Towards to automatic correction of unwanted artifacts observed in digital data continously recorded by a rotational seismograph

I3S 2022 sciforum

Military University of Technology

ELPROMA ELECTRONICS

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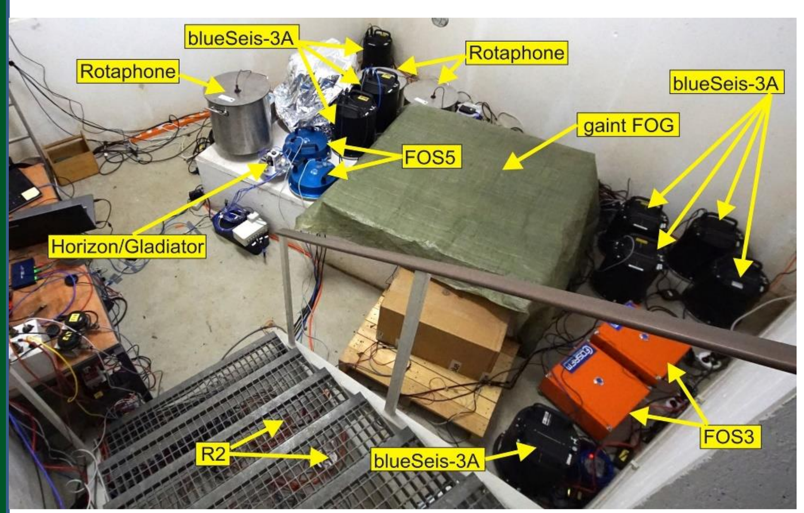
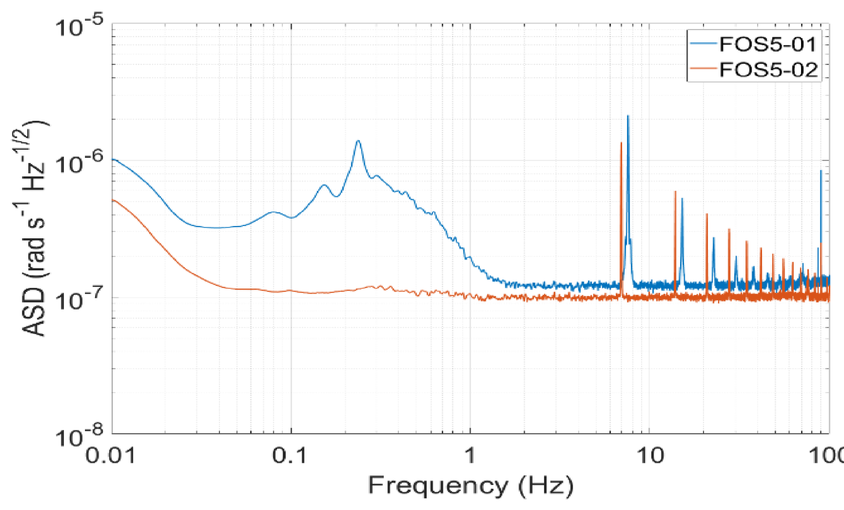
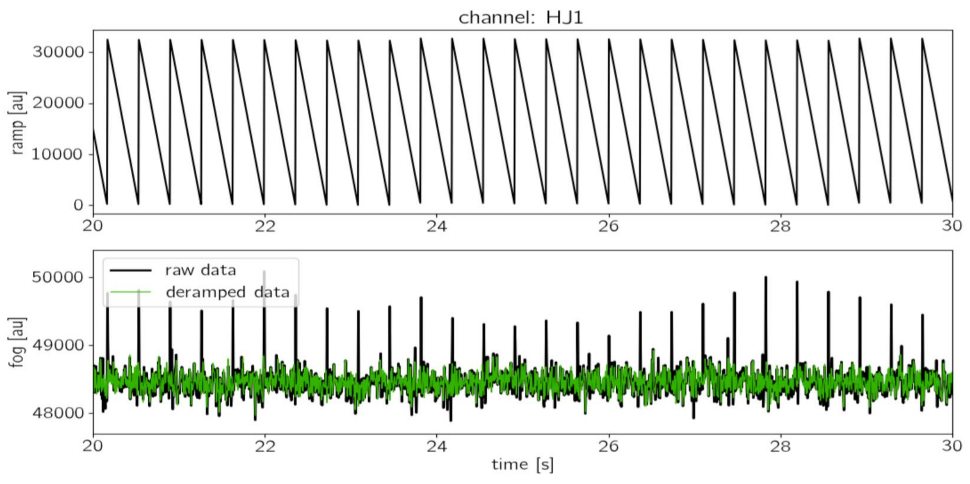
Fibre-Optic Rotational Seismograph use advantage digital systems for data processing. However, used DACs have limited accuracy, so the same artefacts can be observed in streams of data. This situation is generally solved by applying suitable filtering techniques - adequate especially for noise investigation. However, for data recording in real-time, artefacts general disturbed recording process. Although artefacts are easily recorded by human eyes even, at first sight, their automatic elimination is not so easy. Based on our previously research, there we propose a new concept of signal filtering to solve the above problem. Signal filtering is a two-step process. 1. - disturbance detection is performed, and unwanted artefacts are distinguished from the actual measurement signal (by using an algorithm based on the set of conditions with numerous parameters); 2.- eliminating the disturbance in the places indicated by the algorithm - along with the immediate surroundings. Elimination consists in subtracting the model form of the disturbing impulse so as to recreate the measurement signal as much as possible.

