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July 7, 2015

Mr. Greg Knott
Vice President, Regulatory Affairs
Outdoor Power Equipment Institute
341 South Patrick Street
Alexandria, VA 22314

Dear Mr. Knott:

On June 4, 2015, U.S. Consumer Product Safety Commission ("CPSC") staff received a pre-canvass draft of ANSI/OPEI B71.9-201X, *American National Standard for Multipurpose Off-Highway Utility Vehicles*.[1] Staff appreciates the opportunity to comment on the pre-canvass draft and is pleased to see OPEI taking steps to improve the voluntary standard with the addition of requirements in the areas of lateral stability, vehicle handling, and occupant protection.

The proposed standard includes significant changes to ANSI OPEI B71.9 – 2012 as follows:

- Section 1. *Scope* – Deletion of 50 mph top speed from definition of "Multipurpose Off-Highway Utility Vehicles" (MOHUVs);
- Section 5.1.3 *Occupant Restraints* ─ Additional requirements for the seat belt reminder system;
- Section 5.1.4 *Occupant Side Retention Devices* ─ Additional requirements for side retention devices;
- Section 5.11 *Cargo Area* ─ Deletion of requirement for minimum cargo capacity;
- Section 5.18 *Lateral Stability Hang Tag* (renumbered section in proposed standard) ─ Addition of a hang tag requirement to include tilt table results;
- Section 8.6 *Static Stability Coefficient (K_{st})* ─ Deletion of requirement for static stability coefficient (K_{st});
- Section 8.6 *Tilt Table Stability* (renumbered section in proposed standard) ─ Increase in the minimum tilt table angle for vehicle loaded in operator-plus-passenger configuration;

[1] The comments in this letter are those of the CPSC staff and have not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

- Section 8.7 *Dynamic Stability* (renumbered section in proposed standard) ─ Addition to the speed and steering angles in J-turn test procedure; and
- Section 8.8 *Vehicle Handling* (renumbered section in proposed standard) ─ Addition of a divergent instability test using yaw rate slope ratios.

Static Lateral Stability

Tilt Table Stability

Summary of Draft Provision. Section 8.6 specifies a procedure to place a vehicle, with test weights to simulate two different test load configurations, on a tilt platform and laterally tilt the platform until the vehicle lifts both uphill tires ("tip over"). A vehicle configured with two occupants must reach a minimum of 33 degrees before lateral tip over to meet the tilt table requirements. A vehicle configured with the maximum number of occupants and full cargo load must reach a minimum of 24 degrees before lateral tip over to meet the tilt table requirements.

CPSC Staff's Comments. Staff continues to believe that tilt table angles do not correspond well to the actual rollover resistance of ROVs. Staff recognizes that the tilt table test is a quick and easy method to approximate the rollover resistance; however, the static tilt table test is not a true measure of lateral stability because the test does not account for dynamic effects of the vehicle. Staff's tilt table tests of ROVs show poor correspondence between tilt table angle ("TTA") and the lateral acceleration ("Ay") that generates two-wheel lift (and leads to rollover) for several vehicles. [2] Currently, staff is measuring Ay and TTA on newer model ROVs, and we will publish the data when testing is completed.

If the OPEI/ANSI committee is committed to developing a tilt table requirement, CPSC staff recommends a minimum angle of 35 degrees for the driver-plus-one-passenger load condition. Staff's tilt table tests of ROVs show that all models would pass OPEI's minimum tilt table angle requirement of 33 degrees, including the unrepaired Yamaha Rhino that was part of a repair program to increase its stability and vehicle handling. [3] The TTA of an unrepaired Yamaha Rhino measures 33 degrees and the TTA of a repaired Yamaha Rhino measures 35.9 degrees. Therefore, staff recommends a minimum tilt table angle of 35 degrees, to represent the improvement in TTA that was achieved with the Yamaha Rhino repair program.

Rationale for CPSC staff's comment. In March 2009, CPSC staff negotiated a repair program on the Yamaha Rhino 450, 660, and 700 model ROVs to address stability and handling issues with these vehicles. The changes made to the Rhino 700 model vehicle resulted in an increase of the TTA at two-wheel lift from 33 degrees to 35.9 degrees. Staff believes a minimum tilt table angle requirement of 35 degrees will ensure that an unrepaired Yamaha Rhino vehicle does not pass

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[2] CPSC contracted SEA Limited ("SEA") to measure the vehicle characteristics of ROVs, and the evaluation included measurement of the tilt table angle ("TTA") at two-wheel lift of several ROVs. SEA's reports are available on CPSC's website (http://www.cpsc.gov/en/Research--Statistics/Sports--Recreation/ATVs/Technical-Reports/) and staff has previously provided these reports to OPEI.
[3] CPSC Release #09-172, March 31, 2009, Yamaha Motor Corp. Offers Free Repair for 450, 600, and 700 Model Rhino Vehicles.

the tilt table requirement and represents the improvement in TTA that was achieved with the Yamaha Rhino repair program in 2009.

Tilt Table Hang Tag

Summary of Draft Provision. Section 5.18 Lateral Stability Hang Tag requires that vehicles with a maximum speed greater than 30 mph be equipped with a hang tag that provides consumers with the minimum TTA for that vehicle when loaded in the operator-plus-passenger configuration.

CPSC Staff's Comments. As noted previously, CPSC staff believes the minimum dynamic lateral acceleration required for two-wheel lift is the true indicator of the ROV's lateral stability and should be displayed on a hang tag to provide consumers with information that can be compared directly to the stability of other ROVs. However, staff welcomes OPEI's addition of the hang tag, which provides consumers with needed safety-related information.

Although staff is unable to comment fully on the proposed hang tag requirement without more information on the format and content of the hang tag, the hangtag should convey the following:

1. ROVs that exhibit a higher lateral stability metric (Ay, TTA, or other) are more stable and more resistant to rollovers.
2. Rollovers can occur on a flat surface when ROVs turn too sharply or at too high a speed.
3. Consumers should use the stability metric to compare with other vehicles before they make a purchase.

Hang tags should be designed with attention to user-centered design principles: visibility, accessibility, legibility, and language. For instance, icons should be concrete rather than abstract; scales representing rollover resistance should include anchors; and text regarding lateral stability metrics should accommodate non-expert users and should be written at an appropriate reading grade level. Hang tags should also be tested to determine if the correct message is being conveyed to the consumer.

Rationale for CPSC staff's comment. CPSC staff believes that a hang tag should include a metric that is a true representation of the vehicle's capability and should allow consumers to make informed decisions regarding the stability of ROVs when purchasing an ROV. The hang tag information should also provide a comparison between the rollover resistance of different ROV models. Therefore, the hang tag should be effective at conveying information and must be easily understood by a spectrum of consumers. Staff has not seen a sample of the proposed hang tag, but staff believes the research and data that support the effectiveness of OPEI's proposed hang tag should be provided to permit full evaluation of the proposed hang tag design and content.

Dynamic Lateral Stability

Summary of Draft Provision. The dynamic stability section of ANSI/OPEI B71.9-2012 requires that J-turn tests be conducted at a speed of 20 mph with a steering wheel angle of 180 degrees in each steering direction. Vehicle must not exhibit two-wheel lift of the vehicle in either direction to pass Section 8.6 of ANSI/OPEI B71.9-2012.

The pre-canvass draft proposal introduces a procedure for tire break-in, by conducting at least five J-turn tests (that produce two-wheel lift) in each turning direction. The pre-canvass draft proposal retains the 20 mph test speed and 180-degree steer angle J-turn maneuver for vehicles with a maximum speed equal to, or below, 50 mph. The pre-canvass draft proposal adds a J-turn maneuver at 30 mph and 110 degrees of steer angle for vehicles with a maximum speed greater 50 mph. At either test speed or steer angle, the vehicle shall not exhibit two-wheel lift in either steering direction.

CPSC Staff's Comments. CPSC staff has stated in past comments to OPEI and ROHVA, and in the briefing package for the ROV notice of proposed rulemaking ("NPR"), that staff does not believe a crash avoidance maneuver measures the stability of a vehicle because the test does not measure the lateral acceleration required to roll the vehicle over.[4,5] A J-turn crash-avoidance maneuver test limits the performance evaluation of the ROV to one specific input maneuver. Furthermore, the actual steering and severity of the turn will depend on the steering ratio of the ROV. In contrast, the rollover resistance, as measured by the minimum lateral acceleration required for two-wheel lift, indicates when the ROV will roll over in *any* turning maneuver, irrespective of steering wheel input angle or how the lateral acceleration was generated.

The rationale behind using the J-turn test as a crash avoidance maneuver is to simulate the sudden steering that an ROV driver may make to avoid a collision. The J-turn test requirement presumes implicitly that a person will turn the steering wheel 110 degrees to avoid a collision when traveling 30 mph and the ROV should not roll over in the process. However, J-turn tests by SEA and OPEI show that the steering wheel angle measured at two-wheel lift in a J-turn test is not repeatable and can vary by up to 38 percent. [6,7] As such, CPSC staff believes that the J-turn test at 30 mph should be conducted at 138 degrees to represent a conservative case, where 25 percent variability in a steer angle of 110 degrees at two-wheel lift could result in a measured steer angle of 138 degrees.

Rationale for CPSC staff's comment. In 2013, CPSC staff contracted SEA to conduct a study on the repeatability of the J-turn tests.[6] SEA conducted more than 650 J-turn tests at 30 mph. Table 1 summarizes the SEA J-turn test data for Vehicles D, E, G, and J, as measured on different test dates. The data show that steering wheel angle at two-wheel lift can vary up to 22 percent.

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[4] 79 FR 68964 Safety Standard for Recreational Off-Highway Vehicles ("ROVs")
[5] Supplemental Information on Recreational Off-Highway Vehicles ("ROVs"). Retrieved from: http://www.cpsc.gov/Global/Newsroom/FOIA/CommissionBriefingPackages/2015/SupplementalInformation-ROVs.pdf.
[6] Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Appendix E. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf.
[7] RE: Docket No. CPSC-2009-0087, OPEI Comments to 16 CFR Part 1422, Safety Standard for Recreational Off-Highway Vehicles (ROVs). Exhibit I OPEI Round Robin Testing Summary. Retrieved from: http://www.regulations.gov/#!documentDetail;D=CPSC-2009-0087-0693.

Table 1. Comparison of steering wheel angle ("deg") required for two-wheel lift in 30 mph J-turn measured for Vehicles D, E, G, and J on different test dates.

Vehicle	Steering Wheel Angle (deg) SEA report 2011	Steering Wheel Angle (deg) SEA report 2013	Difference in Steer Angle (deg)	Percent Difference from First Measurement
D	100	122	22	22%
E	150	164	14	9%
G	205	210	5	2.5%
J	110	105	-5	-4.5%

Adapted from: Heydinger, G. (2011). Vehicle Characteristics Measurements of Recreational Off-Highway Vehicles – Additional Results for Vehicle J. Appendix B. Retrieved from http://www.cpsc.gov/PageFiles/93928/rovj.pdf. and Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Appendix E. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf

In 2015, OPEI conducted a round robin test to study the repeatability of J-turn testing with three different vehicles and three different test entities.[7] Table 2 summarizes the average steering wheel angle at two-wheel lift for each vehicle at each test location. The data show that steering wheel angle at two-wheel lift can vary up to 38 percent.

Table 2. Comparison of steering wheel angle ("deg") required for two-wheel lift in 30 mph J-turn measured for Vehicles 1,2, and 3 at Site A, B, and C.

	Steering Summary (degrees)			Largest percent difference
	Site A	Site B	Site C	
Vehicle 1	215	205	249	21%
Vehicle 2	168	166	183	10.2%
Vehicle 3	161	191	223	38.5%

Adapted from: RE: Docket No. CPSC-2009-0087, OPEI Comments to 16 CFR Part 1422, Safety Standard for Recreational Off-Highway Vehicles ("ROVs"). Exhibit I OPEI Round Robin Testing Summary. Retrieved from: http://www.regulations.gov/#!documentDetail;D=CPSC-2009-0087-0693.

CPSC staff is concerned that a vehicle that passes the J-turn test requirement by not exhibiting two-wheel lift at a steering input of 110 degrees in one set of test conditions, may exhibit two-wheel lift at a much lower steer angle in a different set of test conditions.

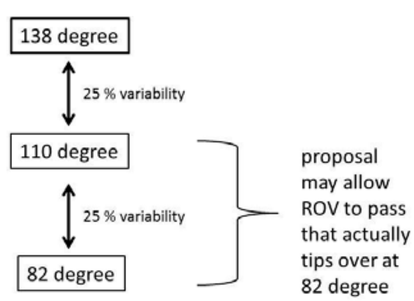


Figure 1. Possible variability in steering wheel angle at two-wheel lift.

Although the data is limited, assuming 25 percent variability in steer angle measured at two-wheel lift appears reasonable. Therefore, Staff believes the minimum steer angle should be increased and set at 138 degrees to ensure that an ROV will exhibit a minimum steer angle of 110 degrees or above at two-wheel lift in a 30 mph J-turn test (see Figure 1).

Vehicle Handling

The pre-canvass draft proposal includes significant changes to ANSI OPEI B71.9 – 2012, with the addition of a vehicle handling requirement in Section 8.8, *Vehicle Handling*.

Summary of Draft Provision. The pre-canvass draft proposal specifies test vehicle configuration, test surface conditions, test instrumentation specifications, and test procedures for conducting a constant steer angle test for an ROV on a 50 foot radius circle.

The test procedure describes a tire break-in procedure, followed by procedures to establish the steer angle required to drive the test vehicle on a 50-foot radius at a slow speed. Once the steer angle is established and the test vehicle's steering wheel is locked at this angle, the driver slowly increases the speed of the vehicle until one of the following occurs:

- The vehicle no longer accelerates,
- The vehicle achieves a lateral slide, or
- The vehicle achieves two-wheel lift.

The test procedure requires five test runs in the clockwise and counter-clockwise directions, with instrumentation recording the vehicle speed, yaw rate, and steer angle. Plots of the vehicle's yaw rate versus speed are used to determine the pass/fail criteria for vehicle handling. The proposed test computations calculate the slope of the yaw rate from 0.1 to 0.2 g[8] (a condition when the vehicle is moving slowly around the circle) and the slope of the yaw rate from 0.4 to 0.5 g (a condition when the vehicle is moving around the circle at higher speed). The ratio R is defined as the slope of the yaw rate plot at the end of the test, divided by the slope of the yaw rate plot at the start of the test, as follows:

$$R = \frac{m_e}{m_s}$$

Where
R = Ratio of the average of the slopes
m_e = Average of the slopes from 0.4 to 0.5 g
m_s = average fof the slopes from 0.1 to 0.2 g

The performance requirements state that no test shall result in a spin-out or two-wheel lift, and the ratio R cannot exceed a value of 3.5 before 0.5 g of lateral acceleration has been achieved.

CPSC Staff's Comments. CPSC staff is encouraged that OPEI introduced specific performance requirements for vehicle handling to avoid divergent instability in ROVs. CPSC staff believes the sudden increase in lateral acceleration that is associated with divergent instability is

[8] Acceleration is expressed as a multiple of free-fall gravity (g), which is equal to 32.3 ft/s^2.

undesirable because it can cause a sudden untripped[9] rollover of a vehicle or can cause a vehicle to slide into limit oversteer[10] and experience tripped[11] rollover.[4,12] Divergent instability is detected as a nonlinear increase in yaw rate (as the vehicle response becomes uncontrollable) and as a nonlinear increase in lateral acceleration (as the resulting decrease in turn radius causes lateral acceleration to increase).

CPSC staff contracted SEA to conduct constant steer angle tests of several ROVs on a 50-foot radius circle. The test results for nine vehicles that have been tested by SEA, in accordance with the constant steer angle protocol followed by Polaris, are attached as Appendix A. Test results show that the constant steer angle test is capable of detecting divergent oversteer as a function of lateral acceleration, as shown in Figure 2. Lateral acceleration gain increase becomes asymptotic in a vehicle exhibiting divergent instability, compared to linear acceleration gain in a stable vehicle.

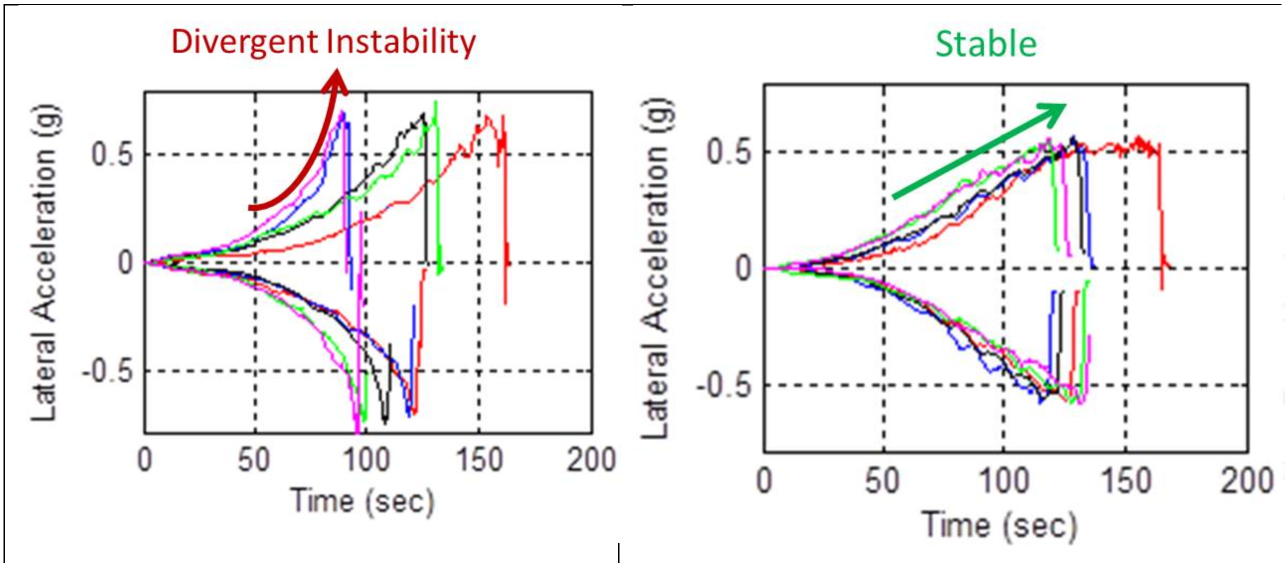


Figure 2. Examples of divergent and stable lateral acceleration gain during constant steer angle test.

Similarly, the constant steer angle shows divergent instability as a function of yaw rate increase, as shown in Figure 3. Yaw rate gain increase becomes asymptotic in a vehicle exhibiting divergent instability compared to linear yaw rate gain in a stable vehicle.

[9] "Untripped" refers to a rollover caused solely as a result of the lateral forces created at the tire-road interface.
[10] "Limit oversteer" refers to the condition when the traction limits of the tires have been reached and the vehicle begins to slide.
[11] "Tripped" refers to rollover caused by a sliding vehicle's impact with an obstacle, such as a berm or curb.
[12] Letter from Caroleene Paul, CPSC, to Tom Yager, ROHVA, dated May 23, 2014. Retrieved at: http://www.cpsc.gov/Global/Regulations-Laws-and-Standards/Voluntary-Standards/ROHVA/052314signedCommentLettertoROHVACanvassDraft03032014.pdf.

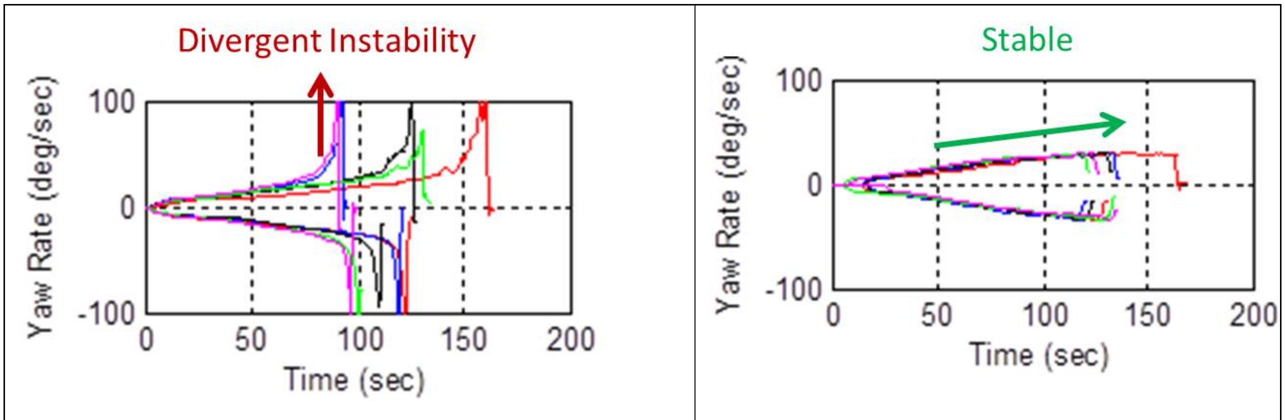


Figure 3. Examples of divergent and stable yaw rate gain during constant steer angle test.

On May 5, 2015, at a public voluntary standards meeting to discuss the Recreational Off-Highway Vehicle Association (ROHVA) standard for ROVs, an engineer from Polaris Industries presented information on divergent instability and how it could be measured in a vehicle using the constant steer angle test. As shown in Figure 4, Polaris plotted yaw rate versus speed and defined divergent instability as the condition where the vehicle's yaw rate increase becomes nonlinear and asymptotic ("it goes vertical").[13] Furthermore, divergent instability that results in multiple m_e slope values is considered unsafe and undesirable. This phenomenon was described as the condition where the various m_e slopes look like "fingers."

The pre-canvass draft proposal plots the yaw velocity versus vehicle speed for each test run, and calculates the average of the absolute value of the slopes of the data from 0.1 to 0.2 g (starting slopes) and the average of the absolute value of the slopes of the data from 0.4 to 0.5 g (end slopes). The pre-canvass draft proposal of OPEI would allow the ratio of the average end slopes divided by the average starting slopes, R, up to a value of 3.5.

CPSC staff is concerned that values of 3.5 for the ratio R will allow vehicles that exhibit divergent instability to pass the vehicle handling requirement.

CPSC staff contracted SEA to conduct constant steer angle tests in accordance with the protocol in the pre-canvass draft, and staff is concerned with the preliminary results. As shown in Figure 5, SEA's test data show that a vehicle that meets the OPEI vehicle handling requirement for R = 3.5 or less exhibits divergent instability, as defined by originally defined by Polaris, in Figure 4.

[13] Presentation titled, "A Handling Quality Metric 100 ft Testing Data." Retrieved from: http://www.cpsc.gov//Global/Newsroom/FOIA/Meeting%20Logs/2015/050515-Meeting-Log-ROHVA.pdf.

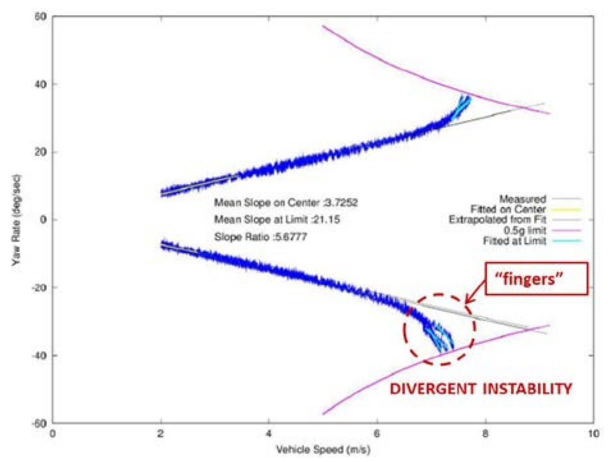


Figure 4. Divergent instability as defined by Polaris.

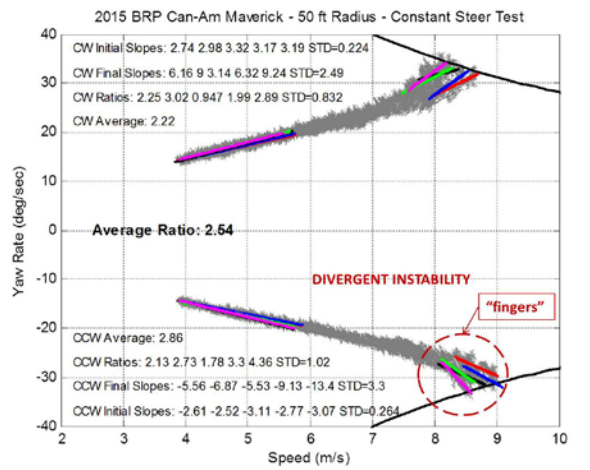
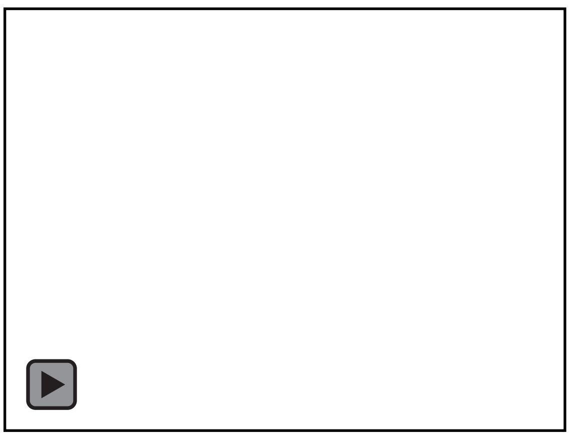


Figure 5. Divergent instability measured in ROV that passes proposed performance requirement.

This vehicle also exhibited undesirable spin-out at approximately 20 mph at the end of the test as shown in the following video:



Staff believes that a vehicle exhibiting such an uncontrollable response is dangerous and should not pass any vehicle handling requirement. Staff agrees with OPEI's position that divergent instability is undesirable and dangerous because the vehicle may slide into a tripped rollover.[14] Therefore, staff is concerned that even though the vehicle in Figure 4 shows "divergence," as originally defined by Polaris and incorporated into the OPEI Draft ballot, and exhibits spin-out during the yaw test, the vehicle passes the proposed vehicle handling requirement with an R value of 2.54.

Figures 4 and 5 also show that the vehicles are tested at speeds of approximately 17 mph (7.5 m/s) and 20 mph (9 m/s) on a radius of 50 feet. Therefore, the pre-canvass draft test procedure evaluates these vehicles at a very low speed range for an ROV (some ROVs exhibit maximum

[14] Meeting log dated March 10, 2015. Retrieved from: http://www.cpsc.gov//Global/Newsroom/FOIA/Meeting%20Logs/2015/Meeting_Log_Polaris-dynamic_stability.pdf.

speeds of 68 mph[4]). Divergent instability at higher speeds is more dangerous than the divergent instability illustrated by the test procedure at 17 to 20 mph; therefore, the R-value should reflect a conservative factor of safety to prevent divergent instability at higher speeds.

Figures 6 and 7 show another vehicle that exhibits divergent instability during the constant steer angle test with severe lateral acceleration gain that curls back on itself. During the test, this vehicle exhibited undesirable spin-out at the end of the test. Staff is concerned that the vehicle in Figure 6 and 7 shows divergence, has negative m_e slopes because the divergence causes spin-out during the yaw test, but still passes the proposed vehicle handling requirement because its R value is 2.91.

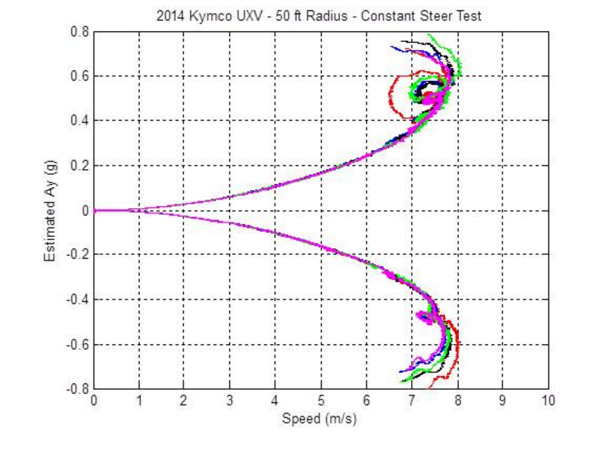


Figure 6. Divergent lateral acceleration gain that curls back on itself.

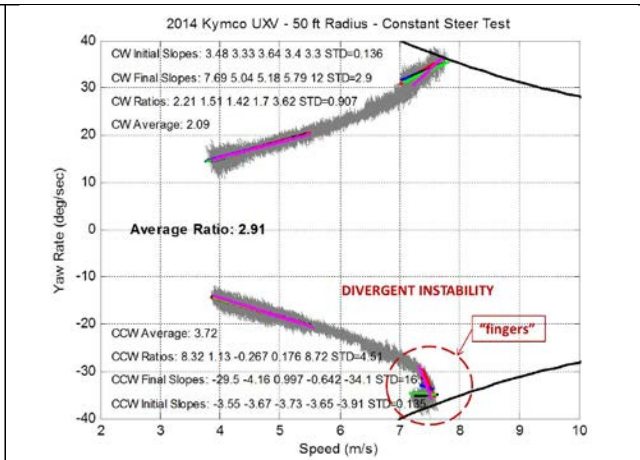


Figure 7. Divergent instability measured in ROV with negative end slopes that passes proposed performance requirement.

Lastly, CPSC staff does not believe divergent instability is acceptable in either the clockwise (right turn) or counterclockwise (left turn) directions. Staff is concerned that the pre-canvass draft proposed test procedure takes the average of the yaw ratios in the left and right turn directions when calculating the R value. A vehicle that exhibits divergent instability in one direction but not the other direction can pass the R value minimum of 3.5 when the ratios are averaged. Staff believes such a vehicle is dangerous because uncontrolled vehicle response is possible. Staff believes the results in each direction should be evaluated separately and should not be averaged to produce an unrealistic overall value for the R.

CPSC staff believes that a performance requirement based on the constant steer angle test can be developed to ensure ROVs do not exhibit divergent instability, if the appropriate criteria are used to determine the pass/fail performance. Staff believes four modifications to the performance criteria would further ensure ROVs do not exhibit divergent instability:

1. Add language to ensure R value that does not allow divergent instability,
2. Add language to not allow negative m_e slopes,
3. Take into account the maximum speed range of the vehicle, and
4. Modify the language to calculate the ratio separately for the left turns and right turns.

