STATUS OF THE WIGGLER MANUFACTURE FOR CLIC DAMPING RING

P.Vobly

Existing design of SC wigglers in BINP

It is based on the use of NbTi wire, the wet winding of the separate poles and subsequent clamping them with help of side and end brackets

Advantages :

- *Minimal value of storage energy*
- *High level of serviceability in case of insulation damage*
- *Minimal length of SC wire in comparison with other wiggler design*

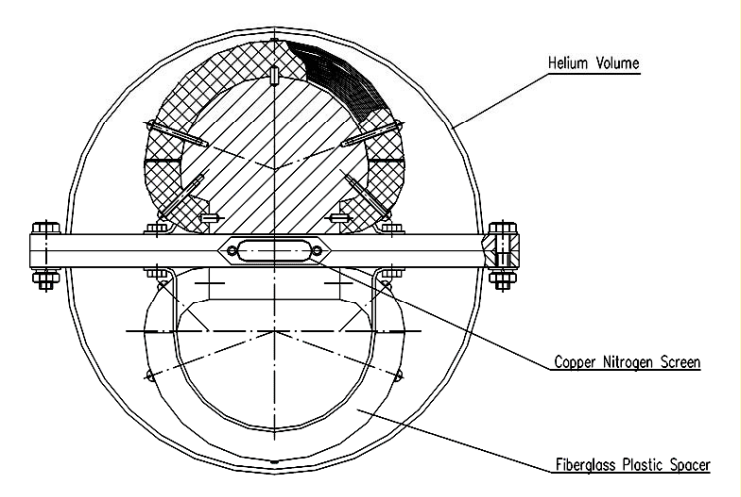
Disadvantages :

- *Wet winding complicates substantially a procedure of wiggler manufacture*
- *Restriction of minimal length period*
- *The use of Nb_3Sn superconductor by this technology is very problematical*

New design of SC wiggler

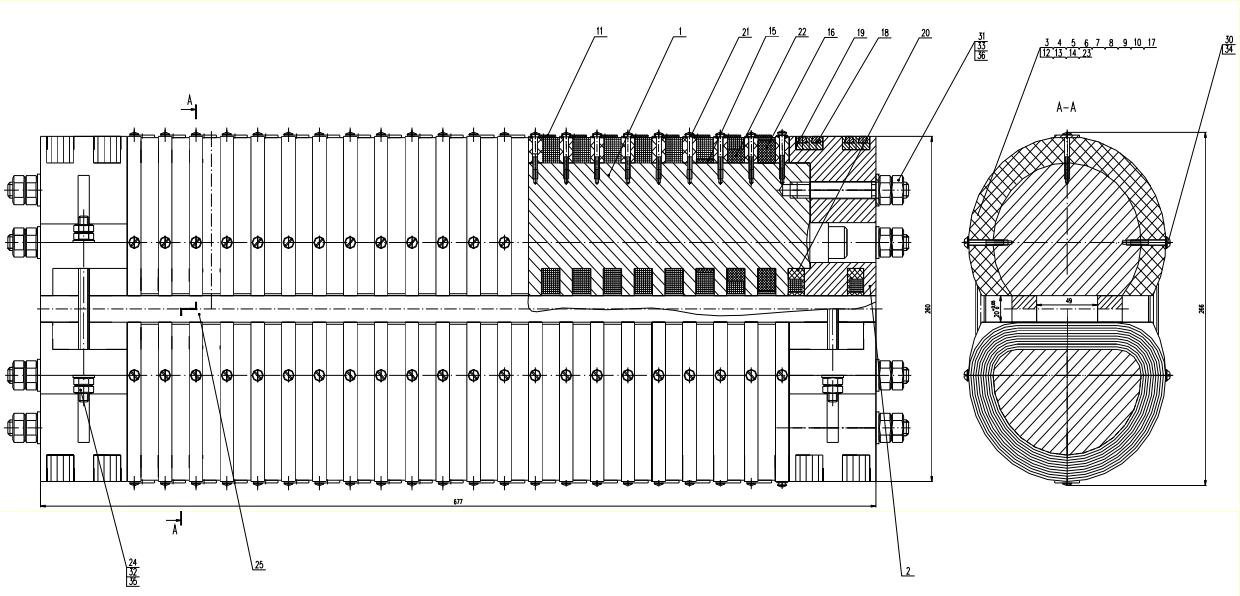
The aim of new wiggler design :

- *This design allows us to use of Nb_3Sn instead of NbTi wire*
- *The use of a dry winding technology substantially reduces time of the wiggler manufacture and manufacture cost*
- *Enhancement of working reliability*



Disadvantages of this design :

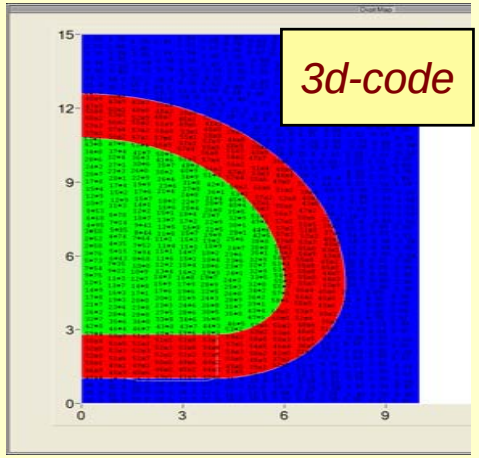
- *This design requires more than two times SC wire length*
- *Large value of storage energy*



