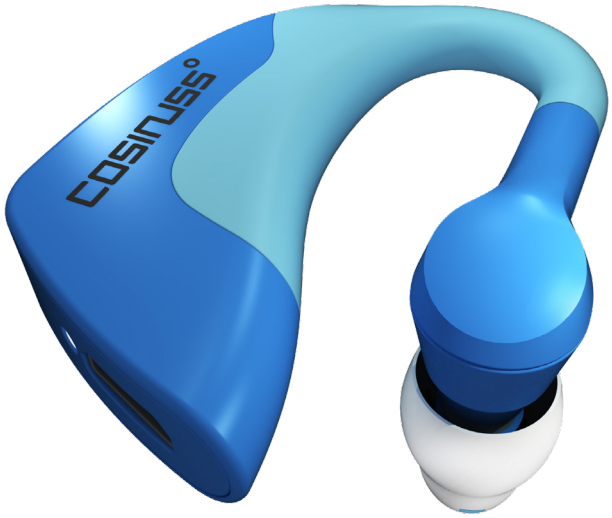

cosinuss°

cosinuss° Engages EBV to Develop a Wearable IoT Device to Monitor Vital Signs

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If you are in a need to monitor your heart activity for many hours, until now the choice was limited to wearing a chest strap, wrist or Holter monitors. Each had their pros and cons for measurement accuracy and convenience of wearing. Plus, if you would like to add the body temperature monitoring too, you would have to wear a second device.

To solve this, the innovative idea that Dr Johannes Kreuzer researched in his doctoral work was based on designing a small size device, convenient to be worn by people different ages, that accurately measured heart rate activity and body temperature. This has resulted in developing a patent-pending earconnect™ technology and an in-ear wearable – cosinuss° device.

"I am measuring my heart rate and even body temperature without being cramped by a chest strap."

Jan Frodeno, Ironman World Champion

CHALLENGES

- **To offer an alternative solution to the chest strap, which is more convenient to wear for longer periods of time without compromising data accuracy.** Chest straps are considered more accurate in measuring heart rate activity vs wrist monitors. Yet they are inconvenient to wear.
- **To provide body temperature monitoring in the same device.** In addition to heart rate, body temperature provides valuable insights to optimise fitness levels and training programs. Changes in body temperature also indicate potential health issues (for instance the ones related to metabolic rate, which can further result in weight gain). Having a device for measuring both these vital signs is ideal for fitness and health monitoring purposes.

SOLUTION

- **Using new technology to measure vital signs via ears.** Earconnect™ technology captures pulse rate, heart rate variability, body temperature and oxygen saturation in the blood. All via sensors in a device conveniently worn in an ear.
- **The algorithms to measure and calibrate vital signs run on the device and data can also be transferred to the cosinuss cloud solution to improve the data accuracy.** This two-step process helps to calibrate the interpretation of sensor values and enhance the accuracy of the device. Users also have a historical overview of their activity to support trainings or give a basis for a consultation with the medical specialist if needed.

TECHNOLOGY & BUSINESS OUTCOMES

- **Measurements accuracy with no straps.** Accurate optical heart rate and body temperature measurement has been achieved at the same precise level as an electrical one.
- **Small size.** The team with support of EBV Elektronik and their guidance on hardware components, designed the smallest and lightest heart rate monitor worldwide.
- **Device compatibility.** cosinuss° One device is compatible with various sportwatches, bike computers and smartphones. A user can use either a Cosinuss App or any other fitness app.
- **Excellent acceptance in sports and fitness community.** Jan Frodeno and Anja Beranek, well-known Ironman world champions, have been successfully using cosinuss° One for their trainings and are acting as brand ambassadors. Earlier in 2017, another partnership has started – the F-1 teams are now using the earconnect™ technology to monitor pulse, heart variability, body temperature and accelerating power of their pilots.
- **Compelling user case for further implementation in healthcare, medical market.** Being convenient and easy to wear, the natural step for the cosinuss° team will be to address the medical market next. Johannes and his team are involved in an “EPITect” project to identify ways their product can support detecting epileptic signs for the patients.

ABOUT COSINUSS°

Founded in 2011 by Dr. Johannes and Greta Kreuzer, cosinuss° resulted from the doctoral thesis work done by Dr. Johannes Kreuzer on mobile vital sign monitoring with an in-ear device. With special algorithms and the latest technology, the team built the cosinuss° One device. It is an in-ear wearable that continuously measures vital signs like heart rate, heart rate variability and body temperature – all without a need of a chest strap. This application is ideal for both professional athletes and fitness enthusiasts.

