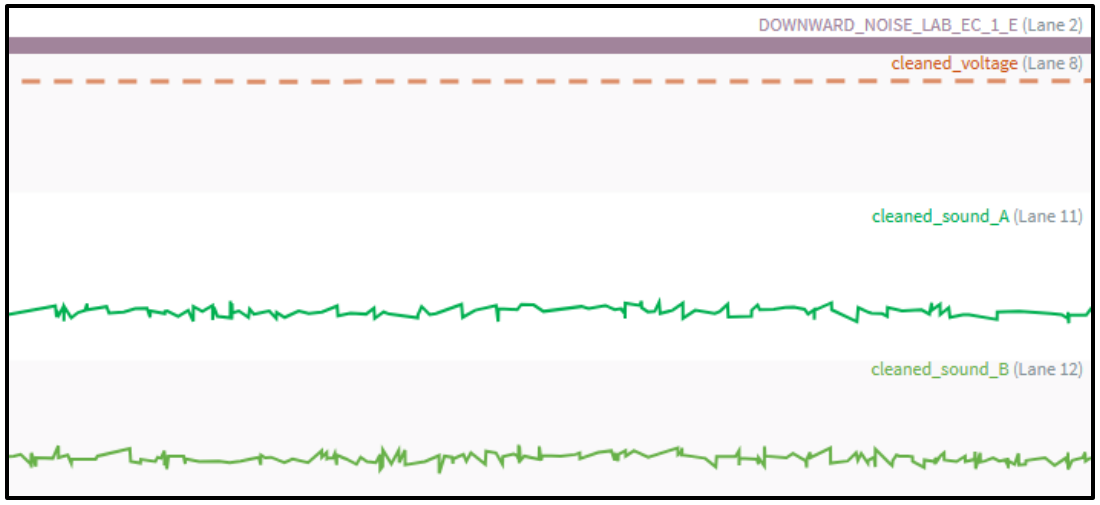
Signal Interference

Dropped Comms.

Notation & Intervention Database: Example 2



Irregular downward spikes in one sensor signal; spikes *do not* reflect real process phenomena



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Notation & Intervention Database: Time Saved

- Lab-scale electrolyzer fleet ALONE produces $2x10^8$ data points per month

	WITHOUT **Seeq**	WITH **Seeq**
Relevant **events notated & viewable** to all colleagues alongside process data?	No	Yes
Colleagues can easily **find, work with, and aggregate all reviewed data**?	No	Yes
Time to **annotate + clean process data, aggregate metadata** for a single one-month experiment?	~12 hours	~2 hours

Throughline: making data accessible to support informed decision-making for any scale and application

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Building on Seeq's Aggregation & Equation Tools

- Reality: Verdagy team members closest to the data routinely use Seeq
- Problem: Team members who are less-close to the data need easily-accessible KPIs summarized from complex data sets
- **Solution**: Build a platform that works with Seeq's data aggregation and equation tools but is limited in scope to only frequently-requested data analysis/extractions and KPIs