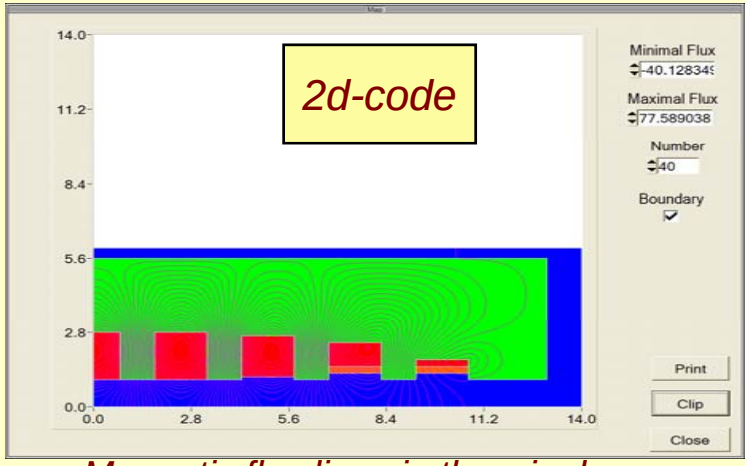
Results of wiggler optimization with help 3d Mermaid code

Wiggler prototype parameters :

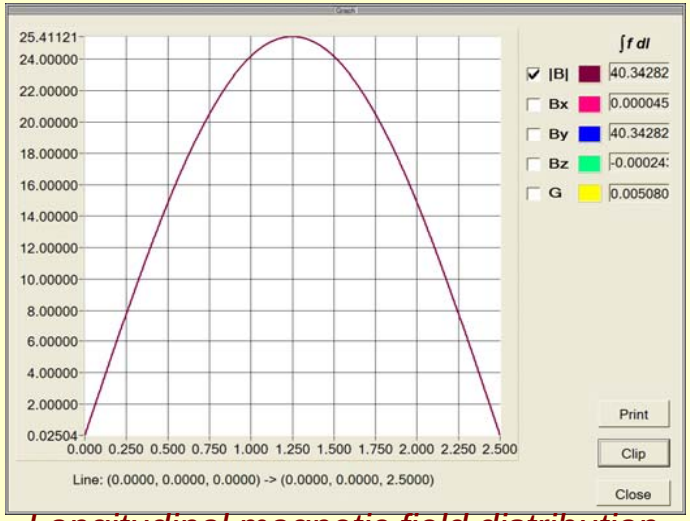
- *Period length - 5.0 cm*
- *Vertical pole gap - 2 cm*
- *Beam aperture - 1.2 cm*
- *Peak field - 2.5 T*
- *Prototype length - 50 cm*
- *Diameter of NbTi wire - 0.9 mm*



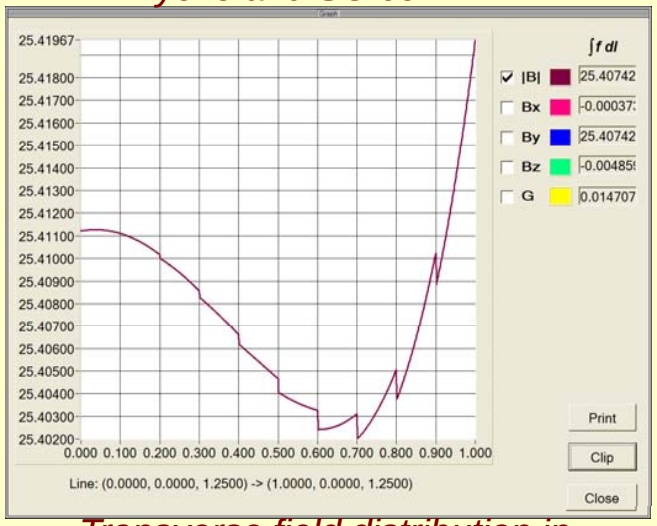
Magnetic induction map inside iron yoke and SC coil



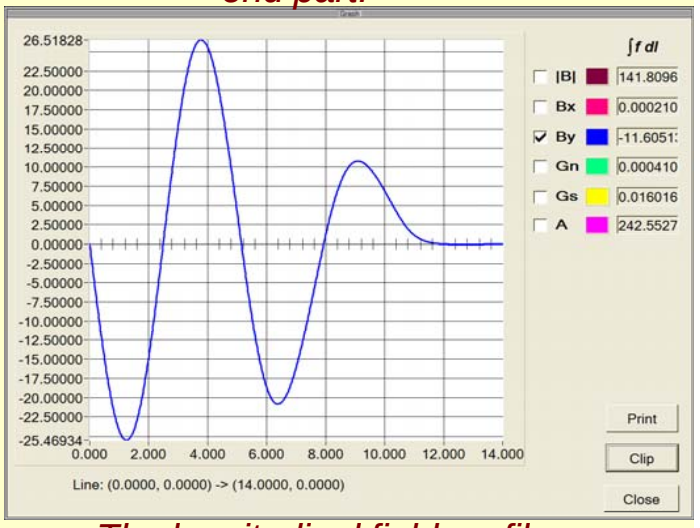
Magnetic flux lines in the wiggler end part.



