



Stationary System for Magnetic Field Monitoring MPD Solenoid ***(Current Design Status)***



T.Bedareva, E.Antokhin



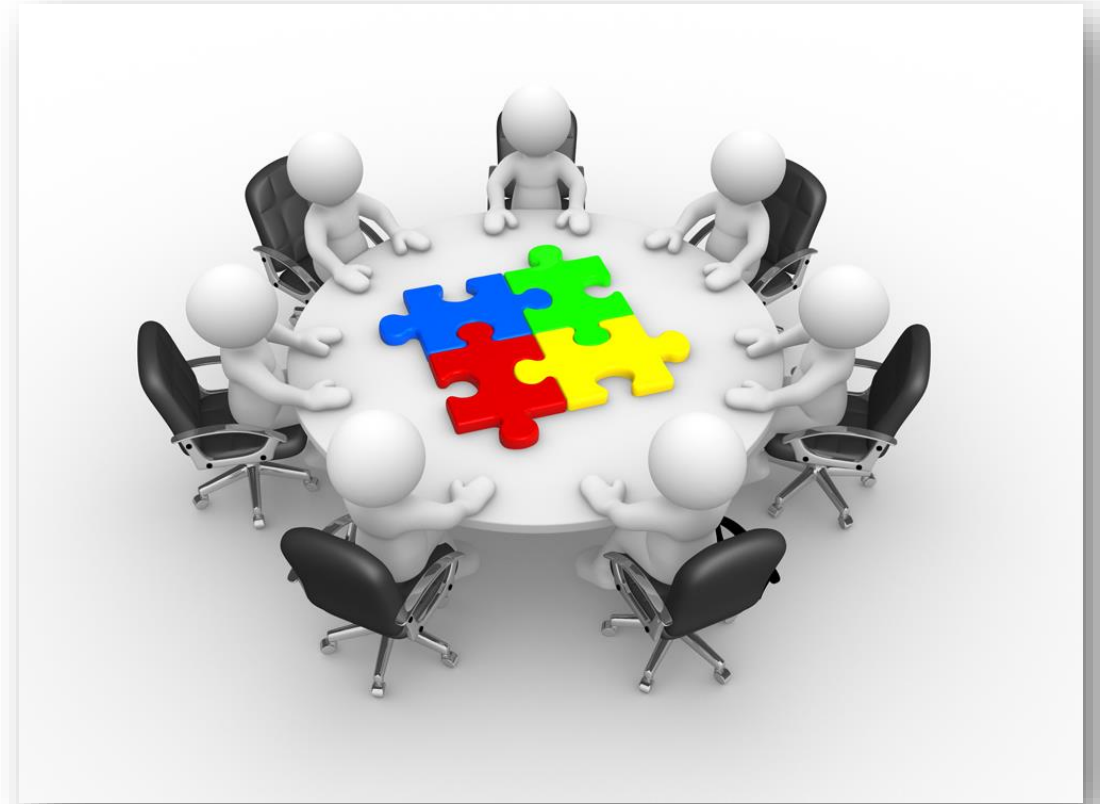
Any device used for scientific research is created in close cooperation between scientists and engineers. The stationary monitoring system is a joint project and involves a large group of specialists from BINP, Novosibirsk (Yu.Tikhonov, K. Zhilyaev, A. Pakhomov, P. Dovgerd, A. Klimenko etc.) and JINR, Dubna (V. Golovatyuk, K. Mukhin, S. Gerasimov, M. Buryakov, S. Buzin, etc.)

The design of any device directly depends on the equipment that will be used in the operation of this device in order to obtain the required level of measurements.

As a result of cooperation, a lot of pre-work has been done to test and compare different types of sensors from different manufacturers with the possibility of further use in this monitoring system.

This report is more of an overview in order to present the amount of preliminary work has been done.

In the future, the collaboration will move to a new level.





General information

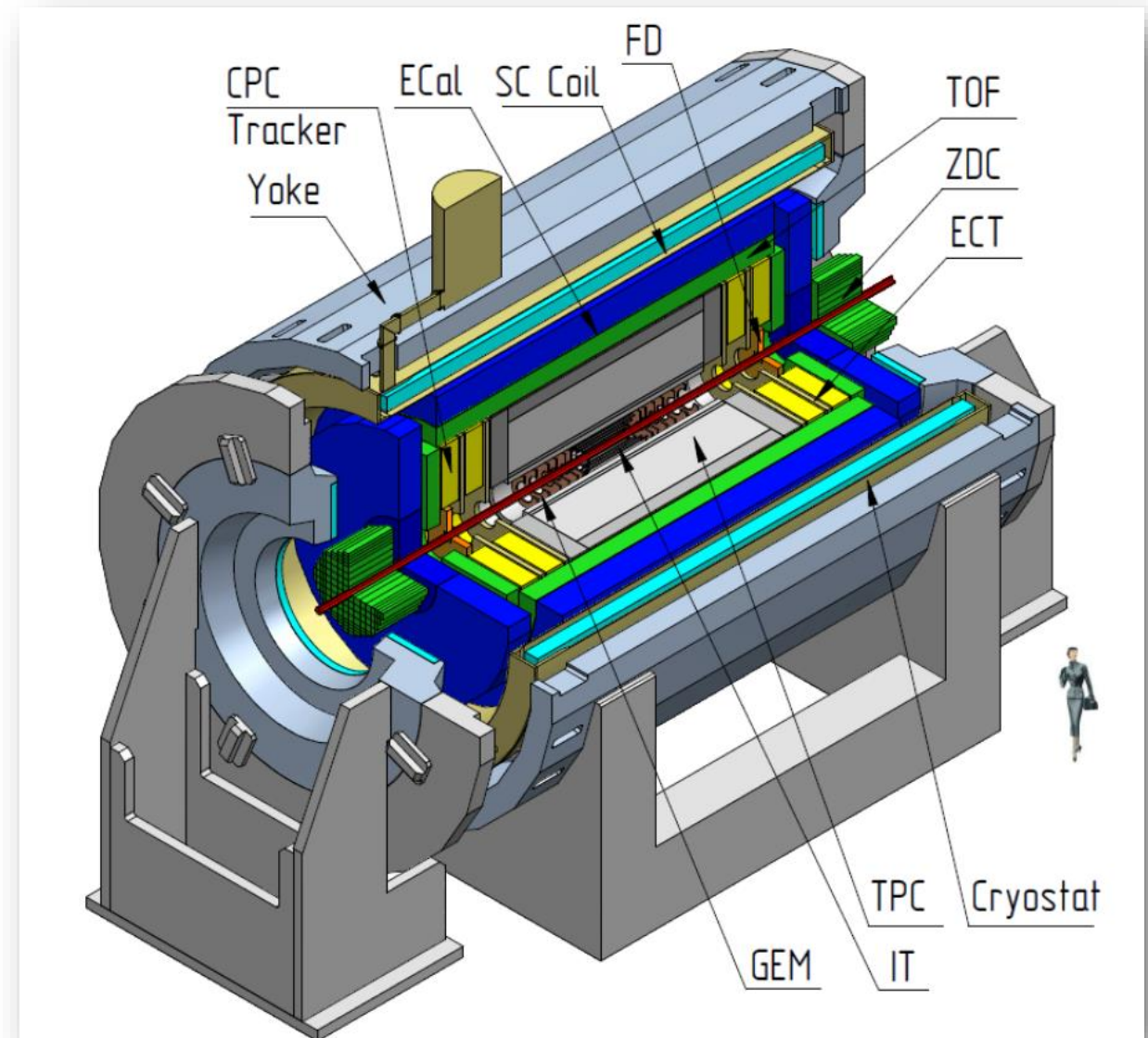
The Multi-Purpose Detector (MPD) superconducting solenoid magnet is designed to provide a highly homogeneous magnetic field of up to 0.57 T (with a default operational setting of 0.5 T).

