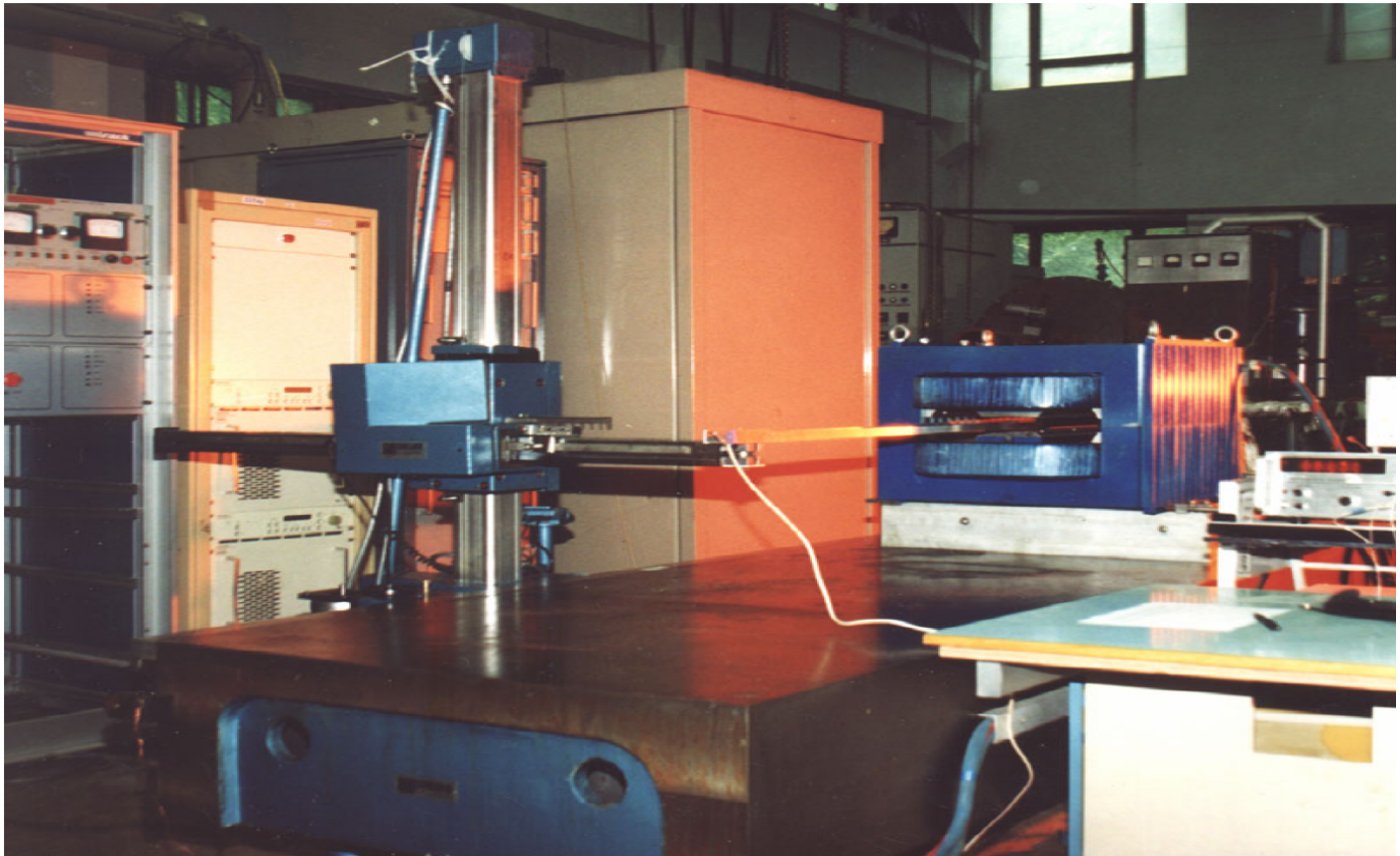
Magnetic field measurement bench commissioning and test

Magnetic field measurement benches –

- ***Hall+NMR***
- ***WVT (wibrating wire technique)***

LNP measurement bench

- The modification of the bench has been realized.