Longitudinal magnetic field distribution within 1/2 wiggler period

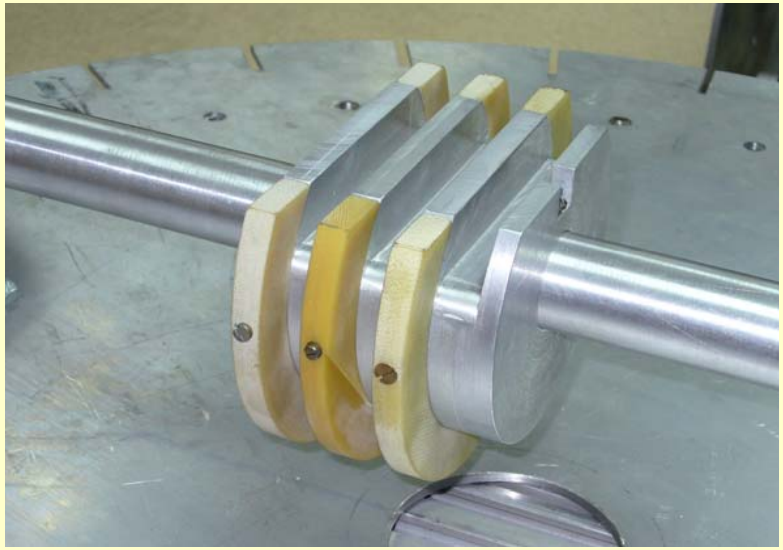


Transverse field distribution in center of iron pole

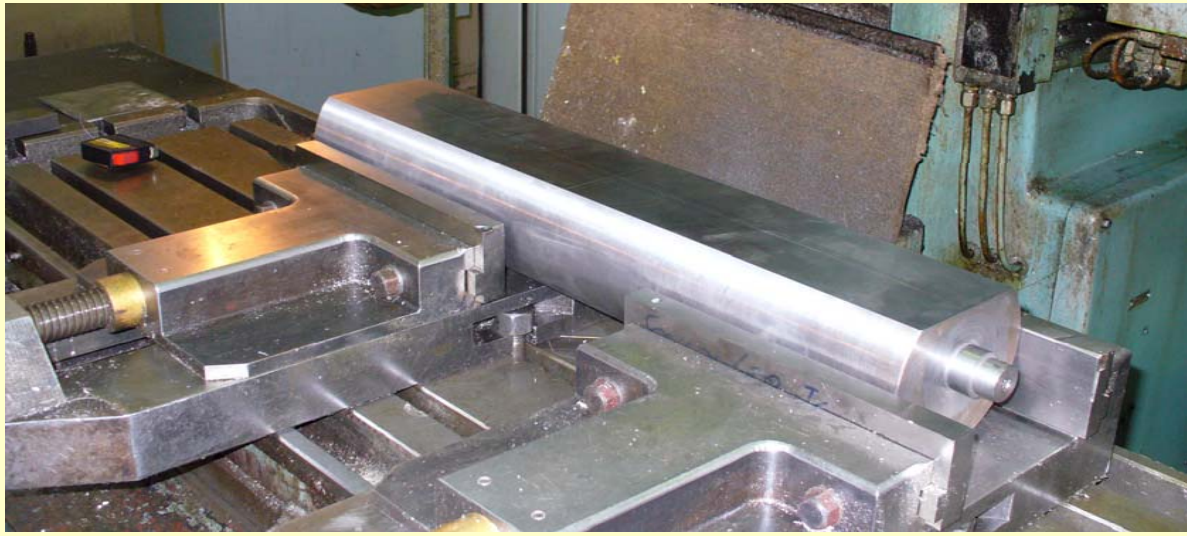


The longitudinal field profile at the wiggler end part

Current situation with wiggler manufacture



Model of iron yoke for coil winding elaboration

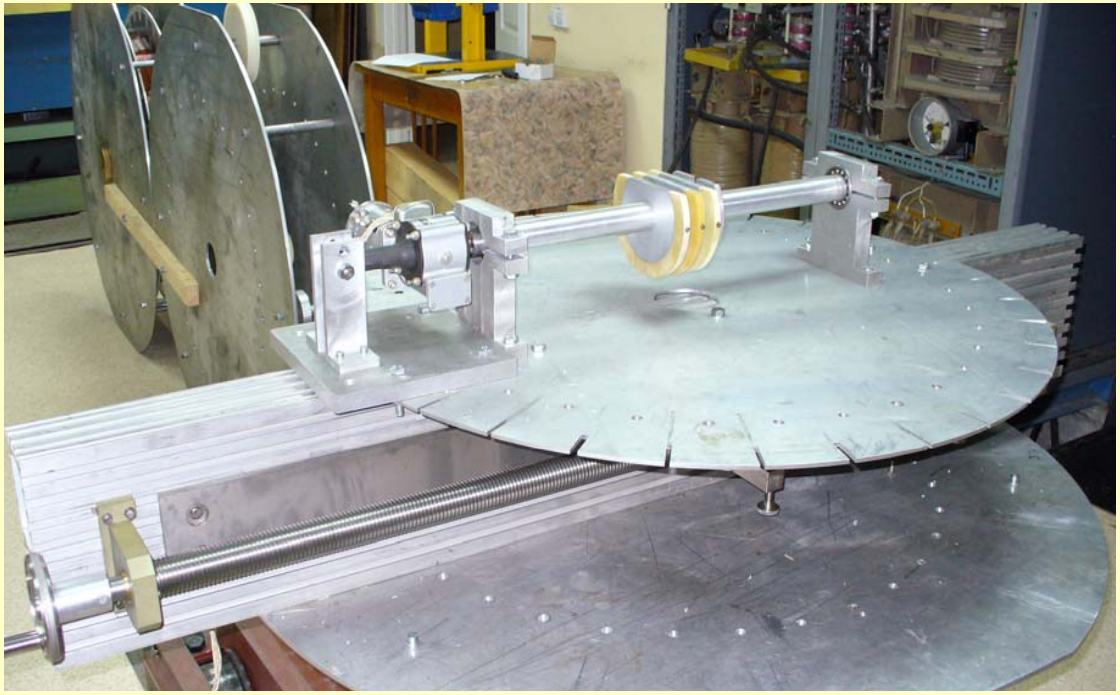


Preparation of one half iron yoke for slot milling

- *All other details for wiggler manufacture are ready now*

Preparation for coil winding

- *Details for coil impregnation inside rubber sack will be ready in several weeks*



