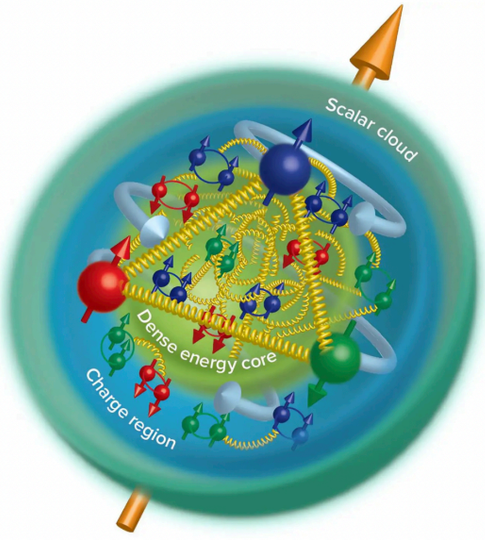
Implementation of the SPD project

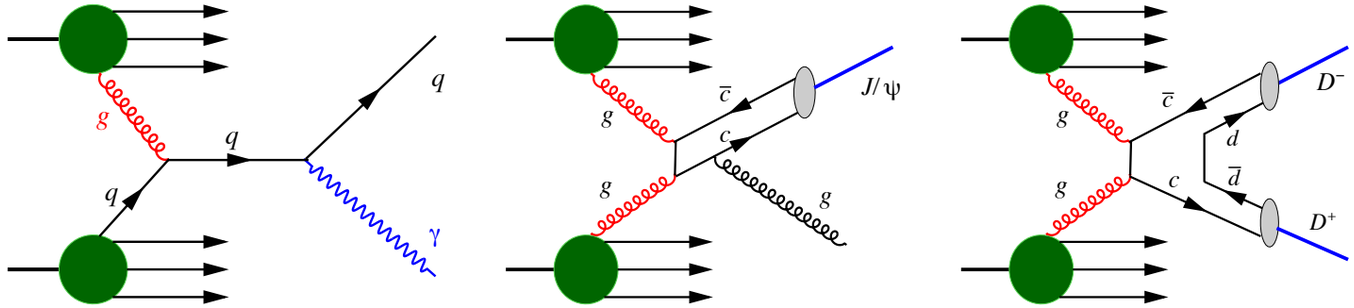
A. Guskov

20.1.25

SPD project



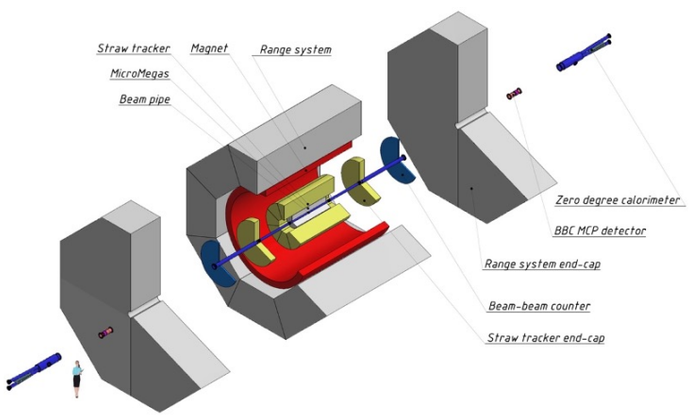
The purpose of the SPD experiment is the study of the nucleon spin structure in collisions of polarized protons and deuterons and other spin-related as well as unpolarized phenomena at $\sqrt{s}$ up to 27 GeV and luminosity up to $10^{32} cm^{-2} s^{-1}$

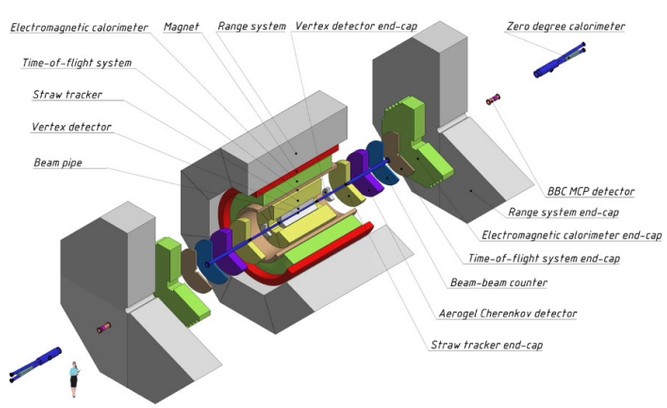


Gluon TMD PDFs will be accessed via 3 complementary processes.

$\sqrt{s}$

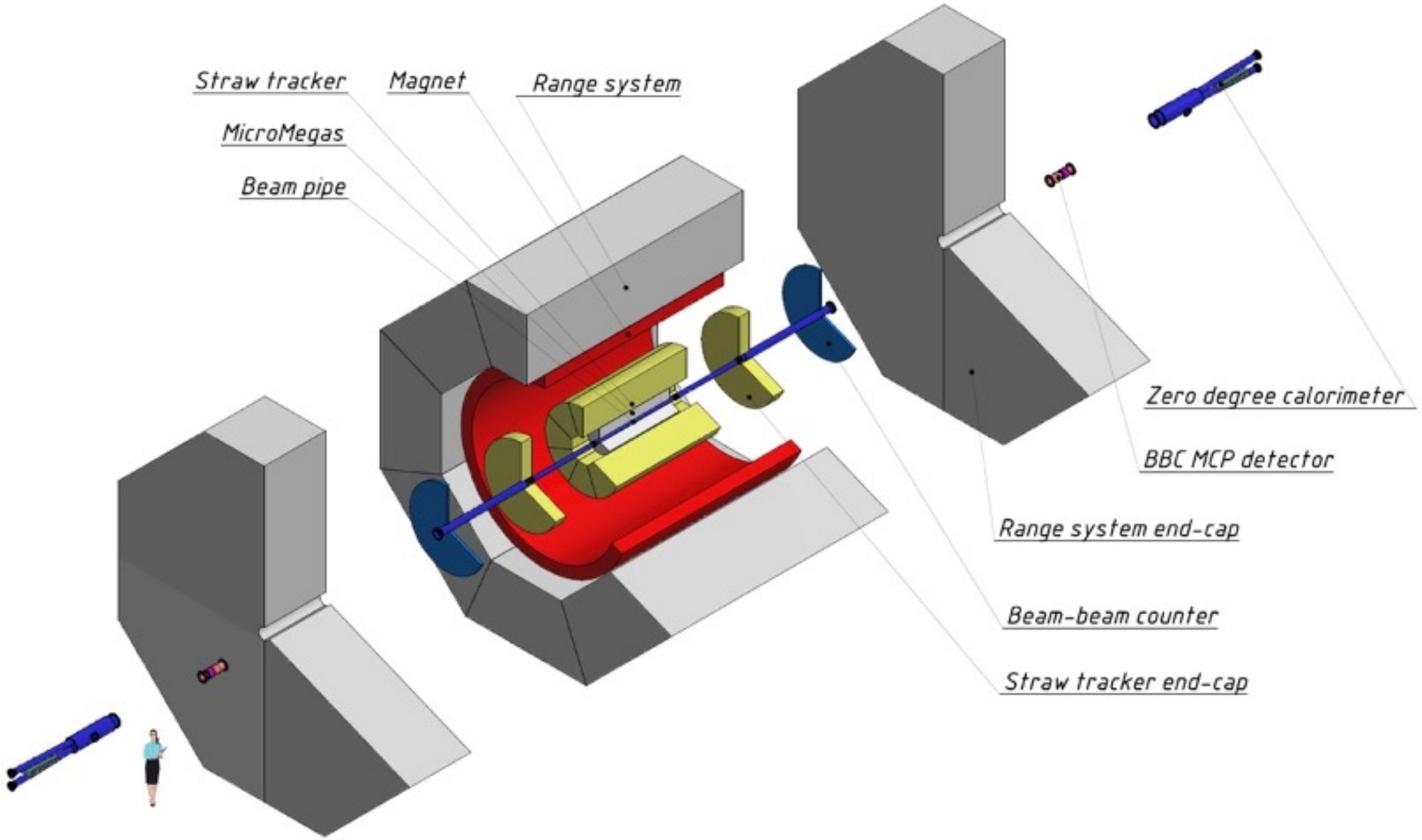
Non-perturbative QCD — *Perturbative QCD*





