

# Harry's GPS LapTimer

Train the Trainer Session April 09 2015

*Disclaimer: This documentation includes snapshots from LapTimer's GrandPrix Edition running iOS7. Availability of views, functionality, and layout may differ in production versions. As iOS and Android versions will converge over time, we have chosen to show one platform only.*



(c) 2014 Harald Schlangmann

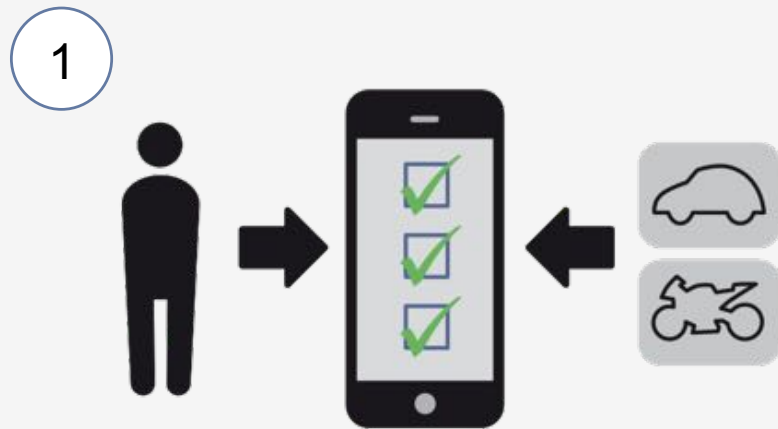
# Why a Smartphone Based Lap Timer?

## Summary

- Processing power available allows **superior functionality**
- **Display quality and screen resolutions** are compelling
- **All sensors on board** for entry level data recording
- **Video integration and overlaying** included
- Connectivity allows immediate **sharing with friend**
- **Weekend experience** can be carried along
- Allows **competitive experience** and pro challenges
- **Sensor quality** shortfalls can be compensated for no money
- **System can be expanded** with raising requirements
- In general: "value for money" is extremely high

# Quick Reference

## Prepare (1)



Personalize **Lap Timer** by entering your **Driver ID**. Then specify a vehicle. Be sure to select the right type (e.g. **Car** or **Motorbike**)!

NB: in case an OBD adapter is attached, it is mandatory to define gear ratios and wheel sizes for your vehicles. Otherwise, gears cannot be calculated.

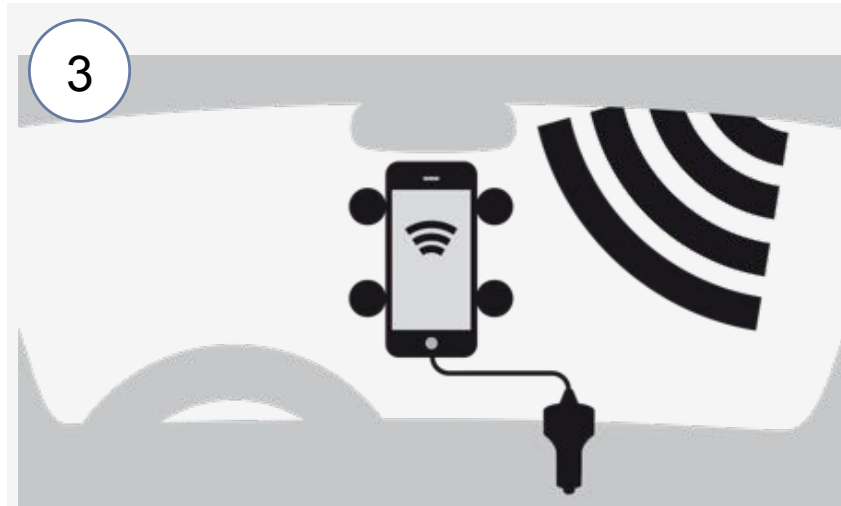


Select **Load Track** for new track locations and configurations. Or set up your own track using **New Autocross** or **New Track**.

NB: in case you do not see your track, make sure you have selected "All" and not "Near By" in the top. The latter will display track nearby only.

