

Vaccinating Commercial Poultry: The Devil is in the Details

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Broiler Vaccination Program

- Nearly 100% of broilers produced in the US get spray vaccinated in the hatchery for some combination of IBV, NDV, or Coccidia
 - May also get a salmonella or IBDV
- For 95% of those broilers, that's the only vaccination they get
 - Most complexes do not field boost unless the birds will be housed longer than ~60 days



Vaccine Target...

Spray application of commercially available live *Mycoplasma gallisepticum* (MG) vaccines is a labor- and time-saving means of mass vaccination of layer chickens (7). The effectiveness of spray application of live MG vaccines to poultry can be affected by numerous factors including vaccine suspension titer (13), chemical properties of the suspension media (22,23), temperature of the suspension media (6), physical characteristics of the spray (29), and temporal effects on viability after resuspension (6,22).

Routes of vaccination via spray application may include inhalation through the nares with subsequent travel into the respiratory system, topical application onto the eye surface and associated adnexa, and ingestion (9). While inhalation through the nares, with subsequent transport through the remainder of the respiratory system, is typically cited as a means of vaccine uptake, the particle size necessary to traverse the respiratory tract to its lower recesses is less than 5 μm (11,16). Hayter and Besch (16) showed that particles which averaged 5 μm or larger were deposited primarily in the upper respiratory system; hence, droplets of vaccine suspension must be

smaller in order to be transported into the lower respiratory system. More recently, Corbanie *et al.* (11) evaluated the transport of particles ranging in size from 1 to 20 μm through the respiratory system in broilers aged 1 day, 2 wk, and 4 wk. The majority of particles 5 μm or greater were found associated with the eyes and nares at least 70% of the time.

Topical application of vaccine onto the surface of the eyes results in drainage into the nasal passages via the nasolacrimal duct (25). Within the nasal passages, most of the lymphoid tissue is present around the choanal and infundibular clefts just rostral to the pharyngeal papillae (15,20,21,32). Vaccine uptake may occur via the secretory duct of the Harderian gland (HG), which connects it to the nictitating membrane (8). The main source of IgA in tears is derived from the HG, and the HG may influence the humoral immune response in other mucosal sites because HG-derived IgA+ B cells have been shown to migrate selectively to cecal tonsils (34). Finally, ingestion of vaccine results in potential stimulation in the upper gastrointestinal tract of lymphoid tissue in the cervical and thoracic parts of the esophagus as well as in the esophageal tonsil and lymphoid tissue in the proventriculus (10).

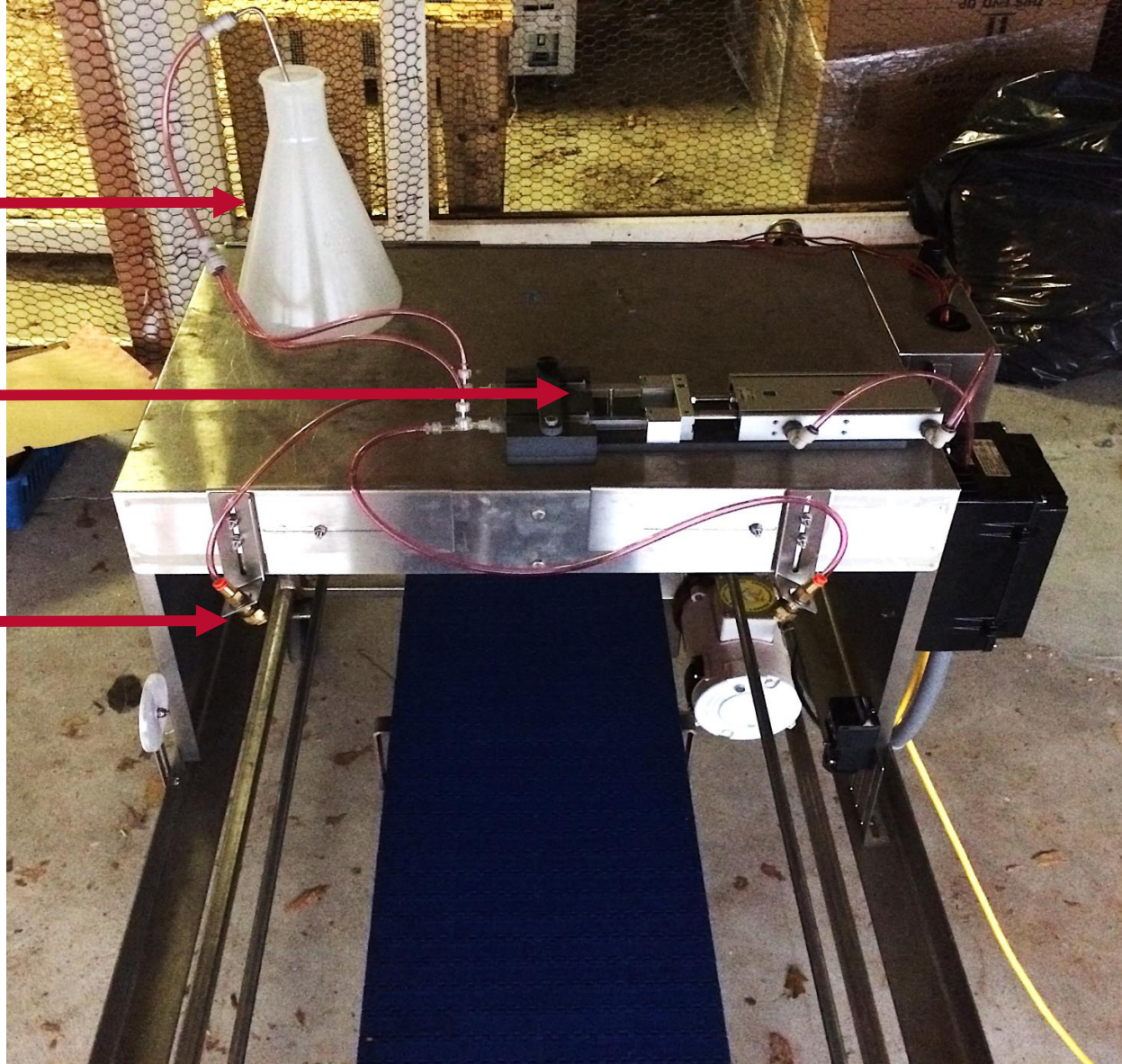
Because a recent assessment of spray characteristics of nozzles commonly used to apply live MG vaccine in layer chicken operations has shown that the amount of respirable droplets (<5 μm) is negligible (29), it is reasonable to assume that the preponderance of both mucosal and systemic immune responses

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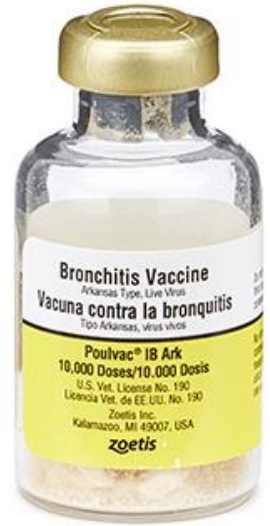
Disclaimer: Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U. S. Department of Agriculture.

Approved for publication as Journal Article No. J-11839 of the Mississippi Agricultural and Forestry Experiment Station, Mississippi State University.

Hatchery Vaccination



Vaccine Preparation



Vaccine Preparation

- Lyophilized is easier to work with
 - Can be stored in fridge...no LN or -20/80 needed
 - Resuspension is very easy

- Frozen (LN)
 - Needs monitoring in the LN
 - Thawing is a potential point of failure



Temperature Can Have an Effect....

Before Temperature Adjustment

		Mass	Ga08
Farm 1	Mean Ct Value	28.91717	32.89219
	Percent Positive	93	53
Farm 2	Mean Ct Value	28.65878	32.61761
	Percent Positive	100	60
Farm 3	Mean Ct Value	30.96956	37.93806
	Percent Positive	100	27
Farm 4	Mean Ct Value	31.23516	37.63699
	Percent Positive	100	27
Farm 5	Mean Ct Value	32.8624	35.67451
	Percent Positive	93	13

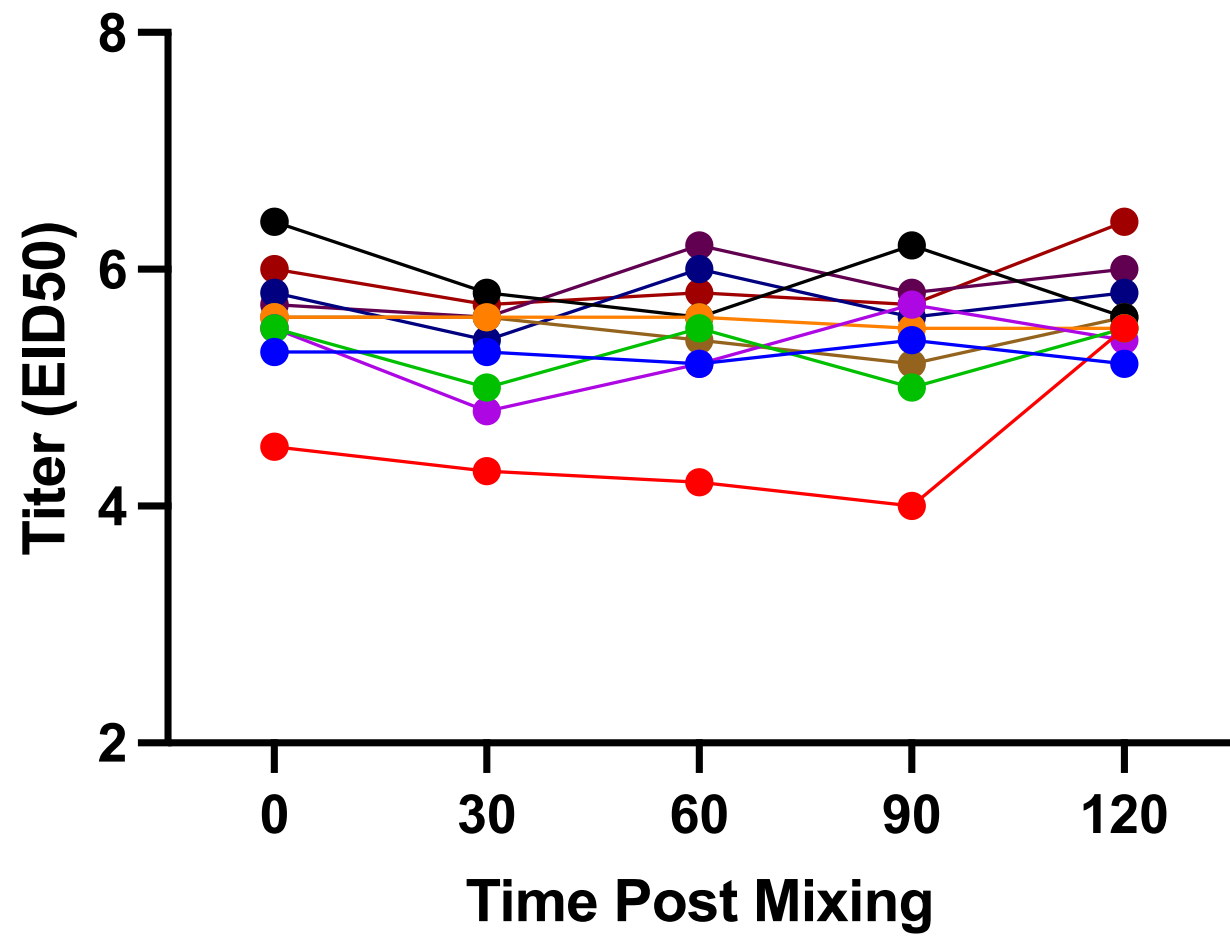
After Temperature Adjustment

		Mass	Ga08
Farm 6	Mean Ct Value	27.83472	23.44711
	Percent Positive	100	100
Farm 7	Mean Ct Value	26.24831	23.36542
	Percent Positive	93	100
Farm 8	Mean Ct Value	29.32748	24.18721
	Percent Positive	100	100
Farm 9	Mean Ct Value	28.31188	27.3158
	Percent Positive	100	100
Farm 10	Mean Ct Value	26.02246	25.67387
	Percent Positive	100	100
Farm 11	Mean Ct Value	25.28575	27.12862
	Percent Positive	100	100
Farm 12	Mean Ct Value	25.84239	25.56308
	Percent Positive	100	100
Farm 13	Mean Ct Value	28.52212	19.81948
	Percent Positive	100	100

