

NSTL Data: Extraction, Training, and Evaluation

1 Data Extraction and Preprocessing

The data for training and testing the network model was extracted from the given MAT files. DVL beam velocity and IMU data were used; GPS data was used wherever available.

1.1 41_min_loiter

The DVL beams velocity data in this trajectory includes a few missing beams as shown in the plot below.



placeholder_loiter_beam_variation.png

Figure 1: Variation in DVL beam velocities — 41_min_loiter

From the above plot, we observe high variations in certain beams. Beams with values of -32 or +5 are considered missing. However, we also identify time intervals with complete four-beam data. These intervals are:

- **Trajectory 4:** 05:46 to 05:51
- **Trajectory 5:** 05:58 to 06:08

These clean intervals were used for training the model. IMU data was aligned to these intervals. No GPS data was available for this trajectory, hence ground truth velocity could not be used.

1.2 300m_lawn_mower

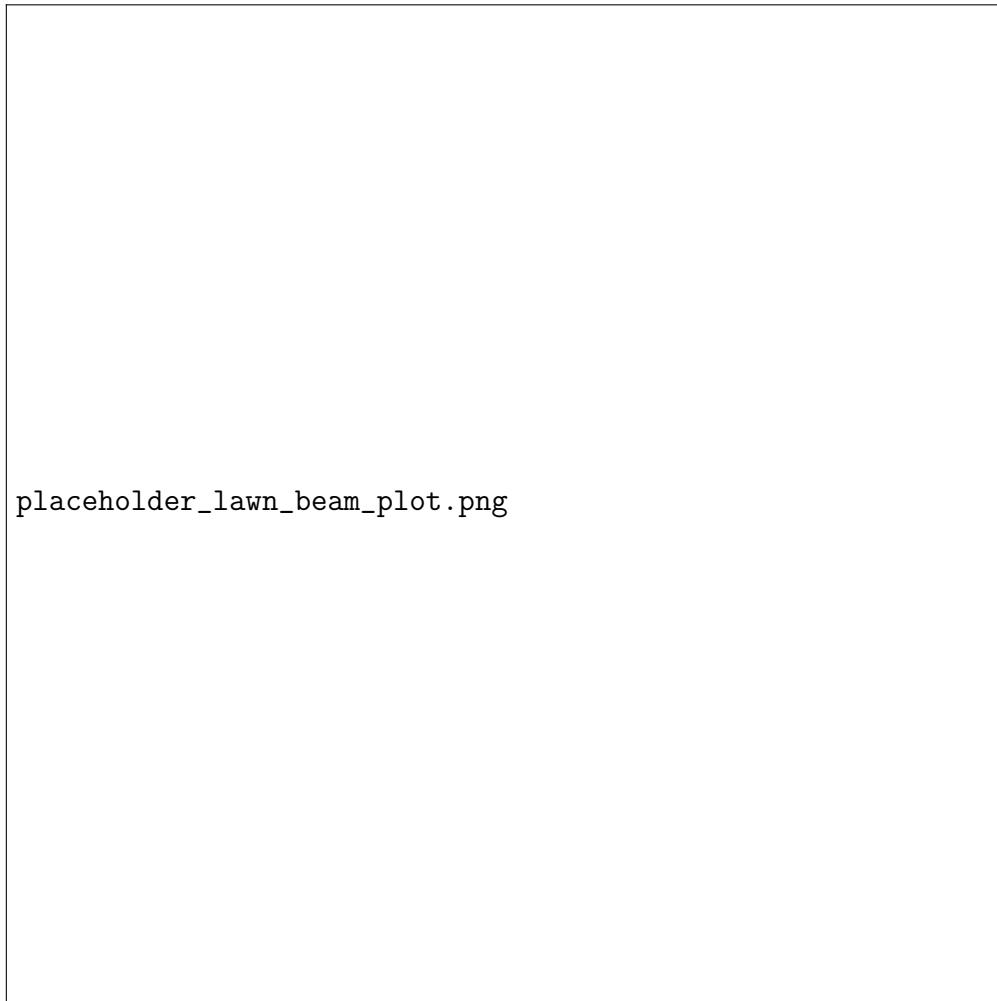


Figure 2: DVL Beam Velocities — 300m_lawn_mower

Using the same criteria as above, we extracted:

- **Trajectory 1:** 11:21 to 11:22
- **Trajectory 2:** 11:27 to 11:29
- **Trajectory 3:** 11:35 to 11:36

GPS data was available throughout this trajectory and exhibited good HDOP values (≤ 1), though the velocity readings from INS_Data_pack appeared inconsistent (range: -10 to 16 m/s).

2 Dataset Summary

Trajectory	Time Interval	DVL Points	IMU Points	Source
1	11:21 - 11:22	1359	9500	300m_lawn_mower
2	11:27 - 11:29	1759	12300	300m_lawn_mower
3	11:35 - 11:36	930	6500	300m_lawn_mower
4	05:46 - 05:51	4287	30000	41_min_loiter
5	05:58 - 06:08	8573	60000	41_min_loiter

Table 1: Summary of Trajectories Used for Training

3 Group-wise Evaluation and Plots

3.1 Group 1: Trajectories 1, 2, 3

Trajectory 1 (11:21–11:22)

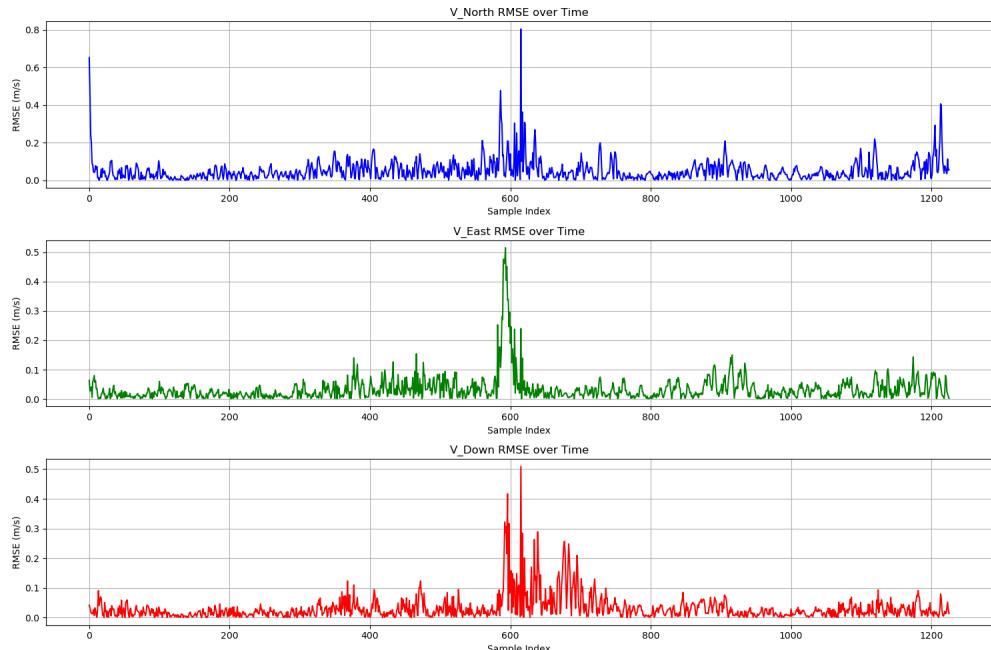


Figure 3: Velocity RMSE for Trajectory 1 (Train)