Stationary Hall probes are installed in the MPD detector to monitor real magnetic field variations **from** the superconducting **and TRIM** coils of the detector.

Stationary Hall probes for magnetic field monitoring should be installed after all magnet tests with volume 3D mapper have been completed.

Stationary Hall probes will be calibrated based on the field measuring by 3D volume mapper.

After long time the field map from 3D mapper may be slightly changed (due to hysteresis, SC coil shifts and etc.). Thus 3D field map can be corrected using the data from stationary Hall probes.

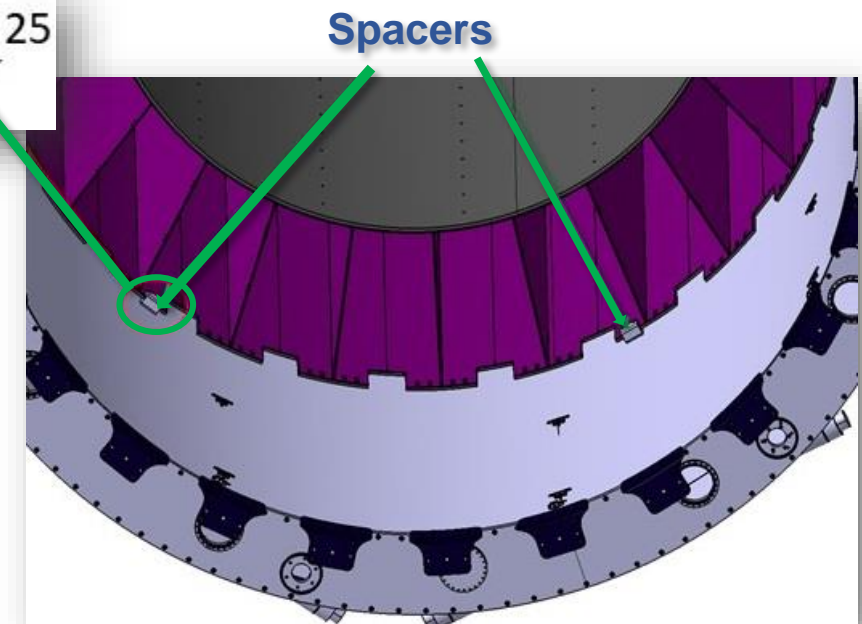
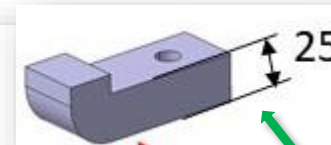
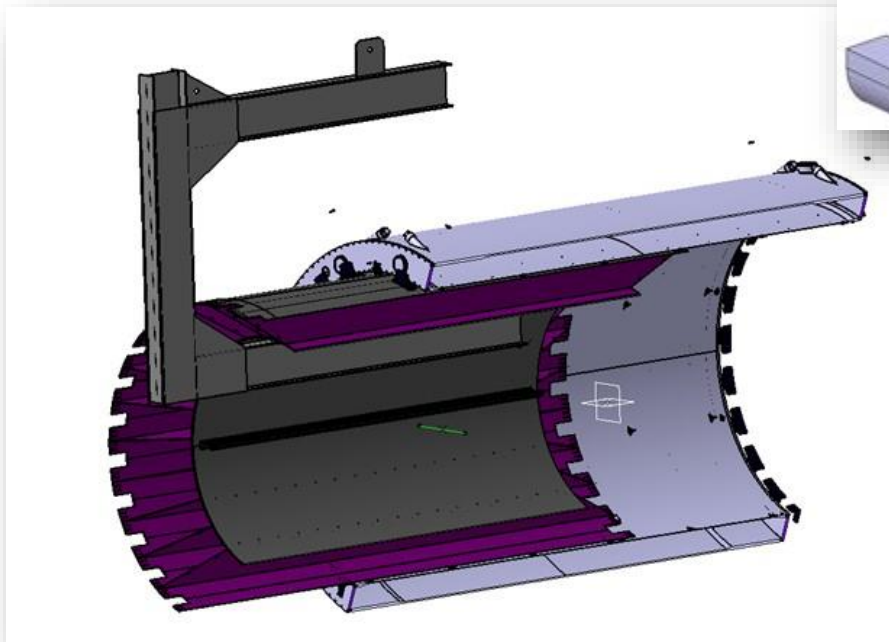
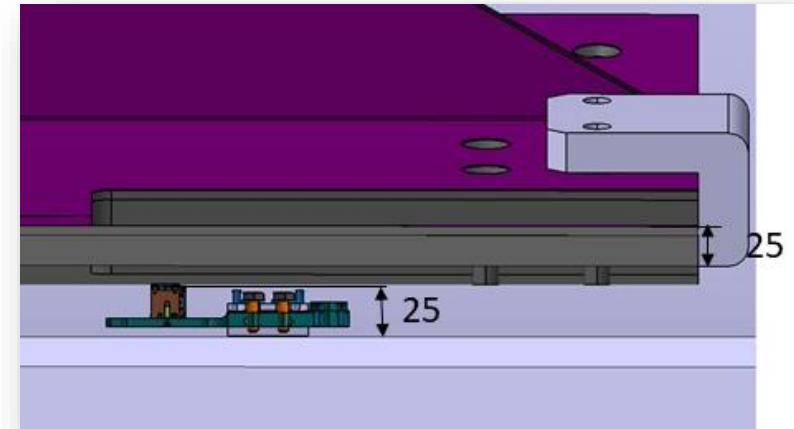




The overall dimensions of the stationary system elements are determined by free space between cryostat and MPD power frame, on which the detector internal components are mounted.

For more information about magnet field stationary Hall probes shall be installed in the area of largest B_r component variation. i.e. at the outer radius at edge of SC coil.

It is planned to use spacers during installation work to avoid damage to the stationary system elements.

