Technical Coordinator's Report

Alexander Korzenev, JINR LHEP

SPD Collaboration Meeting
Yerevan, 12 Nov 2025

Outline

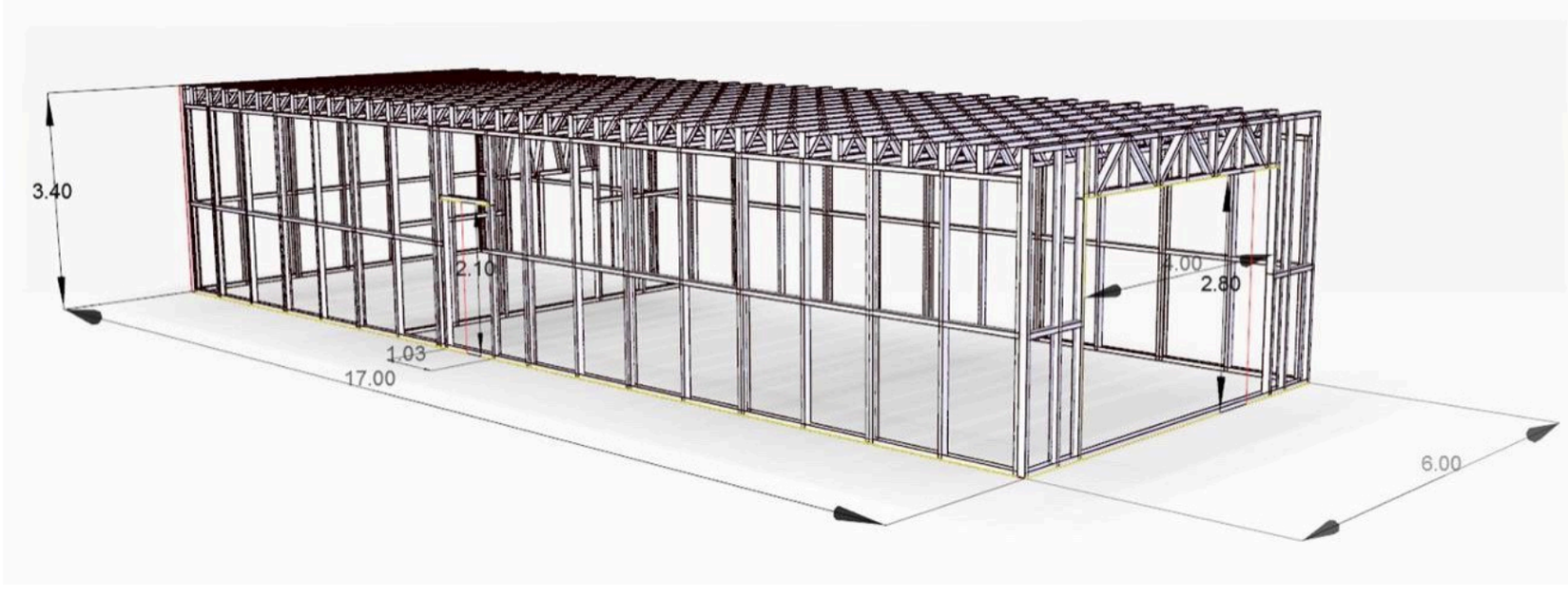
- Experimental hall news
- Power structure of the detector
- Thermal analysis of magnet yoke
- Clean grounding for electronics
- Platforms
- Engineering communications and service pipelines
- Progress on MM cooling system
- Progress on ECal
- Progress on Straw tracker
- Progress on FARICH R&Ds
- Progress on ZDC
- Conclusion

SPD experimental hall in May 2025

- After the installation of the rails in Sep/Oct, the hall was filled with concrete blocks equivalent in weight to the detector
- This is done to speed up the subsidence of the building into the soil
- The acceleration tunnel was isolated from the rest of the hall by concrete blocks

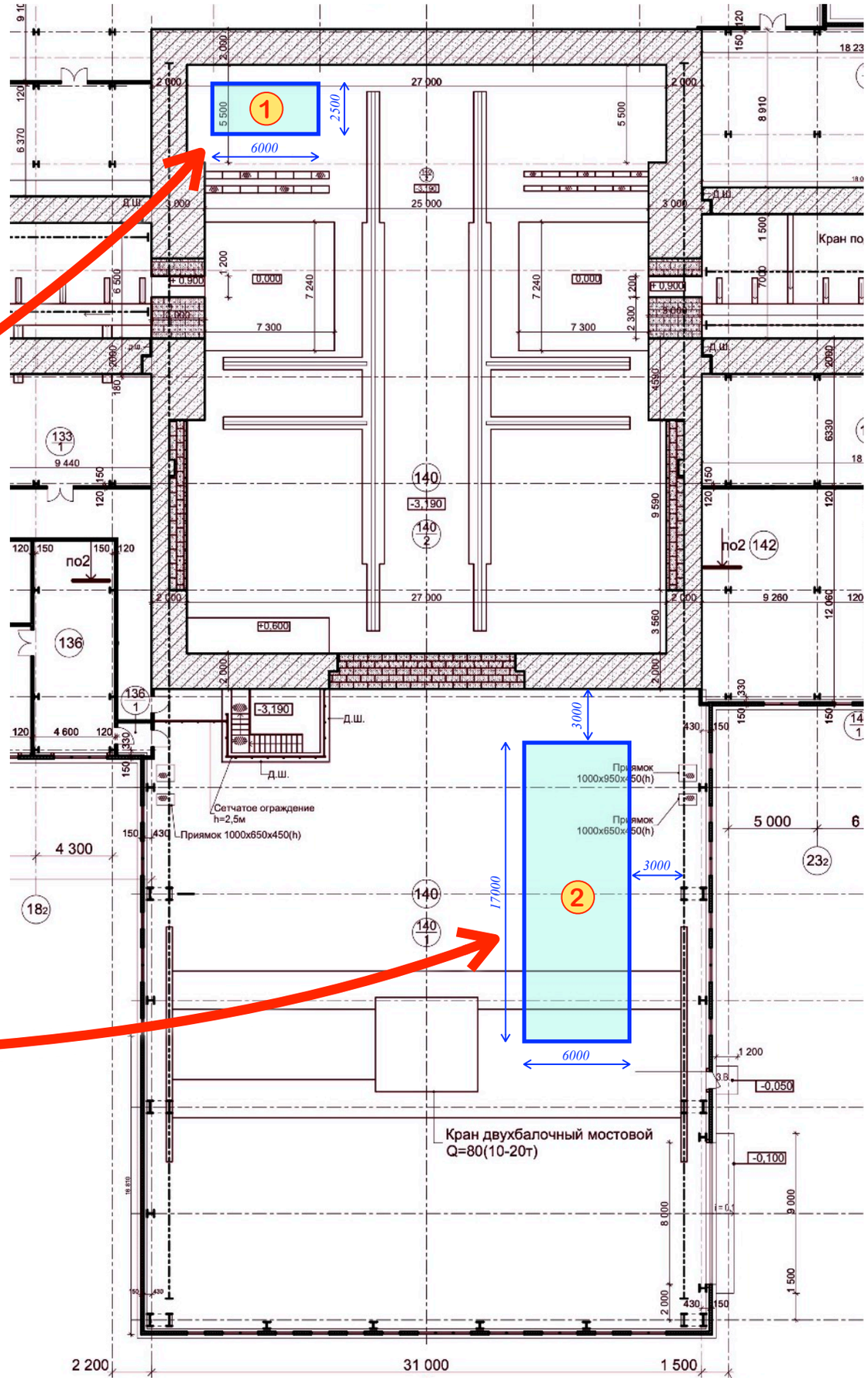
A.Livanov

Hangar for assembly work (March 2025)

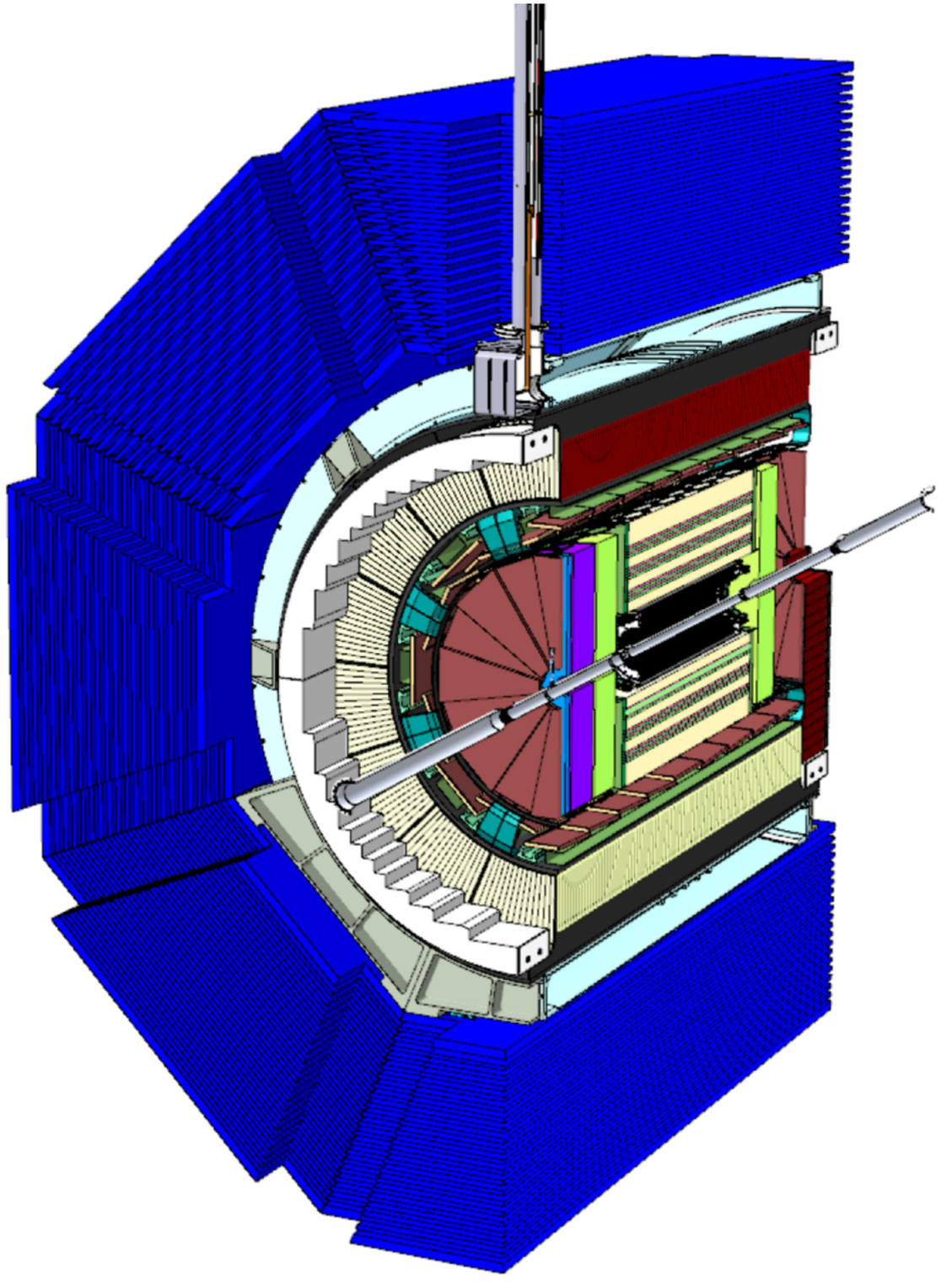


- Hangar is installed using the technology of a prefabricated building made of light steel thin-walled structures.
- Inside there is a partition with a passage dividing the hangar area in a 1:3 ratio.
- The lower part of the hangar is made of profiled metal sheet, the upper part is made of transparent profiled polycarbonate.
- Hangar will be used as a production and storage facility for the experiment.

- The construction work in the SPD hall has not yet been completed
- We may only use two places in the hall for our needs: (1) container cabin and (2) hangar



Developing the power structure of the detector



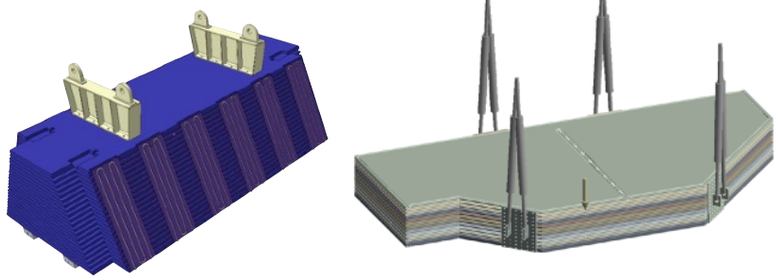
N.Topilin	***Chief designer***
S.Sukhovarov	*Leading designer*
V.Shvetsov	*Leading designer*
S.Gerasimov	*1st category design engineer*
A.Shunko	*1st category design engineer*
K.Basharina	*2nd category design engineer*
I.Kruglova	*2nd category design engineer*
E.Dolbilina	*3rd category design engineer*

- Since the beginning of this year, Design Bureau № 2 of the LHEP has been actively involved in the development of the detector's power structure
- The main focus on developing of stage-1 subsystems:
  - Magnet yoke (Gerasimov, Kruglova, Dolbilina)
  - Platforms for electronics and auxiliary equipment (Shunko, Basharina)
  - ECal-endcap and ToF frames (Shvetsov)
  - Straw tracker (Sukhovarov, Basharina)
  - General power structure of the detector (Sukhovarov)
  - Pipe tracing of the water cooling system (Dolbilina)
- The work is coordinated with engineers from other groups

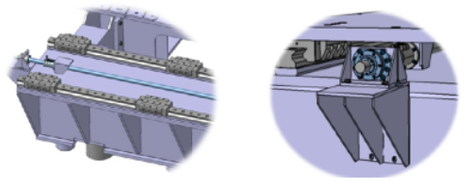
Details in N.Topilin's talk tomorrow

Developing the power structure of the yoke

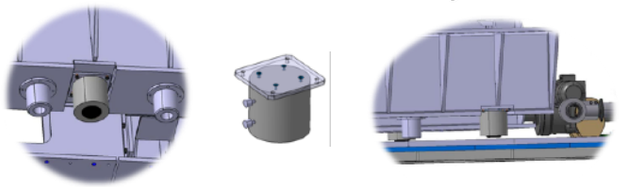
Transportation of modules of barrel and doors

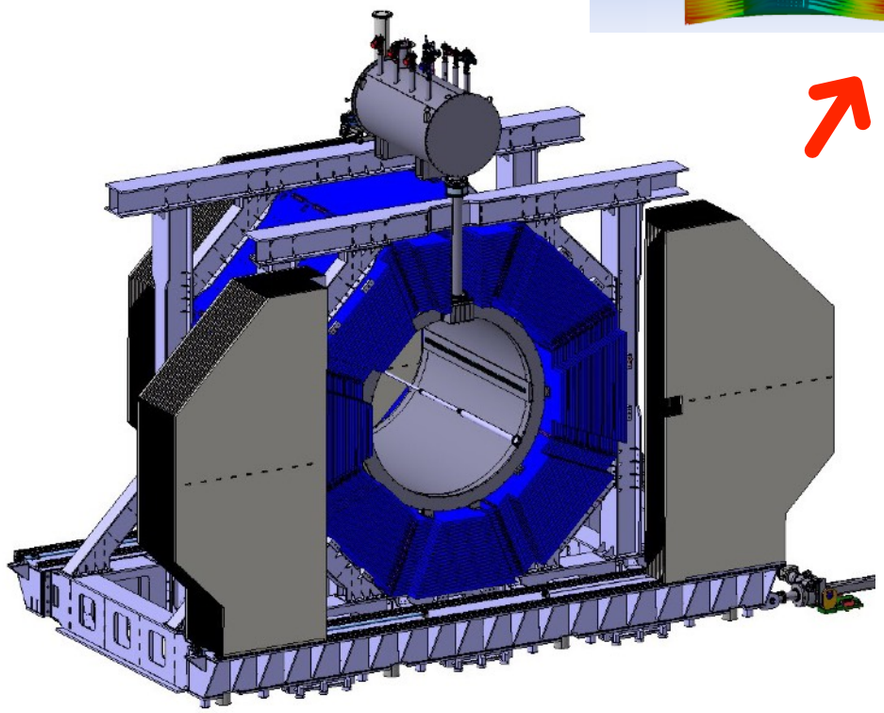


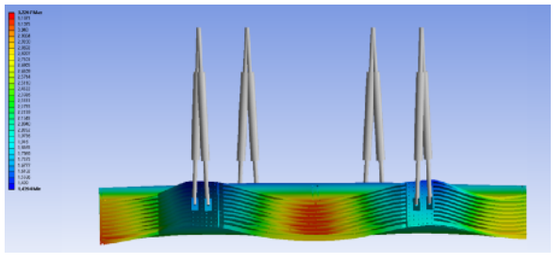
Door moving system



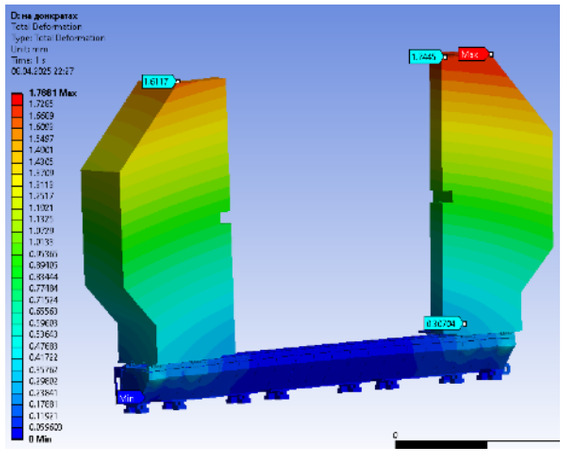
Accommodation of lift jacks

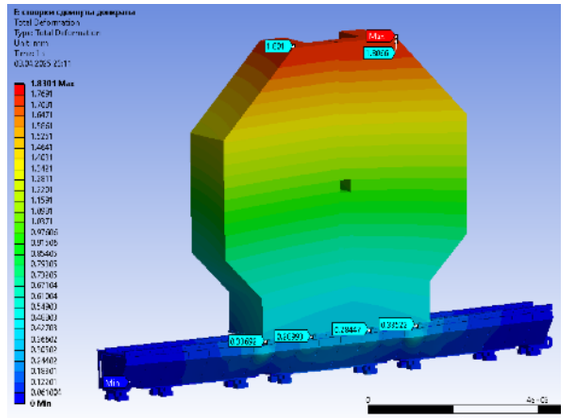






FEA calculations for stresses and deformations





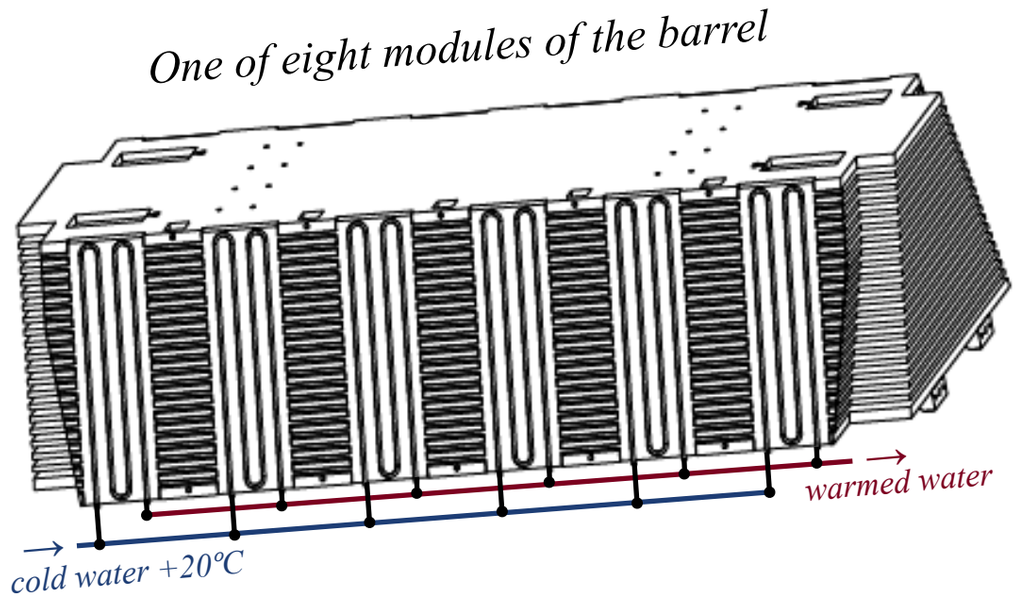
The schedule has not changed yet, but delays are very likely

