THE MAIN TEST RESULTS OF THE 3.5 TESLA 49-POLE SUPERCONDUCTING WIGGLER FOR DLS

E. Bekhtenev, S. Khrushchev, N. Mezentsev, E. Miginsky, V. Shkaruba, V. Tsukanov,
BINP, Novosibirsk, Russia

Abstract

3.5 Tesla 49-pole superconducting wiggler with 16 mm magnetic gap and 60 mm period for Diamond Light Source (England) has been fabricated in Budker INP. A first wiggler test was carried out in bath cryostat in BINP on July 2005. The first wiggler test in own cryostat was performed in BINP on January 2006. This test includes field integrals measurements with stretched wire method and field measurements with hall probe. All this measurements were repeated on April 2006 in DLS. Design of special magnetic measurement system with anti-chamber and main wiggler tests results are presented in this paper.

WIGGLER TEST IN BATH CRYOSTAT

After fabrication and assembling of the wiggler's magnetic system it was tested in the bath cryostat. The first goal of this test was to achieve requested magnetic field value. Total number of the quenches made during training is 24 (see Fig.1). First quench occurred with power supplies currents Is=254 A Ic=254A and corresponded to average magnetic field of 3.022 Tesla. All quenches occurred inside different coils with trend of increasing of the field.

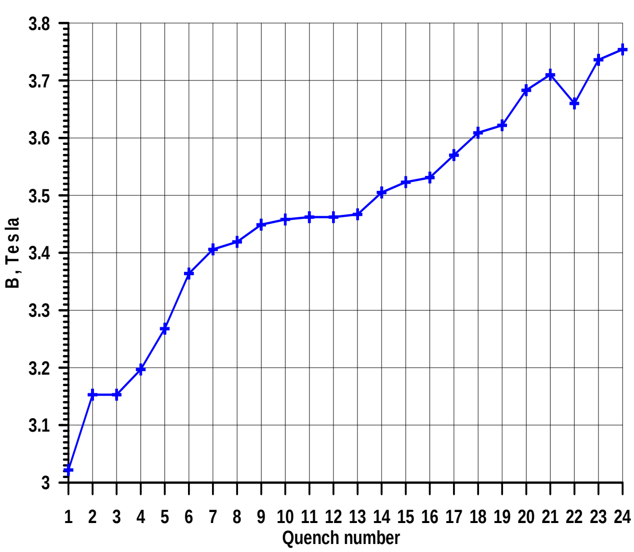

Figure 1: Quench history during bath wiggler test.

The second goal of this test was to receive magnetic field map in wiggler median plane. The magnetic field measurements have been carried out by using the five LakeShore Hall probes array which had been placed inside liquid helium at 4.2K. The Hall probes were mounted on the rotatable disk with 90 degree rotating angle. In spite of the fact that the Hall probes were previously calibrated at 4.2K and high level field there is no guarantee that calibration will be the same after secondary cooling down. In order to increase the field measurements quality the relative calibration procedure was done first. For such calibration procedure Hall probes array was rotated in longitudinal direction. In such case all probes were going by central line following one another. The next measurements have been carried out when the probes are situated perpendicularly to the moving direction. After this measurement we had magnetic field map in median plane.

By using measurements of five Hall probes we could estimate transverse quadrupole and sextupole components (see Fig.2 and Fig.3).

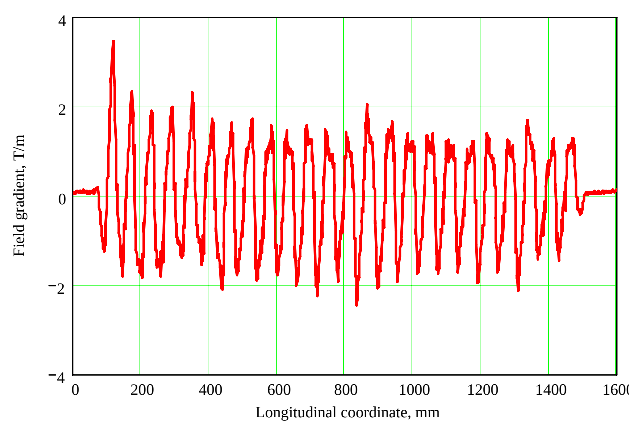

Figure 2: Field gradient along the wiggler estimated with use of 5 Hall probe array.

