Report of the technical coordinator

(focusing on design and assembly procedure)

Alexander Korzenev, JINR LHEP

SPD Collaboration Meeting
Oct 3, 2022

Aerial view of NICA in September 2022


View of SPD from the courtyard


View of SPD from outside

A.Livanov

- Most of interior work in the SPD hall has been completed
- Rail system is ordered (to be installed next year)
- The concrete block wall (biological protection) and the bridge between two balconies will be installed. Thus the accelerator tunnel will be isolated from the hall

Visiting experimental sites on Wednesday morning

Please, register!

Mon 03/10 | Tue 04/10 | **Wed 05/10** | Thu 06/10 | All days

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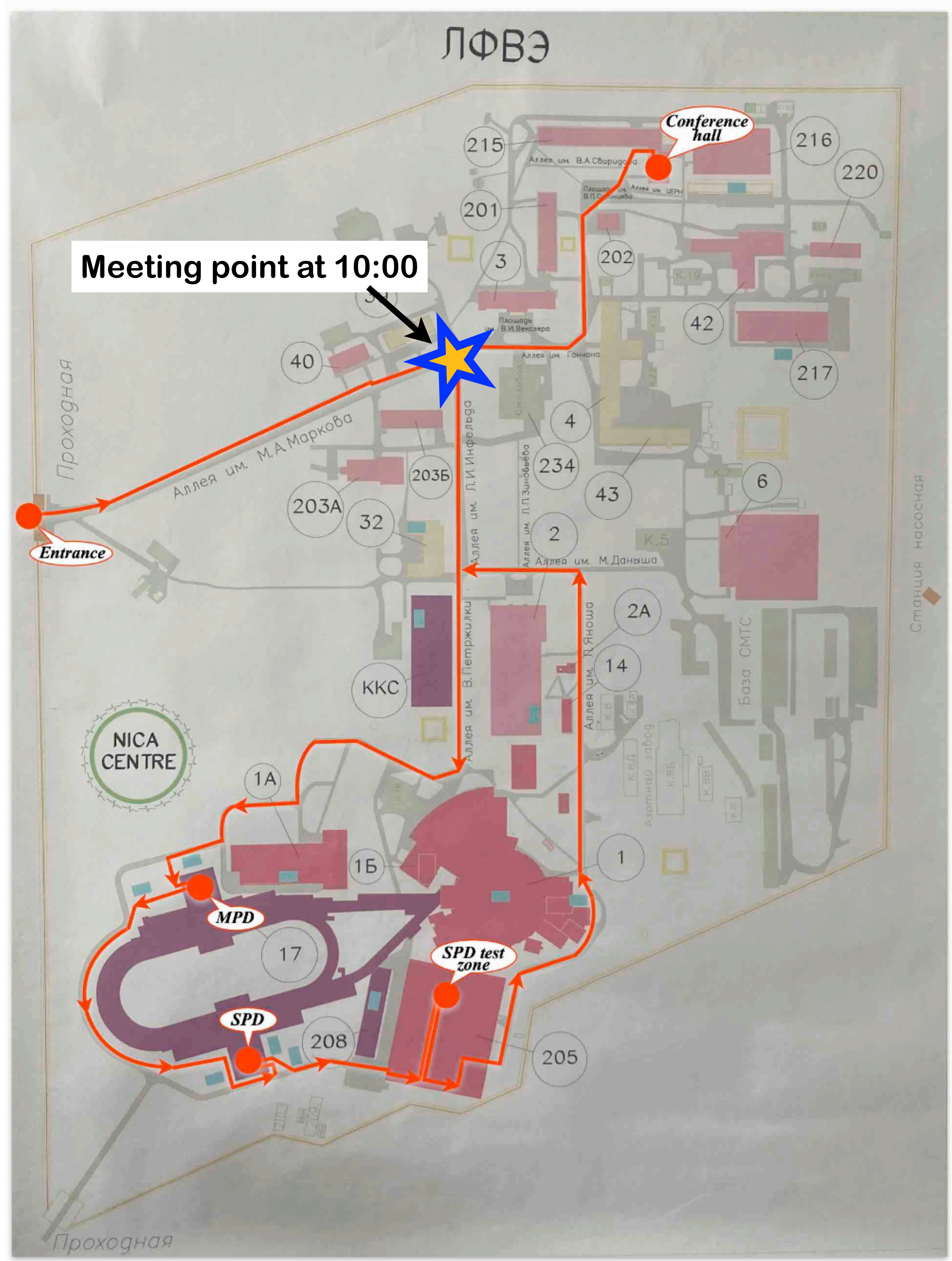
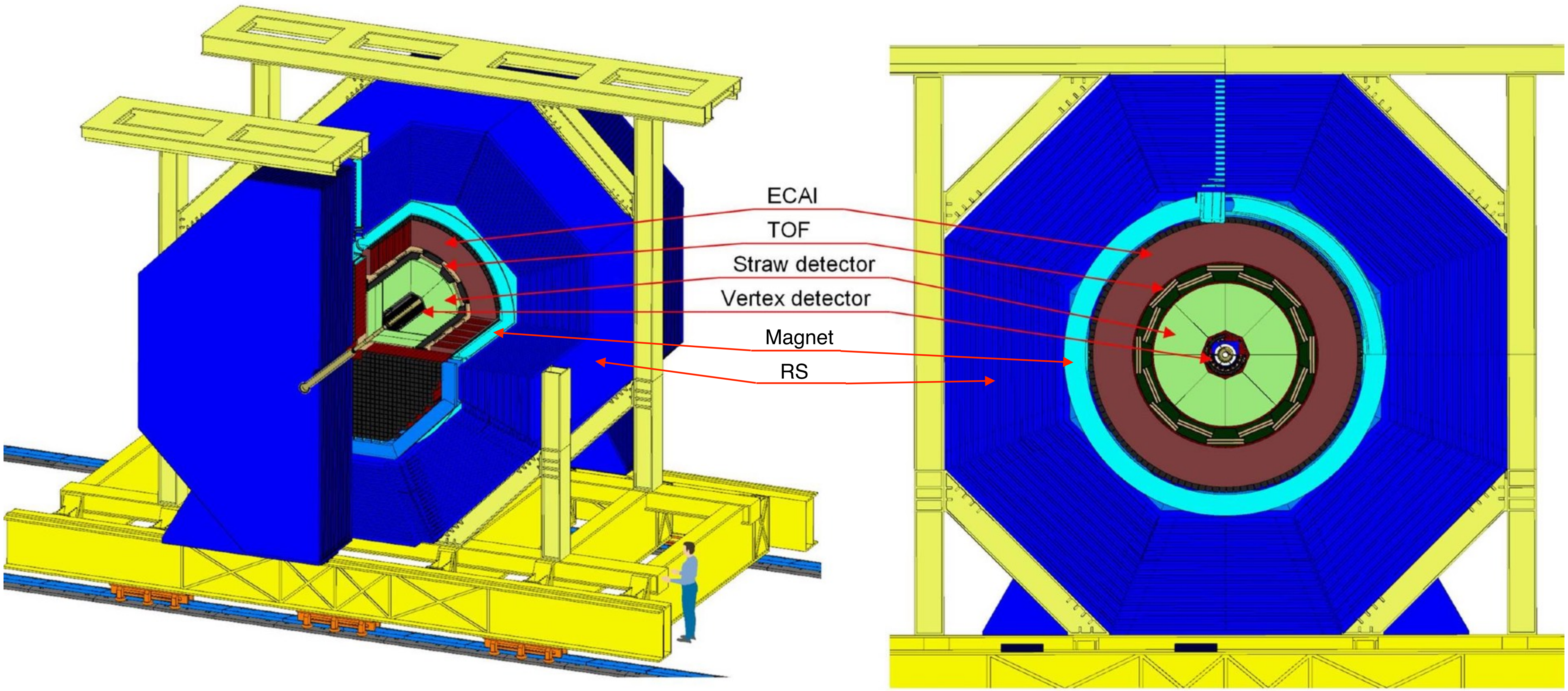
10:00	**Excursion to NICA: MPD (bld.17) -> SPD (bld.17) -> SPD Test Zone (bld.205)** *Building 17, VBLHEP, JINR, Dubna* 10:00 - 12:00
11:00	
12:00	**Lunch** *VBLHEP, JINR, Dubna* 12:00 - 13:30
13:00	**Coffee** *Building 215, VBLHEP, JINR, Dubna* 13:30 - 14:00
14:00	**Computing & Software**



Design & engineering activity



- The main concepts of the SPD setup is finalized. Detector volumes are essentially fixed. Work has begun on the load-bearing elements of individual detectors.
- Lack of design engineers for common integration tasks. I.Moshkovsky left, S.Sukhovarov is taking over.
- Frames for small and light detectors (VD, MM, BBC, ZDC) can be designed and constructed by groups.
- For larger detectors (RS, ECal, ST, TOF) we only prepare our technical requests and outsource them. Experience of MPD and PANDA groups is would be very helpful.
- It is important to centralize design activities to avoid later problems with detector integration. We have to follow industrial procedures, not bricolaging (project documentation according to GOSTs).

Maximum detector weight allowed by the building

Схема 1 – SPD на 8 опорах на сборочной позиции
временная биологическая защита установлена.

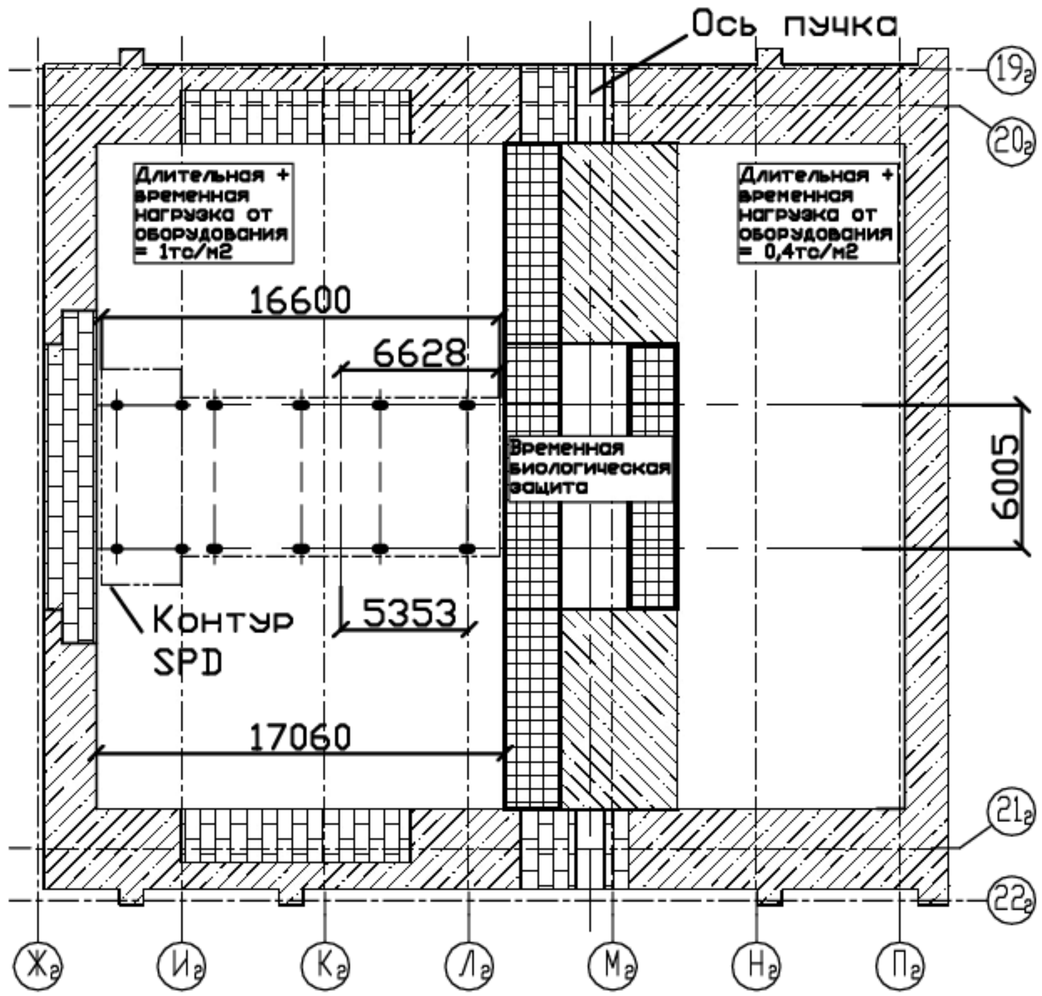
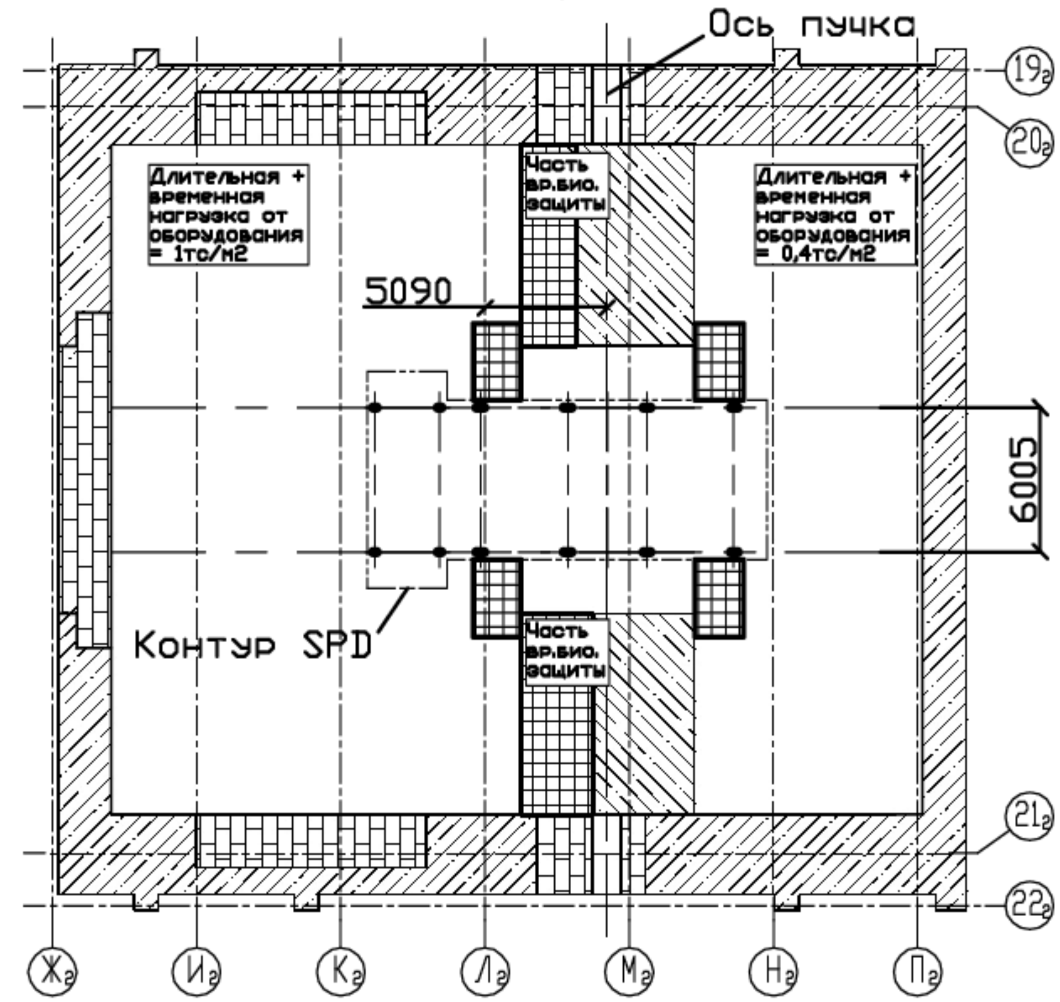


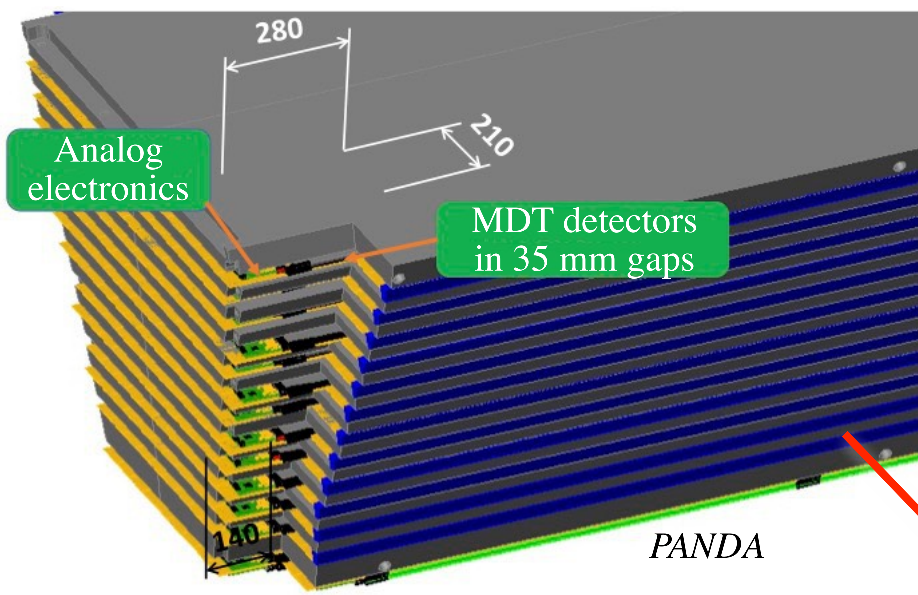
Схема 5 – SPD на 8 опорах на рабочей позиции
временная биологическая защита установлена.



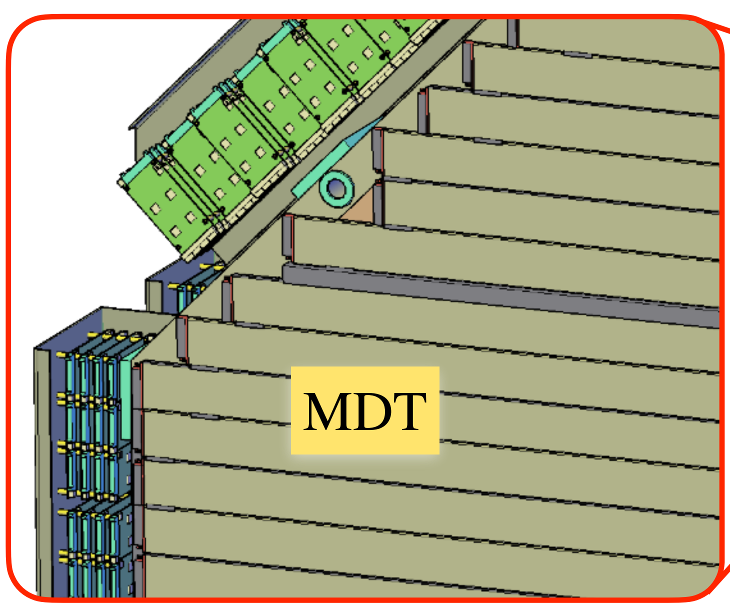
- The total weight of the SPD setup is **~1200 tons** (mainly due to the Range System).
- Concrete floor reinforcement in SPD is slightly different from reinforcement in MPD.
- Signing a contract with KOMETA for verification calculations of the foundation plate of the SPD pavilion

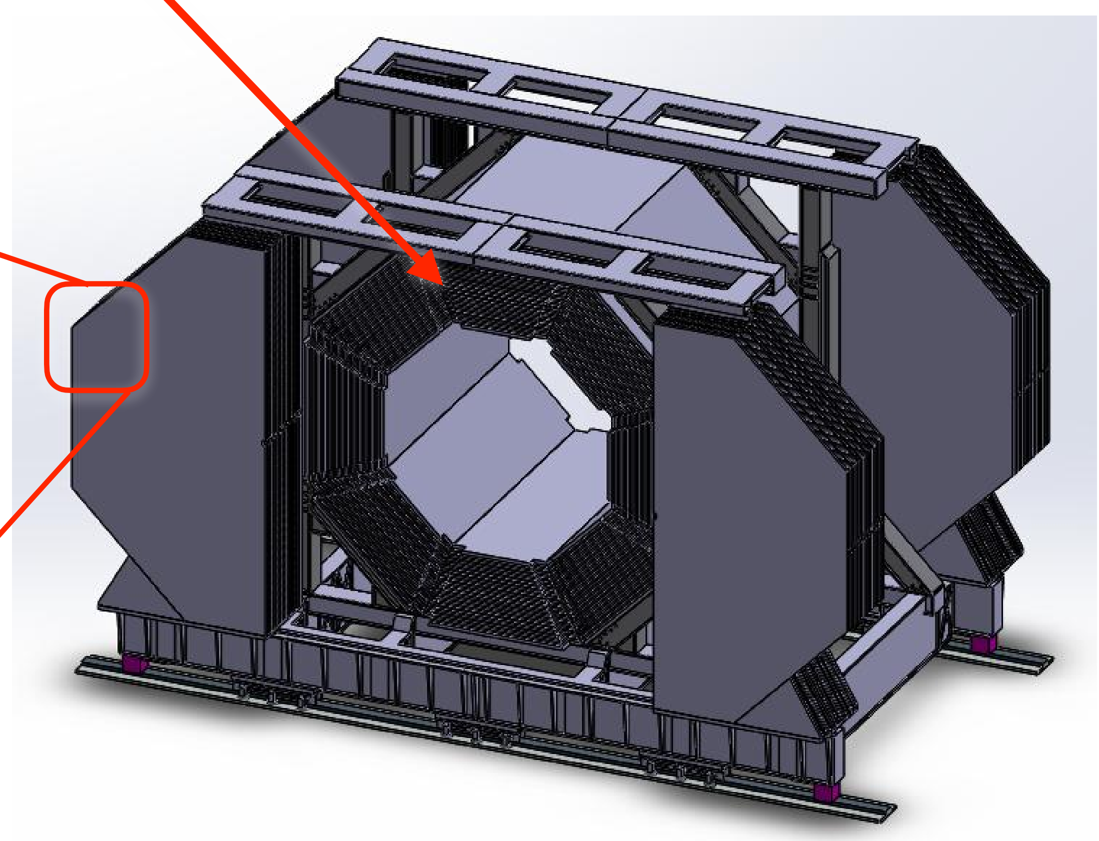
Range System (RS) detector

G. Alexeev,
A. Samartsev

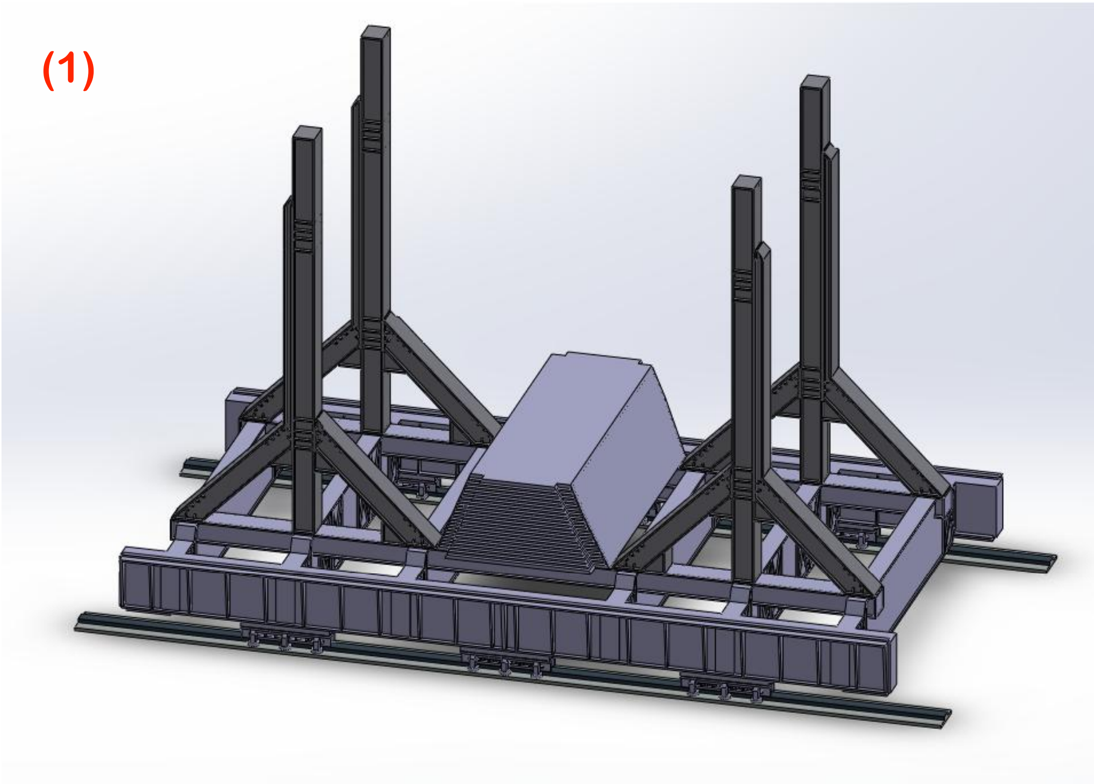


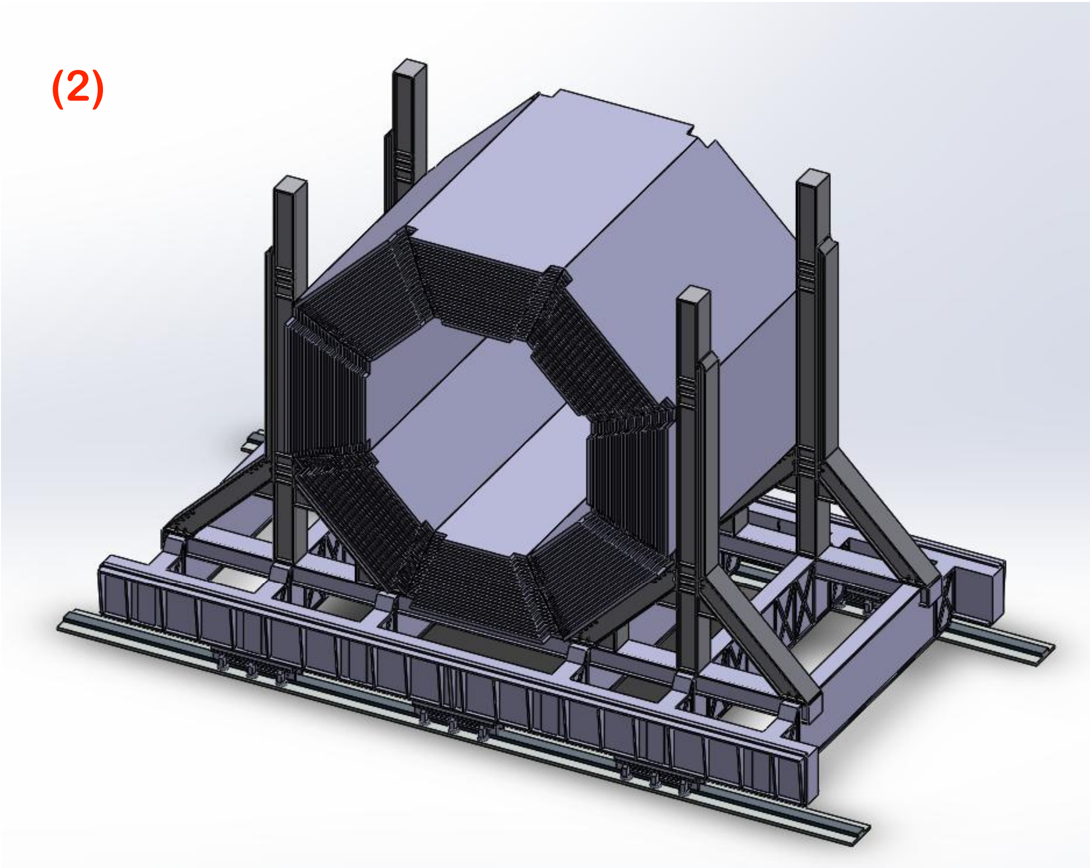
- Purposes: μ identification, rough hadron calorimetry
- 20 layers of Fe (3-6 cm) interleaved with gaps for Mini Drift Tube (MDT) detectors => thickness of 139 cm or $4\lambda_I$
- MDT provide 2 coordinate readout (~100 kch)
- The design will follow closely the one of PANDA, which can be considered as a smaller scale prototype
- RS serves as power frame for all other detectors => will be 1-st detector assembles in the hall