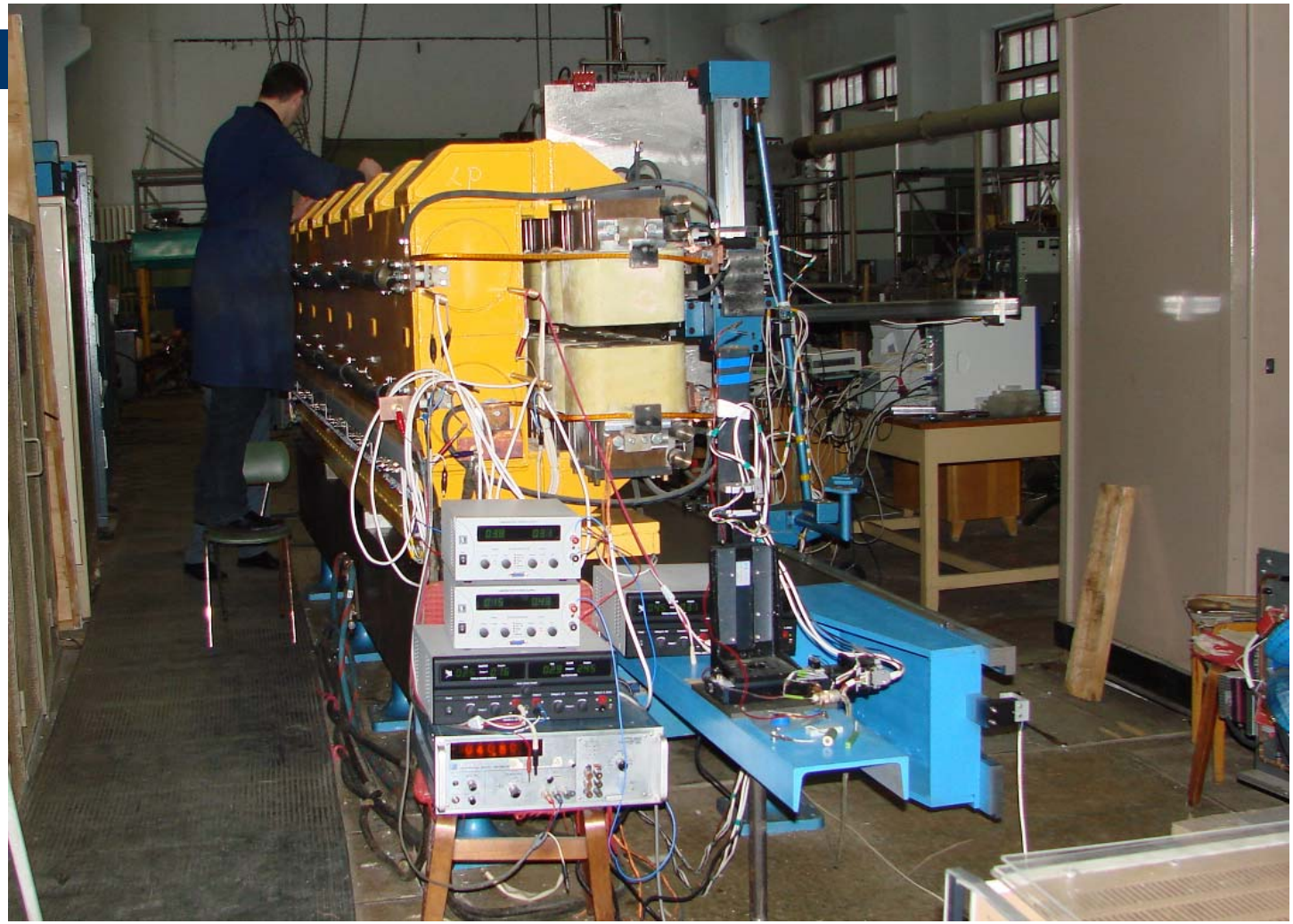


Hall probe method+NMR one

- 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

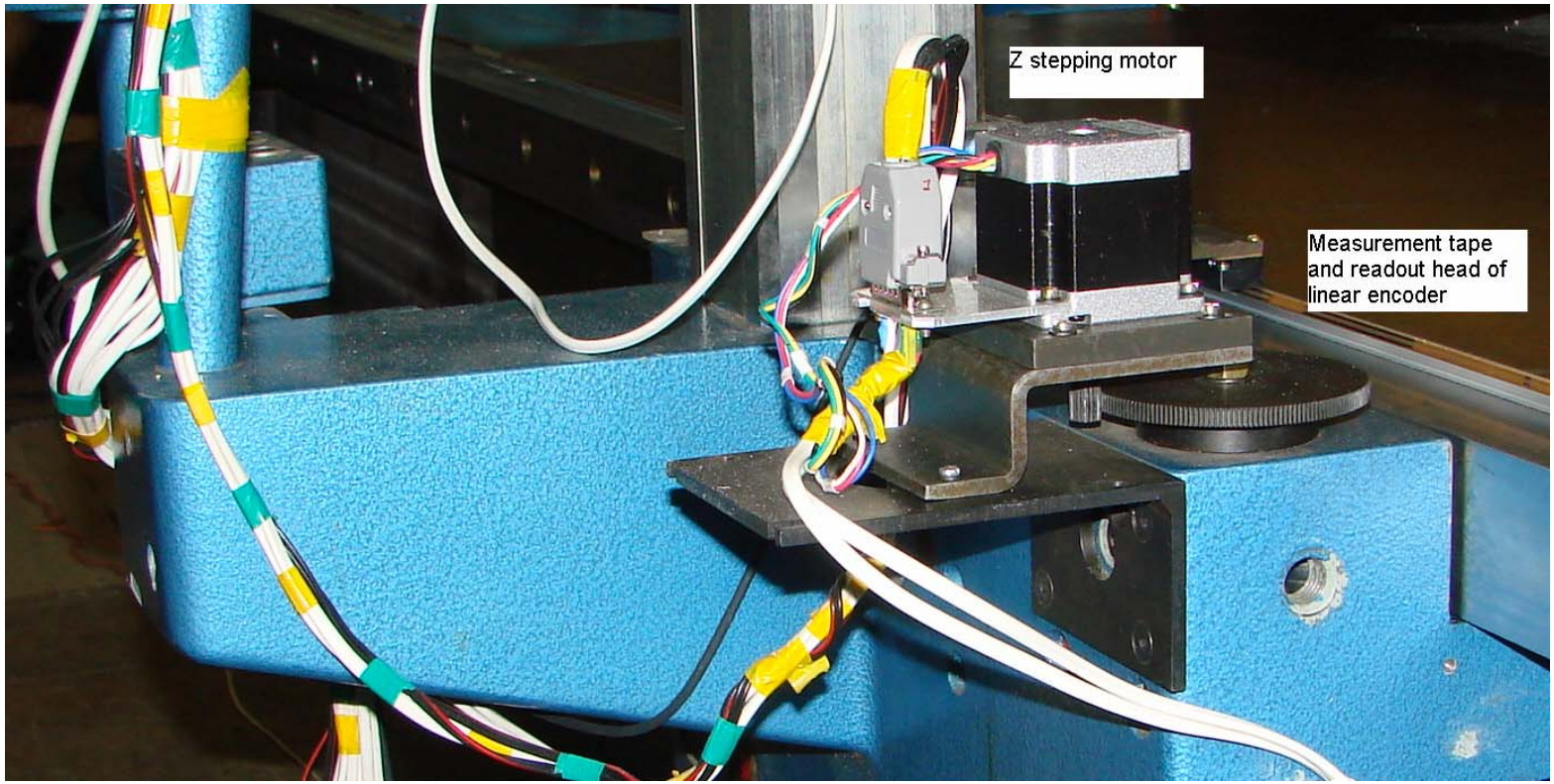
Bench views

Bench views

