

bearing shifted by angular period characteristic to simulated type of bearing fault. Such representation takes under consideration phase-locked time-varying characteristic period of interest (related to instantaneous rotational speed). On the other hand, influence of varying speed and load is not yet taken into account. The bottom panel presents **amplitude modulated angular/temporal – deterministic signal** that takes into account both: varying period of interest as well as varying instantaneous amplitude of the simulated signal.

To present the performance of introduced model let us consider the signal consisting of six shaft-related harmonic component and one related to rolling element bearing. For simplicity both  $A_s(t; \dot{\varphi}(t), l(t))$  and  $A_b(t; \dot{\varphi}(t), l(t))$  characteristics presenting the relation between speed, load and amplitudes are given as first-order surfaces (figure 15).

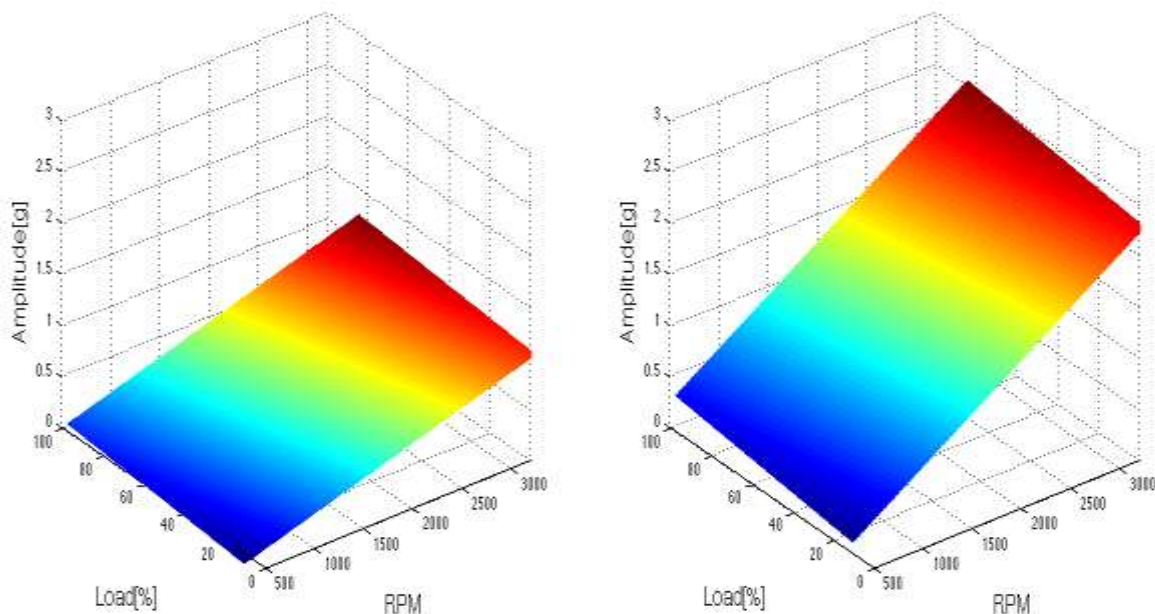


Figure 15.  $A_s(t; \dot{\varphi}(t), l(t))$  (left) and  $A_b(t; \dot{\varphi}(t), l(t))$  (right) characteristics used for simulation.

Additionally, component  $w(t)$  is given as a band limited noise of exponentially decaying amplitude (figure 12). Frequency of  $w(t)$  is ranging between 3 kHz and 5 kHz. Instantaneous speed and load profiles are presented in figure 16 respectively. Time-plot of resulting generated signal is presented on the bottom panel of figure 16.

