



Inkjet Optimization
Yair Kipman: President



Outline

1. Key considerations and tools for inkjet development
 - Overview
 - Ink Development
 - Waveform Design
 - Overview of Development System

2. Inkjet analysis examples:
 - Drop formation
 - Drop measurement
 - Waveform optimization: pulse width, damping, and voltage
 - Inkjet performance testing: frequency, consistency, and sustainability
 - Print quality: Line/edge, bleed, text, dots, and skew/stretch
 - Missing jets
 - Nozzle inspection

3. Questions?



Key Considerations for Inkjet Development: Overview



Printhead

- Nozzle Geometry
- Fluid Compatibility
- Native Resolution
- Native Drop Size
- Max Firing Frequency
- Recirculating
- Greyscale
- Nozzle Coating



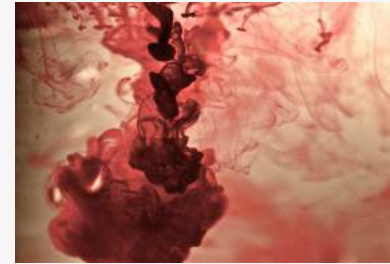
Substrate

- Application Requirements
- Colorfastness
- Required Durability
- Coating



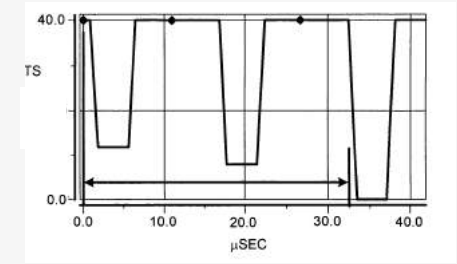
Conditions

- Distance to Substrate
- Firing Frequency
- Idle Time
- Humidity
- Meniscus Pressure
- Ink Temperature



Ink Formulation

- Surface Tension
- Viscosity
- Rheology
- Particle Size
- Drying Speed
- Application Requirements



Waveform

- Voltage
- Pulse Width
- Pulse Spacing
- Rise/Fall Time
- Greyscale



Key Considerations for Inkjet Development: Printhead Selection



Key considerations for selecting a printhead:

- Must be compatible with ink type to be used: UV, solvent, aqueous, or other (metal, etc).
- Must be able to achieve desired print resolution (using multiple printheads, if needed).
- Must be able to print at required frequency.
- Must be able to jet drops of the needed size and velocity.
- Depending on ink formulation and application, may need to be recirculating.



Key Considerations for Inkjet Development: Substrate Selection

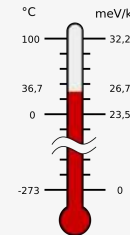
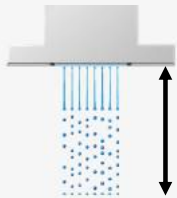


Substrate selection is often primarily driven by the needs of the application, and is often not under the control of ink manufacturers. Nevertheless, substrate selection affects print quality. Key considerations:

- How will ink interact with this substrate? Common problems resulting from poor drop-substrate interaction include bleeding, mottle, pooling, strike through, and color-shifting.
- Could a coating improve the performance of the substrate?
- Does the printed substrate meet colorfastness and durability requirements?



Key Considerations for Inkjet Development: Jetting Conditions

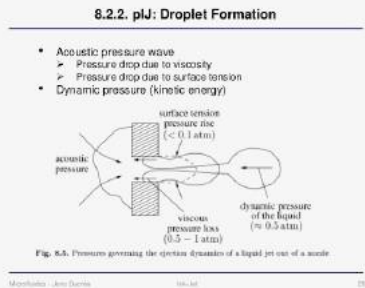


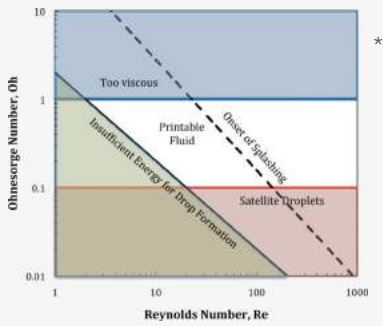
Some conditions may be under the control of the ink developer, and others are determined by the application. Many of these factors impact ink and waveform design. For example:

- A longer throw distance requires larger, faster drops.
- Long idle times require ink designs that limit latency/decap, by reducing solvent evaporation.
- Production conditions, including firing frequencies, should match test conditions.
- Ink temperature adjustments can be used to fine tune ink viscosity and surface tension.

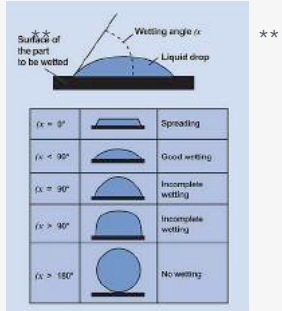


Key Considerations for Inkjet Development: Ink Formulation





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Inkjet Ink must jet well, interact with the substrate well, and also meet the performance needs of the application. Key ink characteristics include:

- Viscosity and surface tension (should be within proper range required for the printhead to be used, usually somewhere in the range of 10-30 cPs, and 20-70 dynes/cm).
- Solids content (pigment, dye, etc).
- Resistance to evaporation
- Substrate interaction
- Viscoelasticity, and other non-newtonian characteristics
- Application requirements, including longevity, durability, etc.

*Adapted from Wolfgang von Ohnesorge, McKinley & Renardy (2011) ** Adapted from Innovating Inkjet Technologies for Plastic Products, Sabreen & Taylor, 2013

*** Microfluidics - Jens Duerr

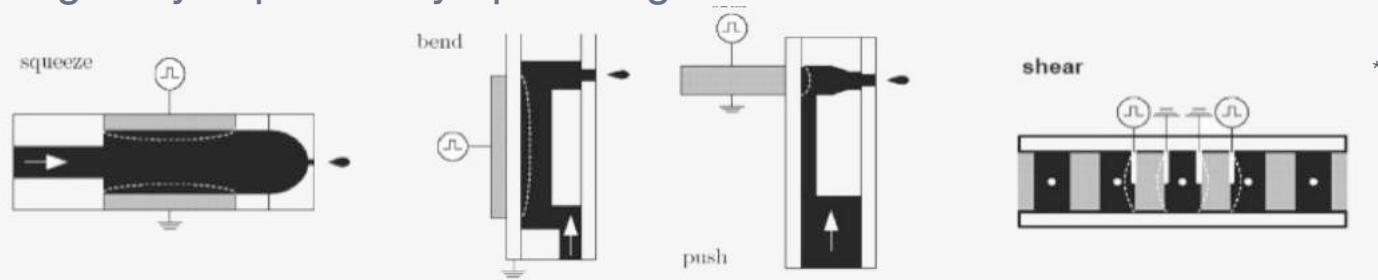


Key Considerations for Inkjet Development: Waveform Design

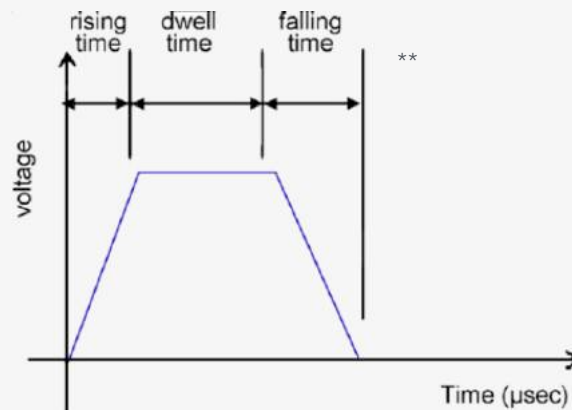


Waveforms are usually designed in conjunction with ink. Often, an ink's jetting performance can be greatly improved by optimizing the waveform.

Nozzle Types:



Basic Waveform:

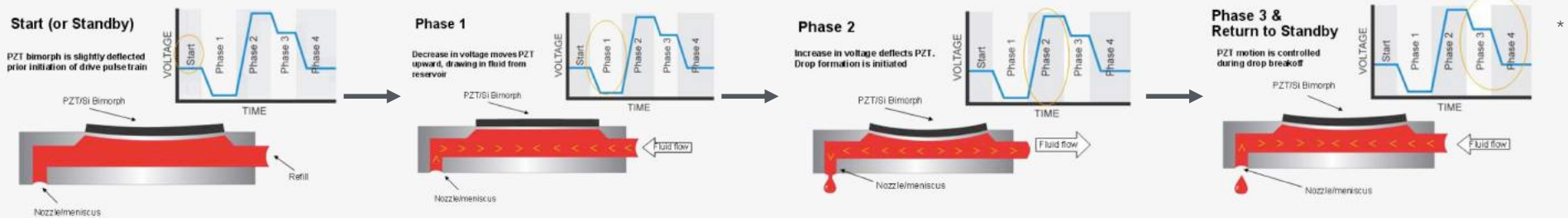


*Adapted from The Dynamics of the Piezo Inkjet Printhead Operation, Wijshoff (2010) **Adapted from Fundamentals of Inkjet printing: The Science of Inkjet and Droplets. SD Hoath(Ed) Wiley-VCH (2016)

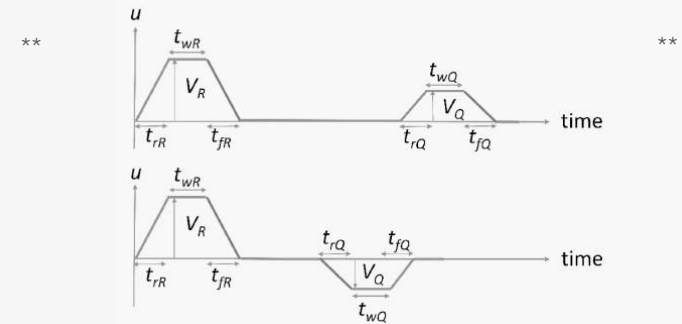
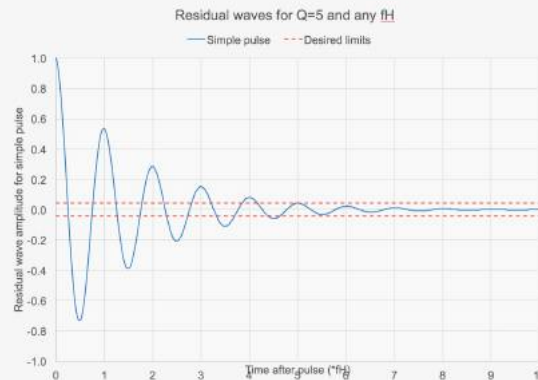
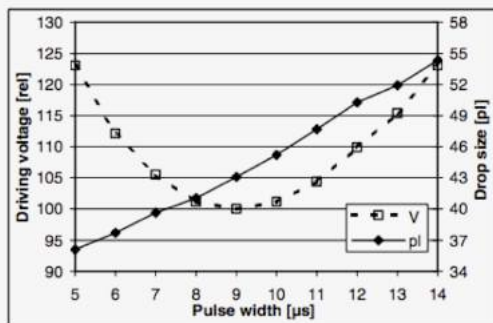


Key Considerations for Inkjet Development: Waveform Design

How a Waveform Works:



Optimization:



*Adapted from Inkjet printing of high molecular weight PVDF-TrFE for flexible electronics, Haque, Vie, Germainy & Boddaert (2015)

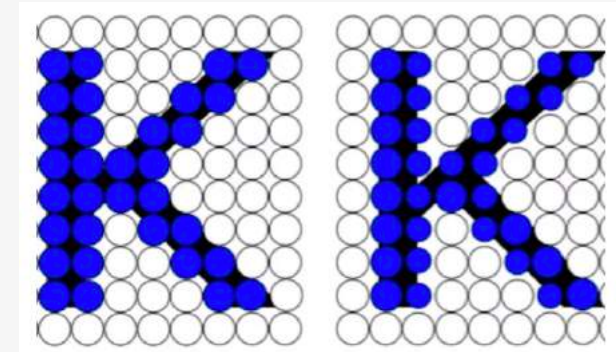
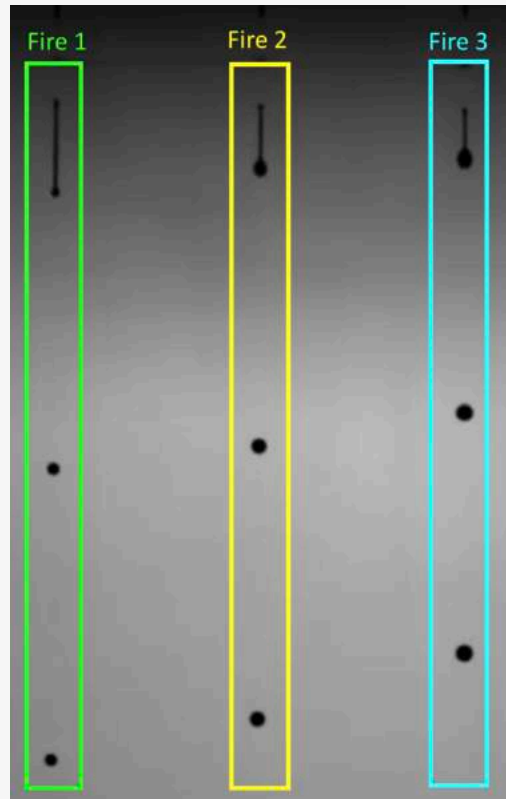
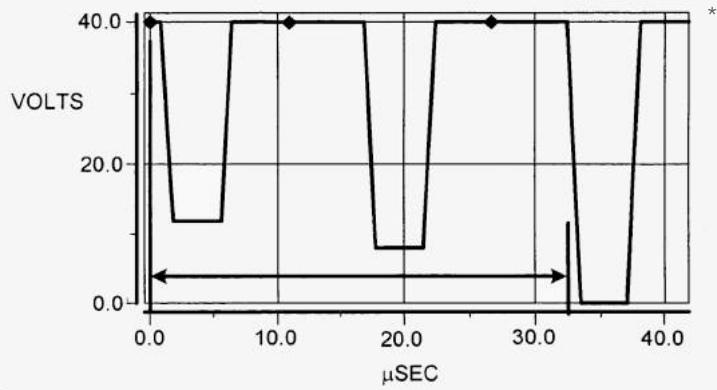
**Adapted from Fundamentals of Inkjet printing: The Science of Inkjet and Droplets, SD Hoath(Ed) Wiley-VCH (2016)



Key Considerations for Inkjet Development: Waveform Design



Greyscale:



*Patent Drawing



Testing Inkjet Performance JetXpert Print Station



JetXpert drop measurement system

Variable print speed up to 2m/s

Vacuum-secured sample

Camera to inspect print quality

Available with a belt or linear stage



Testing Inkjet Performance JetXpert Print Station



JetXpert drop measurement system

Variable print speed up to 2m/s

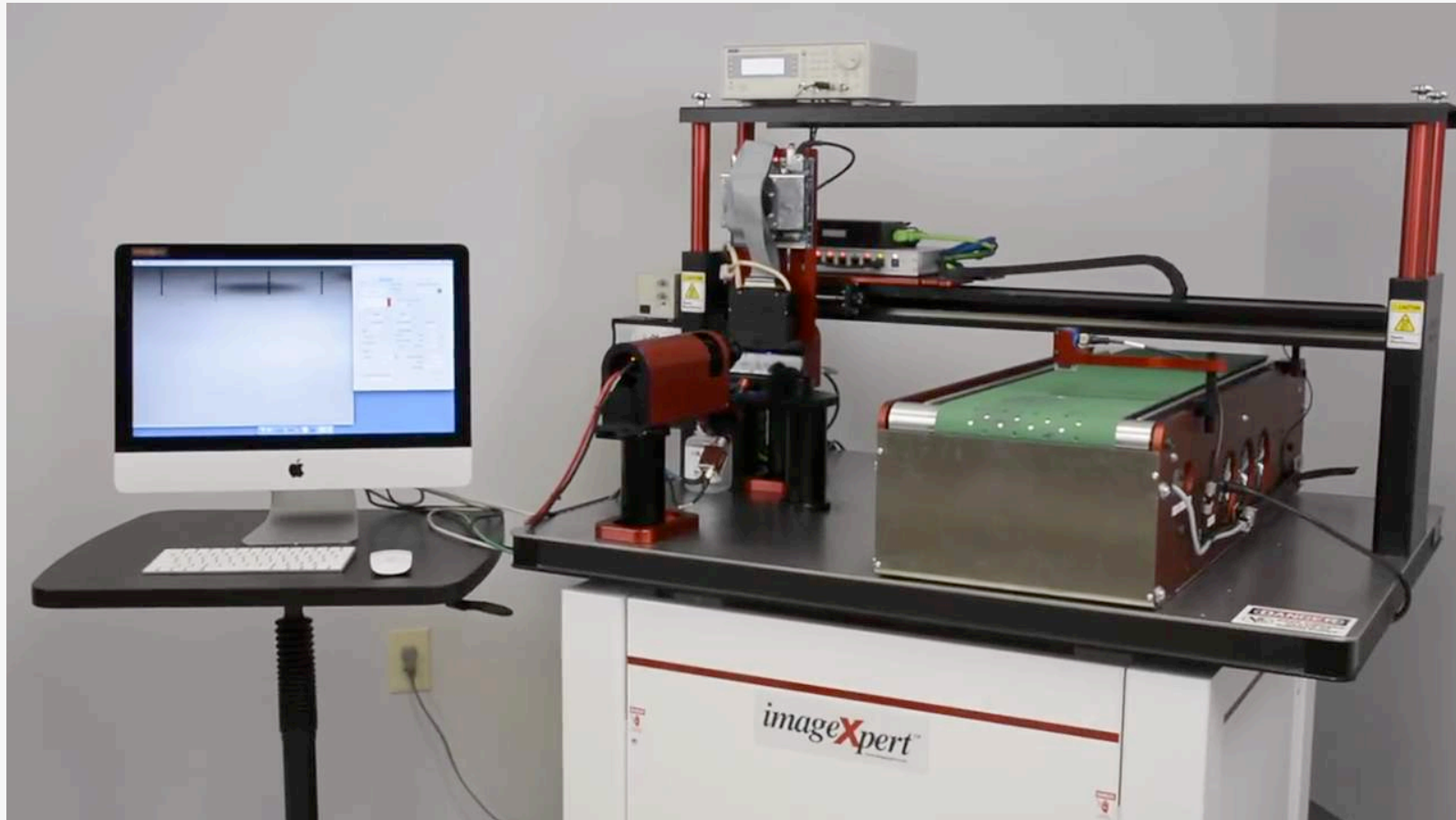
Vacuum-secured sample

Camera to inspect print quality

Available with a belt or linear stage

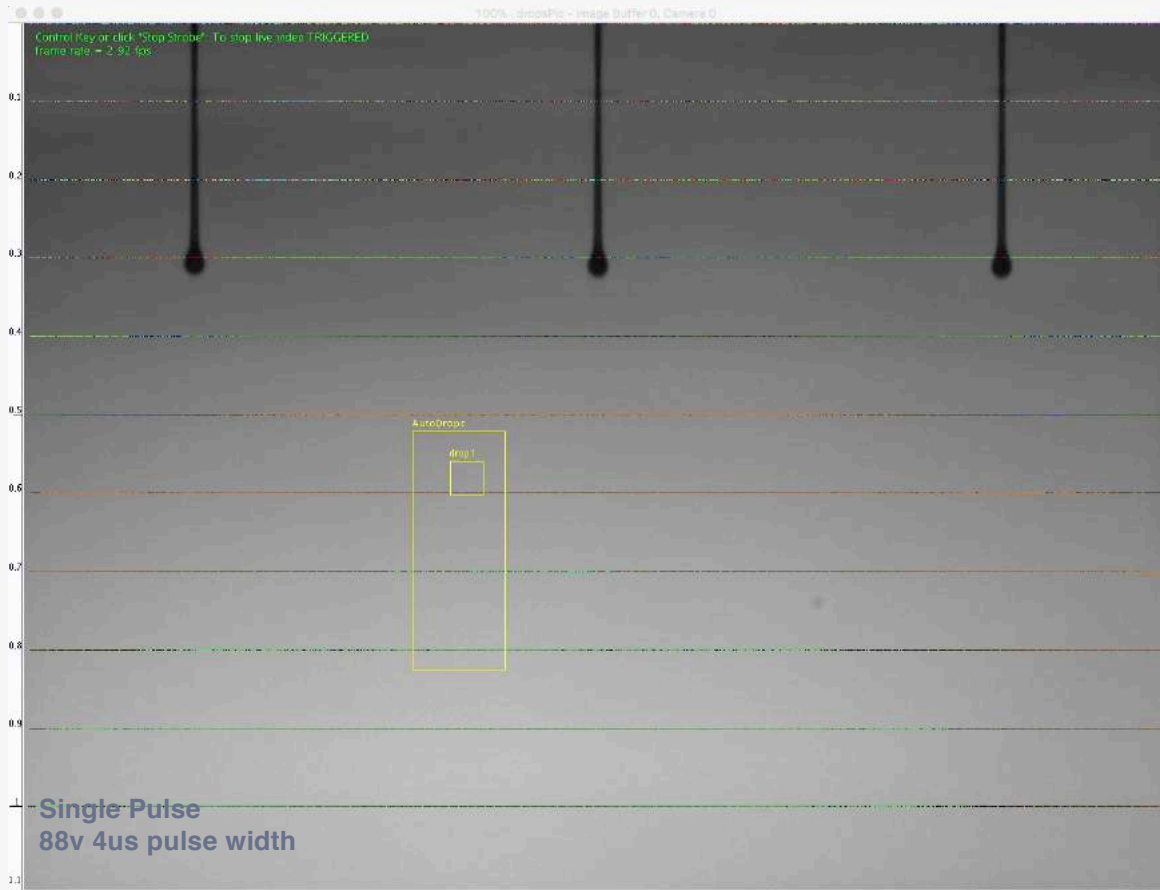


Testing Inkjet Performance JetXpert Print Station





Testing Inkjet Performance: Drop Formation



JetXpert®

Standard Advanced Motion Tasks Stitch NozzleXaminer

Stop Strobe

Pulse Type
 Single Double

Variable Delay

Strobe Delay
Delay 1
201.15 μ s

Use Freq for vel. meas.
1.0 kHz

Brightness
Pulse Width 750 ns
Intensity 80

Start 29.9 μ s
End 220.15 μ s
Step Size 5 μ s
Wetting Shutter 0.4 ms

Analysis
Default Drops
Analyze Now
Analyze Multiple
Zero Statistics

Move ROI

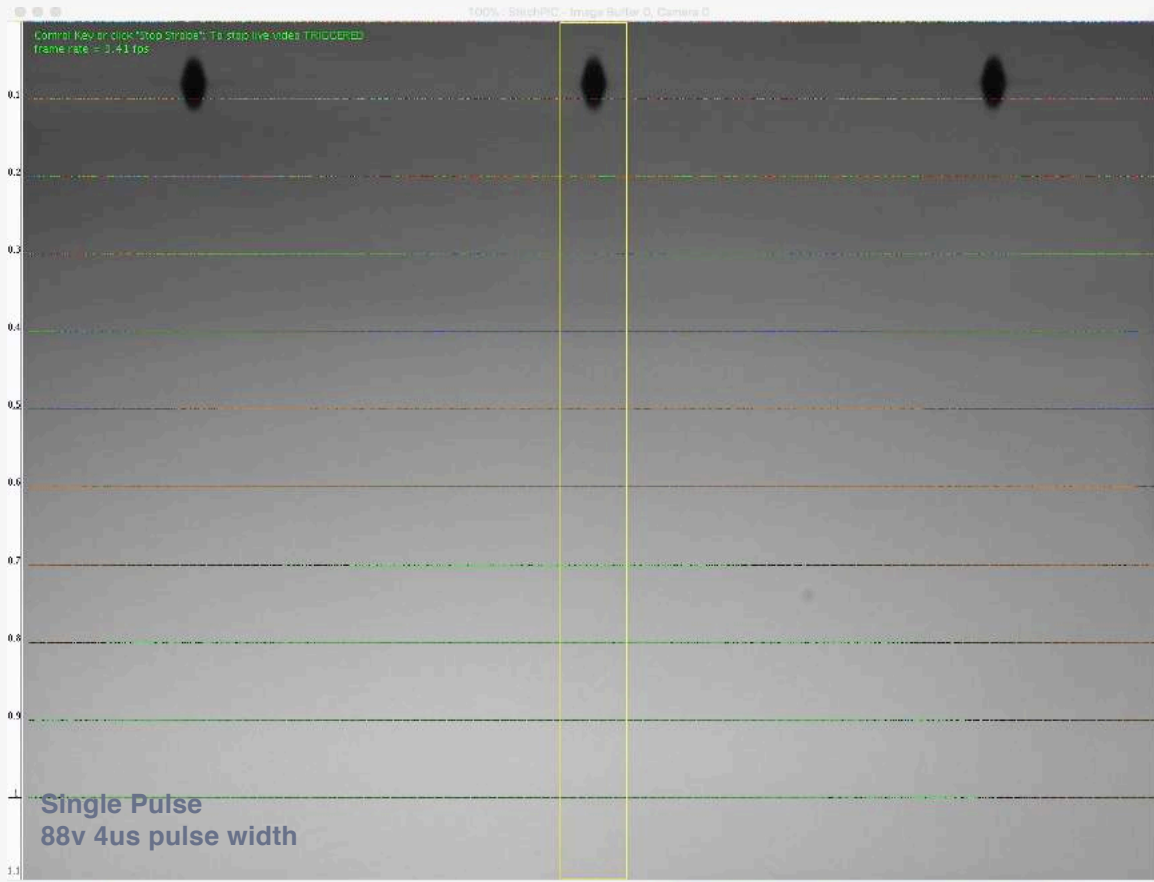
Data File Name 83v.xls
Exp ID expID
Comments

Image/Movie
JetXpert Cam
Start Recording
Save Image

Image/Movie Name movie
 Use timestamp as name



Testing Inkjet Performance: Drop Formation



JetXpert®

Standard Advanced Motion Tasks Stitch NozzleXaminer

Stitch 39 / 39 images

Stitching...

Image/Movie Name movie

Use timestamp as name

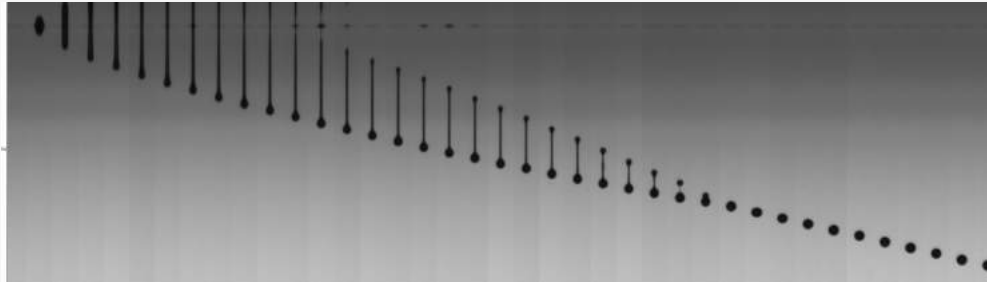
The figure shows the JetXpert software interface. It has a title bar 'JetXpert®' and several tabs: 'Standard', 'Advanced', 'Motion', 'Tasks', 'Stitch', and 'NozzleXaminer'. The 'Stitch' tab is active, showing 'Stitch 39 / 39 images'. Below this, there is a large area with the text 'Stitching...'. At the bottom, there is a text field for 'Image/Movie Name' containing the word 'movie' and a checked checkbox for 'Use timestamp as name'. The bottom half of the window has a blue background.



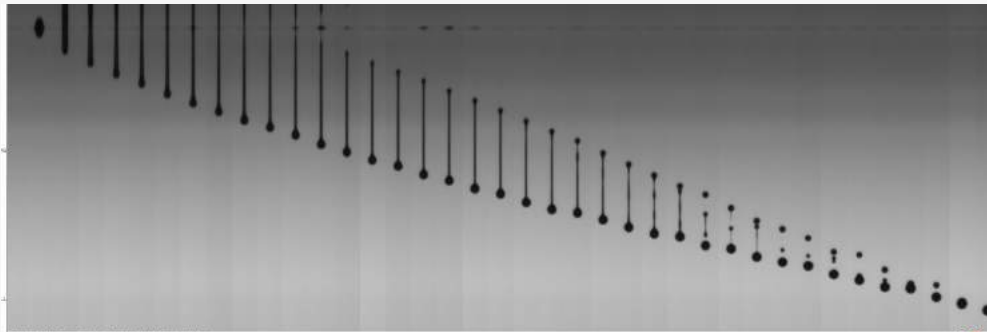
Testing Inkjet Performance: Drop Formation: Stitch



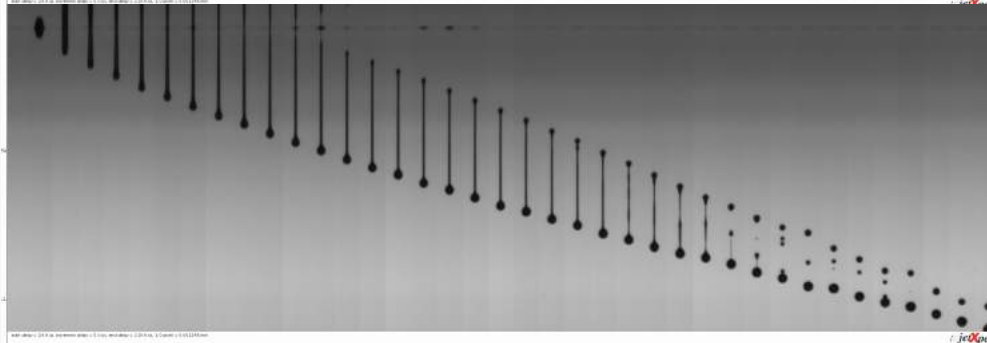
83v



88v



93v



Single Pulse
4us pulse width



Testing Inkjet Performance: Drop Measurement (Volume, Velocity, Trajectory)

The screenshot displays the imageXpert software interface. On the left, a camera view shows several inkjet drops on a surface. A yellow rectangular region of interest (ROI) is drawn around one of the drops. On the right, the software's control panel is visible, featuring various settings and analysis options.

Control Panel Settings:

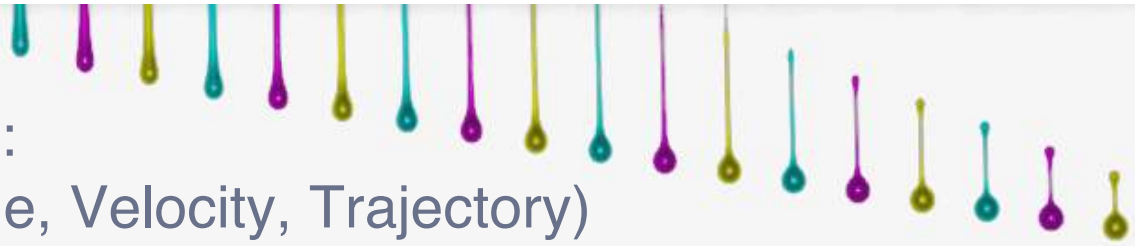
- Stop Strobe:** Button
- Pulse Type:** Single Double Variable Delay
- Strobe Delay:** Delay1: 236.65 μ s, Delay2: 30.04 μ s
- Brightness:** Pulse Width: 500 ns, Intensity: 60, Wetting Shutter: 0.4 ms
- Analysis:** Default Drops, Analyze Now, Analyze Multiple, Zero Statistics, Move ROI (with directional arrows)
- Image/Movie:** JetXpert Cam, Start Recording, Save Image, Image/Movie Name: movie, Use timestamp as name (checked)
- Other fields:** Data File Name: 88v, Exp ID: expID, Comments

Text in the bottom left corner:

Single Pulse
88v 4us pulse width
1mm from head

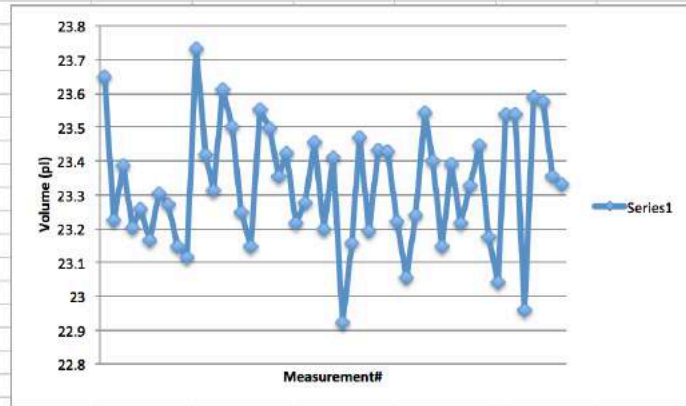
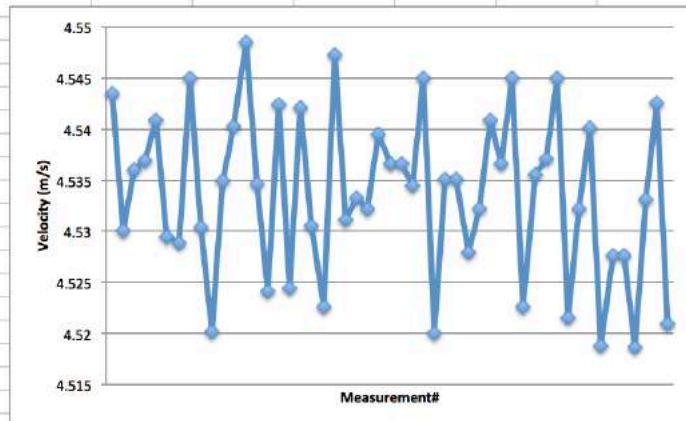


Testing Inkjet Performance: Drop Measurement (Volume, Velocity, Trajectory)



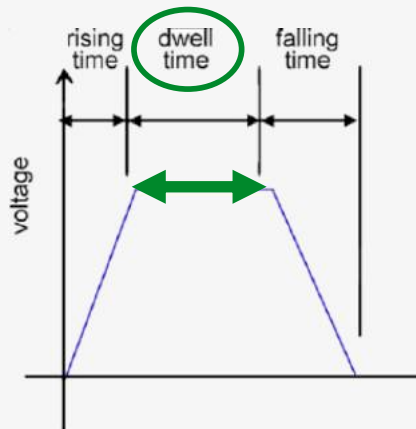
Exp ID	drop1 radius	drop1 volum	trajectory	velocity (m/s)	Comments
expID	1.78E-02	23.64679	89.70172	4.543411	
expID	1.77E-02	23.22714	89.97001	4.53003	
expID	1.77E-02	23.38563	89.99828	4.535925	
expID	1.77E-02	23.20437	89.73144	4.536961	
expID	1.77E-02	23.25911	89.98338	4.540887	
expID	1.77E-02	23.16405	90.0296	4.529499	
expID	1.77E-02	23.30307	89.73118	4.528831	
expID	1.77E-02	23.26943	89.972	4.544915	
expID	1.77E-02	23.14511	90.05304	4.53042	
expID	1.77E-02	23.11716	89.77731	4.520242	
expID	1.78E-02	23.73083	89.90238	4.534983	
expID	1.77E-02	23.41945	90.171	4.540323	
expID	1.77E-02	23.31341	89.88414	4.548492	
expID	1.78E-02	23.61284	89.64214	4.534661	
expID	1.78E-02	23.49952	90.04241	4.524177	
expID	1.77E-02	23.24877	89.9324	4.54232	
expID	1.77E-02	23.14559	89.7114	4.524454	
expID	1.78E-02	23.55384	89.93995	4.542112	
expID	1.78E-02	23.49825	90.01518	4.530474	
expID	1.77E-02	23.35319	89.79762	4.522684	
expID	1.77E-02	23.42442	89.90449	4.547271	
expID	1.77E-02	23.21454	90.16875	4.531139	
expID	1.77E-02	23.2766	89.79346	4.533228	
expID	1.78E-02	23.45519	89.80906	4.532261	
expID	1.77E-02	23.1964	90.13292	4.539538	
expID	1.77E-02	23.40725	89.8188	4.536624	
expID	1.76E-02	22.92242	89.68328	4.536636	
expID	1.77E-02	23.15438	90.04935	4.534411	
expID	1.78E-02	23.46777	89.90148	4.544951	
expID	1.77E-02	23.19534	89.66064	4.520061	
expID	1.78E-02	23.43251	89.98514	4.535129	
expID	1.78E-02	23.42542	89.94243	4.535045	
expID	1.77E-02	23.21938	89.62259	4.52792	
expID	1.77E-02	23.05595	89.98764	4.53225	
expID	1.77E-02	23.23908	89.93388	4.540825	
expID	1.78E-02	23.54078	89.81229	4.536593	
expID	1.77E-02	23.39831	89.92242	4.54505	

Single Pulse
88v 4us pulse width





Optimizing Inkjet Performance: Xsweep



The screenshot shows the Xsweep software interface. On the left, a nozzle is visible with a yellow box highlighting a 'Over trap' area. A status window in the center displays the following information:

xSweeping Status	
Current holdt value:	0
DELAY1:	179900
DELAY2:	30040
No. of holdt values tested:	0

On the right, the control panel includes a 'Run Task' button, 'Printhead: Starfire 0', and 'Pitch (mm): 0.508'. Below this is an 'xSweep' dropdown menu and an 'Edit Task...' button. A note states: 'Automatically use "Default Drops" to measure drop radius, volume, velocity, and trajectory for each parameter value in a specified list.'

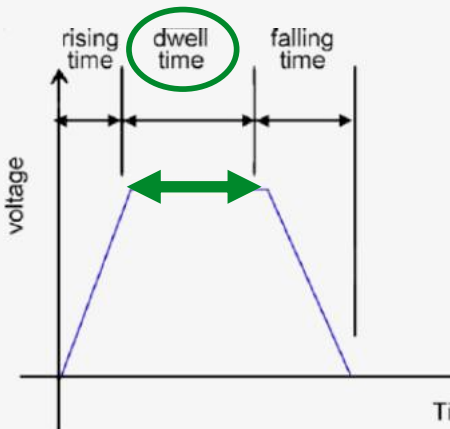
At the bottom right, a 'Jet's part: Measurement Report' window is partially visible, showing a table with columns for 'Bin', 'Measurement Name', 'Mean', 'Std. Deviation', 'Minimum', 'Maximum', and 'Range (in:0.001)'. The table is currently empty.

At the bottom left, a red status bar reads: 'Frozen (BRL) - try to abort the process!'



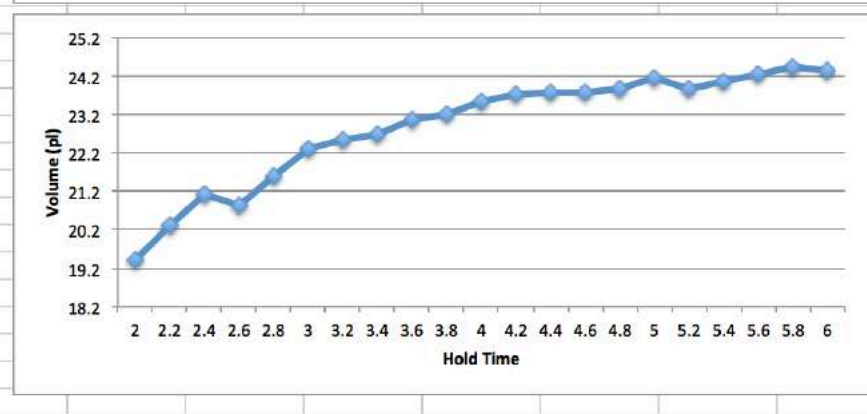
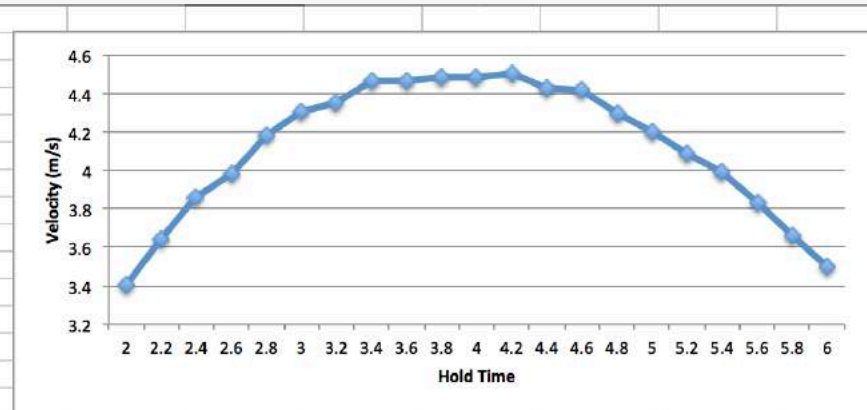