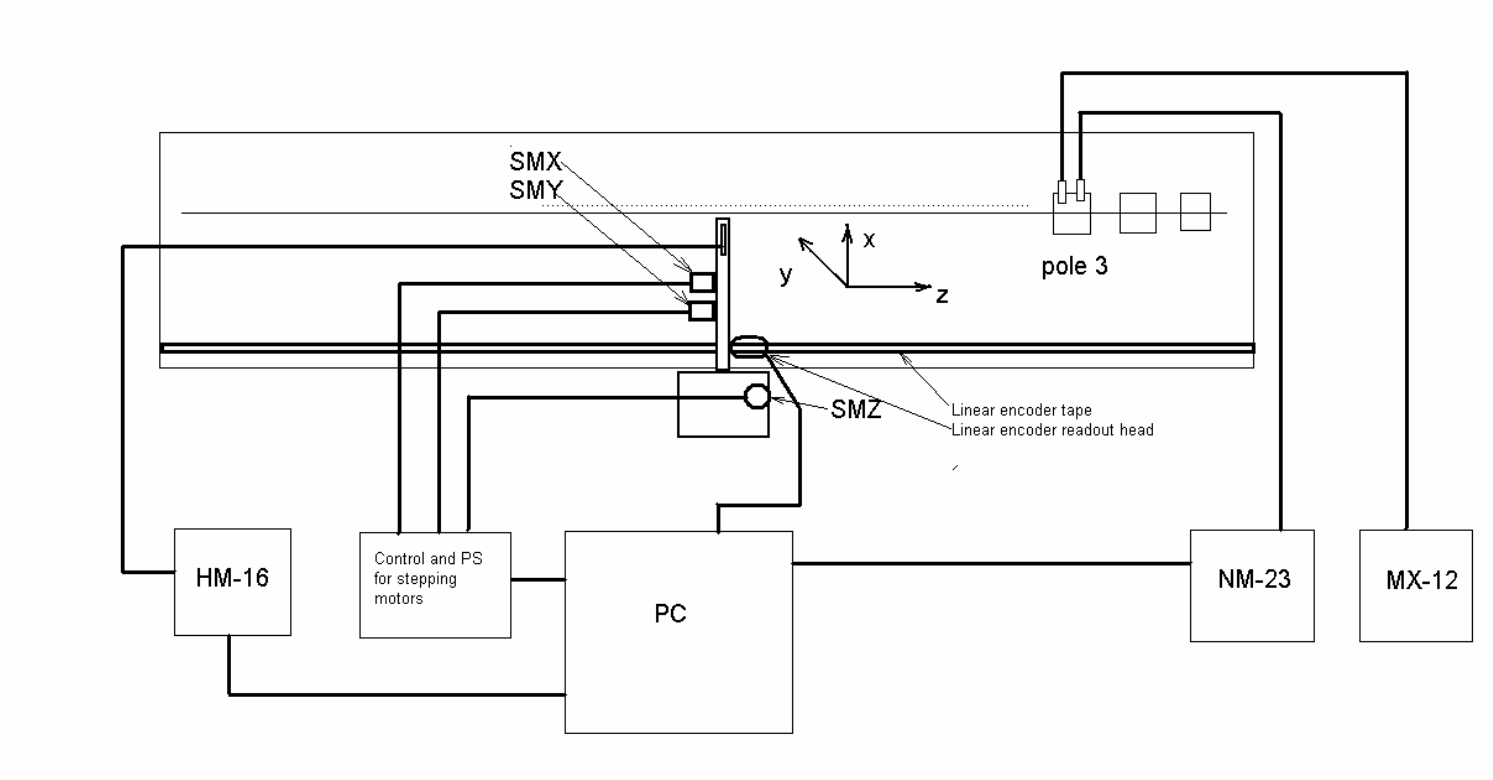


Bench views

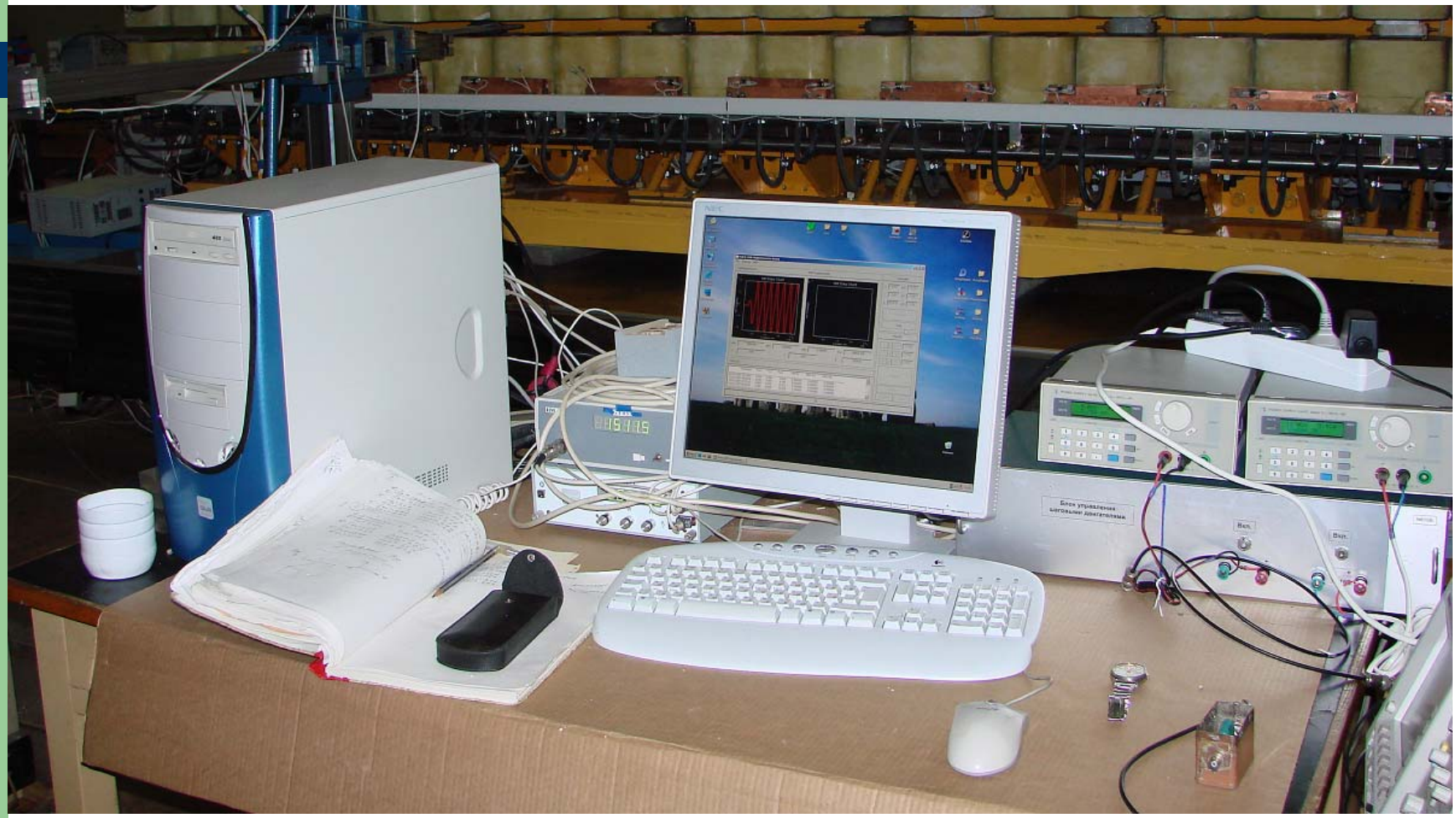
Bench views


Z stepping motor
Measurement tape and readout head of linear encoder

Control and measurement hardware