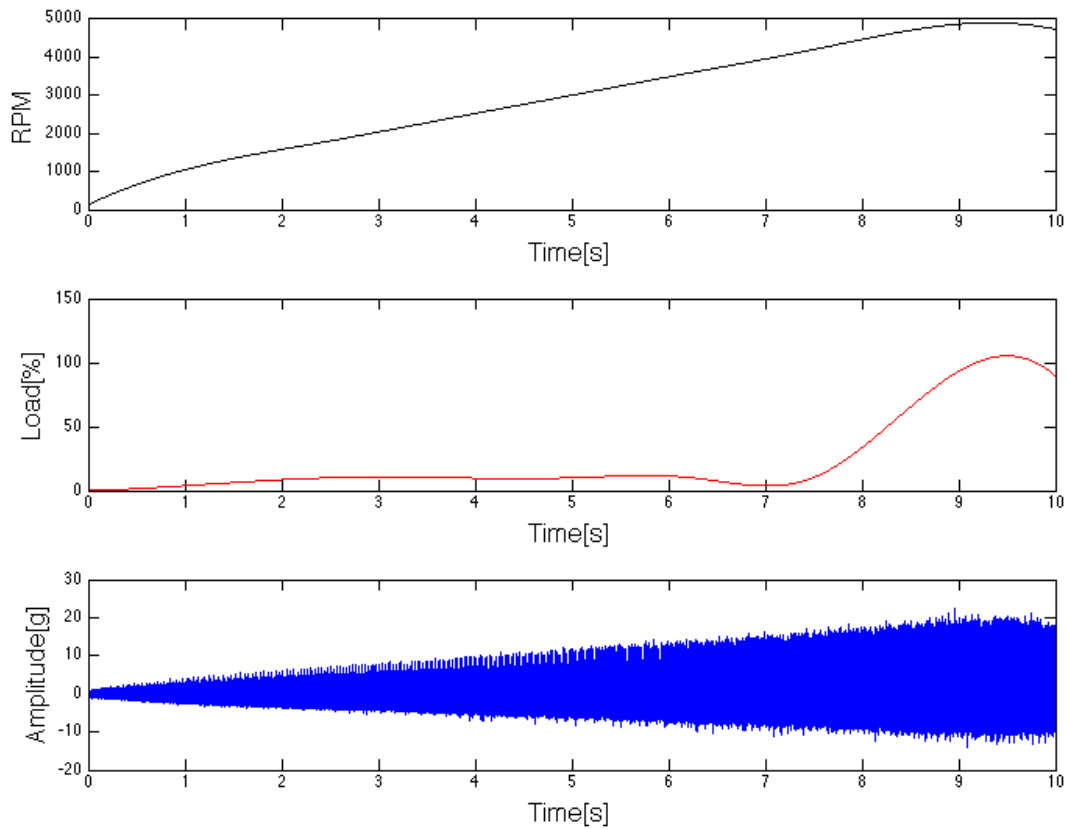


Figure 16. Instantaneous rotational speed profile used for simulation (top). Instantaneous load profile (middle). Resulting simulated vibration signal (bottom).

In order to illustrate non-stationary character of the signal we used spectrogram representation (figure 17).

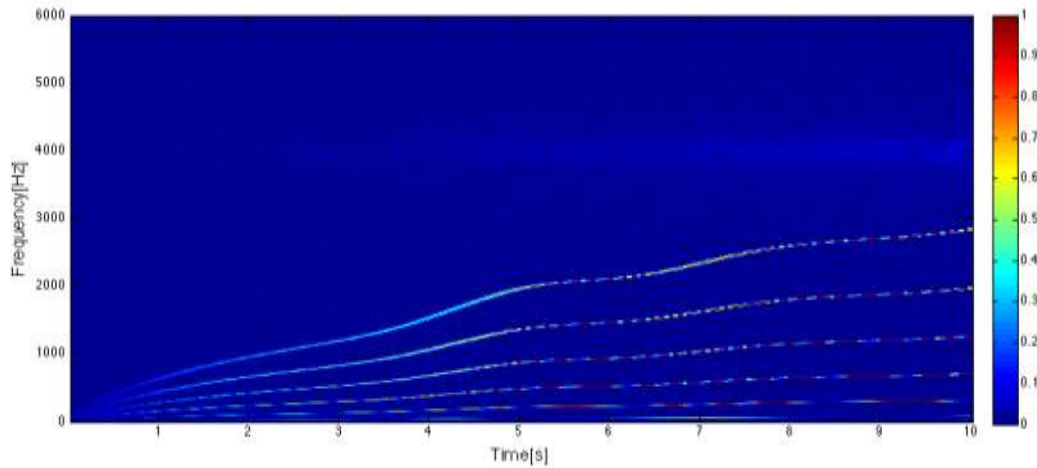


Figure 16. Spectrogram of simulated signal.

