BSIS Alternative Test Procedure – Phase 1

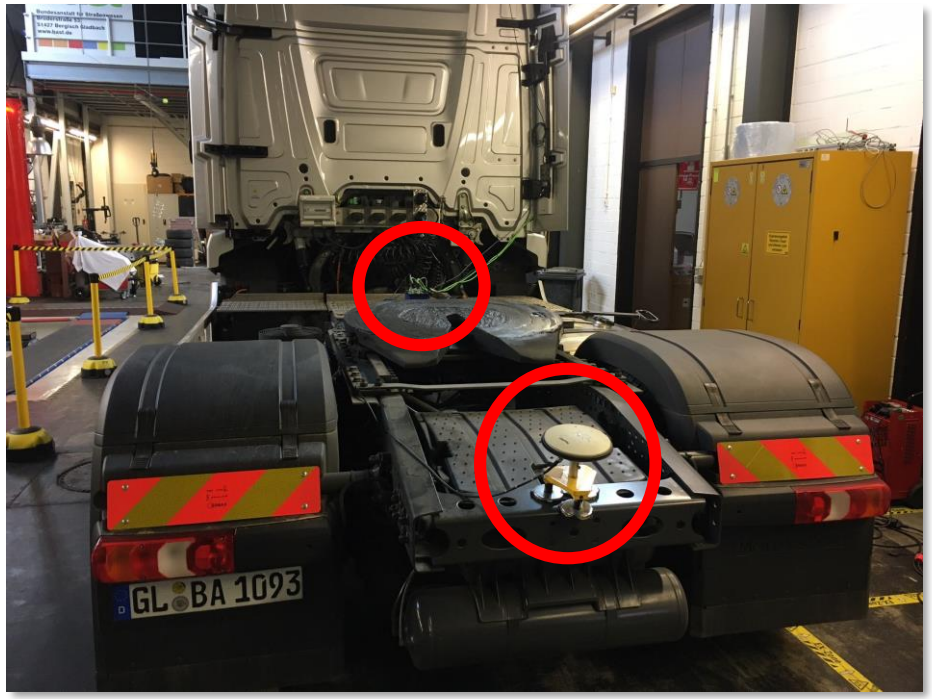
Phases

- Phase 1: Mount robots in truck, check path following in principle
- Phase 2: Record and replay trajectories, check accuracy
- Phase 3: Synchronize vehicle and bicycle dummy