Seeq®

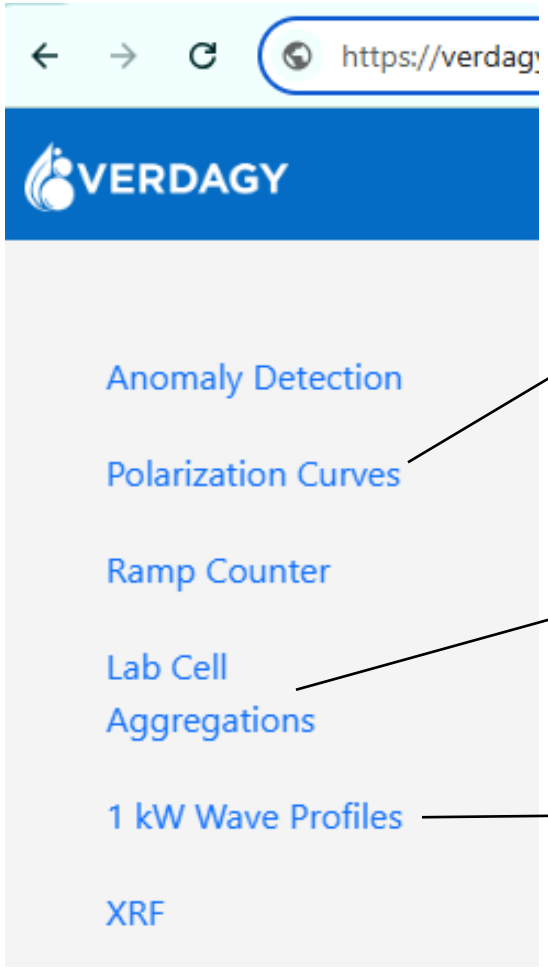
spy library

Flask
web development, one drop at a time

<html>

VERDAGY

Building on Seeq's Aggregation & Equation Tools



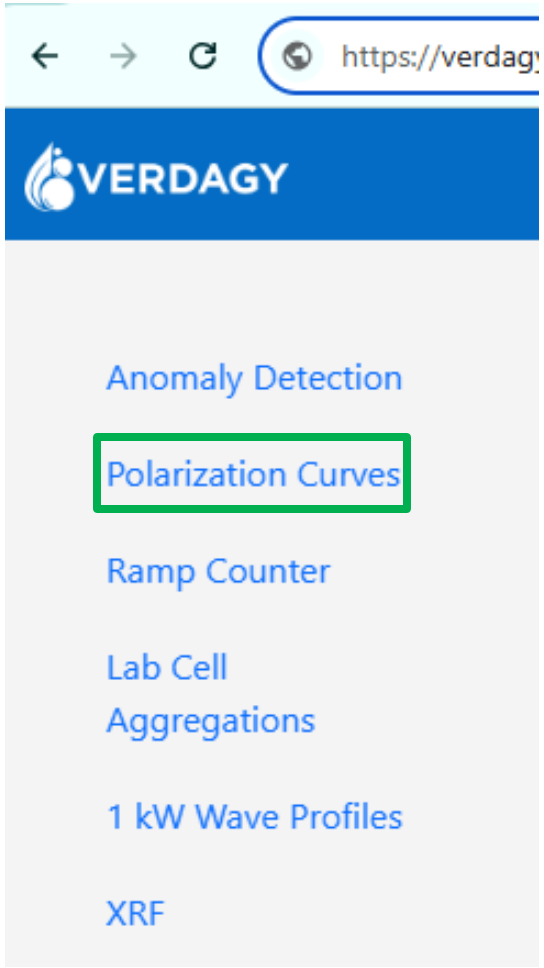
Fine-tuned plant performance from correlated variables across weeks or months of operation and 1,000+ capsules

