Magnetic field measurement of MPD detector magnet

XI Collaboration Meeting of the MPD Experiment at the NICA Facility

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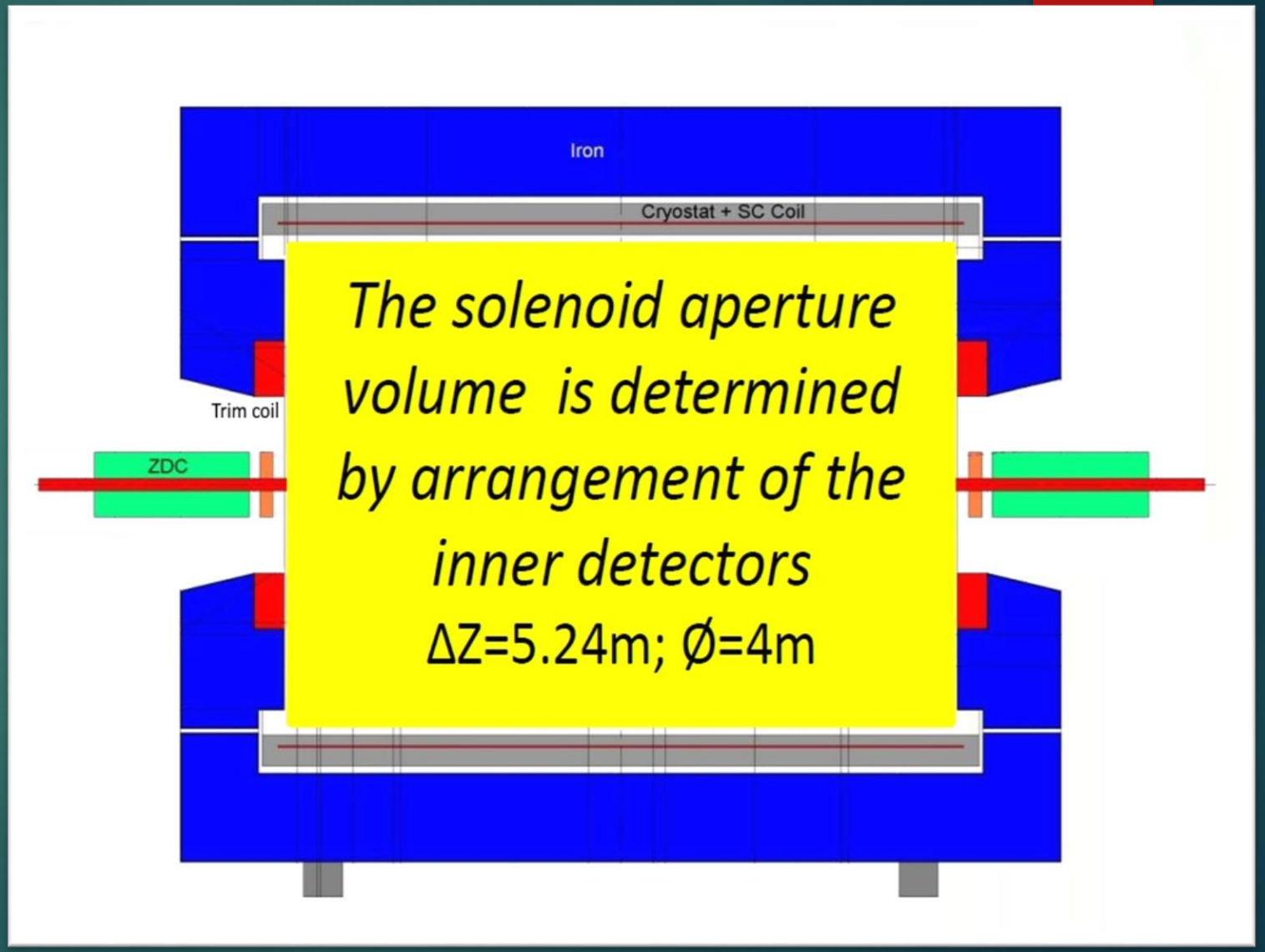
Магнит MPD

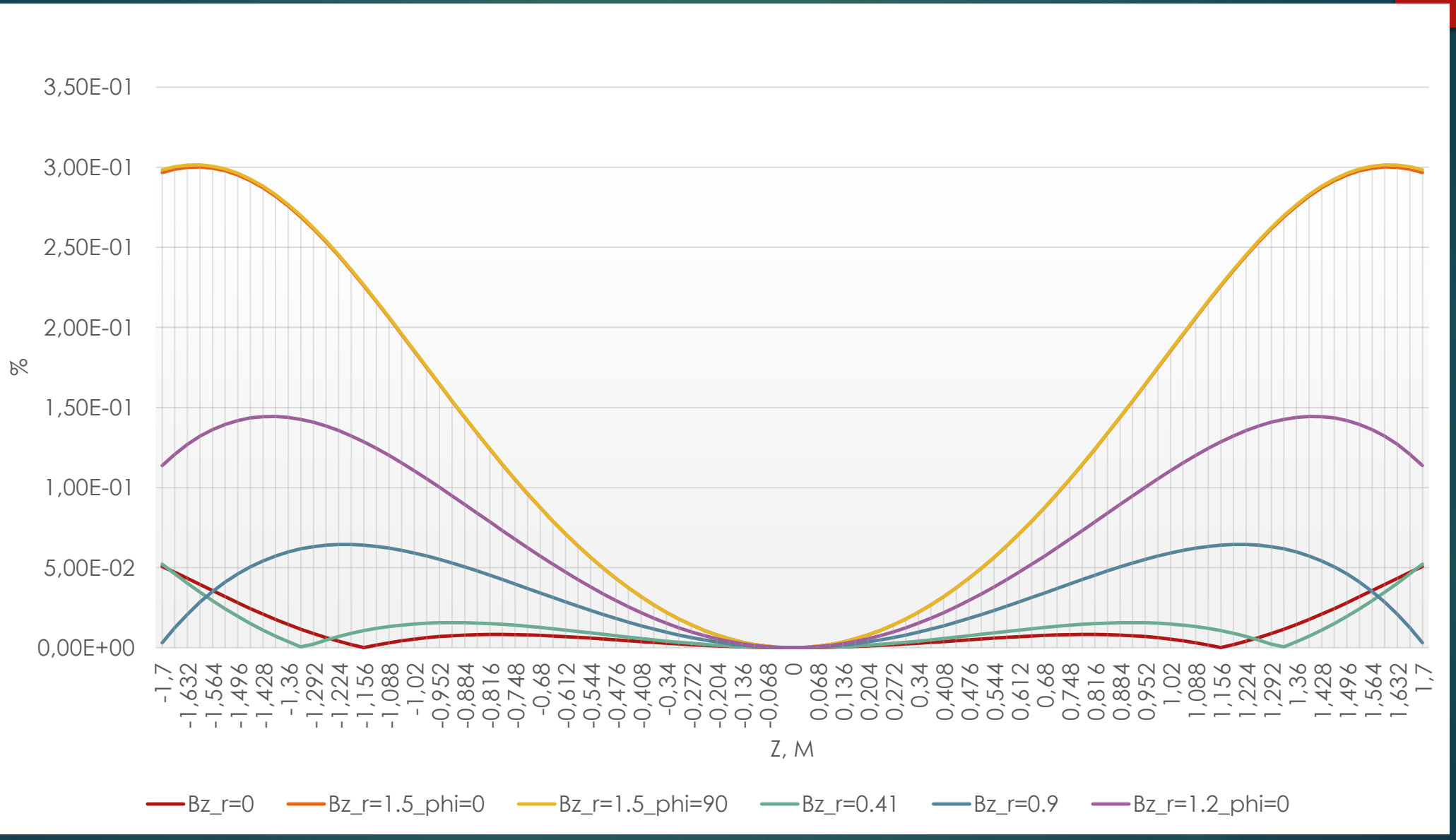
- Magnetic field: 0.2 - 0.56 T
- Superconducting coil: (current 1800 A)
- Two trim coil: (current 2800 A).
- Good field region 1:
- Z=±2.6 м, R=2.2 м.
- Good field region 2: (TPC):
- Z=±1.7 м, R=1.2 м.
- Field uniformity: ± 2×10^{-4}.



