

Comparative measurements between the Mindfield eSense Skin Response Sensor and other high quality systems

Repeatedly Mindfield receives various requests for the measurement quality of the Mindfield eSense Skin Response (and Temperature) sensor. Up to now, we could only show that the quality is high and very precise based on experience values, data sheet values and simulations during development. Now we have measured the eSense on one subject in direct comparison with two other, high quality, significantly more expensive systems. In this document, we show the results.

Materials and methods:

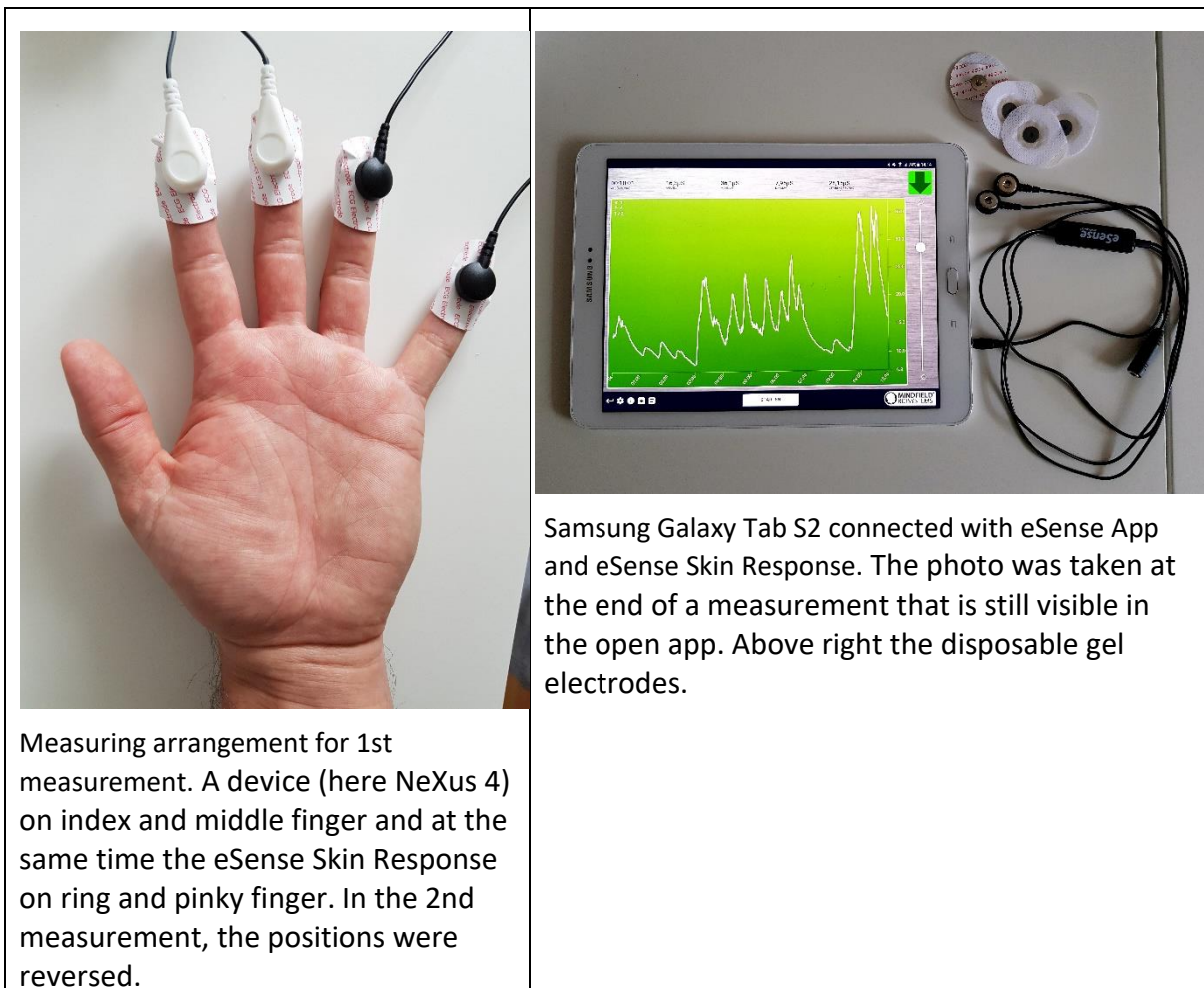
- For measurement with the eSense:
 - Mindfield eSense Skin Response Sensor
 - Samsung Galaxy Tab S2 (SM-T819) with Android 7.0
 - Mindfield eSense App version 2.1.0 from 04/23/2018

