22.1.2024

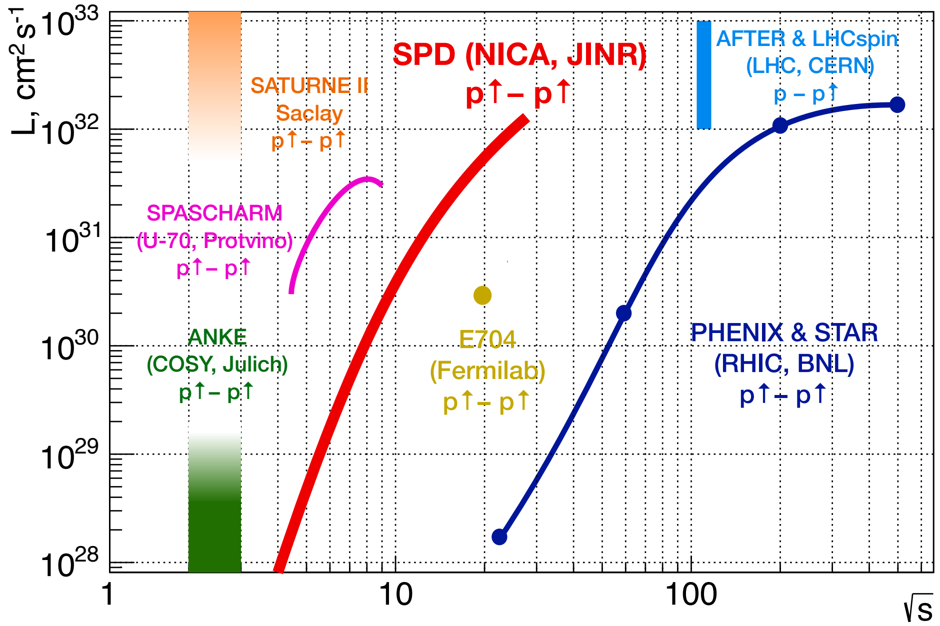
SPD TDR update

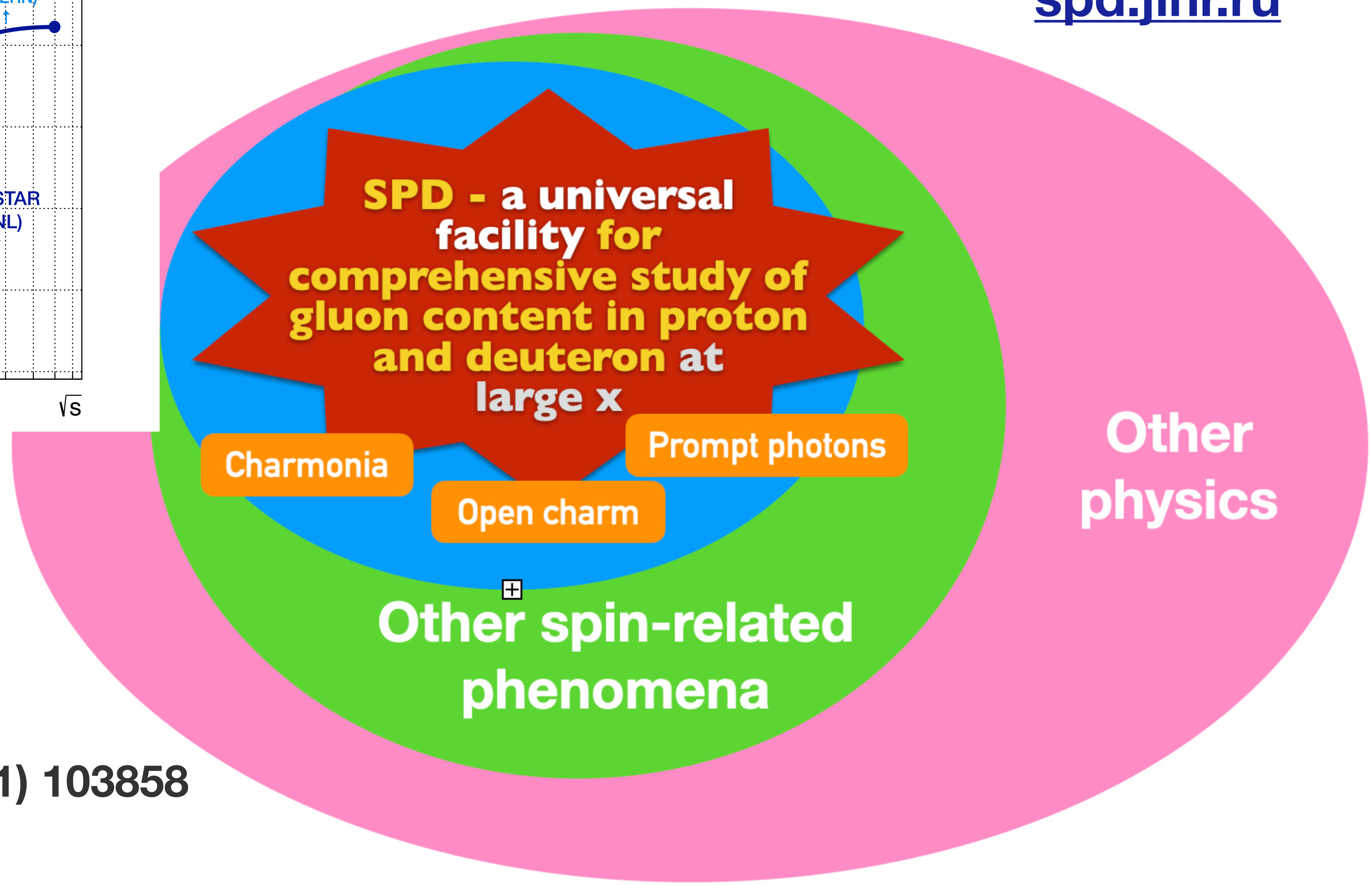
A. Guskov

SPD international collaboration

35 institutes from 15 countries, ~300 members

spd.jinr.ru





Prog.Part.Nucl.Phys. 119 (2021) 103858

arXiv:2011.15005

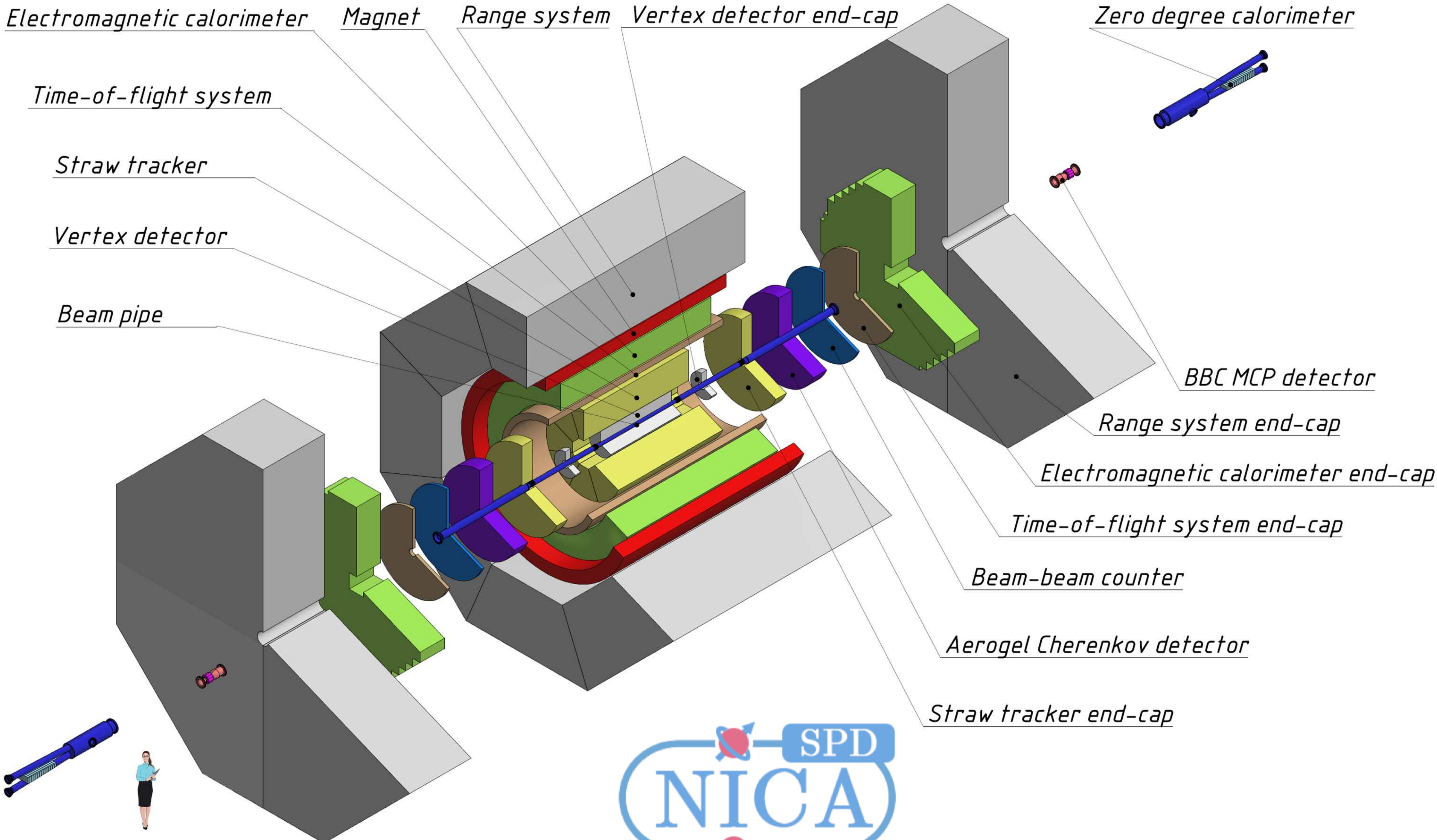
Phys.Part.Nucl. 52 (2021) 6, 1044-1119

arXiv:2102.08477

— SPD CDR was presented at PAC in Jan 2021 and approved by PAC in Jan, 2022

— the first version of SPD TDR was presented at PAC in Jan 2023

SPD setup


Electromagnetic calorimeter
Magnet
Range system
Vertex detector end-cap
Zero degree calorimeter
Time-of-flight system
Straw tracker
Vertex detector
Beam pipe
BBC MCP detector
Range system end-cap
Electromagnetic calorimeter end-cap
Time-of-flight system end-cap
Beam-beam counter
Aerogel Cherenkov detector
Straw tracker end-cap

