# ULTEEMNite – Ultra-long-term EEG Monitoring during Sleep

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*The ULTEEMNite device aims to provide physicians with objective sleep and seizure information collected over ultra-long-term time periods, i.e., weeks to months. Such information will help to significantly improve and personalize treatment of epilepsy. A successful implementation of the solution into the clinical workflow is expected to shorten the part of the patient journey, where patients need to try different drugs and dosages to find the most effective treatment for seizure control and sleep stabilization. In addition to the epilepsy use case, the ULTEEMNite device holds great potential for applications where tracking of the macro- and microstructure of sleep is required.*

Electroencephalography (EEG) is accepted as the gold standard method for diagnosis, monitoring, and treatment follow-up of common neurological disorders, notably epilepsy and sleep disorders. In the context of epilepsy, the clinical practice to adjust epilepsy treatment strongly relies on patients' oral and written reports ("epilepsy diaries") during repetitive clinic visits including short EEG recordings. These two sources of information have known drawbacks: seizure counting by patients is generally inaccurate, particularly missing the nocturnal seizures during sleep and short EEG recordings on-site only give a snapshot of the patient's situation and fail to provide trends. Consequently, the physician has to make decisions based on incomplete or even false information. Objective seizure and sleep information recorded over ultra-long-term periods is therefore expected to help optimize and personalize epilepsy therapy. However, clinical grade EEG systems are bulky for ultra long-term use and consumer grade gadgets are not accurate enough for medical purposes. The ULTEEMNite project aims to address this unmet need by developing a medical-grade and user-friendly wearable device that can be worn during the night to collect EEG signals.

Conceptually and practically, ULTEEMNite functions as a complementary device to its day-use version, the ULTEEM eyeglasses [1]. Two devices combined, 24-hour monitoring of generalized epileptic seizures becomes possible. When this around-the-clock approach is combined with ultra-long-term monitoring the clinicians will receive information, which they have never had the chance to obtain before with non-invasive devices. We anticipate an immediate improvement on personalized medication regime as a result of providing objective seizure counting, particularly nocturnal ones, as they mostly remain undocumented in the epilepsy diaries. The ULTEEMNite project builds upon a successful collaboration between CSEM and Schlaf-Wach-Epilepsie-Zentrum (SWEZ)/NeuroTec. In 2020, to address the unmet medical need of reliable ultra long-term EEG monitoring, a project (ULTEEM) funded by the European Space Agency (ESA) and CSEM had been launched. The pilot study using the device developed by CSEM had been performed by the team of Prof. Schindler and yielded highly promising results [2].

The ULTEEMNite device consists of 3 electronic units: one central and two sensor units (Figure 1 top). Having a washable and even disposable headband combined with a disinfectable housing addresses the important practical need to be able to use the device on multiple patients. The largest part of the system, the central unit, is placed in the middle of the forehead to enable the patients to comfortably sleep on their back or on their sides (Figure 1 bottom). Different head circumferences are addressed with an adjustable soft fixation system at the back of the head and different headband sizes. Importantly, the ULTEEMNite device is equipped with active dry electrodes and achieves high quality physiological signal acquisition thanks to CSEM's patented technology. The device has rechargeable batteries, an on-board memory allowing more than 16 hours of continuous data recording and a Bluetooth Low Energy module for live data streaming. A tablet or a smartphone is used to visualize the streamed data.


*Figure 1: (top) ULTEEMNite device to monitor electric brain signals during sleep. (bottom) ULTEEMNite worn during sleep on the forehead.*

ULTEEMNite measures 1-lead frontal EEG, which contains rich information including sleep spindles and K-complexes (Figure 2) that help to assess different sleep stages.

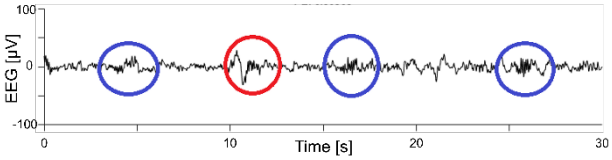


*Figure 2: Sleep spindles (blue circles) and K-complex (red circle) recorded by ULTEEMNite and annotated by expert neurologists of the SWEZ, Inselspital.*

A clinical study to evaluate the signal quality of ULTEEMNite has recently been completed at the Inselspital, Bern. Data analysis comparing ULTEEMNite data against reference EEG data is on-going. This work was partially funded by the Canton of Bern. CSEM is thankful for their support.

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[1] https://www.csem.ch/en/news/ulteem-ultra-long-term-eeg-monitoring

[2] K. Schindler, *et al*. "NeuroTec Sitem-Insel Bern: Closing the Last Mile in Neurology" Clin. Transl. Neurosci. 5 (2021) 13