Robot Implementation Overview

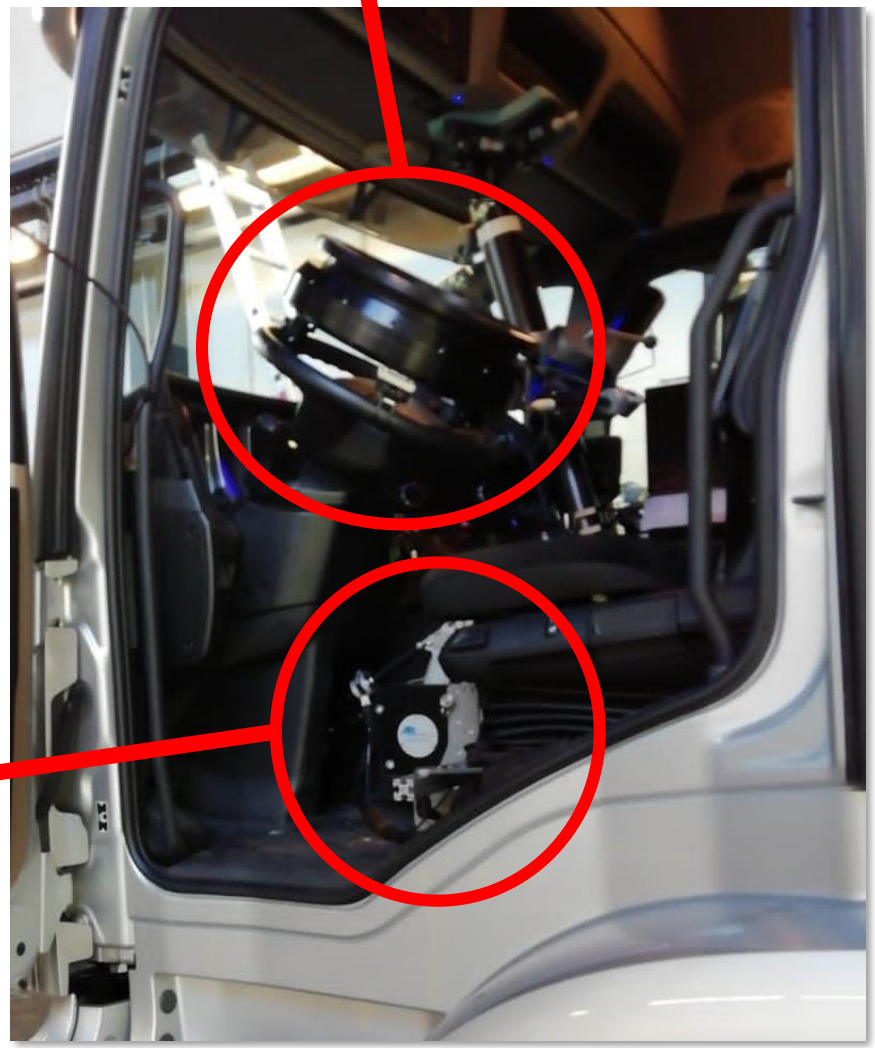
Vehicle

Sensor: ADMA G DGPS IMU



Actor: ABD SR 60

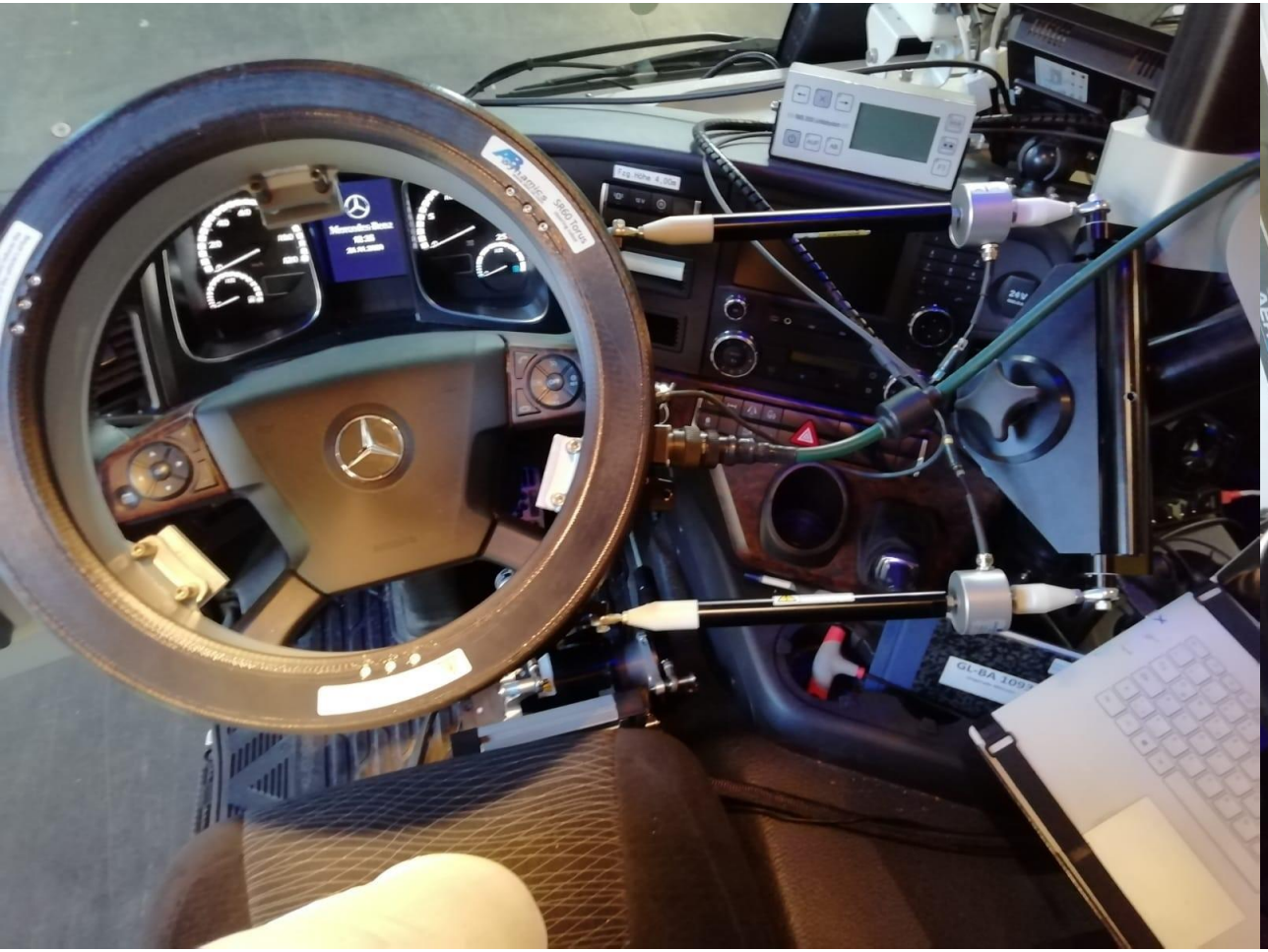
(60 Nm steering robot)