Optimizing Inkjet Performance: Pulse Width



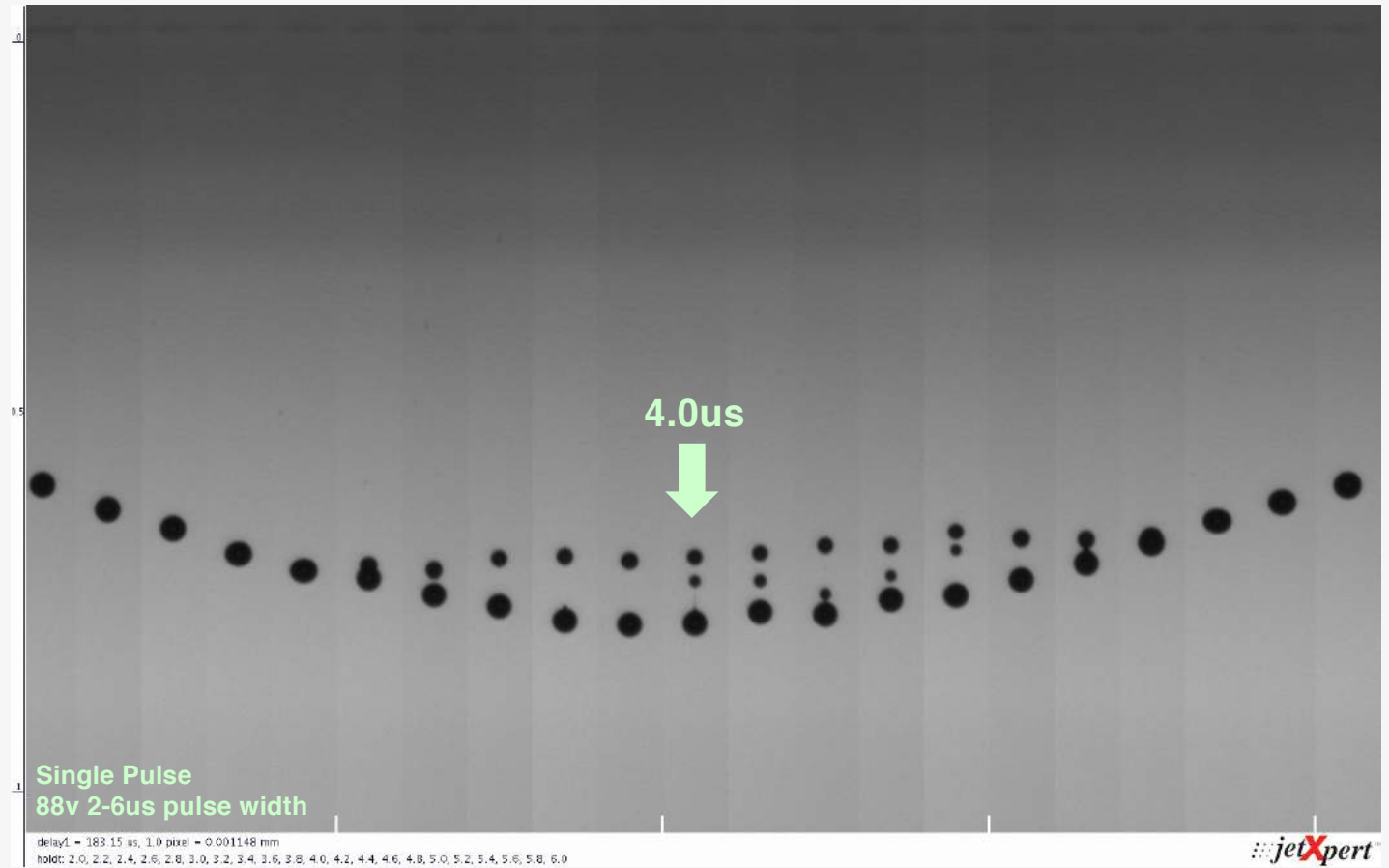
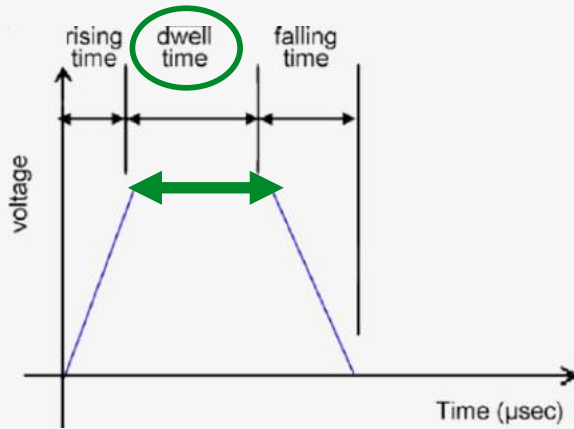
holdt	drop1 radius	drop1 volum	trajectory	velocity (m/s)
2	1.67E-02	19.4144	90.0023	3.404235
2.2	1.69E-02	20.31698	90.02568	3.644608
2.4	1.72E-02	21.13186	89.90416	3.860874
2.6	1.71E-02	20.83785	90.03738	3.980816
2.8	1.73E-02	21.5972	90.00366	4.181574
3	1.75E-02	22.29479	89.98841	4.304615
3.2	1.75E-02	22.56224	89.89004	4.35136
3.4	1.76E-02	22.70885	90.0424	4.470424
3.6	1.77E-02	23.0759	89.97984	4.470698
3.8	1.77E-02	23.20654	89.95087	4.483959
4	1.78E-02	23.51783	89.92339	4.48885
4.2	1.78E-02	23.71209	89.98703	4.508971
4.4	1.78E-02	23.78248	90.02592	4.42682
4.6	1.78E-02	23.79814	89.99418	4.416595
4.8	1.79E-02	23.85868	89.97408	4.293397
5	1.79E-02	24.14144	89.93959	4.203529
5.2	1.79E-02	23.89336	90.03404	4.089494
5.4	1.79E-02	24.0472	90.02541	3.991447
5.6	1.80E-02	24.25488	90.08328	3.832021
5.8	1.80E-02	24.42878	90.02531	3.661388
6	1.80E-02	24.35759	89.99642	3.501859

Single Pulse
88v 2-6us pulse width



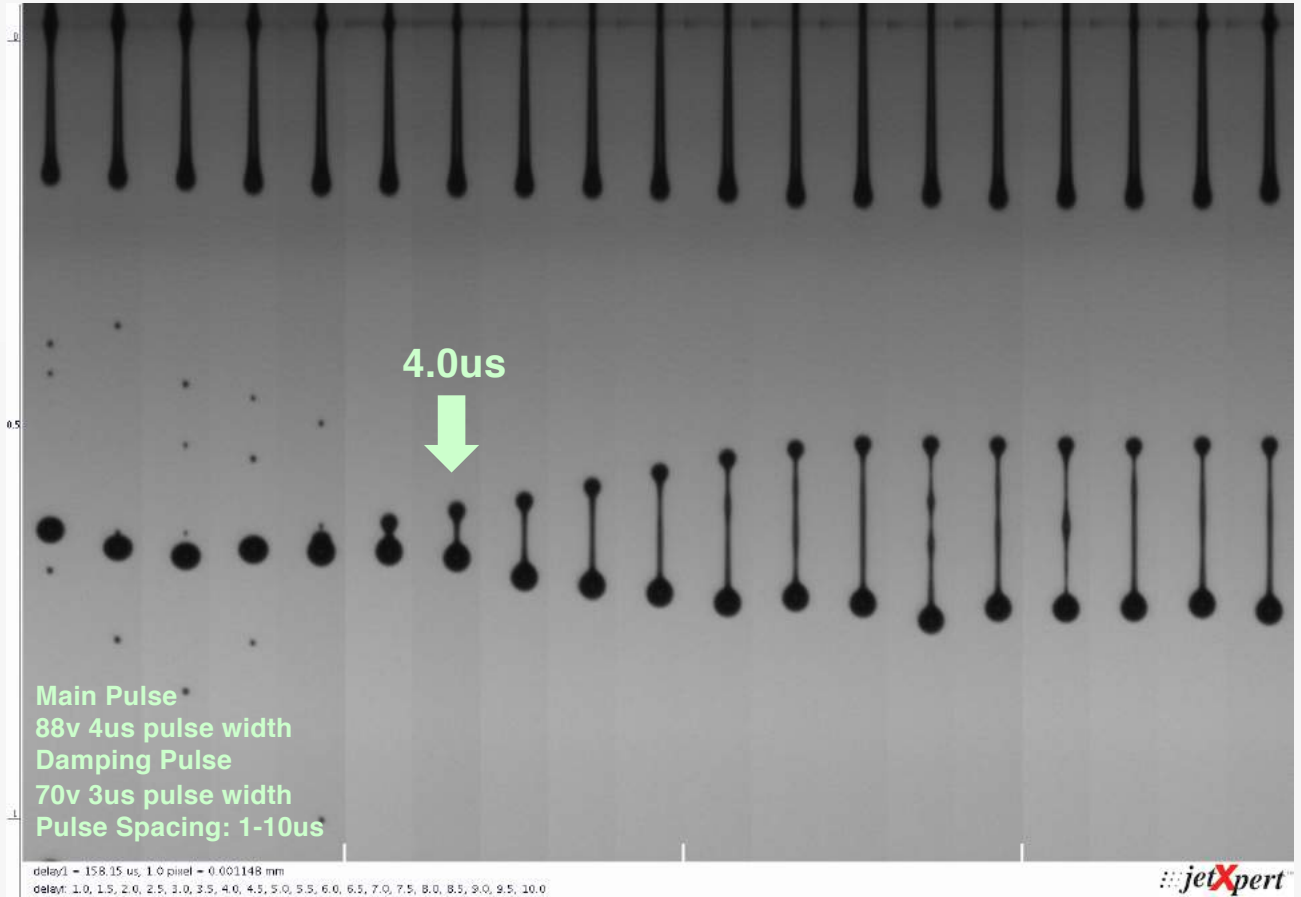
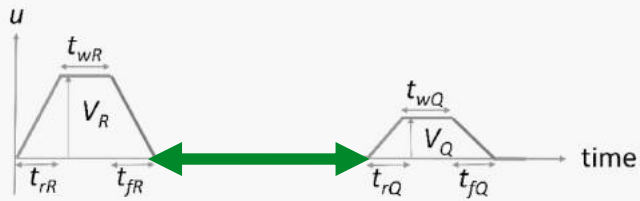


Optimizing Inkjet Performance Pulse Width



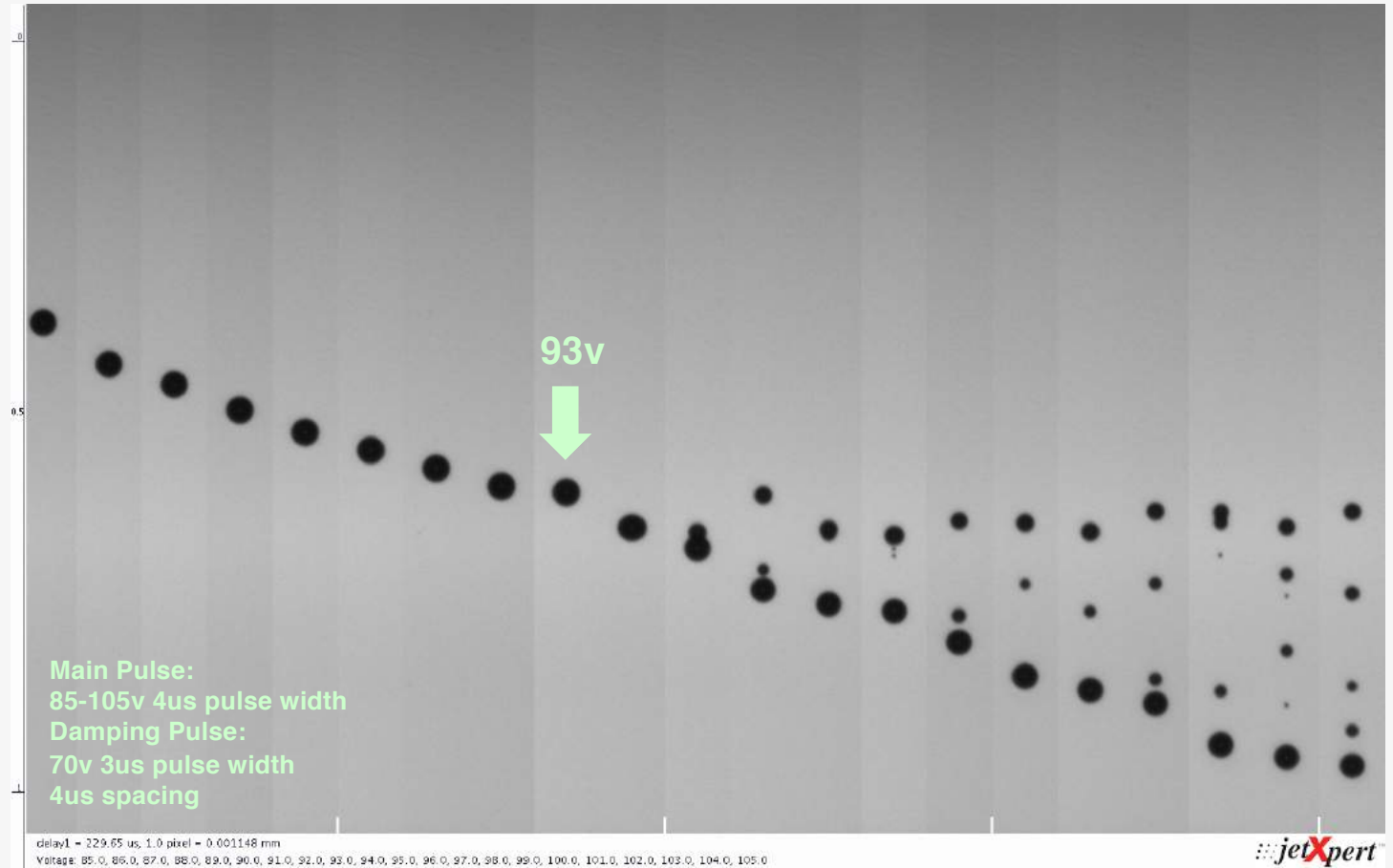
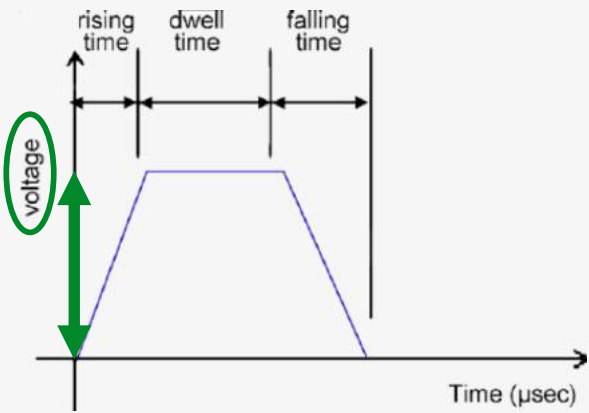


Optimizing Inkjet Performance: Damping Pulse Spacing





Optimizing Inkjet Performance: Voltage





Testing Inkjet Performance: Measuring Nozzles Across the Head



The screenshot displays the imageXpert software interface for testing inkjet performance. The main window shows a grayscale image of a nozzle head with a red rectangular box labeled "AutoCross" highlighting a specific nozzle. To the right, a control panel includes a "Start Strobe" button, printer settings (Printhead: Starfire, Pitch (mm): 0.508), and a "Calibrate Motion" button. Below these are "From Nozzle:" (1), "To Nozzle:" (128), and "Skip:" (0) fields, along with a "Start" button. A "Method:" dropdown is set to "Default Drops".

Overlaid on the bottom right is a "JetXpert: Measurement Report" window. The report title is "Default Drops-wetting 50 52 Run 0 Fail". It contains a table with the following data:

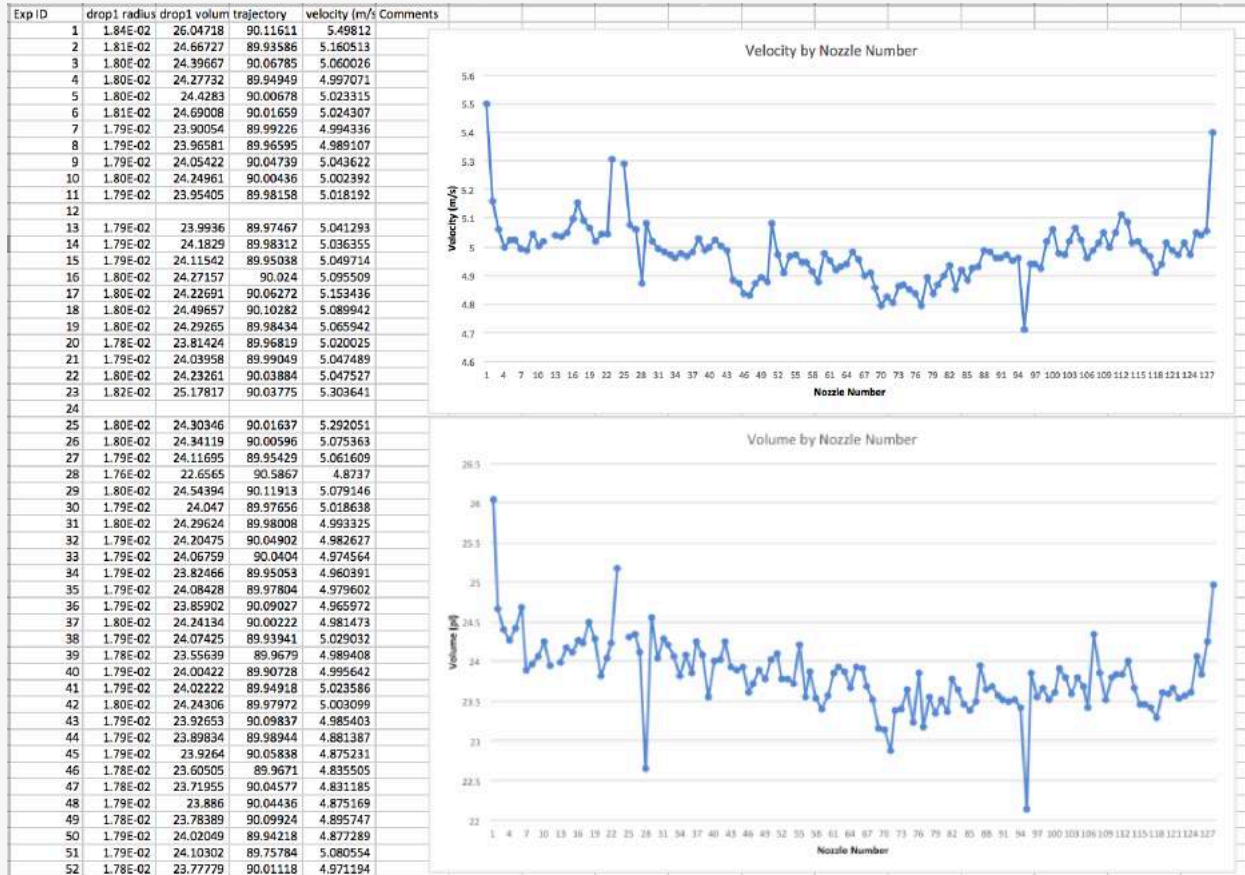
Index	Measurement Name	Value	Nominal	Min. Tolerance	Max. Tolerance
52	drop1 radius	0.018			
52	drop1 volume (pL)	26.947			
52	trajectory	90.116			
52	velocity (m/s)	5.498			

Below this table is a summary table with the following data:

Run	Measurement Name	Mean	Std. Deviation	Minimum	Maximum	Median (n=1000)
52	drop1 radius	0.018	0.000	0.018	0.018	
52	drop1 volume (pL)	23.381	0.017	22.922	26.067	23.331
52	trajectory	89.903	0.156	89.618	90.171	
52	velocity (m/s)	4.552	0.134	4.519	5.498	4.535



Testing Inkjet Performance: Measuring Nozzles Across the Head





Testing Inkjet Performance: Sustainability



The screenshot displays the imageXpert software interface. On the left, a grayscale image of a printhead nozzle test is shown with several ink droplets. A yellow rectangular box highlights one of the droplets. On the right, a control panel is visible with the following elements:

- Buttons: Standard, Advanced, Motion, Tasks, Stitch, NozzleXaminer
- Buttons: Run Task, Edit Task...
- Fields: Printhead: Startline, Pitch (mm): 0.508
- Field: Missingjets
- Text: Use JetXpert Motion to periodically scan the entire printhead; count and identify nozzles that are no longer jetting.

