‘Experiment 2’ – Robot & 5000fps
(Quintic Biomechanics)

- A high-speed camera (5000 fps, resolution: 1024 x 880 pixels) was used to track seven reflective markers strategically placed on both styles of putter shafts.
- In addition to the markers, the robot was also used to simulate different acceleration profiles of golfers, ranging from a smooth pendulum style, to a rapid acceleration popping stroke.
- The transition from the backswing to the downswing was also measured with all the varieties of stroke.

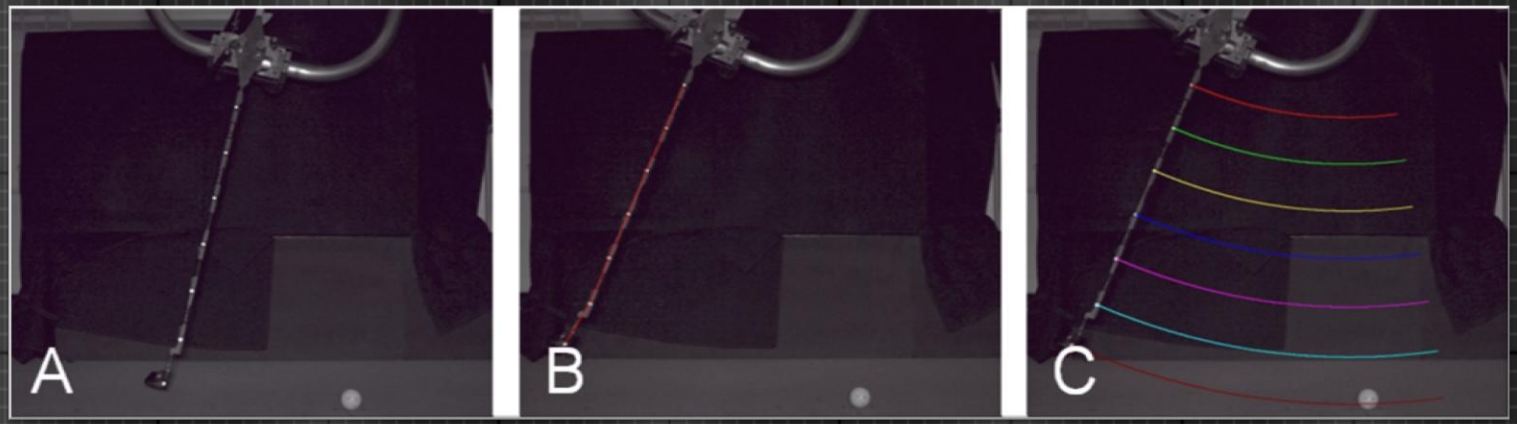


Figure 1. Images displaying the experimental setup, putter in the robot (A), the seven point reference model used during Automatic Tracking (B), and digitised trace for seven markers of the shaft and toe (C).

Paul Hurrion

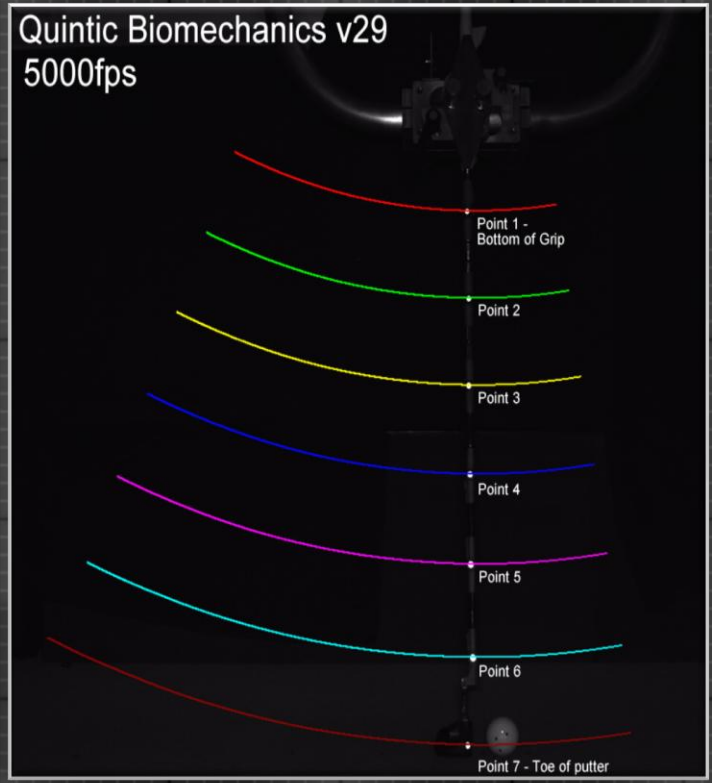
'Experiment 2' – Robot & 5000fps

• **Push** – The club was held at the top of the backswing (static for three seconds), and pushed to simulate a stroke with a sharp acceleration during transition.