Occupant Protection

The pre-canvass draft proposal includes significant changes to Section 5.1 Occupant Protective Systems in ANSI OPEI B71.9 – 2012, with additional requirements for the seat belt reminder system in Section 5.1.3, and the side retention devices in Section 5.1.4.

Seat Belt Reminder/Speed Limitation

Summary of Draft Provision. Section 5.1.3.2 Seat Belt Reminder in ANSI/OPEI B71.9-2012 required a seat belt reminder system that activates a visual reminder to the driver for at least 8 seconds if the driver's seat belt is unbuckled when the vehicle is started. The pre-canvass draft proposal introduces an additional requirement for a system that limits the vehicle's maximum speed to 15 mph if the driver's seat belt is not buckled.[15] The proposal specifies a maximum speed test on level ground with the vehicle loaded in the curb weight plus one operator configuration. The vehicle speed cannot exceed 15 mph with the driver's seat belt unbuckled.

CPSC Staff's Comments. CPSC staff supports OPEI's effort to strengthen significantly the occupant protection of ROVs by introducing a seat belt reminder system that limits the speed of the ROV to 15 mph if the driver's seat belt is unbuckled.

Seat Belts

Summary of Draft Provision. Section 5.1.3.1 Seat Belts in ANSI/OPEI B71.9-2012 requires a Type II 3-point seat belt (lap/shoulder belts) that conforms to SAE J386-FEB2006, *Operator Restraint System for Off-Road Work Machines,* with various exceptions to the SAE requirements.

One exception is:

> e) Replace the requirements of SAE J386, sections 5.4.3.1.a and **5.4.3.1.d** of section 5.4.3, Emergency Locking Retractors (ELR), with the requirement that manufacturers shall determine the appropriate locking point based on the vehicle's intended use.
>
> *NOTE: SAE J386 section* ***5.4.3.1.d The retractor shall lock when its sensing device is tilted by more than 40°***

The ANSI/OPEI B71.9-2012 exemption allows the seatbelts not to have a tilt sensing ELR in the seatbelt retractor. This results in seatbelts that do not lock up during a slow rollover. SEA roll simulator testing showed that ROVs without a solid shoulder retention barrier and a tilt sensing ELR could result in the occupant coming out of the safety zone during a 45-degree roll over. Vehicle H shown in Figure 8 does not have a passive shoulder barrier, nor was it equipped with a tilt sensing ELR. CPSC staff testing of Vehicle H shows that the seat belt does not lock throughout a 90-degree tilt range. Figure 9 shows the occupant coming out of the protective zone of the rollover protective structure ("ROPS") during a simulated roll over.

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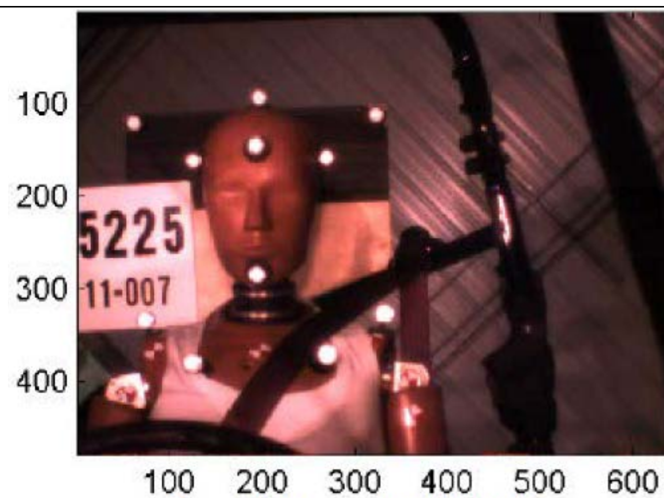
[15] The additional seat belt reminder system is required for vehicles with a maximum speed greater than 30 mph.

 Figure 31: Vehicle H Side View	 Figure 32: Occupant H at 45° Roll
Figure 8. Vehicle H with shoulder and lap belt, without shoulder barrier.	**Figure 9. Occupant coming out of the safety zone during a simulated roll over. Seatbelt does not have a tilt sensing ELR.**

SEA roll simulator testing showed that vehicles with tilt sensing ELR performed better. Vehicle C, shown in Figure 10, does not have a passive shoulder barrier but was equipped with a tilt sensing ELR. CPSC staff test of Vehicle C shows that the seatbelt locks at approximately 53-degree tilt angle. By cross-referencing the lateral acceleration seen in the SEA sled tests with the acceleration associated with the locking angle of the inertial seat belt, the inertial spool lock engaged at approximately 10 degrees of vehicle roll. Figure 11 shows the occupant remaining in the protective zone of the ROPS during a simulated roll over.

 Figure 23: Vehicle C Side View	 Figure 24: Occupant C at 45° Roll
Figure 10. Vehicle C with shoulder and lap belt, without shoulder barrier.	**Figure 11. Occupant remaining in the safety zone during a simulated roll over. Seatbelt has a tilt sensing ELR.**

CPSC staff believes that the combination of the belt routing, the tilt sensing ELR, and other unknown features interacted to limit occupant excursion.

Occupant Side Retention Devices

Summary of Draft Provision. Section 5.1.4 Occupant Side Retention Devices in ANSI/OPEI B71.9-2012 required physical barriers or design features of the vehicle to reduce the possibility of entrapment of a properly belted occupant's head, upper torso and limbs, between the vehicle and the terrain in the event of a quarter-turn rollover. The pre-canvass draft proposal introduces additional performance requirements for vehicles with a maximum speed greater than 30 mph. The performance requirements include a probe test in the occupant shoulder area of the ROV, applied with an outward force of 163 lbs. The occupant side retention device must not deflect more than 2 inches after the probe has been applied for 10 seconds.

CPSC Staff's Comments. CPSC staff supports OPEI's effort to improve the occupant retention performance of ROVs by specifying performance requirements for side retention devices.

CPSC staff continues to recommend passive shoulder barriers. Staff recognizes that one-hand operated doors and nets are passive, once engaged by the consumer; however, staff believes that doors are more likely to be used than nets, and staff remains concerned that nets will not be used. Roll simulation tests show that a belted occupant can come outside of the protection zone of the ROPS if a shoulder barrier is not used. Seatbelts with tilt sensing ELRs may improve occupant containment during a rollover, but SEA testing shows that the combination of a seatbelt and a shoulder restraint is the most effective configuration in retaining occupants in a rollover event. Staff is confident that passive shoulder barriers and seat belts will keep occupants contained within the vehicle. For these reasons, we continue to recommend that ROVs have passive shoulder barriers and seatbelts that limit the ROV's speed, if not used.

Thank you for this opportunity to comment. CPSC staff looks forward to continued communication with OPEI regarding the ANSI/OPEI B71.9-201X draft standard. If you have any questions or comments, please feel free to contact me.

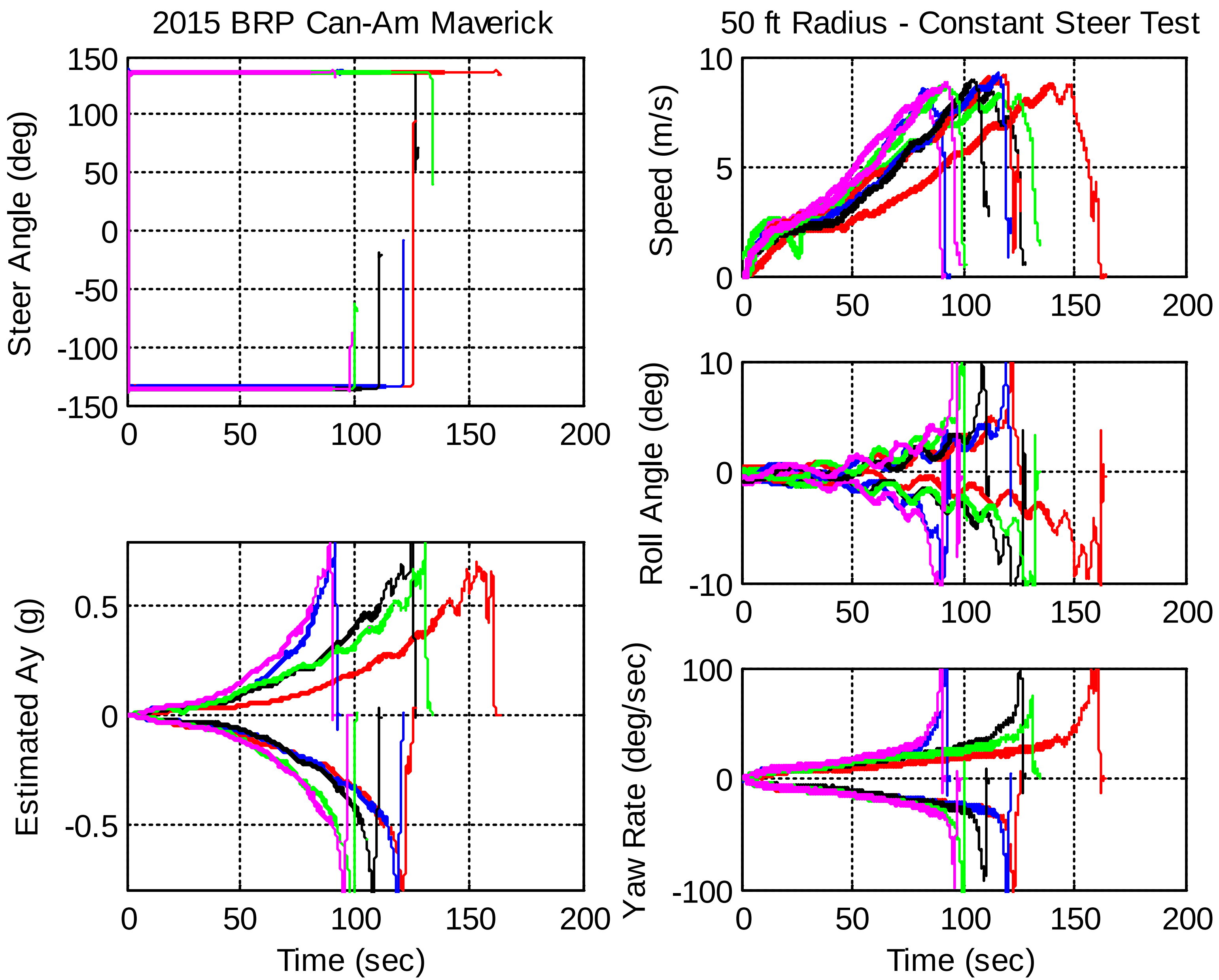
Sincerely,

Caroleene Paul

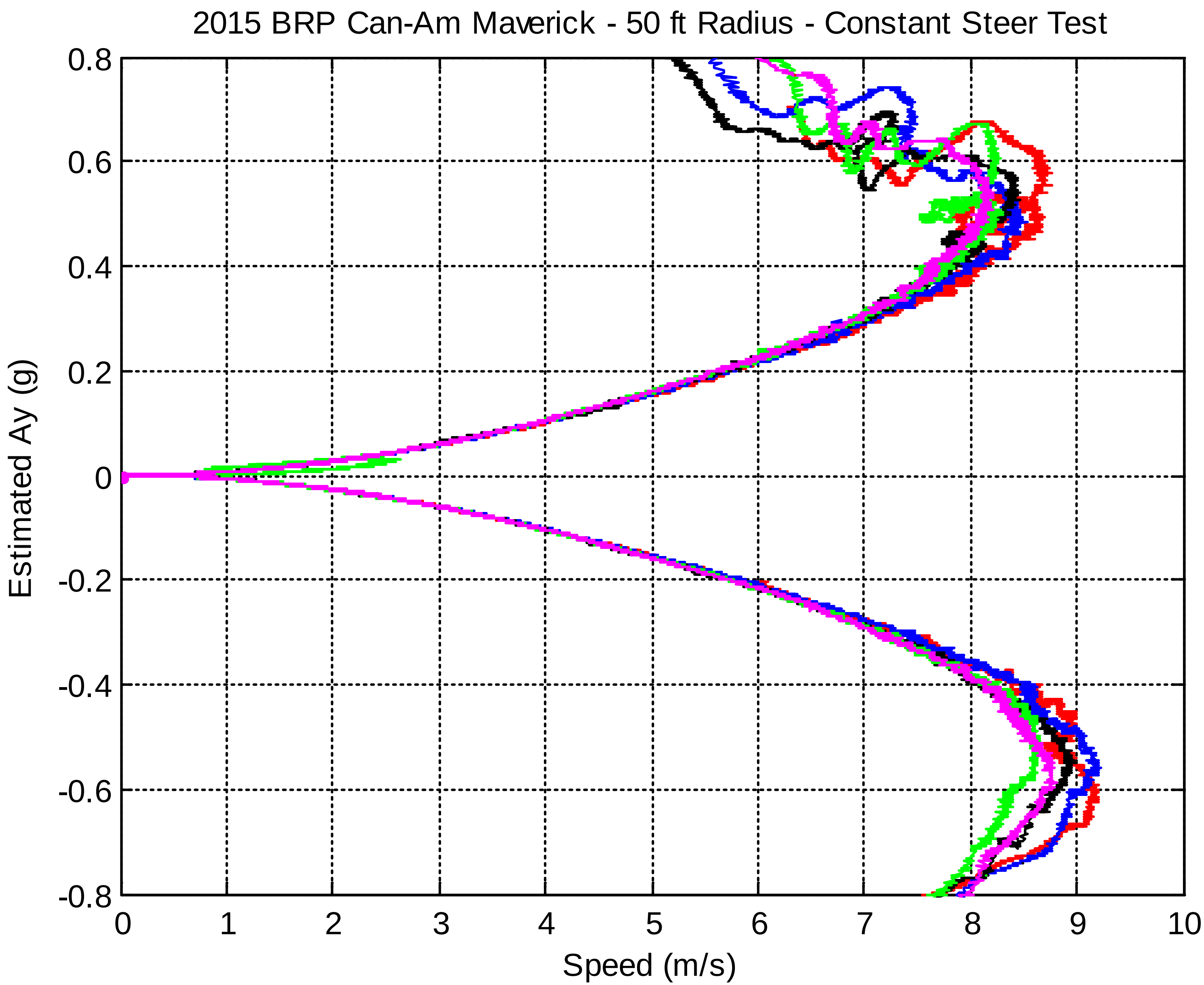
cc: Colin Church, CPSC Voluntary Standards Coordinator

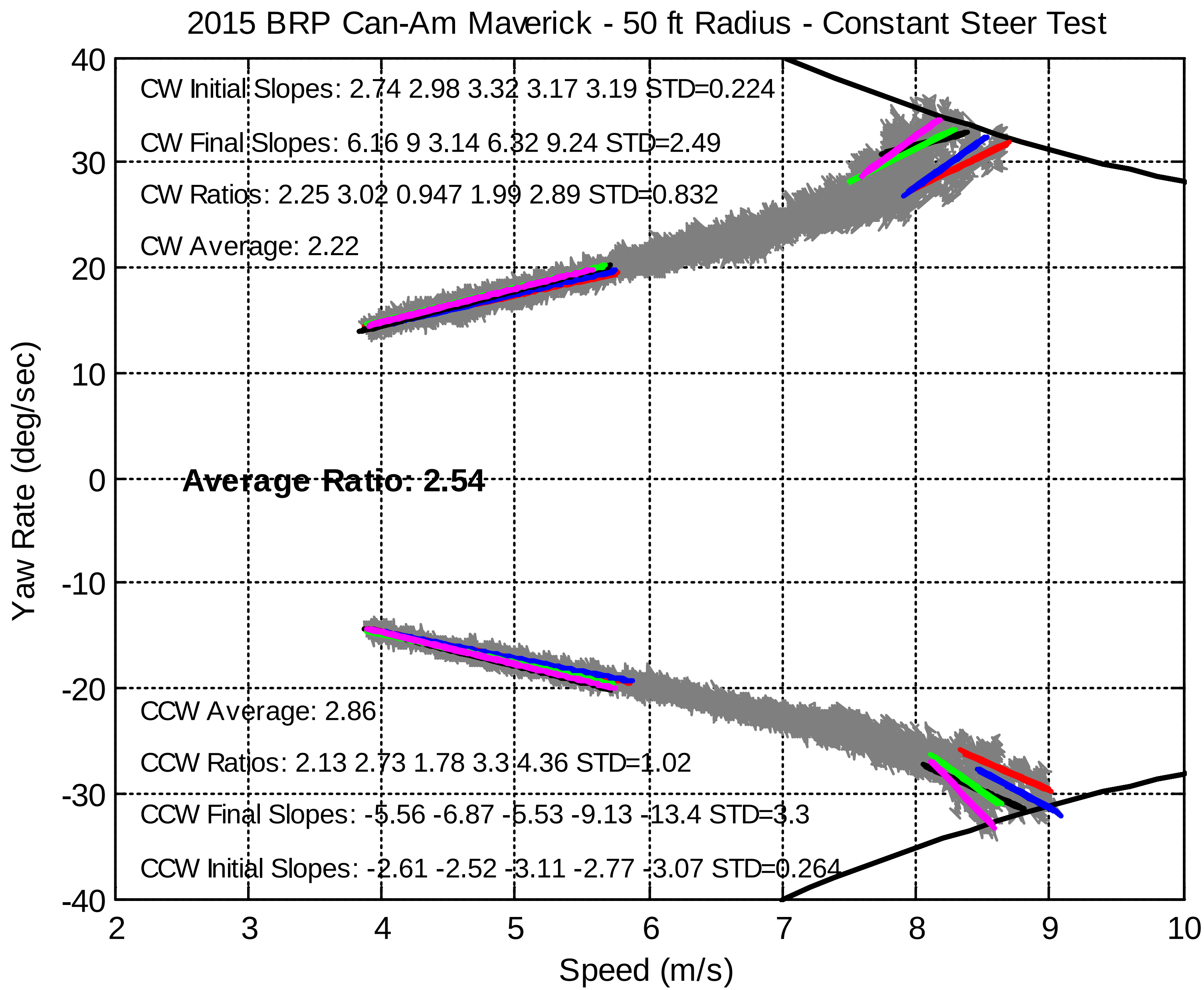
Appendix A

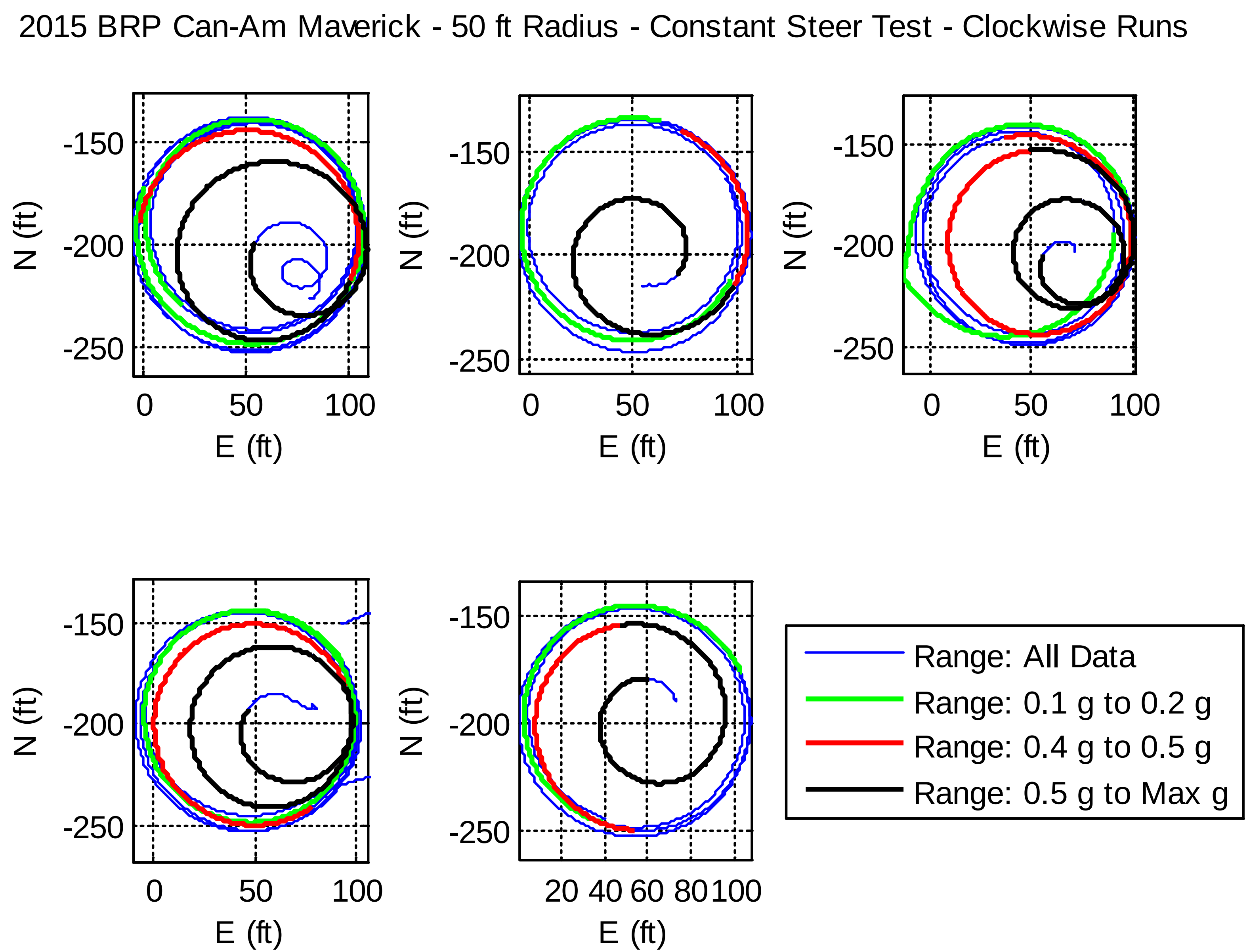
Data from SEA



2015 BRP Can-Am Maverick
50 ft Radius - Constant Steer Test
Steer Angle (deg)
150
100
50
0
-50
-100
-150
0
50
100
150
200
Speed (m/s)
10
5
0
Roll Angle (deg)
-10
Estimated Ay (g)
0.5
-0.5
Yaw Rate (deg/sec)
-100
Time (sec)
Time (sec)

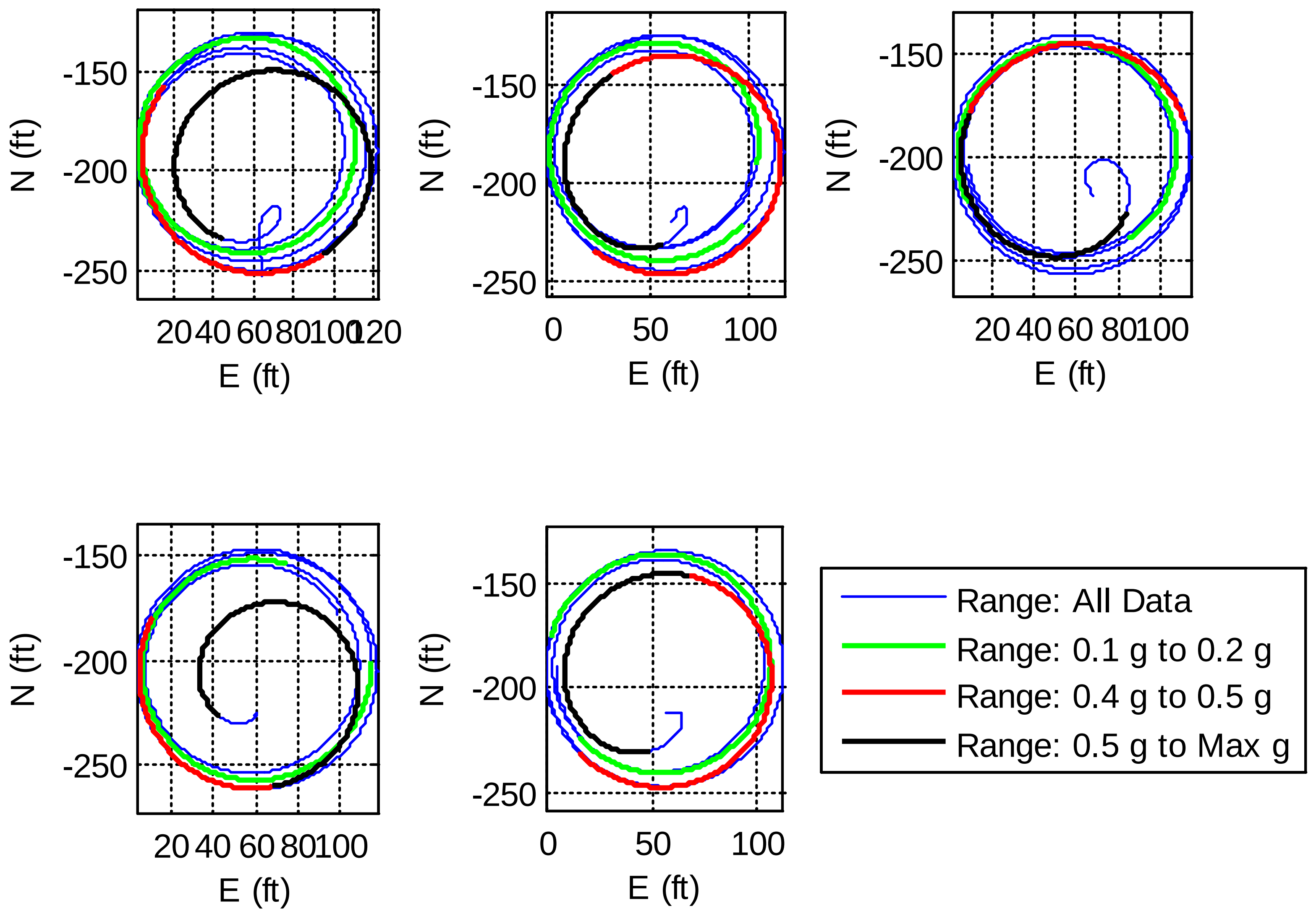

2015 BRP Can-Am Maverick - 50 ft Radius - Constant Steer Test
Estimated Ay (g)
Speed (m/s)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
1
2
3
4
5
6
7
8
9
10

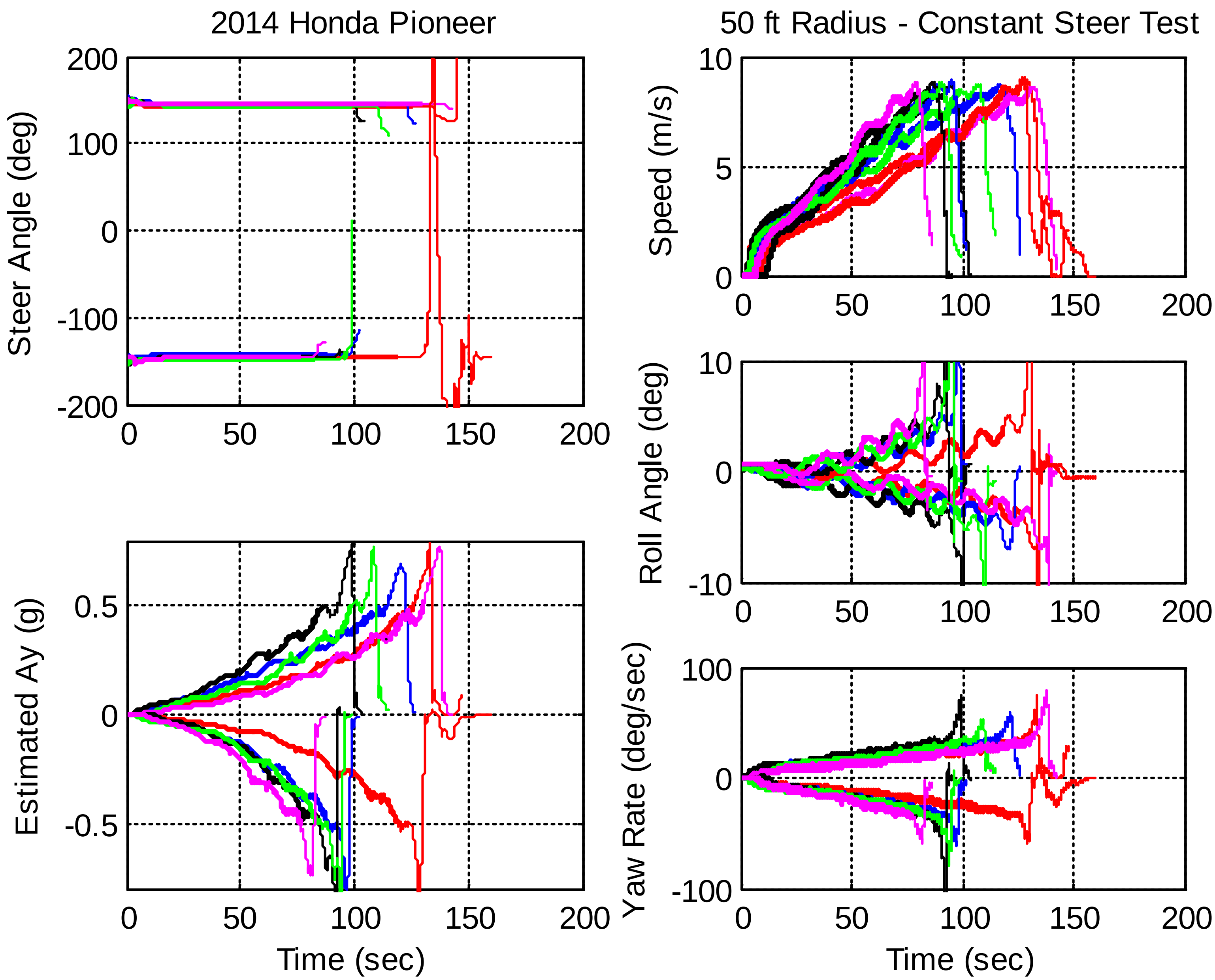

2015 BRP Can-Am Maverick - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 2.74 2.98 3.32 3.17 3.19 STD=0.224
CW Final Slopes: 6.16 9 3.14 6.32 9.24 STD=2.49
CW Ratios: 2.25 3.02 0.947 1.99 2.89 STD=0.832
CW Average: 2.22
Average Ratio: 2.54
CCW Average: 2.86
CCW Ratios: 2.13 2.73 1.78 3.3 4.36 STD=1.02
CCW Final Slopes: -5.56 -6.87 -5.53 -9.13 -13.4 STD=3.3
CCW Initial Slopes: -2.61 -2.52 -3.11 -2.77 -3.07 STD=0.264
Yaw Rate (deg/sec)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10
Speed (m/s)