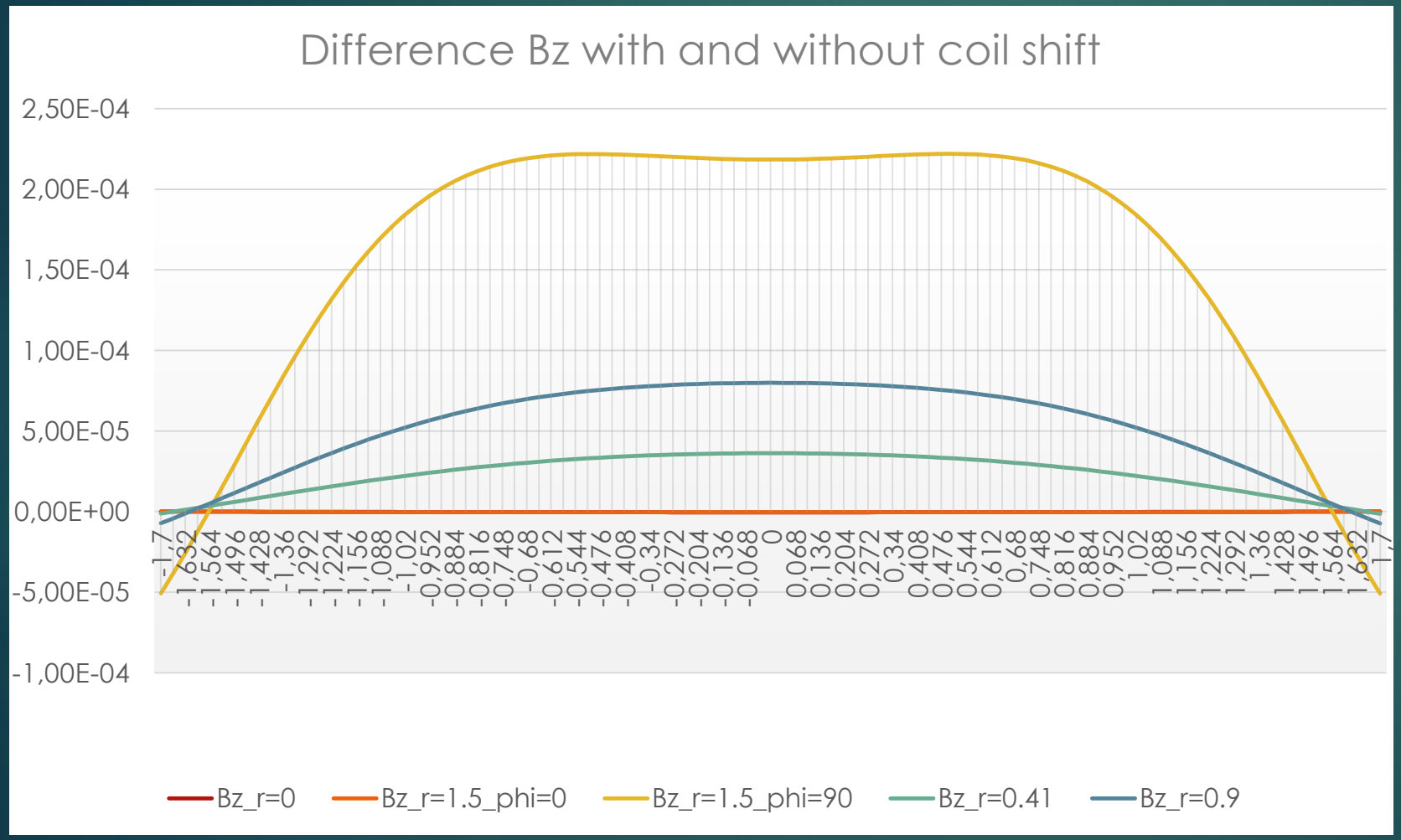
Specification for mapping system

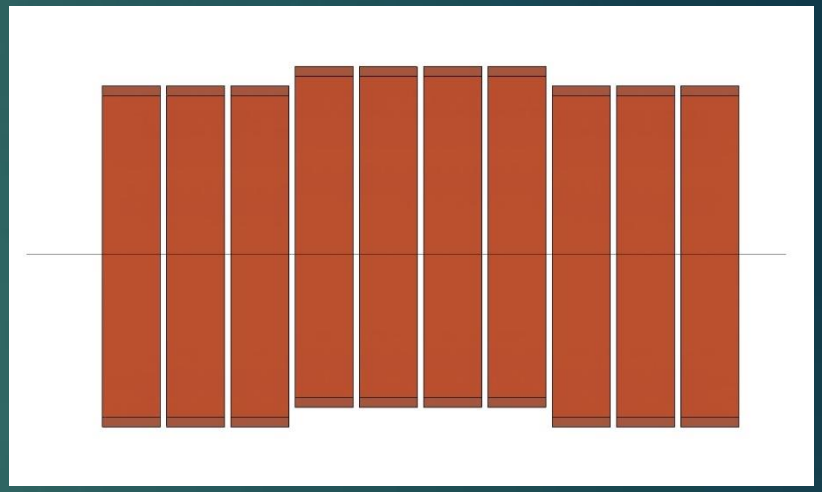
- Using one 3D Hall sensor (HE444).
- Covering all area inside TPC region.
- Accuracy 0.3 Gauss.
- Measuring positions in X, Y, Z with laser tracker.
- Measuring inclination angle of carriage respect to solenoid axis with laser tracker.
- Measuring time 1 sec for one point.
- Possibility to reconstruct the field inside internal volume of cylinder from data measured at cylindrical surface.

