Exhaustive Gait Plots

The following MATLAB Live Script includes the exhaustive individual plots for a total of 49 experiments performed on the orange 4-limbed robot on the black mat. Each experimental gait test is accompanied by the following individual plots: (1) experimental gait trajectory with arrows representing the global robot orientation, (2) twist components w.r.t. both time and global robot orientation, (3) instantaneous center of rotation, and (4) radius of curvature over time.

Extract and define parameters for GaitTest() objects.

From 20220707 Experiments:

Gait B-120 [heavy - not following (restting) - left/up]

Gait E-120 [heavy - not following - left/up]

Gait E-60 [heavy - not following - left/up]

Gait E-60* [heavy - not following - right/up] Caution! Not real E gait! Limb A not actuating

From 20220819 Experiments:

Gait B-120 [light sheath - not following (restting) - right/up]

From 20220829 Experiments:

Gait B Follow (Left)* [light sheath - following - left] Caution! Not real B gait! Limb A not actuating

Gait B Follow (Right)* [light sheath - following - right] Caution! Not real B gait! Limb A not actuating

Gait E Left (sheath on) [light sheath - not following - left]

Gait E Right (sheath on) [no sheath - not following - right]

Gait E Left (sheath off) [no sheath - not following - left]

Gait E Right (sheath off)* [no sheath - not following - right] Caution! Not real E gait! Limb B not actuating

From 20220901 Experiments:

Gait E Left (sheath off) [no sheath - not following - left (flipped)]

Gait B Follow (Left) Trial 1 [light sheath - following - left]

Gait B Follow (Left) Trial 2 [light sheath - following - left (flipped)]

Gait B Left (Sheath on) Trial 1 [light sheath - not following - left]

Gait B Left (Sheath on) Trial 2 [light sheath - not following - left (flipped)]

From 20220908 Experiments:

Gait B Right (sheath on) [sheath - not following - right] (not consistent / semi-following)

Gait B Right Follow (sheath off) Trial 1 [no sheath - following - right]

Gait B Right Follow (sheath off) Trial 2 [no sheath - following - right]

Gait B Left Follow (sheath off) Trial 1 [no sheath - following - left]

Gait B Left Follow (sheath off) Trial 2 [no sheath - following - left]

Gait B Right (sheath off) Trial 1 [no sheath - not following - right] (not consistent / semi-following)

Gait B Right (sheath off) Trial 2 [no sheath - not following - right] (not consistent / semi-following)

Gait B Left (sheath off) Trial 1 [no sheath - not following - left] (not consistent / semi-following)

Gait B Left (sheath off) Trial 2 [no sheath - not following - left] (not consistent / semi-following)

Gait B Right Follow (sheath on) [sheath - following - right]

Gait E Right (sheath off) Trial 1 [no sheath - not following - right] (not consistent / semi-following)

Gait E Right (sheath off) Trial 2 [no sheath - not following - right] (not consistent / semi-following)

Gait E Left (sheath off) Trial 1 [no sheath - not following - left] (not consistent / semi-following)

Gait E Left (sheath off) Trial 2 [no sheath - not following - left] (not consistent / semi-following)

From 20220928 Experiments:

Gait B Left AWG 32 Trial 1 [AWG 32 sheath - not following - left]

Gait B Left AWG 32 Trial 2 [AWG 32 sheath - not following - left]

Gait B Right AWG 32 Trial 1 [AWG 32 sheath - not following - right]

Gait B Right AWG 32 Trial 2 [AWG 32 sheath - not following - right]

Gait B Right AWG 32 Trial 1 [AWG 32 slip ring - not following - right]

Gait B Right AWG 32 Trial 2 [AWG 32 slip ring - not following - right]

From 20221018 Experiments:

Gait F Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]

Gait F Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]

Gait G Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]

Gait G Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]

From 20221102 Experiments:

Gait G Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - right]

Gait G Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - right]

Gait B Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]

Gait B Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - right]

Gait H Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]

Gait H Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]

Gait H Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - right]

Gait H Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - right]

Gait F Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - right]

Gait F Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - right]

Build Experiment Matrix:

	Experiment	Gait	#Cycles	Tether	Protocol	Placement	Trial
1	31	**'B'**	'60'	'32'	'NF'	'L'	1
2	32	**'B'**	'60'	'32'	'NF'	'L'	2
3	33	**'B'**	'60'	'32'	'NF'	'R'	1
4	34	**'B'**	'60'	'32'	'NF'	'R'	2
5	42	**'B'**	'60'	'32SR'	'NF'	'L'	1
6	43	**'B'**	'60'	'32SR'	'NF'	'R'	1
7	35	**'B'**	'60'	'32SR1'	'NF'	'R'	2
8	1	**'B'**	'120'	'H'	'NF'	'L'	1
9	20	**'B'**	'60'	'NS'	'F'	'L'	1
10	21	**'B'**	'60'	'NS'	'F'	'L'	2
11	18	**'B'**	'60'	'NS'	'F'	'R'	1
12	19	**'B'**	'60'	'NS'	'F'	'R'	2
13	24	**'B'**	'60'	'NS'	'NF'	'L'	1
14	25	**'B'**	'60'	'NS'	'NF'	'L'	2
15	22	**'B'**	'60'	'NS'	'NF'	'R'	1
16	23	**'B'**	'60'	'NS'	'NF'	'R'	2
17	13	**'B'**	'60'	'S'	'F'	'L'	1
18	14	**'B'**	'60'	'S'	'F'	'Lf'	1
19	26	**'B'**	'60'	'S'	'F'	'R'	1

	Experiment	Gait	#Cycles	Tether	Protocol	Placement	Trial
20	15	**'B'**	'60'	'S'	'NF'	'L'	1
21	16	**'B'**	'60'	'S'	'NF'	'Lf'	1
22	5	**'B'**	'120'	'S'	'NF'	'R'	1
23	17	**'B'**	'60'	'S'	'NF'	'R'	1
24	6	**'Bs'**	'60'	'S'	'F'	'L'	1
25	7	**'Bs'**	'60'	'S'	'F'	'R'	1
26	2	**'E'**	'120'	'H'	'NF'	'L'	1
27	3	**'E'**	'60'	'H'	'NF'	'L'	1
28	10	**'E'**	'60'	'NS'	'NF'	'L'	1
29	29	**'E'**	'60'	'NS'	'NF'	'L'	2
30	30	**'E'**	'60'	'NS'	'NF'	'L'	3
31	12	**'E'**	'60'	'NS'	'NF'	'Lf'	1
32	27	**'E'**	'60'	'NS'	'NF'	'R'	1
33	28	**'E'**	'60'	'NS'	'NF'	'R'	2
34	8	**'E'**	'60'	'S'	'NF'	'L'	1
35	9	**'E'**	'60'	'S'	'NF'	'R'	1
36	4	**'Es'**	'60'	'H'	'NF'	'R'	1
37	11	**'Es'**	'60'	'NS'	'NF'	'R'	1
38	36	**'F'**	'60'	'32SR'	'NF'	'L'	1
39	37	**'F'**	'60'	'32SR'	'NF'	'L'	2
40	48	**'F'**	'60'	'32SR'	'NF'	'R'	1
41	49	**'F'**	'60'	'32SR'	'NF'	'R'	2
42	38	**'G'**	'60'	'32SR'	'NF'	'L'	1
43	39	**'G'**	'60'	'32SR'	'NF'	'L'	2
44	40	**'G'**	'60'	'32SR'	'NF'	'R'	1
45	41	**'G'**	'60'	'32SR'	'NF'	'R'	2
46	44	**'H'**	'60'	'32SR'	'NF'	'L'	1
47	45	**'H'**	'60'	'32SR'	'NF'	'L'	2
48	46	**'H'**	'60'	'32SR'	'NF'	'R'	1
49	47	**'H'**	'60'	'32SR'	'NF'	'R'	2

Key

Tether: '32' = AWG 32, '32SR' = AWG 32 with slip ring, '32SR1' = AWG 32 with old slip ring, 'H' = old heavy sheath, 'NS' = no sheath, 'S' = light sheath

Protocol: 'NF' = tether not following robot movement, 'F' = tether following robot movement

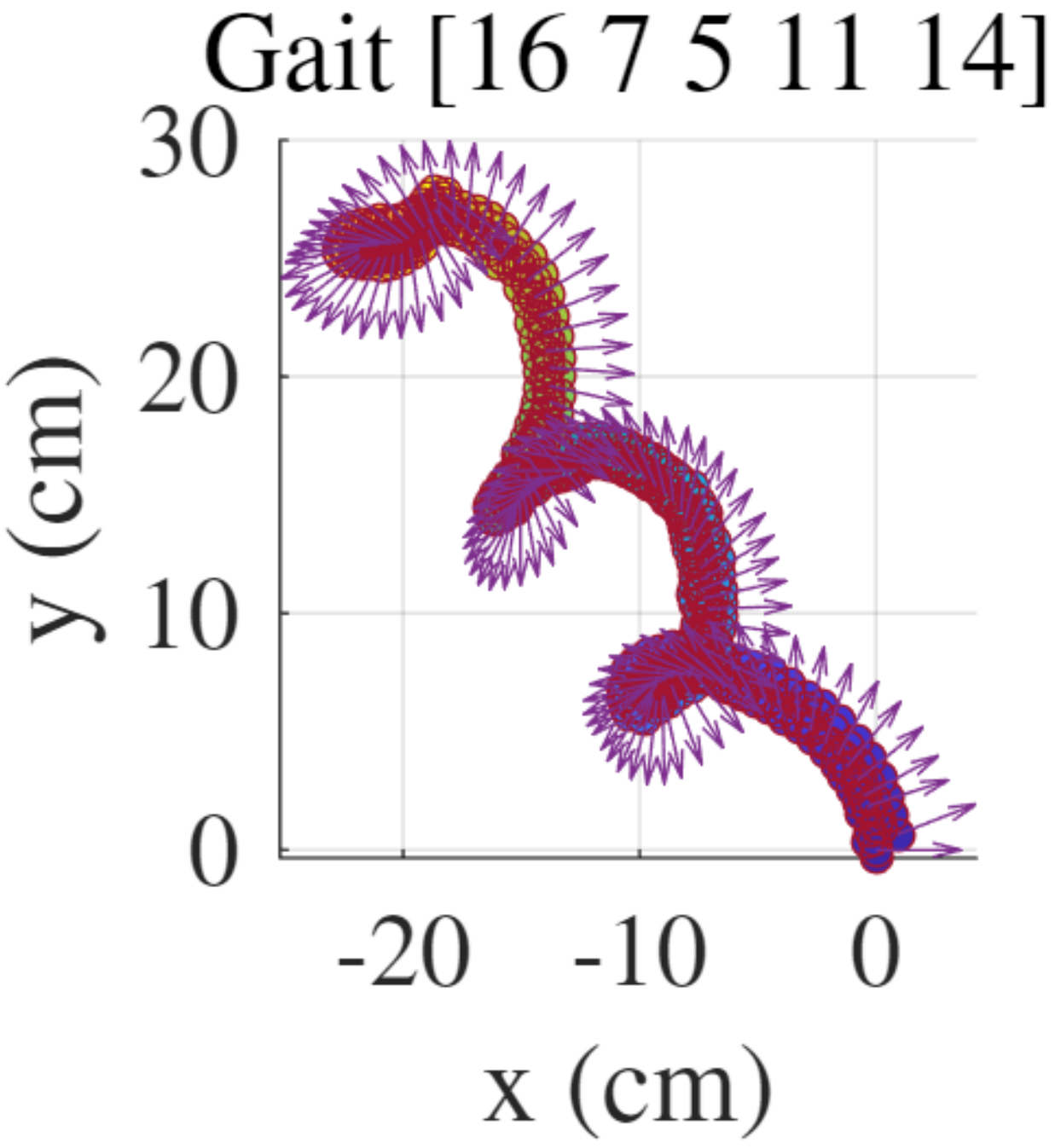
Placement: 'L' = tether positioned to left of robot, 'R' = tether positioned to right of robot

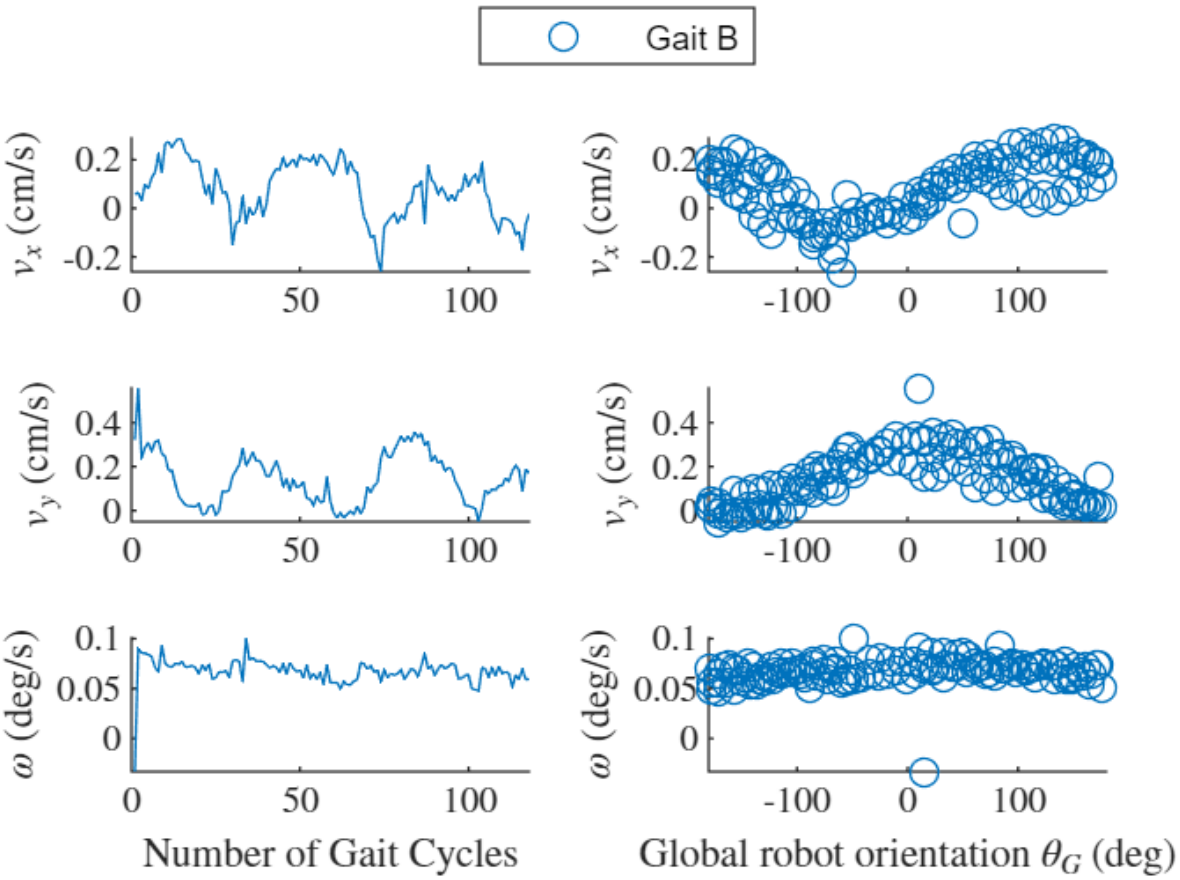
Analyze the experiment data:

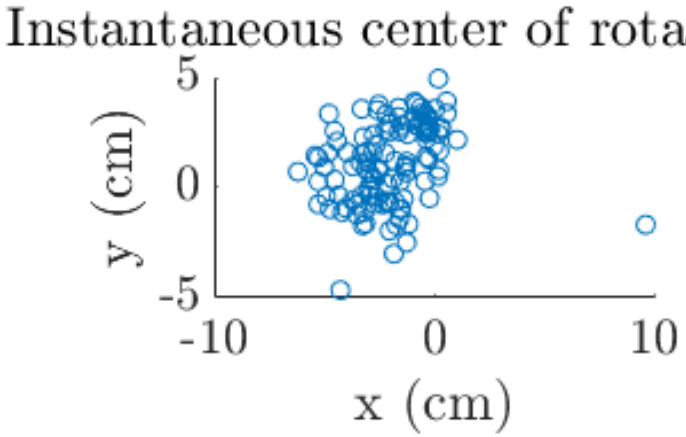
1. Rotate the data w.r.t. the initial global orientation.
2. Instantiate GaitTest() objects for each experimental trial.
3. Calculate twists for each gait experiment.

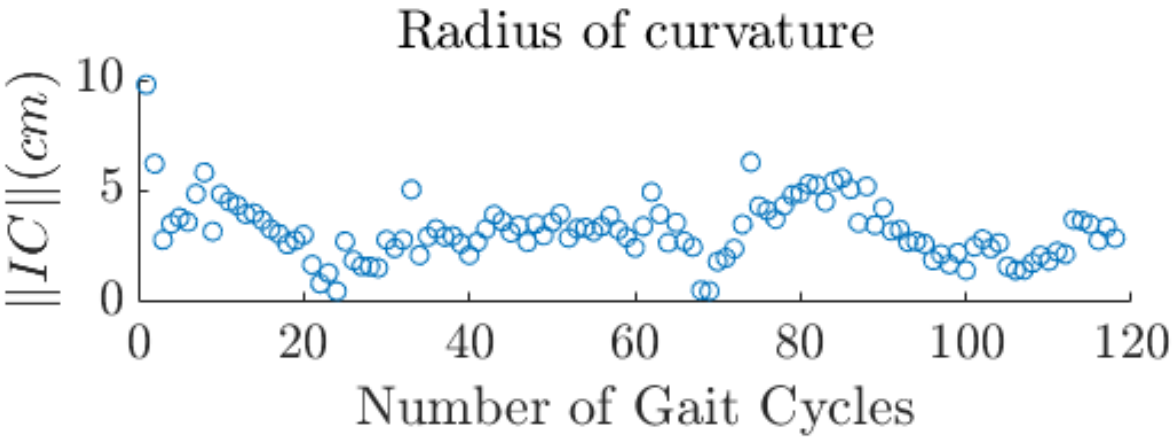
Make exhaustive plots for each experiment.

Experiment 1: 120 cycles of Gait B with heavy sheath tether (left , not following), trial 1

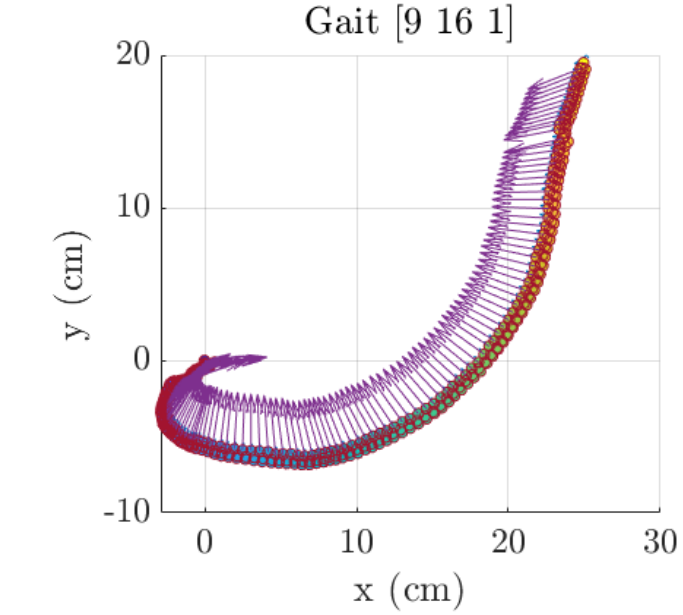


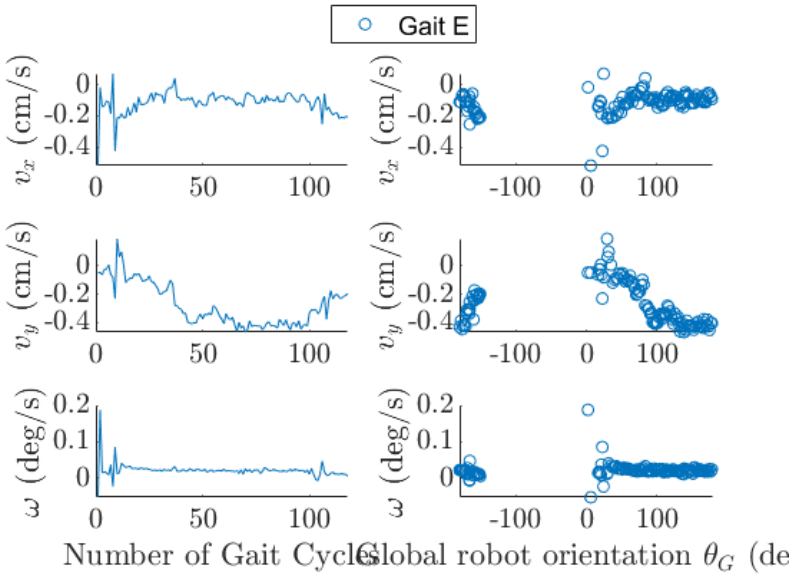

Gait B
v_x (cm/s)
v_y (cm/s)
ω (deg/s)
Number of Gait Cycles
Global robot orientation θ_G (deg)

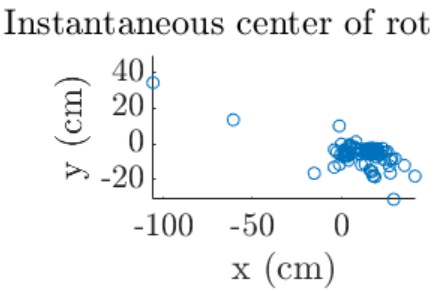

Instantaneous center of rotation IC
y (cm)
x (cm)

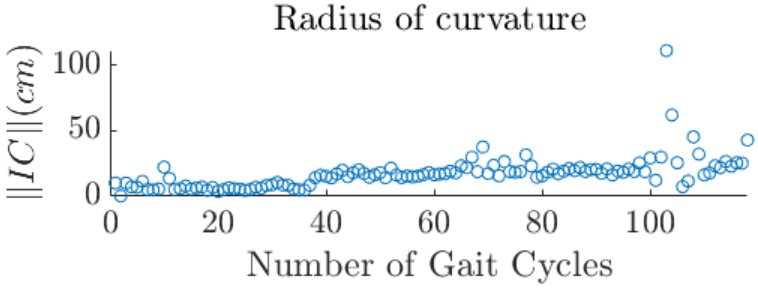

Radius of curvature
$\|IC\|(cm)$
Number of Gait Cycles

Experiment 2 : 120 cycles of Gait E with heavy sheath tether (left , not following), trial 1

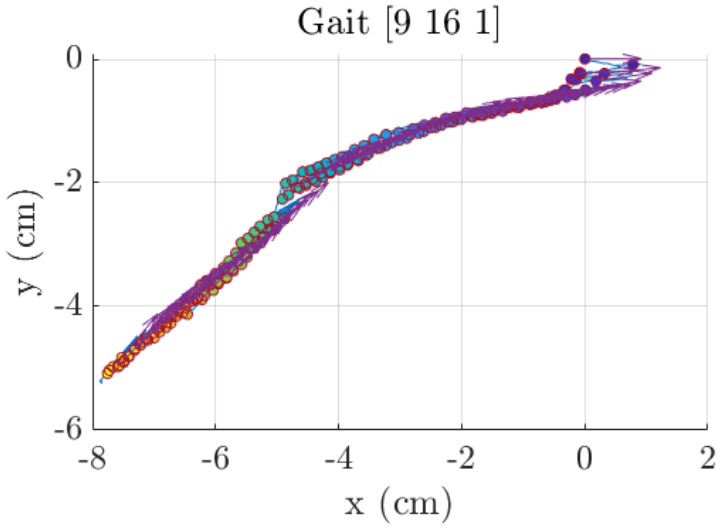


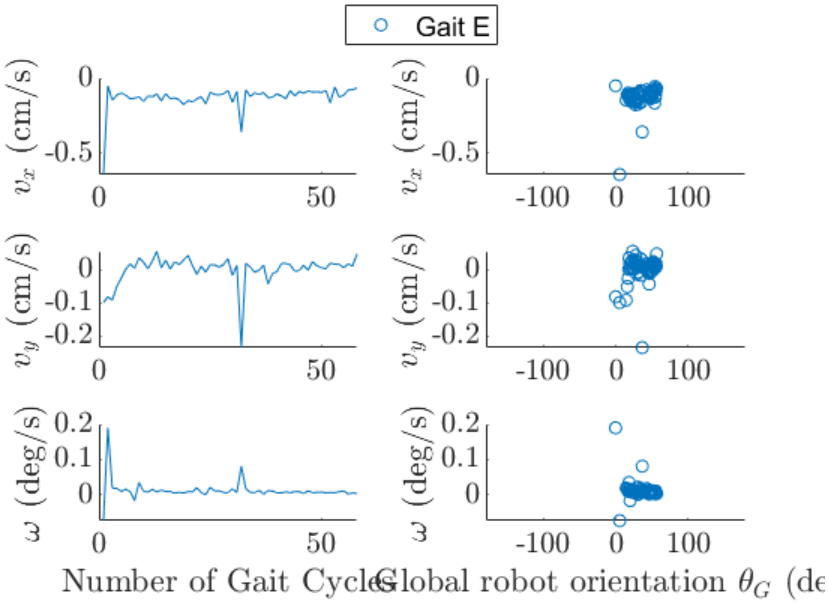


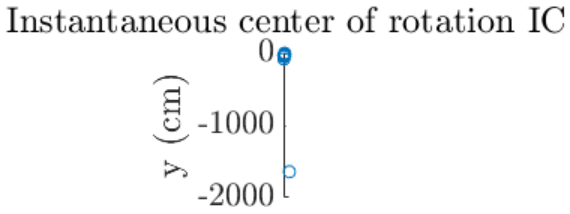


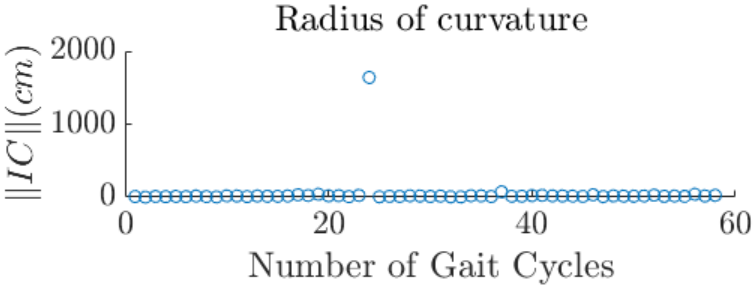


Experiment 3 : 60 cycles of Gait E with heavy sheath tether (left , not following), trial 1