Tool for coil winding into iron yoke slots with help of one wire piece

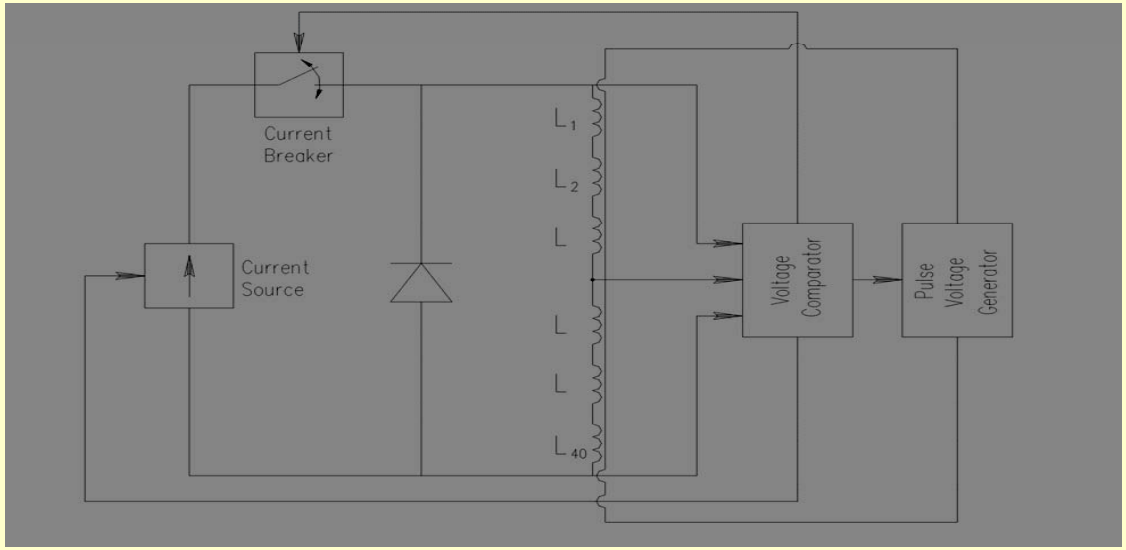
Current situation with preparation for magnetic measurements

Method of wiggler fastening inside cryostat

Test cryostat

Parameters of electronics for study of quench propagation

- *Number of measuring channels - 192*
- *Minimal time interval between measurements in just the same channel - 64 mksec*
- *Memory for each channel - 1024*
- *Continuous scanning of all SC coils*



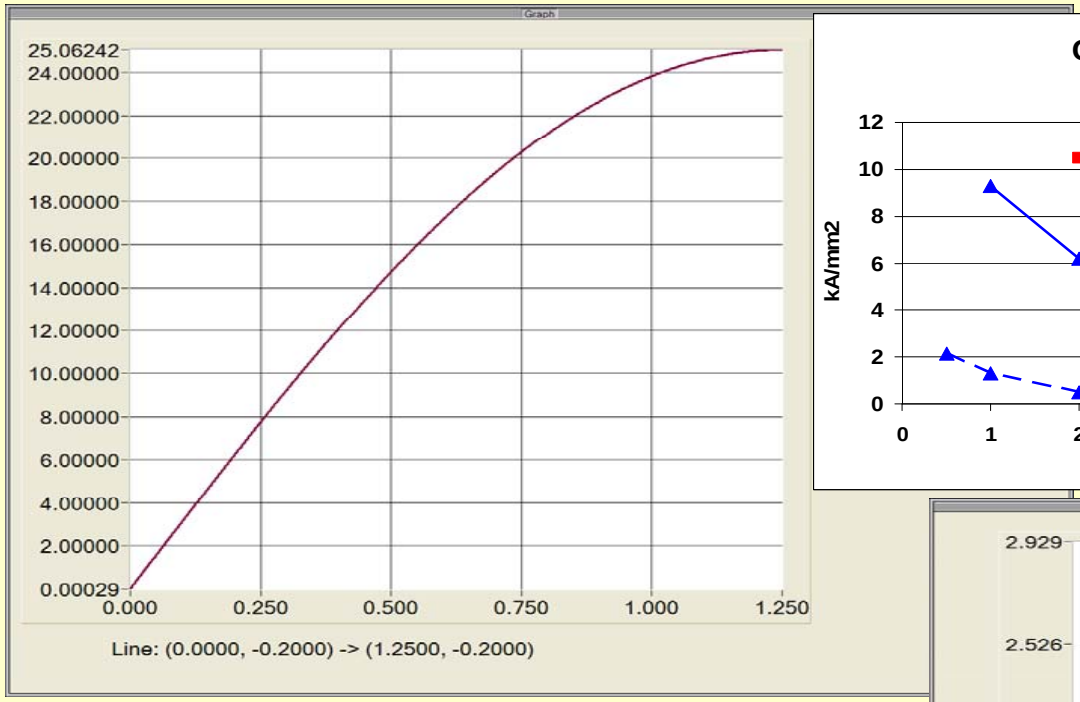
Quench protection circuit

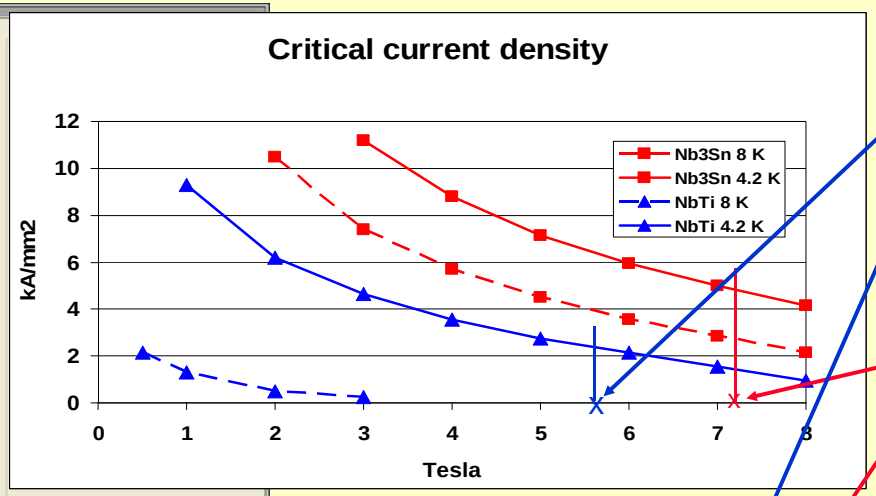
Current source and electronics for study of quench propagation