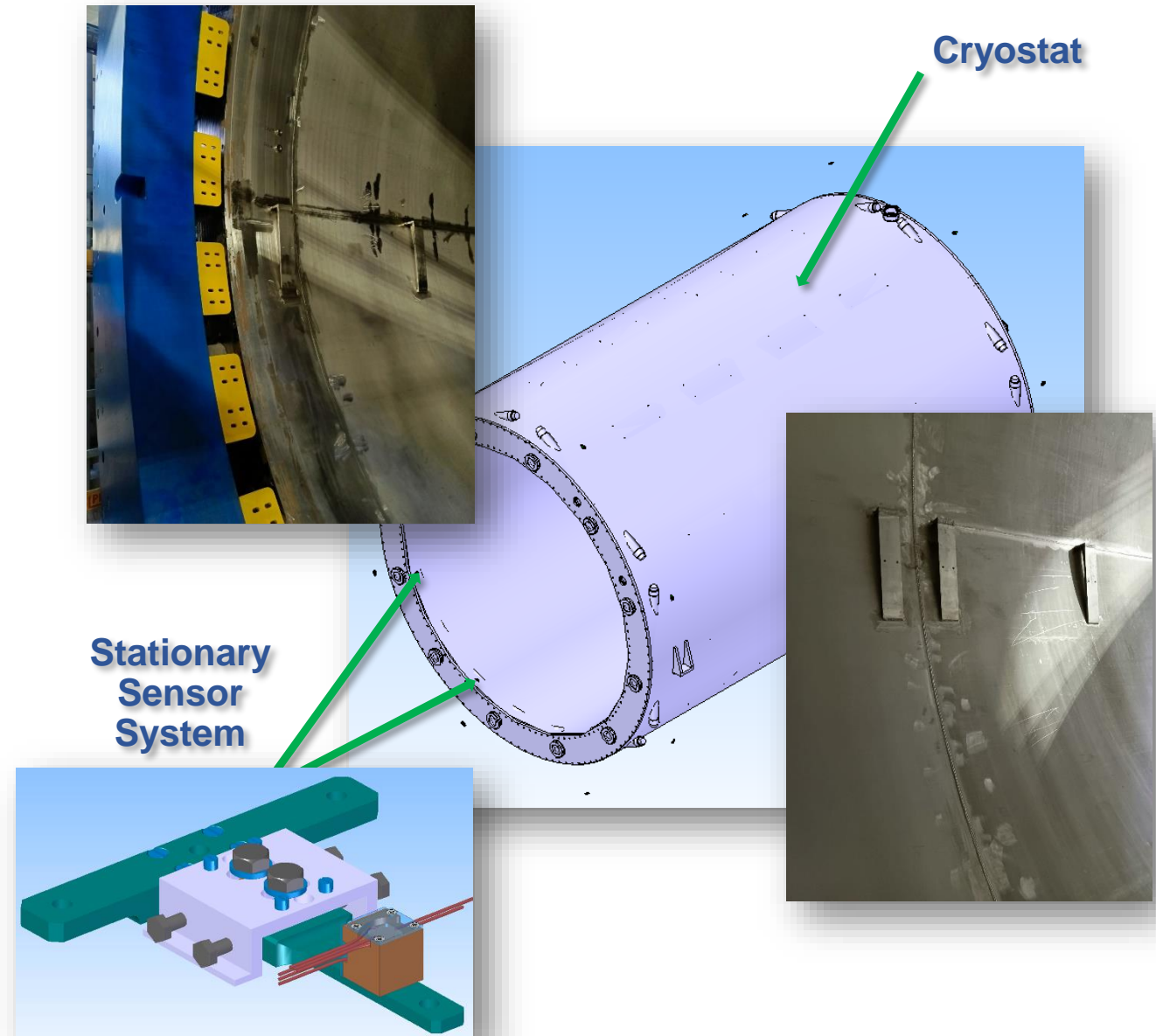




The MPD stationary magnetic field monitoring sensors should be installed in such a way as to avoid damaging them during the process of installing the MPD power frame in the cryostat.

It is assumed to install the sensors of the stationary monitoring system on the surface of the inner wall of the cryostat, where they are as far from the chamber axis as possible. The sensors will be placed in the center zone of the detector (equidistant from the edges) and on the edges of the detector inside the chamber at a distance of 200 mm from the ends.