The presence of six harmonic components of varying instantaneous frequency can be clearly seen. Additionally, bearing related component manifest itself as a raised values of the amplitudes between 3 kHz and 5 kHz.

In general, the proposed class of signals is generally defined as combination of amplitude modulated angle-deterministic components:

$$s(t; \varphi(t), l(t))$$

and amplitude modulated angular/temporal – deterministic components:

$$b(t; \varphi(t), l(t))$$

and will be investigated in details in the next task. During task No.6, the team members will focus on the development of analytical formula for description of amplitude modulated angle-deterministic components and amplitude modulated angular/temporal – deterministic components. Moreover, on the basis of signals recorded on the test rig with highly variable operational parameters, some recipes for estimation of coefficients of the mathematical model will be given.

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## 6 Appendix A – Sessions with a damaged bearing

The Appendix A illustrates remaining 9 sessions controlled manually supplementary to the figure 1.

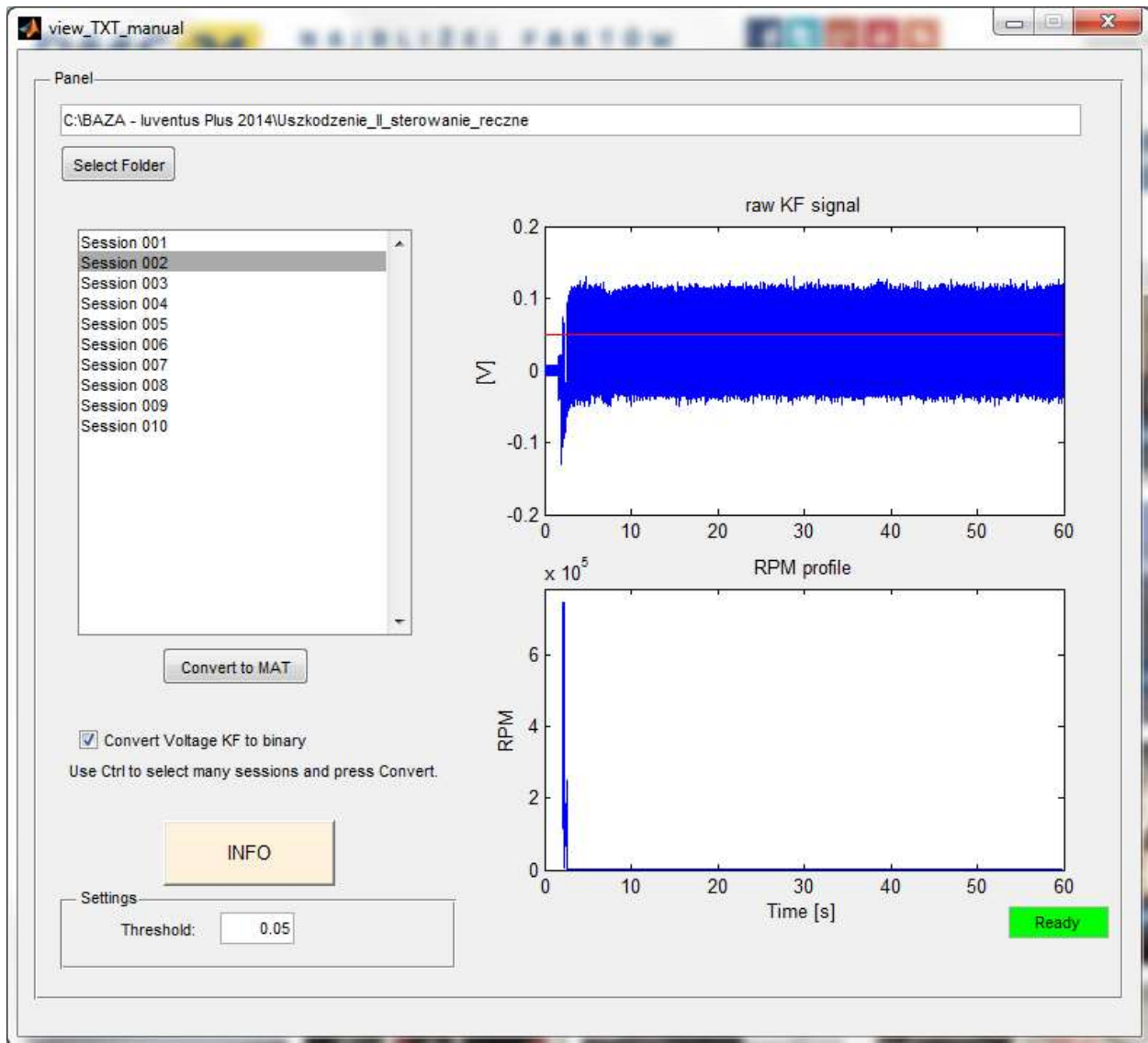


Figure Appendix A 1. Session 002

The Session 002 has been rejected due to improper phase marker readings.