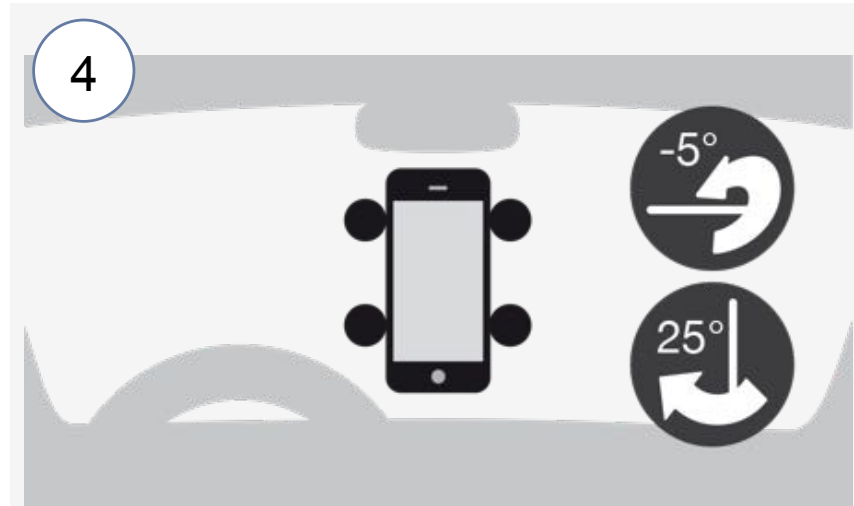
# Quick Reference

## Prepare (2)



Use a stable mount and a power supply. Choose position with best possible GPS accuracy. Ideally, add an external GPS.

NB: never use Lap Timer without an external power supply. Even new phone batteries will be drained within 2 hours.

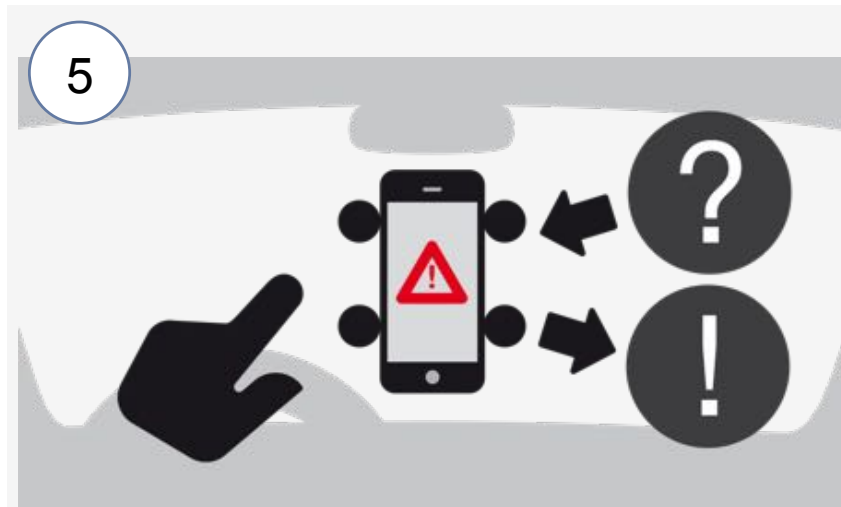


Attach your phone according to one of 4 valid mounting presets or let **Lap Timer** calibrate orientation individually.

The latest version of Lap Timer comes with presets replacing the precise, but sensible individual calibration. Lap Timer will select the preset automatically.

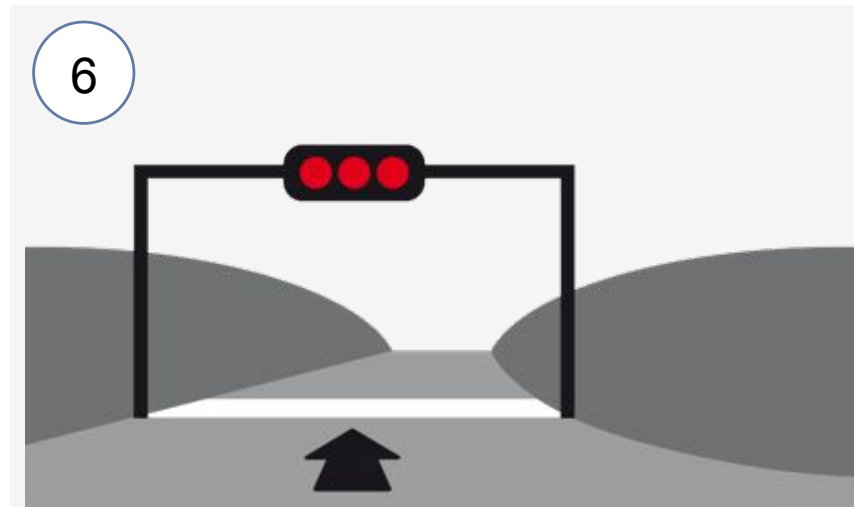
# Quick Reference

## Race (1)



Be sure **Lap Timer's** [System Status](#) shows an overall rating [All Set](#). A red alert should not be ignored—press it to get help.

NB: please make sure the system status is green / no alert is shown directly before leaving the pits.