Requirements for magnetic field inhomogeneity in the wiggler

- *At first stage of the wiggler designing main attention is devoted to obtaining such basic parameters as period, working aperture and maximal field amplitude.*
- *At second stage main priority is a reaching of minimal level of the field inhomogeteity as a rule. If requirements to inhomogeneity level are very high then this circumstance can exert strong influence on the final wiggler design.*
- *For example I can refer to experience of PETRA-3 wiggler manufacture and magnetic field adjustment. Because of highest requirements to inhomogeneity level three ways of magnetic field measurements were used: Hall probe, stretch wire and Lambda coil measurements.*
- *When wiggler for CLIC damping ring has cold vacuum chamber the use of different magnetic measurements is very problematical. To my mind the best damping wiggler design will be if it will have warm vacuum chamber. In this case all problems connected with final wiggler adjustment and placing nearby wigglers synchrotron radiation adsorbers can be solved the best way.*
- *For placing warm vacuum chamber inside wiggler it's needed the increase of vertical gap from 20 mm up to 24 mm. It's possible to obtain 24 mm gap without changing wiggler period and field amplitude if replace NbTi wire for Nb_3Sn.*

Comparison of maximum field strength in coil region for gaps 20 and 24 mm under just the same magnetic field amplitude





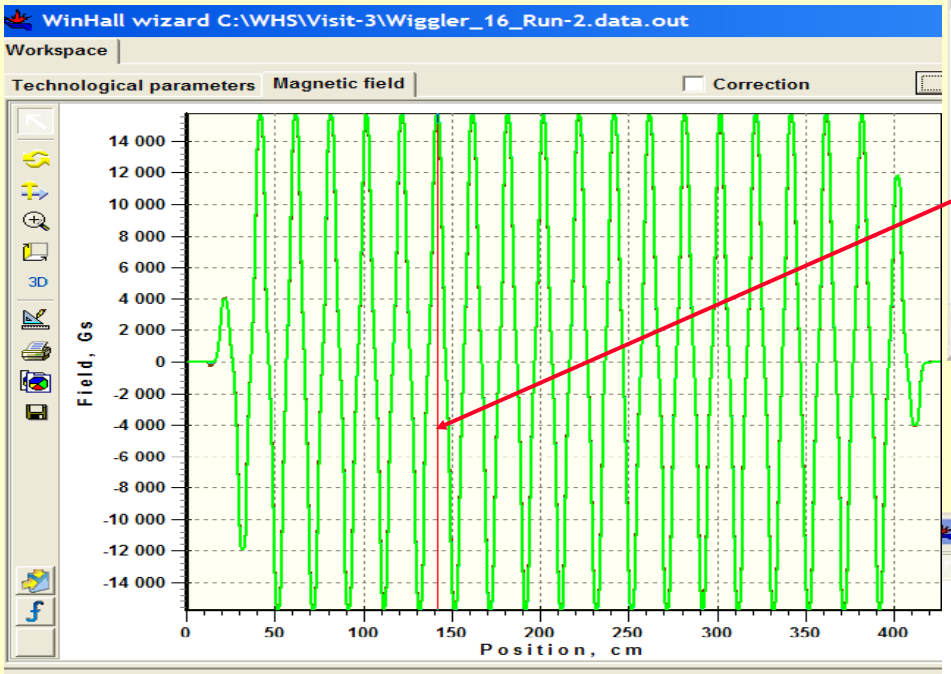
$H(max)_{NbTi}$

$H(max)_{Nb3Sn}$

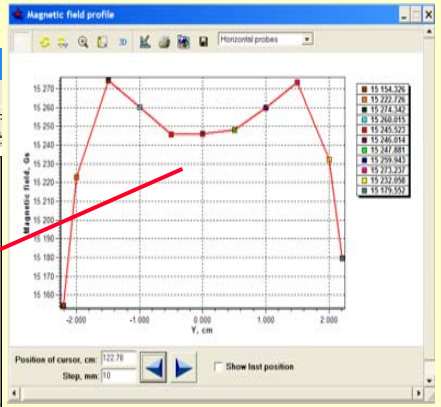
Longitudinal magnetic field distribution within ¼ wiggler period

$$\frac{H(max)_{Nb3Sn}}{H(max)_{NbTi}} = 1.35$$

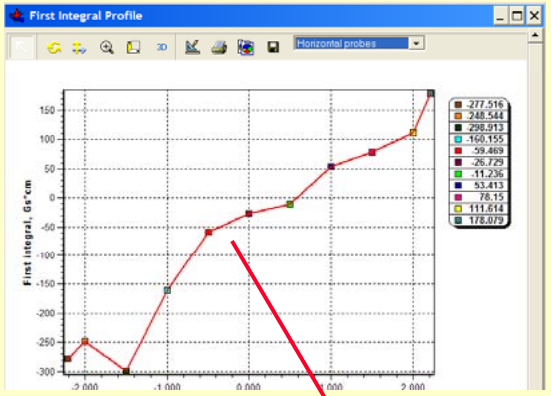
Results of Hall probe magnetic measurements