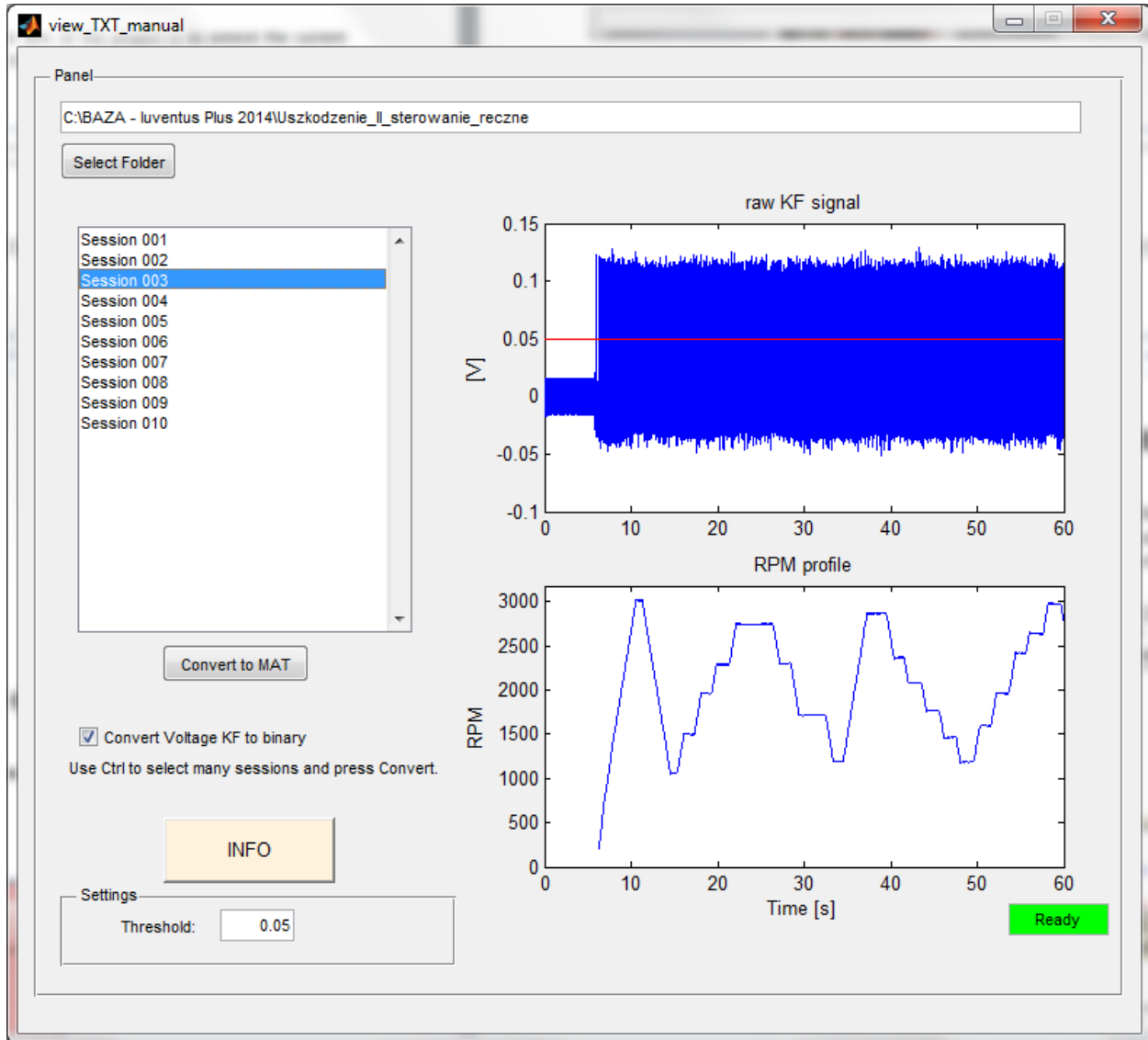


Figure Appendix A 1. Session 003

The Session 003 has been accepted for analysis.