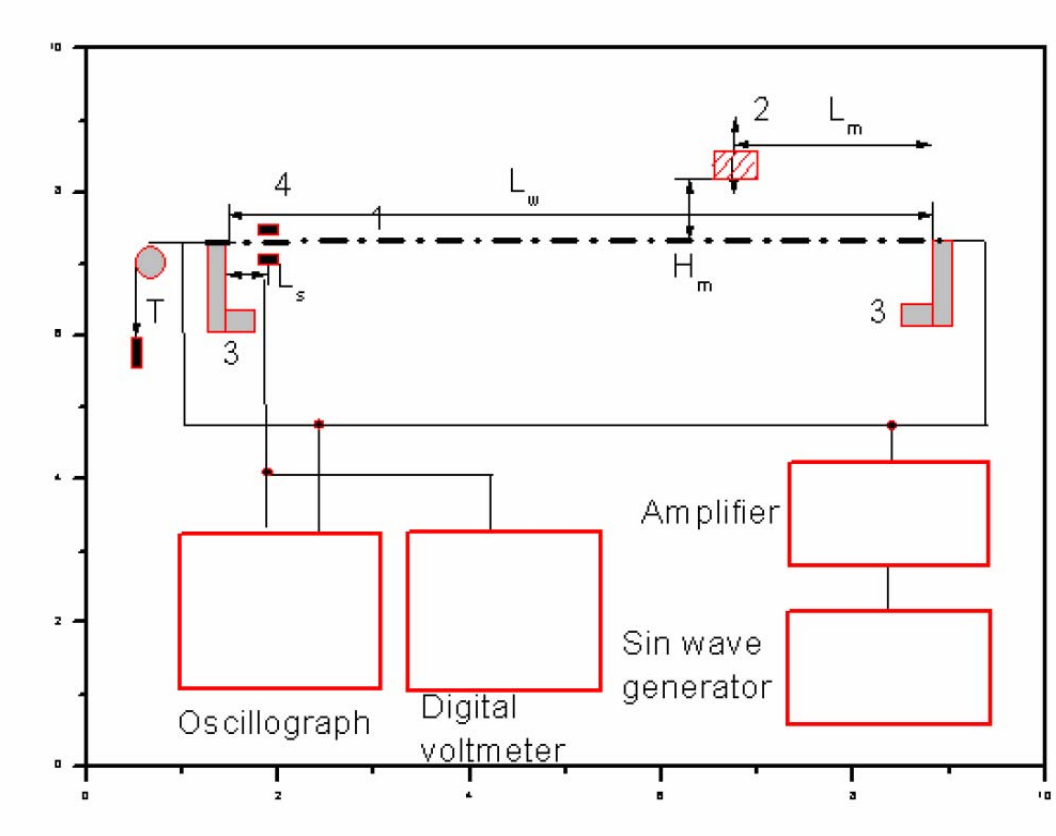


Control and measurement hardware



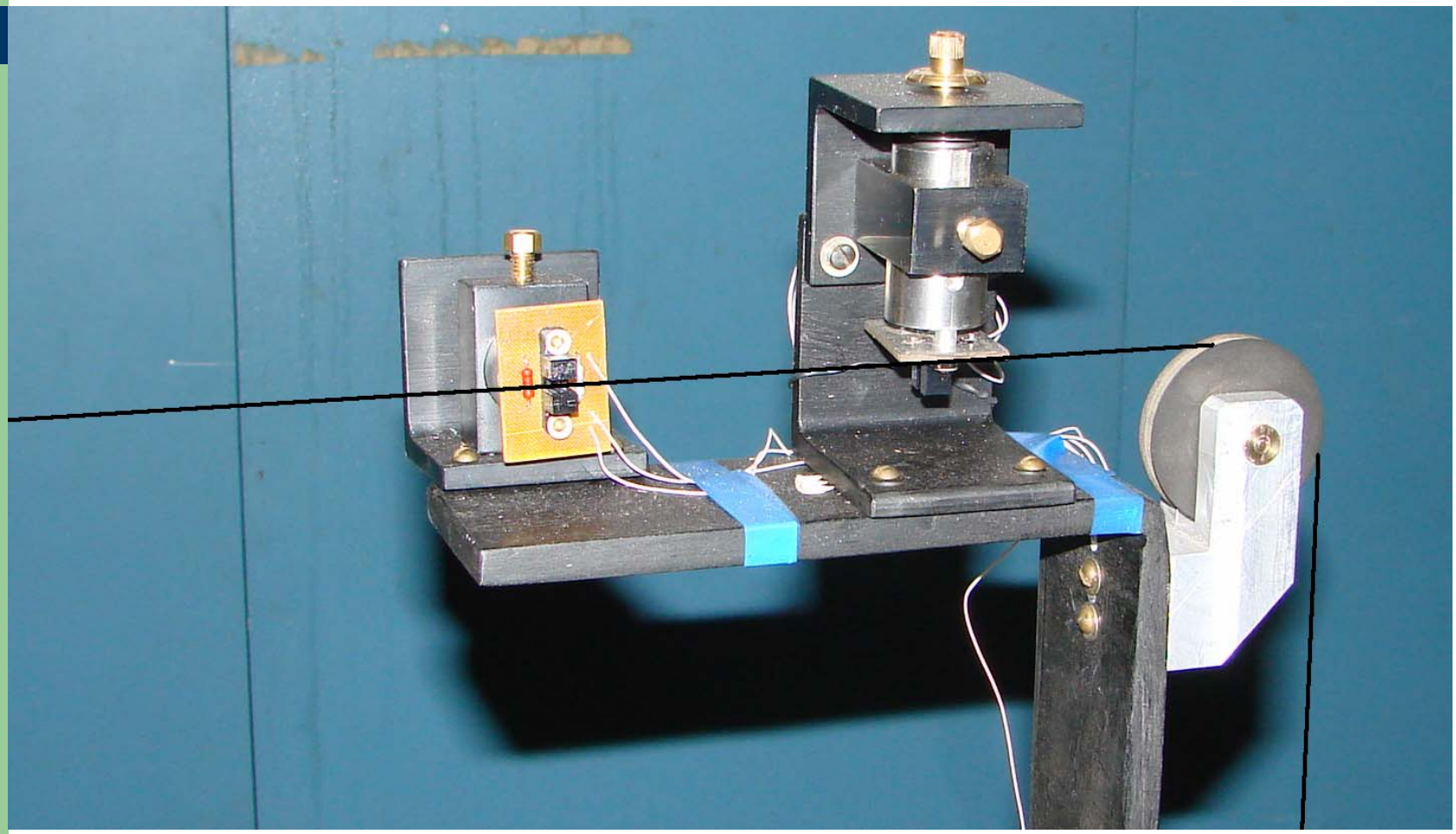
Vibrating wire technique (very sensitive one for measurement of zero field integral)

