Magnetic field measurement of MPD detector magnet

XIII Collaboration Meeting of the MPD Experiment at the NICA Facility

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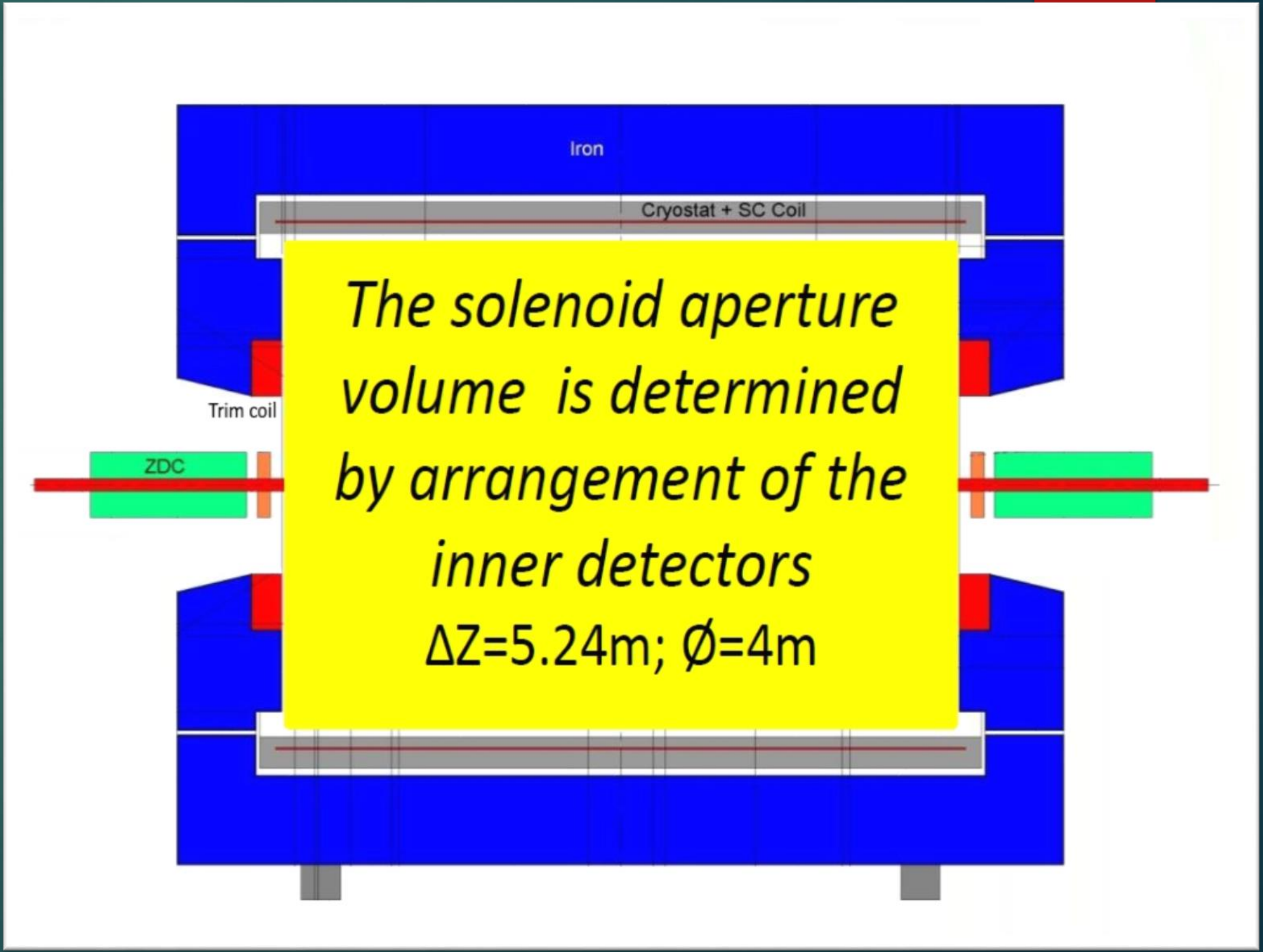
Dubna, Russia.

Magnet MPD

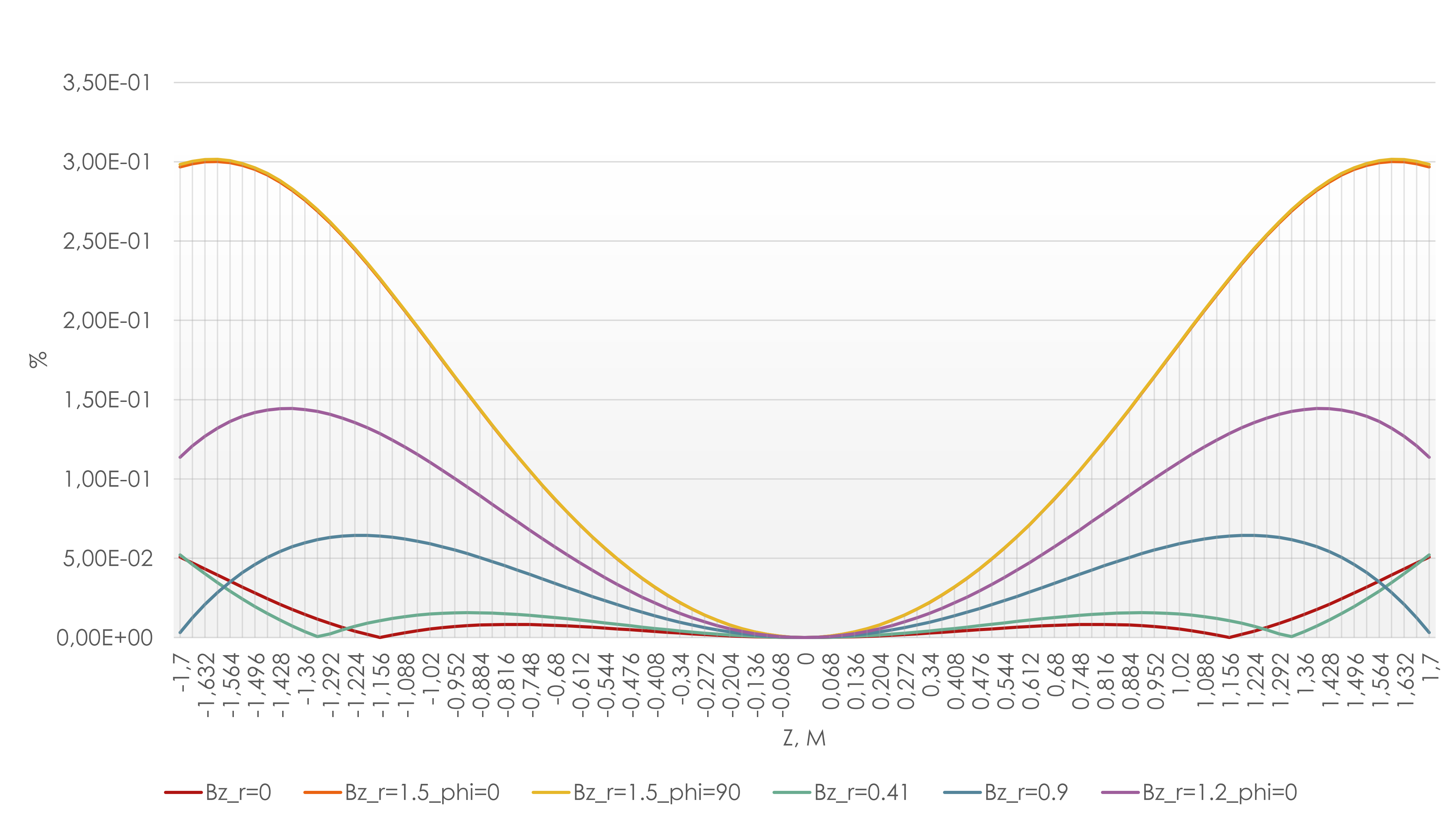
- Magnetic field: 0.2 - 0.56 T
- Superconducting coil: (current 1800 A)
- Two trim coil: (current 2800 A).
- Good field region 1:
- Z=±2.6 м, R=2.2 м.
- Good field region 2: (TPC):
- Z=±1.7 м, R=1.2 м.
- Field uniformity: ± 2×10^{-4}.



