Activity of Dubna Group on the ILC Beam Spectrometer Topics. Status report

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Official status

“Study of $e^+ e^-$ Interactions, Linear Collider Physics and Detector” (02-0-1062-2006/2008)

Leader: A.G. Olshevski

Approved for completion in 2008

Now we are on the crossroads, but the ILC activity at JINR will be continued in any case.

“International Linear Collider: Accelerator Physics and Engineering”

Leaders: A.N. Sissakian, G.D. Shirkov

Dubna is pretending as the ILC site

Main topics our group

- Magnetic bench
- Magnet in the “real” environment
- Simulation
- SR detection

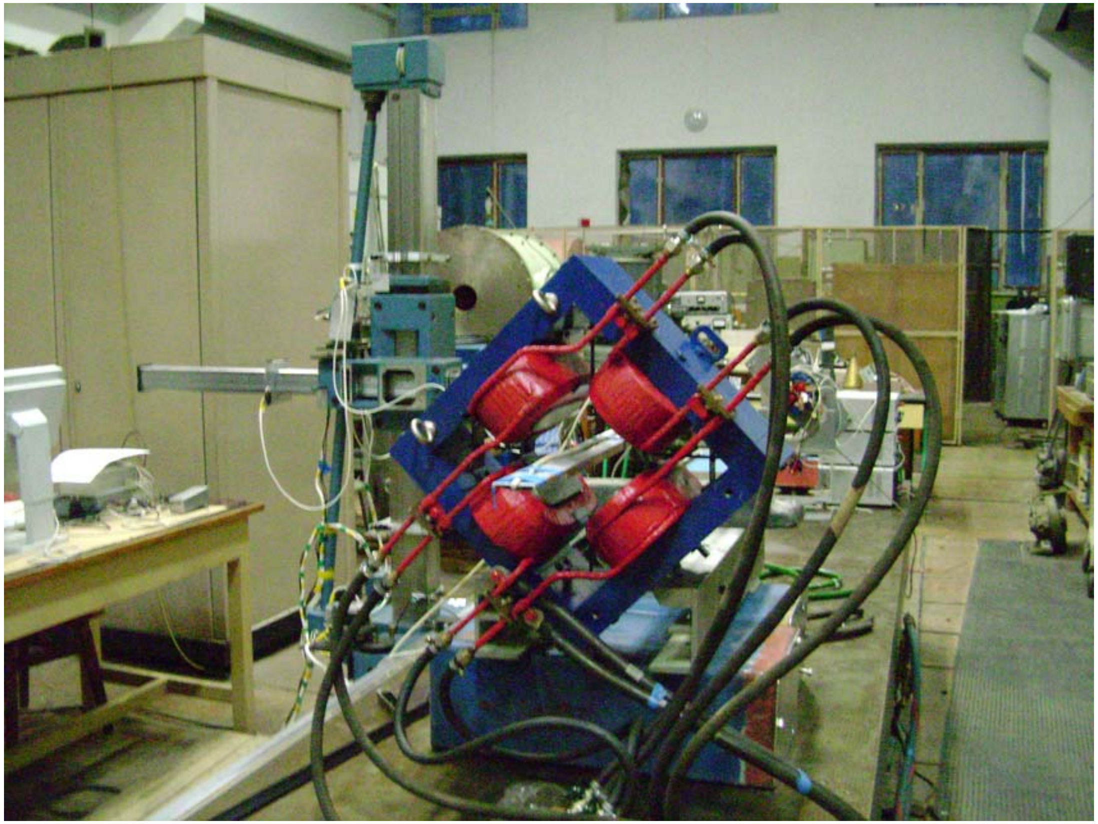
“The Beam Energy Spectrometer at the the International Linear Collider” LC-DET-2004-031, DESY, V.Duginov, H.Henke, K. Hiller et al.

Magnetic field measurement bench

- The NMR+Hall measurement bench was commissioned and tested with new mechanical components and control software.
- A two month working period of the bench for magnetic field mapping and shaping of the DESY infrared undulator has demonstrated the high reliability of the hard- and software involved.

