Pulsed wire field measurements of 38-period superconducting undulator prototype

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Theory [wire-based measurement methods]

There are 3 wire-based methods. All of them are based on the similarity of the interaction of an accelerated charged beam and a conductor with an electric current with a magnetic field. The difference is which kind of current is applied to the wire:

- DC *(Displacement of the wire at the ends of the magnetic device are being explored)*
- AC *(Resonance vibrations of the wire are being explored)*
- Pulse *(A wave that occurs when a short current pulse applied to the wire is being explored)*

In the Pulsed method (PWM), a short (~ 1-100 μs) current pulse, from a unit to tens of amperes, is passed through a wire. Due to the influence of a magnetic field, the wire is deformed, then the resulting deformation propagates along the wire as the acoustic wave. This wave is detected by a wire position sensor located outside the undulator. Data from the sensor directly shows the first or second integral of the field, depending on the pulse duration.

PWM

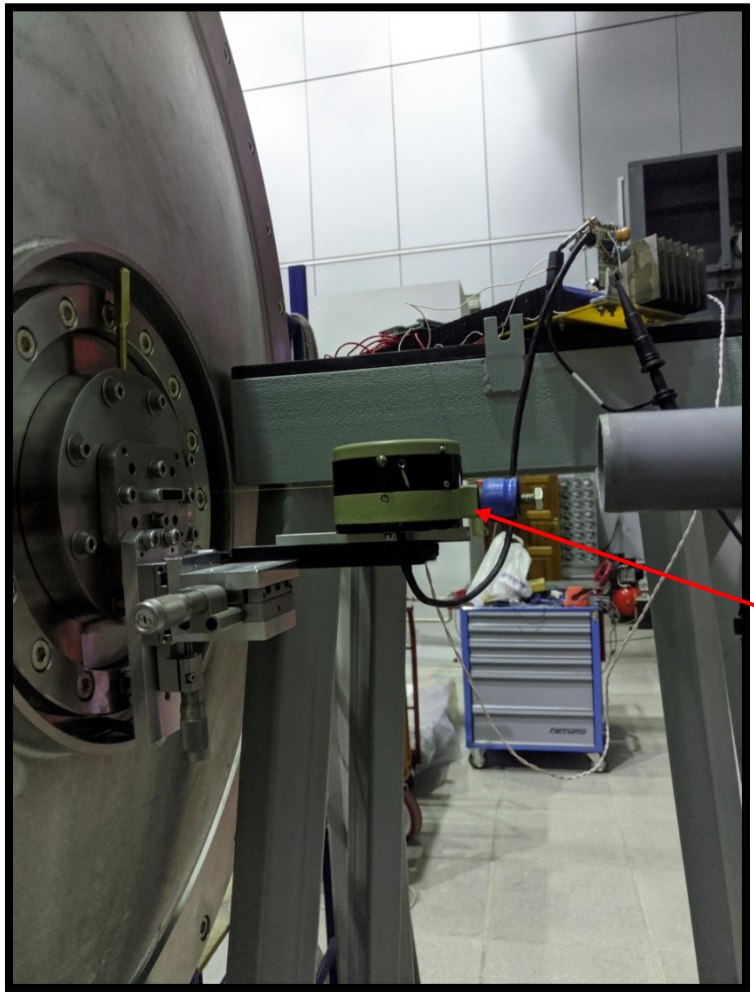
Advantages:

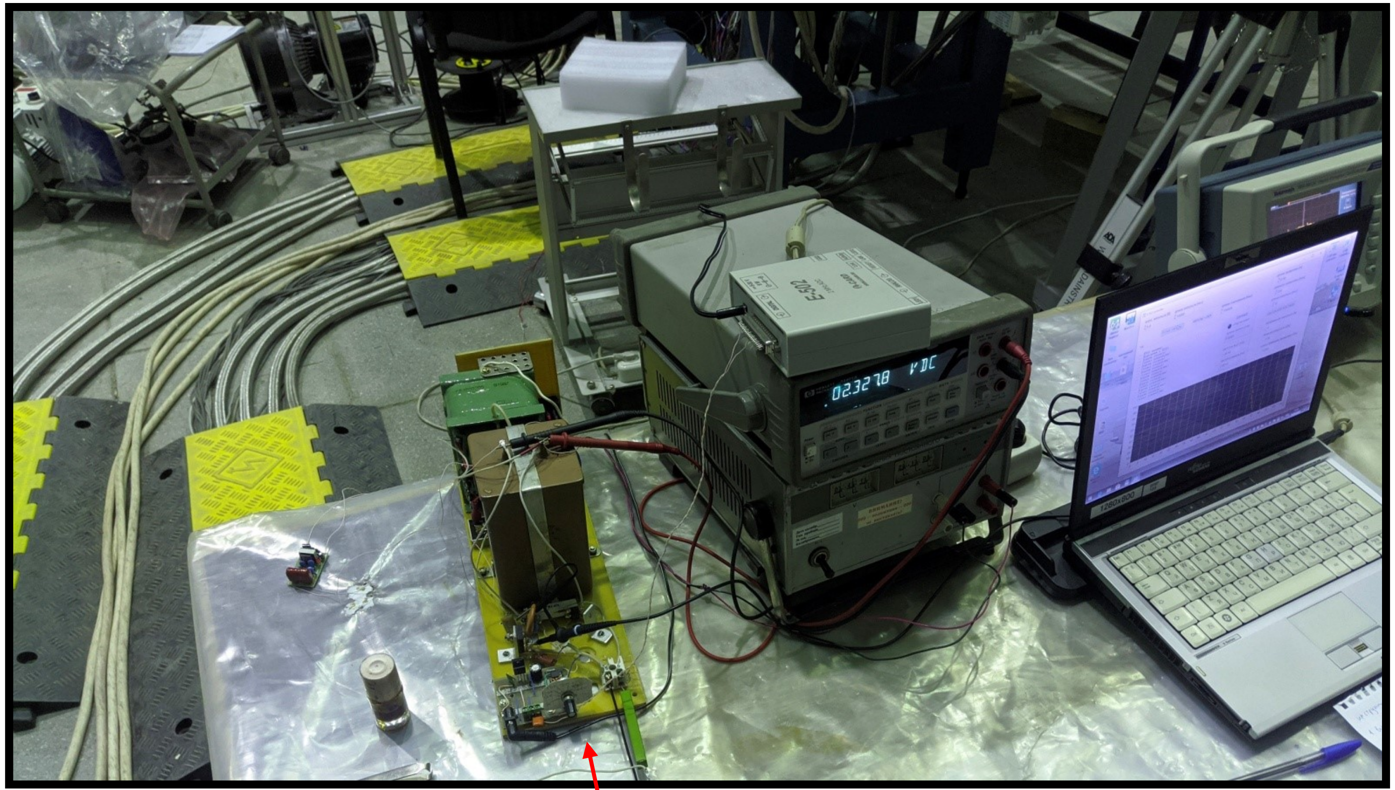
- *Almost* ***no limits on magnetic device aperture****. Wire diameter is close to typical beam transverse size (0.1 mm).*
- ***Rapid data obtaining.*** *Measurements can be made every few seconds.*
- ***Both transversal components can be measured simultaneously.***

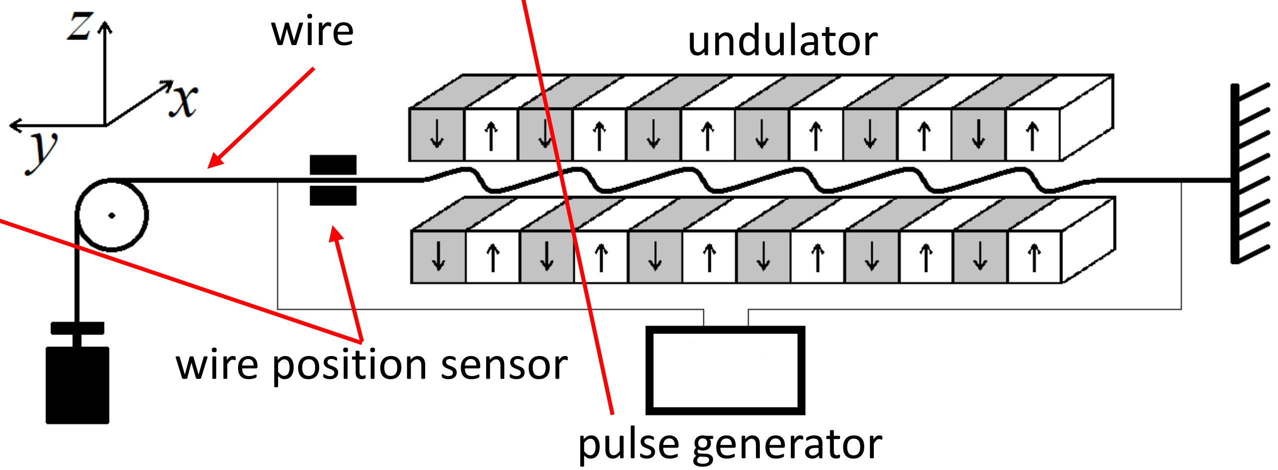
Disadvantages (problems):

