Report of the technical coordinator

Alexander Korzenev, JINR LHEP

SPD Collaboration Meeting
Dec 13, 2021

Outline

Aerial view of NICA in July 2021

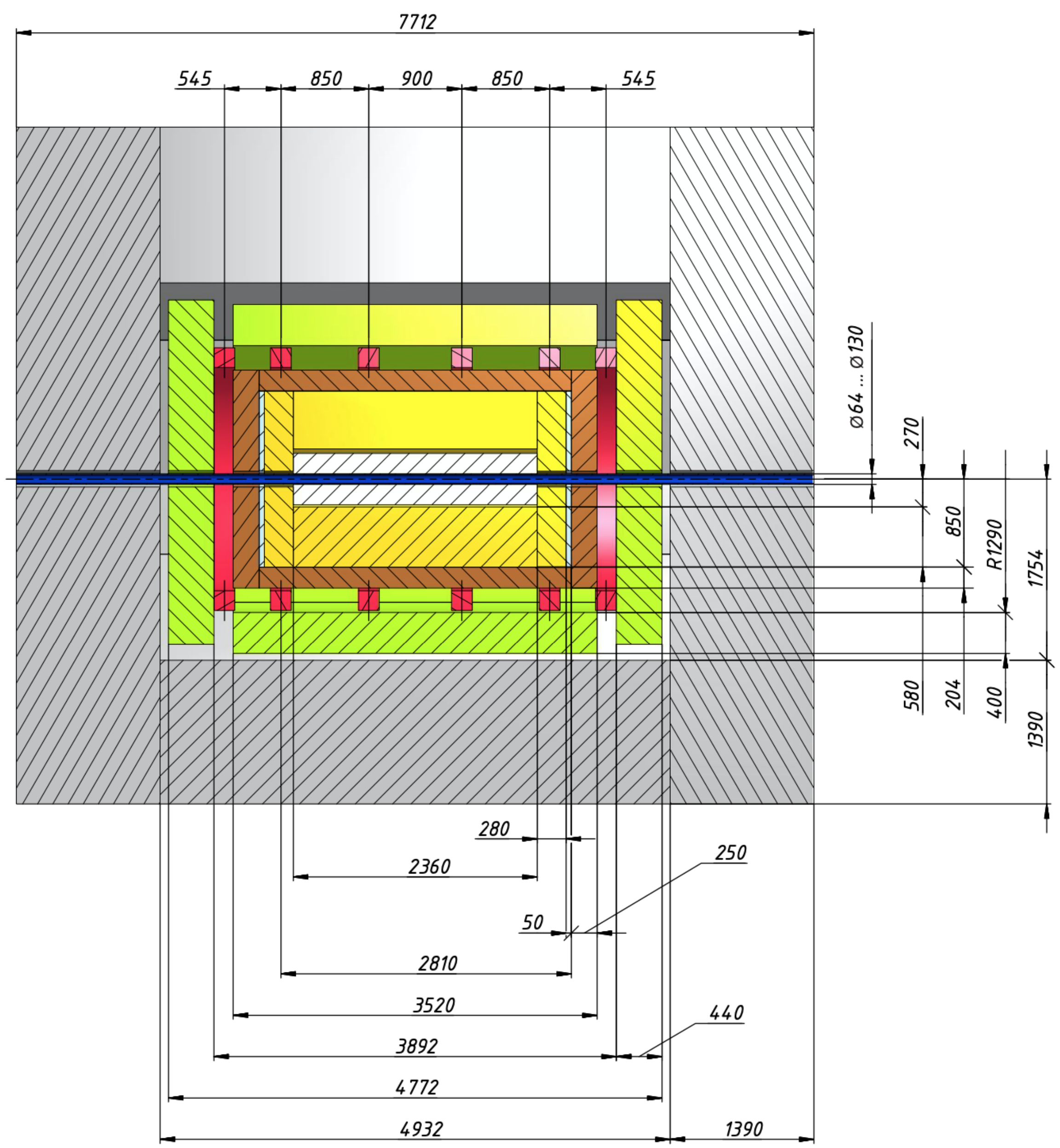

View of SPD from the courtyard


View of SPD from outside

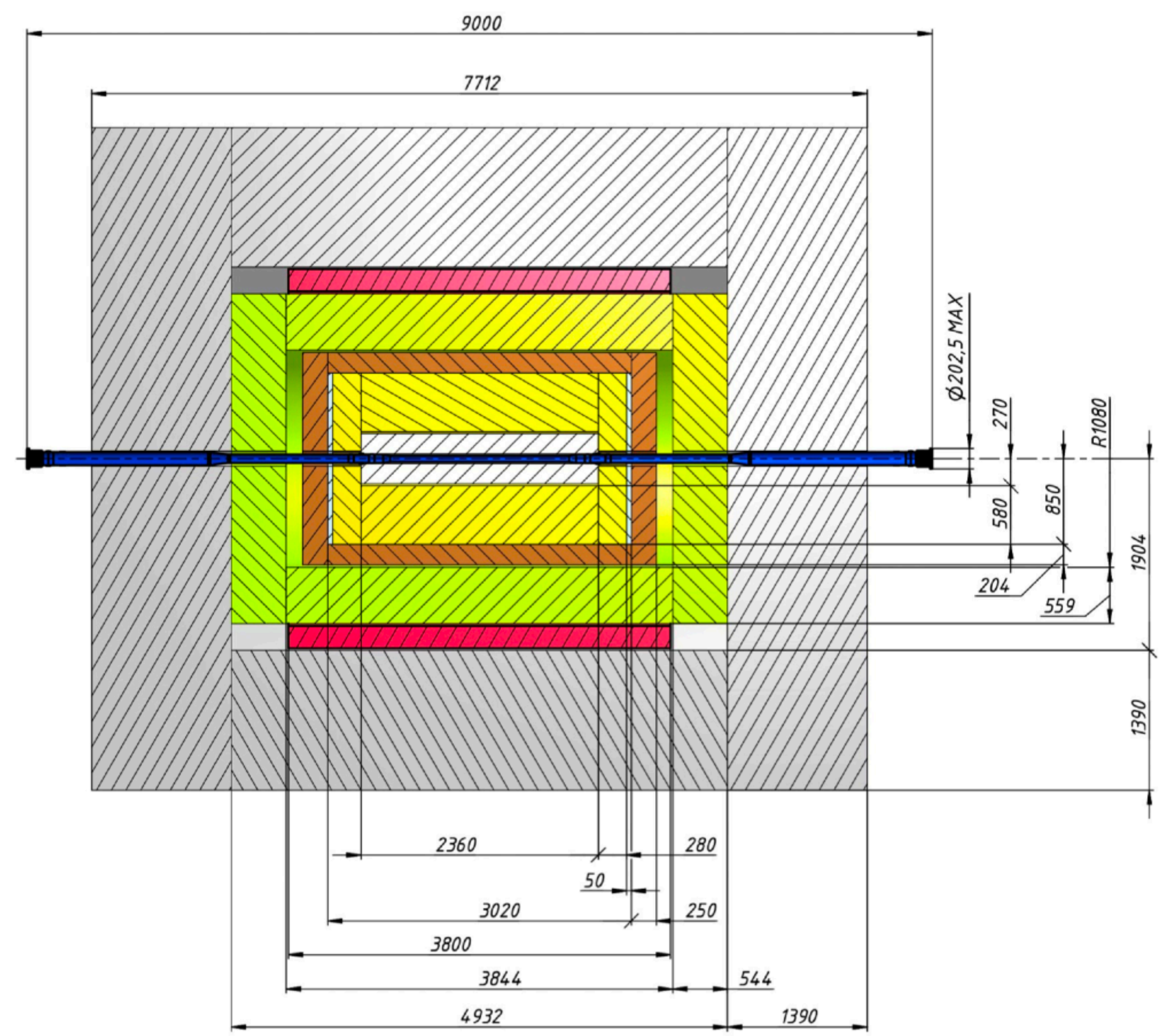
Alexey Livanov

- All interior work in the SPD hall will be completed this winter
- Under-rail plates and rails will be installed next spring
- The concrete block wall (biological protection) and the bridge between two balconies will be installed at the end of spring. Thus the accelerator tunnel will be isolated from the hall

CDR version (**obsolete**)
Magnet inside ECal

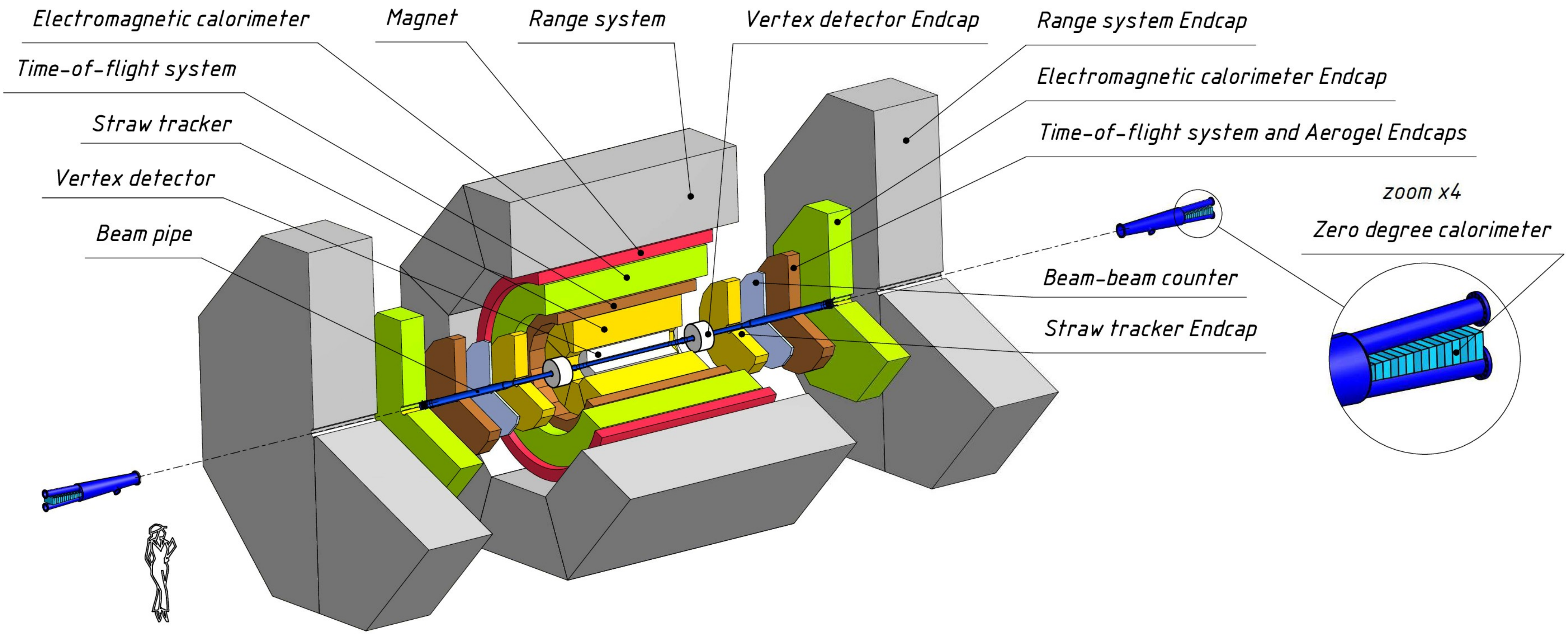


Approved at TB
ECal inside Magnet



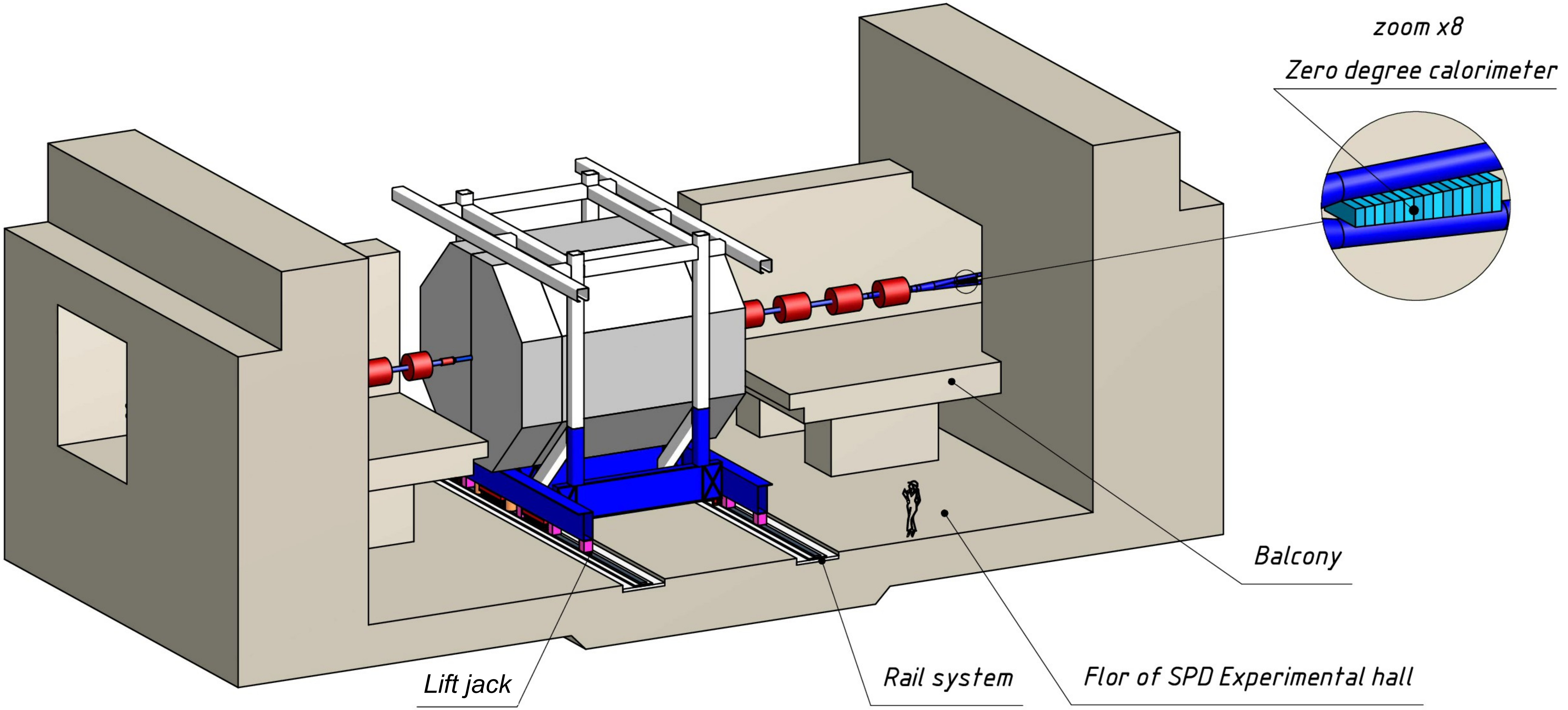
+15 cm in radius w.r.t. CDR

Update for the schematic view of the SPD setup



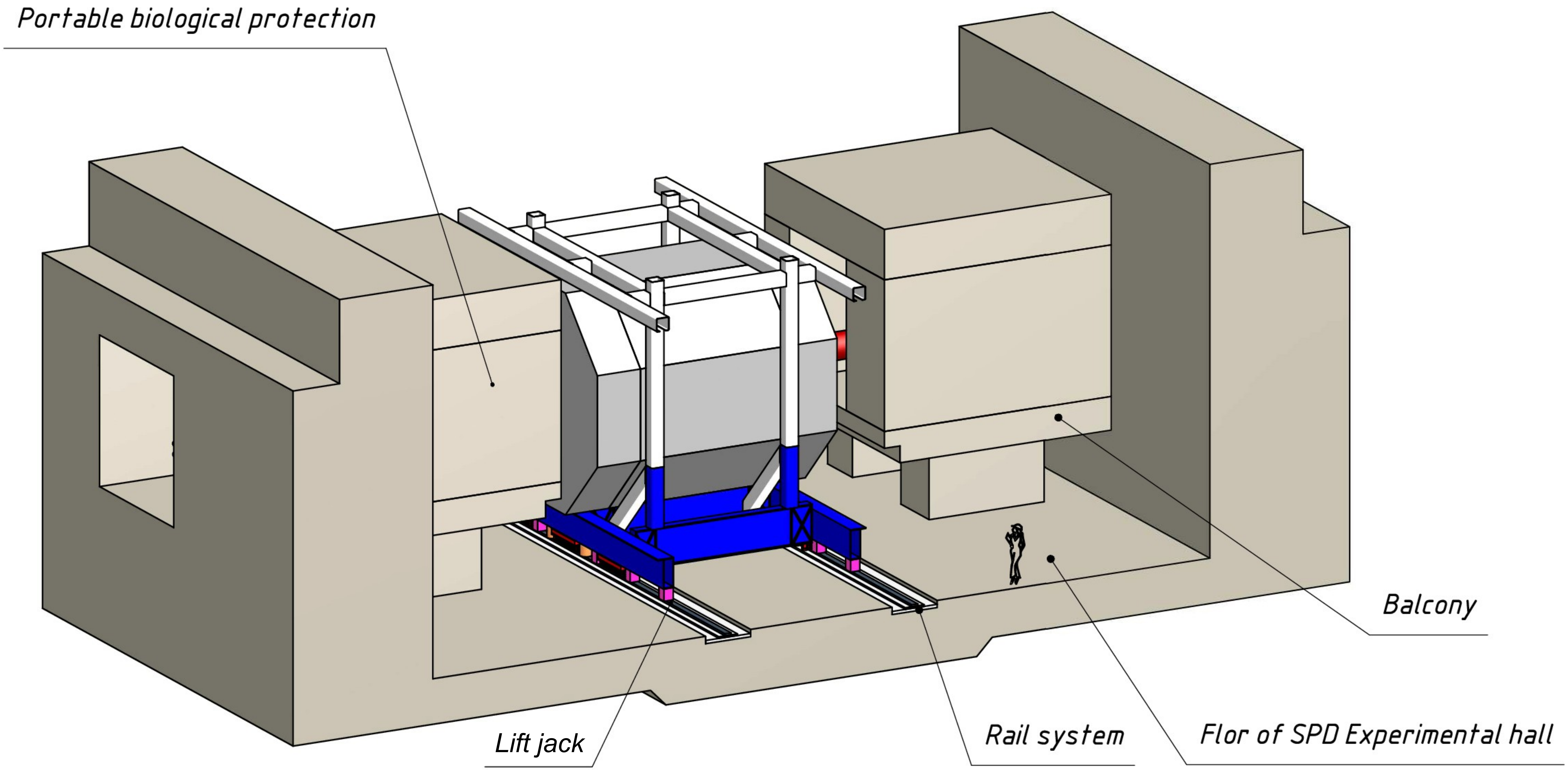
- 6 coils inside ECal were replaced by a single cryostat outside ECal
- Complete set of detectors

Update for the schematic view of the SPD setup



- Position of the detector during data taking

Update for the schematic view of the SPD setup



- Position of the detector during data taking
- Accelerator tunnel will be isolated from experimental hall

Two options for the SC magnet technology

E.Pyata et al.

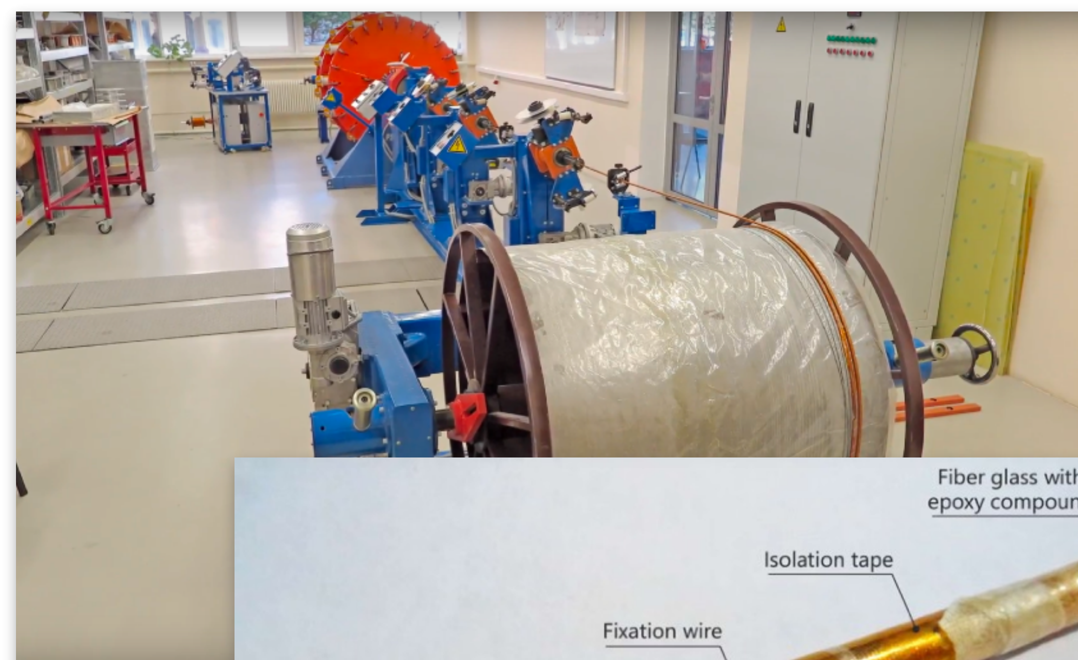
H.Khodzhibagiyan et al.

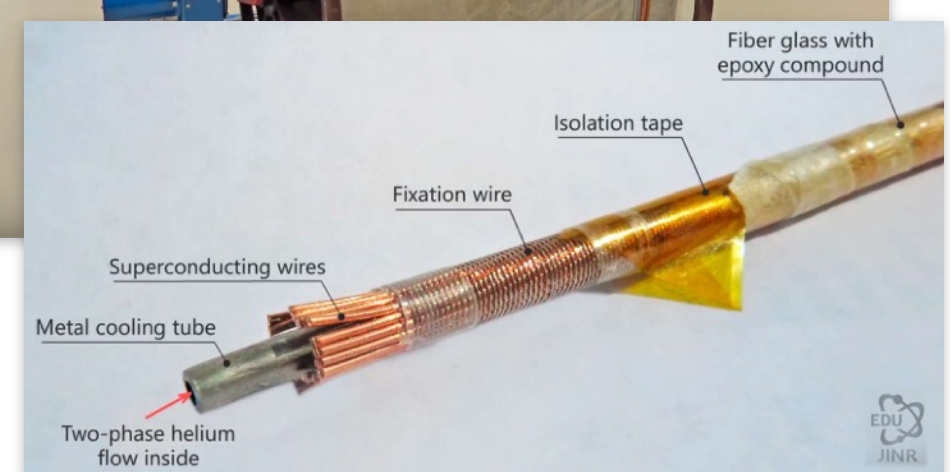
Option based on the PANDA cable

- The team of the Budker Institute of Nuclear Physics / Novosibirsk.
- The PANDA magnet will be moved to GSI in 2024 for final tests
- The Rutherford cable with 8 strands extruded in Al matrix
- Design of cryogenic system (refrigerator, pipelines and so on) in JINR

Option based on the NICA cable

- Coil construction similar to one used for the NICA magnets (produced in JINR)
- Two layers of NbTi/CuNi cable. The same cable as used in Nuclotron magnets: hollow superconductor with the helium flows inside (~4 K)
- Design of cryogenic system (refrigerator, pipelines and so on) in JINR