Magnetic field uniformity

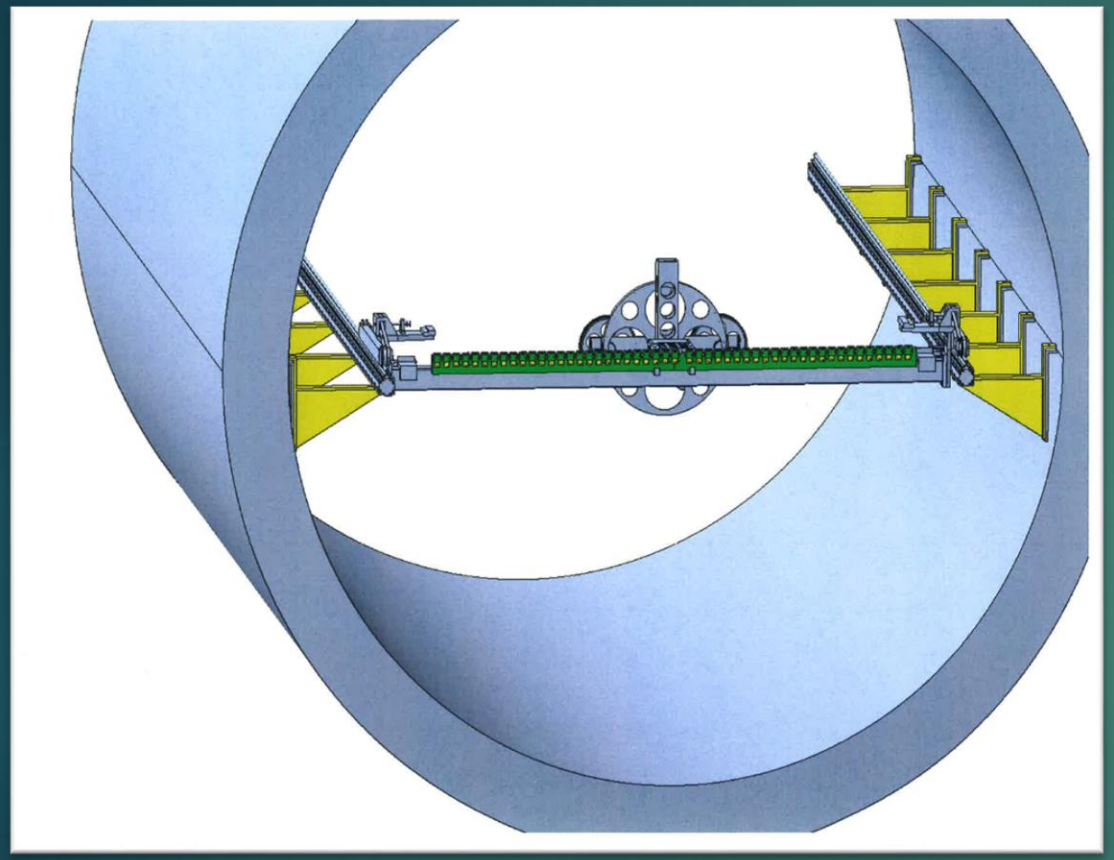


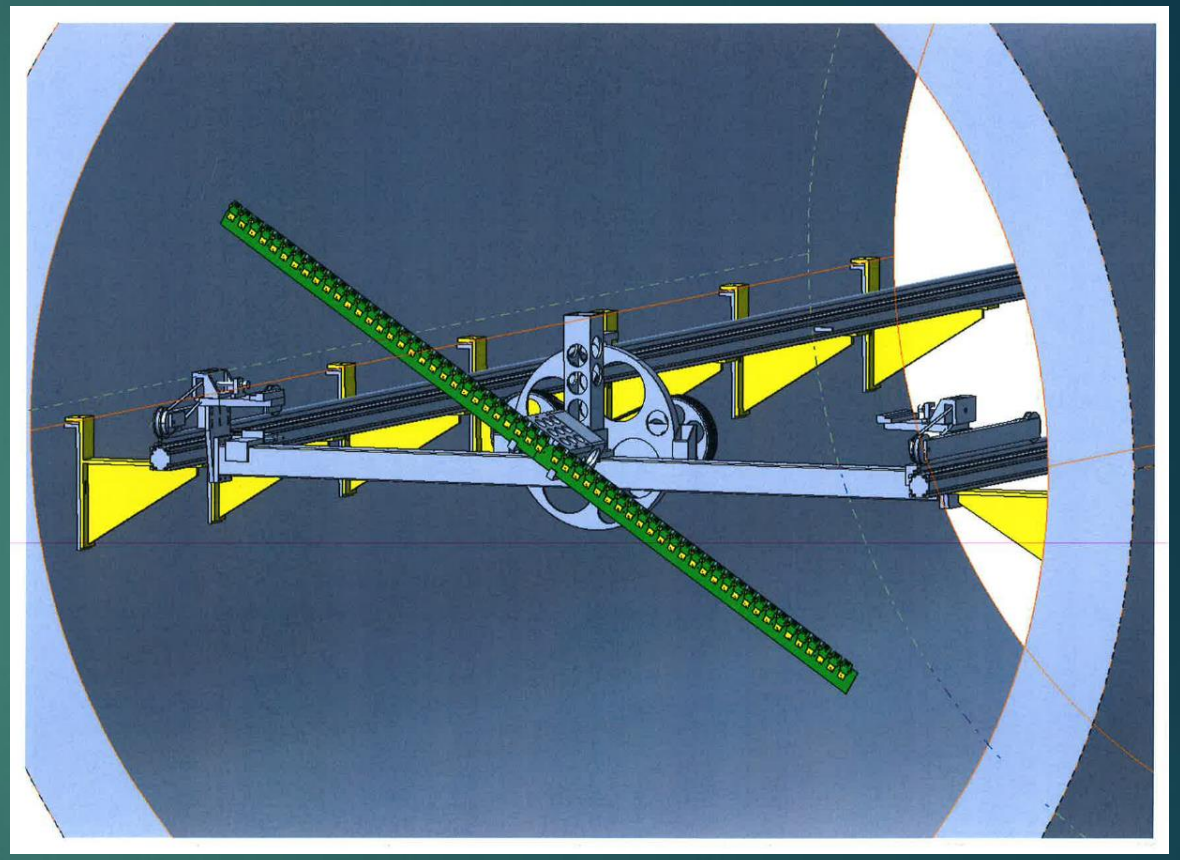
Magnetic field uniformity change due to SC central coil shift 5 mm