I: Deramping procedure

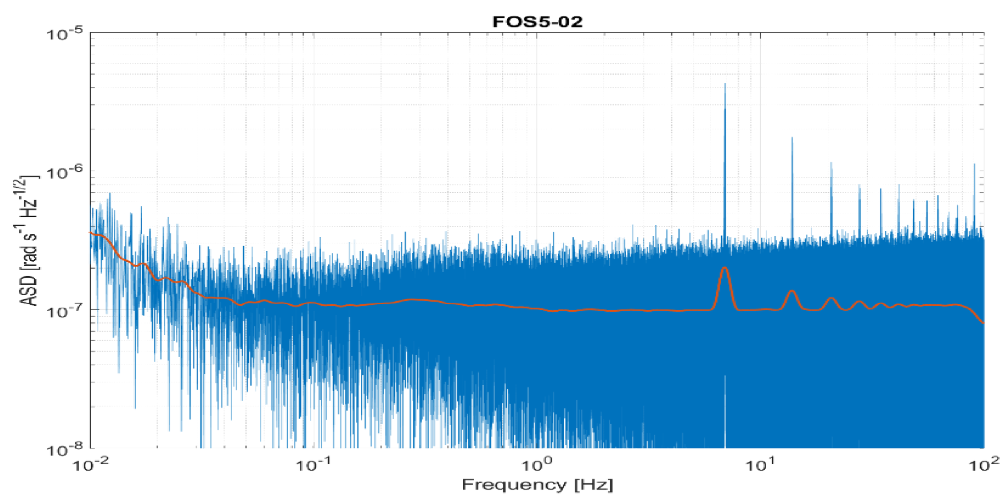




[A. T. Kurzych, *et al. Opto-Electron. Rev.*, **29** (2021), 39]



[https://github.com/fbernauer/blueseis_sandbox – thanks Felix Bernauer]



blue – raw data, red – Konno-Ohmachi filter with a smoothing coefficient 40.

