MODEL HEALTH

Sprint Analysis Report

Subject	Session	Trial	Trial ID
Tom-admin	cut_session	sprint_1	a892384e

Sprint metrics - Highlights

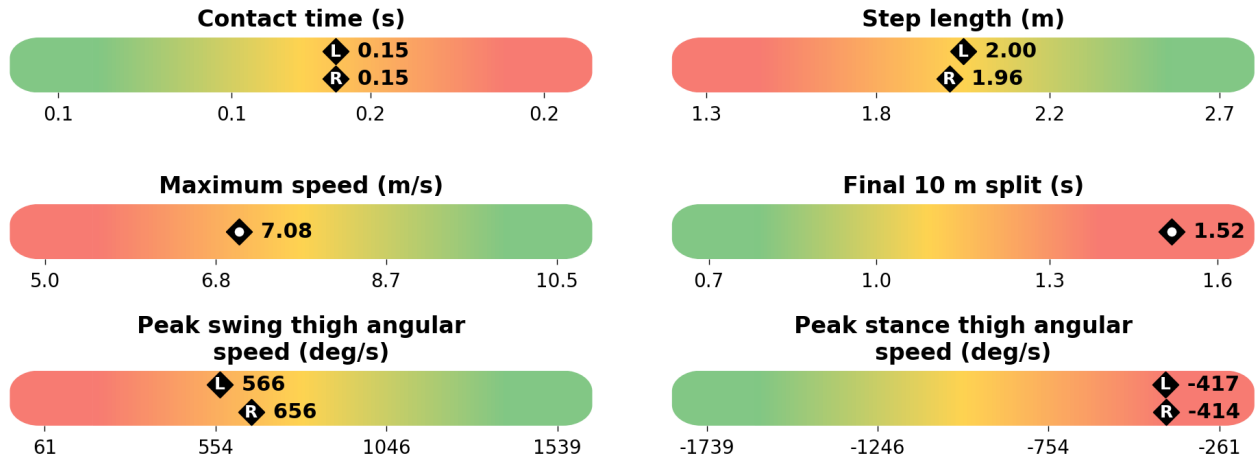


Figure 1: Color coding indicates how results compare to normative targets for recreational (yellow) and elite (green) male sprinters. Values represent the last complete step per leg.

Sprint Mechanics Assessment Score (S-MAS)

This section supports sprint technique analysis using the S-MAS framework (Brahma et al. (2024)). S-MAS evaluates sprinting across five events: toe-off, maximal vertical projection (center-of-mass at its highest point), late swing (maximal knee extension during flight phase), initial contact, and midstance (pelvis directly above the ankle joint). Events are detected to within 10-15ms accuracy. Items and thresholds follow the original paper. Kinograms are included on the next page. *Note: Anterior pelvic tilt items are currently under development and excluded.*

Metric	**Threshold**	Cycle 1	
		L	R
Contralateral hip extension at toe-off	< -45 deg	-28.3	-26.9
Back kick at maximal vertical projection	< 0 deg	5.6	-2.7
Longitudinal torso rotation at maximal vertical projection	$\|value\| > 15$ deg	-12.3	-7.2
Contralateral hip extension at late swing	< -10 deg	-1.1	-4.3
Forward torso lean at initial contact	> 15 deg	24.4	24.4
Thigh separation at initial contact	< -20 deg	-11.4	-14.2
Foot-COM distance at initial contact	> 0.25 m	0.05	0.09
Shin angle at initial contact	< -5 deg	-2.4	-9.1
Foot inclination at initial contact	$\|value\| > 15$ deg	-0.1	1.1
Frontal plane pelvis drop at midstance	< 0 deg	0.7	3.4

Table 1: S-MAS item scores for the last captured cycle per leg. Red values exceed threshold and warrant further investigation. COM = center of mass.