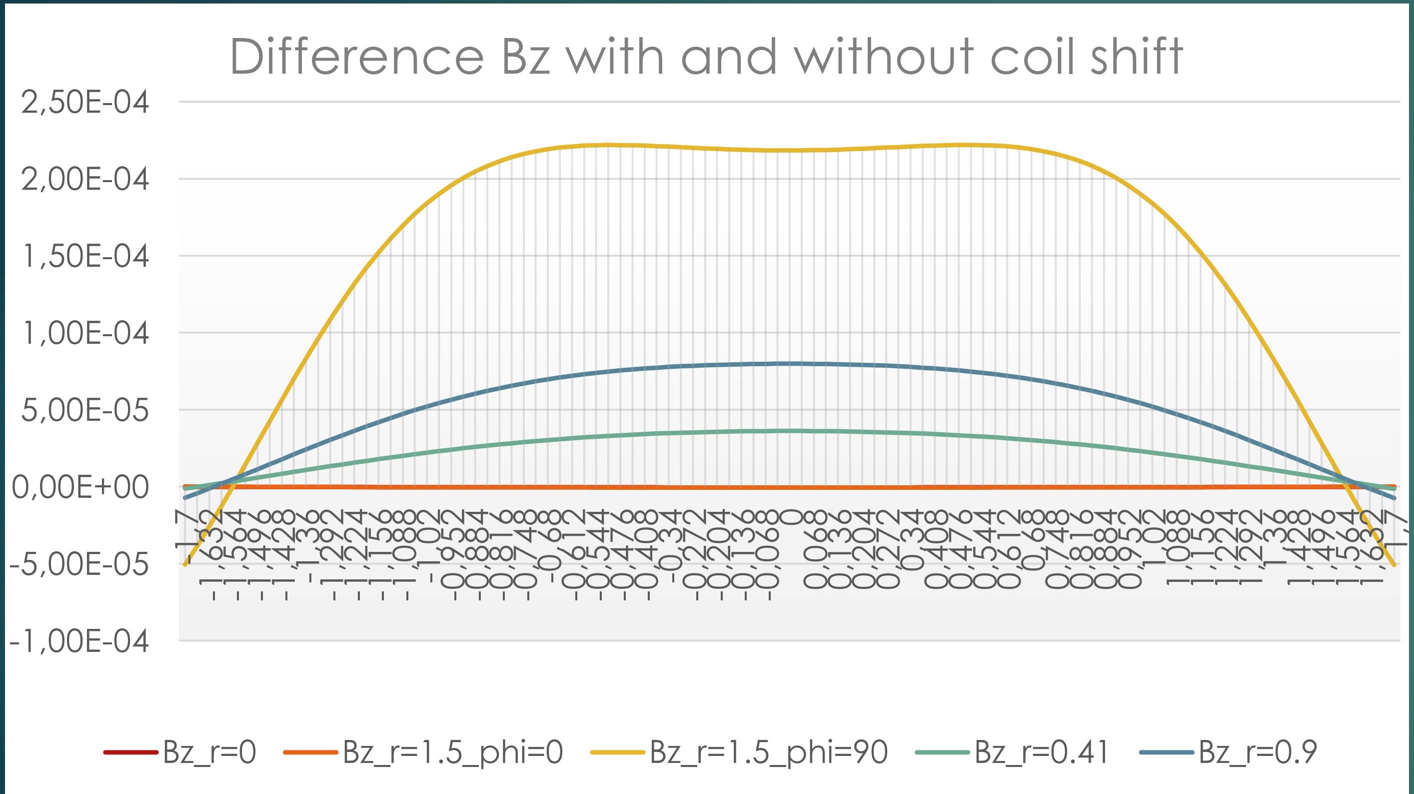
Specification for mapping system

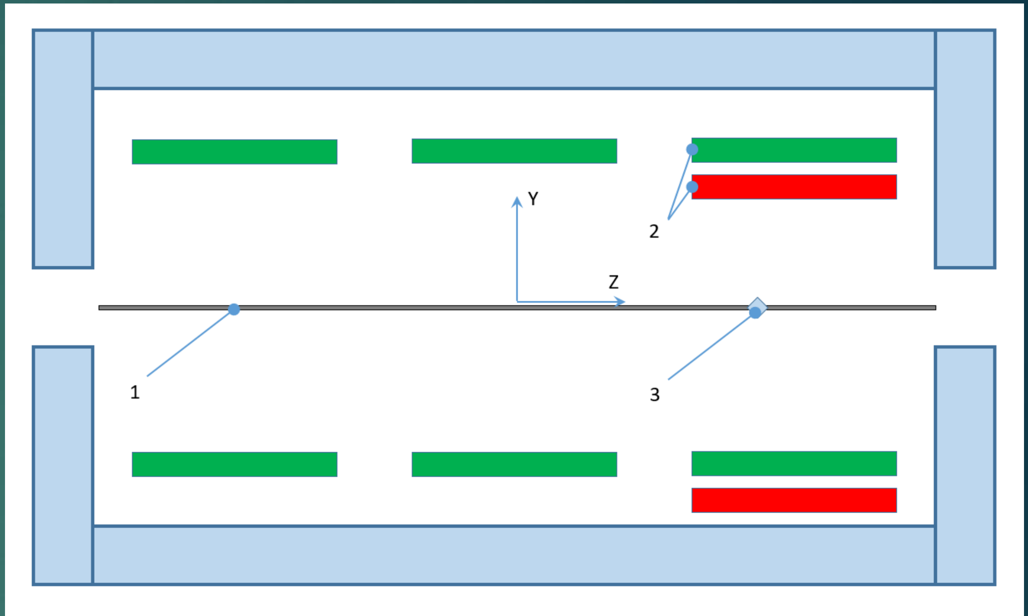
- Using one 3D Hall sensor (HE444).
- Covering all area inside TPC region.
- Accuracy 0.3 Gauss.
- Measuring positions in X, Y, Z with laser tracker.
- Measuring inclination angle of carriage respect to solenoid axis with laser tracker.
- Measuring time 1 sec for one point.
- Possibility to reconstruct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

