Differential Pipettor Precision and Accuracy compared with Gilson and Rainin pipettors from 0.75 µL through 10 µL in the Artel Calibration Laboratory on January 23, 2015

Donald Schwartz, M.D., President and Scientific Director, Differential Pipetting, Inc.
Travis Schafer, Quality Control and Field Applications Scientist, Artel, inc.

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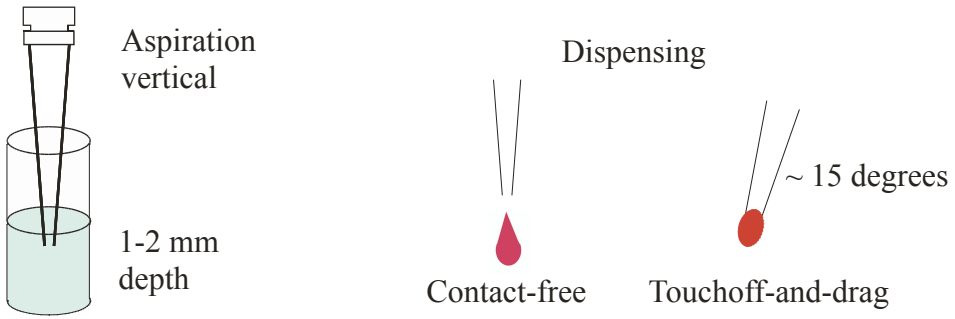
BACKGROUND by Donald Schwartz. My company, Differential Pipetting, developed a Differential Pipettor with a unique and patented core liquid metering design, especially for pipetting small volumes and delivering them contact-free. Barry Godowsky, formerly Vice President for Sales for Artel, had previously introduced me to the capabilities of the unique Artel ratiometric photometry systems, and Bob Pinault, current VP of Sales, recommended the single-channel PCS for our current Differential Pipettor. I found that the Artel PCS was extremely helpful in documenting pipetting performance and especially good in efficiently getting around the evaporation challenges involved in getting stable readings on the very tiny volumes that our unit could handle. When the Differential pipettor was ready for market I went to Artel and told them that they should be extremely well qualified to take an exacting and objective look at the Differential Pipettor technology and that I would like to loan them units to test "*so that you can tell me whether what we have is indeed the best thing* [in pipetting] *since sliced bread or not*". Artel accepted the opportunity and challenge to utilize its PCS and expertise to assess this new technology and I left them an assortment of models.

MATERIALS and METHODS by Travis Schafer. This study was done in our Calibration Laboratory in Westbrook, Maine with our Artel PCS system. I decided to study the Differential Pipettor adjustable 1-10µL and 0.5-5µL models and the fixed 0.75µL and 10µL models. As reference systems I selected our Gilson Pipetman adjustable 10µL P10 and a Rainin adjustable 2 µL unit. I used our regular tips with the Gilson and Rainin pipettors and the LS3 tips with the Differential Pipettor, none of which were low retention tips, taking a new tip each time (without any priming or other preparation). All aspirations were done the same way with my usual technique, holding the pipettor tip reasonably vertically and immersing the tip about 1-2 mm beneath the surface of the sample (dye). Dispensing was done very differently. With our Gilson and Rainin pipettors I dispensed to the wall of the PCS vial by my standard touchoff-and-drag technique, holding the tip as close to vertical as possible, which is in the 10 - 20 degree range, to minimize any tip flow restriction, and dragging the tip about 1/8" - 1/4" uniformly while dispensing so that the end of the drag is on a theoretically clean surface without liquid build up at the end. In my experience this optimizes liquid transfer and gives the most consistent results from touchoff-and-drag dispensing at small volumes. For the Differential Pipettor, I dispensed in the contact-free blowoff manner by pointing the tip generally towards the center of the PCS vial and blowing the sample off, without any contact between the tip and the vial wall or vial liquid (Reference 1); I did the blowoff from a comfortable but non-precision distance, and in an approximately vertical orientation though I am told that doesn't much matter.



THE DATA from the PCS printouts is shown in the following table for the 4 different models of Differential Pipettors and 2 trusted traditional reference Pipettors that were used -- a total of 6 different pipettors. 10 series of 10 measurements each cover the range 0.75 µL through 10 µL, a total of 100 pipettings, with no statistical outlier.

