Hitting the metrics, missing the angles: closing the directional gap in run-based compensatory training

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Headline

In elite football, a congested fixture schedule makes the period immediately after a match the most appropriate window to stimulate the players who did not play or played only briefly (Buchheit et al., 2021a). Placed here, the stimulus sits as far as possible from the next competition, with the aim of maintaining physical performance as much as possible, without creating too much fatigue leading to the next match (i.e., within 48 h). The challenge is that this short window is also the most constrained training session of the week: it's often impossible to use a ball, and the available training time is short because the team must often travel straight after the match; and the number of available players may not be enough for an ideal small-sided game or other ball-based work.

When the football context cannot be recreated, the practical question becomes what gives these players the least bad compensatory stimulus. Across elite football, practitioners commonly fall back on no-ball, running-based compensation for these players (Buchheit et al., 2021a; Rice et al., 2026): high-speed running top-ups such as box-to-box runs, shuttle runs to add accelerations and deceleration stimuli, often complemented with near-maximal-speed sprints that expose players to high sprinting velocities (>90% of maximal sprint speed, MSS).

Football is a multidirectional sport where players perform high-intensity actions across a wide range of angles and trajectories (Ade et al., 2016). On a traditional GPS dashboard, which does not capture how those actions occur, the above-mentioned exercises look adequate, hitting the usual targets for high-speed-zone distance, acceleration and deceleration counts and peak speed (Little & Buchheit, 2025). From a multidirectional perspective, however, these compensatory exercises may only partly reproduce match-like demands, lowering the quality of the stimulus these non-participating players receive, leaving out in turn a component that could be central to keeping them ready for the next match (Buchheit et al., 2026b; Buchheit, 2026a).

GPS-derived mechanical work and mechanical power are a new generation of player-tracking metrics (e.g., so-called GPS 3.0 metrics produced while using Athletic Data Innovations, ADI, Hudl) that combine position and velocity data to quantify the mechanical demands of locomotion beyond traditional distance and speed measures (Buchheit & Simpson, 2017; Buchheit et al., 2026b). Because they account for the full acceleration vector, including changes of direction, they make visible the directional content that a compensatory exercise actually delivers, or fails to deliver.

Aim

This paper has three aims. First, to show what the current run-based compensatory toolkit looks like, and what it misses, in terms of locomotor demands. Second, to introduce a new compensatory exercise, named "What The Compensation" (WTC), designed to close the multidirectional gap these standard exercises leave. Third, to show how to integrate this new exercise with existing practice into a post-match compensatory session that covers both directional and high-speed demands to optimally prepare players for the next match. It is worth stating up front that this paper evaluates compensatory drills through their mechanical and directional load only. The cardiovascular stimulus, that is the time spent in high heart rate zones, is an equally important part of what a compensatory session must deliver (Buchheit et al., 2025; Buchheit et al., 2026d), and we return to this as a key limitation.

1. The current run-based compensatory toolkit

1.1 What most practitioners do today

Across elite football clubs, the post-match compensatory session for players with limited match time follows a recognisable pattern: high-speed and maximal-speed running paired with some change-of-direction work, executed in 15 – 25 minutes without a ball. Five running exercises cover the great majority of cases (Figure 1):

- **Box-to-Box (BtB):** a straight ~72 m run between the two penalty-area edges. It complements the metabolic work of the session while accumulating the session's high-speed running (HSR) "target" (Buchheit, 2019).
- **Halfway BtB:** the same idea, but from the penalty-area edge to the halfway line and back, adding one 180° turn per repetition. The turn brings in thigh mechanical work (MW: accelerations, decelerations, and changes of direction) on top of the metabolic stimulus (Buchheit, 2019).
- **Shuttle 4×16 m:** four 16 m shuttles between two lines, generating repeated decelerations and turns. With a change of direction every 16 m, it pushes thigh MW further still while sustaining a high metabolic demand (Buchheit, 2019).
- **Max Sprint:** maximal-speed straight sprints of ~50 m (goal line to halfway line), at >90% of maximal sprinting speed, with full walk-back recovery between efforts. Here the purpose is purely neuromuscular: the high hamstring activation during near-maximal running (>85% of maximal

sprint speed) makes this exposure essential to protect the integrity of that muscle group (Buchheit et al., 2023).

- **BtB S-Run:** Box-to-box distance, but instead of running in a straight line, smooth curves are introduced to add curvilinear loading. Rather than an established protocol, it is a practice-driven addition that some clubs have begun integrating into warm-ups and compensatory exercises with a dual aim: 1) to reflect the curvilinear nature of in-game sprinting, and 2) to allow players to accumulate more running distance, whilst minimising HSR distance (since the high-speed-running threshold will not be reached) (Buchheit, 2019). We include it here to explore its directional contribution while acknowledging its novelty.

In an attempt to better characterize the locomotor demands of these 5 common run-based exercises (Figure 1), 10 players (age: 24.6, professional level) performed each exercise 2 times during a single experimental session. Although such compensatory exercise should ideally be individualised for each player's locomotor profile (Buchheit et al., 2021b), all players were requested to perform the same exercises to mimic the suboptimal current practices. As a matter of fact, the distances and the work-to-rest ratios were homogeneous across players. A generic scheme of 8 repetitions of 15 s work / 15 s rest (4 min total per block) was therefore applied to all exercises shown, except for the >90% peak speed exposures, where players performed 3 runs with full recovery of approximately 60 s.