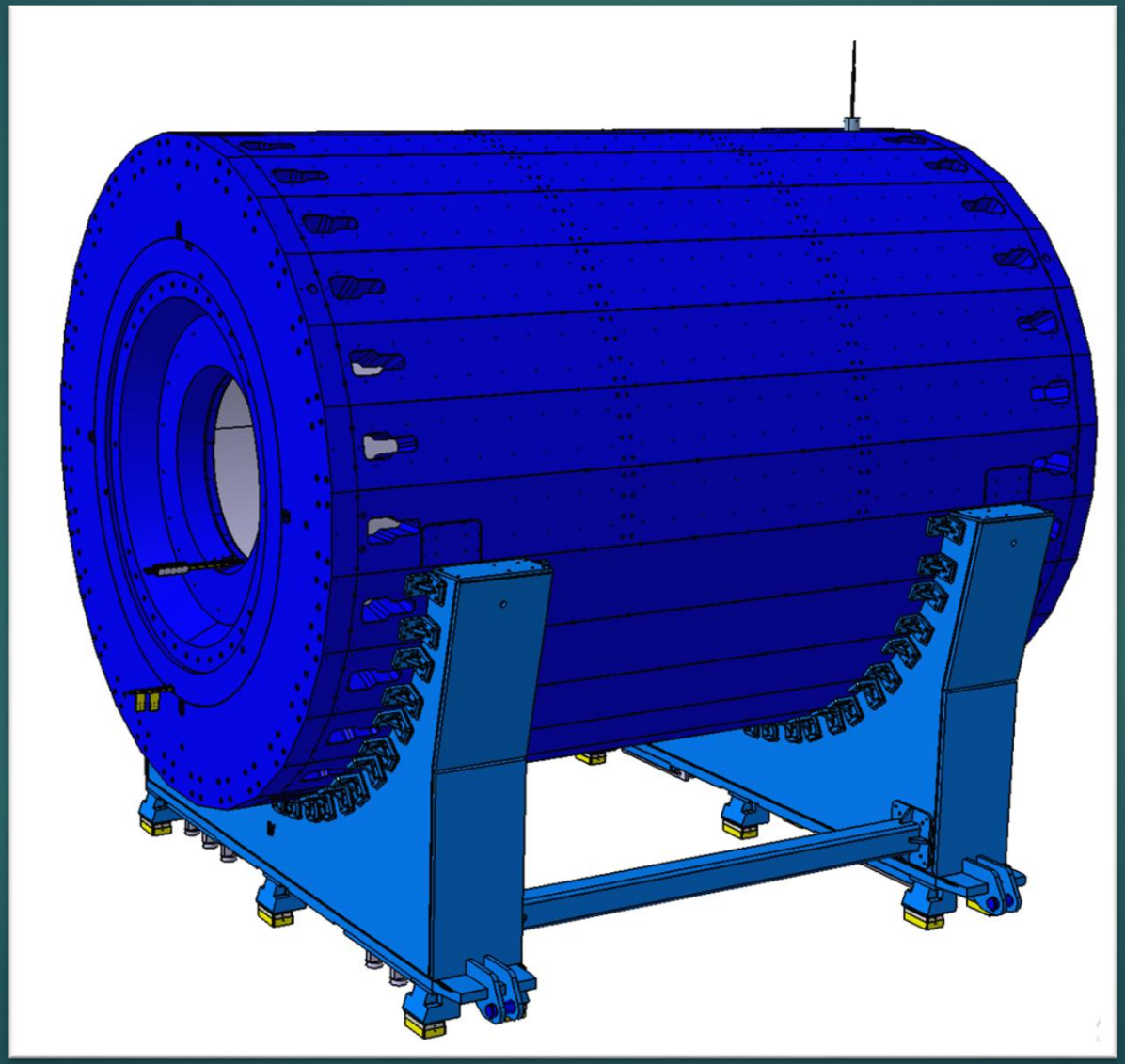
CERN mapper for MPD magnet



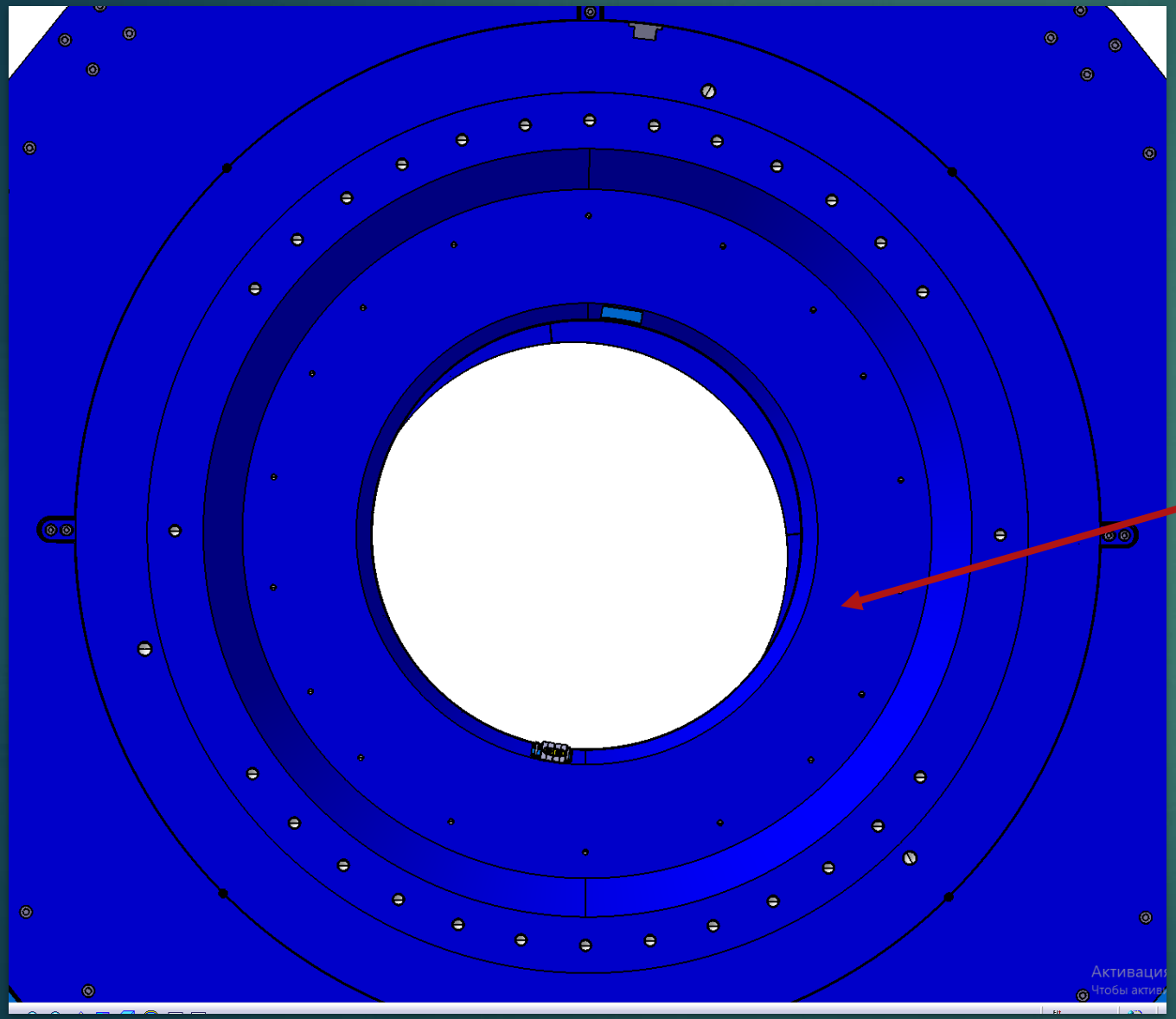


- 38 planar Hall sensors.
- Mapper accuracy – 2-3 Gs.

