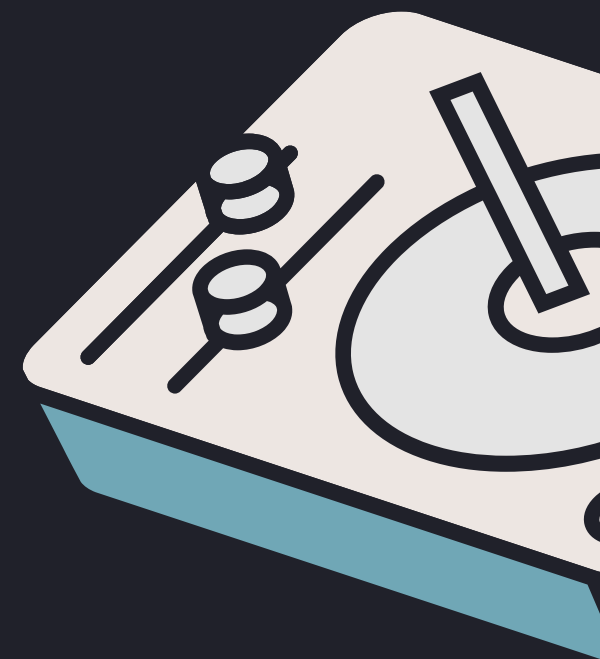


PRZETWARZANIE I ANALIZA DŹWIĘKÓW

z wykorzystaniem
transformaty Fouriera

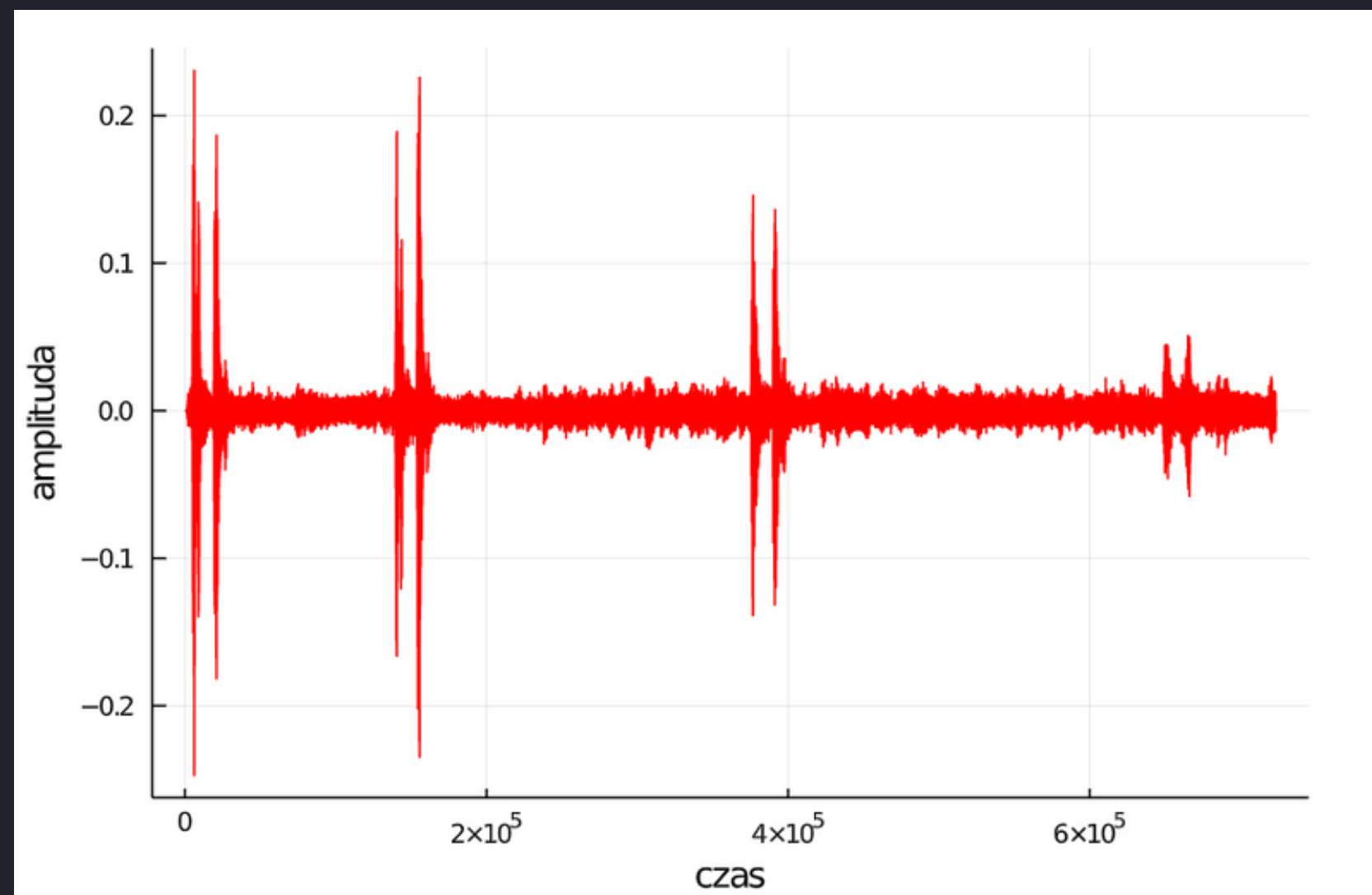


Dyskretna Transformata Fouriera [DFT]

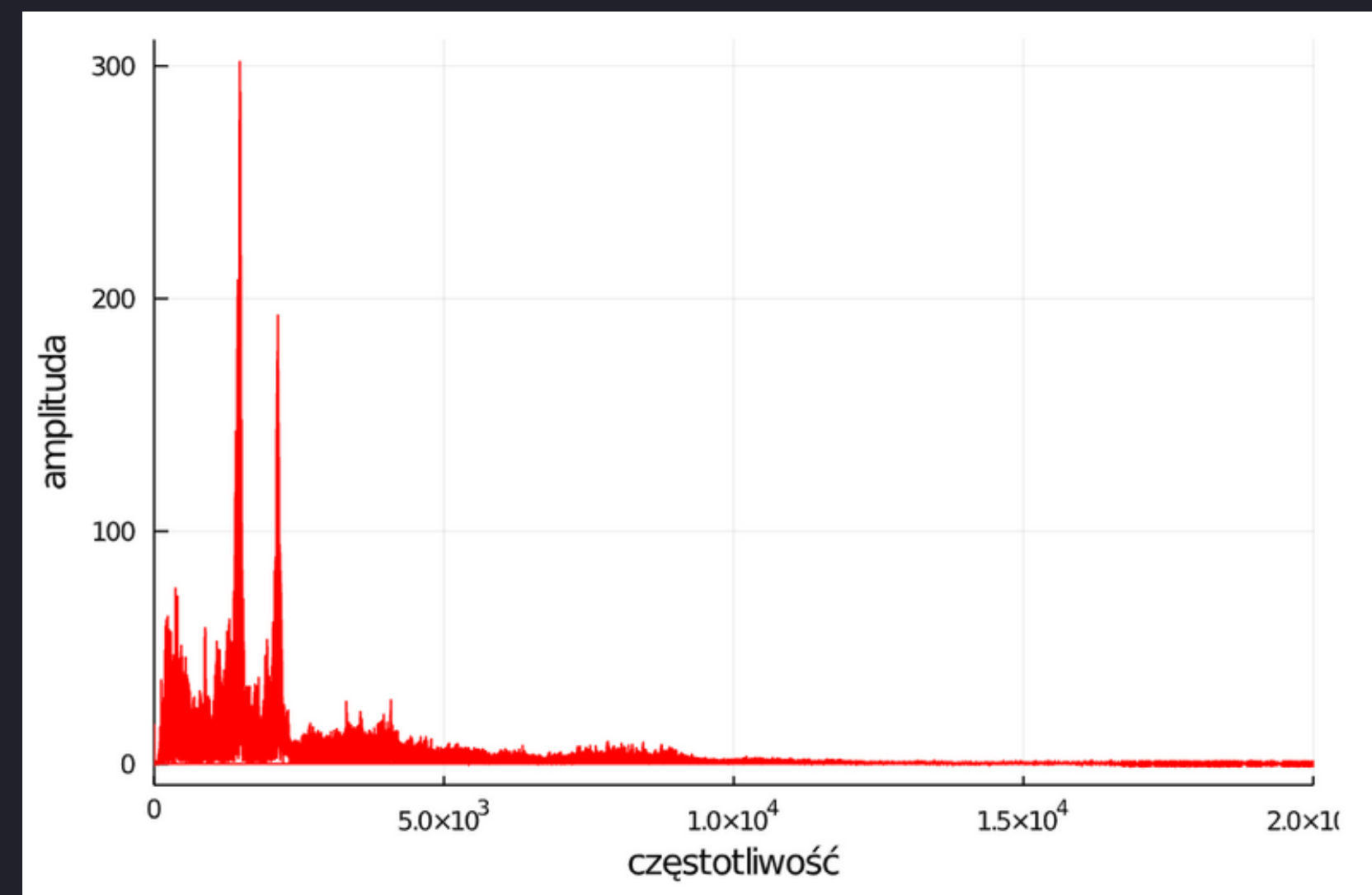
$$X_k = \sum_{n=0}^{N-1} x_n \cdot e^{-i2\pi kn/N}$$



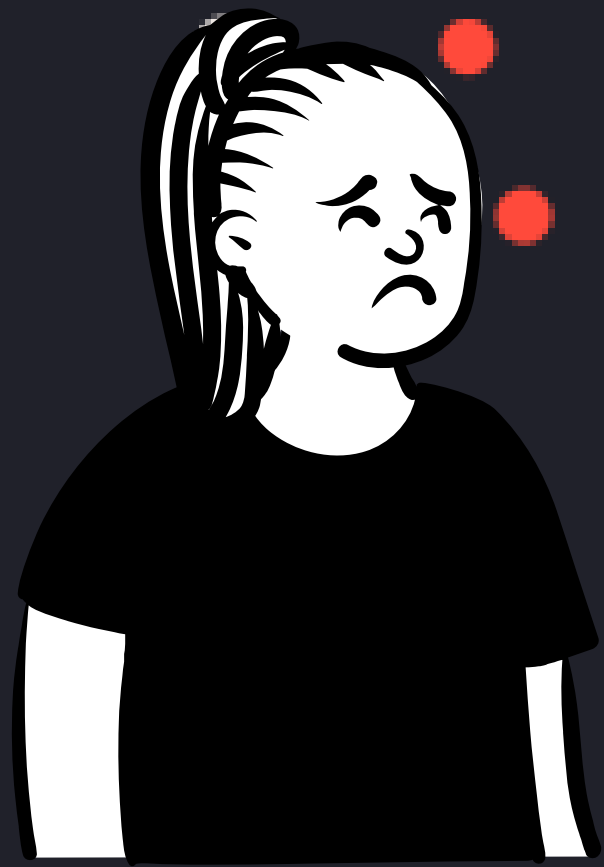
Mamy



Chcemy

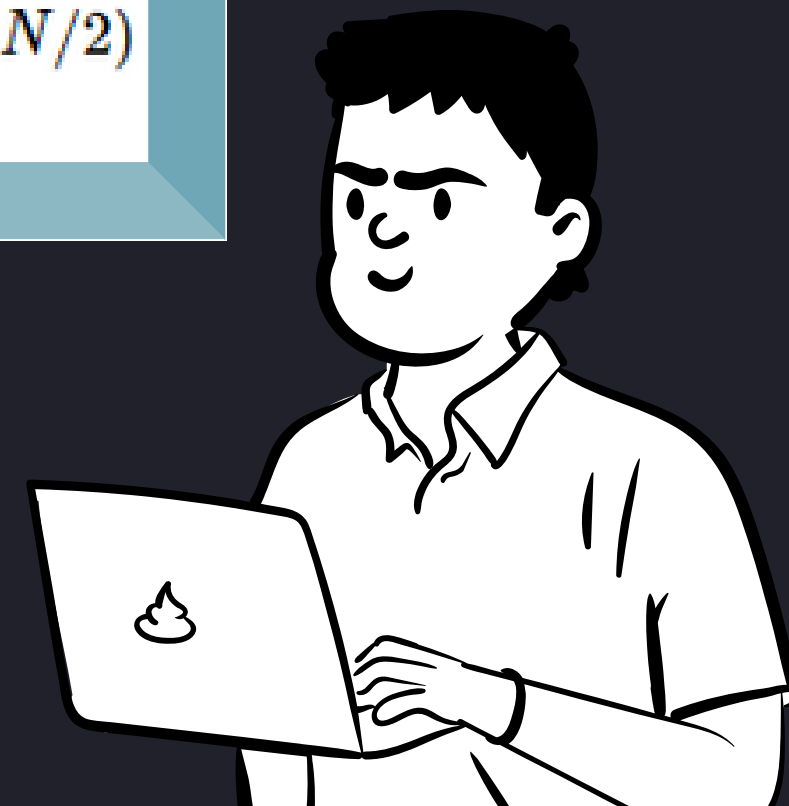
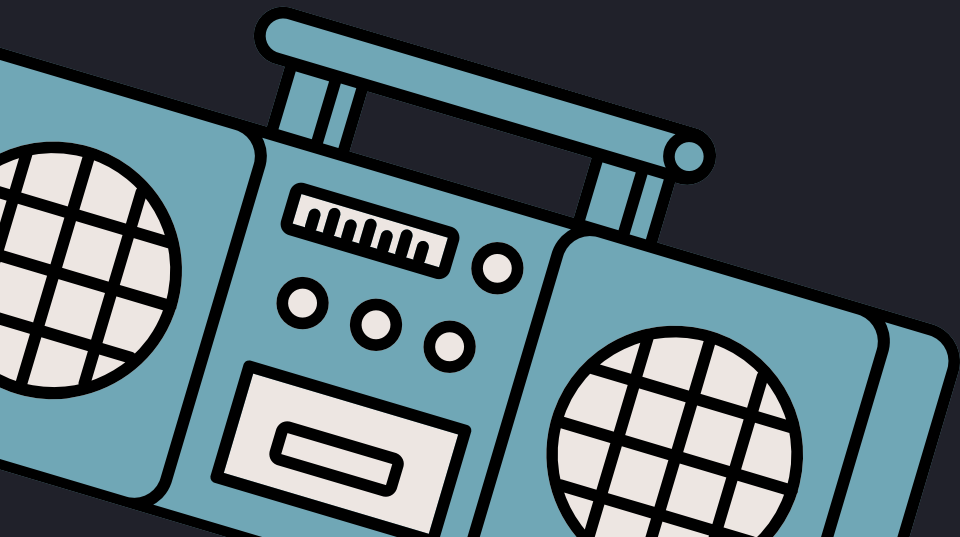


**Dyskretna Transformata nie daje
jednak rady na rzeczywistych
nagraniach**



FFT - Algorytm Cooleya-Tukeya

$$\begin{aligned} X_k &= \sum_{n=0}^{N-1} x_n \cdot e^{-i 2\pi k n / N} \\ &= \sum_{m=0}^{N/2-1} x_{2m} \cdot e^{-i 2\pi k (2m) / N} + \sum_{m=0}^{N/2-1} x_{2m+1} \cdot e^{-i 2\pi k (2m+1) / N} \\ &= \sum_{m=0}^{N/2-1} x_{2m} \cdot e^{-i 2\pi k m / (N/2)} + e^{-i 2\pi k / N} \sum_{m=0}^{N/2-1} x_{2m+1} \cdot e^{-i 2\pi k m / (N/2)} \end{aligned}$$



Porównanie czasów

Długość	DFT	Nasze FFT	FFTW
16	0,000011 s.	0,000039 s.	0,000069 s.
20021	1,413017 s.	0,031262 s.	0,014466 s.
194688	329,5816 s.	0,230134 s.	0,033141 s.
405504	---	0,947576 s.	0.046260 s.
1024^2	---	0,599275 s.	0,064808 s.
804349	---	1,019822 s.	0,140973 s.