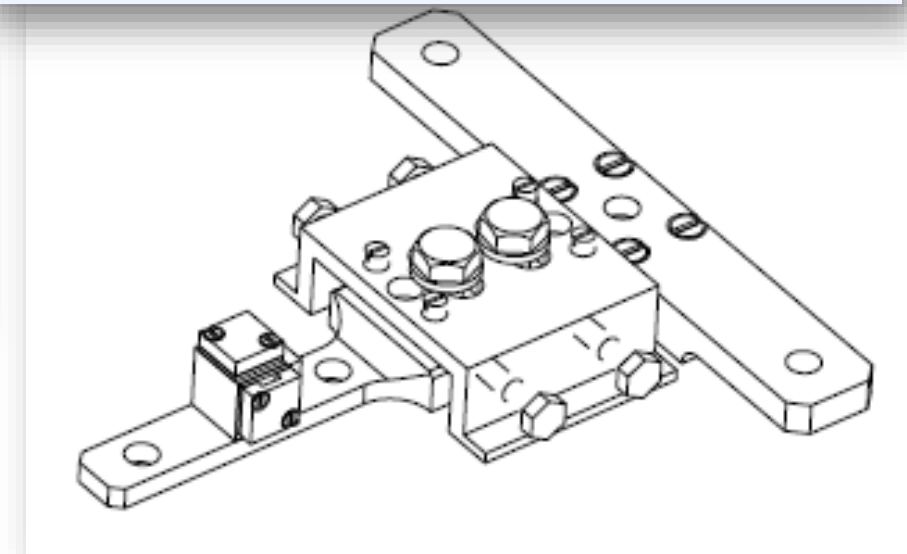
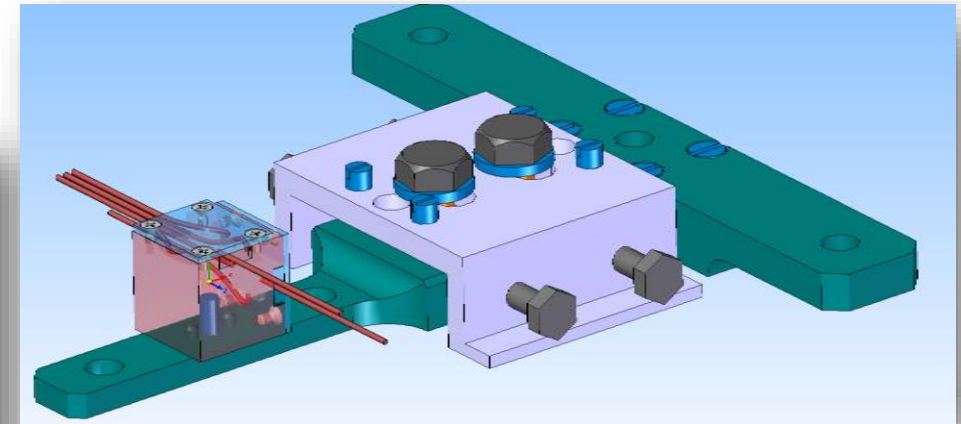
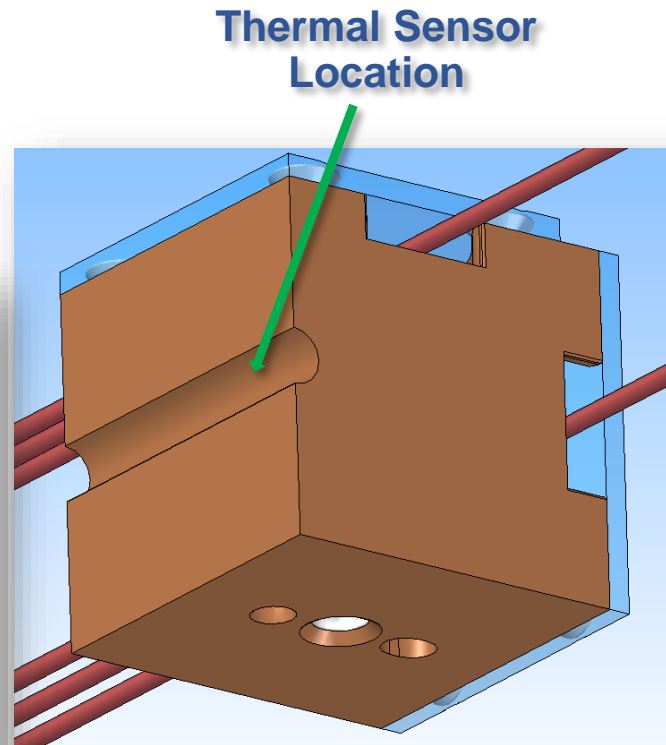
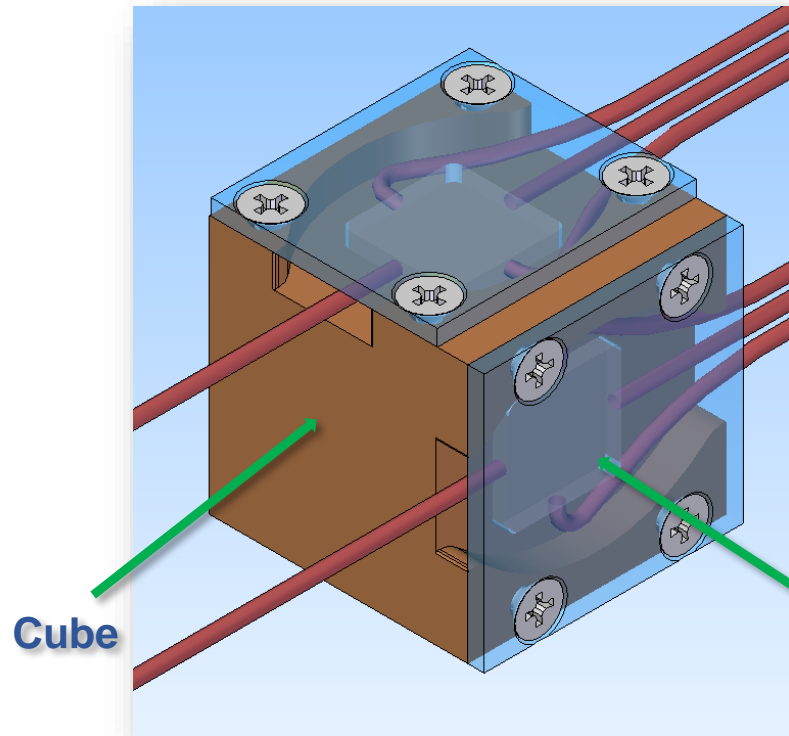
In the central area, the sensors are placed at 90° - 4 sensor intervals. Sensors at the edges of the measurement zone are placed at 45° intervals, i.e. 16 sensors on each side of the detector. A total of 36 sensors are used to monitor the entire volume.





Stationary Sensors System Design

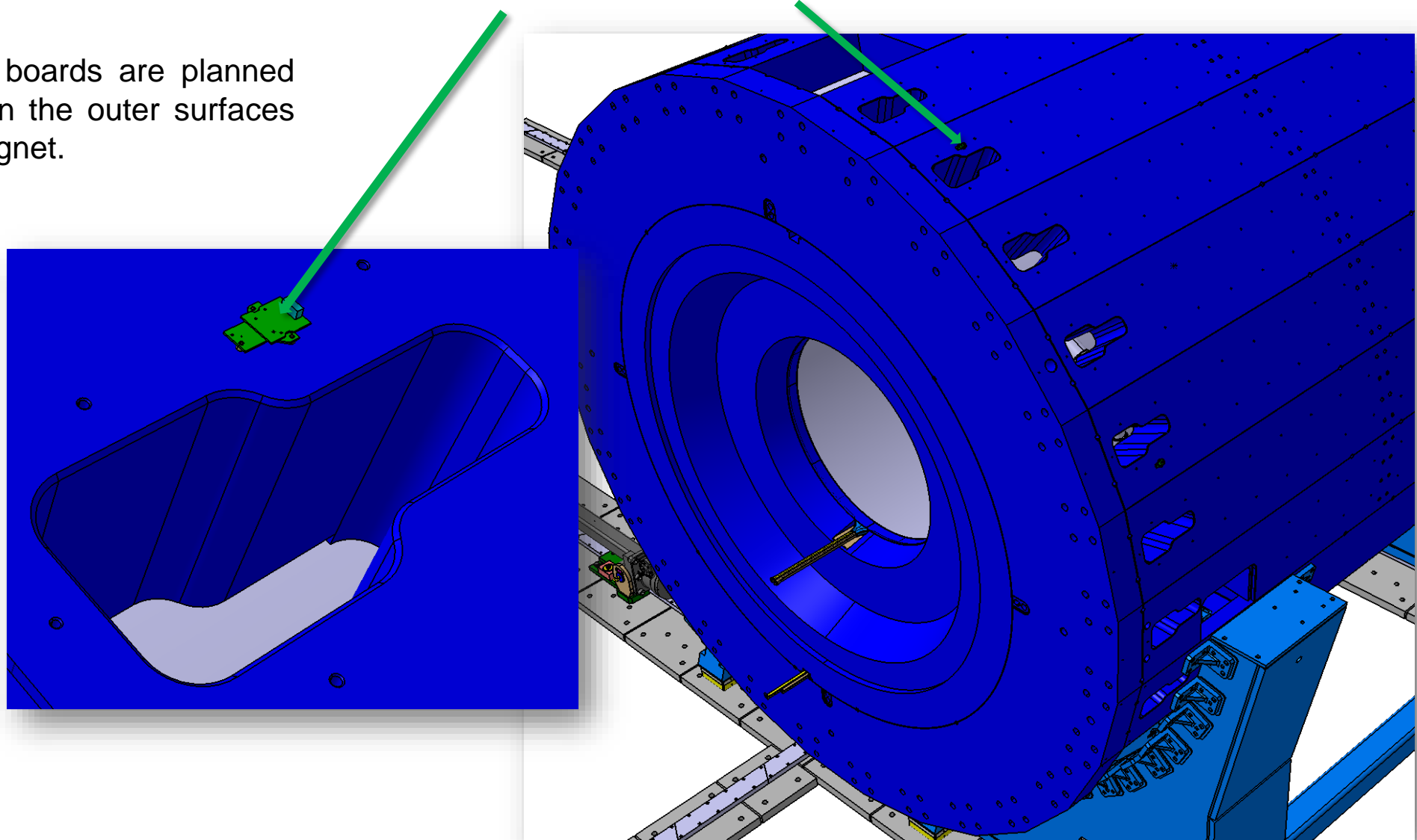
The sensor stationary monitoring system includes a cube for Hall probes and devices for the cube fixation and mounting this system to a cryostat inner wall.