Magnetic field uniformity



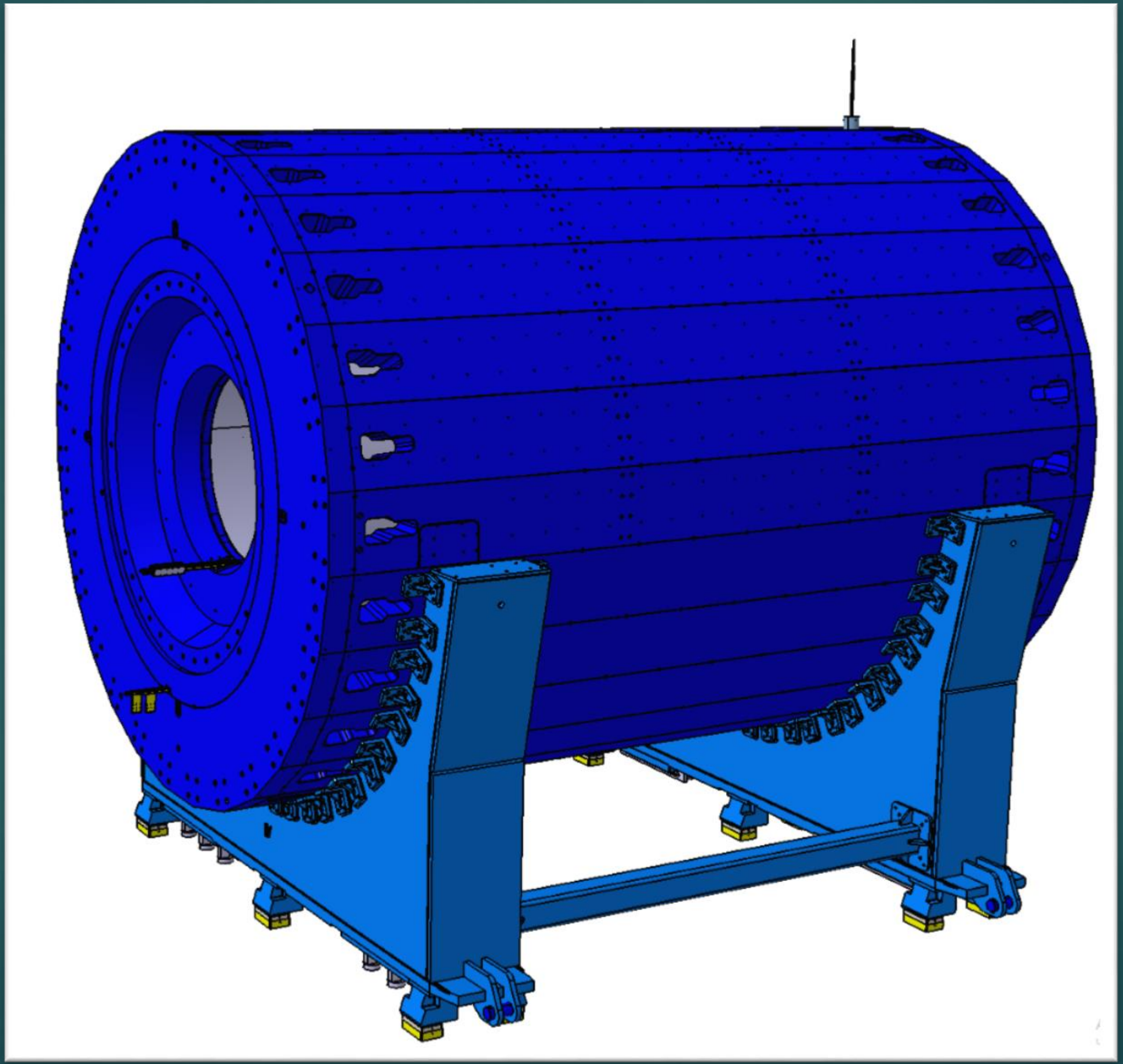
Magnetic field uniformity change due to SC central coil shift 5 mm