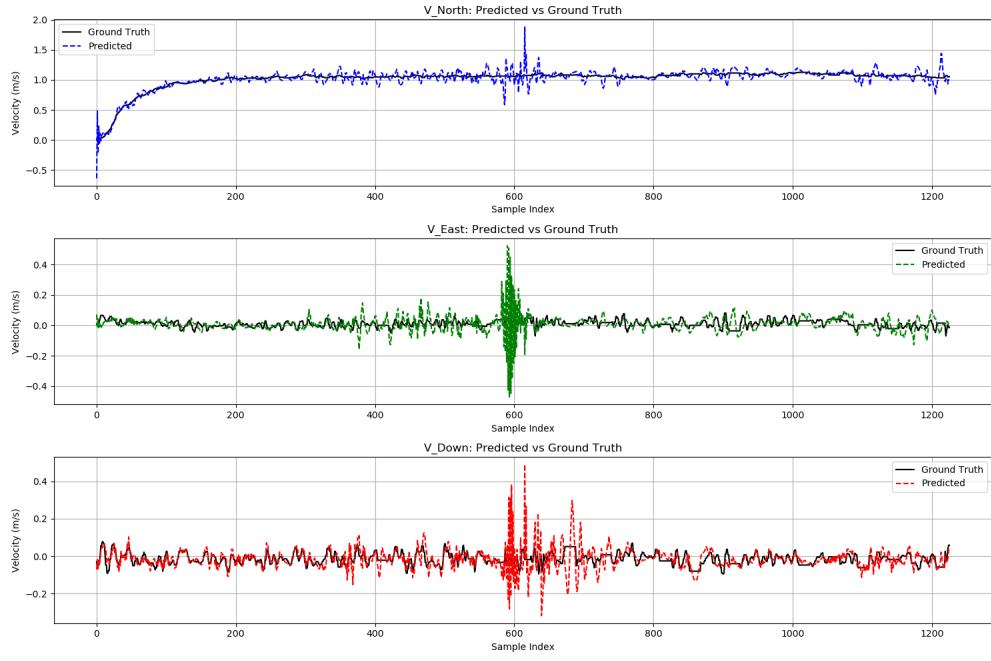


Figure 4: Predicted vs Ground Truth Velocity — Trajectory 1 (Train)

Trajectory 2 (11:27–11:29)

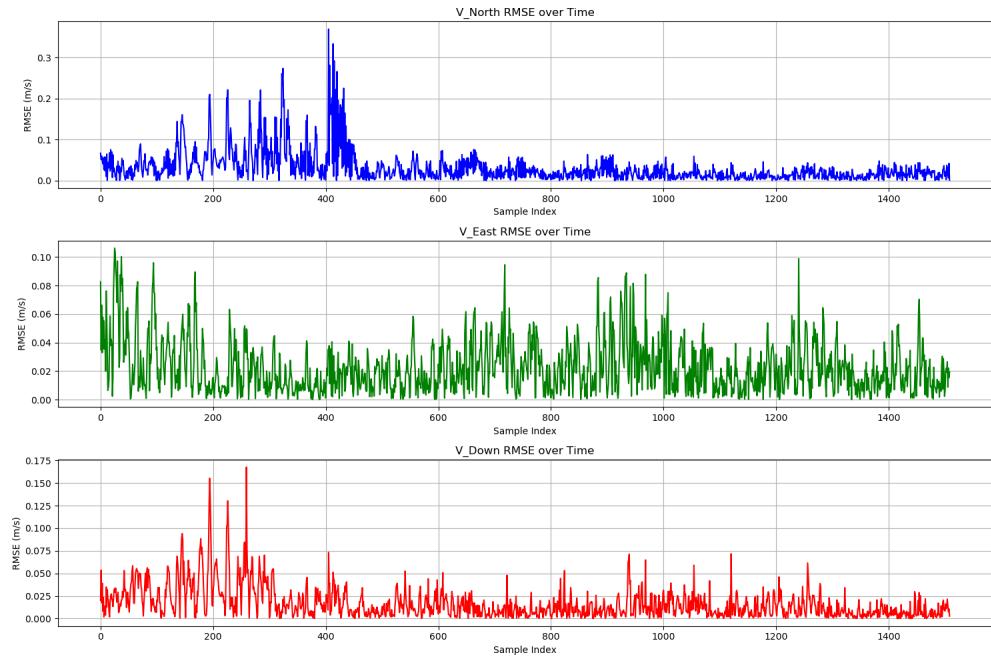


Figure 5: Velocity RMSE for Trajectory 2 (Train)

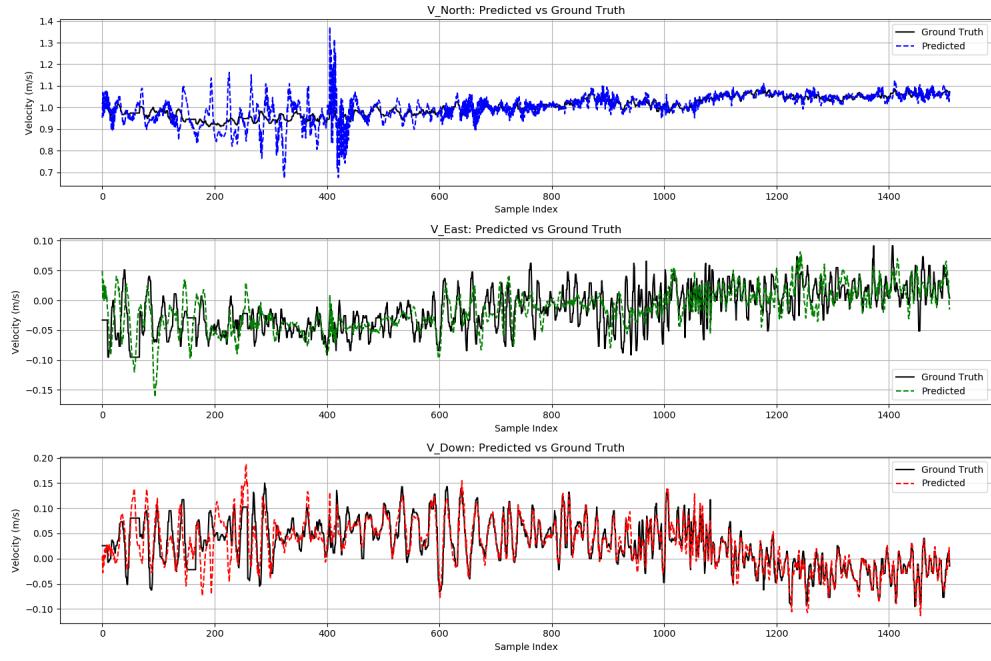


Figure 6: Predicted vs Ground Truth Velocity — Trajectory 2 (Train)