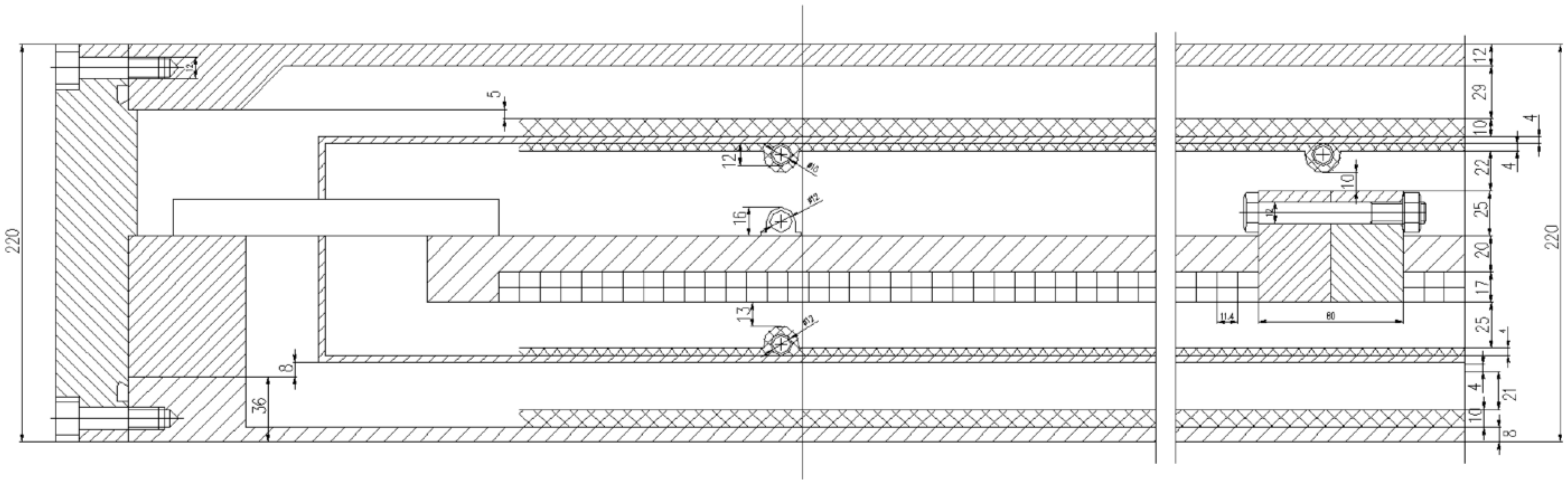


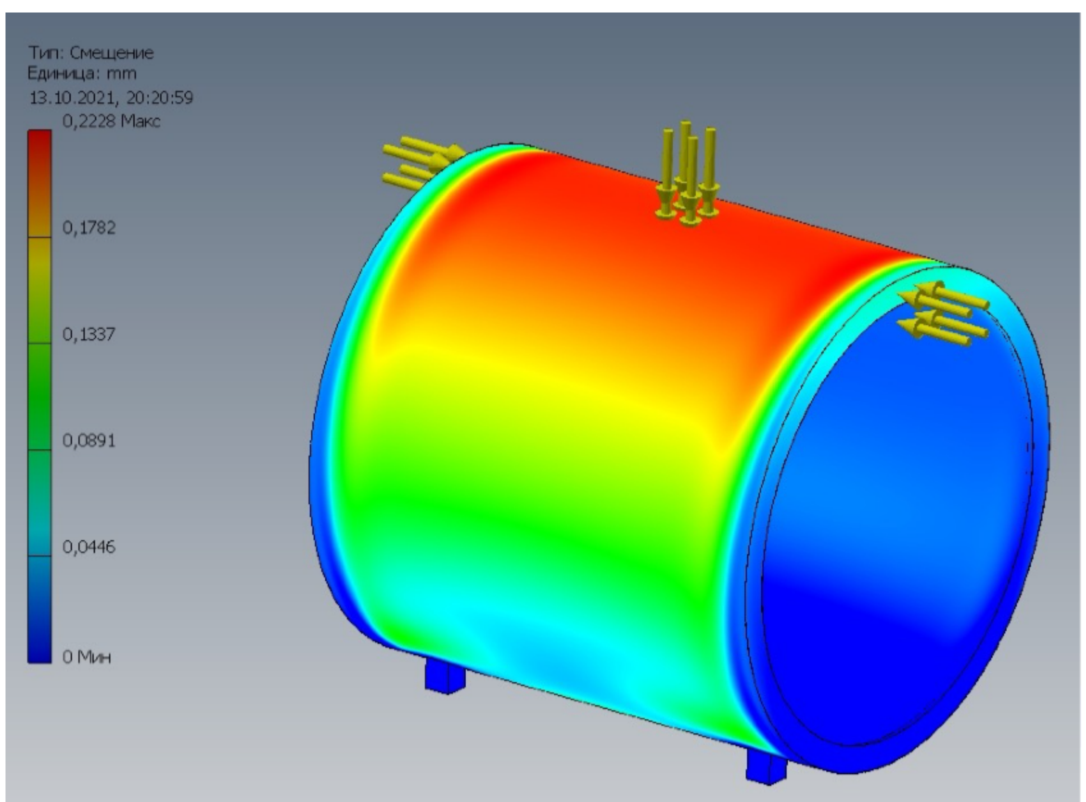


E.Pyata
S.Pivovarov
A.Krasnov

Option based on the PANDA cable

- The Rutherford cable with 8 strands extruded in Al matrix
- Cooling provided by liquid helium which circulates in pipes welded to the outside of the coil former

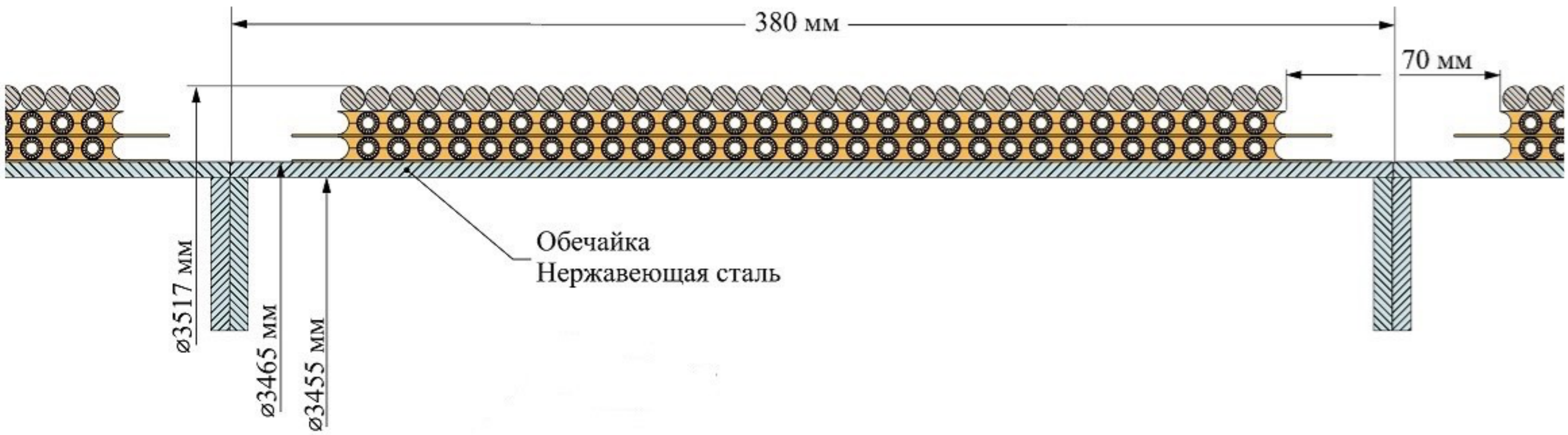




- Preliminary estimates for deformations shows satisfactory results
- The BINP team visited JINR for one week in October
- The PANDA magnet will be moved to GSI in 2024 for final tests. Engineers will be available for the SPD magnet in 2023-2024

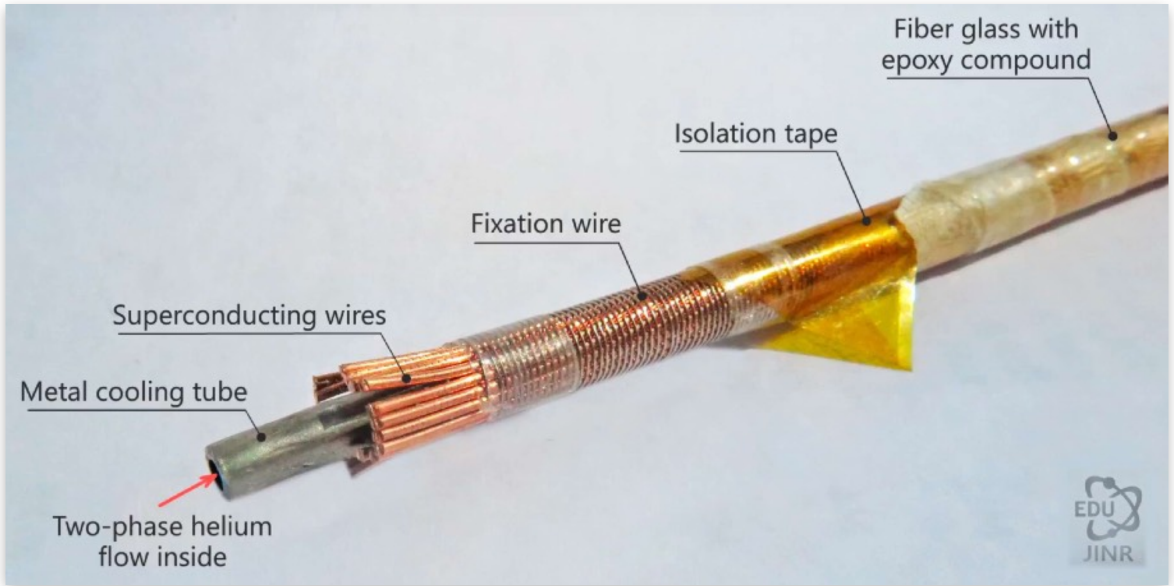
H.Khodzhibagiyan et al.

Option based on the NICA cable



- Two layers of NbTi/CuNi cable. The same cable as used in Nuclotron magnets: hollow superconductor with the helium flows inside (~4 K)
- Will require an intensive R&D since coils of large size made of Nuclotron-type cable has never been constructed before
- Main issue is a quench handling

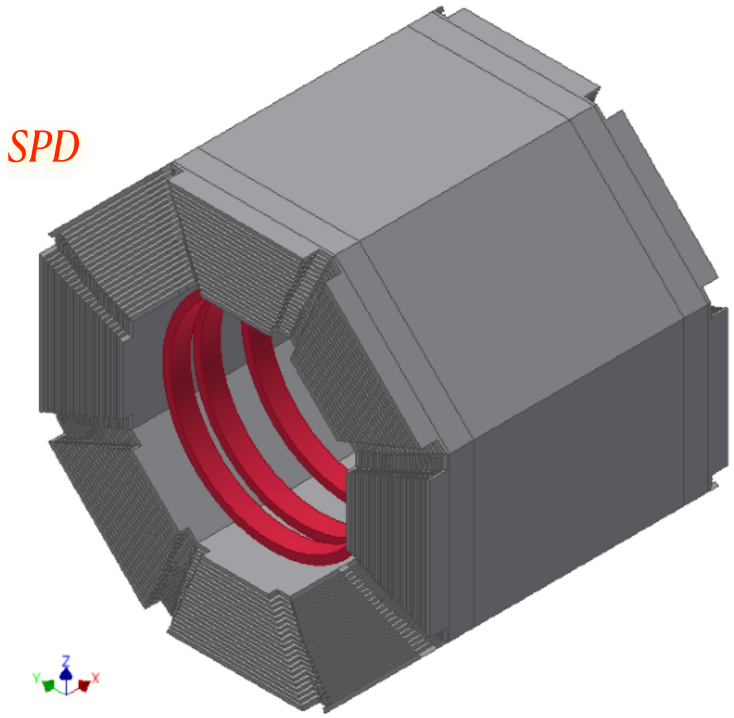
Cable used for magnets of Nuclotron



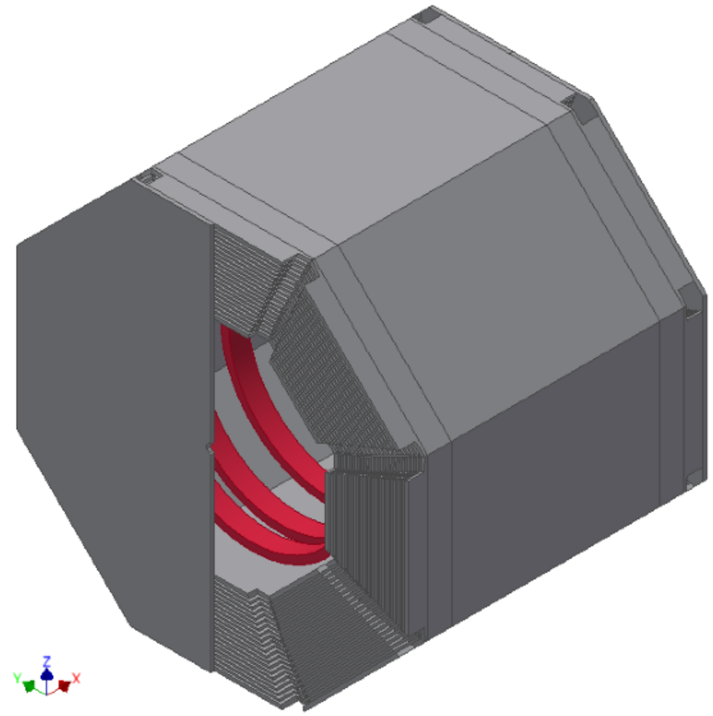
I.Moshkovsky

Magnetic field calculation (cryostat outside ECal)

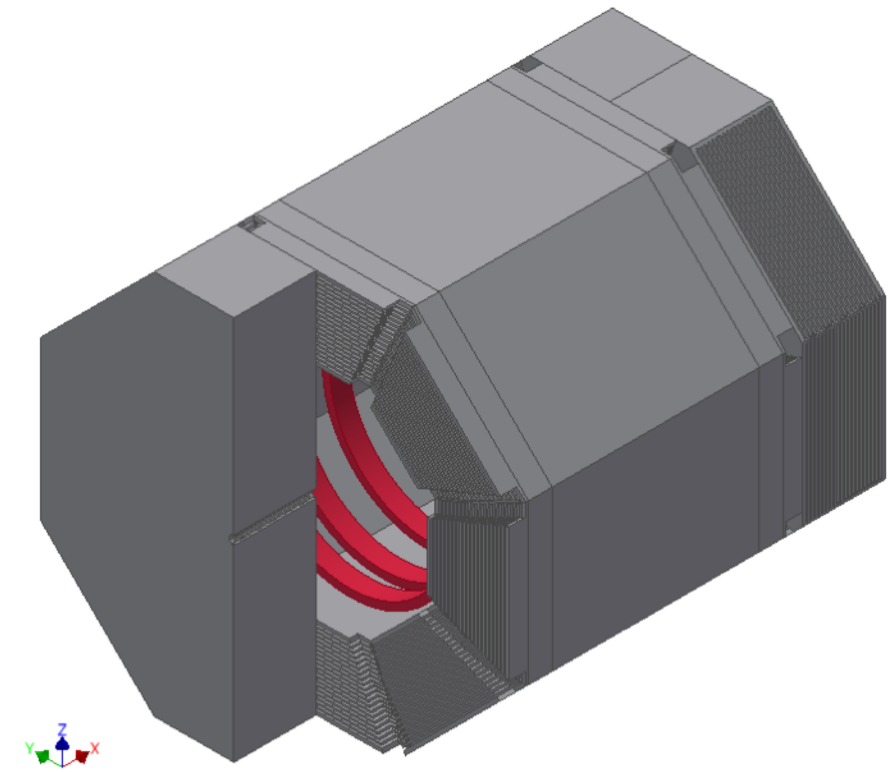
Without endcaps

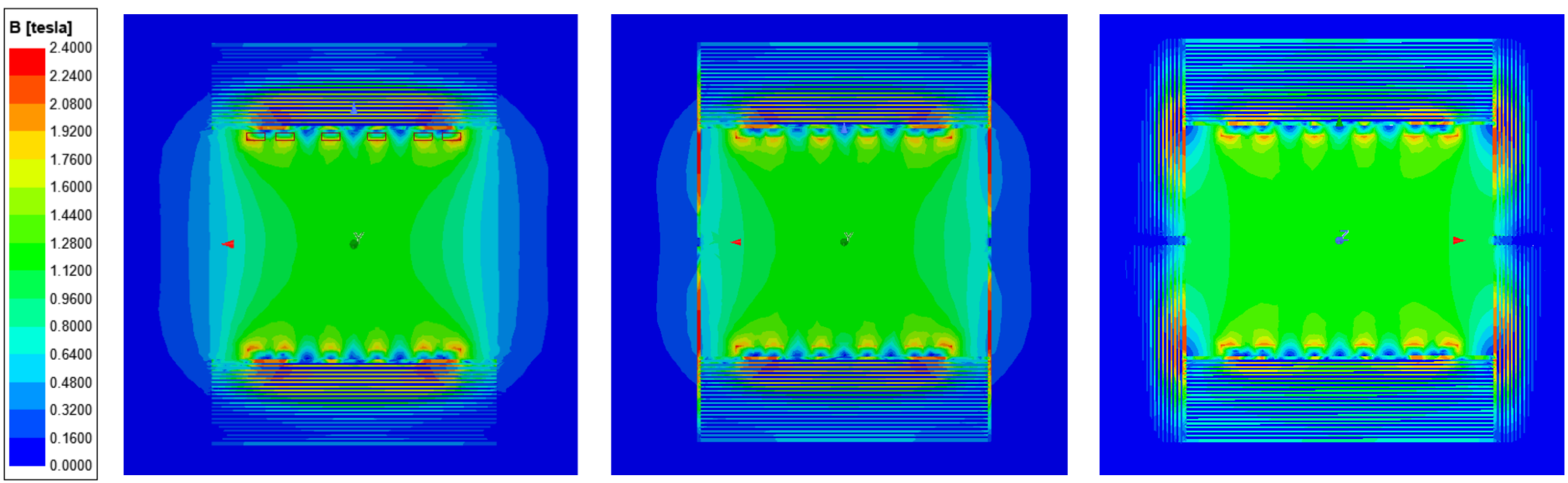


6 cm thick endcap



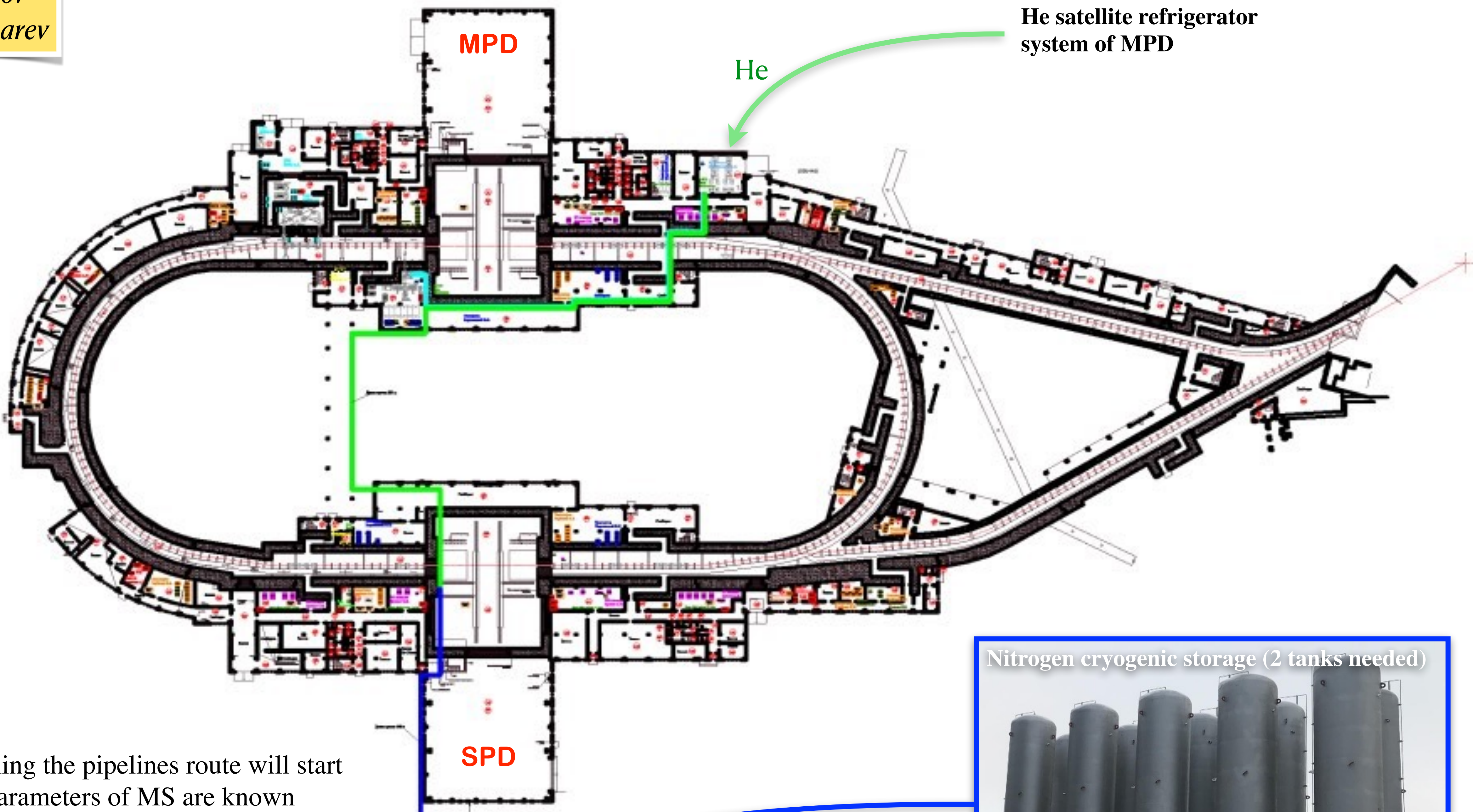
Full construction





Infrastructure for the cryogenic system

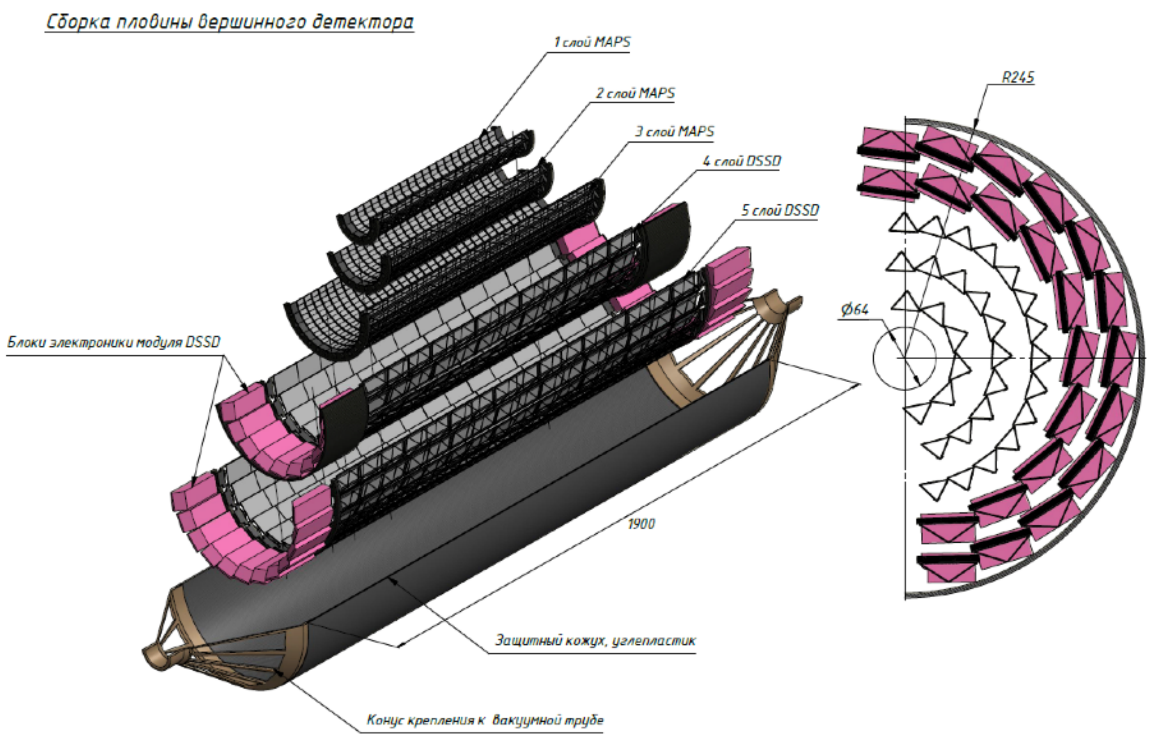
D.Nikiforov
A.Ponomarev



- Designing the pipelines route will start once parameters of MS are known
- Requires strobing passages in the walls ⇒ better to do earlier (next year)

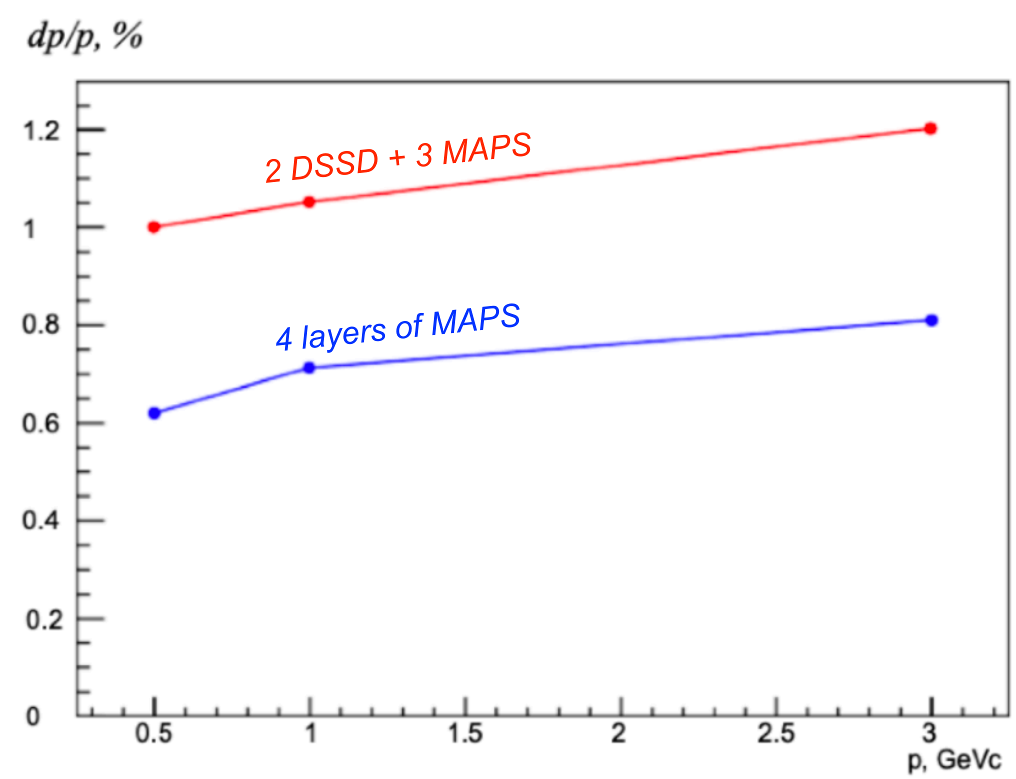
N. Zamiatin

Silicon Vertex Detector (VD)



- Inner tracking system of SPD: barrel + endcaps
- Reconstruction of D meson decay vertices
- 5 layers = 2 DSSD + 3 MAPS (CDR version)
    - Double Side Silicone Strip (DSSD), 300 μm thickness, strip pitch 95 μm - 281 μm
    - Monolithic Active Pixel Sensors (MAPS) designed and produced for ALICE, pixel size 29 μm × 27 μm

- DAC requested to consider MAPS-only option
- There is no sizable impact to the spatial resolution of the vertex position
- Momentum resolution was improved significantly, by the factor of ~1.5
- Silicon VD will not be built by the start of data taking (2028). To be replaced by something else (MicroMegas?)