SPD: two stages

Creating of polarized infrastructure

Upgrade of polarized infrastructure

Start of NICA operation

+4 years

+6 years

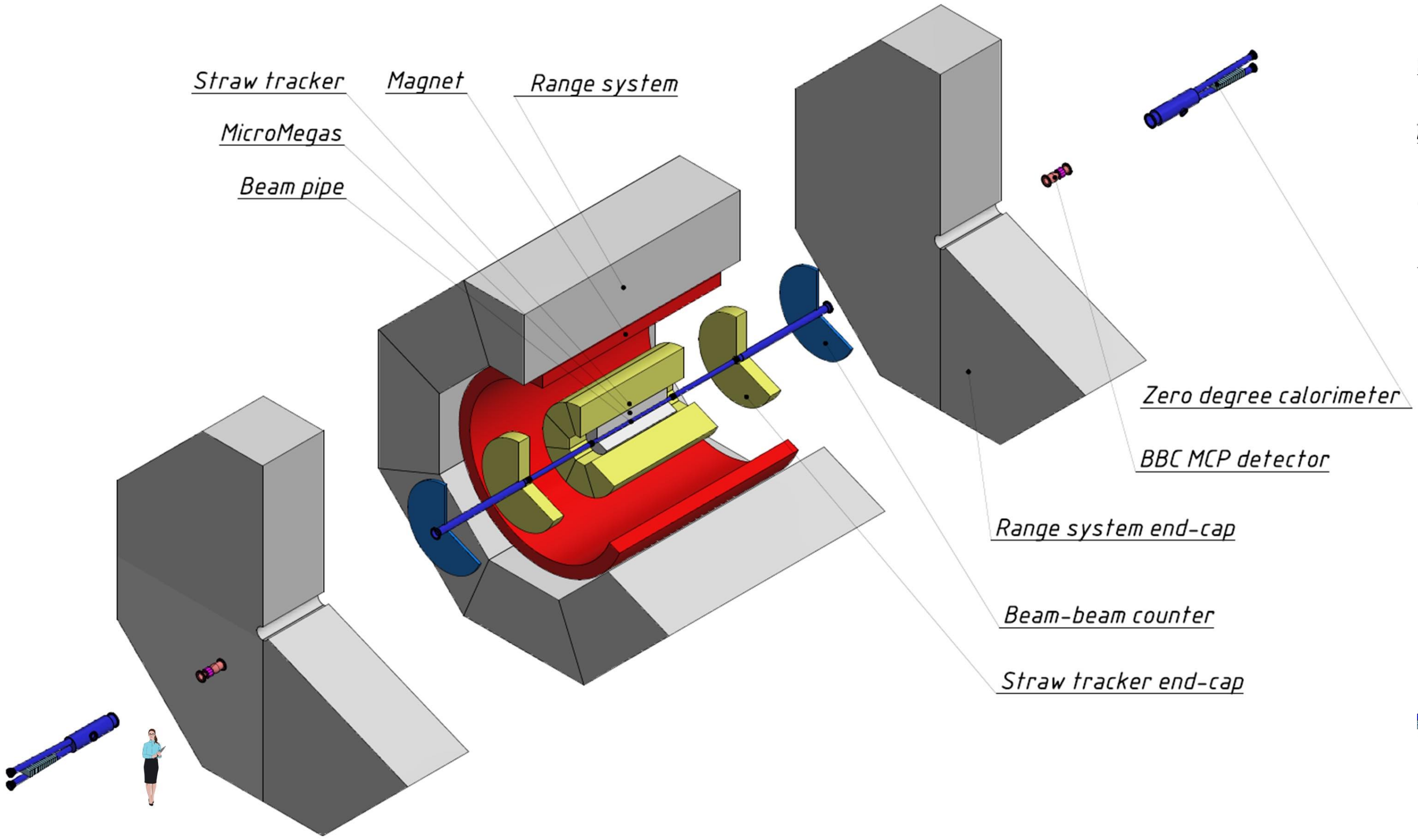
+8 years

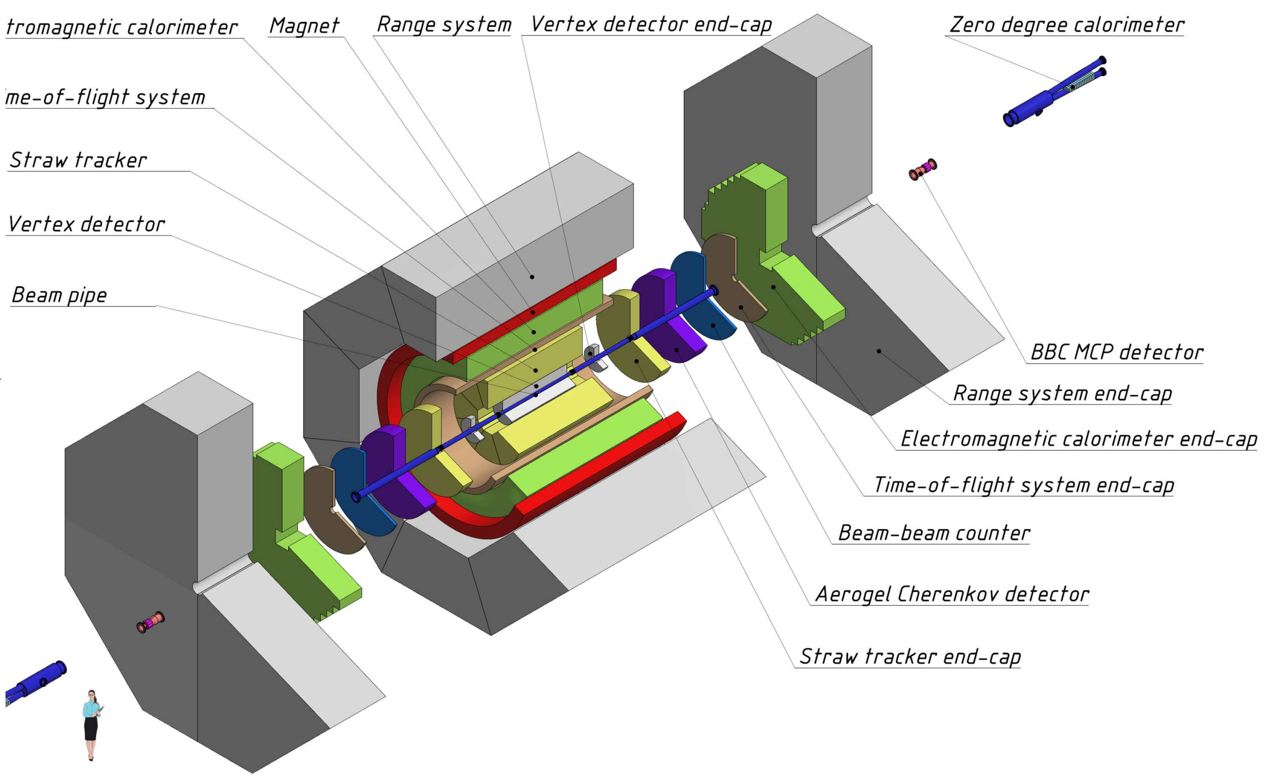
SPD construction

1st stage of operation

SPD upgrade

2nd stage of operation





MoU signed

1 A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute), Yerevan
2 NRC “Kurchatov Institute” - PNPI, Gatchina
3 Samara National Research University (Samara University), Samara
4 Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow
5 Institute for Nuclear Research of the RAS, Moscow
6 Lebedev Physical Institute of RAS, Moscow