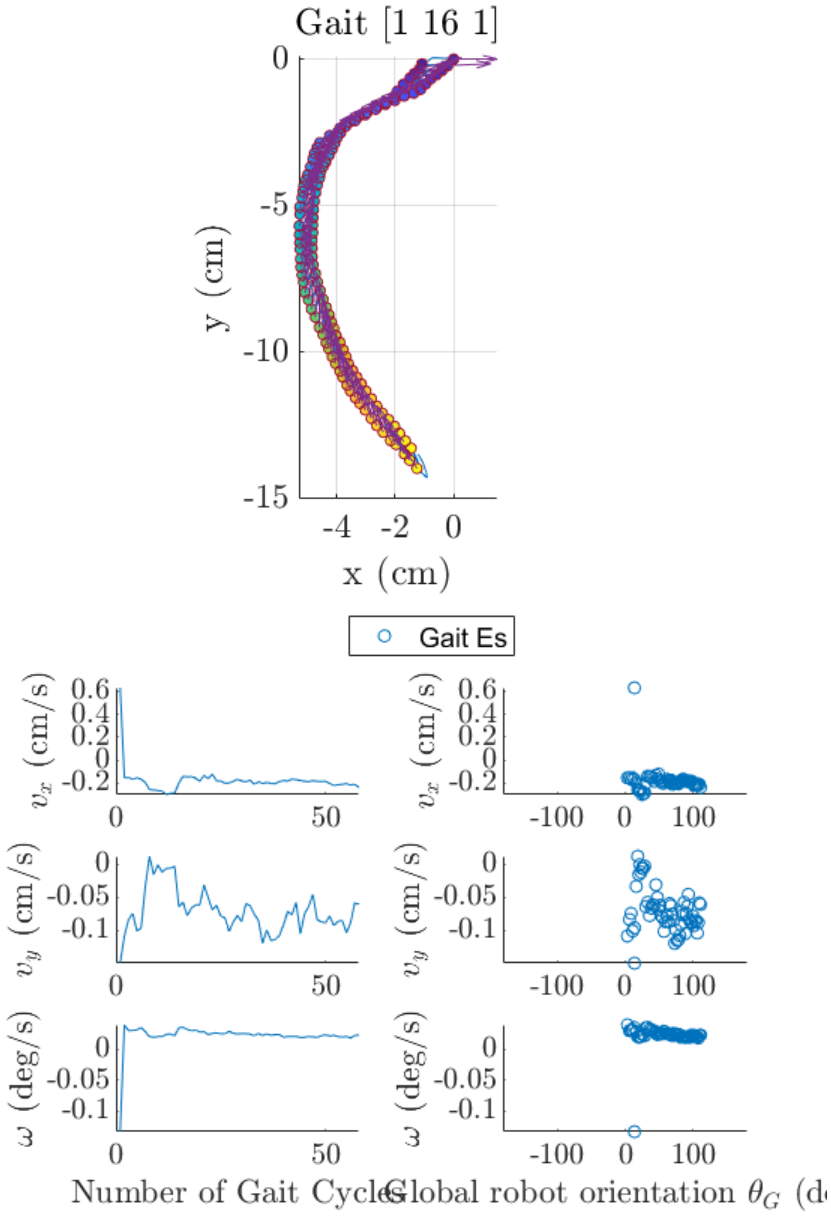


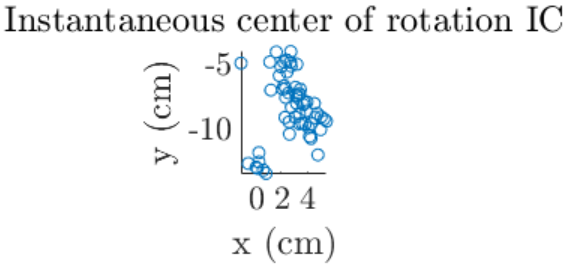


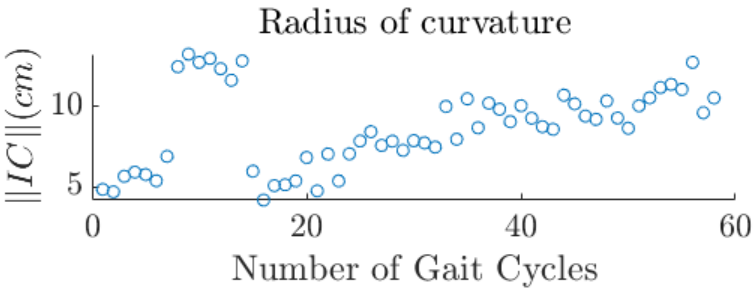




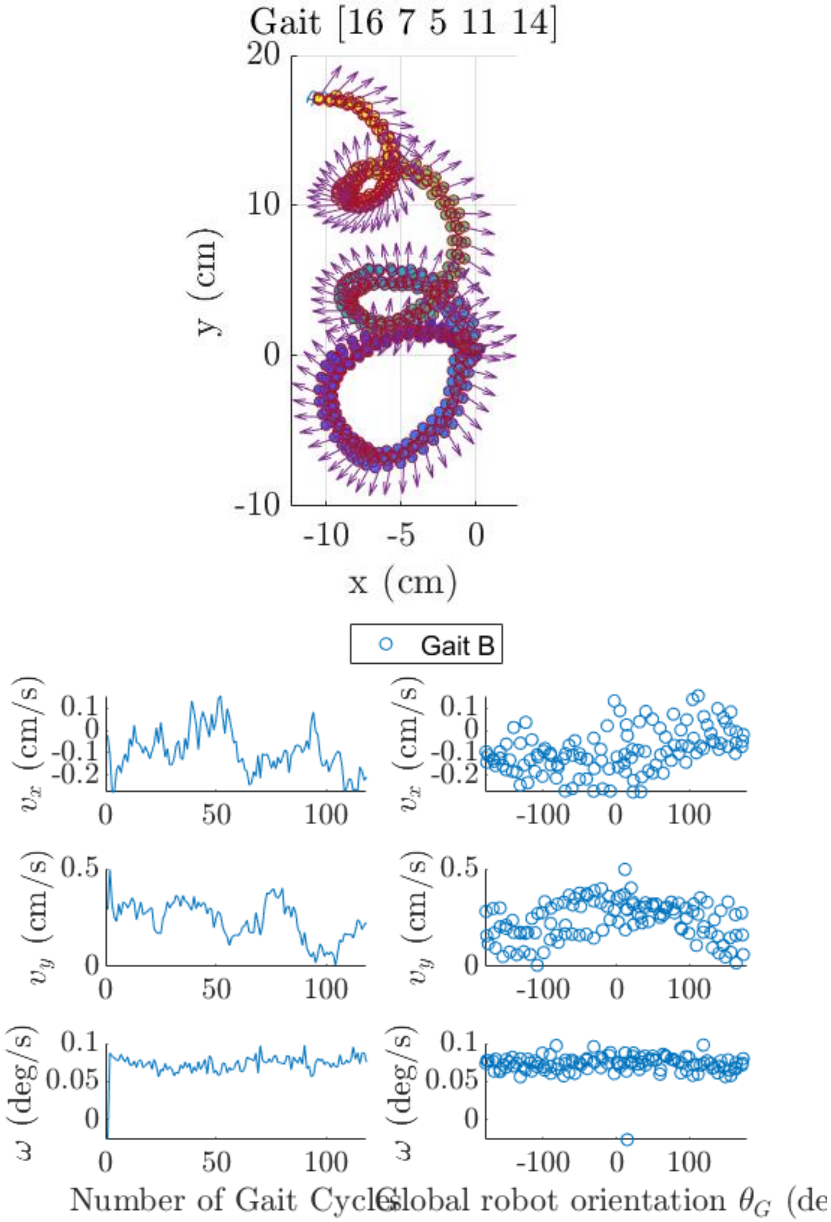
Experiment 4 : 60 cycles of Gait Es with heavy sheath tether (right , not following), trial 1

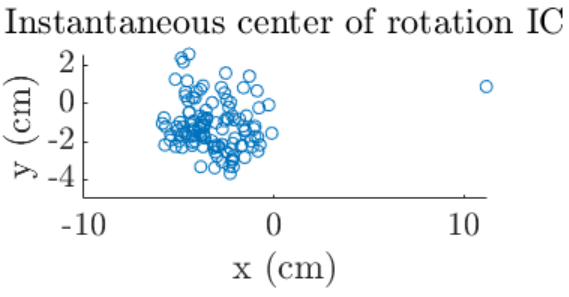


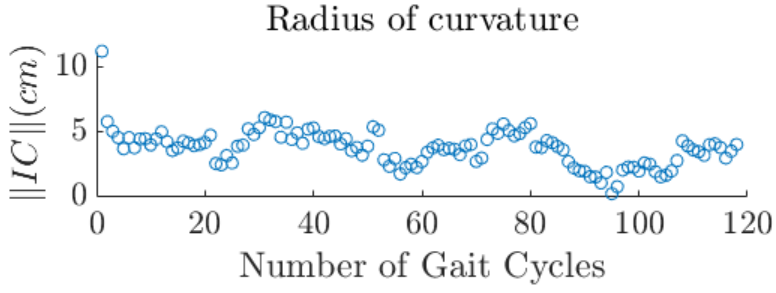




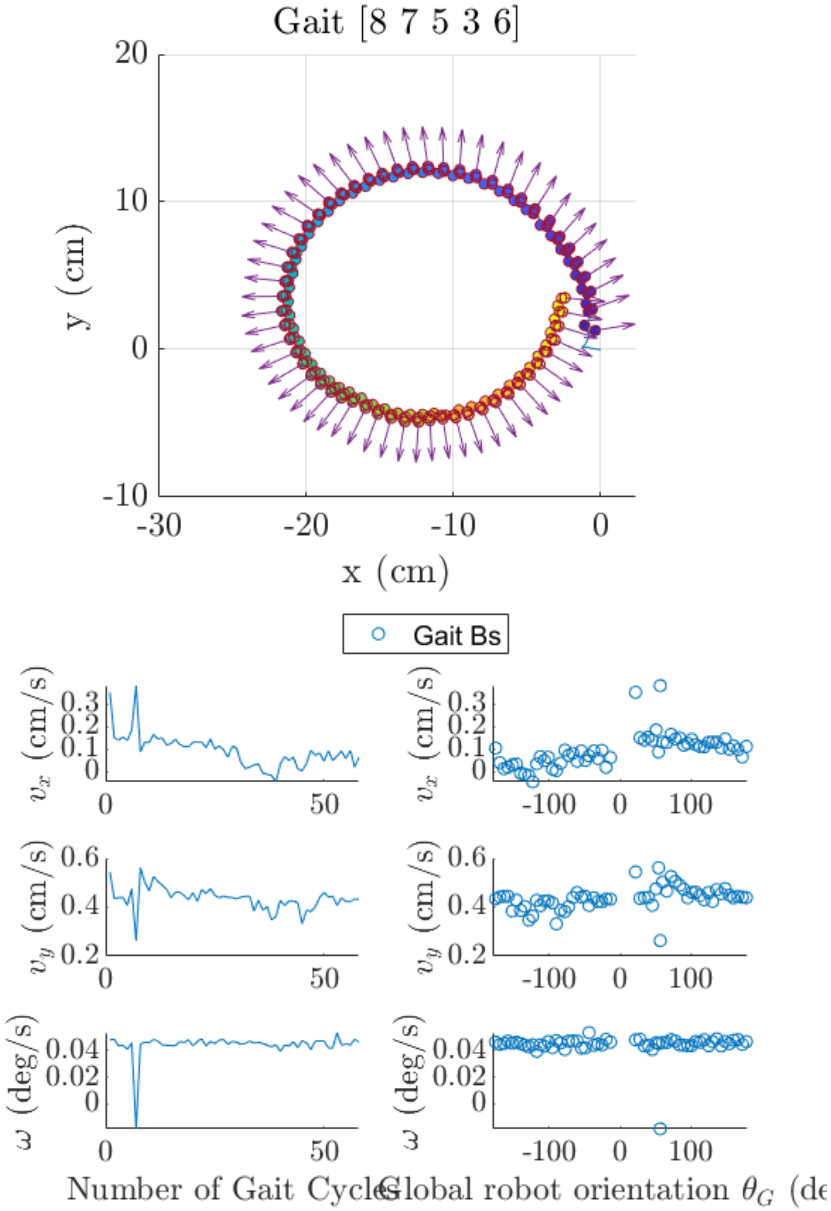
Experiment 5 : 120 cycles of Gait B with light sheath tether (right , not following), trial 1

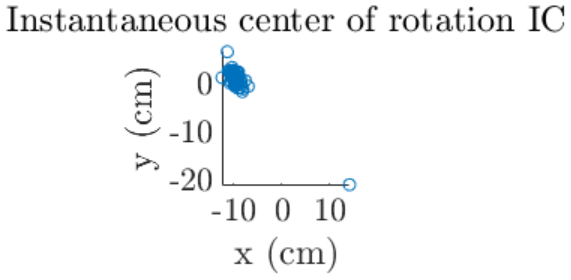


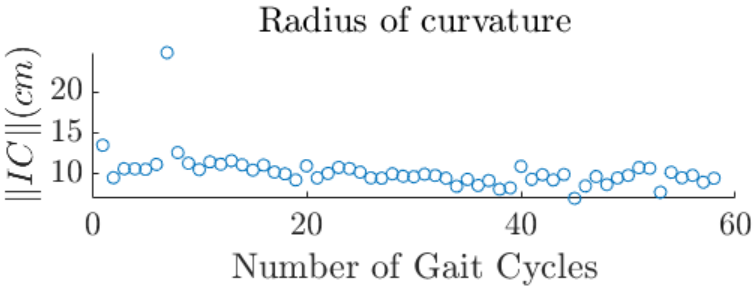




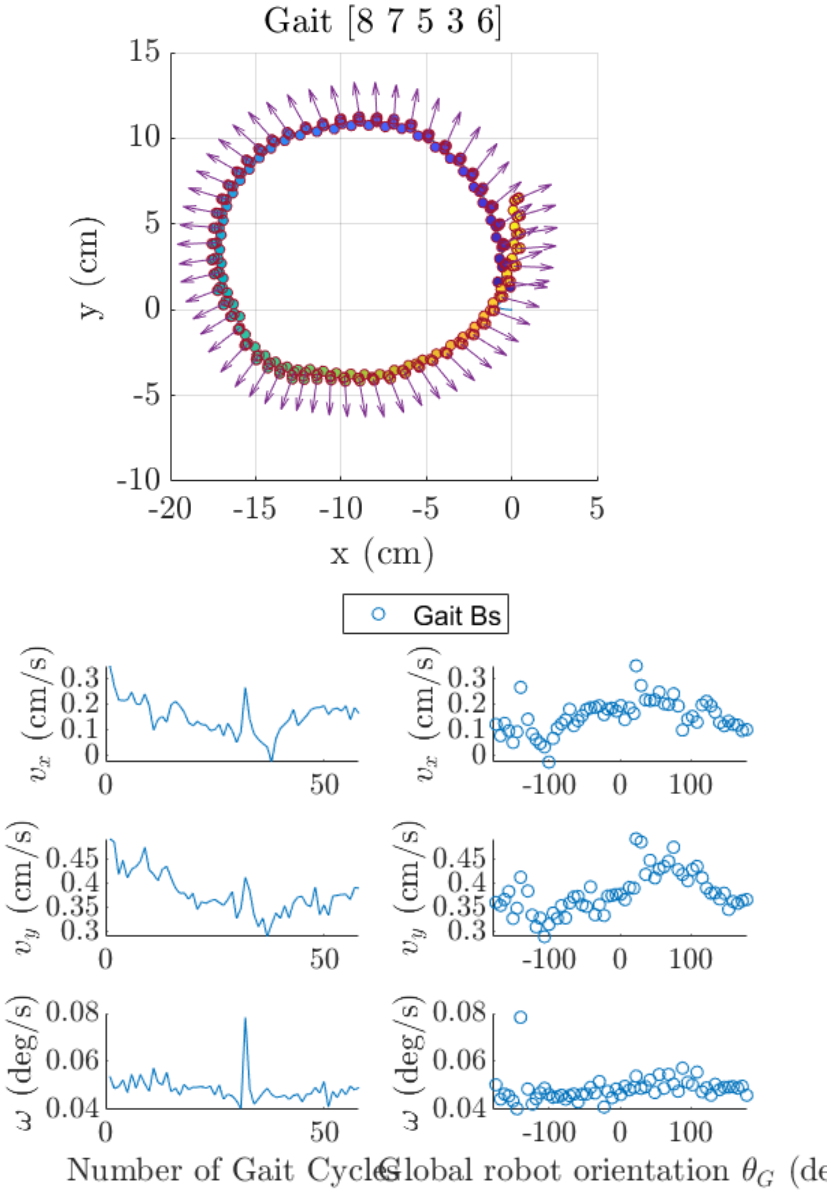
Experiment 6 : 60 cycles of Gait Bs with light sheath tether (left , following), trial 1

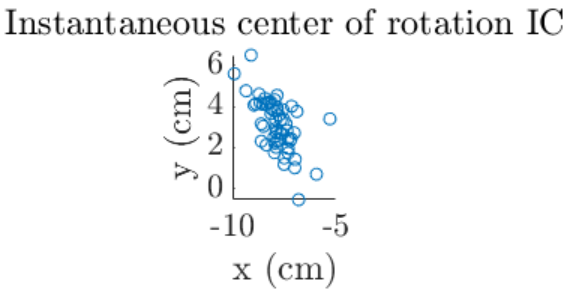


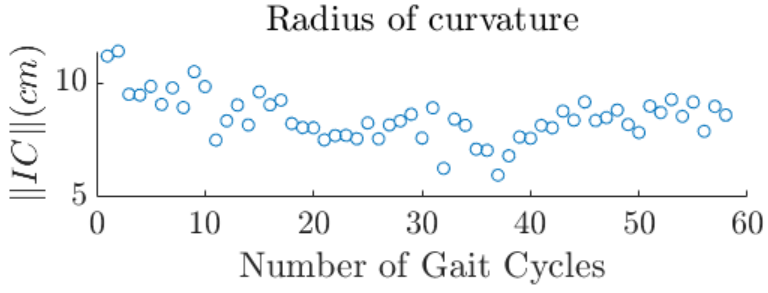




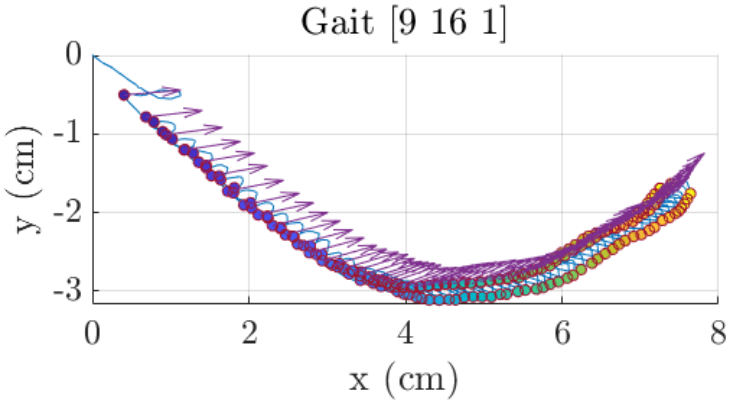
Experiment 7 : 60 cycles of Gait Bs with light sheath tether (right , following), trial 1

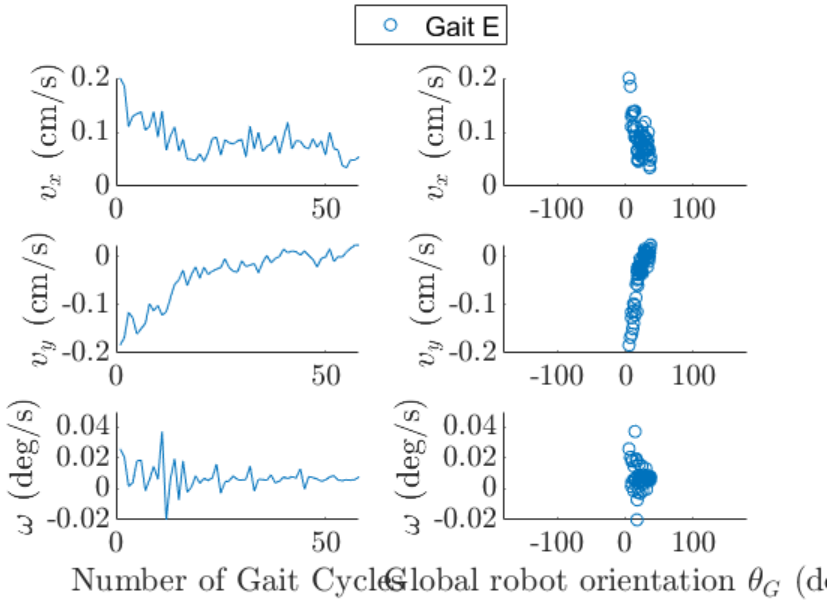


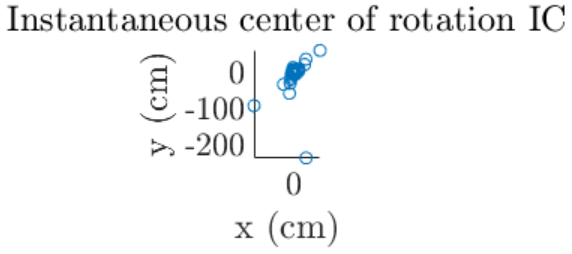


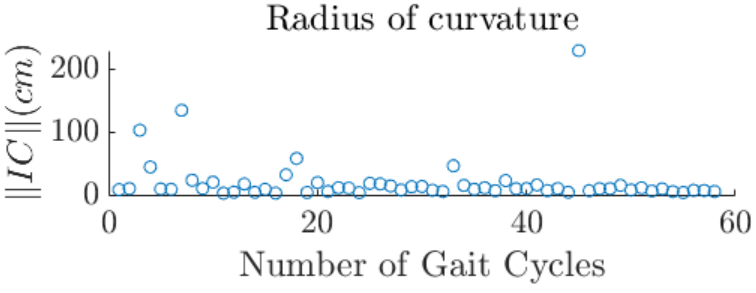


Experiment 8 : 60 cycles of Gait E with light sheath tether (left , not following), trial 1

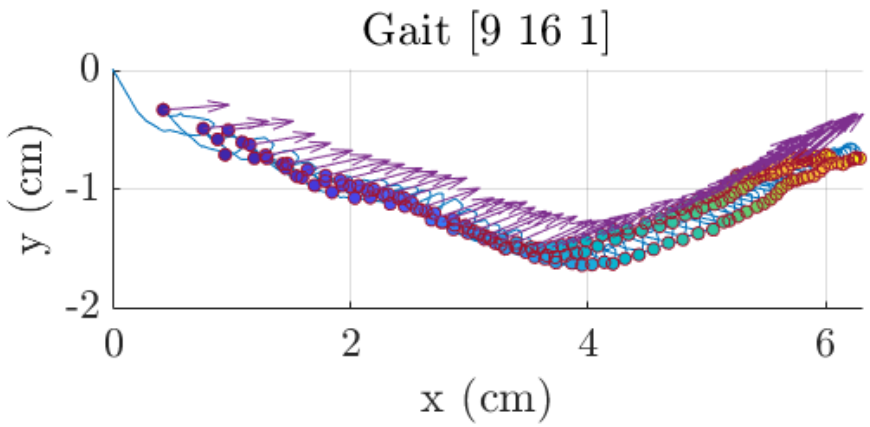


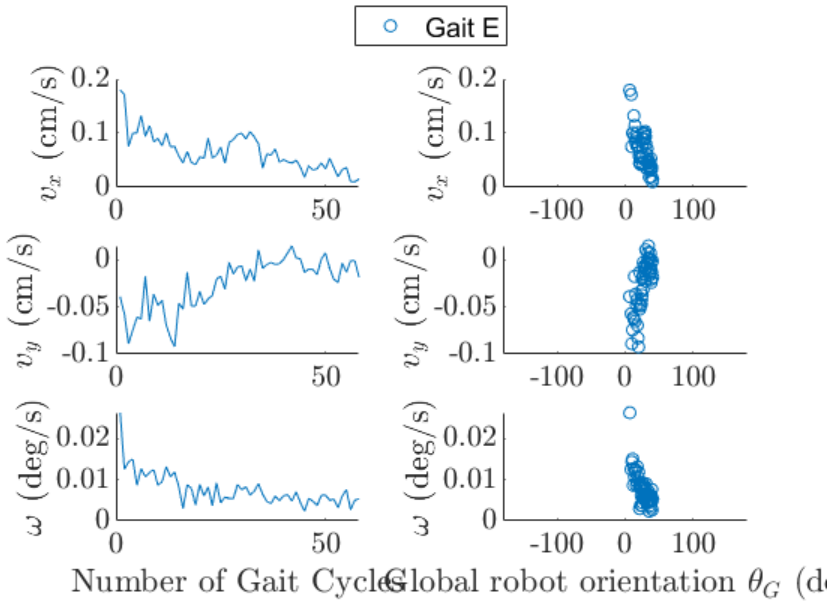


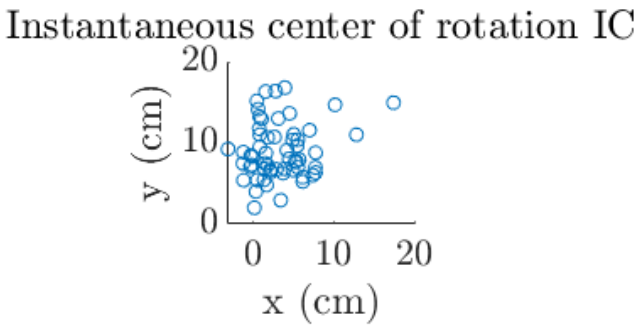


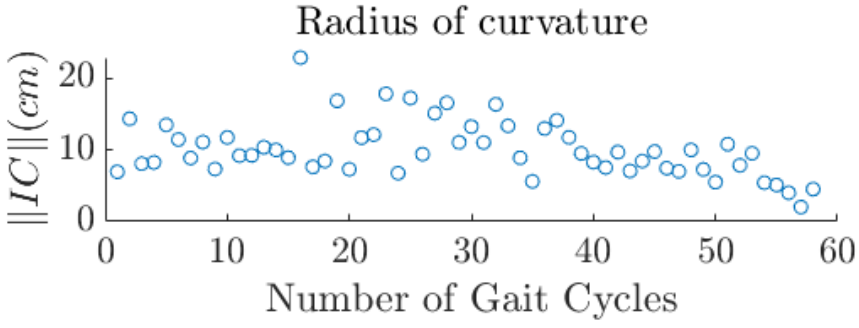


Experiment 9 : 60 cycles of Gait E with light sheath tether (right , not following), trial 1

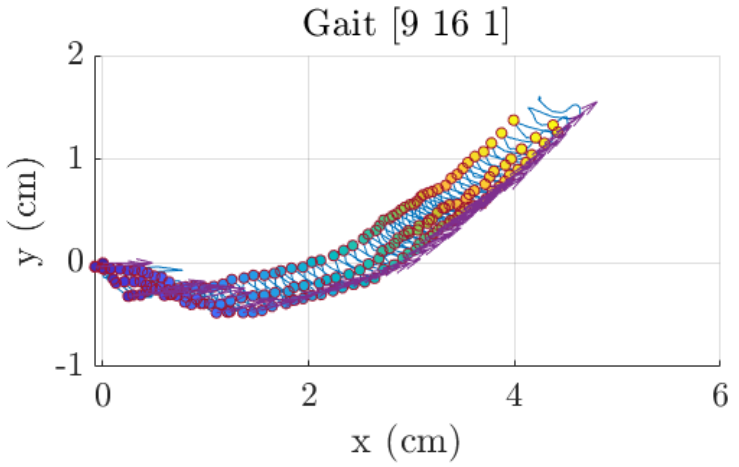


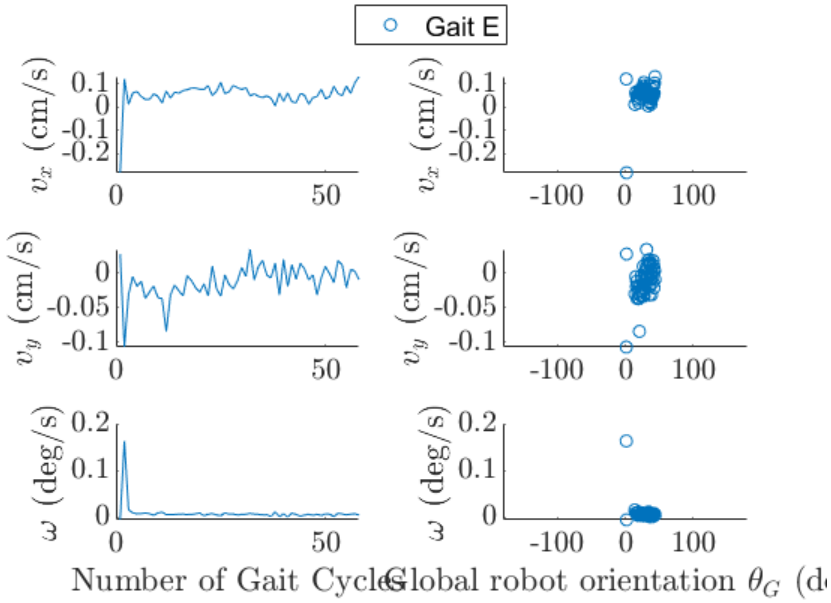


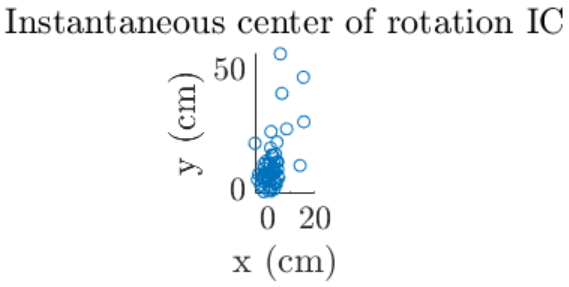


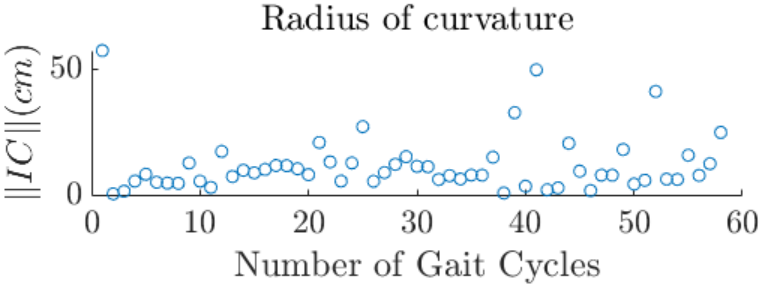


Experiment 10 : 60 cycles of Gait E with no sheath tether (left , not following), trial 1