Trajectory 3 (11:35–11:36)

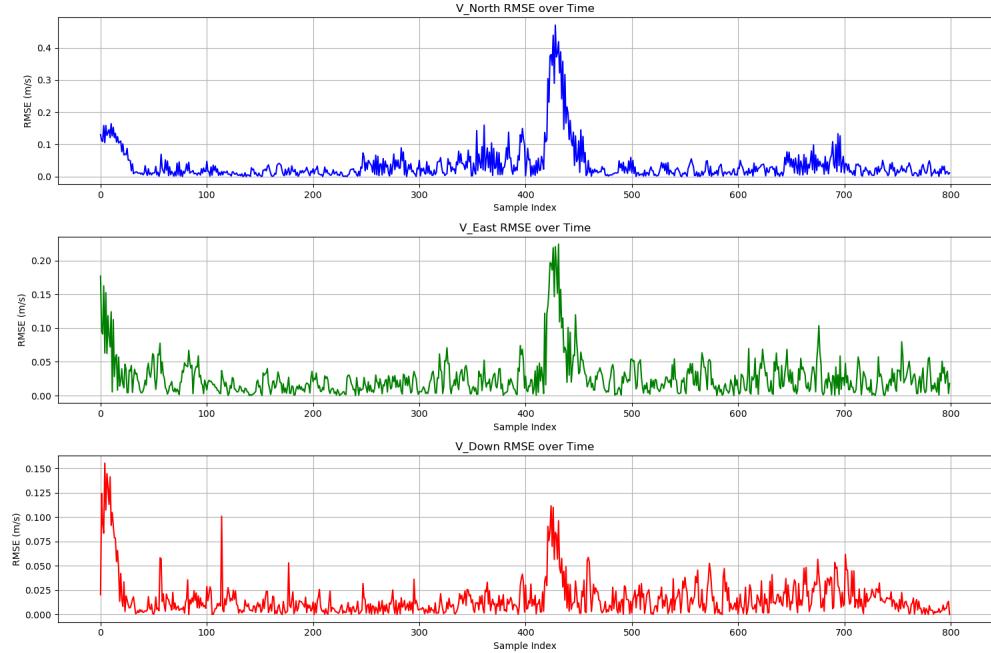


Figure 7: Velocity RMSE for Trajectory 3 (Train)

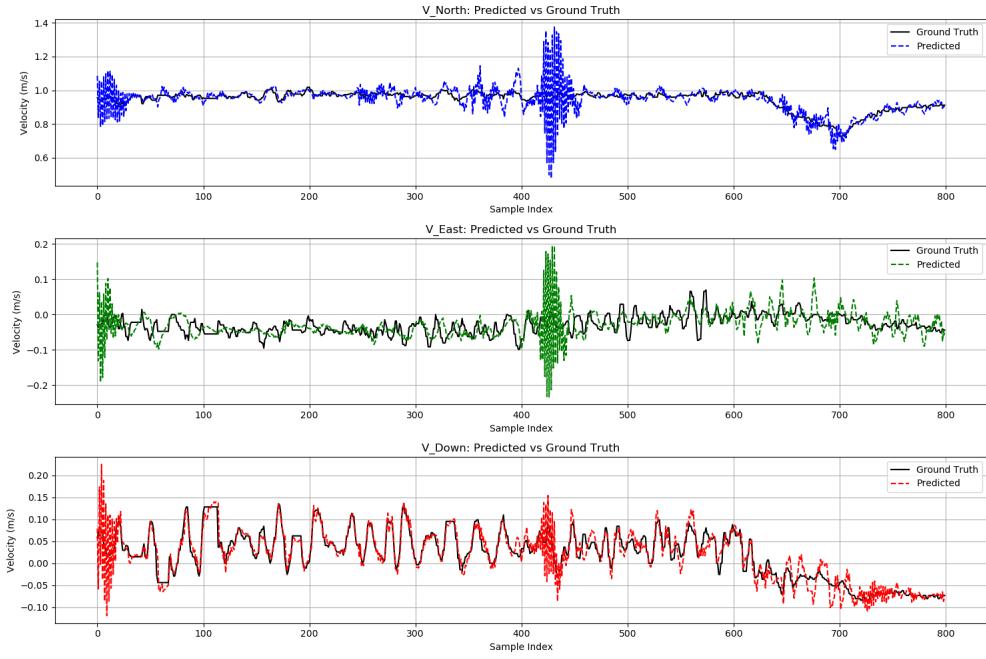


Figure 8: Predicted vs Ground Truth Velocity — Trajectory 3 (Train)

3.2 Group 2: Trajectories 4, 5

Trajectory 4 (05:46–05:51)

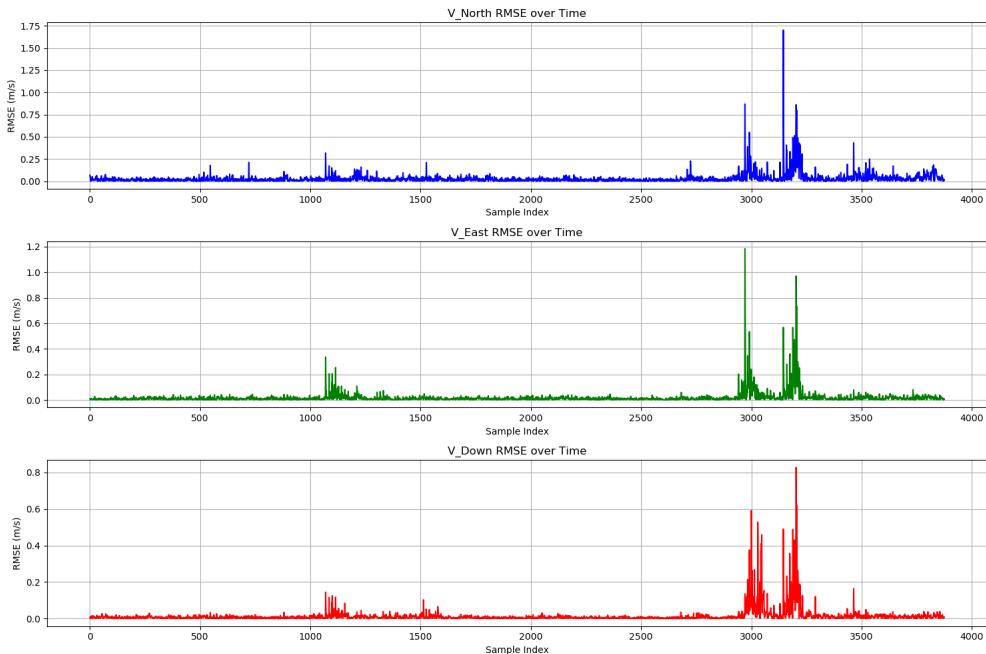


Figure 9: Velocity RMSE for Trajectory 4 (Train)