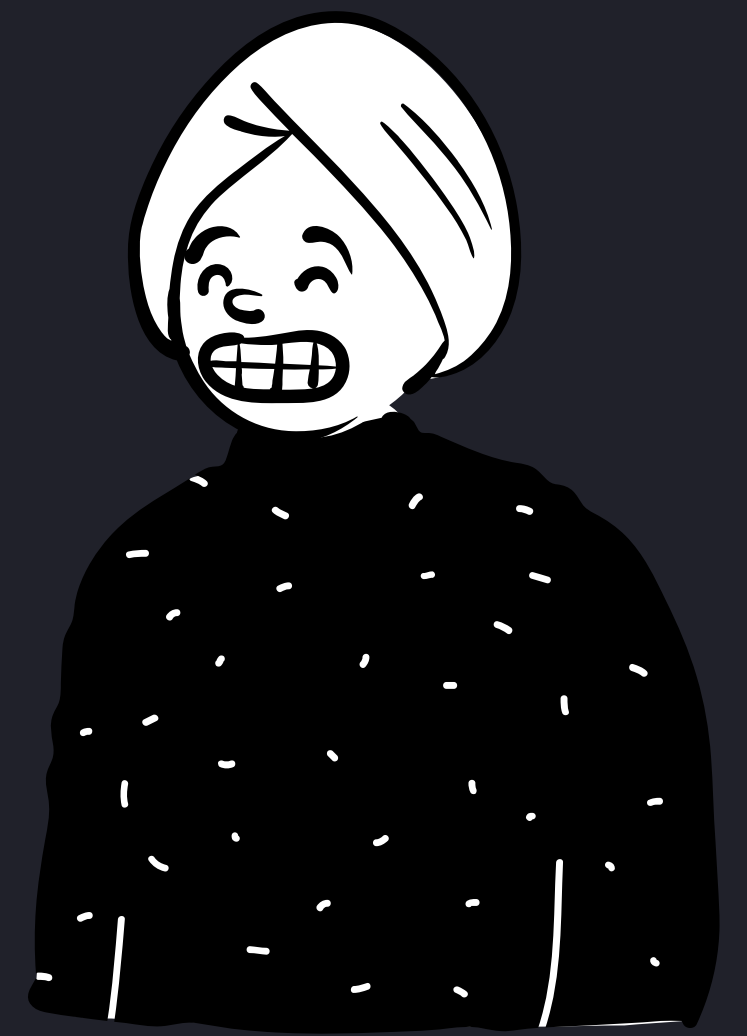


**Potrzeba jednak też czegoś w
drugą stronę!**



Odwrotna Dyskretna Transformata Fouriera

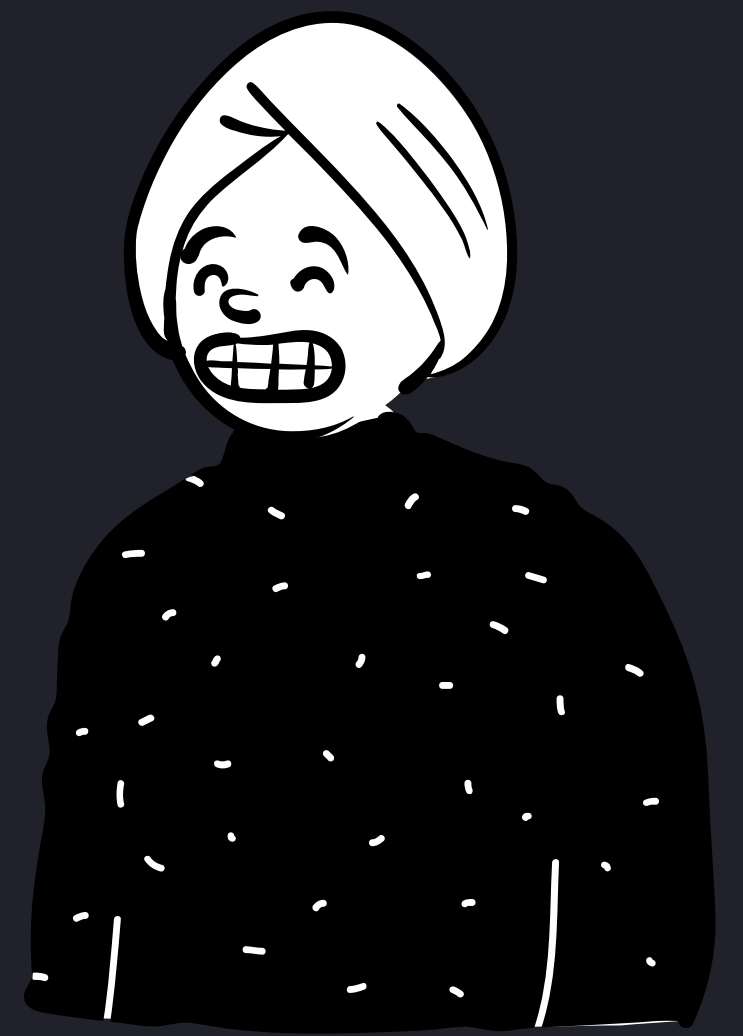
$$x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k \cdot e^{i2\pi kn/N}$$



Odwrotna Dyskretna Transformata Fouriera

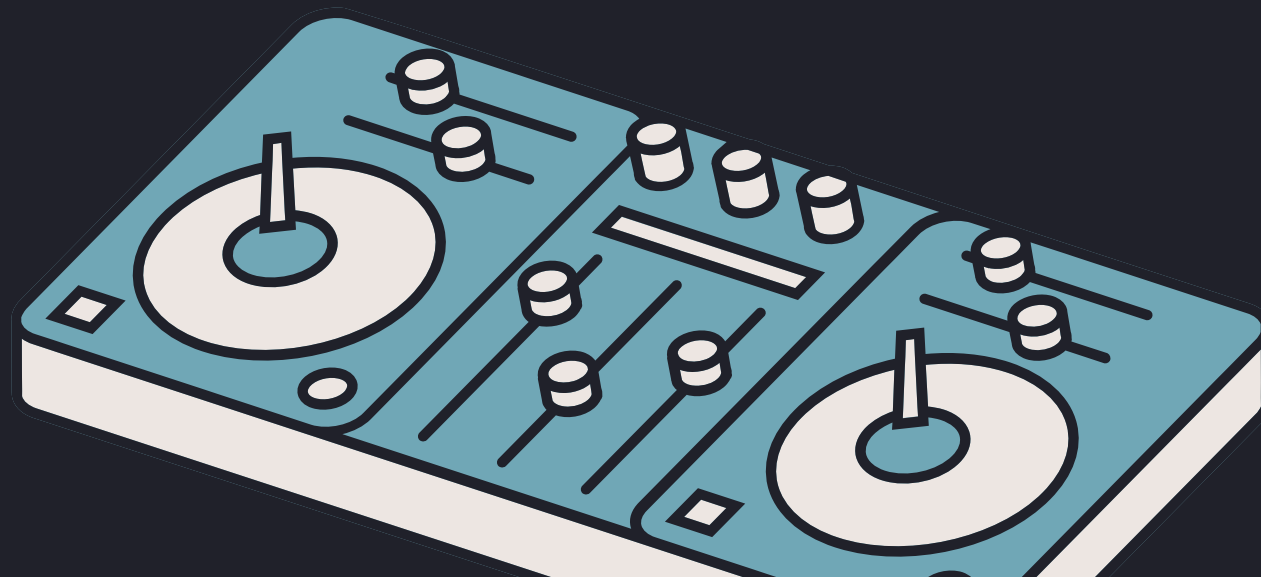
$$x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k \cdot e^{i2\pi kn/N}$$

$$X_k = \sum_{n=0}^{N-1} x_n \cdot e^{-i2\pi kn/N}$$

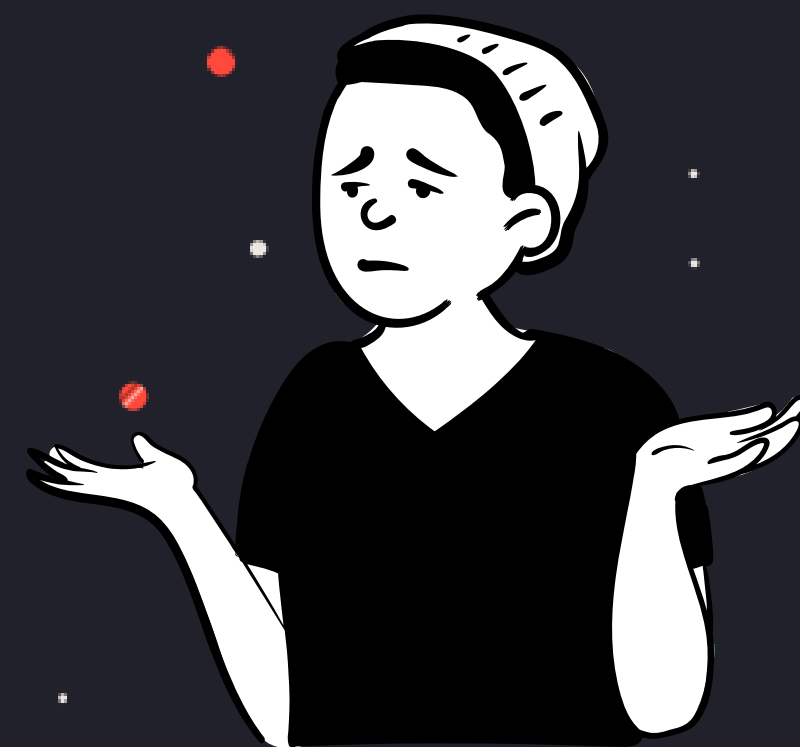
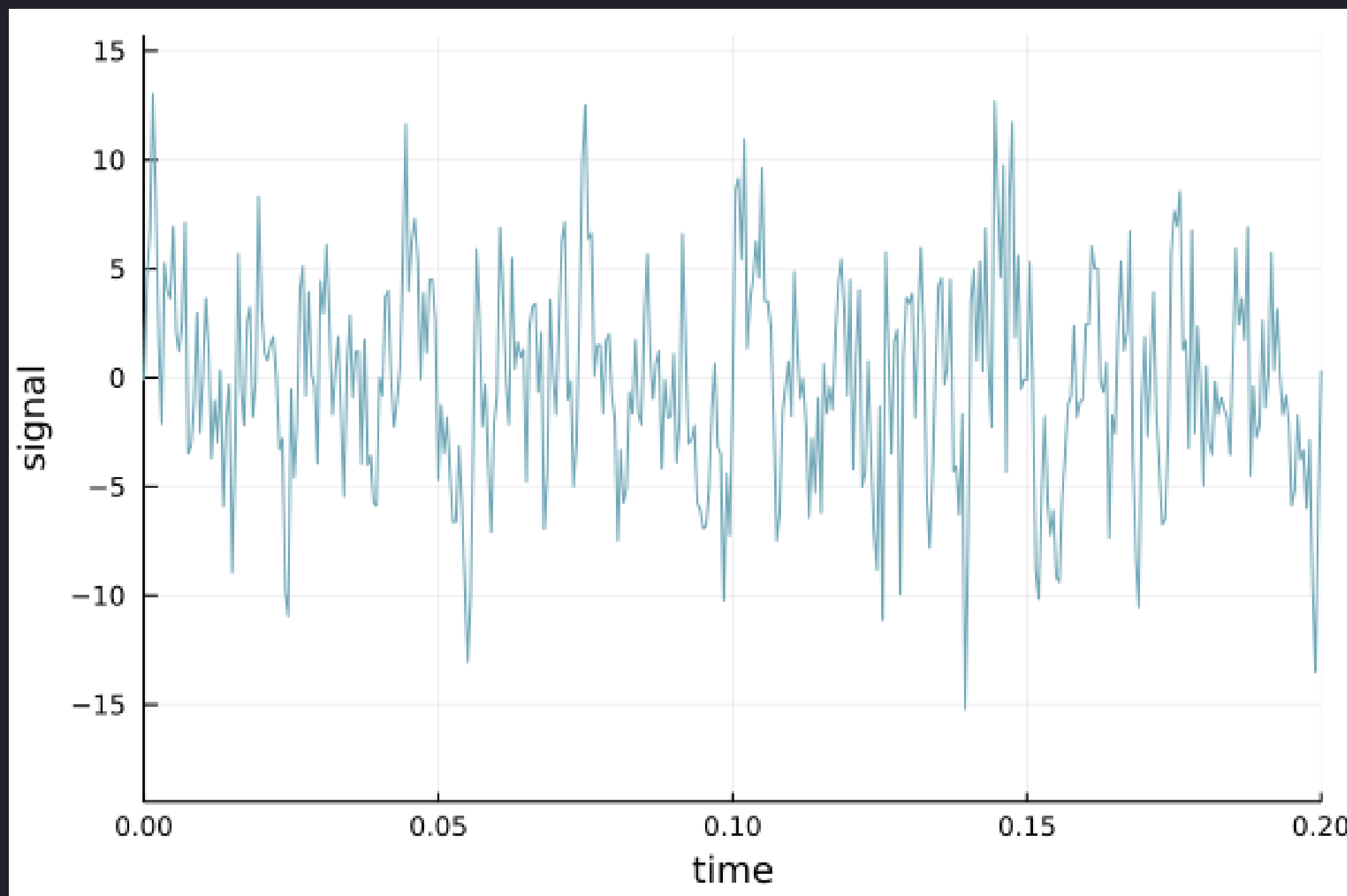




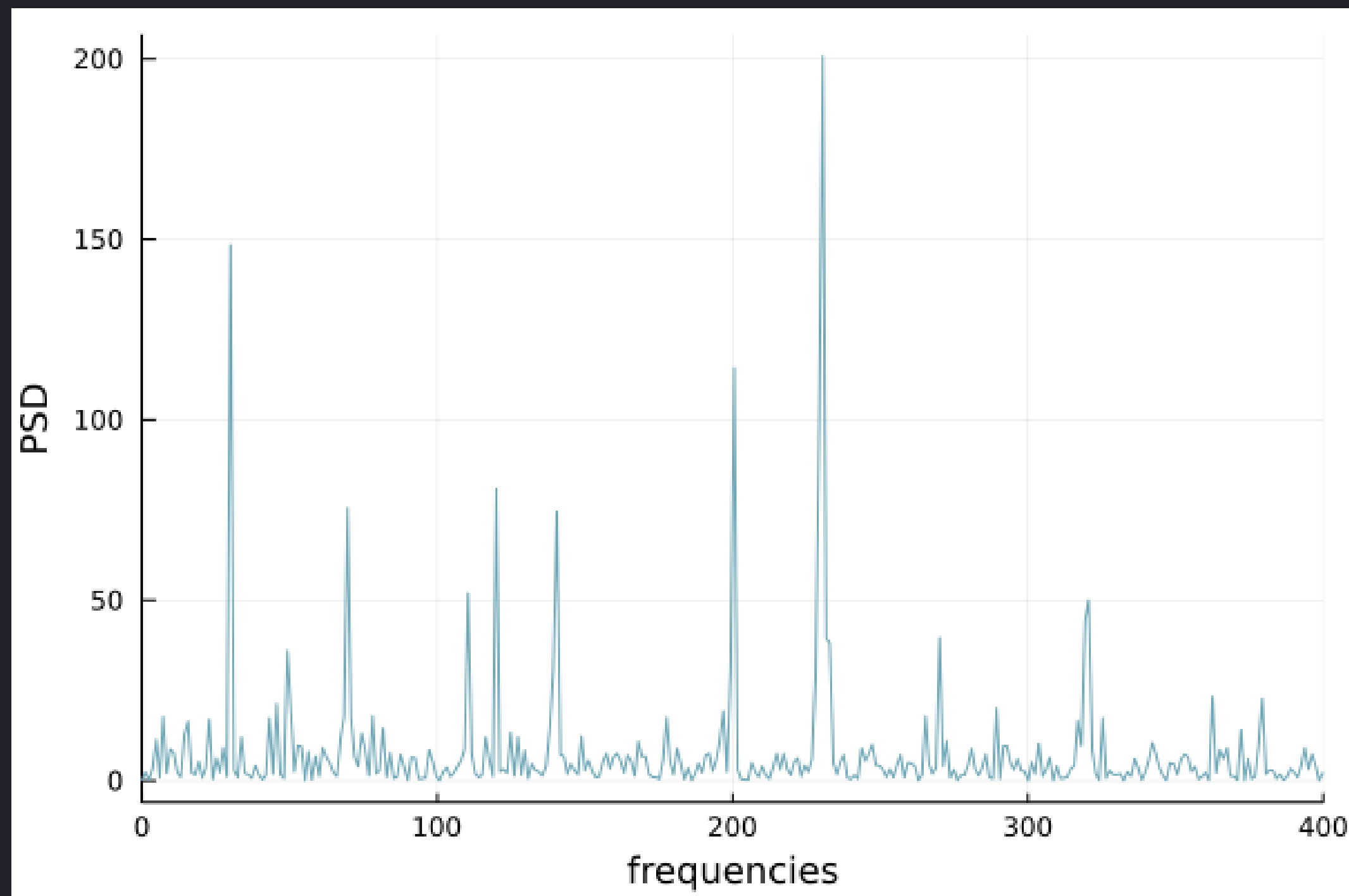
**Do czego możemy wykorzystać
transformatę Fouriera?**



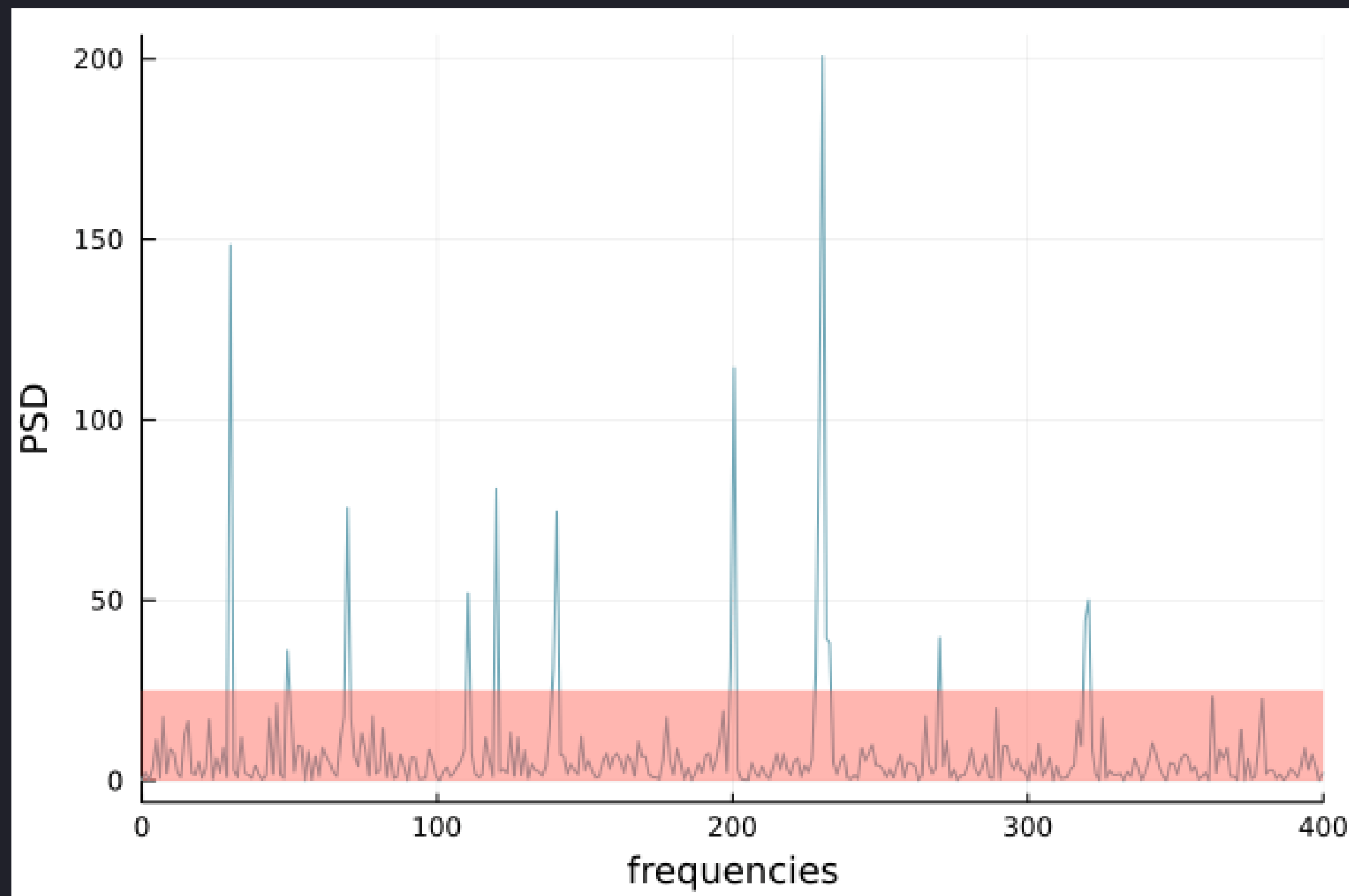
WYKRES DŹWIĘKU I CO Z TEGO?



