Data-Driven and Model-Guided Antibody Solutions

bio-techne® / R&D SYSTEMS

Customized Workflows Accelerate Immunoassay Development with High-Content Biophysics and Modeling

"Unlocking High-Throughput Biology"

Carterra 2025 Symposium Series
Boston, MA 06 May 2025

Wesley Errington, PhD

Sr. Scientist, Antibody Development
R&D Systems, Bio-Techne

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Expertise that Runs Deep

High-Quality Reagents, Analytical Instruments, and Precision Diagnostics

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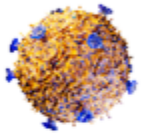

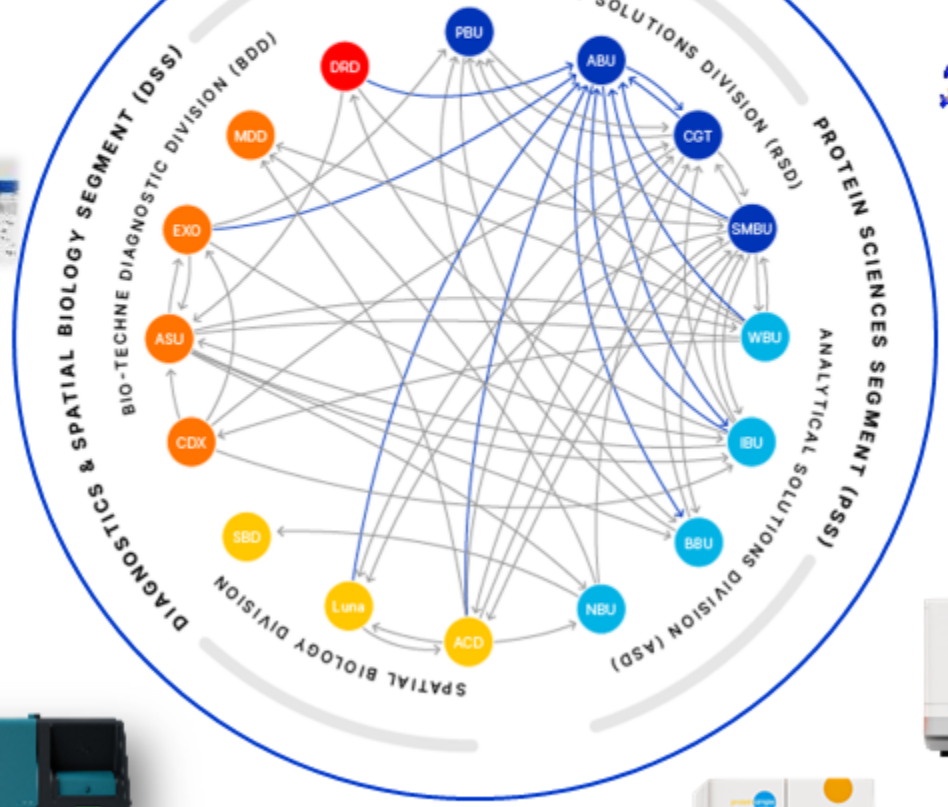

The antibody business unit generates content for businesses and applications **across Bio-Techne** and **externally as Custom Services**

Our antibodies enable gold-standard immunoassays

Proteins used as immunogens are expressed in mammalian cells to produce full length, properly folded, properly glycosylated, bioactive antigens

Our unique position enables us to better meet the specialized needs of our customers

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Our Antibodies

Model-Guided Solutions

R&D Systems Antibodies

Top-performing Molecular Toolsets

400,000
Antibody Products

200,000
Peer-reviewed Citations

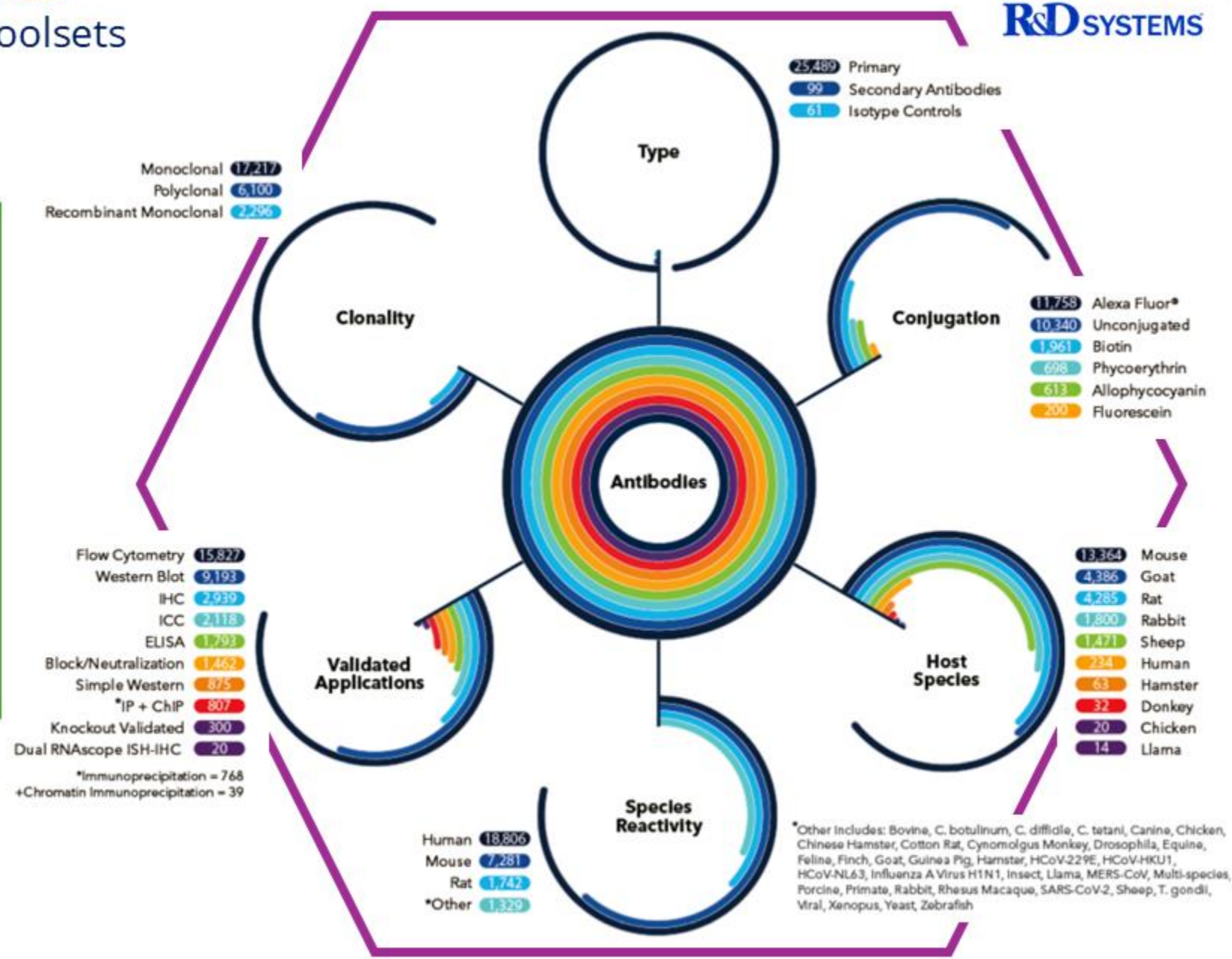
100,000
Proprietary Clones

10,000
Clones tested by Advanced Verification of specificity

42
Validated Applications

70
Species

Destination of Choice



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R&D Systems Antibodies

Antibody Reagents Power Immunoassay Technologies

400,000
Antibody Products

200,000
Peer-reviewed Citations

100,000
Proprietary Clones

10,000
Clones tested by Advanced Verification of specificity

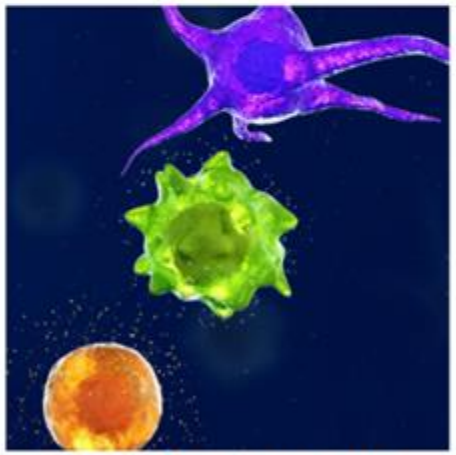
42
Validated Applications

70
Species

Destination of Choice

ANTIBODIES

PROTEINS



IMMUNOASSAYS

INSTRUMENTS

R&D SYSTEMS | NOVUS BIOLOGICALS | proteinsimple

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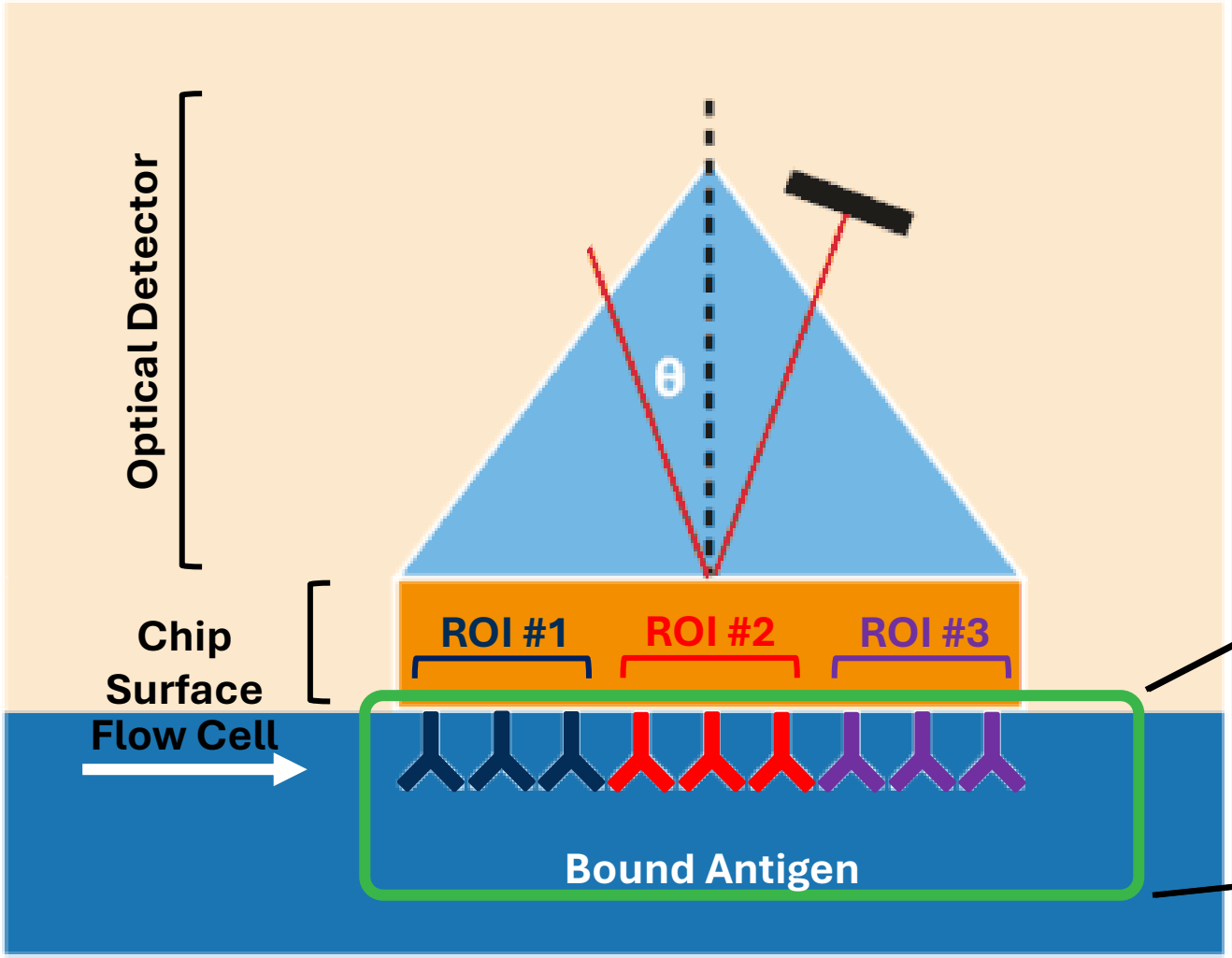
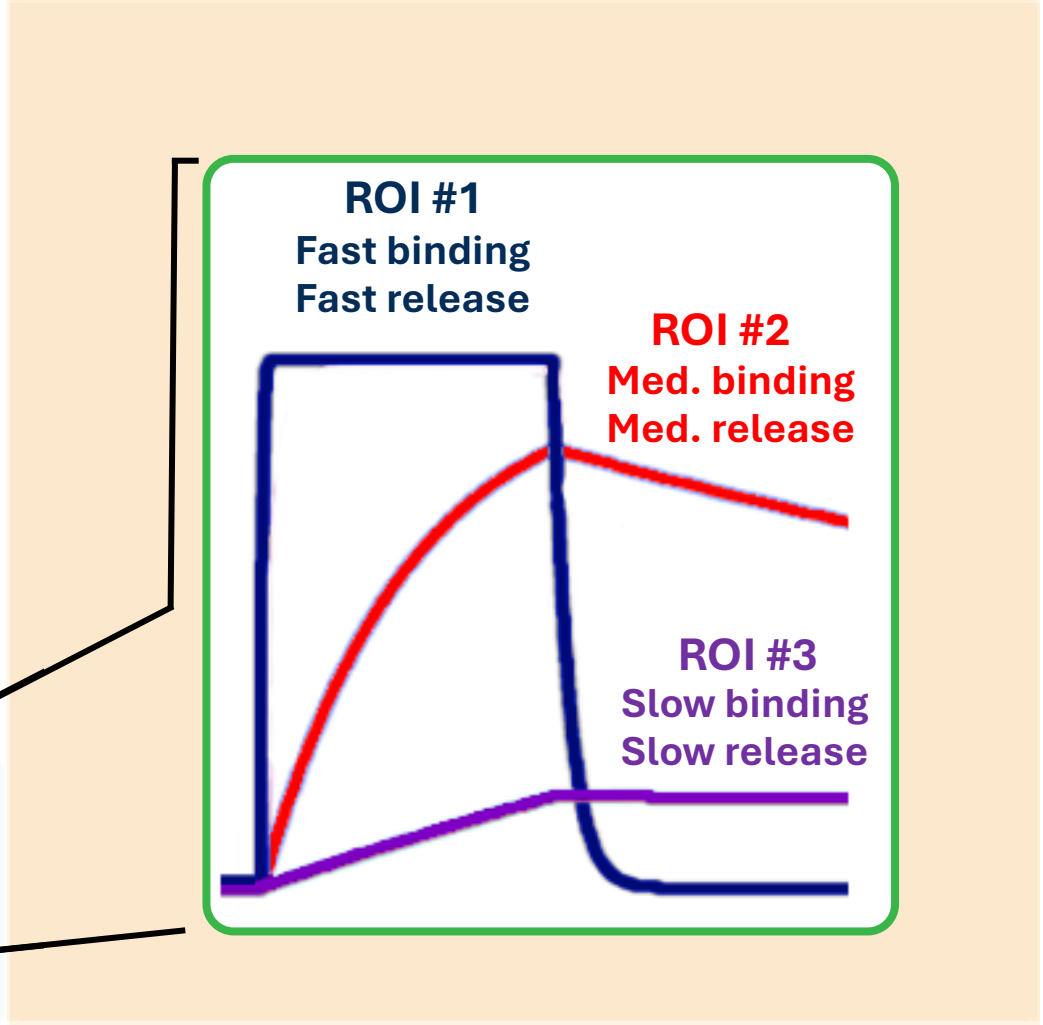
Information-rich HT-SPR Enhances Design and Development