	2024				2025				2026				2027				2028			
3D model development																				
Preparation of design documentation																				
Supplier search, tender, contract signing																				
Production																				
Shipment to Dubna																				
Installation in SPD																				

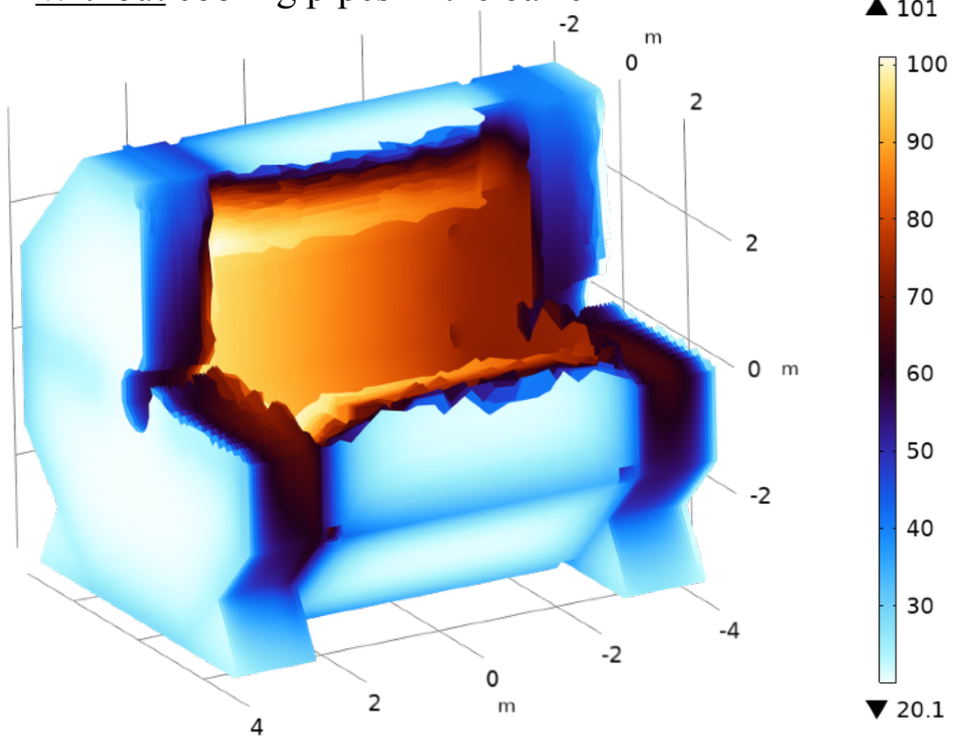
P.Dergachev (MISIS)
M.Gorshenkov (MISIS)

Thermal state analysis of the magnet yoke (RS system)

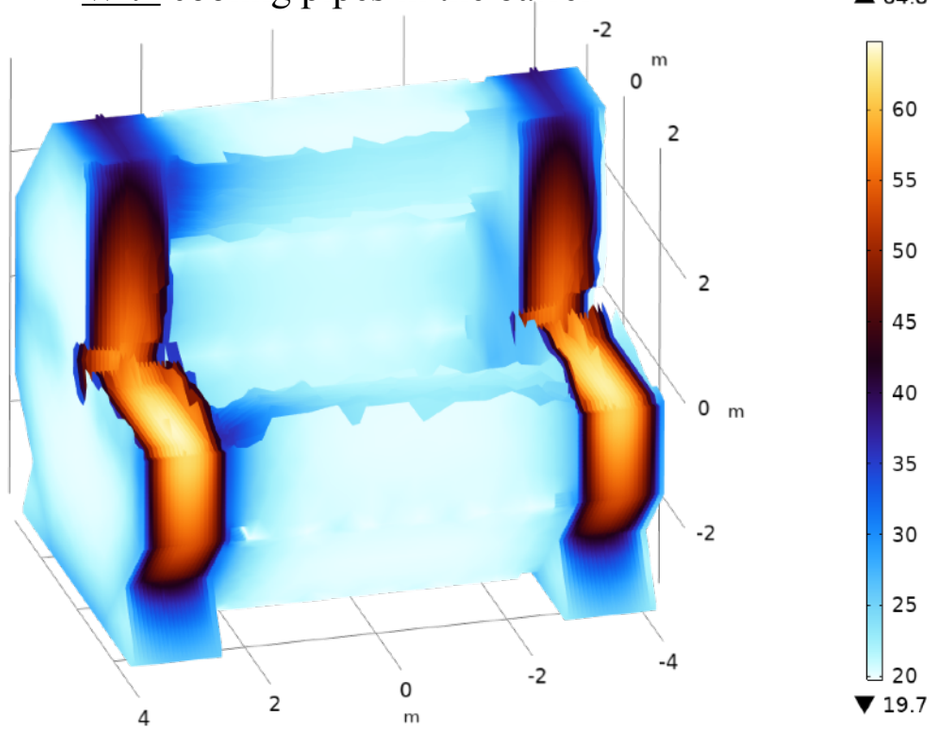
- A simplified geometry of the RS detector was implemented with an approximate layout of FEE cards (without MDT itself)
- Heat dissipation of FEE cards (reading tubes)
  - 2.1W ×10448 = 21.7 kW
- Heat dissipation of FEE cards (reading strips)
  - 3.1W ×5944 = 18.3 kW
- It is assumed that convective heat transfer occurs only outside the barrel h = 20 W/m²/K
- The layout of the cooling tubes for the doors is currently under discussion



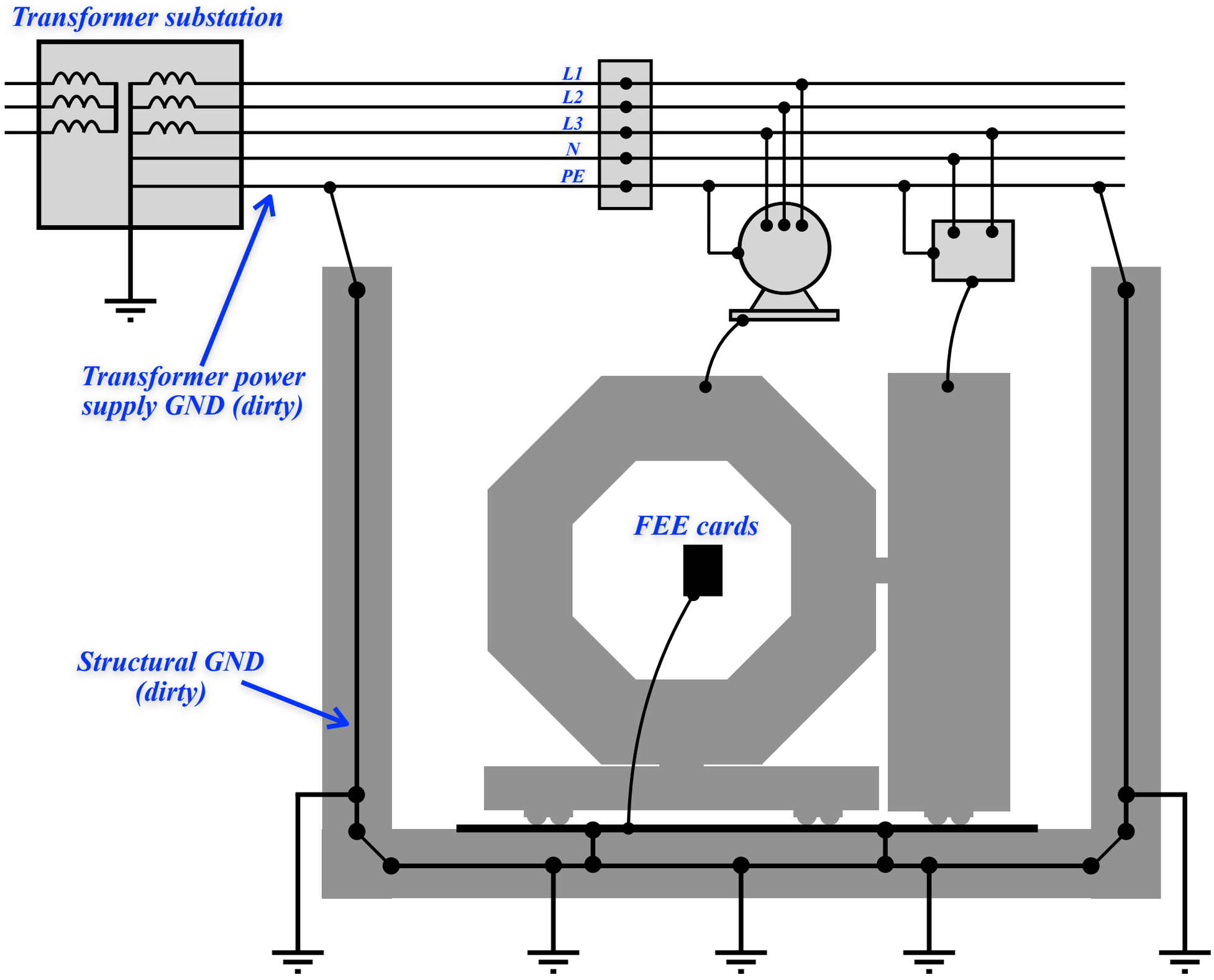
Without cooling pipes in the barrel



With cooling pipes in the barrel

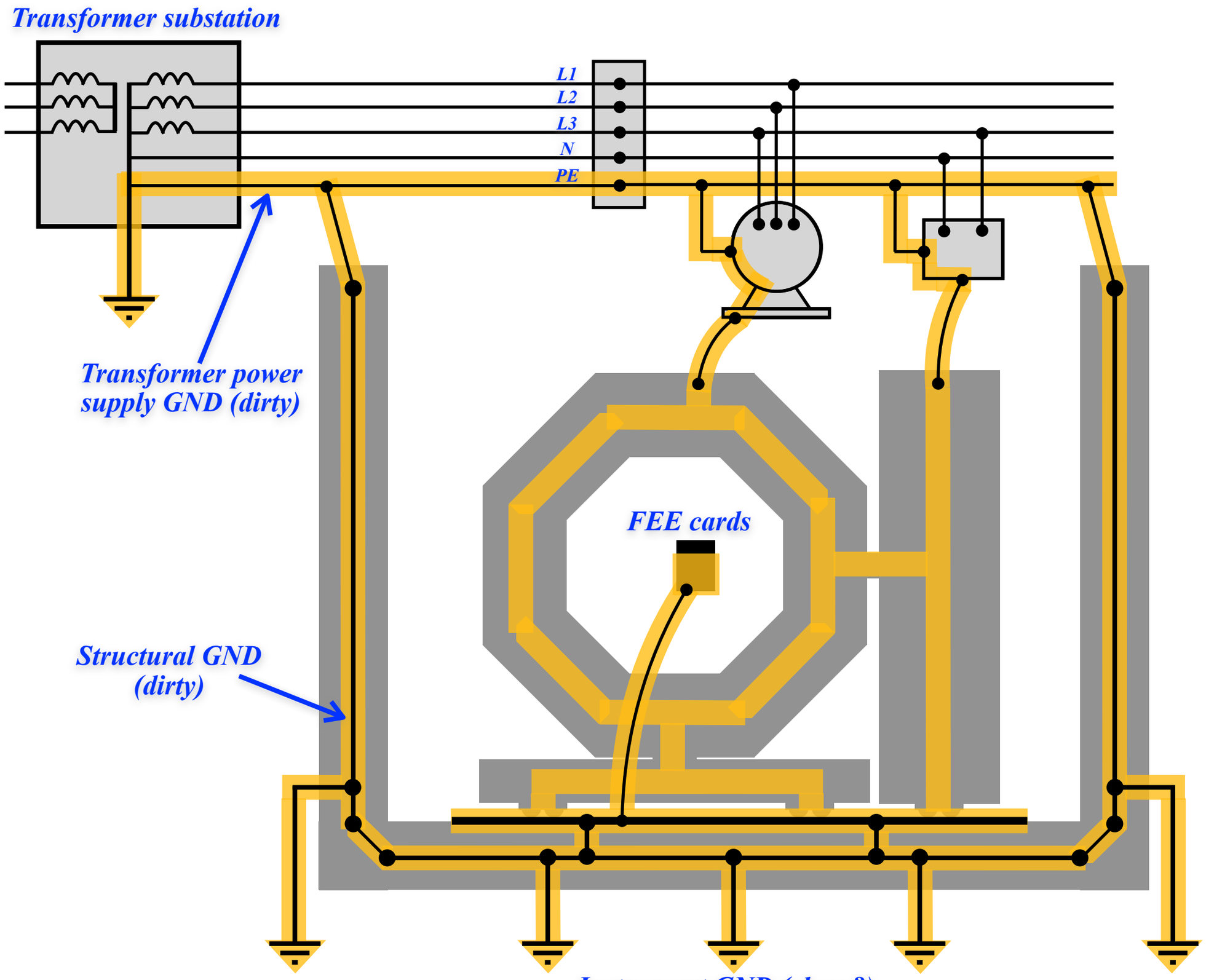


Searching for clean grounding for FEE



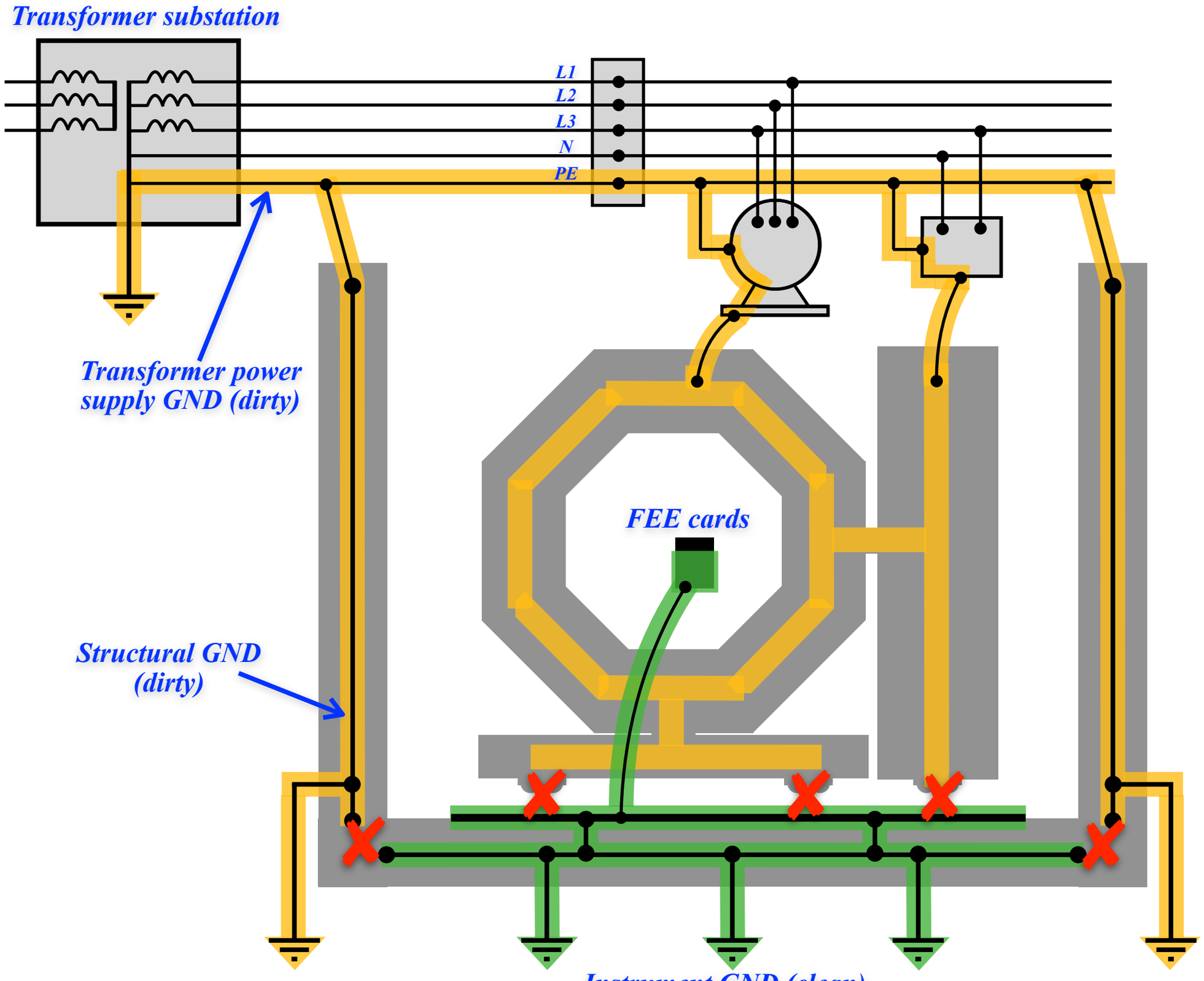
- Clean ground is required for FEE
- Trigerless electronics: noise and interference from FEE increases the volume of data