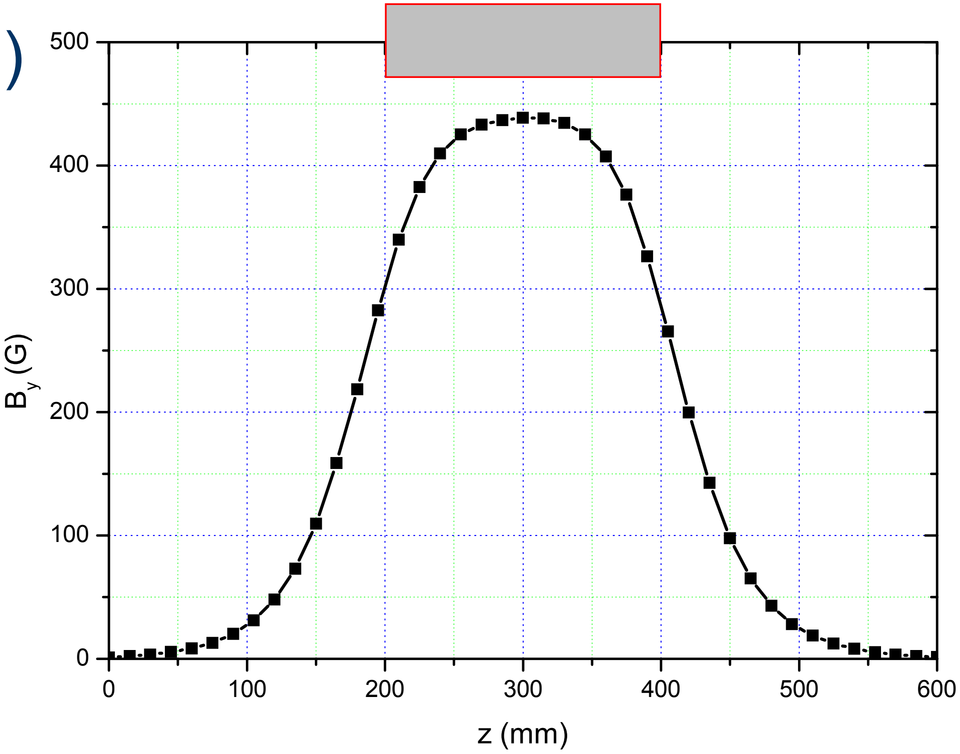
Measurement bench was in the intense use for mapping and calibration of the quadrupole magnets for IREN project

- IREN quadrupole magnet Q2



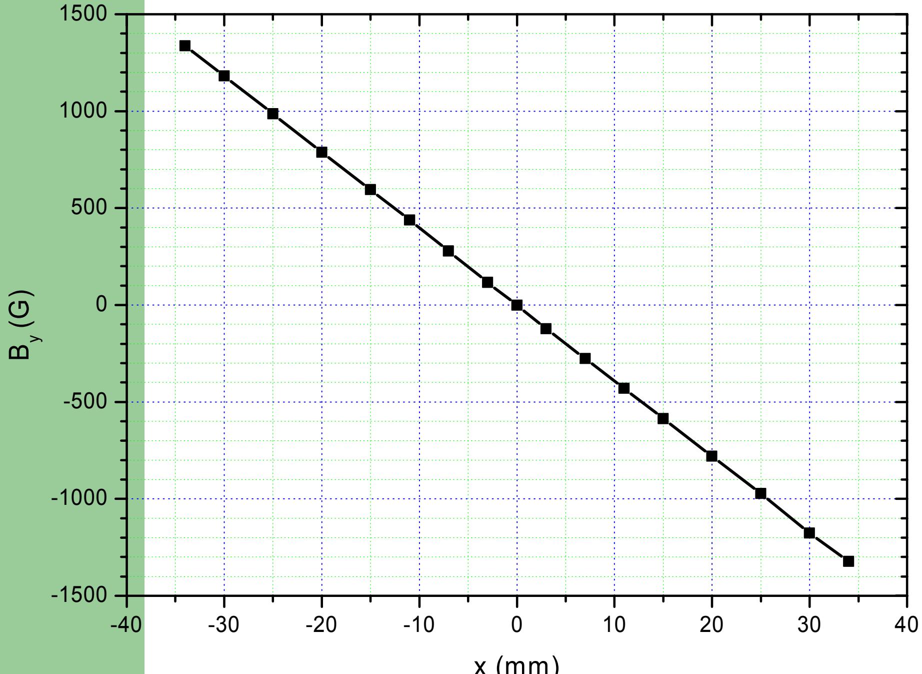
Magnetic field mapping of Q2

- Magnetic field along quadrupole (X=11 mm)