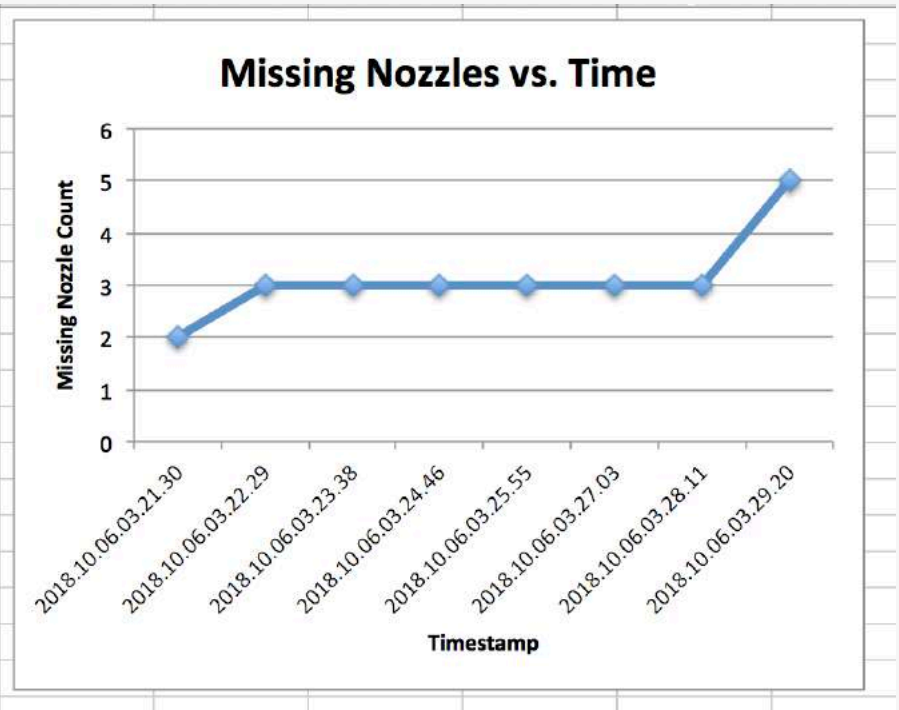
Below the control panel, a 'Measurement Report' window is open, showing a table with the following structure:

Run	Measurement Name	Value	Normal	Min. Tolerance	Max. Tolerance	Media (x1000)



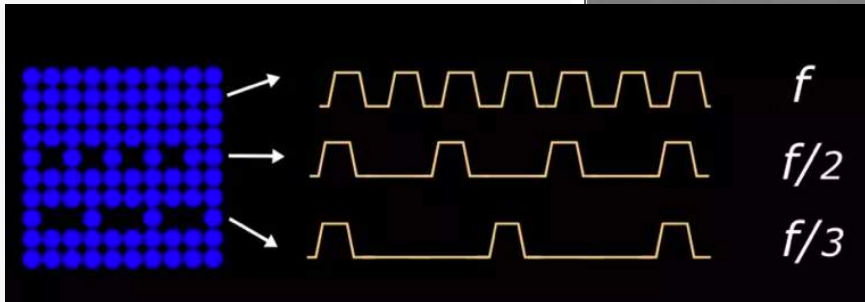
Testing Inkjet Performance: Sustainability

time	#FailedNozzles	#totalNozzles	#failed_list
2018.10.06.03.21.30	2	128	24, 95,
2018.10.06.03.22.29	3	128	24, 42, 95,
2018.10.06.03.23.38	3	128	24, 42, 95,
2018.10.06.03.24.46	3	128	24, 42, 95,
2018.10.06.03.25.55	3	128	24, 42, 95,
2018.10.06.03.27.03	3	128	24, 42, 95,
2018.10.06.03.28.11	3	128	24, 42, 95,
2018.10.06.03.29.20	5	128	24, 28, 42, 50, 95,





Testing Inkjet Performance: Frequency



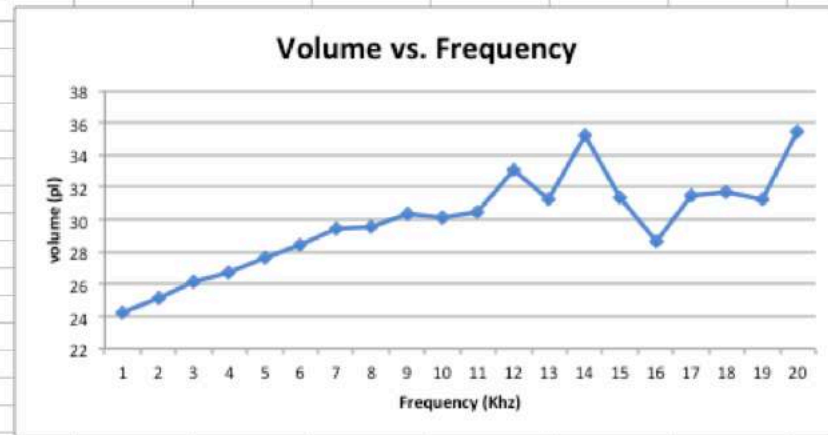
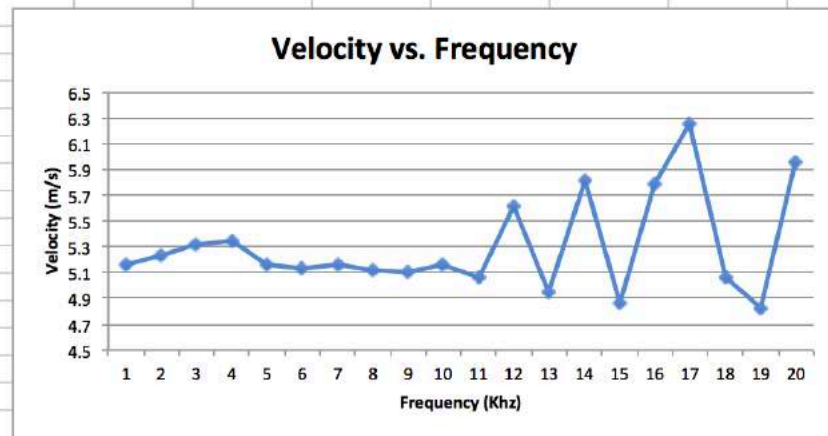
deltaL = 240.4 us, 1.0 pixel = 0.001148 mm
Freqs (kHz): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0





Testing Inkjet Performance: Frequency

Frequency (kHz)	drop1 radius	drop1 volume (pL)	trajectory	velocity (m/s)
1	1.80E-02	24.25241	89.97337	5.16386
2	1.82E-02	25.09501	89.99296	5.238451
3	1.84E-02	26.19967	90.07301	5.319919
4	1.85E-02	26.7219	89.97034	5.344988
5	1.88E-02	27.63136	90.02897	5.168274
6	1.89E-02	28.42394	90.07417	5.139957
7	1.92E-02	29.44158	89.99537	5.155534
8	1.92E-02	29.53142	89.96075	5.115504
9	1.94E-02	30.36416	89.97836	5.105206
10	1.93E-02	30.13937	89.94465	5.161822
11	1.94E-02	30.48748	89.92979	5.063175
12	1.99E-02	33.1057	89.93591	5.612579
13	1.95E-02	31.21084	89.91512	4.952079
14	2.03E-02	35.26918	89.88316	5.810924
15	1.96E-02	31.38365	89.82558	4.8679
16	1.90E-02	28.62666	89.9332	5.784729
17	1.96E-02	31.43763	89.97241	6.248661
18	1.96E-02	31.68546	89.96257	5.063194
19	1.95E-02	31.25376	89.95438	4.827392
20	2.04E-02	35.41389	89.96015	5.961308





Print Quality Measurement



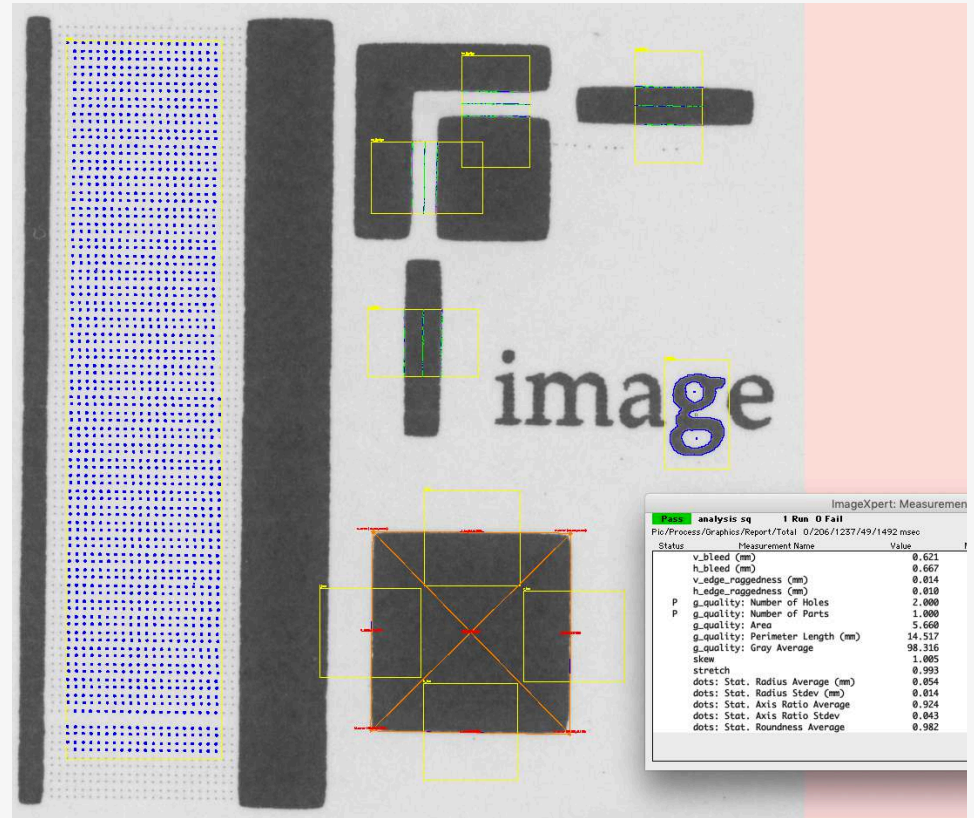
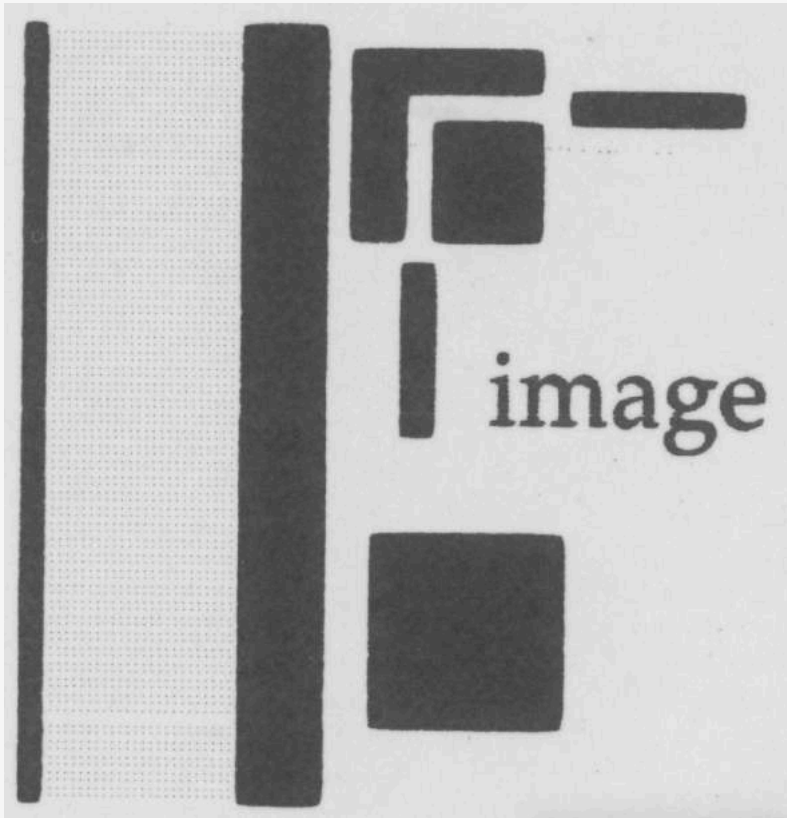
2400 DPI color

Up to size A3

Transparency option



Analyzing Print Quality



ImageXpert: Measurement

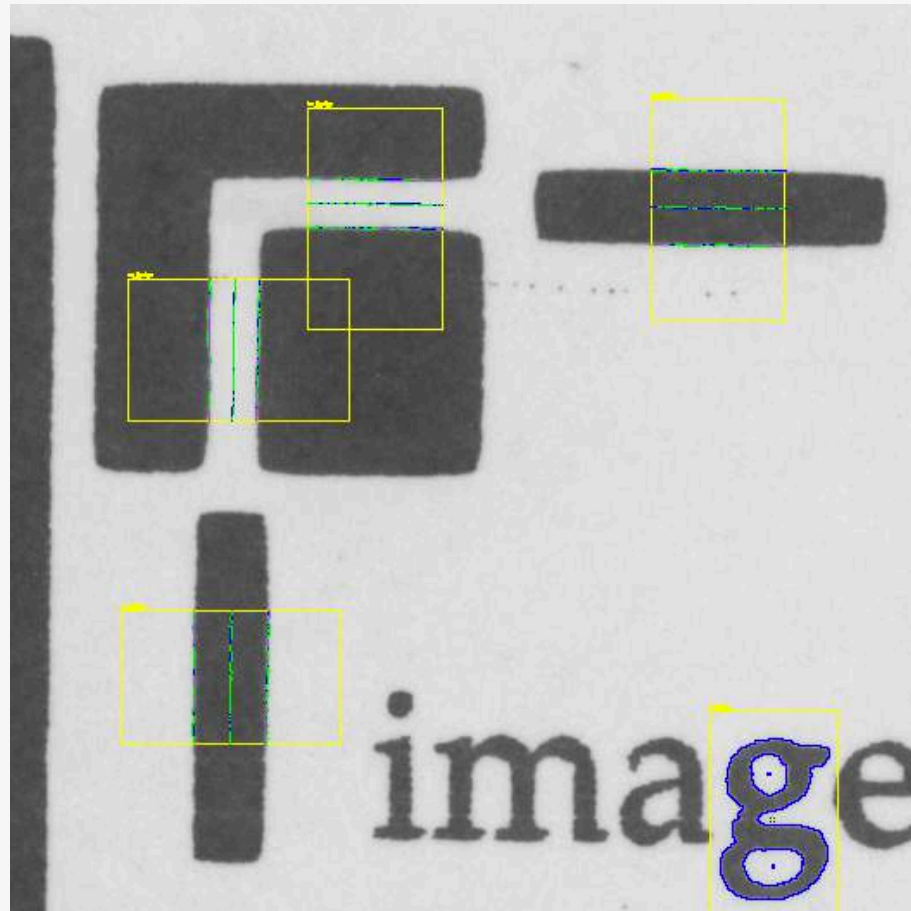
Pass analysis sq 1 Run 0 Fail

File/Process/Graphics/Report/Total 0/206/1237/49/1492 msec

Status	Measurement Name	Value
	v_bleed (mm)	0.621
	h_bleed (mm)	0.667
	v_edge_roughness (mm)	0.014
	h_edge_roughness (mm)	0.010
P	g_quality: Number of Holes	2.000
P	g_quality: Number of Parts	1.000
	g_quality: Area	5.660
	g_quality: Perimeter Length (mm)	14.517
	g_quality: Gray Average	98.316
	skew	1.005
	stretch	0.993
	dots: Stat. Radius Average (mm)	0.054
	dots: Stat. Radius Stdev (mm)	0.014
	dots: Stat. Axis Ratio Average	0.924
	dots: Stat. Axis Ratio Stdev	0.043
	dots: Stat. Roundness Average	0.982

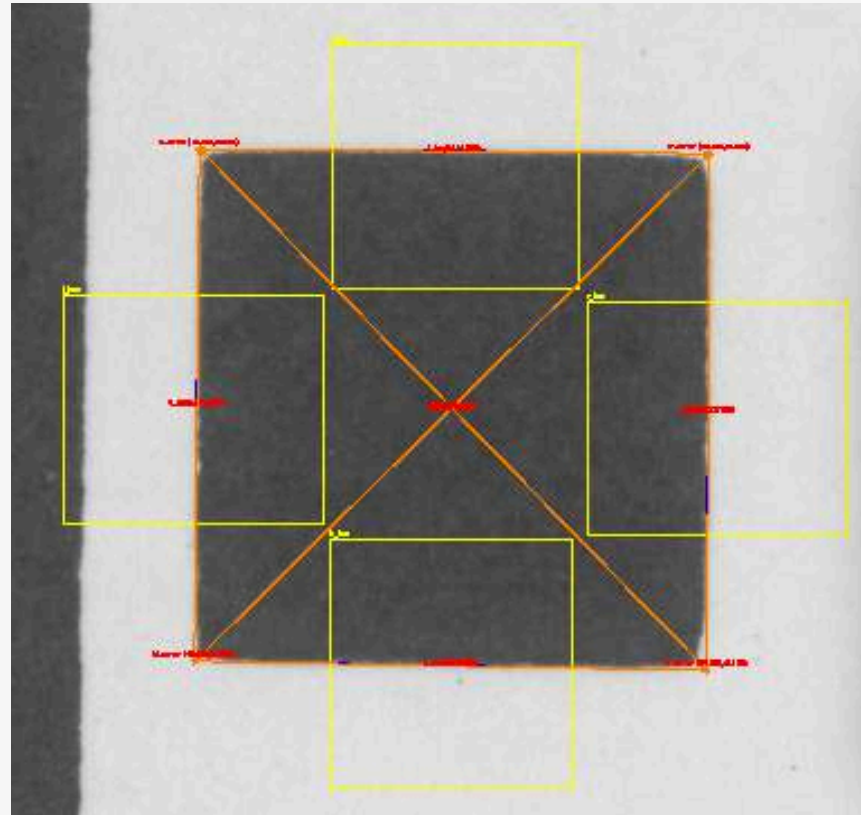


Print Quality Measurement: Line Quality/Bleed





Print Quality Measurement: Skew/Stretch



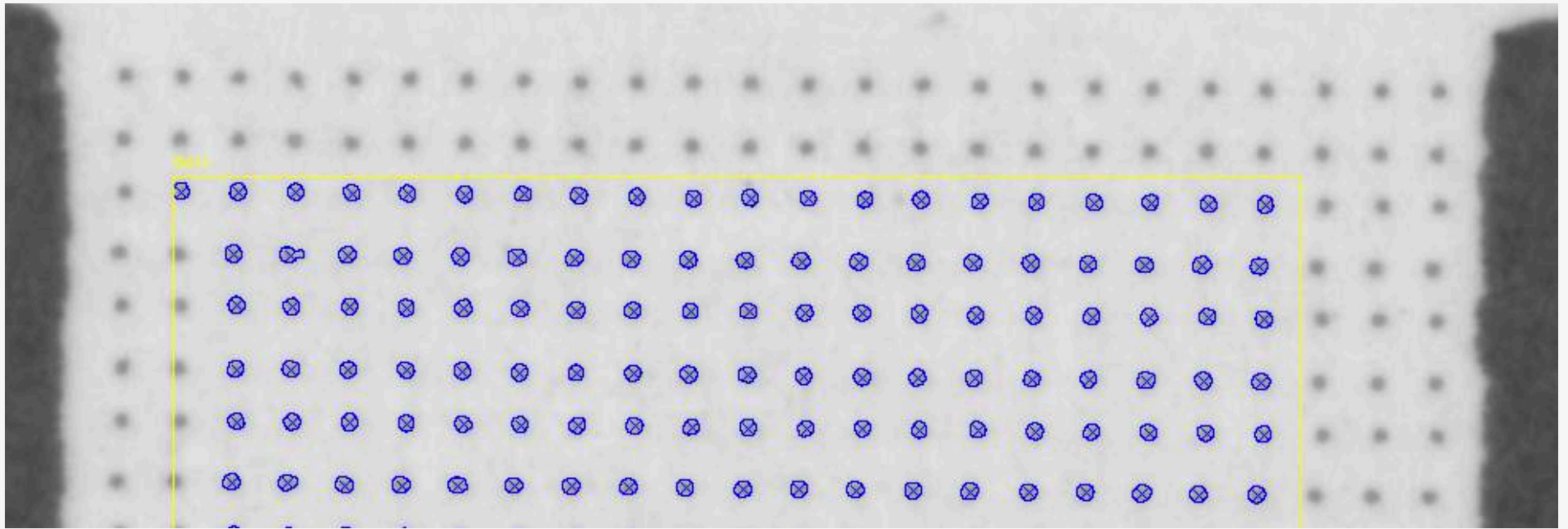


Print Quality Measurement: Text Quality



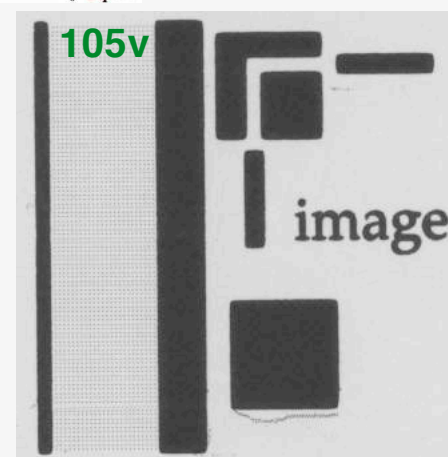
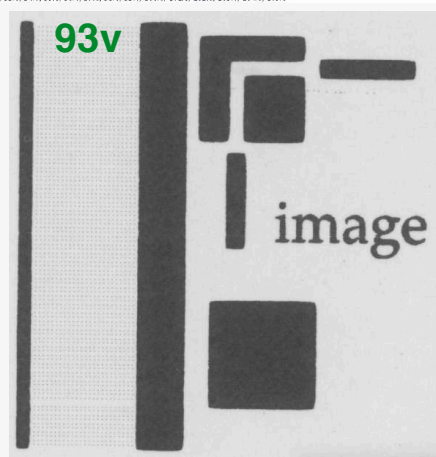
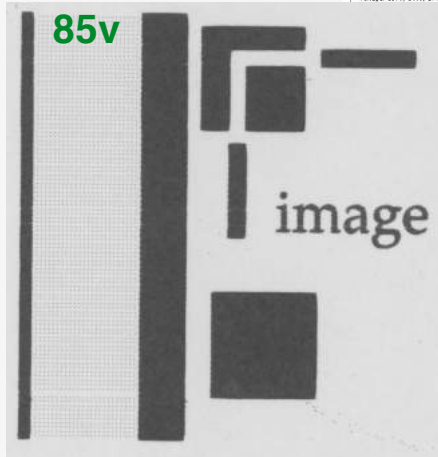
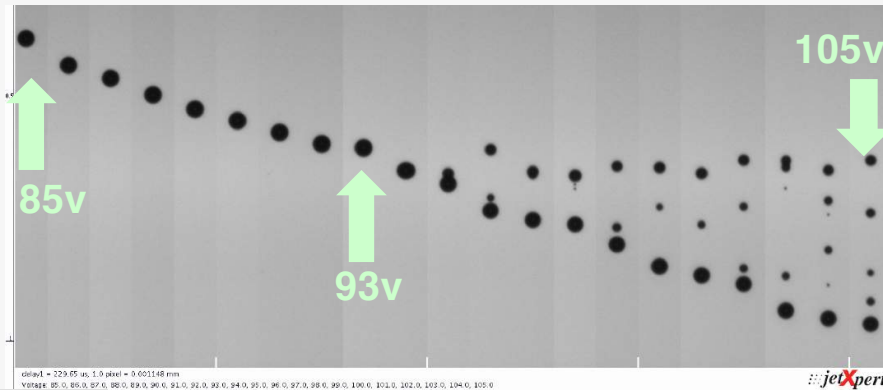