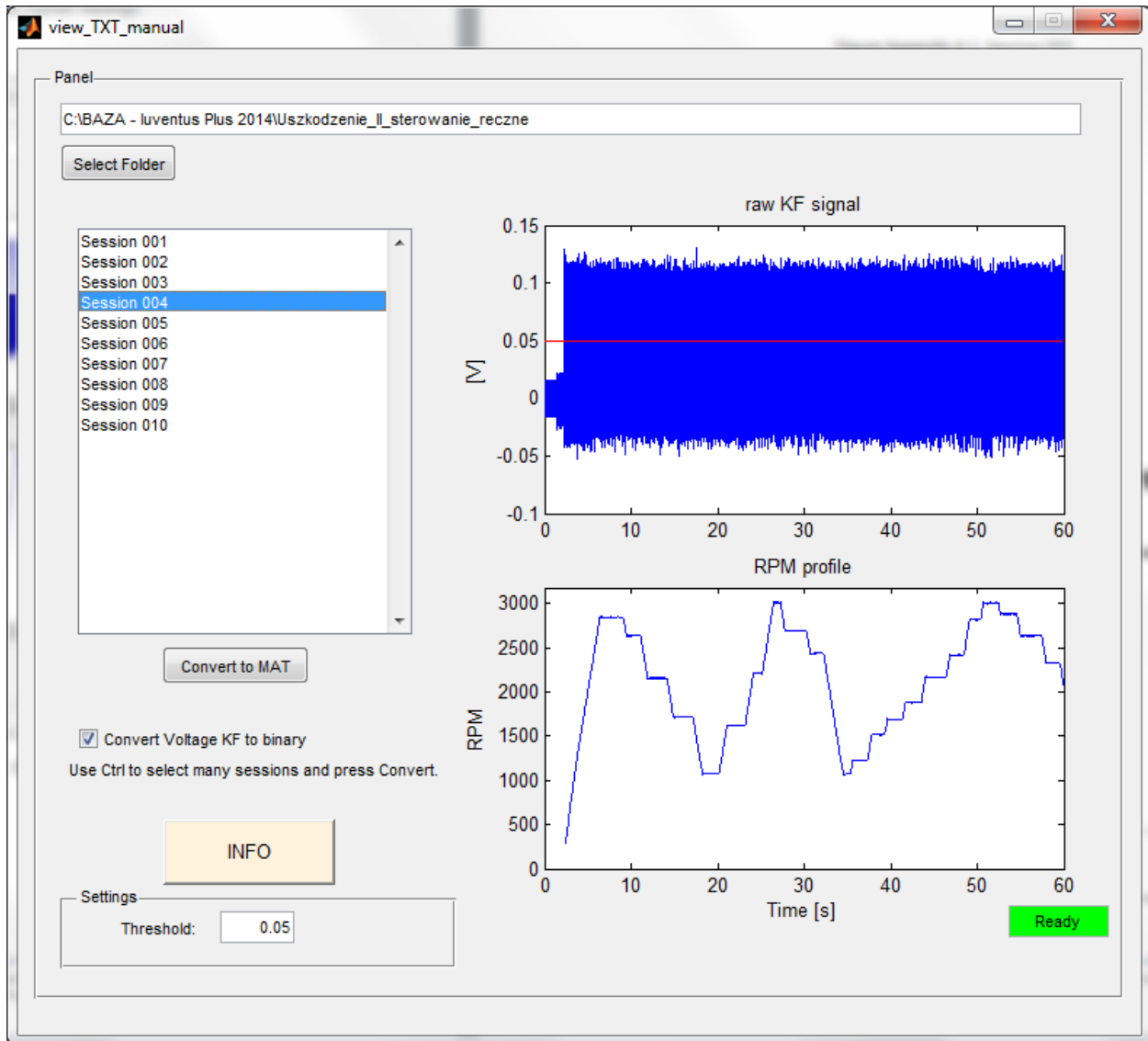


Figure Appendix A 1. Session 004

The Session 004 has been accepted for analysis.

