

Interictal epileptiform discharges show multidien cycles in ultra long-term subcutaneous EEG

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Key Points

- Multidien cycles of interictal epileptiform discharges can be found and tracked with ultra long-term subcutaneous EEG.
- The period of the cycles were between five and 15 days. Longer cycles may possibly be observed with longer recording times.

Introduction

- Research during the last decade has revived the scientific interest of multidien cycles of epileptiform activity in people with epilepsy (PWE)**.
- The surge in interest was led by observations in data from intracranial devices demonstrating cycles of interictal activity and their coupling to seizures.
- Here we investigated if multidien cycles of interictal epileptiform discharges (IEDs) could be measured objectively and directly using a minimally invasive device recording ultra long-term EEG.

Methods

- A subset of five PWE were selected from the MTLE study* with a recording length of approx. three months each.
- Inclusion criteria were: observed IEDs and a device adherence above 50%.
- IEDs were found using an automatic algorithm.
- A Lomb-Scargle periodogram of the IED rate was computed for each PWE (e.g., Figure 1) along with the false alarm probability (FAP) for the most prominent peak. The maximum period equaled the data length divided by 5.
- FAP is the probability that a signal with no periodic component would lead to a peak of similar amplitude and a cycle was present if the FAP was beneath 0.01.

Results

- Multidien IED cycles were found for four out of five PWE (e.g., Table 1). A representative cycle is demonstrated in Figure 2.
- The period of the cycles (i.e., time between two cycle peaks) were between five and 15 days.
- More data is necessary to test for near-monthly cycles.

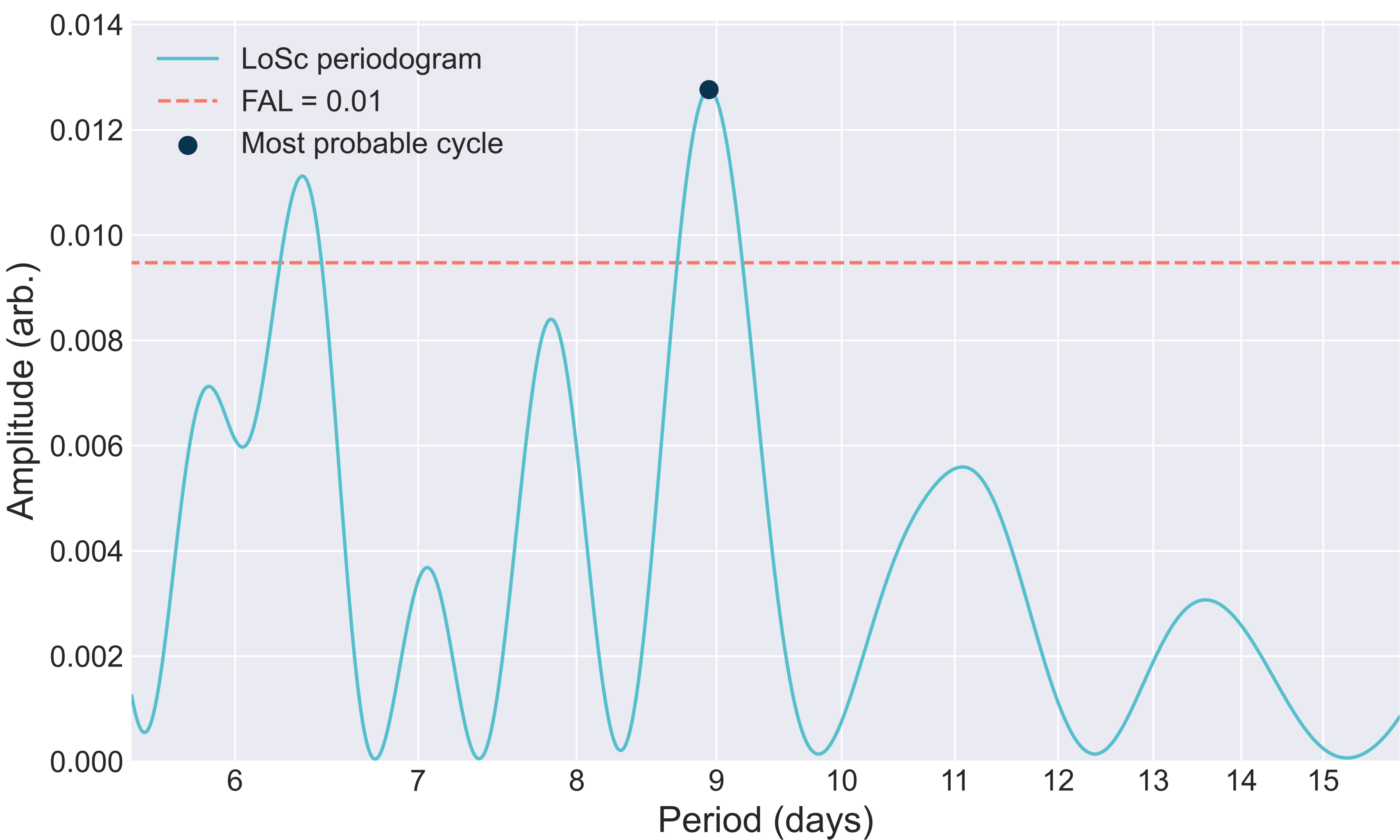


Figure 1. Lomb-Scargle periodogram of the interictal epileptiform discharges for PWE B, indicating that the most probable seizure cycle has a period length of nine days. The blue line shows the Lomb-Scargle periodogram. The rosa line indicates the false alarm level (FAL) corresponding to a false alarm probability of 0.01 (note that the FAP of the most prominent peak is lower – see Table 1). The dark blue dot is placed at the highest peak indicative of the most probable cycle. The x-axis is logarithmic.