7 Saint Petersburg Polytechnic University St. Petersburg **2023**
8 Saint Petersburg State University, St. Petersburg **2023**
9 Tomsk State University, Tomsk **2023**
10 Belgorod State University, Belgorod **2023**
11 National Research Nuclear University MEPhI, Moscow **2023**
12 Institute of Nuclear Physics (INP RK), Almaty 2023
13 Institute for Nuclear Problems of BSU, Minsk 2024

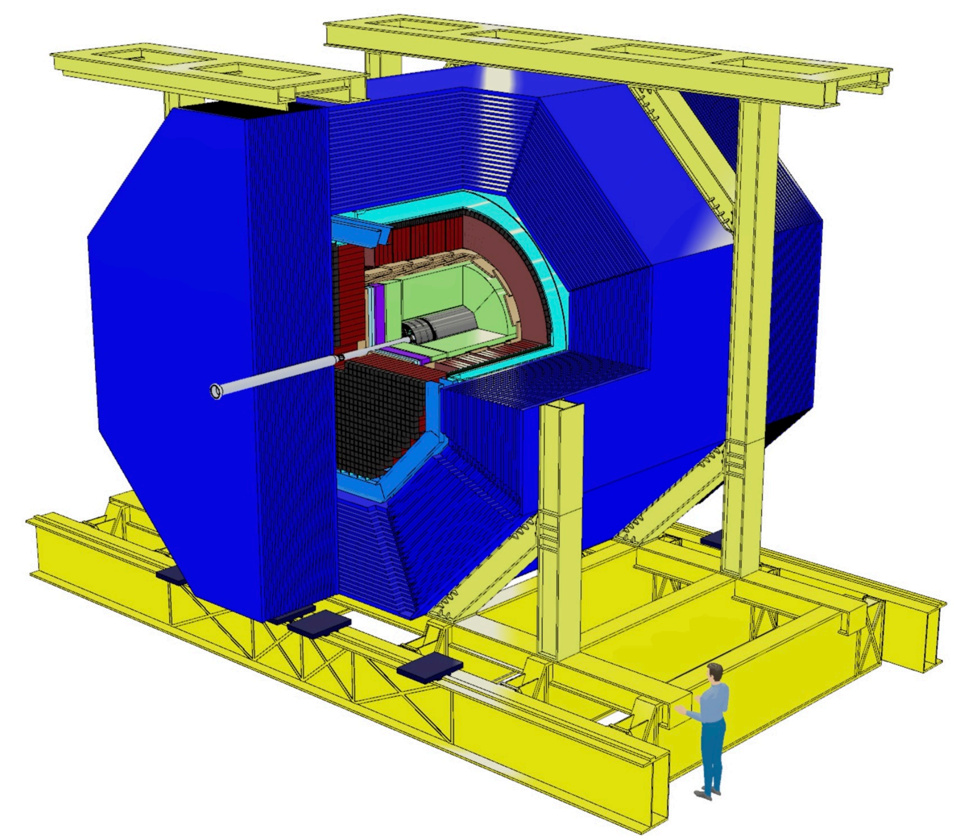
14 NRC “Kurchatov Institute”, Moscow (NRC KI)
15 Higher Institute of Technologies and Applied Sciences, Havana

Two new groups in 2023:

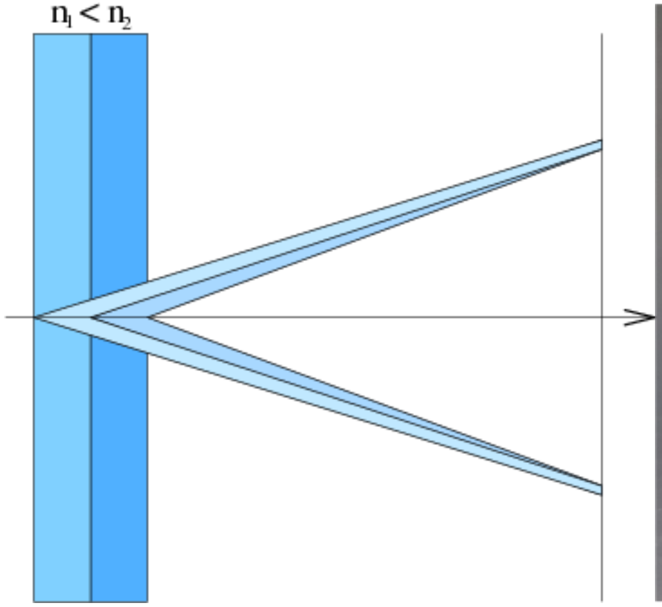
Budker Institute of Nuclear Physics (Novosibirsk)
Higher School of Economics (Moscow)