Sensitivity of the VWT ~ 0.1 G*cm

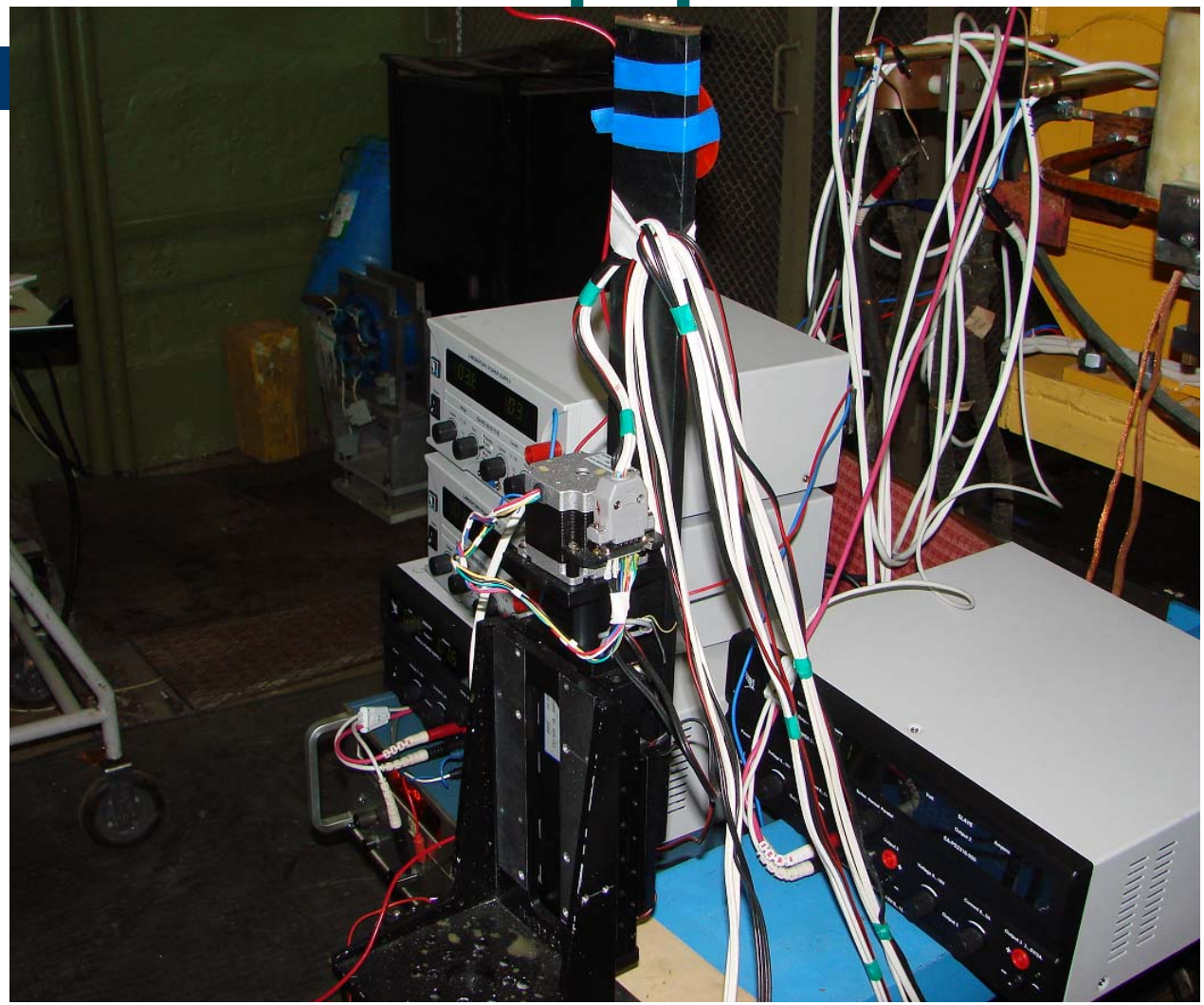


VWT equipment

VWT equipment



VWT equipment



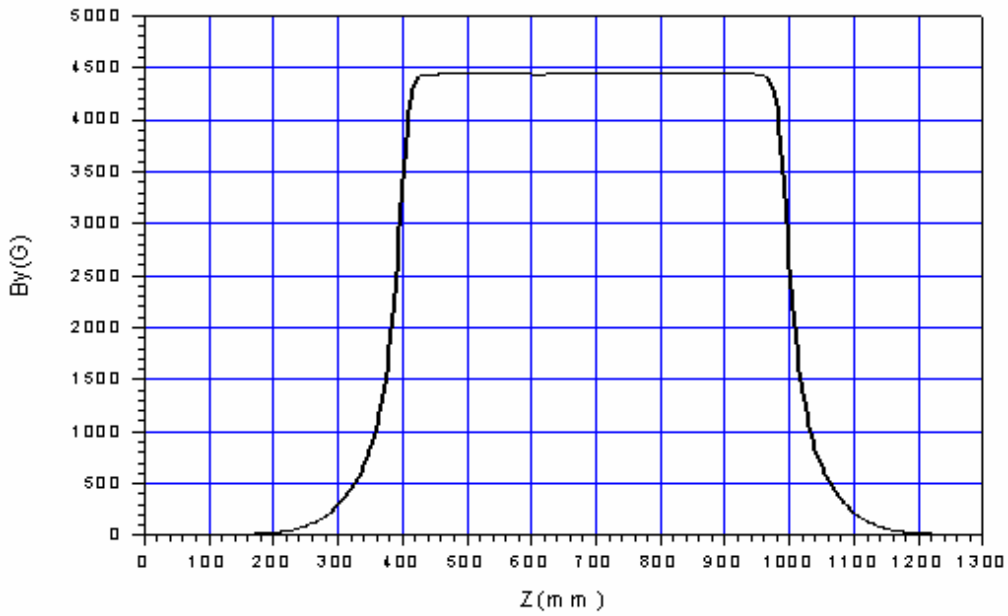
Power supply

- 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

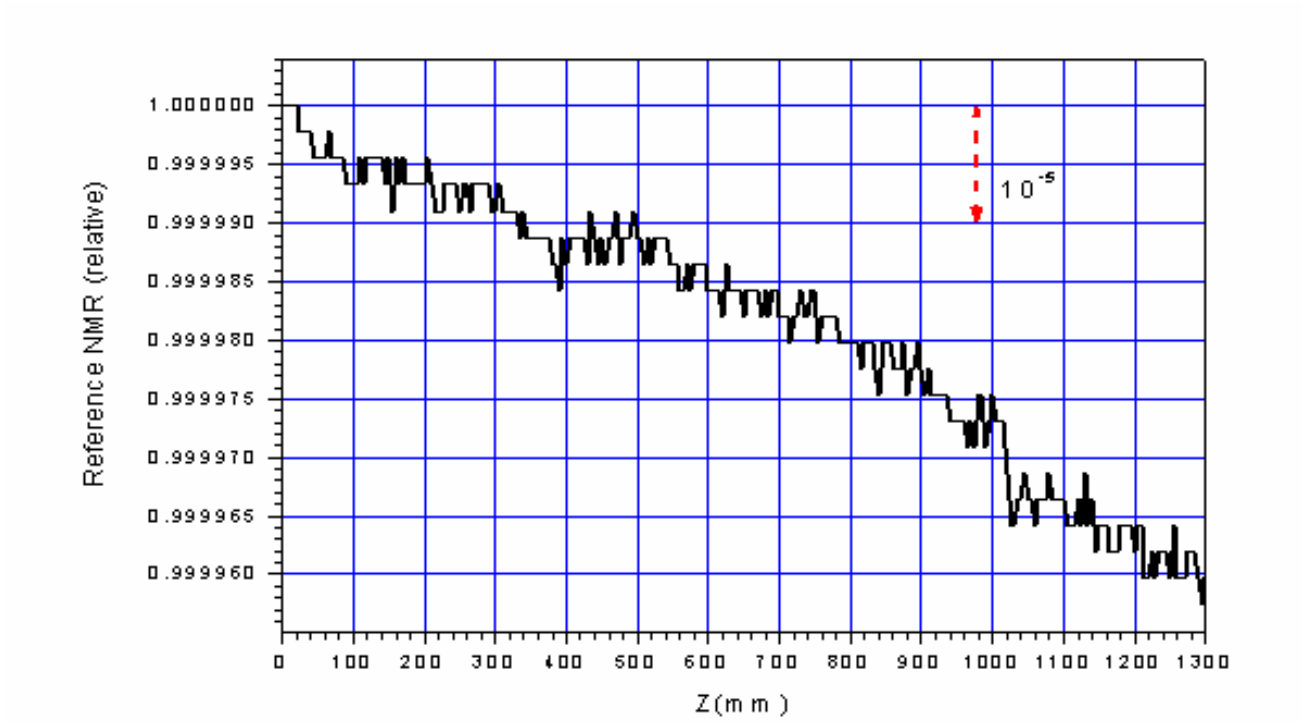
Hall+NMR probe bench commissioning
Test dipole magnet (L=600 mm, g=37 mm)

- Accuracy of the magnetic field integral measuremets ~$6*10^{-4}$



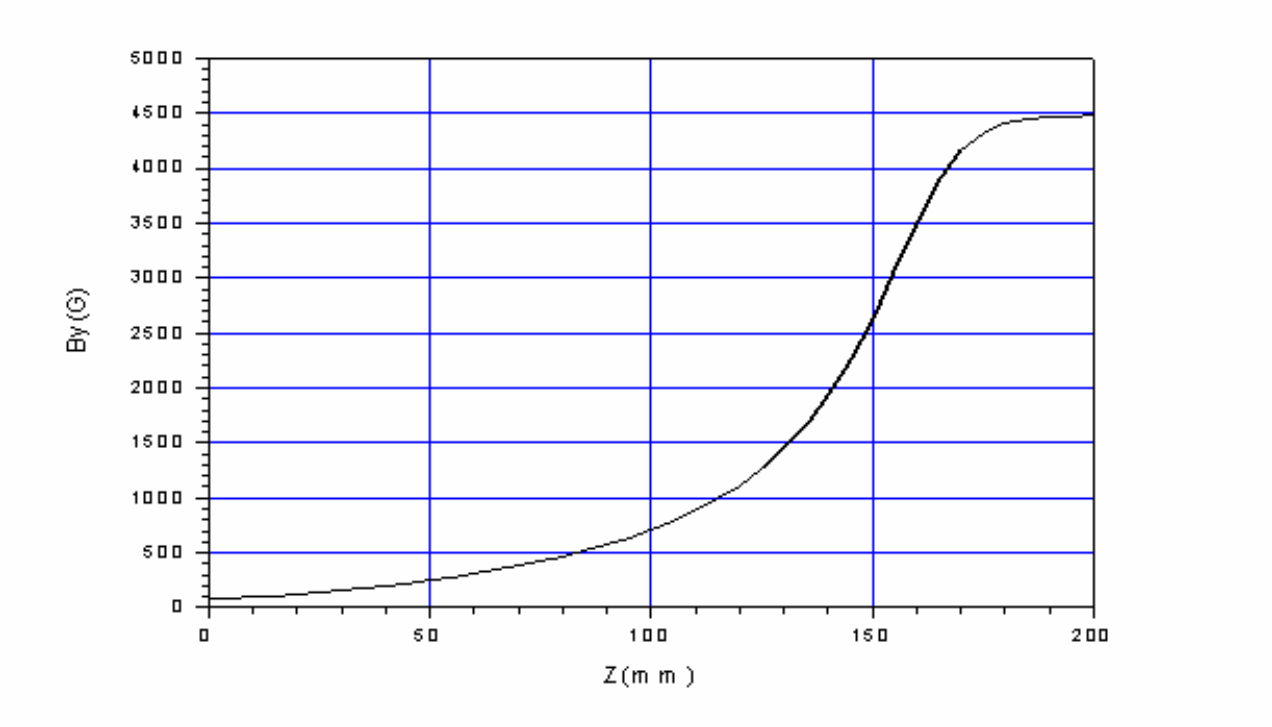
Hall+NMR probe bench commissioning
Test dipole magnet (L=600 mm, g=37 mm)