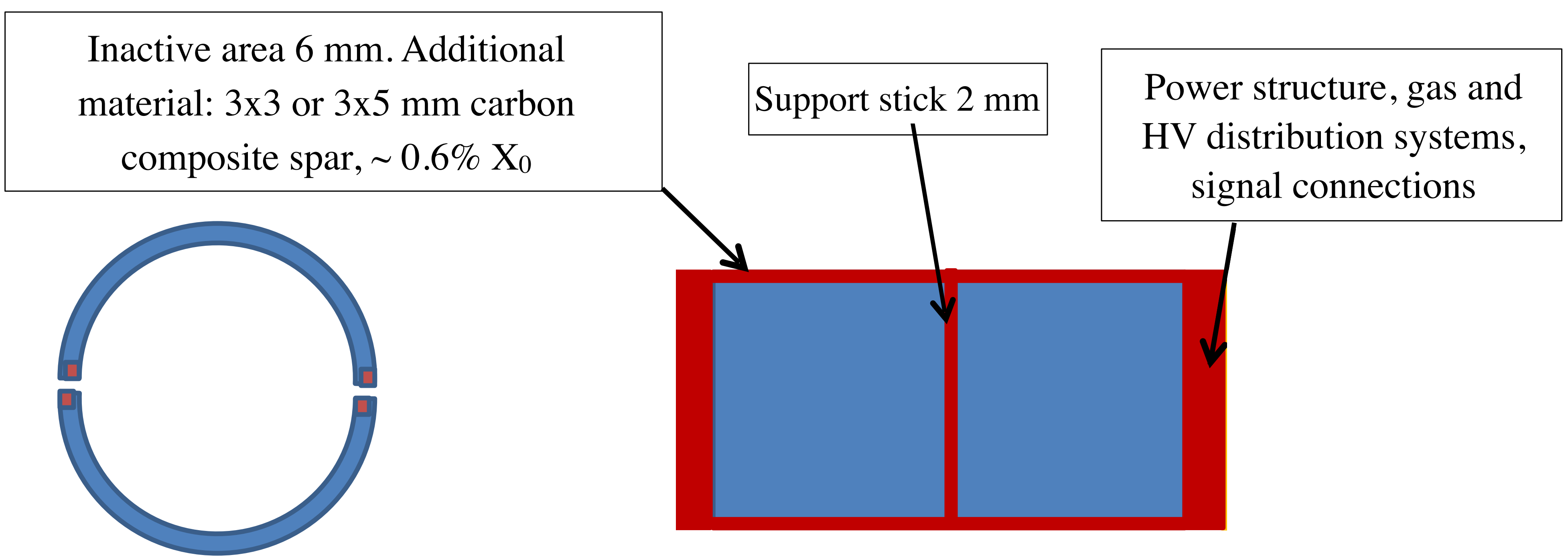


D.Dedovich
A.Gongadze

MicroMegas proposal for the Vertex Detector

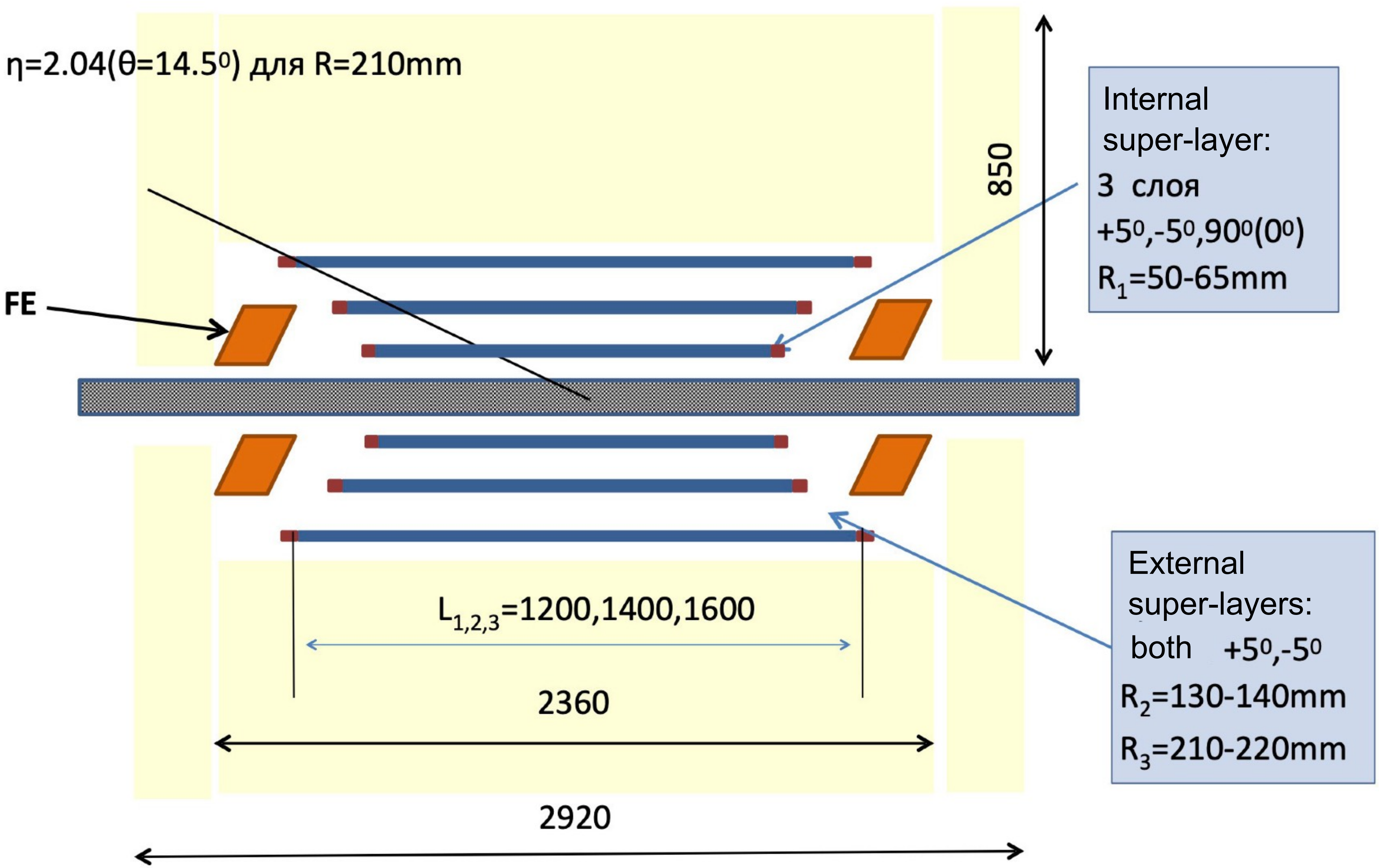
- For the first years of the experiment, it is proposed to replace the silicon vertex detector with a simpler and cheaper to manufacture MicroMegas
- It is assumed that MicroMegas for SPDs will be manufactured using bulk technology. Namely, PCB (~ 300 μm) with readout strips and a grid represent a single module made by photolithography methods. The cathode is glued to this module on a cylindrical frame. The gap and the shape of the detector are set by the power elements glued along the edges.
- A FE board based on the VMM3 chip is supposed to be used as the readout electronics. A convenient option for us is hybrid128 (2 VMM3 chips, 128 channels), developed by the RD51 collaboration.

Cross section and developed views of one detector



MicroMegas proposal for the Vertex Detector

- The number of channels is about 25 thousand (~ 200 boards, ~ 400 chips), power consumption ~ 2 kW. It is necessary to develop a cooling system



Production of MM in CEA/Saclay for the CLAS12 experiment in JLAB

Cylindrical Micromegas

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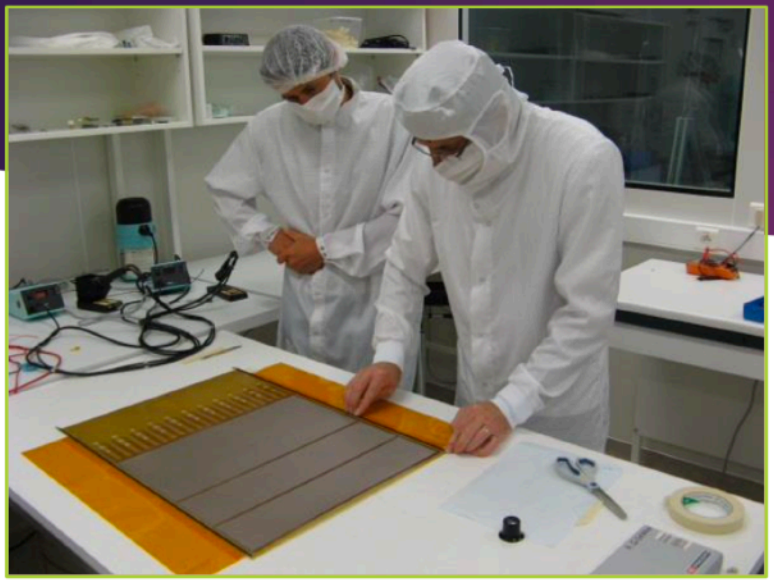
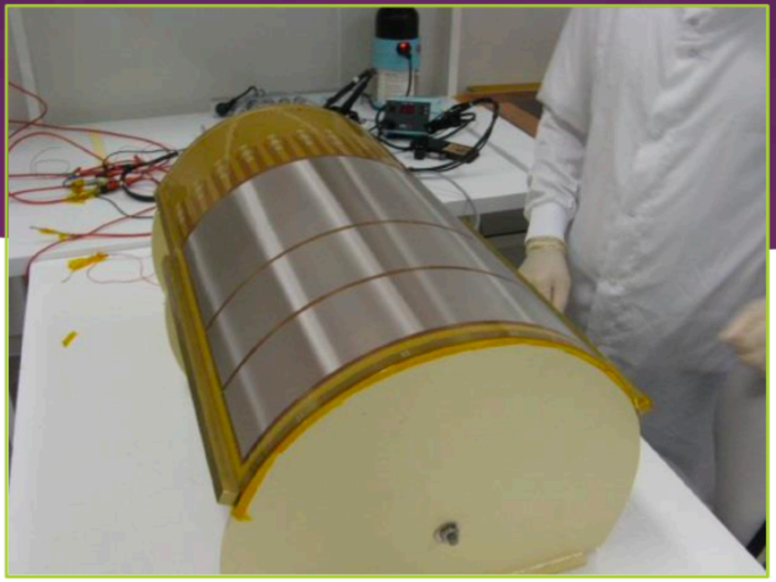
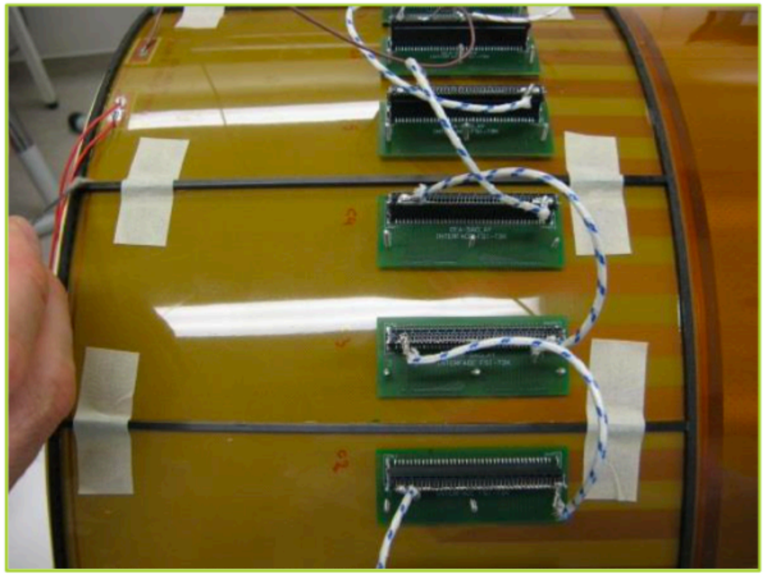


Segmentation and preparation

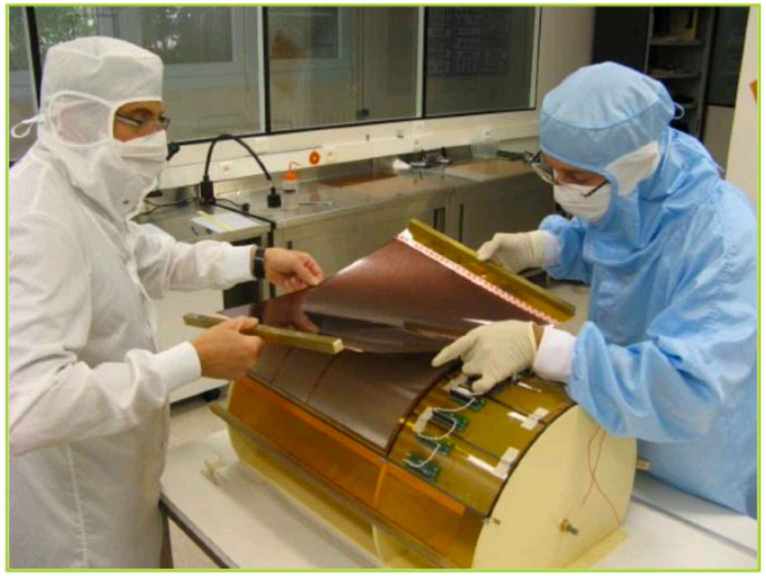


Gluing of the side carbon ribs on circular shape

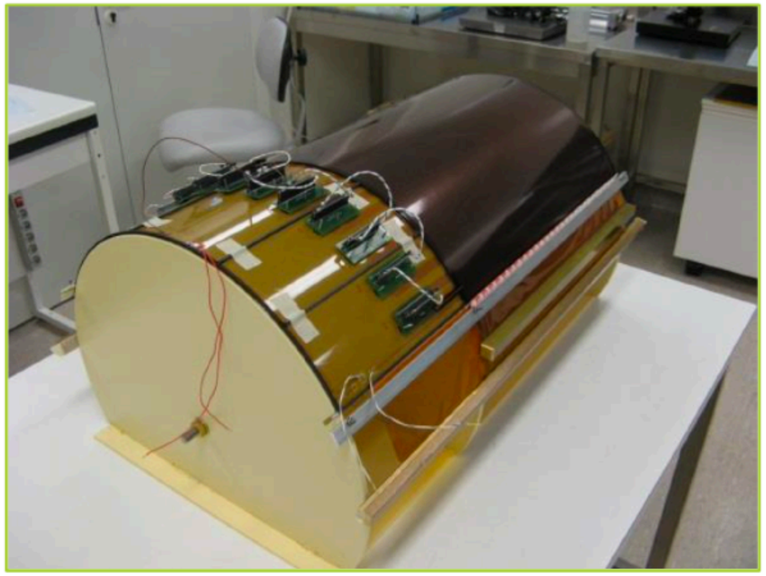
Electric leak test



Gluing of additional ribs



Setting drift plane



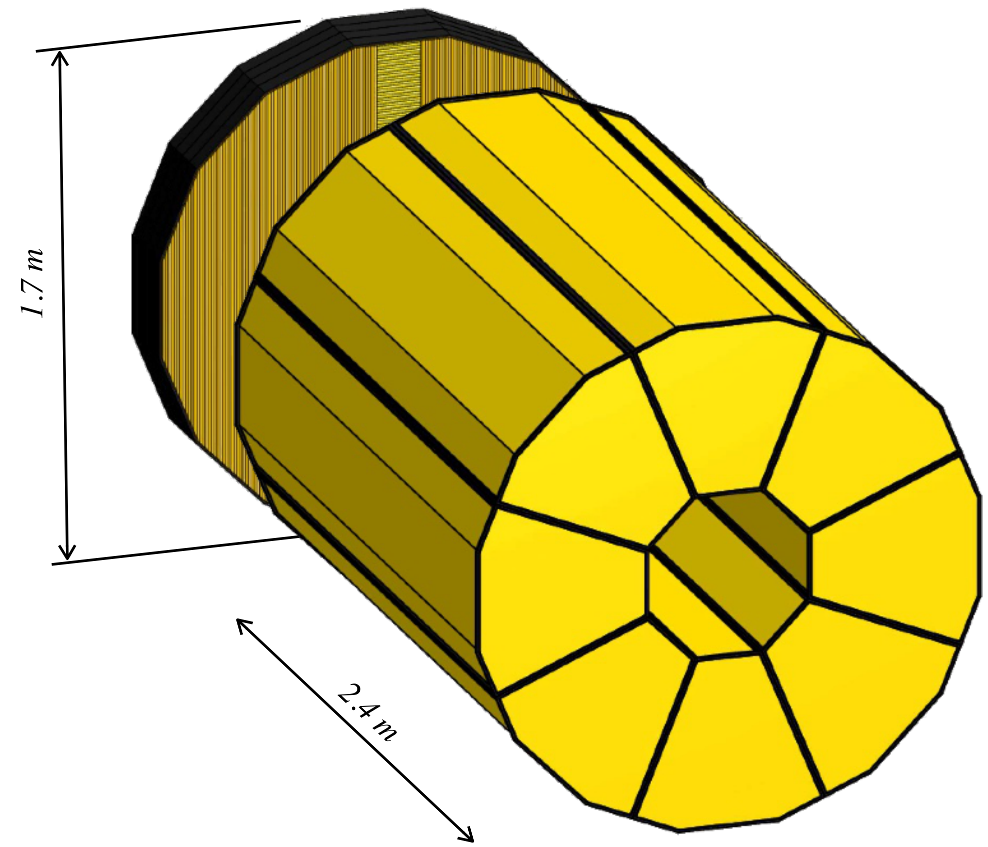
Gluing of the drift plane

CEA/IRFU - Maxence Vandenbroucke – RD51 – 12/2

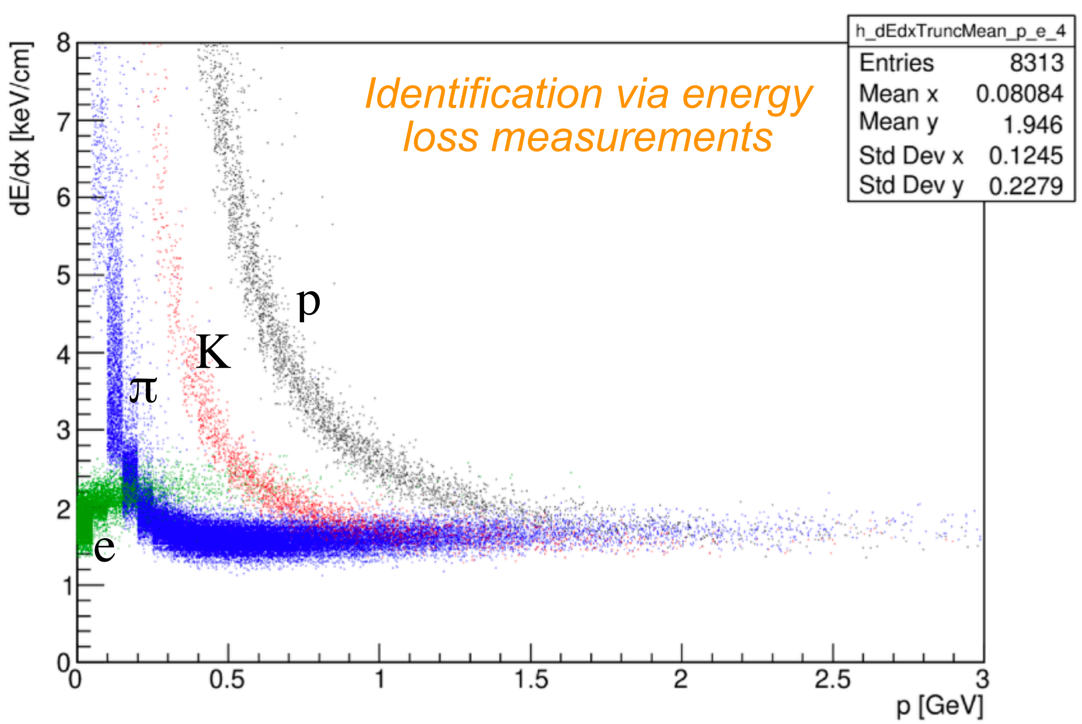
Negotiation with the team of CEA/Saclay is ongoing!

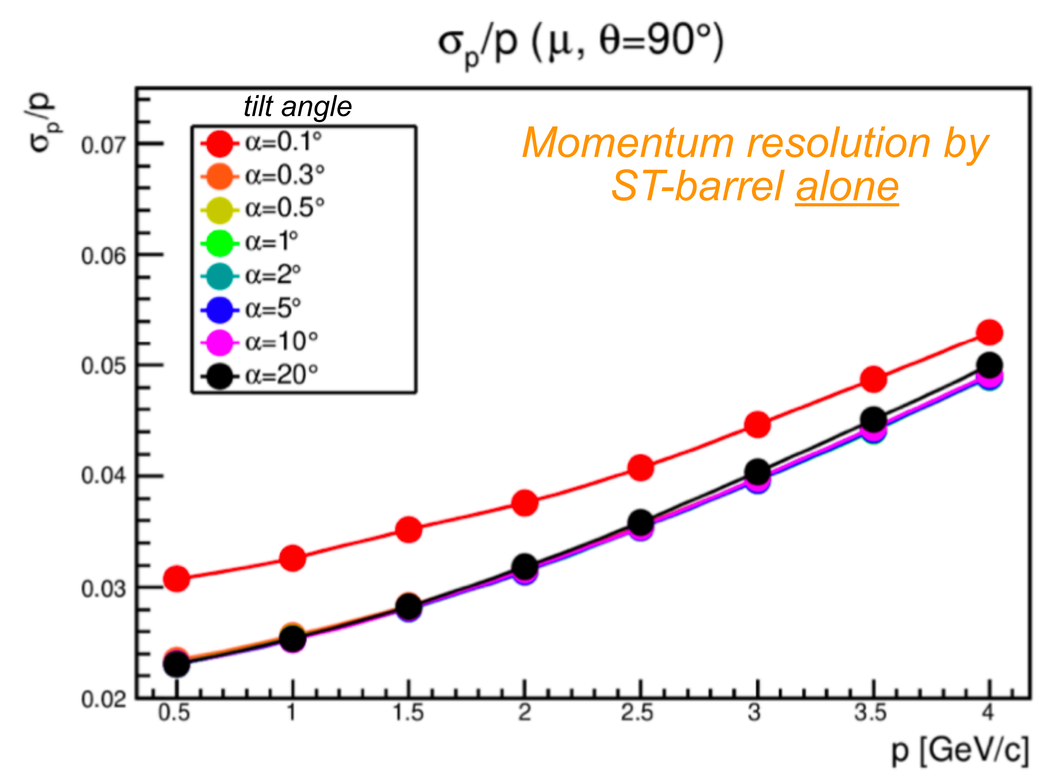
Temur Enik

Straw Tracker (ST)



- Main tracker system of SPD
- Barrel is made of 8 modules with up to 30 double-layers, with the *ZUV* orientation
- Endcaps are made of 12 double-layers with the *XYUV* orientation
- Maximum drift time of 120 ns for ∅=10mm straw
- Spatial resolution of 150 μm
- Expected DAQ rate up to MHz. Electronics is a limiting factor. VMM3 as ASIC for readout
- Number of readout channels ~50k





The straw tracker are using of in the different experiments.

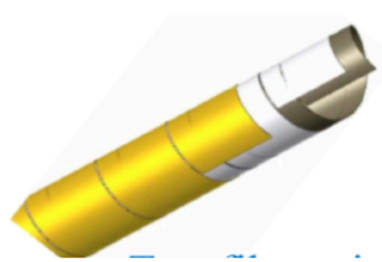
Straw winding

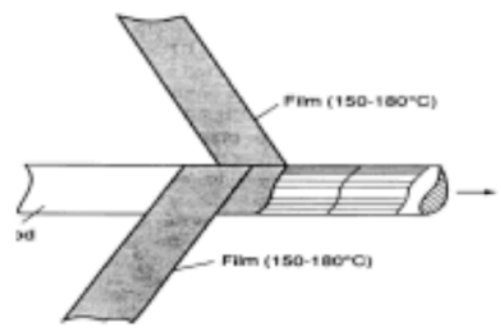
- ATLAS
- LHCb
- PANDA(overpressure)
- CBM
- COMPASS
- Mu2e(vacuum)
- NA64
- SVD-2
- GLUEX
- COZY-TOF
- ..

Straw welding

- NA62(vacuum)
- COMET(vacuum)
- SHiP(vacuum)
- DUNE(overpressure)
- ..