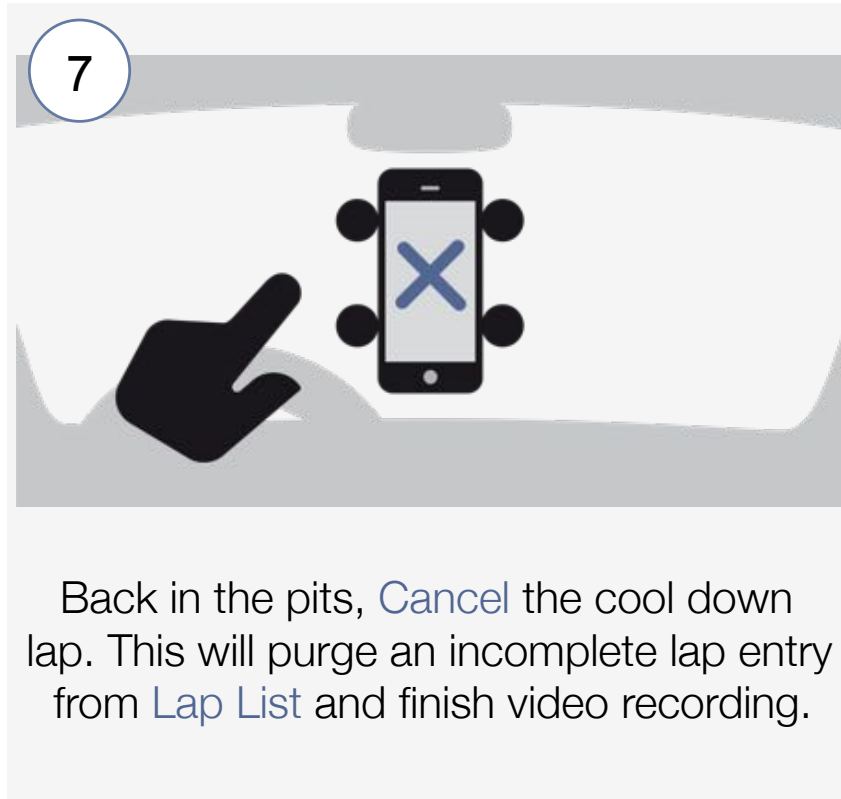


Select a timer view (e.g. [Timer](#) or [Speedo](#)) before leaving the pits. For video, press the [Video](#) button.

NB: the recommended view for driving is [Timer](#). It has an ergonomic design dedicated to on track operation.

# Quick Reference

## Race (2)



- Lap Timer submits the position on track (with Driver ID) constantly. This allows others (and trainers) to monitor users ([Online View](#)).
- When finishing a lap, the lap time is submitted to the server automatically for analysis (e.g. regularity penalties)
- This works in real time provided an Internet connection is available.
- Otherwise, data is queued and re-submitted once the device has access to the Internet again. Bandwidth needed is extremely low.
- In case this doesn't work, times can be resent ([Lap Details](#) / [Hall of Fame](#)).

# Quick Reference

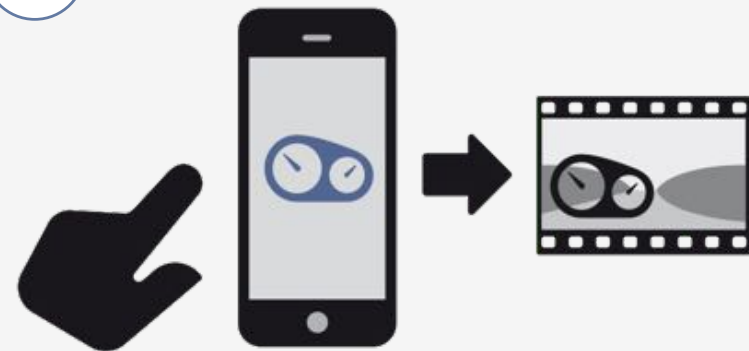
## Analysis

8



Select any lap from [Lap List](#) and follow [Data Recordings](#) to analyse your drive using the many built-in charts and graphs.

9



Select any lap from [Lap List](#) and press [Overlay](#) to add telemetry to your video ready for upload to [YouTube](#).

Please read the "Help Users to Read Their Data" section for more details.