- ***Wave dispersion.*** *Signal is need to be corrected via Fourier analysis.*
- *Wire is* ***very sensitive to vibrations*** *(incl. sounds) of the environment.*
- ***Wire sagging.***

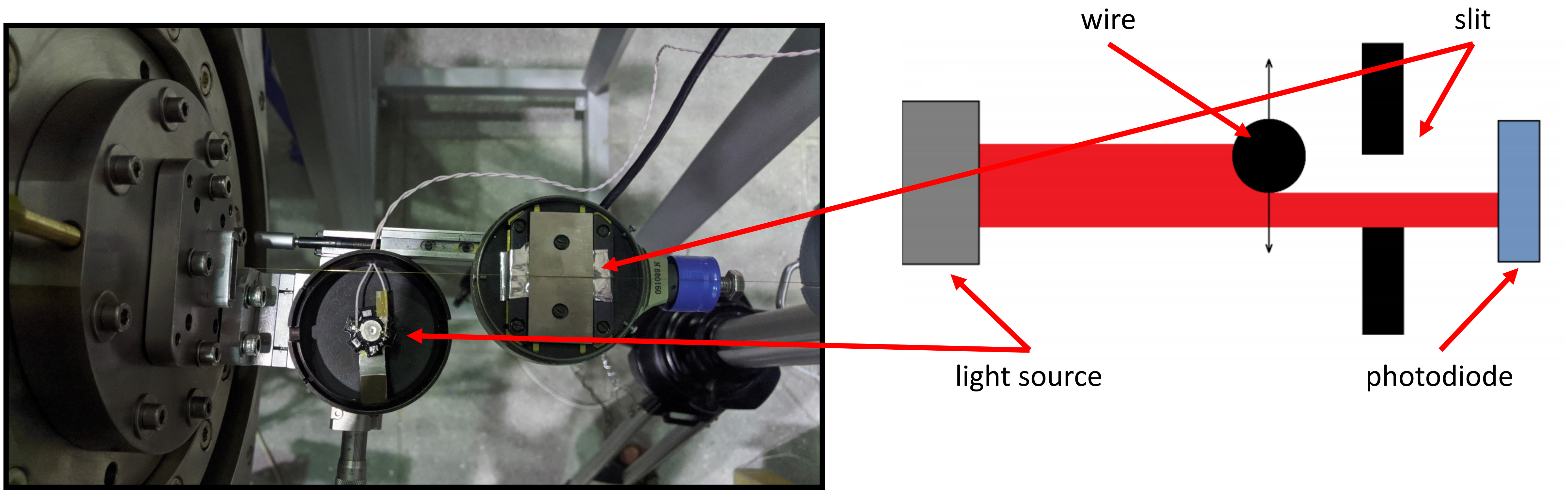
Experimental setup







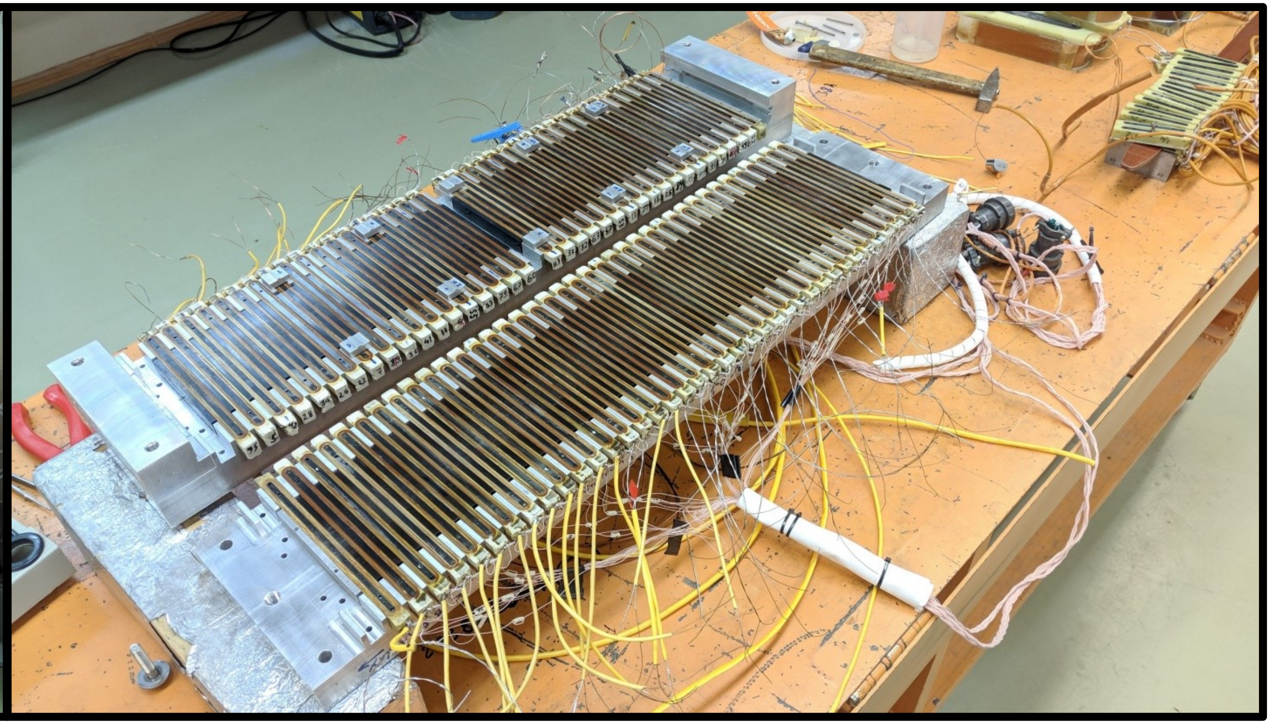
Wire position sensor



Test undulator (outside the cryostat)

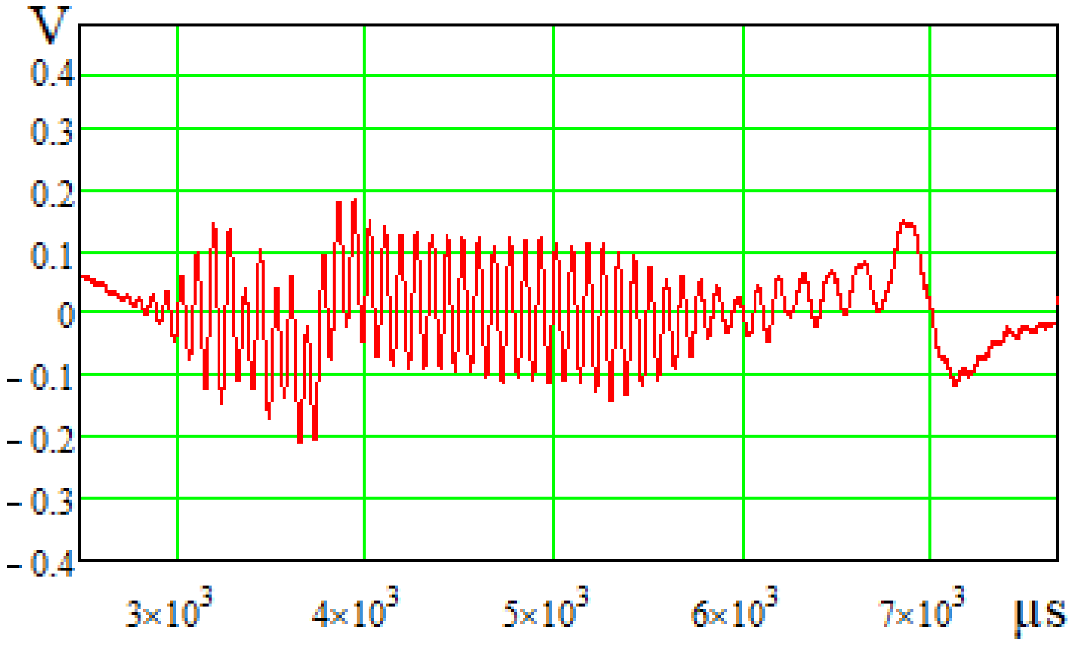
Parameters:

- Period ≈ 3 cm
- Field amplitude = 0.75 Tesla
- K ≈ 2.2

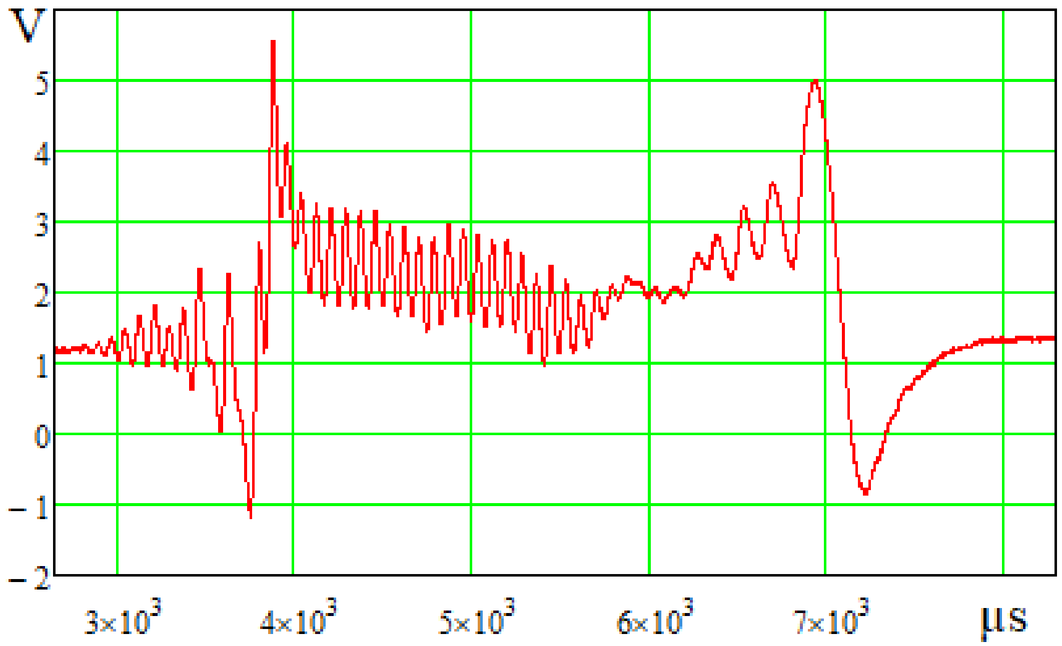


Results

[Raw data from wire position sensor, CuBe wire Ø200 µm]