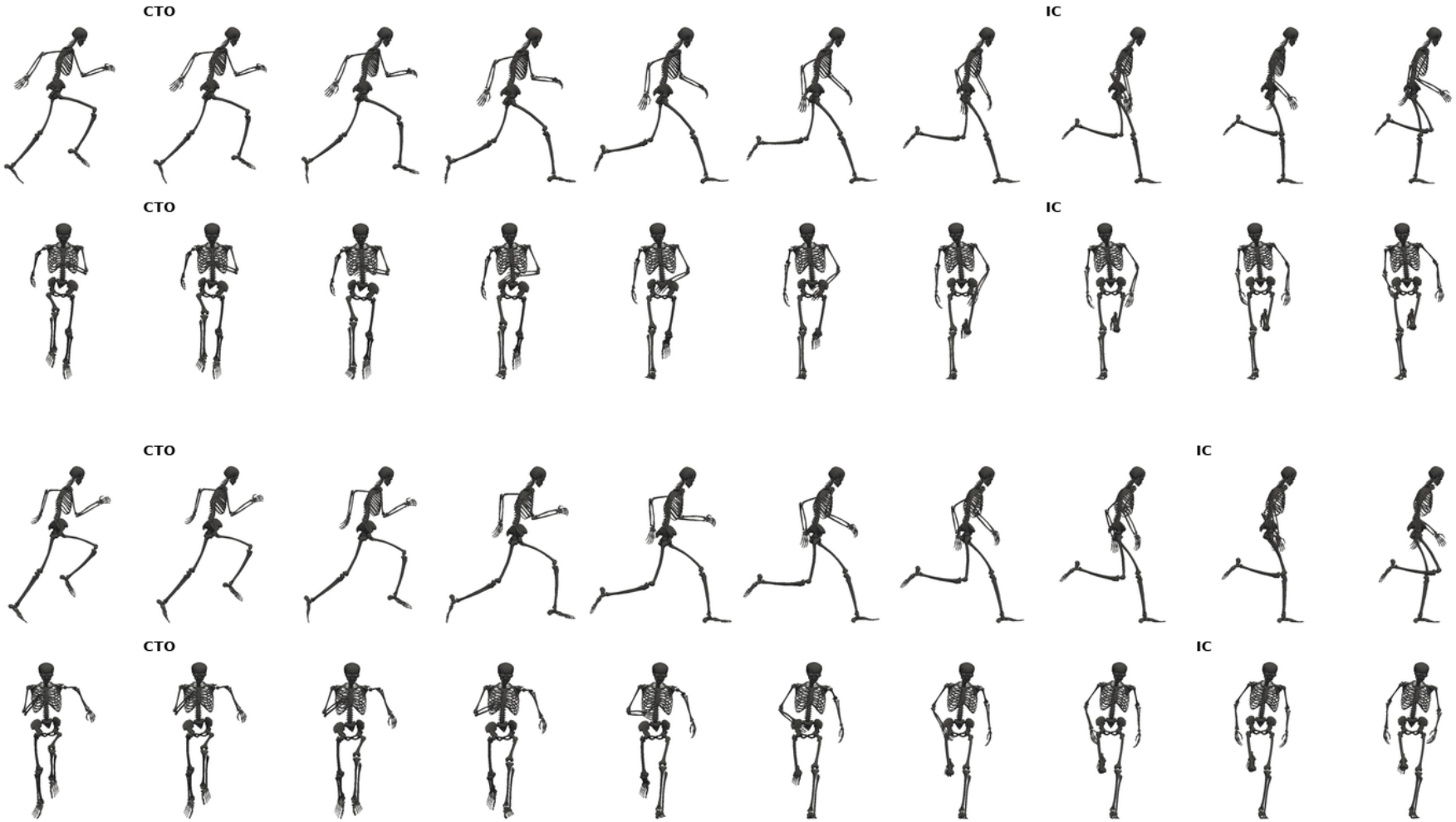
Threshold violations

S-MAS item and threshold description. Full metric descriptions with interpretation are on page 5.

- **1. Contralateral hip extension at toe-off**: The trailing femur is oriented more than 45° from vertical at toe-off, typically with a fully extended knee.
- **2. Back kick at maximal vertical projection**: The heel of the swing leg rises above the calf, with the shin at or above parallel to the floor.
- **3. Longitudinal torso rotation at maximal vertical projection**: Excessive longitudinal rotation is visible, indicated by a large arm swing or the far-side shoulder/upper arm coming into view.
- **4. Contralateral hip extension at late swing**: The trailing knee remains behind the gluteal muscles, indicating a backside-dominant leg cycle.
- **6. Forward torso lean at initial contact**: Forward trunk lean exceeds 15° at initial contact.
- **8. Thigh separation at initial contact**: The thigh gap exceeds 20° at initial contact, or the trailing knee is positioned behind the back.
- **9. Foot-COM distance at initial contact**: The horizontal foot-to-center of mass (COM) distance at initial contact is large enough to fit another foot.
- **10. Shin angle at initial contact**: The shin is inclined backwards at initial contact, with the ankle in front of the knee.
- **11. Foot inclination at initial contact**: A visible gap between foot and floor is present at initial contact, either forefoot or heel, indicating excessive strike inclination.
- **12. Frontal plane pelvis drop at midstance**: The pelvis drops on the contralateral side at midstance, often accompanied by increased knee flexion and ankle dorsiflexion.