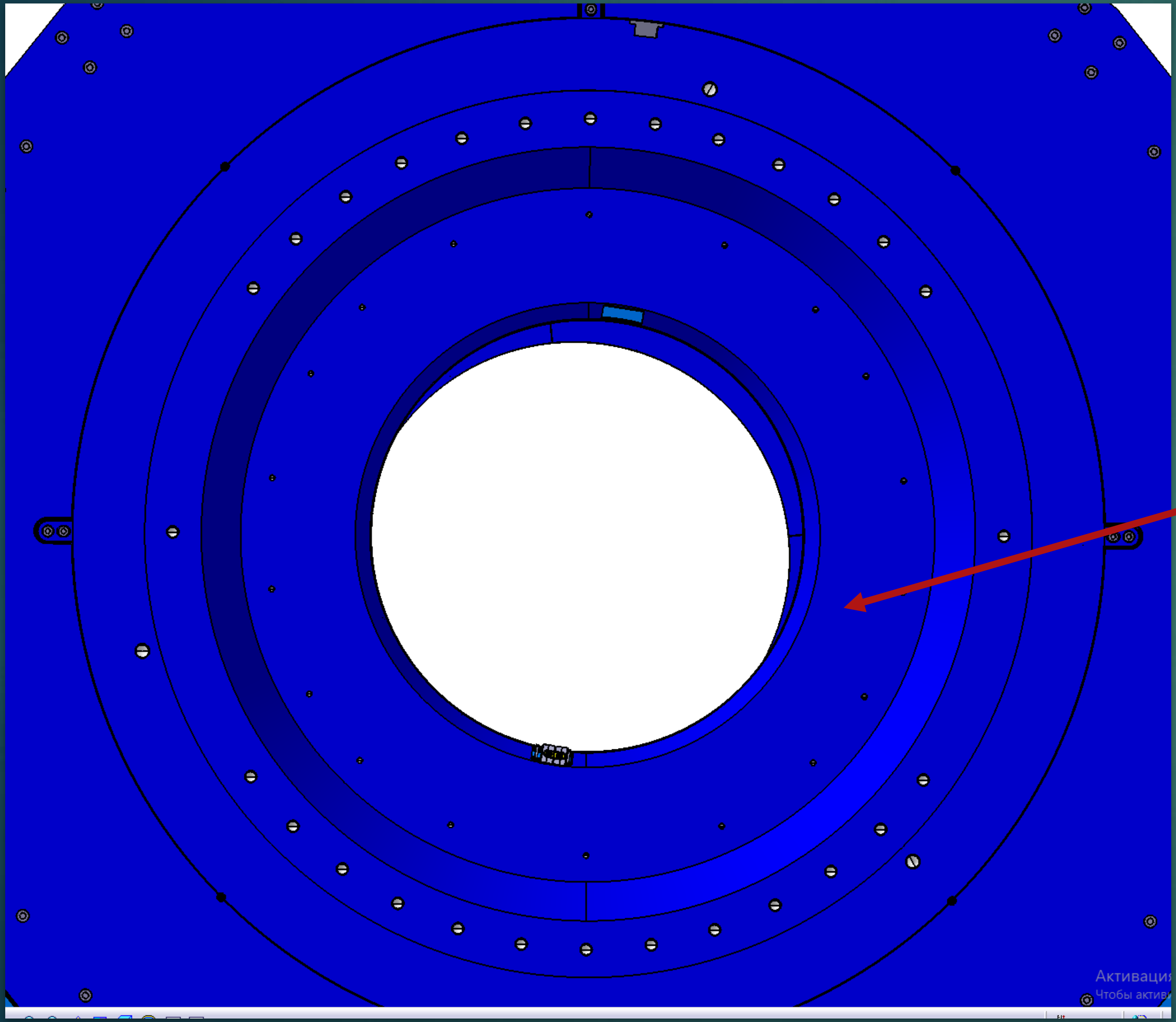


Acceptable shift of coil section is 5 mm

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



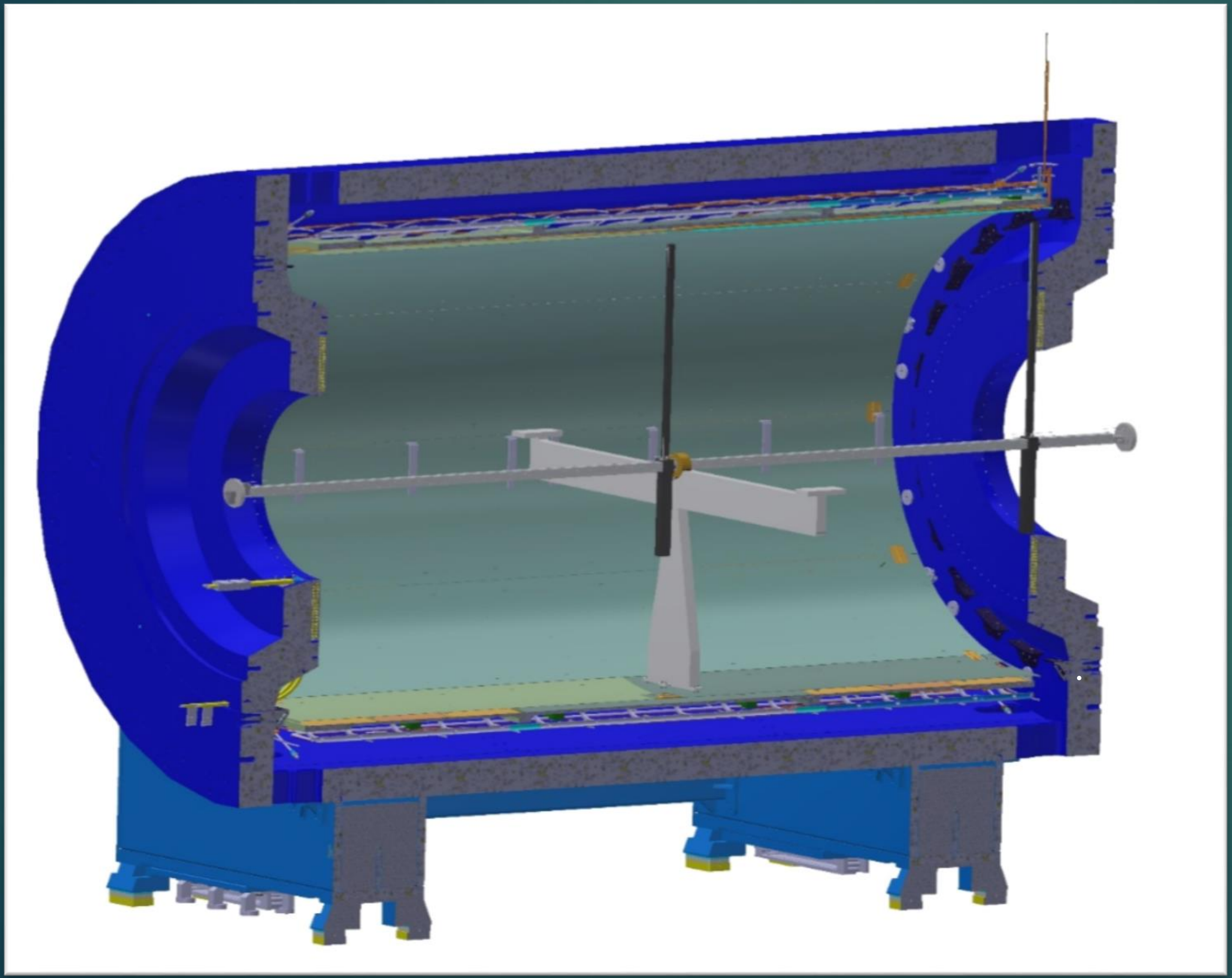
Very precise vertical flange.

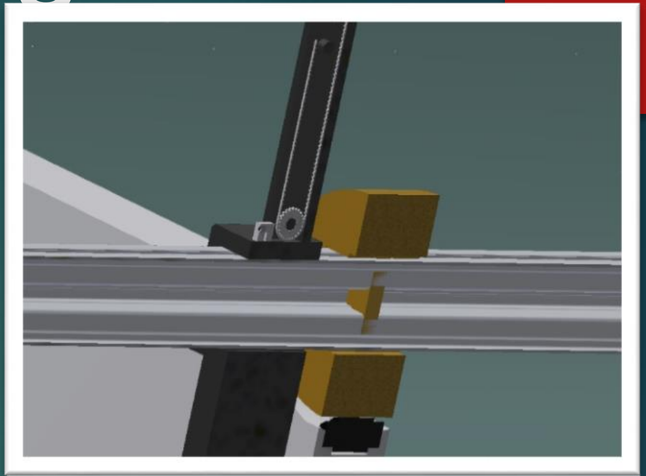


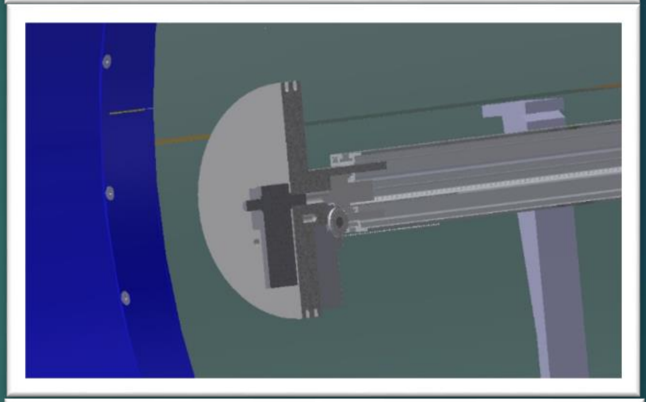
Accuracy of manufacturing and assembly of the magnetic yoke about 0.2 mm.

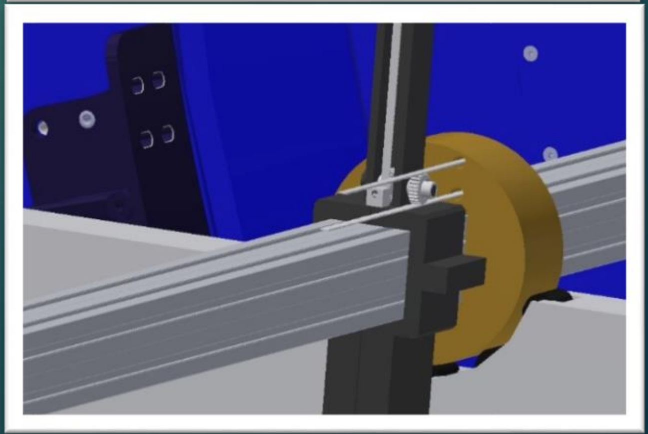
We must take advantage of this!

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.

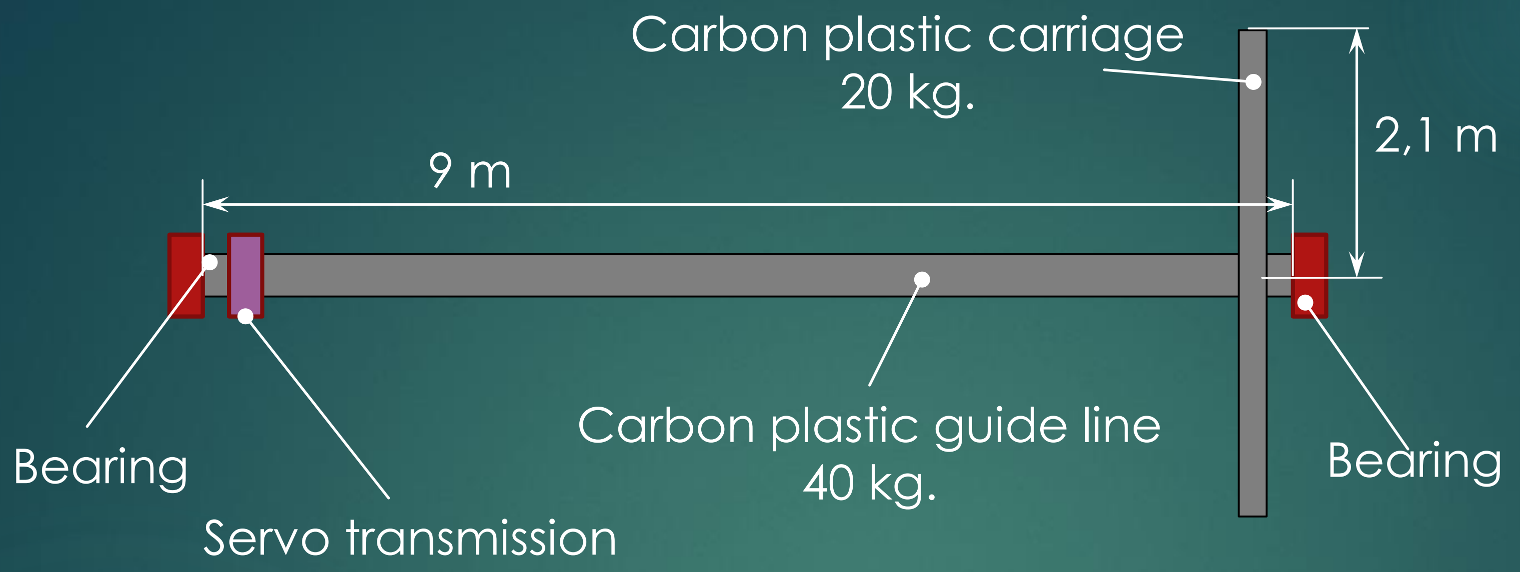
The control code uses a procedure that first moves through all the values of the azimuth angle at the same position in Z at the minimum radius, then rotates back 360°, then steps along the radius, with rotation in azimuth at each radius, and reaching the maximum radius.