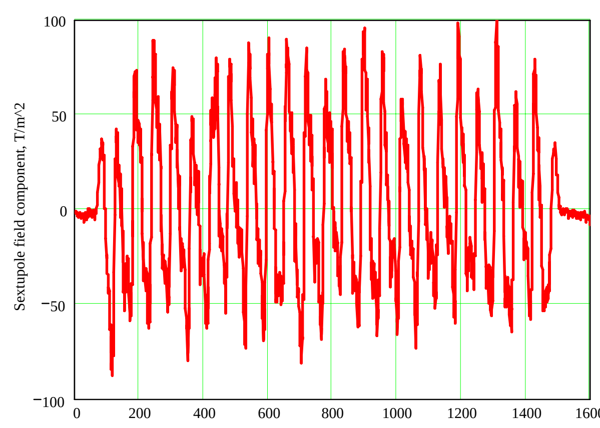

Figure 3: Field sextupole component along the wiggler estimated with use of 5 Hall probe array.

WIGGLER TEST IN OWN CRYOSTAT

3.785 Tesla magnetic field was achieved after three quenches in own cryostat.

The magnetic measurements of the wiggler assembled in own cryostat have been done with using of special scanning measuring system. The accessible aperture for magnetic measurements is a 10x80 mm and it is defined by the copper liner (with temperature about 20 K). Thus to make the magnetic measurement a room temperature anti-chamber have been used inside the copper liner. This is a titanium tube with 6 mm internal diameter (see Fig.4).

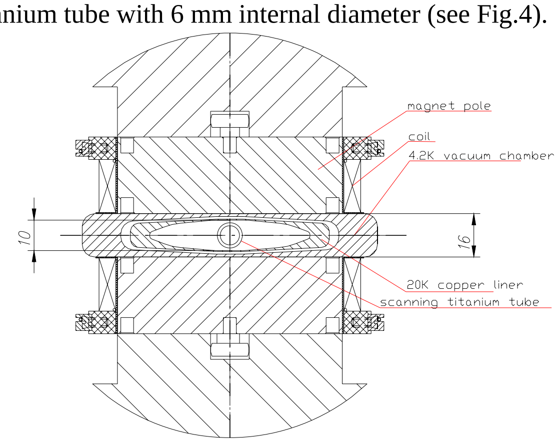

Figure 4: The copper liner and the tube position.

This tube is movable and it is a part of the scanning system. Two types of the measurements can be done with this tube - the magnetic map measurements with using the Hall probe inside the tube and the field integrals measurements with the wire with current placed inside the tube. The scanning range of the tube is ±15 mm in horizontal plane and ±1 mm in vertical plane (in the central horizontal position only). The photo of the one part of the system is presented on the Fig.5.

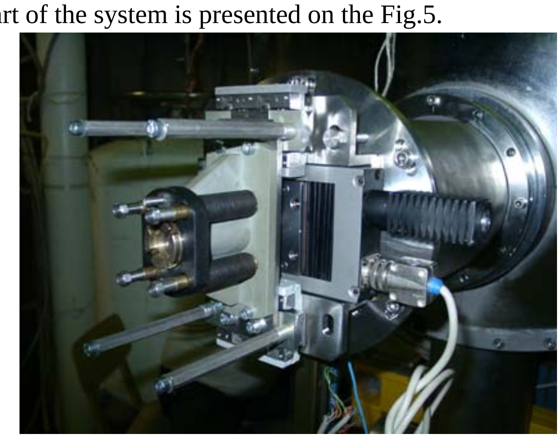

Figure 5: Photo of scanning part of the system

Due to small internal size of the tube only two Hall probes were used for magnetic map measurements. These two probes were mounted perpendicularly one to another to simultaneous measure of vertical B_y and horizontal B_x magnetic field components. Simultaneous measurements of magnetic field components B_x and B_y gave a possibility to make correction of magnetic field value in case of rotation of Hall probes as whole during longitudinal scanning. The minimum step between measurements along the wiggler is 0.1 mm.

3-D magnetic field map is a result of scanning of tube ends in X and Y directions and moving of the Hall probes inside the tube with respect steps.

Magnetic measurements with use of two Hall probes as perpendicular array was conducted at following field levels: B=0 (after slow ramping down and after quench), 1.0, 1.5, 2.0, 2.5, 2.8, 3.0, 3.2, 3.4, 3.5, 3.6 Tesla at x=0, ±5 mm, ±10 mm. Longitudinal magnetic field distribution at 3.5 Tesla magnetic field is presented in Fig.8.

Stretched wire method was used for magnetic field integrals measurements. This method was already applied for previous wigglers measurements [3].

For this measurement the Hall probes were replaced by a wire with current. The DC current of the wire is 2 A. The wire was stretched with force of 19N for modeling of 2.9 GeV electron beam. The AC current with 1.125 MHz are used for wire position monitoring during measurements. The measurements precision of the ±1 mkm corresponds to the 2 Gs*cm of the first field integral and 500 Gs*cm^2 for the second field integral.

The scheme of the wire method is presented on the Fig.6. The current relationship for zero first integral was found by this method (see Fig.7).