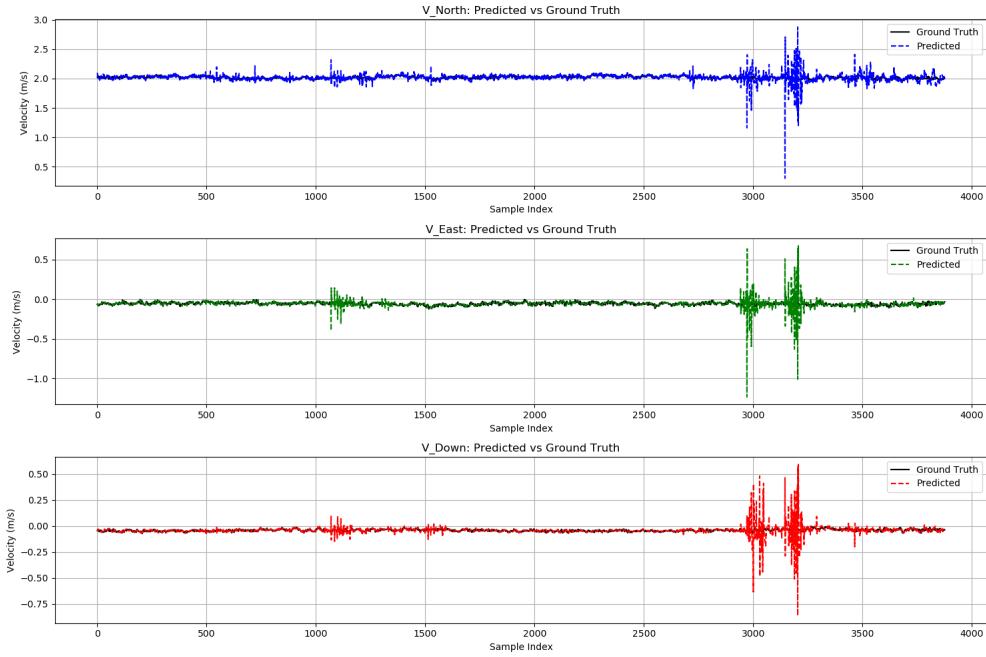


Figure 10: Predicted vs Ground Truth Velocity — Trajectory 4 (Train)

Trajectory 5 (05:58–06:08)

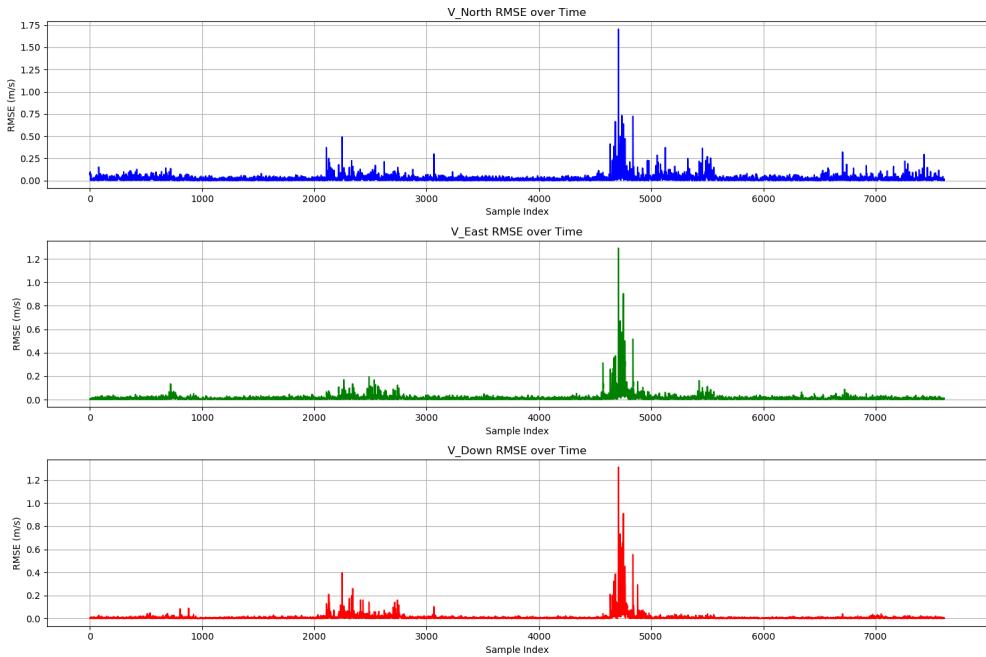


Figure 11: Velocity RMSE for Trajectory 5 (Train)

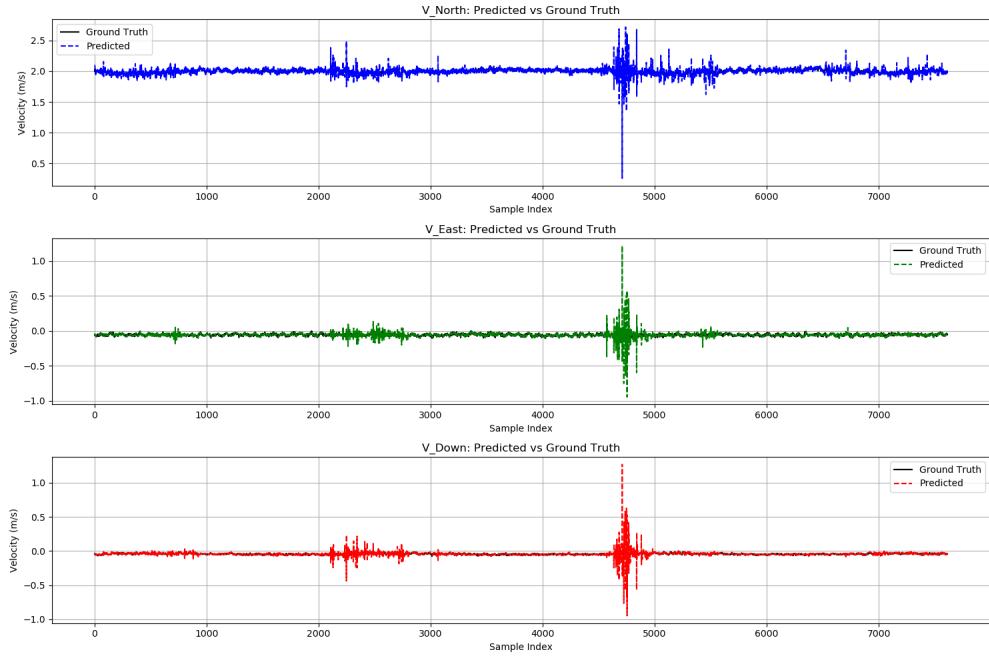


Figure 12: Predicted vs Ground Truth Velocity — Trajectory 5 (Train)

3.3 Group 3: Corrupted Test Trajectories 6–10

These trajectories are corrupted versions of Trajectories 1–5 respectively, with approximately 10% random corruption introduced per DVL beam.