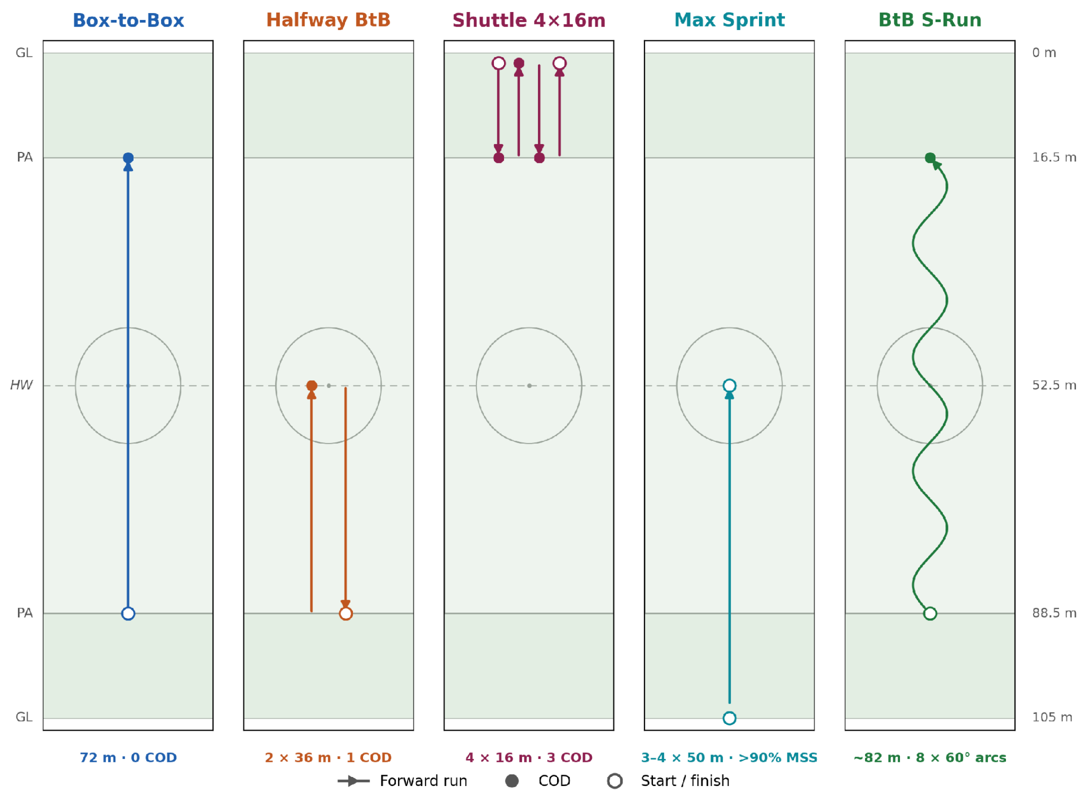

Fig. 1. **The five run-based compensatory exercises, drawn to scale on a pitch. GL: goal line; PA: penalty area front edge; HW: half way; COD: change of direction; MSS: maximal sprint speed.**

Table 1. **Average traditional GPS metrics values for each block of compensatory exercise. Values are the mean of 10 players performing each exercise twice. †Total time including 15 s on / 15 s off intervals. TD: total distance; HSR: high-speed-running distance, >19.8 km·h^{-1}; Acc: acceleration above 3 m·s^{-2}; Dec: deceleration above 3 m·s^{-2}.**

Compensatory exercise	Time† (min)	TD (m)	HSR (m)	Acc (count)	Dec (count)	Max Acc (m·s^{-2})	Max Dec (m·s^{-2})	Peak Speed (km·h^{-1})
Box-to-Box	4.5	650 ± 19	404 ± 47	7 ± 1.4	0 ± 0	4.6 ± 0.5	2.2 ± 0.2	22.4 ± 0.5
Halfway BtB	4.1	630 ± 27	156 ± 15	14 ± 1.8	7 ± 1.1	4.8 ± 0.4	4.2 ± 1.1	22.0 ± 0.7
Shuttle 4×16m	4.5	583 ± 9	0 ± 0	20 ± 4	20 ± 4	4.2 ± 0.5	4.4 ± 1.2	19.5 ± 0.9
Max Sprint	2.3	258 ± 11	159 ± 19	3 ± 0	0 ± 0	5.7 ± 0.7	2.4 ± 0.2	30.1 ± 1.3
BtB S-Run	4.5	747 ± 21	58 ± 13	0 ± 0	0 ± 0	2.9 ± 0.3	1.6 ± 0.3	20.8 ± 0.5

1.2 What a traditional GPS dashboard sees

Table 1 reports the average values for these traditional GPS metrics over a single block of work.

Illustrated this way, each exercise can be categorised into different groups. Box-to-Box stands out for high-speed-running volume (404 m of HSR), while the Max Sprint reaches by far the highest peak speed (30 km·h^{-1}), the only compensatory exercise to expose true peak speed. The Shuttle dominates the acceleration and deceleration counts (20 and 20 counts). The Halfway BtB sits in the middle. The S-Run, despite covering the most distance (747 m), registers as designed almost nothing above HSR threshold on any variable, and could easily be read as producing little stimulus at all.

A traditional dashboard, then, captures how much running was done against various speed and acceleration thresholds, but not how it was produced, which is exactly where the directional reading begins.

1.3 What the dashboard cannot see

Traditional GPS metrics share a blind spot: they describe locomotor output (how far, how fast) without describing direction. A straight sprint and a curved sprint at the same speed register identically, despite the centripetal force the curve demands (Granero-Gil et al., 2020; Buchheit et al., 2026b). A box-to-box run and an S-run over the same distance look similar in the session summary. The metric was built to quantify how much running was done, not in which direction, nor against what mechanical demand.

These GPS 3.0 metrics, derived through advanced signal processing of raw GPS data (e.g., Athletic Data Innovations, ADI, Hudl), have gained increasing interest for external training-load monitoring, return-to-performance assessment, and match analysis, which allows for better uncovering the directional demands of each compensatory exercise performed. The consequence is visible the moment we look at the movement signature of an exercise, as the directional fingerprint shows us which angular sectors are loaded (Buchheit et al., 2026b; Buchheit, 2026a). Figure 2 shows a full-match player signature, with cuts and arcs distributed across every sector; for the same player, Figure 3 shows the signature of a Box-to-Box session. Both produce a comparable HSR volume, yet the two have little in common: a match demands all four angular sectors, whereas the box-to-box fills only the anterior and posterior planes. Figures 4 to 7 confirm the same pattern across the rest of the toolkit: the Halfway BtB, the Shuttle, the Max Sprint and the BtB S-Run.

Across the toolkit, the pattern is the same. All five are linear exercises by design, and the evidence of the signatures is consistent: the work concentrates on the anterior and posterior planes, while the 45° forward-diagonal, 90° lateral, and 135° backward-diagonal sectors stay essentially empty. This is the gap. And, when ball-based work is not available, closing it requires a compensatory exercise explicitly designed to load the sectors that these ~4-min exercises leave empty. That is what the next section introduces.

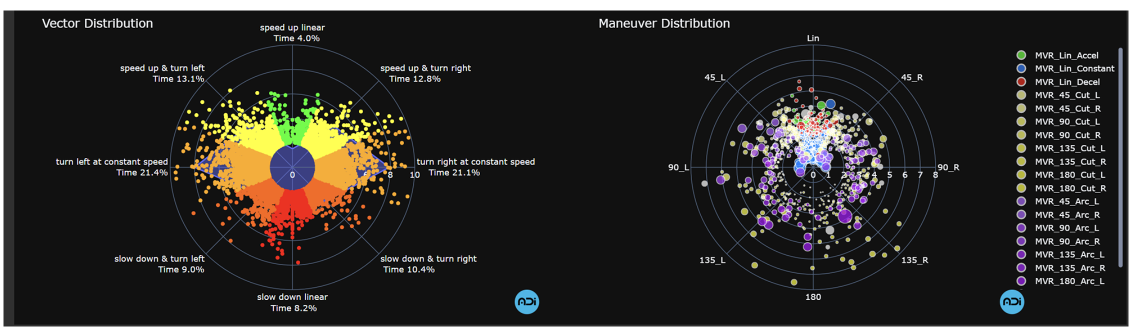

Fig. 2. Match reference - full-match directional signature. The left panel shows the vector distribution: each dot is a single high-intensity action, placed by its turn angle (45°, 90°, 135°, 180°) and side (left/right), so its angular position shows the direction of the effort and its distance from the centre shows the magnitude. The right panel shows the maneuver distribution, grouping those same actions into maneuver types to quantify how the work is shared across angular sectors and sides. Here every angular sector is loaded, on both sides and in a balanced way. This is what football naturally produces.