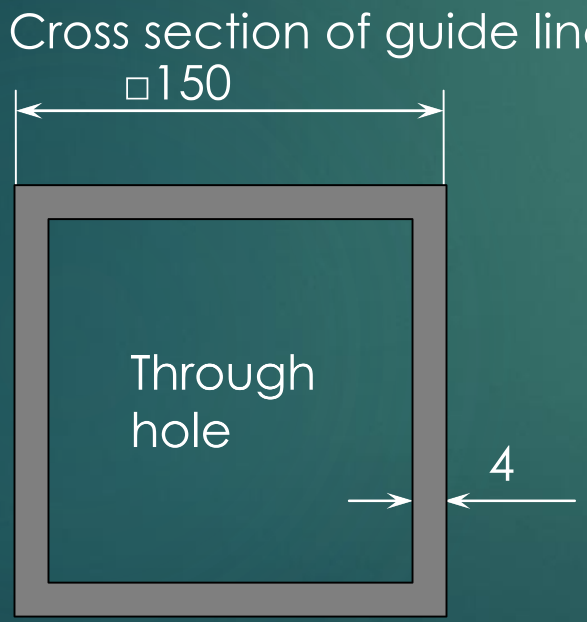
It is necessary to determine the coordinates of the 3D Hall sensor at each measurement point. To do this, one need to use a laser tracker with a set of reflectors and mirrors.

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	9 m (2 × 4.5 m)
Length of movement for R	0.1 – 2.2 m
Rotation of measurement block	360 deg.
Accuracy of movement for Z	50 microns
Accuracy of movement for R	50 microns
Accuracy of rotation	0.2 deg.
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	4 mm
Weight of mapper	60 kg
Reading time per one measurement	1 sec

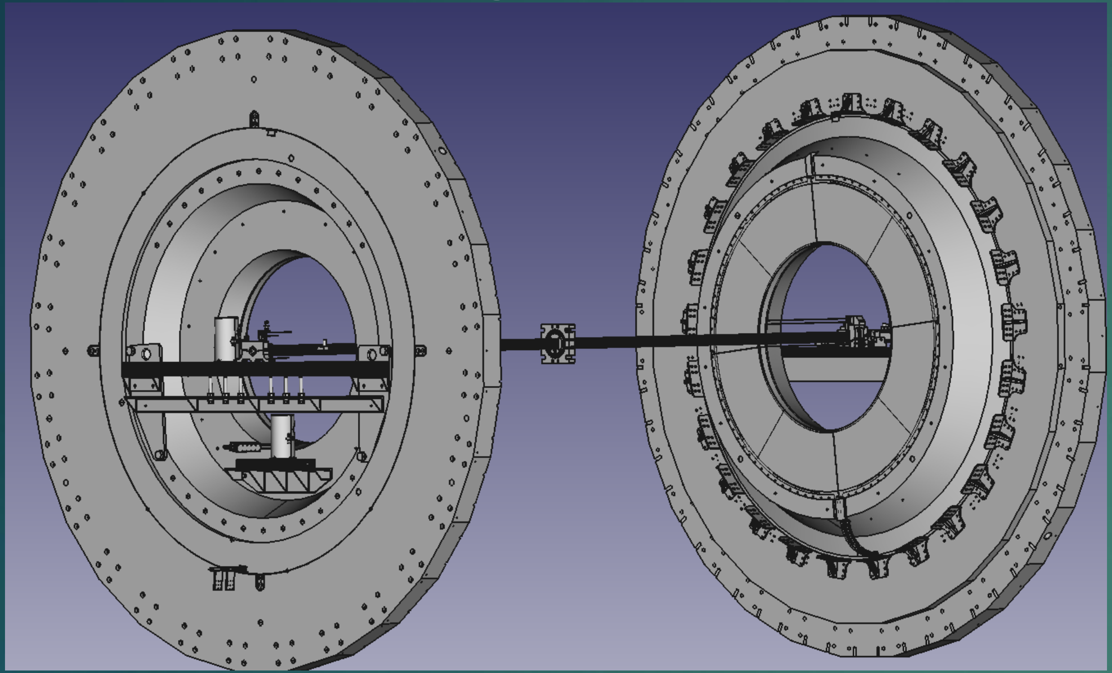


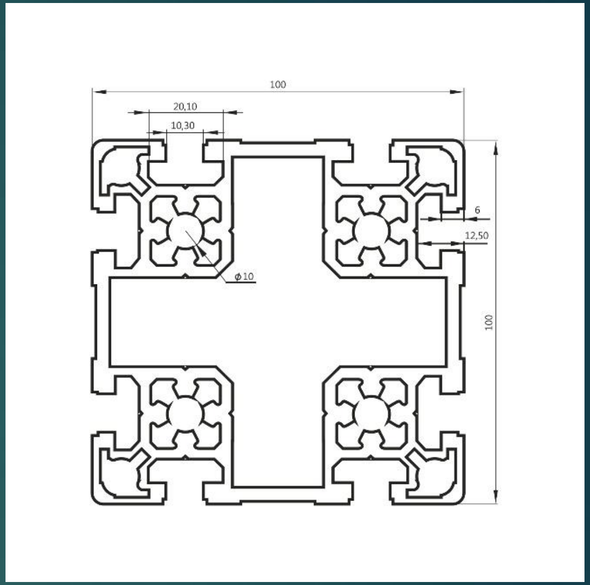


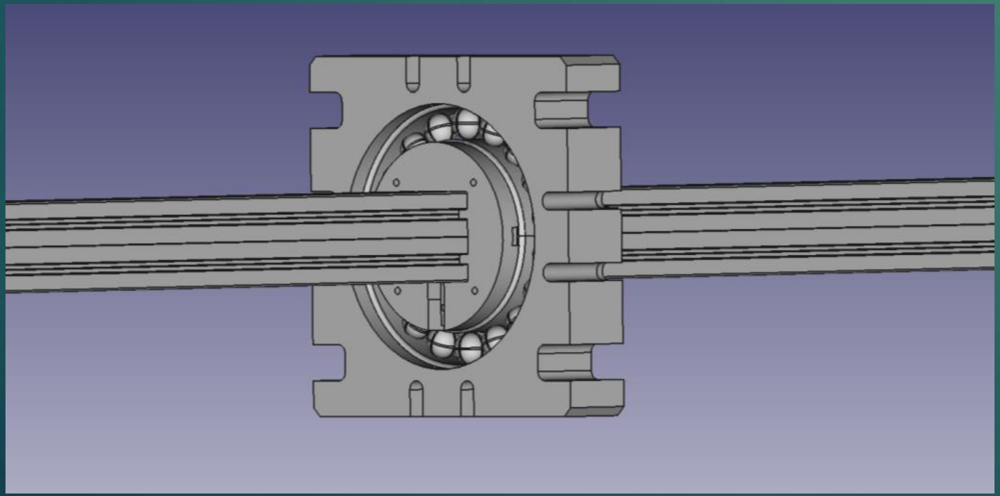
- The weight of the carriage is symmetrical about the axis of the guide
- Young's modulus for carbon plastic 180 Gpa
- The servo drive will be a belt drive. On the servo shaft and on the guide. there will be toothed pulleys.
- The carriage is in the furthest position from the servo for calculation of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