Trajectory 6 (Corrupted version of Trajectory 1)

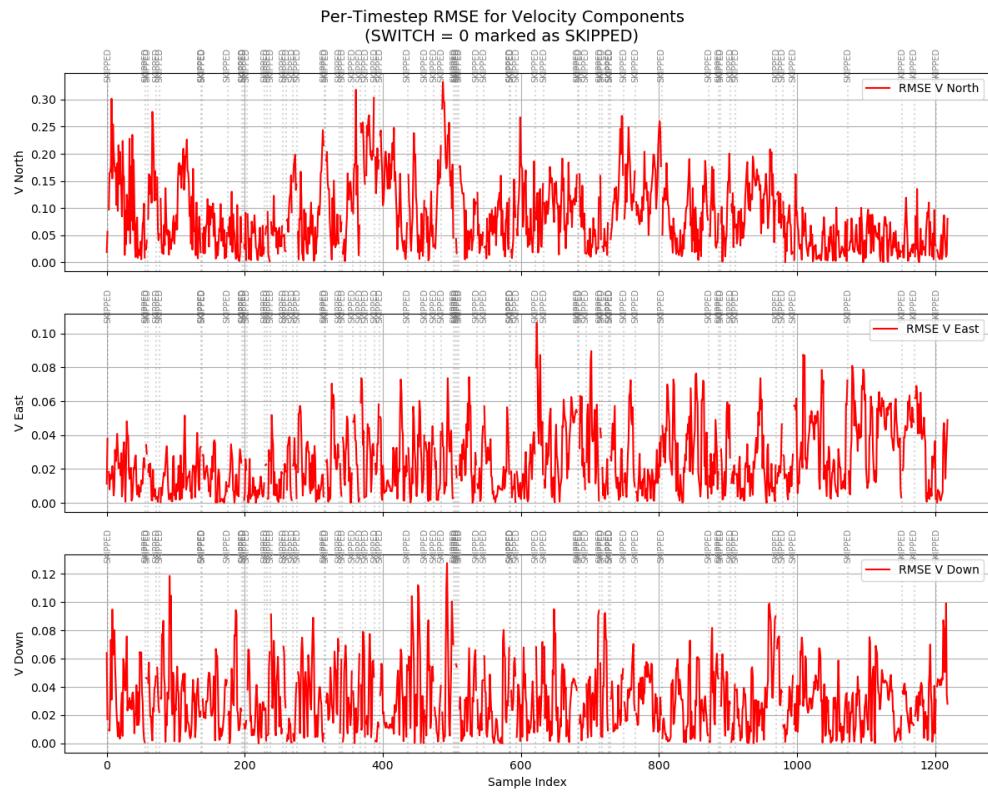


Figure 13: Velocity RMSE for Trajectory 6 (Test, Corrupted)

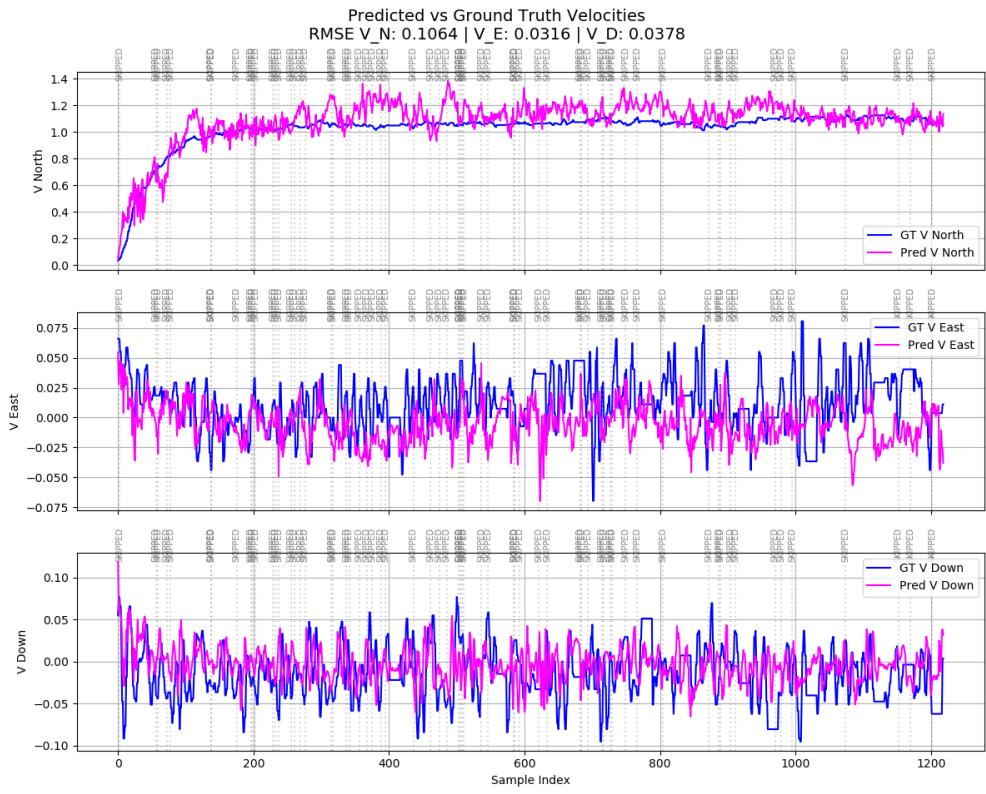


Figure 14: Predicted vs Ground Truth Velocity — Trajectory 6 (Test, Corrupted)

Trajectory 7 (Corrupted version of Trajectory 2)