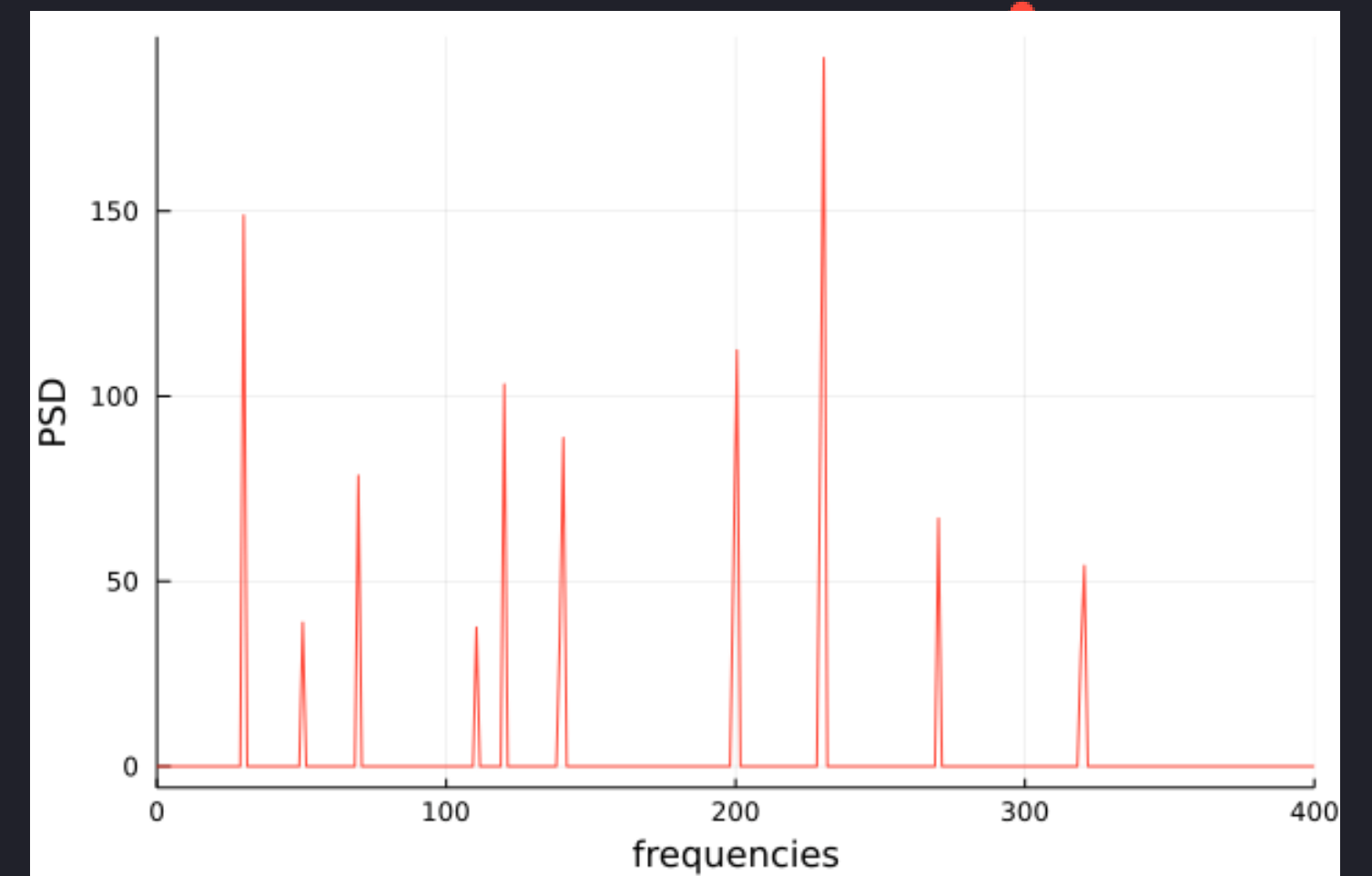
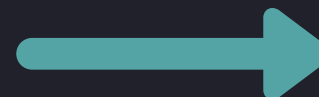
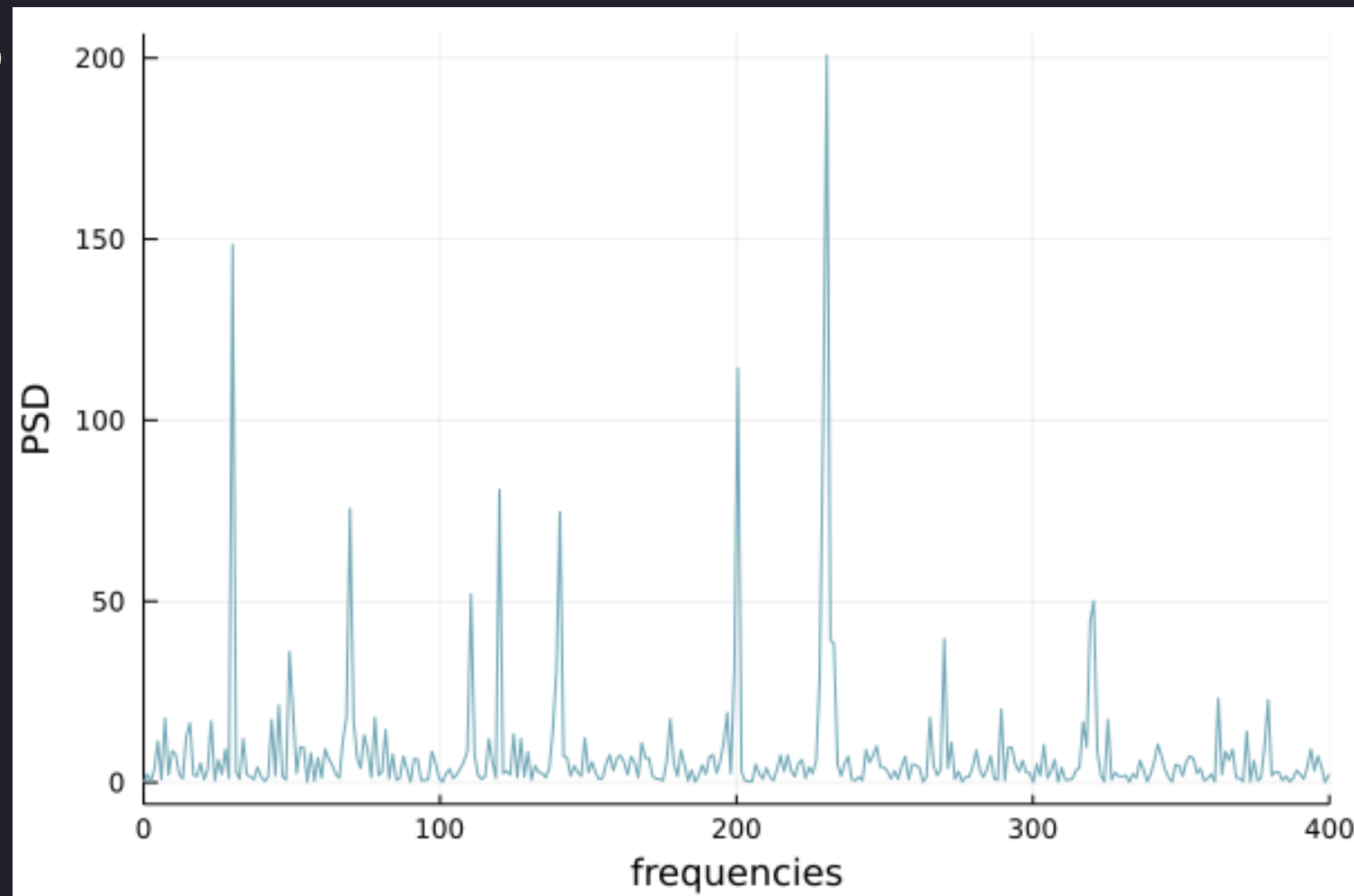
POLICZMY WIDMOWĄ GĘSTOŚĆ MOCY



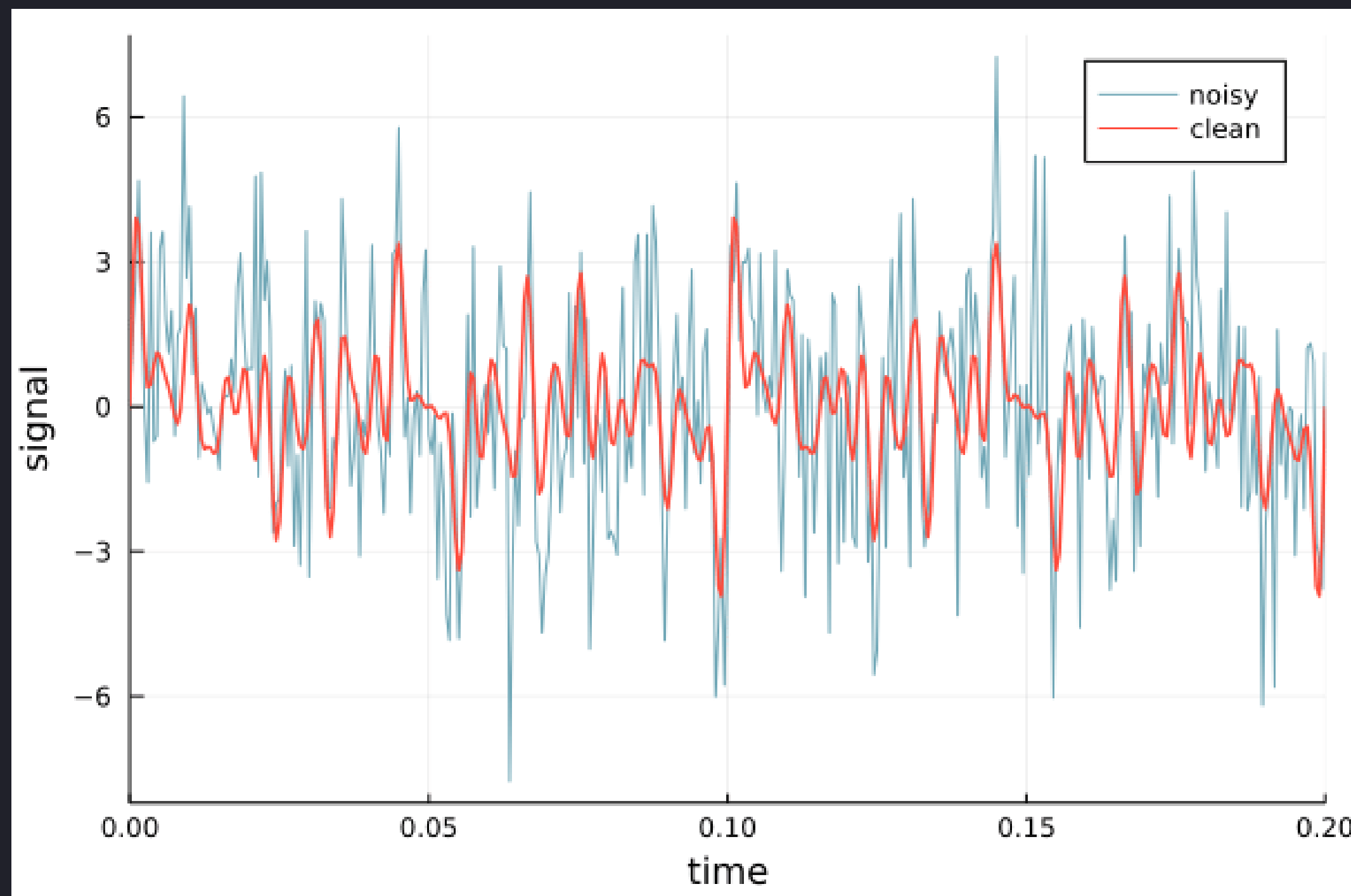
POLICZMY WIDMOWĄ GĘSTOŚĆ MOCY



MAMY ODSZUMIANIE!



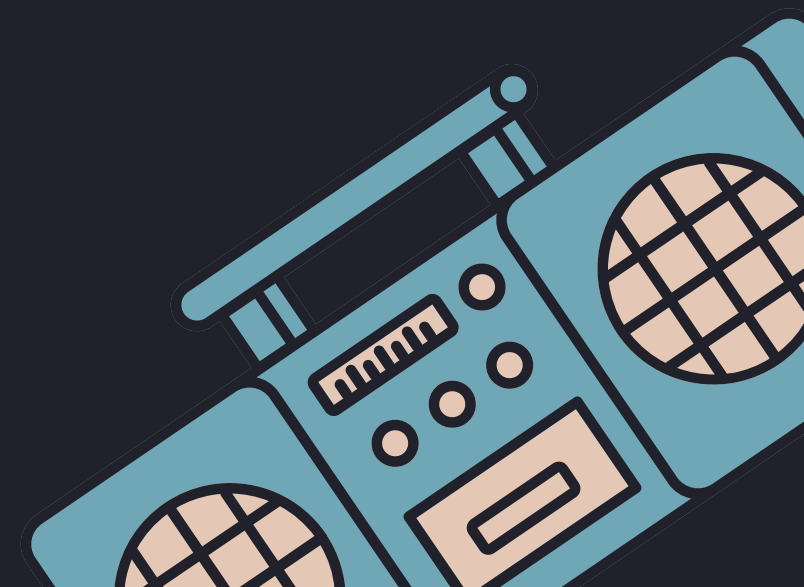
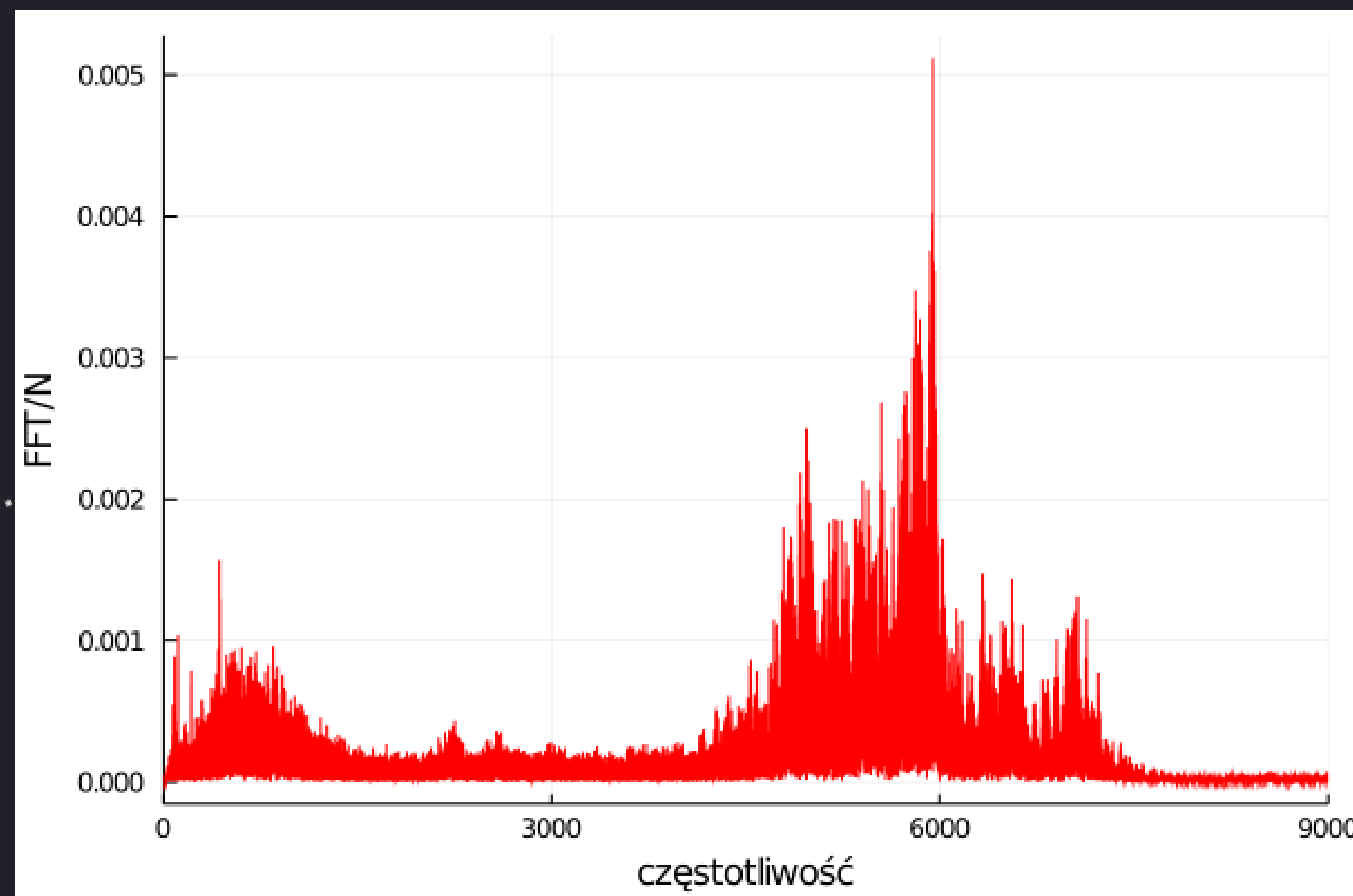
UDAŁO SIĘ!