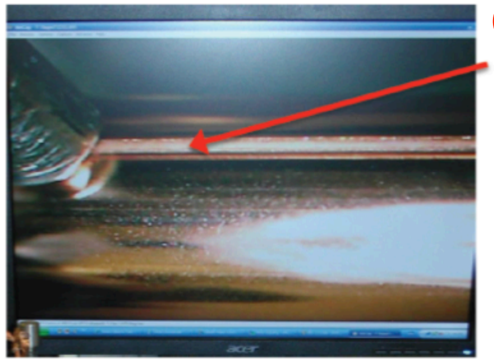
Two design of the straw-tube production



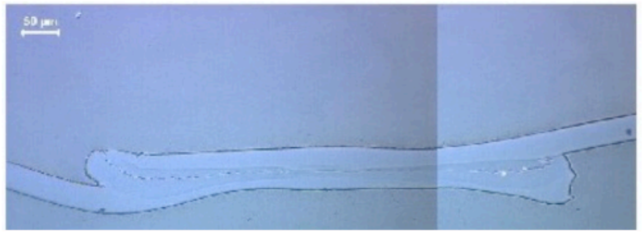


Straw winding. Two films revolve and stick together among themselves.

straw diameter from 2 mm to 18 mm



Weld seam (zoom x20 on a PC monitor)



Ultrasonic welding of straws

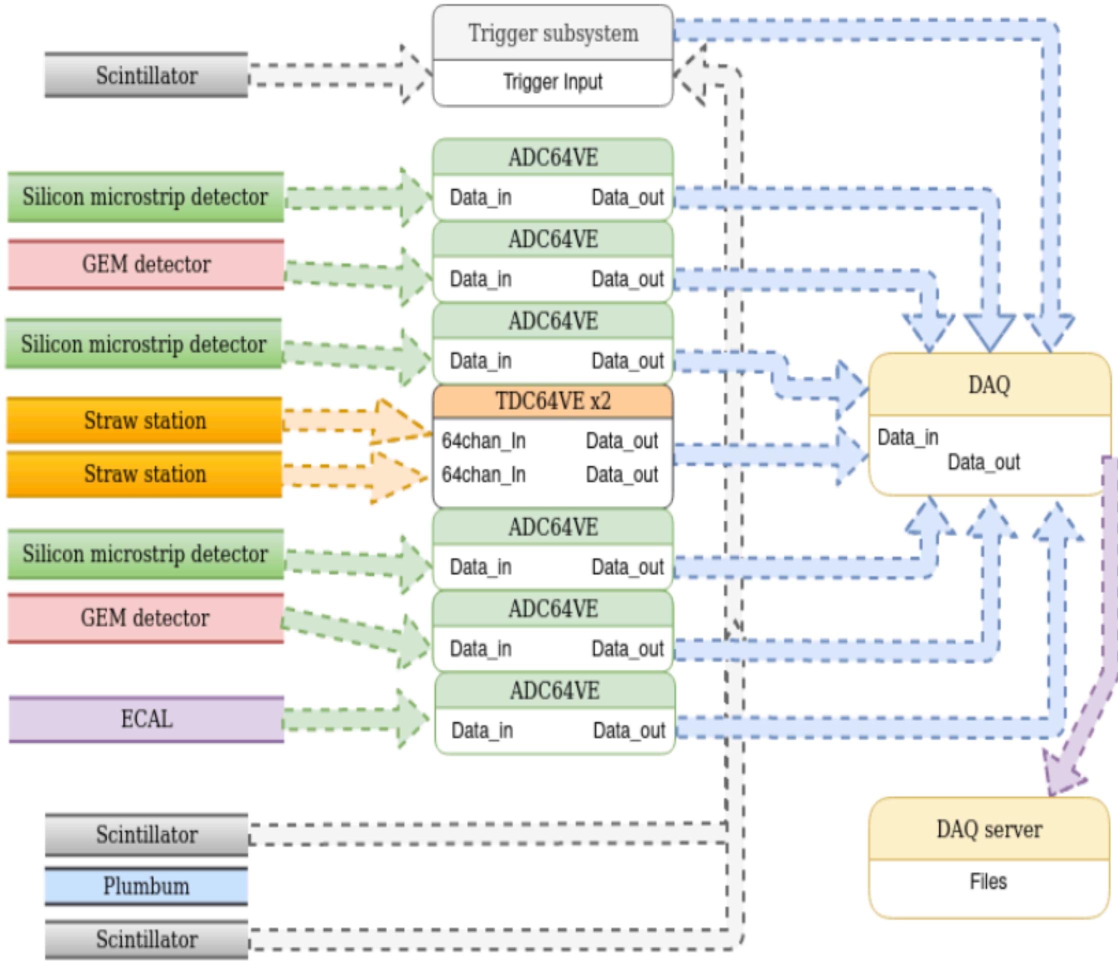
straw diameter from 5 mm to 20 mm

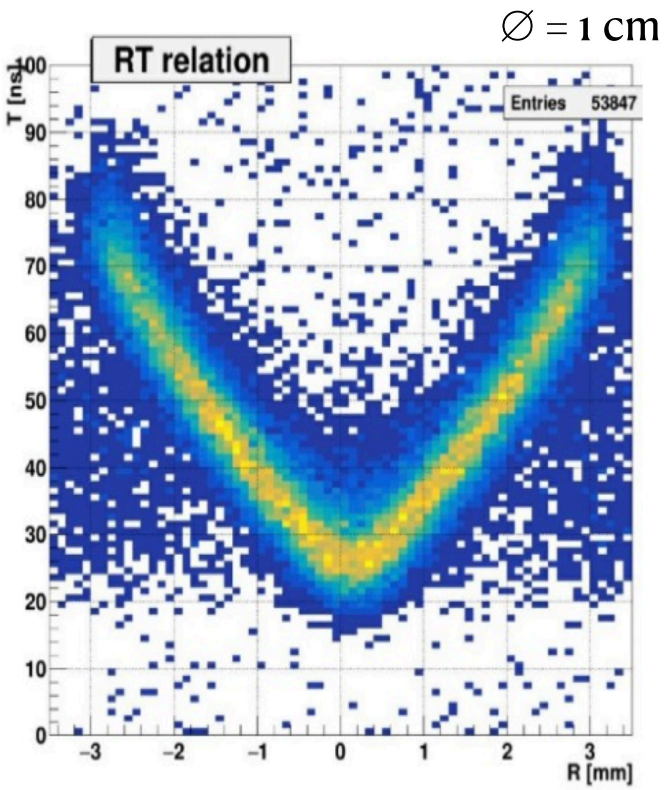
both of these technologies are well developed at JINR

MiniSPD testing facility

DAQ BM&N and MPD

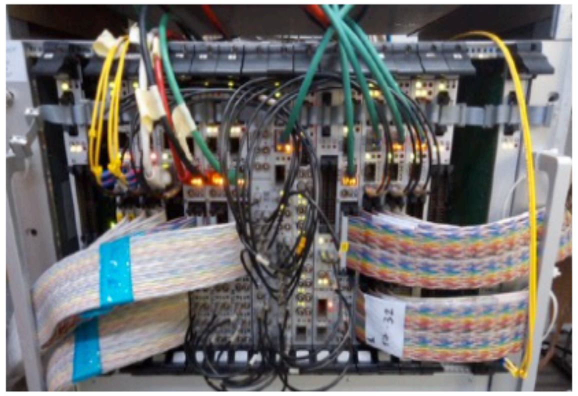
Straw+Vertex+Colorimeter

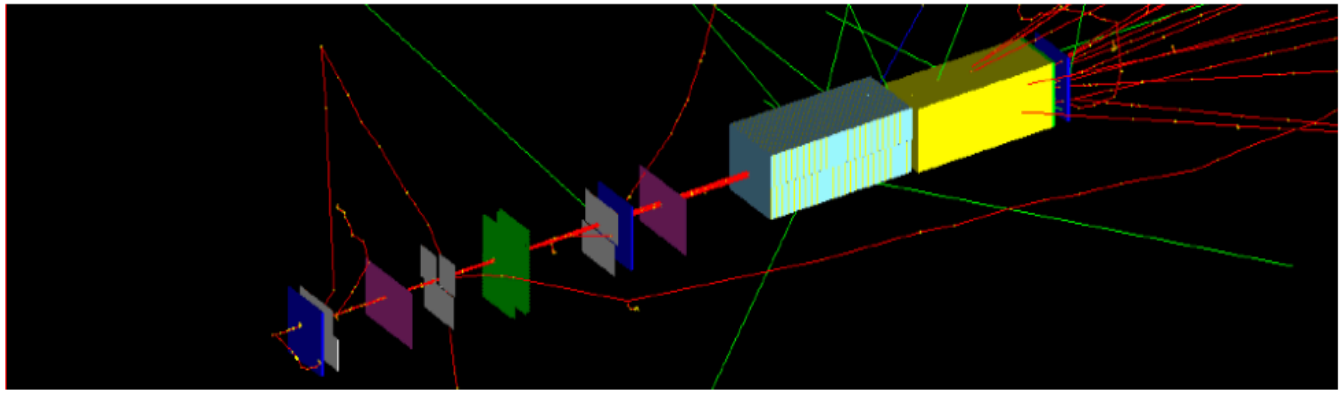




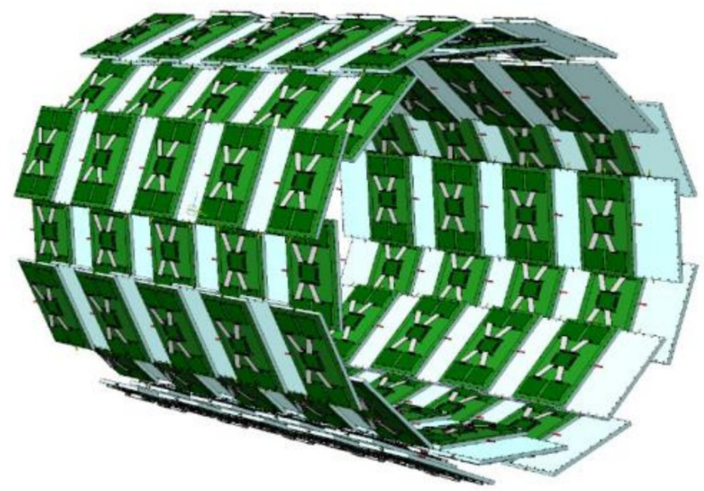
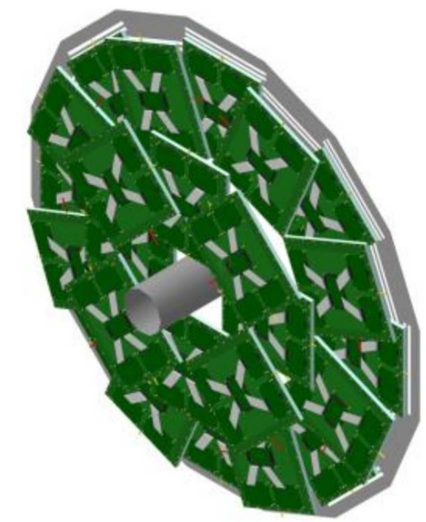
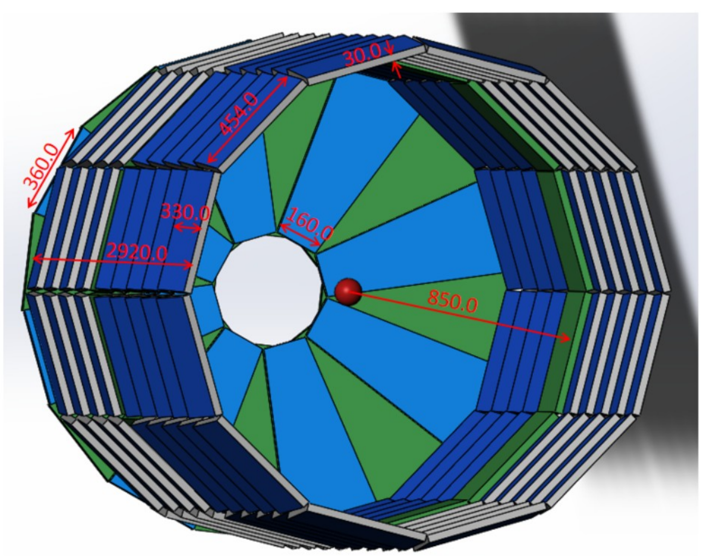
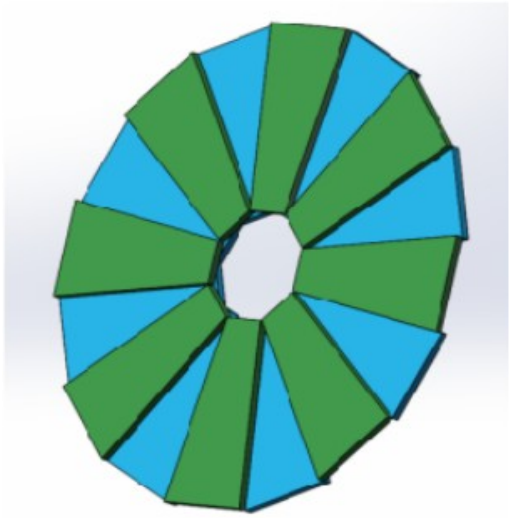
Spatial resolution 180mkm

(should be ~150 um for a single tube)



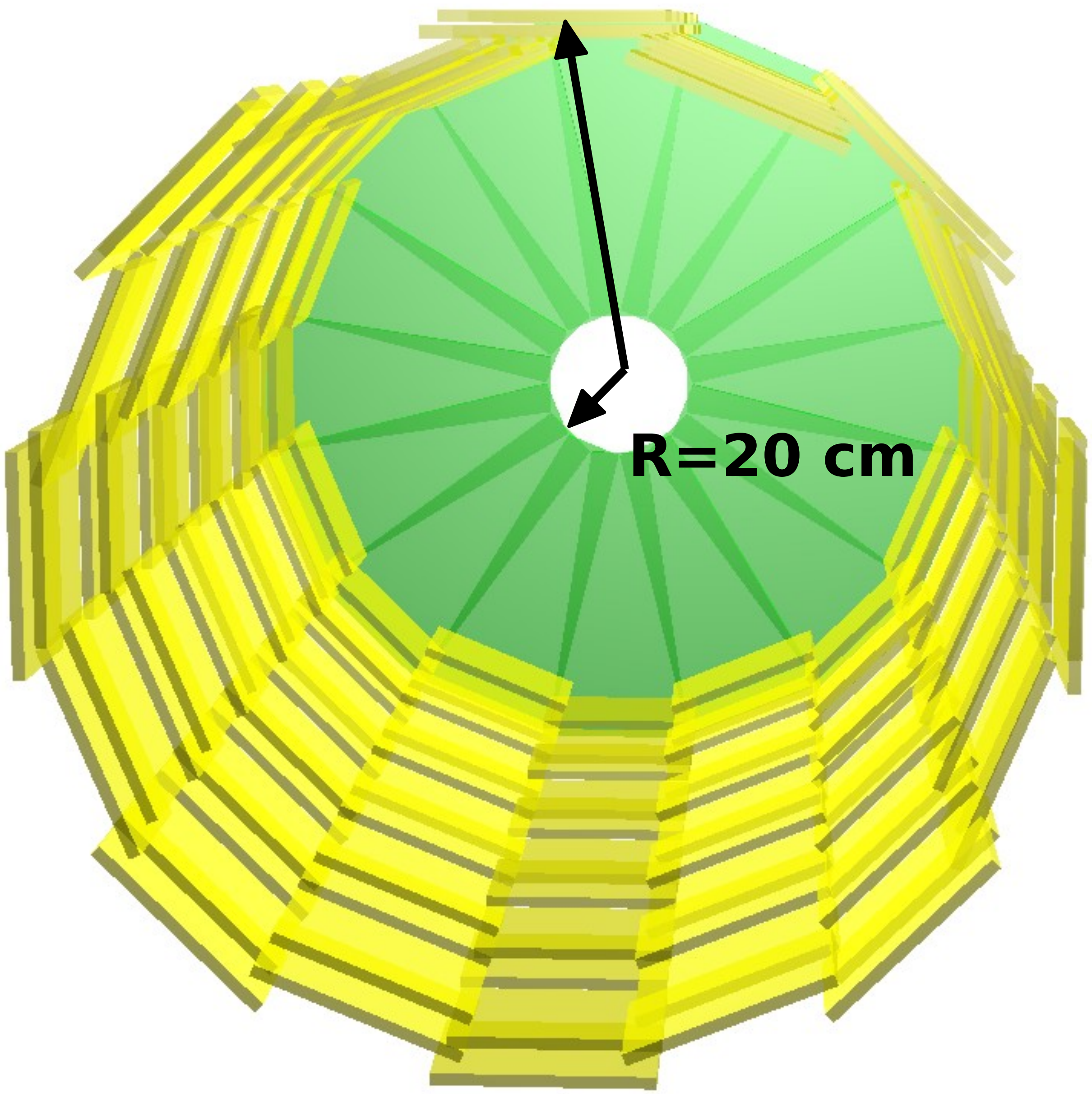


TOF system: Tsinghua and Protvino

geometry	Barrel	End-cap
A.Semak Protvino		
Yi Wang Tsinghua		

Hybrid TOF system

R=85 → 105 cm



Barrel-module (Protvino)
Length=40 → 44 cm
Width=33 cm
Height=2.5 cm

Geometry Barrel as from Protvino

End-cap-module (Tsinghua)
Width1=14.0 cm
Width2=34.0 → 42 cm
Length=70 → 85.0 cm
Height=3.0 cm

Geometry End-Cap as from Tsinghua

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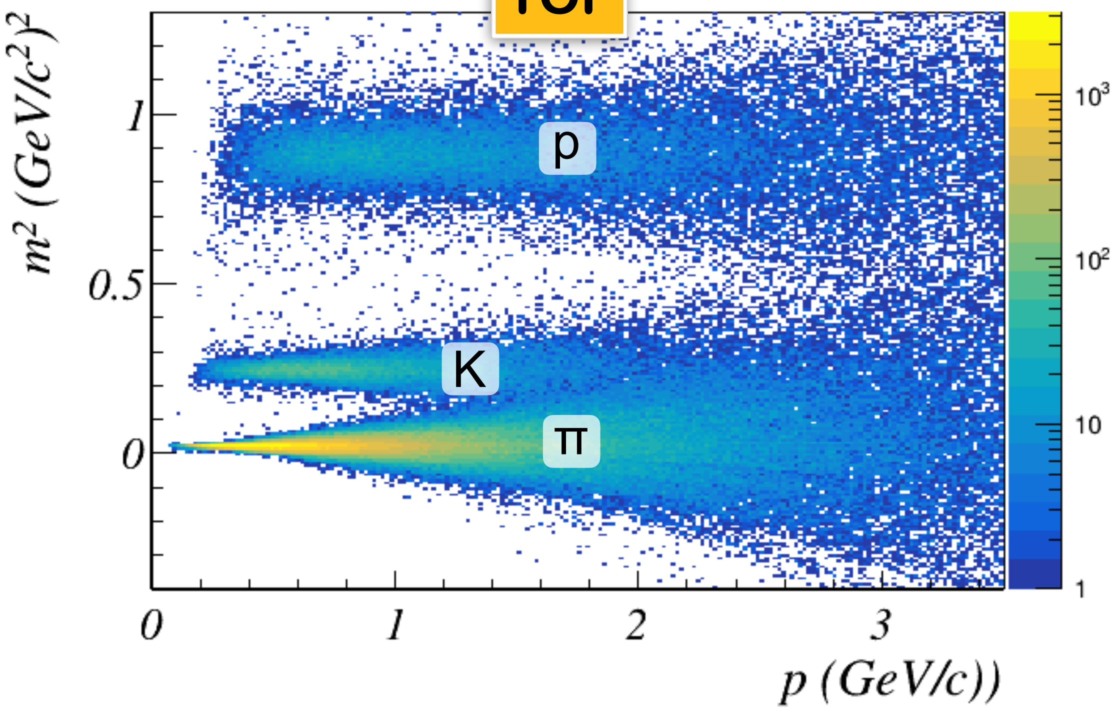
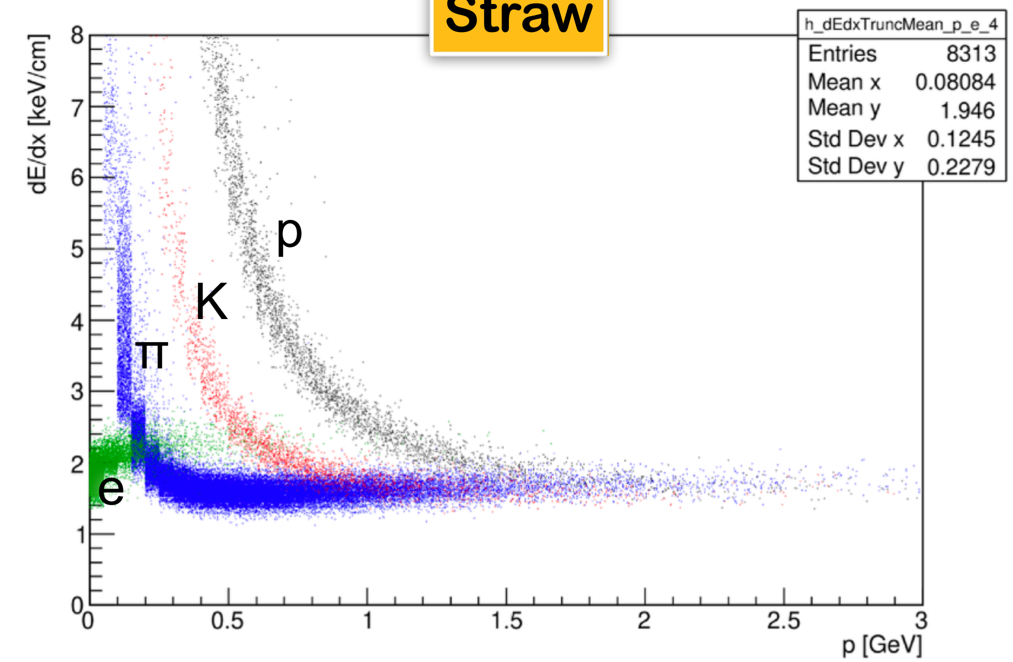
Presented by A.Ivanov at S&C meeting on 26.10.2021

PID analysis in SPD (π, K, p)

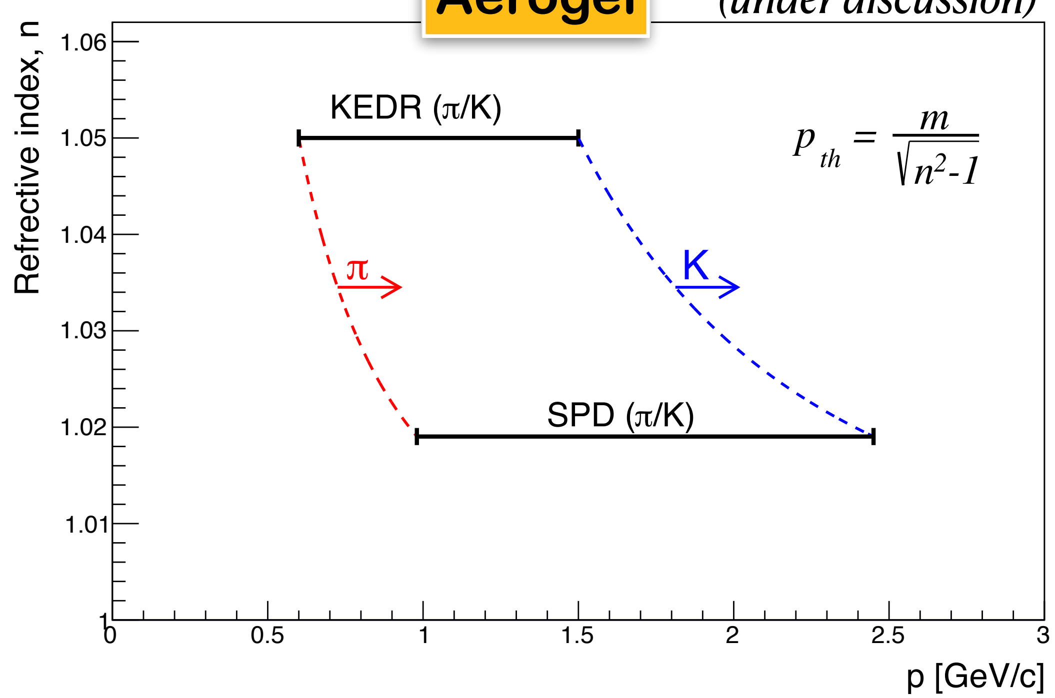
TOF



Straw



Aerogel *(under discussion)*



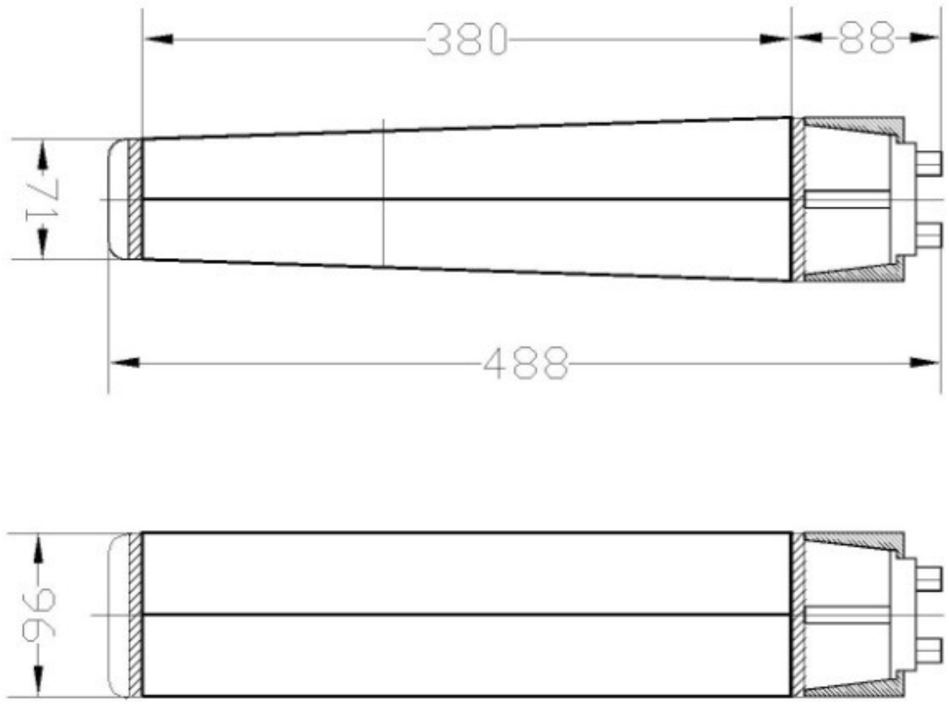
π/K separation

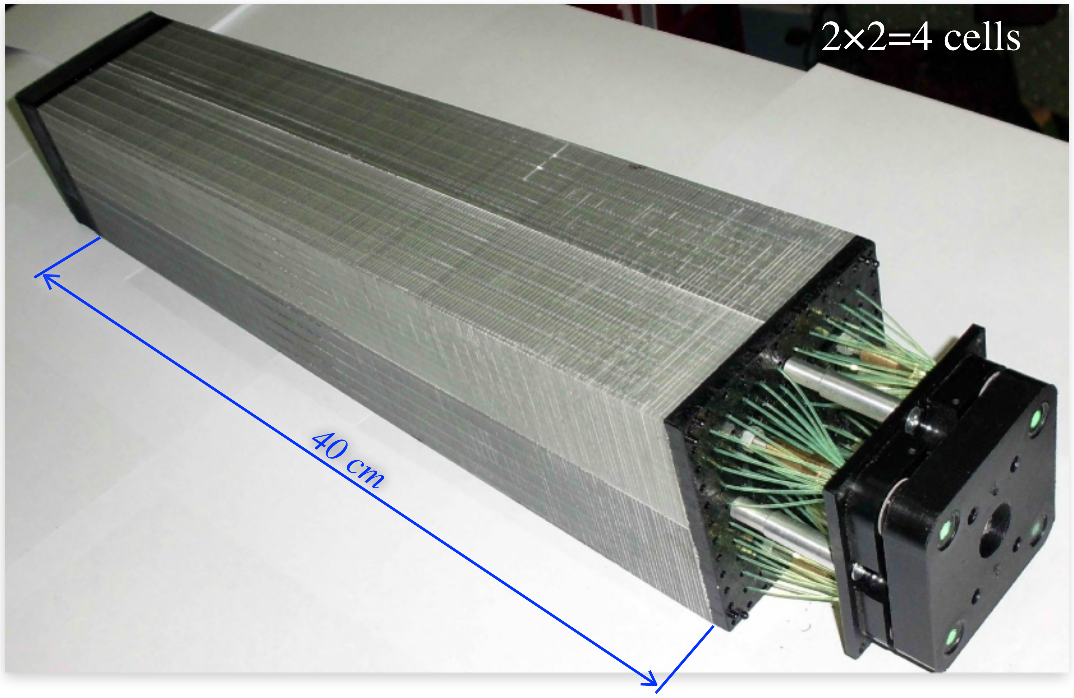
- Short tracks (R<1m) to be identified by straw up to 0.7 GeV/c
- Long tracks (R>1m) to be identified by straw+TOF up to 1.5 GeV/c
- tracks with p>1.5 GeV/c to be identified by aerogel