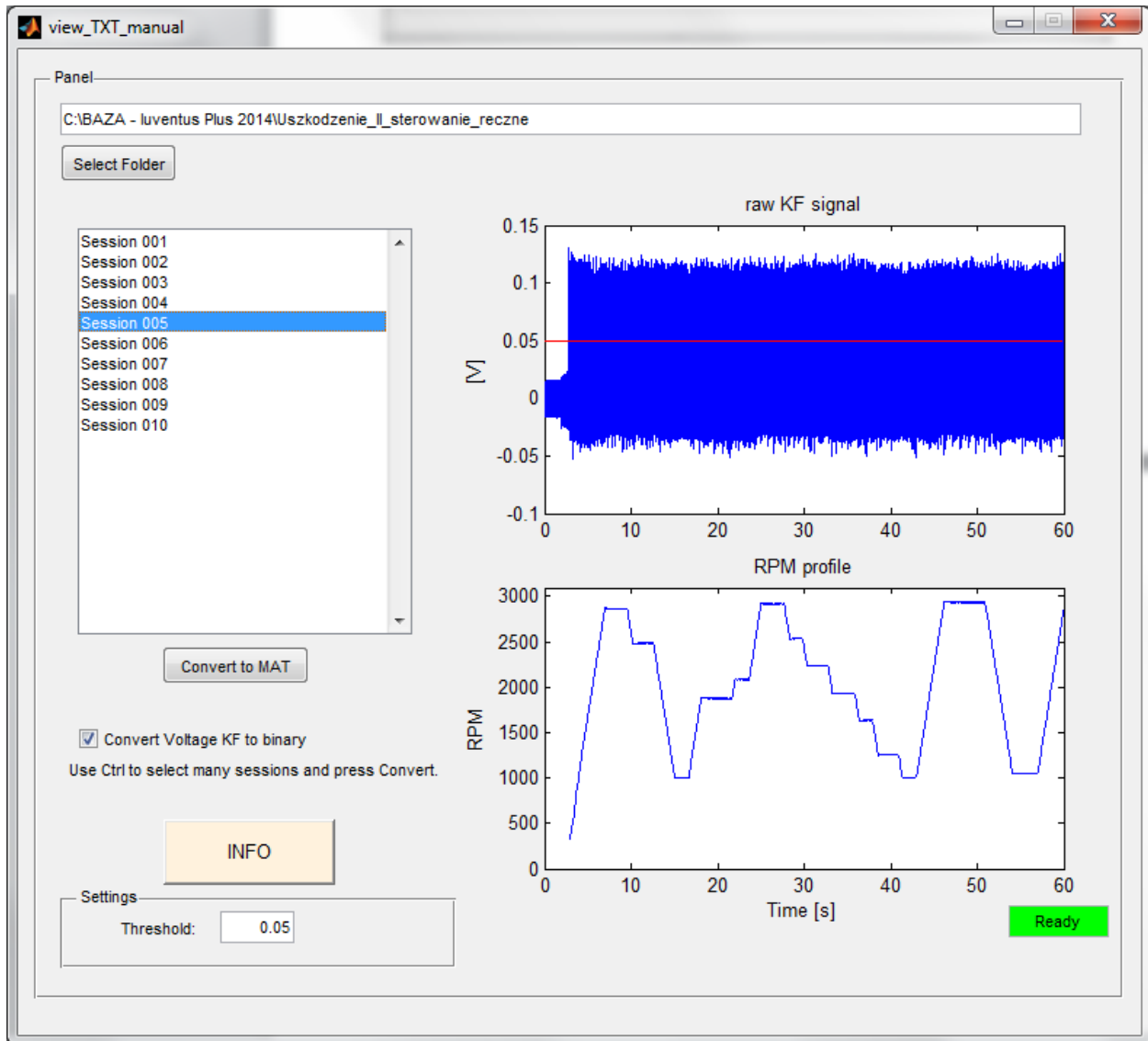


Figure Appendix A 1. Session 005

The Session 005 has been accepted for analysis.