Searching for clean grounding for FEE



- Clean ground is required for FEE
- Trigerless electronics: noise and interference from FEE increases the volume of data
- Presently all grounds (dirty and clean) are connected!
- Instrument ground has to be disconnected from dirty grounds

Searching for clean grounding for FEE



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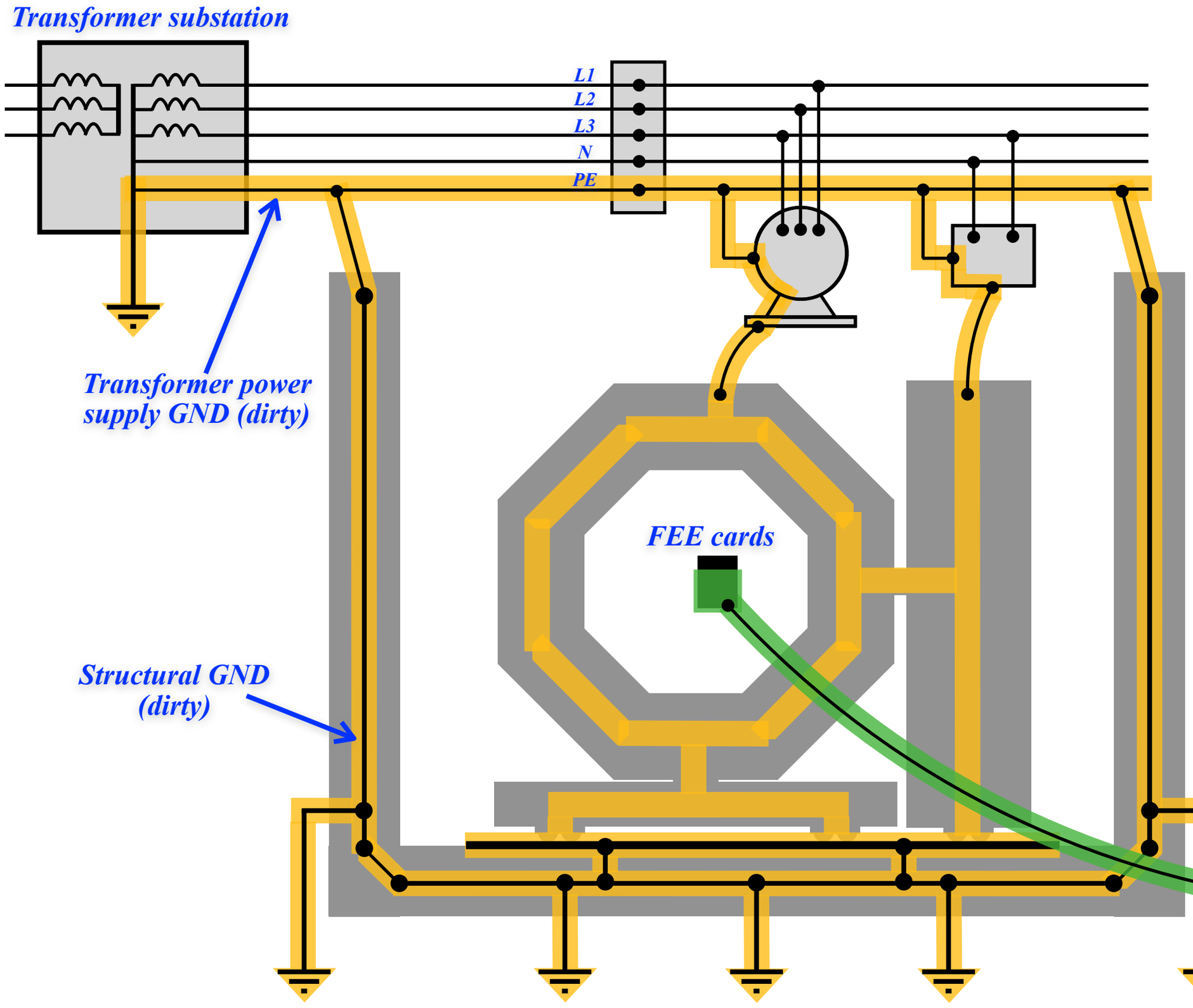
1. Removing jumpers between transformer & structural grounds. Isolate the detector from the rails

Searching for clean grounding for FEE



- Clean ground is required for FEE
- Trigerless electronics: noise and interference from FEE increases the volume of data
- Presently all grounds (dirty and clean) are connected!
- Instrument ground has to be disconnected from dirty grounds

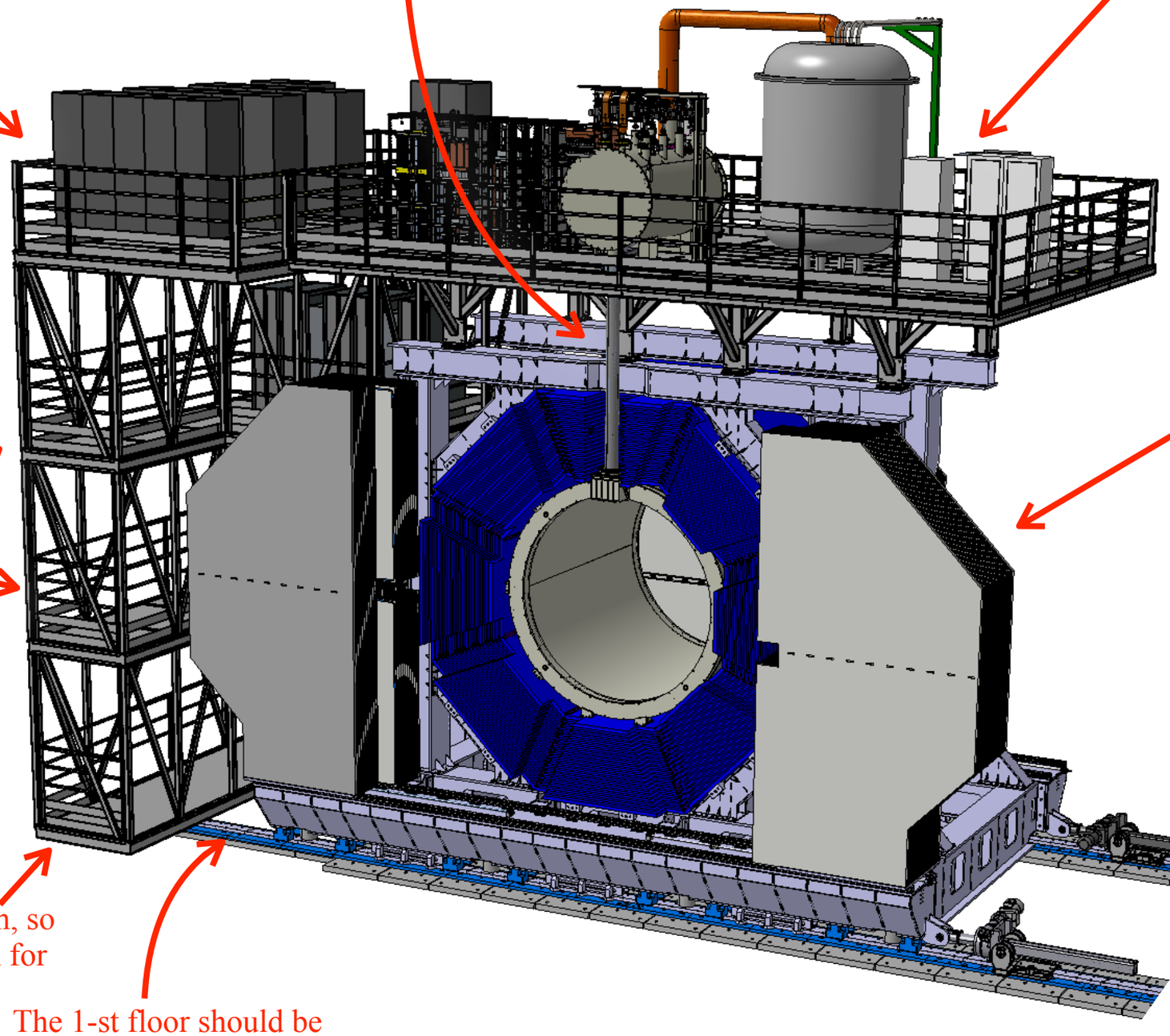
1. Removing jumpers between transformer & structural grounds. Isolate the detector from the rails
2. Create a new ground

Development of platforms for various equipment

Will we use the attic floor?
The height is 1.8 m

The upper platform is entirely dedicated to cryogenic equipment

The area of 4th floor is 8.6 x 4.1 m²



Is all this space dedicated to a water cooling system?

The floor is T-shaped.
The usable area for racks is only 4.8 x 4.8 m²

The width is only 1.7 m, so there is not much room for equipment

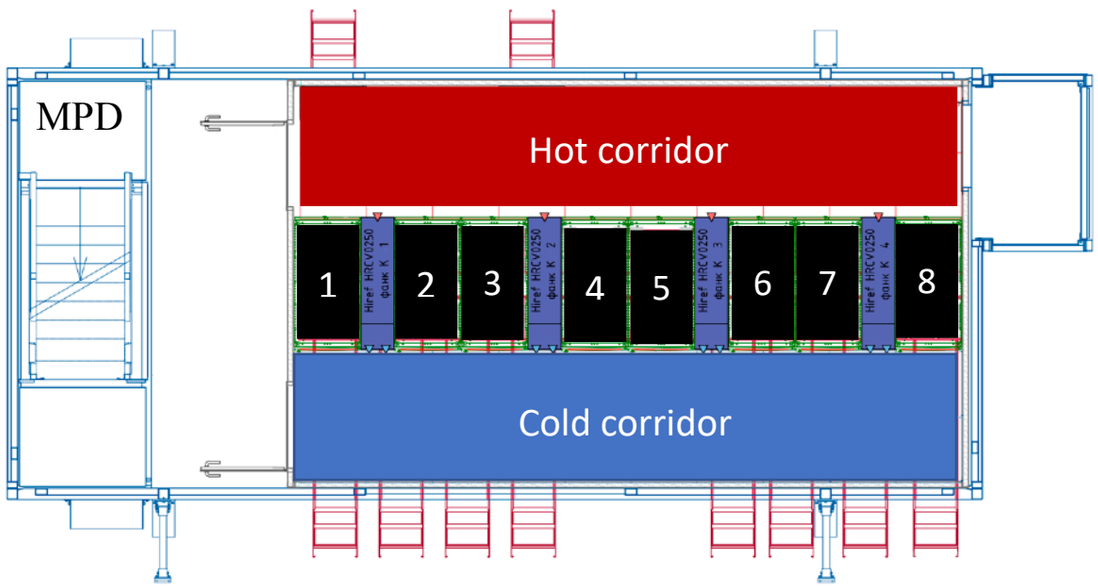
The 1-st floor should be a walk-through floor

