Tile detector configurations testing for the SPD Beam-Beam Counter prototype

A. M. Zakharov [a], F. A. Dubinin [c, a], A. Yu. Isupov [b], V. P. Ladygin [b], A. D. Manakonov [a], G. A. Nigmatkulov [a, †], S. G. Reznikov [b], P. E. Teterin [a], A. V. Tishevsky [b], I. S. Volkov [b], A. O. Zhurkina [a]

[a] National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Kashirskoe Shosse 31, 115409 Moscow, Russia

[b] Veksler and Baldin Laboratory of High Energy Physics, Joint Institute for Nuclear Research, Dubna, Moscow region, 141980 Russia

[c] Lebedev Physical Institute of the Russian Academy of Sciences (RAS), Leninsky Avenue 53, 119991, Moscow, Russia

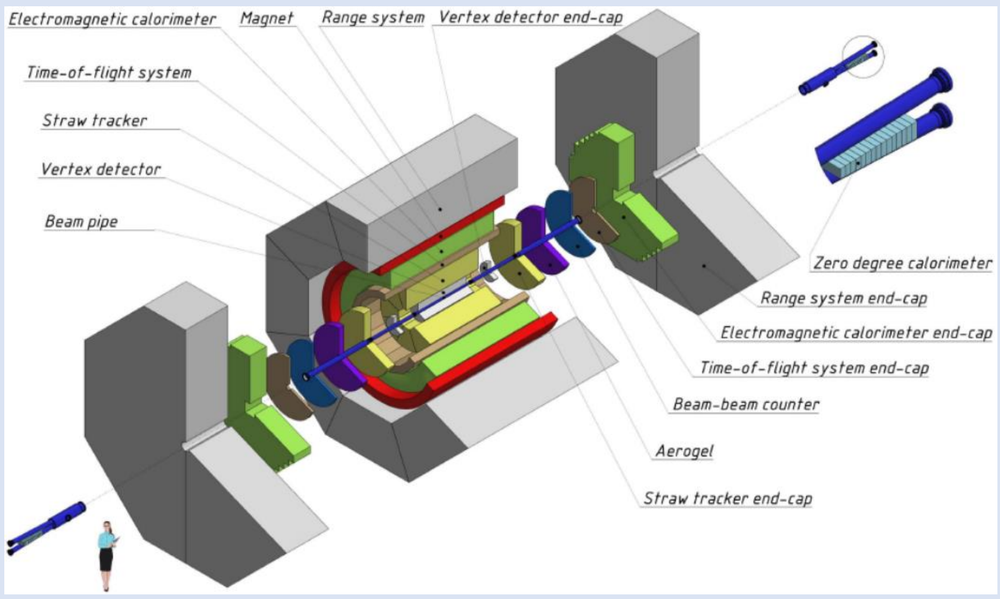
[†] Currently at: Univeristy of Illinois Chicago, West Harrison St. 1200, 60607, Chicago, Illinois, USA

Abstract

The Spin Physics Detector is an experiment at NICA designed to study the spin structure of the proton and deuteron and other spin-related phenomena using polarized beams. Two Beam-Beam Counters (BBCs) will be installed symmetrically aside from the interaction point in the end-cups of SPD setup and will serve as a tool for beam diagnostics including local polarimetry. The outer part of the BBC wheel is based on fast scintillator tiles and cover the polar angels between 60 and 500 mrad. In this talk, we discuss testing different materials configurations for the BBC prototype based on scintillator tiles. The light collection depends on material combinations - **different fibers** (Saint Gobain BCF91AS, BCF92S, and Kuraray Y-11), different **ways of covering tile surface** (Matted and double covered with Tyvek sheets tiles), as well as different **optical cements** (CKTN mark E, OK-72) were used in the study. SensL 3x3 mm^2 SiPM readout provides an opportunity to measure light collection dependence with high energy resolution using radioactive source and cosmic rays.

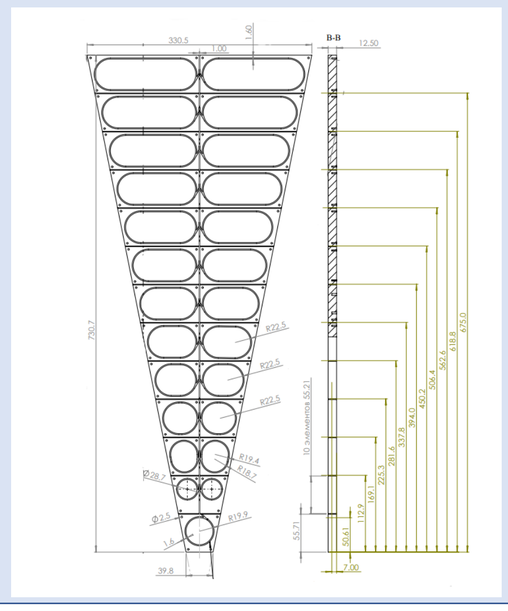
Spin Physics Detector

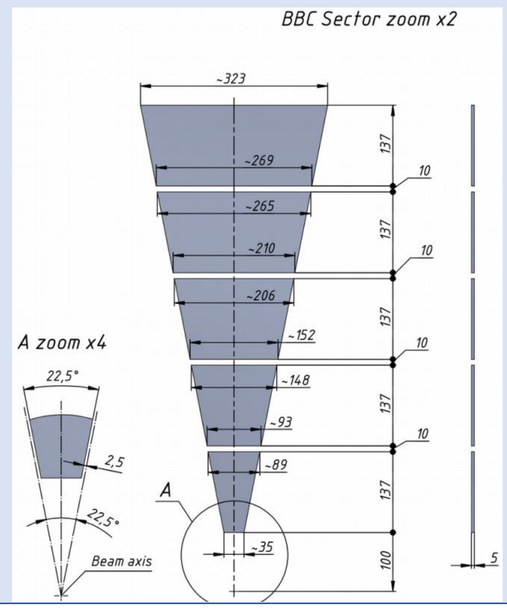
- The Spin Physics Detector is an experiment at NICA designed to study the spin structure of the proton and deuteron
- SPD will operate with polarized proton and deuteron beams
- $\sqrt{s}$ = 27 GeV
- L =10^{32} cm^{-2} s^{-1}.



