TECHNICAL PAPER

GNSS monitoring on the phone in your hand

When the position gets worse, and what a phone is allowed to say about it.

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Abstract

A phone keeps producing a position after the measurements behind it have degraded, and it does not say why. The instrument that would separate a building, a charger, and energy in the satellite band is not the phone already in use. This paper is the check Fieldwatch runs on the measurements Android already delivers from that phone: receiver gain against the strength of the locked satellites, the last ten readings against the fifty before them. A warning is a change of a known shape on this handset. It is not a source, a distance, or a device, and it stays off until the phone has a saved outdoor calibration.

1. When the position gets worse

Someone is out with a phone, and the position they are using gets worse. The dot jumps, the accuracy circle grows, or the fix goes away and comes back somewhere else. A building, a charger on the dash, a router on the table, a hand over the phone, and energy in the same band as the satellites can all do that. The phone keeps producing a position for as long as it can. It does not say which of those it was. The person still has to decide whether to trust the fix.

The instrument that would show energy in the band is a survey receiver, or a spectrum display, carried for that job. It is not the phone already in the pocket, and it is not something an application can add. What an application can read is the set of measurements Android already delivers from the receiver the phone has: how hard that receiver is amplifying, how clearly the satellites stand out, whether the fix still agrees with the network, and whether another app is supplying the position. Those measurements move for ordinary reasons. A threshold copied from a paper, or from a different handset, will call a kitchen a hit.

This paper is the check Fieldwatch runs on that one phone. The question is whether the receiver just changed in a shape that published work treats as interference, or, when a person turns a second check on, in a shape treated as more consistent with a false signal. The answer is allowed to be a change on this phone. It is not allowed to be a source, a distance, or a device. A warning that named a cause would be saying more than the measurements hold. The rest of this paper is how that change is measured, why this particular phone has to be calibrated before it is allowed to warn, and what is kept when the warning ends.

2. What this phone can measure

The measurements the rest of this paper uses are the ones Android already delivers from the receiver in the phone. They move when a charger, a router, a second phone, a car radio, or a hand is near the antenna, and they move when extra energy arrives in the band. Those two causes are not labeled. From here the question is whether the measurements just changed in a shape the published work already treats as worth reporting, and how this particular phone is kept from treating its own restlessness as that shape.

The answer is a change on this phone. It is not a location of a transmitter, and it is not a name for one. The wording on the phone is deliberate. A hit is “possible GPS interference,” or, when the second check is on, “possible GPS spoofing.” The sit report says “Possible GNSS interference” or “Possible GNSS spoofing.” The software does not say a jammer was found, and it does not say a spoofer was found.

3. Two patterns, and why they are not the same

Automatic gain control is the receiver turning its own amplifier up or down so the incoming energy stays in range. When extra energy arrives in the band, the gain usually falls. Carrier-to-noise density, written C/N0 and shown in the product as signal, is how clearly each satellite stands out of that energy. The useful pair is the direction those two numbers move.

If the gain falls and the satellite signals fall with it, the receiver is being asked to hear through something louder than the sky it had a minute ago. That is the interference pattern. If the gain falls and the satellite signals hold, or even rise, the receiver has turned its amplifier down while the signals it is tracking still look strong. Published work treats that second shape as more consistent with a false signal than with broadband noise. Fieldwatch keeps the second check off by default. A wrong position can also be a side effect of interference, and a careful false signal can be built to avoid both shapes.

A third notice is not a radio event at all. If Android reports that a mock-location app is supplying the fix, Fieldwatch says so, in those words. That is the developer switch. It is not a radio spoofer.

4. Prior work this check follows

The comparison of gain and C/N0 on Android is not original to Fieldwatch. Spens, Lee, Nedelkov, and Akos, writing in NAVIGATION in 2022, set out four things an ordinary Android application can see without a radio front end of its own: gain together with C/N0, the GNSS fix against the network fix, the mock-location flag, and GNSS time against the phone's idea of time. They demonstrated the set in an application called GNSSAlarm. Google's developer note on detecting GNSS jamming and spoofing states the same gain-and-signal rule in short form, and points at that paper's figure. Sean Barbeau's GPSTest made the raw measurements inspectable on a phone, which is how a person can see the gain number Fieldwatch is using.