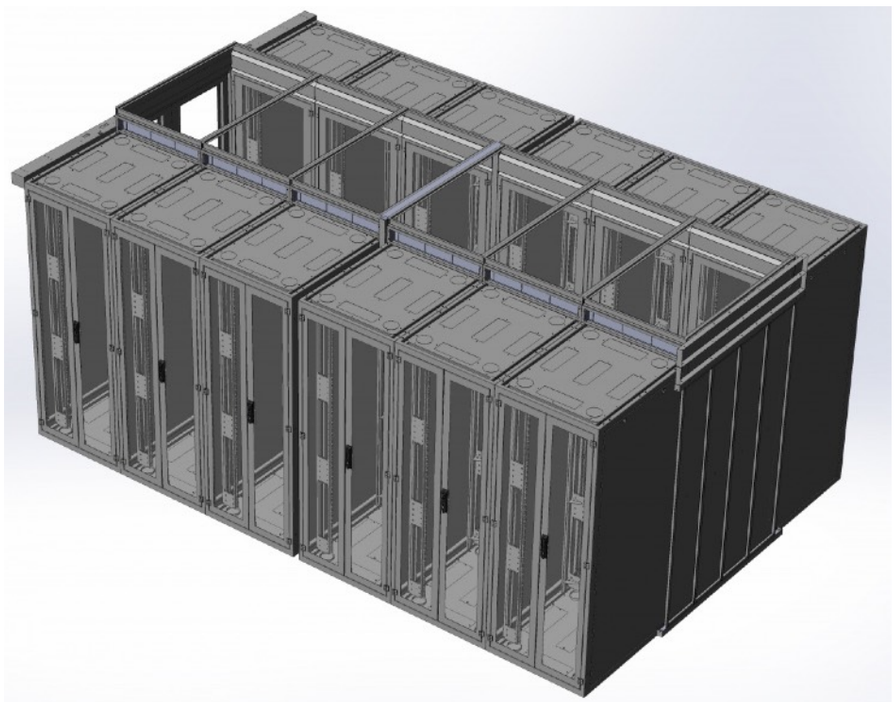
Equipment for the electronics platform

Cabinet or just racks

Different options for cabinet

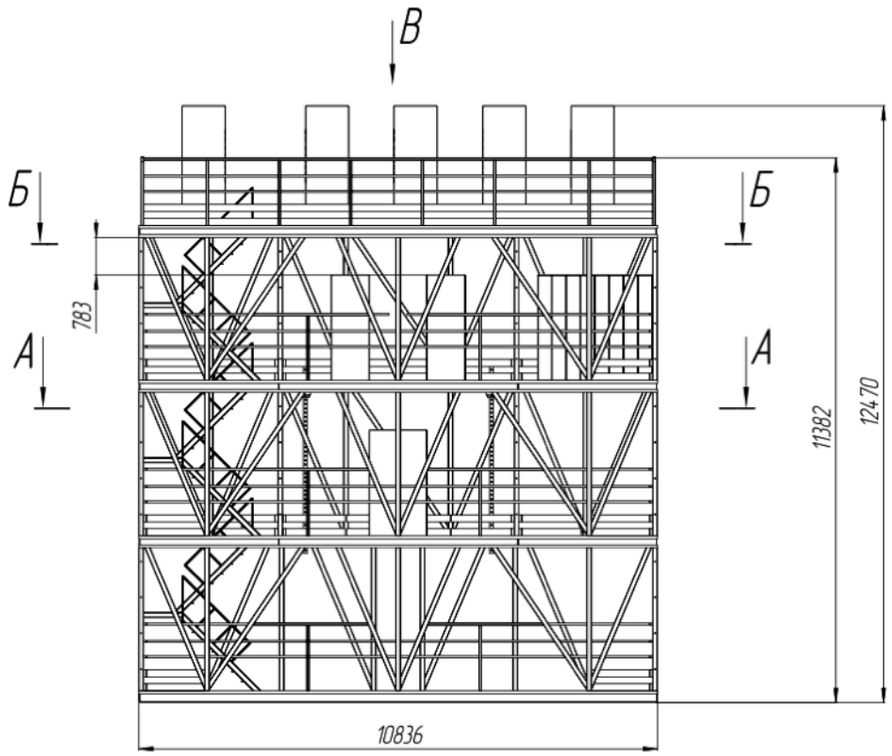
Single or dual row layout

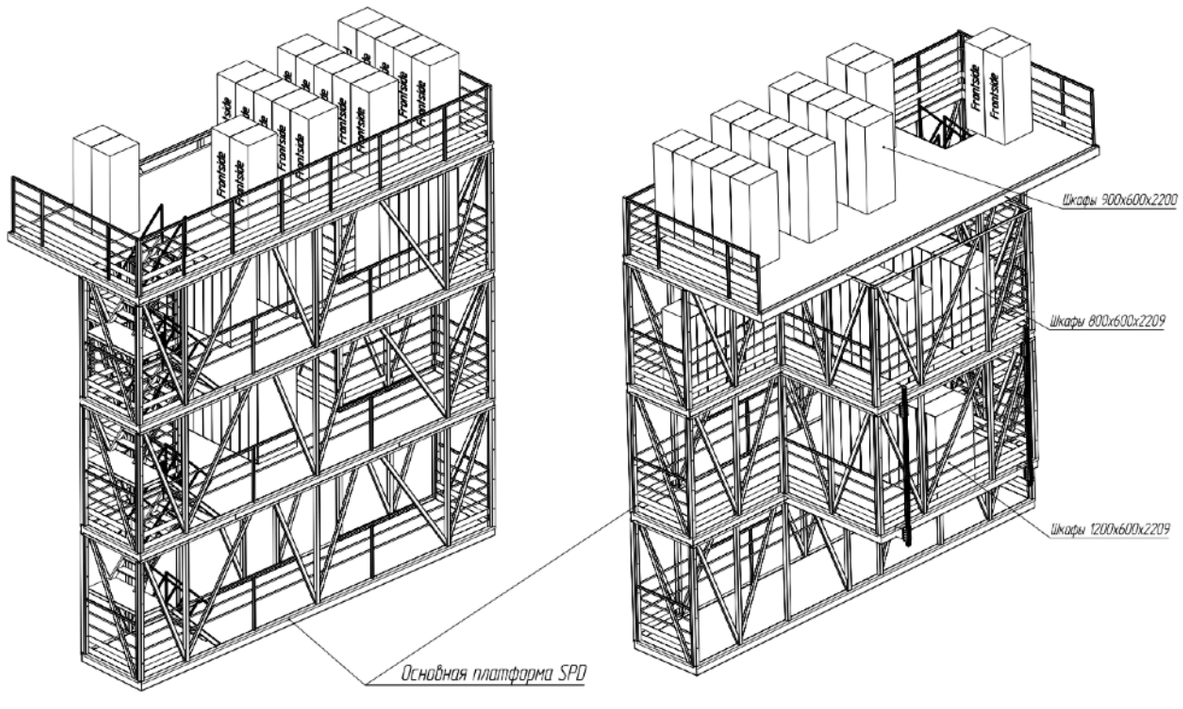




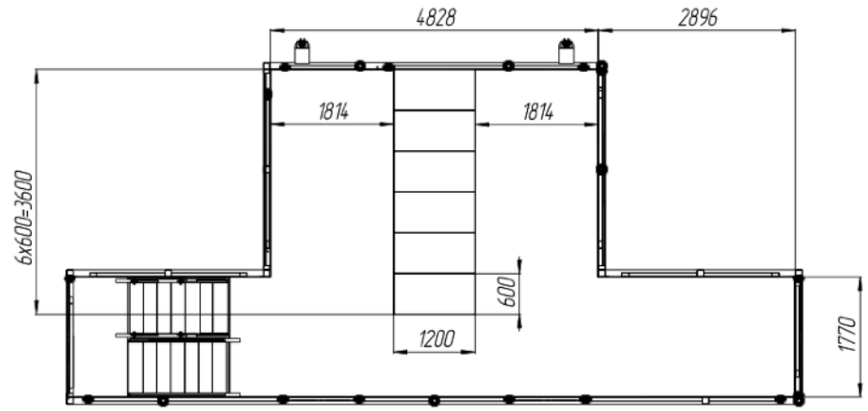
A.Shunko,
K.Basharina

Development of the electronics platform

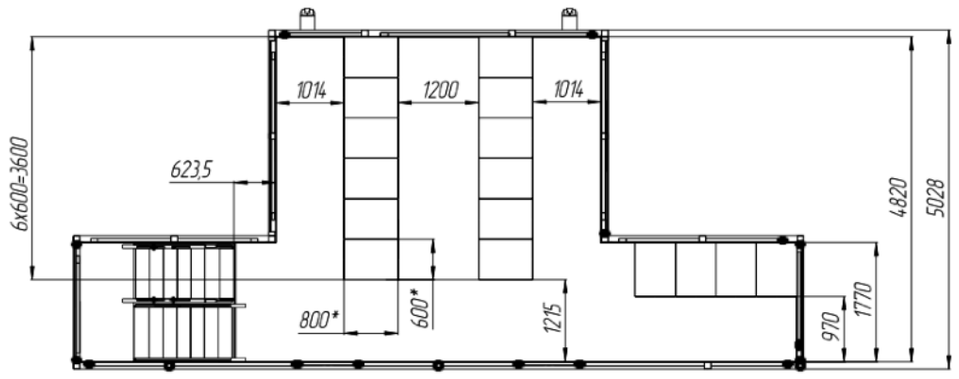




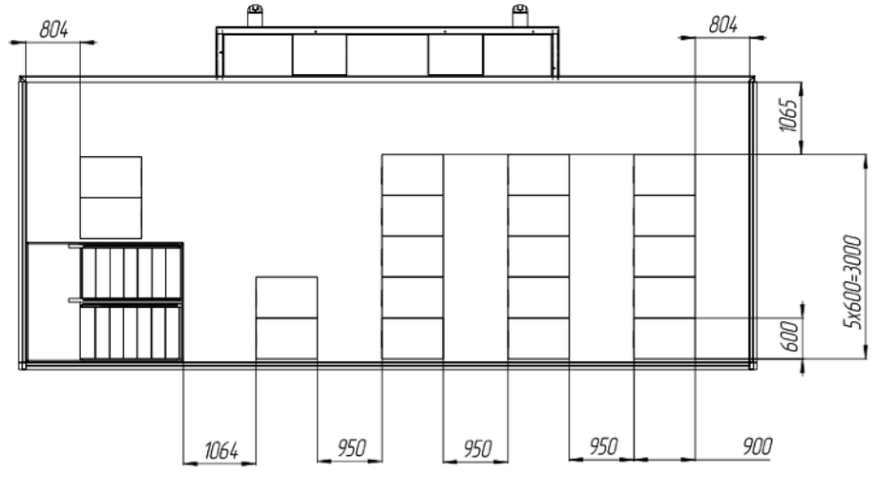
A-A, 2nd floor



Б-Б, 3rd floor

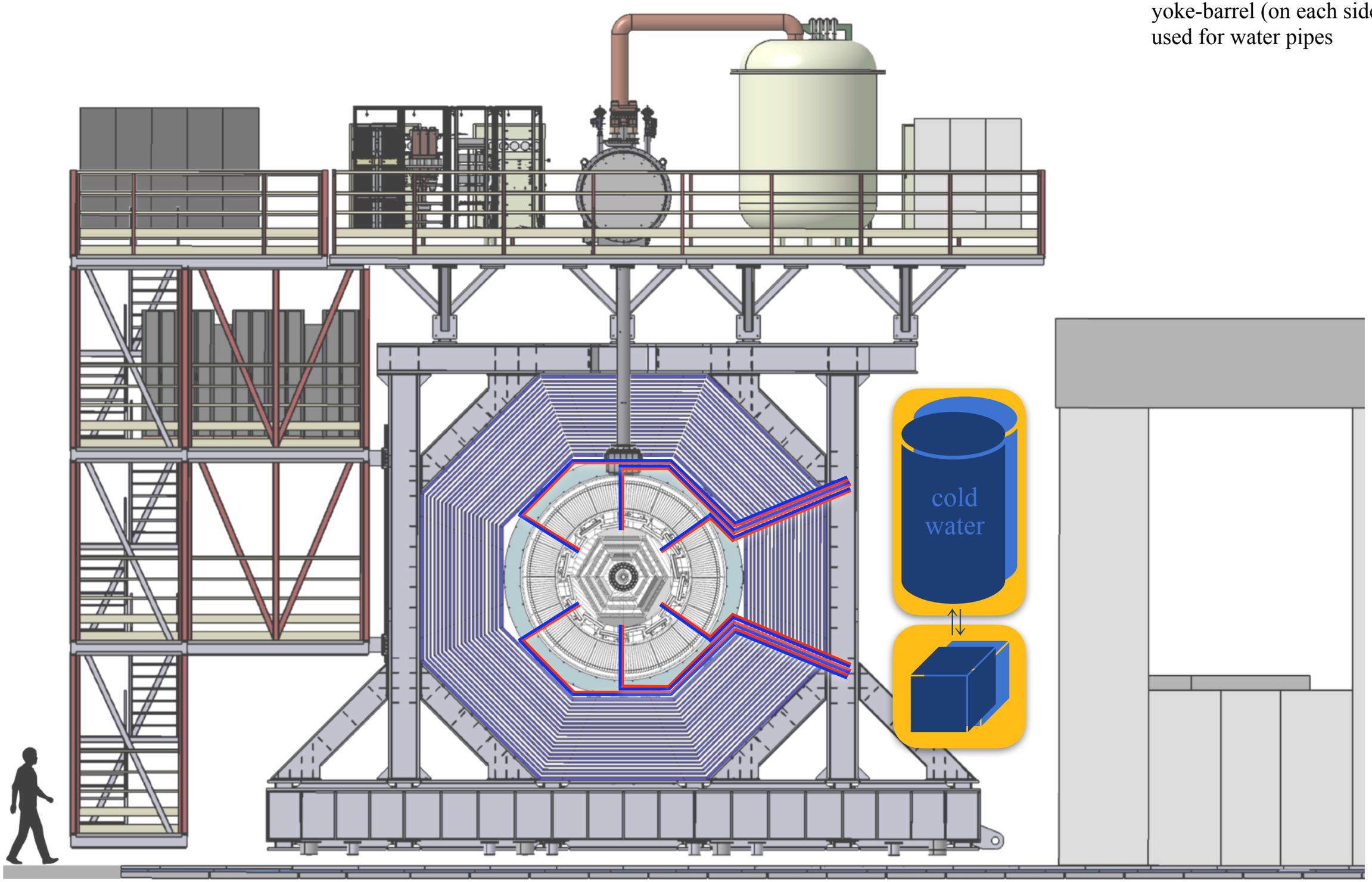


B-B, 4th floor



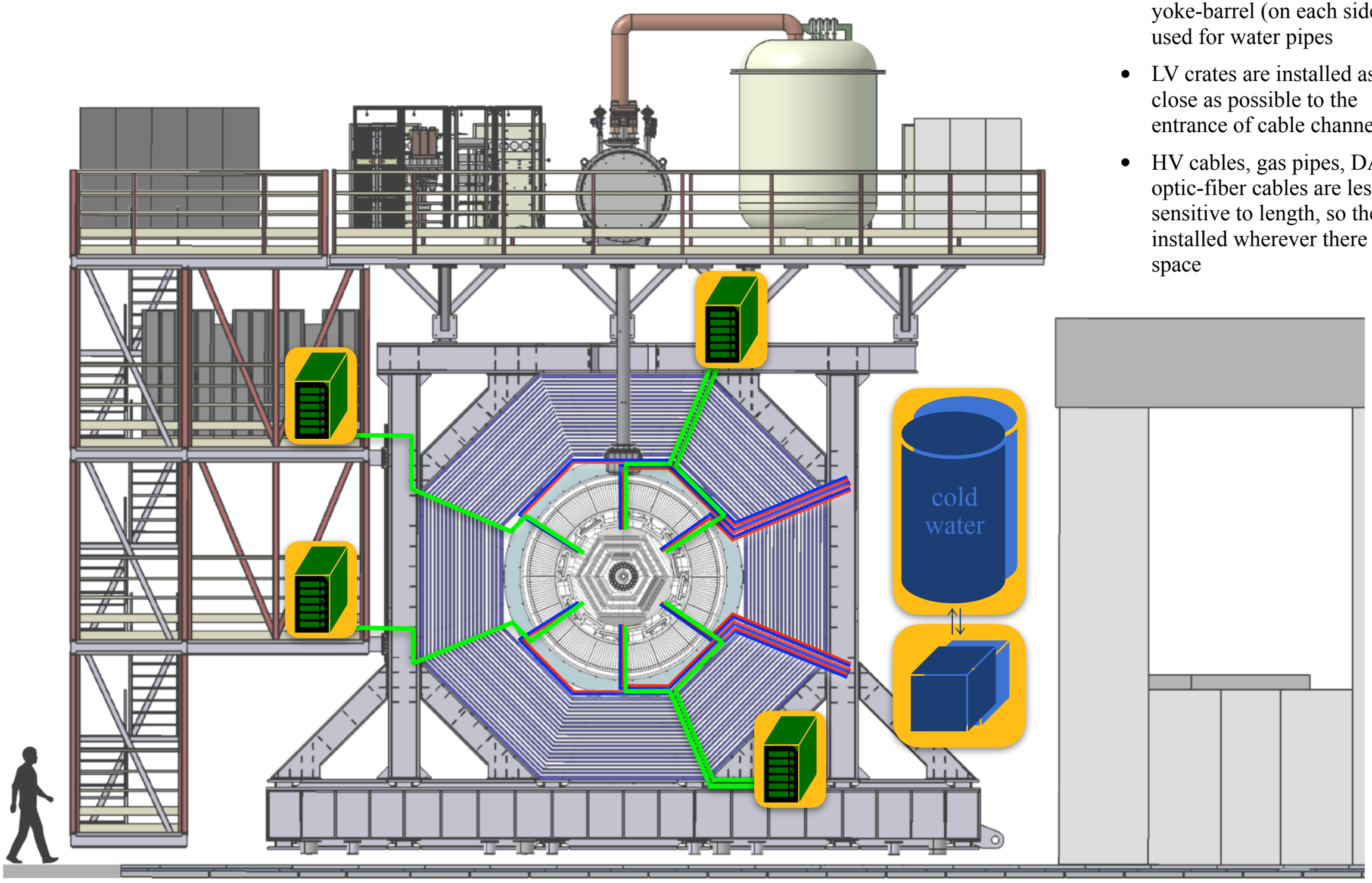
Engineering communications and service pipelines

- Only two cable channel of yoke-barrel (on each side) are used for water pipes



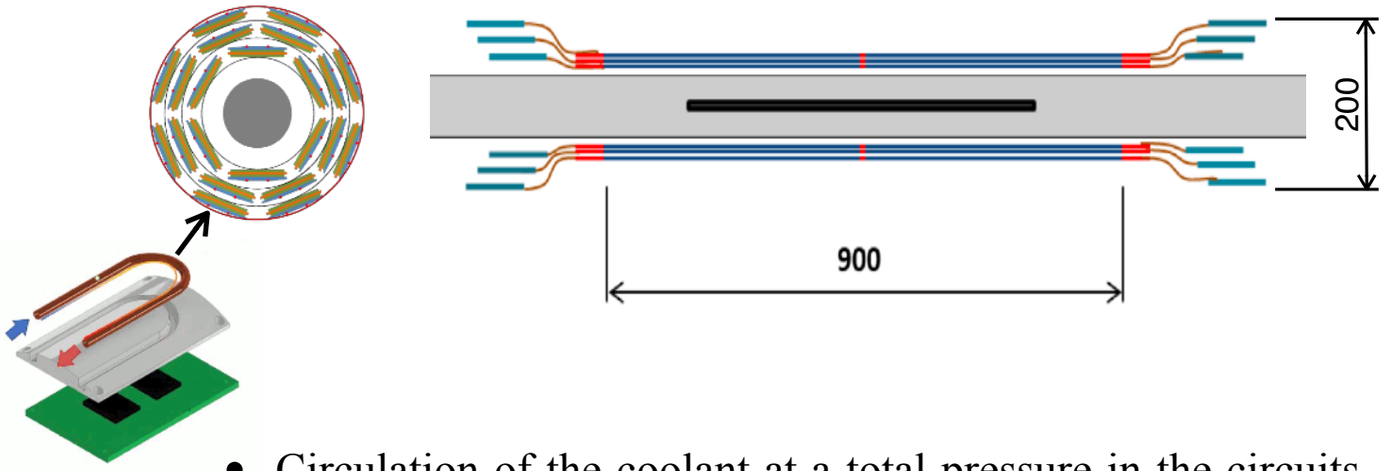
Engineering communications and service pipelines

- Only two cable channel of yoke-barrel (on each side) are used for water pipes
- LV crates are installed as close as possible to the entrance of cable channels
- HV cables, gas pipes, DAQ optic-fiber cables are less sensitive to length, so they are installed wherever there is space



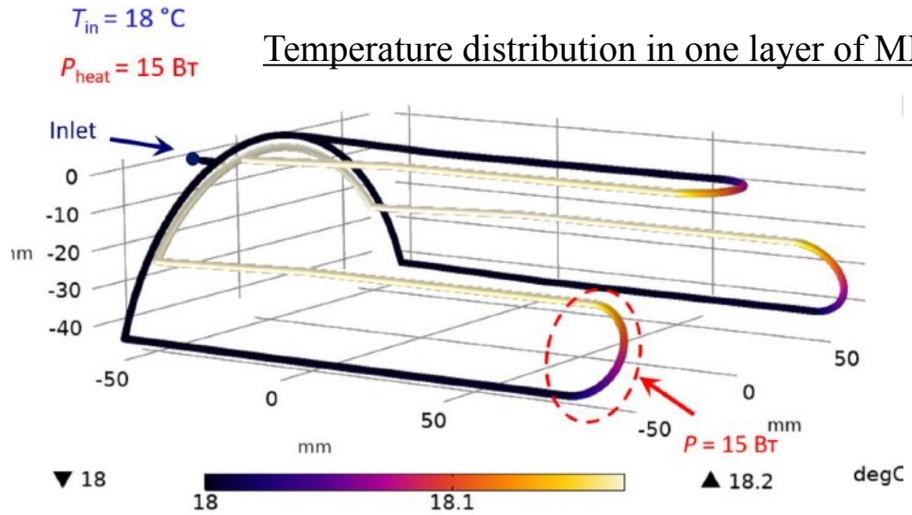
D.Dedovich,
I.Zur (BSU)

Progress on MM cooling system

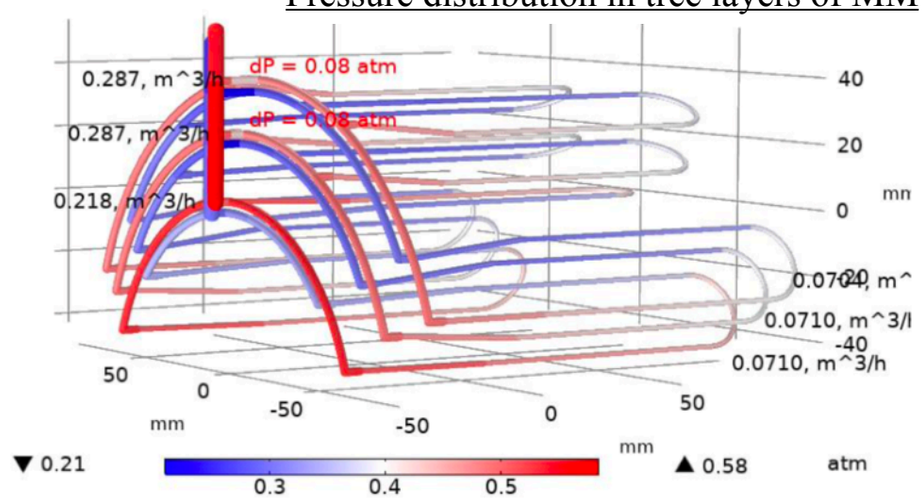


- Circulation of the coolant at a total pressure in the circuits less than atmospheric (so-called leakless mode)
  - There is no risk of water leakage onto critical detector systems, as atmospheric air acts as a sealing pressure
- Input MM parameters for calculation:
  - radiator pipe ∅=3 mm, manifold pipe ∅ = 5 mm, supplying pipeline ∅=10 mm
  - Heat power per FEE card P_{heat} = 15 W
- Results of calculation (recommendation):
  - Coolant flow rate for 3 layers q = 0.21 m³/h
  - Speed of water in the radiator pipes is 2.9 m/s
  - Drop of pressure at each layer Δp = 0.28 atm
  - Water superheating ΔT = 0.19°C
- The results of MM cooling are absolutely satisfactory. It can be also applied to silicon VD detectors (4 times higher power)

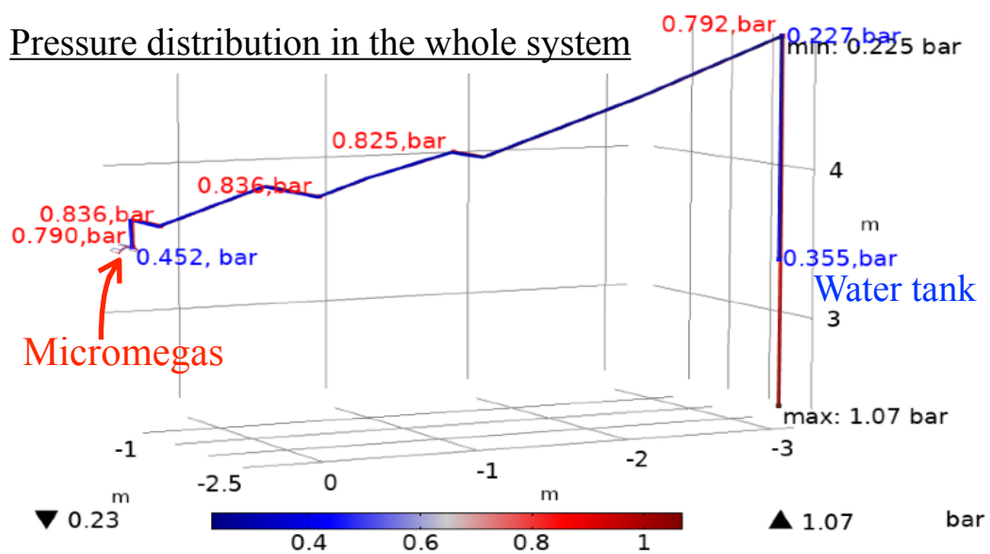
Temperature distribution in one layer of MM



