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Reaction Time and the 0.005-Second Margin

Reading level 13 · 1560 words

On August 4, 2024, eight men lined up for the Olympic 100-meter final at the Stade de France in Paris. When it ended, the official results page showed the first two finishers with the same time, 9.79 seconds, yet it put Noah Lyles of the United States first. The photo-finish reading, reported by several outlets, was 9.784 for Lyles and 9.789 for Kishane Thompson of Jamaica. This book follows the measuring that produced that order: the start signal, the blocks, the camera, and the rules that tie them together. Team USA called the finish a seven-way photo finish, so the question is a practical one: how much weight can a thousandth of a second bear?

Every sprint time begins at a signal. World Athletics' current Technical Rules, in the July 2026 edition, say that a photo-finish system must start by itself from the starter's signal, with a delay of no more than 0.001 second. The rulebook speaks of a gun, but in Paris the signal came from speakers behind each runner, press reports said, so that every athlete hears it at the same moment. The clock does not wait for the runners to react. Whatever time they take to move is already inside the final number, and a test before each session checks that the link between signal and clock holds.

The gap between signal and movement is the reaction time, and the blocks measure it. They carry sensors that record when a runner's push begins. In the Paris final, the official table lists the eight reaction times between 0.108 and 0.178 second. Lyles' was 0.178. Because the clock starts at the signal, those 0.178 second are inside his 9.784, so by this book's arithmetic his running time from the first movement was about 9.6 seconds. The rules require a crouch start, with both hands and at least one knee on the ground and both feet on the plates, so every push is measured from the same position.

The rules treat any start under 0.100 second as suspect. In the rulebook's words, the start system sounds an alert "when the reaction time is less than 0.100 second," and the starter then studies the data to decide who, if anyone, caused it. The athlete responsible is disqualified. Strictly, a false start is defined by motion: a foot leaving a foot plate, or a hand leaving the ground, before the report of the gun. The 0.100 line is an electronic flag for that motion, not the definition itself. World Athletics' 100-meter page puts it simply: a reaction time of less than 0.1 seconds is deemed a false start, and all athletes are recalled.

Why 0.100? The rule rests on an assumption. A 2007 paper by Matthew Pain and Adrian Hibbs says the simple reaction time to a sound is thought to be "rarely less than 100 ms." They tested nine athletes on instrumented blocks. Five had average reaction times under 100 ms in at least one condition, and 20 percent of starts in the first two conditions were under 100

ms. They concluded that the muscle response alone can be under 85 ms. The paper tested nine athletes, so it could not by itself say where the line should sit, but it showed the assumption was an estimate and not a law of nature. The current World Athletics page still uses the 0.1-second line.

The race itself is a story in positions, and Team USA reported that Lyles was last, eighth, through the first 40 meters. In the last 10 meters, it said, he and Thompson were dipping, leaning into the line, along with five other sprinters, which made a seven-way photo finish. World Athletics noted that all eight finished under ten seconds, the first time that eight men had done so in one wind-legal race. In the semifinals, World Athletics added, a sub-10 run failed to reach the final for the first time at an Olympic Games. Team USA added that Lyles was the first American to win this Olympic race since Athens in 2004.

Wind-legal has a definition. A 100-meter time counts as wind legal only if the wind is 2 meters per second or less. The rulebook says the gauge reads for the first ten seconds after the gun, and the reading is rounded up to the next tenth of a meter per second. The Paris reading was +1.0. World Athletics says an anemometer close to the track makes the measurement. In a 200-meter race on a 400-meter track, the same ten seconds begin only when the first athlete enters the straight. The 200 is run on half of a 400-meter track, with staggered start lines so that every lane covers the same distance, and each lane is 1.22 meters wide, line included.

Dipping answers a finish rule. Athletes are placed by when the torso, "as distinguished from the head, neck, arms, legs, hands or feet," reaches the vertical plane of the nearer edge of the finish line. The same rule fixes the moment for timing. A sprinter who leans the chest forward in the last stride reaches that plane a little sooner than one who stays upright. In a race this close, a few centimeters of chest position can decide the order, and the rules were written to count exactly that part of the body, which is why runners lean at the line.

