Progress in the spectrometer magnetic field

Magnetic field simulation for the SLAC prototype magnetic spectrometer experiment

Magnetic field measurements at SLAC

Magnetic field measurement benches

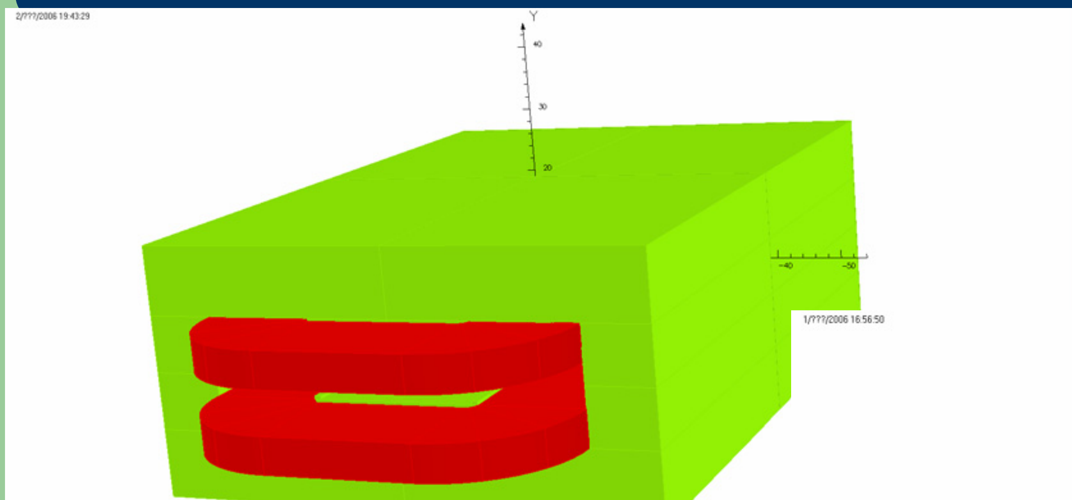
Magnetic field simulation for the SLAC experiment

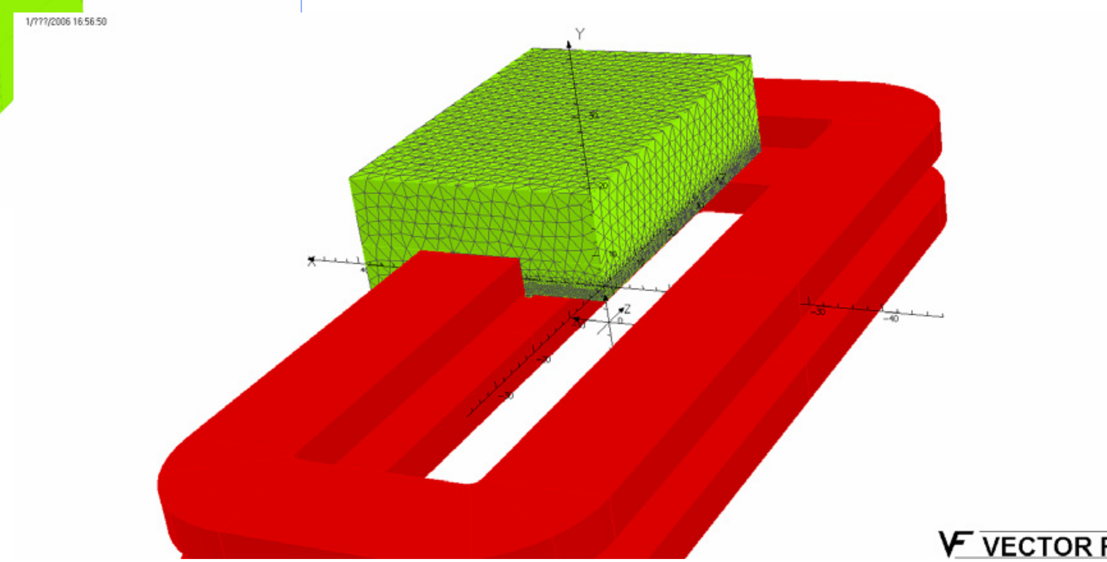
Basic goals:

- To predict the dipole magnets field (region of measurements, points for control NMR probes placement, suitability of the mirror plates)
- To get information on the tolerance for the dipole magnets simulation

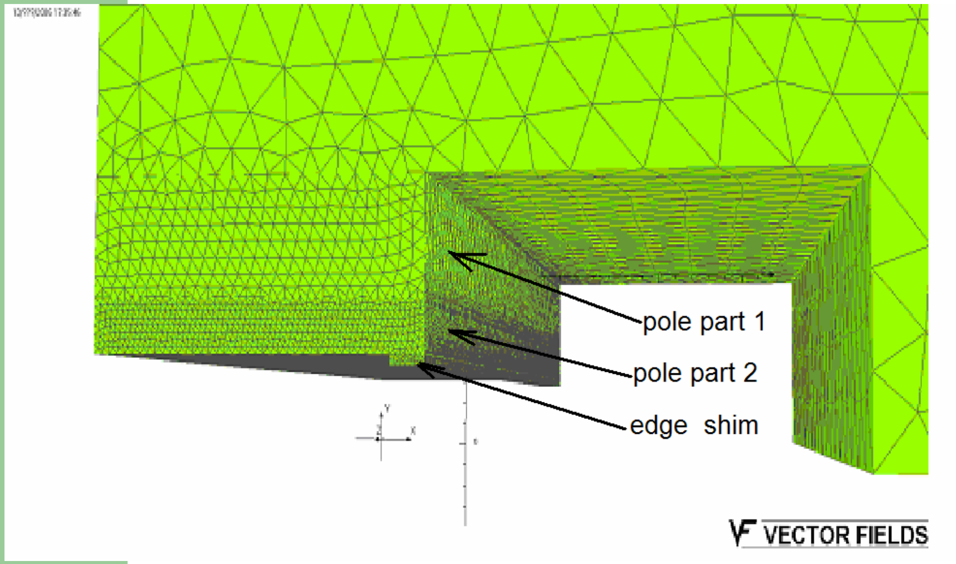
Code used – 3D TOSCA

Simulation for the 10D45 dipole magnet

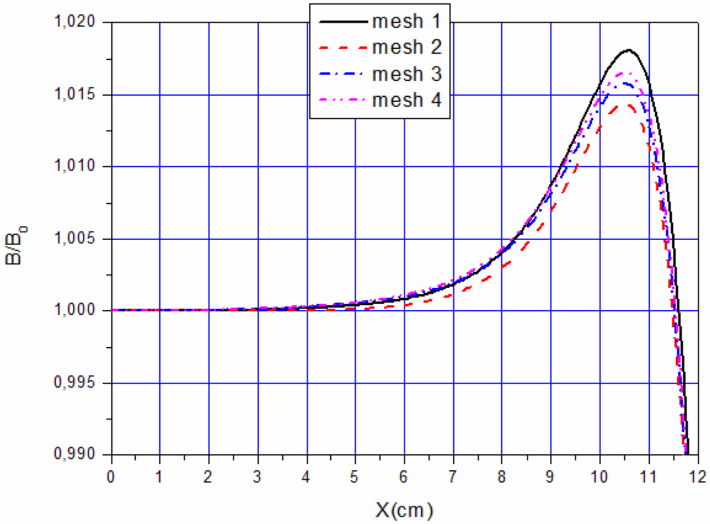




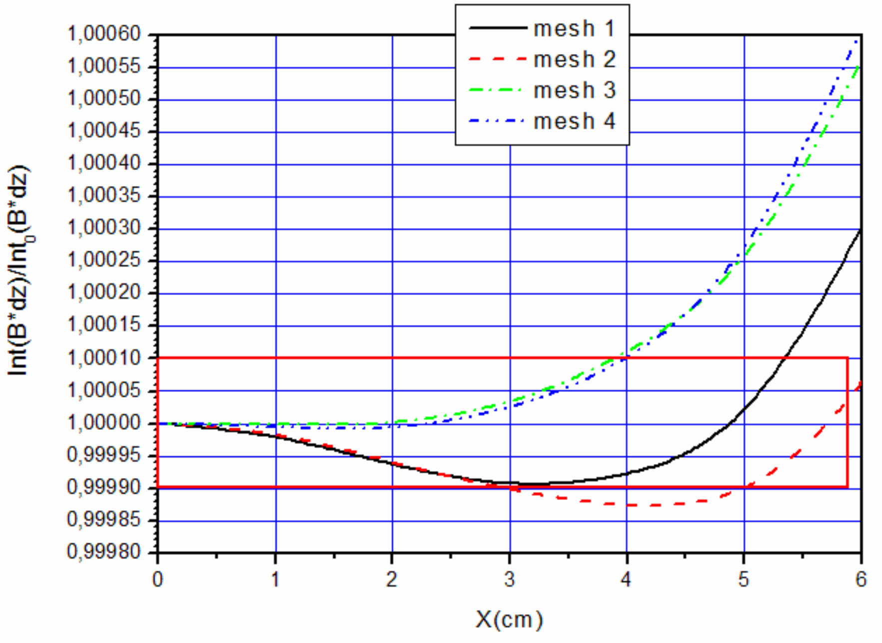
10D45 dipole magnet

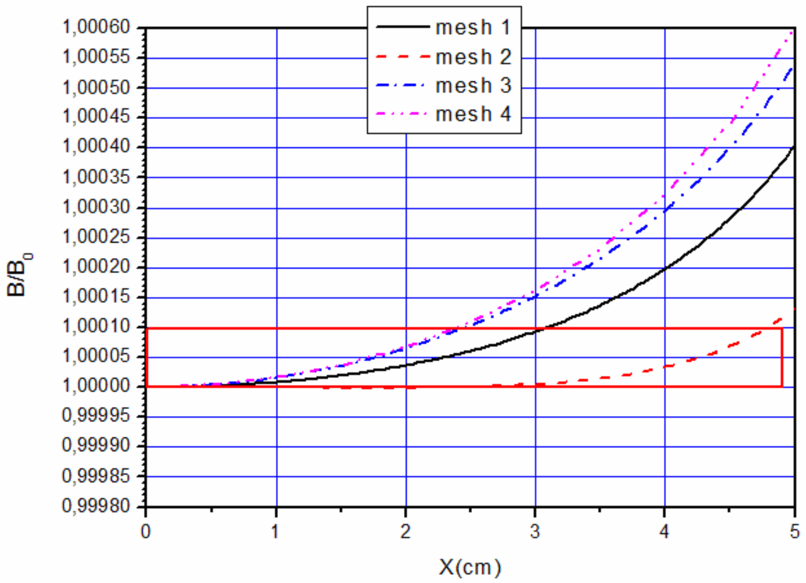


Number of curve	Part 1	Part 2	Edge shim
1	2	0.5	0.3
2	2	0.3	0.2
3	1	0.3	0.2
4	0.7	0.3	0.2