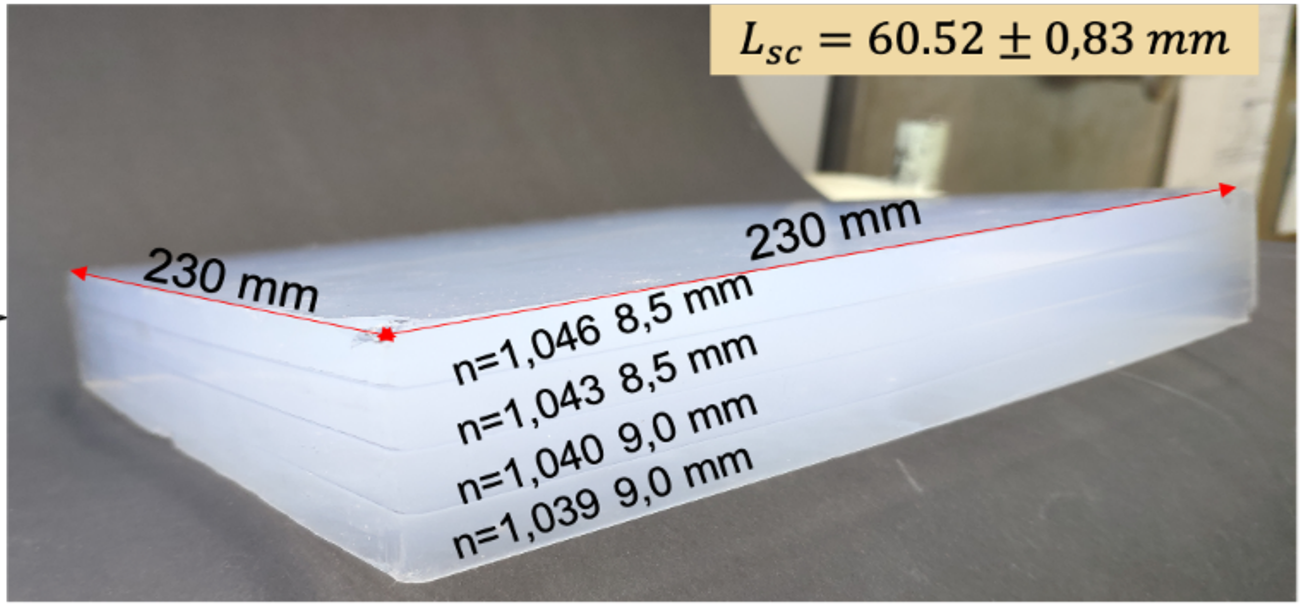
Main changes compared with the first version:

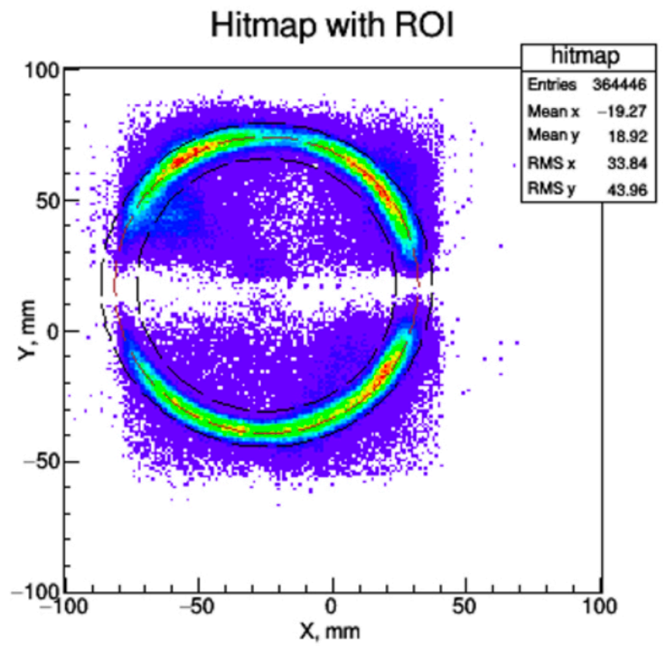
- Increasing the size (and weight!) of the detector, update of the Support and Transportation System.
- More sophisticated FARICH detector instead of the simple threshold Cherenkov aerogel detector.
- Simplified design of the Micromegas-based Central Tracker for the first stage.
- Beam-Beam Counter design update: higher radial and azimuthal granularity.
- Alternatives for the front-end electronics of the first-stage detectors.
- Update on the prototype production and tests (Straw Tracker, Micromegas-based Central Tracker).
- Update on DAQ and computing.
- Cost estimate update.