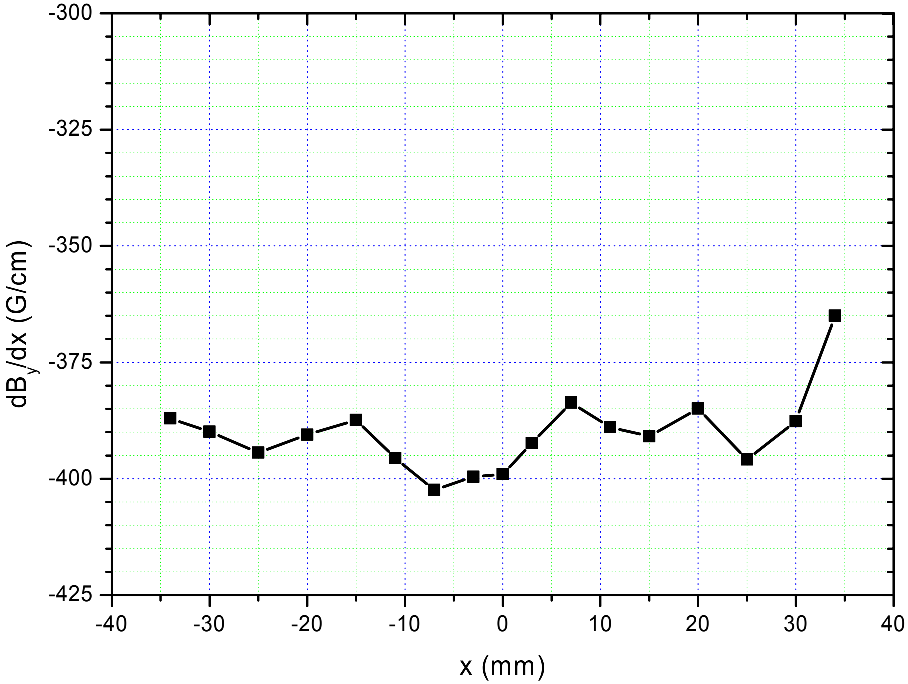


Magnetic field mapping of Q2

- Magnetic field in the middle section
-

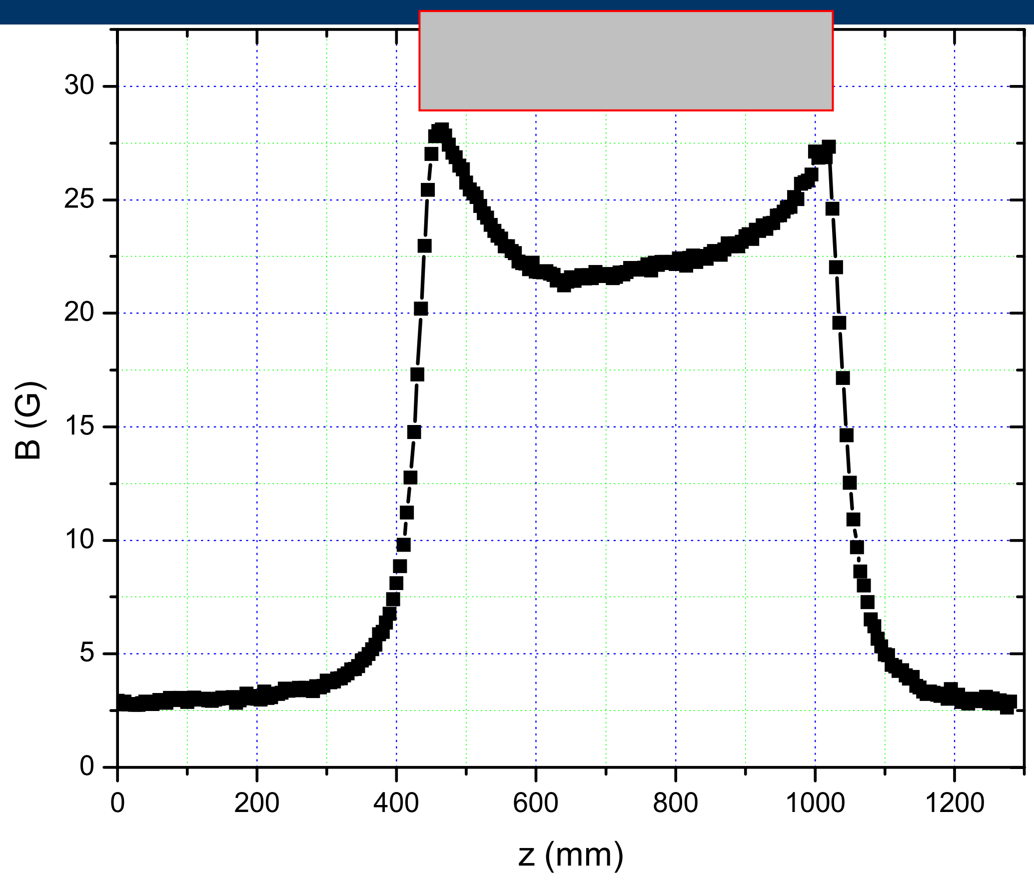


Magnetic field gradient in the middle section



Mapping of the residual field of the dipole magnet

Residual field distribution



The accuracy of Hall method is rather far from requirements

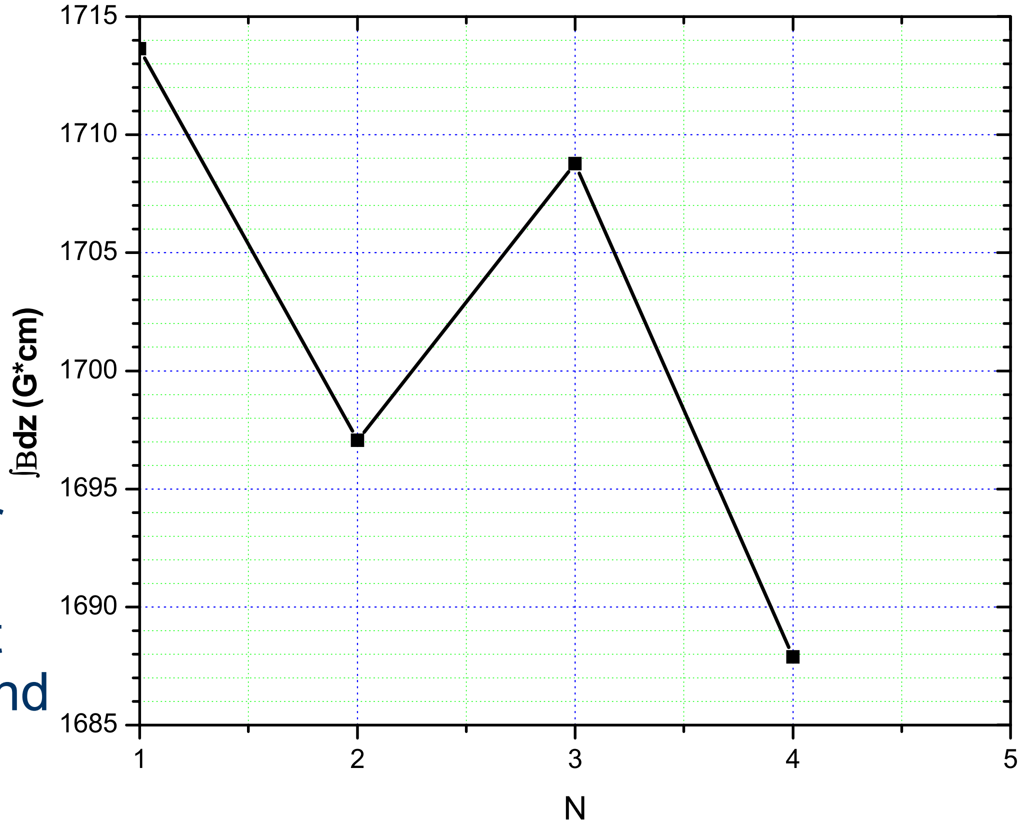
Accuracy:

- absolute ±13 G*cm
- relative ± $8*10^{-3}$

Requirements:

- absolute ±(1-10) G*cm
- relative ± $5*10^{-5}$