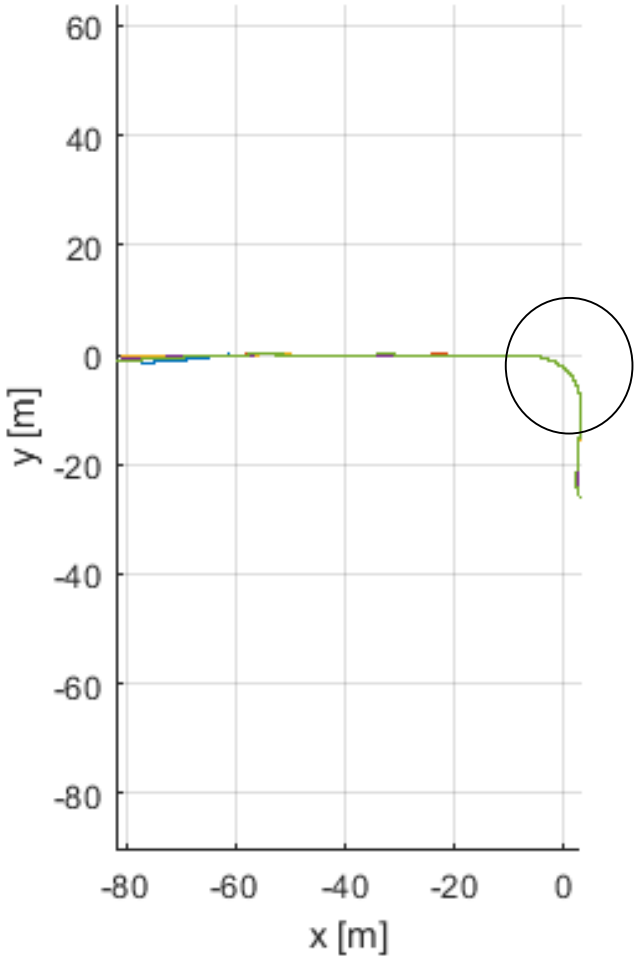
Actor: ABD CBAR

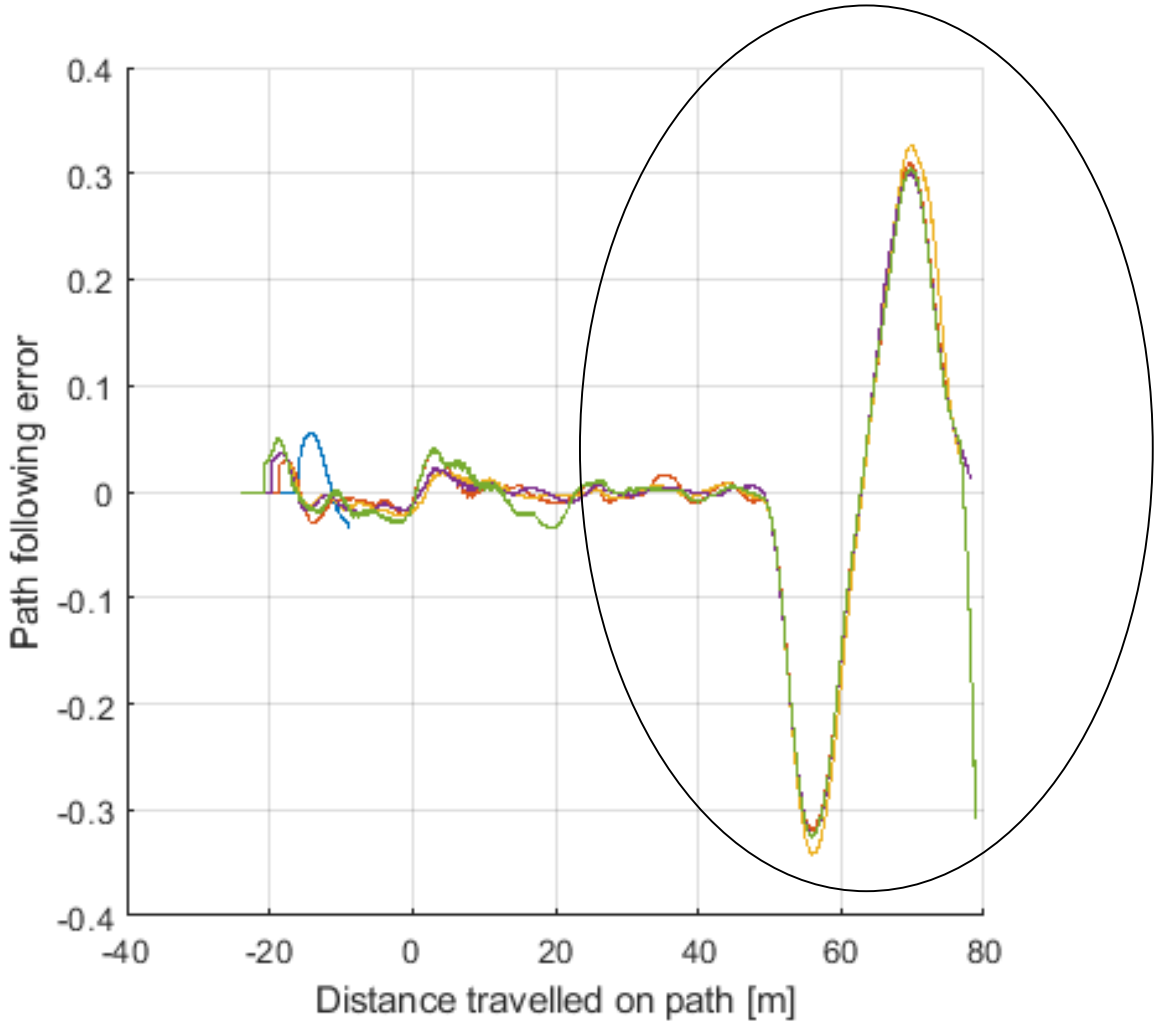
(combined brake + accelerator robot)

Steering Controller (Details)



Results: 15 km/h, Klothoide → ±0.35 m error





Conclusions – Phase 1

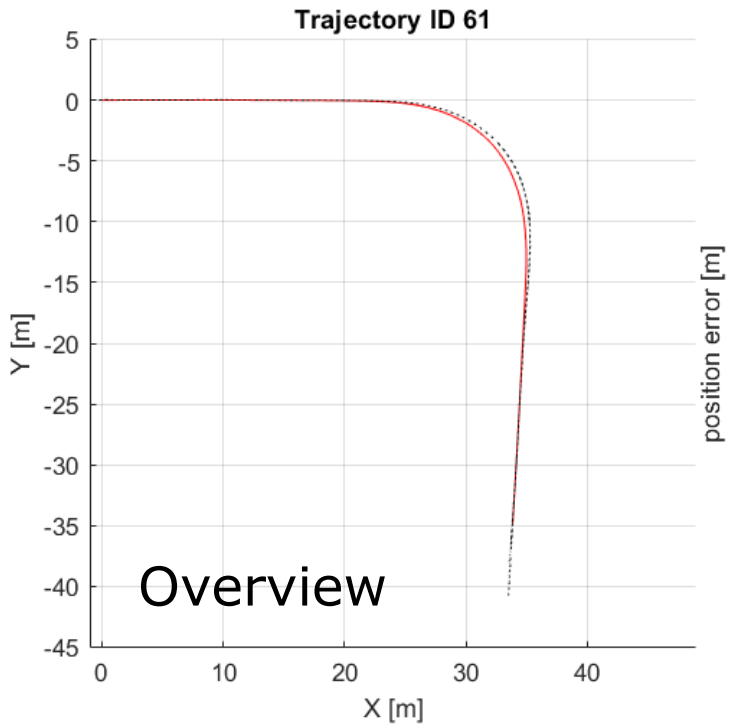
- Robot can be implemented with just minor changes to fixation mechanism
- Path following is possible
- Accuracy for path following at this time lower than expected
  - Trajectory: from Euro NCAP for passenger cars
  - Parameter tuning has not been done
  - Expectation: accuracy will be better with truck trajectories (record/replay)
- Open issues:
  - DGPS-IMU + GPS antenna position with trailer?
- Next steps probably week December 7 - 11

Phase 2

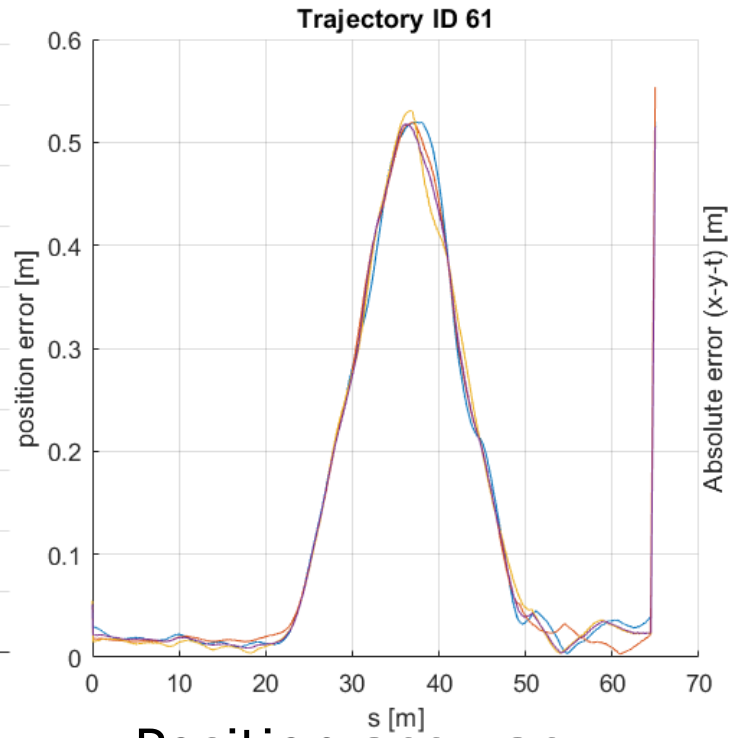
- Goal: Record and replay trajectories
- Trajectories recorded by an VM **with different vehicles**
- With what accuracy can they be replayed (place and time/velocity)?