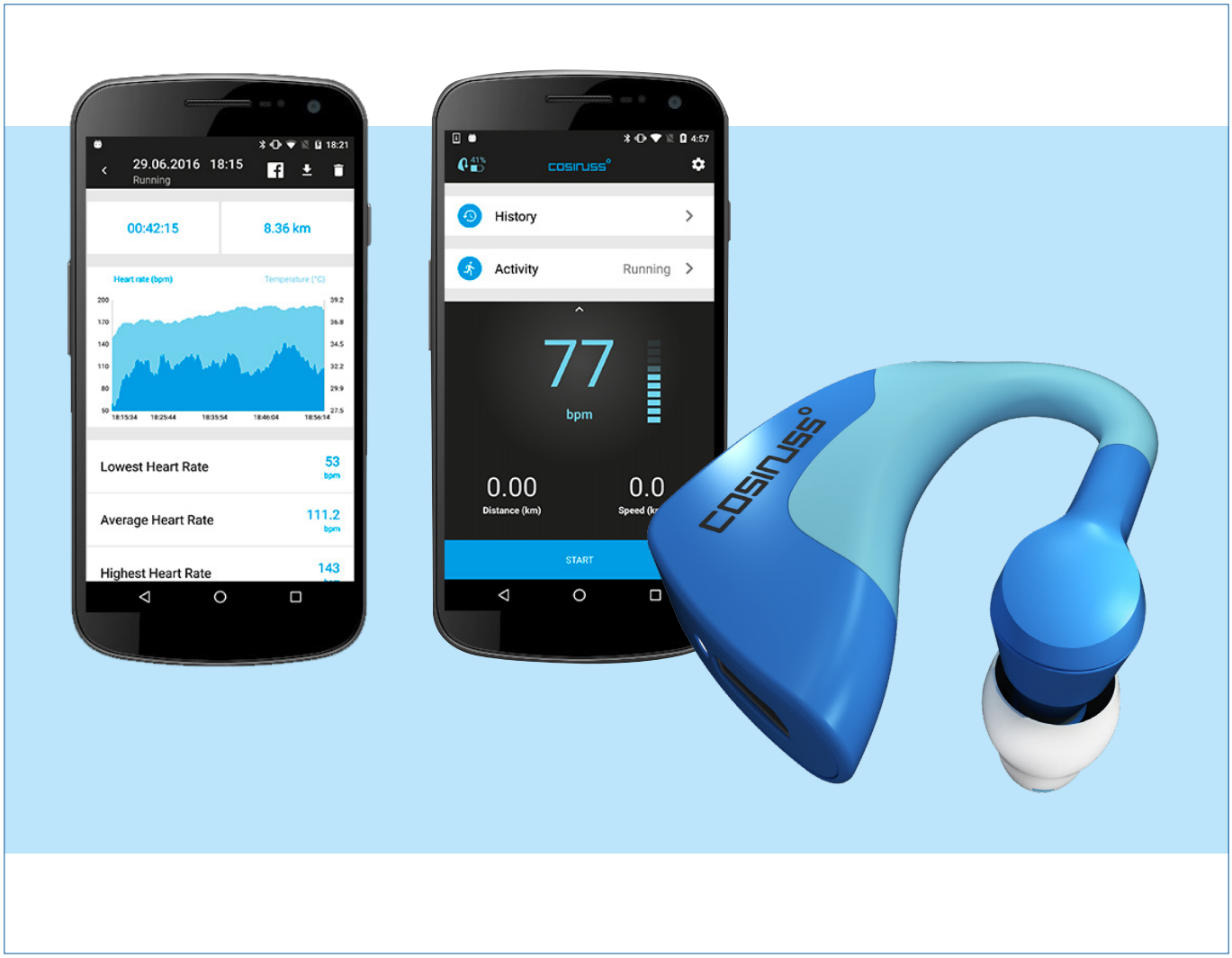
COSINUSS° ONE FOR PRECISE HEART RATE AND TEMPERATURE MONITORING

The cosinuss° One is an in-ear wearable that accurately measures heart rate, heart rate variability, core body temperature and arterial oxygen saturation of the blood continuously and accurately from within the ear canal. It is small, light-weight, non-intrusive and convenient to use.

Data generated from the device is wireless sent to any Bluetooth or ANT+ compatible phones or smart watches. Data is visualised using either cosinuss° One App or 3rd party apps like Garmin.

By combining heart rate data with body temperature athletes can optimise performance and fitness levels. Function and wear comfort were extensively tested by athletes from different disciplines.

cosinuss° One devices are in production and can be purchased directly from their website or retail outlets like Amazon.



HOW COSINUSS° ONE WORKS

Using cosinuss' developed patent-pending earconnect™ technology, vital signs in the human external auditory canal are measured. earconnect™ employs intelligent algorithms that accurately measure pulse rate from optical data generated using an LED and a photodiode. The body temperature is detected with a resistance temperature sensor. The sensor data is digitised and wirelessly sent to smartphones or sports watches via Bluetooth or ANT+. Data can be visualized and monitored via the cosinuss° app or other 3rd party apps. Another feature of the new cosinuss° One App is the capability to perform over-the-air updates. This keeps the software and the algorithms in the device always up-to-date. Key semiconductor components in the cosinuss° One wearable include a Bluetooth and ANT+ SoC, photodiode, LED, accelerometer, and an analog front-end.