Roll-up statistics across databases

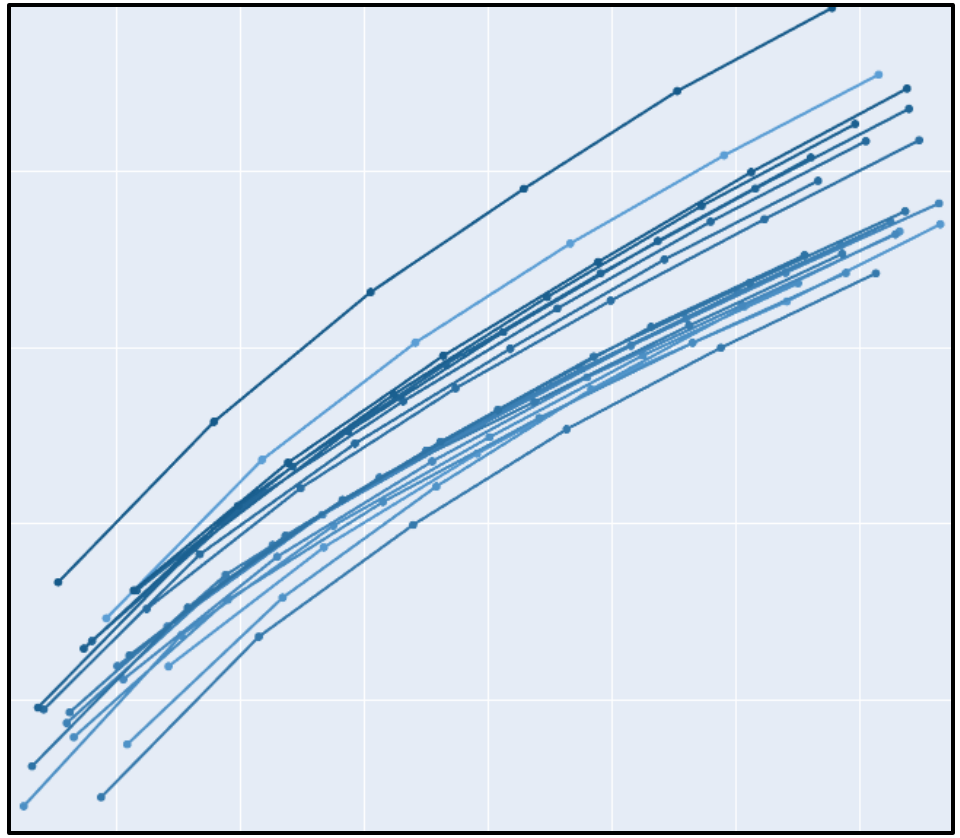
Analyses across 10,000+ cycles

VERDAGY

Building on Seeq's Tools: Example 1



- Polarization curve trends yield valuable info about cell and electrolyzer health
  - 4 clicks to query data, extract polarization curves, and trend relevant parameters (example parameters: slope and intercept)



Example:

- **Plot Voltage vs Current for specific capsules**
- Fit linear region of curve
- Extract fit parameters
- Trend fit parameters over time

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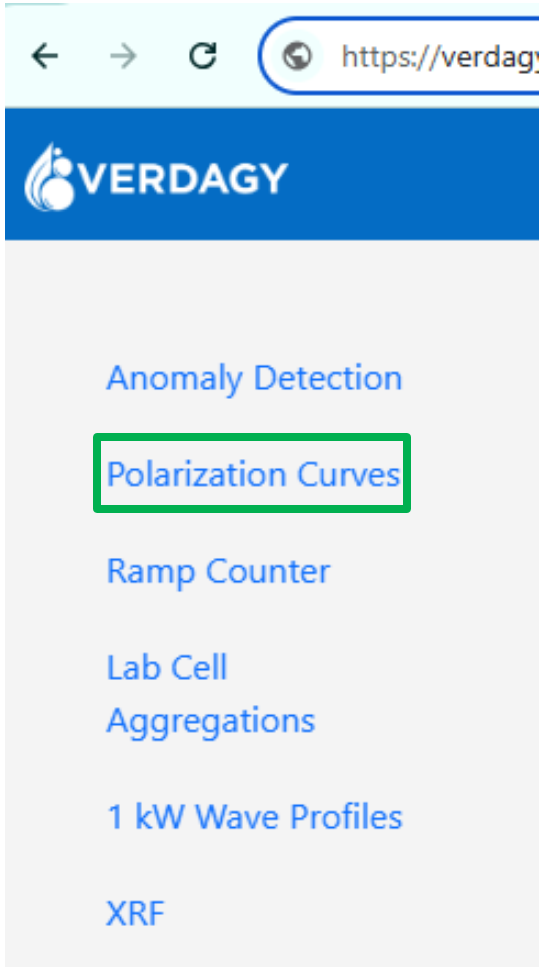
Building on Seeq's Tools: Example 1



