FE-FF2/Following Error at Start/Following Error due to FF2

FE-FF1/Following Error at Constant Velocity Region/Following Error due to FF1

VF-FF2/Velocity Feedback at Start/High Velocity Feedback due to FF2

VF-FF1/Velocity Feedback at Constant Velocity Region/High Velocity Feedback due to FF2

Overshoot at End

$$Output = K_p \cdot e + K_I \cdot e + K_D \cdot e + FF_0 \cdot C + FF_1 \cdot \frac{dc}{dt} + FF_2 \cdot \frac{d^2c}{dt^2}$$

where, C = Commanded Position

F = Feedback Position

$e = F - C$ = error

Following PID and FEED Forward Tuning Parameter is used and kept constant for all experiment	
Kp	10
Ki	0
Kd	0
FF0	0
FF1	1.001
FF2	0.0309

MAX_VELOCITY/STEPGEN_MAXVEL	20/25 mm/sec
MAX_ACCELERATION/STEPGEN_MAXACCEL	100/125 mm/sec^2

Discussion

i. 1, 5, 10, 30, and 50 mm travel length is considered
ii. 1, 5, 10, 50, 100, 500, and 1000 mm/minute feed rate is considered.
iii. Following error (FE) due to FF2 and FF1 is shown.
iv. Velocity feedback (VF) due to FF2 and FF1 is shown.
v. Overshoot is shown in micro-meter.