Making the Invisible Visible through the Lens of SPR





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Information-rich HT-SPR Enhances Design and Development

Simulated SPR to Drive the Design, Build, Test of Complex Molecular Tools

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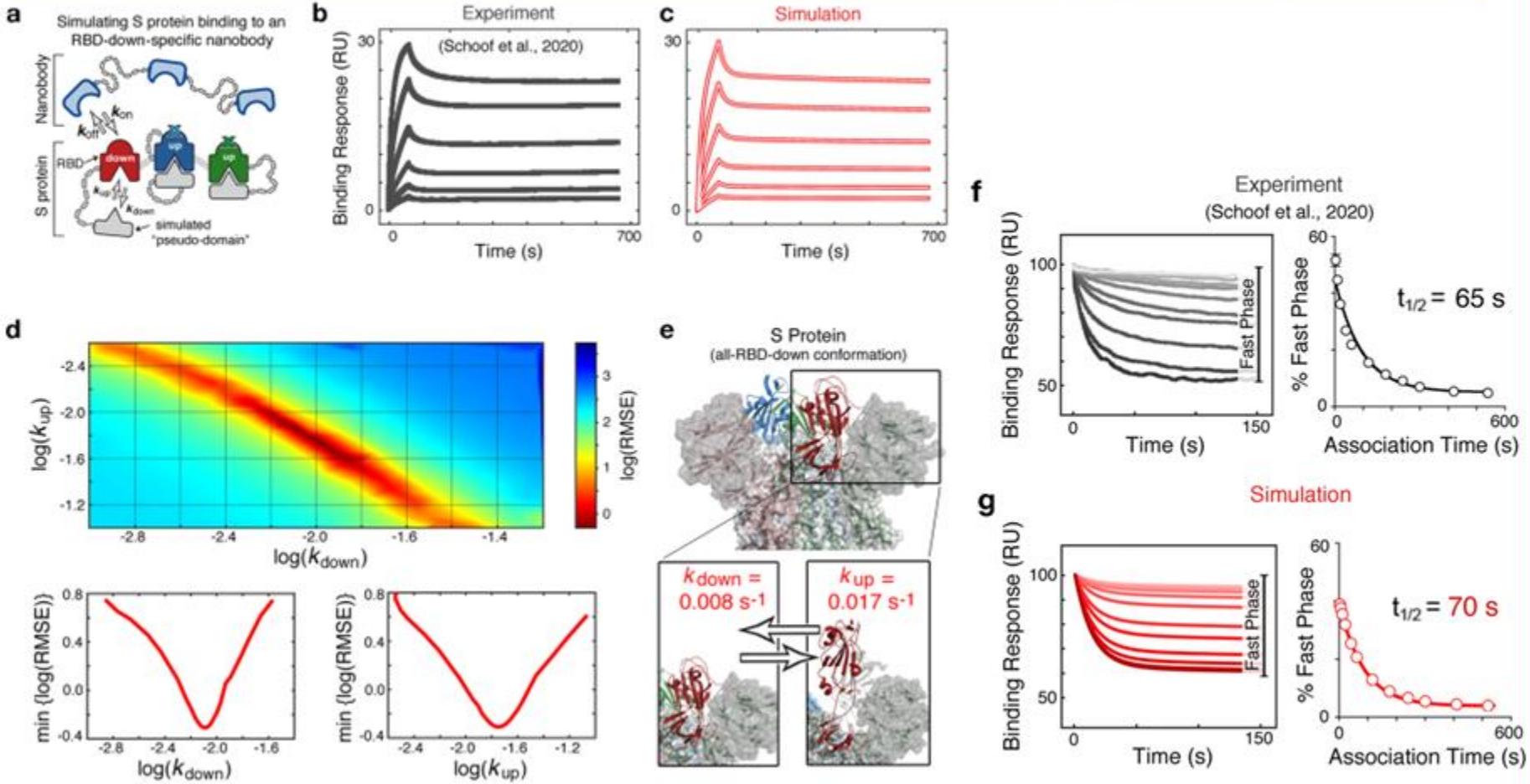
Programming Info-rich SPR-based Modeling – simulating dynamic systems



Bruncics B., Errington W.J., et. al. (2022) *Nat. Comm.*

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Information-rich HT-SPR Enhances Design and Development

Simulated SPR to Drive the Design, Build, Test of Complex Molecular Tools

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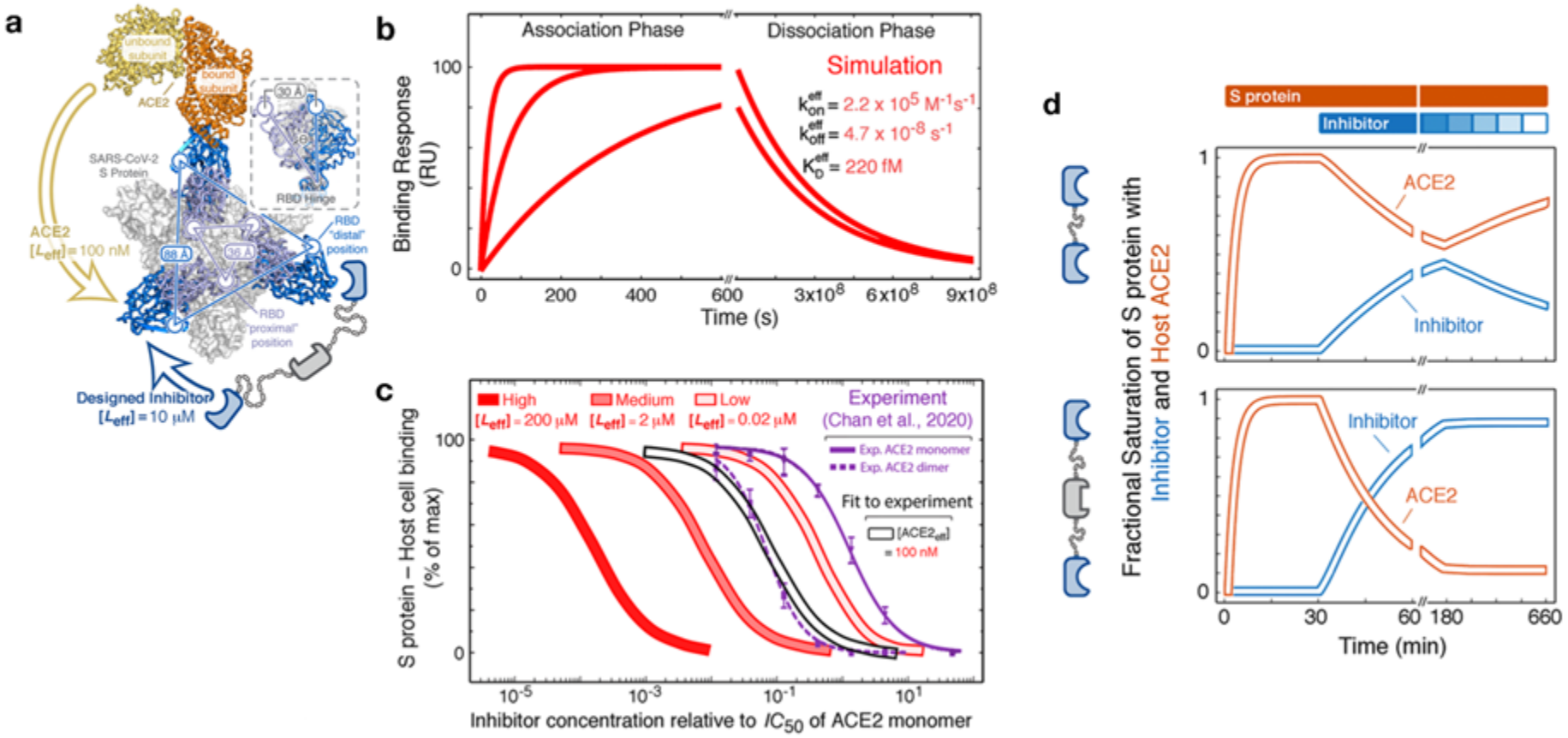
Programming Info-rich SPR-based Modeling – exploring unreachable spaces



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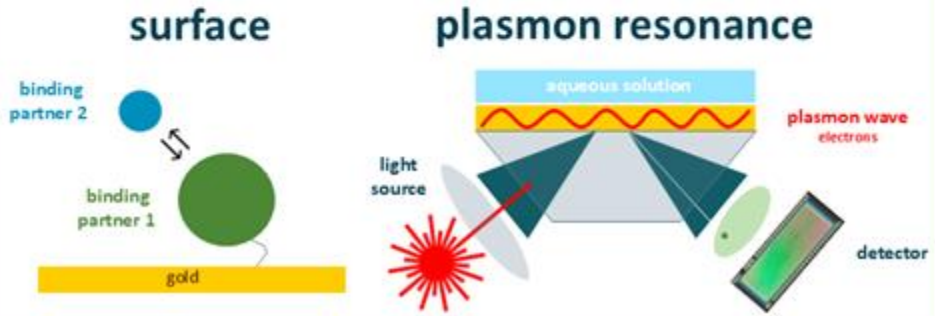
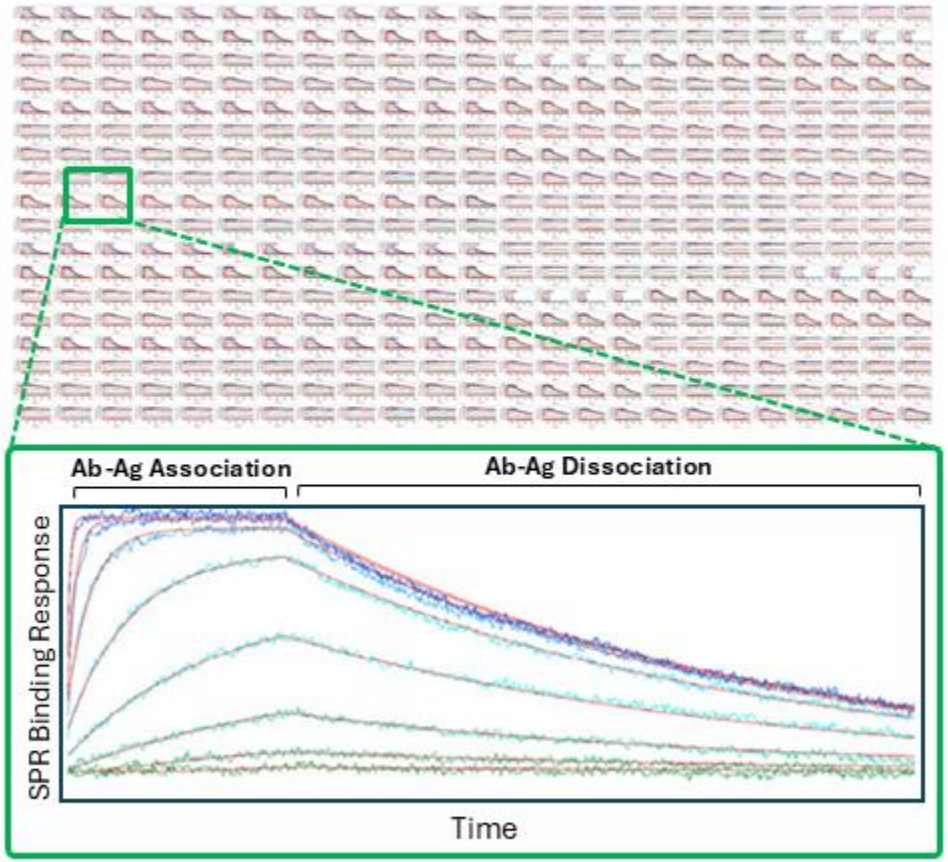
Information-rich HT-SPR Enhances Design and Development