Vaccine Preparation

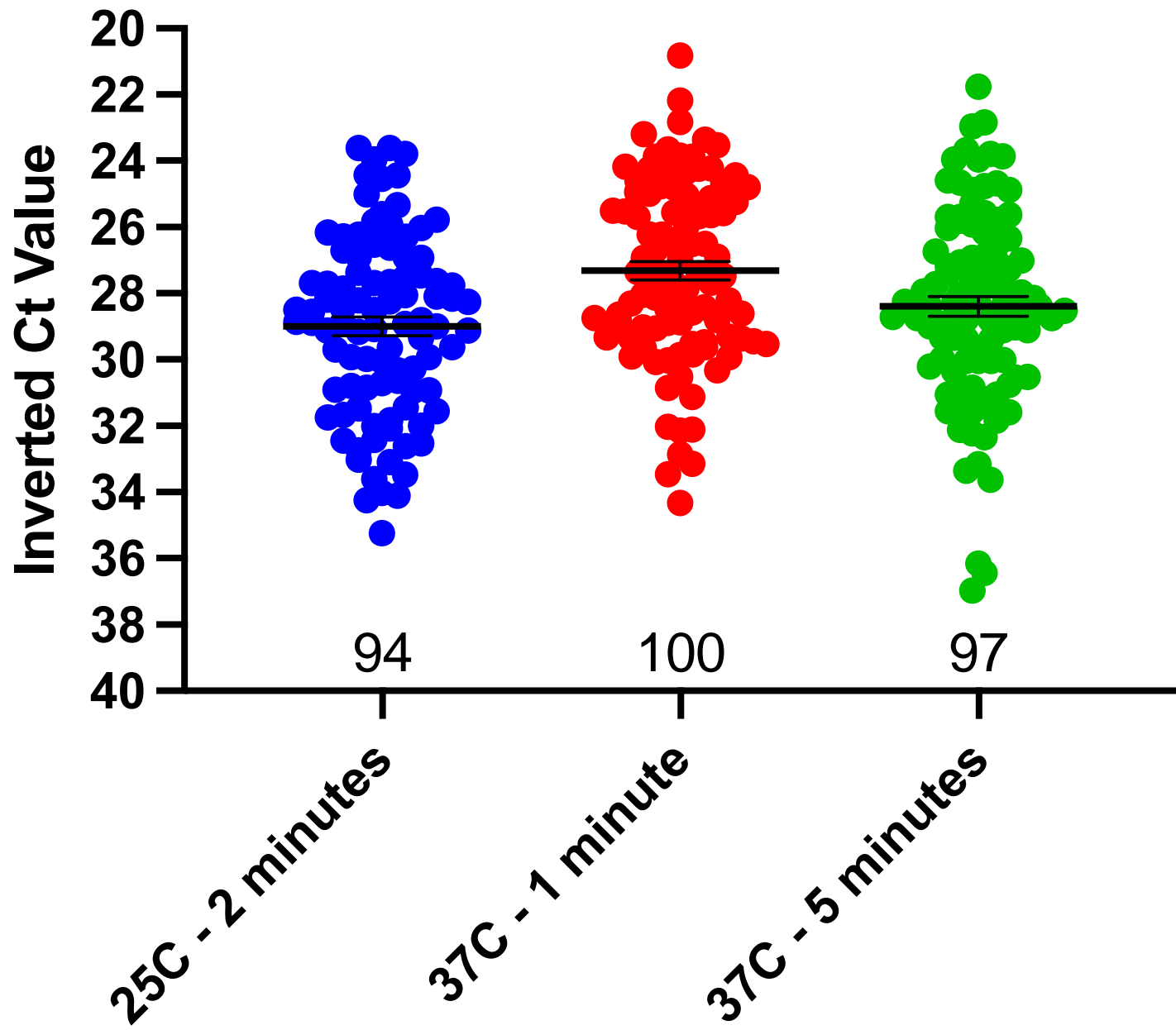


Frozen Vaccines

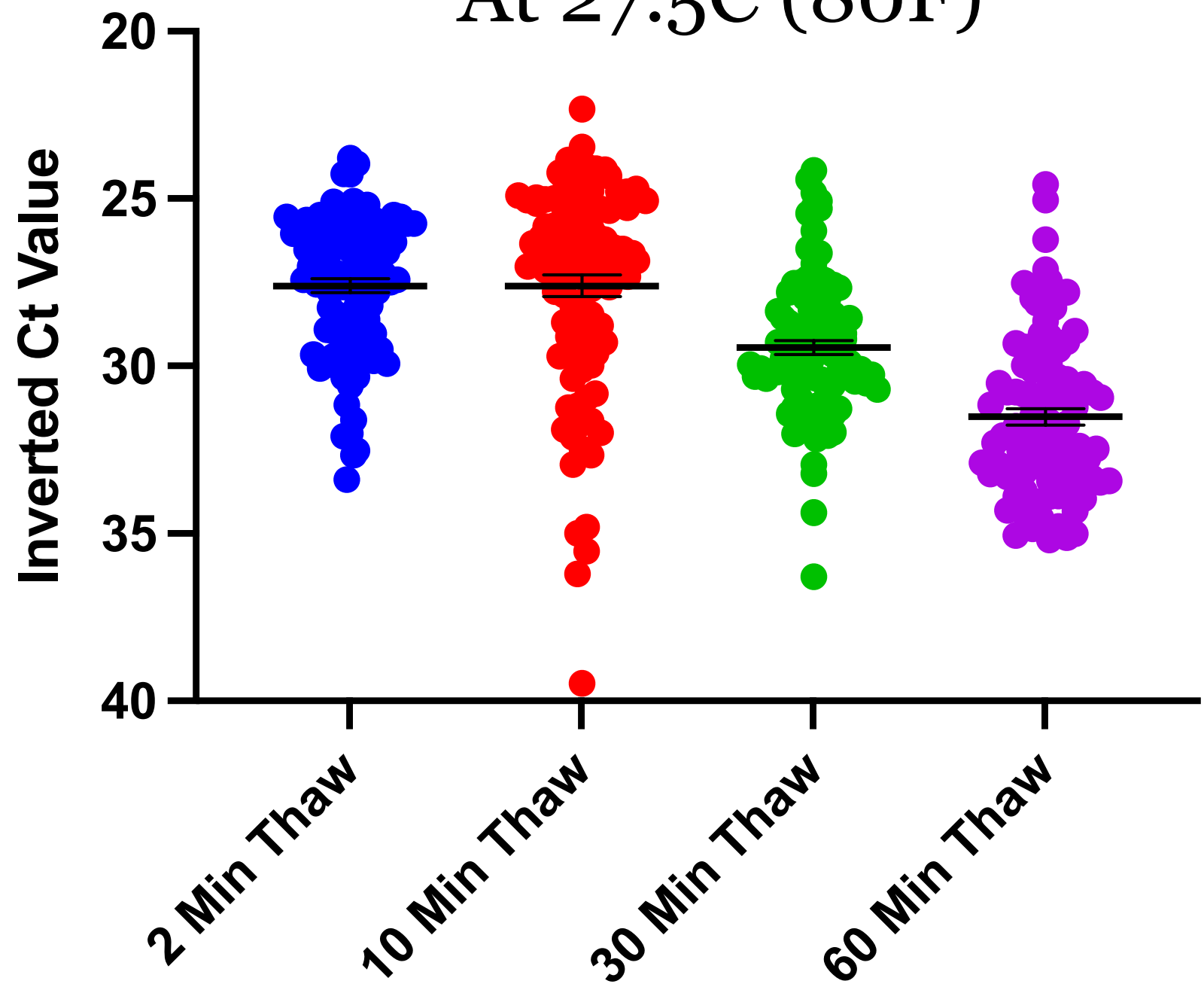


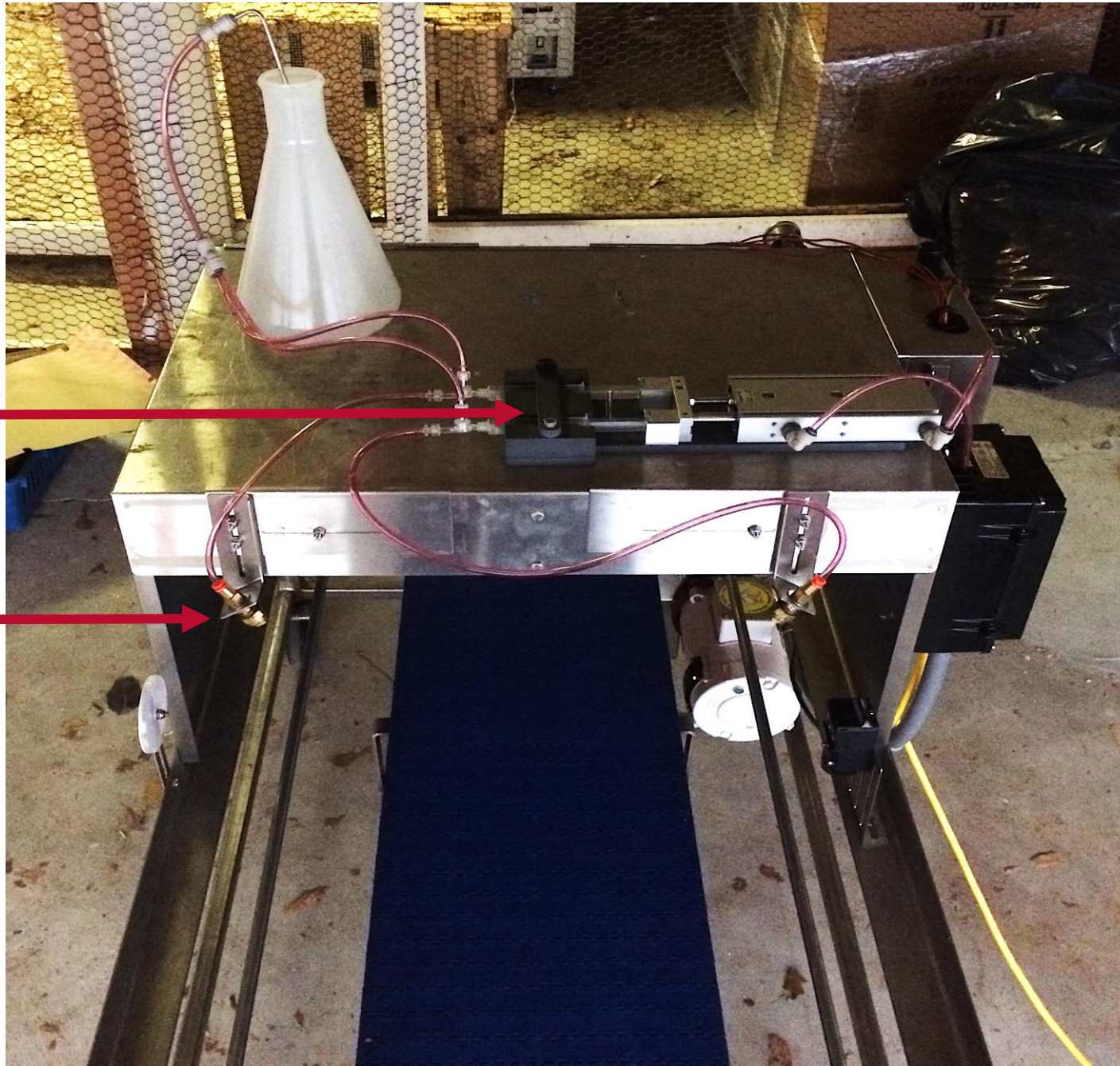
- BI Mass, 25C, 2 Min
- BI Mass, 25C, 5 Mins
- BI Mass, 37C, 1 Min
- BI Mass, 37C, 5 Min
- Poulvac GA08, 25C, 2 Min
- Poulvac GA08, 25C, 5 Min
- Poulvac GA08, 37C, 1 Min
- Poulvac GA08, 37C, 5 Min
- Poulvac GA08, 37C, 10 Min
- Poulvac GA08, 16 Hour

GA08

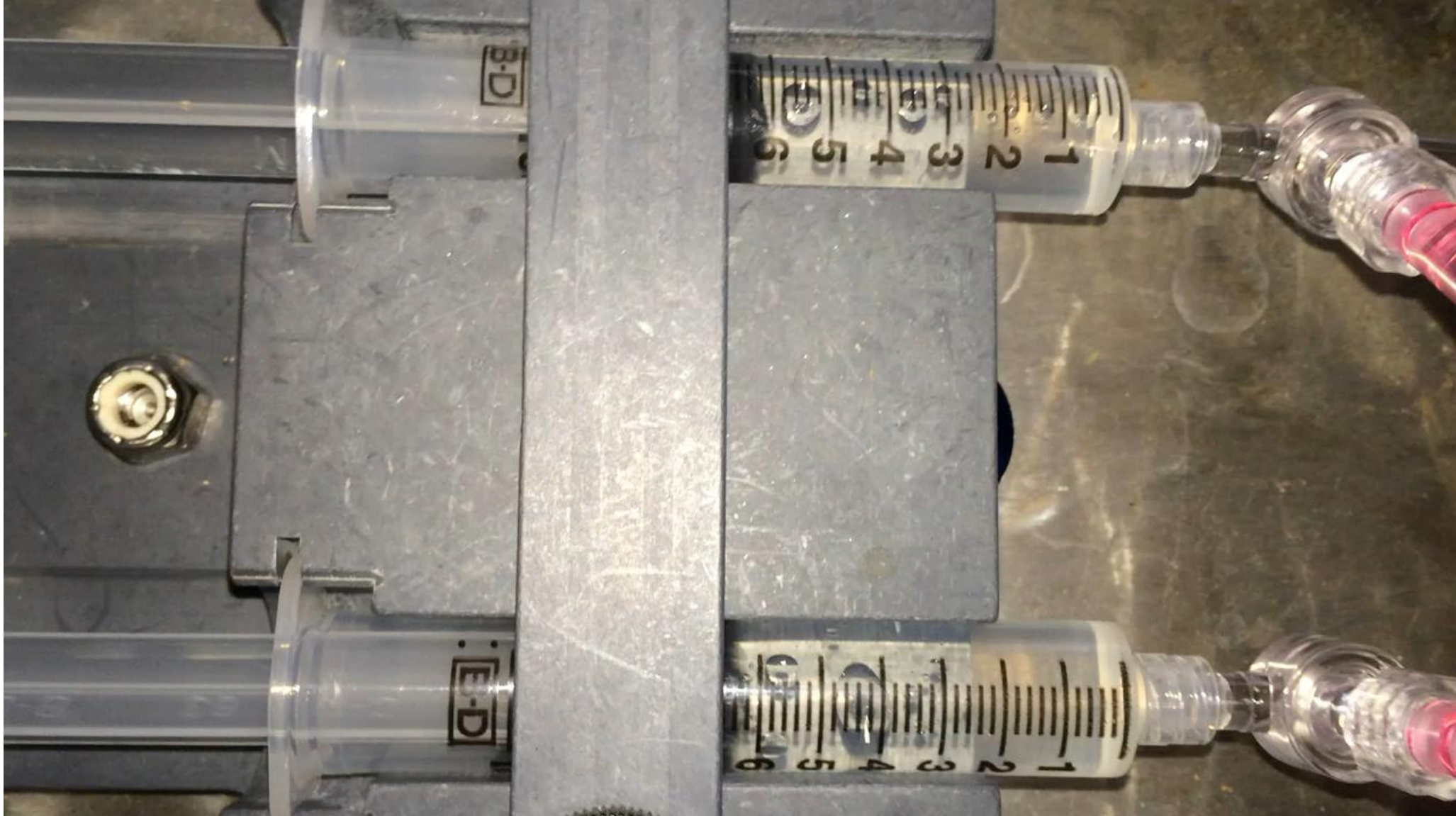


At 27.5C (80F)