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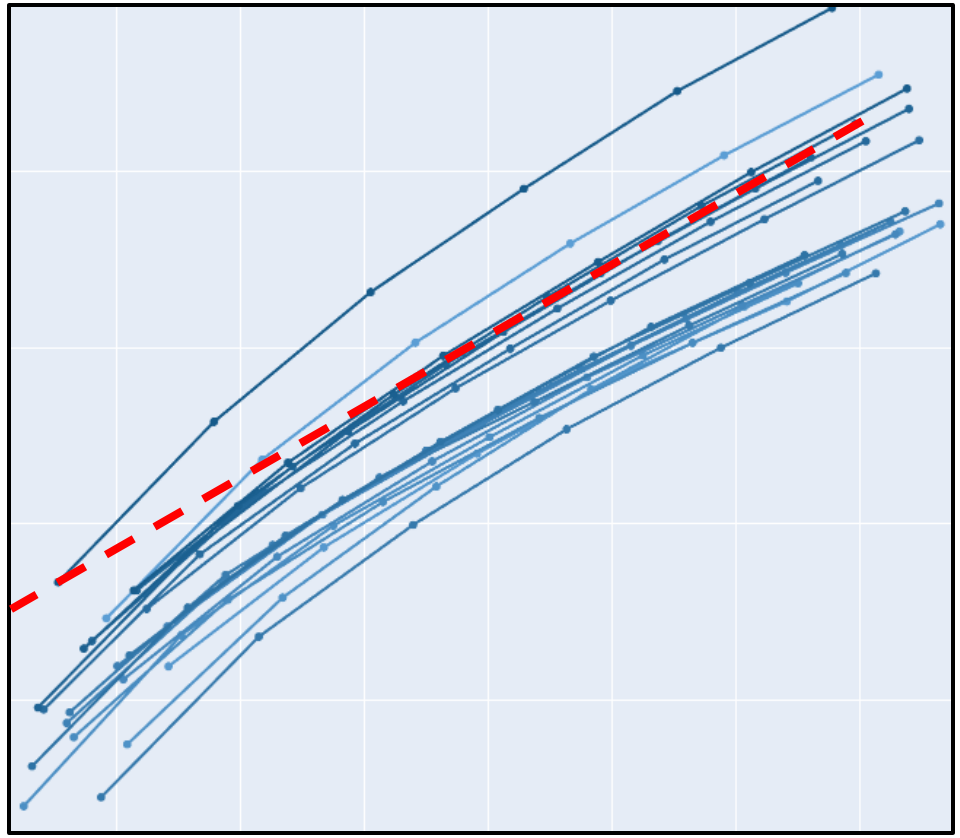

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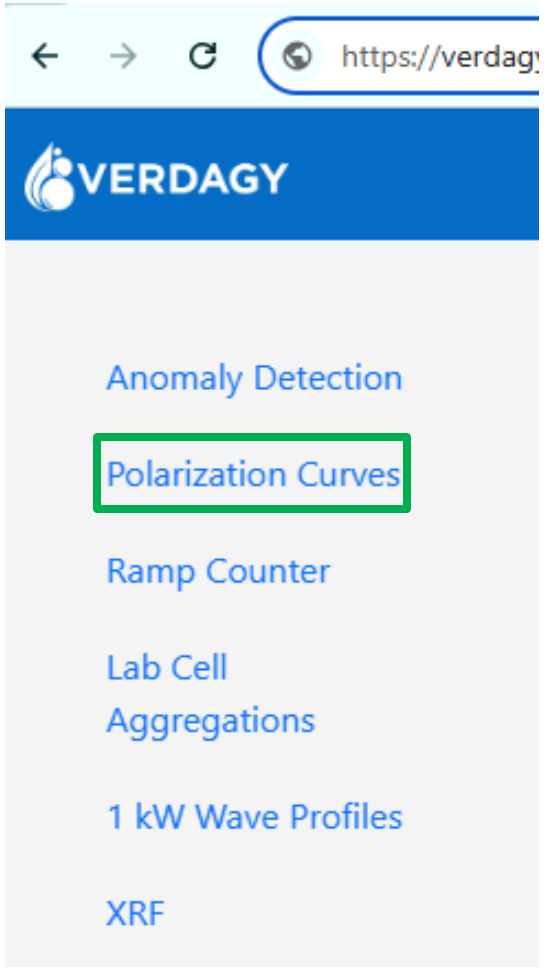