Print Quality Measurement: Dot Quality





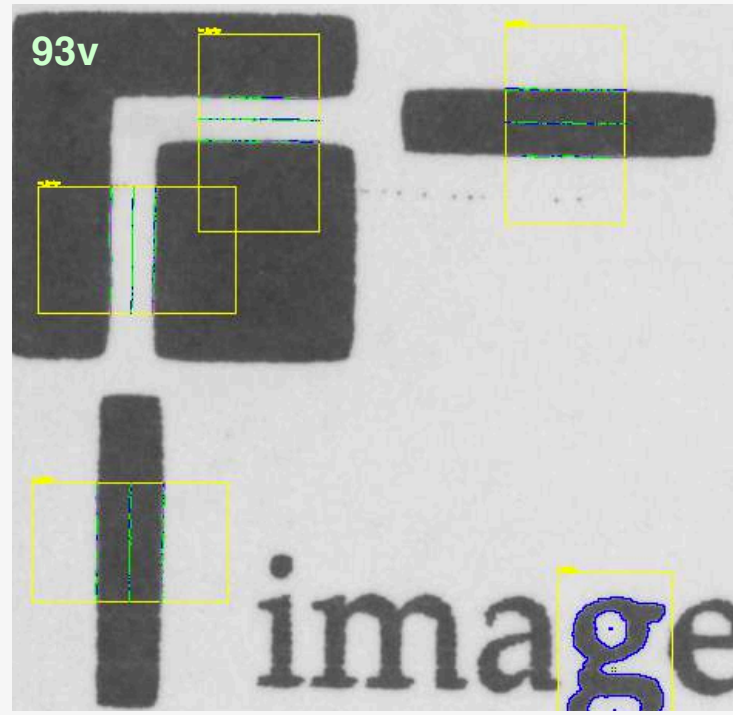
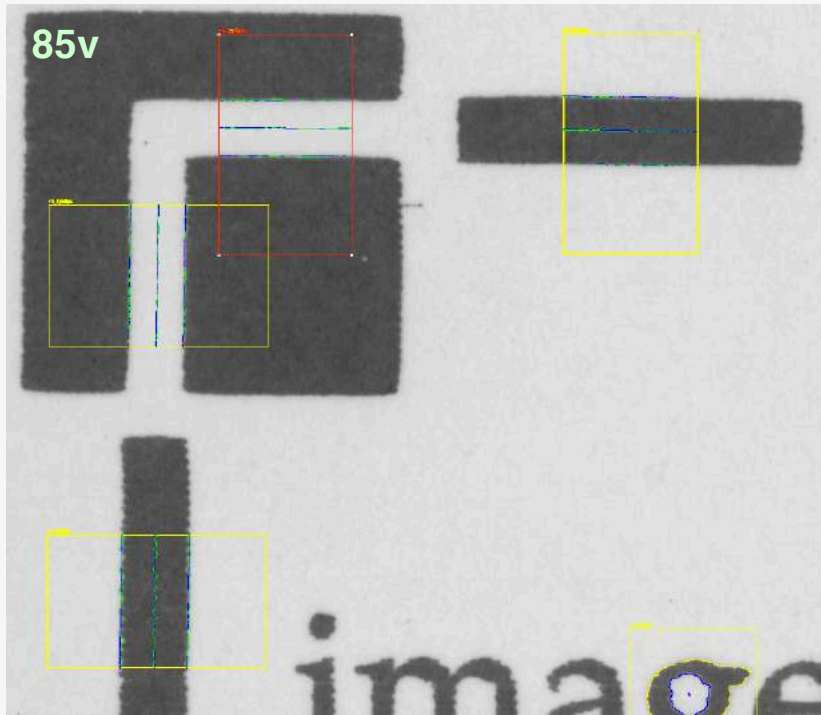
Analyzing Print Quality



Sample ID	v_bleed (mm)	h_bleed (mm)	v_edge_ragg	h_edge_ragg	g_quality: Nu	g_quality: Nu	g_quality: Ar	g_quality: Pe	g_quality: Gr	skew	stretch	dots: Stat. R _z	dots: Stat. R _z	dots: Stat. A _z	dots: Stat. A _z	dots: Stat. Roundnes
85v	0.303	0.292	0.02	0.01	2	1	5.144	14.899	100.708	1.001	0.992	0.051	0.013	0.921	0.042	0.982
93v	0.621	0.668	0.014	0.01	2	1	5.66	14.517	98.316	1.005	0.993	0.054	0.014	0.925	0.043	0.982
105v	0.625	0.659	0.011	0.01	2	1	6.254	14.511	93.604	1	0.99	0.069	0.024	0.754	0.114	0.929

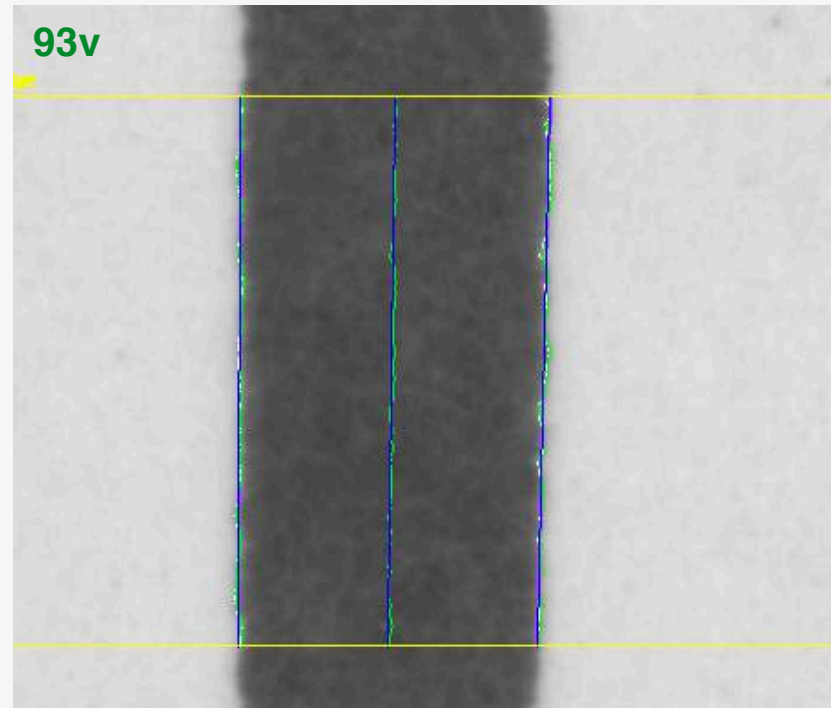
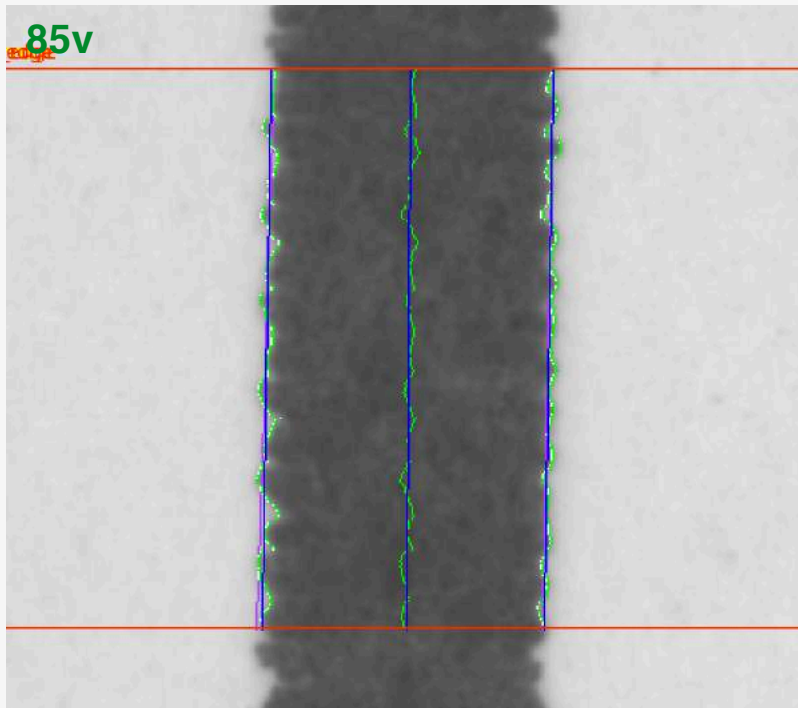


Print Quality Measurement: Bleed Comparison



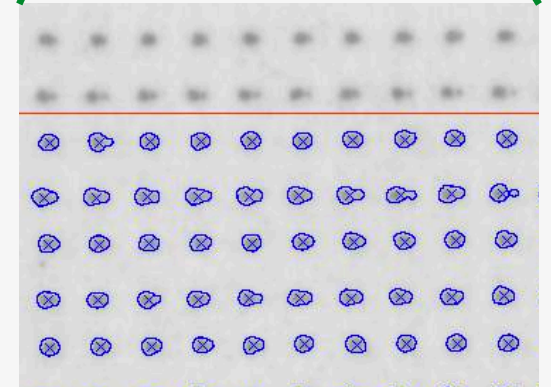
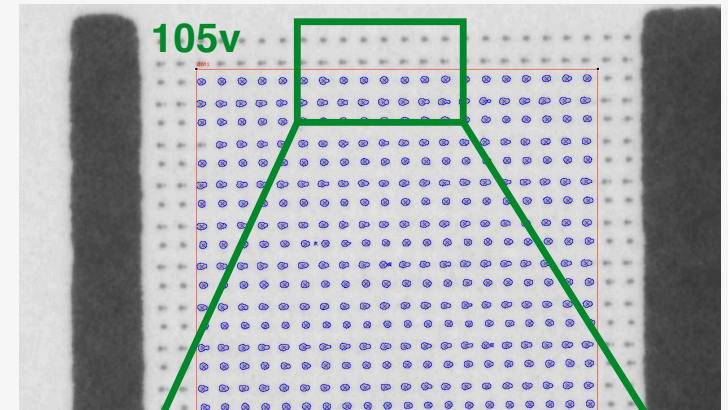
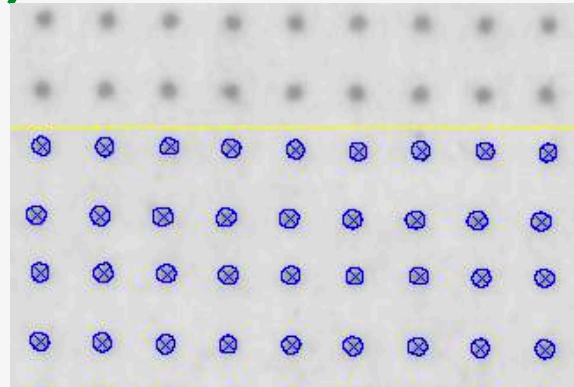
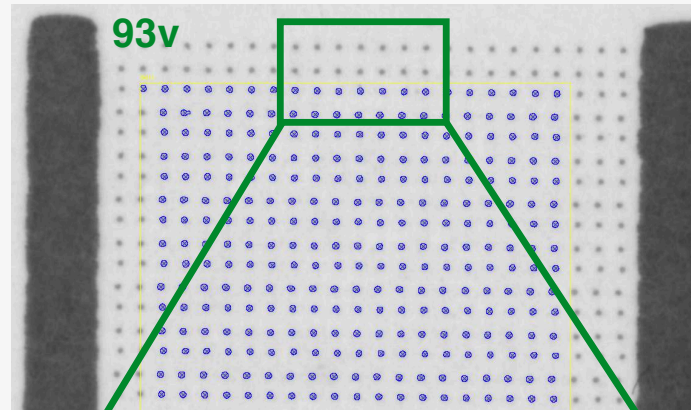
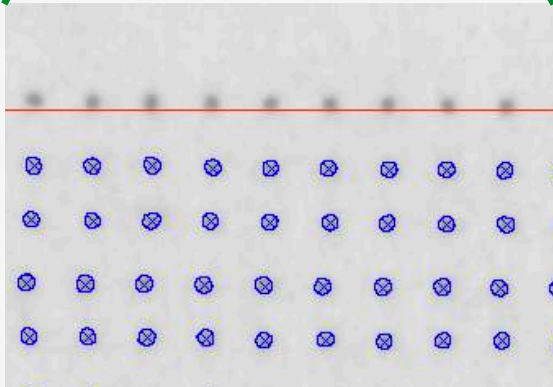
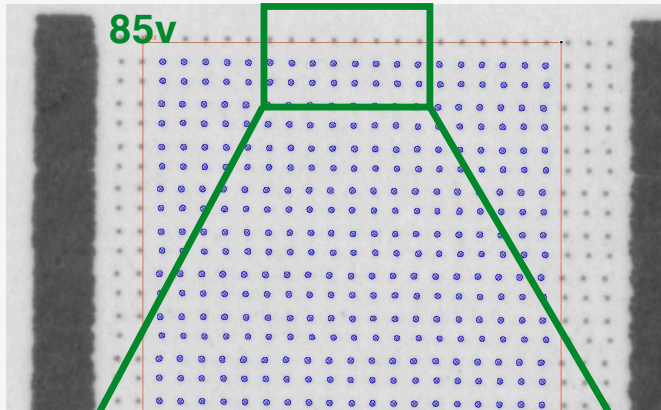