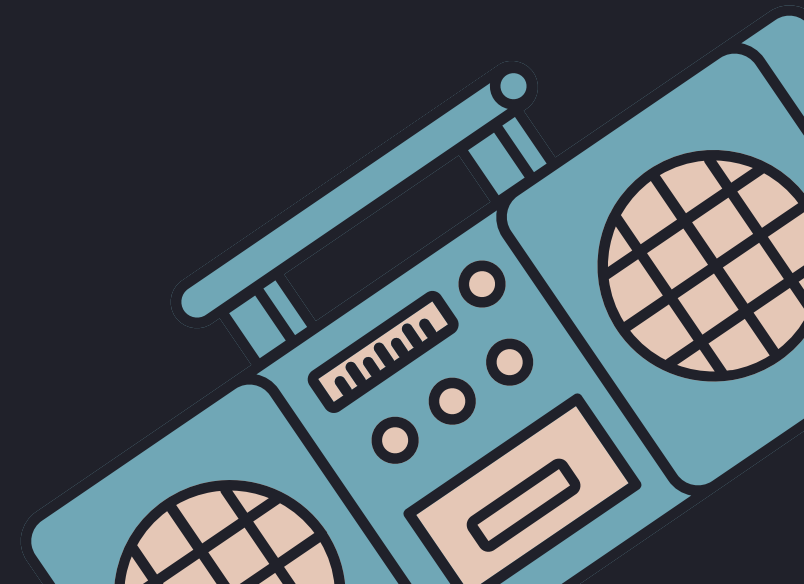
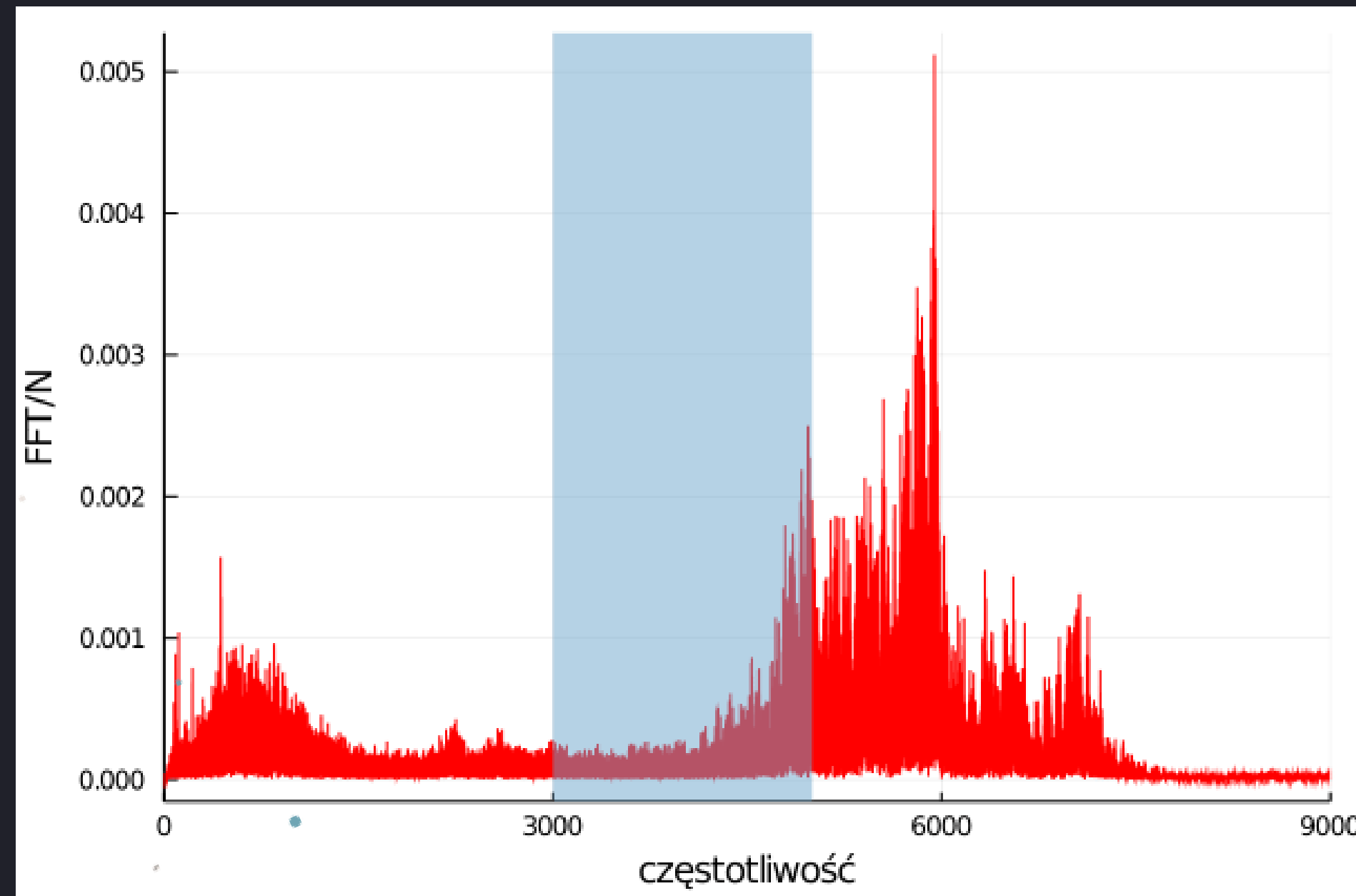
CZAS NA ZABAWĘ Z CZĘSTOTLIWOŚCIAMI



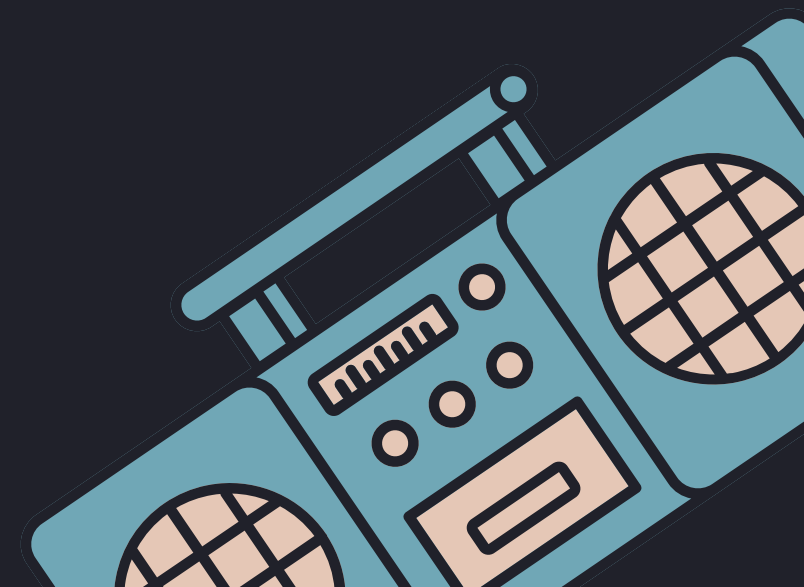
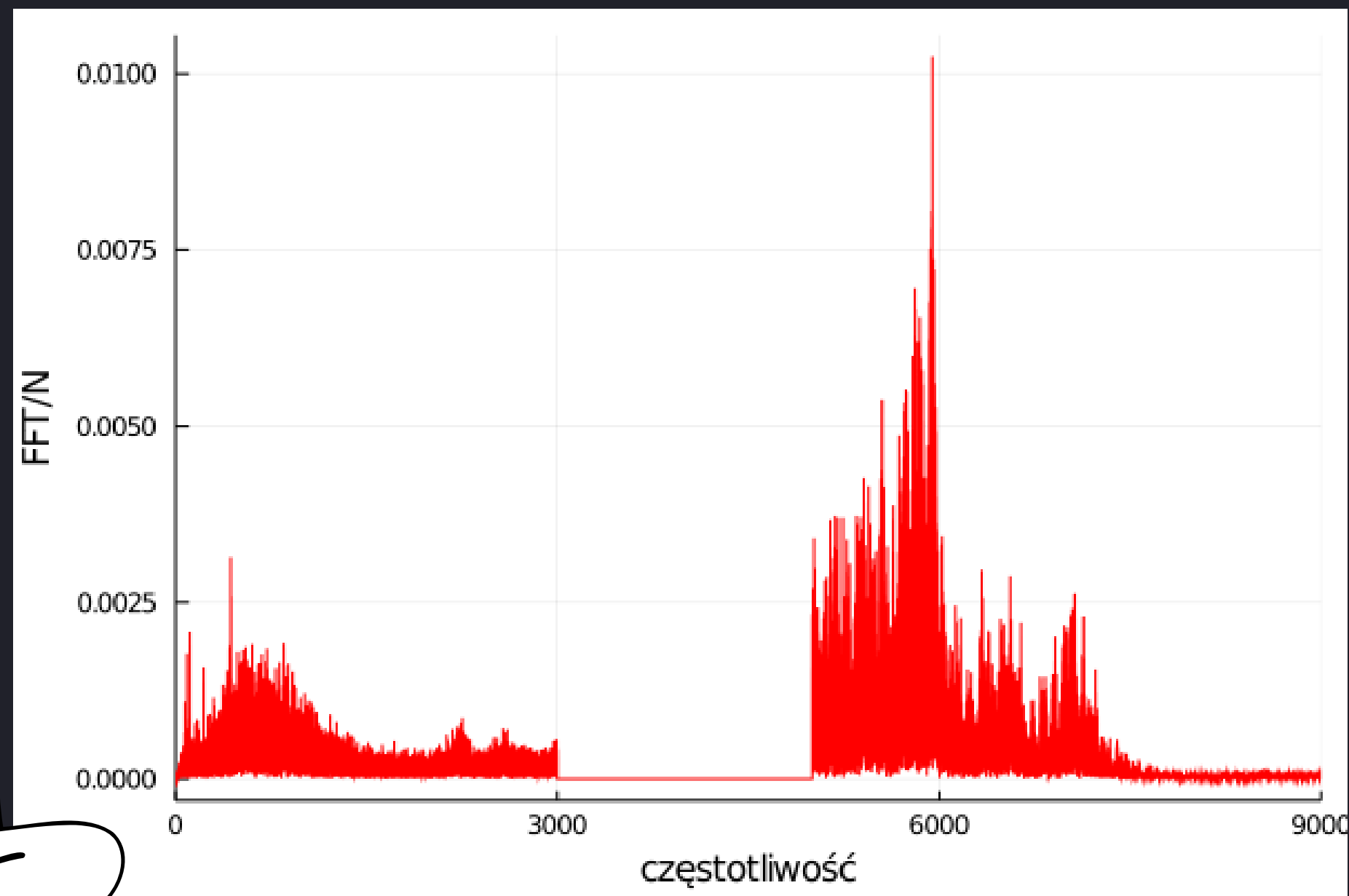
USUNĀMY WYBRANE CZĘSTOTLIWOŚĆI