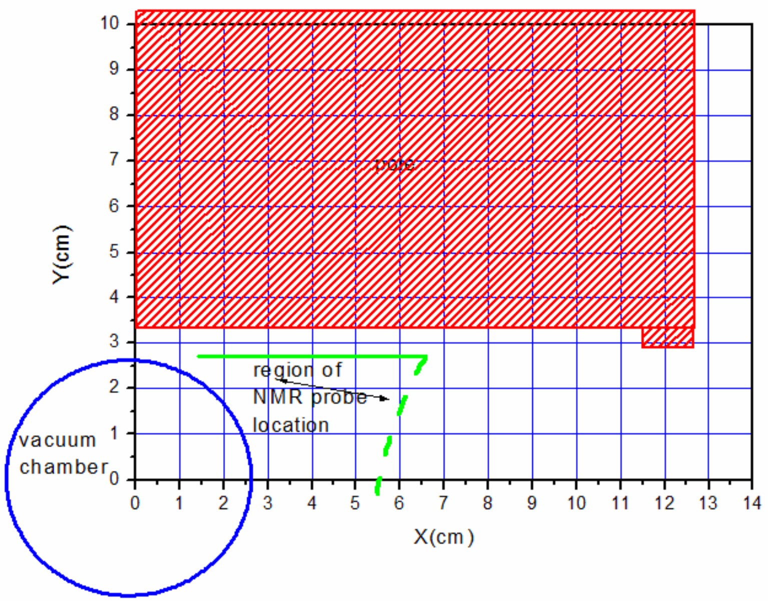


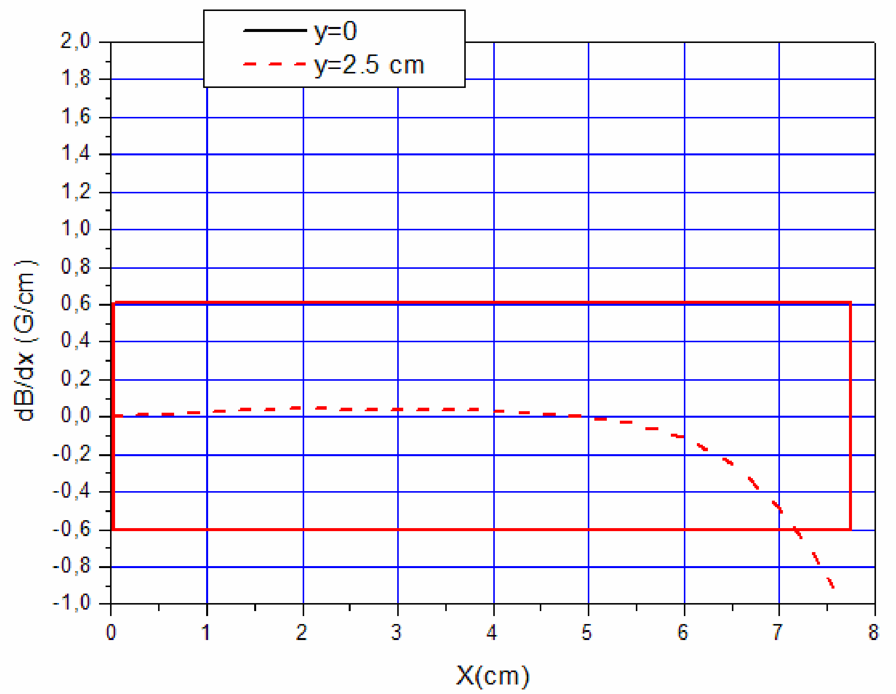
10D45 dipole magnet



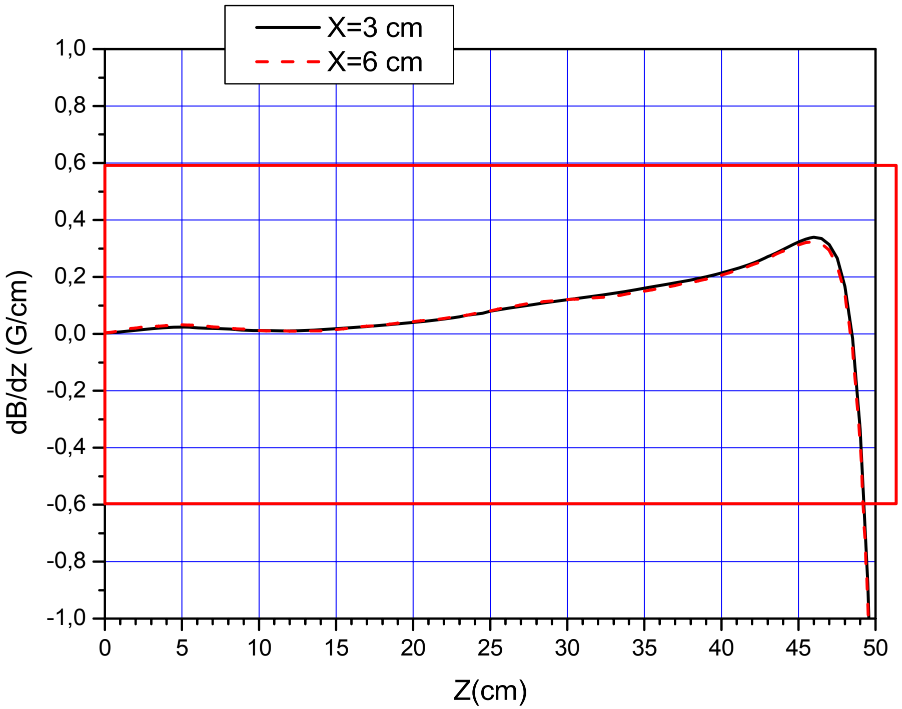


10D45 dipole magnet





10D45 dipole magnet

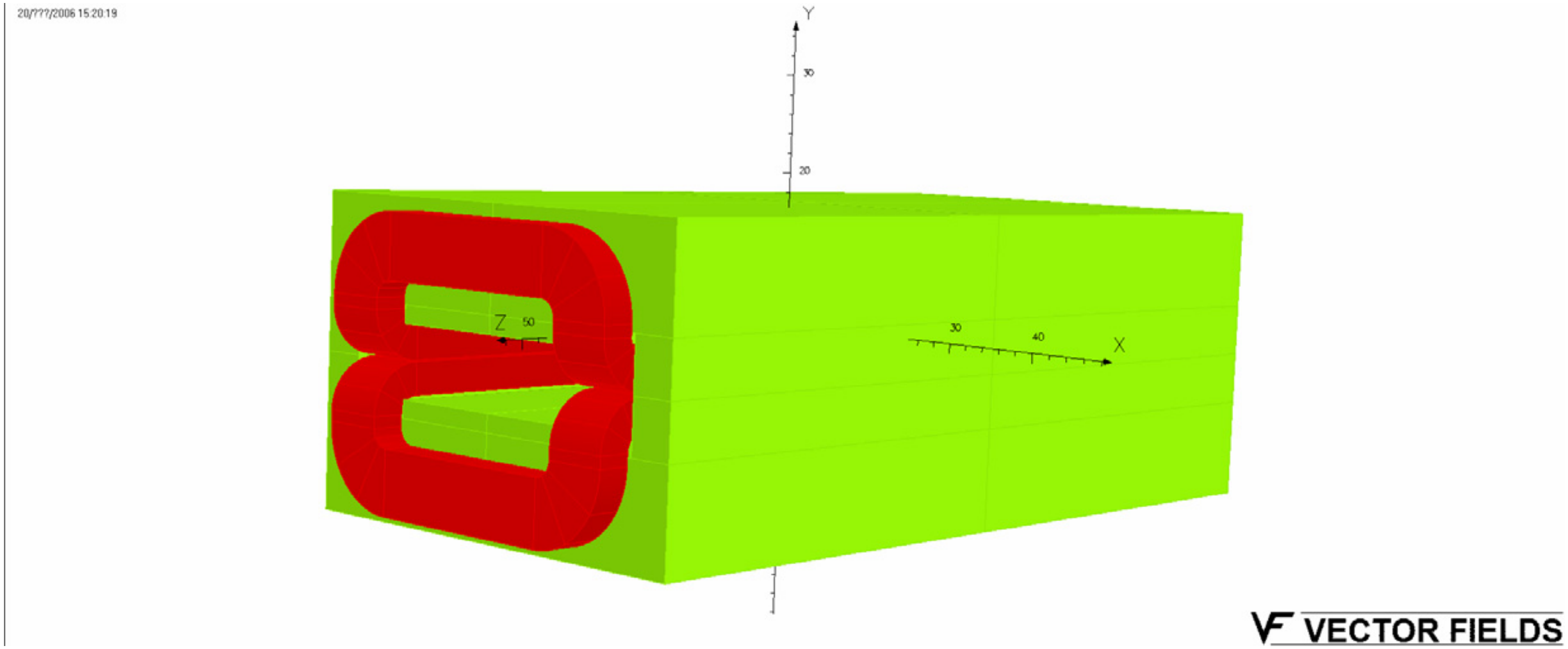


Magnetic field simulation for 10D37 dipole magnet

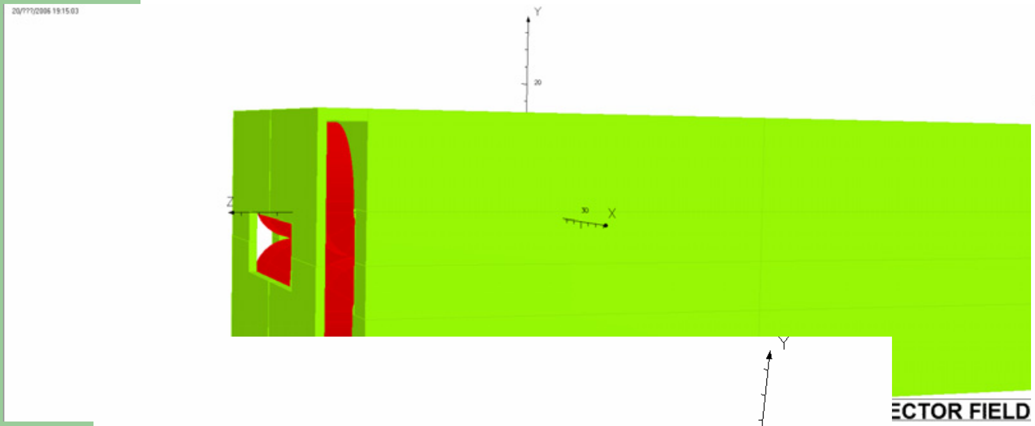
Three variants of the magnet geometry:

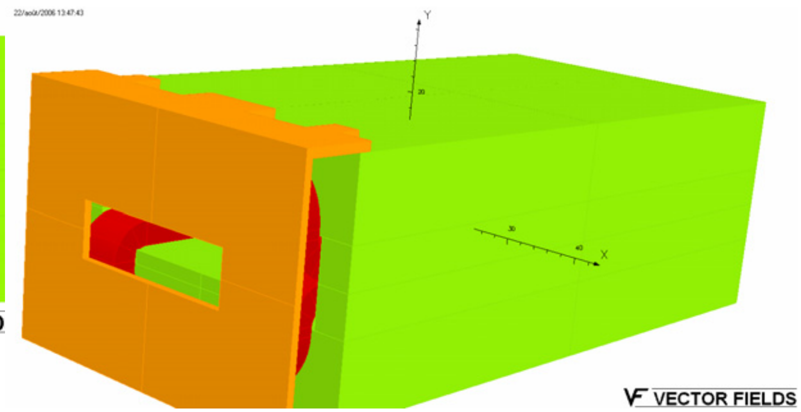
1. Without mirror plates.
2. With mirror plates at the different distance from the yoke
3. With mirror plates at the same distance from the yoke

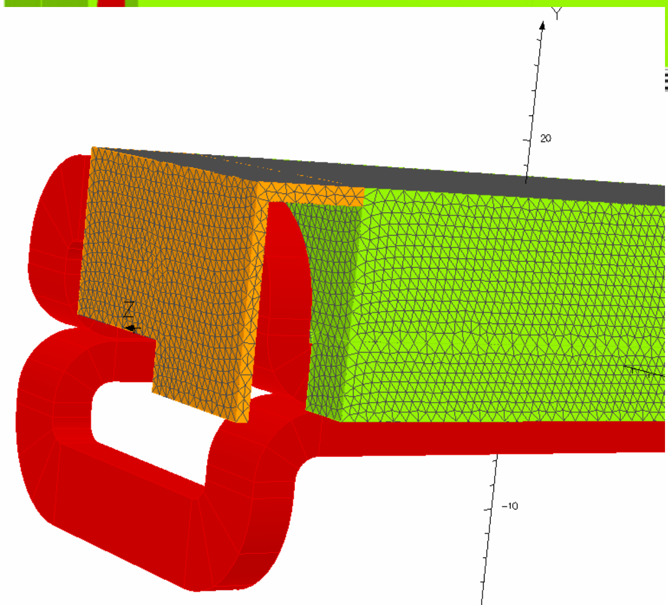
Magnetic field simulation for 10D37 dipole magnet



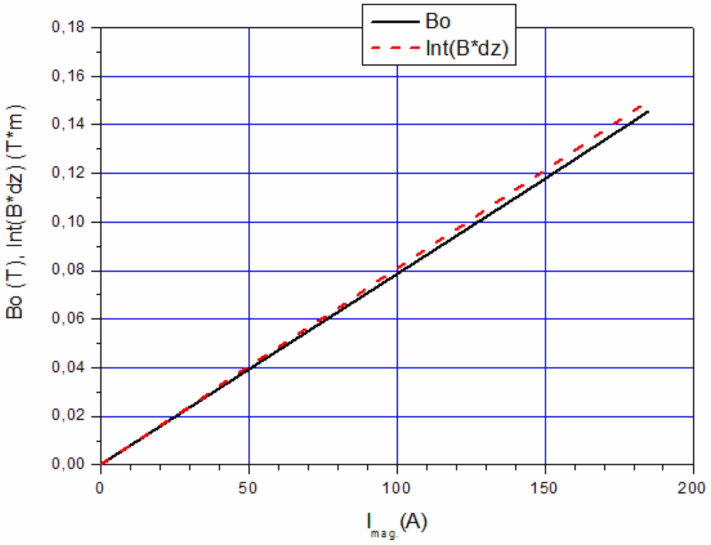
Magnetic field simulation for 10D37 dipole magnet