Syringe Mechanics



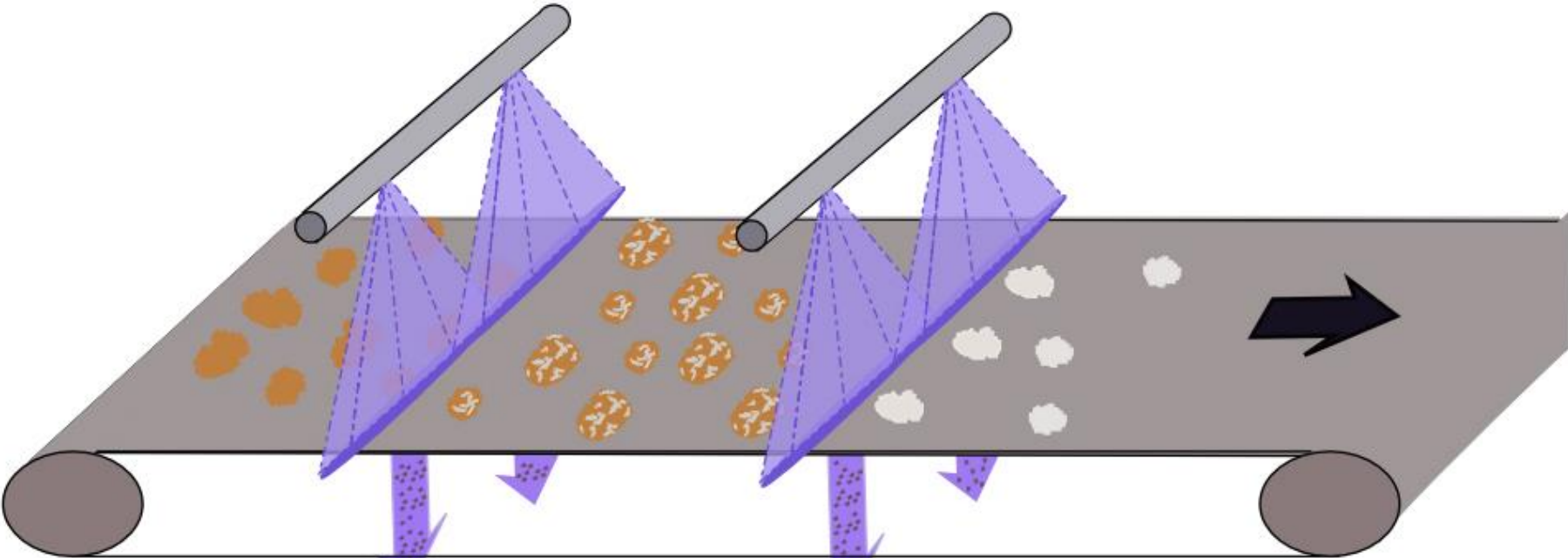
Syringe Mechanics



Nozzle Mechanics



Nozzle Mechanics

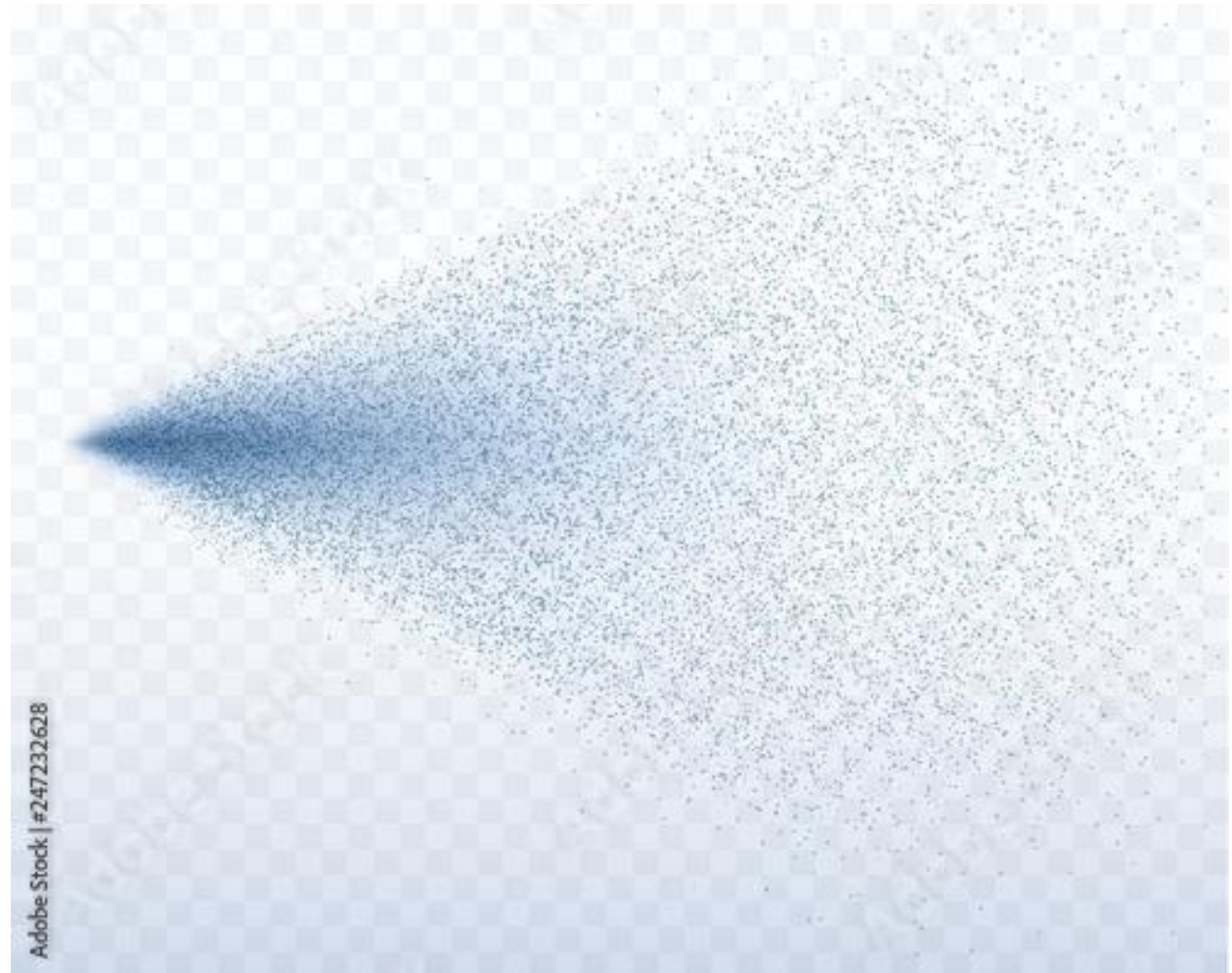


Nozzle Mechanics



If You Remember Nothing Else....

Everything is centered
around creating larger
droplets for spray
application



Droplet Size is Always a Range

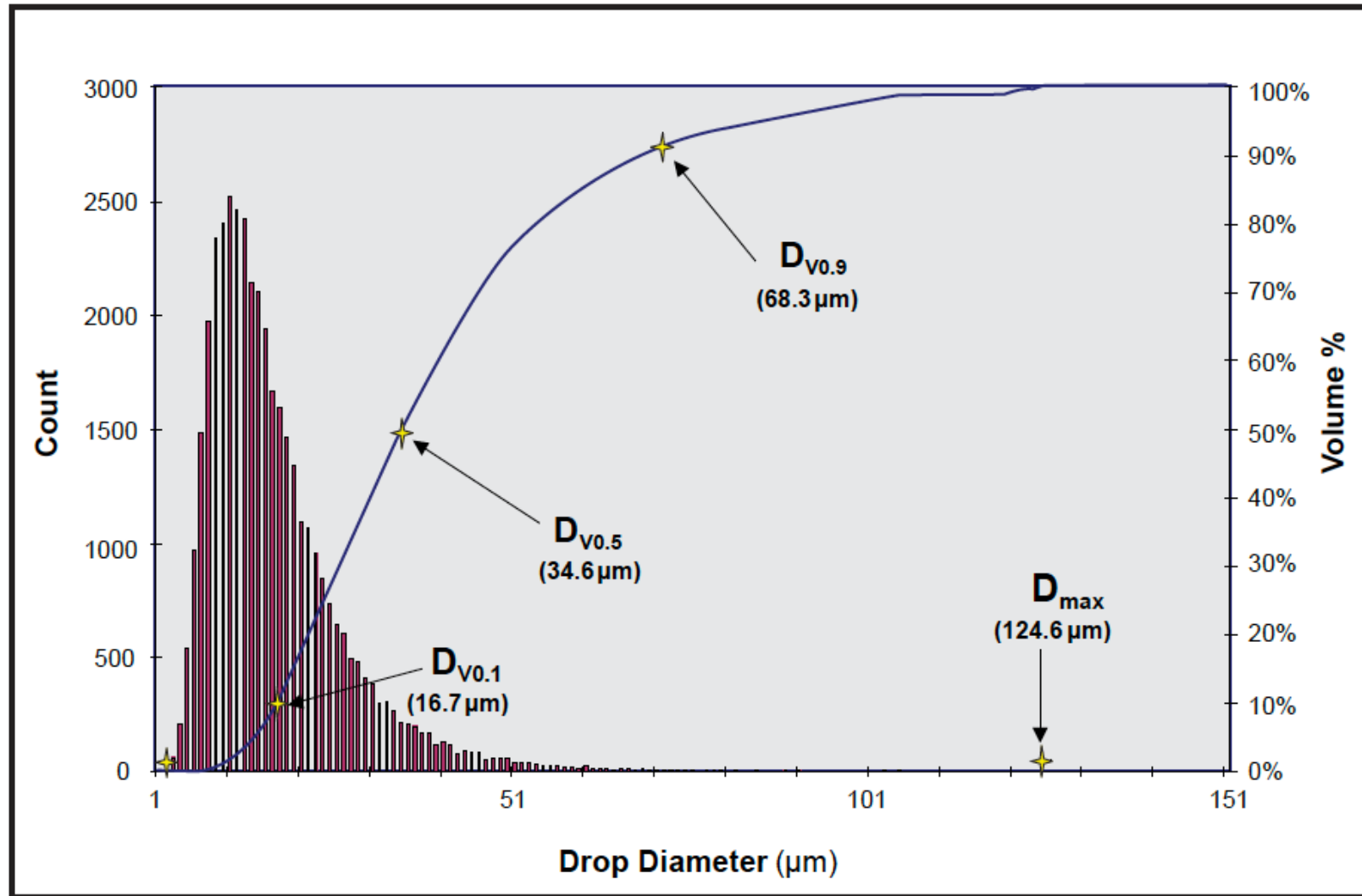


Figure 5. Typical drop size distribution.

Smaller Droplets are Less Stable

Evaporation of water droplets

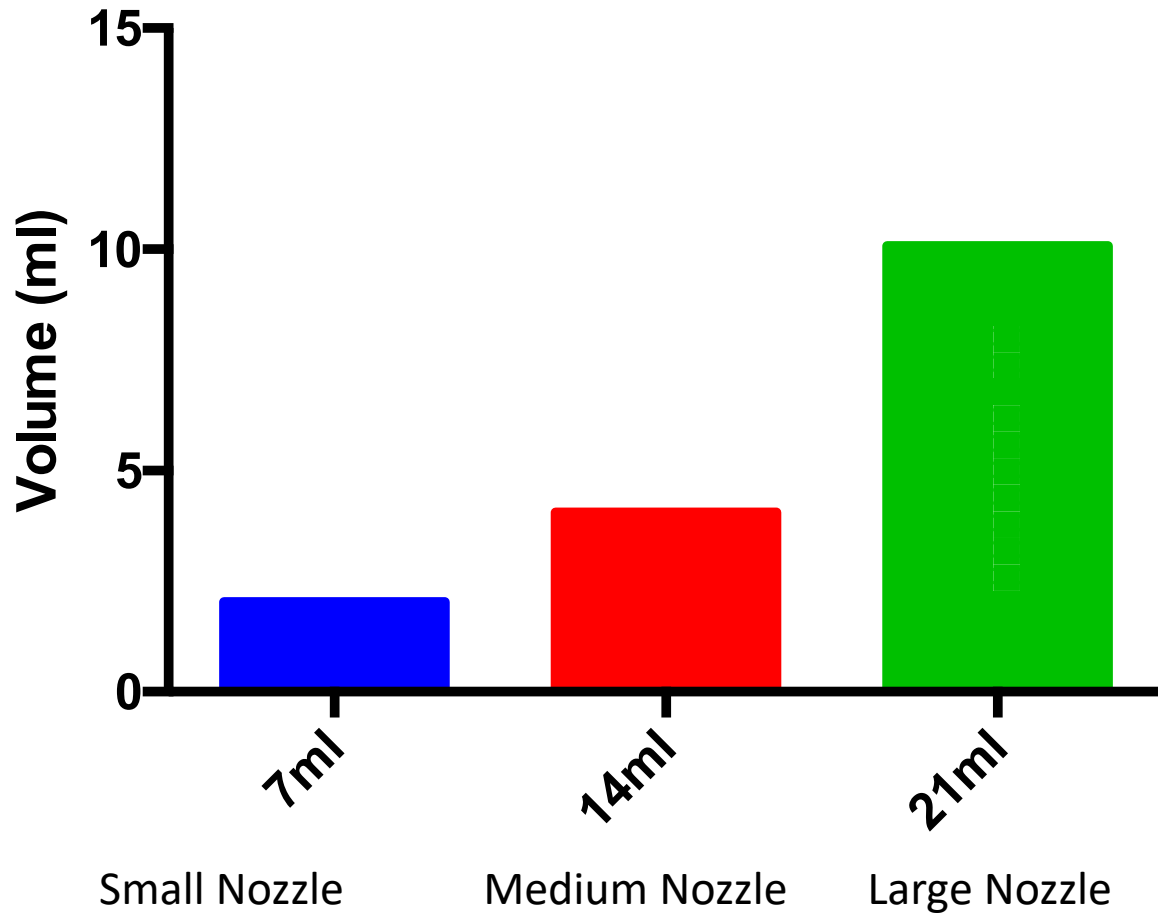
Droplet diameter μm	Temperate: cool		Temperate summer, Dry sub-tropical		Humid tropical		
	T ($^{\circ}\text{C}$)	RH (%)	$\Delta T =$	lifetime (s)	fall dist. (m)	lifetime (s)	fall dist. (m)
	16	58	4.5			25	30
						50	89
						7	1.5
				lifetime (s)	fall dist. (m)	lifetime (s)	fall dist. (m)
10				0.3	0.0004	0.8	0.0013
20				1.1	0.007	3.3	0.020
30				2.5	0.03	7.5	0.10
40				4.4	0.11	13	0.32
50				6.9	0.26	21	0.78
75				16	1.3	47	3.96
100				28	4.2	83	12.5
150				63	21	188	63
200				111	67	333	200
300				250	338	750	1013
500				694	2604	2083	7813
1000				2778	41667	8333	125000

(estimates based on Amsden, 1962)