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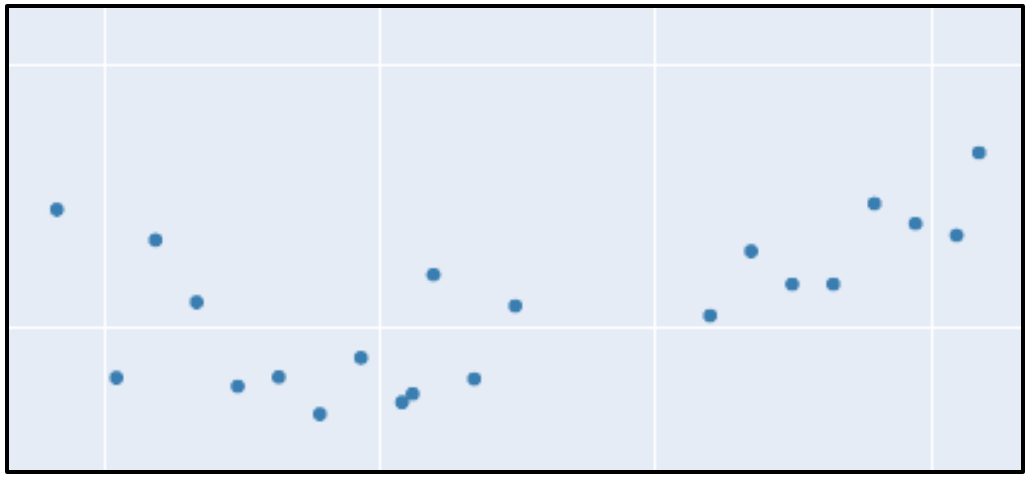
Linear Fit Parameter:

Extracted and trended over time



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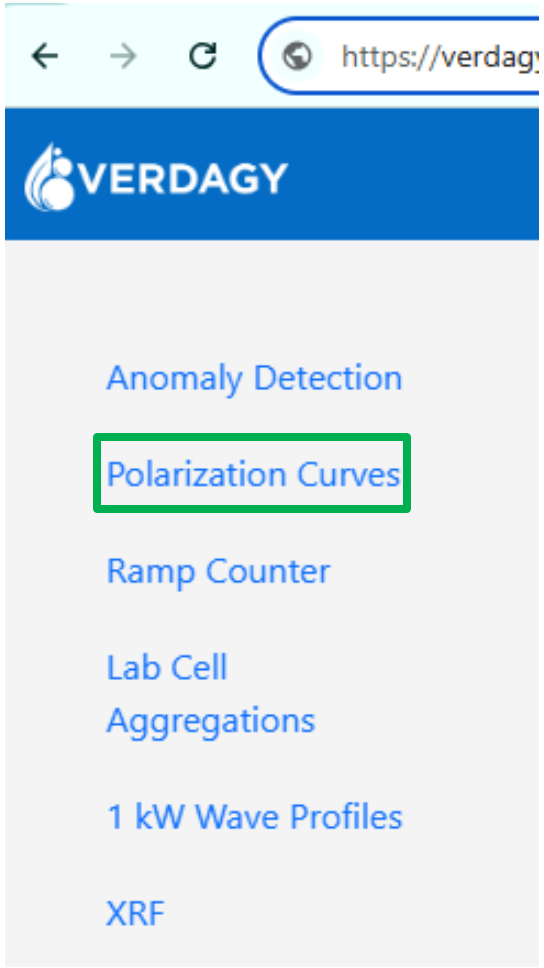

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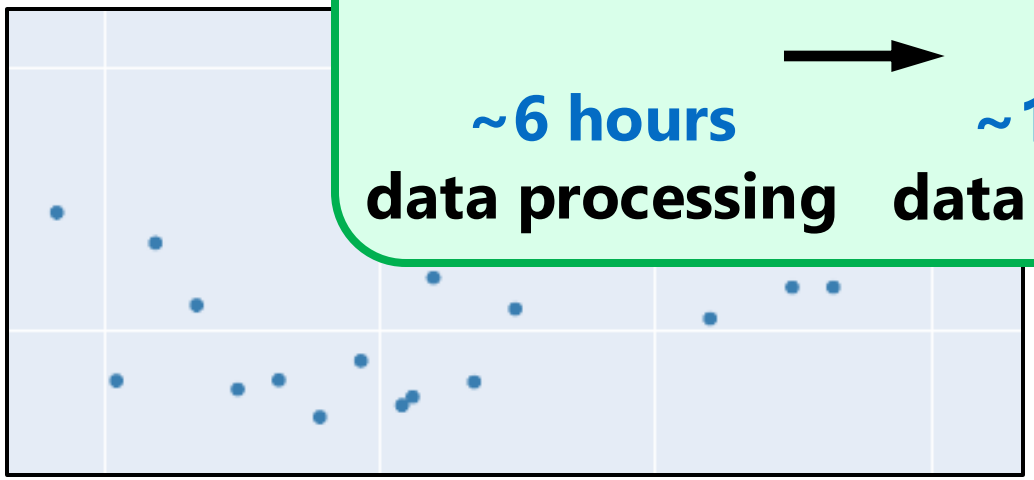
Linear Fit Pa