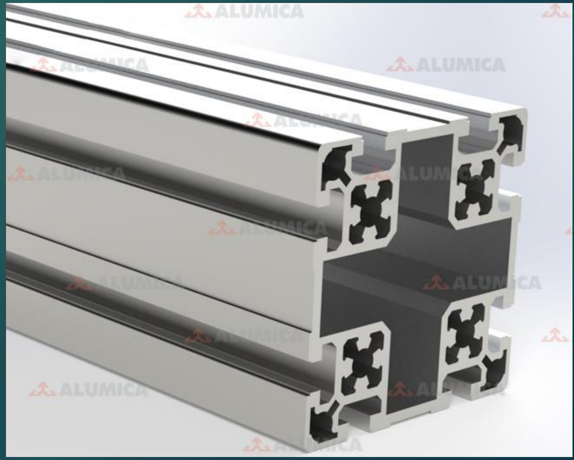
We have to refuse from carbon plastic and change to Al guide line.

Mapper design with 9 m carbon plastic guide line had been changed to two 4.5 m Aluminum guide lines.

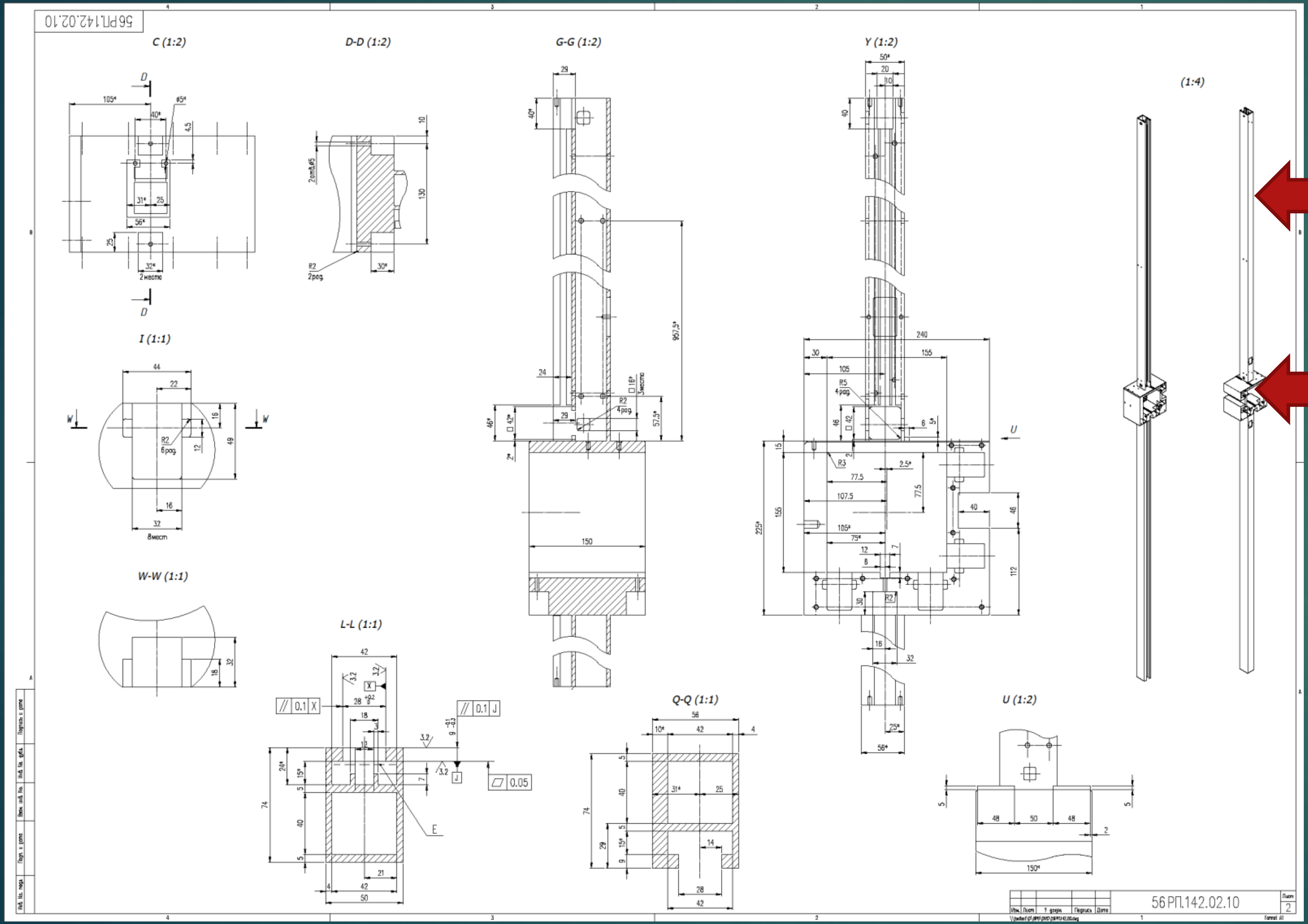








Design of moved parts with Hall sensor are some changed for using Al and polyamide materials.



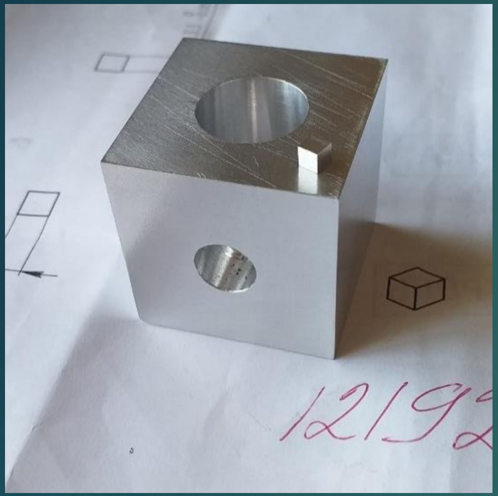
Polyamide

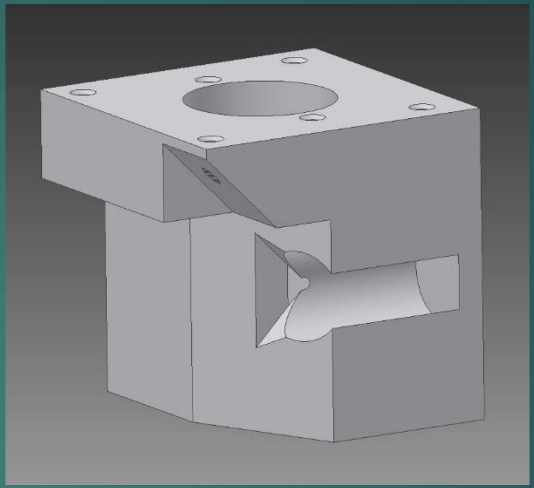
Aluminum

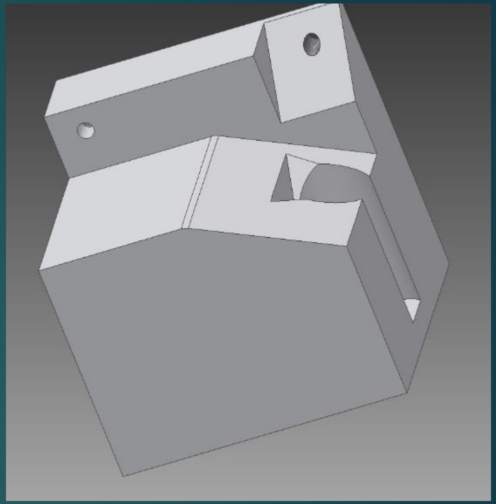
Status of project.