Electronic Boards

The electronic boards are planned to be placed on the outer surfaces of the MPD magnet.





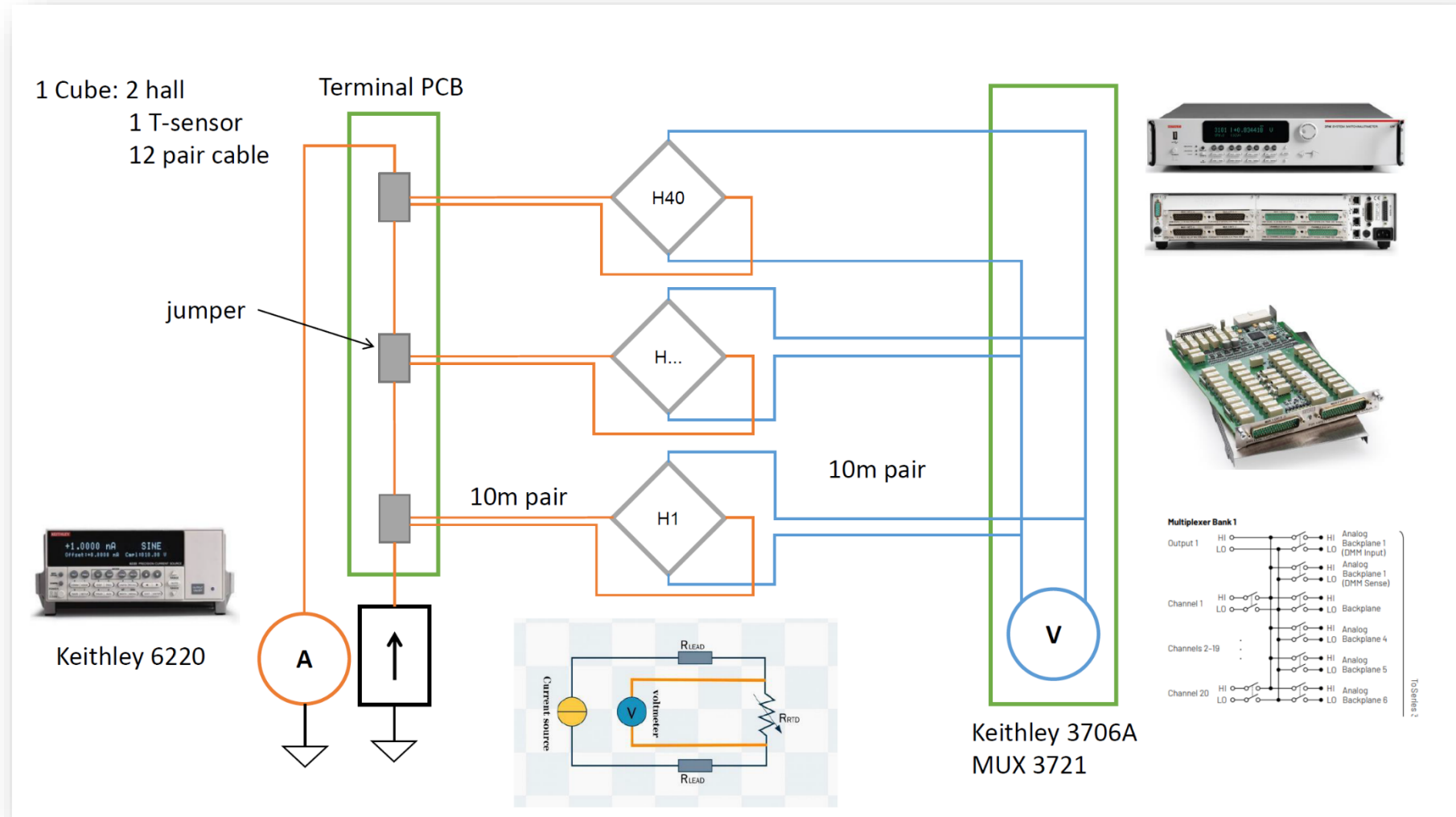
Commutation Scheme

M. Buryakov, S. Buzin (JINR, Dubna)



Hall probes
commutation with
nano voltmeter and
commutator inside
MPD solenoid.