• **Pull** – The club was gently pulled to the top of the backswing and released just prior to the putter reaching the transition.

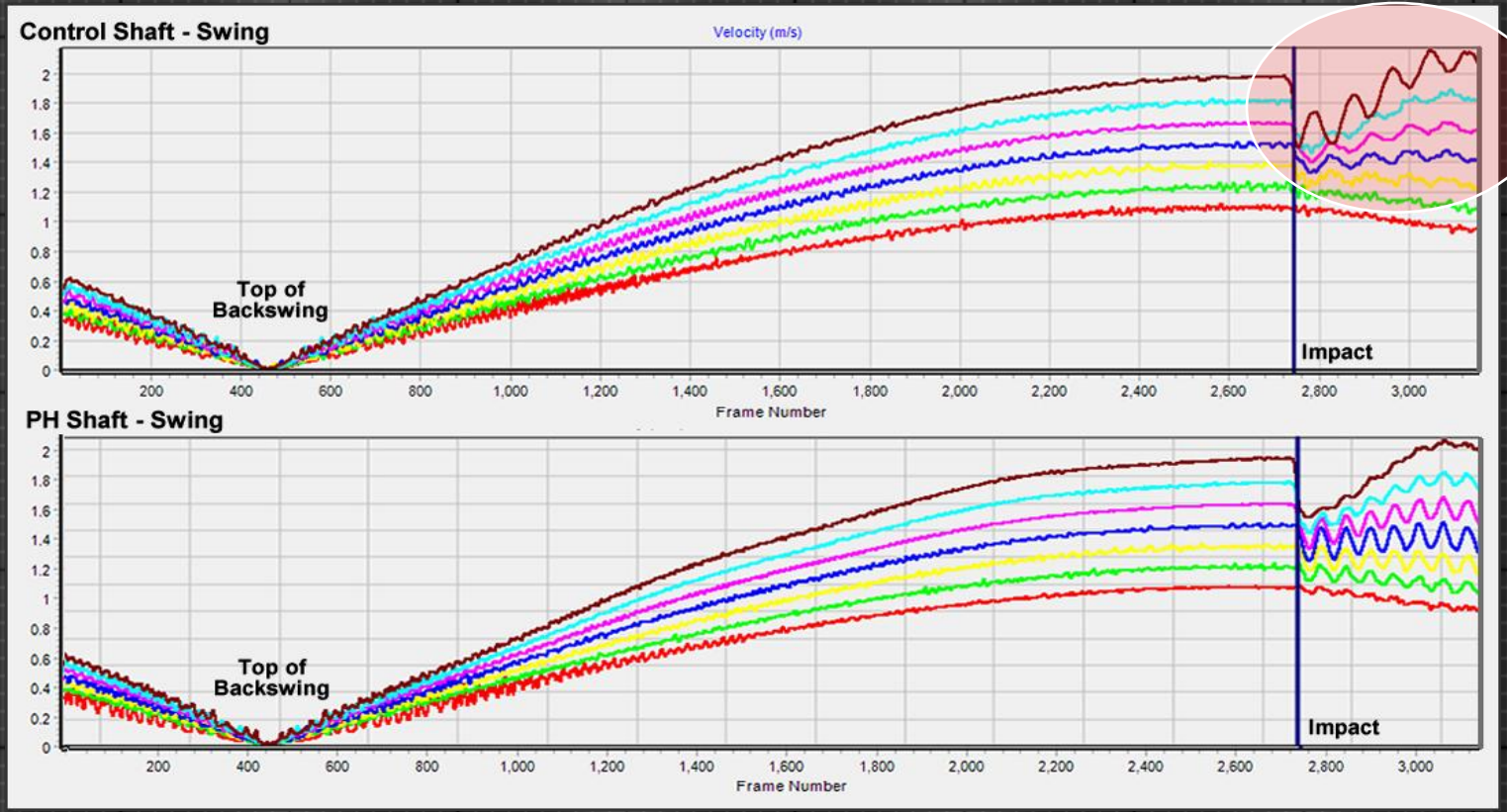
• **Static** – The club was held static at the top of the backswing for 5 seconds (no vibration of the shaft) before release. As a result the weight of the Clubhead created a small amount of club droop.

• **Swing** – The club robot was allowed to achieve a perfect pendulum motion (multiple swings back and through) **before** the ball was placed. This allowed any vibration in the shaft to be reduced to a minimum.