Enhancing Development Pipelines with High-content Biophysical Platforms

- SPR (Surface Plasmon Resonance) Physics
- Antibody–Antigen Binding Seen in Real-Time



- Simultaneous Analysis of 384 Antibodies
- Assess 150,000 Candidate Matched Pairs



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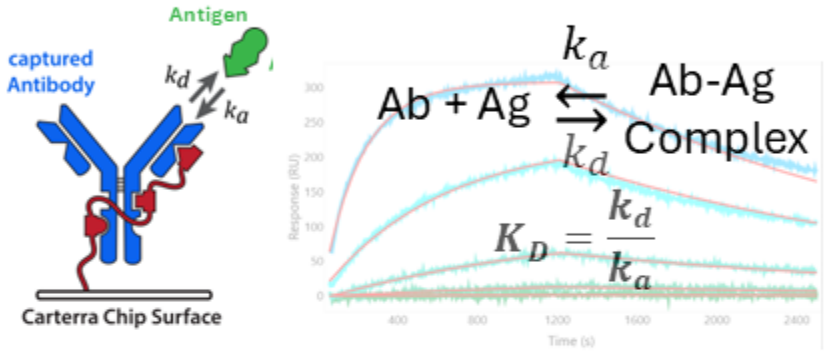
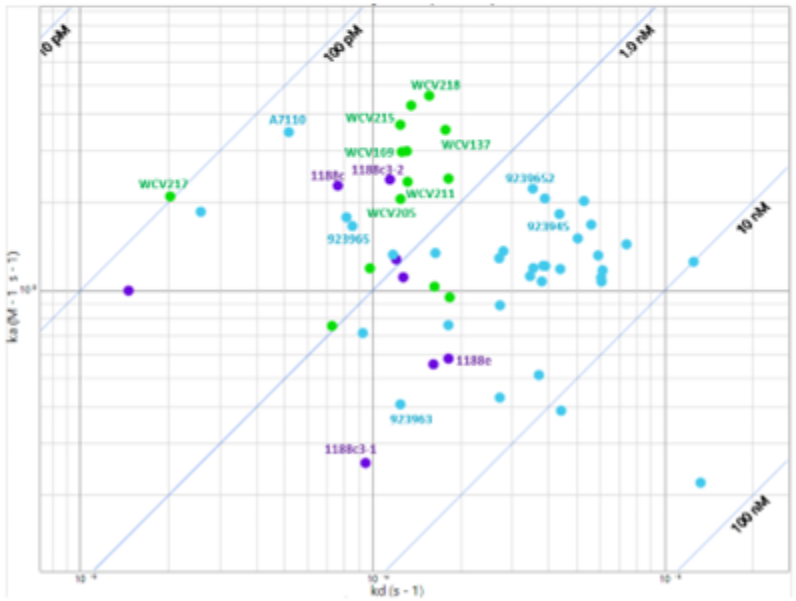
Information-rich HT-SPR Enhances Design and Development

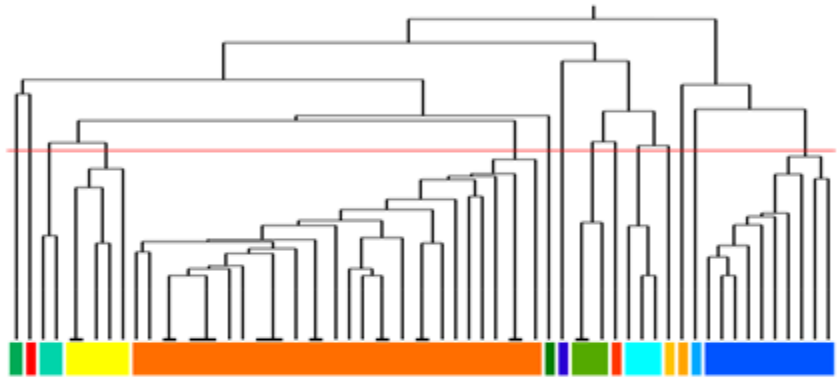
Surrounding our Extensive Antibody Content with Information-rich Datasets

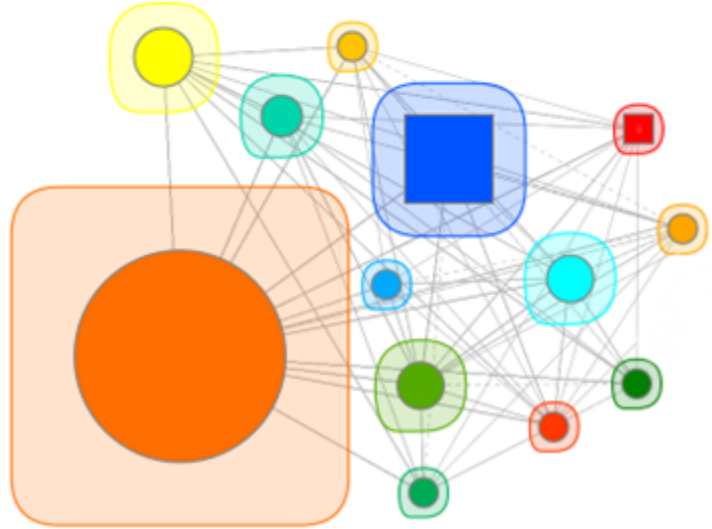
- Understanding Antibodies through Kinetics
- Clustering Indicates Similarities/Diversity





- Epitope Binning Localizes Antibody Binding
- Structure-Guided Analysis IDs Candidates





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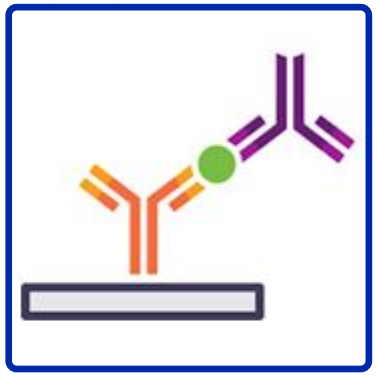
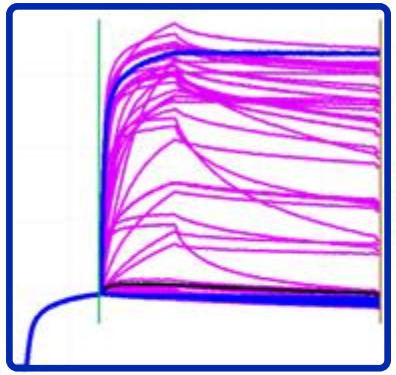
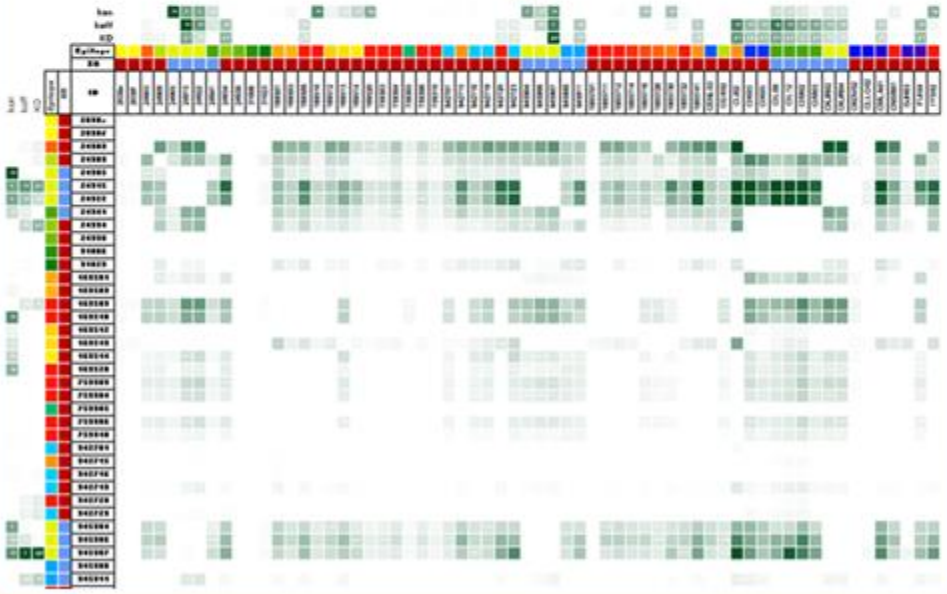
Information-rich HT-SPR Enhances Design and Development

Customized Data Analytics Drive Decision-making and Solutions

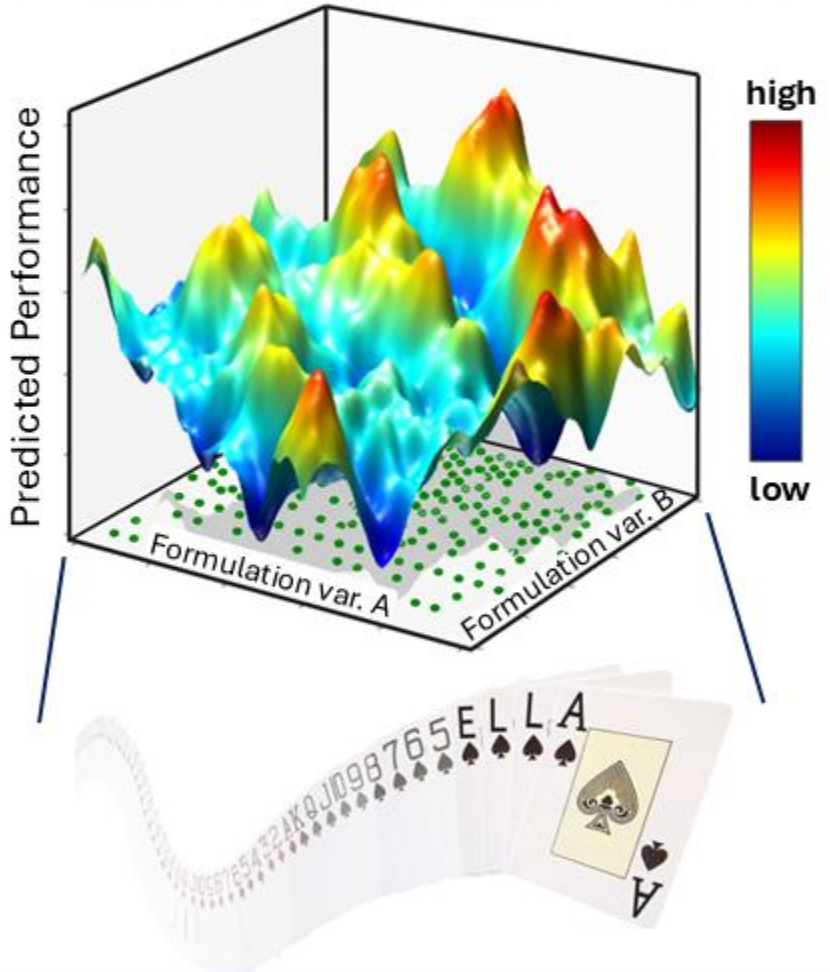
- Integrate Structure and Kinetic Datasets
- Score Attributes for Target Assay Application







- Rank Formulations for Predicted Performance
- Leads Move Downstream to Development



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High-Throughput Antibody Development Workflows

The Conventional Model-Guided Solutions

20 of 50 (40%)

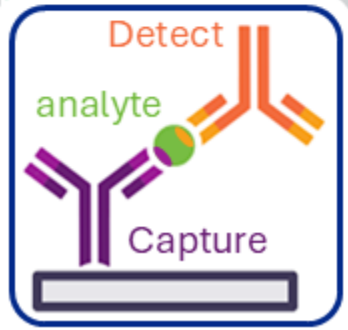
Sampled Content (Conventional)

Low-Information

1. High Standard Signal
2. n.d.
3. n.d.
4. n.d.
5. n.d.
6. n.d.

Sampled Combinations (Conventional)

400 of 2500 (16%)



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High-Throughput Antibody Development Workflows