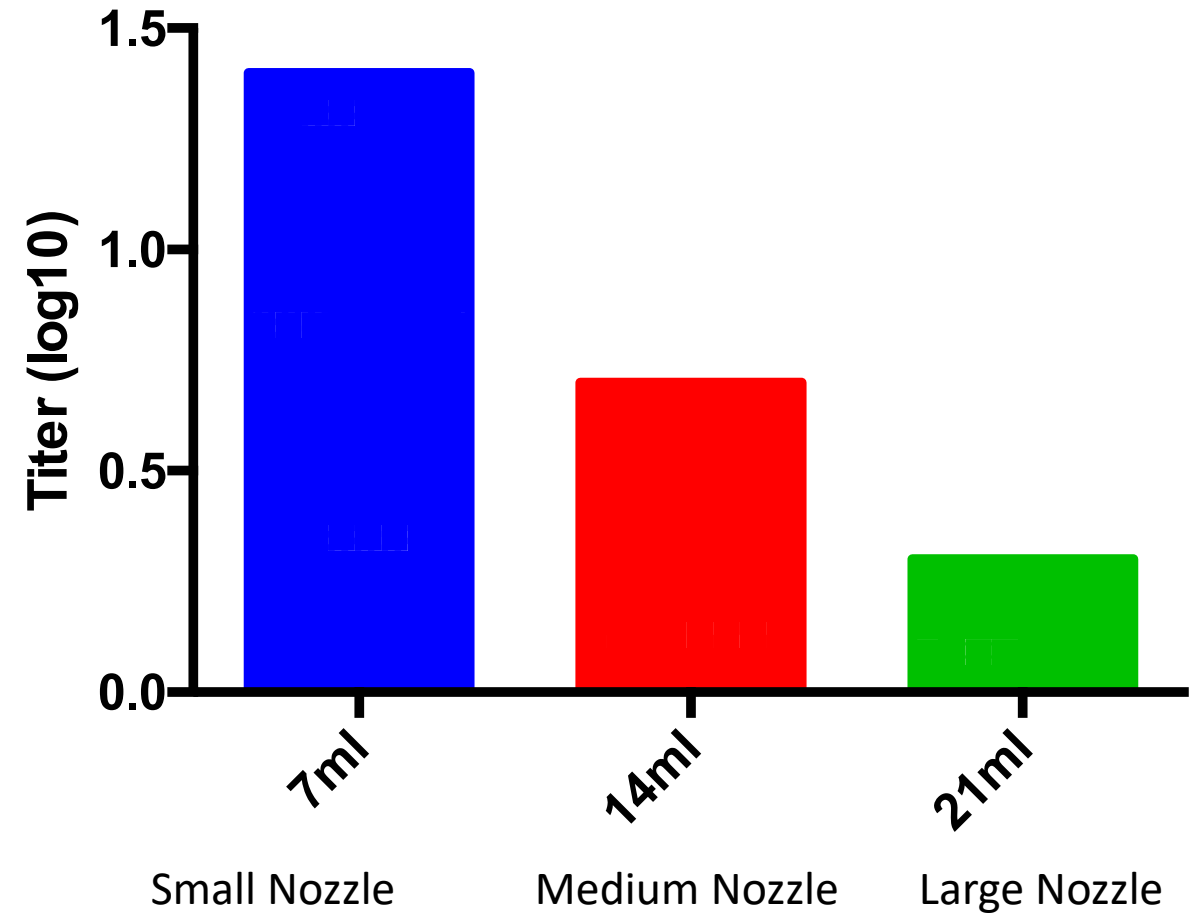


More Volume = More Virus to Chicks

Spray Volume Reaching Chicks



Titer Loss from Nozzle to Chick



Lost Vaccine from Small Droplets



Less Lost Vaccine from Large Droplets



Tools For Hatchery Quality Control Checks

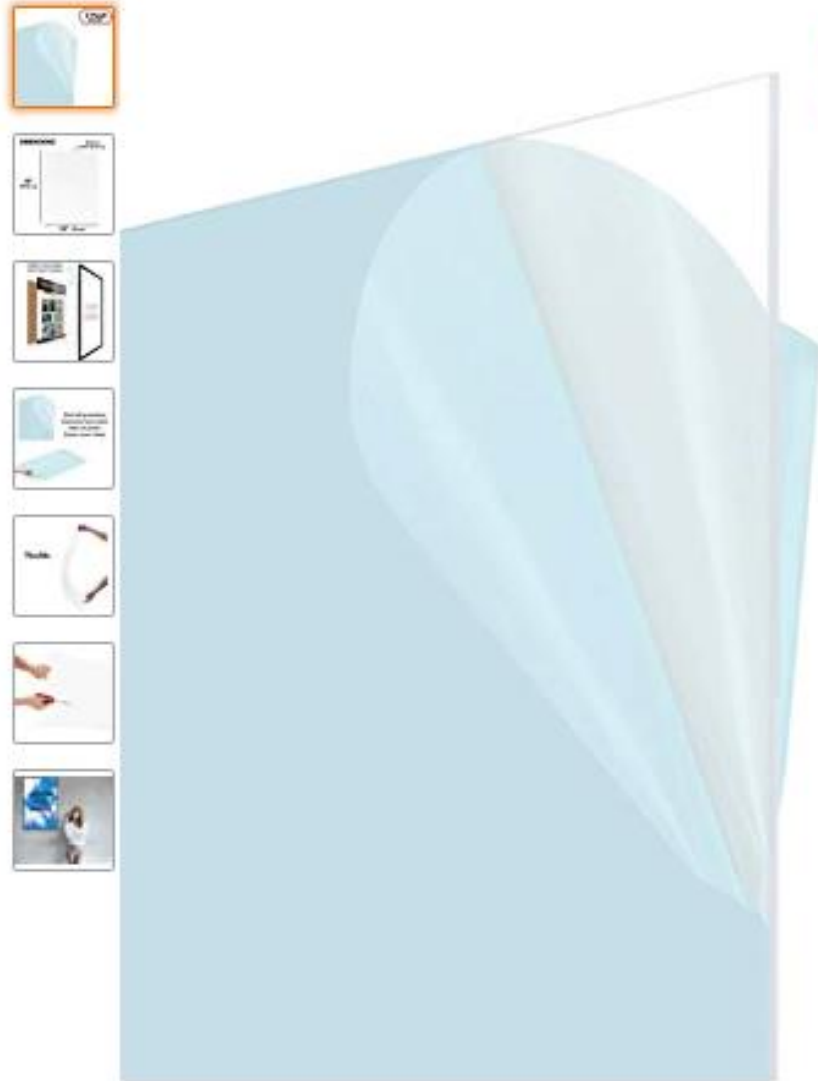


➤ Plexiglass, thermal imaging, and vaccine takes

Checking Spray Patterns with Chick Paper?



Plexiglass Sheets



2 Pack
24x36"

Roll over image to zoom in

- CRYSTAL CLEAR PLASTIC SHEET - Protects posters against moisture and dust
- PERFECT FOR DIY PROJECTS - Similar to acrylic or plexiglass but thinner and able to be cut with a craft knife or scissors; Easy to write on with dry-erase markers and leaves no residue after wiping off
- SAFE AND RECYCLABLE - Made from recyclable PET; Clear, waterproof, shatter-resistant, and crack-resistant
- INCLUDES - 2 Pieces of 24x36 inches (61x91.4cm) - 0.03" (0.8mm) thick PET sheets shipped with protective film on both sides
- PERFECT REPLACEMENT - For poster frames glass that is broken, cracked, scratched, yellowed, or aged; Handy manageable size for DIY projects; Icona Bay PET sheets are available in a variety of sizes: 4x6, 5x7, 8x10, 8.5x11, 11x14, 12x24, 24x24, 18x24,

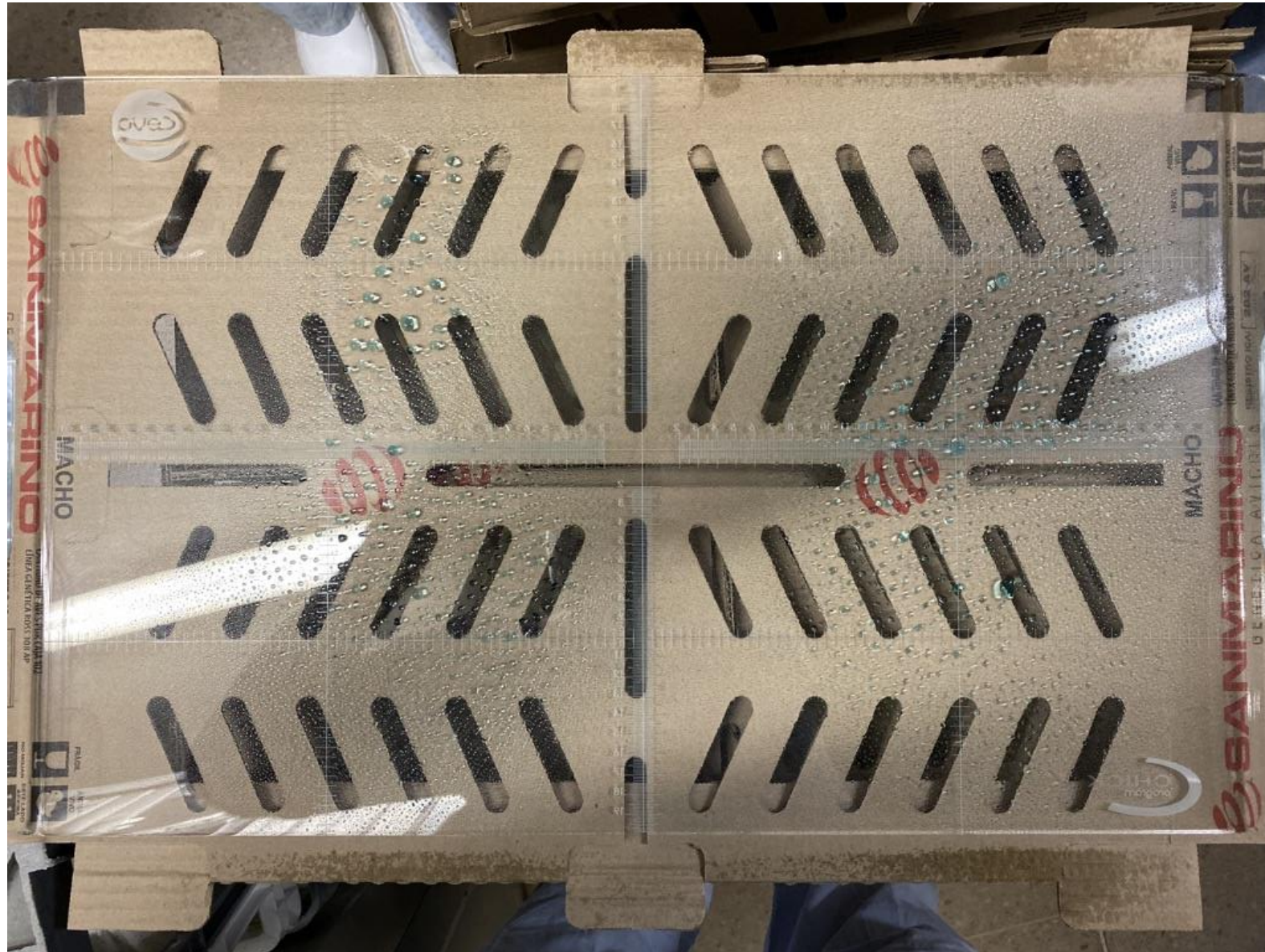
Poor Spray Application



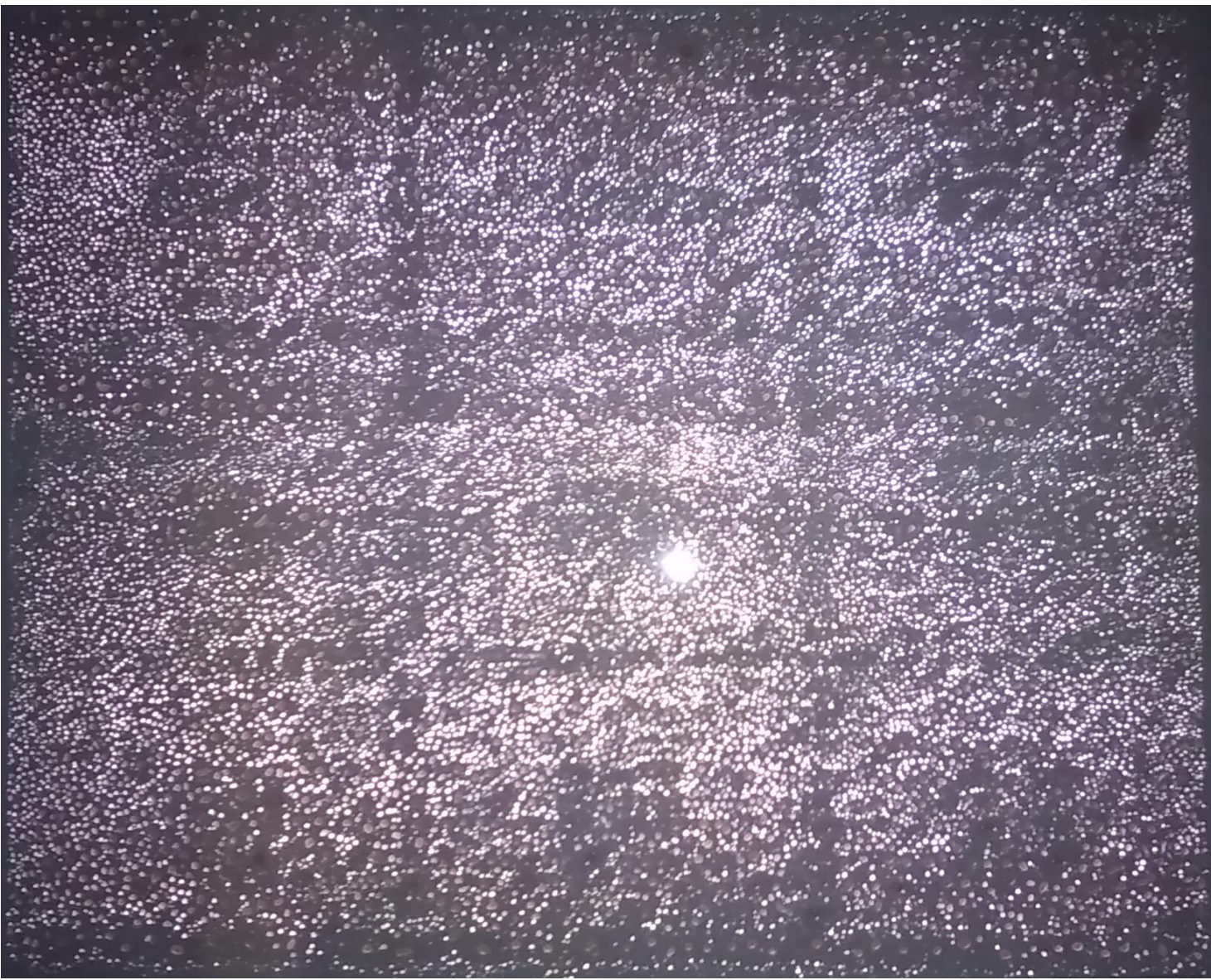
Poor Spray Application



Poor Spray Application



Optimized Spray Application



Thermal Imaging



PRO-GRADE THERMAL
CAMERA FOR SMARTPHONES

FLIR One Pro LT

MODEL: FLIR ONE PRO LT
IOS

[Go to Product Support »](#)