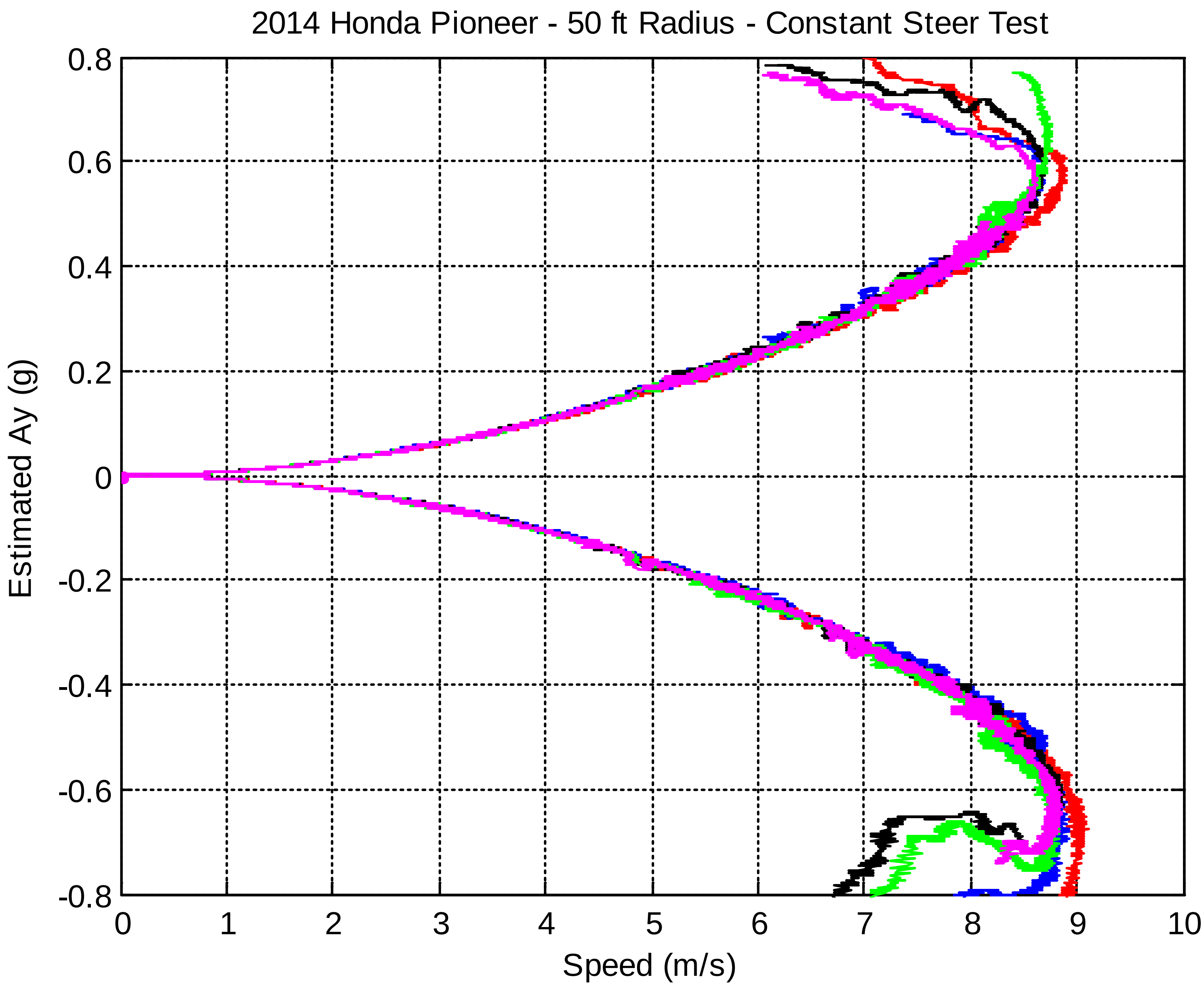


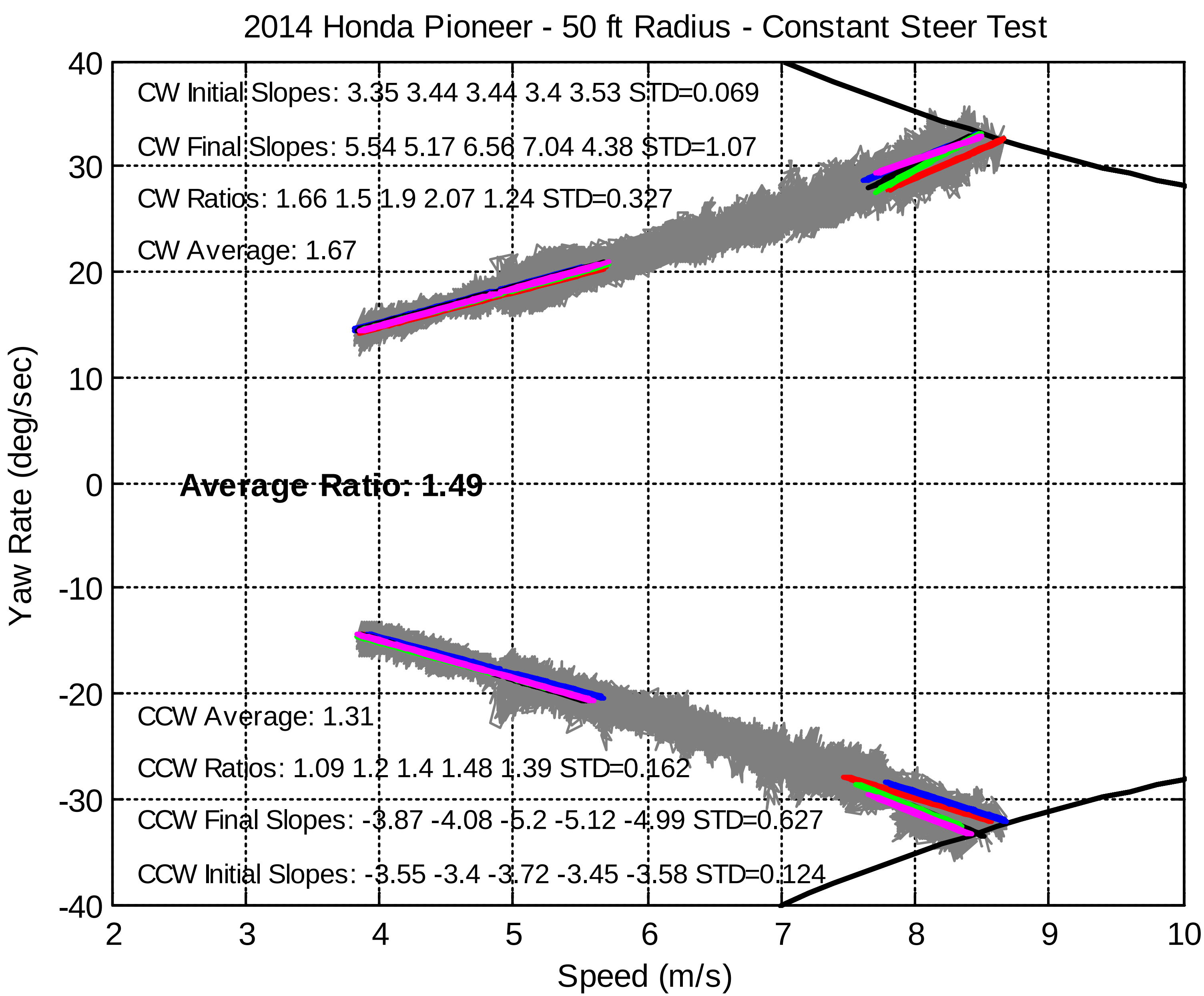
2015 BRP Can-Am Maverick - 50 ft Radius - Constant Steer Test - Clockwise Runs
-150
-200
-250
N (ft)
0
50
100
E (ft)
20 40 60 80 100
Range: All Data
Range: 0.1 g to 0.2 g
Range: 0.4 g to 0.5 g
Range: 0.5 g to Max g

2015 BRP Can-Am Maverick - 50 ft Radius - Constant Steer Test - Counterclockwise Runs

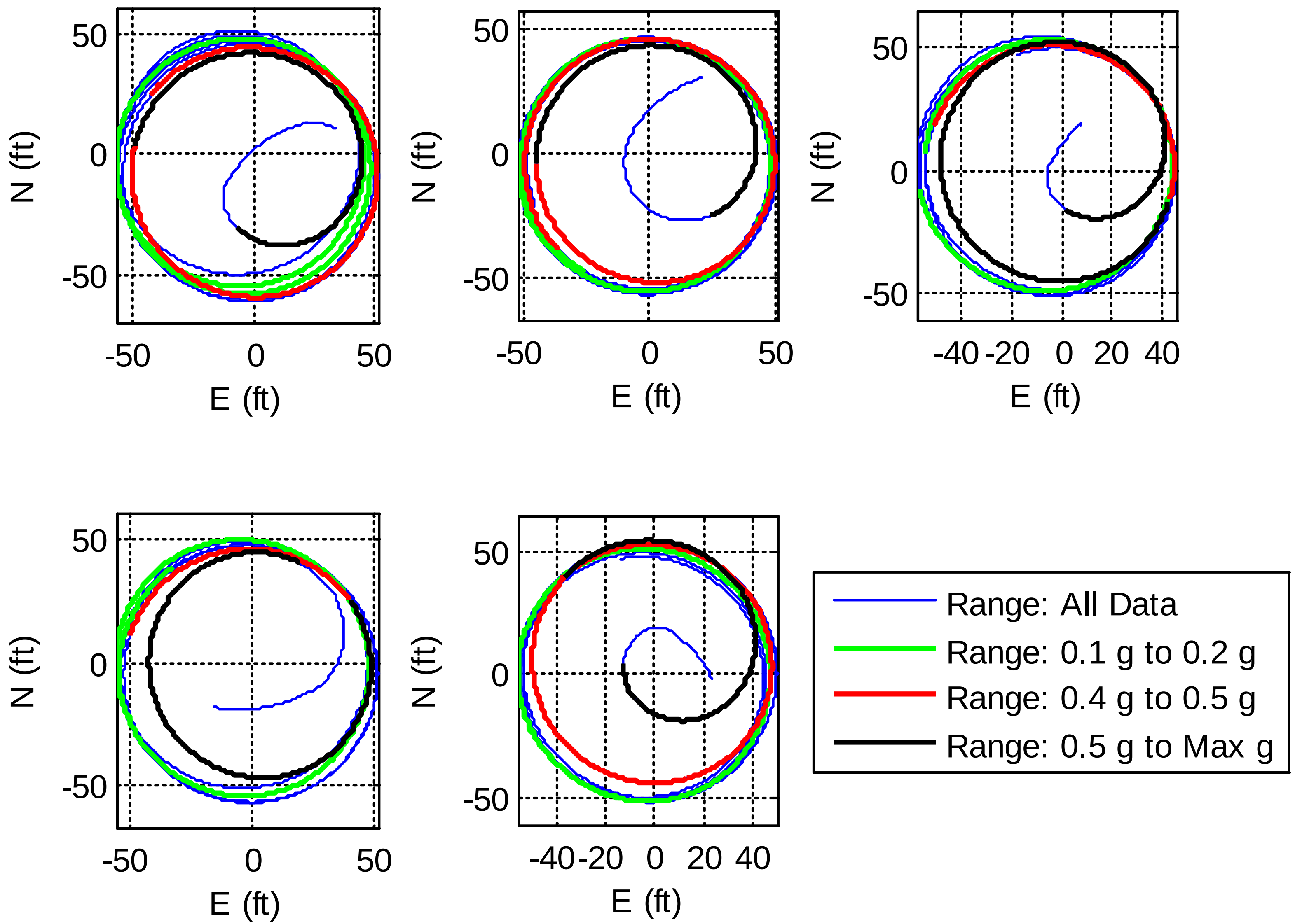



2014 Honda Pioneer
50 ft Radius - Constant Steer Test
Steer Angle (deg)
Estimated Ay (g)
Speed (m/s)
Roll Angle (deg)
Yaw Rate (deg/sec)
Time (sec)
Time (sec)

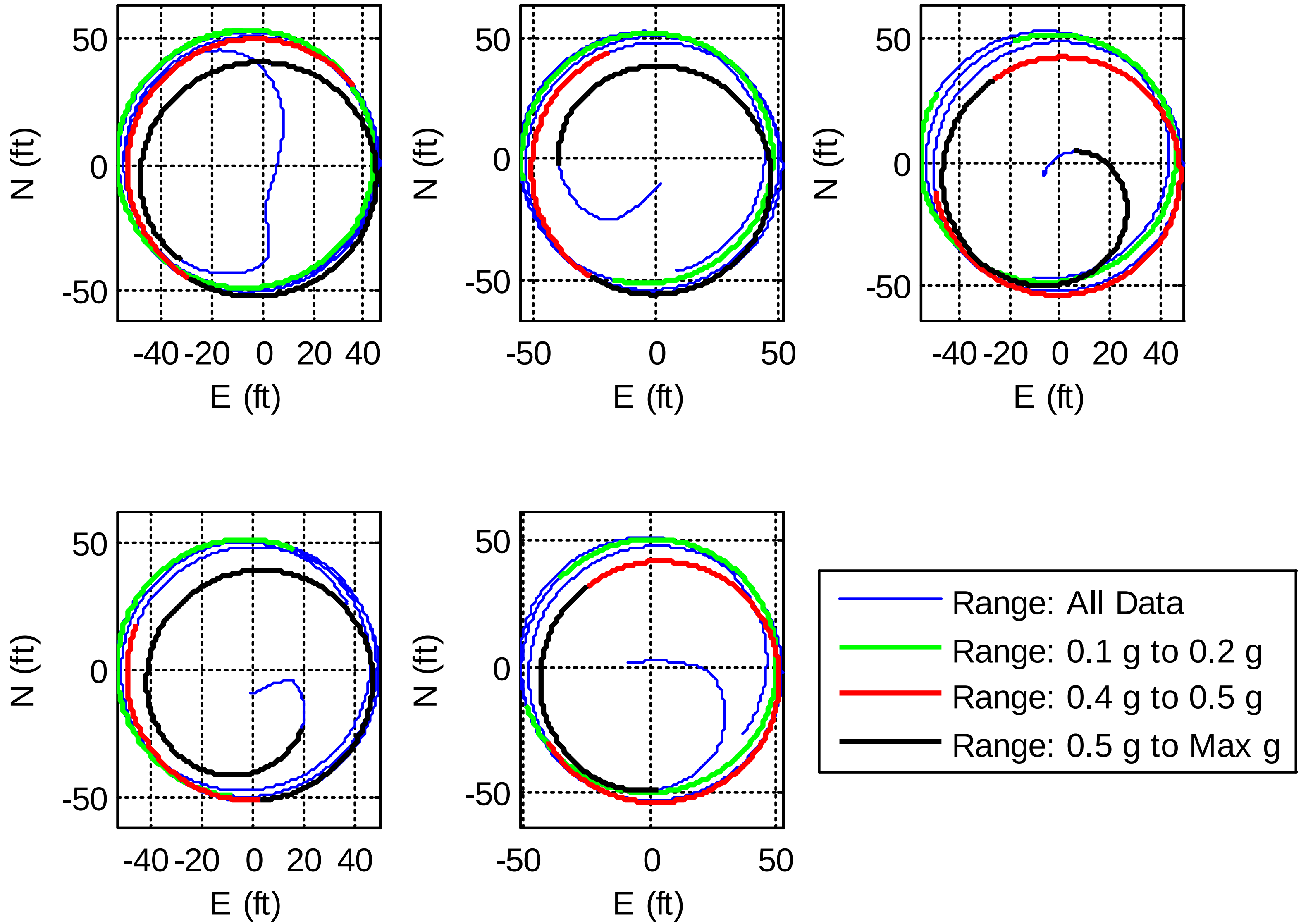

2014 Honda Pioneer - 50 ft Radius - Constant Steer Test
Estimated Ay (g)
Speed (m/s)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
1
2
3
4
5
6
7
8
9
10

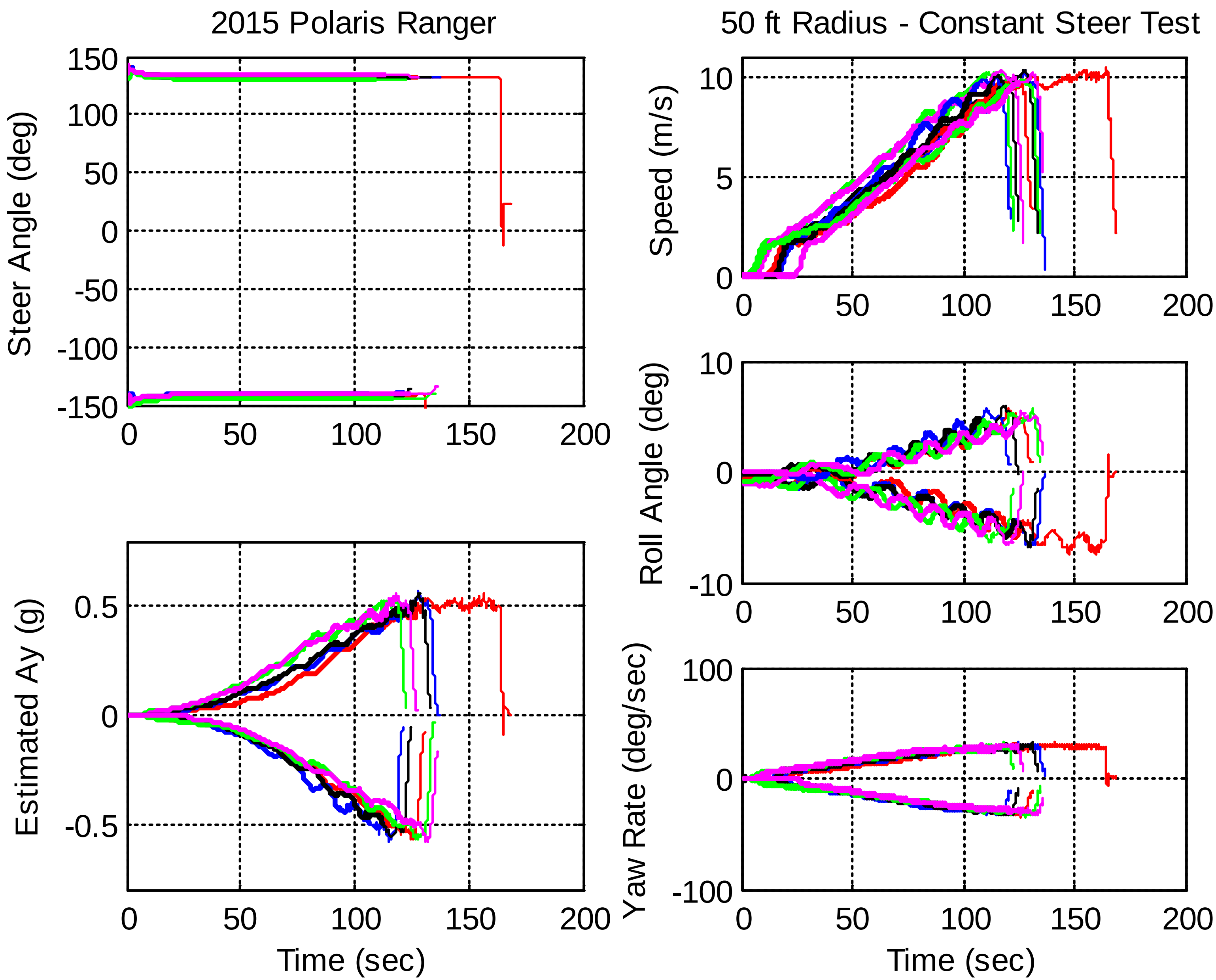

2014 Honda Pioneer - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 3.35 3.44 3.44 3.4 3.53 STD=0.069
CW Final Slopes: 5.54 5.17 6.56 7.04 4.38 STD=1.07
CW Ratios: 1.66 1.5 1.9 2.07 1.24 STD=0.327
CW Average: 1.67
Average Ratio: 1.49
CCW Average: 1.31
CCW Ratios: 1.09 1.2 1.4 1.48 1.39 STD=0.162
CCW Final Slopes: -3.87 -4.08 -5.2 -5.12 -4.99 STD=0.627
CCW Initial Slopes: -3.55 -3.4 -3.72 -3.45 -3.58 STD=0.124
Yaw Rate (deg/sec)
Speed (m/s)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10

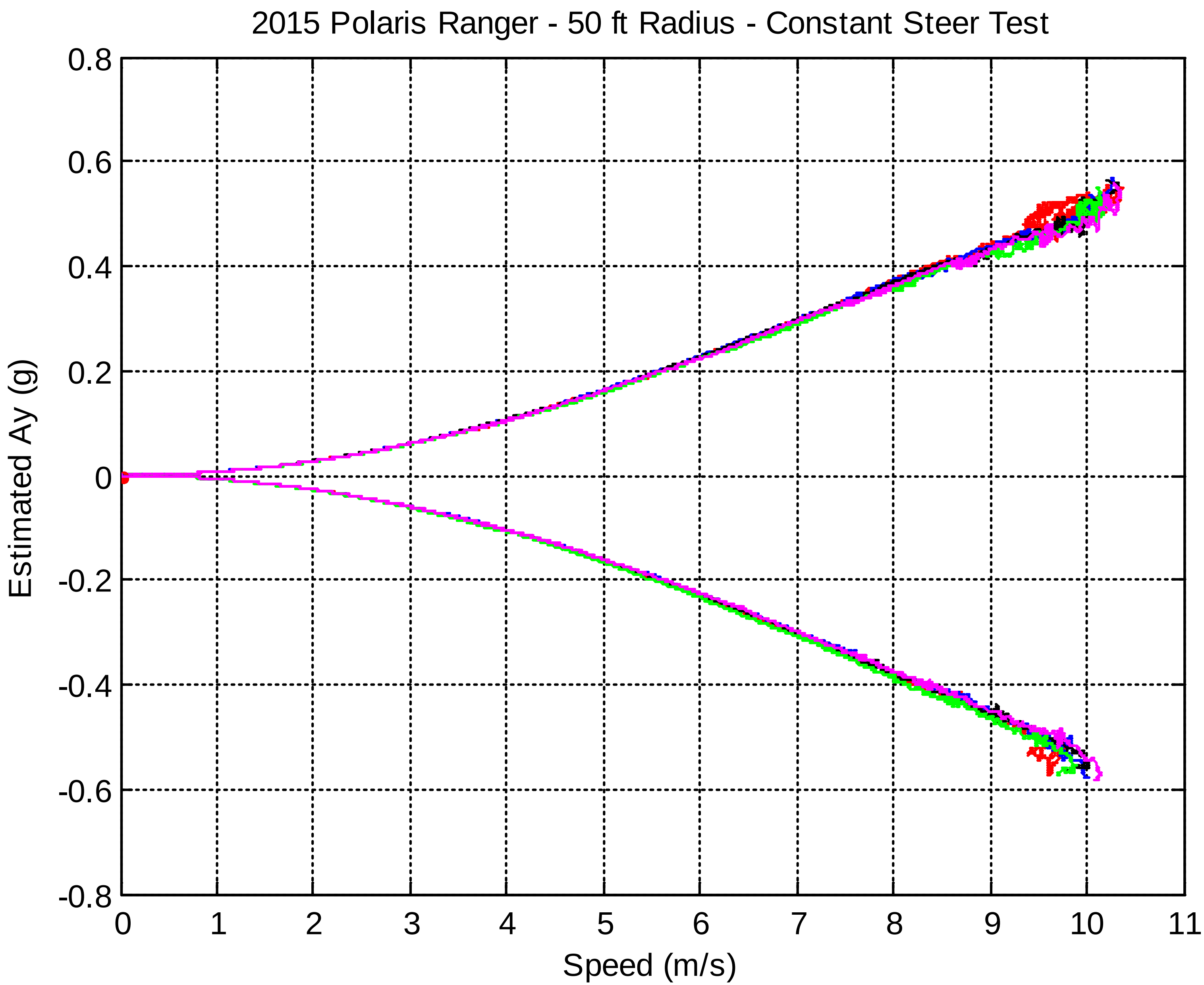
2014 Honda Pioneer - 50 ft Radius - Constant Steer Test - Clockwise Runs



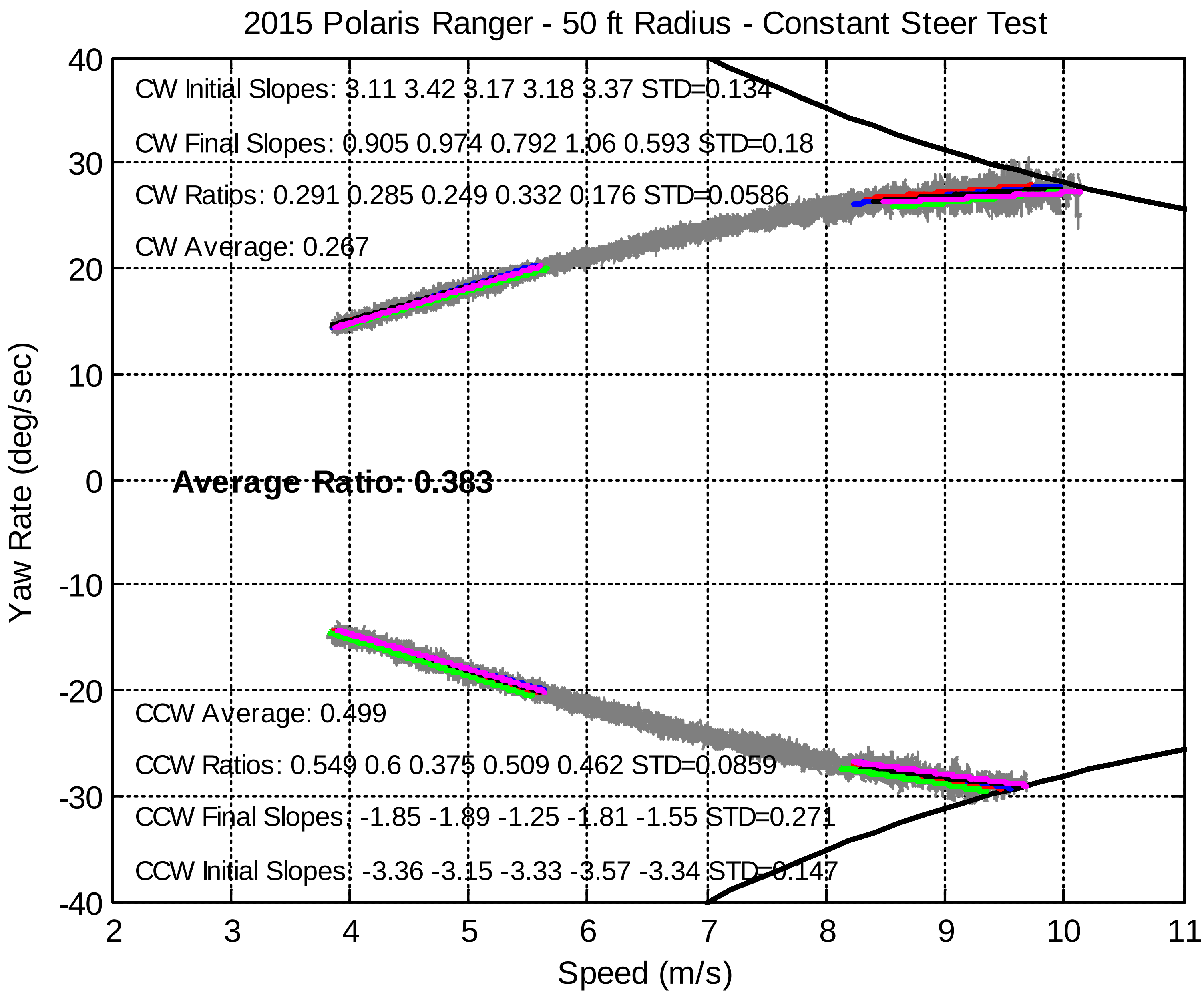
2014 Honda Pioneer - 50 ft Radius - Constant Steer Test - Counterclockwise Runs



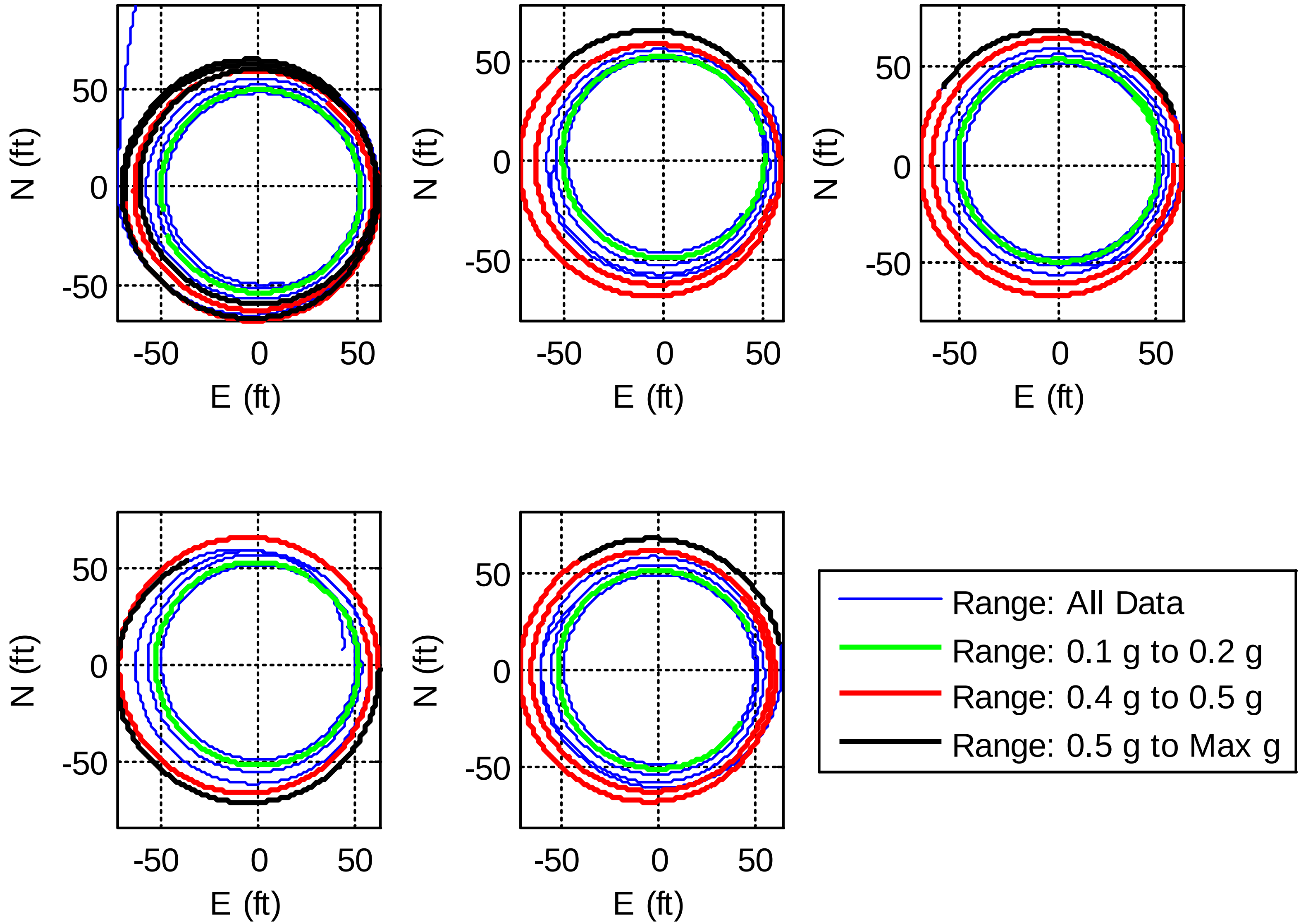

2015 Polaris Ranger
50 ft Radius - Constant Steer Test
Steer Angle (deg)
150
100
50
0
-50
-100
-150
0
50
100
150
200
Speed (m/s)
10
5
0
Roll Angle (deg)
-10
Estimated Ay (g)
0.5
-0.5
Time (sec)
Yaw Rate (deg/sec)
100
-100
Time (sec)