Kinograms

Kinograms show the last complete step per leg as an evenly-spaced sequence from 20 ms before contralateral toe-off (CTO) to ipsilateral initial contact (IC).



Sprint metrics - All

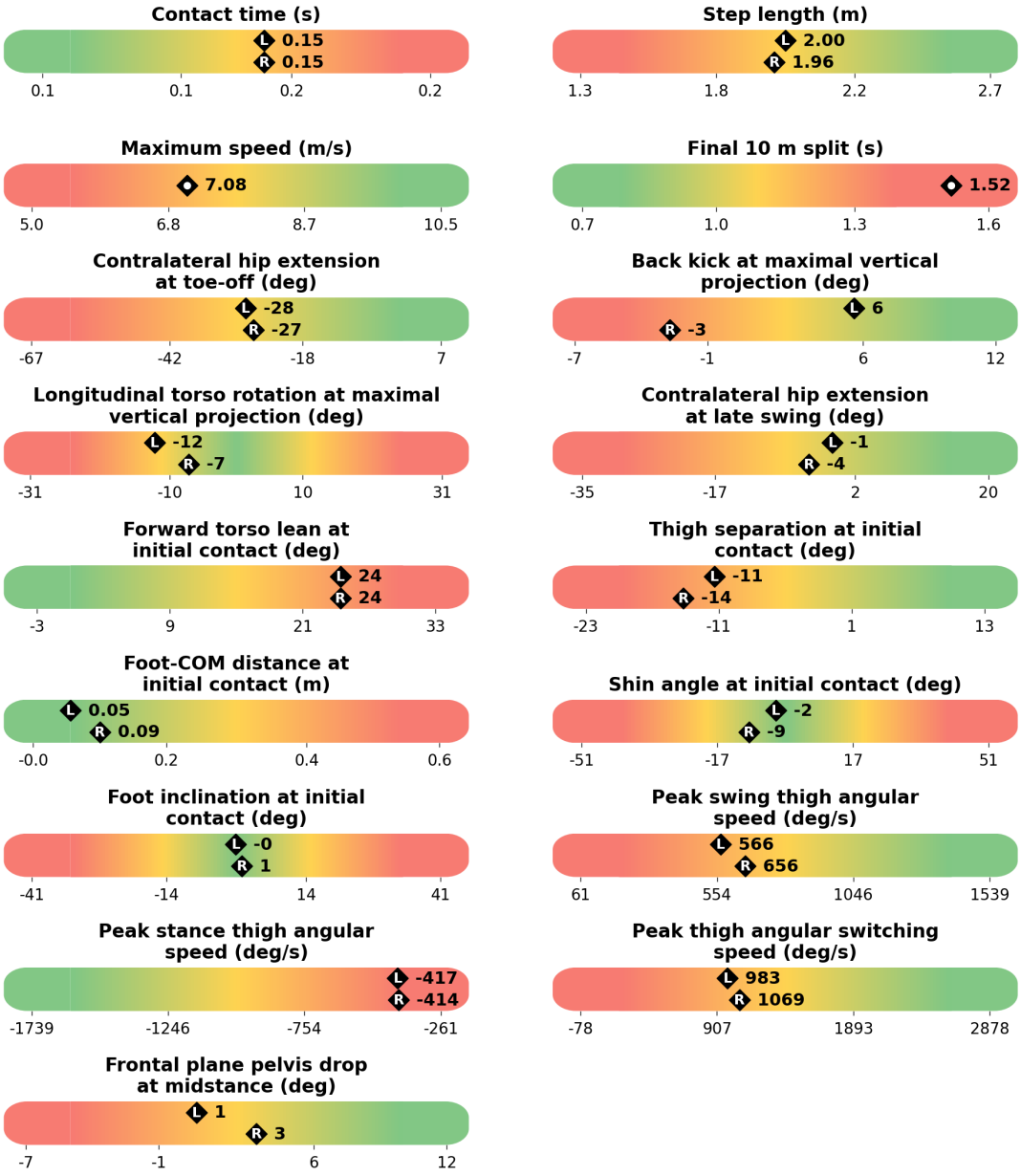


Figure 2: Color coding indicates performance relative to normative targets for recreational (yellow) and elite (green) male sprinters. Values represent the last complete step per leg.