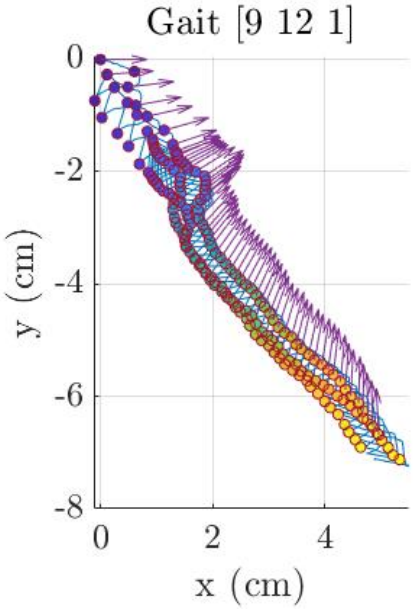


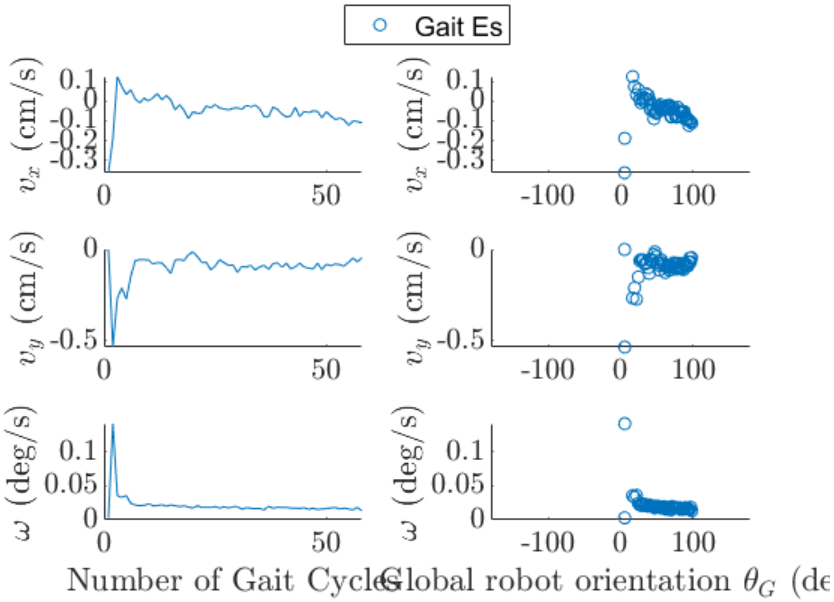


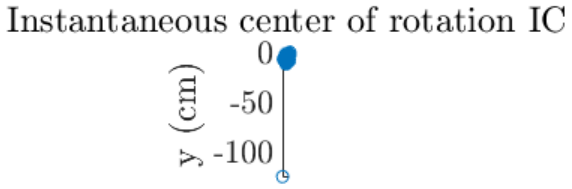


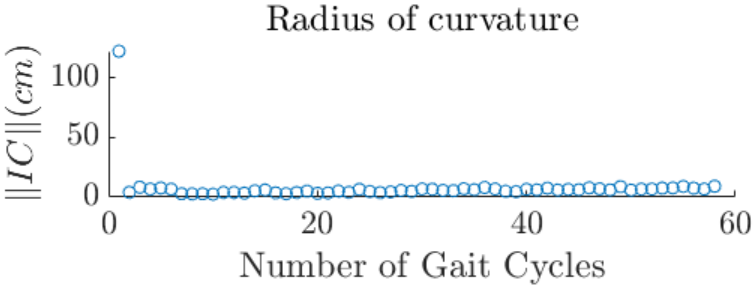


Experiment 11 : 60 cycles of Gait Es with no sheath tether (right , not following), trial 1

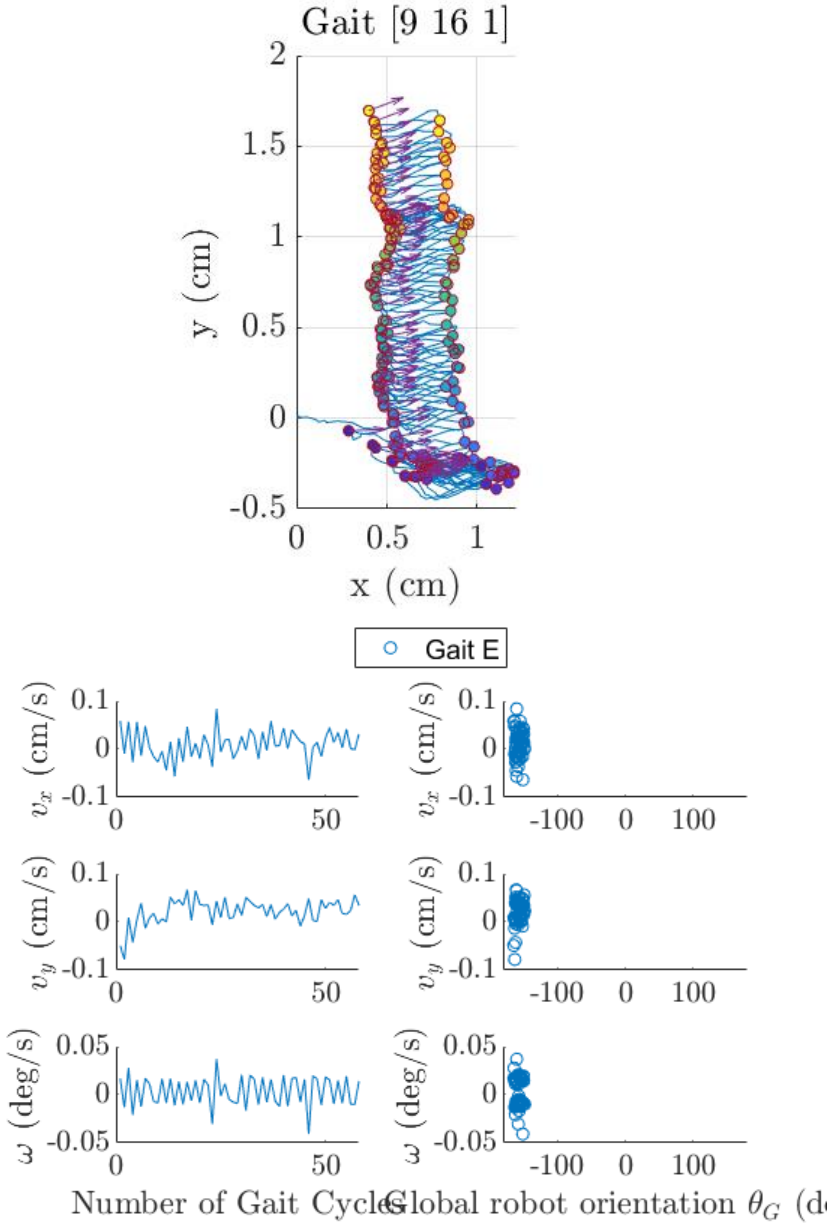


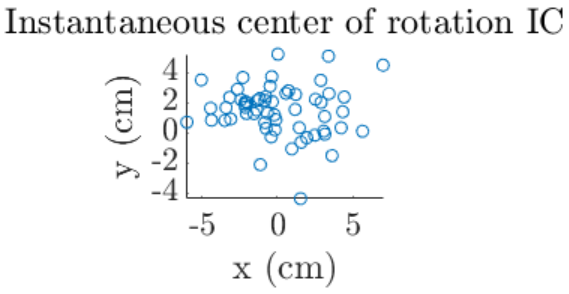


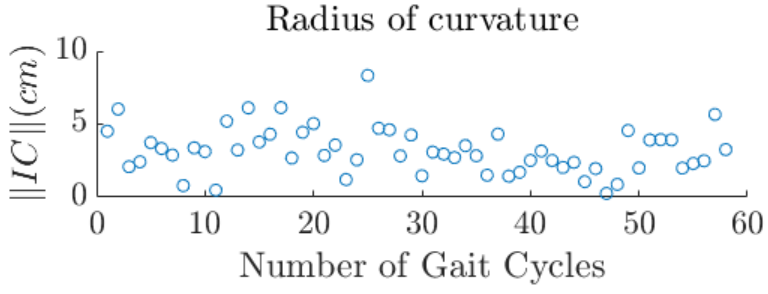




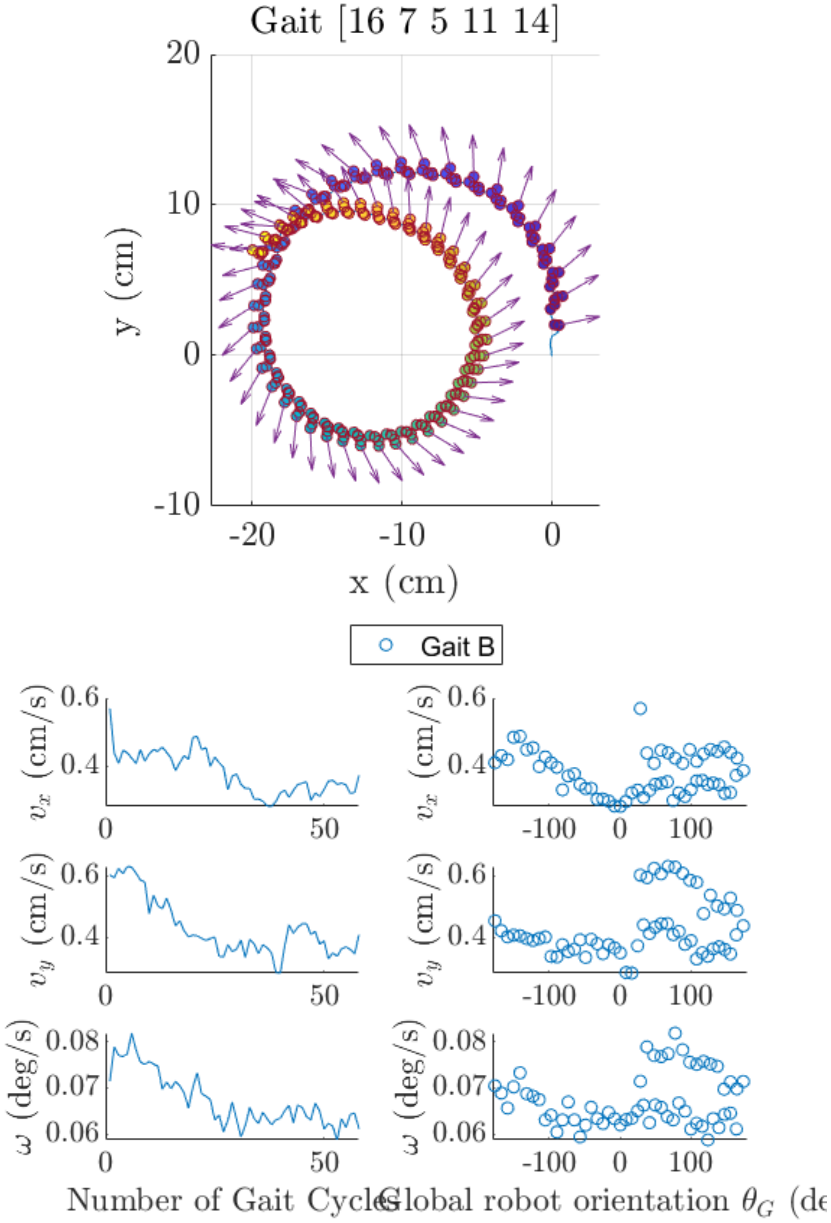
Experiment 12 : 60 cycles of Gait E with no sheath tether (Lf , not following), trial 1

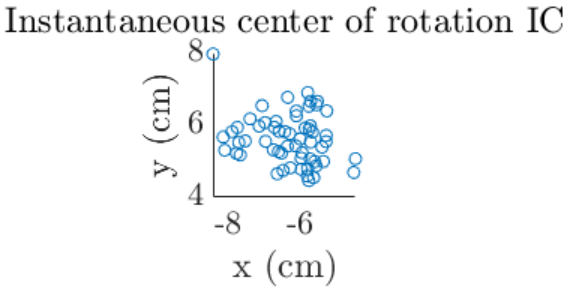


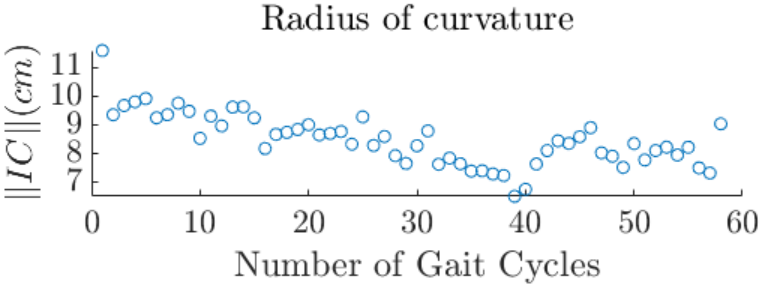




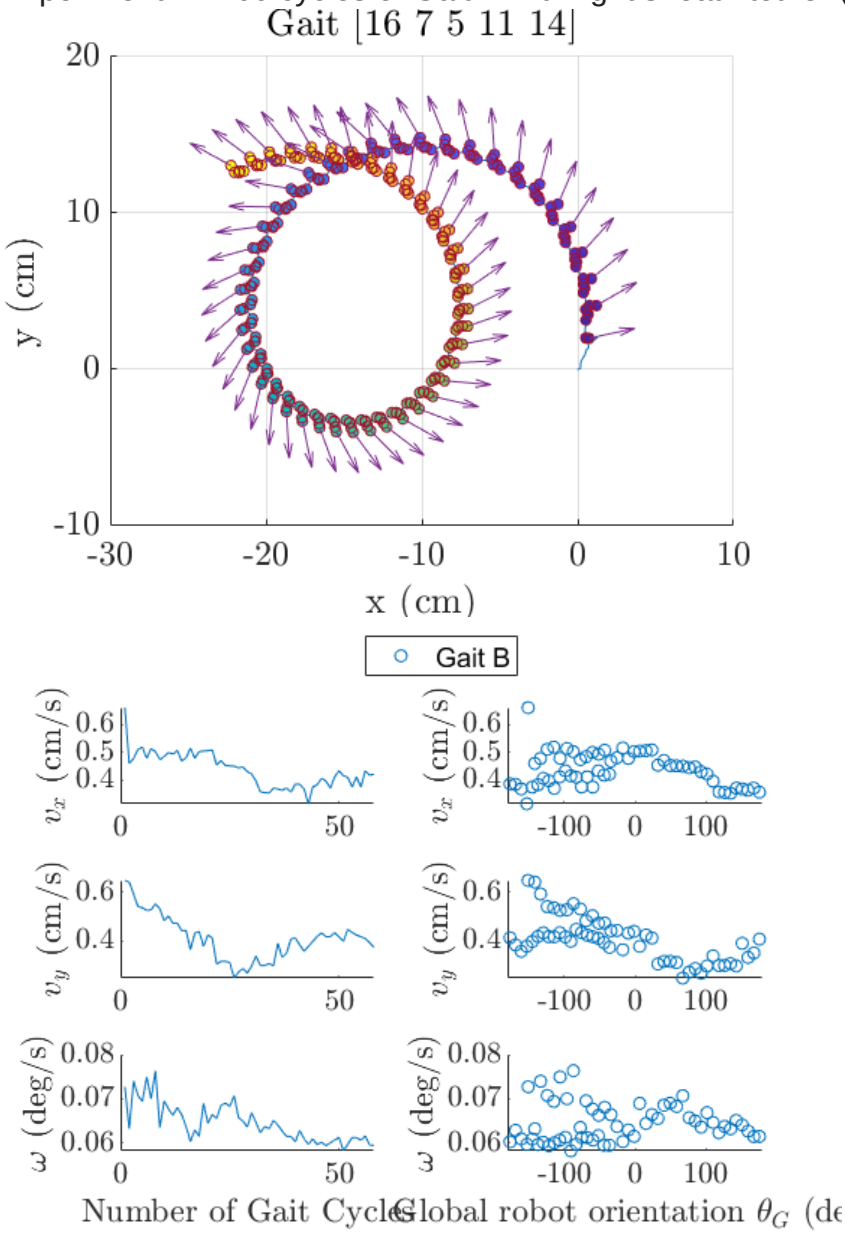
Experiment 13 : 60 cycles of Gait B with light sheath tether (left , following), trial 1

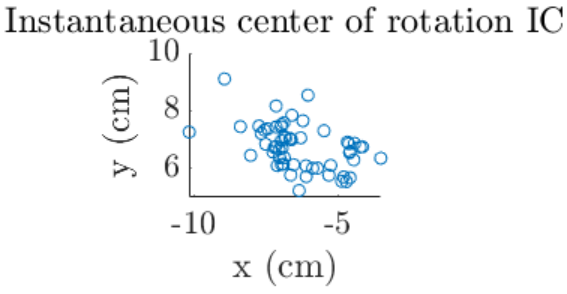


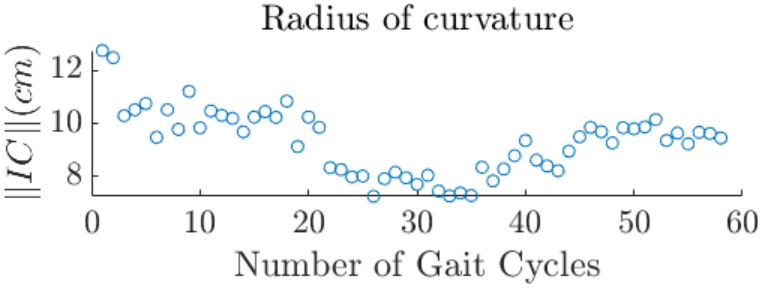




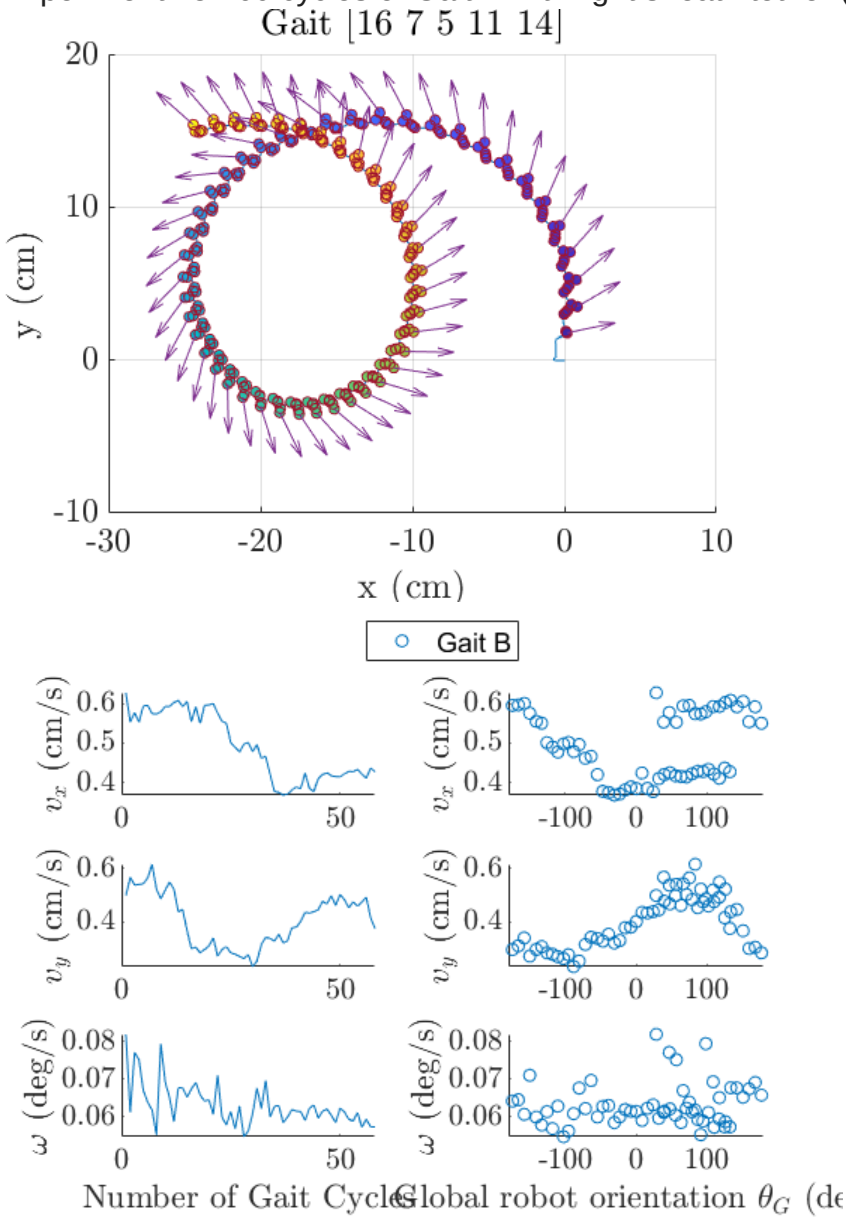
Experiment 14 : 60 cycles of Gait B with light sheath tether (Lf , following), trial 1

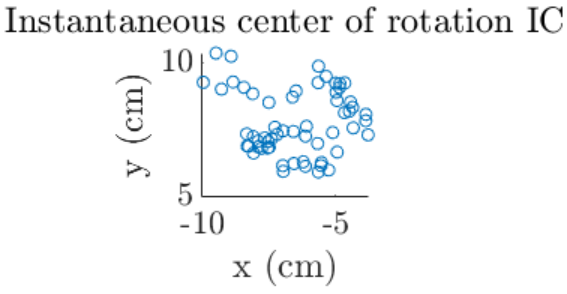


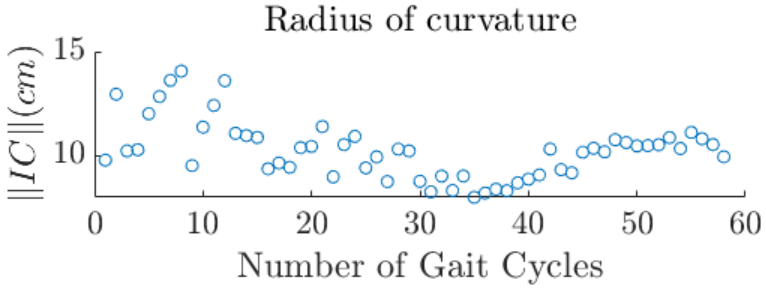




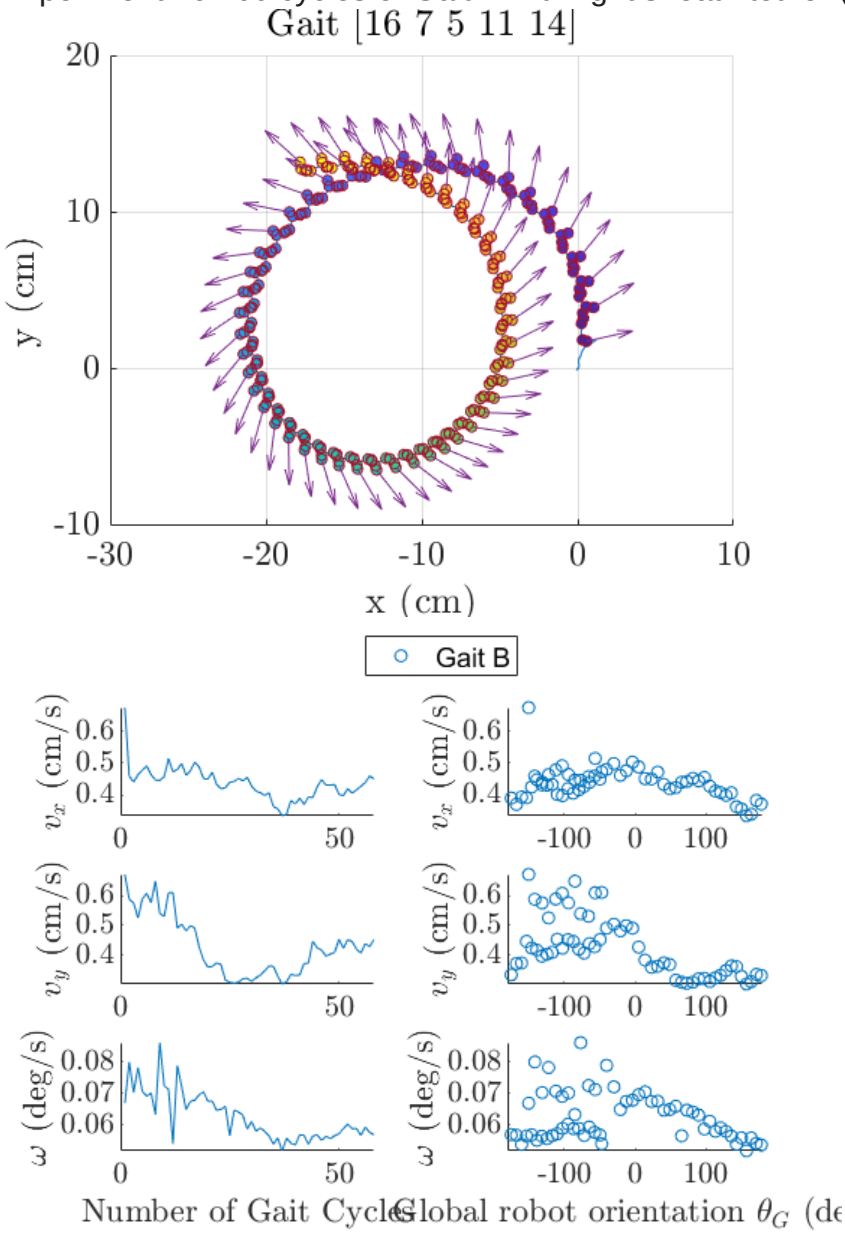
Experiment 15 : 60 cycles of Gait B with light sheath tether (left , not following), trial 1

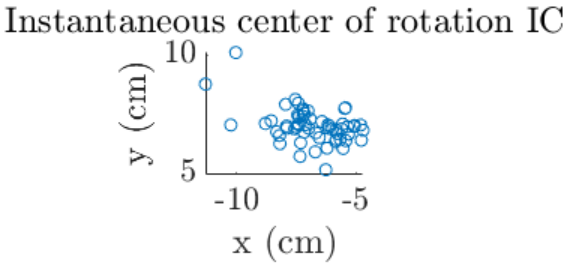


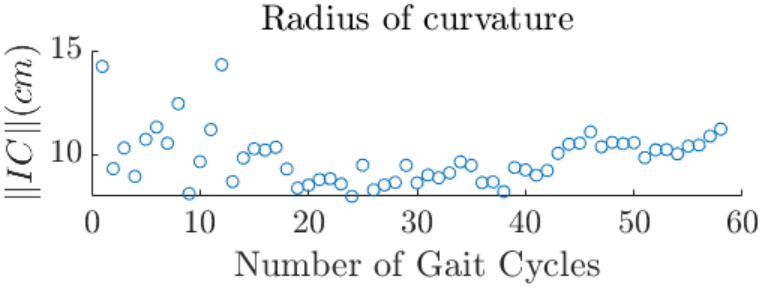




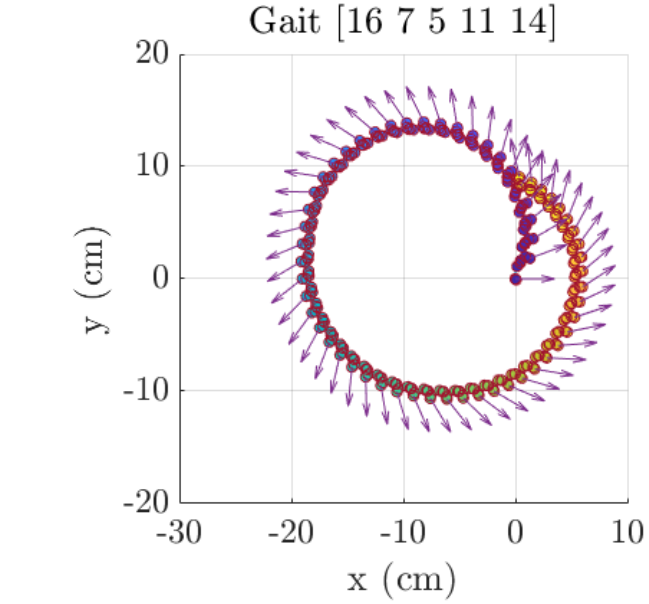
Experiment 16 : 60 cycles of Gait B with light sheath tether (Lf , not following), trial 1