35 A
5 µs



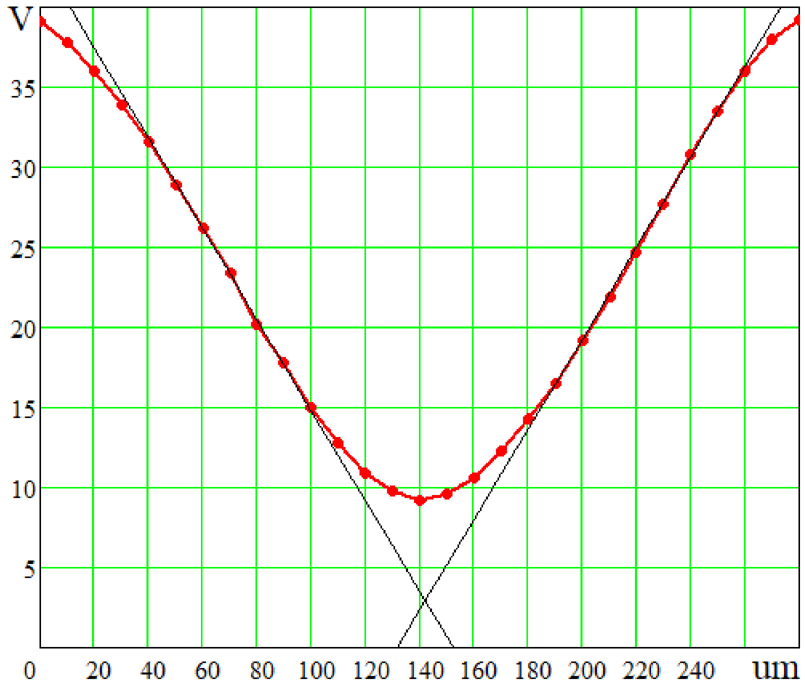
35 A
100 µs

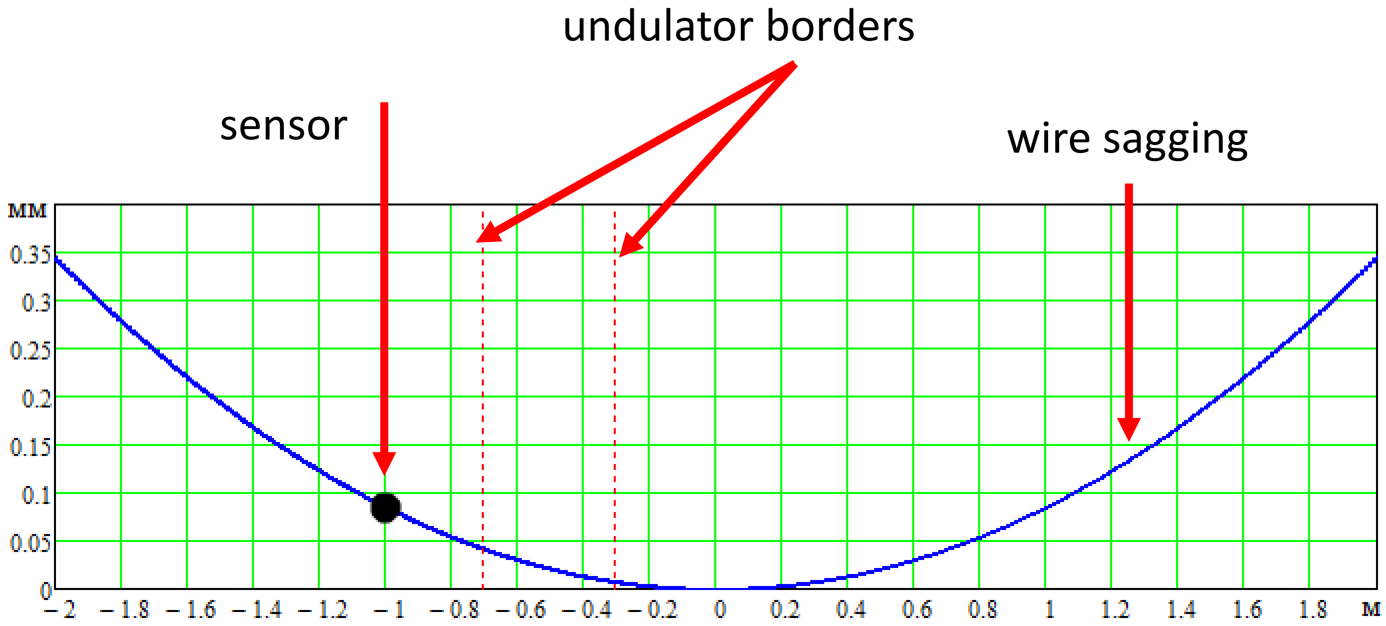
Results

[“preparations”, brass wire Ø140 μm]