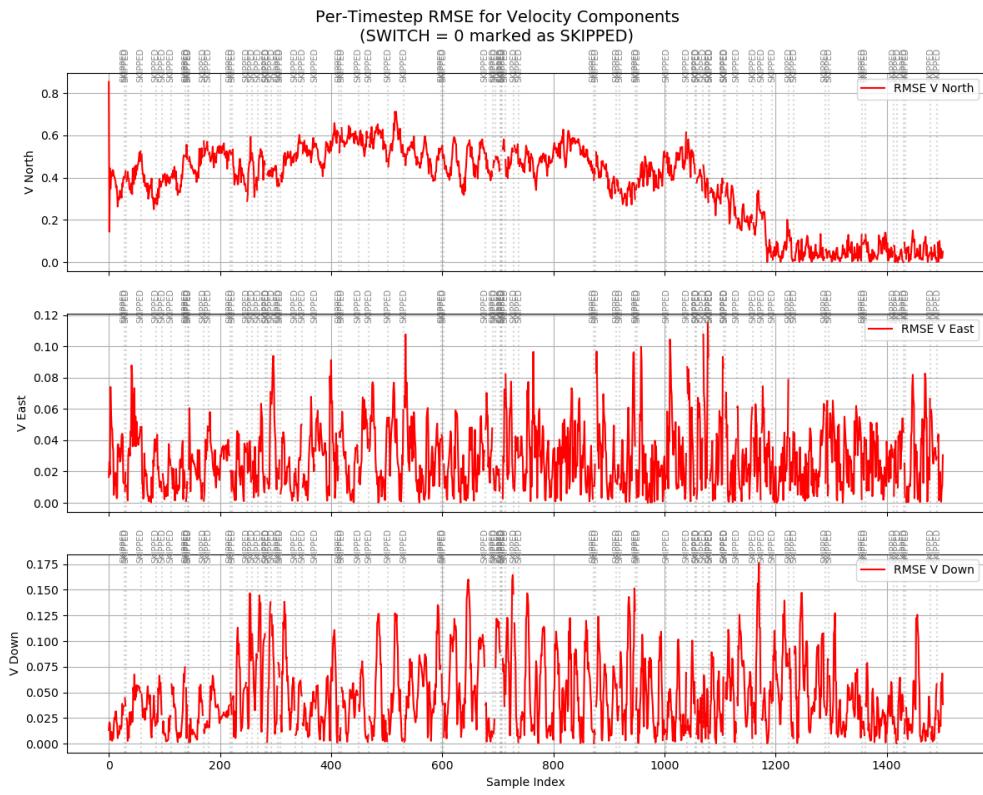


Figure 15: Velocity RMSE for Trajectory 7 (Test, Corrupted)

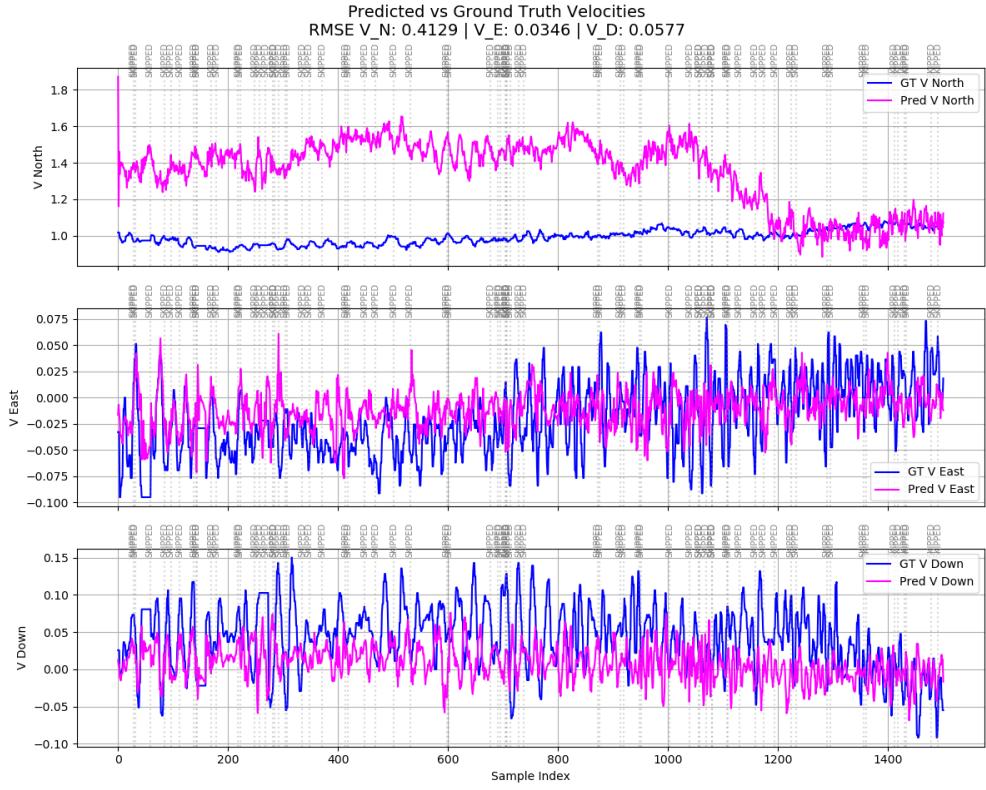


Figure 16: Predicted vs Ground Truth Velocity — Trajectory 7 (Test, Corrupted)

Trajectory 8 (Corrupted version of Trajectory 3)

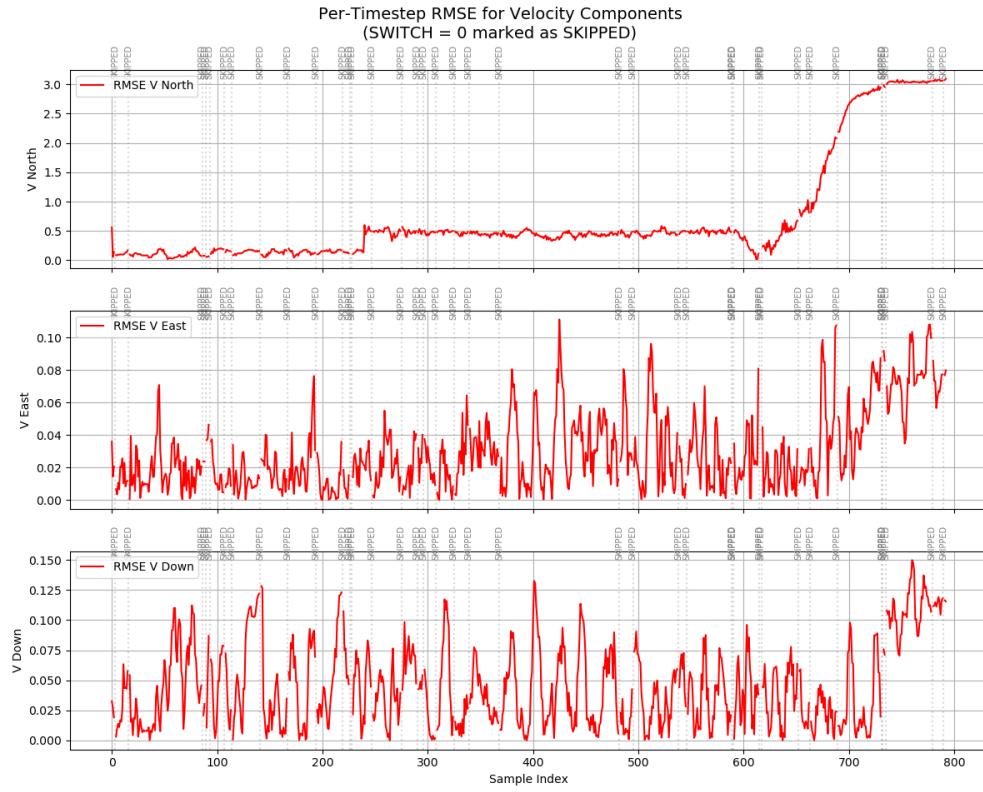


Figure 17: Velocity RMSE for Trajectory 8 (Test, Corrupted)