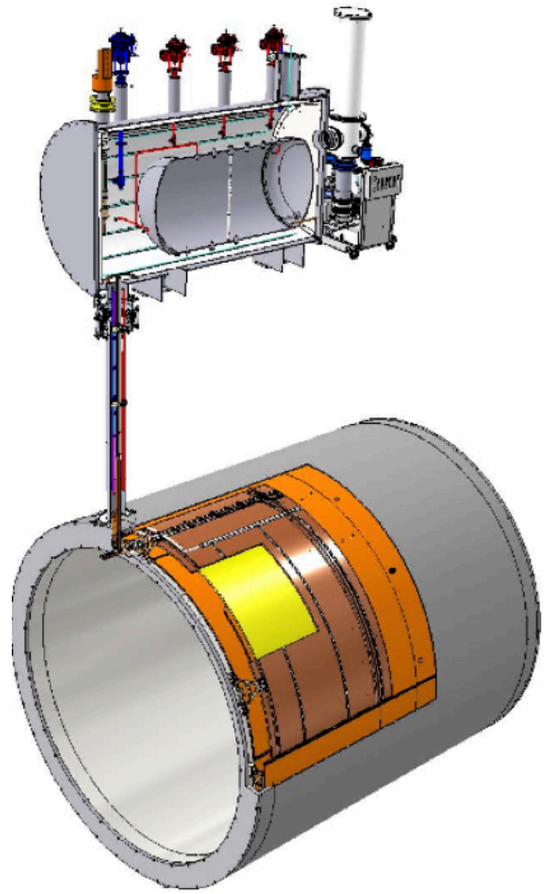
The project is planned to be implemented in two phases