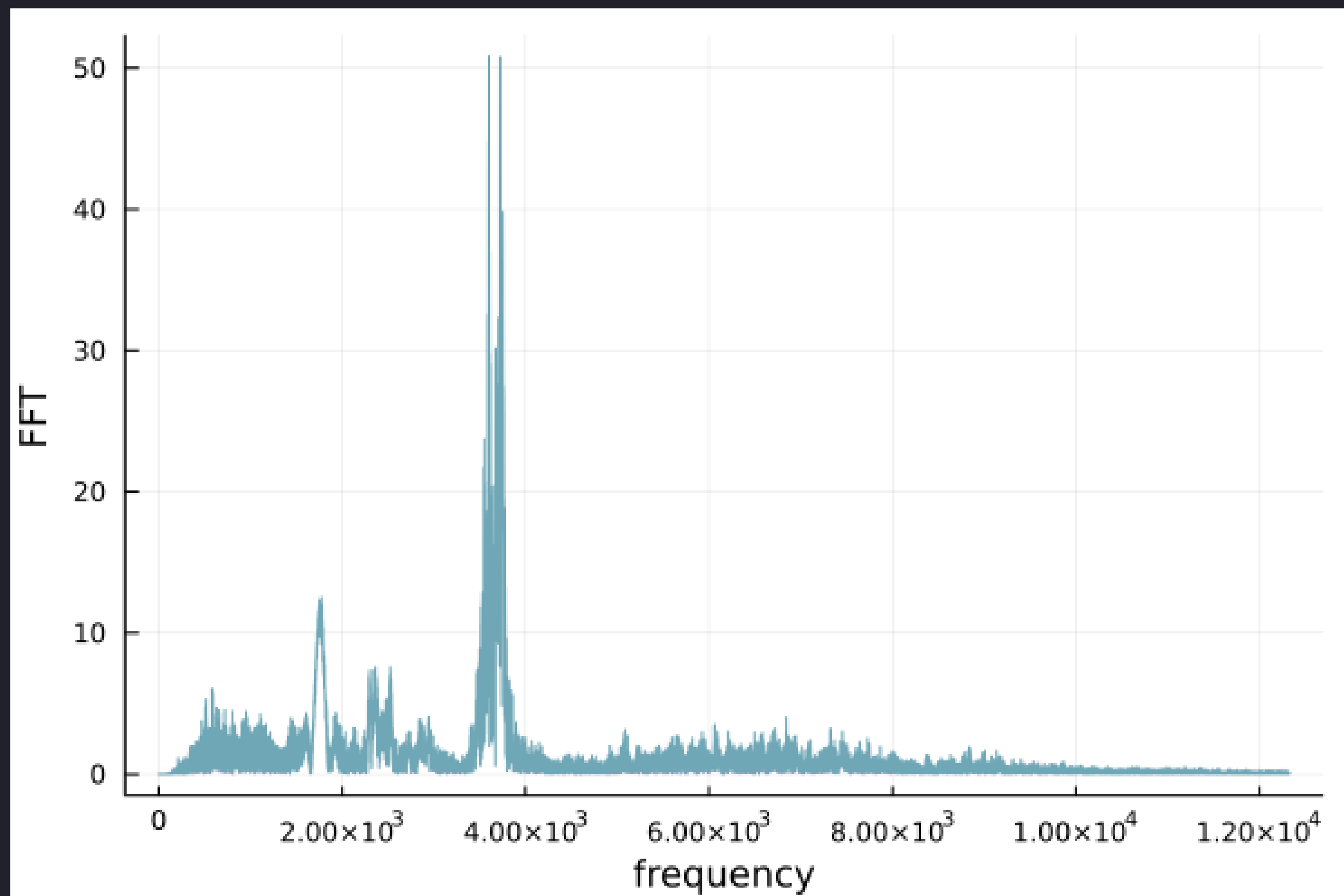
USUNĲMY WYBRANE CZĘSTOTLIWOŚĆI



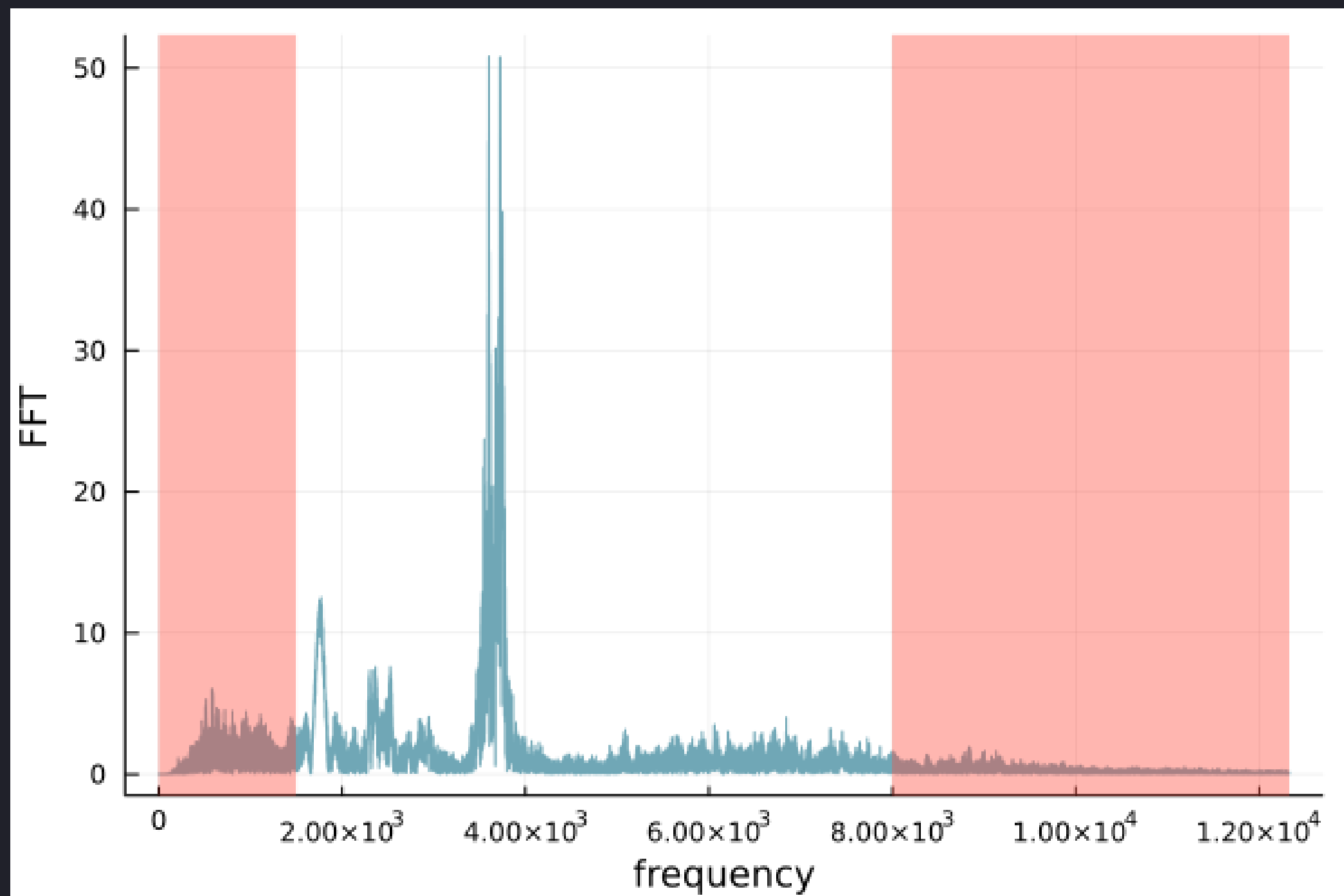
USUNĲMY WYBRANE CZĘSTOTLIWOŚĆI



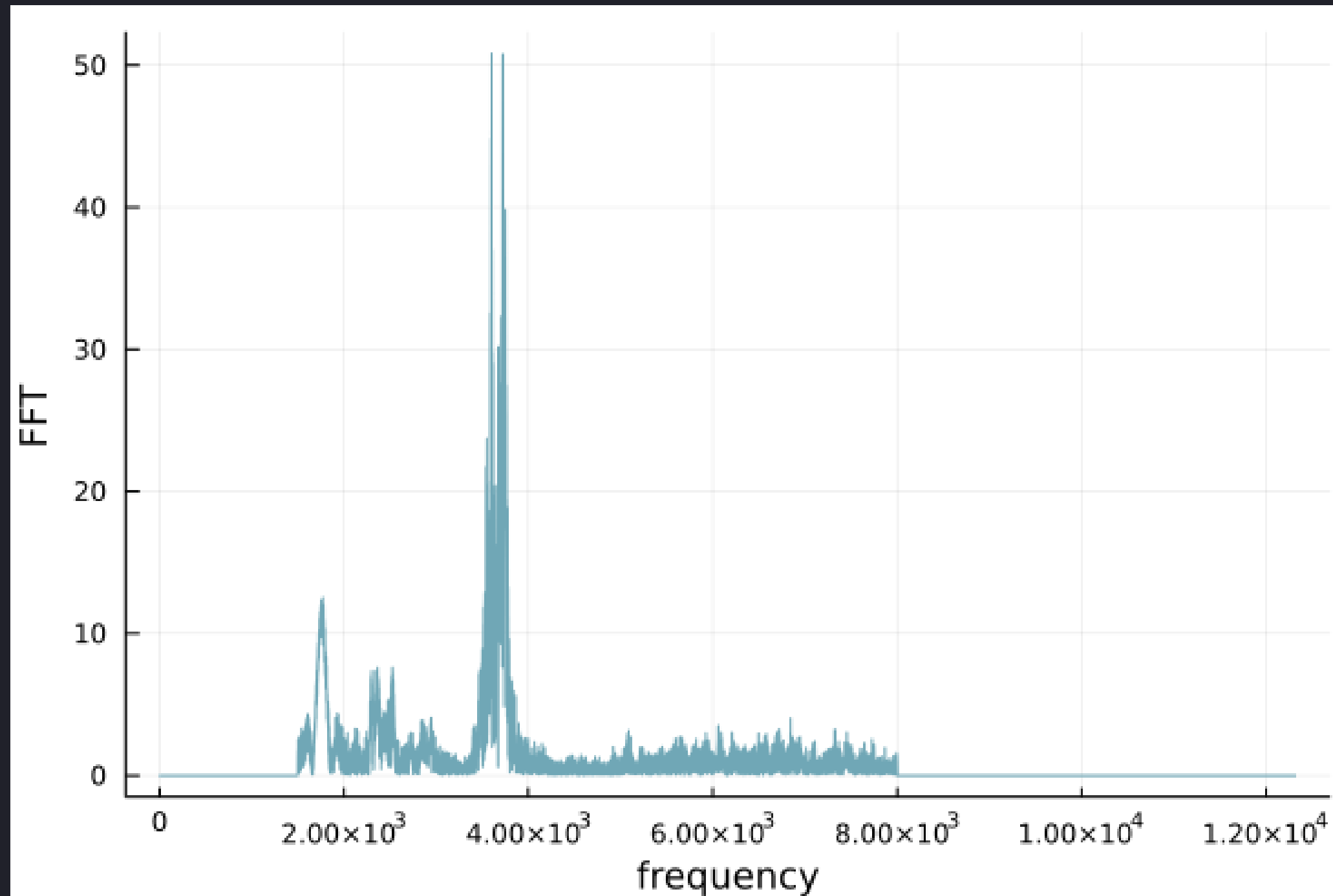
FILTRY CZĘSTOTLIWOŚCI



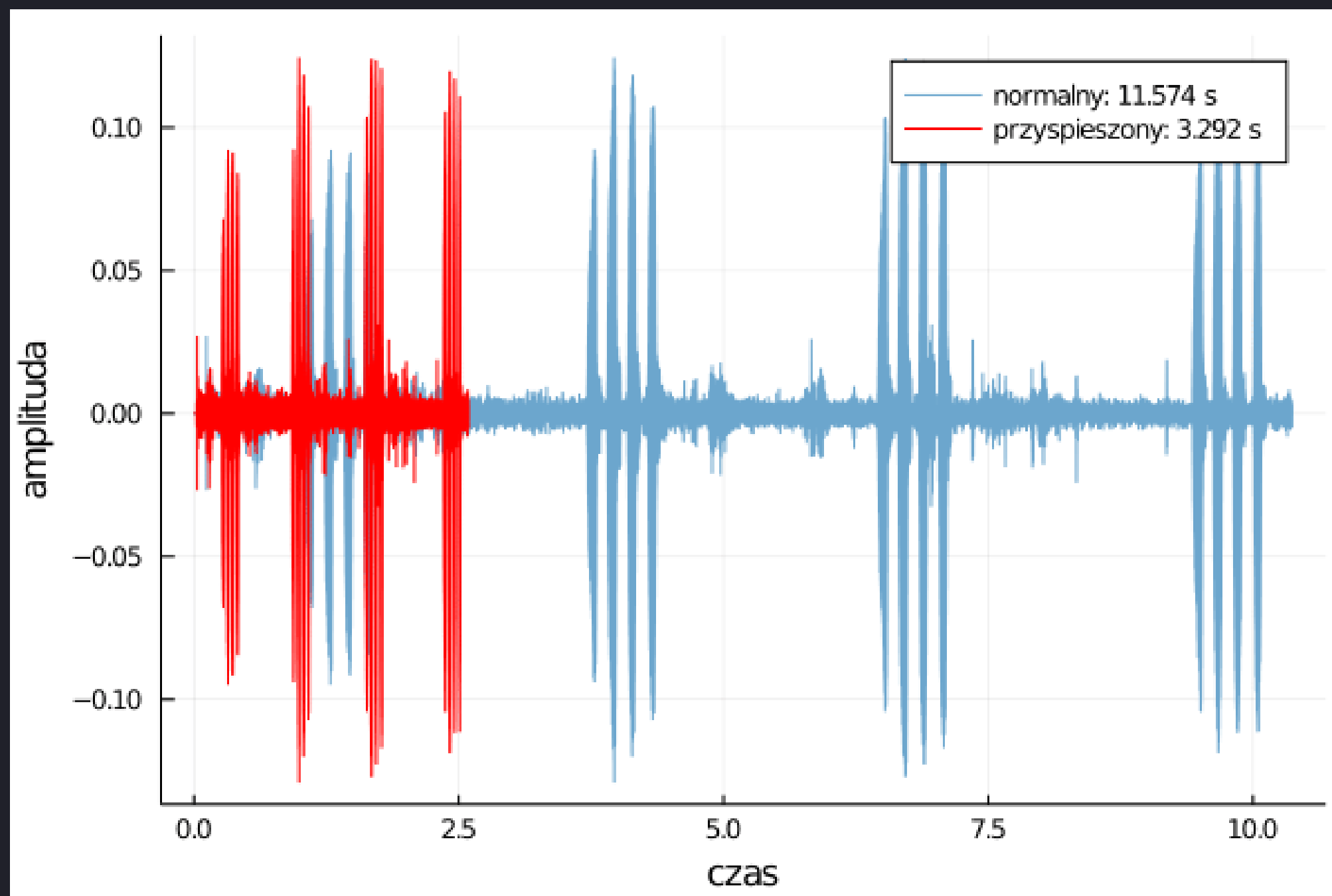
FILTRY CZĘSTOTLIWOŚCI



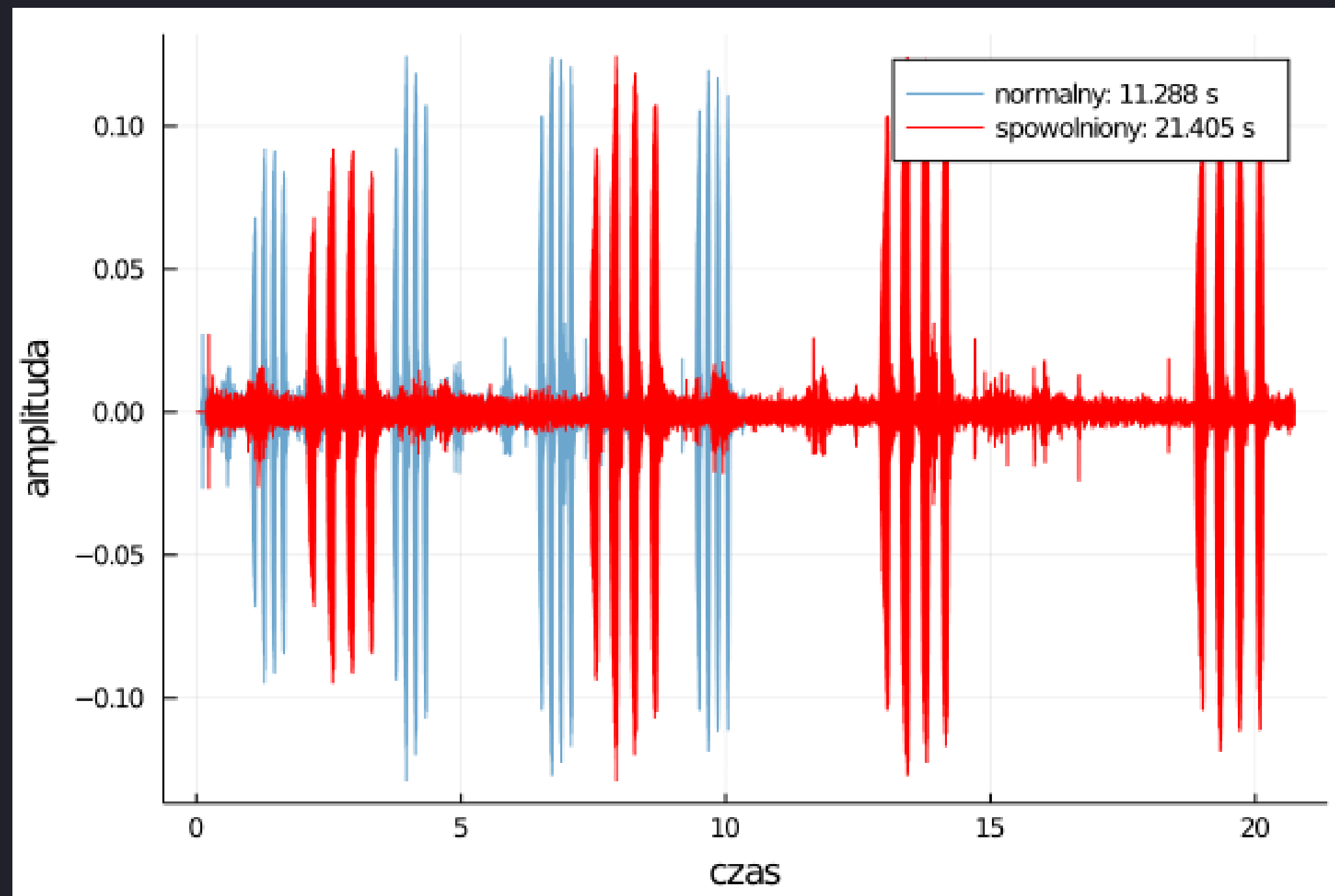
FILTRY CZĘSTOTLIWOŚCI



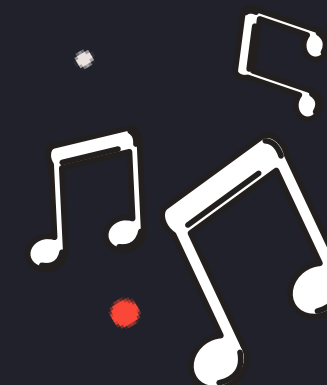
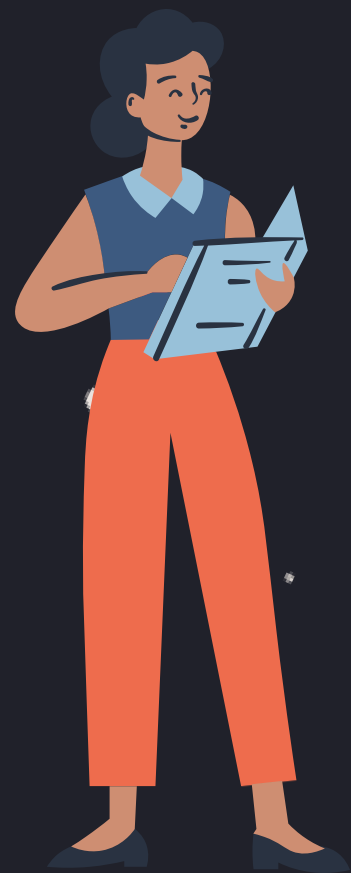
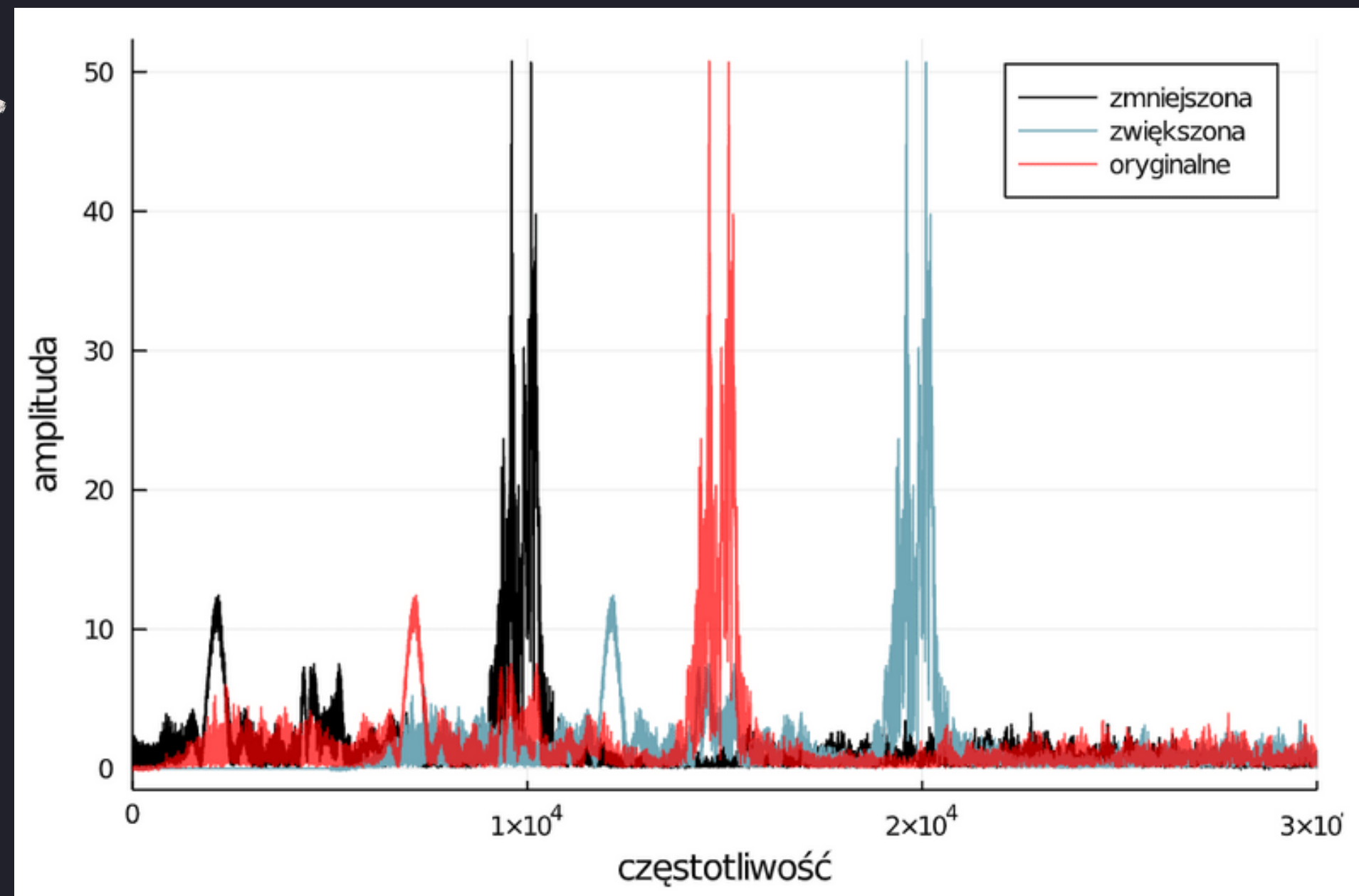
PRZYSPIESZMY