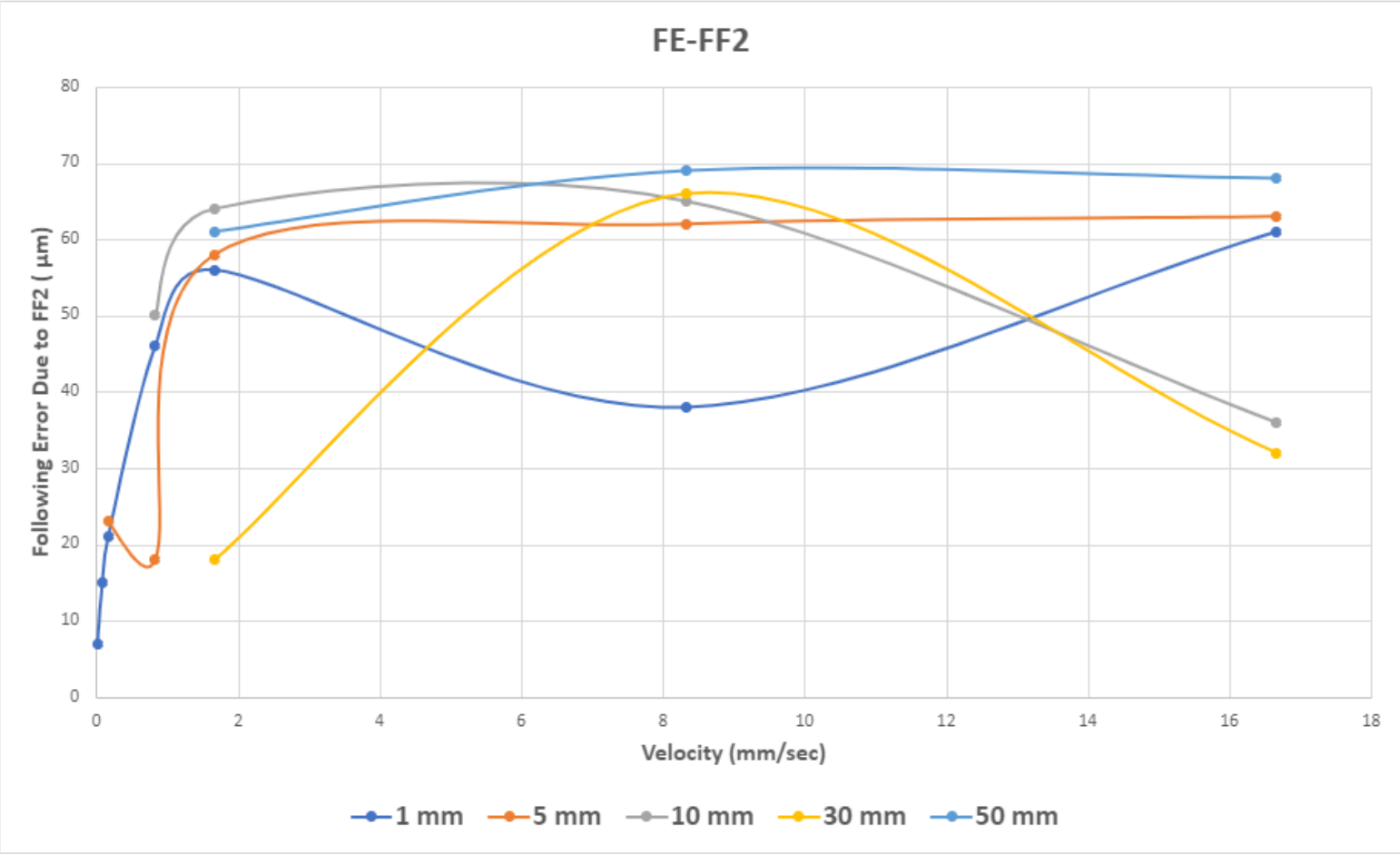
Experiment Data

Length (mm)	Feed (mm/minute)	Feed (mm/sec)	FE-FF2 (µm)	FE-FF1 (µm)	VF-FF2 (mm/sec)	VF-FF1 (mm/sec)	OVERSHOOT (µm)
1	F1	0.017	7	1	0.093	0.035	8
	F5	0.083	15	1	0.21	0.096	4
	F10	0.167	21	1	0.29	0.195	6
	F50	0.833	46	3	2.1	0.819	11
	F100	1.667	56	5	3.209	1.607	11
	F500	8.333	38	38	8.504	8.504	35
	F1000	16.667	61	61	7.653	7.653	25
5	F10	0.167	23	1	0.625	0.159	4
	F50	0.833	18	4	2.125	0.869	10
	F100	1.667	58	7	3.098	1.727	8
	F500	8.333	62	19	9.605	8.468	30
	F1000	16.667	63	38	17.312	17.312	52
10	F50	0.833	50	3	2.125	0.869	7
	F100	1.667	64	9	3.089	1.72	7
	F500	8.333	65	25	10	8.468	36
	F1000	16.667	36	31	18.063	16.81	46
30	F100	1.667	18	8	3.21	1.72	6
	F500	8.333	66	24	10	8.46	37
	F1000	16.667	32	30	18.063	16.81	48
50	F100	1.667	61	10	3.248	1.74	8
	F500	8.333	69	25	10	8.468	35
	F1000	16.667	68	32	18.163	16.81	45