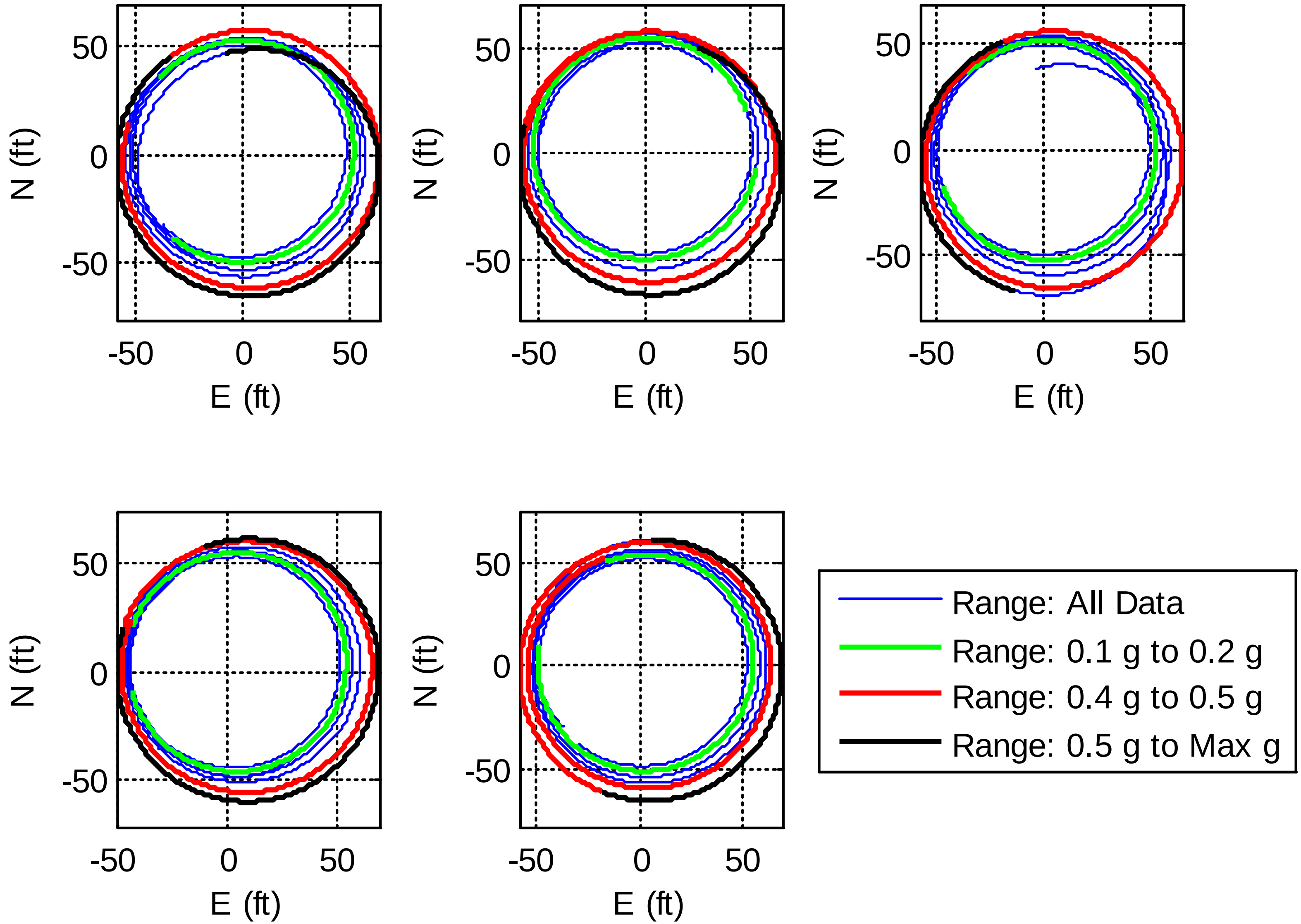
2015 Polaris Ranger - 50 ft Radius - Constant Steer Test
Estimated Ay (g)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
1
2
3
4
5
6
7
8
9
10
11
Speed (m/s)

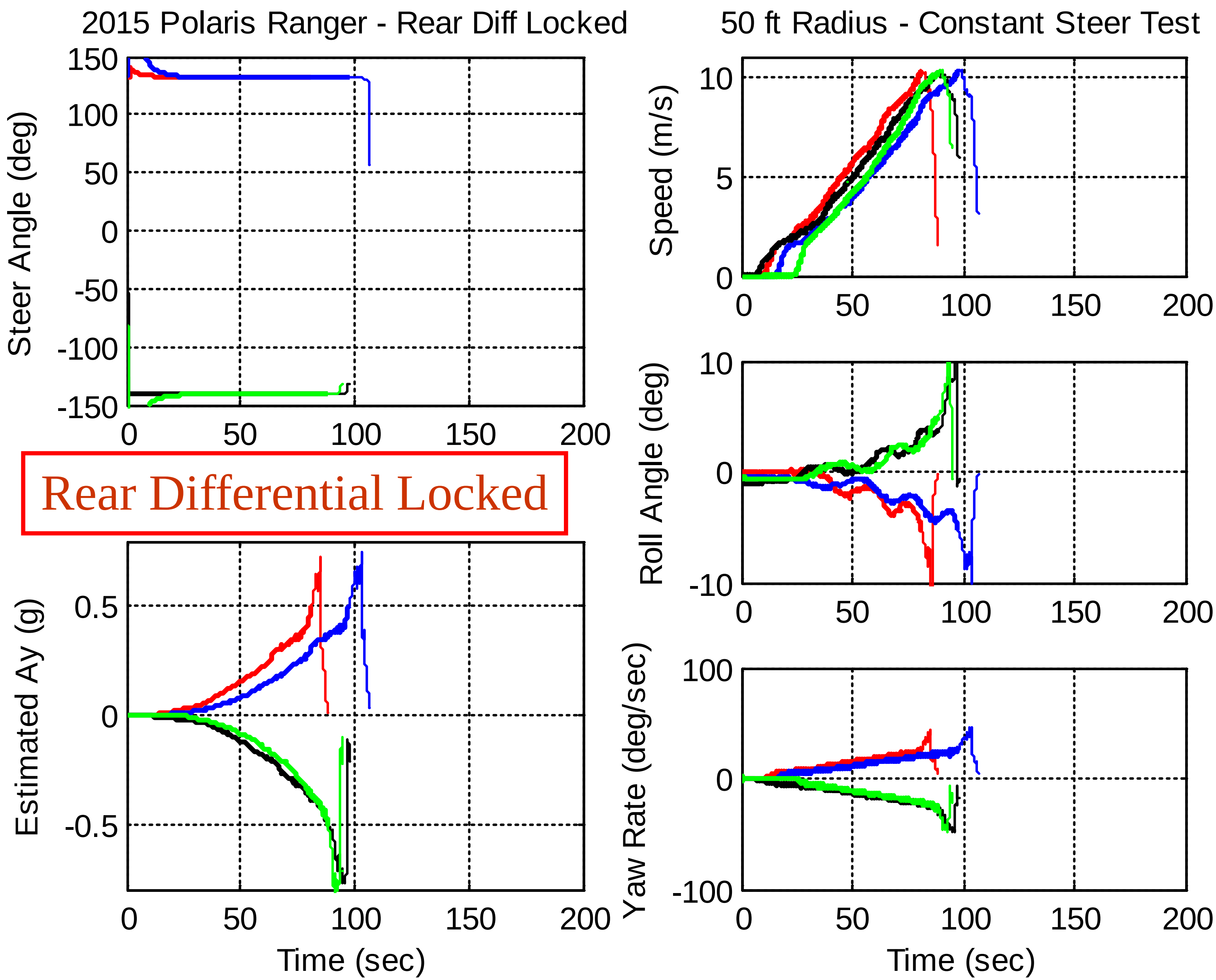

2015 Polaris Ranger - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 3.11 3.42 3.17 3.18 3.37 STD=0.134
CW Final Slopes: 0.905 0.974 0.792 1.06 0.593 STD=0.18
CW Ratios: 0.291 0.285 0.249 0.332 0.176 STD=0.0586
CW Average: 0.267
Average Ratio: 0.383
CCW Average: 0.499
CCW Ratios: 0.549 0.6 0.375 0.509 0.462 STD=0.0859
CCW Final Slopes: -1.85 -1.89 -1.25 -1.81 -1.55 STD=0.271
CCW Initial Slopes: -3.36 -3.15 -3.33 -3.57 -3.34 STD=0.147
Yaw Rate (deg/sec)
Speed (m/s)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10
11

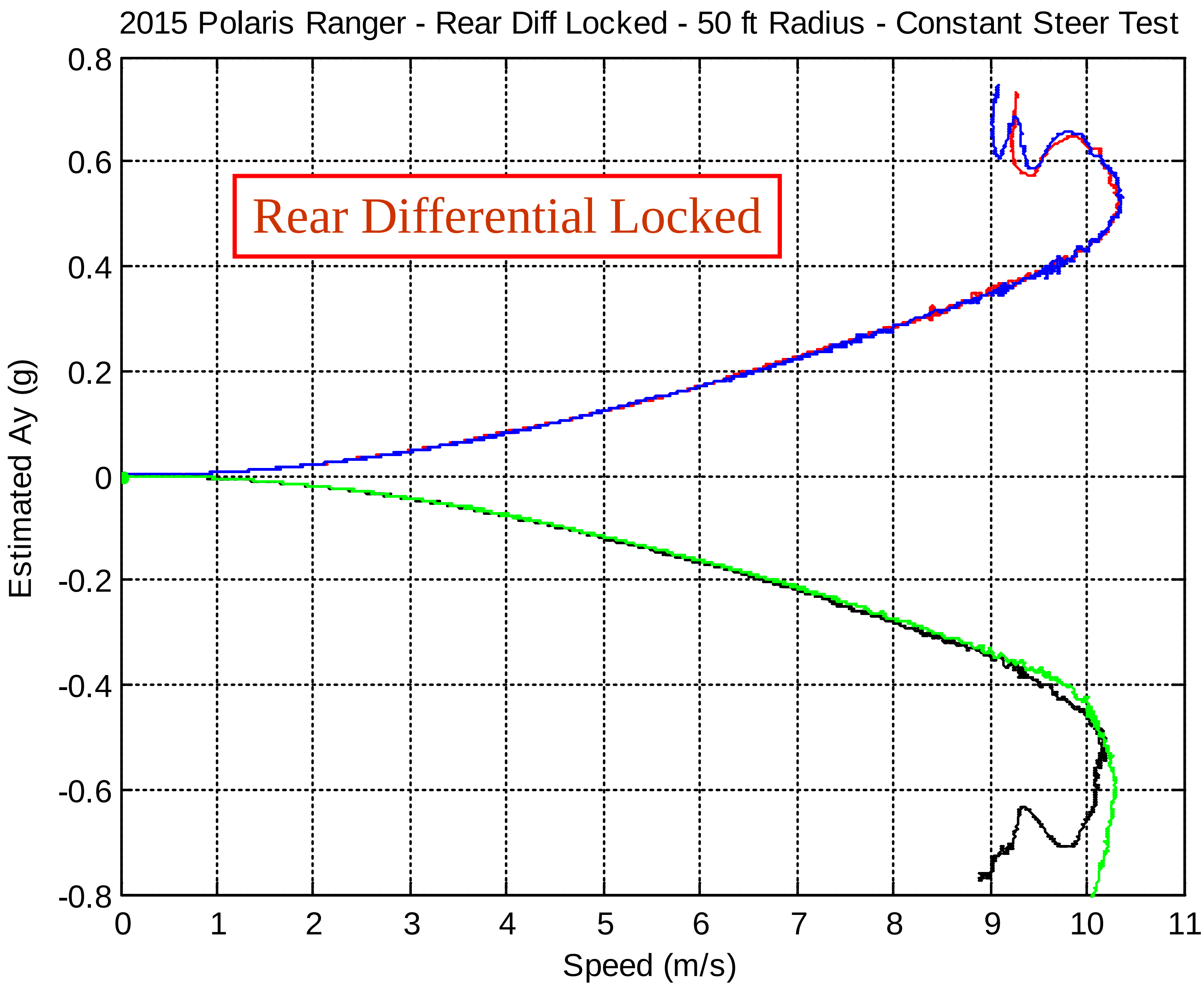
2015 Polaris Ranger - 50 ft Radius - Constant Steer Test - Clockwise Runs

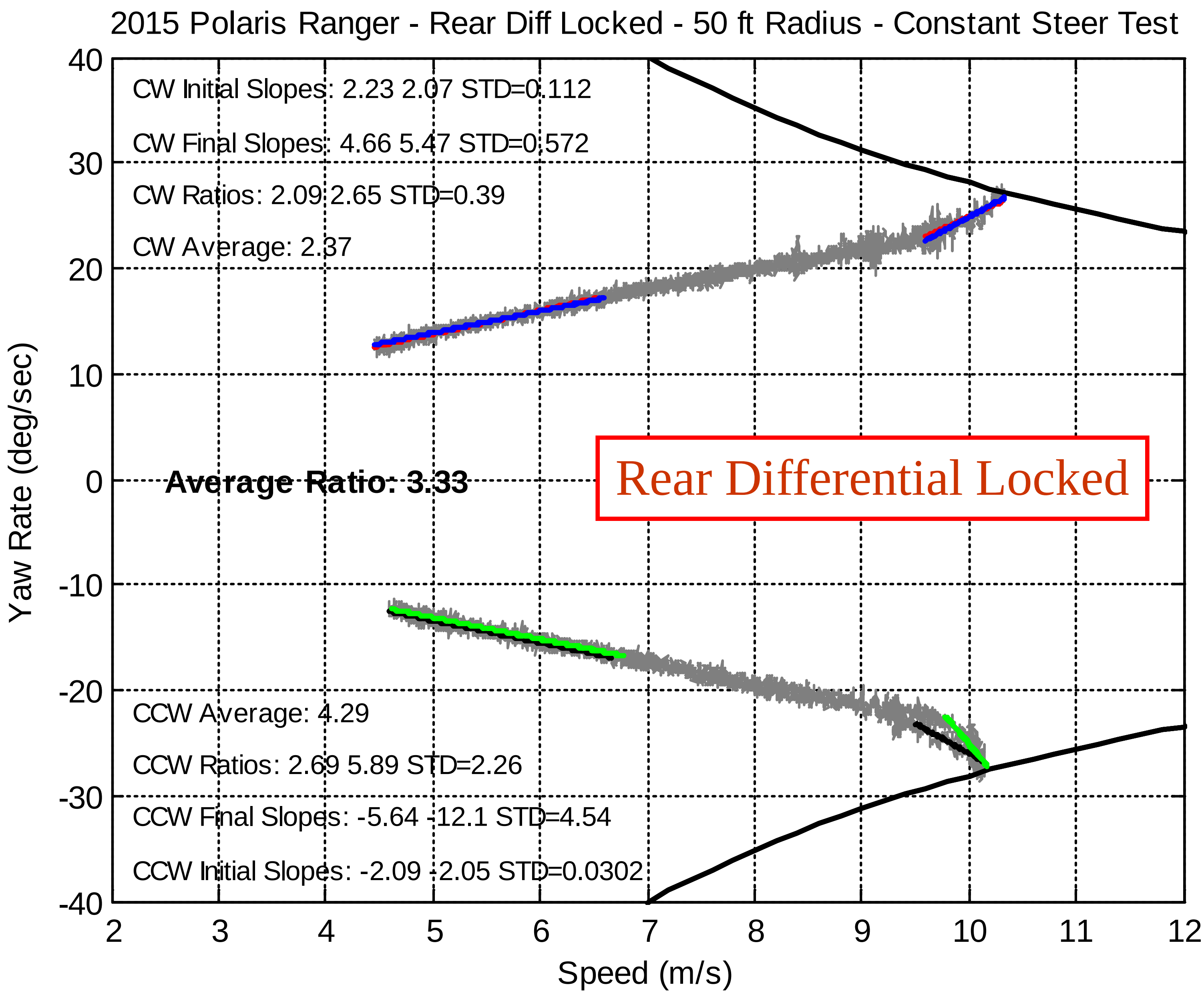


2015 Polaris Ranger - 50 ft Radius - Constant Steer Test - Counterclockwise Runs

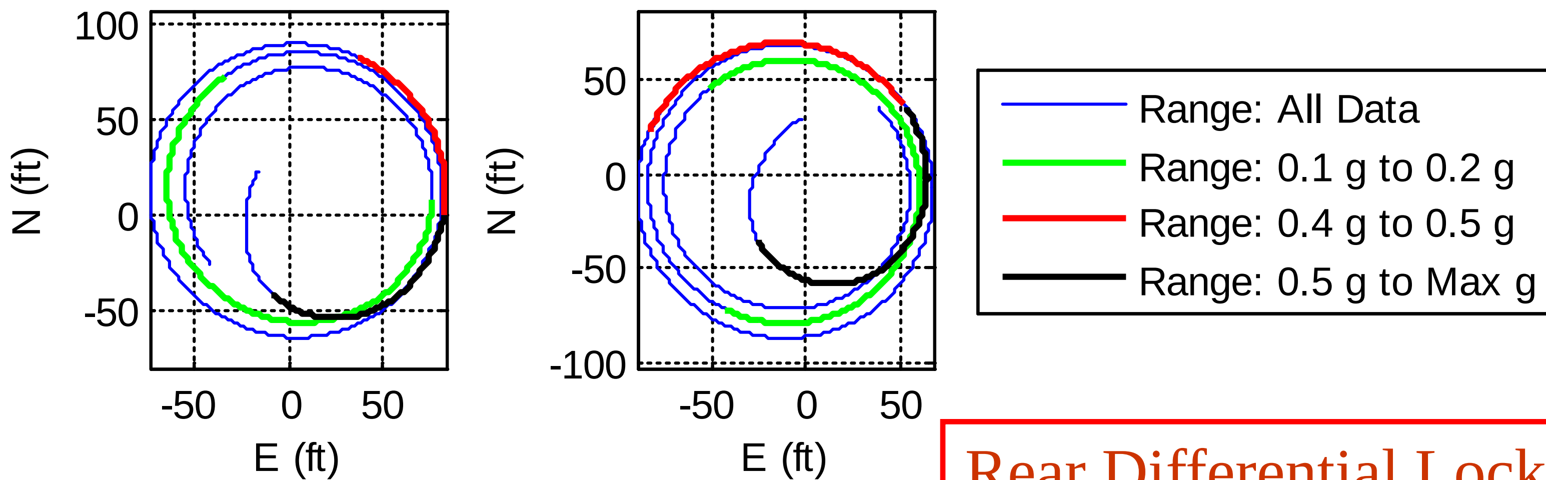



2015 Polaris Ranger - Rear Diff Locked
50 ft Radius - Constant Steer Test
Steer Angle (deg)
150
100
50
0
-50
-100
-150
0
50
100
150
200
Speed (m/s)
10
5
0
Roll Angle (deg)
10
0
-10
Rear Differential Locked
Estimated Ay (g)
0.5
0
-0.5
Yaw Rate (deg/sec)
100
0
-100
Time (sec)
Time (sec)


2015 Polaris Ranger - Rear Diff Locked - 50 ft Radius - Constant Steer Test
Rear Differential Locked
Estimated Ay (g)
Speed (m/s)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
1
2
3
4
5
6
7
8
9
10
11

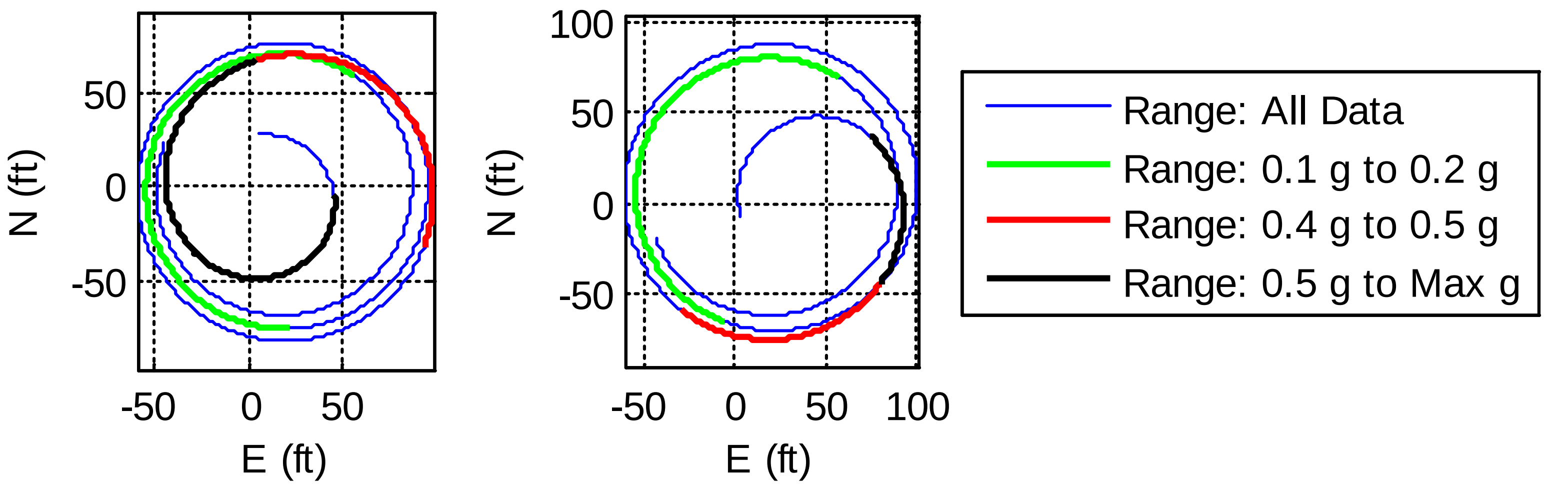

2015 Polaris Ranger - Rear Diff Locked - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 2.23 2.07 STD=0.112
CW Final Slopes: 4.66 5.47 STD=0.572
CW Ratios: 2.09 2.65 STD=0.39
CW Average: 2.37
Average Ratio: 3.33
Rear Differential Locked
CCW Average: 4.29
CCW Ratios: 2.69 5.89 STD=2.26
CCW Final Slopes: -5.64 -12.1 STD=4.54
CCW Initial Slopes: -2.09 -2.05 STD=0.0302
Yaw Rate (deg/sec)
Speed (m/s)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10
11
12

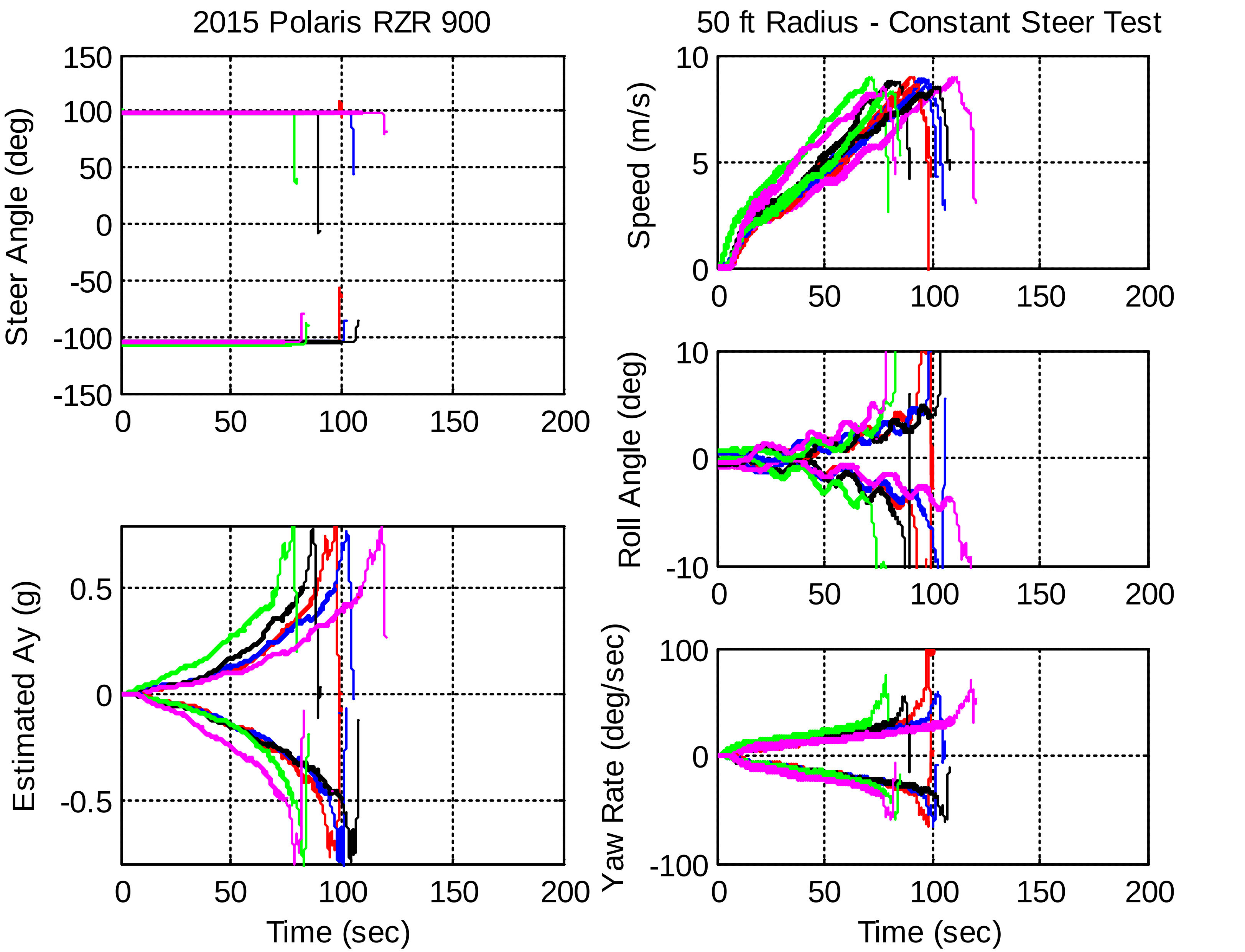
2015 Polaris Ranger - Rear Diff Locked - 50 ft Radius - Constant Steer Test - Clockwise Runs