New Hall magnetometer and the vibrating wire technique measurement bench was completed and commissioned including associated software.



Magnet in the real environment

Magnet in the real environment

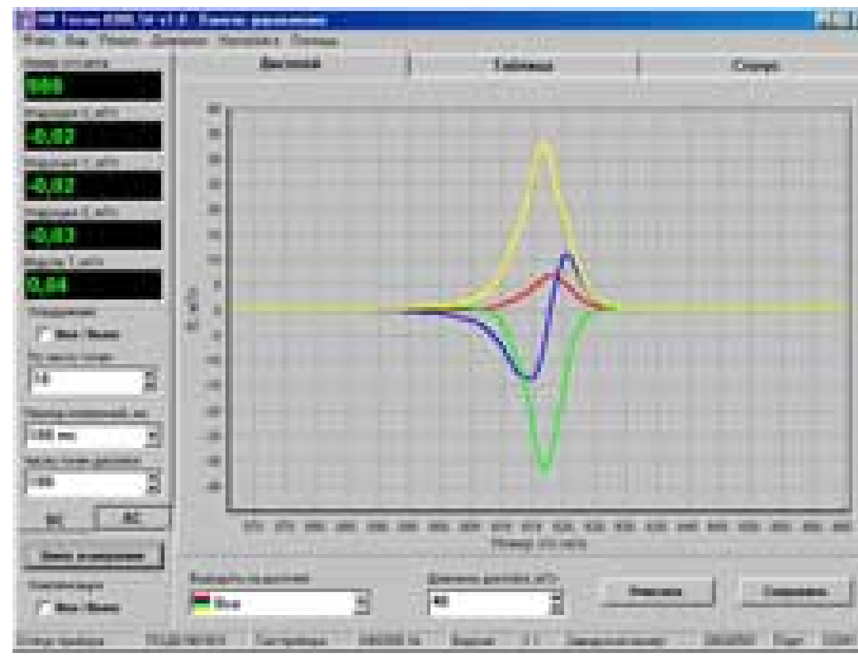
- The long term measurement with the water cooled magnet to study the stability of the temperature was performed.
- This magnet was equipped with the 3-axis fluxgate gaussmeter (B=+/- 100 microT, ΔB=0.1 microT) for the demagnetization procedures
- NMR magnetometer