The Enhanced Model-Guided Solutions

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50 of 50 (100%)

Sampled Content (Enhanced)

Sampled Combinations (Enhanced)

2500 of 2500 (100%)

High-Information

1 Specificity
2 Sensitivity
3 Cross-Reactivity
4 Stability/Drift
5 Epitope Compatibility
... [add. info/future dev.]

Detect
analyte
Capture

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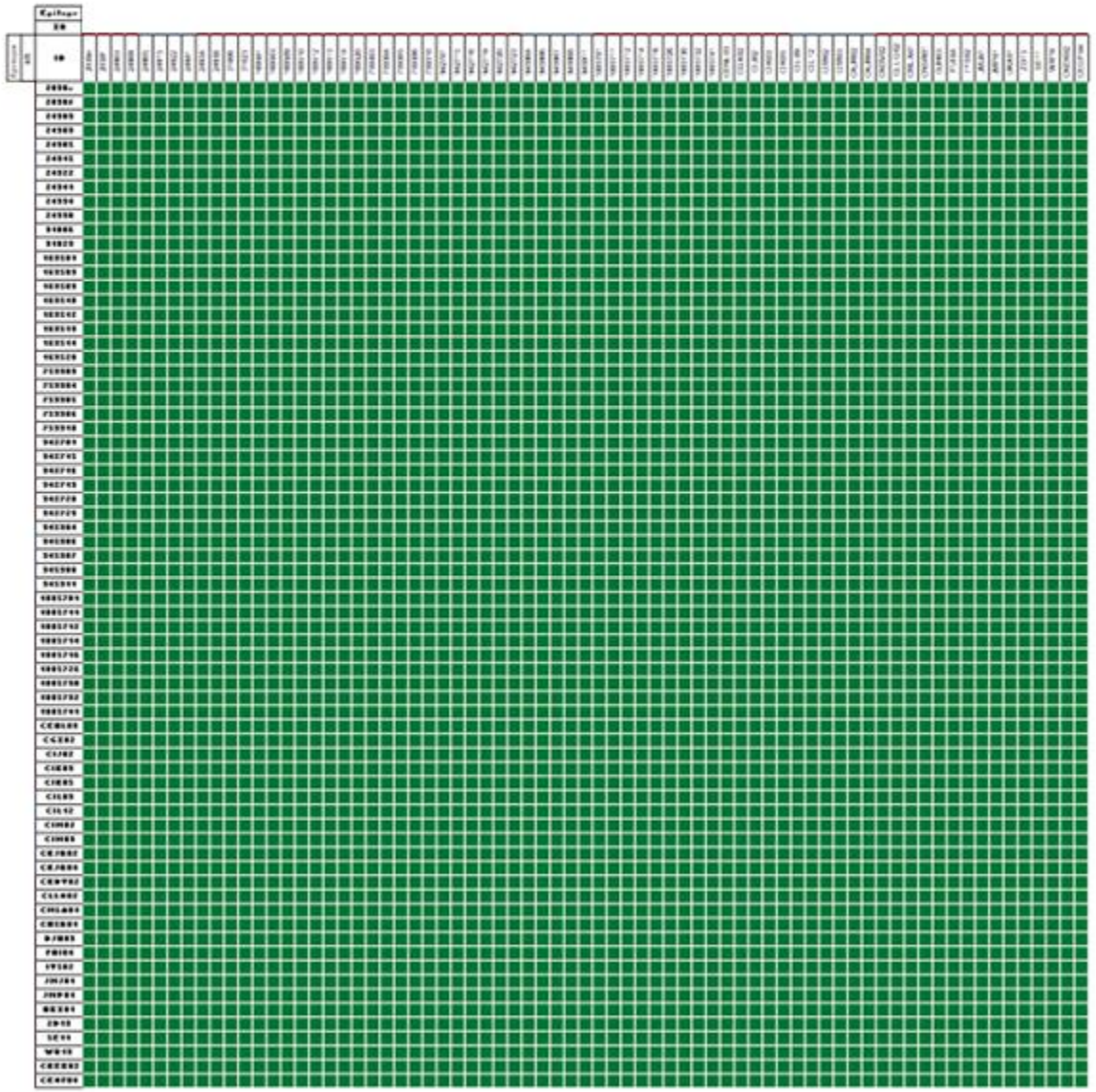
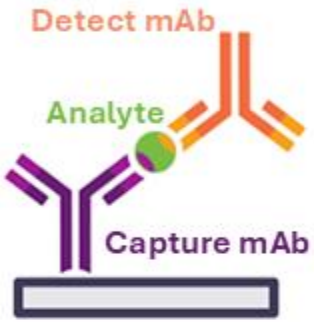
High-Throughput Antibody Development Workflows

70 candidate **Detect Abs**

70 candidate **Capture Abs**





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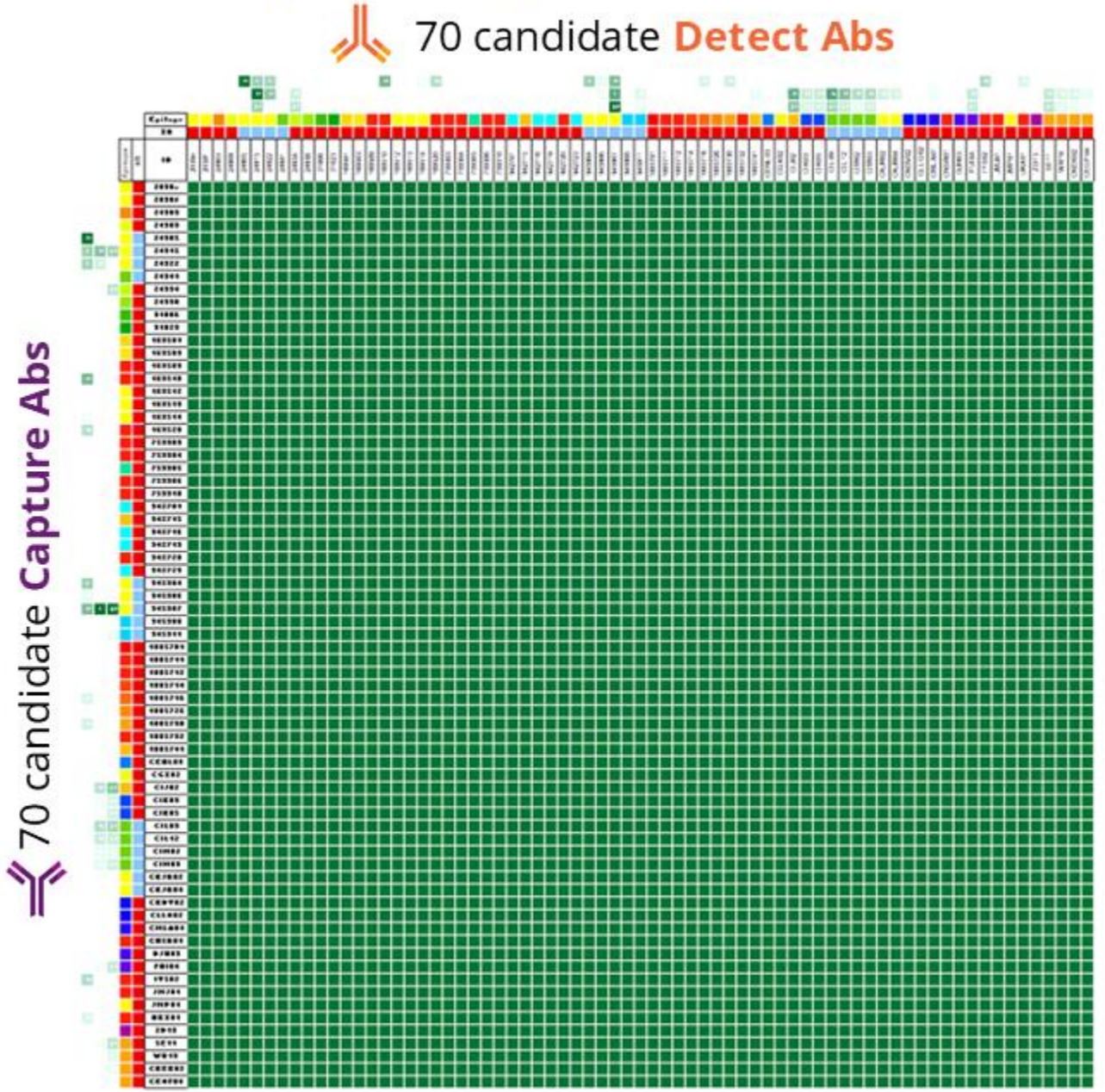
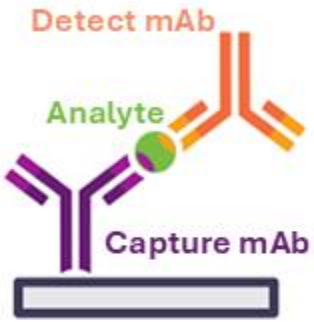
High-Throughput Antibody Development Workflows





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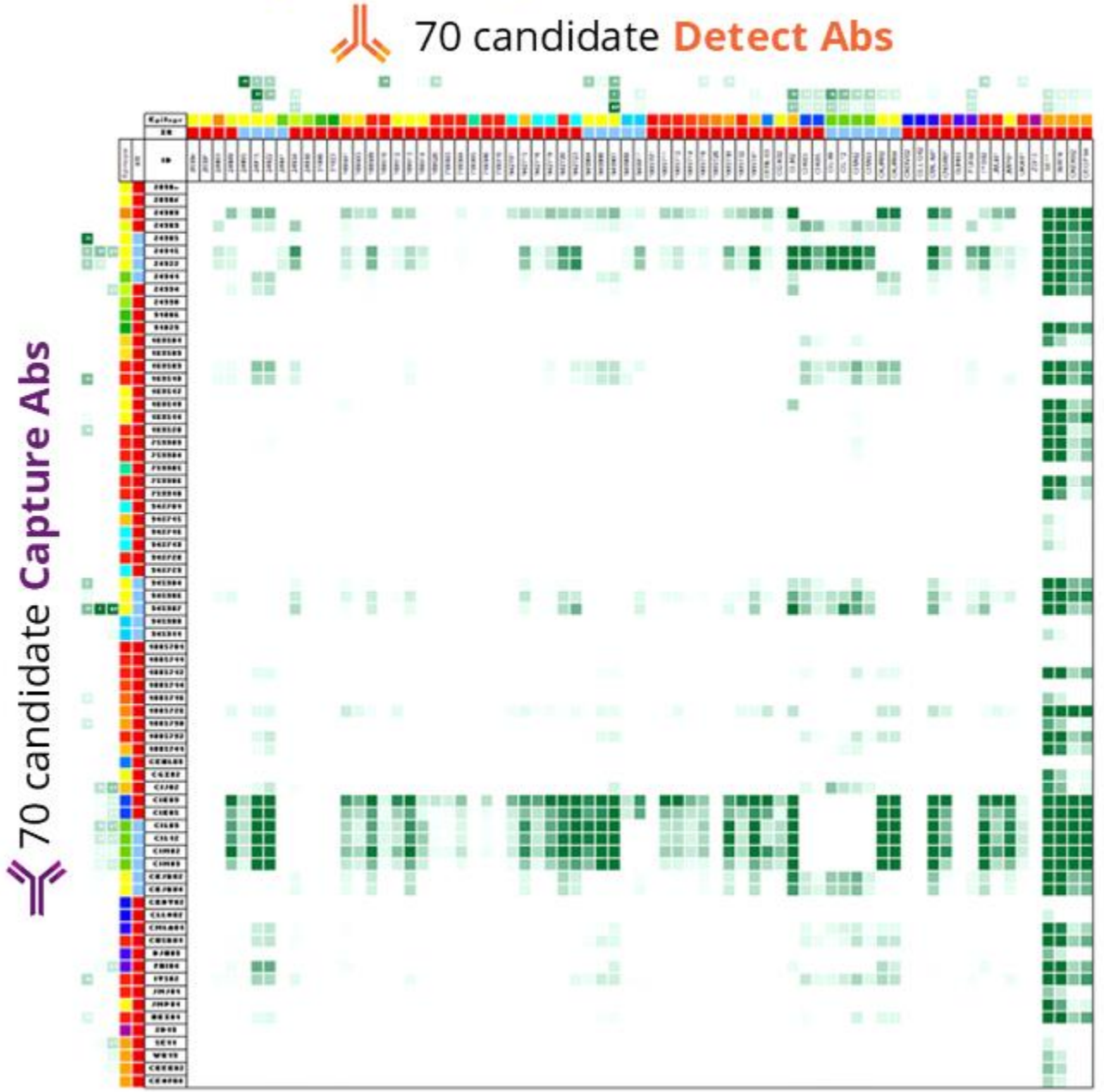
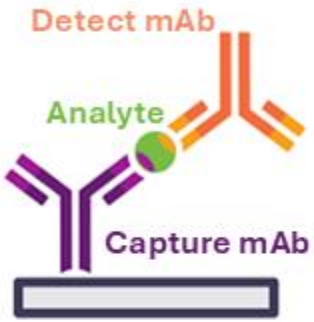
High-Throughput Antibody Development Workflows