Paul Hurrion

'Experiment 2' – Swing : Robot & 5000fps



The above graphs highlight the velocity of the seven markers during the PULL Condition for the Control Shaft and the PH Shaft : (Blue Vertical line = Impact)

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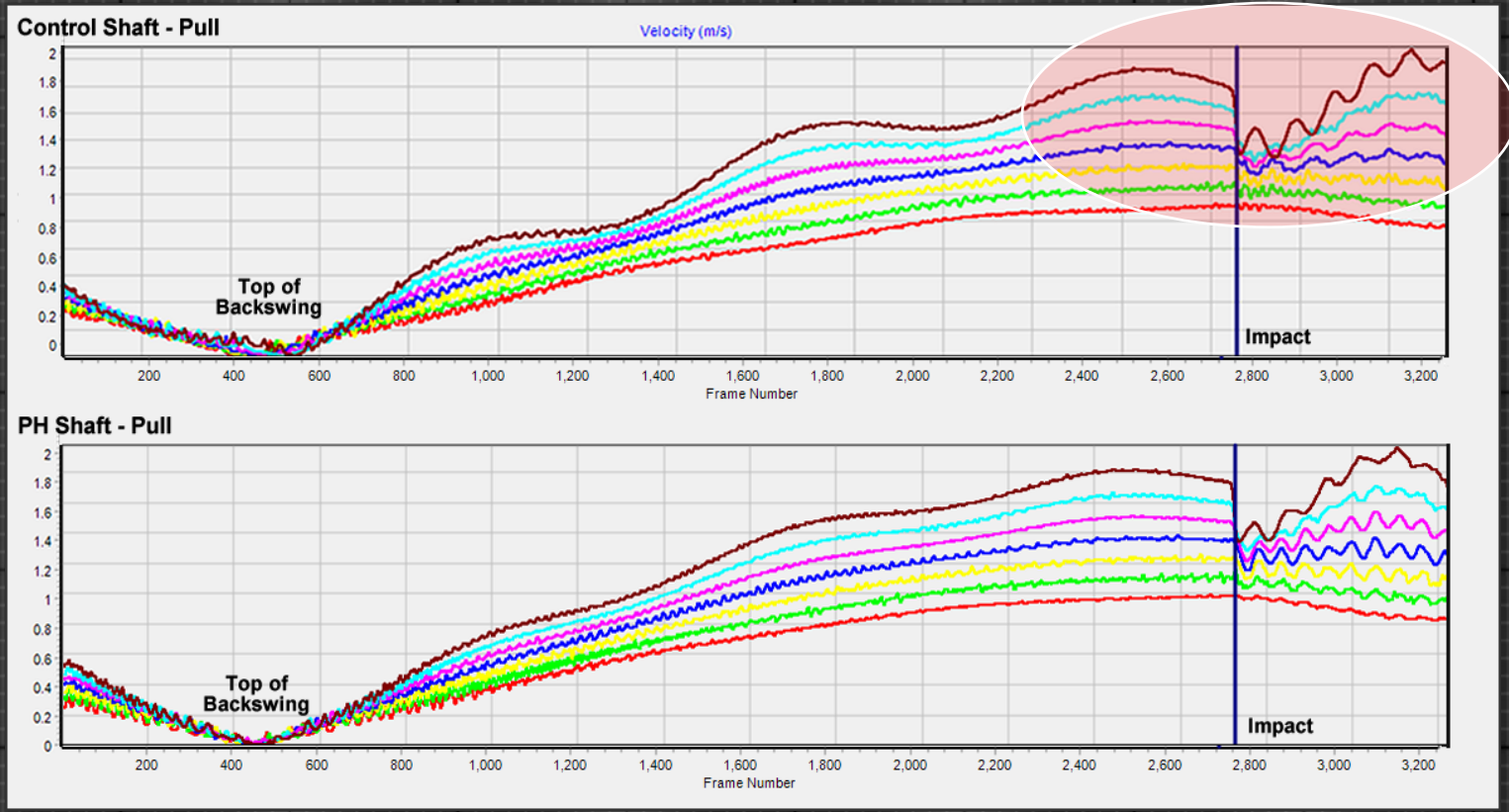
‘Experiment 2’ – Pull : Robot & 5000fps



The above graphs highlight the velocity of the seven markers during the PULL Condition for the Control Shaft and the PH Shaft : (Blue Vertical line = Impact)

