

Card-Based Spray Pattern Testing

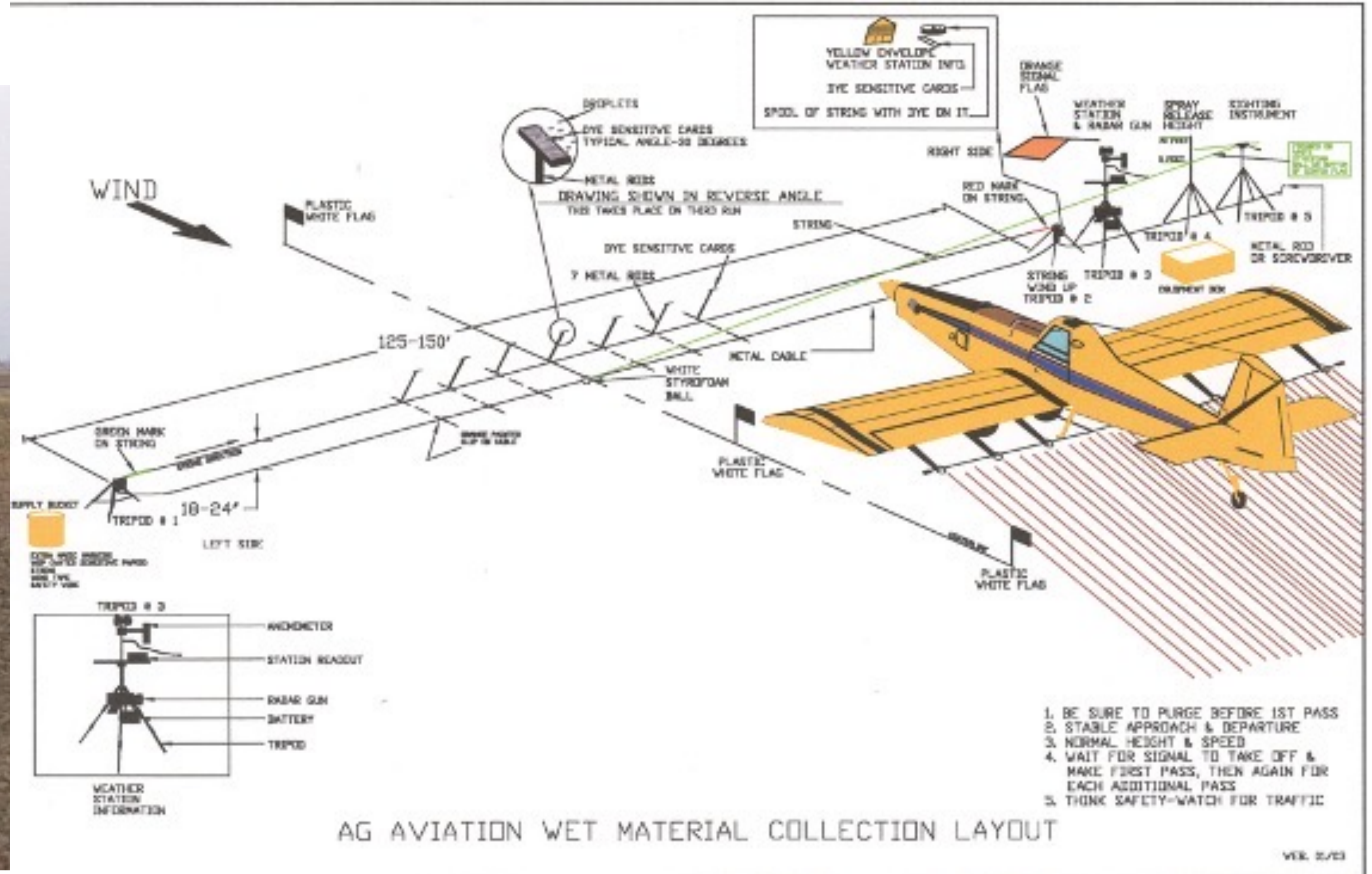
Software Designed for Aerial Applicators to Use