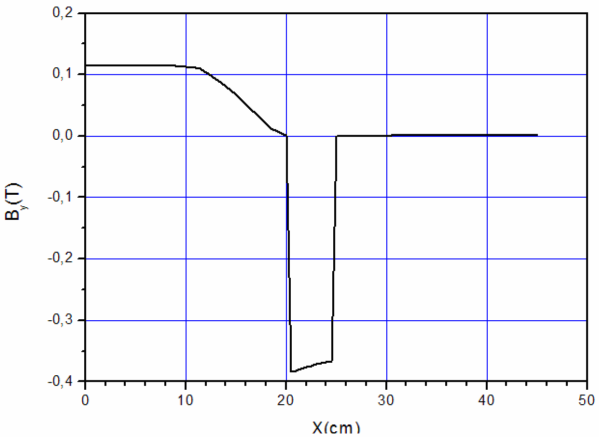


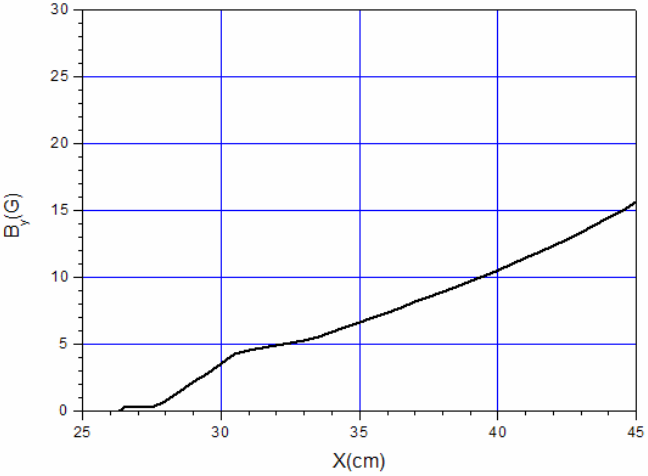




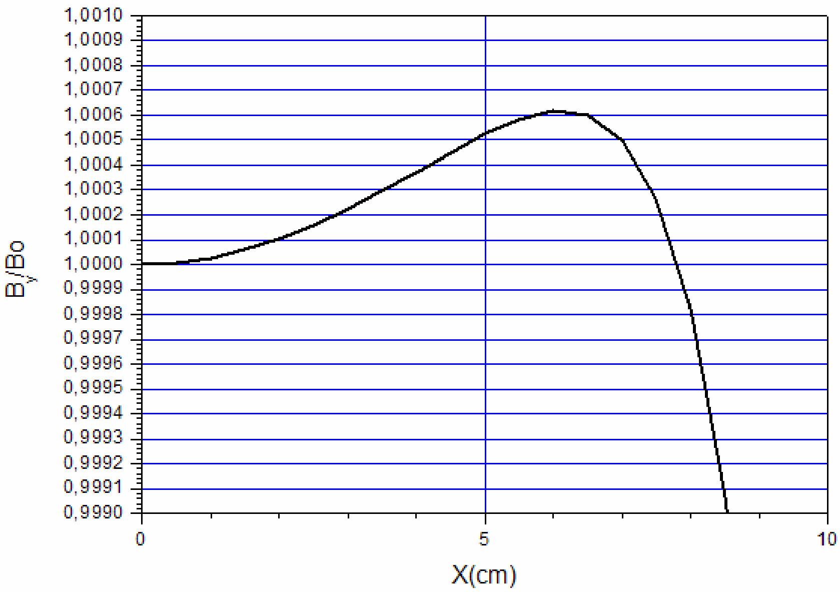
10D37 dipole magnet

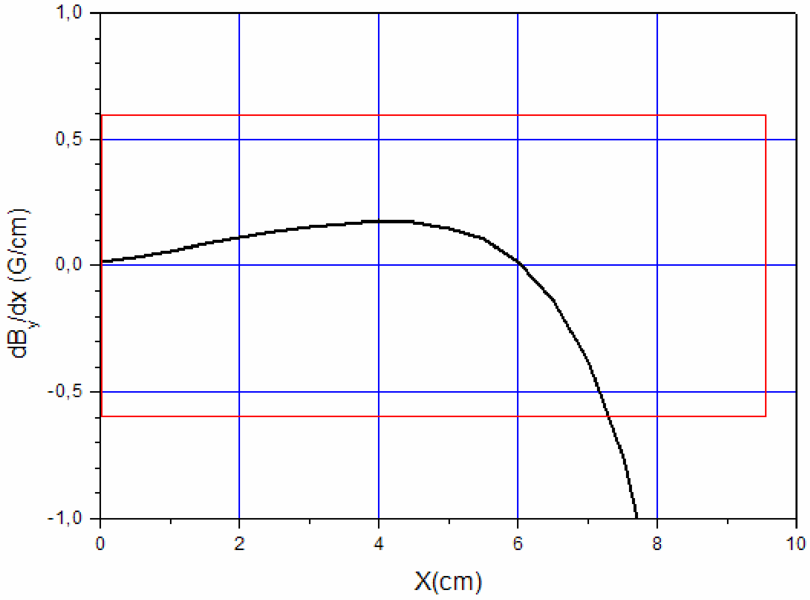




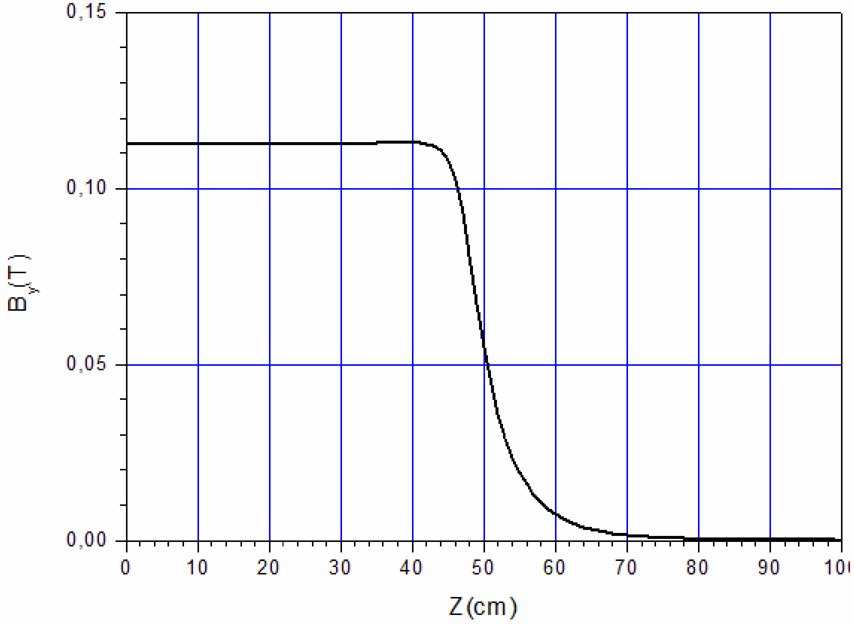


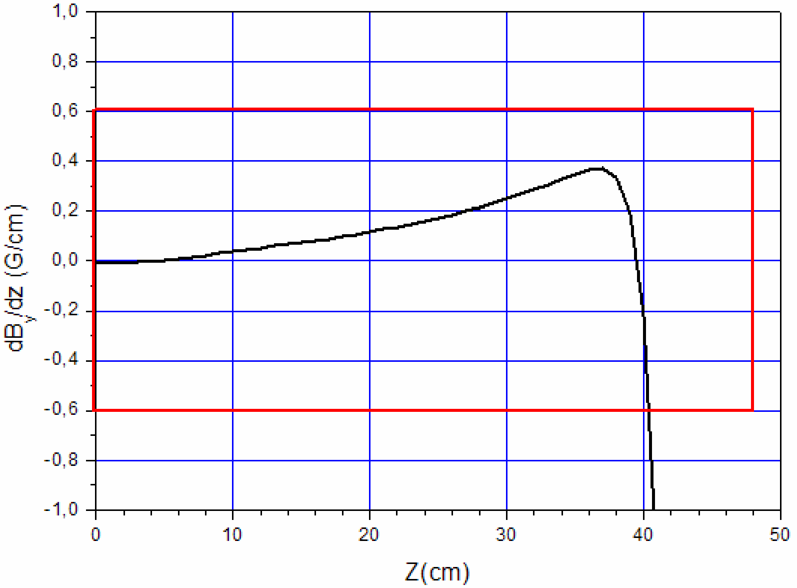
10D37 dipole magnet



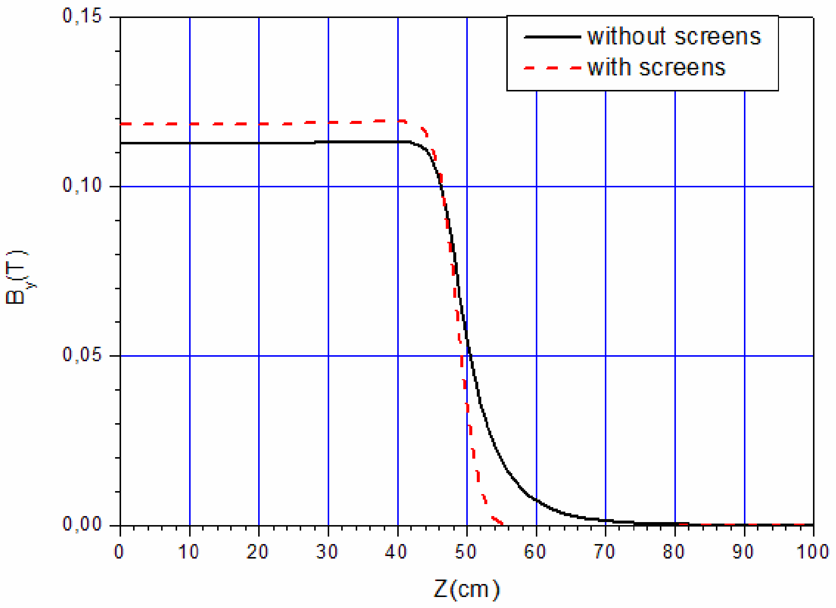


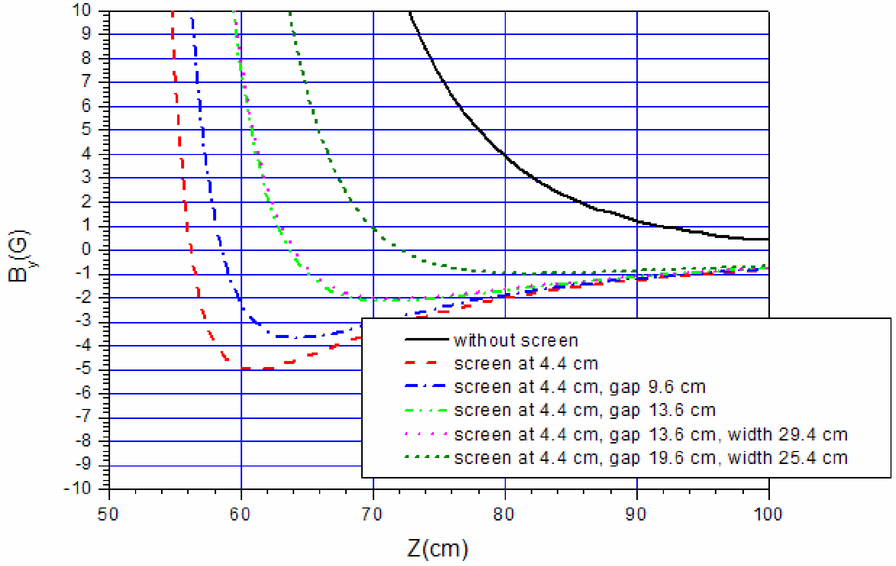
10D37 dipole magnet



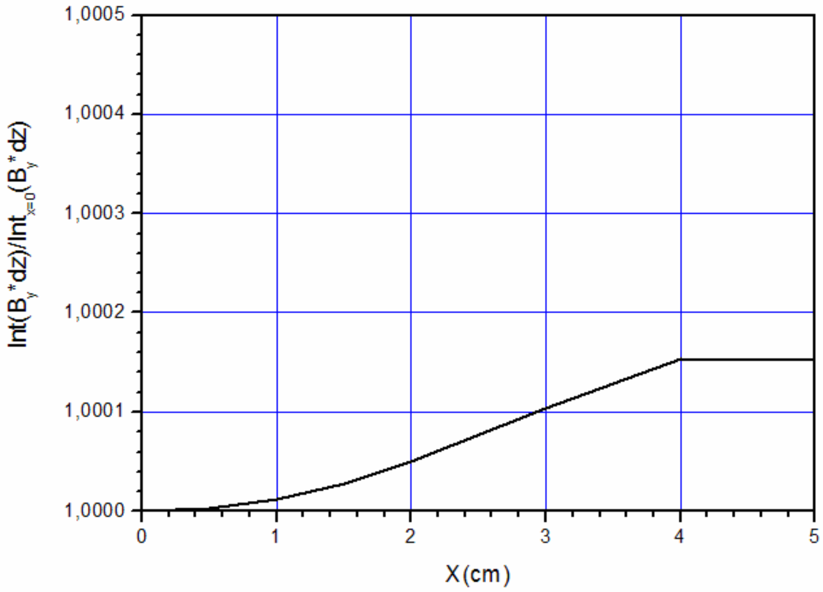


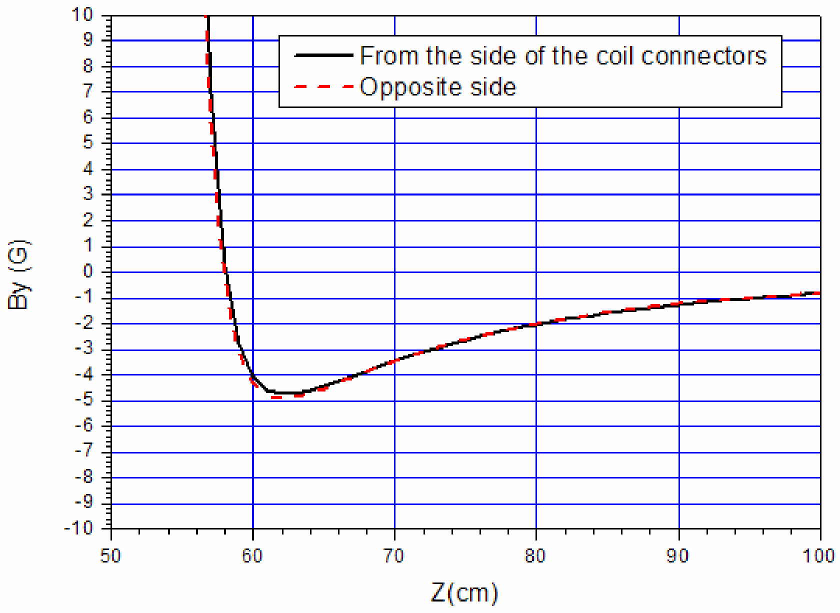
10D37 dipole magnet





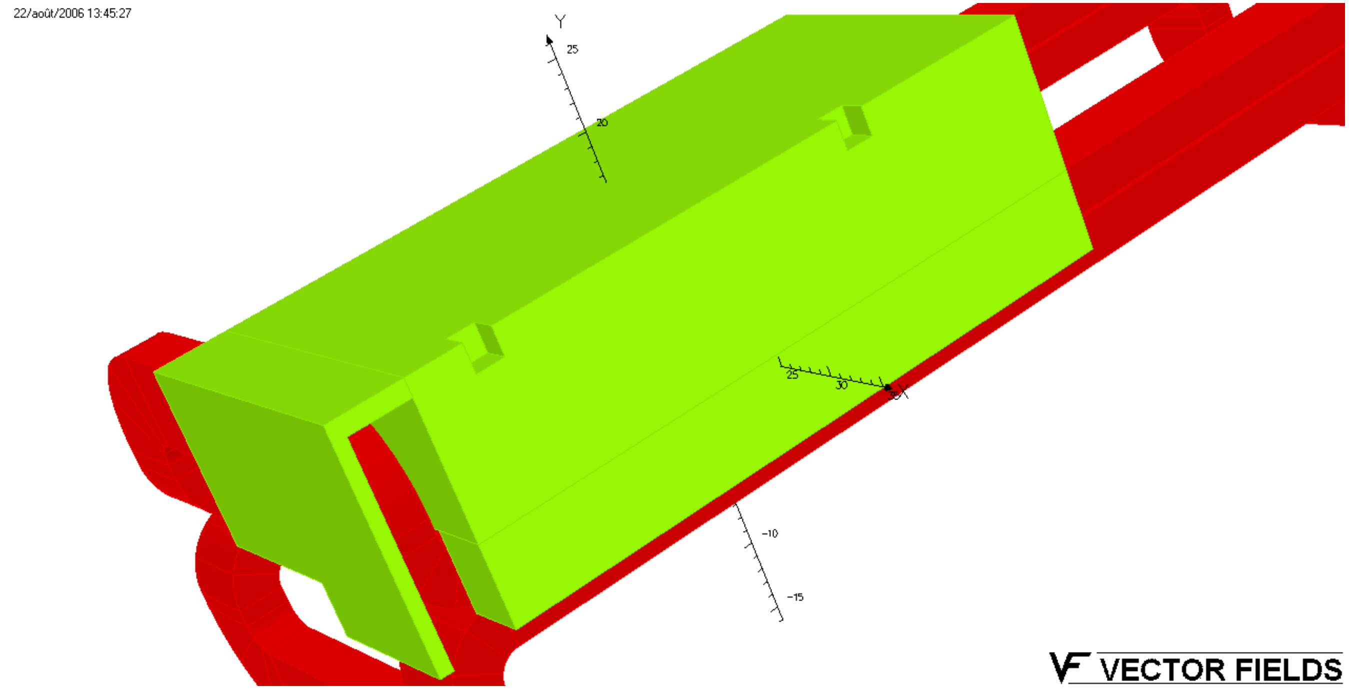
10D37 dipole magnet





10D37 dipole magnet

The grooves influence < 0.1 G



10D37 dipole magnet

Magnetic field integral temperature factor:

1. The factor for iron expansion temperature coefficient - 2.7 10^{-5} 1/C^{o}
2. The magnetization curve temperature factor – 3.4 10^{-5} 1/C^{o}

Summary magnet temperature factor – 6.1 10^{-5} 1/C^{o}

Magnetic field measurements at the SLAC (laboratory)

	Problem	Measurements
1.	Magnetization curve, hysteresis effects, optimal degaussing procedure, restore of the magnet working point.	Hall probe measurements along the magnet central line, NMR probes in two fixed points of the magnet.