Print Quality Measurement: Edge Comparison



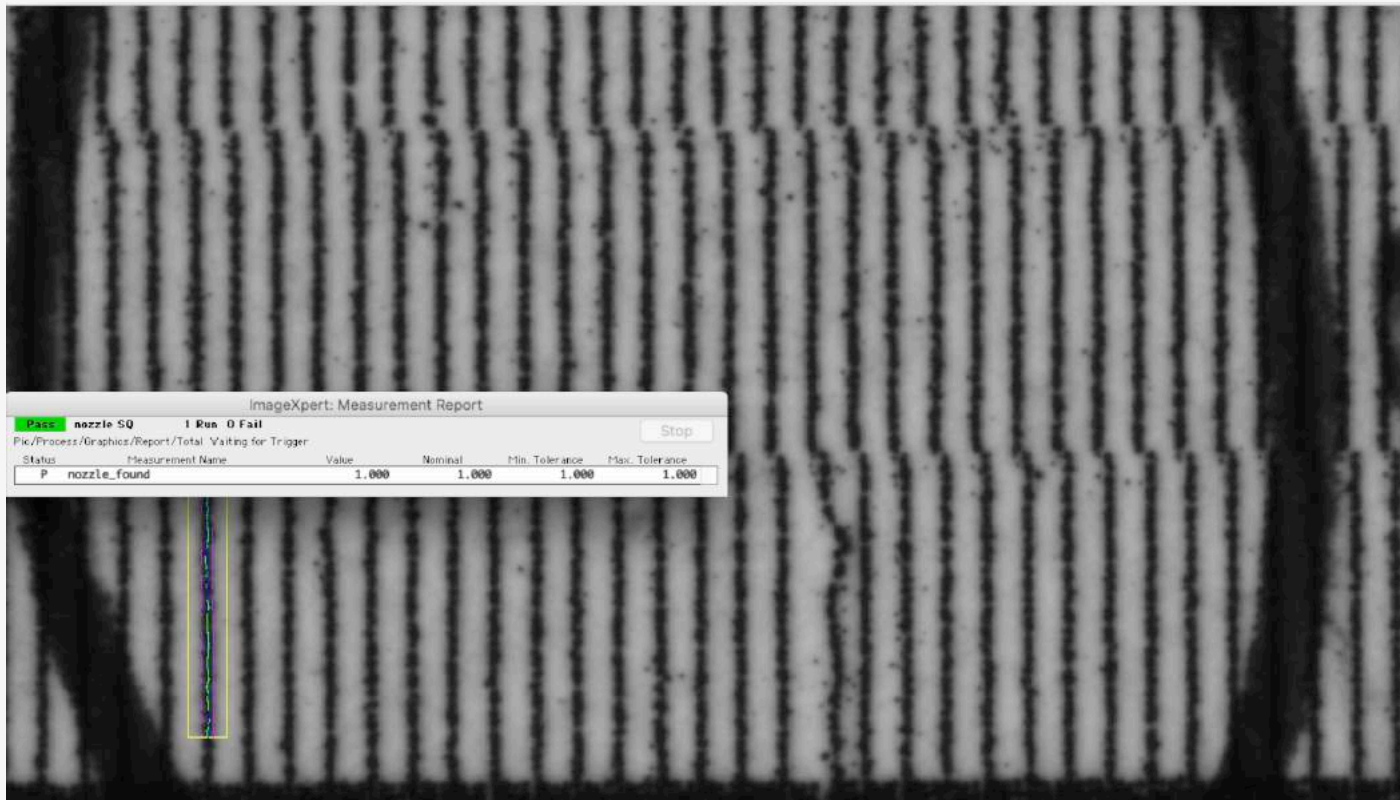


Print Quality Measurement: Dot Quality





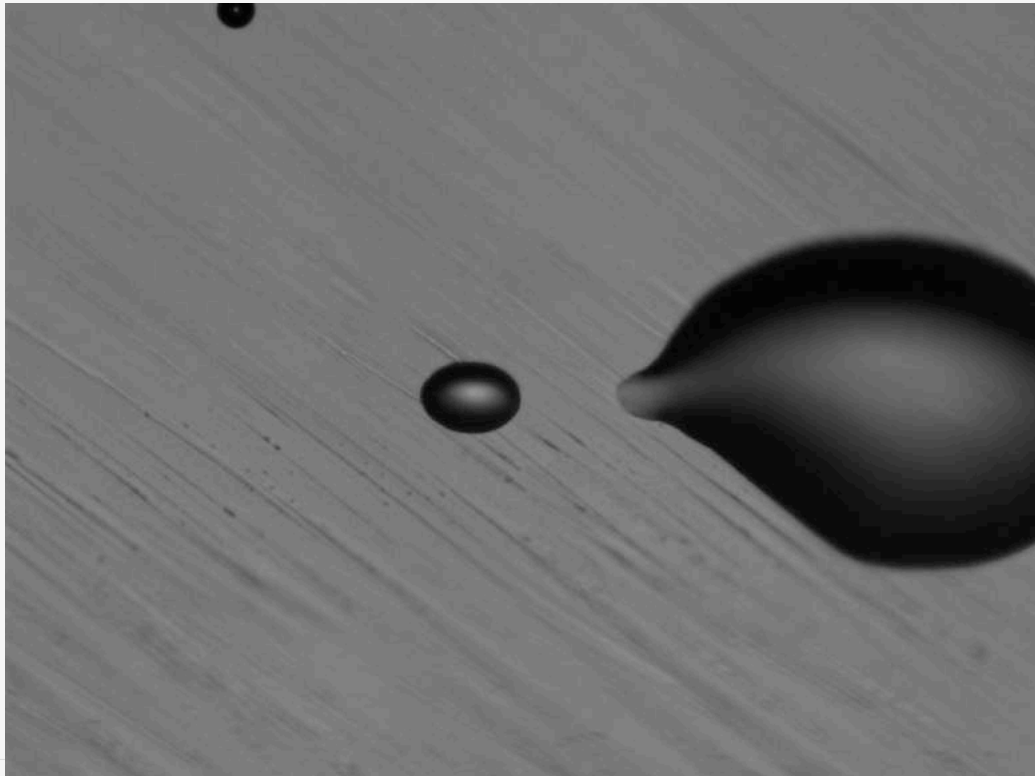
Other Analysis: Missing Jets





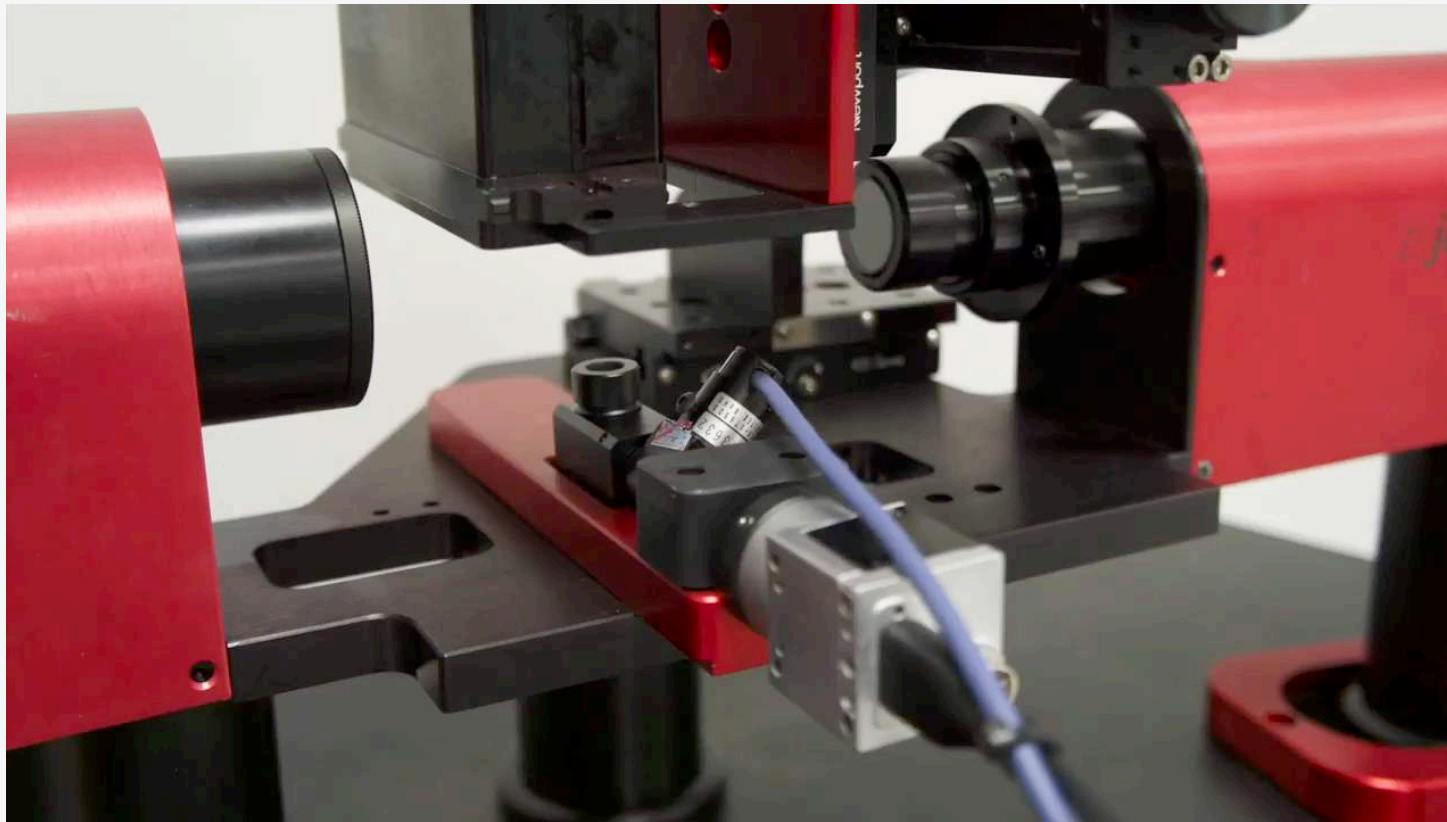
Option: Drop on surface

Kyocera head 30pl drops



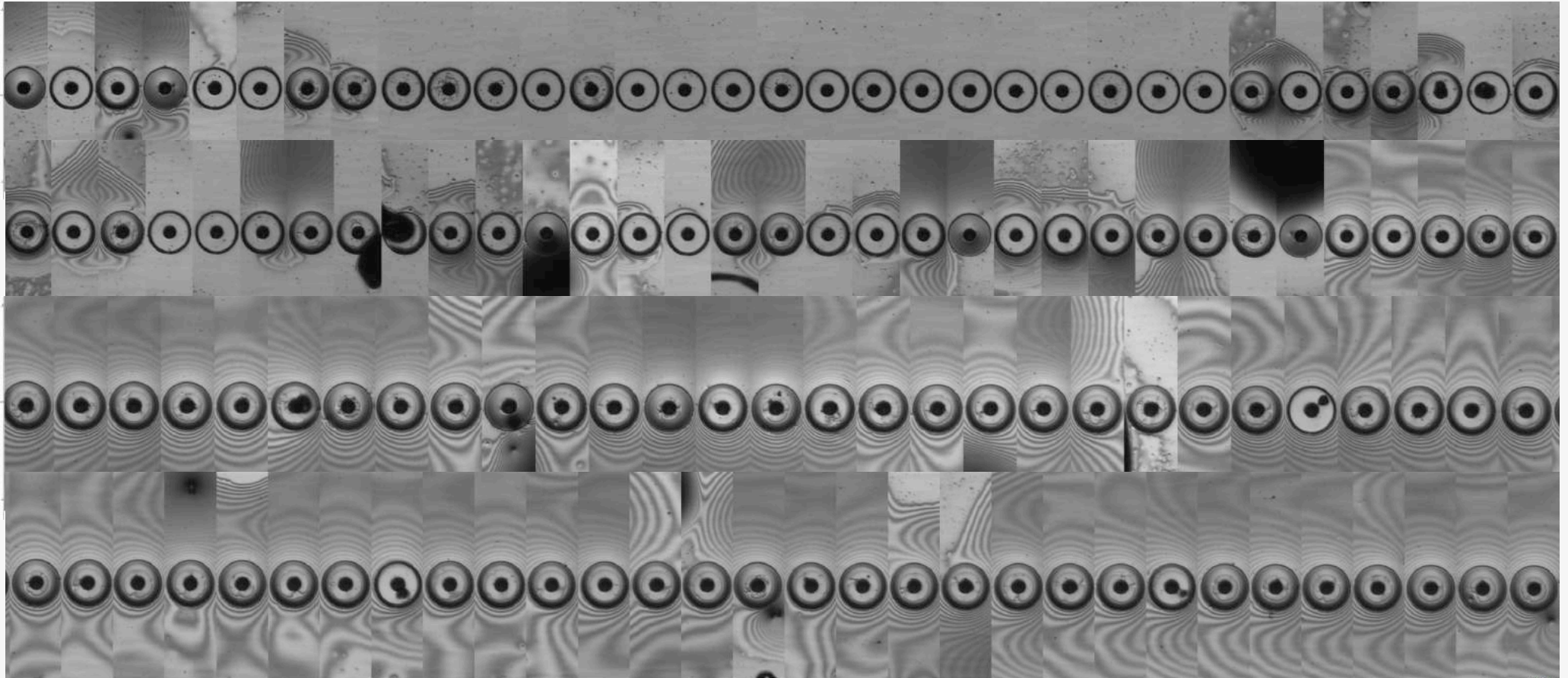


Other Analysis: Nozzle Inspection





Other Analysis: Nozzle Inspection





Thank You!

imageXpert[®]

Come visit us at booth 834



Thank You!

Questions?





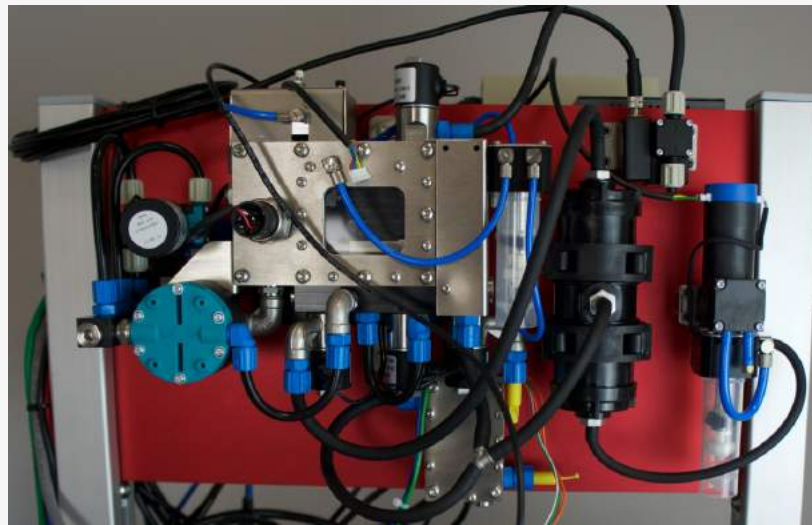
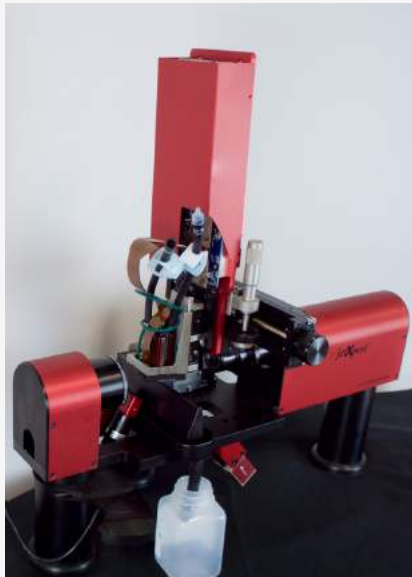
Thank You!

Extra Slides:



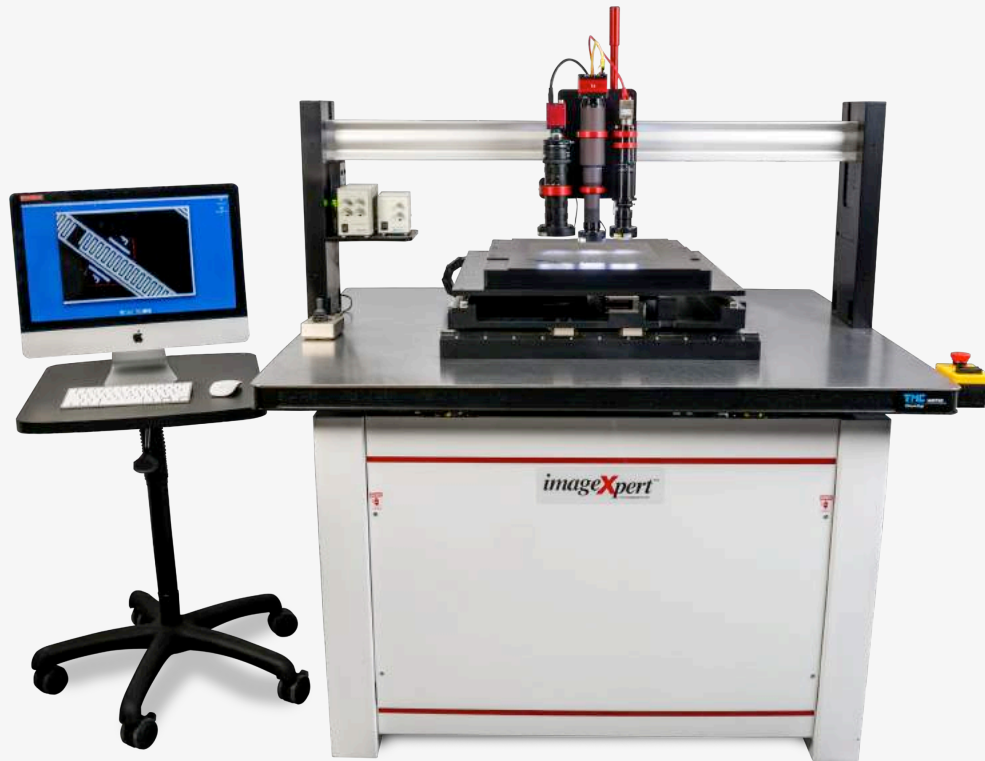


Testing Inkjet Performance: New: Integrated Control Electronics, Ink Supply





Print Quality Measurement



1 Micron/ pixel resolution

Multiple cameras

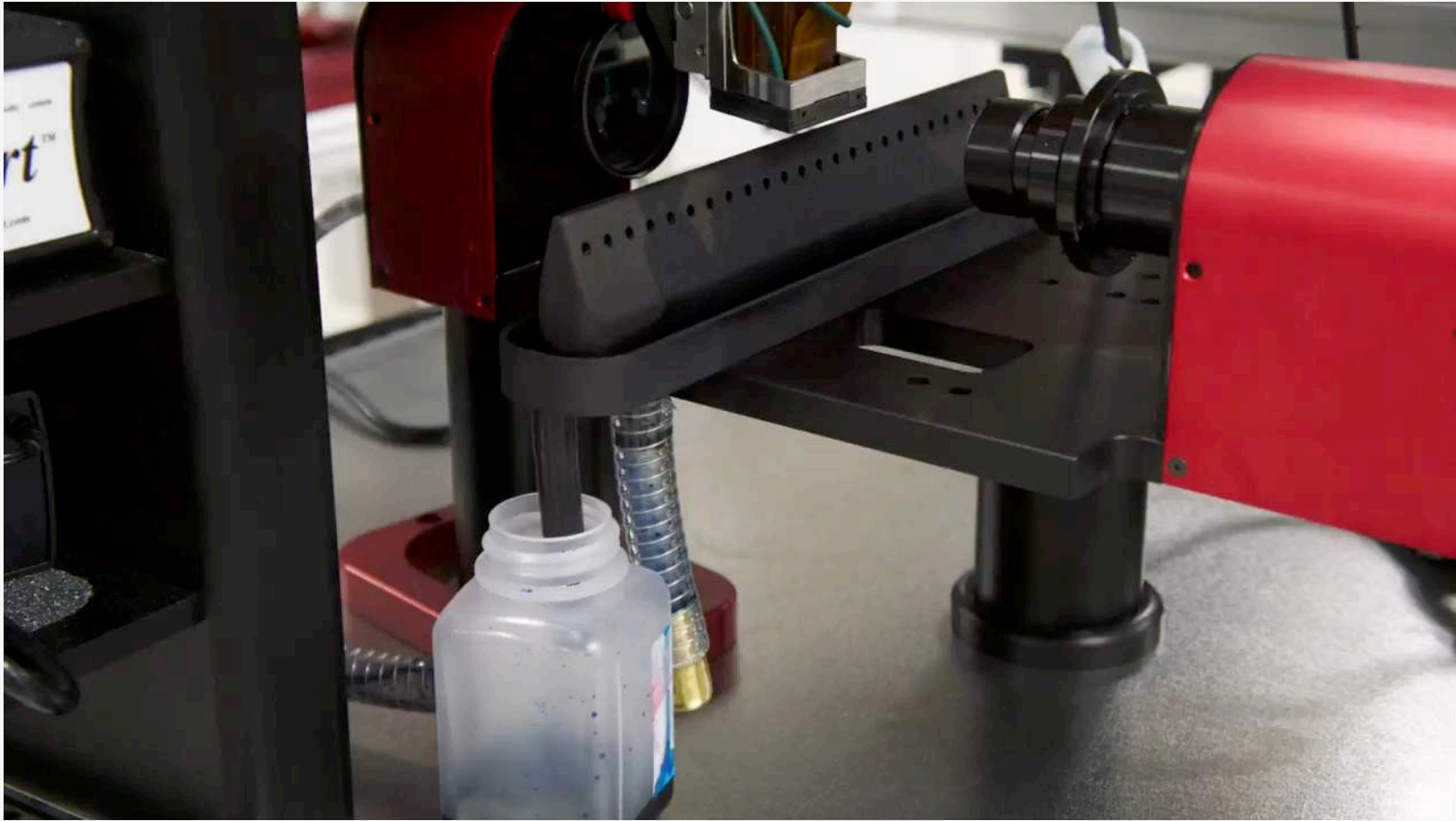
Spectrophotometer

Glossmeter

18"x18" XY travel



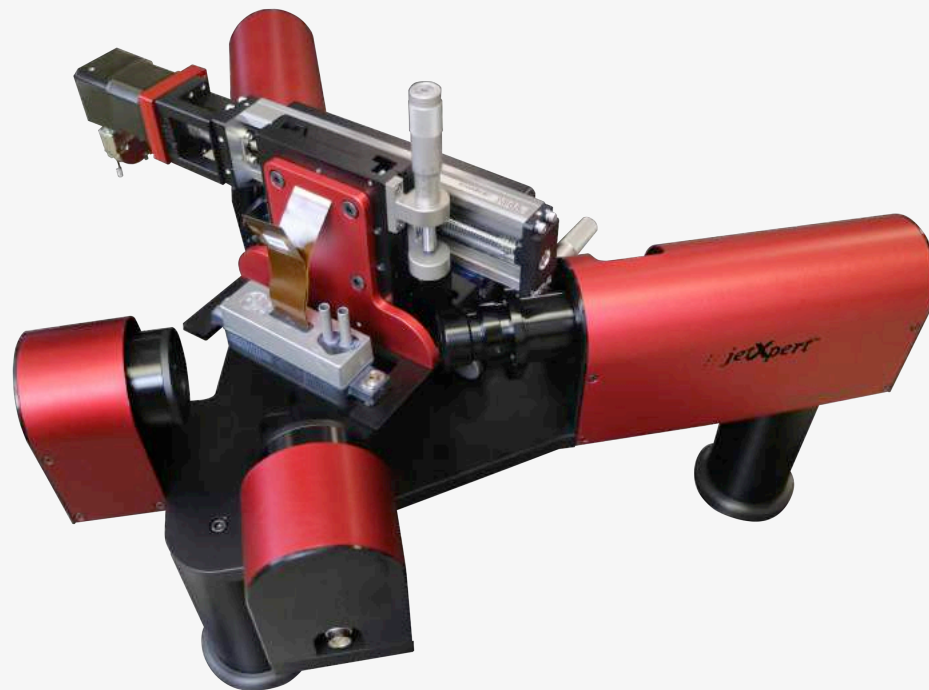
Testing Inkjet Performance New: Vacuum Ink Collector





Option: JetXpert 3D

Measure drop trajectory in two planes simultaneously





Option: JetXpert OEM

In situ drop analysis





Camera-based system

High resolution measurements



1 Micron/pixel resolution

Multiple cameras



Testing Inkjet Performance

Drop Watching

JetXpert

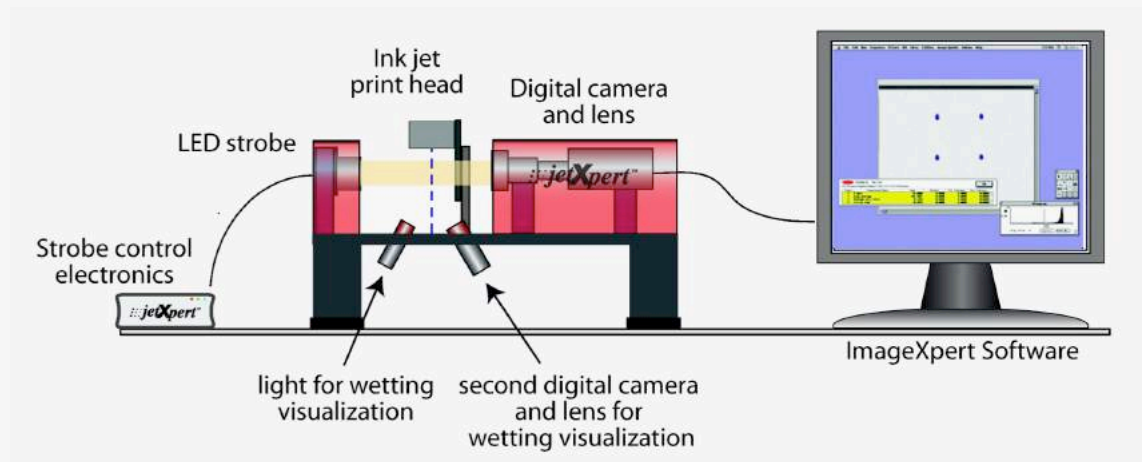
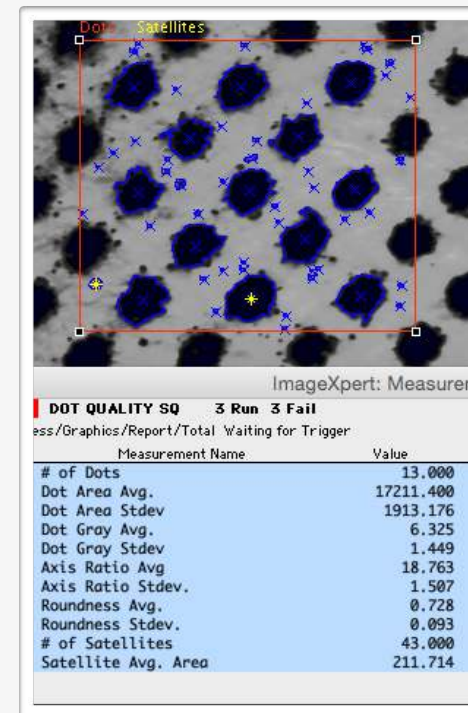
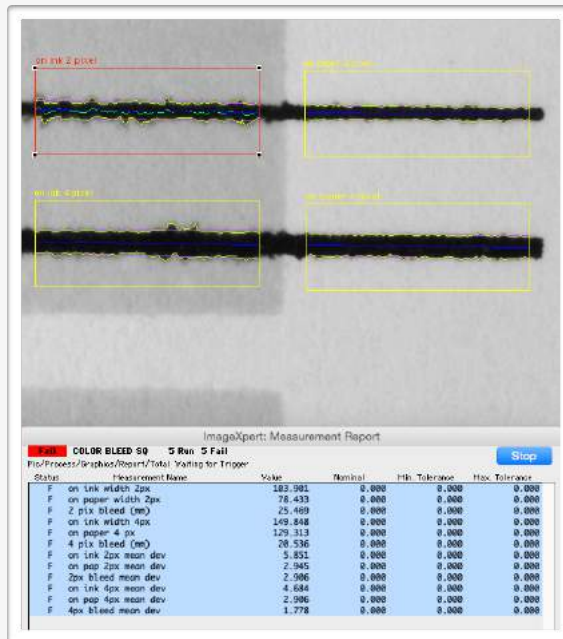