*The remainder of this slide deck provides background information on Lap Timer operation. It is not an introduction on user level. Instead, it provides information to trouble shoot issues and to help un-trained users to use the system efficiently. In addition to best practices and caveats, it includes additional information to use the analytics capabilities built into all Lap Timer editions.*

# Train the Trainer

## Agenda

- ① Basic concepts of GPS based lap timers
- ② Prepare Lap Timer for operation
- ③ Help users to read their data
- ④ Q&A

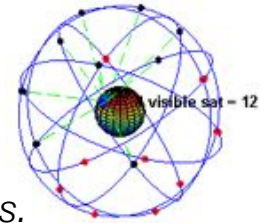
# Basic concepts of GPS based lap timers

## Introduction

- Definition (Wikipedia):

*The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.*

*The system provides critical capabilities to military, civil and commercial users around the world. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver.*



- GPS sensors **deliver a sequence of distinct "fixes"** at a sensor specific rate (consumer devices: 1 – 10 Hz)
- **Accuracy depends on the number and geometry of satellites** locked, as well as on error correction capabilities
- **Accuracies delivered can be as good as 1.5 meters** (DGPS) for consumer level devices, but are guaranteed for 95% of all fixes only
- Alternatives: GLONASS (Russian), Galileo (EU)

# Basic concepts of GPS based lap timers

## Introduction to Track Sets



- Set of positions defining a track configuration
- Made up from
  - Triggers (Stop / Go, Splits, ...)
  - Points of Interest
  - Others
- Triggers define a position Lap Timer should take an action when passed
- To make Lap Timer aware of a track, the track set needs to be loaded
- Only one track configuration must be loaded at a time

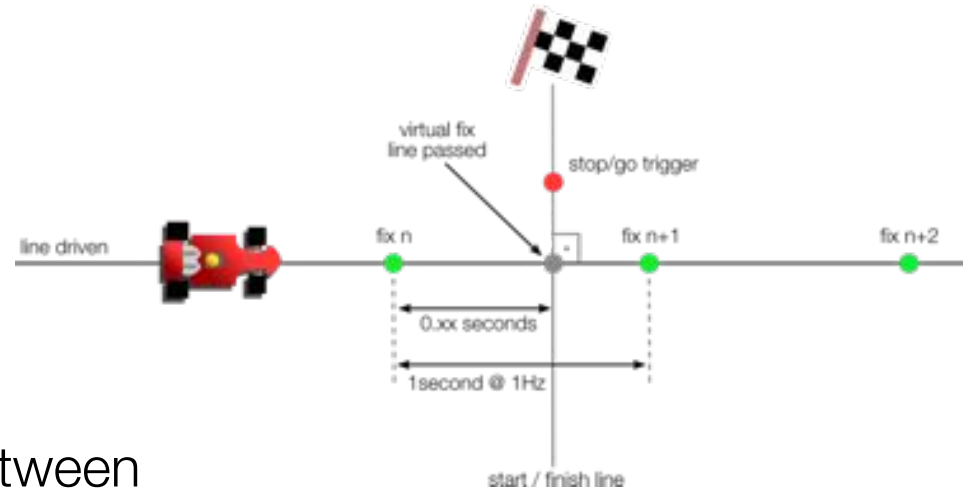


# Basic concepts of GPS based lap timers

Timing accuracy for 1 Hz GPS devices

## Interpolation<sup>(\*)</sup>

- calculate the position of the perpendicular projection of stop/go to the line driven to receive a position  $fix_v$
- calculate the distance  $d_n$  between  $fix_n$  and  $fix_{n+1}$ , as well as the distance  $d_v$  between  $fix_n$  and the  $fix_v$
- assuming a constant acceleration and  $v_i = speed@fix_i$   
$$a = \delta v / \delta t = (v_{n+1} - v_n) / 1 \text{ second}$$
- calculate time between  $fix_n$  and  $fix_v$  to adjust  $fix_n$  time  
$$t_v = (\sqrt{v_n^2 + 2 a d_v} - v_n) / a \text{ for } a \neq 0$$




*At 4 meters accuracy, and typical speed characteristics for start / finish lines, this results in accuracy better than 0.05 seconds for 1 Hz devices*

<sup>(\*)</sup> Simplified presentation

# Basic concepts of GPS based lap timers

## Summary

- There is no "good enough accuracy"; GPS accuracy always needs to be optimized to the best possible 
- Even when doing everything right, **there may be drop outs on some days of the year** (Sun eruptions, atmospheric disturbances, etc.)
- To allow Lap Timer to operate automatically, **load the track day's track configuration (track set) ahead of the session**
- Even for low update rate receivers like those built into recent smart phones, **timing accuracy better than 0.05 seconds is feasible**
- **Higher update rate receivers** (5, 10, 20, 50 Hz available) improve operation and accuracy