Discussion

i. The plot shows random variation

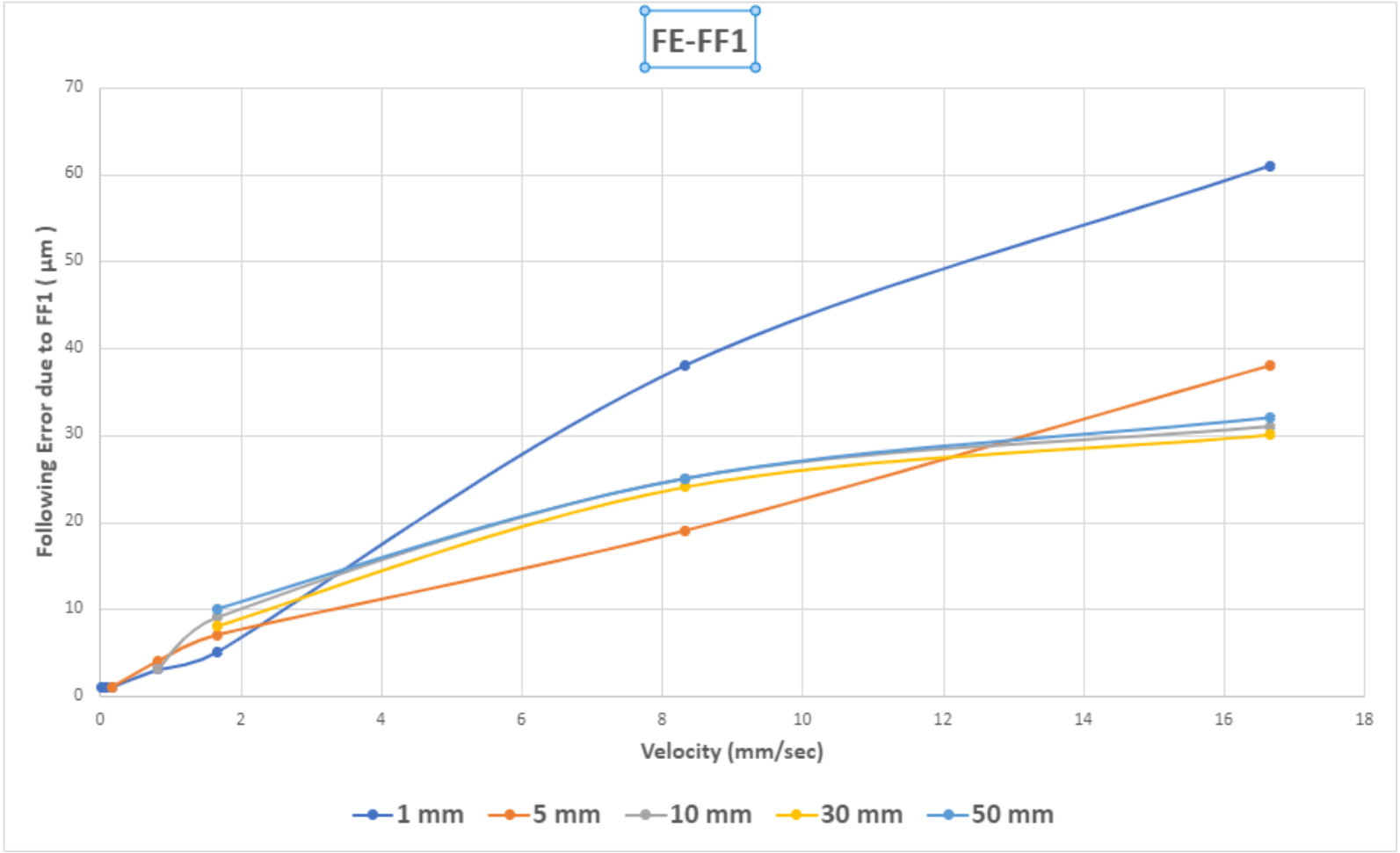
Following Error due to FF2 vs. Velocity



Discussion

i. The plot shows FE increases with velocity

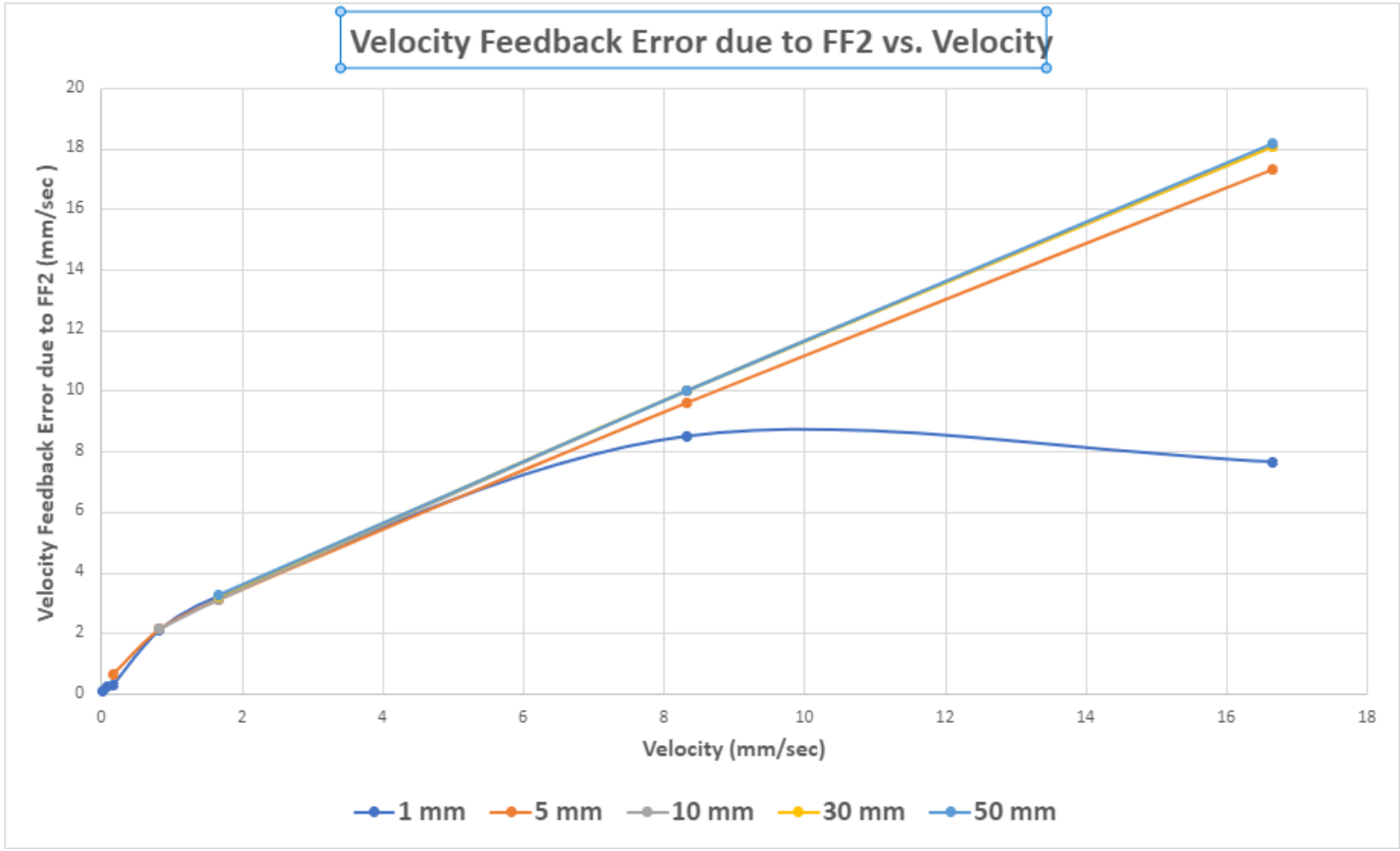