II: Resamping procedure

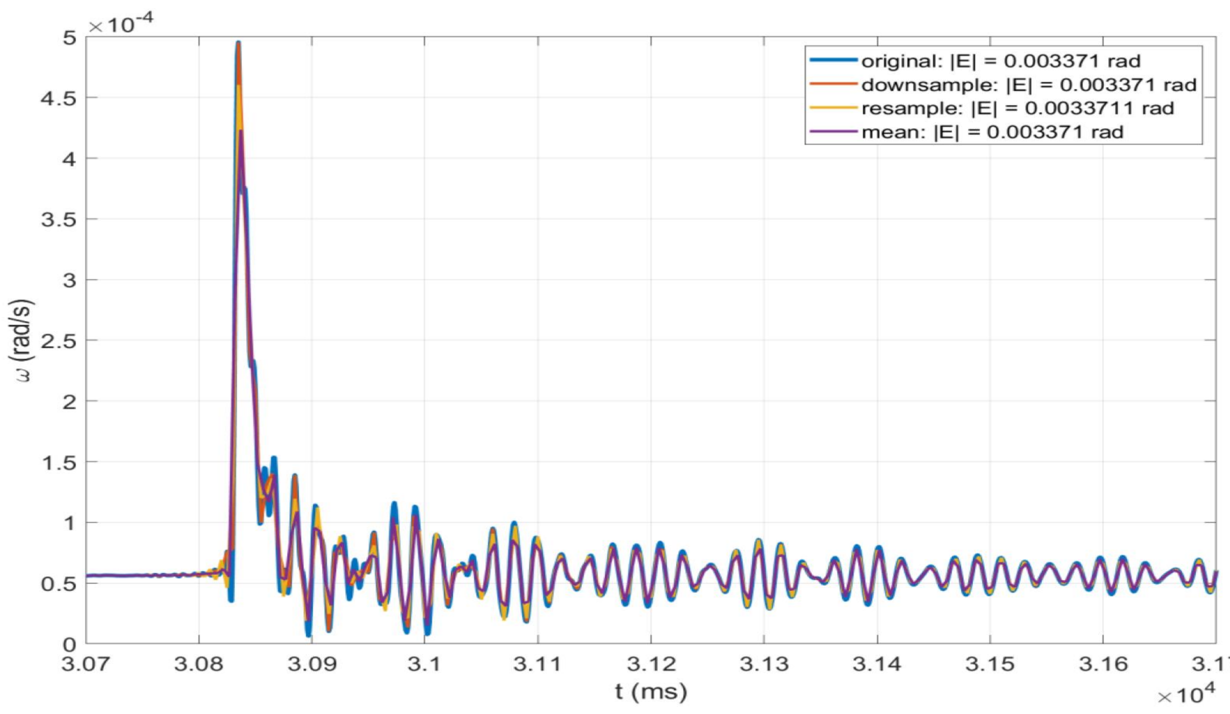
FOS5-01, -02 in field test Fürstenfeldbruck

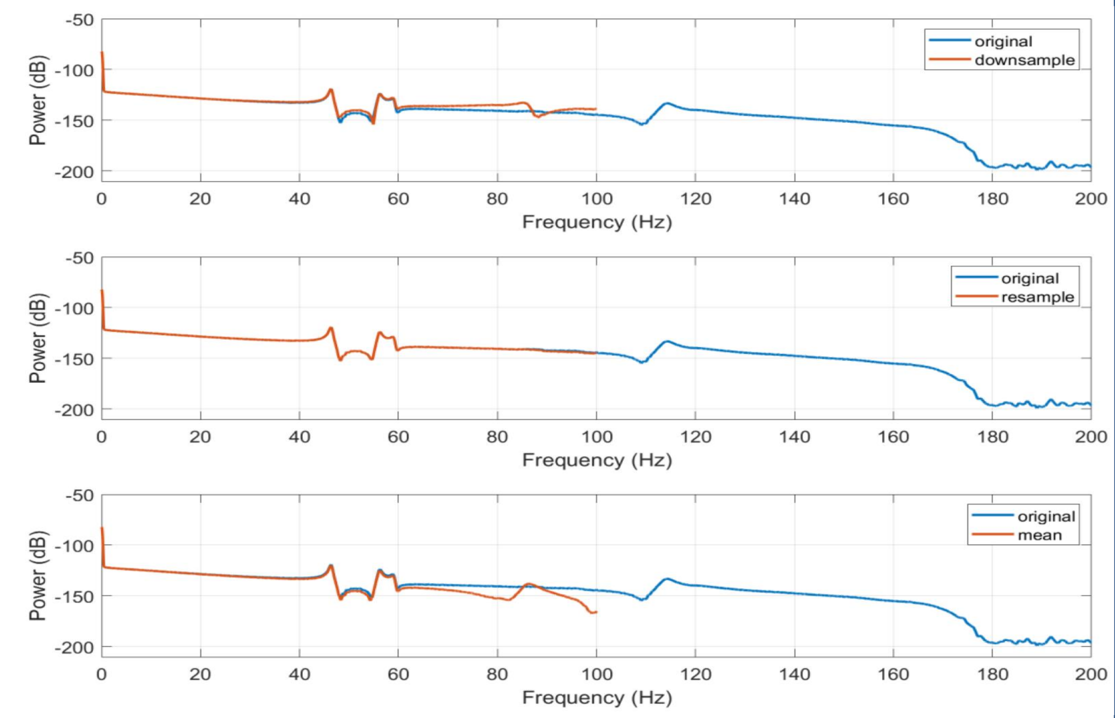
FOS5 – raw data 1000 Hz -> miniSEED 115 MB/h/channel => 24h miniSEED ~ 8.2 GB ☹☹☹ SeisGram2K needs to 80-100 MB → **resampling to 200 Hz.**