# Train the Trainer

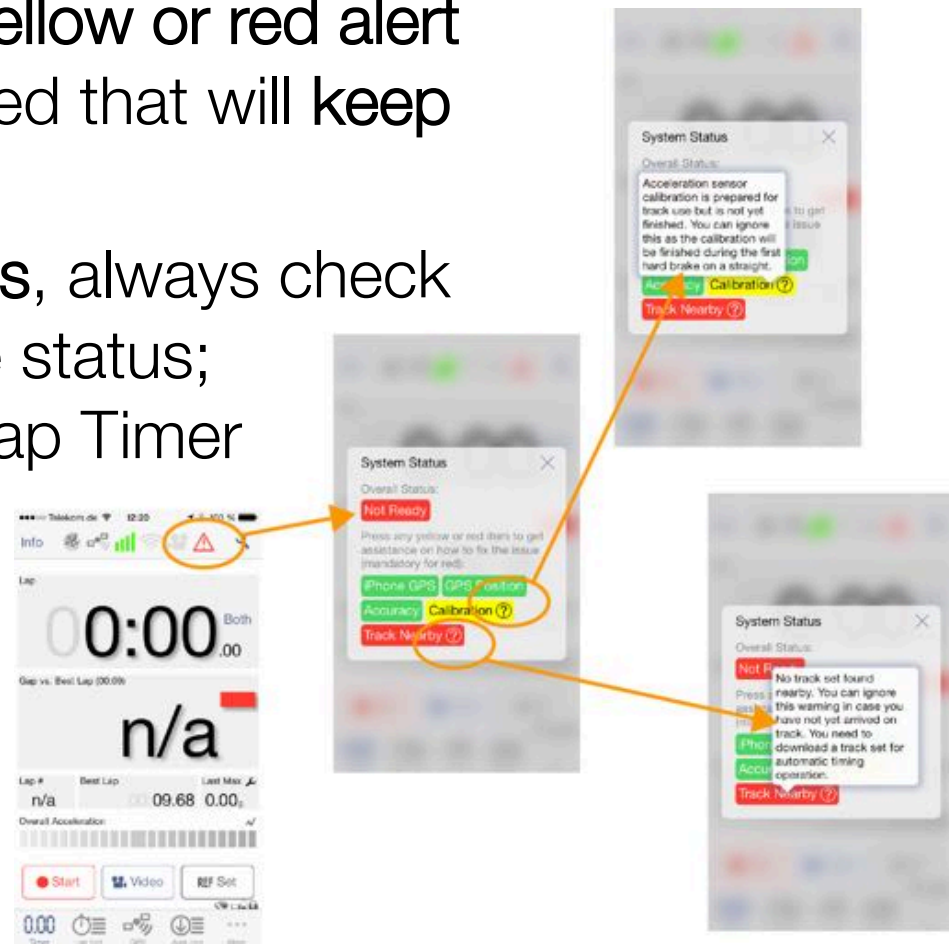
## Agenda

- ① Basic concepts of GPS based lap timers
- ② Prepare Lap Timer for operation
- ③ Help users to read their data
- ④ Q&A

# Prepare Lap Timer for operation



## Self Check

- For common issues, Lap Timer has self checks built in
- The status bar shows a **yellow** or **red** alert in case an issue is detected that will **keep Lap Timer from working**
- In case a **red** alert appears, always check the reason by tapping the status; in general, "red" means Lap Timer will not function properly
- For issues found, Lap Timer displays the reason and a solution



# Prepare Lap Timer for operation

## Other Topics

- Take care the smart phone has a **power supply attached** 
- During serious racing, please discourage video operation; video operation adds additional system load that potentially overheats the device or fills up memory completely
- Incoming calls will interrupt the application 
  - Forward incoming calls to the mailbox
    - iOS: Settings ▶ Phone ▶ Call Forwarding
    - Android: Phone ▶ Options Button ▶ Call Settings ▶ Call Forwarding
  - Using Airplane Mode will not work as it disables Location Services
- It is recommended to kill / stop any apps running in background and accessing GPS (navigation, motion logs)

# Train the Trainer

## Agenda

- ① Basic concepts of GPS based lap timers
- ② Prepare Lap Timer for operation
- ③ Help users to read their data
- ④ Q&A

# Help users to read their data

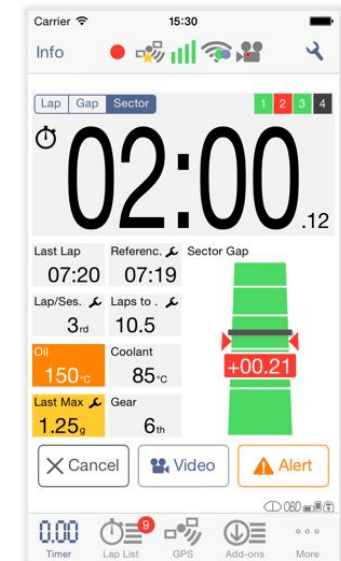
## Introduction

- Truth is, most occasional track day visitors face **problems to improve their driving style based in data recorded**
- This section shows a wealth of **analytic tools built into Lap Timer** and how to "read" them
- Compared to classic logger / analytics approaches, Lap Timer allows **complete "in-car" analysis greatly speeding up the learning curve**
- All data formats and interfaces used in Lap Timer are **fully interoperable between iPhone / iPad / Android devices**; in addition, data can be **exported to desktop systems**