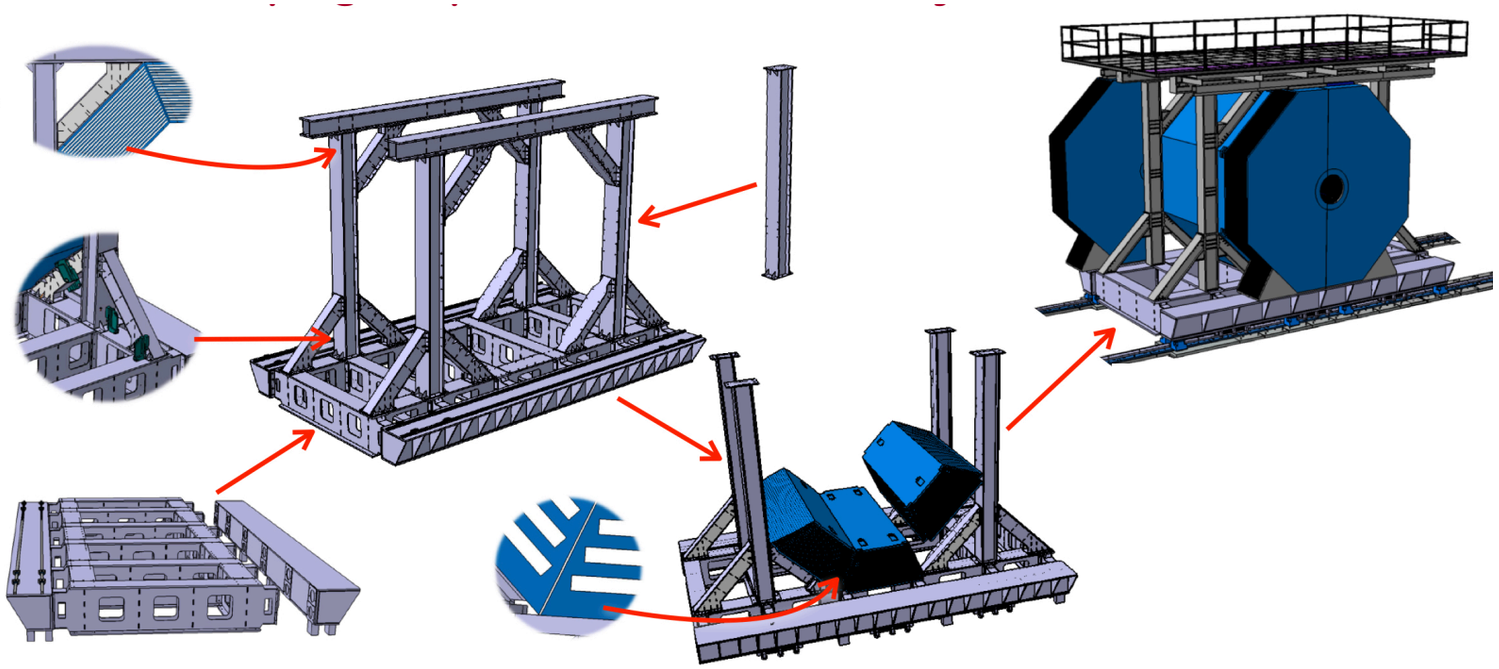
Experimental setup, stage 1

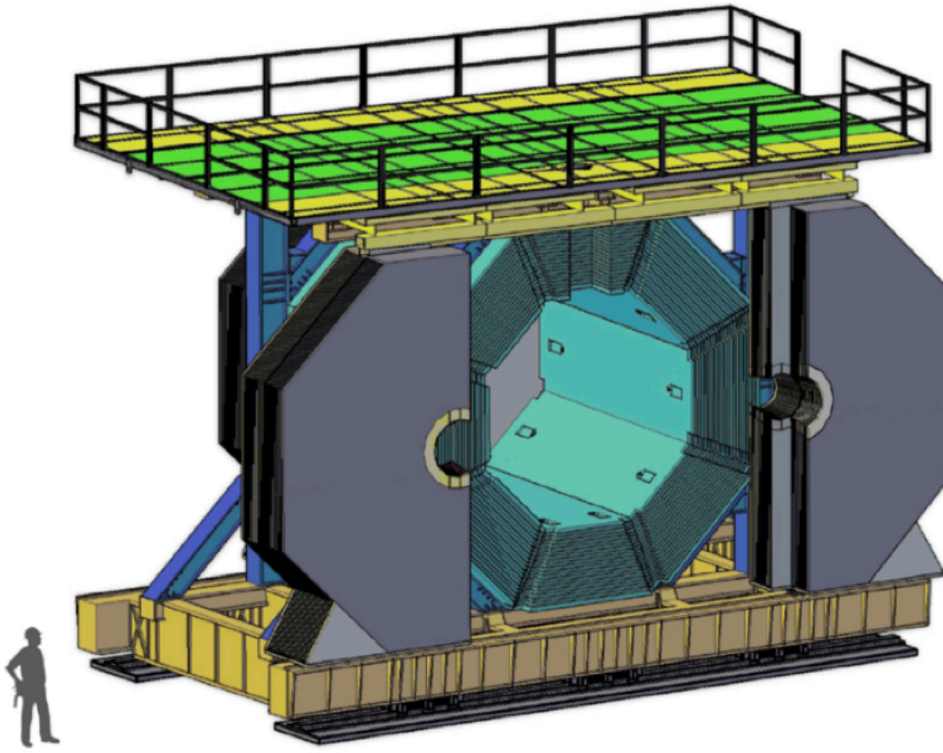


Magnetic system

- Solenoid+Dewar — documentation development contract, BINP 2024
- Cryogenic system — development of technical specifications for a cryogenic plant and a platform for cryogenic tanks is in an active phase
- Magnet yoke — under design, production planned for 2026