Beam-Beam Counter

- Two endcap detector wheels of scintillator-based BBCs are planned to be located in front of the TOF system of the SPD setup
- The main goals of the BBCs are the local polarimetry, based on the measurements of the azimuthal asymmetries, and the monitoring of the beam collisions.





Scintillator's cover selection

We used:

- tile covered with white acrylic paint (so called "matted")
- tile, double covered with a unique non-woven material made from high-density polyethylene continuous filaments (Tyvek)

Row

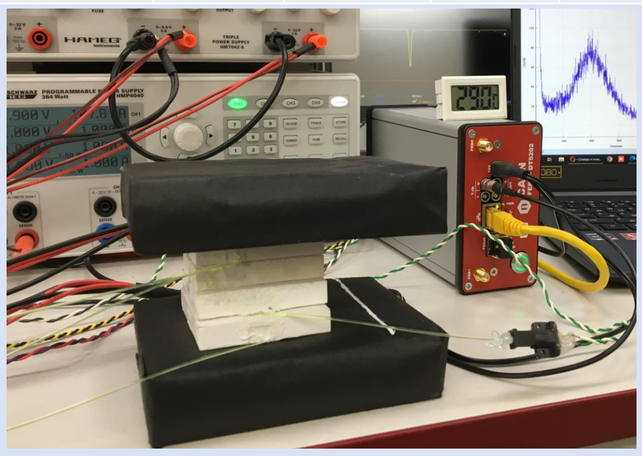
3 (L;R)

2 (L;R)

1 (L;R)

central

Fit Param-s	Row 1 Matted	Row 1 Tyvek	Row 3 Matted	Row 3 Tyvek
Mean, Channels	372.9	346.7	406.9	348.3
Width, Channels	28.5	30.0	30.3	27.5



✓ Due to higher peak position and technological complexity of mass production for Tyvek covers, the option with matted one is more appropriate.

Conclusion

- The scintillator detector prototype tests and material selection with CAEN FERS-5200 readout system has been started.
- **Matted** tiles proved to be more efficient than Tyvek covered in both ways: amount of reflected light and convenience.
- **OK-72** optical cement is practically more convenient to use than CKTN, but the **epoxy composition influence on the light collection** in tiles is found.
- Due to fact, that **Y-11** fiber collects more light than SG BCF91AS and BCF92S fibers, it proved to be more efficient for our goals.

Optical cement selection

We compared different optical cements:

- CKTN MED mark E
- OK-72

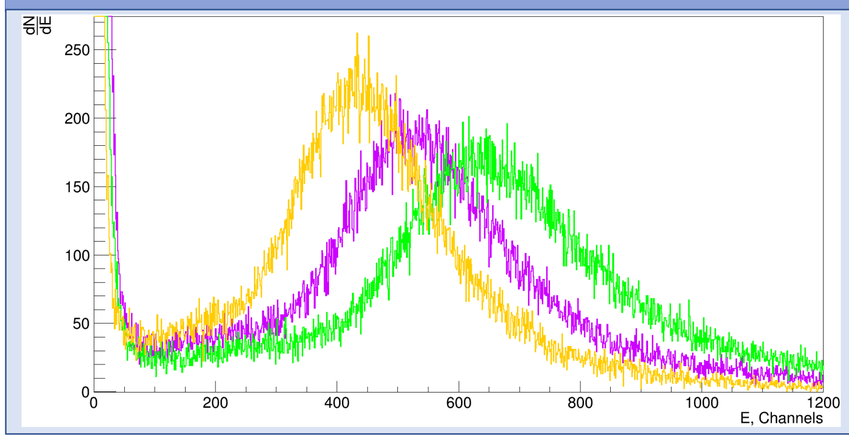
Brand	Viscosity, cPs	Operating T Range	Spectral Characteristics	Refractive index
CKTN MED E	15 · 10^3	—	92-96% at 500 nm	1.606
OK-72	—	-60 to +60 °C	99% at 400-2700 nm	1.587

Row 1: 76.24% A to 23.66% B
Row 3: 70% A to 30% B

✓ The deeper research should be conducted in future

Fit Param-s	Row 1 CKTN	Row 1 OK-72	Row 3 CKTN	Row 3 OK-72
Mean, Channels	372.9	254.4	406.9	412.3
Width, Channels	28.5	17.6	30.3	36.2

WLS fiber selection



Fit Param-s	Saint-Gobain BCF92S	Saint-Gobain BCF91AS	Kuraray Y-11
Mean, Channels	402.3	481.9	596.3
Width, Channels	24.7	35.2	43.5

We compared:

- Saint-Gobain Crystals BCF91AS
- Saint-Gobain Crystals BCF92S
- Kuraray Y-11 WLS fibers.

✓ Due to the fact, that Kuraray Y-11 fiber collects more light, the choice of Y-11 fibers is more appropriate.