# Help users to read their data

## Predictive lap timing

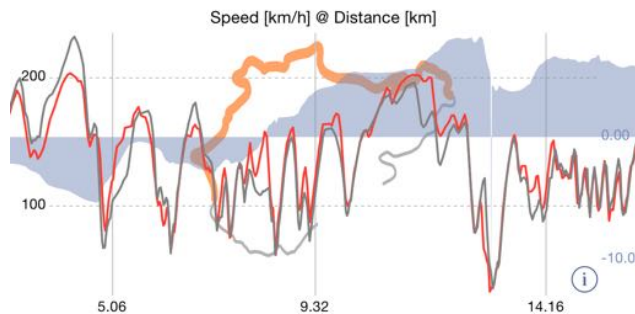
- Predictive lap timing (Gap calculation) allows real time comparison between the current lap and any reference lap recorded before
- Reference lap can be the best lap, the last lap, or any lap marked as reference lap (Set)
- Prediction is calculated by comparing the current time with the time at the current position when driving the reference
- Sample: behind reference is shown with a "+" and red background (" +00.21 "); the green street means driver is improving currently
- Prediction is available both on lap and sector level



# Help users to read their data

## Lap2Lap comparison

- Accumulated gap analysis allows identification of win / loss scenarios easily:
  - A second (blue) axis displays time lost or made good
  - **Steep changes** for the gap indicate areas to analyze in detail
- Lap2Lap comparison views available include

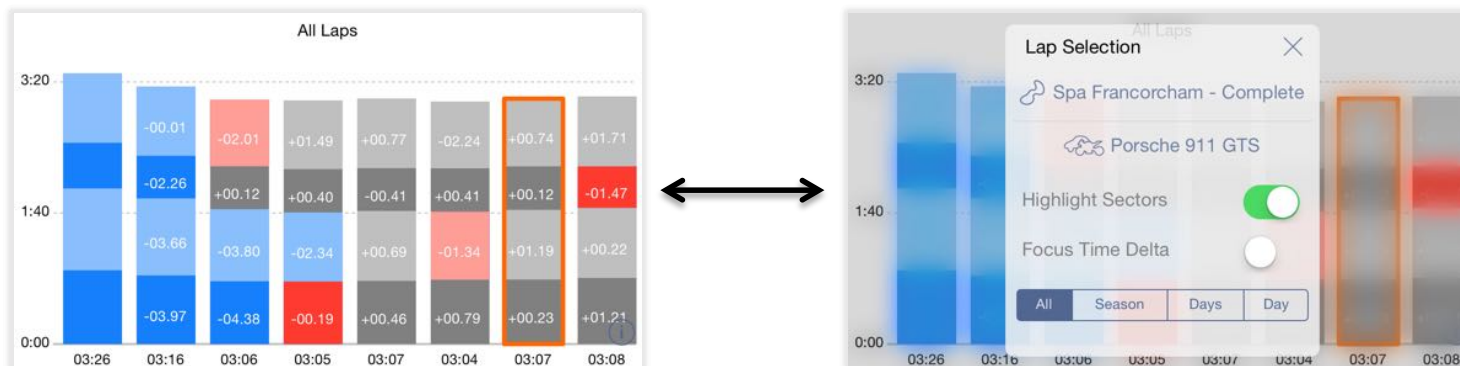
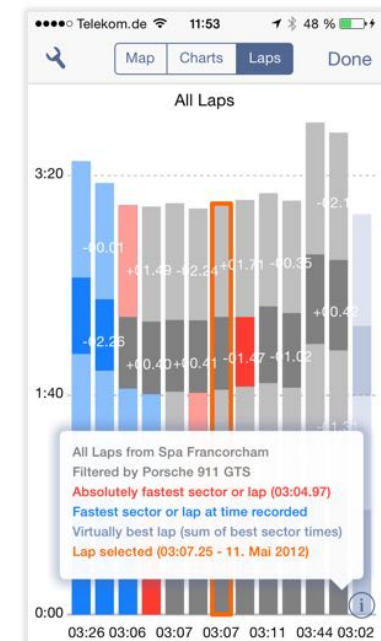


- Line driven GPS
  - Min, max speeds GPS, OBD
  - Speed GPS, OBD
  - Overall, lateral, longitudinal acceleration ACCEL
  - Yaw rate GPS
  - Height GPS
  - Engine rpm OBD
  - Throttle OBD
  - Oil and coolant temperature OBD
- Parameters recorded can be drilled-down, and compared to reference laps
- Select any lap from Lap List and scroll to the **Data Recordings section** to find the options