- Magnetic field integral influence ~$3*10^{-5}$



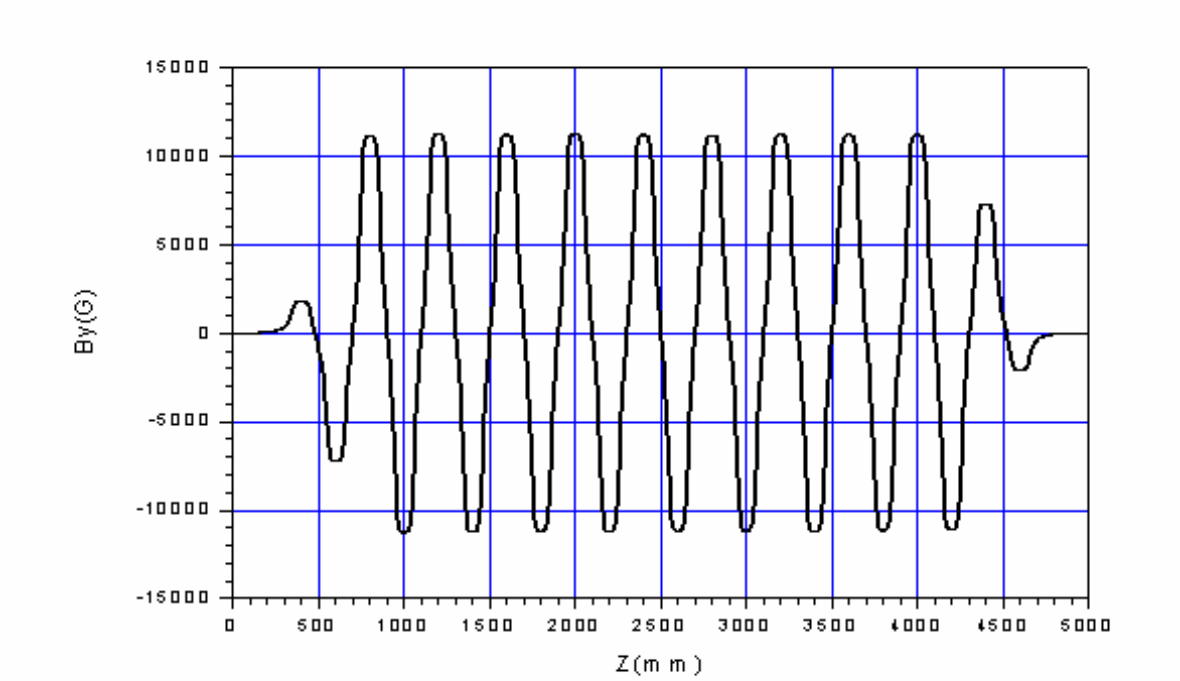
Hall+NMR probe bench commissioning
Edge field measurement

- Edge field integral ~25% of the total one
- Accuracy (optimal step 5 mm) ~$1*10^{-3}$



Hall+NMR probe bench test and work

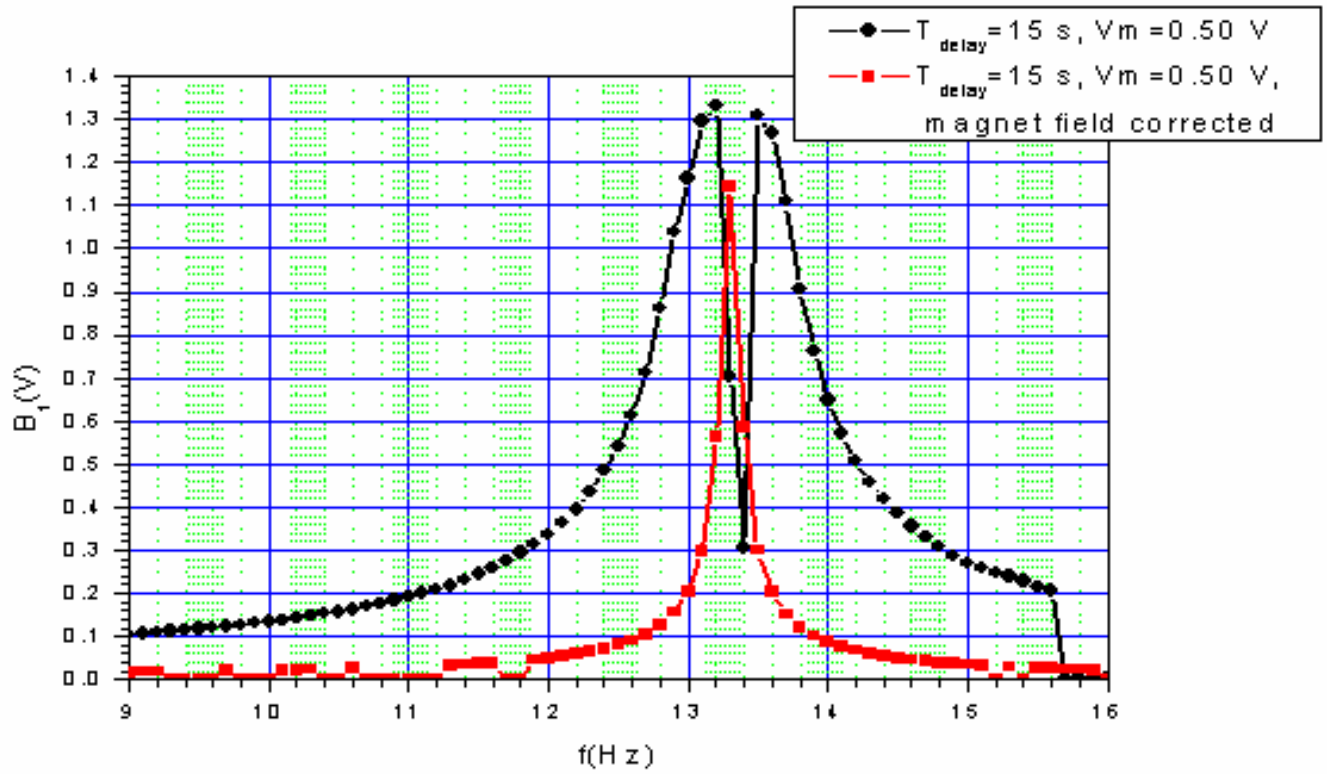
- Realization of the magnetic field mapping for DESY electromagnetic undulator
- More then 200 maps, ~500 hours of mapping
- Accuracy ~$1*10^{-4}$ (it means averaging for 22 poles)



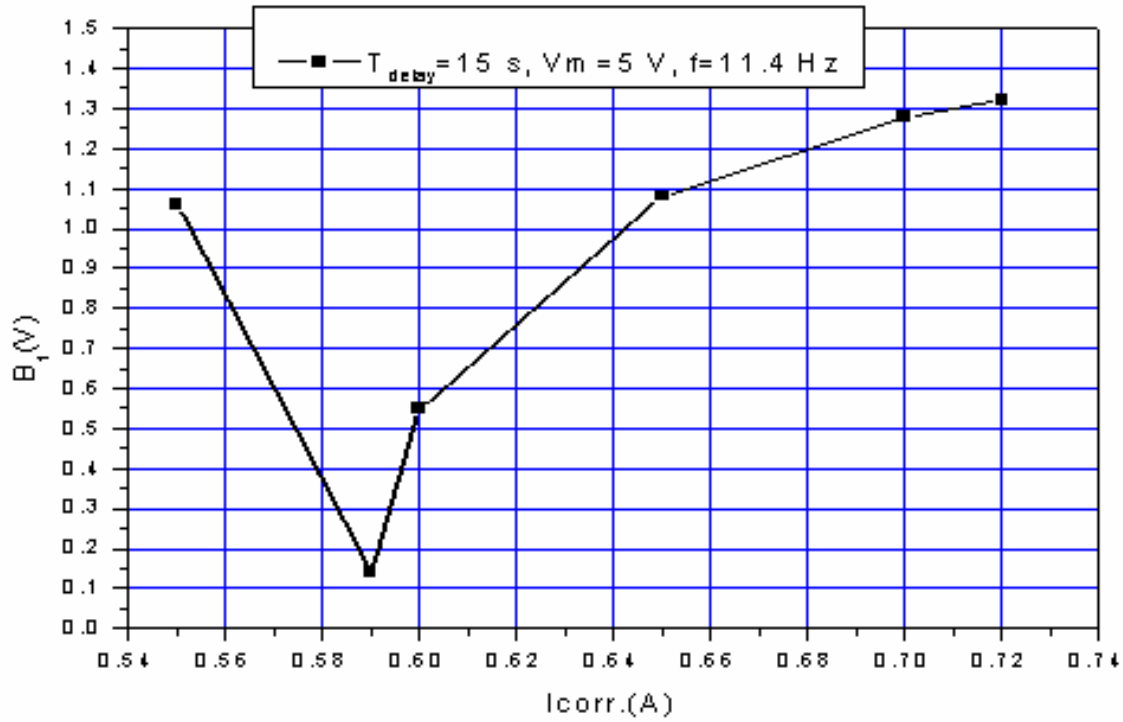
Hall+NMR probe bench plans

- Continue test magnet mapping
- Use NMR probe for uniform region mapping
- Equipped magnet with temperature probes and add them into field mapping procedure