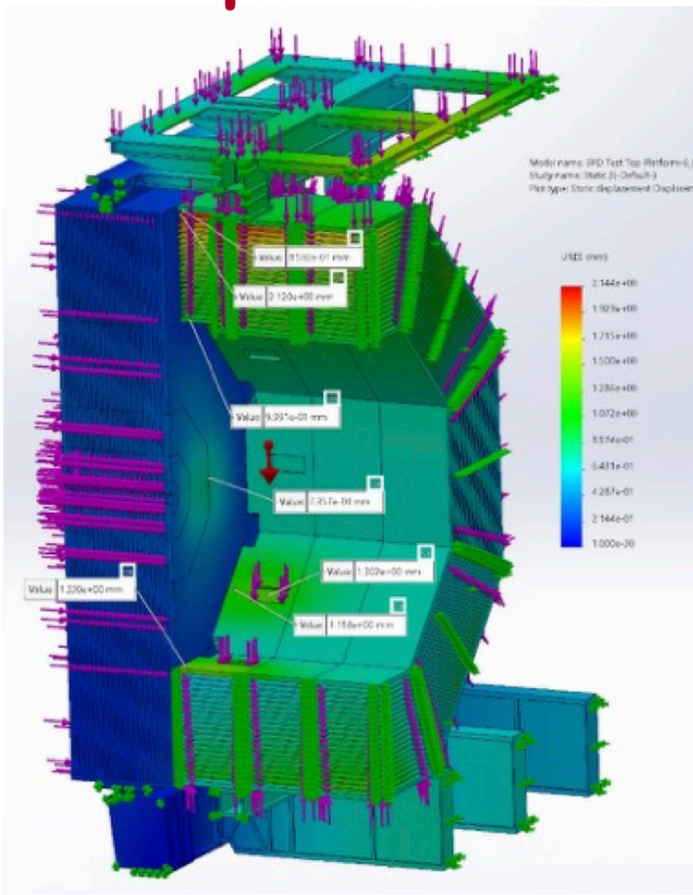


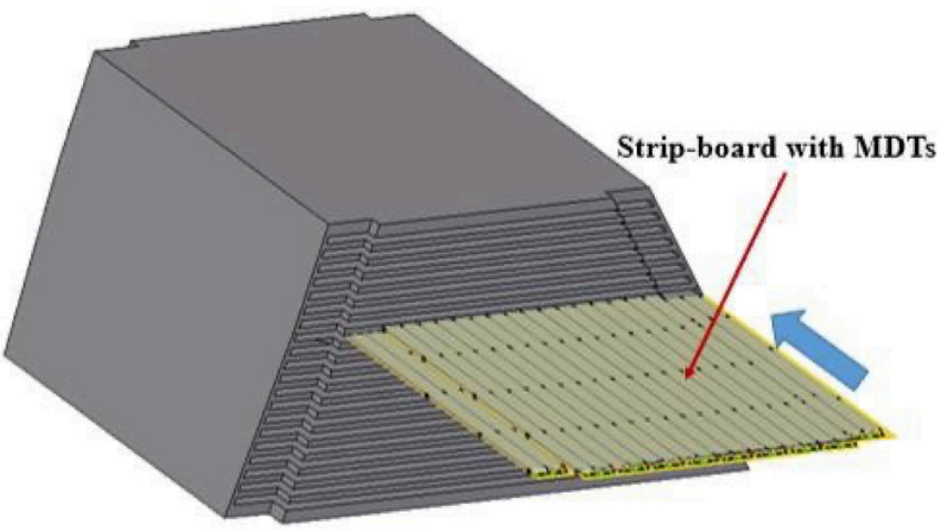


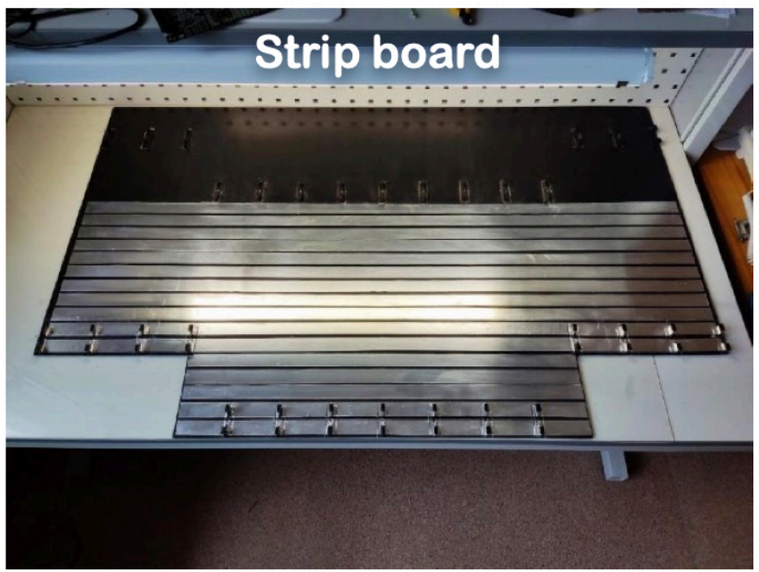
Range (muon) system

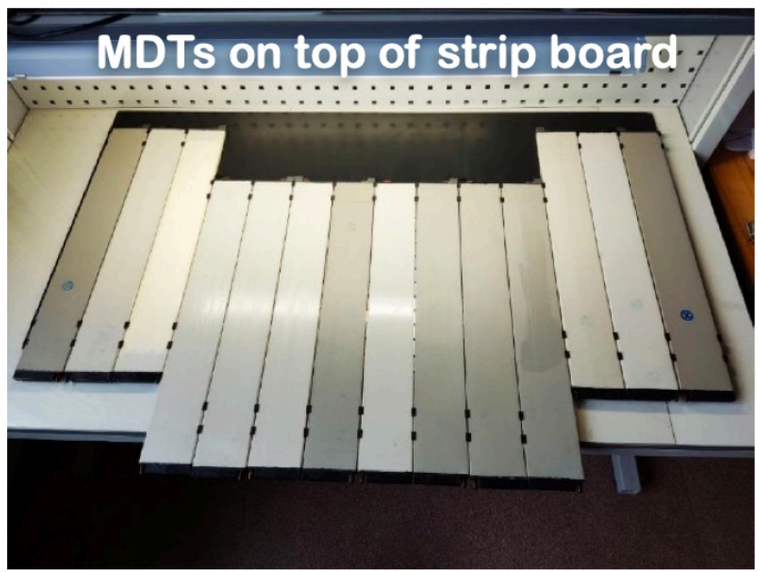
- RS prototype is mounted in beam position on support/ transportation system at the Nuclotron test beam area
- Design of detecting plane (new strip board concept) is under development
- Amplifier chip (Ampl-8.53) preproduction at INTEGRAL (Minsk) is being monitored
- Currently working on establishing connection of RS prototype digital module with prototype L1/DAQ concentrator
- Preparations for deployment of equipment for MDTs mass production –area for tuning the equipment is found
- Development and optimization of the PID algorithms for pion/muon separation is ongoing

Displacement



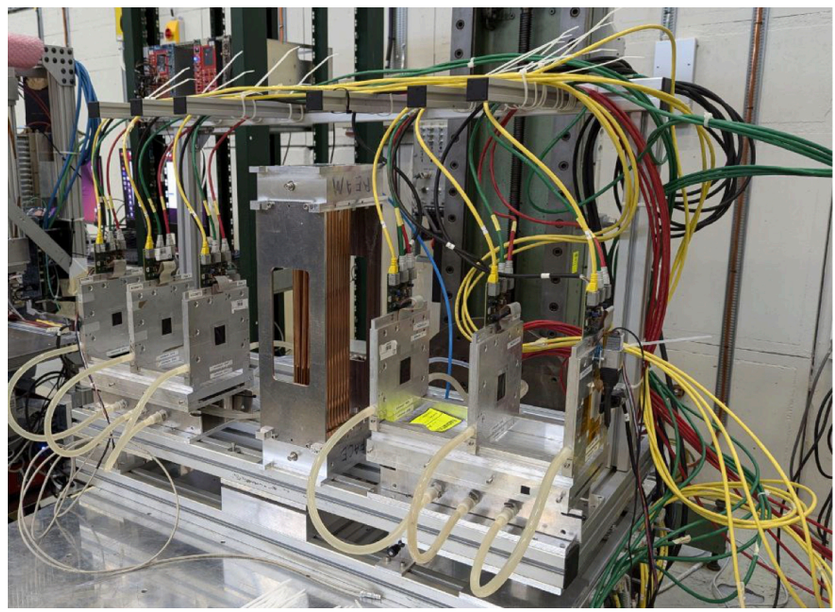




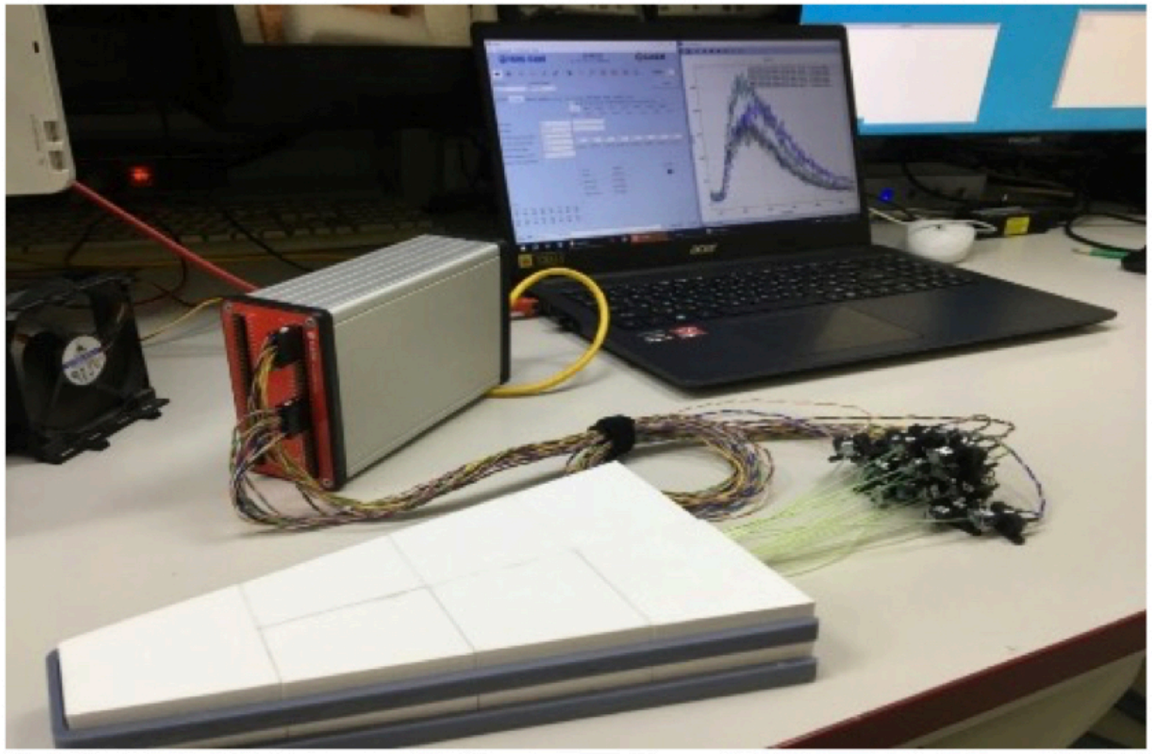


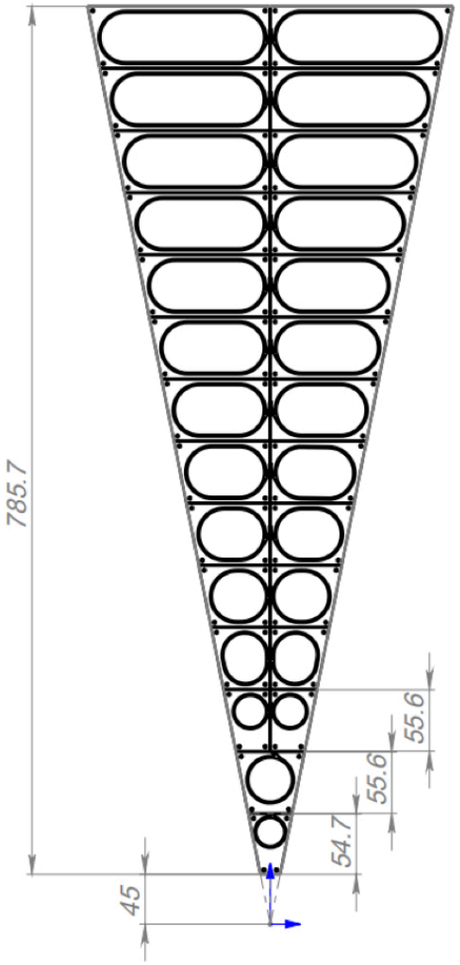
Tracking (ST + MCT)