O.Gavrischuk

Electromagnetic Calorimeter (ECal)

- Purpose: detection of prompt photons and photons from π^0, η and χ_c decays, discrimination $h \leftrightarrow l$
- Number of radiation lengths $18.6X_0$
- 200 layers of lead (0.5 mm) and scintillator (1.5mm)
  - Size of one sandwich: $4 \times 4 \times 40\ cm^3$
- Energy resolution is ~5% at 1 GeV
- Total weight is 40t (barrel)+2×14t (endcap) = 68t
- Total number of channels is ~30k



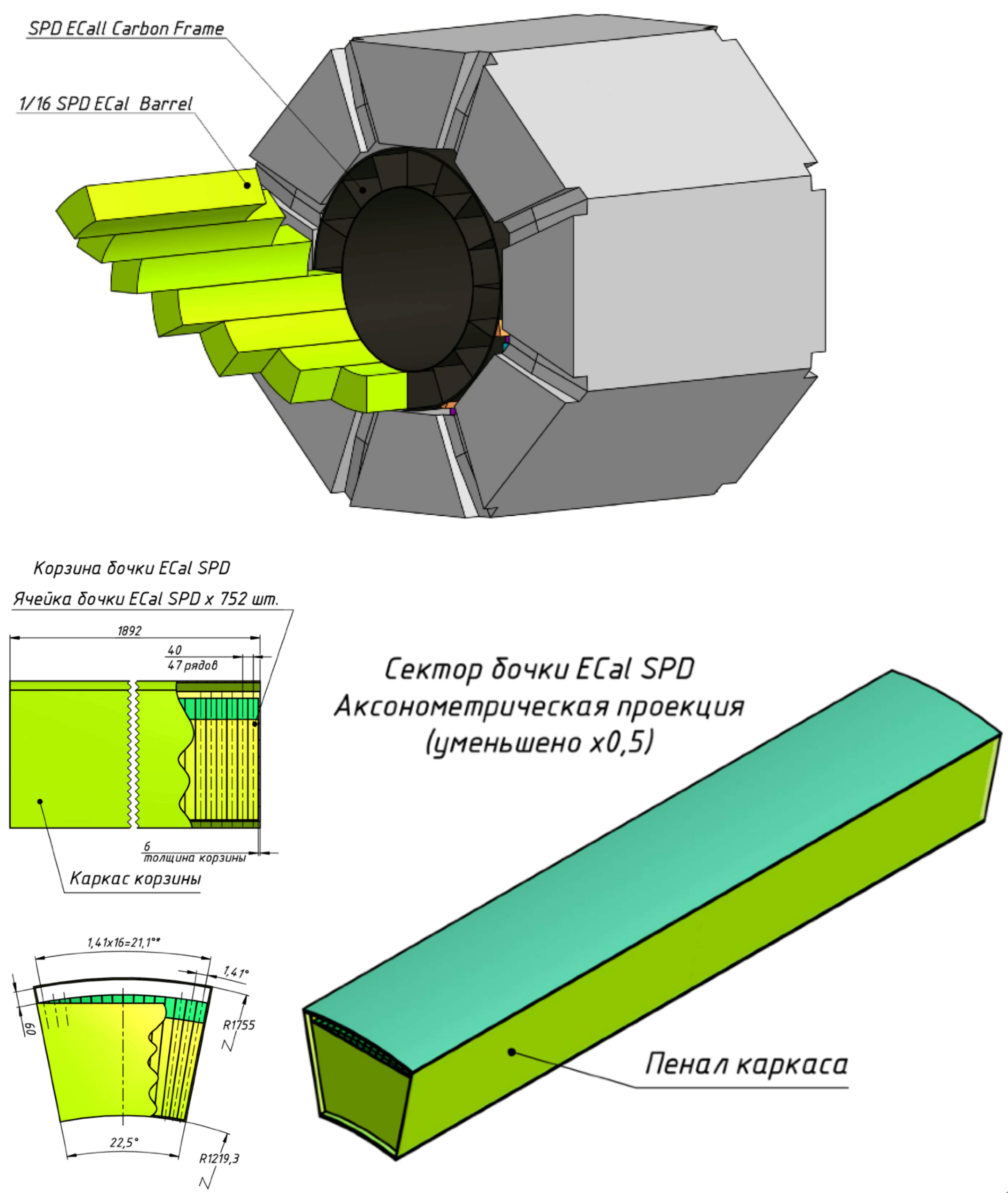


Electromagnetic Calorimeter (ECal)

CDR

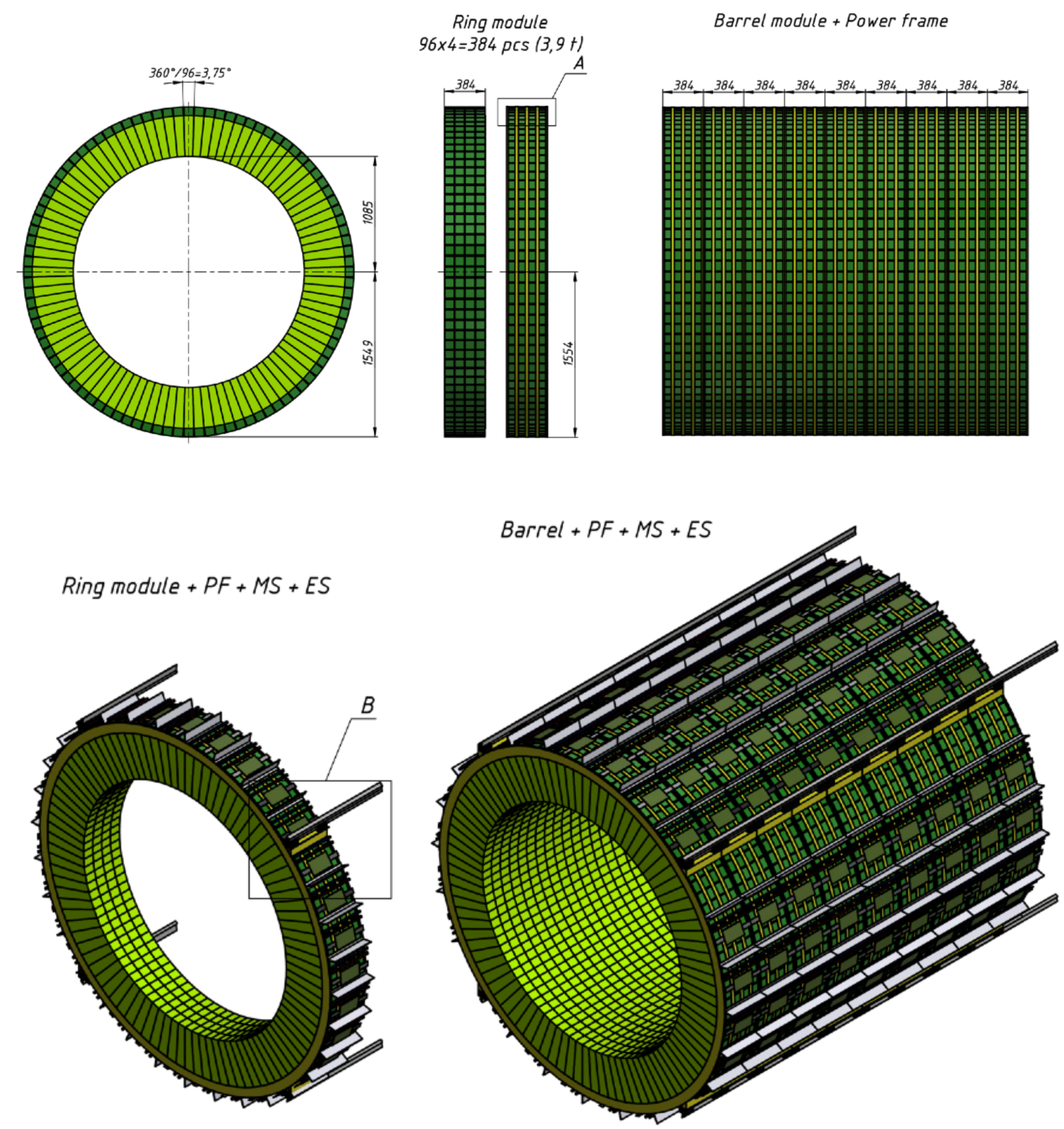
Half-sector approach

Similarly as it is employed in the MPD experiment



Rim approach

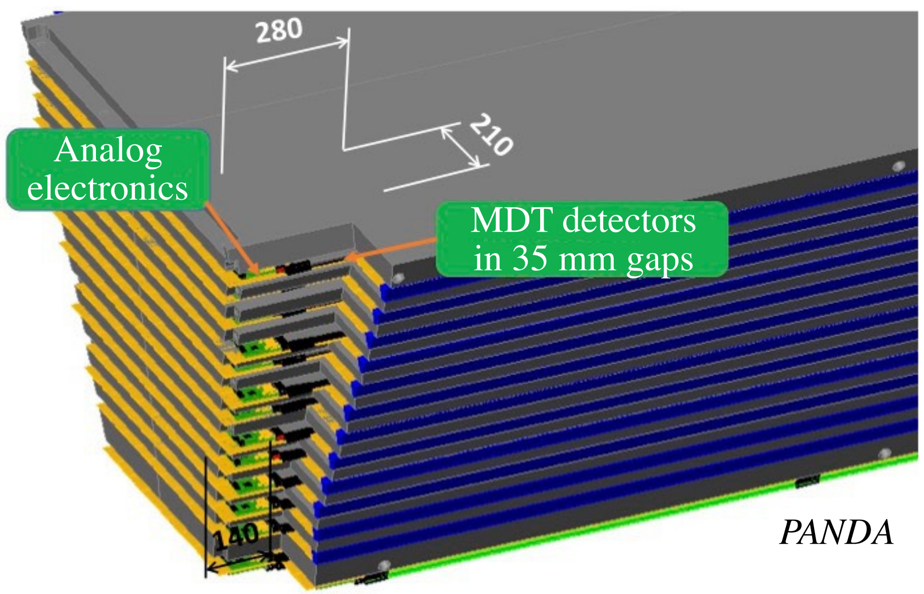
It was proposed in order to avoid inefficiency regions distributed azimuthally



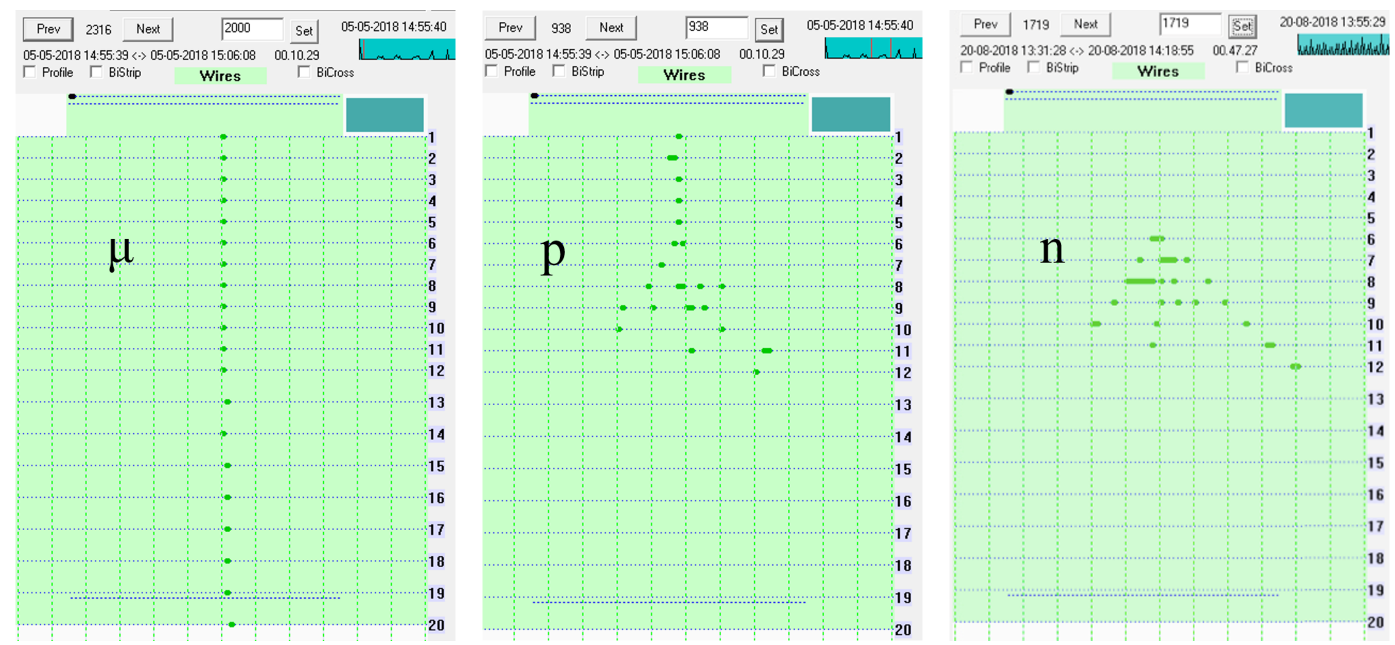
G. Alexeev,
A. Samartsev

Range System (RS)

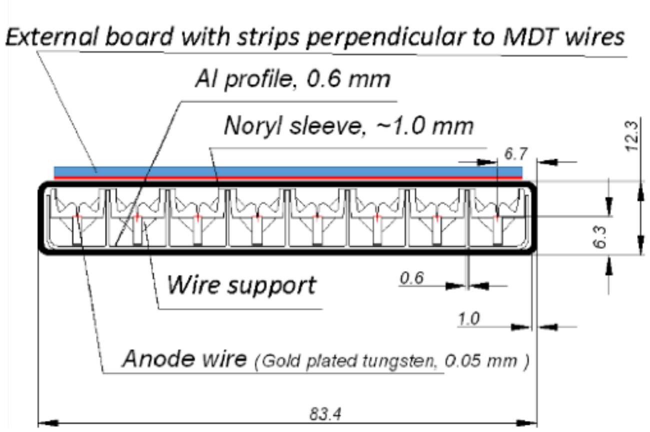
barrel = 8 modules

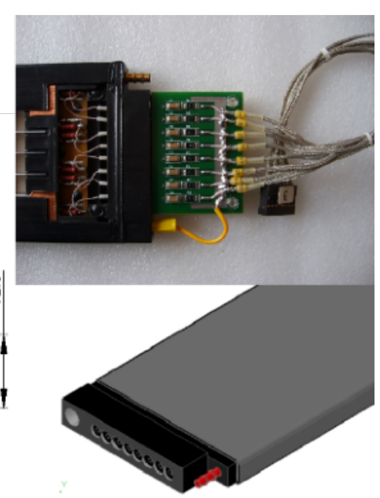


Results of beam tests of RS prototype (10 ton, 4k ch) at CERN



MDT with open cathode geometry and external pickup electrodes (strips) cross-section





- Purposes: μ identification, rough hadron calorimetry
- 20 layers of Fe (3-6 cm) interleaved with gaps for Mini Drift Tube (MDT) detectors
- Total mass ~850 t, at least $4\lambda_I$
- The design will follow closely the one of PANDA
- MDT provide 2 coordinate readout (~100 kch)
  - Al extruded comb-like 8-cell profile with anode wires + external electrodes (strips) perpendicular to the wires

FEA for stress and deflections

Deflection of upper module downward under its own weight is about **2 mm**

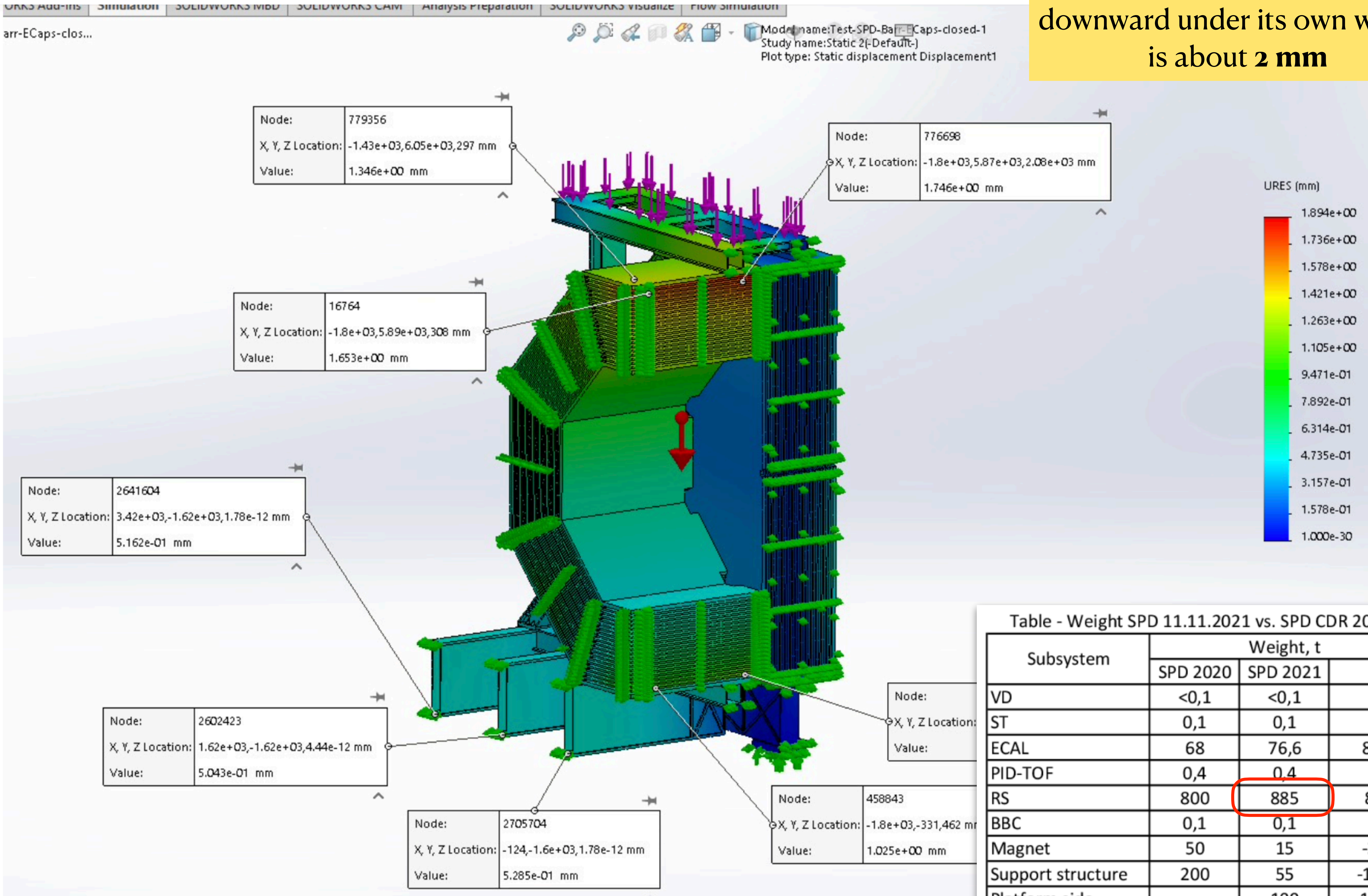


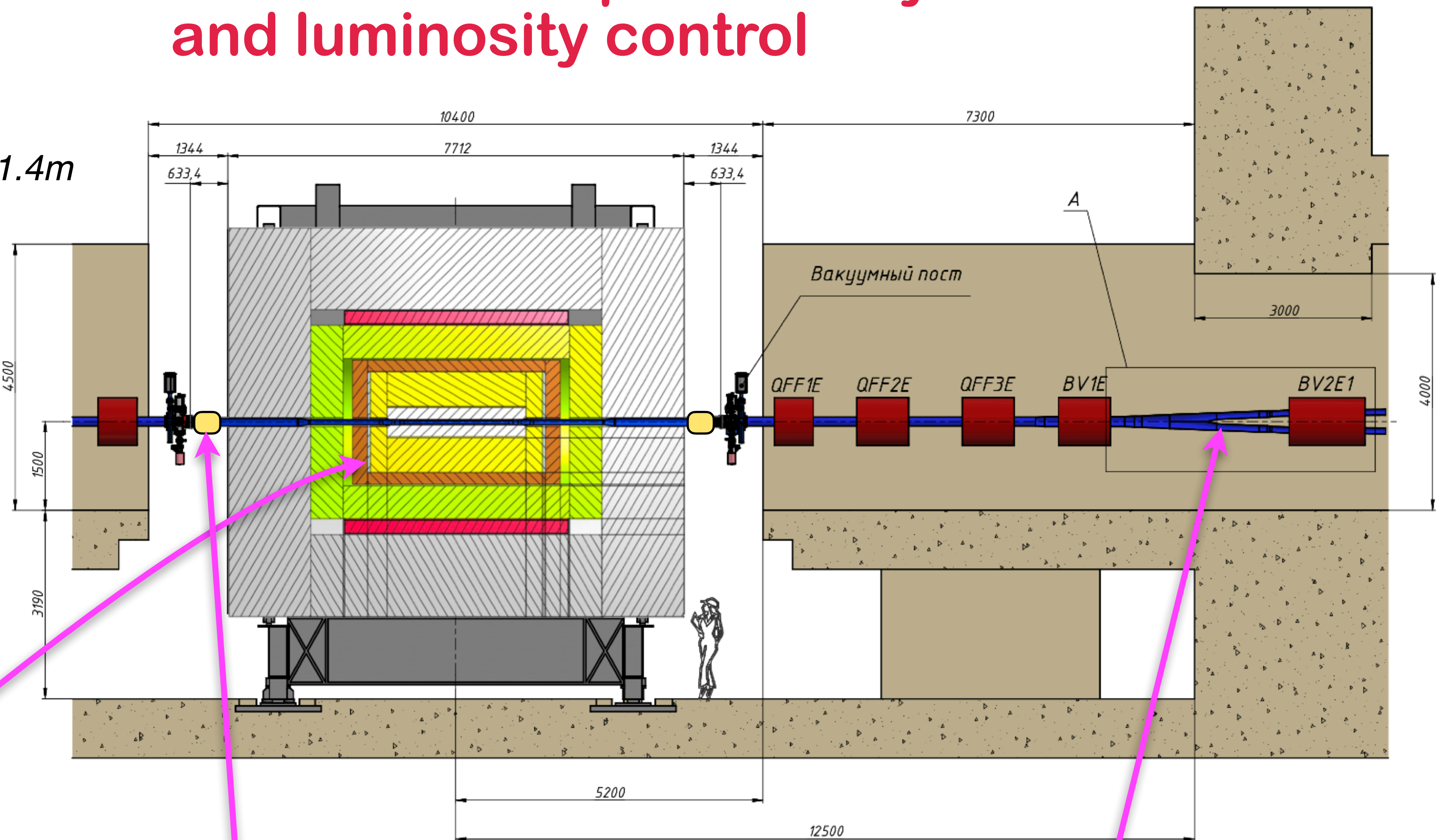
Table - Weight SPD 11.11.2021 vs. SPD CDR 2020.