Description of the metrics

Performance

- **Contact time (s)**: Duration of the foot contact phase from initial contact to toe-off. Shorter times indicate greater leg stiffness and reactive push-off; longer times reflect a less explosive stance and lower sprint velocity.
- **Step length (m)**: Horizontal distance from contralateral toe-off to ipsilateral contact. Greater step length drives higher sprint velocity, though optimal values depend on a trade-off with step frequency.
- **Maximum speed (m/s)**: Peak center-of-mass velocity in the running direction. The primary indicator of sprinting capacity.
- **Final 10 m split (s)**: Time to cover the last 10 m of the trial, measured back from the final captured step.
- **Peak swing thigh angular speed (deg/s)**: Maximum angular speed of the thigh during the forward swing of the trailing leg. Higher values reflect a more aggressive leg drive, faster leg switching, and greater propulsive capacity.
- **Peak stance thigh angular speed (deg/s)**: Maximum angular speed of the thigh during hip extension on the stance leg. Higher absolute values reflect greater force generation during the propulsive phase.
- **Peak thigh angular switching speed (deg/s)**: Maximum rate of thigh direction change from extension to flexion during the flight phase. Higher values indicate more rapid and efficient leg switching, a key determinant of sprint speed.

S-MAS

- **Contralateral hip extension at toe-off (deg)**: Thigh orientation of the trailing leg relative to vertical at toe-off; more negative values indicate greater hip extension. Excessive extension during this phase may contribute to increased anterior pelvic tilt and delayed hip flexion recovery, potentially increasing hamstring strain demands on the subsequent swing leg and impairing rapid ground contact mechanics in the following step.
- **Back kick at maximal vertical projection (deg)**: Tibia orientation of the swing leg relative to horizontal at maximal vertical projection; negative values place the heel above the knee. Excessive back kick typically co-occurs with hip overextension at toe-off and carries the same mechanical penalties.
- **Longitudinal torso rotation at maximal vertical projection (deg)**: Transverse-plane trunk rotation at the moment of maximal vertical projection. Trunk rotation counterbalances pelvic and lower limb rotation in the transverse plane. Excessive or asymmetric values are inefficient and potentially caused by reduced core stability or compensatory mechanics.
- **Contralateral hip extension at late swing (deg)**: Thigh orientation of the trailing leg relative to vertical when the leading leg is in late swing; more negative values indicate greater extension. Overextension at this phase drives anterior pelvic tilt, increases leading hamstring load, and delays hip flexion recovery for the next ground contact.
- **Forward torso lean at initial contact (deg)**: Forward inclination of the torso at foot contact. Excessive lean is typical during acceleration but increases hamstring load on the stance leg and should be minimized at top-speed sprinting.
- **Thigh separation at initial contact (deg)**: Angle between the two thighs at foot contact; more negative values indicate the swing leg is further behind the stance leg. Greater separation increases hamstring load and signals delayed hip flexion recovery, reducing reactivity at the next ground contact.
- **Foot-COM distance at initial contact (m)**: Horizontal distance from the contact foot to the whole-body center of mass at foot strike. Greater distances indicate overstriding, which generates braking forces and reduces mechanical efficiency.
- **Shin angle at initial contact (deg)**: Tibia angle relative to vertical at foot strike. A vertical or slightly forward-inclined shin minimizes braking forces; backward inclination indicates overstriding.

- **Foot inclination at initial contact (deg)**: Foot pitch at foot strike; positive values indicate heel-dominant contact, negative values forefoot contact. Sprinters should land flat or forefoot to minimize contact time and braking impulse.
- **Frontal plane pelvis drop at midstance (deg)**: Frontal-plane pelvic tilt at midstance; negative values indicate contralateral drop. Drop on the contralateral side reflects reduced leg stiffness and is associated with lower mechanical efficiency.