The Joint Research Centre's work, reported by Tegedor, Gioia, Barbero, Luzardi, and Folloni, uses the same Android gain measurement for a different job. Their approach collects phones and looks across them. They are plain that a small gain change is not always interference, and that one phone model does not behave like the next. Fieldwatch is the opposite arrangement: one phone, on that phone, with no server. The JRC result is one reason the calibration described below exists. A threshold copied from a different handset is not a threshold.

Rustamov, Minetto, and Dovis showed that C/N0 series from several satellites start to move together when those satellites are coming from one false antenna rather than from the sky. Their journal paper is the 2023 IEEE Open Journal of the Communications Society article; the same group described the correlation test at ION GNSS+ the same year. Fieldwatch does not copy their statistic. The optional switch “Count satellites fading together” is a much smaller version of the idea, and it starts off, because a pocket, a hand, or the act of getting into a car fades satellites together too.

The debt is real, and the implementation is not a port of any of those systems. The bars, the hold times, the per-phone calibration, and the decision to leave the second pattern off are Fieldwatch's.

5. What Android actually hands over

While Fieldwatch is scanning, a monitor registers for GNSS measurements. It starts about a second after the radios, so it does not share their first frame. Each event becomes one epoch. The epoch is a map from constellation and carrier frequency to a small set of numbers.

On Android 13 and newer, the preferred gain is the event-level report, one value per constellation and carrier. On an older phone, or when that report is absent, the gain is the median of the per-satellite gain values in the same event. A reading below -80 dB is dropped. It is not a quiet sky. It is a number the check has learned not to trust. C/N0 for a band is the average of the three strongest satellites on that band that currently have a code lock. Satellites that are visible but not locked do not enter that average. The count of locked satellites is kept beside it.

Carrier frequency is folded into a band name: GPS and Galileo L1/E1 near 1575.42 MHz, BeiDou B1I, GLONASS G1, L2, L5, Galileo E5b, E6, and an unknown bin when the frequency is missing or far from those centers. A missing frequency is treated as L1, which is the honest default for a measurement that did not say. Two bands that report the same gain, within half a decibel, across the last thirty samples are treated as one gain group. A chipset that copies one gain number onto every band should not be counted as several independent receivers.

“Keep the GPS receiver awake” asks Android 12 and newer for full tracking. It uses more battery. Older phones ignore the request. It starts off. It is not required for a hit to count.

6. The minute it learns, and the ten seconds it tests

Nothing is scored until a band has sixty readings. On a receiver that reports about once a second, that is about a minute, but the unit is readings, not the clock. The last ten are the recent window. The fifty before them are the baseline. The test is the difference of the two means. A single spike does not move the mean enough to matter, and a slow wander that was already in the fifty is already in the baseline.

The first minute after the check starts is thrown away. Diagnostics says “settling,” with the seconds left. The receiver is still finding its gain. Those readings are not the baseline. The next minute fills the sixty. Diagnostics says “learning.” A warning is not possible until that second minute has finished. Restarting the scan starts the wait over.

A drop has to persist. Each band keeps the last seven yes-or-no answers for gain and for signal. Five of the seven have to say yes. One noisy reading does not open a hit, and one quiet reading does not clear one.

While a hit is open, the baseline is frozen. The bad stretch is not allowed to become the new normal. The comparison stays the sky from before the drop. That is why a long event does not quietly re-arm at the worse level.

7. How a drop becomes a level

Sensitivity picks the bars. Medium starts at about 5 dB of gain and about 3 dB of signal. Low waits for about 8 dB and 5 dB. High speaks at about 3 dB and 2 dB. Calibration can raise those bars. It never lowers them. A Good phone keeps the bars the person picked.

The level is then a small ladder, not a vote of every satellite.

- Gain and signal both down, on one gain group, is medium.
- The same pair on two gain groups that are not copies of each other is high. So is an event-level gain drop that arrives with the satellites dropping out: none left, or a quarter of the baseline count, or the fix itself gone.
- Gain down on its own, with the signal not meeting its bar, stays low.
- A phone that has never reported gain can still warn, and only at low. Every tracked band must be down by a slightly deeper signal bar (6 dB at Medium, 8 dB at Low, 4 dB at High), and about half the locked satellites must be gone.

Warning level is a separate control, and it also starts at Medium. It decides when the popup, the red line, the beep, and the voice start. A weaker hit still goes into Diagnostics and into the sit. The sit is the record. The popup is the interruption.