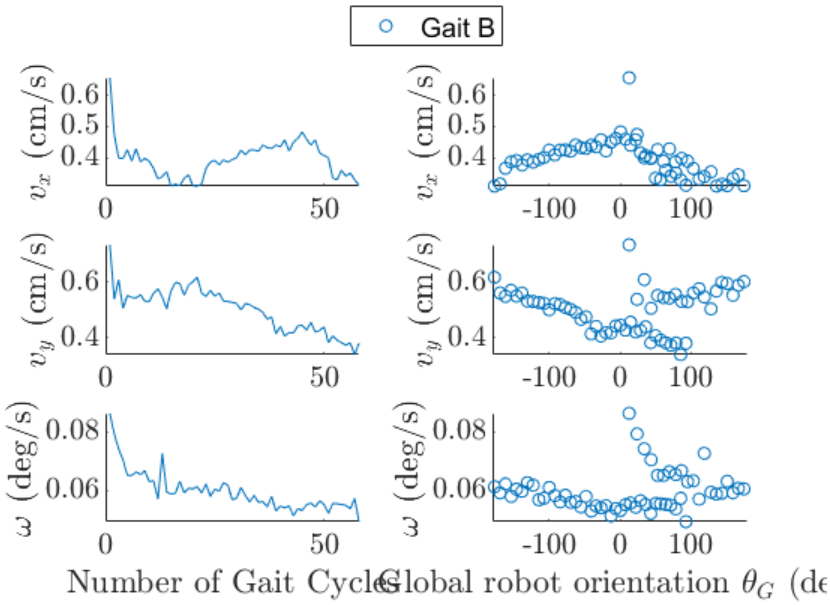


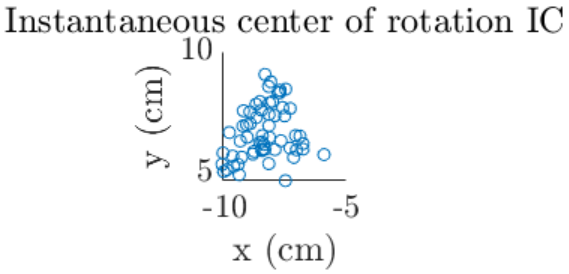


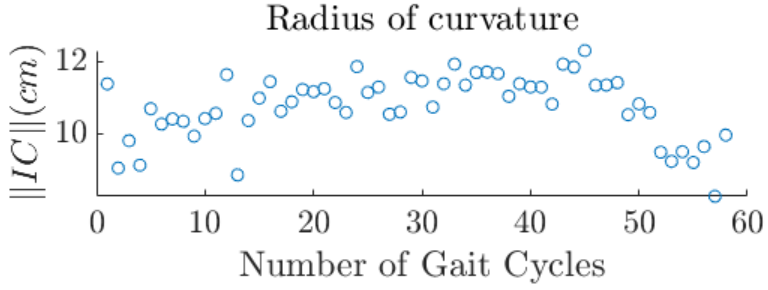


Experiment 17 : 60 cycles of Gait B with light sheath tether (right , not following), trial 1

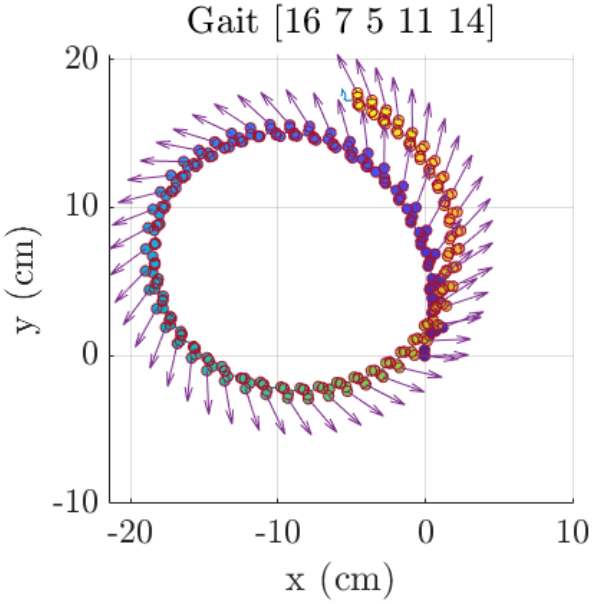


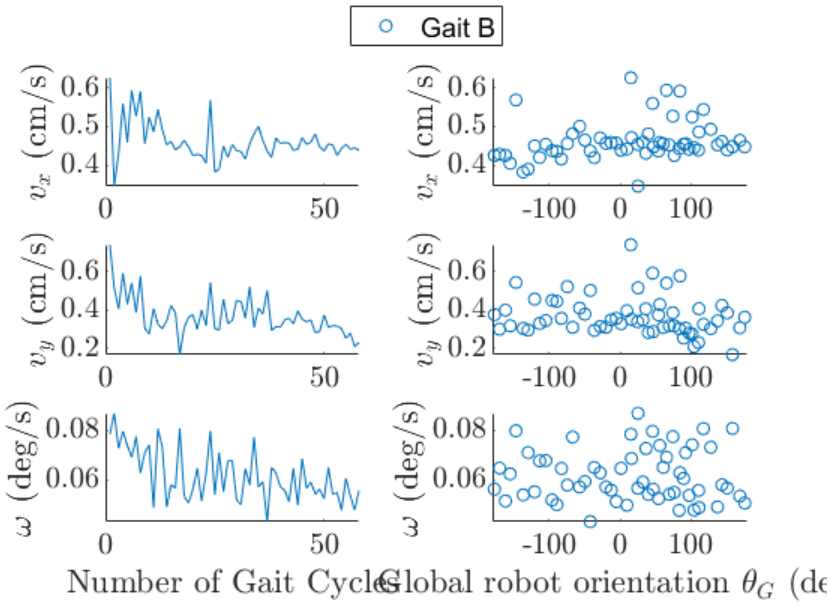


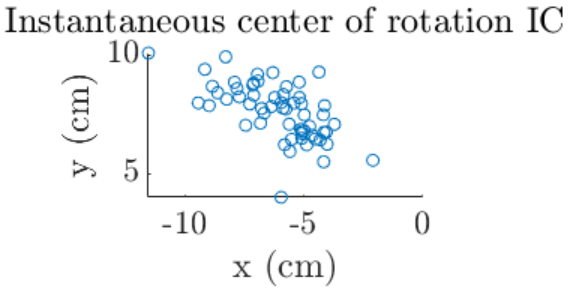


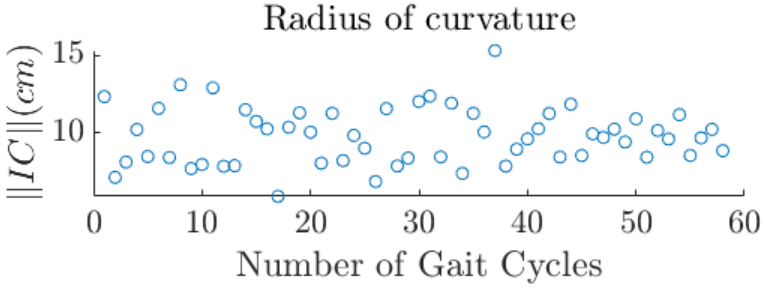


Experiment 18 : 60 cycles of Gait B with no sheath tether (right , following), trial 1

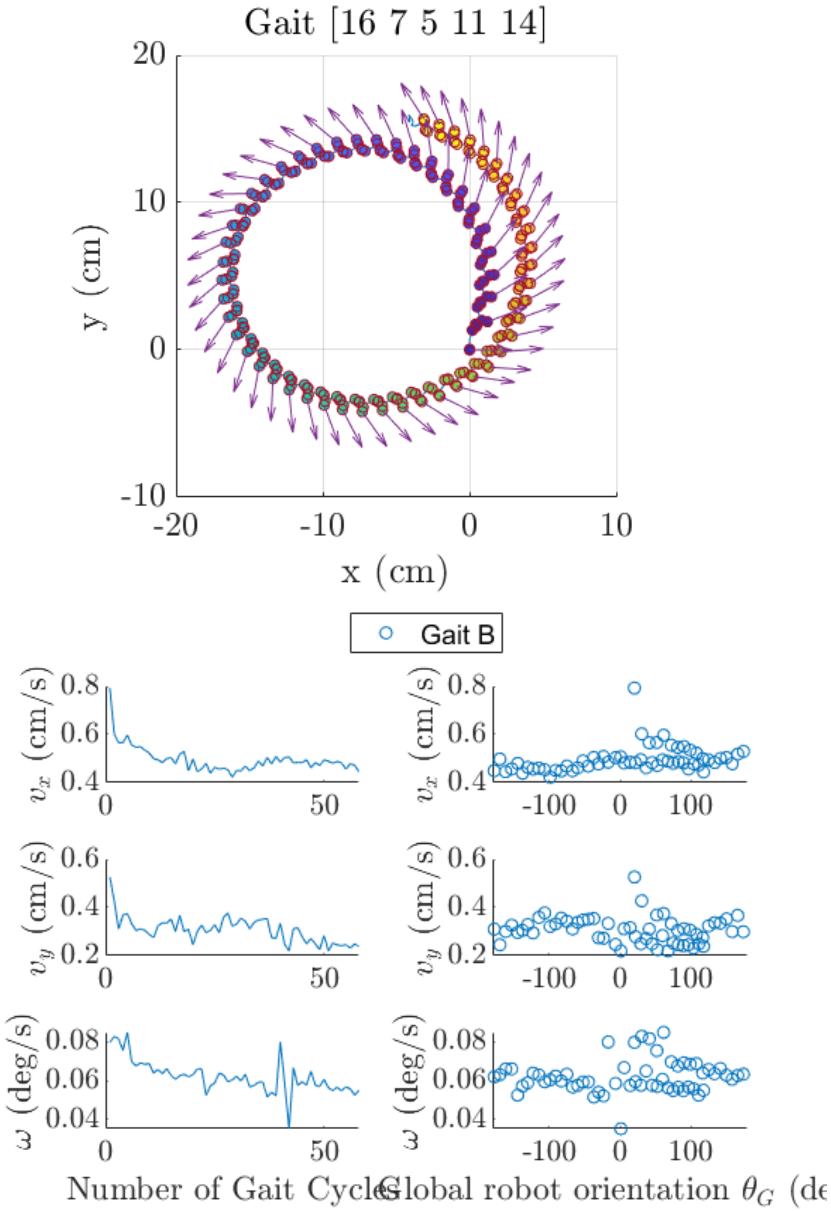


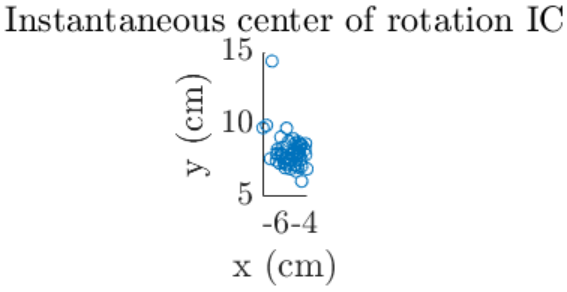


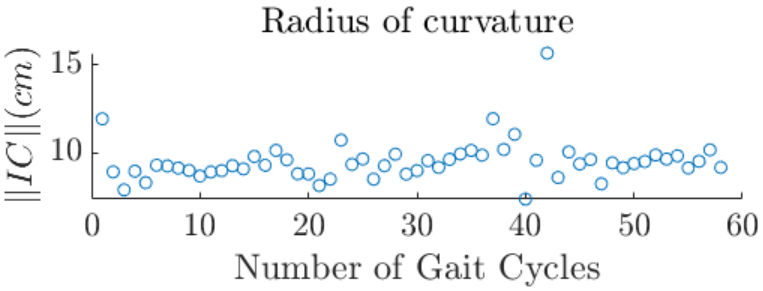




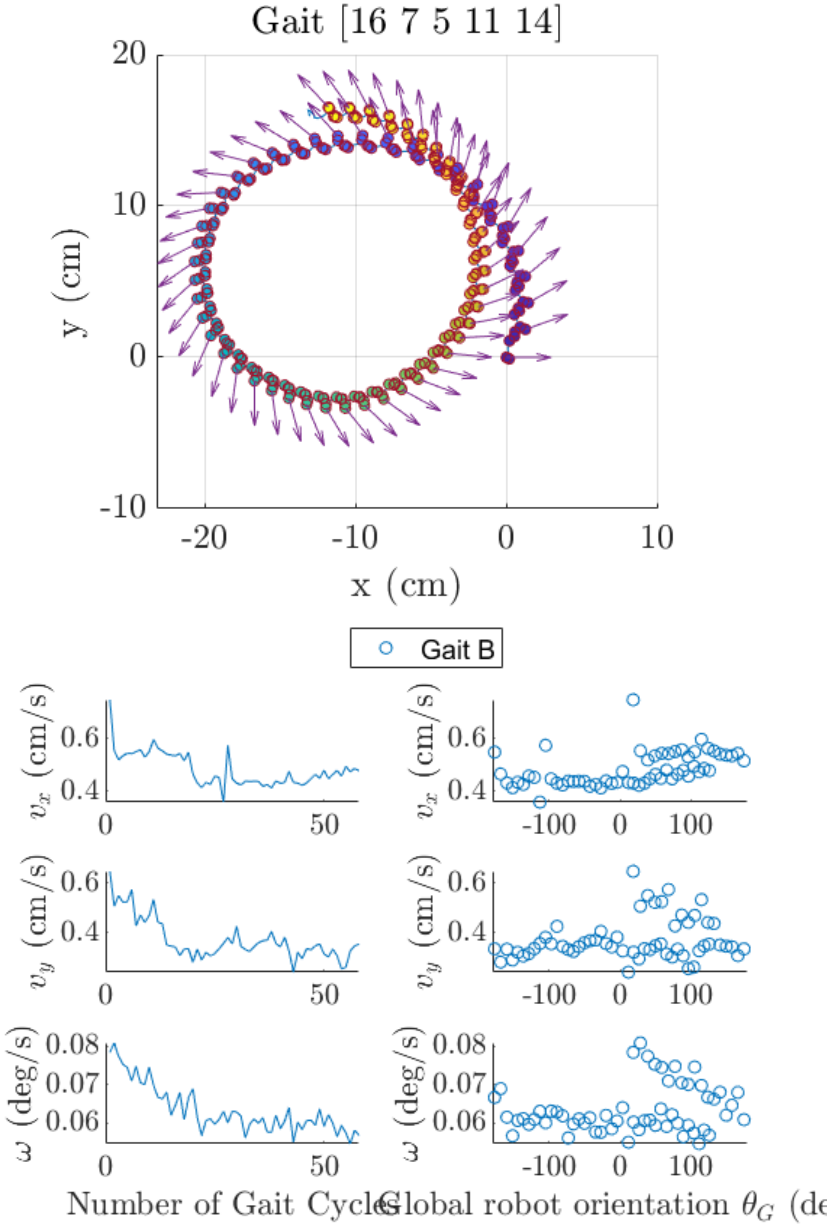
Experiment 19 : 60 cycles of Gait B with no sheath tether (right , following), trial 2

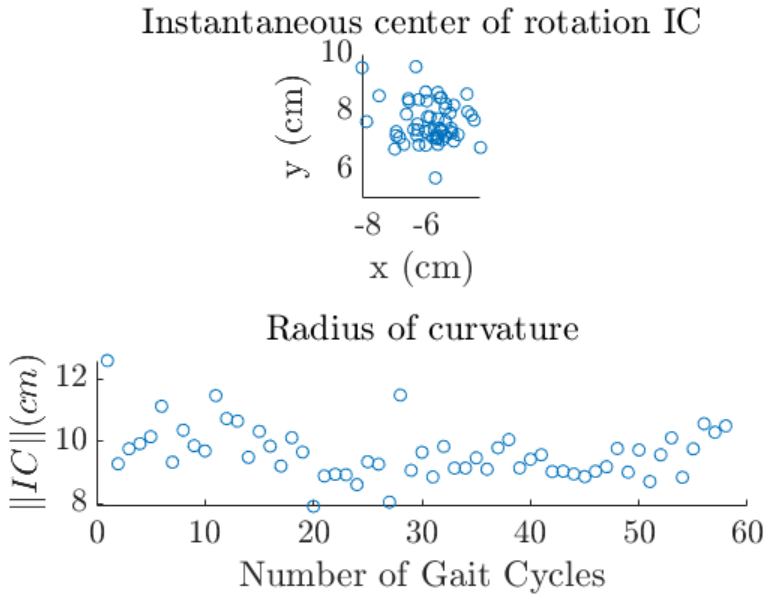




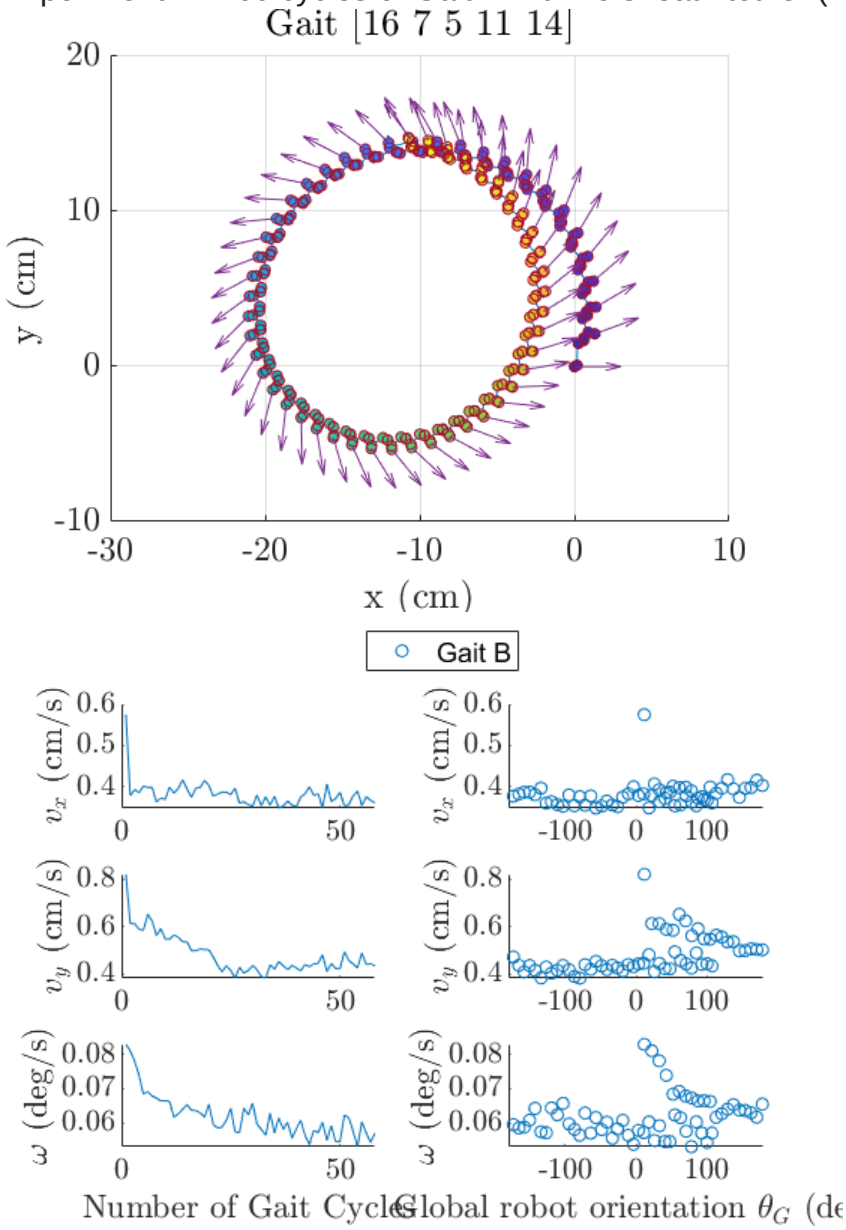


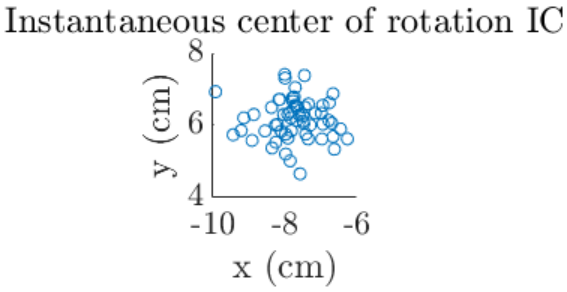
Experiment 20 : 60 cycles of Gait B with no sheath tether (left , following), trial 1

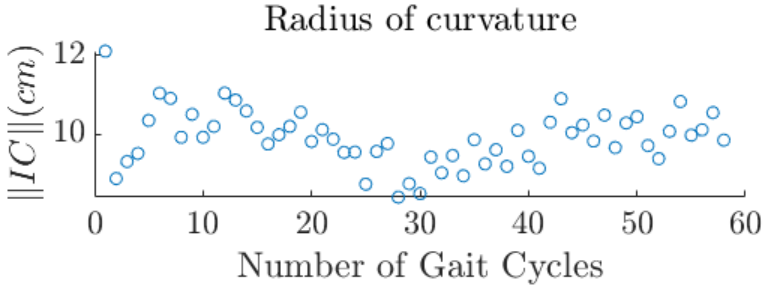




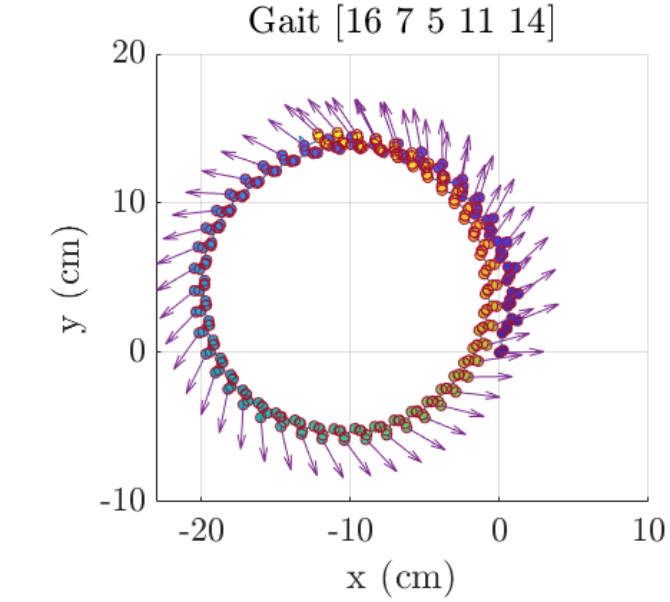
Experiment 21 : 60 cycles of Gait B with no sheath tether (left , following), trial 2

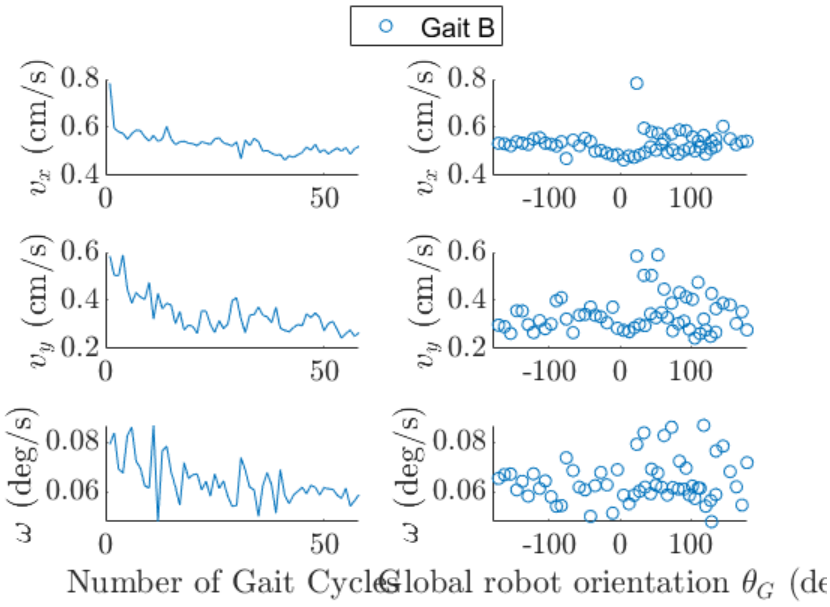


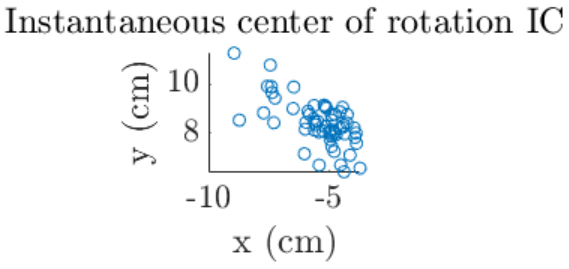


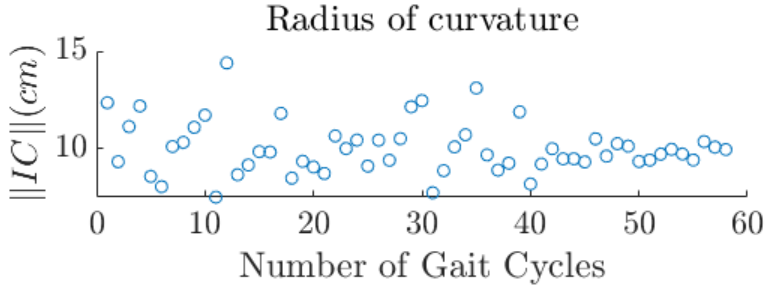


Experiment 22 : 60 cycles of Gait B with no sheath tether (right , not following), trial 1