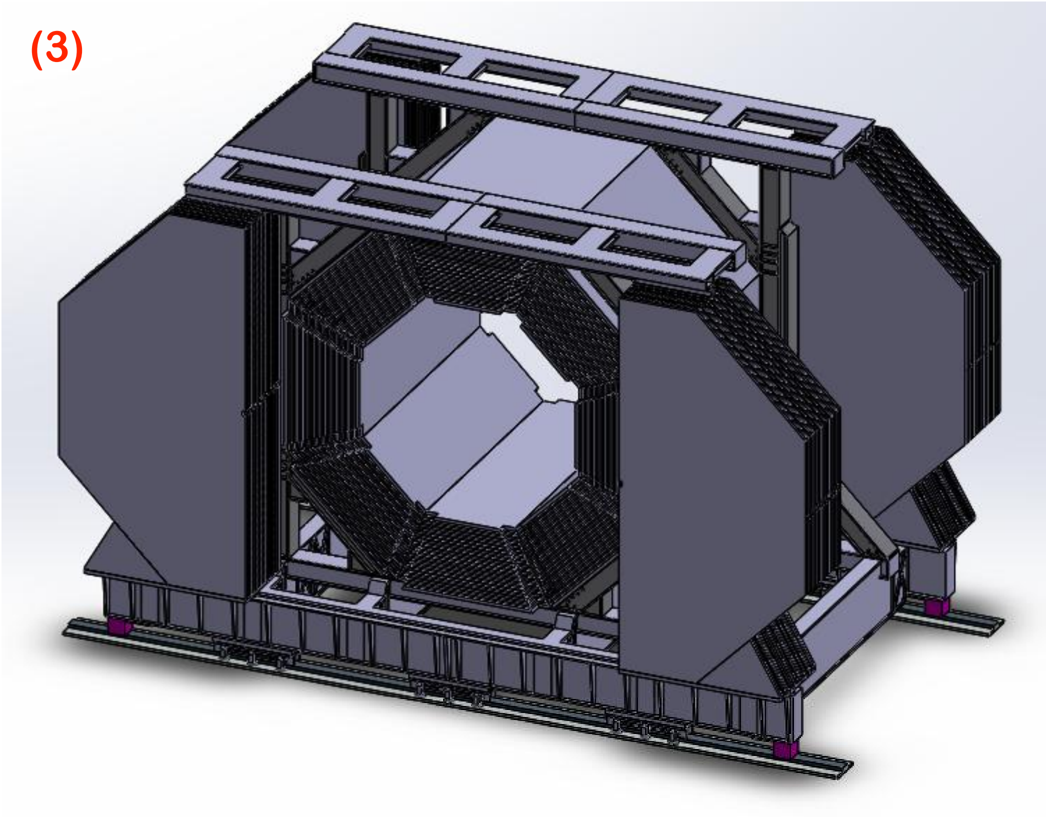




RS assembling procedure



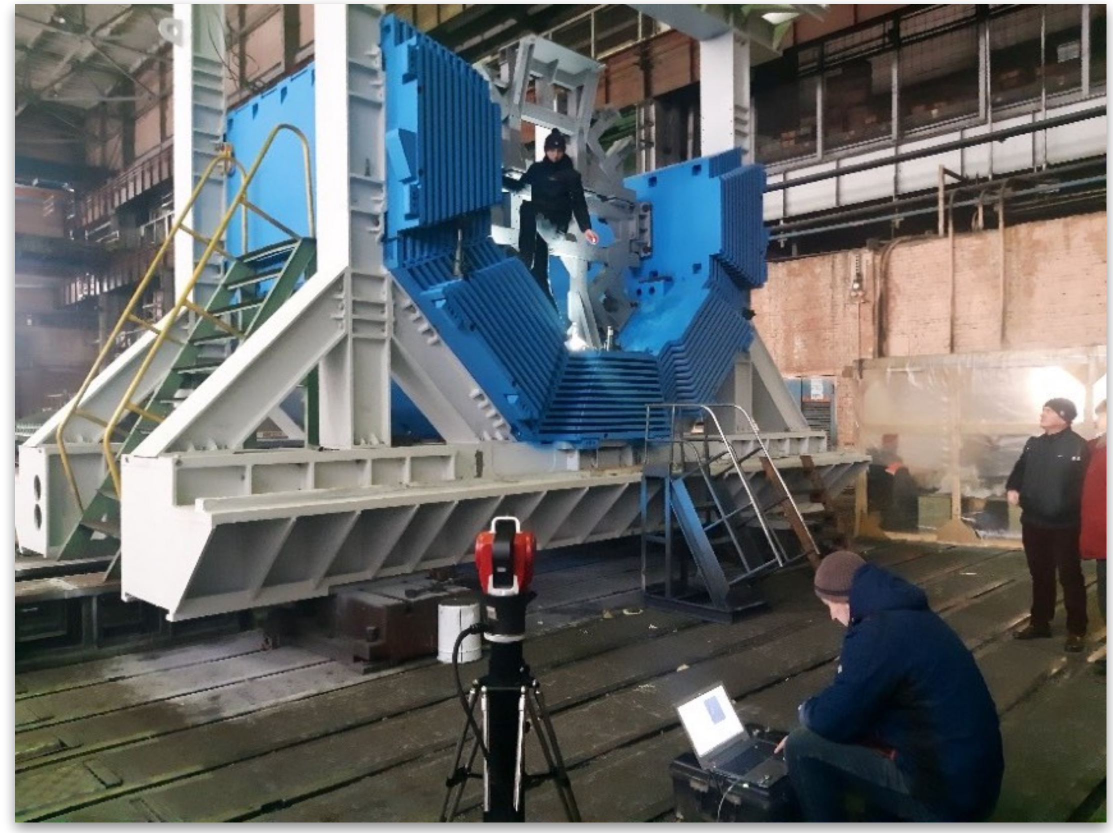




- Weight of barrel: 8 × 60 tons = 480 tons
- Weight of endcaps: 4 × 111 tons = 444 tons
- Weight of the support and transportation system (STS) is 78 tons
- Total weight is **927 tons**

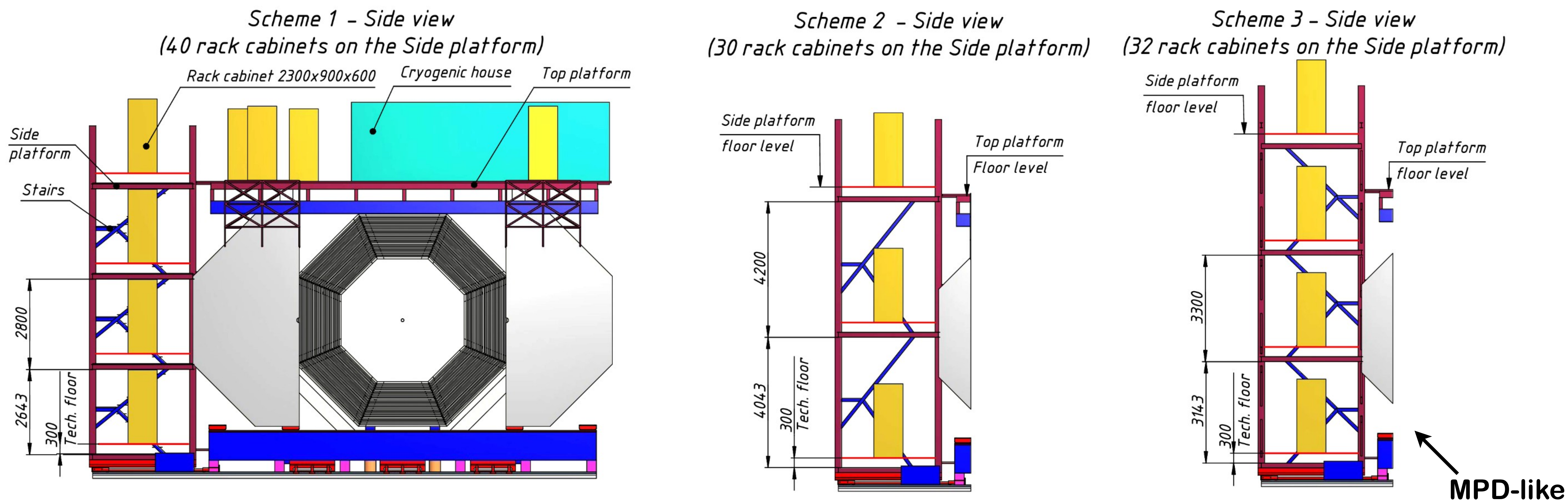
- RS will be the 1-st detector assembles in the hall
- All other detectors and the magnet will be inserted axially (not from top as in MPD)
- RS will ensure the rigidity of the entire system

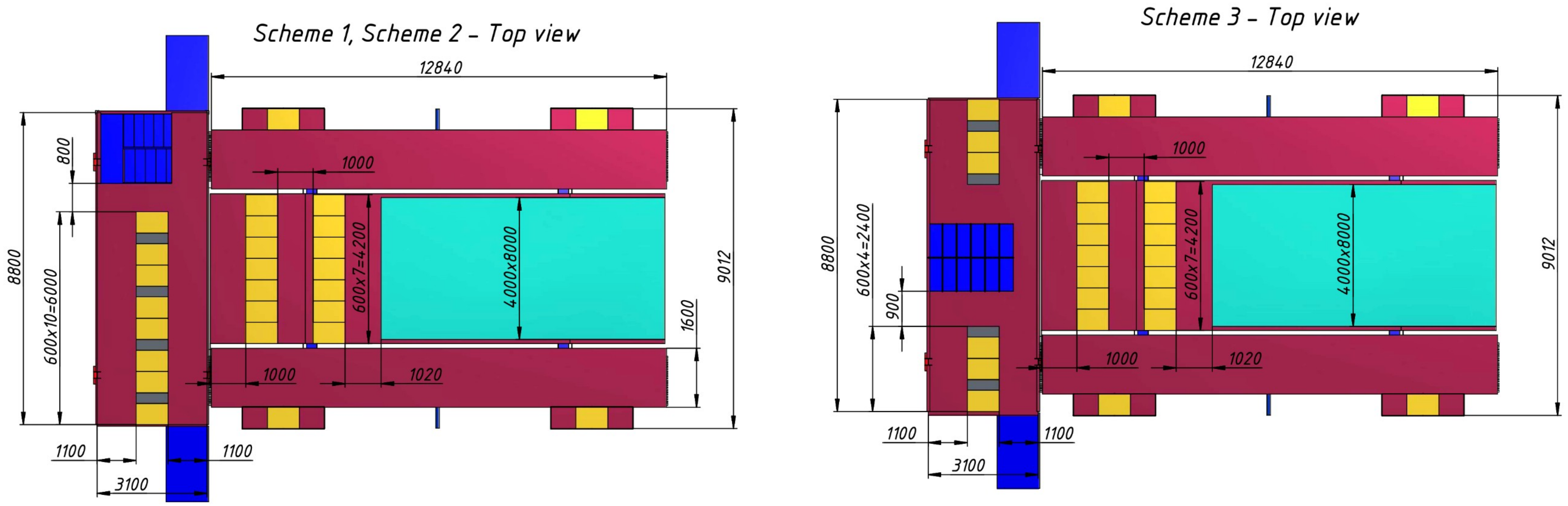
Muon detection system of PANDA (assembling in Novosibirsk)



Options for the electronics platform

I.Moshkovsky





E.Pyata et al.

Two options for the SC magnet technology

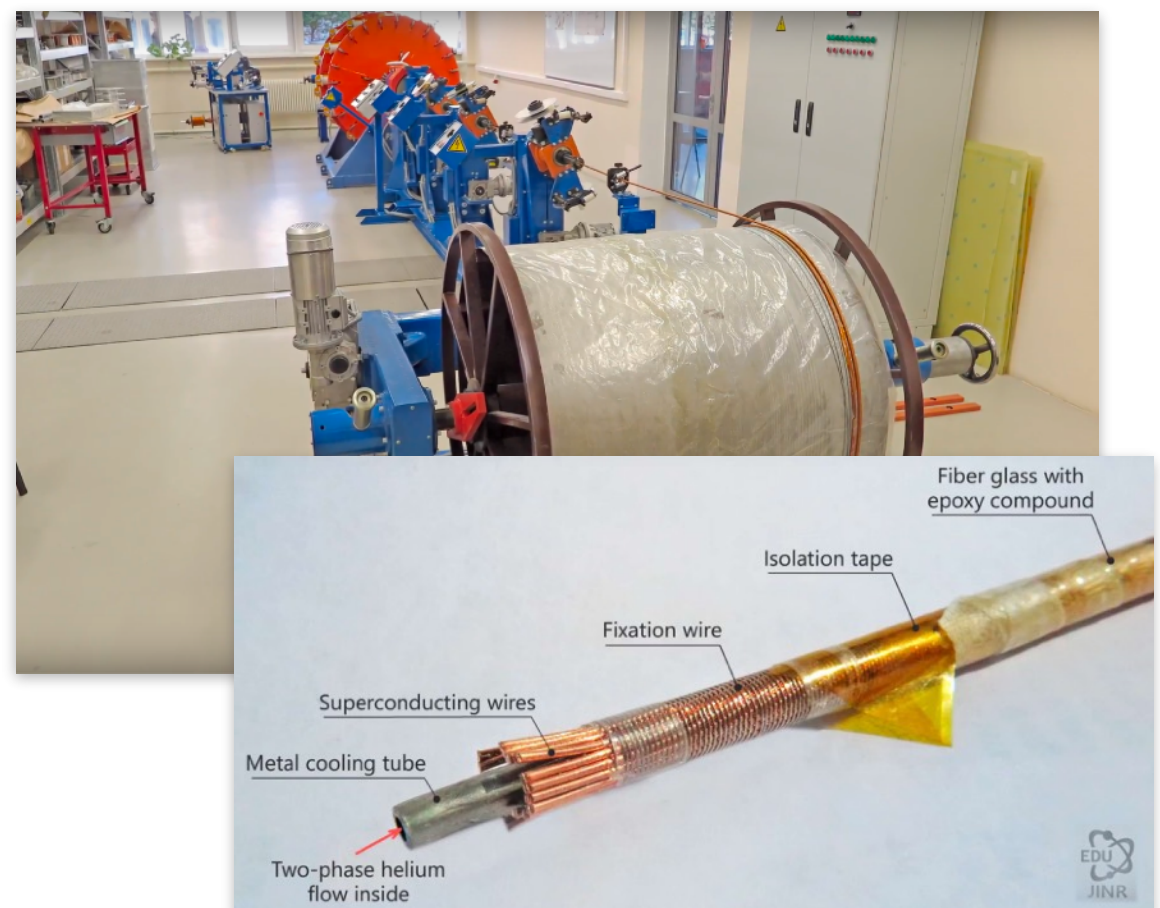
H.Khodzhibagiyan et al.

Option based on the <u>PANDA cable</u>

- The team of the Budker Institute of Nuclear Physics / Novosibirsk
- The Rutherford-type cable with 8 strands extruded in Al matrix (PANDA, LHC, MPD)
- The PANDA magnet was scheduled to be ready to ship to GSI in 2024 for final testing

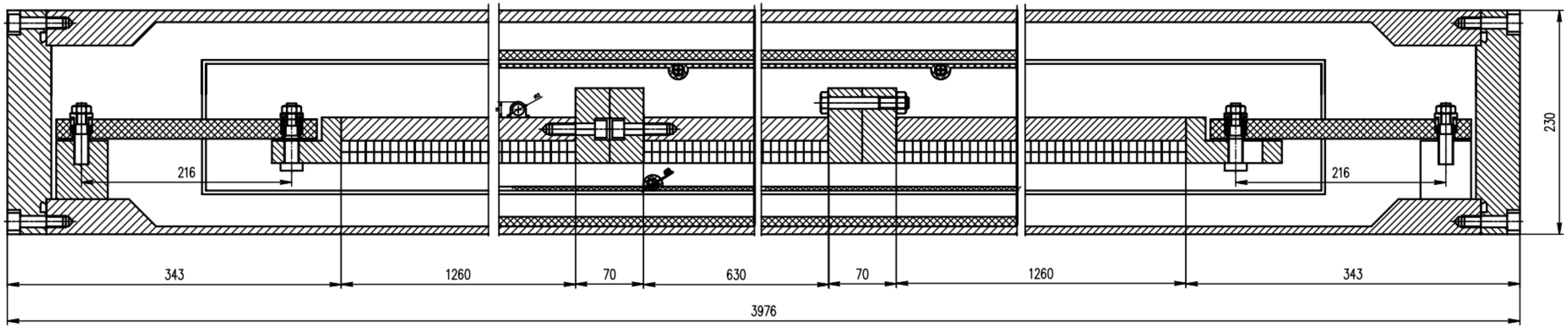
Option based on the <u>NICA cable</u>

- Coil construction similar to one used for the NICA magnets (produced in JINR)
- The same NbTi/CuNi cable as used in Nuclotron magnets: hollow superconductor with the helium flows inside (~4 K)
- The working group of engineers to be formed

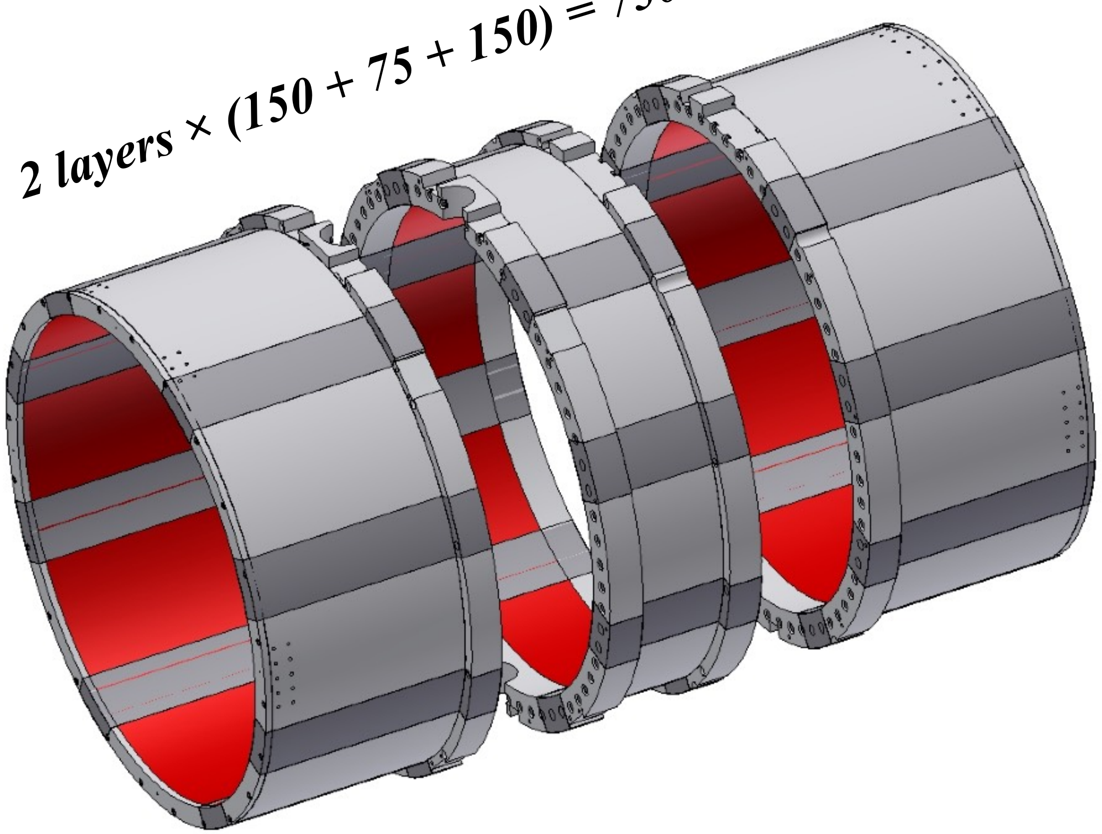


E.Pyata
S.Pivovarov

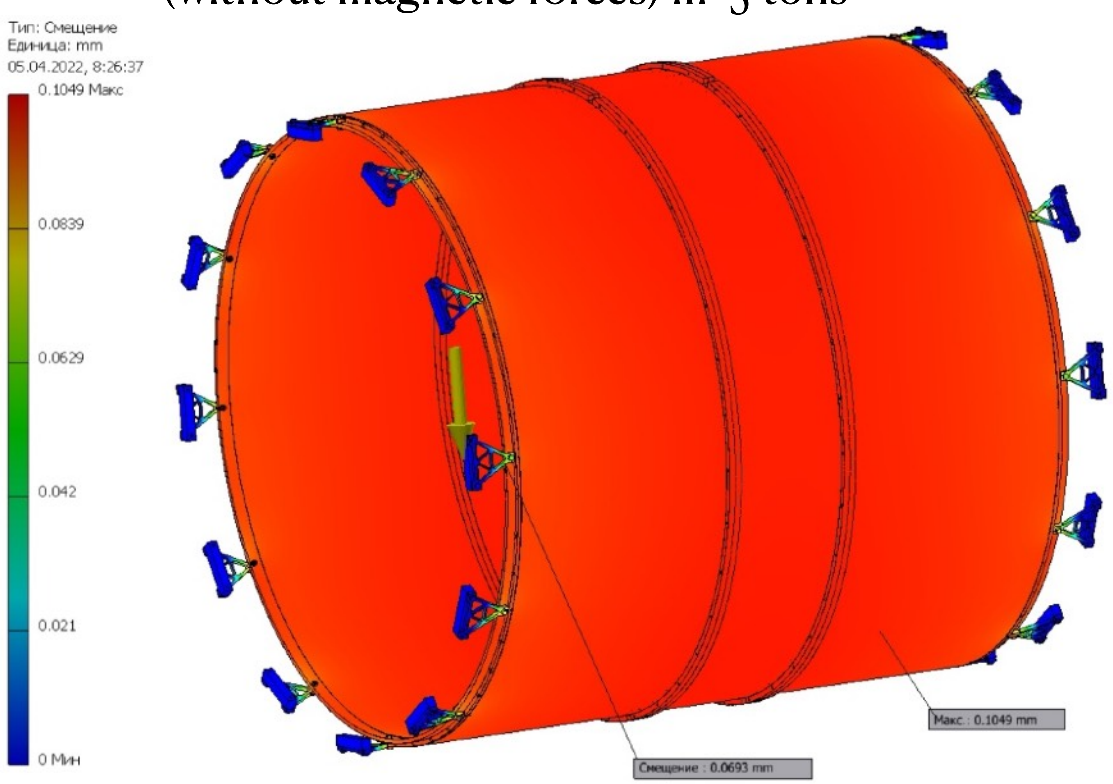
Option based on the PANDA magnet



2 layers × (150 + 75 + 150) = 750 turns



Results of deformation calculations
(without magnetic forces) m=5 tons



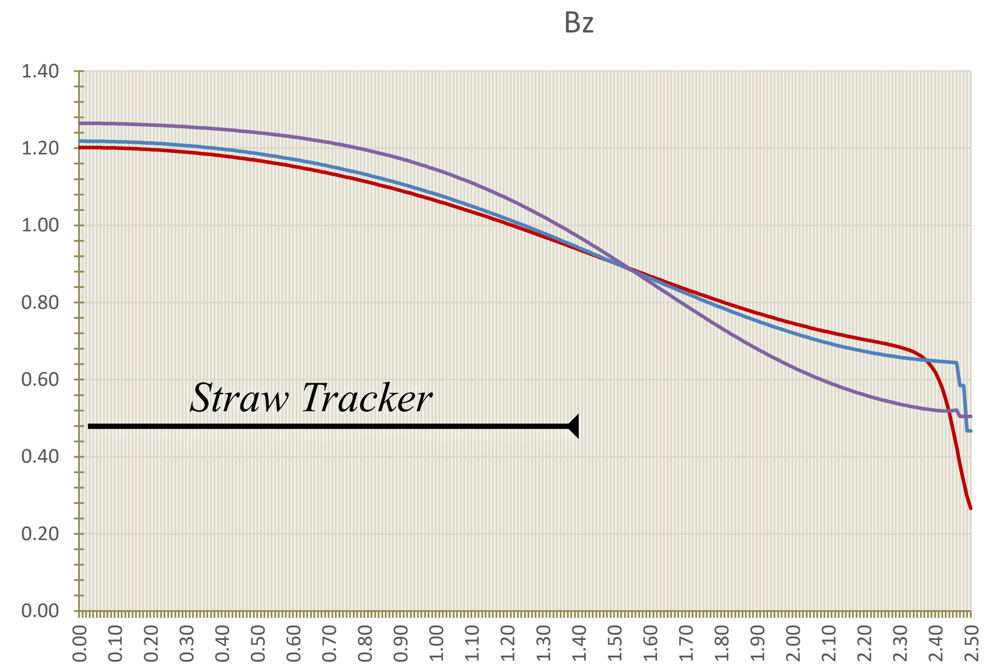
E.Antokhin et al.

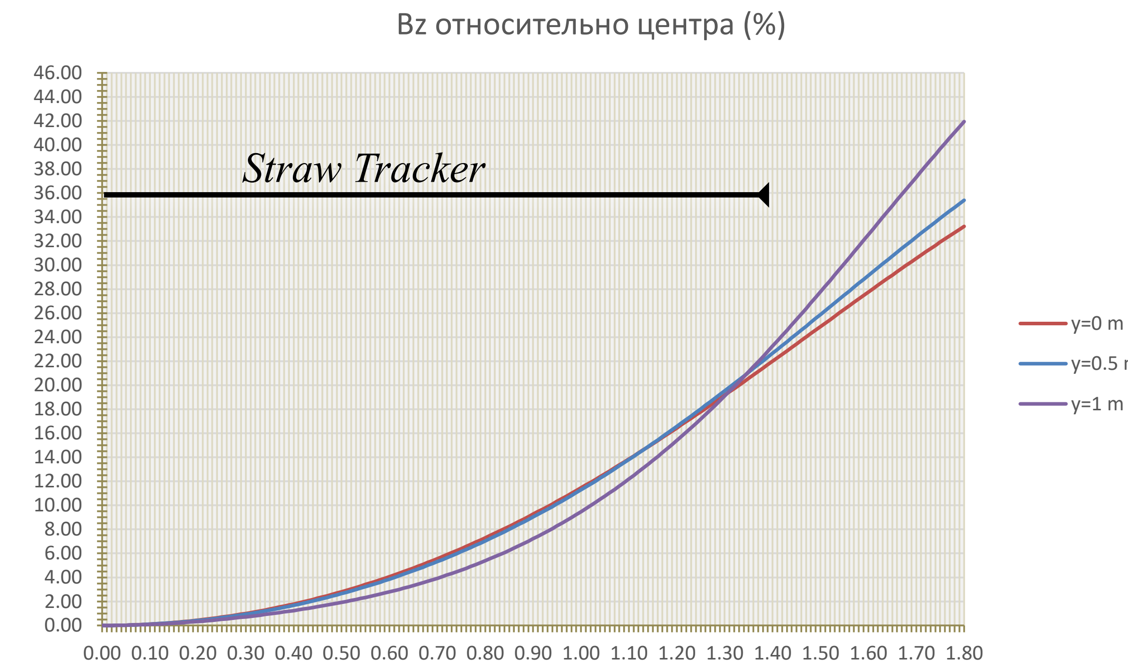
Magnet options with 3 and 2 coils

There is no room inside for either correction coils (as in MPD) or yoke pieces (which attract magnetic lines). In general, field uniformity is not so critical for Straw drift detectors.