Matt Gill — 5 December 2022

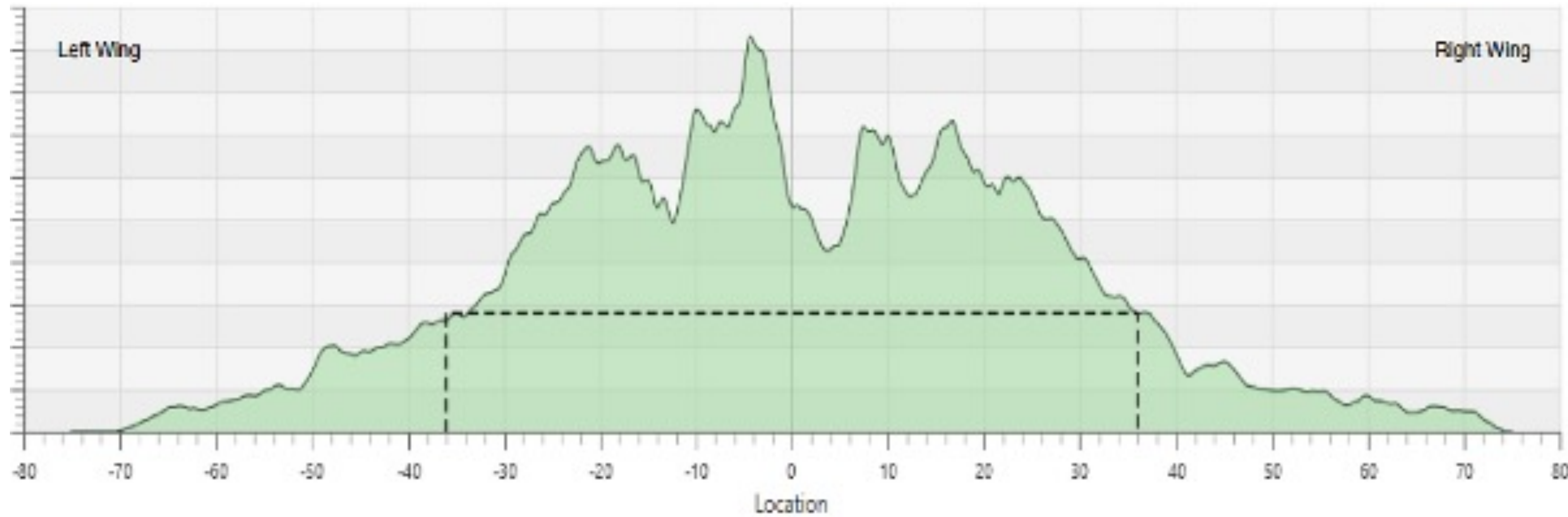
Spray Pattern Testing

Where we are now



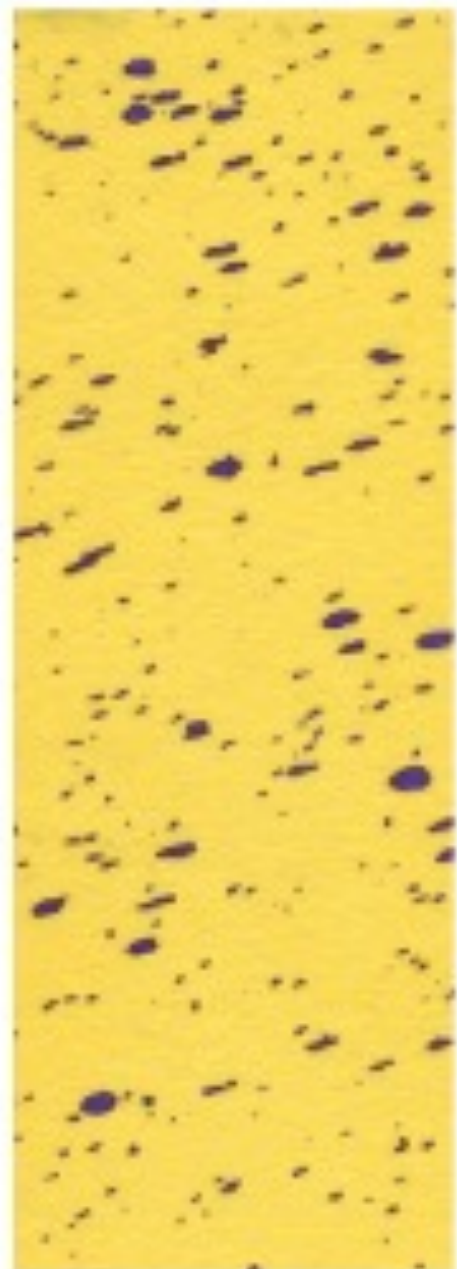
Spray Pattern Testing

Where we are now

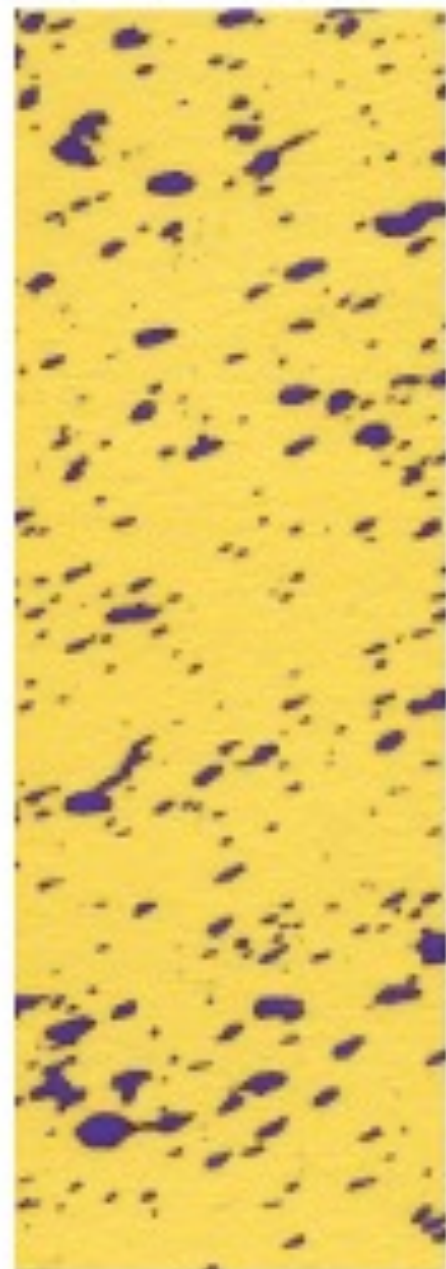


Spray Pattern Testing

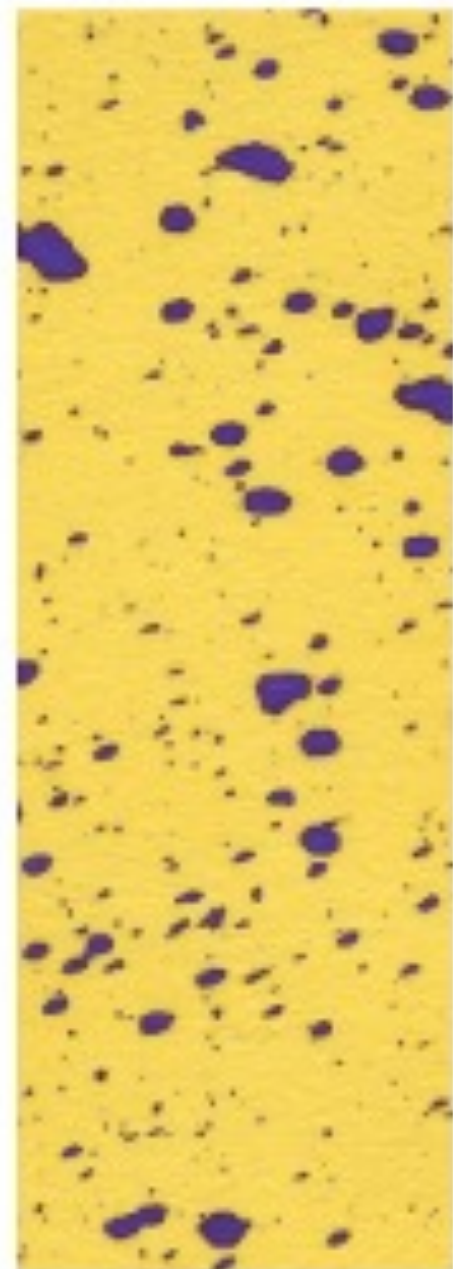
Where we are now



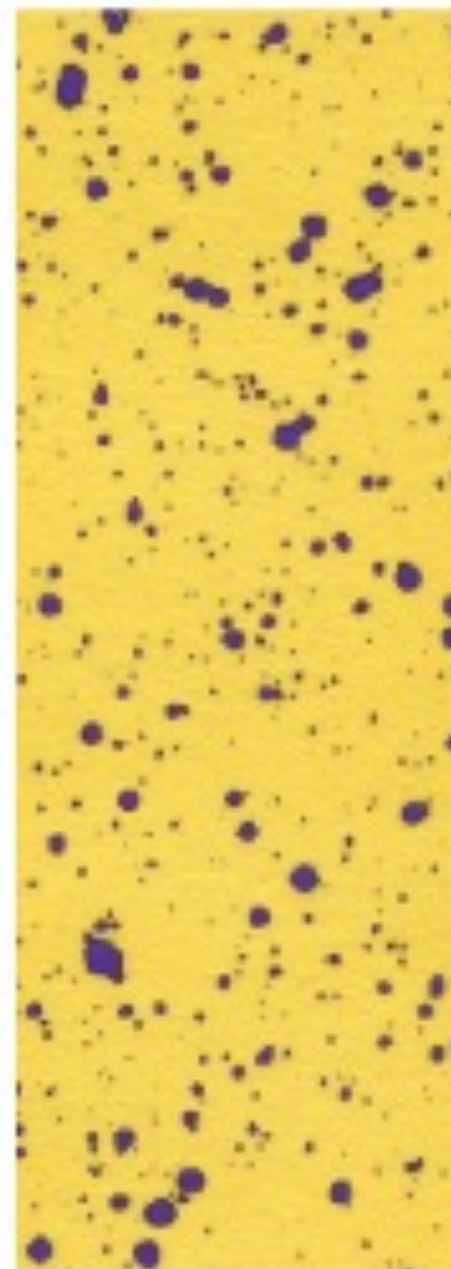
L-32
VMD: 352
DV01: 190
DV09: 434
COV: 4.40%



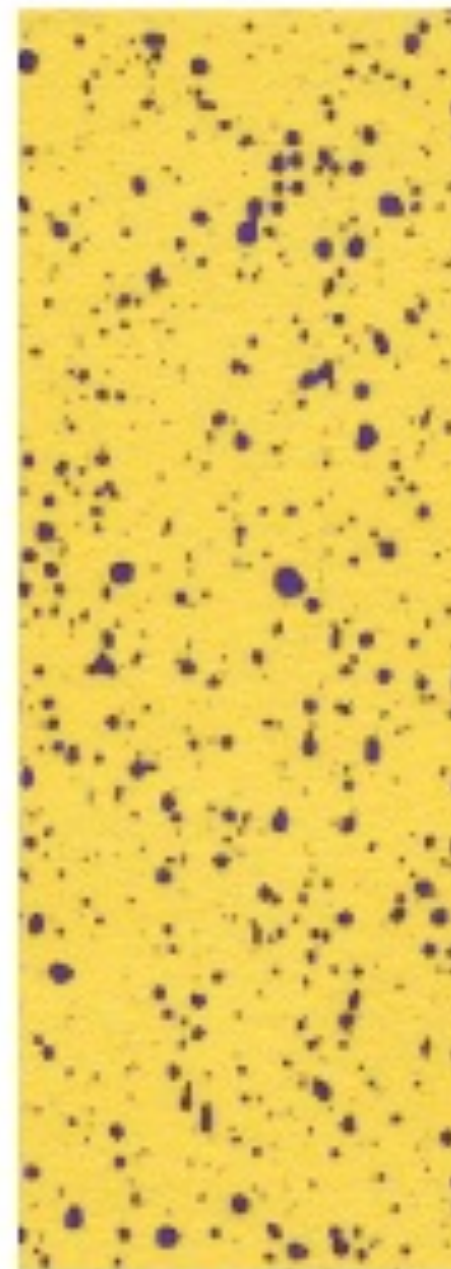
L-24
VMD: 404
DV01: 219
DV09: 582
COV: 9.57%