ZWOLNIJMY



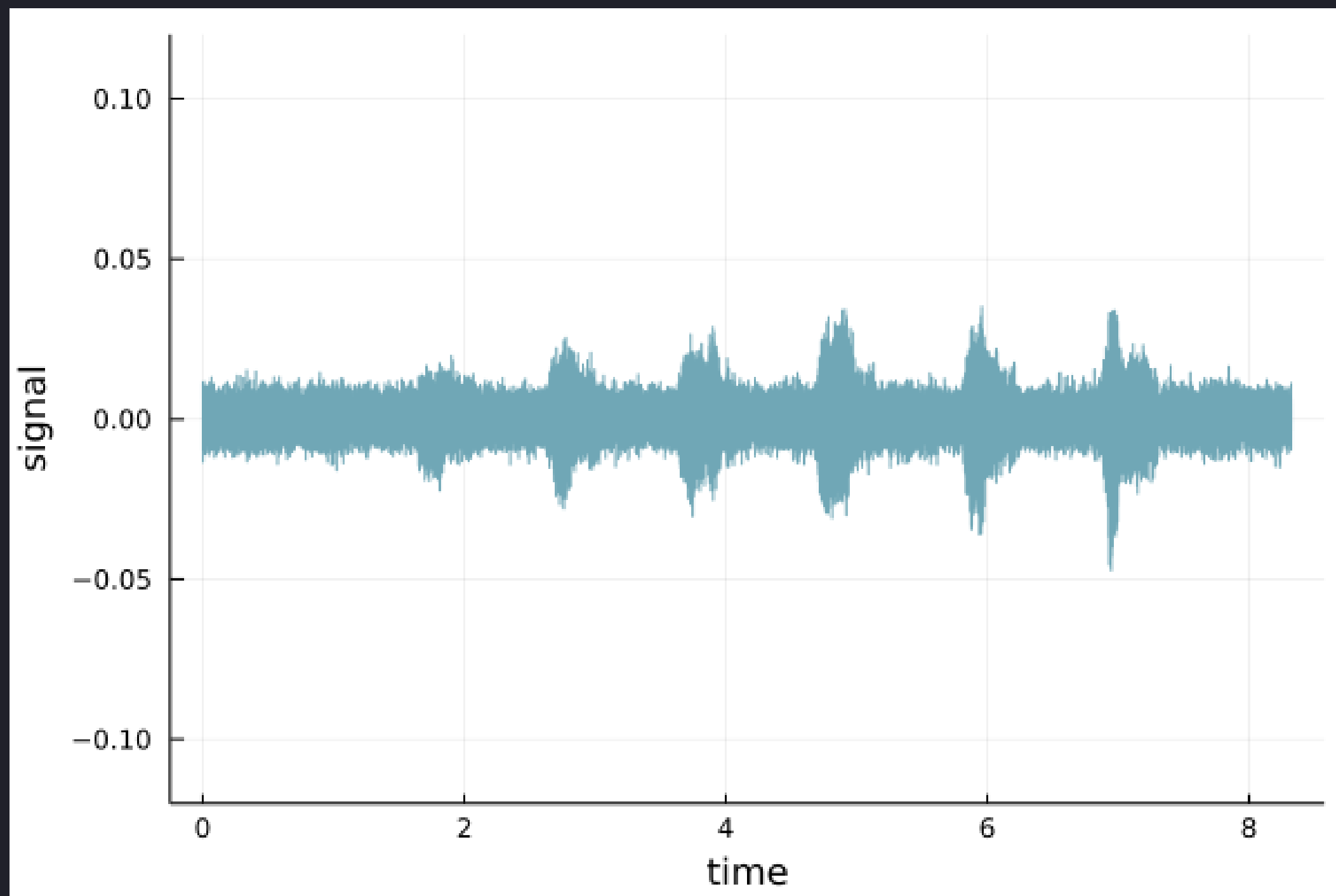
MANIPULACJA CZĘSTOTLIWOŚCI



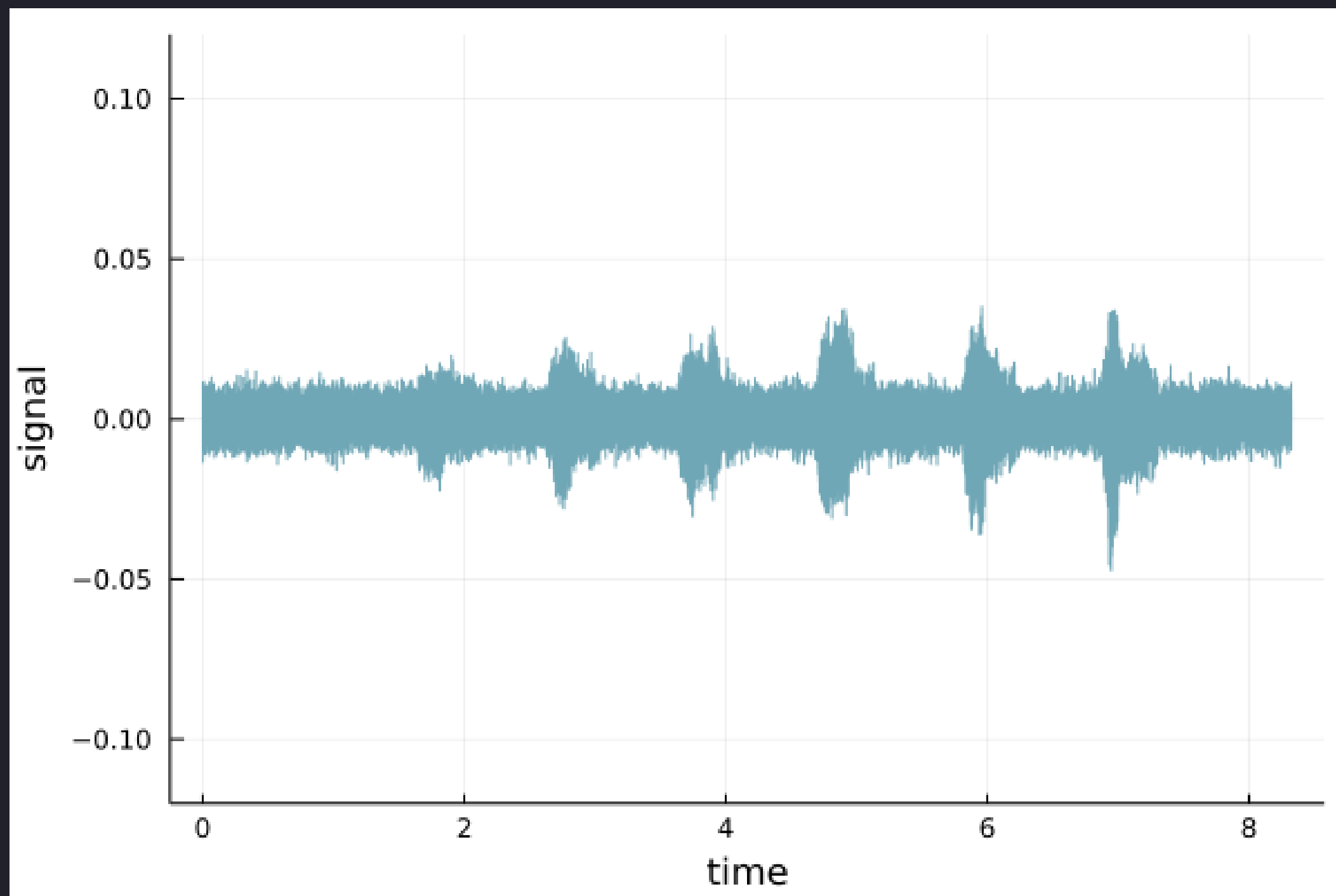
MUZYKA JEST ZA CICHÓ?
ŻADEN PROBLEM!