Option with 3 coils
I = 5200 A

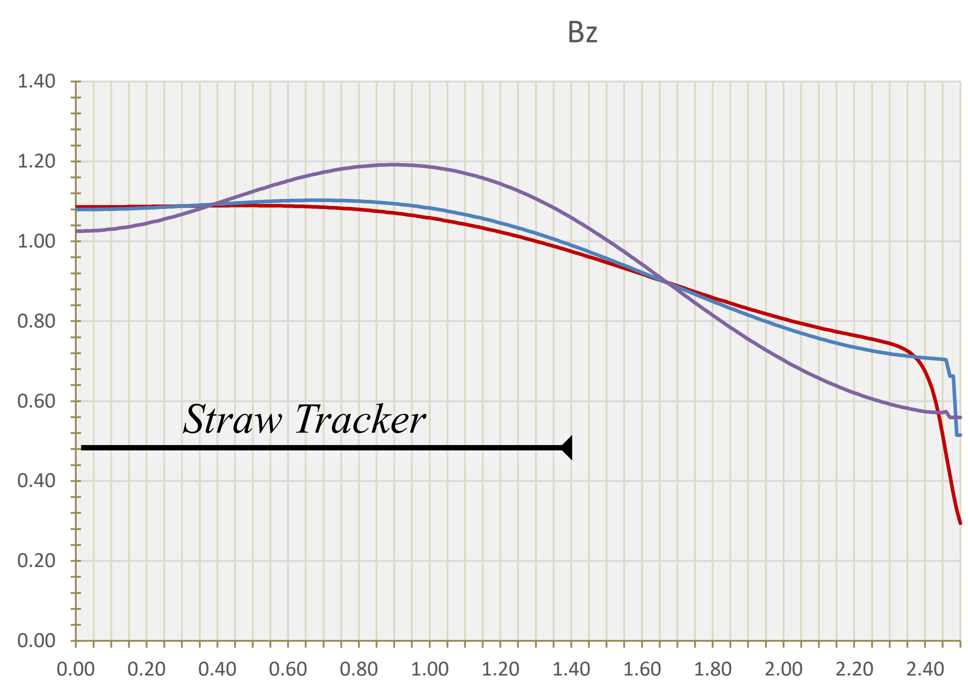
~20% decrease within 1.4 m (Straw Tracker)

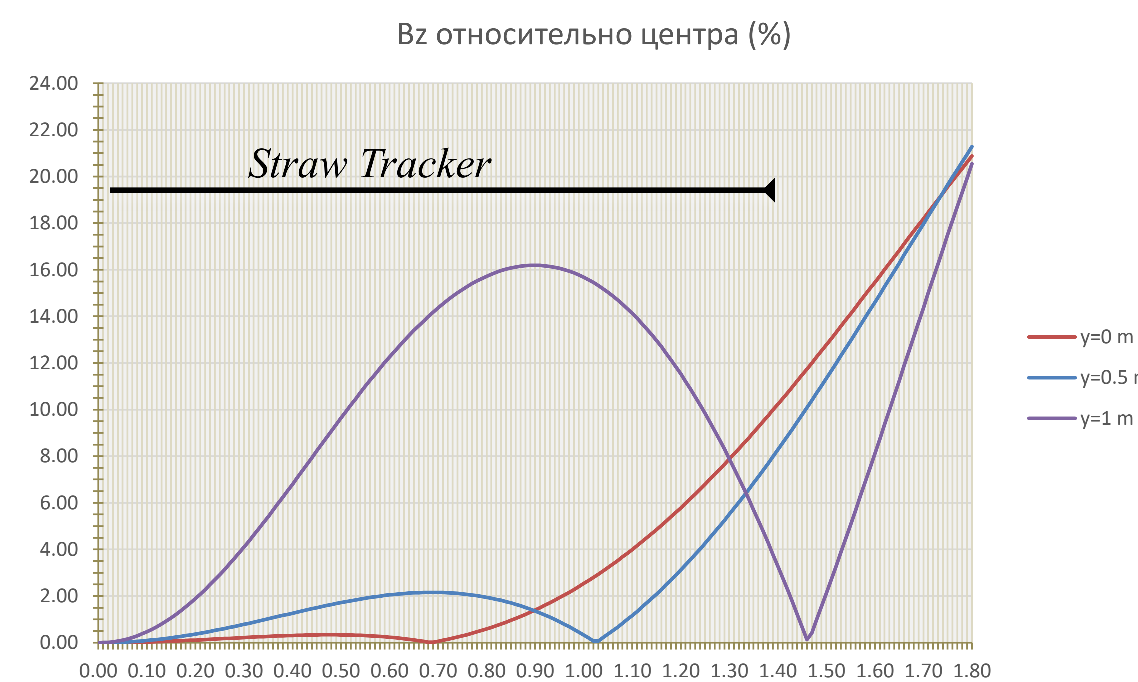




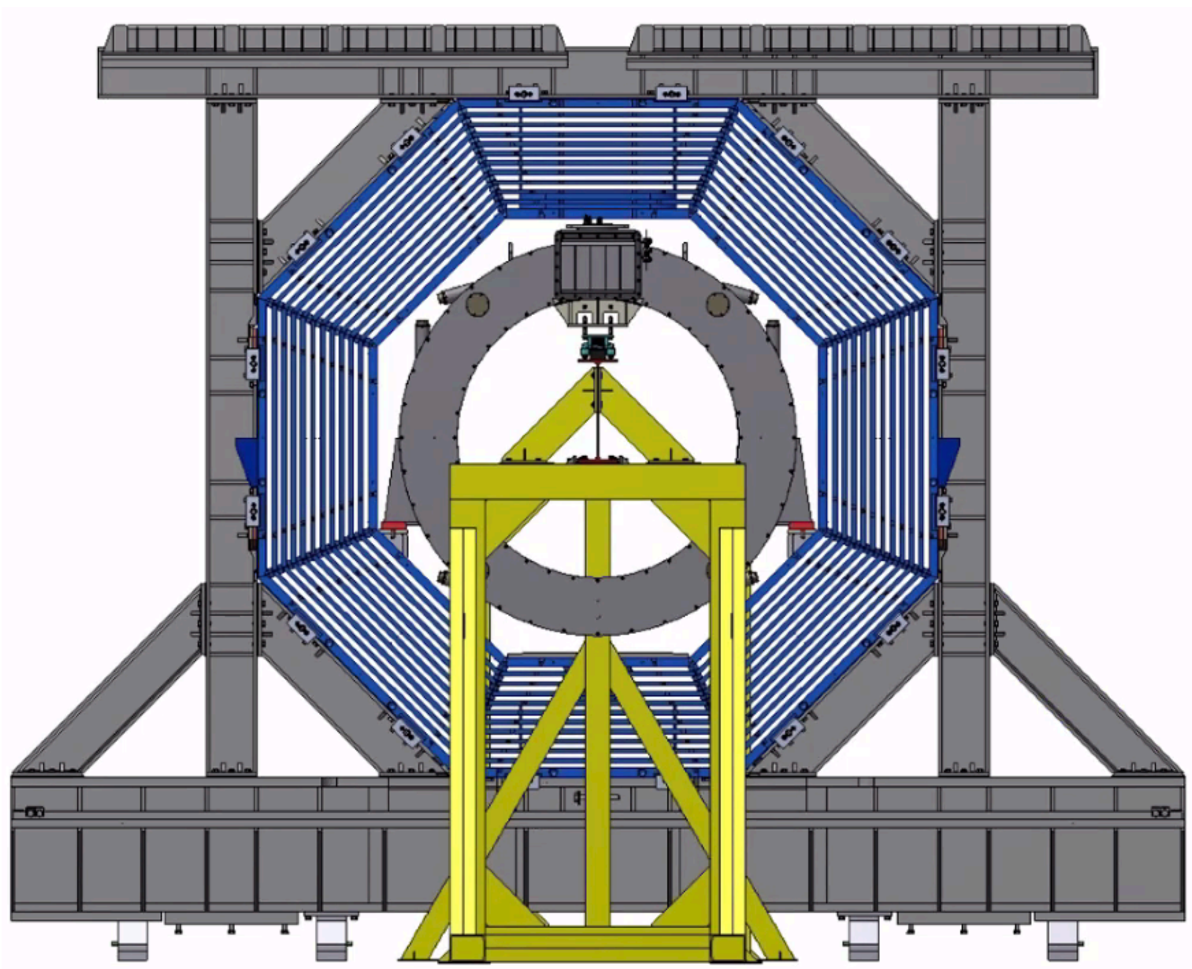
Option with 2 coils
(without central coil)
I = 6500 A

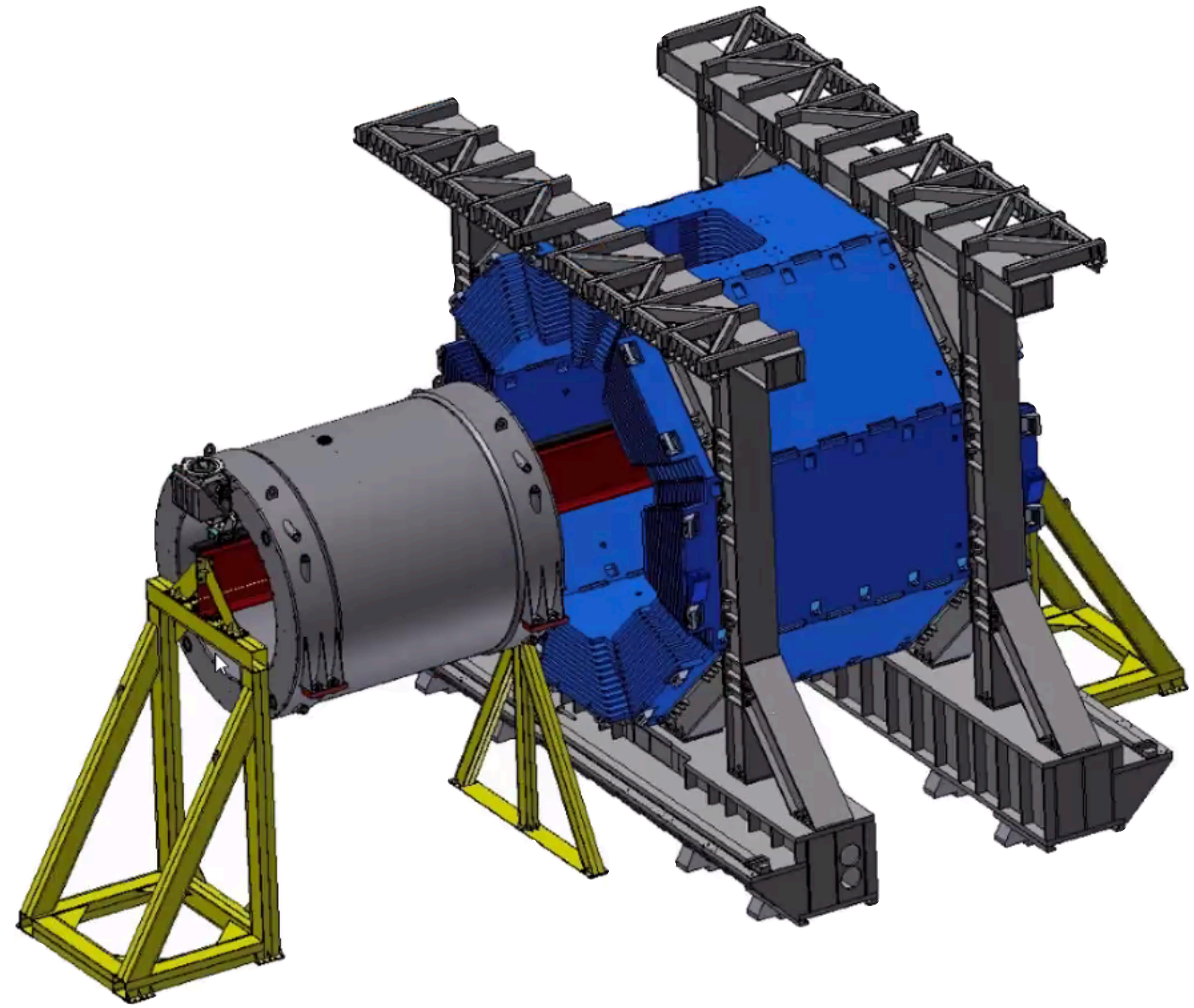
~10% decrease within 1.4 m (Straw Tracker)



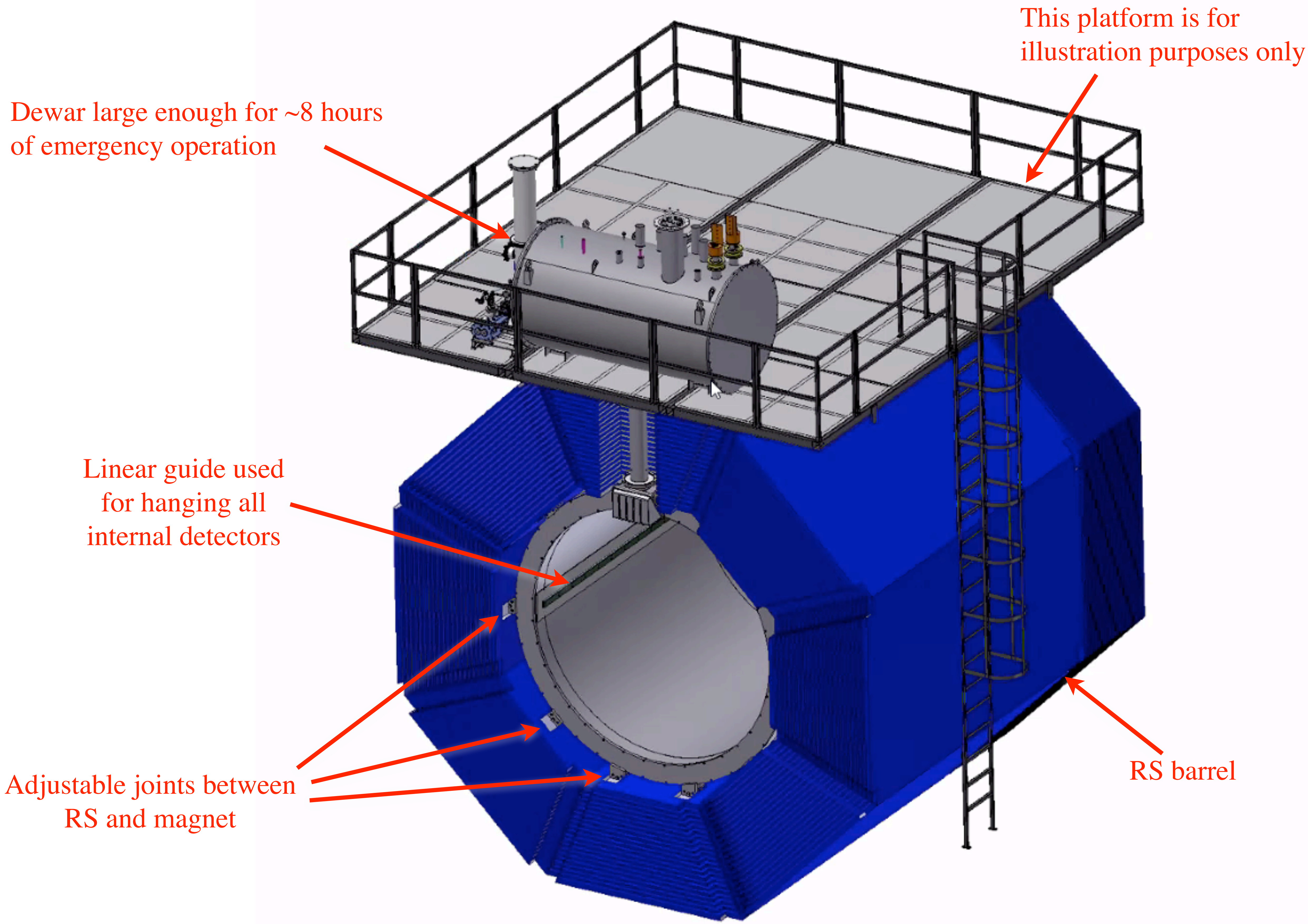


Installation procedure of the magnet proposed for PANDA

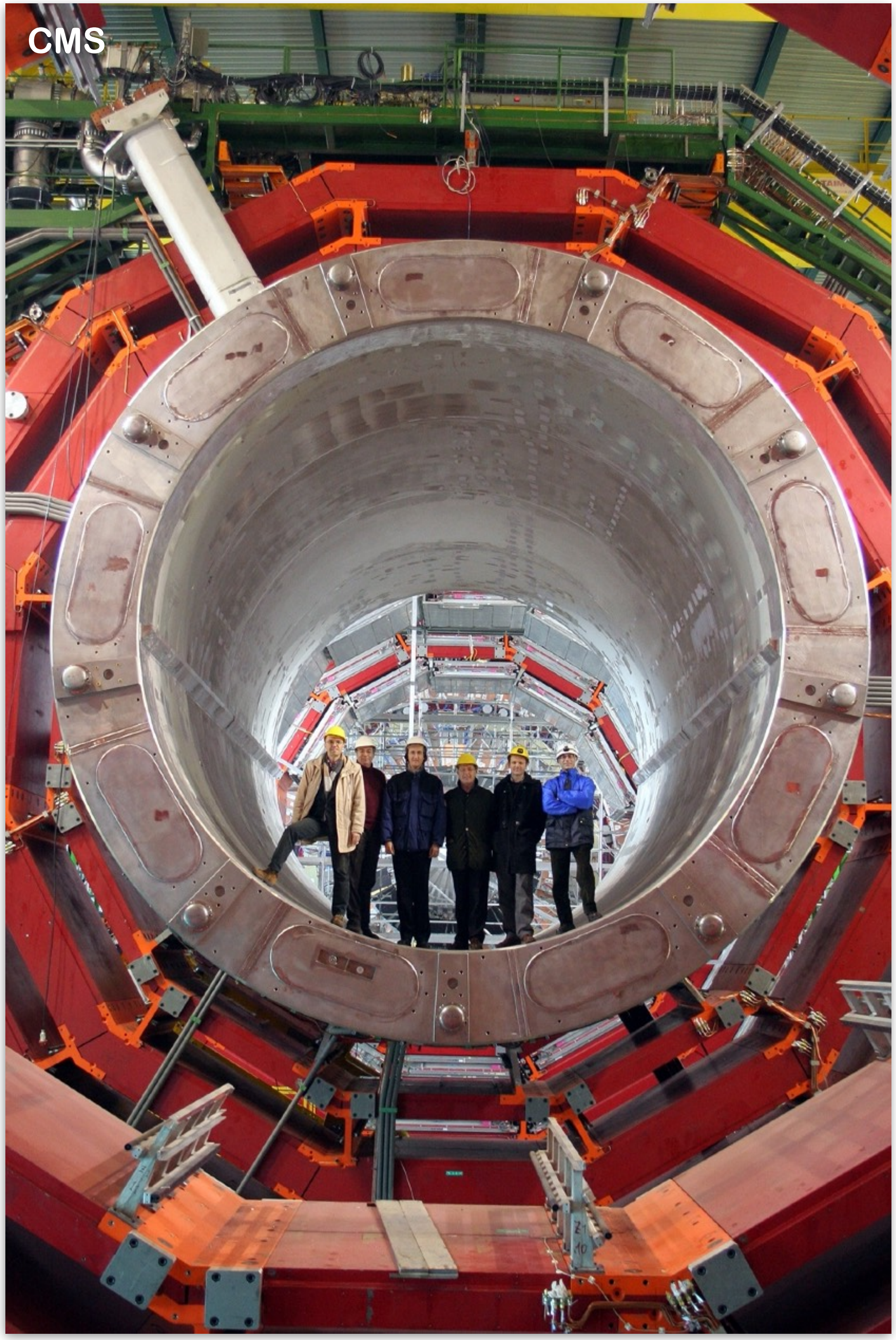


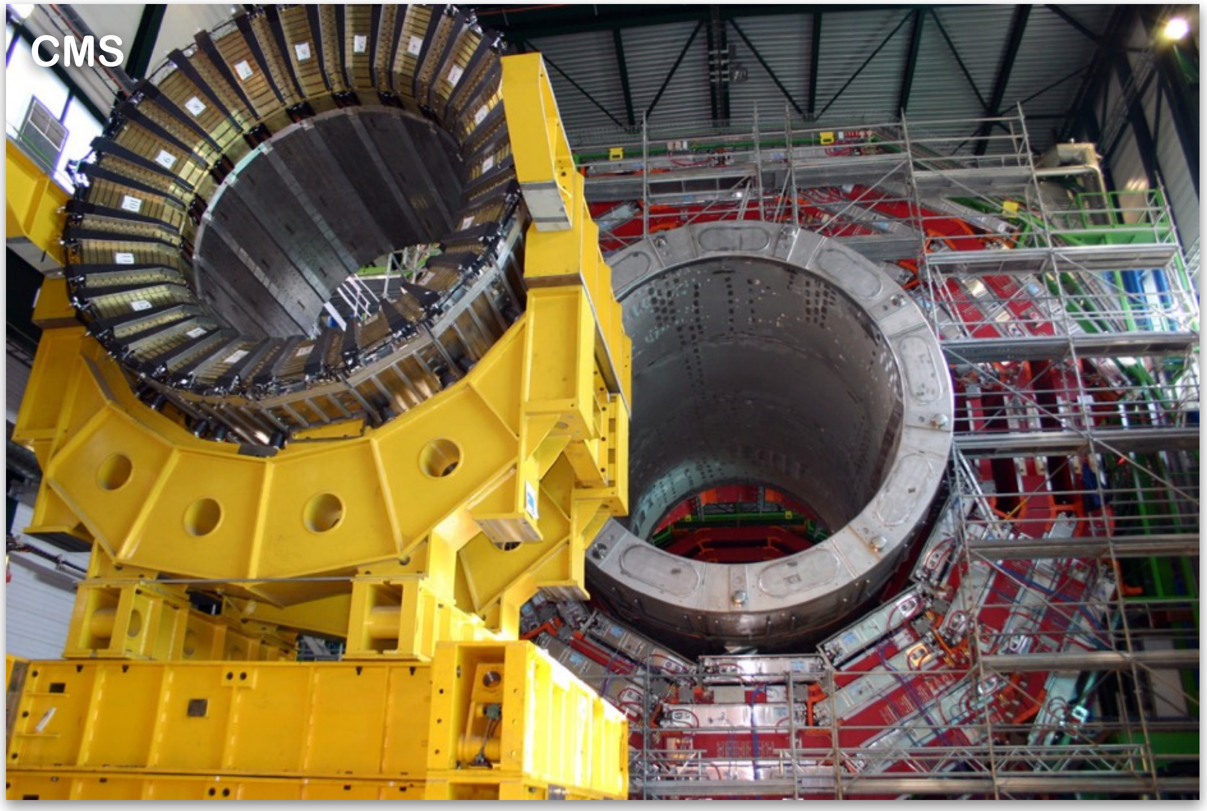


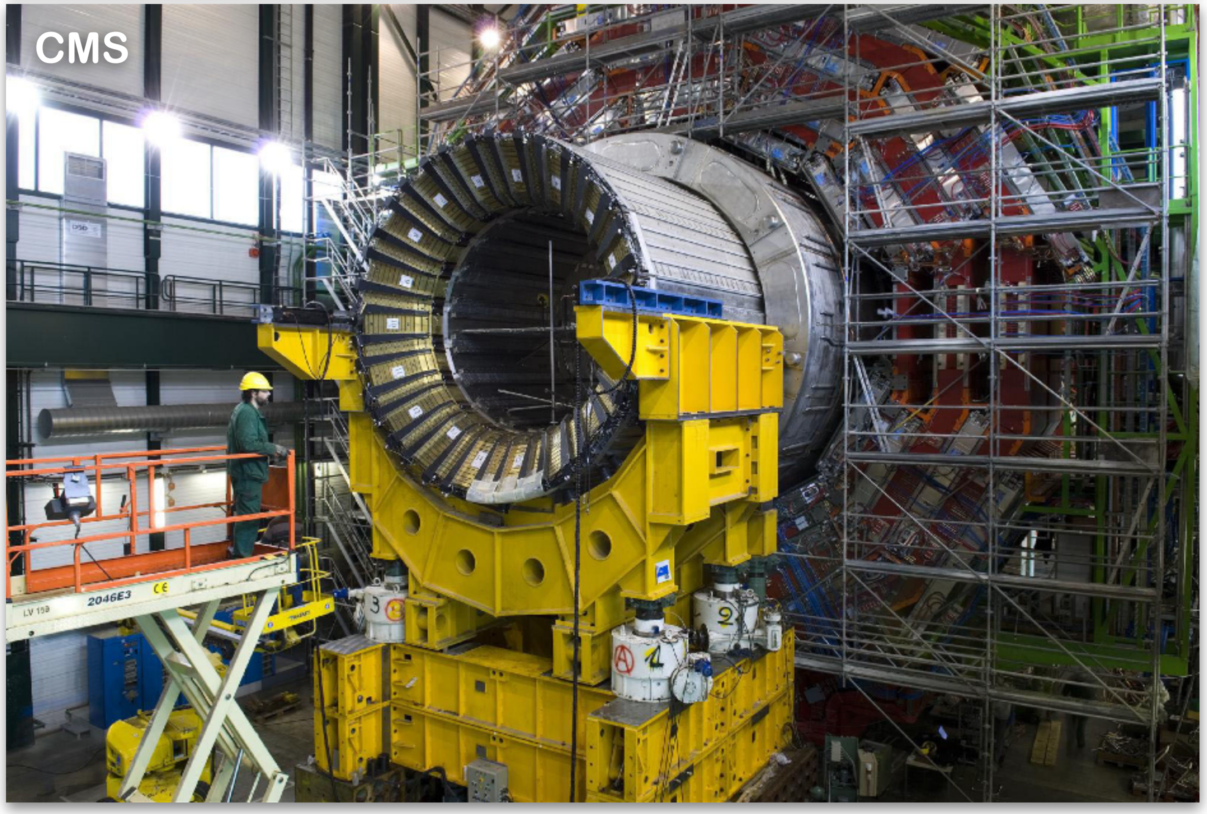
- The same stand used to assemble the magnet can also be used to insert the magnet into the RS
- Two roller skates are used to transfer the magnet along a steel I-shaped beam.


This platform is for illustration purposes only
Dewar large enough for ~8 hours of emergency operation
Linear guide used for hanging all internal detectors
Adjustable joints between RS and magnet
RS barrel

Calorimeter suspension scheme in CMS/LHC







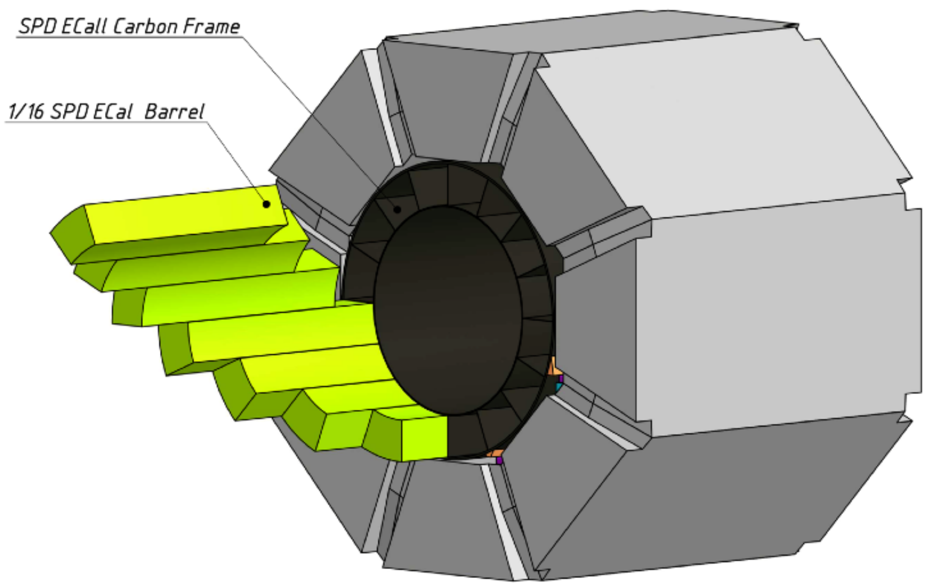
Barrel of Electromagnetic Calorimeter (ECal)

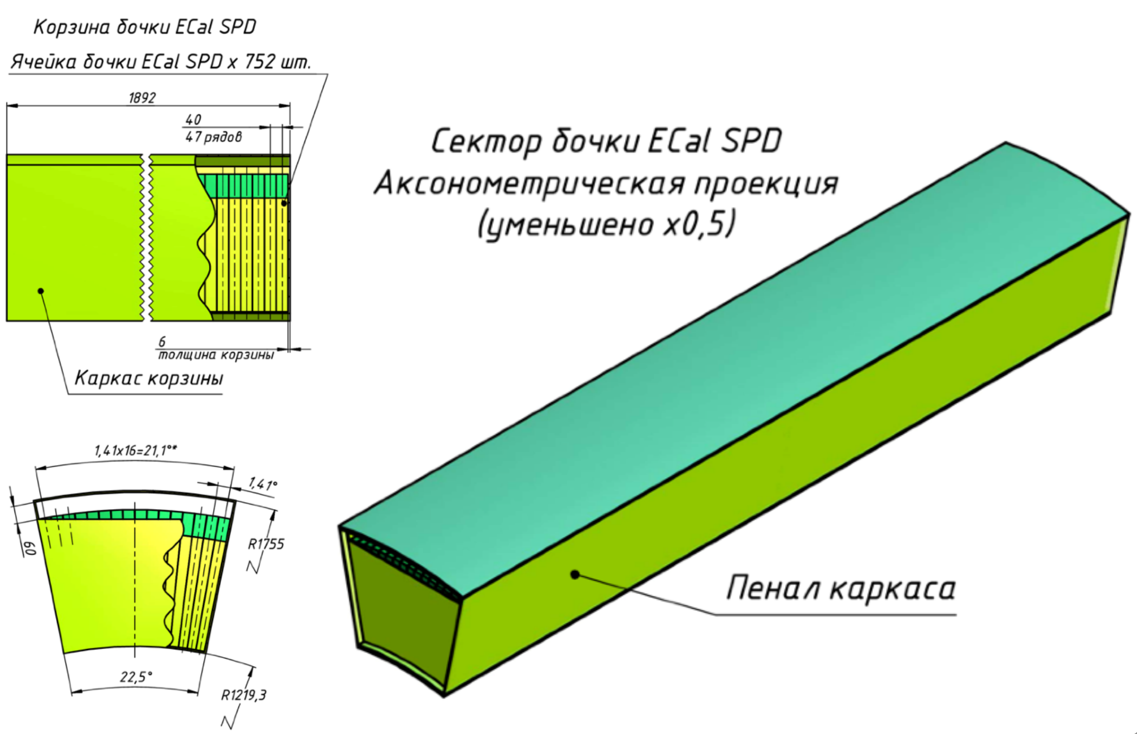
O.Gavrischuk

CDR

Half-sector approach

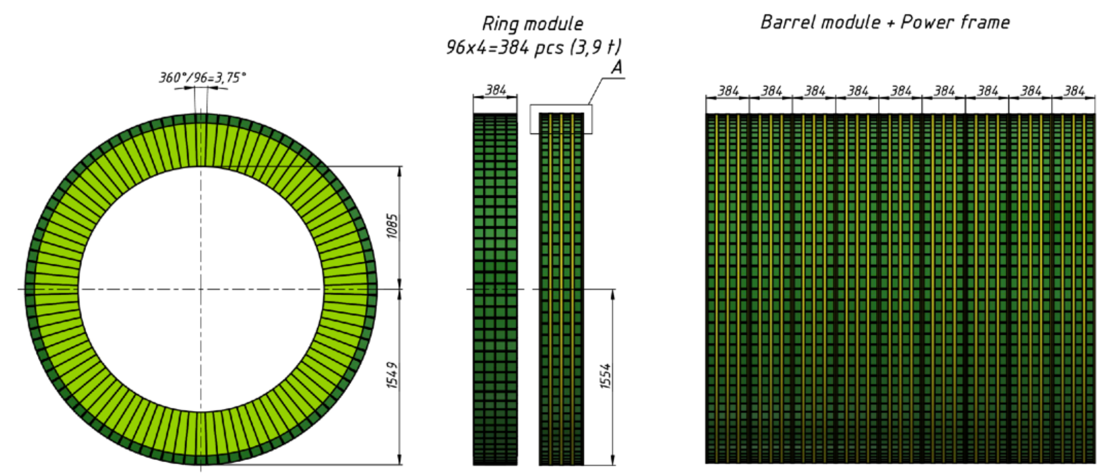
Similarly as it is employed in the MPD experiment