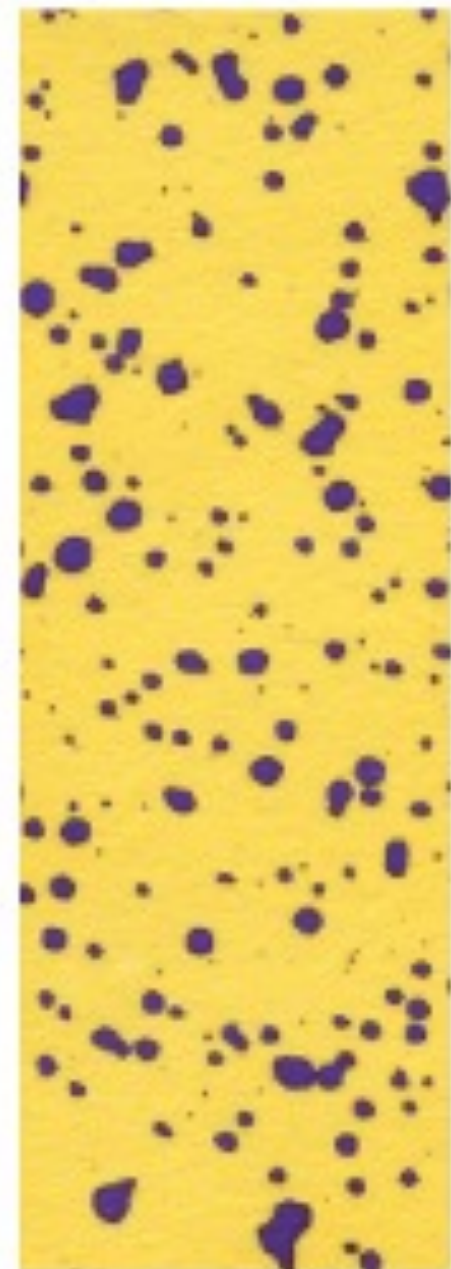
L-16
VMD: 449
DV01: 225
DV09: 603
COV: 8.10%



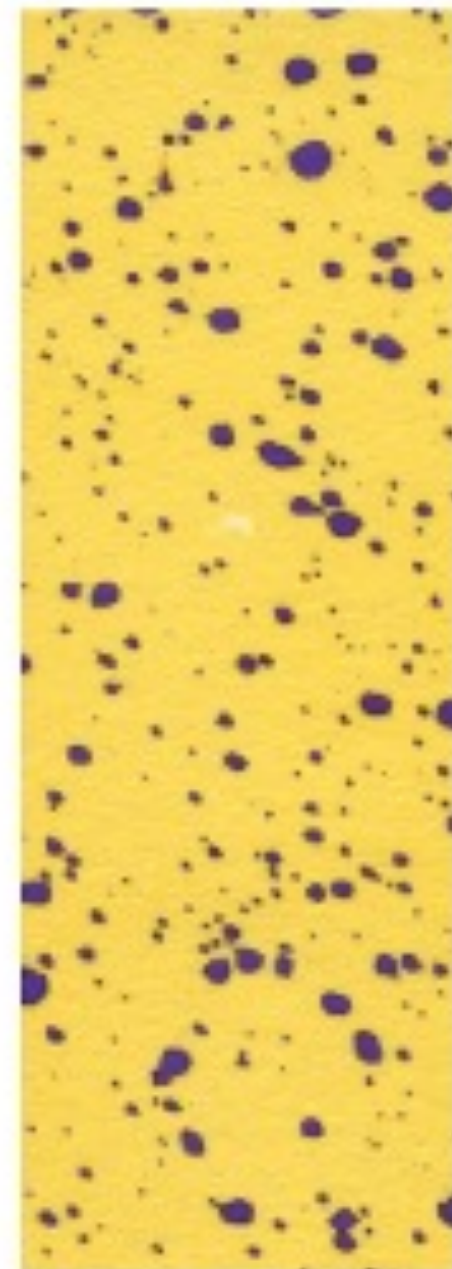
L-8
VMD: 356
DV01: 174
DV09: 524
COV: 7.27%



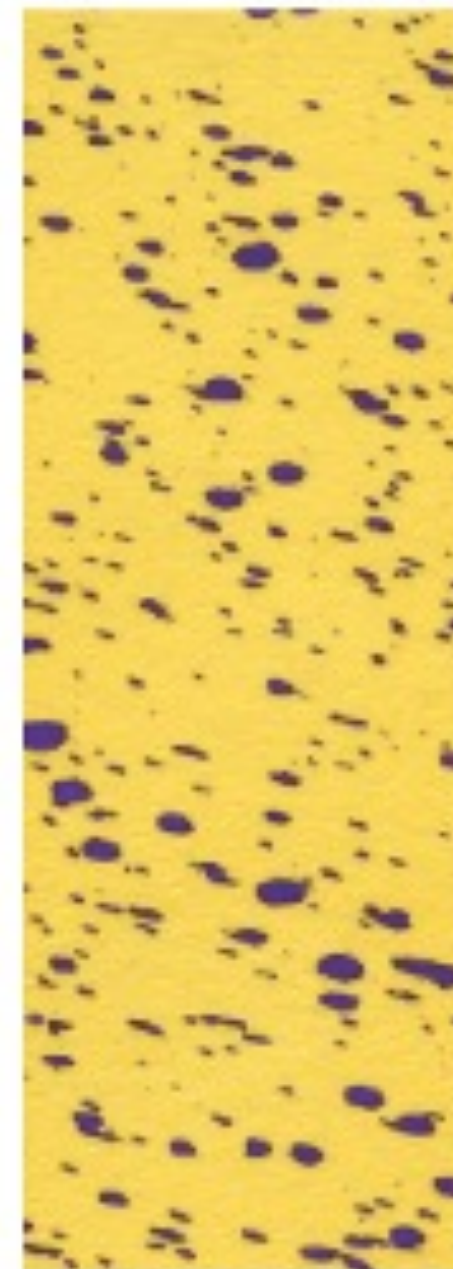
CENTER
VMD: 308
DV01: 181
DV09: 405
COV: 8.06%



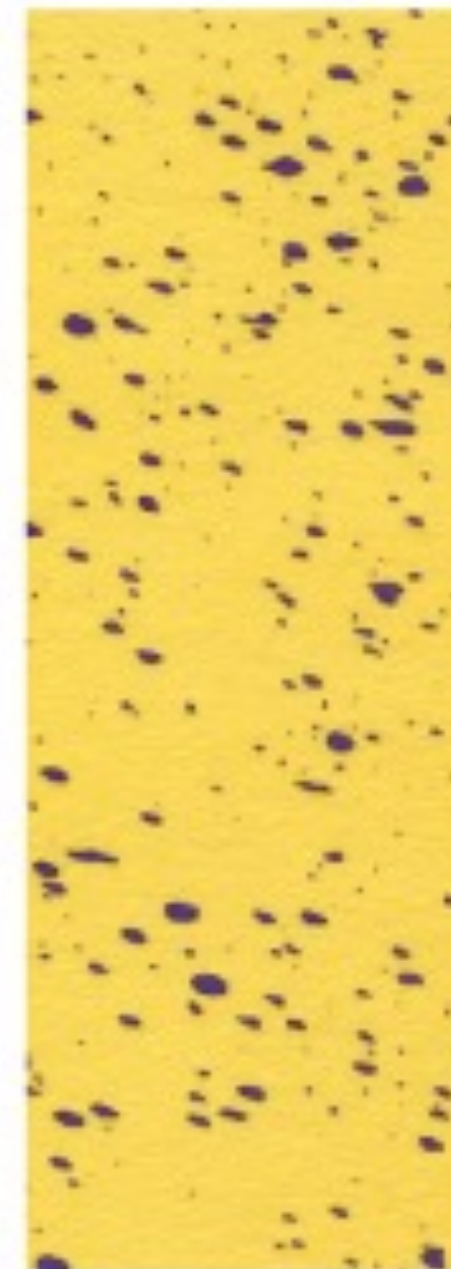
R-8
VMD: 449
DV01: 322
DV09: 572
COV: 11.15%



