



# **Second Spectrum**

## **Physical Performance Metrics**

File Documentation Details

Version 1.1

# Version History

Version	Date	Notes
v0.1	2020/5/14	Initial Version
v0.2	2021/5/18	Separate instantaneous and sustained speed definitions, clarify use of FIFA pace thresholds
v1.0	2022/1/21	Release v1.0 documentation
v1.1	2023/04/07	Update documentation for clarity

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# 1. Summary

As the Official Tracking Provider, Second Spectrum strives to deliver a comprehensive data and analytics platform which the clubs value and use to push the league to new heights in performance and competition. An important component of the platform are the physical metrics derived from tracking data for each match. This document provides an overview of the underlying methodology for calculating the physical metrics.

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## 2. Speed Calculation

The instantaneous speed in kilometres per hour (km/h) for a given frame is based on the 5 frames centred around the current time. Specifically, player velocity at  $(x_0, y_0)$  is calculated as the slope of the regression line through the  $N$  player locations before and  $N$  player locations after  $(x_0, y_0)$ :

$$v_{x0} = \frac{\sum_{n=-N}^N x_n t_n}{\sum_{n=-N}^N t_n^2}, \quad v_{y0} = \frac{\sum_{n=-N}^N y_n t_n}{\sum_{n=-N}^N t_n^2}$$

where

$$t_n = n\Delta T$$

and  $\Delta T$  is the interframe period. Speed is then calculated as the magnitude of the velocity. In our calculations,  $N=2$ , which corresponds to a 5 frame window, as mentioned above.

The sustained speed for a given frame is the mean of the instantaneous speeds over the 25 frames centered around the current time.

### Top Speeds

For the purposes of reporting top and average speeds, **sustained speed** is used.

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### 3. Speed Interval (Pace) Thresholds

Distances and occurrences are broken down for each team and player according to the FIFA speed thresholds:

Pace label	Zone	Speed range
Walking	Zone 1	0-7 km/h
Jogging	Zone 2	7-15 km/h
Running	Zone 3	15-20 km/h
High speed running	Zone 4	20-25 km/h
Sprinting	Zone 5	> 25 km/h

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## 4. Distance Calculations

The distance covered by a player is added when they have moved at least 1 metre from their previous detected position. This means that for a player who takes a step shorter than one metre in one direction and an equally short step back, the distance will not increase.

When conditions are satisfied to accrue distance to a player's total, the distance is categorised into the five pace categories, based on the **instantaneous speeds** (defined in section 2) calculated since the last time distance was allocated.

For clarity, we do not count any distance a player moves within a 1 metre radius, even if he moves back and forth multiple times in that area, and count only the straight-line distance between the previous position and the first new position outside of the 1 metre radius. This new position then becomes the reference position for measuring subsequent distance travelled.

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## 5. Speed Interval Occurrences

A pace occurrence is registered whenever a player's sustained speed (defined in section 2) enters the corresponding speed range, except that if a second sequence of the same pace interval starts within 25 frames after the end of the last one, only one occurrence is counted.