- Mind-Media NeXus-4 (4-channel physiological measuring system, Medical CE certified (IIa), FDA registered (II) (www.mindmedia.com))

- Consensys GSR, Shimmer3 GSR System (high quality wearable sensor platform, www.shimmersensing.com)

- disposable gel electrodes
 - Standard hospital accessories
 - fulfils all medical requirements
 - defined, always identical gel quantity
 - exchanged after each measurement
 - available in the Mindfield Online shop in packs of 50 pieces: <https://mindfield-shop.com/de/zubehoer/elektroden/emg-ekg-eda-einwegelektroden-fuer-erwachsene-mit-angenehm-luftdurchlaessigem-stoff-und-vorgegelt-50-stueck.html>

Photos of the devices and the measuring arrangement:



Measuring arrangement for 1st measurement. A device (here NeXus 4) on index and middle finger and at the same time the eSense Skin Response on ring and pinky finger. In the 2nd measurement, the positions were reversed.

Samsung Galaxy Tab S2 connected with eSense App and eSense Skin Response. The photo was taken at the end of a measurement that is still visible in the open app. Above right the disposable gel electrodes.

Measurements:

Four measurements were carried out. Two measurements each with NeXus 4 and eSense in parallel and two measurements each with Shimmer GSR and eSense in parallel.

As shown above, another device and the eSense were always connected to the left hand of the test person. After the first measurement, the electrodes were exchanged for new electrodes and the finger positions were changed. I.e. during the first measurement, the other device was on the index and middle finger, the eSense on the ring and pinky finger, during the second measurement then the other device on the ring and pinky finger and the eSense on the index and middle finger.

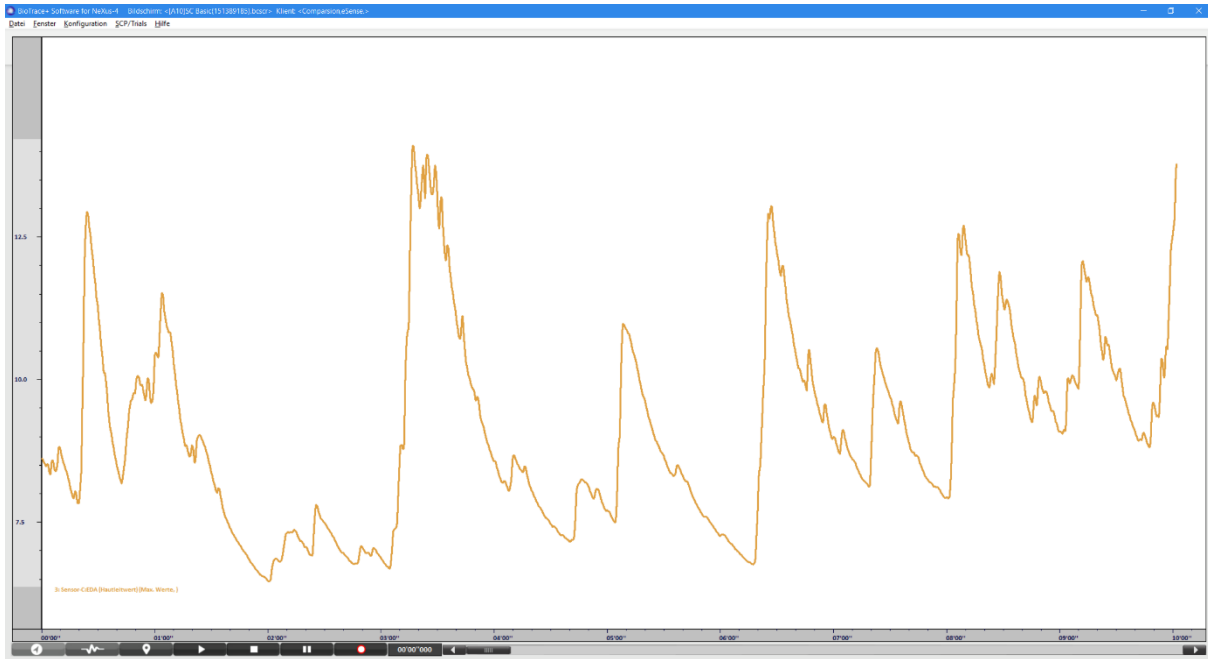
1. Measurement of NeXus 4 and eSense Skin Response