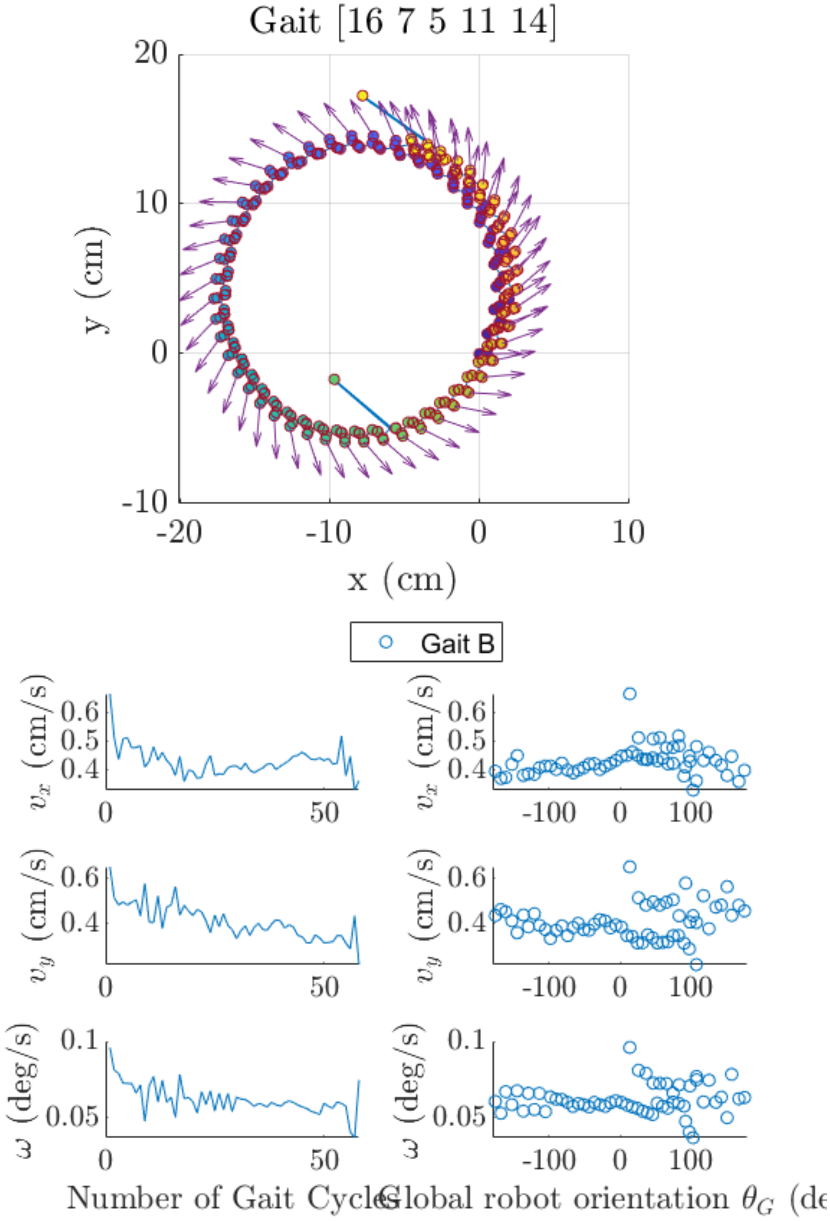


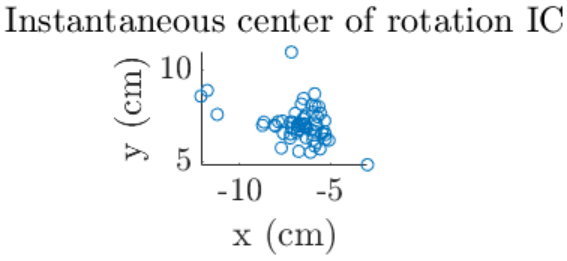


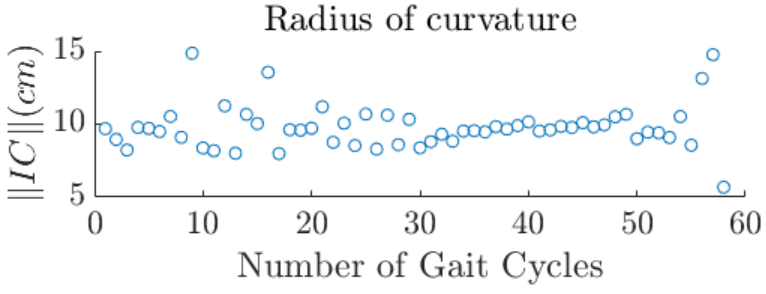




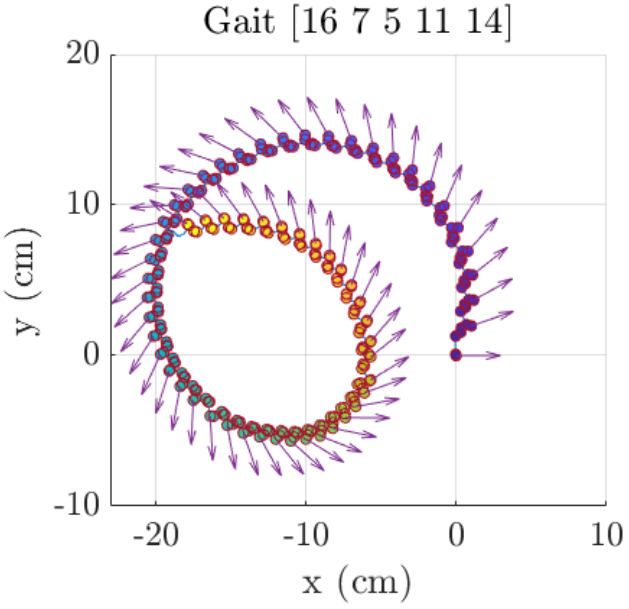
Experiment 23 : 60 cycles of Gait B with no sheath tether (right , not following), trial 2

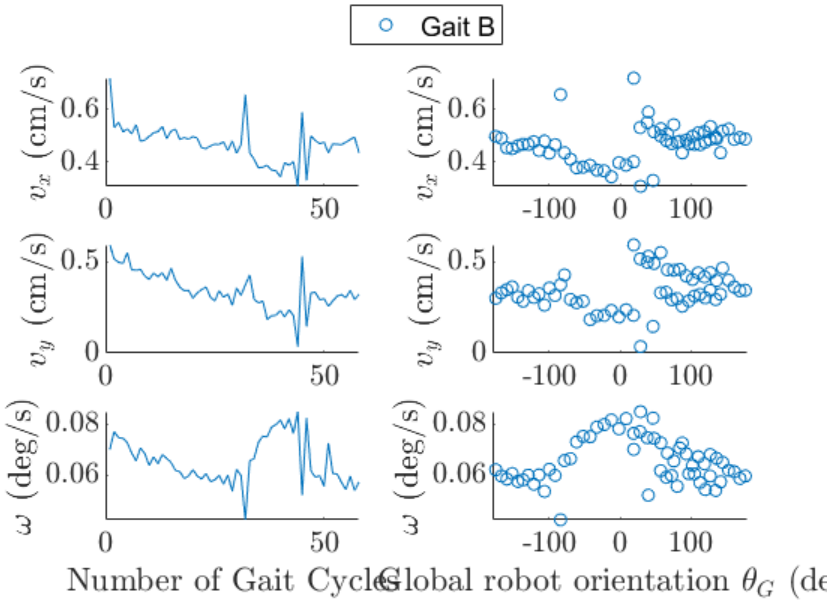


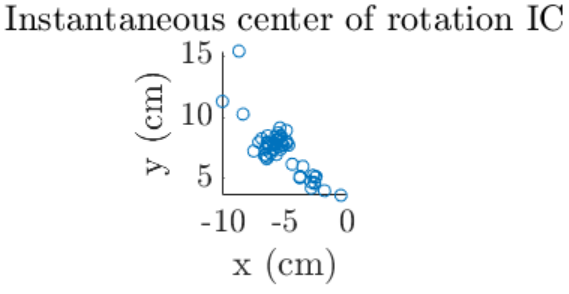


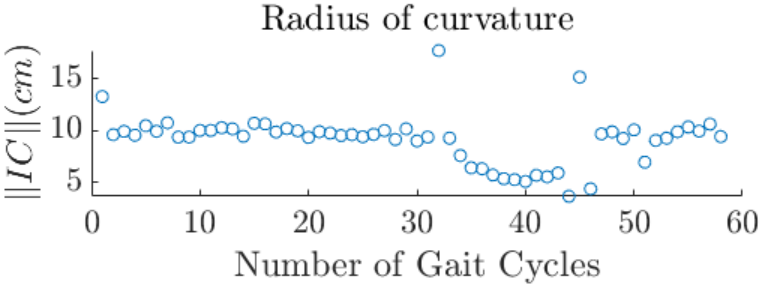


Experiment 24 : 60 cycles of Gait B with no sheath tether (left , not following), trial 1

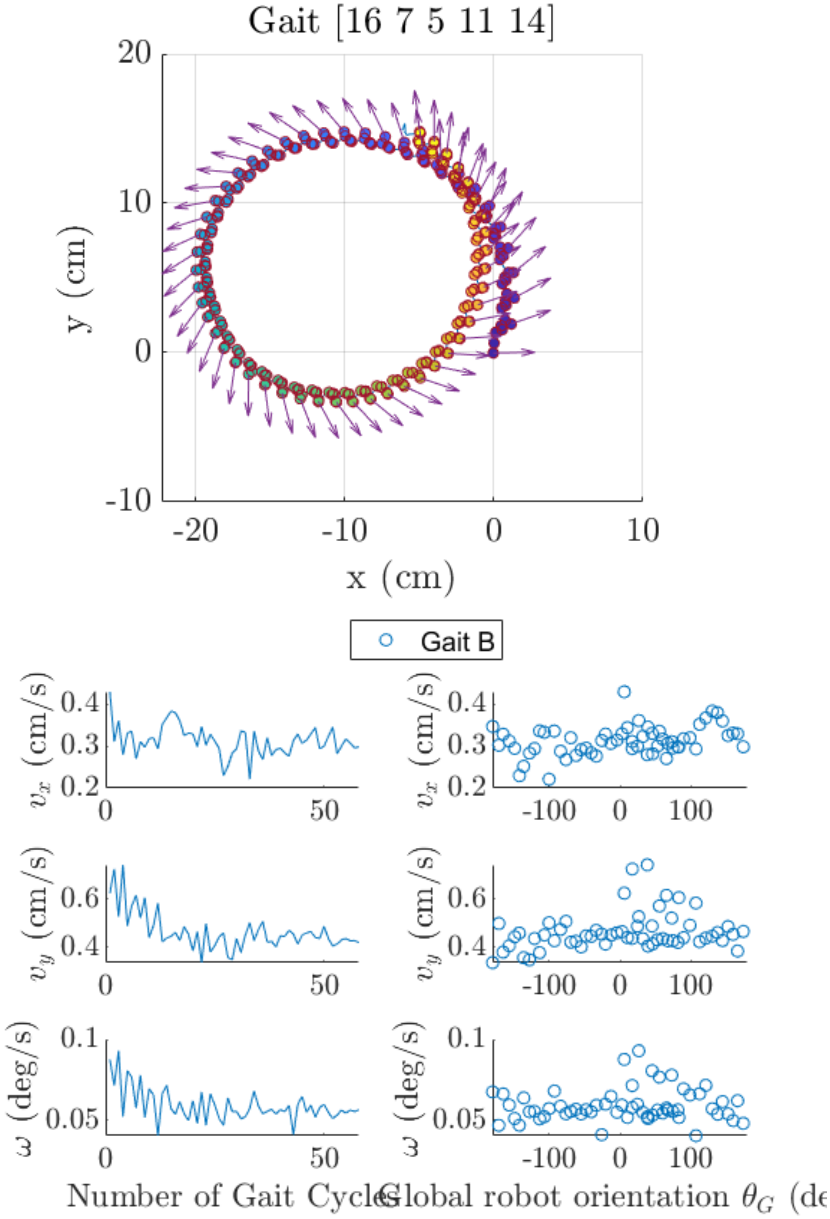


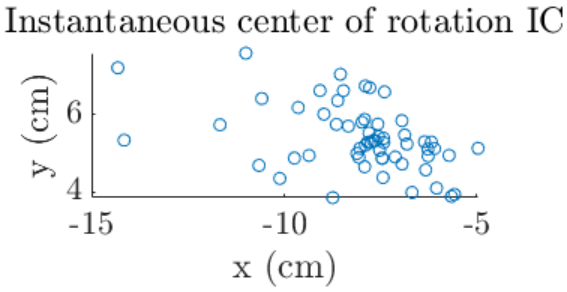


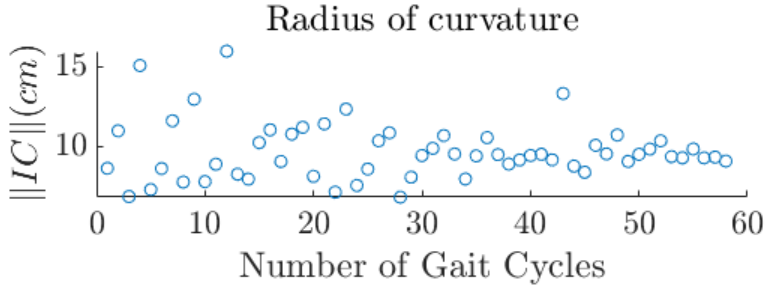




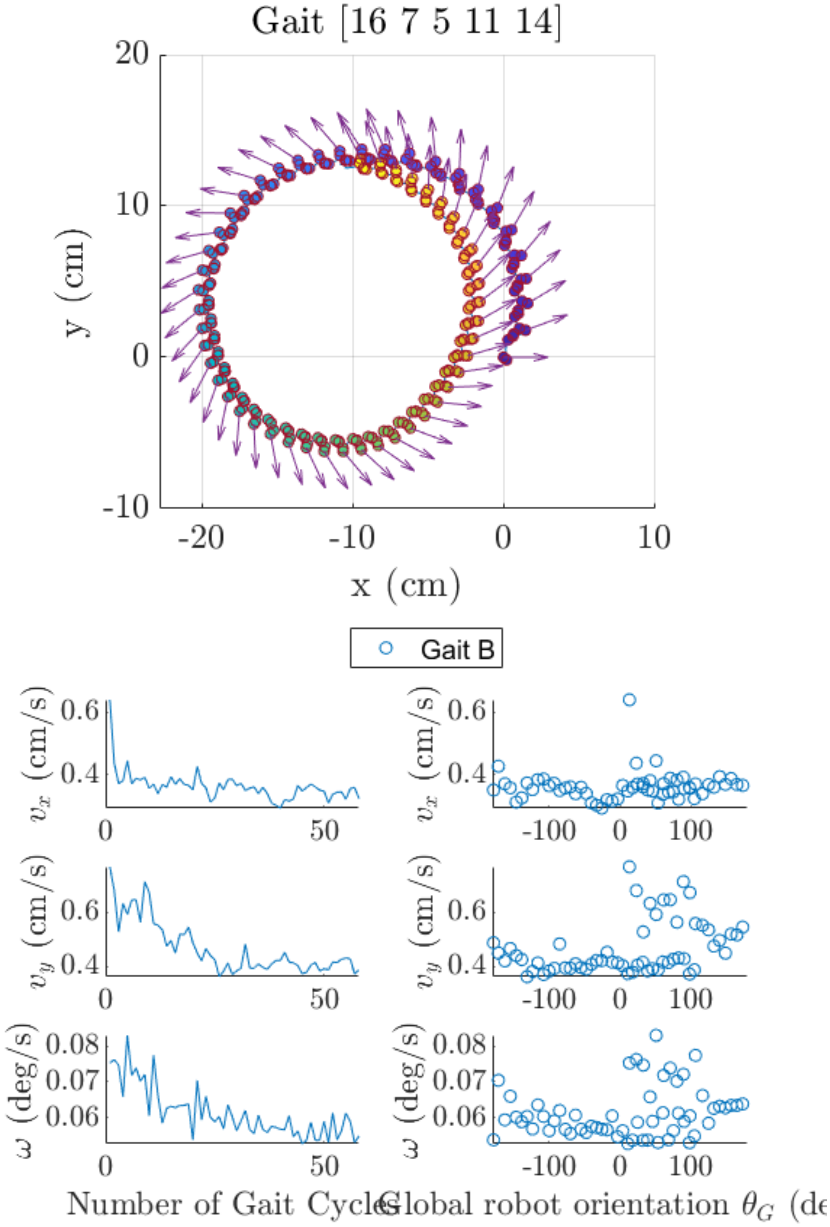
Experiment 25 : 60 cycles of Gait B with no sheath tether (left , not following), trial 2

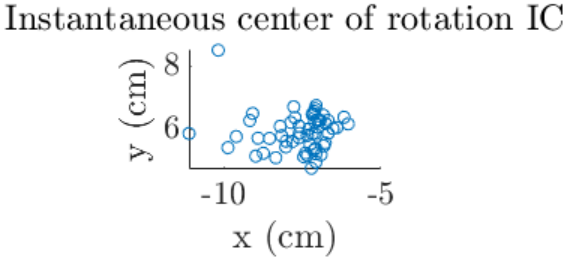


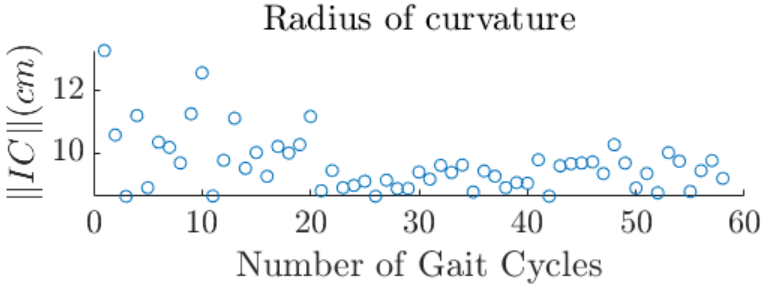




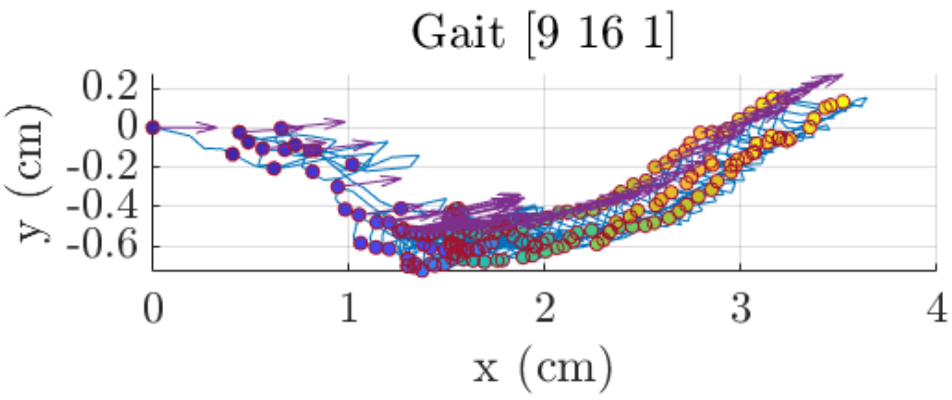
Experiment 26 : 60 cycles of Gait B with light sheath tether (right , following), trial 1

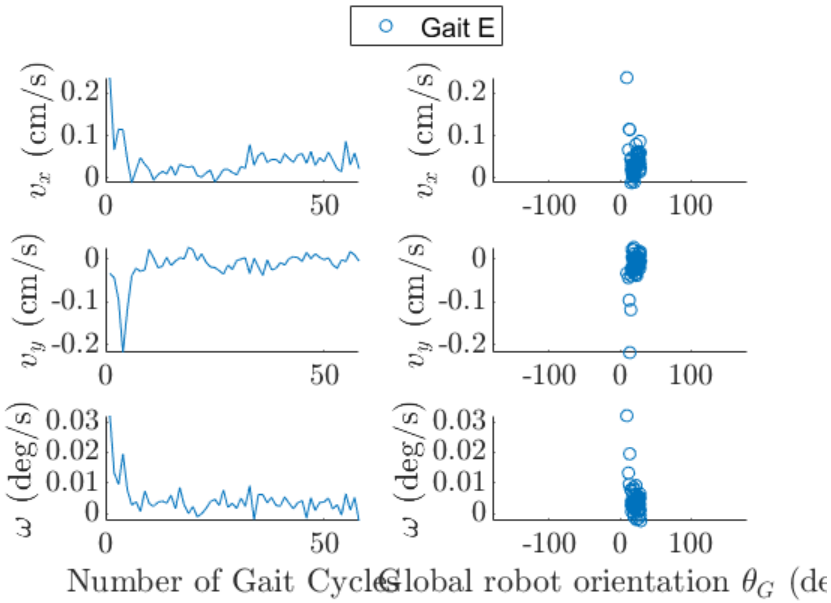


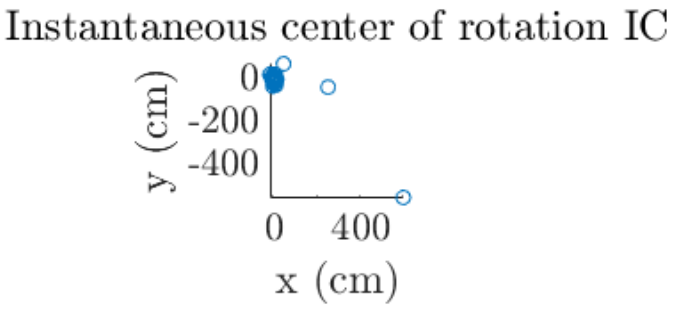


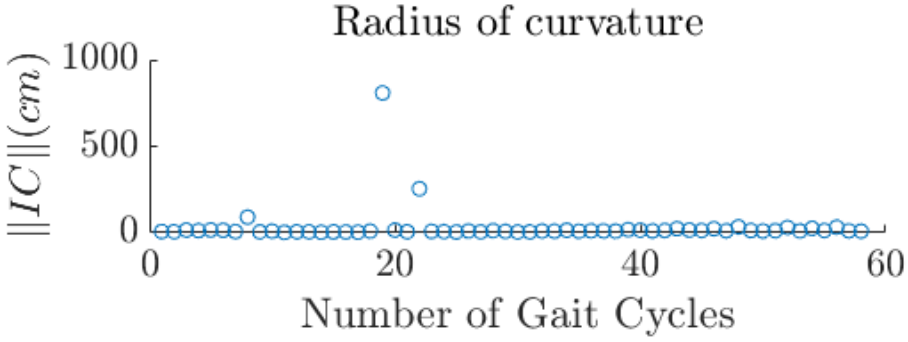


Experiment 27 : 60 cycles of Gait E with no sheath tether (right , not following), trial 1

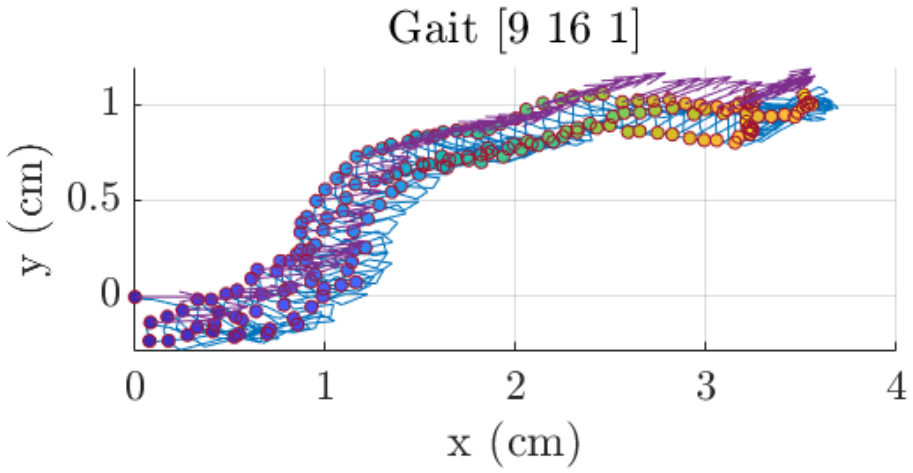


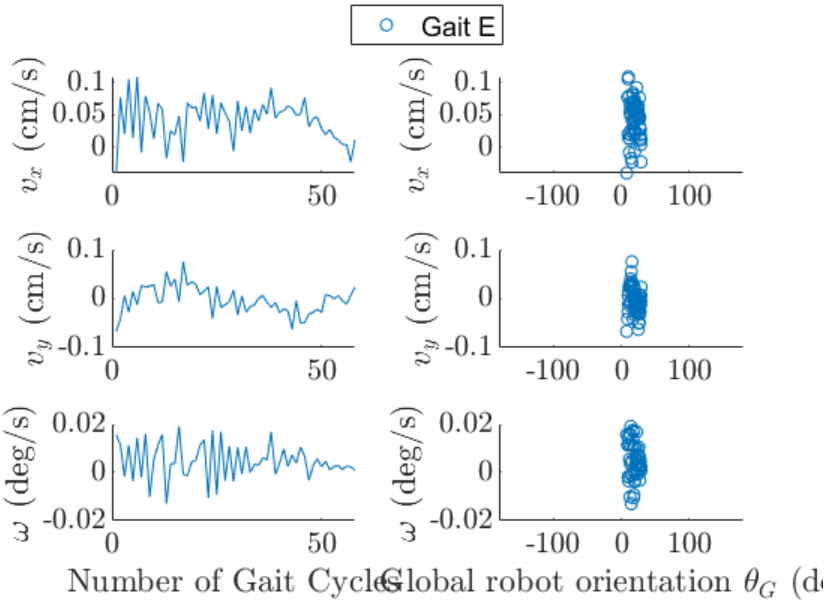


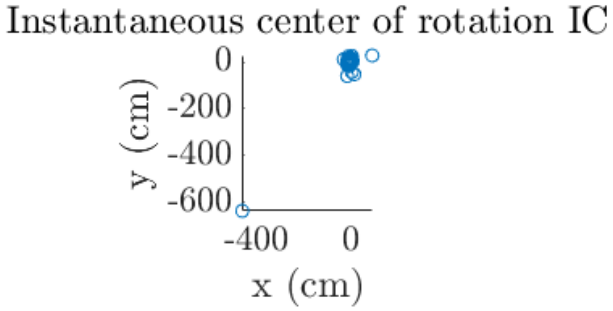


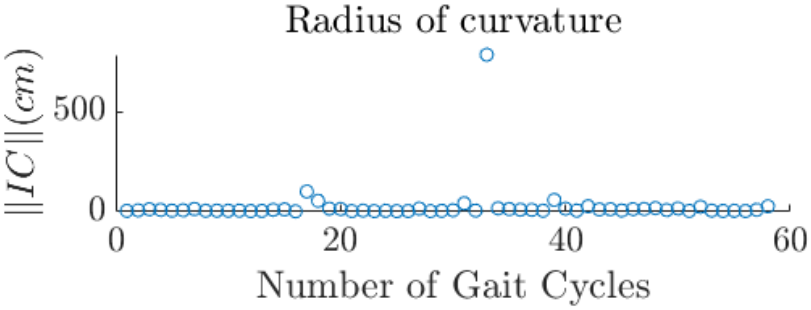


Experiment 28 : 60 cycles of Gait E with no sheath tether (right , not following), trial 2

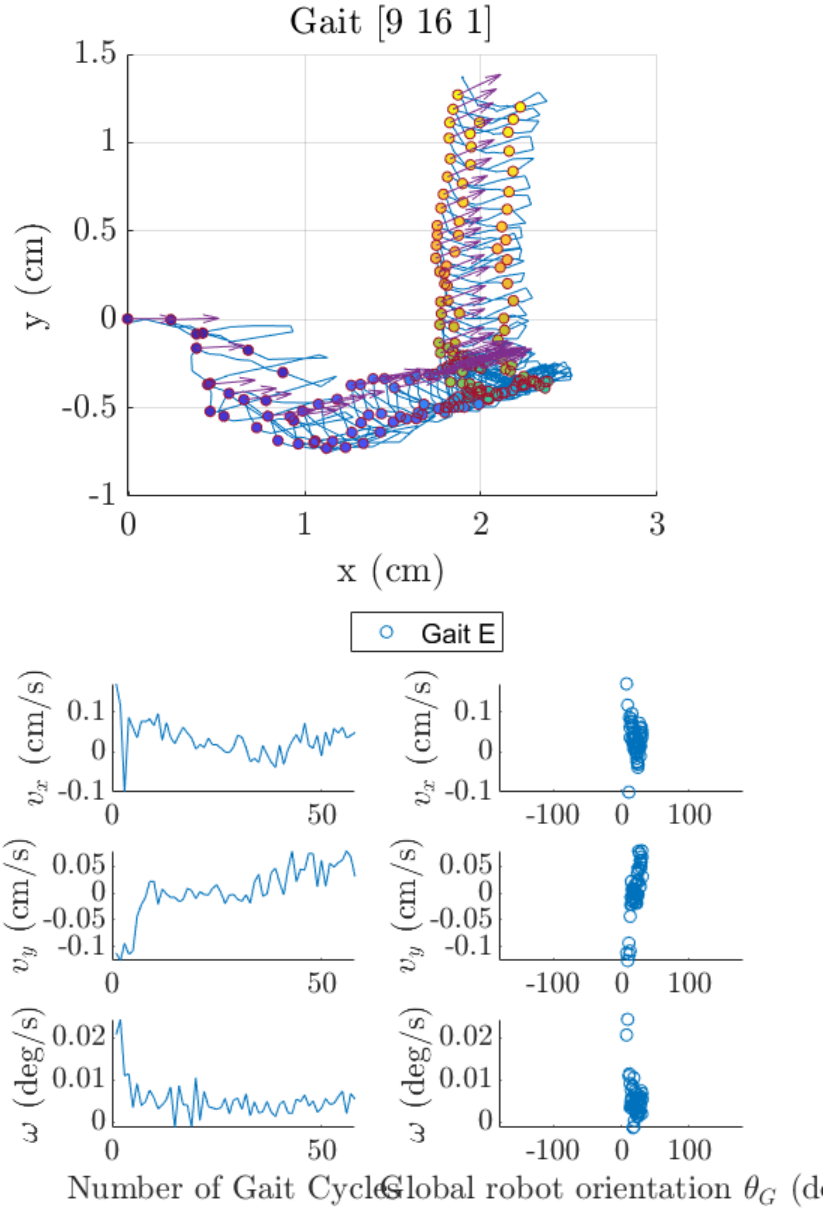


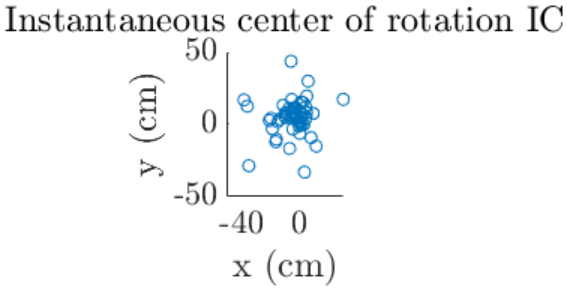


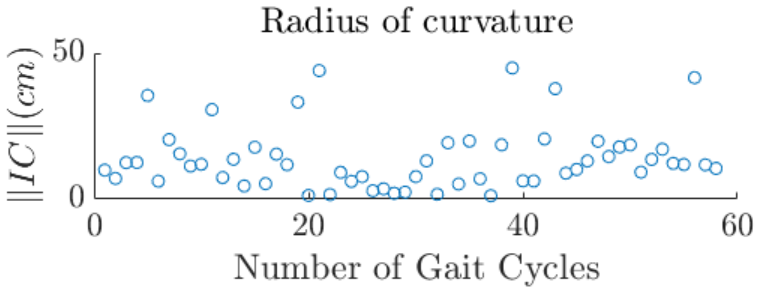




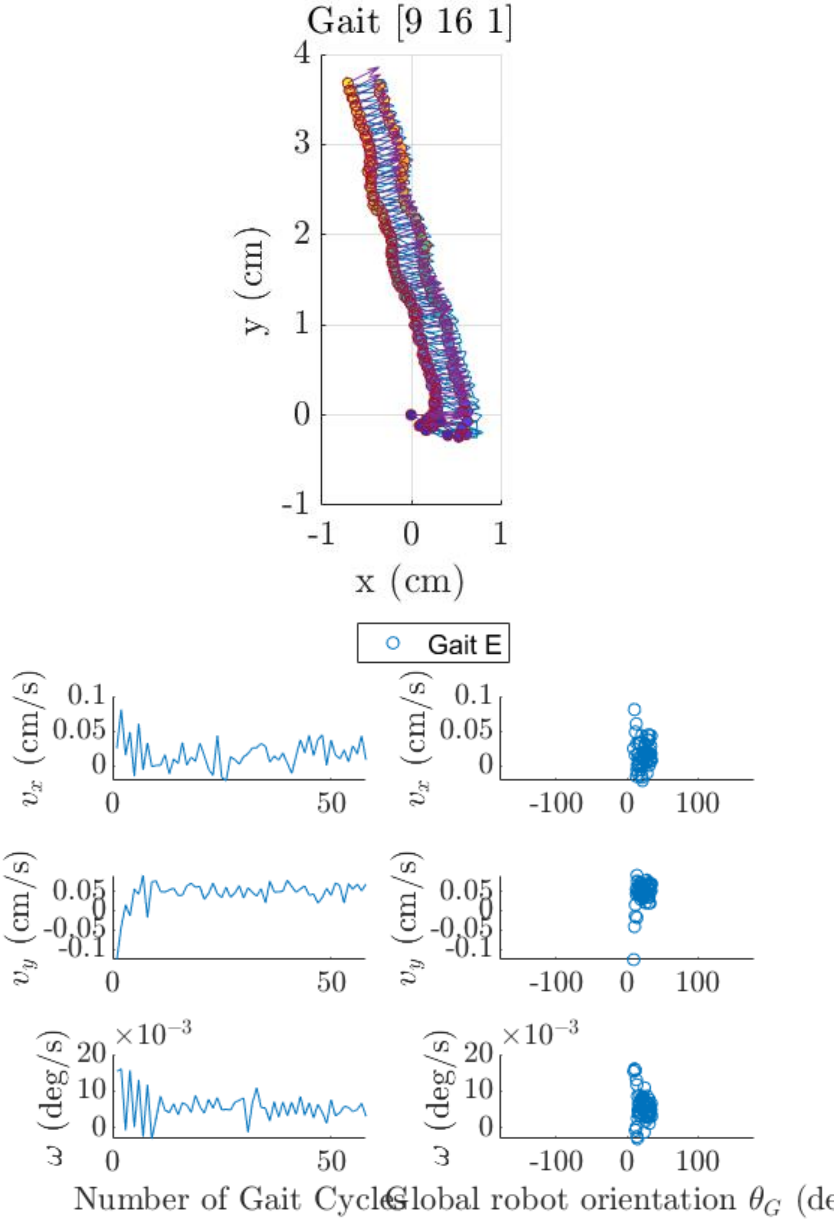
Experiment 29 : 60 cycles of Gait E with no sheath tether (left , not following), trial 2