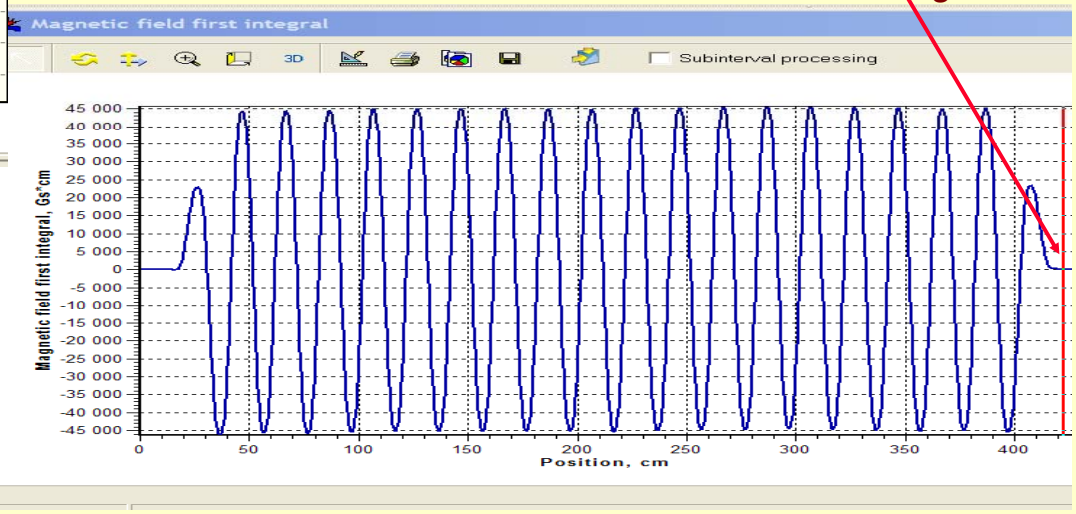
The longitudinal field profile along wiggler