Image quality

Line quality and dot measurements

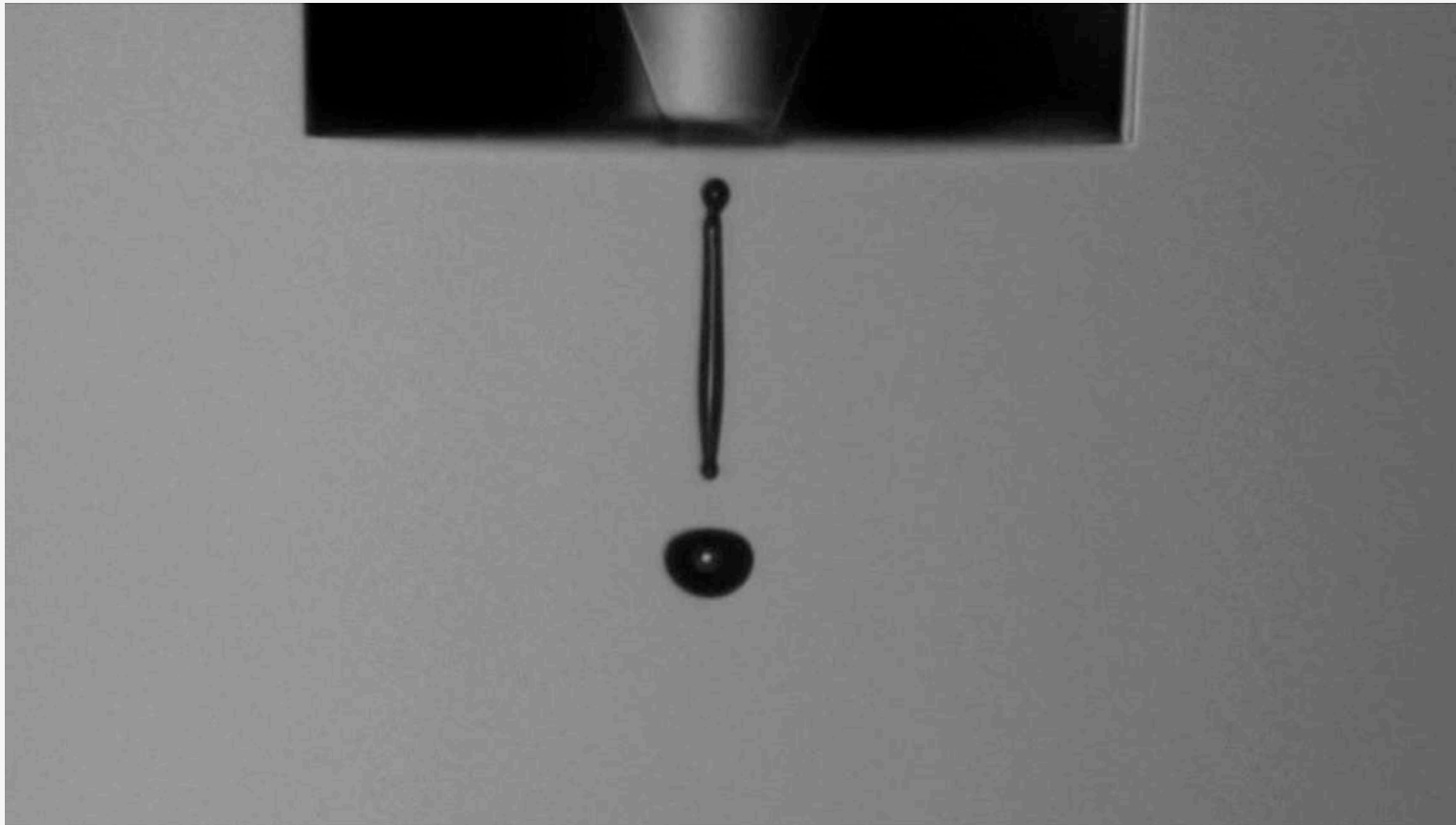




Testing Inkjet Performance

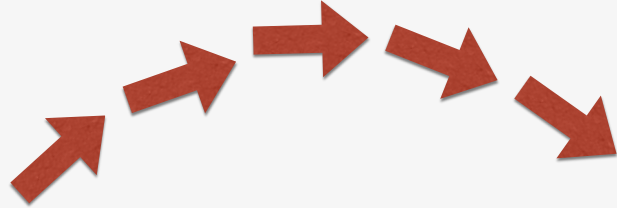
Drop Watching

JetXpert





Testing Inkjet Performance Why Testing Matters



- Ink Formulation
- Waveform
- Jetting Conditions
- Printhead

- Dot / Line / Text Quality
- Satellites / Overspray
- Color Bleed
- Banding



Testing Inkjet Performance: Why Testing Matters





Testing Inkjet Performance

Drop Watching

JetXpert

The screenshot displays the JetXpert software interface, which is used for testing inkjet performance. The interface is divided into several sections:

- Measurement Report:** A table showing the results of a test run. The report indicates a status of "Default Drops 50 1 Run 1 Fail" and "failing for Trigger".
- Control Panel:** A panel on the right side of the interface containing various settings and controls for the test run.

Measurement Report Data:

Status	Measurement Name	Value	Nominal	Min. Tolerance	Max. Tolerance
F	dropl: Average Radius	0.021	0.000	0.000	0.000
F	dropl volume (pl)	39.468	0.000	0.000	0.000
F	trjectory	90.288	0.000	0.000	0.000
F	velocity (m/s)	4.672	0.000	0.000	0.000

Fail	Measurement Name	Mean	Std. Deviation	Minimum	Maximum
1	dropl: Average Radius	0.021	0.000	0.021	0.021
1	dropl volume (pl)	39.468	0.000	39.468	39.468
1	trjectory	90.288	0.000	90.288	90.288
1	velocity (m/s)	4.672	0.000	4.672	4.672

Control Panel Settings:

- Stop Strobe:** Button to stop the strobe light.
- Mode:** Radio buttons for "Single", "Double", "Free run", and "Triggered".
- Delay1:** 554.79 μ s
- Delay2:** 20.05 μ s
- Pulse Width:** 625 ns
- Shutter Speed:** 1 ms
- Intensity:** 65
- Variable Delay:** Radio buttons for "On", "Incremental", and "Cyclic".
- Analysis:** Method: Default Drops; Data File Name: drops.xls; Exp ID: expID.
- Filename Prefix for movie:** movie



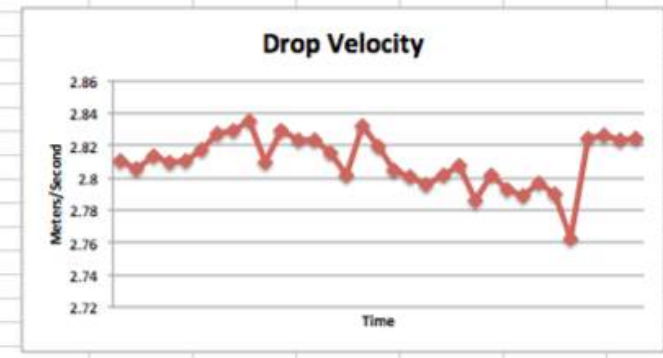
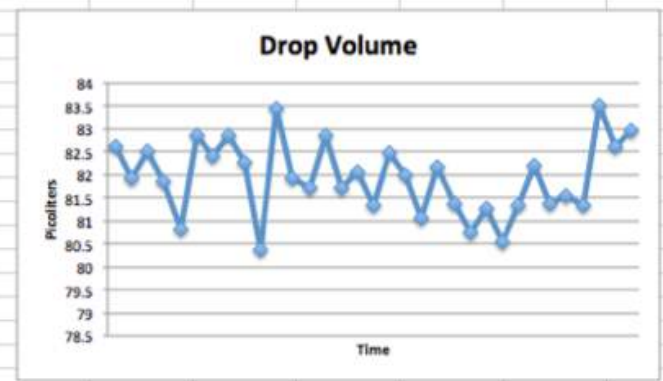
Testing Inkjet Performance

Drop Watching

JetXpert

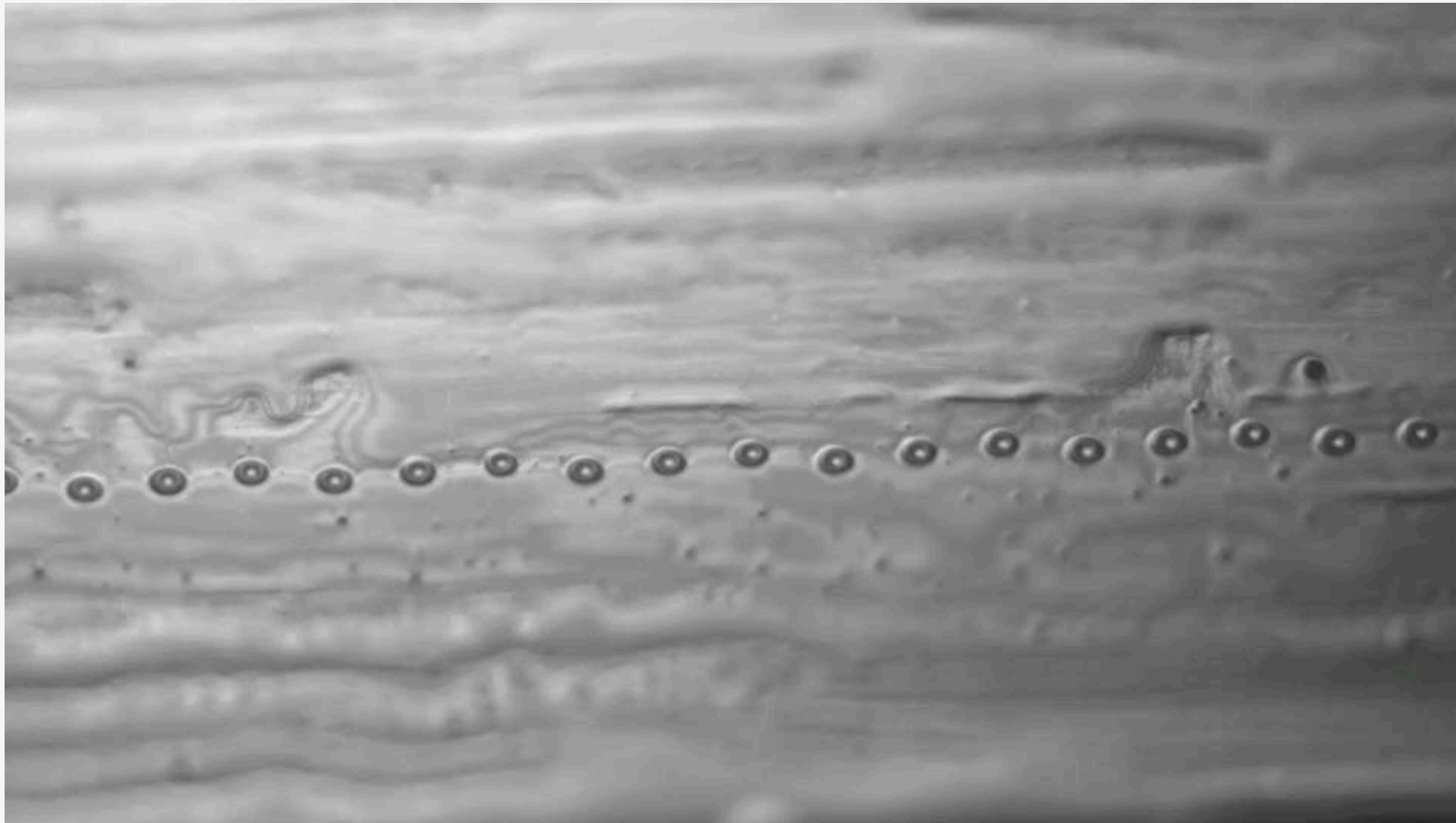


	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Exp ID	drop1: Average Radius	drop1 volume (pl)	trajectory	velocity (m/s)	Comments							
2	explD	2.70E-02	82.59902	90.34734	2.810377								
3	explD	2.69E-02	81.92004	90.26538	2.805462								
4	explD	2.70E-02	82.51237	90.31779	2.813141								
5	explD	2.69E-02	81.86227	90.34512	2.809216								
6	explD	2.68E-02	80.82324	90.34123	2.810189								
7	explD	2.70E-02	82.84831	90.25301	2.817132								
8	explD	2.70E-02	82.39166	90.33254	2.827205								
9	explD	2.70E-02	82.85435	90.26772	2.829492								
10	explD	0.026978	82.24663	90.23643	2.83524								
11	explD	2.68E-02	80.35029	90.37906	2.80994								
12	explD	2.71E-02	83.42861	90.31487	2.828665								
13	explD	2.69E-02	81.90157	90.24297	2.823571								
14	explD	2.69E-02	81.70437	90.2906	2.823064								
15	explD	2.70E-02	82.83242	90.26447	2.815511								
16	explD	2.69E-02	81.72195	90.20704	2.801593								
17	explD	2.70E-02	82.0435	90.30197	2.831982								
18	explD	2.69E-02	81.33885	90.24323	2.819198								
19	explD	2.70E-02	82.47418	90.2083	2.804973								
20	explD	2.70E-02	81.99509	90.3025	2.800565								
21	explD	2.68E-02	81.04761	90.23068	2.795382								
22	explD	2.70E-02	82.15066	90.19217	2.802033								
23	explD	2.69E-02	81.35635	90.16116	2.807508								
24	explD	2.68E-02	80.75811	90.07607	2.785419								
25	explD	2.69E-02	81.26146	90.09369	2.801683								
26	explD	2.68E-02	80.53992	90.19228	2.792685								
27	explD	0.026878	81.3354	90.08604	2.789279								
28	explD	2.70E-02	82.18834	90.15737	2.796326								
29	explD	2.69E-02	81.35461	90.12866	2.789792								
30	explD	2.69E-02	81.53654	90.0044	2.762346								
31	explD	2.69E-02	81.33968	90.24271	2.824192								
32	explD	2.71E-02	83.51846	90.22217	2.825986								
33	explD	2.70E-02	82.59348	90.32095	2.82281								
34	explD	2.71E-02	82.96806	90.20089	2.824322								





Testing Inkjet Performance Wetting Camera





Testing Inkjet Performance Stage for Head Scanning



imageXpert Measurement Report

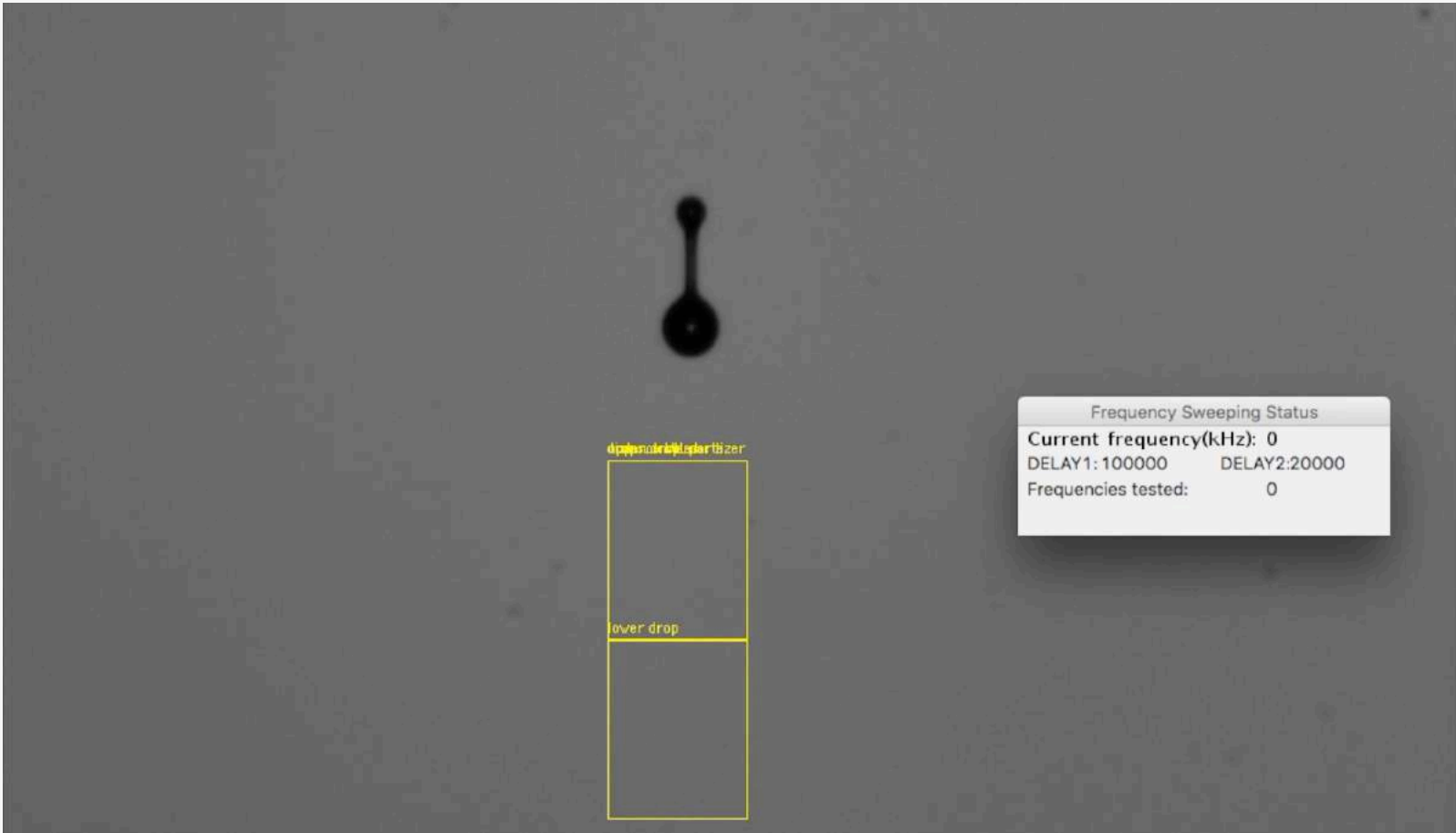
Status	Measurement Name	Value	Nominal	Min. Tolerance	Max. Tolerance
0 Run					
0 Fail					

File/Process/Graphics/Report/Total: Waiting for Trigger

Fail	Measurement Name	Mean	Std. Deviation	Minimum	Maximum
------	------------------	------	----------------	---------	---------