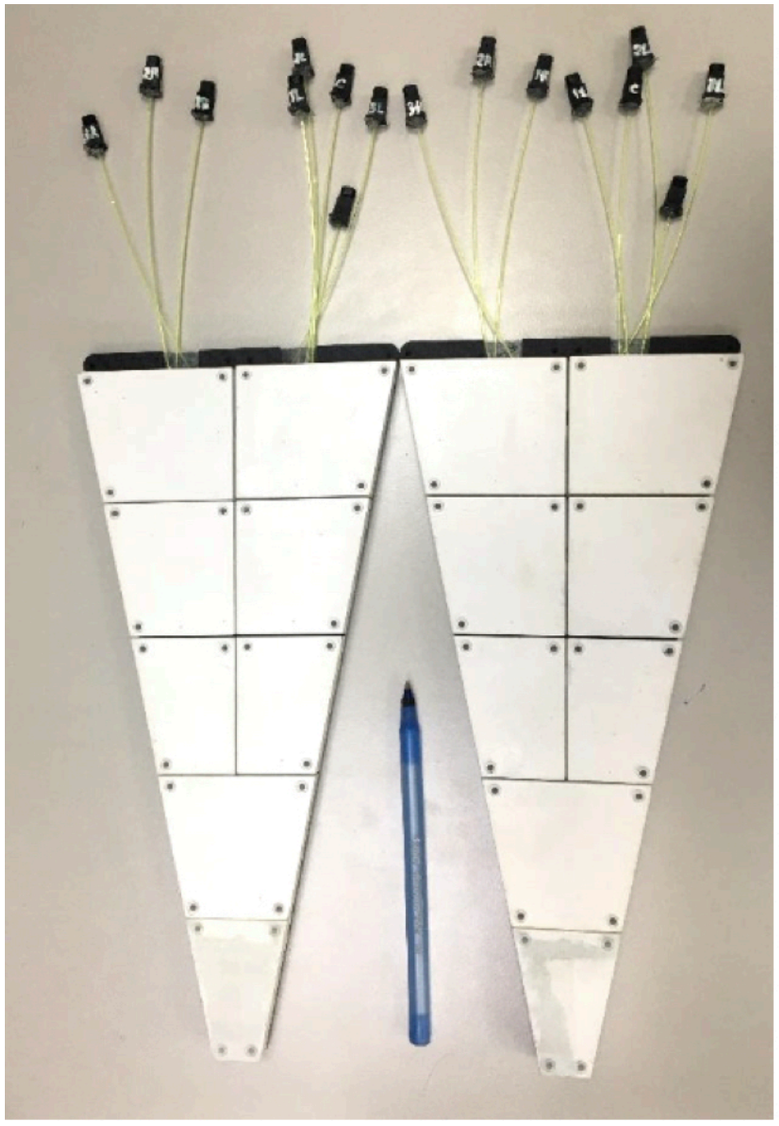
- Production line and assembling place are under preparation (JINR and INP Almaty)
- Small-scale prototype of the ST end-cap to test the assembly technology
- Beam tests of straw and Micromegas-based detectors at CERN with different type of electronics



BBC

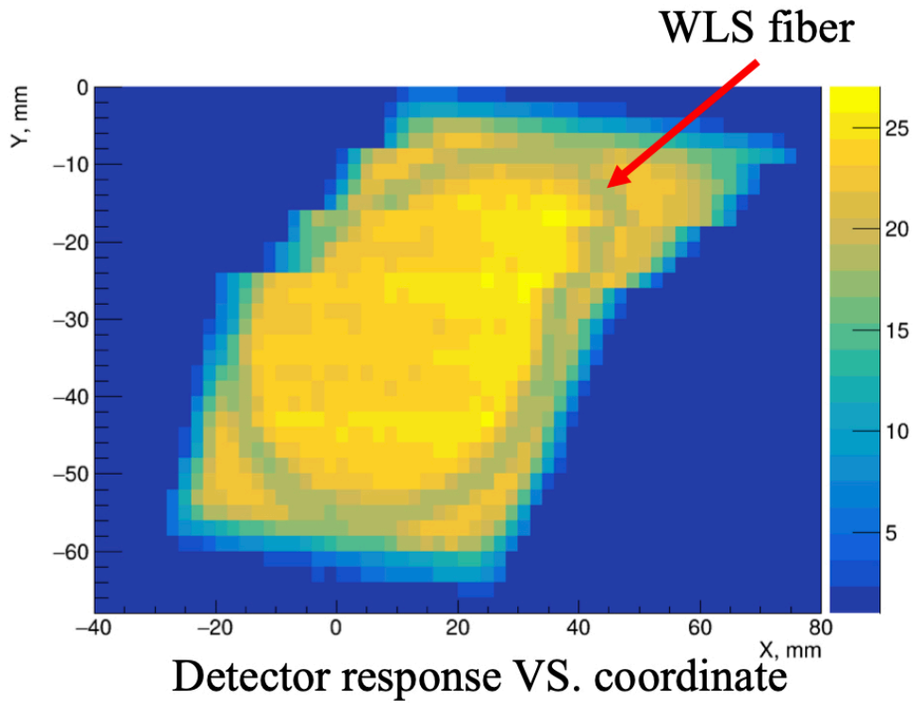






Prototypes test with CAEN FERS-5200

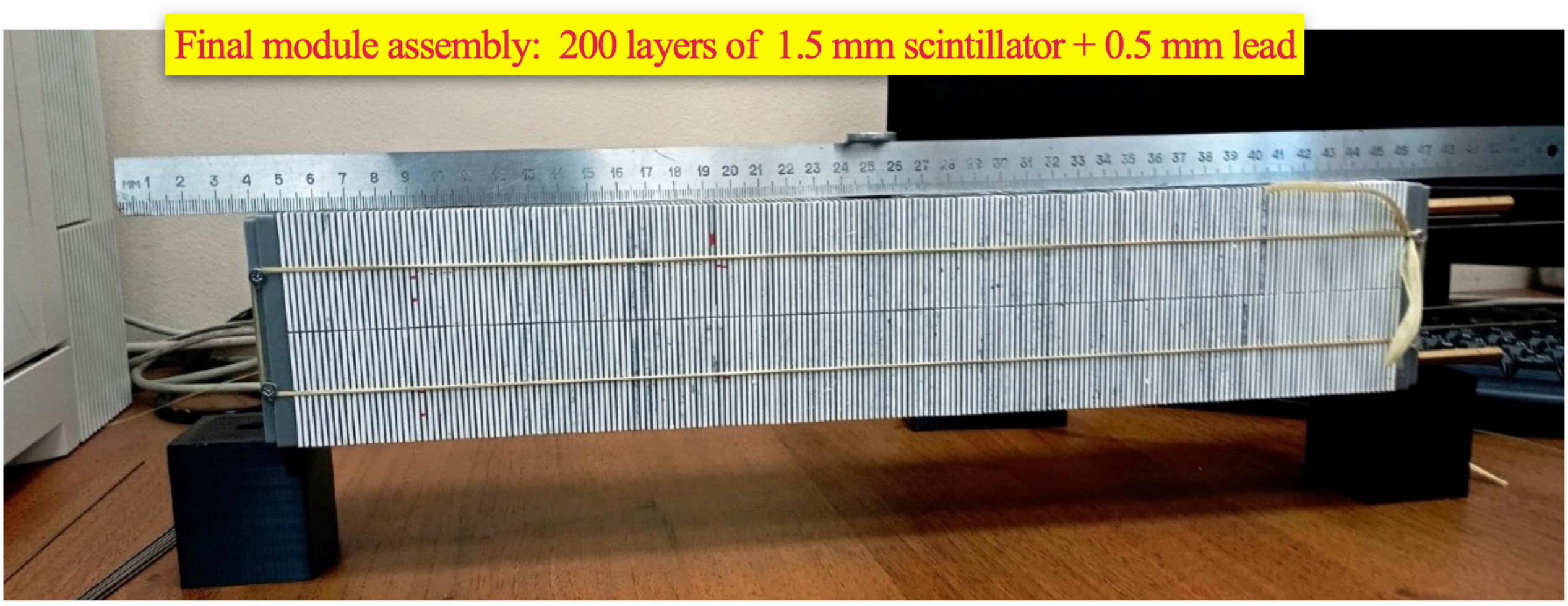
- Tests with a one-sector small-scale prototype
- Full-weel prototype should be ready in 2025