Downsample:<data(m)=rawdata[5(n+1)] n = [0, 1, 2, .., N-1] >

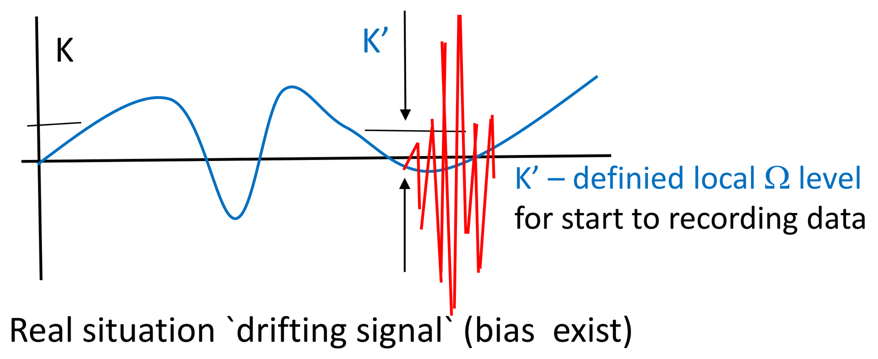
Resample: < trend elimin. -> FIR -> downsample -> delay compensate >

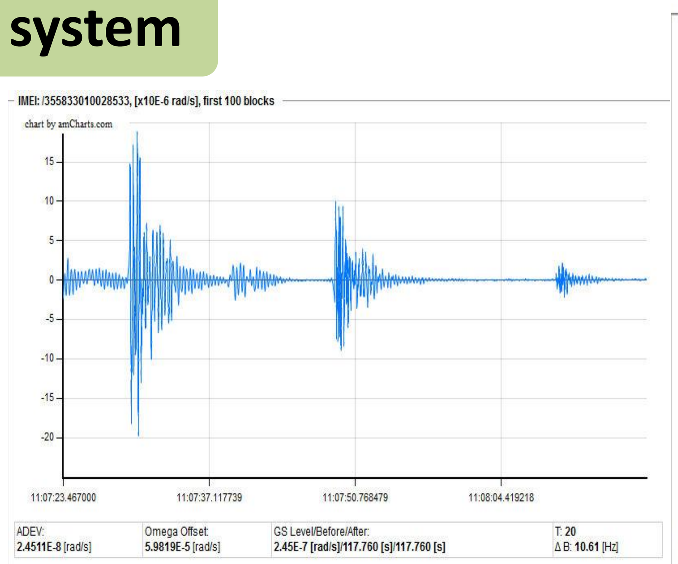
Means: < data=1/5$\sum_{i=1}^{5}$ rawdata(5*n+i), n=[0, 1, 2, …, n-1] >