Data gathered by the cosinuss° One App is stored locally on the mobile phone. For special purposes data is sent to a private cloud database for refining algorithms, enhancing measurement accuracy, and developing pattern recognition mechanisms. Insights gathered by analysing this data is used to inform the user with ways to optimise training and fitness levels and provide early warning signals on health issues.

DESIGN CHALLENGES FOR COSINUSS°

1. Go-to-market approach
Taking an idea and creating a market and demand are challenging – especially in the start-up environment where resources are limited and a short time-to-market is a key success factor.

Design choices, business models and customer acquisition approaches had to be considered and adjusted to ensure the product gains market acceptance. cosinuss° had to decide if the product should be sold to consumers directly or to other businesses, whether to add the capability to play audio, should the device be medical grade with the right compliance and certification standards. Making these choices requires a solid understanding of the constantly evolving wearables and consumer markets, visibility into new technologies and standards, and expert guidance.

2. Progressing a product from prototype to production
Designing a commercial-ready product involves skills in hardware and software engineering, industrial design, manufacturing, supply chain and product lifecycle management. Acquiring these skills or hiring consultants requires money, time and effort. Having a trusted advisor

and finding the right partners who can help manage and guide through this process has a big influence on the overall success of the business.

3. Minimising power consumption
cosinuss° One had to consume the least battery power so users can wear for many hours continuously or not require charging often. Selecting low-power components, optimising software and ensuring optimal power design were key in achieving long battery life for a single charge (cosinuss° operates for up to 8 hours non-stop, and only requires an hour to charge).

4. Maintaining a small form-factor
The size and weight of the product had to be small to keep it comfortable during wear. Picking small form-factor components to designing PCBs with tight space requirements posed a considerable challenge. Signal quality, interference and other noise issues had to be minimal to ensure sensing accuracy was not affected.

BENEFITS OF PARTNERING WITH EBV

Markus Vogt, the Director of Healthcare Segment at EBV first met the cosinuss° team at a connected Health Forum in Munich in 2011 year. From the first meeting, Markus was engaged with cosinuss° on several fronts. His extensive knowledge in the healthcare, wearables and start up markets made him the ideal candidate to advice cosinuss° on various approaches to the business model and go-to-market strategies. "We had several discussions with Johannes about their go-to-market approach. In the end, we agreed that the solution with their own B2C platform is the best to start with", said Markus. By being involved from the early stages, Markus could contribute to the direction of the company strategy and product definition.

Markus guided the cosinuss° team to focus on the high-end consumer segment instead of creating a medical-grade device, which involves a greater risk due to FDA compliance certifications and much longer product development time. "The requirements are totally different. That's why we chose to concentrate first on the consumer sector – because the market is simply faster. The switch to the medical sector will then happen at a later stage" said Dr. Johannes Kreuzer. By focusing on the consumer segment, the cosinuss° team can directly engage customers through many channels including their online store, 3rd party retailers like Amazon, bike stores, and even the kickstarter program for their in-ear thermometer product for children – the degree°.

On the hardware front, EBV helped identify components for the entire signal chain that met power, cost, size and accuracy requirements. EBV was also instrumental in educating the cosinuss° team on various methods to minimize power consumption via microcontroller settings. Further, the EBV team was proactive in providing updates on latest product releases and roadmaps, and educated the cosinuss° team on technology trends and emerging standards. "EBV helped us a lot in finding the right components for our very special requirements. They also showed us where the manufacture's

Markus Vogt, Director Healthcare Segment, EBV Elektronik

road map will go to, which is important to know for the next product generation" said Dr. Johannes Kreuzer. This unbiased technology advice enabled cosinuss° engineers make the right design choices to meet current requirements and future-proof the product for enhancements. EBV introduced cosinuss° to local and regional EMS partners so the product can be built in Europe.

Another benefit with the EBV partnership is the opportunity to engage the big ecosystem and network that Markus built in the healthcare and wearables segment. EBV introduced cosinuss° to other healthcare/wearables companies interested in the technology built by cosinuss°. In addition, cosinuss° was featured in EBV's "TQ for Wearables" magazine and both companies agreed to partner at various industry events and trade shows. Such activities help raise the cosinuss° brand and increase product awareness in the wearables market.

COSINUSS° CUSTOMER TESTIMONIALS

"Since the beginning, I always had to wear a chest strap during training for pulse measurement. Now that's not necessary anymore, and with the small sensor in the ear, it's much more precise. And in addition to pulse, the wearable even continuously measures body temperature. We'll use these additional measurements as important parameters for analysis in the future, and thereby optimize training and competition. That's because even in extreme heat, body temperature has a direct influence on performance"

Jan Frodeno, Olympic Champion and Triathelete

REFERENCES AND PRESS RELATED TO COSINUSS°

https://www.kickstarter.com/projects/690312019/degree-continuous-in-ear-thermometer-for-children?ref=category_newest

ebv.com/tq

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