Detector response VS. coordinate

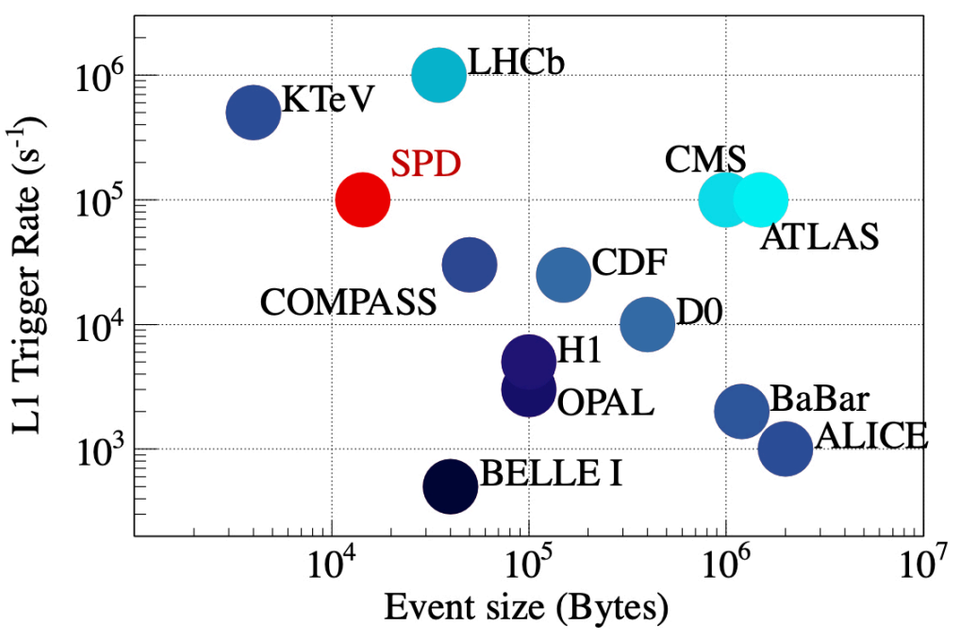
ECAL

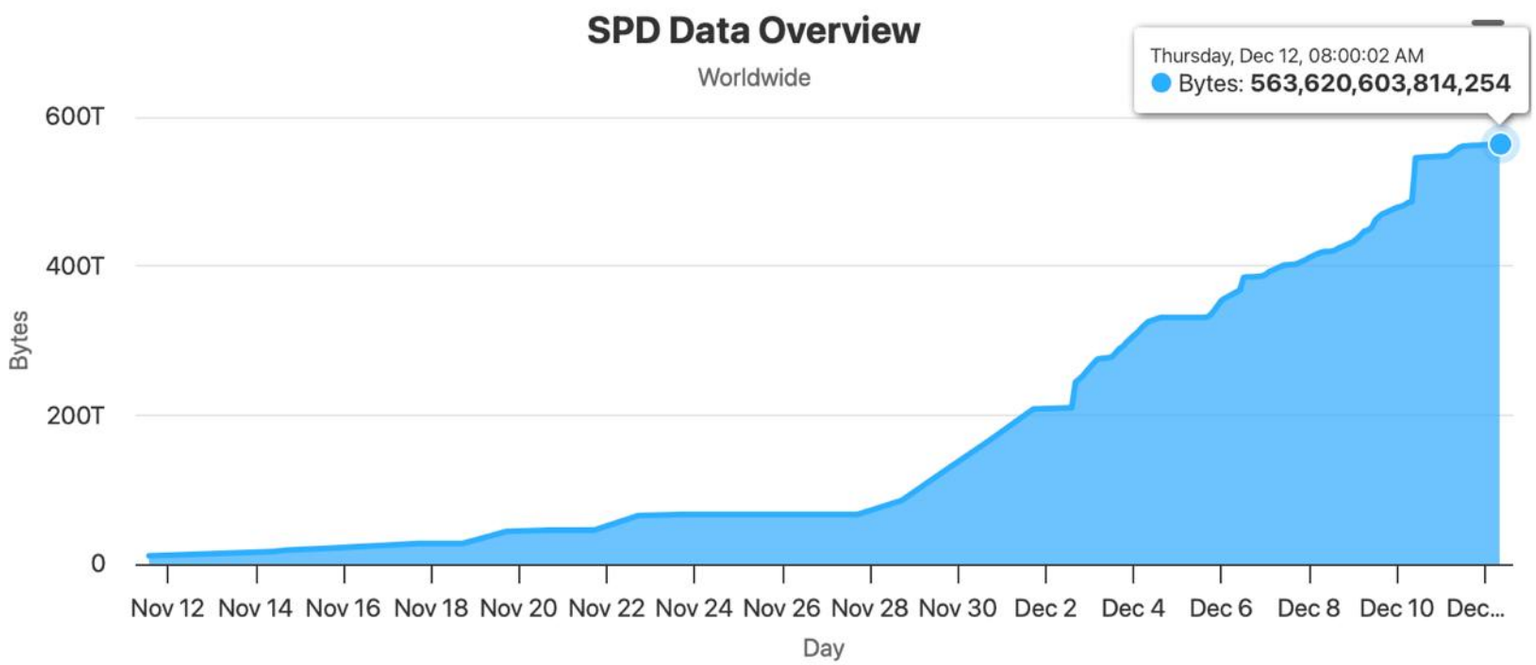
- New matrix form for scintillator production in Vladimir is ready. Stamp form for lead is under production.
- Modules are under assembling at JINR.
- WLS produced by Tver are testing now.
- ADC & FFE are under development (DLNP JINR).