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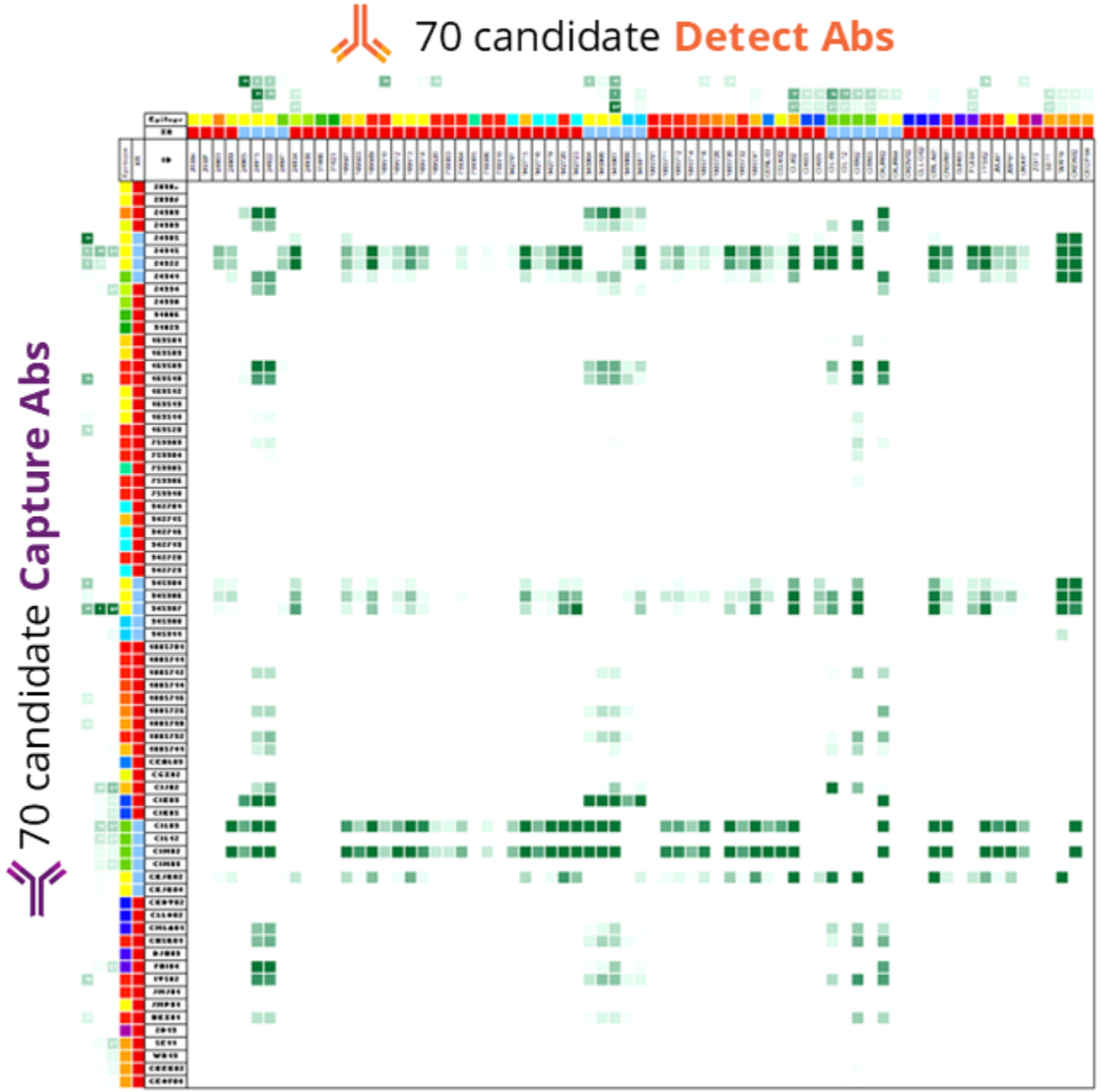
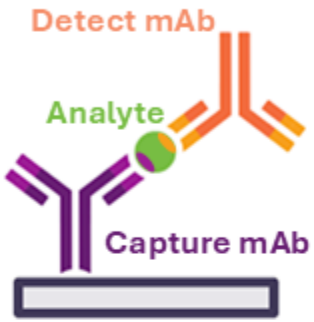
High-Throughput Antibody Development Workflows





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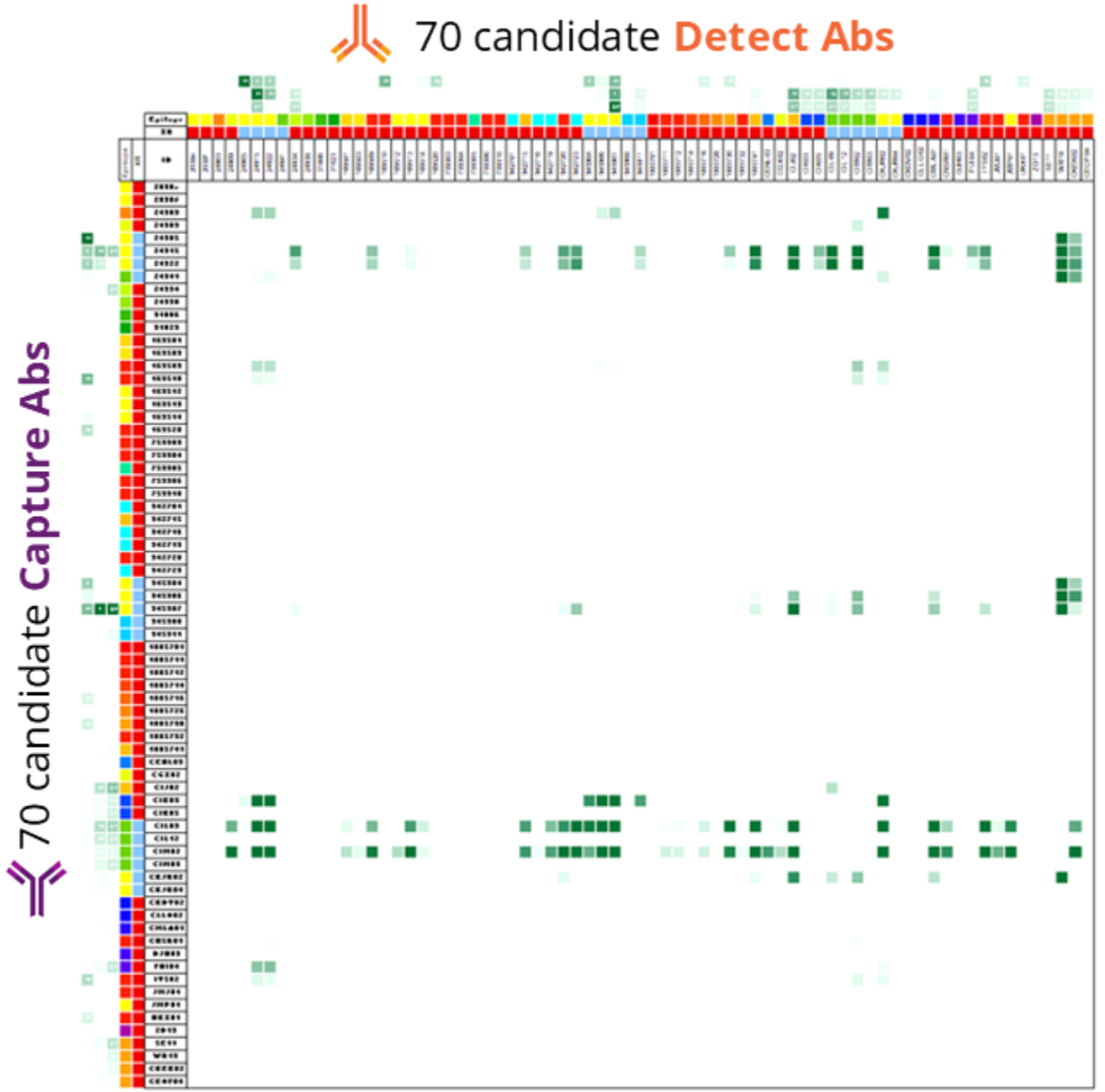
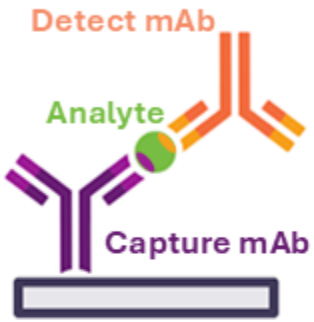
High-Throughput Antibody Development Workflows





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High-Throughput Antibody Development Workflows

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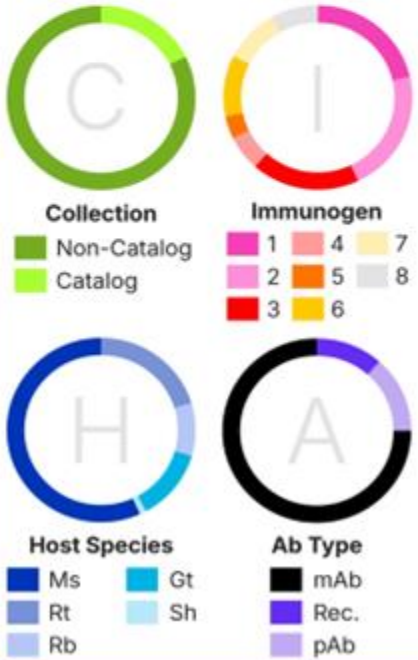
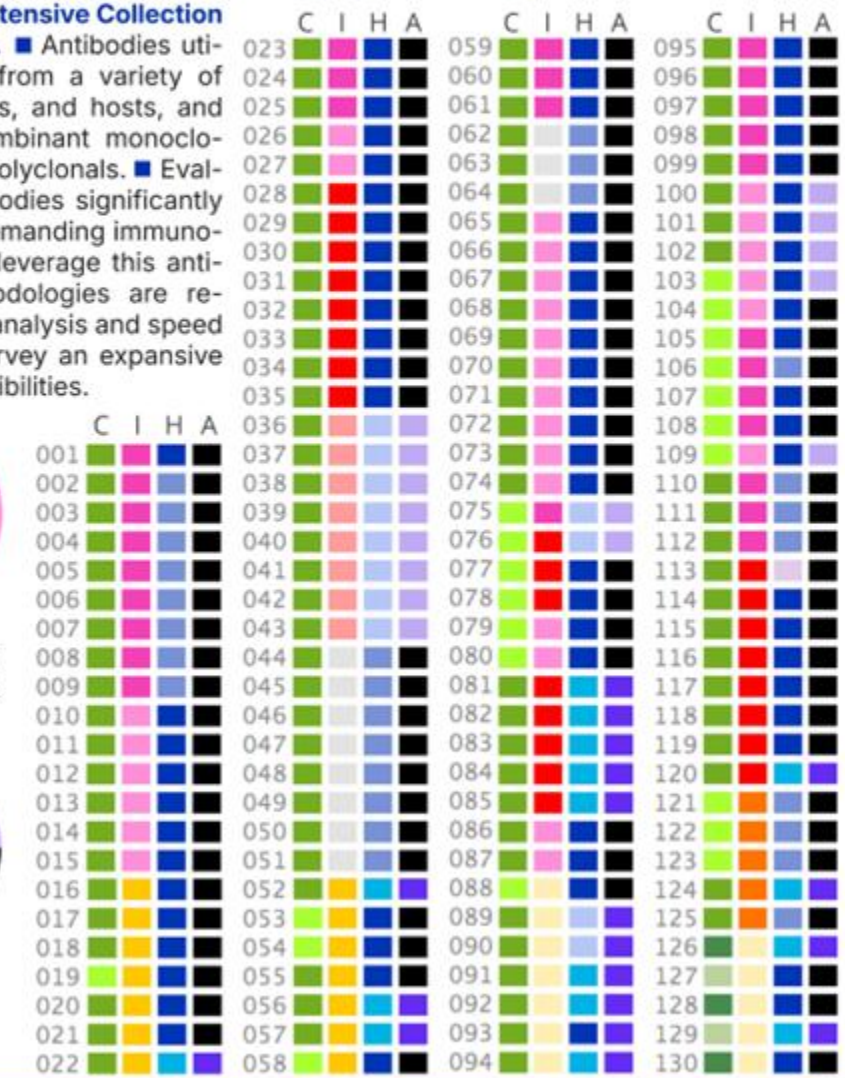
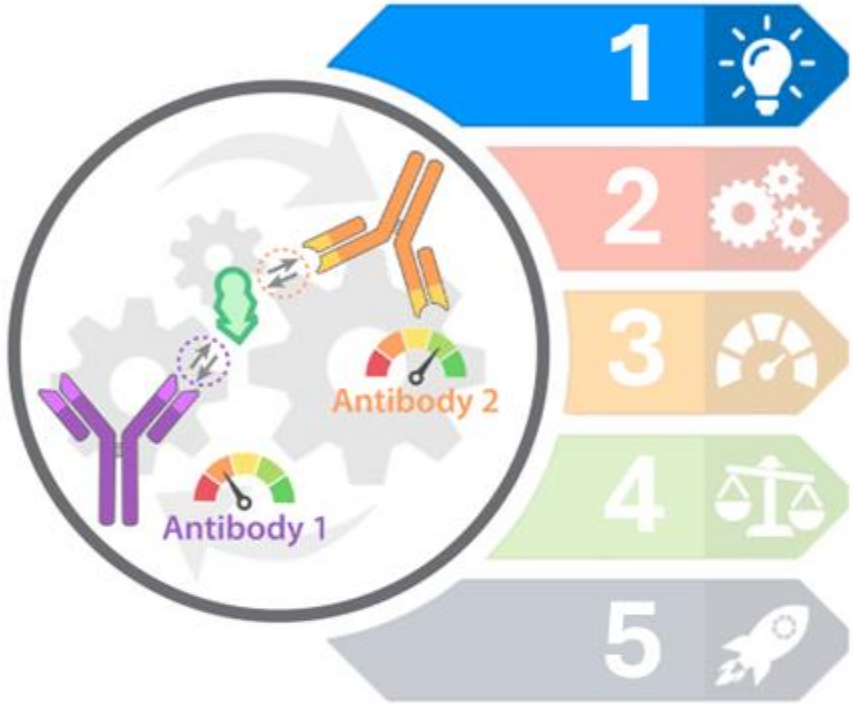
01 // Unlocking the Antibody Vault

Our Workflow Leverages Our Extensive Collection for Immunoassay Development. ■ Antibodies utilized in our workflows derive from a variety of methods, designed immunogens, and hosts, and comprise hybridoma and recombinant monoclonals, and natural and designed polyclonals. ■ Evaluating large collections of antibodies significantly increases the success rate of demanding immunoassay development. ■ To fully leverage this antibody content, next-gen methodologies are required that afford both depth of analysis and speed to thoroughly and efficiently survey an expansive combinatorial landscape of possibilities.