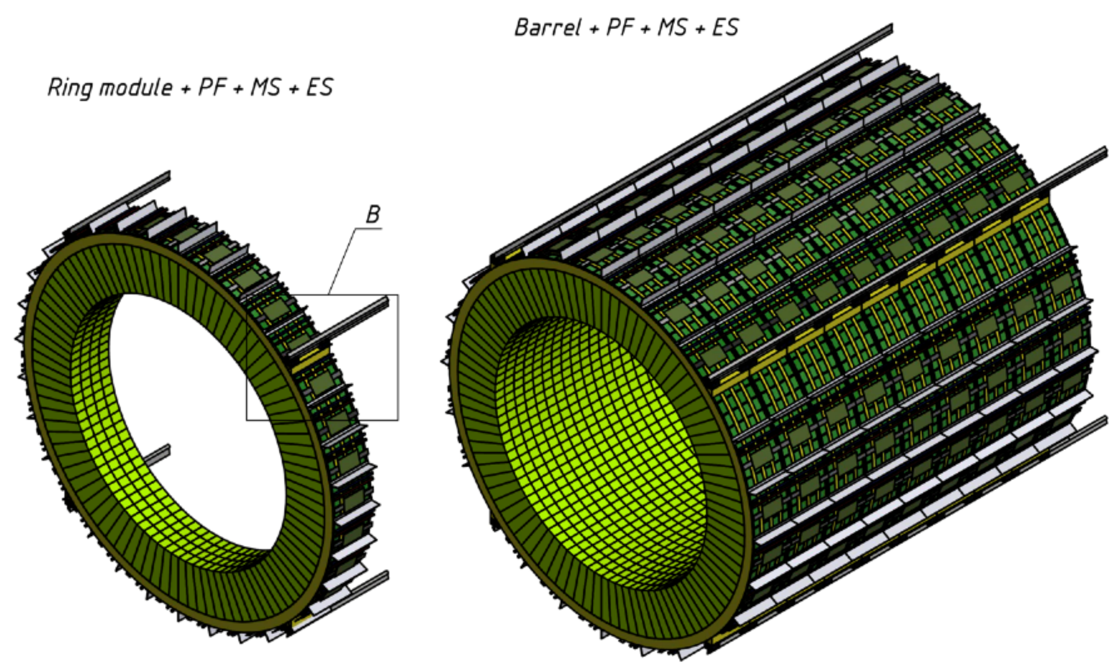




Ring approach

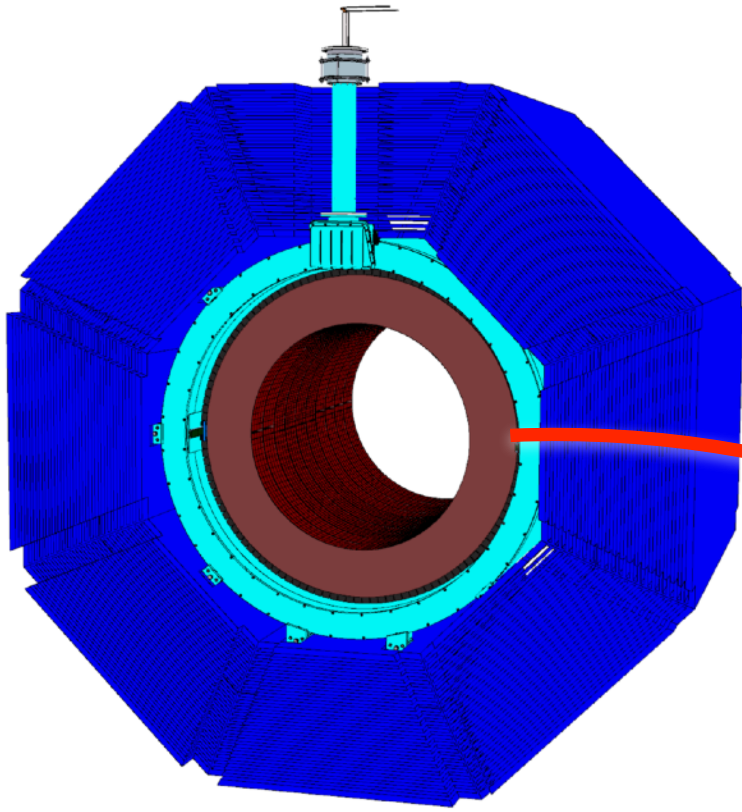
It was proposed in order to avoid inefficiency regions distributed azimuthally

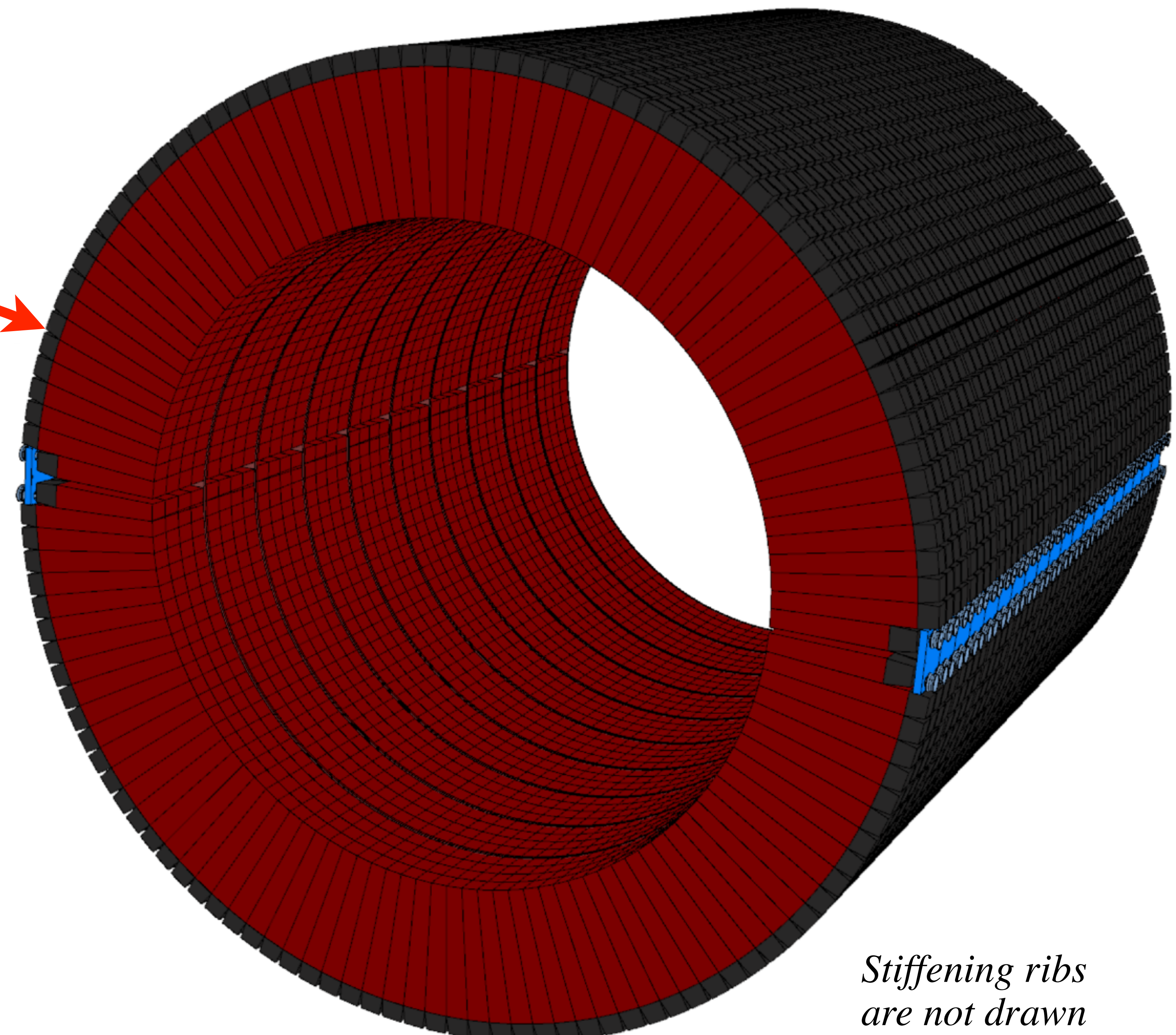




S.Sukhovarov

Barrel of Electromagnetic Calorimeter (ECal)



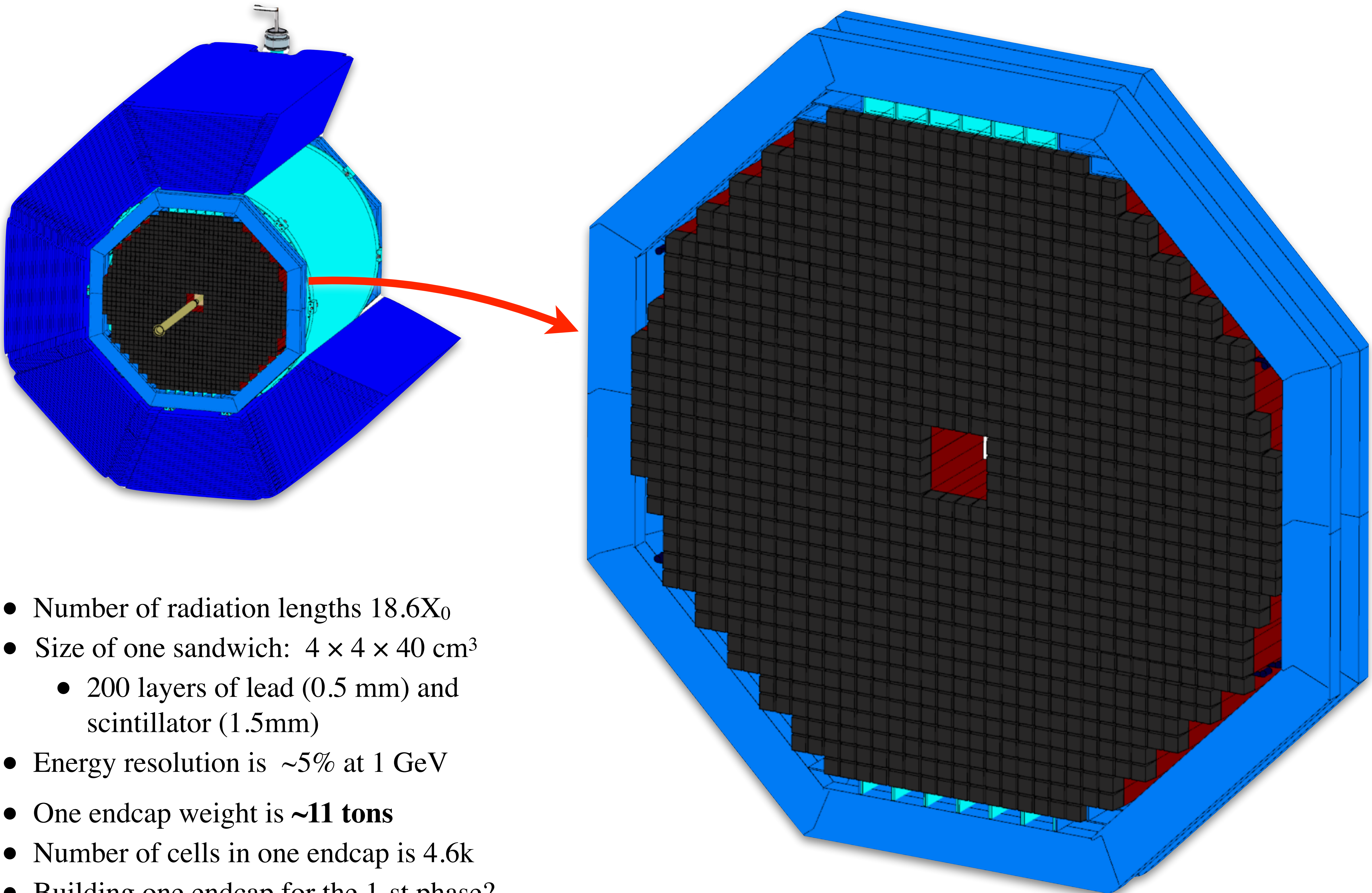


- Number of radiation lengths $18.6X_0$
- Size of one sandwich: $4 \times 4 \times 40$ cm^3
  - 200 layers of lead (0.5 mm) and scintillator (1.5mm)
- Energy resolution is ~5% at 1 GeV
- Barrel weight is **~40 tons**
- Total number of cells in barrel is 13.8k
- Possibility to replace ECal with passive material for the 1-st phase

Stiffening ribs are not drawn for clarity

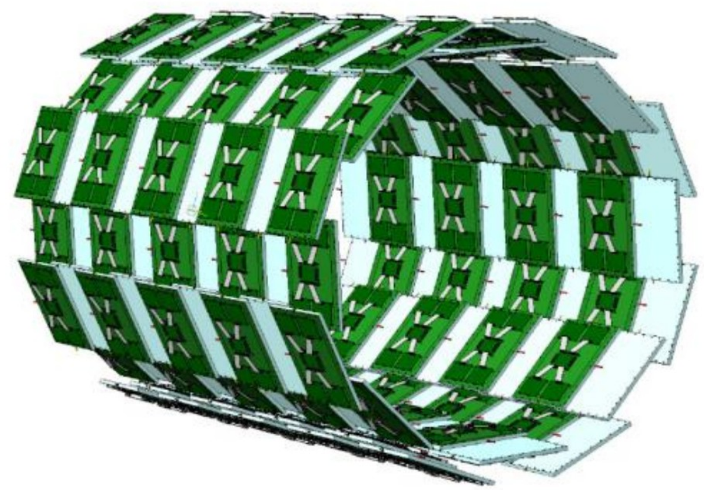
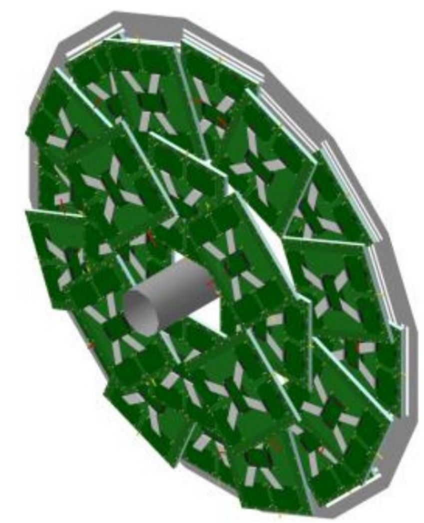
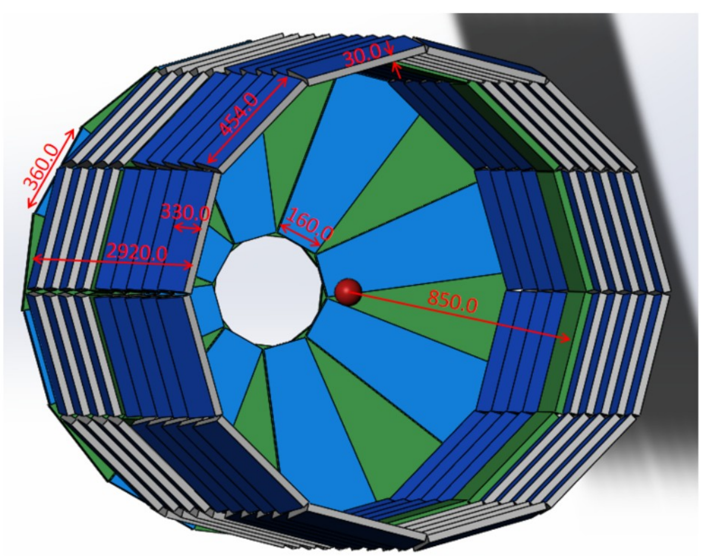
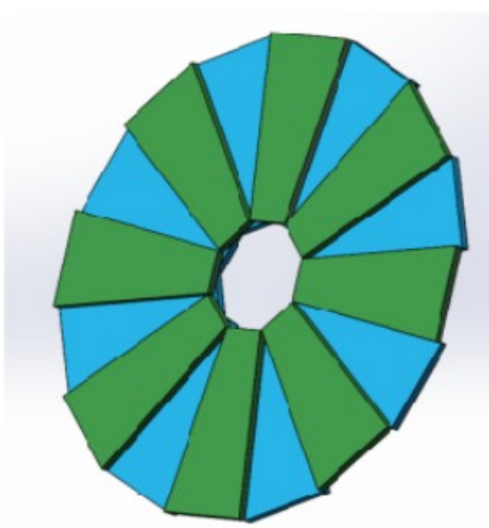
End-cap of Electromagnetic Calorimeter (ECal)

S.Sukhovarov

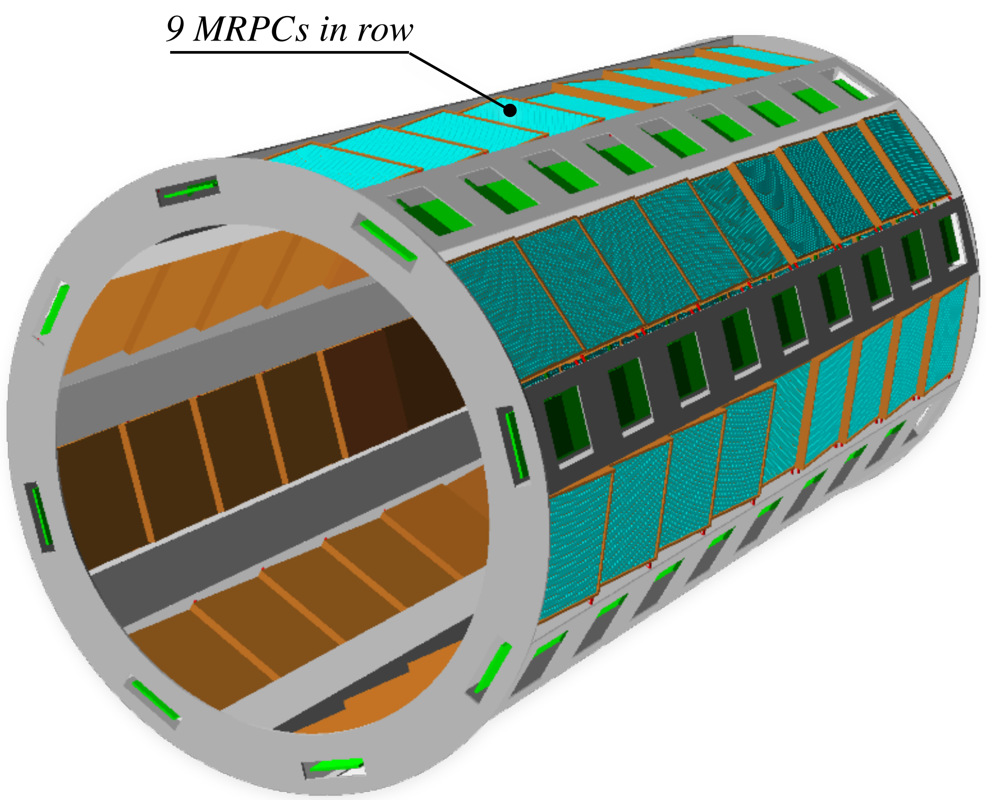


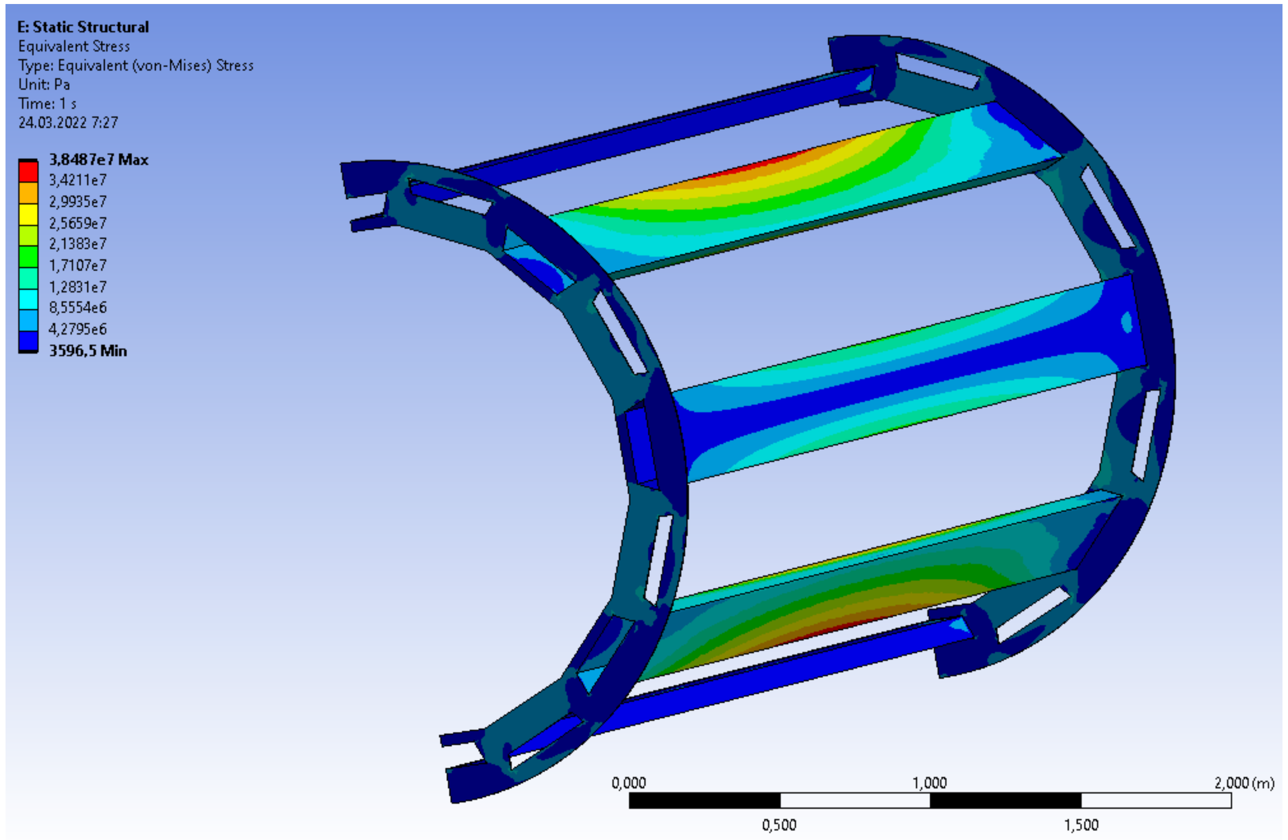
- Number of radiation lengths $18.6X_0$
- Size of one sandwich: $4 \times 4 \times 40$ cm^3
    - 200 layers of lead (0.5 mm) and scintillator (1.5mm)
- Energy resolution is ~5% at 1 GeV
- One endcap weight is **~11 tons**
- Number of cells in one endcap is 4.6k
- Building one endcap for the 1-st phase?

Time-of-Flight (TOF) system

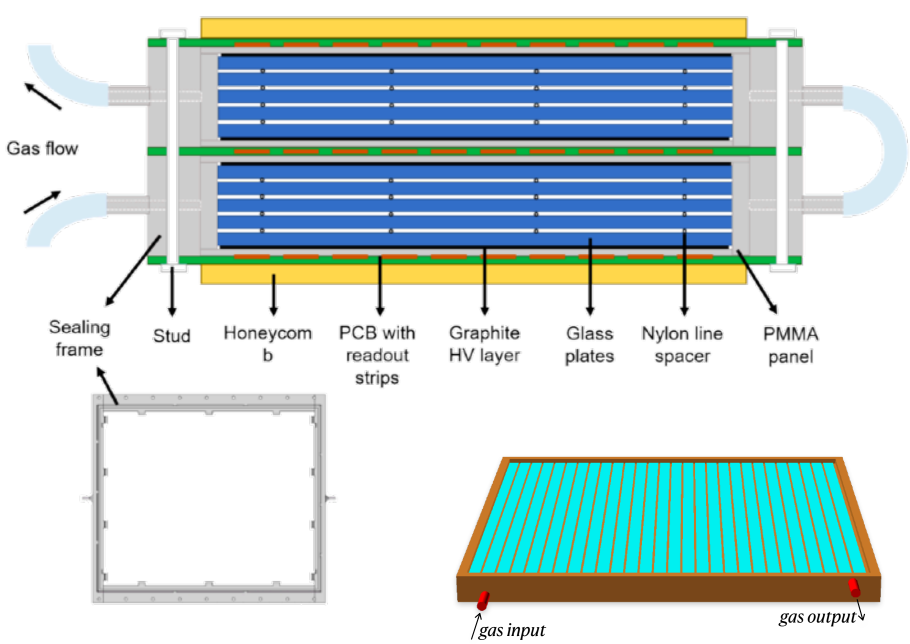
geometry	Barrel	End-cap
A.Semak, E.Ladyguine A.Snesarev et al. IHEP Protvino LPI Moscow		
Yi Wang Tsinghua Uni		

Time-of-Flight (TOF) system





Based on sealed MRPC proposed for CBM-TOF

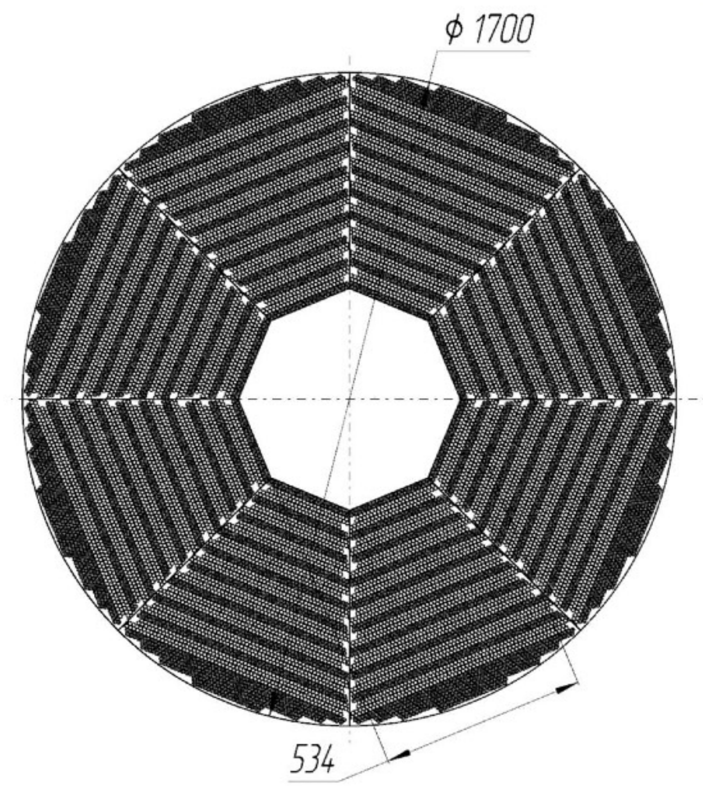


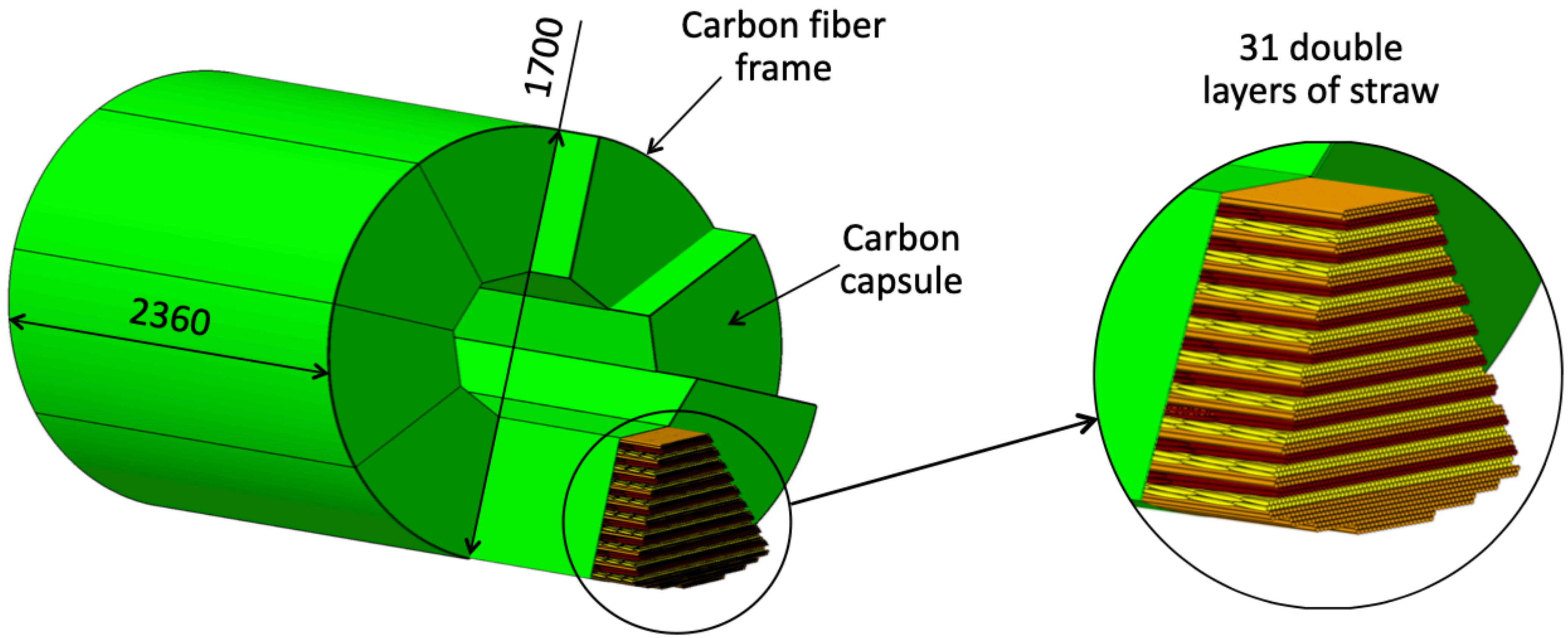
- The TOF barrel contains 144 staggered MRPC chambers of 43 cm × 44 cm size
- It is proposed to use a self-supporting truss structure for mounting the chambers
- Weight of the structure with MRPCs is ~4 tons
- The engineer who led the project quit JINR. The study remains incomplete
- Potentially, a development contract can be signed with Khotkovo engineers.