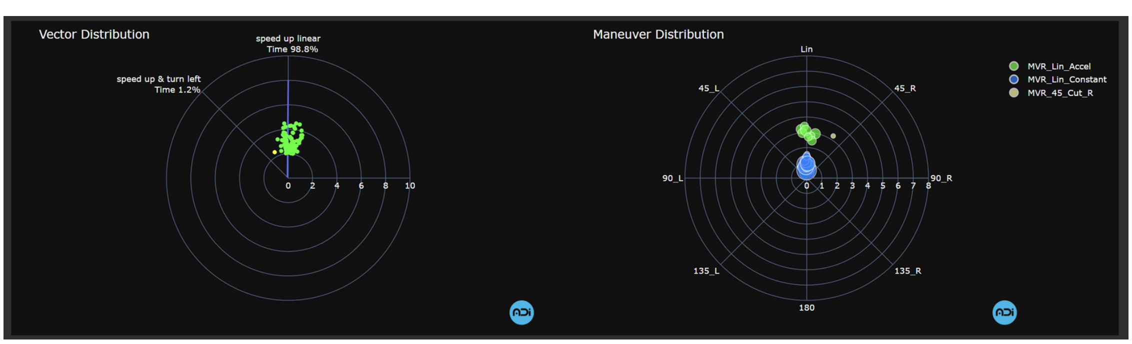

Fig. 3. Box-to-Box - directional signature. Almost entirely straight-line running (~99%). Three movement patterns only. The 45° forward-diagonal and 90° lateral sectors are absent.

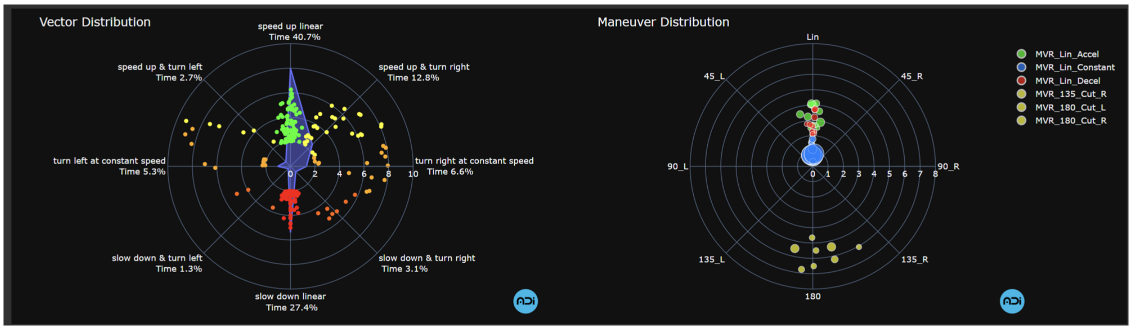

Fig. 4. **Halfway BtB - directional signature. Straight running plus a hard 180° turn-back. Loading at 135° and 180°; the 45° and 90° sectors stay empty.**

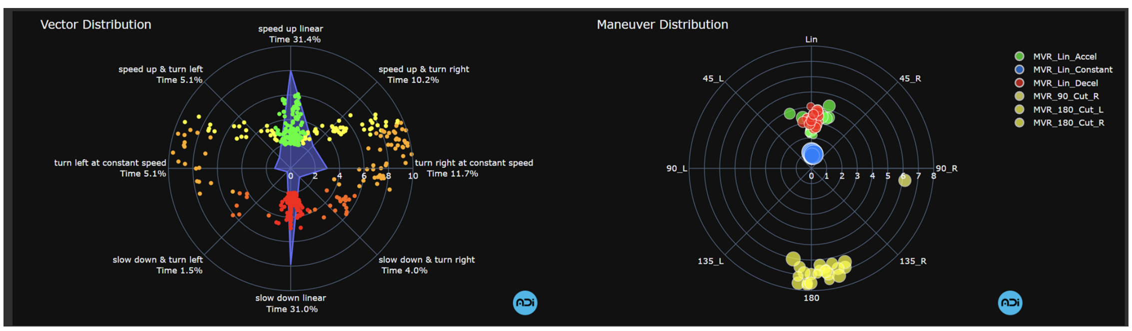

Fig. 5. **Shuttle 4×16m - directional signature. Repeated decelerations and turns, dominated by 135-180°. Forward-diagonal and lateral loading absent.**

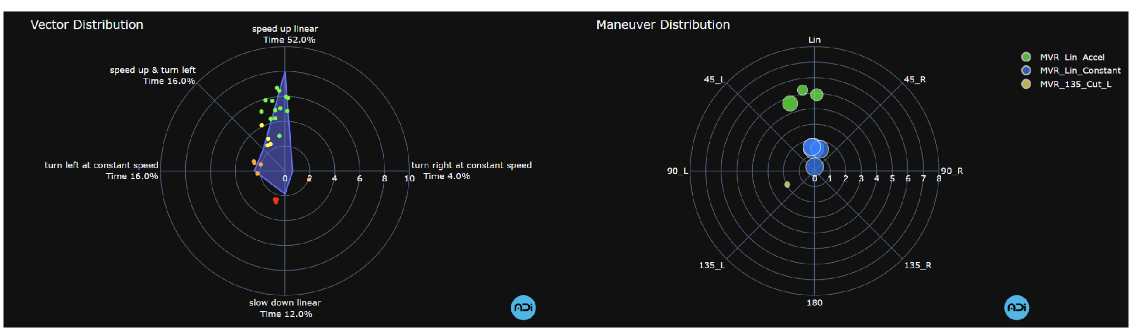

Fig. 6. **Max Sprint - directional signature. Anterior, near-peak-velocity straight running (∼96% linear). Peak speed and peak-power exposure; the 45°, 90° and lateral sectors stay empty.**

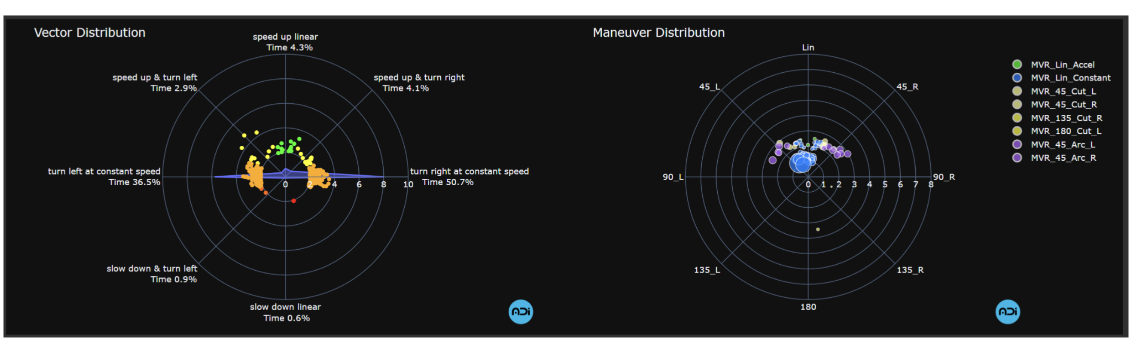

Fig. 7. **BtB S-Run - directional signature. Bilateral 45° curved running. Real centripetal loading, but invisible to a traditional dashboard. The 90°, 135° and 180° sectors stay absent.**

2. The "What The Compensation" Work

2.1 Genesis

The starting point was a match. When we looked at the directional signature of full-match data (Figure 2), every angular sector lit up: all cuts, all arcs, both sides, populated and balanced. That is the picture football itself produces, and when a ball is available, in addition to bringing a complete stimulus (cognitive and physical altogether), ball-based play likely reproduces the natural movements of competition more specifically than any exercise, so it remains obviously the first choice. The problem this paper addresses is the run-based window, where that option is off the table.