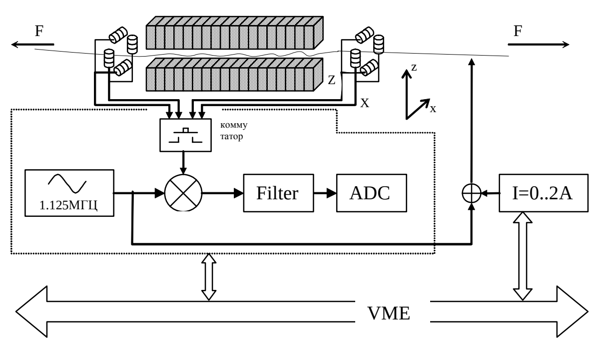

Figure 6: The scheme of the stretched wire method.

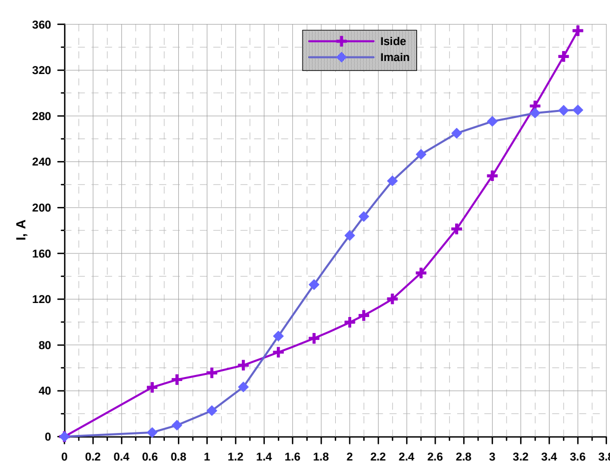

Figure 7: The currents I_{side} and I_{main} for zero first field integral versus magnetic field.

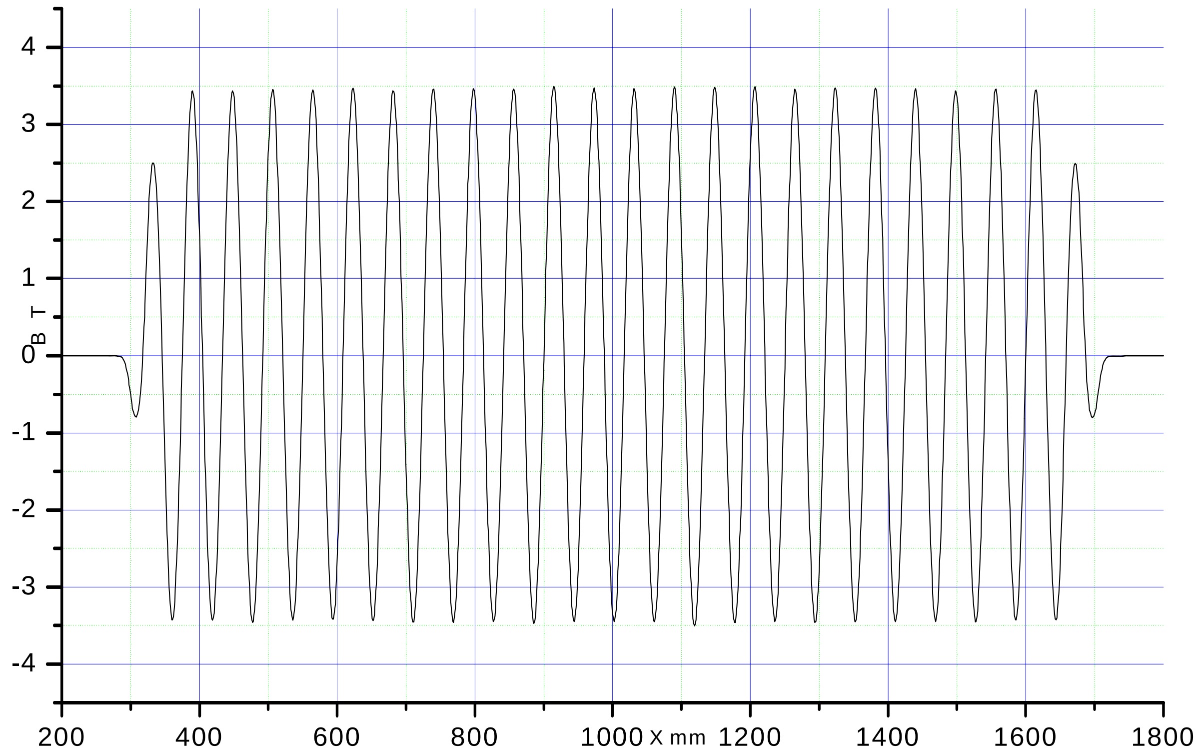

Figure 8: Longitudinal magnetic field distribution at 3.5 Tesla.

All this measurements were repeated on April 2006 in DLS without any essential differences.

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