R-16
VMD: 382
DV01: 230
DV09: 510
COV: 7.99%



R-24
VMD: 377
DV01: 230
DV09: 521
COV: 9.53%



R-32
VMD: 338
DV01: 214
DV09: 436
COV: 5.24%

Using Paper Samplers for Pattern Testing

A Great, if Cumbersome, Alternative

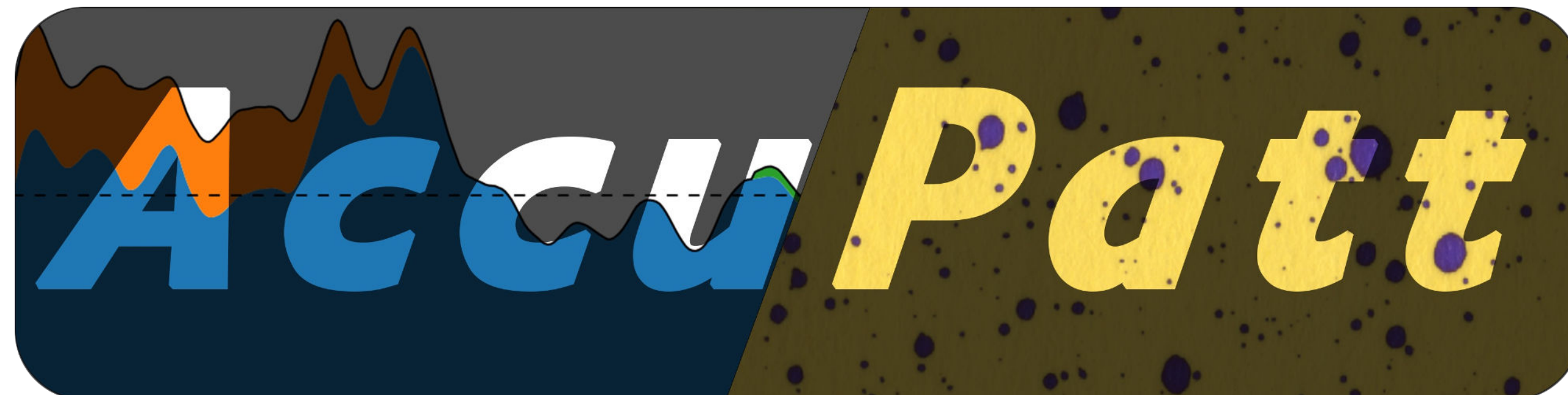
1. Lay out cards at 2-3 ft spacing across a 150 ft sampling line
2. Spray the cards flying into the wind
3. Collect and Scan Cards
4. **Analyze Spray Pattern and Droplet Spectrum with the help of AccuPatt**



AccuPatt - Spray Pattern Testing Software

For Analysts and Applicators

- Same software used by Operation SAFE Analysts for String and Card Analysis
- Can use for card-only testing
- Supports any type of spray-card (and any color dye, as applicable)



AccuPatt 2.0.15

File Options Export to Excel Report Help

Application Info String Analysis Card Analysis

Fly-In Info

Event Name: 2022 Example Fly-In

Location: Fisher, IL

Date: 13 Jul 2022 11 Aug 2022

Analyst(s): Joe Analyst

Aircraft Info

Reg. # / Series: N802EX 1

Aircraft Make: Air Tractor

Aircraft Model: AT-802A

Wingspan: 59 ft

Winglets?: No

Nozzle Info

Nozzle Set 1 + -

Type: CP11TT 40°F

Size: 25

Deflection: 0

Quantity: 54

Applicator Info

Pilot: Dusty Crophopper

Business: Dusty's Fly-On Farming

Street: 123 Airport Rd

City: Anywhersville State: IL

ZIP: 61802 Phone: 2178675309

Email: dusty@dustysflyonfarming.com

Spray System Info

Target Swath: 70 ft

Target Rate: 5 gal/a

Boom Pressure: 45 psi

Boom Width: 43 ft

Boom Drop: 18 in

Nozzle Spacing: 11 in

Pass Observables

Notes

Setup Notes:

Increased pump fan pitch

Analyst Notes (not printed on report):

1st pass appeared visually to not be fully purged; ran a 4th pass

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AccuPatt 2.0.15

File Options Export to Excel Report Help

Application Info String Analysis **Card Analysis**

Individual Passes Composite Simulations Droplet Distribution

Card Data

- Pass 1
- Pass 2
- Pass 3
- Pass 4

Edit Pass 4

Pass Options

- Smooth
- Align Center

Advanced

Series Options

- Smooth Average
- Align Center Average

Advanced

Swath Width: 70 ft

Plot Options

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Last Save: 2022-08-08 14:51:47



AccuPatt 2.0.9

| Name | In Composite | Location | Units | Has Image? | DPI | Threshold Type | Grayscale Method | Grayscale Threshold | Hue | | |
|--------|-------------------------------------|----------|-------|------------|-------------------------------------|----------------|------------------|---------------------|------|-----|----|
| L-32 | <input checked="" type="checkbox"/> | Yes | -32 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| L-24 | <input checked="" type="checkbox"/> | Yes | -24 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| L-16 | <input checked="" type="checkbox"/> | Yes | -16 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| L-8 | <input checked="" type="checkbox"/> | Yes | -8 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| Center | <input checked="" type="checkbox"/> | Yes | 0 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| R-8 | <input checked="" type="checkbox"/> | Yes | 8 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| R-16 | <input checked="" type="checkbox"/> | Yes | 16 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| R-24 | <input checked="" type="checkbox"/> | Yes | 24 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| R-32 | <input checked="" type="checkbox"/> | Yes | 32 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |

SAFE Fly-In (White Cards)

Image Upload Method: One File, Multiple Cards

OK

Observables Image

Pass 4

Ground Speed: 140 mph

Spray Height: 17 ft

Pass Heading: 171 °

Wind Direction: 190 °

Wind Speed: 7 mph

Temperature: 85 °F

Relative Humidity: 37 %



AccuPatt 2.0.12

File

| Name | In |
|--------|--------------------------|
| L-32 | <input type="checkbox"/> |
| L-24 | <input type="checkbox"/> |
| L-16 | <input type="checkbox"/> |
| L-8 | <input type="checkbox"/> |
| Center | <input type="checkbox"/> |
| R-8 | <input type="checkbox"/> |
| R-16 | <input type="checkbox"/> |
| R-24 | <input type="checkbox"/> |
| R-32 | <input type="checkbox"/> |

Image Characteristics

Pixels Per Inch: 1200

Calculated Image Size: 7.8"x7.9"

Single Pixel Width/Height: 21 microns

Image Options

Flip Horizontal:

Flip Vertical:

Acquisition Options

Sampling Area: 70%

Orientation: Horizontal

Order: Increasing

0 2000 4000 6000 8000

-2000 0 2000 4000 6000 8000 10000

Cancel OK

AccuPatt 2.0.9

| Name | In Composite | Location | Units | Has Image? | DPI | Threshold Type | Grayscale Method | Grayscale Threshold | Hue | | |
|--------|-------------------------------------|----------|-------|------------|-------------------------------------|----------------|------------------|---------------------|------|-----|----|
| L-32 | <input checked="" type="checkbox"/> | Yes | -32 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| L-24 | <input checked="" type="checkbox"/> | Yes | -24 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| L-16 | <input checked="" type="checkbox"/> | Yes | -16 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| L-8 | <input checked="" type="checkbox"/> | Yes | -8 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| Center | <input checked="" type="checkbox"/> | Yes | 0 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| R-8 | <input checked="" type="checkbox"/> | Yes | 8 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| R-16 | <input checked="" type="checkbox"/> | Yes | 16 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| R-24 | <input checked="" type="checkbox"/> | Yes | 24 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |
| R-32 | <input checked="" type="checkbox"/> | Yes | 32 | ft | <input checked="" type="checkbox"/> | Yes | 600 | HSB | Auto | 152 | 14 |