2.	Restore of the magnets working point in case of the serial connection.	NMR probes in two fixed points of the each magnet
2.	Magnet ‘zero’ field integral, restore of ‘zero’ field integral	Hall probe + fluxgate measurements along the magnet central line, fluxgate probe in one or two fixed points of the magnet.
3.	Magnetic field mapping (with and without mirror plates)	Hall probe measurements (X, Y, Z mesh), NMR probes in two fixed points of the magnet. A set of temperature sensors.
4.	Long term stability of the magnetic field integral	Hall probe measurements along the magnet central line, NMR probes in two fixed points of the magnet. A set of temperature sensors.
5.	Magnetic field out of the main measurement region boundaries	Hall probe + fluxgate measurements

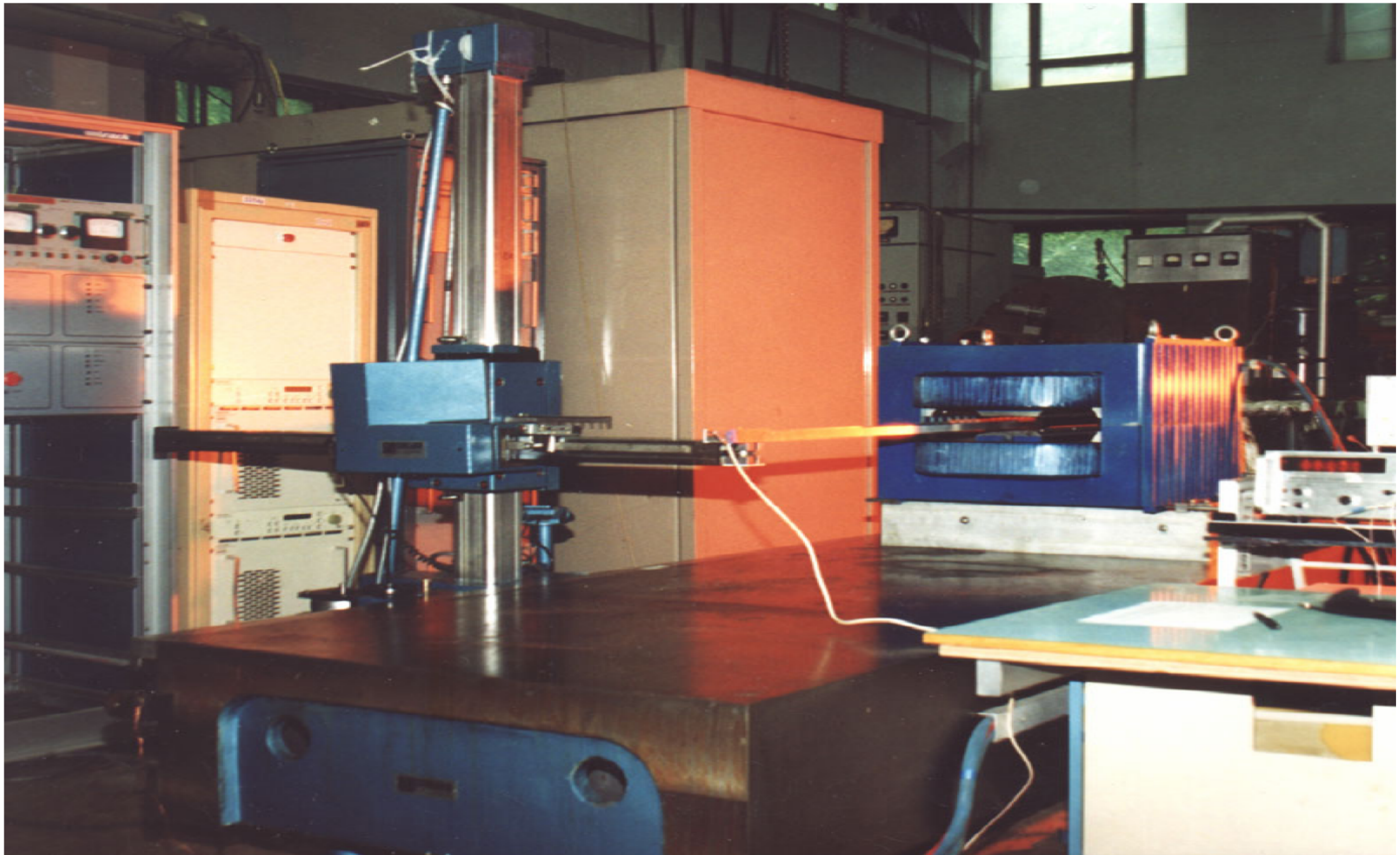
Magnetic field measurement benches

- Two methods have been proposed to use for magnetic field measurements:

1. Hall +NMR probe technique (added by NMR probes for measurement of the field stability).
2. Vibrating wire technique.

LNP measurement bench

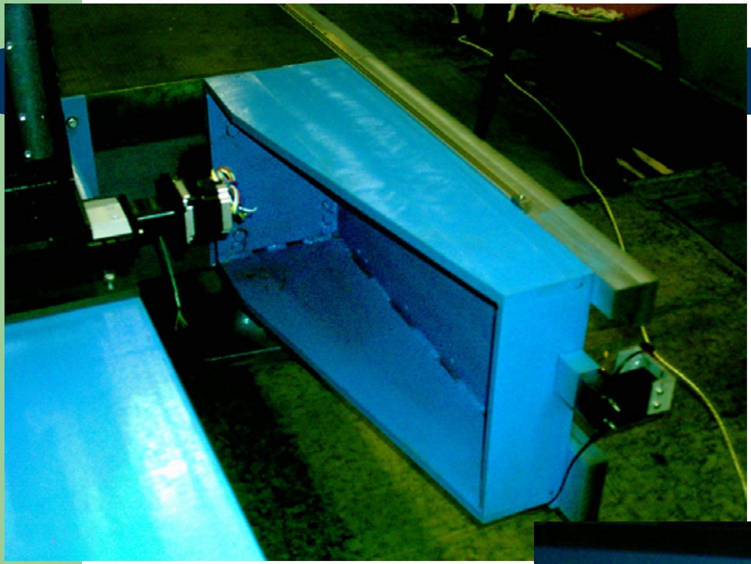
- The modification of the bench has been realized.