3-axis fluxgate gaussmeter

1. Fluxgate probe
2. Commutation box
3. Power adapter
4. PC

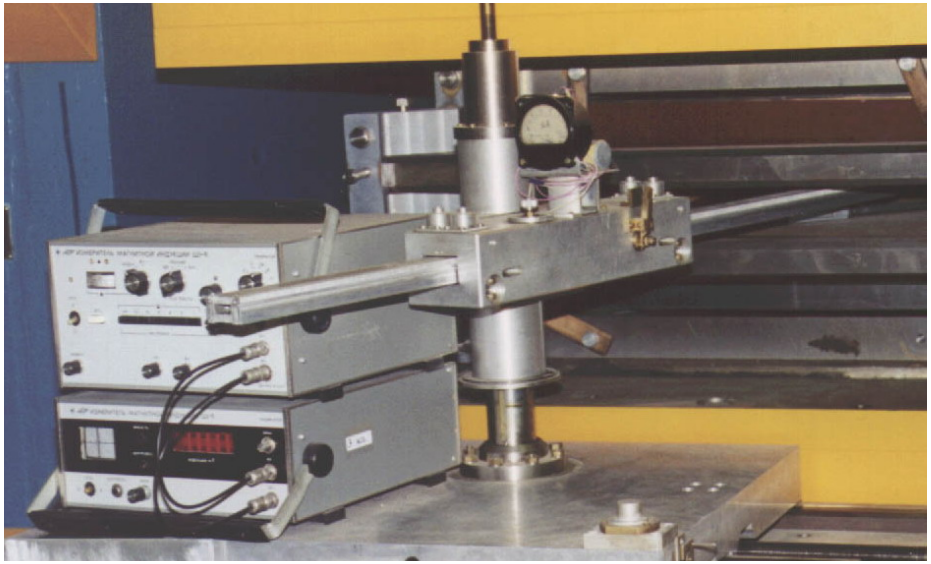
We are discussing with the NVLab the analog autonomous demagnetization system.

The 3-axis fluxgate gaussmeter



NMR-magnetometer

- Field.topography
- Long.term.stability
- Influence of EM environment in real experimental hall



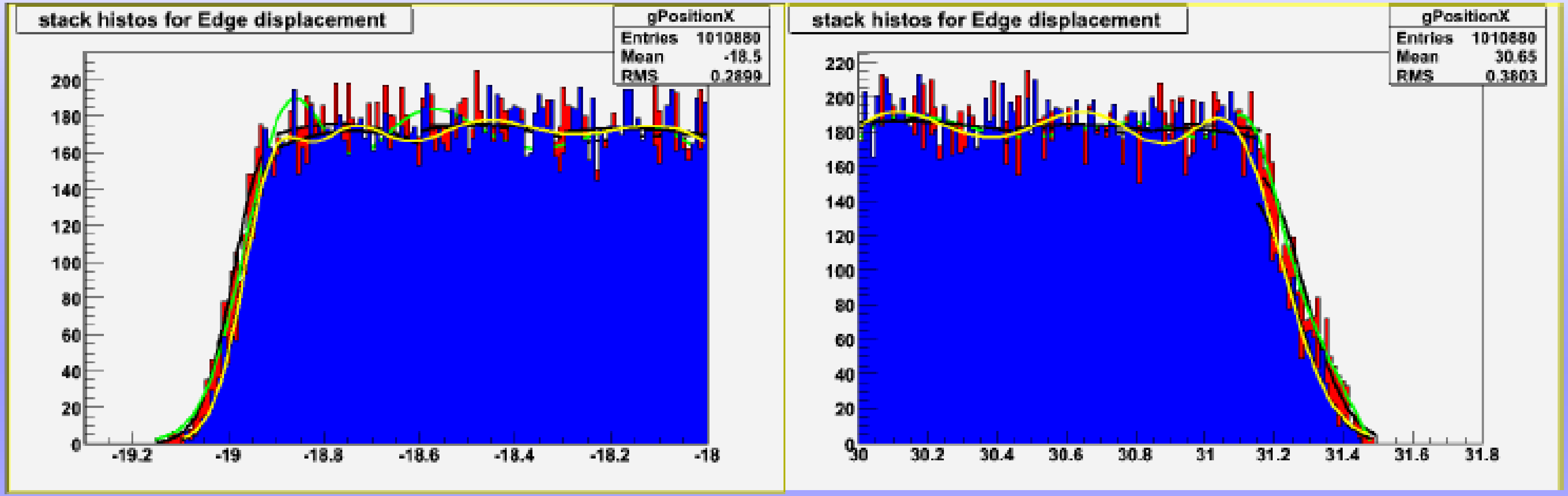
Future plans

- Vibrating wire technique study of the residual field
- Residual field and type of the magnet core (laminated or solid)
- Magnets demagnetization study
- New Hall magnetometer - **Lake Shore** 460 Gaussmeter