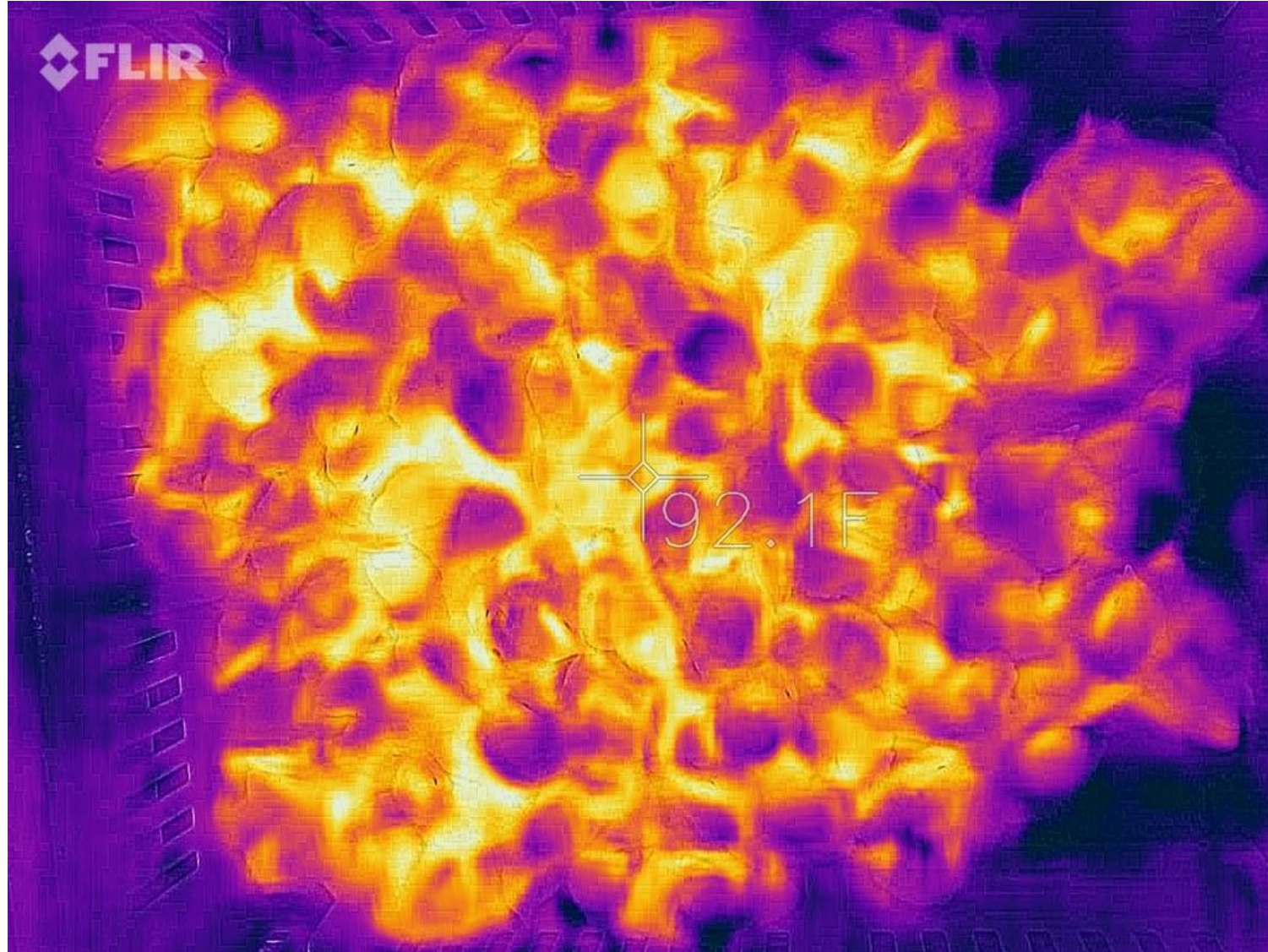
FLIR ONE Pro LT has the power to find hidden problems faster than ever. With the enhanced resolution of FLIR VividIR™ processing, added perspective of FLIR MSX®, and the convenience of the OneFit™ adjustable connector, FLIR ONE Pro LT works as hard as you do. Whether you're a professional or just focused on DIY projects, the FLIR ONE Pro LT has the powerful features you need at an affordable price.



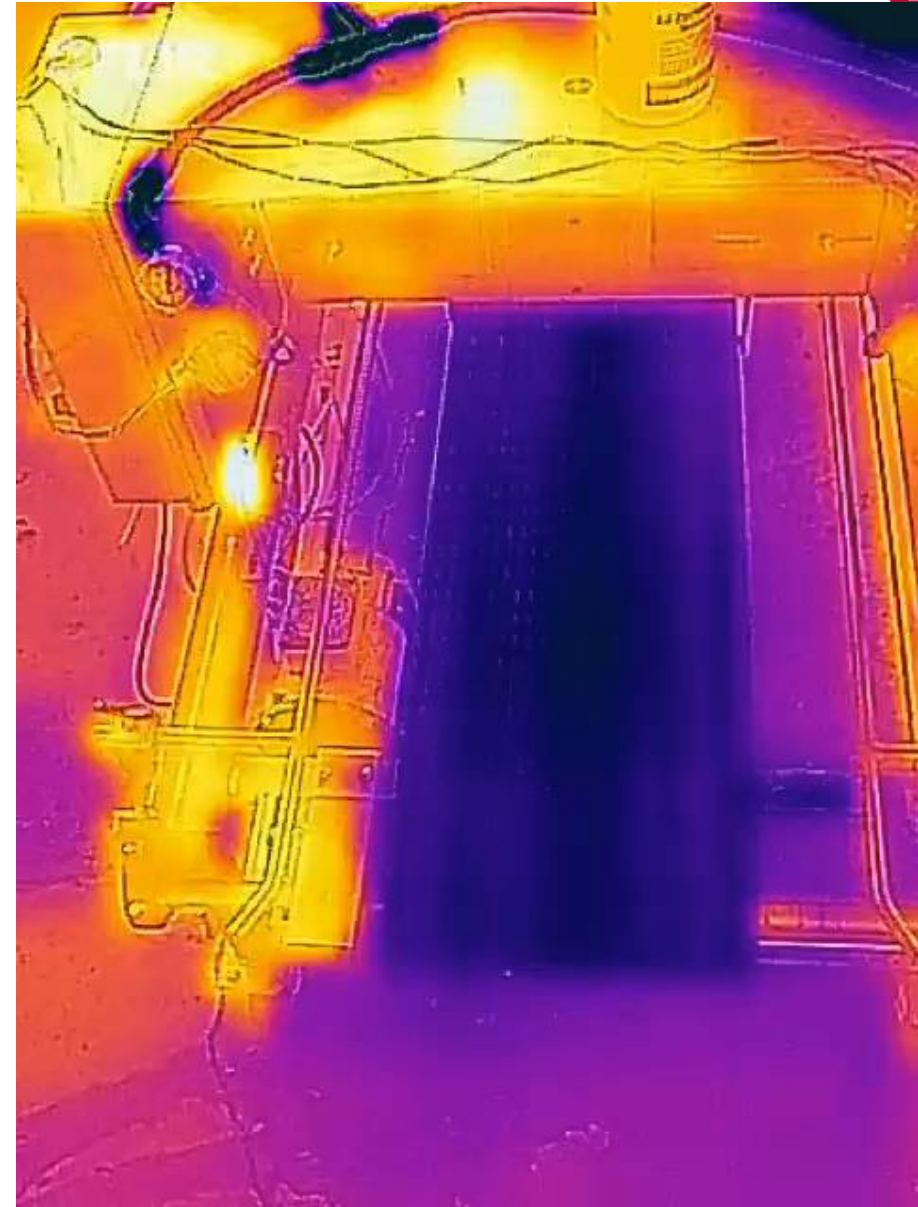
Optimized Spray Application



Optimized Spray Application



Optimized Spray Vaccination



Use Real-Time PCR to Check and See if Chicks Received Vaccine: Vaccine Takes





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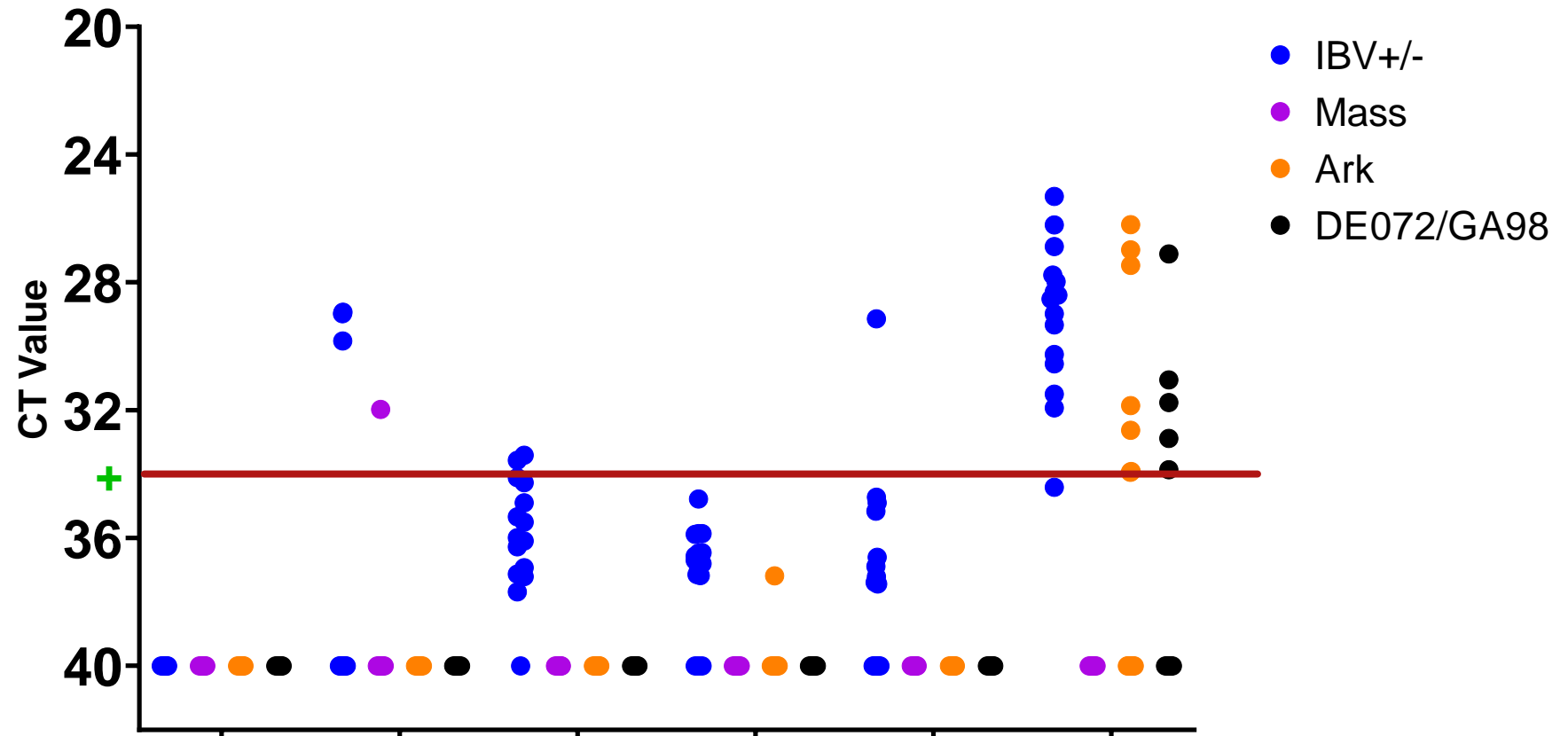
Pullet Vaccination Program (Layer or Broiler-Breeder)

- Multiple applications of live-attenuated vaccine (especially IBV and NDV) during rearing
- Majority of these applications are spray, but some are through the drinking water
- Much harder to do correctly