Following Error due to FF1 vs. Velocity



Discussion

Velocity Feedback due to FF2 (VF-FF2) vs. Velocity

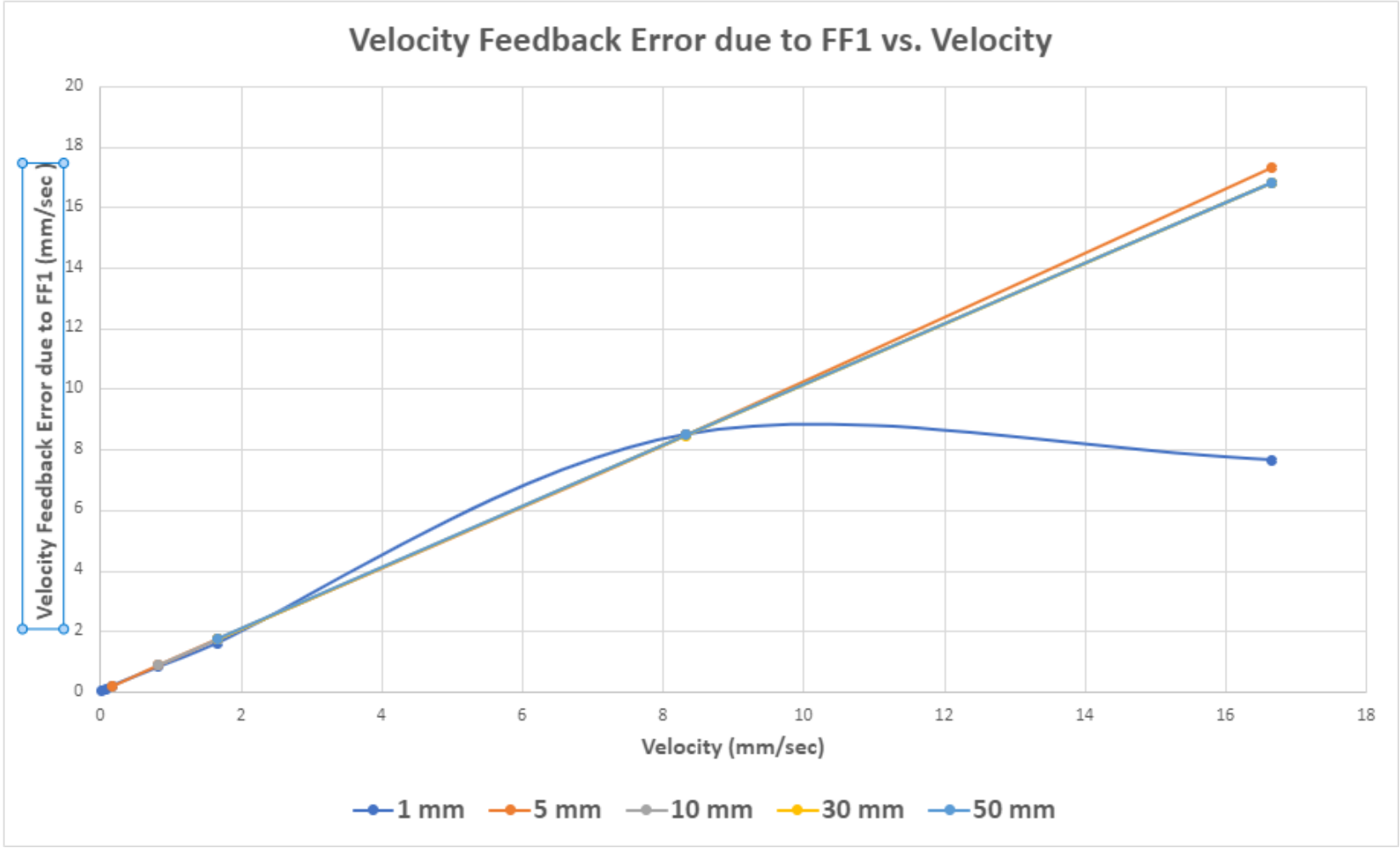
i. The plot shows Velocity Feedback Error increases with velocity