The uncomfortable answer came from our own run-based compensatory exercises, the ones we had been prescribing for years: box-to-box, halfway, shuttle, the maximal sprint, even the S-run (Figures 3-7) (Buchheit, 2019). Their signatures collapsed into a narrow band, concentrated on the anterior and posterior planes, while the 45° forward-diagonal, the 90° lateral arc, the 135° backward-diagonal and the curved accelerations and decelerations went unloaded. We were hitting the volume targets but losing the richness: compensating for how much, but not how.

That gap triggered the design. Looking at the sectors the toolkit left empty, we (i.e., ALS and MB) started asking what shapes would force exactly those patterns while needing little space and no setup. After several combinations, three letters covered the three gaps: W for the bilateral 135° cuts, T for the 90° lateral arc, and C for the curved accelerations and decelerations, all of which could be drawn quickly inside the centre circle without much preparation. This is how the WTC (What The Compensation) emerged.

2.2 The three shapes

All three shapes are run inside the centre circle (radius 9.15 m), with cones marking the change-of-direction points. Figure 8 shows the layout. Each repetition follows a target work time that depends on the shape and on the player's capacity band (see Section 2.3), followed by 15 s of rest. A full WTC block is 8 repetitions in a 3–3–2 mix: three W, three T, two C, each shape executed in both directions, amounting to ~4 minutes of work.

- **W-shape, the backward-diagonal.** Double-diagonal (W) path across the centre circle: out along a diagonal, a sharp cut back across the circle, a second diagonal out, a final cut. Each cone imposes a direction change of about 135°, so the shape loads the 135° backward-diagonal sector, bilaterally.
- **T-shape, the lateral arc.** Run from the circle edge to the centre, 90° turn, lateral sprint to one side of the circle, then back across (180°) to the other side. Loads the 90° lateral arc, the only pattern absent from every linear run-based compensatory exercise.
- **C-shape, curved acceleration and deceleration arc mechanics.** Curved run along the arc of the centre circle to the far side and back. Loads curved acceleration and deceleration and arc mechanics.

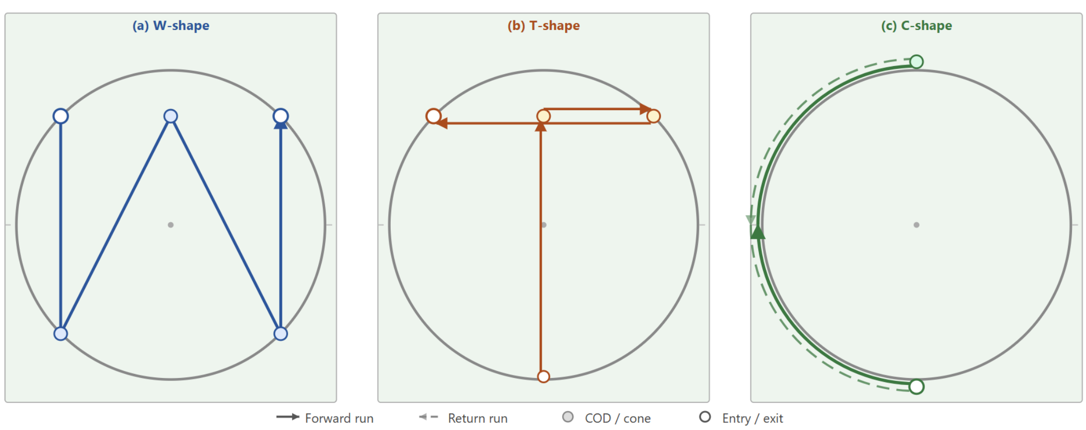

Fig. 8. The WTC work, drawn to scale inside the centre circle. W: double-diagonal path across the circle, three ~135° cuts (video *link*). T: sprint to the centre, 90° turn, lateral sprints to each side (video *link*). C: curved run along the perimeter and back (video *link*).

2.3 Adjusting intensity to player capacity

We need to adjust the intensity at which the WTC is executed to each player's acceleration and deceleration maximum capacity (Buchheit et al., 2026c). Because the W, T and C paths are covered largely by accelerating and decelerating, a strong accelerator-decelerator completes them faster at the same relative effort, while a player with lower capacity must work at a higher percentage of their maximum to hit the same time. To equalise the relative intensity, the target time per shape is set by band according to each player's acceleration and deceleration capacity (Buchheit et al., 2026c).

Reference bands were derived from an internal database of 110 elite international players (≥10 sessions each). Following the framework of Buchheit et al. (2026c), maximal acceleration and deceleration were taken as raw GPS match peaks, and each player's near-maximal capacity was defined as the 95th percentile of their per-session maxima (discarding non-maximal efforts). Both were combined into a single capacity index (the mean of a player's maximal acceleration and deceleration, $m{\cdot}s^{-2}$) whose terciles set the band cut-offs (Table 2); the resulting ranges are consistent with those reported for elite football in that work. Target times then follow from the same logic: each shape is a fixed, change-of-direction-dominated path (W ≈ 65 m, T ≈ 37 m, C ≈ 57 m), and, as the time cost of a direction change scales inversely with acceleration and deceleration capacity (Buchheit et al., 2026c), a more capable player covers the path faster at the same relative effort. Anchoring the middle band to the reference times and the outer bands to the squad's 10th and 90th capacity percentiles gives the times in Table 2, all placing the player at a comparable relative intensity (around 85–90% of their own maximum).

Table 2 provides a simple, practical guide for prescribing the execution intensity (time) of each shape according to the player's maximal acceleration and deceleration capacity. To use it, the practitioner classifies a player by these values and reads off the target time for each shape.

Table 2. Player capacity bands and target time per shape. Bands are defined by a combined capacity index (mean of a player's maximal acceleration and deceleration, m·s^{-2}). S: seconds per repetition that place each band at a comparable relative intensity (∼85–90% of individual maximum).

Acceleration Capacity	Max Acc (m·s^{-2})	Max Dec (m·s^{-2})	Combined index (m·s^{-2})	W (s)	T (s)	C (s)
High	> 5.7	> 6.8	> 6.2	10	8	8
Medium	5.3 – 5.7	6.4 – 6.8	5.9 – 6.2	11	9	9
Low	< 5.3	< 6.4	< 5.9	12	10	10

2.4 The WTC on a traditional dashboard

The same 10 players performed the WTC twice, so their outputs are reported on the same basis as the five run-based compensatory exercises. As we did at the start of this work in Table 1, from a conventional GPS dashboard a full WTC ∼4-min block covers 456 m of total distance, of which 54 m are HSR, reaches a peak speed of 20.8 km·h^{-1}, and accumulates 20 high-intensity accelerations and 16 decelerations (with peaks of 4.8 and 4.9 m·s^{-2}), all in ∼3.7 min. Read this way, it looks like just another compensatory exercise, neither the highest in volume nor in speed, nor in accelerations and decelerations. What a traditional dashboard cannot show is the directional content behind those numbers, which is what the next section examines.