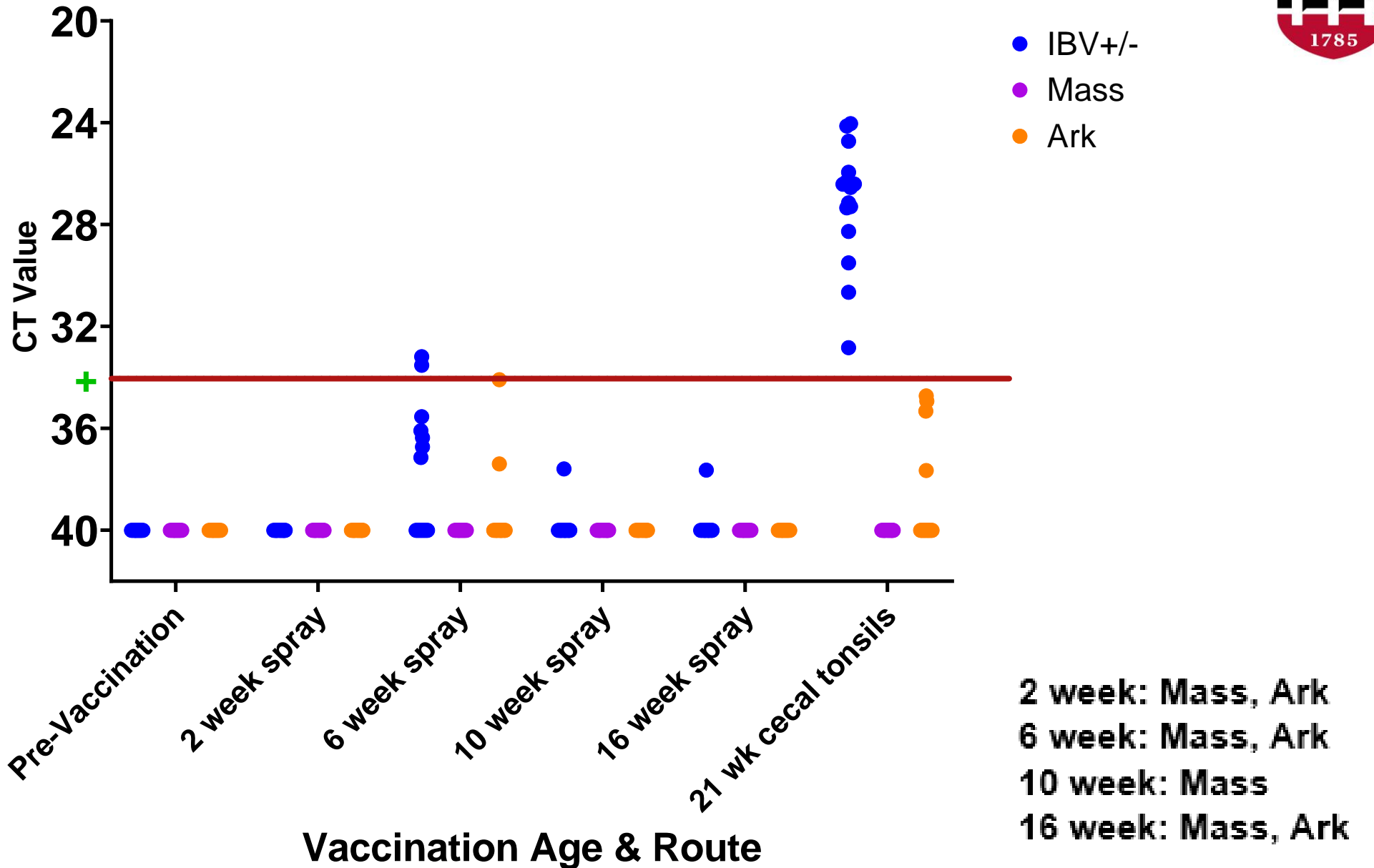
Complex A



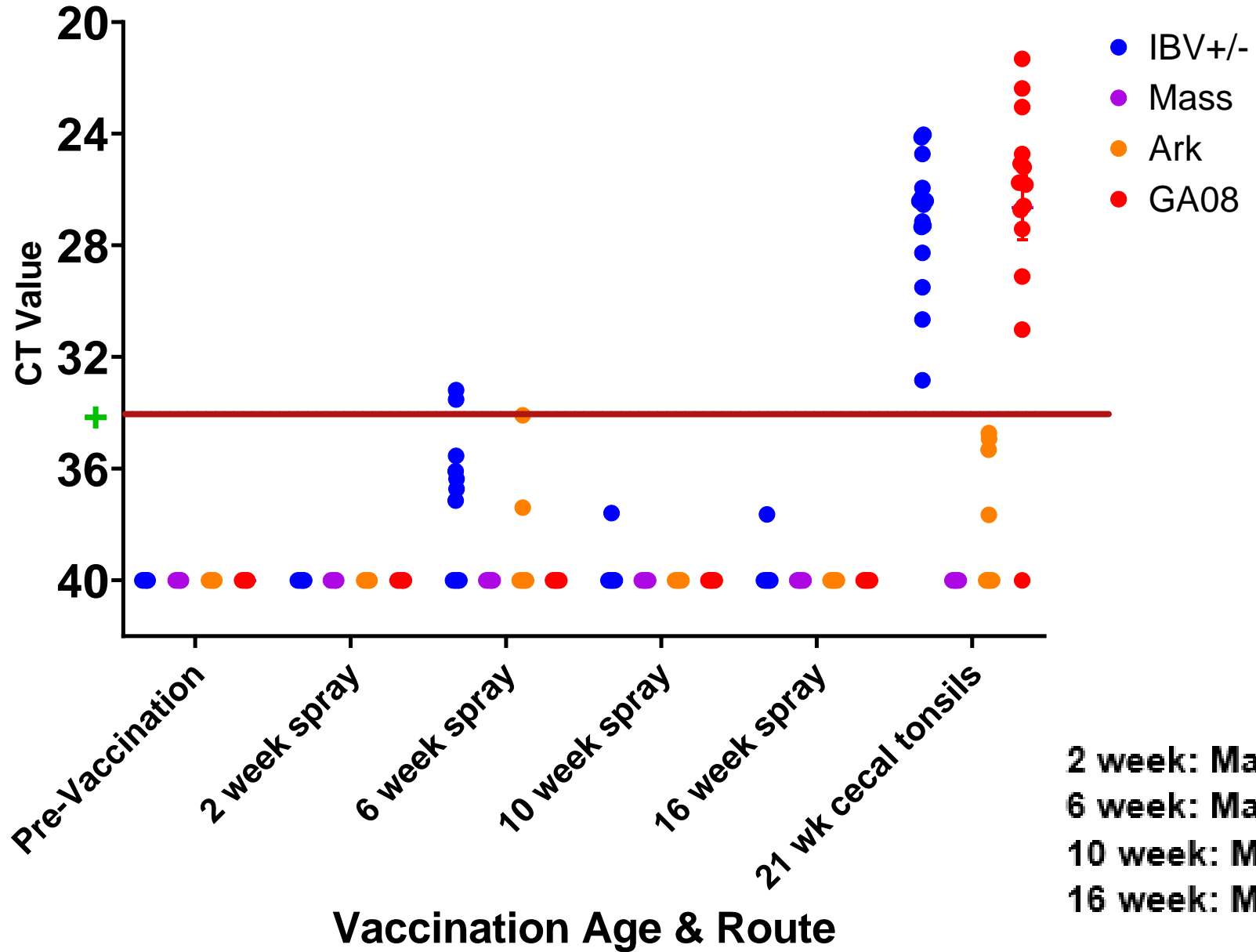
2 week: Mass, Ark, GA98
6 week: Mass, Ark
10 week: Mass
16 week: Mass, Ark