Subsystem	Weight, t		
	SPD 2020	SPD 2021	Δ
VD	<0,1	<0,1	0
ST	0,1	0,1	0
ECAL	68	76,6	8,6
PID-TOF	0,4	0,4	0
RS	800	885	85
BBC	0,1	0,1	0
Magnet	50	15	-35
Support structure	200	55	-145
Platform side		100	100
Platform top		40	40
TOTAL:	**1118,6**	**1172,2**	**53,6**

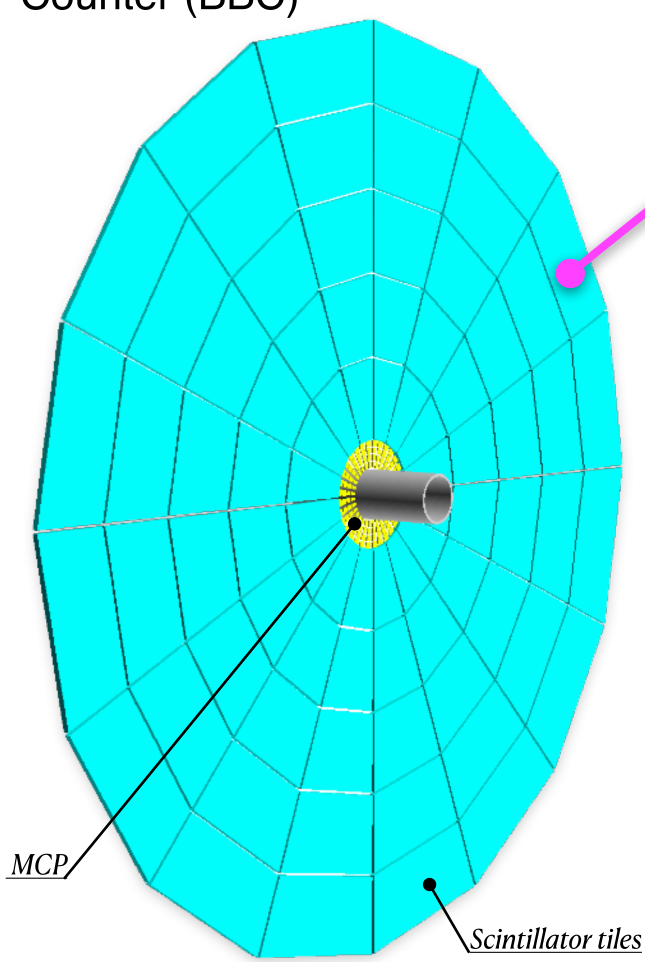
BBC: V.Ladygin, A.Baldin
ZDC: I.Alekseev

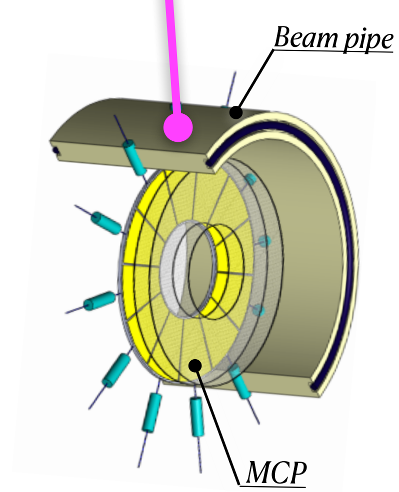
Detectors for local polarimetry and luminosity control

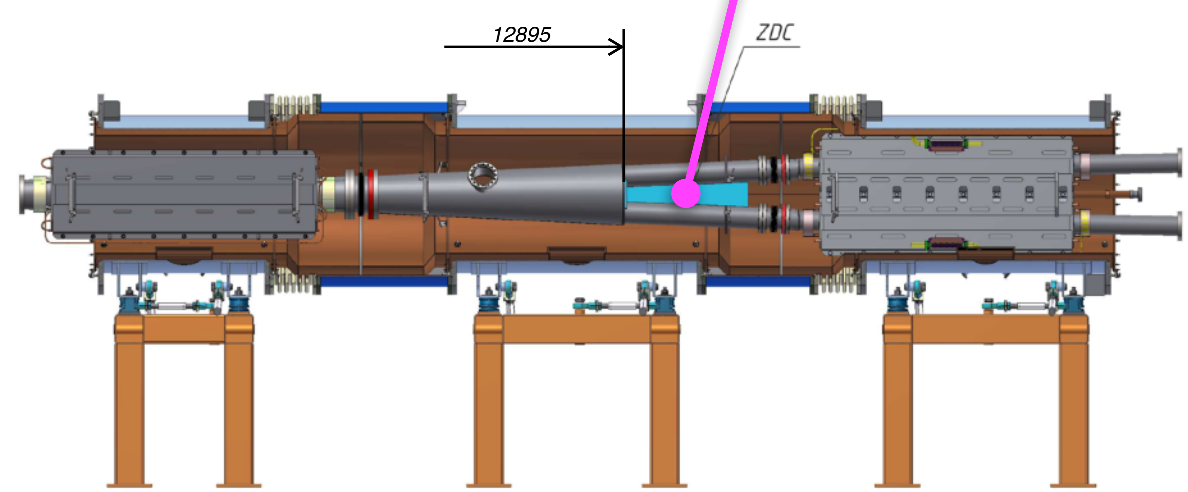
- BBC (MCP+SciTil) at *z=±1.4m*
- MCP at *z=±3.9m*
- ZDC at *z=±12.9m*



Beam-Beam Counter (BBC)

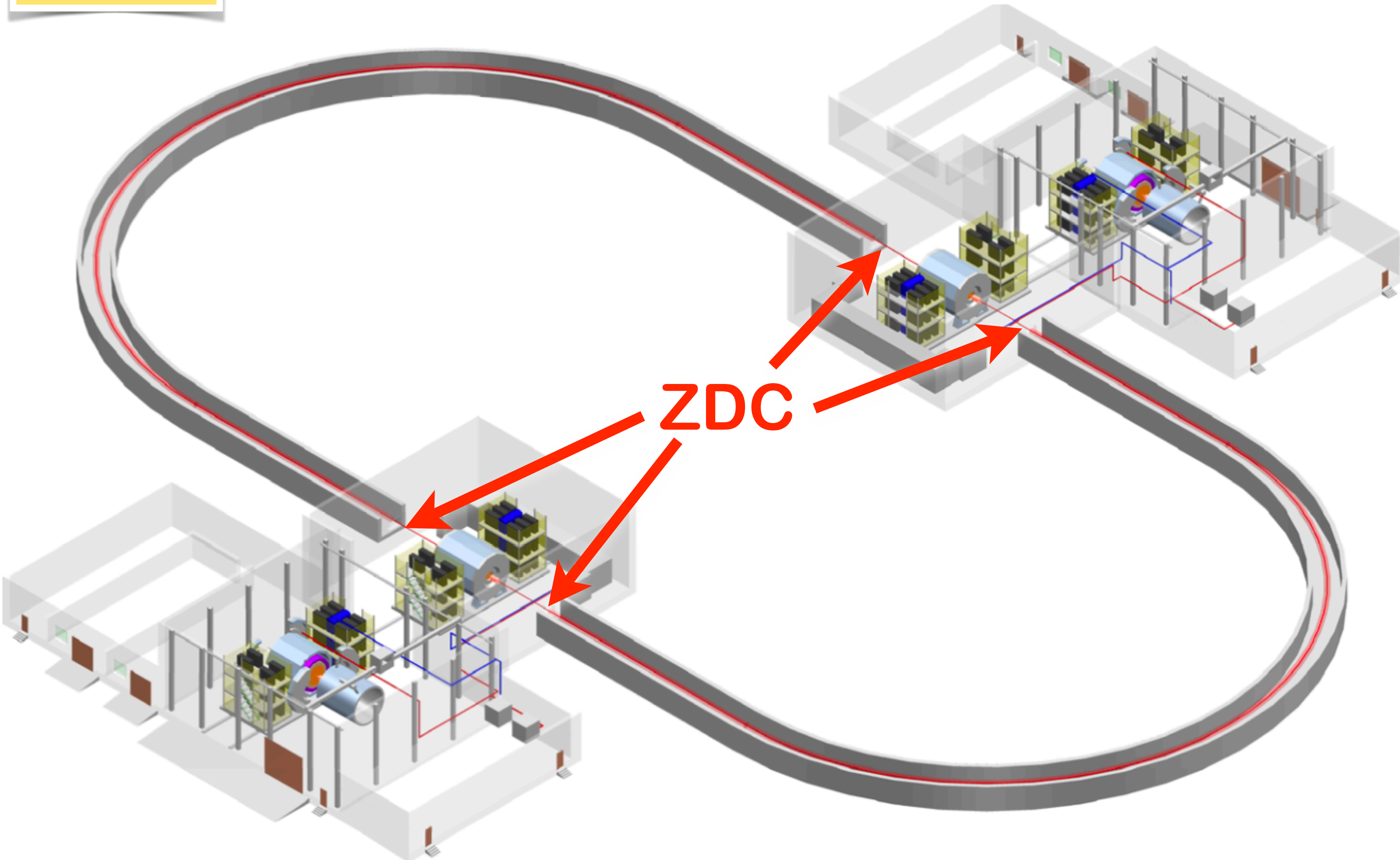




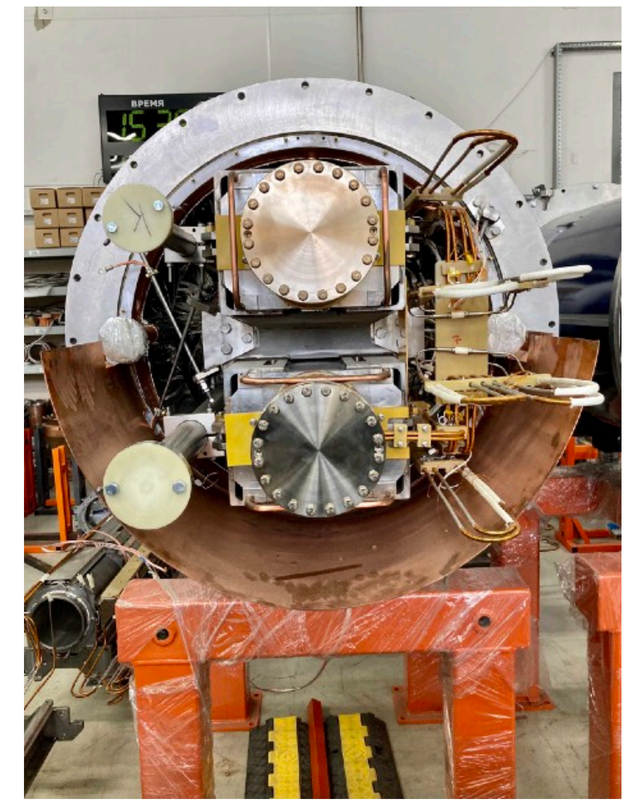


I.Alekseev
S.Shimansky

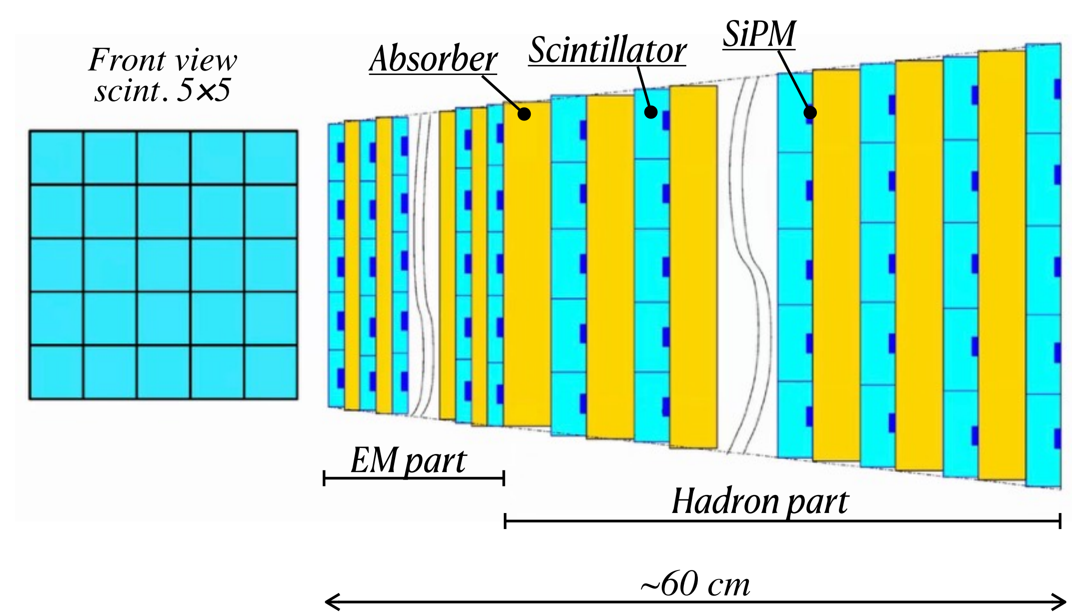
Zero Degree Calorimeter (ZDC)



ZDC will be locates in 'cold' zone between two beampipes

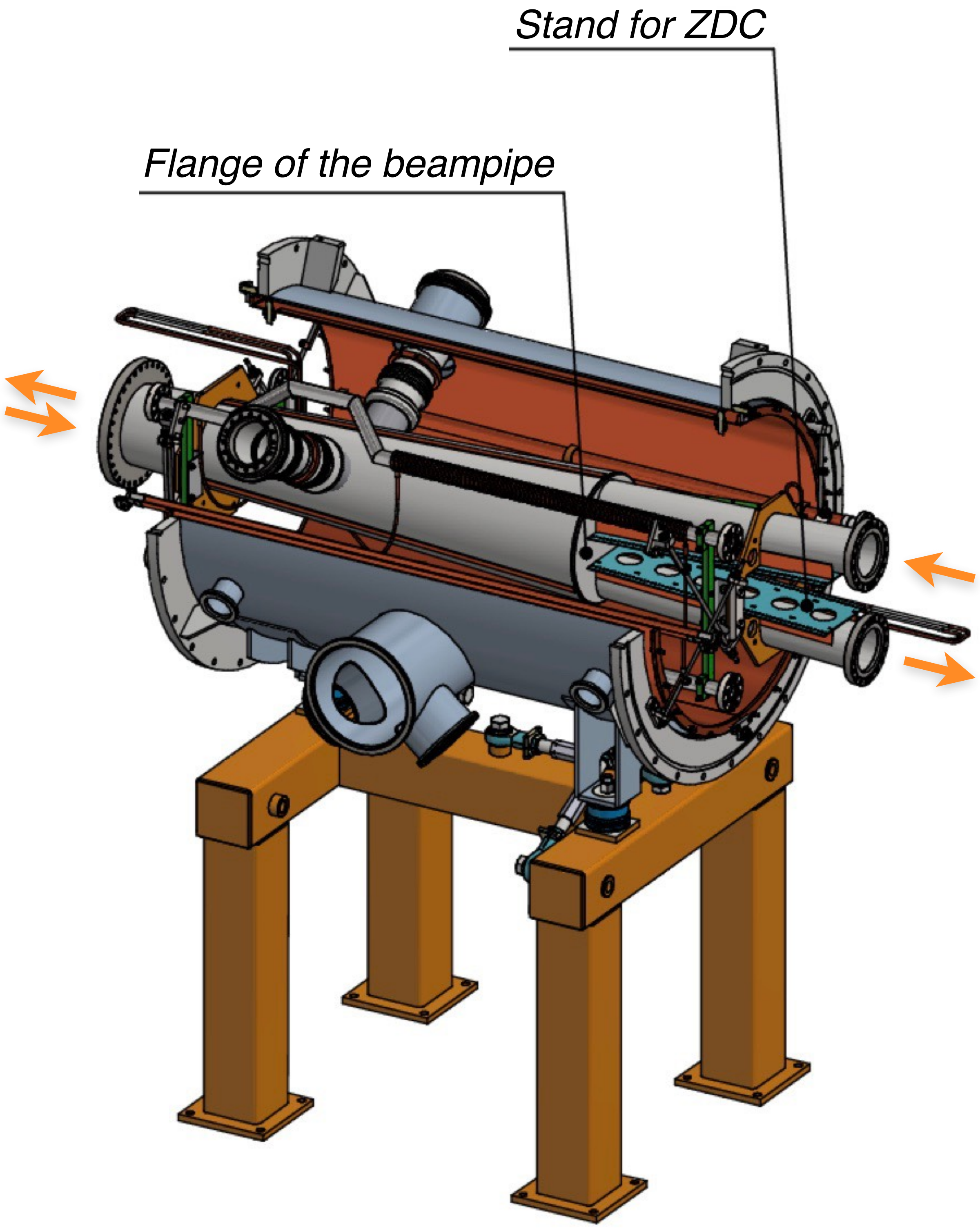


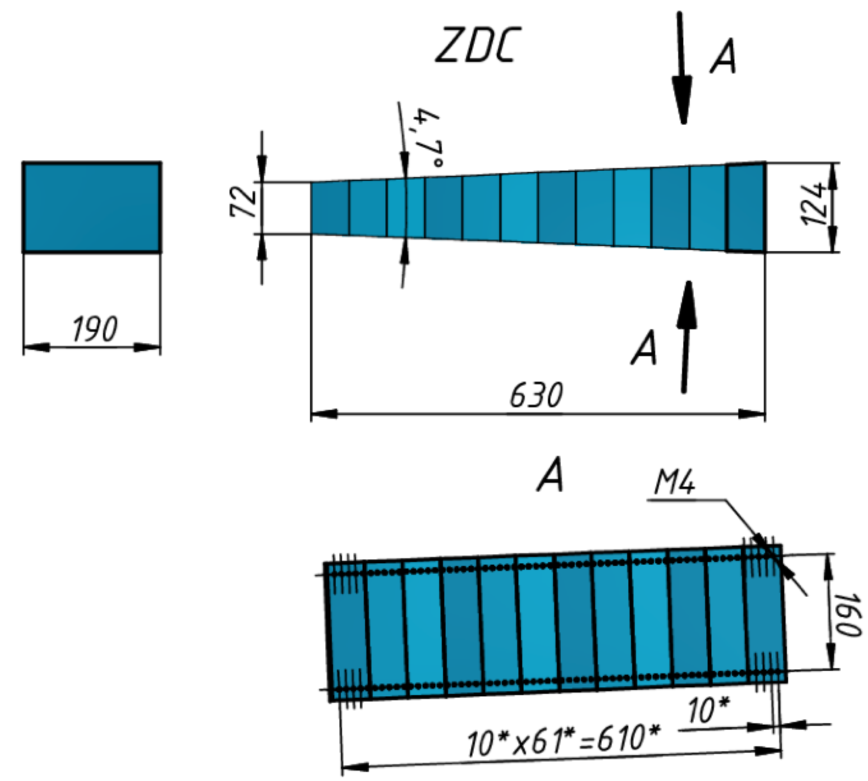
- Discussion with accelerator people (Syresin, Meshkov, Butenko) on 27.10.2021.
- Agreed on: 4 identical zones in the region of beampipe merging to be allocated for ZDC
- Funds to be shared in equal proportion between SPD, MPD and Accelerator teams.
- Two ZDC prototypes to be ready in 2023



Yu. Gusakov
O. Golubictkiy

Zero Degree Calorimeter (ZDC)





- Weight is ~100 kg
- Located inside the cryostat (vacuum, about -200 ˙C)
- To be loaded section-by-section
- About 1000 DAQ channels
- Two few-section ZDC prototypes to be ready by the beginning of 2023

- Hardware session tomorrow
- FEE and DAQ today after lunch

Mon 13/12 | **Tue 14/12** | Wed 15/12 | All days

Print | PDF | Full screen | Detailed view | Filter

Session legend

Hardware Session: accelerator,

11:00	Spin transparency mode at the NICA collider	Yury Filatov	11:00 - 11:20
	SPD experimental hall status	Alexey Livanov	11:20 - 11:35
	SPD magnet based on PANDA cable	Evgeniy Pyata	11:35 - 11:55
12:00	SPD magnet based on NICA cable	Hamlet Khodzhibagiyan	11:55 - 12:15
	MM proposal for VD	Dmitry Dedovich	12:15 - 12:35
	Straw Tracker (ST)	Temur Enik	12:35 - 12:55
13:00			
14:00	MRPC for PID system (Tsinghua)	Yi Wang	14:00 - 14:20
	MRPC for PID system (Protvino)	Artem Semak	14:20 - 14:40
	Electromagmetic Calorimeter (ECal)	Oleg Gavrishchuk	14:40 - 15:00
15:00	Range System (RS)	Guennadi Alexeev	15:00 - 15:20
	Beam-Beam Counters (BBC)	Aleksey Tishevskiy	15:20 - 15:40
	Zero Degree Calorimeter (ZDC)	Igor Alekseev	15:40 - 16:00
16:00	Detector Control System (DCS)	Alexander Chepurnov	16:00 - 16:20
	MCP and the SPD test zone at extracted beams of Nuclotron	Anton Baldin	16:20 - 16:40

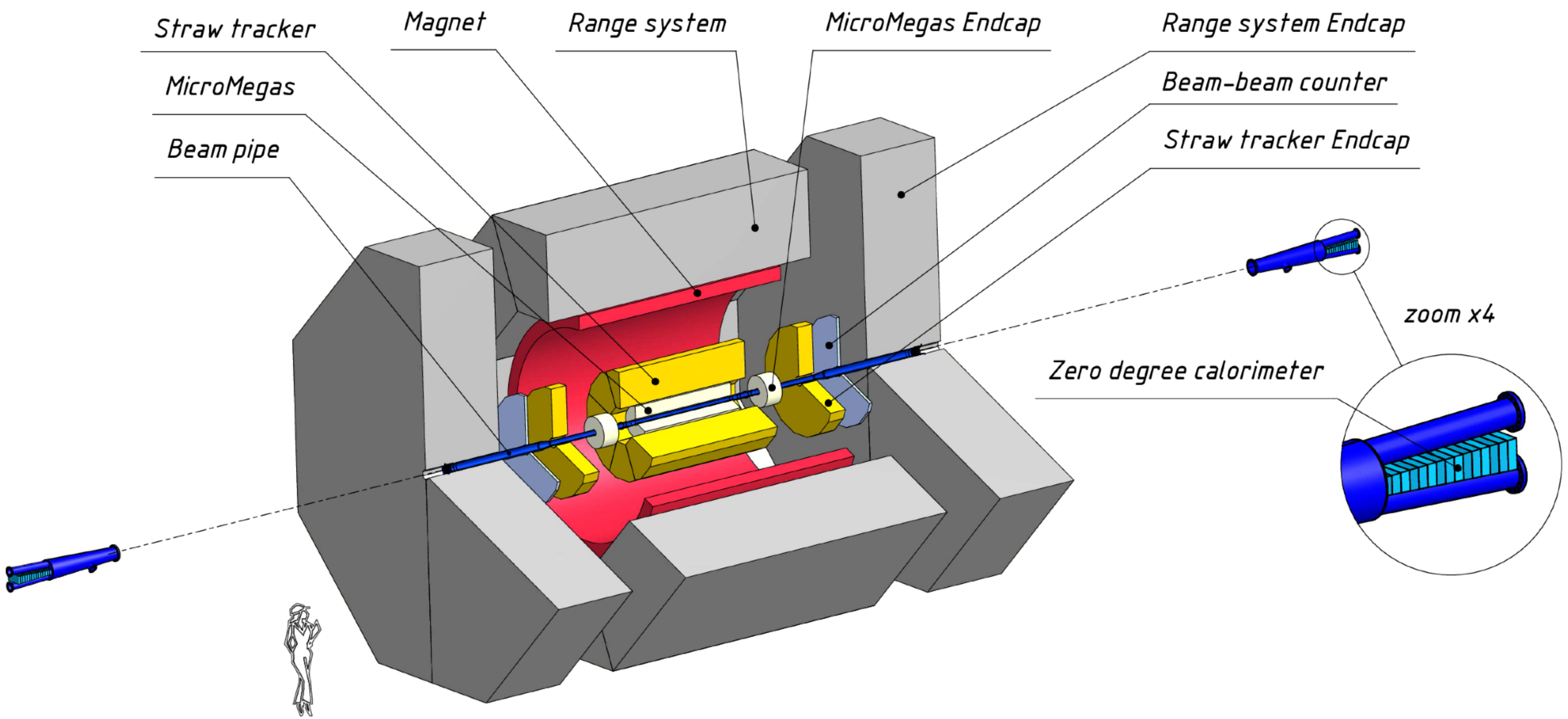
14:00	Updated approach for DAQ and Front-End Electronics Interface.	Leonid Afanasyev	14:00 - 14:25
	Proposed approaches for the time synchronization in the streaming DAQ at SPD.	Andrei Antonov	14:25 - 14:50
	Status of the offline computing system	Artem Petrosyan et al.	14:50 - 15:10
15:00	Experience with the simulation and reconstruction software for the Super c-tau factory	Dr Andrey Sukharev	15:10 - 15:30
	Status of the online filter		15:30 - 15:55
16:00	Status of ECAL fast reconstruction	Dimitrije Maletic	15:55 - 16:15
	Status of offline software	Artur Tkachenko	16:15 - 16:40
	DIRAC for user's simulation and analysis	Igor Pelevanyuk	16:40 - 17:00
17:00			