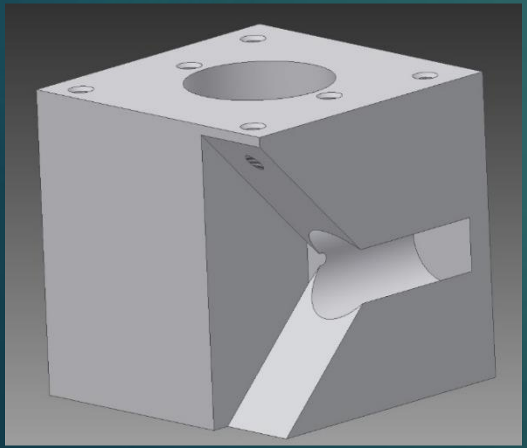
- The 3D STEP model and 2D drawings done for carbon plastic design. But had redesigned for Al and polyamide.
- Servomotors, driving belts, pulleys had got and tested.
- Preparation of test facility for simulating the attachment of the mapper to the MPD magnet and testing the mapper on the Earth's field (at the BINP side).
- Control software had developed and under testing.
- Control unit electronic blocks had been purchased.
- Mechanical parts are in process of manufacturing, the main are polyamide radial barbell and aluminum moved box.

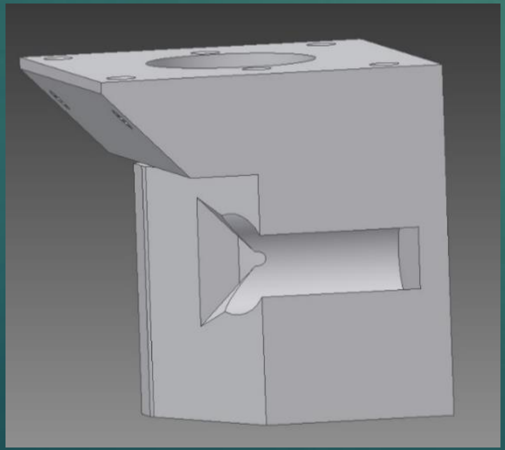
Status of project. Examples of measuring block.

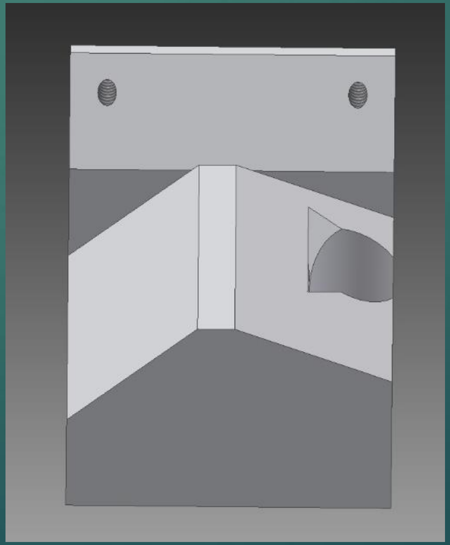


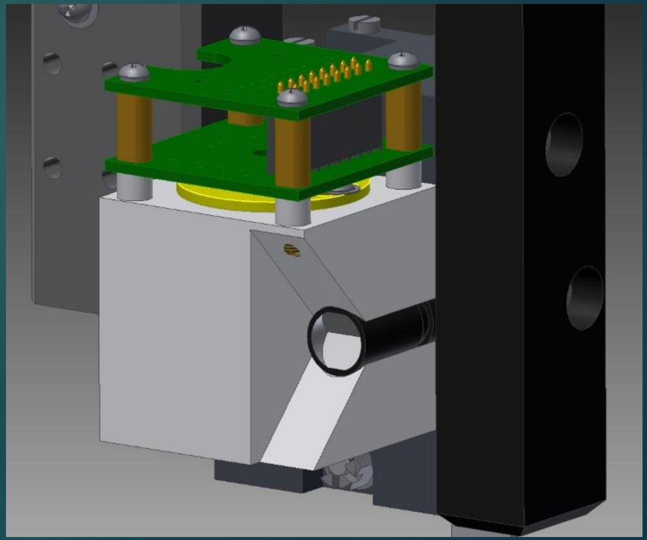






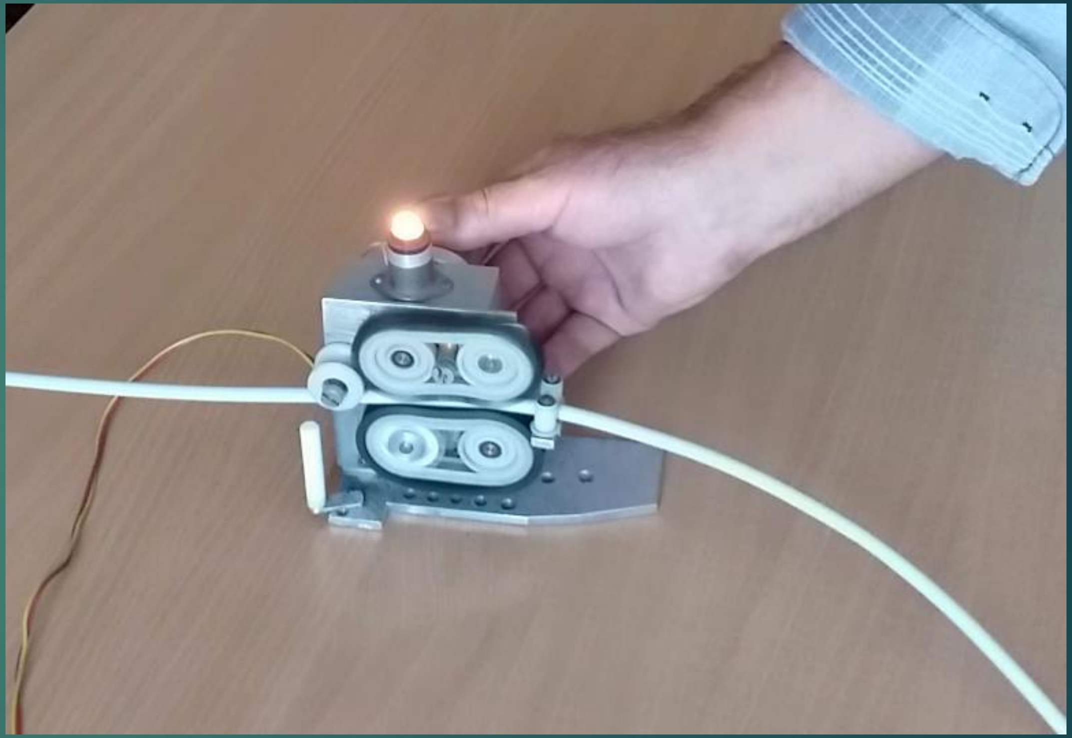






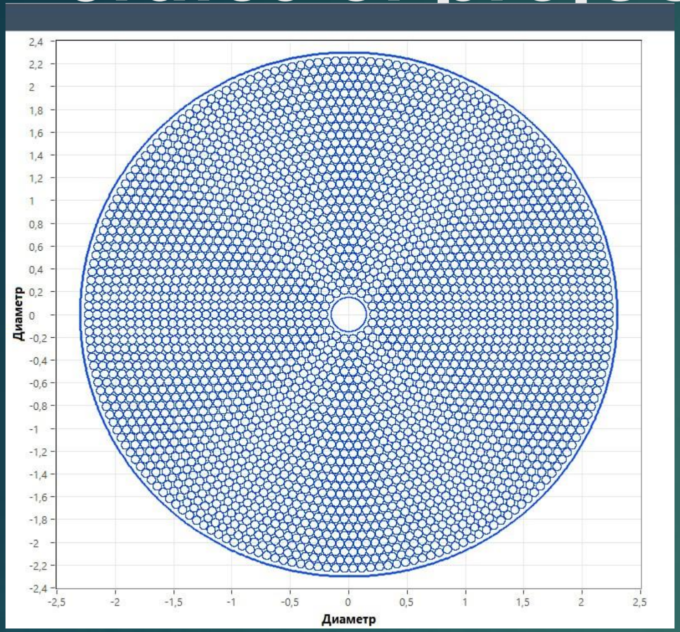
Status of project. Examples.