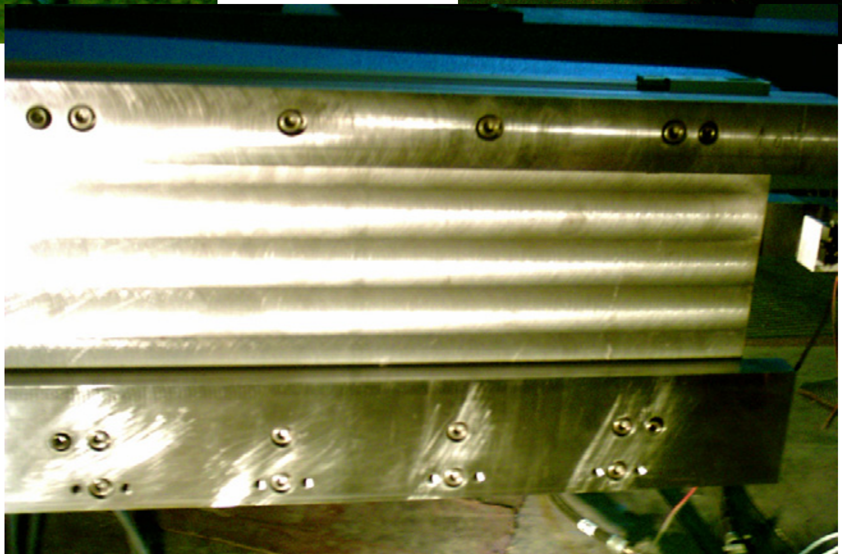


Hall probe method

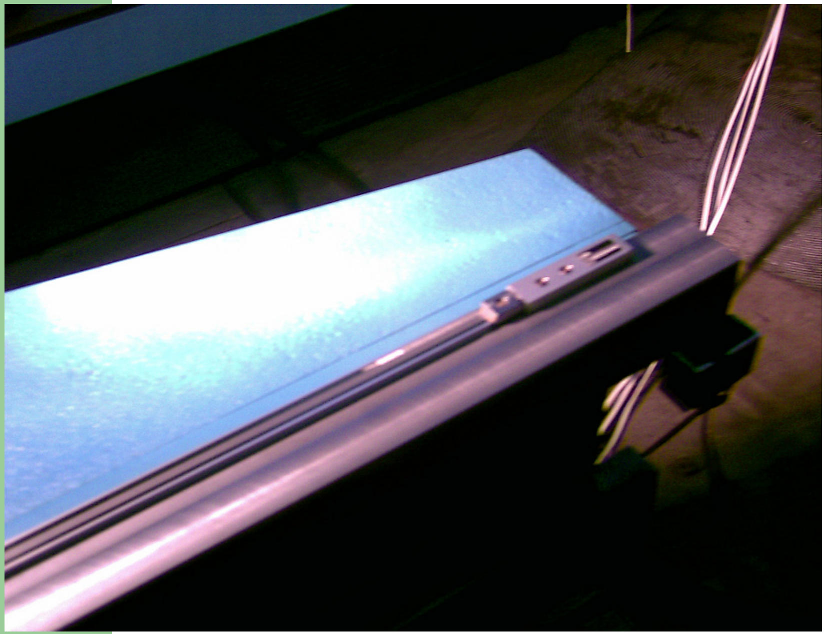
- Elongation of the longitudinal measurement base (3.5 -> 5 m)
- Installation of the high accuracy (~ some μm) linear encoder (HEIDENHAIN LIDA-485)
- Change of the old DC motors by modern stepping ones
- Change of the old control hardware (70-th) by the modern one
- Development of the control software

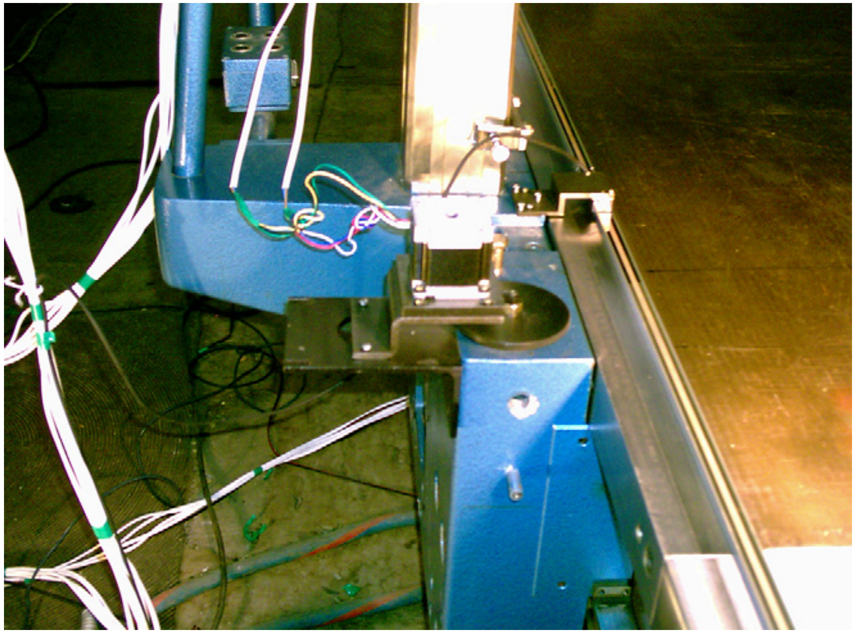
Additional stage with rails





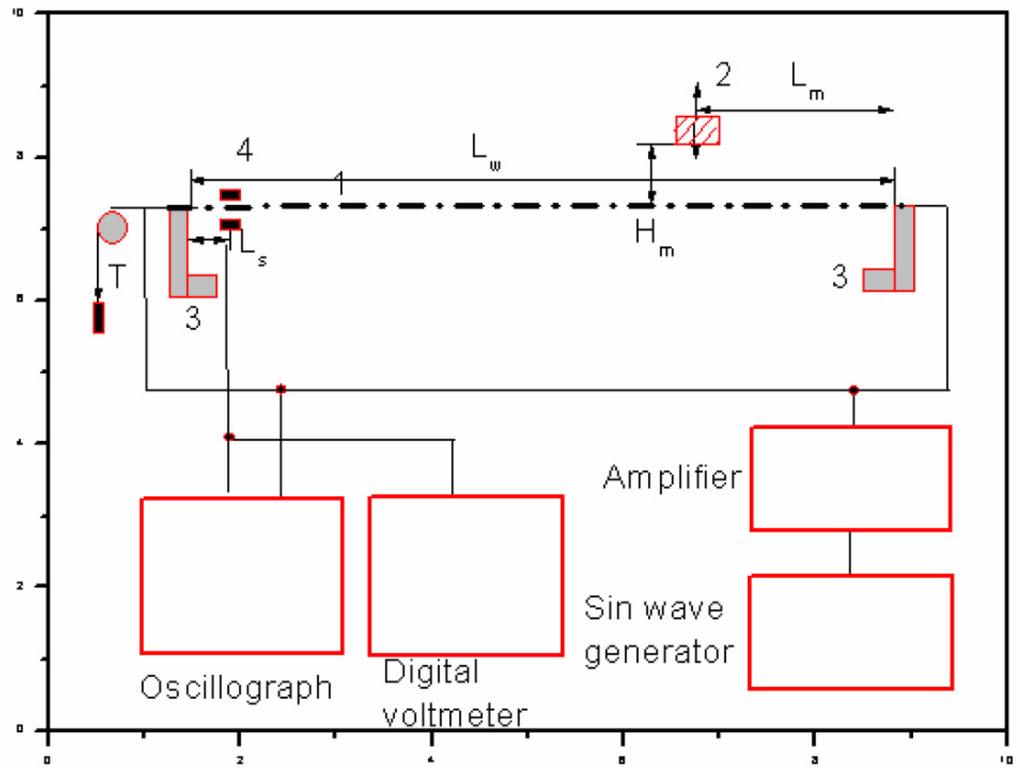
Linear encoder and stepping motors





Vibrating wire technique
(very sensitive one for measurement of zero field integral)