8. Calibration is a measurement of the phone, not of the sky

Phones do not have the same GPS. A bar that is quiet on one handset is a string of false hits on another. Calibration is one minute, outdoors, held still, away from other radios. The check stays off until a result is saved on that phone. The result is not part of Export settings. Another phone needs its own minute.

The minute is rejected, and the previous result kept, when there are not enough readings, no usable GPS fix, the phone moved, too few satellites, or a signal too weak to grade. The saved profile keeps the mean signal, how far the signal and the gain wandered, the typical step between distinct gain readings, and how often the measurements gapped. It does not store a clean gain to subtract later, and it does not store the coordinates of the spot where the person stood.

Good means an open sky the check can work with: signal mean at least 32 dB-Hz, on the order of 18 satellites, wander within about 1.2 dB, gain steps within about 1.5 dB, and few gaps. Fair is the ordinary remainder. Poor is a wild minute, or a weak receiver that is also noisy. On Fair and Poor, the wander raises the bars, scaled by 2.5 and capped at 8 dB, so the phone's own restlessness is less likely to be called interference. On Poor, the popup, the red line, the beep, and the voice stay off. Path tagging still works. The grade is a statement about that phone's GPS, not about the neighborhood.

9. The second pattern

“Warn when the signal holds” starts off. When it is on, the gain test is the opposite of the interference test: gain down by the sensitivity bar, and signal not down. “Not down” here means the signal change is no worse than about 1 dB. That pattern alone opens a low warning immediately. If it holds about 30 seconds, the warning becomes medium. If it has held about 10 seconds and the clock or the position also disagrees, it can become high.

The side checks are witnesses. They are computed in the monitor and passed in without coordinates.

- Time. On Android 13 and newer, GNSS time and the phone's network time have to differ by more than a second. Older phones report the comparison as unavailable, and it does not vote.
- Position. The GNSS fix and the network fix both have to be younger than 10 seconds. A network accuracy of 100 m or worse cannot vote. The two centers have to sit clearly past both accuracy circles, with another 100 m of daylight between them, and that disagreement has to hold for 15 seconds.
- A jump. A later GPS fix that covers at least 40 m in at least 0.8 seconds, faster than about 150 km/h, is marked for the next few epochs. Walking and ordinary driving stay under that. The path filter uses the same ceiling for a different reason: it drops a glitch from the drawn line.

One of those three, by itself, does not open a warning. Two of them together can open a medium warning even without the gain pattern. The optional correlation check can do the same job as a second witness: at least four satellites, each with twenty C/N0 samples, pairwise correlation of their sample-to-sample changes averaging 0.5 or better for three windows in a row. With the gain pattern, that raises the warning to medium. Alone, it is low. The switch starts off.

If an interference warning is already open, or one ended within about two minutes, a spoofing warning on that stretch is marked down a level. The implementation's own note is that this may be a side effect of the interference. A clock jump also clears the correlation history. It does not, by itself, open anything.

10. Pauses, adaptation, and a hit that was already there

If the receiver stops, or every measurement disappears after the check has seen a lock, Live says “GNSS paused by the phone.” That is not a hit. There is no popup, no red line, and nothing is added on TAK. The readings already learned stay where they are. After measurements return, five clean epochs are kept out of the score, and then the check watches for a drop again. A pause is the phone resting the receiver. Unrestricted battery and full tracking do not stop the phone from doing it.

A hit stays open at least a minute, and it takes about twenty quiet readings to clear. If the change is still there after about fifteen minutes, the warning closes and the record says the receiver may have adapted. The condition may still be present. The receiver has made the new level its level, and there is no longer a drop to point at. One stretch is one warning. The level can rise. It does not open a second warning for the same stretch. Debrief keeps one row.

A hit that was already underway when the check started can be missed. The receiver is sitting in the changed state. There is no drop against a baseline, because the baseline is the changed state. The introduction on the settings page says this in one sentence, and it is a limit of the method rather than a case the method handles.

11. What the person sees, and what is kept

The popup leads with a plain reason and puts the band numbers under Details. Voice, which starts on, says “possible GPS interference” or “possible GPS spoofing,” and it speaks again only when the level rises. Beep starts on and is the same sound as the other warnings, on the media volume. The popup and the red line still show if beep is off. System notification starts off. It is a silent notification, separate from the watchlist's own notification switch. After the hit clears, the red line remains for about ten minutes and then says the warning ended.