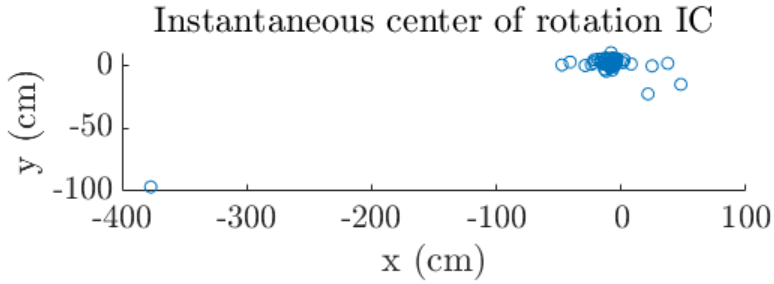


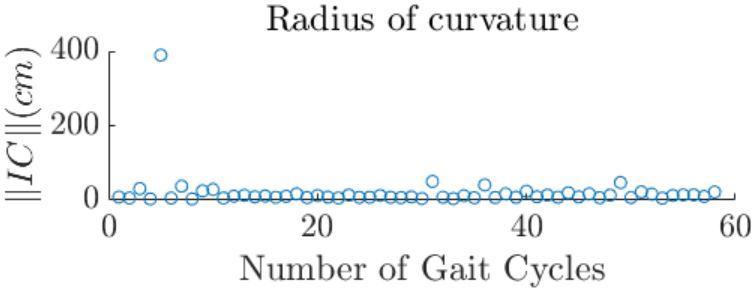




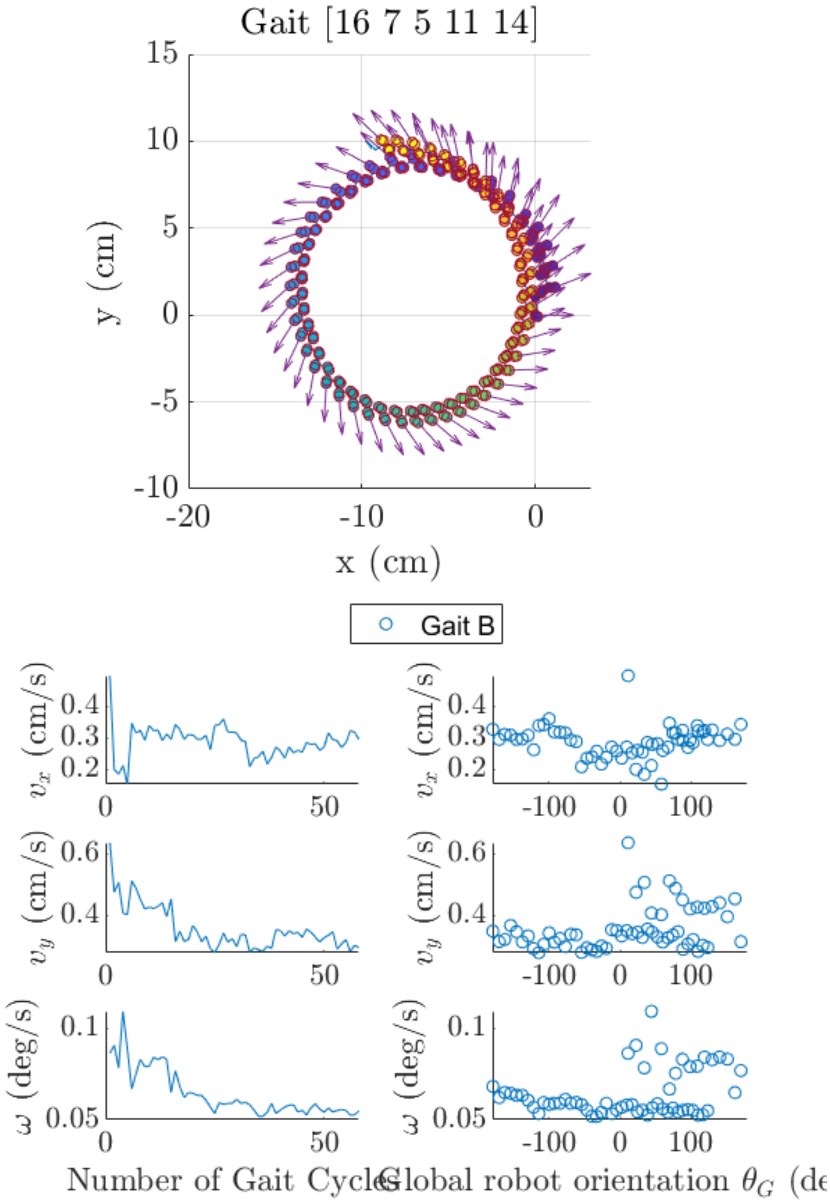
Experiment 30 : 60 cycles of Gait E with no sheath tether (left , not following), trial 3

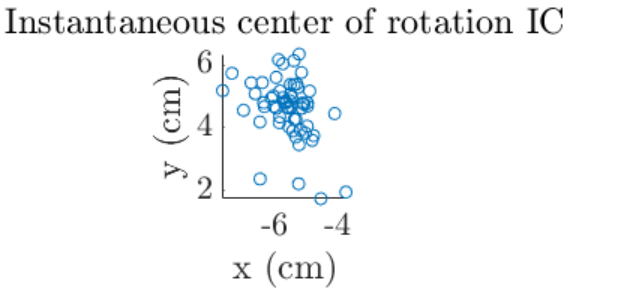


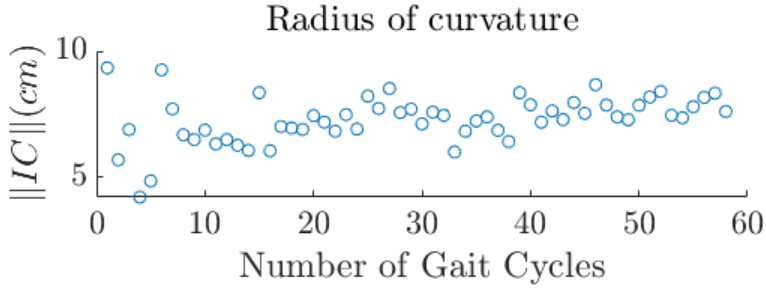




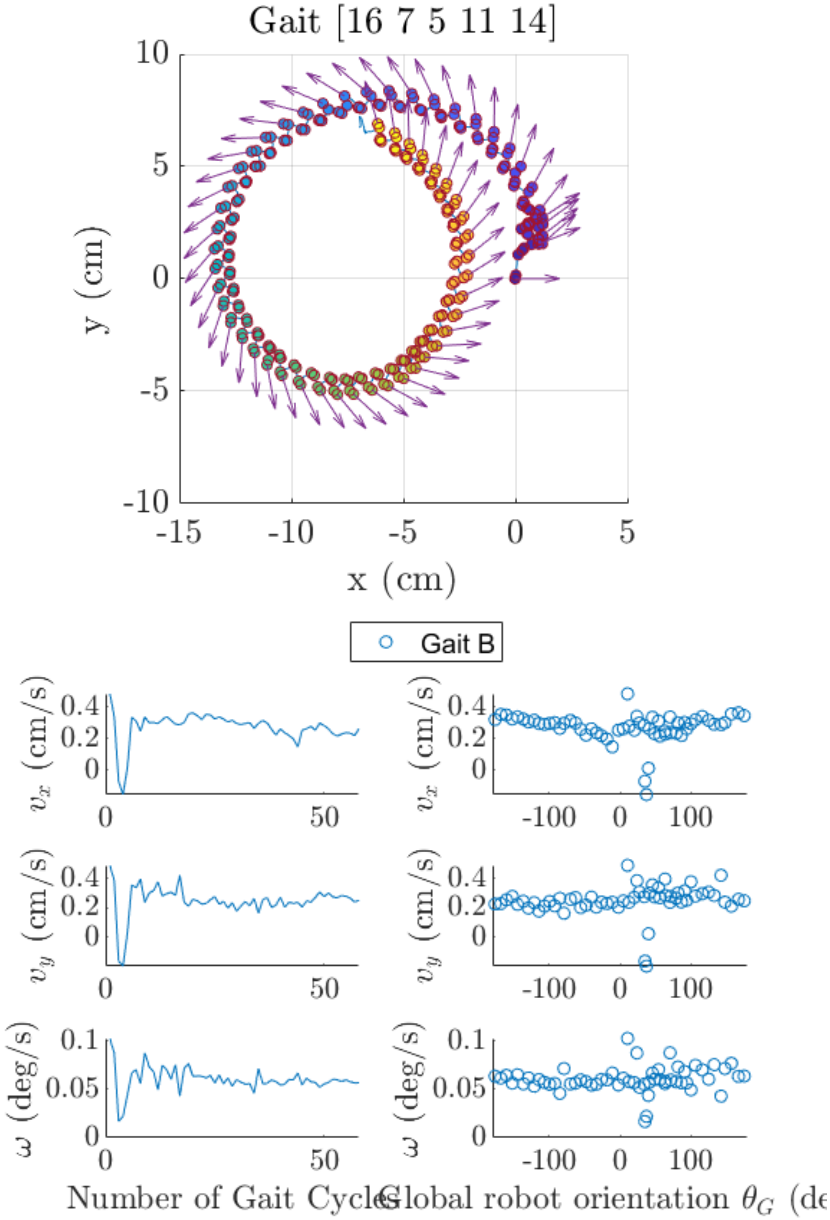
Experiment 31 : 60 cycles of Gait B with 32 AWG tether (left , not following), trial 1

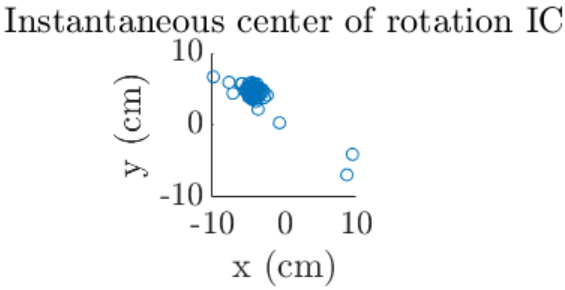


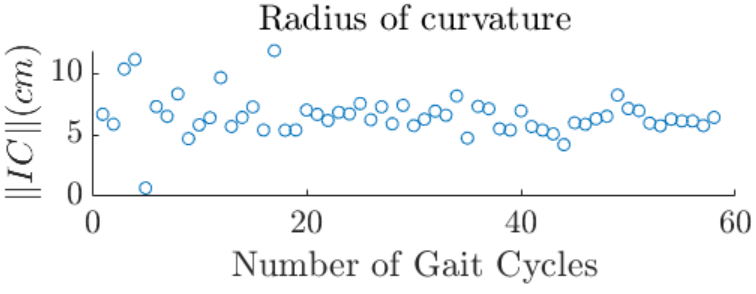




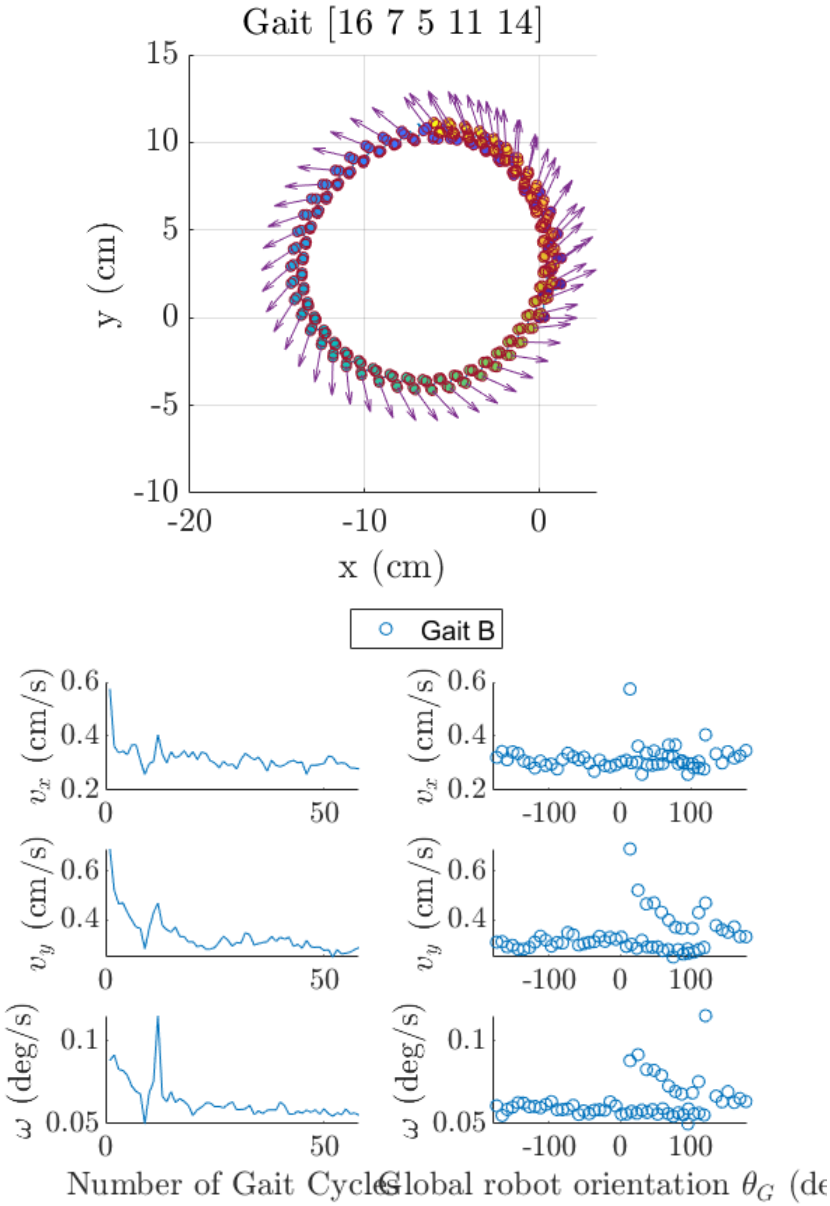
Experiment 32 : 60 cycles of Gait B with 32 AWG tether (left , not following), trial 2

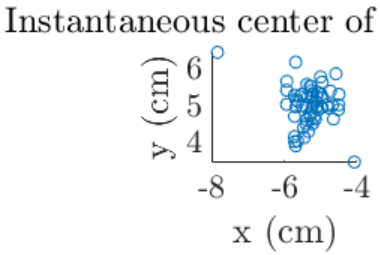


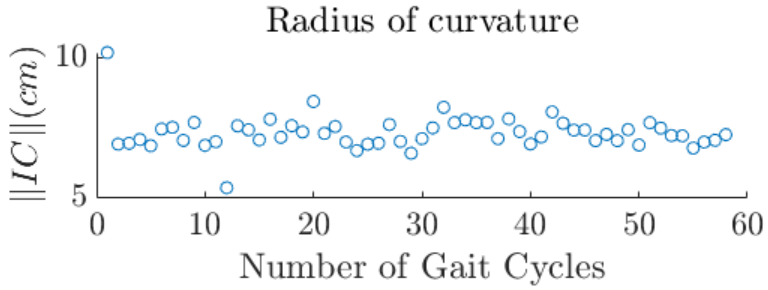




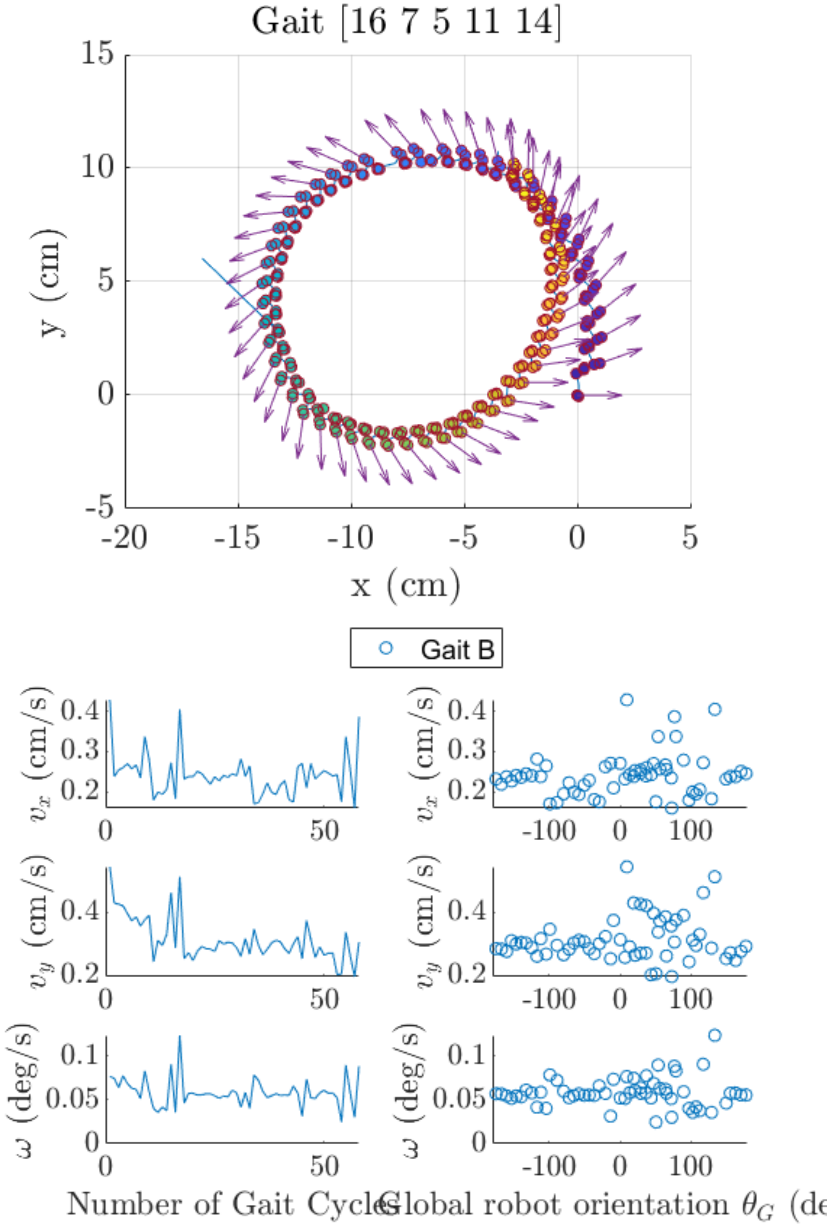
Experiment 33 : 60 cycles of Gait B with 32 AWG tether (right , not following), trial 1

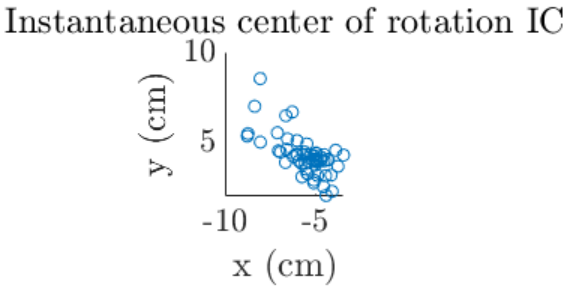


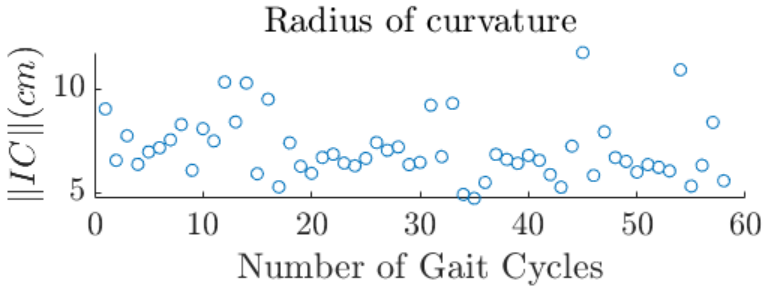




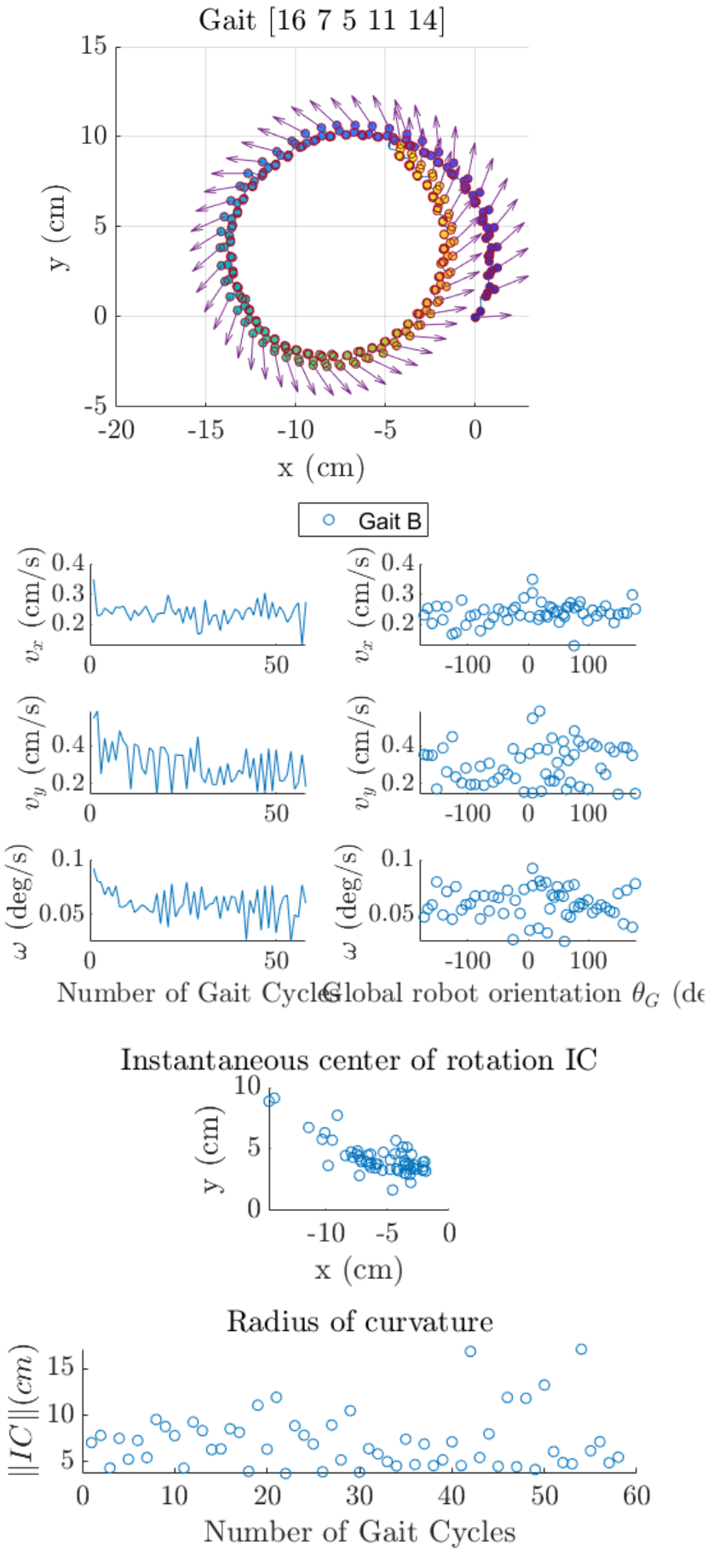
Experiment 34 : 60 cycles of Gait B with 32 AWG tether (right , not following), trial 2