Results

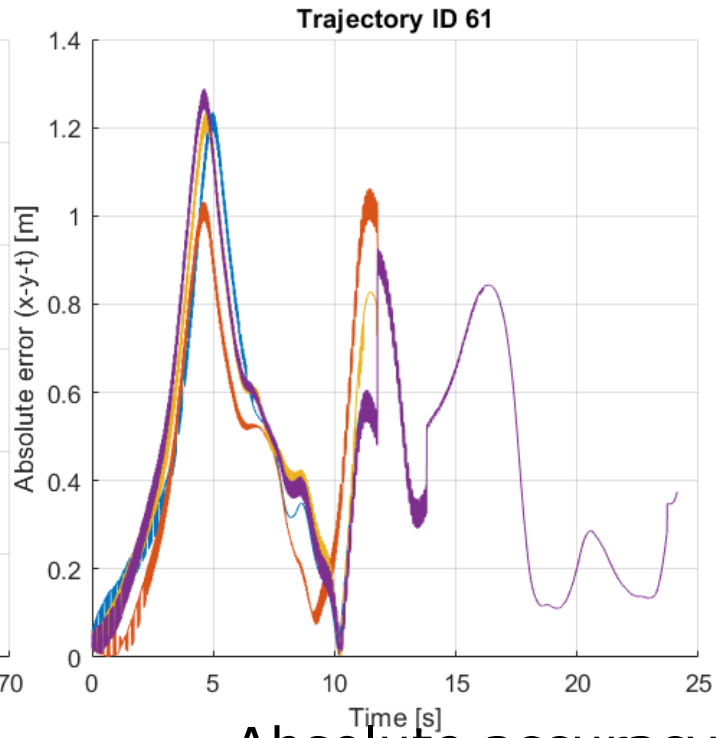
- Available records: 7 configs, up to 10 runs
- We did use one trajectory per run and replayed that up to 5 times
- Results (see also following slides):



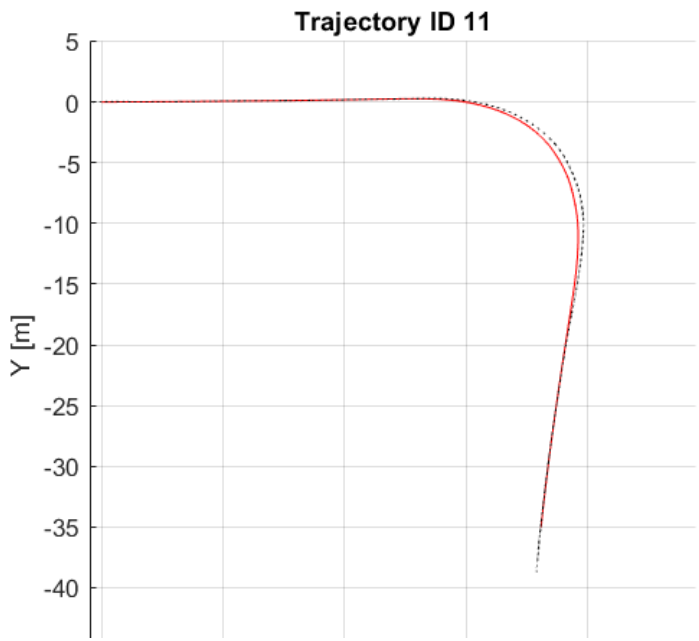
Overview

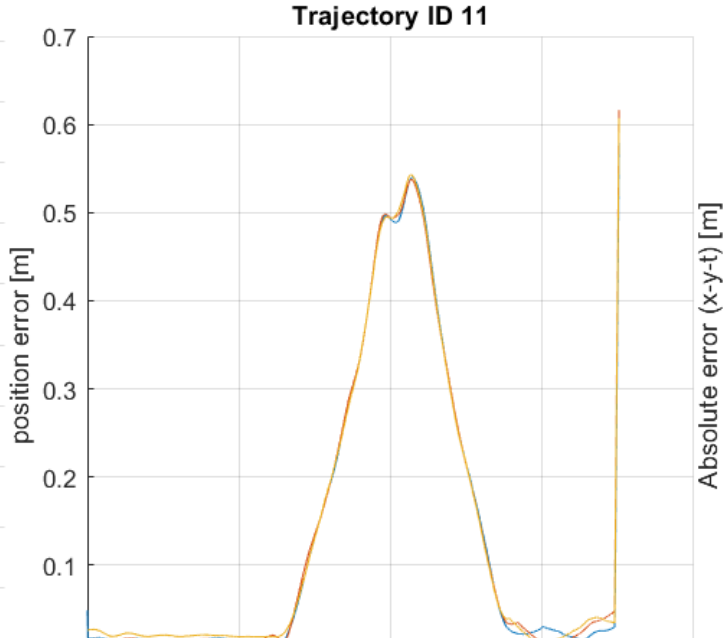


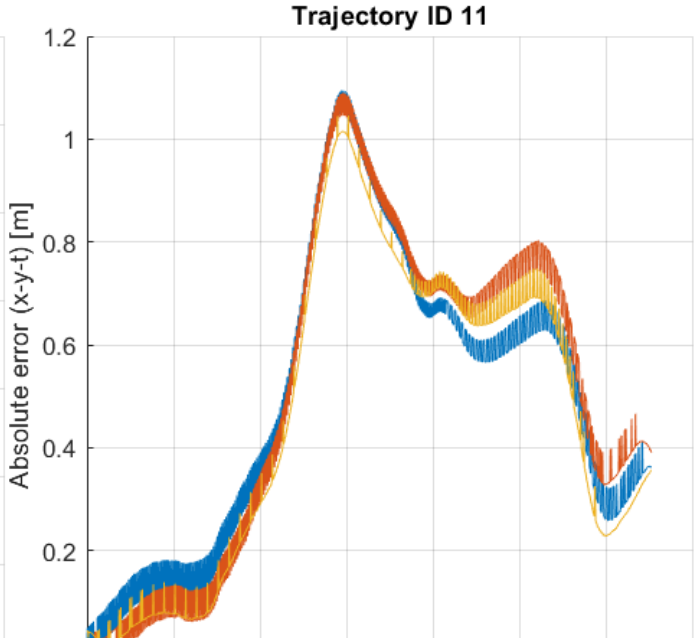
Position accuracy
(not looking at speed)