SR detector for the E_B measurement

K. Hiller, H.J. Schreiber, R. Makarov, E. Syresin and B. Zalikhanov "ILC beam energy measurement based on synchrotron radiation from a magnetic spectrometer." Nucl. Instrum. Meth. A 580: (2007), 1191-1200

SR edges displacement

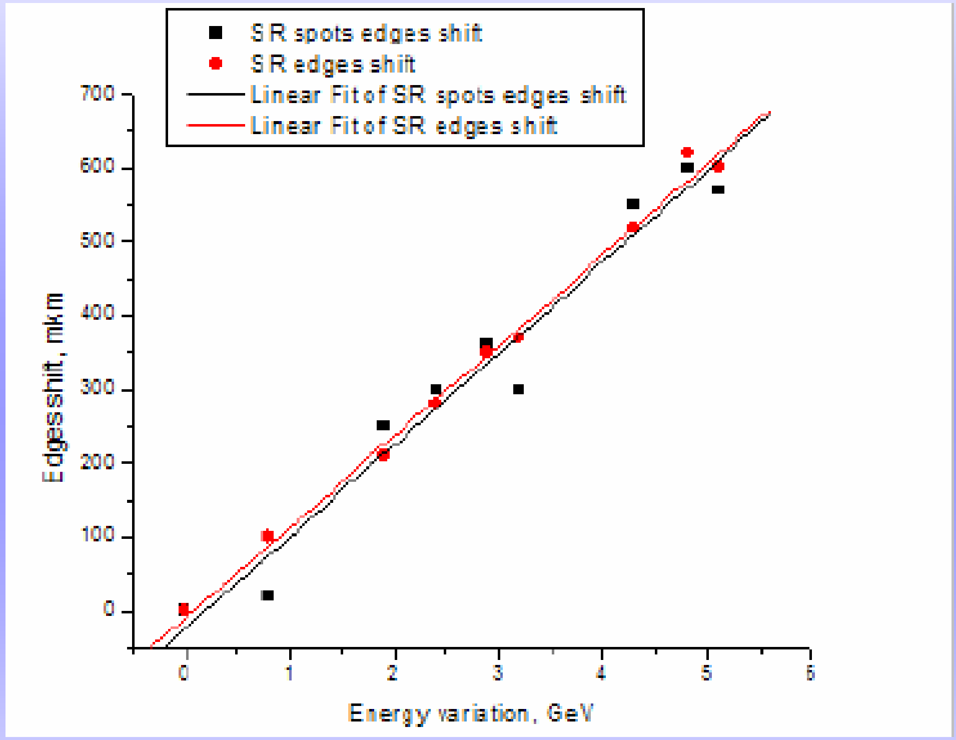


E = 250 GeV blue histogram

E = 250 GeV – 300 MeV red histogram

SR fan left edge displacement	**$\Delta x_{left} \approx 42\text{-}48\ \mu m$**
SR fan right displacement	**$\Delta x_{right} \approx 30\text{-}36\ \mu m$**
Simulated energy resolution	**75 μm/300 MeV**
Required resolution	**30 μm + 30 μm /300 MeV**

Dependence SR fan edges displacement versus energy variation



Red line for SR fan edges displacement, black one for soft radiation reflected on mirrors

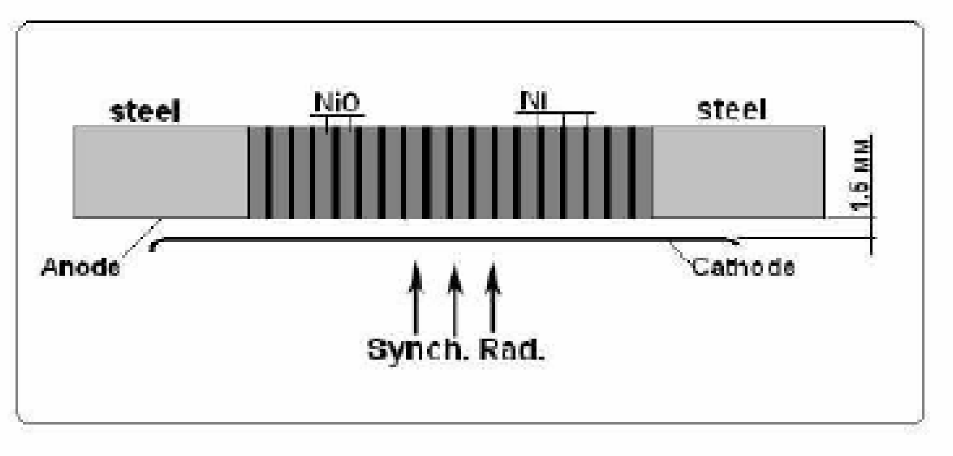
Linear Regression for SpotsShift
Y = A + B * X