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High-Throughput Antibody Development Workflows

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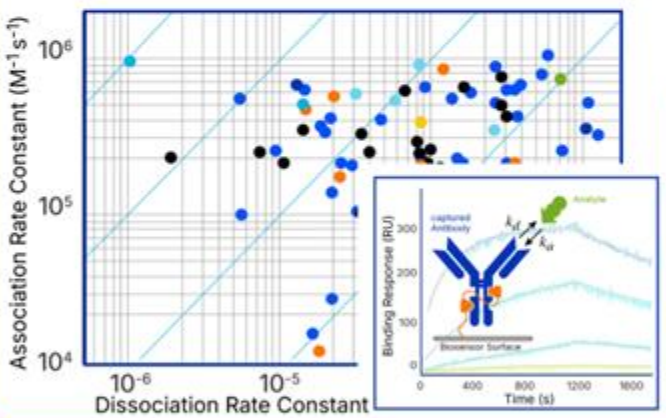
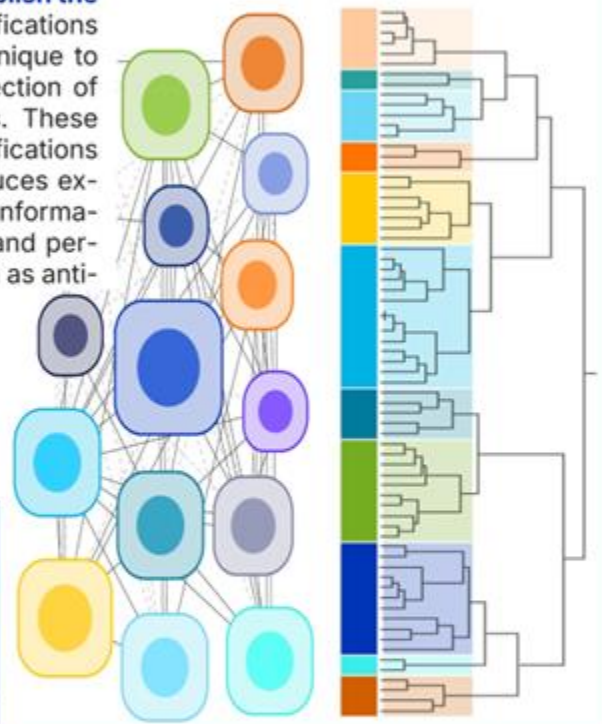
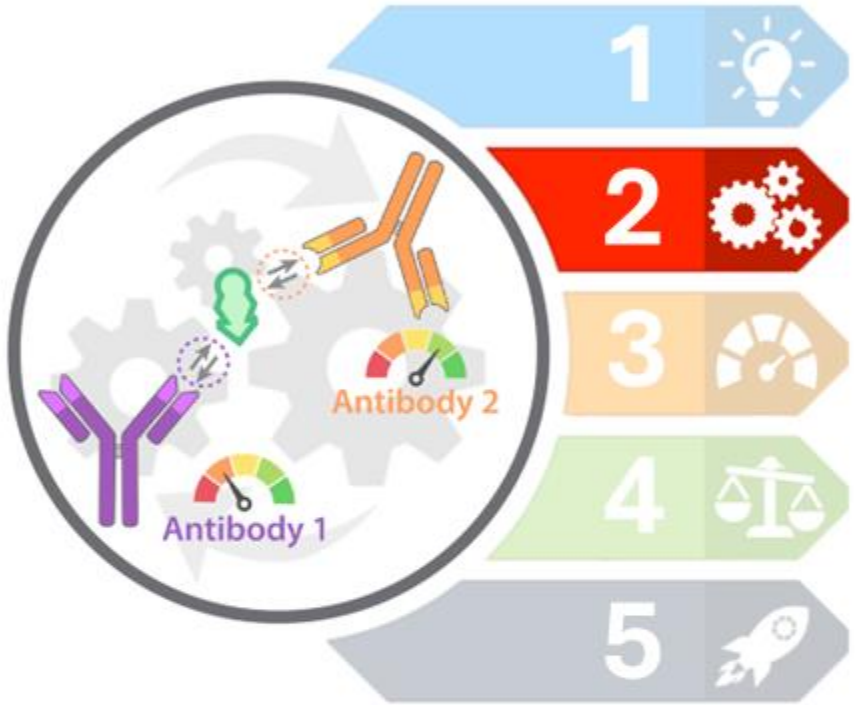
02 // High-Content Biophysics

Antibody Biophysics and Biomarker Interaction Establish the Lead Landscape. ■ High-performance assay specifications derive from a variety of engineered optimizations unique to each platform. ■ Principal among these is the selection of matched-pairs of capture and detection antibodies. These matched-pais require optimal attributes for the specifications of a particular immunoassay. ■ Our workflow produces expansive datasets that are untilized to populate information-rich landscapes that describe all combinations and permutations of assay performance design element such as antibody pairing, titer, sample type, and incubation time.







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High-Throughput Antibody Development Workflows

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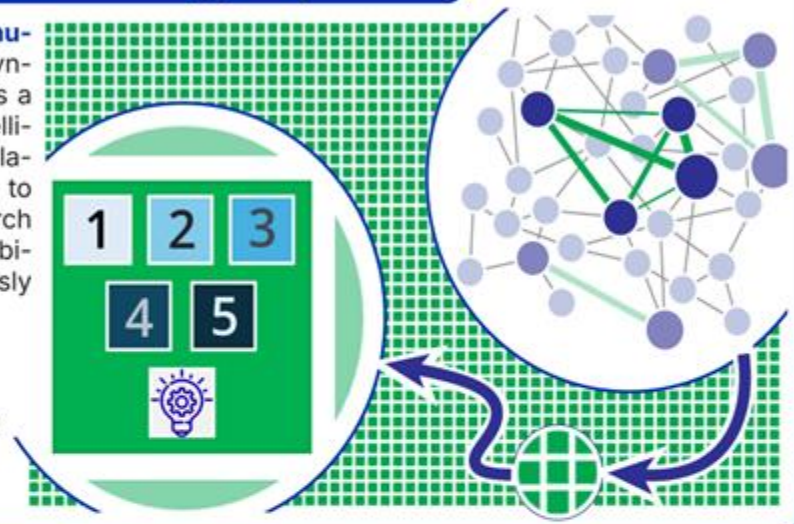
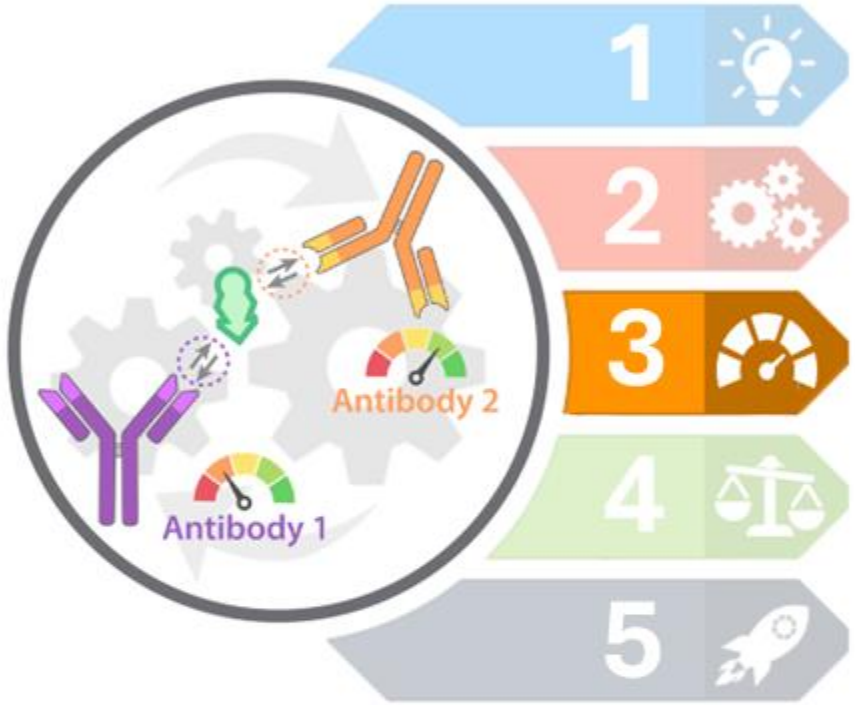
03 // Navigating the Design Space

Modeling Drives Combinatorial Immunoassay Design. ■ Our approach synthesizes **1.** our domain-knowledge, as a deterministic rule layer; and **2.** intelligently-guided combinatorial formulation, as a metaheuristic search layer; to **3.** navigate the high-dimensional search space to uncover immunoassay combinations with properties simultaneously optimized for multiple specifications.

1 sensitivity
2 epitope
3 specificity
4 precision
5 dynamic range
custom specs





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High-Throughput Antibody Development Workflows