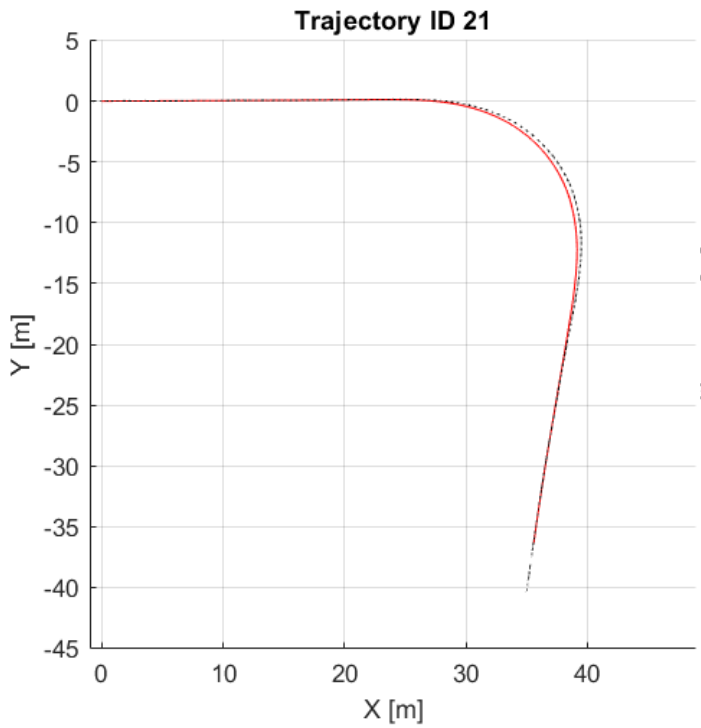


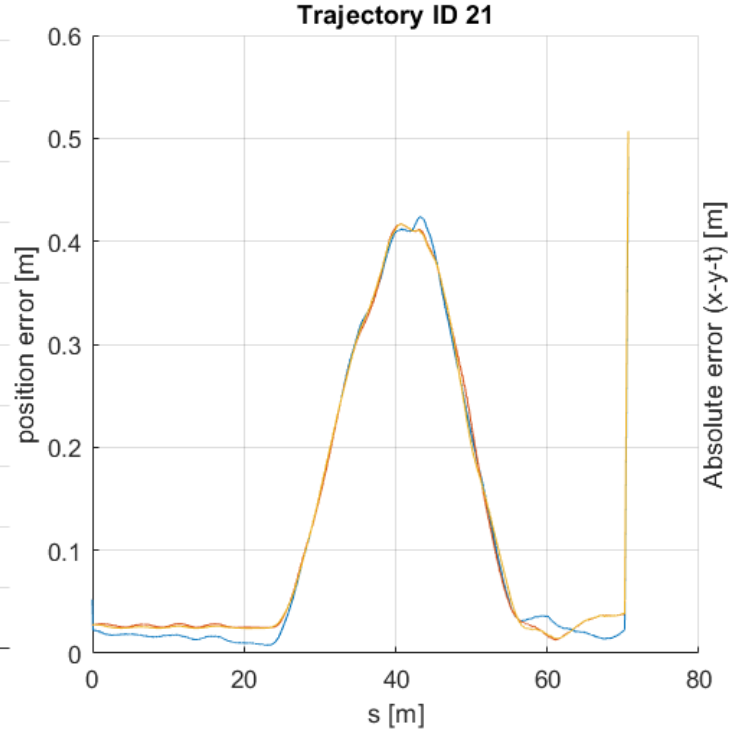
Absolute accuracy
(desired/actual place(time))