Transverse dependence of vertical field

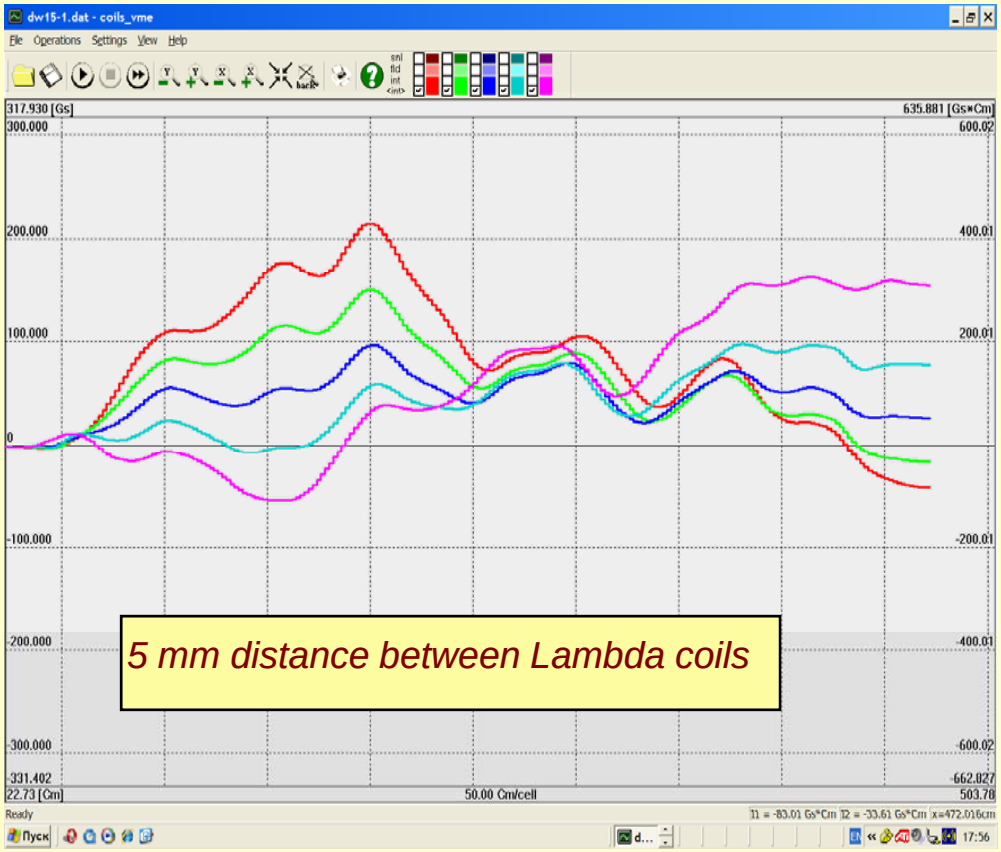


Transverse dependence of vertical field 1st integral

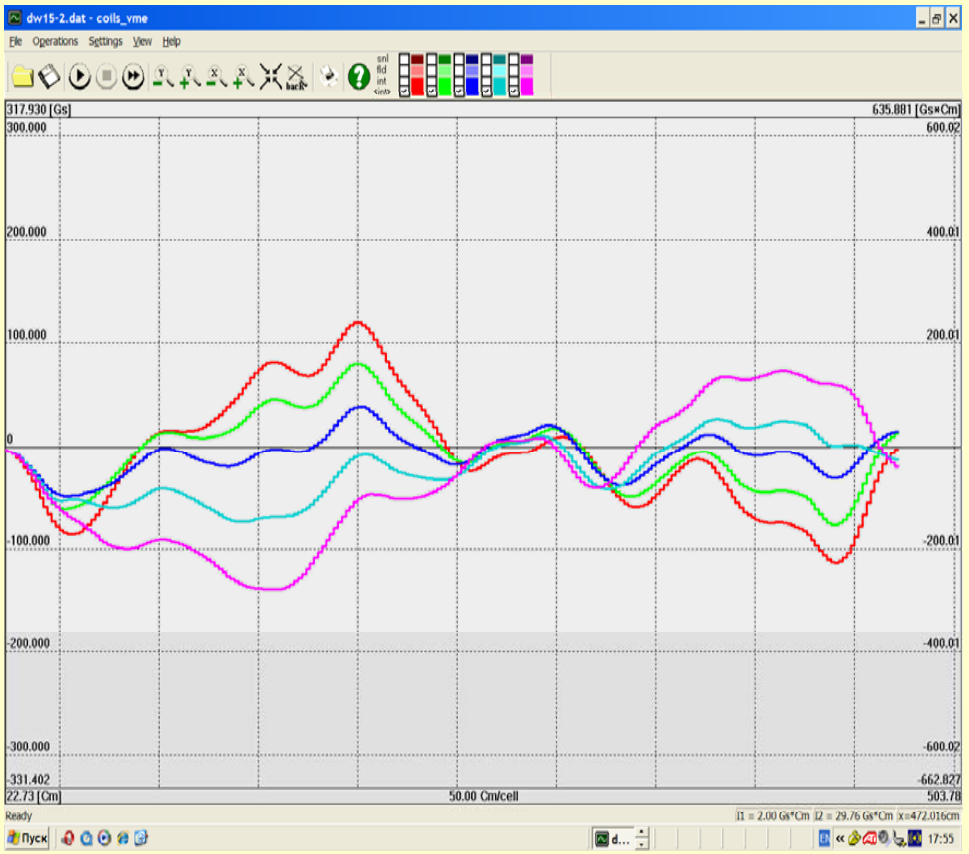


The longitudinal field profile of 1st integral along wiggler

Results of PETRA-3 wiggler adjustment with help of Lambda-coil

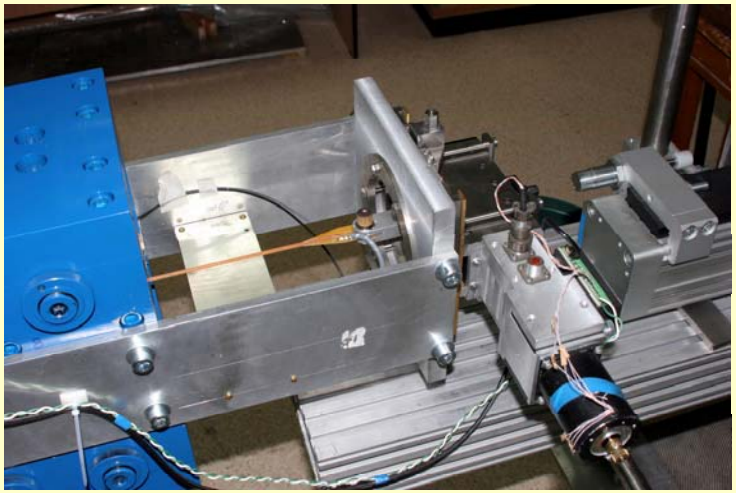


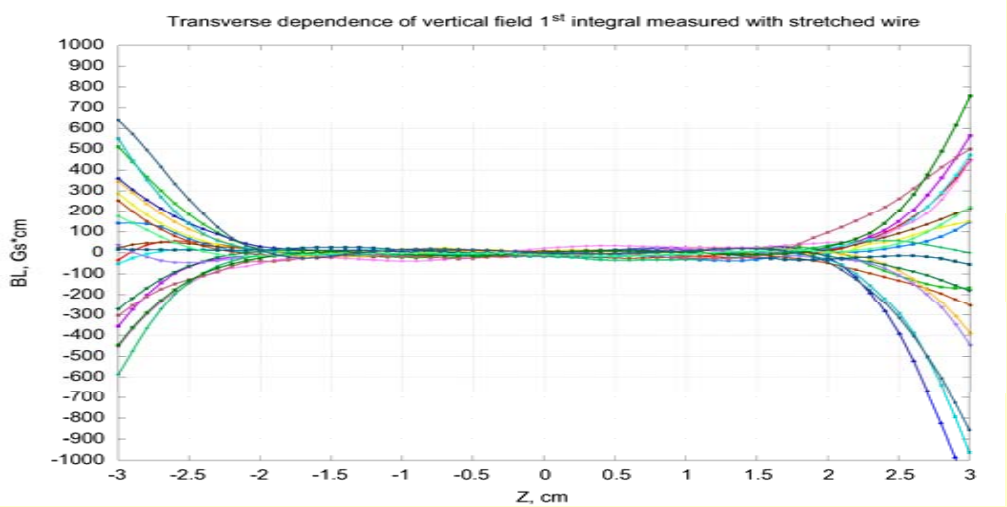
Longitudinal distribution of the1st horizontal magnetic field integrals along wiggler measured 5 channel Lanbda coil (before correction)

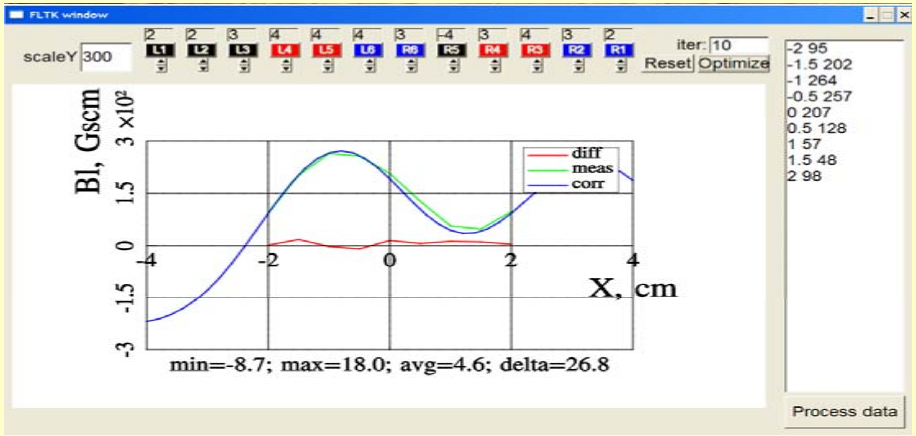


Longitudinal distribution of the1st horizontal magnetic field integrals after their correction with help of finger correctors