# Help users to read their data

## Multi lap comparison

- Multi lap comparison is used to understand the general lap and sector time development
- Blue and red are improvement and best times
- Identify areas to improve from sector to sector development and virtual best calculation
- Laps compared can be selected by track, time, and car

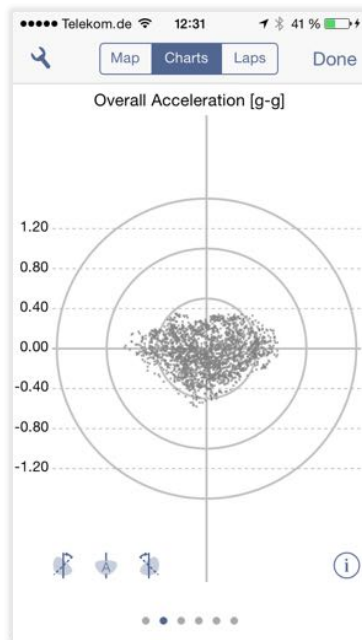


Colors outdated, latest version uses green instead of red for best times / sectors.

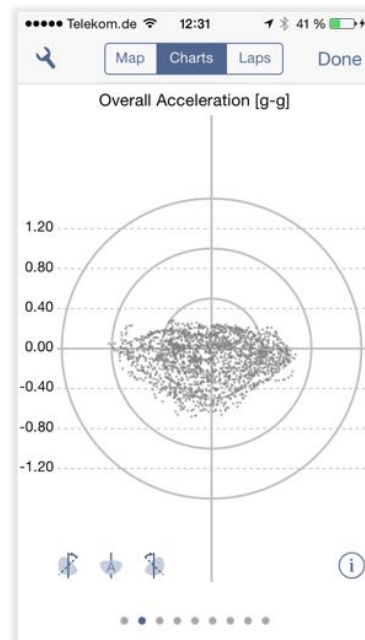
# Help users to read their data

## G-G chart

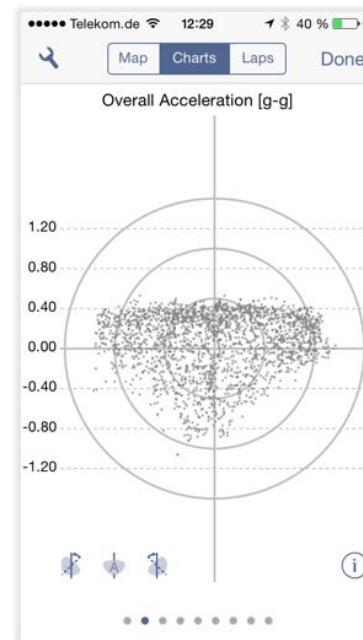
- G-G charts are well suited to understand driver maturity



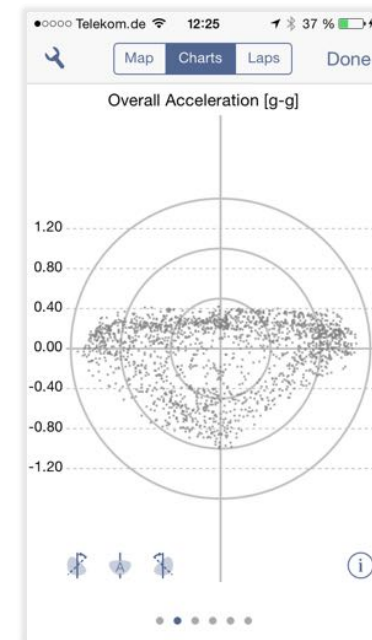
Beginner, **acceleration**  
(except full throttle)  
**potential not used**



Beginner, "**preferred  
cornering**" visible  
(right corners faster)