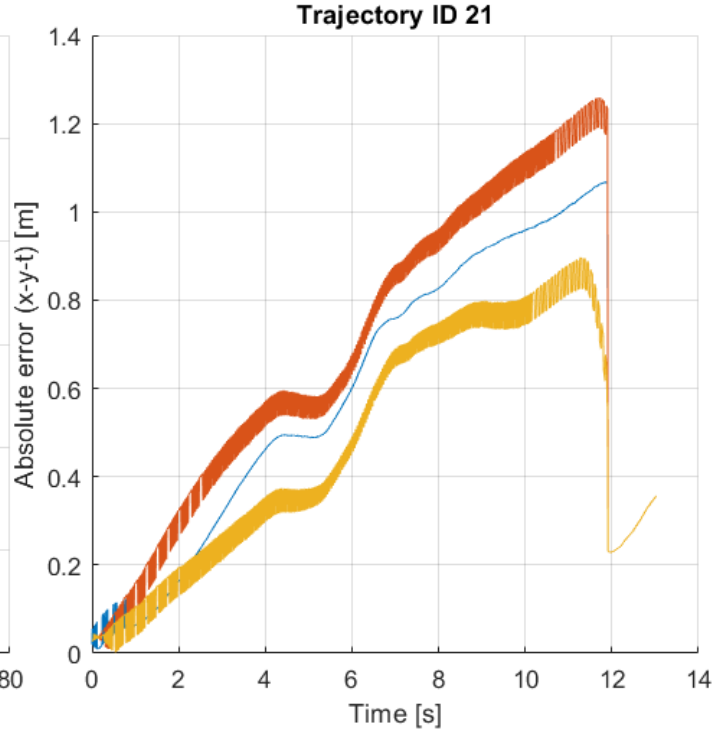

Trajectory ID 11
Y [m]
5
0
-5
-10
-15
-20
-25
-30
-35
-40

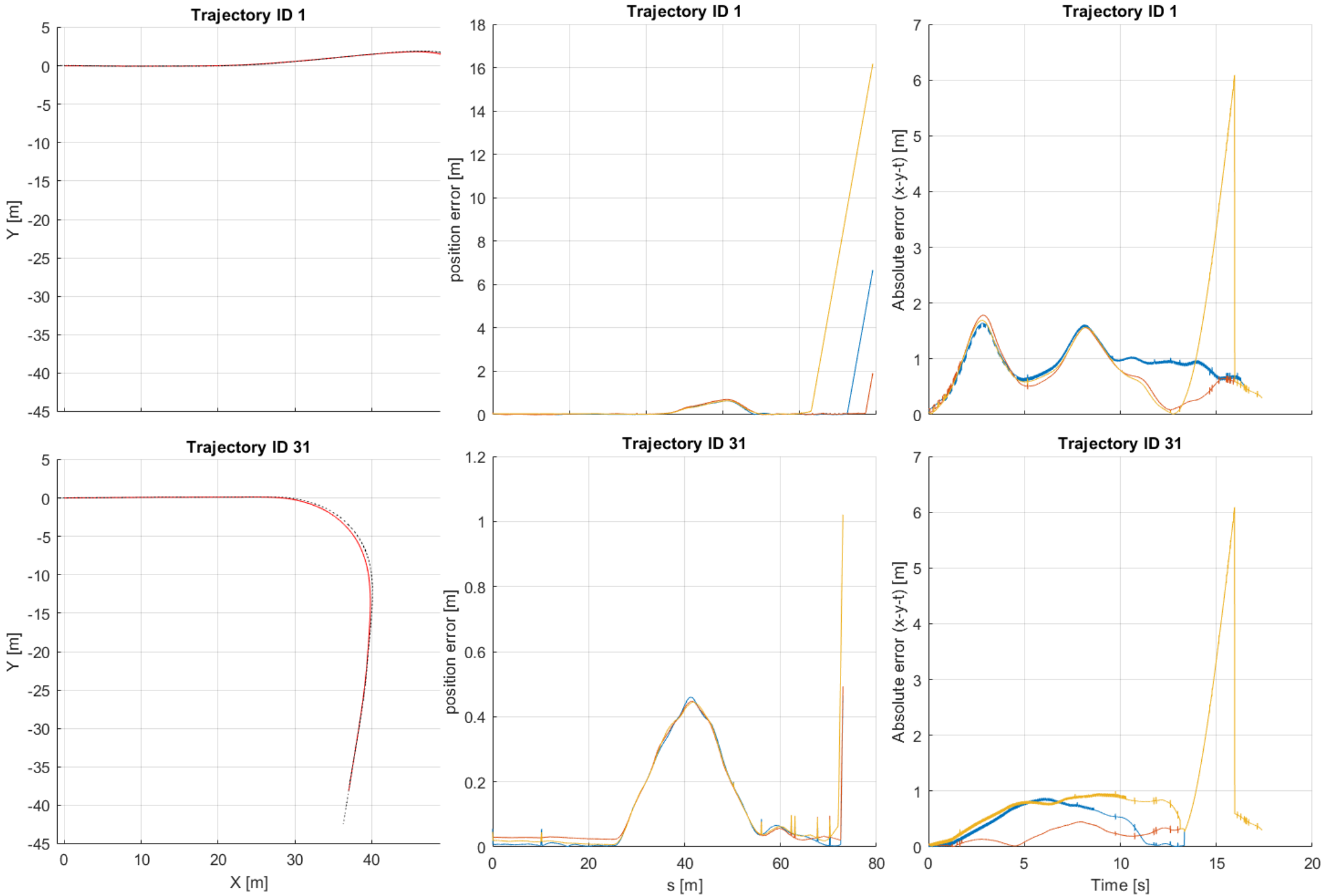

Trajectory ID 11
position error [m]
0.7
0.6
0.5
0.4
0.3
0.2
0.1

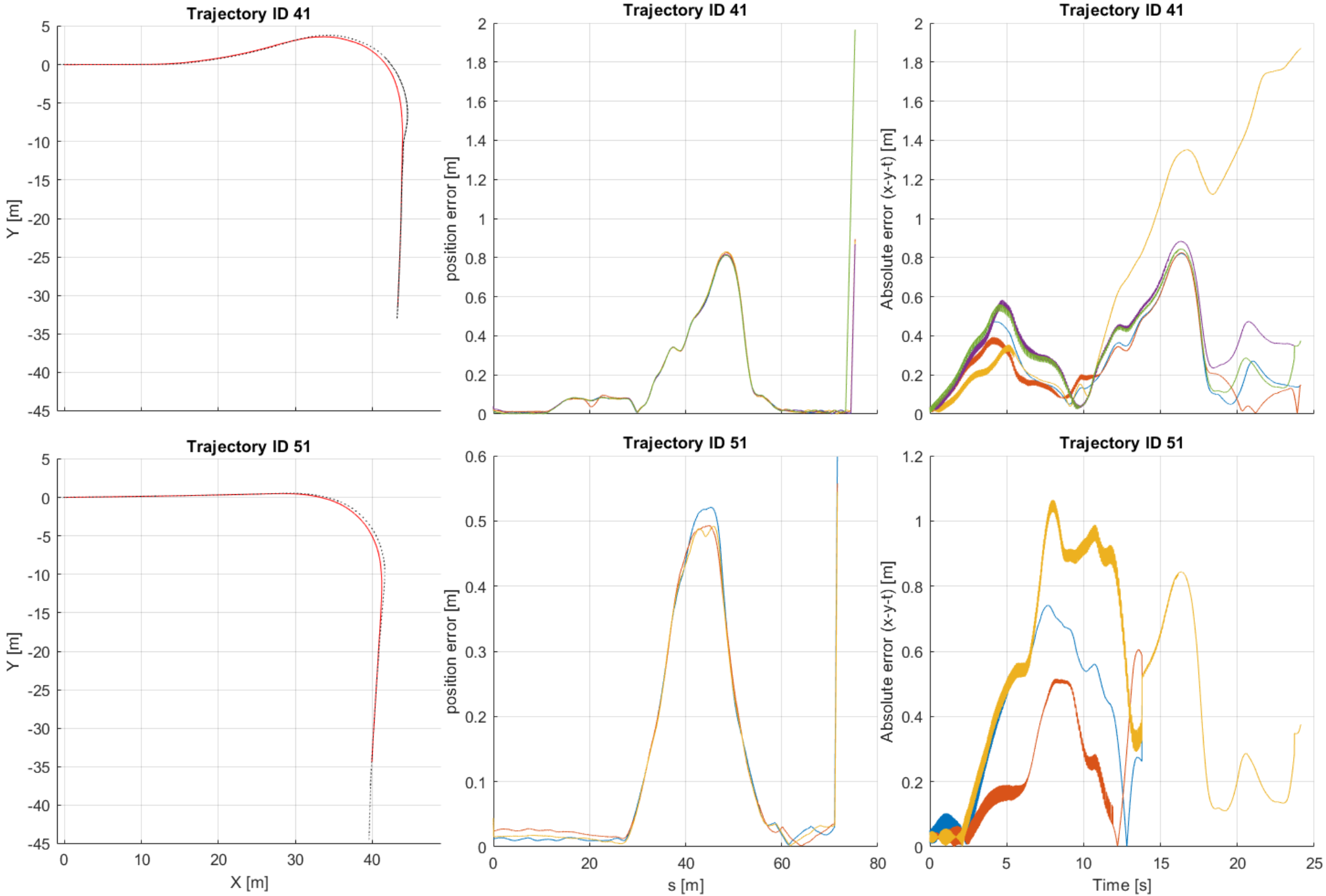

Trajectory ID 11
Absolute error (x-y-t) [m]
1.2
1
0.8
0.6
0.4
0.2


Trajectory ID 21
Y [m]
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
0
10
20
30
40
X [m]