3. How does each compensatory exercise perform? A three-layer analysis

Section 1 showed the contrast between the movement richness of a match and the compensatory exercise practitioners commonly use. Section 2 introduced the WTC as a way to load the angular sectors that the traditional toolkit overlooks. This section analyses every compensatory exercise, including the WTC, through three layers: the decomposition of mechanical work, the movement signature, and the intensity exposure relative to the most intense period (MIP) of competition.

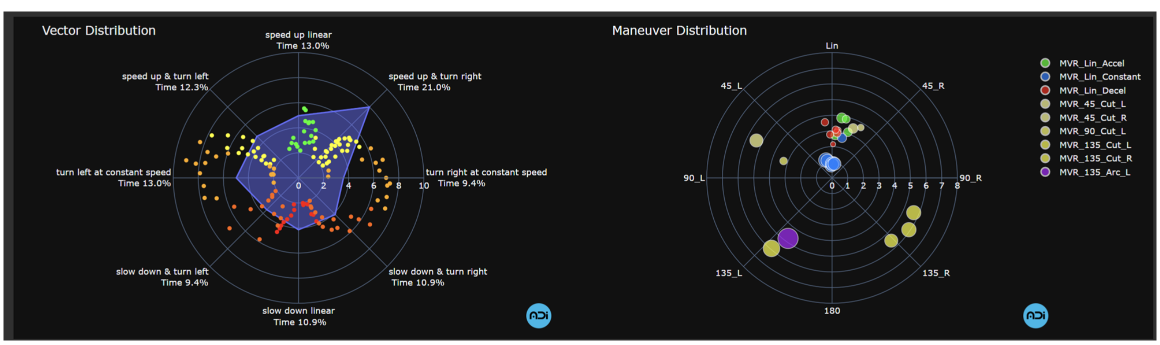

Fig. 9. WTC - directional signature. All angular sectors loaded, both sides. The only run-based compensatory exercise producing a fingerprint that resembles a match (Figure 2).

Table 3. Qualitative summary of movement signatures. Linear % = share of movement time in straight-line running. Each row distills the directional character of each block of work; Figures 2-7 and 9 show the full signatures.

Compensatory exercise	Linear %	Dominant pattern	Character
Box-to-Box	∼99%	Anterior straight-line	Pure forward running. Other sectors are absent.
Halfway BtB	∼68%	Posterior turn-back (135° –180°)	Forward run with hard turn. Diagonal and lateral sectors absent.
Shuttle 4×16m	∼43%	Posterior turning (180°)	Repeated decelerations and turns. Diagonal and lateral sectors absent.
Max Sprint	∼96%	Anterior peak-velocity straight running	Peak speed exposure. Forward running. Other sectors are absent.
BtB S-Run	∼9%	Bilateral 45° curved running	Genuine 45° curved loading. 90°, 135° and 180° sectors absent.
WTC	∼27%	All directional sectors	Omnidirectional. The only run-based exercise covering every match sector.

3.1 Movement signatures: where the work happens

Section 1 already showed the directional signatures of the match and the five linear compensatory exercises (Figures 2-7): each linear option covers only the anterior and posterior planes, leaving the 45° forward-diagonal, 135° backward-diagonal and 90° lateral sectors empty. Placing the WTC signature (Figure 9) alongside them completes the comparison.

Together, the figures confirm what the geometry already predicted. The five linear compensatory exercises cover the anterior and posterior planes (with the S-Run adding 45°). The 90° lateral sector stays empty in every linear option. The WTC is the only run-based exercise to light up all four. Table 3 summarises this directional character per work.

3.2 Mechanical work: thigh vs stride

Mechanical work (MW) quantifies the total mechanical load of locomotion, derived from the full acceleration vector rather than from speed alone (Buchheit et al., 2026b). It can be split into two functional components. MWstride captures the work done against gravity in constant-speed running. MWthigh captures the work done against the changes in motion themselves: accelerations, decelerations, and changes of direction. The first is the linear locomotor footprint, essentially what every GPS already measures; the second is the directional and acceleration footprint.

The match set the reference. Over a full game, MW carried a substantial directional share (41% MWthigh), produced naturally by the game (Table 4). Most compensatory exercises fell well short of that MWthigh proportion (15–26% MWthigh). Only the Shuttle (48% MWthigh) and the WTC (69% MWthigh) came close, owing to the high density of changes of direction in both.

Unlike the threshold-based traditional metrics, the absolute volume of MW of a full match cannot realistically be matched by short compensatory blocks of exercises, which is to be expected. Beyond the absolute values, the practical message is one of balance: a session should cover both the stride-dominant and the thigh-dominant work, with the WTC a strong option for the latter, while avoiding several compensatory exercises that overlap in the same orientation. Among the compensatory exercises analysed, the WTC was the one whose profile sat closest to the match on the directional side, the part that the linear toolkit consistently misses.

Table 4. Mechanical work for ∼4-min exercise. %: distribution of total MW between the thigh and stride components, by exercise. ∼4-min exercise values are the mean of 10 players, each performing each exercise twice; the match reference is the average of 54 full-match observations from outfield players (goalkeepers excluded) across playing positions in a professional Ligue 1 club.

Compensatory exercise	Time (min)	MW (J)	MWthigh (J)	MWthigh (%)	MWstride (J)	MWstride (%)
Box-to-Box	4.5	28.2 ± 2.1	4.3 ± 0.3	15%	24.0 ± 3.8	85%
Halfway BtB	4.1	50.8 ± 4.7	12.2 ± 1.3	24%	38.6 ± 4.2	76%
Shuttle 4×16m	4.5	63.8 ± 5.1	30.8 ± 2.7	48%	33.0 ± 2.4	52%
Max Sprint	2.3	3.5 ± 0.2	0.9 ± 0.1	26%	2.6 ± 0.8	74%
BtB S-Run	4.5	69.5 ± 4.3	15.7 ± 1.5	23%	53.7 ± 5.1	77%
WTC	3.7	40.9 ± 3.2	28.1 ± 2.8	69%	12.7 ± 2.5	31%
Match	98.6	987.2 ± 186	405.9 ± 95	41%	581.3 ± 117	59%

3.3 Intensity exposure

The remaining question is how mechanically "intense" each ∼4-min exercise is. To answer it, we used Intensity Exposure Time (IET), a metric introduced within the GPS 3.0 framework that quantifies the cumulative time a player spends above a given relative-intensity mechanical threshold, rather than the distance accumulated within fixed speed zones (Buchheit et al., 2026b). Conceptually, it mirrors cardiovascular monitoring, where load is expressed as time spent above a percentage of an individual's maximum (e.g., %HRmax), but applied here to external mechanical intensity. This maximal reference can be defined in two ways: a player's true physiological capacity, which is the sounder choice, or match demands, which is less appropriate but is what was available here (Buchheit et al., 2026b). We computed the IET of each ∼4-min exercise in a single player from the same sample (midfielder; professional level), dividing every exercise into 1-minute windows.

Lacking dedicated physical testing to establish each player's locomotor profile and maximal capacity, we used match demands as the reference. For that player, we took the average of his most intense match minute (the 1-min Most Intense Period, MIP) across the matches available, and then quantified how long, within each exercise, he stayed above 60% and 70% of that 1-min match MIP, for every variable.