Discussion

i. The plot shows Velocity Feedback Error increases with velocity

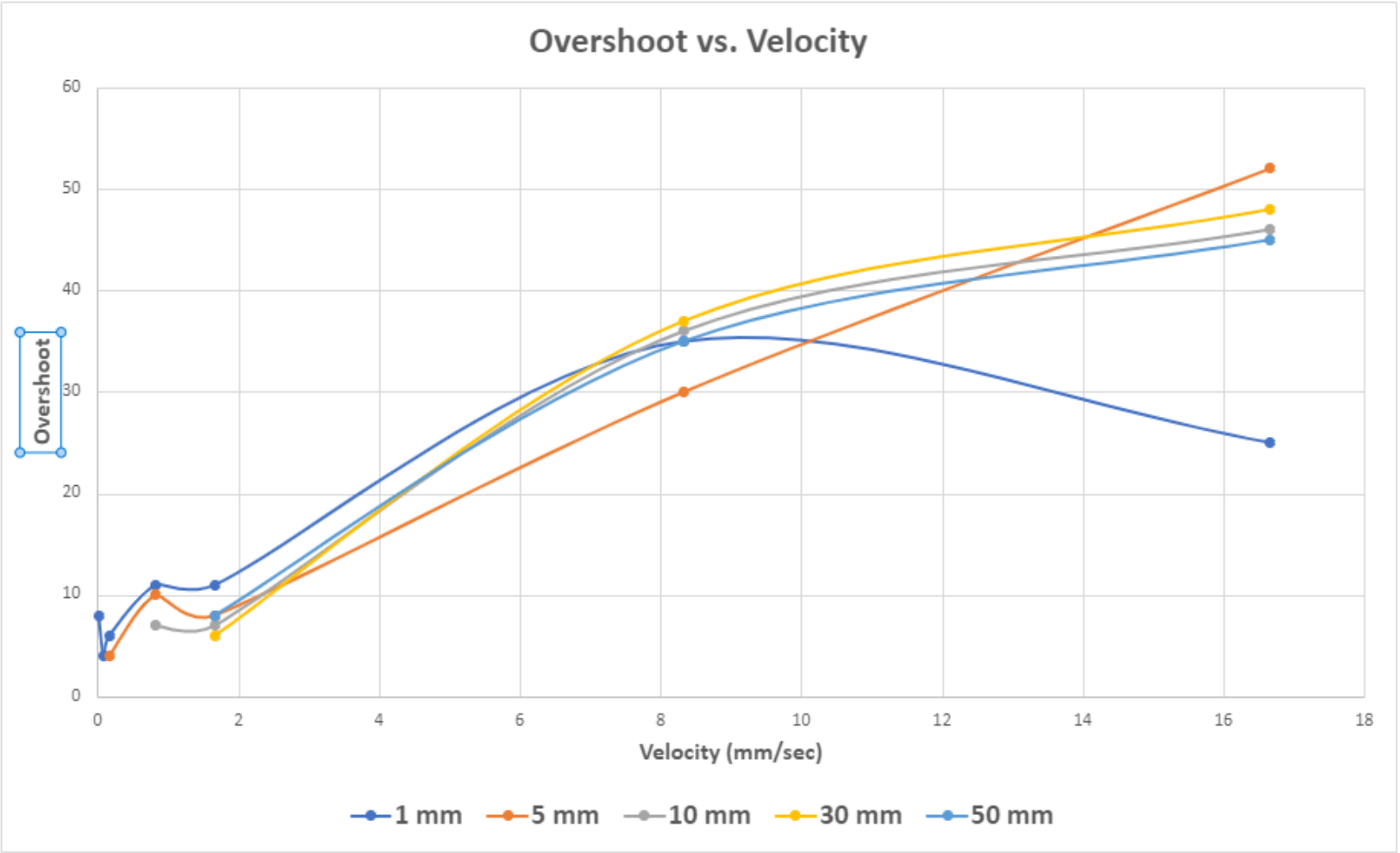
Velocity Feedback due to FF1 (VF-FF1) vs. Velocity