Calibration curve of wire position sensor

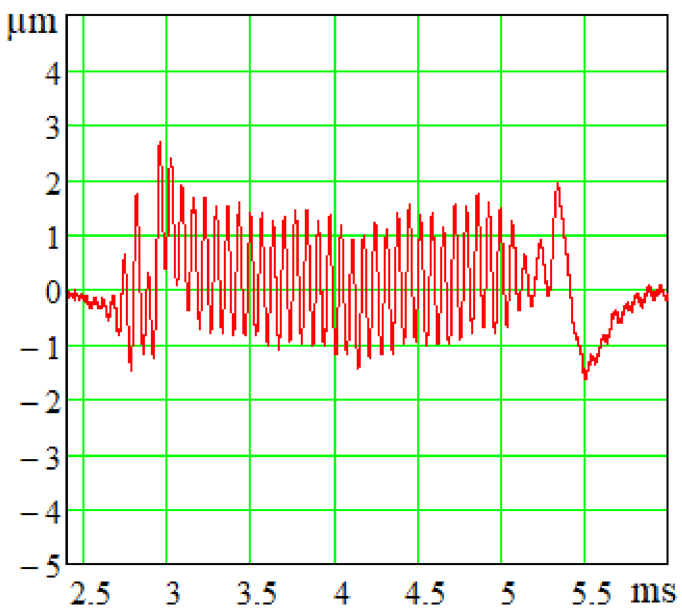
Sensitivity – 0.283 Volts/μm



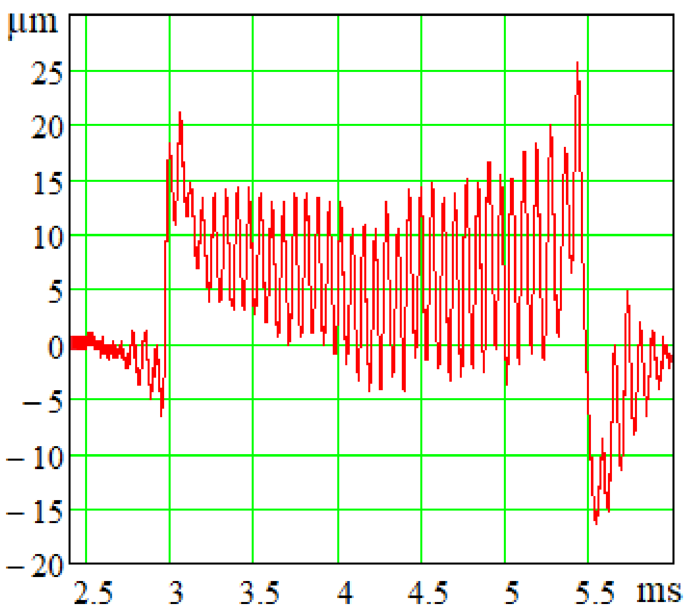


Results

[Raw data from wire position sensor, brass wire Ø140 µm]