Pressure distribution in tree layers of MM



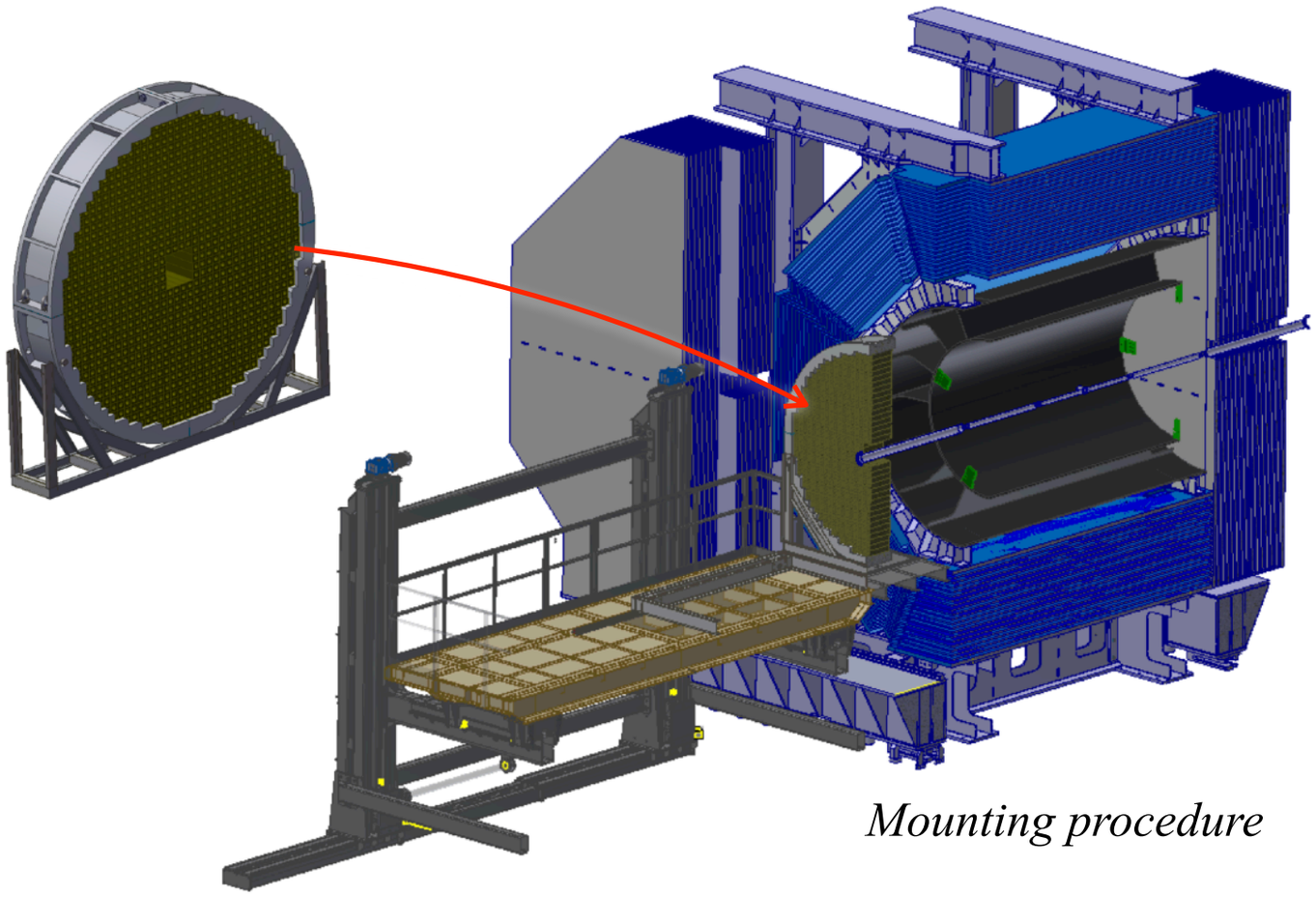
Pressure distribution in the whole system



O.Gavrishchuk (LHEP)
+LNP team

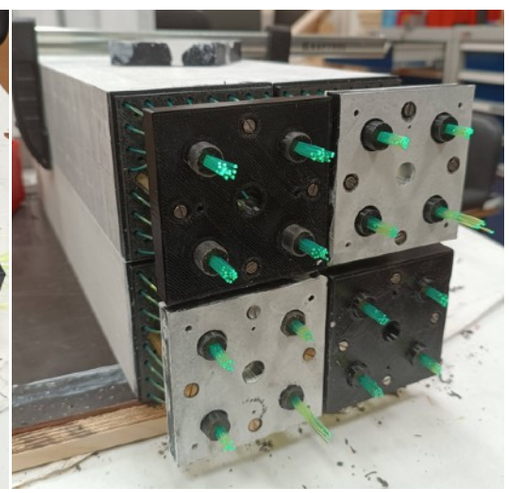
Progress on ECal-endcap

- A new version of the endcap support for 928 modules (3712 cells each 40x40 mm^2) was proposed by V.Shvetsov
- Frame consist of 4 parts (sectors) made of molded Aluminum
- There are no stretched steel ribbons in the frame. The modules just lie on top of each other
- ECal-endcap will be completely assembled externally and mounted in the frame as a whole.
- Total weight of one endcap is ~10 tons



Mounting procedure

Assembly of modules is ongoing in LHEP

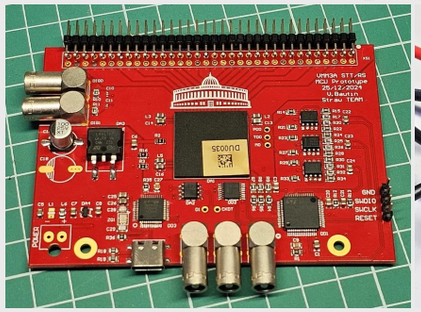


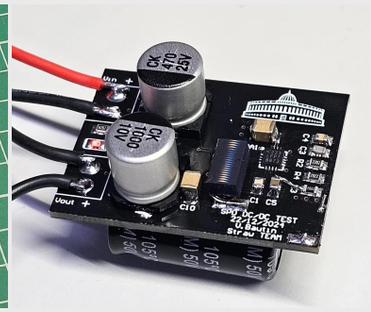
- 200 modules (1000 cells) will be assembled in LHEP in 2025
- It is planned to assemble 500 modules in “Uniplast” in 2026
- Front-end electronics is being developed in LNP (N.Anfimov, I.Kreslo)

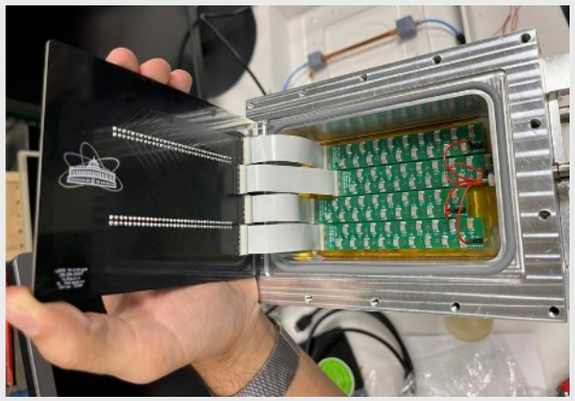
T.Enik (+PNPI & INP teams)

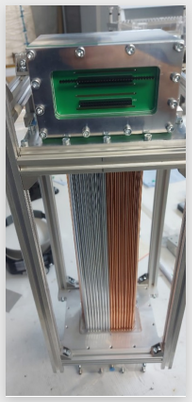
Progress on Straw-barrel

V.Bautin



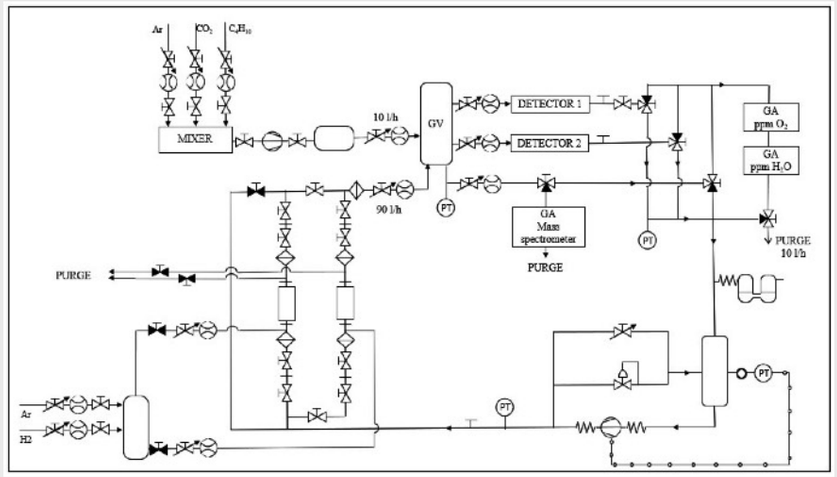






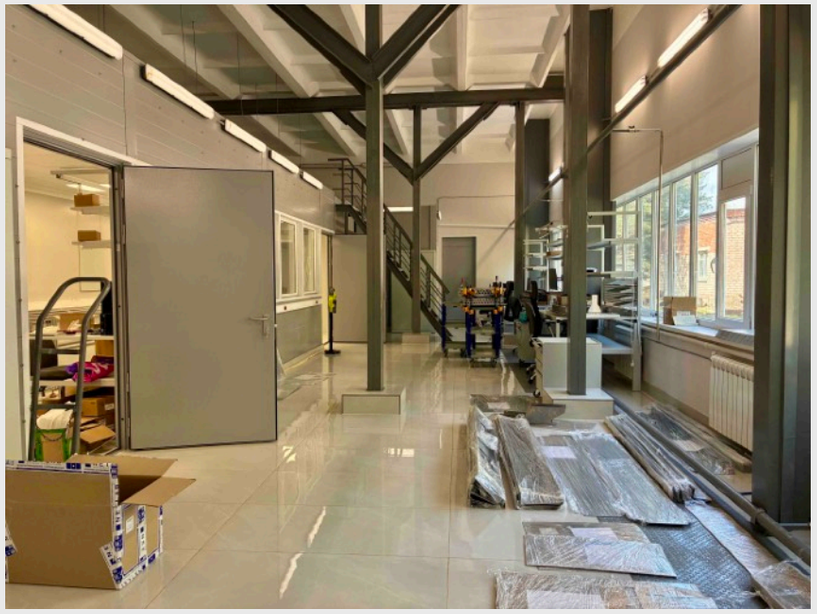
- VMM3-based prototype card has been developed and tested in testbeam in CERN
- Prototype of DC/DC converter to be used in magnetic field has been developed
- A gas system suitable for operating a 5 m³ detector with Ar+CO_2 to be developed
- Regulation of the differential pressure and composition of the mixture while monitoring its temperature, oxygen and water vapor contents.

CMS group (V.Karjavine)



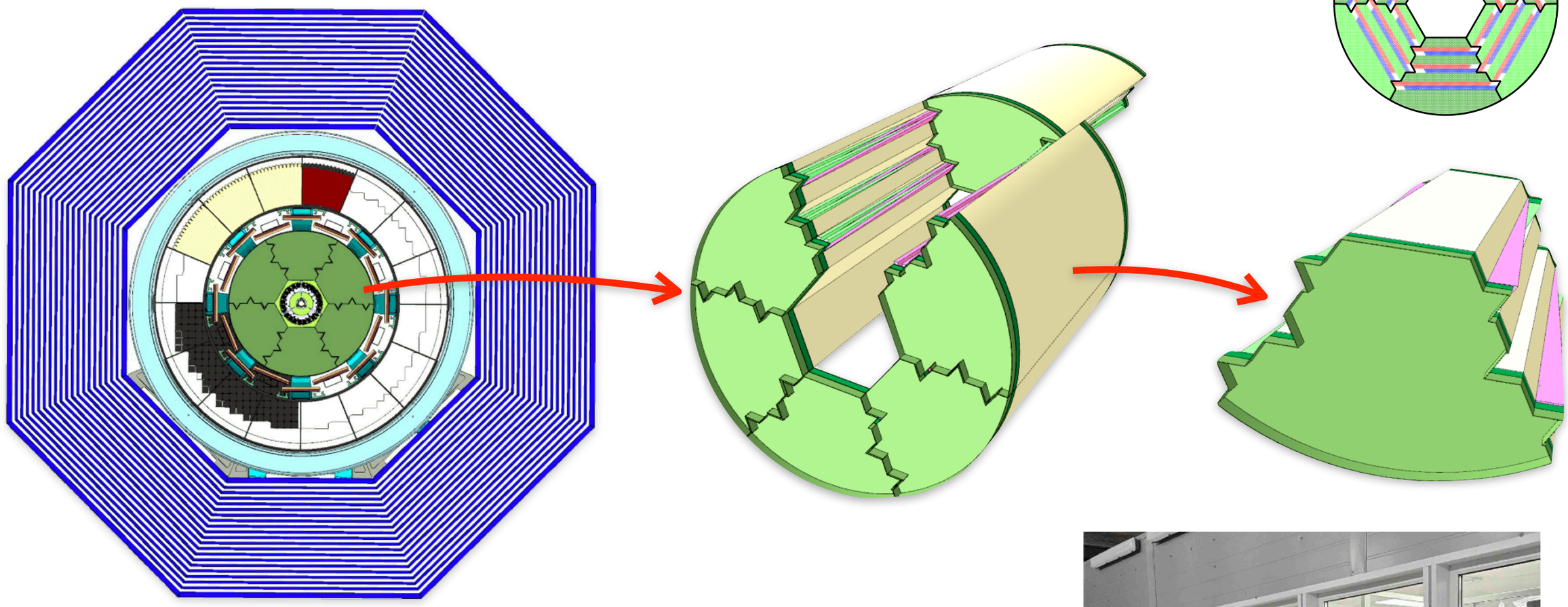
Production line and assembling hall

- Area ~200 m², clean room ~100 m²
- Production line length ~12 m
- Construction work in the hall has already been completed
- Commissioning works begins in May 2025
- All necessary materials and equipment have been purchased
- Straw production speed 1-2 m/min



T.Enik (+PNPI & INP teams)

Progress on Straw-barrel

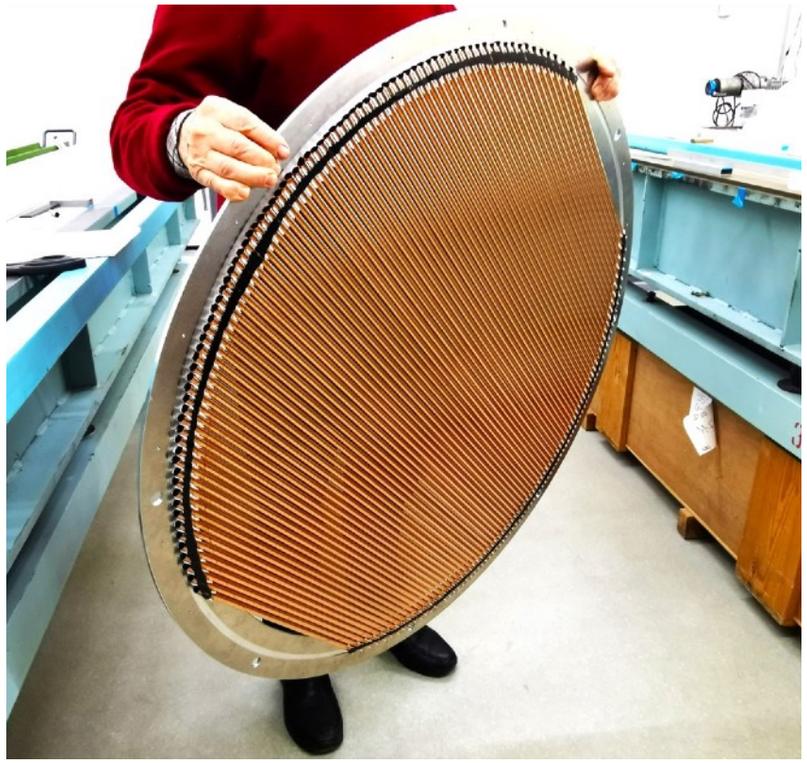


- Octants are replaced by sextant modules due to better packing ratio and also because the radial ribs can be removed.
- The power frame will be formed by an outer cylinder and a set of straw tubes in the center, which will be replaced by carbon fiber tubes of the same diameter.
- The six modules will be assembled using the Lego principle to avoid areas without layers of oblique straw-tubes.
- A full-size mockup made of styrofoam will be assembled in May
- The detailed procedure for assembling the detector is still under discussion.