Conclusions

- Major update in the detector layout: magnet coils are outside ECal
- Good development progress in the SC magnet design. Several meetings with the local magnet team and the Novosibirsk team recently
- Discussion ongoing about layout and dimensions of ST, TOF, ECal
- Agreement on ZDC location has been concluded
- MM detector in place of silicon VD for the 1-st stage of SPD
- TDR preparation is in active phase

Backup slides

Update for the schematic view of the SPD setup



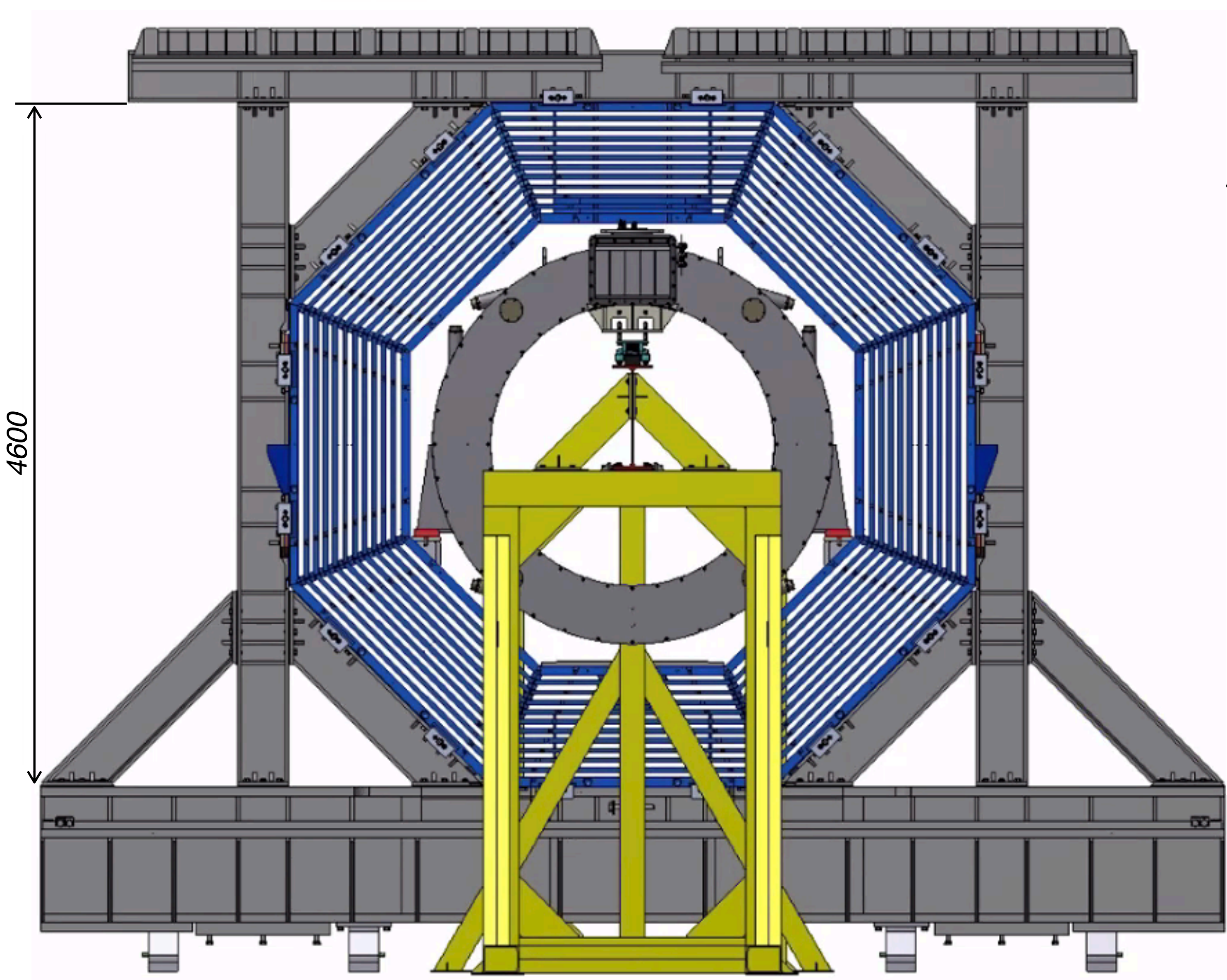
- First stage of experiment: without ECal and PID

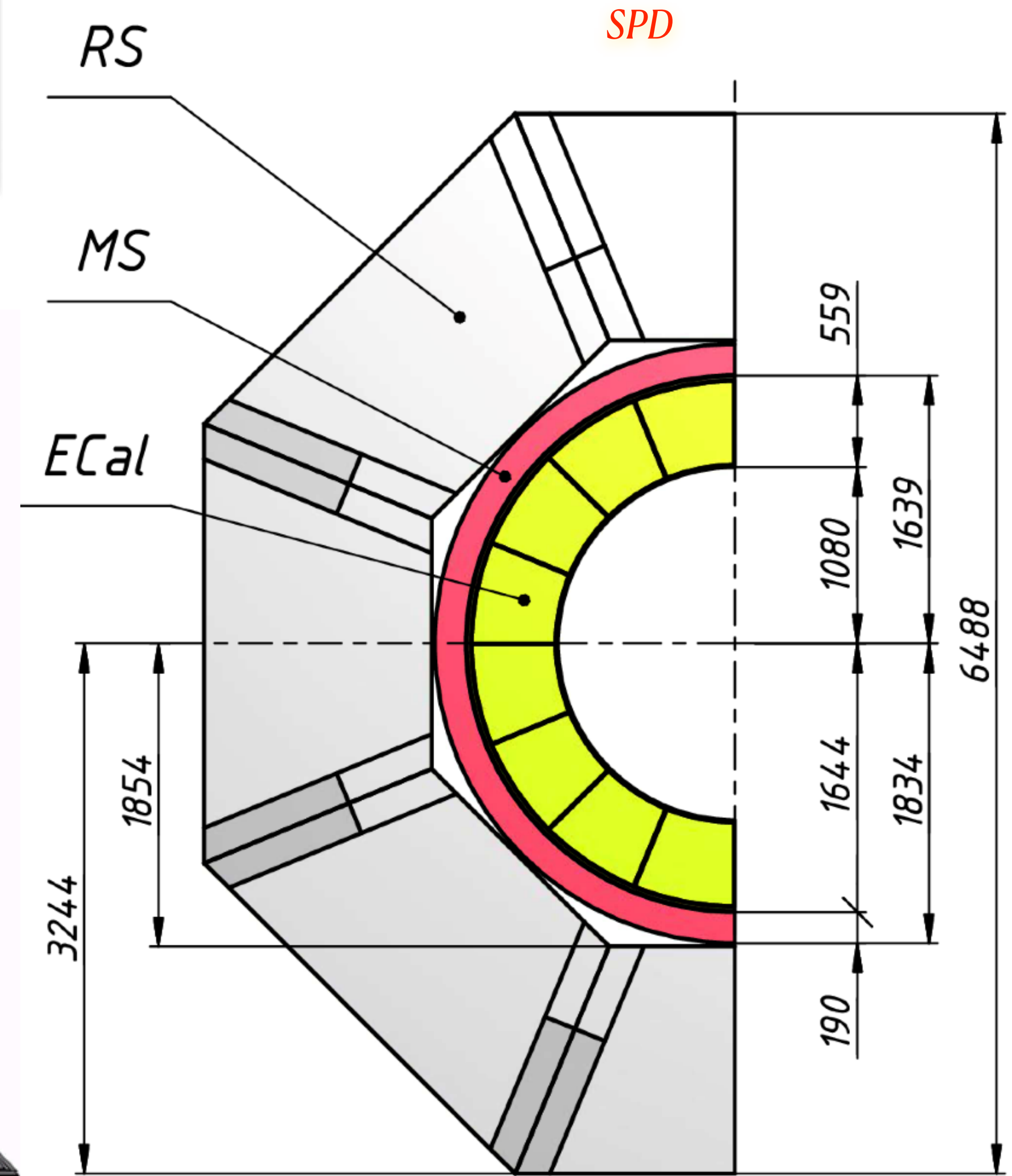
E.Pyata
S.Pivovarov
A.Krasnov

PANDA compared to SPD

(scale 1:1)

PANDA

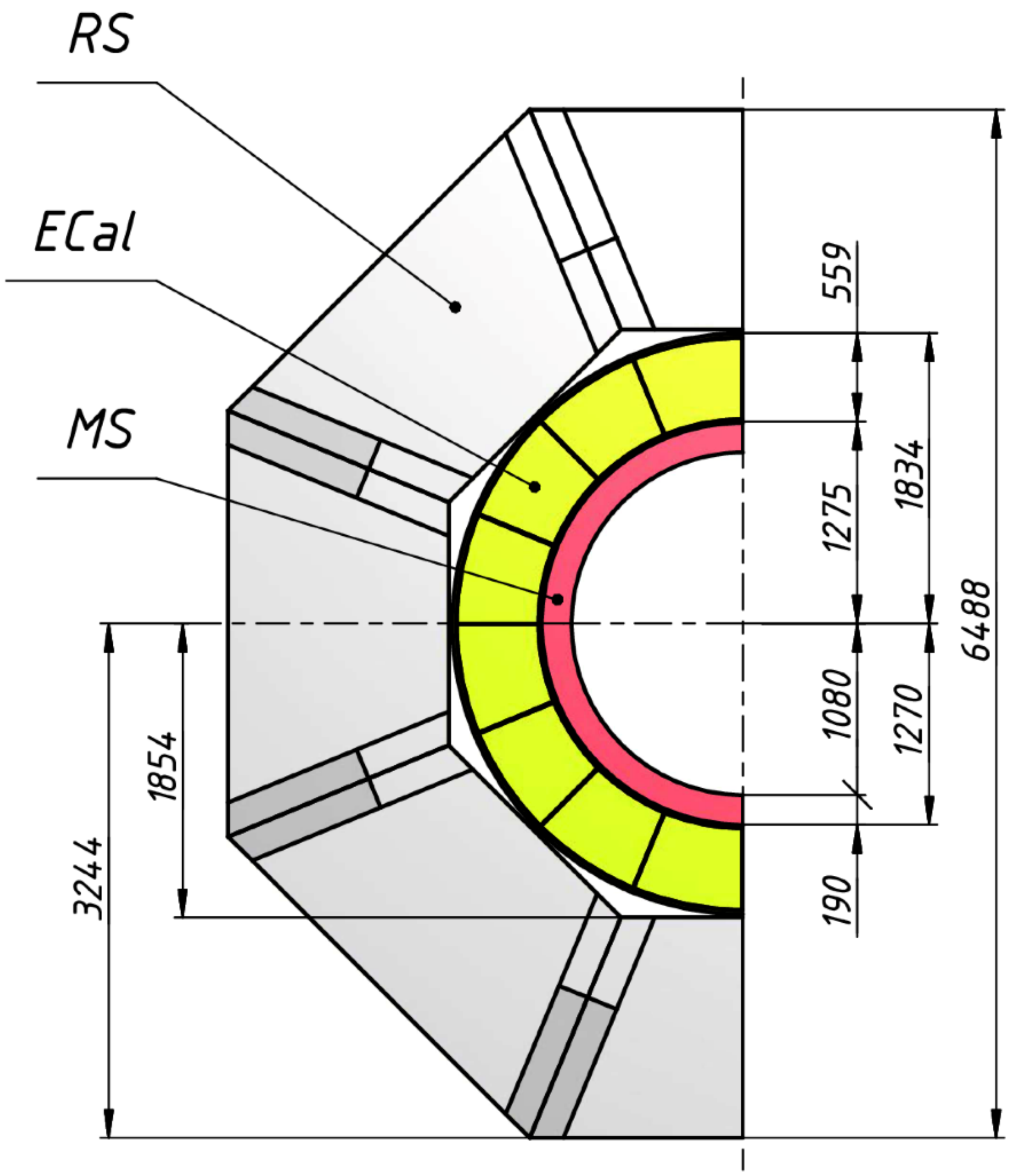




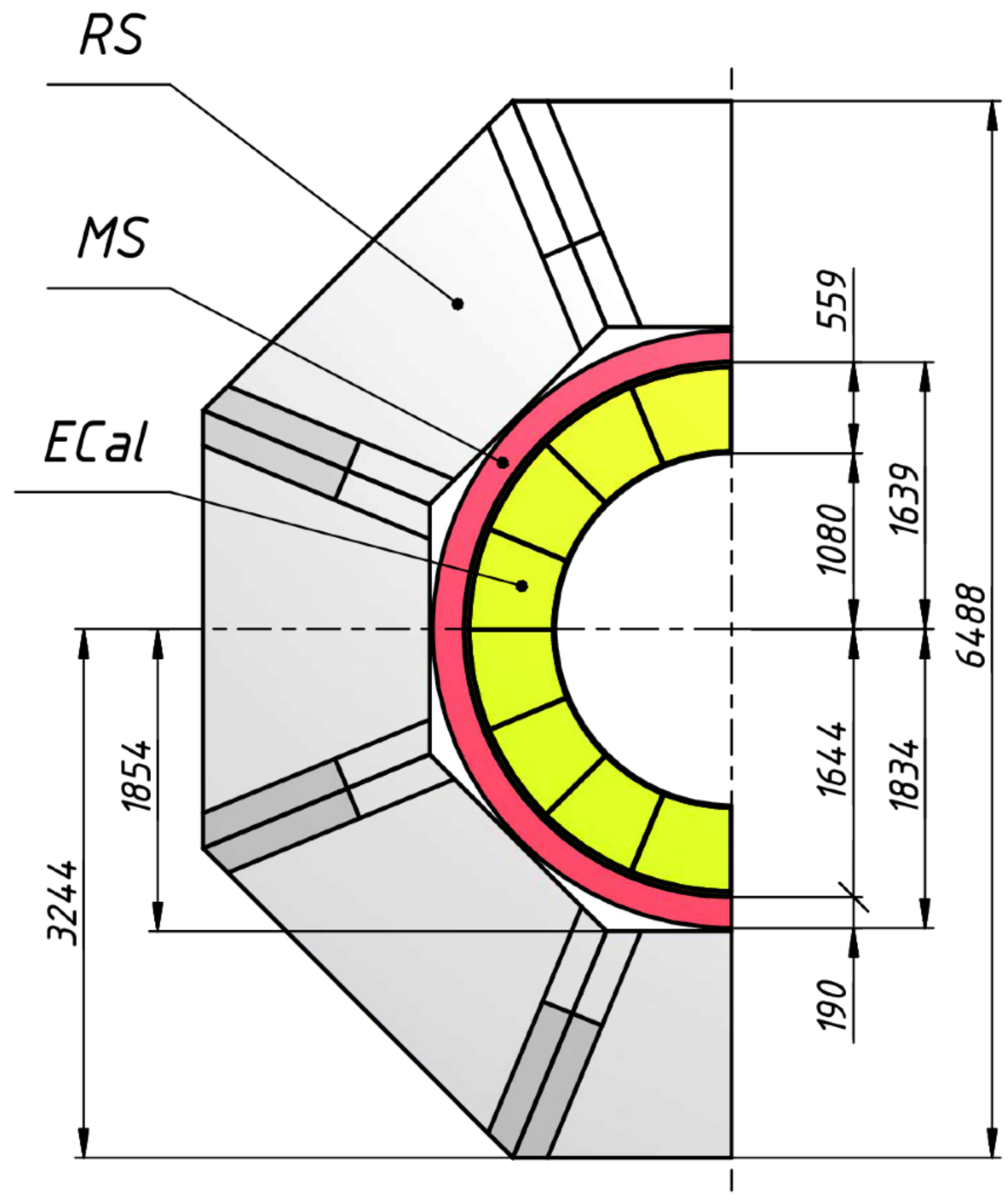
- Radial thickness of cryostat will have to reduced from ~40 cm (PANDA) to ~20 cm
- Example: solenoid of KEDR is 22.5 см thick

SC magnet location with respect to ECal

<u>CDR version (**obsolete**)</u>
6 separated coils inside ECal

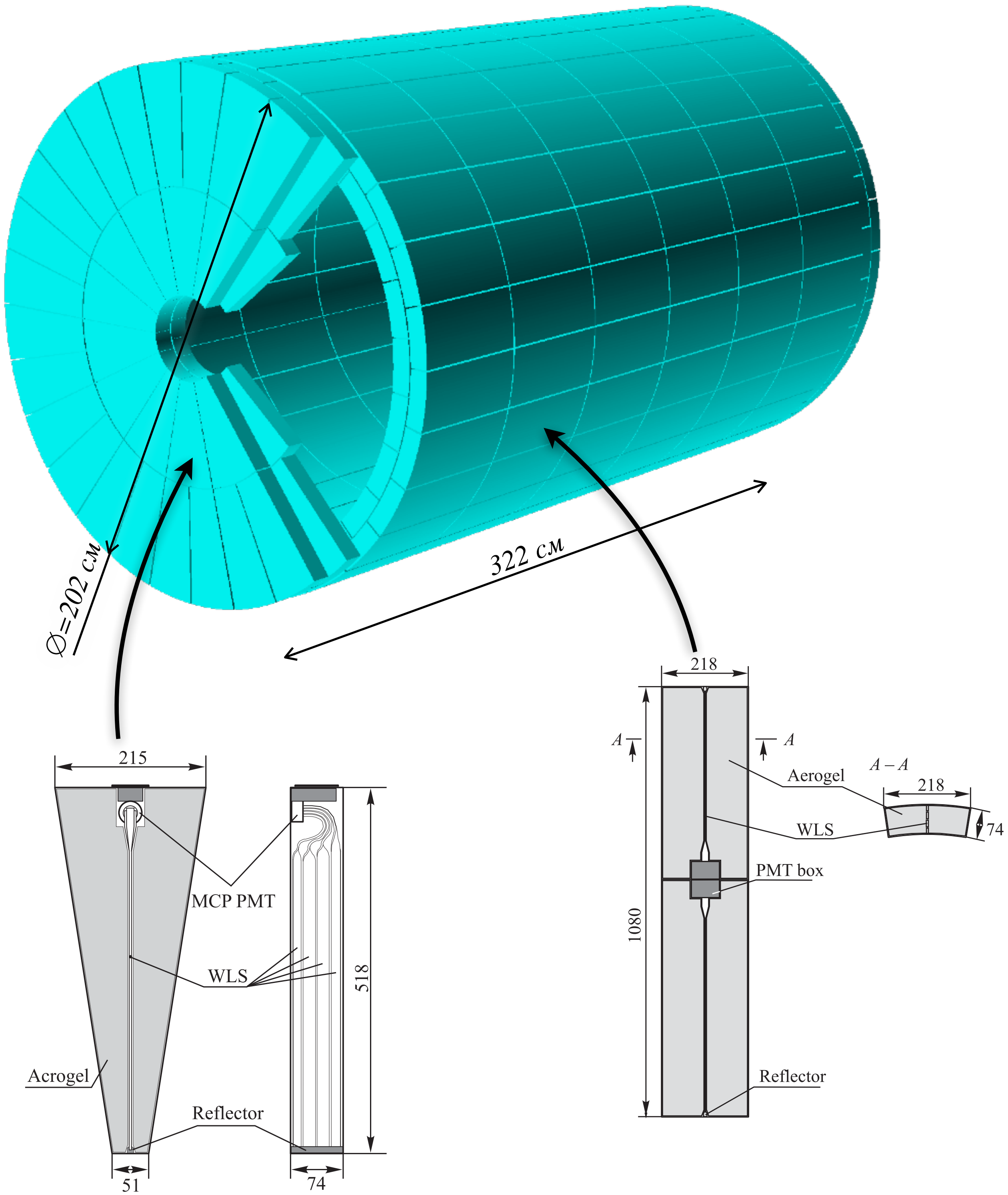


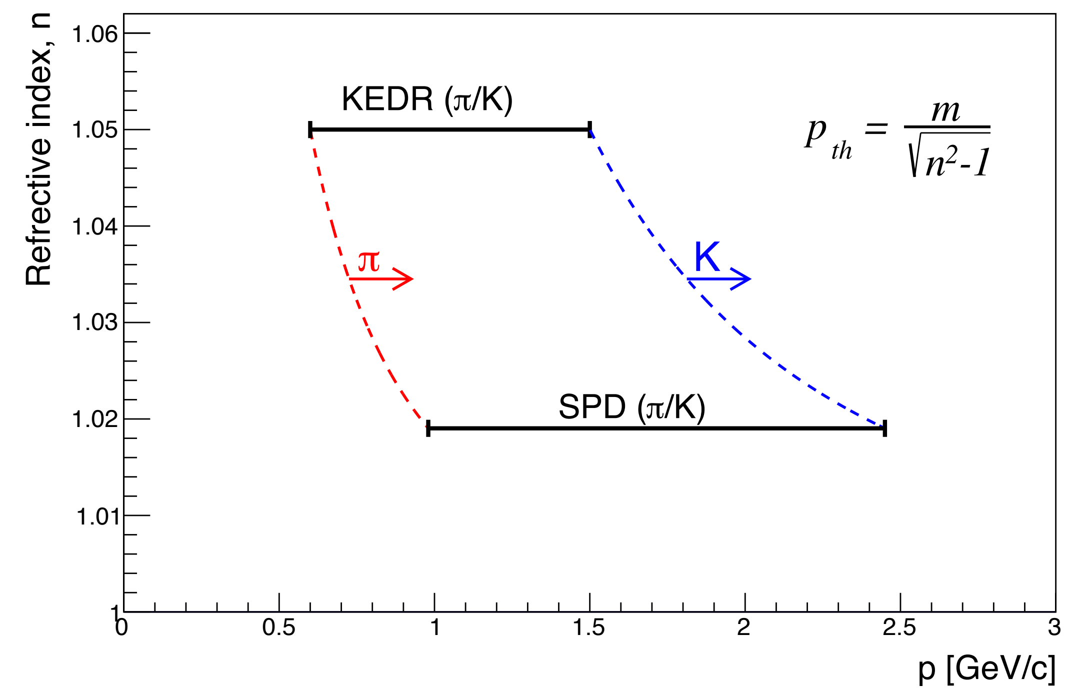
<u>Option under development</u>
A single cryostat with several coils