Extracted anc



WITHOUT Custom Tools → **WITH Custom Tools**

~6 hours data processing → **~1 minute data processing**

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ic capsules
region of curve

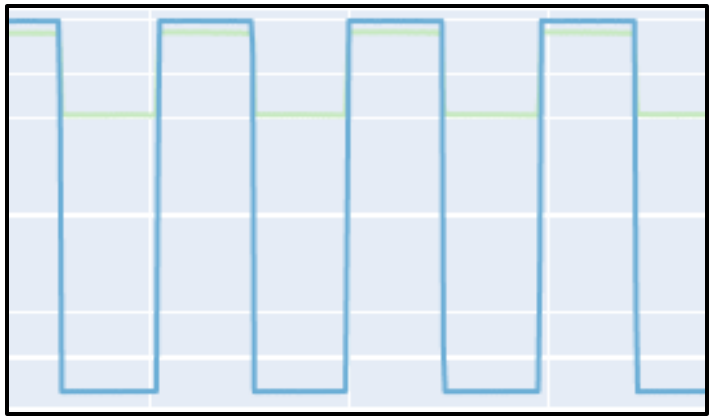
- Extract fit parameters
- Trend fit parameters over time

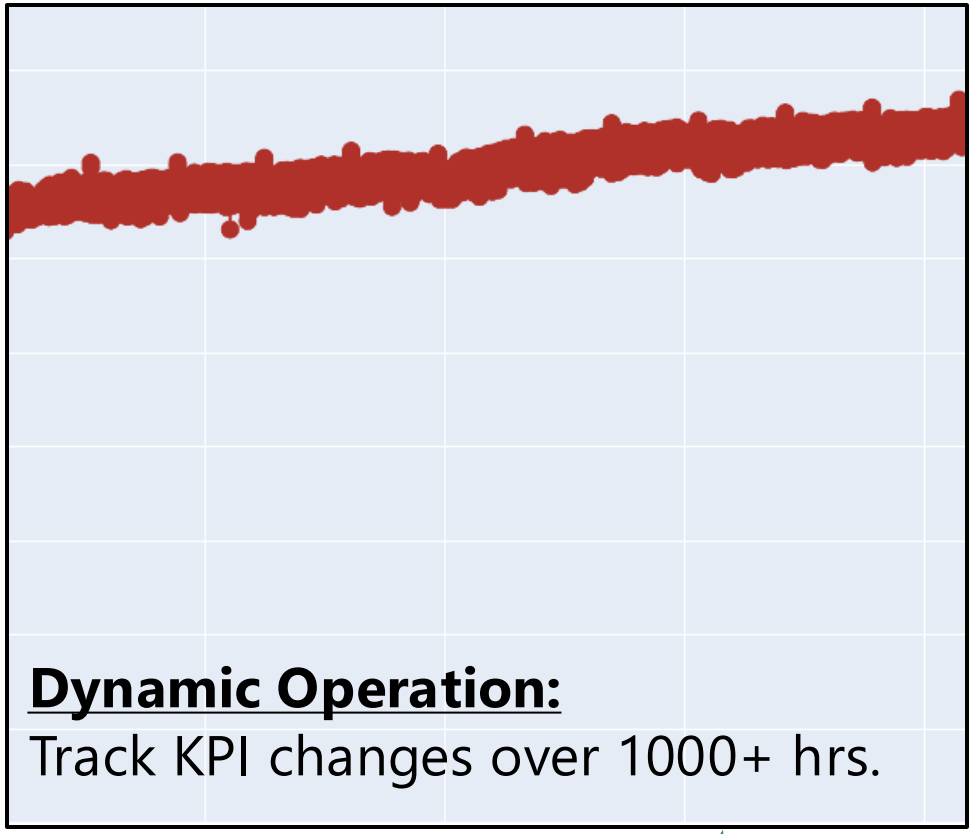
VERDAGY

Building on Seeq's Tools: Example 2

- Accelerated Lifetime Testing relies on tracking changes in polarization curves AND performance at specific conditions across 1,000s of hours of dynamic operation

Dynamic Operation:
Square Wave: 1000+ hours





Dynamic Operation:
Track KPI changes over 1000+ hrs.