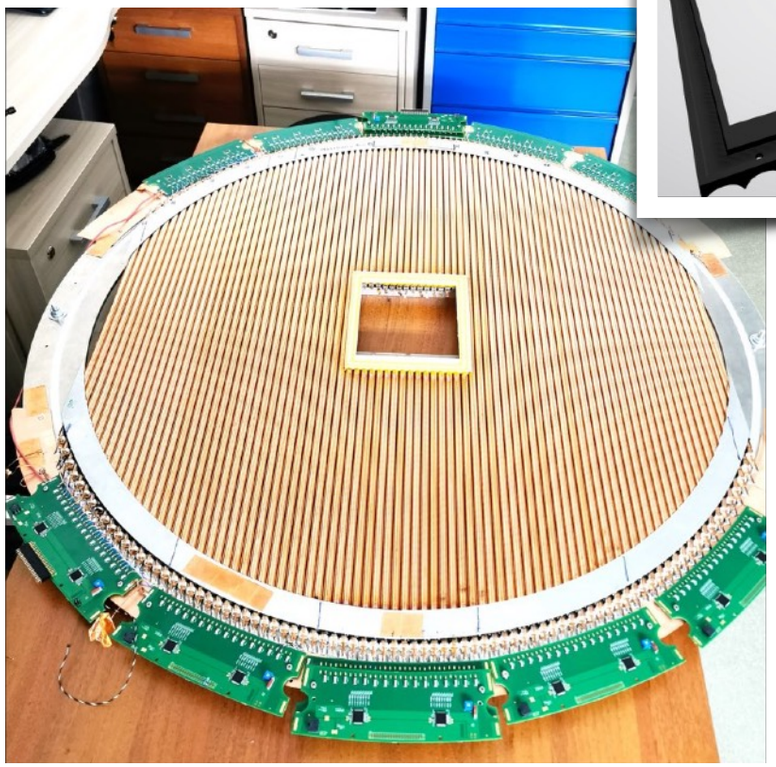
G.Kekelidze
V.Kramorenko

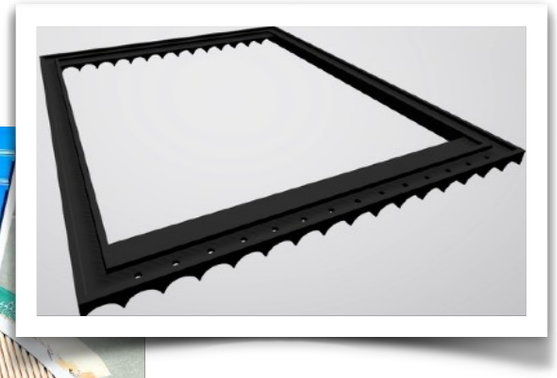
Progress on Straw-endcap

2024

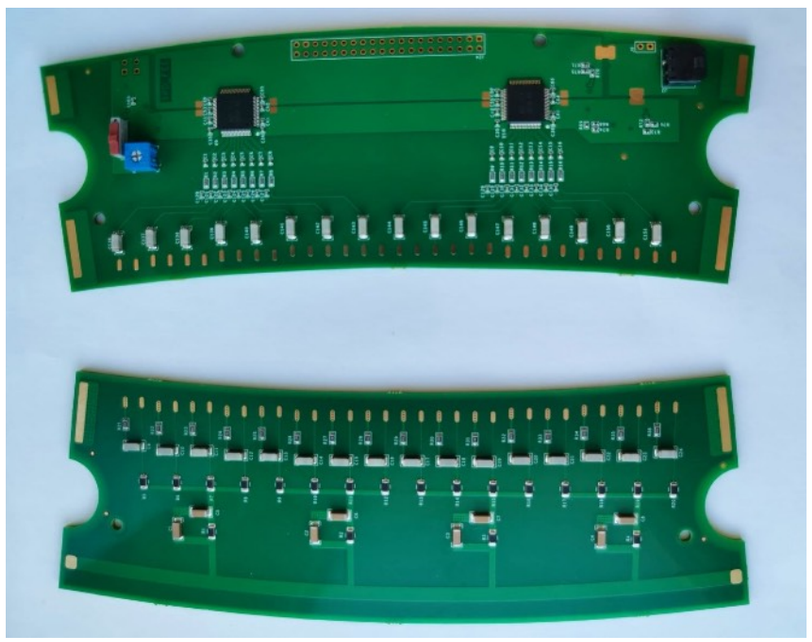


2025

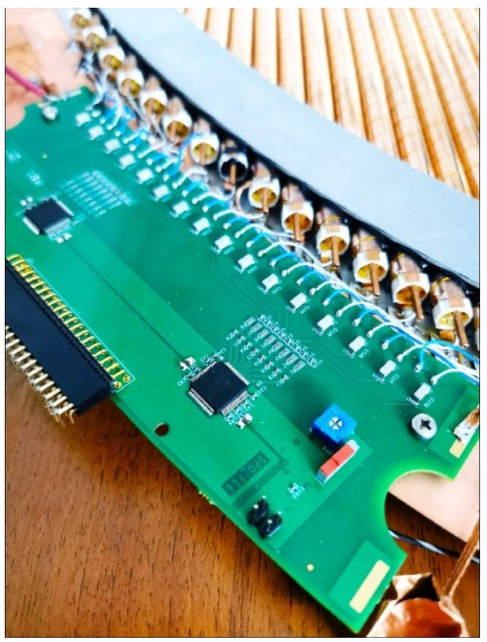




A rectangular hole 14×15 cm^2 was added to the prototype of ∅=1m



- The prototype has passed numerous inspections: checking for tightness of the pipes (no gas leaks were detected), checking for electrical insulation (voltage 2.1 kV), etc.
- There are two types of boards developed by A.Solin BSU
  - an amplifying 16-channel AST-1
  - a high-voltage board
- The boards are installed on opposite sides of the straw tubes

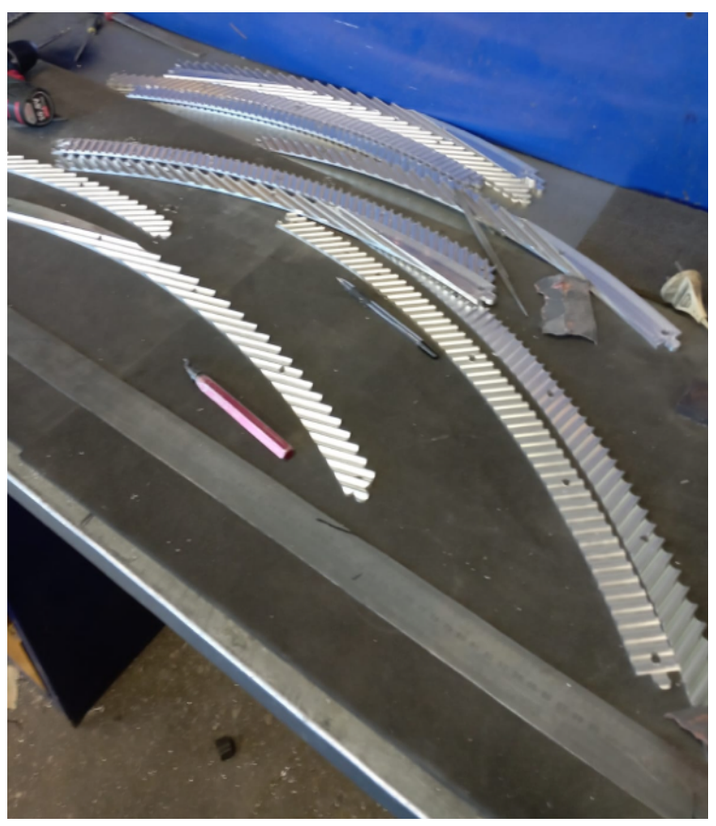


G.Kekelidze
V.Kramorenko

Progress on Straw-endcap

Two versions of end-plug have been developed for straw: standard and light (for the central hole).

Production of frame elements for a full-size prototype camera at the “Artmash” company in Belarus
(delivered to JINR in May)

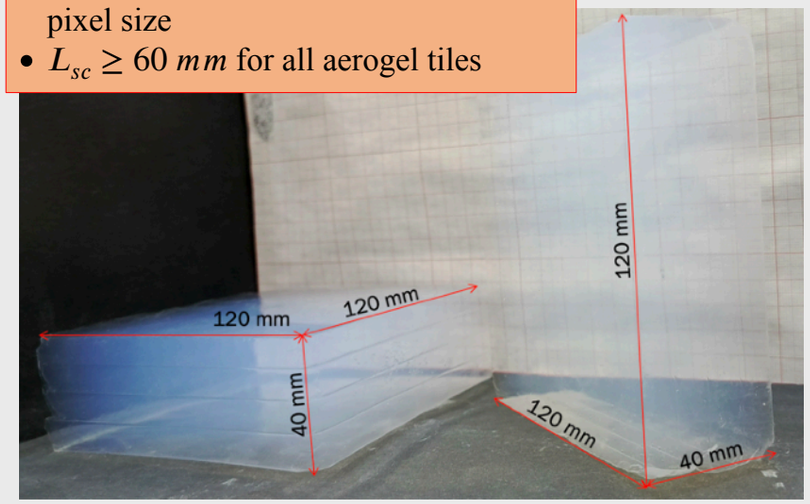


Progress on FARICH R&Ds

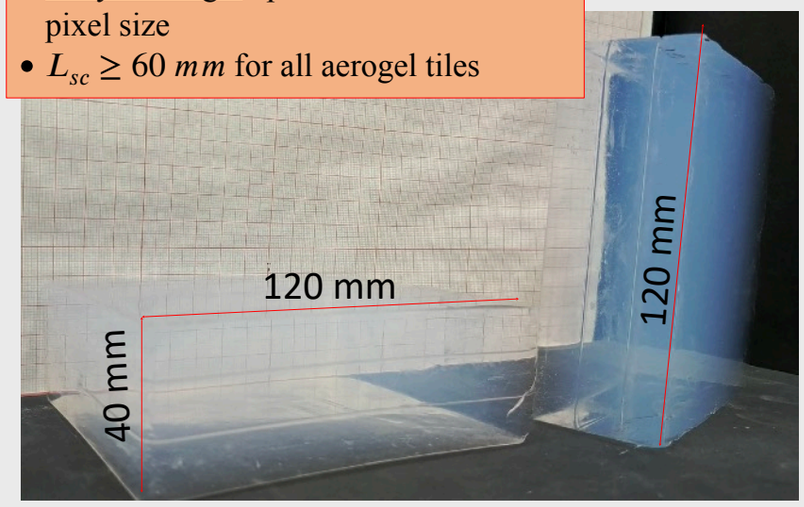
Aerogel optimisation

Details in Alexander Kattsin's talk

- 4-layer aerogel optimized for 6x6 mm² pixel size
- $L_{sc} \geq 60\ mm$ for all aerogel tiles



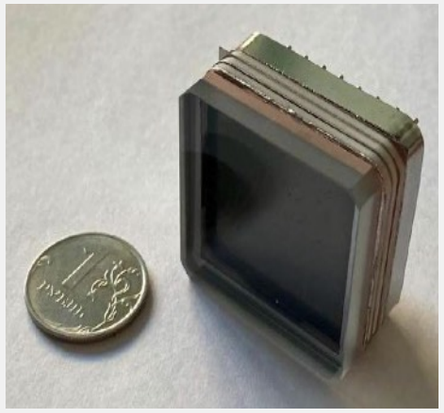
- 3-layer aerogel optimized for 6x6 mm² pixel size
- $L_{sc} \geq 60\ mm$ for all aerogel tiles

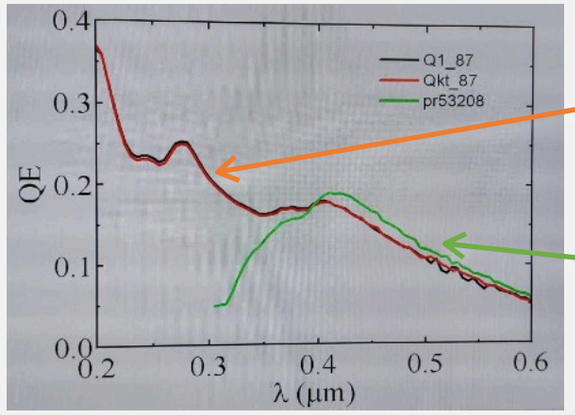


- Samples were manufactured in 2024
- Plan to test with beams in 2025

MCP PMT development

Details in Alexander Barniakov's talk



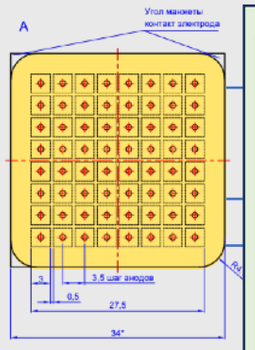


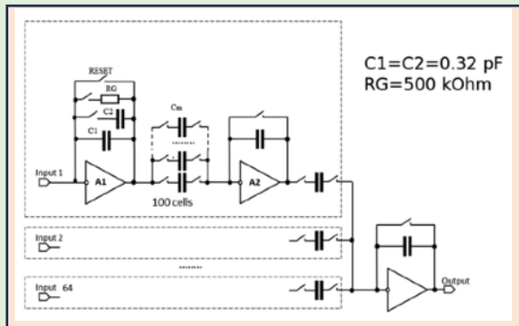
New Multi-Alkali PCs sputtered on quartz optimized to detect Cherenkov radiation

Regular Multi-Alkali PC

FEE for FARICH prototype

Details in Ivan Kuyanov's talk





DMXG64 ASIC:

- 64 channels with 100 memory cells
- operation rate – 10MHz
- Input signals $\leq 2 \times 10^6 e^-$
- ENC – 2700÷3200 e^-

High-speed ADC:

- Rate ≥10 MSPS
- Channels 1 or 2
- ADS4145 (14-bit, 125 MSPS)

FPGA

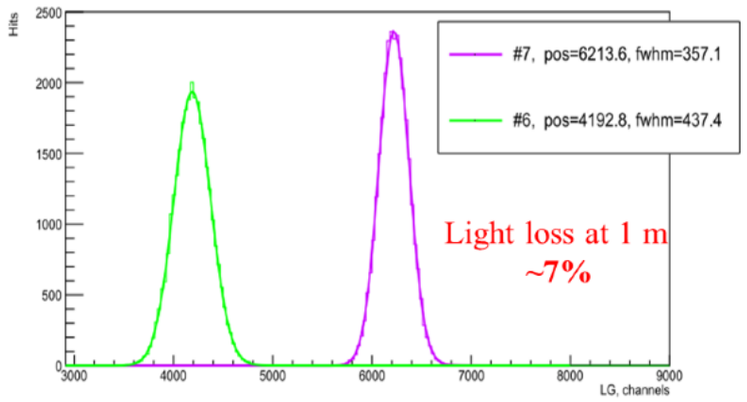
PC

- ONE ASIC / MCP PMT 8x8 pxs
- ONE ADC / 64 pixels MCP PMT
- $T_{r/o} \leq 6.4$ μsec to read out 64 pixels

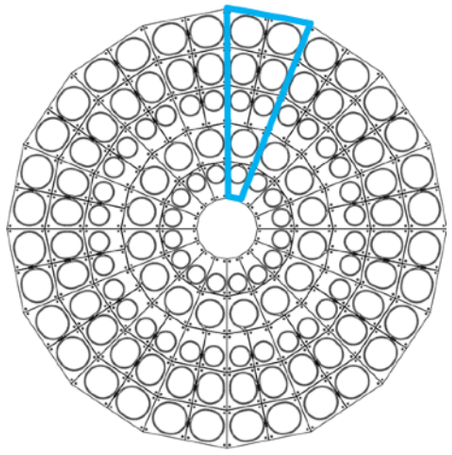
It is good enough for prototype!
For real DAQ optimization is needed

Progress on BBC

The optical cables prototype test

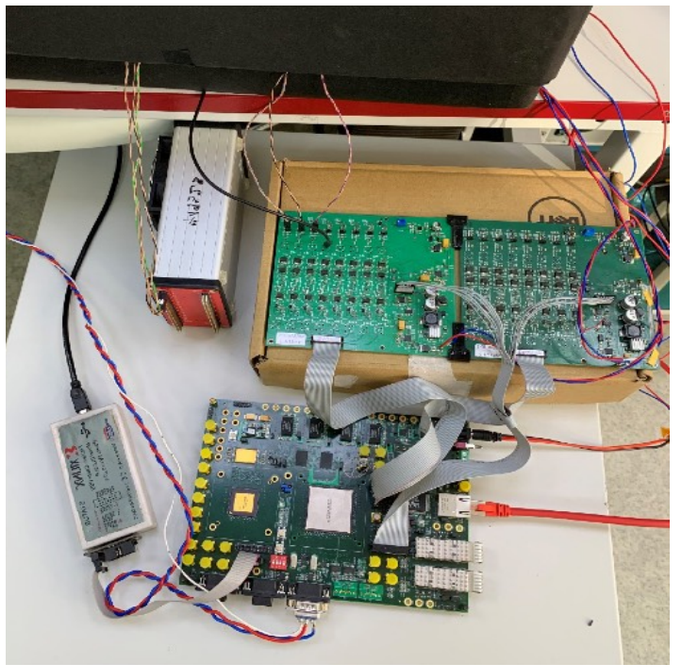


128 tiles (8x16)



reduced prototype wheel (x2)
(at the 1-st stage)

The grooving map is finalizing

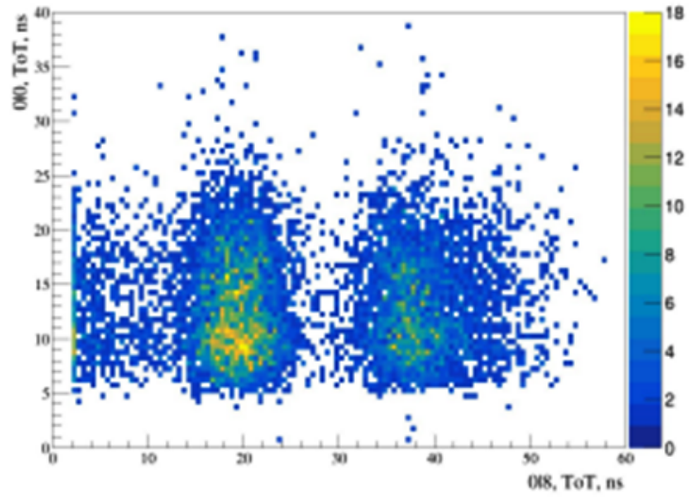


FEE & Readout system:

CAEN FERS-5200 (1) — for Phase 0

NEW ELECTRONICS (2) — for Phase ≥1

(1)



(2)

- Tests of the new electronics showed reasonable results
- The upgraded version of FEE with FPGA KINTEX-7 based readout system are under development
- The cables prototype with clear fiber produced by Kuraray has been developed and tested

Plans:

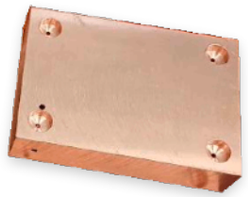
I. The R&D phase for **optical and transmission connectors,** as well as **methods of express sector checking** to be continued.