Trajectory ID 21
position error [m]
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
s [m]


Trajectory ID 21
Absolute error (x-y-t) [m]
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
14
Time [s]


Trajectory ID 1
Y [m]
position error [m]
Absolute error (x-y-t) [m]
Trajectory ID 31
X [m]
s [m]
Time [s]


Trajectory ID 41
Y [m]
Trajectory ID 41
position error [m]
Trajectory ID 41
Absolute error (x-y-t) [m]
Trajectory ID 51
Y [m]
X [m]
Trajectory ID 51
position error [m]
s [m]
Trajectory ID 51
Absolute error (x-y-t) [m]
Time [s]

Conclusions – Phase 2

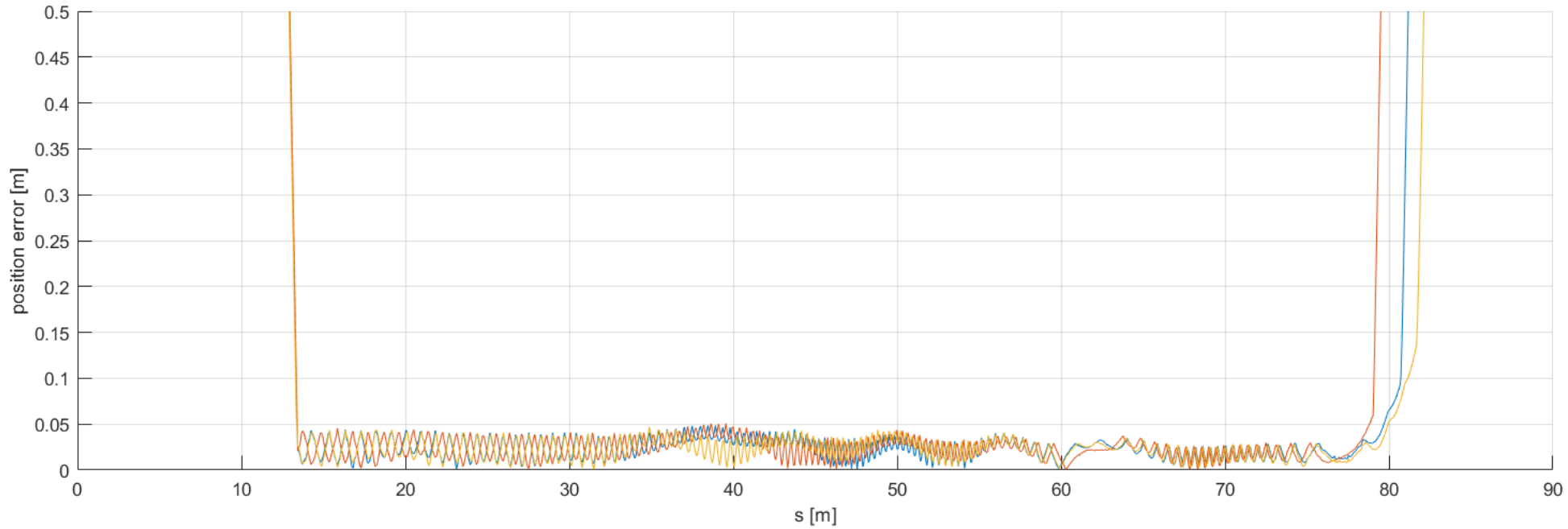
- Results do not look as promising as expected
- Absolute accuracy (including speed profile) in the range of 1.2 m

- Questions for next phase
  - Is this sufficient?
  - Will this improve with dummy synchronisation?