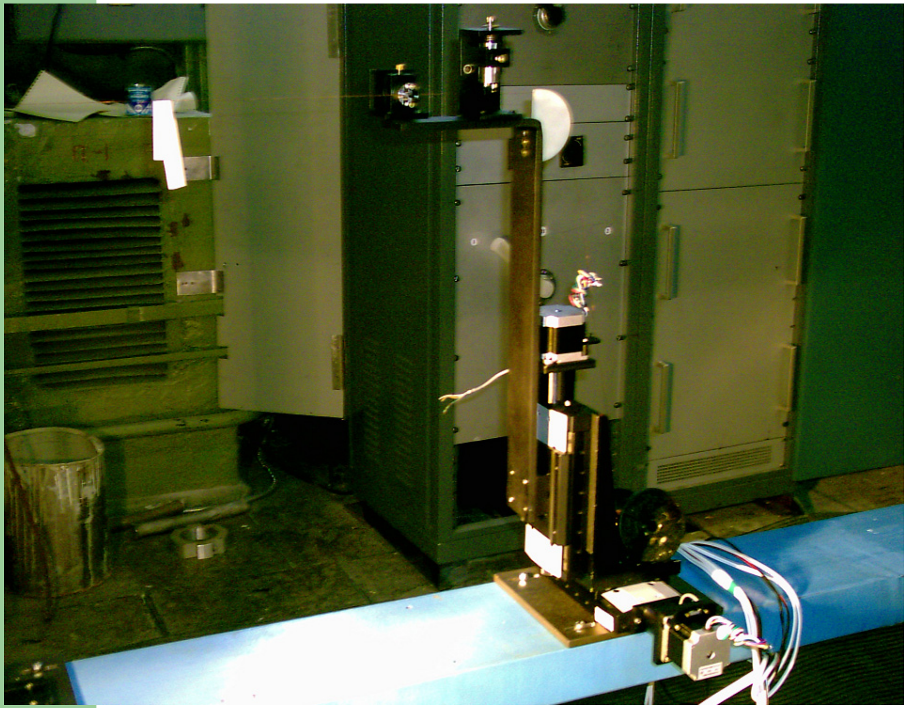
Sensitivity of the VWT ~ 0.1 G*cm

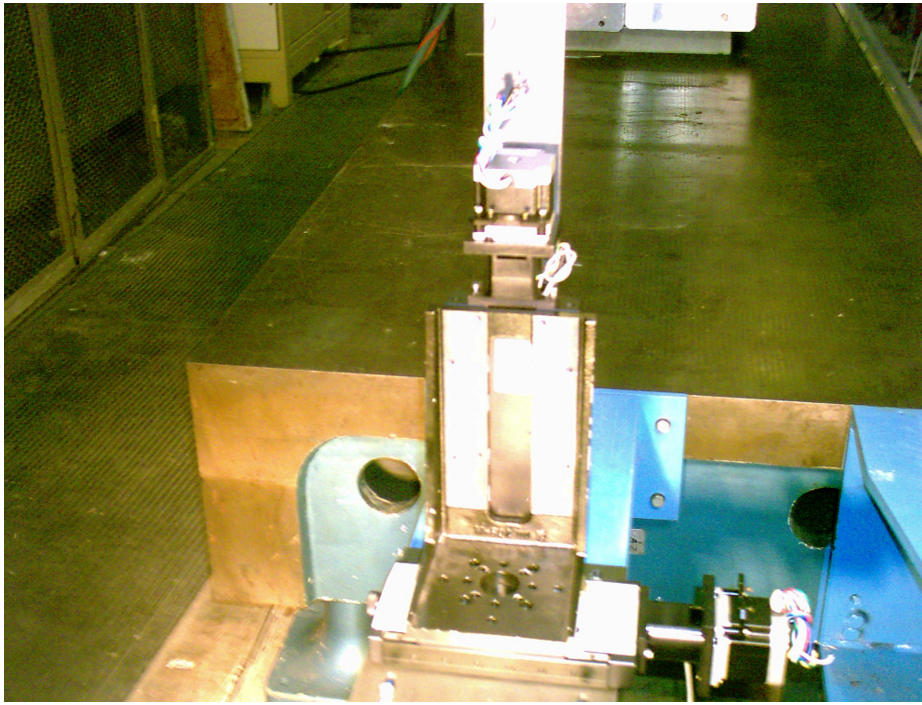


Vibrating wire technique

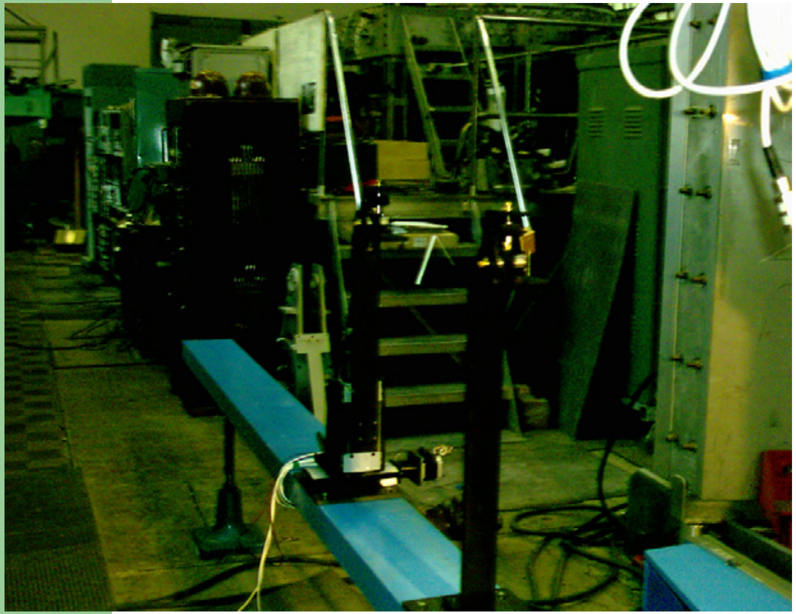
- The design and manufacturing of the mechanical elements was done
- The control hardware design was realized
- The software was developed