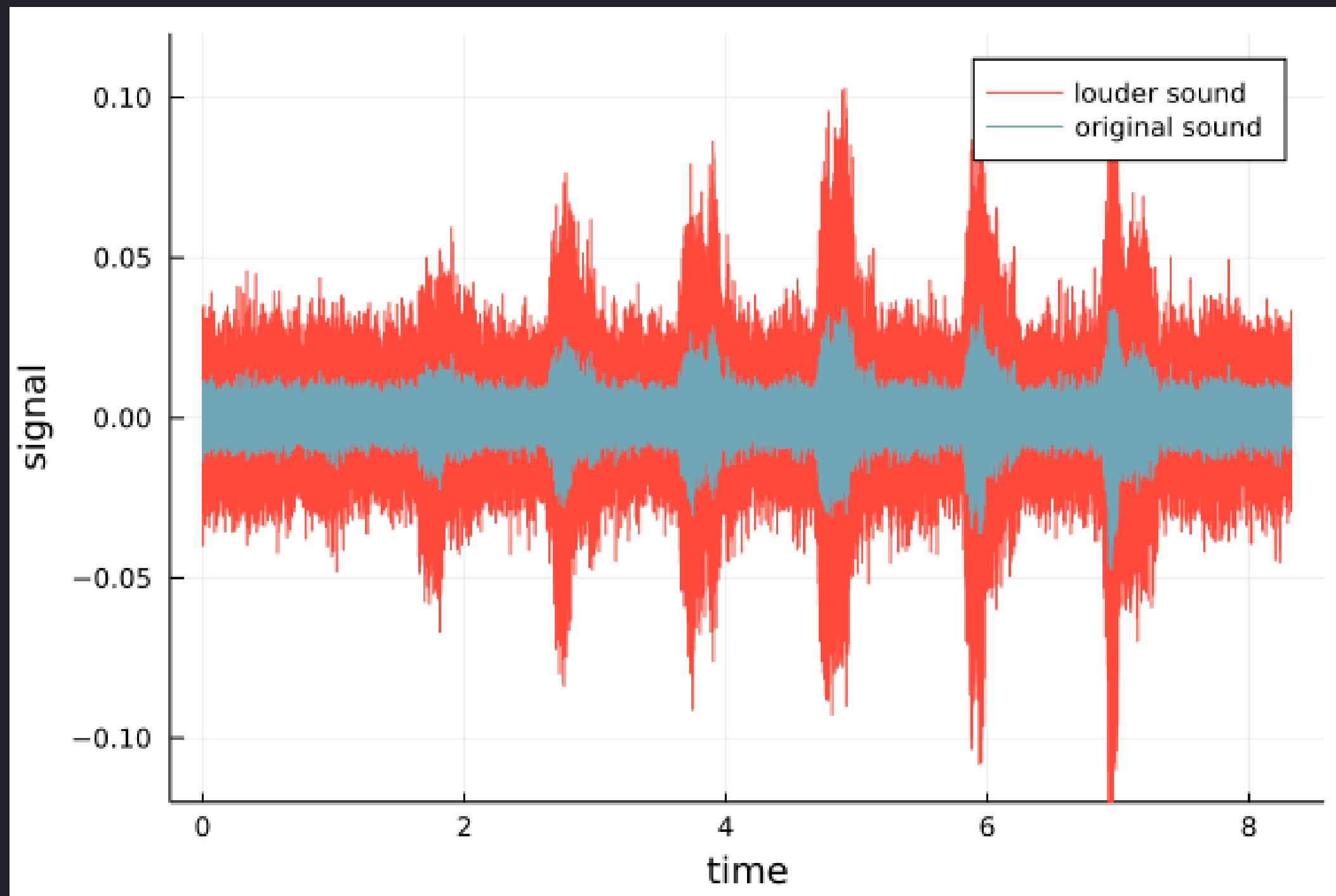
ZMIANA GŁOŚNOŚCI



ZMIANA GŁOŚNOŚCI



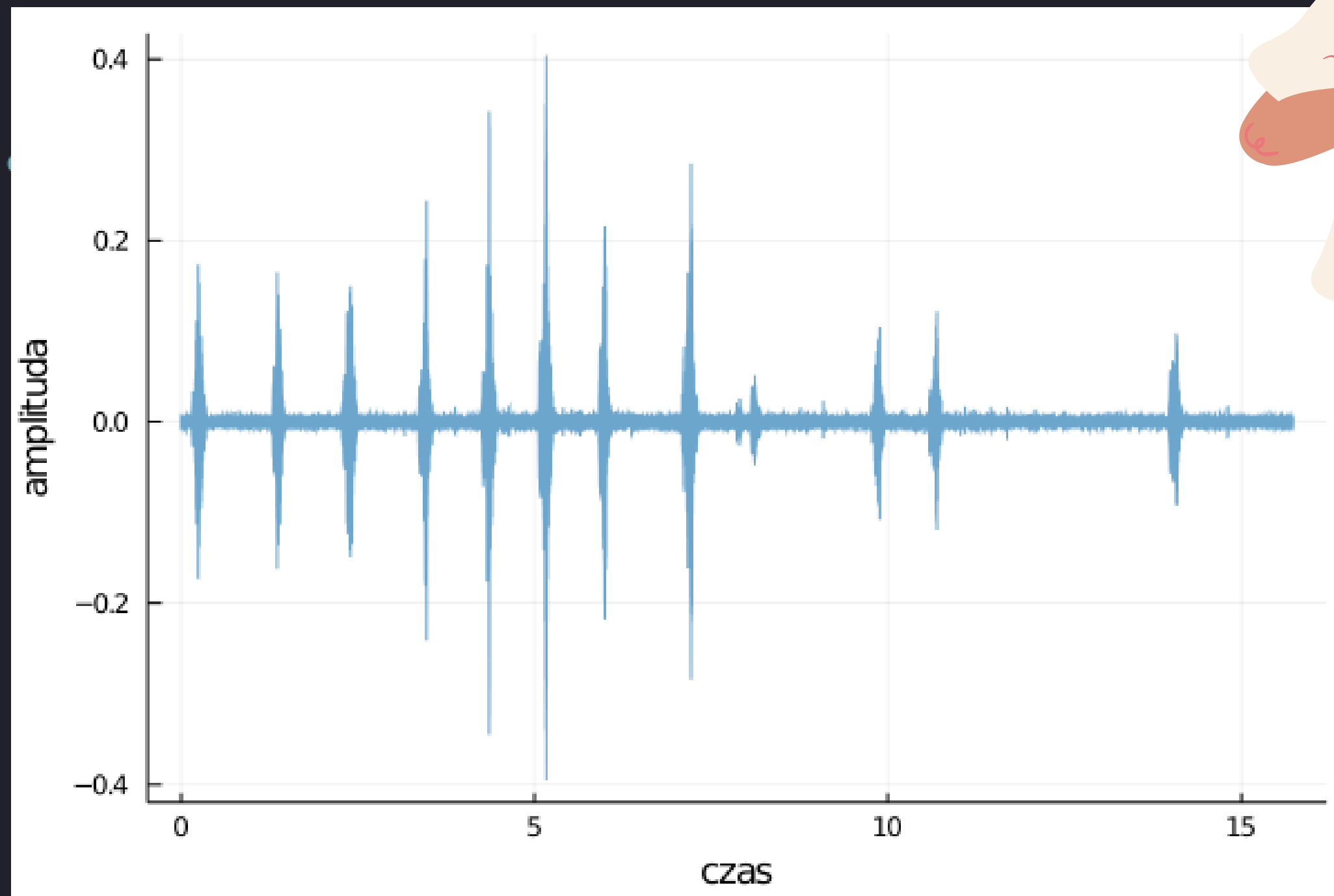
ZMIANA GŁOŚNOŚCI



**A CO JEŚLI NAGRANIE
JEST ZA DŁUGIE?**

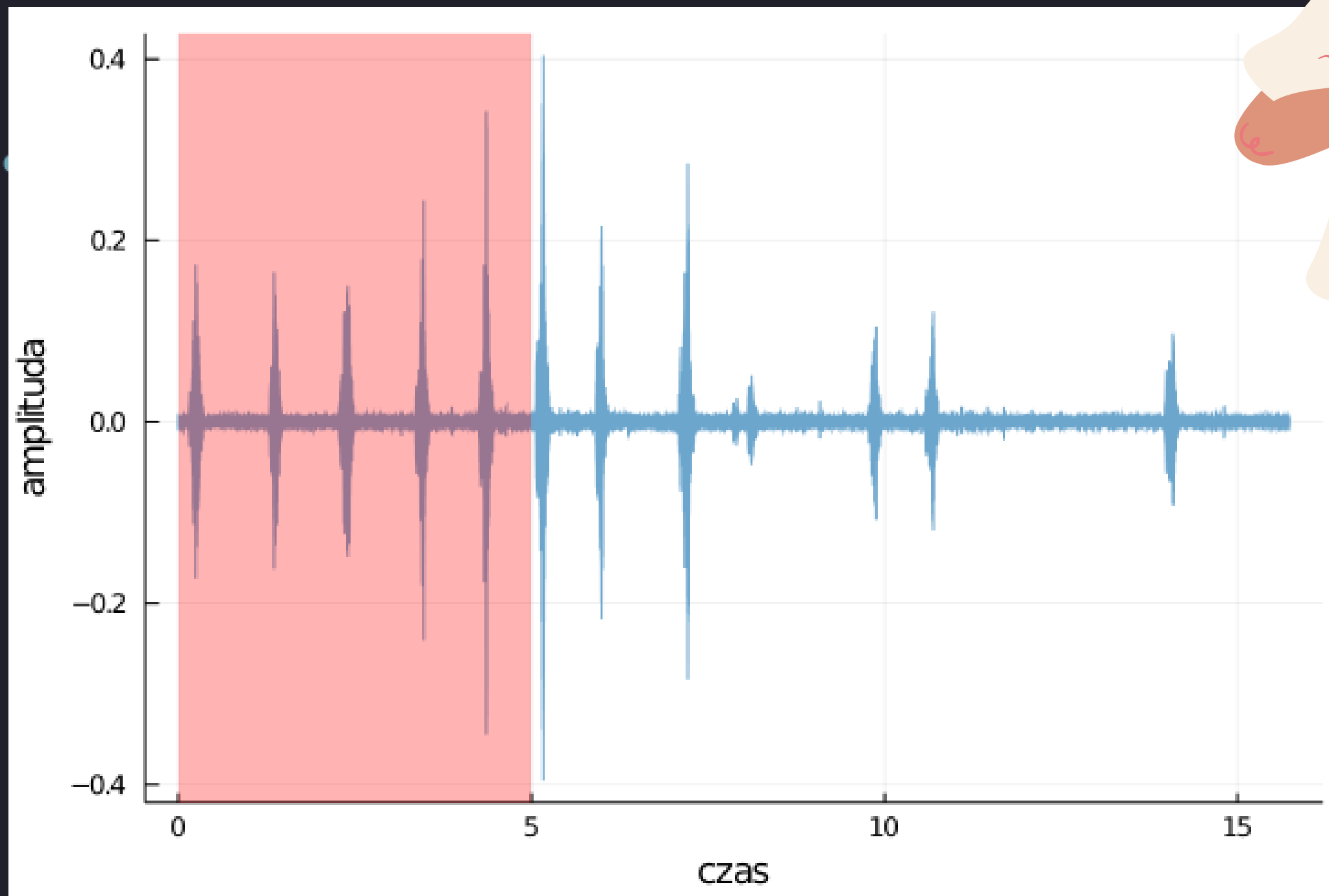


PRZYCIANIE NAGRANIA

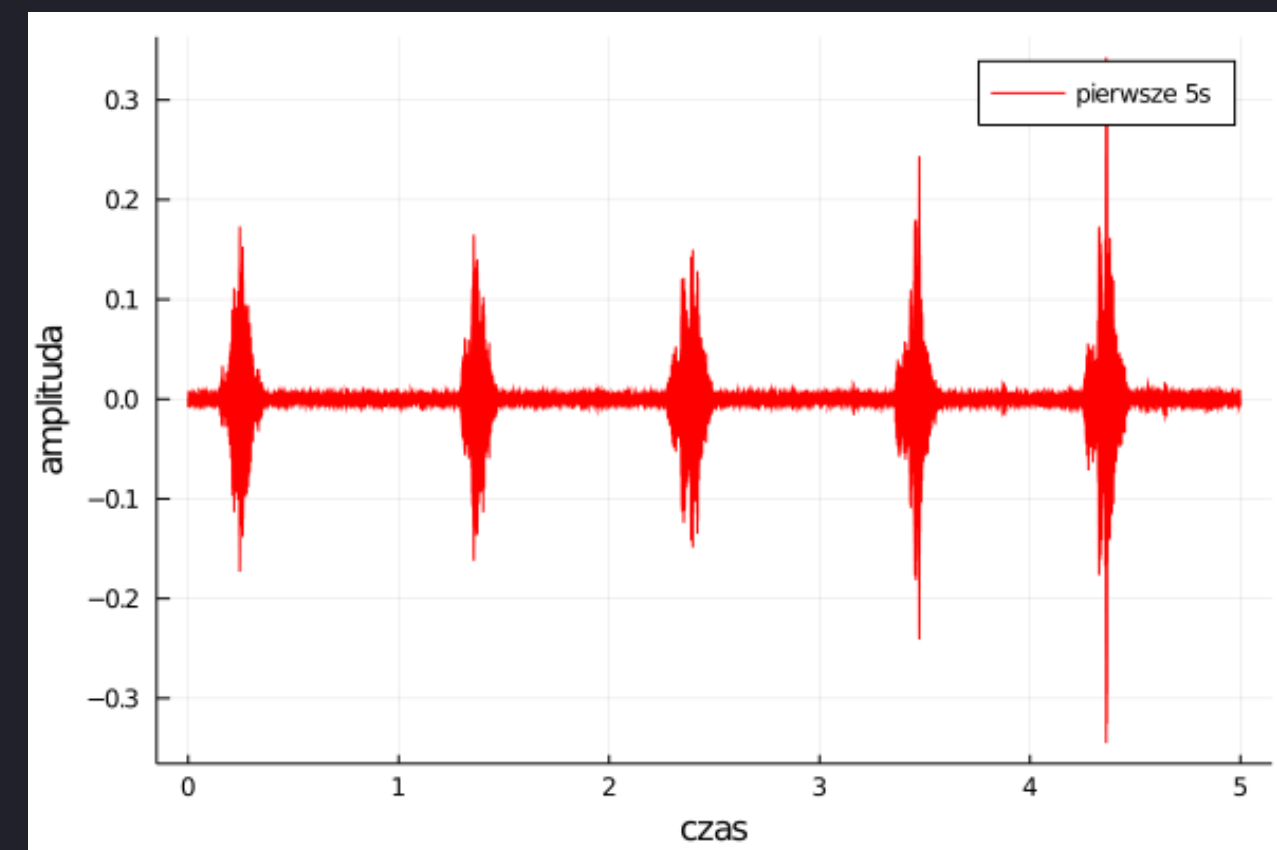
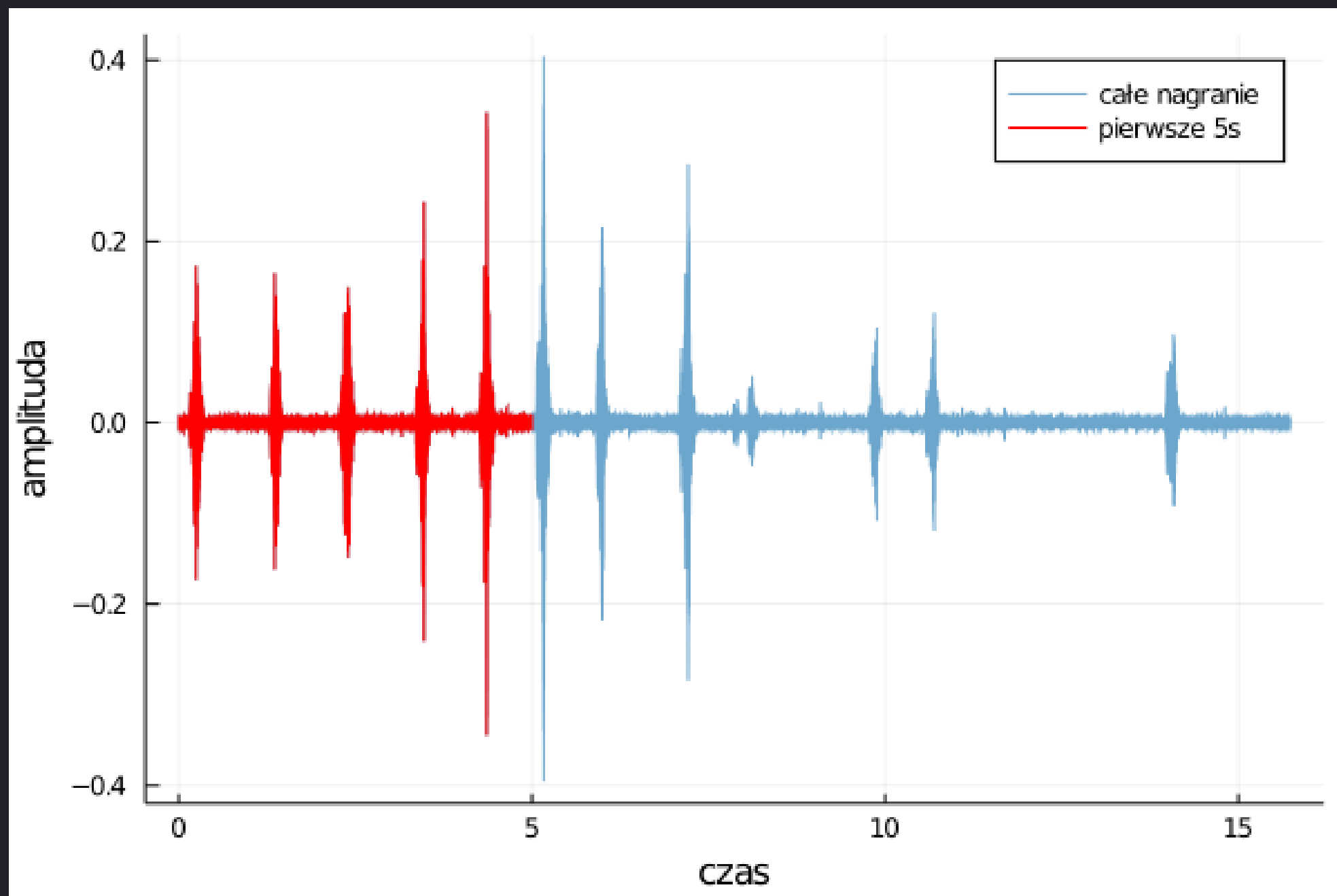




PRZYCINANIE NAGRANIA

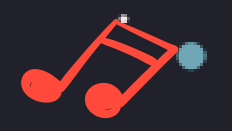
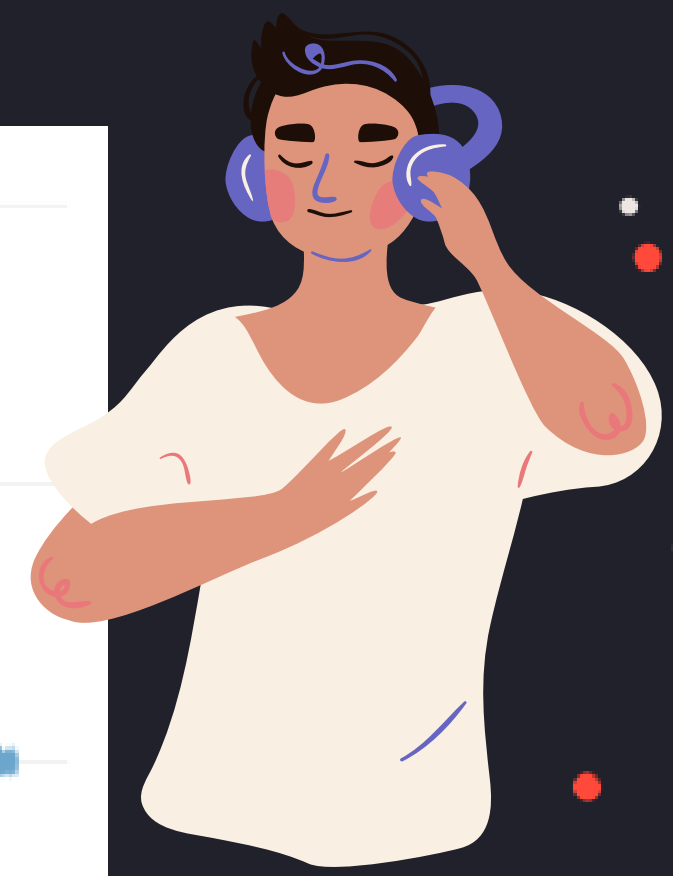
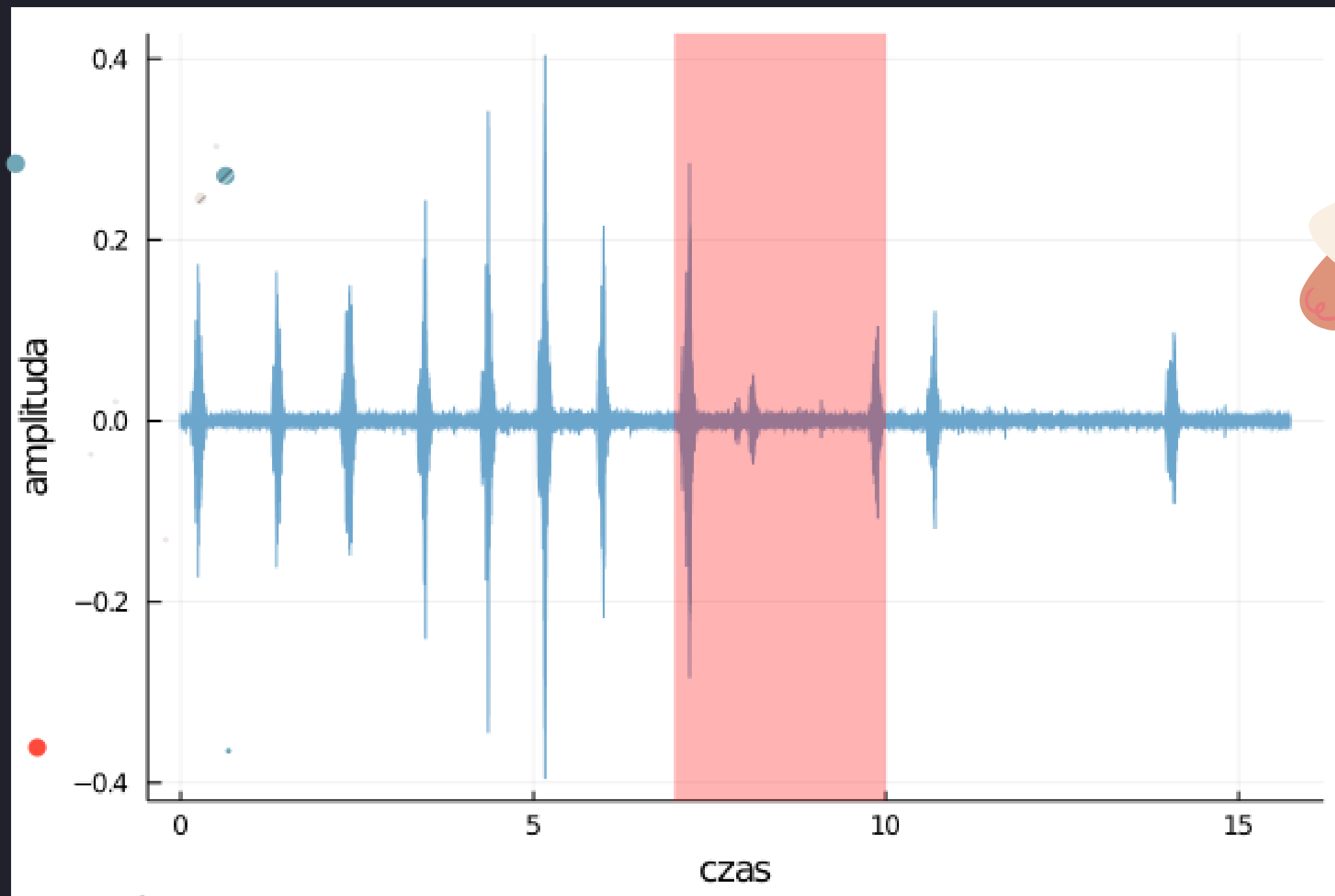