Vaccination Age & Route

Complex C



Complex C

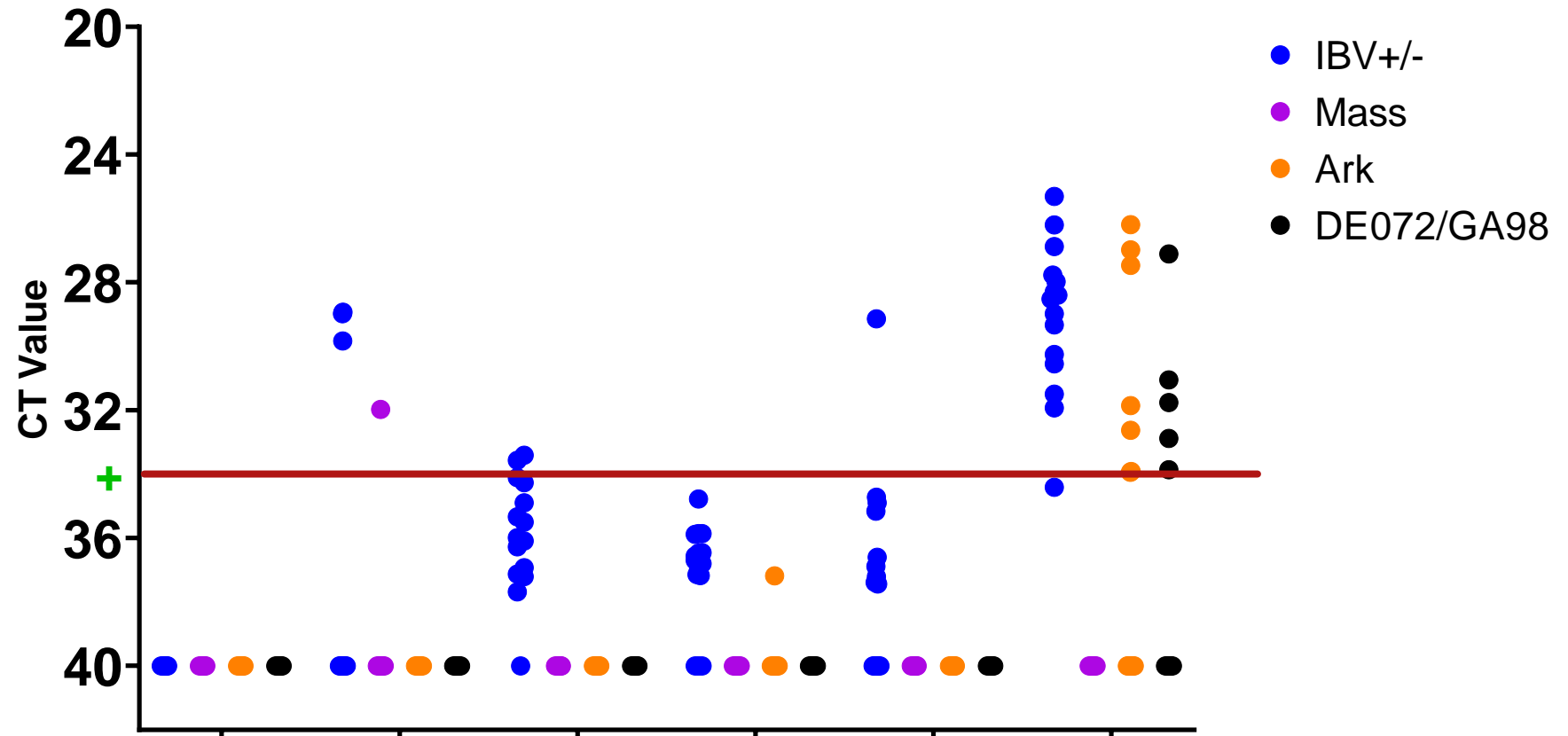








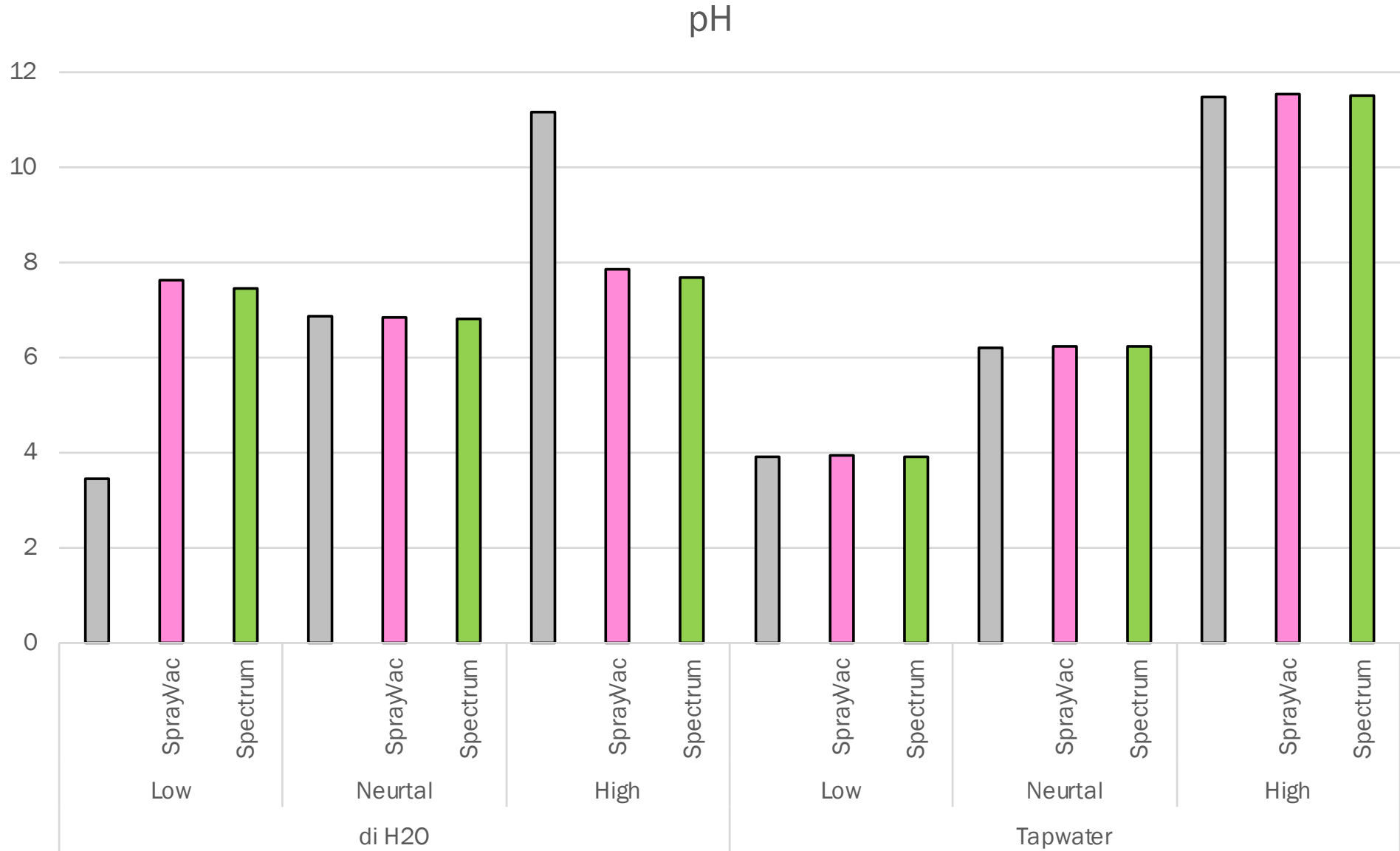
Complex A



2 week: Mass, Ark, GA98
6 week: Mass, Ark
10 week: Mass
16 week: Mass, Ark

Vaccination Age & Route

Water Source and pH Also Matter





Smaller Droplets are Less Stable

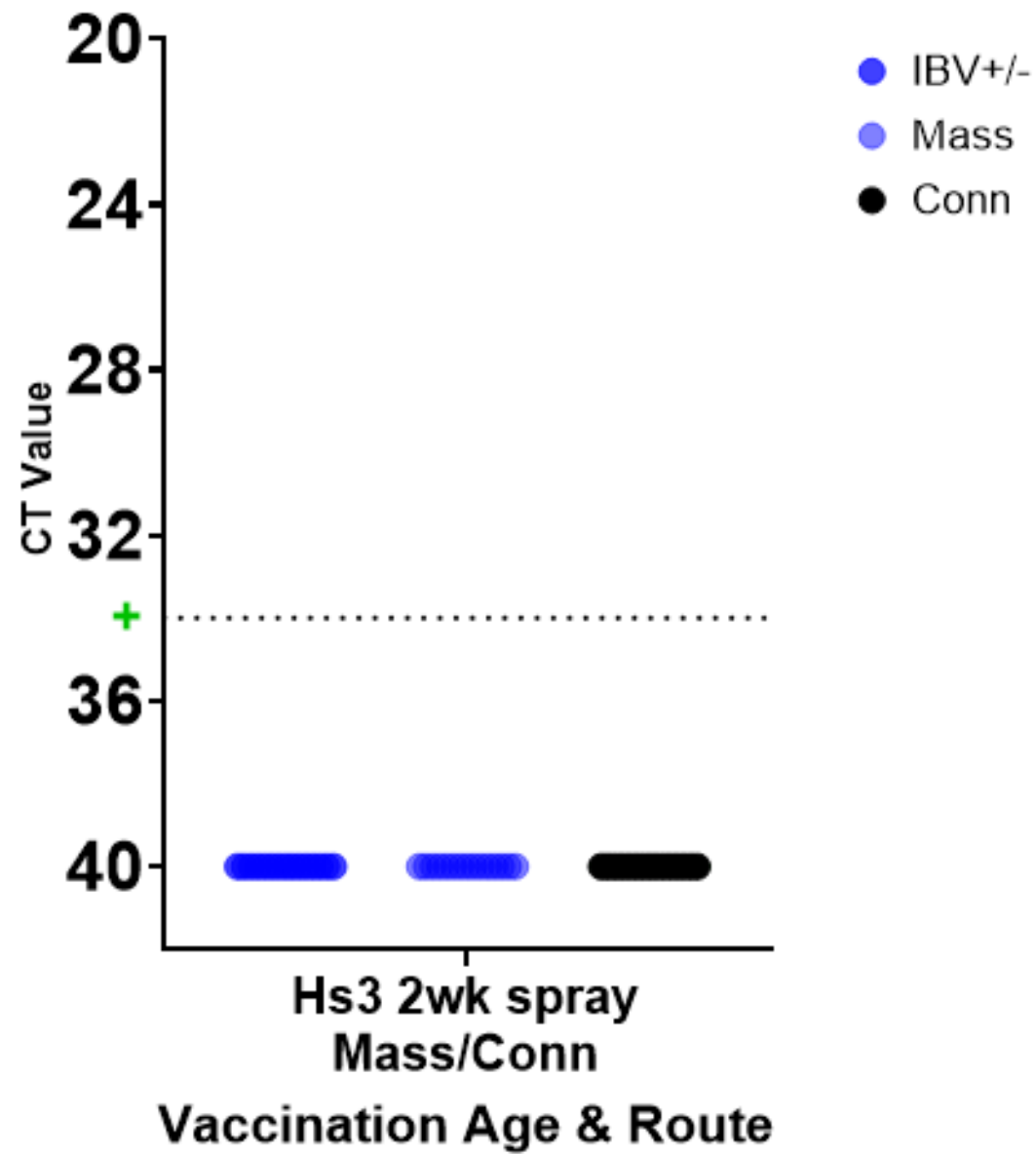
Evaporation of water droplets

Droplet diameter μm	Temperate: cool			Temperate summer, Dry sub-tropical		Humid tropical	
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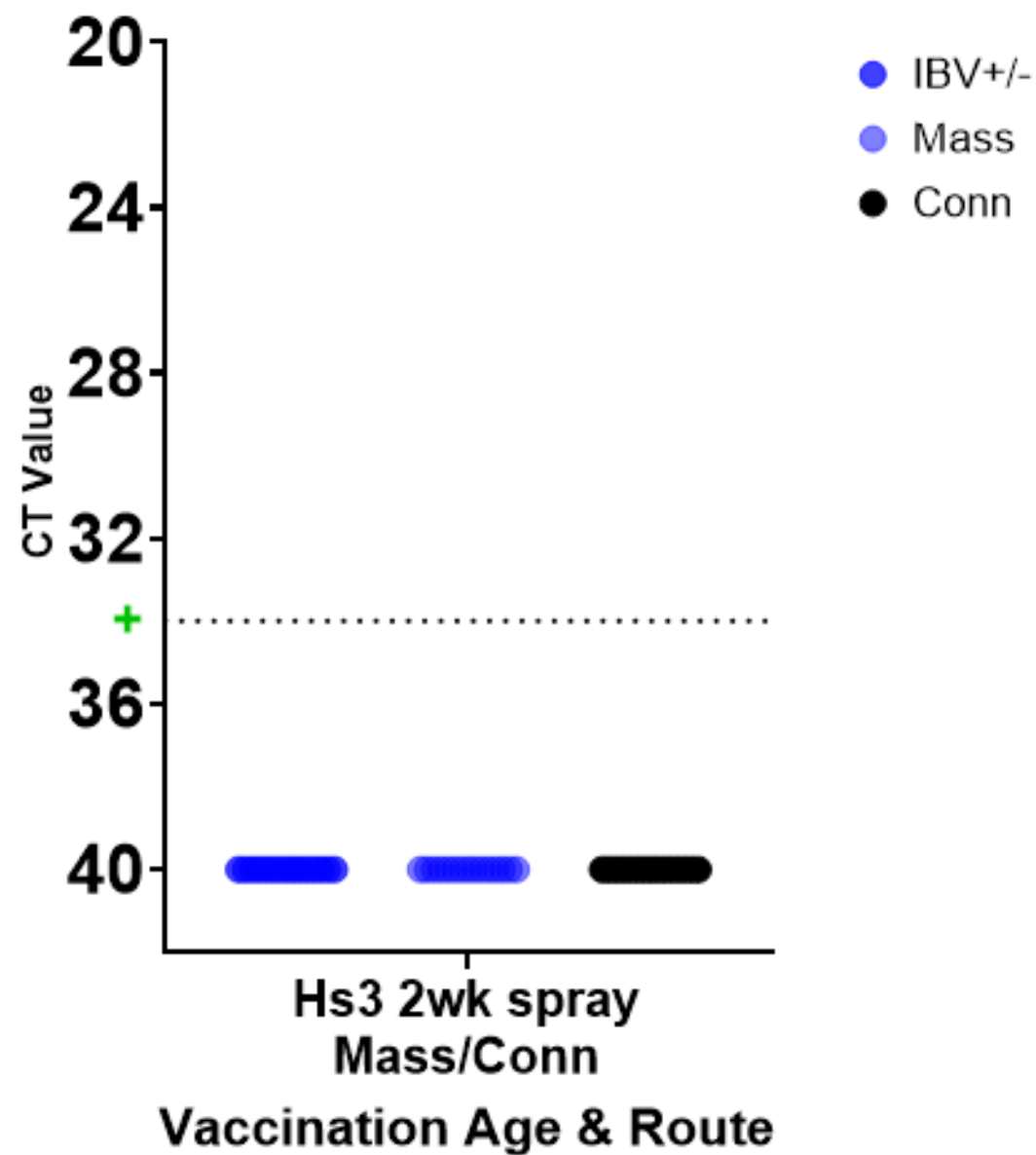


Complex E

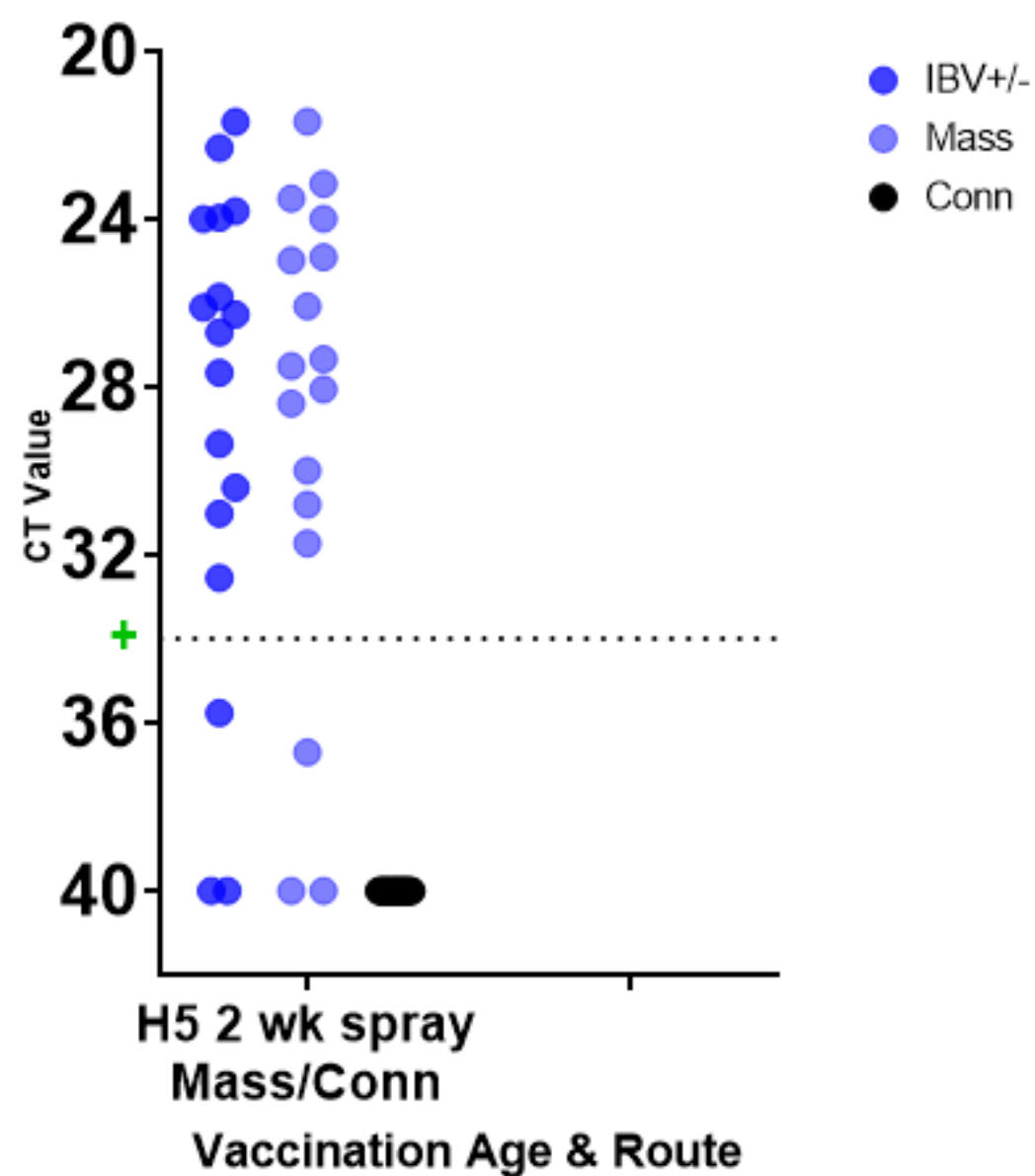




Complex E



Complex E





Spray Vaccination Recommendations

- Volume is critical. You must have enough diluent to adequately deliver the vaccine
- Use larger flow rate nozzles...you get better maintenance of IBV during the spray and larger droplets which will settle faster and carry more vaccine per droplet
- Congregate birds?

Not All Vaccines are Created Equal



➤ Which vaccines give me the best shot?



Vaccine Take Data Set

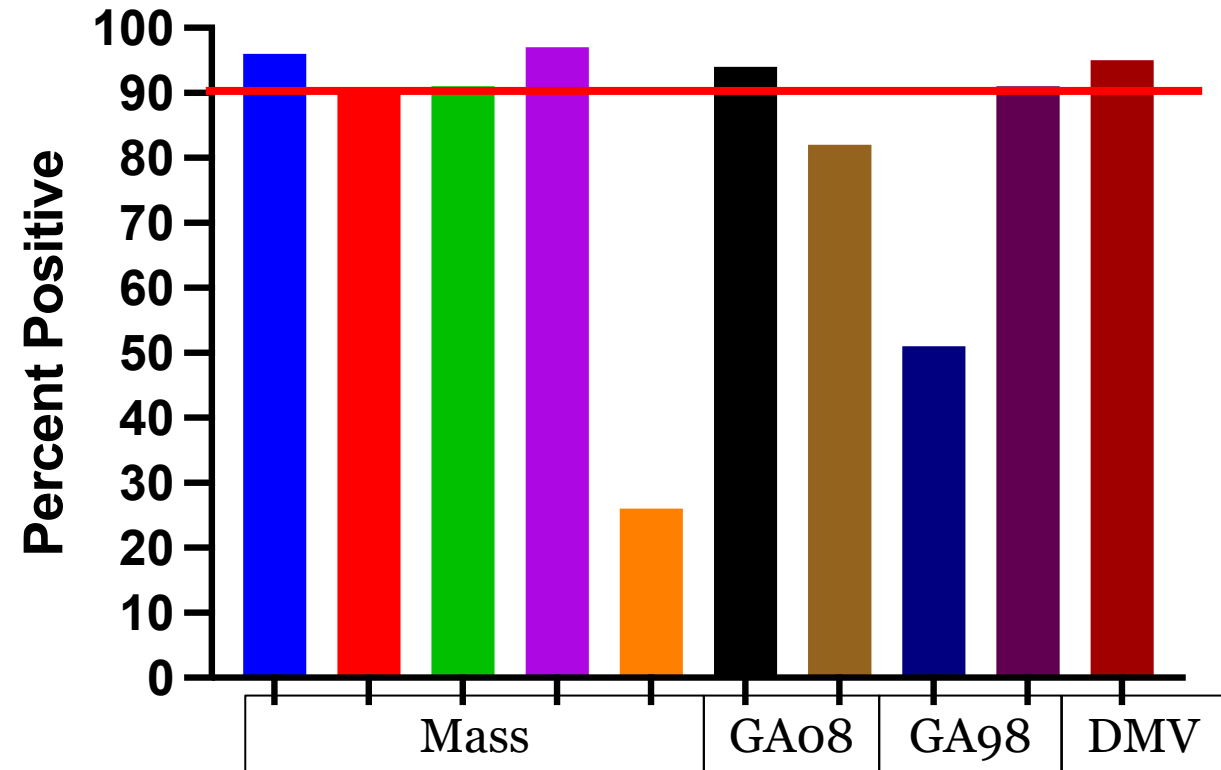
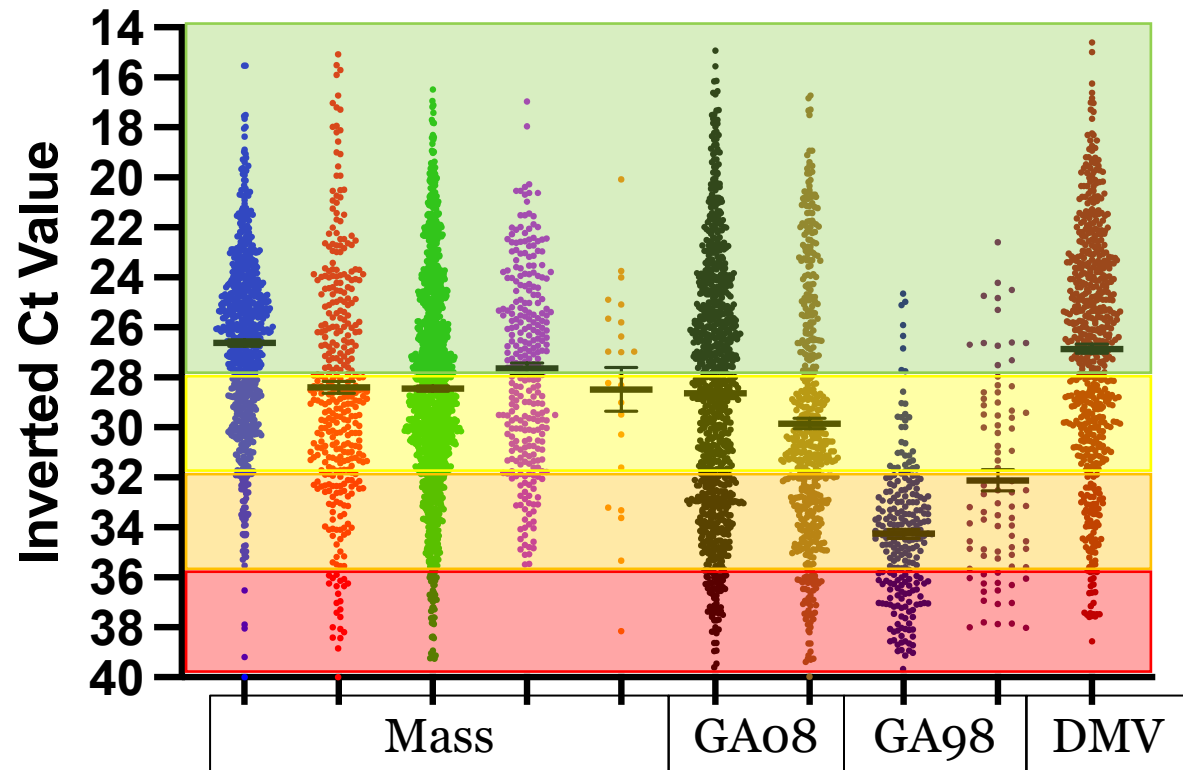
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- Total of 5,855 real-time PCR reactions, ~3,500 samples, all samples collected at 7 days of age
- 14 different integrators across 13 states