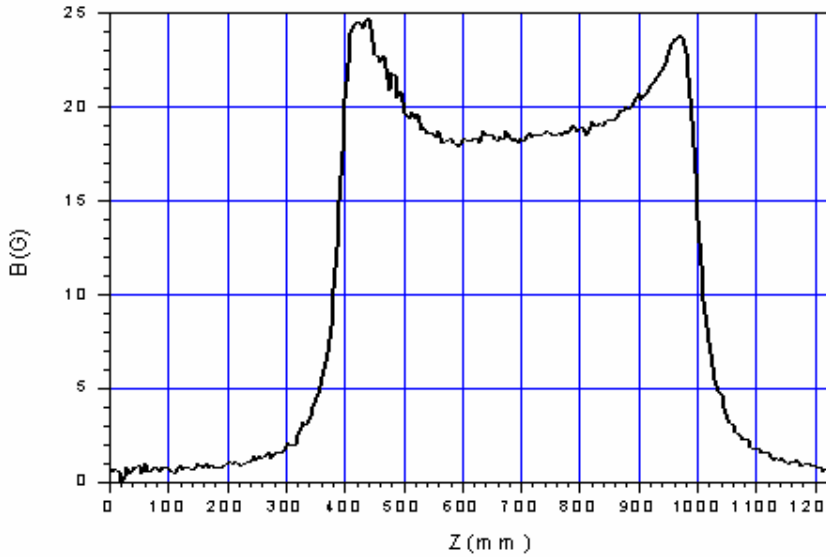
VWT commissioning

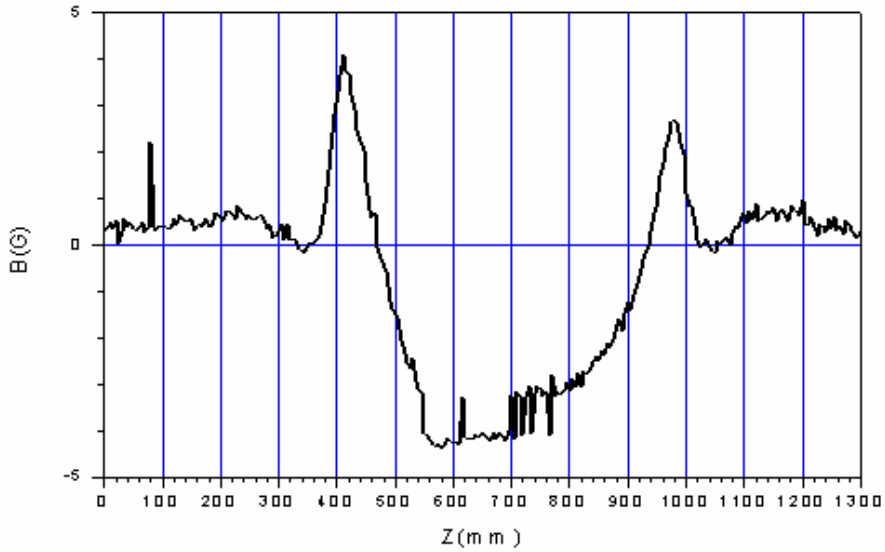


VWT commissioning



VWT commissioning



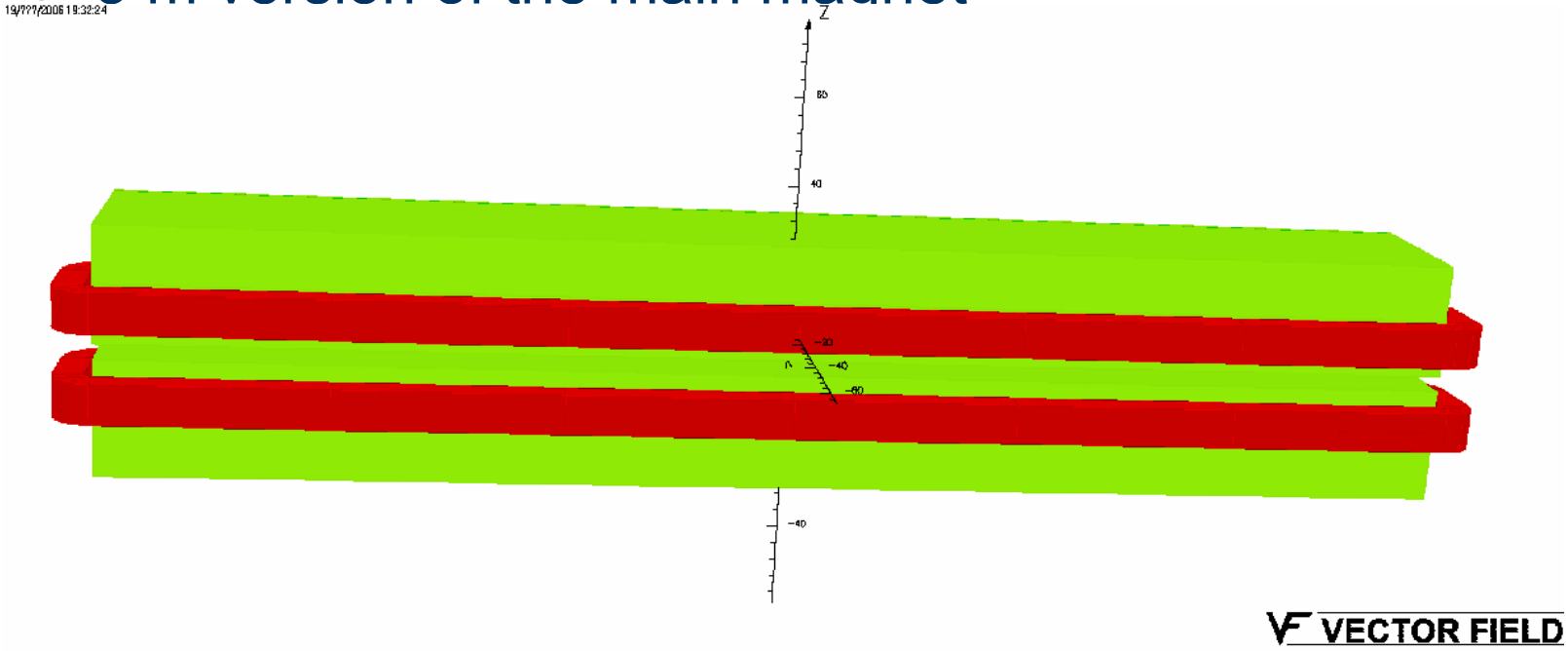


VWT and remanent field study

- Demagnetization and remanent field
- Remanent field and type of magnet core (laminated or solid)
- Remanent field and magnet time history