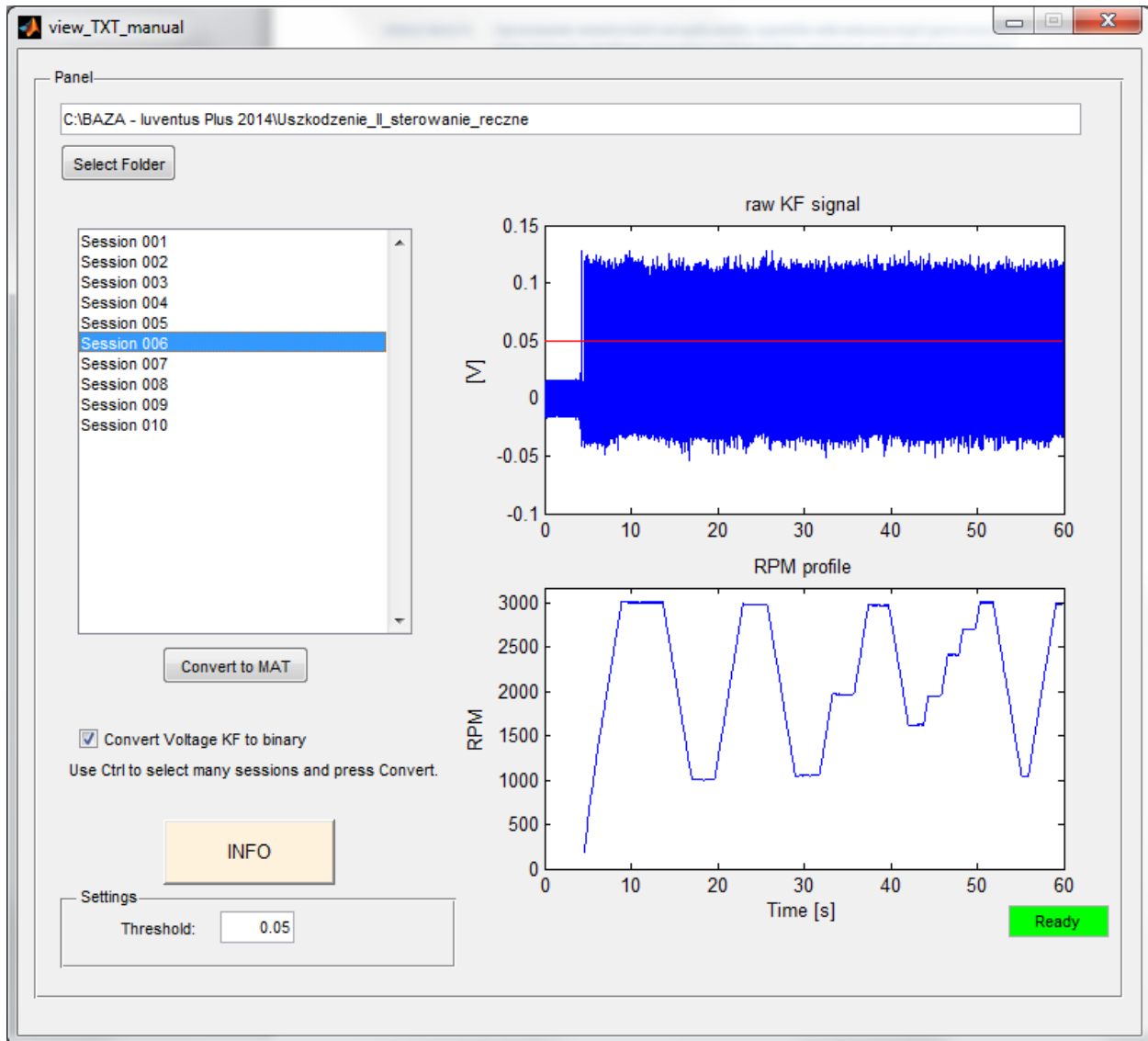


Figure Appendix A 1. Session 006

The Session 006 has been accepted for analysis.