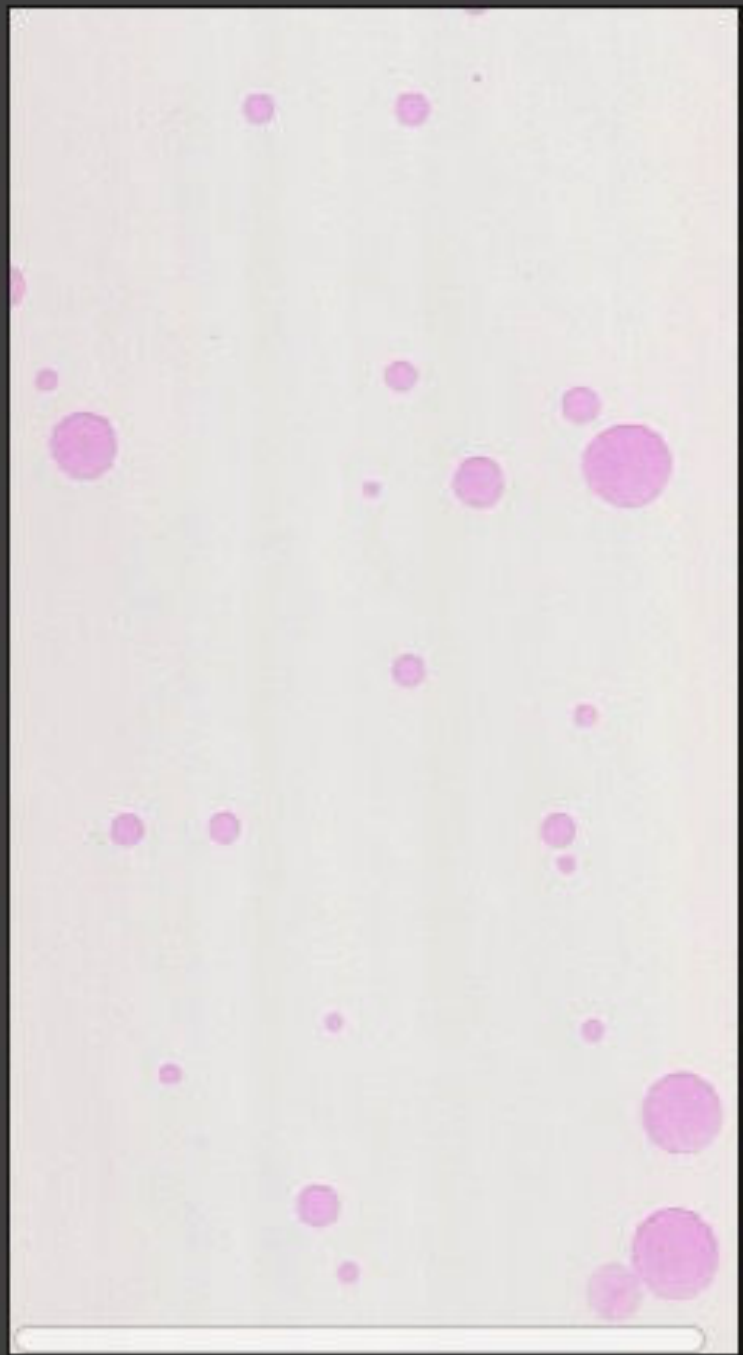
SAFE Fly-In (White Cards)

Image Upload Method: One File, Multiple Cards

Observables **Image**

Pass 4 - L-8

Original **Outline** Processed



Process Options

16:14

Threshold Type: HSB

HSB Threshold Parameters

Hue Pass

0 110

Saturation Pass

9 255

Brightness Pass

0 255

Post-Threshold Processing

Minimum Stain Size (px2): 4

Watershed Segmentation:

Stain Approximation:

None

On Save

Apply to current cards in Pass

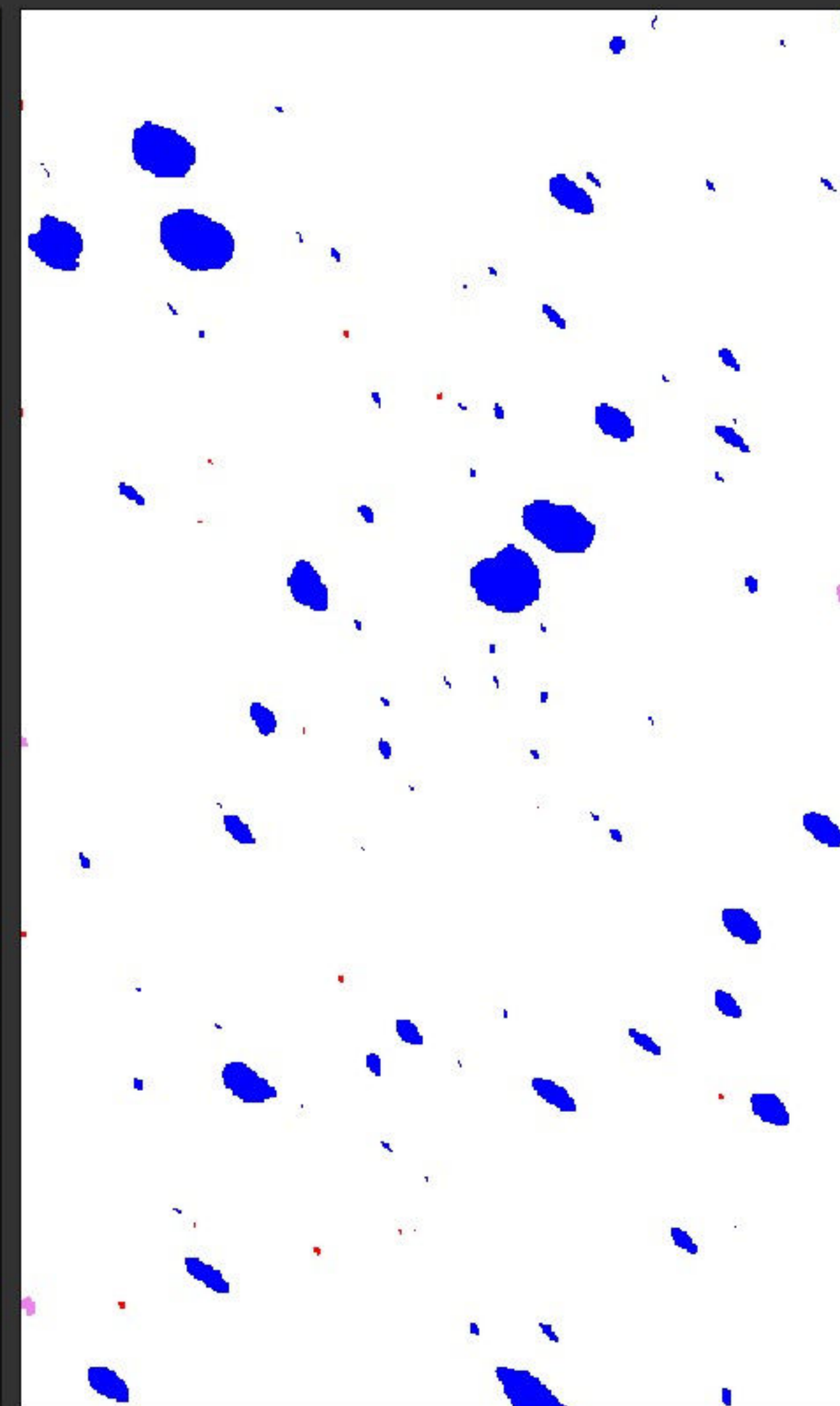
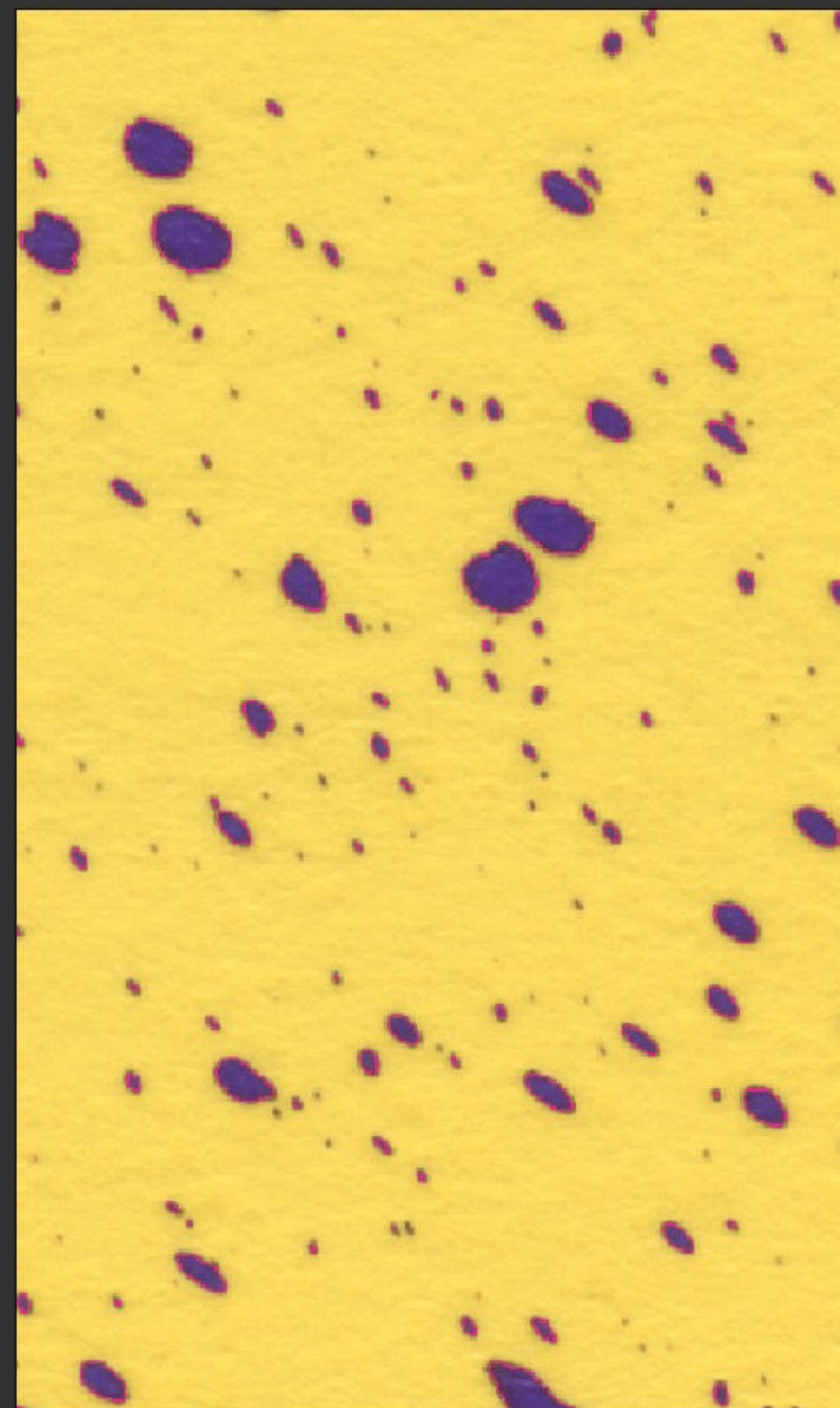
Apply to current cards in series