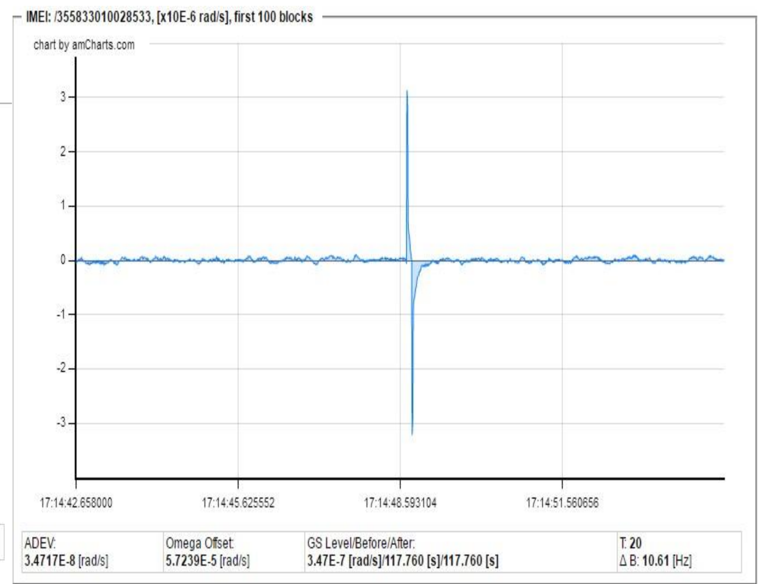




III: Artifacts correction – open-loop system





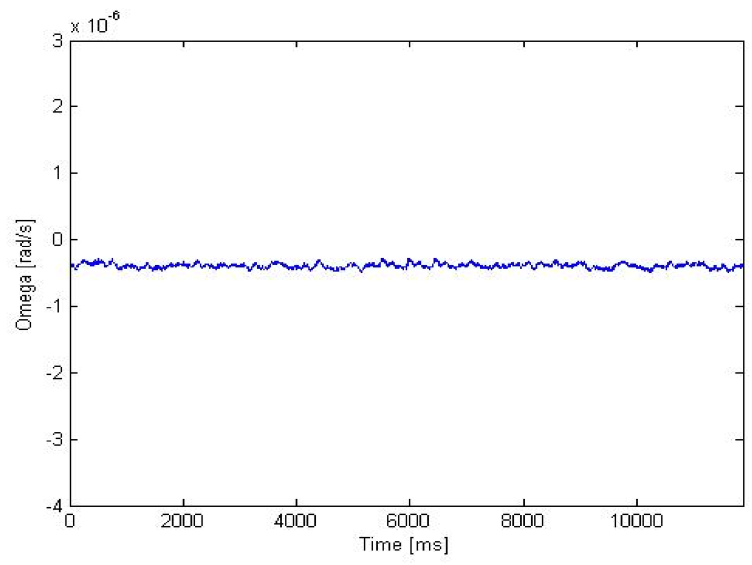


$$|\Omega_{av}(x_l)-\Omega_{x_l}| > \Delta\Omega_{av}(x_l)k_L \quad l=1,2,3,$$

$$\Omega(x_1)\Omega(x_2)<0;\quad \Omega(x_2)\Omega(x_3)<0,$$

$$0<x_2-x_1<t_L;\quad 0<x_3-x_2<t_L,$$

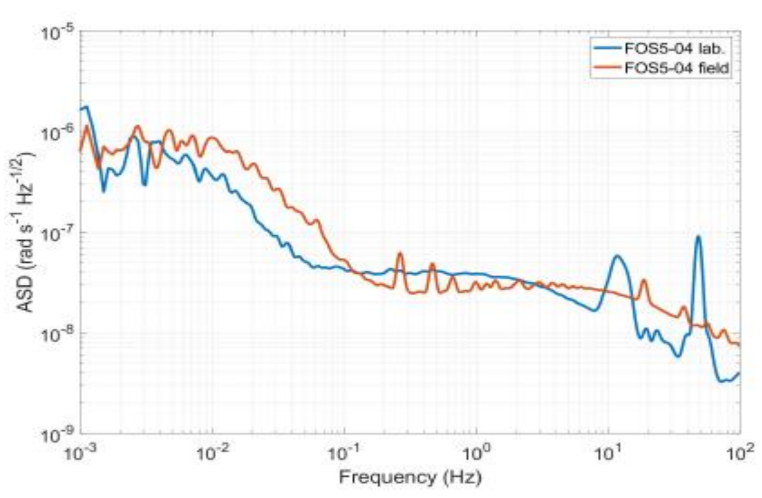
k_L – detection threshold,
t_L – time of detection chosen experimentaly