Duration with eSense: 10:05 Duration at NeXus 4: 10:02

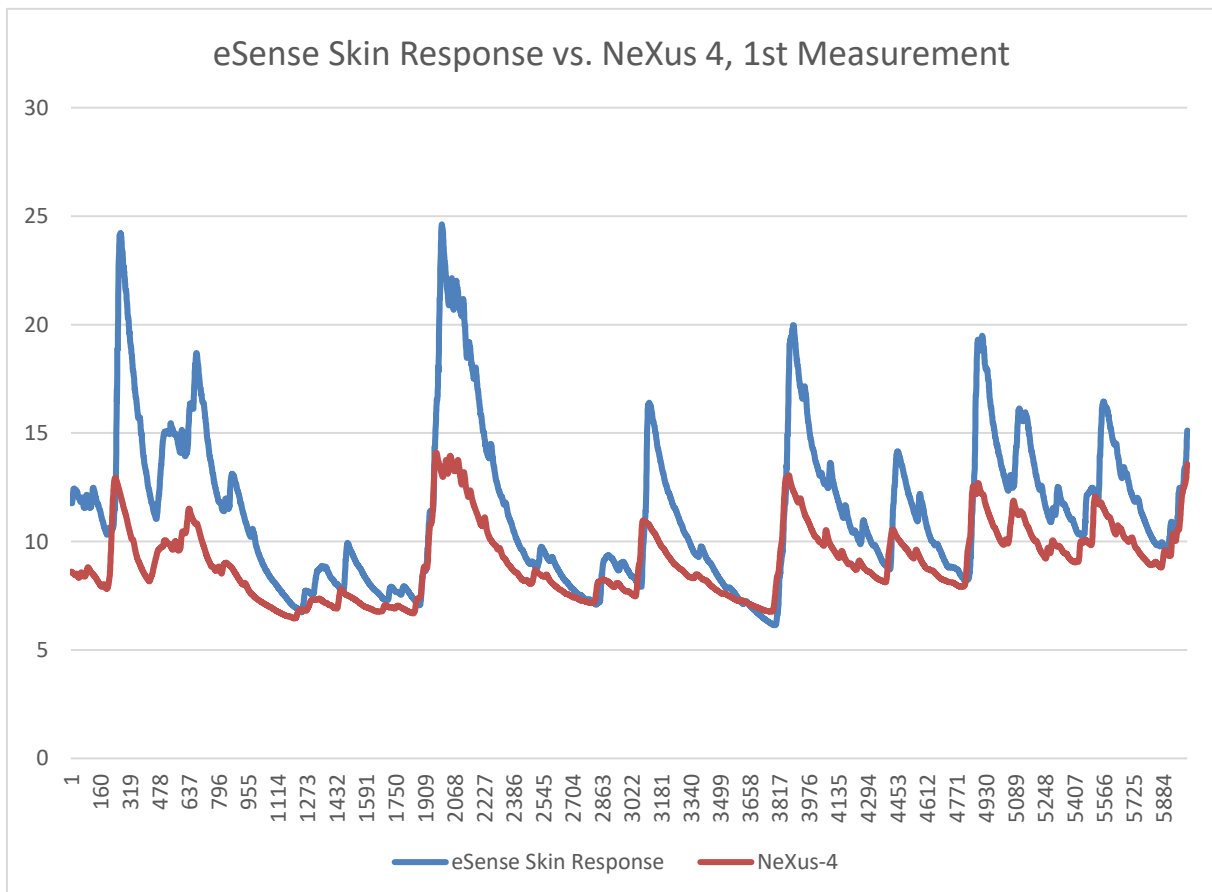
Screenshot of the curve from eSense App:



Screenshot of the curve from NeXus Software (BioTrace V2017A)



Excel diagram by CSV export (10Hz sampling) of the data from the eSense app and from the NeXus software (32Hz sampling, down sampling in Excel to 10Hz), both lines superimposed:



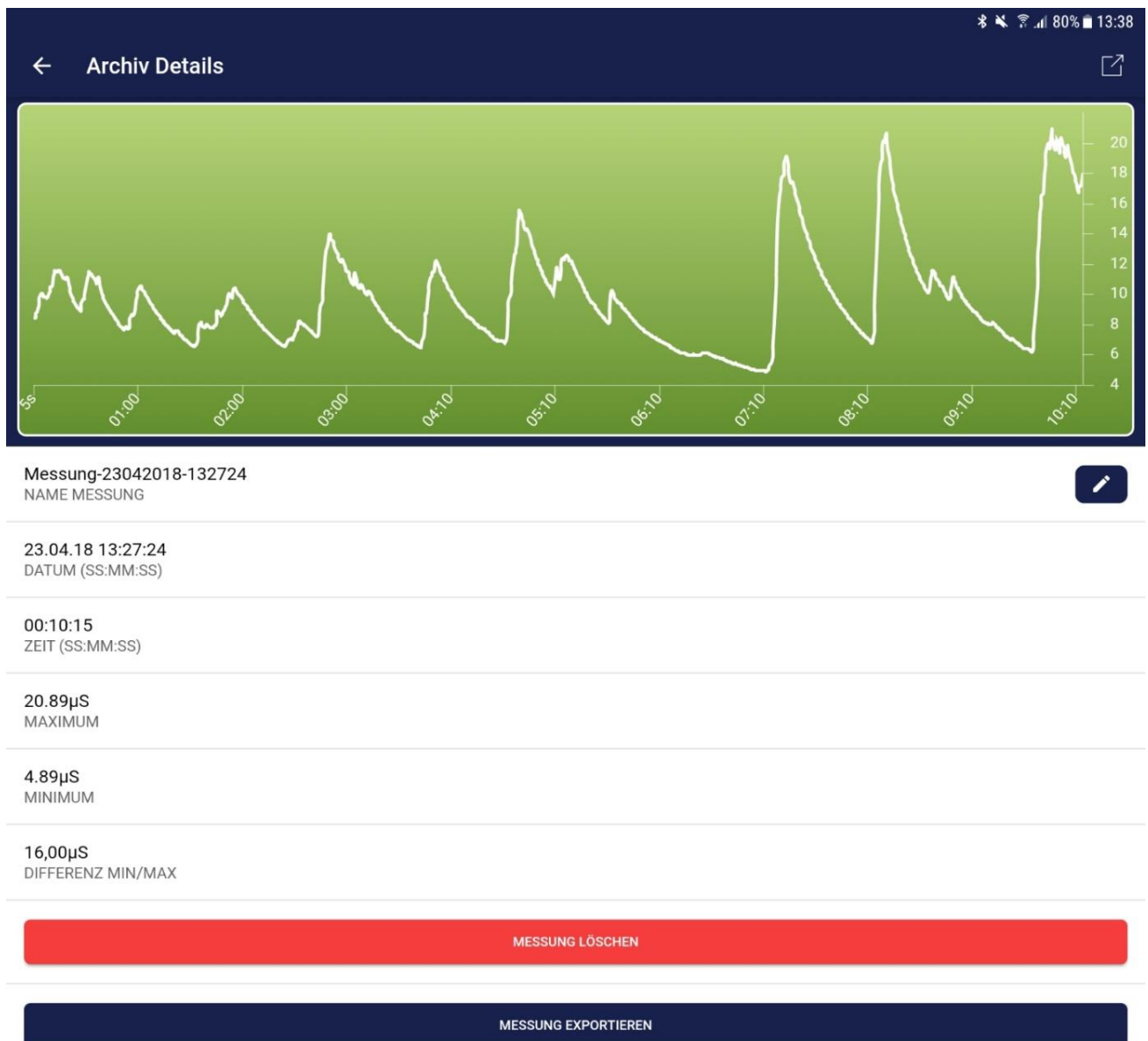
2. Measurement of NeXus 4 and eSense Skin Response

In the second measurement, the eSense Skin Response now was on the index and middle finger, the NeXus-4 on the ring and pinky finger.