II. The manufacture of **reduced BBC wheels** (128 tiles each) for SPD Phase 0 is planned to the mid of 2025.

ITEP: I.Alekseev +4
JINR: V.Poliakov, S.Shimanskiy, A.Tishevsky

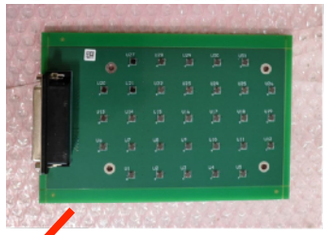
Progress on the ZDC detector

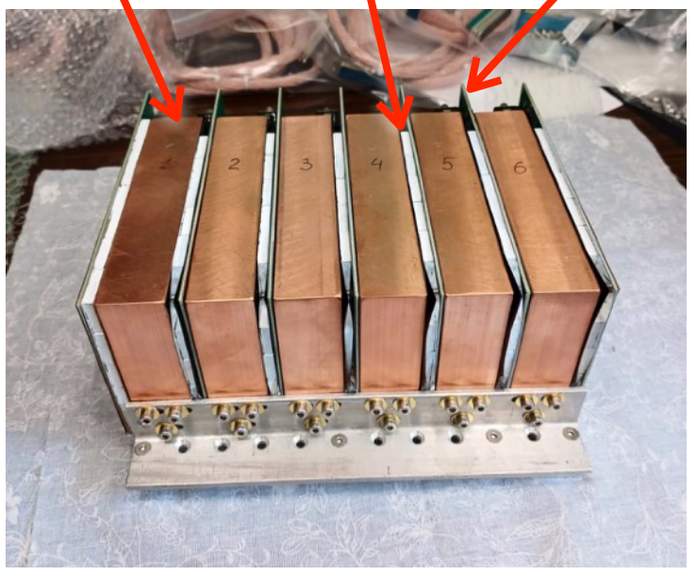
Copper radiator

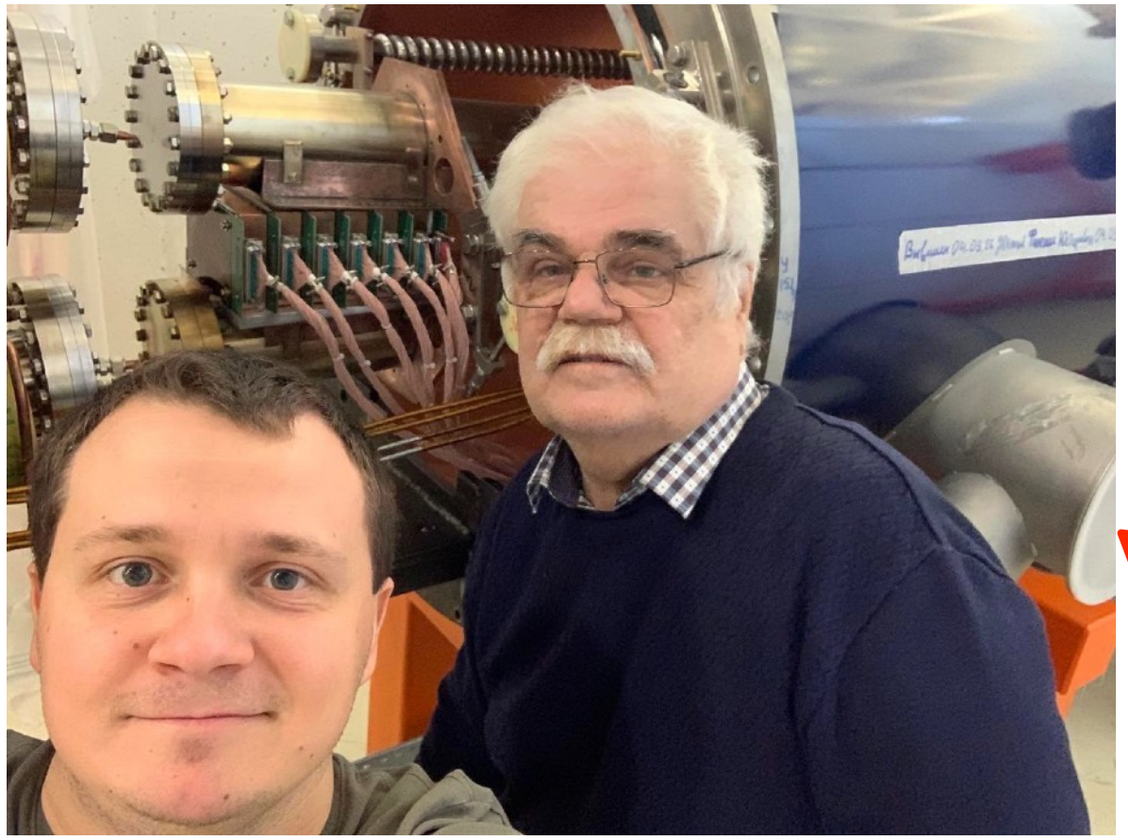


31 scintillator tiles in one layer

PCB with 31 SiPMs







- Configuration for the beginning of the NICA run: two detectors from both sides of IP
  - The 1st detector was installed in the cryostat of Y-chamber on April 2
  - The 2nd detector will be assembled by the end of month and installed in June
- The first stage ZDC detector: 6 layers of rectangular geometry + 1 veto layer
  - 37 mm thick layer = 30 mm copper radiator + 5 mm scintillator + 2 mm PCB
- Readout by CAEN FERS-5200 system:
  - DT5202 64-channel Citiroc units + DT5215 concentrator board
- Two barrels with homemade connectors for running wires through the cryostat are ready
  - Temporary solution for the beginning of datataking. It will have to be rebuild later

Barrel with 30 connectors

FEE and DAQ on Monday

14:00	**Status of DAQ system**	*Dr Leonid Afanasyev* 14:00 - 14:20
	Status of L1 concentrator	*Александр Бойков* 14:20 - 14:40
	Current status of TSS development. White Rabbit calibration automatization and modeling of TSS network	*Daniil Kozyrev* 14:40 - 15:00
15:00	**Current status of TSS development. TSS control protocol v.2. First test runs**	*Kirill Kotov* 15:00 - 15:20
	Coffee Break	15:20 - 15:40
	L2 concentrator firmware status	*Andrei Berngardt* 15:40 - 16:00
16:00	**RUNO ASIC for TOF**	*Dr Evgeny Usenko* 16:00 - 16:20
	Status of ASICs development for NICA-SPD track system	*Alexandr Solin* 16:20 - 16:40

Dense agenda for the meeting!

Magnet & detectors on Tuesday

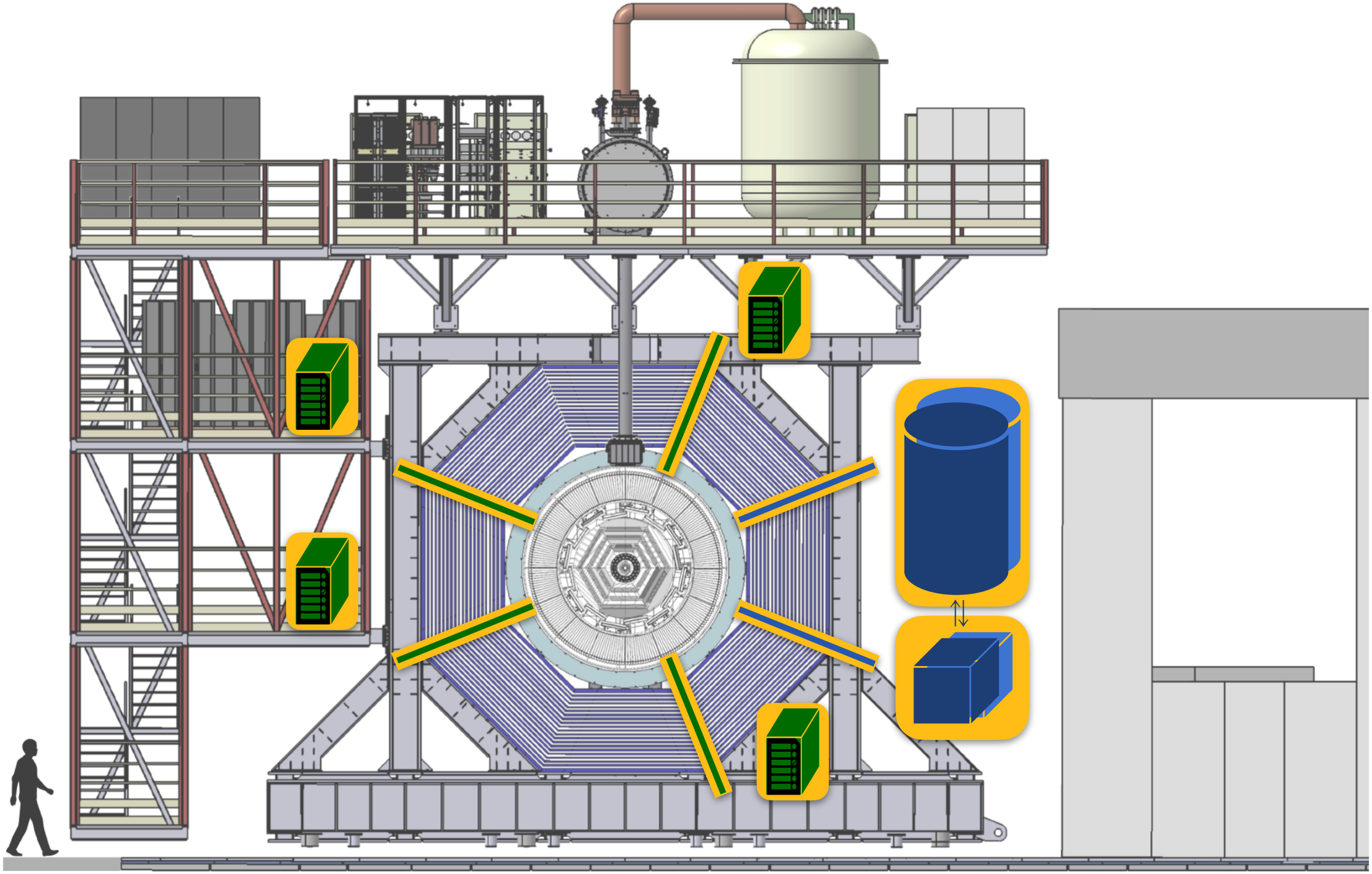
	Status of magnet work at BINP	*Evgeniy Pyata* 09:30 - 09:50
10:00	**Status of the SPD Solenoid Magnet Development**	*Sergey Pivovarov* 09:50 - 10:10
	Status of the cryogenic system development	*Юрий Беспалов* 10:10 - 10:30
	Status of development of magnet yoke	*Nikolay Topilin* 10:30 - 10:50
11:00	**Coffee break**	10:50 - 11:10
	RS status report	*Gennady Alexeev* 11:10 - 11:30
	ECal status report	*Dr Олег Гаврищук* 11:30 - 11:50
	Straw-barrel status report	*Темур Еник* 11:50 - 12:10
12:00	**FEE for straw tracker**	*Vitaly Bautin* 12:10 - 12:30
	Lunch	12:30 - 14:00
14:00	**Aerogel Cherenkov Detector Studies for NICA SPD Experiment**	*Argine Hakobyan* 14:00 - 14:20
	Readout electronics for the FARICH prototype (status and perspectives)	*Ivan Kuyanov* 14:20 - 14:40
	Recent progress of aerogel Cherenkov radiators production in Novosibirsk	*Alexander Katcin* 14:40 - 15:00
15:00	**Status of R&Ds for the SPD project at the BINP**	*Alexander Barnyakov* 15:00 - 15:20
	Coffee break	15:20 - 15:40
	Status of TOF development	*Валерий Чмиль* 15:40 - 16:00
16:00	**Micomegas status report**	*Дмитрий Дедович* 16:00 - 16:20
	BBC status report	*Aleksey Tishevsky* 16:20 - 16:40
	BBC at Phase-0	*Иван Волков* 16:40 - 17:00
17:00	**Ongoing BBC detector activities in MEPhI**	*Andrei Durov* 17:00 - 17:20

Summary

- Strong involvement of Design Bureau № 2 of LHEP under the leadership of N.Topilin since the beginning of this year
- Significant progress in the overall power structure of the detector and platforms
- Discussion of issues of engineering communications and service pipelines has begun
- Progress in R&D of many detector subsystems
- According to present schedule we can have the 1-st stage detector by the end of this decade. *Clear planning required from corresponding groups.*

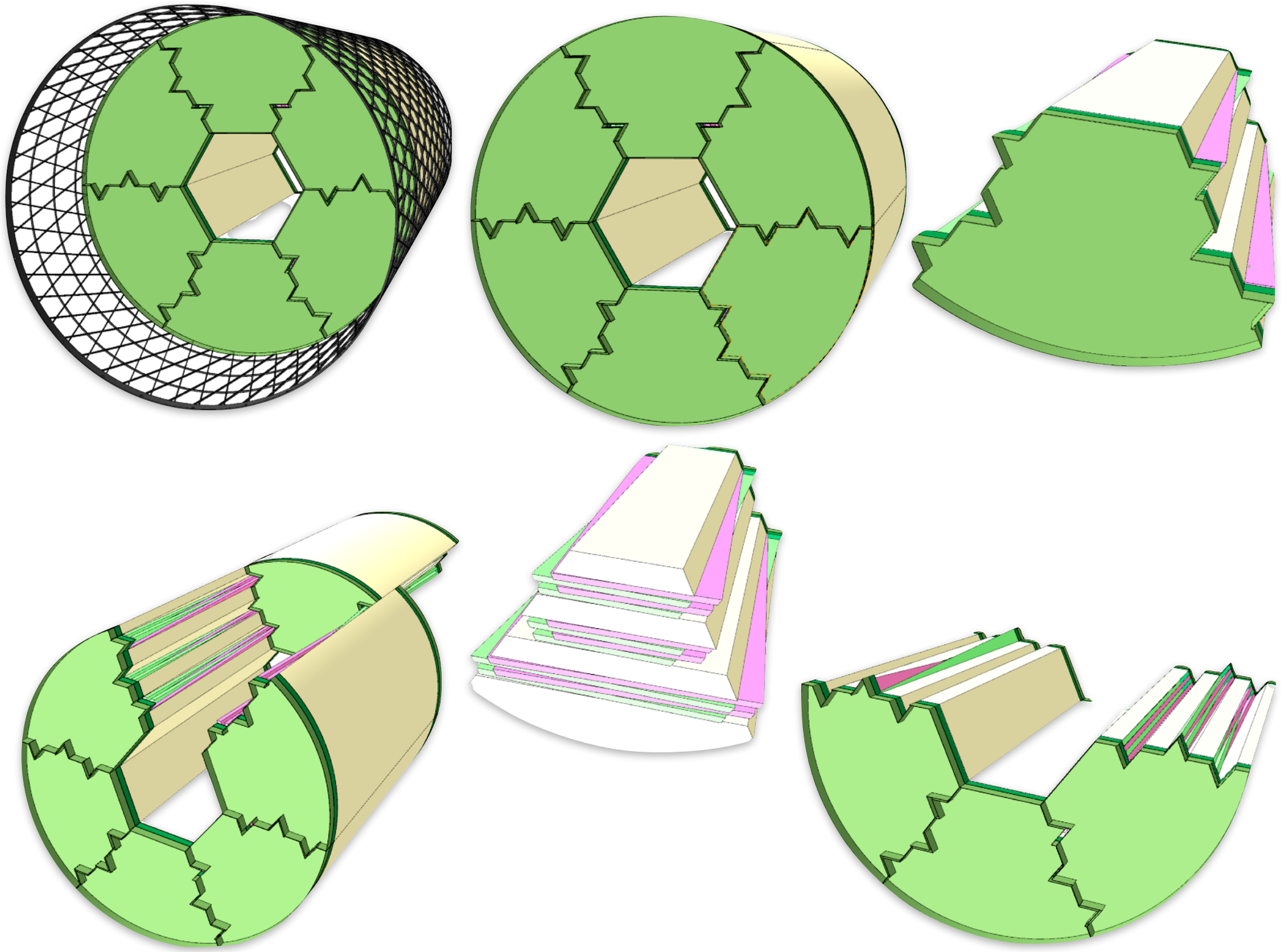
backup

Engineering communications and service pipelines



S.Sukhovarov

Progress on Straw-barrel



Range (muon) System Status

- Participation in developing the engineering Yoke design, especially in part concerning the impact of MDT detectors and electronics
- Organization/deployment of MDT test production equipment is in progress
- Execution of pre-production contract JINR-Minsk/Integral on amplifier chips (Ampl-8.53) is in progress
- Pre-production contract JINR-Minsk/Integral on preamplifier and discriminator chips (Ampl-8.11R-G5, Disc-8.17) is under discussion
- Tests on data transmission from digital FDM-192 module to L1 concentrator have been successfully performed using SerDes interface
- Main parameters of strip board (capacity and wave imperdace) were measured with Detector Layer Prototype (DLP)
- Preparations to the beam tests (Cherenkov counter at LINAC-200 and Range System Prototype at NUCLOTRON beam) are in progress

E.Pyata, March 2024

Schedule for Solenoid+Dewar production

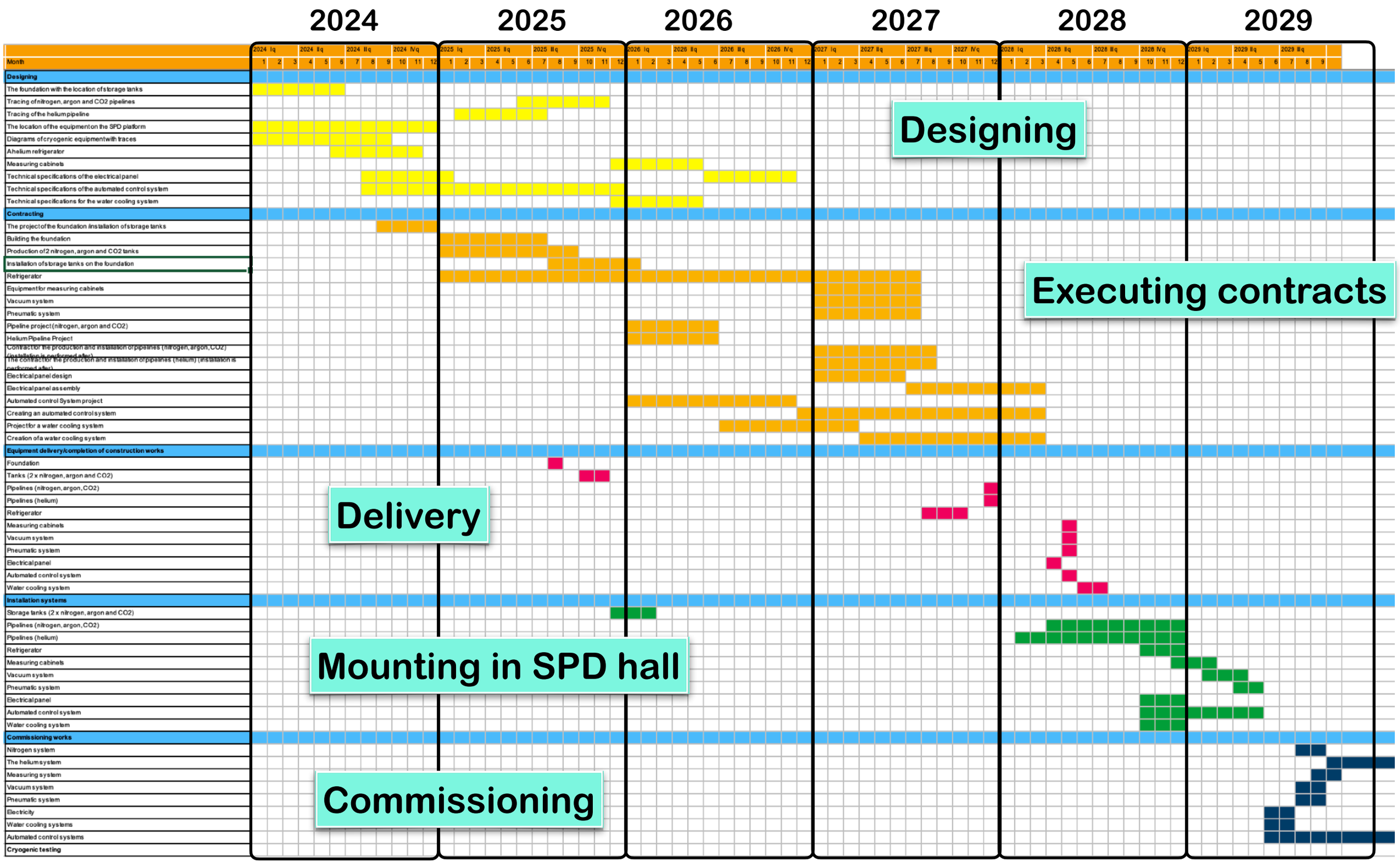
	2024				2025				2026				2027				2028		
Project management and testing																			
TDR																			
Plan Review																			
Prelim. Design Review																			
SAT full solenoid																			
Conductor																			
Contract with external firm																			
FDR conductor																			
Production by exter. firm																			
FAT conductor																			
Cryostat and cold mass																			
Cryostat design																			
FDR cryostat																			
Procurement & production																			
FAT cryostat																			
SAT cryostat																			
Control dewar and corresponding cryogenics																			
Dewar design																			
Dewar vacuum equipment																			
FDR cryostat																			
FAT dewar																			
SAT dewar																			
Electrical components																			
Contract elec. component																			
FDR elec. component																			
Procurement																			
FAT elec. component																			
Magnet alarm safety system																			
FDR safety system																			
Procurement																			
FAT safety system																			
Coil winding																			
Design coil winding																			
Tooling design																			
FDR coil																			
Procurement																			
FAT coil winding																			
Cold mass integration																			