DAQ & computing

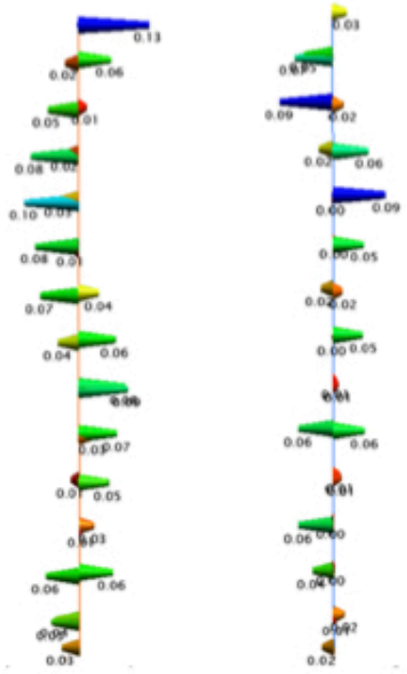
- Development of Time Synchronization System (TSS) based on the White Rabbit protocol (WR). Using the WR equipment produced by SyncTechnology (China) it was demonstrated that the required time accuracy has been achieved: clock skew < 300ps; relative jitter < 20ps; temperature drift 30 ps/°C. WR protocol now is considered as the main approach for the further DAQ development.
- Development of L1 and L2 data concentrators. The protype board of L1 has been produced in JINR. The prototype of L2 has been purchased. Firmware developments for the both concentrators continue in Dubna and Tomsk. Test packages have been transmitted through the full chain: L1→fiber→L2→PCIe→Server.
- For the first time a mass data processing (MC generation) on the PNPI cluster within the GRID system has been performed





Experimental hall

Rail positioning accuracy measured in October in mm:

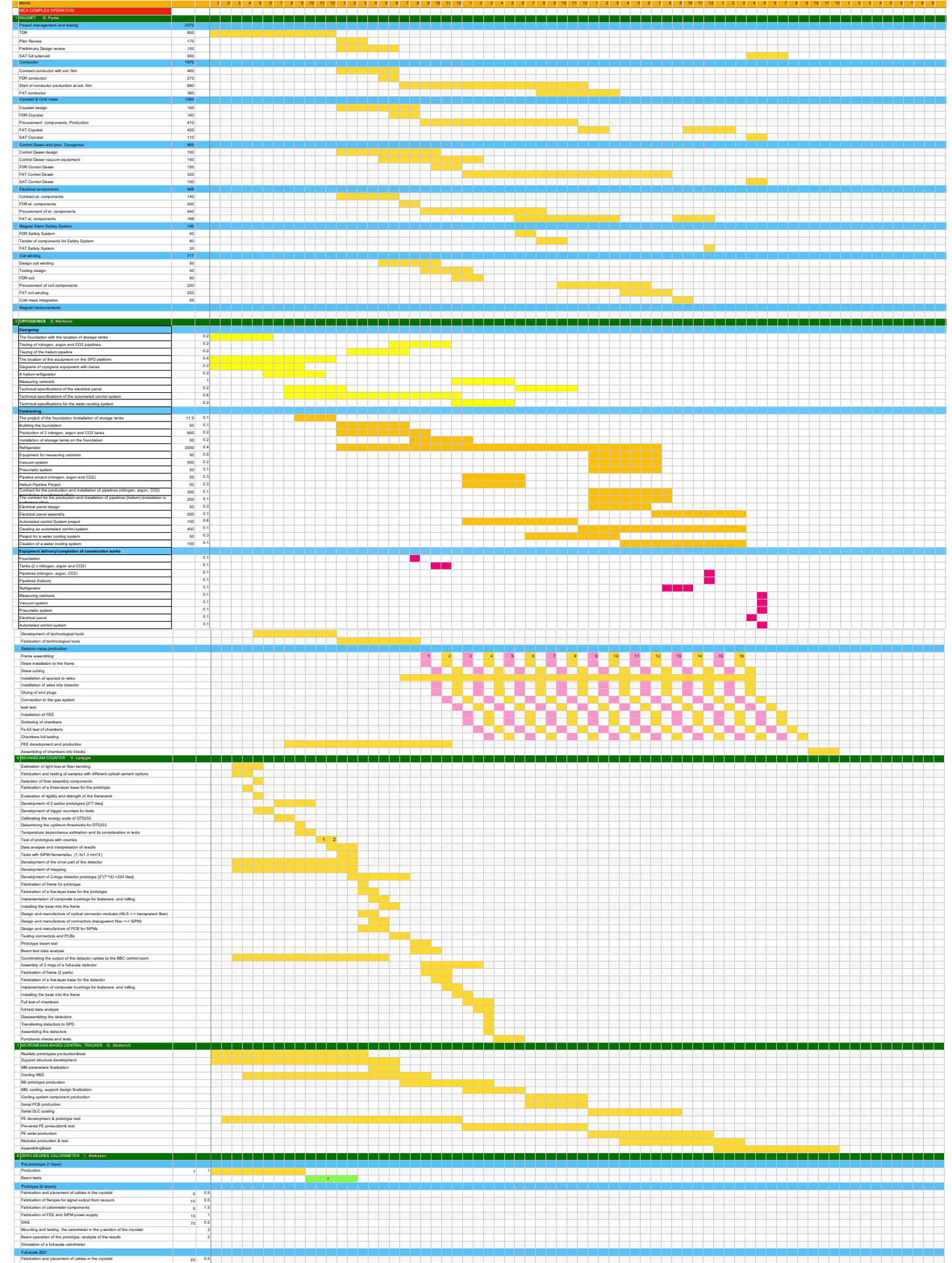


Requirement for the smooth motion of roller skates: ±0.5 mm

SPD Chief Designer

In November, 2024 Nikolay Topilin has been appointed as a chief designer of the SPD setup.

Monthly plan for building the first phase of the detector



Physics updates

FIRST-STAGE PLANS

We must have a few **realistic scenarios of data taking**. For each scenario we should denote:

- beam species, beam momentum, beam polarization, luminosity
- set of physics tasks with the necessary minimal and optimal statistics for each one and the detector requirements
- reasonable combining of tasks leading to new results and repetitions of previous measurements
- prioritisation of the tasks (run schedule)

SECOND-STAGE PLANS

We need to prioritise our main physics program.

- do we really need longitudinal proton beam polarization at any energy or just at some fixed energy points?
- which beams do we need first: protons or deuterons?
- energy scan vs. long data taking in our main energy points
- does reaching 27 GeV at low luminosity (or/and polarization) make sense?
- longitudinal vs. transverse physics
- He-3 ?