Free holes of the magnetic yoke at the time of magnetic field measurement



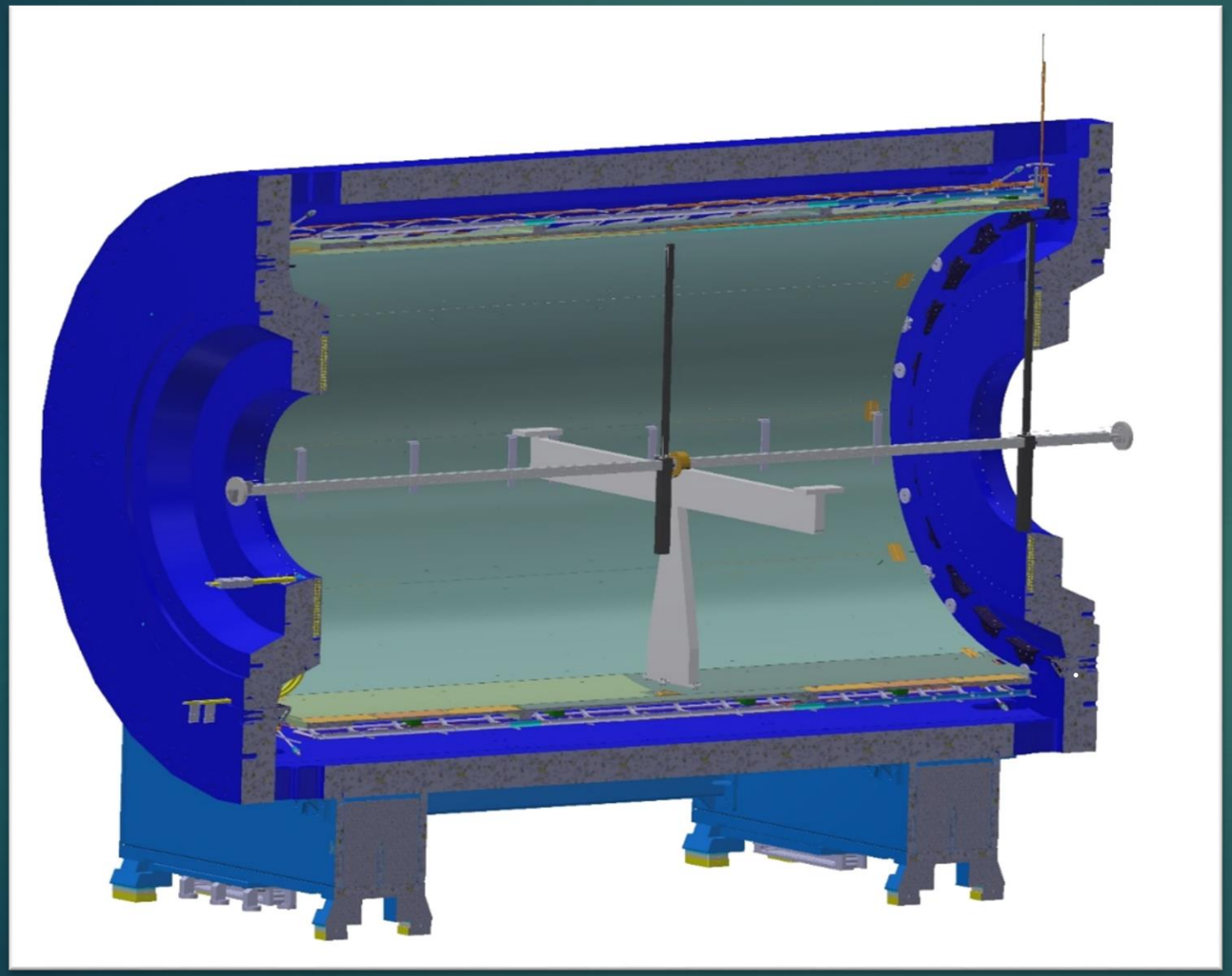
Very precise vertical flange.