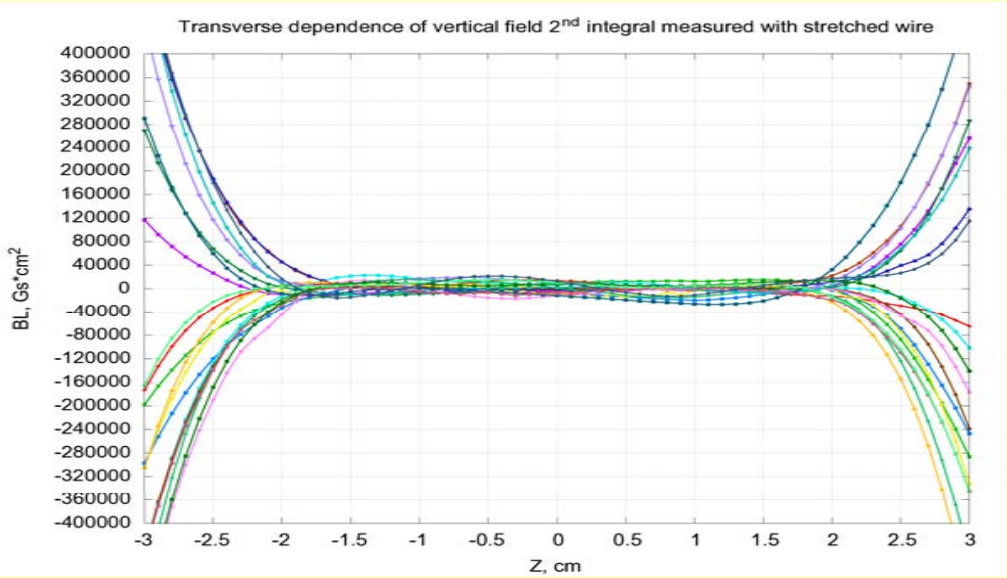
Results of PETRA-3 wiggler adjustment with help of stretch wire





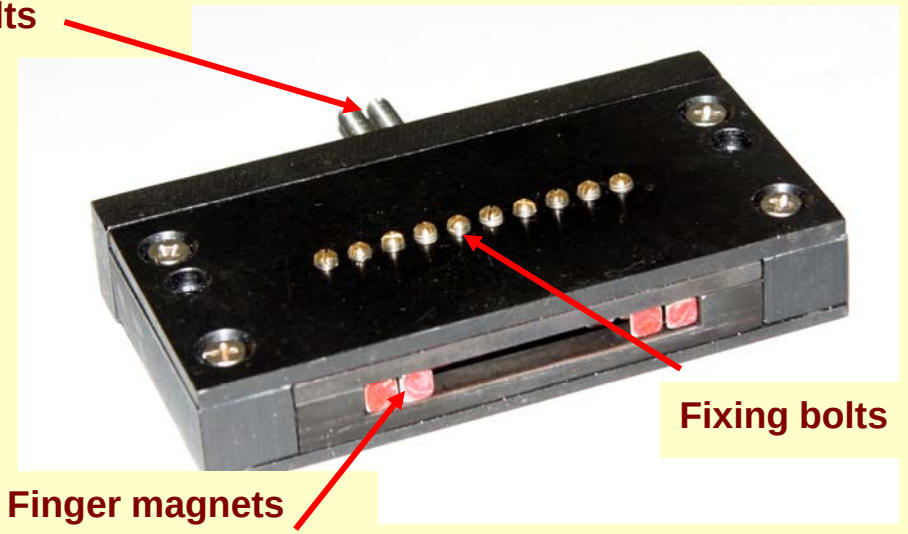


Compensation methods of the horizontal field inhomogeneity in damping wiggler

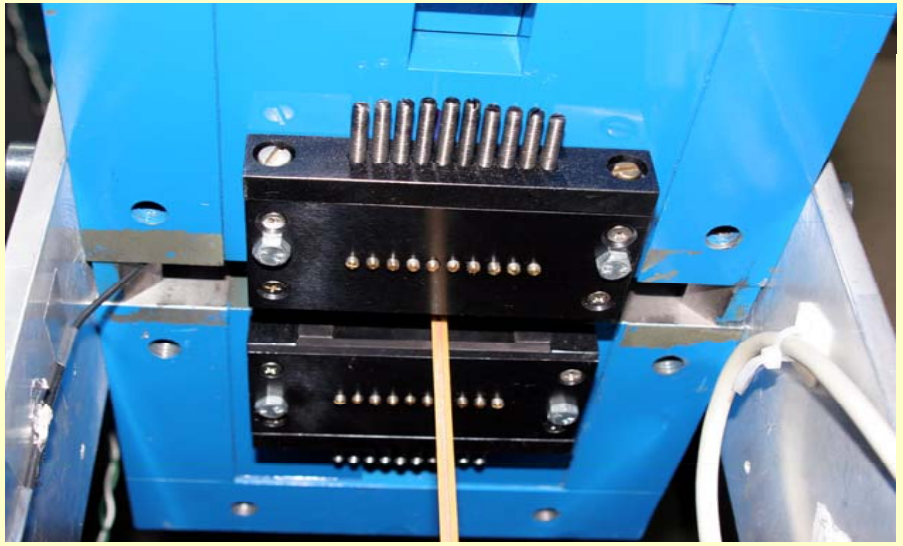


Wiggler tuning procedure

- *1-st integral wire measurement and its tuning by the output finger corrector (accuracy 5 G-cm, ~1 hour).*
- *2-nd integral wire measurement and its tuning by the input finger corrector (accuracy 2000 G-cm^2, ~1 hour).*



Finger corrector



Conclusion

- *We plan to get first results of wiggler test by the end of this year*
- *Before final choice of wiggler design it's necessary to formulate requirements to magnetic field inhomogeneity within working aperture*