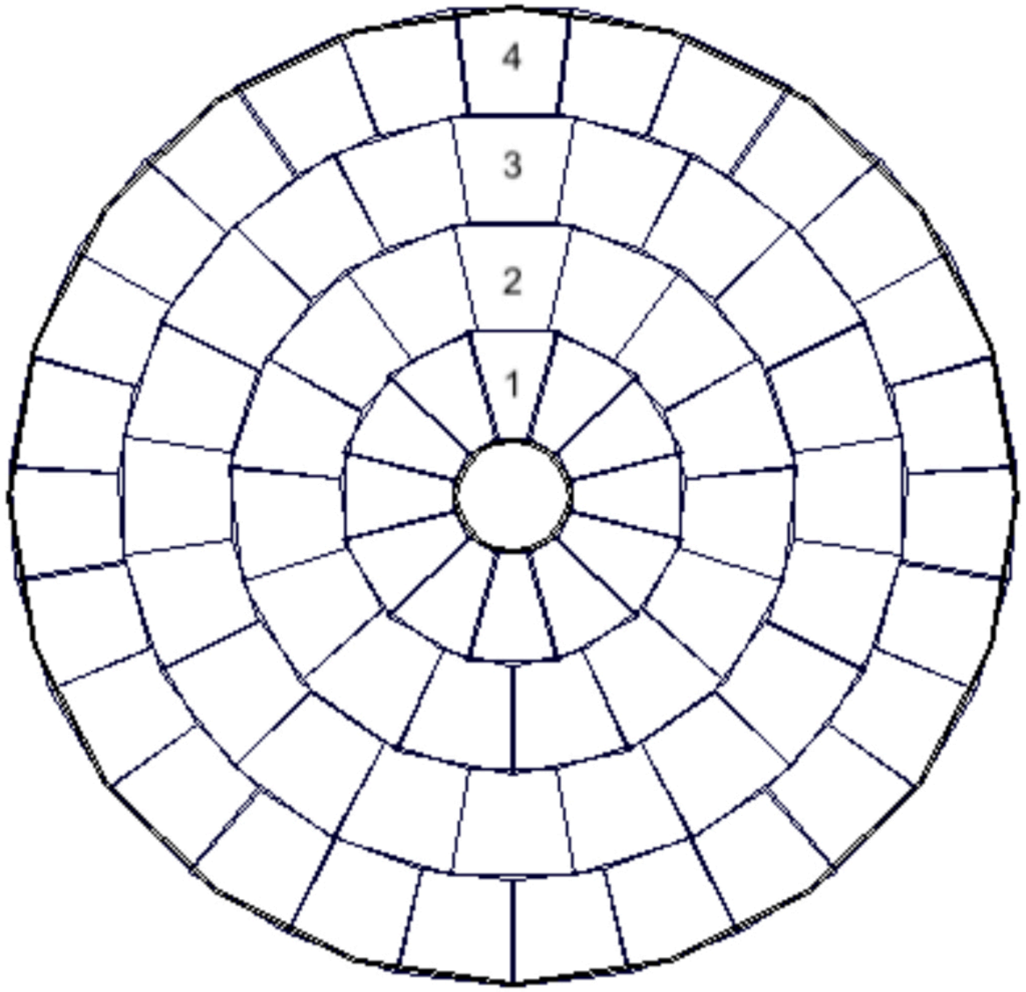


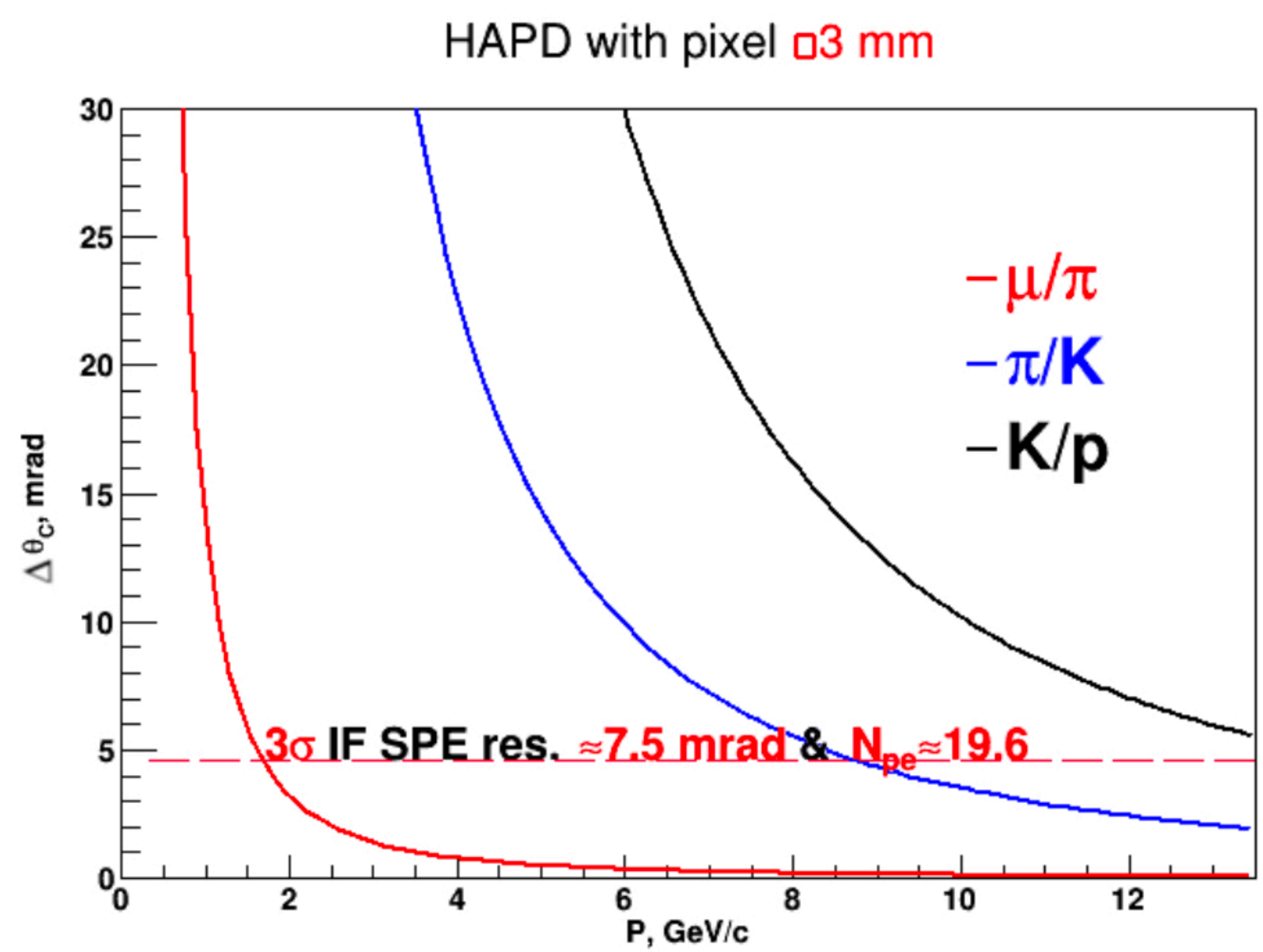
Focusing Aerogel RICH





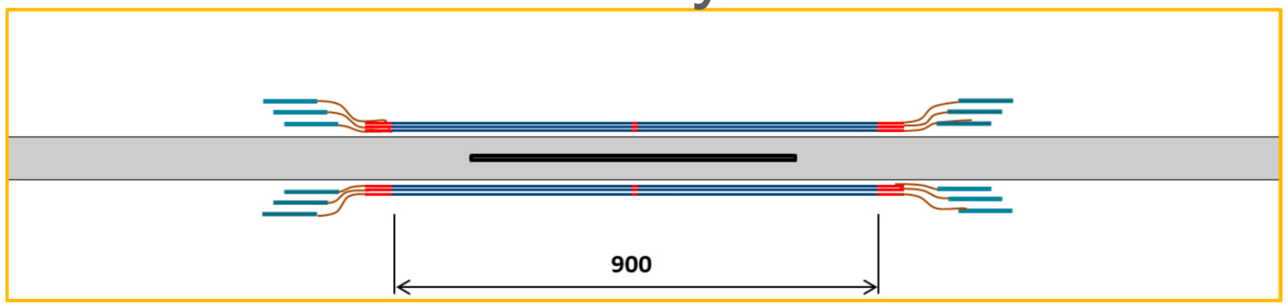


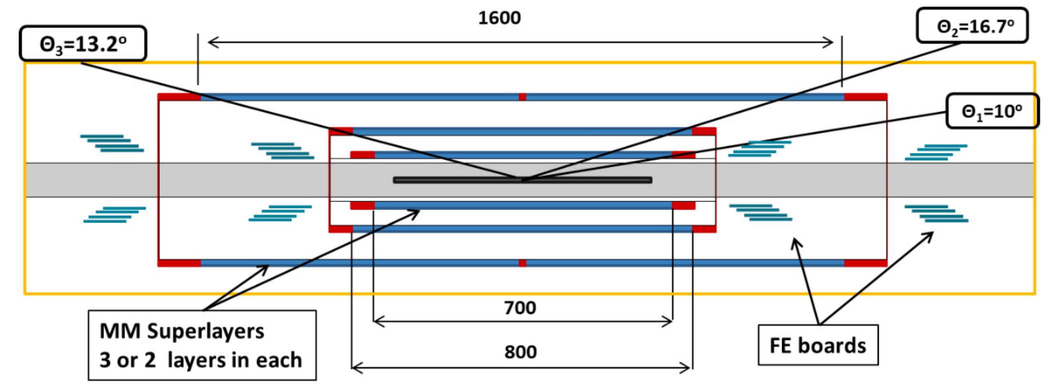




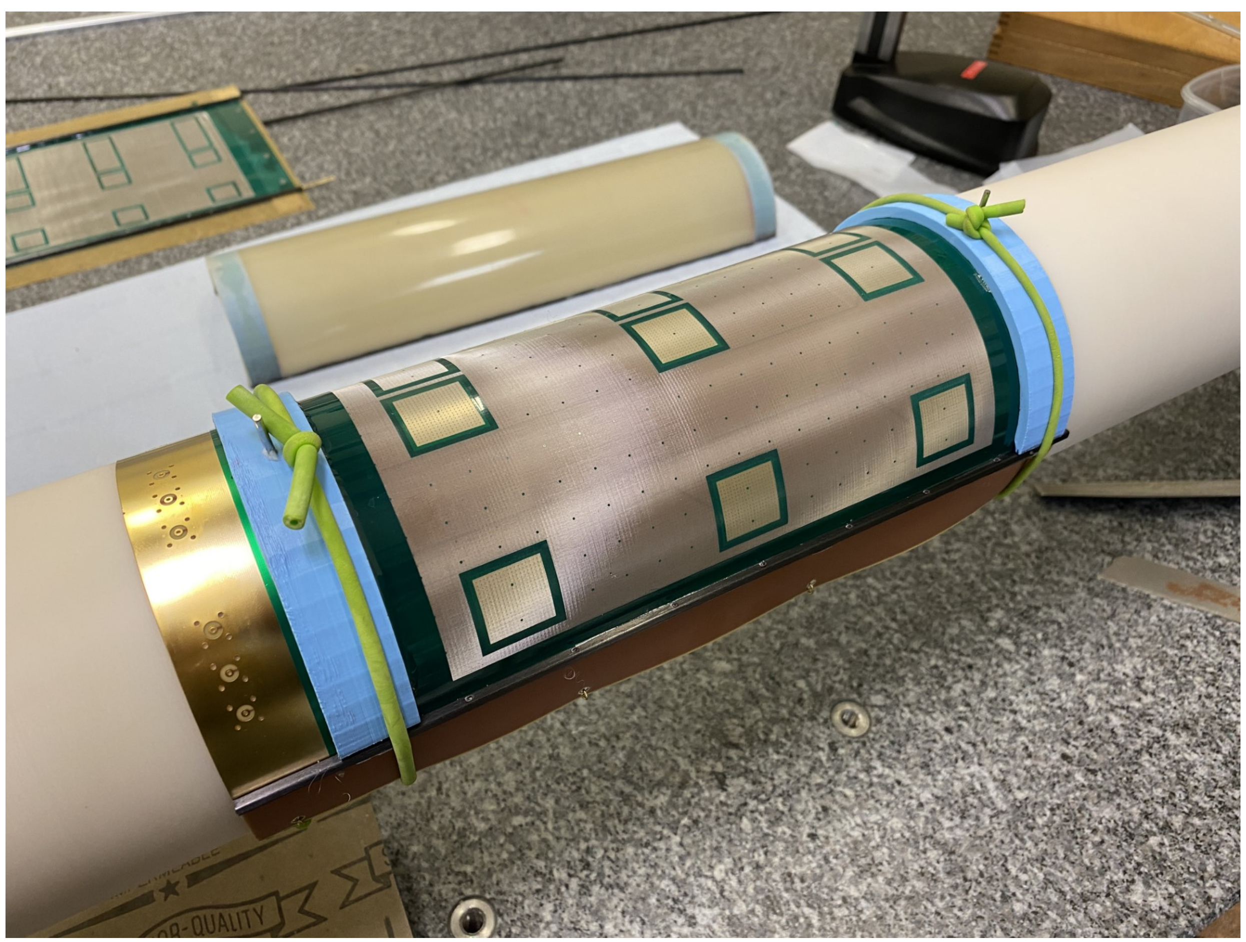
Micromegas-based CT

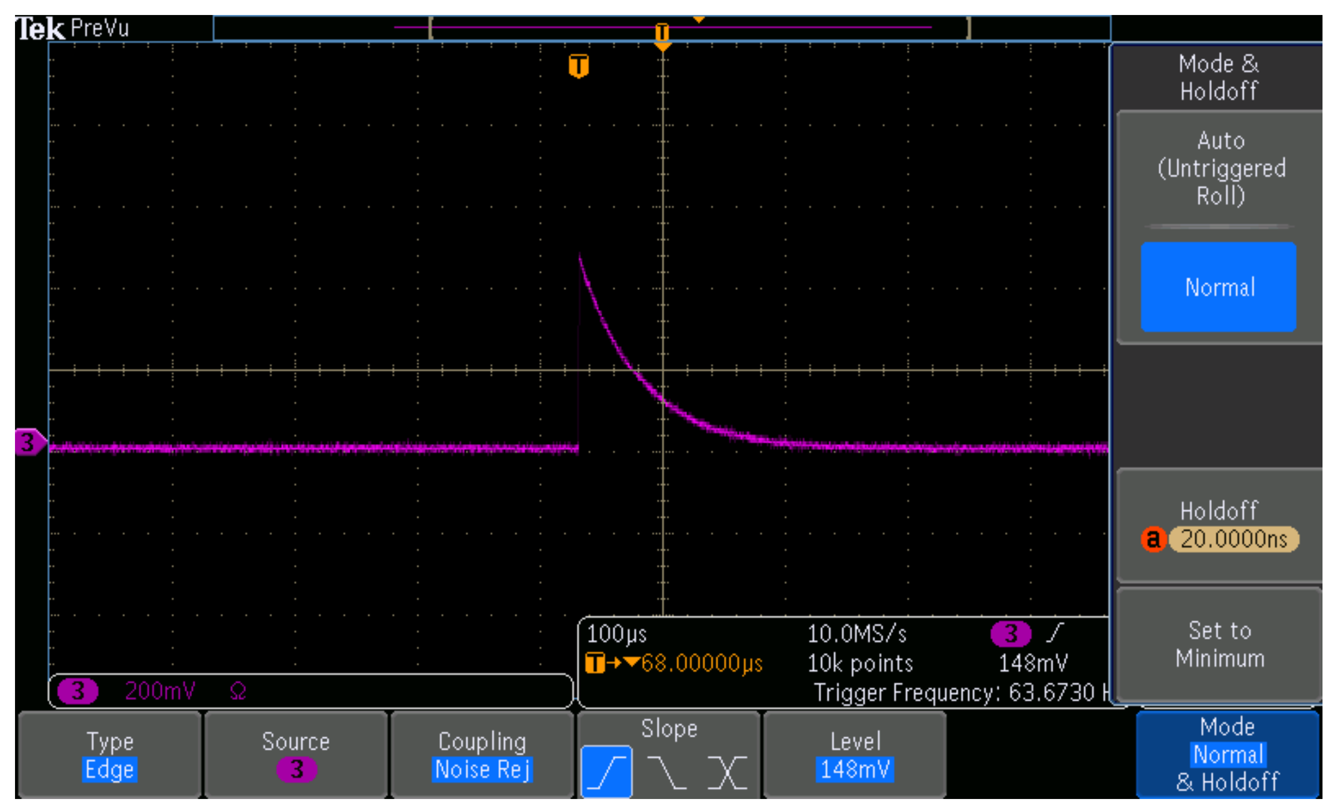
New layout





The first prototype of cylindrical Micromegas detector

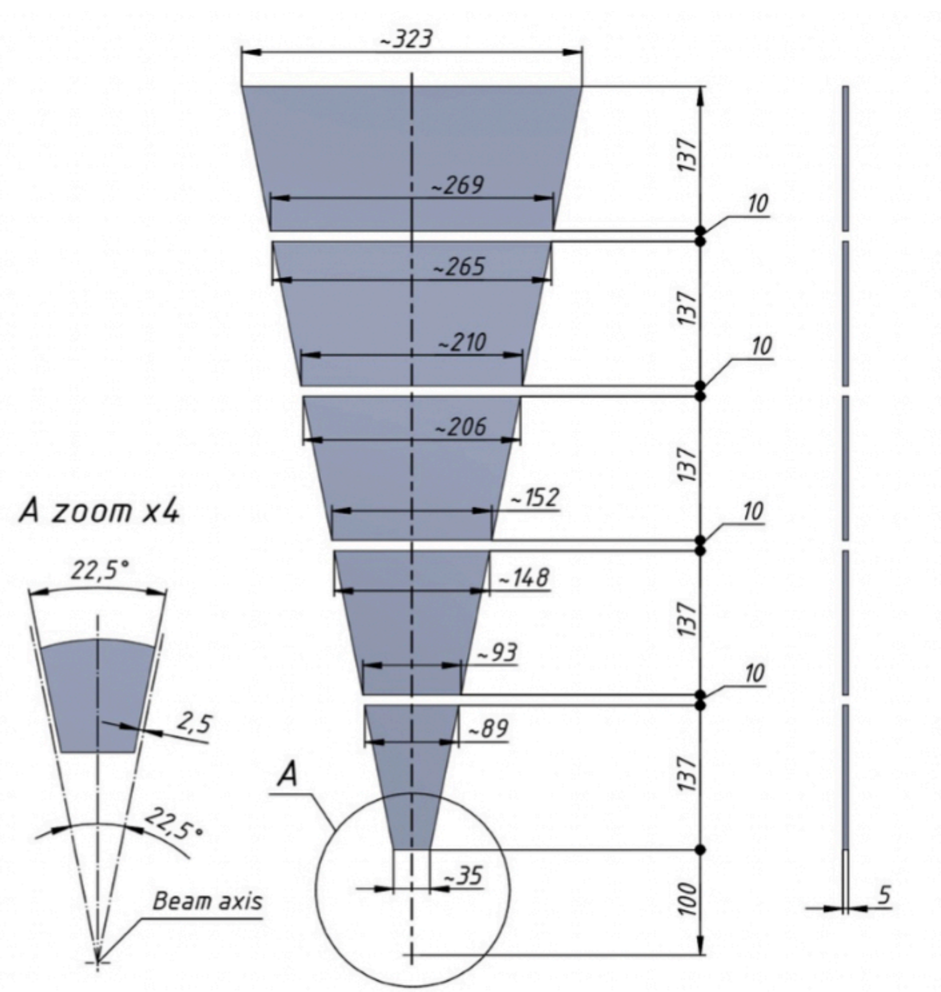


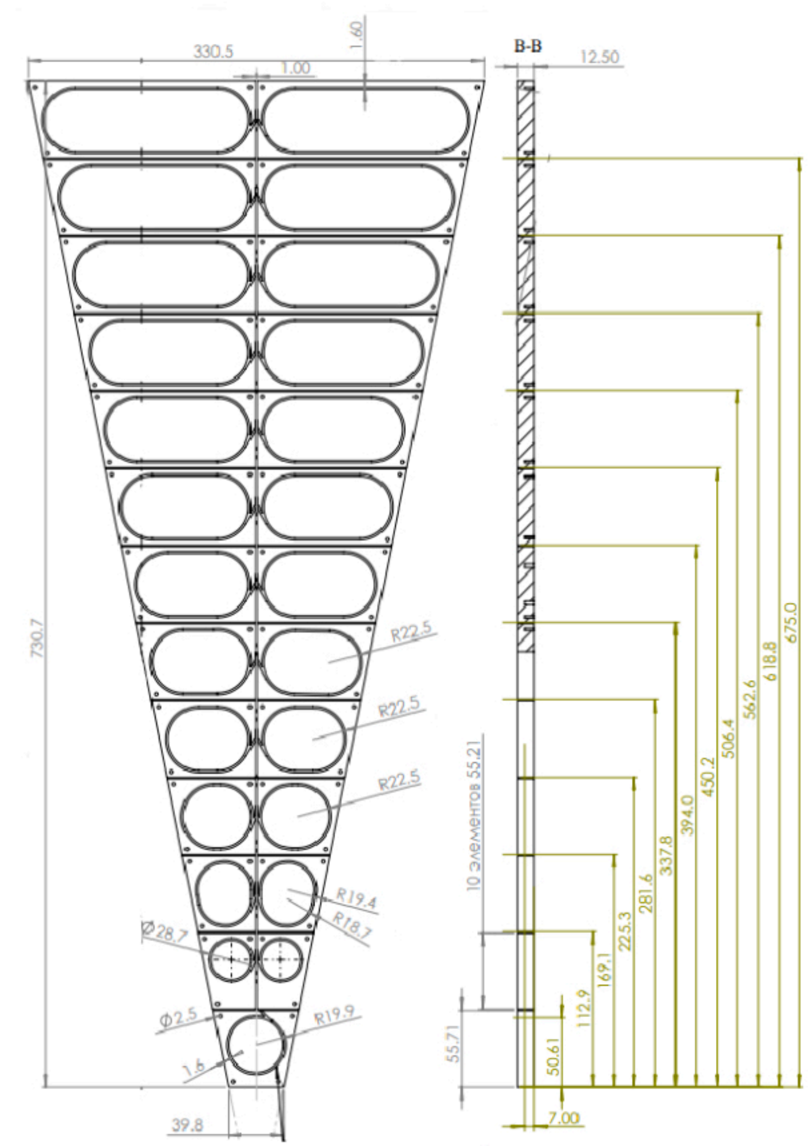


Alexey Guskov, Joint Institute for Nuclear Research

BBC

16 -> 32 sectors

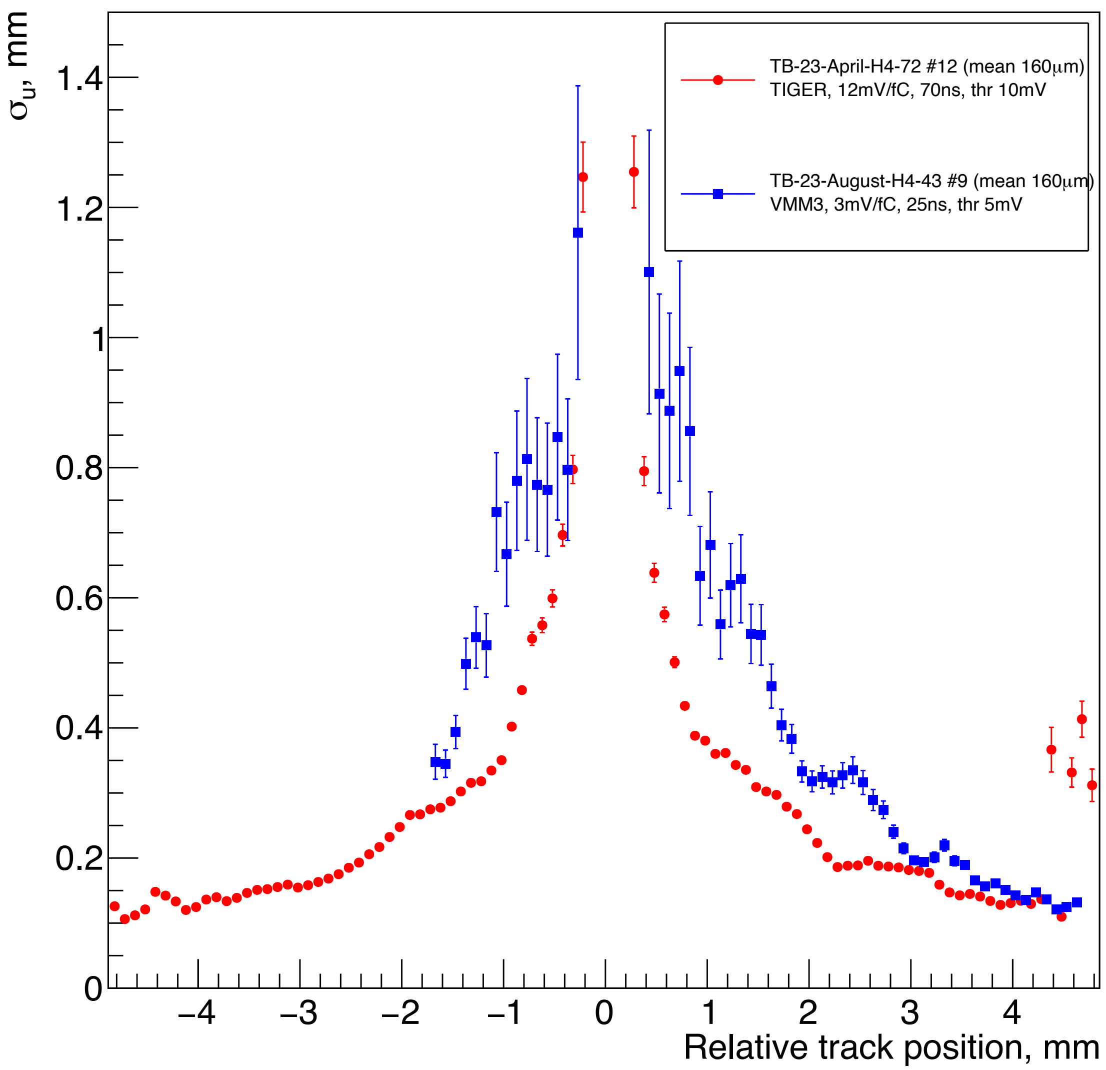


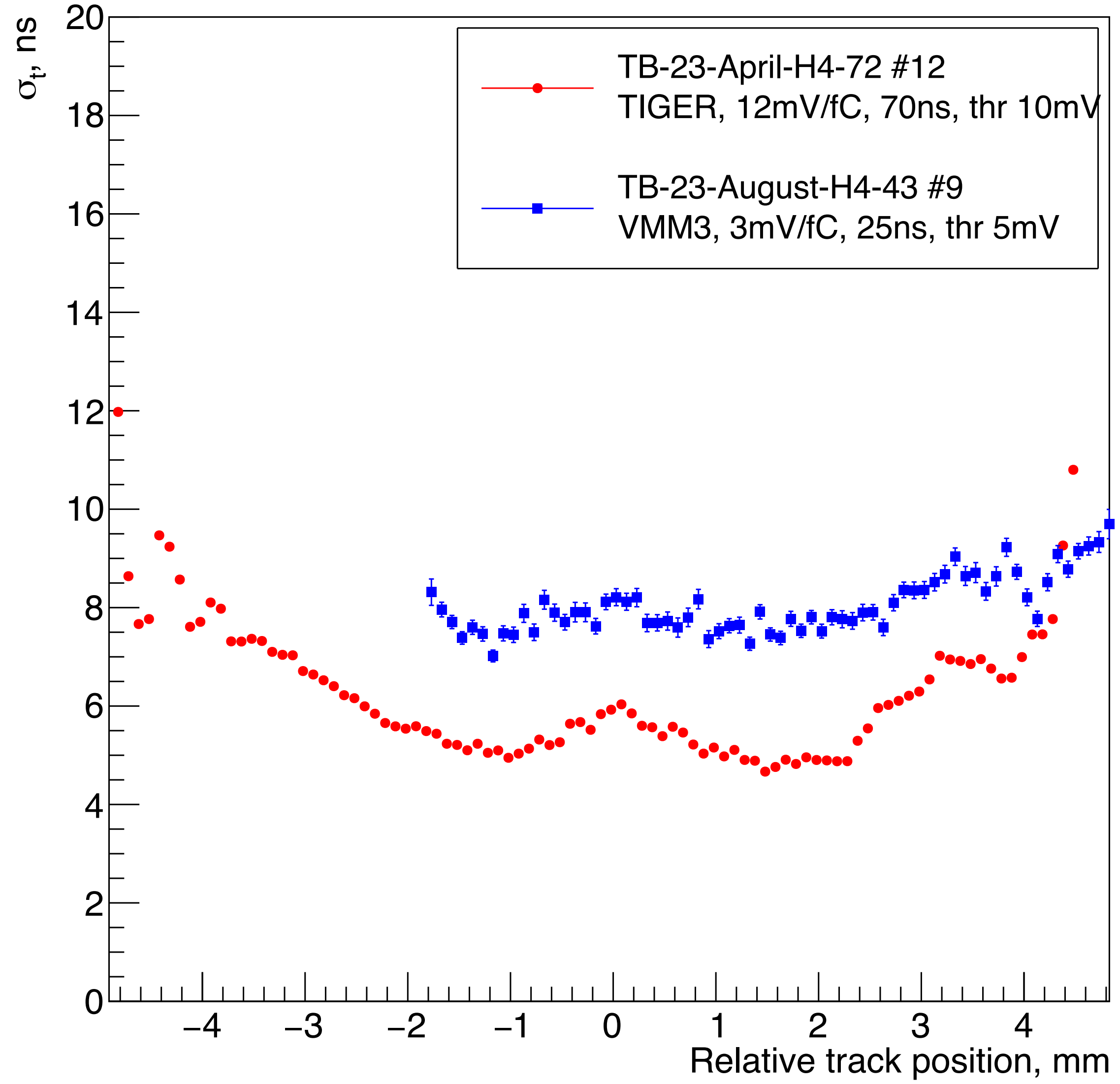


Alexey Guskov, Joint Institute for Nuclear Research

Straw tubes

Beam tests of the Straw Tracker prototype at CERN with different FEE.





Alexey Guskov, Joint Institute for Nuclear Research

Availability of equipment, materials and technologies

- There is no critical dependency excluding:
    - electronics (first of all FFE and its components)
    - MAPS technology