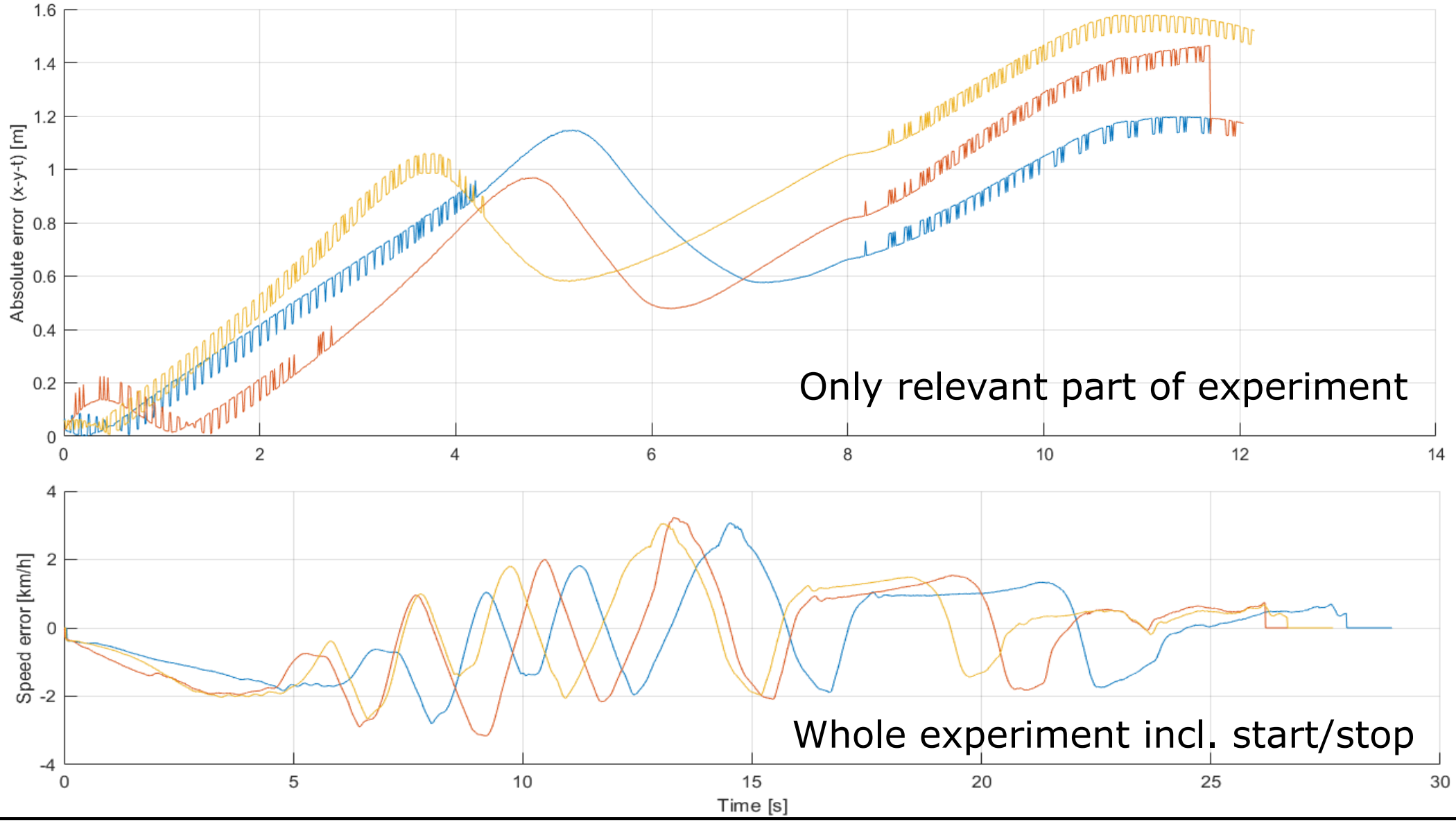
Phase 2b

- Goal: Record and replay trajectories
- Trajectories recorded **with the exact same vehicle**
- With what accuracy can they be replayed (place and time/velocity)?

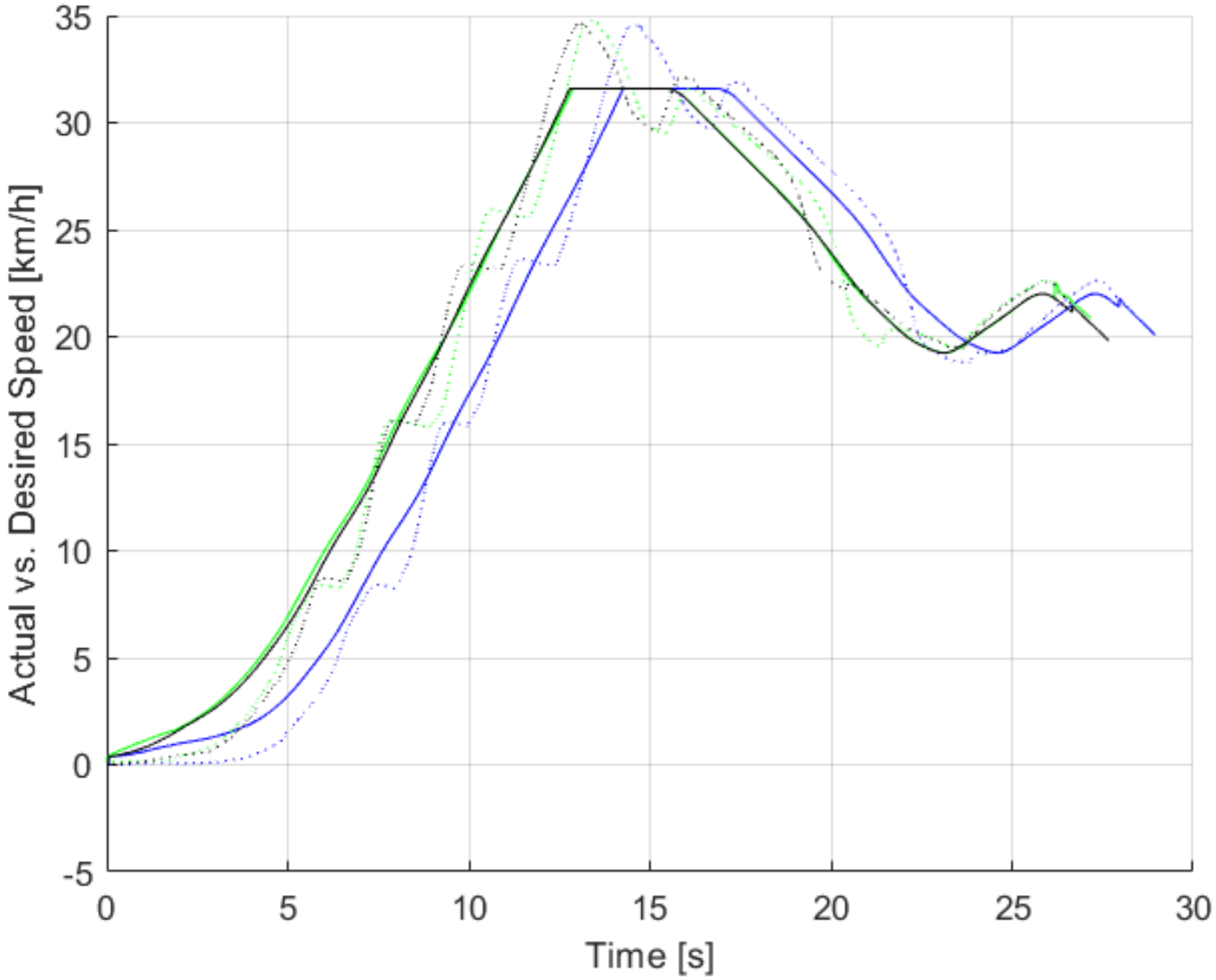
Position accuracy is far better: **approx. 5 cm!**



Absolute and speed accuracy



Actual vs. Desired Speed



Conclusions – Phase 2b

- Position accuracy becomes quite well when same vehicle is used for record and replay (→ 5 cm)
- Absolute accuracy (including speed profile) still in the range of 1.2 m
- Major source of inaccuracy is speed control!

- Option a) Record trajectory and replay only path with constant speed
- Option b) Further investigate speed control of robots