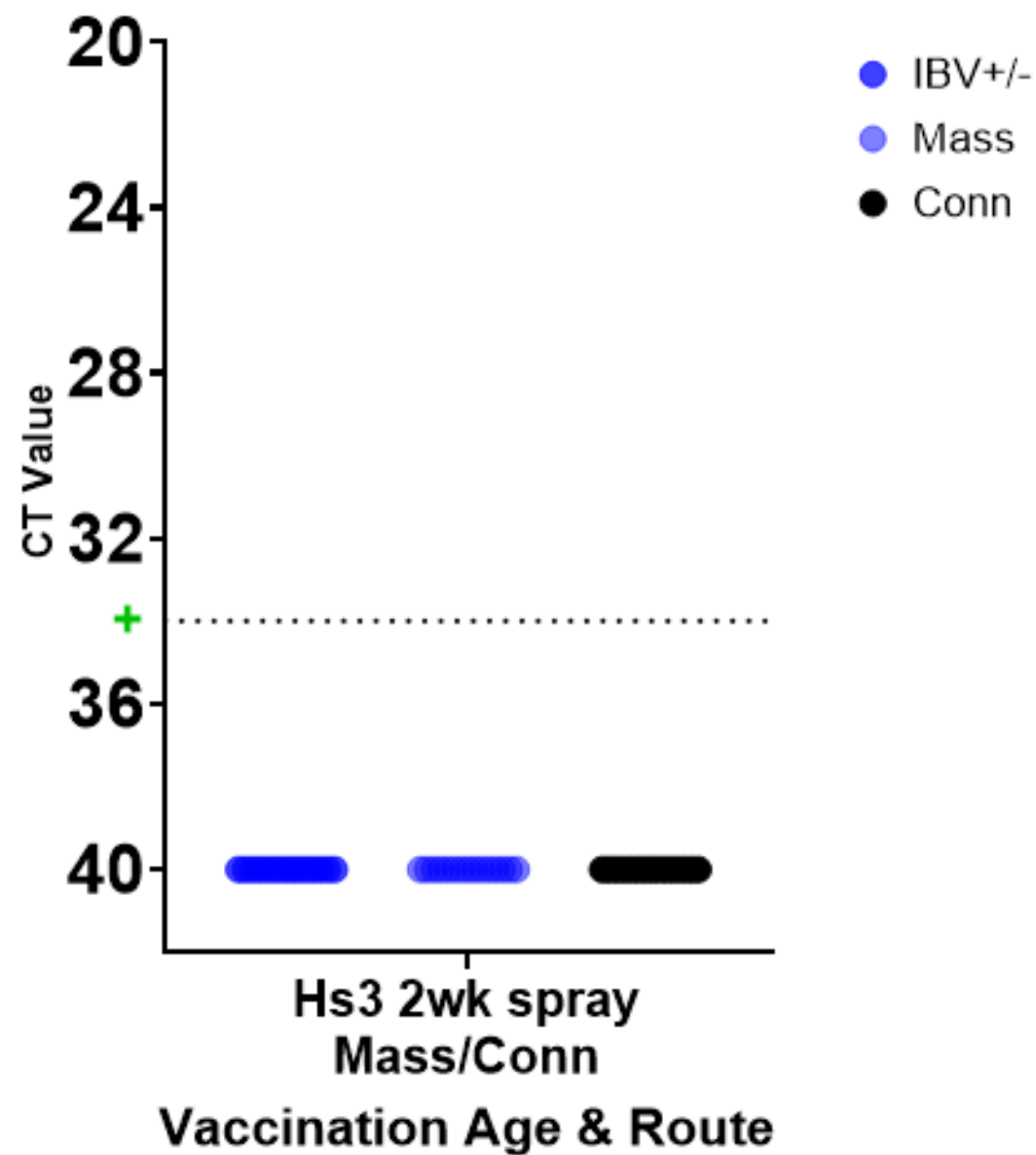
Vaccine Take Data Set

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- Total of 5,855 real-time PCR reactions, ~3,500 samples, all samples collected at 7 days of age
- 14 different integrators across 13 states
- Four main vaccines used; Mass, GA08, GA98, and recently DMV
 - Only had 1 Mass/Conn or DE072 dataset (excluded)
 - Ark vaccine usage dramatically declined starting in 2018, so any Ark datasets were excluded

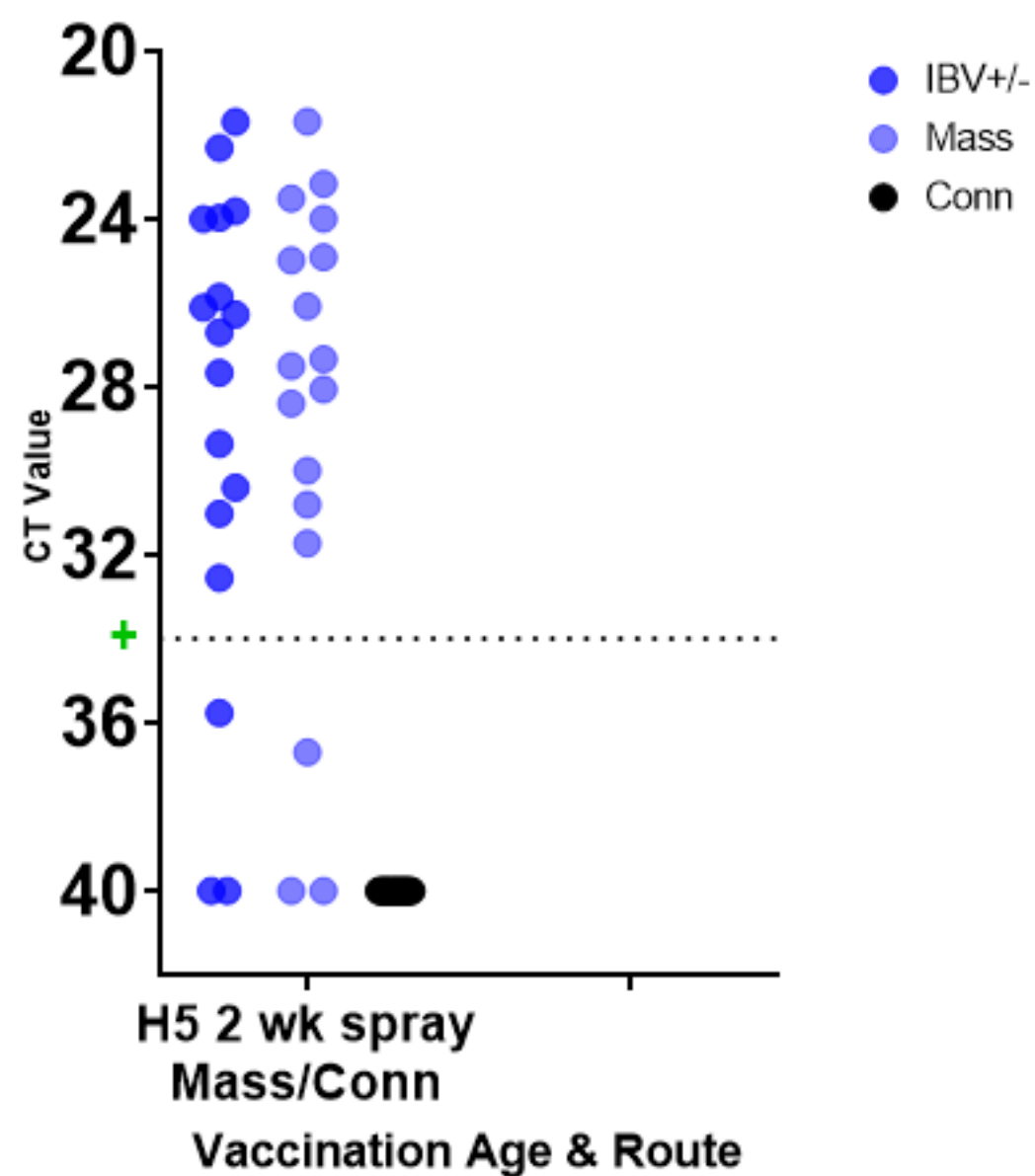
Summary



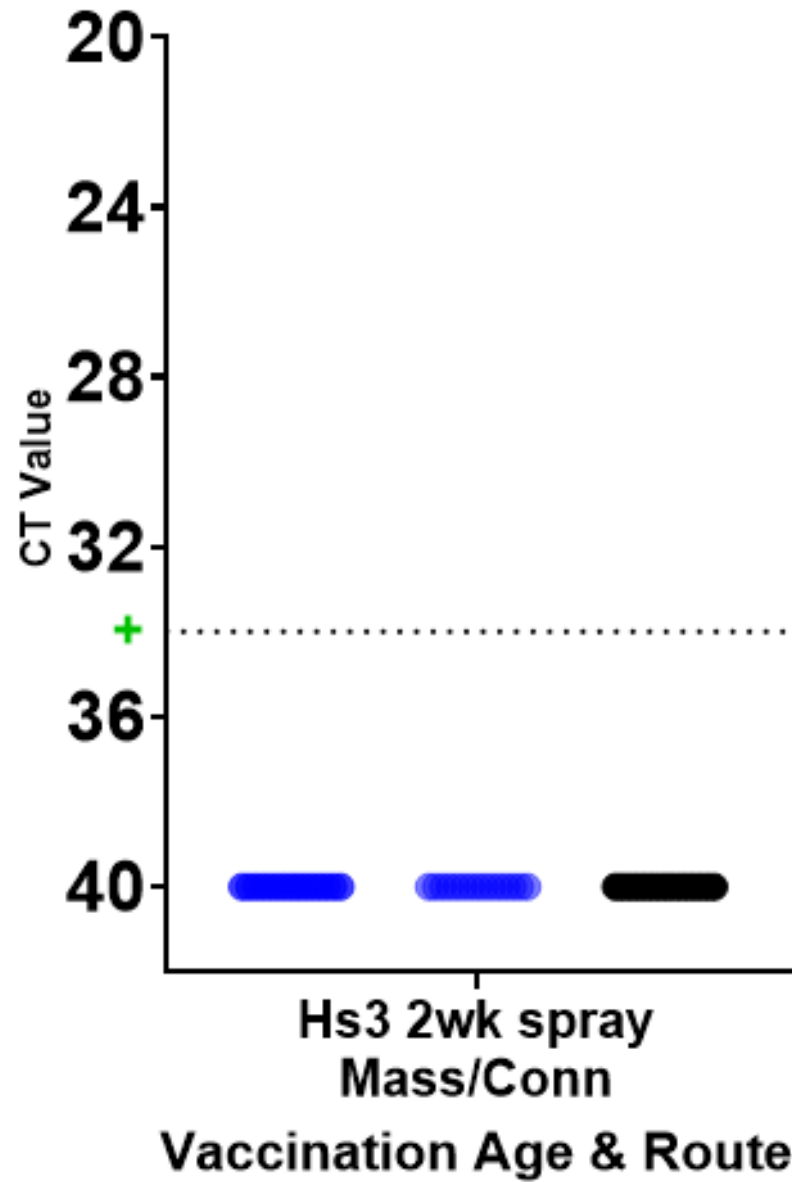
Complex E



Complex E

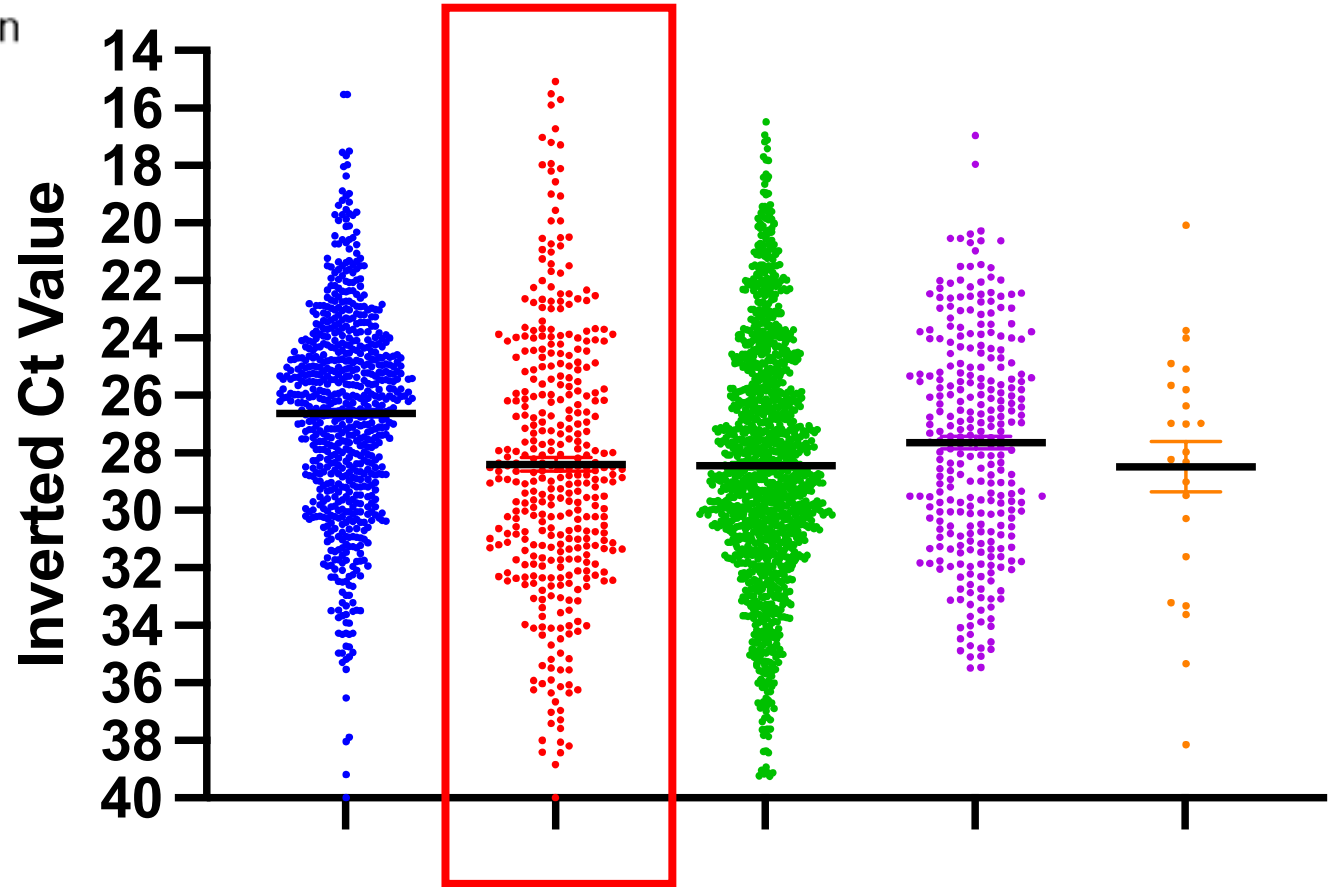


Complex E



- IBV+/-
- Mass
- Conn

Mass Positives





Mass Vaccination Recommendations

- Follow the SOPs as written, but don't be afraid to check up
- Dosing and diluent volume are extremely important, and we often undershoot both
- We now have tools and labs to evaluate how effective we are



Many Thanks

- Alix Nelson
- Maggie Thompson
- Izzy Hannay
- Eric Shepherd
- Sunny Cheng
- Debbie Hilt
- Mark Jackwood
- Kim Bouwman
- Cory Yarbrough

Questions??