Parameter	Value	Error	
A	-22,35225	31,19995	
B	124,06182	9,54306	
R	SD	N	P
0,97991	47,25073	9	<0.0001

Linear Regression for xDistShift
Y = A + B * X

Parameter	Value	Error	
A	-8,10732	12,44364	
B	122,95141	3,80611	
R	SD	N	P
0,99666	18,84525	9	<0.0001

GAS AMPLIFICATION DETECTOR



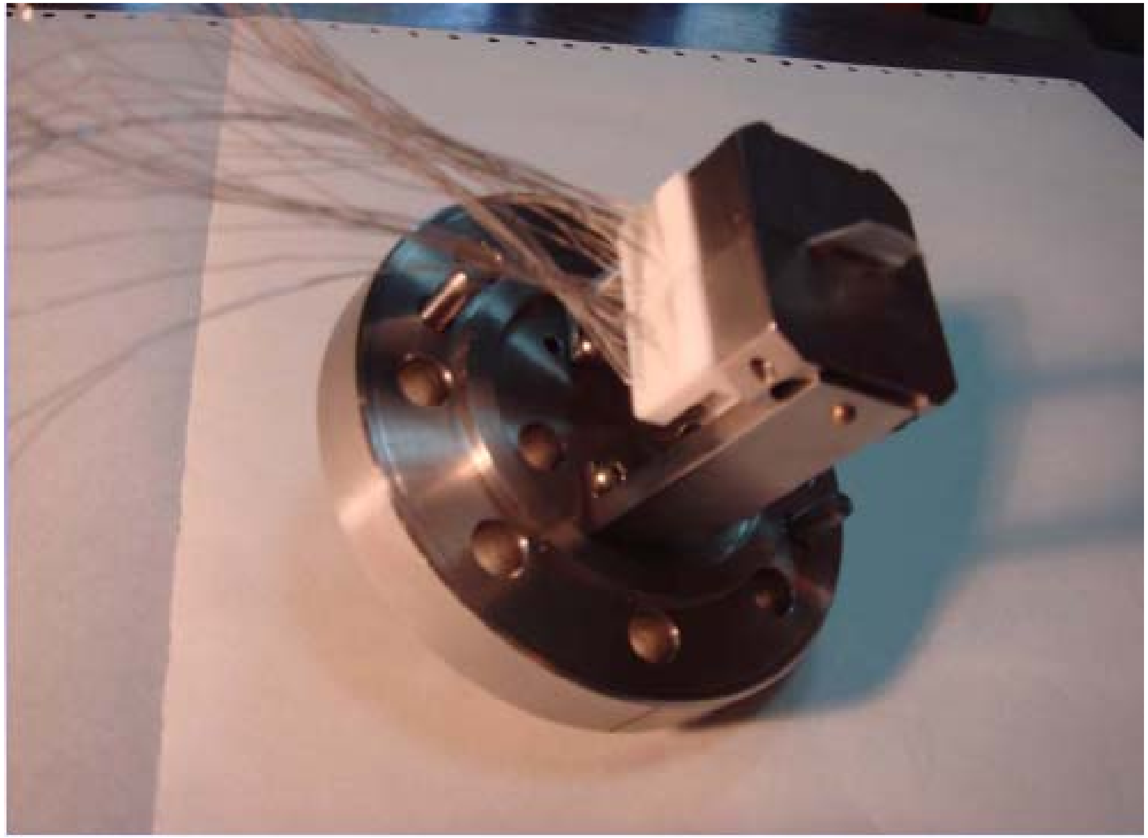
$$N = N_0 \exp(\alpha d_{c\text{-}a})$$

P=60 Atm at t=16 C- critical pressure for liquid Xe
liquid Xe density is of 3.05 g/cm^3

720 Ni layers at a thickness of 1 mkm
strip pitch is 3 mkm

Number of soft photons at E≈10 keV per strip	$N_\gamma \approx 10^6$
Number of secondary electrons per strip	$N_e \approx 10^8$
After amplification at K=10	$N_e \approx 10^9$
The signal at amplifier conversion of 5 V/1 nC	$V \approx 1.5$ V

Several technologies of detector manufacturing were tested. For example, the laser cutting technology for the detector of soft SR γ-quanta with sub- micrometer resolution is in progress.