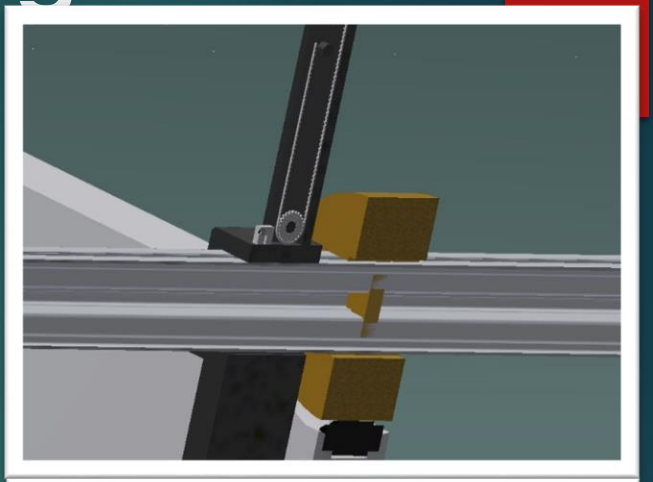


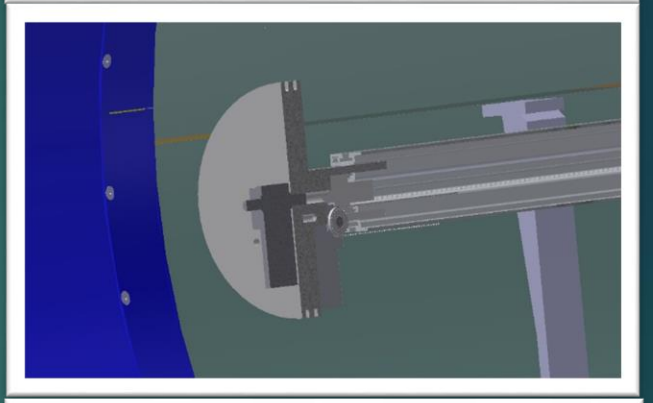
Accuracy of manufacturing and assembly of the magnetic yoke about 0.2 mm.

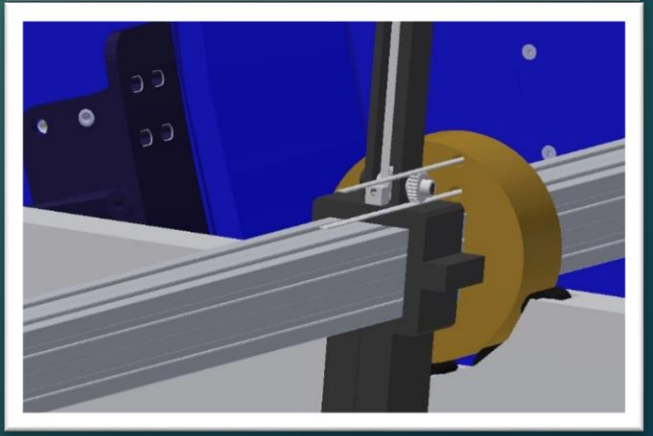
We must take advantage of this!

Our proposal for MPD magnet









Our proposal for MPD magnet. Measurement procedure.

The field map will be built in a Cartesian system, while the measurement results are issued in cylindrical coordinate system.

The direction of the Z axis of the local system obviously coincides with the Z axis of the laboratory system.

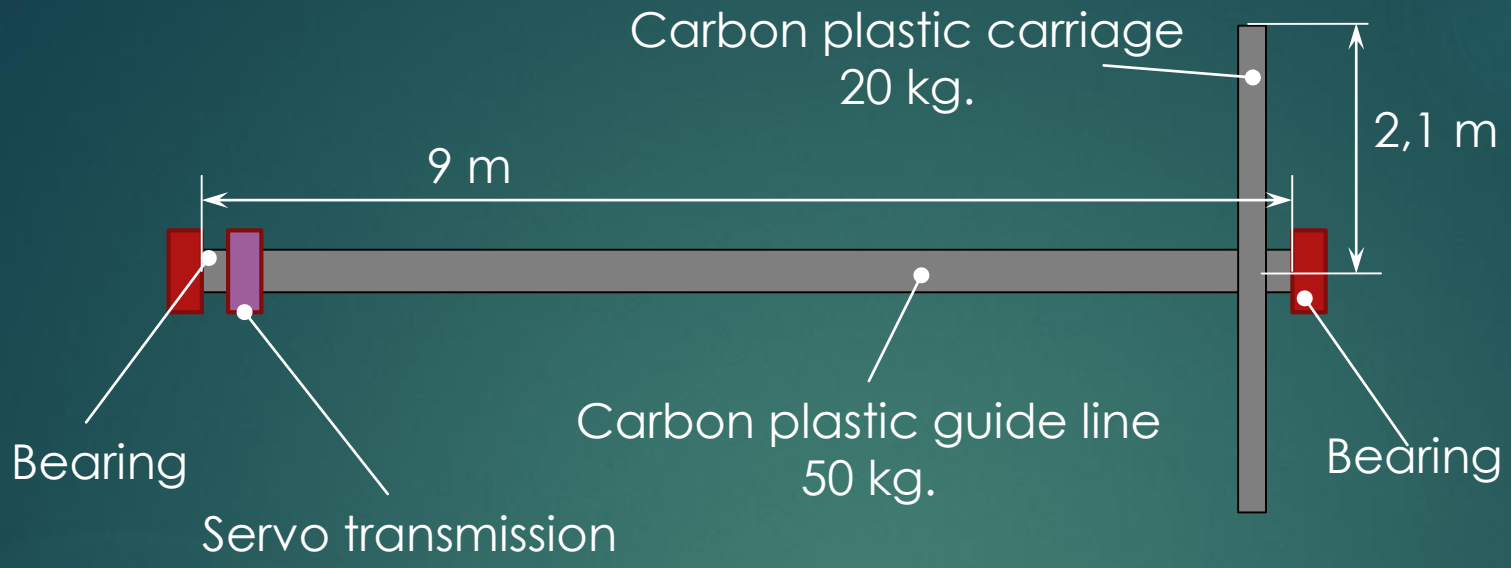
The control code uses a procedure that first moves through all the values of the azimuth angle at the same position in Z at the minimum radius, then rotates back 360°, then steps along the radius, with rotation in azimuth at each radius, and reaching the maximum radius.

It is necessary to determine the coordinates of the 3D Hall sensor at each measurement point. To do this, one need to use a laser tracker with a set of reflectors and mirrors.