**Commutation Scheme
was provided by
M.Buryakov and S.Buzin
(JINR, Dubna)**

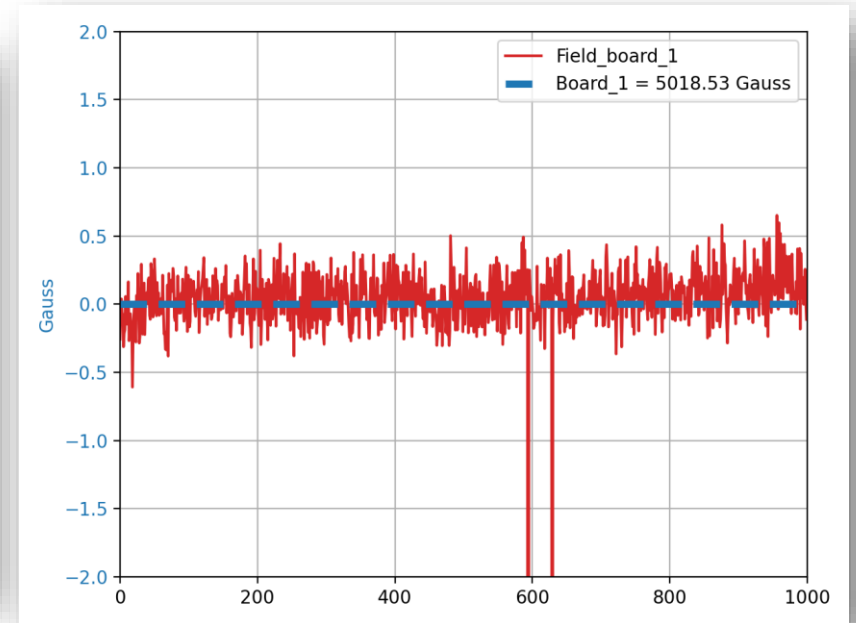
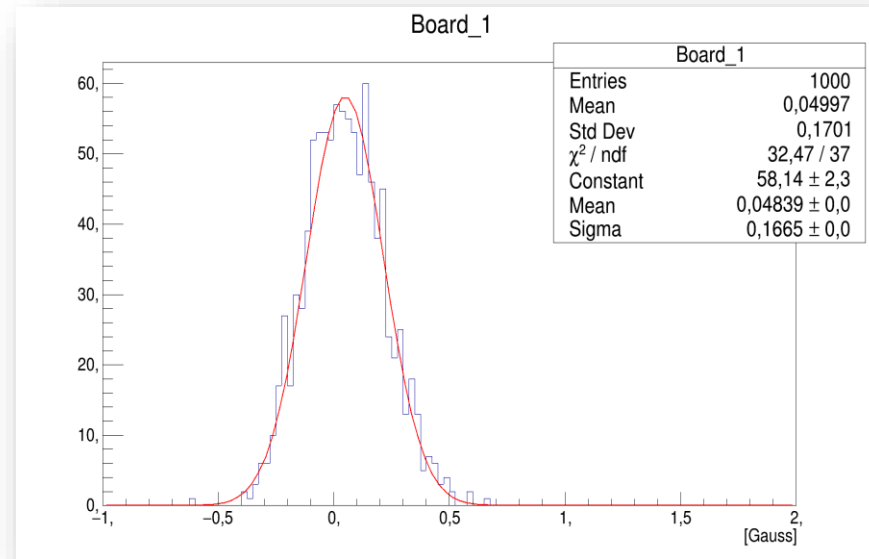
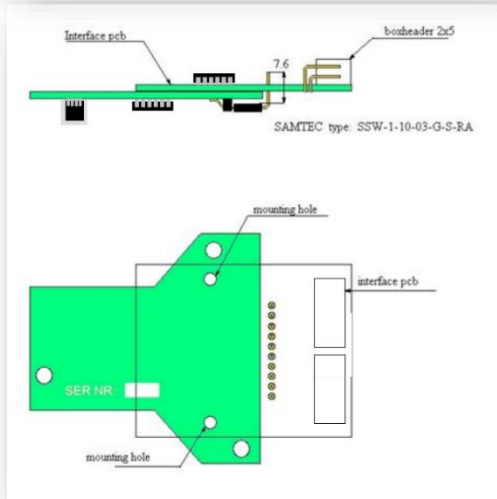
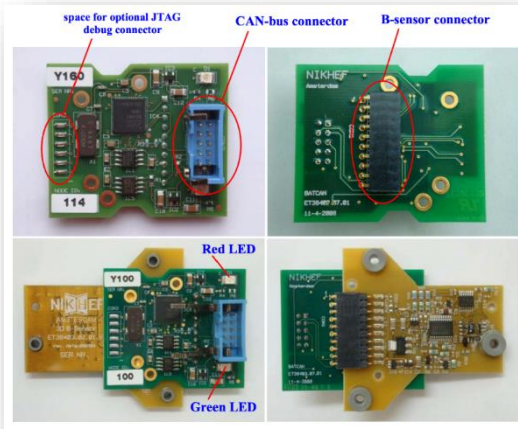




Sensors Verification: Electronic Boards

M. Buryakov, S. Buzin (JINR, Dubna)

The existing in JINR electronic boards will be used in a monitoring field system for MPD magnet. Each board has 3D Hall probe and own analog-digital converter. Digitization allows transfer signal to long distance.



Measurements of noise were done and found out as ± 0.5 Gs.
That is out of specification for field monitoring.

For detailed information on sensor verification please contact M.Buryakov and S.Buzin (JINR, Dubna)



Sensors Verification: Nizhniy Novgorod State University Hall probes

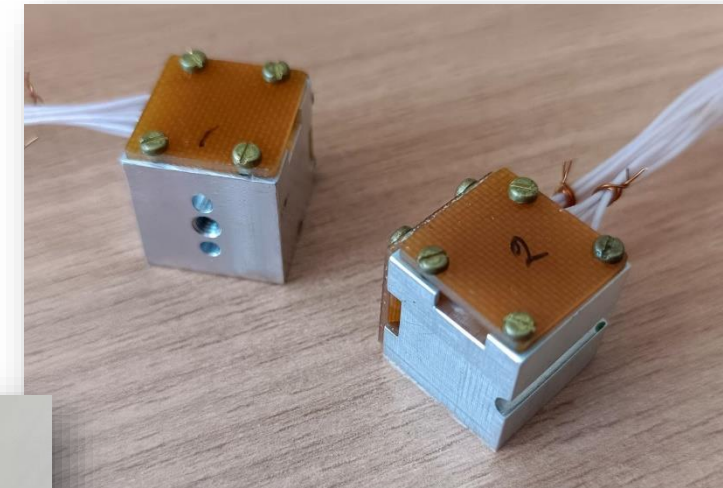
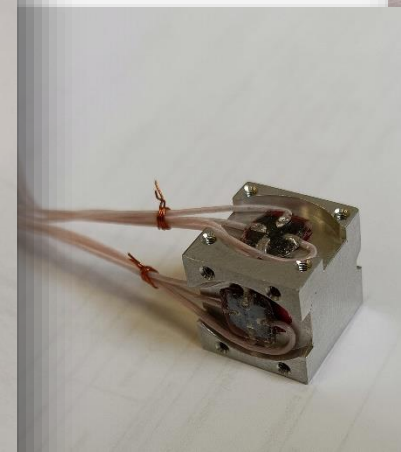
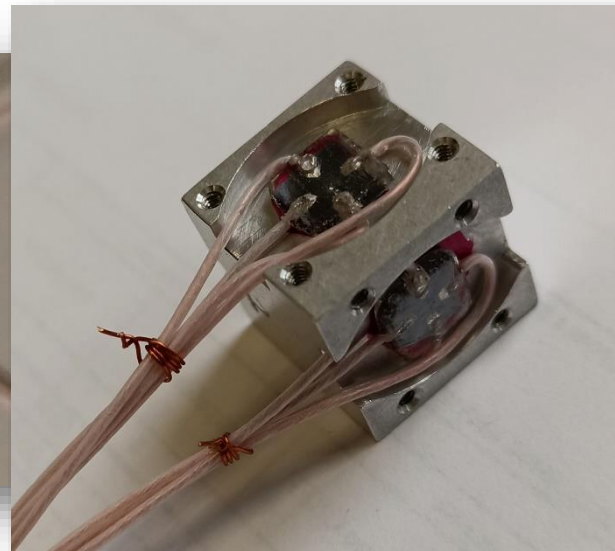
45 Hall probes were developed and produced for MPD magnet field monitoring with high parameters as:

Magnetic sensitivity	15 mkV/Gs
Temperature coefficient of magnetic sensitivity	$\leq 0,01\%/C$
Residual voltage	100 mkV
Temperature coefficient of residual voltage	1-2 mkV/C (or 0,05-0,1 Gs/C)

Aluminum sample



Hall sensor



Hall probes installed onto aluminum base for measuring B_z and B_r components of the MPD solenoid.