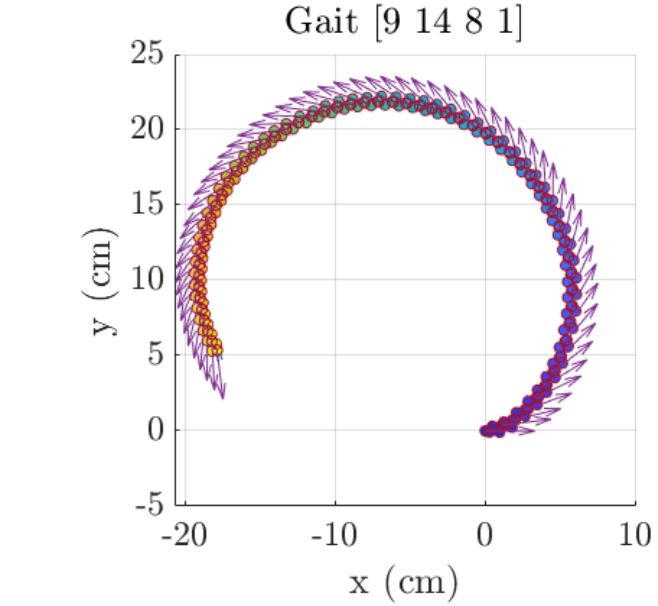


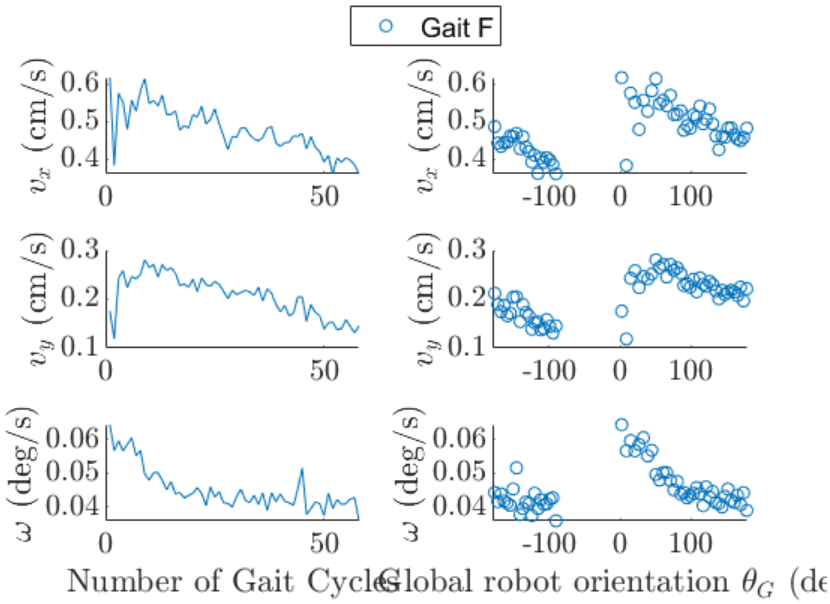


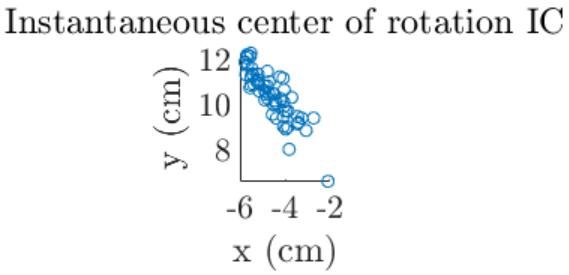
Experiment 35 : 60 cycles of Gait B with 32 AWG with old slip ring tether (right , not following), trial 2

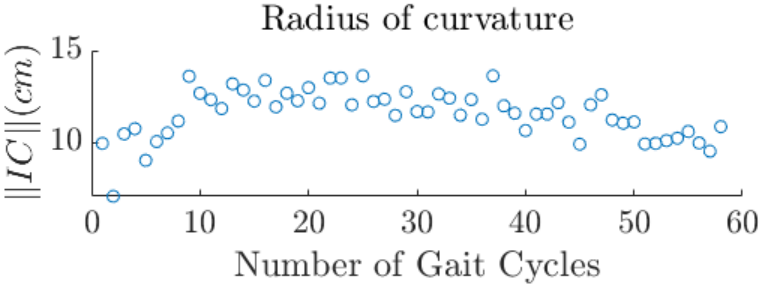


Experiment 36 : 60 cycles of Gait F with 32 AWG with slip ring tether (left , not following), trial 1

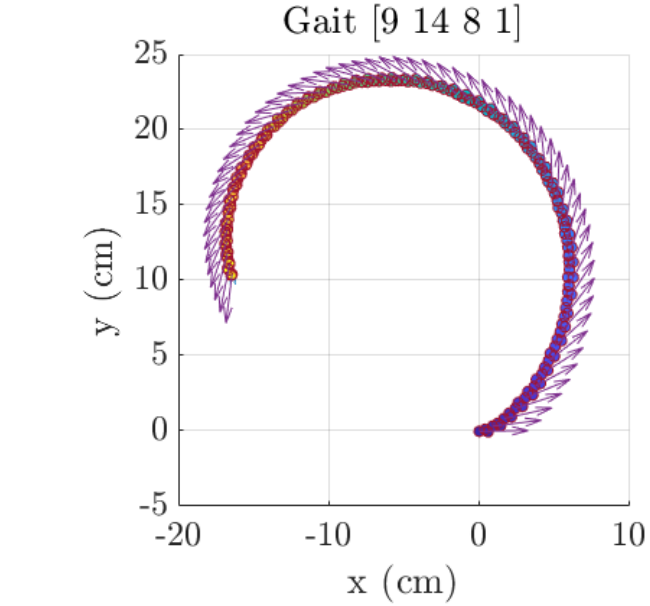


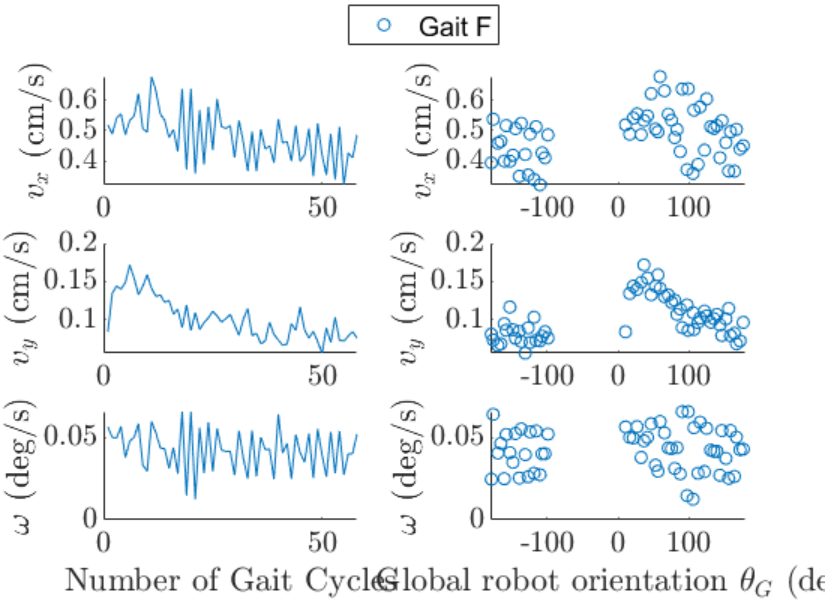


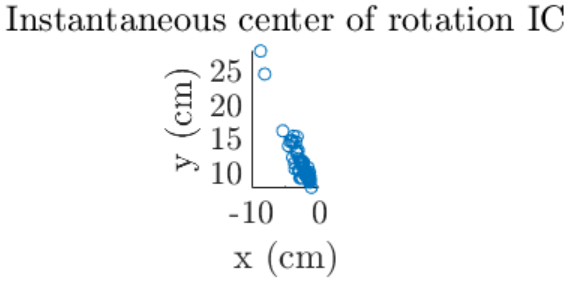


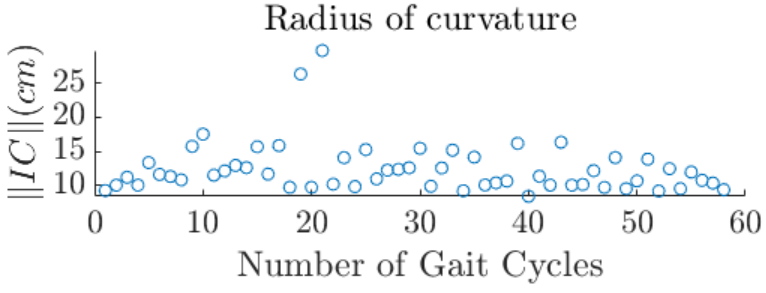


Experiment 37 : 60 cycles of Gait F with 32 AWG with slip ring tether (left , not following), trial 2

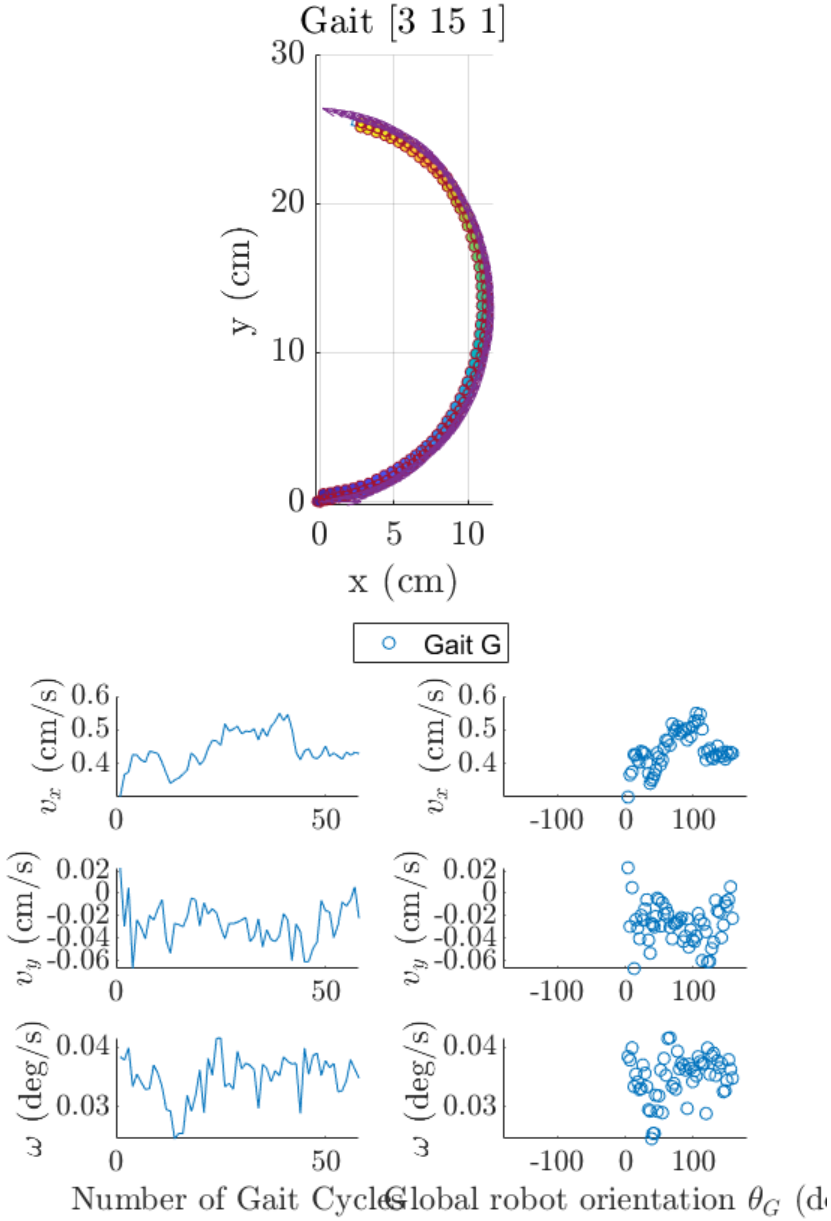


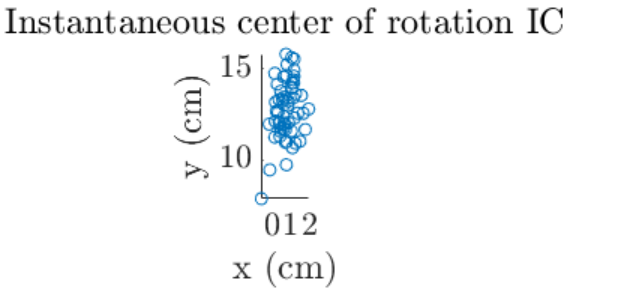


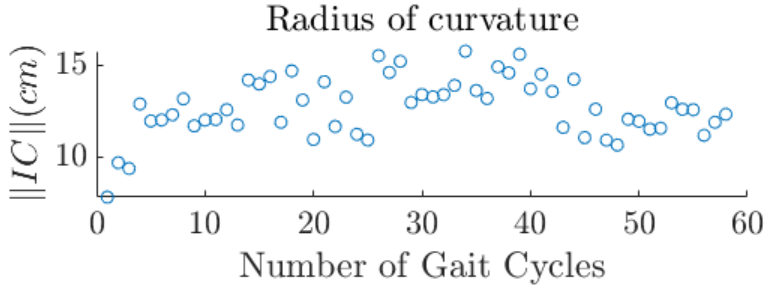




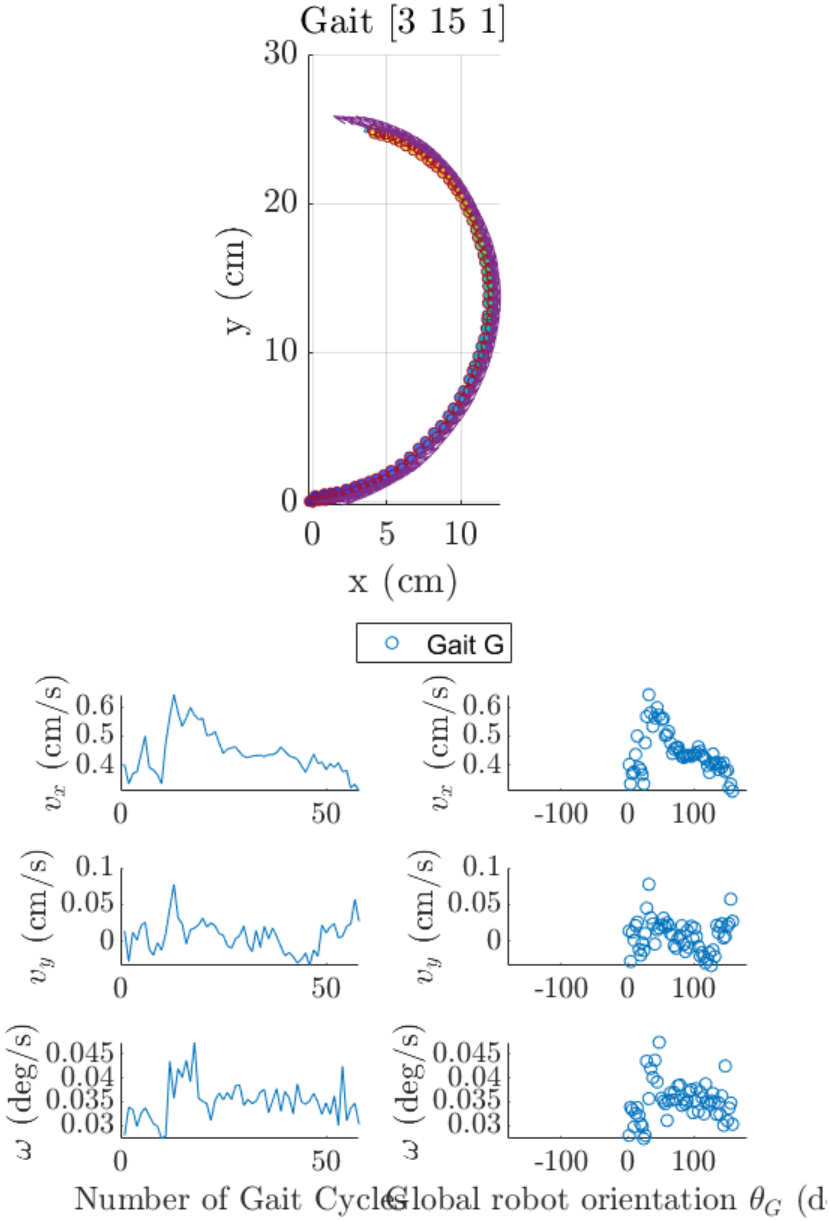
Experiment 38 : 60 cycles of Gait G with 32 AWG with slip ring tether (left , not following), trial 1

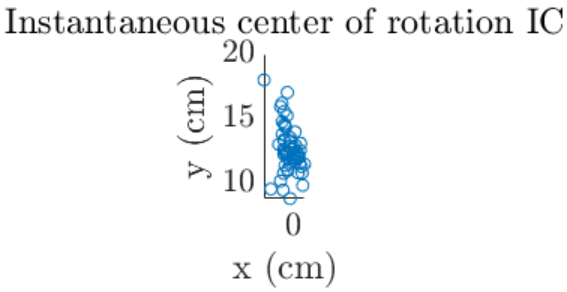


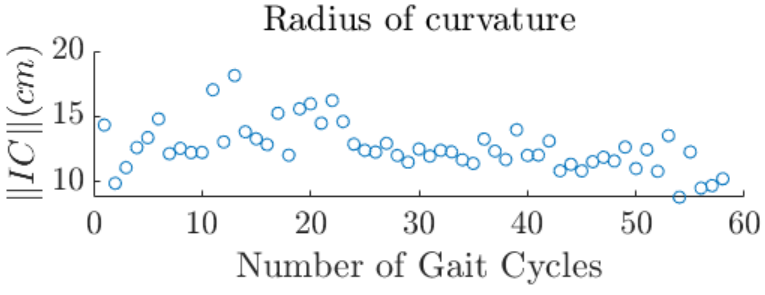




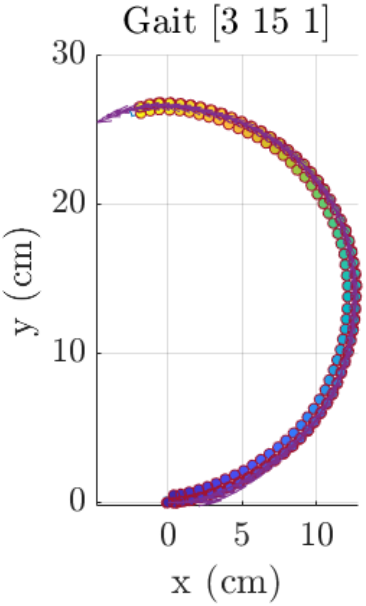
Experiment 39 : 60 cycles of Gait G with 32 AWG with slip ring tether (left , not following), trial 2

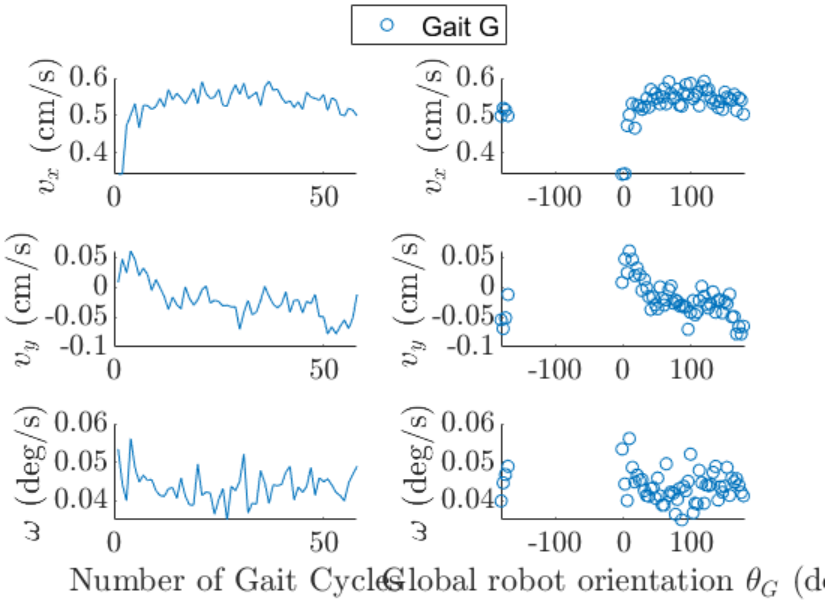


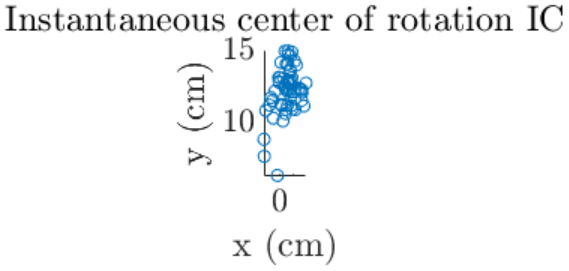


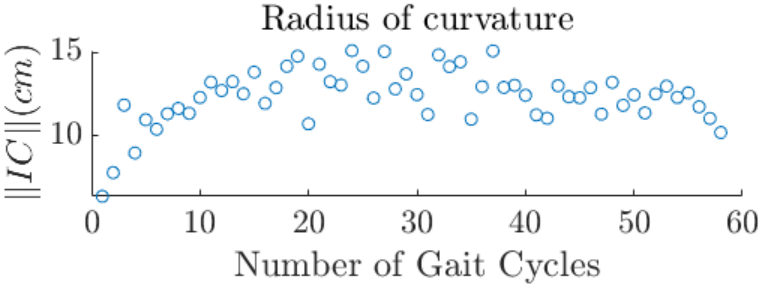


Experiment 40 : 60 cycles of Gait G with 32 AWG with slip ring tether (right , not following), trial 1

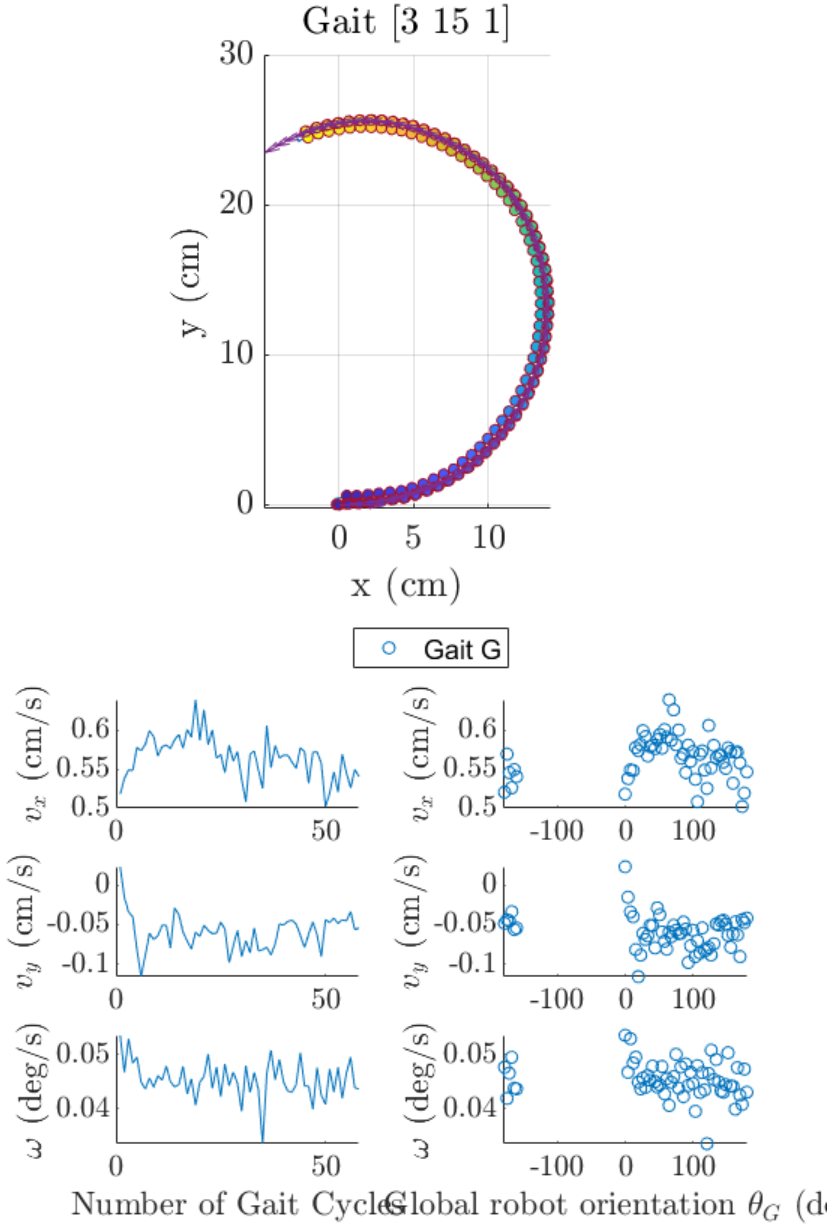


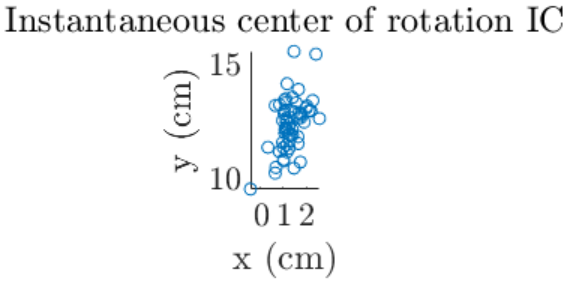


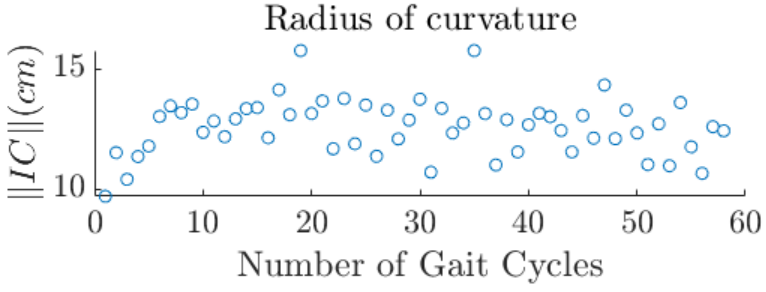




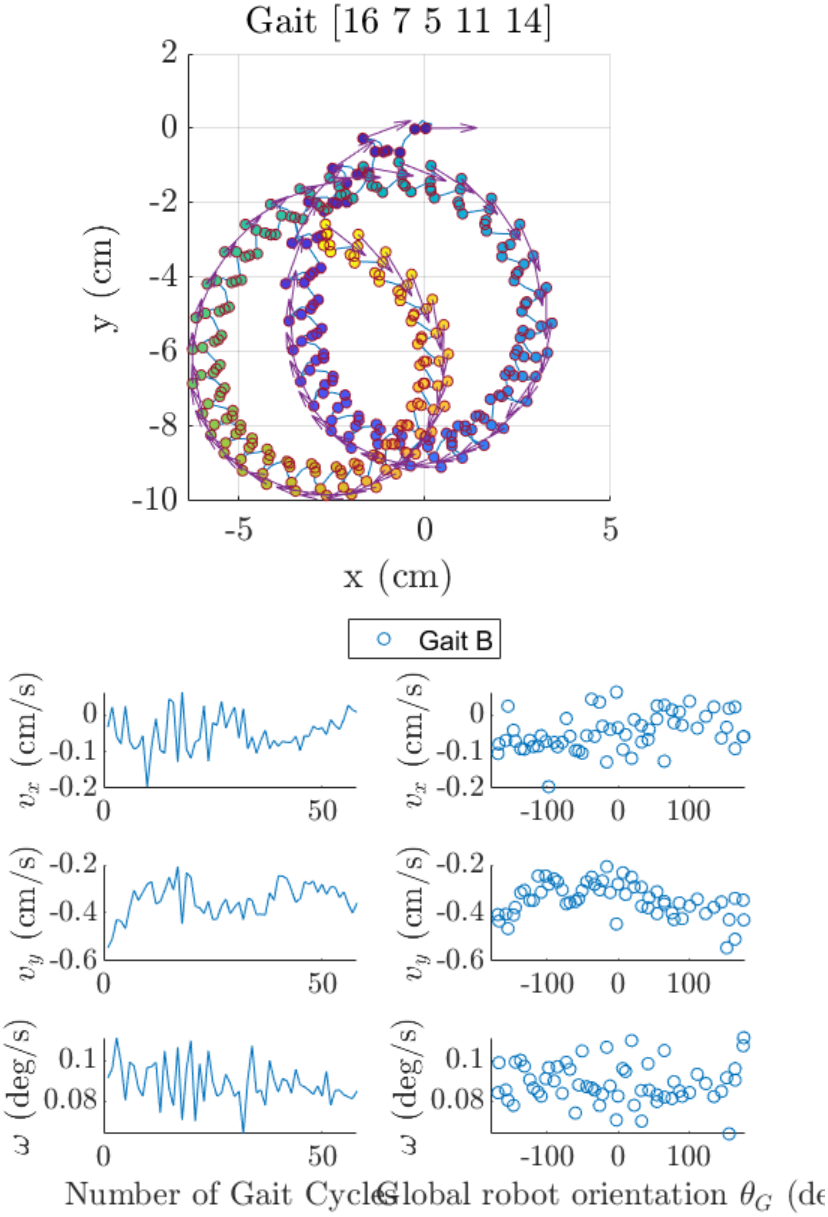
Experiment 41 : 60 cycles of Gait G with 32 AWG with slip ring tether (right , not following), trial 2