Barrel of Straw Tracker (ST)

T.Enik

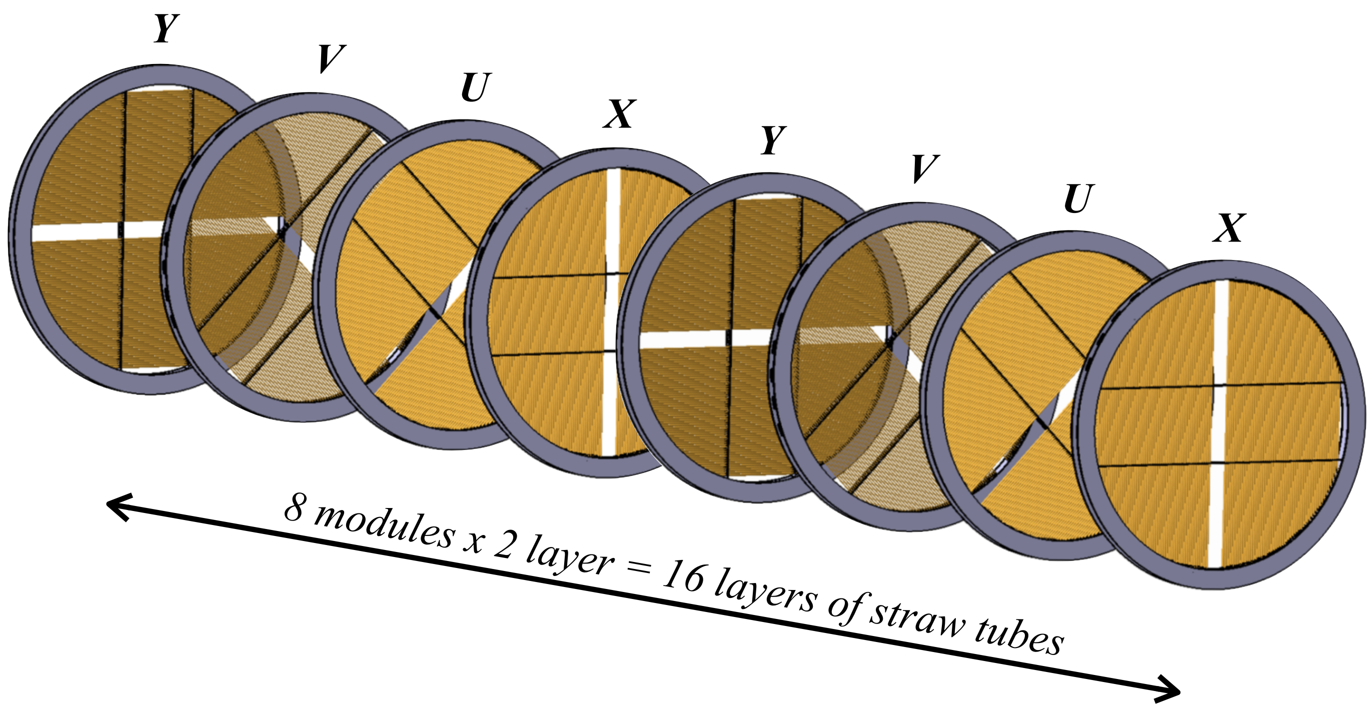
- ST barrel consists of 8 modules (octants)
- One octant contains ~3.2k tubes in total, which are arranged in layers with orientation *Z, +3º, -3º*
- Total number of tubes is 3.2k tubes × 8 modules = 25.6k tubes
- The radial size of one octant is 58 cm
- One straw is made of a PET foil ultrasonic welded longitudinally thus forming a tube with ∅ = 9.8 mm
- Contract for designing a composite frame with Khotkovo next year

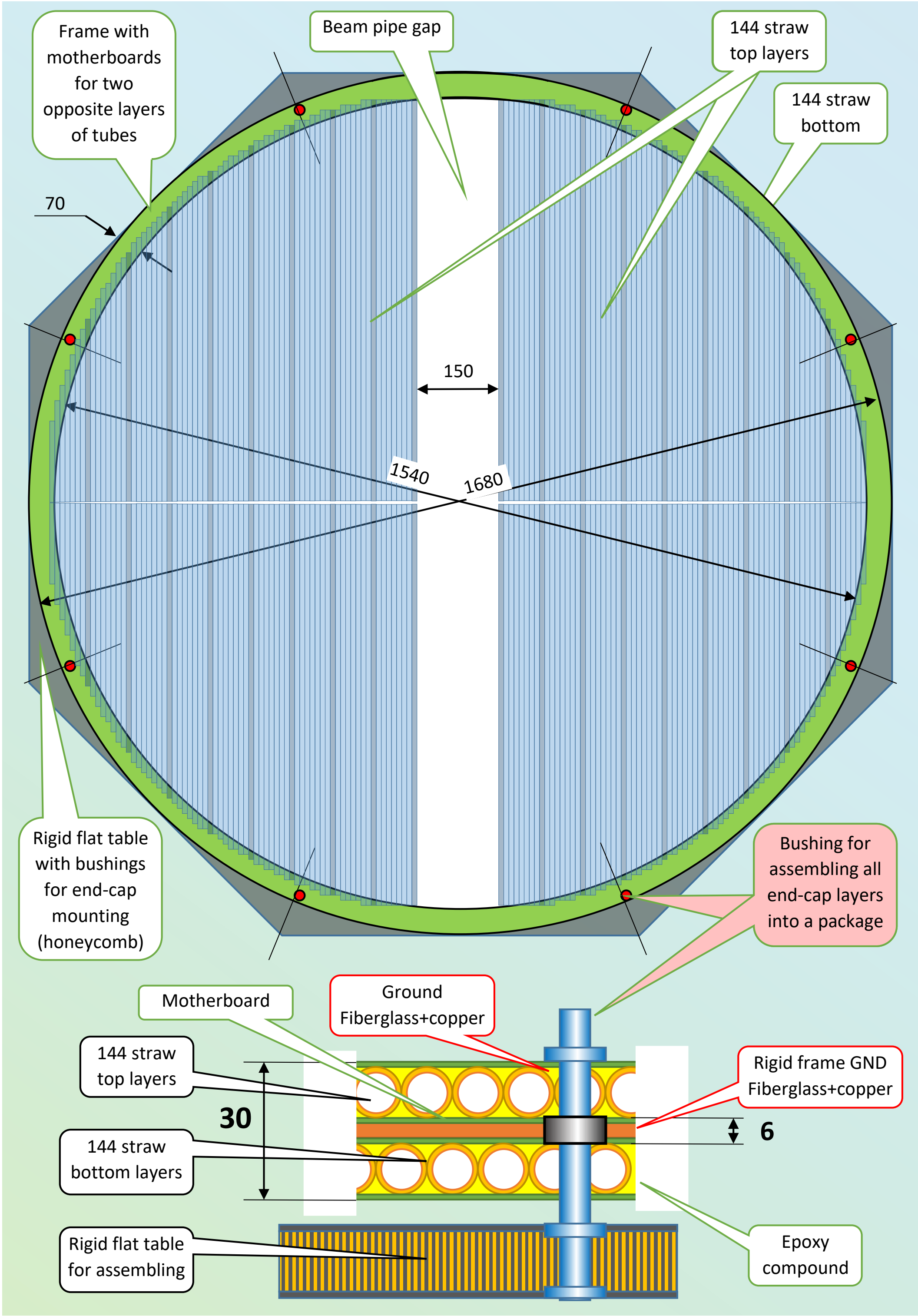




Endcap of Straw Tracker (ST)

G.Kekelidze
V.Kramorenko





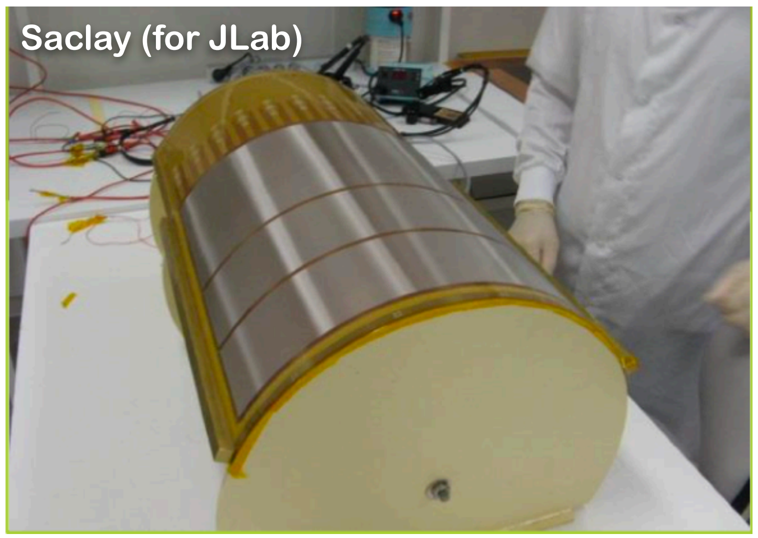
- One ST endcap contains 8 modules: *X, +45º, -45º, Y*
- One module contains 288 tubes in total, which are arranged in two layers shifted by half a tube
- Total number of tubes in two endcaps is

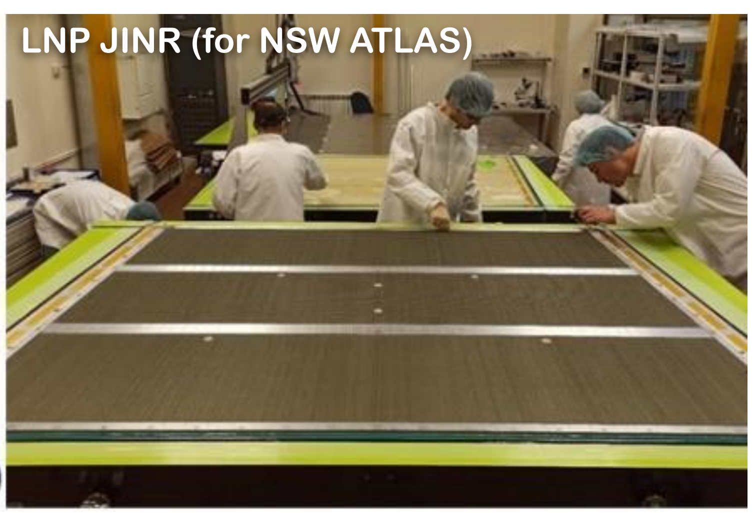
  288 tubes × 16 modules × 2 endcaps = 9216 tubes
- The thickness of one module is 30 mm
- Eight coordinate planes are mounted together on a rigid flat table to form a 240 mm thick rigid block
- One straw is made by winding two "kapton" tapes forming a tube with ∅ = 9.56 mm

Inner Tracker System of SPD

Micro pattern gaseous detector for the <u>1-st phase</u> of SPD

Cylindrical MicroMegas (MM)



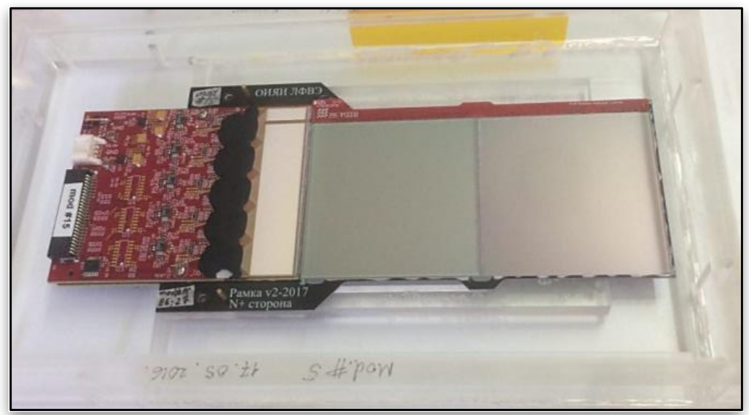


Typical pitch size 350 μm

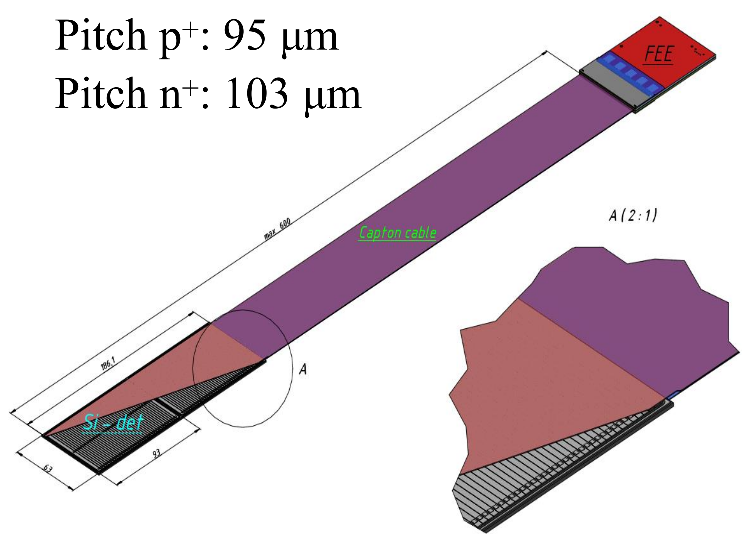
D.Dedovich

Silicon Vertex Detectors (VD) for the <u>2-nd phase</u> of SPD

Double-Sided Silicon Detector (DSSD)



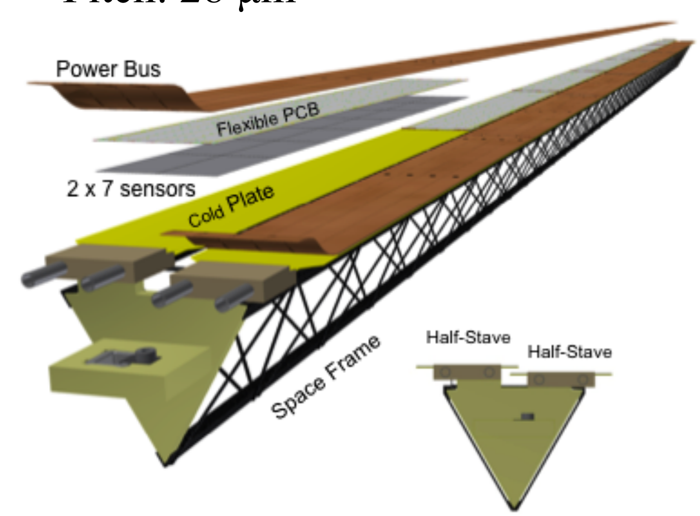
Size: 63×63×0.3 mm³
Pitch p⁺: 95 μm
Pitch n⁺: 103 μm



N.Zamiatin

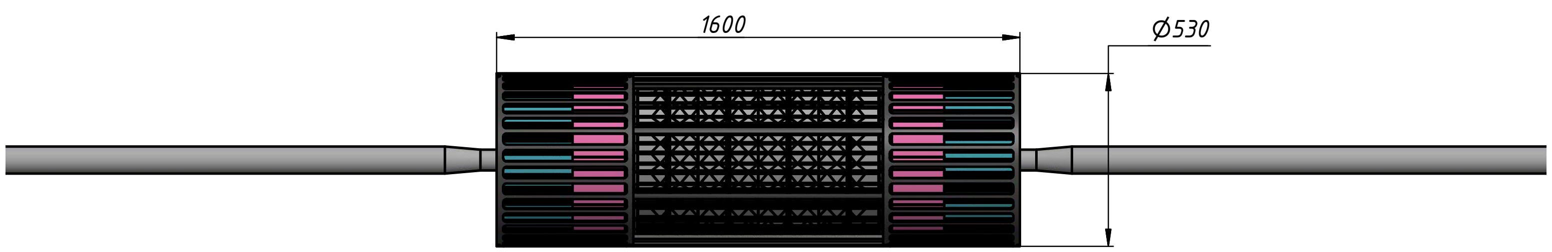
Monolithic Active Pixel Sensors (MAPS)

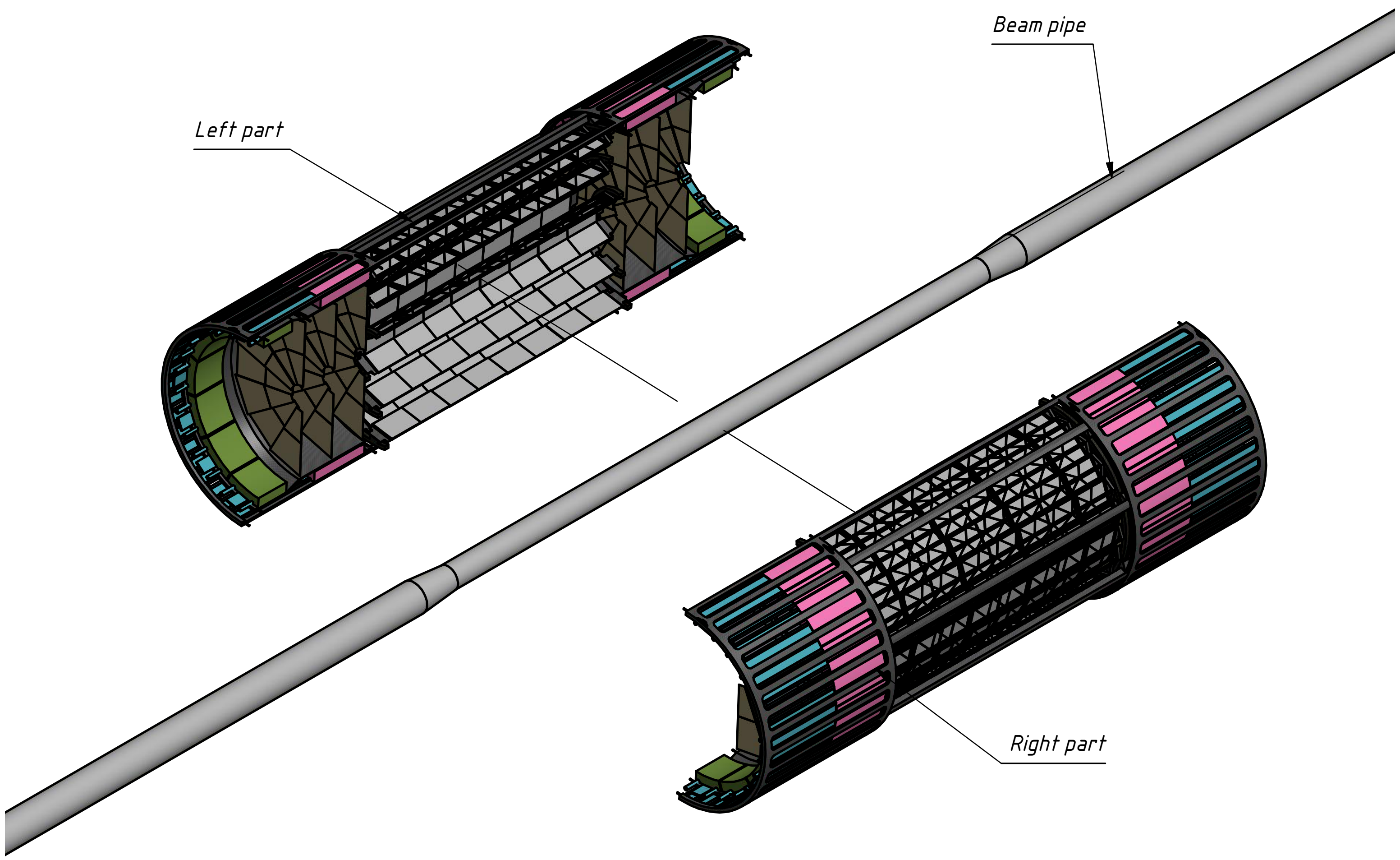
Size: 30×15×0.05 mm³
Pitch: 28 μm



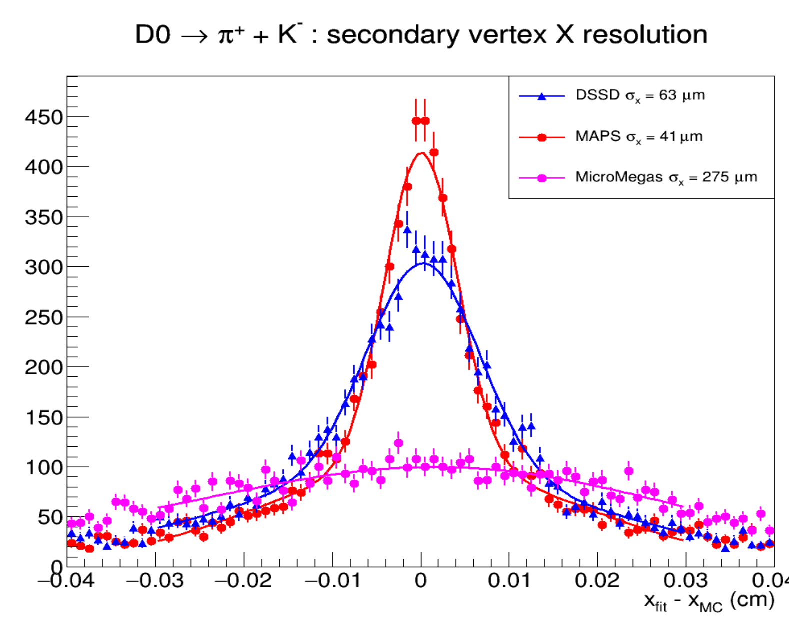
G.Feofilov, V.Zherebchevsky

Vertex Detector (DSSD option)



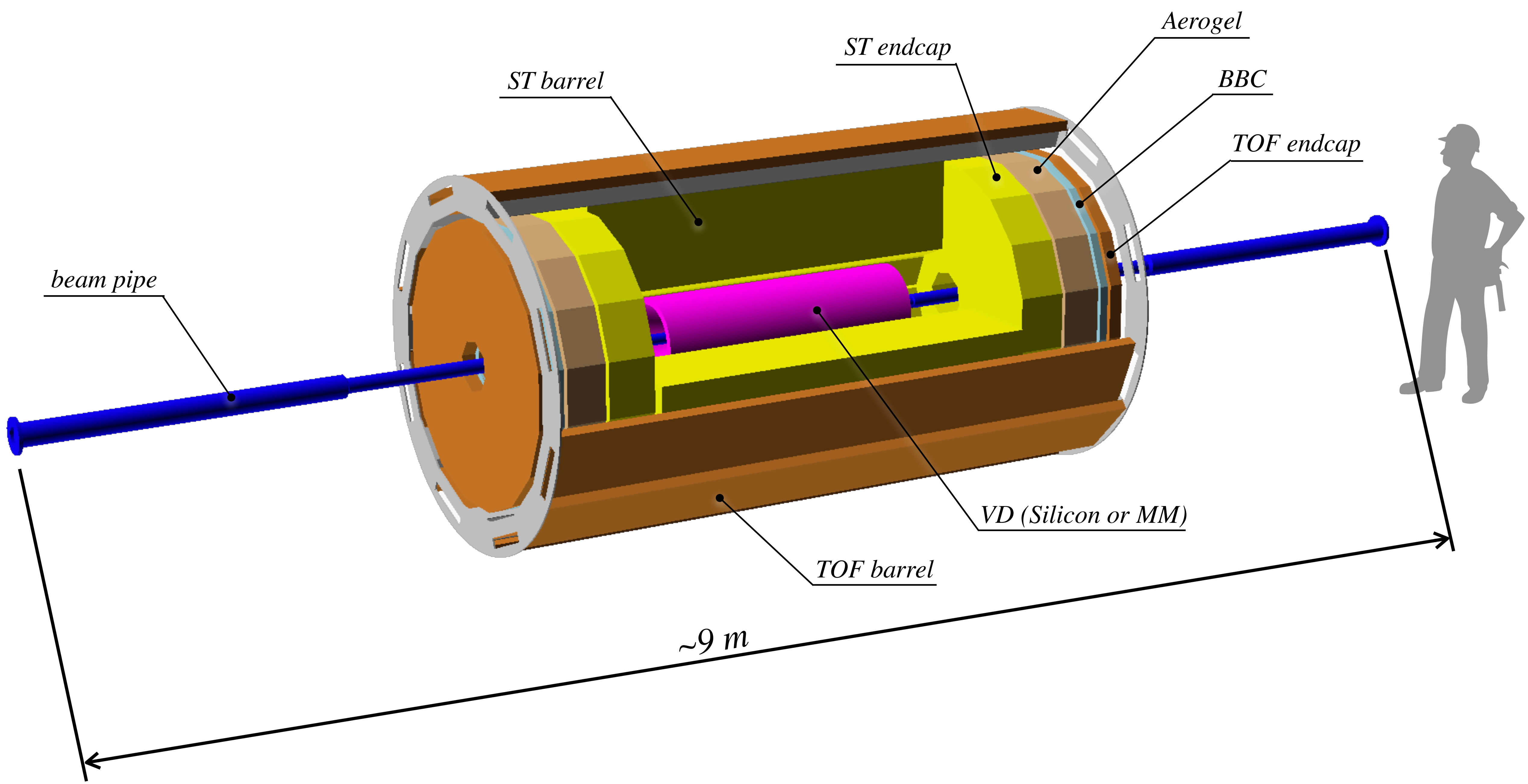


- Passing the pipe through the VD is not feasible because of the conically expanding pipe shape
- Detector is divided into halves, which are assembled separately
- Once VD is closed it will form a single module with the beam pipe
- The detector will not touch the pipe to avoid heat transfer
- It will be a common frame on which both the VD and the pipe will be attached
- All these considerations are equally applicable to MAPS and MM

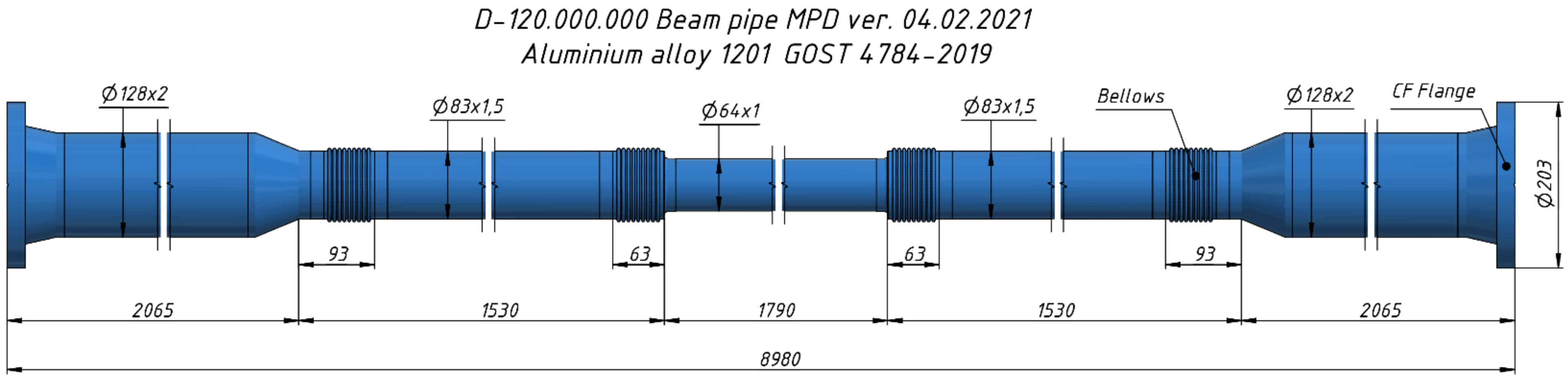


Assembling procedure for the TOF + ST + VD + BBC + Aerogel + pipe

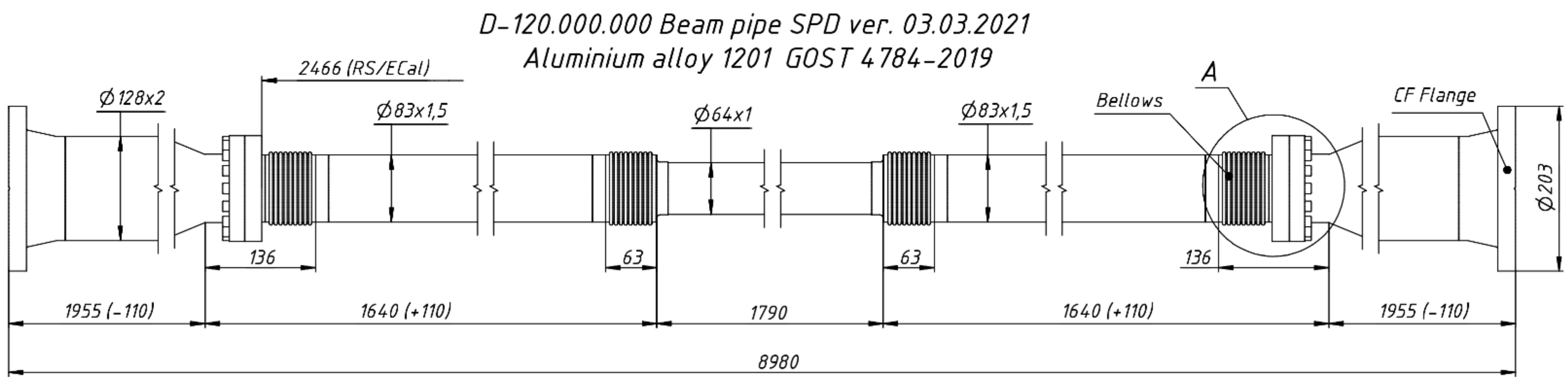
- The beam pipe flange has a diameter of ~20 cm. How to make the central hole of detectors smaller?
- Beam pipe is long and fragile. How do we mount all endcaps?