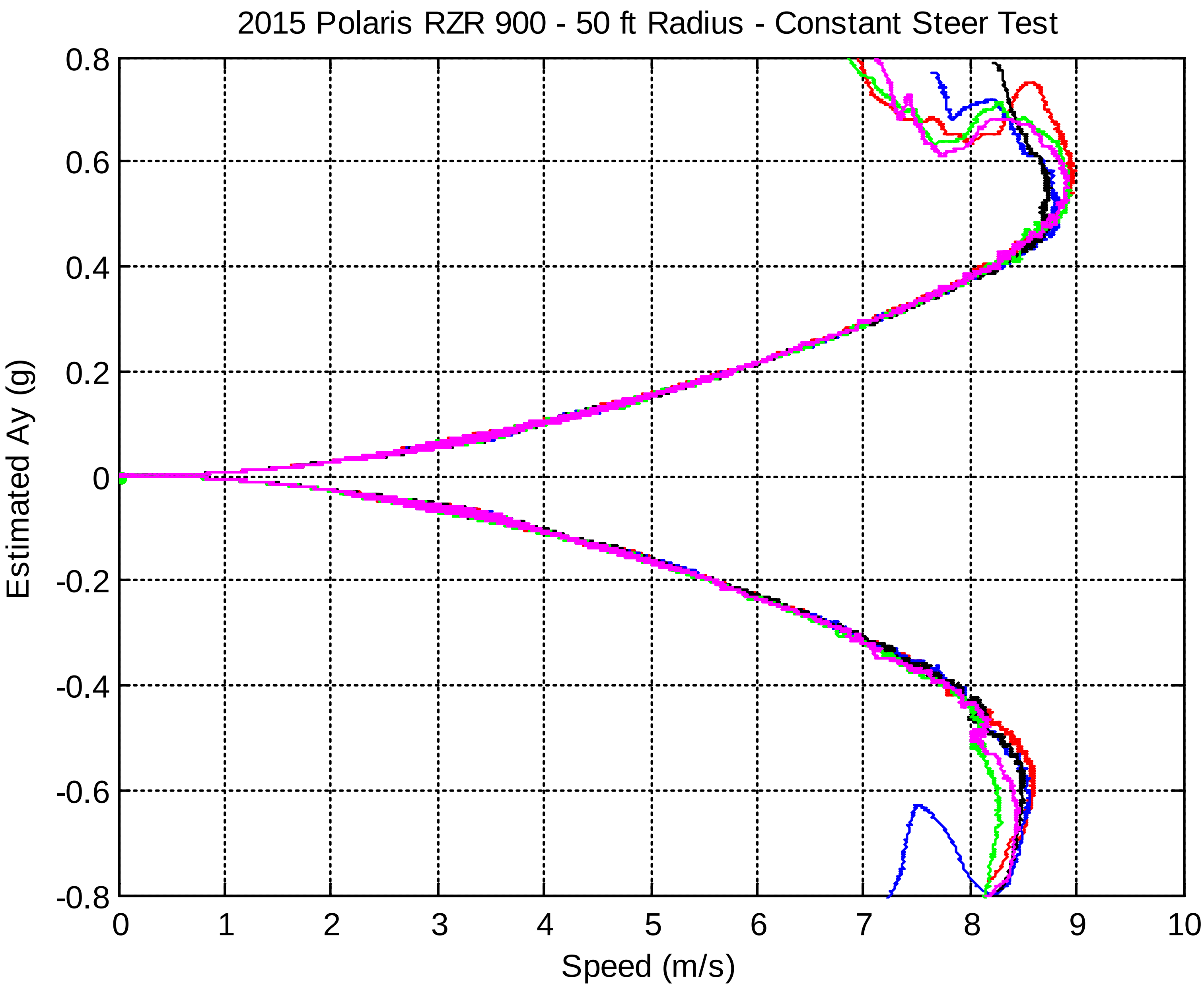


Rear Differential Locked

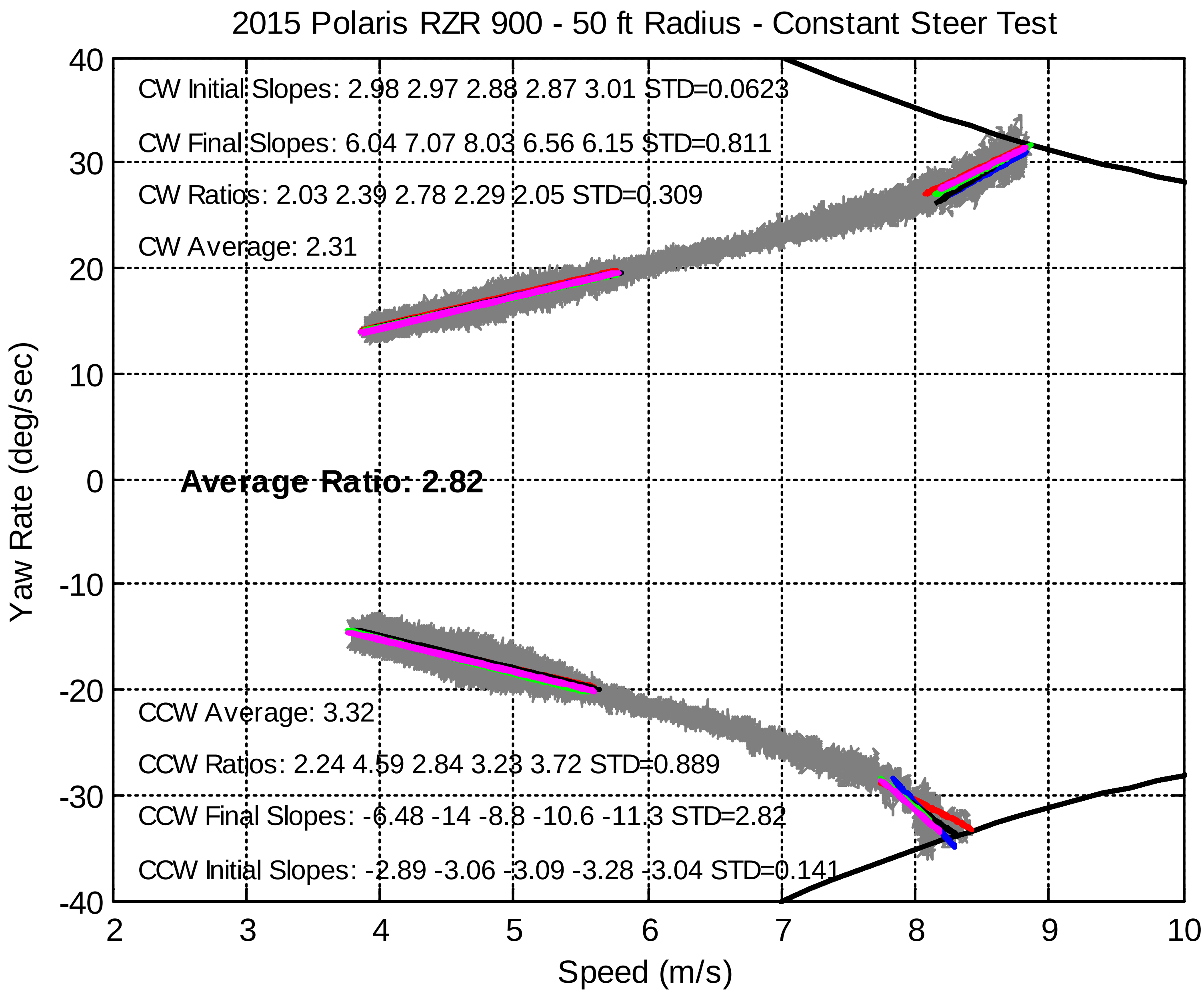
2015 Polaris Ranger - Rear Diff Locked - 50 ft Radius - Constant Steer Test - Counterclockwise R

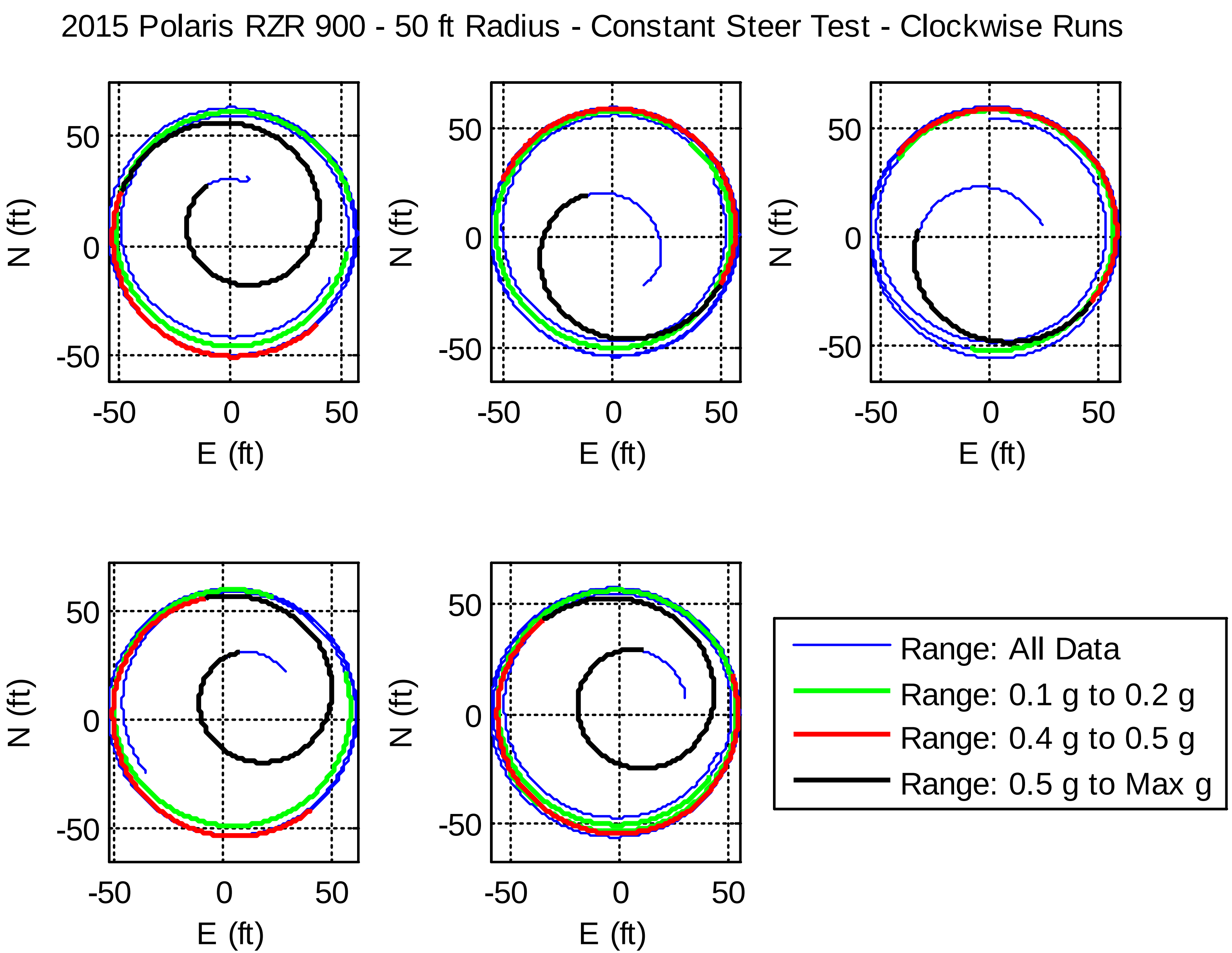


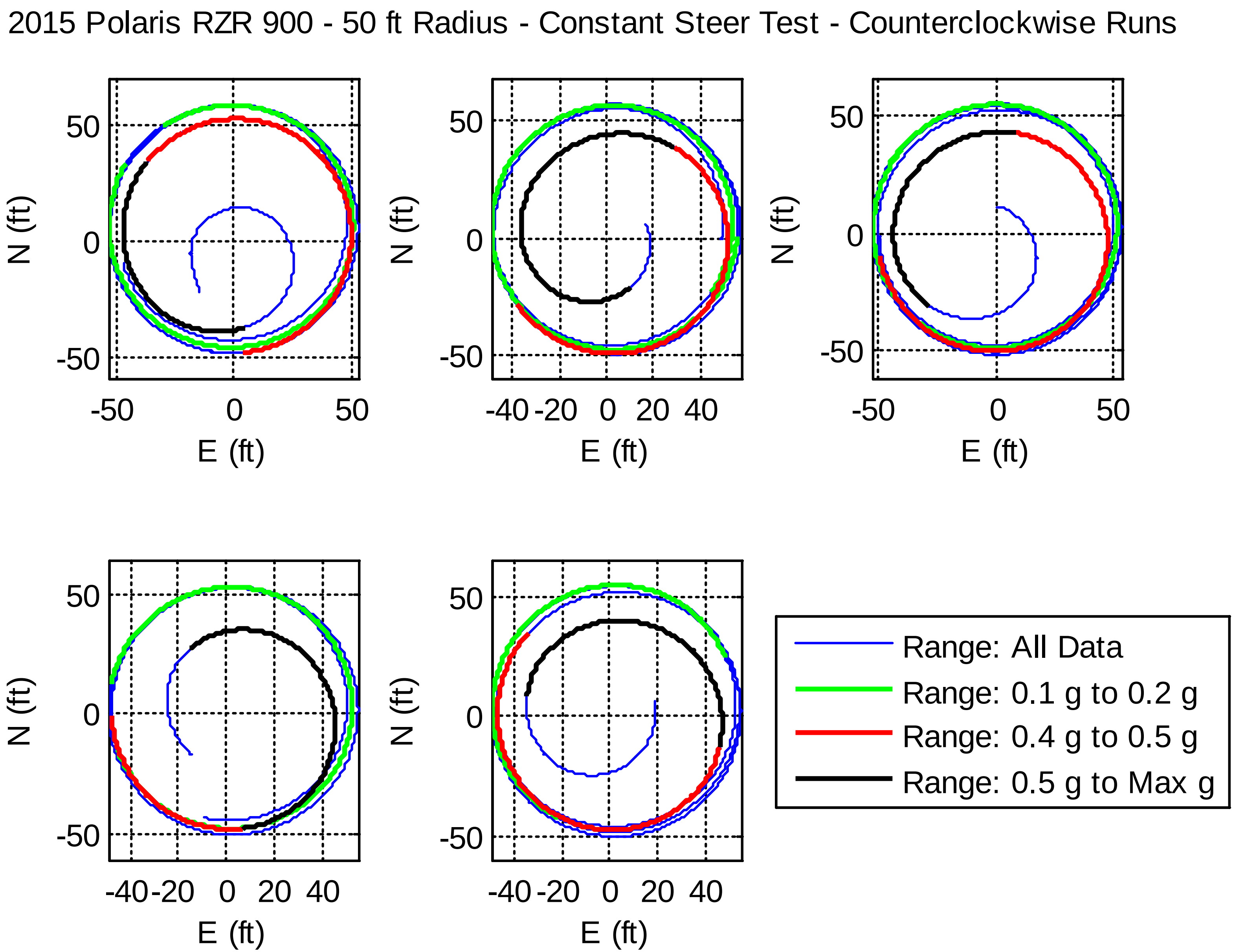

2015 Polaris RZR 900
50 ft Radius - Constant Steer Test
Steer Angle (deg)
150
100
50
0
-50
-100
-150
0
50
100
150
200
Speed (m/s)
10
5
0
Roll Angle (deg)
10
0
-10
Estimated Ay (g)
0.5
0
-0.5
Yaw Rate (deg/sec)
100
0
-100
Time (sec)
Time (sec)



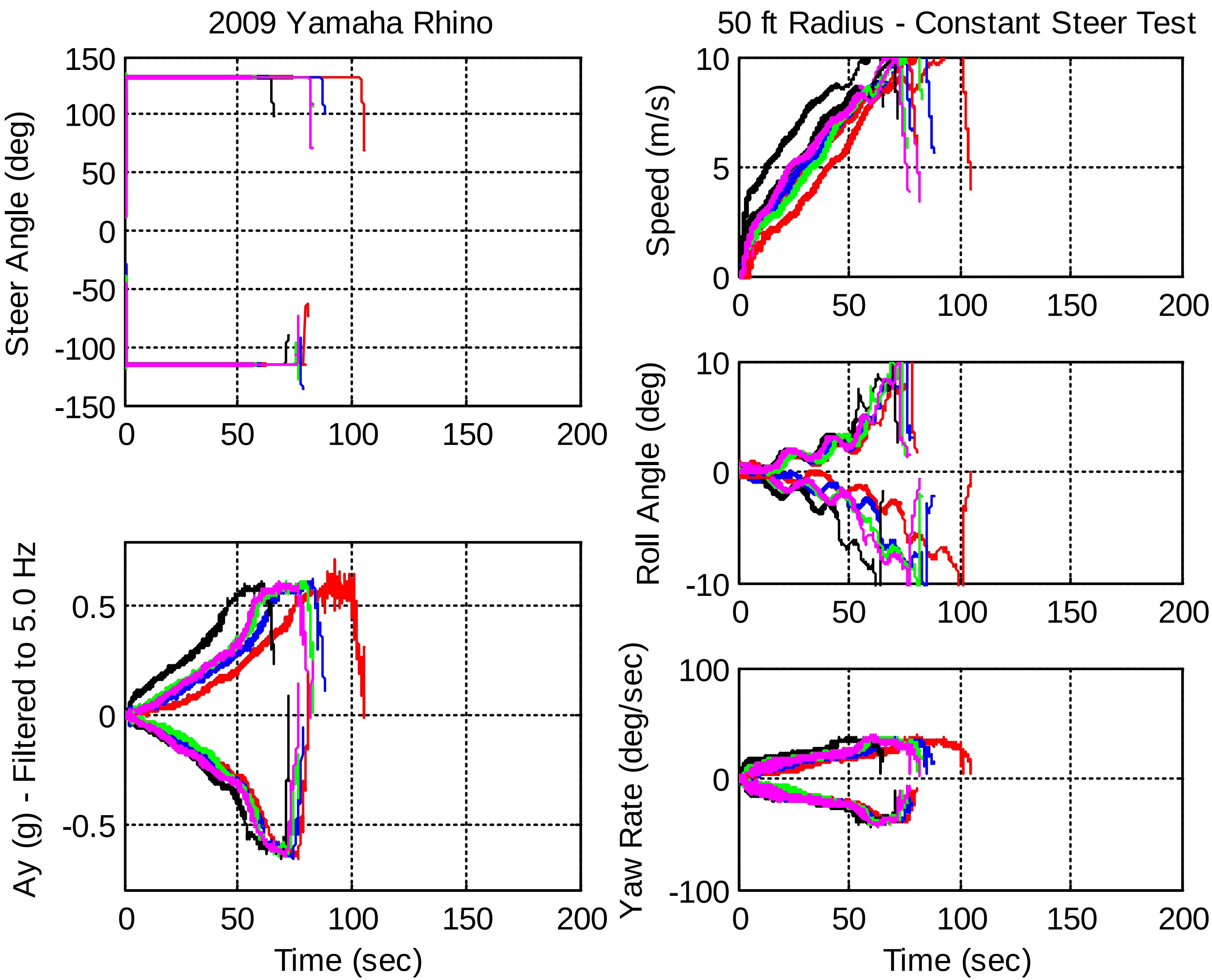
2015 Polaris RZR 900 - 50 ft Radius - Constant Steer Test
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Estimated Ay (g)
0
1
2
3
4
5
6
7
8
9
10
Speed (m/s)

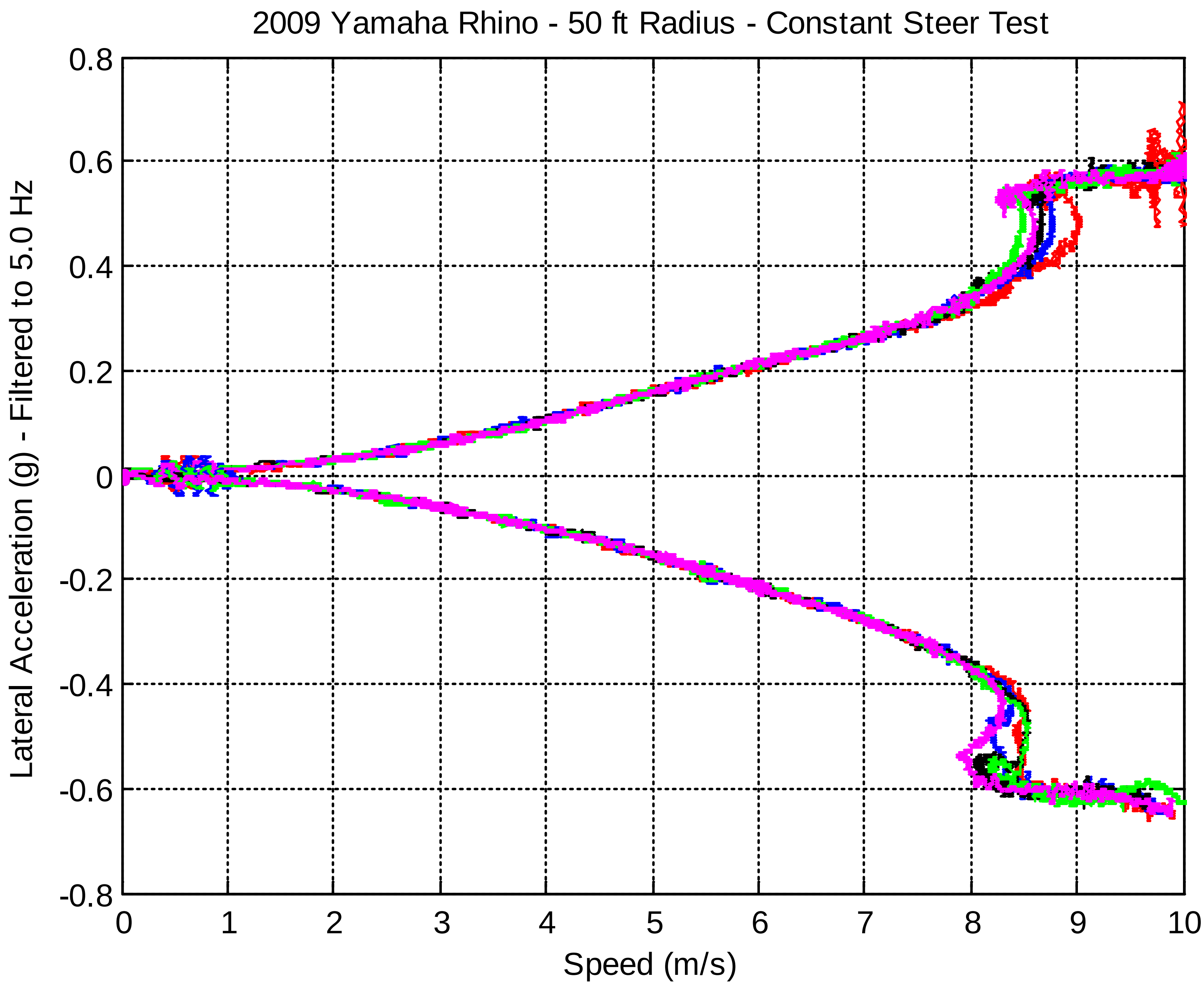

2015 Polaris RZR 900 - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 2.98 2.97 2.88 2.87 3.01 STD=0.0623
CW Final Slopes: 6.04 7.07 8.03 6.56 6.15 STD=0.811
CW Ratios: 2.03 2.39 2.78 2.29 2.05 STD=0.309
CW Average: 2.31
Average Ratio: 2.82
CCW Average: 3.32
CCW Ratios: 2.24 4.59 2.84 3.23 3.72 STD=0.889
CCW Final Slopes: -6.48 -14 -8.8 -10.6 -11.3 STD=2.82
CCW Initial Slopes: -2.89 -3.06 -3.09 -3.28 -3.04 STD=0.141
Yaw Rate (deg/sec)
Speed (m/s)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10

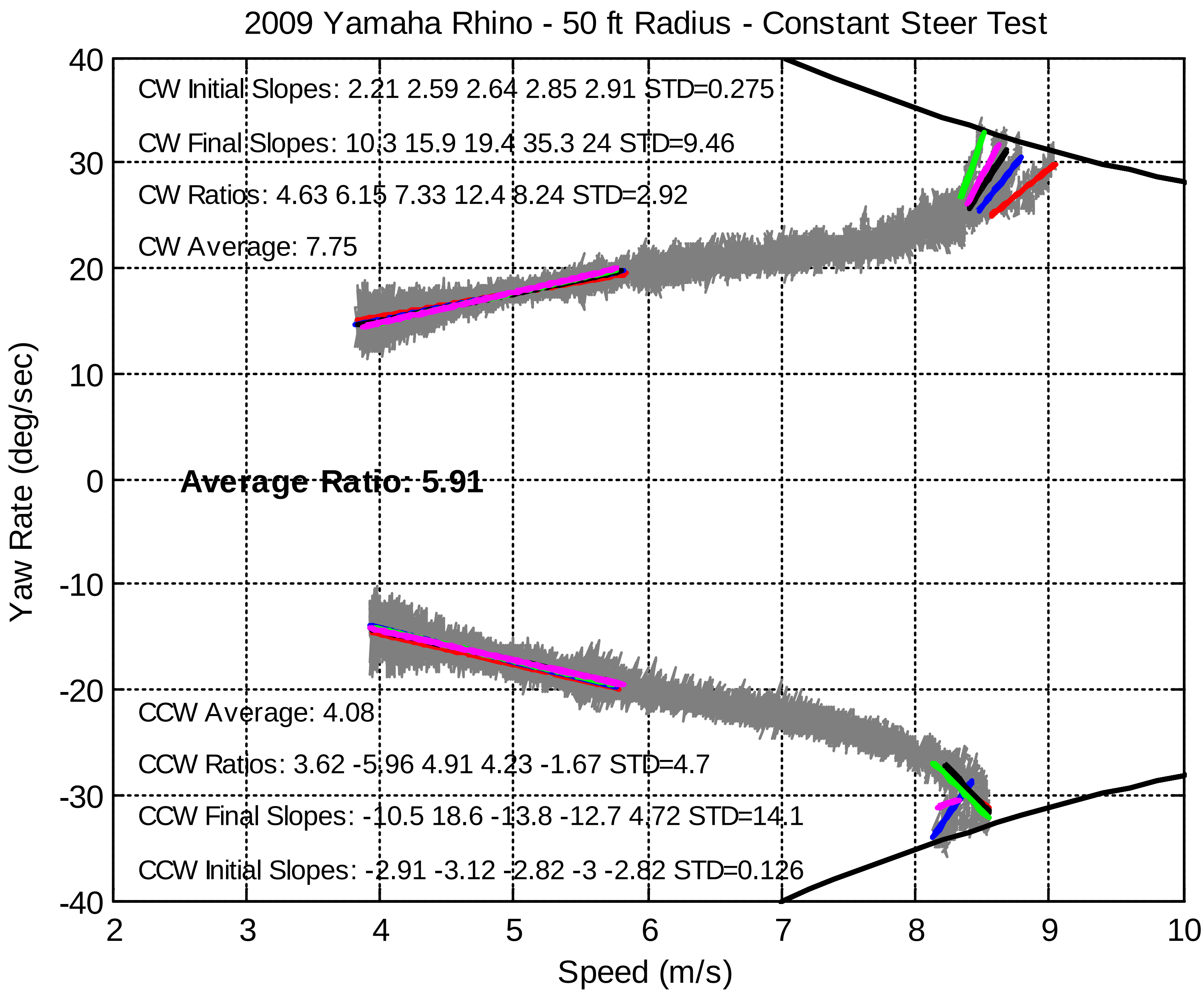

2015 Polaris RZR 900 - 50 ft Radius - Constant Steer Test - Clockwise Runs
N (ft)
E (ft)
50
0
-50
Range: All Data
Range: 0.1 g to 0.2 g
Range: 0.4 g to 0.5 g
Range: 0.5 g to Max g



2015 Polaris RZR 900 - 50 ft Radius - Constant Steer Test - Counterclockwise Runs
N (ft)
E (ft)
50
0
-50
-40
-20
20
40
Range: All Data
Range: 0.1 g to 0.2 g
Range: 0.4 g to 0.5 g
Range: 0.5 g to Max g

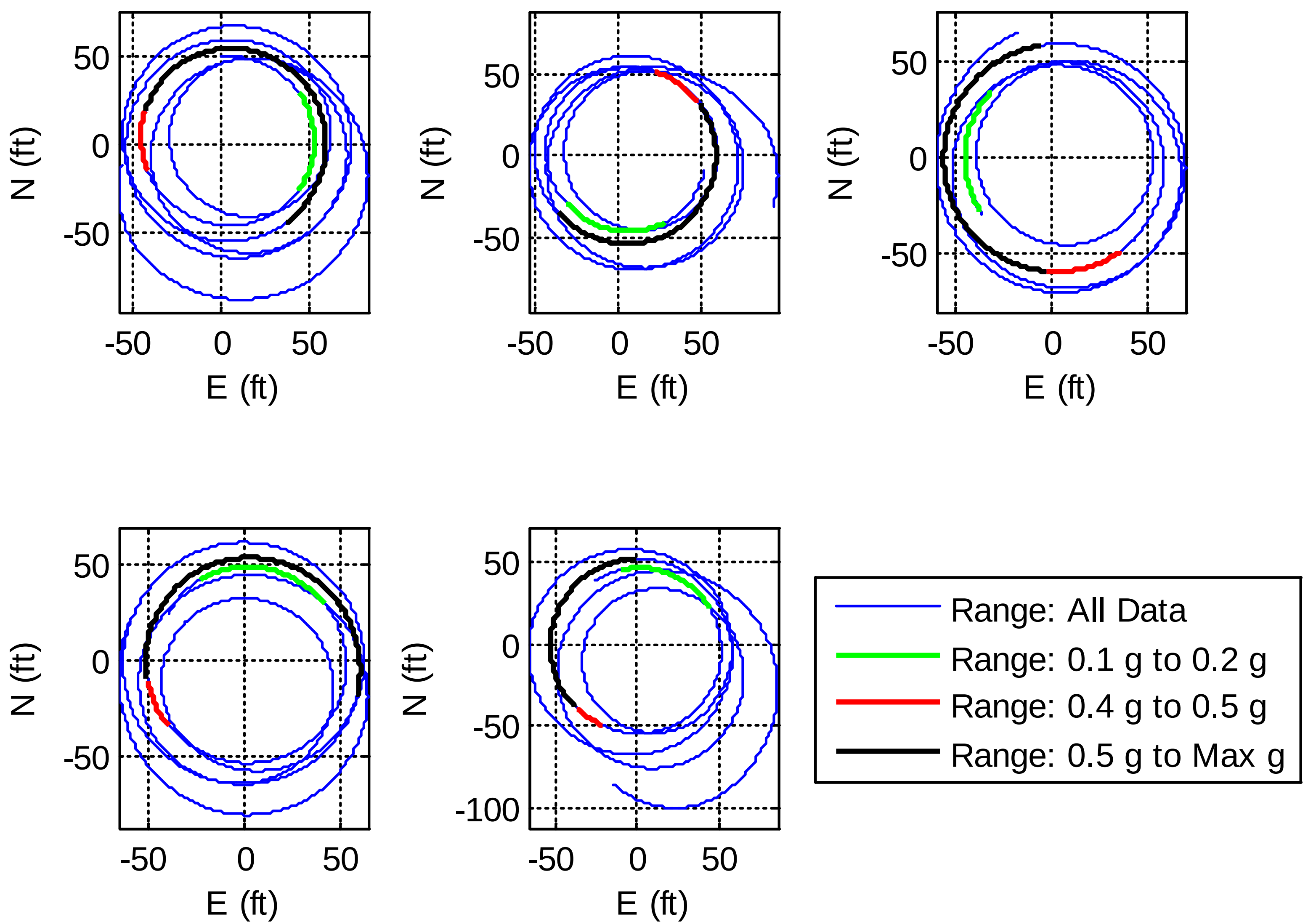

2009 Yamaha Rhino
50 ft Radius - Constant Steer Test
Steer Angle (deg)
150
100
50
0
-50
-100
-150
0
50
100
150
200
Speed (m/s)
10
5
0
Roll Angle (deg)
10
0
-10
Ay (g) - Filtered to 5.0 Hz
0.5
0
-0.5
Time (sec)
Yaw Rate (deg/sec)
100
0
-100
Time (sec)