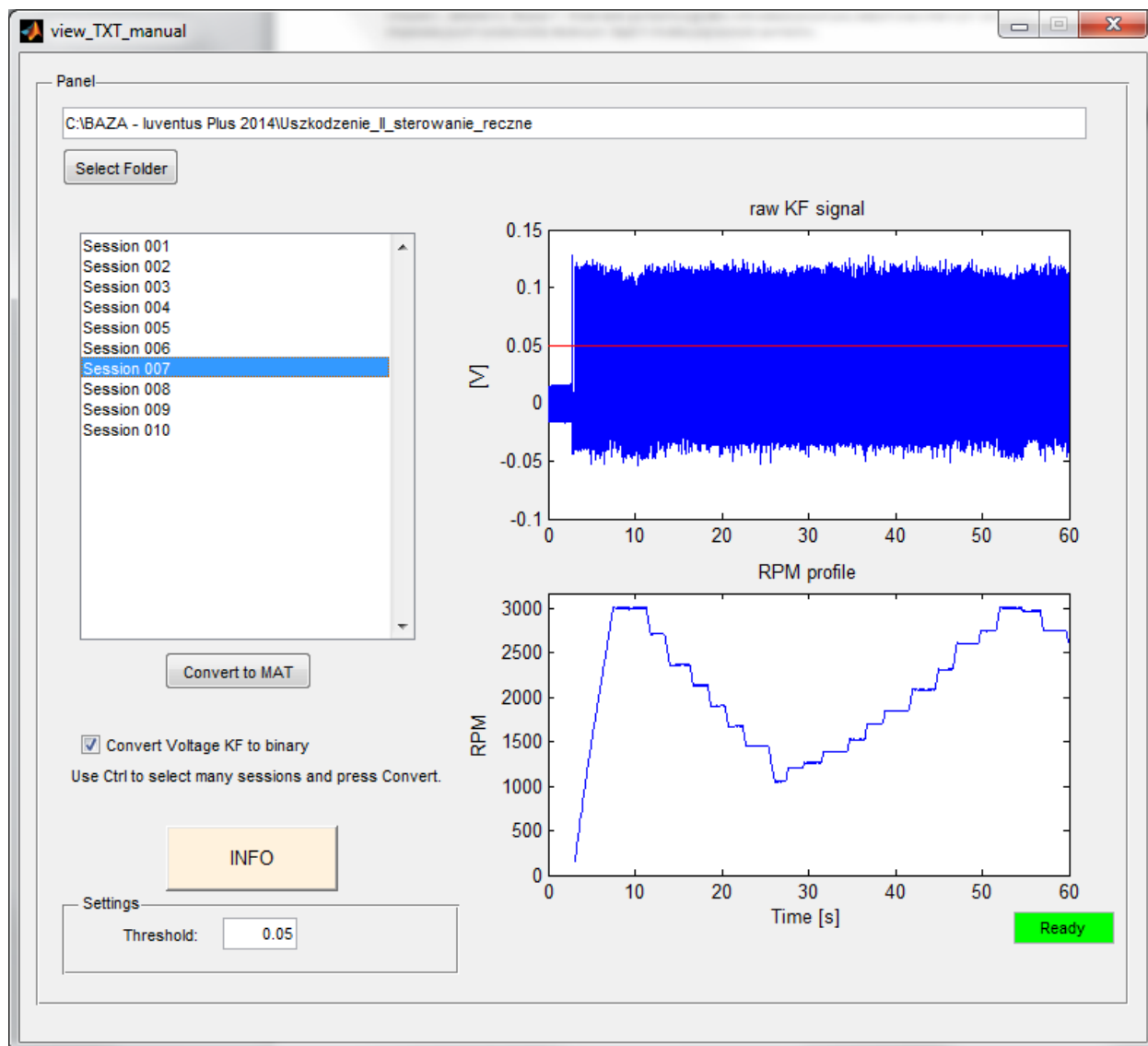


Figure Appendix A 1. Session 007

The Session 007 has been accepted for analysis.