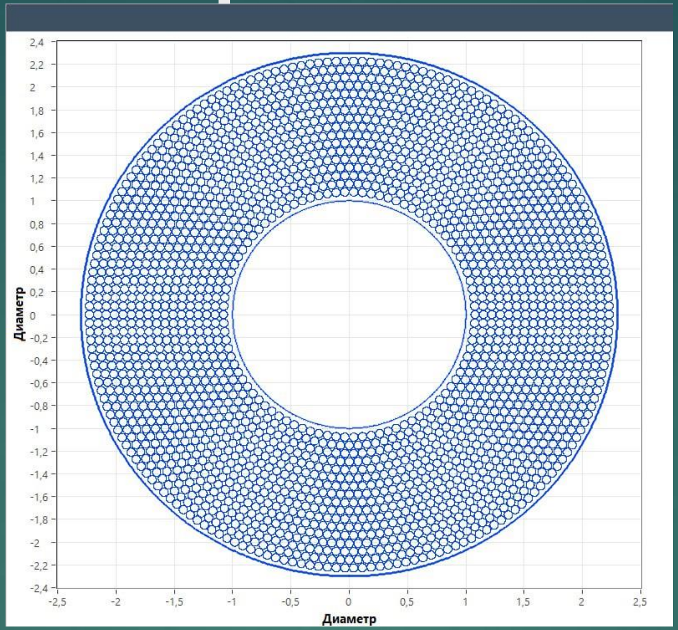
Servomotor with reducer.

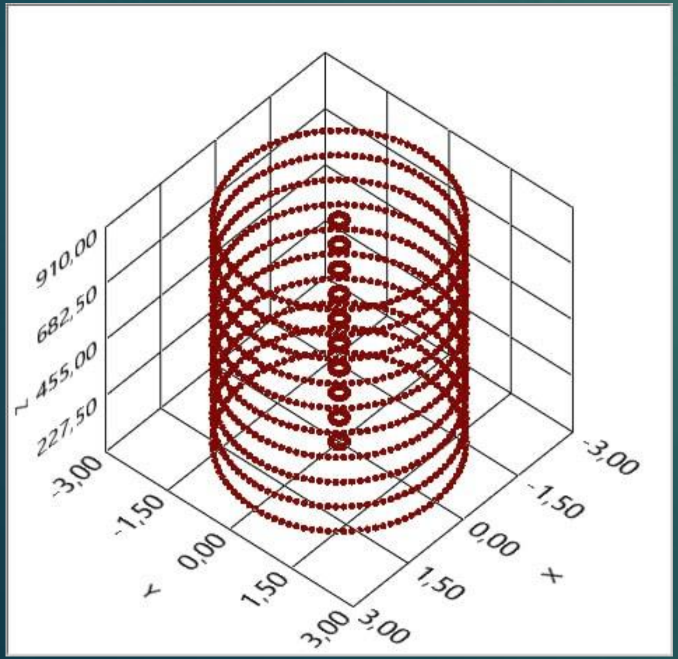


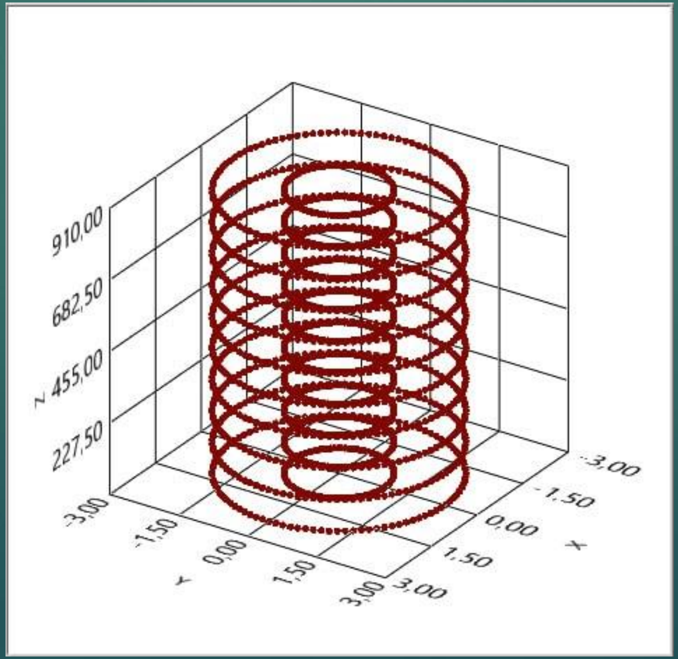
Device for winding up wire.

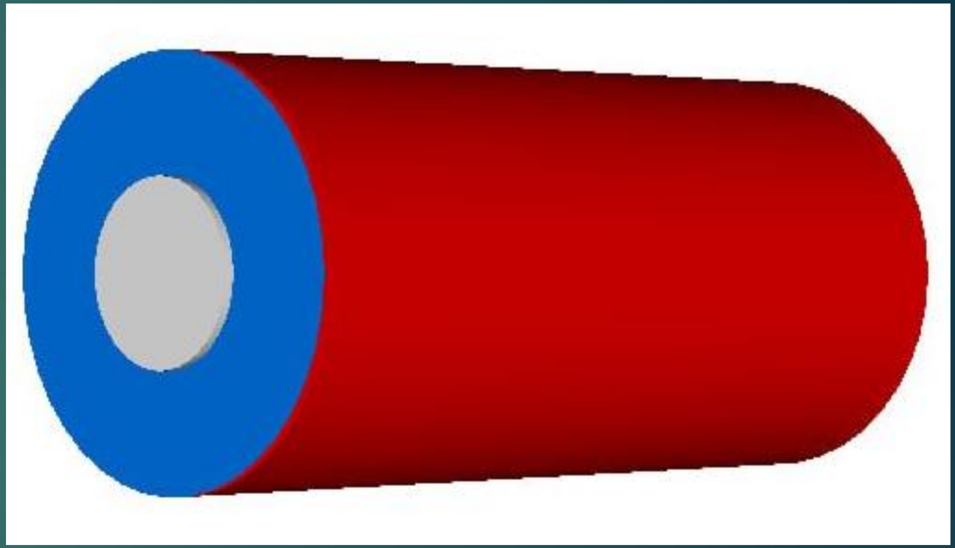
Status of project. Example of control software testing.











Time schedule

Works / Time, month	May	June	July	August	September	October
Aluminum guide line, carriage. and polyamide box						
Control code testing						
Servomotors and related parts (belts, bearings)	done					
Mechanical parts (bearings and soon)						
Production and alignment of testing facility for Earth field measurement (at BINP side).						
Assembling of mapper on testing facility at BINP.						
Test with Earth field at BINP						
Assembling of mapper at JINR						
Measurements and correction of magnetic field in JINR.						

Thank you for attention.