Sensors Verification: Nizhniy Novgorod State University Hall probes data measuring

A.Pakhomov, K. Zhilyaev (BINP, Novosibirsk)



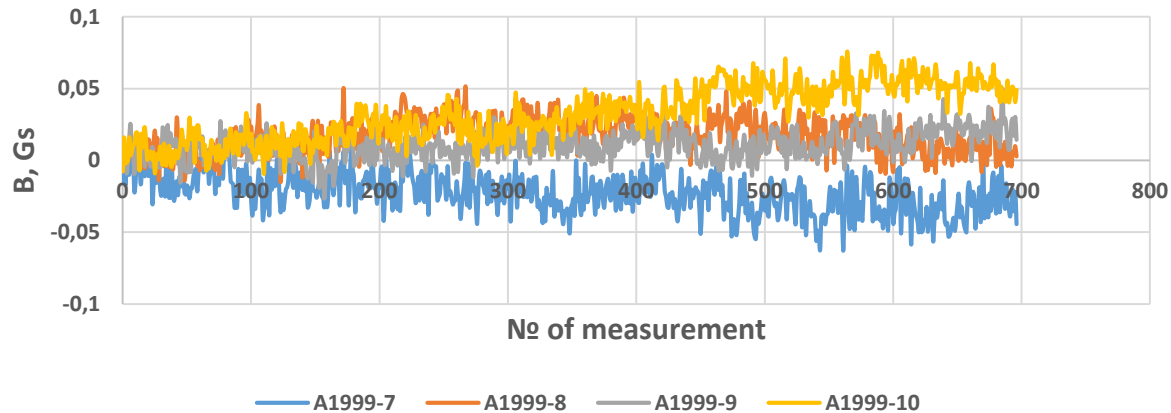
№	Уост, мкВ		γ, μV/Gs	Расходимость, %		Нелинейность, %		ТКОИ				ТКЧ(0.5 Тл)		ТКЧ(-0.5 Тл)		Шум (peak to peak)		
	5mA	-5mA		0.1 Тл	1Тл	1 Тл	-1Тл	5mA		-5mA		Gs/°C	%°C	Gs/°C	%°C	В экране, Gs	При 0.5 Тл	
								Gs/°C	μV/°C	Gs/°C	μV/°C						Gs	%
A1998-01	-10	10	12,3	-0,01	-0,01	0,4	0,4	-0,16	-2,0	0,18	2,2	-1,11	-2,2E-04	0,84	-1,7E-04	0,05	0,07	1E-05
A1998-02	12	-6	12,3	-0,02	0,00	0,5	0,4	-0,09	-1,1	0,07	0,9	-1,11	-2,2E-04	0,95	-1,9E-04	0,05	0,07	1E-05
A1998-03	252	-265	12,7	-0,01	-0,01	0,5	0,4	-0,07	-0,9	0,07	0,9	-1,01	-2,0E-04	0,95	-1,9E-04	0,05	0,08	2E-05
A1998-04	-374	378	12,7	-0,01	0,01	0,5	0,4	-0,06	-0,8	0,09	1,1	-1,08	-2,2E-04	0,98	-2,0E-04	0,04	0,09	2E-05
A1998-05	28	-26	12,7	-0,01	0,00	0,4	0,4	-0,07	-0,9	0,07	0,9	-1,09	-2,2E-04	0,96	-1,9E-04	0,04	0,08	2E-05
A1998-06	-161	167	12,5	0,00	-0,01	0,5	0,5	0,01	0,1	-0,02	-0,2	-1,04	-2,1E-04	1,03	-2,1E-04	0,04	0,10	2E-05
A1998-07	38	-38	12,2	-0,01	0,00	0,5	0,5	-0,01	-0,1	0,01	0,1	-1,13	-2,3E-04	1,09	-2,2E-04	0,04	0,08	2E-05
A1998-08	223	-224	12,3	-0,01	-0,02	0,5	0,5	-0,02	-0,2	0,03	0,4	-1,05	-2,1E-04	0,99	-2,0E-04	0,04	0,09	2E-05
A1998-09	-695	701	12,5	-0,01	0,01	0,5	0,4	-0,03	-0,4	0,04	0,5	-1,05	-2,1E-04	0,98	-2,0E-04	0,04	0,07	1E-05
A1998-10	-579	577	12,6	-0,01	-0,01	0,4	0,4	-0,05	-0,6	0,03	0,4	-1,11	-2,2E-04	0,98	-2,0E-04	0,04	0,08	2E-05
A1998-11	-103	96	12,3	-0,01	0,01	0,5	0,4	-0,03	-0,4	0,01	0,1	-1,09	-2,2E-04	1,00	-2,0E-04	0,09	0,10	2E-05
A1998-13	119	-112	13,1	-0,01	0,00	0,4	0,4	-0,10	-1,3	0,08	1,0	-1,24	-2,5E-04	1,04	-2,1E-04	0,05	0,11	2E-05
A1998-14	360	-436	12,6	-0,02	0,01	0,5	0,5	-	#ЗНАЧ!	-	#ЗНАЧ!	-	#ЗНАЧ!	-	#ЗНАЧ!	0,63	0,32	6E-05
A1998-15	215	-224	13,1	-0,01	-0,01	0,4	0,4	-0,01	-0,1	0,02	0,3	-1,14	-2,3E-04	1,10	-2,2E-04	0,04	0,10	2E-05
A1998-16	6	-13	12,6	-0,01	0,00	0,4	0,4	0,03	0,4	0,01	0,1	-1,06	-2,1E-04	1,12	-2,2E-04	0,08	0,09	2E-05
A1998-17	-162	157	12,1	-0,01	0,00	0,5	0,5	-0,01	-0,1	0,02	0,2	-1,08	-2,2E-04	1,06	-2,1E-04	0,04	0,08	2E-05
A1999-03	99	-99	12,9	-0,02	-0,01	0,4	0,4	0,03	0,4	-0,02	-0,3	-1,04	-2,1E-04	1,07	-2,1E-04	0,04	0,08	2E-05
A1999-04	-115	115	12,8	-0,03	0,00	0,4	0,4	-0,03	-0,4	-0,01	-0,1	-1,18	-2,4E-04	1,09	-2,2E-04	0,05	0,10	2E-05
A1999-05	-350	352	12,3	-0,02	0,00	0,4	0,4	0,03	0,4	0,03	0,4	-1,02	-2,0E-04	1,05	-2,1E-04	0,04	0,10	2E-05
A1999-06	-376	375	12,7	-0,01	0,01	0,4	0,4	0,06	0,8	-0,05	-0,6	-1,04	-2,1E-04	1,13	-2,3E-04	0,09	0,11	2E-05
A1999-07	230	-234	12,5	-0,01	0,00	0,5	0,5	-0,06	-0,8	0,08	1,0	-1,15	-2,3E-04	0,99	-2,0E-04	0,06	0,08	2E-05
A1999-08	-67	58	11,9	-0,01	0,00	0,4	0,4	-0,27	-3,2	0,36	4,3	-1,13	-2,3E-04	0,83	-1,7E-04	0,05	0,10	2E-05
A1999-09	186	-192	11,6	-0,01	0,00	0,4	0,4	0,14	1,6	-0,13	-1,5	-0,83	-1,7E-04	1,11	-2,2E-04	0,04	0,08	2E-05
A1999-10	-29	25	12,3	-0,01	-0,01	0,4	0,4	-0,09	-1,1	0,08	1,0	-1,10	-2,2E-04	0,93	-1,9E-04	0,08	0,08	2E-05
A1999-11	46	-48	12,5	-0,02	0,00	0,5	0,4	0,03	0,4	-0,02	-0,2	-1,04	-2,1E-04	1,09	-2,2E-04	0,04	0,09	2E-05
A1999-12	-433	433	12,7	-0,03	0,00	0,5	0,4	-0,05	-0,6	0,09	1,1	-1,10	-2,2E-04	1,03	-2,1E-04	0,04	0,10	2E-05
A1999-13	362	-362	12,3	0,00	-0,01	0,4	0,5	-0,07	-0,9	0,14	1,7	-1,06	-2,1E-04	0,93	-1,9E-04	0,17	0,10	2E-05
A1999-14	-10	9	12,6	-0,03	-0,01	0,5	0,4	-0,17	-2,1	0,16	2,0	-1,21	-2,4E-04	0,85	-1,7E-04	0,04	0,09	2E-05
A1999-15	-15	11	12,4	-0,02	0,00	0,5	0,4	0,01	0,1	0,01	0,1	-1,04	-2,1E-04	1,07	-2,1E-04	0,05	0,09	2E-05
A1999-16	-106	103	12,5	-0,01	0,01	0,4	0,4	-0,06	-0,7	0,07	0,9	-1,09	-2,2E-04	0,99	-2,0E-04	0,09	0,09	2E-05
A1999-17	189	-190	12,4	-0,02	-0,01	0,5	0,4	-0,01	-0,1	0,01	0,1	-1,04	-2,1E-04	1,07	-2,1E-04	0,05	0,08	2E-05
A1999-18	-197	197	12,4	-0,02	0,01	0,5	0,4	-0,06	-0,7	0,04	0,5	-1,10	-2,2E-04	1,01	-2,0E-04	0,10	0,10	2E-05
A1999-19	15520	-15495	12,5	-0,12	-0,29	0,4	0,6	-1,10	-13,7	0,87	10,9	-2,04	-4,1E-04	-0,01	2,0E-06	2,07	1,54	3E-04
A1999-20	-4	12	12,7	-0,01	0,00	0,4	0,4	-0,07	-0,9	0,10	1,3	-1,11	-2,2E-04	0,96	-1,9E-04	0,05	0,11	2E-05
A1999-21	72	-71	12,8	-0,01	0,00	0,4	0,4	0,08	1,0	-0,07	-0,9	-0,99	-2,0E-04	1,09	-2,2E-04	0,04	0,07	1E-05
A1999-22	-58	62	12,2	-0,01	0,00	0,4	0,4	-0,11	-1,3	0,11	1,3	-1,02	-2,0E-04	0,81	-1,6E-04	0,04	0,11	2E-05
A1999-23	11	-9	12,6	0,00	0,01	0,4	0,4	0,00	0,0	0,02	0,3	-1,05	-2,1E-04	1,04	-2,1E-04	0,04	0,09	2E-05
A1999-24	-123	124	12,4	-0,01	0,00	0,5	0,5	-0,17	-2,1	0,20	2,5	-1,17	-2,3E-04	0,84	-1,7E-04	0,07	0,10	2E-05
A1999-25	20	-24	12,4	-0,03	0,00	0,5	0,5	-0,27	-3,3	0,27	3,3	-1,25	-2,5E-04	0,77	-1,5E-04	0,04	0,09	2E-05
A1999-26	-195	199	12,4	-0,01	0,00	0,5	0,5	-0,17	-2,1	0,18	2,2	-1,09	-2,2E-04	0,80	-1,6E-04	0,05	0,09	2E-05
A1999-27	80	-77	12,3	0,01	0,00	0,5	0,5	0,17	2,1	-0,17	-2,1	-0,92	-1,8E-04	1,10	-2,2E-04	0,10	0,09	2E-05
A1999-28	-13771	13702	12,6	0,46	0,12	0,1	0,5	2,55	32,2	-2,56	-32,4	1,52	3,0E-04	3,57	-7,1E-04	0,17	0,07	1E-05