	Differential Pipettors used						Artel reference pipettor systems used			
Time	11:26	11:31	11:42	12:04	12:14	12:23	14:41	15:07	15:11	15:15
Run #	1	2	3	4	5	6	7	8	9	10
Pipettor	Diff Pip Fixed 0.75uL	Diff Pip Fixed 10uL	Diff Pip Variable 10uL	Diff Pip Variable 10uL	Diff Pip Variable 5uL	Diff Pip Variable 5uL	Rainin Variable 2uL	Gilson Variable 10uL	Gilson Variable 10uL	Gilson Variable 10uL
Tip dip during aspiration	1-2 mm	1-2 mm	1-2 mm	1-2 mm	1-2 mm	1-2 mm	1-2 mm	1-2 mm	1-2 mm	1-2 mm
Dispensing method	Contact-free	Contact-free	Contact-free	Contact-free	Contact-free	Contact-free	Touchoff Drag	Touchoff Drag	Touchoff Drag	Touchoff Drag
Target volume in uL	0.750	10.000	10.000	1.000	5.000	1.000	0.750	10.000	5.000	1.000
										
MEAN UL	**0.765**	**10.102**	**9.991**	**1.085**	**4.944**	**0.985**	**0.723**	**10.035**	**4.977**	**1.0013**
Absolute inaccuracy uL	0.015	0.101	-0.009	0.085	-0.560	-0.015	-0.027	0.035	-0.023	0.001
Relative inaccuracy	**1.93%**	**1.01%**	**-0.09%**	**8.50%**	**-1.20%**	**-1.53%**	**-3.65%**	**0.35%**	**-0.45%**	**0.13%**
Standard Deviation uL	0.015	0.040	0.013	0.018	0.020	0.012	0.008	0.018	0.013	0.017
COEF. OF VARIATION CV	**1.93%**	**0.40%**	**0.13%**	**1.62%**	**0.40%**	**1.22%**	**1.11%**	**0.18%**	**0.25%**	**1.65%**
Temp deg C	20.4	20.4	20.5	20.6	20.7	20.7	20.7	20.7	20.7	20.8
Total points run	10	10	10	10	10	10	10	10	10	10
# 2 SD outliers rejected	0	0	0	0	0	0	0	0	0	0
Points used in calculation	10	10	10	10	10	10	10	10	10	10

ANALYSIS, DISCUSSION and CONCLUSIONS

Precision was under 2% in all 10 studies and all the pipettors were really excellent. Accuracy was under 4% in all but Run 4*.

The Differential Pipettor precision and accuracy appears to be every bit as good as that from the Gilson Pipetman and Rainin reference pipettors over the entire range of 0.75 µL to 10 µL. The limited data shows no statistical difference. The Whitehead Institute study (Reference 2) against their Pipetman P20 appears to have found the same thing at 20 µL.

Beyond the raw precision and accuracy data, the contact-free dispensing by the Differential Pipettor was easy and did not require any particular or careful technique. Minimal user technique for dispensing would theoretically result in minimal user dispensing variability. If many different people were using this in different environments, the absolute values and precision would therefore be expected to come out tighter than with conventional pipettors on the basis of dispensing alone, but that is something that only time and extensive field experience could show. The dispensing step is also faster and each pipetting cycle has less total hand motion.

*Donald Schwartz note. When this data was tabulated the Run 4 Differential Pipettor relative inaccuracy of 8.5% stood out. We checked the manufacturing records and found that this unit had gotten out for loan to Artel in haste without the final calibration scale adjustment. If the calibration scale adjustment had been done in the usual manner the 0.085 uL offset would have shifted to the high, 10 uL end, resulting in a Run 4 relative inaccuracy improvement to under 2% and a Run 3 relative inaccuracy worsening to about -1%.

REFERENCES

Reference 1 www.DifferentialPipetting.com Science section, item SCIENCE 2 (dispensing into PCS).

Reference 2 www.DifferentialPipetting.com Science section, item SCIENCE 5 (Whitehead Institute Ploegh Lab 20 µL study).

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