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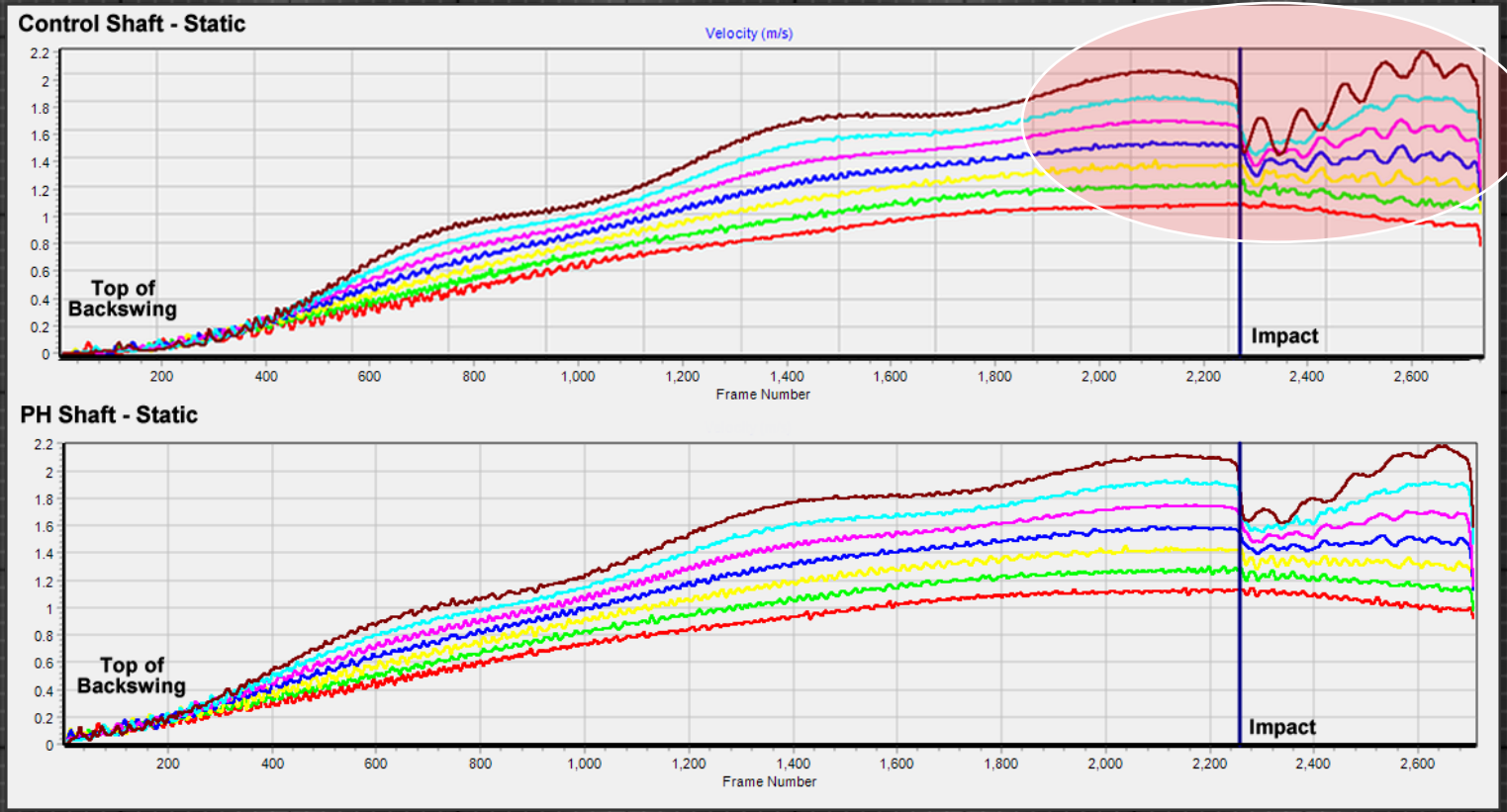
‘Experiment 2’ – Static : Robot & 5000fps



The above graphs highlight the velocity of the seven markers during the PULL Condition for the Control Shaft and the PH Shaft : (Blue Vertical line = Impact)