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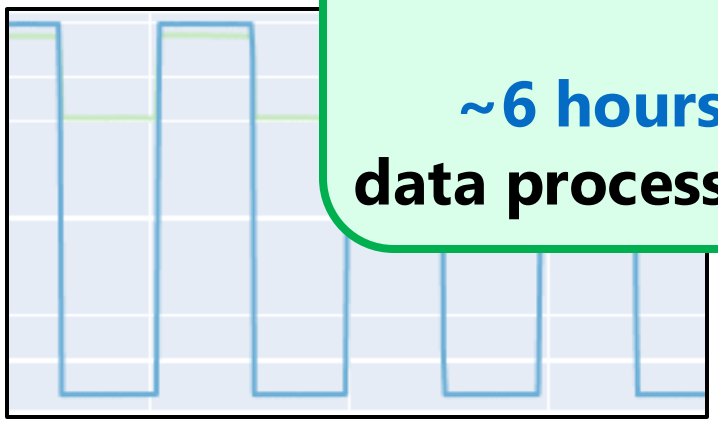
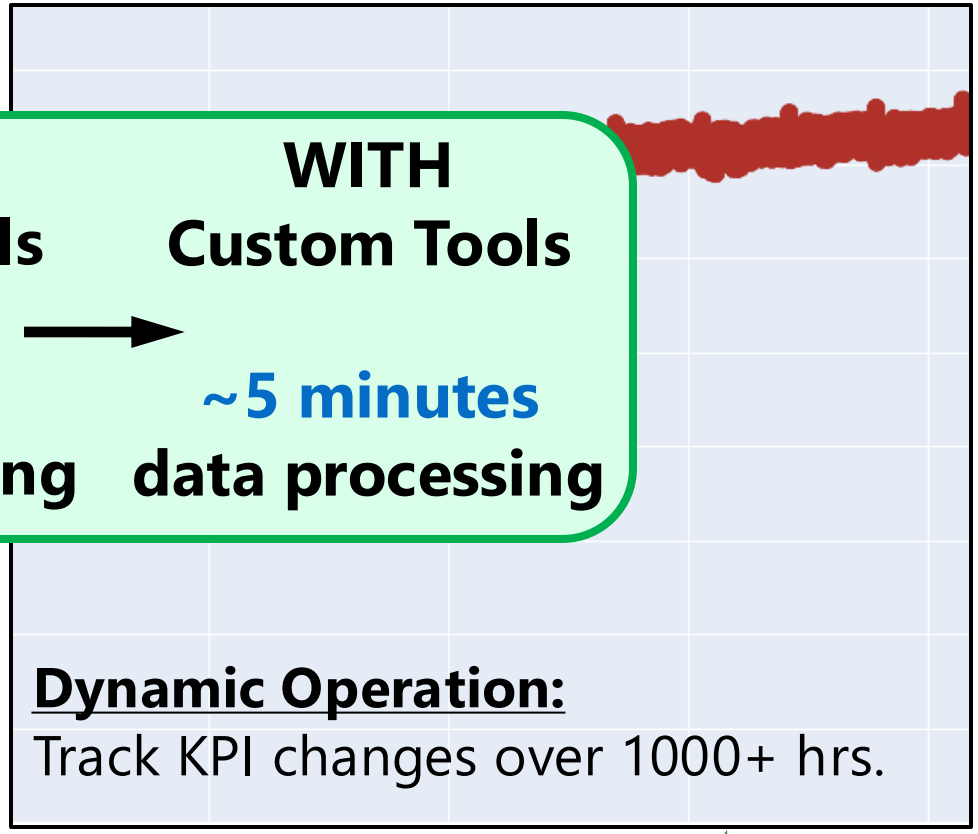