No responsable

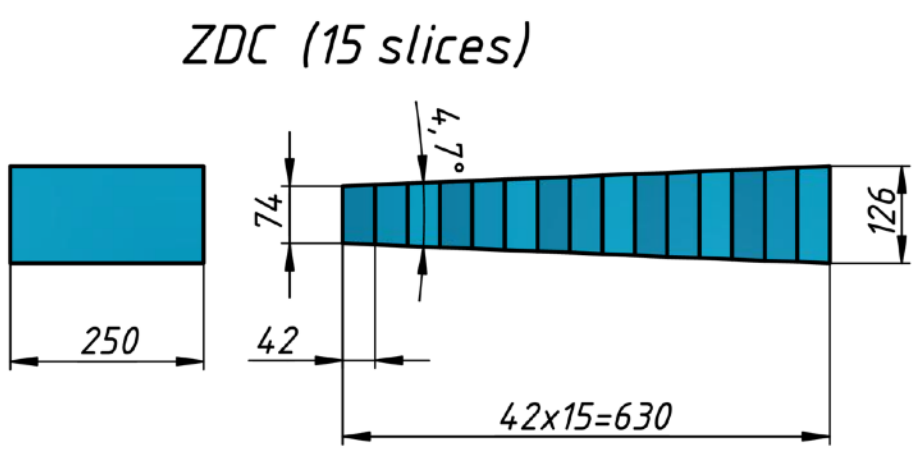
Aerogel counters for PID

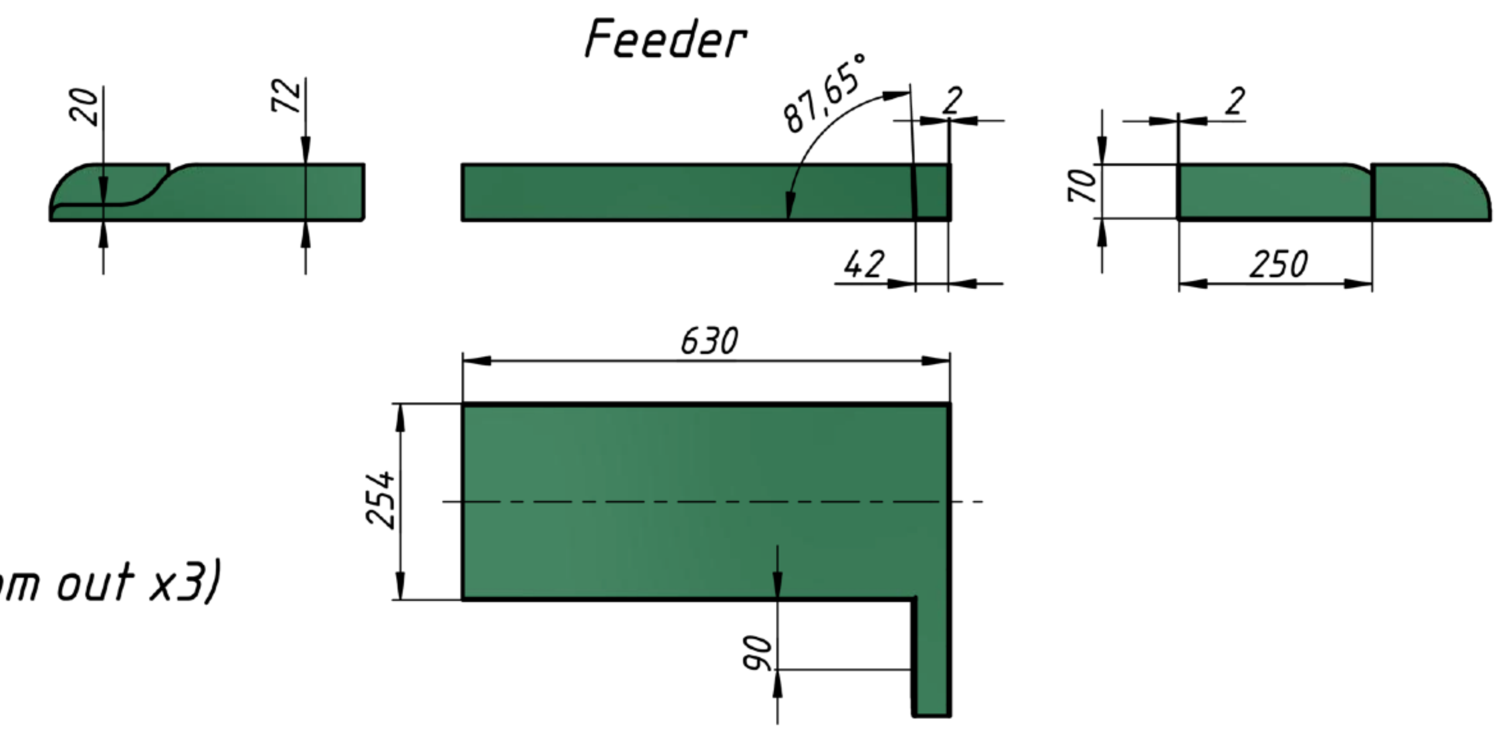


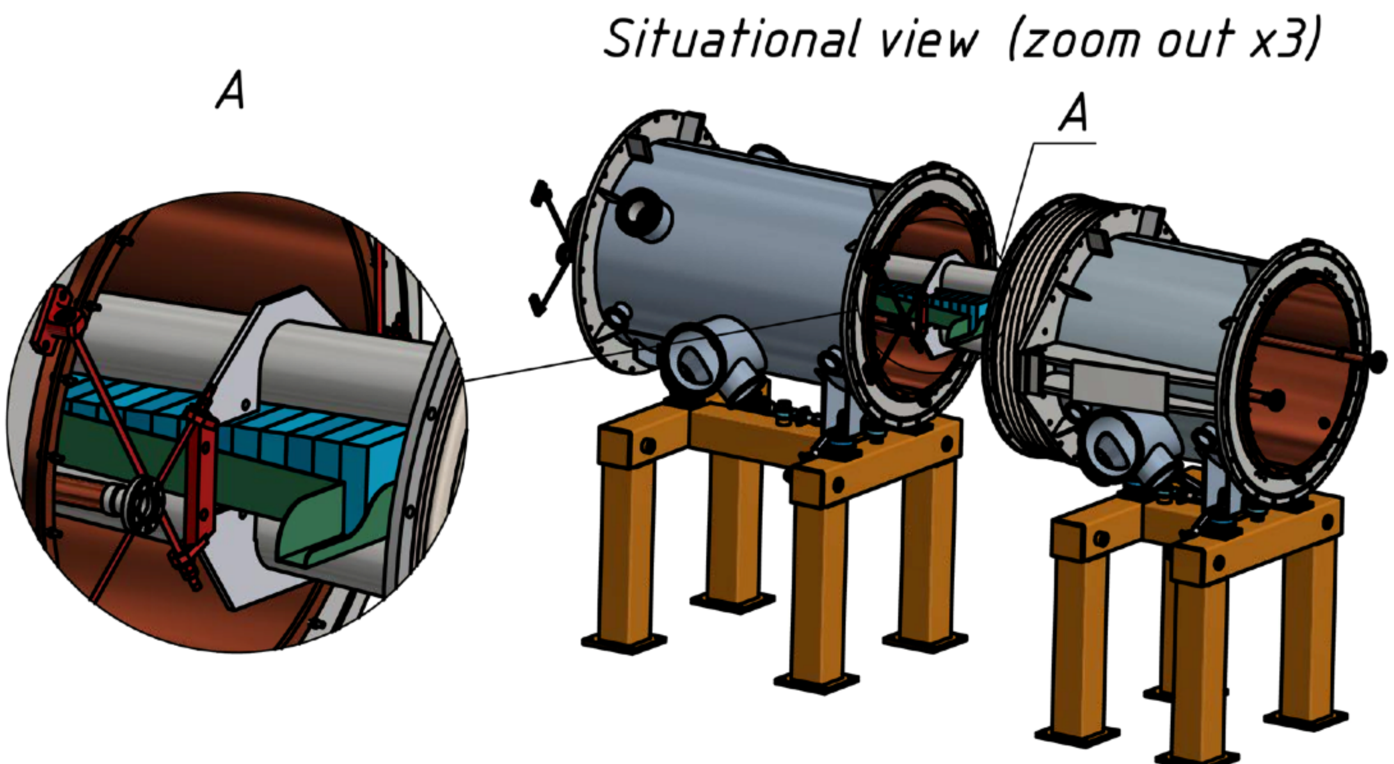


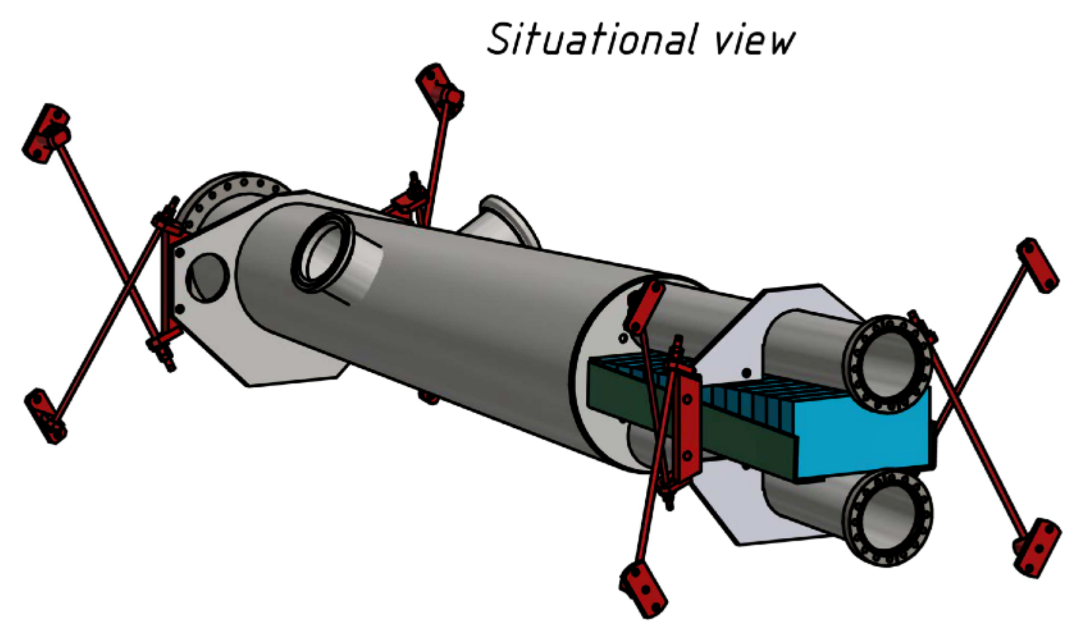
- Identification based on Cherenkov light radiation
- Range of π/K separation is a function of refractive index *n*
- The design follow closely the one of KEDR (Novosibirsk)
- Low light yield ~6 p.e.
- Can be used only in endcaps since there is more space and it is a region of higher momentum particles

Zero Degree Calorimeter (ZDC)



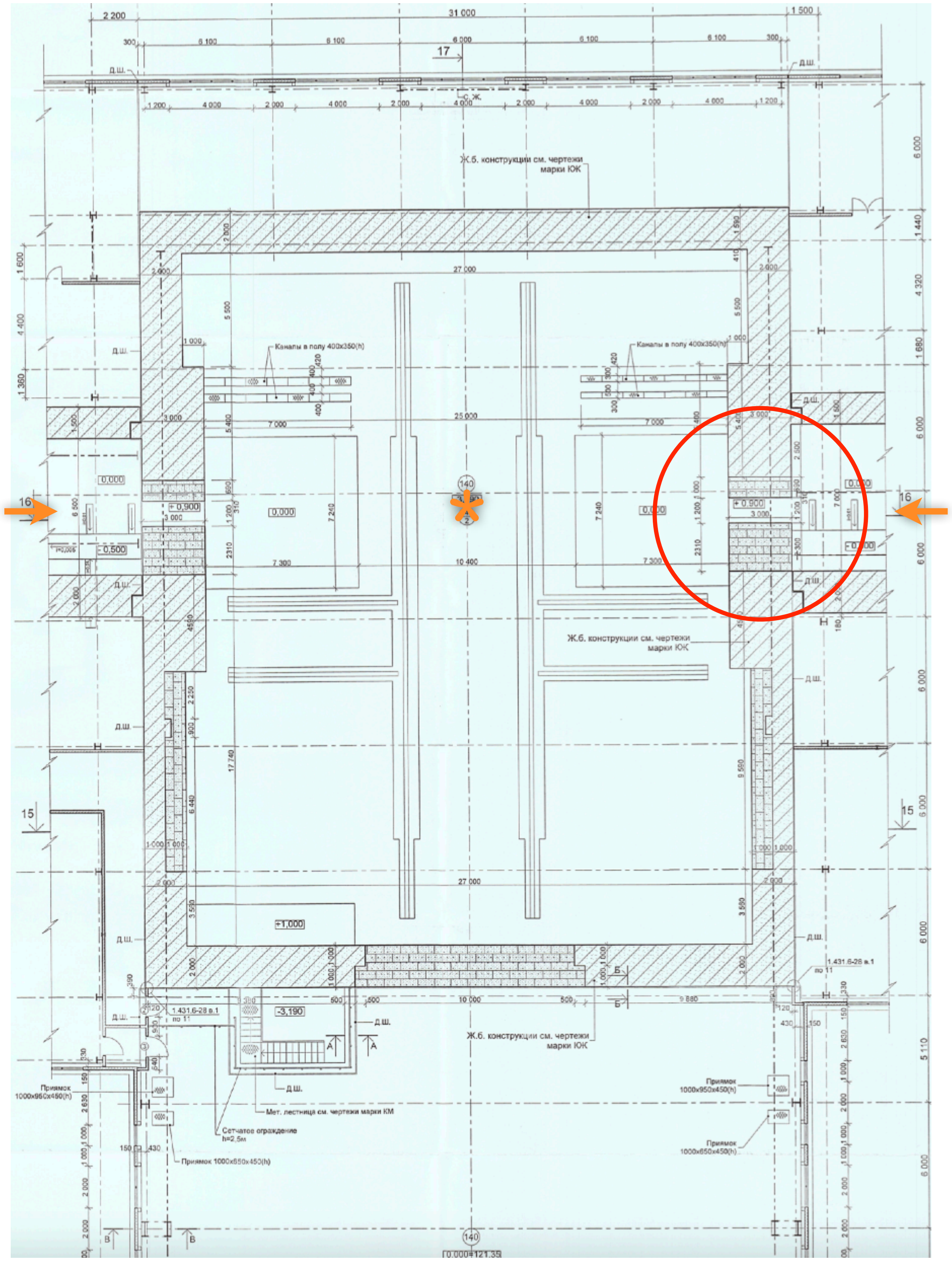


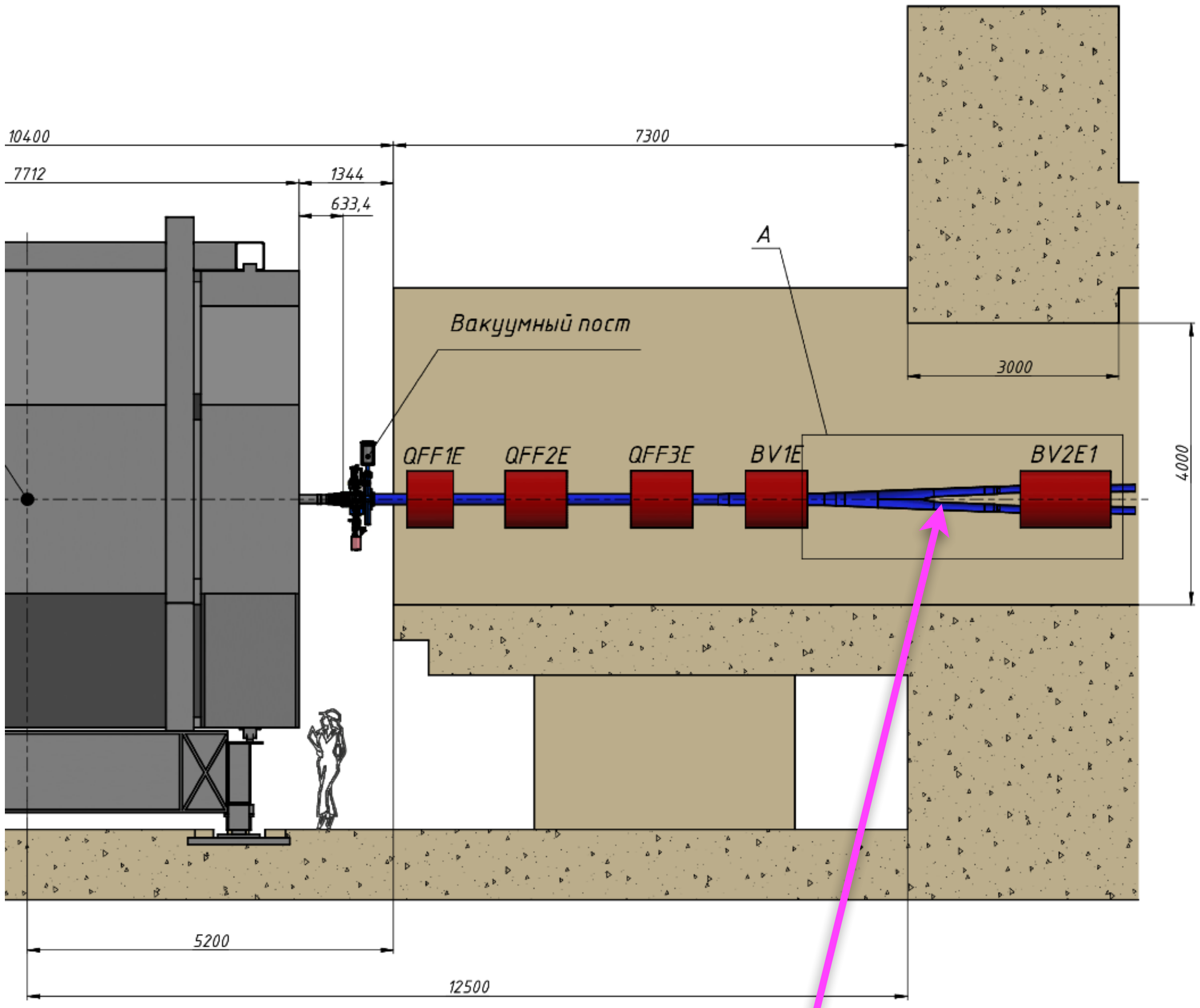


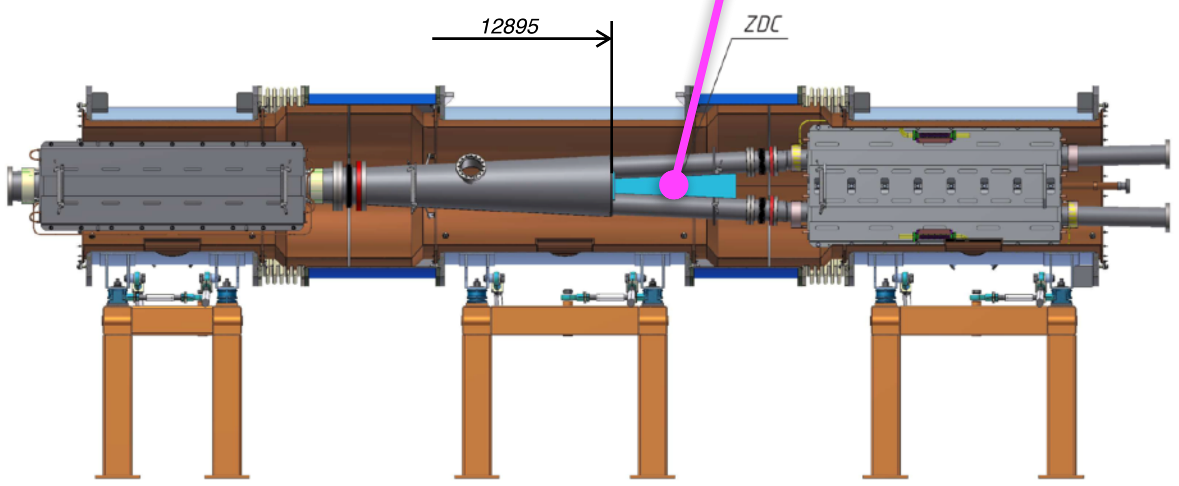


- Weight is ~100 kg
- Located inside the cryostat (vacuum, about -200 ·C)
- Loaded section-by-section

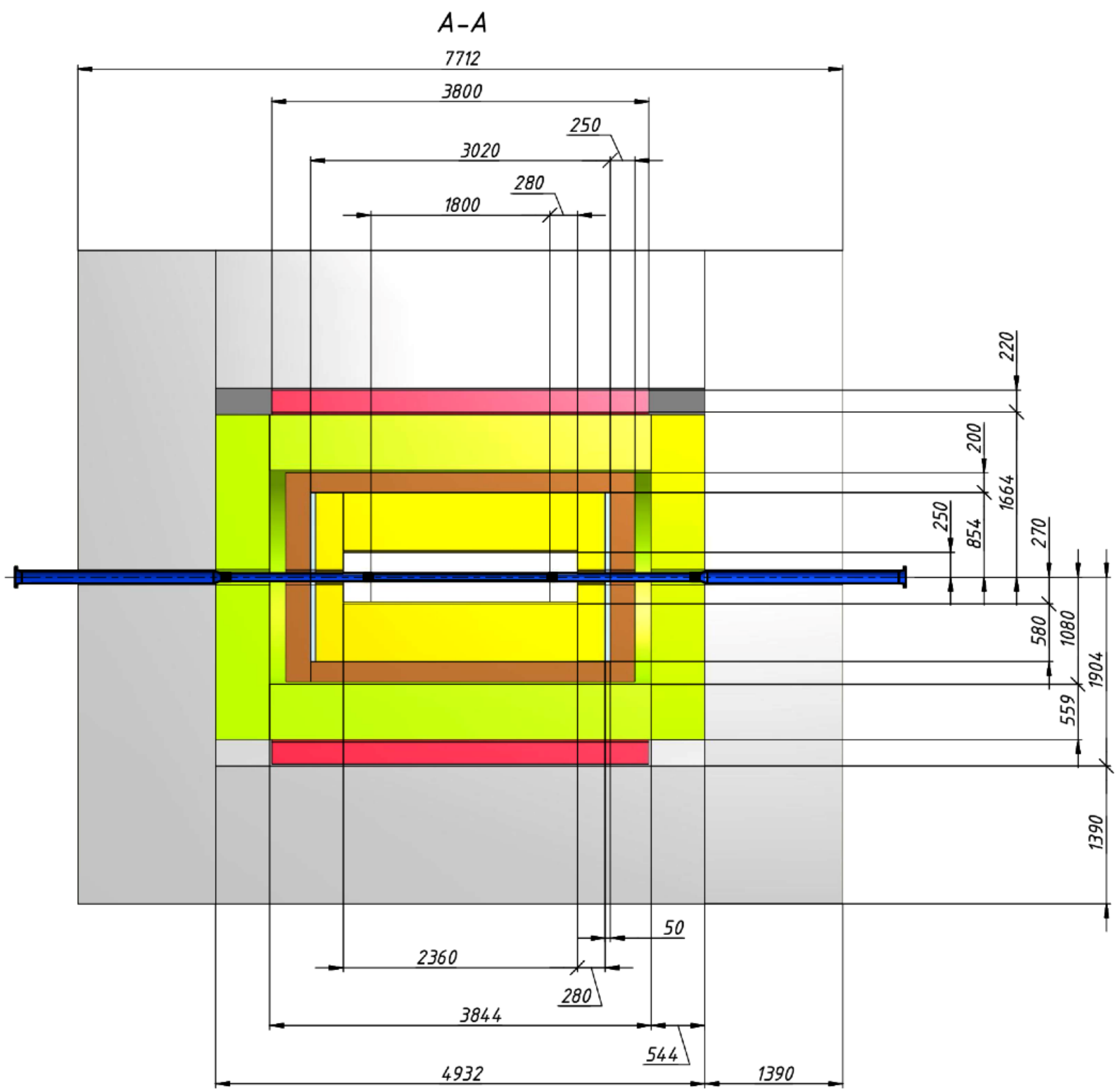
Location of ZDC in the SPD hall



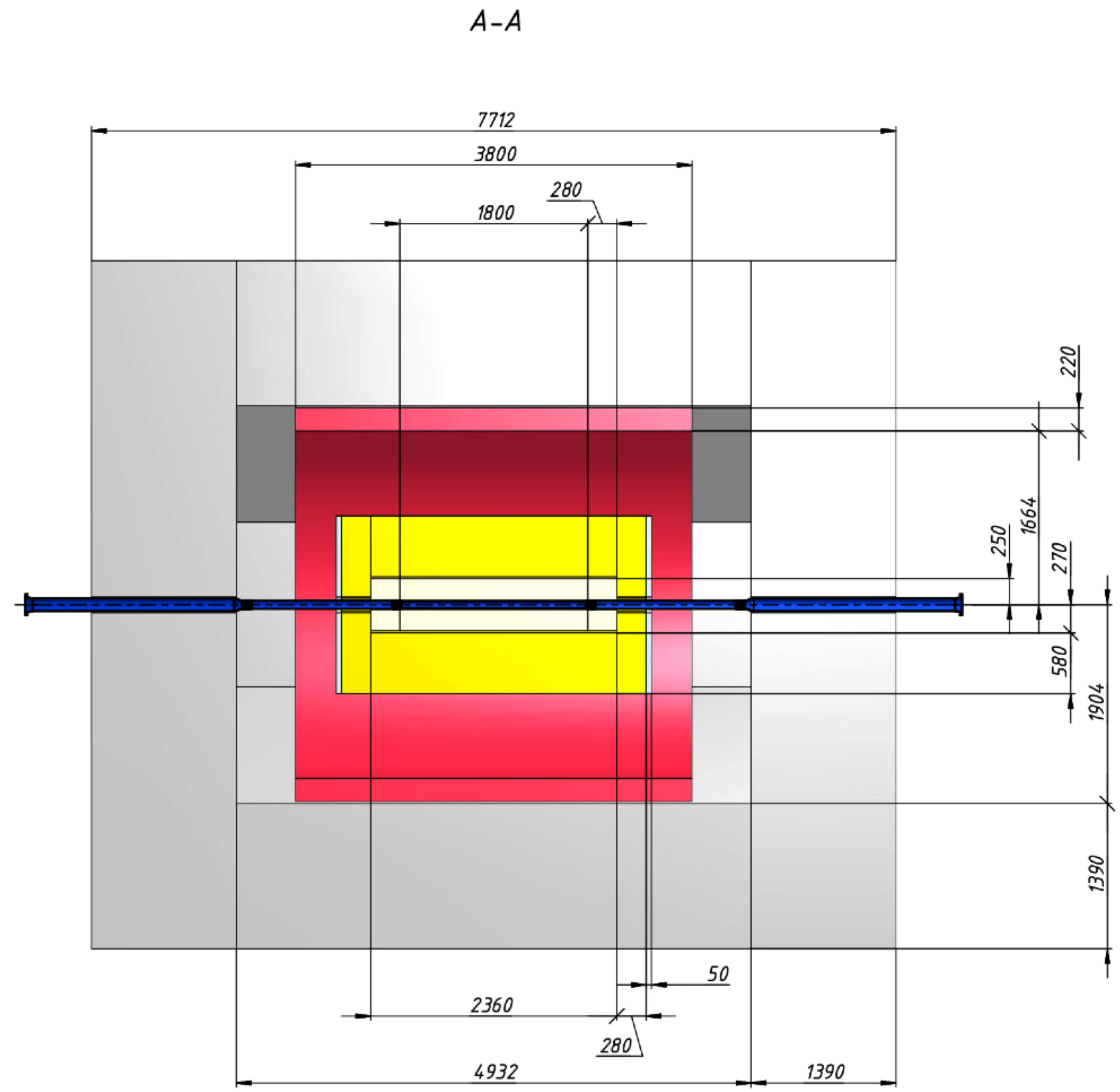




Complete setup



1-st stage of experiment



Subsystems in view of the construction stages of SPD

Systems employed before start of physics programme	First stage of experiment	Following stages of experiment
ZDC, MCP, BBC	Magnet, RS, ST, MM (a.k.a. VD)	VD, TOF, ECal, Aerogel
• Detectors for local polarimetry and luminosity control • Elastic scattering	• Charmonia • SSA for π and K • Light vector mesons • $\bar{p}$ production • Physics with light ions	• Open charm • Prompt photon

CDR

Table 4.1: Required setup configuration for each point of the SPD physics program. (+++) - absolutely needed, (++) - extremely useful, (+) - useful, (-) - not needed.

Program	Vertex detector	Straw tracker	PID system	Electromagnetic calorimeter	Beam-beam counter	Range system
Gluon content with:						
charmonia	+	++	+	++	+	+++
open charm	+++	++	++	+	+	++
prompt photons	+	+	-	+++	+	-
SSA for π and K	+	++	+++	++	+	-
Light vector meson production	+	++	-	+	+	-
Elastic scattering	+	++	-	-	+++	-
$\bar{p}$ production	+	++	+++	++	+	-
Physics with light ions	++	+++	+	++	++	+