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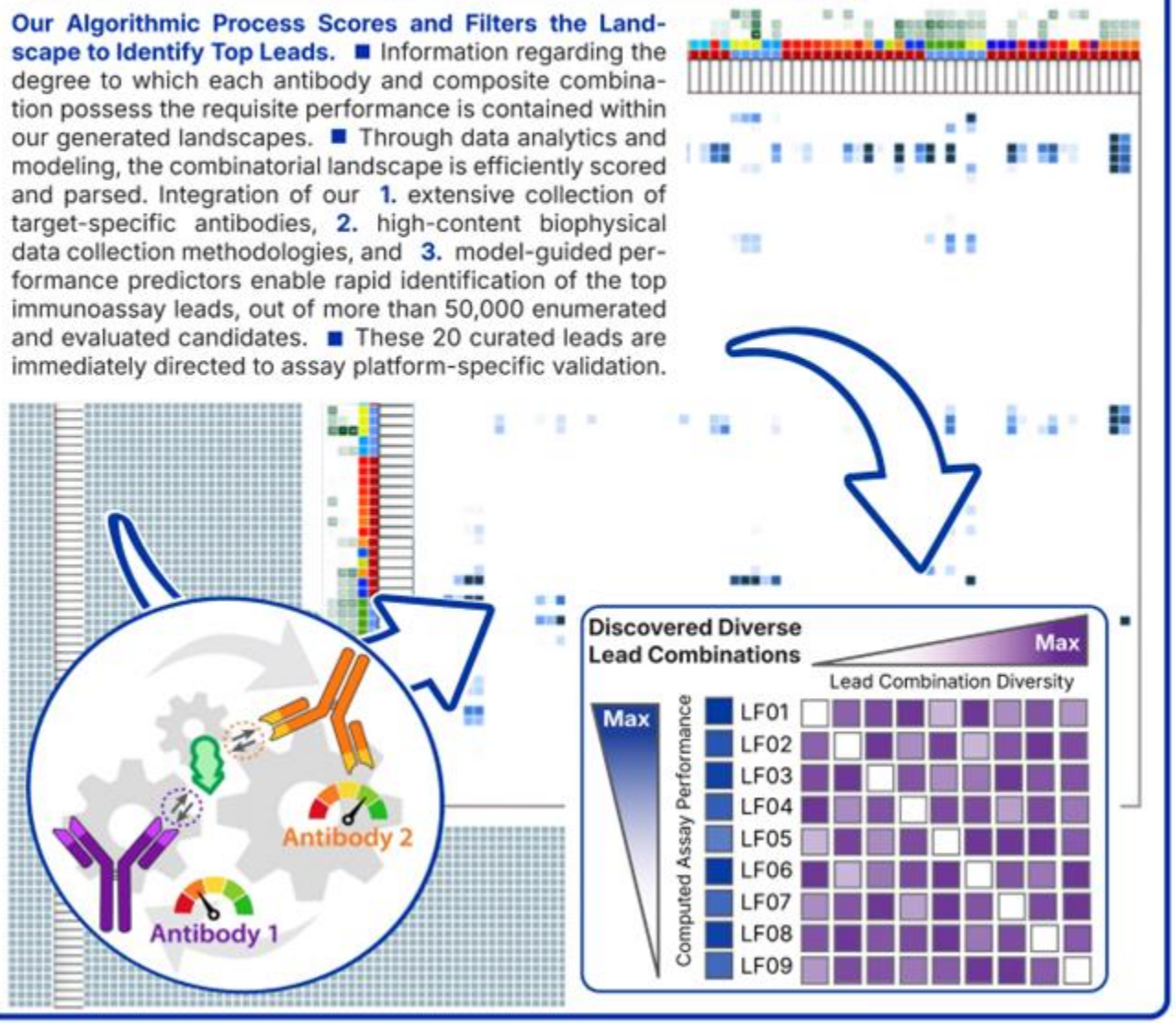
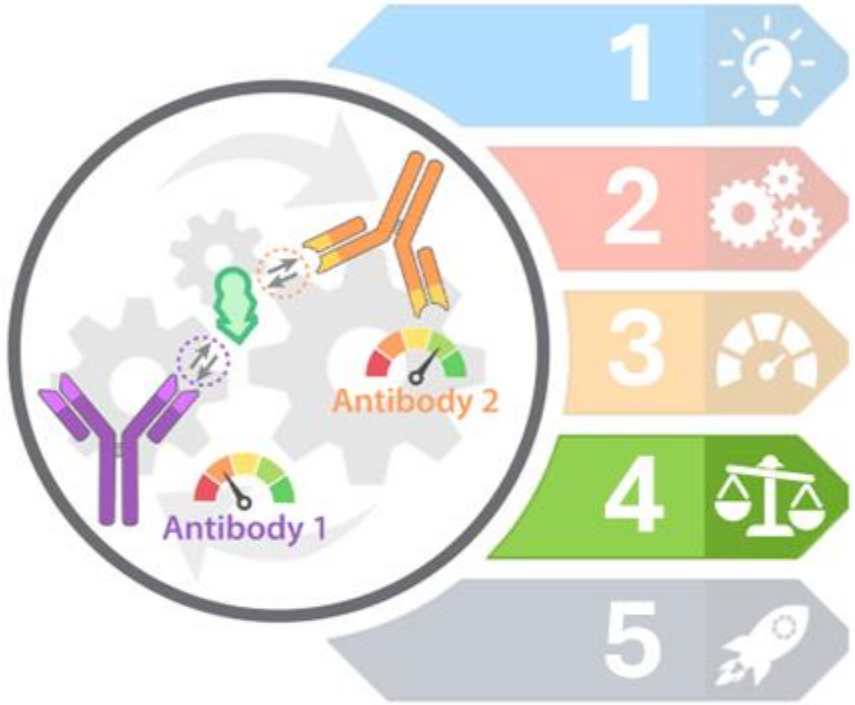
04 // Data Integration & Modeling

Our Algorithmic Process Scores and Filters the Landscape to Identify Top Leads. ■ Information regarding the degree to which each antibody and composite combination possess the requisite performance is contained within our generated landscapes. ■ Through data analytics and modeling, the combinatorial landscape is efficiently scored and parsed. Integration of our **1.** extensive collection of target-specific antibodies, **2.** high-content biophysical data collection methodologies, and **3.** model-guided performance predictors enable rapid identification of the top immunoassay leads, out of more than 50,000 enumerated and evaluated candidates. ■ These 20 curated leads are immediately directed to assay platform-specific validation.





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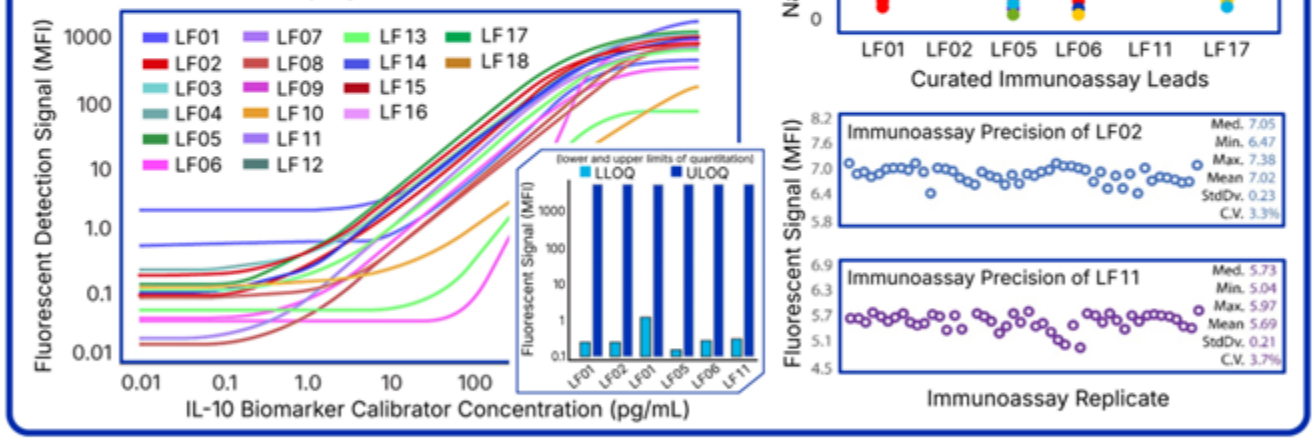
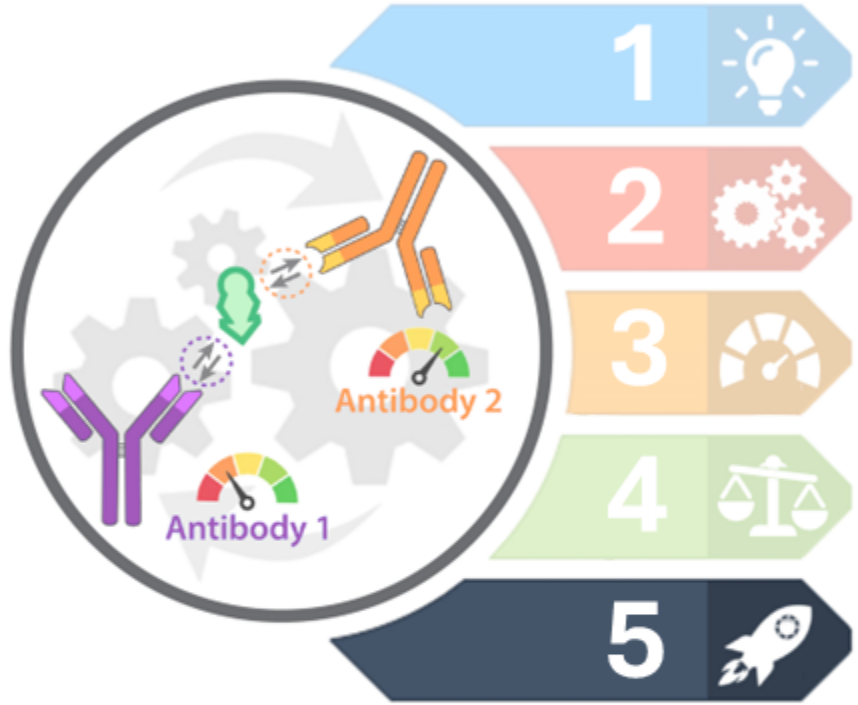
High-Throughput Antibody Development Workflows

05 // Discovered Lead Validation

Curated Leads Accelerate Development of High-Sensitivity Immunoassay. ■ To illustrate the performance of our workflow, here we evaluated 20 curated lead combinations according to the high-performance specifications of the Simple Plex Ella assay platform. ■ This assay development process involves a sequence of specific tests, including core performance criteria such as **1.** quantification of the detectability dose-response profile; **2.** assessment of the quantitative limits of detection; **3.** detectability of endogenous levels of natural samples, and **4.** statistical precision. LF02 and LF11 were rapidy validated for all benchmarks.





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High-Throughput Antibody Development Workflows

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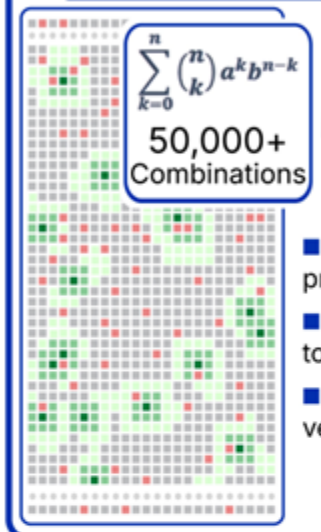
The Performance Advantage



$$\sum_{k=0}^{n} \binom{n}{k} a^k b^{n-k}$$

50,000+ Combinations

Custom Workflow
comprehensive survey

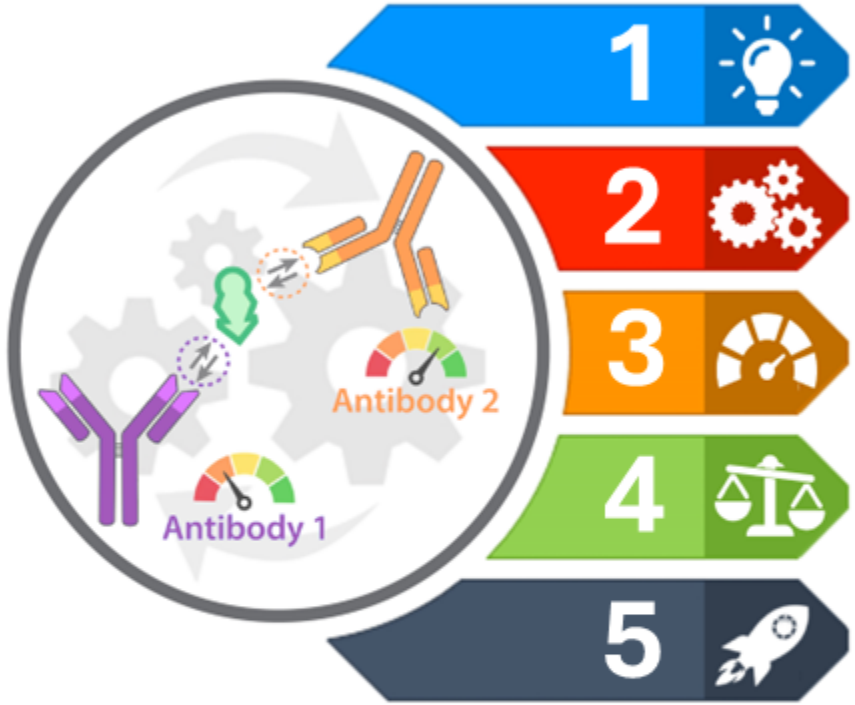
20 → 18 → 6 → 2 → 2 ✓ Pass

Step 1 Step 2 Step 3 Step 4

very sparse sampling
Conventional Approach

2700 → 160 → 13 → 2 → 0 ✗ Fail

- Combining leading antibody collections, analytics, and models, our custom approach is tailored to the performance priorities of your immunoassay application.
- Our approach rapidly and comprehensively surveys the multi-factor combinatorial design spaces of assay development to discover curated leads.
- We maximize success rates and eliminate weeks of work from your assay development and validation pipelines.