WITHOUT Custom Tools → **WITH Custom Tools**

~6 hours data processing → **~5 minutes data processing**



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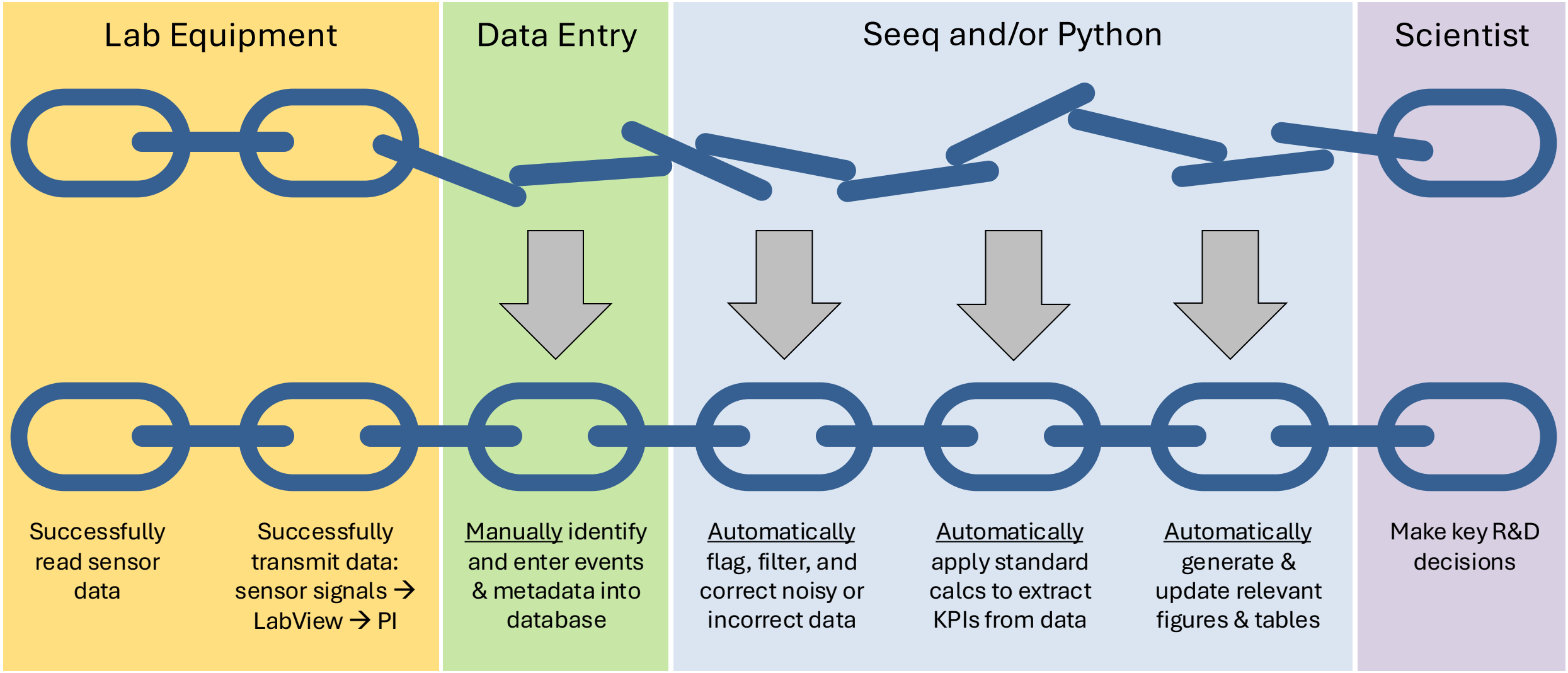

Takeaways

- Using Seeq in conjunction with online relational databases facilitates easy integration of daily Operations Logs with existing time-series data

- Building on Seeq's capabilities facilitated diverse use of these data analysis tools across Verdagy

- Widespread tool use led to:
  - ~90% reduction in data analysis time
  - Substantially faster turnaround time for KPI communication
  - Data analysis democratization while maintaining a consistent way of filtering data and applying common calculations

Throughline: making data accessible to support informed decision-making for any scale and application

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NO PARKING FIRE LANE

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Questions?

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Thank You