PWE	Adherence	Most probable cycle	FAP
B	77%	9 d	$< 0.1 * 10^{-5}$
D	70%	15 d	$< 0.1 * 10^{-10}$
E	63%	No cycle	N/A
G	81%	5 d	< 0.001
I	71%	12 d	$< 0.1 * 10^{-5}$

Table 1. Results of the Lomb-Scargle periodogram analysis. Multidien IED cycles were found in data from the four PWE with the highest device adherence.

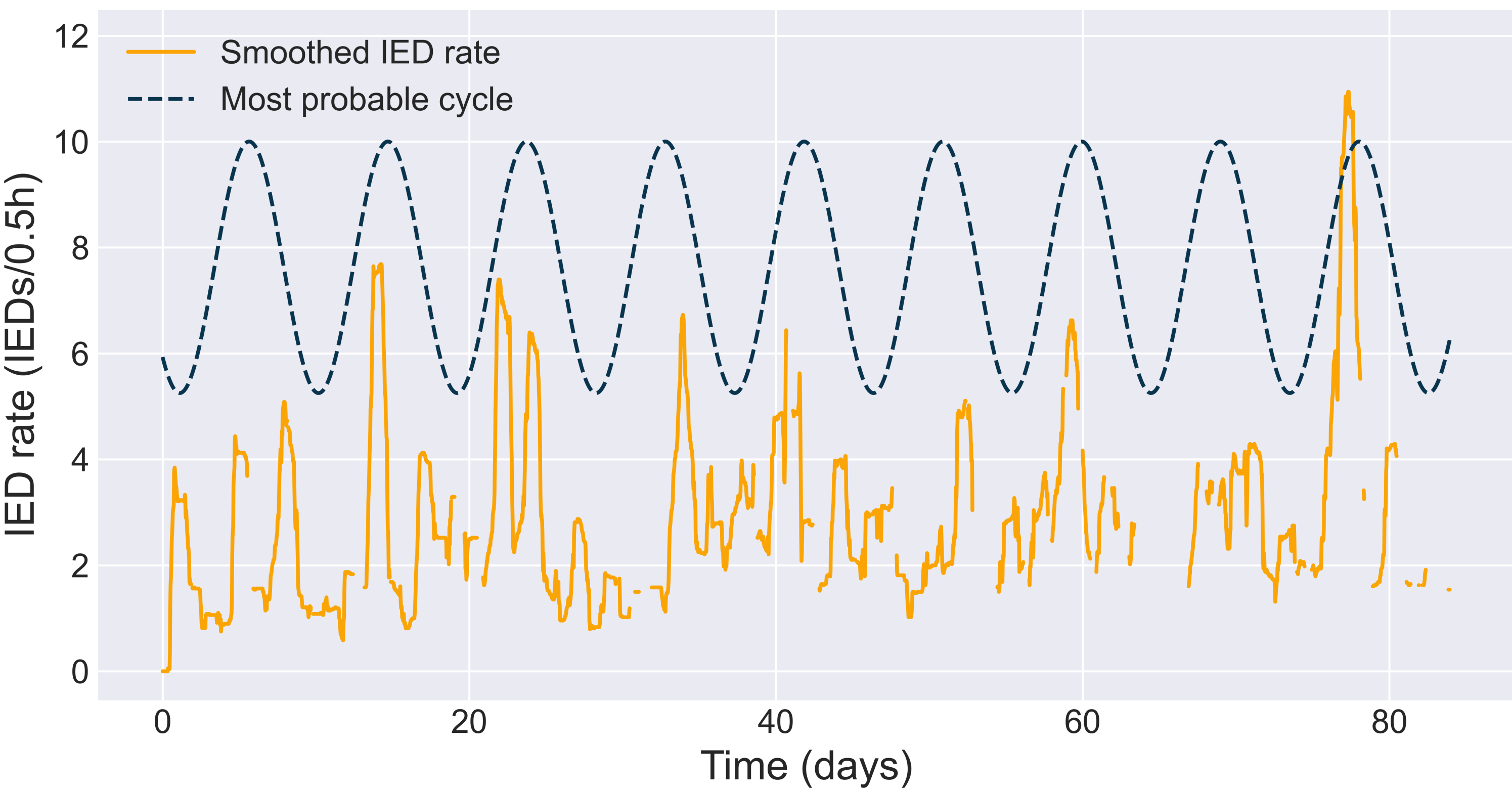


Figure 2. Best fit between the most probable cycle length of interictal epileptiform discharges (IEDs) and the rate of IEDs for PWE B. The orange graph is the smoothed IED rate over time and the dark blue graph is a fitted sinusoid with the period length set to nine days equal to the most probable cycle length found in Figure 1.

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** Karoly, P. J., Rao, V. R., Gregg, N. M., Worrell, G. A., Bernard, C., Cook, M. J., & Baud, M. O. (2021). Cycles in epilepsy. Nature Reviews Neurology, Nature Reviews Neurology,