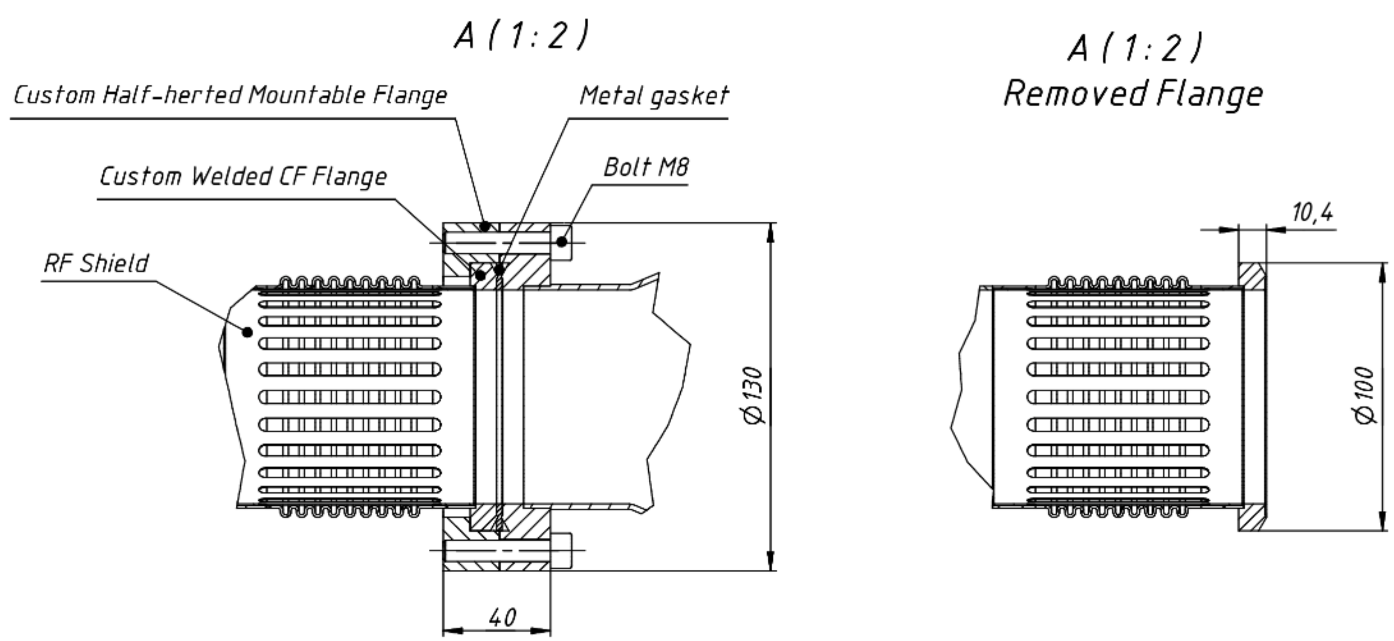


MPD pipe



SPD pipe

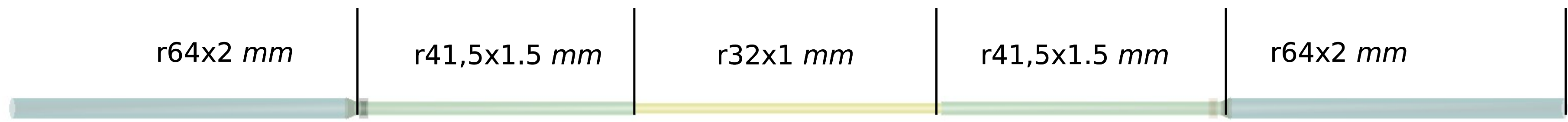


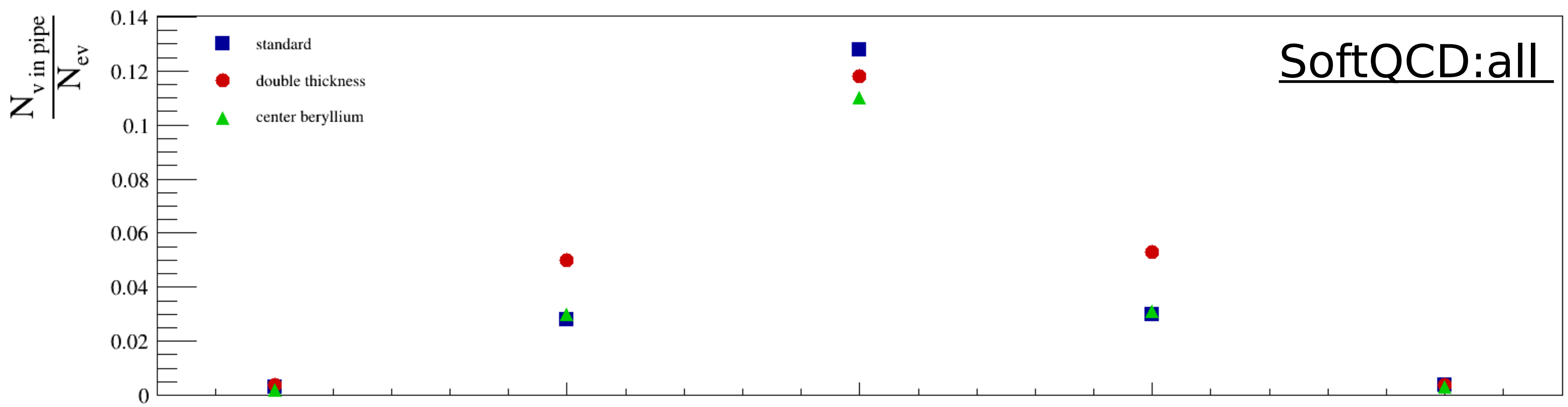


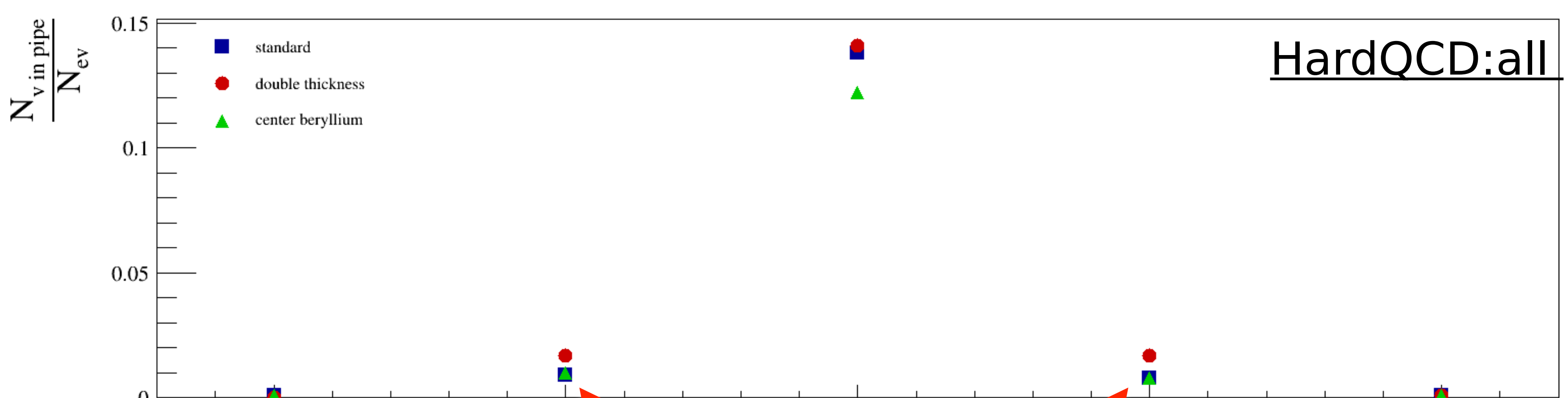
A.Ivanov

Secondary interactions in the beam pipe

- Can we make the non-central pipe segments thicker to improve stiffness?
- How strongly do secondary interactions in non-central segments pollute events with tertiary particles?



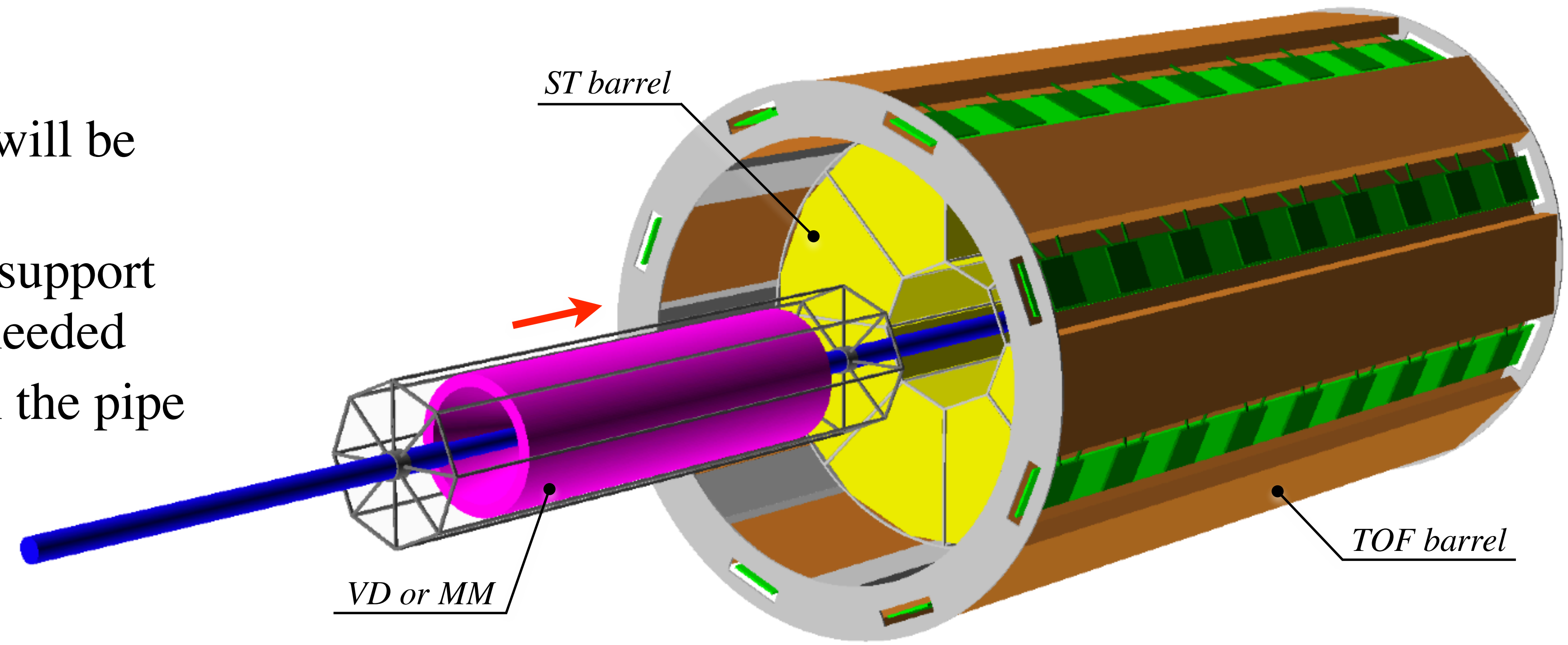


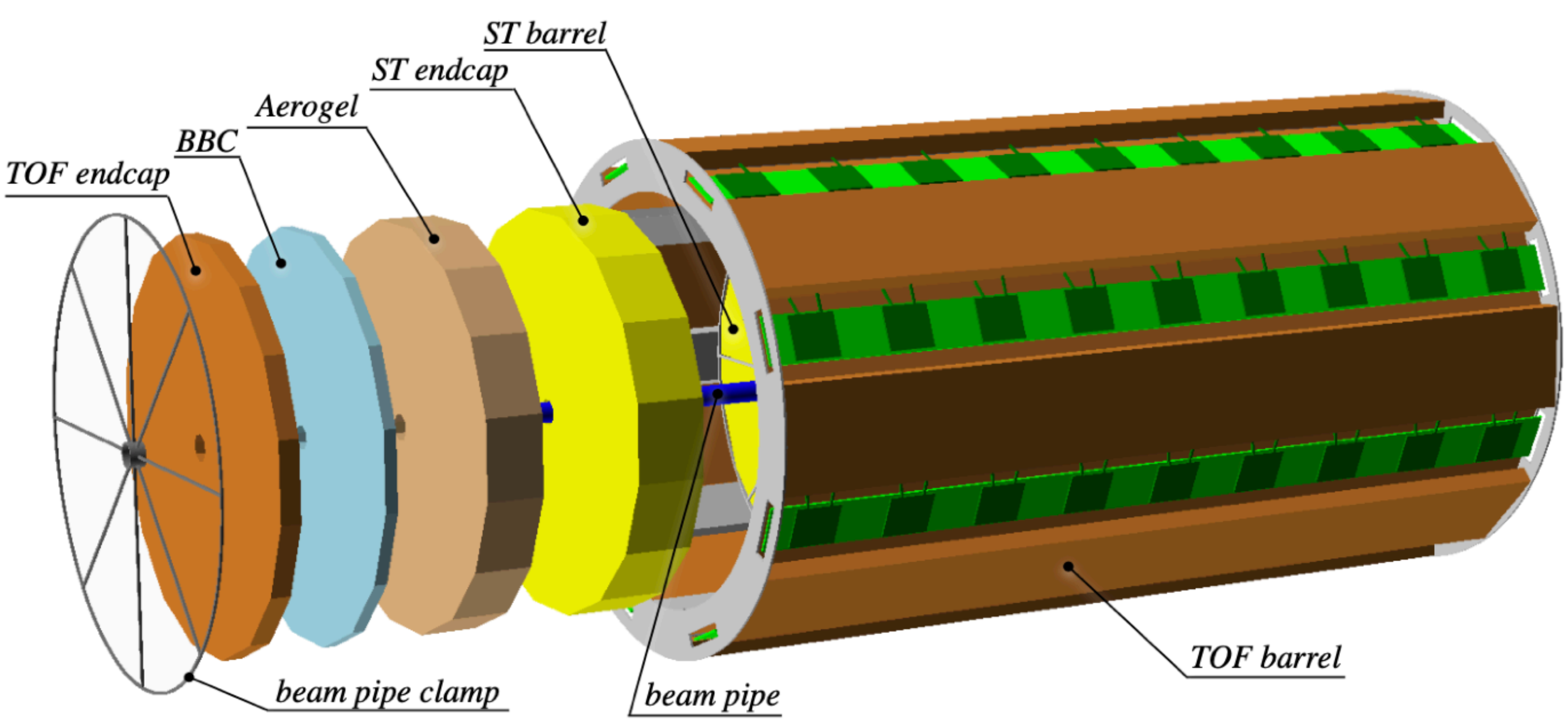


With an increase in thickness of 1.5 mm -> 3 mm,
the interaction rate increases by 1% -> 2%

Assembling procedure

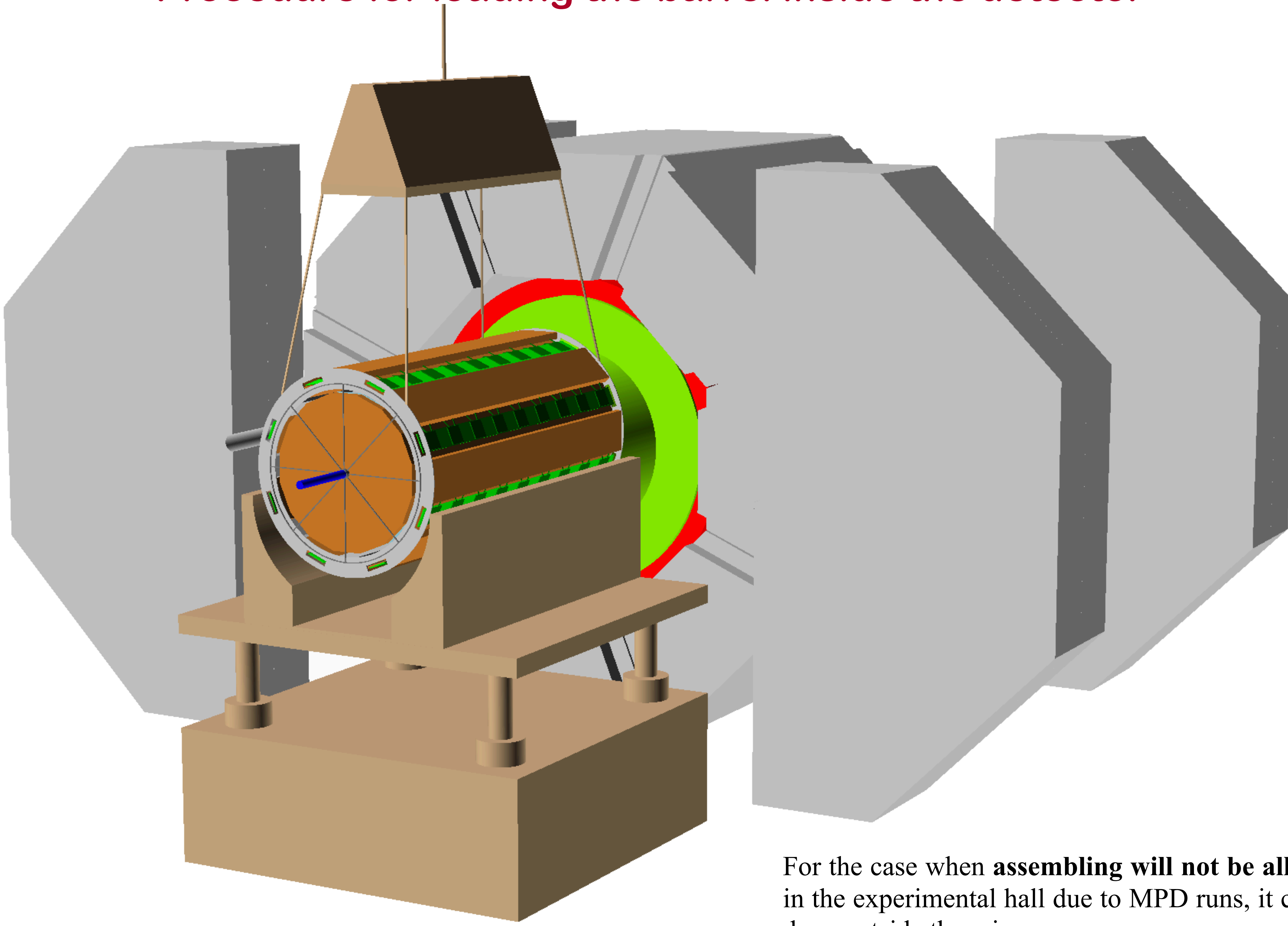
- ITS with a ~5m long pipe will be loaded as a single unit.
- Presumably, no additional support for the beam pipe will be needed
- All end caps will be put on the pipe





- All endcaps are loaded one-by-one presumably by hand
- No need to divide the endcap detectors into two halves

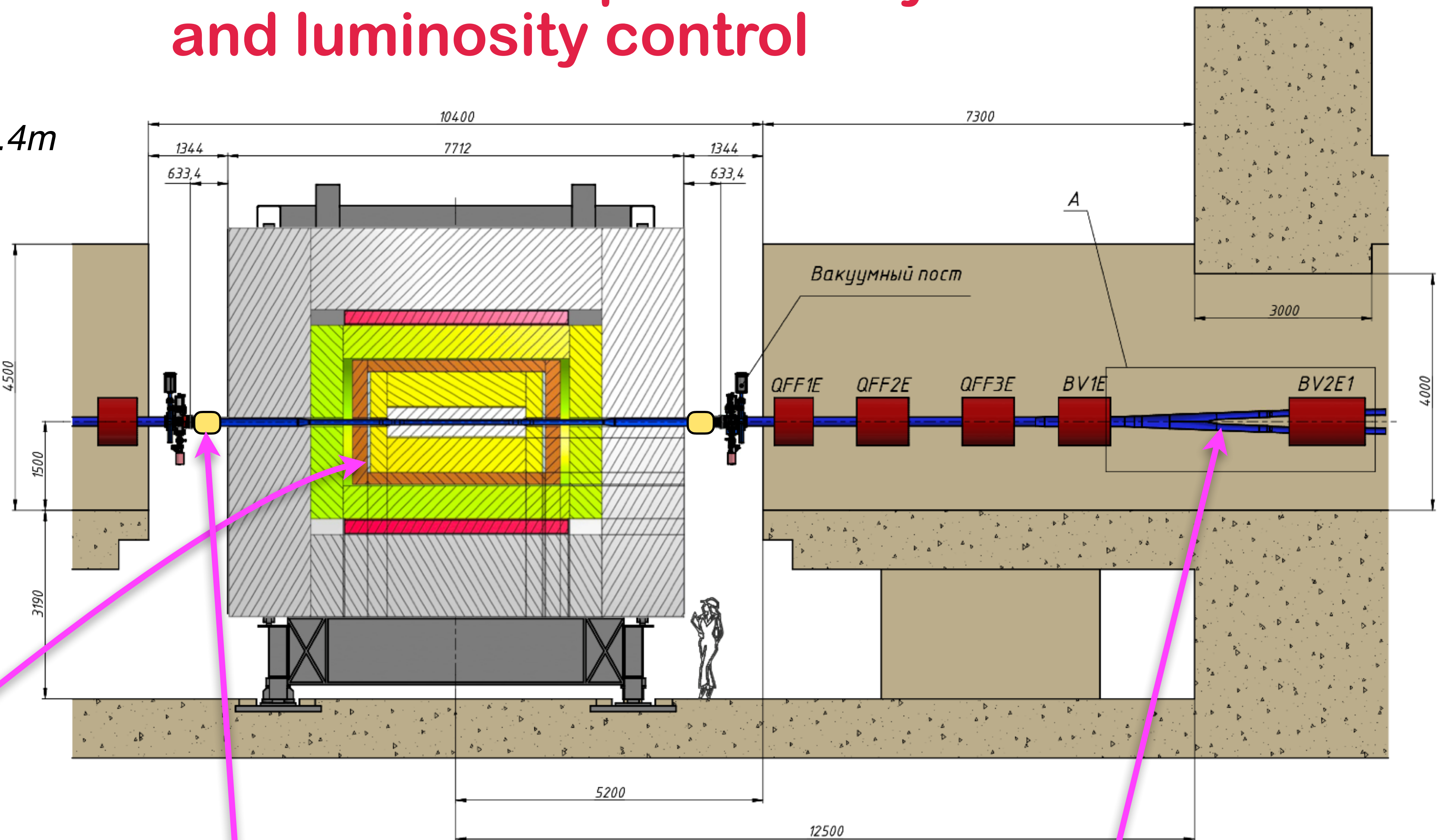
Procedure for loading the barrel inside the detector



For the case when **assembling will not be allowed** in the experimental hall due to MPD runs, it can be done outside the aria.