Collaboration update

MoU signed: +2

A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute), Yerevan
NRC “Kurchatov Institute” - PNPI, Gatchina
Samara National Research University (Samara University), Samara
Saint Petersburg Polytechnic University St. Petersburg
Saint Petersburg State University, St. Petersburg
Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow
Tomsk State University, Tomsk
Belgorod State University, Belgorod
Lebedev Physical Institute of RAS, Moscow
Institute for Nuclear Research of the RAS, Moscow
National Research Nuclear University MEPhI, Moscow
Institute of Nuclear Physics (INP RK), Almaty
Institute for Nuclear Problems of BSU, Minsk
Budker Institute for Nuclear Physics, Novosibirsk
Higher Institute of Technologies and Applied Sciences, Havana
iThemba LABS, SA

New members:

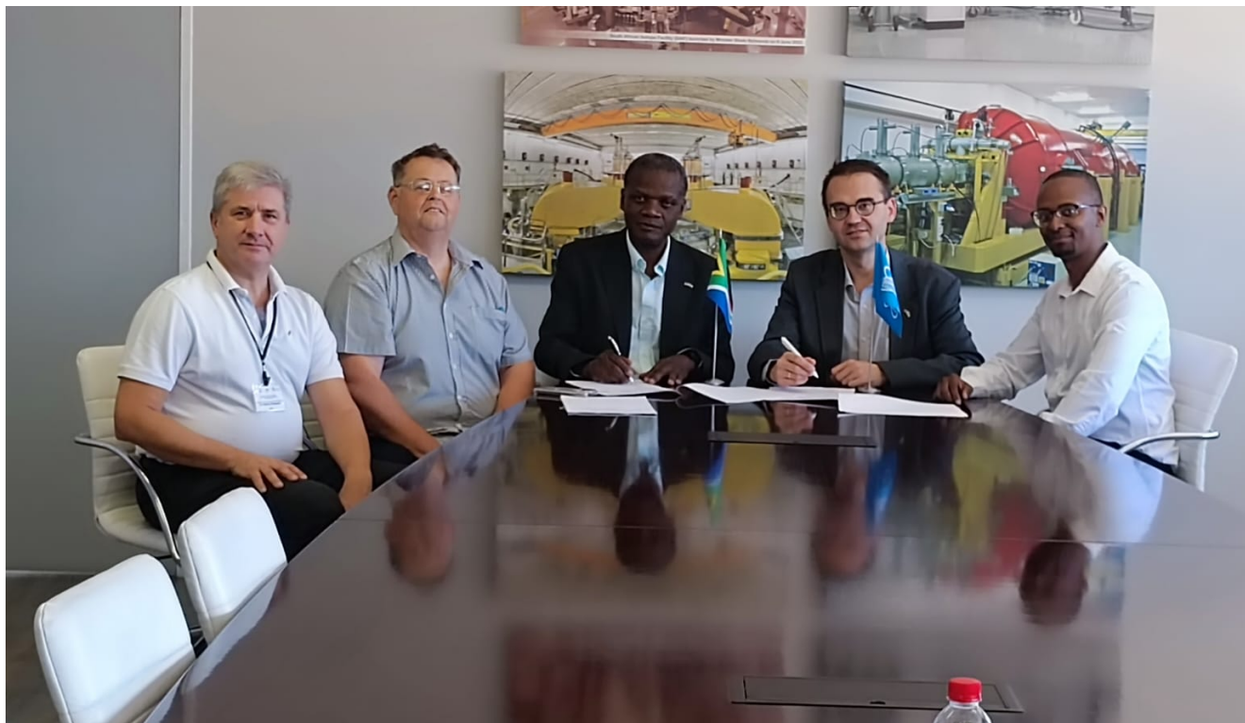
National University of Science and Technology MISiS (Moscow)

New contacts:

USTC (China)

Shandong university (China)

Vinca Institut (Serbia)



Collaboration meeting

Dubna, Nov. 5-8

~120 participants in person
the most of Russian institutes,
Armenia, Belorussia, Kazakhstan

71 talk and report

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Technical Design Report of the Spin Physics Detector at NICA

V. Abazov[1], V. Abramov[2], L. Afanasyev[1], R. Akhunzyanov[1], A. Akindinov[3], I. Alekseev[3], A. Aleshko[4], V. Alexakhin[1], G. Alexeev[1], L. Alimov[5], A. Allakhverdieva[1], A. Amoroso[6], V. Andreev[7], V. Andreev[8], E. Andronov[9], Yu. Anikin[10], S. Anischenko[11], A. Anisenkov[12], V. Anosov[1], E. Antokhin[12], A. Antonov[13], S. Antsupov[13], A. Anufriev[5], K. Asadova[1], S. Ashraf[14], V. Astakhov[1], A. Aynikeev[4], M. Azarkin[7], N. Azorskiy[1], A. Bagulya[7], D. Baigarashev[1,15], A. Baldin[1], E. Baldina[1], N. Barbashina[16], A. Barnyakov[12], S. Barsov[17], A. Bartkevich[11], V. Baryshevsky[11], K. Basharina[1], A. Baskakov[5], V. Baskov[7], M. Batista[18], M. Baturitsky[19], V. Bautin[1], T. Bedareva[12], S. Belokurova[9], A. Belova[1], E. Belyaeva[1], A. Berdnikov[13], Ya. Berdnikov[13], A. Berezhnoy[4], A. Berngardt[10], Yu. Bespalov[1], V. Bleko[1], L. Bliznyuk[19], D. Bogoslovskii[1], A. Boiko[13], A. Boikov[1], M. Bolsunovskya[13], E. Boos[4], V. Borisov[1], V. Borsch[10], D. Budkouski[1], S. Bulanova[17], O. Bulekov[16], V. Bunichev[4], N. Burtebayev[15], D. Bychanok[11], A. Casanova[18], G. Cesar[18], D. Chemezov[1], L. Chen[20], A. Chepurnov[4], V. Chmill[1], A. Chukanov[1], A. Chuzo[16], A. Danilyuk[21], A. Datta[1], D. Dedovich[1], M. Demichev[1], G. Deng[20], I. Denisenko[1], O. Denisov[6], T. Derbysheva[12], D. Derkach[22], A. Didorenko[1], M.-O. Dima[1], A. Doinikov[13], S. Doronin[16], V. Dronik[23], F. Dubinin[16], V. Dunin[1], A. Durum[2], A. Egorov[17], R. El-Kholy[14], T. Enik[1], D. Ermak[11], D. Erofeev[10], A. Erokhin[12], D. Ezhov[13], O. Fedin[17], Ju. Fedotova[11], G. Feofilov[9], Yu. Filatov[1,24], S. Filimonov[10], V. Frolov[1], K. Galaktionov[9], A. Galoyan[1], A. Garkun[25], O. Gavrishchuk[1], S. Gerasimov[1], S. Gerassimov[7], M. Gilts[23], L. Gladilin[1,4], G. Golovanov[1], S. Golovnya[2], V. Golovtsov[17], A. Golubev[3], S. Golubykh[1], P. Goncharov[1], A. Gongadze[1], N. Greben[1], A. Gregoryev[16], D. Gribkov[4], A. Gridin[1], K. Gritsay[1], D. Gubachev[1], J. Guo[20], Yu. Gurchin[1], A. Gurinovich[11], Yu. Gurov[16], A. Guskov*[1], D. Gutierrez[18], F. Guzman[18], A. Hakobyan[26], D. Han[27], S. Harkusha[19], Sh. Hu[20], S. Igolkin[9], A. Isupov[1], A. Ivanov[1], N. Ivanov[1,26]

Summary

- We have an important new stage ahead of us - the construction of the first-phase experimental setup that includes the superconducting magnet and cryogenic infrastructure, range system, straw tracker, Miscromegas-based central tracker, BBC, ZDC and a part of ECAL.

- We continue R&D for the silicon vertex detector, TOF and FARICH.

- We are working on prioritisation of the measurements based on our stated physical program, taking into account the capabilities and development plans of the accelerator complex.

- SPD collaboration is in a good shape and developing dynamically.