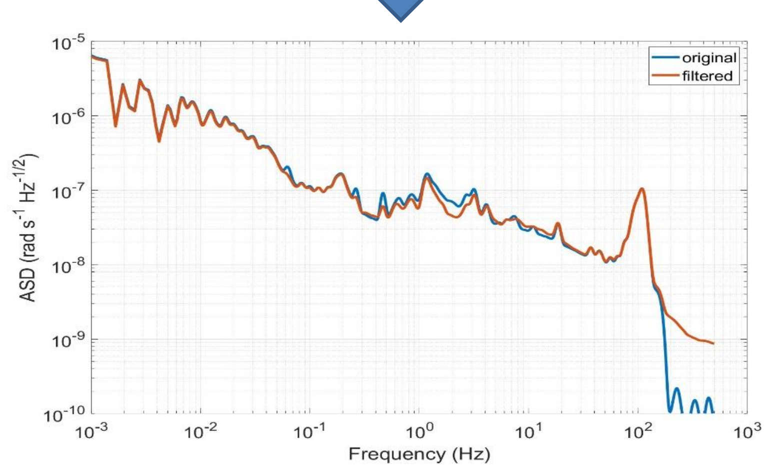


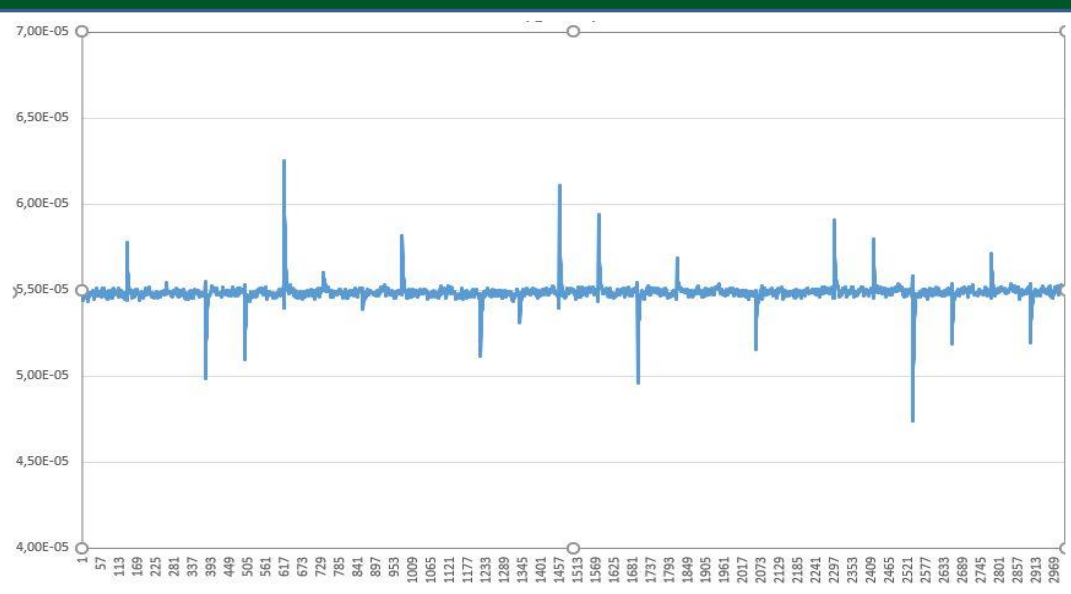
[A. Kurzych *et al., Opto-Electron. Rev.*, **24** (2016), 134]