- To solve problem with electronics we initiated the development of the required components in Russian and Belorussian organizations
- We are closely monitoring the experience of our colleagues from MPD. Discussion on the development of Russian MAPS-detectors is also initiated

Cost estimate update

Jan, 22 → Nov, 23

Stage I: 44.4 → 50.1 M$
Stage I+II: 83.4 → 110.4 M$

Subsystem	Option	Stage	Cost, M$
SPD setup	Vertex detector:		
	– DSSD	II	8.8
	– MAPS	II	13.5
	Micromegas Central Tracker	I	0.7
	Straw tracker	I+II	3.7
	PID system:		
	– TOF	II	2.2
	– FARICH	II	16.7
	ECal		
	– mock-up	I	0.4
		II	11.6
	Range system	I+II	17.3*
	ZDC	I+II	0.7
	BBC (inner+outer)	I+II	0.8
	Magnetic system		9.4
	& cryogenic infrastructure		6.4
	Beam pipe		
	– Al	I	0.1
	– Be	II	0.4
General infrastructure			
		I	1.8
		I+II	2.5
Detector Control System			
		I	1.5
		I+II	2.7
Data Acquisition System			
		I	1.3
		I+II	4.1
Computing			
		I	6
		I+II	17**
TOTAL COST	stage I		50.1
	stage I+II		110.4