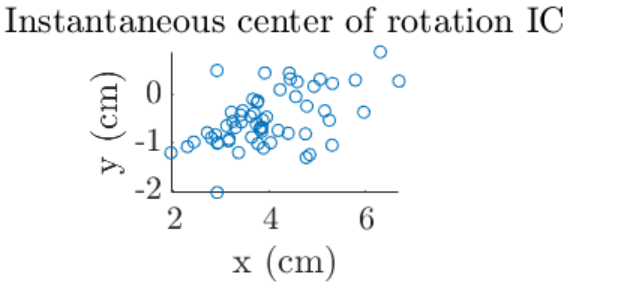


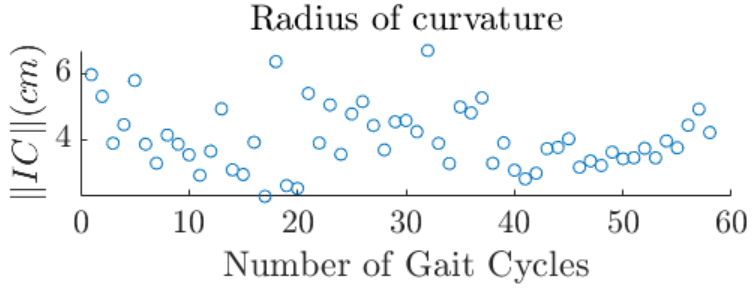




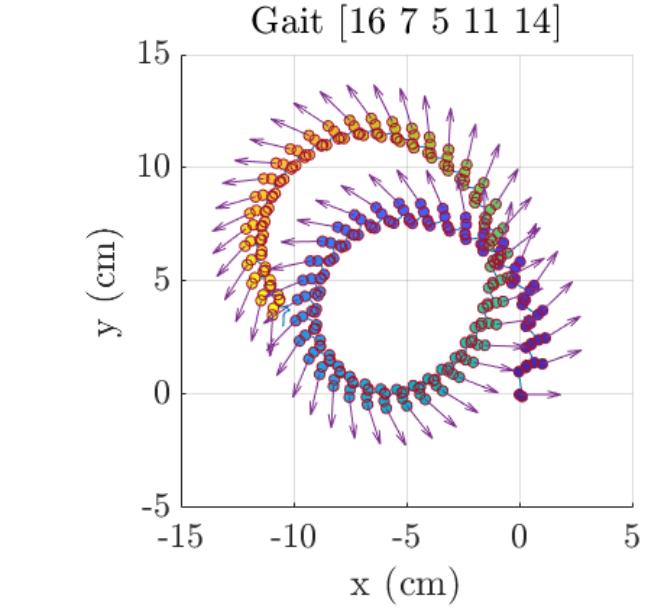
Experiment 42 : 60 cycles of Gait B with 32 AWG with slip ring tether (left , not following), trial 1

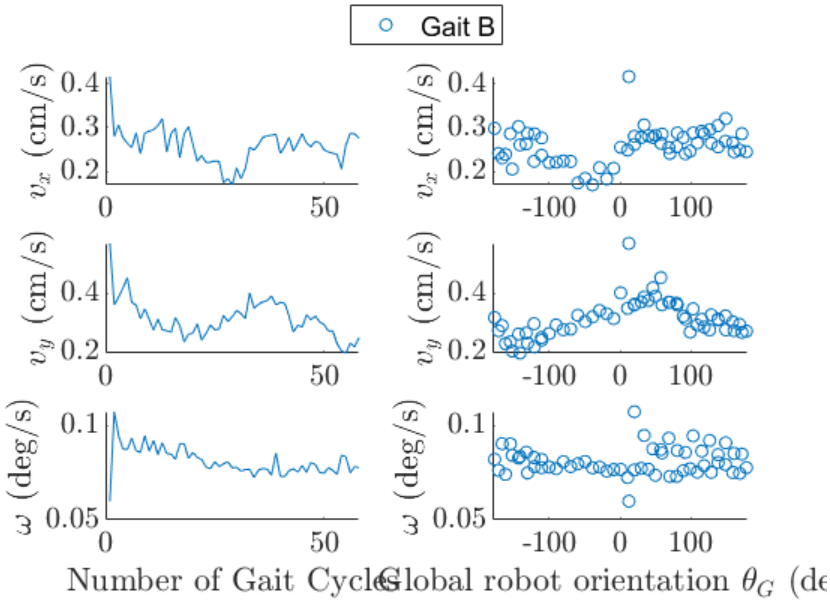


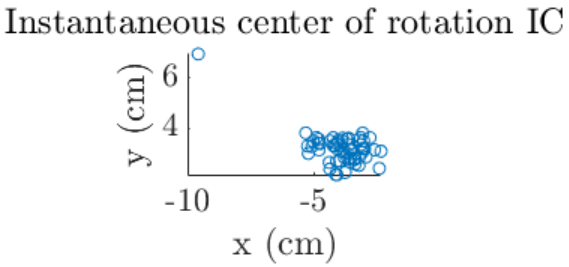


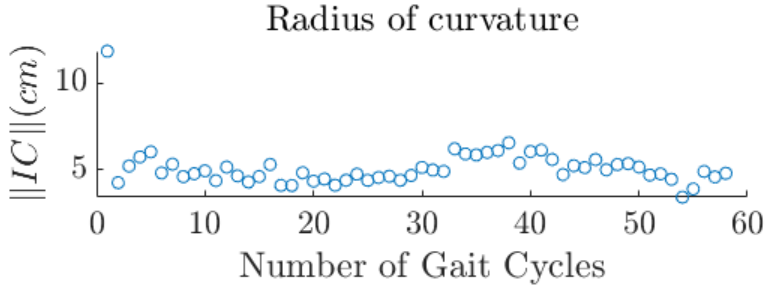


Experiment 43 : 60 cycles of Gait B with 32 AWG with slip ring tether (right , not following), trial 1

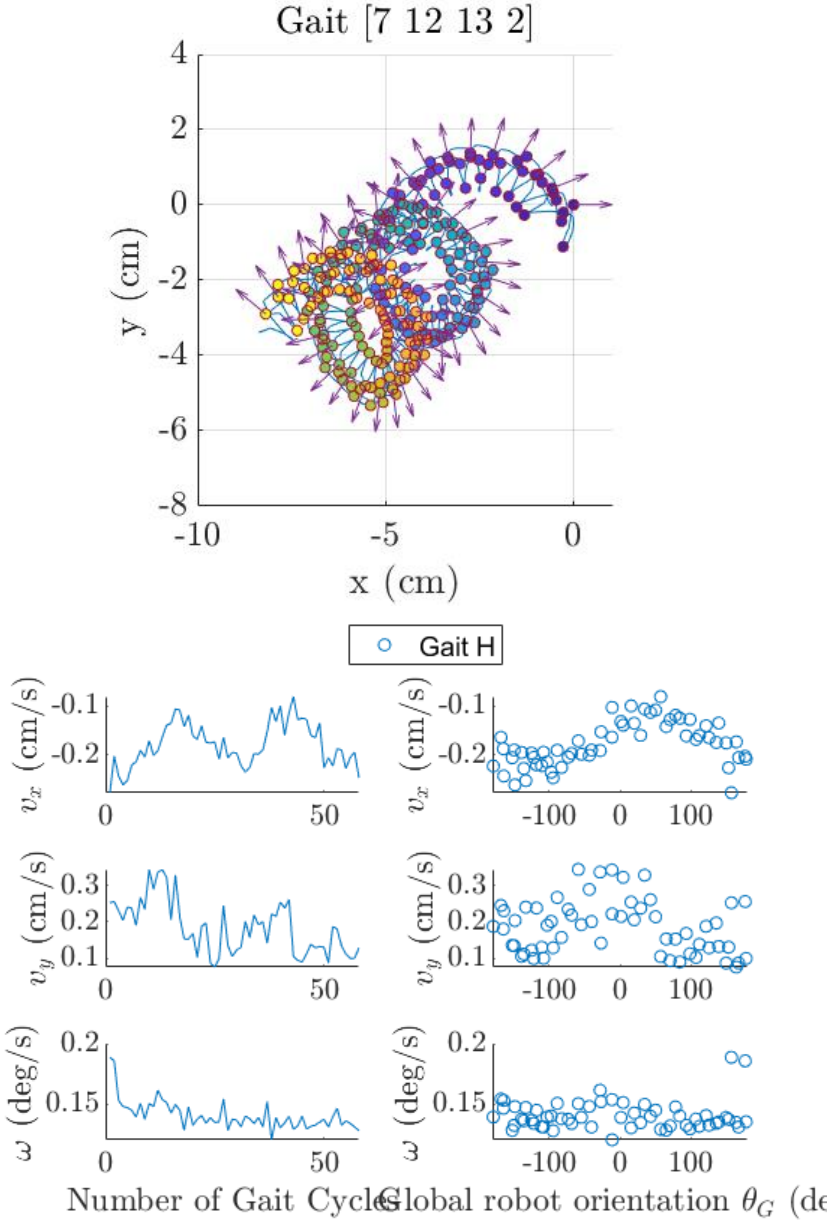


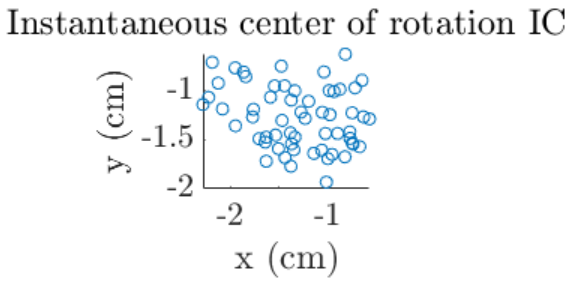


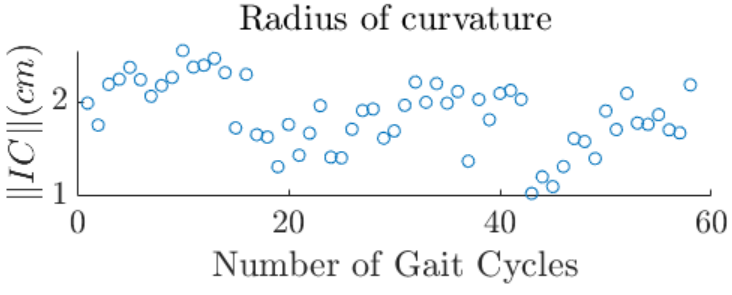




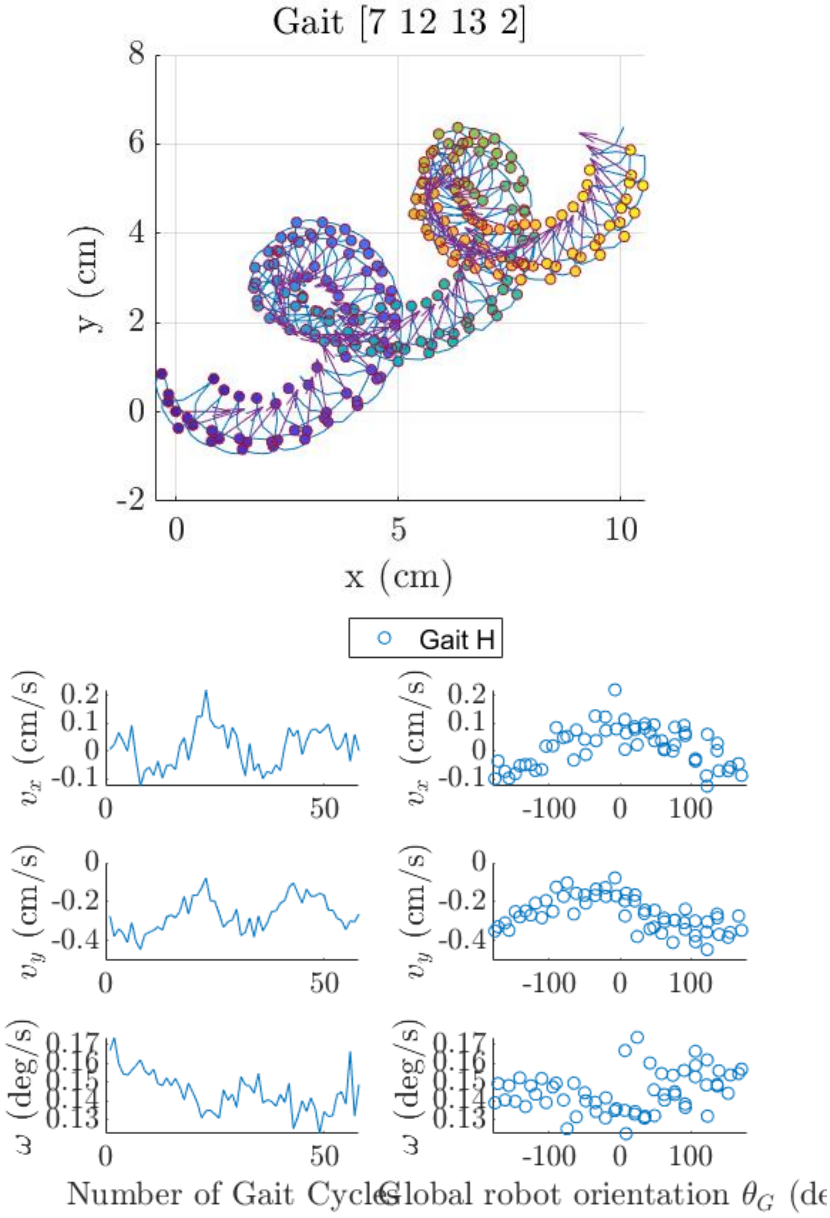
Experiment 44 : 60 cycles of Gait H with 32 AWG with slip ring tether (left , not following), trial 1

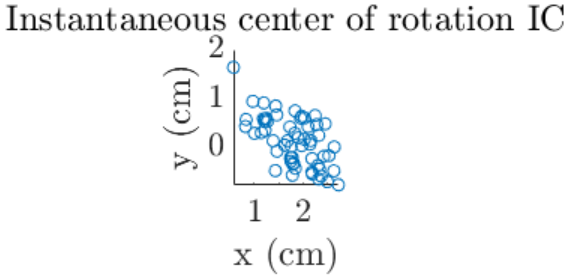


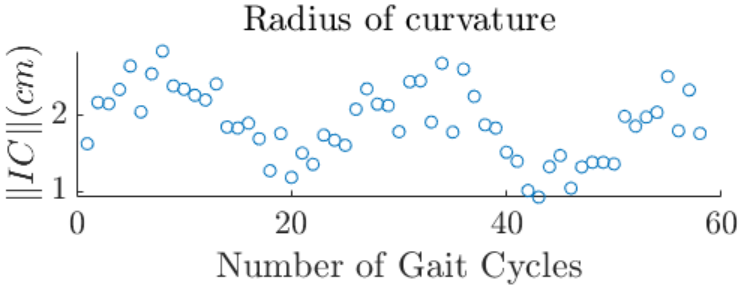




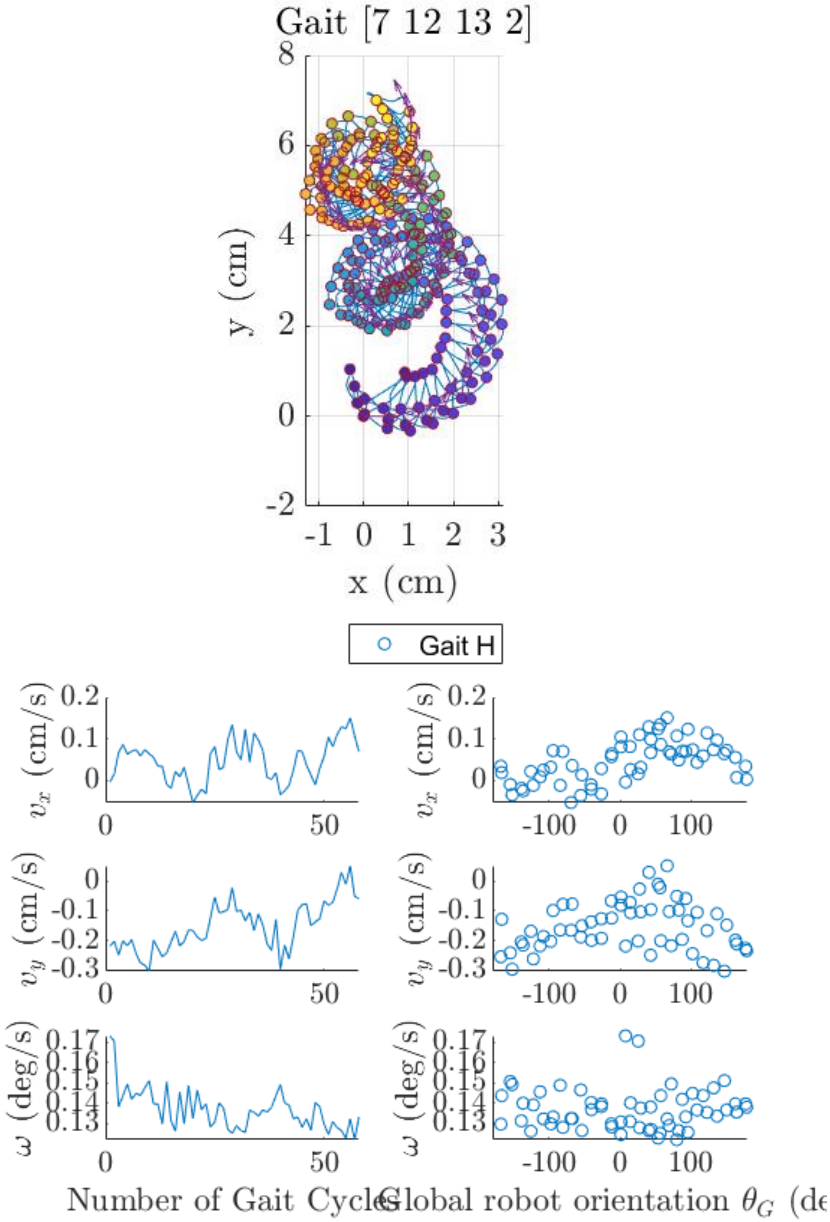
Experiment 45 : 60 cycles of Gait H with 32 AWG with slip ring tether (left , not following), trial 2

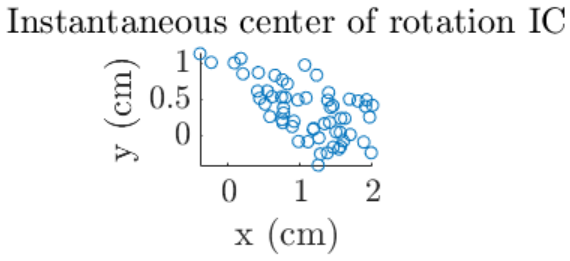


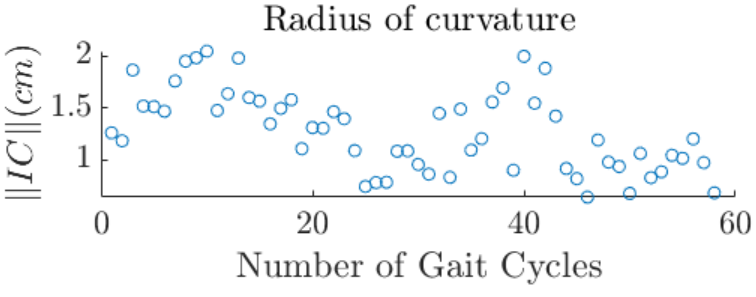




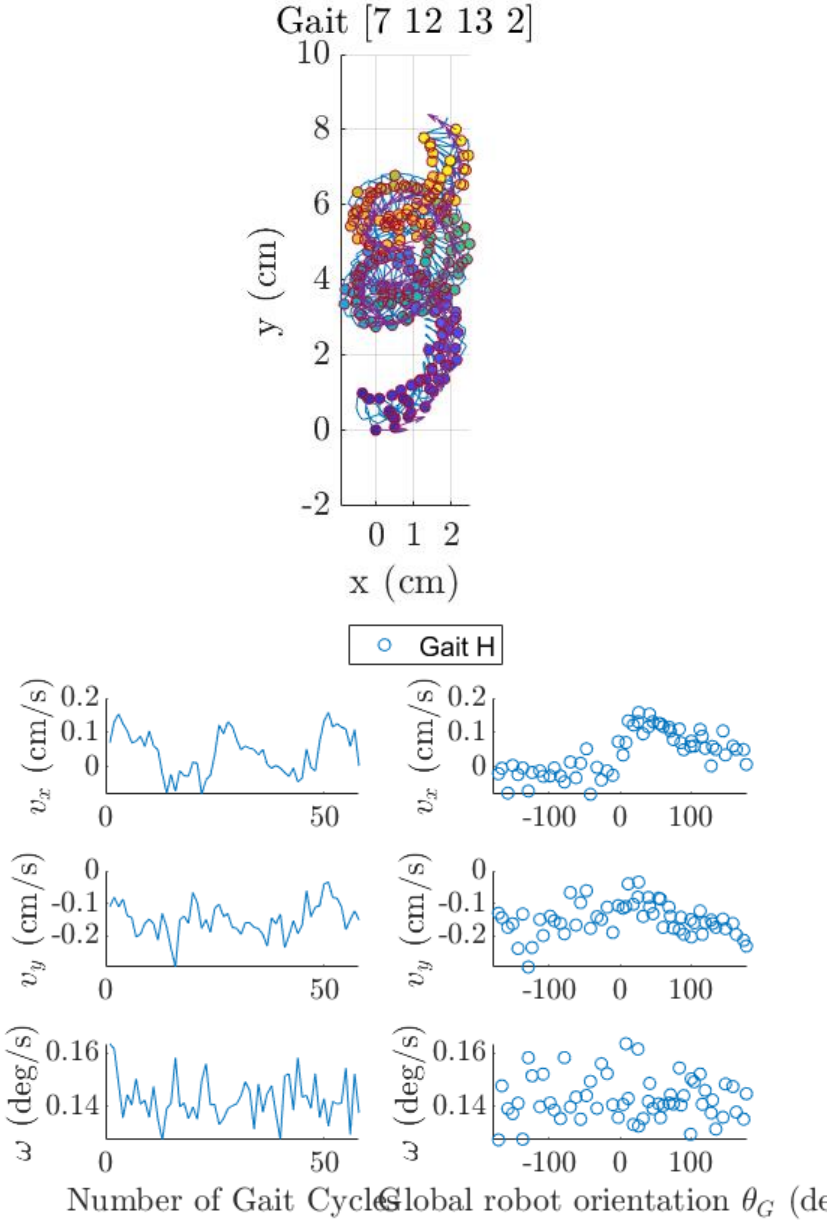
Experiment 46 : 60 cycles of Gait H with 32 AWG with slip ring tether (right , not following), trial 1

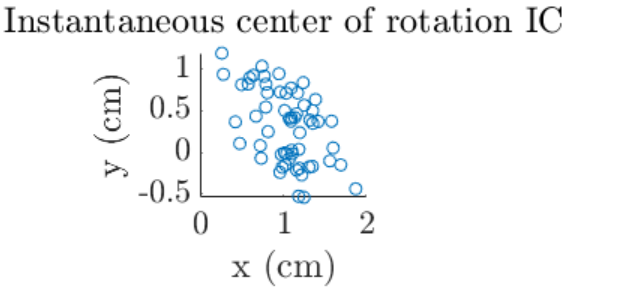


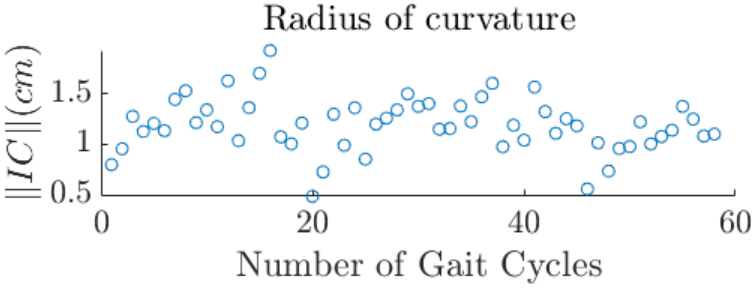




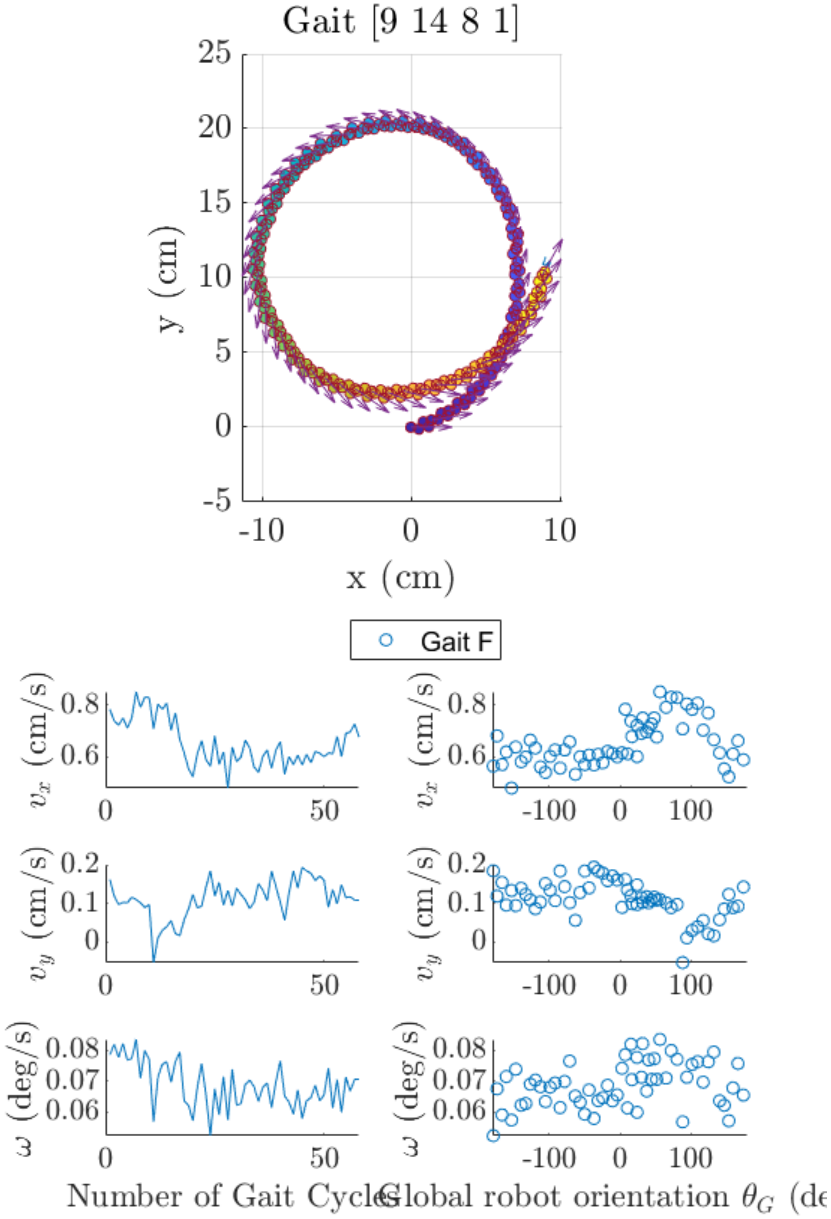
Experiment 47 : 60 cycles of Gait H with 32 AWG with slip ring tether (right , not following), trial 2

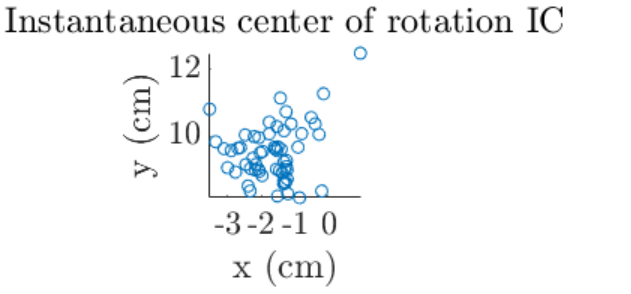


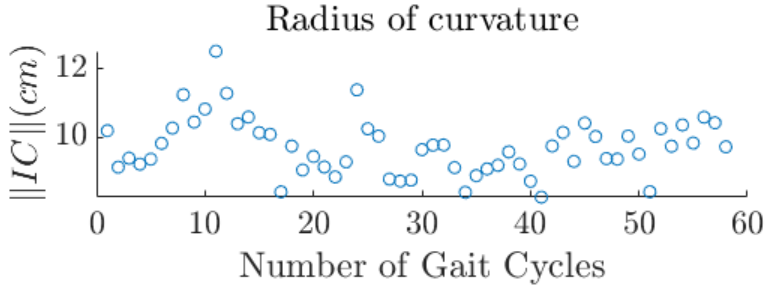




Experiment 48 : 60 cycles of Gait F with 32 AWG with slip ring tether (right , not following), trial 1







Experiment 49 : 60 cycles of Gait F with 32 AWG with slip ring tether (right , not following), trial 2