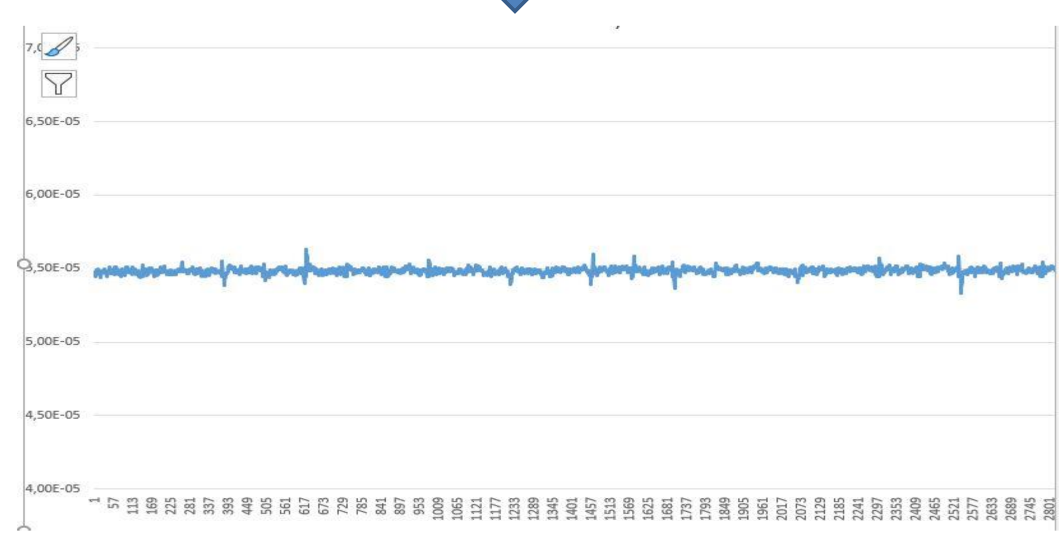
III: Artifacts correction – closed-loop system

FOS5-04 in Książ castle







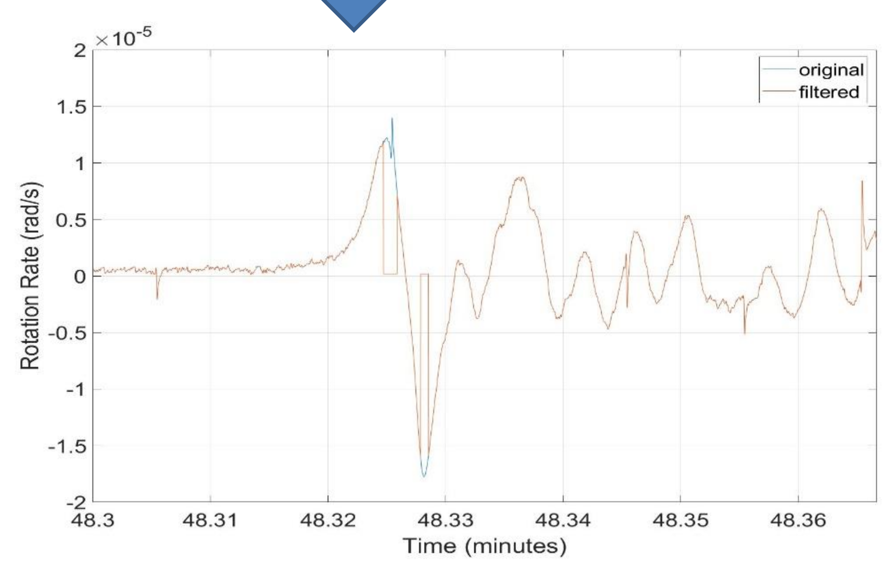


Step 1: artifacts detection:

1. local extreme with a value exceeding a specified number of times the average value of the original signal's modulus,
2. in their vicinity, selected samples have the same sign,
3. in the immediate vicinity of the sample there is no similar one but in the opposite sign.

Step 2: artifacts eliminating consists in subtracting the model form of the disturbing impulse so as to recreate the measurement signal as much as possible.

BUT



This research was financially supported by the Ministry of the National Defense of the Republic of Poland, Statutory activity of MUT as well as the National Centre for Research and Development, Poland project – POIR.01.01.01-00-1553/20-00