

Geometry update for inner tracker detectors of the BM@N setup for RUN-7 and the next run configurations

Baranov Dmitry

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Introduction

Talk topics:

- Geometry update for the inner tracker detectors (GEM and SILICON) of the BM@N setup for the following runs:
 - RUN-7 (2018)
 - the next run (2021-2022)
- Calculation of material budget for these configurations



The common view of the BM@N experimental setup



Geometry design of the BM@N inner tracker for the RUN-7 (left) and the next run (right)

□ The detailed ROOT geometry was created for the following configurations:

- GEM RUN-7 (Spring 2018)
- GEM RUN SRC (Spring 2018)
- GEM Future Configuration (2020-2021)
- Forward SILICON Future Configuration (2020-2021)

□ The design of these detector has a lot of supporting elements, such as frames, electronics and others. It influences the detector efficiency.

□ There are two versions of the ROOT geometry (simplified and detailed) for each configuration.

Forward Silicon Detector

Forward Si in our BM@N configuration is a silicon based semiconductor detector consisting of separate si-modules which are combined into stations of 10, 14 and 18 modules (42 modules in total).

At the moment we have complete ROOT geometry for this detector in the BMNROOT repository for using it in simulation and reconstruction procedures.



10 modules

Three stations of the Forward Si detector (left) and ROOT geometry of them for MC-simulation (right)





Scheme of the Forward Si detector (E. Zubarev)

Schemes of a single Si-module (left) and their composition in the first station (right) (E. Zubarev)

Forward Silicon Detector



Full assembly of Forward Silicon detector



Parts of one half-plane of Forward Silicon Detector





Description of the parts

Scheme of one half-plane: front and side views

Forward Silicon Detector: ROOT geometry



Simplified ROOT geometry: only sensitive planes composed of basic silicon-modules





Detailed ROOT geometry: sensitive planes and supporting elements (passive volumes)



Forward Silicon Detector: ROOT geometry



Forward Silicon Detector: ROOT geometry in EventDisplay



We can change the visualization level in EventDisplay to display only modules or modules with passive elements

Forward Silicon Detector: material budget



Material budget in the BM@N, Integrated radiation length, X/X0 [%]



Material budget in the BM@N, Integrated radiation length, X/X0 [%]

Material budget for the Forward Silicon Detector: Left – simplified geometry (only sensitive planes), right – detailed geometry

GEM: configuration for RUN-7 (RunSpring2018)



Simplified ROOT geometry of GEMs for RUN-7: only sensitive planes (as volumes filled with a gas mixture) and ordinary frames. ROOT file: GEMS_RunSpring2018.root Detailed ROOT geometry of GEMs for RUN-7: passive elements (such as frames, electronics and material layers in sensitive areas) were added . ROOT file: GEMS_RunSpring2018_detailed.root

To generate these ROOT files we have corresponding macros located inside the directory '**BMNROOT/macro/geometry**"

GEM: configuration for RUN-7 (RunSpring2018)



Detailed geometry of GEMs for RUN-7: common view



Detailed geometry of GEMs for RUN-7: front view (XY)



Detailed ROOT geometry have been prepared according to the schemes of half-planes provided by S. Piyadin (and others)



Detailed geometry of GEMs for RUN-7: side view (ZY)

GEM: configuration for the next run (FutureConfig2020)





Simplified ROOT geometry of GEMs for the next run: only sensitive planes (as volumes filled with a gas mixture) and ordinary frames. ROOT file: GEMS_FutureConfig2020.root Detailed ROOT geometry of GEMs for the next run: passive elements (such as frames, electronics and material layers in sensitive areas) were added . ROOT file: GEMS_FutureConfig2020_detailed.root

GEM: configuration for the next run (FutureConfig2020)



Detailed geometry of GEMs for the next run: common view



Detailed geometry of GEMs for the next run: front view (XY)



Detailed geometry of GEMs for the next run: side view (ZY)



Detailed ROOT geometry have been prepared according to the schemes of *half-planes* provided by S. Piyadin (and others)



Scheme of GEM chambers composition (S. Piyadin)

GEM: structure of sensitive area





Besides frames and electronic elements, layers of materials in sensitive areas have been added to the detailed geometry.

The thickness of some layer is a summary thickness of all layers with the same material.

Layer structure of a sensitive area for one half-plane of GEM (S. Piyadin)

copper:	35µm + 35µm + 7µm + 7µm + 7µm + 5µm + 35µm = 131µm				
glue:	50μm + 50μm +50μm + 50μm = 200μm				
epoxide:	0.5mm + 0.5mm + 100μm + 0.5mm + 0.5mm = 2.1mm				
honeycomb: 15mm + 15mm = 30mm					
polyamide:	110μm + 30μm + 30μm + 30μm + 50μm = 250μm				

GEM: Material budget

layer	material	density [g/cm-3]	thickness (X) [cm]	X0 [cm]	X/X0 [%]
gas	ArCO2 (70/30)	0.0019	0.9	10960.2	0.0082
copper	copper	8.96	0.0131	1.435	0.9129
glue	acrylic glue	1.25	0.02	32.1603	0.0622
epoxide	polyurethane (high dens.)	1.8	0.21	22.5351	0.9319
	polyurethane (medium dens.)	0.59	0.21	68.7512	0.3055
	polyurethane (low dens.)	0.25	0.1	162.253	0.1295
honeycomb	nomex aramid honeycomb (kevlar chemical structure)	0.048	3.0	755.397	0.3971
polyamide	polyamide	1.14	0.025	36.4052	0.0687

Table: properties of material layers in the sensitive area of GEM chambers

Material budget: GEM configuration for RUN-7

100 100 y [cm] 90 80 50 70 60 50 40 30 -50 X/X0 = 0.0082 % 20 10 -100<u>li</u> -100 -50 50 100 0 x [cm] Material budget of one station for tracks parallel to Z axis (simplified geometry)

Material budget in the BM@N, Integrated radiation length, X/X0 [%]

Material budget in the BM@N, Integrated radiation length, X/X0 [%]



Material budget in the BM@N, Integrated radiation length, X/X0 [%]



Material budget in the BM@N, Integrated radiation length, X/X0 [%]



Material budget: GEM configuration for the next run (FutureConfig2020)

100

90

80

70

60

50

40

30

20

10

0



Material budget in the BM@N, Integrated radiation length, X/X0 [%]



Material budget in the BM@N, Integrated radiation length, X/X0 [%]



100 r y [cm] 80 60 40 20 -20 -40 -60 X/X0 = 0.0574 % -80 -100 -80 -40 40 60 80 -60 -20 0 20 100 x [cm] Material budget of seven stations for tracks parallel to Z axis (simplified geometry)

Material budget in the BM@N, Integrated radiation length, X/X0 [%]

Summary

- ✓ The detailed geometry for the inner tracker detectors (GEM and SILICON) of the BM@N setup was prepared for the following runs:
 - RUN-7 (2018)
 - the next run (2021-2022)
- ✓ The material budget distribution for each configuration was calculated

Thank you for your attention...