* including 6.2 M$ of the steel yoke of the SC solenoid
** + 4.5 M$ per year for tapes at the stage II

Cost update

	Stage	Jan, 2022, M$	Nov, 2023, M$	Δ, M$	Δ, %
MAPS vertex detector	**2**	13.5	13.5	0	0
DSSD vertex detector	**2**	7.3	8.8	1.5	+20
Micromegas-based CT	**1**	0.9	0.7	-0.2	-22
Straw Tracker	**1**	3.0	3.7	0.7	+23
Time-of-Flight system	**2**	2.0	2.2	0.2	+10
Aerogel detector	**2**	2.4	16.7	14.3	+720
ECal	**2**	9.8	12.0	2.2	+22
Range System	**1**	16.1	17.3	1.2	+7
ZDC	**1**	0.6	0.7	0.1	+17
BBC	**1**	0.6	0.8	0.2	+33
Magnet & Cryogenics	**1**	14.7	15.8	1.1	+7
General infrastructure	**1+2**	1.7	2.5	0.8	+47
Detector Control System	**1+2**	1.7	2.7	1.0	+59
DAQ	**1+2**	1.8	4.1	2.3	+128
Computing	**1+2**	15	17	2.0	+13

New SPD Detector Advisory Committee

Formed in December, 2023

1) **Prof Ivan Logashenko** (chair)
Budker Institute of Nuclear Physics (Novosibirsk)
DAQ, detectors, data analysis

2) **Prof Eduard Kistenev**
Brookhaven National Laboratory (retired in 2023)
Experience with hardware in PHENIX and sPHENIX Collaborations

3) **Prof. Huang Xingtao**
Shandong University
An expert in HEP Computing and Software

4) **Prof. Heng Yuekun**
IHEP CAS
The system manager of BESIII TOF system, central detector of Daya Bay and JUNO, an expert of scintillators and other detector system.

Summary

- We have updated the Technical Design of the Spin Physics Detector at NICA, a sophisticated experimental apparatus for the study of the spin structure of the proton and deuteron, as well as fundamental properties of the strong interaction, taking into account present conditions.
- Updated cost of the project is 110.4 M$ (50.1 M$ - first stage).
- We do not see any strong show-stopper for the first phase of the SPD detector from point of available technologies and components.
- New international DAC is formed and began to familiarize with the SPD TDR.
- We consider that now SPD is the most elaborated new project on particle physics on the territory of Russia and JINR member states.