Finding that plane takes a camera that works differently from a snapshot. A photo-finish camera is a slit camera. Its sensor is a single column of pixels lined up with the finish line, read again and again and stacked into one picture in which the horizontal axis is time. Omega, the Olympic timekeeper, said its Scan'O'Vision ULTIMATE could capture up to 40,000 images per second at Paris 2024, replacing a camera that managed 10,000. Heise, a German technology publisher, put that at a time step of 25 microseconds. Because the picture is built from time, runners look stretched or squeezed according to their speed.

Twenty-five microseconds is very short. Lyles' speed at one point was reported as 43.6 kilometers per hour, or 12.1 meters per second. In 25 microseconds, by this book's arithmetic, he moves about 0.3 millimeter. Two limits apply to that precision. Heise noted that Omega has not published detailed technical data, so 40,000 images per second is the company's own figure. And the rulebook asks far less of a top championships: at least 1,000 frames per second, on a time scale marked in hundredths of a second. The camera at Paris exceeded

the minimum by a wide margin, if the maker's claim is right, although a fine slice of time still needs a judge to decide where the torso is.

People read the image. The rules make the Chief Photo Finish Judge responsible for each athlete's placing and, as a result, official time. The place where lane lines cross the finish line is colored black, so that the judge can line the picture up with the track. A cursor, held square to the time scale, marks each finisher. At least two cameras should work, one from each side, and the second view is used only if there is reason to doubt the first or to resolve an athlete hidden in the image. Photo-finish times are official unless an official decides they must obviously be inaccurate.

Then the numbers are rounded. The rulebook says photo-finish times for races up to 10,000 meters are recorded to the next longer 0.01 second, and it gives the example that 26:17.533 becomes 26:17.54. By that rule, both 9.784 and 9.789 become 9.79. That is why the results page shows two equal times, while the order came from the image. The rounding only shortens the printed number; it does not decide who crossed first. If judges cannot separate athletes for a place at all, the rules call it a tie, and the tie stays. In Paris, the judges could separate them, and the placing was made from the picture.

What does the margin mean in distance? Because Lyles ran 100 meters in 9.784 seconds, an average of about 10.2 meters per second, a gap of 0.005 second is about 5 centimeters, or two inches, by this book's arithmetic, whereas Heise, using his top speed, estimated about 6 centimeters. The same scale applies in the 200 meters. On July 21, 2022, in Eugene, the board first showed 19.32 for Lyles, equal to the American record Michael Johnson set in 1996, before the official time changed to 19.31. At that pace, a hundredth of a second is about 10 centimeters of running, so the Paris gap was about 5 centimeters and the Eugene hundredth about 10.

Here is what is certain and what is not. Certain: the official page prints 9.79 for both finishers, and the photo finish placed Lyles first, by five thousandths of a second as World Athletics reported it. A maker's or one outlet's figure: Omega's 40,000 images per second, which Heise could not check against published technical data. Another is Team USA's account of the positions at 40 meters and in the final 10. It called his reaction "the slowest," yet the official table gives 0.178 for two runners. An assumption: the 0.100-second line. It rests on a model of human reaction that a published study questioned in 2007. World Athletics' 100-meter page still uses it.

Questions

1. Why does Lyles' 9.784 seconds include his 0.178-second reaction time?

A. The clock starts at the signal

B. The judges add it later

C. The runner starts the clock

2. What does a photo-finish slit camera record?

A. A full video from above the track
B. One pixel column, over and over
C. A still photo of the finish

3. Why do the official results show 9.79 for both of the first two finishers?

A. The judges declared a tie
B. One time was lost
C. Times round up to 0.01 second

4. In the sentence "The rule rests on an assumption," what does assumption mean?

A. A belief
B. A penalty
C. A reading

5. What did the 2007 study of nine athletes find?

A. No one reacted in under 100 ms
B. Some starts were under 100 ms
C. All nine were disqualified

6. What counts as the finish for placing a sprinter?

A. The first foot over the line
B. The head reaching the line
C. The torso

Words to know

assumption: unproven belief
torso: trunk of body
disqualified: removed from race
microsecond: millionth of second

Answer key: Reaction Time and the 0.005-Second Margin

1. A. The clock starts at the signal
2. B. One pixel column, over and over
3. C. Times round up to 0.01 second
4. A. A belief
5. B. Some starts were under 100 ms
6. C. The torso