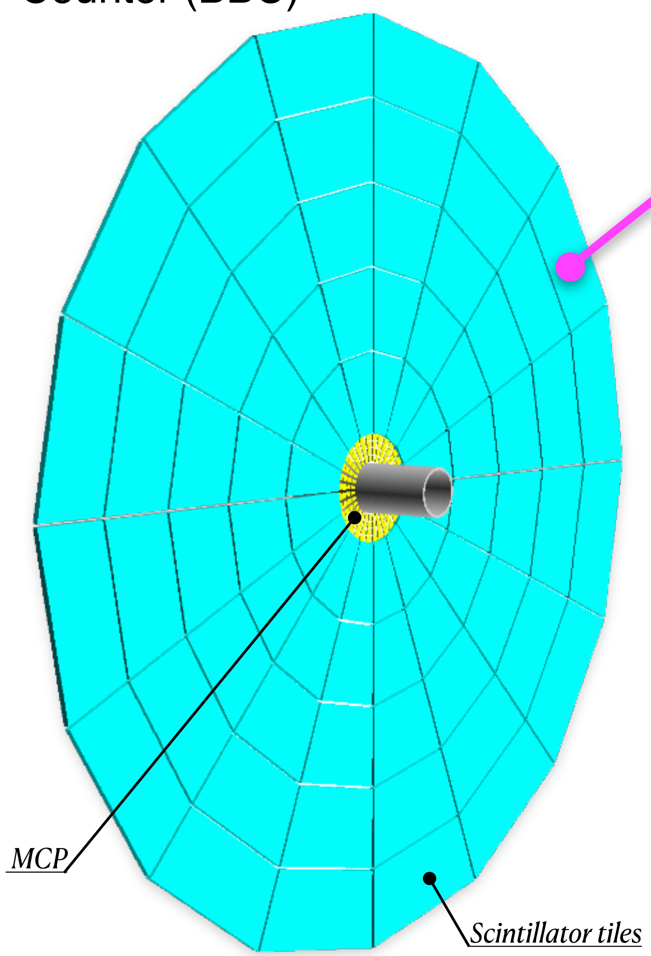
Detectors for local polarimetry and luminosity control

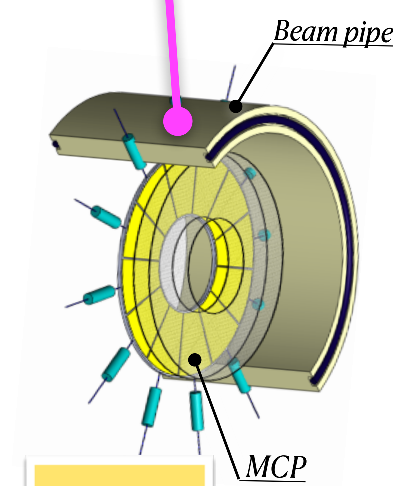
- BBC (MCP+SciTil) at *z=±1.4m*
- MCP at *z=±3.9m*
- ZDC at *z=±12.9m*



Beam-Beam Counter (BBC)

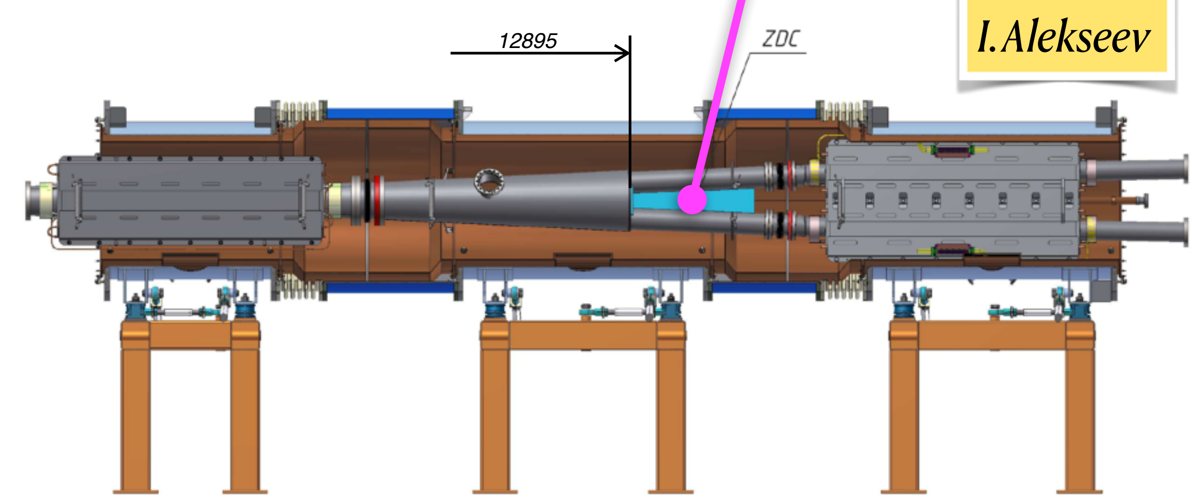
V.Ladygin





A.Baldin

I.Alekseev



- Hardware session tomorrow
- FEE + DAQ today after lunch

14:00			VBLHEP, JINR, Dubna	13:10 - 14:20
	SPD DAQ, current view	Leonid Afanasyev	Conference Hall, Building 215, VBLHEP, JINR, Dubna	14:20 - 14:40
	Frame time structure and slice building	Konstantin Gritsay	Conference Hall, Building 215, VBLHEP, JINR, Dubna	14:40 - 15:00
15:00	DAQ hardware	Viacheslav Tereschenko	Conference Hall, Building 215, VBLHEP, JINR, Dubna	15:00 - 15:20
	COMPASS compatible TCS encoder on modern hardware components	Daniil Peshkov	Conference Hall, Building 215, VBLHEP, JINR, Dubna	15:20 - 15:40
	TSS hardware development platform	Andrei Antonov	Conference Hall, Building 215, VBLHEP, JINR, Dubna	15:40 - 16:00
16:00	Coffee-break		Building 215, VBLHEP, JINR, Dubna	16:00 - 16:30
	ASIC's for SPD, beginning	Dr Evgeny Usenko	Conference Hall, Building 215, VBLHEP, JINR, Dubna	16:30 - 16:50
	Development of the SPD NINO prototype ASIC	Eduard Atkin	Conference Hall, Building 215, VBLHEP, JINR, Dubna	16:50 - 17:10
17:00	Development of an ASIC for straw and micromegas detectors of the NICA-SPD project	Alexander Solin	Conference Hall, Building 215, VBLHEP, JINR, Dubna	17:10 - 17:30
	Development of integrated readout electronics for Integral SiPM detector	Alexander Solin	Conference Hall, Building 215, VBLHEP, JINR, Dubna	17:30 - 17:50

Mon 03/10 | Tue 04/10 | Wed 05/10 | Thu 06/10 | All days

Print | PDF | Full screen | Detailed view | Filter

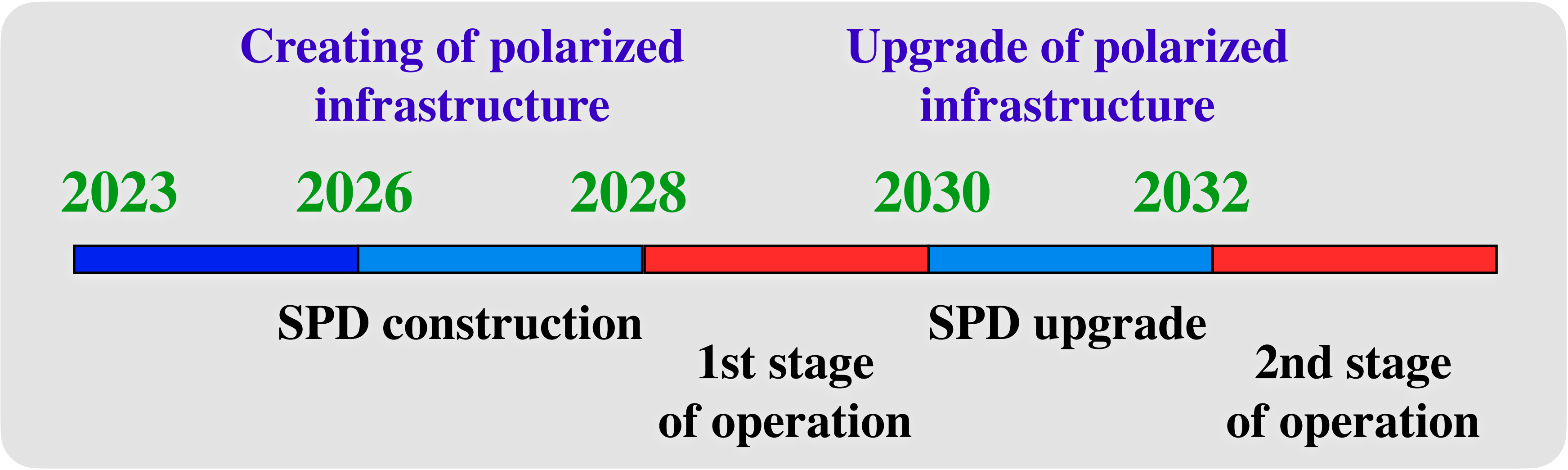
Session legend

Hardware Session: accelerator,

10:00	Formation of polarized proton beams in the NICA complex	Evgeny Syresin	Conference Hall, Building 215, VBLHEP, JINR, Dubna	10:00 - 10:30
	Control of the polarization of protons and deuterons in the NICA complex in the spin transparency mode	Yury Filatov	Conference Hall, Building 215, VBLHEP, JINR, Dubna	10:30 - 11:00
11:00	NICA Absolute Polarimeter Status Report	Nikita Dunin	Conference Hall, Building 215, VBLHEP, JINR, Dubna	11:00 - 11:30
	Coffee break		Building 215, VBLHEP, JINR, Dubna	11:30 - 12:00
12:00	SPD Test Area Status Report	Anton Baldin	Conference Hall, Building 215, VBLHEP, JINR, Dubna	12:00 - 12:30
	SPD superconducting magnet	Evgeniy Pyata	Conference Hall, Building 215, VBLHEP, JINR, Dubna	12:30 - 13:00
13:00	Lunch		VBLHEP, JINR, Dubna	13:00 - 14:10
14:00	Cryogenic system of SPD	Dmitrii Nikiforov	Conference Hall, Building 215, VBLHEP, JINR, Dubna	14:10 - 14:30
	Study on high time precision MRPC	Kai Sun	Conference Hall, Building 215, VBLHEP, JINR, Dubna	14:30 - 14:50
15:00	MicroMegas status report	Dmitry Dedovich	Conference Hall, Building 215, VBLHEP, JINR, Dubna	14:50 - 15:10
	Straw Tracker Barrel status report	Temur Enik	Conference Hall, Building 215, VBLHEP, JINR, Dubna	15:10 - 15:30
	Straw Tracker End-Cap status report	Viktor Kramarenko	Conference Hall, Building 215, VBLHEP, JINR, Dubna	15:30 - 15:50
16:00	Coffee break		Building 215, VBLHEP, JINR, Dubna	15:50 - 16:20
	BBC status report	Vladimir LADYGIN	Conference Hall, Building 215, VBLHEP, JINR, Dubna	16:20 - 16:40
	ECal status report	Oleg Gavrishchuk	Conference Hall, Building 215, VBLHEP, JINR, Dubna	16:40 - 17:00
17:00	RS status report	Guennadi Alexeev	Conference Hall, Building 215, VBLHEP, JINR, Dubna	17:00 - 17:20
	ZDC status report	Igor Alekseev	Conference Hall, Building 215, VBLHEP, JINR, Dubna	17:20 - 17:40

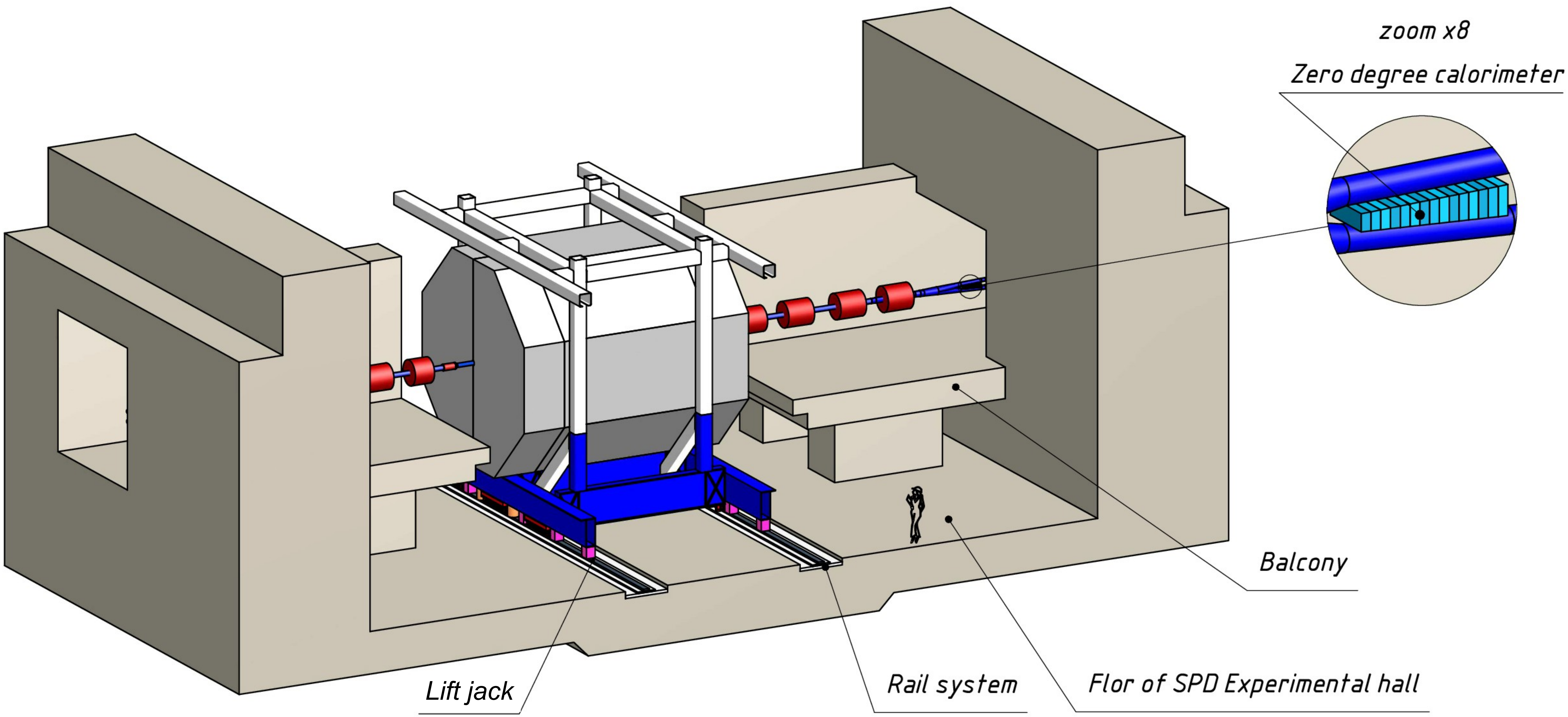
Conclusions

- First version of TDR will be released this month and will contain quite a few changes compared to CDR (Jan 2021)
- Concept of the SPD setup is finalized. Detector volumes are essentially fixed. Work has begun on the load-bearing elements of individual detectors
  - Lack of engineering personnel capable of working on the project
  - Outsourcing for the power frames of most detectors
- Main systems for the 1-st stage of operation: RS, ST, MM and Magnet
- According to present plans, only 5 years left before the datataking starts. Clear planning required from corresponding groups. Financial support will certainly be matter.



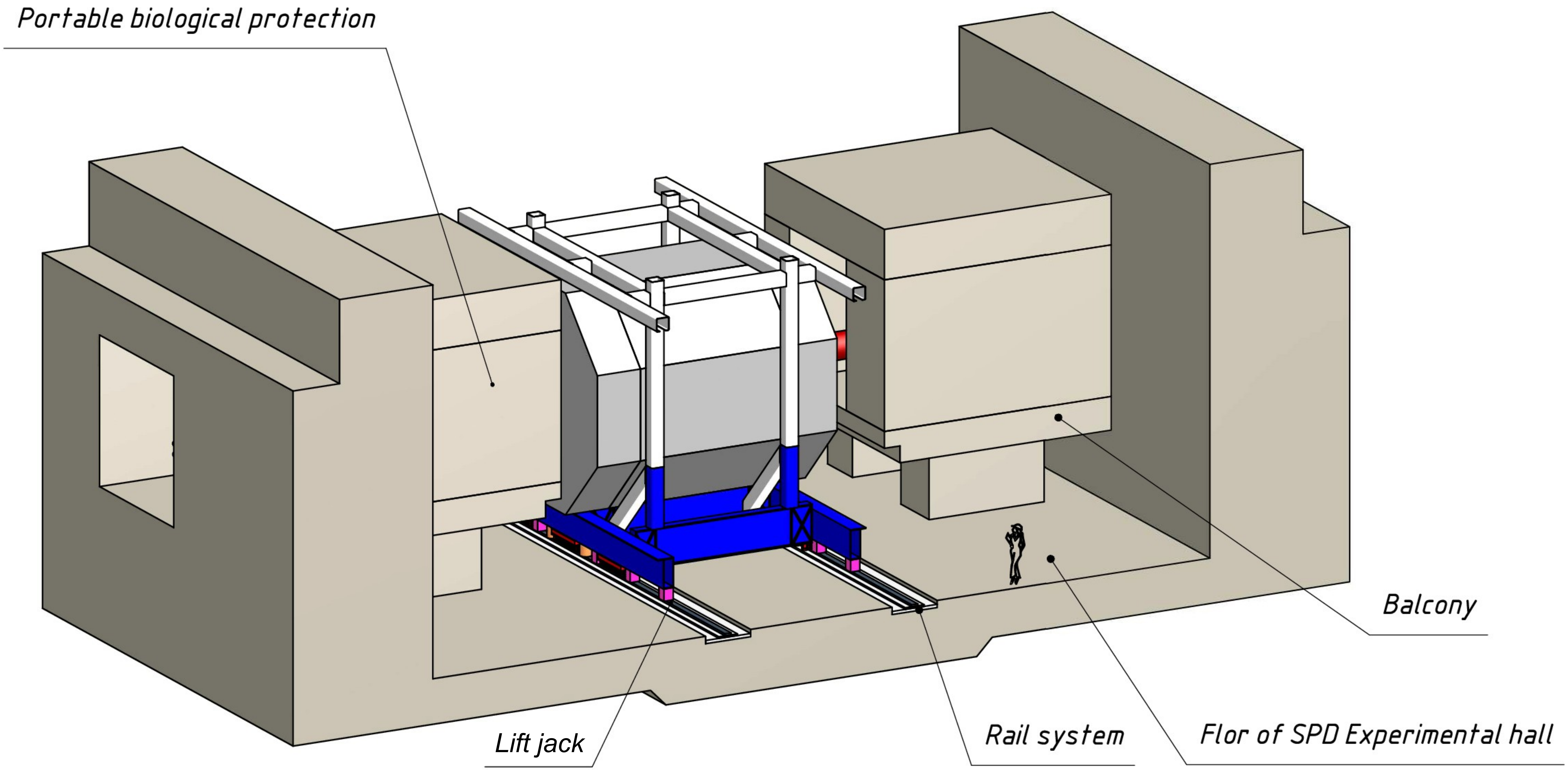
Backup slides

Update for the schematic view of the SPD setup



- Position of the detector during data taking

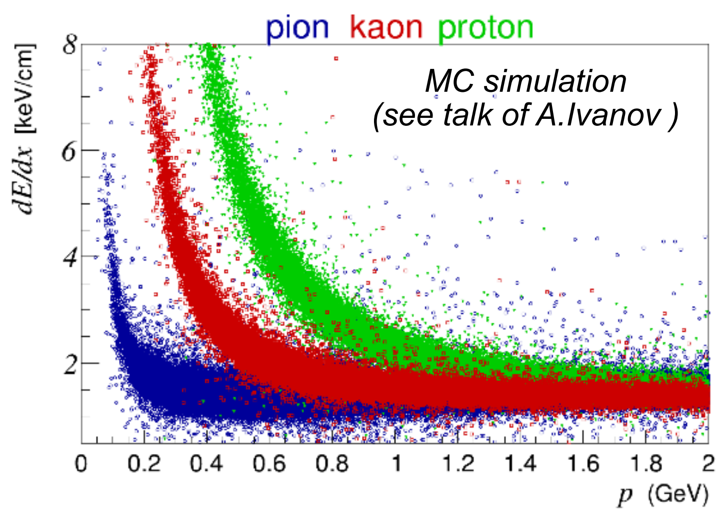
Update for the schematic view of the SPD setup



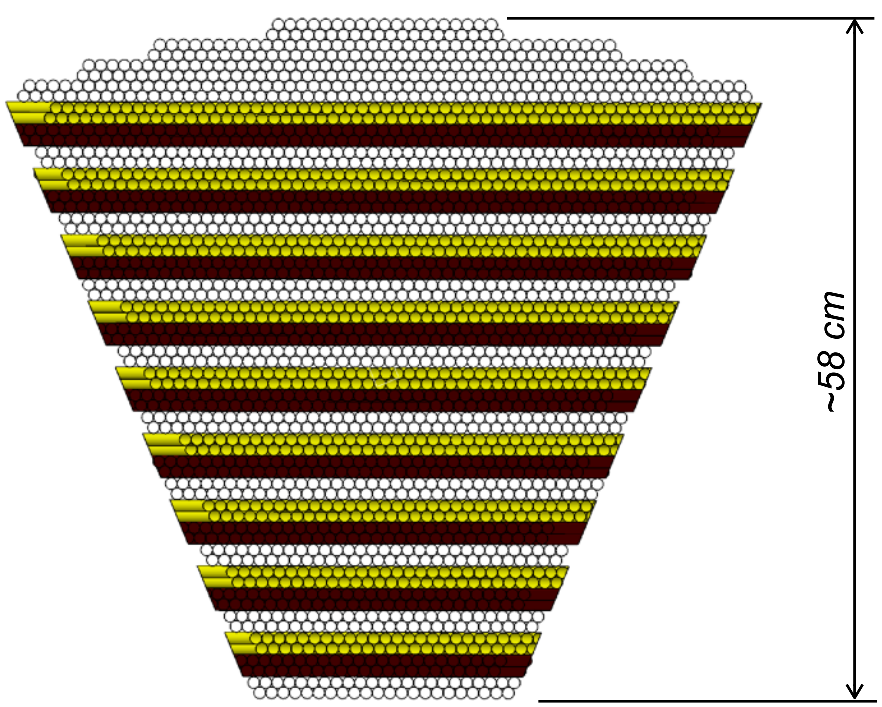
- Position of the detector during data taking
- Accelerator tunnel will be isolated from experimental hall

Application of ST for the dE/dx analysis

- Number of primary ionized e- per straw is about the same as per pad in TPC => similar abilities for identification
- Using TDC+ADC for readout. See VMM3 as an example



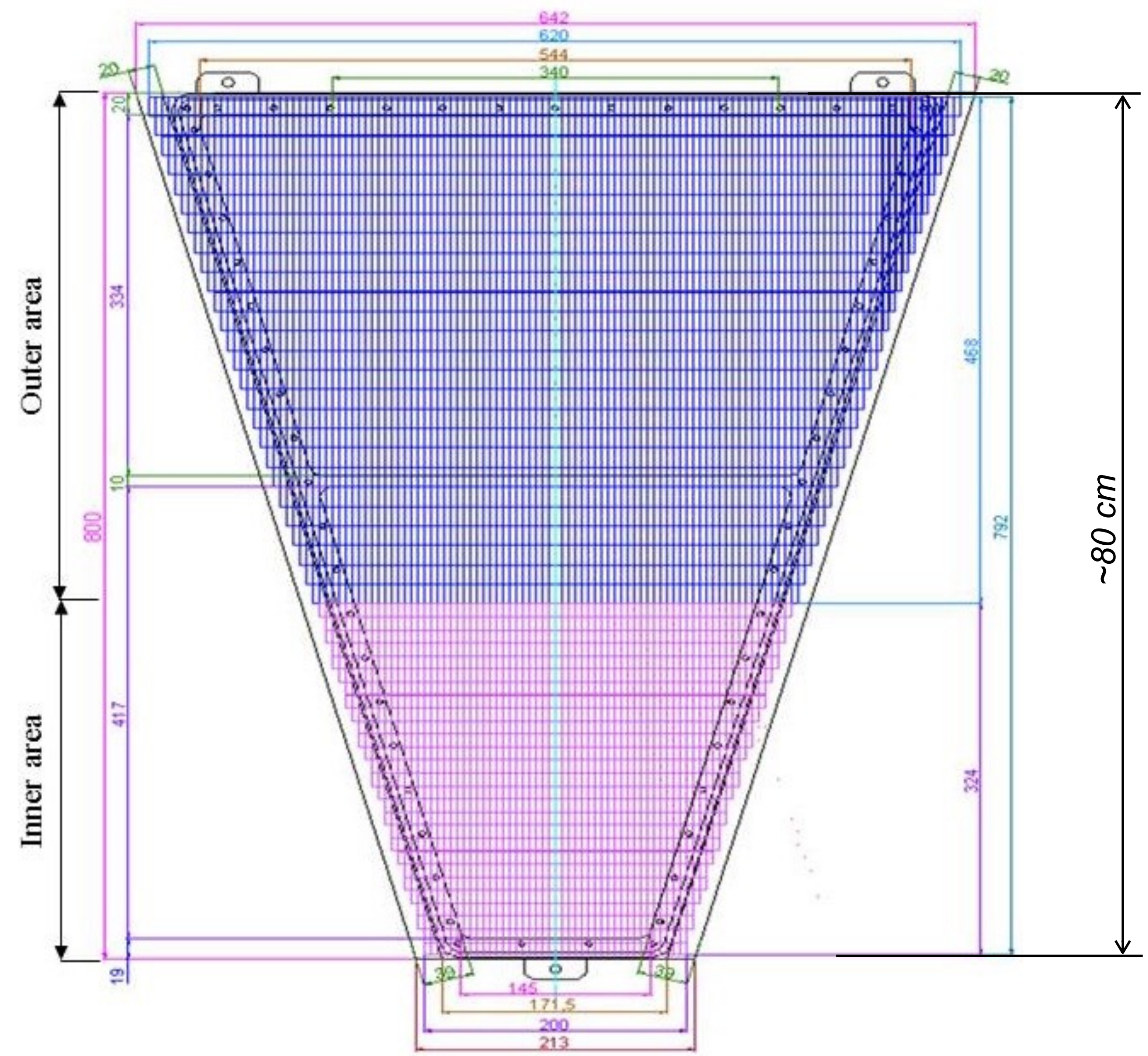
Straw of SPD



∅=10mm straw: $S = 78mm^2$

Maximum drift distance 5 mm

TPC of MPD (for comparison)

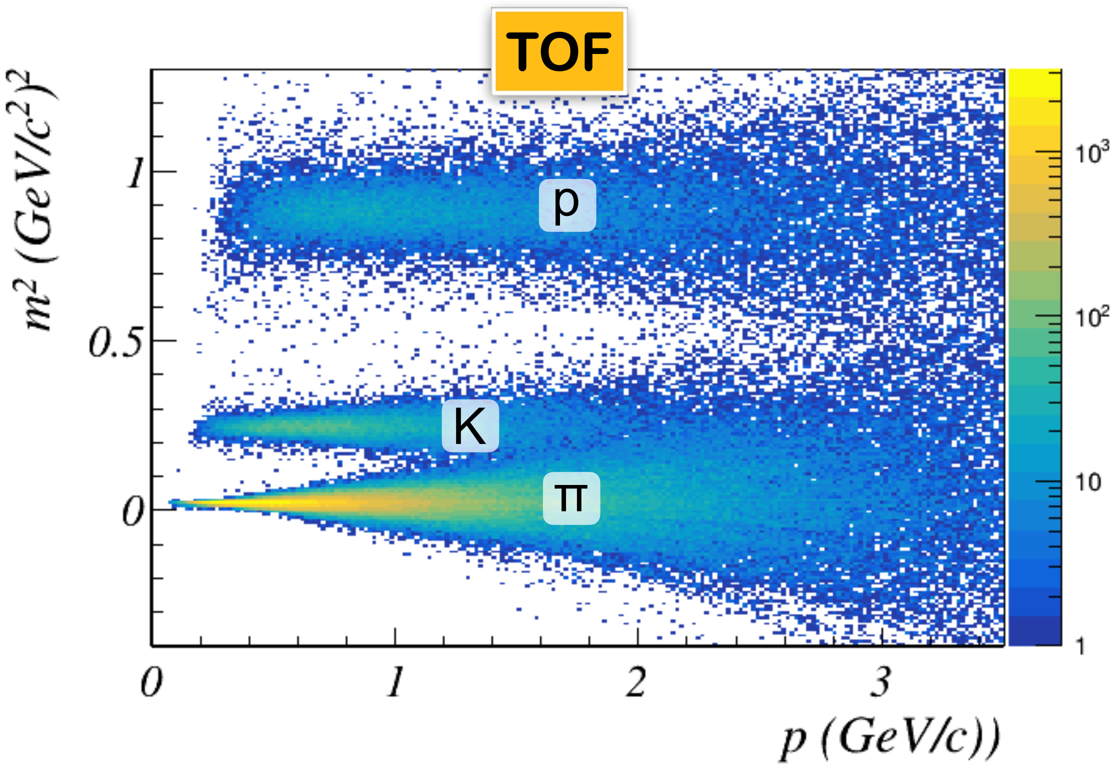


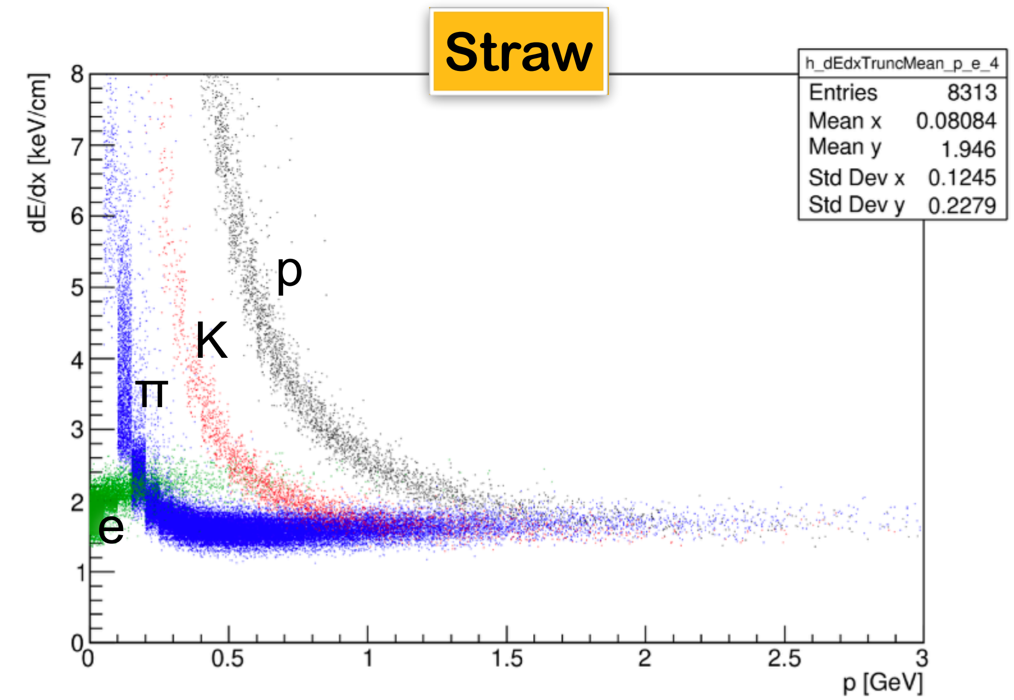
Inner pads: $S = 5mm \times 12mm = 60mm^2$