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High-Throughput Antibody Development Workflows

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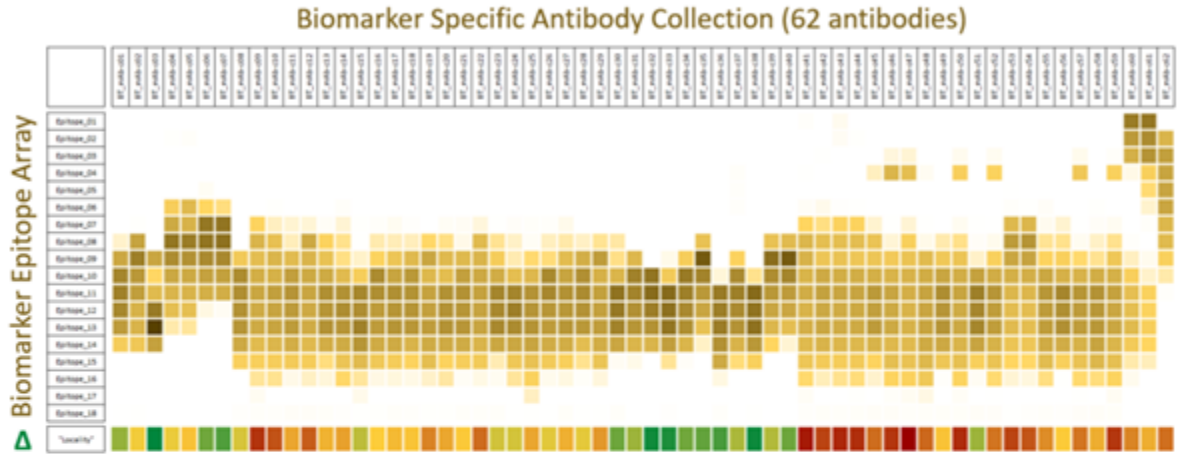
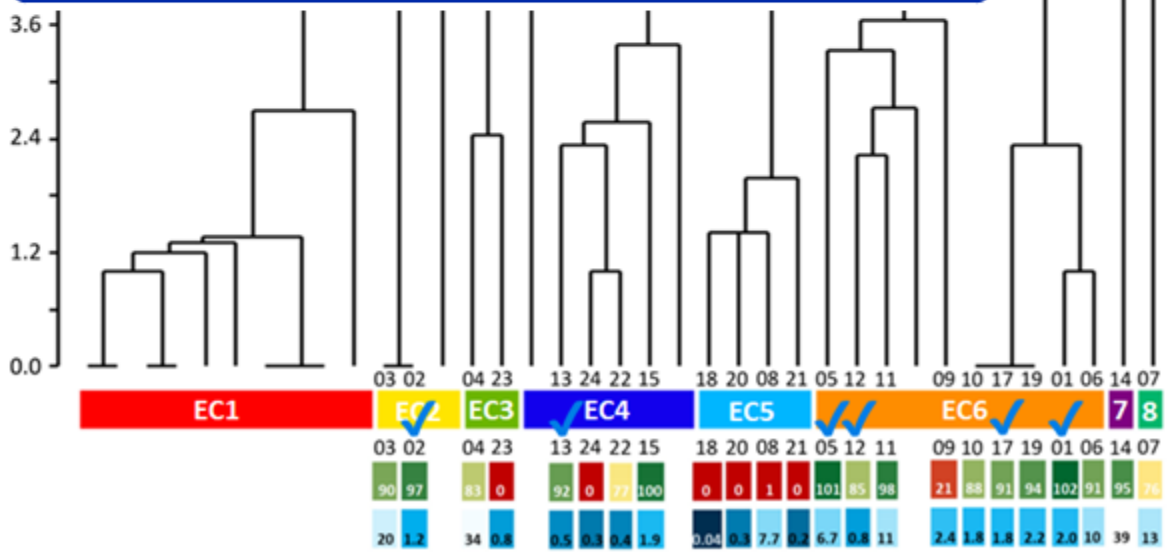
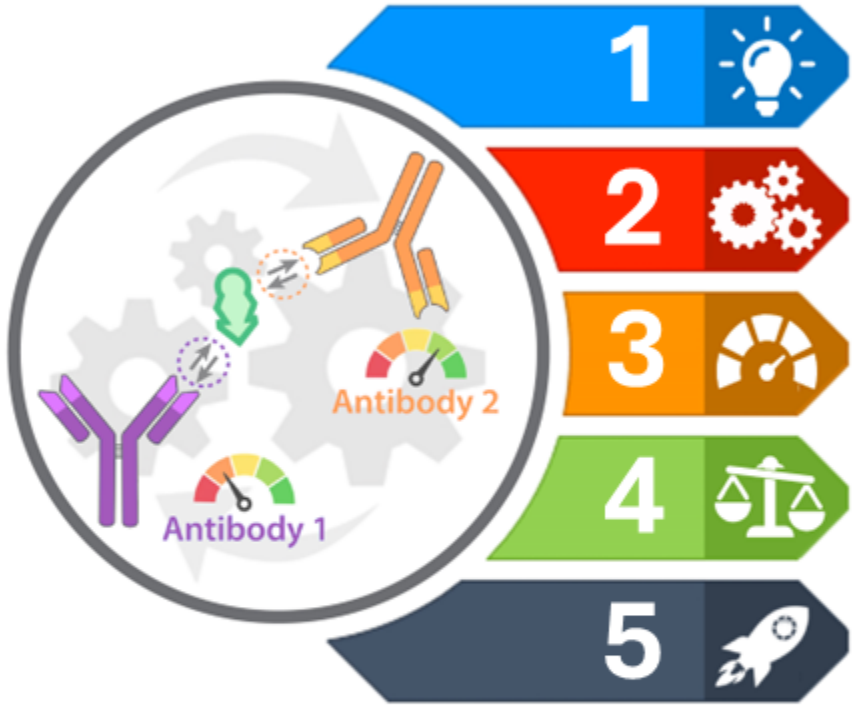
Extended Solutions – IVD Epitope Mapping



Extended Solutions – PK/PD Assay Design





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Data-Driven and Model-Guided Antibody Solutions

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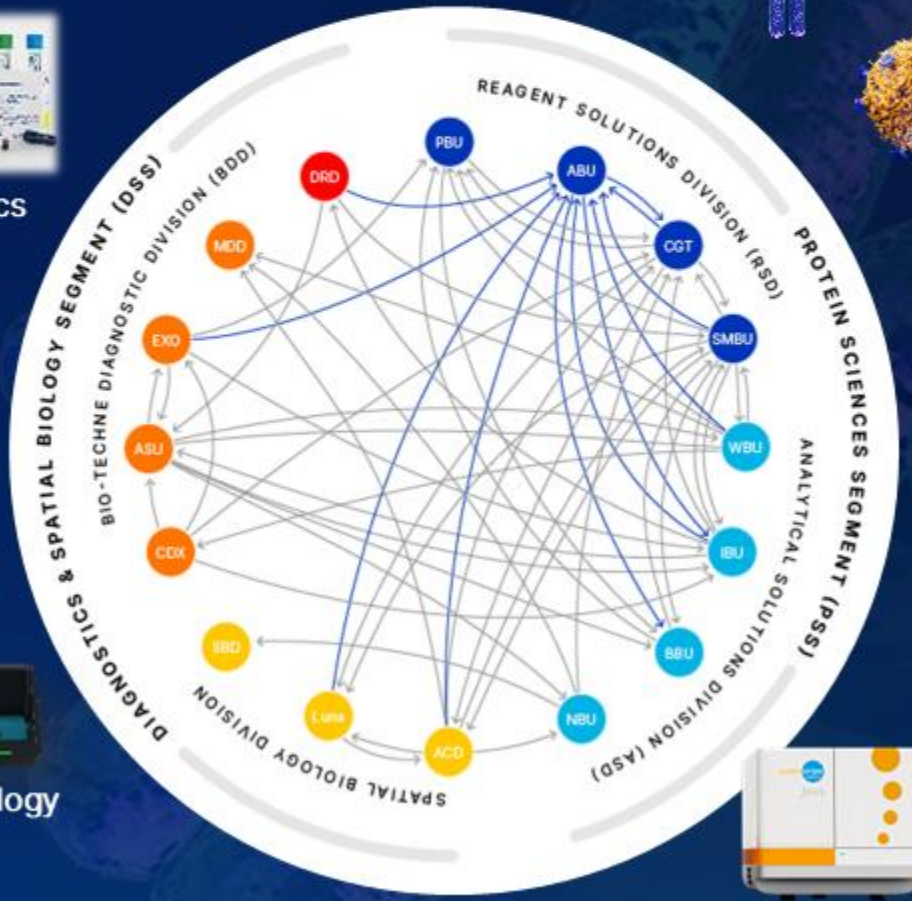
Thank you

Diagnostics

Molecular Diagnostics

Spatial Biology



ELLA: Immunoassay

Maurice: Capillary electrophoresis

Jess/Leo: Automated WB

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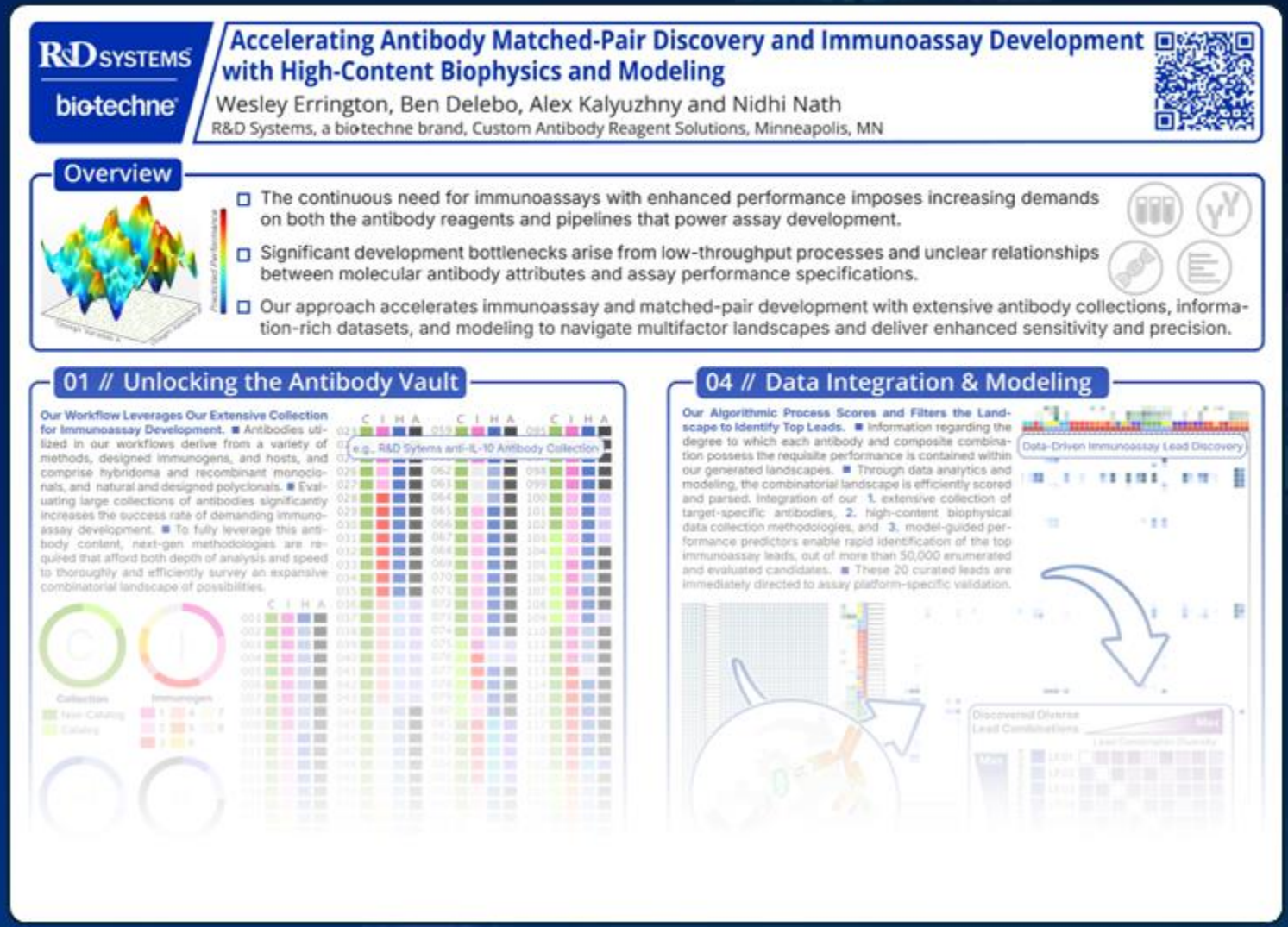
Thank you



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Accelerating Antibody Matched-Pair Discovery and Immunoassay Development with High-Content Biophysics and Modeling

Wesley Errington, Ben Delebo, Alex Kalyuzhny and Nidhi Nath
R&D Systems, a bio-techne brand, Custom Antibody Reagent Solutions, Minneapolis, MN

Overview

- The continuous need for immunoassays with enhanced performance imposes increasing demands on both the antibody reagents and pipelines that power assay development.
- Significant development bottlenecks arise from low-throughput processes and unclear relationships between molecular antibody attributes and assay performance specifications.
- Our approach accelerates immunoassay and matched-pair development with extensive antibody collections, information-rich datasets, and modeling to navigate multifactor landscapes and deliver enhanced sensitivity and precision.

01 // Unlocking the Antibody Vault

Our Workflow Leverages Our Extensive Collection for Immunoassay Development. ■ Antibodies utilized in our workflows derive from a variety of methods, designed immunogens, and hosts, and comprise hybridoma and recombinant monoclonals, and natural and designed polyclonals. ■ Evaluating large collections of antibodies significantly increases the success rate of demanding immunoassay development. ■ To fully leverage this antibody content, next-gen methodologies are required that afford both depth of analysis and speed to thoroughly and efficiently survey an expansive combinatorial landscape of possibilities.

e.g., R&D Sytems anti-IL-10 Antibody Collection

04 // Data Integration & Modeling

Our Algorithmic Process Scores and Filters the Landscape to Identify Top Leads. ■ Information regarding the degree to which each antibody and composite combination possess the requisite performance is contained within our generated landscapes. ■ Through data analytics and modeling, the combinatorial landscape is efficiently scored and parsed. Integration of our **1.** extensive collection of target-specific antibodies, **2.** high-content biophysical data collection methodologies, and **3.** model-guided performance predictors enable rapid identification of the top immunoassay leads, out of more than 50,000 enumerated and evaluated candidates. ■ These 20 curated leads are immediately directed to assay platform-specific validation.

Data-Driven Immunoassay Lead Discovery

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