Advanced, **combined  
lateral / lineal  
acceleration not used**



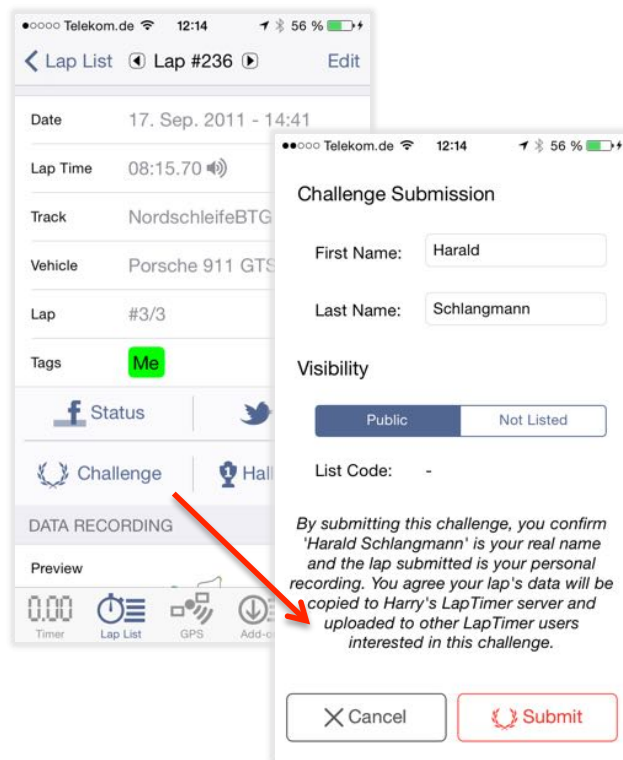
Advanced, **roll phases  
are largely eliminated**  
(limited center dots)

# Help users to read their data

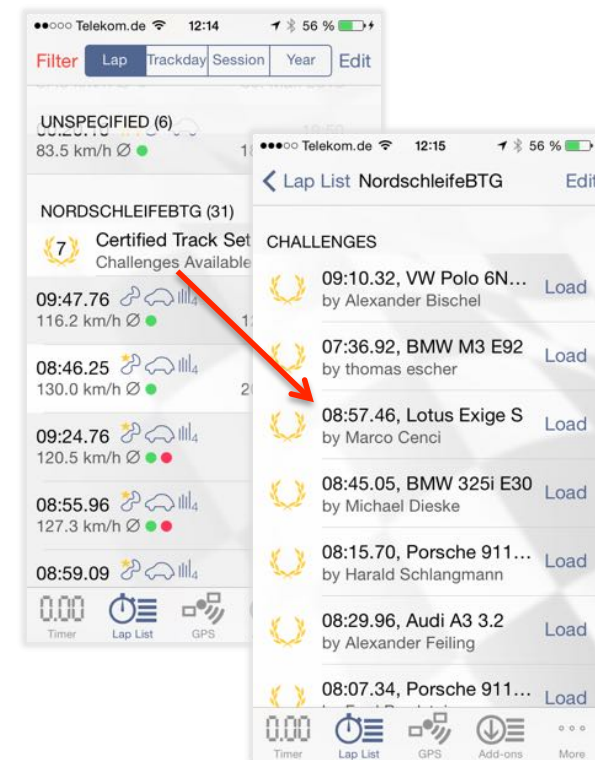
## Challenges

- Challenges allow the exchange of data between drivers
- Using challenges, complete recordings are exchanged

### Upload



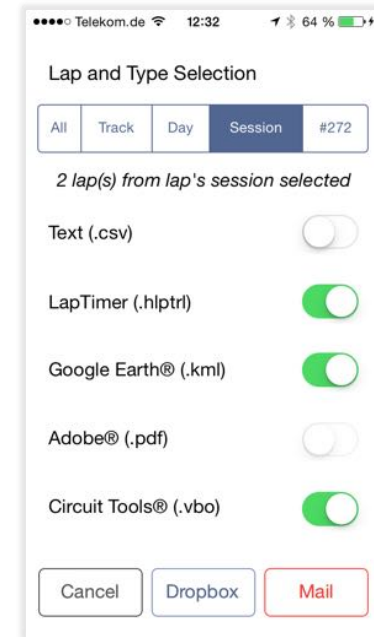
### Download



# Help users to read their data

## Data Export

- Various **data exports** are provided to allow **external analysis**
  - **CSV** is a **versatile** and complete export of all data recorded; use for any post processing and video overlays
  - **HLPTR** is **Lap Timer's own format** and is the only one allowing both export and import; use for data exchange and **backup / restore**
  - **KML** is Google's format displayed in **Google Earth** and Google Maps; Google Earth allows various view selections and drill-downs
  - **VBO (and NMEA)** are **logger formats**; use for Racelogic's Circuit Tools 2 and other desktop analytic tools



# Train the Trainer

## Agenda

- ① Basic concepts of GPS based lap timers
- ② Prepare Lap Timer for operation
- ③ Help users to read their data
- ④ Q&A

# Pilot's Check List

## Summary



*To summarize all critical items mentioned in this presentation, here is the Pilot's Check List to go through before "Take Off":*

- ✓ Make sure the **latest app version** is installed from the stores
- ✓ Always **use a mount and a power supply**
- ✓ Make sure you get **best possible GPS accuracy**
- ✓ Make sure a proper **Track Set** is loaded and conflict free
- ✓ For external sensors, verify they update as expected
- ✓ Make sure **acceleration shows zero** while in the pits
- ✓ Make sure you have **forwarded incoming calls to the box**