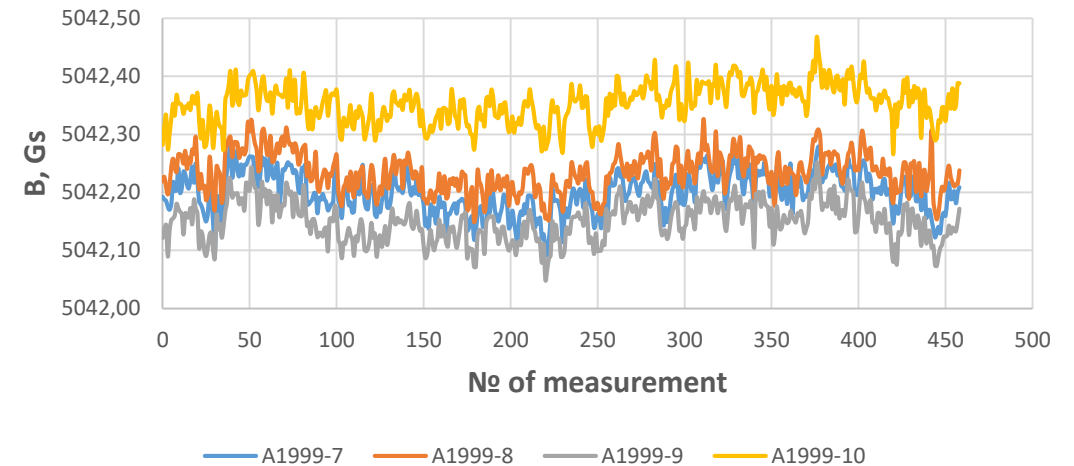
Sensors Verification: Nizhniy Novgorod State University Hall probes noise study

A. Pakhomov (BINP, Novosibirsk)

Field noise in magnetic shield (at zero field)



Field noise at 0.5 T



Hall probes noise is about ± 0.1 Gs. Well suitable for MPD magnet monitoring.
To keep the total system noise at this level we have to use the nano voltmeter with commutator!

For detailed information on sensor verification please contact A.Pakhomov and K.Zhilyaev (BINP, Novosibirsk)



***Thank you for your
attention!***