The sit stores time and text: when it started, when it ended, the kind, the level, and what changed. It does not store a coordinate for the hit. Debrief and Compare list each hit that way, including a hit below the warning level, so a weaker event is in the record even when it never interrupted anyone. Diagnostics shows the same class of numbers and does not add a coordinate either.

“Record raw GNSS during interference” starts off, and it stays dim until the check is on. It keeps this phone's raw measurements from about a minute before a hit until thirty seconds after the hit ends, in the text column layout used by common GNSS logging tools. It is not the sit log. Privacy mode does not record. Older files are removed once the saved set passes about 20 MB. Share last recording is how the file leaves the phone.

12. The mark on a TAK map

A hit can also leave a mark where this phone was. The chips are Off, While alerting, Red line, and Any hit. Off sends nothing and removes marks this phone still knows. A pause is not a hit. A Poor grade does not send an interference hit. Under about 100 m of travel during the hit, the mark is a pin at the fix where the hit opened. Past that, it is one ellipse. The tips sit on the opening fix and the latest fix, the center is halfway between them, and the full width is half the length. The ellipse stops growing when the hit ends. The ten-minute ended line does not stretch it.

The callsign is “Possible GNSS interference.” The card says the mark is where this phone was, not the source. There are no coordinates in that card. The mark refreshes on a short timer, or after the phone has moved. How long it stays is a separate choice: one hour, six hours, twenty-four hours, or until deleted. The clock starts at the last update. Until deleted stays until GNSS warnings are set to Off. Turning the feed off, or turning Privacy mode on, stops sending and does not remove a mark already on the map. A client that can only draw a point shows the ellipse's center. The mark needs the check armed, the feed on, Privacy off, and a GPS fix no coarser than about 75 m and no older than about 30 s.

> **What a warning is not**
>
> It is not a direction, and it is not a distance. It is not a finding that a particular device was present. A roof, a pocket, or a hand over the phone can look like interference. So can a charger, a Wi-Fi router, a car radio, or a second phone against this one. High sensitivity speaks on a smaller change, so those ordinary neighbors are more likely to count. In a car, the steadier place has been a holder above the dash, with a view of the sky, and the phone off the charger. On foot, the same idea is the chest, clear of the body and of other radios. A quiet check is an empty report. It is not an all-clear, and a hit that began before the check was armed can pass unseen.

13. From the callback to an epoch

While the check is on, the monitor registers for GNSS measurement events. Full tracking, on Android 12 and newer, is a measurement request with full tracking set. Older phones ignore that request. The callback does not run on the main thread. Unless a calibration minute is underway, the event is turned into one epoch and passed to the detector.

The epoch is a map from constellation and band to a handful of numbers. On Android 13 and newer the event-level gain list is read first. A value that is not finite, or is below -80 dB, is skipped. What remains is stored against that constellation and that carrier. Every measurement in the event is then filed the same way. A missing or non-positive frequency is treated as L1. Otherwise the carrier, in megahertz, is matched to the nearest center within 10 MHz: 1575.42 for L1 and E1, 1561.098 for B1I, 1227.60 for L2, 1176.45 for L5, 1207.14 for E5b, and 1268.52 or 1278.75 for E6. A carrier from 1588 to 1616 MHz is G1. Anything farther out is an unknown band.

A measurement joins the signal only when its carrier-to-noise density is finite and above zero and the code-lock bit is set. Those values are kept per satellite. The band's signal is the mean of the three strongest. The satellite count is how many passed the test. Satellites that are visible and not locked do not enter either number. Per-measurement gain, when the phone reports it and it is at least -80 dB, is collected beside the event-level value. The gain written on the epoch is the event-level number when one exists, and otherwise the median of the per-measurement numbers. An even count uses the mean of the two middle values. The epoch also carries the elapsed-time clock, the wall clock, and the hardware clock-discontinuity count.

If three seconds pass with no new event, the monitor delivers an empty epoch. A status that says the engine stopped does the same. Both are how a pause reaches the detector when the callback itself has gone quiet.

14. What happens before a band is scored

The detector keeps one track per constellation and band. A track is a deque of at most 60 samples, two short histories of yes-or-no answers, and, once a hit is open, a frozen copy of the baseline. The rest of the detector's memory is three episodes at most, one for interference, one for the second pattern, and one for a mock-location flag, plus the per-satellite signal history used by the optional correlation check.

An engine stop, or an epoch with no measurements after a lock has already been seen, is a pause. The tracks are left where they are. Nothing is scored, and the snapshot says the receiver paused. When measurements return, the next five epochs are treated the same way. Those five are not pushed onto the tracks. The baseline that was already learned is the baseline the check returns to.

