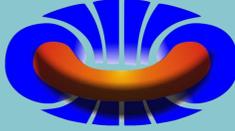


Novel rotating coil setup for the definition of the magnetic field quality for XFEL magnets



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Abstract: The definition of the magnetic field quality is important part for the accelerator magnets production. The quadrupole magnets which are situated in the accelerator beam line have to be characterized with respect to magnetic axis stability and higher field error. The paper presents a rotating coil setup which provides synchronized measurements of the magnetic axis stability and harmonic analyses at the different currents as well as higher order field error. The described rotating coils setup was used for the acceptance tests of the normal and superconducting dipoles and quadrupoles magnets.

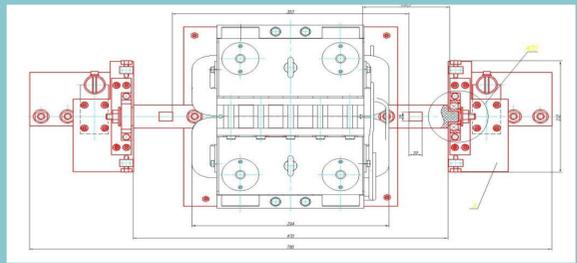
Rotating coil method

Setup for harmonic analyses and definition of the magnetic axis stability



The National Instruments hardware

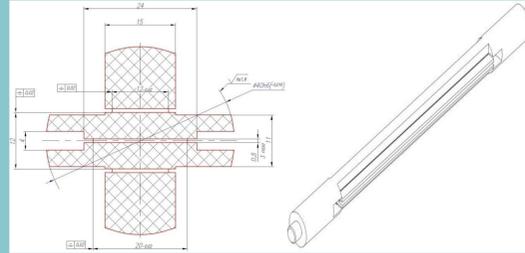
- The automated control system comprises:
- chassis NI PXI-1042;
 - Controller NI PXI-8119;
 - 4-input channel 24-bit NI PXI-4462 ADC;
 - NI PXI-7330 motion controller;
 - universal motion interface UMI-7772;
 - position sensor;



The LabView software

- The measurements are monitored by LabView software in order to provide:
- control of the measuring unit;
 - data acquisition;
 - digital filtering;
 - data array processing;
 - integration;
 - tabular and graphic data representation.

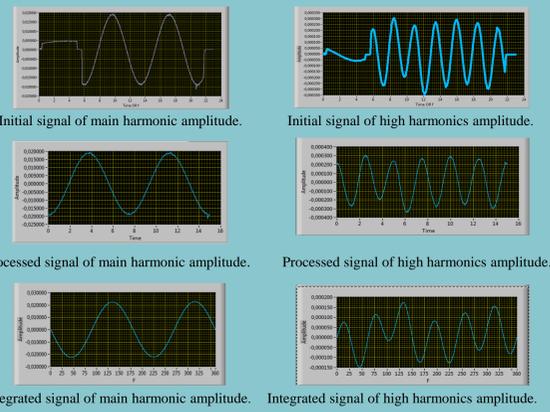
Type of rotating coil



- Construction has four coils:
- quadrupole coil;
 - high harmonic coil;
 - dipole coil;
 - central coil for magnetic axis.



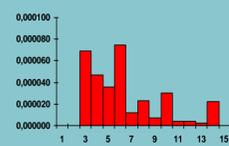
The results of processing and integration



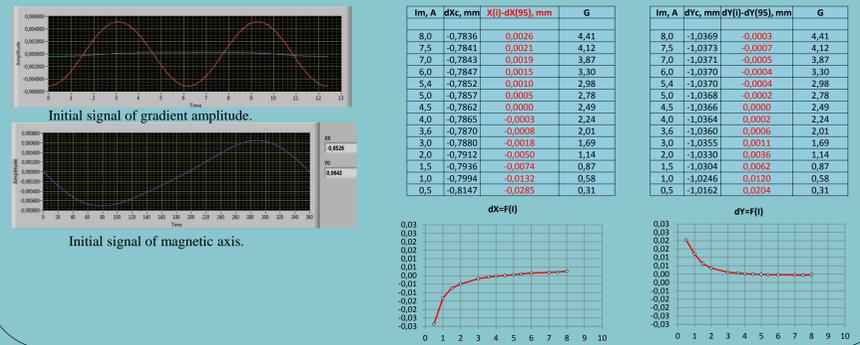
Fourier analysis results

K	a(k)	b(k)
3	0.000005	-0.000069
4	-0.000014	0.000044
5	0.000025	0.000025
6	0.000009	0.000074
7	-0.000011	0.000005
8	0.000008	0.000021
9	-0.000001	-0.000006
10	-0.000002	-0.000030
11	0.000000	-0.000001
12	-0.000003	-0.000003
13	0.000001	-0.000001
14	0.000001	-0.000022
15	0.000000	0.000028

$S = \sum_{k=1}^n (a_k^2 + b_k^2)$



The definition of the magnetic axis stability



Types of used board with Hall probes



- Characteristics of Hall probes:
- Residual voltage – 20 μ V,
 - Temperature coefficient of sensitivity – 0,005 %/C,
 - Temperature coefficient of residual voltage – 0,8 μ V/C,
 - Magnetic sensitivity – 732,1 μ V/ μ T (B=0,1 T),
 - Nonlinearity coefficient – 0,5 % (B=2 T),
 - Temperature range – 1,5-373 K.

Hall probes method

3-axis coordinate device



modified 3-axis device



example of using modified device

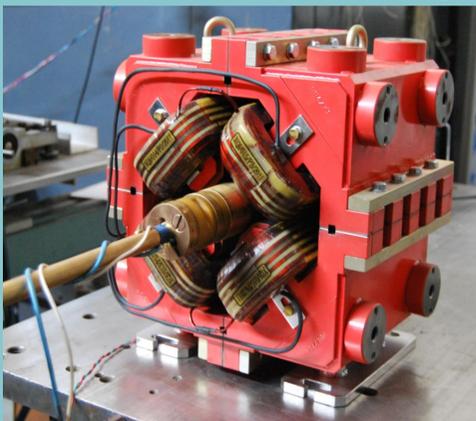


- Characteristics of 3-axis coordinate device:
- Horizontal moving range 1000 mm,
 - Vertical moving range 400 mm,
 - Longitudinal moving range 400 mm,
 - Location error \pm 50 μ m.

- Characteristics of modified 3-axis device:
- Horizontal moving range 1000 mm,
 - Vertical moving range 400 mm,
 - Longitudinal automated moving range 1180 mm,
 - Location error \pm 35 μ m at step 5 mm,
 - Maximum velocity of moving 2 mm per second.

Types of tested magnets

quadrupole



dipole



HTS dipole



superconducting solenoid



Conclusions

A modified measuring setup is described that was applied to testing laboratory magnets. The measurement accuracy was validated in comparison with experimental results obtained with common testing facilities. The using of the rotating coil has reduce the time and accuracy of measuring because of same time measuring harmonic analyses and the magnetic axis stability. In the near future this setup will be used for field mapping of 6 T superconducting solenoid and acceptance test of the HTS magnets.