Update defaults with selection

Restore Defaults

Cancel

Save



AccuPatt 2.0.15

File Options Export to Excel Report Help

Application Info String Analysis **Card Analysis**

Individual Passes Composite Simulations Droplet Distribution

Card Data

- Pass 1
- Pass 2
- Pass 3
- Pass 4

Edit Pass 4

Pass Options

- Smooth
- Align Center

Advanced

Series Options

- Smooth Average
- Align Center Average

Advanced

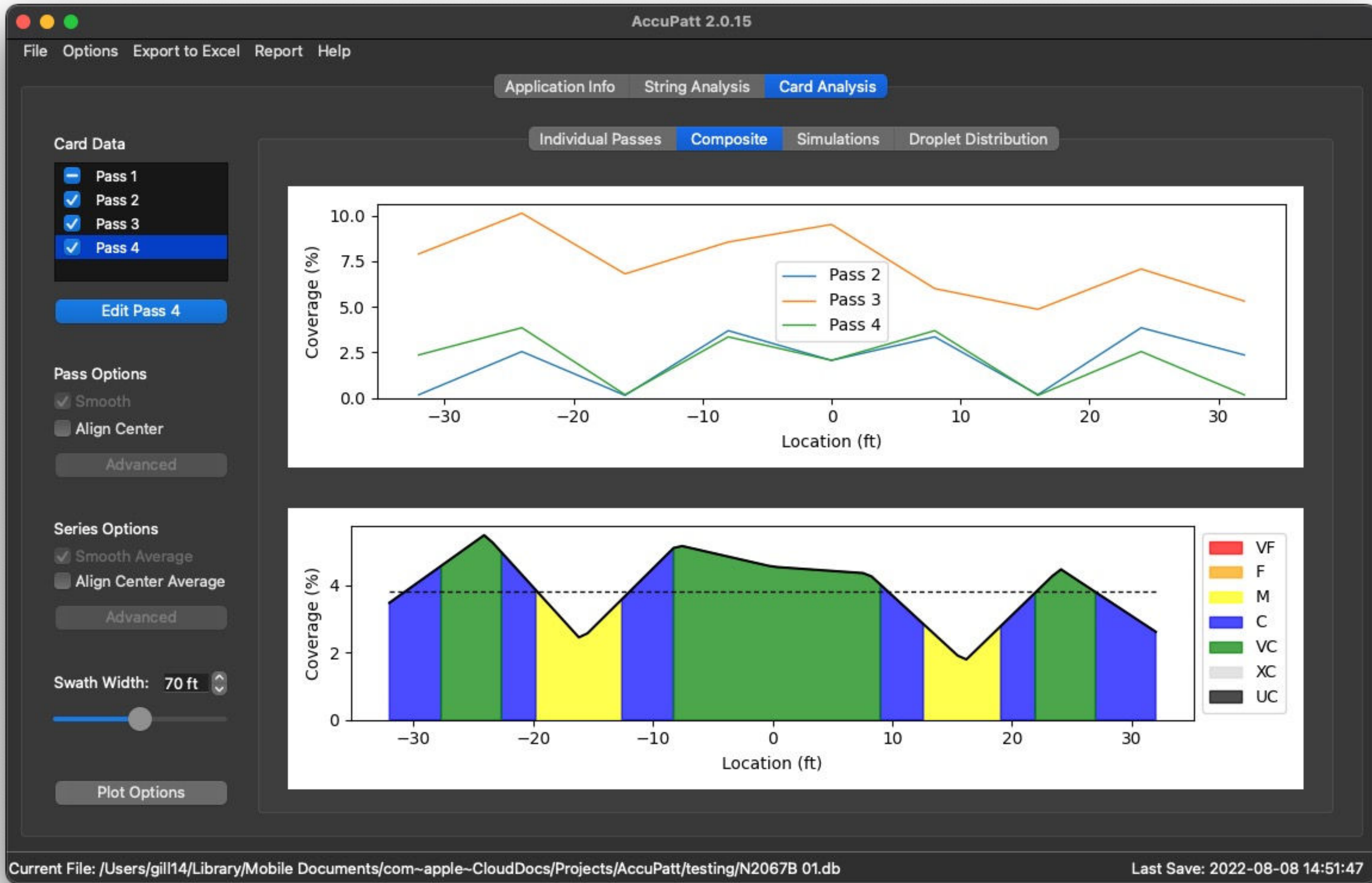
Swath Width: 70 ft

Plot Options

| Name | In Composite | Location | Units | Category | Dv0.1 | Dv0.5 | Dv0.9 | RS | gal/a | Coverage | Stai | |
|--------|-------------------------------------|----------|-------|----------|-------|--------|--------|--------|-------|----------|-------|----|
| L-32 | <input checked="" type="checkbox"/> | Yes | -32 | ft | XC | 366 μm | 549 μm | 637 μm | 0.49 | 0.68 | 2.36% | 28 |
| L-24 | <input checked="" type="checkbox"/> | Yes | -24 | ft | XC | 369 μm | 523 μm | 654 μm | 0.54 | 0.98 | 3.85% | 33 |
| L-16 | <input checked="" type="checkbox"/> | Yes | -16 | ft | M | 193 μm | 274 μm | 302 μm | 0.40 | 0.05 | 0.19% | 9 |
| L-8 | <input checked="" type="checkbox"/> | Yes | -8 | ft | VC | 381 μm | 492 μm | 659 μm | 0.57 | 1.03 | 3.35% | 41 |
| Center | <input checked="" type="checkbox"/> | Yes | 0 | ft | XC | 328 μm | 574 μm | 670 μm | 0.60 | 0.43 | 2.07% | 22 |

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AccuPatt 2.0.15

File Options Export to Excel Report Help

Application Info String Analysis **Card Analysis**

Individual Passes Composite Simulations Droplet Distribution

Card Data

- Pass 1
- Pass 2
- Pass 3
- Pass 4

Edit Pass 4

Pass Options

- Smooth
- Align Center

Advanced

Series Options

- Smooth Average
- Align Center Average

Advanced

Swath Width: 70 ft

Plot Options

Number of Simulated Adjacent Passes (Each Side):