The first 60 seconds of elapsed time after the check starts are returned as settling, with the seconds left. No sample is stored. Resetting the detector, which is what stopping the check does, clears the tracks and the settle clock, so the wait starts over.

A change in the hardware clock-discontinuity count, after the first epoch, clears the per-satellite signal history and the correlation streak. It does not, by itself, open an episode.

Each band present in the epoch is then pushed. Gain below -80 dB is dropped a second time here, so a number the epoch builder let through cannot become a sample either. A new sample past 60 drops the oldest. A band that is absent from this epoch is not given a blank sample. Its deque stays as it was, and the next comparison still sees that last window.

15. The two means, then five of seven

A track is not scored until it holds 60 samples. Armed, for the whole check, means the longest track has reached 60. The last 10 samples are the recent window. The 50 before them are the baseline. The gain change is the mean of the recent gains minus the mean of the baseline gains. Samples with no gain are left out of that mean. The signal change is the same subtraction on carrier-to-noise density. The baseline satellite count is the mean of the counts in the baseline window. If a hit is already open, those three baseline figures are the ones frozen when the hit opened, and later windows compare against that frozen baseline rather than against a window that has slid into the hit.

The gain change can be sign-flipped for a handset whose gain moves the other way. That is a config flag, off unless set. The bars in this paper assume the usual sign. Down is negative.

A band counts as measured when it still has a satellite or a signal. Gain-down is measured, and the gain change is at or below the negative of the gain bar. Signal-down is the same test on the signal change. Each band keeps the last seven answers for each test. Five or more yeses is a standing flag. One epoch does not open a flag, and one quiet epoch does not clear one.

Bands that are copying one gain are one group. The test looks at the last 30 gain samples of each pair. Both tracks have to have 30 values, and every pair of values has to sit within half a decibel. The grouping is a union over the tracks that pass. Two bands in one group are not two receivers when the level is chosen.

16. The level, as the branch is written

The bars are the sensitivity triple, then raised by the calibration floors. A floor never lowers a bar. The signal-only bar is raised by the signal floor. The gain bar is raised by the gain floor.

The interference level is one chain, and the first match wins. If gain has never been seen, and every band that has a signal change is down by the signal-only bar, and the satellite count across those bands is at most half the baseline count, the level is low. That test does not run once any gain has been seen. If gain has been seen, the level is high when two or more gain groups have both flags, or when both flags arrive with an event-level gain and the satellites collapsed or the fix was lost. Collapse is zero satellites, or no more than a quarter of that band's baseline count. One group with both flags is medium. Gain-down on its own is low. Anything else is no interference level.

An open interference episode is not a second episode. The level can rise during the stretch. It does not fall. A quiet epoch increments a recover count. An epoch that still has a level resets it. The episode stays at least 60 seconds, and it then needs 20 quiet epochs to close. If a level is still present 15 minutes after the start, the episode closes and is marked adapted, which is the sentence about the receiver having made the new level its level. Closing clears the frozen baseline. While the episode is open, the baseline stays frozen, and the saved mark is updated in place, keyed by the start time and the kind, with the list capped at 40.

17. The second pattern, after the first

The spoof check runs only when its switch is on. With the switch off, an open spoof episode is ended once it has lasted 60 seconds, and the clock for the gain pattern is cleared. The test itself is any band whose gain change meets the gain bar and whose signal change is no worse than -1 dB. The clock starts on the first such epoch and clears on the first epoch without it.

Correlation, when its own switch is on, needs at least four satellites that each have 20 signal samples. The statistic is the mean of the pairwise Pearson correlation of the sample-to-sample differences. A mean of 0.5 or better increments a streak. Three epochs in a row count. A shorter mean resets the streak. The clock discontinuity described above has already thrown that history away.

The witnesses are computed in the monitor and passed in as three booleans. Time, on Android 13 and newer, is the absolute difference between the phone's network time and the GNSS fix time, greater than one second. Older phones report the comparison as unavailable, and the boolean stays false. Position requires both fixes younger than 10 seconds, a network accuracy under 100 m, and a separation greater than the sum of the two accuracy circles plus another 100 m, and that raw disagreement has to hold for 15 seconds before the boolean is set. A hop is a later GPS fix that covers more than 40 m in at least 0.8 seconds and is faster than 42 m/s. That sets a counter of eight epochs, decremented once per epoch.