Applied to our case, the match MIPs were 15.3 J·min^{-1} for MWthigh, 16.4 J·min^{-1} for MWstride, 28.3 J·min^{-1} for MW, and 6.8 W·kg^{-1} for mechanical power (MP). These values are not additive: each MIP is the most intense minute for that specific metric, and those minutes do not coincide, so the peak MW minute is lower than the sum of the individual MWthigh and MWstride peaks. Table 5 reports the MIP each exercise reaches as a percentage of the match MIP. Table 6 reports the corresponding IET (minutes of the exercise at or above 60% and 70% of the match MIP).

Read this way, intensity, not volume, is what separates the exercises. Each ∼4-min exercise tends to reach high relative intensity only in the component it was built around: the linear exercises approach the match in MWstride but collapse in MWthigh, while the WTC is the mirror image, high in the directional component and low in stride. It does so more completely than the Shuttle, because its directional load comes from genuine multidirectional patterns (135° and 45° cuts, 90° arcs, and curved actions) rather than from 180° turns alone. The Max Sprint sits apart, low on every per-minute metric, because its work-to-minute ratio is the lowest of all: roughly 5 s of maximal effort followed by ∼60 s walking or standing, so the per-minute average is heavily diluted. Read with that in mind, the practical message is that no single exercise is intense across the full mechanical spectrum, so the directional and the linear components must be supplied by combining exercises.

The IET makes the same point in stricter terms: reaching a high relative intensity for an instant is not the same as sustaining it for a full minute; 4x15 s is not the same as 60 s. Once duration is required, each exercise sustains intensity only in its own component: the WTC exclusively in accelerations, decelerations, and changes of direction (i.e., MWthigh), while the other exercises sustain high intensity as a mix of both MWthigh and MWstride, depending on their patterns (types and number of CODs and distance run to reach a substantial amount of MWthigh, respectively). In fact, the WTC is the only run-based compensatory exercise that allows players to sustain a full minute at or above 70% of the match MWthigh MIP while loading several angular sectors (Figure 9), the very exposure that the linear toolkit never reaches. This is worth reading as a density, not just an absolute time: one minute above threshold within a ∼4-min block means roughly 25% of the exercise is spent above 70% of the match MIP, whereas across a full match, only about 6% of total time (6.2 / 98.6 min = 6.3%). In relative terms, then, an intermittent compensatory block can concentrate that high-intensity multidirectional exposure into a short, dense window, a real advantage given the limited time available after a match. Two exercises sit apart. The Max Sprint clears no intensity threshold at all, because its few maximal efforts are too brief and too widely spaced to build per-minute density, a reminder that its role is peak speed exposure, not MW accumulation, and that the IET lens is simply not the one that captures its value. The Box-to-Box is more surprising: despite having the highest HSR volume, it accumulates no MWstride IET either, most likely because the speed required to cover the box-to-box distance in 15 s (i.e., ∼17 km·h^{-1}) was not high enough to exceed the MWstride threshold.

Taken together, Tables 5 and 6 deliver one consistent message: each compensatory exercise is intense only where it is designed to be, and none is intense everywhere. Reading them through mechanical, direction-sensitive metrics rather than distance and speed is what makes this visible, and it turns the practical question from "which exercise is best?" into "which pieces, combined, get closer to the broad and varied demands of the match?"

Table 5. Exercise most intense period (MIP) and its value as a percentage of the match MIP, by mechanical component. For each exercise, the MIP is the highest 1-minute window reached during that exercise; the match MIP is the average of the player's highest 1-minute window per metric across his matches. All values correspond to a single professional player (N=1). MW: mechanical work; MP: mechanical power; MIP: most intense period.

Compensatory exercise	MW (J·min^{-1})	% match MIP	MWthigh (J·min^{-1})	% match MIP	MWstride (J·min^{-1})	% match MIP	Peak MP (W·kg^{-1})	% match MIP
Box-to-Box	7.8	28%	1.2	8%	6.7	41%	2.9	43%
Halfway BtB	14.7	52%	3.5	23%	11.9	72%	3.8	57%
Shuttle 4×16m	17.3	61%	8.6	57%	9.6	59%	4.6	69%
Max Sprint	2.1	7%	0.4	3%	1.8	11%	1.5	22%
BtB S-Run	16.5	58%	8.4	55%	13.2	80%	4.9	72%
WTC	18.0	64%	11.5	76%	6.5	40%	5.1	76%
Match MIP	28.3 ± 3.4	100%	15.3 ± 1.7	100%	16.4 ± 2.2	100%	6.8 ± 0.8	100%

Table 6. Intensity Exposure Time (IET) per ∼4-min exercise above 60% and 70% of the match 1-min MIP. Values correspond to the same single professional player as in Table 5. Dash (-): the player did not sustain his activity above the threshold for at least 1 minute. MW: mechanical work; MP: mechanical power; MIP: most intense period.

Compensatory exercise	MWthigh >60%	MWthigh >70%	MWstride >60%	MWstride >70%	MP >60%	MP >70%
Box-to-Box	-	-	-	-	-	-
Halfway BtB	-	-	2	1	-	-
Shuttle 4×16m	2	-	1	-	3	1
Max Sprint	-	-	-	-	-	-
BtB S-Run	-	-	3	3	4	1
WTC	2	1	-	-	2	1
Match	10.2	6.2	14.1	8.0	21.5	12.1

3.4 Reading the three layers together

Each layer answers a different question. Layer 1 (movement signatures, Table 3) assesses which angular sectors each exercise actually covers, the quality of the work rather than its amount. Layer 2 (MW decomposition, Table 4) quantifies how much mechanical work is produced and how it splits between stride and thigh-directional components. Layer 3 (intensity against match MIPs, Tables 5 and 6) shows how close each exercise gets to the most demanding minutes of competition, and how densely. Read together, the three layers point to the same gap (Table 7): the current toolkit loads the stride and anterior-posterior planes well, and the traditional metrics confirm that some compensatory exercises earn their place on HSR volume or peak speed, but none of them meaningfully reaches the 45°, 90° and 135° directional sectors that carry much of a match's load. That is not a matter of mixing more of the same, it is a missing dimension. The WTC is designed precisely to add it: the multidirectional variability the previous toolkit never produced. This does not turn the linear compensatory exercises into the wrong choice for what they do well, but it does mean a complete session cannot be built from them alone. The practical question, then, is not to pick a winner but to combine each exercise for the job it does, while ensuring the directional gap, the one component none of the linear options covers, is actually filled, and that is the WTC's role.

Table 7. Directional and locomotor qualities covered by each compensatory exercise. ●●●: high contribution; ●●: moderate; ●: low; -: absent; HSR: high-speed running (>19.8 km·h^{-1}); peak speed exposure: running above 90% of maximal sprint speed.