PRZYCINANIE NAGRANIA

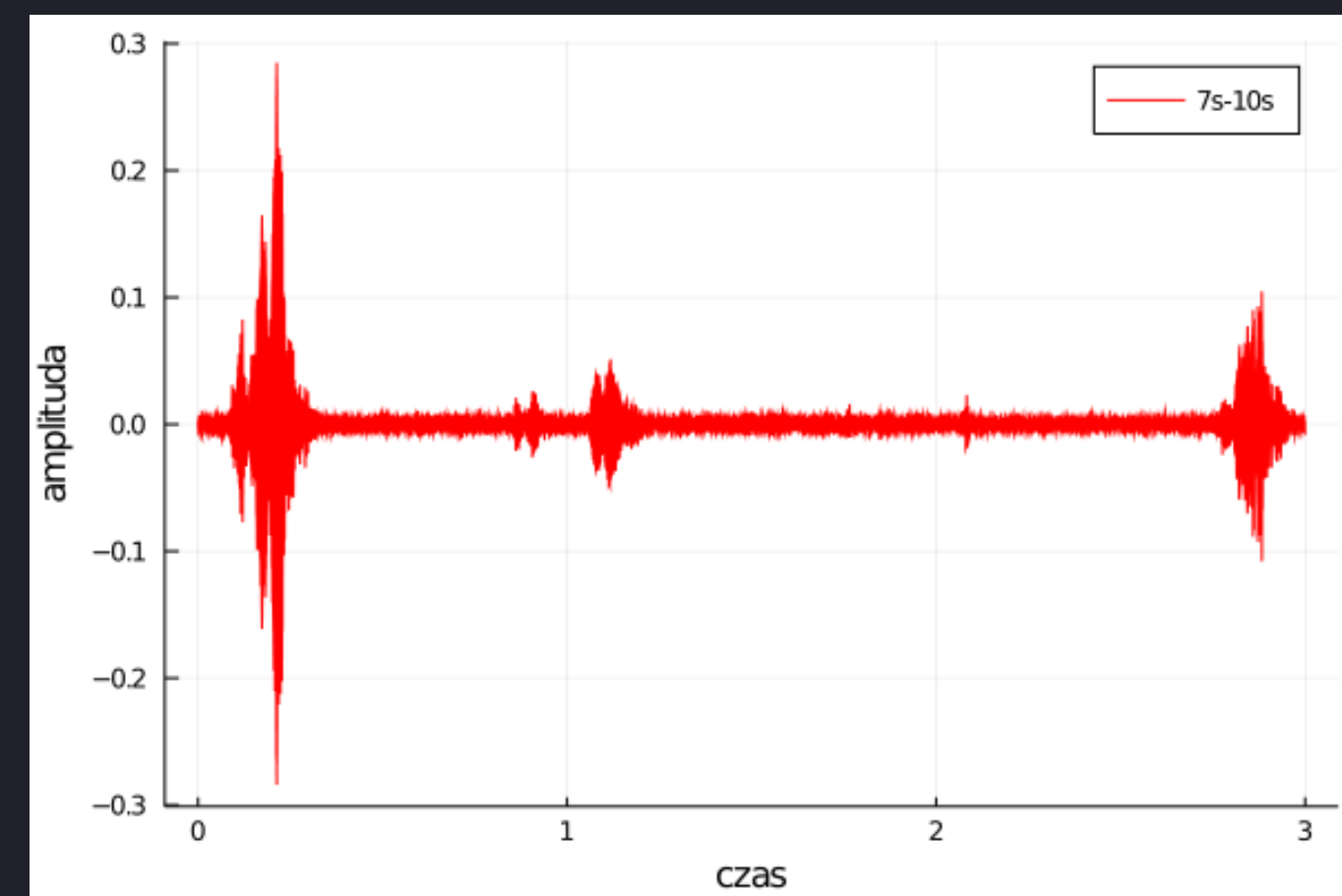
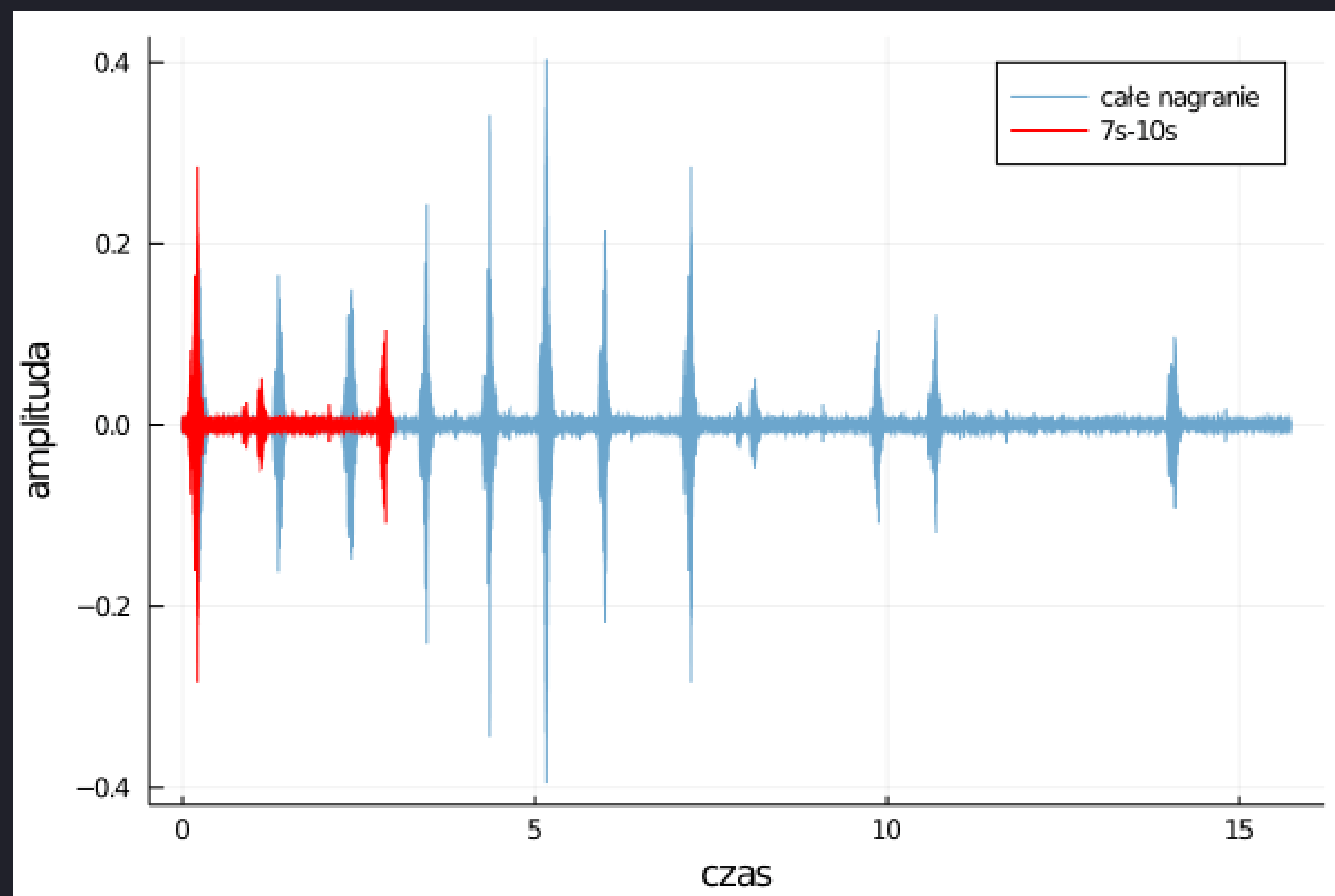




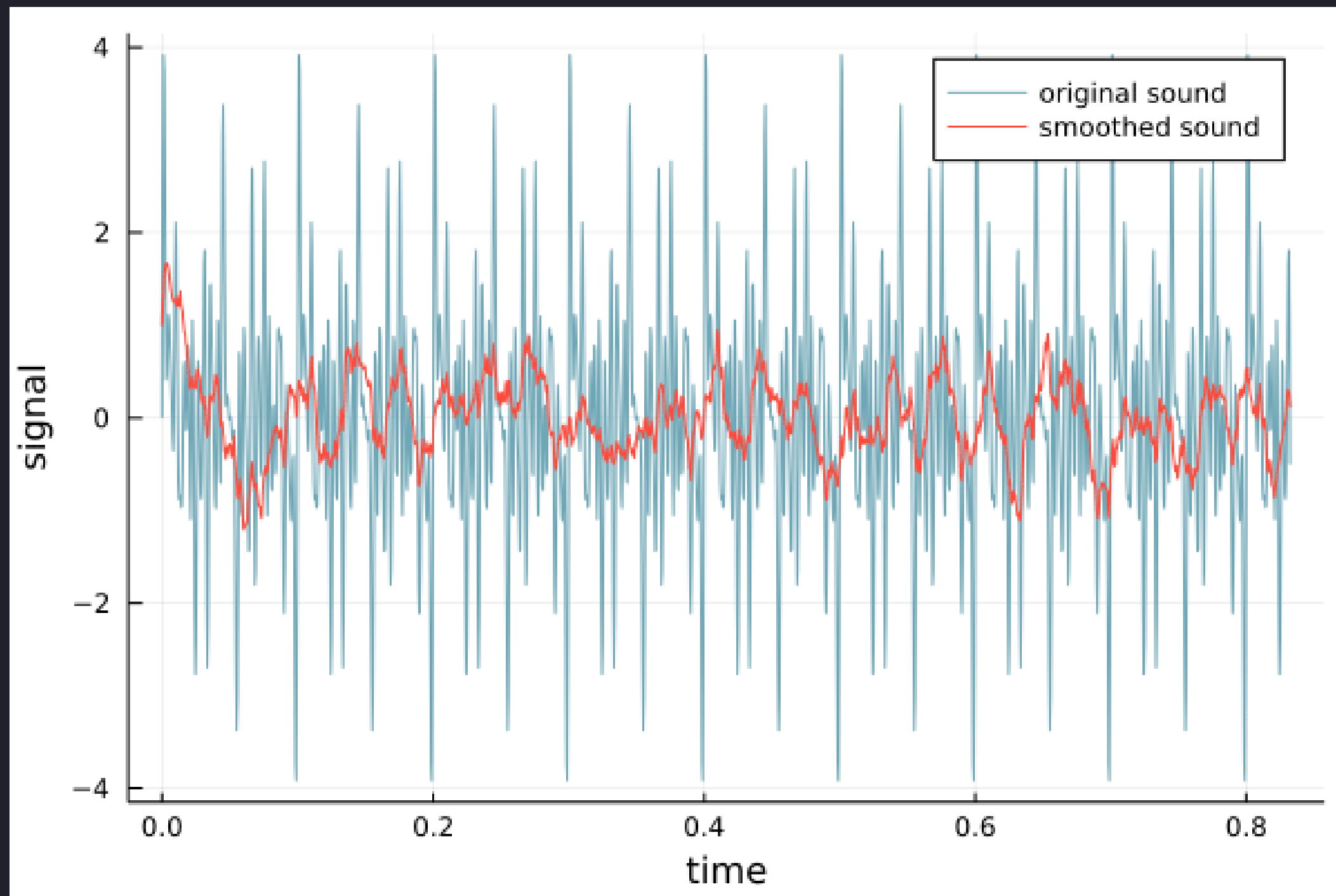
PRZYCIANIE NAGRANIA



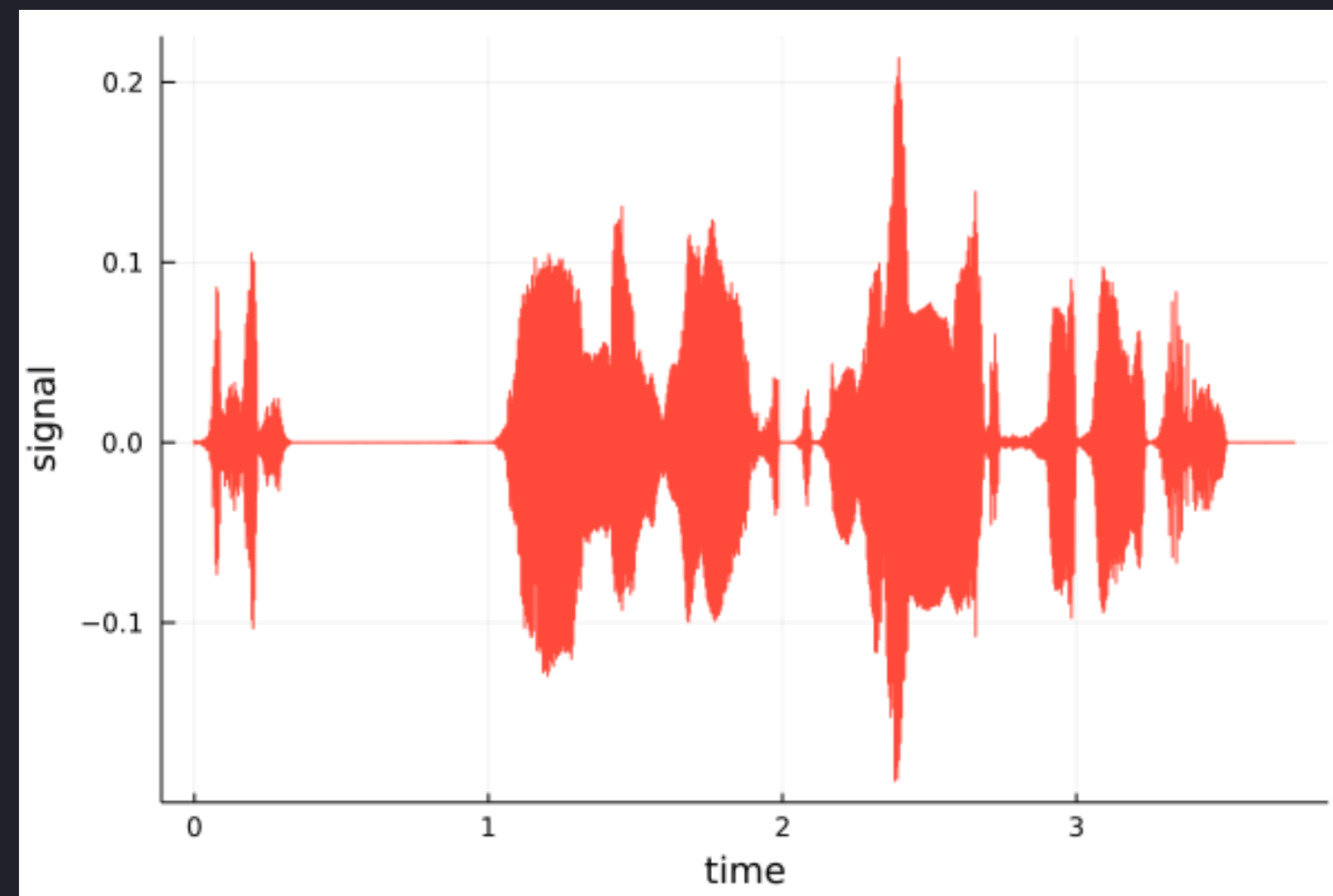
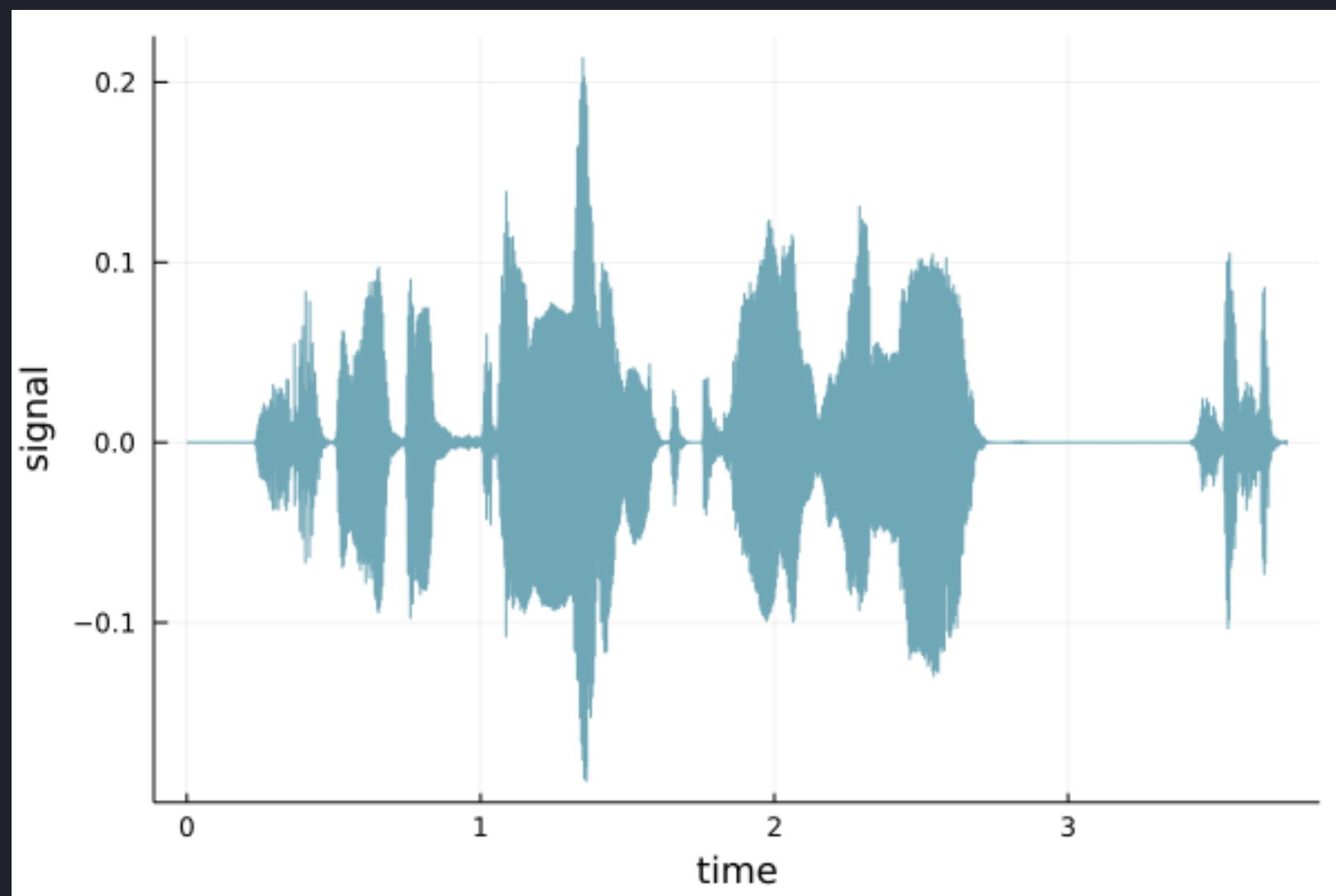
PRZYCINANIE NAGRANIA



WYGŁADZANIE DŹWIĘKU



ODWRACANIE DŹWIĘKU



TERAZ POKAŻEMY NASZE GUI