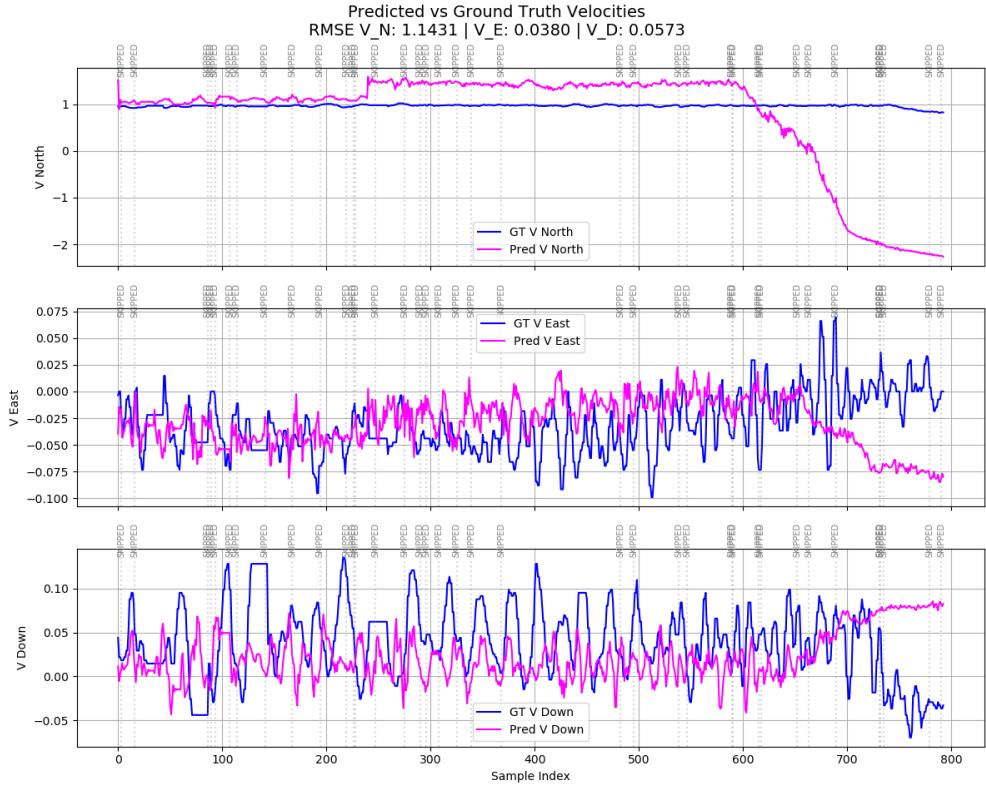


Figure 18: Predicted vs Ground Truth Velocity — Trajectory 8 (Test, Corrupted)

Trajectory 9 (Corrupted version of Trajectory 4)

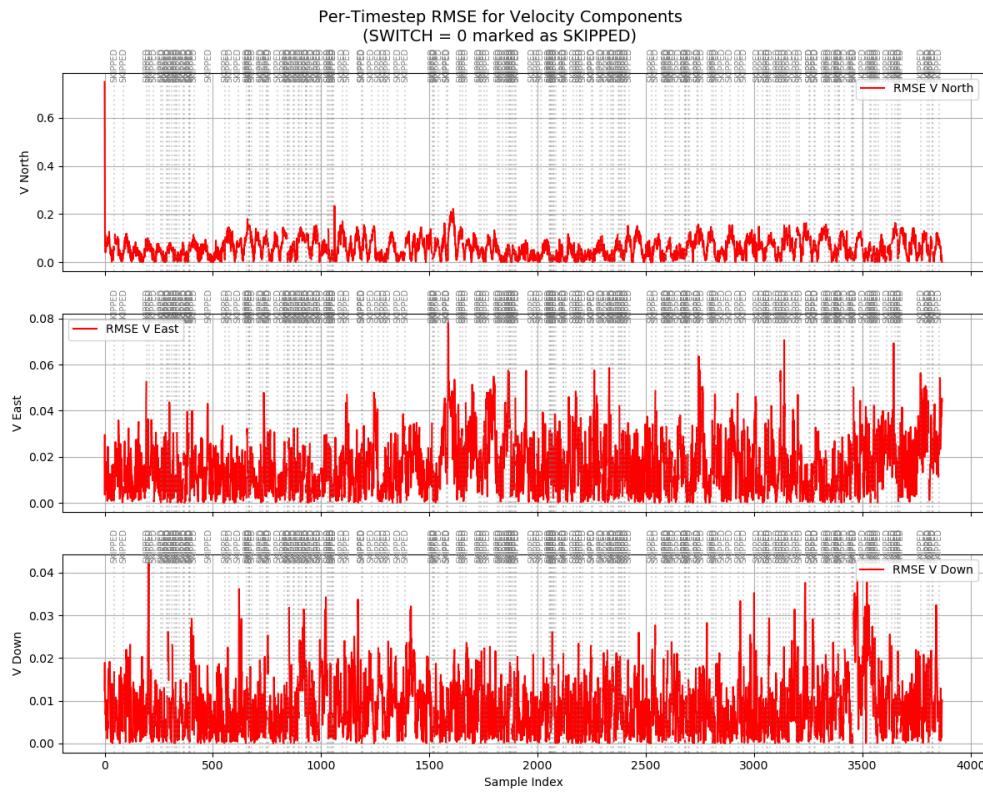


Figure 19: Velocity RMSE for Trajectory 9 (Test, Corrupted)