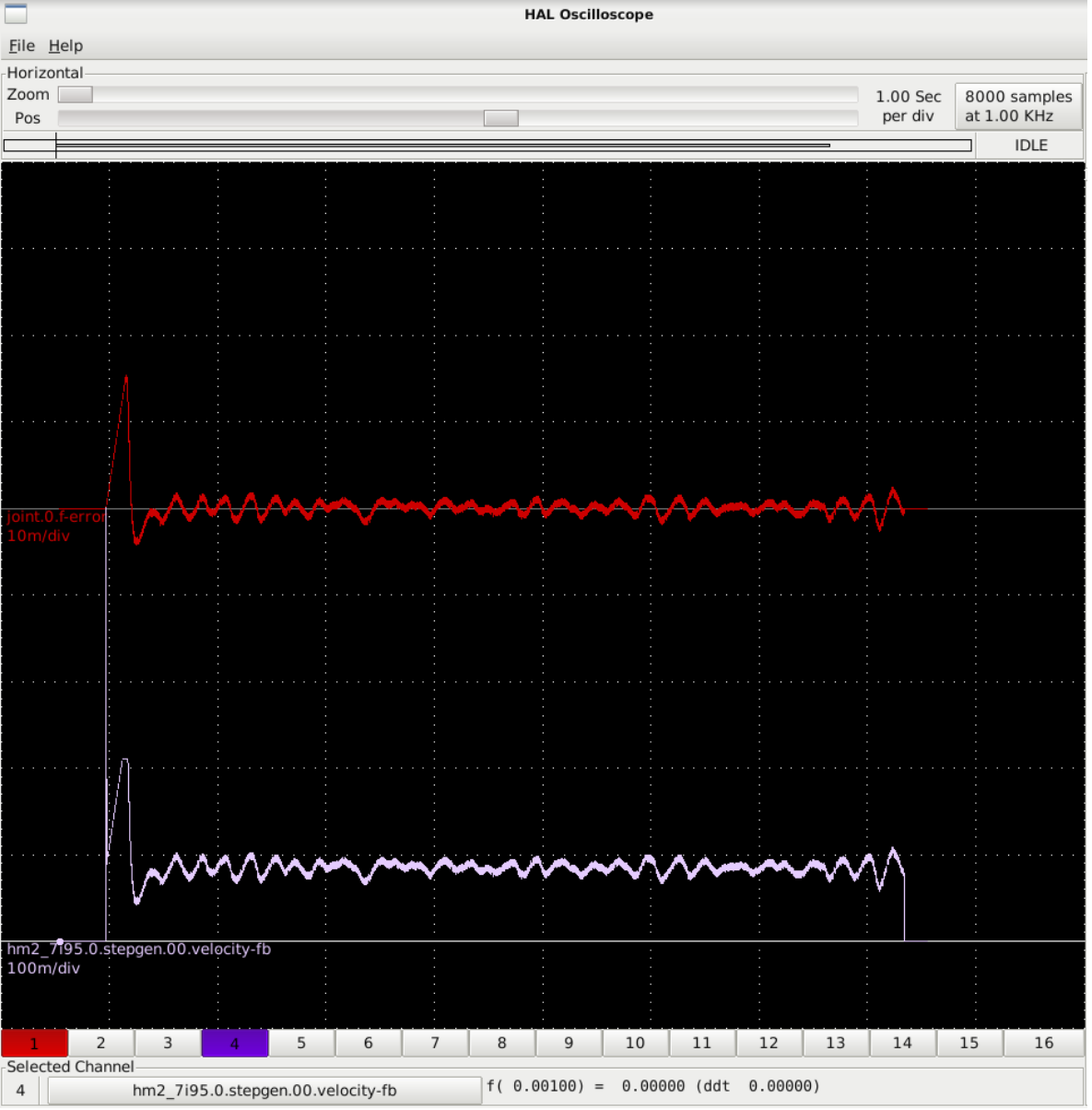


Discussion

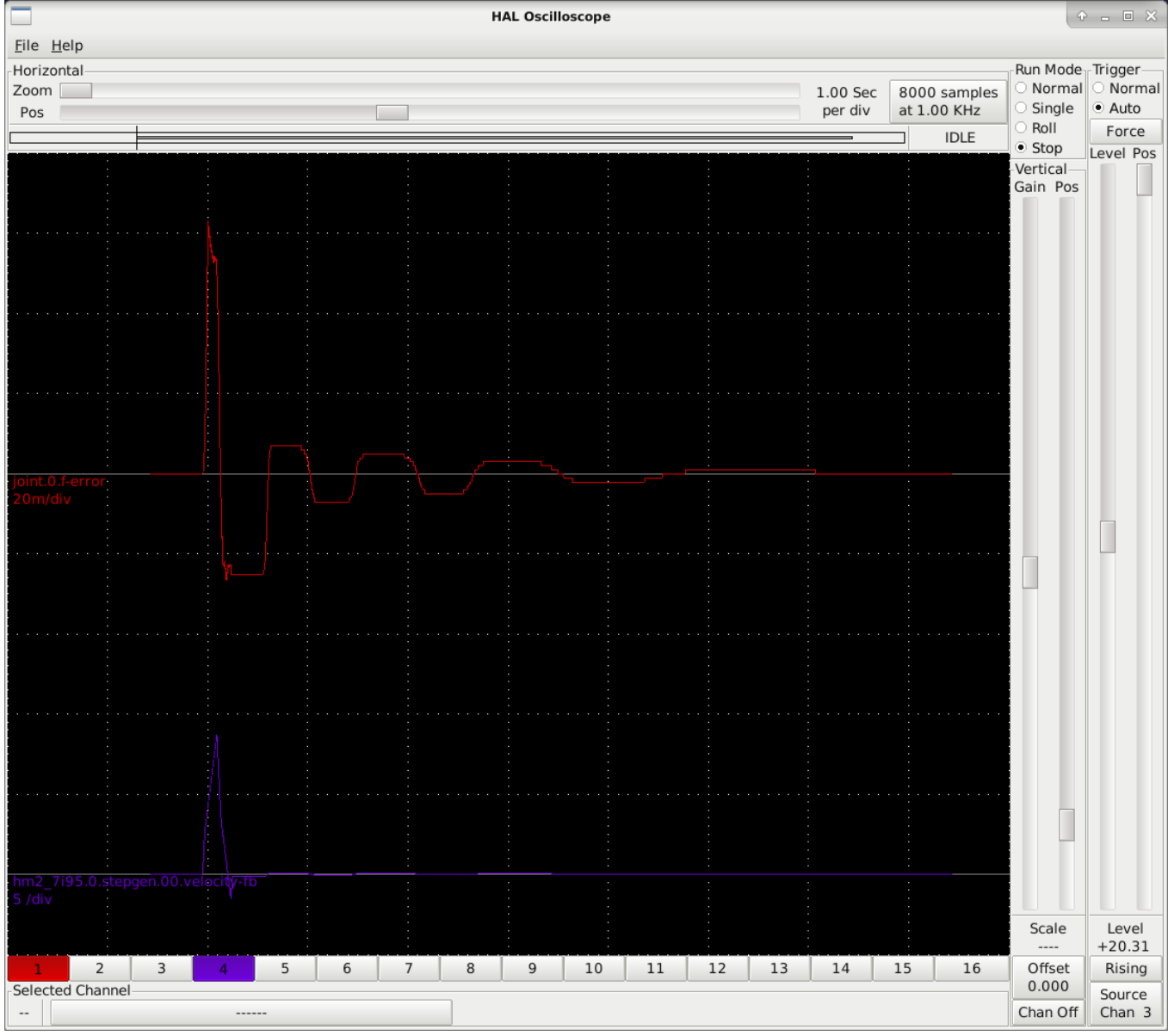
i. Overshoot increases with velocity

Overshoot vs. Velocity

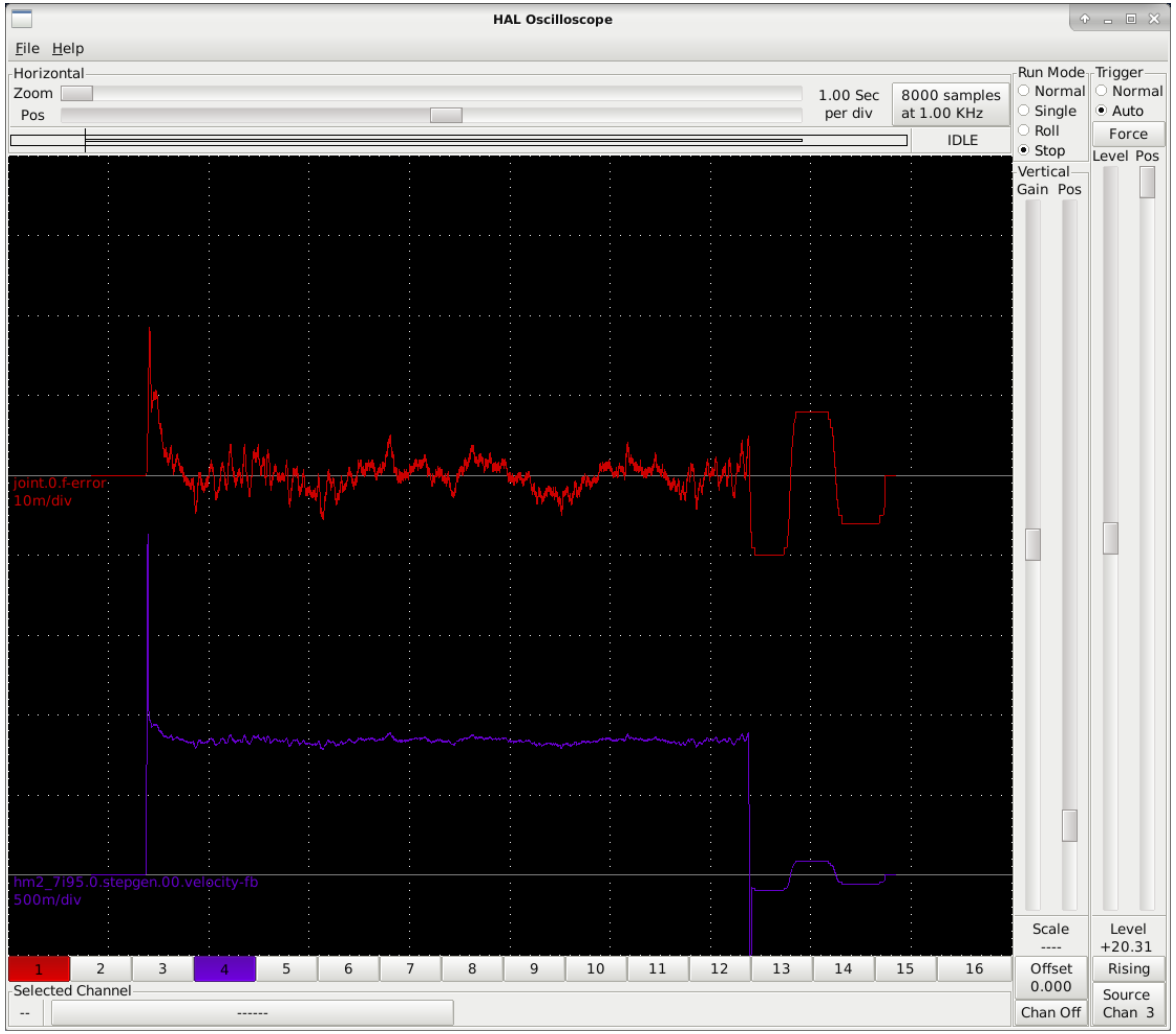




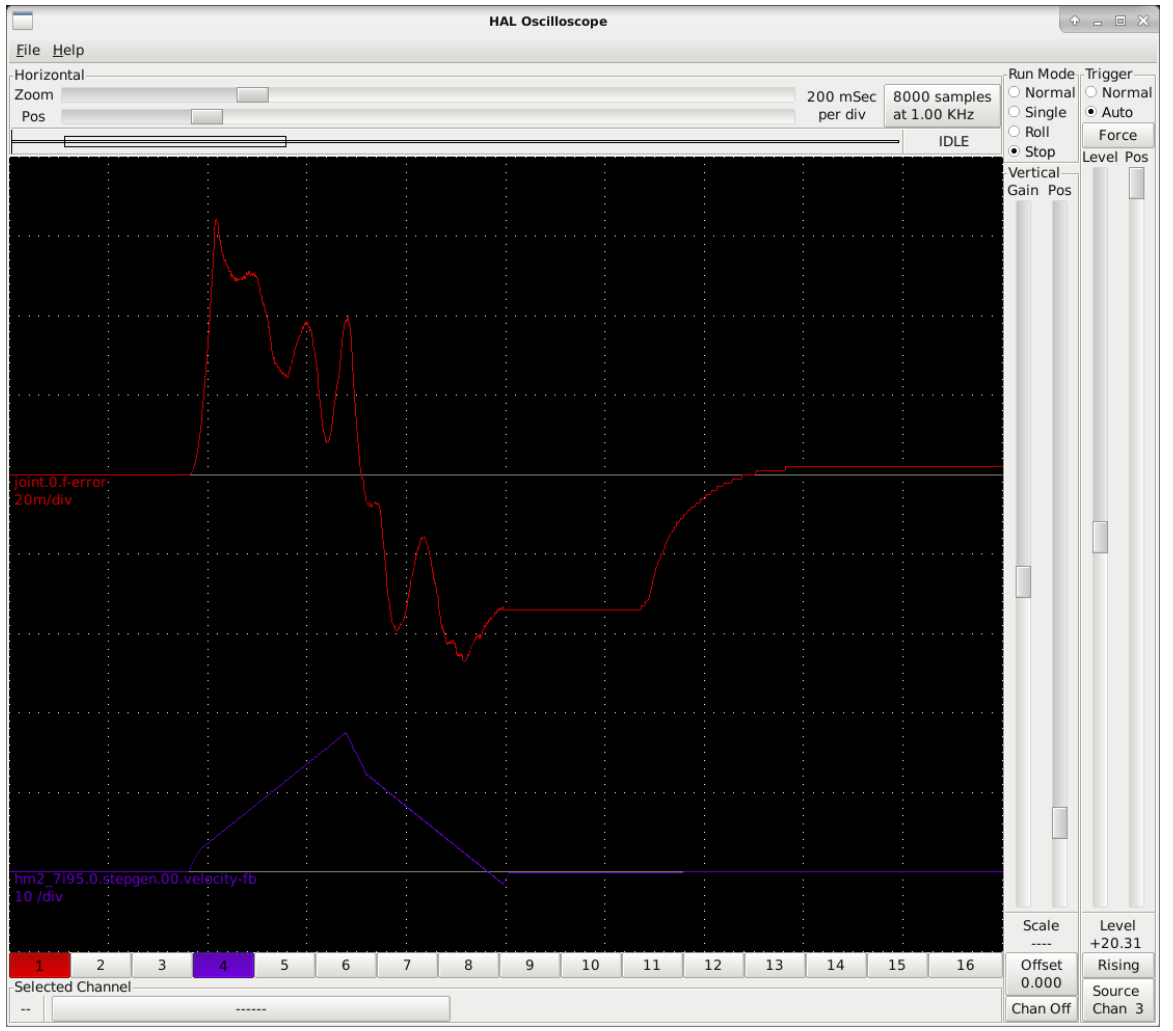
X1 F5



X1 F1000



X5 F50



X5 F1000

Conclusion

i. Following Error, Velocity Feedback Error, and Overshoot should increase with increasing velocity. And the results shows good agreement.

ii. Ideally, length of travel shouldn't effect the following, velocity feedback, and overshoot error, and results also show good agreement with coinciding graphs of different length onto each other (Except 1mm travel).

iii. Sometimes length of travel is too short (ex. 1 mm) to reach to the commanded velocity (ex. 16.67 mm/sec), so Velocity Feedback error is too high in such case.

iv. Initial undershoot and end overshoot is caused by FF2, and it is not yet tuned perfectly. Facing more trouble to tune FF2.

Thank You!