2

Coefficient of Variation

| Swath | RT | B&F |
|-------|------|------|
| 60 ft | 36 % | 38 % |
| 62 ft | 34 % | 35 % |
| 64 ft | 30 % | 32 % |
| 66 ft | 33 % | 33 % |
| 68 ft | 33 % | 33 % |
| 70 ft | 33 % | 33 % |
| 72 ft | 33 % | 33 % |
| 74 ft | 33 % | 33 % |
| 76 ft | 33 % | 33 % |
| 78 ft | 33 % | 33 % |
| 80 ft | 33 % | 33 % |

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AccuPatt 2.0.15

File Options Export to Excel Report Help

Application Info String Analysis **Card Analysis**

Individual Passes Composite Simulations **Droplet Distribution**

Card Data

- Pass 1
- Pass 2
- Pass 3
- Pass 4

Edit Pass 4

Pass Options

- Smooth
- Align Center

Advanced

Series Options

- Smooth Average
- Align Center Average

Advanced

Swath Width: 70 ft

Plot Options

Showing Distribution For:

Pass 2

Pass Composite

| Category | M |
|---------------------|----------------------|
| Dv0.1 | 192 μm |
| Dv0.5 | 342 μm |
| Dv0.9 | 464 μm |
| RS | 0.80 |
| Cov. | 7.33% |
| Area | 9.92 in ² |
| Stains | 2359 |
| D / in ² | 238 |

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| | |
|------------|------------|
| Applicator | [Redacted] |
| | [Redacted] |
| | [Redacted] |
| | [Redacted] |

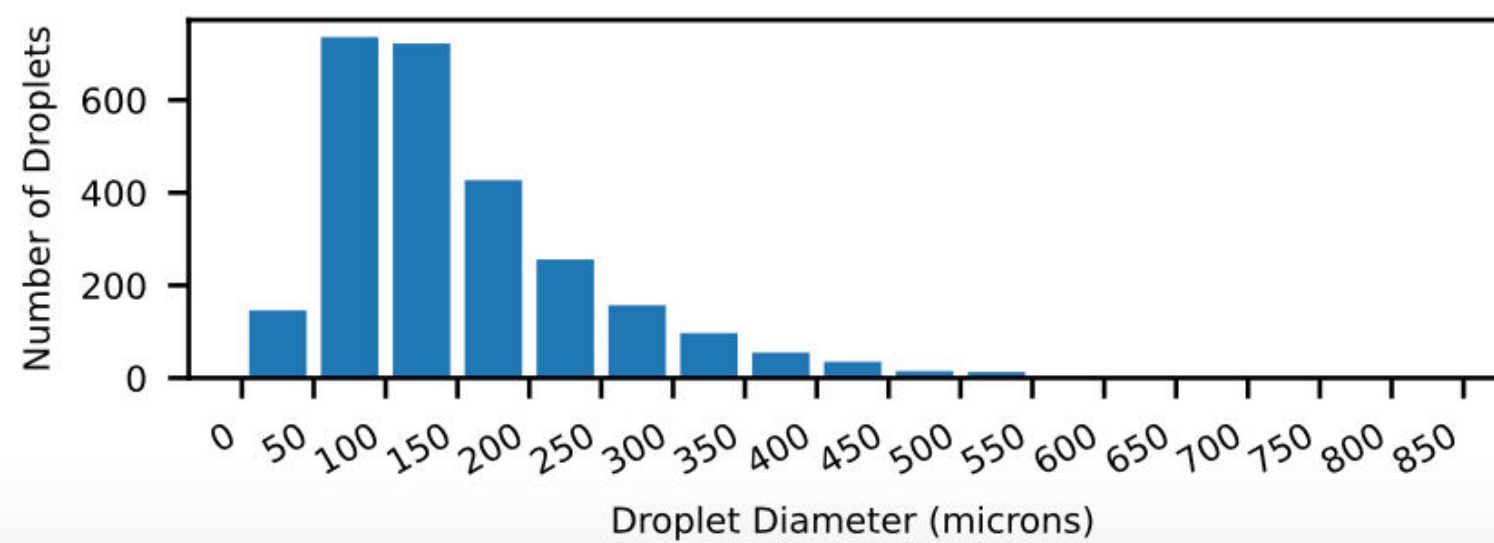
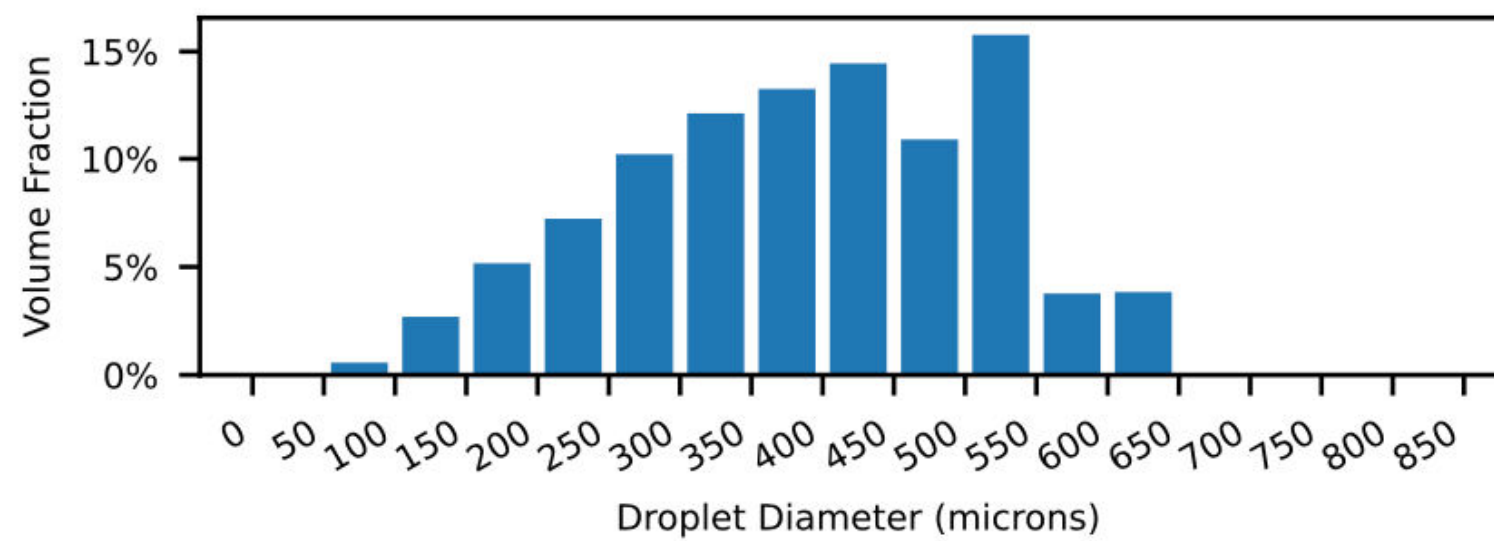
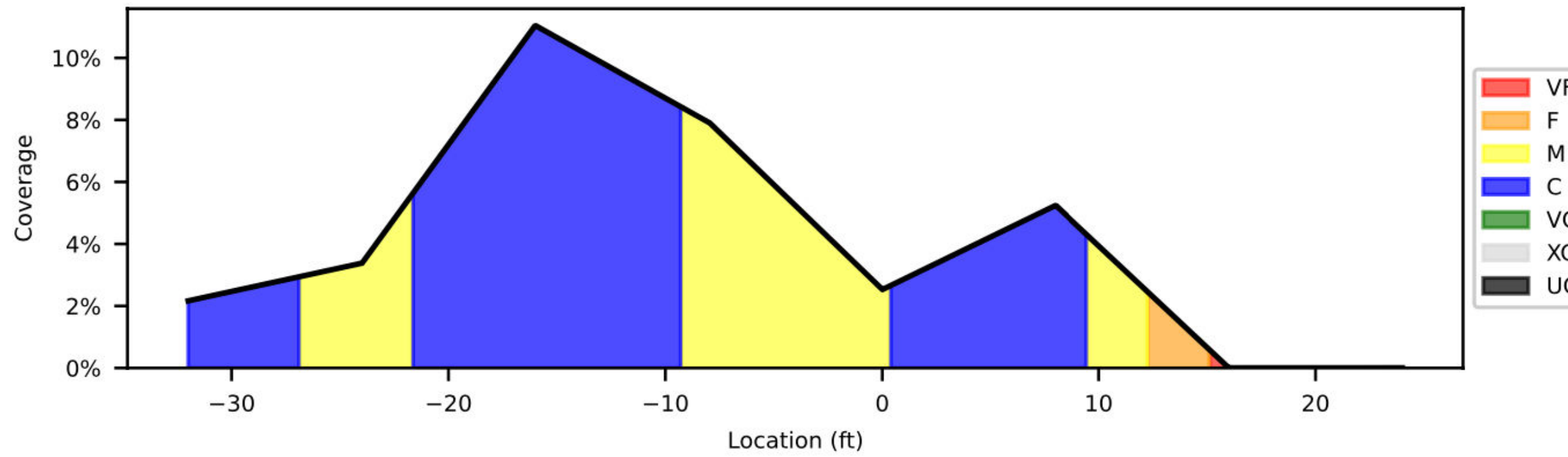
| | | |
|------------|-----------|-------------|
| Aircraft | Reg. #: | [Redacted] |
| | Series: | 2 |
| | Make: | Cessna |
| | Model: | 188 AgWagon |
| | Wingspan: | 42 ft |
| Winglets?: | No | |