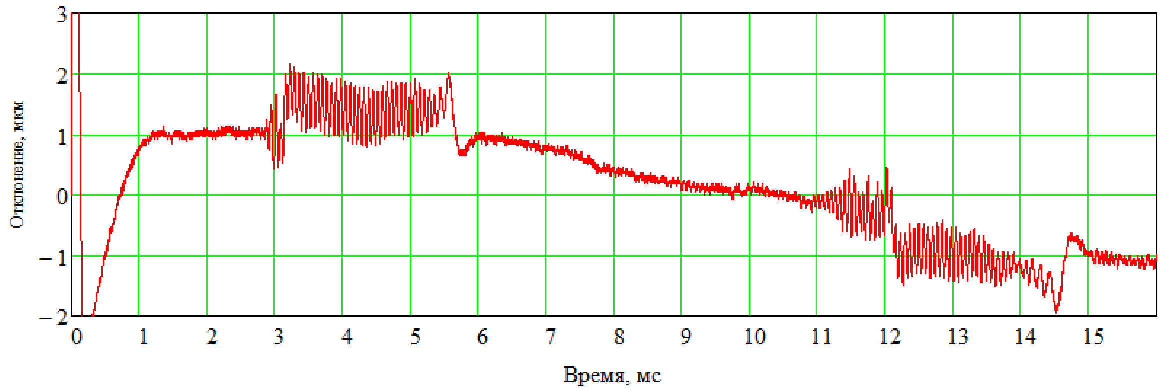


30 A
10 µs



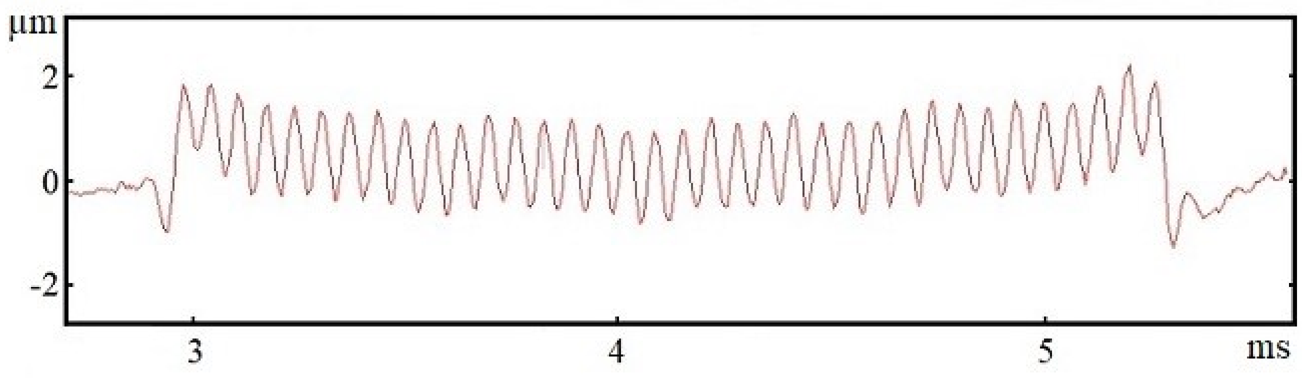
30 A
100 µs

Wave reflection

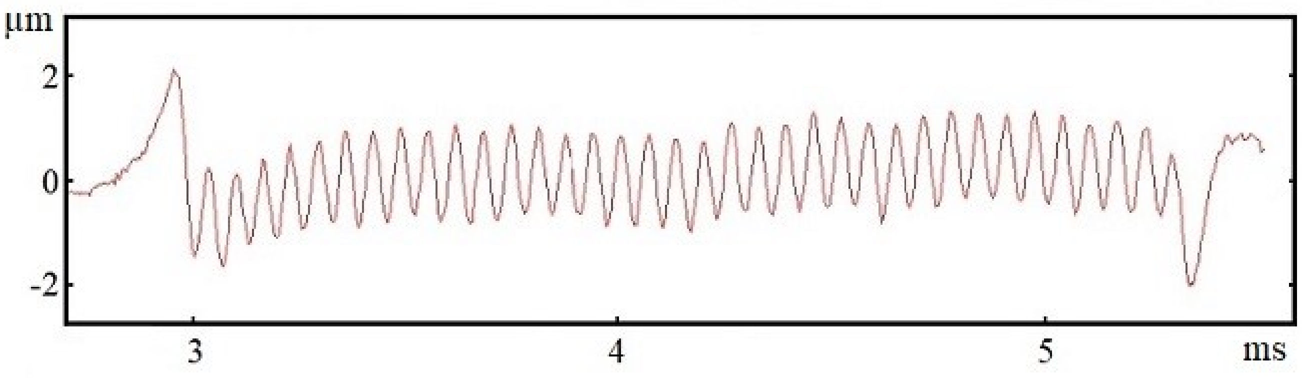


Results

[reconstructed, brass wire Ø140 µm, 30 A 10 µs pulse]



60+160 A in SC coils

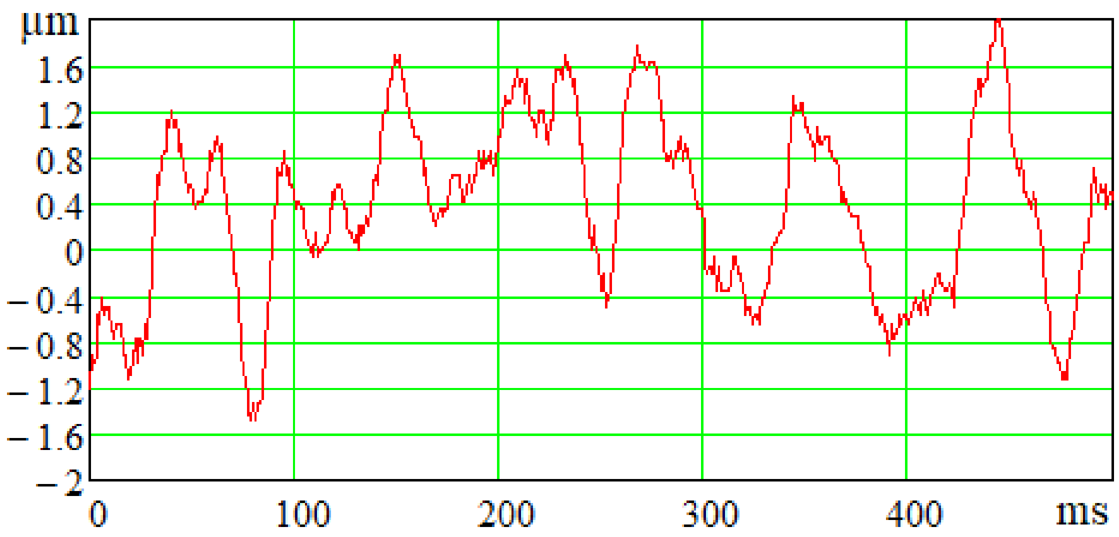


160+60 A in SC coils

Further work

- Find the dependence of wire displacement on field amplitude and integral value
- Obtaining 1st and 2nd field integrals separately from each other

- Wire vibrations (caused by environment) suppressing:



Thank you for attention!

Note: *This paper is based on my bachelor diploma work and will be continued*