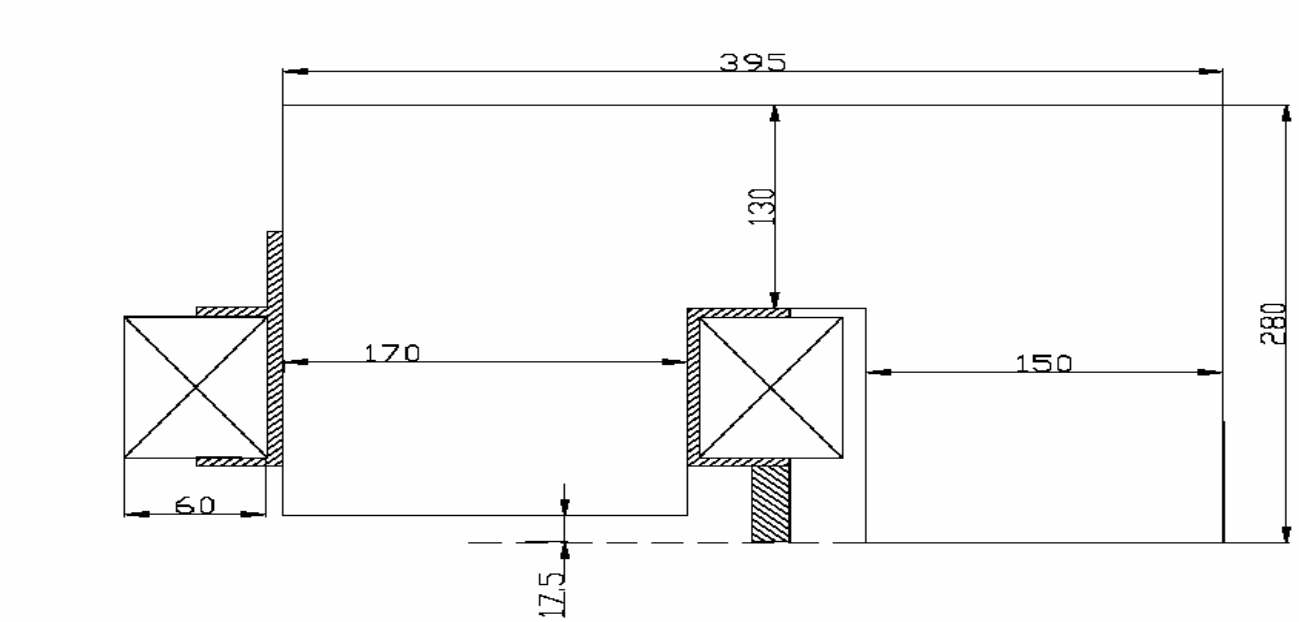
Test magnet design and manufacturing

- 3 m version of the main magnet



Test magnet design and manufacturing

Cross-section of the analyzing magnet (1/2 part)



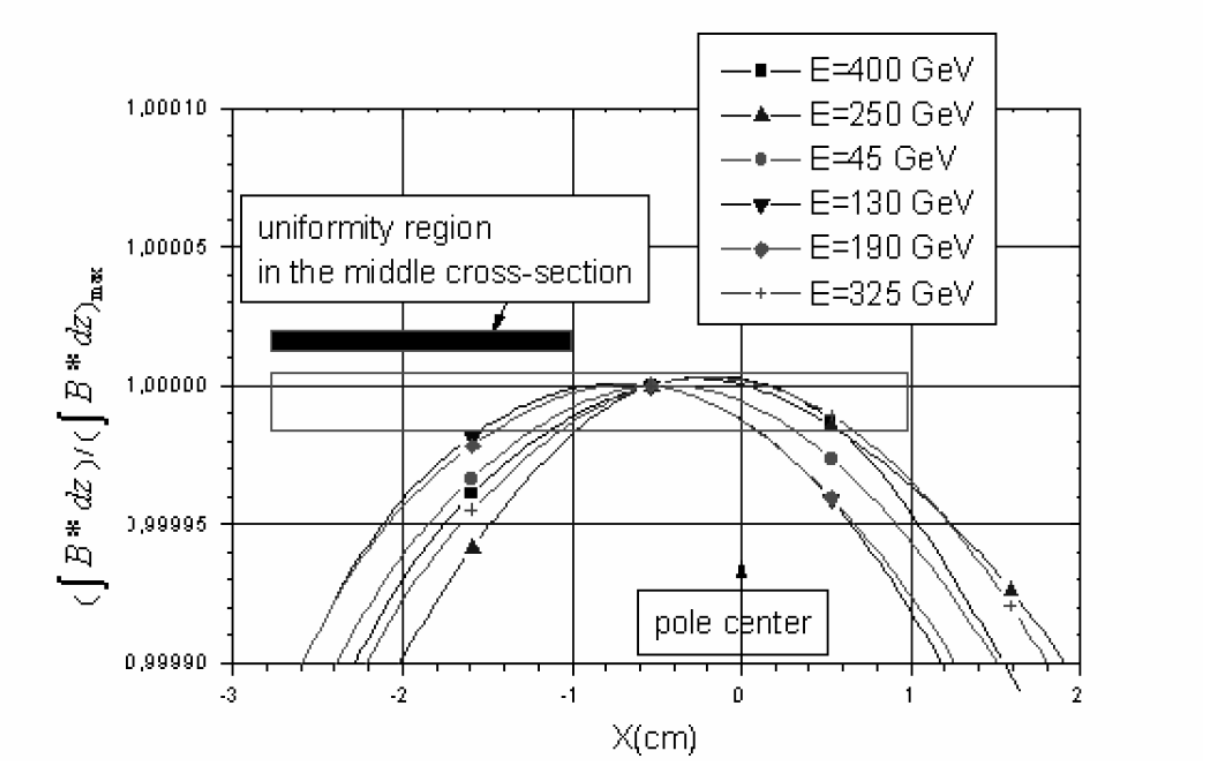
Test magnet design and manufacturing

Basic technical parameters of the analyzing magnet.

	Analyzing magnet
Magnetic field (min/max)(T)	0.05/0.44
Pole gap (mm)	35
Yoke type	C
Yoke dimensions (mm)	395x560x3000
Yoke weight (t)	4.51
A*turns (1 coil)(max)	6335
Number of turns (1 coil)	6*4=24
Conductor type, sizes (mm)	Cu, 12.5x12.5, ⌀7.5
Conductor weight (t)	0.36
Coil current (max)(A)	264
Current density (max)(A/mm^2)	2.4
Coil voltage (max)(V)	13.3
Coils power dissipation (max)(kW)	3.5
Number of water cooling loops	6
Length of cooling loop (m)	56
Water input pressure (Bar)	6
Water input temperature (deg C)	30
Maximal temperature rise of the cooling water (deg C)	1.4

Test magnet design and manufacturing

Normalized longitudinal magnetic field integral



Motivations for the test magnet design

- We have done the preliminary RD
- Now our aim is to do some steps to ED
- No doubts that we can build the magnets
- Measurement of B·L with accuracy 100 ppm is more or less routine procedure
- Motion from 100 -> 50 -> 10 ppm (absolute value) is not simple. It is required practical experience and training. At least two measurement methods have to be used for cross check.

Motivations for the test magnet design (scientific proposals have to be checked by experiments)

- Main goal – magnetic field integral measurement (absolutely) with accuracy 50 ppm or ever better
- Magnet technology (manufacturing with accuracy 50 mkm)
- Temperature stabilization
- Interference between field integral and reference probes
- Development and test of magnetic field measurement equipment
- Remanent magnetic field
- Hysteresis effects

Test magnet design and manufacturing

- 13 k$ (from A.Olshevsky)
- Magnet design ~ 3 k$
- Cu conductor and isolation ~ 5 k$
- Iron ~ 5 k$
- 3 – 4 k$ (from E.Syresin)
- To provide the equipment design for the coils fabrication