| | | |
|-----------------|----------------|---------|
| Spray System | Target Swath: | 70 ft |
| | Target Rate: | 2 gal/a |
| | Boom Pressure: | 29 psi |
| | Boom Width: | |
| | Boom Drop: | |
| Nozzle Spacing: | | |

| | |
|----------------|----------------|
| Nozzles | Set #1 |
| | CP03 @ 30° |
| | Orif#0.078 x33 |
| | Set #2 |
| CP03 @ 30° | |
| Orif#0.062 x10 | |

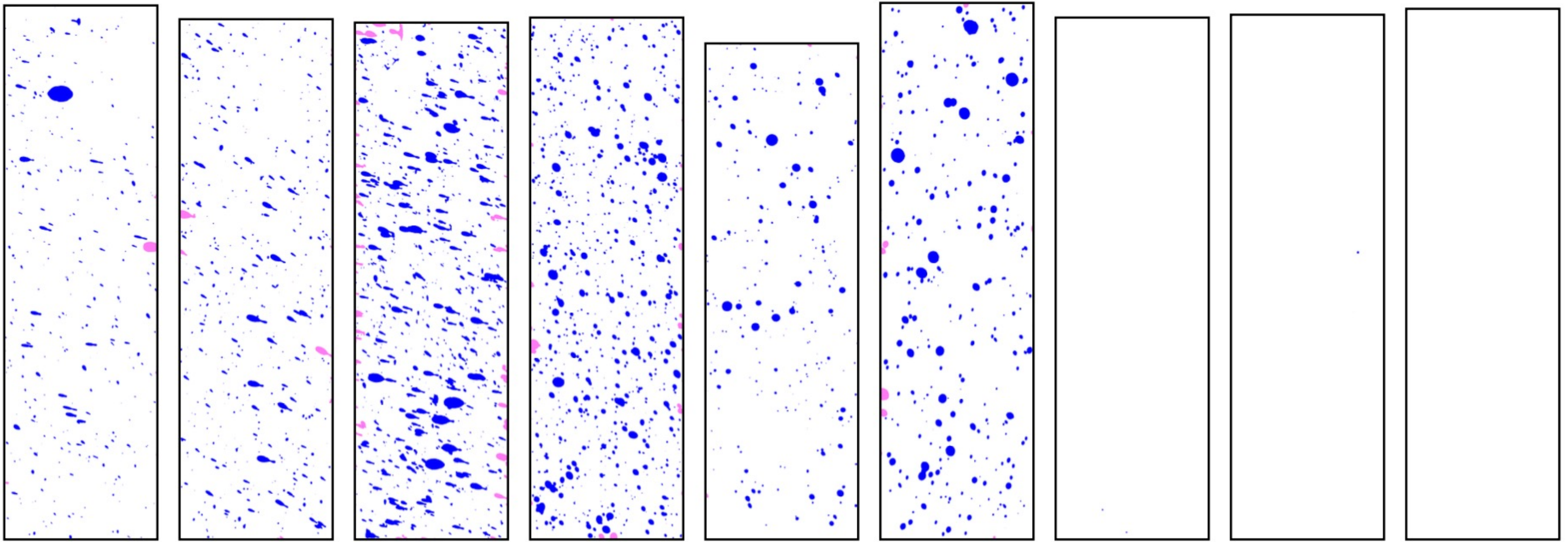
| Observables | Pass 3 | Average | |
|-------------|---------------|---------|---------|
| | Airspeed: | 130 | 130 mph |
| | Spray Height: | 11 | 11 ft |
| | Wind Speed: | 7 | 7 mph |
| | X-Wind Speed: | 3.7 | 3.7 mph |
| | Temperature: | 84 | 84 °F |
| | Humidity: | 38 | 38% |

Setup Notes
Turned 5 EA side to smaller orifice to get pressure up



| Composite - Pass 3 | Category | Measured ^{1,2} | USDA Model ³ |
|--------------------|---------------------|-------------------------|-------------------------|
| | Dv0.1 | 209 μm | - |
| | Dv0.5 | 395 μm | - |
| | Dv0.9 | 530 μm | - |
| | RS | 0.81 | - |
| | Cov. | 3.60% | |
| | Area | 15.83 in ² | |
| | Stains | 2662 | |
| | D / in ² | 168 | |

¹ Based on inputs, minimum detectable droplet diameter is 28 μm.
² Measured Droplet Spectrum Category is calculated with reference nozzle data, and should not be considered absolute.
³ USDA Model flow-weighted and interpolated composite calculation based on stated nozzle configuration and quantities.



| L-32 | | L-24 | | L-16 | | L-8 | | Center | | R-8 | | R-16 | | R-24 | | R-32 | |
|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| DSC | C | DSC | M | DSC | C | DSC | M | DSC | M | DSC | C | DSC | VF | DSC | F | DSC | |
| Dv0.1 | 173 μm | Dv0.1 | 173 μm | Dv0.1 | 252 μm | Dv0.1 | 194 μm | Dv0.1 | 209 μm | Dv0.1 | 220 μm | Dv0.1 | 100 μm | Dv0.1 | 152 μm | Dv0.1 | |
| VMD | 409 μm | VMD | 329 μm | VMD | 427 μm | VMD | 345 μm | VMD | 355 μm | VMD | 415 μm | VMD | 100 μm | VMD | 152 μm | VMD | |
| Dv0.9 | 583 μm | Dv0.9 | 439 μm | Dv0.9 | 529 μm | Dv0.9 | 462 μm | Dv0.9 | 472 μm | Dv0.9 | 529 μm | Dv0.9 | 103 μm | Dv0.9 | 152 μm | Dv0.9 | |
| RS | 1.00 | RS | 0.81 | RS | 0.65 | RS | 0.78 | RS | 0.74 | RS | 0.74 | RS | 0.03 | RS | 0.00 | RS | 0.00 |
| Cov. | 2.17% | Cov. | 3.37% | Cov. | 11.05% | Cov. | 7.93% | Cov. | 2.53% | Cov. | 5.25% | Cov. | 0.00% | Cov. | 0.01% | Cov. | 0 |
| Area | 1.72 in^2 | Area | 1.77 in^2 | Area | 1.78 in^2 | Area | 1.76 in^2 | Area | 1.86 in^2 | Area | 1.71 in^2 | Area | 1.76 in^2 | Area | 1.75 in^2 | Area | 1.72 in^2 |
| St. | 301 | St. | 448 | St. | 690 | St. | 713 | St. | 239 | St. | 268 | St. | 2 | St. | 1 | St. | 0 |
| St./ in^2 | 175 | St./ in^2 | 253 | St./ in^2 | 387 | St./ in^2 | 405 | St./ in^2 | 128 | St./ in^2 | 157 | St./ in^2 | 1 | St./ in^2 | 1 | St./ in^2 | 0 |

What To Do Next

Your Data Is Yours, But SAFE Analysts Can Help

- Print or save your report
- Consult with an Operation SAFE Analyst if:
 1. You have questions about addressing problems with your pattern
 2. You would like a second opinion
 3. You would like to have them record your official participation in Operation SAFE



Card-Based Spray Pattern Testing

Software Designed for Aerial Applicators to Use



Matt Gill

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