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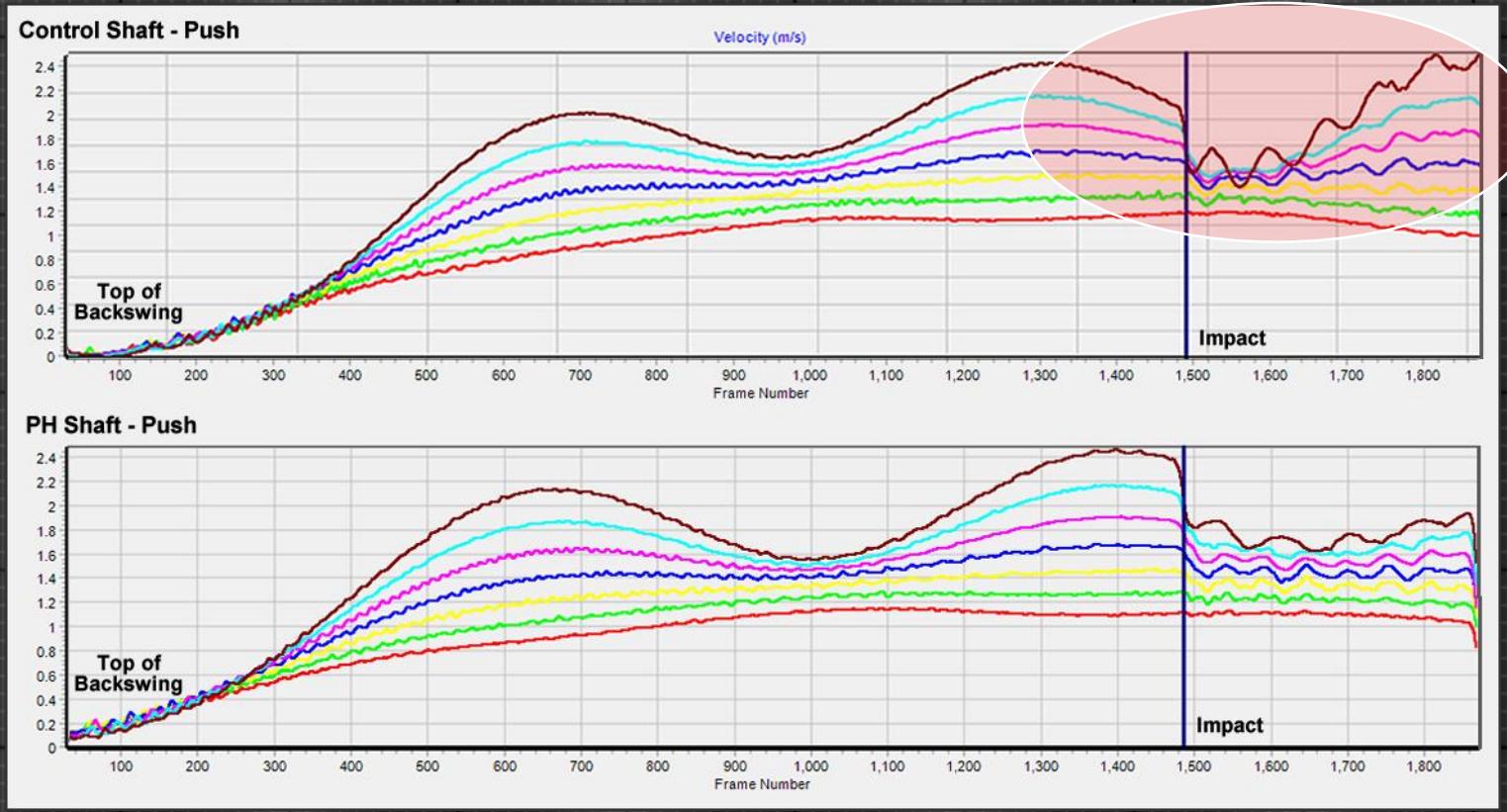
‘Experiment 2’ – Push : Robot & 5000fps



The above graphs highlight the velocity of the seven markers during the PULL Condition for the Control Shaft and the PH Shaft : (Blue Vertical line = Impact)

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Summary

- It is interesting to note that in all conditions the reduced oscillation in the PH Balanced Shaft during the downswing, and/or immediately after impact.
- It is also interesting to note that the control shaft would actually be slowing down prior to impact. The peak speed of the shaft was variable (putt to putt and condition to condition).
- The variability in oscillation of the control shaft during the four robot conditions is effectively creating the inconsistency of the shaft angle at impact.
- An increase in shaft angle variability will then lead to an increase in the range and therefore more inconsistency in 'Launch Angle' and therefore the distance and time to 'Zero Skid'.
- How a golf ball reacts on first contact with the surface has an influence on the balls direction, ball speed, the height of the next bounce, the distance to 'true roll' and how the ball ultimately slows down and comes to rest.

The PH Balanced shaft is more stable at impact, there is less variability in the club shaft oscillation, leading to a more consistent face and shaft angle at impact. This is especially important today as putter head weights are increasing!

The R&A has ruled that the 'PH Balanced Putter Shaft' does conform to the Rules of Golf

Paul Harrison