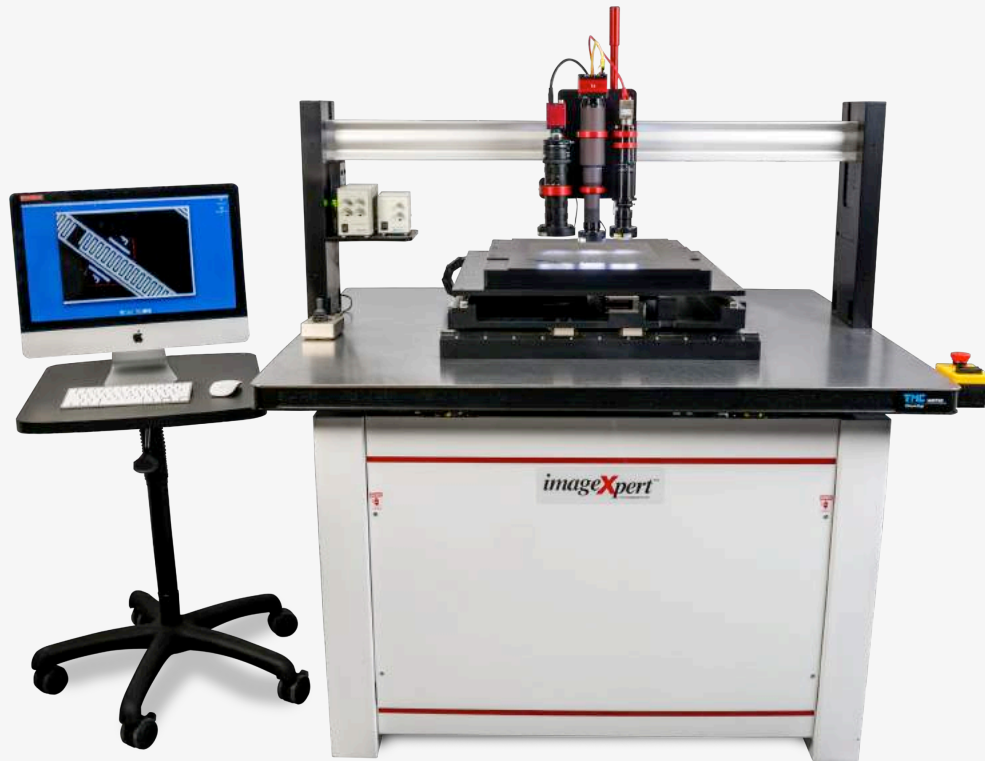


Testing Inkjet Performance Scanning Frequencies





Testing Inkjet Performance Print Quality Inspection



1 Micron/ pixel resolution

Multiple cameras

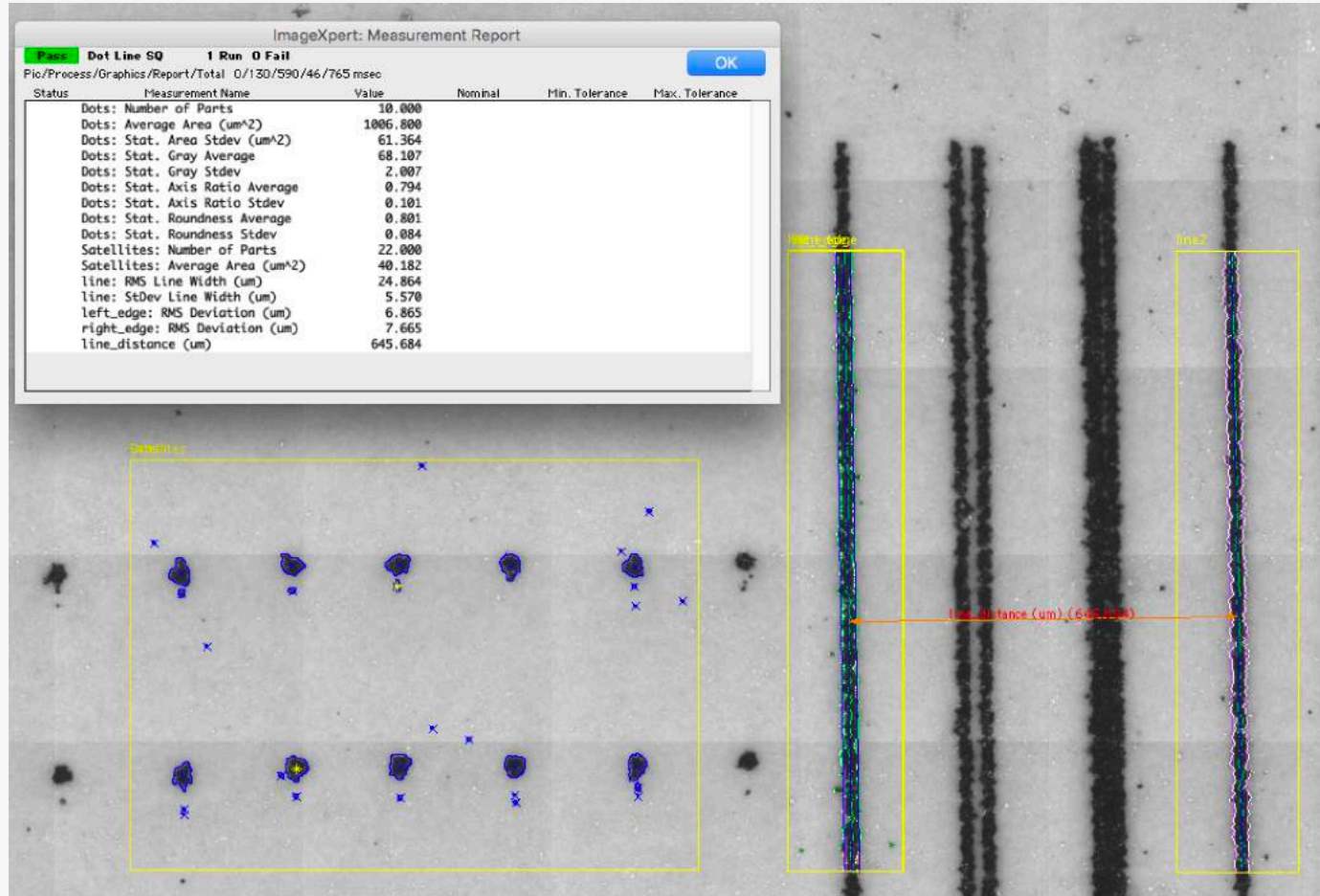
Spectrophotometer

Glossmeter

18"x18" XY travel

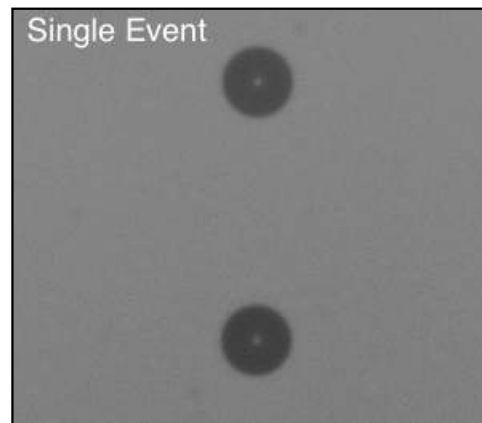


Testing Inkjet Performance Print Quality Inspection

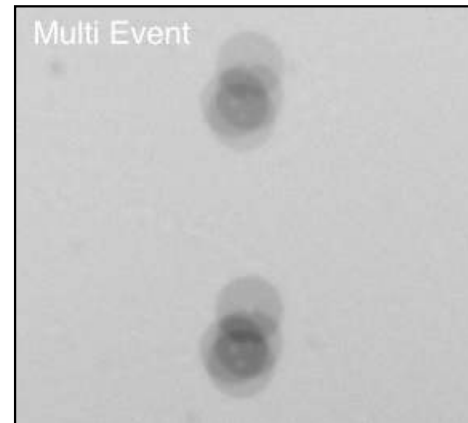


SINGLE EVENT IMAGING

Each image is of a single drop, rather than averaging or summing images of several drops.



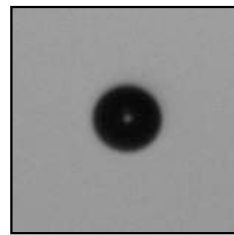
Single Event



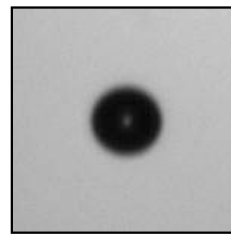
5 Drop Aggregate

SHORT EXPOSURE TIME

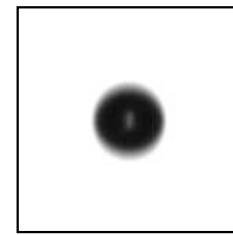
The further a drop travels while being imaged, the greater the blur.



750 ns



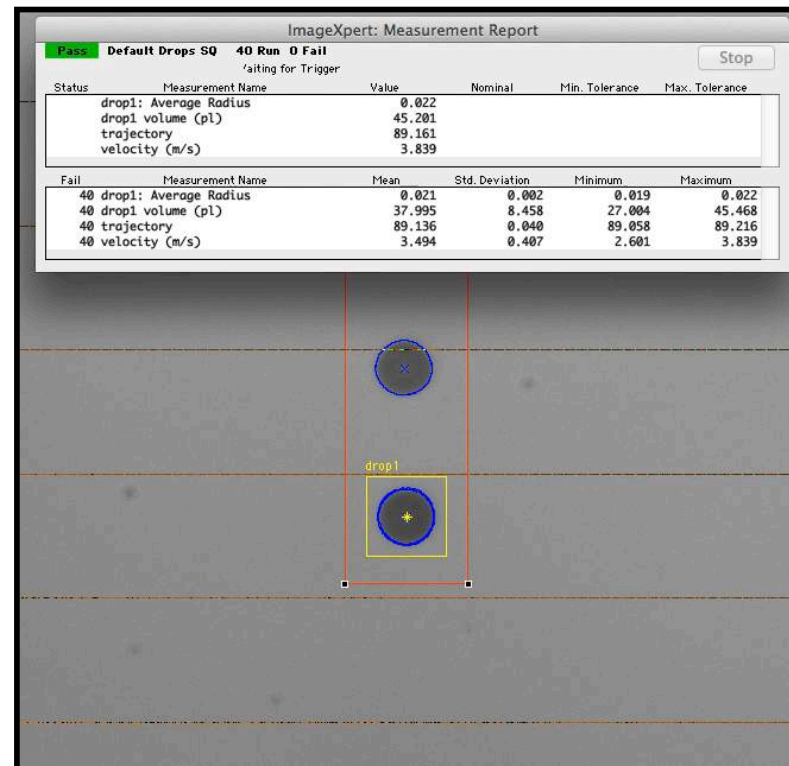
1750 ns



2750 ns

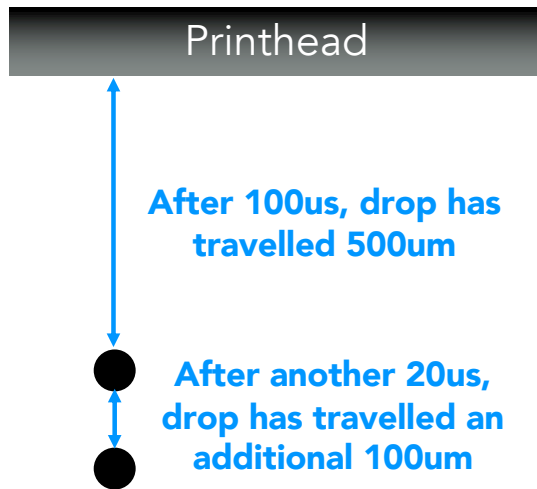
DOUBLE STROBE METHOD

The most accurate way to measure velocity of a single drop at a single moment in time.



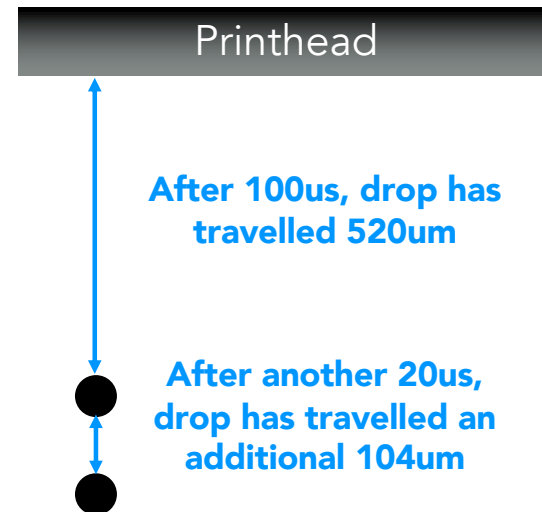
DOUBLE STROBE METHOD

First Drop Travels at 5 m/s



Double strobe method calculates the drop has travelled 100um in 20us and reports a velocity of 5m/s (correct)

Next Drop Travels at 5.2 m/s



Double strobe method calculates the drop has travelled 104um in 20us and reports a velocity of 5.2m/s (correct)

SINGLE STROBE METHOD

First Drop Travels at 5 m/s

Printhead



After 100us, drop has travelled 500um



Next Drop Travels at 5.2 m/s

Printhead



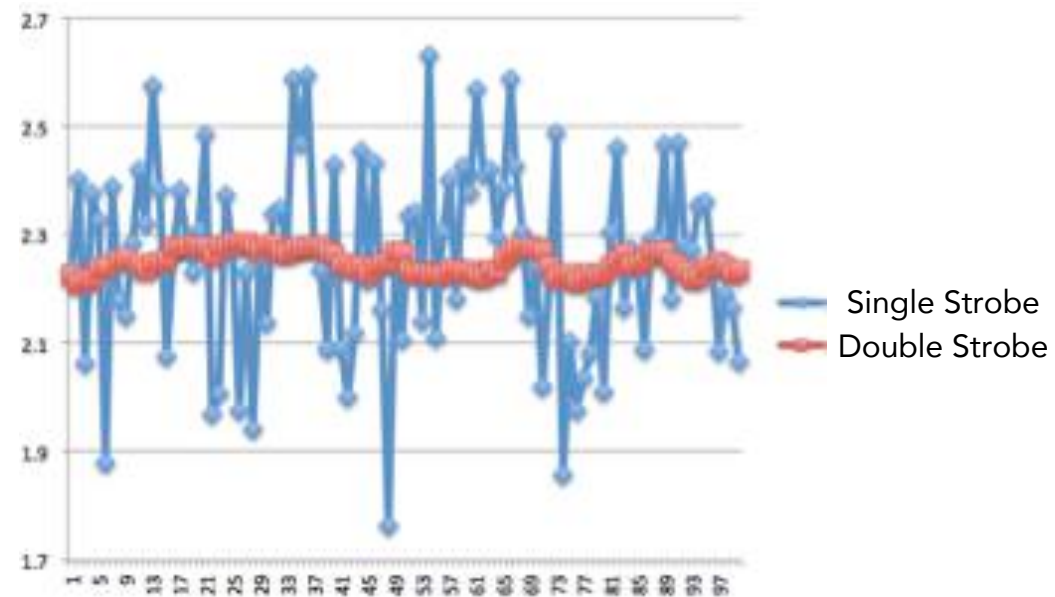
After 120us, drop has travelled 624um



Single strobe method calculates that the drop has travelled 124um in 20us and reports a velocity of 6.2m/s (incorrect)

DOUBLE VS. SINGLE

Comparison of Velocity Measurement Consistency

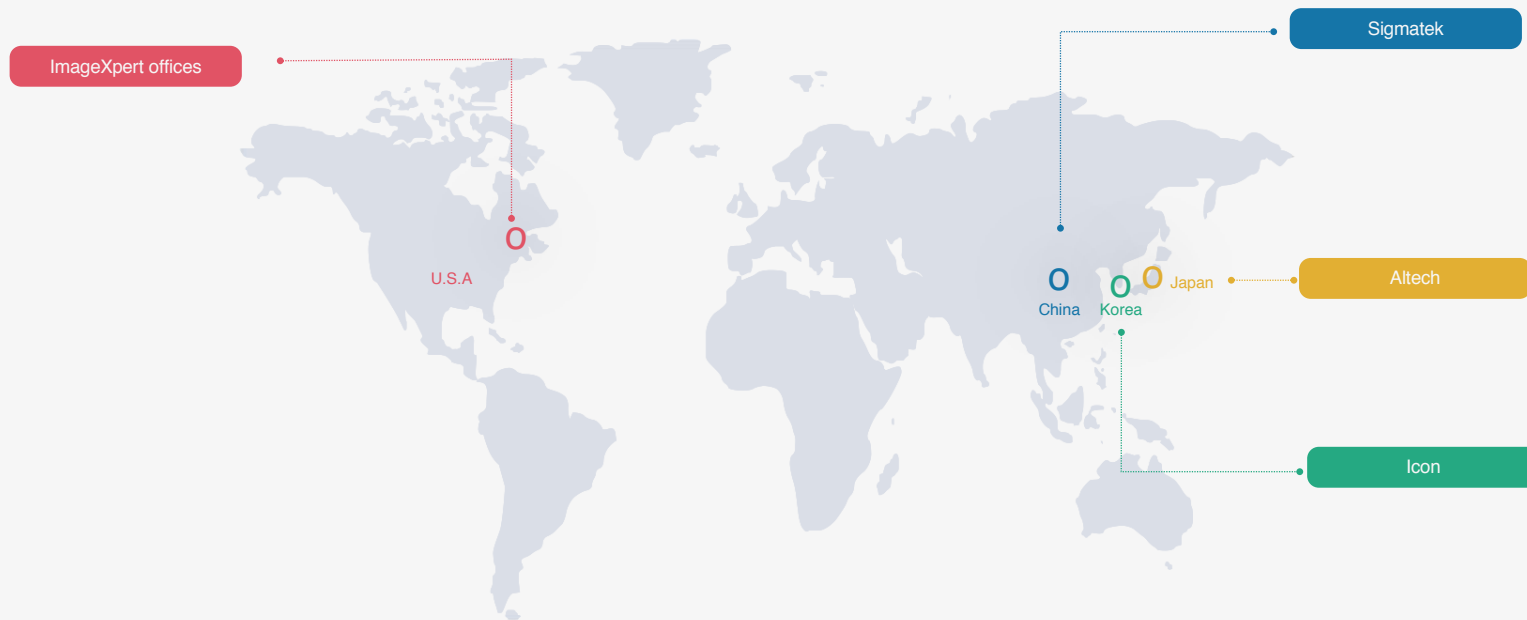


Data captured using a Dimatix S Class Printhead with XL50 Model Fluid



ImageXpert Inc.

Worldwide representation





Supported Inkjet Printheads

Integrated equipment for all printheads on the market



Drivers and software

Ink supply (gravity and recirculating)

Printhead mechanical mounts

Integration into JetXpert system

Xaar

Dimatix

Konica Minolta

Xerox

Ricoh

Kyocera

Seiko

Etc.



Option: Latency measurement

Study the effects of latency to maximize open time and minimize recovery time

The screenshot displays the imageXpert software interface. On the left, a camera view shows a spray nozzle with a red 'AutoDrop' box. A 'Latency Status' window is overlaid on the camera view, showing 'Current Idle time(s): 1.0' and 'Drop number: 1/5'. On the right, the control panel includes a 'Run Task' button, a 'Latency Multi-Drop' dropdown menu, and an 'Edit Task...' button. Below the control panel, the 'ImageXpert: Measurement Report' window is open, showing a table of measurement data.

State	Measurement Name	Value	Normal	Min. Tolerance	Max. Tolerance
Fail	Measurement Name	Mean	Std. Deviation	Minimum	Maximum
0	drop1: Average Radius	0.816	0.008	0.816	0.816
0	drop1: volume (pL)	16.966	0.092	16.874	17.059
0	trajectory				
0	velocity (m/s)				



Option: Stitch

Automatically capture drops at different delay settings in a single image

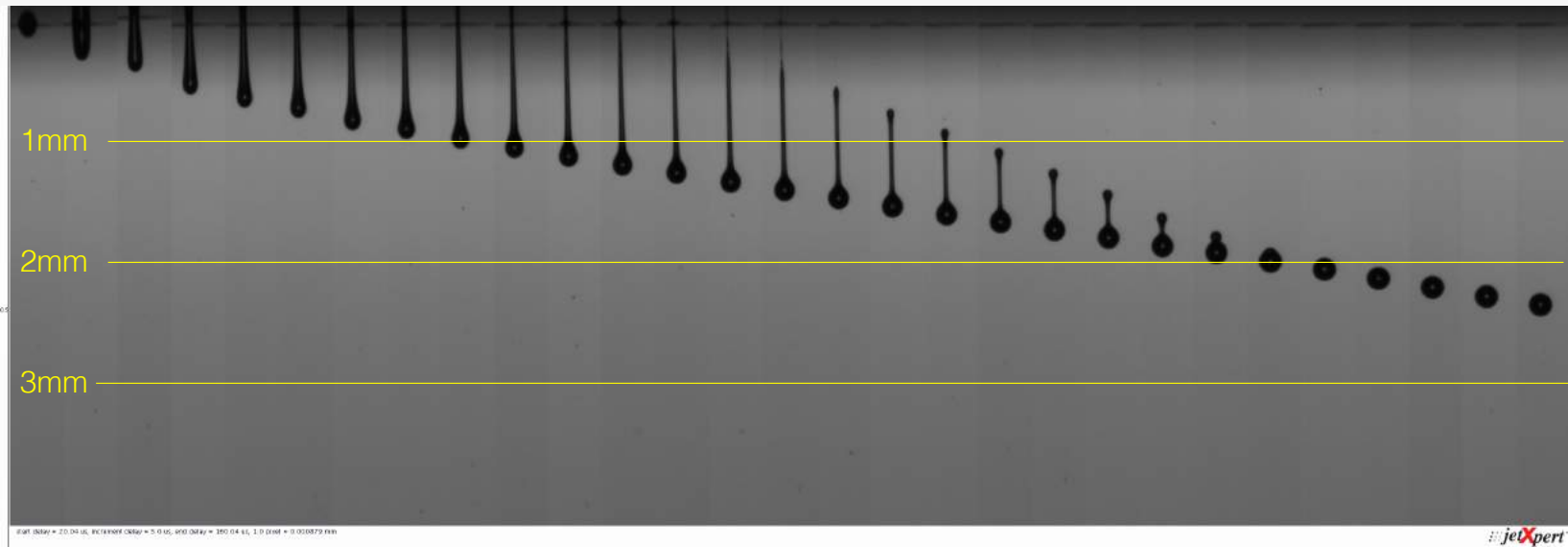




Image quality

Measure image quality attributes

S N

Line quality

Text quality (80%)

Inter-color bleed

Dot quality (0.01")

Text quality arrays for visual assessment (positive and negative)

8pt: e f g T H

10pt: e f g T H

12pt: e f g T H

4pt: e f g T H

6pt: e f g T H

10pt: e f g T H

12pt: e f g T H

Date: _____

Other information: _____

Tone Reproduction

	12.5%	25%	37.5%	50%	62.5%	75%	87.5%	100%
Black								
Cyan								
Magenta								
Yellow								
Red								
Green								
Blue								

Spot area quality

Uniformity

imageXpert

144 jet test target (see 8) designed and copyrighted by imageXpert Inc. 2005
www.imageXpert.com Tel: 603.898.2500 USA

⊕ Marks for automatic scaling correction

Dot quality

Line quality

Mottle

Dimensions

Color

Text quality



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