- **Assembling detector**
  Creation of electronic system
  Test experiments with Eγ of several tenth keV

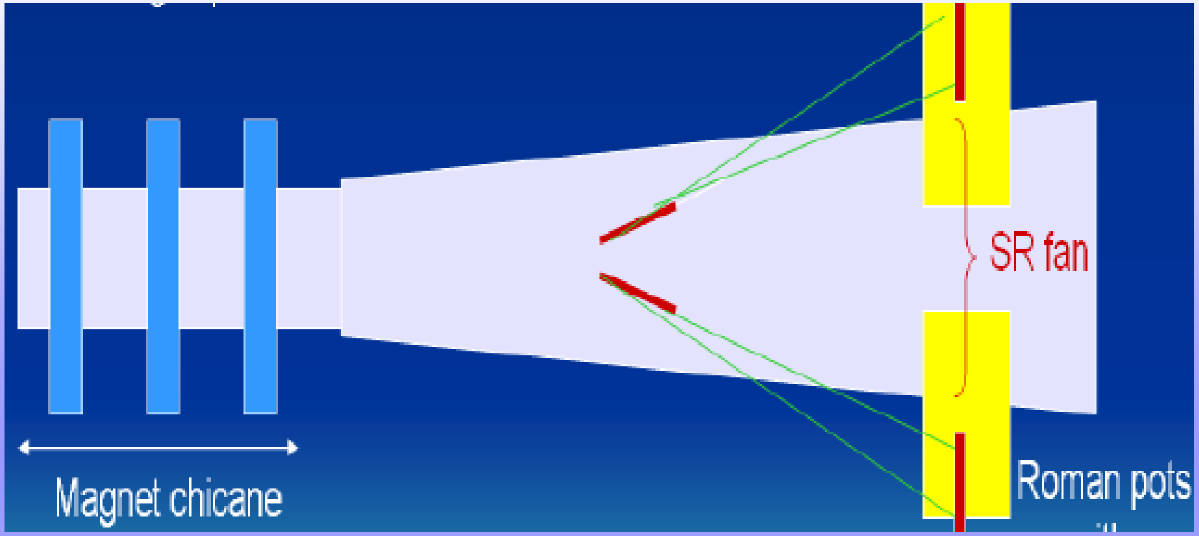
High pressure chamber with beryllium window for SR

Simulation

- For the SLAC ESA T-474 experiment magnetic field 3D simulations were provided for the D37 dipole magnets. Also, field mapping of the D37 magnets and the remnant fields at the SLAC test energy spectrometer was performed. (See talk of A. Lyapin)
- Simulations of SR by means of GEANT-4 for the new configuration of the ILC magnetic energy spectrometer were performed. In particular, separation of soft from hard SR by means of a Rh mirror was studied in detail.

SR Simulation

REFLECTION MIRRORS FOR SOFT SR



The application of mirrors permits to avoid the problems related to SR radiation protection however the installation of mirrors reduces the energy resolution at fixed coordinate resolution and detector position.

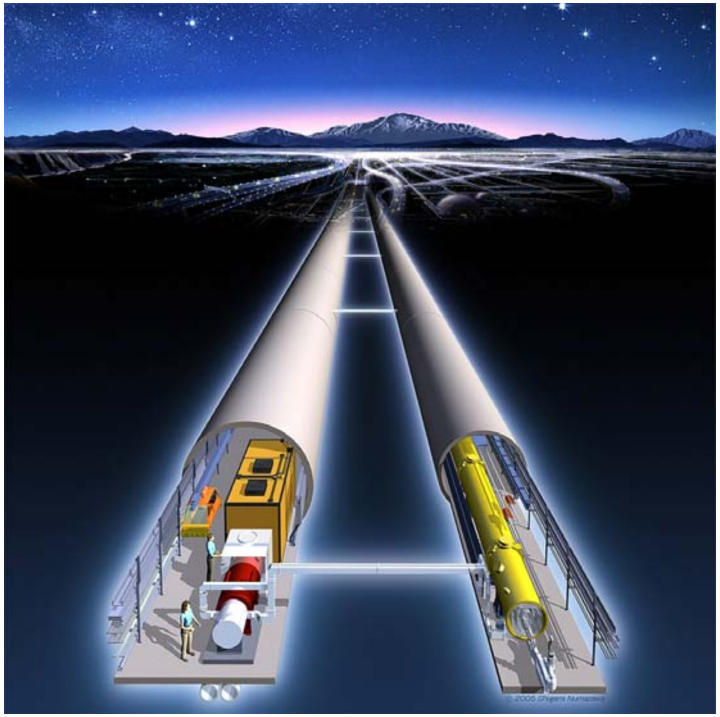
L_{am}=40 m

mirror-spectrometer magnet distance

$L_{m\text{-}d}$=10 m

mirror-detector distance

Conclusion



Let's hope! Let's work!