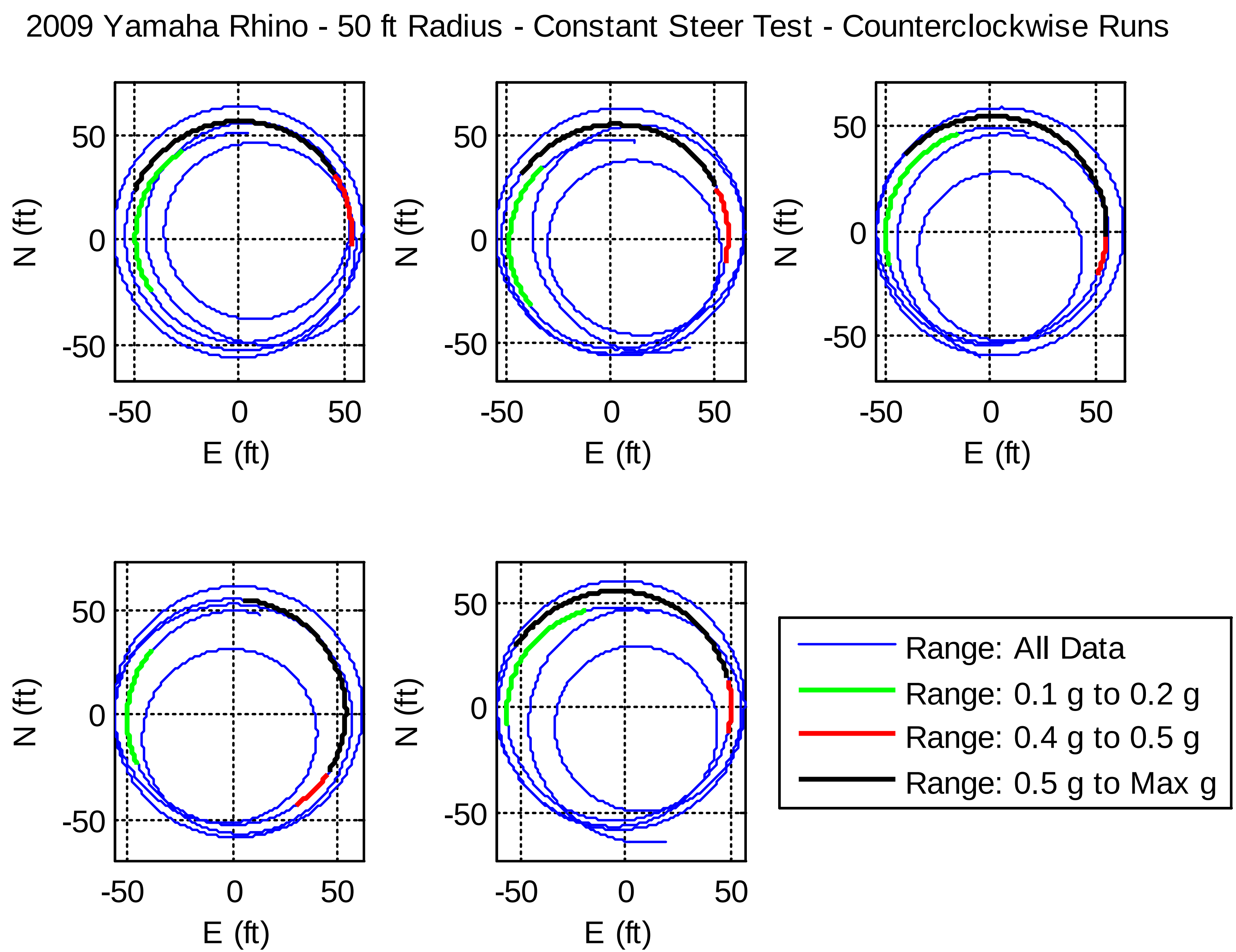

2009 Yamaha Rhino - 50 ft Radius - Constant Steer Test
Lateral Acceleration (g) - Filtered to 5.0 Hz
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
1
2
3
4
5
6
7
8
9
10
Speed (m/s)

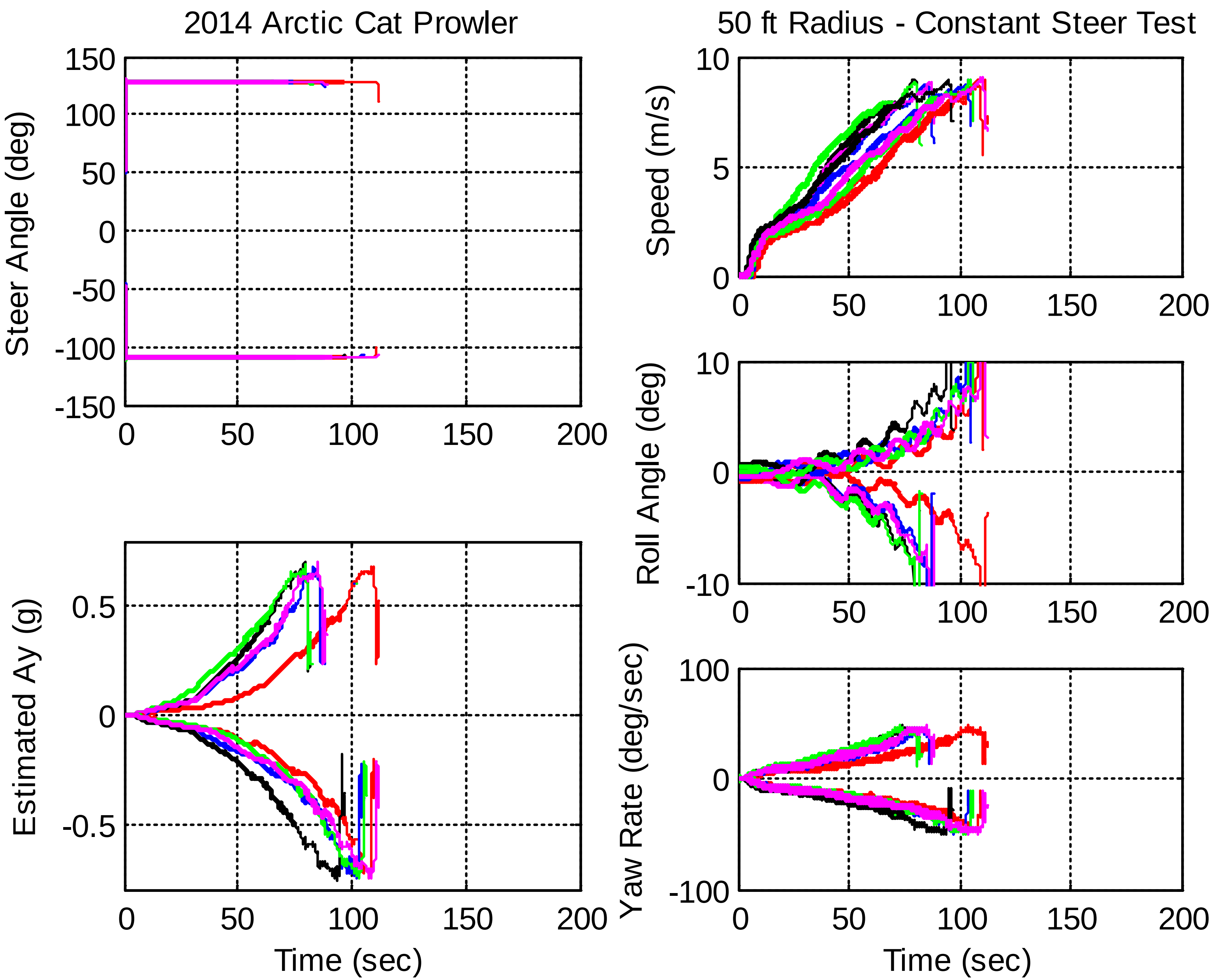


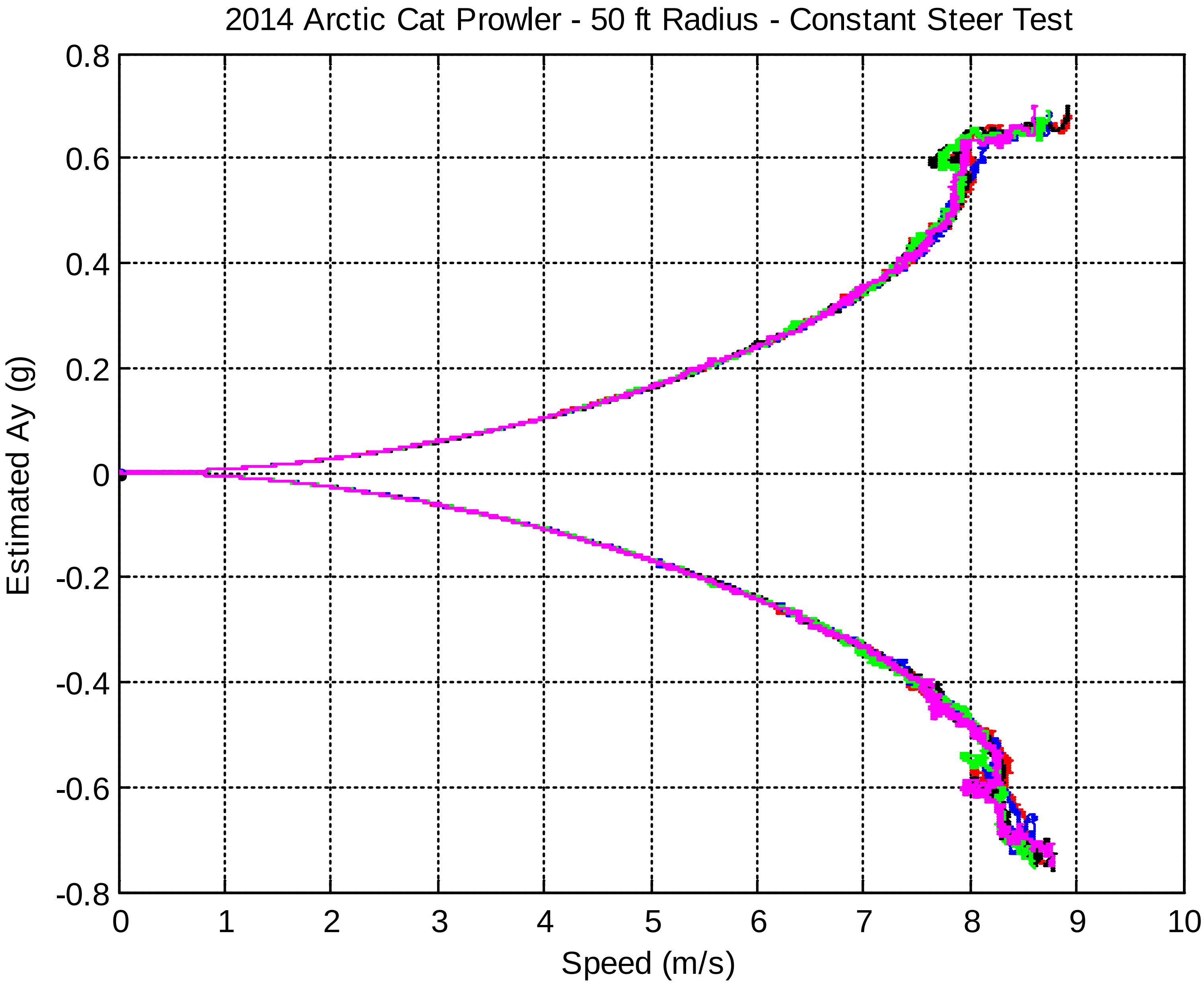
2009 Yamaha Rhino - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 2.21 2.59 2.64 2.85 2.91 STD=0.275
CW Final Slopes: 10.3 15.9 19.4 35.3 24 STD=9.46
CW Ratios: 4.63 6.15 7.33 12.4 8.24 STD=2.92
CW Average: 7.75
Average Ratio: 5.91
CCW Average: 4.08
CCW Ratios: 3.62 -5.96 4.91 4.23 -1.67 STD=4.7
CCW Final Slopes: -10.5 18.6 -13.8 -12.7 4.72 STD=14.1
CCW Initial Slopes: -2.91 -3.12 -2.82 -3 -2.82 STD=0.126
Yaw Rate (deg/sec)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10
Speed (m/s)

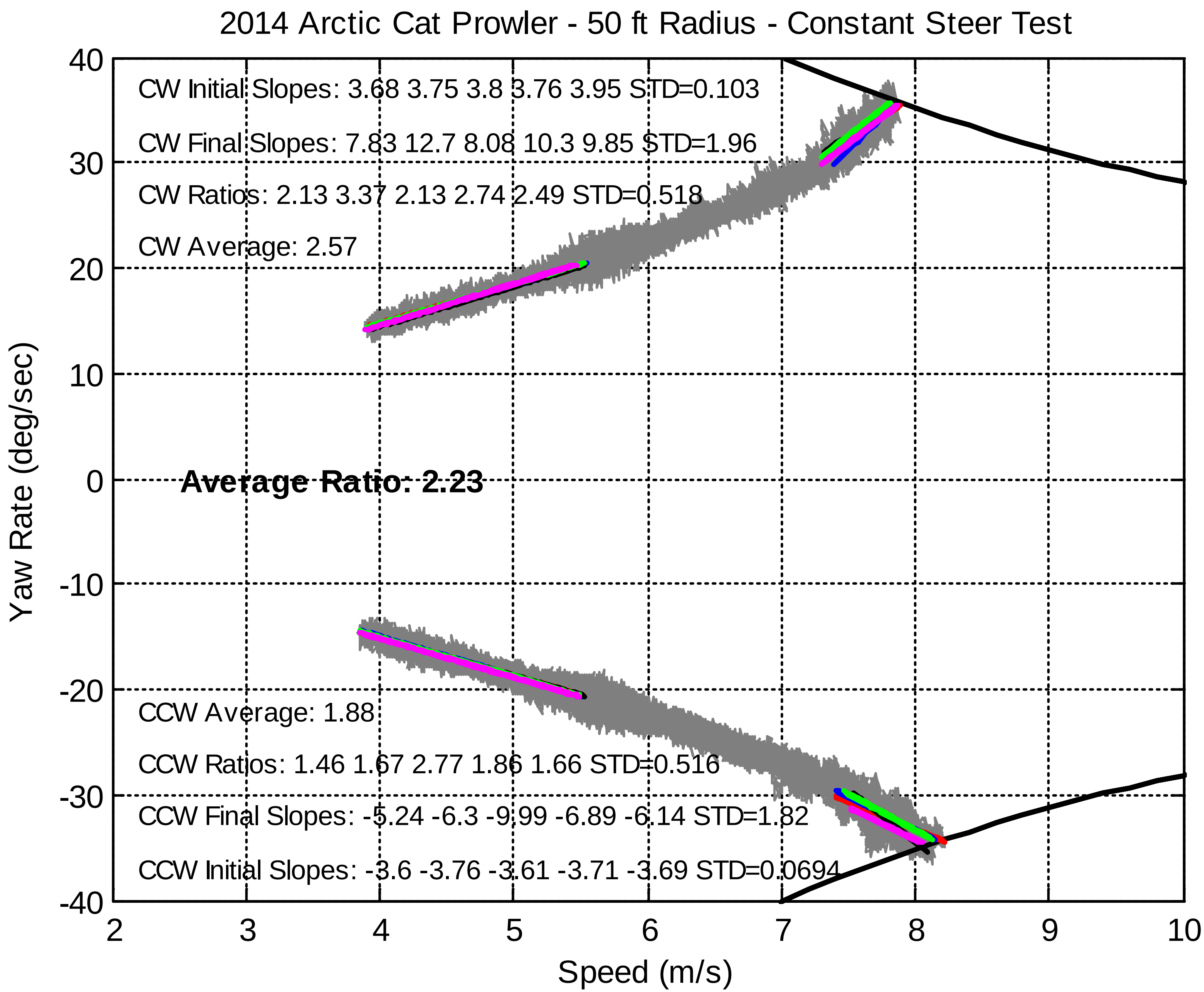
2009 Yamaha Rhino - 50 ft Radius - Constant Steer Test - Clockwise Runs

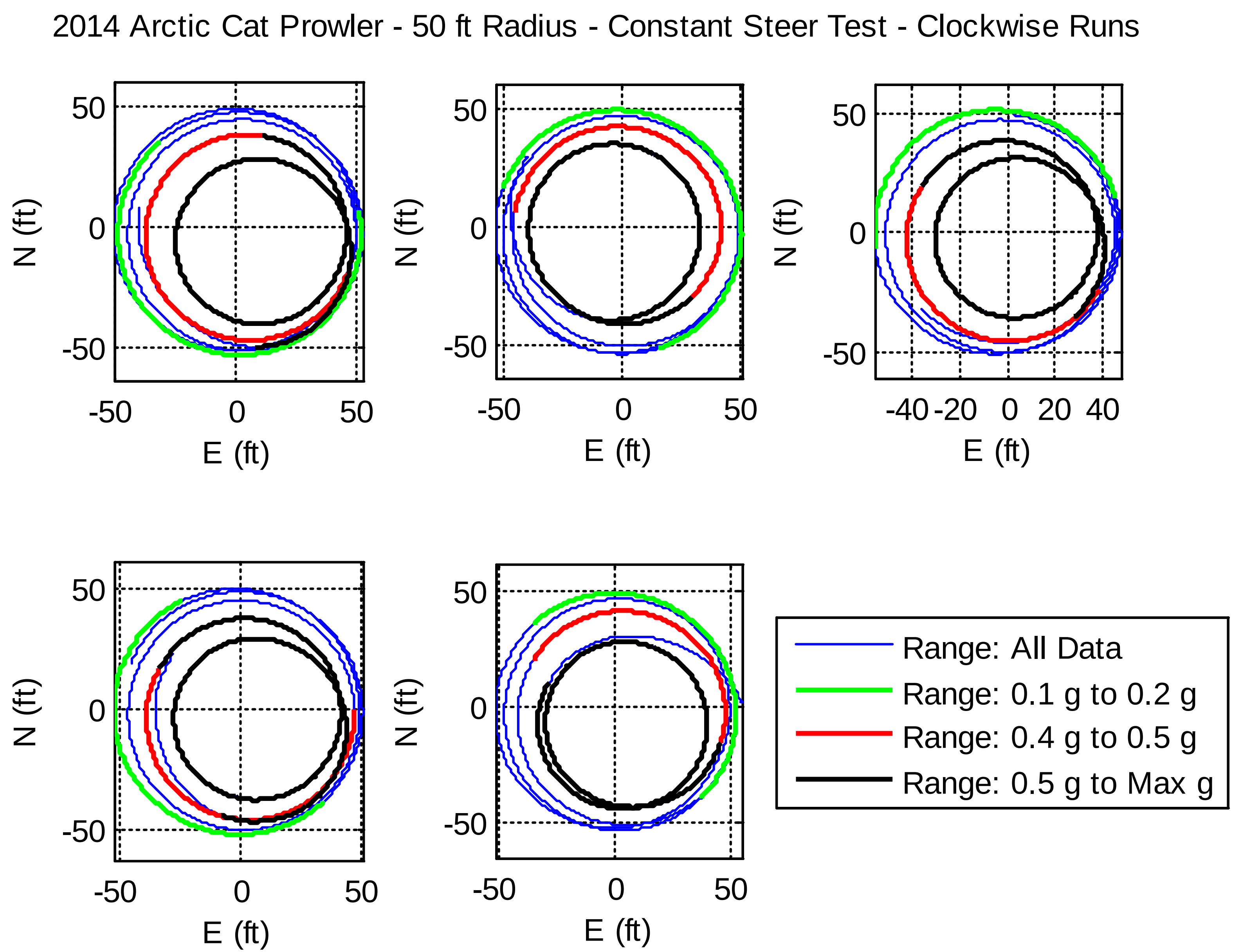



2009 Yamaha Rhino - 50 ft Radius - Constant Steer Test - Counterclockwise Runs
N (ft)
E (ft)
50
0
-50
Range: All Data
Range: 0.1 g to 0.2 g
Range: 0.4 g to 0.5 g
Range: 0.5 g to Max g

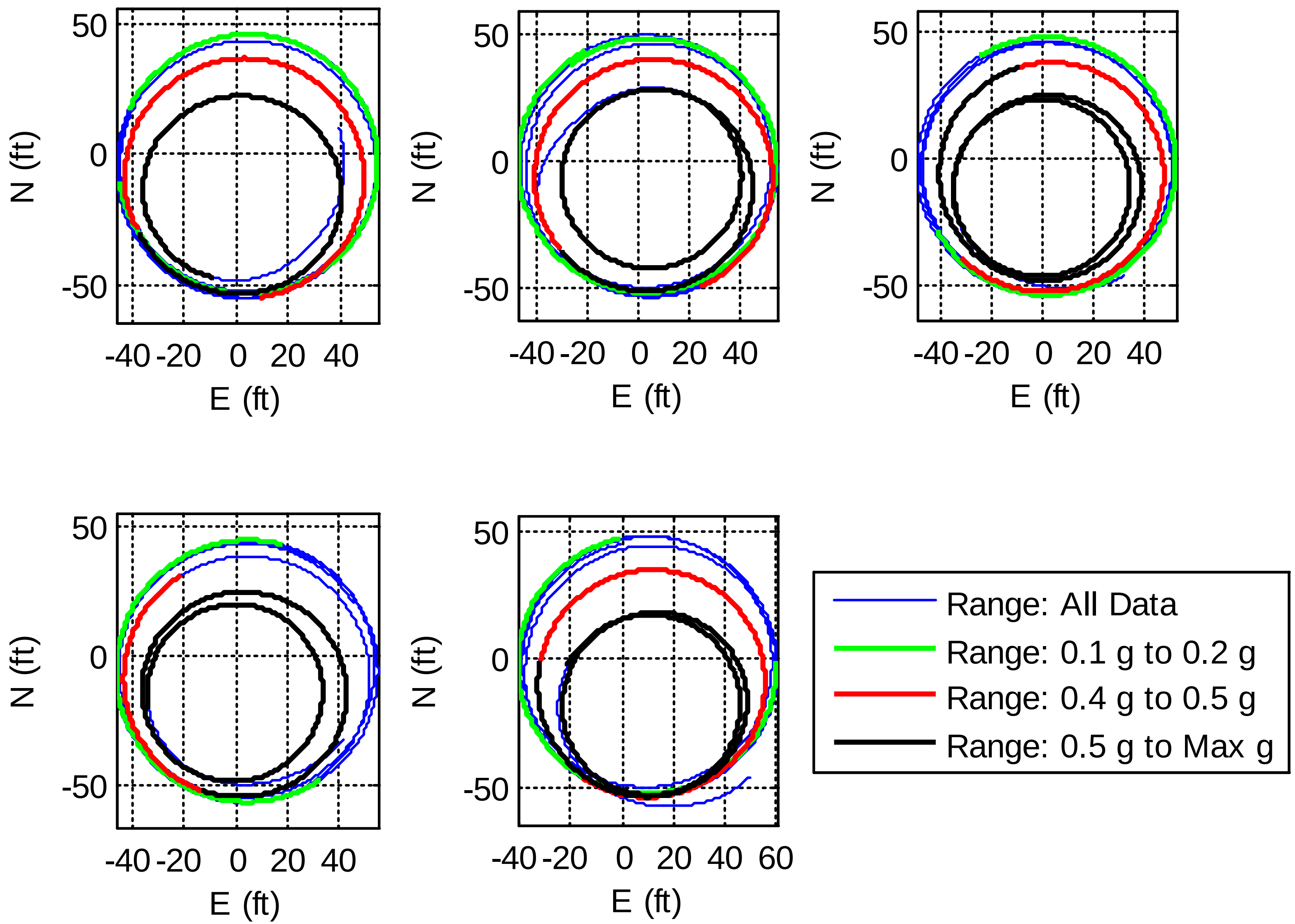

2014 Arctic Cat Prowler
50 ft Radius - Constant Steer Test
Steer Angle (deg)
150
100
50
0
-50
-100
-150
0
50
100
150
200
Speed (m/s)
10
5
0
Roll Angle (deg)
10
0
-10
Estimated Ay (g)
0.5
0
-0.5
Yaw Rate (deg/sec)
100
0
-100
Time (sec)
Time (sec)

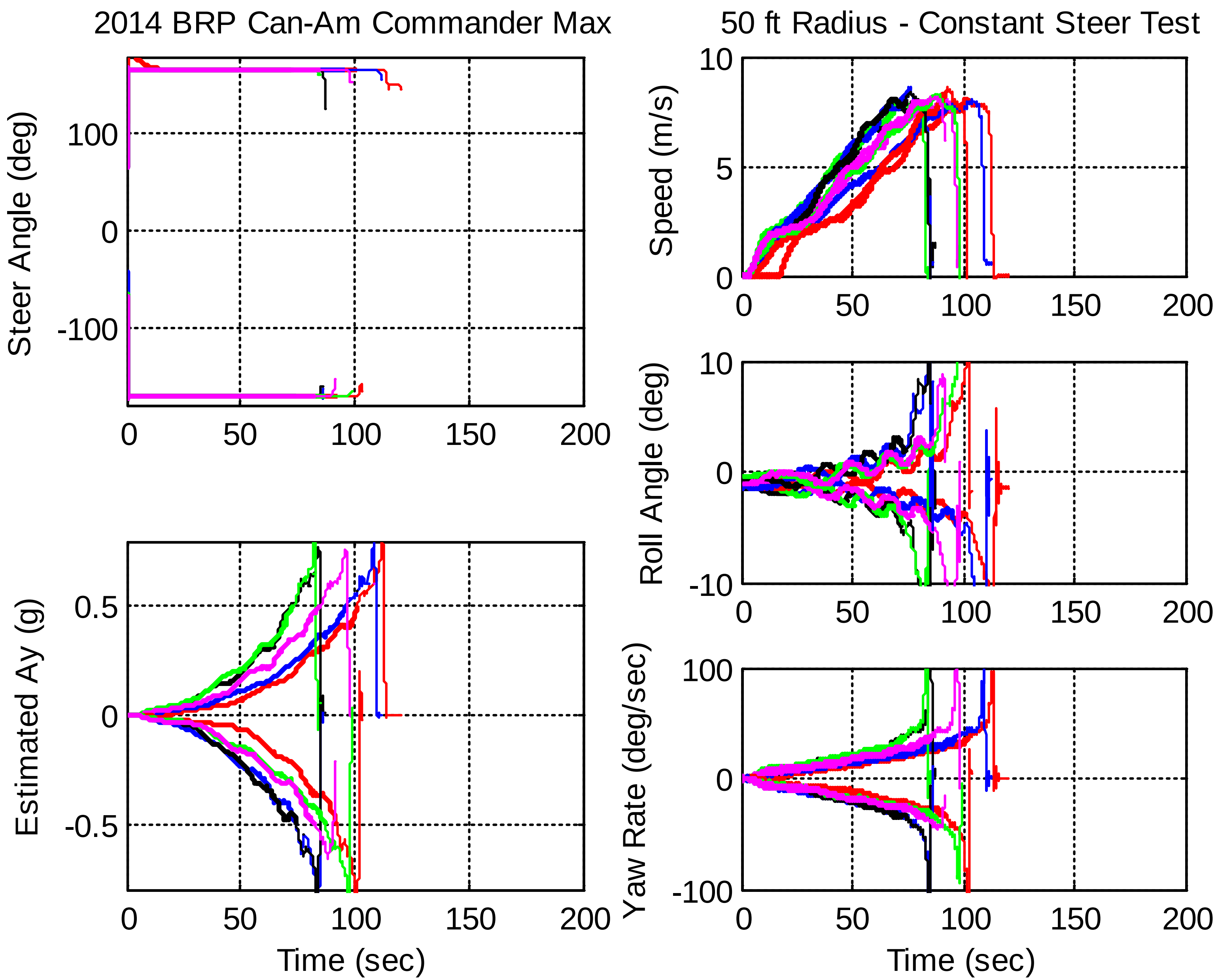

2014 Arctic Cat Prowler - 50 ft Radius - Constant Steer Test
Estimated Ay (g)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
1
2
3
4
5
6
7
8
9
10
Speed (m/s)

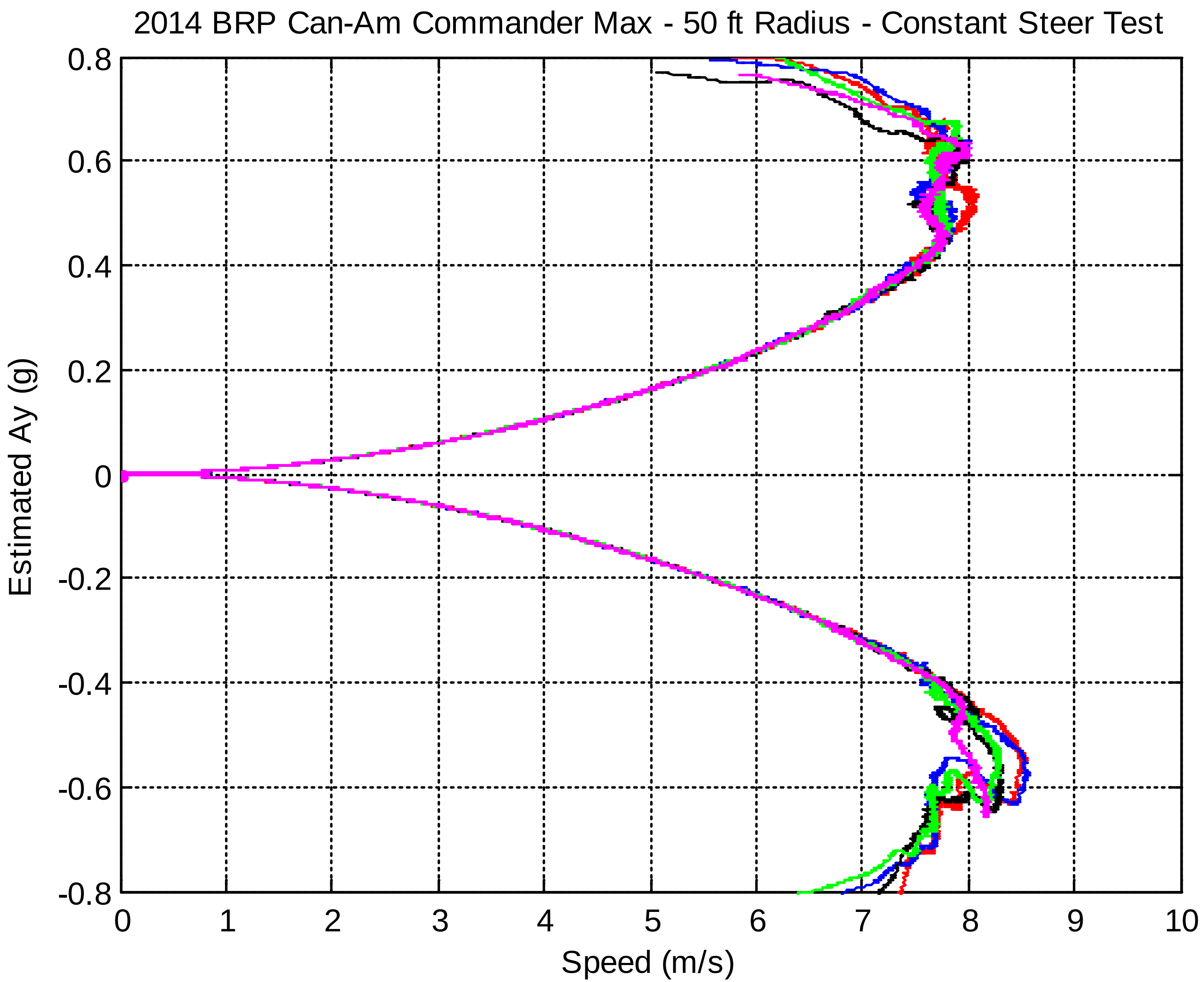

2014 Arctic Cat Prowler - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 3.68 3.75 3.8 3.76 3.95 STD=0.103
CW Final Slopes: 7.83 12.7 8.08 10.3 9.85 STD=1.96
CW Ratios: 2.13 3.37 2.13 2.74 2.49 STD=0.518
CW Average: 2.57
Average Ratio: 2.23
CCW Average: 1.88
CCW Ratios: 1.46 1.67 2.77 1.86 1.66 STD=0.516
CCW Final Slopes: -5.24 -6.3 -9.99 -6.89 -6.14 STD=1.82
CCW Initial Slopes: -3.6 -3.76 -3.61 -3.71 -3.69 STD=0.0694
Yaw Rate (deg/sec)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10
Speed (m/s)