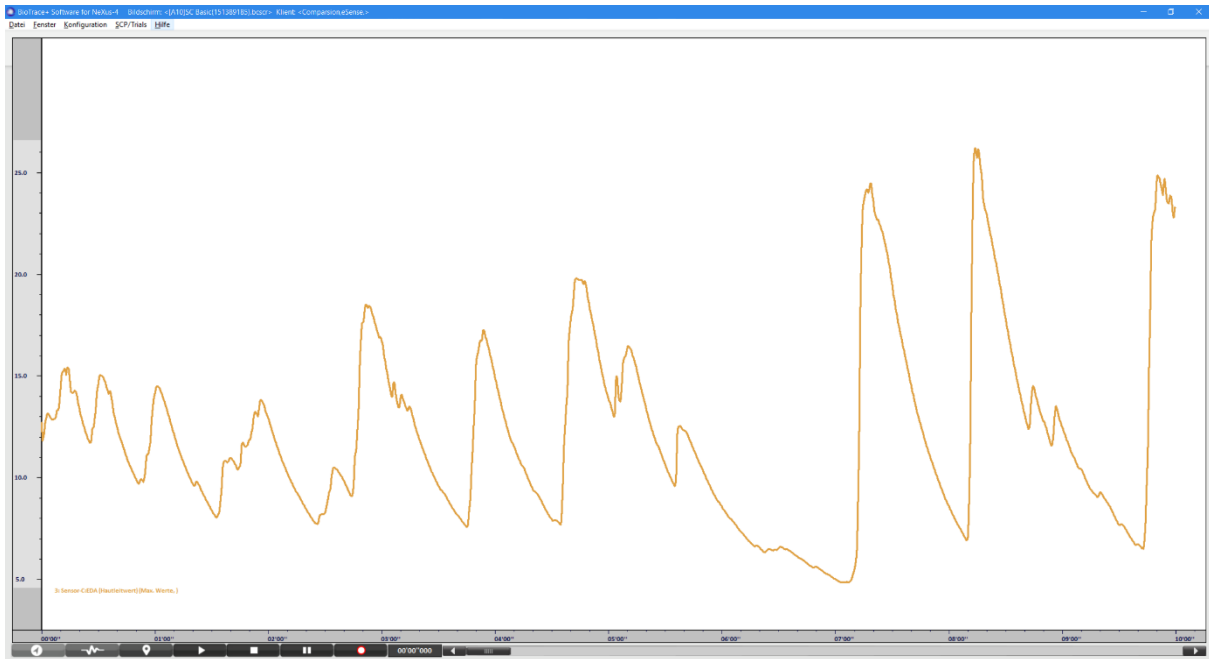
Duration at eSense: 10:15

Duration at NeXus 4: 10:00

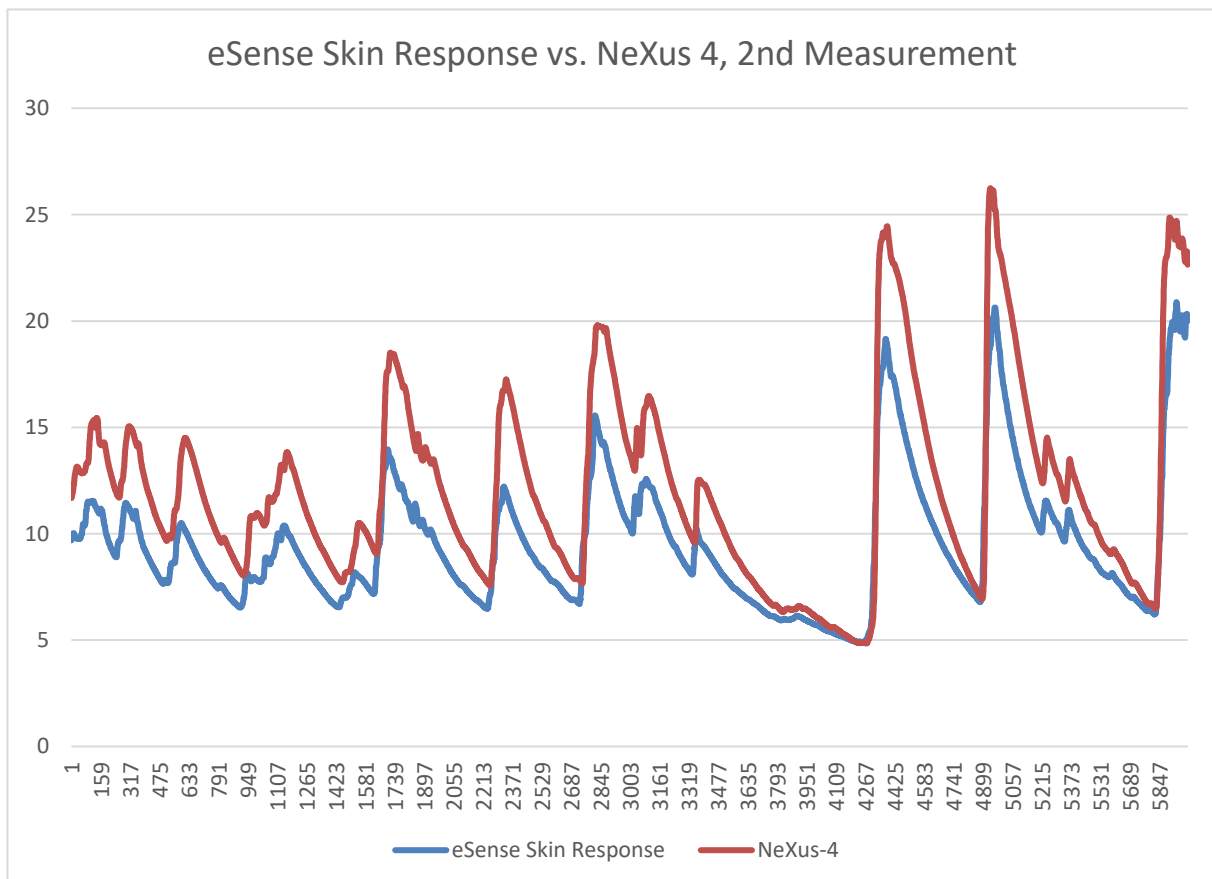
Screenshot of the curve from the eSense App:



Screenshot from the curve of the NeXus Software (BioTrace V2017A)



Excel diagram by CSV export (10Hz sampling) of the data from the eSense app and from the NeXus software (32Hz sampling, downsampling in Excel to 10Hz), both lines superimposed:



If the two measurements are compared, an offset of the curves becomes apparent when the waveform largely matches. The curve of the device, which was attached to the index and middle finger, is always smaller than the curve of the device, which was attached to the ring and pinky finger. A possible explanation for this is a stronger cornification of the index and middle fingers, as these are used more frequently, e.g. when typing on a PC keyboard or holding a pen.

1. Measurement of the Shimmer3 GSR System and eSense Skin Response

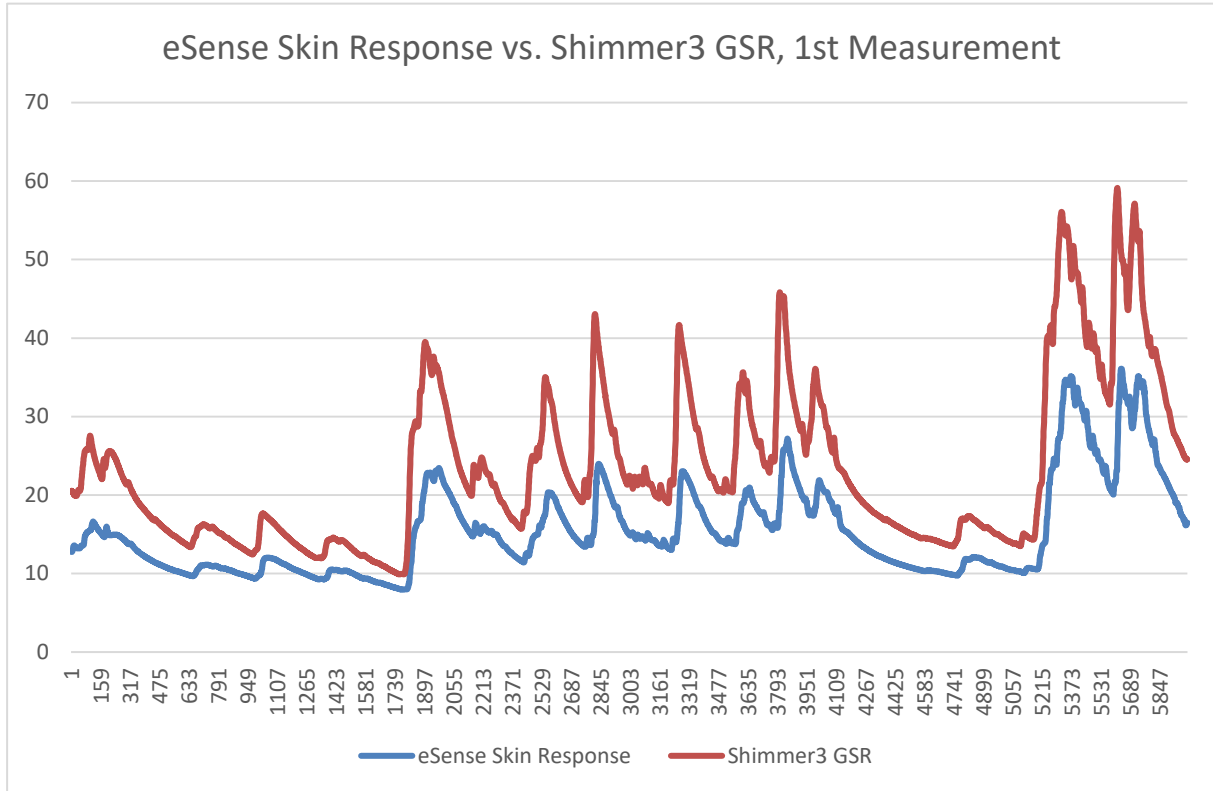
Duration at eSense: 10:01

Duration at Shimmer3 GSR: 10:02

Screenshot of the curve from the eSense App:



Excel diagram by CSV export (10Hz sampling) of the data from the eSense app and from the Consensys Basic software (10Hz sampling), both lines superimposed:

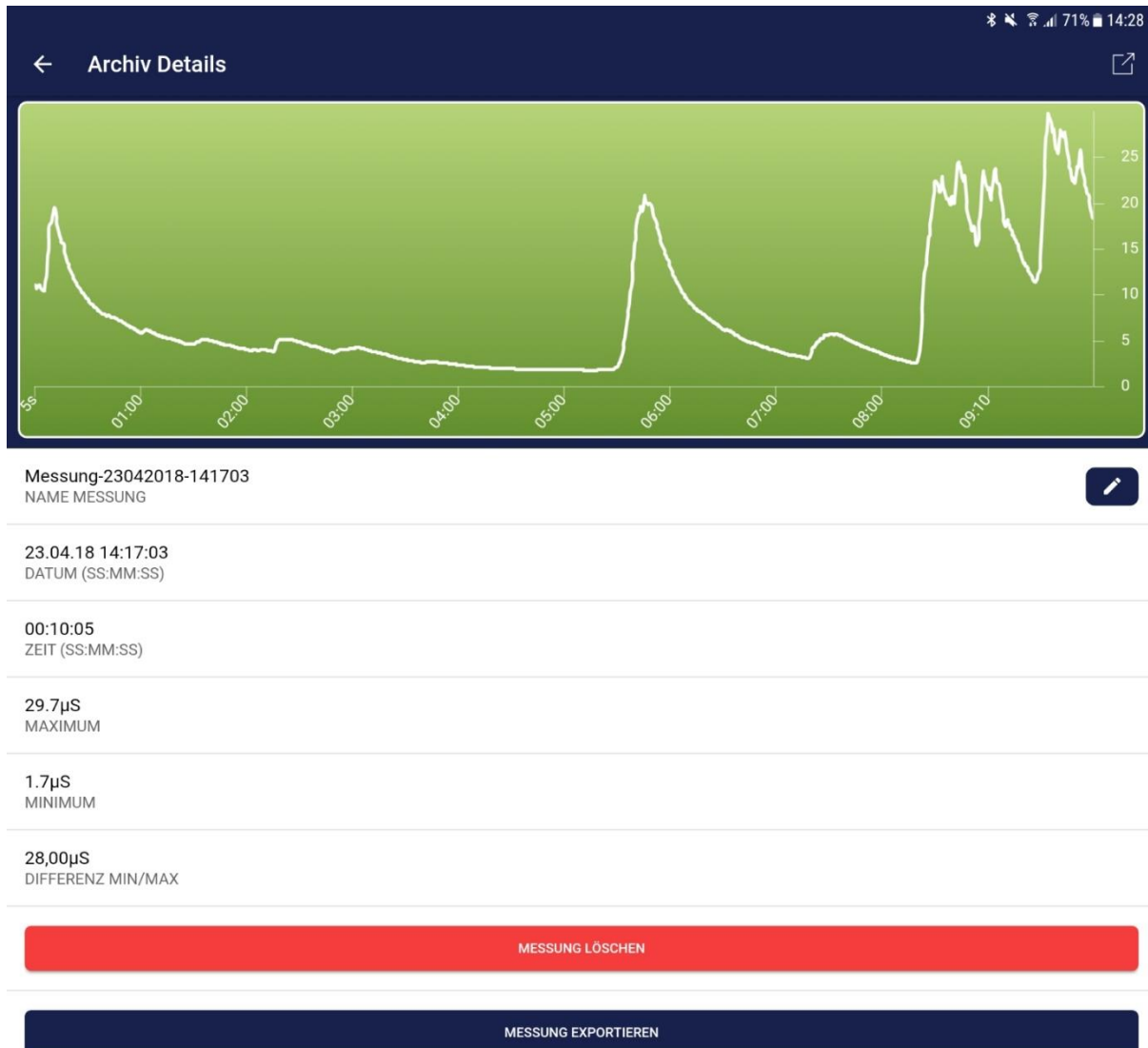


2. Measurement of the Shimmer3 GSR System and eSense Skin Response

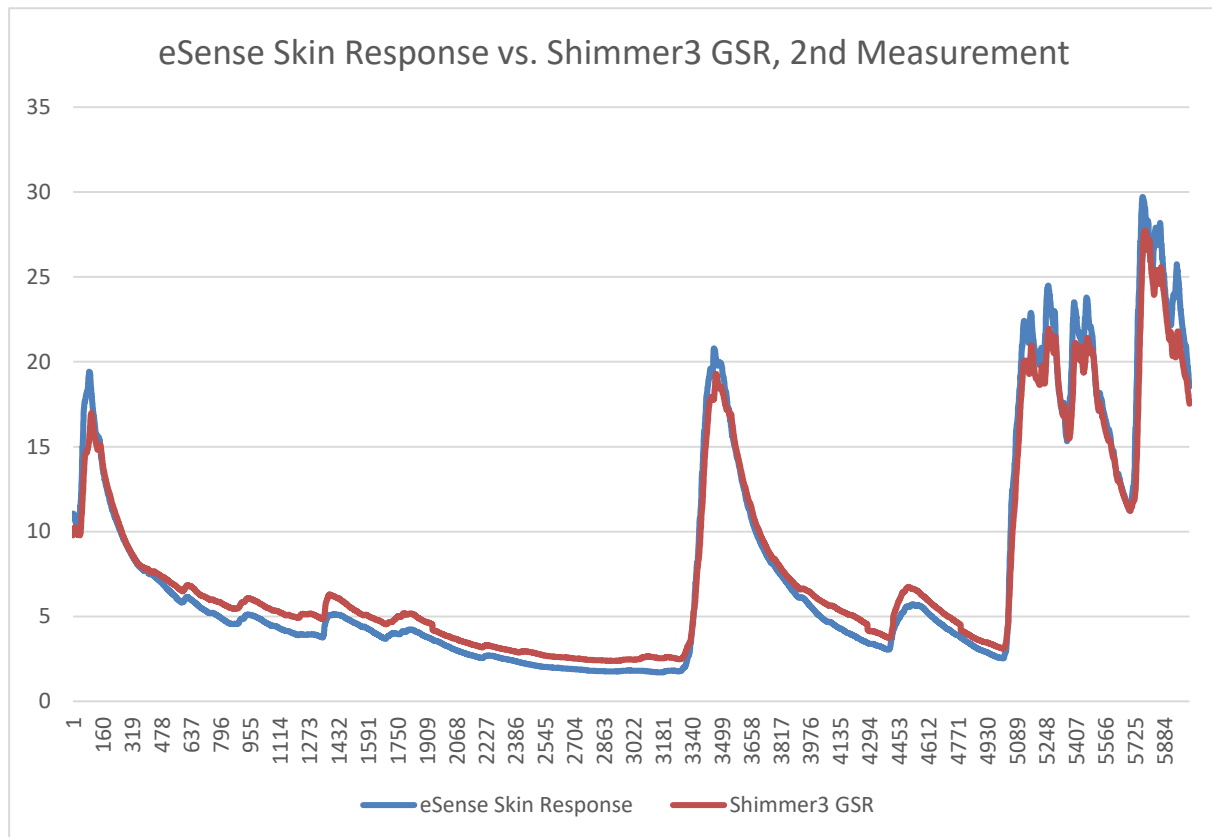
Duration at eSense: 10:01

Duration at Shimmer3 GSR: 10:02

Screenshot of the curve from the eSense App:



Excel diagram by CSV export (10Hz sampling) of the data from the eSense app and from the Consensus Basic software (10Hz sampling), both lines superimposed:



If the two measurements are compared, an offset of the curves is also noticeable if the waveform largely corresponds. In this case, deviating from the comparison measurements to the NeXus-4, the first measurement shows a larger amplitude of the Shimmer3 GSR, although this was attached to the index and ring finger. Here it is noticeable that this measurement had higher values than all other measurements. In the second measurement, on the other hand, the curves are almost identical and the measured values are lower. The offset from eSense to Shimmer3 GSR seems to be lower the smaller the measured values are.

Conclusion:

The comparison measurements show that the absolute amplitude (scaling) of the measured values depends on many factors such as device, measuring method, electrode position and condition and the complex resistance system of the skin. However, it is clear to see that changes in the skin conductance of all systems are accurately and comparably mapped and that the eSense does not have to fear comparison with significantly more expensive systems in terms of its precision. Thus, the eSense fulfils its purpose to enable an optimal biofeedback training and is quite suitable for scientific studies.