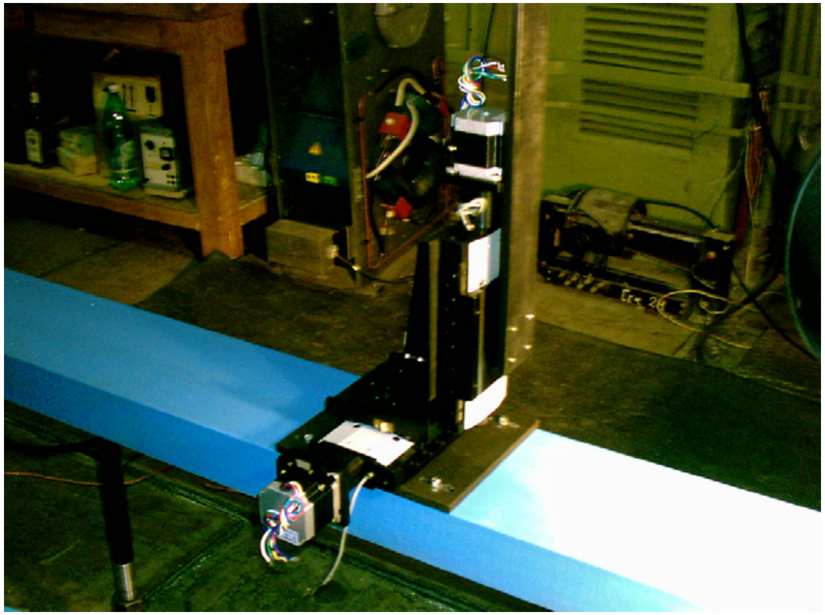
Moving stages for the wire



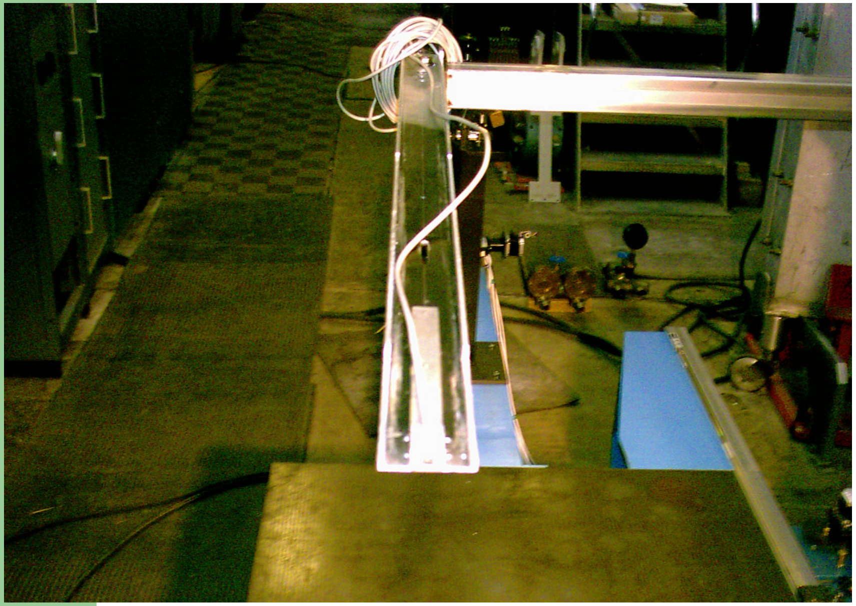


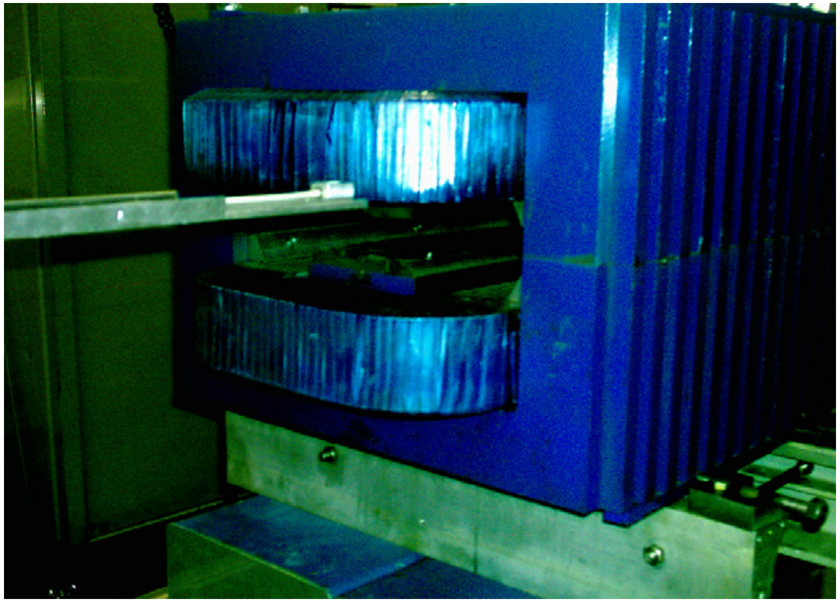
Tables for stages placement



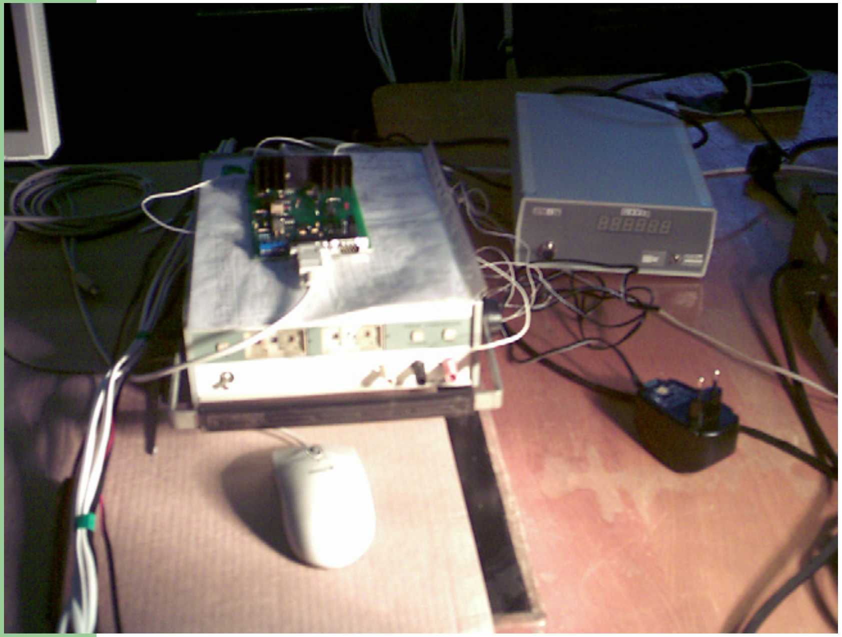


Hall probe and test magnet for the benches commissioning





Computer control by all benches



Power supply

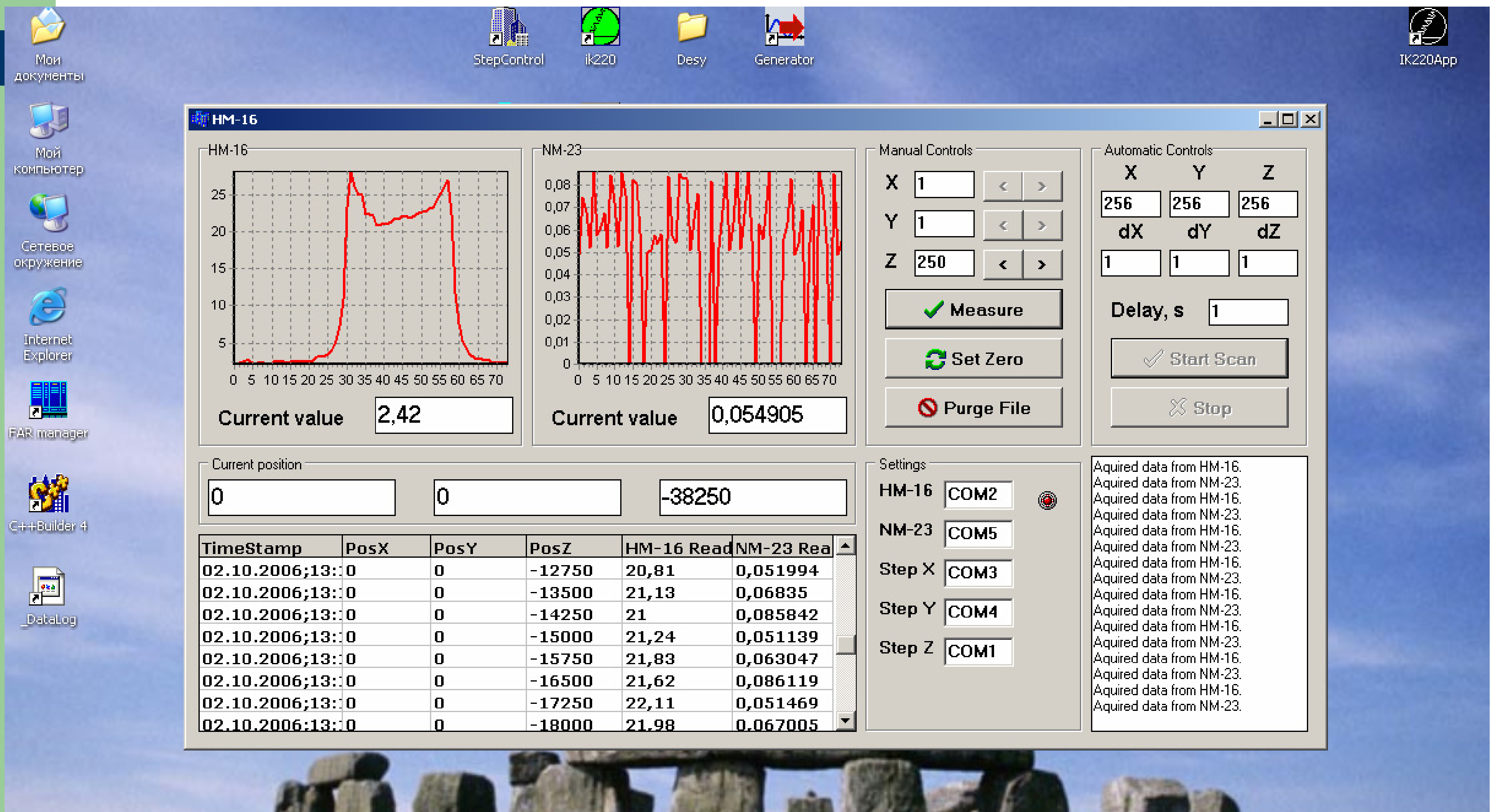
- BRUKER 450 A/130 V, stability 10^{-5}
- Motor-generator 450 A/230 V, stability 10^{-4}
- Connectors for power supply communication
- Unit for the magnet demagnetization procedure

BRUKER power supply and rock with connectors and demagnetization unit

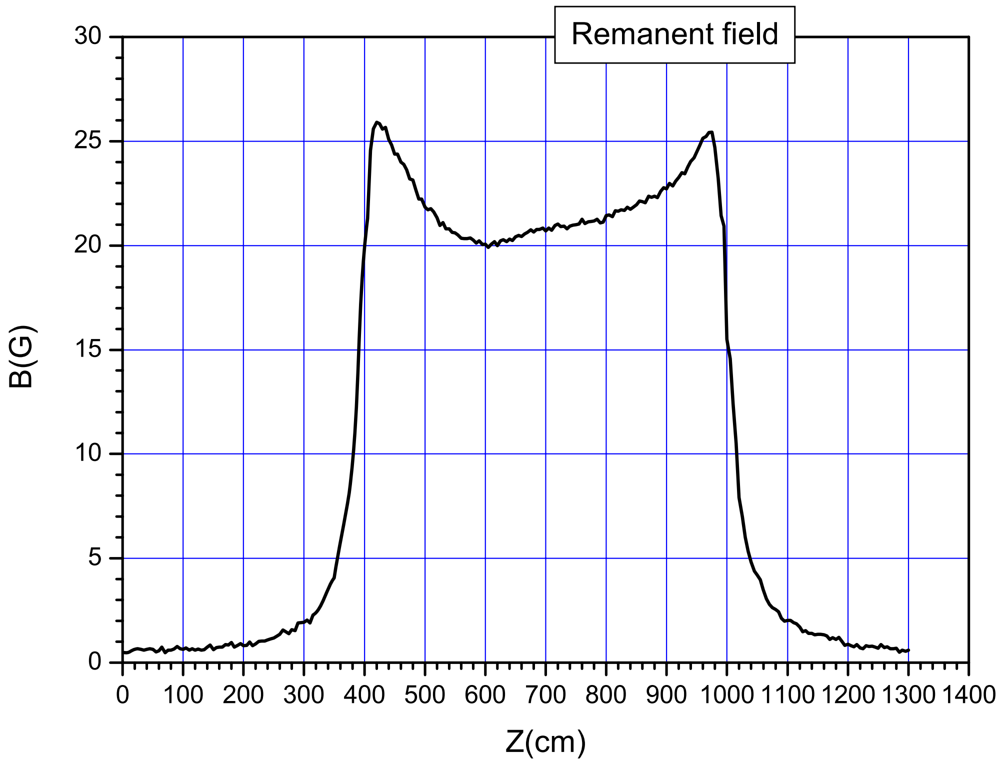
Hall probe bench commissioning

- The commutations and connections for all hardware are realized
- The control software is ready
- The test of hardware and software is started
- We are planning to provide the Hall+NMR probe bench commissioning during the nearest 2 weeks

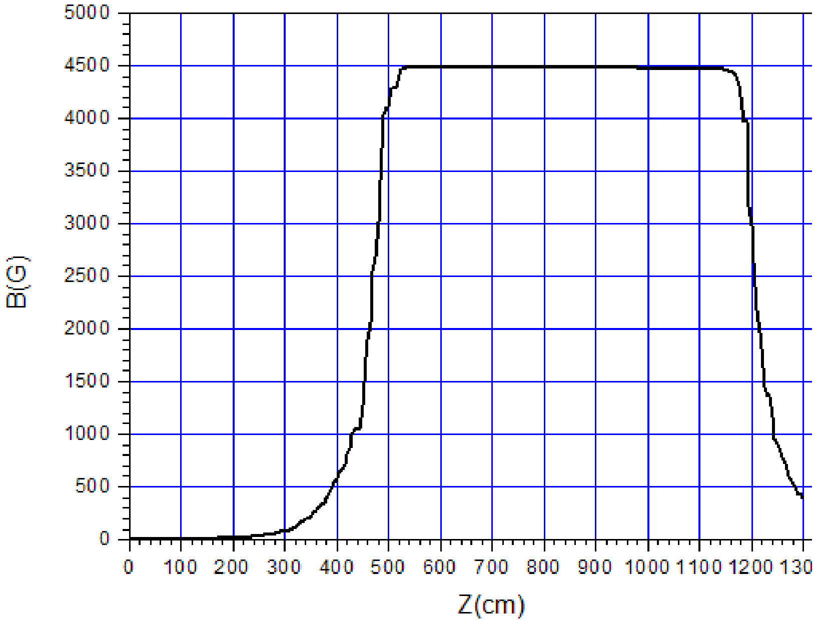
Hall+NMR probes bench commissioning

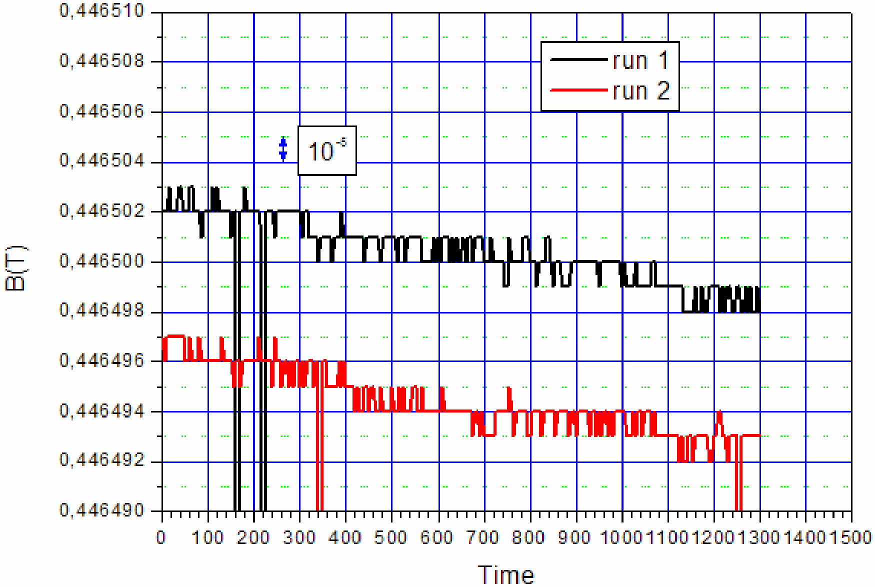


Hall+NMR probes bench commissioning

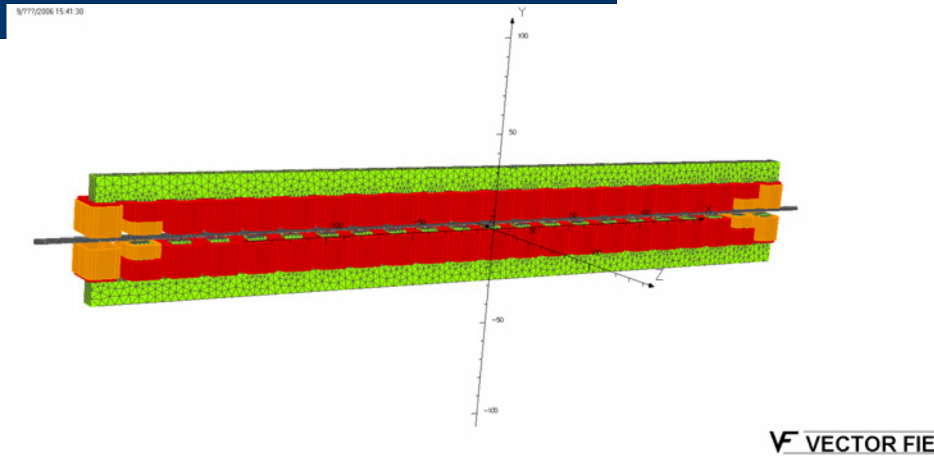


Hall+NMR probes bench commissioning





Future plans



- To realize the full commissioning of both benches.
- To provide the working testing of the benches by realizing the magnetic field measurement and shaping program for the DESY undulator magnet.
- To equip the test magnet by the temperature sensors.
- To provide the magnetic field measurement program for the test dipole magnet as it was suggested for the SLAC magnets (to take into account the nearest SLAC experience).