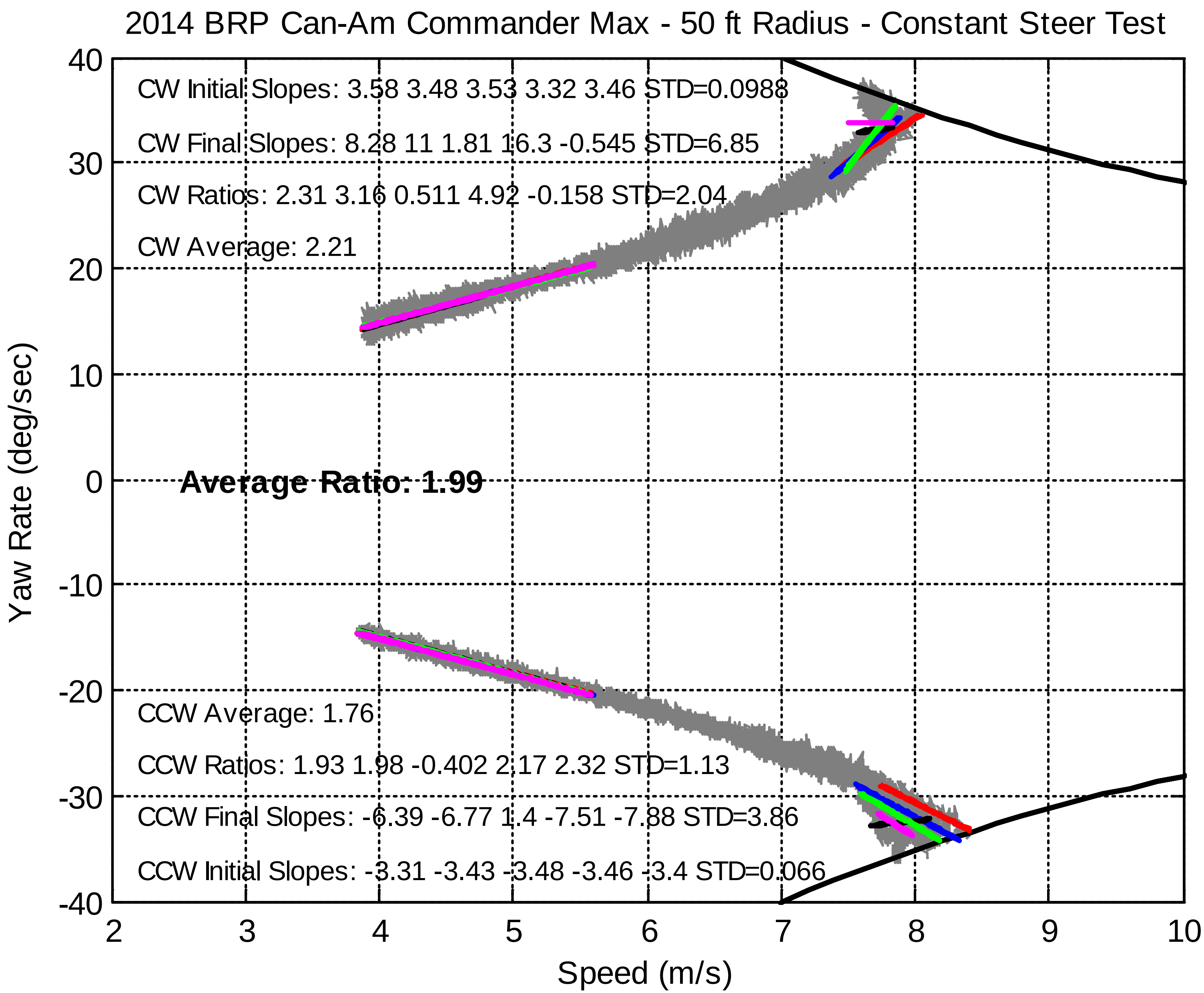

2014 Arctic Cat Prowler - 50 ft Radius - Constant Steer Test - Clockwise Runs
N (ft)
E (ft)
50
0
-50
-40
-20
20
40
Range: All Data
Range: 0.1 g to 0.2 g
Range: 0.4 g to 0.5 g
Range: 0.5 g to Max g

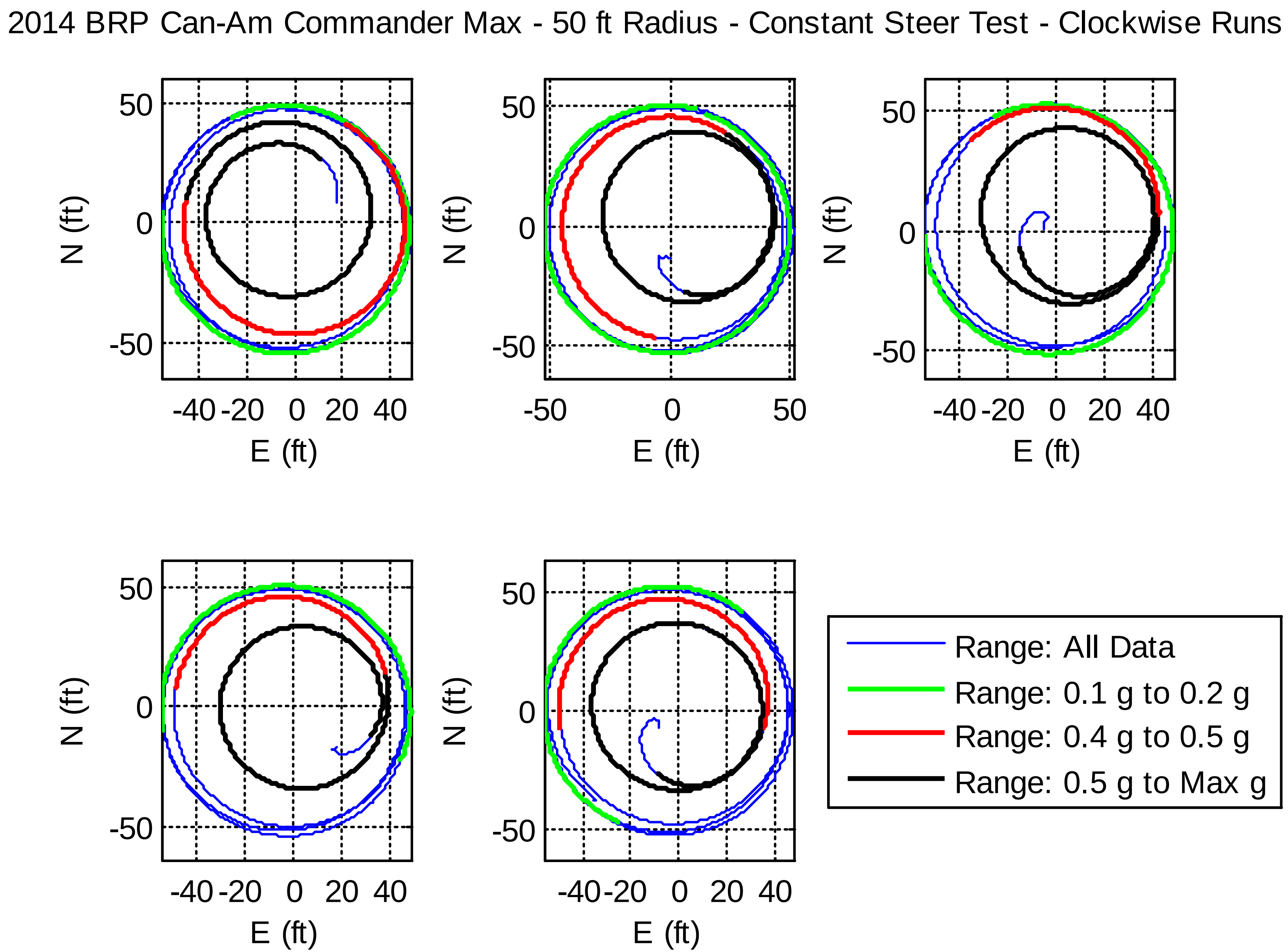
2014 Arctic Cat Prowler - 50 ft Radius - Constant Steer Test - Counterclockwise Runs



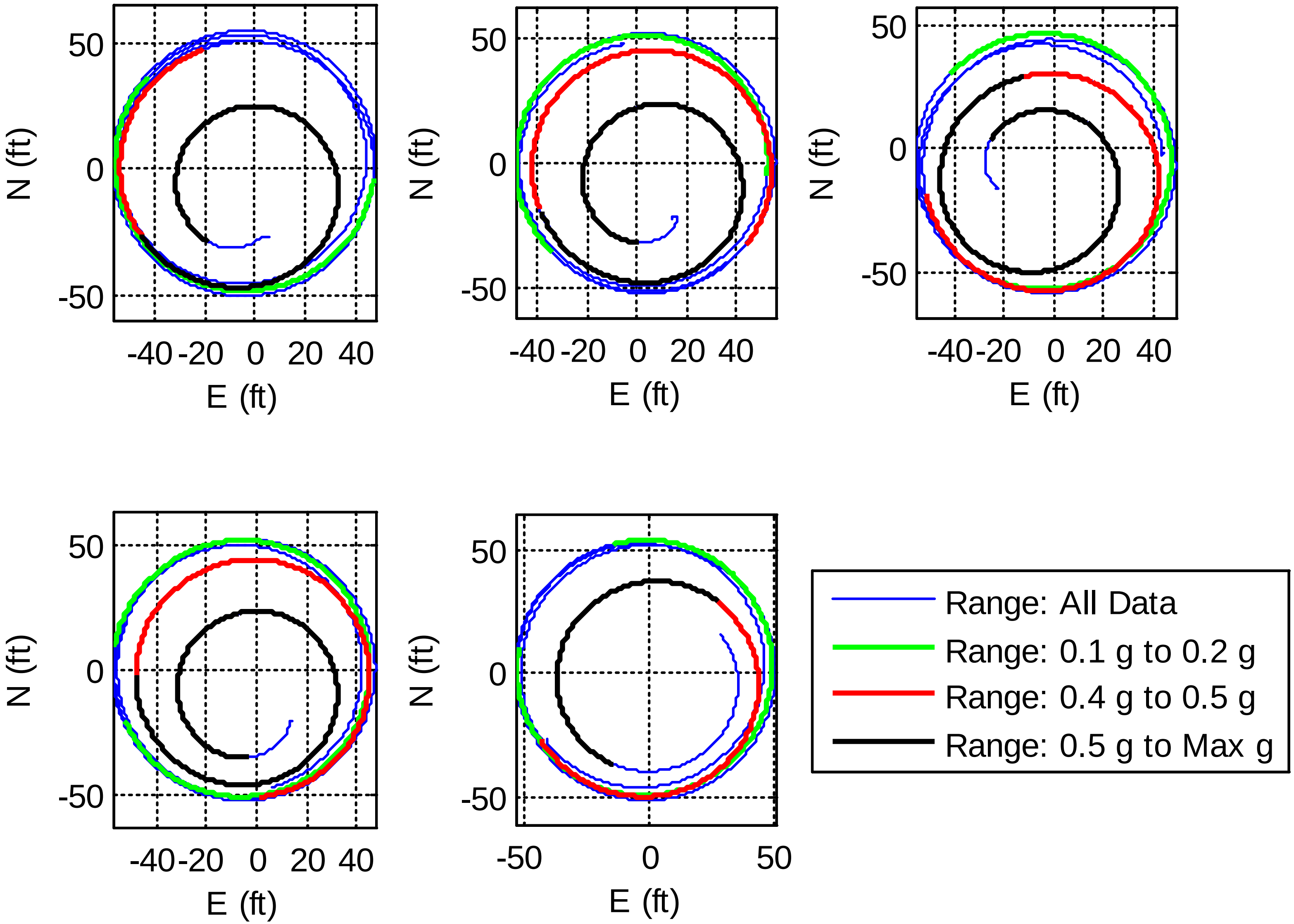

2014 BRP Can-Am Commander Max
50 ft Radius - Constant Steer Test
Steer Angle (deg)
100
0
-100
0
50
100
150
200
Speed (m/s)
10
5
0
Roll Angle (deg)
10
0
-10
Estimated Ay (g)
0.5
0
-0.5
Time (sec)
Yaw Rate (deg/sec)
100
0
-100
Time (sec)

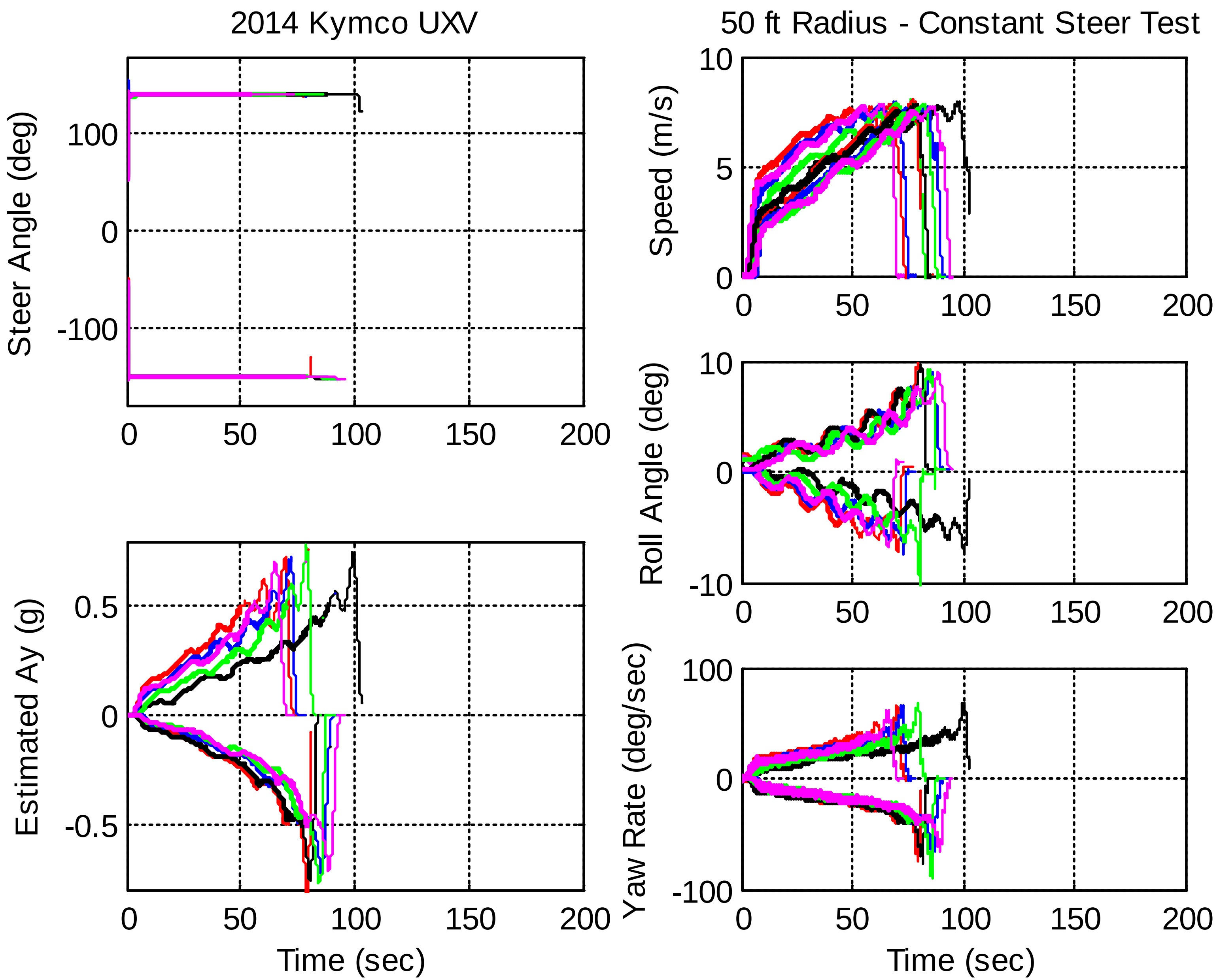

2014 BRP Can-Am Commander Max - 50 ft Radius - Constant Steer Test
Estimated Ay (g)
Speed (m/s)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
1
2
3
4
5
6
7
8
9
10


2014 BRP Can-Am Commander Max - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 3.58 3.48 3.53 3.32 3.46 STD=0.0988
CW Final Slopes: 8.28 11 1.81 16.3 -0.545 STD=6.85
CW Ratios: 2.31 3.16 0.511 4.92 -0.158 STD=2.04
CW Average: 2.21
Average Ratio: 1.99
CCW Average: 1.76
CCW Ratios: 1.93 1.98 -0.402 2.17 2.32 STD=1.13
CCW Final Slopes: -6.39 -6.77 1.4 -7.51 -7.88 STD=3.86
CCW Initial Slopes: -3.31 -3.43 -3.48 -3.46 -3.4 STD=0.066
Yaw Rate (deg/sec)
Speed (m/s)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10

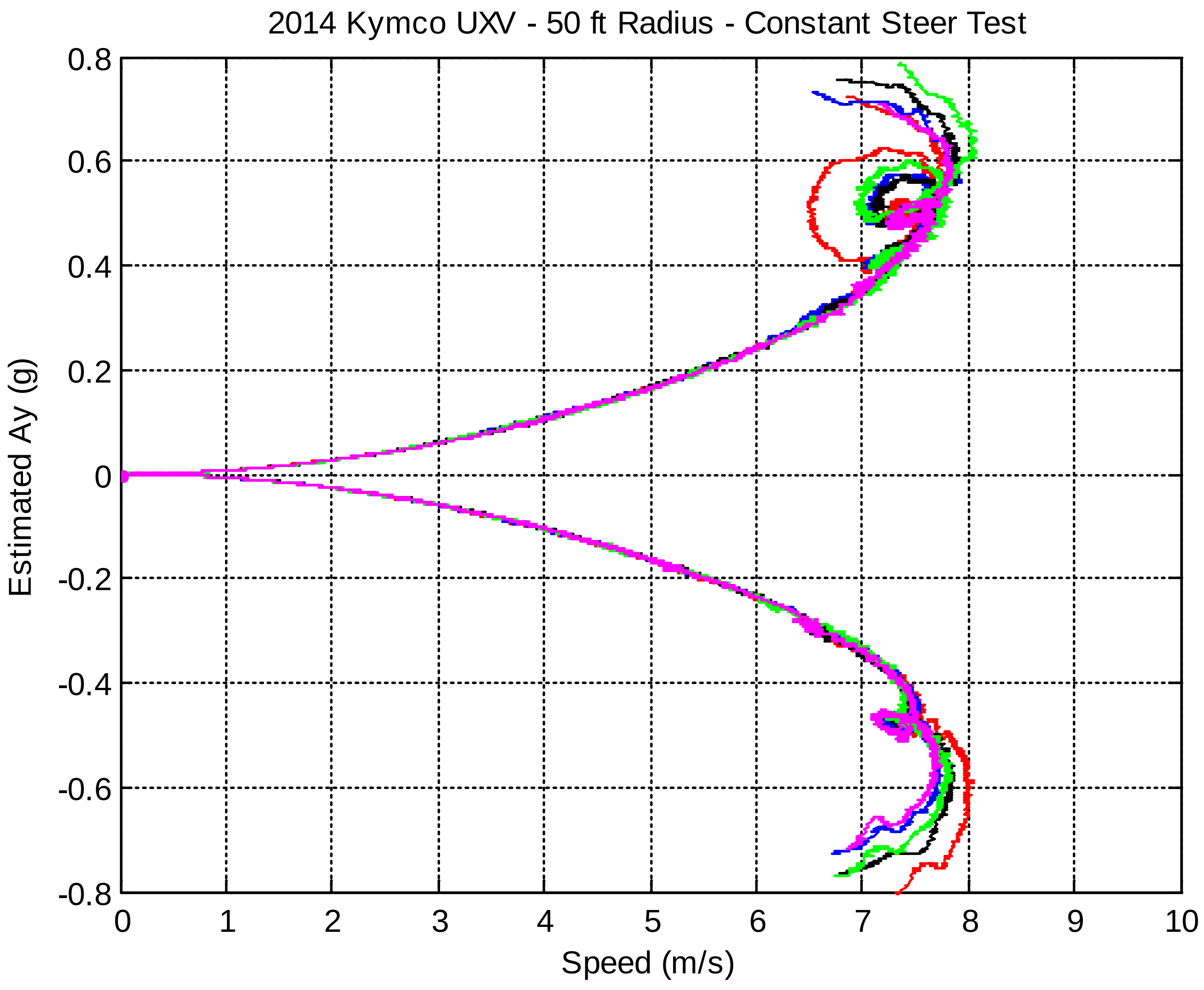

2014 BRP Can-Am Commander Max - 50 ft Radius - Constant Steer Test - Clockwise Runs
N (ft)
E (ft)
50
0
-50
-40
-20
20
40
Range: All Data
Range: 0.1 g to 0.2 g
Range: 0.4 g to 0.5 g
Range: 0.5 g to Max g

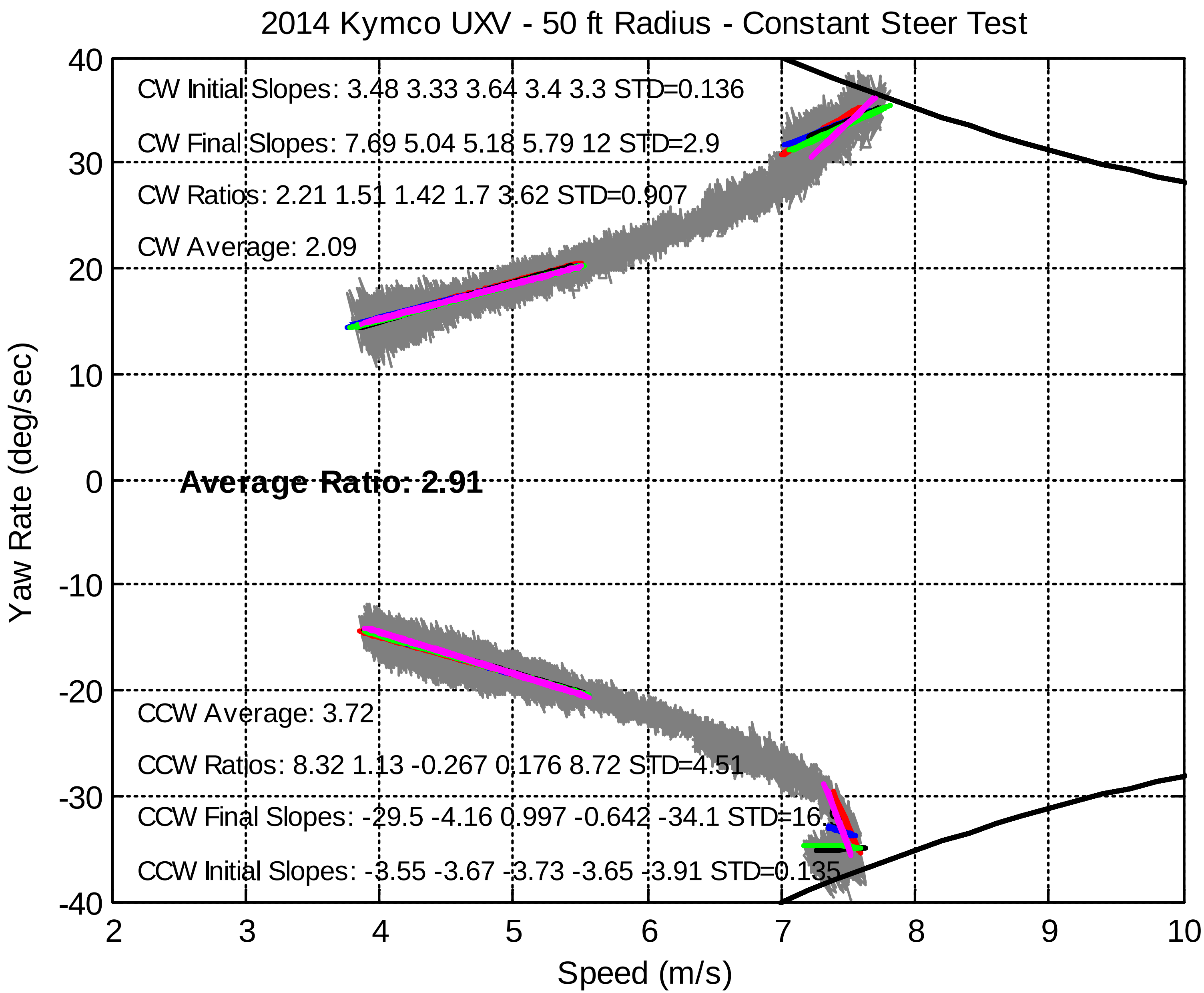
2014 BRP Can-Am Commander Max - 50 ft Radius - Constant Steer Test - Counterclockwise Ru



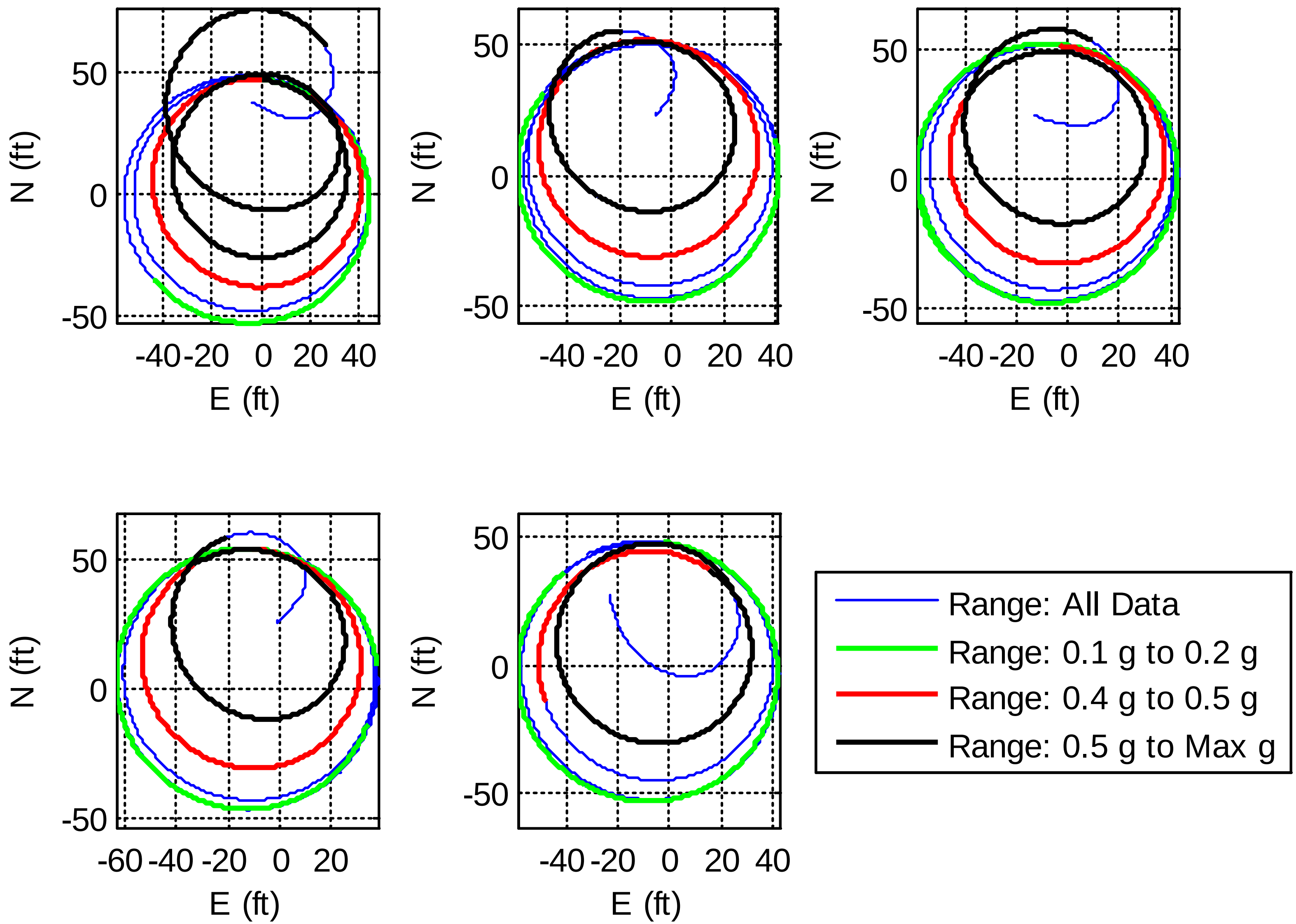


2014 Kymco UXV
50 ft Radius - Constant Steer Test
Steer Angle (deg)
100
0
-100
0
50
100
150
200
Speed (m/s)
10
5
0
Roll Angle (deg)
-10
Estimated Ay (g)
0.5
-0.5
Time (sec)
Yaw Rate (deg/sec)