Compensatory Exercise	45° cuts	90° lateral	135° cuts	180° turns	Arc accel	Arc decel	HSR exposure	Peak speed exposure
Box-to-Box	-	-	-	-	-	-	●●●	-
Halfway BtB	-	-	●	●●●	-	-	●	-
Shuttle 4×16 m	-	-	●	●●●	-	-	-	-
Max Sprint	-	-	-	-	-	-	●●	●●●
BtB S-Run	●●	-	-	-	●●●	-	●	-
WTC	●●	●●●	●●●	●●	●●●	●●●	●	-

4. Building a complete post-match compensatory session

Whenever it is operationally possible, ball-based work (i.e., small-sided game) remains the first choice, as it reproduces the movements of competition with greater specificity. When it is not, a complete run-based compensatory session should combine two complementary priorities: a directional component, delivered by the WTC, and a high-speed component, delivered by the linear toolkit (Box-to-Box runs and the Max Sprint). The WTC covers the four angular sectors that the linear compensatory exercises leave empty; the Box-to-Box supplies the high-speed-running volume and the Max Sprint the peak speed exposure, neither of which the WTC can produce inside the centre circle. With these three pieces in place, the remaining linear options are no longer needed. The Halfway BtB and the Shuttle provide neither HSR nor peak speed, and their acceleration and deceleration work stays in the anterior-posterior plane, which the WTC already loads more completely and multidirectionally. The BtB S-Run adds some curvilinear acceleration, but the player rarely accumulates HSR or reaches peak speed through it, and that curved component is already delivered by the WTC. Including any of them would only duplicate stimuli the session already provides, so they can be dropped. The whole session fits in roughly 25 to 30 minutes. The volumes below are orientative and should be individualised to each player's profile and stage (Buchheit et al., 2021b).

4.1 How much WTC to prescribe

There is no established evidence on how much of a match a non-participating player should compensate for. In practice, common guidelines aim to accumulate at least 60 to 70% of match locomotor volumes (Buchheit et al., 2021a), and, at the cardiovascular level, around 10 to 20 minutes in high-intensity zones (i.e., >85% of maximal heart rate) across the session (Buchheit et al., 2025; Buchheit et al., 2026d). This exposes a tension in how compensation is prescribed. The mechanical dose we anchor the WTC to (directional MWthigh exposure) and the cardiovascular dose (time above 85% HRmax) are different currencies, and hitting one does not guarantee the other. The available evidence suggests the cardiovascular target is the one most often missed for non-starters (Buchheit et al., 2026d), so a session optimised only for mechanical and directional load may still leave the highest heart rate zones under-stimulated. A complete prescription should track both, ideally by recording HR during these drills.

In the absence of a clear directional guideline, we anchored the WTC dose to roughly 60% of a match's high-intensity directional exposure (Lacome et al., 2018). Each WTC block sustains about 1 minute at or above 70% of the match MWthigh MIP, against ∼6.2 minutes in a full match, so exposure scales approximately linearly: three blocks reproduce close to half of that match exposure and four blocks close to 60%. These are estimates, since fatigue makes later repetitions less intense than the first ones. Table 8 turns this into a practical guide.

4.2 A practical session template

Recommended post-match compensatory session (run-based, ∼25 min)

Setup: a centre circle (any pitch), a ∼50 m straight, and 4–6 cones. No ball.

Directional component - WTC work, 3 blocks of ∼4 min. Each block is 8 repetitions in a 3-3-2 mix of W, T and C, with 15 s rest between reps; per-shape work times set by the player's capacity band (refer to Table 2). Loads the four angular sectors inside the centre circle, delivering ∼21% of a match's MWthigh and ∼50% (∼3 min) of the IET above 70% of the match MWthigh MIP.

High-speed volume component - Box-to-Box runs, 2 blocks of ∼4 min. Provides high-speed-running volume: among the linear compensatory exercises, the Box-to-Box is the one that accumulates the most HSR (404 m per block), making it the right tool for this part of the session. Intensity and running distance should be adjusted to the player.

Peak speed component - Max Sprint, 3 to 4 maximal efforts of ∼50 m (goal line to halfway line) at >90% of MSS, with full walk-back recovery (>45 s). Exposes the player to peak running velocity, the only compensatory exercise of the toolkit to reach it, which is its specific contribution to the session.

Flexible delivery: groups can alternate, one group running the ∼4-min WTC while in parallel the other runs the Box-to-Box block, then they swap; when blocks are performed consecutively, allow ∼90 to 120 s of recovery between them.

Putting the three components together, Table 9 shows the traditional (GPS 2.0) and mechanical (GPS 3.0) loads a full session would accumulate (10 players; warm-up excluded), together with what each load represents relative to match demands. For MW specifically, the picture reverses. Whereas on traditional metrics the session meets or even exceeds match demands in HSR and accelerations, in MW volume it falls well short of a match (~19-30% of match MWthigh, ~13-18% of MWstride). Without the WTC, the session would deliver less than 3% of the match MWthigh. Yet when read as intensity rather than volume, using the match 1-min MIP as reference in the absence of maximal physiological values from physical testing, the IET of the whole session reaches about 3 min (± 0.6) above 70% of the match directional (MWthigh) MIP, roughly 48% of that reference (Table 8), an exposure delivered almost entirely by the WTC.

Figure 10 shows the movement signature of the complete post-match compensatory session. Read this way, the combined exercises reproduce the multidirectional richness that no single one delivers on its own: linear accelerations and decelerations, constant-speed turns to both sides, and the full range of cuts and arcs (45°, 90°, 135°) are all populated. This is the picture a compensatory session should aim for, and the one a traditional dashboard never reveals.

Table 8. Estimated volume-prescription guide for the WTC compensatory exercise.

WTC blocks	Total time (incl. rest)	MWthigh delivered (J)	% match MWthigh	IET ≥70% (min)	% match IET
1 block	~4 min	~28 J	~7%	~1 min	~ 16%
2 blocks	~9–10 min	~56 J	~14%	~2 min	~ 32%
3 blocks	~14–15 min	~84 J	~21%	~3 min	~48%
4 blocks	~19–21 min	~112 J	~28%	~4 min	~64%

Table 9. GPS 2.0 and GPS 3.0 load of the complete recommended session, expressed in absolute terms and as a percentage of match-day demands. TD: total distance; HSR: high-speed running distance (> 19.8 km·h^{-1}); Acc/Dec: count of accelerations/decelerations above 3 m·s^{-2}; MW: mechanical work.

Compensatory exercise	TD (m)	% TD match	HSR (m)	% HSR match	Acc	% Acc match	Dec	% Dec match	MWthigh (J)	% MWthigh match	MW-stride (J)	% MW-stride match
WTC (3 blocks)	1368 ± 17	12-14%	162 ± 18	17-34%	60 ± 5.2	96-130%	48 ± 5.2	73-117%	84.3 ± 4.8	17-27%	38.1 ± 2.2	5-8%
Box-to-Box (2 blocks)	1 300 ± 27	12-14%	808 ± 66	82-168%	14 ± 2.0	22-30%	0 ± 0	0%	8.6 ± 0.4	2-3%	48.0 ± 5.4	7-10%
Max Sprint (1 block)	258 ± 11	2-3%	159 ± 19	16-33%	3 ± 0	5-6%	0 ± 0	0%	0.9 ± 0.1	0.2-0.3%	2.6 ± 0.8	< 1%
Total post-match session	~2926 ± 29	27-31%	~1129 ± 69	115-200%	~77 ± 5.6	123-169%	~48 ± 5.2	73-117%	~93.8 ± 4.8	19-30%	~88.7 ± 5.9	13-18%