The level is high when the gain pattern has held 10 seconds and the time witness or the position witness is set. It is medium when the gain pattern is joined by correlation, or two of the three witnesses are set, or the gain pattern has held 30 seconds. It is low when the gain pattern or the correlation is set alone. One witness does not open a level. If an interference episode is open, or one ended within 120 seconds, and any witness is set, the level is lowered one step. A low that is lowered becomes no level, and the episode ends once its 60-second hold has passed. The same update rule applies: one episode, the level can rise, and the mark is rewritten in place.

A mock-location flag is a third episode. It does not use this ladder. It opens at low for as long as the side information says a mock location app is supplying the fix, and it ends on the epoch where that flag is clear.

18. What the calibration minute writes back

The minute is a list of epochs and a list of fixes, graded after the minute ends. It is rejected, and the previous profile kept, when the window is under 50 seconds, the epoch count is under 20, the span from the first epoch to the last is under 45 seconds, fewer than eight fixes are tighter than 25 m, the phone moved more than 40 m or four fixes were at 2.5 m/s or faster, the mean signal is under 18 dB-Hz, or the mean satellite count is under 8.

A minute that is kept is graded from the standard deviation of the signal, the standard deviation of the gain, the typical step between distinct gain readings, and the fraction of gaps between epochs. Good requires gain to have been seen, a signal mean of at least 32 dB-Hz, a satellite mean of at least 18, wander within 1.2 dB, a gain step within 1.5 dB, and a gap fraction under 0.08. Poor is wander at or above 3.5 dB, a step at or above 6 dB, a gap fraction at or above 0.20, or a weak receiver that is also noisy. Fair is what remains. Good writes floors of zero. Fair and Poor write a signal floor of 2.5 times the signal wander, capped at 8 dB, and a gain floor from the gain wander on the same scale, or from the step plus half a decibel when the step is coarse, also capped at 8. Poor also sets the flag that keeps the popup, the red line, the beep, and the voice off. On later epochs the detector takes the greater of the chosen bar and that floor.

19. Parameters

Parameter	What the implementation uses
Score window	60 readings. The last 10 against the 50 before them. About one reading a second on a typical receiver.
Agreement	5 of the last 7 readings must agree, separately for gain and for signal.
Sensitivity, Low	Gain 8 dB and signal 5 dB. Signal-only, when the phone reports no gain: 8 dB.
Sensitivity, Medium	Gain 5 dB, signal 3 dB. Signal-only: 6 dB. This is the start.
Sensitivity, High	Gain 3 dB, signal 2 dB. Signal-only: 4 dB.
Gain ignored	Below -80 dB, whether it came from the event or from a satellite.
Settle, then learn	The first 60 seconds of readings are discarded. The next minute fills the window.
Hold and clear	At least 60 seconds open, then about 20 quiet readings. Still changed after 15 minutes: close, and say the receiver may have adapted.
After a pause	Five clean epochs are kept out of the score. The old baseline stays.
Spoofing, off by default	Gain down and signal within about 1 dB of its baseline. Low at once, medium after about 30 seconds, high after about 10 seconds if clock or position also disagrees.
Position witness	Both fixes under 10 seconds old, network accuracy better than 100 m, centers farther apart than both accuracies plus 100 m, held 15 seconds.
Time witness	Android 13 and newer. More than one second between GNSS time and network time.
Jump witness	At least 40 m in at least 0.8 s, faster than about 150 km/h. One witness does not open a warning.
Calibration	About one minute. Good keeps the chosen bars. Fair and Poor can raise them, up to 8 dB. Poor suppresses the popup. Not exported.
Raw recording	Off until turned on. About 60 seconds before a hit through 30 seconds after. Not recorded in Privacy mode. About 20 MB kept.
TAK mark	Pin under a 100 m span. Past that, one ellipse, width half the length, tips on the start fix and the latest fix.

The signal-only figure is a separate test, used only when the phone has never reported gain. It is deeper than the signal bar in the paired test. A phone that does report gain is judged on the pair, not on the signal-only number.

References

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A note on this paper

This paper describes GNSS monitoring as implemented in Fieldwatch 1.1.37, dated 29 October 2026, and still the same in 1.1.39. It is a description of a method. It is not a test report from a range, not a certification, and not a claim that every phone will grade Good. The research credit belongs with the people named above. Fieldwatch uses the ideas on this phone, with the limits written here.