FDR - Final Design Review
FAT - Factory Acceptance Test
SAT - Site Acceptance Test

** Transportation time is not taken into account*

D.Nikiforov

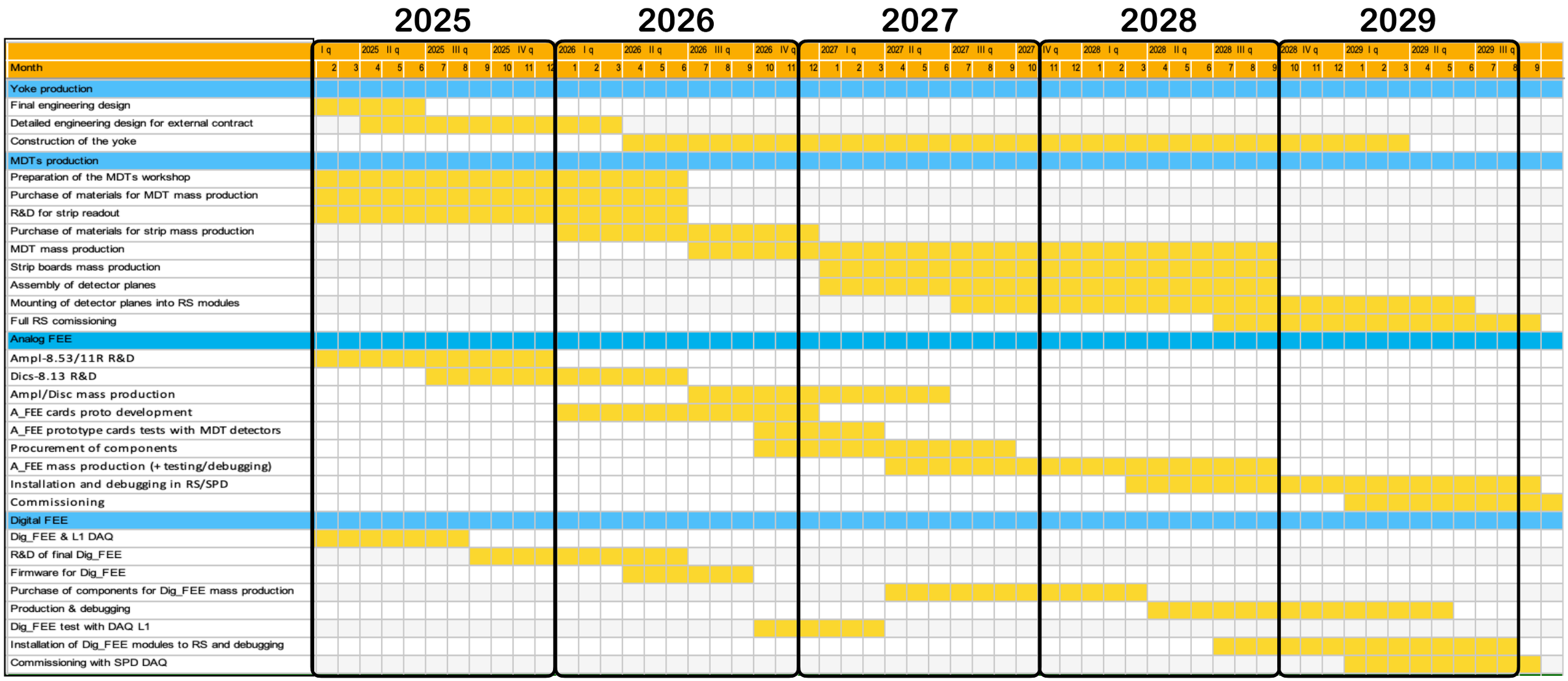
LHe cryogenic system, cryocomplex, pipelines



** Commissioning is only possible with the magnetic yoke installed.*

Range (muon) System project

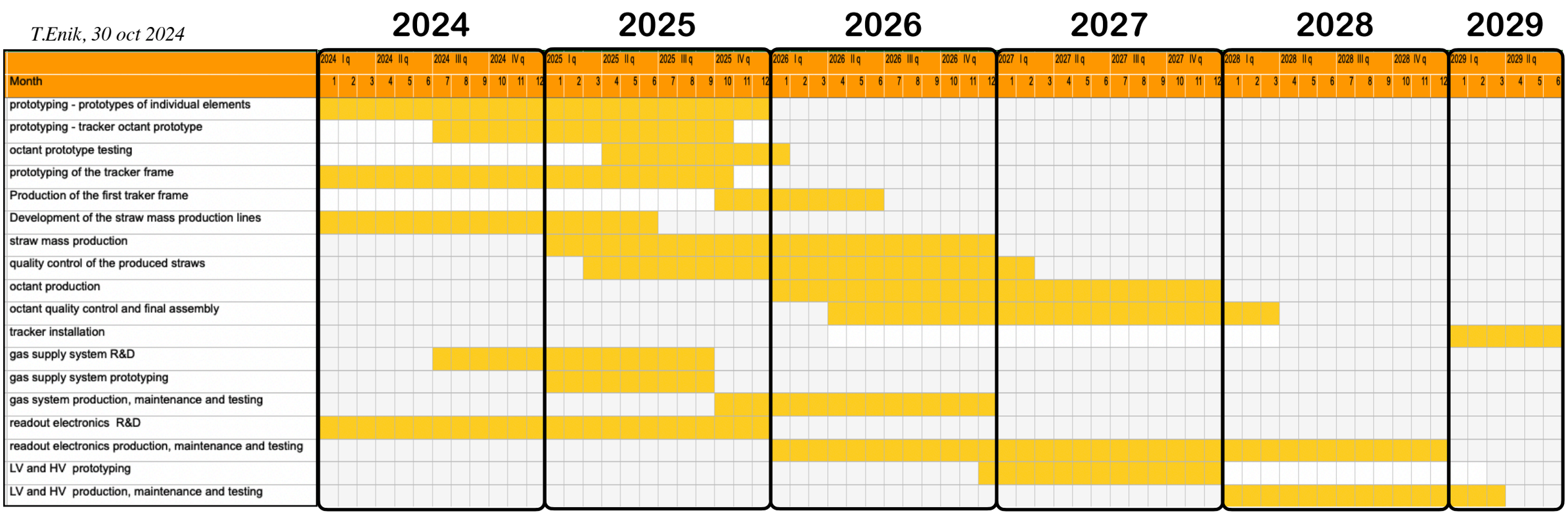
Project leader	JINR: G.Alexeev
Magnet yoke design and MDT detecting planes assembling and mounting into slots of the yoke	JINR: A.Samartsev, E.Boltushkin, S.Kakurin, S.Gerasimov
Gas system (as part of DCS)	MSU: K.Korolev + 1
Analog and digital electronics	JINR: N.Zhuravlev + 4 Minsk: M.Baturitsky + 3, A.Solin +1 MSU: A.Chepurnov, A.Nikolaev, A.Aynikeev + 3
MDT detectors and strip boards production and assembling	JINR: V.Abazov, A.Piskun, S.Kutuzov, I.Prokhorov, Yu.Vertogradova
Software and analysis	JINR: A.Verkheev, L.Vertogradov. MEPhI: A.Osterov.



Straw-barrel project

Project leaders	**T.Enik (JINR)**, E.Kuznetsova (PNPI), Y.Mukhamejanov (JINR, INP).
Power frame and assembling procedure	JINR: K.Basharina, Y.Ershov, A.Salamatin, S.Sukhovarov.
Gas system	JINR: V.Perelygin, V.Karjavine, D.Kozlov.
Electronics	JINR: V.Bautin, M.Buryakov, N.Gorbunov, A.Golunov, V.Karjavine, S.Kochepasov, O.Minko, K.Salamatin BSU: A.Solin, A.Solin.
Tube production and assembling	JINR: Y.Kambar, S.Romakhov, A.Rymshina. INP: O.Kalikulov, N.Yerezhep, S.Shinbulatov, Sh.Utei, A.Baktoraz, S.Adilkhan
Software and analysis	JINR: R.Akhunzyanov, A.Chukanov, A.Lapkin, A.Mukhamejanova (JINR, INP), D.Myktybekov (JINR, INP), O.Samoylov, D.Baigarashev (JINR, INP), D.Kereibay (JINR, INP) PNPI: S.Bulanova, E.Mosolova, D.Sosnov, A.Zelenov.

T.Enik, 30 oct 2024



G.Kekelidze
V.Kramorenko

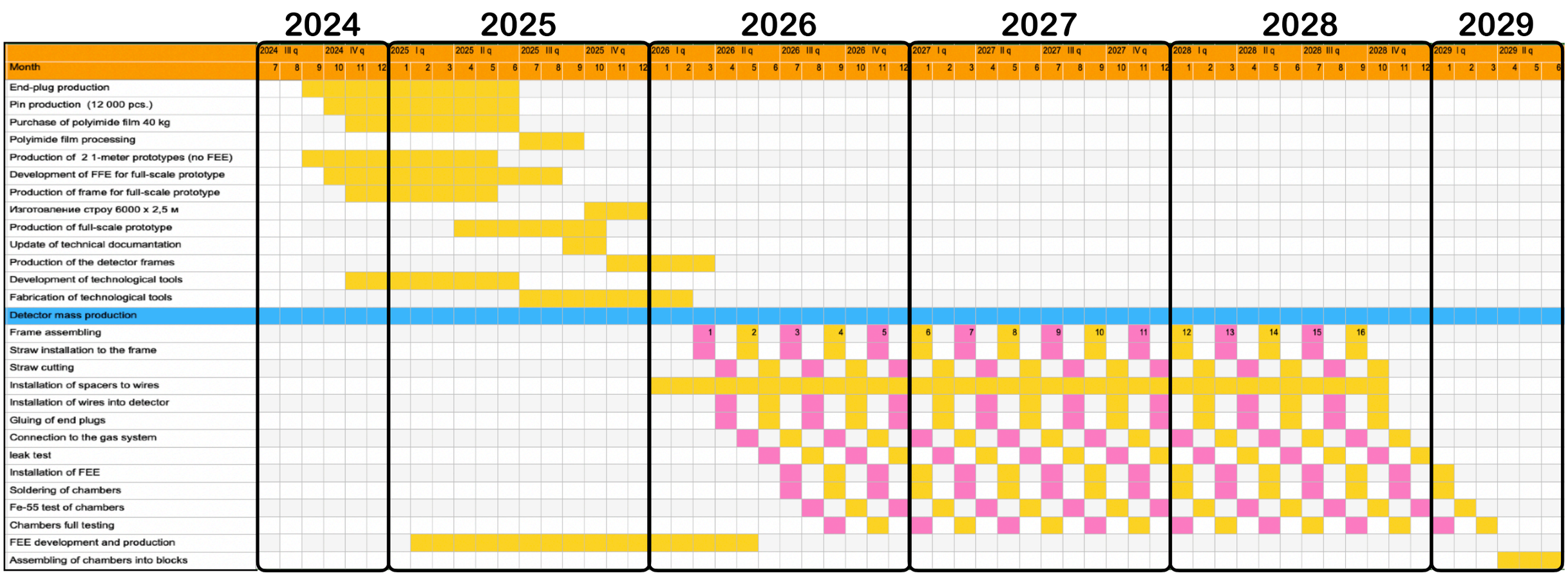
Progress on Straw-endcap

Small scale prototype, ∅=1 m

- The purpose of building the prototype with 80 tubes and aluminum frame is to test the assembly technology:
  1. stretching straws before gluing them to the frame
  2. keep straws in a humid environment before gluing
- Behaviours of the tubes will be studied throughout the year in order to choose the best technology

Full scale prototype, ∅=1.6 m

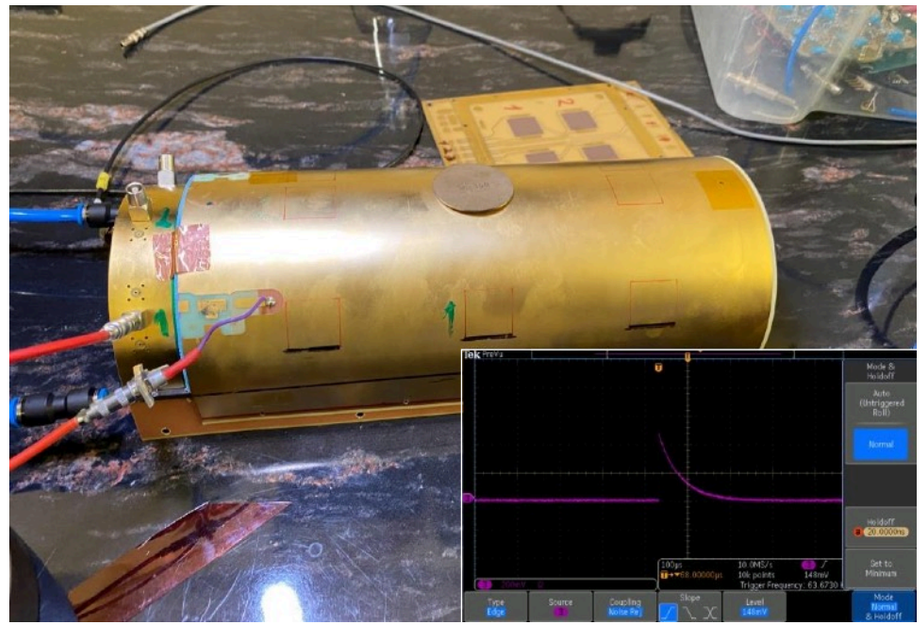
- Fiberglass frame of full size with mounted lodgements for tubes will be delivered by the end of this year
- Electronics, plugs, pins, films have been ordered and are being produced.

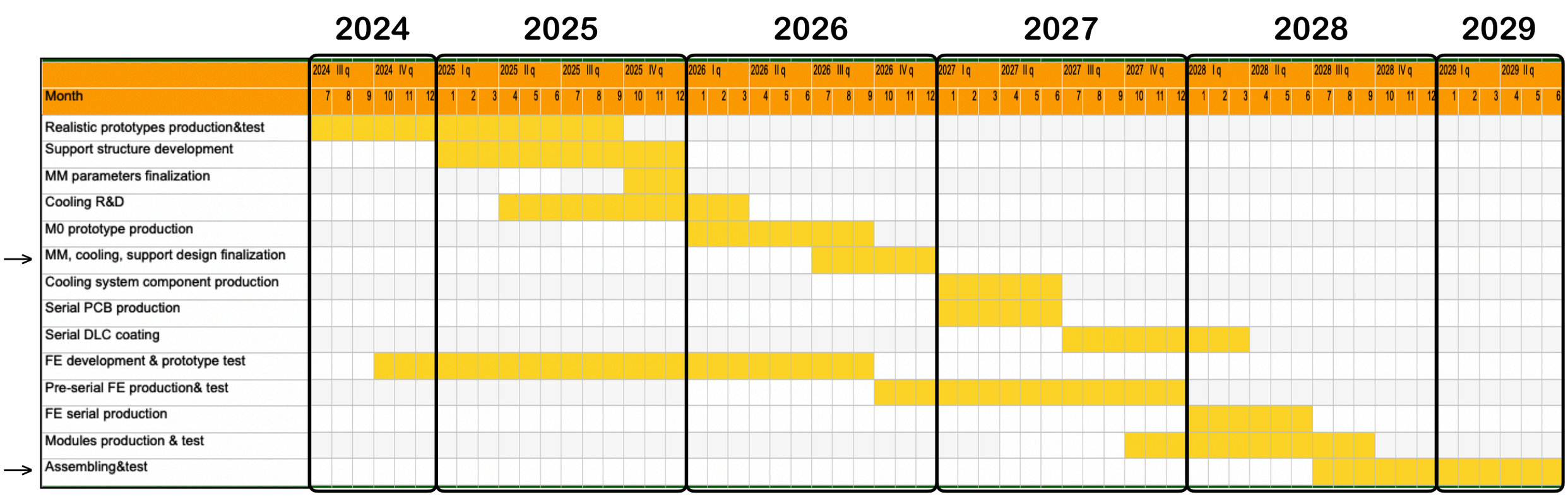


MicroMeGaS-based central tracker

Project leader	JINR: D.Dedovich
Micromegas detector production	JINR: A.Gongadze, I.Liashko, N.Koviazina
Micromegas PCB development	JINR: U.Kruchenak
Detector simulation	JINR: N.Koviazina
Software and analysis	JINR: D.Dedovich, N.Koviazina
FE electronic	JINR: A.Boikov, Svetlana Tereshchenko
ASIC sertification	TSU: S.Filimonov +3

First prototype of cylindrical MM chamber (early 2024)





Beam-Beam-Counter (BBC) project

Project leader	V.Ladygin (JINR)
Deputy	P.Teterin (MEPhI)
Manufacture, tests, assembling	MEPhI: A.Zakharov, Ph.Dubinin, P.Teterin JINR: Yu.Gurchin, A.Tishevsky, A.Livanov
FERS5200 based FEE&DIGI&DAQ (Phase0)	JINR: A.Isupov, S.Reznikov, I.Volkov

FEE, FPGA based TDC design and tests	MEPhI: P.Nekrasov, A.Melekesov JINR: A.Isupov, S.Reznikov, A.Tishevsky, I.Volkov
BBC interface to SPD DAQ	JINR: A.Isupov
Express off-line and data analysis	JINR: I.Volkov, K.Volkova MEPhI: E.Soldatov
Simulation	JINR: A.Terekhin, K.Volkova MEPhI: A.Durov, A.Levkov, E.Soldatov