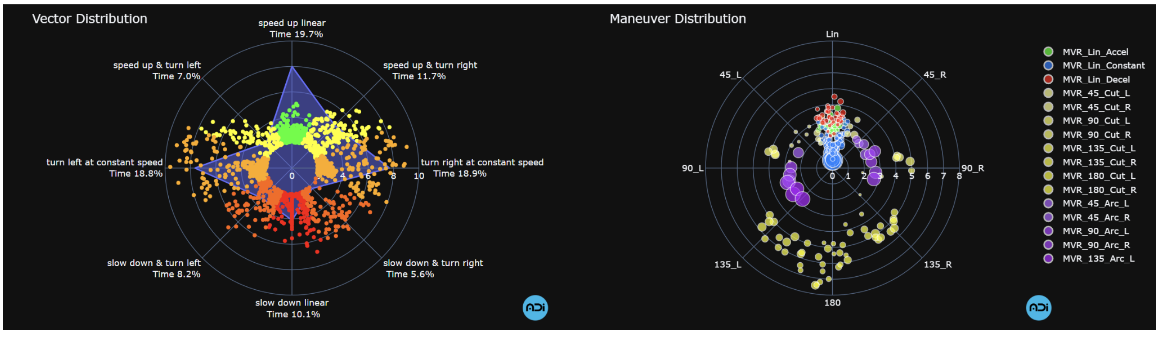

Fig. 10. Movement signature of the complete post-match compensatory session. All angular sectors are populated on both sides, from linear efforts to cuts and arcs across 45°, 90°, and 135°. Together, the three works recreate the all-sector directional demand that a match imposes (Figure 2), which no single run-based exercise achieves on its own.

4.3 When the WTC is not the right answer

The WTC fills one specific slot: the run-based, limited-space, limited-time post-match session for players with insufficient match exposure. It is not a replacement for ball-based training. Whenever a ball-based exercise is operationally possible, a small-sided game naturally should always be preferred for its overall football specificity and, on the pure physical aspect, since it produces the all-sector directional richness the WTC intends to reproduce structurally. The WTC is the answer to a narrower question: when the football context is not available, what gives the player the least bad available compensatory stimulus in terms of mechanical load?

Limitations

Several limitations should be kept in mind. First, the running outputs presented for each exercise are representative of the 10 players involved, each performing the compensatory exercise twice. These are proof-of-concept sample sizes. Reference ranges across playing positions, fitness levels and execution speeds should be established with larger cohorts before the values reported here are read as norms.

Second, the volume-prescription guide in Table 8 is an extrapolation. It scales a single block's directional work linearly and expresses it against one match reference. Real dose-response is unlikely to be perfectly linear: as fatigue accumulates across successive blocks, the directional work produced per block will probably decline rather than hold constant. The percentages should therefore be treated as a practical starting point, not exact targets, and the dose must be individualised case by case.

Third, the individualised time bands used to equalise execution intensity should be read as a reasoned guide. The inverse-capacity model is a simplification appropriate to change-of-direction-dominated paths, the cut-offs derive from a single squad, and the anchoring intensity (∼85–90% of maximum) is an approximation rather than a validated value.

Fourth, the comparison between exercise MIPs and match MIPs is constrained by the intermittent nature of the compensatory exercises: they are built from work-rest cycles, so each 1-minute window mixes work and rest and reflects the exercise as it is actually prescribed. Match MIPs are more continuous, though not free of the micro-recoveries interspersed between high-intensity actions. The per-minute values should therefore be read as a comparison among exercises analysed on the same basis, and as an indication of how close each compensatory exercise gets to match intensity and which directional sectors it loads, rather than as a literal fraction of match demand.

Finally, and most importantly, this paper evaluates compensatory drills on a single axis: mechanical and directional external load. It says nothing about the internal cardiovascular response they produce. This matters because the primary purpose of post-match compensation for non-participating players is maintaining physical fitness, and the cardiovascular stimulus, expressed as time in high heart rate zones, is central to that goal (Buchheit et al., 2025). Two points follow. First, external mechanical load and internal cardiovascular load can dissociate: a drill can hit mechanical or directional targets while delivering little time above 90% HRmax, the zone most associated with aerobic maintenance and improvement (Buchheit et al., 2025). Note that the two thresholds are not interchangeable: the session guidance above is expressed against 85% HRmax, whereas the studies cited here define their targets against 90% HRmax. Second, this dissociation is not hypothetical in the compensation context. Descriptive data from nearly 1000 professional microcycles show that non-starters receive adequate external and moderate-intensity HR load through compensation, but only around one in five reach the 30 minute weekly target above 90% HRmax, well below starters (Buchheit et al., 2026d). A complete audit of a compensatory session therefore requires both a mechanical and directional reading, as presented here, and a cardiovascular one. We did not record HR during the drills analysed in this paper, and future work should quantify both axes simultaneously so that a session can be checked against mechanical, directional and cardiovascular targets at once (Buchheit et al., 2025).

Key points

- Scope: The WTC does not replace ball-based training. Whenever a played exercise (i.e., a small-sided game) is possible, it remains the first choice, as it reproduces the all-sector directional richness naturally. The WTC answers a narrower question: when the football context cannot be recreated, it provides the best available compensatory stimulus for the directional load that linear exercises leave uncovered.
- Dashboards mislead: A traditional GPS dashboard can show a session "hitting targets" when the directional stimulus is incomplete, and can show an exercise as low-intensity when the player is working hard. Volume and locomotor metrics alone are not enough to audit a compensatory session.
- The gap: The standard run-based toolkit (Box-to-Box, Halfway BtB, Shuttle, S-Run) concentrates its work on the anterior and posterior planes, leaving the 45° forward-diagonal, 90° lateral and 135° backward-diagonal sectors essentially empty, the very directional content a match produces across every sector.
- What the WTC adds: It is the only run-based exercise analysed that loads all four angular sectors, reaching a 69% thigh-directional work share and 76% of the match MWthigh MIP, and the only one to sustain a full minute at or above 70% of that MIP (Tables 4-6).
- Angles drive mechanical work: Adding angles raises mechanical work well above what linear exercises produce, with the WTC delivering ∼28 J of MWthigh per block compared with ∼4 J for the Box-to-Box (Table 4). Consequently, despite the complete session accumulating only approximately 19–30% of match MWthigh and 13–18% of match MWstride (Table 9), removing the WTC would reduce MWthigh to less than 3% of match demands. This contrasts with traditional external load GPS 2.0 metrics, for which the same session meets or even exceeds match demands for high-speed running and accelerations.
- No single exercise does everything: Each is intense only where it is designed to be. A complete session is built from complementary pieces: the WTC for directional load, the Box-to-Box for HSR volume, and the Max Sprint for peak speed exposure.
- Prescribe against directional exposure: Each WTC block sustains ∼1 min above 70% of the match MWthigh MIP (a match reaches ∼6.2 min, Table 6), so three blocks cover roughly half of that exposure. A practical default is three WTC blocks combined with the HSR and peak speed work of the linear toolkit, all volumes individualised to the player.
- One axis only: This paper audits mechanical and directional load. It does not measure the cardiovascular response. Since the aim of compensation for non-starters is fitness maintenance, and since time above 90% HRmax is the stimulus most often missed in compensation work (Buchheit et al., 2026d), a complete session should be checked against both mechanical/directional and heart rate zone targets, not one alone.

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