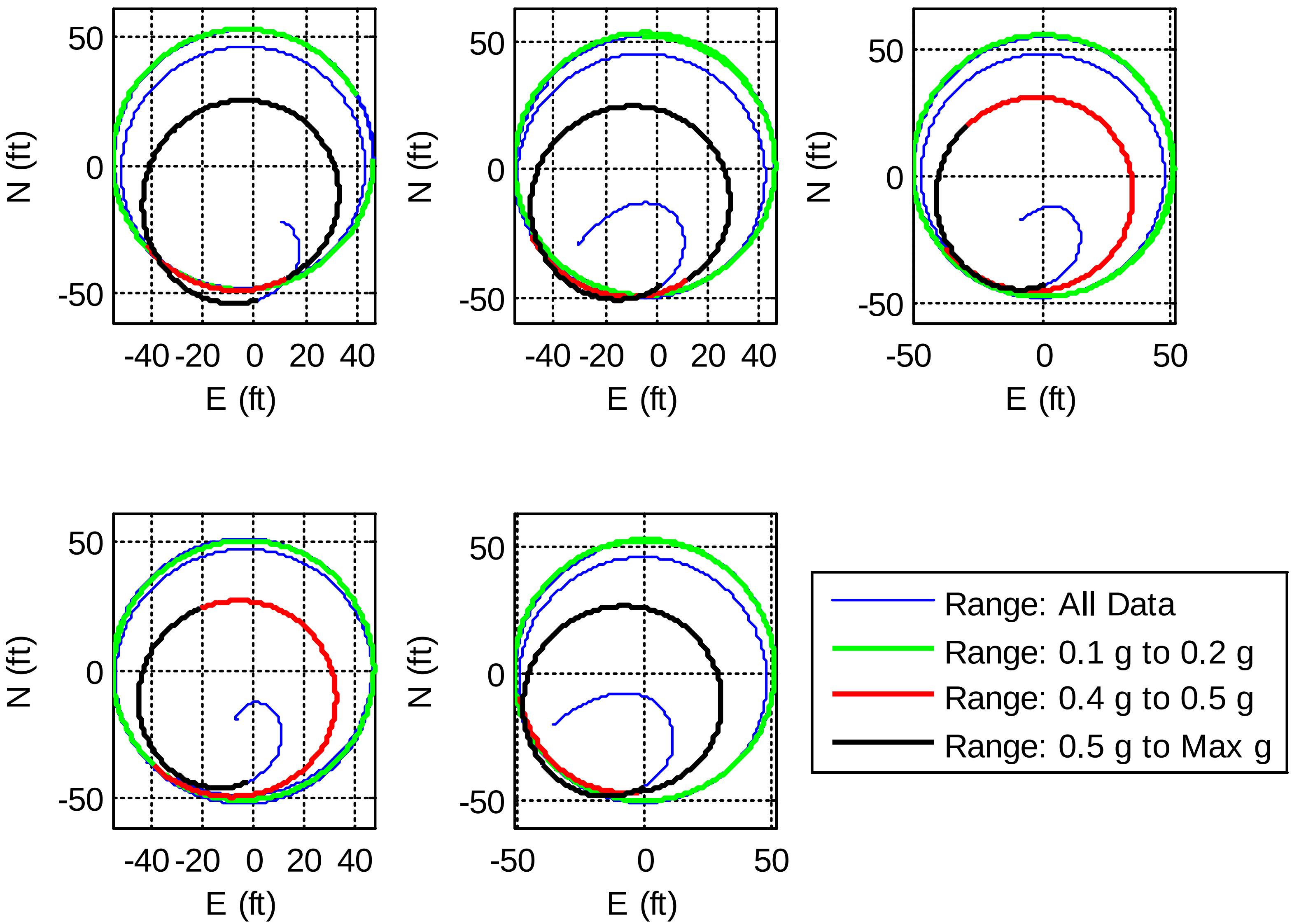

2014 Kymco UXV - 50 ft Radius - Constant Steer Test
Estimated Ay (g)
Speed (m/s)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
1
2
3
4
5
6
7
8
9
10

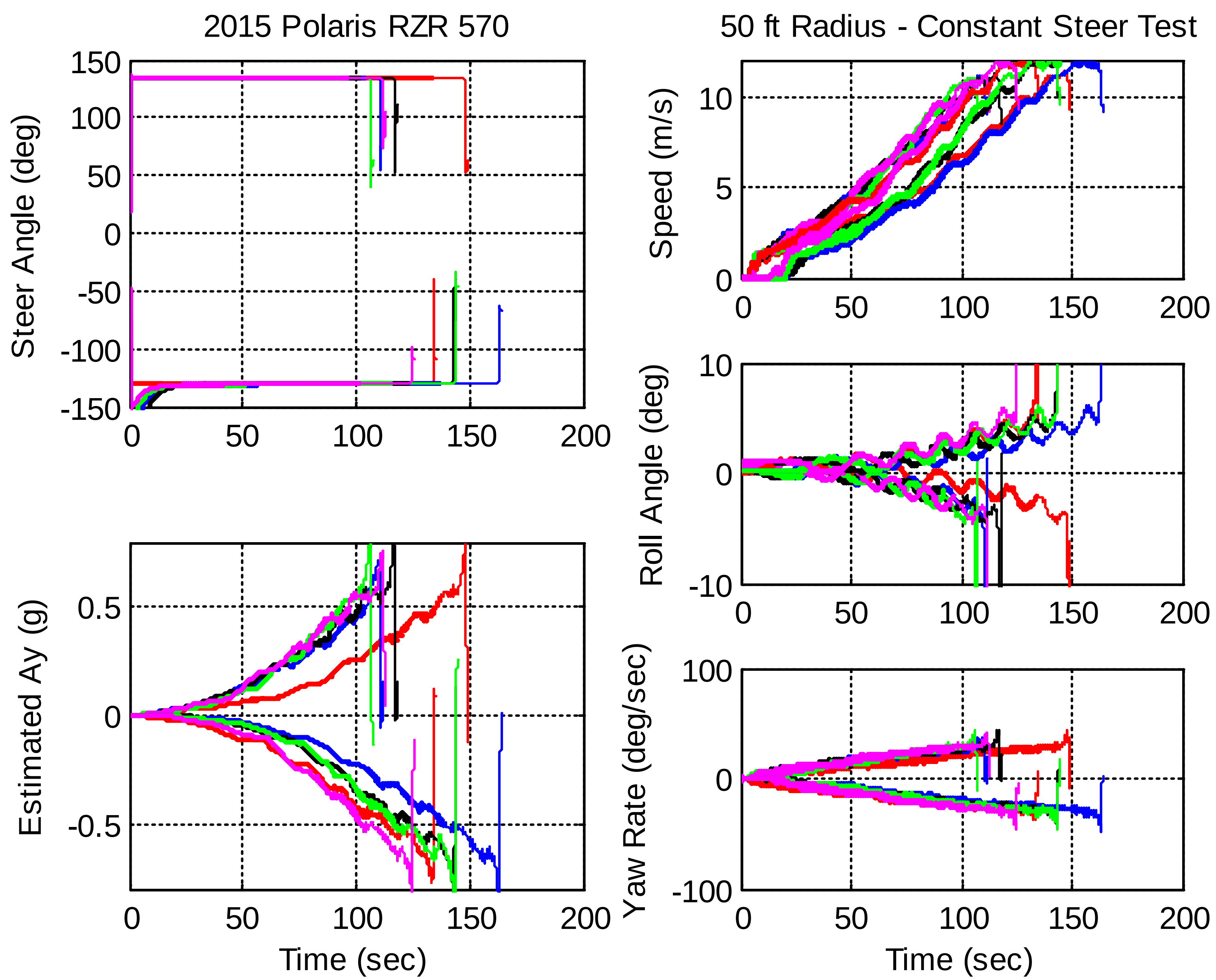

2014 Kymco UXV - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 3.48 3.33 3.64 3.4 3.3 STD=0.136
CW Final Slopes: 7.69 5.04 5.18 5.79 12 STD=2.9
CW Ratios: 2.21 1.51 1.42 1.7 3.62 STD=0.907
CW Average: 2.09
Average Ratio: 2.91
CCW Average: 3.72
CCW Ratios: 8.32 1.13 -0.267 0.176 8.72 STD=4.51
CCW Final Slopes: -29.5 -4.16 0.997 -0.642 -34.1 STD=16.9
CCW Initial Slopes: -3.55 -3.67 -3.73 -3.65 -3.91 STD=0.135
Yaw Rate (deg/sec)
Speed (m/s)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10

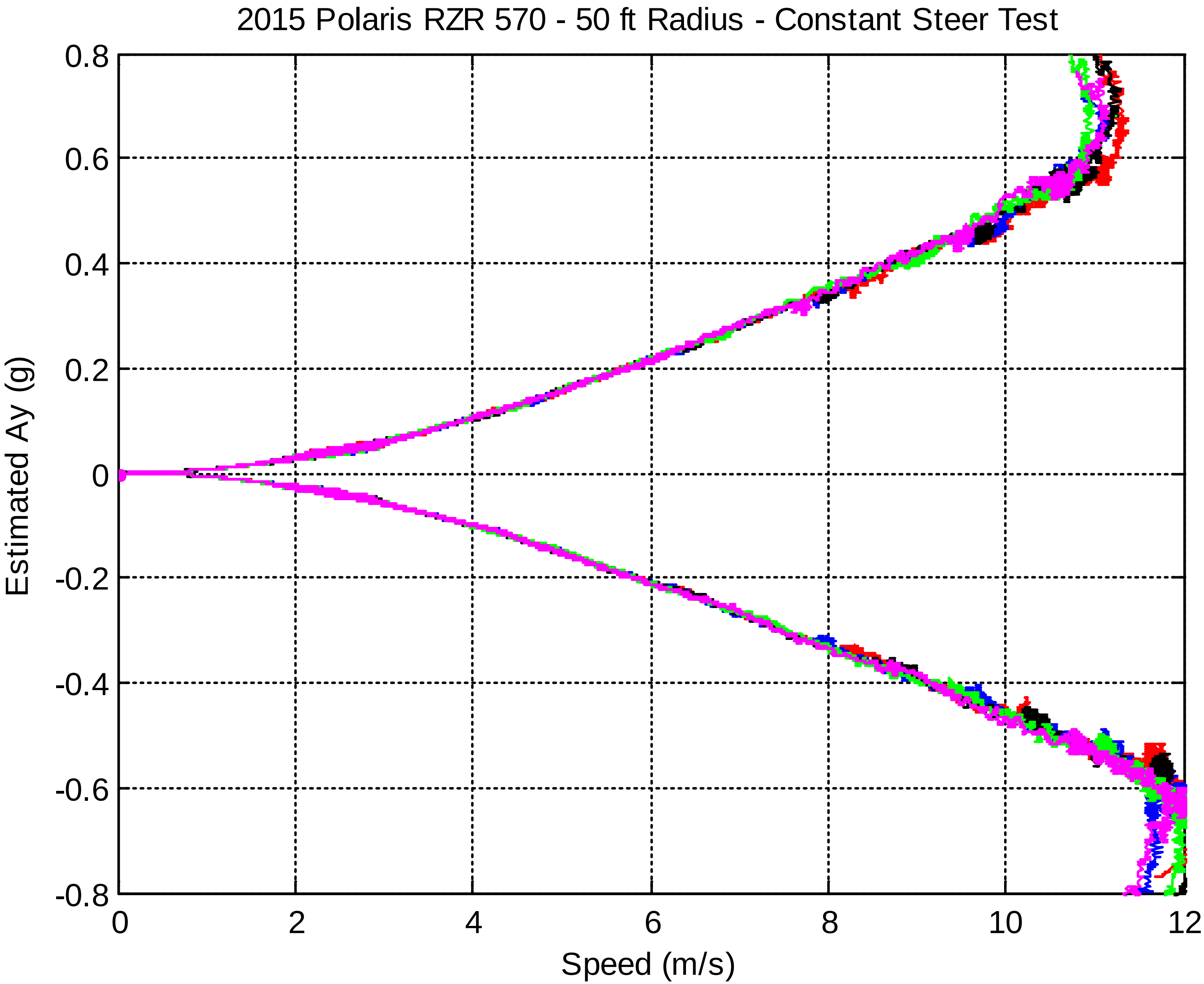
2014 Kymco UXV - 50 ft Radius - Constant Steer Test - Clockwise Runs

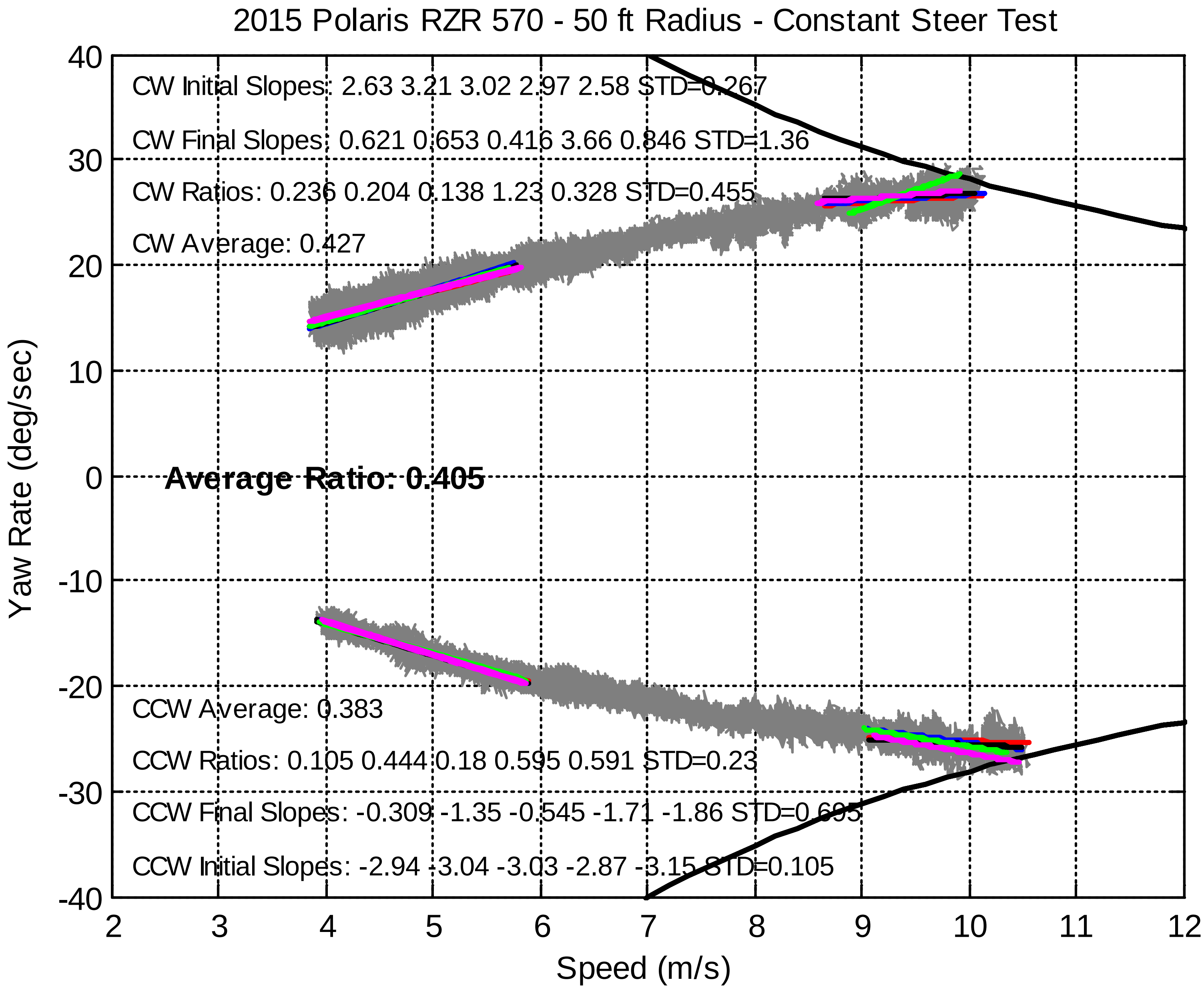


2014 Kymco UXV - 50 ft Radius - Constant Steer Test - Counterclockwise Runs

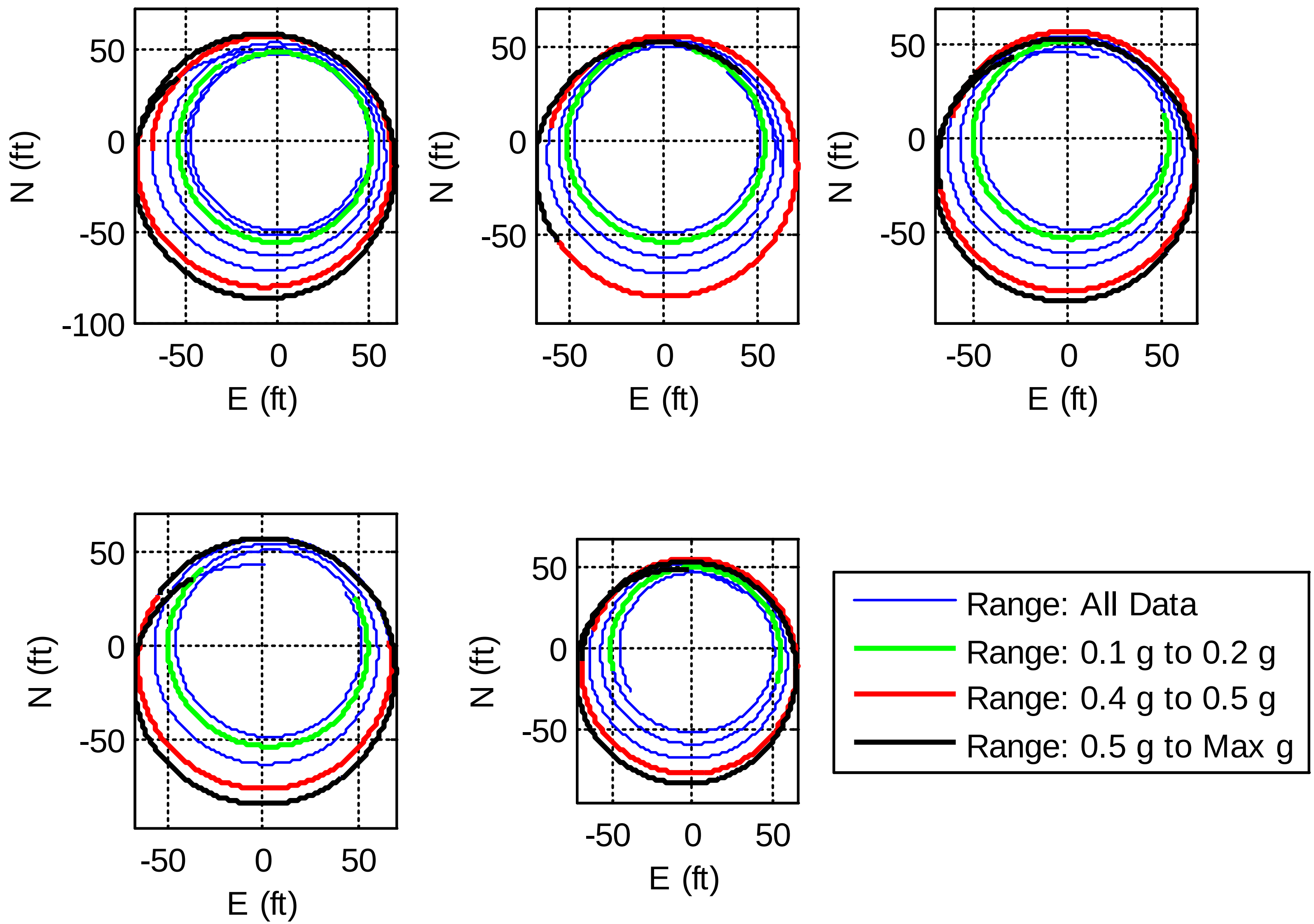



2015 Polaris RZR 570
50 ft Radius - Constant Steer Test
Steer Angle (deg)
Speed (m/s)
Roll Angle (deg)
Estimated Ay (g)
Yaw Rate (deg/sec)
Time (sec)
Time (sec)
150
100
50
0
-50
-100
-150
0
50
100
150
200
10
5
0
10
0
-10
0.5
0
-0.5
100
0
-100

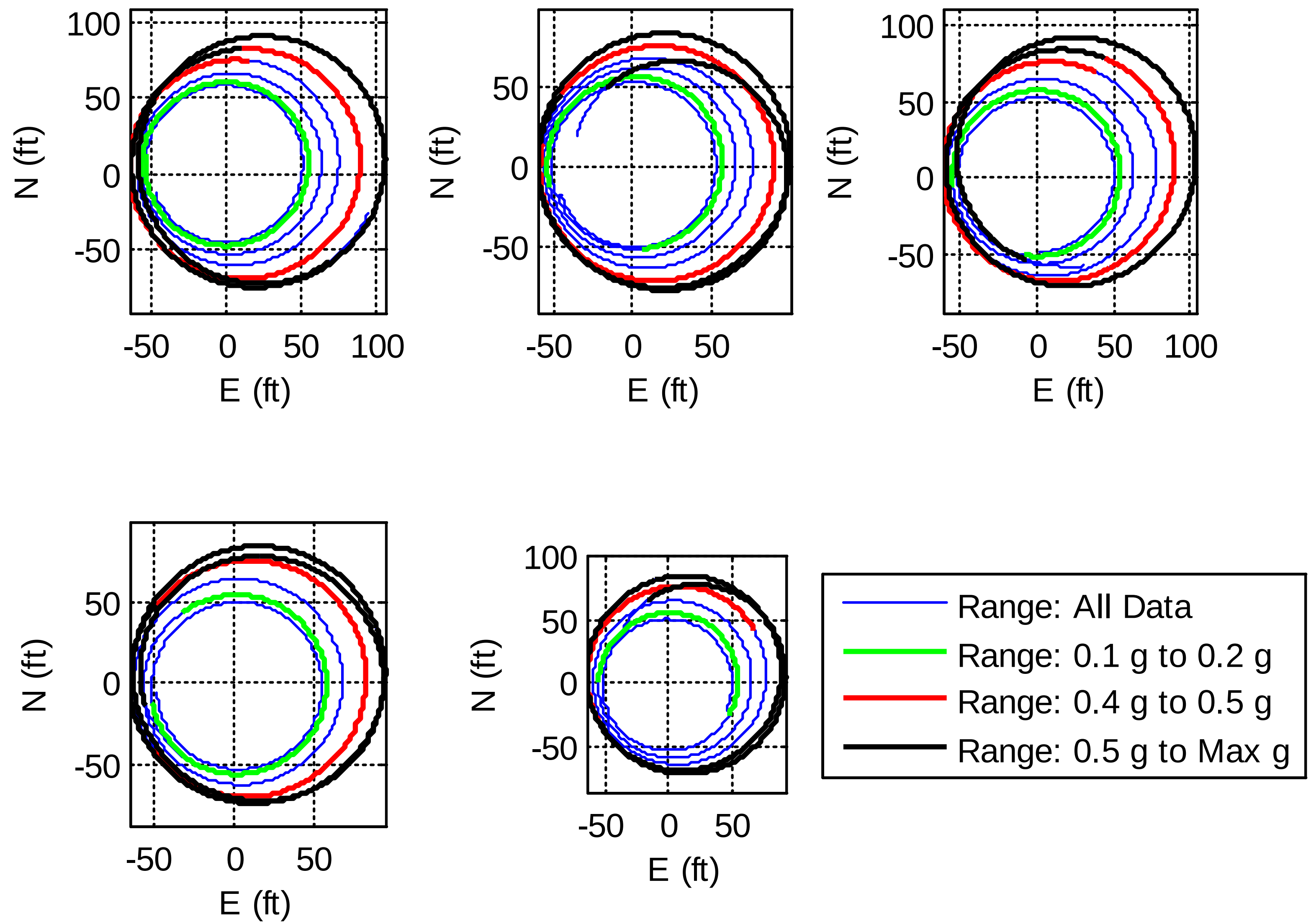

2015 Polaris RZR 570 - 50 ft Radius - Constant Steer Test
Estimated Ay (g)
Speed (m/s)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
2
4
6
8
10
12

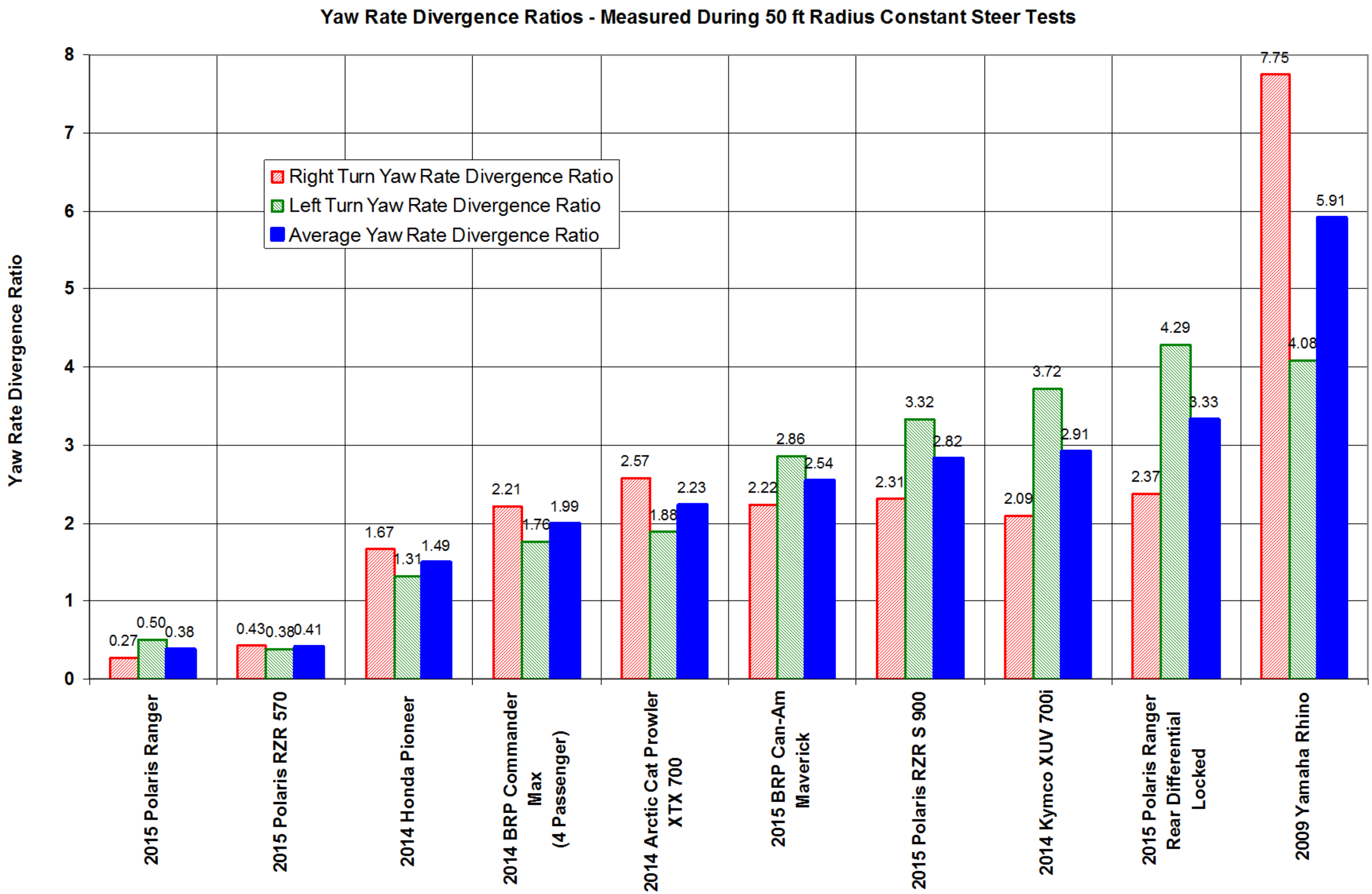

2015 Polaris RZR 570 - 50 ft Radius - Constant Steer Test
CW Initial Slopes: 2.63 3.21 3.02 2.97 2.58 STD=0.267
CW Final Slopes: 0.621 0.653 0.416 3.66 0.846 STD=1.36
CW Ratios: 0.236 0.204 0.138 1.23 0.328 STD=0.455
CW Average: 0.427
Average Ratio: 0.405
CCW Average: 0.383
CCW Ratios: 0.105 0.444 0.18 0.595 0.591 STD=0.23
CCW Final Slopes: -0.309 -1.35 -0.545 -1.71 -1.86 STD=0.695
CCW Initial Slopes: -2.94 -3.04 -3.03 -2.87 -3.15 STD=0.105
Yaw Rate (deg/sec)
Speed (m/s)
40
30
20
10
0
-10
-20
-30
-40
2
3
4
5
6
7
8
9
10
11
12

2015 Polaris RZR 570 - 50 ft Radius - Constant Steer Test - Clockwise Runs



2015 Polaris RZR 570 - 50 ft Radius - Constant Steer Test - Counterclockwise Runs




Yaw Rate Divergence Ratios - Measured During 50 ft Radius Constant Steer Tests
Yaw Rate Divergence Ratio
0
1
2
3
4
5
6
7
8
Right Turn Yaw Rate Divergence Ratio
Left Turn Yaw Rate Divergence Ratio
Average Yaw Rate Divergence Ratio
0.27
0.50
0.38
0.43
0.38
0.41
1.67
1.31
1.49
2.21
1.76
1.99
2.57
1.88
2.23
2.22
2.86
2.54
2.31
3.32
2.82
2.09
3.72
2.91
2.37
4.29
3.33
7.75
4.08
5.91
2015 Polaris Ranger
2015 Polaris RZR 570
2014 Honda Pioneer
2014 BRP Commander Max (4 Passenger)
2014 Arctic Cat Prowler XTX 700
2015 BRP Can-Am Maverick
2015 Polaris RZR S 900
2014 Kymco XUV 700i
2015 Polaris Ranger Rear Differential Locked
2009 Yamaha Rhino