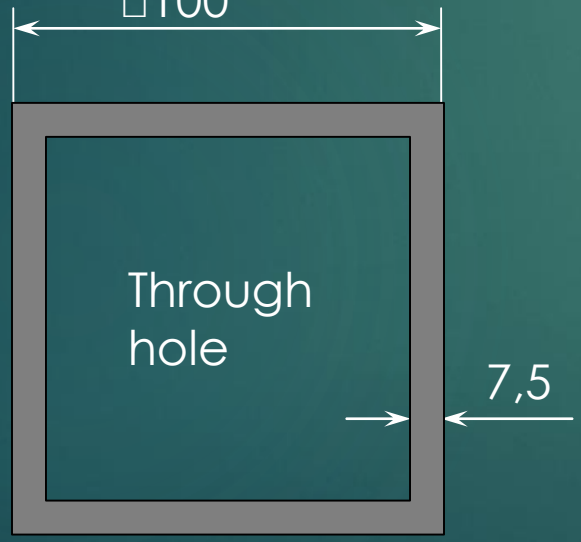
It is necessary to measure the inclination of the rod with the measuring block of the Hall sensor as a function of the length of the solenoid Z in advance and make correction table. The output file shall be as: N X Y Z Bx By Bz

Our proposal for MPD magnet. Mapper specification.

Parameter	Value
Length of movement for Z	2× 4,5 m
Length of movement for R	0.1 – 2.2 m
Rotation of measurement block	3600
Accuracy of movement for Z	50 microns
Accuracy of movement for R	50 microns
Accuracy of rotation	0.20
Hall 3D sensor	HE444, HE Hoeben Electronix,
Hall 3D sensor accuracy	0.1 Gs
Hall 3D sensor accuracy total (with accuracy of laser tracker and temperature correction)	0.3 Gs
Sag of guide line	5 mm
Weight of mapper	100 kg
Reading time per one measurement	1 sec



Cross section of guide line



- The weight of the carriage is symmetrical about the axis of the guide
- Young's modulus for carbon plastic 180 Gpa
- The servo drive will be a belt drive. On the servo shaft and on the guide. there will be toothed pulleys.
- The carriage is in the furthest position from the servo for calculation of torque

Our proposal for MPD magnet. Carbon plastic beam.