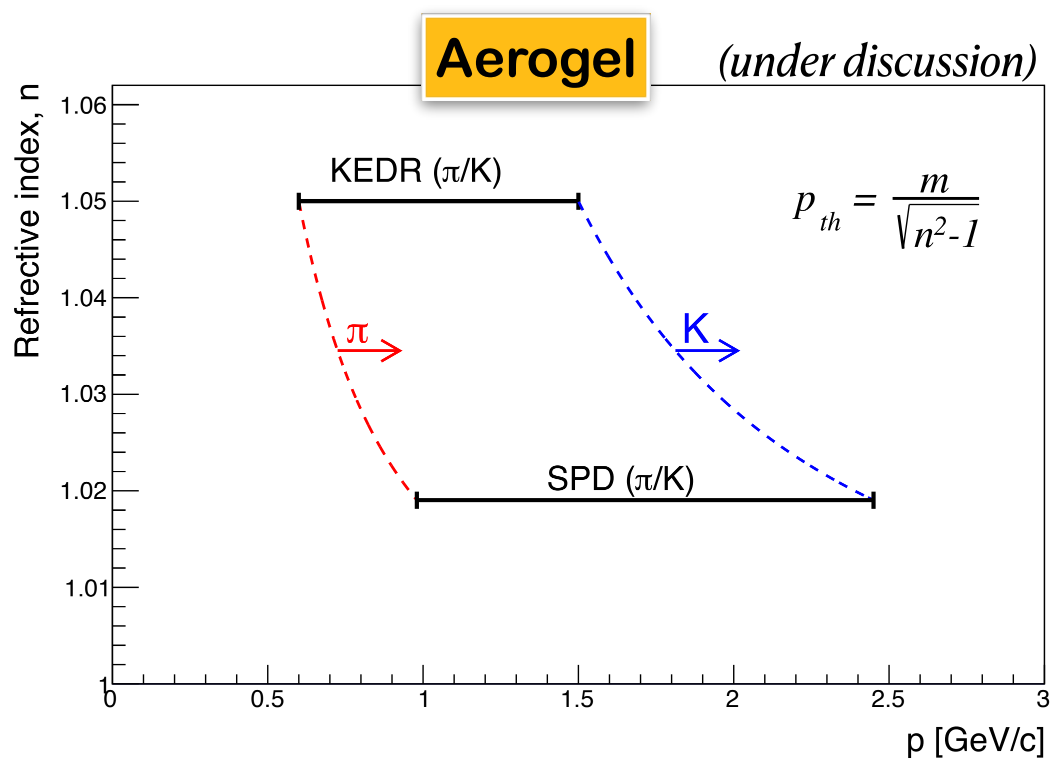
Outer pads: $S = 5mm \times 18mm = 90mm^2$

Maximum drift distance 1500 mm

PID analysis in SPD (π, K, p)

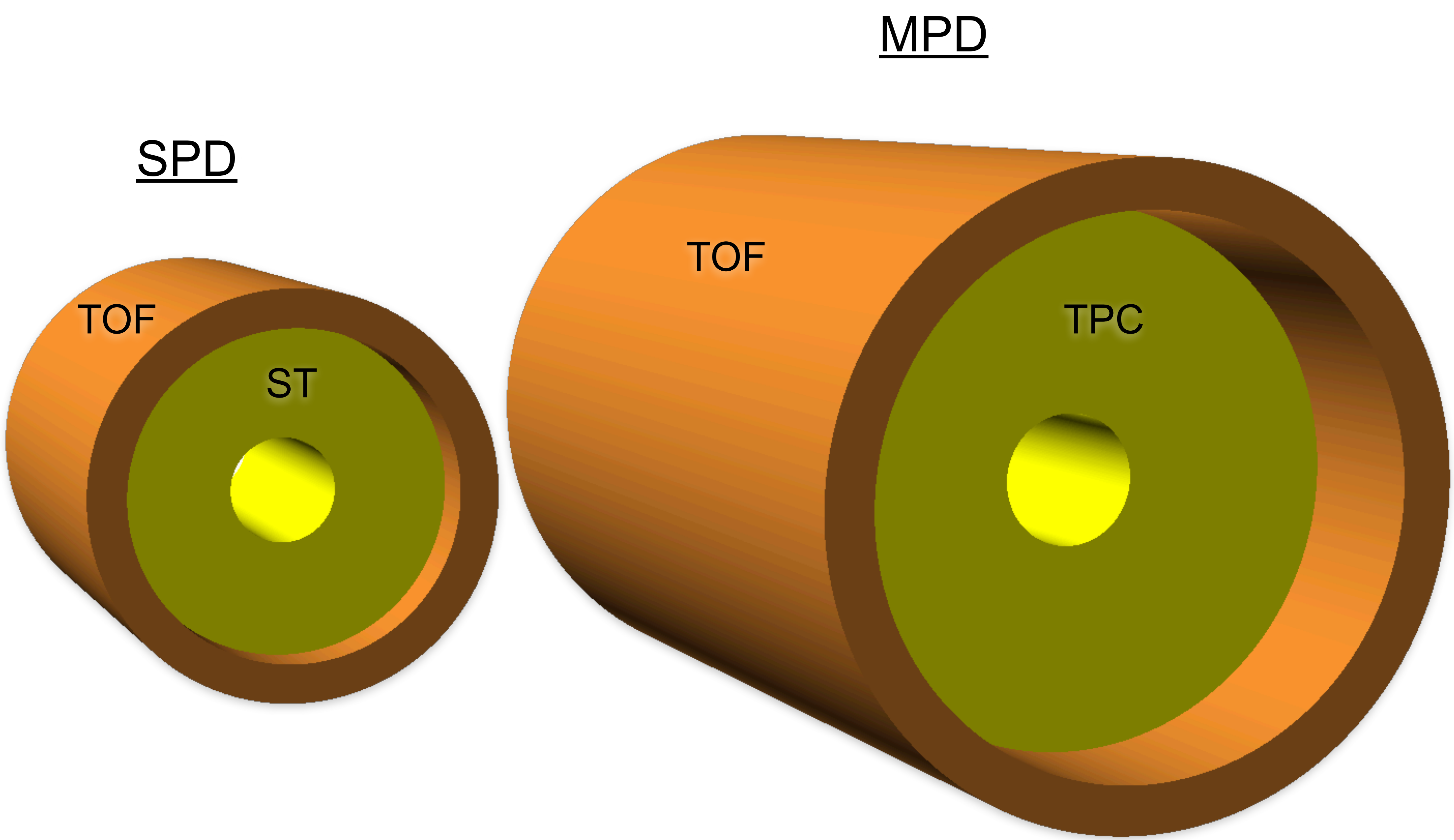




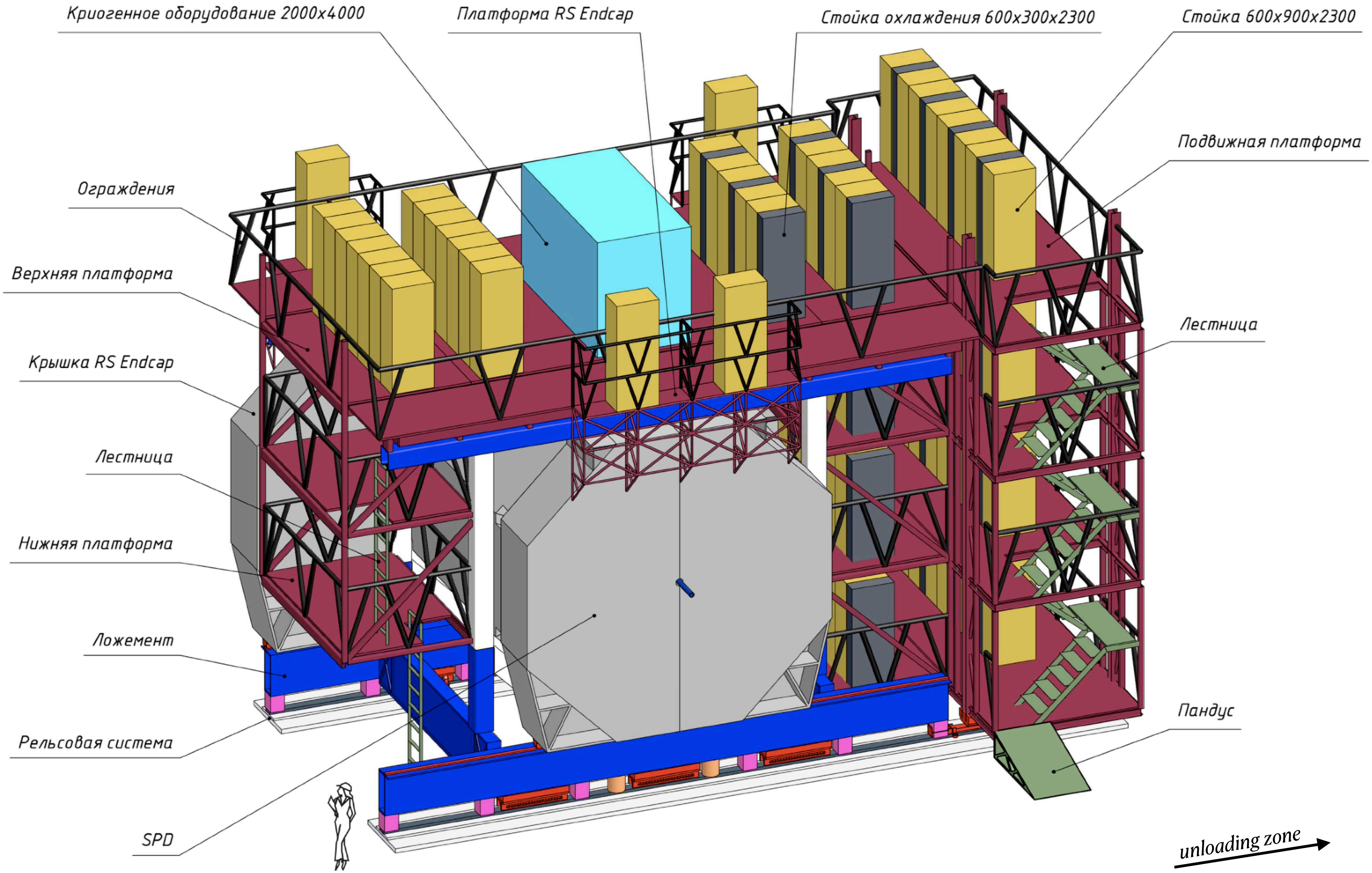


π/K separation

- 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
- *See the PID talk by A.Ivanov on Thursday*



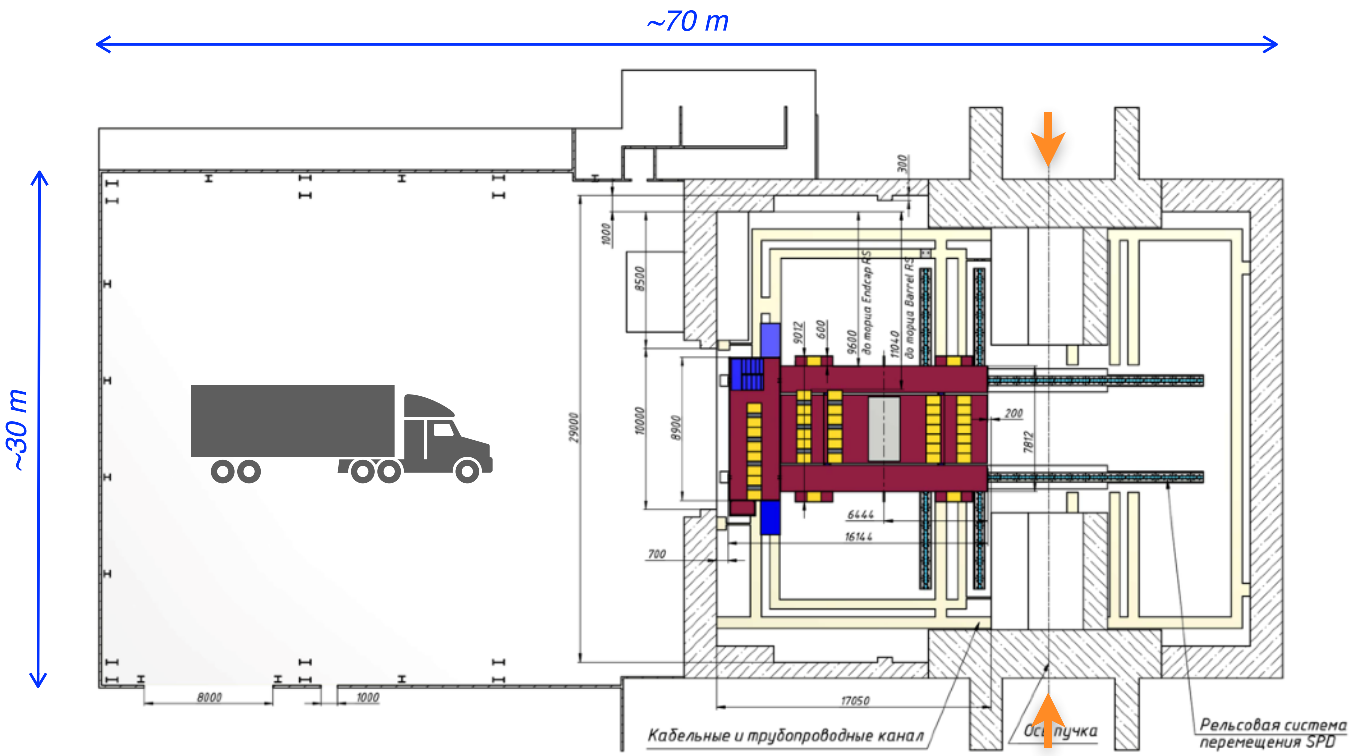
- The radial dimensions of the SPD and MPD detectors are approximately the same. However, the radial size of the SPD yoke is 139 cm, while in the MPD it is 35 cm $\Rightarrow$ All inner detectors of SPD are effectively reduced in size wrt to those of MPD.
- The size of the TOF+Tracker system in SPD is noticeably smaller than in MPD: R_{ext} = 105 см (SPD) vs 171 см (MPD).

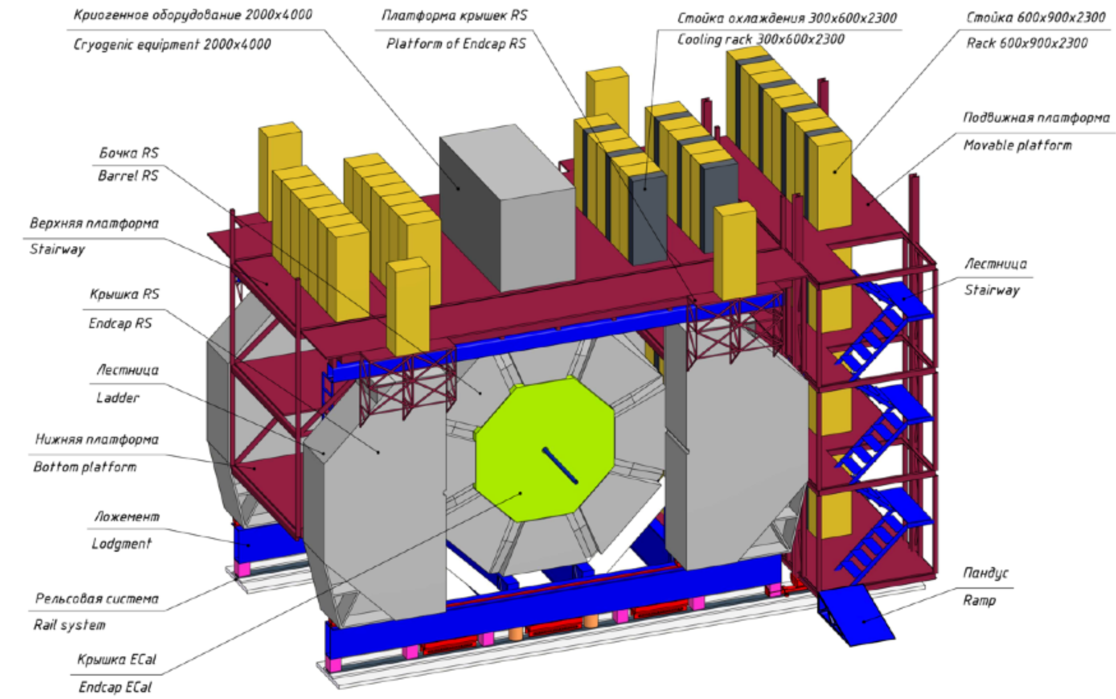


Криогенное оборудование 2000х4000
Платформа RS Endcap
Стойка охлаждения 600х300х2300
Стойка 600х900х2300
Подвижная платформа
Ограждения
Верхняя платформа
Крышка RS Endcap
Лестница
Лестница
Нижняя платформа
Ложемент
Рельсовая система
SPD
Пандус
unloading zone

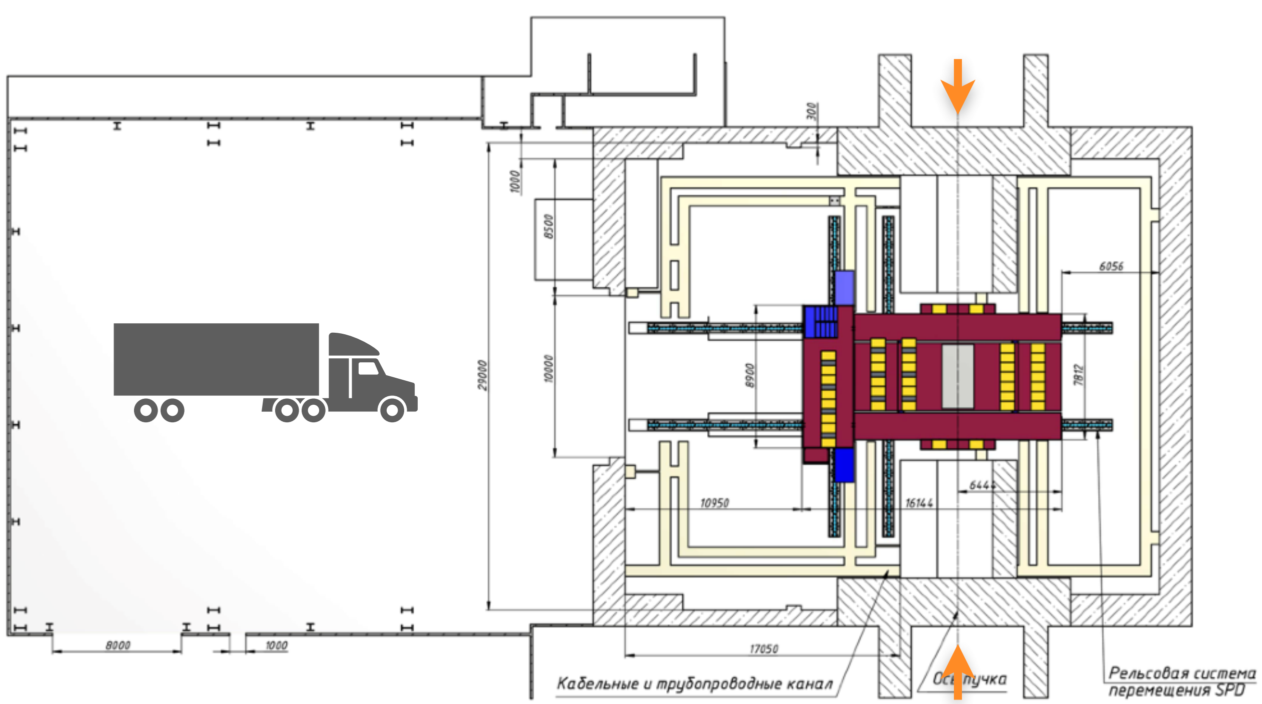
Ivan Moshkovskiy, Nikolay Topilin

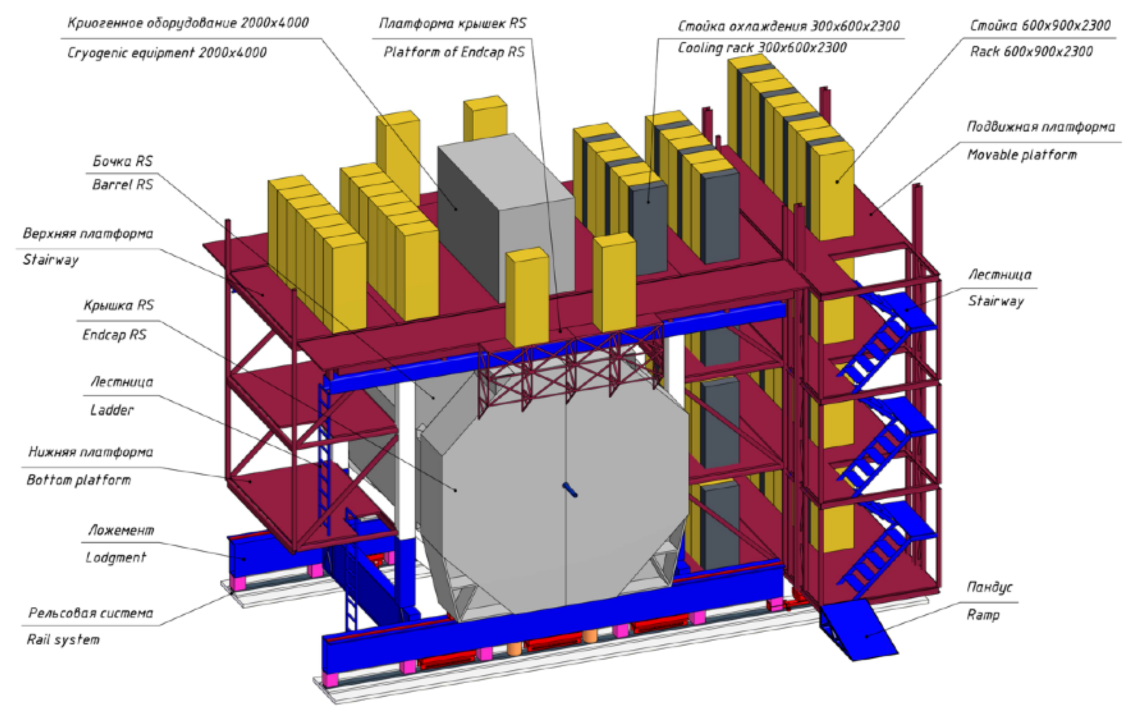
Assembling position





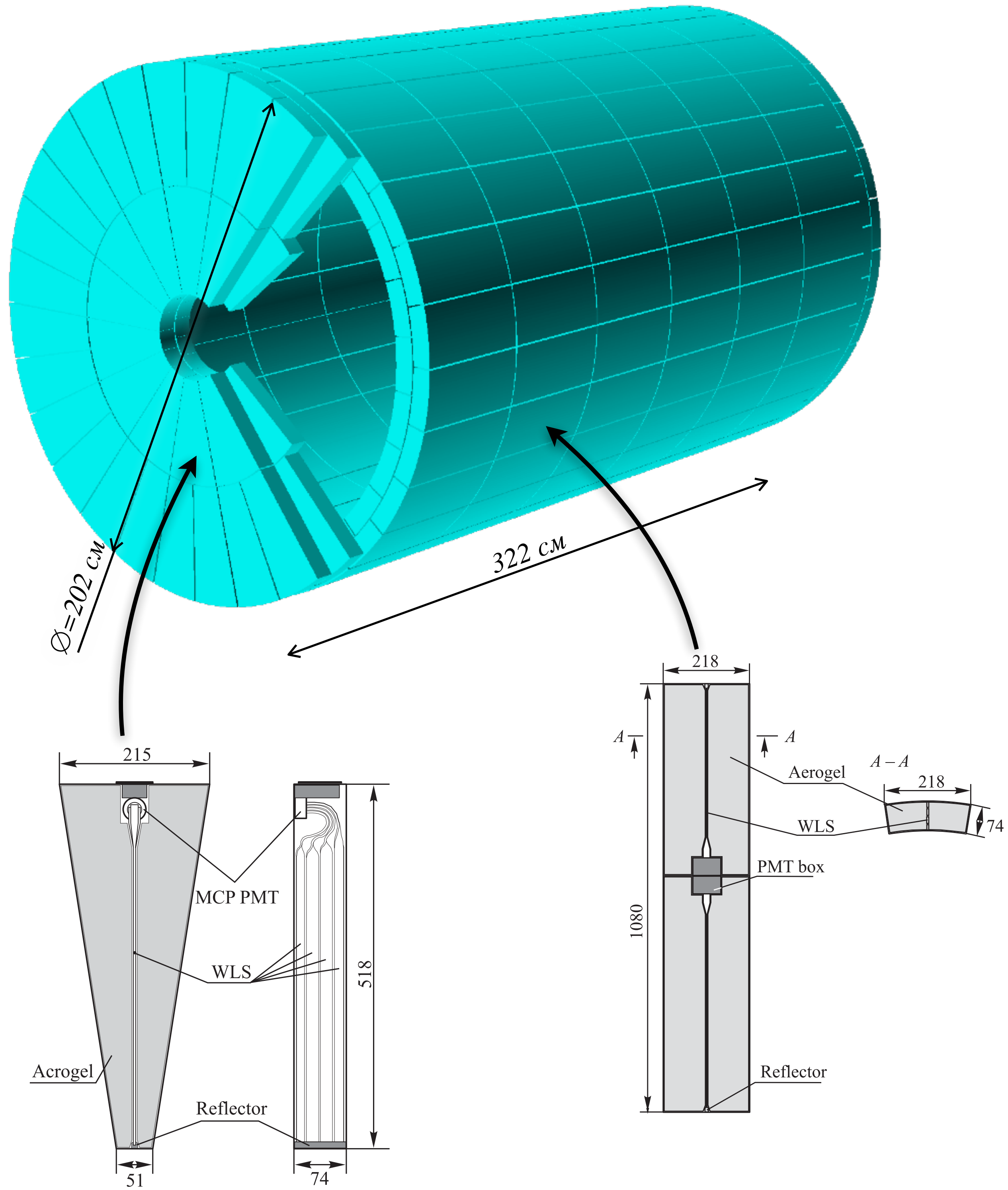
Beam position

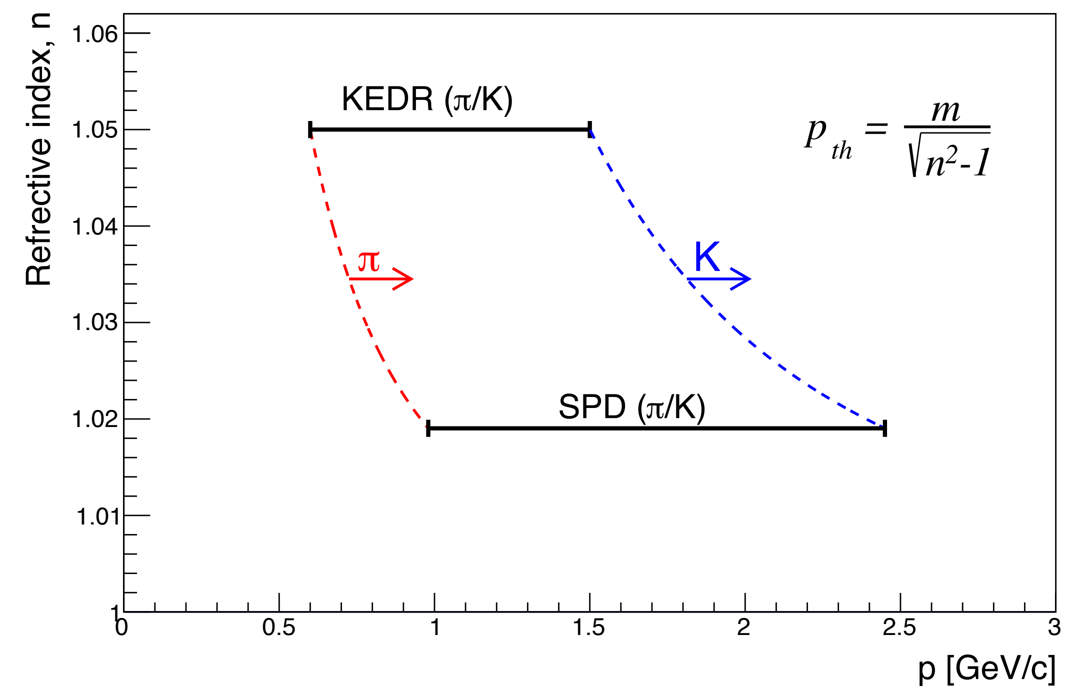




No responsable

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