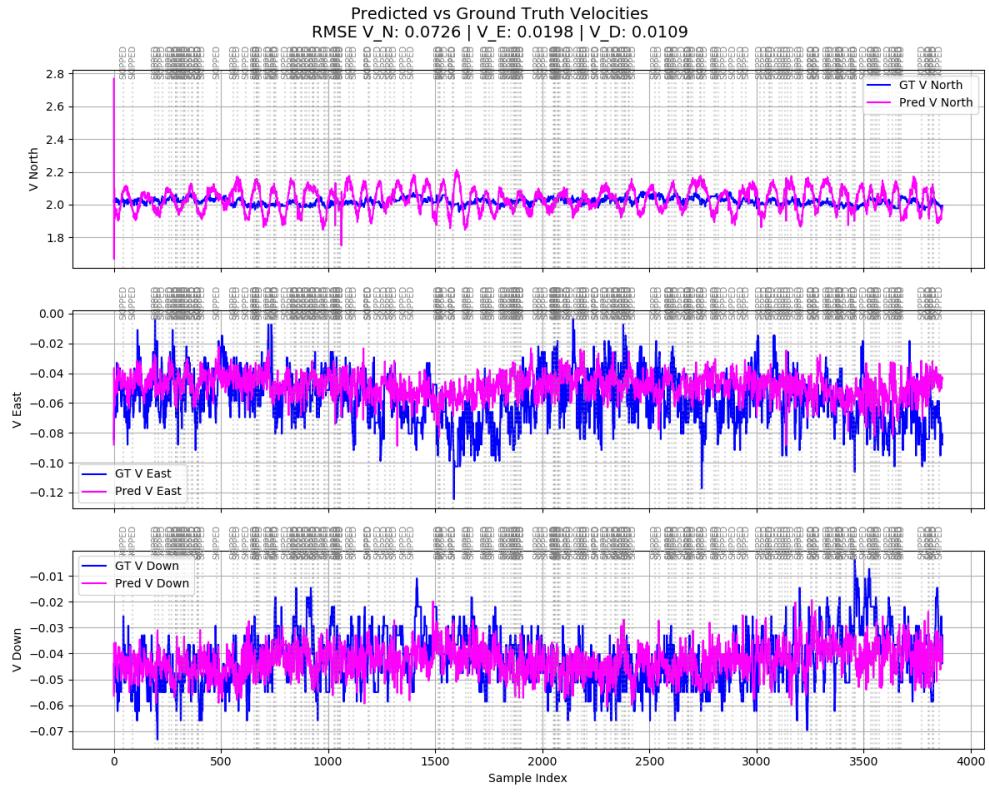


Figure 20: Predicted vs Ground Truth Velocity — Trajectory 9 (Test, Corrupted)

Trajectory 10 (Corrupted version of Trajectory 5)

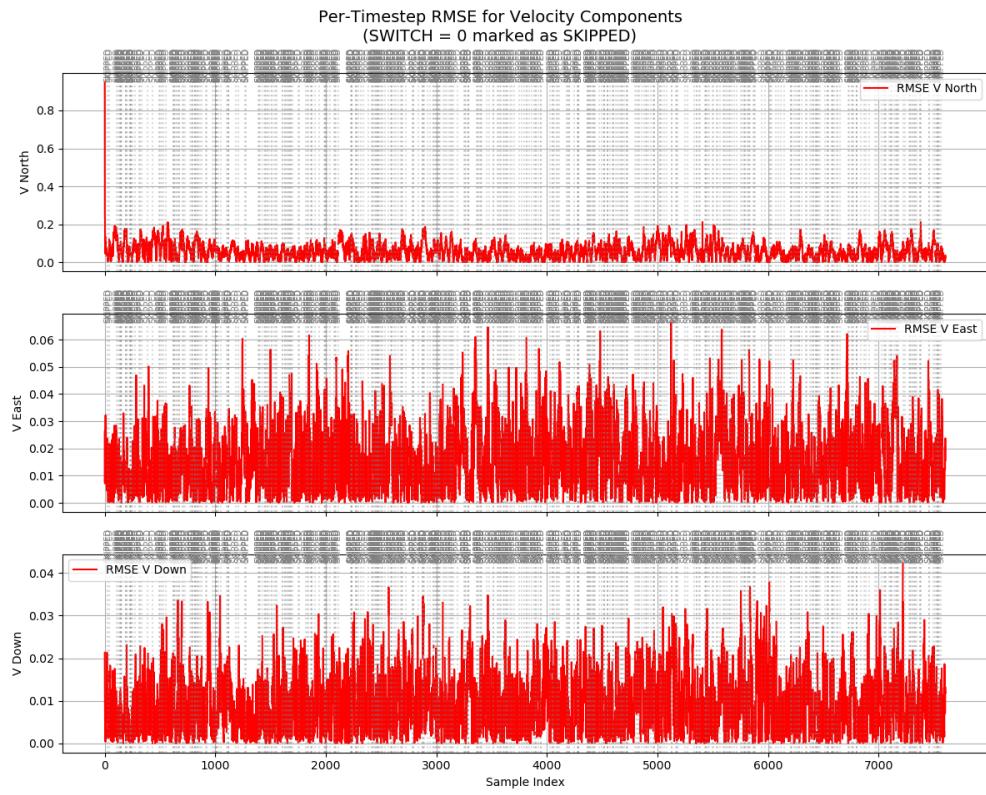


Figure 21: Velocity RMSE for Trajectory 10 (Test, Corrupted)

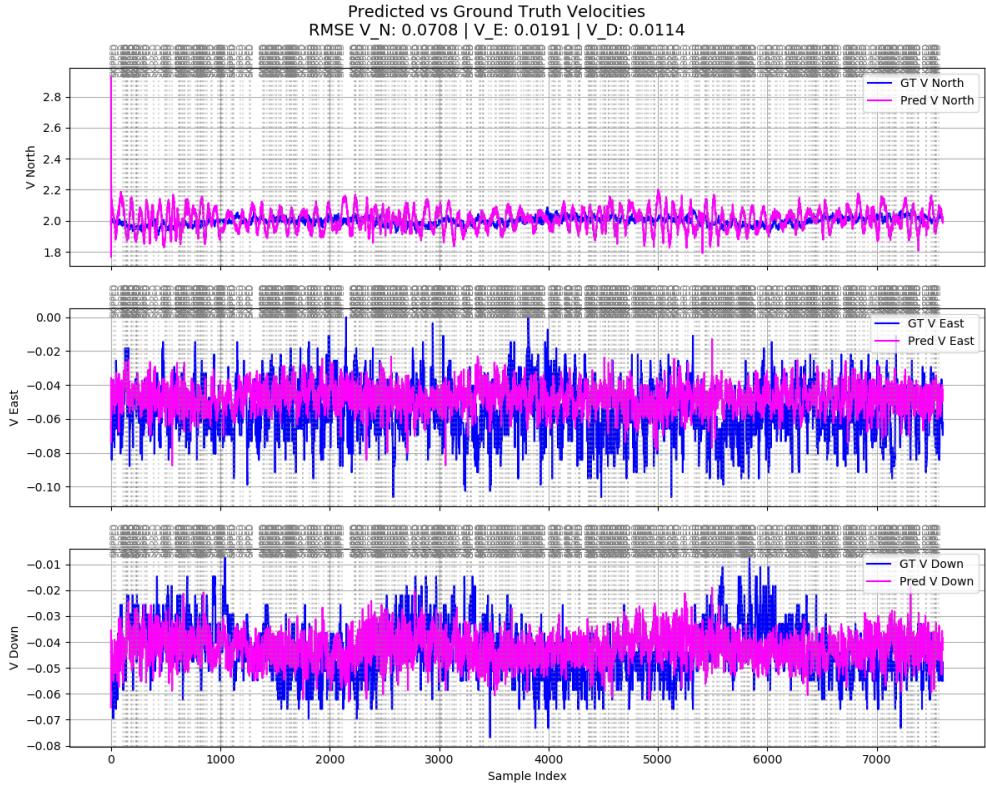


Figure 22: Predicted vs Ground Truth Velocity — Trajectory 10 (Test, Corrupted)