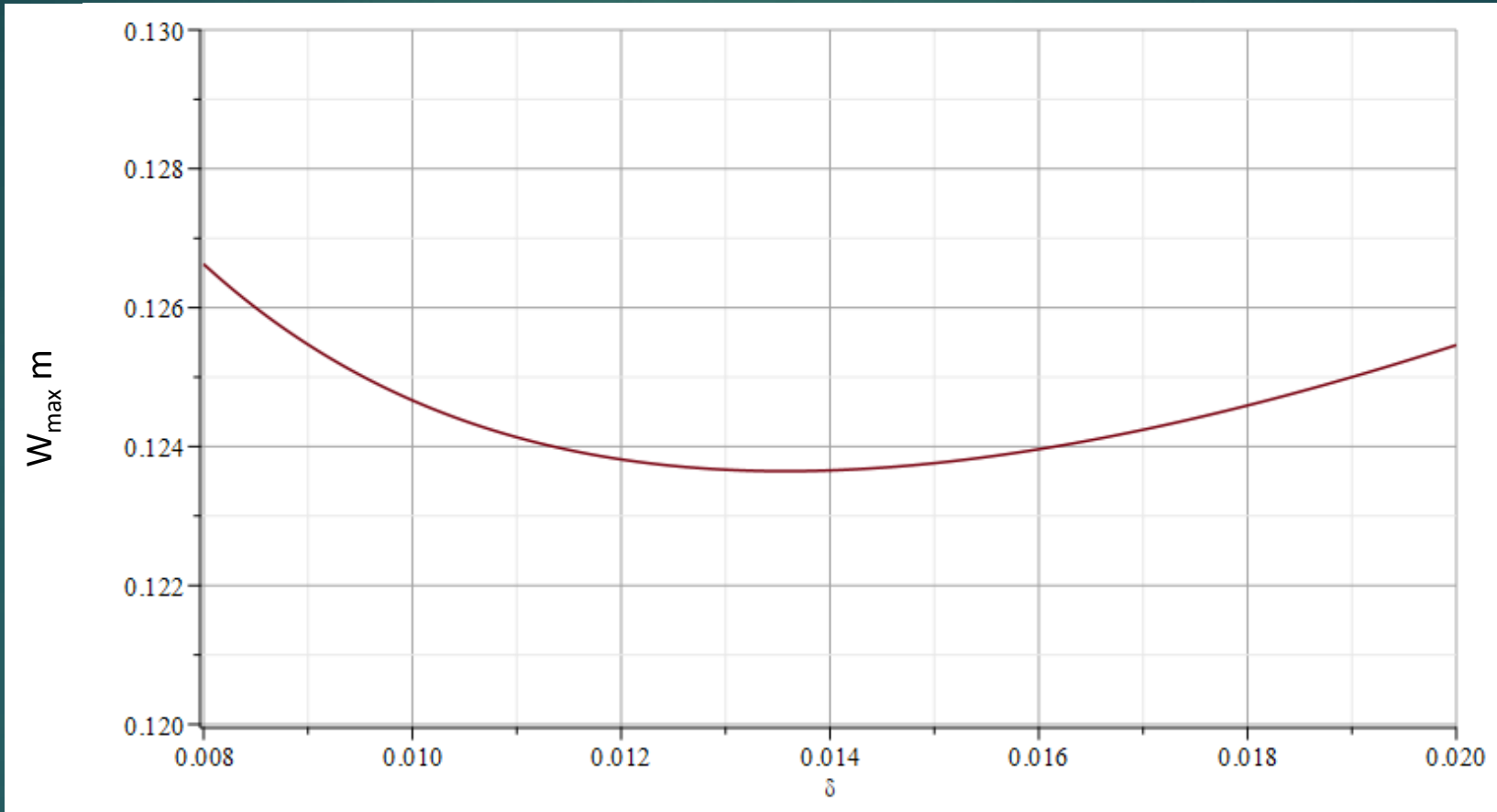


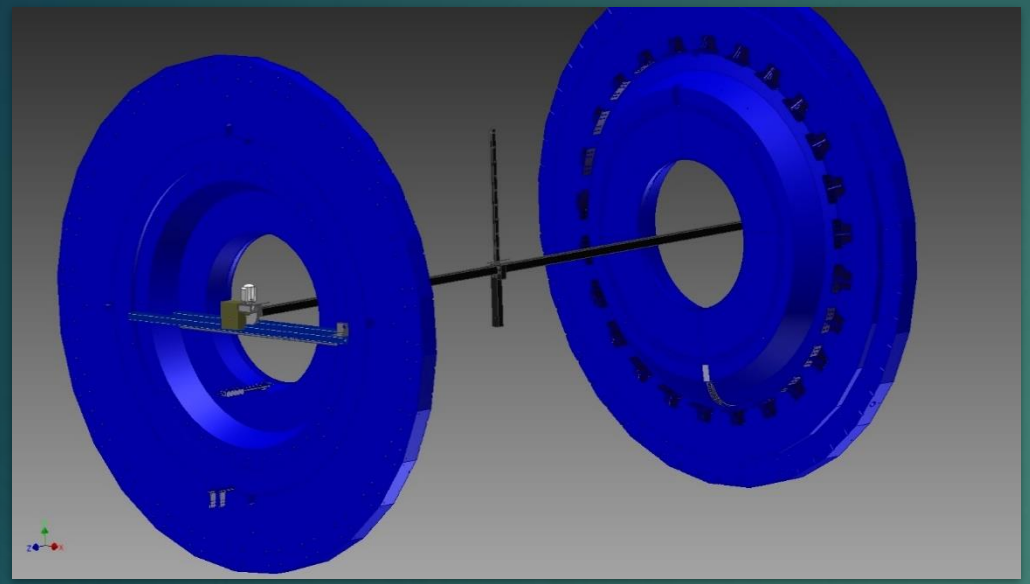
Fig. 1. Dependence of the outer dimension of the guide line section on the wall thickness for carbon fiber reinforced plastics based on UMT530 fibers for a given maximum guide line displacement (5 mm)

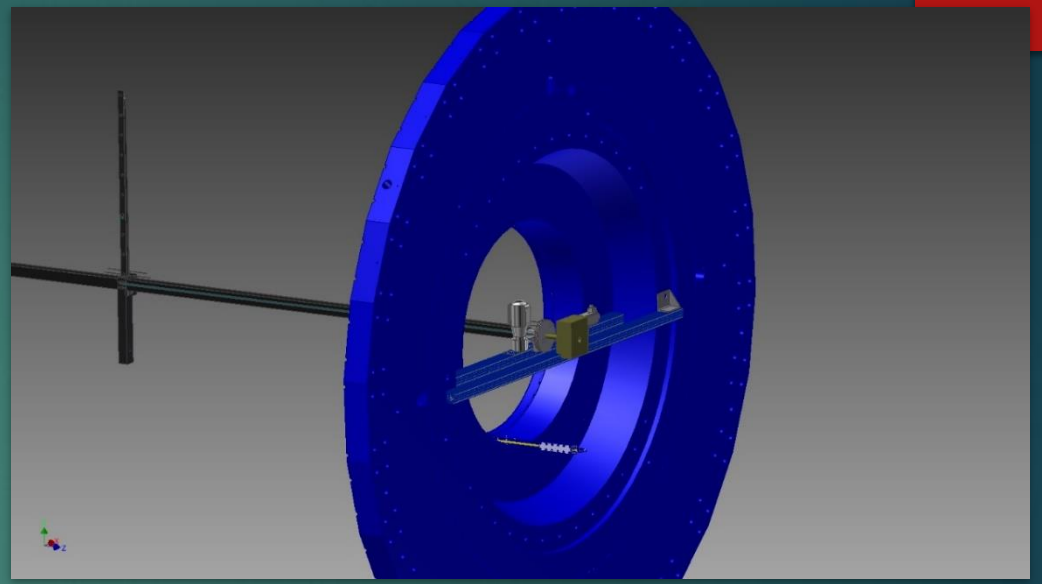
Our proposal for MPD magnet .
Carbon plastic beam data.

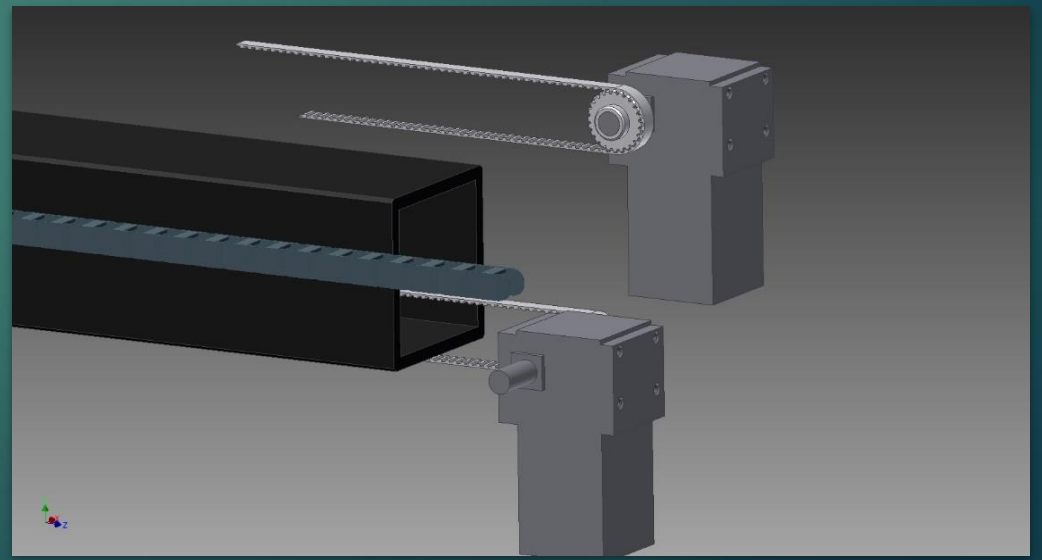
CFRP based on UMT530 fibers and epoxy binder. The effective modulus of elasticity of the multilayer package in the longitudinal direction Ex = 179 GPa, the effective shear modulus in the plane of the package Gxy = 17.6 GPa.

On Fig. 1. shows the dependence of the external dimension of the cross section of the beam on the wall thickness under the condition of displacements equal to 5 mm. It follows from this figure that the minimum external cross-sectional dimension of 124 mm is achieved with a wall thickness of 14 mm.

New mapper design with 9 m carbon plastic guide line







Status of project.

- The basic STEP model done.
- The calculation of the kinematic scheme is made. Mechanical requirements for the servomotors are derived.
- Servomotor type selection done. Negotiations with suppliers are in progress
- Preparation of a test facility for simulating the attachment of the mapper to the MPD magnet and testing the mapper on the Earth's field (at the BINP side).
- Software work started.
- Technical specification for a 9 m carbon fiber guide line has been drawn up. There is a basic design.

Thank you for attention.